Υλοποίηση Δικτυακών Υποδομών και Υπηρεσιών: Εισαγωγή στο IOS

Δρ. Απόστολος Γκάμας

Διδάσκων 407/80

gkamas@uop.gr

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

What is IOS?

— Internetwork Operating System

— A derivative of BSD UNIX

— Custom built by Cisco for each platform

— Pre-packaged and static.

— Features available in different revisions (for a price!)

— GUI's available, but 90%+ of users still prefer command-line configuration.

Υλοποίηση Δικτυακών Υποδομών και Υπηρεσιών

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

IOS and Hardware

— IOS is designed to be hardware independent. A high end router may use ASIC's for fast routing, while a smaller access router may use the central processor. Configuration and monitoring commands should be almost identical!

— The OS not only configures the device, but is an abstraction to make it easier for humans!

Components of a router

| Component	Definition
CPU	System initialization, routing functions and interface control
RAM	Routing table, fast switching cache, running-config and queues
Flash	Holds a full Cisco IOS software image
NVRAM	Stores the startup configuration
Buses	Communication between CPU, interfaces and slots
ROM	Permanently stores start up diagnostic code and minimal IOS
Interfaces	Connects the router to external media
Power Supply	Provides power to operate internal components

Υλοποίηση Δικτυακών Υποδομών και Υπηρεσιών

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

Router Components RAM

- RAM

  - Temporary storage of config files

  - All content is lost on power-down

  - May be very large to hold large routing tables

- Stores

  - Routing tables (remember: usually built dynamically)

  - ARP cache (again, built dynamically and ephemeral)

  - Fast-switching cache

 - Packet buffers

  - Packet hold queues

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ
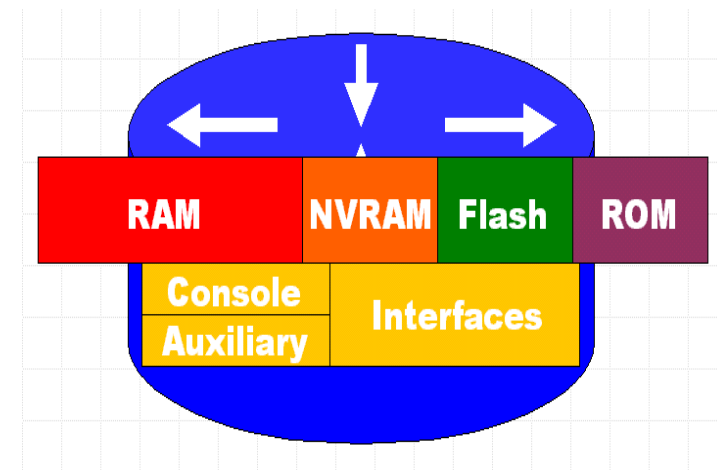
Router Components NVRAM

— NVRAM

— Non-volatile RAM

— Not especially fast

— Content is NOT LOST on power cycle.

— Usually less than 100 Kbytes

— Stores

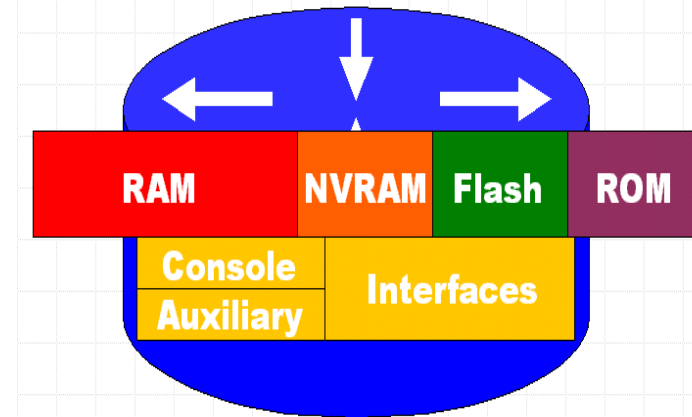— Exclusively used to store configuration scripts that are parsed on power-up.

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ
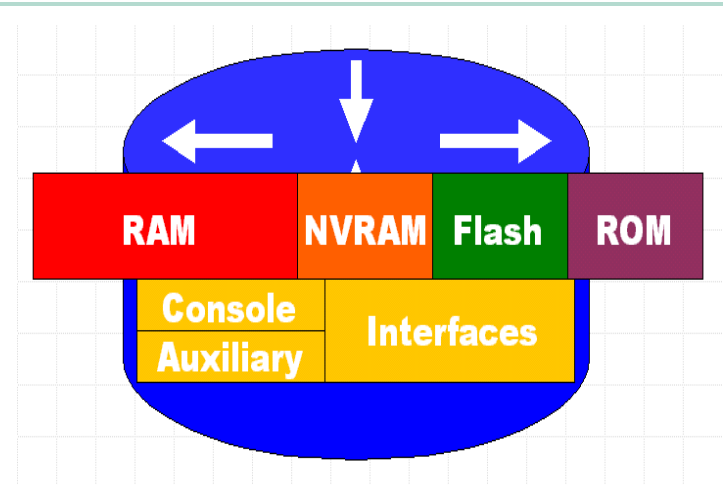
Router Components FLASH

— FLASH

  — EEPROM (Electronically Erasable Programmable Read-Only Memory)
  — Retained on power-down.
  — May be off-board in the form of flashcards.

— Stores

  — IOS versions. Allows for upgrading Operating System without replacing chip.
  — Multiple versions of IOS may be stored at once (GREAT for testing install of a new version!)
 — Off-board configuration allows you to "put OS in your pocket".

RAM NVRAM Flash ROM

Console Auxiliary

Interfaces

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

Router Components ROM

— ROM

— Read-Only Memory.

— Generally installed in factory and never touched again!

— Stores

— POST (power-on self test)

— Bootstrap program that calls IOS.

— Bare-bones version of an IOS. If IOS load routine fails, it defaults back to this version, giving limited functionality.
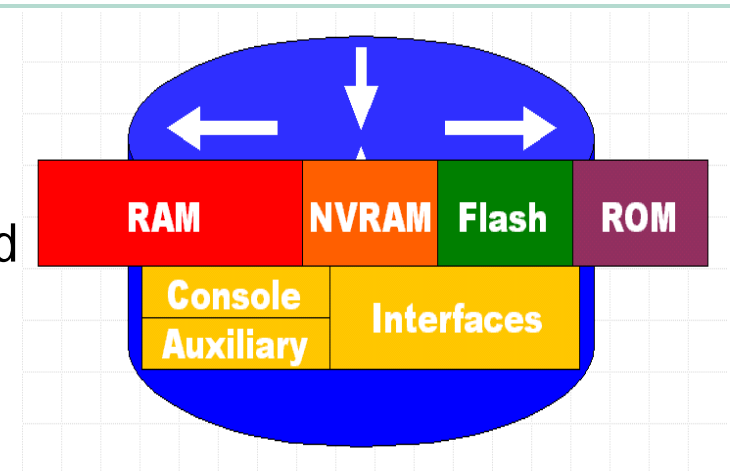
ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

Interface

— Connects router to network for frame entry/exit

— Can be on motherboard or separate module

— Connects routers to LANs and WANs

Management Connections

— Console and Aux ports

  — Non-network connections

  — Asynchronous serial connections

— Used for initial configuration

— Troubleshooting problems

— Monitoring the system

Υλοποίηση Δικτυακών Υποδομών και Υπηρεσιών

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

Configuring a Router

— Routers should be given a unique names as one of the first configuration tasks:

```
Router(config)#
Tokyo(config)# _
```

— Passwords should be configured for vty lines, the console and to control access to privileged EXEC mode:

```
Router(config)# enable secret class
Router(config)# line con 0
Router(config-line)#password cisco
Router(config-line)# login
```

Getting Help

— In any command mode, you can get a list of available commands by entering a question mark (?).

      Router>**?**

— To obtain a list of commands that begin with a particular character sequence, type in those characters followed immediately by the question mark (?).
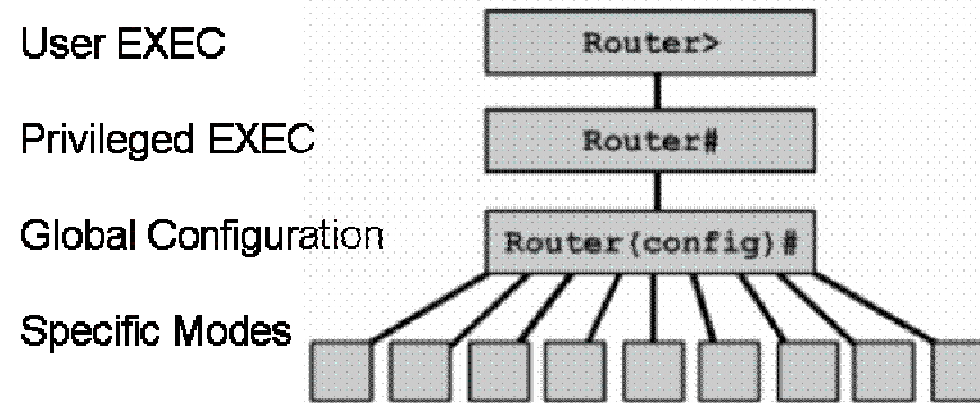
      Router#**co?**

      configure connect copy

— To list keywords or arguments, enter a question mark in place of a keyword or argument. Include a space before the question mark.

      Router#**configure ?**

      memory Configure from NV memory

      network Configure from a TFTP network host

      terminal Configure from the terminal

Υλοποίηση Δικτυακών Υποδομών και Υπηρεσιών

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

Router Interface Modes

Configuration Mode	Prompt
Interface	Router(config-if)#
Subinterface	Router(config-subif)#
Controller	Router(config-controller)#
Map-list	Router(config-map-list)#
Map-class	Router(config-map-class)#
Line	Router(config-line)#
Router	Router(config-router)#
IPX-router	Router(config-ipx-router)#
Route-map	Router(config-route-map)#

User EXEC — Router>
Privileged EXEC — Router#
Global Configuration — Router(config)#
Specific Modes

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

Logging into the Router

— The user mode and is mostly used to view statistics, though it is also a stepping-stone to logging into privileged mode. You can only view and change the configuration of a Cisco router in privileged mode, which you enter with the command enable.
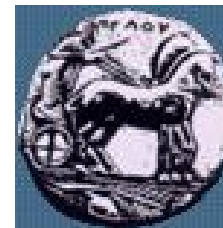
Router>

Router>**enable**

Router#

— You now end up with a Router#, which indicates you are in privileged mode. You can both view and change the configuration in privileged mode. You can go back from privileged mode to user mode by using the disable command.

Router#**disable**

Router>

— At this point you can type logout to exit the console.

Router>**logout**

CLI Prompts

Router(config)#**interface ?**

Async Async interface

BVI Bridge-Group Virtual Interface

Dialer Dialer interface

FastEthernet FastEthernet IEEE 802.3

Group-Async Async Group interface

Lex Lex interface

Loopback Loopback interface

Multilink Multilink-group interface

Null Null interface

Port-channel Ethernet Channel of interfaces

Tunnel Tunnel interface

Virtual-Template Virtual Template interface

Virtual-TokenRing Virtual TokenRing

Router(config)#**interface fastethernet 0/0**

Router(config-if)#

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

Gathering Basic Routing Information

— The command show version will provide basic configuration for the system hardware as well as the software version, the names and sources of configuration files, and the boot images.

— Router#**sh version**

Setting privileged level Password

Router(config)#**enable ?**

last-resort Define enable action if no TACACS servers respond

password Assign the privileged level password

secret Assign the privileged level secret

use-tacacs Use TACACS to check enable passwords

Router(config)#**enable secret test**

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

Setting Console level Password

Router(config)#**line console ?**

<0-0> First Line number

Router(config)#**line console 0**

Router(config-line)#**login**

Router(config-line)#**password todd1**

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

Setting Telnet level Password

Router(config-line)#**line vty 0 ?**

<1-197>Last Line Number

<cr>

Router(config-line)#**line vty 0 197**

Router(config-line)#**login**

Router(config-line)#**password todd2**

Υλοποίηση Δικτυακών Υποδομών και Υπηρεσιών

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

Banners

— You can set a banner on a Cisco router so that when either a user logs into the router or an administrator telnets into the router, for example, a banner will give them the information you want them to have. Another reason for having a banner is to add a security notice to users dialing into your internetwork. There are four different banners available:

Router(config)#**banner ?**

LINE c banner-text c, where 'c' is a delimiting character

exec Set EXEC process creation banner

incoming Set incoming terminal line banner

login Set login banner

motd Set Message of the Day banner

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

Router Interfaces

— Router(config)#**int serial 5**

— Router(config)-if)#

— Router(config)#**int ethernet 0**

— Router(config-if)#

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

Configuring an IP Address on an Interface

— Router(config)#**int e0**

— Router(config-if)#**ip address 172.16.10.2 255.255.255.0**

— Router(config-if)#**no shut**

Υλοποίηση Δικτυακών Υποδομών και Υπηρεσιών

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

Hostnames

— You can set the hostname of the router with the hostname command. This is only locally significant, which means it has no bearing on how the router performs name lookups on the internetwork.

Router#**config t**

Enter configuration commands, one per line. End with

CNTL/Z.

Router(config)#**hostname todd**

todd(config)#**hostname Atlanta**

Atlanta(config)#

Υλοποίηση Δικτυακών Υποδομών και Υπηρεσιών

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

Descriptions

— Setting descriptions on an interface is helpful to the administrator and, like the hostname, only locally significant. This is a helpful command because it can be used to keep track of circuit numbers, for example.

Atlanta(config)#**int e0**

Atlanta(config-if)#**description Sales Lan**

Atlanta(config-if)#**int s0**

Atlanta(config-if)#**desc Wan to Miami circuit:6fdda4321**

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ
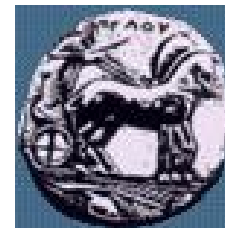
Bringing Up an Interface

— You can turn an interface off with the interface command shutdown or turn it on with the no shutdown command. If an interface is shut down, it will display administratively down when using the show interface command, and the show running-config command will show the interface as shut down. All interfaces are shut down by default.

Router#**config t**

Enter configuration commands, one per line. End with

CNTL/Z.

Router(config)#**int e0**

Router(config-if)#**no shutdown**

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

Configuration Files

— Configuration Files Any time you make changes to the router configuration, you must save the changes to memory because if you do not they will be lost if there is a system reload or power outage. There are two types of configuration files: the running (current operating) configuration and the startup configuration.

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

Use the following privileged mode commands to work with configuration files.

— configure terminal – modify the running configuration manually from the terminal.

— show running-config – display the running configuration.

— show startup-config – display the startup configuration.

— copy running-config startup-config – copy the running configuration to the startup configuration.

— copy startup-config running-config – copy the startup configuration to the running configuration.

— erase startup-config – erase the startup-configuration in NVRAM.

— copy tftp running-config – load a configuration file stored on a Trivial File Transfer Protocol (TFTP) server into the running configuration.

— copy running-config tftp – store the running configuration on a TFTP server.

Show commands

Command	Displays
show interfaces	Displays all the statistics for all the interfaces on the router
show int s0/1	Statistics for a specific interface (serial 0/1)
show controllers s0/1	Displays information-specific to the interface hardware
show clock	Shows the time set in the router
show hosts	Displays a cached list of host names and addresses
show users	Displays all users who are connected to the router
show history	Displays a history of commands that have been entered
show flash	Information about flash memory and IOS files stored there
show version	Information about the router and the IOS running in RAM
show arp	Displays the ARP table of the router
show protocol	Global and interface specific status of Layer 3 protocols
show startup-config	The saved configuration located in NVRAM
show running-config	Displays configuration currently running in RAM

Υλοποίηση Δικτυακών Υποδομών και Υπηρεσιών

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ