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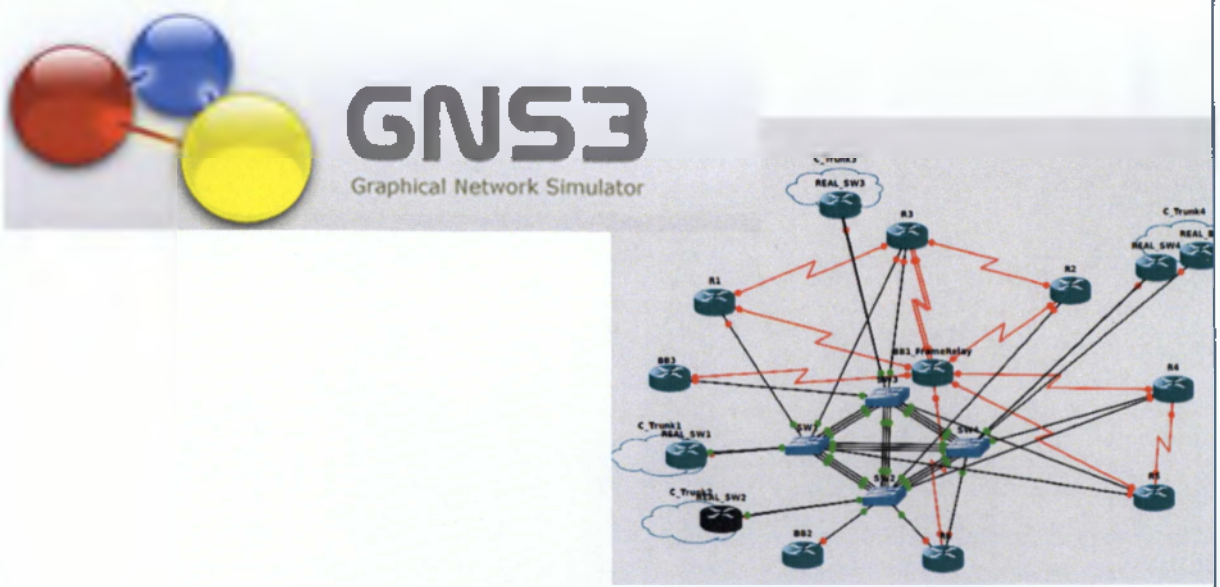
– ΠΑΡΑΡΤΗΜΑ ΣΠΑΡΤΗΣ –
ΤΜΗΜΑ ΤΕΧΝΟΛΟΓΙΑΣ ΠΛΗΡΟΦΟΡΙΚΗΣ
ΚΑΙ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

ΑΝΑΠΤΥΞΗ ΔΙΑΔΙΚΤΥΑΚΟΥ ΠΕΡΙΒΑΛΛΟΝΤΟΣ ΕΞΟΜΟΙΩΣΗΣ ΤΩΝ ΤΕΧΝΟΛΟΓΙΩΝ ΤΗΣ CISCO ΜΕ ΤΗ ΧΡΗΣΗ ΤΟΥ OPEN SOURCE ΛΟΓΙΣΜΙΚΟΥ GNS3



ΠΤΥΧΙΑΚΗ ΕΡΓΑΣΙΑ ΤΗΣ
ΚΑΠΡΑΡΙΟΥ ΝΤΑΝΑ-ΜΑΡΙΑ

ΕΠΙΒΛΕΠΩΝ ΚΑΘΗΓΗΤΗΣ
Κ. ΜΠΑΡΔΗΣ ΓΕΩΡΓΙΟΣ

-2012-

Πίνακας Περιεχομένων

Λίστα πινάκων

Λίστα Σχημάτων

ΕΥΧΑΡΙΣΤΙΕΣ

Με την ολοκλήρωση τους πτυχιακής μου εργασίας θα ήθελα να επισημάνω πόσο θαυμαστός είναι ο κόσμος τους Πληροφορικής και των Τηλεπικοινωνιών. Όσα έμαθα τα τελευταία τέσσερα χρόνια έχουν διαμορφώσει το ποια είμαι και αποτελούν γερά εφόδια για την μετέπειτα πορεία μου.

Θα ήθελα να ευχαριστήσω ιδιαίτερα τον επιβλέποντα καθηγητή μου κ. Μπάρδη Γεώργιο για την στήριξη, την εμπιστοσύνη που μου είχε και τον πολύτιμο χρόνο που αφιέρωσε σε όλη τη διάρκεια τους εκπόνησης τους πτυχιακής μου εργασίας.

Θα ήθελα να ευχαριστήσω θερμά την οικογένειά μου για τη συμπαράσταση και τη στήριξη που μου παρείχε όλα αυτά τα χρόνια με την ελπίδα να τους ανταποδώσω όσα περισσότερα μπορώ στο μέλλον.

Σπάρτη Νοέμβριος 2012

Καπραρίου Ντάνα-Μαρία

ΠΕΡΙΛΗΨΗ

Η εκπόνηση της παρούσας πτυχιακής εργασίας πραγματοποιήθηκε με σκοπό τη δημιουργία έτοιμων ασκήσεων οι οποίες θα καλύπτουν όλη την εξετάσιμη ύλη της πιστοποίησης CCNA. Η εργασία χωρίζεται σε δύο μέρη.

Στο πρώτο μέρος, το οποίο αποτελεί το γενικό μέρος γίνεται μία εκτενής αναφορά στην Cisco Systems, μία από τις κορυφαίες εταιρίες δικτύωσης στον κόσμο. Στη συνέχεια παρουσιάζεται ο εξοπλισμός δικτύου και οι πιστοποιήσεις της Ακαδημίας Δικτύωσης που η ίδια έχει δημιουργήσει. Στη συνέχεια γίνεται μία αναφορά στα εικονικά εργαστήρια και το σκοπό της δημιουργίας τους και παρουσιάζονται κάποιοι βασικοί προσομοιωτές δικτύων.

Στο δεύτερο μέρος υλοποιούνται οι ασκήσεις που αποτελούν την ύλη της πιστοποίησης CCNA της Cisco με τη χρήση του περιβάλλοντος GNS3. Αρχικά παρουσιάζονται τα βήματα για την εγκατάσταση και το τρόπο λειτουργίας του προγράμματος και στη συνέχεια αναπτύσσονται οι ασκήσεις της ύλης της πιστοποίησης με τη σχεδίαση απλών αλλά και σύνθετων δικτυακών τοπολογιών και η προσομοίωση της λειτουργίας τους.

Τέλος, γίνεται μία συνοπτική αναφορά στα βασικά σημεία της εργασίας και αναλύονται τα συμπεράσματα στα οποία καταλήξαμε.

ΕΙΣΑΓΩΓΗ

Είμαστε πολύ τυχεροί! Στον 21° αιώνα που ζούμε, υπάρχει πρόκληση, ελπίδα, δημιουργία! Ο καθημερινός άνθρωπος έχει τη δυνατότητα να μάθει, να ταξιδέψει, να μοιραστεί, να ζήσει όλα όσα δεν μπορούσαν ακόμα και οι αυτοκράτορες των περασμένων αιώνων να διανοηθούν...

Αναπόσπαστο κομμάτι της καθημερινότητάς μας αποτελεί το Διαδίκτυο που εμφανίζει ολοένα και περισσότερες εφαρμογές και υπηρεσίες. Οι επενδύσεις πάνω στην δικτύωση έχουν επιφέρει δραματική αύξηση της παραγωγικότητας, με αποτέλεσμα να βλέπουμε αύξηση του βιοτικού επιπέδου. Η αύξηση της παραγωγικότητας δεν επιτυγχάνεται απλά με την αγορά εξοπλισμού δικτύωσης. Πλέον χρειάζονται ειδικευμένοι επαγγελματίες που απαιτούνται για το σχεδιασμό, την εγκατάσταση, την ανάπτυξη, τη διαμόρφωση, τη λειτουργία, τη συντήρηση και την αντιμετώπιση προβλημάτων των δικτύων. Οι διαχειριστές δικτύων πρέπει να φροντίζουν να έχουν σχεδιάσει την ασφάλεια και να είναι σε θέση να εφαρμόσουν νέες δυνατότητες ανάλογα με τις απαιτήσεις κάθε επιχείρησης.

Για να βοηθήσει να αντιμετωπιστεί η αυξανόμενη ζήτηση εξειδικευμένων επαγγελματιών, η Cisco έχει δημιουργήσει την Ακαδημία Δικτύωσης η οποία προσφέρει πλήρη εκπαίδευση πάνω σε τεχνολογίες δικτύων και τεχνικές γνώσεις υπολογιστών για όσους επιθυμούν να ασχοληθούν επαγγελματικά με την επιστήμη της πληροφορικής.

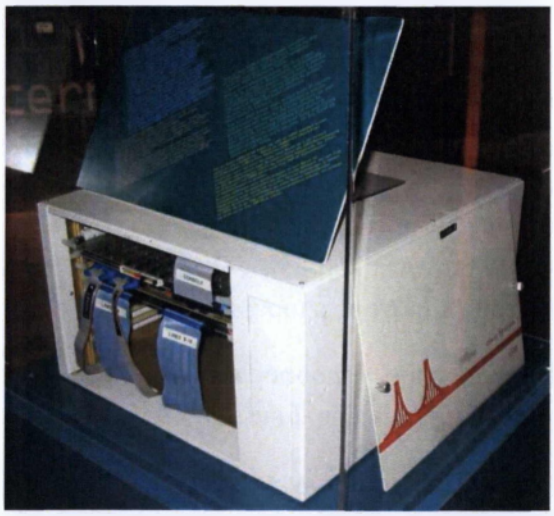
Η παρούσα εργασία είναι μια προσπάθεια δημιουργίας έτοιμων εργαστηρίων, τα οποία θα καλύπτουν όλη την εξετάσιμη ύλη της πιστοποίησης CCNA που αποτελεί το πρώτο βήμα για να μπει κάποιος στον κόσμο των δικτύων μέσω της Cisco. Μέσα από την εξομοίωση των εργαστηριακών ασκήσεων με τη χρήση του προγράμματος GNS3 γίνεται μία προσπάθεια να προσφέρουμε στον αναγνώστη μία μικρή εισαγωγή στον υπέροχο κόσμο της δικτύωσης. Απώτερος σκοπός είναι η παραμετροποίηση των δρομολογητών και των μεταγωγών που έχει πραγματοποιηθεί με τη βοήθεια του εξομοιωτή GNS να διατεθεί στους φοιτητές του τμήματός μας ως ένα ισχυρό βοήθημα για τη προετοιμασία τους με στόχο την απόκτηση της πιστοποίησης CCNA.

1. ΙΣΤΟΡΙΚΗ ΑΝΑΔΡΟΜΗ

Η εταιρία τεχνολογίας Cisco System είναι ο μεγαλύτερος προμηθευτής προϊόντων δικτύωσης ηλεκτρονικών υπολογιστών, συστημάτων και υπηρεσιών που υπάρχει στον κόσμο. Η έδρα της εταιρίας βρίσκεται στο San Francisco, έχει όμως υποκαταστήματα στις περισσότερες χώρες του κόσμου. Το λογισμικό της είναι το IOS βασισμένο στο CLI που χρησιμοποιείται στις συσκευές της.

Η Cisco Systems δημιουργήθηκε το Δεκέμβριο του 1984 στο Melon Park της California από ένα παντρεμένο ζευγάρι, τον A Bosack και τη Sandy Lerner, οι οποίοι εργάζονταν στο πανεπιστήμιο του Stanford. Ο Bo sack ήταν διευθυντής του εργαστηρίου του Τμήματος Επιστήμης Υπολογιστών και η Lerner επέβλεπε τους υπολογιστές στο τμήμα Graduate School of Business. Οι δύο επιστήμονες επινόησαν έναν τρόπο να συνδέουν τα δύο τοπικά δίκτυα στα αντίστοιχα τμήματα όπου εργάζονταν, 500 μέτρα από την πανεπιστημιούπολη.

Το πρωτογενές προϊόν της εταιρίας ήταν από την αρχή ο δρομολογητής διαδικτύωσης (internetworking router), μία συσκευή που ενσωματώνει αυτόματα το λογισμικό που επιλέγει την αποτελεσματικότερη διαδρομή για μεταφορά δεδομένων μεταξύ των δικτύων. Οι δρομολογητές Cisco ήταν πρωτοπόροι στην υποστήριξη πολλών πρωτοκόλλων και μπορούσαν να συνδέουν διαφορετικά δίκτυα μεταξύ τους. Η Cisco ήταν η πρώτη εταιρία δικτύων που κατάφερε να δημιουργήσει έναν δρομολογητή, μία συσκευή που συνδέει πολλά LAN (Local Area Network) συμβατά με το πρωτόκολλο TCP/IP[1] (Transmission Control Protocol/Internet Protocol).



Εικόνα 1 Ο 1ος δρομολογητής της Cisco Systems ASM/2-32EM στην Ευρώπη. Είχε εγκατασταθεί στο CERN το 1987.

Η αρχιτεκτονική τους βασισμένη στη CPU[2] και η ευελιξία του λειτουργικού συστήματος τους IOS τους επέτρεπαν να συμβαδίζουν με την συνεχόμενη εξέλιξη της

τεχνολογίας, χάρη στις συχνές αναβαθμίσεις του λογισμικού. Ένα από τα γνωστά μοντέλα της εποχής (Cisco 2500) κατάφερε να μείνει στην αγορά σχεδόν μια δεκαετία - ένα σπάνιο για την εποχή φαινόμενο. Η εταιρία όμως ήθελε να βελτιώσει ακόμη περισσότερο την αξία της στην αγορά, εισάγοντας νέες σειρές προϊόντων υψηλής χωρητικότητας όπως η Cisco 7000 και Cisco 7500.

Τα επόμενα χρόνια η Cisco απέκτησε αρκετές εταιρίες, οι κυριότερες από τις οποίες ήταν οι Kalpana, Grand Junction και Crescendo οι οποίες μαζί σχημάτισαν την επιχειρησιακή μονάδα Catalyst. Εκείνη την εποχή, η εταιρία οραματιζόταν δρομολόγηση επιπέδου 3 και μεταγωγή επιπέδου 2 (Ethernet[3], Token Ring[4]) ως συμπληρωματικές λειτουργίες μιας διαφορετικής αρχιτεκτονικής. Η φιλοσοφία αυτή κυριάρχησε στα προϊόντα της Cisco σε όλη τη δεκαετία του 1990.

Εικόνα 2 Δρομολογητής Cisco 2500

Η ραγδαία ανάπτυξη του διαδικτύου στα τέλη της δεκαετίας του 1990 άλλαξε το τοπίο στις τηλεπικοινωνίες. Καθώς το Internet Protocol (IP) άρχισε να χρησιμοποιείται ευρέως, η ανάγκη των πολλαπλών πρωτοκόλλων δρομολόγησης μειώθηκε. Η Cisco όμως φρόντισε να προσαρμοστεί στις ανάγκες της αγοράς δημιουργώντας προϊόντα από AS5200 μέχρι GSR[5] δρομολογητές που έγιναν γρήγορα ζωτικής σημασίας για τους παρόχους υπηρεσιών Διαδικτύου.

Το 2000 η Cisco έγινε η πιο κερδοφόρα εταιρία στον κόσμο με κεφάλαιο που ξεπερνούσε τα 500 δισεκατομμύρια δολάρια.

Εν τω μεταξύ, η πολυπλοκότητα των λειτουργιών προγραμματισμού οδήγησε τις εταιρίες στην αναζήτηση νέων τρόπων επεξεργασίας IP πακέτων. Μία από αυτές, η Juniper Networks, κατάφερε σε ένα χρόνο να αποσπάσει το 30% του μεριδίου που είχε στην αγορά η Cisco, η οποία δεν έμεινε με δεμένα τα χέρια, αλλά απάντησε σε αυτή την πρόκληση λανσάροντας τα νέα της προϊόντα γρήγορης επεξεργασίας, όπως κάρτες για GSR δρομολογητές και μεταγωγείς Catalyst 6500. Το 2005 η Cisco λάνσαρε το λογισμικό IOS-XR και το CRS (Carrier Routing System).

Το 2006 η Cisco ξεκίνησε την διαφημιστική καμπάνια 'The Human Network' (Το Ανθρώπινο Δίκτυο), μία εκστρατεία που επικεντρώνεται στο αντίκτυπο που έχουν τα δίκτυα στους ανθρώπους και τις επιχειρήσεις. Μέσω της μάρκας Linksys, αποσκοπούσε στην πώληση των προϊόντων της απευθείας στους καταναλωτές.

Τα επόμενα χρόνια η εταιρία συνέχισε να αναπτύσσει την επιχείρησή της επικεντρωμένη στην δρομολόγηση, τη μεταγωγή και την ασφάλεια. Η ανάπτυξη του Ethernet επηρέασε τις νέες σειρές προϊόντων της εταιρίας, με αποτέλεσμα να λανσάρει το επιτυχημένο μοντέλο Catalyst Switch 6500 Ethernet για όλες τις Cisco 7600 πλατφόρμες δρομολόγησης. Αυτό οδήγησε σε μία νέα οικογένεια προϊόντων ASR9000.

Στα μέσα του 2000 η Cisco σημείωσε μία αξιόλογη παρουσία στην Ινδία, ιδρύοντας το Παγκόσμιο Κέντρο της στην Ανατολή, στο Μπανγκαλόρ με 1 δις δολάρια, σχεδιάζοντας πως το 20% μετόχων της Cisco θα βασίζεται εκεί. Ωστόσο, η Cisco συνέχιζε να αμφισβητείται εγχώρια από τις Alcatel-Lucent, Juniper Networks, αλλά και από ανταγωνιστές του εξωτερικού. Εξαιτίας των χαμηλότερων από τα αναμενόμενα κέρδη το 2011, η Cisco αναγκάστηκε να μειώσει τα ετήσια έξοδά της κατά 1 δις δολάρια. Η εταιρεία μείωσε περίπου κατά 3.000 τους υπαλλήλους, μέσω ενός προγράμματος πρόωρης σύνταξης για όσους δέχτηκαν την εξαγορά και σχεδίασε την εξάλειψη 10.000 θέσεων εργασίας (περίπου το 14% των, συνολικά, 73.400 εργαζομένων πριν από τις περικοπές). Κατά τη διάρκεια αναλυτικής πρόσκλησης του 2011, ο διευθύνων σύμβουλος της Cisco John Chambers κάλεσε ονομαστικά ορισμένους ανταγωνιστές, συμπεριλαμβανομένων και των Juniper και HP. Στις 24 Ιουλίου του 2012, η Cisco έλαβε τη έγκριση της ΕΕ για την απόκτηση του NDS (προγραμματιστής λογισμικού τηλεόρασης) για 5 δις δολάρια.

2. Ο ΕΞΟΠΛΙΣΜΟΣ ΔΙΚΤΥΟΥ ΤΗΣ CISCO

Με τον εξοπλισμό δικτύου της η Cisco Systems παρέχει μεγάλη ποικιλία προϊόντων που προσφέρουν αυξημένη παραγωγικότητα, καλύτερη ικανοποίηση των πελατών και ένα σημαντικό ανταγωνιστικό πλεονέκτημα στην αγορά.

Η εταιρία εστιάζει τα προϊόντα και τις υπηρεσίες της σε τρεις τομείς της αγοράς: τηλεπικοινωνιακοί πάροχοι, μικρές επιχειρήσεις και προϊόντα για οικιακή χρήση.

Επιχειρήσεις και τηλεπικοινωνιακοί πάροχοι

- Δίκτυα χωρίς περιορισμούς[6]: δρομολογητές, μεταγωγείς, ασύρματη δικτύωση, ασφάλεια, συστήματα φυσικής ασφάλειας και ασφάλειας κτηρίων, οπτική δικτύωση, διαχείριση και αυτοματοποίηση δικτύων.
- Συνεργασία[7]: υπηρεσίες TelePresence,παροχής βίντεο και περιεχομένου, ευρυζωνικής καλωδίωσης σύνδεσης, δια λειτουργικών συστημάτων και εξυπηρέτησης πελατών.
- Data Center και Virtualization[8]: ενοποιημένο υπολογιστικό σύστημα, data center switches.
  Ενοποιημένο υπολογιστικό σύστημα[9], υπηρεσίες δικτύωσης εφαρμογών, δικτύωση συστημάτων αποθήκευσης και Data Center switches (nexus 7000,5000,4000,3000,2000,1000V,6500,4900)

Μικρές επιχειρήσεις[10]

- Δρομολογητές και μεταγωγείς
- Ασφάλεια και επιτήρηση
- Φωνή και διάσκεψη
- Ασύρματη δικτύωση
- Αποθήκευση δικτύου

Προϊόντα για οικιακή χρήση[11]

- Οικιακή δικτύωση
- Set-top καλωδιακής TV

Ασύρματη δικτύωση[12]:

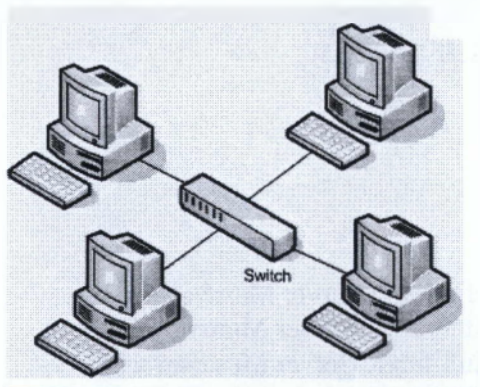
Ελεγκτές ασύρματου LAN, διαχείριση ασύρματου δικτύου, συσκευές ορατότητας, οι οποίες προσφέρουν απλή και αξιόπιστη παροχή εφαρμογών πολλαπλών συσκευών και δικτύων για την υποστήριξη ενός μεγάλου οικοσυστήματος συνεργατών. Η Cisco προσφέρει επίσης ασύρματη τεχνολογία για εξωτερικούς χώρους.

Ασφάλεια[13]:

Ασφάλεια e-mail και Web, μειώνοντας τις δαπανηρές διακοπές λειτουργίας που σχετίζονται με το spam και τους ιούς στο mail και τις απειλές στο Web.
Ασφάλεια δικτύου, που ανιχνεύει και αποτρέπει επιθέσεις λογισμικού και απόπειρες πρόσβασης κακόβουλων χρηστών.
Έλεγχο ασφαλούς πρόσβασης, που επιβάλει πολιτικές ασφάλειας δικτύου, ελέγχους για ασφαλή πρόσβαση από χρήστες και σε κεντρικούς υπολογιστές.

2.1 Μεταγωγείς Cisco

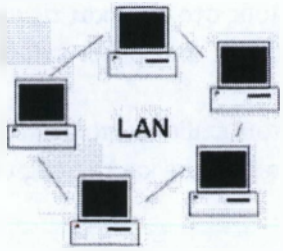
Η τοπολογία είναι η φυσική διάταξη του δικτύου. Στην τοπολογία αστέρα (star topology), που χρησιμοποιείται συνήθως σε μικρά, μεσαία ή μεγάλα δίκτυα, όλοι οι κόμβοι συνδέονται κεντρικά με μία συσκευή, έναν επαναλήπτη[14] ή έναν μεταγωγέα. Πλέον, στις περισσότερες τοπολογίες χρησιμοποιείται ο μεταγωγέας[15] επειδή είναι ταχύτερο και καλύτερο σαν συσκευή. Ο μεταγωγέας είναι μία συσκευή που λειτουργεί στο δεύτερο επίπεδο του μοντέλου OSI[16] (Data Link Layer) που φιλτράρει και προωθεί ένα πακέτο δεδομένων μεταξύ των τμημάτων ενός δικτύου. Διατηρεί μία βάση δεδομένων που ονομάζεται MAC Address Table όπου καταχωρεί τις MAC[17] διευθύνσεις που μαθαίνει από τις συσκευές που είναι απευθείας συνδεδεμένες πάνω του.



Εικόνα 3 Τοπολογία Αστέρα

Για ταχύτερη και καλύτερη επικοινωνία, η Cisco συνιστά τους μεταγωγείς για την σύνδεση τοπικών δικτύων (Local Area Networks). Οι μεταγωγείς της Cisco είναι συσκευές με λογισμικό IOS που διαχειρίζεται από τη γραμμή εντολών. Κάθε διαχειρίσιμος μεταγωγέας έχει μία θύρα κονσόλας για διοικητική διαχείριση και βασική παραμετροποίηση σε ένα νέο μεταγωγέα. Η βασικές διαφορές μεταξύ των

διάφορων μοντέλων είναι η πυκνότητα των θυρών και η χωρητικότητα τους, όπως ο αριθμός των θυρών Ethernet, FastEthernet και Gigabit όπως και η μονάδα ATM του μεταγωγέα. Τα διάφορα μοντέλα ποικίλουν επίσης βάση της έκδοσης του λογισμικού IOS της Cisco το οποίο είναι εγκατεστημένο στους μεταγωγείς Cisco.



Εικόνα 4 Τοπικό Δίκτυο

Η Cisco παρέχει μια ολοκληρωμένη σειρά λύσεων μεταγωγής για δίκτυα χωρίς περιορισμούς, data center και μικρότερες επιχειρήσεις. Αυτές οι λύσεις βελτιστοποιούνται για μια μεγάλη σειρά κλάδων, συμπεριλαμβανομένων των τηλεπικοινωνιακών παρόχων, των χρηματοοικονομικών υπηρεσιών και του δημόσιου τομέα.

Μεταγωγείς Data Center[18]:

- Cisco Catalyst 6400, 4900.
- Nexus 7000,5000,4000,3000,2000,1000V

Βιομηχανικοί μεταγωγείς Ethernet[19]:

- Cisco Catalyst 2955
- Cisco IE 3000,3010

Μεταγωγείς InfiniBand:

- Σειρά Cisco SFS 7000 InfiniBand Server Μεταγωγείς
- Σειρά Cisco SFS 3500 Multifabric Server Μεταγωγείς
- Σειρά Cisco SFS 3000 Multifabric Server Μεταγωγείς

Μεταγωγείς Τοπικού Δικτύου:

- Σειρές Cisco Catalyst : 4500,3750,37500-E,37500-X,3560,3560-E,3560-X,3550,2975,2960,2955,2950,2940,2360,2350,3560-C,2960-C,6500,4900,4500,

Μεταγωγείς για μικρές επιχειρήσεις:

- Cisco Catalyst 2960 Σειρά Μεταγωγών
- Cisco Small Business ESW500 Σειρά Μεταγωγών

- Cisco Small Business Managed Μεταγωγείς
- Cisco Small Business Smart Μεταγωγείς
- Cisco Small Business Unmanaged Μεταγωγείς
- Cisco Small Business 300 Series Managed Μεταγωγείς
- Cisco Small Business 200 Series Smart Μεταγωγείς
- Cisco Small Business 100 Series Unmanaged Μεταγωγείς

Μεταγωγείς για Τηλεπικοινωνιακούς Παρόγους:

- Cisco Catalyst 6500 Σειρά Μεταγωγών
- Cisco Catalyst 4500 Σειρά Μεταγωγών
- Cisco ME 6500 Series Ethernet Μεταγωγείς
- Cisco ME 4900 Series Ethernet Μεταγωγείς
- Cisco ME 3800X Series Carrier Ethernet Switch Routers
- Cisco Catalyst 3750 Metro Series Switches
- Cisco ME 3600X Series Ethernet Access Switches
- Cisco ME 3400 Series Ethernet Access Switches
- Cisco ME 3400E Series Ethernet Access Switches
- Cisco Small Business Gigabit SP Switches

- Μεταγωγείς WAN:
  Σειρές IGX 8400,BPX 8600, MGX 8900,8880,8850,8800,8250,8230,8200

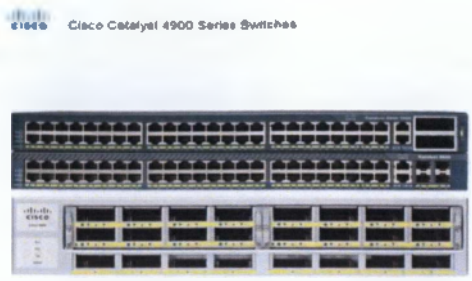
Παρακάτω παρουσιάζονται μερικά από τα σημαντικά μοντέλα μεταγωγών Cisco:

Εικόνα 5 Μεταγωγείς Cisco Catalyst 2960

Εικόνα 6 Μεταγωγείς Cisco Catalyst 3560

Εικόνα 7 Μεταγωγείς Cisco Catalyst 3750

Εικόνα 8 Μεταγωγείς Cisco Catalyst 4500

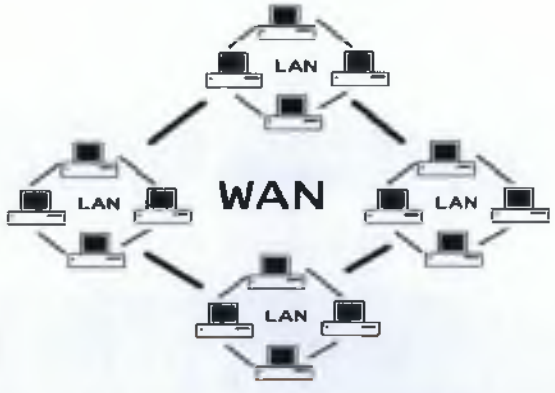


Εικόνα 9 Μεταγωγείς Cisco Catalyst 4900

Εικόνα 10 Μεταγωγείς Cisco Catalyst 6500

2.2 Δρομολογητές Cisco

Για τη σύνδεση ενός WAN[20] χρησιμοποιούμε δρομολογητές[21]



Εικόνα 11 Δίκτυο Ευρείας Περιοχής (WAN)

Ο δρομολογητής είναι μια ηλεκτρονική συσκευή η οποία αναλαμβάνει την αποστολή και λήψη πακέτων δεδομένων μεταξύ ενός ή περισσοτέρων διακομιστών, άλλων δρομολογητών και πελατών, κατά μήκος πολλαπλών δικτύων (δρομολόγηση). Η δρομολόγηση, κεντρική λειτουργία του επιπέδου δικτύου, γίνεται με βάση διάφορα κριτήρια και τελικώς επιλέγεται μία ανάμεσα σε διάφορες πιθανές διαδρομές.

Οι δρομολογητές ανήκουν στο επίπεδο 3 του μοντέλου OSI, το επίπεδο δικτύου (Network Layer[22]).

Κάθε δρομολογητής χρησιμοποιεί ένα ή περισσότερα πρωτόκολλα δρομολόγησης. Με βάση αυτά τα πρωτόκολλα ο δρομολογητής καθορίζει ποιος ή ποιοι διακομιστές ή δρομολογητές είναι οι καταλληλότεροι κάθε χρονική στιγμή και δρομολογεί τα πακέτα δεδομένων προς αυτούς.

Η Cisco παρέχει μία ολοκληρωμένη σειρά λύσεων δρομολόγησης για όλες τις επιχειρήσεις.

Branch Routers :

- Σειρές 3900,3800,3200,2900,2800,1900,1800,800

Connected Grid Routers :

- Σειρά 2000

Πλατφόρμες διασύνδεσης data center :

- Σειρές 7600,7200,ASR 1000[23]

Δρομολογητές για Mobile Internet :

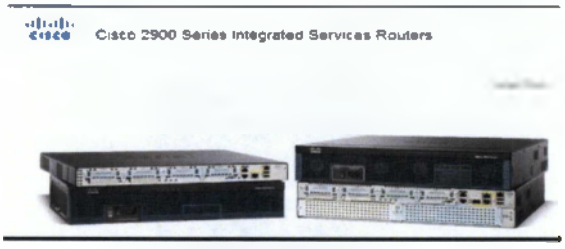
- Σειρά Cisco 5900 Embedded Services Routers
- Σειρά Cisco MWR 2900 Mobile Wireless Routers
- Cisco MWR 1900 Mobile Wireless Routers
- Δρομολογητές για Τηλεπικοινωνιακούς Παρόχους:
  (12000,10000,7600,7500,7300,7200, ASR 9000,ASR 1000, XR 12000)

Παρακάτω παρουσιάζονται μερικά μοντέλα δρομολογητών της Cisco:

Εικόνα 12 Δρομολογητές Cisco σειρά 1800

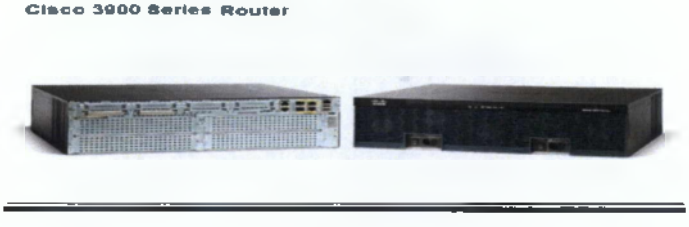
Εικόνα 13 Δρομολογητής Cisco σειρά 1900

Εικόνα 14 Δρομολογητές Cisco σειρά 2800

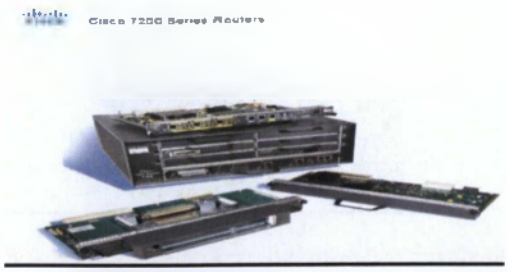


Εικόνα 15 Δρομολογητές Cisco σειρά 2900

Εικόνα 16 Δρομολογητές Cisco σειρά 3800



Εικόνα 17 Δρομολογητής Cisco σειρά 3900



Εικόνα 18 Δρομολογητές Cisco σειρά 7200

Εικόνα 19 Δρομολογητές Cisco σειρά 7600

Εικόνα 20 Δρομολογητές Cisco σειρά 12000

Οι περισσότερες επιχειρήσεις επιλέγουν συσκευές της Cisco για τη δημιουργία των δικτύων τους, καθώς θεωρούνται πιο αξιόπιστα.

3 ΑΚΑΔΗΜΙΑ ΔΙΚΤΥΩΣΗΣ ΤΗΣ CISCO

Προκειμένου να ανταποκριθεί στις ανάλογες εκπαιδευτικές απαιτήσεις διαδικτύωσης, η Cisco Systems δημιούργησε το Πρόγραμμα Ακαδημαϊκής Δικτύωσης[24], ένα ολοκληρωμένο πρόγραμμα εκμάθησης που παρέχει στους σπουδαστές τις ειδικευμένες γνώσεις της τεχνολογίας δικτύων. Η ακαδημία της Cisco ενσωματώνει πρόσωπο με πρόσωπο διδασκαλία, web-based περιεχόμενο, online αξιολόγηση, παρακολούθηση των επιδόσεων των σπουδαστών, hands-on εργαστήρια και προετοιμασία για τις πιστοποιήσεις. Δημιουργήθηκε το 1997 στοχεύοντας στην κατάρτιση ικανών τεχνικών και ειδικών πληροφορικής και δικτύων αλλά και στην αντιμετώπιση της αυξανόμενης ζήτησης εξειδικευμένων επαγγελματιών βελτιώνοντας τις πιθανότητες καριέρας και εκπαίδευσης για τους σπουδαστές σε όλο τον κόσμο.

Η Δικτυακή Ακαδημία παραδίδει κατάλληλες δεξιότητες σε περίπου 500,000 σπουδαστές σε περισσότερες από 160 χώρες κάθε χρόνο, καθώς οι Ακαδημίες βρίσκονται σε σχολεία, φροντιστήρια πληροφορικής, κολέγια, πανεπιστήμια και οργανισμούς σε περισσότερες από 10,000 περιοχές σε όλο τον κόσμο. Όλοι οι σπουδαστές έχουν πρόσβαση στην ίδια, υψηλής ποιότητας e-learning διδακτέα ύλη, εργαστήρια και εργασίες και αποκτούν παγκόσμια αναγνωρισμένες πιστοποιήσεις οι οποίες αποτελούν εφόδια ζωής και καριέρας.

Το Διαδίκτυο έχει τη δύναμη να αλλάξει τον τρόπο με τον οποίο οι άνθρωποι εργάζονται, ζουν, παίζουν και μαθαίνουν και η Ακαδημία Δικτύωσης της Cisco είναι στην πρώτη γραμμή αυτού του μετασχηματισμού.

3.1 Οι πιστοποιήσεις της Ακαδημίας Δικτύωσης της Cisco

Οι πιστοποιήσεις της Cisco αποτελούν ισχυρά εφόδια για την αγορά εργασίας στον τομέα της πληροφορικής και ξεχωρίζουν ανάμεσα σε χιλιάδες πιστοποιήσεις από άλλους φορείς ανά τον κόσμο. Η Cisco Systems απαιτεί από τους επίσημους πιστοποιημένους φορείς που συνεργάζονται μαζί της να απασχολούν τεχνικούς που διαθέτουν μία ή περισσότερες από αυτές τις πιστοποιήσεις. Οι πιστοποιήσεις της Cisco αποτελούν πλέον αναγκαιότητα για τους τεχνικούς συστημάτων πληροφορικής και δικτύων.

Οι πιστοποιήσεις πάνω στην εκπαιδευτική ακαδημία της Cisco χωρίζονται σε πέντε κατηγορίες: entry, associate, expert, architect.

3.1.1 Entry[25]

Είναι το χαμηλότερο επίπεδο των πιστοποιήσεων. Στην κατηγορία αυτή ανήκει η πιστοποίηση CCENT.

CCENT (Cisco Certified Entry Networking Technician)

Η πιστοποίηση CCENT επικυρώνει την ικανότητα εγκατάστασης, διαχείρισης και επίλυσης προβλημάτων σε ένα δίκτυο μικρών εταιριών, συμπεριλαμβανομένου και των βασικών ρυθμίσεων της ασφάλειας δικτύου. Οι κάτοχοι της πιστοποίησης CCENT αποδεικνύουν πως έχουν τα προσόντα που απαιτούνται για εισαγωγικές θέσεις υποστήριξης δικτύου – την αφετηρία της επιτυχημένης καριέρας στο χώρο της δικτύωσης. Η εκπαίδευση αναφέρεται σε βασικές έννοιες δικτύωσης, τεχνολογίες WAN, βασική παραμετροποίηση security και wireless, βασικές έννοιες routing και switching και ρύθμιση απλών δικτύων. Η πιστοποίηση CCENT αποτελεί το 1° βήμα προς την απόκτηση της πιστοποίησης CCNA, που επικυρώνει γνώσεις σε ένα δίκτυο επιχειρήσεων μεσαίου μεγέθους με πιο πολύπλοκες συνδέσεις.

3.1.2 Associate[26]

Είναι το δεύτερο επίπεδο των πιστοποιήσεων της Cisco και τα πιστοποιητικά που περιλαμβάνει είναι τα ακόλουθα:

CCNA (Cisco Certified Network Associate)

Με την πιστοποίηση αυτή, οι σπουδαστές θα είναι σε θέση να κατανοήσουν τις λειτουργίες των τοπικών δικτύων. Θα αποκτήσουν τη δυνατότητα τόσο να εφαρμόζουν και να αναπτύσσουν τοπικά δίκτυα σε μία εταιρία όσο και να μάθουν τον αποτελεσματικότερο τρόπο διαχείρισης και συντήρησής τους. Η πιστοποίηση της Cisco διασφαλίζει πως ο κάτοχός της έχει όλες τις απαραίτητες γνώσεις για τα δίκτυα μικρού και μεσαίου μεγέθους, ακόμα και για τα τμήματα μεγαλύτερων δικτύων. Με την ολοκλήρωση του προγράμματος σπουδών του CCNA, ο κάτοχός του θα είναι ικανός να εγκαταστήσει και να παραμετροποιήσει τοπικά δίκτυα (LANs), δίκτυα ευρείας περιοχής (WANs) και υπηρεσίες πρόσβασης σε δίκτυα υπολογιστών (DNS,DHCP). Στην διδακτέα ύλη του CCNA καλύπτονται θέματα δικτυακών τεχνολογιών και πρωτοκόλλων σε βάθος ανάλογων αυτών που διδάσκονται σε πανεπιστημιακό επίπεδο. Οι σπουδαστές μαθαίνουν τις βασικές τεχνολογίες και τα πρωτόκολλα δρομολόγησης (routing), μεταγωγής (switching) και άλλων τεχνολογιών υψηλού επιπέδου.

CCNA Security (Certified Network Associate Security)[27]

Το CCNA Security απευθύνεται σε όσους έχουν ήδη πιστοποίηση CCNA που θέλουν να εξειδικευτούν σε θέματα ασφαλείας δικτύων Η/Υ.

Τα μαθήματα στοχεύουν στην εξοικείωση των εκπαιδευόμενων με τις έννοιες της ακεραιότητας, εμπιστευτικότητας και διαθεσιμότητας δεδομένων και συσκευών, τις πρακτικές ασφάλειας δικτύων και την απόκτηση δεξιοτήτων που είναι απαραίτητες για τον σωστό σχεδιασμό, εφαρμογή και υποστήριξή τους.

Μετά την ολοκλήρωση των μαθημάτων και αφού περάσουν από θεωρητικές και πρακτικές εξετάσεις, οι εκπαιδευόμενοι λαμβάνουν πιστοποίηση παρακολούθησης από την Ακαδημία Cisco. Το πρόγραμμα σπουδών κάνει μια εισαγωγή στις έννοιες της ασφάλειας καθώς και τις βασικές δεξιότητες που απαιτούνται για την εγκατάσταση, την αντιμετώπιση προβλημάτων και την συντήρηση των δικτυακών συσκευών για τη διατήρηση της ακεραιότητας, της εμπιστευτικότητας, και της διαθεσιμότητας των δεδομένων και των συσκευών.

CCNA Voice (Cisco Certified Network Associate Voice)

Η πιστοποίηση Cisco Certified Network Associate Voice επιβεβαιώνει τις βασικές γνώσεις και ικανότητες που απαιτούνται για τη διαχείριση ενός Voice δικτύου. Επικυρώνει τις απαιτούμενες δεξιότητες που χρειάζονται για εξειδικευμένους ρόλους εργασίας σε τεχνολογίες φωνής, όπως διαχειριστής, μηχανικός κ.α., καθώς και γνώσεις σε τεχνολογίες VoIP όπως IP PBX, IP τηλεφωνία, handset (ακουστικά), call control και λύσεις voicemail.

CCNA Wireless

Ο πιστοποιημένος Cisco Certified Network Associate Wireless αποδεικνύει σε εισαγωγικό επίπεδο τις γνώσεις και τις ικανότητες που χρειάζονται για τη ρύθμιση και την υποστήριξη ασύρματων LANs και ειδικά αυτών που χρησιμοποιούν εξοπλισμό Cisco. Είναι σε θέση να παραμετροποιεί ένα βασικό ασύρματο δίκτυο σε ένα Cisco WLAN από ένα μικρομεσαίο έως και ένα μεγάλο εταιρικό δίκτυο. Το πεδίο γνώσεών του περιέχει τις δεξιότητες που χρειάζονται για την προετοιμασία της ρύθμισης, επίβλεψης και επίλυσης προβλημάτων βασικών εργασιών σε ένα Cisco WAN.

CCNA Service Provider (CCNA SP)

Το CCNA SP επικεντρώνεται στην τελευταία λέξη της δικτυακής τεχνολογίας των παρόχων υπηρεσιών των βιομηχανιών και παρέχει στους κατόχους της πιστοποίησης τις απαραίτητες γνώσεις και δεξιότητες για την ανάπτυξη και διατήρηση της παροχής υπηρεσιών σε δίκτυα επόμενης γενιάς. Η πιστοποίηση δίνει έμφαση στην ευθύνη του τεχνικού δικτύου για την σωστή ρύθμιση, εφαρμογή και αντιμετώπιση προβλημάτων των τεχνικών υποδομών.

Το πρόγραμμα σπουδών του CCNA SP περιλαμβάνει το εύρος των τεχνολογιών δικτύου που αναπτύσσονται στο δίκτυο παροχής υπηρεσιών και δημιουργεί μηχανικούς ικανούς να διαμορφώσουν,βελτιστοποιήσουν και να αντιμετωπίσουν ένα δίκτυο παροχής υπηρεσιών.

CCNA Service Provider Operations (CCNA SP Operations)

Η πιστοποίηση αυτή επικυρώνει τις βασικές γνώσεις και δεξιότητες για την αντιμετώπιση προβλημάτων σε ένα περιβάλλον με υποδομή δικτύου carrier-class[1] IP NGN[2].

3.1.3 Professional[28]

Η κατηγορία αυτή περιλαμβάνει τα παρακάτω πιστοποιητικά:

CCDP (Cisco Certified Design Professional)

Η πιστοποίηση αυτή επικυρώνει τις προηγμένες γνώσεις των εννοιών και των αρχών σχεδιασμού ενός δικτύου. Ο μηχανικός δικτύου που έχει στην κατοχή του το CCDP είναι σε θέση να σχεδιάσει και να δημιουργήσει προηγμένη διευθυνσιοδότηση και δρομολόγηση, ασφάλεια, data center. Το πρόγραμμα σπουδών του CCDP περιλαμβάνει επεκτάσιμη διαδικτύωση, δημιουργία πολλαπλών δικτύων μεταγωγής και σχεδιασμό της αρχιτεκτονικής υπηρεσιών δικτύου.

CCIP (Cisco Certified Internetwork Professional)

Με την πιστοποίηση αυτή, ο μηχανικός δικτύου αποκτά προχωρημένες γνώσεις και δεξιότητες οι οποίες απαιτούνται για διαχείριση υποδομών δικτύου των πάροχων υπηρεσιών. Ο κάτοχος του CCIP που εργάζεται σε μία εταιρία παροχής υπηρεσιών διαδικτύου, κατέχει εξειδικευμένες γνώσεις σε λύσεις υποδομής IP δικτύωσης.

CCNP (Cisco Certified Network Professional)

Ο κάτοχος του CCNP είναι σε θέση να σχεδιάζει, να υλοποιεί, να ελέγχει και να αντιμετωπίζει προβλήματα σε τοπικά και ευρείας ζώνης δίκτυα, εργαζόμενος σε συνεργασία με ειδικούς σε λύσεις προχωρημένης ασφάλειας, φωνής, ασύρματης δικτύωσης και βίντεο. Η συγκεκριμένη πιστοποίηση είναι ιδανική για όσους έχουν ήδη κάποια εμπειρία δικτύωσης και είναι έτοιμοι να αναπτύξουν τις δεξιότητές τους και να εργαστούν σε σύνθετες δικτυακές λύσεις. Πληρούν τις απαραίτητες γνώσεις που χρειάζονται σε απαιτητικούς ρόλους εργασίας όπως ο τεχνικός δικτύων, ο

[1] *Αναφέρεται σε κάποιο υλικό ή λογισμικό που είναι αυθεντικό και αξιόπιστο έτσι ώστε να ικανοποιήσει τις απαιτήσεις του φορέα.*
[2] *Next Generation Network-Δίκτυο Επόμενης Γενιάς.*

μηχανικός υποστήριξης, ο μηχανικός δικτύων και ο μηχανικός πληροφοριακών συστημάτων.

Κατά την διάρκεια της εκπαίδευσής τους οι σπουδαστές διδάσκονται τον τρόπο σχεδιασμού, εγκατάστασης και χειρισμού πολύπλοκης μορφής Τοπικών (LAN) και Ευρείας Χρήσης (WAN) Δικτυακών εφαρμογών.

CCSP (Cisco Certified Security Professional)

Η πιστοποίηση CCSP επικυρώνει προχωρημένες γνώσεις και δεξιότητες που απαιτούνται για την ασφάλεια δικτύων. Ο κάτοχος του CCSP γνωρίζει να εφαρμόζει ασφάλεια και να διαχειρίζεται υποδομές δικτύων για να προστατέψει την παραγωγικότητά τους, να μετριάσει τις απειλές και να μειώσει τα κόστη. Η πιστοποίηση δίνει έμφαση στα χαρακτηριστικά ασφαλείας των Cisco Router IOS (ISP) και Catalyst Switch, στην προσαρμοσμένη εφαρμογή ασφαλείας (ASA), στην ασφαλή σύνδεση VPN, στα συστήματα προστασίας εισβολών (IPS), στον Cisco Security Agent (CSA), στην εφαρμογή ασφαλείας επιχειρήσεων και στη διαχείριση συσκευών, στον εισαγωγικό έλεγχο δικτύου (NAC), καθώς και σε τεχνικές βελτιστοποίησης αυτών των τεχνολογιών σε μία ενιαία ολοκληρωμένη λύση ασφαλούς δικτύου.

CCNP Service Provider

Η πιστοποίηση του πάροχου υπηρεσιών CCNP πιστοποιεί τις γνώσεις και τις δεξιότητες που απαιτείται να κατέχουν οι επαγγελματίες δικτύων ώστε να παρέχουν μία κλιμακούμενη υποδομή carrier-grade, με δυνατότητες ταχείας επέκτασης ώστε να μπορεί να υποστηρίξει τη συνεχή εισαγωγή νέων διαχειριζόμενων υπηρεσιών και άλλων απαιτήσεων των πελατών.

CCNP Service Provider Operations

Η πιστοποίηση αυτή παρέχει στους μηχανικούς δικτύων τις απαιτούμενες γνώσεις προκειμένου να μπορεί να απομονώνει προβλήματα απόδοσης δικτύου, και να εφαρμόζει προληπτικά μέτρα βλάβης.

CCVP (Cisco Certified Voice Professional)

Η πιστοποίηση CCVP αποδεικνύει προχωρημένες γνώσεις και δεξιότητες βασικών αρχιτεκτονικών δικτύωσης. Επίσης περιλαμβάνει ένα σύνολο δεξιοτήτων όσον αφορά την εφαρμογή, τη λειτουργία, τη ρύθμιση και την αντιμετώπιση προβλημάτων σε ένα δίκτυο. Ένας CCVP μπορεί να βοηθήσει στη δημιουργία μιας επεκτάσιμης, εύκολα διαχειρίσιμης λύσης τηλεφωνίας. Οι γνώσεις του CCVP εστιάζονται στον Cisco Unified Communication Manager, στην ποιότητα των υπηρεσιών (QoS), σε gateways, σε εφαρμογές voice και σε εφαρμογές Cisco routers και Cisco Catalyst Switches.

CCNP Wireless

Το CCNP Wireless πιστοποιεί τις γνώσεις σχεδιασμού, υλοποίησης και λειτουργίας δικτύων Cisco Wireless και κινητικότητας υποδομών. Ο κάτοχος της συγκεκριμένης πιστοποίησης κατέχει τις αρχές και τη θεωρία ασύρματης δικτύωσης. Το CCNP Wireless πιστοποιεί επίσης τον επαγγελματία για την τεχνογνωσία και την τεχνική οξυδέρκειά του και επαληθεύει ότι μπορεί να αξιολογήσει και να μεταφράσει τις επιχειρηματικές απαιτήσεις μιας εταιρίας σε τεχνικές προδιαγραφές που με τη σειρά τους ενσωματώνονται σε επιτυχημένες εγκαταστάσεις.

CCIP (Cisco Certified Internetwork Professional)

Το CCIP πιστοποιεί τις προχωρημένες γνώσεις και δεξιότητες που απαιτούνται για διαχείριση υποδομών δικτύου των πάροχων υπηρεσιών. Ο CCIP που εργάζεται σε μία εταιρία παροχής υπηρεσιών διαδικτύου, κατέχει εξειδικευμένες γνώσεις για λύσεις υποδομής IP δικτύωσης (IP routing, IP QoS, BGP, MPLS)

3.1.4 Expert[29]

CCDE Cisco Certified Design Expert

Η πιστοποίηση αυτή έχει γίνει γρήγορα αποδεκτή σε όλο τον κόσμο ως ένα από τα πιο αναγνωρισμένα πιστοποιητικά στον κλάδο των δικτύων. Οι μηχανικοί δικτύου που κατέχουν το CCDE αναγνωρίζονται για τις υψηλές γνώσεις που κατέχουν στην σχεδίαση υποδομής δικτύων και έχουν τα κατάλληλα προσόντα να φέρουν εις πέρας και τις πιο δύσκολες αποστολές σχεδιασμού δικτύων.

CCIE(Cisco Certified Internetwork Expert)

Η πιστοποίηση CCIE αποτελεί την κορυφαία πιστοποίηση της Cisco και απευθύνεται σε επαγγελματίες με εξαιρετική εμπειρία στον τομέα των δικτύων. Οι μηχανικοί δικτύων που κατέχουν την πιστοποίηση Cisco CCIE αναγνωρίζονται για τις εξειδικευμένες δεξιότητές τους ως μηχανικοί δικτύων και τη γνώση των προϊόντων και λύσεων της Cisco. Η κοινότητα της CCIE έχει εδραιώσει τη φήμη του καθοδηγητή της βιομηχανίας δικτύων στη βαθιά τεχνική γνώση των δικτύων και αναπτύσσονται στις πιο δύσκολες, τεχνικά, εργασίες δικτύων. Το πρόγραμμα συνεχώς ανανεώνει και αναθεωρεί τα εργαλεία και τις μεθοδολογίες ελέγχου, ώστε να διασφαλίσει την απαράμιλλη ποιότητα, καταλληλότητα και αξία του προγράμματος. Μέσω μίας αυστηρής γραπτής εξέτασης και ένα εργαστήριο βασισμένο στις επιδόσεις, το πρόγραμμα CCIE καθορίζει τα πρότυπα της διαδικτυακής εμπειρίας.

Η Cisco εισήγαγε την πιστοποίηση CCIE το 1993 για να βοηθήσει τη βιομηχανία να διακρίνει το κορυφαίο κλιμάκιο των ειδικών της διαδικτύωσης παγκοσμίως. Σήμερα, όσοι κατέχουν την πιστοποίηση CCIE αντιπροσωπεύουν λιγότερο από το 3% όλων των πιστοποιημένων ειδικών της Cisco και λιγότερο από το 1% των ειδικών δικτύων παγκοσμίως.

CCIE Security

Το πρόγραμμα ασφαλείας CCIE παρέχει στους μηχανικούς δικτύου τις απαραίτητες γνώσεις και δεξιότητες για την υλοποίηση, συντήρηση και υποστήριξη για της ασφάλειας χρησιμοποιώντας τις τελευταίες τεχνολογίες και πρακτικές της βιομηχανίας.

CCIE Wireless

Η πιστοποίηση αυτή αξιολογεί και επικυρώνει την εμπειρία των μηχανικών δικτύου στην ασύρματη δικτύωση. Οι κάτοχοι του CCIE Wireless αποδεικνύουν την θεωρητική γνώση που έχουν αποκτήσει στην ασύρματη δικτύωση και την κατανόηση τεχνολογιών των ασύρματων τοπικών δικτύων (WAN) από τη Cisco.

3.1.5 Architect[30]

Cisco Certified Architect:

Η πιστοποίηση Cisco Certified Architect αναγνωρίζει την εμπειρία και την ικανότητα σε θέματα αρχιτεκτονικής των σχεδιαστών δικτύων οι οποίοι μπορούν να υποστηρίξουν όλο και πιο πολύπλοκα δίκτυα παγκόσμιων οργανισμών και να μετατρέψουν αποτελεσματικά τις επιχειρησιακές στρατηγικές σε επαναστατικές στρατηγικές τεχνολογίας.

Οι συνεργάτες καναλιών της Cisco παίζουν ουσιαστικό ρόλο στο να δώσουν στους πελάτες τους τη δυνατότητα να αναπτύξουν νέες προηγμένες τεχνολογίες, υποστηριζόμενοι από τους επαγγελματίες που διαθέτουν τις απαραίτητες ικανότητες να χρησιμοποιούν αυτές τις καινοτόμες λύσεις.

Η πιστοποίηση είναι πάνω από το expert-level CCIE ως προς τη δυσκολία, δίνοντας έμφαση σε ειδικές γνώσεις σε αρχιτεκτονική υποδομής δικτύων, αλλά και στην ικανότητα για συνεργασία με πελάτες-στελέχη από τον χώρο των επιχειρήσεων.

4. ΕΙΚΟΝΙΚΑ ΕΡΓΑΣΤΗΡΙΑ

Οι σπουδαστές, προκειμένου να αποκτήσουν τις ειδικευμένες γνώσεις της τεχνολογίας δικτύου και να είναι κατάλληλα προετοιμασμένοι για τις εξετάσεις της Cisco, πρέπει να πειραματίζονται πάνω στον εξοπλισμό της Cisco και να τον παραμετροποιούν. Λόγω του περιορισμένου χώρου εργαστηρίων, της έλλειψης εξοπλισμού και του υψηλού κόστους των συσκευών, έχουν δημιουργηθεί διάφορα προγράμματα για προσομοίωση λειτουργίας και προγραμματισμού δικτύωσης. Οι κυριότεροι λόγοι της χρήσης εικονικών εργαστηρίων είναι οι εξής:

1. Σε ένα κανονικό περιβάλλον εργαστηρίου είναι δύσκολο να στήσουμε ολόκληρο εξοπλισμό δικτύου της Cisco, καθώς είναι πολύ ακριβός. Συνήθως έχουμε κάποιους βασικούς δρομολογητές και μεταγωγείς, όπως τα μοντέλα δρομολογητών 1600, 1700, 2600 και 1900, 2900 μεταγωγών αντίστοιχα. Ο εξοπλισμός αυτός είναι σε θέση να υποστηρίξει μερικά βασικά πειράματα, αλλά για μεγάλες τοπολογίες απαιτείται εξοπλισμός υψηλότερου επιπέδου που είναι πολύ πιο ακριβός. Επιπλέον, ο αριθμός των διεπαφών υλικού είναι περιορισμένος και δεν μπορεί να υποστηρίξει τα πειράματα μεγάλων τοπολογιών.

2. Εξαιτίας του περιορισμένου αριθμού των συσκευών, ο εξοπλισμός που παρέχεται στα εργαστήρια είναι δύσκολο να υποστηρίξει ένα ολόκληρο τμήμα κάθε φορά. Τις περισσότερες φορές οι σπουδαστές χωρίζονται σε ομάδες για τα πειράματα με αποτέλεσμα κάποιοι σπουδαστές να μην έχουν την δυνατότητα να παραμετροποιήσουν τις συσκευές.

3. Λόγω της συχνής χρήσης, ο εξοπλισμός των εργαστηρίων μπορεί να πάθει μεγάλη ζημιά. Σε κάθε πείραμα, η τοπολογία θα είναι διαφορετική από τη προηγούμενη. Οι σπουδαστές θα πρέπει να μετακινούν τον εξοπλισμό και να επανασυνδέουν τα καλώδια, πράγμα που οδηγεί σε σοβαρή βλάβη των συσκευών.

Για τους παραπάνω λόγους, έχουν δημιουργηθεί τα εικονικά περιβάλλοντα για την εξάσκηση των σπουδαστών.

Σύμφωνα με την εγκυκλοπαίδεια Britanica, η εικονική πραγματικότητα είναι η χρήση της μοντελοποίησης και της προσομοίωσης μέσω υπολογιστικών συστημάτων προκειμένου να δώσει στον χρήστη την δυνατότητα να αλληλεπιδράσει με ένα τεχνητό τρισδιάστατο οπτικό περιβάλλον. Οι εφαρμογές της εικονικής πραγματικότητας βαπτίζουν το χρήστη σε ένα υπολογιστικό περιβάλλον, το οποίο προσομοιώνει την πραγματικότητα μέσω της χρήσης interactive (διαδραστικών) συσκευών, οι οποίες στέλνουν και λαμβάνουν πληροφορία.

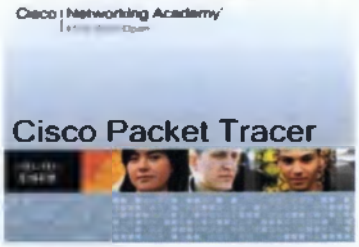
Το αποτέλεσμα που παράγεται από ένα σύστημα εικονικής πραγματικότητας ονομάζεται εικονικό περιβάλλον. Ο στόχος του είναι να δημιουργήσει στον χρήστη

την ψευδαίσθηση ότι είναι φυσικά τοποθετημένος σε ένα συνθετικά παραγόμενο περιβάλλον. Έτσι δημιουργήθηκε το εικονικό εργαστήριο, ένα σύστημα εκπαίδευσης με υπολογιστές βασισμένο στην προσομοίωση. Τα εικονικά εργαστήρια που έχουν δημιουργηθεί για τα δίκτυα προσομοιώνουν την λειτουργία και τον προγραμματισμό δικτύωσης και επιτρέπουν την εξομοίωση πολύπλοκων ή μη τοπολογιών δικτύων. Δεν μπορούν να αντικαταστήσουν από μόνα τους τα πραγματικά εργαστήρια, βοηθούν όμως σημαντικά στην απόκτηση γνώσεων.

Εικονικό εργαστήριο μπορεί να θεωρηθεί κάθε σύστημα λογισμικού όταν αποτελείται κατ΄ ελάχιστο, από ένα σύστημα προσομοίωσης και ένα λογικό σύστημα διαχείρισης (Robinson, 2003). Ένα τέτοιο σύστημα θα μπορούσε να θεωρηθεί επιτυχημένο όταν παρέχει την δυνατότητα γρήγορης και οικονομικά συμφέρουσας παραγωγής ενός υψηλής ποιότητας εικονικού εργαστηρίου. Παράλληλα ο όρος εικονικό εργαστήριο μπορεί να χρησιμοποιηθεί και για εφαρμογές οι οποίες επιτρέπουν την διαχείριση από απόσταση πραγματικών εργαστηρίων (Keating, 2000).

Παρακάτω παρουσιάζονται μερικοί από τους πιο γνωστούς προσομοιωτές που χρησιμοποιούνται από τους σπουδαστές που έχουν σκοπό να αποκτήσουν κάποια πιστοποίηση της Cisco.

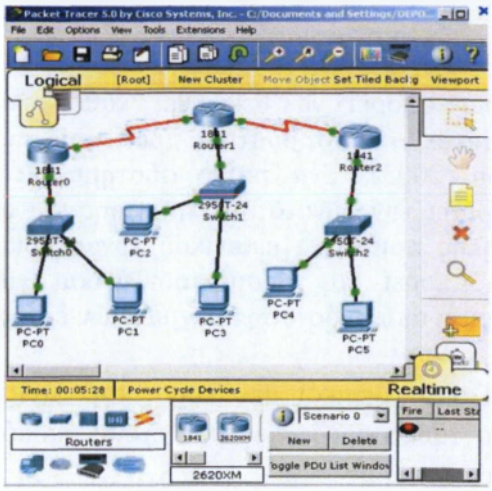
4.1 Cisco Packet Tracker



Εικόνα 21 Packet Tracker

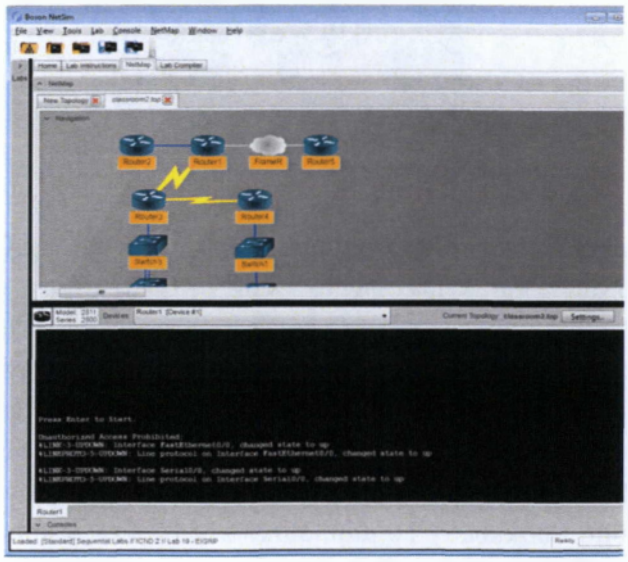
Το Packet Tracker[31] είναι το πρόγραμμα κλειστού κώδικα της Cisco για εξομοίωση δικτύων δεδομένων και τηλεφωνίας VoIP. Είναι ένα ισχυρό πρόγραμμα προσομοίωσης δικτύων που επιτρέπει στους σπουδαστές να πειραματιστούν με την συμπεριφορά του δικτύου. Προσφέρει προσομοίωση, απεικόνιση, συγγραφή και αξιολόγηση και διευκολύνει την διδασκαλία και την εκμάθηση των σύνθετων εννοιών της τεχνολογίας δικτύων. Το Packet Tracker συμπληρώνει τον φυσικό εξοπλισμό του εργαστηρίου, επιτρέποντας στους σπουδαστές να δημιουργήσουν δίκτυα με σχεδόν απεριόριστο αριθμό συσκευών. Το μαθησιακό περιβάλλον που είναι βασισμένο στην προσομοίωση βοηθά τους σπουδαστές να αναπτύξουν σύγχρονες δεξιότητες, όπως η λήψη αποφάσεων, δημιουργικότητα και κριτική σκέψης και επίλυση προβλημάτων. Το Packet Tracker συμπληρώνει το πρόγραμμα σπουδών της Ακαδημίας Δικτύου της Cisco , επιτρέποντας στους εκπαιδευτές να διδάξουν και δύσκολες τεχνικές έννοιες

και συστήματα σχεδιασμού δικτύων. Οι σπουδαστές μπορούν να χτίσουν, να διαμορφώσουν και να αντιμετωπίσουν προβλήματα δικτύων με τη χρήση εικονικού εξοπλισμού. Το πρόγραμμα αυτό βοηθά μαθητές και εκπαιδευτές να δημιουργήσουν το δικό τους εικονικό κόσμο δικτύου για εξερεύνηση, πειραματισμό και επεξήγηση εννοιών και τεχνολογιών δικτύωσης.



Εικόνα 22 Τοπολογία στον εξομοιωτή Packet Tracker

4.2 Boson NetSim™ Network Simulator



Εικόνα 23 Τοπολογία στον εξομοιωτή Boson NetSim

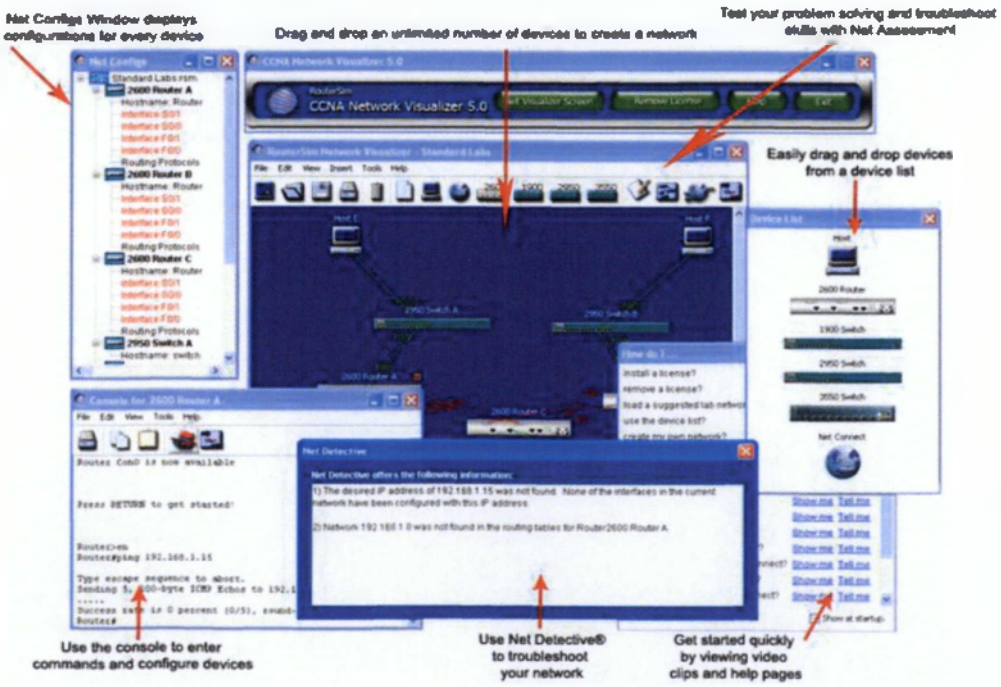
Το Boson NetSim[32] προσομοιώνει μία μεγάλη σειρά δρομολογητών της Cisco, συμπεριλαμβανομένου των 2500,2600,2800 και 3600 καθώς και τις σειρές

μεταγωγέων Catalyst 1900,2900 και 3500. Υποστηρίζει πολλαπλά πρωτόκολλα δρομολόγησης όπως RIP,EIGRP,OSPF,BGP. Οι εργασίες που υλοποιούνται πάνω στο NetSim δεν απαιτούν πρόσβαση σε κάποιον εξωτερικό δρομολογητή ή μεταγωγέα, αλλά μπορούν να γίνουν με τη χρήση των συσκευών και λειτουργιών του.

4.3 RouterSim Network Visualizer

Το Routersim[33] είναι μία εφαρμογή στην οποία οι χρήστες μπορούν να προσομοιώνουν ένα περιβάλλον λειτουργικού συστήματος ενός δρομολογητή προκειμένου να εξασκηθούν πάνω στη διαχείριση ενός δρομολογητή από τη γραμμή εντολών. Είναι μία ανεξάρτητη πλατφόρμα και δεν απαιτεί την φόρτωση λογισμικού firmware.

Το λογισμικό RouterSim είναι πραγματικά μια εξαιρετική μέθοδος άσκησης για την αποσαφήνιση των πληροφοριών που απαιτούνται για τις εξετάσεις της Cisco. Αυτό το εργαλείο βοηθάει τους χρήστες να κατανοήσουν πλήρως πώς επιτυγχάνεται η δικτύωση με τη χρήση προϊόντων της Cisco.



Εικόνα 24 Εξομοιωτής RouterSim

4.4 Dynamips Network Simulator

Το Dynamips[34] αναπτύχθηκε το 2005 από τον Christophe Fillot και μπορεί να εξομοιώνει σχεδόν όλα τα είδη δρομολογητών και μεταγωγών της Cisco σε μία ενιαία πλατφόρμα. Εξομοιώνει τον εξοπλισμό δικτύου φορτώνοντας απευθείας πραγματική εικόνα IOS της Cisco. Το Dynamips μπορεί να τρέξει σε Linux και Windows. Ο ίδιος ο κατασκευαστής του έχει πει πως μπορεί να χρησιμοποιηθεί ως πλατφόρμα εκπαίδευσης που επιτρέπει στους χρήστες να εξοικειωθούν με τις συσκευές της Cisco. Το πρόγραμμα αυτό δεν μπορεί φυσικά να αντικαταστήσει τον πραγματικό εξοπλισμό της Cisco, αλλά μπορεί να χρησιμοποιηθεί ως ένα εργαλείο για την υλοποίηση ασκήσεων πάνω στα δίκτυα.

5. GNS3 – GRAPHICAL NETWORK SIMULATOR

5.1 Εισαγωγή στο GNS3

Το GNS3[35] είναι ένα ελεύθερο πρόγραμμα για προσομοίωση λειτουργίας και προγραμματισμού δικτύωσης που επιτρέπει στους χρήστες να τρέχουν το λειτουργικό σύστημα Cisco IOS στους υπολογιστές τους σε ένα γραφικό περιβάλλον. Αποτελεί ένα εξαιρετικό εργαλείο που συμπληρώνει το πραγματικό εργαστήριο για τους μηχανικούς δικτύου, τους διαχειριστές και τους σπουδαστές που επιθυμούν να αποκτήσουν κάποια από τις πιστοποιήσεις της Cisco. Το πρόγραμμα μπορεί να χρησιμοποιηθεί σε πολλά λειτουργικά συστήματα, όπως Windows, Linux, MacOS X. Αναπτύχθηκε από τον Jeremy Grossman σε συνεργασία με τους προγραμματιστές David Ruiz, Romain Lamaison, Aurélien Levesque, and Xavier Alt. Το GNS επιτρέπει την εξομοίωση του Cisco IOS στον υπολογιστή του κάθε χρήστη.

Στους περισσότερους εξομοιωτές, υπάρχουν εντολές που δεν υποστηρίζονται από τους εξομοιωτές. Το GNS λειτουργεί με πραγματικές εικόνες του λειτουργικού συστήματος IOS της Cisco και έτσι ο χρήστης έχει πρόσβαση σε κάθε εντολή ή παράμετρο που υποστηρίζεται από αυτό. Το GNS είναι ένα open source, δωρεάν πρόγραμμα. Ωστόσο, εξαιτίας των περιορισμών αδειοδότησης, ο χρήστης χρειάζεται να προμηθεύεται το δικό του Cisco IOS προκειμένου να μπορέσει να χρησιμοποιήσει το πρόγραμμα. Το GNS παρέχει γύρω στα 1000 πακέτα το δευτερόλεπτο σε ένα εικονικό περιβάλλον σε αντίθεση με ένα router, που στέλνει εκατοντάδες φορές περισσότερα πακέτα. Ο σκοπός του GNS όμως δεν είναι να πάρει τη θέση μιας πραγματικής τοπολογίας δικτύου, αλλά, έχει σχεδιαστεί ως ένα εργαλείο πρακτικής και μάθησης.

5.2 Εγκατάσταση GNS

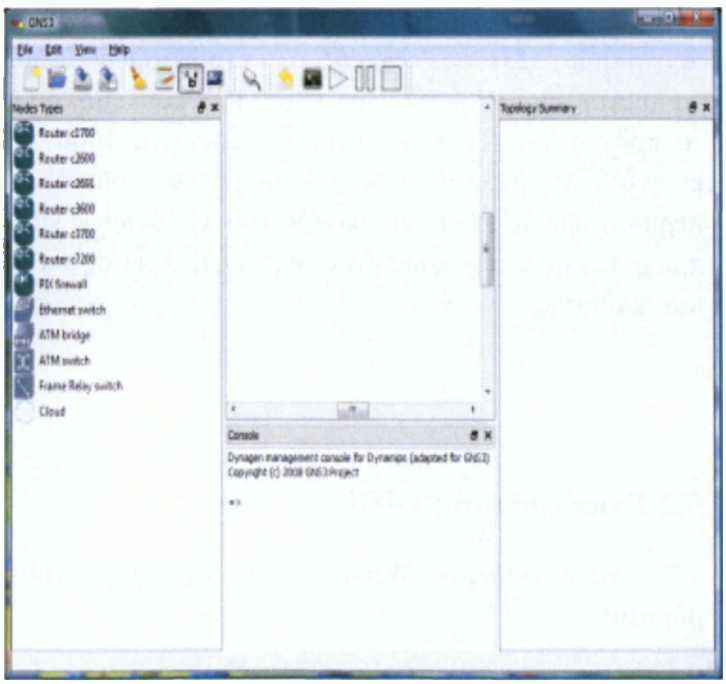
Σε ένα περιβάλλον Windows, για την εγκατάσταση ακολουθούμε τα παρακάτω βήματα:

Αρχικά κατεβάζουμε το πρόγραμμα.

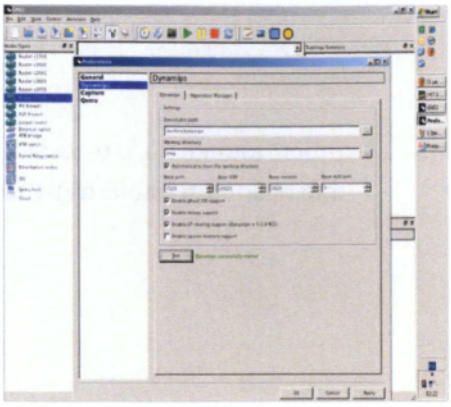
Εικόνα 25 Download GNS3

Αφού "κατέβει" το αρχείο, σώζεται στον κατάλογο του υπολογιστή. Γίνεται διπλό "κλικ" στο αρχείο για να ξεκινήσει η εγκατάσταση. Μόλις ολοκληρωθεί η εγκατάσταση, μπορούμε να ανοίξουμε το πρόγραμμα και να κάνουμε τις αρχικές ρυθμίσεις.

Στην εικόνα βλέπουμε την κεντρική κονσόλα του προγράμματος. Στα αριστερά φαίνονται όλα τα μοντέλα των μηχανημάτων που υποστηρίζονται από το πρόγραμμα. Στο κεντρικό μέρος είναι η κονσόλα όπου θα τοποθετούνται τα μηχανήματα και στο topology βρίσκονται όλα τα μηχανήματα που έχουν προστεθεί. Κάθε ένα μηχάνημα απαιτεί όπως και στην πραγματικότητα κάποιο IOS



Έλεγχος dynamips

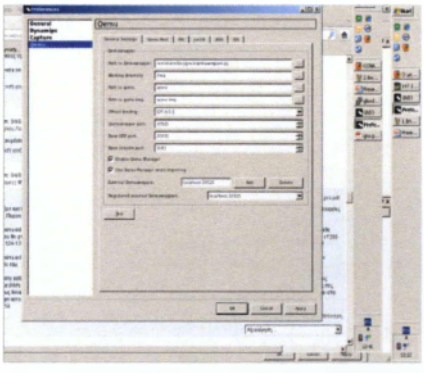


Για να ξεκινήσουμε οποιαδήποτε δραστηριότητα, πρώτα ελέγχουμε αν λειτουργούν τα dynamips.

Για να το διαπιστώσουμε αυτό πάμε από το menu->edit->Preferences->Dynamips

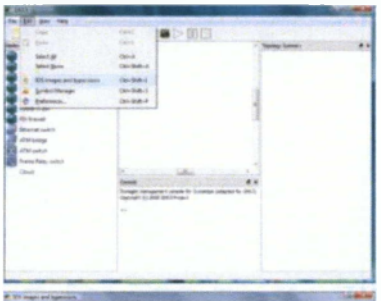
και εισάγουμε τους αριθμούς για τις πόρτες που θέλουμε να βάλουμε. Στη συνέχεια κάνουμε test πατώντας το κουμπί, για να βεβαιωθούμε πως τα dynamips δουλεύουν σωστά.

Έλεγχος Qemu

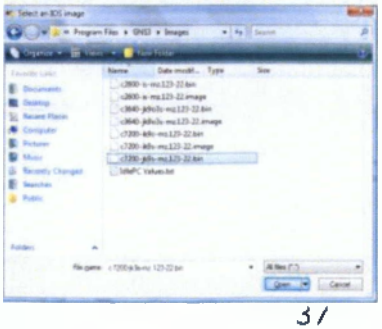


Το Qemu χρησιμοποιείται για να φτιάξουμε τους hosts για τις τοπολογίες που θα στήσουμε αργότερα. Βάζουμε ένα όνομα στο πεδίο Identifier Name. Όπως και στα dynamips, θα πρέπει να ελέγξουμε εάν δουλεύουν σωστά, κάνοντας test. Για να το διαπιστώσουμε αυτό πάμε από το menu->edit->Preferences->Qemu.

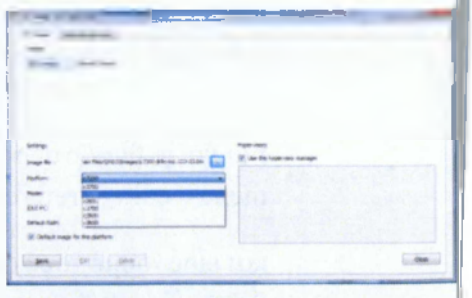
Για να φορτώσουμε το IOS image, ακολουθούμε τη διαδρομή Edit->IOS image and hypervisors.



Κάτω από το πεδίο IOS images, πατάμε το και βρίσκουμε το αρχείο όπου βρίσκεται το IOS το οποίο εισάγουμε στο πεδίο.



Ακριβώς από κάτω, στο πεδίο Platform επιλέγουμε τη πλατφόρμα η οποία αντιστοιχεί στο αρχείο IOS.



Στη συνέχεια επιλέγουμε το μοντέλο που αντιστοιχεί στο αρχείο IOS.

Σώζουμε τις ρυθμίσεις μας.

6. ΥΛΟΠΟΙΗΣΗ ΤΩΝ ΑΣΚΗΣΕΩΝ ΤΟΥ ΣΕΜΙΝΑΡΙΟΥ CCNA ΤΗΣ CISCO ΜΕ ΤΗ ΧΡΗΣΗ ΤΟΥ GNS3

Την περίοδο της εκπόνησης της πτυχιακής μου εργασίας, παρακολούθησα παράλληλα το Σεμινάριο Προχωρημένες Γνώσεις Δικτύων - Cisco Certified Network Associate (CCNA) του Εργαστηρίου Τεχνολογίας Πολυμέσων του ΕΜΠ[36]. Το σεμινάριο πραγματοποιείται μέσω e-learning, δηλαδή μέσω της τηλεκπαίδευσης ή ηλεκτρονικής μάθησης, που προσφέρει έναν συνδυασμό εκπαιδευτικών υλικών δίνοντας στους εκπαιδευόμενους τη δυνατότητα να εργαστούν οπουδήποτε έχοντας τη δυνατότητα παράλληλα να επικοινωνούν με τους εκπαιδευτικούς και τους υπόλοιπους συμμετέχοντες . Η διεξαγωγή των μαθημάτων γίνεται με τέτοιο τρόπο έτσι ώστε να προσφέρει τις ίδιες δυνατότητες με αυτές που θα είχαν και σε μία πραγματική αίθουσα διδασκαλίας. Μέσω της τηλεκπαίδευσης, οι εκπαιδευόμενοι μπορούν να εργαστούν ρυθμίζοντας το πρόγραμμα ο καθένας όπως επιθυμεί καταφέρνοντας παράλληλα να ασχοληθούν με οποιαδήποτε άλλη δραστηριότητα ή υποχρέωση. Το σεμινάριο έχει διάρκεια περίπου 7 μήνες και αποτελείται από 14 ενότητες, οι οποίες καλύπτουν πλήρως όλη την ύλη της πιστοποίησης CCNA. Η κάθε διάλεξη έχει ένα θεωρητικό και ένα πρακτικό μέρος. Το θεωρητικό μέρος αποτελείται από βιβλία της Cisco, multimedia διαλέξεις και σημειώσεις. Το πρακτικό μέρος αποτελείται από τεστ πολλαπλής επιλογής και ασκήσεις πάνω στα δίκτυα, με τη χρήση του εξομοιωτή GNS3. Το εκπαιδευτικό υλικό είναι αναρτημένο πάνω στην πλατφόρμα moodle[37], ένα λογισμικό κατάλληλο για υποστήριξη της εκπαίδευσης εξ αποστάσεως.

Στις επόμενες σελίδες παρουσιάζονται οι ενότητες του σεμιναρίου και οι ασκήσεις πάνω στα δίκτυα οι οποίες υλοποιήθηκαν με τη χρήση του προγράμματος προσομοίωσης GNS3.

6.1 Internetworking - Review of Ethernet Networking and Data Encapsulation

Η 1η ενότητα αποτελείται από τα βασικά στοιχεία που συνθέτουν ένα δίκτυο υπολογιστών. Δίνεται έμφαση στο υλικό (hardware) μέρος του δικτύου και το λογισμικό (software) μέρος αλλά και στα 7 επίπεδα του OSI και τις λειτουργίες που εκτελεί το κάθε ένα από αυτά.

6.2 Introduction to TCP/IP

Η 2η ενότητα του σεμιναρίου περιλαμβάνει τα βασικά στοιχεία που συνθέτουν ένα δίκτυο τεχνολογίας IP, όπως είναι το Internet. Αναλύει τα βασικά πρωτόκολλα που χρησιμοποιούνται, τον τρόπο λειτουργίας τους και τις διαφορές που υπάρχουν μεταξύ τους. Αναλύει τον τρόπο με τον οποίο γίνονται οι επικοινωνίες μεταξύ των υπολογιστών με την χρήση αυτών των πρωτοκόλλων.

6.3 Easy Subnetting - Variable Length Subnet Masks(VLSMs), and Troubleshooting TCP/IP

Η 3η ενότητα του σεμιναρίου αναλύει τις IP διευθύνσεις και τις κλάσεις τους καθώς και την εφαρμογή των μεθόδων υποδικτύωσης (Subnetting) και υπερδικτύωσης (Supernetting) για τις ανάγκες υλοποίησης ενός μικρομεσαίου (enterprize) IP δικτύου.

Υλοποίηση Ασκήσεων

6.3.1 Vocabulary Exercises

Definition	
a. With classfull routing. _____ must be avoided because they are not visible across classfull network boundaries.	**k** classless inter-domain routing
b. does not advertise subnet mask information.	**g** classless routing protocol
c. describes the combination of multiple contiguous classful network addresses into one advertisement.	**j** prefix length
D. the policy of advertising routes at the classfull boundary.	**a** discontiguous subnets
e. When using a classfull routing protocol, it is important that all subnets have the same as mask. This is sometimes referred to as _____	**f** route aggregation
f. process of combining multiple subnets into one advertisement with a common prefix length (not necessarily on a classfull boundary).	**c** fixed-length subnet masking (FLSM)
g. advertises subnet mask information.	**h** default route
h. When a router does not have an interface for the destination network, it sends traffic to its_____.	**d** automatic summarization
i. With classless routing protocols, the subnet	

mask can be different from subnet to subnet. This is called _____.	i variable-length subnet mask (VLSM)
j. also referred to as CIDR notation, bitmask, and network mask, the number of bits that are shared in common by all addresses in the address space.	f route summarization
k. specified by RFC 1519 to address the critical problems of exhaustion of Class B address space and the growth in size of Internet routing tables.	c supernetting
	b classfull routing protocol

6.3.2 Subnetting Review Exercises

Exercise 1: Class B Subnetting Scenario: Use address space 172.16.0.0/16 and subnet it to provide 2000 subnets.

How many bits do you need to borrow? **11**
Assuming subnet 0 and the all-1s subnet are both useable, what is the total number of subnets? **2048**
What is the total number of useable hosts per subnet? **30**
What is the new subnet mask in dotted-decimal notation? **255.255.255.224**
What is the new subnet mask in CIDR notation? **/27**
What is the magic number or subnet multiplier? **32**

- Fill in the following table for the first ten usable subnets.

Subnet No.	Subnet Address	Host Range	Broadcast Address
0	**172.16.0.32**	**172.16.0.33-172.16.0.62**	**172.16.0.63**
1	**172.16.0.64**	**172.16.0.65-172.16.0.94**	**172.16.0.95**
2	**172.16.0.96**	**172.16.0.97-172.16.0126**	**172.16.0.127**

3	172.16.0.128	172.16.0.129-172.16.0.158	172.16.0.159
4	172.16.0.160	172.16.0.161-172.16.0.190	172.16.0.191
5	172.16.0.192	172.16.0.193-172.16.0.222	172.16.0.223
6	172.16.0.224	172.16.0.225-172.16.0.254	172.16.0.255
7	172.16.1.0	172.16.1.1-172.16.1.30	172.16.1.31
8	172.16.1.32	172.16.1.33-172.16.1.62	172.16.1.63
9	172.16.1.64	172.16.1.65-172.16.1.94	172.16.1.95

Exercise 2: Class A Subnetting Scenario: Use the address space 10.0.0.0/8 and subnet it to provide enough addresses for 30.000 hosts.

How many bits do you need to borrow? **12**
Assuming subnet 0 and the all-1s subnet are both useable, what is the total number of subnets? **4096**
What is the total number of useable hosts per subnet? **4094**
What is the new subnet mask in dotted-decimal notation? **255.255.240.0**
What is the new subnet mask in CIDR notation? **/20**
What is the magic number or subnet multiplier? **16**

- Fill in the following table for the first ten usable subnets.

Subnet No.	Subnet Address	Host Range	Broadcast Address
0	10.0.16.0	10.0.16.1-10.0.31.254	10.0.31.255
1	10.0.32.0	10.0.32.1-10.0.47.254	10.0.47.255
2	10.0.48.0	10.0.48.1-10.0.63.254	10.0.63.255

3	10.0.64.0	10.0.64.1-10.0.79.254	10.0.79.255
4	10.0.80.0	10.0.80.1-10.0.95.254	10.0.95.255
5	10.0.96.0	10.0.96.1-10.0.111.254	10.0.111.255
6	10.0.112.0	10.0.112.1-10.0.127.254	10.0.127.255
7	10.0.128.0	10.0.128.1-10.0.143.254	10.0.143.255
8	10.0.144.0	10.0.144.1-10.0.159.254	10.0.159.255
9	10.0.160.0	10.0.160.1-10.0.175.254	10.0.175.255

6.3.3 Prefix Length Use Exercises

Exercise 1: Convert the following subnets and subnet masks shown in dotted-decimal format into the equivalent prefix length format.

A/A	Network	Subnet Mask	Dotted-Decimal Format
1	192.168.1.0	255.255.255.0	192.168.1.0/24
2	192.168.1.0	255.255.255.128	192.168.1.0/25
3	192.168.1.128	255.255.255.192	192.168.1.128/26
4	192.168.1.32	255.255.255.224	192.168.1.32/27
5	192.168.1.96	255.255.255.248	192.168.1.96/29
6	192.168.1.48	255.255.255.252	192.168.1.48/30
7	172.16.128.0	255.255.224.0	172.16.128.0/19
8	172.16.8.0	255.255.255.128	172.16.8.0/25
9	172.16.160.0	255.255.254.0	172.16.160.0/23

Exercise 2: Convert the following subnets and subnet masks shown in prefix length format into the equivalent dotted decimal format.

A/A	Network	Subnet Mask	Dotted-Decimal Format
1	172.16.0.0	/16	255.255.0.0

2	192.168.2.240	/29	**255.255.255.248**
3	192.168.2.32	/28	**255.255.255.240**
4	192.168.2.0	/25	**255.255.255.128**
5	192.168.2.240	/30	**255.255.255.252**
6	192.168.2.192	/26	**255.255.255.192**
7	172.20.34.0	/25	**255.255.255.128**
8	172.20.64.0	/18	**255.255.192.0**
9	172.20.224.0	/20	**255.255.240.0**

Exercise 3: Understanding how a router determines the network or subnet address for a given IP address is a fundamental skill to implementing VLSM and interpreting routing tables. In the following exercises, use binary math to "AND" the host IP address and subnet mask **to determine the subnet address**. After completing the binary math, write the subnet address in dotted-decimal format.

192.168.1.67/28				
	1st Octet	2nd Octet	3rd Octet	4th Octet
IP address	**11000000**	**10101000**	**00000001**	**01000011**
Subnet mask	**11111111**	**11111111**	**11111111**	**11110000**
Subnet address	**11000000**	**10101000**	**00000001**	**01000000**
Dotted-decimal	**192**	**168**	**1**	**64**

192.168.18.237/27				
	1st Octet	2nd Octet	3rd Octet	4th Octet
IP address	**11000000**	**10101000**	**00010010**	**11101000**
Subnet mask	**11111111**	**11111111**	**11111111**	**11100000**
Subnet address	**11000000**	**10101000**	**00010010**	**11100000**
Dotted-decimal	**192**	**168**	**18**	**224**

192.168.35.142/29				
	1st Octet	2nd Octet	3rd Octet	4th Octet
IP address	**11000000**	**10101000**	**00100011**	**10001110**
Subnet mask	**11111111**	**11111111**	**11111111**	**11111000**
Subnet address	**11000000**	**10101000**	**00100011**	**10001000**
Dotted-decimal	**192**	**168**	**35**	**136**

172.28.23.54/21				
	1st Octet	2nd Octet	3rd Octet	4th Octet
IP address	**10110010**	**00011100**	**00010111**	**00111000**
Subnet mask	**11111111**	**11111111**	**11111000**	**00000000**
Subnet address	**10110010**	**00011100**	**00010000**	**00000000**
Dotted-decimal	**172**	**28**	**16**	**0**

172.31.32.69/25				
	1st Octet	2nd Octet	3rd Octet	4th Octet
IP address	**10110010**	**00011111**	**00100000**	**01000101**
Subnet mask	**11111111**	**11111111**	**11111111**	**10000000**
Subnet address	**10110010**	**00011111**	**00100000**	**00000000**
Dotted-decimal	**172**	**31**	**32**	**0**

6.3.4 VLSM Subnetting a Subnet Exercises

1	192.168.1.128/25
Objective	Further subnet this address to provide eight additional subnets with at least ten hosts

	per subnet. List the first five subnets in network address/prefix format.	
	Subnet No.	Network Address/Prefix
	0	**192.168.1.128**
	1	**192.168.1.144**
	2	**192.168.1.160**
	3	**192.168.1.176**
	4	**192.168.1.192**

2	172.16.32.0/19	
Objective	Further subnet this address to provide eight additional subnets with at least 1000 hosts per subnet. List the first five subnets in network address/prefix format.	
	Subnet No.	Network Address/Prefix
	0	**172.16.32.0**
	1	**172.16.36.0**
	2	**172.16.40.0**
	3	**172.16.44.0**
	4	**172.16.48.0**

2a	Write at this point which is the subnet	
Objective	Use subnet 2 from the last question and further subnet this address to provide eight additional subnets with at least 100 hosts per subnet. List the first five subnets in network address/prefix format.	
	Subnet No.	Network Address/Prefix
	0	**172.16.40.0**
	1	**172.16.40.128**
	2	**172.16.41.0**
	3	**172.16.41.128**
	4	**172.16.42.0**

Objective	Use subnet 4 from the last question and further subnet this address to provide eight

	additional subnets with at least ten hosts per subnet. List the first five subnets in network address/prefix format	
	Subnet No.	Network Address/Prefix
	0	**172.16.42.0**
	1	**172.16.42.16**
	2	**172.16.42.32**
	3	**172.16.42.48**
	4	**172.16.42.64**

Objective	Use subnet 0 from the last question and further subnet this address to provide four additional subnets to be used for point-to-point links. List all four subnets in network address/prefix format.	
	Subnet No.	Network Address/Prefix
	0	**172.16.42.0**
	1	**172.16.42.4**
	2	**172.16.42.8**
	3	**172.16.42.12**
	4	**172.16.42.16**

	10.1.0.0/16	
Objective	Further subnet this address to **provide 30 additional subnets** with at **least 2000 hosts per subnet**. List the first five subnets in network address/prefix format.	
	Subnet No.	**Network Address/Prefix**
	0	**10.1.0.0**
	1	**10.1.8.0**
	2	**10.1.16.0**
	3	**10.1.24.0**
	4	**10.1.32.0**

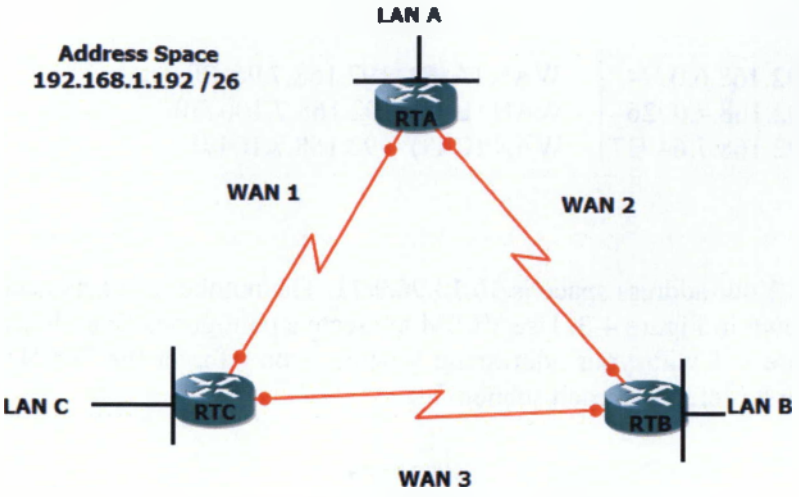
Objective	Use subnet 4 from the last question and further subnet this address to provide 30 additional subnets with at least 60 hosts per subnet. List the first five subnets in

	network address/prefix format.	
	Subnet No.	Network Address/Prefix
	0	**10.1.32.0**
	1	**10.1.32.64**
	2	**10.1.32.128**
	3	**10.1.32.192**
	4	**10.1.33.0**

Objective	Use subnet 1 from the last question and further subnet this address to provide 16 additional subnets to be used for point-to-point links. List the first 5 subnets in network address/prefix format.	
	Subnet No.	Network Address/Prefix
	0	10.1.32.64
	1	10.1.32.68
	2	10.1.32.72
	3	10.1.32.76
	4	10.1.32.80

6.3.5 VLSM Addressing Design Exercises

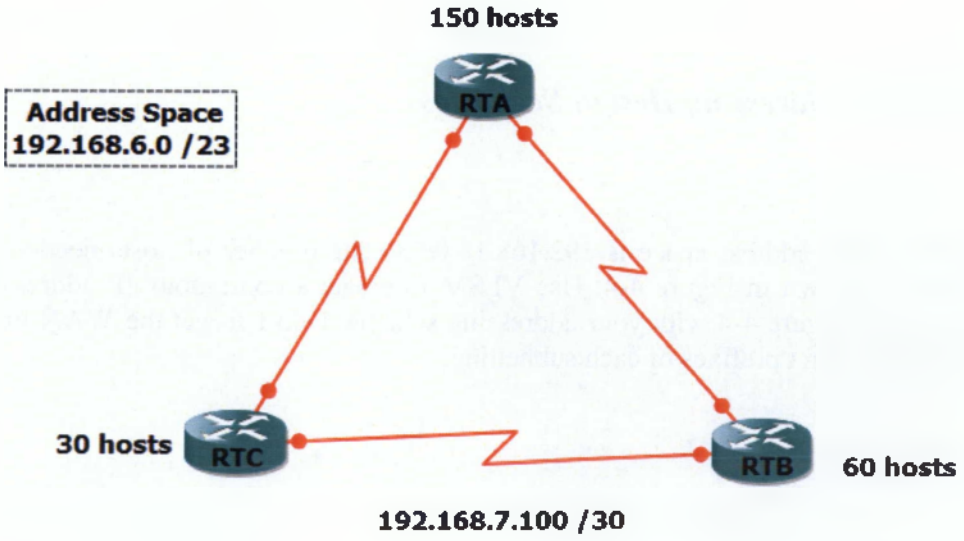
Exercise 1: Your address space is 192.168.1.192/26. Each LAN needs to support ten hosts. Use VLSM to create a contiguous IP addressing scheme. Label Figure 4-1 with your addressing scheme. Don't forget the WAN links. Write down the first prefixes of each subnetting.



Εικόνα 26 VLSM Exercise 1 Topology

LAN A -192.168.1.192 /28	WAN 1 -192.168.1.240 /30
LAN B -192.168.1.208 /28	WAN 2 -192.168.1.244 /30
LAN C -192.168.1.224 /28	WAN 3 -192.168.1.248 /30

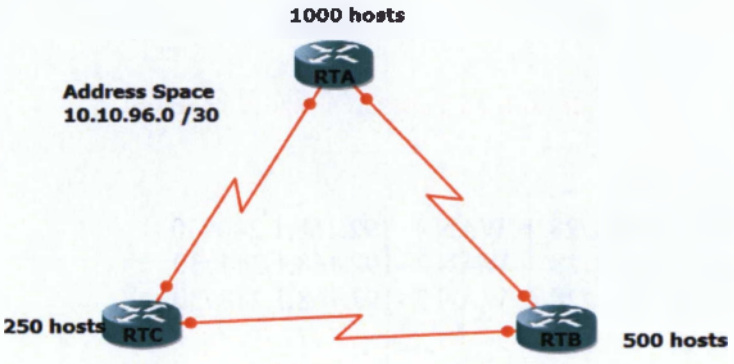
Exercise 2: Your address space is **192.168.6.0/23**. The number of hosts needed for each LAN is shown in Figure 4-2. Use VLSM to create a contiguous IP addressing scheme. Label Figure 4-2 with your addressing scheme. Don't forget the WAN links. Write down the first prefixes of each subnetting.



Εικόνα 27 VLSM Exercise 2 Topology

LAN A -192.168.6.0 /24	WAN (A-B) -192.168.7.96 /30
LAN B -192.168.7.0 /26	WAN (B-C) -192.168.7.100 /30
LAN C -192.168.7.64 /27	WAN (C-A) -192.168.7.104 /30

Exercise 3: Your address space is **10.10.96.0/21**. The number of hosts needed for each LAN is shown in Figure 4-3. Use VLSM to create a contiguous IP addressing scheme. Label Figure 4-3 with your addressing scheme. Don't forget the WAN links. Write down the first prefixes of each subnetting.

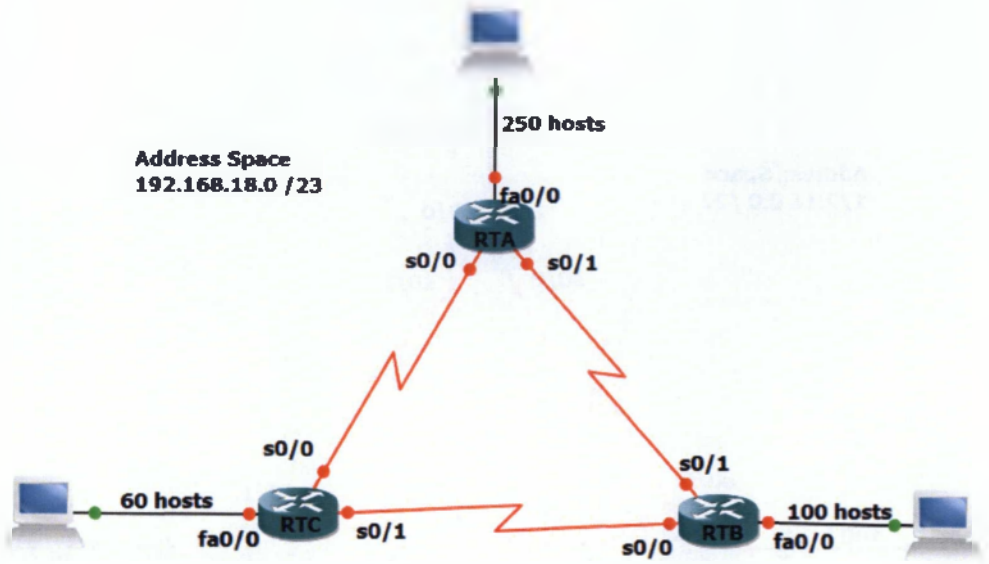


Εικόνα 28 VLSM Exercise 3 Topology

LAN A -10.10.96.0 /22	WAN (A-B) -10.10.103.0 /30
LAN B -10.10.100.0 /23	WAN (B-C) -10.10.103.4 /30
LAN C -10.10.102.0 /24	WAN (C-A) -10.10.103.8 /30

6.3.6 VLSM Addressing Design Scenarios

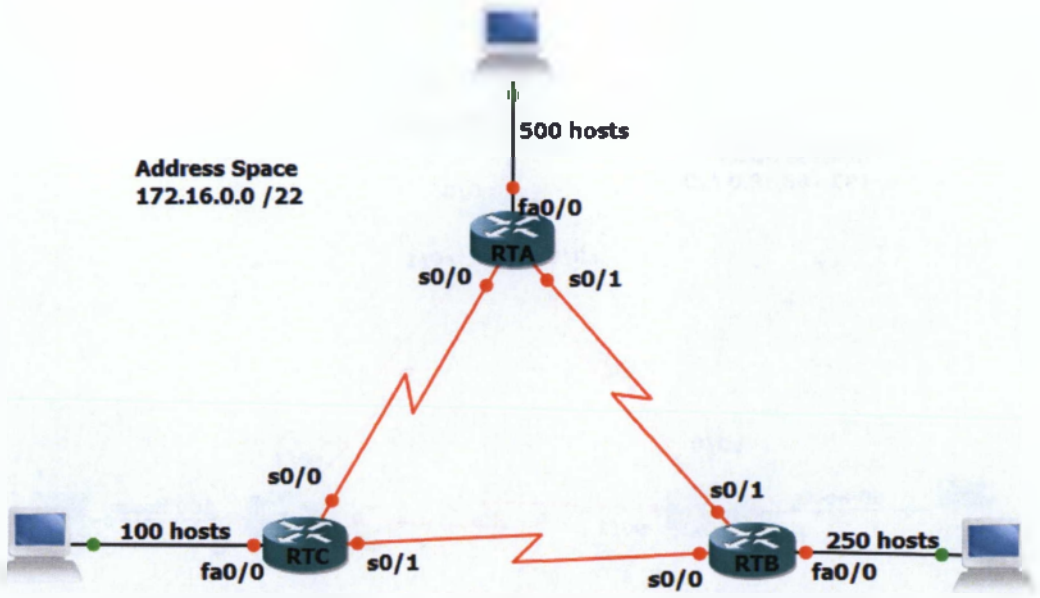
Exercise 1: Your address space is 192.168.18.0/23. The number of hosts needed for each LAN is shown in Figure 4-4. Use VLSM to create a contiguous IP addressing scheme. Label Figure 4-4 with your addressing scheme. Don't forget the WAN links. Write down the first prefixes of each subnetting.



Εικόνα 29 VLSM Addressing Design Scenario 1 Topology

Device	Interface	IP Address	Subnet Mask	Default Gateway
RTA	Fa0/0	192.168.18.1	255.255.255.0	N/A
	S0/1	192.168.19.193	255.255.255.252	N/A
	S0/0	192.168.19.197	255.255.255.252	N/A
RTB	Fa0/0	192.168.19.1	255.255.255.128	N/A
	S0/1	192.168.19.194	255.255.255.252	N/A
	S0/0	192.168.19.201	255.255.255.252	N/A
RTC	Fa0/0	192.168.19.129	255.255.255.192	N/A
	S0/1	192.168.19.202	255.255.255.252	N/A
	S0/0	192.168.19.198	255.255.255.252	N/A
Host A	N/A	192.168.18.2	255.255.255.0	192.168.18.1
Host B	N/A	192.168.19.2	255.255.255.128	192.168.19.1
Host C	N/A	192.168.19.130	255.255.255.192	192.168.19.129

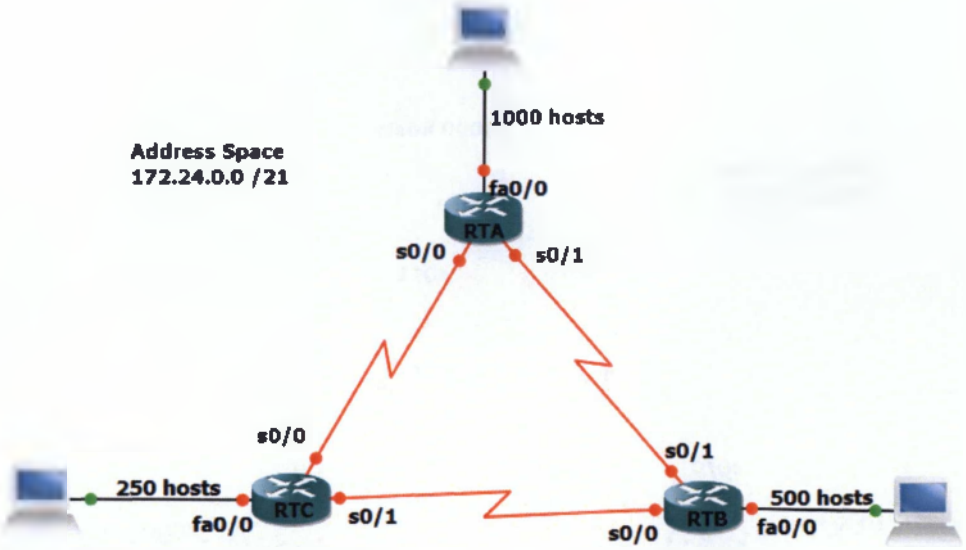
Exercise 2: Your address space is **172.16.0.0/22**. The number of hosts needed for each LAN is shown in Figure 4-5. Use VLSM to create a contiguous IP addressing scheme. Label Figure 4-5 with your addressing scheme. **Don't forget the WAN links.** Write down the first prefixes of each subnetting.



Εικόνα 30 VLSM Addressing Design Scenario 2 Topology

Device	Interface	IP Address	Subnet Mask	Default Gateway
RTA	Fa0/0	172.16.0.1	255.255.254.0	N/A
	S0/1	172.16.3.129	255.255.255.252	N/A
	S0/0	172.16.3.133	255.255.255.252	N/A
RTB	Fa0/0	1.2.16.2.1	255.255.255.0	N/A
	S0/1	172.16.3.130	255.255.255.252	N/A
	S0/0	172.16.3.137	255.255.255.252	N/A
RTC	Fa0/0	172.16.3.1	255.255.255.128	N/A
	S0/1	172.16.3.138	255.255.255.252	N/A
	S0/0	172.16.3.134	255.255.255.252	N/A
Host A	N/A	172.16.0.2	255.255.254.0	172.16.0.1
Host B	N/A	172.16.2.2	255.255.255.0	172.16.2.1
Host C	N/A	172.16.3.2	255.255.255.128	172.16.3.1

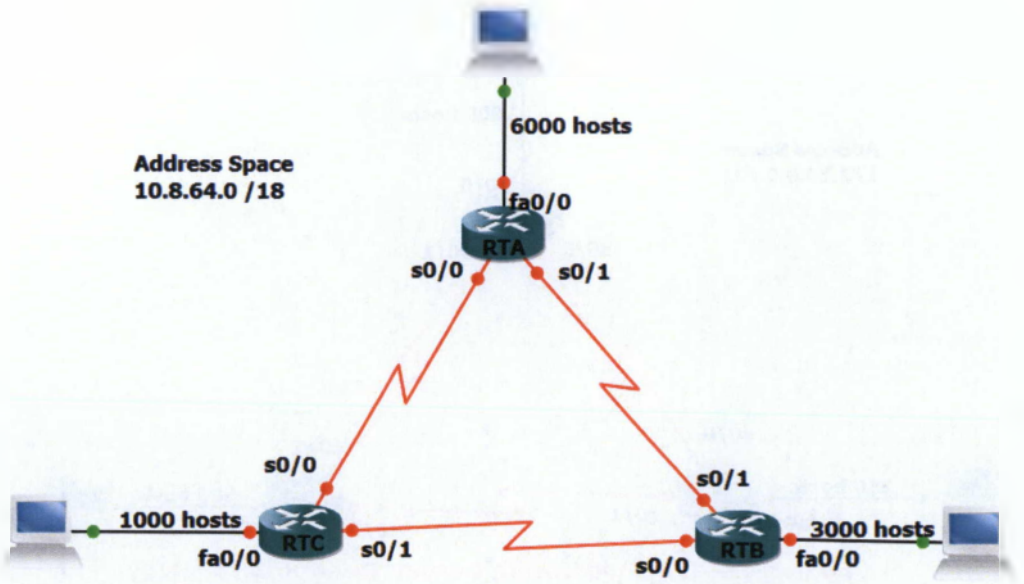
Exercise 3: Your address space is 172.24.0.0/21. The number of hosts needed for each LAN is shown in Figure 4-6. Use VLSM to create a contiguous IP addressing scheme. Label Figure 4-6 with your addressing scheme. Don't forget the WAN links. Write down the first prefixes of each subnetting.



Εικόνα 31 VLSM Addressing Design Scenario 3 Topology

Device	Interface	IP Address	Subnet Mask	Default Gateway
RTA	Fa0/0	172.24.0.1	255.255.252.0	N/A
	S0/1	172.24.7.1	255.255.255.252	N/A
	S0/0	172.24.7.5	255.255.255.252	N/A
RTB	Fa0/0	172.24.4.1	255.255.254.0	N/A
	S0/1	172.24.7.2	255.255.255.252	N/A
	S0/0	172.24.7.9	255.255.255.252	N/A
RTC	Fa0/0	172.24.6.1	255.255.255.0	N/A
	S0/1	172.24.7.10	255.255.255.252	N/A
	S0/0	172.24.7.6	255.255.255.252	N/A
Host A	N/A	172.24.0.2	255.255.252.0	172.24.0.1
Host B	N/A	172.24.4.2	255.255.254.0	172.24.4.1
Host C	N/A	172.24.6.2	255.255.255.0	172.24.6.1

Exercise 4: Your address space is 10.8.64.0/18. The number of hosts needed for each LAN is shown in Figure 4-7. Use VLSM to create a contiguous IP addressing scheme. Label Figure 4-7 with your addressing scheme. Don't forget the WAN links. Write down the first prefixes of each subnetting.

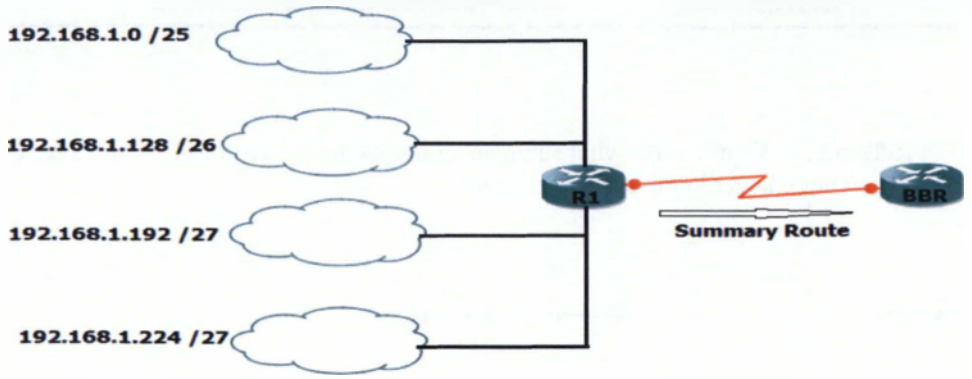


Εικόνα 32 VLSM Addressing Design Scenario 4 Topology

Device	Interface	IP Address	Subnet Mask	Default Gateway
RTA	Fa0/0	10.8.64.1	255.255.224.0	N/A
	S0/1	10.8.116.1	255.255.255.252	N/A
	S0/0	10.8.116.9	255.255.255.252	N/A
RTB	Fa0/0	10.8.96.1	255.255.240.0	N/A
	S0/1	10.8.116.2	255.255.255.252	N/A
	S0/0	10.8.116.5	255.255.255.252	N/A
RTC	Fa0/0	10.8.112.1	255.255.252.0	N/A
	S0/1	10.8.116.6	255.255.255.252	N/A
	S0/0	10.8.116.10	255.255.255.252	N/A
Host A	N/A	10.8.64.2	255.255.224.0	10.8.64.1
Host B	N/A	10.8.96.2	255.255.240.0	10.8.96.1
Host C	N/A	10.8.112.2	255.255.252.0	10.8.112.1

6.3.7 Summary Route Exercises

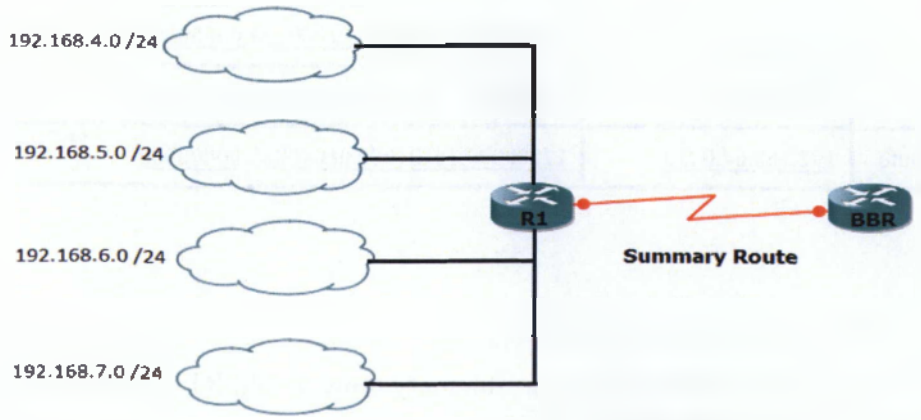
Exercise 1: Referring to Figure 1-17, what summary route would R1 send to BBR for the four networks? Write your answer in the space provided.



Εικόνα 33 Summary Route Exercise 1 Topology

	Decimal Format	Binary Format
First IP	192.168.1.0	11000000.10101000.00000001.00000000
Last IP	192.168.1.255	11000000.10101000.00000001.11111111
Summary Route	192.168.1.0 /24	11000000.10101000.00000001.00000000

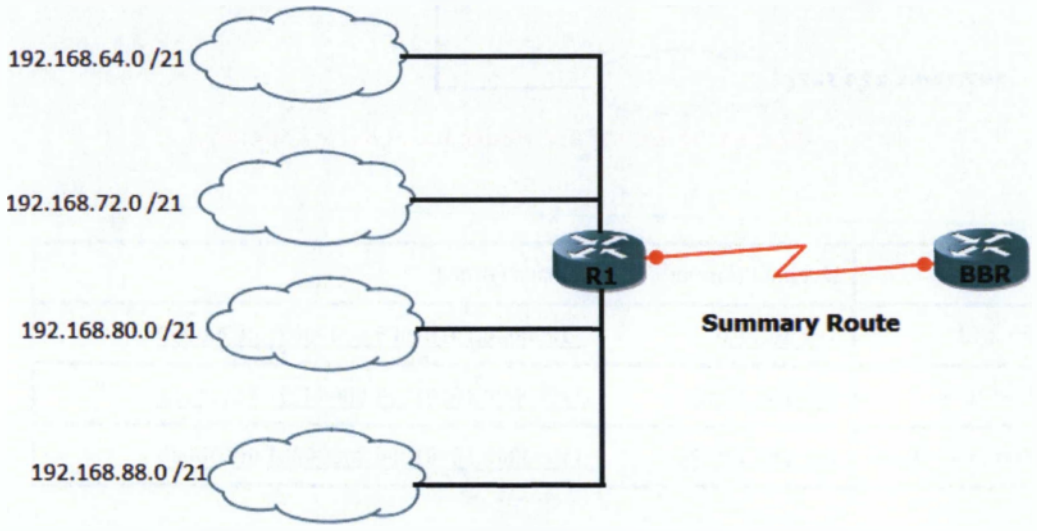
Exercise 2. Referring to Figure 1-18, what summary route would R1 send to BBR for the four networks? Write your answer in the space provided



Εικόνα 34 Summary Route Exercise 2 Topology

	Decimal Format	Binary Format
First IP	192.168.4.0	11000000.10101000.00000100.00000000
Last IP	192.168.7.255	11000000.10101000.00000111.11111111
Summary Route	192.168.4.0 /22	11000000.10101000.00000111.00000000

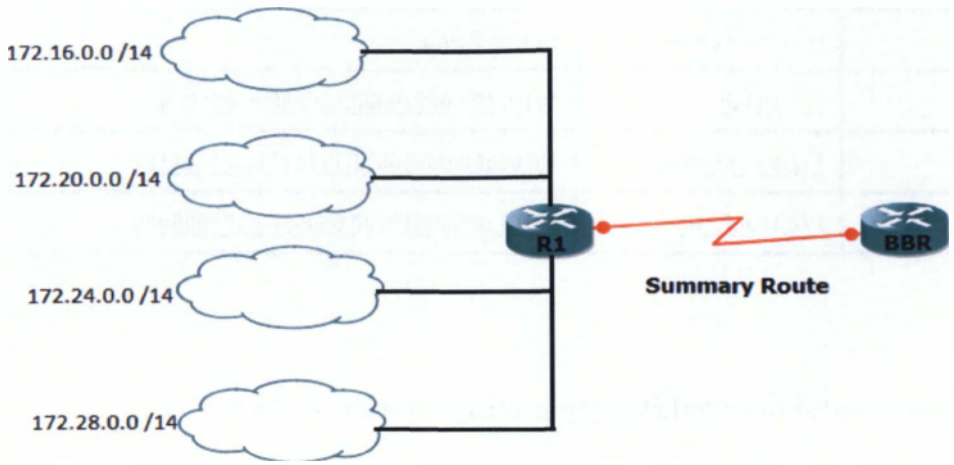
Exercise 3: Referring to Figure 1-19, what summary route would R1 send to BBR for the four networks? Write your answer in the space provided.



Εικόνα 35 Summary Route Exercise 3 Topology

	Decimal Format	Binary Format
First IP	192.168.64.0	11000000.10101000.01000000.00000000
Last IP	192.168.95.255	11000000.10101000.01010101.11111111
Summary Route	192.168.64.0 /19	11000000.10101000.01000000.00000000

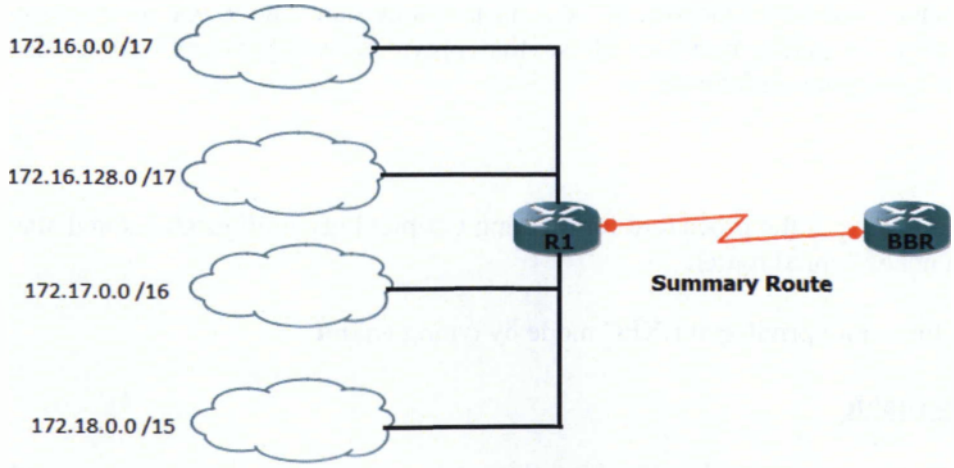
Exercise 4: Referring to Figure 1-20, what summary route would R1 send to BBR for the four networks? Write your answer in the space provided.



Εικόνα 36 Summary Route Exercise 4 Topology

	Decimal Format	Binary Format
First IP	172.16.0.0	10101100.00010000.00000000.00000000
Last IP	172.31.255.255	10101100.00011111.11111111.11111111
Summary Route	172.16.0.0 /12	10101100.00010000.00000000.00000000

Exercise 5: Referring to Figure 1-21, what summary route would R1 send to BBR for the four networks? Write your answer in the space provided.



Εικόνα 37 Summary Route Exercise 5 Topology

	Decimal Format	Binary Format
First IP	172.16.0.0	10101100.00010000.00000000.00000000
Last IP	172.19.255.255	10101100.00010011.11111111.11111111
Summary Route	172.16.0.0 /14	10101100.00010000.00000000.00000000

6.4 Cisco's Internetworking Operating System (IOS)

Η 4η ενότητα του μαθήματος καλύπτει την διαδικασία εκκίνησης, τις βασικές εντολές παραμετροποίησης και διάγνωσης λειτουργίας μέσω του Command Line Interface (CLI) αλλά και μέσω του γραφικού περιβάλλοντος του Security Device Manager (SDM) καθώς και το βασικό υλικό για ένα Cisco Router που τρέχει το λειτουργικό σύστημα IOS.

Υλοποίηση Ασκήσεων

6.4.1 Erasing and Reloading the Router

For some of the CCNA labs, it is necessary to start with a basic unconfigured router; otherwise, the configuration parameters you enter might combine with previous ones and produce unpredictable results. The instructions here allow you to prepare the router prior to performing the lab so that previous configuration options do not interfere with your configurations.

The following is the procedure for clearing out previous configurations and starting with an unconfigured router.

Step 1. Enter into privileged EXEC mode by typing **enable**.

Router>enable

If prompted for a password, enter **class**. (If that does not work, ask your instructor.)

Step 2. In privileged EXEC mode, enter the command **erase startup-config**.

Router#erase startup-config

The response from the router will be

Erasing the nvram filesystem will remove all files! Continue? [confirm]

Step 3. Press **Enter** to confirm.

The response will be

Erase of nvram: complete

Step 4. Now in privileged EXEC mode, enter the command **reload**.

Router#reload

response:

System configuration has been modified. Save? [yes/no]:

Step 5. Type **n** and then press **Enter**.

The router will respond with the following:

Proceed with reload? [confirm]

Step 6. Press **Enter** to confirm.

The first line of the response will be

Reload requested by console.

After the router reloads, the prompt will be

Would you like to enter the initial configuration dialog? [yes/no]:

Step 7. Type **n** and then press **Enter**.

The responding prompt will be

Press RETURN to get started!

Step 8. Press **Enter**.

Now, the router is ready for you to perform the assigned lab.

6.4.2 Review of Basic Router Configuration

Εικόνα 38 Basic Couter Configuration Topology

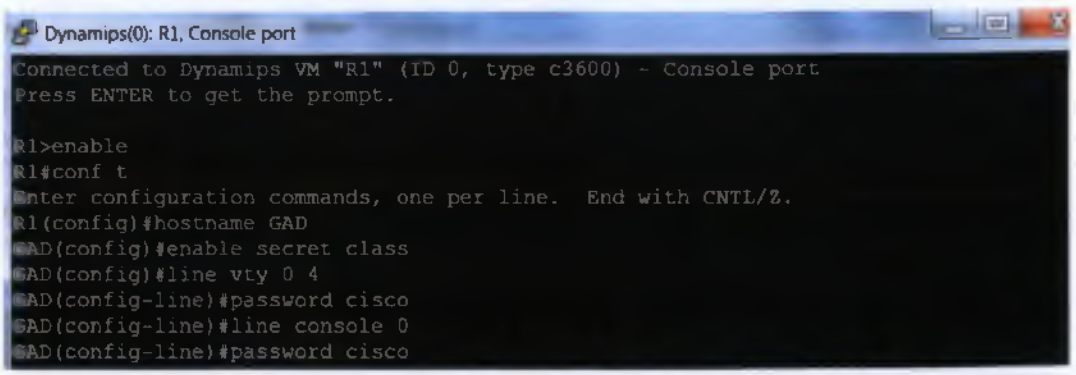
Router Designation	Router Name	Fast Ethernet 0 Address	Interface Type	Serial 0 Address
Router 1	GAD	172.16.0.1	DCE	172.17.0.1
Router 2	BHM	172.18.0.1	DTE	172.17.0.2

Πίνακας 1 Equipment Configurations

1. Cable and configure workstations and routers.
2. Set up an IP addressing scheme by using Class B networks.
3. The enable secret password for both routers is **class**.
4. The enable, VTY, and console password for each router is **cisco**.
5. The subnet mask for both interfaces on both routers is **255.255.0.0**.
6. Verify that Host1 can ping successfully to Host2.

Routers and hosts configuration

Router GAD

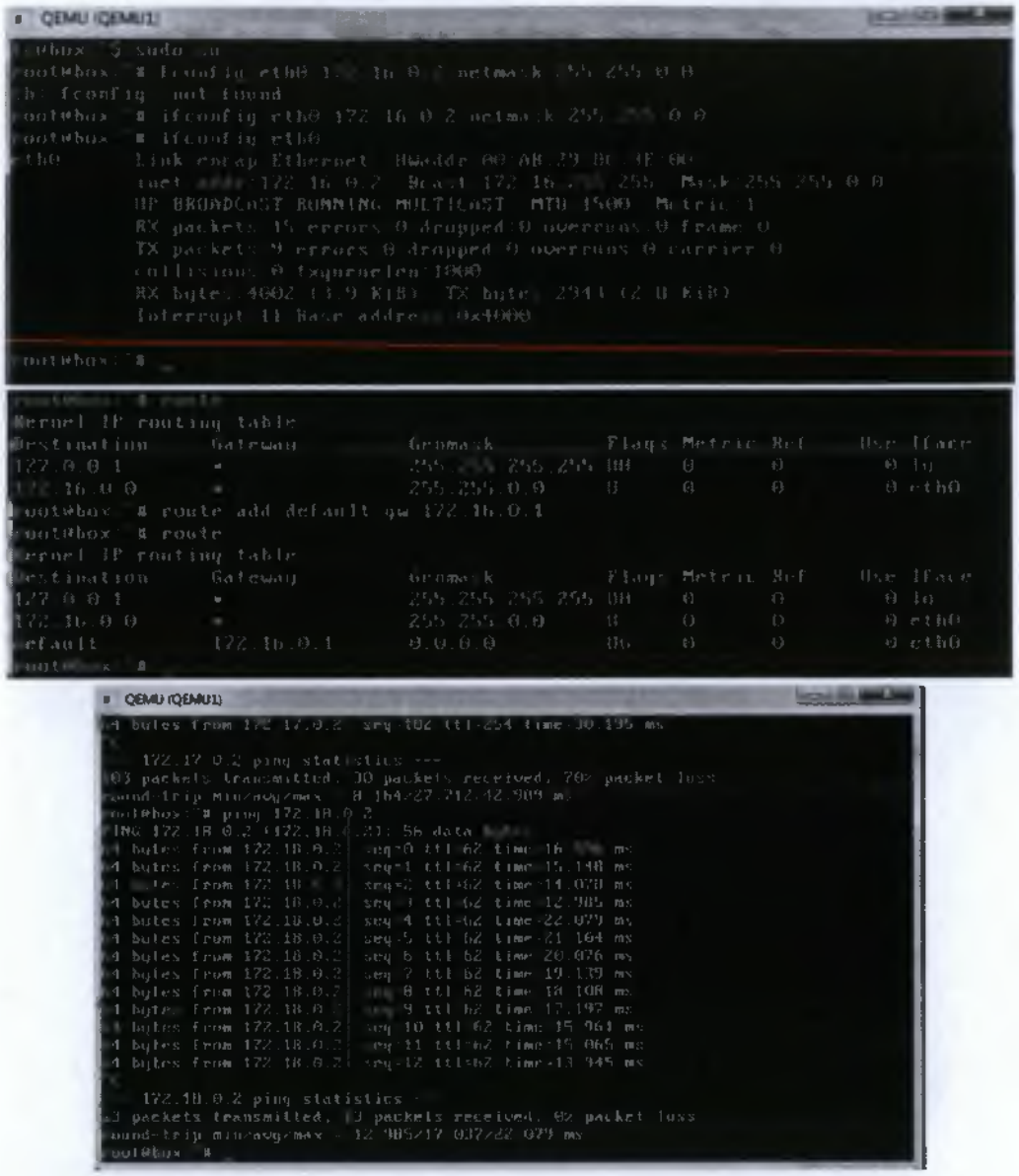


```
GAD(config)#int f1/0
GAD(config-if)#description Link To Switch!!!!
GAD(config-if)#ip address 172.16.0.1 255.255.0.0
GAD(config-if)#no shut
GAD(config-if)#int s
*Mar  1 00:07:46.495: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state t
o up
*Mar  1 00:07:47.495: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthern
et1/0, changed state to up
GAD(config-if)#int s0/0
GAD(config-if)#description Link To BHM!!!
GAD(config-if)#ip address 172.17.0.1 255.255.0.0
GAD(config-if)#no shut
GAD(config-if)#
*Mar  1 00:08:24.623: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
GAD(config-if)#
*Mar  1 00:08:25.627: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
 changed state to up
GAD(config-if)#clock rate 64000
```

Router BHM

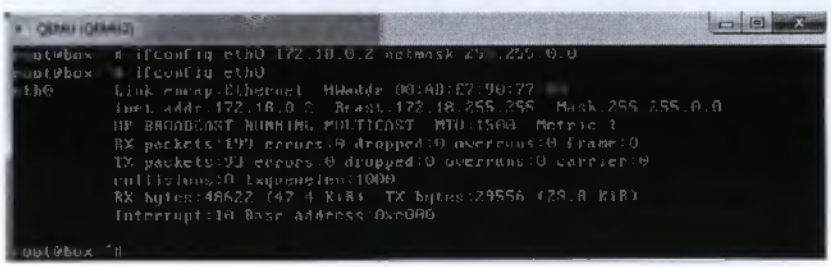
```
Dynamips(1): R2, Console port
Connected to Dynamips VM "R2" (ID 1, type c3600) - Console port
Press ENTER to get the prompt.

R2>enable
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#hostname BHM
BHM(config)#enable secret class
BHM(config)#line vty 0 4
BHM(config-line)#password cisco
BHM(config-line)#line console 0
BHM(config-line)#password cisco
BHM(config-line)#int f1/0
BHM(config-if)#description Link To Host2!!!
BHM(config-if)#ip address 172.18.0.1 255.255.0.0
BHM(config-if)#no shut
BHM(config-if)#int
*Mar  1 00:16:31.959: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed stat
o up
*Mar  1 00:16:32.959: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEt
et1/0, changed state to up
BHM(config-if)#int s0/0
BHM(config-if)#description Link To GAD!!!
BHM(config-if)#ip address 172.17.0.2 255.255.0.0
BHM(config-if)#no shut
BHM(config-if)#
*Mar  1 00:16:59.443: %LINK-3-UPDOWN: Interface Serial0/0, changed state to u
BHM(config-if)#
*Mar  1 00:17:00.447: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0
 changed state to up
BHM(config-if)#
```

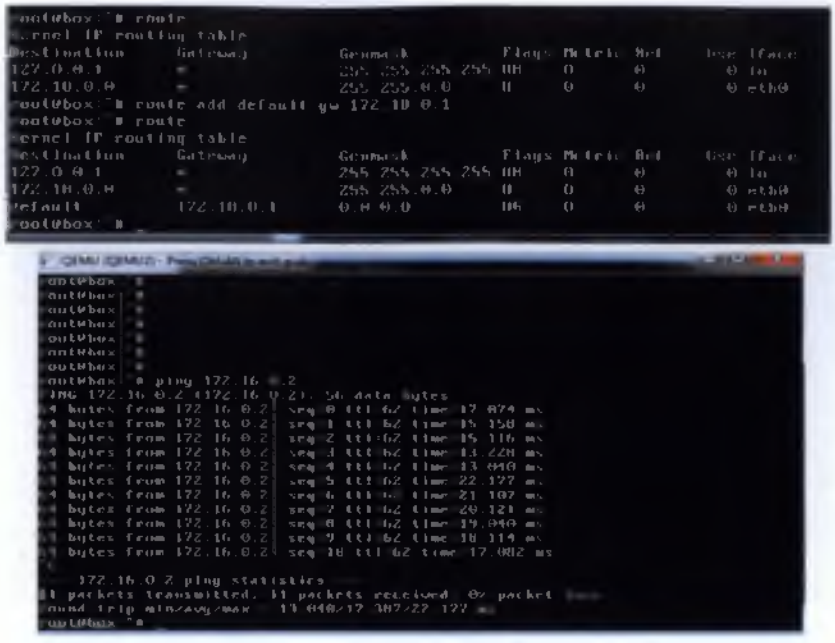
Host 1


QEMU (QEMU1)
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
172.0.0.1 * 255.255.255.255 UH 0 0 0 lo
172.16.0.0 * 255.255.0.0 U 0 0 0 eth0
root@box:~# route add default gw 172.16.0.1
root@box:~# route
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
127.0.0.1 * 255.255.255.255 UH 0 0 0 lo
172.16.0.0 * 255.255.0.0 U 0 0 0 eth0
default 172.16.0.1 0.0.0.0 UG 0 0 0 eth0
root@box:~#

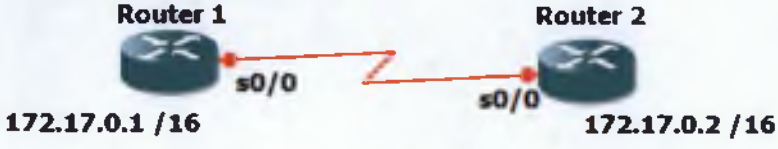
QEMU (QEMU1)
172.17.0.2 ping statistics ---
packets transmitted, 30 packets received, 70% packet loss
root@box:~# ping 172.18.0.2
PING 172.18.0.2 (172.18.0.2): 56 data bytes
64 bytes from 172.18.0.2: seq=0 ttl=62 time=16.536 ms
64 bytes from 172.18.0.2: seq=1 ttl=62 time=15.148 ms
64 bytes from 172.18.0.2: seq=2 ttl=62 time=14.078 ms
64 bytes from 172.18.0.2: seq=3 ttl=62 time=12.985 ms
64 bytes from 172.18.0.2: seq=4 ttl=62 time=22.079 ms
64 bytes from 172.18.0.2: seq=5 ttl=62 time=21.164 ms
64 bytes from 172.18.0.2: seq=6 ttl=62 time=20.076 ms
64 bytes from 172.18.0.2: seq=7 ttl=62 time=19.139 ms
64 bytes from 172.18.0.2: seq=8 ttl=62 time=18.108 ms
64 bytes from 172.18.0.2: seq=9 ttl=62 time=17.192 ms
64 bytes from 172.18.0.2: seq=10 ttl=62 time=15.961 ms
64 bytes from 172.18.0.2: seq=11 ttl=62 time=15.065 ms
64 bytes from 172.18.0.2: seq=12 ttl=62 time=13.945 ms
172.18.0.2 ping statistics ---
packets transmitted, 13 packets received, 0% packet loss
round-trip min/avg/max = 12.985/17.017/22.079 ms
root@box:~#

Host 2


QEMU (QEMU2)
root@box:~# ifconfig eth0 172.18.0.2 netmask 255.255.0.0
root@box:~# ifconfig eth0
eth0 Link encap:Ethernet HWaddr 00:AB:E7:90:77
inet addr:172.18.0.2 Bcast:172.18.255.255 Mask:255.255.0.0
UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
RX packets:297 errors:0 dropped:0 overruns:0 frame:0
TX packets:93 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:1000
RX bytes:48622 (47.4 KiB) TX bytes:29556 (28.8 KiB)
Interrupt:10 Base address:0xc040
root@box:~#



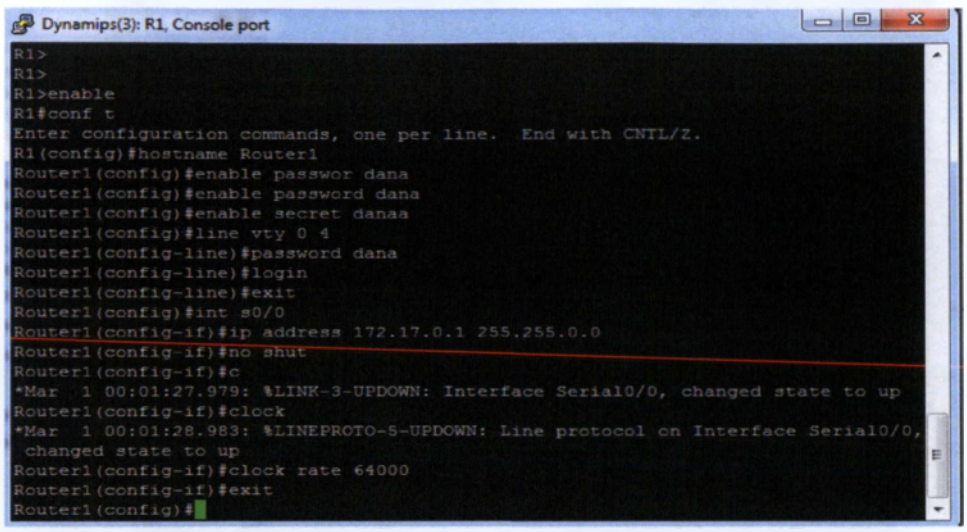
6.4.3 *Configure Telnet Remote Access*



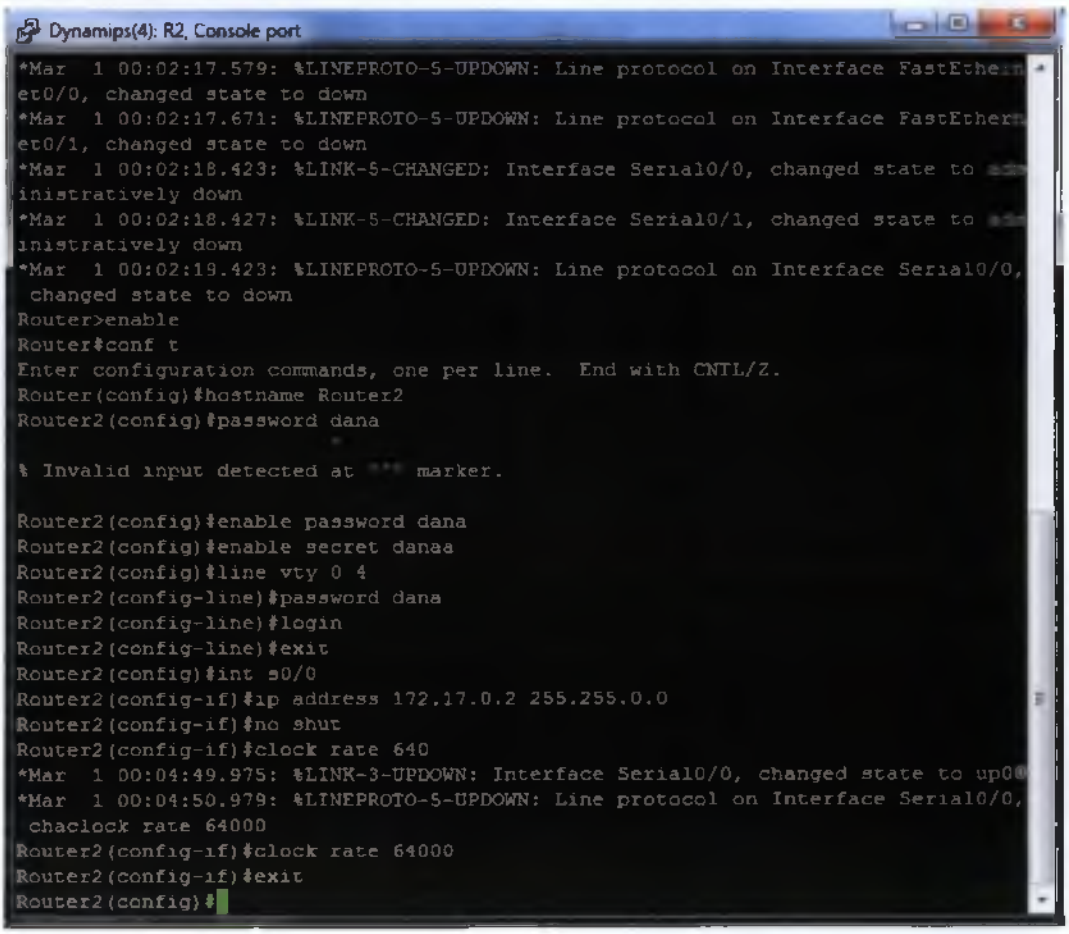
Εικόνα 39 Telnet Configuration Topology

- Configure routers names are Router 1 and Router 2.
- Set the privilege password and the vty line password on both Routers
- Configure the Serial Interface on both Routers (do not forget that one will act as DCE and the other as DTE

Router 1



Router 2



- Telnet from Router 1 to Router 2

```
Router1#telnet 172.17.0.2
Trying 172.17.0.2 ... Open


User Access Verification

Password:
Router2>
```

- View other users that telneted to Router 2

```
Router2#sh users
    Line       User       Host(s)              Idle       Location
*   0 con 0                idle                 00:00:00
  162 vty 0                idle                 00:00:20 172.17.0.1

  Interface    User               Mode         Idle     Peer Address

Router2#
```

- Create a loopback interface on either of the routers and specify an IP address

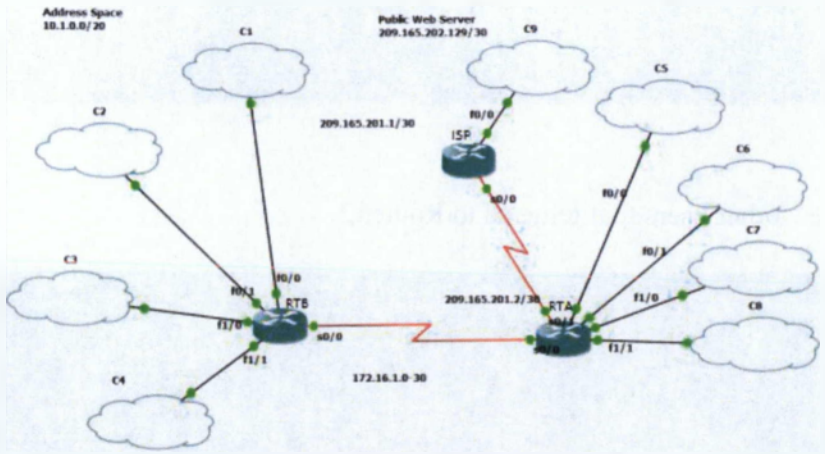
```
Router1(config)#interface loopback 1
Router1(config-if)#
*Mar  1 00:13:46.759: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1,
 changed state to up
Router1(config-if)#ip address 172.18.1.1 255.255.0.0
Router1(config-if)#end
Router1#
*Mar  1 00:23:13.371: %SYS-5-CONFIG_I: Configured from console by console
Router1#
```

```
Router2#
*Mar  1 00:25:26.927: %SYS-5-CONFIG_I: Configured from console by console
Router2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router2(config)#interface loopback 2
Router2(config-if)#ip address 172.18.0.2 255.255.0.0
Router2(config-if)#end
Router2#
*Mar  1 00:26:34.483: %SYS-5-CONFIG_I: Configured from console by console
```

```
Router1#
*Mar  1 00:23:13.371: %SYS-5-CONFIG_I: Configured from console by console
Router1#copy ru
Router1#copy running-config st
Router1#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
Router1#
```

```
Router2#copy ru
Router2#copy running-config st
Router2#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
Router2#
```

6.4.4 *VLSM Design and Router Configuration*



Εικόνα 40 VLSM Topology

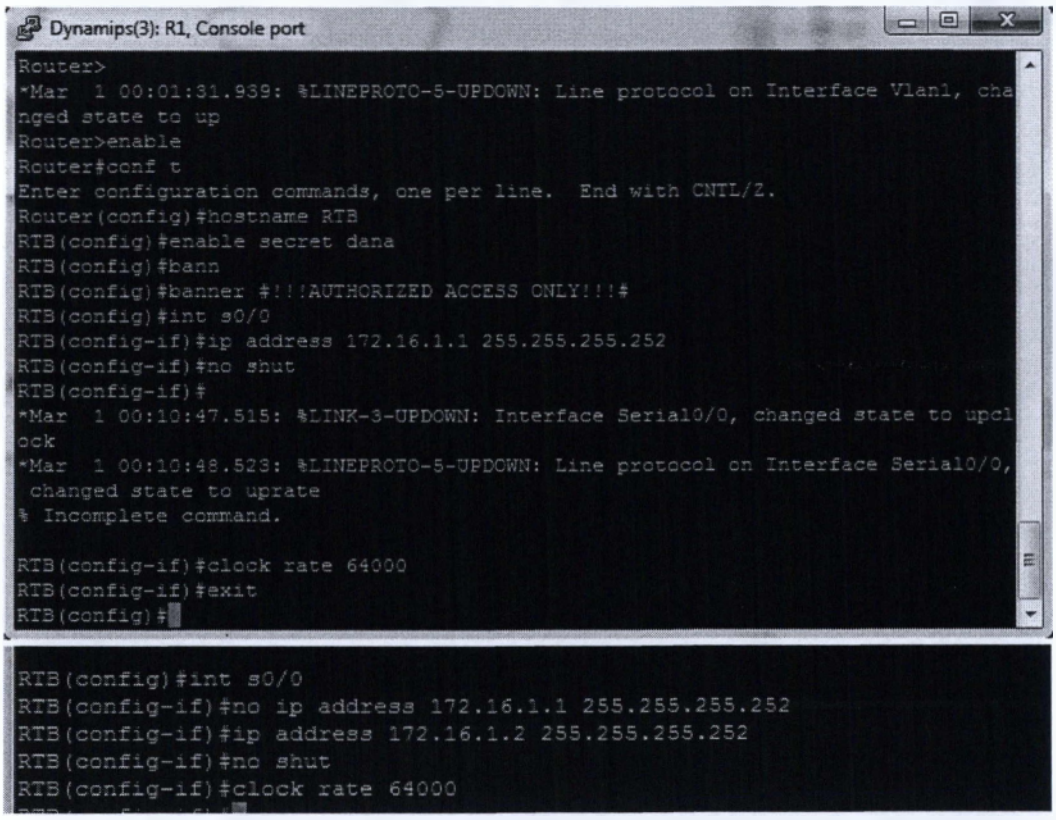
Device	Interface	IP Address	Subnet Mask
ISP	S0/0	209.165.201.1	255.255.255.252
	Lo0/0	209.165.202.129	255.255.255.252
RTA	S0/1	209.165.201.2	255.255.255.252
	S0/0	172.16.1.1	255.255.255.252
	Lo1	**10.1.4.1**	**255.255.255.128**
	Lo2	**10.1.4.129**	**255.255.255.128**
	Lo3	**10.1.5.1**	**255.255.255.128**
	Lo4	**10.1.5.129**	**255.255.255.128**
RTB	S0/1	172.16.1.2	255.255.255.252
	Lo1	**10.1.0.1**	**255.255.255.128**
	Lo2	**10.1.0.129**	**255.255.255.128**
	Lo3	**10.1.1.1**	**255.255.255.128**
	Lo4	**10.1.1.129**	**255.255.255.128**

Πίνακας 2 Subnet Addresses for VLSM Topology

RTA and RTB will share the 10.1.0.0/20 address space equally. Split the address space into two equal subnets. Record your subnets with prefix notation in the space provided.

Each simulated LAN requires a minimum of 100 host addresses. Subnet the address space for both RTA and RTB, maximizing the total number of subnets while still providing enough host addresses for each simulated LAN. You will use the first four subnets in each address space. Record your subnets with prefix notation in the space provided.

Router RTB




```
RTB(config)#int s0/0
RTB(config-if)#no ip address 172.16.1.1 255.255.255.252
RTB(config-if)#ip address 172.16.1.2 255.255.255.252
RTB(config-if)#no shut
RTB(config-if)#clock rate 64000
```


Dynamips(3): R1, Console port
RTB(config)#int
RTB(config)#interface loopback 0
RTB(config-if)#ip address 10.1.4.1 255.255.255.128
RTB(config-if)#end
RTB#c
*Mar 1 00:54:22.907: %SYS-5-CONFIG_I: Configured from console by consoleconf t
Enter configuration commands, one per line. End with CNTL/Z.
RTB(config)#int
RTB(config)#interface loo
RTB(config)#interface loopback 1
RTB(config-if)#ip address 10.1.4.129 255.255.255.128
RTB(config-if)#end
RTB#
*Mar 1 00:54:47.387: %SYS-5-CONFIG_I: Configured from console by consoleconf t
Enter configuration commands, one per line. End with CNTL/Z.
RTB(config)#ip address 10.1.5.1 255.255.255.128
% Invalid input detected at '^' marker.
RTB(config)#interface loopback 2
RTB(config-if)#ip address 10.1.5.1 255.255.255.128
*Mar 1 00:55:11.691: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback2,
changed state to up
RTB(config-if)#ip address 10.1.5.1 255.255.255.128
RTB(config-if)#end
RTB#
*Mar 1 00:55:22.191: %SYS-5-CONFIG_I: Configured from console by console
RTB#conf t
Enter configuration commands, one per line. End with CNTL/Z.
RTB(config)#int
RTB(config)#interface loop
RTB(config)#interface loopback 3
RTB(config-if)#ip address 10.1.5.1 255.255.255.128
*Mar 1 00:56:03.571: %LINEPROTO-5-UPDOWN: Line protocol on Interip address 10.1
.5.129 255.255.255.128
RTB(config-if)#end
RTB#
*Mar 1 00:56:19.783: %SYS-5-CONFIG_I: Configured from console by console
RTB#
RTB(config)#
RTB(config)#router rip
RTB(config-router)#network 10.1.4.0
RTB(config-router)#network 10.1.4.128
RTB(config-router)#network 10.1.5.0
RTB(config-router)#network 10.1.5.128
RTB(config-router)#network 172.16.1.0
RTB(config-router)#^Z
RTB#
Dynamips(3): R1, Console port
RTB#
RTB#
RTB#ping 10.1.1.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/9/36 ms
RTB#ping 10.1.1.129
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.129, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/12/56 ms
RTB#ping 10.1.0.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.0.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/8/28 ms
RTB#ping 10.1.0.129
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.0.129, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/14/56 ms
RTB#
RTB#
RTB#
RTB#
RTB#
RTB#

<u>Router RTA</u>

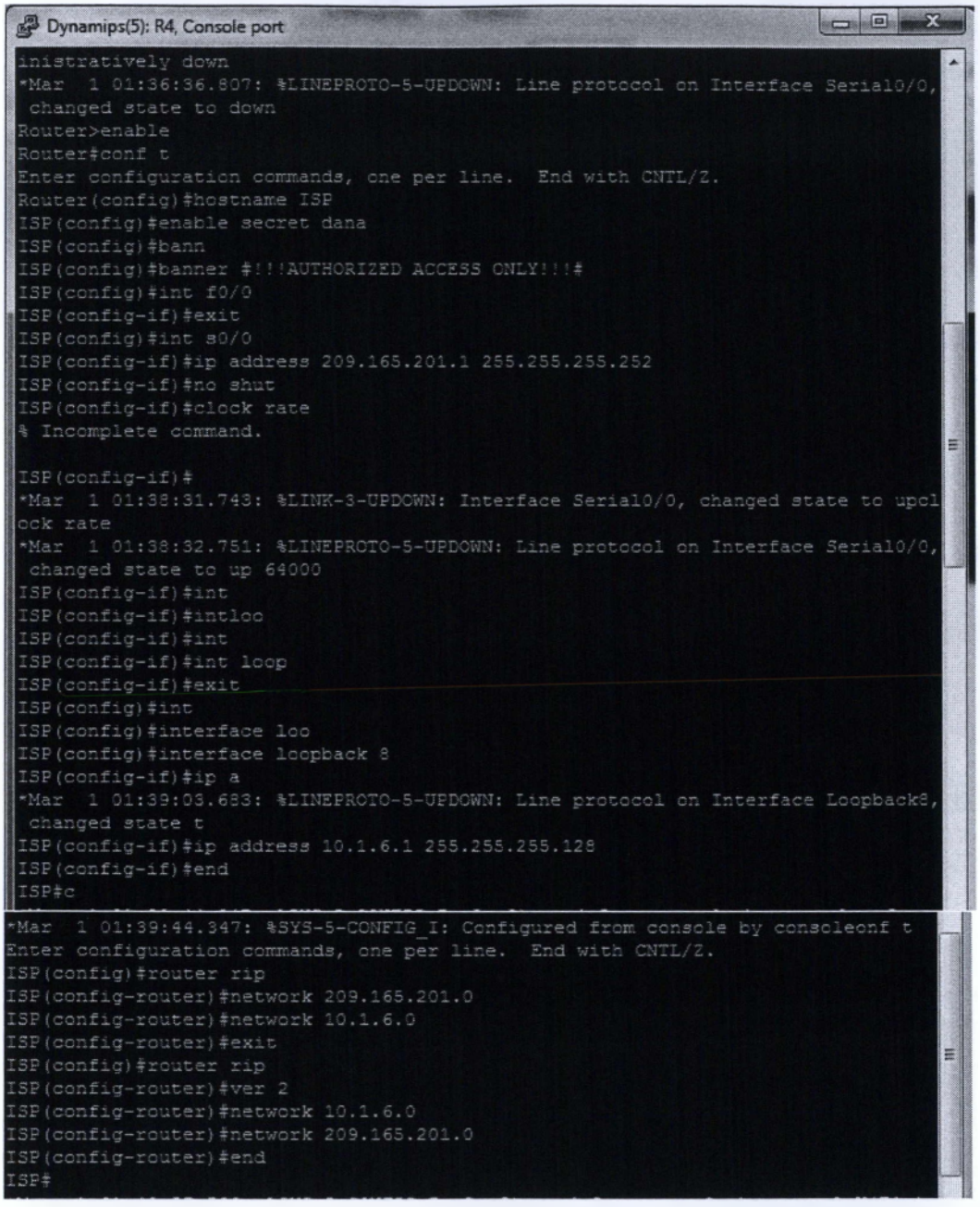
```
RTA(config)#router rip
RTA(config-router)#no network 10.1.0.0
RTA(config-router)#no network 10.1.0.128
RTA(config-router)#no network 10.1.4.0
RTA(config-router)#no network 10.1.4.128
RTA(config-router)#no network 10.1.5.0
RTA(config-router)#no network 10.1.5.128
RTA(config-router)#network 10.1.0.0
RTA(config-router)#network 10.1.0.128
RTA(config-router)#network 10.1.1.0
RTA(config-router)#network 10.1.1.128
RTA(config-router)#network 209.165.201.0
RTA(config-router)#
RTA(config-router)#^Z
```

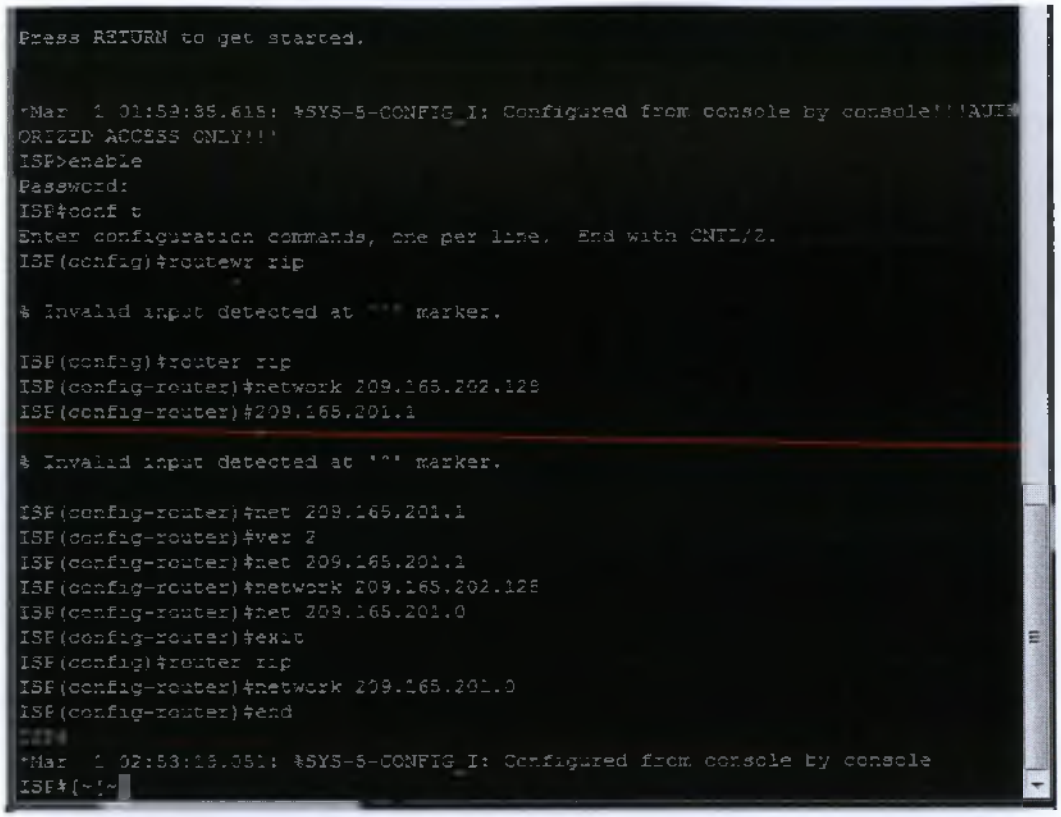
```
RTA(config)#ip subnet-zero
RTA(config)#router rip
RTA(config-router)#ver 2
RTA(config-router)#net
RTA(config-router)#network 172.16.1.0
RTA(config-router)#network 10.1.0.0
RTA(config-router)#network 10.1.0.128
RTA(config-router)#network 10.1.1.0
RTA(config-router)#network 10.1.1.128
RTA(config-router)#end
RTA#
*Mar  1 01:27:30.623: %SYS-5-CONFIG_I: Configured from console by console
RTA#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
RTA(config)#router rip
RTA(config-router)#ver 2
RTA(config-router)#net
% Incomplete command.

RTA(config-router)#net
RTA(config-router)#network 209.165.201.0
RTA(config-router)#end
RTA#
```

Dynamips(4): R2, Console port

```
RTA#
RTA#
RTA#ping 10.1.4.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.4.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/11/44 ms
RTA#ping 10.1.4.129

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.4.129, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/9/36 ms
RTA#ping 10.1.5.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.5.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/9/36 ms
RTA#ping 10.1.5.129

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.5.129, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/14/60 ms
RTA#
RTA#
```

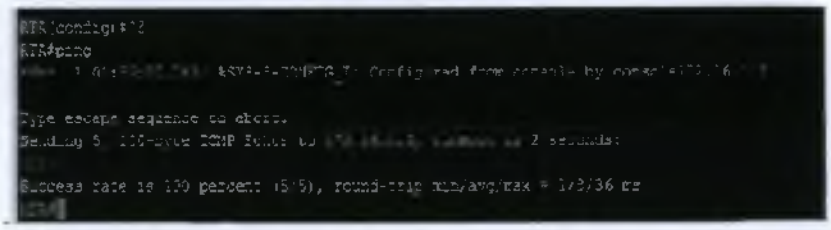
Router ISP


Dynamips(5): R4, Console port
inistratively down
*Mar 1 01:36:36.807: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to down
Router>enable
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname ISP
ISP(config)#enable secret dana
ISP(config)#bann
ISP(config)#banner #!!!AUTHORIZED ACCESS ONLY!!!#
ISP(config)#int f0/0
ISP(config-if)#exit
ISP(config)#int s0/0
ISP(config-if)#ip address 209.165.201.1 255.255.255.252
ISP(config-if)#no shut
ISP(config-if)#clock rate
% Incomplete command.
ISP(config-if)#
*Mar 1 01:38:31.743: %LINK-3-UPDOWN: Interface Serial0/0, changed state to upclock rate
*Mar 1 01:38:32.751: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up 64000
ISP(config-if)#int
ISP(config-if)#intloo
ISP(config-if)#int
ISP(config-if)#int loop
ISP(config-if)#exit
ISP(config)#int
ISP(config)#interface loo
ISP(config)#interface loopback 8
ISP(config-if)#ip a
*Mar 1 01:39:03.683: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback8, changed state t
ISP(config-if)#ip address 10.1.6.1 255.255.255.128
ISP(config-if)#end
ISP#c
*Mar 1 01:39:44.347: %SYS-5-CONFIG_I: Configured from console by consoleconf t
Enter configuration commands, one per line. End with CNTL/Z.
ISP(config)#router rip
ISP(config-router)#network 209.165.201.0
ISP(config-router)#network 10.1.6.0
ISP(config-router)#exit
ISP(config)#router rip
ISP(config-router)#ver 2
ISP(config-router)#network 10.1.6.0
ISP(config-router)#network 209.165.201.0
ISP(config-router)#end
ISP#



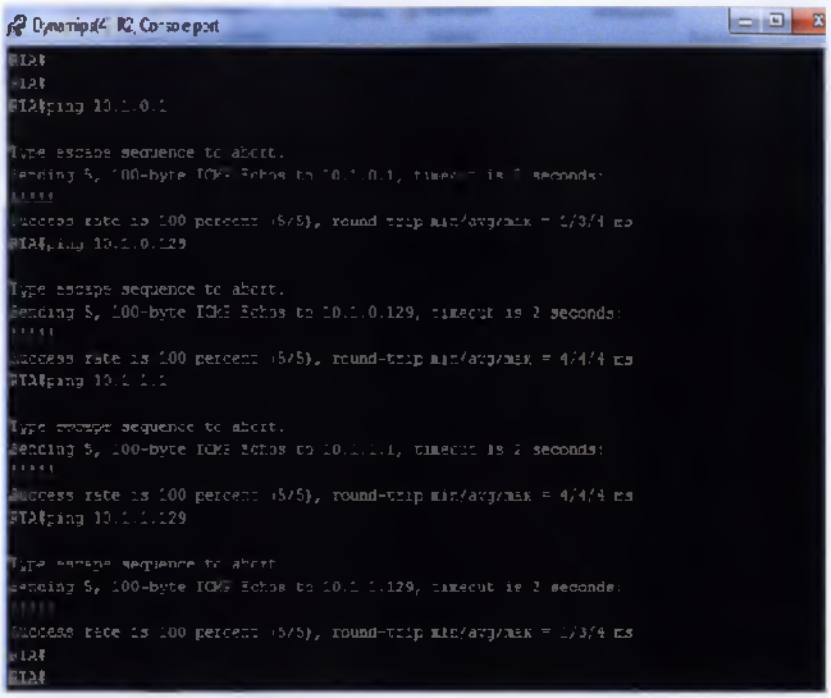
Verify connectivity

- RTA can ping RTB serial interface? **Yes**

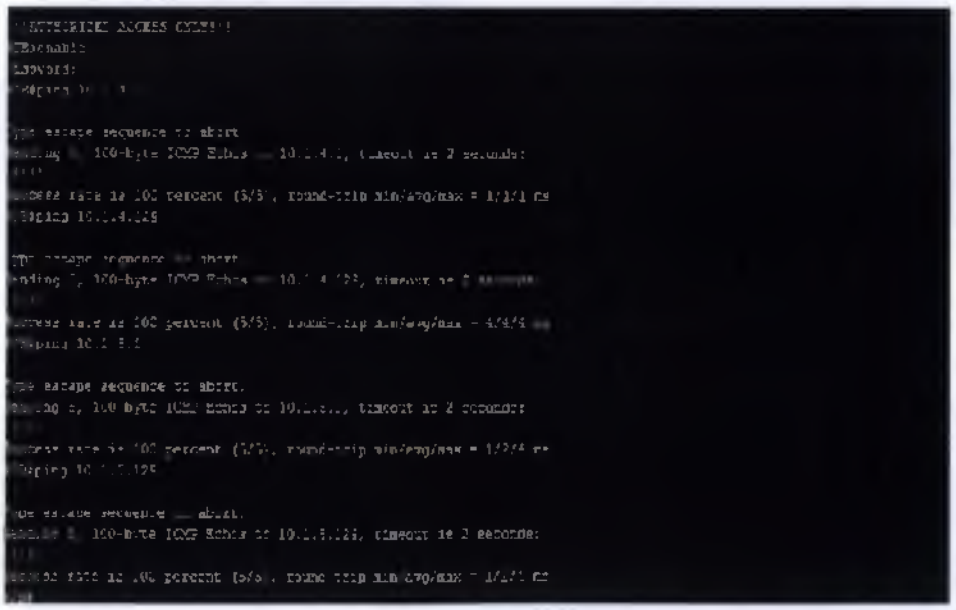


- RTA can ping ISP router? **Yes**

- RTA can ping all its local loopback interface LAN simulated IPs? **Yes**



- RTB can ping all its local loopback interface LAN simulated IPs? **Yes**

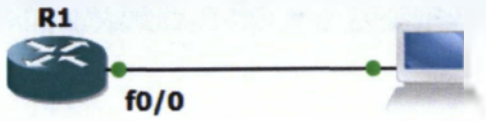


6.5 Managing a Cisco Internetwork

Η 5η ενότητα περιλαμβάνει την παραμετροποίηση, επαλήθευση και επίλυση προβλημάτων που αφορούν βασικές λειτουργίες ενός δρομολογητή, καθώς και δρομολόγηση σε συσκευές της Cisco. Περιλαμβάνει τη διαχείριση του Cisco IOS και των αρχείων παραμετροποίησής του (αποθήκευση, επεξεργασία, αναβάθμιση και αποκατάσταση). Γίνεται επαλήθευση της συνδεσιμότητας του δικτύου με διάφορες εντολές και εργαλεία.

Υλοποίηση Ασκήσεων

6.5.1 Recovering Passwords



Εικόνα 41 Recovery Passwords Topology

- Lab Requirements:

1. The router name is R1.
2. Set the password of the router to ccna and save the settings.
3. Restart the router and recover the password.

Configurations on the router

Router(config)#hostname R1
R1(config)#enable secret ccna
R1(config)#exit
R1#copy running-config startup-config
R1#reload

Recovering the password

1. Boot the router & interrupt the boot sequence by performing a break using the Ctrl+Break key combination.
2. Change the configuration register to turn on bit 6 (0x2142).

rommon>confreg 0x2142

You must reset or power cycle for new config to take effect.

3. Reload the router.

– Type **reset**

The router will reload & ask if you want to enter setup mode.

– Answer **NO**

4. Enter the privileged mode.

R1>enable
R1#

5. Copy the *startup-config* to *running-config*.

R1#copy startup-config running-config

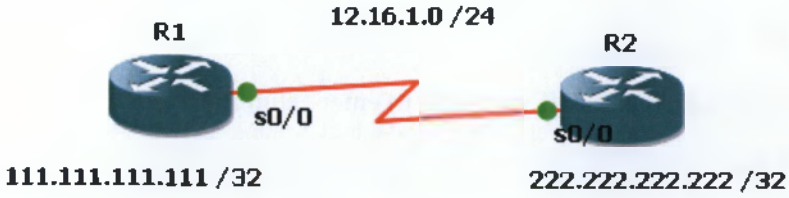
6. Change the password.
R1#config t
R1(config)#enable secret cisco

7. Reset the configuration register to the default value.

R1(config)#config-register 0x2102

8. Reload the router.
R1#reload

6.5.2 CDP Lab



Εικόνα 42 CDP Lab Topology

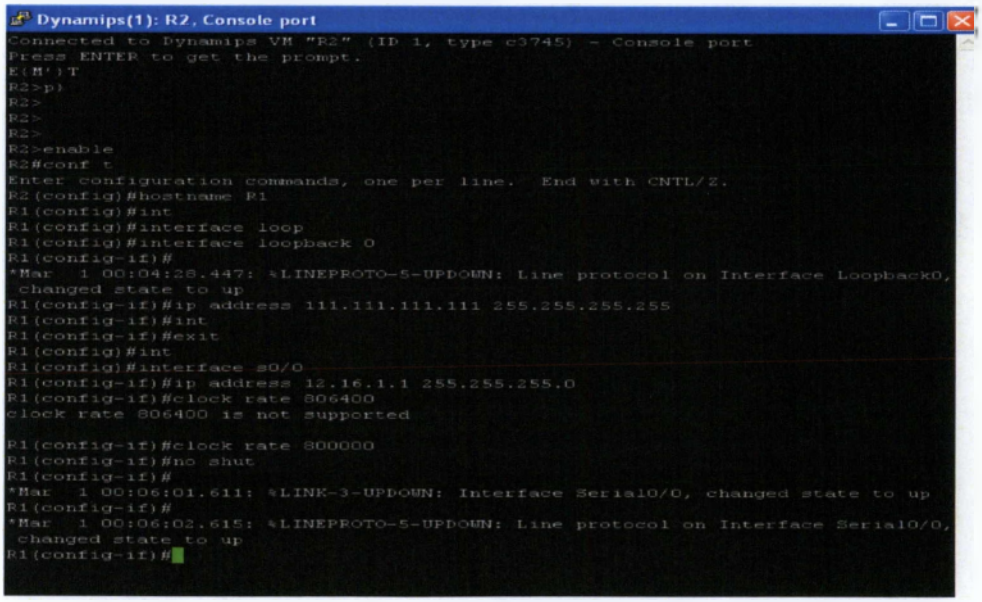
Router R1:

```
hostname R1
!
interface Loopback0
ip address 111.111.111.111 255.255.255.255
!
interface Serial0/0
ip address 12.16.1.1 255.255.255.0
clockrate 806400
no shutdown
```

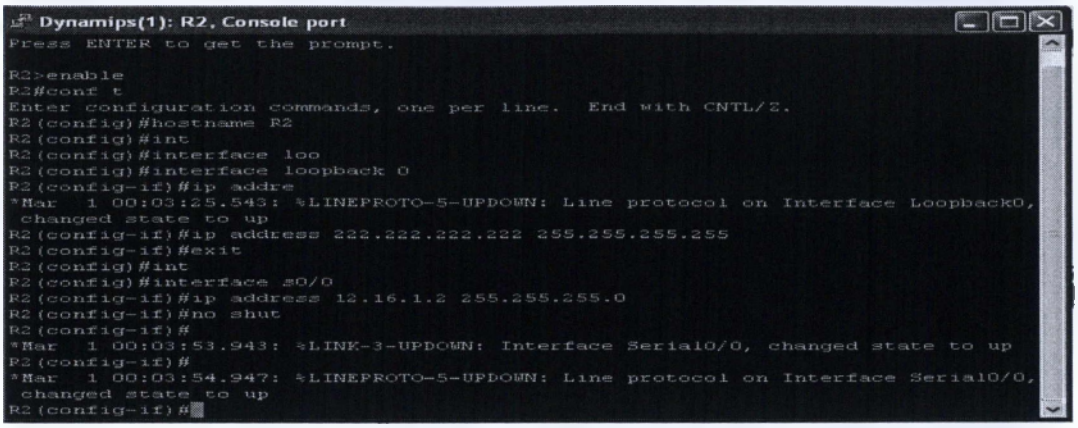
Router R2:

```
hostname R2
!
interface Loopback0
ip address 222.222.222.222 255.255.255.255
!
interface Serial0/0
ip address 12.16.1.2 255.255.255.0
no shutdown
```

Router R1



Router R2



- Display CDP information for R1 and R2.

```
R1#
R1#sh cdp
Global CDP information:
        Sending CDP packets every 60 seconds
        Sending a holdtime value of 180 seconds
        Sending CDPv2 advertisements is  enabled
```

```
R2#
R2#sh cdp
Global CDP information:
        Sending CDP packets every 60 seconds
        Sending a holdtime value of 180 seconds
        Sending CDPv2 advertisements is  enabled
R2#
```

- Display summary information about CDP neighbors for R1 and R2.

```
R1#
R1#sh cdp neighbors
Capability Codes: R - Router, T - Trans Bridge, B - Source Route Bridge
                  S - Switch, H - Host, I - IGMP, r - Repeater

Device ID        Local Intrfce     Holdtme    Capability  Platform  Port ID
R2               Ser 0/0           144         R S I      3745      Ser 0/0
R1#
```

```
R2#
R2#sh cdp neighbors
Capability Codes: R - Router, T - Trans Bridge, B - Source Route Bridge
                  S - Switch, H - Host, I - IGMP, r - Repeater

Device ID        Local Intrfce     Holdtme    Capability  Platform  Port ID
R1               Ser 0/0            139        R S I      3745      Ser 0/0
R2#
```

- Detail display detailed information about CDP neighbors for R1 and R2.

```
R1#
R1#sh cdp neighbors detail
-------------------------
Device ID: R2
Entry address(es):
  IP address: 12.16.1.2
Platform: Cisco 3745,  Capabilities: Router Switch IGMP
Interface: Serial0/0,  Port ID (outgoing port): Serial0/0
Holdtime : 164 sec

Version :
Cisco IOS Software, 3700 Software (C3745-ADVENTERPRISEK9-M), Version 12.4(25), R
ELEASE SOFTWARE (fc2)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2009 by Cisco Systems, Inc.
Compiled Tue 21-Apr-09 14:41 by prod_rel_team

advertisement version: 2
VTP Management Domain: ''

R1#
```

```
R2#
R2#sh cdp neighbors detail
-------------------------

Device ID: R1
Entry address(es):
  IP address: 12.16.1.1
Platform: Cisco 3745,  Capabilities: Router Switch IGMP
Interface: Serial0/0,  Port ID (outgoing port): Serial0/0
Holdtime : 153 sec

Version :
Cisco IOS Software, 3700 Software (C3745-ADVENTERPRISEK9-M), Version 12.4(25),
ELEASE SOFTWARE (fc2)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2009 by Cisco Systems, Inc.
Compiled Tue 21-Apr-09 14:41 by prod_rel_team

advertisement version: 2
VTP Management Domain: ''

R2#
```

- Display information about CDP data packets for R1 and R2.

```
R1#
R1#sh cdp traffic
CDP counters :
        Total packets output: 13, Input: 8
        Hdr syntax: 0, Chksum error: 0, Encaps failed: 0
        No memory: 0, Invalid packet: 0, Fragmented: 0
        CDP version 1 advertisements output: 0, Input: 0
        CDP version 2 advertisements output: 13, Input: 8
R1#
```

```
R2#sh cdp traffic
CDP counters :
        Total packets output: 32, Input: 27
        Hdr syntax: 0, Chksum error: 0, Encaps failed: 0
        No memory: 0, Invalid packet: 0, Fragmented: 0
        CDP version 1 advertisements output: 0, Input: 0
        CDP version 2 advertisements output: 32, Input: 27
R2#
```

- Display all the information about adjacent routers for R1 and R2.

```
R1#
R1#sh cdp neighbors
Capability Codes: R - Router, T - Trans Bridge, B - Source Route Bridge
                  S - Switch, H - Host, I - IGMP, r - Repeater

Device ID        Local Intrfce     Holdtme    Capability  Platform  Port ID
R2               Ser 0/0            144        R S I      3745      Ser 0/0
R1#
```

```
R2#
R2#sh cdp neighbors
Capability Codes: R - Router, T - Trans Bridge, B - Source Route Bridge
                  S - Switch, H - Host, I - IGMP, r - Repeater

Device ID        Local Intrfce     Holdtme    Capability  Platform  Port ID
R1               Ser 0/0            139        R S I      3745      Ser 0/0
R2#
```

- Configure CDP timers on R1 & R2 as follows:

R1 timer : 5s
R1 Holdtime : 15s
R2 timer: 10s
R2 holdtime:30s

```
R1(config)#cdp holdtime 15
R1(config)#cdp timer 5
```

```
R2(config)#cdp holdtime 30
R2(config)#cdp timer 10
```

- Configure R1 and R2 to insert their loopback0's IP addresses in all CDP packets.

```
R1(config)#cdp source-interface lo0
R1(config)#
R2(config)#cdp source-interface lo0
R2(config)#
```

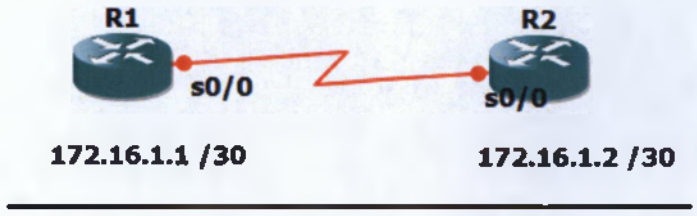
- Disable CDP on the serial0/0 interfaces

```
R1(config)#
R1(config)#int s0/0
R1(config-if)#no cdp enable
R1(config-if)#
R2(config)#int
R2(config)#interface s0/0
R2(config-if)#no cdp enable
R2(config-if)#
```

- Disable CDP on the two routers.

```
R1(config)#
R1(config)#no cdp run
R1(config)#
R2(config)#
R2(config)#no cdp run
R2(config)#
```

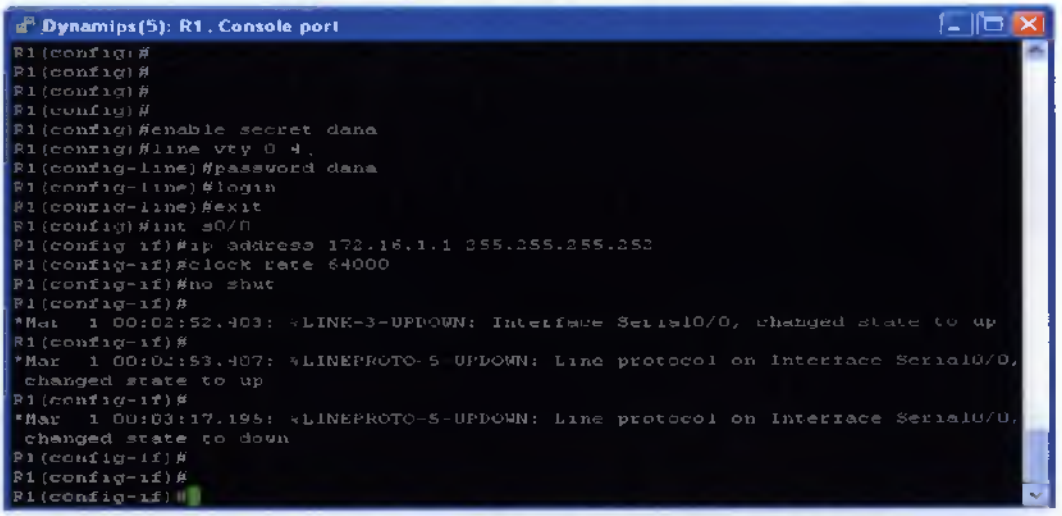
6.5.2 Host Tables and Sessions



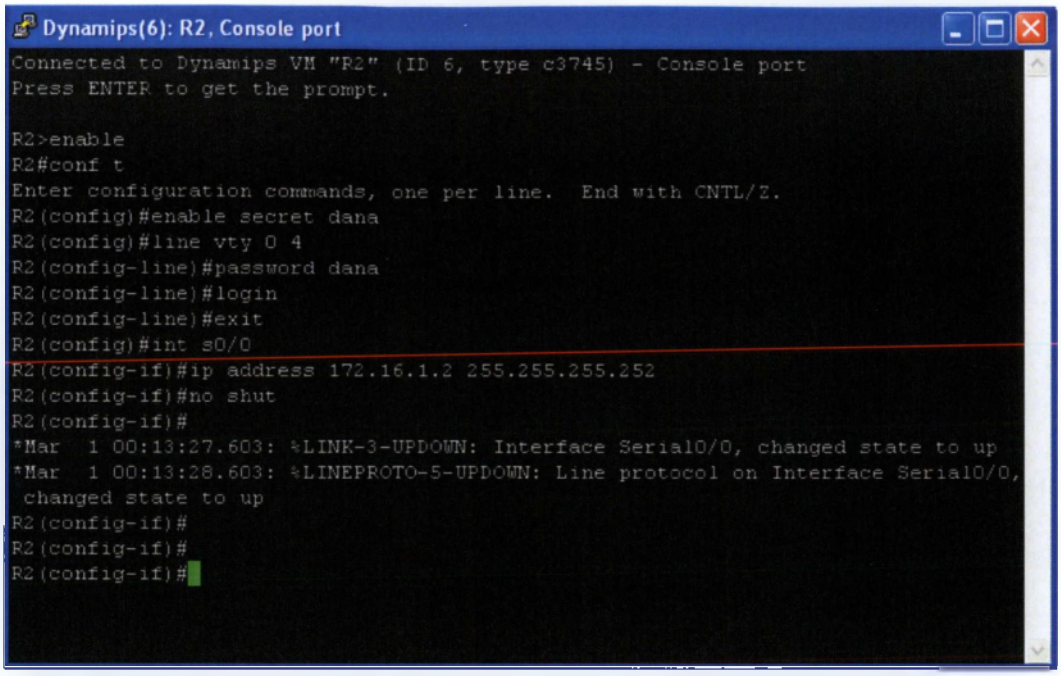
Εικόνα 43 Host Table Topology

1. Configure Routers R1 and R2 with IPs.
2. Configure VTY for R1 and R2.

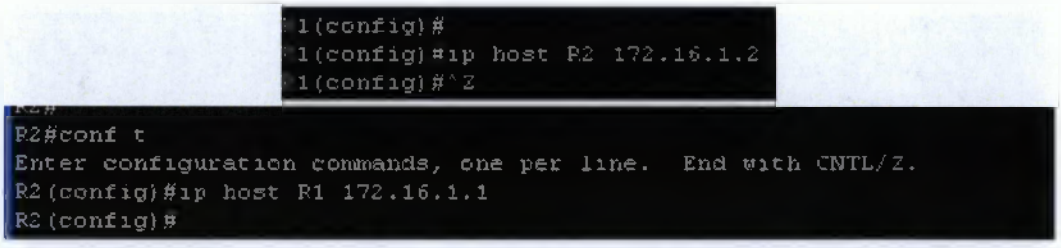
Router R1



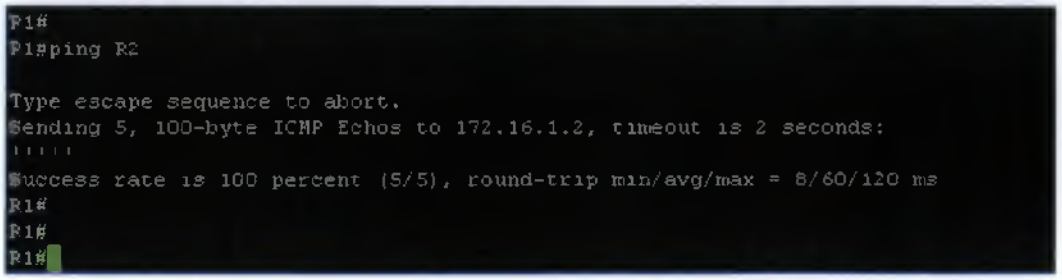
Router R2



- Configure Host Table for R1 and R2.



- Ping Routers with the hostnames.



```
R2#ping R1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/21/60 ms
R2#
```

- Display R1 and R2 host table entries.

```
R1#
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#do sh hosts
Default domain is not set
Name/address lookup uses static mappings

Codes: UN - unknown, EX - expired, OK - OK, ?? - revalidate
       temp - temporary, perm - permanent
       NA - Not Applicable None - Not defined

Host                      Port  Flags      Age Type   Address(es)
R1                        None  (perm, OK)  0   IP     172.16.1.1
R2                        None  (perm, OK)  0   IP     172.16.1.2
R1(config)#
```

```
R2#
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#
R2(config)#do sh hosts
Default domain is not set
Name/address lookup uses static mappings

Codes: UN - unknown, EX - expired, OK - OK, ?? - revalidate
       temp - temporary, perm - permanent
       NA - Not Applicable None - Not defined

Host                      Port  Flags      Age Type   Address(es)
R2                        None  (perm, OK)  0   IP     172.16.1.2
R1                        None  (perm, OK)  0   IP     172.16.1.1
R2(config)#
```

- Telnet from R1 to R2.

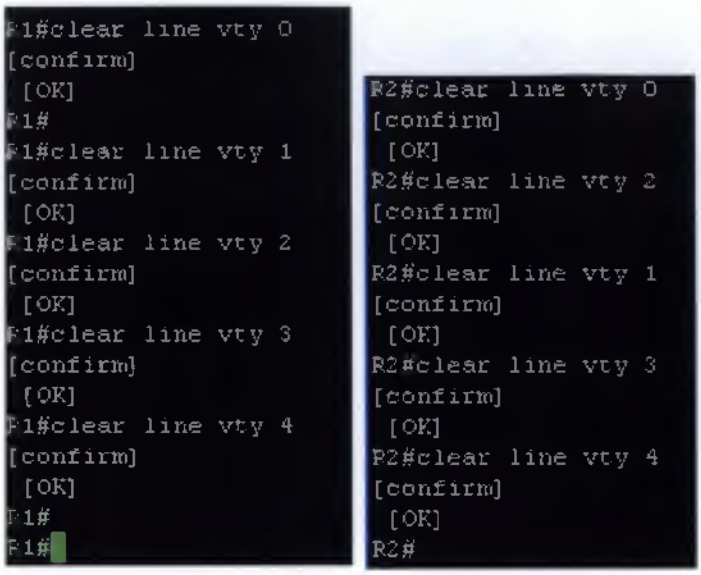
```
R1>
R1>
R1>enable
Password:
R1#telnet R2
Trying R2 (172.16.1.2)... Open


User Access Verification

Password:
R2>
R2>
R2>exit

[Connection to R2 closed by foreign host]
R1#
R1#
```

- Display users.

```
R2>enable
Password:
R2#sh users
    Line       User       Host(s)              Idle       Location
*162 vty 0                 idle                 00:00:00 172.16.1.1

  Interface    User               Mode         Idle     Peer Address

R2#
```

```
R1#sh users
    Line       User       Host(s)              Idle       Location
   0 con 0                 R2                   00:01:13
*162 vty 0                 idle                 00:00:00 R2

  Interface    User               Mode         Idle     Peer Address

R1#
```

- Kill VTY user.



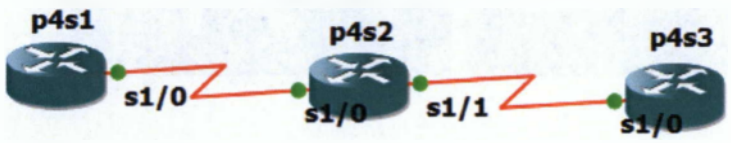
- Remove host entries from R1 and R2 host tables.

6.6 IP Routing

Η ενότητα αυτή καλύπτει λεπτομερώς την IP δρομολόγηση. Αναλύει την παραμετροποίησή της (static routing, καθώς και dynamic routing πρωτόκολλα όπως το RIPv1 και RIPv2) και πως χρησιμοποιεί frames για να μεταφέρει τα πακέτα μεταξύ των δρομολογητών και των hosts.

Υλοποίηση Ασκήσεων

6.6.1 Configure Static and Default Route



Εικόνα 44 Static And Default Route Topology

- The router names are **p4s1**, **p4s2** and **p4s3**.

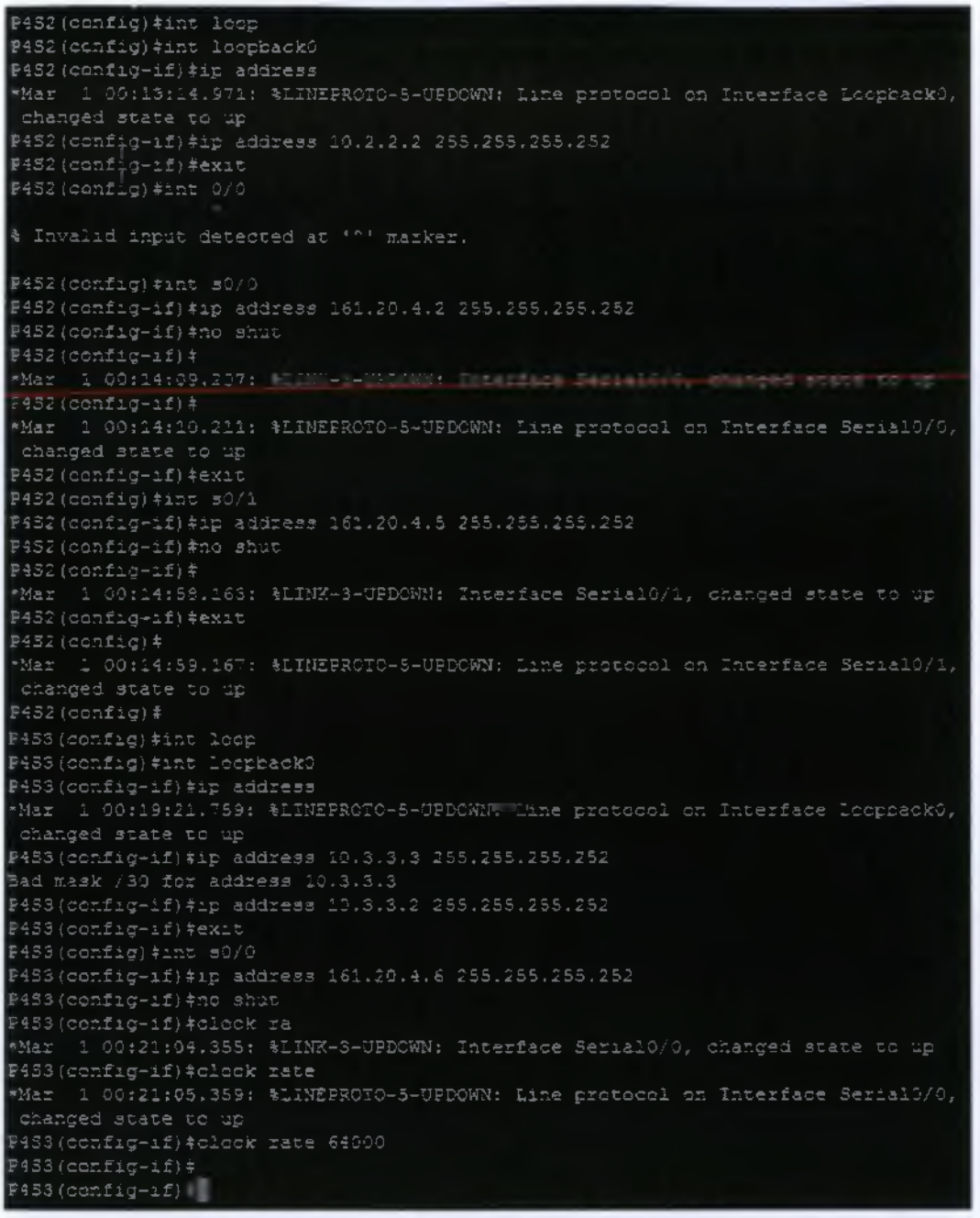
```
Dynamips(0): R1, Console port
Connected to Dynamips VM "R1" (ID 0, type c3745) - Console port
Press ENTER to get the prompt.

R1>enable
R1#conf t
Enter configuration commands, one per line.  End with CNTL/2.
R1(config)#hostname P4S1
P4S1(config)#enable secret dana
```

```
Dynamips(1): R2, Console port
Connected to Dynamips VM "R2" (ID 1, type c3745) - Console port
Press ENTER to get the prompt.

R2>enable
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#hostname P452
P452(config)#enable secret dana
```

```
Dynamips(2): R3, Console port
Connected to Dynamips VM "R3" (ID 2, type c3745) - Console port
Press ENTER to get the prompt.

R3>enable
R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#hostname P453
P453(config)#
```

- Configure routers with IPs and loopbacks.

```
P451(config)#int loop
P451(config)#int loopback0
P451(config-if)#ip add
*Mar  1 00:10:15.871: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
 changed state to up
P451(config-if)#ip address 10.1.1.1 255.255.255.252
P451(config-if)#exit
P451(config)#int s0/0
P451(config-if)#ip address 161.20.4.1
% Incomplete command.

P451(config-if)#ip address 161.20.4.1 255.255.255.252
P451(config-if)#no shut
P451(config-if)#clock rate
*Mar  1 00:11:33.539: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
P451(config-if)#clock rate 64000
*Mar  1 00:11:34.543: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
 changed state to up
P451(config-if)#clock rate 64000
P451(config-if)#^Z
P451#
```


P452(config)#int loop
P452(config)#int loopback0
P452(config-if)#ip address
*Mar 1 00:13:14.971: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
changed state to up
P452(config-if)#ip address 10.2.2.2 255.255.255.252
P452(config-if)#exit
P452(config)#int 0/0
% Invalid input detected at '^' marker.
P452(config)#int s0/0
P452(config-if)#ip address 161.20.4.2 255.255.255.252
P452(config-if)#no shut
P452(config-if)#
*Mar 1 00:14:09.207:
P452(config-if)#
*Mar 1 00:14:10.211: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
changed state to up
P452(config-if)#exit
P452(config)#int s0/1
P452(config-if)#ip address 161.20.4.5 255.255.255.252
P452(config-if)#no shut
P452(config-if)#
*Mar 1 00:14:58.163: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up
P452(config-if)#exit
P452(config)#
*Mar 1 00:14:59.167: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1,
changed state to up
P452(config)#
P453(config)#int loop
P453(config)#int loopback0
P453(config-if)#ip address
*Mar 1 00:19:21.759: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
changed state to up
P453(config-if)#ip address 10.3.3.3 255.255.255.252
Bad mask /30 for address 10.3.3.3
P453(config-if)#ip address 10.3.3.2 255.255.255.252
P453(config-if)#exit
P453(config)#int s0/0
P453(config-if)#ip address 161.20.4.6 255.255.255.252
P453(config-if)#no shut
P453(config-if)#clock ra
*Mar 1 00:21:04.355: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
P453(config-if)#clock rate
*Mar 1 00:21:05.359: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
changed state to up
P453(config-if)#clock rate 64000
P453(config-if)#
P453(config-if)#

- Configure default routes on p4s1 and p4s3.

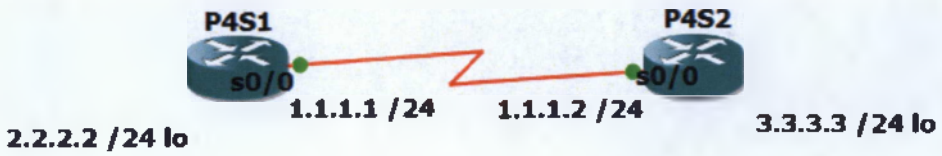
```
P4S1(config)#
P4S1(config)#ip route 0.0.0.0 0.0.0.0 161.20.4.2
P4S1(config)#ip class
P4S1(config)#ip classless
P4S1(config)#do show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is 161.20.4.2 to network 0.0.0.0

     10.0.0.0/30 is subnetted, 1 subnets
C       10.1.1.0 is directly connected, Loopback0
     161.20.0.0/30 is subnetted, 1 subnets
C       161.20.4.0 is directly connected, Serial0/0
S*   0.0.0.0/0 [1/0] via 161.20.4.2
P4S1(config)#
```

```
P4S3#
P4S3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
P4S3(config)#ip route 0.0.0.0 0.0.0.0 161.20.4.5
P4S3(config)#ip class
P4S3(config)#ip classless
P4S3(config)#do show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is 161.20.4.5 to network 0.0.0.0

     10.0.0.0/30 is subnetted, 1 subnets
C       10.3.3.0 is directly connected, Loopback0
     161.20.0.0/30 is subnetted, 1 subnets
C       161.20.4.4 is directly connected, Serial0/0
S*   0.0.0.0/0 [1/0] via 161.20.4.5
P4S3(config)#
```

- Configure a static route on p4s2.

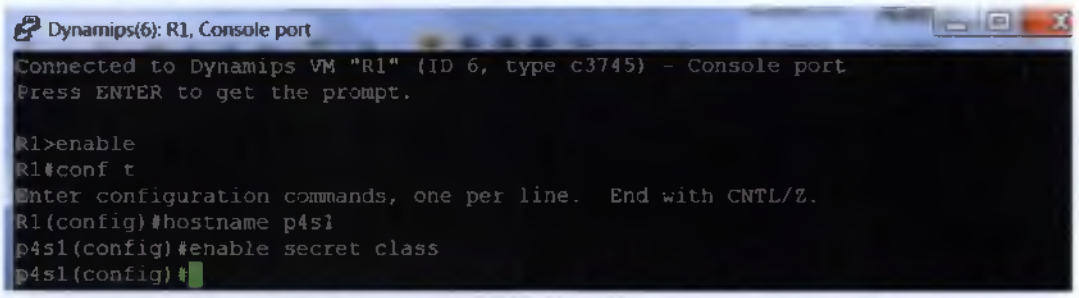
```
P4S2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
P4S2(config)#ip route 161.20.4.0 255.255.255.252 161.20.4.1
P4S2(config)#ip route 161.20.4.4 255.255.255.252 161.20.4.6
P4S2(config)#
P4S2(config)#
P4S2(config)#show ip route

% Invalid input detected at '^' marker.

P4S2(config)#^Z
P4S2#
*Mar  1 01:06:22.107: %SYS-5-CONFIG_I: Configured from console by console
P4S2#
P4S2#
P4S2#
P4S2#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/30 is subnetted, 1 subnets
C       10.2.2.0 is directly connected, Loopback0
     161.20.0.0/30 is subnetted, 2 subnets
C       161.20.4.0 is directly connected, Serial0/0
C       161.20.4.4 is directly connected, Serial0/1
P4S2#
```

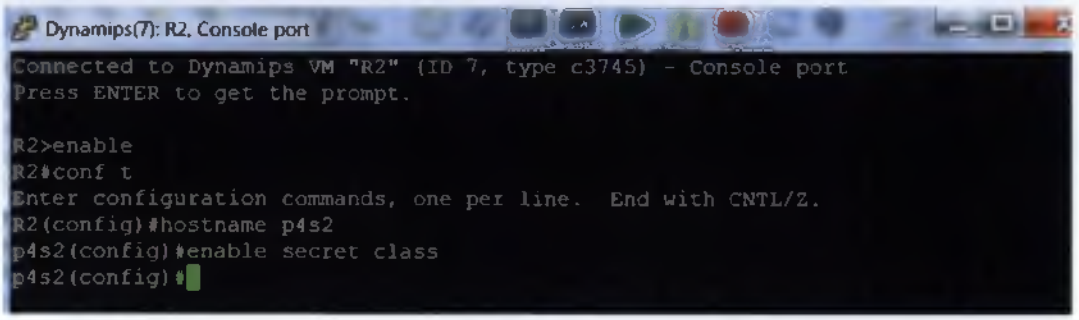
6.6.2 Configure RIPv1 Dynamic Route (Part 1)



Εικόνα 45 RIPv1 (Part1) Topology

- The router names are **p4s1** and **p4s2**.





- Configure the routers with ips and loopbacks.

Router p4s1

```
p4s1(config)#
p4s1(config)#int loopback0
p4s1(config-if)#ip address 2.2.2.2 255.255.255.0
p4s1(config-if)#int s0/0
p4s1(config-if)#ip address 1.1.1.1 255.255.255.0
p4s1(config-if)#no shut
p4s1(config-if)#clock rate
*Mar  1 00:11:07.223: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
p4s1(config-if)#clock rate 5
*Mar  1 00:11:08.687: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
 changed state to up
p4s1(config-if)#clock rate 64000
p4s1(config-if)#
```

Router p4s2

```
p4s2(config)#int loopback0
p4s2(config-if)#ip
*Mar  1 00:08:31.475: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
 changed state to up
p4s2(config-if)#ip address 3.3.3.3 255.255.255.0
p4s2(config-if)#int s0/0
p4s2(config-if)#ip address 1.1.1.2 255.255.255.0
p4s2(config-if)#no shut
p4s2(config-if)#
*Mar  1 00:09:21.207: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
p4s2(config-if)#
*Mar  1 00:09:22.211: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
 changed state to up
p4s2(config-if)#
p4s2(config-if)#
p4s2(config-if)#
```

- Start the RIP routing protocol on both routers.

```
P4S1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
P4S1(config)#router rip
P4S1(config-router)#network 3.3.3.0
P4S1(config-router)#version 2
P4S1(config-router)#exit
P4S1(config)#^Z
P4S1#ping
*Mar  1 01:37:26.579: %SYS-5-CONFIG_I: Configured from console by console
```

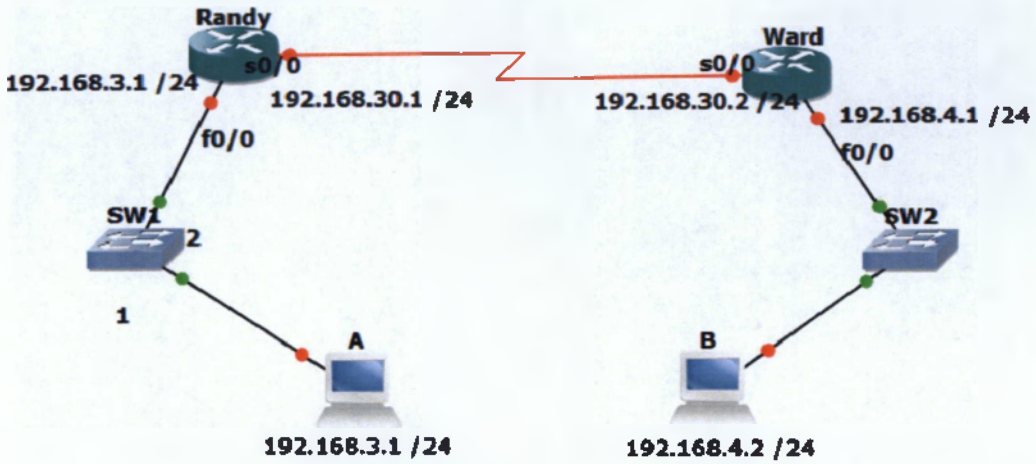
```
P4S2#
P4S2#conf t
Enter configuration commands, one per line.  End with CNTL/2.
P4S2(config)#router rip
P4S2(config-router)#network 2.2.2.0
P4S2(config-router)#version 2
P4S2(config-router)#exit
P4S2(config)#^Z
P4S2#
*Mar  1 01:39:05.963: %SYS-5-CONFIG_I: Configured from console by console
```

- View the routing table on the router and run the **ping** command to test connectivity for both loopback IPs and Interface IPs.

```
Dynamips(0): R1, Console port
P4S1#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     1.0.0.0/24 is subnetted, 1 subnets
C       1.1.1.0 is directly connected, Serial0/0
     2.0.0.0/24 is subnetted, 1 subnets
C       2.2.2.0 is directly connected, Loopback0
R    3.0.0.0/8 [120/1] via 1.1.1.2, 00:00:21, Serial0/0
P4S1#
P4S1#
P4S1#ping 3.3.3.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/5/20 ms
P4S1#ping 1.1.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 1.1.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/6/16 ms
P4S1#
P4S1#ping 2.2.2.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
P4S1#
```

```
P452#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     1.0.0.0/24 is subnetted, 1 subnets
C       1.1.1.0 is directly connected, Serial0/0
R    2.0.0.0/8 [120/1] via 1.1.1.1, 00:00:21, Serial0/0
     3.0.0.0/24 is subnetted, 1 subnets
C       3.3.3.0 is directly connected, Loopback0
P452#
P452#ping 3.3.3.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
P452#ping 2.2.2.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/6/20 ms
P452#ping 1.1.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 1.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/6/16 ms
P452#
```

6.6.3 Configure RIPv1 Dynamic Route (Part 2)



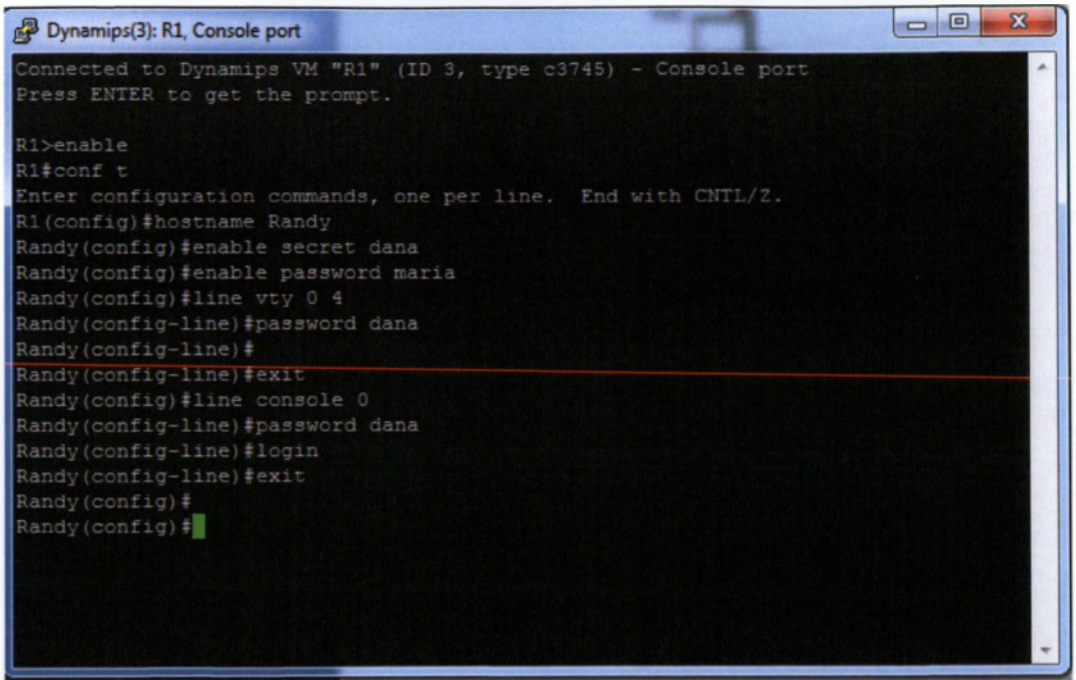
Εικόνα 46 RIPv1 (Part2) Topology

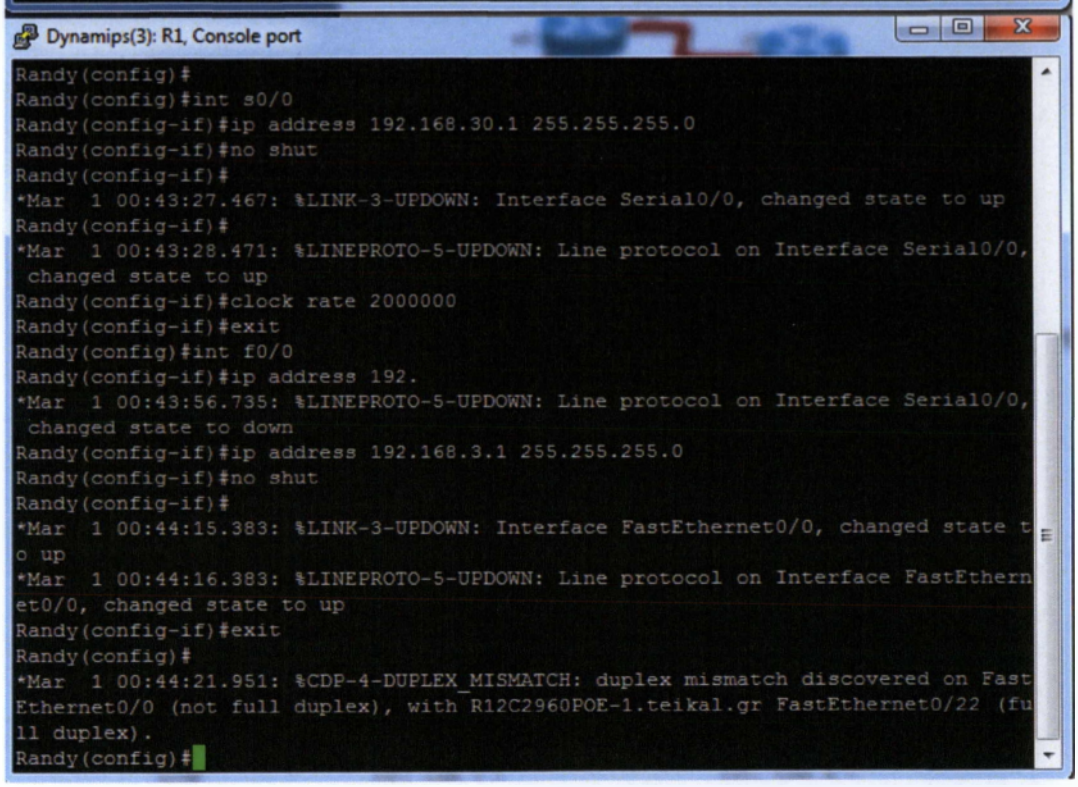
Addressing:

Routers		
Hostnames	Randy	Ward
E0	192.168.3.1 /24	192.168.4.1 /24
S0	192.168.30.1 /24 (DCE)	n/a
S0	n/a	192.168.30.2 /24 (DTE)
Workstations	A	B
IP	192.168.3.2	192.168.4.2
SM	255.255.255.0	255.255.255.0
GW	192.168.3.1	192.168.4.1

- Set up the "router basics" on each router (VTY, Passwords etc.).
- Configure the interfaces on each router.
- Configure RIP routing protocol on each router.

Router Randy

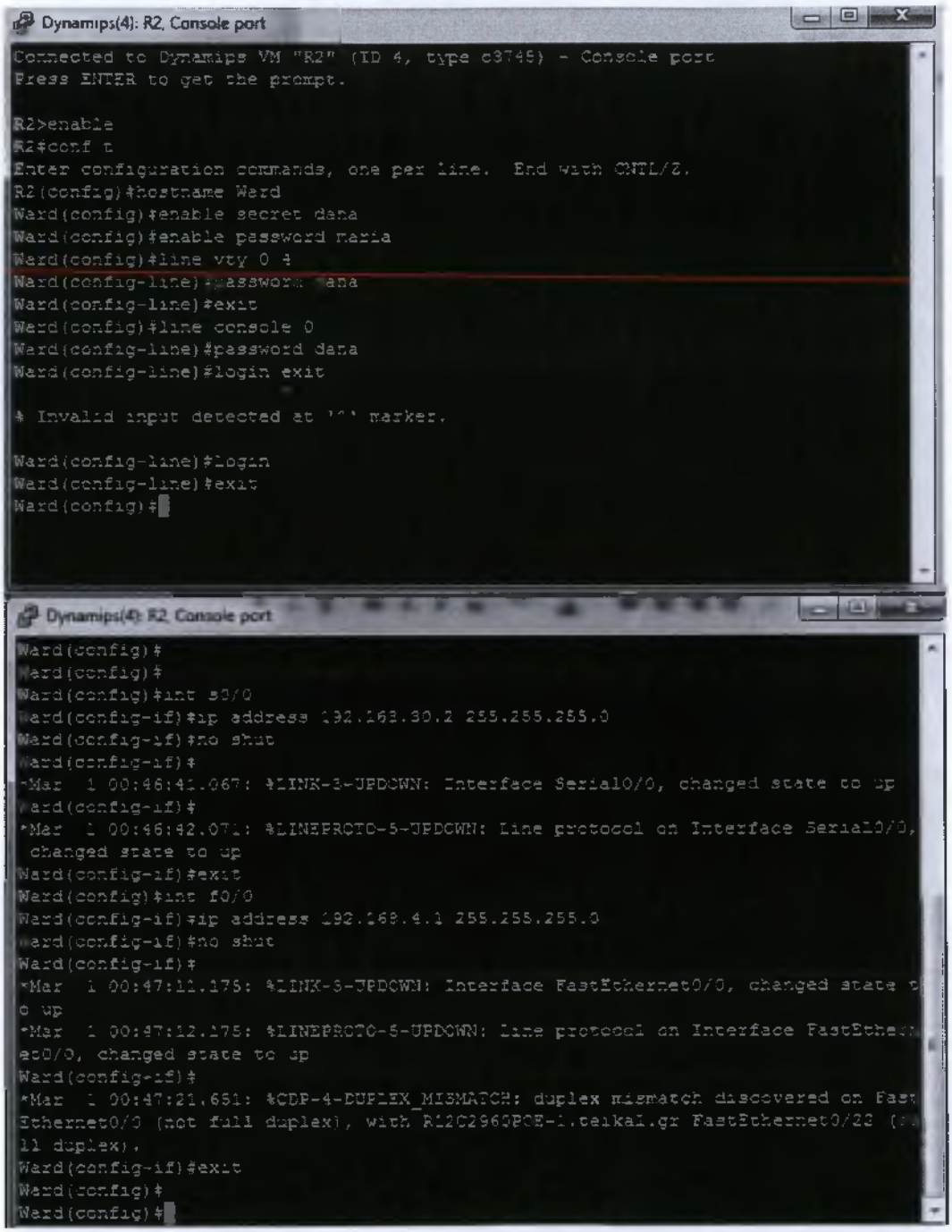


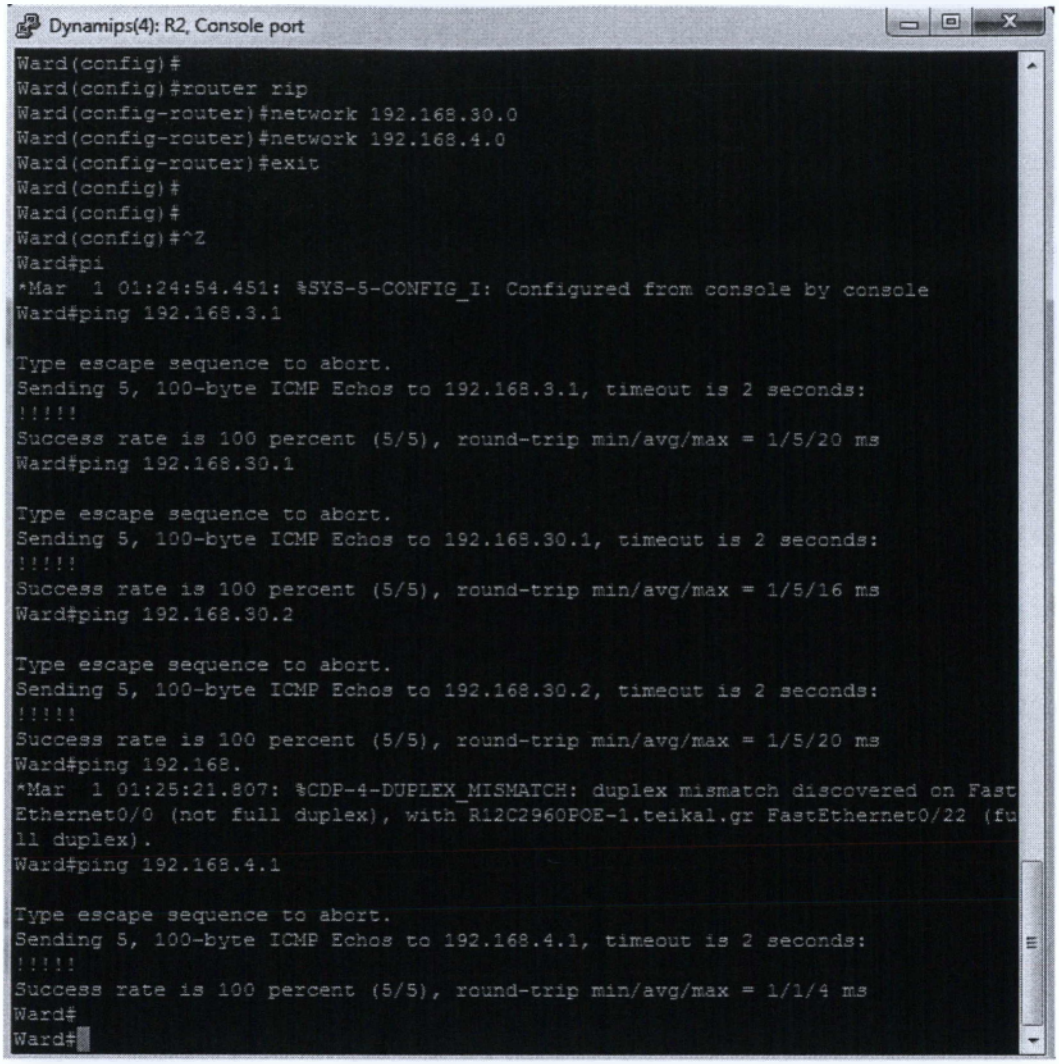


```
Randy(config)#router rip
*Mar  1 01:18:22.087: %CDP-4-DUPLEX_MISMATCH: duplex mismatch discovered on Fast
Ethernet0/0 (not full duplex), with R12C2960POE-1.teikal.gr FastEthernet0/22 (fu
ll duplex).
Randy(config)#router rip
*Mar  1 01:19:22.091: %CDP-4-DUPLEX_MISMATCH: duplex mismatch discovered on Fast
Ethernet0/0 (not full duplex), with R12C2960POE-1.teikal.gr FastEthernet0/22 (fu
ll duplex).
Randy(config)#router rip
*Mar  1 01:20:22.091: %CDP-4-DUPLEX_MISMATCH: duplex mismatch discovered on Fast
Ethernet0/0 (not full duplex), with R12C2960POE-1.teikal.gr FastEthernet0/22 (fu
ll duplex).
Randy(config)#router rip
*Mar  1 01:21:22.095: %CDP-4-DUPLEX_MISMATCH: duplex mismatch discovered on Fast
Ethernet0/0 (not full duplex), with R12C2960POE-1.teikal.gr FastEthernet0/22 (fu
ll duplex).
Randy(config)#router rip
*Mar  1 01:22:22.099: %CDP-4-DUPLEX_MISMATCH: duplex mismatch discovered on Fast
Ethernet0/0 (not full duplex), with R12C2960POE-1.teikal.gr FastEthernet0/22 (fu
ll duplex).
Randy(config)#router rip
Randy(config-router)#
*Mar  1 01:23:22.103: %CDP-4-DUPLEX_MISMATCH: duplex mismatch discovered on Fast
Ethernet0/0 (not full duplex), with R12C2960POE-1.teikal.gr FastEthernet0/22 (fu
ll duplex).
Randy(config-router)#network 192.168.50.0 255.255.255.0

% Invalid input detected at '^' marker.

Randy(config-router)#network 192.168.30.0
Randy(config-router)#network 192.168.30.0192.168.3.0

% Invalid input detected at '^' marker.

Randy(config-router)#network 192.168.3.0
Randy(config-router)#exit
Randy(config)#
```

```
Randy#ping 192.168.3.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.3.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/4 ms
Randy#ping 192.168.30.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.30.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/7/20 ms
Randy#ping 192.168.30.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.30.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/5/16 ms
Randy#ping 192.168.4.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.4.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/8/20 ms
Randy#
```

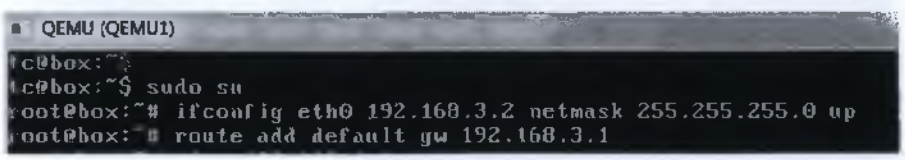
Router Ward


Dynamips(4): R2, Console port
Connected to Dynamips VM "R2" (ID 4, type c3745) - Console port
Press ENTER to get the prompt.
R2>enable
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#hostname Ward
Ward(config)#enable secret dana
Ward(config)#enable password maria
Ward(config)#line vty 0 4
Ward(config-line)#password dana
Ward(config-line)#exit
Ward(config)#line console 0
Ward(config-line)#password dana
Ward(config-line)#login exit
% Invalid input detected at '^' marker.
Ward(config-line)#login
Ward(config-line)#exit
Ward(config)#
Dynamips(4): R2, Console port
Ward(config)#
Ward(config)#
Ward(config)#int s0/0
Ward(config-if)#ip address 192.168.30.2 255.255.255.0
Ward(config-if)#no shut
Ward(config-if)#
*Mar 1 00:46:41.067: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
Ward(config-if)#
*Mar 1 00:46:42.071: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
changed state to up
Ward(config-if)#exit
Ward(config)#int f0/0
Ward(config-if)#ip address 192.168.4.1 255.255.255.0
Ward(config-if)#no shut
Ward(config-if)#
*Mar 1 00:47:11.175: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state t
o up
*Mar 1 00:47:12.175: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthern
et0/0, changed state to up
Ward(config-if)#
*Mar 1 00:47:21.651: %CDP-4-DUPLEX_MISMATCH: duplex mismatch discovered on Fast
Ethernet0/0 (not full duplex), with R12C2960POE-1.teikal.gr FastEthernet0/22 (f
ull duplex).
Ward(config-if)#exit
Ward(config)#
Ward(config)#

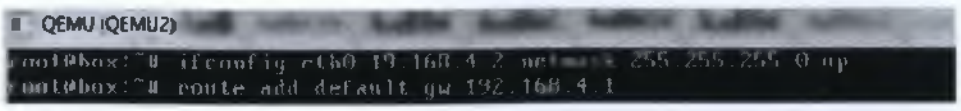


- Setup the workstations with IP address, subnet masks, and gateways addresses.

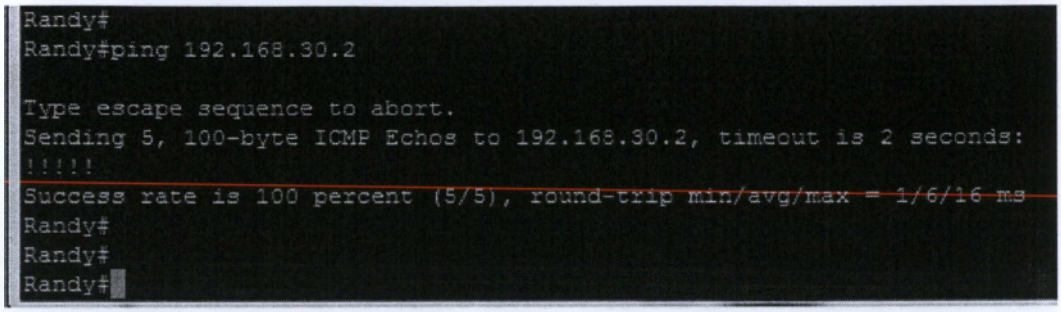
Workstation A



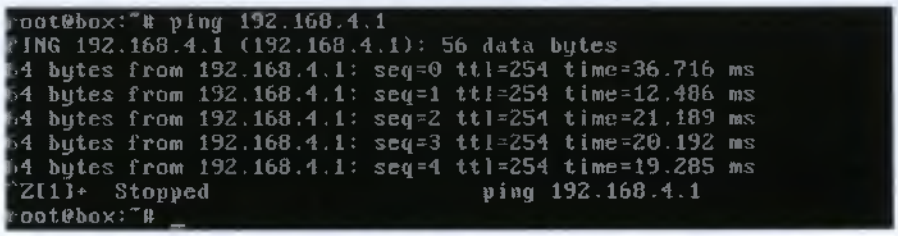
Workstation B



- Test connectivity from router to router (from the router) by using ping from Randy to Ward.

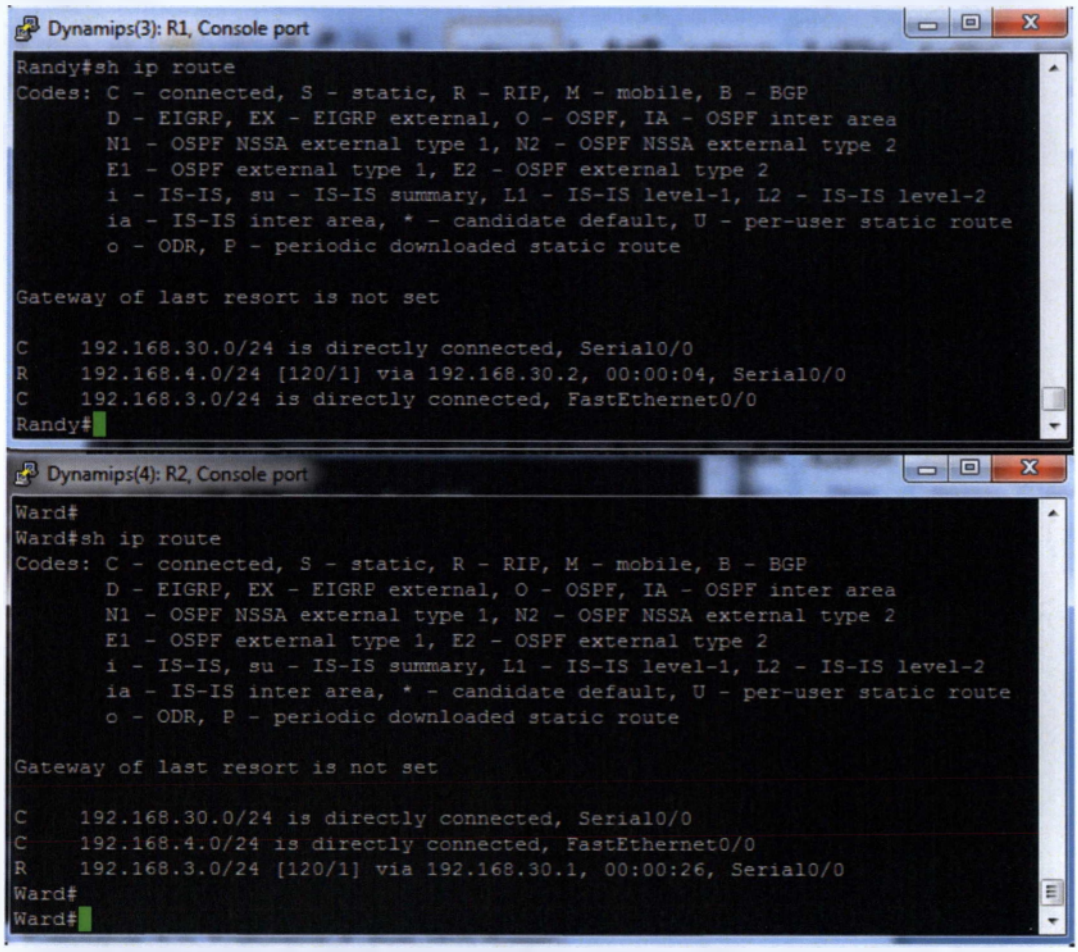


- Test connectivity from workstation to workstation by using ping from workstation A to workstation B.

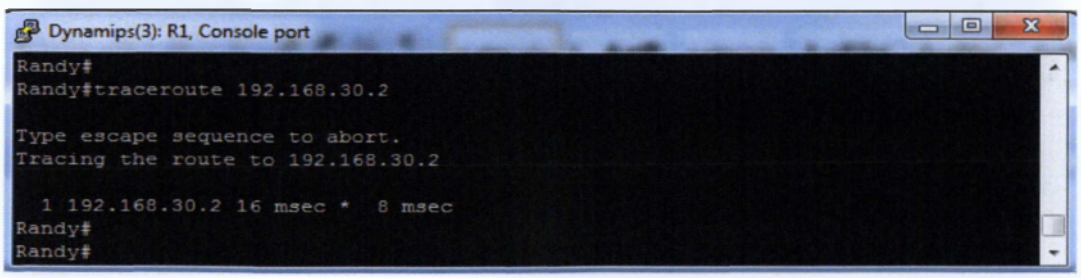


- See the route from Workstation A to Workstation B.

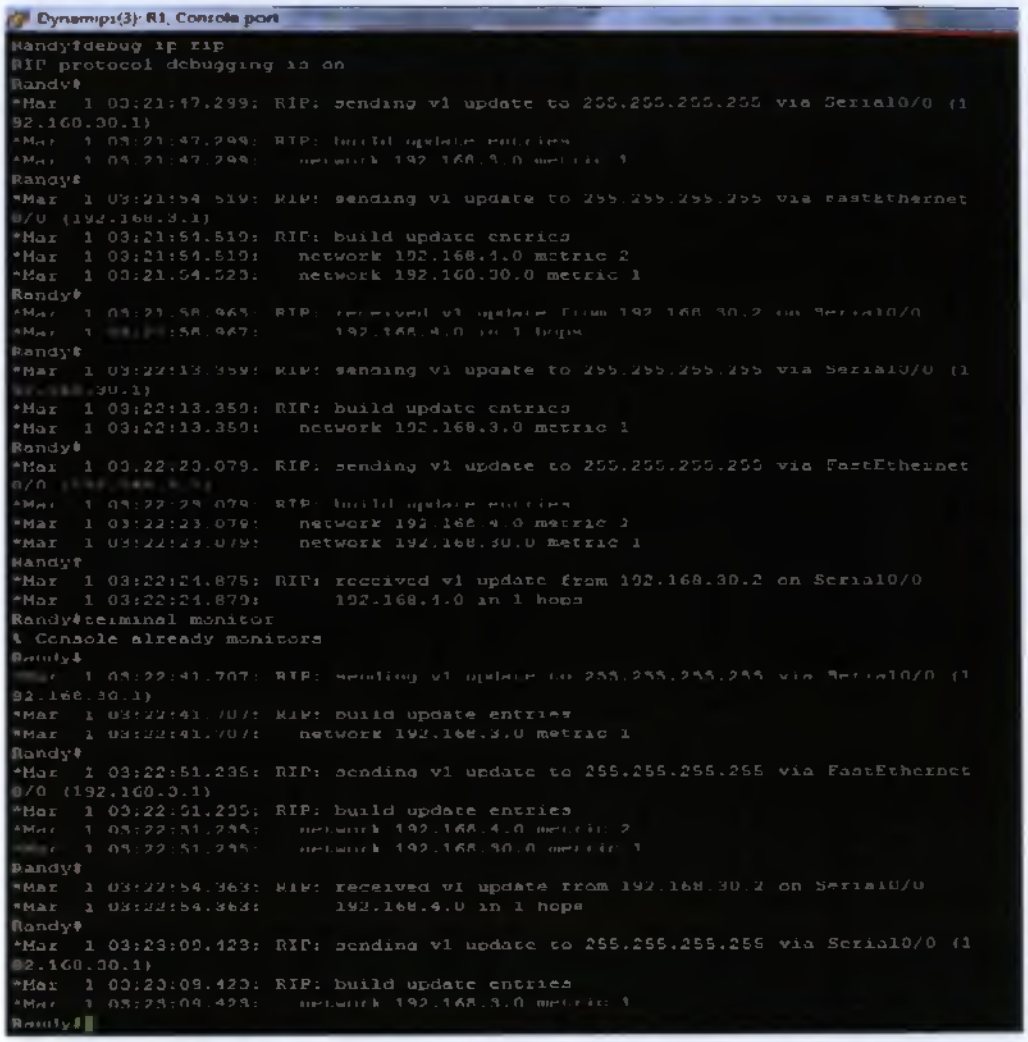
- See the route from one router to another.

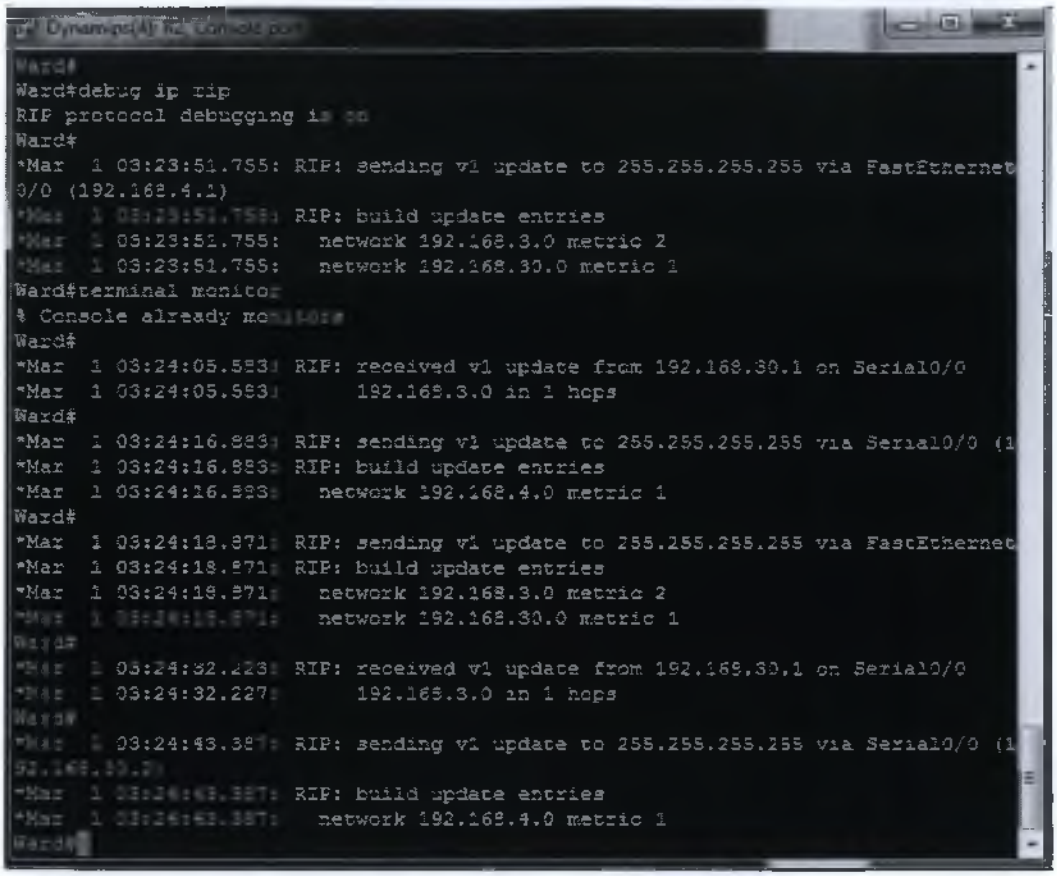


- Watch ICMP packets as they pass from one router to another.

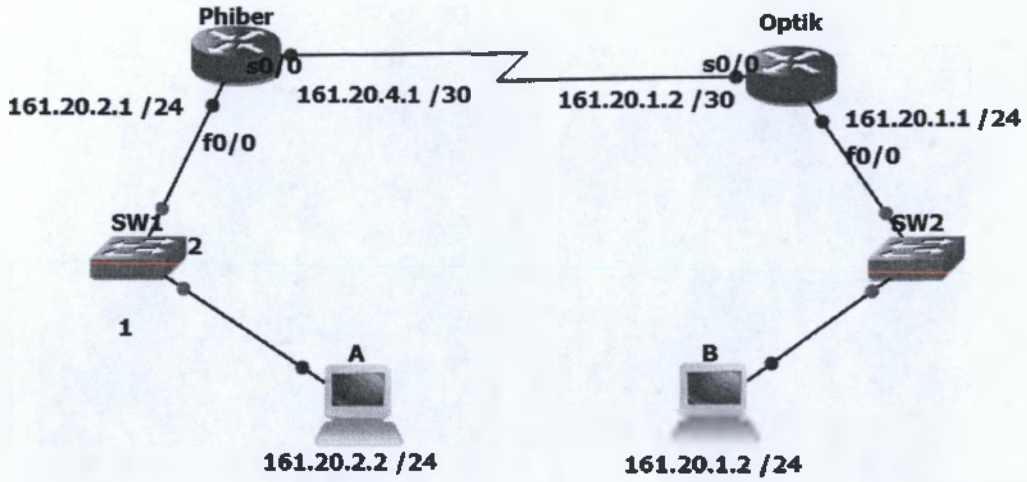


- See the rip updates as they pass through the routers.




Ward#
Ward#debug ip rip
RIP protocol debugging is on
Ward#
*Mar 1 03:23:51.755: RIP: sending v1 update to 255.255.255.255 via FastEthernet
0/0 (192.168.4.1)
*Mar 1 03:23:51.755: RIP: build update entries
*Mar 1 03:23:51.755: network 192.168.3.0 metric 2
*Mar 1 03:23:51.755: network 192.168.30.0 metric 1
Ward#terminal monitor
% Console already monitor#
Ward#
*Mar 1 03:24:05.583: RIP: received v1 update from 192.168.30.1 on Serial0/0
*Mar 1 03:24:05.583: 192.168.3.0 in 1 hops
Ward#
*Mar 1 03:24:16.883: RIP: sending v1 update to 255.255.255.255 via Serial0/0 (1
*Mar 1 03:24:16.883: RIP: build update entries
*Mar 1 03:24:16.883: network 192.168.4.0 metric 1
Ward#
*Mar 1 03:24:18.871: RIP: sending v1 update to 255.255.255.255 via FastEthernet
*Mar 1 03:24:18.871: RIP: build update entries
*Mar 1 03:24:18.871: network 192.168.3.0 metric 2
*Mar 1 03:24:18.871: network 192.168.30.0 metric 1
Ward#
*Mar 1 03:24:32.223: RIP: received v1 update from 192.168.30.1 on Serial0/0
*Mar 1 03:24:32.227: 192.168.3.0 in 1 hops
Ward#
*Mar 1 03:24:43.387: RIP: sending v1 update to 255.255.255.255 via Serial0/0 (1
92.168.30.2)
*Mar 1 03:24:43.387: RIP: build update entries
*Mar 1 03:24:43.387: network 192.168.4.0 metric 1
Ward#

6.6.4 Configure RIPv2 Dynamic Route

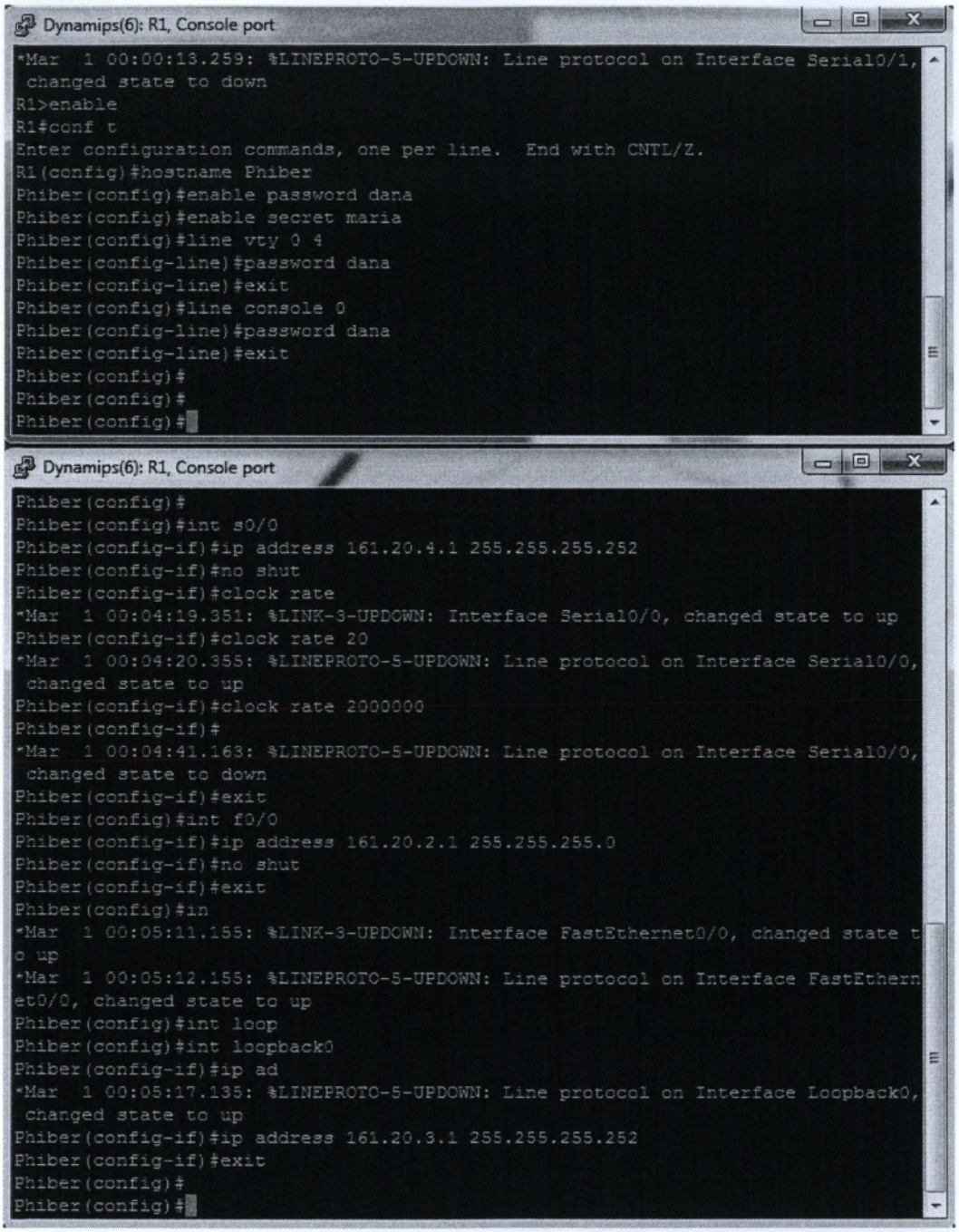


Εικόνα 47 RIPv2 Topology

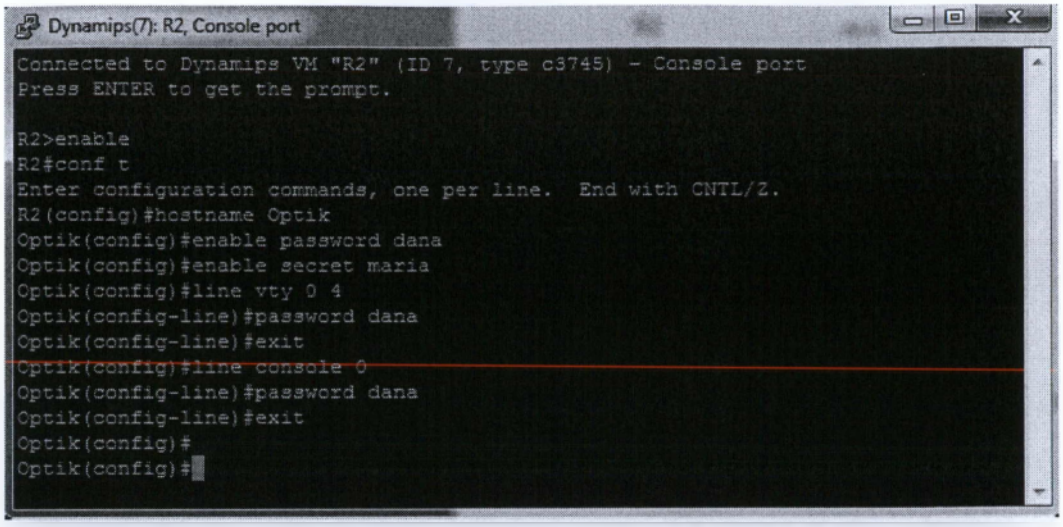
	Workstation "A"	Workstation "B"
Addressing:		
Routers		
Hostnames	Phiber	Optik
S0	161.20.4.1/30 (DCE)	161.20.4.2/30 (DTE)
S1	n/a	n/a
L0	161.20.3.1/30	161.20.5.1/30
E0	161.20.2.1/24	161.20.1.1/24
Workstations	A	B
IP	161.20.2.2	161.20.1.2
SM	255.255.255.0	255.255.255.0
GW	161.20.2.1	161.20.1.1

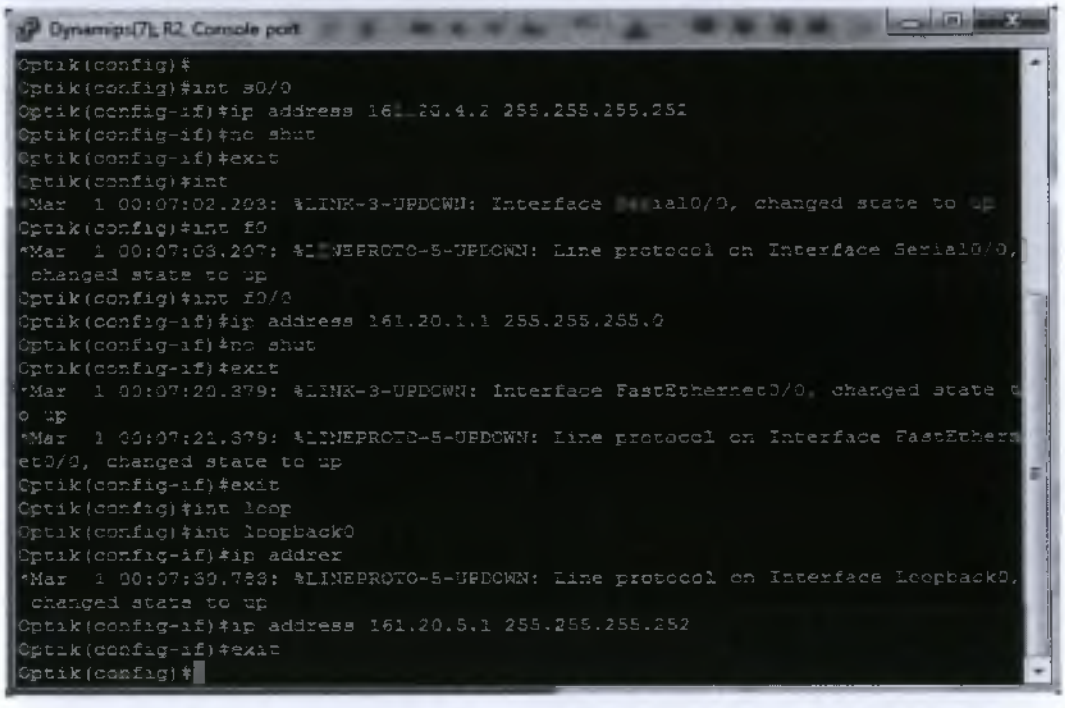
- Set up the "router basics" on each router (VTY, Passwords etc.).
- Configure the interfaces on each router.

Router Phiber



Router Optik



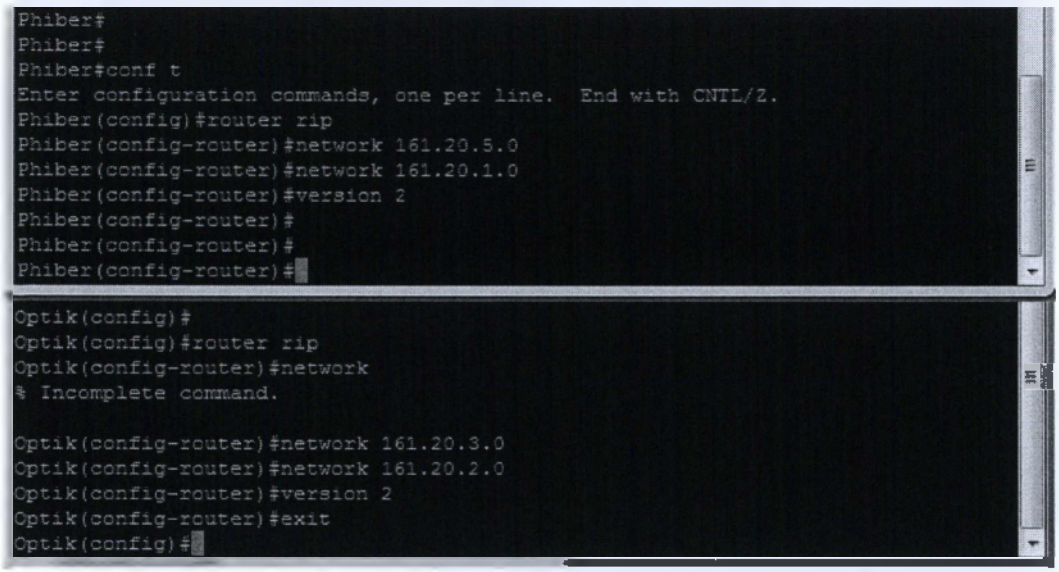


- Configure the workstations.

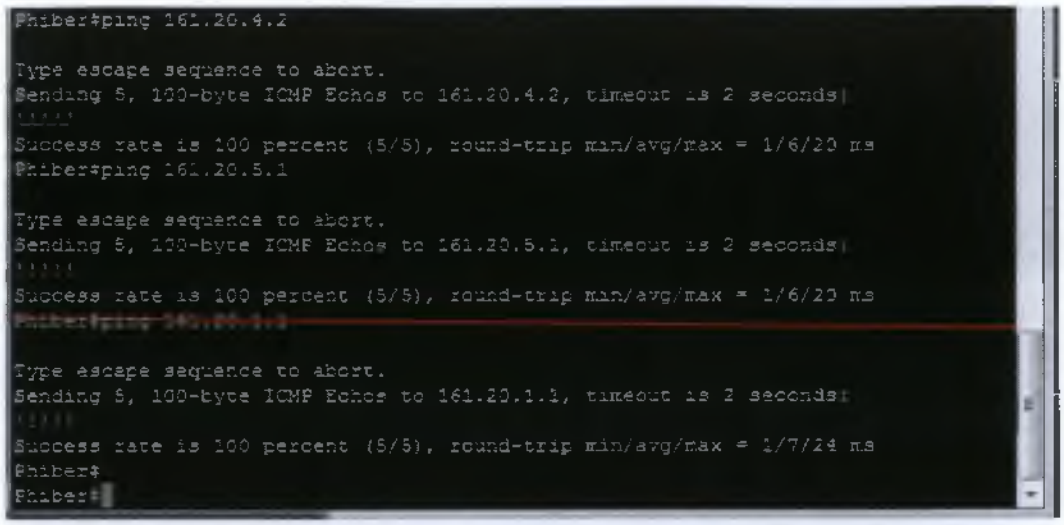
Workstation A

Workstation B

- Configure RIP version 2 on each router.

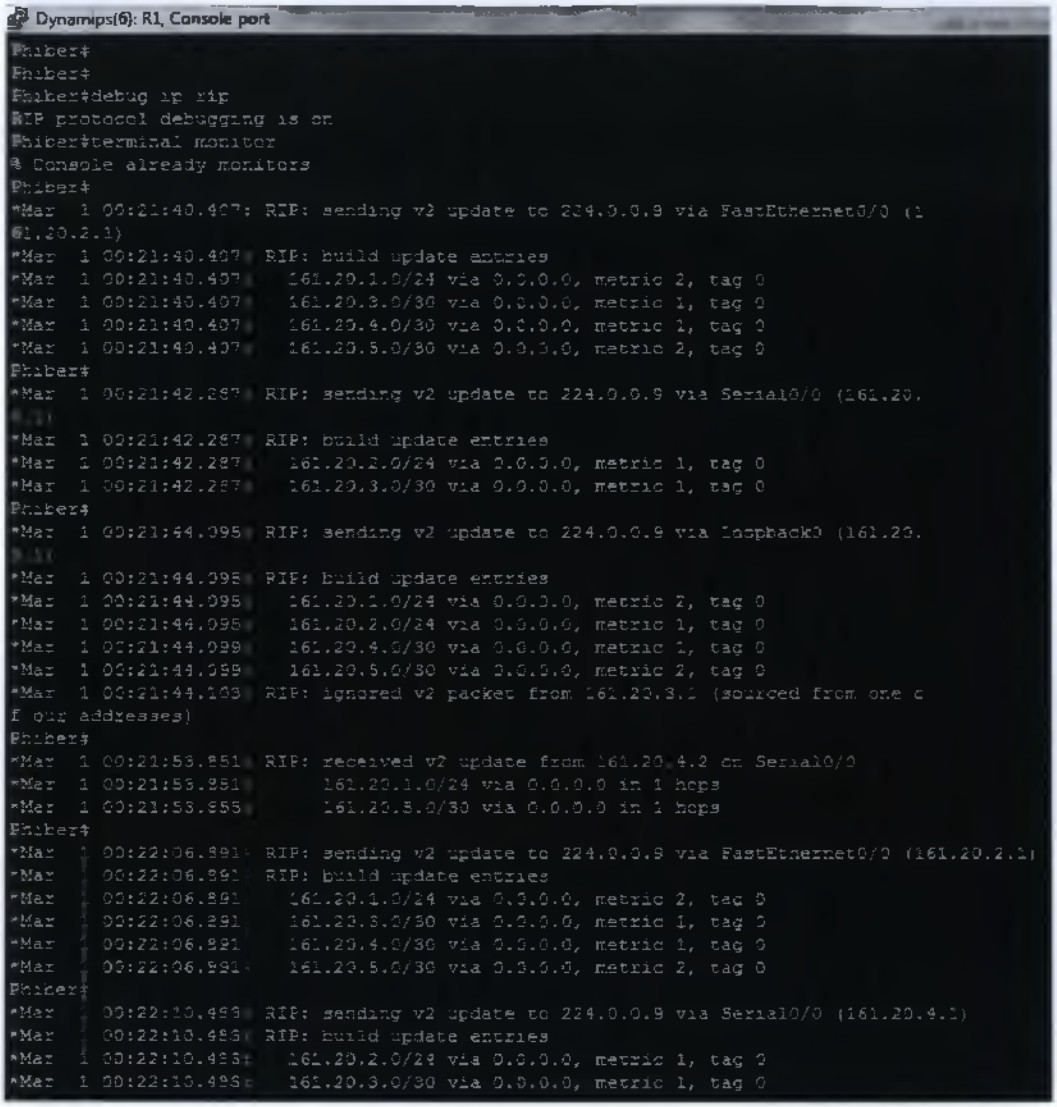


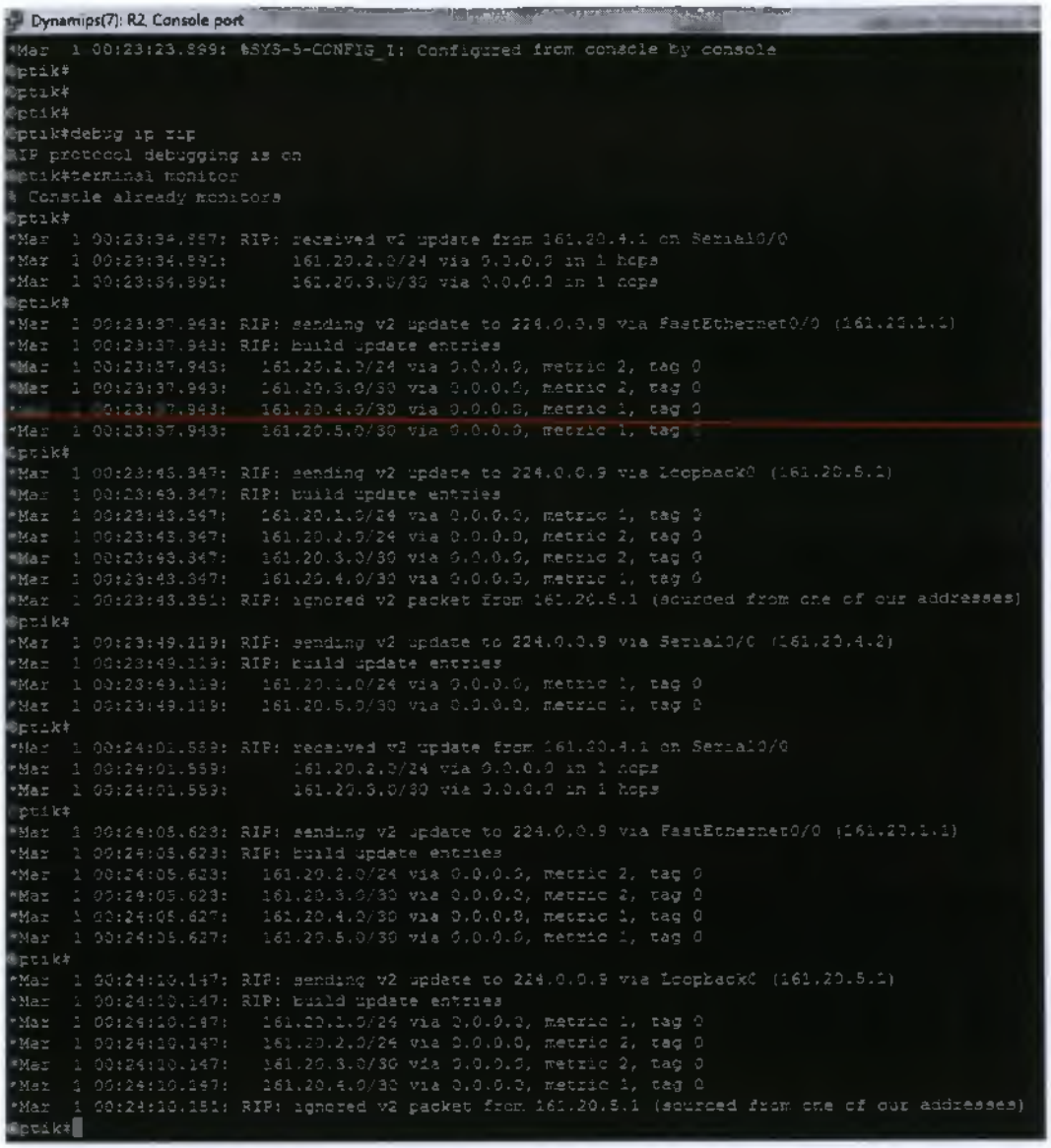
- Test connectivity from router to router (from the router) by using ping from Phiber to Optik.



- Test connectivity from workstation to workstation by using ping from workstation A to workstation B.

- See the rip updates as they pass through the routers.




Dynamips(7): R2 Console port
*Mar 1 00:23:23.899: %SYS-5-CONFIG_I: Configured from console by console
R2#
R2#
R2#
R2#debug ip rip
RIP protocol debugging is on
R2#terminal monitor
% Console already monitors
R2#
*Mar 1 00:23:34.887: RIP: received v2 update from 161.20.4.1 on Serial0/0
*Mar 1 00:23:34.891: 161.20.2.0/24 via 0.0.0.0 in 1 hops
*Mar 1 00:23:34.891: 161.20.3.0/30 via 0.0.0.0 in 1 hops
R2#
*Mar 1 00:23:37.943: RIP: sending v2 update to 224.0.0.9 via FastEthernet0/0 (161.20.1.1)
*Mar 1 00:23:37.943: RIP: build update entries
*Mar 1 00:23:37.943: 161.20.2.0/24 via 0.0.0.0, metric 2, tag 0
*Mar 1 00:23:37.943: 161.20.3.0/30 via 0.0.0.0, metric 2, tag 0
*Mar 1 00:23:37.943: 161.20.4.0/30 via 0.0.0.0, metric 1, tag 0
*Mar 1 00:23:37.943: 161.20.5.0/30 via 0.0.0.0, metric 1, tag 0
R2#
*Mar 1 00:23:43.347: RIP: sending v2 update to 224.0.0.9 via Loopback0 (161.20.5.1)
*Mar 1 00:23:43.347: RIP: build update entries
*Mar 1 00:23:43.347: 161.20.1.0/24 via 0.0.0.0, metric 1, tag 0
*Mar 1 00:23:43.347: 161.20.2.0/24 via 0.0.0.0, metric 2, tag 0
*Mar 1 00:23:43.347: 161.20.3.0/30 via 0.0.0.0, metric 2, tag 0
*Mar 1 00:23:43.347: 161.20.4.0/30 via 0.0.0.0, metric 1, tag 0
*Mar 1 00:23:43.351: RIP: ignored v2 packet from 161.20.5.1 (sourced from one of our addresses)
R2#
*Mar 1 00:23:49.119: RIP: sending v2 update to 224.0.0.9 via Serial0/0 (161.20.4.2)
*Mar 1 00:23:49.119: RIP: build update entries
*Mar 1 00:23:49.119: 161.20.1.0/24 via 0.0.0.0, metric 1, tag 0
*Mar 1 00:23:49.119: 161.20.5.0/30 via 0.0.0.0, metric 1, tag 0
R2#
*Mar 1 00:24:01.559: RIP: received v2 update from 161.20.4.1 on Serial0/0
*Mar 1 00:24:01.559: 161.20.2.0/24 via 0.0.0.0 in 1 hops
*Mar 1 00:24:01.559: 161.20.3.0/30 via 0.0.0.0 in 1 hops
R2#
*Mar 1 00:24:05.623: RIP: sending v2 update to 224.0.0.9 via FastEthernet0/0 (161.20.1.1)
*Mar 1 00:24:05.623: RIP: build update entries
*Mar 1 00:24:05.623: 161.20.2.0/24 via 0.0.0.0, metric 2, tag 0
*Mar 1 00:24:05.623: 161.20.3.0/30 via 0.0.0.0, metric 2, tag 0
*Mar 1 00:24:05.627: 161.20.4.0/30 via 0.0.0.0, metric 1, tag 0
*Mar 1 00:24:05.627: 161.20.5.0/30 via 0.0.0.0, metric 1, tag 0
R2#
*Mar 1 00:24:10.147: RIP: sending v2 update to 224.0.0.9 via Loopback0 (161.20.5.1)
*Mar 1 00:24:10.147: RIP: build update entries
*Mar 1 00:24:10.147: 161.20.1.0/24 via 0.0.0.0, metric 1, tag 0
*Mar 1 00:24:10.147: 161.20.2.0/24 via 0.0.0.0, metric 2, tag 0
*Mar 1 00:24:10.147: 161.20.3.0/30 via 0.0.0.0, metric 2, tag 0
*Mar 1 00:24:10.147: 161.20.4.0/30 via 0.0.0.0, metric 1, tag 0
*Mar 1 00:24:10.151: RIP: ignored v2 packet from 161.20.5.1 (sourced from one of our addresses)
R2#

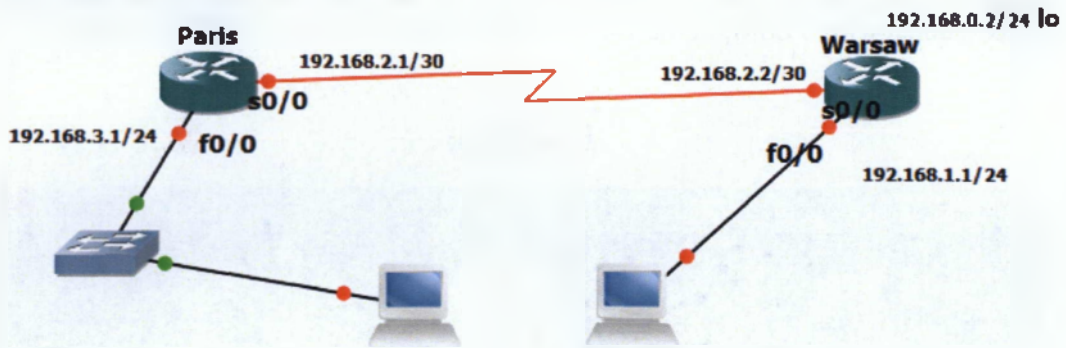
6.7 Enhanced IGRP (EIGRP)

Το κεφάλαιο αυτό παρουσιάζει τα βασικά στοιχεία του πρωτοκόλλου δρομολόγησης Enhanced Interior Gateway Protocol (EIGRP)

Συμπεριλαμβάνει:
•Data-State σε σχέση με τα Distance-Vector πρωτόκολλα δρομολόγησης.
•Σύνοψη και Έννοιες του EIGRP.
•Λειτουργία του EIGRP.
•Παραμετροποίηση του EIGRP.
•Εξακριβώνοντας τη σωστή λειτουργία (troubleshooting) του EIGRP.

Υλοποίηση Ασκήσεων

6.7.1. Configuring EIGRP Routing



Εικόνα 48 EIGRP 1 Topology

Router Designation	Router Name	Routing Protocol	Network Statements
Router 1	Paris	EIGRP	192.168.3.0
			192.168.2.0
Router 2	Warsaw	EIGRP	192.168.1.0
			192.168.2.0

Πίνακας 3 Address Scheme 1 for EIGRP 1 Topology

Router Designation	IP Host Table Entry	Fast Ethernet 0 Address/ Subnet Mask	Interface Type Serial 0	Serial 0 Address/ Subnet Mask	Loopback 0 Subnet Mask Address/
Router 1	Paris	192.168.3.1/24	DCE	192.168.2.1/30	192.168.0.2/24
Router 2	Warsaw	192.168.1.1/24	DTE	192.168.2.2/30	No address

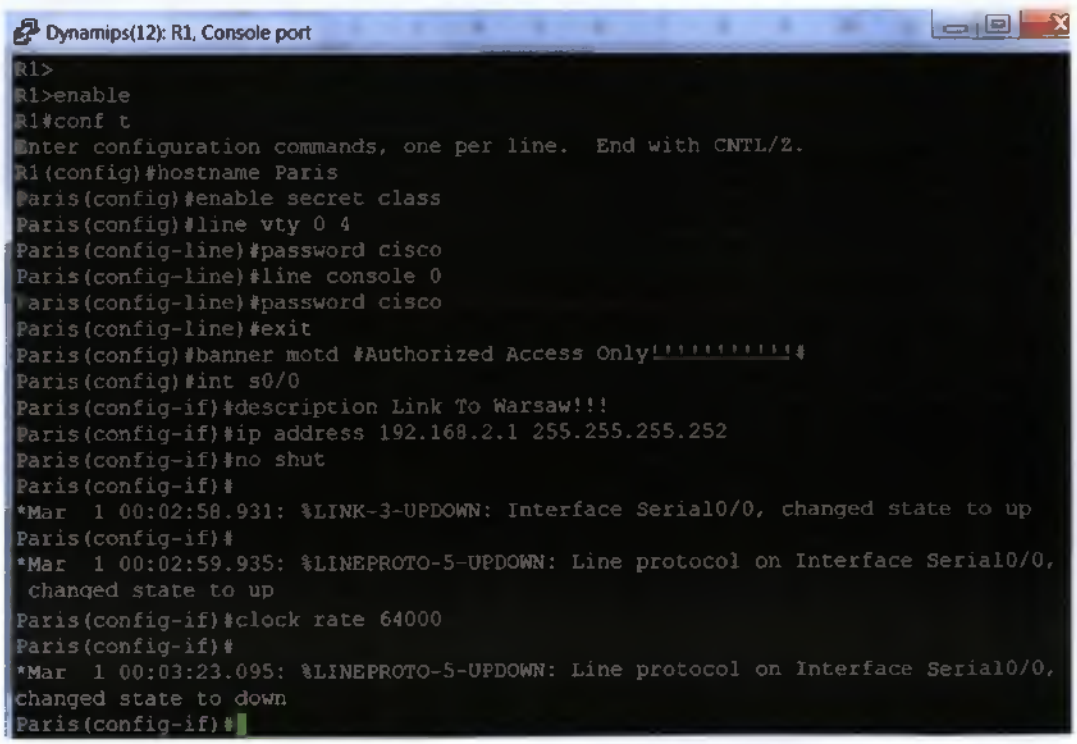
Πινακας 4 3 Address Scheme 2 for EIGRP 1 Topology

1. The enable secret password for all routers is **class**.
2. The VTY, and console password for each router is **cisco**.
3. The "IP Host Table Entry" column contents ***indicate the names of the other routers*** in the IP host table.
4. Configure the motd.
5. Do not forget to write the description of each interface.
6. IP addressing of the topology.
7. Configure each host according to the topology.
8. Save each configuration in each router.

The first 6 tasks are the main body of the exercises. You have to succesfully complete in order to proceed to the rest tasks.

Note: You may need to add the command **ip subnet-zero** because of the use of the ZERO subnet with VLSM on the 192.168.1.0/30 and 192.168.1.128/26 networks.

Router Paris

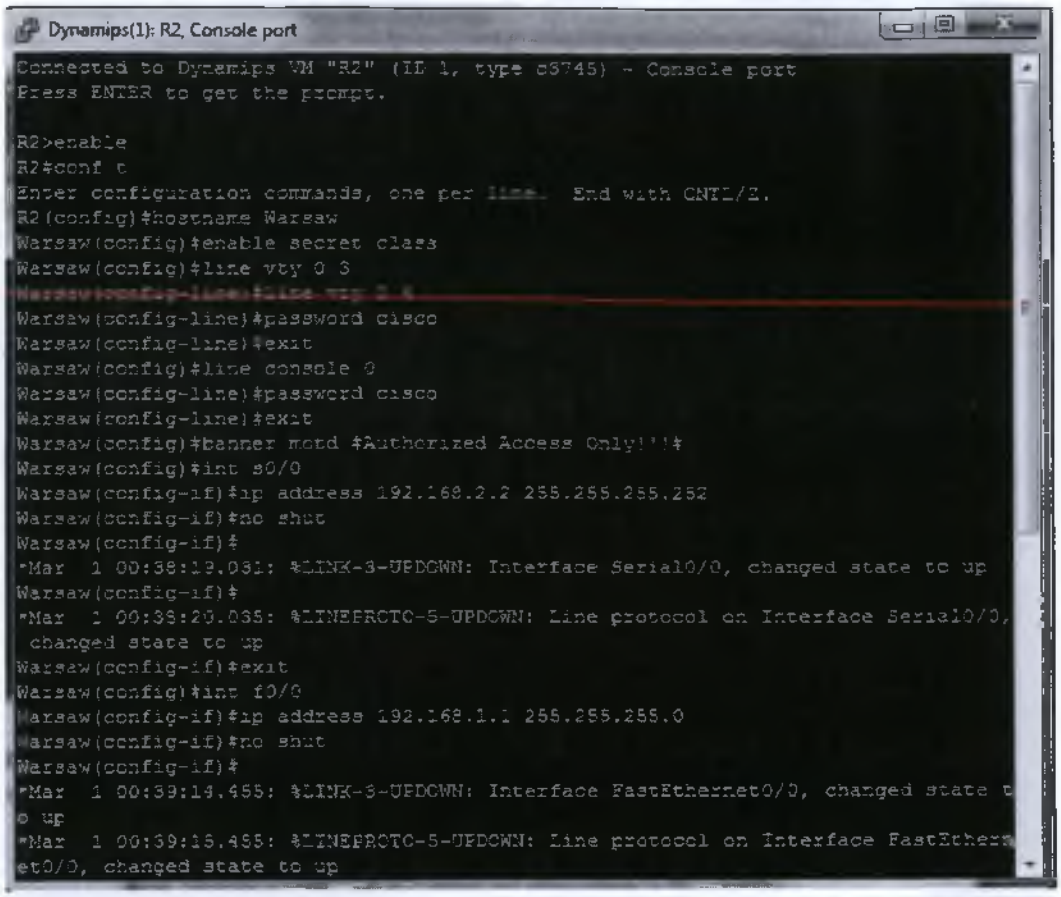


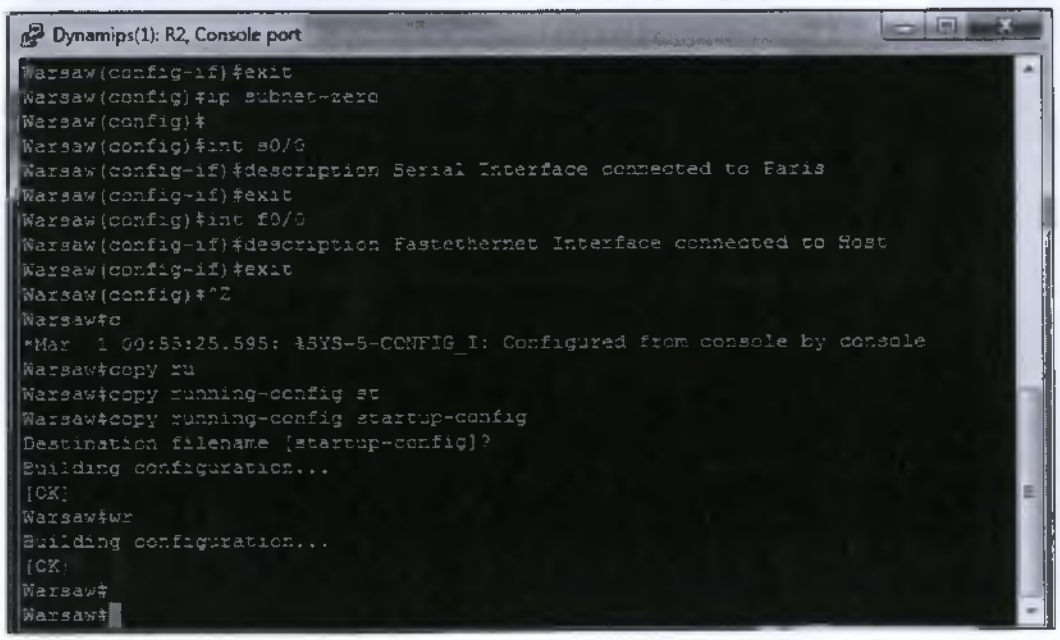
```
Paris(config)#int f0/0
Paris(config-if)#ip address 192.168.3.1 255.255.255.0
Paris(config-if)#no shut
Paris(config-if)#
*Mar  1 00:35:21.259: %LINK-5-UPDOWN: Interface FastEthernet0/0, changed state t
o up
*Mar  1 00:35:22.259: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEther
net0/0, changed state to up
Paris(config-if)#exit
Paris(config)#int loopback 0
Paris(config-if)#ip addr
*Mar  1 00:35:30.335: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
 changed state to up
Paris(config-if)#ip address 192.168.0.2 255.255.255.0
Paris(config-if)#exit
Paris(config)#
*Mar  1 00:38:25.287: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
 changed state to up
Paris(config)#ip subnet-zero
Paris(config)#
Paris(config)#int s0/0
Paris(config-if)#description Serial Interface Connected to Warsaw
Paris(config-if)#exit
Paris(config)#int f0/0
Paris(config-if)#description Fastethernet Interface Connected to switch
Paris(config-if)#exit
Paris(config)#exit
Paris#copy
*Mar  1 00:52:40.499: %SYS-5-CONFIG_I: Configured from console by console
Paris#copy ru
Paris#copy running-config st
Paris#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
Paris#wr
Building configuration...
[OK]
Paris#
Paris#
```

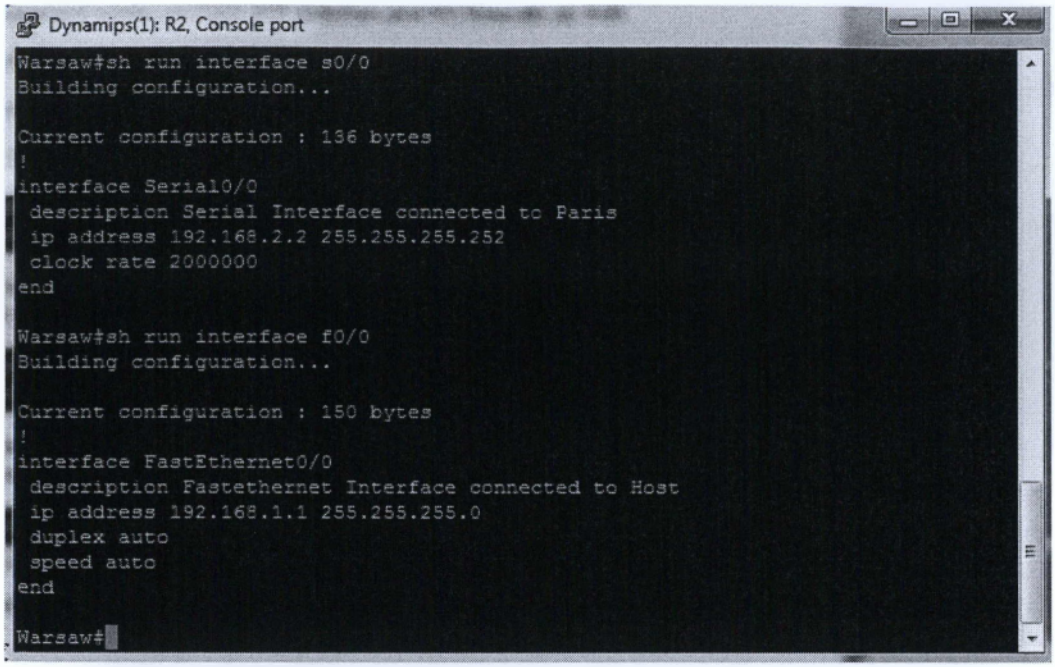
Dynamips(0): R1, Console port

```
Paris#sh run interface s0/0
Building configuration...

Current configuration : 137 bytes

interface Serial0/0
 description Serial Interface Connected to Warsaw
 ip address 192.168.2.1 255.255.255.252
 clock rate 2000000
end

Paris#sh run interface f0/0
Building configuration...

Current configuration : 152 bytes

interface FastEthernet0/0
 description Fastethernet Interface Connected to switch
 ip address 192.168.3.1 255.255.255.0
 duplex auto
 speed auto
end

Paris#
```

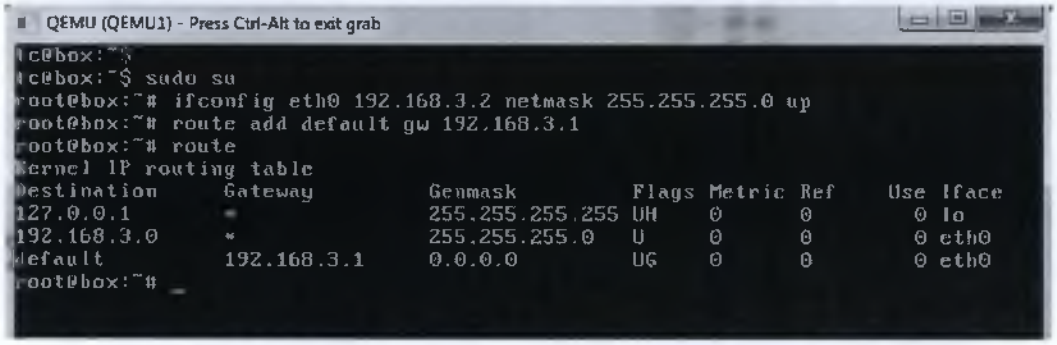
Router Warsaw



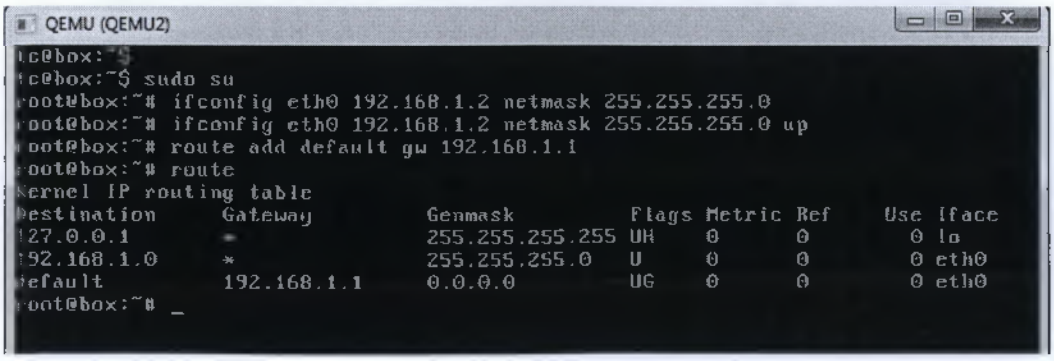




Workstation 1

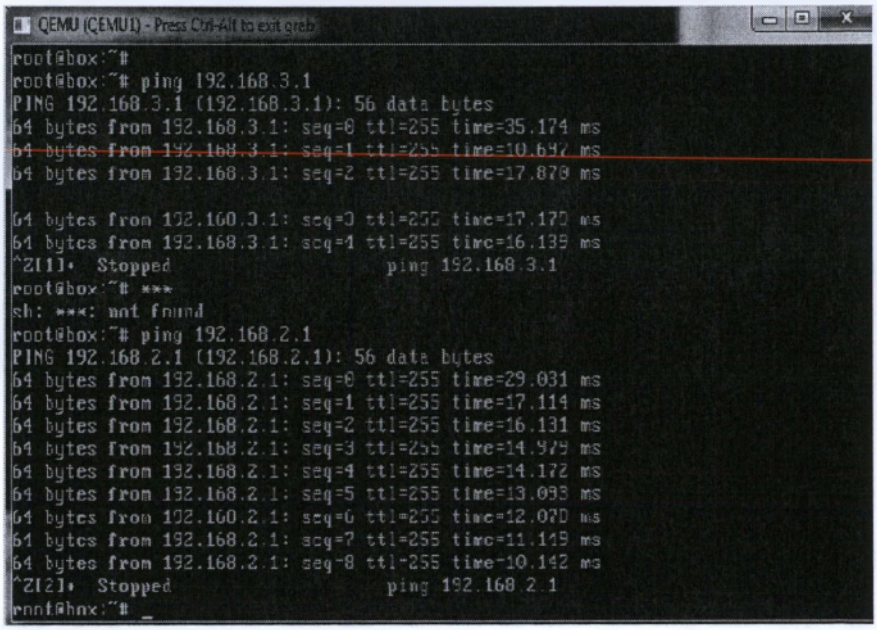


Workstation 2

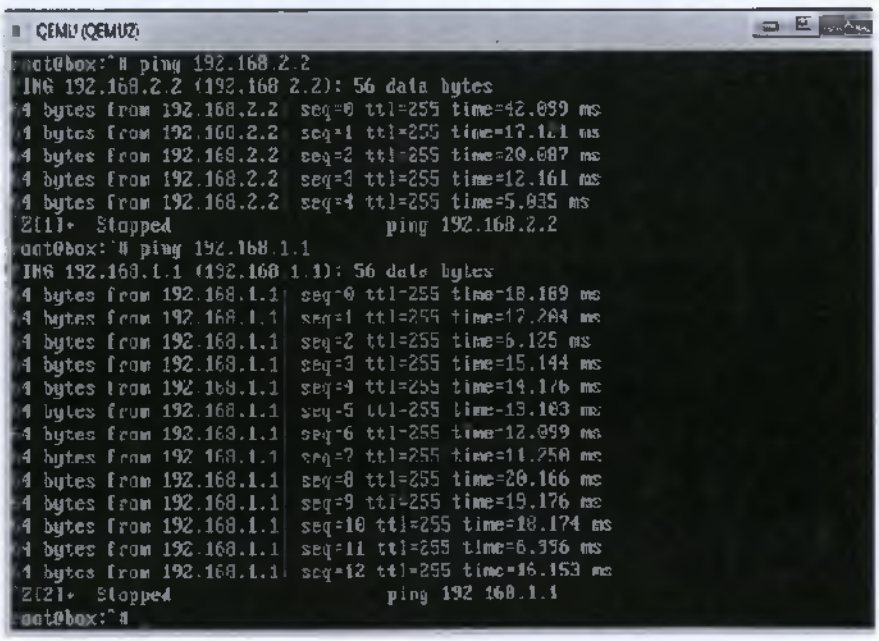


Verify host local connectivity

- Ping from workstation 1 to workstation 2

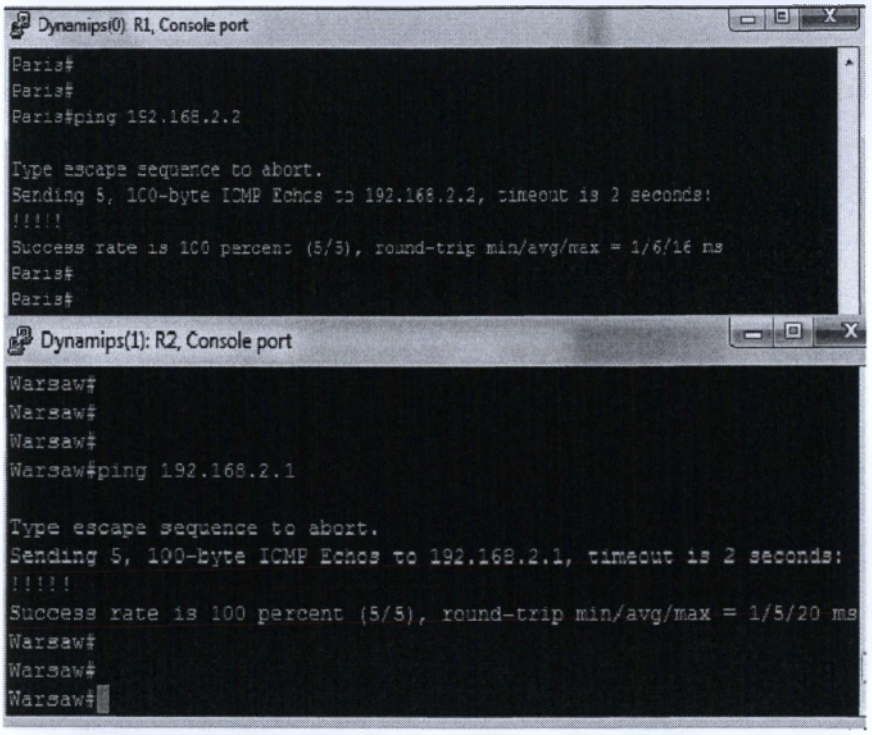


- Ping from workstation 2 to workstation 1



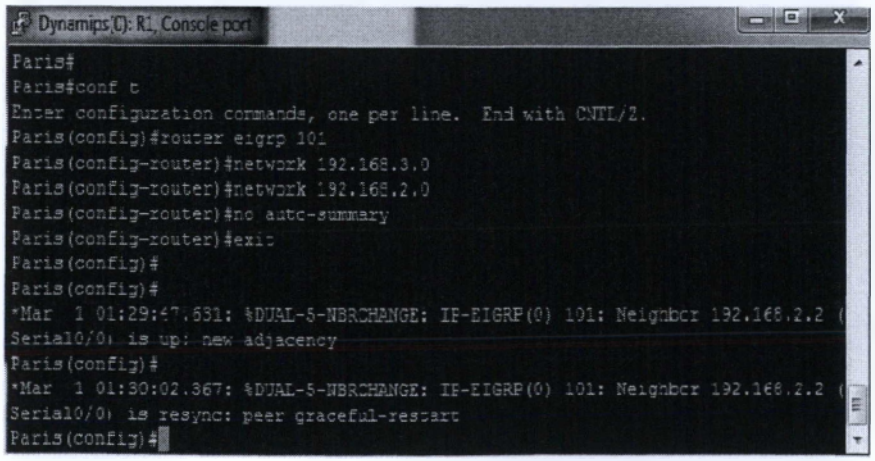
Verify Interface information

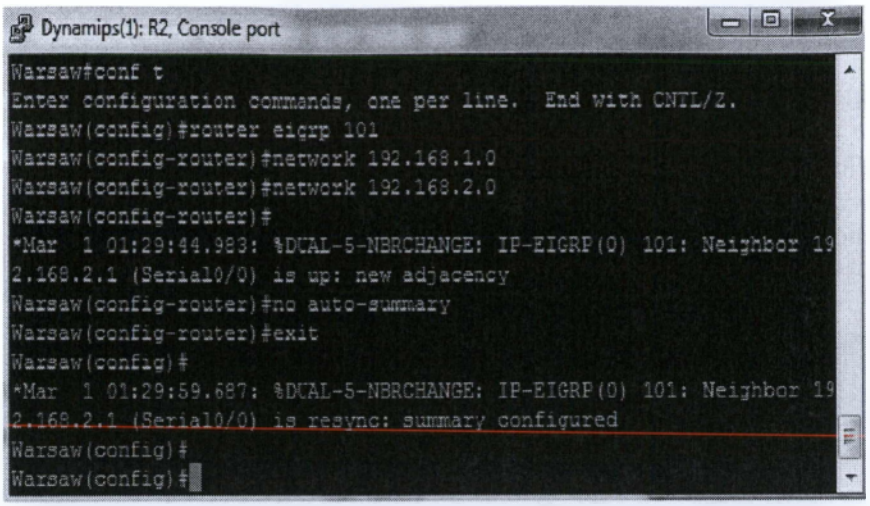
- Ping from one of the connected serial interfaces to the other. If the ping was not successful, troubleshoot the router configuration until the ping is successful.



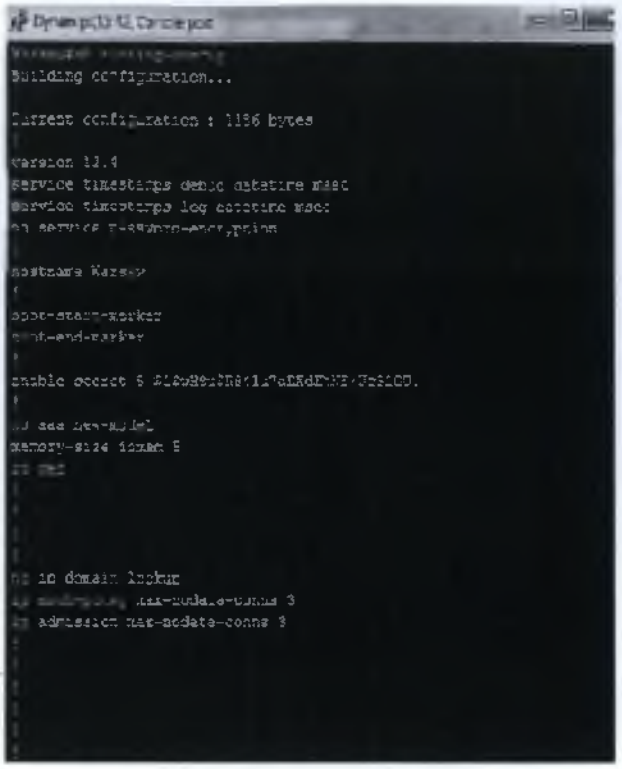
Configure EIGRP routing on routers.

Enable the EIGRP routing process on router all and configure the networks it will advertise. Use EIGRP autonomous system number 101.

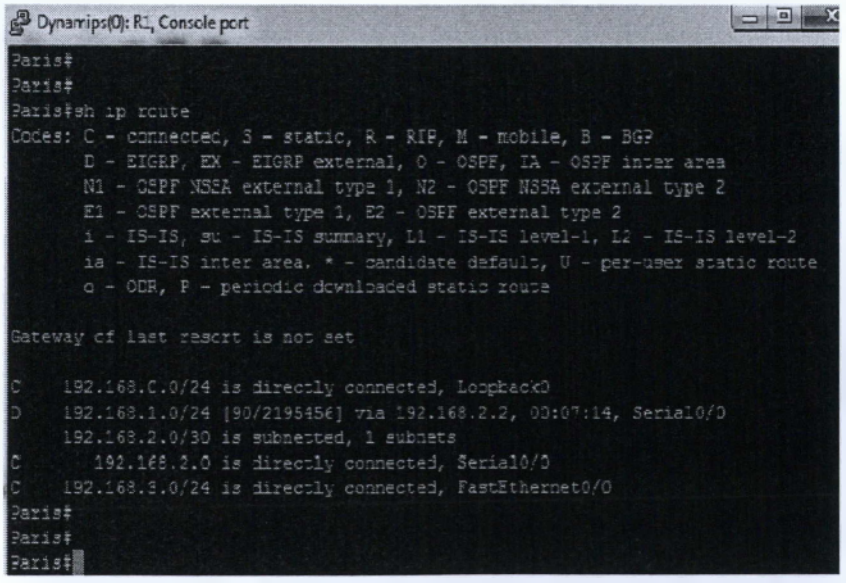


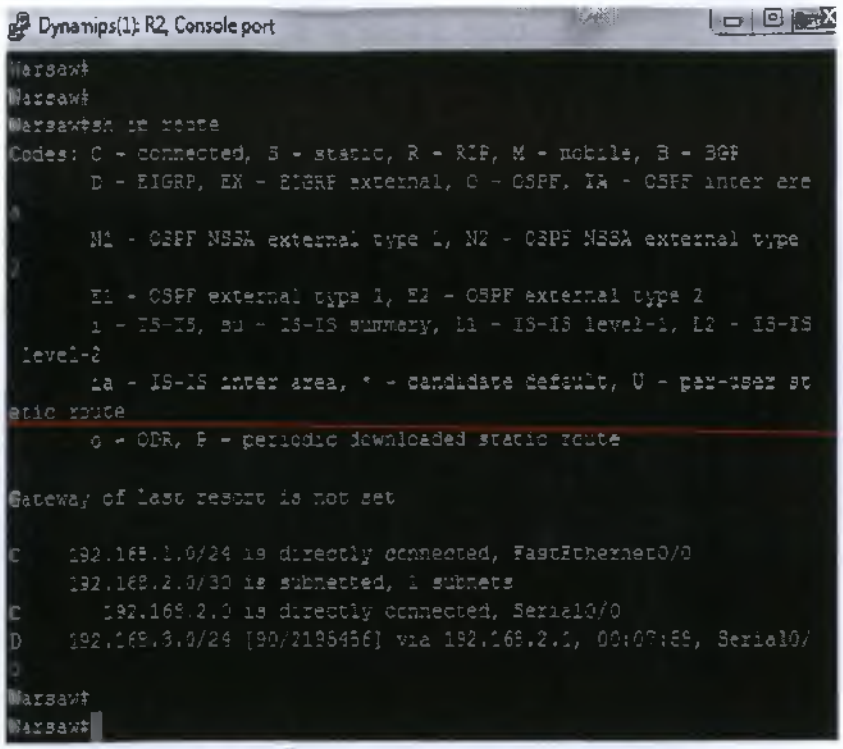


- Examine the routers that are running configuration files.



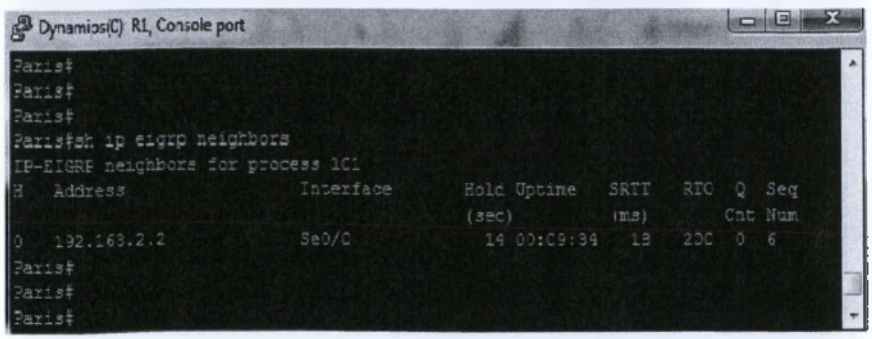
- Show the routing table for both routers.





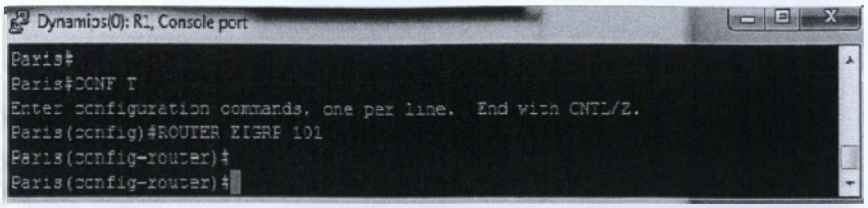
Show EIGRP neighbors

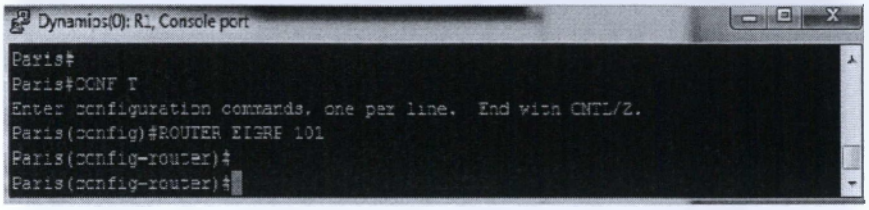
- From the Paris router, show any neighbors that are connected by using the **show ip eigrp neighbors** command at the privileged EXEC mode prompt.



Verify connectivity based on EIGRP

- Enable the EIGRP routing process .Use EIGRP autonomous system number 101.





- Examine the routers that are running configuration files.

```
Warsaw#sh run
Warsaw#sh running-config
Building configuration...

Current configuration : 1186 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Warsaw
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$wH9u$R941u7aDXdEbME/Jg31GJ.
!
no aaa new-model
memory-size iomem 5
ip cef
!
!
!
!
no ip domain lookup
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
```

- Show the routing tables

```
Paris#
Paris#
*Mar  1 01:50:00.679: %SYS-5-CONFIG_I: Configured from console by console
Paris#
Paris#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.0.0/24 is directly connected, Loopback0
R    192.168.1.0/24 [90/21954560] via 192.168.2.2, 00:20:17, Serial0/0
     192.168.2.0/30 is subnetted, 1 subnets
C       192.168.2.0 is directly connected, Serial0/0
C    192.168.3.0/24 is directly connected, FastEthernet0/0
Paris#
Paris#
```

```
Warsaw#
Warsaw#
Warsaw#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS l
evel-2
       ia - IS-IS inter area, * - candidate default, U - per-user stat
ic route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, FastEthernet0/0
     192.168.2.0/30 is subnetted, 1 subnets
C       192.168.2.0 is directly connected, Serial0/0
D    192.168.3.0/24 [90/2195456] via 192.168.2.1, 00:21:03, Serial0/0
Warsaw#
Warsaw#
```

View the topology table

- To view the topology table, issue the **show ip eigrp topology all-links** command.

```
Paris#
Paris#show ip eigrp topology all-links
IP-EIGRP Topology Table for AS(101)/ID(192.168.0.2)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 192.168.1.0/24, 1 successors, FD is 2195456, serno 4
        via 192.168.2.2 (2195456/281600), Serial0/0
P 192.168.2.0/30, 1 successors, FD is 2169856, serno 2
        via Connected, Serial0/0
P 192.168.3.0/24, 1 successors, FD is 281600, serno 1
        via Connected, FastEthernet0/0
Paris#
Paris#
Paris#
```

```
Warsaw#
Warsaw#show ip eigrp topology all-links
IP-EIGRP Topology Table for AS(101)/ID(192.168.2.2)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 192.168.1.0/24, 1 successors, FD is 281600, serno 1
        via Connected, FastEthernet0/0
P 192.168.2.0/30, 1 successors, FD is 2169856, serno 2
        via Connected, Serial0/0
P 192.168.3.0/24, 1 successors, FD is 2195456, serno 4
        via 192.168.2.1 (2195456/281600), Serial0/0
Warsaw#
Warsaw#
Warsaw#
```

- How many routes are in passive mode? **3 routes**

- To view more specific information about a topology table entry, use an IP address with this command: Paris#show ip eigrp topology 192.168.1.0.

```
Paris#
Paris#show ip eigrp topology 192.168.1.0
IP-EIGRP (AS 101): Topology entry for 192.168.1.0/24
  State is Passive, Query origin flag is 1, 1 Successor(s), FD is 2195456
  Routing Descriptor Blocks:
  192.168.2.2 (Serial0/0), from 192.168.2.2, Send flag is 0x0
      Composite metric is (2195456/281600), Route is Internal
      Vector metric:
        Minimum bandwidth is 1544 Kbit
        Total delay is 21000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 1
Paris#
```

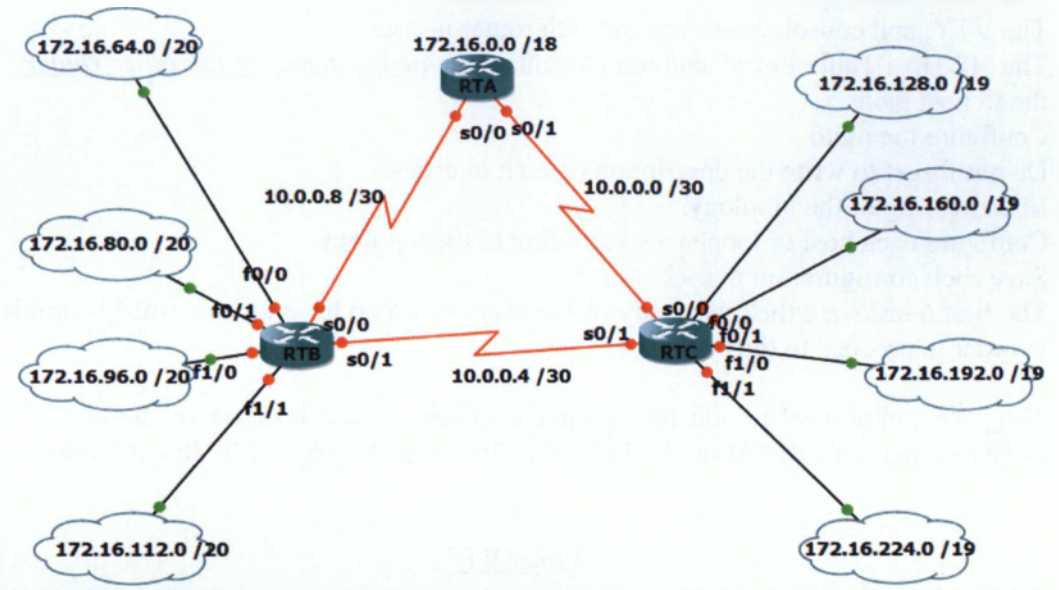
- Based on the output of this command, does it tell what external protocol originated this route to 192.168.2.0? **No, because route is Internal.**

- Use show commands to view key EIGRP statistics. On the Paris router, issue the show ip eigrp traffic command.

```
Paris#show ip eigrp traffic
IP-EIGRP Traffic Statistics for AS 101
  Hellos sent/received: 903/404
  Updates sent/received: 4/5
  Queries sent/received: 0/1
  Replies sent/received: 1/0
  Acks sent/received: 2/2
  SIA-Queries sent/received: 0/0
  SIA-Replies sent/received: 0/0
  Hello Process ID: 213
  PDM Process ID: 212
  IP Socket queue:   0/2000/2/0 (current/max/highest/drops)
  Eigrp input queue: 0/2000/2/0 (current/max/highest/drops)

Paris#
```

- How many hello packets has the Paris router received? **Paris router has received 404 packets.**
- How many has it sent? **Paris router has sent 903 packets**

6.7.2 Comprehensive EIGRP Configuration



Εικόνα 49 EIGRP 2 Topology

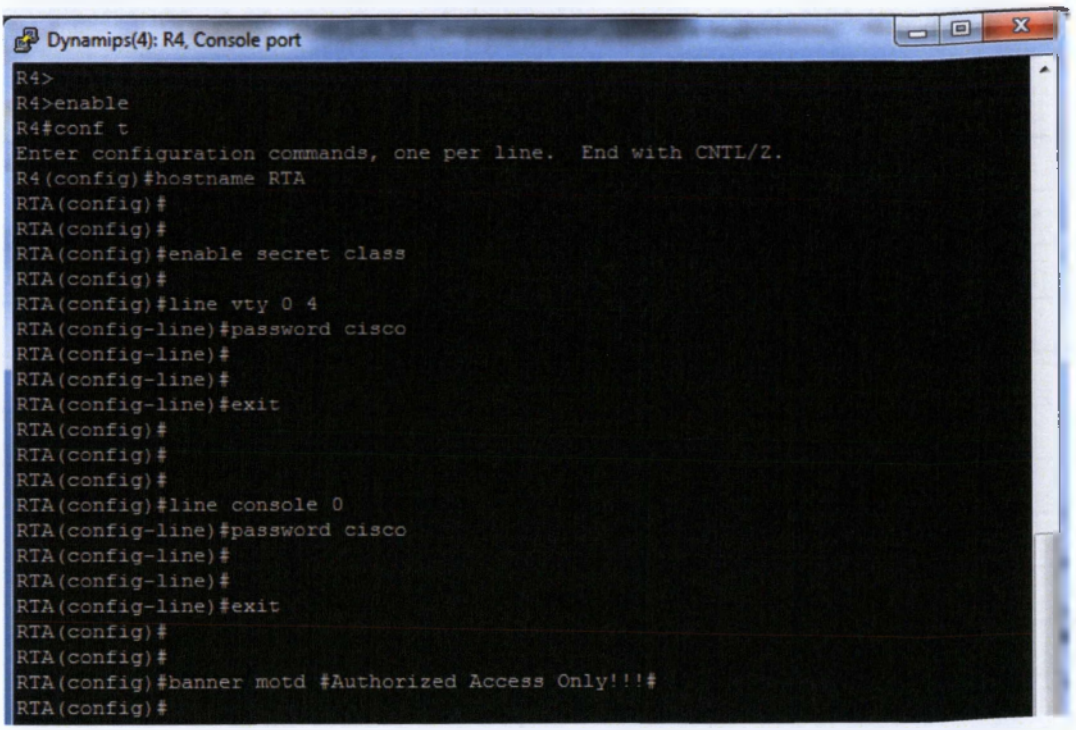
Device	Interface	IP Address	Subnet Mask
RTA	S0/1	10.0.0.1	255..255.255.252
	S0/0	10.0.0.9	255.255.255.252
	Fa0/0	172.16.0.1	255.255.192.0
RTB	S0/1	10.0.0.2	255.255.255.252
	S0/0	10.0.0.6	255.255.255.252
	Lo1	172.16.128.1	255.255.224.0
	Lo2	172.16.160.1	255.255.224.0
	Lo3	172.16.192.1	255.255.224.0
	Lo4	172.16.224.1	255.255.224.0
RTC	S0/1	10.0.0.5	255.255.255.252
	S0/0	10.0.0.10	255.255.255.252
	Lo1	172.16.64.1	255.255.240.0
	Lo2	172.16.80.1	255.255.240.0
	Lo3	172.16.96.1	255.255.240.0
	Lo4	172.16.112.0	255.255.240.0

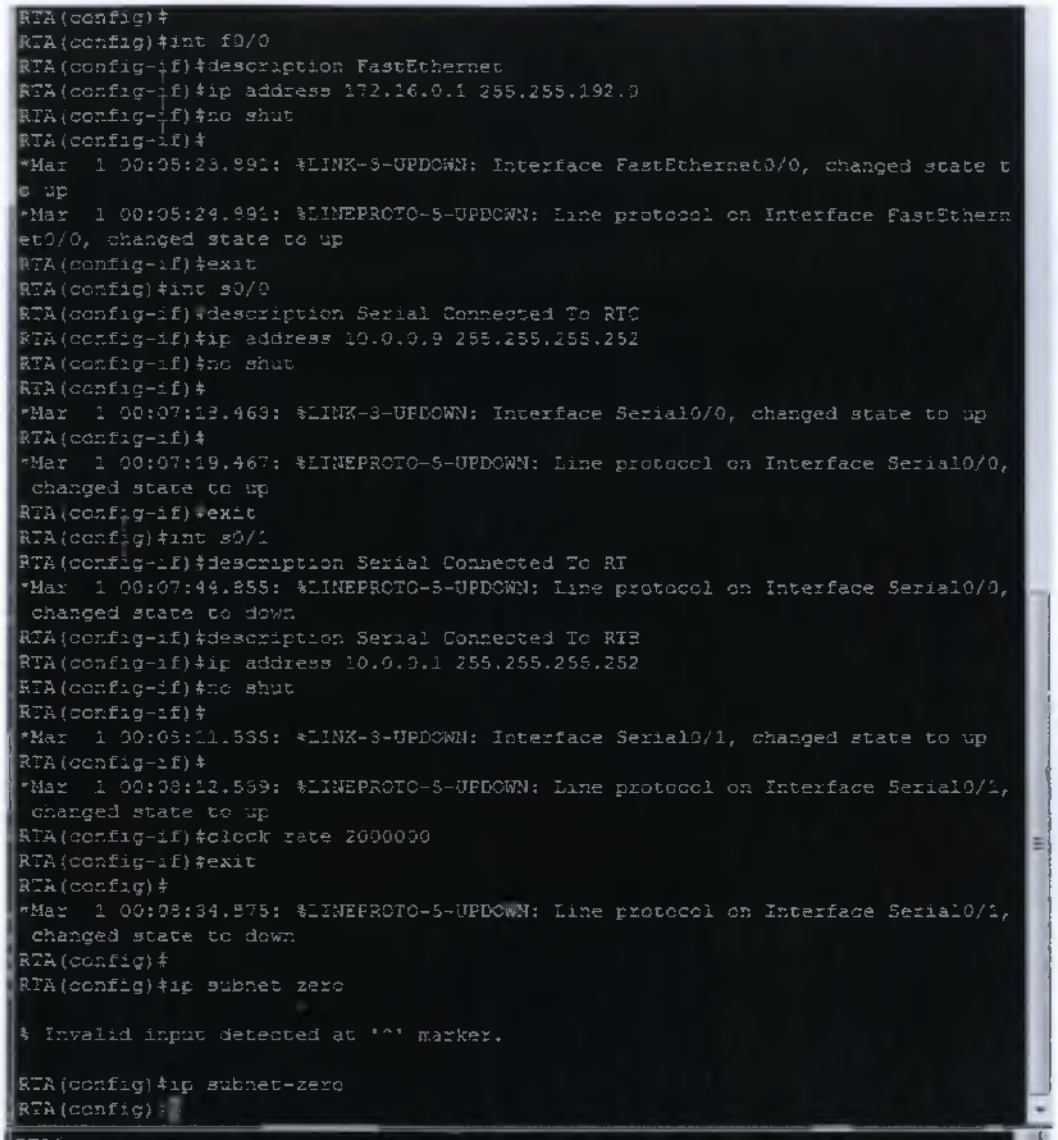
Πινακας 5 Addressing Scheme for EIGRP 2 Topology

1. The enable secret password for all routers is class.
2. The VTY, and console password for each router is cisco.
3. The "IP Host Table Entry" column contents *indicate the names of the other routers* in the IP host table.
4. Configure the motd
5. Do not forget to write the description of each interface
6. IP addressing of the topology.
7. Configure each host or loopbacks according to the topology.
8. Save each configuration in each router
9. The first 6 tasks are the main body of the exercises. You have to succesfully complete in order to proceed to the rest tasks.

Note: You may need to add the command ip subnet-zero because of the use of the ZERO subnet with VLSM on the 192.168.1.0/30 and 192.168.1.128/26 networks.

Router RTA



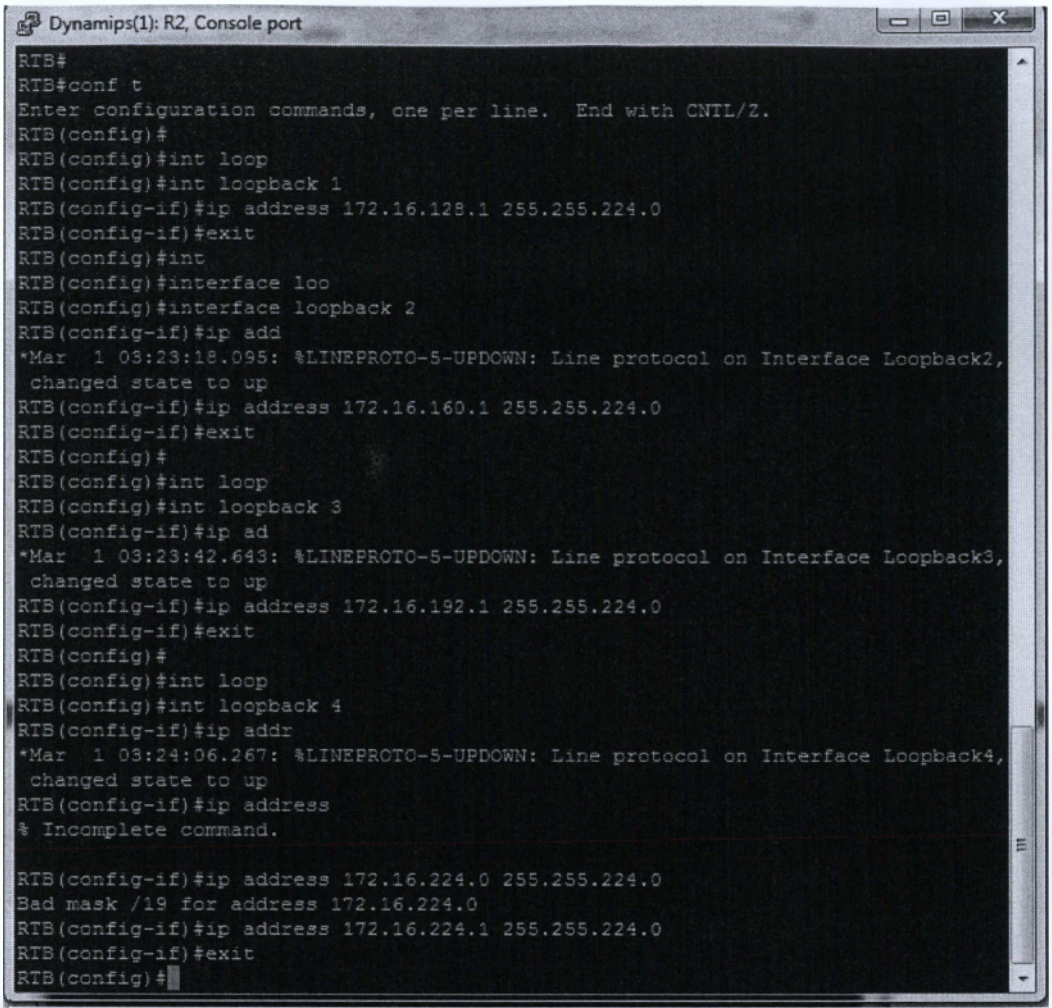

RTA(config)#
RTA(config)#int f0/0
RTA(config-if)#description FastEthernet
RTA(config-if)#ip address 172.16.0.1 255.255.192.0
RTA(config-if)#no shut
RTA(config-if)#
*Mar 1 00:05:23.991: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state t
o up
*Mar 1 00:05:24.991: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthern
et0/0, changed state to up
RTA(config-if)#exit
RTA(config)#int s0/0
RTA(config-if)#description Serial Connected To RTC
RTA(config-if)#ip address 10.0.0.9 255.255.255.252
RTA(config-if)#no shut
RTA(config-if)#
*Mar 1 00:07:18.469: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
RTA(config-if)#
*Mar 1 00:07:19.467: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
changed state to up
RTA(config-if)#exit
RTA(config)#int s0/1
RTA(config-if)#description Serial Connected To RT
*Mar 1 00:07:44.855: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
changed state to down
RTA(config-if)#description Serial Connected To RTB
RTA(config-if)#ip address 10.0.0.1 255.255.255.252
RTA(config-if)#no shut
RTA(config-if)#
*Mar 1 00:08:11.535: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up
RTA(config-if)#
*Mar 1 00:08:12.569: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1,
changed state to up
RTA(config-if)#clock rate 2000000
RTA(config-if)#exit
RTA(config)#
*Mar 1 00:08:34.875: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1,
changed state to down
RTA(config)#
RTA(config)#ip subnet zero
% Invalid input detected at '^' marker.
RTA(config)#ip subnet-zero
RTA(config)#
RTA#copy ru
RTA#copy running-config st
RTA#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
RTA#
RTA#wr
Building configuration...
[OK]
RTA#
RTA#

Router RTB

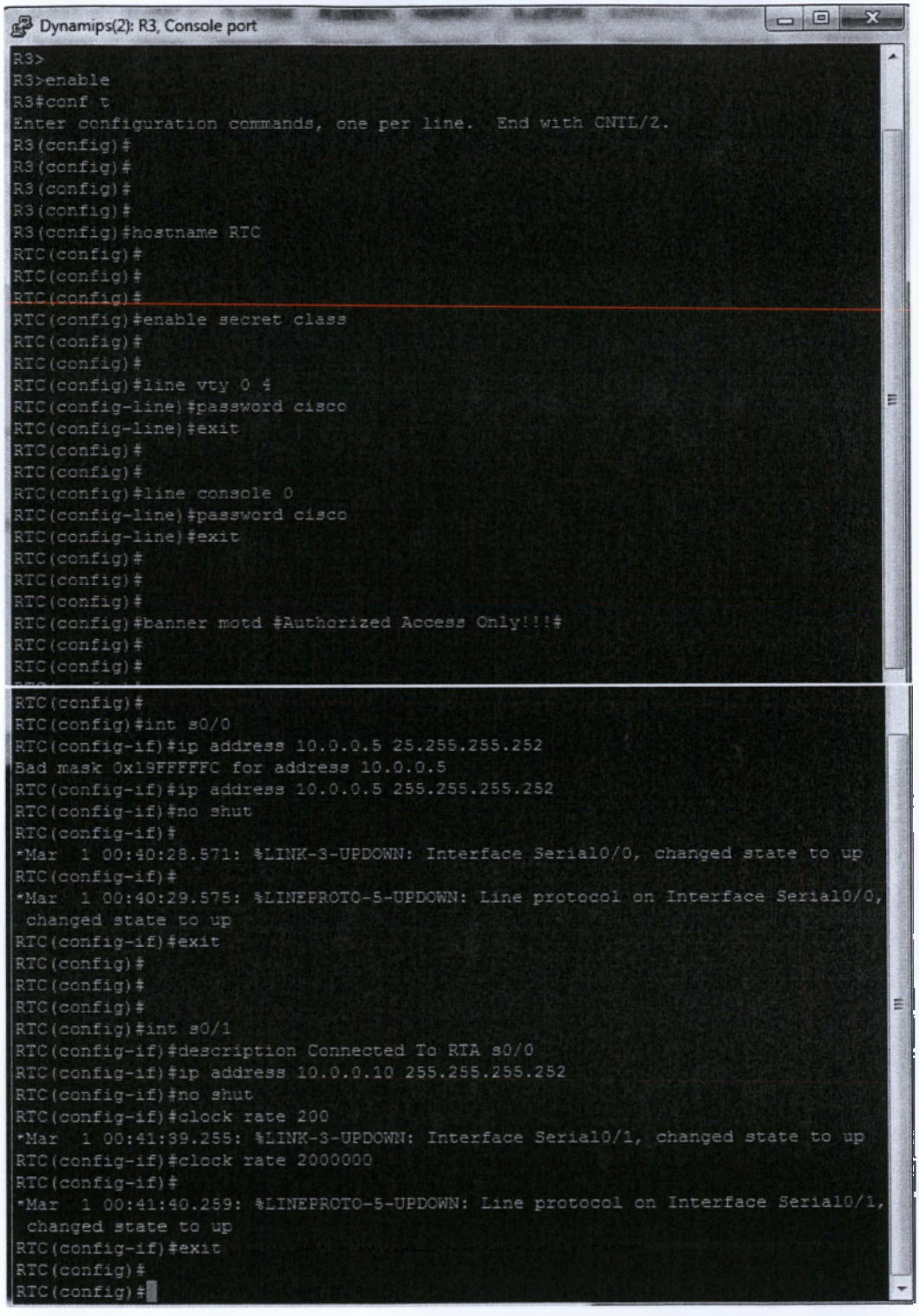
```
R2>
R2>enable
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#hostname RTB
RTB(config)#
RTB(config)#
RTB(config)#enable secret class
RTB(config)#
RTB(config)#
RTB(config)#line vty 0 4
RTB(config-line)#password cisco
RTB(config-line)#exit
RTB(config)#
RTB(config)#
RTB(config)#
RTB(config)#line console 0
RTB(config-line)#password cisco
RTB(config-line)#
RTB(config-line)#
RTB(config-line)#exit
RTB(config)#
RTB(config)#
RTB(config)#
RTB(config)#banner motd #Authorized Access Only!!!#
RTB(config)#
```

Dynamips(1): R2, Console port

```
RTB(config)#int s0/0
RTB(config-if)#description Connected To RTA s0/1
RTB(config-if)#ip address 10.0.0.2 255.255.255.252
RTB(config-if)#no shut
RTB(config-if)#
RTB(config-if)#
*Mar  1 00:22:46.387: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
RTB(config-if)#
*Mar  1 00:22:47.391: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
 changed state to up
RTB(config-if)#exit
RTB(config)#
RTB(config)#
RTB(config)#int s0/1
RTB(config-if)#description Connected to RTC s0/0
RTB(config-if)#ip address 10.0.0.6 255.255.255.252
RTB(config-if)#no shut
RTB(config-if)#clock rate
*Mar  1 00:23:46.823: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up
RTB(config-if)#clock rate 20
*Mar  1 00:23:47.827: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1,
 changed state to up
RTB(config-if)#clock rate 2000000
RTB(config-if)#exit
```


Dynamips(1): R2, Console port
RTB#
RTB#conf t
Enter configuration commands, one per line. End with CNTL/Z.
RTB(config)#
RTB(config)#int loop
RTB(config)#int loopback 1
RTB(config-if)#ip address 172.16.128.1 255.255.224.0
RTB(config-if)#exit
RTB(config)#int
RTB(config)#interface loo
RTB(config)#interface loopback 2
RTB(config-if)#ip add
*Mar 1 03:23:18.095: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback2,
 changed state to up
RTB(config-if)#ip address 172.16.160.1 255.255.224.0
RTB(config-if)#exit
RTB(config)#
RTB(config)#int loop
RTB(config)#int loopback 3
RTB(config-if)#ip ad
*Mar 1 03:23:42.643: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback3,
 changed state to up
RTB(config-if)#ip address 172.16.192.1 255.255.224.0
RTB(config-if)#exit
RTB(config)#
RTB(config)#int loop
RTB(config)#int loopback 4
RTB(config-if)#ip addr
*Mar 1 03:24:06.267: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback4,
 changed state to up
RTB(config-if)#ip address
% Incomplete command.
RTB(config-if)#ip address 172.16.224.0 255.255.224.0
Bad mask /19 for address 172.16.224.0
RTB(config-if)#ip address 172.16.224.1 255.255.224.0
RTB(config-if)#exit
RTB(config)#
Dynamips(1): R2, Console port
RTB#copy ru
RTB#copy running-config st
RTB#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
RTB#
RTB#wr
Building configuration...
[OK]

Router RTC


Dynamips(2): R3, Console port
R3>
R3>enable
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#
R3(config)#
R3(config)#
R3(config)#
R3(config)#hostname RTC
RTC(config)#
RTC(config)#
RTC(config)#
RTC(config)#enable secret class
RTC(config)#
RTC(config)#
RTC(config)#line vty 0 4
RTC(config-line)#password cisco
RTC(config-line)#exit
RTC(config)#
RTC(config)#
RTC(config)#line console 0
RTC(config-line)#password cisco
RTC(config-line)#exit
RTC(config)#
RTC(config)#
RTC(config)#
RTC(config)#banner motd #Authorized Access Only!!!#
RTC(config)#
RTC(config)#
RTC(config)#
RTC(config)#int s0/0
RTC(config-if)#ip address 10.0.0.5 25.255.255.252
Bad mask 0x19FFFFFC for address 10.0.0.5
RTC(config-if)#ip address 10.0.0.5 255.255.255.252
RTC(config-if)#no shut
RTC(config-if)#
*Mar 1 00:40:28.571: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
RTC(config-if)#
*Mar 1 00:40:29.575: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
changed state to up
RTC(config-if)#exit
RTC(config)#
RTC(config)#
RTC(config)#
RTC(config)#int s0/1
RTC(config-if)#description Connected To RTA s0/0
RTC(config-if)#ip address 10.0.0.10 255.255.255.252
RTC(config-if)#no shut
RTC(config-if)#clock rate 200
*Mar 1 00:41:39.255: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up
RTC(config-if)#clock rate 2000000
RTC(config-if)#
*Mar 1 00:41:40.259: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1,
changed state to up
RTC(config-if)#exit
RTC(config)#
RTC(config)#

```
RTC(config)#
RTC(config)#int loop
RTC(config)#int loopback 1
RTC(config-if)#ip address 172.16.64.1 255.255.240.0
RTC(config-if)#exit
RTC(config)#
RTC(config)#int loop
RTC(config)#int loopback 2
RTC(config-if)#ip addres
*Mar  1 03:37:04.399: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback2,
 changed state to up
RTC(config-if)#ip address 172.16.80.1 255.255.240.0
RTC(config-if)#exit
RTC(config)#
RTC(config)#int loop
RTC(config)#int loopback 3
RTC(config-if)#ip address
*Mar  1 03:37:28.203: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback3,
 changed state to up
RTC(config-if)#ip address 172.16.96.1 255.255.240.0
RTC(config-if)#exit
RTC(config)#
RTC(config)#int loop
RTC(config)#int loopback 4
RTC(config-if)#ip ad
*Mar  1 03:37:49.251: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback4,
 changed state to up
RTC(config-if)#ip address 172.16.112.1 255.255.240.0
RTC(config-if)#exit
RTC(config)#
RTC(config)#
```

```
RTC#copy ru
RTC#copy running-config st
RTC#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
RTC#
RTC#wr
Building configuration...
[OK]
RTC#
RTC#
RTC#
```

Verify interface information

- Ping from one of the connected serial interfaces to the other. If the ping was not successful, troubleshoot the router configuration until the ping is successful.

```
RTA#ping 10.0.0.10 source 10.0.0.9

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.10, timeout is 2 seconds:
Packet sent with a source address of 10.0.0.9
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/15/48 ms
RTA#
RTA#
```

```
RTB#ping 10.0.0.1 source 10.0.0.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.1, timeout is 2 seconds:
Packet sent with a source address of 10.0.0.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/19/64 ms
RTB#
```

```
RTC#
RTC#ping 10.0.0.9 source 10.0.0.10

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.9, timeout is 2 seconds:
Packet sent with a source address of 10.0.0.10
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/18/32 ms
RTC#
RTC#
```

- Using the show ip interface brief command, check the status of each interface.

```
RTA#show ip interface brief
Interface                  IP-Address      OK? Method Status                Proto
col
FastEthernet0/0            172.16.0.1      YES manual up                    up

Serial0/0                  10.0.0.9        YES manual up                    up

FastEthernet0/1            unassigned      YES unset  administratively down down

Serial0/1                  10.0.0.1        YES manual up                    up

RTA#
```

```
RTB#show ip interface brief
Interface                  IP-Address      OK? Method Status                Prot
ocol
FastEthernet0/0            unassigned      YES unset  administratively down d
Serial0/0                  10.0.0.2        YES manual up                    up

FastEthernet0/1            unassigned      YES unset  administratively down
Serial0/1                  10.0.0.6        YES manual up                    up

FastEthernet1/0            unassigned      YES unset  up
```

```
C#show ip interface brief
Interface                  IP-Address      OK? Method Status                Prot
ocol
FastEthernet0/0            unassigned      YES unset  administratively down
Serial0/0                  10.0.0.5        YES manual up                    up

FastEthernet0/1            unassigned      YES unset  administratively down
Serial0/1                  10.0.0.10       YES manual up                    up
```

Configure EIGRP Routing to all routers

- Enable the EIGRP routing process .Use EIGRP autonomous system number 101.

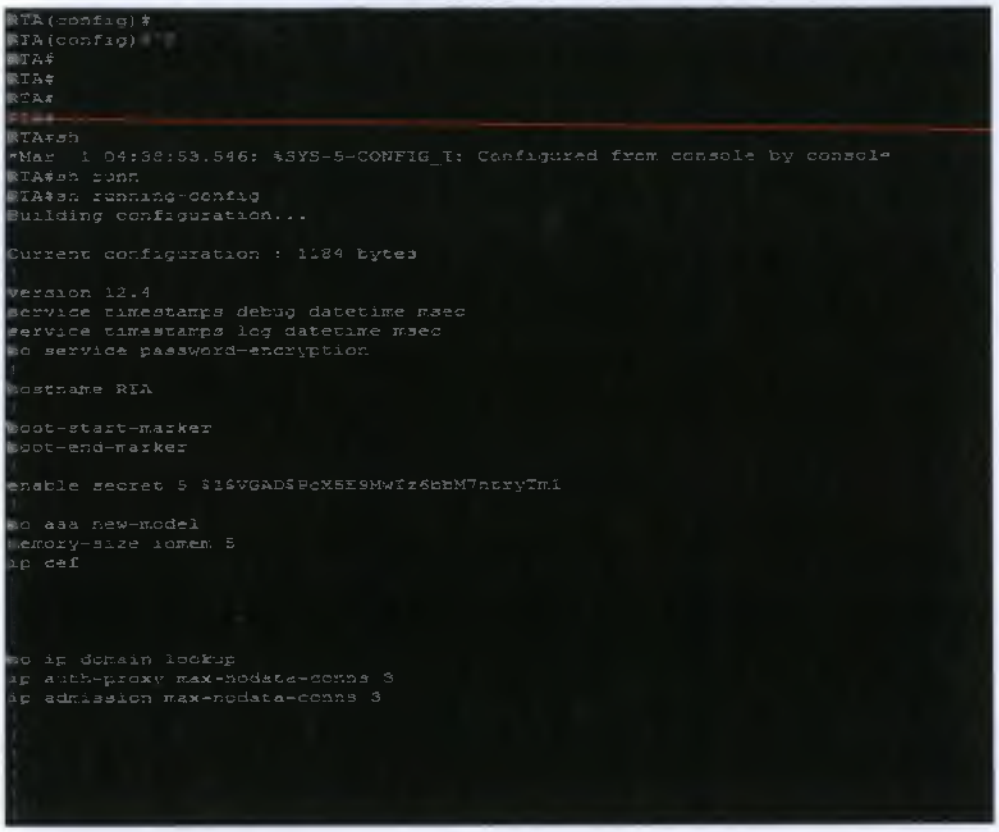
```
RTA#
RTA#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
RTA(config)#
RTA(config)#router eigrp 101
RTA(config-router)#network 172.16.0.0
RTA(config-router)#network 10.0.0.8
RTA(config-router)#network 10.0.0.0
RTA(config-router)#no auto-summary
RTA(config-router)#exit
RTA(config)#ip subnet-zero
RTA(config)#
```

```
RTB#
RTB#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
RTB(config)#router eigrp 101
RTB(config-router)#network 10.0.0.0
RTB(config-router)#network 10.0.0.0
*Mar  1 04:30:50.062: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 101: Neighbor 10.0.0.1 (Serial0/
0) is up: new adjacency
RTB(config-router)#network 10.0.0.4
RTB(config-router)#network 172.16.128.0
RTB(config-router)#network 172.16.160.0
RTB(config-router)#network 172.16.192.0
RTB(config-router)#network 172.16.224.0
RTB(config-router)#no auto-summary
RTB(config-router)#
*Mar  1 04:31:45.230: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 101: Neighbor 10.0.0.1 (Serial0/
0) is resync: summary configured
RTB(config-router)#exit
RTB(config)#
RTB(config)#ip subnet-zero
RTB(config)#
RTB(config)#
```

```
RTC(config)#
RTC(config)#router eigrp 101
RTC(config-router)#network 10.0.0.4
RTC(config-router)#network 10.0.0.
*Mar  1 04:33:30.170: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 101: Neighbor 10.0.0.9 (Ser
ial0/1) is up: new adjacency
*Mar  1 04:33:30.174: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 101: Neighbor 10.0.0.6 (Ser
ial0/0) is up: new adjacency
RTC(config-router)#network 10.0.0.8
RTC(config-router)#network 172.16.64.0
RTC(config-router)#network 172.16.80.0
RTC(config-router)#network 172.16.96.0
RTC(config-router)#network 172.16.112.0
RTC(config-router)#no auto summary

% Invalid input detected at '^' marker.

RTC(config-router)#no auto-summary
RTC(config-router)#
*Mar  1 04:34:22.254: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 101: Neighbor 10.0.0.6 (Ser
ial0/0) is resync: summary configured
*Mar  1 04:34:22.254: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 101: Neighbor 10.0.0.9 (Ser
ial0/1) is resync: summary configured
RTC(config-router)#exit
RTC(config)#
RTC(config)#
RTC(config)#ip subnet-zero
RTC(config)#
RTC(config)#
```

- Examine the routers that are running configuration files.

RTA



```
interface FastEthernet0/0
 description FastEthernet
 ip address 172.16.0.1 255.255.192.0
 duplex auto
 speed auto

interface Serial0/0
 description Serial Connected To RTC
 ip address 10.0.0.9 255.255.255.252
 clock rate 2000000

interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto

interface Serial0/1
 description Serial Connected To RTB
 ip address 10.0.0.1 255.255.255.252
 clock rate 2000000

router eigrp 101
 network 10.0.0.0
 network 172.16.0.0
 no auto-summary

ip forward-protocol nd


no ip http server
no ip http secure-server



control-plane
```

```
banner motd ^CAuthorized Access Only!!!^C

line con 0
 exec-timeout 0 0
 password cisco
 logging synchronous
line aux 0
line vty 0 4
 password cisco
 login


end

#
#
```

RTB

```
RTB#sh run
RTB#sh running-config
Building configuration...

Current configuration : 1173 bytes
!
Version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname RTB
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$Py1I$UCmKA8SM1uR4A2YfRwGWO/
!
no aaa new-model
memory size iomem 5
ip cef



no ip domain lookup
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
```

```
interface Loopback1
 ip address 172.16.128.1 255.255.224.0

interface Loopback2
 ip address 172.16.160.1 255.255.224.0

interface Loopback3
 ip address 172.16.192.1 255.255.224.0

interface Loopback4
 ip address 172.16.224.1 255.255.224.0

interface FastEthernet0/0
 no ip address
 shutdown
 duplex auto
 speed auto

interface Serial0/0
 description Connected To RTA s0/1
 ip address 10.0.0.2 255.255.255.252
 clock rate 2000000
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto

interface Serial0/1
 description Connected to RTC s0/0
 ip address 10.0.0.6 255.255.255.252
 clock rate 2000000

interface FastEthernet1/0

interface FastEthernet1/1

interface FastEthernet1/2

interface FastEthernet1/3

interface FastEthernet1/4
```

```
interface Vlan1
 no ip address

router eigrp 101
 network 10.0.0.0
 network 172.16.0.0
 no auto-summary

ip forward-protocol nd

no ip http server
no ip http secure-server



control-plane









banner motd ^CAuthorized Access Only!!!^C

line con 0
 exec-timeout 0 0
 password cisco
 logging synchronous
line aux 0
line vty 0 4
 password cisco
 login

end

RT3#
```

RTC

```
RTC#sh run
RTC#sh running-config
Building configuration...

Current configuration : 1837 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname RTC
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$A/hU$hwpWKaWStSdhUyis78UzZ.
!
no aaa new-model
memory-size iomem 5
ip cef
!
!
!
!
no ip domain lookup
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
```

```
interface Vlan1
 no ip address
!
router eigrp 101
 network 10.0.0.0
 network 172.16.0.0
 no auto-summary
!
ip forward-protocol nd
!
!
no ip http server
no ip http secure-server
!
!
!
!
control-plane
!
!
!
!
!
!
!
!
!
banner motd ^CAuthorized Access Only!!!^C
!
line con 0
 exec-timeout 0 0
 password cisco
 logging synchronous
line aux 0
line vty 0 4
 password cisco
 login
!
!
end

RTC#
```

- Show the routing table

```
RTA#
RTA#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/16 is variably subnetted, 9 subnets, 3 masks
D       172.16.160.0/19 [90/2297856] via 10.0.0.2, 00:18:48, Serial0/1
D       172.16.128.0/19 [90/2297856] via 10.0.0.2, 00:18:48, Serial0/1
D       172.16.224.0/19 [90/2297856] via 10.0.0.2, 00:18:48, Serial0/1
D       172.16.192.0/19 [90/2297856] via 10.0.0.2, 00:18:48, Serial0/1
C       172.16.0.0/18 is directly connected, FastEthernet0/0
D       172.16.112.0/20 [90/2297856] via 10.0.0.10, 00:17:56, Serial0/0
D       172.16.96.0/20 [90/2297856] via 10.0.0.10, 00:18:01, Serial0/0
D       172.16.80.0/20 [90/2297856] via 10.0.0.10, 00:18:01, Serial0/0
D       172.16.64.0/20 [90/2297856] via 10.0.0.10, 00:18:01, Serial0/0
     10.0.0.0/30 is subnetted, 3 subnets
C       10.0.0.8 is directly connected, Serial0/0
C       10.0.0.0 is directly connected, Serial0/1
D       10.0.0.4 [90/2681856] via 10.0.0.10, 00:18:58, Serial0/0
                 [90/2681856] via 10.0.0.2, 00:18:58, Serial0/1
RTA#
```

```
RTB#
RTB#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/16 is variably subnetted, 9 subnets, 3 masks
C       172.16.160.0/19 is directly connected, Loopback2
C       172.16.128.0/19 is directly connected, Loopback1
C       172.16.224.0/19 is directly connected, Loopback4
C       172.16.192.0/19 is directly connected, Loopback3
D       172.16.0.0/18 [90/2195456] via 10.0.0.1, 00:20:04, Serial0/0
D       172.16.112.0/20 [90/2297856] via 10.0.0.5, 00:19:12, Serial0/1
D       172.16.96.0/20 [90/2297856] via 10.0.0.5, 00:19:12, Serial0/1
D       172.16.80.0/20 [90/2297856] via 10.0.0.5, 00:19:18, Serial0/1
D       172.16.64.0/20 [90/2297856] via 10.0.0.5, 00:19:18, Serial0/1
     10.0.0.0/30 is subnetted, 3 subnets
D       10.0.0.8 [90/2681856] via 10.0.0.5, 00:20:10, Serial0/1
                 [90/2681856] via 10.0.0.1, 00:20:10, Serial0/0
C       10.0.0.0 is directly connected, Serial0/0
C       10.0.0.4 is directly connected, Serial0/1
RTB#
```

```
RTC#
RTC#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/16 is variably subnetted, 9 subnets, 5 masks
D       172.16.160.0/19 [90/2297856] via 10.0.0.6, 00:21:42, Serial0/0
D       172.16.128.0/19 [90/2297856] via 10.0.0.6, 00:21:42, Serial0/0
D       172.16.224.0/19 [90/2297856] via 10.0.0.6, 00:21:42, Serial0/0
D       172.16.192.0/19 [90/2297856] via 10.0.0.6, 00:21:42, Serial0/0
D       172.16.0.0/19 [90/2195456] via 10.0.0.9, 00:21:42, Serial0/1
C       172.16.112.0/20 is directly connected, Loopback4
C       172.16.96.0/20 is directly connected, Loopback3
C       172.16.80.0/20 is directly connected, Loopback2
C       172.16.64.0/20 is directly connected, Loopback1
     10.0.0.0/30 is subnetted, 3 subnets
C       10.0.0.8 is directly connected, Serial0/1
D       10.0.0.0 [90/2681856] via 10.0.0.9, 00:21:46, Serial0/1
                 [90/2681856] via 10.0.0.6, 00:21:46, Serial0/0
C       10.0.0.4 is directly connected, Serial0/0
RTC#
```

- Ping from loopbacks.

```
RTB#
RTB#
RTB#ping 172.16.128.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.128.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/3/4 ms
RTB#ping 172.16.160.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.160.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
RTB#ping 172.16.192.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.192.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
RTB#ping 172.16.224.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.224.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/3/4 ms
RTB#
```

```
RTB#ping 172.16.64.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.64.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/30/88 ms
RTB#ping 172.16.80.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.80.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/25/64 ms
RTB#ping 172.16.96.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.96.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/18/76 ms
RTB#ping 172.16.112.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.112.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/19/64 ms
RTB#
```

```
RTC#
RTC#ping 172.16.64.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.64.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
RTC#ping 172.16.80.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.80.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/3/4 ms
RTC#ping 172.16.96.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.96.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/3/4 ms
RTC#ping 172.16.112.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.112.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
RTC#
```

```
RTC#
RTC#ping 172.16.128.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.128.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/53/80 ms
RTC#ping 172.16.160.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.160.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/20/60 ms
RTC#ping 172.16.192.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.192.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/29/64 ms
RTC#ping 172.16.224.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.224.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/29/116 ms
RTC#
```

Show CDP neighbors

- From the RTA router, show any neighbors that are connected by using the **show ip eigrp neighbors** command at the privileged EXEC mode prompt.

```
RTA#
RTA#show ip eigrp neighbors
IP-EIGRP neighbors for process 101
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
1   10.0.0.10               Se0/0            14 00:35:59   91   546  0  16
0   10.0.0.2                Se0/1            11 00:38:40   66   396  0  22
RTA#
```

- Are neighbours shown? **Yes.**

Verify connectivity based on EIGRP

- Enable the EIGRP routing process .Use EIGRP autonomous system number 101.

```
RTB(config)#router eigrp 101
```

```
RTA(config)#router eigrp 101
```

- Show the routing table

```
RTA#s
*Mar  1 05:34:07.662: %SYS-5-CONFIG_I: Configured from console by console
RTA#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/16 is variably subnetted, 9 subnets, 3 masks
D       172.16.160.0/19 [90/2297856] via 10.0.0.2, 00:15:08, Serial0/1
D       172.16.128.0/19 [90/2297856] via 10.0.0.2, 00:15:08, Serial0/1
D       172.16.224.0/19 [90/2297856] via 10.0.0.2, 00:15:08, Serial0/1
D       172.16.192.0/19 [90/2297856] via 10.0.0.2, 00:15:08, Serial0/1
C       172.16.0.0/18 is directly connected, FastEthernet0/0
D       172.16.112.0/20 [90/2297856] via 10.0.0.10, 00:16:56, Serial0/0
D       172.16.96.0/20 [90/2297856] via 10.0.0.10, 00:17:02, Serial0/0
D       172.16.80.0/20 [90/2297856] via 10.0.0.10, 00:17:02, Serial0/0
D       172.16.64.0/20 [90/2297856] via 10.0.0.10, 00:17:02, Serial0/0
     10.0.0.0/30 is subnetted, 3 subnets
C       10.0.0.8 is directly connected, Serial0/0
C       10.0.0.0 is directly connected, Serial0/1
D       10.0.0.4 [90/21024000] via 10.0.0.10, 00:15:34, Serial0/0
                 [90/21024000] via 10.0.0.2, 00:15:34, Serial0/1
RTA#
```

```
R1#
*Mar  1 05:38:30.483: %SYS-5-CONFIG_I: Configured from console by console
R1#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/16 is variably subnetted, 9 subnets, 3 masks
C       172.16.160.0/19 is directly connected, Loopback2
C       172.16.128.0/19 is directly connected, Loopback1
C       172.16.224.0/19 is directly connected, Loopback4
C       172.16.192.0/19 is directly connected, Loopback3
D       172.16.0.0/16 [90/20537600] via 10.0.0.1, 00:17:38, Serial0/0
D       172.16.112.0/20 [90/20640000] via 10.0.0.5, 00:17:39, Serial0/1
D       172.16.96.0/20 [90/20640000] via 10.0.0.5, 00:17:39, Serial0/1
D       172.16.80.0/20 [90/20640000] via 10.0.0.5, 00:17:44, Serial0/1
D       172.16.64.0/20 [90/20640000] via 10.0.0.5, 00:17:44, Serial0/1
     10.0.0.0/30 is subnetted, 3 subnets
D       10.0.0.8 [90/21024000] via 10.0.0.5, 00:17:44, Serial0/1
                 [90/21024000] via 10.0.0.1, 00:17:44, Serial0/0
C       10.0.0.0 is directly connected, Serial0/0
C       10.0.0.4 is directly connected, Serial0/1
R1#
```

```
RTC#
RTC#
*Mar  1 05:39:05.546: %SYS-5-CONFIG_I: Configured from console by console
RTC#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/16 is variably subnetted, 9 subnets, 3 masks
D       172.16.160.0/19 [90/20640000] via 10.0.0.6, 00:16:31, Serial0/0
D       172.16.128.0/19 [90/20640000] via 10.0.0.6, 00:16:31, Serial0/0
D       172.16.224.0/19 [90/20640000] via 10.0.0.6, 00:16:31, Serial0/0
D       172.16.192.0/19 [90/20640000] via 10.0.0.6, 00:16:31, Serial0/0
D       172.16.0.0/16 [90/20537600] via 10.0.0.9, 00:16:31, Serial0/1
C       172.16.112.0/20 is directly connected, Loopback4
C       172.16.96.0/20 is directly connected, Loopback3
C       172.16.80.0/20 is directly connected, Loopback2
C       172.16.64.0/20 is directly connected, Loopback1
     10.0.0.0/30 is subnetted, 3 subnets
C       10.0.0.8 is directly connected, Serial0/1
D       10.0.0.0 [90/21024000] via 10.0.0.9, 00:16:35, Serial0/1
                 [90/21024000] via 10.0.0.6, 00:16:35, Serial0/0
C       10.0.0.4 is directly connected, Serial0/0
RTC#
```

- According to the topology, RTB and RTC are connected with a 128-kbps link. Enter the commands on both routers necessary to adjust the default bandwidth to match the actual speed.

```
RTB#
RTB#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
RTB(config)#int s0/0
RTB(config-if)#bandwidth 128
RTB(config-if)#exit
RTB(config)#
RTB(config)#
RTB(config)#int s0/1
RTB(config-if)#bandwidth 128
RTB(config-if)#exit
RTB(config)#
```

```
RTC#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
RTC(config)#
RTC(config)#int s0/0
RTC(config-if)#bandwidth 128
RTC(config-if)#exit
RTC(config)#
RTC(config)#int s0/1
RTC(config-if)#bandwidth 128
RTC(config-if)#exit
RTC(config)#
```

- Display the routing table on RTA.

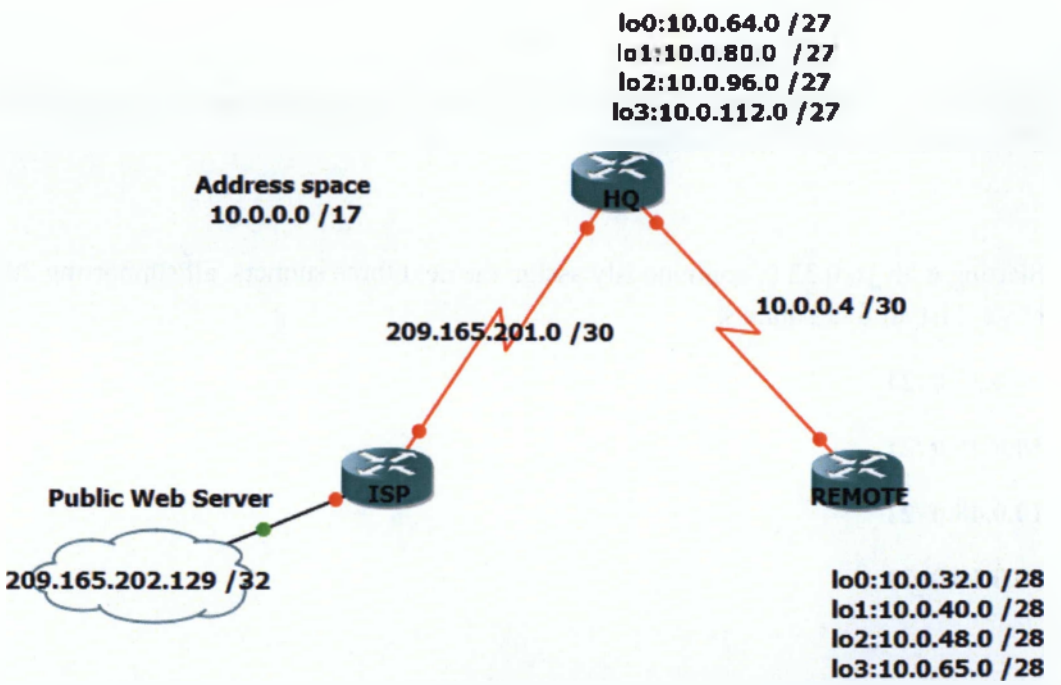
```
RTA#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/16 is variably subnetted, 9 subnets, 3 masks
D       172.16.160.0/19 [90/2297856] via 10.0.0.2, 00:15:08, Serial0/1
D       172.16.128.0/19 [90/2297856] via 10.0.0.2, 00:15:08, Serial0/1
D       172.16.224.0/19 [90/2297856] via 10.0.0.2, 00:15:08, Serial0/1
D       172.16.192.0/19 [90/2297856] via 10.0.0.2, 00:15:08, Serial0/1
C       172.16.0.0/19 is directly connected, FastEthernet0/0
D       172.16.112.0/20 [90/2297856] via 10.0.0.10, 00:16:56, Serial0/0
D       172.16.96.0/20 [90/2297856] via 10.0.0.10, 00:17:02, Serial0/0
D       172.16.80.0/20 [90/2297856] via 10.0.0.10, 00:17:02, Serial0/0
D       172.16.64.0/20 [90/2297856] via 10.0.0.10, 00:17:02, Serial0/0
     10.0.0.0/30 is subnetted, 3 subnets
C       10.0.0.8 is directly connected, Serial0/0
C       10.0.0.0 is directly connected, Serial0/1
D       10.0.0.4 [90/21024000] via 10.0.0.10, 00:15:34, Serial0/0
                 [90/21024000] via 10.0.0.2, 00:15:34, Serial0/1
RTA#
```

- Notice that RTA does not have routes to the simulated LANs on RTB and RTC. Enter the command to disable automatic summarization on all three routers.

```
RTB(config)#
RTB(config)#router eigrp 101
RTB(config-router)#no auto-summary
RTB(config-router)#exit
RTB(config)#
```

```
RTC(config)#
RTC(config)#router eigrp 101
RTC(config-router)#no auto-summary
RTC(config-router)#exit
RTC(config)#
```

6.7.3 EIGRP Design and Configuration



Εικόνα 50 EIGRP Design And Configuration Topology

You are given the address space, 10.0.0.0/17. The four loopback interfaces on HQ and four loopback interfaces on REMOTE are used to simulate different parts of a global network. Complete the following steps to design your addressing scheme.

1. For HQ, begin with the 10.0.64.0 address as the subnet for loopback 0. What subnet mask would you use to provide enough space for 4000 users while maximizing the number of subnets?

   Answer

   255.255.240.0 (/20) because we need 4000 hosts, which means 12 bits for hosts. 2^{12}-2=4094 for each subnet

2. Starting with 10.0.64.0, contiguously assign the next three subnets, all supporting 4000 hosts. List all four subnets.

   Answer

   10.0.64.0, 10.0.80.0, 10.0.96.0, 10.0.112.0

3. For REMOTE, begin with the 10.0.32.0 address as the subnet for loop back 0. What subnet mask would you use to provide enough space for 2000 users while maximizing the number of subnets?

   Answer

   255.255.248.0 or /21 because we need 2000 hoists, whitch means 11 bits for hosts. 2^{11}-2=2046 hosts for each subnet.

4. Starting with 10.0.32.0, contiguously assign the next three subnets, all supporting 2000 hosts. List all four subnets.

   10.0.32.0 /21

   10.0.40.0 /21

   10.0.48.0 /21

   10.0.56.0 /21

5. Now pick a WAN subnet for the link shared by HQ and REMOTE. List the subnet you assigned.
   10.0.0.8 /21

6. Label the topology with the networks and finish filling in the IP address table with your chosen addressing scheme. Use the first available IP address in each subnet as the interface address. For the WAN subnet, assign HQ the first address.

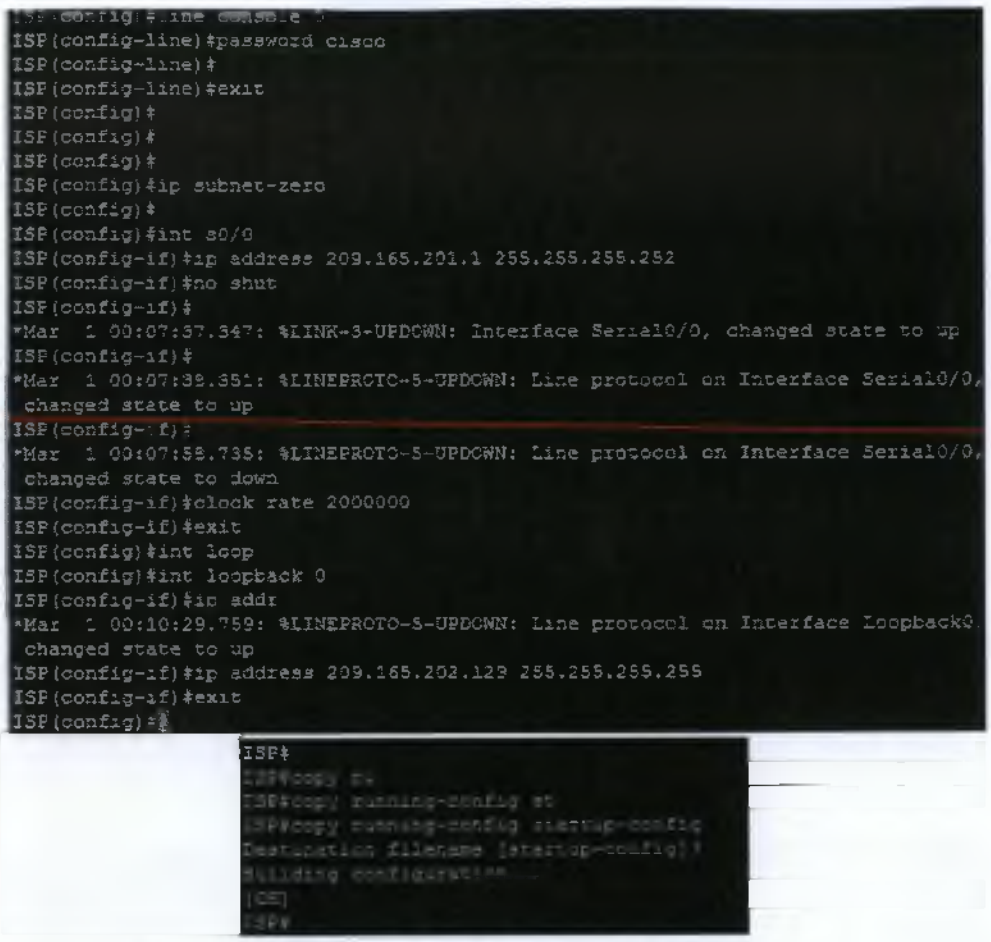
Device	Interface	IP Address	Subnet Mask
ISP	Lo0	209.165.202.129	255.255.255.255
	S0/0	209.165.201.1	255.255.255.252
HQ	S0/0	209.165.201.2	255.255.255.252
	S0/1	**10.0.0.5**	**255.255.255.252**
	Lo0	**10.0.64.1**	**255.255.240.0**
	Lo1	**10.0.80.1**	**255.255.240.0**
	Lo2	**10.0.96.1**	**255.255.240.0**
	Lo3	**10.0.112.1**	**255.255.240.0**
REMOTE	S0/1	**10.0.0.6**	**255.255.255.252**
	Lo0	**10.0.32.1**	**255.255.248.0**
	Lo1	**10.0.40.1**	**255.255.248.0**
	Lo2	**10.0.48.1**	**255.255.248.0**
	Lo3	**10.0.56.1**	**255.255.248.0**

- Configure the routers with basic configurations including interface addresses.

ISP

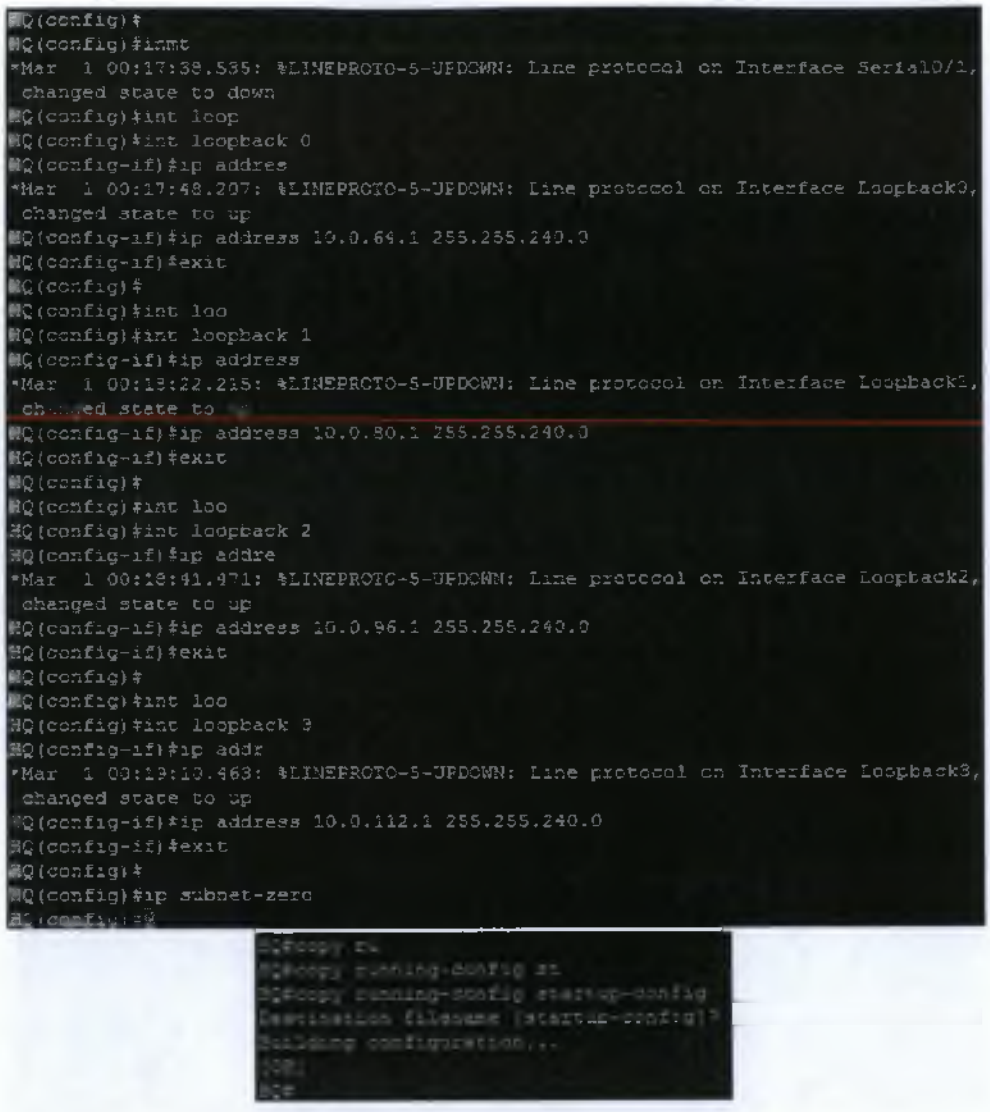
```
Connected to Dynamips VM "R1" (ID 0, type c3745) - Console port
Press ENTER to get the prompt.

R1>enable
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#hostname ISP
ISP(config)#enable secret class
```


```
Connected to Dynamips VM "R1" (ID 0, type c3745) - Console port
Press ENTER to get the prompt.

R1>enable
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#hostname ISP
ISP(config)#enable secret class
```


ISP(config)#line console 0
ISP(config-line)#password cisco
ISP(config-line)#
ISP(config-line)#exit
ISP(config)#
ISP(config)#
ISP(config)#
ISP(config)#ip subnet-zero
ISP(config)#
ISP(config)#int s0/0
ISP(config-if)#ip address 209.165.201.1 255.255.255.252
ISP(config-if)#no shut
ISP(config-if)#
*Mar 1 00:07:37.347: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
ISP(config-if)#
*Mar 1 00:07:38.351: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
changed state to up
ISP(config-if)#
*Mar 1 00:07:55.735: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
changed state to down
ISP(config-if)#clock rate 2000000
ISP(config-if)#exit
ISP(config)#int loop
ISP(config)#int loopback 0
ISP(config-if)#ip addr
*Mar 1 00:10:29.759: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
changed state to up
ISP(config-if)#ip address 209.165.202.129 255.255.255.255
ISP(config-if)#exit
ISP(config)#
ISP#

HQ

```
Connected to Dynamips VM "R2" (ID 1, type c3745) - Console port
Press ENTER to get the prompt.

R2>enable
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#hostname HQ
HQ(config)#enable secret class
HQ(config)#
HQ(config)#line vty 0 4
HQ(config-line)#password cisco
HQ(config-line)#exit
HQ(config)#
HQ(config)#
HQ(config)#line console 0
HQ(config-line)#password cisco
HQ(config-line)#exit
HQ(config)#
HQ(config)#
HQ(config)#int s0/0
HQ(config-if)#description Link to ISPF
HQ(config-if)#ip address 209.165.201.2 255.255.255.252
HQ(config-if)#no shut
HQ(config-if)#
*Mar  1 00:16:08.291: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
*Mar  1 00:16:09.291: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
 changed state to up
HQ(config-if)#exit
HQ(config)#
HQ(config)#
HQ(config)#int s0/1
HQ(config-if)#description Link To REMOTE
HQ(config-if)#ip address 10.0.0.5 255.255.255.252
HQ(config-if)#no shut
HQ(config-if)#clock rate 20
*Mar  1 00:17:08.959: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up
HQ(config-if)#clock rate 200000
*Mar  1 00:17:09.963: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1,
 changed state to up
HQ(config-if)#clock rate 2000000
HQ(config-if)#exit
HQ(config)#
```


HQ(config)#
HQ(config)#inmt
*Mar 1 00:17:38.535: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1, changed state to down
HQ(config)#int loop
HQ(config)#int loopback 0
HQ(config-if)#ip addres
*Mar 1 00:17:48.207: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
HQ(config-if)#ip address 10.0.64.1 255.255.240.0
HQ(config-if)#exit
HQ(config)#
HQ(config)#int loo
HQ(config)#int loopback 1
HQ(config-if)#ip address
*Mar 1 00:18:22.215: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
HQ(config-if)#ip address 10.0.80.1 255.255.240.0
HQ(config-if)#exit
HQ(config)#
HQ(config)#int loo
HQ(config)#int loopback 2
HQ(config-if)#ip addre
*Mar 1 00:18:41.471: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback2, changed state to up
HQ(config-if)#ip address 10.0.96.1 255.255.240.0
HQ(config-if)#exit
HQ(config)#
HQ(config)#int loo
HQ(config)#int loopback 3
HQ(config-if)#ip addr
*Mar 1 00:19:10.463: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback3, changed state to up
HQ(config-if)#ip address 10.0.112.1 255.255.240.0
HQ(config-if)#exit
HQ(config)#
HQ(config)#ip subnet-zero

REMOTE

```
R3>enable
R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#hostname REMOTE
REMOTE(config)#enable secret class
REMOTE(config)#line vty 0 4
REMOTE(config-line)#password cisco
REMOTE(config-line)#exit
REMOTE(config)#
REMOTE(config)#line console 0
REMOTE(config-line)#password cisco
REMOTE(config-line)#exit
REMOTE(config)#
REMOTE(config)#ip subnet-zero
REMOTE(config)#
REMOTE(config)#int s0/0
REMOTE(config-if)#description Link To HQ
REMOTE(config-if)#
REMOTE(config-if)#ip address 10.0.0.6 255.255.255.252
REMOTE(config-if)#no shut
REMOTE(config-if)#exi
*Mar  1 00:23:35.731: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
REMOTE(config-if)#exit
REMOTE(config)#
*Mar  1 00:23:36.735: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
 changed state to up
REMOTE(config)#
```

```
REMOTE(config)#
REMOTE(config)#int loo
REMOTE(config)#int loopback 0
REMOTE(config-if)#ip addres
*Mar  1 00:23:47.287: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
 changed state to up
REMOTE(config-if)#ip address 10.0.32.1 255.255.248.0
REMOTE(config-if)#exit
REMOTE(config)#
REMOTE(config)#int loo
REMOTE(config)#int loopback 1
REMOTE(config-if)#ip addre
*Mar  1 00:24:12.283: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1,
 changed state to up
REMOTE(config-if)#ip address 10.0.40.1 255.255.248.0
REMOTE(config-if)#exit
REMOTE(config)#
REMOTE(config)#int loo
REMOTE(config)#int loopback 2
REMOTE(config-if)#ip address
*Mar  1 00:24:33.803: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback2,
 changed state to up
REMOTE(config-if)#ip address 10.0.48.1 255.255.248.0
REMOTE(config-if)#exit
REMOTE(config)#
REMOTE(config)#int loo
REMOTE(config)#int loopback 3
REMOTE(config-if)#ip addr
*Mar  1 00:24:52.291: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback3,
 changed state to up
REMOTE(config-if)#ip address 10.0.56.1 255.255.248.0
REMOTE(config-if)#exit
REMOTE(config)#
```

```
REMOTE#
*Mar  1 00:09:31.147: %SYS-5-CONFIG_I: Configured from console by console
REMOTE#copy ru
REMOTE#copy running-config st
REMOTE#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
```

Configure EIGRP Routing and Default Routing

- Configure both HQ and REMOTE to use EIGRP as the routing protocol. Enter the simulated LAN subnets and the WAN link between HQ and REMOTE. Do not advertise the 209.165.201.0/30 network. Make sure you disable automatic summarization.

```
ISP(config)#
ISP(config)#router eigrp 101
ISP(config-router)#network 209.165.202.128
ISP(config-router)#no auto-summary
ISP(config-router)#exit
ISP(config)#
```

```
HQ(config)#
HQ(config)#router eigrp 101
HQ(config-router)#network 10.0.64.0
HQ(config-router)#network 10.0.80.0
HQ(config-router)#network 10.0.96.0
HQ(config-router)#network 10.0.112.0
HQ(config-router)#no auto-summary
HQ(config-router)#exit
HQ(config)#
```

```
REMOTE(config)#router eigrp 101
REMOTE(config-router)#network 10.0.0.4
REMOTE(config-router)#network 10.0.0.4
*Mar  1 01:37:53.123: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 101: Neighbor 10.0.0.5 (Ser
ial0/0) is up: new adjacency
REMOTE(config-router)#network 10.0.32.0
REMOTE(config-router)#network 10.0.40.0
REMOTE(config-router)#network 10.0.48.0
REMOTE(config-router)#network 10.0.56.0
REMOTE(config-router)#no auto-summary
REMOTE(config-router)#exit
*Mar  1 01:38:30.027: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 101: Neighbor 10.0.0.5 (Ser
ial0/0) is resync: summary configured
REMOTE(config-router)#exit
REMOTE(config)#
```

- Configure ISP with a static route pointing to the 10.0.0.0/17 Address Space .

```
HQ(config)#
HQ(config)#ip route 0.0.0.0 0.0.0.0 s0/0
HQ(config)#
HQ(config)#ip classless
HQ(config)#
HQ(config)#
```

- Configure HQ to advertise the default route to REMOTE with the **redistribute static** command within the EIGRP routing process. Write down the command.

```
HQ(config)#
HQ(config)#router eigrp 101
HQ(config-router)#redistribute static
HQ(config-router)#exit
```

- Verify HQ and REMOTE routing tables.

```
HQ#
HQ#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

     209.165.201.0/30 is subnetted, 1 subnets
C       209.165.201.0 is directly connected, Serial0/0
     10.0.0.0/8 is variably subnetted, 9 subnets, 3 masks
C       10.0.0.4/30 is directly connected, Serial0/1
D       10.0.40.0/21 [90/2297856] via 10.0.0.6, 01:04:30, Serial0/1
D       10.0.32.0/21 [90/2297856] via 10.0.0.6, 01:04:30, Serial0/1
D       10.0.56.0/21 [90/2297856] via 10.0.0.6, 01:04:30, Serial0/1
D       10.0.48.0/21 [90/2297856] via 10.0.0.6, 01:04:30, Serial0/1
C       10.0.64.0/20 is directly connected, Loopback0
C       10.0.80.0/20 is directly connected, Loopback1
C       10.0.96.0/20 is directly connected, Loopback2
C       10.0.112.0/20 is directly connected, Loopback3
S*   0.0.0.0/0 is directly connected, Serial0/0
HQ#
```

```
REMOTE#
REMOTE#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is 10.0.0.5 to network 0.0.0.0

     10.0.0.0/8 is variably subnetted, 9 subnets, 3 masks
C       10.0.0.4/30 is directly connected, Serial0/0
C       10.0.40.0/21 is directly connected, Loopback1
C       10.0.32.0/21 is directly connected, Loopback0
C       10.0.56.0/21 is directly connected, Loopback3
C       10.0.48.0/21 is directly connected, Loopback2
D       10.0.64.0/20 [90/2297856] via 10.0.0.5, 01:05:43, Serial0/0
D       10.0.80.0/20 [90/2297856] via 10.0.0.5, 01:05:43, Serial0/0
D       10.0.96.0/20 [90/2297856] via 10.0.0.5, 01:05:44, Serial0/0
D       10.0.112.0/20 [90/2297856] via 10.0.0.5, 01:05:44, Serial0/0
D*EX 0.0.0.0/0 [170/2621856] via 10.1.0.5, 00:02:18, Serial0/0
REMOTE#
```

- HQ should have six directly connected routes, four EIGRP routes, and one static route.

- REMOTE should have five directly connected routes, four EIGRP routes, and one EIGRP external route. Yes or No? **Yes.**

- Verify that REMOTE can ping the Simulated Web Server at 209.165.202.129.

```
REMOTE#ping 209.165.202.129

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 209.165.202.129, timeout is 2 seconds:

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/20 ms
REMOTE#
```

Manual Summarization

- Because the simulated LANs on both HQ and REMOTE were assigned contiguously, you can summarize the routing updates to reduce the size of the routing tables. What command will summarize the simulated LANs on HQ?

```
HQ(config)#
HQ(config)#
HQ(config)#int s0/1
HQ(config-if)#ip summary-address eigrp 101 10.0.64.0 255.255.192.0
HQ(config-if)#
*Mar  1 03:02:06.567: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 101: Neighbor 10.0.0.6 (Ser
ial0/1) is resync: summary configured
HQ(config-if)#
 (config-if)#exit
```

- What command will summarize the simulated LANs on REMOTE?

```
REMOTE(config)#
REMOTE(config)#int s0/0
REMOTE(config-if)#ip summary eigrp 101 10.0.32.0 255.255.224.0
REMOTE(config-if)#
*Mar  1 03:05:06.927: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 101: Neighbor 10.0.0.5 (Ser
ial0/0) is resync: summary configured
REMOTE(config-if)#exit
REMOTE(config)#
```

Verification and Documentation

- Ping output from REMOTE pinging the Simulated Web Server.

```
REMOTE#
REMOTE#ping 209.165.202.129

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 209.165.202.129, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/11/49 ms
REMOTE#
```

- Capture **show ip route** on all three routers: ISP, HQ, and REMOTE.

```
ISP#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     209.165.201.0/30 is subnetted, 1 subnets
C       209.165.201.0 is directly connected, Serial0/0
     209.165.202.0/32 is subnetted, 1 subnets
C       209.165.202.129 is directly connected, Loopback0
     10.0.0.0/17 is subnetted, 1 subnets
S       10.0.0.0 [1/0] via 209.165.201.2
ISP#
```

```
HQ#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

     209.165.201.0/30 is subnetted, 1 subnets
C       209.165.201.0 is directly connected, Serial0/0
     10.0.0.0/8 is variably subnetted, 7 subnets, 4 masks
C       10.0.0.4/30 is directly connected, Serial0/1
D       10.0.32.0/19 [90/2297856] via 10.0.0.6, 00:06:44, Serial0/1
C       10.0.64.0/20 is directly connected, Loopback0
D       10.0.64.0/18 is a summary, 00:09:45, Null0
C       10.0.80.0/20 is directly connected, Loopback1
C       10.0.96.0/20 is directly connected, Loopback2
C       10.0.112.0/20 is directly connected, Loopback3
S*   0.0.0.0/0 is directly connected, Serial0/0
HQ#
```

```
REMOTE#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is 10.0.0.5 to network 0.0.0.0

     10.0.0.0/8 is variably subnetted, 7 subnets, 4 masks
C       10.0.0.4/30 is directly connected, Serial0/0
C       10.0.40.0/21 is directly connected, Loopback1
C       10.0.32.0/21 is directly connected, Loopback0
D       10.0.32.0/19 is a summary, 00:07:14, Null0
C       10.0.56.0/21 is directly connected, Loopback3
C       10.0.48.0/21 is directly connected, Loopback2
D       10.0.64.0/18 [90/2297856] via 10.0.0.5, 00:10:14, Serial0/0
D*EX 0.0.0.0/0 [170/2681856] via 10.0.0.5, 00:31:08, Serial0/0
REMOTE#
```

- Capture **show ip eigrp neighbor** and **show ip eigrp topology** on HQ and REMOTE.

```
HQ#
HQ#sh ip eigrp neighbor
IP-EIGRP neighbors for process 101
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
0   10.0.0.6                Se0/1            12 01:35:17   22   200  0  13
HQ#
HQ#
HQ#sh ip eigrp topology
IP-EIGRP Topology Table for AS(101)/ID(10.0.112.1)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 0.0.0.0/0, 1 successors, FD is 2169856
        via Rstatic (2169856/0)
P 10.0.0.4/30, 1 successors, FD is 2169856
        via Connected, Serial0/1
P 10.0.32.0/19, 1 successors, FD is 2297856
        via 10.0.0.6 (2297856/128256), Serial0/1
P 10.0.64.0/18, 1 successors, FD is 128256
        via Summary (128256/0), Null0
P 10.0.64.0/20, 1 successors, FD is 128256
        via Connected, Loopback0
P 10.0.80.0/20, 1 successors, FD is 128256
        via Connected, Loopback1
P 10.0.96.0/20, 1 successors, FD is 128256
        via Connected, Loopback2
P 10.0.112.0/20, 1 successors, FD is 128256
        via Connected, Loopback3
HQ#
```

```
REMOTE#
REMOTE#sh ip eigrp neighbor
IP-EIGRP neighbors for process 101
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
0   10.0.0.5                Se0/0             14 01:36:59   14   200  0  13
REMOTE#
REMOTE#sh ip eigrp topology
IP-EIGRP Topology Table for AS(101)/ID(10.0.56.1)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 0.0.0.0/0, 1 successors, FD is 2681856
        via 10.0.0.5 (2681856/2169856), Serial0/0
P 10.0.0.4/30, 1 successors, FD is 2169856
        via Connected, Serial0/0
P 10.0.40.0/21, 1 successors, FD is 128256
        via Connected, Loopback1
P 10.0.32.0/19, 1 successors, FD is 128256
        via Summary (128256/0), Null0
P 10.0.32.0/21, 1 successors, FD is 128256
        via Connected, Loopback0
P 10.0.56.0/21, 1 successors, FD is 128256
        via Connected, Loopback3
P 10.0.48.0/21, 1 successors, FD is 128256
        via Connected, Loopback2
P 10.0.64.0/18, 1 successors, FD is 2297856
        via 10.0.0.5 (2297856/128256), Serial0/0
REMOTE#
```

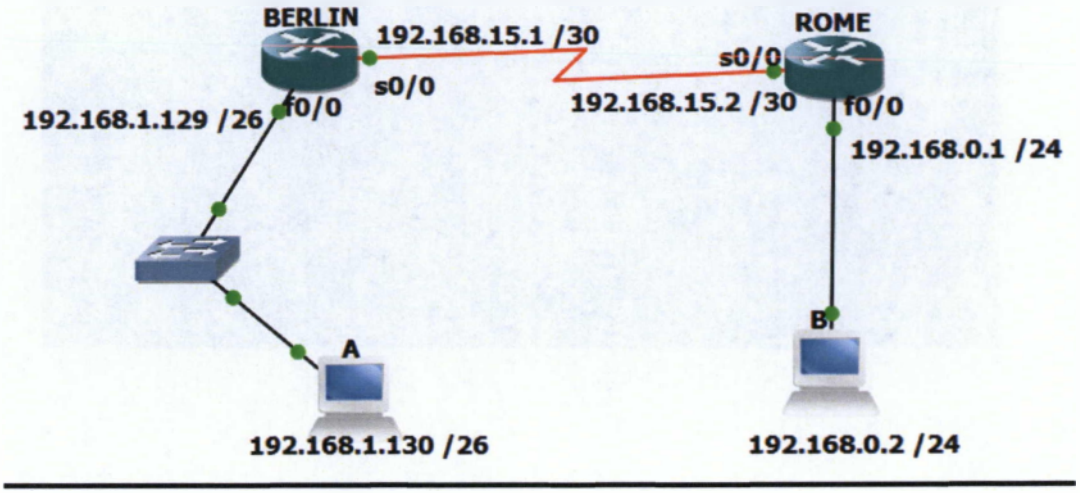
6.8 Open Shortest Path First (OSPF)

Το κεφάλαιο αυτό παρουσιάζει τα βασικά στοιχεία του πρωτοκόλλου δρομολόγησης Open Shortest Path First (OSPF).

Συμπεριλαμβάνει:

•Σύνοψη και Έννοιες του OSPF.
•Λειτουργία του OSPF.
•Παραμετροποίηση του OSPF σε μία περιοχή λειτουργίας (single area).
•Εξακριβώνοντας τη σωστή λειτουργία (troubleshooting) του OSPF.

6.8.1 Configuring the OSPF Routing Process and verify costs and authentication.



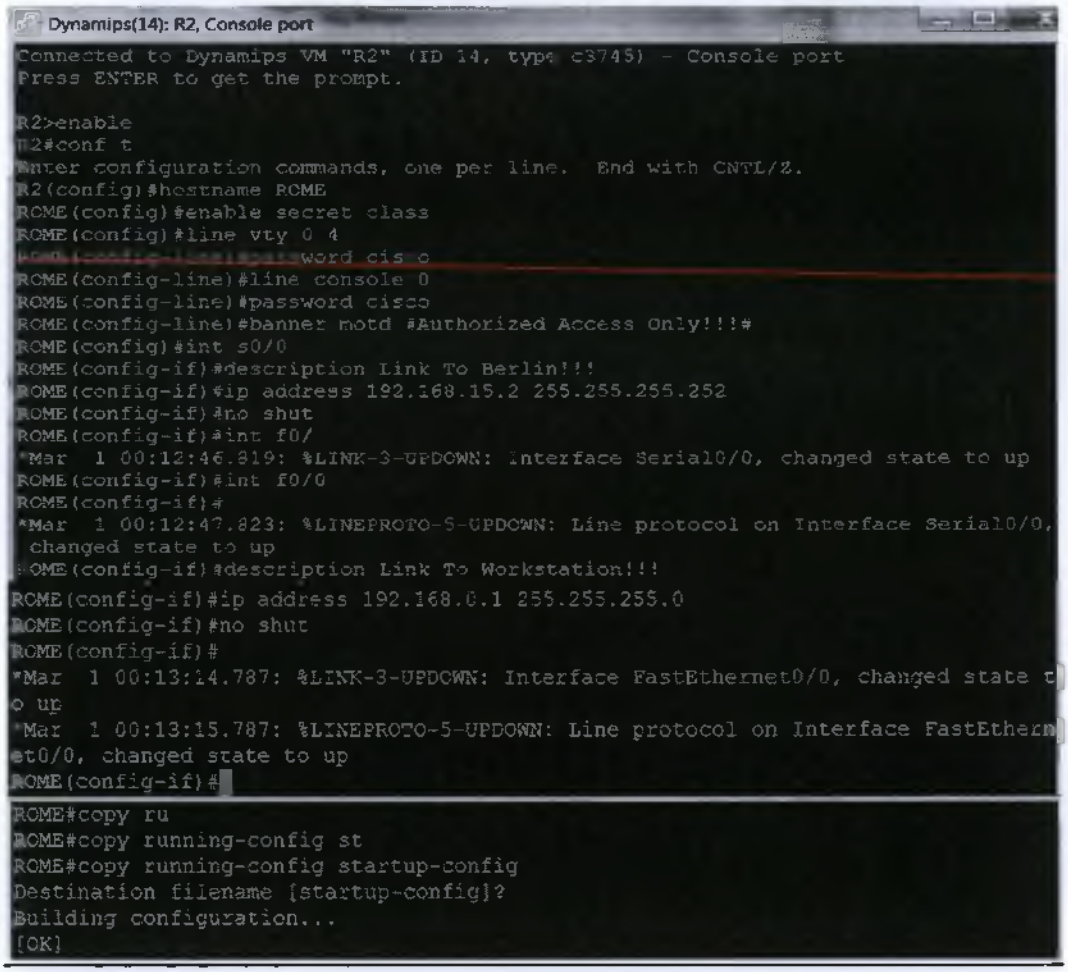
Εικόνα 51 OSPF Topology

1. The enable secret password for all routers is class.
2. The VTY, and console password for each router is cisco.
3. The "IP Host Table Entry" column contents *indicate the names of the other routers* in the IP host table.
4. Configure the motd
5. Do not forget to write the description of each interface
6. IP addressing of the topology.
7. Configure each host according to the topology.
8. Save each configuration in each router.

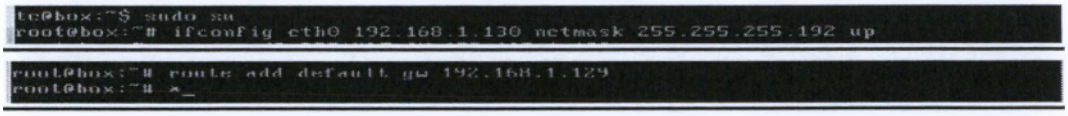
The first 6 tasks are the main body of the exercises. You have to succesfully complete in order to proceed to the rest tasks.

Router BERLIN

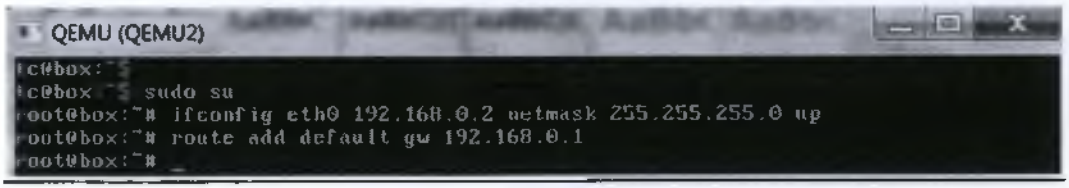
Router ROME



Workstation A

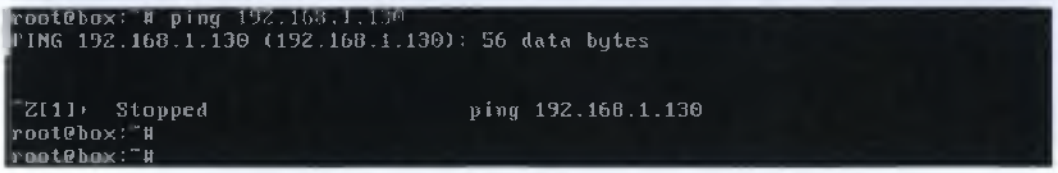


Workstation B



Verify host local connectivity

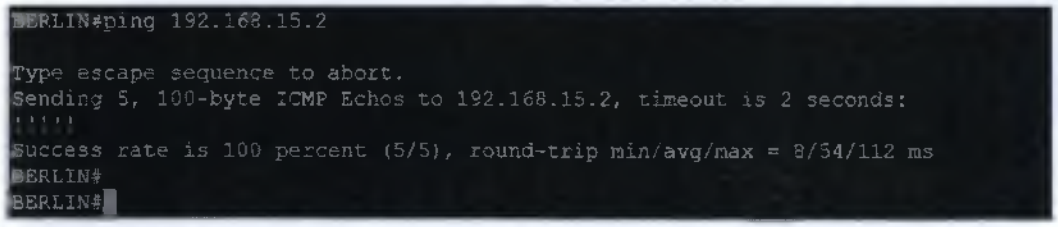
- At this point, the workstations will not be able to communicate with each other. The following tasks will demonstrate the process that is required to get communication working while using OSPF as the routing protocol.

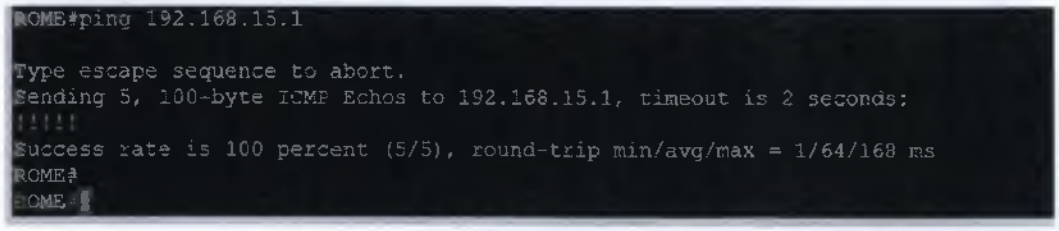


Verify Interface Information

- Ping from one of the connected serial interfaces to the other. If the ping was not successful, troubleshoot the router configuration until the ping is successful.

NOTE: *Using the show ip interface brief command, check the status of each interface.*





Configure OSPF Routing on Router Berlin

- Configure an OSPF routing process on router BERLIN. Use OSPF process number 1 and ensure that all networks are in area 0.

```
BERLIN#
BERLIN#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
BERLIN(config)#router ospf 1
BERLIN(config-router)#network 192.168.1.128 0.0.0.63 area 0
BERLIN(config-router)#network 192.168.15.0 0.0.0.3 area 0
BERLIN(config-router)#end
BERLIN#
*Mar  1 00:41:40.063: %SYS-5-CONFIG_I: Configured from console by console
BERLIN#
```

- Examine the routers that are running configuration files.

```
BERLIN#sh running-config
Building configuration...

Current configuration : 1186 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname BERLIN
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$urkf$RSLS7H6zTAH2qWRBOoB9e/
!
no aaa new-model
memory-size iomem 5
ip cef
!
!
!
!
no ip domain lookup
 --More-- $
```

```
interface FastEthernet0/0
 description Link To workstation!
 ip address 192.168.1.129 255.255.255.192
 duplex auto
 speed auto
!
interface Serial0/0
 description Link To Rome!!
 ip address 192.168.15.1 255.255.255.252
 clock rate 64000
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/1
 no ip address
 shutdown
 clock rate 2000000
!
router ospf 1
 log-adjacency-changes
 network 192.168.1.128 0.0.0.63 area 0
 network 192.168.15.0 0.0.0.3 area 0
!
ip forward-protocol nd
!
!
no ip http server
no ip http secure-server
!
!
```

```
!
banner motd ^CAuthorized Access Only!!!!^C
!
line con 0
 exec-timeout 0 0
 password cisco
 logging synchronous
line aux 0
line vty 0 4
 password cisco
 login
!
!
end

BERLIN#
```

- Type the following commands:

BERLIN (config-router)#**log-adjacency-changes**

```
BERLIN#
BERLIN#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
BERLIN(config)#router ospf 1
BERLIN(config-router)#log-adjacency-changes
BERLIN(config-router)#
```

- Show the routing table for the BERLIN router.

```
BERLIN(config)#do sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static rou
te
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     192.168.15.0/30 is subnetted, 1 subnets
C       192.168.15.0 is directly connected, Serial0/0
     192.168.1.0/26 is subnetted, 1 subnets
C       192.168.1.128 is directly connected, FastEthernet0/0
BERLIN(config)#
```

Configure OSPF Routing on Router Rome

- Configure an OSPF routing process on router ROME. Use OSPF process number 1 and ensure that all networks are in area 0.

```
ROME#
ROME#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
ROME(config)#router ospf 1
ROME(config-router)#network 192.168.15.0 0.0.0.3 area 0
ROME(config-router)#network 192.168.15.0 0.0.0.3 area 0
*Mar  1 00:57:11.011: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.15.1 on Serial0/0
from LOADING to FULL, Loading Done
ROME(config-router)#network 192.168.0.0 0.0.0.255 area 0
ROME(config-router)#
ROME(config-router)#
```

- The ROME router running configuration files.

```
ROME(config)#do show running-config
Building configuration...

Current configuration : 1185 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname ROME
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$cL3WSPTHTbEk2eUW/W8foqgLyK1
!
no aaa new-model
memory-size iomem 5
ip cef
!
!
!
no ip domain lookup
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
 --More--
```

```
!
interface FastEthernet0/0
 description Link To Workstation!!!
 ip address 192.168.0.1 255.255.255.0
 duplex auto
 speed auto
!
interface Serial0/0
 description Link To Berlin!!!
 ip address 192.168.15.2 255.255.255.252
 clock rate 2000000
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/1
 no ip address
 shutdown
 clock rate 2000000
!
router ospf 1
 log-adjacency-changes
 network 192.168.0.0 0.0.0.255 area 0
 network 192.168.15.0 0.0.0.3 area 0
!
ip forward-protocol nd
!
 --More-- 
```

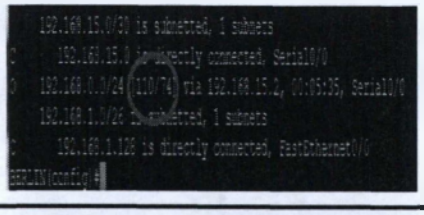
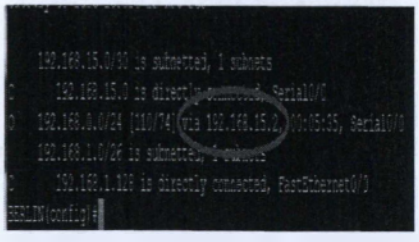
```
!
anner motd ^CAuthorized Access Only!!!^C
!
line con 0
 exec-timeout 0 0
 password cisco
 logging synchronous
line aux 0
line vty 0 4
 password cisco
 login
!
!
end

OME(config)#
```

- Type the following commands:
  Rome(config-router)#log-adjacency-changes

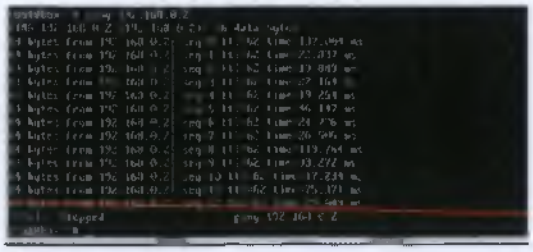
```
ROME(config)#router ospf 1
ROME(config-router)#log-adjacency-changes
OME(config-router)#
```

- Show the routing table for the BERLIN router.

```
BERLIN(config)#do show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static rou
te
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     192.168.15.0/30 is subnetted, 1 subnets
C       192.168.15.0 is directly connected, Serial0/0
O    192.168.0.0/24 [110/74] via 192.168.15.2, 00:05:35, Serial0/0
     192.168.1.0/26 is subnetted, 1 subnets
C       192.168.1.128 is directly connected, FastEthernet0/0
BERLIN(config)#
```

Are there OSPF entries in the routing table now?	Yes,because rome is also configured with ospf.
What is the metric value of the OSPF route?	
What is the VIA address in the OSPF route?	
Are routes to all networks shown in the routing table?	Yes
Are routes to all networks shown in the routing table?	Yes, they are.

- Test Network Connectivity

Ping the BERLIN host from the ROME host. Was it successful If not, troubleshoot as necessary.	Yew, the ping was successful. 

Look at OSPF cost on the Berlin Router interfaces.

- Show the properties of the BERLIN router serial and Fast Ethernet interfaces by using the **show interfaces** command.

```
BERLIN#sh int s0/0
Serial0/0 is up, line protocol is up
  Hardware is GT96K Serial
  Description: Link To Rome!!
  Internet address is 192.168.15.1/30
  MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:04, output 00:00:01, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: weighted fair
  Output queue: 0/1000/64/0 (size/max total/threshold/drops)
     Conversations  0/1/256 (active/max active/max total)
     Reserved Conversations 0/0 (allocated/max allocated)
     Available Bandwidth 1158 kilobits/sec
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     531 packets input, 38780 bytes, 0 no buffer
     Received 409 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     643 packets output, 46849 bytes, 0 underruns
     0 output errors, 0 collisions, 17 interface resets
     0 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
     DCD=up  DSR=up  DTR=up  RTS=up  CTS=up

BERLIN#
BERLIN#
```

```
BERLIN#show int f0/0
FastEthernet0/0 is up, line protocol is up
  Hardware is Gt96k FE, address is c40d.09f0.0000 (bia c40d.09f0.0000)
  Description: Link To workstation!
  Internet address is 192.168.1.129/26
  MTU 1500 bytes, BW 10000 Kbit/sec, DLY 1000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Half-duplex, 10Mb/s, 100BaseTX/FX
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:20, output 00:00:06, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     742 packets input, 158662 bytes
     Received 380 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     0 watchdog
     0 input packets with dribble condition detected
     985 packets output, 87323 bytes, 0 underruns
     0 output errors, 0 collisions, 1 interface resets
     0 unknown protocol drops
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier
     0 output buffer failures, 0 output buffers swapped out
BERLIN#
BERLIN#
```

What is the default bandwidth of the interfaces	Serial:128 kbit Fethernet:100000 kbit
Calculate the OSPF cost.	Serial:64 FEthernet:1

Record the OSPF cost on the Serial and Fast Ethernet Interfaces.

Using the show ip ospf interface command, record the OSPF cost of the serial and Fast Ethernet interfaces

NOTE: The clock rate set for the interface should have been 64,000. This is what has been used as a default to this point and specified in previous sections Lab, "Review of Basic Router Configuring with RIP." Therefore, to calculate the cost of this bandwidth, you need to divide 10^8 by 64,000

- OSPF cost of serial interface

```
BERLIN#show ip ospf interface
Serial0/0 is up, line protocol is up
  Internet Address 192.168.15.1/30, Area 0
  Process ID 1, Router ID 192.168.15.1, Network Type POINT_TO_POINT, Cost: 6

  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
```

- OSPF cost of Ethernet interface

```
FastEthernet0/0 is up, line protocol is up
  Internet Address 192.168.1.129/26, Area 0
  Process ID 1, Router ID 192.168.15.1, Network Type BROADCAST, Cost: 10
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 192.168.15.1, Interface address 192.168.1.129
```

Manually Set The Cost on the Serial Interface and verify

- On the serial interface of the BERLIN router, set the OSPF cost to 1562 at the serial interface configuration mode prompt.

NOTE: that it is essential that all connected links agree about the cost for consistent calculation of the SPF in an area.

```
BERLIN(config)#int s0/0
BERLIN(config-if)#ip ospf cost 1562
BERLIN(config-if)#
BERLIN(config-if)#
```

- Record the new OSPF cost of the serial interface

```
BERLIN(config)#do show ip ospf int s0/0
Serial0/0 is up, line protocol is up
  Internet Address 192.168.15.1/30, Area 0
  Process ID 1, Router ID 192.168.15.1, Network Type POINT_TO_POINT, Cost: 1562
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
```

- Reverse the effect of this command by entering the command **no ip ospf cost** in interface configuration mode (i.e. change the cost and display it)

```
BERLIN(config)#int s0/0
BERLIN(config-if)#no ip ospf cost 1562
BERLIN(config-if)#
BERLIN(config-if)#
BERLIN(config-if)#exit
BERLIN(config)#
BERLIN(config)#do show ip ospf int s0/0
Serial0/0 is up, line protocol is up
  Internet Address 192.168.15.1/30, Area 0
  Process ID 1, Router ID 192.168.15.1, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:03
```

- Enter the command **bandwidth 2000** at the serial 0 interface configuration mode prompt.

```
BERLIN(config)#int s0/0
BERLIN(config-if)#bandwidth 2000
BERLIN(config-if)#end
```

- Record the new OSPF cost of the serial interface

```
BERLIN#show ip ospf int s0/0
Serial0/0 is up, line protocol is up
  Internet Address 192.168.15.1/30, Area 0
  Process ID 1, Router ID 192.168.15.1, Network Type POINT_TO_POINT, Cost: 50
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
```

- You can set the speed on an Ethernet interface. Will this affect the OSPF cost of that interface? **Yes, this will affect ODPF cost of the interface.**

- Reset the bandwidth on the serial interface by using **no bandwidth 2000** at the serial 0 interface configuration mode prompt.

```
BERLIN(config)#int s0/0
BERLIN(config-if)#no bandwidth 2000
BERLIN(config-if)#
```

Set up OSPF authentication on interface

OSPF authentication is being established on the routers in the network. First, introduce authentication only on the BERLIN router.

- What is the appropriate command?

  BERLIN(config-if)#ip ospf message-digest-key 1 md5 7 cisco

- What is the OSPF password that is being used for MD5 authentication? **Cisco**
- What encryption type is being used? **Type 7**

- Enable OSPF authentication in area 0

- What is the appropriate command to Enable OSPF Authentication in this Area, Area 0?

  BERLIN(config)#router ospf 1
  BERLIN(config-router)#area 0 authentication

- Wait for a few seconds. Does the router generate output? **Yes, it does.**

- Give the command to check the **ospf neighborship.**

```
BERLIN#show ip ospf neighbor

BERLIN#
```

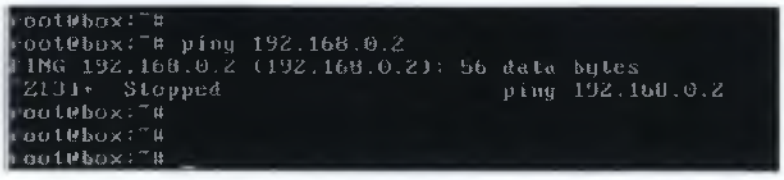
- Are there OSPF neighbours? **No, there are no neighbours.**

- Give the command to check the routing table

```
BERLIN#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     192.168.15.0/30 is subnetted, 1 subnets
C       192.168.15.0 is directly connected, Serial0/0
     192.168.1.0/26 is subnetted, 1 subnets
C       192.168.1.128 is directly connected, FastEthernet0/0
BERLIN#
```

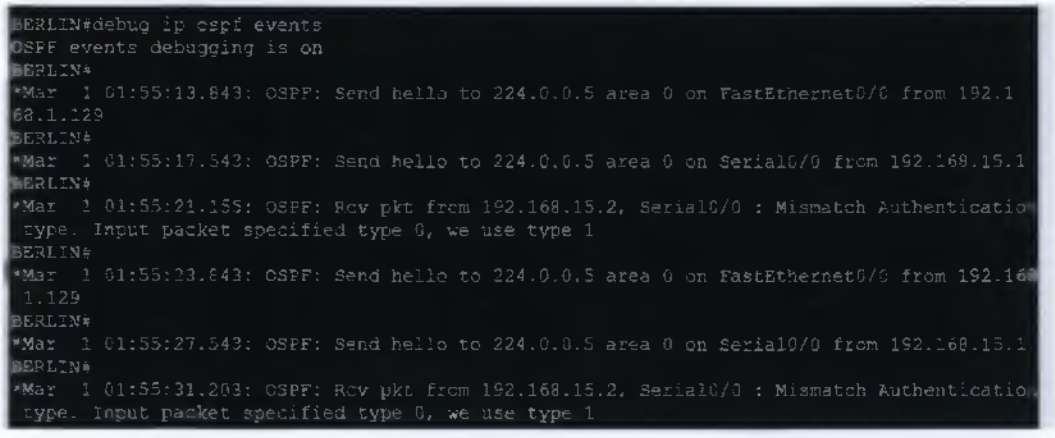
- Are there OSPF routes in the BERLIN router routing table? No, **there are no OSPF router on BERLIN router routing table.**

- Can the host ping each other? **No, they cannot.**



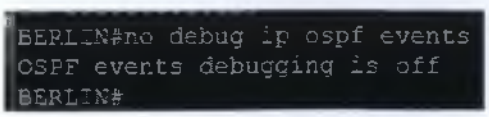
Observe OSPF Traffic

- At privileged EXEC mode, type the command **debug ip ospf events** and observe the output.



- How frequently are Hello messages sent? **Hello messages are sent every 3 seconds.**

- Turn off debugging by typing no debug ip ospf events or undebug all



Show the hello and dead interval timers on the Rome router Ethernet and serial interfaces by entering the command **show ip ospf interface** in privileged EXEC mode. Record the Hello and Dead interval timers for these interfaces:	
Hello interval?	**10**
Dead interval?	**40**
What is the purpose of the dead interval?	**The time the router waits to hear a HELLO from its neighbor before it announces to the ospf environment that the specific neighbor is "down".**

Modify the OSPF Timers

- Modify the Hello and Dead interval timers to smaller values to try to improve performance. On the Rome router only, change the hello and dead intervals to 5 and 20 (4*5) seconds respectively, using the appropriate commands.

```
ROME(config)#int s0/0
ROME(config-if)#ip ospf hello-interval 5
ROME(config-if)#ip ospf dead-interval 20
ROME(config-if)#int f0/0
ROME(config-if)#ip ospf hello-interval 5
ROME(config-if)#ip ospf dead-interval 20
ROME(config-if)#end
ROME#
```

Wait for a minute and then check the ospf neighbors with the consistent command	
Write down the command?	**ROME#sh ip ospf neighbor**
Do OSPF neighbours exist?	**no**

- Examine the Routing Table

Do OSPF routes exist in the table	**no**
Wait for a minute and then check the ospf neighbors with the consistent command	
Can the host ping each other?	**No**

- Look at the OSPF Data Transmissions

Enter the command **debug ip ospf events** in privileged EXEC mode.	
If there is, what is the issue?	AUTHENTICATion tipe is not the same on router Rome.

- Check the Berlin Routing Table Status

On the Berlin router, check the routing table	
Do OSPF routes exist in the table ?	**no**

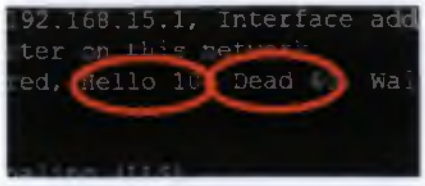
Set the Rome Router Interval timers

- Match the timer values on the Berlin serial link with the Rome router.

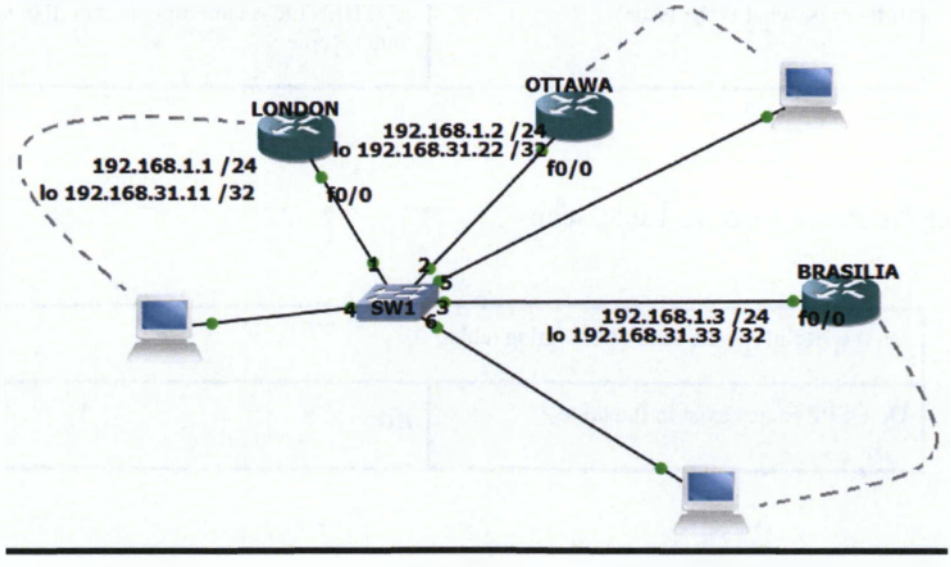
```
BERLIN(config)#int s0/0
BERLIN(config-if)#no ip ospf hello-interval 5
BERLIN(config-if)#no ip ospf dead-interval 20
BERLIN(config-if)#int f0/0
BERLIN(config-if)#no ip ospf hello-interval 5
BERLIN(config-if)#no ip ospf dead-interval 20
BERLIN(config-if)#
```

Verify that the interval timers are turned to the dafaults

- Use the **show ip ospf interface** command to verify that the timers are reset to their default values.



6.8.2 Configuring OSPF with Loopback Addresses



Εικόνα 52 OSPF Loopback Address Configuration Topology

Router Designation	Router Name	Routing Protocol	OSPF Routing ID	Network Statements
Router 1	London	OSPF	1	192.168.1.0
Router 2	Ottawa	OSPF	1	192.168.1.0
Router 3	Brasilia	OSPF	1	192.168.1.0

Πίνακας 6 Equipment Configuration: Part I

Router Designation	IP Host Table Entry	Fast Ethernet 0 Address/Subnet Mask	Loopback Interface/ Subnet Mask
Router 1	Ottawa Brasilia	192.168.1.1/24	192.168.31.11/32
Router 2	London Brasilia	192.168.1.2/24	192.168.31.22/32
Router 3	London Ottawa	192.168.1.3/24	192.168.31.33/32

Πινακας 7 Equipment Configuration: Part II

1. The enable secret password for all routers is class.
2. The VTY, and console password for each router is cisco.
3. The "IP Host Table Entry" column contents *indicate the names of the other routers* in the IP host table.
4. Configure the motd
5. Do not forget to write the description of each interface
6. IP addressing of the topology.
7. Configure each host according to the topology.
8. Save each configuration in each router

The first 6 tasks are the main body of the exercises. You have to succefully complete in order to proceed to the rest tasks.

Router Configuration

London

```
Router>
Router>enable
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#hostname LONDON
LONDON(config)#ENABLE SECRET class
LONDON(config)#line vty 0 4
LONDON(config-line)#password cisco
LONDON(config-line)#login
LONDON(config-line)#exit
LONDON(config)#line console 0
LONDON(config-line)#password cisco
LONDON(config-line)#login
LONDON(config-line)#exit
[redacted]
LONDON(config)#ip subnet-zero
LONDON(config)#int f0/0
LONDON(config-if)#description LINK TO HUB!!!
LONDON(config-if)#ip address 192.168.1.1 255.255.255.0
LONDON(config-if)#no shut
LONDON(config-if)#
*Mar  1 00:05:06.079: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state t
o up
*Mar  1 00:05:07.079: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthern
et0/0, changed state to up
LONDON(config-if)#exit
```

```
LONDON#copy ru
LONDON#copy running-config st
LONDON#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
LONDON#
```

Ottawa

```
Press ENTER to get the prompt.

R2>enable
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#hostname OTTAWA
OTTAWA(config)#enable secret class
OTTAWA(config)#line vty 0 4
OTTAWA(config-line)#password cisco
OTTAWA(config-line)#login
OTTAWA(config-line)#exit
OTTAWA(config)#line console 0
OTTAWA(config-line)#password cisco
OTTAWA(config-line)#login
OTTAWA(config-line)#exit
OTTAWA(config)#banner motd #AUTHORIZED ACCESS ONLY!!!!#
OTTAWA(config)#ip subnet-zero
OTTAWA(config)#int f0/0
OTTAWA(config-if)#description LINK TO HUB!!!!
OTTAWA(config-if)#ip address 192.168.1.2 255.255.255.0
OTTAWA(config-if)#no shut
OTTAWA(config-if)#
*Mar  1 00:10:42.139: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state t
*Mar  1 00:10:43.139: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEther
```

```
OTTAWA#copy ru
OTTAWA#copy running-config st
OTTAWA#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
OTTAWA#
```

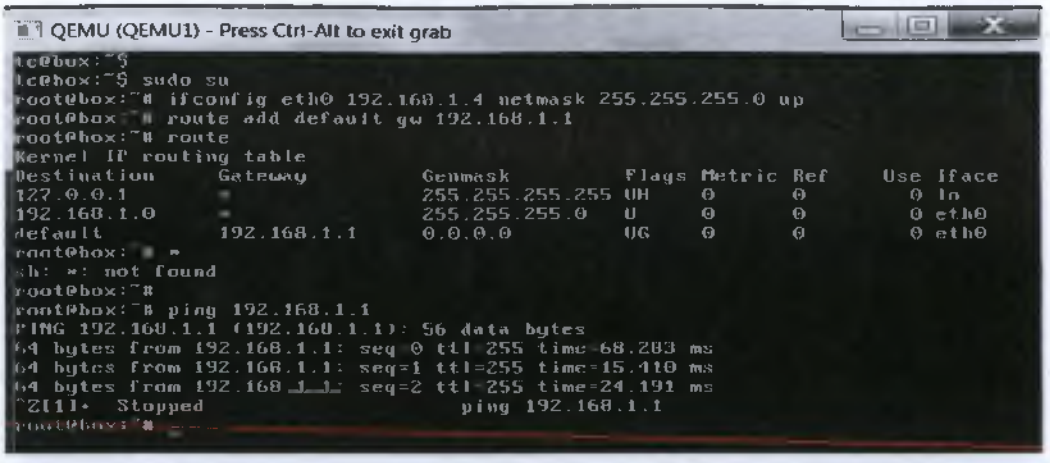
Brasilia

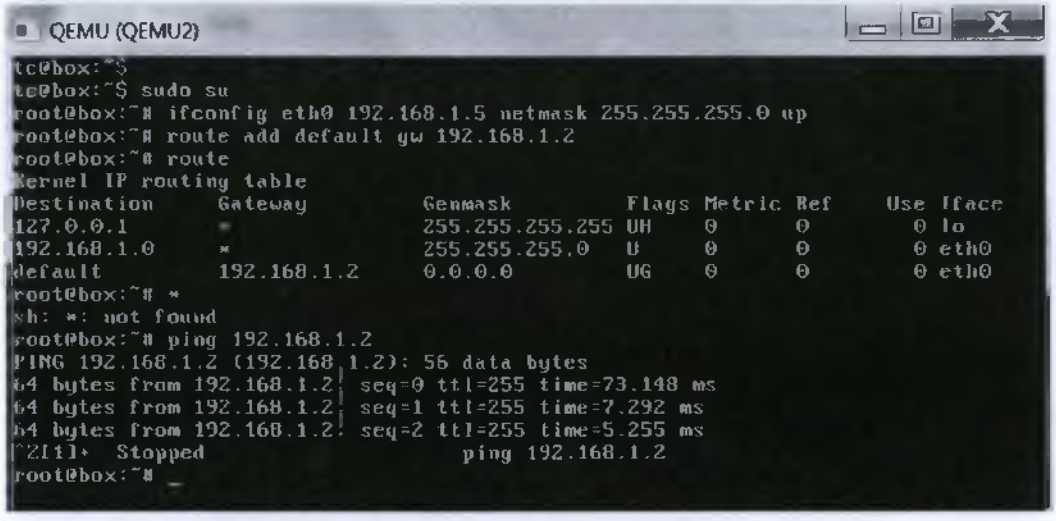
```
R3(config)#hostname BRASILIA
BRASILIA(config)#enable secret class
BRASILIA(config)#line vty 0 4
BRASILIA(config-line)#password cisco
BRASILIA(config-line)#login
BRASILIA(config-line)#exit
BRASILIA(config)#line console 0
BRASILIA(config-line)#password cisco
BRASILIA(config-line)#login
BRASILIA(config-line)#exit
BRASILIA(config)#banner motd #AUTHORIZED ACCESS ONLY!!!!#
BRASILIA(config)#ip subnet-zero
BRASILIA(config)#int f0/0
BRASILIA(config-if)#description LINK TO HUB!!!!
BRASILIA(config-if)#ip address 192.168.1.3 255.255.255.0
BRASILIA(config-if)#no shut
BRASILIA(config-if)#
*Mar  1 00:15:39.363: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state t
o up
*Mar  1 00:15:40.363: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthe
et0/0, changed state to up
```

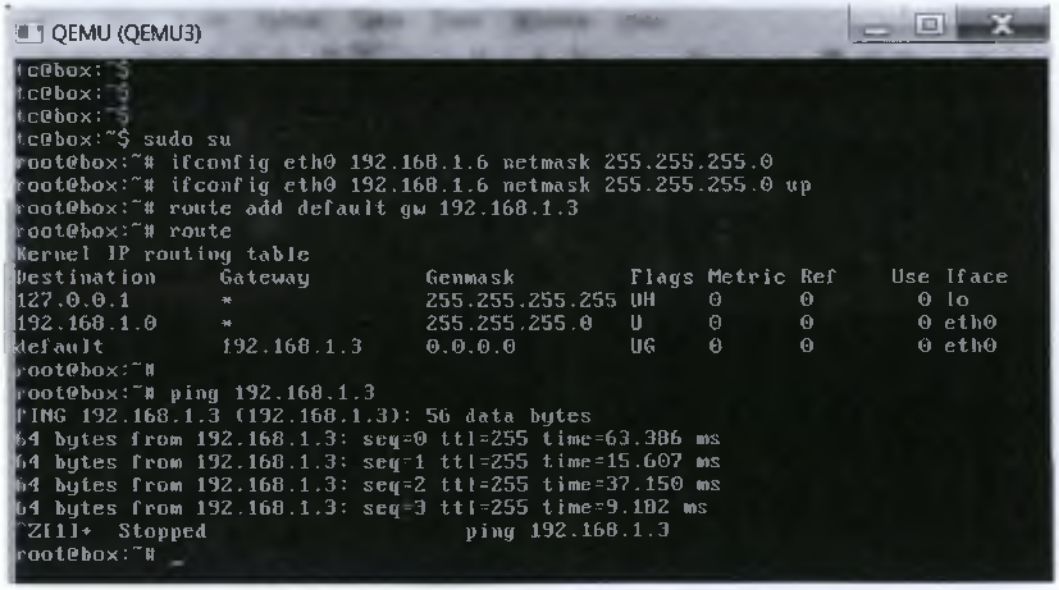
```
BRASILIA#copy ru
BRASILIA#copy running-config st
BRASILIA#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
BRASILIA#
BRASILIA#
```

Verify host local connectivity

- Each workstation should be able to ping the attached router. Troubleshoot as necessary.


QEMU (QEMU1) - Press Ctrl-Alt to exit grab
tc@box:~$
tc@box:~$ sudo su
root@box:~# ifconfig eth0 192.168.1.4 netmask 255.255.255.0 up
root@box:~# route add default gw 192.168.1.1
root@box:~# route
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
127.0.0.1 * 255.255.255.255 UH 0 0 0 lo
192.168.1.0 * 255.255.255.0 U 0 0 0 eth0
default 192.168.1.1 0.0.0.0 UG 0 0 0 eth0
root@box:~# *
sh: *: not found
root@box:~#
root@box:~# ping 192.168.1.1
PING 192.168.1.1 (192.168.1.1): 56 data bytes
64 bytes from 192.168.1.1: seq=0 ttl=255 time=68.283 ms
64 bytes from 192.168.1.1: seq=1 ttl=255 time=15.410 ms
64 bytes from 192.168.1.1: seq=2 ttl=255 time=24.191 ms
^Z[1]+ Stopped ping 192.168.1.1


QEMU (QEMU2)
tc@box:~$
tc@box:~$ sudo su
root@box:~# ifconfig eth0 192.168.1.5 netmask 255.255.255.0 up
root@box:~# route add default gw 192.168.1.2
root@box:~# route
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
127.0.0.1 * 255.255.255.255 UH 0 0 0 lo
192.168.1.0 * 255.255.255.0 U 0 0 0 eth0
default 192.168.1.2 0.0.0.0 UG 0 0 0 eth0
root@box:~# *
sh: *: not found
root@box:~# ping 192.168.1.2
PING 192.168.1.2 (192.168.1.2): 56 data bytes
64 bytes from 192.168.1.2: seq=0 ttl=255 time=73.148 ms
64 bytes from 192.168.1.2: seq=1 ttl=255 time=7.292 ms
64 bytes from 192.168.1.2: seq=2 ttl=255 time=5.255 ms
^Z[1]+ Stopped ping 192.168.1.2
root@box:~#


QEMU (QEMU3)
tc@box:~$ sudo su
root@box:~# ifconfig eth0 192.168.1.6 netmask 255.255.255.0
root@box:~# ifconfig eth0 192.168.1.6 netmask 255.255.255.0 up
root@box:~# route add default gw 192.168.1.3
root@box:~# route
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
127.0.0.1 * 255.255.255.255 UH 0 0 0 lo
192.168.1.0 * 255.255.255.0 U 0 0 0 eth0
default 192.168.1.3 0.0.0.0 UG 0 0 0 eth0
root@box:~#
root@box:~# ping 192.168.1.3
PING 192.168.1.3 (192.168.1.3): 56 data bytes
64 bytes from 192.168.1.3: seq=0 ttl=255 time=63.386 ms
64 bytes from 192.168.1.3: seq=1 ttl=255 time=15.607 ms
64 bytes from 192.168.1.3: seq=2 ttl=255 time=37.150 ms
64 bytes from 192.168.1.3: seq=3 ttl=255 time=9.102 ms
^Z[1]+ Stopped ping 192.168.1.3
root@box:~#

Verify Interface Information

- Ping from one of the connected serial interfaces to the other. If the ping was not successful, troubleshoot the router configuration until the ping is successful.

```
BRASILIA#ping 192.168.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 16/28/48 ms
BRASILIA#
BRASILIA#
```

```
OTTAWA#ping 192.168.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 20/36/48 ms
OTTAWA#
```

```
LONDON#ping 192.168.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/24/44 ms
LONDON#
```

Configure OSPF Routing on each Router in the given topology

- Configure an OSPF routing process on router **London Ottawa Brasilia**. Use OSPF process number 1 and ensure that all networks are in area 0.

```
LONDON(config)#
LONDON(config)#router ospf 1
LONDON(config-router)#network 192.168.1.0 0.0.0.255 area 0
LONDON(config-router)#end
LONDON#
```

```
OTTAWA(config)#router ospf 1
OTTAWA(config-router)#network 192.168.1.0 0.0.0.255 area 0
OTTAWA(config-router)#en
*Mar  1 00:36:57.391: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.1.1 on FastEthernet
0/0 from LOADING to FULL, Loading Done
OTTAWA(config-router)#end
```

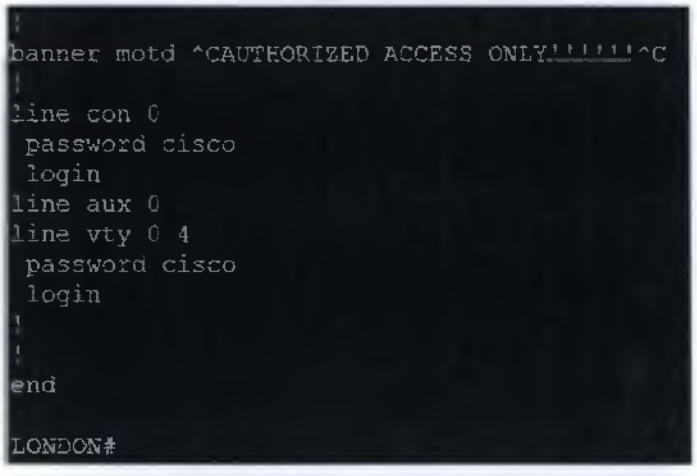
```
BRASILIA#
BRASILIA#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
BRASILIA(config)#router ospf 1
BRASILIA(config-router)#network 192.168.1.0 0.0.0.255 area 0
BRASILIA(config-router)#end
BRASILIA#
*Mar  1 00:38:15.147: %SYS-5-CONFIG_I: Configured from console by console
BRASILIA#
*Mar  1 00:38:17.059: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.1.2 on FastEthernet
0/0 from LOADING to FULL, Loading Done
*Mar  1 00:38:17.063: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.1.1 on FastEthernet
0/0 from LOADING to FULL, Loading Done
BRASILIA#
```

- Examine the routers that are running configuration files.

London

```
LONDON#sh run
LONDON#sh running-config
Building configuration...

Current configuration : 909 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname LONDON
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$7311$skTnx29NKIhV92nTAdWaS/
!
no aaa new-model
memory-size iomem 5
ip cef
!
```


!
interface FastEthernet0/0
 description LINK TO HUB!!!
 ip address 192.168.1.1 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
router ospf 1
 log-adjacency-changes
 network 192.168.1.0 0.0.0.255 area 0
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!


!
banner motd ^CAUTHORIZED ACCESS ONLY!!!!!!^C
!
line con 0
 password cisco
 login
line aux 0
line vty 0 4
 password cisco
 login
!
!
end

LONDON#

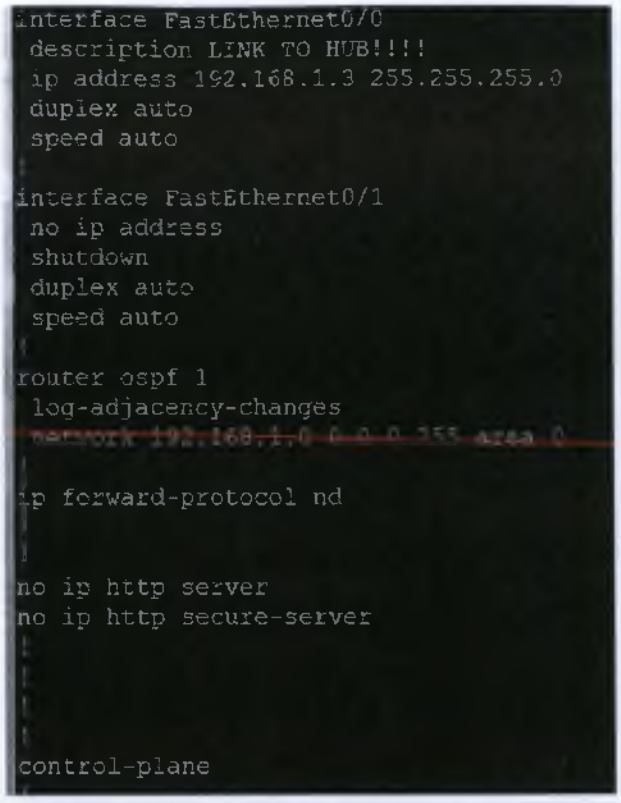
Ottawa

```
OTTAWA#sh run
OTTAWA#sh running-config
Building configuration...

Current configuration : 970 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname OTTAWA
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$ghdK$1frwpzXro9q/cjzZGhD9e/
!
no aaa new-model
memory-size iomem 5
ip cef
!
!
!
no ip domain lookup
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
interface FastEthernet0/0
 description LINK TO HUB!!!!
 ip address 192.168.1.2 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
router ospf 1
 log-adjacency-changes
 network 192.168.1.0 0.0.0.255 area 0
!
ip forward-protocol nd
!
!
no ip http server
no ip http secure-server
!
!
!
!
control-plane
```

```
!
!
anner motd ^CAUTHORIZED ACCESS ONLY!!!!^C
!
line con 0
 exec-timeout 0 0
 password cisco
 logging synchronous
 login
line aux 0
line vty 0 4
 password cisco
 login
!
!
end

OTTAWA#
```

Brasilia

```
BRASILIA#sh running-config
Building configuration...

Current configuration : 972 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname BRASILIA
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$li8J$XV3OqmuVetiTcEiajgzYX.
!
no aaa new-model
memory-size iomem 5
ip cef
!
!
!
no ip domain lookup
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
```



- Type the following commands:

  Router (config-router)#**log-adjacency-changes**

```
LONDON#
LONDON#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
LONDON(config)#router ospf 1
LONDON(config-router)#log-adjacency-changes
LONDON(config-router)#
```

```
OTTAWA#
OTTAWA#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
OTTAWA(config)#router ospf 1
OTTAWA(config-router)#log-adjacency-changes
OTTAWA(config-router)#end
OTTAWA#
```

```
BRASILIA#
BRASILIA#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
BRASILIA(config)#router ospf 1
BRASILIA(config-router)#log-adjacency-changes
BRASILIA(config-router)#end
BRASILIA#
```

- Show and examine the routing table for each router.

```
LONDON#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, FastEthernet0/0
LONDON#
```

```
OTTAWA#
OTTAWA#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, FastEthernet0/0
OTTAWA#
```

```
BRASILIA#
BRASILIA#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, FastEthernet0/0
BRASILIA#
BRASILIA#
```

Ping the Brasilia router from the London router. Was it successful?	Yes, the ping was succesfull.
	`BRASILIA#ping 192.168.1.1`
	`Type escape sequence to abort.`
	`Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:`
	`!!!!!`
	`Success rate is 100 percent (5/5), round-trip min/avg/max = 20/31/52 ms`
	`BRASILIA#`
	`BRASILIA#`

Configure the Loopback Interfaces

- Configure Loopback for London router.

```
LONDON#
LONDON#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
LONDON(config)#int loo
LONDON(config)#int loopback 0
LONDON(config-if)#ip addres
*Mar  1 00:58:02.023: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
 changed st
LONDON(config-if)#ip address 192.168.31.11 255.255.255.255
LONDON(config-if)#end
LONDON#
```

- Configure Loopback for Ottawa router.

```
OTTAWA(config)#int loo
OTTAWA(config)#int loopback 0
OTTAWA(config-if)#ip addr
*Mar  1 00:58:54.767: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
 changed state to up
OTTAWA(config-if)#ip address 192.168.31.22 255.255.255.255
OTTAWA(config-if)#end
OTTAWA#
*Mar  1 00:59:13.059: %SYS-5-CONFIG_I: Configured from console by console
OTTAWA#
```

- Configure Loopback for Brasilia router.

```
BRASILIA(config)#int loo
BRASILIA(config)#int loopback 0
BRASILIA(config-if)#
*Mar  1 00:59:31.391: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
 changed state to up
BRASILIA(config-if)#ip address 192.168.31.33 255.255.255.255
BRASILIA(config-if)#end
BRASILIA#
```

Show OSPF Adjacency

- Verify that the OSPF routing has formed adjacencies.

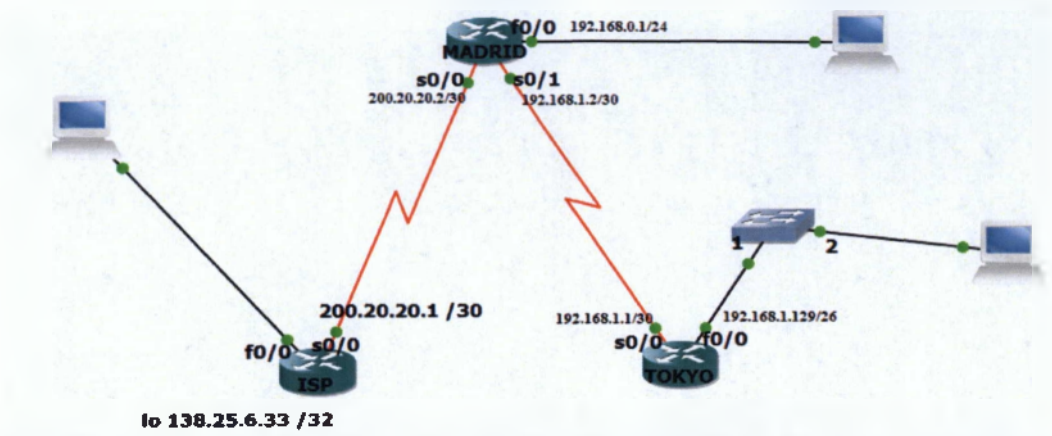
```
LONDON#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.1.2       1   FULL/BDR        00:00:38    192.168.1.2     FastEthernet0/
0
192.168.1.3       1   FULL/DROTHER    00:00:34    192.168.1.3     FastEthernet0/
0
LONDON#
```

```
OTTAWA#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.1.1       1   FULL/DR         00:00:31    192.168.1.1     FastEthernet0/
0
192.168.1.3       1   FULL/DROTHER    00:00:30    192.168.1.3     FastEthernet0/
0
OTTAWA#
```

```
BRASILIA#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.1.1       1   FULL/DR         00:00:33    192.168.1.1     FastEthernet0/
0
192.168.1.2       1   FULL/BDR        00:00:36    192.168.1.2     FastEthernet0/
0
BRASILIA#
```

Is there a designated router identified	**yes**
Is there a backup designated router	**yes**
What is the neighbor priority of 192.168.1.1 from router Brasilia	**1**
What interface is identified as being part of area 0	**F0/0**
Is there a designated router identified	**yes**
What are the Router ID and link address of the DR	**192.168.31.33** **192.169.1.3**
Is there a backup designated router	**yes**
What are the Router ID and link address of the BDR	**192.168.31.22** **192.168.1.2**
Which interface is identified as being part of area 0	**F0/0**

6.8.3 Propagating Default Routes in an OSPF Domain.



Εικόνα 53 OSPF Default Routes Topology

Router Designation	Router Name	Routing Protocol	Network Statements	Loopback 0	Address/ Subnet Mask
Router 1	Tokyo	OSPF	192.168.1.0	192.168.31.11/32	
Router 2	Madrid	OSPF	192.168.1.0	192.168.0.0	192.168.31.22/32

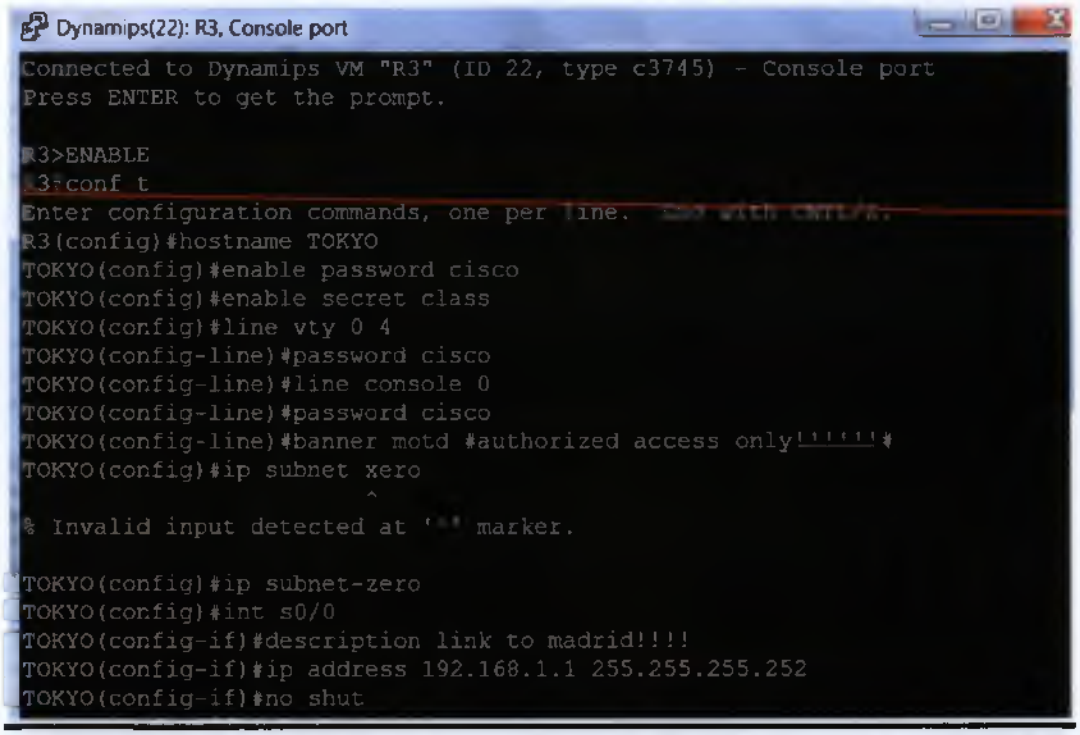
Πίνακας 8 Address Scheme 1 for OSPF Default Routes Topology

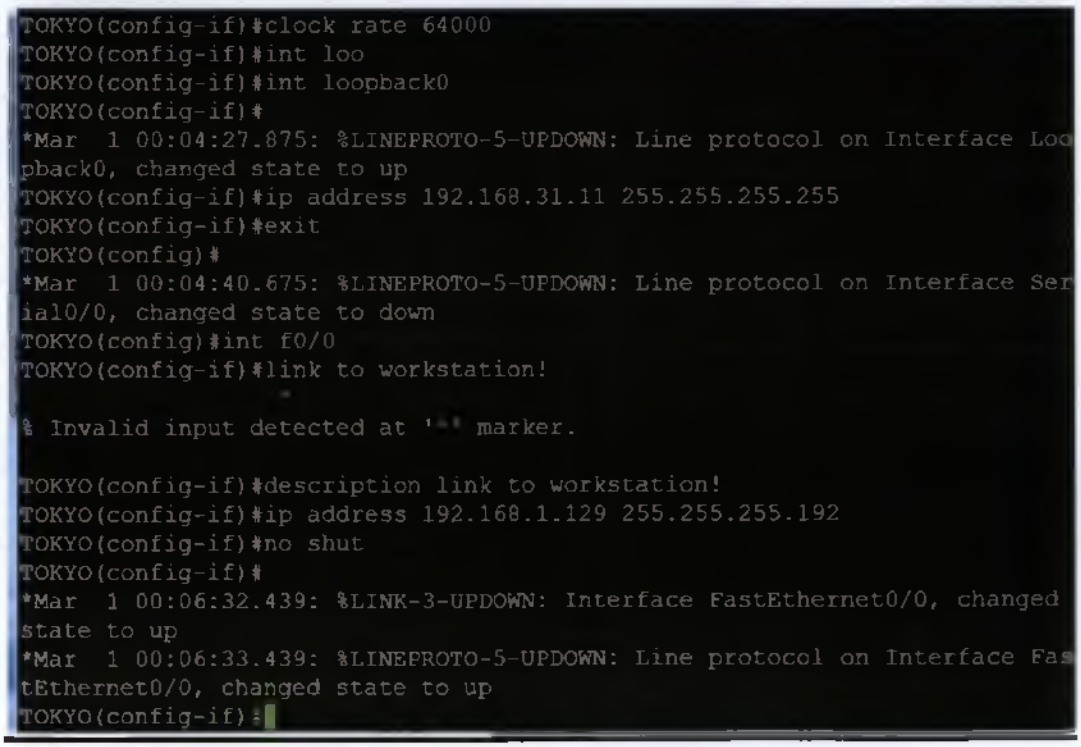
Router Designation	IP Host Table Entry	Fast Ethernet 0 Address/Subnet Mask	Interface Type Serial 0	Serial 0 Address/Subnet Mask	Interface Type Serial 1	Serial 1 Address/ Subnet Mask
Router 1	Madrid	192.168.1.129/26	DCE	192.168.1.1/30	N/A	N/A
Router 2	Tokyo	192.168.0.1/24	DTE	192.168.1.2/30	DTE	200.20.20.2/30

Πίνακας 9 Address Scheme 2 for OSPF Default Routes Topology

- Configure the routers

Tokyo





```
TOKYO#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
```

Madrid

Dynamips(21): R2, Console port

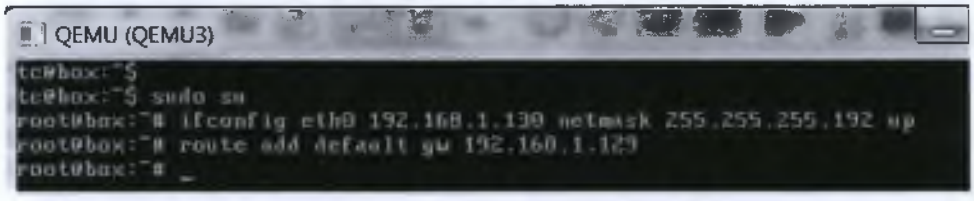
```
Connected to Dy
Press ENTER to

R2>enable
R2#conf t
Enter configura
tion commands,
one per line.
End with CNTL/Z
.
R2(config)#host
name MADRID
MADRID(config)
MADRID(config)#enable password cisco
MADRID(config)#enable secret class
MADRID(config)#line vty 0 4
MADRID(config-line)#assword cisco
                    ^
% Invalid input detected at '^' marker.

MADRID(config-line)#password cisco
MADRID(config-line)#line console 0
MADRID(config-line)#password cisco
MADRID(config-line)#exit
MADRID(config)#banner motd #authorized access only!!!#
MADRID(config)#int f0/0
MADRID(config-if)#description link to workstation!!!
```

```
MADRID(config-if)#no shut
MADRID(config-if)#int
*Mar  1 00:11:01.455: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:11:02.455: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, cha
nged state to up
MADRID(config-if)#int s0/0
MADRID(config-if)#desription link to ISP!!!!

% Invalid input detected at '^' marker.

MADRID(config-if)#
MADRID(config-if)#description link to ISP!!!!
MADRID(config-if)#ip address 200.20.20.2 255.255.255.252
MADRID(config-if)#no shut
MADRID(config-if)#int s
*Mar  1 00:11:50.531: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
MADRID(config-if)#int s
*Mar  1 00:11:51.535: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed s
tate to up
MADRID(config-if)#int s0/1
MADRID(config-if)#description link to TOKYO!!!
```

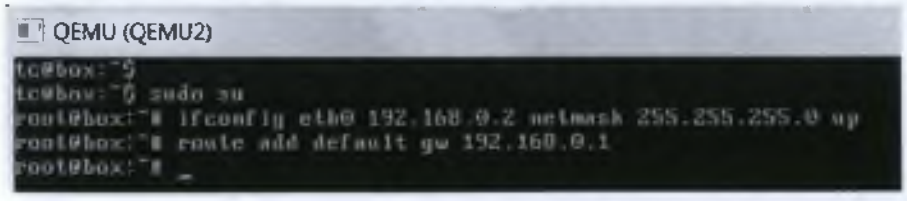
```
MADRID#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
MADRID#
```

- Verify Host Conectivity

Host Connected to Tokyo



Host Connected to Madrid



- At this point, the workstations will not be able to communicate with each other. The following tasks will demonstrate the process that is required to get communication working while using OSPF as the routing protocol.

```
root@box:~# ping 192.168.0.2
PING 192.168.0.2 (192.168.0.2): 56 data bytes

^Z[2]+  Stopped                    ping 192.168.0.2
root@box:~#
root@box:~# _
```

Verify Interface Information

- Ping from one of the connected serial interfaces to the other. If the ping was not successful, troubleshoot the router configuration until the ping is successful

```
TOKYO#ping 192.168.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/57/92 ms
TOKYO#
TOKYO#
```

```
MADRID#ping 192.168.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/47/128 ms
MADRID#
MADRID#
```

Configure OSPF routing on each router in area 0.

- Configure an OSPF routing process on router. Use OSPF process number 1 and ensure that all networks are in area 0.

```
MADRID(config)#router ospf 1
MADRID(config-router)#network 192.168.1.0 0.0.0.3 area 0
MADRID(config-router)#network 192.168.0.0 0.0.0.255 area 0
MADRID(config-router)#
```

```
TOKYO(config)#router ospf 1
TOKYO(config-router)#network 192.168.1.128 0.0.0.127 area 0
TOKYO(config-router)#network 192.168.1.0 0.0.0.3 area 0
TOKYO(config-router)#
```

- Examine the routers that are running configuration files.

MADRID

```
Building configuration...

Current configuration : 1252 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname MADRID
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$42pj$8d2g/nTqYkX5612KIcpb7/
enable password cisco
!
no aaa new-model
memory-size iomem 5
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
```

```
!
interface Loopback0
 ip address 192.168.31.22 255.255.255.255
!
interface FastEthernet0/0
 description link to workstation!!!
 ip address 192.168.0.1 255.255.255.0
 duplex auto
 speed auto
!
interface Serial0/0
 description link to ISP!!!
 ip address 200.20.20.2 255.255.255.252
 clock rate 2000000
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/1
 description link to TOKYO!!!
 ip address 192.168.1.2 255.255.255.252
 clock rate 2000000
!
router ospf 1
 log-adjacency-changes
 network 192.168.0.0 0.0.0.255 area 0
 network 192.168.1.0 0.0.0.3 area 0
!
```

```
!
!
banner motd ^Cauthorized access only!!!!^C
!
line con 0
 password cisco
line aux 0
line vty 0 4
 password cisco
 login
!
!
end

[illegible]
```

TOKIO

```
TOKYO#sh run
Building configuration...

Current configuration : 1191 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname TOKYO
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$OqgC$VQDXFMvCt8gkmhgzLBmXH/
!
no aaa new-model
memory-size iomem 5
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
```

```
interface Loopback0
 ip address 192.168.31.11 255.255.255.255
!
interface FastEthernet0/0
 description link to workstation!!!!
 ip address 192.168.1.129 255.255.255.192
 duplex auto
 speed auto
!
interface Serial0/0
 description link to madrid!!!
 ip address 192.168.1.1 255.255.255.252
 clock rate 64000
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/1
 no ip address
 shutdown
 clock rate 2000000
!
router ospf 1
 log-adjacency-changes
```

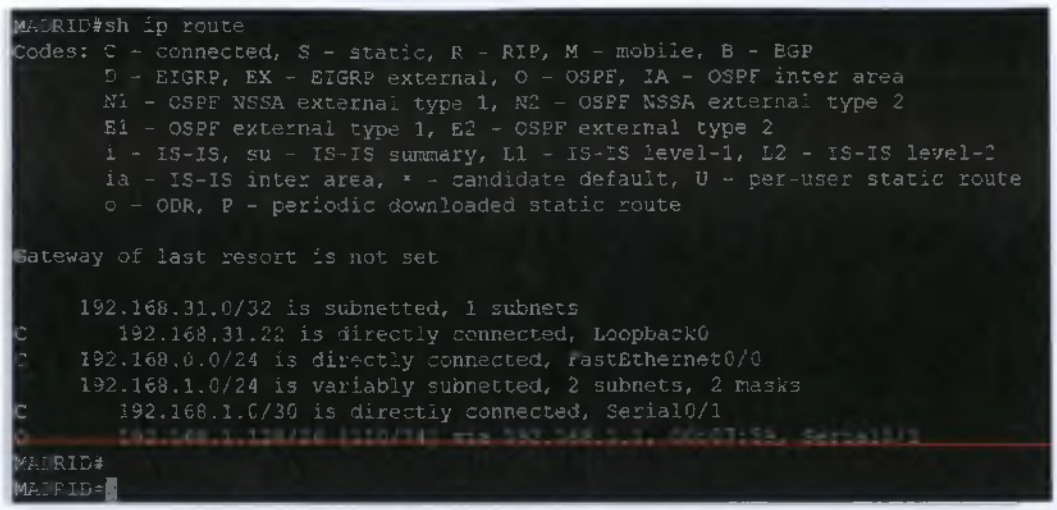
```
router ospf 1
 log-adjacency-changes
 network 192.168.1.0 0.0.0.3 area 0
 network 192.168.1.128 0.0.0.127 area 0

ip forward-protocol nd


ip http server
no ip http secure-server

banner motd ^Cauthorized access only!!!^C

line con 0
 password cisco
line aux 0
line vty 0 4
 password cisco
 login


end

TOKYO#
```

- Type the following commands: Router (config-router)#**log-adjacency-changes**

```
TOKYO(config)#router ospf 1
TOKYO(config-router)#log-adjacency-changes
TOKYO(config-router)#
```

- Show and examine the routing table for each router.

```
TOKYO#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     192.168.31.0/32 is subnetted, 1 subnets
C       192.168.31.11 is directly connected, Loopback0
O    192.168.0.0/24 [110/74] via 192.168.1.2, 00:07:32, Serial0/0
     192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.1.0/30 is directly connected, Serial0/0
C       192.168.1.128/26 is directly connected, FastEthernet0/0
TOKYO#
```



Configure the loopback interfaces.

Configure all Loopback interfaces according the topology.

Normally, the ISP would configure the ISP router (Router 3). For the purpose of this lab, after you erase the old configuration, configure the ISP router (Router 3) by typing the following:

Router>**enable**
Router#**configure terminal**
Router(config)#**hostname ISP**
ISP(config)#**line vty 0 4**
ISP(config-line)#**password cisco**
ISP(config-line)#**login**
ISP(config-line)#**interface serial 1**
ISP(config-if)#**ip address 200.20.20.1 255.255.255.252**
ISP(config-if)#**clock rate 64000**
ISP(config-if)#**no shutdown**
ISP(config-if)#**interface loopback 0**
ISP(config-if)#**ip address 138.25.6.33 255.255.255.255**
ISP(config-if)#**exit**
ISP(config)#**ip route 192.168.1.0 255.255.255.0 200.20.20.2**
ISP(config)#**ip route 192.168.0.0 255.255.255.0 200.20.20.2**
ISP(config)#**end**
ISP#**copy running-config startup-config**
Destination filename [startup-config]? [**Enter**]
Building configuration...
[OK]
ISP#

ISP

```
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#hostname ISP
ISP(config)#line vty 0 4
ISP(config-line)#password cisco
ISP(config-line)#login
ISP(config-line)#int s0/0
ISP(config-if)#ip address 200.20.20.1 255.255.255.252
ISP(config-if)#clock rate 64000
ISP(config-if)#no shut
ISP(config-if)#int loopback
*Mar  1 00:48:46.059: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
ISP(config-if)#int loopback0
ISP(config-if)#
*Mar  1 00:48:47.063: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
 changed state to up
ISP(config-if)#ip addre
*Mar  1 00:48:48.811: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
 changed state to up
ISP(config-if)#ip address 138.25.6.33 255.255.255.255
ISP(config-if)#exit
ISP(config)#ip route 192.168.1.0 255.255.255.0 200.20.20.2
ISP(config)#ip route 192.168.0.0 255.255.255.0 200.20.20.2
ISP(config)#end
ISP#
*Mar  1 00:49:34.499: %SYS-5-CONFIG_I: Configured from console by console
ISP#copy ru
ISP#copy running-config st
ISP#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
ISP#
```

- At privileged EXEC mode, type the command **debug ip ospf events on ISP** and observe the output. Is there OSPF traffic

```
ISP#debug ip ospf events
OSPF events debugging is on
ISP#
```

- Turn off debugging by typing **no debug ip ospf events** or **undebug all**.

```
ISP#undebug all
All possible debugging has been turned off
ISP#
```

Create a default route to the ISP

- On the Madrid router only, type a static default route via the serial 1 interface. Write the command **ip route 0.0.0.0 0.0.0.0 200.200.200.1**

```
MADRID(config)#
MADRID(config)#ip route 0.0.0.0 0.0.0.0 200.200.200.1
MADRID(config)#
```

Verify connectivity from the Madrid Router

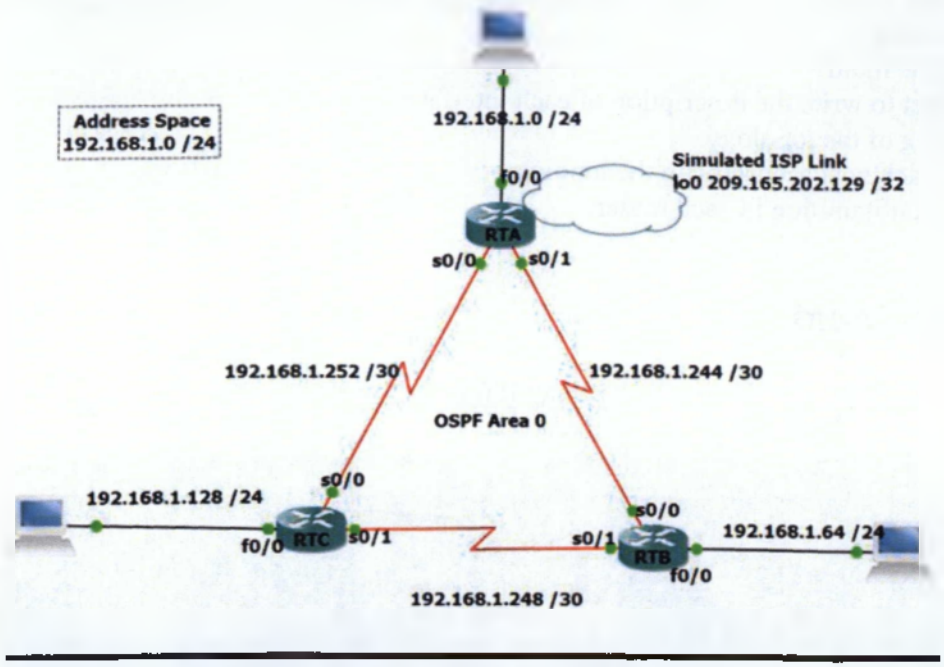
- Verify connectivity from the Madrid router by pinging the ISP serial 1 interface from the Madrid router.

```
MADRID#ping 200.20.20.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 200.20.20.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 52/164/320 ms
MADRID#
```

- Ping from a DOS window on the host that is attached to the Madrid router Fast Ethernet interface to the ISP router serial 1 interface.

```
root@box:~# ping 200.20.20.1
PING 200.20.20.1 (200.20.20.1): 56 data bytes
64 bytes from 200.20.20.1: seq=0 ttl=254 time=1225.099 ms
64 bytes from 200.20.20.1: seq=1 ttl=254 time=195.159 ms
64 bytes from 200.20.20.1: seq=2 ttl=254 time=119.799 ms
64 bytes from 200.20.20.1: seq=3 ttl=254 time=176.098 ms
64 bytes from 200.20.20.1: seq=4 ttl=254 time=211.954 ms
64 bytes from 200.20.20.1: seq=5 ttl=254 time=522.358 ms
64 bytes from 200.20.20.1: seq=6 ttl=254 time=65.544 ms
64 bytes from 200.20.20.1: seq=7 ttl=254 time=266.577 ms
64 bytes from 200.20.20.1: seq=8 ttl=254 time=106.749 ms
64 bytes from 200.20.20.1: seq=9 ttl=254 time=186.182 ms
64 bytes from 200.20.20.1: seq=10 ttl=254 time=685.113 ms
64 bytes from 200.20.20.1: seq=11 ttl=254 time=108.794 ms
64 bytes from 200.20.20.1: seq=12 ttl=254 time=226.868 ms
64 bytes from 200.20.20.1: seq=13 ttl=254 time=149.289 ms
64 bytes from 200.20.20.1: seq=14 ttl=254 time=340.326 ms
64 bytes from 200.20.20.1: seq=15 ttl=254 time=512.754 ms
64 bytes from 200.20.20.1: seq=16 ttl=254 time=101.221 ms
64 bytes from 200.20.20.1: seq=17 ttl=254 time=132.382 ms
64 bytes from 200.20.20.1: seq=18 ttl=254 time=293.654 ms
64 bytes from 200.20.20.1: seq=19 ttl=254 time=63.663 ms
64 bytes from 200.20.20.1: seq=20 ttl=254 time=327.326 ms
^Z[1]+  Stopped                    ping 200.20.20.1
root@box:~#
```

6.8.4 All in one configutration



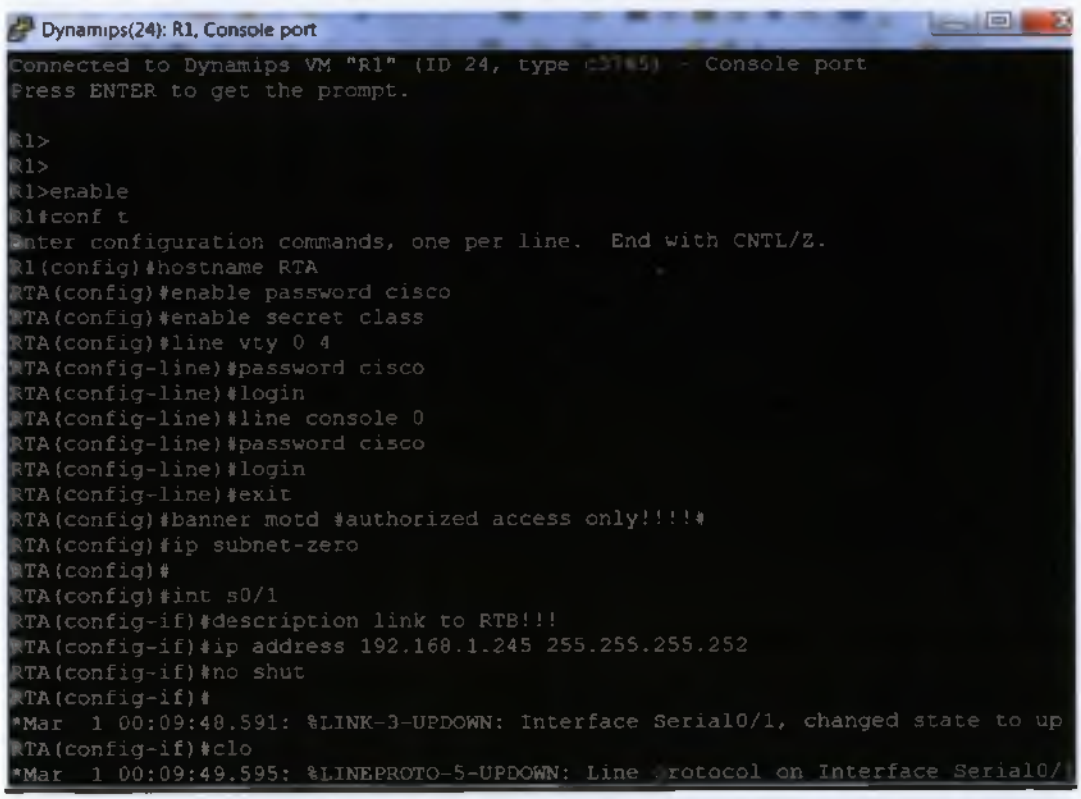
Εικόνα 54 All In One Configuration Topology

Device	Interface	IP Address	Subnet Mask
RTA	Fa0/0	192.168.1.1	255.255.255.192
	S0/1	192.168.1.245	255.255.255.252
	S0/0	192.168.1.254	255.255.255.252
	Lo0	209.165.202.129	255.255.255.255
RTB	S0/1	192.168.1.246	255.255.255.252
	Fa0/0	192.168.1.65	255.255.255.192
	S0/0	192.168.1.249	255.255.255.252
RTC	S0/1	192.168.1.250	255.255.255.252
	Fa0/0	192.168.1.129	255.255.255.192
	S0/0	192.168.1.253	255.255.255.252

1. The enable secret password for all routers is **class**.
2. The VTY, and console password for each router is **cisco**.
3. The "IP Host Table Entry" column contents ***indicate the names of the other routers*** in the IP host table.
4. Configure the motd
5. Do not forget to write the description of each interface
6. IP addressing of the topology.
7. Configure each host according to the topology.
8. Save each configuration in each router.

Configure the Routers

Router RTA

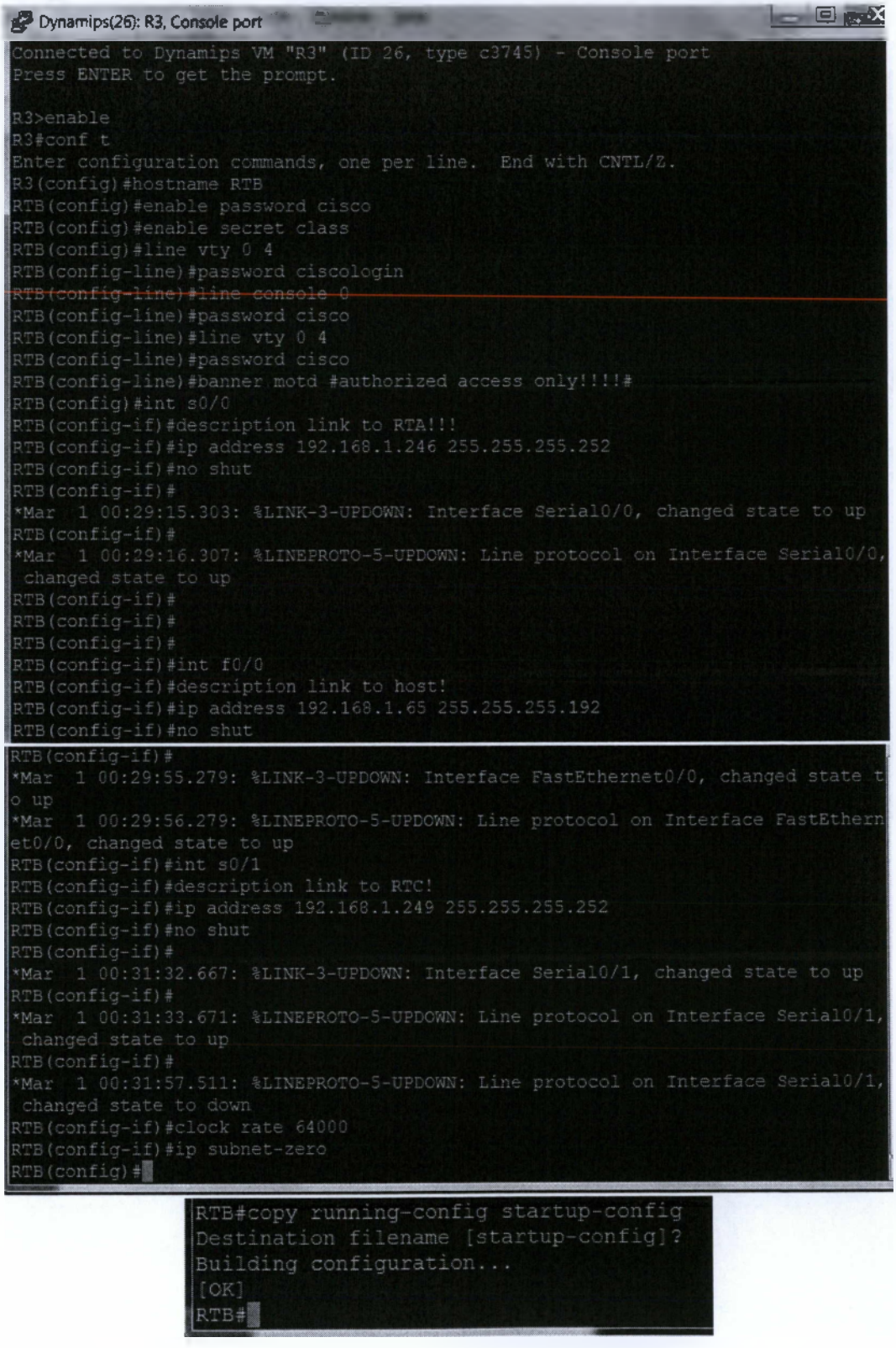


```
RTA(config-if)#clockrate 64000
RTA(config-if)#
*Mar  1 00:10:10.455: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/
 changed state to down
RTA(config-if)#int s0/0
RTA(config-if)#link to RTC!!!!
               ^
% Invalid input detected at '^' marker.

RTA(config-if)#description link to RTC!!!!
RTA(config-if)#ip address 192.168.1.254 255.255.255.252
RTA(config-if)#no shut
RTA(config-if)#
*Mar  1 00:12:18.283: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
RTA(config-if)#
*Mar  1 00:12:19.287: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/
 changed state to up
RTA(config-if)#
RTA(config-if)#
RTA(config-if)#
RTA(config-if)#int f0/0
RTA(config-if)#
*Mar  1 00:12:40.455: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/
 changed state to down
RTA(config-if)#description link to host!
RTA(config-if)#ip address 192.168.1.1 255.255.255.192
RTA(config-if)#no shut
RTA(config-if)#
```

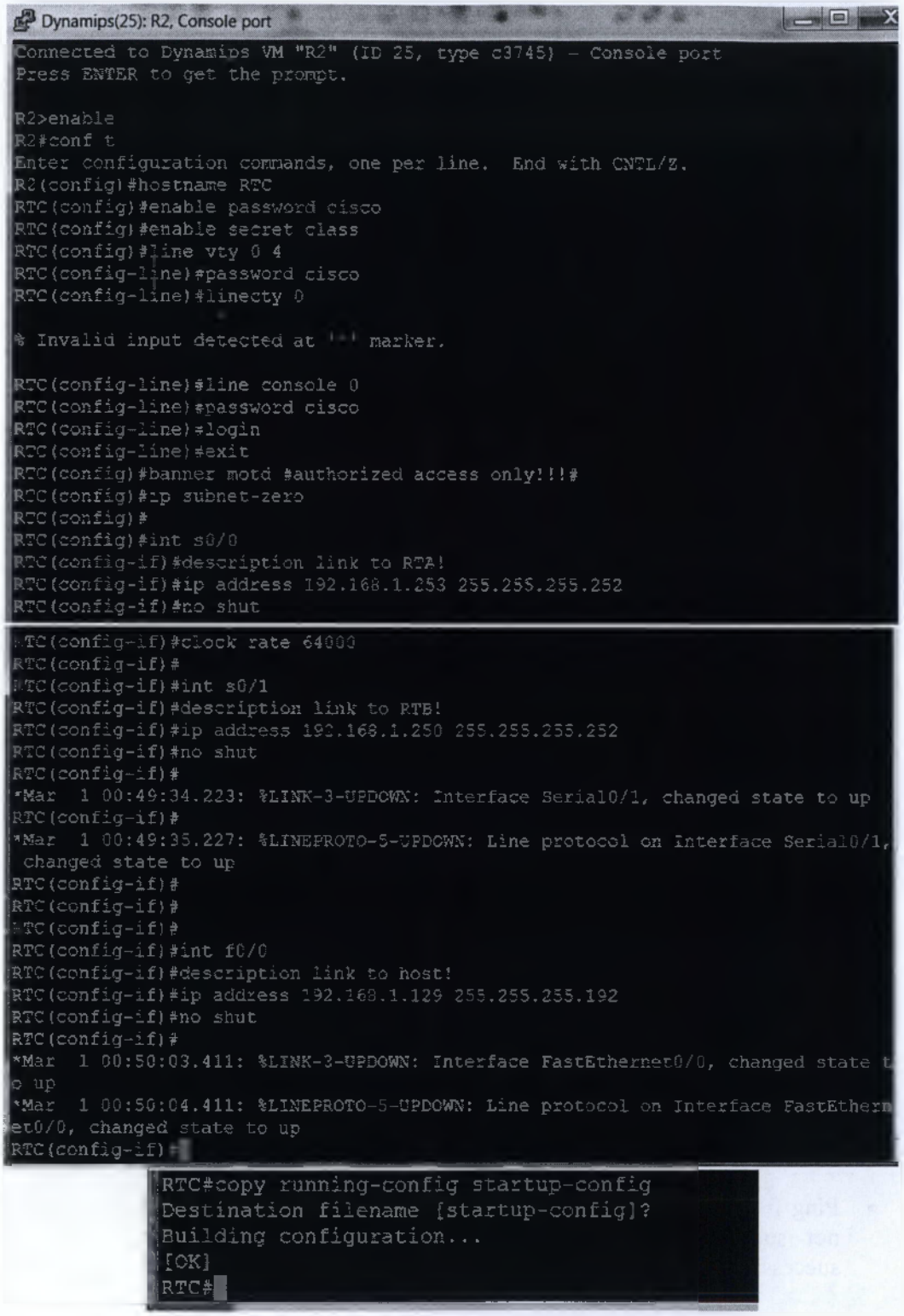
```
RTA(config-if)#int loopback0
RTA(config-if)#ip address
*Mar  1 00:15:08.599: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback
 changed state to up
RTA(config-if)#ip address 209.165.202.129 255.255.255.255
RTA(config-if)#
```

```
RTA#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
RTA#
```

Router RTB

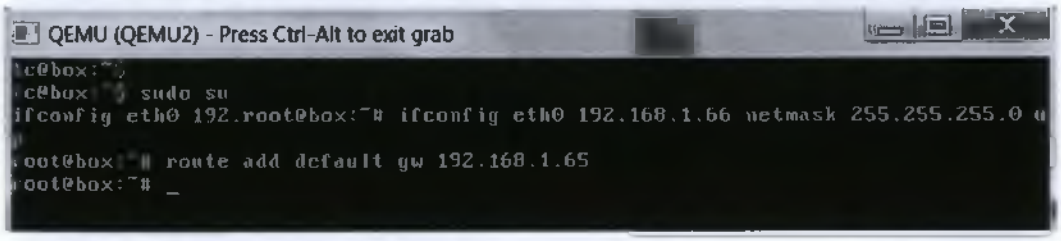

Dynamips(26): R3, Console port
Connected to Dynamips VM "R3" (ID 26, type c3745) - Console port
Press ENTER to get the prompt.
R3>enable
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#hostname RTB
RTB(config)#enable password cisco
RTB(config)#enable secret class
RTB(config)#line vty 0 4
RTB(config-line)#password ciscologin
RTB(config-line)#line console 0
RTB(config-line)#password cisco
RTB(config-line)#line vty 0 4
RTB(config-line)#password cisco
RTB(config-line)#banner motd #authorized access only!!!!#
RTB(config)#int s0/0
RTB(config-if)#description link to RTA!!!
RTB(config-if)#ip address 192.168.1.246 255.255.255.252
RTB(config-if)#no shut
RTB(config-if)#
*Mar 1 00:29:15.303: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
RTB(config-if)#
*Mar 1 00:29:16.307: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
changed state to up
RTB(config-if)#
RTB(config-if)#
RTB(config-if)#
RTB(config-if)#int f0/0
RTB(config-if)#description link to host!
RTB(config-if)#ip address 192.168.1.65 255.255.255.192
RTB(config-if)#no shut
RTB(config-if)#
*Mar 1 00:29:55.279: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state t
o up
*Mar 1 00:29:56.279: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthern
et0/0, changed state to up
RTB(config-if)#int s0/1
RTB(config-if)#description link to RTC!
RTB(config-if)#ip address 192.168.1.249 255.255.255.252
RTB(config-if)#no shut
RTB(config-if)#
*Mar 1 00:31:32.667: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up
RTB(config-if)#
*Mar 1 00:31:33.671: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1,
changed state to up
RTB(config-if)#
*Mar 1 00:31:57.511: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1,
changed state to down
RTB(config-if)#clock rate 64000
RTB(config-if)#ip subnet-zero
RTB(config)#
RTB#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
RTB#

Router RTC

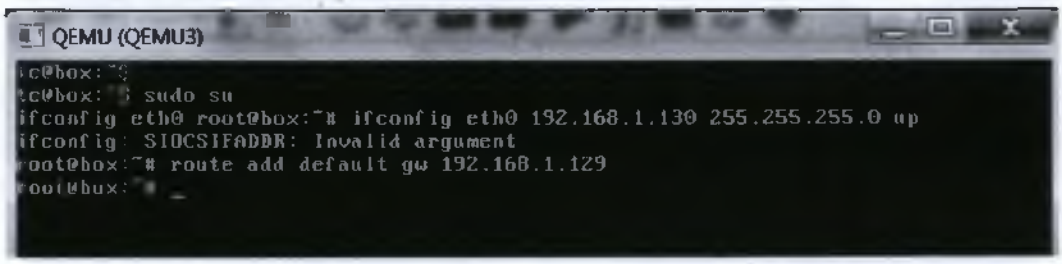

Dynamips(25): R2, Console port
Connected to Dynamips VM "R2" (ID 25, type c3745) - Console port
Press ENTER to get the prompt.
R2>enable
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#hostname RTC
RTC(config)#enable password cisco
RTC(config)#enable secret class
RTC(config)#line vty 0 4
RTC(config-line)#password cisco
RTC(config-line)#linecty 0
% Invalid input detected at '^' marker.
RTC(config-line)#line console 0
RTC(config-line)#password cisco
RTC(config-line)#login
RTC(config-line)#exit
RTC(config)#banner motd #authorized access only!!!#
RTC(config)#ip subnet-zero
RTC(config)#
RTC(config)#int s0/0
RTC(config-if)#description link to RTA!
RTC(config-if)#ip address 192.168.1.253 255.255.255.252
RTC(config-if)#no shut
RTC(config-if)#clock rate 64000
RTC(config-if)#
RTC(config-if)#int s0/1
RTC(config-if)#description link to RTB!
RTC(config-if)#ip address 192.168.1.250 255.255.255.252
RTC(config-if)#no shut
RTC(config-if)#
*Mar 1 00:49:34.223: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up
RTC(config-if)#
*Mar 1 00:49:35.227: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1,
changed state to up
RTC(config-if)#
RTC(config-if)#
RTC(config-if)#
RTC(config-if)#int f0/0
RTC(config-if)#description link to host!
RTC(config-if)#ip address 192.168.1.129 255.255.255.192
RTC(config-if)#no shut
RTC(config-if)#
*Mar 1 00:50:03.411: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state t
o up
*Mar 1 00:50:04.411: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthern
et0/0, changed state to up
RTC(config-if)#
RTC#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
RTC#

Host 1

Host 2



Host 3



Verify Interface Connection

- Ping from one of the connected serial interfaces to the other. If the ping was not successful, troubleshoot the router configuration until the ping is successful.

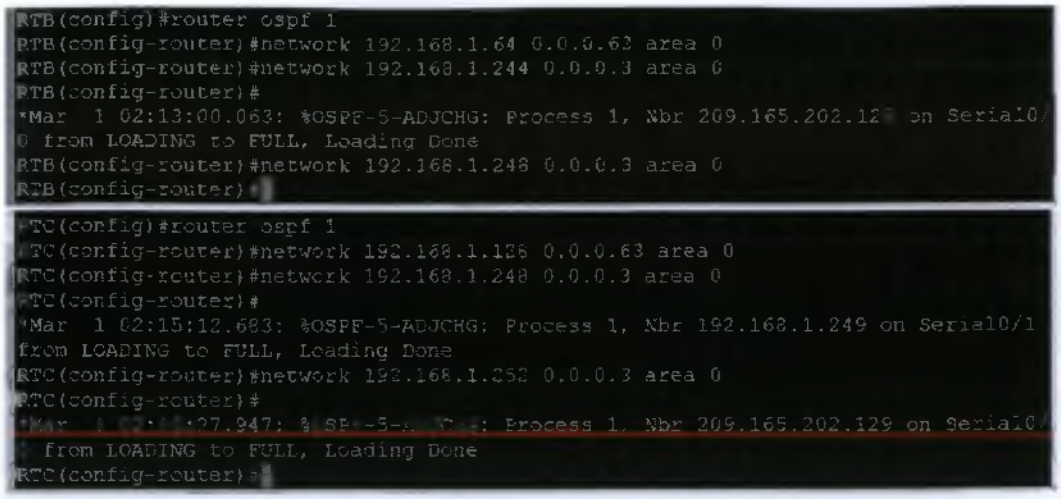
```
RTA#ping 192.168.1.246

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.246, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 8/45/96 ms
RTA#ping 192.168.1.253

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.253, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/45/128 ms
RTA#
```

```
RTB#ping 192.168.1.245

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.245, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 8/52/152 ms
RTB#ping 192.168.1.250

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.250, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/53/140 ms
RTB#
```

```
RTC#ping 192.168.1.249

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.249, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/73/128 ms
RTC#ping 192.168.1.254

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.254, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 8/55/100 ms
RTC#
```

- Configure an OSPF routing process on router. Use OSPF process number 1 and ensure that all networks are in area 0.

```
RTA(config)#router ospf 1
RTA(config-router)#network 192.168.1.9 0.0.0.63
% Incomplete command.

RTA(config-router)#network 192.168.1.9 0.0.0.63 area 0
RTA(config-router)#network 192.168.1.0 0.0.0.63 area 0
RTA(config-router)#network 192.168.1.244 0.0.0.3 area 0
RTA(config-router)#network 192.168.1.252 0.0.0.3 area 0
```



- Examine the routers that are running configuration files.

RTA

```
!
banner motd ^Cauthorized access only!!!!^C
!
line con 0
 exec-timeout 0 0
 password cisco
 logging synchronous
 login
line aux 0
line vty 0 4
 password cisco
 login
!
!
end

RTA#
```

```
interface Loopback0
 ip address 209.165.202.129 255.255.255.255
!
interface FastEthernet0/0
 description link to host!
 ip address 192.168.1.1 255.255.255.192
 duplex auto
 speed auto
!
interface Serial0/0
 description link to RTC!!!!
 ip address 192.168.1.254 255.255.255.252
 clock rate 2000000
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/1
 description link to RTB!!!
 ip address 192.168.1.245 255.255.255.252
 clock rate 64000
!
router ospf 1
 log-adjacency-changes
 network 192.168.1.244 0.0.0.3 area 0
 network 192.168.1.252 0.0.0.3 area 0
!
ip forward-protocol nd
!
```

RTB

```
interface FastEthernet0/0
 description link to host!
 ip address 192.168.1.65 255.255.255.192
 duplex auto
 speed auto
!
interface Serial0/0
 description link to RTA!!!
 ip address 192.168.1.246 255.255.255.252
 clock rate 2000000
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/1
 description link to RTC!
 ip address 192.168.1.249 255.255.255.252
 clock rate 64000
!
router ospf 1
 log-adjacency-changes
 network 192.168.1.64 0.0.0.63 area 0
 network 192.168.1.244 0.0.0.3 area 0
 network 192.168.1.248 0.0.0.3 area 0
!
ip forward-protocol nd
!
!
banner motd ^Cauthorized access only!!!!^C
!
line con 0
 exec-timeout 0 0
 password cisco
 logging synchronous
line aux 0
line vty 0 4
 password cisco
 login
!
!
end

RTB#
```

RTC

```
RTC#sh run
Building configuration...

Current configuration : 1285 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname RTC
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$np59$oq2dSUqQ2feGf1NKEXiq30
enable password cisco
!
no aaa new-model
memory-size iomem 5
ip cef
!
!
!
!
no ip domain lookup
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
```

```
interface FastEthernet0/0
 description link to host!
 ip address 192.168.1.129 255.255.255.192
 duplex auto
 speed auto
!
interface Serial0/0
 description link to RTA!
 ip address 192.168.1.253 255.255.255.252
 clock rate 64000
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/1
 description link to RTB!
 ip address 192.168.1.250 255.255.255.252
 clock rate 2000000
!
router ospf 1
 log-adjacency-changes
 network 192.168.1.128 0.0.0.63 area 0
 network 192.168.1.248 0.0.0.3 area 0
 network 192.168.1.252 0.0.0.3 area 0
!
ip forward-protocol nd
!
!
no ip http server
```

```
banner motd ^Cauthorized access only!!!^C
!
line con 0
 exec-timeout 0 0
 password cisco
 logging synchronous
 login
line aux 0
line vty 0 4
 password cisco
 login
!
!
end

RTA#
```

- Type the following command: Router (config-router)#**log-adjacency-changes** and show the routing table for all routers.

```
RTA(config)#router ospf 1
RTA(config-router)#log-adjacency-changes
RTA(config-router)#do sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     209.165.202.0/32 is subnetted, 1 subnets
C       209.165.202.129 is directly connected, Loopback0
     192.168.1.0/24 is variably subnetted, 6 subnets, 2 masks
O       192.168.1.64/26 [110/74] via 192.168.1.246, 00:10:08, Serial0/1
C       192.168.1.0/26 is directly connected, FastEthernet0/0
O       192.168.1.248/30 [110/128] via 192.168.1.253, 00:10:08, Serial0/0
                         [110/128] via 192.168.1.246, 00:10:08, Serial0/1
C       192.168.1.252/30 is directly connected, Serial0/0
C       192.168.1.244/30 is directly connected, Serial0/1
O       192.168.1.128/26 [110/74] via 192.168.1.253, 00:10:13, Serial0/0
RTA(config-router)#
```

```
RTB(config)#router ospf 1
RTB(config-router)#log-adjacency-changes
RTB(config-router)#
RTB(config-router)#do sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     192.168.1.0/24 is variably subnetted, 5 subnets, 2 masks
C       192.168.1.64/26 is directly connected, FastEthernet0/0
C       192.168.1.248/30 is directly connected, Serial0/1
O       192.168.1.252/30 [110/128] via 192.168.1.250, 00:10:46, Serial0/1
                         [110/128] via 192.168.1.245, 00:10:46, Serial0/0
C       192.168.1.244/30 is directly connected, Serial0/0
O       192.168.1.128/26 [110/74] via 192.168.1.250, 00:10:46, Serial0/1
RTB(config-router)#
```

```
RTC(config)#router ospf 1
RTC(config-router)#log-adjacency-changes
RTC(config-router)#
RTC(config-router)#do sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     192.168.1.0/24 is variably subnetted, 5 subnets, 2 masks
O       192.168.1.64/26 [110/74] via 192.168.1.249, 00:11:09, Serial0/1
C       192.168.1.248/30 is directly connected, Serial0/1
C       192.168.1.252/30 is directly connected, Serial0/0
O       192.168.1.244/30 [110/128] via 192.168.1.254, 00:11:09, Serial0/0
                         [110/128] via 192.168.1.249, 00:11:09, Serial0/1
C       192.168.1.128/26 is directly connected, FastEthernet0/0
RTC(config-router)#
```

Modify OSPF Cost

- At this point, all routers are using the default bandwidth for serial interfaces: for 2500s and 2600s, 1544 kbps; for 1700s, 128 kbps. Use the **show interface serial** command to view the bandwidth used to calculate cost.

```
RTA#sh int s0/0
Serial0/0 is up, line protocol is up
  Hardware is GT96K Serial
  Description: link to RTC!!!!
  Internet address is 192.168.1.254/30
  MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:04, output 00:00:00, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: weighted fair
  Output queue: 0/1000/64/0 (size/max total/threshold/drops)
```

When RTB pings the LAN interface on RTC, it sends it directly to RTC even though the path through RTA is faster. How do you verify this?	`RTB#traceroute 192.168.1.129`
	
	`Type escape sequence to abort.`
	`Tracing the route to 192.168.1.129`
	
	`  1 192.168.1.250 100 msec *  4 msec`
	`RTB#`

- Configure both RTB and RTC with the correct bandwidth. Write down the command

```
RTB(config)#int s0/0
RTB(config-if)#bandwidth 386
RTB(config-if)#int s0/1
RTB(config-if)#bandwidth 386
RTB(config-if)#
```

- How you can verify that RTB sends pings destined for the LAN on RTC to RTA, which then routes the ping to RTC. Write down the command(s)

```
RTB#traceroute 192.168.1.129

Type escape sequence to abort.
Tracing the route to 192.168.1.129

  1 192.168.1.250 120 msec *  0 msec
RTB#
```

Configure MD5 Authentication

To make sure routing updates come from trusted sources, configure each router to use MD5 authentication

After configuring authentication on each router, neighbour adjacency will go to the DOWN state and then reinitialize. Which commands are you going to use to verify reconvergence and that ospf routes are present on the Routing Table again?

```
RTA(config)#int s0/0
RTA(config-if)#ip ospf message-digest-key 1 md5 7 allrouters
```

```
RTA(config-if)#
RTA(config-if)#int s0/1
RTA(config-if)#ip ospf message-digest-key 1 md5 7 allrouters
RTA(config-if)#router ospf 1
RTA(config-router)#area 0 authentication message-digest
```

```
RTB(config-if)#int s0/0
RTB(config-if)#ip ospf message-digest-key 7 md5 7 allrouters
```

```
RTB(config-if)#int s0/1
RTB(config-if)#ip ospf message-digest-key 7 md5 7 allrouters
```

```
RTB(config-if)#
RTB(config-if)#router ospf 1
RTB(config-router)#area 0 authentication message-digest
RTB(config-router)#
```

```
RTC(config-if)#int s0/0
RTC(config-if)#ip ospf message-digest-key 1 md5 7 allrouters
```

```
RTC(config-if)#int s0/1
RTC(config-if)#ip ospf message-digest-key 1 md5 7 allrouters
```

```
RTC(config-if)#router ospf 1
RTC(config-router)#area 0 authentication message-digest
RTC(config-router)#
```

How you can verify authentication on each link. Write down the command(s)

show ip ospf

show ip ospf interface

Adjust OSPF Timers

- Notice in the previous output for **show ip ospf interface** that the Hello and dead interval timers are shown as 10 and 40, respectively.

```
RTA#sh ip ospf int
Serial0/0 is up, line protocol is up
  Internet Address 192.168.1.254/30, Area 0
  Process ID 1, Router ID 209.165.202.129, Network Type POINT_TO_POINT, Cost:
64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:05
  Supports Link-local Signaling (LLS)
  Index 3/3, flood queue length 0
  Next 0x0(0)/0x0(0)
```

- Configure these intervals to be 40 and 160 on all three routers.

```
RTA(config)#int s0/0
RTA(config-if)#ip ospf hello-interval 40
RTA(config-if)#ip ospf dead-interval 160
RTA(config-if)#int s0/1
RTA(config-if)#ip ospf hello-interval 40
RTA(config-if)#ip ospf dead-interval 160
RTA(config-if)#
```

```
RTB(config-router)#int s0/0
RTB(config-if)#ip ospf hello-interval 40
RTB(config-if)#ip ospf dead-interval 160
RTB(config-if)#int s0/1
RTB(config-if)#ip ospf hello-interval 40
RTB(config-if)#ip ospf dead-interval 160
RTB(config-if)#
```

```
RTC(config-if)#int s0/0
RTC(config-if)#ip ospf hello-interval 40
RTC(config-if)#ip ospf hello-interval 160
*Mar  1 03:03:53.367: %OSPF-5-ADJCHG: Process
0 from LOADING to FULL, Loading Done
RTC(config-if)#ip ospf dead-interval 160
RTC(config-if)#int s0/1
RTC(config-if)#ip ospf hello-interval 40
RTC(config-if)#ip ospf dead-interval 160
RTC(config-if)#
RTC(config-if)#
```

- Verify that all routers have full routing tables and have re-established neighbor adjacencies. If adjacency has not been re-established, you can use the **debug ip ospf events** command to find where there might be a timing mismatch

```
RTA#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     209.165.202.0/32 is subnetted, 1 subnets
C       209.165.202.129 is directly connected, Loopback0
     192.168.1.0/24 is variably subnetted, 5 subnets, 2 masks
C       192.168.1.0/26 is directly connected, FastEthernet0/0
O       192.168.1.248/30 [110/323] via 192.168.1.253, 00:02:12, Serial0/0
C       192.168.1.252/30 is directly connected, Serial0/0
C       192.168.1.244/30 is directly connected, Serial0/1
O       192.168.1.128/26 [110/74] via 192.168.1.253, 00:02:12, Serial0/0
RTA#^Z
RTA#
```

```
RTB#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     192.168.1.0/24 is variably subnetted, 3 subnets, 2 masks
C       192.168.1.64/26 is directly connected, FastEthernet0/0
C       192.168.1.248/30 is directly connected, Serial0/1
C       192.168.1.244/30 is directly connected, Serial0/0
RTB#
```

```
RTC#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     192.168.1.0/24 is variably subnetted, 4 subnets, 2 masks
C       192.168.1.248/30 is directly connected, Serial0/1
C       192.168.1.252/30 is directly connected, Serial0/0
O       192.168.1.244/30 [110/323] via 192.168.1.254, 00:02:34, Serial0/0
C       192.168.1.128/26 is directly connected, FastEthernet0/0
RTC#
```

Configure and propagate a default route

- Because the ISP is only simulated, RTA does not have a real default route. However, you can simulate a default route by configuring it to forward to a null interface.

```
RTA(config)#
RTA(config)#ip route 0.0.0.0 0.0.0.0 null 0
RTA(config)#
```

- Now, you can configure RTA to propagate the default route to RTB and RTC.

```
RTA(config)#router ospf 1
RTA(config-router)#default-information originate
RTA(config-router)#
```

- RTB and RTC should now be able to successfully ping the 209.165.202.129 interface, which verifies that both routers have a working default route. Is that true? **Yes, it is true.**

```
RTC#
RTC#ping 209.165.202.129

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 209.165.202.129, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/60/196 ms
RTC#
```

6.9 Layer 2 Switching and Spanning Tree Protocol (STP)

Η ενότητα αυτή αναλύει λεπτομερώς την λειτουργία των LAN switches και bridges (γεφυρων) και πως παραμετροποιούνται και χρησιμοποιούν τις MAC διευθύνσεις για να μεταφέρουν frames μέσα σε ένα switched δίκτυο. Επίσης αναλύει τα προβλήματα που δημιουργούνται σε reduntant τοπολογίες με την χρήση των switches και bridges και πως μπορούμε να τα αποφύγουμε με την χρήση του Spanning Tree πρωτοκόλου.

Υλοποίηση Ασκήσεων

6.9.1 Verifying Default Switch Configuration

Εικόνα 55 Switch Configuration Topology

- Examine the current running configuration file:

```
Switch#sh run
Building configuration...

Current configuration : 1051 bytes
!
```

```
interface FastEthernet0/13
!
interface FastEthernet0/14
!
interface FastEthernet0/15
!
interface Vlan1
 no ip address
!
no ip http server
no ip http secure-server
```

- How many Ethernet and Fast Ethernet interfaces does the switch have? **The switch has 16 FastEthernet interfaces.**
- What is the range of values shown for the VTY lines? **The range of values is 5 to 15.**

- Examine the current content of NVRAM.

```
Switch#sh startup-config
startup-config is not present
Switch#
```

- Why does the switch give this response? **Because there is nothing stored in NVRAM because of the erase startup.**

- Show the current IP address of the switch.

```
Switch#sh int vlan 1
Vlan1 is up, line protocol is up
  Hardware is EtherSVI, address is cc00.08d8.0000 (bia cc00.08d8.0000)
  MTU 1500 bytes, BW 100000 Kbit/sec, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:00, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     41 packets input, 13407 bytes, 0 no buffer
     Received 41 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 1 interface resets
     0 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
Switch#
```

- Is an IP address set on the switch? **No**
- What is the MAC address of this virtual switch interface? **cc00.08d8.0000**
- Is this interface up? **Yes**

- Show the IP properties of the interface.

```
Switch#sh ip int vlan 1
Vlan1 is up, line protocol is up
  Internet protocol processing disabled
Switch#
```

Get Cisco IOS Software Information

- Examine the version information that the switch reports.

```
Switch#sh version
Cisco IOS Software, 3600 Software (C3640-IK9O3S-M), Version 12.4(25c), RELEASE S
OFTWARE (fc2)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2010 by Cisco Systems, Inc.
Compiled Fri 12-Feb-10 00:48 by prod_rel_team

ROM: ROMMON Emulation Microcode
ROM: 3600 Software (C3640-IK9O3S-M), Version 12.4(25c), RELEASE SOFTWARE (fc2)

Switch uptime is 11 minutes
System returned to ROM by unknown reload cause - suspect boot_data[BOOT_COUNT] 0
x0, BOOT_COUNT 0, BOOTDATA 19
System image file is "tftp://255.255.255.255/unknown"


This product contains cryptographic features and is subject to United
States and local country laws governing import, export, transfer and
use. Delivery of Cisco cryptographic products does not imply
third-party authority to import, export, distribute or use encryption.
Importers, exporters, distributors and users are responsible for
compliance with U.S. and local country laws. By using this product you
agree to comply with applicable laws and regulations. If you are unable
to comply with U.S. and local laws, return this product immediately.

A summary of U.S. laws governing Cisco cryptographic products may be found at:
http://www.cisco.com/wwl/export/crypto/tool/stqrg.html

If you require further assistance please contact us by sending email to
export@cisco.com.

Cisco 3640 (R4700) processor (revision 0xFF) with 124928K/6144K bytes of memory.
Processor board ID FF1045C5
R4700 CPU at 100MHz, Implementation 33, Rev 1.2
16 FastEthernet interfaces
DRAM configuration is 64 bits wide with parity enabled.
125K bytes of NVRAM.
8192K bytes of processor board System flash (Read/Write)

Configuration register is 0x2102

Switch#
```

```
Cisco 3640 (R4700) processor (revision 0xFF) with 124928K/6144K bytes of memory.
Processor board ID FF1045C5
R4700 CPU at 100MHz, Implementation 33, Rev 1.2
16 FastEthernet interfaces
DRAM configuration is 64 bits wide with parity enabled.
125K bytes of NVRAM.
8192K bytes of processor board System flash (Read/Write)

Configuration register is 0x2102

Switch#
```

- What is the IOS version that the switch is running?

```
Switch#sh version
Cisco IOS Software, 3600 Software (C3640-IK9O3S-M), Version 12.4(25c), RELEASE S
OFTWARE (fc2)
Technical Support: http://www.cisco.com/techsupport
```

- What is the system image filename?

```
Switch#sh version
Cisco IOS Software, 3600 Software (C3640-IK9O3S-M), Version 12.4(25c), RELEASE S
OFTWARE (fc2)
Technical Support: http://www.cisco.com/techsupport
```

- What is the bajse MAC address of this switch?

```
address is cc00.08d8.0000
```

- Is the switch running Enterprise Edition software? **No**
- Is the switch running Enhanced Image software, indicated by the letters EA in the IOS filename? **Yes**

- Examine the default properties of the Fast Ethernet interfaces. As an example, examine the properties of the fourth interface:

```
Switch#sh int f0/4
FastEthernet0/4 is up, line protocol is down
  Hardware is Fast Ethernet, address is cc00.08d8.f004 (bia cc00.08d8.f004)
  MTU 1500 bytes, BW 100000 Kbit/sec, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Auto-duplex, Auto-speed
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     0 input packets with dribble condition detected
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 collisions, 2 interface resets
     0 unknown protocol drops
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier
     0 output buffer failures, 0 output buffers swapped out
Switch#
```

- Is the interface up or down? **The interface is down.**
- What event would make an interface go up? **Connecting a host to the interface, it would make it to go up.**

- What is the MAC address of the interface?

```
Switch#sh int f0/4
FastEthernet0/4 is up, line protocol is down
  Hardware is Fast Ethernet, address is cc00.08d8.f004 (bia cc00.08d8.f004)
  MTU 1500 bytes, BW 100000 Kbit/sec, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
```

- What is the speed and duplex setting of the interface? **Auto**

- Examine the contents of the startup configuration file.

```
Switch#sh startup-config
startup-config is not present
Switch#
```

- Copy the current configuration to NVRAM. This setup ensures that any changes made will be available to the switch if there is a reload or if the power goes off.

```
Switch#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
Switch#
```

- Show the contents of NVRAM.

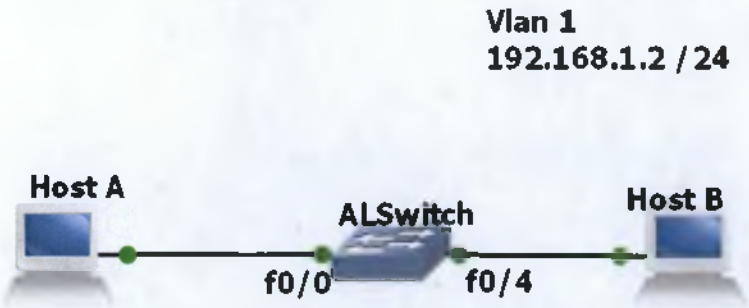
```
Switch#sh startup-config
Using 1051 out of 129016 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Switch

boot-start-marker
boot-end-marker


no aaa new-model
memory-size iomem 5


ip cef
no ip domain lookup


ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
```

```
interface Vlan1
 no ip address
!
no ip http server
no ip http secure-server
!
ip forward-protocol nd
!
!
!
!
control-plane
!
!
!
!
!
!
!
!
!
line con 0
 exec-timeout 0 0
 logging synchronous
line aux 0
line vty 0 4
 login
!
!
end
```

- Exit to the switch welcome screen.

```
Switch#exit
```

6.9.2 Basic Switch Configuration



Εικόνα 56 Basic Switch Configuration Topology

- Examine the current running configuration file:

```
Switch#sh run
Building configuration...

Current configuration : 1051 bytes
!
```

- Examine the current content of NVRAM.

```
Switch#sh startup-config
startup-config is not present
Switch#
```

- Why does the switch give this response? **Because there is nothing stored in NVRAM yet.**

- Enter enable and then configuration mode. Configuration mode allows the management of the switch. Enter the name by which this switch will be referred, ALSwitch.

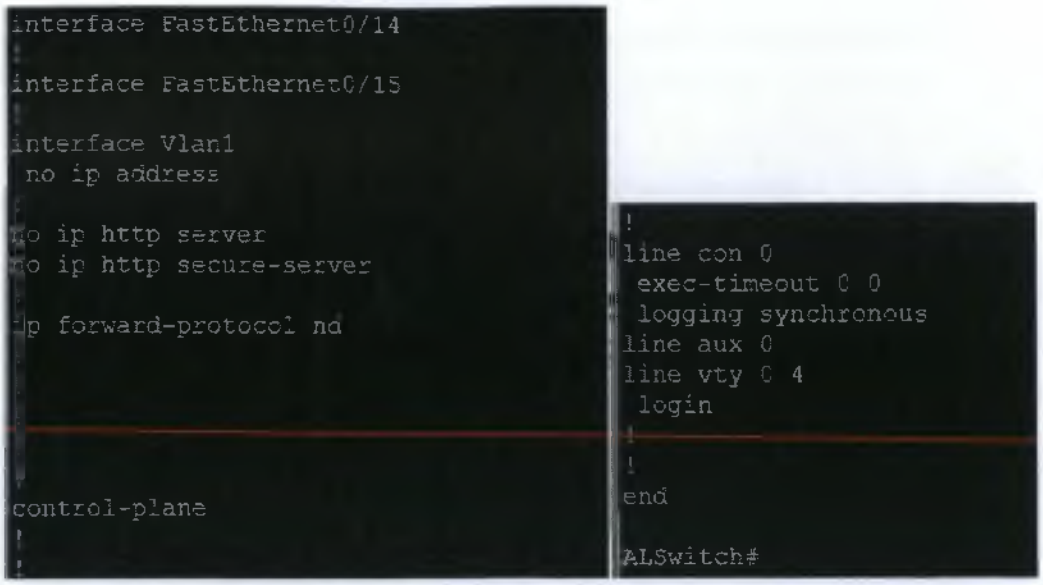
```
Switch(config)#hostname ALSwitch
```

- Notice that the prompt changed to reflect its new name. Type **exit** or press **Ctrl-Z** to go back into privileged mode.

```
ALSwitch(config)#
ALSwitch(config)#^Z
ALSwitch#
*Mar  1 00:04:11.543: %SYS-5-CONFIG_I: Configured from console by console
ALSwitch#
```

- Examine the current configuration to verify that there is no configuration except for the hostame.

```
ALSwitch#sh running-config
Building configuration...

Current configuration : 1053 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname ALSwitch
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
memory-size iomem 5
!
!
ip cef
no ip domain lookup
!
```



- Are any passwords set on lines? **No**
- What does the configuration show as the hostname of this switch? **ALSwitch.**

- Enter config-line mode for the console. Set the password on this line to **cisco** for login. Configure the VTY lines 5 to 15 with the password **cisco**.

```
ALSwitch(config)#line vty 0 15
ALSwitch(config-line)#password cisco
ALSwitch(config-line)#login
ALSwitch(config-line)#line console 0
ALSwitch(config-line)#password cisco
ALSwitch(config-line)#login
ALSwitch(config-line)#
```

- Set the enable password to **cisco** and the enable secret password to **class**.

```
ALSwitch(config-line)#enable password cisco
ALSwitch(config)#enable secret class
```

- Which password takes the precedence: the enable password or the enable secret password? **The enable secret password takes the precedence.**

- Set the IP address of the switch to 192.168.1.2 with a subnet mask of 255.255.255.0. Note that this is done on the internal virtual interface VLAN 1.

```
ALSwitch(config)#int vlan 1
ALSwitch(config-if)#ip address 192,168,1,2
ALSwitch(config-if)#ip address 192.168.1.2 255.255.255.0
ALSwitch(config-if)#no shut
ALSwitch(config-if)#
```

- Verify the interface settings on VLAN 1.

```
ALSwitch(config-if)#do sh int vlan 1
Vlan1 is administratively down, line protocol is down
  Hardware is EtherSVI, address is cc02.08d8.0000 (bia cc02.08d8.0000)
  Internet address is 192.168.1.2/24
  MTU 1500 bytes, BW 100000 Kbit/sec, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:04, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 1000 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     183 packets input, 59841 bytes, 0 no buffer
     Received 183 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 2 interface resets
     0 unknown protocol drops
     0 output
```

- What is the bandwidth on this interface?

```
ALSwitch(config-if)#do sh int vlan 1
Vlan1 is administratively down, line protocol is down
  Hardware is EtherSVI, address is cc02.08d8.0000 (bia cc02.08d8.0000)
  Internet address
  MTU 1500 bytes, BW 100000 Kbit/sec, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
```

- What are the VLAN states?

```
ALSwitch(config-if)#do sh int vlan 1
Vlan1 is administratively down, line protocol is down
  Hardware is EtherSVI, address is cc02.08d8.0000 (bia cc02.08d8.0000)
```

- Enable the virtual interface.

```
ALSwitch(config-if)#int vlan 1
ALSwitch(config-if)#no shut
ALSwitch(config-if)#
*Mar  1 00:20:04.543: %LINK-3-UPDOWN: Interface Vlan1, changed state to up
*Mar  1 00:20:05.543: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, cha
nged state to up
ALSwitch(config-if)#
```

- Prepare to configure the fastethernet 0/4 interface.

```
ALSwitch#
ALSwitch#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
ALSwitch(config)#int f0/4
ALSwitch(config-if)#
```

- Set the port speed of interface fastethernet 0/4 to 100 Mbps and to operate in full-duplex mode.

```
ALSwitch(config)#int f0/4
ALSwitch(config-if)#speed 100
ALSwitch(config-if)#duplex full
ALSwitch(config-if)#
```

```
ALSwitch(config-if)#do sh int f0/1
FastEthernet0/1 is up, line protocol is down
  Hardware is Fast Ethernet, address is cc02.08d8.f001 (bia cc02.08d8.f001)
  MTU 1500 bytes, BW 100000 Kbit/sec, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Auto-duplex, Auto-speed
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     0 input packets with dribble condition detected
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 collisions, 2 interface resets
     0 unknown protocol drops
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier
     0 output buffer failures, 0 output buffers swapped out
ALSwitch(config-if)#
```

Save the Configuration

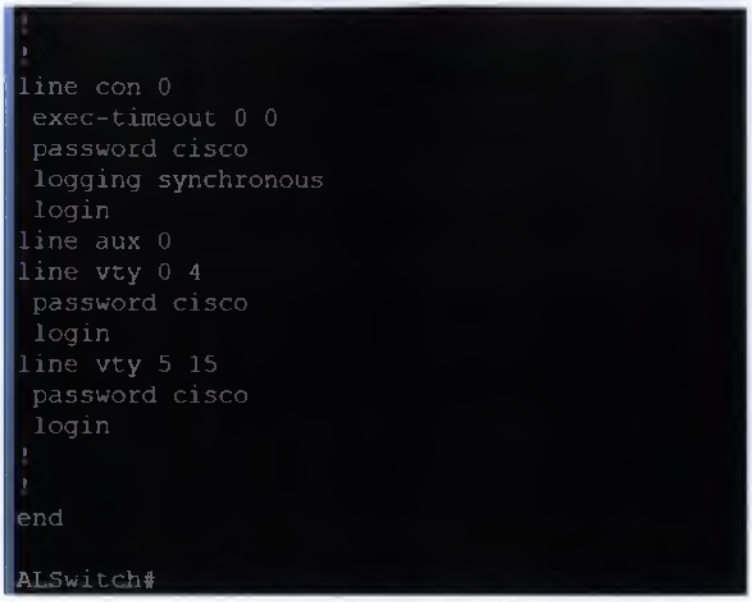
- The basic configuration of the switch has just been completed. Back up the running configuration file to NVRAM. This ensures that the changes made will not be lost if the system is rebooted or loses power.

```
ALSwitch#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
ALSwitch#
```

- Examine the Startup Configuration File

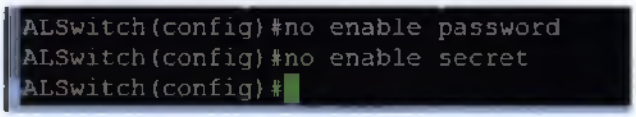
```
ALSwitch#sh startup-config
Using 1245 out of 129016 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname ALSwitch
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$13eg$1ZaOqSohotILtTTrtmpQk1
enable password cisco
!
no aaa new-model
memory-size iomem 5
!
!
ip cef
no ip domain lookup
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
 --More--
```

```
interface FastEthernet0/0
!
interface FastEthernet0/1
!
interface FastEthernet0/2
!
interface FastEthernet0/3
!
interface FastEthernet0/4
 duplex full
 speed 100
!
interface FastEthernet0/5
!
interface FastEthernet0/6
!
interface FastEthernet0/7
!
interface FastEthernet0/8
!
interface FastEthernet0/9
!
interface FastEthernet0/10
!
interface FastEthernet0/11
!
interface FastEthernet0/12
!
interface FastEthernet0/13
!
interface FastEthernet0/15
!
interface Vlan1
 ip address 192.168.1.2 255.255.255.0
!
no ip http server
no ip http secure-server
!
ip forward-protocol nd
!
!
!
!
!
control-plane
!
!
```

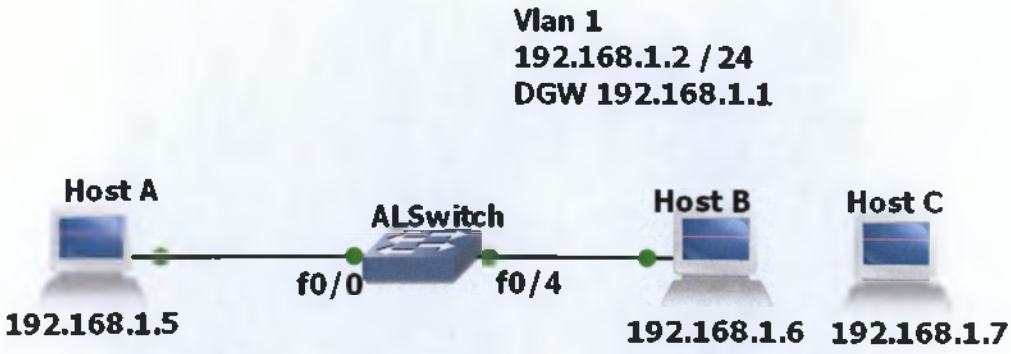


- Are all the changes that were entered recorded in the file? **Yes**

- Remove the Enable and Enable Secret Passwords



6.9.3 Managing the MAC Address Table



Εικόνα 57 Switch MAC Configuration Topology

- Configure the hostname and passwords, as well as the management VLAN 1 settings for the switch.

```
Switch(config)#hostname ALSwitch
```

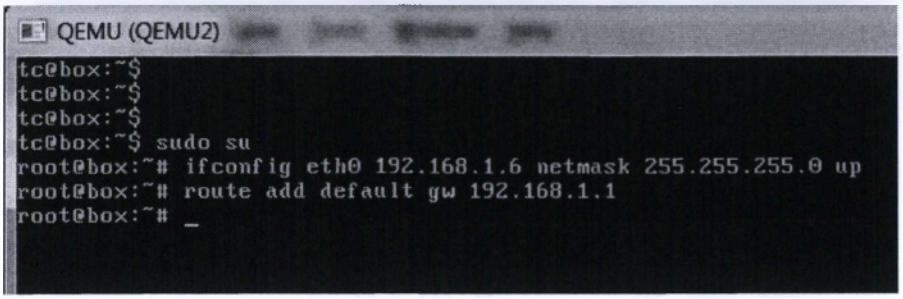
```
ALSwitch(config-line)#enable password cisco
ALSwitch(config)#enable secret class
```

```
ALSwitch(config)#line vty 0 15
ALSwitch(config-line)#password cisco
ALSwitch(config-line)#login
ALSwitch(config-line)#line console 0
ALSwitch(config-line)#password cisco
ALSwitch(config-line)#login
ALSwitch(config-line)#
```

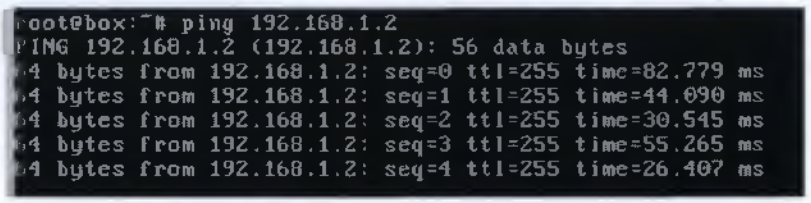
- Configure the Vlan 1 with ip address 192.168.1.2 /24 and gefault gateway 192.168.1.1

```
ALSwitch(config)#ip default-gateway 192.168.1.1
ALSwitch(config)#int vlan 1
ALSwitch(config-if)#ip address 192.168.1.2 255.255.255.0
ALSwitch(config-if)#
```

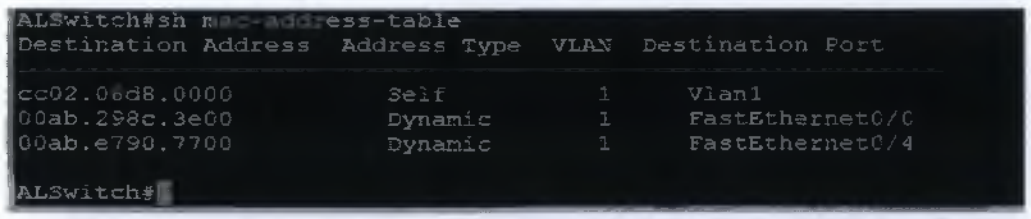
- Configure the hosts to use the same IP subnet for addresses, masks, and the default gateway as the switch.



- To verify that the hosts and switch are correctly configured, ping the switch IP address from the hosts.



- Determine the MAC Addresses that the Switch Has Learned



- Determine the options that the **show mac-address-table** command has by using the **?** option.

```
ALSwitch#sh mac-address-table ?
  address      mac address name
  aging-time   Show address aging time
  count        Show address count
  dynamic      Show 802.1d dynamic addresses
  interface    interface name
  multicast    Show multicast addresses for selected wildcard
  secure       Show secure addresses
  self         Show system self addresses
  static       Show static addresses
  vlan         vlan name
               output modifiers
  <cr>

ALSwitch#sh mac-address-table
```

- How many options are available for the show mac-address-table command? **10**

- Show the MAC address table for the switch. How many total MAC addresses exist? **3**

```
ALSwitch#sh mac-address-table
Destination Address  Address Type  VLAN  Destination Port
-------------------  ------------  ----  --------------------

cc02.08d8.0000       Self          1     Vlan1
00ab.298c.3e00       Dynamic       1     FastEthernet0/0
00ab.e790.7700       Dynamic       1     FastEthernet0/4

ALSwitch#
```

- Show only the MAC address table addresses that were learned dynamically.

```
ALSwitch#sh mac-address-table dynamic
Non-static Address Table:
Destination Address  Address Type  VLAN  Destination Port

00ab.298c.3e00       Dynamic       1     FastEthernet0/0
00ab.e790.7700       Dynamic       1     FastEthernet0/4
```

- How many exist? **3 dynamic MAC addresses exist**

- Clear the MAC Address Table

```
ALSwitch#clear mac-address-table
```

- Determine the options that are available.

```
ALSwitch#clear mac-address-table ?
  address     mac address name
  dynamic     Clear 802.1d dynamic addresses
  interface   interface name
  secure      Clear secure addresses
  static      Clear static addresses
  vlan        vlan number
  <cr>

ALSwitch#clear mac-address-table
```

- How many options exist? **6 options exist**

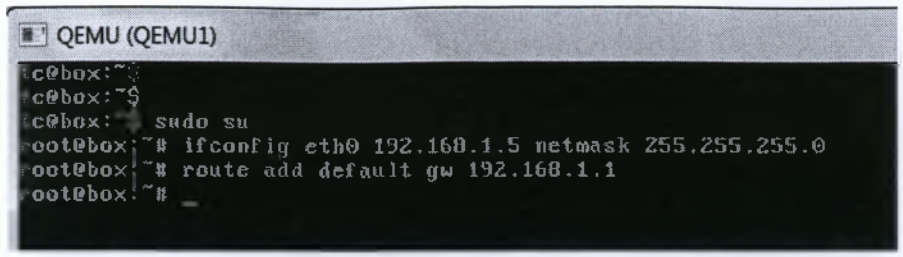
- Configure the hostname and passwords, as well as the management VLAN 1 settings for the switch.

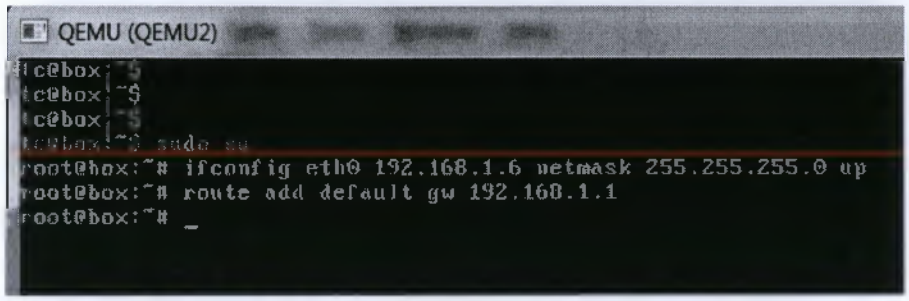
```
Switch(config)#hostname ALSwitch
```

```
ALSwitch(config-line)#enable password cisco
ALSwitch(config)#enable secret class
```

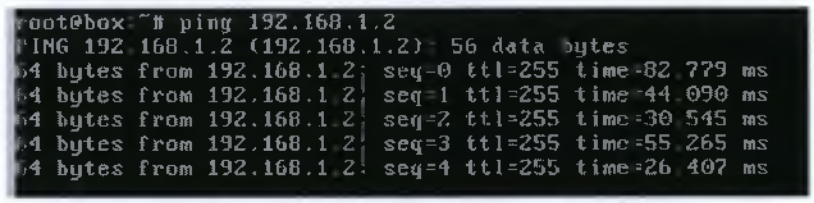
```
ALSwitch(config)#line vty 0 15
ALSwitch(config-line)#password cisco
ALSwitch(config-line)#login
ALSwitch(config-line)#line console 0
ALSwitch(config-line)#password cisco
ALSwitch(config-line)#login
ALSwitch(config-line)#
```

- Configure the Hosts that Are Attached to the Switch



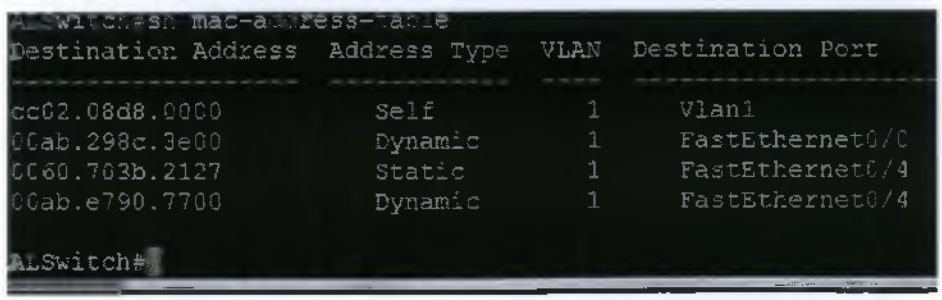


- To verify that the hosts and switch are correctly configured, ping the switch IP address from the hosts.



- Set up a static MAC address on Fast Ethernet interface 0/4.

- Verify the MAC address table entries.



- Remove the static MAC address from the table.

```
ALSwitch(config)#no mac-address static 0060.703b.2127 int f0/4 vlan 1
ALSwitch(config)#
```

- Determine options for setting port security on interface Fast Ethernet 0/4.

```
ALSwitch(config-if)#switchport ?
  access    Set access mode characteristics of the interface
  mode      Set trunking mode of the interface
  priority  Set 802.1p priorities
  trunk     Set trunking characteristics of the interface
  voice     Voice appliance attributes
  <cr>
```

- Allow the switch port fastethernet 0/4 to accept only one device.

ALSwitch(config)#int f0/4
ALSwitch(config-if)#switchport mode access
ALSwitch(config-if)#switchport port-security
ALSwitch(config-if)#switchport port-security mac-address sticky

- On interface fastethernet 0/4, set the port security maximum MAC count to 1.

ALSwitch(config-if)#switchport port-security maximum 1

- Disconnect the PC that is attached to fastethernet 0/4 and connect to that port the PC that has been given the IP address 192.168.1.7. This PC has not been attached to the switch. To generate some traffic, you might need to ping the switch address 192.168.1.2.
- Reconnect the PC that had previously been connected to Fast Ethernet 0/4 to Fast Ethernet 0/8. The PC has been moved to a new location. This could be to another VLAN, but in this instance, all switch ports are in VLAN 1 and network 192.168.1.0. From this PC on Fast Ethernet 0/8, ping **192.168.1.2 -n 50.** Was this successful? **No, because we set port security, so it will not allow another user to access the switch.**

- Observe that Fast Ethernet 0/4 is secure but that the security should be applied to the machine on port 0/8 because that is the machine that was moved from port 0/4. Remove port security from interface Fast Ethernet 0/4.
- Apply port security with a max-mac-count of 1 to interface Fa0/8.

ALSwitch(config)#int f0/8

ALSwitch(config-if)#switchport mode access

ALSwitch(config-if)#switchport port-security

ALSwitch(config-if)#switchport port-security mac-address sticky

ALSwitch(config-if)#switchport port-security maximum 1

6.10 Virtual LANs (VLANs)

Τα VLAN δημιουργούνται για να παρέχουν υπηρεσίες κατάτμησης που παραδοσιακά παρέχονται από τους routers σε LAN τοπολογίες παρέχουν φιλτράρισμα των broadcasts, ασφάλεια, address και διαχείριση της ροής της κυκλοφορίας. Εξ ορισμού, τα switches ίσως δεν δρομολογούν
κυκλοφορία IP μεταξύ VLAN domain του VLAN. Χρησιμοποιώντας VLAN, μπορούμε να ελέγχουν τα μοτίβα κυκλοφορίας και να αντιδρούμε γρήγορα στις μετεγκαταστάσεις. Τα VLAN παρέχουν την ευελιξία να προσαρμόζονται στις αλλαγές στις απαιτήσεις του δικτύου και να επιτρέπουν την απλοποιημένη διαχείριση.

Στις συσκευές Cisco, το VTP (VLAN Trunking Protocol) διατηρεί την συνέπεια των VLAN παραμέτρων σε ολόκληρο το δίκτυο. Χρησιμοποιεί Layer 2 trunk που είναι σε κατάσταση λειτουργίας VTP server. Το VTP είναι υπεύθυνο για συγχρονισμό των VLAN πληροφοριών μέσα σε έναν τομέα VTP και μειώνει την ανάγκη να ρυθμίσετε τις ίδιες πληροφορίες VLAN για κάθε switch. Ελαχιστοποιεί τις ασυνέπειες σε πιθανή ρύθμιση παραμέτρων που ανακύπτουν όταν γίνονται αλλαγές. Το VTP παρέχει ένα σχήμα αντιστοίχησης που επιτρέπει κάθε είδους trunking μέσα σε ένα δίκτυο που απασχολεί μεικτά μέσα τεχνολογιών.

6.10.1 Verifying Default Switch Configuration

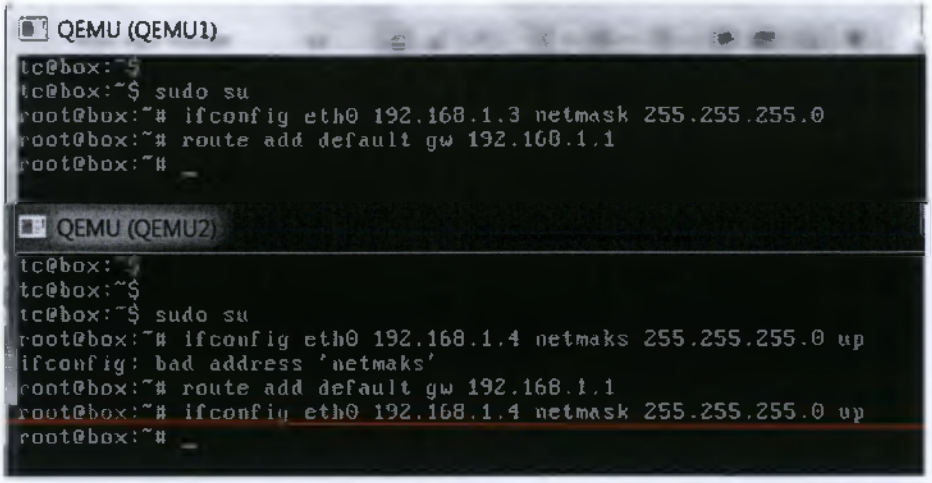
Εικόνα 58 Default Switch Configuration Topology

Configure the Switch

- Configure the hostnames and passwords, as well as the management VLAN 1 settings for the switch, as indicated in Table 1.

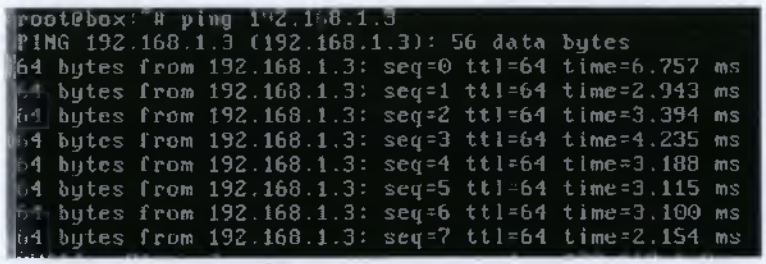
```
R1(config)#hostname Switch_A
Switch_A(config)#ennable password cisco

% Invalid input detected at '^' marker.

Switch_A(config)#
Switch_A(config)#
Switch_A(config)#enable password cisco
Switch_A(config)#enable secret class
Switch_A(config)#line vty 0 15
Switch_A(config-line)#password cisco
Switch_A(config-line)#login
Switch_A(config-line)#line console 0
Switch_A(config-line)#password cisco
Switch_A(config-line)#login
Switch_A(config-line)#banner motd #authorized access only!!!#
Switch_A(config)#int vlan 1
Switch_A(config-if)#ip address 192.168.1.2 255.255.255.0
Switch_A(config-if)#no shut
Switch_A(config-if)#exit
Switch_A(config)#ip default-gateway 192.168.1.2
Switch_A(config)#
```

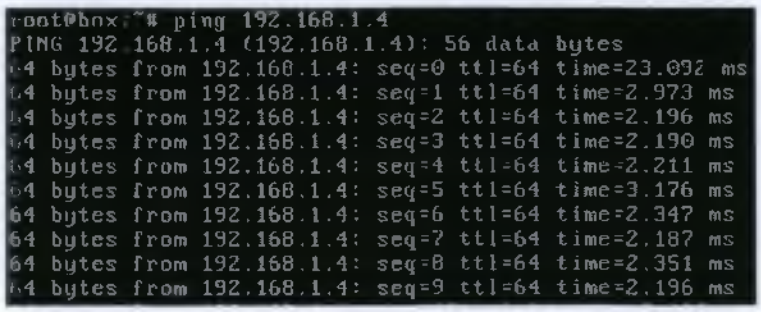
- Configure the host to use the same subnet for addresses, masks, and the default gateway as the switch.



Verify Connectivity

- To verify that the hosts and switch are correctly configured, ping the switch from the hosts.





Show the Cisco IOS Version

- It is important that you know the version of the operating system. Differences between versions might change how you enter commands. Enter the **show version** command at the user EXEC or privileged EXEC mode prompt.

Switch_A#sh version

Cisco IOS Software, C2960 Software (C2960-LANBASE-M), Version 12.2(25)FX, RELEASE SOFTWARE (fc1)
Copyright (c) 1986-2005 by Cisco Systems, Inc.
Compiled Wed 12-Oct-05 22:05 by pt_team

ROM: C2960 Boot Loader (C2960-HBOOT-M) Version 12.2(25r)FX, RELEASE SOFTWARE (fc4)

System returned to ROM by power-on

Cisco WS-C2960-24TT (RC32300) processor (revision C0) with 21039K bytes of memory.

24 FastEthernet/IEEE 802.3 interface(s)
2 Gigabit Ethernet/IEEE 802.3 interface(s)

63488K bytes of flash-simulated non-volatile configuration memory.
Base ethernet MAC Address : 00D0.FFC0.4CD3
Motherboard assembly number : 73-9832-06
Power supply part number : 341-0097-02
Motherboard serial number : FOC103248MJ
Power supply serial number : DCA102133JA
Model revision number : B0
Motherboard revision number : C0
Model number : WS-C2960-24TT
System serial number : FOC1033Z1EY
Top Assembly Part Number : 800-26671-02
Top Assembly Revision Number : B0
Version ID : V02
CLEI Code Number : COM3K00BRA
Hardware Board Revision Number : 0x01

Switch Ports Model SW Version SW Image
------ ----- ----- ---------- ----------
* 1 26 WS-C2960-24TT 12.2 C2960-LANBASE-M

Configuration register is 0xF

Switch_A#

- What version of the switch IOS is displayed? **Version 12.2(25)FX**

Display the VLAN Interface Information

- On Switch_A, enter the appropriate command at the privileged EXEC mode prompt to display the VLAN interface information.

```
Switch_A#sh vlan

VLAN Name                Status  Ports
---- -------------------- ------ -------------------------------
1    default              active  Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                  Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                  Fa0/9, Fa0/10, Fa0/11, Fa0/12
                                  Fa0/13, Fa0/14, Fa0/15, Fa0/16
                                  Fa0/17, Fa0/18, Fa0/19, Fa0/20
                                  Fa0/21, Fa0/22, Fa0/23, Fa0/24
                                  Gig1/1, Gig1/2
1002 fddi-default             act/unsup
1003 token-ring-default       act/unsup
1004 fddinet-default          act/unsup
1005 trnet-default            act/unsup

VLAN Type  SAID       MTU   Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
---- ----- ---------- ----- ------ ------ -------- ---- -------- ------ ------
1    enet  100001     1500  -      -      -        -    -        0      0
1002 fddi  101002     1500  -      -      -        -    -        0      0
1003 tr    101003     1500  -      -      -        -    -        0      0
1004 fdnet 101004     1500  -      -      -        ieee -        0      0
1005 trnet 101005     1500  -      -      -        ibm  -        0      0

Remote SPAN VLANs
------------------------------------------------------------------------------

Primary Secondary Type              Ports
------- --------- ----------------- ------------------------------------------

Switch_A#
```

- Which ports belong to the default VLAN?
  Fa0/1, Fa0/2, Fa0/3, Fa0/4
  Fa0/5, Fa0/6, Fa0/7, Fa0/8
  Fa0/9, Fa0/10, Fa0/11, Fa0/12
  Fa0/13, Fa0/14, Fa0/15, Fa0/16
  Fa0/17, Fa0/18, Fa0/19, Fa0/20
  Fa0/21, Fa0/22, Fa0/23, Fa0/24
  Gig1/1, Gig1/2

- How many VLANs are set up by default on the switch? **5 default Vlans**

- What does the VLAN 1003 represent? **It represents the default Token Ring TrCRF Vlan**
- How many ports are in the 1003 VLAN? **0**

Create and Name two VLANs

- Enter the appropriate commands to create two named VLANs with names VLAN2 and VLAN3:

Switch_A#vlan database
Switch_A(vlan)#vlan 2 name VLAN2
Switch_A(vlan)#vlan 3 name VLAN3

Display the VLAN interface Information

- On Switch_A, enter the appropriate command at the privileged EXEC mode prompt to display the VLAN interface information.

Switch_A#sh vlan

- Are new VLANs in the listing? If so, which ones? **Yes, they are. VLAN2 and VLAN3**
- Do these VLANs have ports assigned to them yet? **Not yet**

Assign a Port to VLAN 2

- You must assign ports to VLANs from the interface mode. Enter the appropriate commands to add port 2 to VLAN 2:

Switch_A#conf t
Switch_A(config)# int f0/1
Switch_A(config-if)# switchport mode access
Switch_A(config-if)# switchport access vlan 2

Display the VLAN Interface Information

- On Switch_A, enter the appropriate command at the privileged EXEC mode prompt to display the VLAN interface information.

Switch_A#sh vlan

- Is port 2 assigned to VLAN 2? **Yes**
- Is the port still listed in the default VLAN? **No**

Assign a Port to VLAN 3

- You must assign ports to VLANs from the interface mode. Enter the appropriate commands to add port 3 to VLAN 3:

Switch_A#conf t
Switch_A(config)# int f0/2
Switch_A(config-if)# switchport mode access
Switch_A(config-if)# switchport access vlan 3

Display the VLAN Interface Information

- On Switch_A, enter the appropriate command at the privileged EXEC mode prompt to display the VLAN interface information.

Switch_A#sh vlan

- Is port 3 assigned to VLAN 3? **Yes.**
- Is the port still listed in the default VLAN? **No.**

Look Only at VLAN 2 Information

- Instead of displaying all the VLANs, enter the appropriate command at the privileged EXEC mode prompt to display only the VLAN 2 information.

Switch_A#sh int vlan 2

- Does this command supply more information than the **show vlan** command? **Yes**
- After you complete the previous step, log off (by typing **exit**) and turn all the devices off. Then, remove and store the cables and adapter.

6.10.2 Verifying VLAN Configurations

Εικόνα 59 Verifying VLAN Configuration Topology

- The hostname of the switch is Switch_A.
- The enable secret password is **class.**
- The enable VTY and console password is **cisco.**
- Create a basic switch configuration and verify it.
- Create two VLANs.
- Name the VLANs and assign multiple member ports to them.
- Test functionality by moving a workstation from one VLAN to another.
- The Vlan 1 IP address is 192.168.1.2 /24
- The default gateway is 192.168.1.1

- Configure the hostnames and passwords, as well as the management VLAN 1 settings for the switch, as indicated in Table 1.

Switch>
Switch>enable

Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname Switch_A
Switch_A(config)#enable password cisco
Switch_A(config)#enable secret class
Switch_A(config)#line vty 0 15
Switch_A(config-line)#password cisco
Switch_A(config-line)#login
Switch_A(config-line)#exit
Switch_A(config)#line console 0
Switch_A(config-line)#password cisco
Switch_A(config-line)#login
Switch_A(config-line)#exit
Switch_A(config)#int vlan 1
Switch_A(config-if)#ip address 192.168.1.2 255.255.255.0
Switch_A(config-if)#no shut

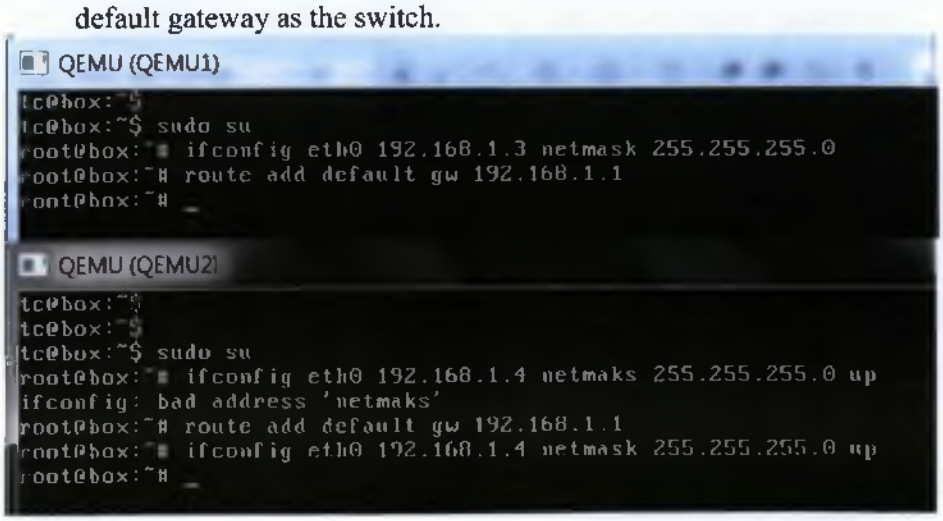
%LINK-5-CHANGED: Interface Vlan1, changed state to up

Switch_A(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to up

Switch_A(config-if)#
Switch_A(config-if)#exit
Switch_A(config)#ip default-gateway 192.168.1.1
Switch_A(config)#

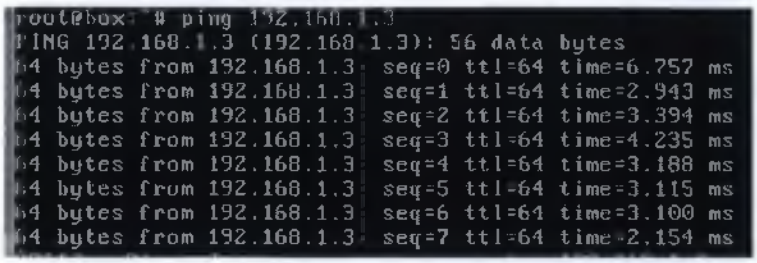
Configure the Hosts Attached to the Switch

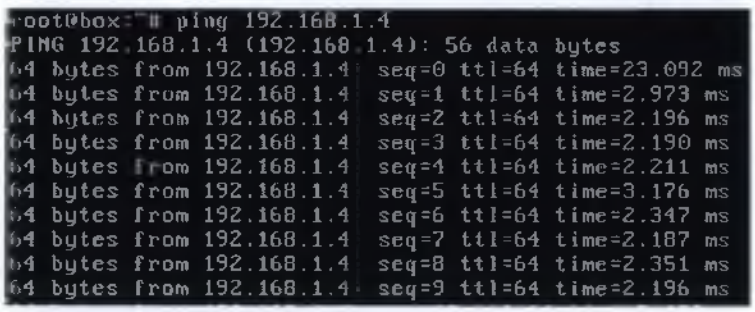
- Configure the host to use the same subnet for addresses, masks, and the default gateway as the switch.



Verify Connectivity

- To verify that the hosts and switch are correctly configured, ping the switch from the hosts.





Display the VLAN Interface Information

- On Switch_A, enter the appropriate command at the privileged EXEC mode prompt to display the VLAN interface information.

  Switch_A#sh vlan brief

- Which ports belong to the default VLAN?

Fa0/1, Fa0/2, Fa0/3, Fa0/4
Fa0/5, Fa0/6, Fa0/7, Fa0/8
Fa0/9, Fa0/10, Fa0/11, Fa0/12
Fa0/13, Fa0/14, Fa0/15, Fa0/16
Fa0/17, Fa0/18, Fa0/19, Fa0/20
Fa0/21, Fa0/22, Fa0/23, Fa0/24
Gig1/1, Gig1/2

Create and Name Two VLANs

- Enter the appropriate commands to create two named VLANs with names VLAN2 and VLAN3:

```
Switch_A#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch_A(config)#vlan 2
Switch_A(config-vlan)#name VLAN2
Switch_A(config-vlan)#vlan 3
Switch_A(config-vlan)#name VLAN3
Switch_A(config-vlan)#EXIT
Switch_A(config)#
```

Assign Ports to VLAN 2

- You must assign ports to VLANs from the interface mode. Enter the appropriate commands to add ports 4, 5, and 6 to VLAN 2:

```
Switch_A#conf t
Switch_A(config)# int f0/4
Switch_A(config-if)# switchport mode access
Switch_A(config-if)# switchport access vlan 2
Switch_A(config)# int f0/5
Switch_A(config-if)# switchport mode access
Switch_A(config-if)# switchport access vlan 2
Switch_A(config)# int f0/6
Switch_A(config-if)# switchport mode access
Switch_A(config-if)# switchport access vlan 2
```

Display the VLAN Interface Information

- On Switch_A, enter the appropriate command at the privileged EXEC mode prompt to display the VLAN interface information.

Switch_A#sh vlan

- Are ports 4 through 6 assigned to VLAN 2? **Yes**

Assign Ports to VLAN 3

- Enter the appropriate commands to assign ports 7,8 and 9 to VLAN 3:

```
Switch_A#
Switch_A#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch_A(config)#int f0/7
Switch_A(config-if)#switchport mode access
Switch_A(config-if)#switchport access vlan 3
Switch_A(config-if)#int f0/8
Switch_A(config-if)#switchport mode access
Switch_A(config-if)#switchport access vlan 3
Switch_A(config-if)#int f0/9
Switch_A(config-if)#switchport mode access
Switch_A(config-if)#switchport access vlan 3
Switch_A(config-if)#
Switch_A(config-if)#exit
Switch_A(config)#
```

Display the VLAN Interface Information

- On Switch_A, enter the appropriate command at the privileged EXEC mode prompt to display the VLAN interface information.

Switch_A#sh vlan

- Are ports 7 through 9 assigned to VLAN 3? **Yes**

Test the VLANs

- Ping from the host in port 0/4 to the host in port 0/1.
- Was the ping successful? **No**
- Why? **Because the 2 hosts do no belong in the same VLANs.**

- Ping from the host in port 0/1 to the host in port 0/4.
- Was the ping successful? **No**
- Why? **Because the 2 hosts do no belong in the same VLAN**

- Ping from the host in port 0/4 to the switch IP 192.168.1.2.
- Was the ping successful? **No**
- Why? **Because host in port 0/4 belong in VLAN2 and the switch ip is in VLAN1**

- Ping from the host in port 0/1 to the switch IP 192.168.1.2.

- Was the ping successful? **Yes**
- Why? **Because they belong in the same VLAN1.**

Move the host in port 0/4 to port 0/3, wait until the port LED turns green.

Test the VLANs

- Ping from the host in port 0/3 to the host in port 0/1.
- Was the ping successful? **Yes.**
- Why? **Because they belong on the same VLAN (VLAN1)**
- Ping from the host in port 0/1 to the host in port 0/3.

- Was the ping successful? **Yes. The ping was successful because they belong on the same VLAN (VLAN1)**
- Ping from the host in port 0/3 to the switch IP 192.168.1.2.
- Was the ping successful? **Yes. The ping was successful because they belong on the same VLAN (VLAN1)**

Move the host in port 0/3 to port 0/4 and the host in port 0/1 to port 0/5, wait until the port LED turns green, and then go to the next task.

Test the VLANs

- Ping from the host in port 0/4 to the host in port 0/5.
- Was the ping successful? **Yes. The ping was successful because they belong on the same VLAN (VLAN2)**
- Ping from the host in port 0/5 to the host in port 0/4.
- Was the ping successful? **Yes. The ping was successful because they belong on the same VLAN (VLAN2)**
- Ping from the host in port 0/4 to the switch IP 192.168.1.2.
- Was the ping successful? **No. The ping was NOT successful because they do not belong on the same VLAN**
- Ping from the host in port 0/5 to the switch IP 192.168.1.2.
- Was the ping successful? **No. The ping was NOT successful because they do not belong on the same VLAN**

Move the host in port 0/4 to port 0/8, wait until the port LED turns green, and then go to the next task.

Test the VLANs

- Ping from the host in port 0/4 to the host in port 0/8.
- Was the ping successful? NO. **The ping was NOT successful because they do not belong on the same VLAN**
- Ping from the host in port 0/8 to the host in port 0/4.
- Was the ping successful? **NO.The ping was NOT successful because they do not belong on the same VLAN**
- Ping from the host in port 0/4 to the switch IP 192.168.1.2.
- Was the ping successful? **No. Ping was NOT successful because they do not belong on the same VLAN**

- Ping from the host in port 0/8 to the switch IP 192.168.1.2.

Was the ping successful? **NO.The ping was NOT successful because they do not belong on the same VLAN**

After you complete the previous steps, log off (by typing **exit**) and turn all the devices off. Then, remove and store the cables and adapter.

6.10.3 Deleting VLAN Configuations

- To remove a host from a VLAN, use the appropriate form of the **switchport** commands in port interface configuration mode.

```
Switch_A#conf t
Switch_A(config)# int f0/4
Switch_A(config-if)# no switchport access vlan 2
```

Delete a VLAN

- To remove an entire VLAN, enter the VLAN database mode and use the negative form of the appropriate command.

  Switch_A(config)#no vlan 3

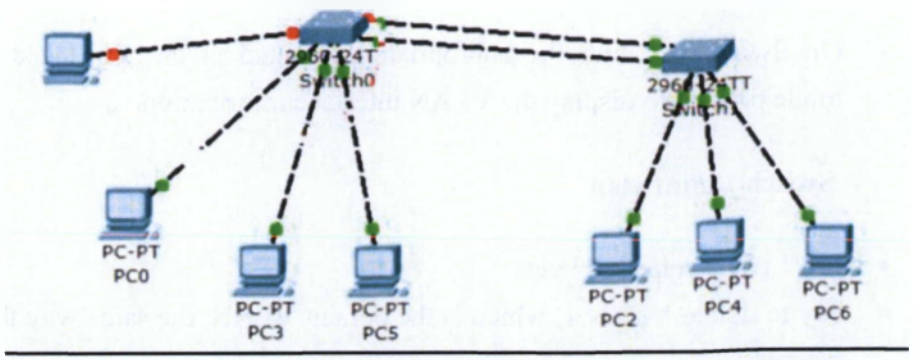
- On Switch_A, enter the appropriate command at the privileged EXEC mode prompt to display the VLAN interface information.

  Switch_A#int vlan

- Is VLAN 3 removed? **yes**
- Try to delete VLAN 1, which is the default VLAN, the same way that you deleted VLAN 3.
  Switch_A(config)#no vlan 1
  Default VLAN 1 may not be deleted.
  Switch_A(config)#

- Can the default VLAN be deleted? **no**

6.10.4 Static VLANs, STP and Port Security



Εικόνα 60 STP Topology

- Create and assign VLANs.
- Configure root bridges for STP.
- Configure port security.

Equipment

The topology shown above is using 2950 switches.

Cable the Topology and Basic Configuration

Configure the following VLANs on both SWA and SWB:

- VLAN 10 is the Accounting VLAN
- VLAN 20 is the Marketing VLAN
- VLAN 30 is the Purchasing VLAN

1. Configure the switches according to your instructor's required basic configurations, including hostnames, passwords, host tables, banner, and lines. Configure each of the switches with the correct VLAN 1 IP addresses and the correct default gateway.

SWA

```
Switch>enable
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname
% Incomplete command.
Switch(config)#hostname SWA
SWA(config)#enable password cisco
SWA(config)#enable secret class
SWA(config)#line vty 0 15
SWA(config-line)#password cisco
SWA(config-line)#login
SWA(config-line)#exit
SWA(config)#line console -
^
% Invalid input detected at '^' marker.
SWA(config)#line console 0
SWA(config-line)#password cisco
SWA(config-line)#login
SWA(config-line)#exit
SWA(config)#int vlan 1
SWA(config-if)#ip address 10.1.0.2 266.255.0.0
^
% Invalid input detected at '^' marker.
SWA(config-if)#ip address 10.1.0.2 255.255.0.0
SWA(config-if)#no shut

%LINK-5-CHANGED: Interface Vlan1, changed state to up

SWA(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state
to up

SWA(config-if)#int vlan 10
SWA(config-if)#ip address 10.10.0.1 255.255.0.0
SWA(config-if)#no shut
SWA(config-if)#int vlan 20
SWA(config-if)#ip address 10.20.0.1 255.255.0.0
SWA(config-if)#int vlan 30
SWA(config-if)#ip address 10.30.0.1 255.255.0.0
SWA(config-if)#no shut
SWA(config-if)#int vlan 20
SWA(config-if)#no shut
SWA(config-if)#exit
SWA(config)#ip default-gateway 10.1.0.1
```

SWA(config)#exit

%SYS-5-CONFIG_I: Configured from console by console
SWA#
SWA(config)#vlan 10

%LINK-5-CHANGED: Interface Vlan10, changed state to up
SWA(config-vlan)#name Accounting
SWA(config-vlan)#exit
SWA(config)#
SWA(config)#vlan 20

%LINK-5-CHANGED: Interface Vlan20, changed state to up
SWA(config-vlan)#name Marketing
SWA(config-vlan)#exit

SWA(config)#vlan 30

%LINK-5-CHANGED: Interface Vlan30, changed state to up
SWA(config-vlan)#name Purchasing
SWA(config-vlan)#exit
SWA(config)#

SWB

Switch>
Switch>
Switch>enable
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname SWB
SWB(config)#enable password cisco
SWB(config)#enable secret class
SWB(config)#line vty 0 15
SWB(config-line)#password cisco
SWB(config-line)#login
SWB(config-line)#line console 0
SWB(config-line)#password cisco
SWB(config-line)#exit
SWB(config)#int vlan 1
SWB(config-if)#ip address 10.1.0.3 255.255.0.0
SWB(config-if)#no shut

%LINK-5-CHANGED: Interface Vlan1, changed state to up

SWB(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to up
int vlan 10
SWB(config-if)#int vlan 10
SWB(config-if)#ip address 10.10.0.2 255.255.0.0
SWB(config-if)#no shut
SWB(config-if)#int vlan 20
SWB(config-if)#ip address 10.20.0.1 255.255.0.0
SWB(config-if)#no shut
SWB(config-if)#int vlan 30
SWB(config-if)#ip address 10.30.0.1 255.255.0.0
SWB(config-if)#no shut
SWB(config-if)#
SWB(config)#vlan 10

%LINK-5-CHANGED: Interface Vlan10, changed state to up
SWB(config-vlan)#name Accounting

SWB(config-if)#vlan 20

%LINK-5-CHANGED: Interface Vlan20, changed state to up
SWB(config-vlan)#name Marketing
SWB(config-vlan)#vlan 30

%LINK-5-CHANGED: Interface Vlan30, changed state to up
SWB(config-vlan)#name Purchasing
SWB(config-vlan)#exit
SWB(config)

2. Configure the appropriate ports on SWA and SWB for trunking with the appropriate command. Verify trunking is properly configured with the apprpriate command on both SWA and SWB.

SWA

SWA(config-if)#int f0/2
SWA(config-if)#switchport mode trunk
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up
SWA(config-if)#

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan10, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan20, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan30, changed state to up
SWA(config-if)#int f0/3
SWA(config-if)#switchport mode trunk
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
SWA(config-if)#

SWB

SWB(config)#
SWB(config)#int f0/2
SWB(config-if)#switchport mode trunk
SWB(config-if)#int f0/3
SWB(config-if)#switchport mode trunk
SWB(config-if)#

3. The Fa0/1 port is unused on both SWA and SWB. For enhanced security, administratively shut down this port. Otherwise, the port will activate whenever it detects a device on the other end.

SWA(config-if)#int f0/1
SWA(config-if)#shut
%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down
SWA(config-if)#

SWB(config-if)#int f0/1
SWB(config-if)#shut
%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down
SWB(config-if)#

4. Configure access mode on the rest of the ports using the appropriate command. Assign the access ports to their correct VLAN as specified in the topology.

SWA

```
SWA(config)#int f0/4
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 10
SWA(config-if)#int f0/5
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 10
SWA(config-if)#int f0/6
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 10
SWA(config-if)#int f0/7
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 10
SWA(config-if)#int f0/8
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 10
SWA(config-if)#int f0/9
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 20
SWA(config-if)#int f0/10
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 20
SWA(config-if)#int f0/11
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 20
SWA(config-if)#int f0/12
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 20
SWA(config-if)#int f0/13
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 20
SWA(config-if)#int f0/14
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 20
SWA(config-if)#int f0/15
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 20
SWA(config-if)#int f0/16
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 20
SWA(config-if)#int f0/17
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 30
```

```
SWA(config-if)#int f0/18
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 30
SWA(config-if)#int f0/19
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 30
SWA(config-if)#int f0/20
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 30
SWA(config-if)#int f0/21
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 30
SWA(config-if)#int f0/22
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 30
SWA(config-if)#int f0/23
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 30
SWA(config-if)#int f0/24
SWA(config-if)#switchport mode access
SWA(config-if)#switchport access vlan 30
SWA(config-if)#
```

SWB

```
SWB(config-if)#int f0/4
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 10
SWB(config-if)#int f0/5
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 10
SWB(config-if)#int f0/6
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 10
SWB(config-if)#int f0/7
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 10
SWB(config-if)#int f0/8
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 10
SWB(config-if)#int f0/9
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 20
SWB(config-if)#int f0/10
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 20
SWB(config-if)#int f0/11
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 20
```

```
SWB(config-if)#int f0/12
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 20
SWB(config-if)#int f0/13
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 20
SWB(config-if)#int f0/14
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 20
SWB(config-if)#int f0/15
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 20
SWB(config-if)#int f0/16
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 20
SWB(config-if)#int f0/17
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 30
SWB(config-if)#int f0/18
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 30
SWB(config-if)#int f0/19
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 30
SWB(config-if)#int f0/20
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 30
SWB(config-if)#int f0/21
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 30
SWB(config-if)#int f0/22
SWB(config-if)#
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 30
SWB(config-if)#int f0/23
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 30
SWB(config-if)#int f0/24
SWB(config-if)#switchport mode access
SWB(config-if)#switchport access vlan 30
SWB(config-if)#exit
SWB(config)#
```

5. Verify the VLAN configuration on both switches with the appropriate command. Your output should look similar to the following output:

1 default **active Fa0/1, Gig1/1, Gig1/2**
10 Accounting **active Fa0/4, Fa0/5, Fa0/6, Fa0/7**
Fa0/8
20 Marketing **active Fa0/9, Fa0/10, Fa0/11, Fa0/12**
Fa0/13, Fa0/14, Fa0/15, Fa0/16

30 Purchasing **active Fa0/17, Fa0/18, Fa0/19, Fa0/20**
Fa0/21, Fa0/22, Fa0/23, Fa0/24

Configure the Root Bridge for STP

- For VLANs 1, 10, and 30, SWA should always be the root bridge. Configure SWA with a spanning-tree priority of 4096 for these three VLANs.

SWA(config)#spanning-tree vlan 1 priority 4096
SWA(config)#spanning-tree vlan 10 priority 4096
SWA(config)#spanning-tree vlan 30 priority 4096

- For VLAN 20, SWA is to never be the root bridge. Configure SWA with a spanning tree priority of 61,440.

  SWA(config)#spanning-tree vlan 20 priority 61440

- What is the default priority? **32768**

- Verify SWA is the root with the appropriate command. SWA should be listed as the root bridge, as shown in the following output below:

SWA#sh spanning-tree summary
Switch is in pvst mode
Root bridge for: default Accounting Purchasing
Extended system ID is enabled
Portfast Default is disabled
PortFast BPDU Guard Default is disabled
Portfast BPDU Filter Default is disabled
Loopguard Default is disabled
EtherChannel misconfig guard is disabled

UplinkFast is disabled
BackboneFast is disabled
Configured Pathcost method used is short

Name	Blocking	Listening	Learning	Forwarding	STP Active
VLAN0001	0	0	0	2	2
VLAN0010	0	0	0	4	4
VLAN0020	1	0	0	1	2
VLAN0030	0	0	0	2	2
4 vlans	1	0	0	9	10

SWA#

Configure Port Security

- Configure the access ports (Fa0/4 through 24) for access mode and turn on port security.

SWA(config-if)#switchport port-security
SWA(config-if)#int f0/24

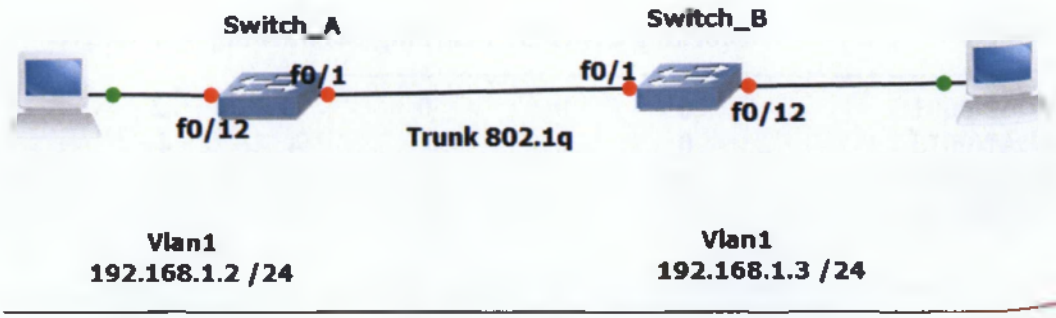
- Enter the command to make the first MAC address learned "stick" to the port. No other MAC addresses should be allowed (maximum of one MAC per port).

SWA(config-if)#int f0/4
SWA(config-if)#switchport port-security mac-address sticky

- Enter the command that will automatically shut down the port if a security violation occurs.

SWA(config-if)#switchport port-security violation shutdown

6.10.5 Trunking with 802.1q



Εικόνα 61 VLAN-Trunking Topology

Switch Designation	Switch Name	VLAN 1 IP Address	VLAN Names and Numbers	Switch Port Assignments
Switch 1	Switch_A	192.168.1.2	VLAN 1 Native	Fa0/2 – 0/3
			VLAN 10 Accounting	Fa0/4 – 0/6
			VLAN 20 Marketing	Fa0/7 – 0/9
			VLAN 30 Engineering	Fa0/10 – 0/12
Switch 2	Switch_B	192.168.1.3	VLAN 1 Native	Fa0/2 – 0/3
			VLAN 10 Accounting	Fa0/4 – 0/6
			VLAN 20 Marketing	Fa0/7 – 0/9
			VLAN 30 Engineering	Fa0/10 – 0/12

Πινακας 11 Address Scheme For Trunking Configuration

The enable secret password is **class.**

The enable VTY and console password for both switches is **cisco.**

The subnet mask for both switches is 255.255.255.0

Objectives

- Create a basic switch configuration and verify it.
- Create multiple VLANs, name them, and assign multiple member ports to them.
- Create an 802.1q trunk line between the two switches to allow communication between paired VLANs.

- Test the VLANs' functionality by moving a workstation from one VLAN to another.

Configure the Switch

- Configure the hostname, access and command mode passwords, as well as the management VLAN 1 settings.

Switch_A

```
Switch(config)#hostname Switch_A
Switch_A(config)#enable password cisco
Switch_A(config)#enable secret class
Switch_A(config)#line vty 0 15
Switch_A(config-line)#password cisco
Switch_A(config-line)#login
Switch_A(config-line)#exit
Switch_A(config)#line console 0
Switch_A(config-line)#password cisco
```

Switch_B

```
Switch(config)#hostname Switc_B
Switc_B(config)#enable password cisco
Switc_B(config)#enable secret class
Switc_B(config)#line vty 0 15
Switc_B(config-line)#password cisco
Switc_B(config-line)#line console 0
Switc_B(config-line)#password cisco
```

- Configure the host to use the same subnet for addresses, masks, and the default gateway as the switch.

Verify Connectivity

- To verify that the hosts and switches are correctly configured, ping the switches from the hosts.

Were the pings successful? **Yes**

Display the VLAN Interface Information

- On Switch_A, enter the appropriate command to display the vlan interface information

Switch_A#sh vlan

Create and Name Three VLANs

- Use the appropriate commands to create the three named VLANs

```
Switch_A(config)#vlan 10
Switch_A(config-vlan)#name Accounting
Switch_A(config-vlan)#vlan 20
Switch_A(config-vlan)#name Marketing
Switch_A(config-vlan)#vlan 30
Switch_A(config-vlan)#name Engineering
Switch_A(config-vlan)#exit
```

Assign Ports to VLAN 10

- You must assign ports to VLANs from the interface mode. Enter the appropriate commands to add ports 0/4 to 0/6 to VLAN 10.

```
Switch_A(config-if)#int f0/4
Switch_A(config-if)#switch mode access
Switch_A(config-if)#switchport access vlan 10
Switch_A(config-if)#int f0/5
Switch_A(config-if)#switch mode access
Switch_A(config-if)#switchport access vlan 10
Switch_A(config-if)#int f0/6
Switch_A(config-if)#switch mode access
Switch_A(config-if)#switchport access vlan 10
```

Assign Ports to VLAN 20

- Enter the appropriate commands to add ports 0/7 to 0/9 to VLAN 20.

Switch_A(config-if)#int f0/7
Switch_A(config-if)#switch mode access
Switch_A(config-if)#switchport access vlan 20
Switch_A(config-if)#int f0/8
Switch_A(config-if)#switch mode access
Switch_A(config-if)#switchport access vlan 20
Switch_A(config-if)#int f0/9
Switch_A(config-if)#switch mode access
Switch_A(config-if)#switchport access vlan 20

Assign Ports to VLAN 30

- Enter the appropriate commands to add ports 0/10 to 0/12 to VLAN 30.

Switch_A(config-if)#int f0/10
Switch_A(config-if)#switch mode access
Switch_A(config-if)#switchport access vlan 30
Switch_A(config-if)#int f0/10
Switch_A(config-if)#int f0/11
Switch_A(config-if)#switch mode access
Switch_A(config-if)#int f0/10
Switch_A(config-if)#int f0/11
Switch_A(config-if)#switch mode access
Switch_A(config-if)#switchport access vlan 30
Switch_A(config-if)#int f0/12
Switch_A(config-if)#switch mode access
Switch_A(config-if)#switchport access vlan 30
Switch_A(config-if)#

- Create VLANs on Switch_B

Switc__B(config)#vlan 10
Switc__B(config-vlan)#name Accounting
Switc__B(config-vlan)#vlan 20

```
Switc__B(config-vlan)#name Marketing
Switc__B(config-vlan)#vlan 30
Switc__B(config-vlan)#name Engineering
Switc__B(config-vlan)#exit
Switc__B(config)#int f0/2
Switc__B(config-if)#switchport mode access
Switc__B(config-if)#switchport access vlan 1
Switc__B(config-if)#int f0/3
Switc__B(config-if)#switchport mode access
Switc__B(config-if)#switchport access vlan 1
Switc__B(config-if)#int f0/4
Switc__B(config-if)#switchport mode access
Switc__B(config-if)#switchport access vlan 10
Switc__B(config-if)#int f0/5
Switc__B(config-if)#switchport mode access
Switc__B(config-if)#switchport access vlan 10
Switc__B(config-if)#int f0/6
Switc__B(config-if)#switchport mode access
Switc__B(config-if)#switchport access vlan 10
Switc__B(config-if)#int f0/7
Switc__B(config-if)#switchport mode access
Switc__B(config-if)#switchport access vlan 20
Switc__B(config-if)#int f0/8
Switc__B(config-if)#switchport mode access
Switc__B(config-if)#switchport access vlan 20
Switc__B(config-if)#int f0/9
Switc__B(config-if)#switchport mode access
Switc__B(config-if)#switchport access vlan 20
Switc__B(config-if)#int f0/10
Switc__B(config-if)#switchport mode access
Switc__B(config-if)#switchport access vlan 30
Switc__B(config-if)#int f0/11
Switc__B(config-if)#switchport mode access
Switc__B(config-if)#switchport access vlan 30
Switc__B(config-if)#int f0/12
Switc__B(config-if)#switchport mode access
Switc__B(config-if)#switchport access vlan 30
Switc__B(config-if)#
```

Display the VLAN interface Information

- On Switch_A, enter the appropriate command to display the vlan interface information

Switc__A#sh vlan

- Are ports 0/10 to 0/12 assigned to VLAN 30? **yes**

Test the VLANs

- Ping from the host in Switch_A port 0/12 to the host in Switch_B port 0/12.
- Was the ping successful? **No, because there is no trunk.**
- Ping from the host in Switch_A port 0/12 to the switch IP 192.168.1.2.
- Was the ping successful? **No. The interfaces belong in different Vlans.**

Create the Trunk

- On both Switch_A and Switch_B, enter the appropriate command at the Fast Ethernet 0/1 interface.

Switch_A#
Switch_A#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch_A(config)#int f0/1
Switch_A(config-if)#switchport mode trunk

Switc__B(config)#int f0/1
Switc__B(config-if)#switchport mode trunk

Verify the Trunk

- To verify that port Fast Ethernet 0/1 has been established as a trunk port, enter the appropriate command at the privileged EXEC mode prompt.

Switch_A#sh int f0/1 switchport
Name: Fa0/1
Switchport: Enabled
Administrative Mode: trunk
Operational Mode: trunk
Administrative Trunking Encapsulation: dot1q
Operational Trunking Encapsulation: dot1q
Negotiation of Trunking: On
Access Mode VLAN: 1 (default)

Trunking Native Mode VLAN: 1 (default)
Voice VLAN: none
Administrative private-vlan host-association: none
Administrative private-vlan mapping: none
Administrative private-vlan trunk native VLAN: none
Administrative private-vlan trunk encapsulation: dot1q
Administrative private-vlan trunk normal VLANs: none
Administrative private-vlan trunk private VLANs: none
Operational private-vlan: none
Trunking VLANs Enabled: ALL
Pruning VLANs Enabled: 2-1001
Capture Mode Disabled
Capture VLANs Allowed: ALL
Protected: false

- What type of trunking encapsulation is shown in the output? **dot1q**
- On the fragment "Trunking VLANs Enable" from the last output, what does the word ALL mean? **It means that traffic from all VLANs pass through the trunked link.**
- What would happen if the two ports of the trunk were using different encapsulation? **Will not be able to operate the trunk port if we have a different encapsulation.**

Test the VLANs and the Trunk

- To test the VLANs and the trunk, ping from the host in Switch_A port 0/12 to the host inSwitch_B port 0/12.
- Was the ping successful? **Yes, because we activated the trunk port on intf0 / 1 and the 2 hosts are now on the same VLAN.**
- Ping from the host in Switch_A port 0/12 to the switch IP 192.168.1.2.
- Was the ping successful? **No, Because they belong in different Vlans.**

Move the host in Switch_A from port 0/12 to port 0/8, wait until the port LED turns green.

Test the VLANs and the Trunk

- To test the VLANs and the trunk, ping from the host in Switch_A port 0/8 to the host in Switch_B port 0/1

- Was the ping successful? **No. Because they belong in different Vlans.**
- Ping from the host in Switch_A port 0/8 to the switch IP 192.168.1.2.
- Was the ping successful? **No. Because they belong in different Vlans.**

Move the host in Switch_B from port 0/12 to port 0/7, wait until the port LED turns green.

Test the VLANs and the Trunk

- To test the VLANs and the trunk, ping from the host in Switch_A port 0/8 to the host in Switch_B port 0/7.
- Was the ping successful? **Yes.Because they belong in the same Vlan now.**
- Ping from the host in Switch_A port 0/8 to the switch IP 192.168.1.2.
- Was the ping successful? **No.Because the int belon in different Vlans.**

Move the host in Switch_A from port 0/8 to port 0/2, wait until the port LED turns green.

Test the VLANs and the Trunk

- To test the VLANs and the trunk, ping from the host in Switch_A port 0/2 to the host in Switch_B port 0/7.
- Was the ping successful? **No**.
- Ping from the host in Switch_A port 0/2 to the switch IP 192.168.1.2.
- Was the ping successful? **Yes.Because the 2 interfaces are in the same Vlan1.**

Move the host in Switch_B from port 0/7 to port 0/3, wait until the port LED turns green, and then go to the next task.

Test the VLANs and the Trunk

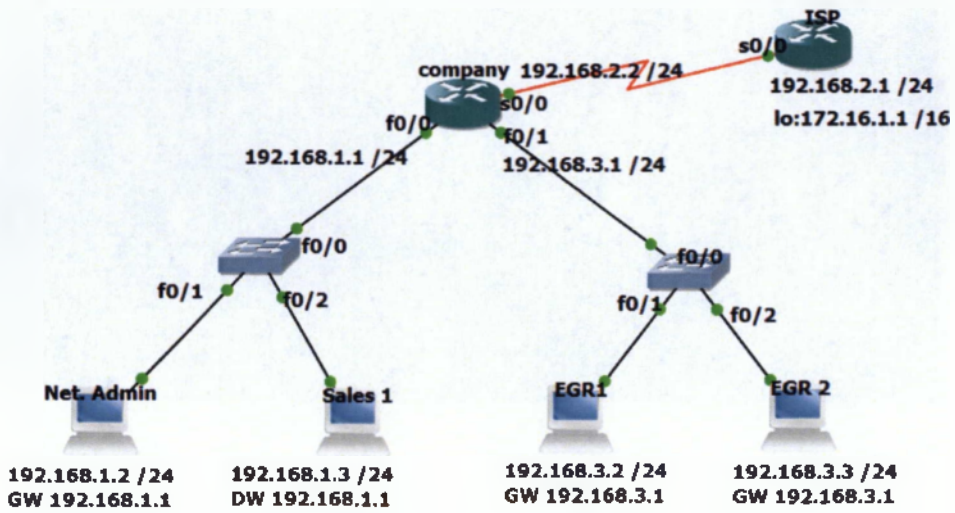
- To test the VLANs and the trunk, ping from the host in Switch_A port 0/2 to the host in Switch_B port 0/3.
- Was the ping successful? **Yes. Because host belong to the same Vlan**
- Ping from the host in Switch_B port 0/3 to the switch IP 192.168.1.2.
- Was the ping successful? **Yes. Because the 2 interfaces are in the same Vlan1.**
- Ping from the host in Switch_B port 0/3 to the switch IP 192.168.1.3.
- Was the ping successful? **Yes.Because the 2 interfaces are in the same Vlan1.**
- What conclusions can you draw from the testing that you just performed in regard to VLAN membership and VLANs across a trunk? **Hosts must be in the same Vlan in order to communicate to eachother. To accomplish this, we usw trunk links.**

6.11 Security

Σε αυτή την ενότητα θα μάθουμε πως να εντοπίζουμε απειλές προς την ασφάλεια του δικτύου μας, καθώς και μεθόδους για την αντιμετώπισή τους. Επίσης θα μάθουμε να παραμετροποιούμε και να επαληθεύουμε βασικές λειτουργίες του Router και της δρομολόγησης όσον αφορά τις ACLs και τέλος να εφαρμόζουμε, να επιλύουμε και να λύνουμε προβλήματα των ACLs.

Υλοποίηση Ασκήσεων

6.11.1 Implement an extended access control list on a simple network



Εικόνα 62 Access List Topology

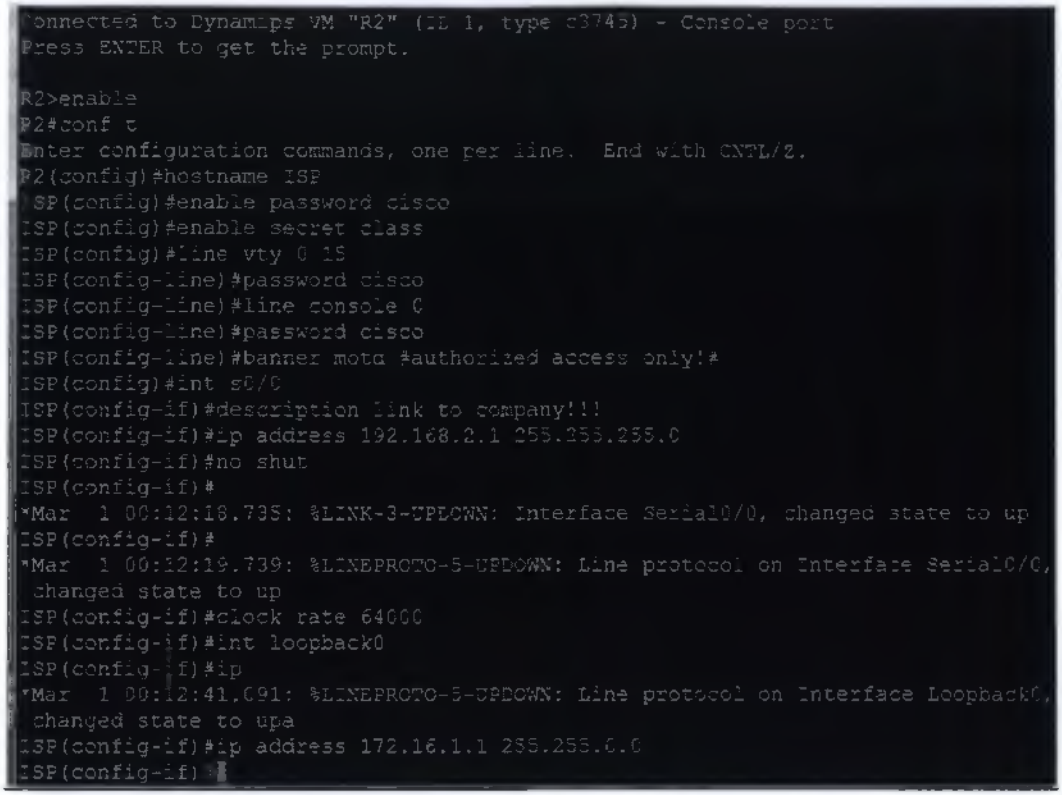
Configure the routers according to the topology.

Company

```
R1>ENABLE
R1#CONF T
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#hostname company
company(config)#enable passwrod cisco

% Invalid input detected at '^' marker.

company(config)#enable password cisco
company(config)#enable secret class
company(config)#line vty 0 15
company(config-line)#password cisco
company(config-line)#login
company(config-line)#line console 0
company(config-line)#password cisco
company(config-line)#login
company(config)#banner motd #authorized access only!!!#
company(config)#
company(config)#ip subnet-zero
company(config)#int s0/0
company(config-if)#descriptio link to ISP!
company(config-if)#ip address 192.168.2.2 255.255.255.0
company(config-if)#no shut
company(config-if)#
*Mar  1 00:09:29.131: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
company(config-if)#
*Mar  1 00:09:30.135: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
 changed state to up
company(config-if)#int f0/0
```

```
company(config-if)#description link to Switch1
company(config-if)#ip address 192.168.1.1 255.255.255.0
company(config-if)#no shut
company(config-if)#
*Mar  1 00:10:28.083: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state t
o up
*Mar  1 00:10:29.083: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEther
et0/0, changed state to up
company(config-if)#int f0/1
company(config-if)#description link to Switch2
company(config-if)#ip address 192.168.3.1 255.255.255.0
company(config-if)#no shut
company(config-if)#
*Mar  1 00:11:02.359: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state t
o up
*Mar  1 00:11:03.359: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEther
et0/1, changed state to up
```

ISP



Hosts Configuration

1. Test ping from one workstation to one other and to the loopback interface.

PC>ping 192.168.1.3

Pinging 192.168.1.3 with 32 bytes of data:

Reply from 192.168.1.3: bytes=32 time=18ms TTL=128

Reply from 192.168.1.3: bytes=32 time=7ms TTL=128

Reply from 192.168.1.3: bytes=32 time=7ms TTL=128

Reply from 192.168.1.3: bytes=32 time=8ms TTL=128

Ping statistics for 192.168.1.3:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 7ms, Maximum = 18ms, Average = 10ms

PC>ping 172.16.1.1

Pinging 172.16.1.1 with 32 bytes of data:

Reply from 172.16.1.1: bytes=32 time=15ms TTL=254

Reply from 172.16.1.1: bytes=32 time=17ms TTL=254

Reply from 172.16.1.1: bytes=32 time=13ms TTL=254

Reply from 172.16.1.1: bytes=32 time=11ms TTL=254

Ping statistics for 172.16.1.1:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 11ms, Maximum = 17ms, Average = 14ms

PC>

2. Write an extended ACL to deny ICMP from 192.168.1.2 to everywhere.

company(config)#access-list 111 deny icmp host 192.168.1.2 any

company(config)#access-list 111 permit ip any any

company(config)#in f0/0

company(config-if)#ip access-group 111 in

company(config-if)#

3. From 192.168.1.2 try to ping 192.168.3.3. It should not work and be unreachable.

PC>ping 192.168.3.3

Pinging 192.168.3.3 with 32 bytes of data:

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Ping statistics for 192.168.3.3:

Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

4. Try to ping from 192.168.1.2 to 192.168.3.2 and 172.16.1.1...both will not work.

PC>ping 192.168.3.2

Pinging 192.168.3.2 with 32 bytes of data:

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Ping statistics for 192.168.3.2:

Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

PC>

PC>ping 172.16.1.1

Pinging 172.16.1.1 with 32 bytes of data:

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Ping statistics for 172.16.1.1:

Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

PC>

5. Modify the ACL so you can ping to 172.16.1.1 but not to 192.168.3.0 (network).

company(config)#access-list 111 deny icmp host 192.168.1.2 192.168.3.0 0.0.0.255

company(config)#access-list 111 permit icmp any any

company(config)#

PC>ping 172.16.1.1

Pinging 172.16.1.1 with 32 bytes of data:

Reply from 172.16.1.1: bytes=32 time=8ms TTL=254

Reply from 172.16.1.1: bytes=32 time=13ms TTL=254

Reply from 172.16.1.1: bytes=32 time=6ms TTL=254

Reply from 172.16.1.1: bytes=32 time=15ms TTL=254

Ping statistics for 172.16.1.1:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 6ms, Maximum = 15ms, Average = 10ms

PC>ping 192.168.3.2

Pinging 192.168.3.2 with 32 bytes of data:

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Ping statistics for 192.168.3.2:

Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

PC>

6. Let's add another ACL to stop 192.168.3.2 from telnetting to 172.16.1.1.

company(config)#access-list 112 deny tcp host 192.168.3.2 any eq 23

company(config)#access-list 112 permit tcp any any

company(config)#int f0/1

company(config-if)#ip access-group 112 in

company(config-if)#

6.11.2 Use OSPF Routing Protocol for the above network.

According το Access List Topology (above), answer the questions.

- Write a named ACL to deny ICMP from 192.168.1.2 to everywhere. Include a named ACL to deny telnet from 192.168.3.2 to everywhere.

company(config)#ip access-list ?

extended Extended Access List

standard Standard Access List

company(config)#ip access-list extended DENYICMP

company(config-ext-nacl)#deny icmp host 192.168.1.2 any

company(config-ext-nacl)#permit icmp any any

company(config-ext-nacl)#

company(config)#ip access-list extended NOTELNET

company(config-ext-nacl)#deny tcp host 192.168.3.2 ANY EQ 23

company(config-ext-nacl)#permit tcp any any

company(config-ext-nacl)#

company(config)#int f0/0

company(config-if)#ip access-group DENYICMP in

company(config-if)#int f0/1

company(config-if)#ip access-group NOTELNET in

company(config-if)#

- From 192.168.1.2 try to ping 192.168.3.3. It should not work and be unreachable.

PC>ping 192.168.3.3

Pinging 192.168.3.3 with 32 bytes of data:

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Ping statistics for 192.168.3.3:

Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

- Try to ping from 192.168.1.2 to 192.168.3.2 and 172.16.1.1…both will not work. Telnet to 172.16.1.1 should work on 192.168.3.3 but not on 192.168.3.2.

PC>ping 192.168.3.2

Pinging 192.168.3.2 with 32 bytes of data:

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Ping statistics for 192.168.3.2:

Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

PC>

PC>ping 172.16.1.1

Pinging 172.16.1.1 with 32 bytes of data:

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Reply from 192.168.1.1: Destination host unreachable.

Ping statistics for 172.16.1.1:

Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

PC>

- TELNET FROM 192.168.3.2

PC>TELNET 172.16.1.1

Trying 172.16.1.1 ...Open

User Access Verification

Password:

ISP>enable

Password:

ISP#

- TELNET FROM 192.168.3.3

PC>telnet 172.16.1.1

Trying 172.16.1.1 ...

% Connection timed out; remote host not responding

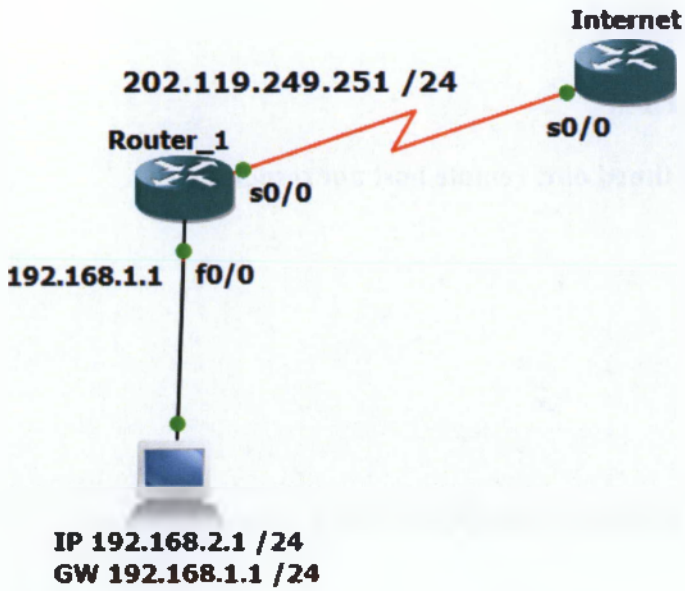
PC>

6.12 Network Address Translation (NAT)

Από τις αρχές έως τα μέσα της δεκαετίας του 90, έγινε σαφές ότι το Internet αυξάνεται τόσο γρήγορα, όπου όλοι οι αριθμοί IP δικτύων θα ανατίθενται από τα μέσα της δεκαετίας! Έτσι προέκυψε ανησυχία ότι τα διαθέσιμα δίκτυα θα ανατεθούν εντελώς και ορισμένοι οργανισμοί δεν θα ήταν σε θέση να συνδεθούν στο Internet . Ο Μεταφραστής Διευθύνσεων Δικτύου σχεδιάστηκε για απλοποίηση και διατήρηση των IP διευθύνσεων αφού αυτό που κάνει είναι να επιτρέπει σε ιδιωτικά δίκτυα που χρησιμοποιούν μη εγγεγραμμένες IP διευθύνσεις να έχουν σύνδεση με το Internet. Το σύστημα NAT λειτουργεί σε κάποιον δρομολογητή, ο οποίος συνδέει συνήθως δύο δίκτυα και μεταφράζει τις ιδιωτικές (μη μοναδικές στον παγκόσμιο ιστό) διευθύνσεις του εσωτερικού δικτύου σε νόμιμες διευθύνσεις προτού τα πακέτα προωθηθούν σε άλλο δίκτυο. Σαν μέρος αυτής της λειτουργίας το NAT μπορεί να ρυθμιστεί να κάνει γνωστή μόνο μία διεύθυνση στον έξω κόσμο για ολόκληρο το δίκτυο που συνδέει με αυτόν. Αυτό το χαρακτηριστικό παρέχει επιπλέον ασφάλεια αφού κρύβει ολόκληρο το εσωτερικό δίκτυο από το κόσμο πίσω από μία διεύθυνση.

Υλοποίηση Ασκήσεων

6.12.1 PAT Application



Εικόνα 63 PAT Topology

Configure the router

Router_1 Configuration

```
R1>ENABLE
R1#CONF T
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#hostname Router_1
Router_1(config)#enable password cisco
Router_1(config)#enable secret class
Router_1(config)#line vty 0 15
Router_1(config-line)#password cisco
Router_1(config-line)#line console 0
Router_1(config-line)#password cisco
Router_1(config-line)#banner motd #authorized access only!!!!#
Router_1(config)#int s0/0
Router_1(config-if)#description link to Internet!!!
Router_1(config-if)#ip address 202.119.249.251 255.255.255.0
Router_1(config-if)#no shut
Router_1(config-if)#
*Mar  1 00:02:32.203: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
Router_1(config-if)#
*Mar  1 00:02:33.207: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
 changed state to up
Router_1(config-if)#int f0/0
Router_1(config-if)#description link to host!
Router_1(config-if)#ip address 192
*Mar  1 00:02:58.667: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
 changed state to down.
Router_1(config-if)#ip address 192.168.1.1 255.255.255.0
Router_1(config-if)#no shut
```

- Enable all PCs on network 192.168.1.0 to use a single public IP address by using PAT.
- A PC on the public network accesses any port of 202.119.249.250/24. Direct the connection to server 192.168.1.2/24 by using PAT and complete all mapping services.
- A PC on the public network accesses port 80 of 202.119.249.250/24. Direct the connection to server 192.168.1.2/24. Map only the HTTP service of port 80.

```
Router_1(config)#ip default-gateway 202.229.249.2
Router_1(config)#access-list 1 permit 192.168.1.0 0.0.0.255
Router_1(config)#$2.119.249.250 202.119.249.250 netmask 255.255.255.0
Router_1(config)#
*Mar  1 00:04:27.579: %LINEPROTO-5-UPDOWN: Line protocol on Interface NVI0, chan
ged state to up
Router_1(config)#ip nat inside source list 1 pool xouter overload
Router_1(config)#ip nat inside source static 192.168.1.2 202.119.249.250
Router_1(config)#$de source static tcp 192.168.1.2 80 202.119.249.250 80
Router_1(config)#
Router_1(config)#
```

Configuring Dynamic NAT

- Two private IP addresses can access the Internet through two public IP addresses by using NAT.
- Any other private IP addresses cannot access the Internet.

```
Router_1(config)#int f0/0
Router_1(config-if)#description this is the inside interface!!!
Router_1(config-if)#int s0/0
Router_1(config-if)#description this is the outside interface!!!
Router_1(config-if)#int f0/0
Router_1(config-if)#ip nat inside
Router_1(config-if)#access-list 1 permit 192.168.1.0 0.0.0.255
Router_1(config)#$2.119.249.251 202.119.249.252 netmask 255.255.255.0
Router_1(config)#ip nat inside source list 1 pool router
Router_1(config)#
```

6.13 Cisco's Wireless Technologies

Παρότι οι λύσεις ενσύρματης δικτύωσης παρείχαν ικανές επιδόσεις, ήταν ανεπαρκείς σε αρκετές περιπτώσεις εφαρμογών. Η ευελιξία που παρέχουν οι ασύρματες τεχνολογίες φάνηκε από νωρίς πως θα άνοιγε ένα τεράστιο πεδίο νέων εφαρμογών. Παράλληλα η τεχνολογική εξέλιξη, έκανε δυνατή την παραγωγή συσκευών με πολύ μικρό κόστος και σε μεγάλες ποσότητες. Το αποτέλεσμα όλων αυτών είναι ότι την τελευταία δεκαετία βιώνουμε την όλο και πιο έντονη παρουσία των ασύρματων τεχνολογιών.

6.14 Internet Protocol Version 6 (IPv6)

Η δυνατότητα της κλιμάκωσης των δικτύων για τις μελλοντικές απαιτήσεις απαιτεί έναν απεριόριστο εφοδιασμό από διευθύνσεις IP και βελτιωμένη κινητικότητα. Το IP version 6 συνδυάζει εκτεταμένη διευθυνσιοδότηση με πιο αποτελεσματικό τρόπο και με μια πιο πλούσια σε δυνατότητες κεφαλίδα για να ικανοποιηθούν οι απαιτήσεις για διαβαθμισμένα δίκτυα στο μέλλον.

Το IPv6 ικανοποιεί και τις πιο πολύπλοκες απαιτήσεις για ιεραρχική διευθυνσιοδότηση που το IP version 4 δεν μπορούσε να παρέχει. Ένα βασικό όφελός του είναι ότι IPv6 μπορεί να ξαναδημιουργήσει end-to-end επικοινωνίες χωρίς την ανάγκη για μετάφραση των διευθύνσεων δικτύου (NAT), μια απαίτηση για μια νέα γενιά κοινής χρήσης καιreal-time εφαρμογών.

Για την μετάβαση σε IPv6 από υλοποιήσεις IPv4 μπορούν να χρησιμοποιηθούν μια ποικιλία τεχνικών, συμπεριλαμβανομένων και μιας συνάρτησης αυτόματης παραμετροποίησης.

ΣΥΜΠΕΡΑΣΜΑΤΑ

Καθώς η εξάρτησή μας από τα δίκτυα συνεχίζει να αυξάνεται, οι τεχνολογίες εξελίσσονται συνεχώς με αποτέλεσμα οι παγκόσμιοι οργανισμοί δικτύων (όπως η Cisco Systems) να αναπτύσσονται προκειμένου να ανταπεξέλθουν στις απαιτήσεις της. Πλέον είναι απαραίτητο οι μηχανικοί δικτύων να έχουν τις απαιτούμενες γνώσεις και η Cisco, μέσω των πιστοποιήσεων που έχει δημιουργήσει μπορεί να τις παρέχει στον κάθε ενδιαφερόμενο. Μετά την ολοκλήρωση της παραμετροποίησης των δρομολογητών και μεταγωγών, κατέληξα στο συμπέρασμα πως το GNS3 είναι ένα πραγματικά πολύ καλό πρόγραμμα το οποίο εξομοιώνει πιστά το περιβάλλον των συσκευών Cisco, δεδομένου ότι τρέχει καθαυτό το λειτουργικό τους σύστημα, σε σχέση με άλλα προγράμματα εξομοίωσης τα οποία απλά «ξεπατικώνουν» το γραφικό περιβάλλον και τις δυνατότητες του λειτουργικού. Τέλος, πρέπει να σημειωθεί πως η παρούσα εργασία μπορεί να χρησιμοποιηθεί ως οδηγός για τους σπουδαστές, για την υλοποίηση των ασκήσεων τη εξετάσιμης ύλης του CCNA.

ΠΑΡΑΡΤΗΜΑΤΑ

CLI : Command Line Interface - Γραμμή Εντολών

TCP/IP : Πρωτόκολλο Ελέγχου μετάδοσης και Πρωτόκολλο του Internet- μία συλλογή πρωτοκόλλων επικοινωνίας στα οποία βασίζεται το διαδίκτυο και ένα μεγάλο ποσοστό εμπορικών δικτύων

CPU : Κεντρική Μονάδα Επεξεργασίας – Το κεντρικό εξάρτημα ενός ηλεκτρονικού υπολογιστή. Ελέγχει τη λειτουργία του υπολογιστή και εκτελεί τις λειτουργίες επεξεργασίας δεδομένων.

Ethernet : Το συνηθέστερα χρησιμοποιημένο πρωτόκολλο ενσύρματης τοπικής δικτύωσης υπολογιστών. Αναπτύχθηκε από την εταιρία Xerox κατά τη δεκαετία του '70 και έγινε δημοφιλές αφότου η Digital Equipment Corporation και η Intel, από κοινού με τη Xerox, προχώρησαν στην προτυποποίησή του το 1980. Το 1985 το Ethernet έγινε αποδεκτό επίσημα από τον οργανισμό IEEE ως το πρότυπο 802.3 για ενσύρματα τοπικά δίκτυα (LAN).

Token ring : Ένας τύπος τοπικού δικτύου υπολογιστών. Στην πράξη υλοποιείται από ένα σύνολο υπολογιστών με συνδέσεις από σημείο σε σημείο. Μειονέκτημά του είναι ότι αν υπάρξει διακοπή στο καλώδιο τότε ο δακτύλιος πεθαίνει, αλλά αυτό το πρόβλημα λύνεται με τη χρήση κέντρου καλωδίωσης.
GSR : Gigabit Switched Router, ένας δρομολογητής που δημιουργήθηκε για να δίνει στους πάροχους υπηρεσιών τη ---- τεχνολογιών επόμενης γενιάς.

Carrier Ethernet : Είναι ένας όρος μάρκετινγκ που αφορά τις επεκτάσεις Ethernet προκειμένου να επιτρέπει στους πάροχους τεχνολογιών δικτύου να παρέχουν υπηρεσίες Ethernet στους πελάτες και να χρησιμοποιούν τεχνολογίες Ethernet στα δίκτυά τους.

Επαναλήπτης : Ένα κοινό σημείο σύνδεσης συσκευών ενός δικτύου. Οι επαναλήπτες χρησιμοποιούνται συχνά για να συνδέσουν τμήματα ενός δικτύου. Ένα hub έχει πολλαπλές πόρτες/εισόδους. Όταν ένα πακέτο δεδομένων φτάνει σε μια πόρτα, αυτό αναμεταδίδεται σε όλες τις άλλες πόρτες/εισόδους, ώστε όλα τα τμήματα του δικτύου μπορούν να διαβάσουν όλα τα δεδομένα.
Media Access Control (MAC) : Έλεγχος Πρόσβασης Σε Μέσα (διεύθυνση MAC) είναι ένας δεκαεξαδικός σειριακός αριθμός (ως προς την αναπαράσταση) ο οποίος είναι μοναδικός για κάθε δικτυακή συσκευή. Ο αριθμός έχει τη μορφή xx:xx:xx:xx:xx:xx, για παράδειγμα 0A:12:A1:B2:AE:04 για την 16-δική αναπαράσταση. Η διεύθυνση MAC χρησιμοποιείται για την επικοινωνία μεταξύ των δικτυακών συσκευών εντός ενός τοπικού δικτύου. Σε κάθε επικοινωνία οποιασδήποτε δικτυακής συσκευής με μια άλλη, ο αριθμός αυτός αποκαλύπτεται από τον αποστολέα (source) στον παραλήπτη (destination).

Wide Area Network (WAN): Δίκτυο Ευρείας Περιοχής ή Ζώνης. Είναι ένα σύνολου υπολογιστών που εκτείνονται σε μια ευρεία γεωγραφική περιοχή [ή αλλιώς πολλά LAN's μαζί] και δημιουργούν μεταξύ τους ένα δίκτυο επικοινωνίας.

OSI: Open Systems Interconnection (Μοντέλο αναφοράς Ανοικτής Διασύνδεσης Συστημάτων). Το μοντέλο OSI υποδιαιρεί τις λειτουργίες ενός τηλεπικοινωνιακού δικτύου σε μια «κατακόρυφη» στοίβα από επίπεδα, για το καθένα από τα οποία μπορεί να οριστεί κάποιο πρωτόκολλο σε μία συγκεκριμένη υλοποίηση. Κάθε επίπεδο αξιοποιεί τις λειτουργίες του κατώτερού του στη στοίβα επιπέδου, ενώ στόχος του είναι να παρέχει λειτουργικότητα στο αμέσως ανώτερο επίπεδό του.

Firmware: Ένα πρόγραμμα λογισμικού ή σύνολο οδηγιών μιας συσκευής υλικού. Παρέχει τις απαραίτητες οδηγίες για τον τρόπο που επικοινωνεί η συσκευή με το υπόλοιπο υλικό του υπολογιστή. Το firmware βρίσκεται στη ROM.

Moodle: Modular Object-Oriented Dynamic Learning Environment (Αρθρωτό Αντικειμενοστραφές Δυναμικό Μαθησιακό Περιβάλλον).

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