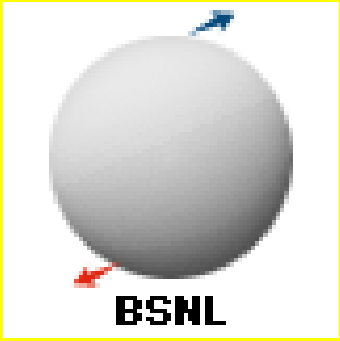


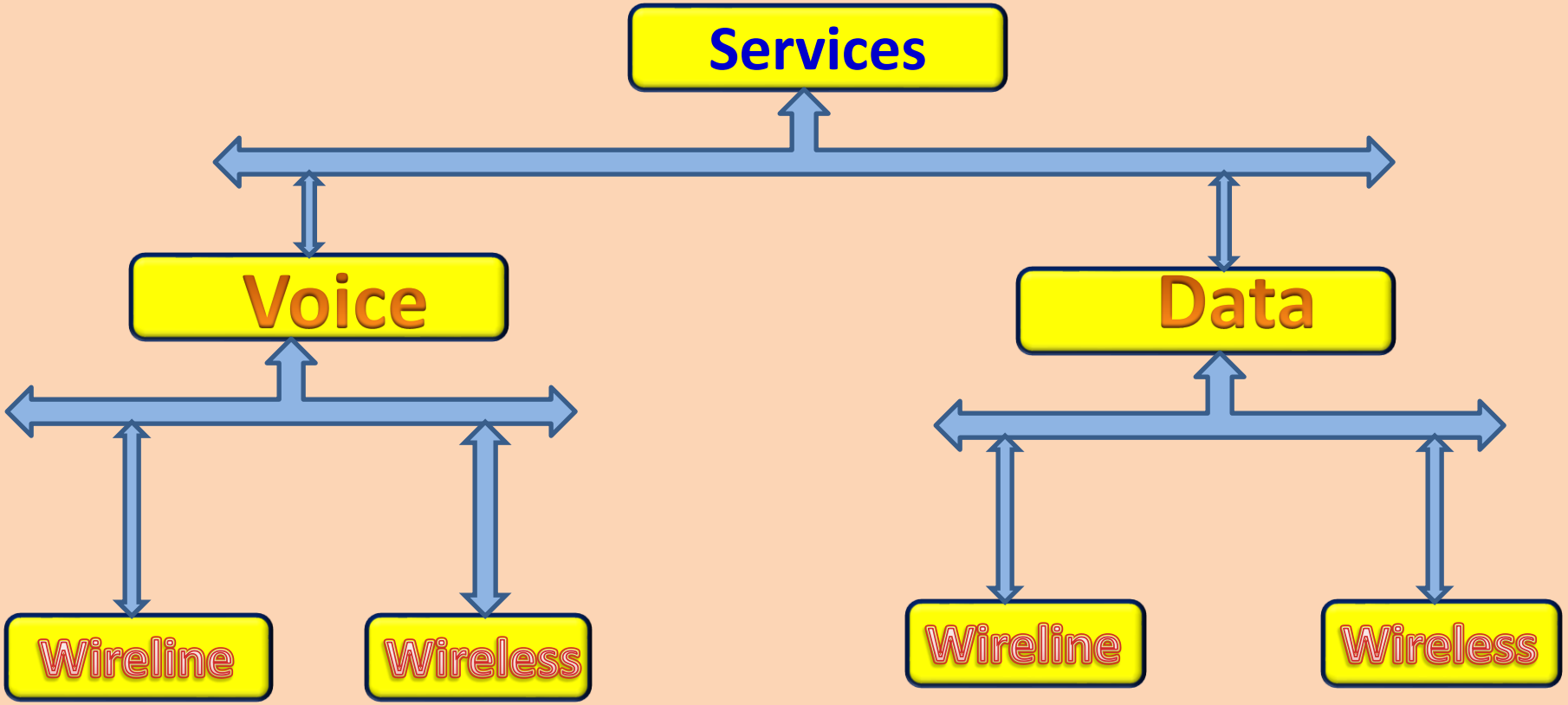
WELCOMES

AP GENCO, VJA

ENGINEERS

B.S.N.L. AP CIRCLE.,
VIJAYAWADA

SERVICES OF BSNL




BHARAT SANCHAR NIGAM LTD.
టెలిఫోన్ ఎక్స్‌ఛేంజి


BSNL
BHARAT SANCHAR BHAWAN


BSNL


BSNL


BSNL
Mumbai77.com
14-Jun-06 6:33 pm

ABOUT BUSINESS IN INDIA TELECOM

No. of Mobile Customers in India = 132 Cr

No. of Landlines working in India = 3 Cr

No. of Data Customers in India = 82 Cr

Business Turn-over in India = Rs 400000 Cr per annum

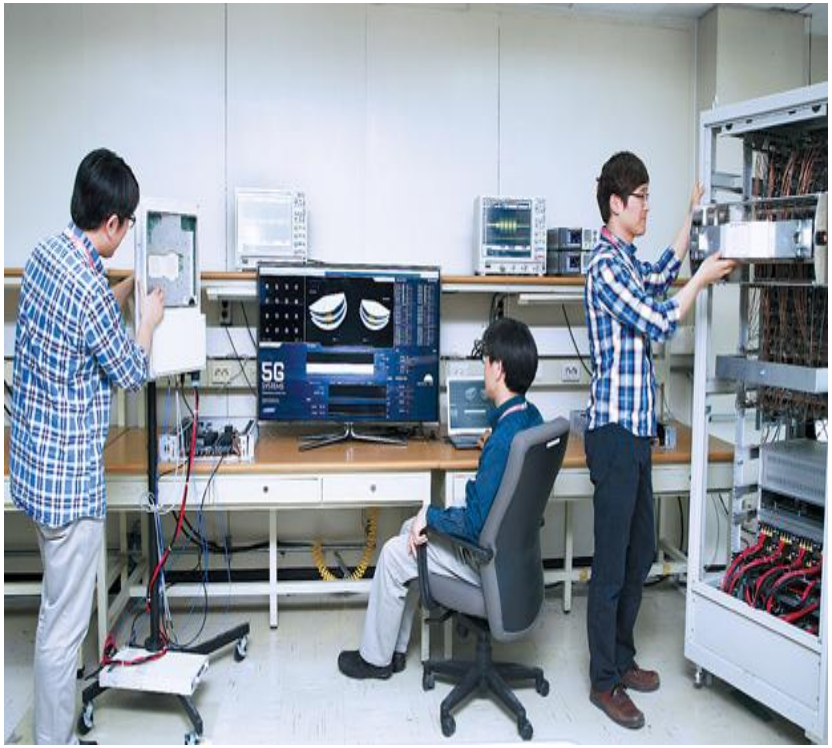
SALIENT FEATURES

EMPLOYABILITY

(A) TELECOM MANUFACTURING SIDE

(B) TELECOM OPERATIONS SIDE


DaVinci


5G


ALMASRYNETWORK.com


AT&T
811


BT


bharti
airtel


vodafone


Alcatel-Lucent
© 2009 Rob Huntley


Nokia Siemens
Networks


NORTEL
NETWORKS


MOTOROLA
blog.ChicagoArchitecture.info

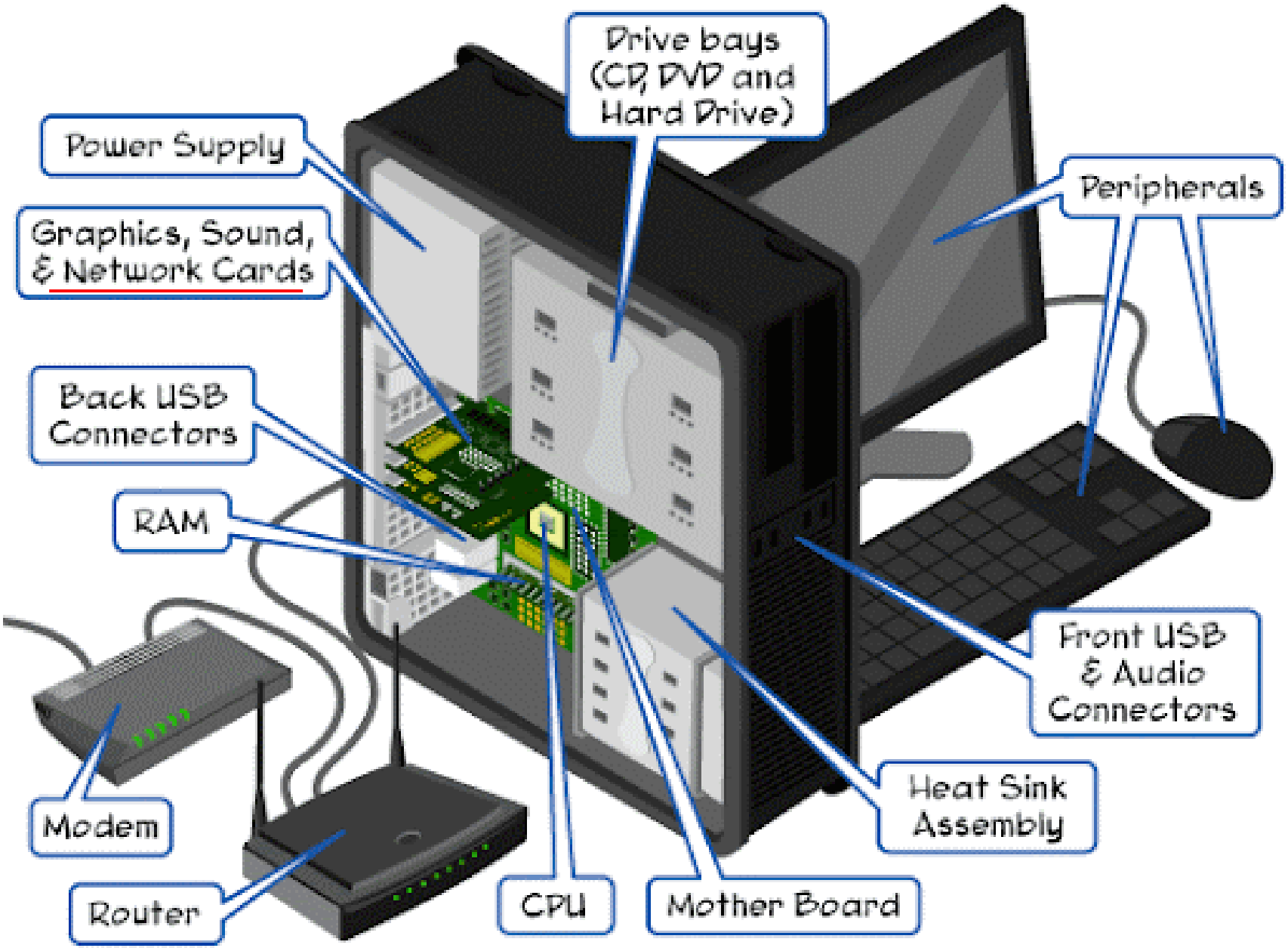

SIEMEN


ALCATEL

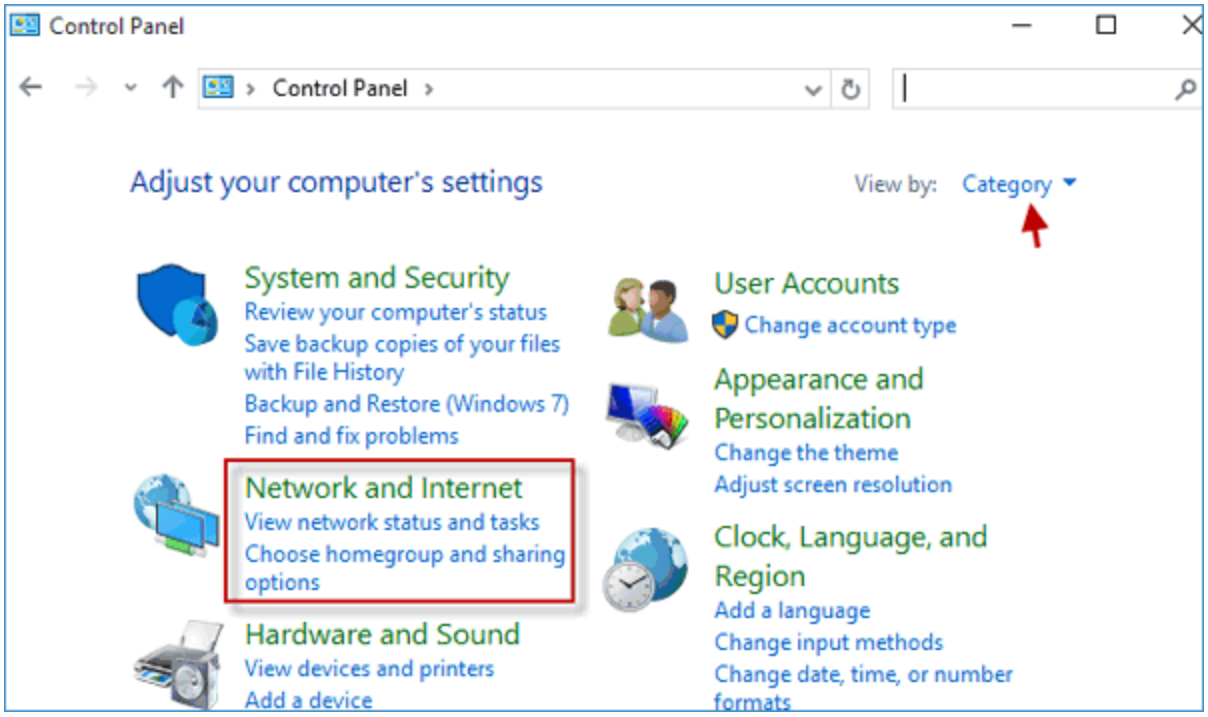

ZTE中兴

60% of present day IT projects are Telecom Software developments

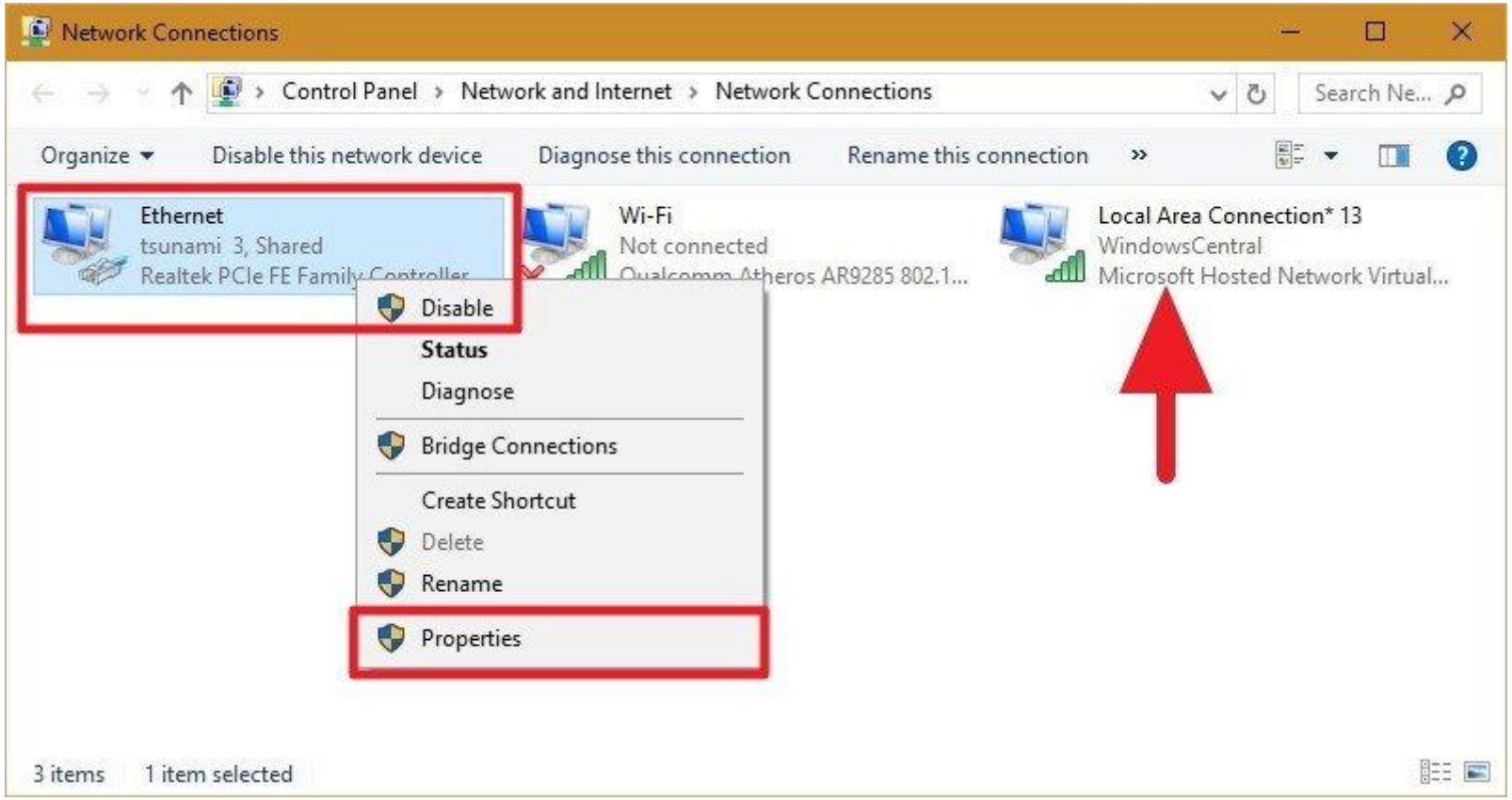
DATA SERVICES

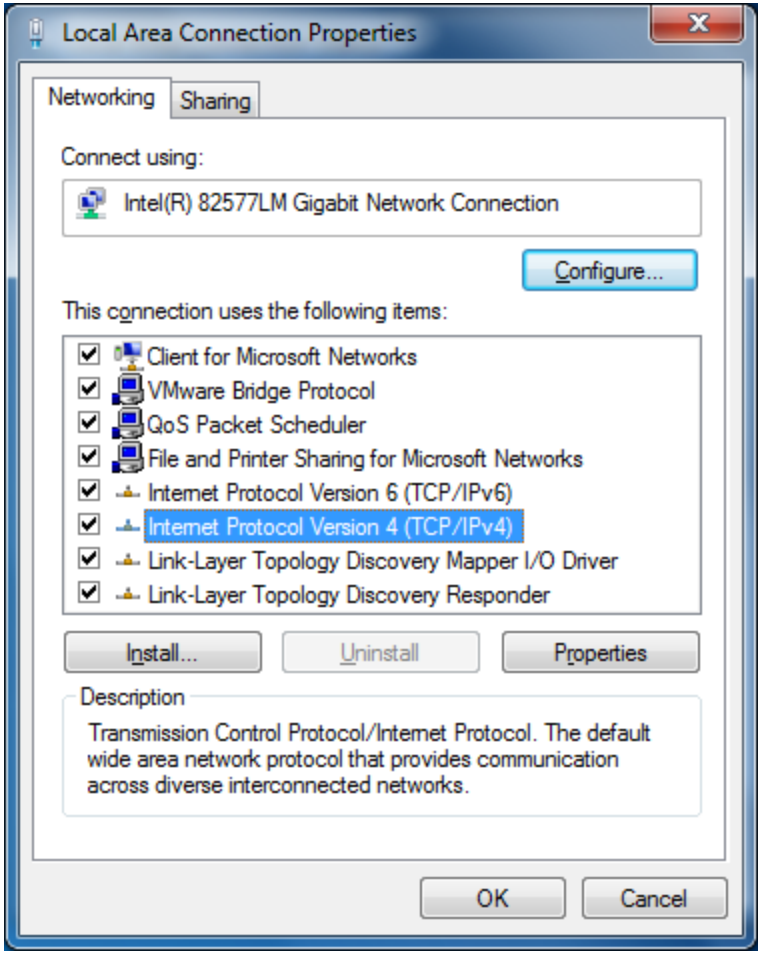

Drive bays (CD, DVD and Hard Drive)
Power Supply
Graphics, Sound, & Network Cards
Back USB Connectors
RAM
Peripherals
Front USB & Audio Connectors
Heat Sink Assembly
Modem
Router
CPU
Mother Board

NIC CARD

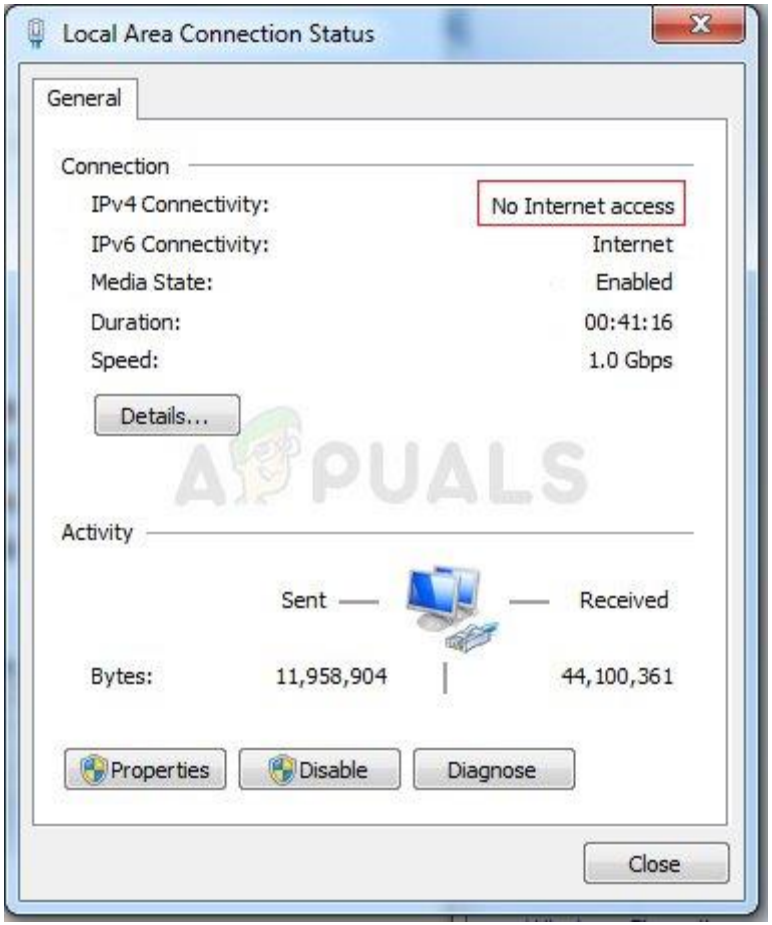

Control Panel
Control Panel
Adjust your computer's settings
View by: Category
System and Security
Review your computer's status
Save backup copies of your files with File History
Backup and Restore (Windows 7)
Find and fix problems
Network and Internet
View network status and tasks
Choose homegroup and sharing options
Hardware and Sound
View devices and printers
Add a device
User Accounts
Change account type
Appearance and Personalization
Change the theme
Adjust screen resolution
Clock, Language, and Region
Add a language
Change input methods
Change date, time, or number formats

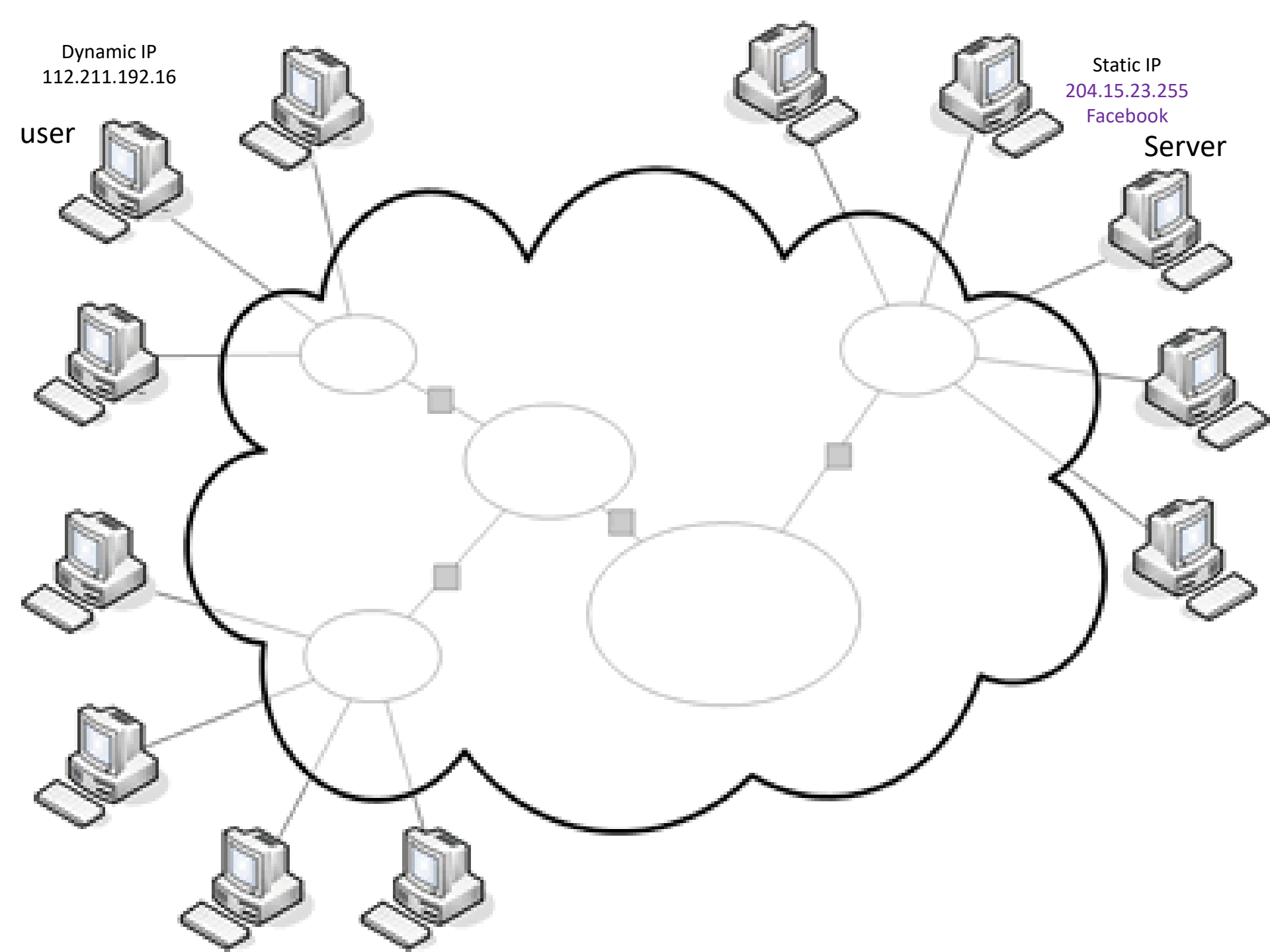

« Network and Internet ▸ Network Connections ▸
Search Network Connections
Organize
Local Area Connection
Network 4
Intel(R) 82566MM Gigabit Network ...
Office Dialup
Disconnected
ThinkPad Modem
Wireless Network Connection
Imperial Wambooli
11a/b/g Wireless LAN Mini PCI Expr...
Wireless Network Connection 2
Not connected
Microsoft Virtual WiFi Miniport Ad...


Network Connections
Control Panel › Network and Internet › Network Connections
Search Ne...
Organize
Disable this network device
Diagnose this connection
Rename this connection
Ethernet
tsunami 3, Shared
Realtek PCIe FE Family Controller
Wi-Fi
Not connected
Qualcomm Atheros AR9285 802.1...
Local Area Connection* 13
WindowsCentral
Microsoft Hosted Network Virtual...
Disable
Status
Diagnose
Bridge Connections
Create Shortcut
Delete
Rename
Properties
3 items
1 item selected

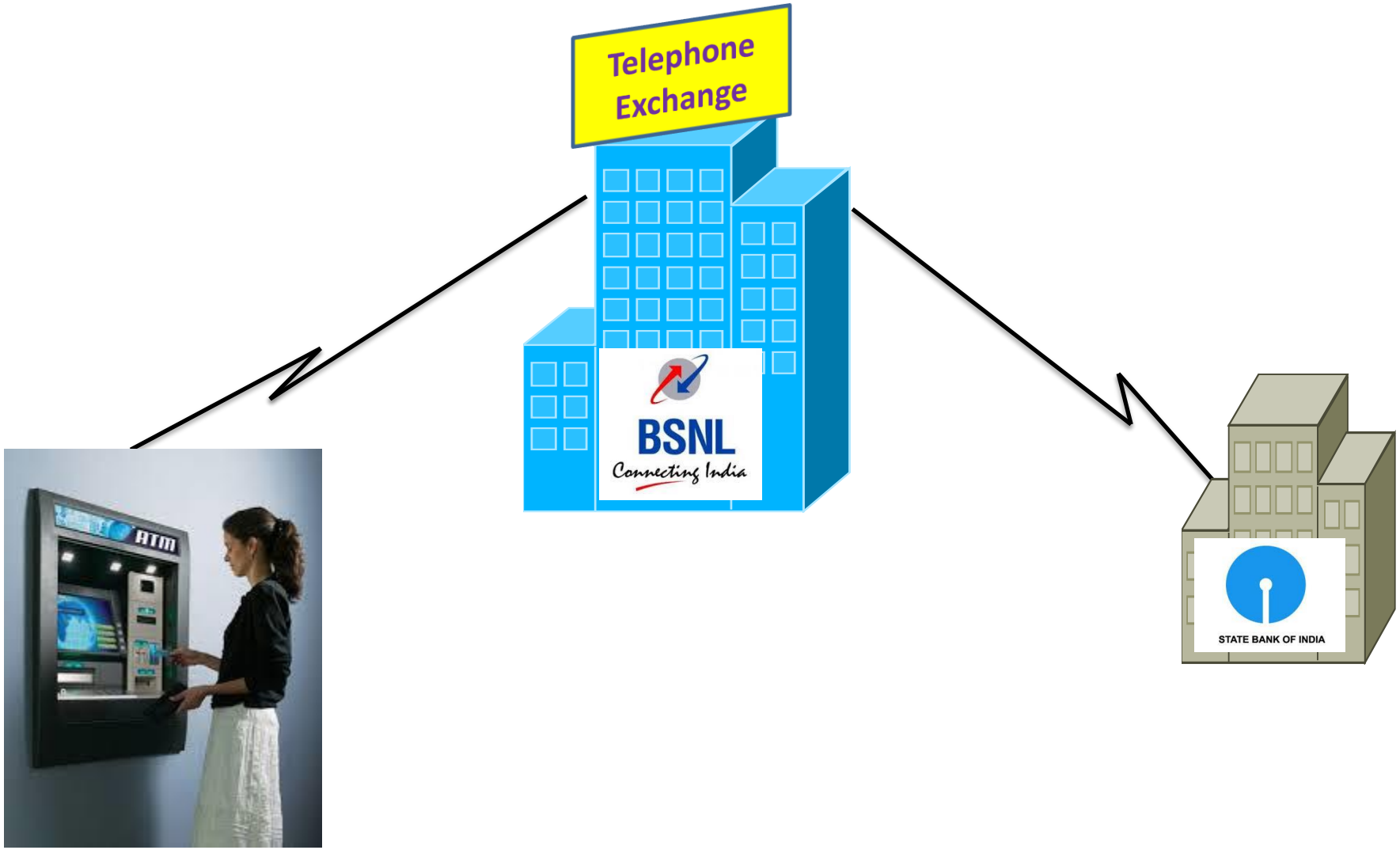

Local Area Connection Properties
Networking
Sharing
Connect using:
Intel(R) 82577LM Gigabit Network Connection
Configure...
This connection uses the following items:
Client for Microsoft Networks
VMware Bridge Protocol
QoS Packet Scheduler
File and Printer Sharing for Microsoft Networks
Internet Protocol Version 6 (TCP/IPv6)
Internet Protocol Version 4 (TCP/IPv4)
Link-Layer Topology Discovery Mapper I/O Driver
Link-Layer Topology Discovery Responder
Install...
Uninstall
Properties
Description
Transmission Control Protocol/Internet Protocol. The default wide area network protocol that provides communication across diverse interconnected networks.
OK
Cancel


Internet Protocol Version 4 (TCP/IPv4) Properties
General
Alternate Configuration
You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.
Obtain an IP address automatically
Use the following IP address:
IP address:
Subnet mask:
Default gateway:
Obtain DNS server address automatically
Use the following DNS server addresses:
Preferred DNS server:
Alternate DNS server:
Validate settings upon exit
Advanced...
OK
Cancel

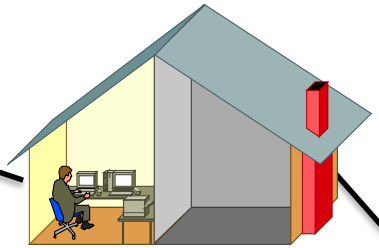

Local Area Connection Status
General
Connection
IPv4 Connectivity:
No Internet access
IPv6 Connectivity:
Internet
Media State:
Enabled
Duration:
00:41:16
Speed:
1.0 Gbps
Details...
Activity
Sent
Received
Bytes:
11,958,904
44,100,361
Properties
Disable
Diagnose
Close


Dynamic IP
112.211.192.16
user
Static IP
204.15.23.255
Facebook
Server

TELECOM EXAMPLES

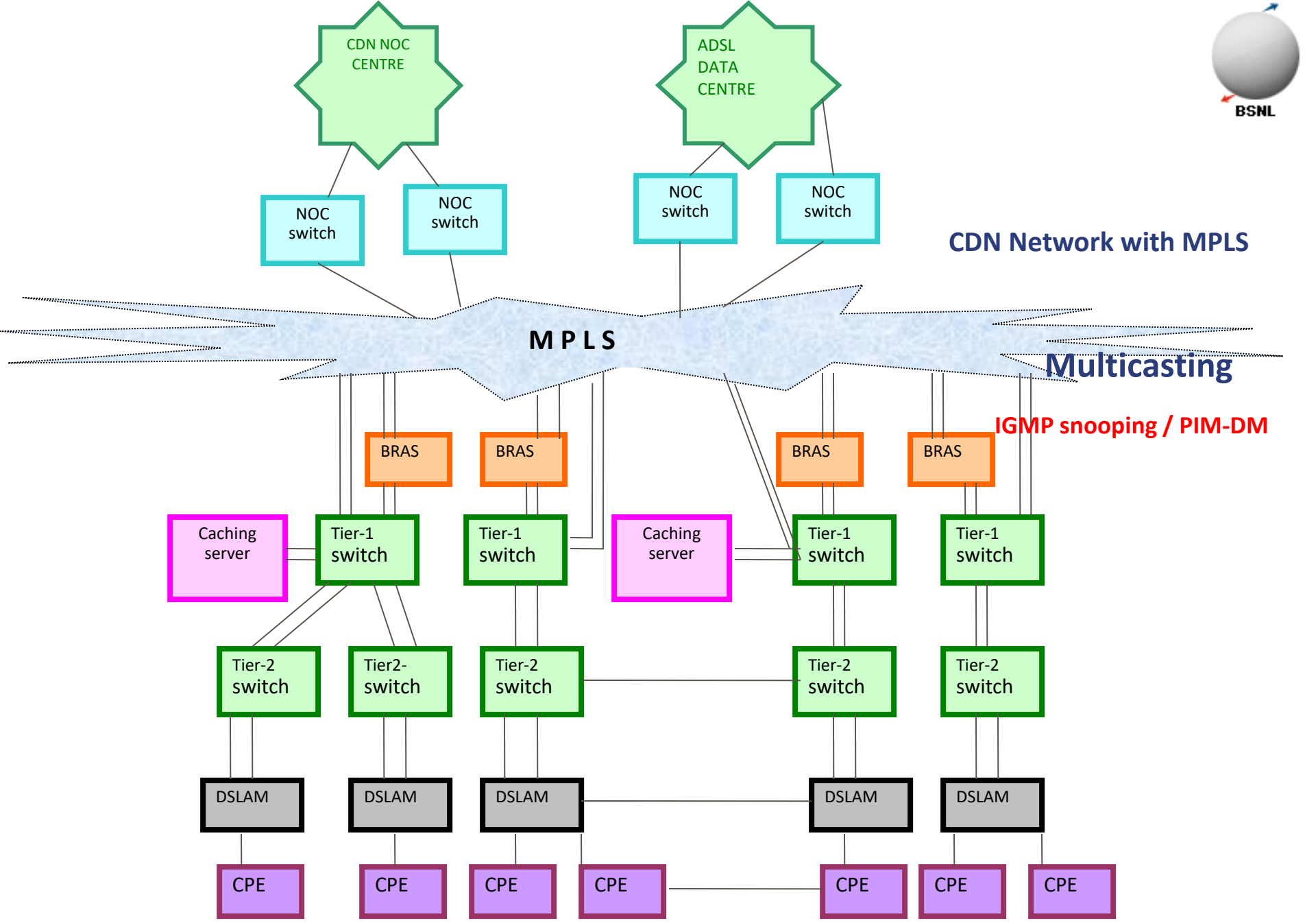


TELECOM EXAMPLES



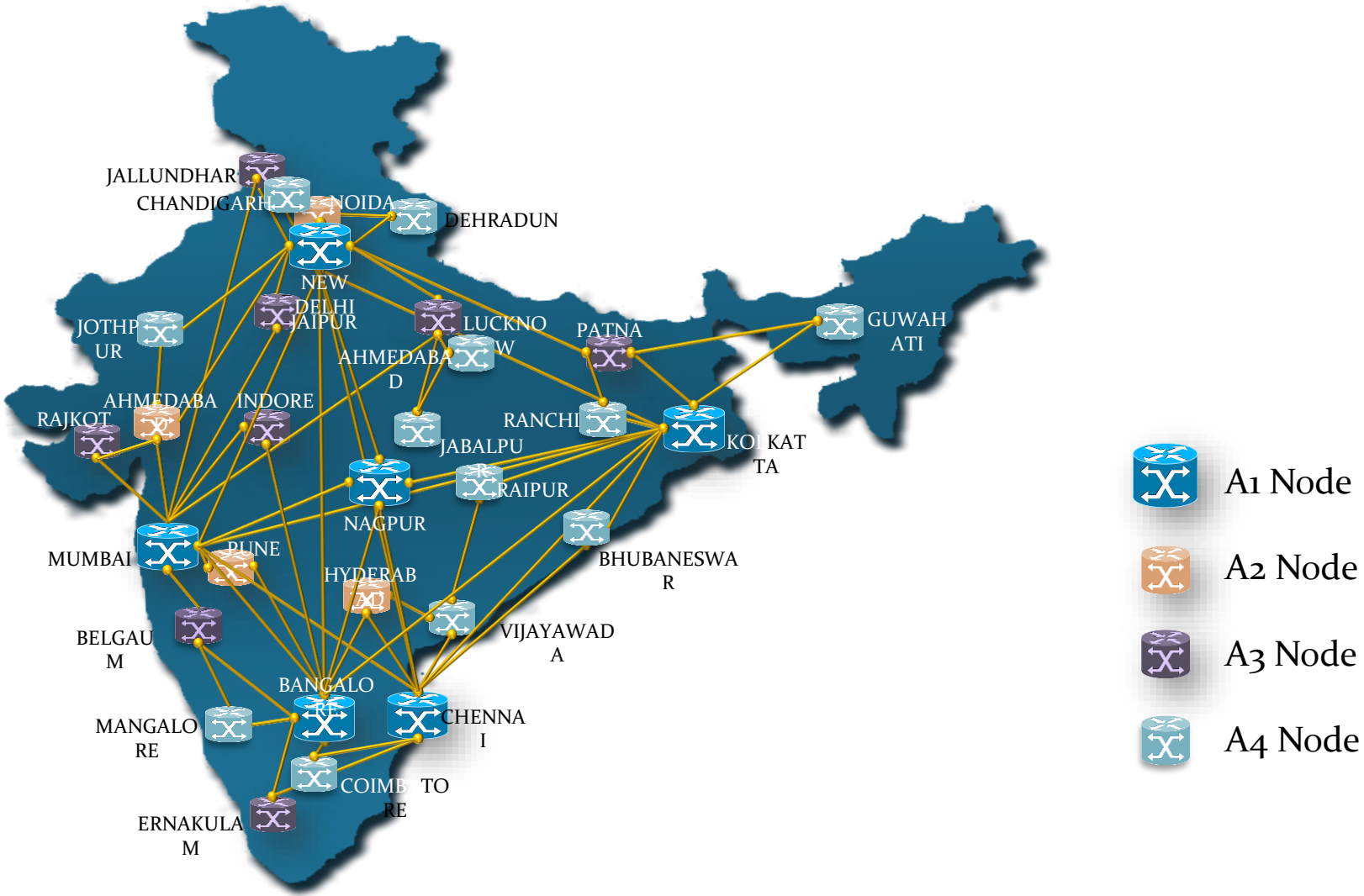
air costa
Branch
office

air costa
Server
Point


CDN NOC CENTRE
ADSL DATA CENTRE
NOC switch
NOC switch
NOC switch
NOC switch
CDN Network with MPLS
MPLS
Multicasting
IGMP snooping / PIM-DM
BRAS
BRAS
BRAS
BRAS
Caching server
Tier-1 switch
Tier-1 switch
Caching server
Tier-1 switch
Tier-1 switch
Tier-2 switch
Tier2- switch
Tier-2 switch
Tier-2 switch
Tier-2 switch
DSLAM
DSLAM
DSLAM
DSLAM
DSLAM
CPE
CPE
CPE
CPE
CPE
CPE
CPE
BSNL

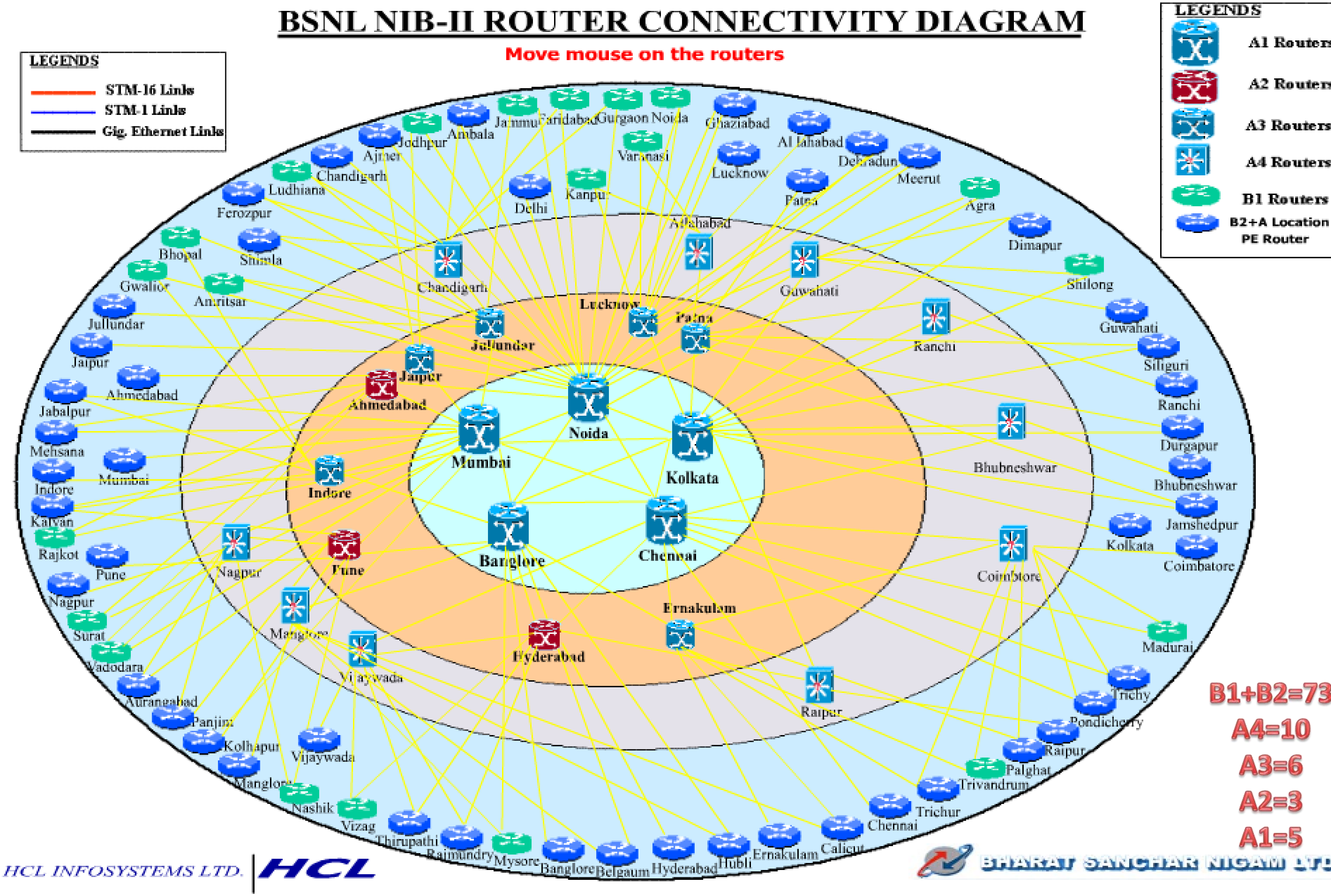
Broadband Equipment

Current MPLS Core



BSNL NIB-II ROUTER CONNECTIVITY DIAGRAM

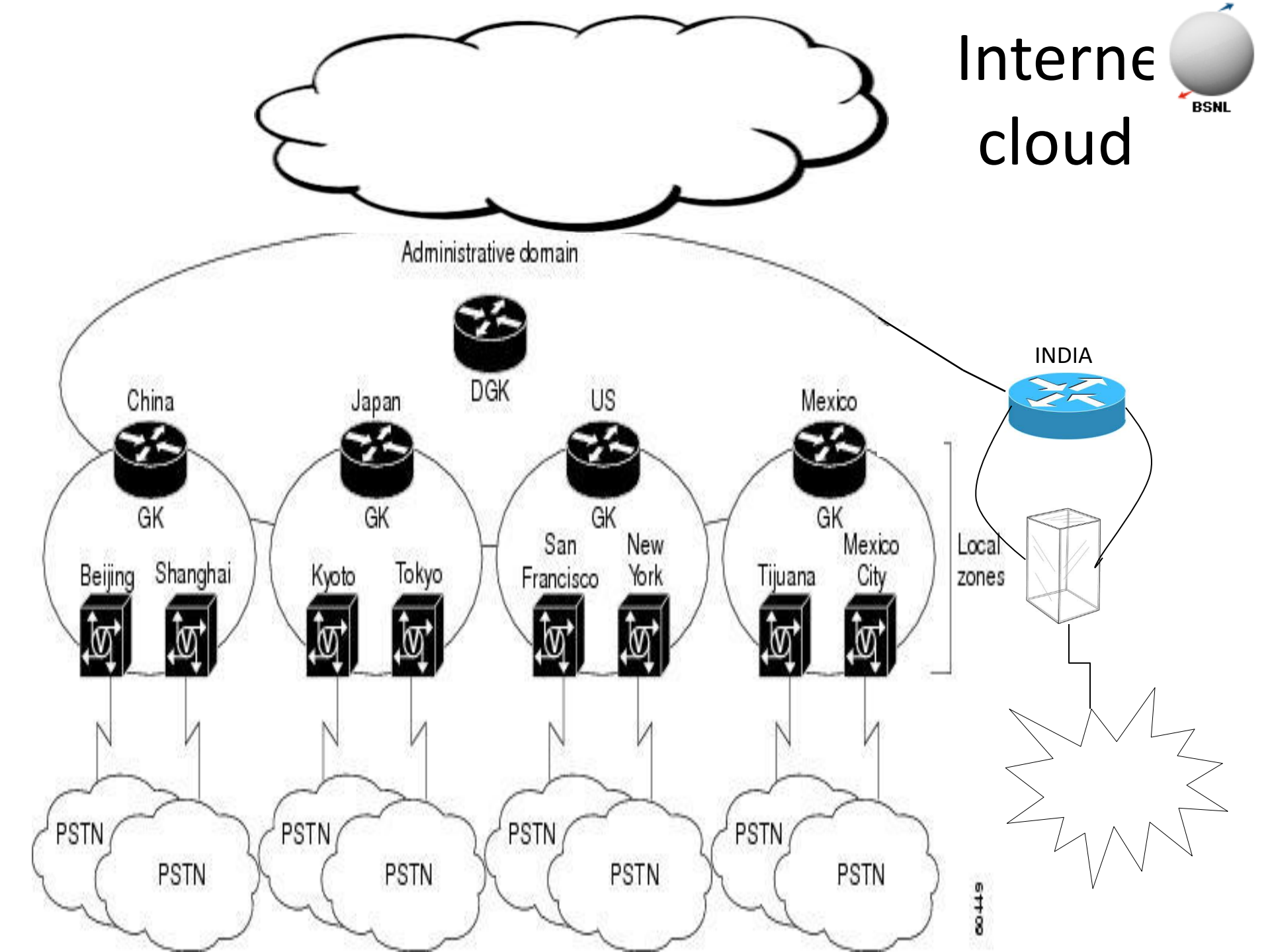
Move mouse on the routers

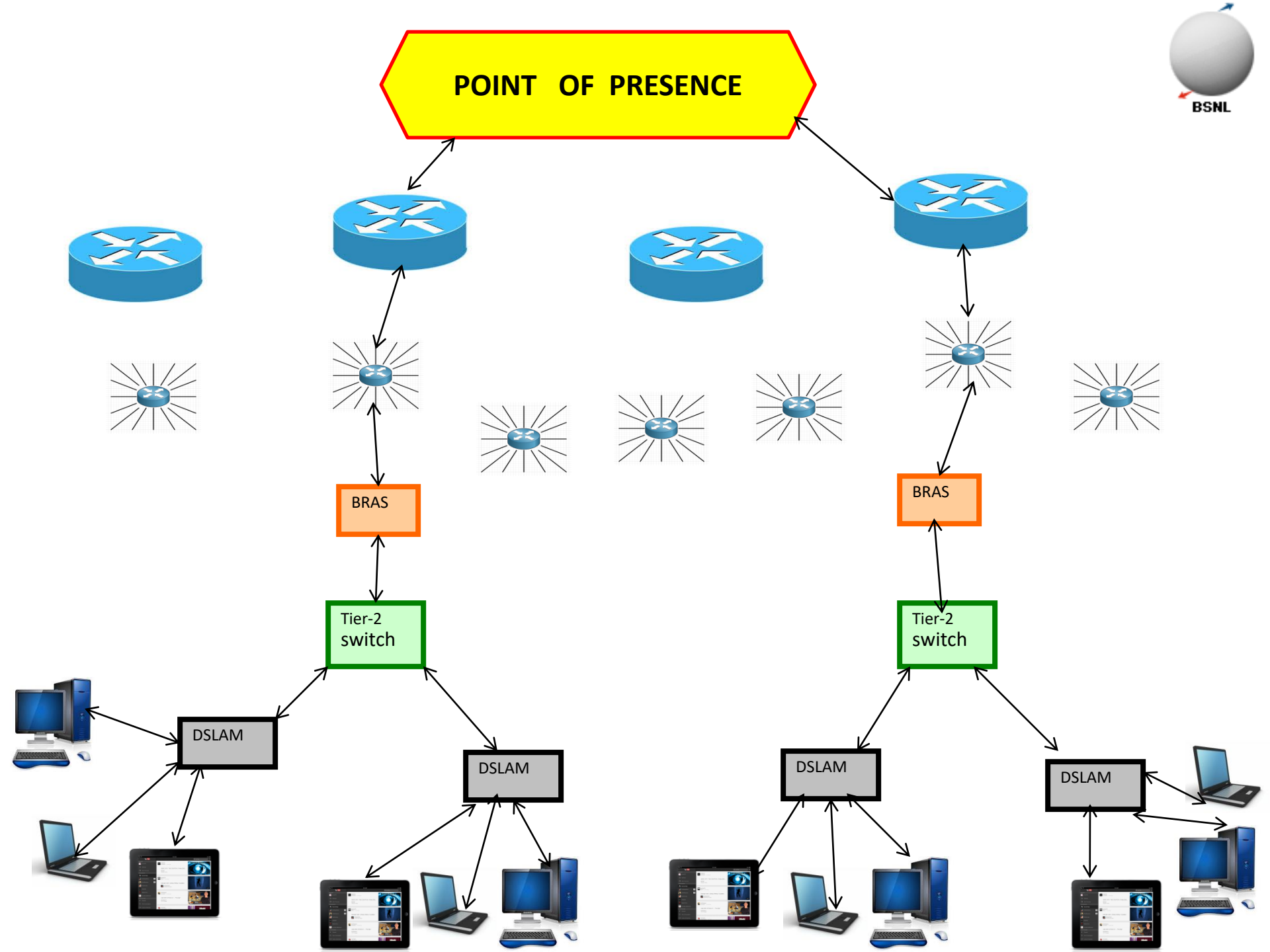


B1+B2=73
A4=10
A3=6
A2=3
A1=5

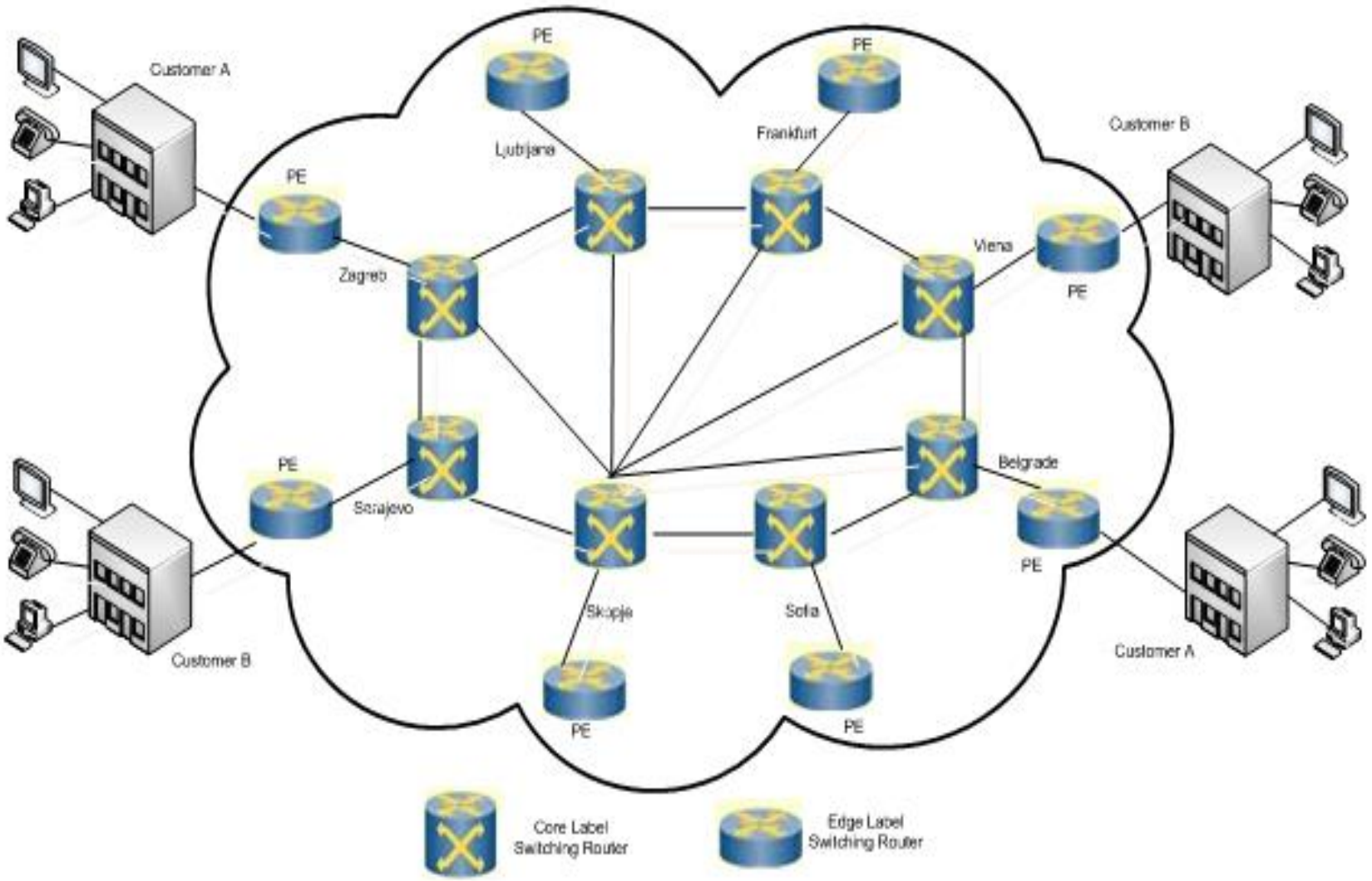
HCL INFOSYSTEMS LTD. | HCL

BHARAT SANCHAR NIGAM LTD

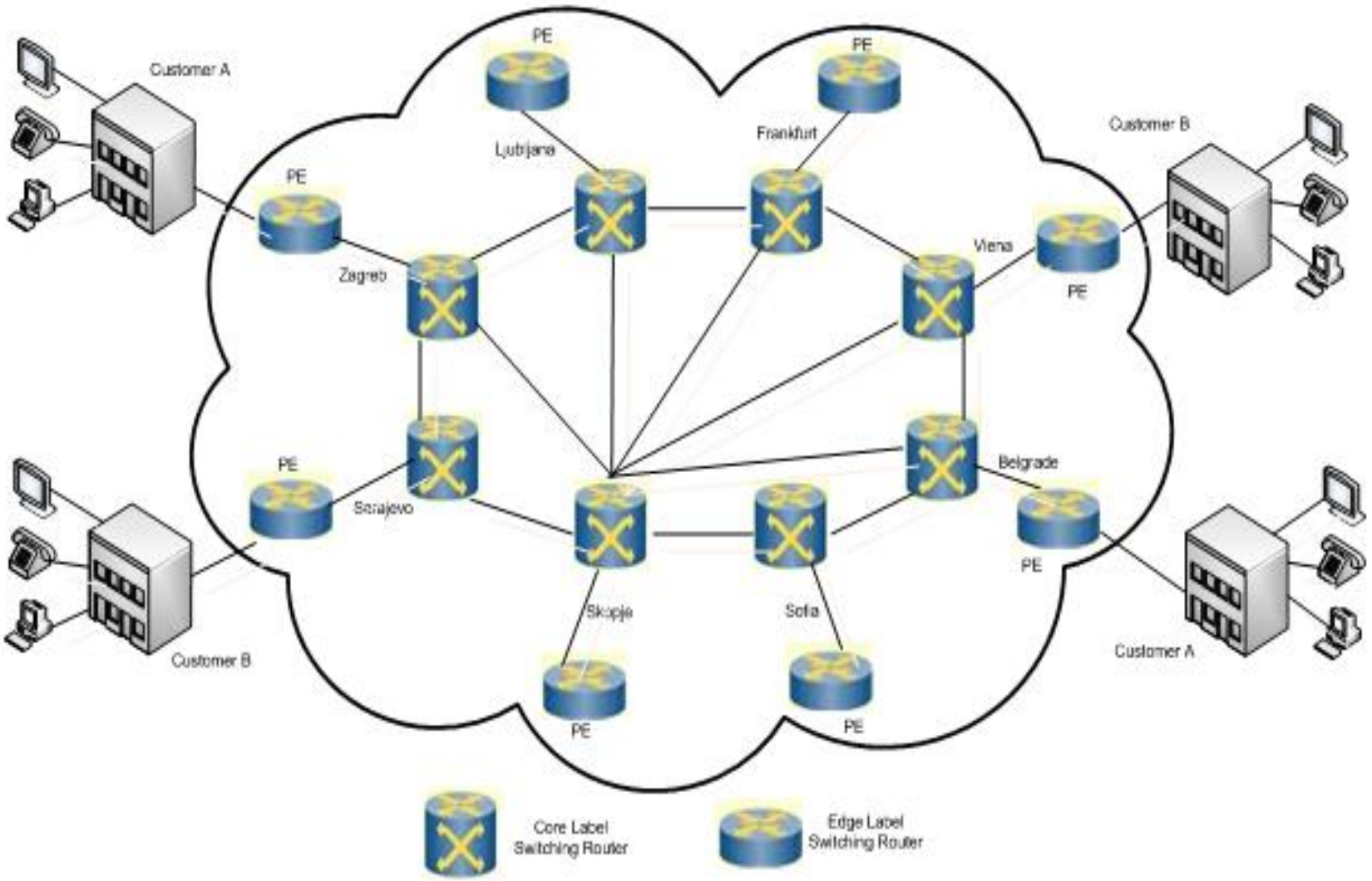

Interne
cloud
BSNL
Administrative domain
DGK
China
Japan
US
Mexico
INDIA
GK
GK
GK
GK
Beijing
Shanghai
Kyoto
Tokyo
San Francisco
New York
Tijuana
Mexico City
Local zones
PSTN
PSTN
PSTN
PSTN
PSTN
PSTN
PSTN
PSTN
60449


POINT OF PRESENCE
BSNL
BRAS
BRAS
Tier-2
switch
Tier-2
switch
DSLAM
DSLAM
DSLAM
DSLAM

MPLS VPN

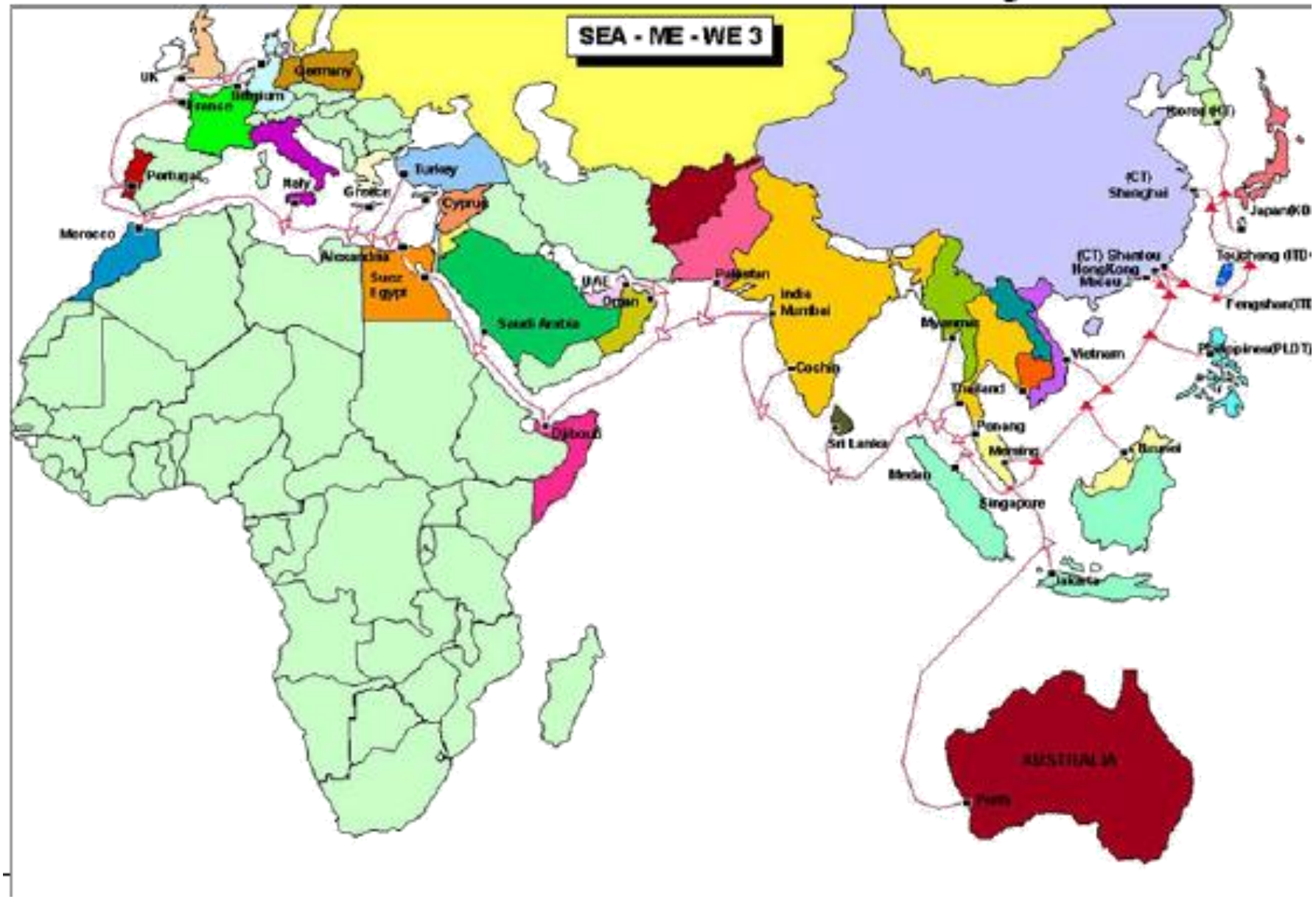

Customer A
PE
PE
Ljubljana
Frankfurt
Customer B
PE
Zagreb
Viena
PE
PE
Sarajevo
Belgrade
PE
Skopje
Sofia
Customer B
Customer A
PE
PE
Core Label Switching Router
Edge Label Switching Router

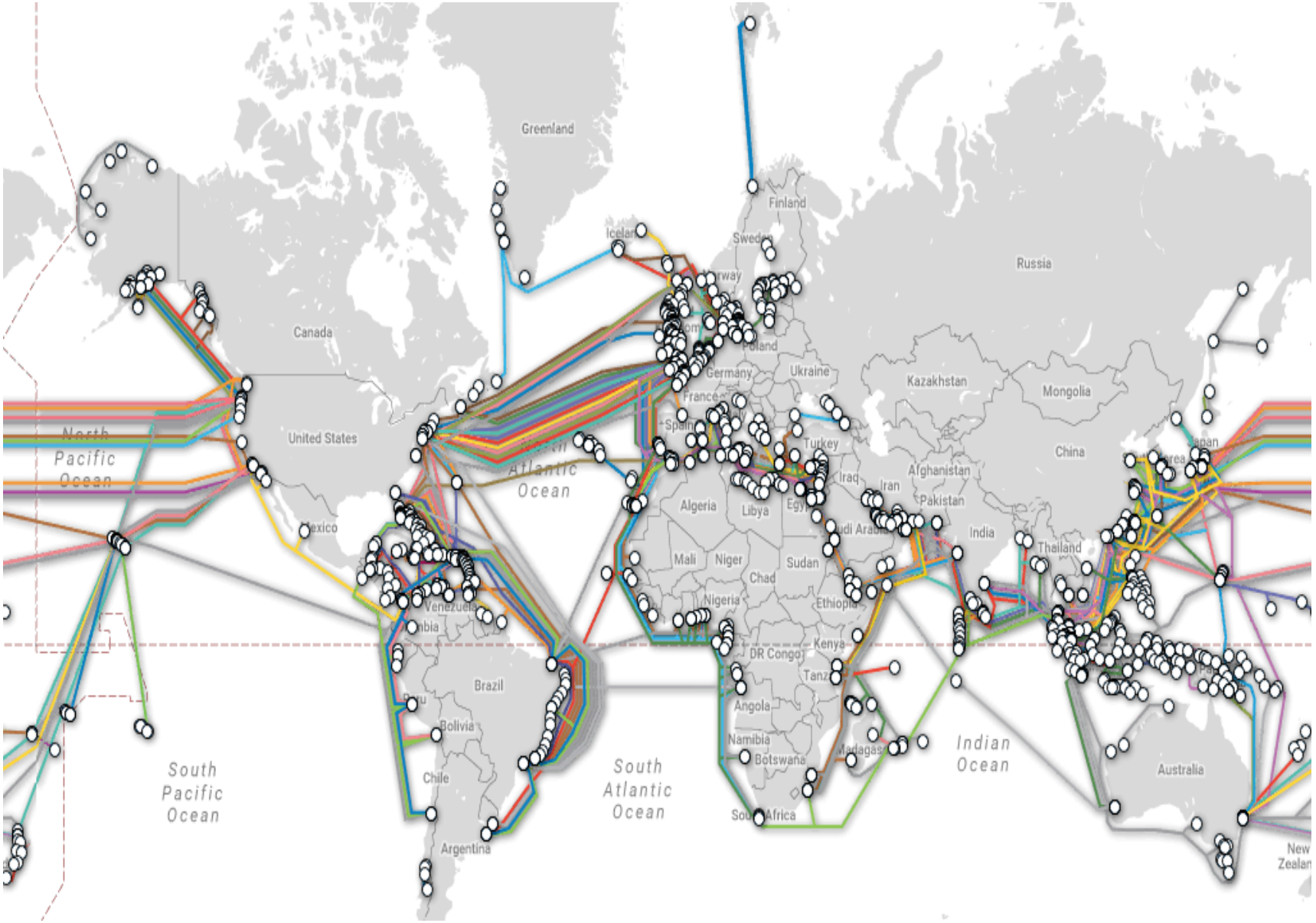
Internet Cloud




Azure Services Platform
BUNGEEconnect
salesforce.com
BSNL
3tera
Microsoft
Gmail
by Google
Sun
microsystems
force.com
platform as a service
YAHOO! DEVELOPER NETWORK
Google
App Engine
ORACLE
On Demand
vmware
ACROBAT.COM
Work. Together. Anywhere.
IBM
Google
EMC²
where information lives
Sun Grid Compute Utility
intel
MOSSO
amazon
web services™
NETSUITE
Joyent Accelerators
OpenID
facebook
DELL

SEA-ME-WE 3 Cable System



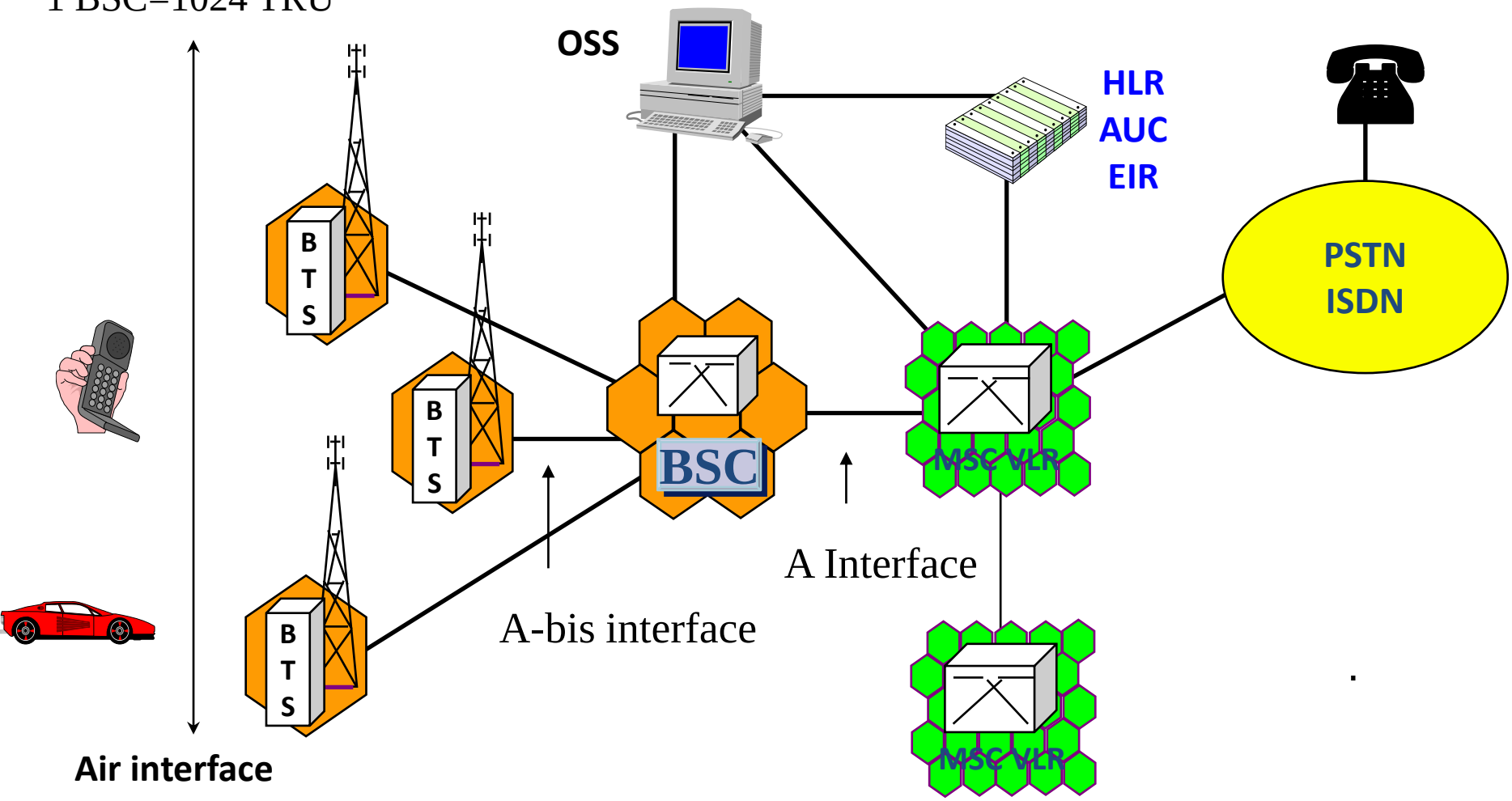

Greenland
Canada
United States
Mexico
Russia
Finland
Sweden
Iceland
Norway
Poland
Germany
France
Spain
Ukraine
Kazakhstan
Mongolia
China
Turkey
Iraq
Iran
Afghanistan
Pakistan
India
Thailand
Algeria
Libya
Egypt
Mali
Niger
Chad
Sudan
Nigeria
Ethiopia
Kenya
DR Congo
Tanzania
Angola
Namibia
Botswana
Madagascar
South Africa
Australia
New Zealand
Brazil
Bolivia
Chile
Argentina
Venezuela
Peru
North Pacific Ocean
South Pacific Ocean
North Atlantic Ocean
South Atlantic Ocean
Indian Ocean

UNDER OCEAN OF CABLES

Network Architecture

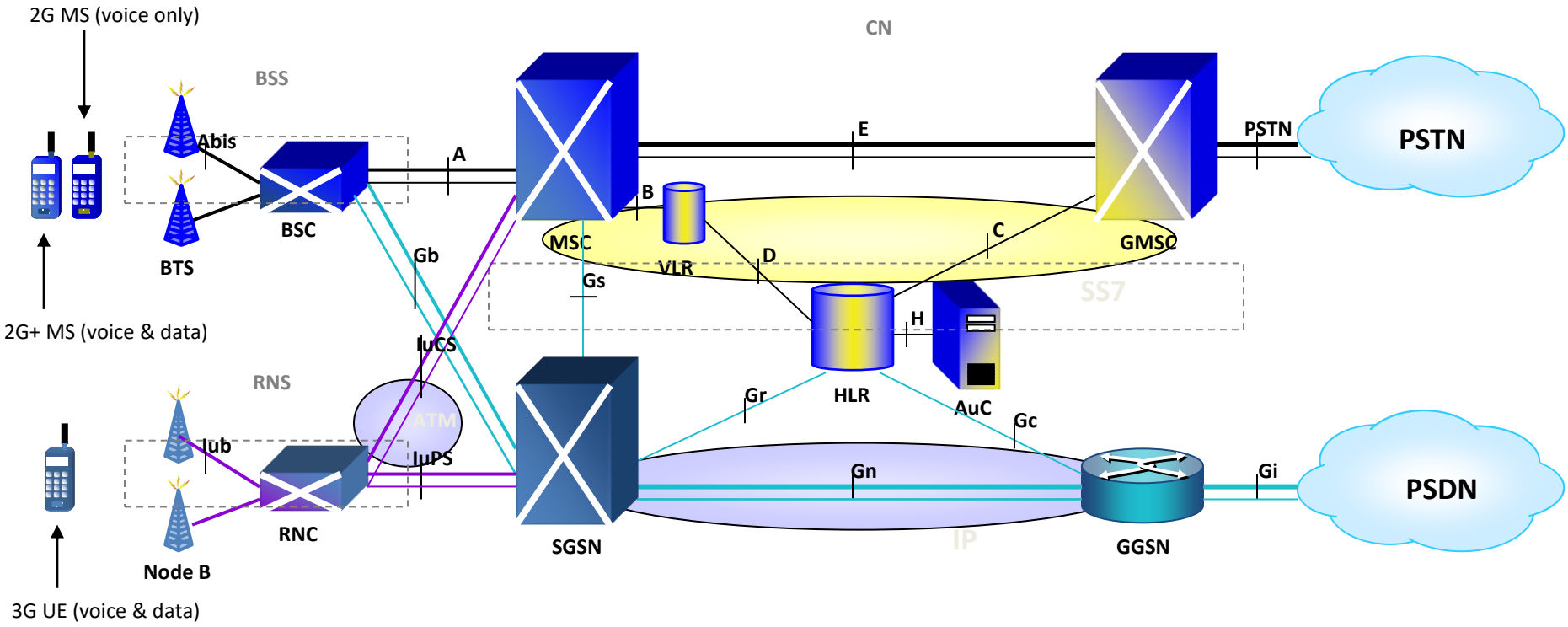
1 MSC=16 BSC

1 BSC=1024 TRU



BSC:BASE STATION CONTROLLER, BTS: BASE TRANSRECEIVER STATION, OSS: OPERATION AND SUPPORT SUBSYSTEM.ss

3G rel99 Architecture (UMTS) - 3G Radios



BSS Base Station System

BTS Base Transceiver Station

BSC Base Station Controller

RNS Radio Network System

RNC Radio Network Controller

CN Core Network

MSC Mobile-service Switching Controller

VLR Visitor Location Register

HLR Home Location Register

AuC Authentication Server

GMSC Gateway MSC

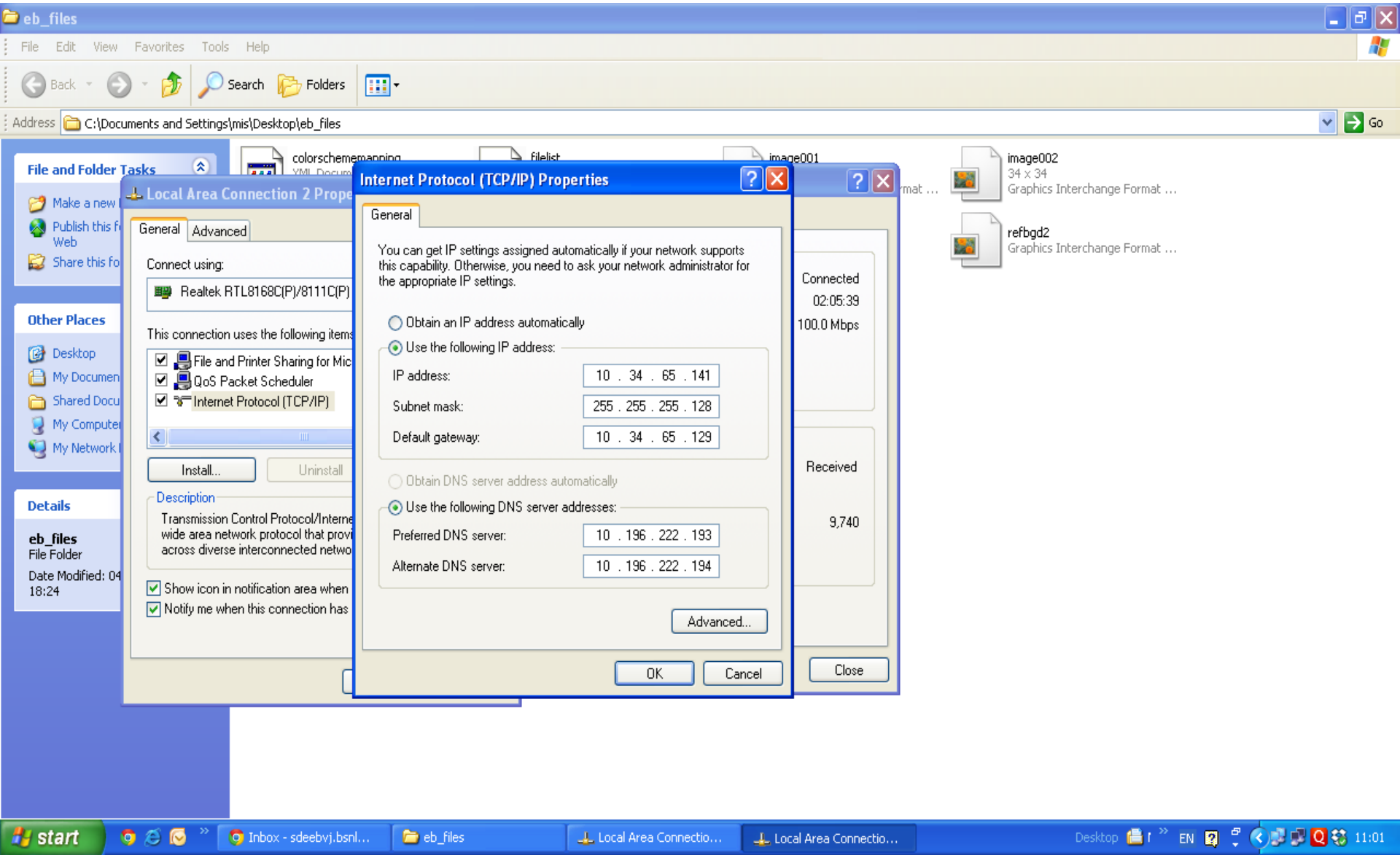
SGSN Serving GPRS Support Node

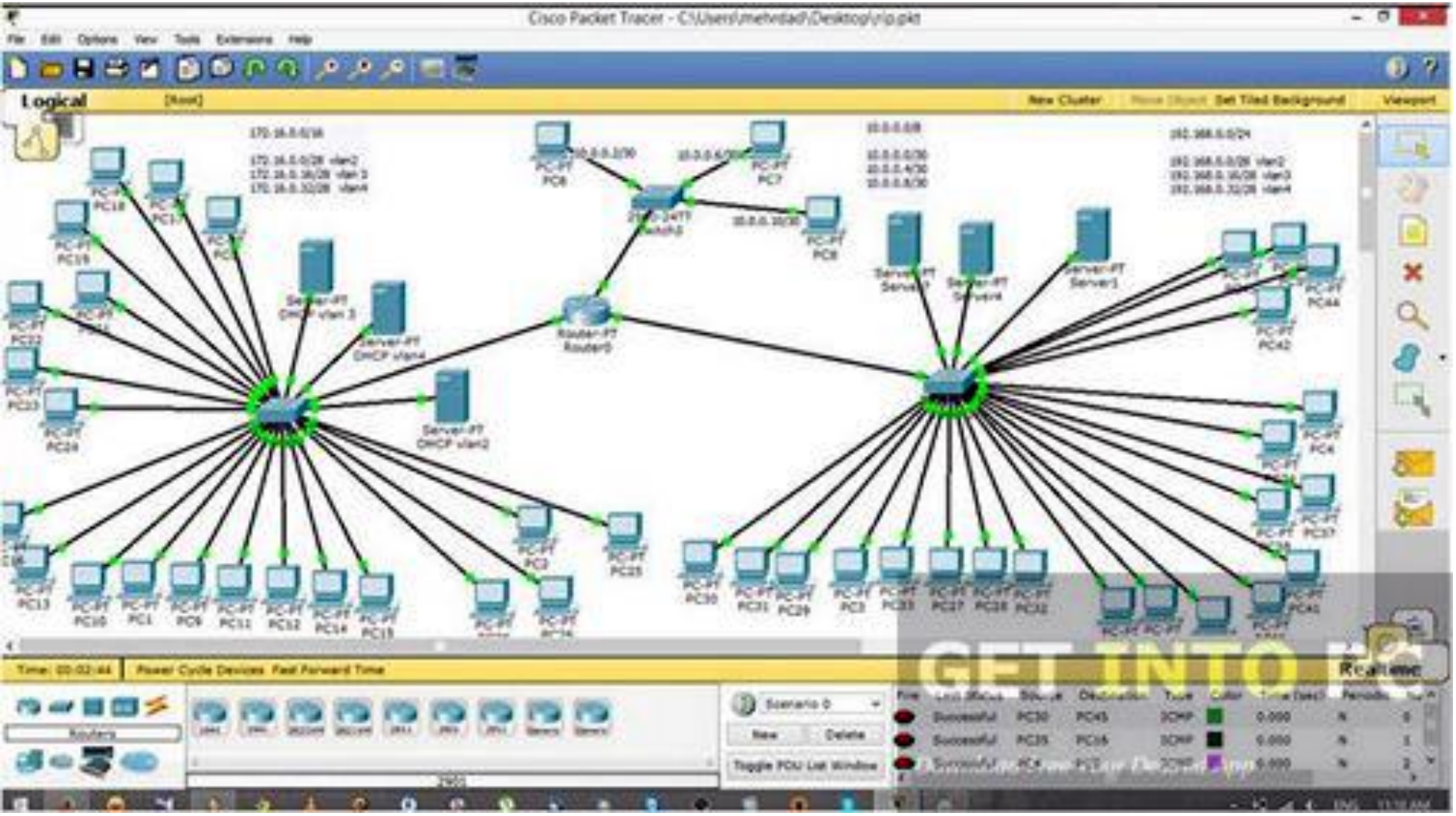
GGSN Gateway GPRS Support Node

UMTS Universal Mobile Telecommunication System

AP BSNL INTRANET IP ASSIGNING

TO CONNECT TO INTERNET, USER NEED UNIQUE IP



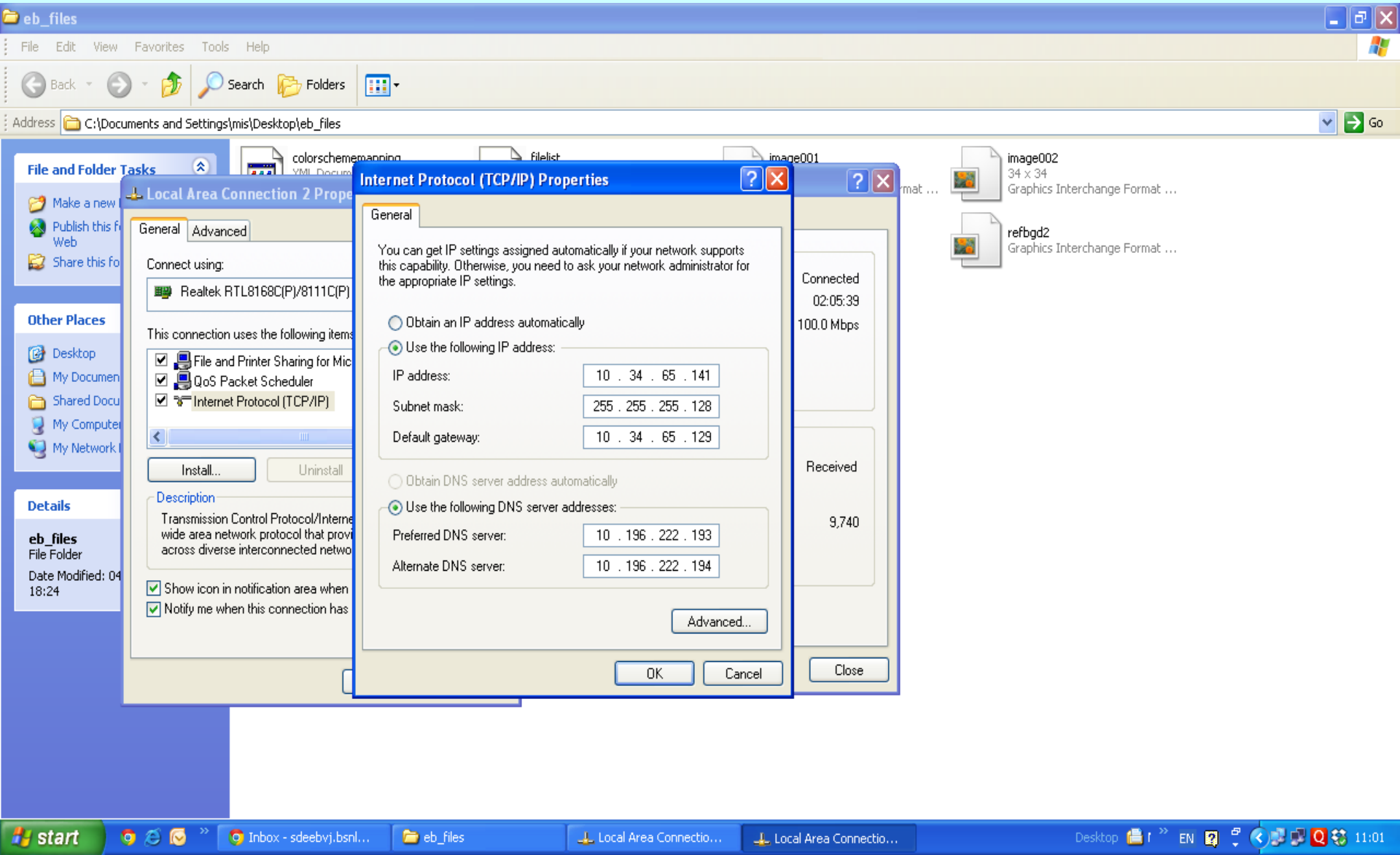

Cisco Packet Tracer - C:\Users\mehrdad\Desktop\rip.pkt
File Edit Options View Tools Extensions Help
Logical
[Root]
New Cluster
Set Tiled Background
Viewport
Router-PT Router0
Server-PT DHCP vlan2
Server-PT DHCP vlan3
Server-PT DHCP vlan4
Server-PT Server1
Time: 00:02:44
Power Cycle Devices
Fast Forward Time
Realtime
Routers
Scenario 0
New
Delete
Toggle PDU List Window


I.P. V4

Definition of IP Address

* “A unique string of decimal numbers separated by full stops that identifies each computer using the Internet Protocol to communicate over a network.”
* It is a Four Fielded Octet
* It indicates Network
* It indicates Host
* Ex : 121.25.122.2

AP BSNL INTRANET IP ASSIGNING



IP REQUIRED FOR

(1) Website Administrators

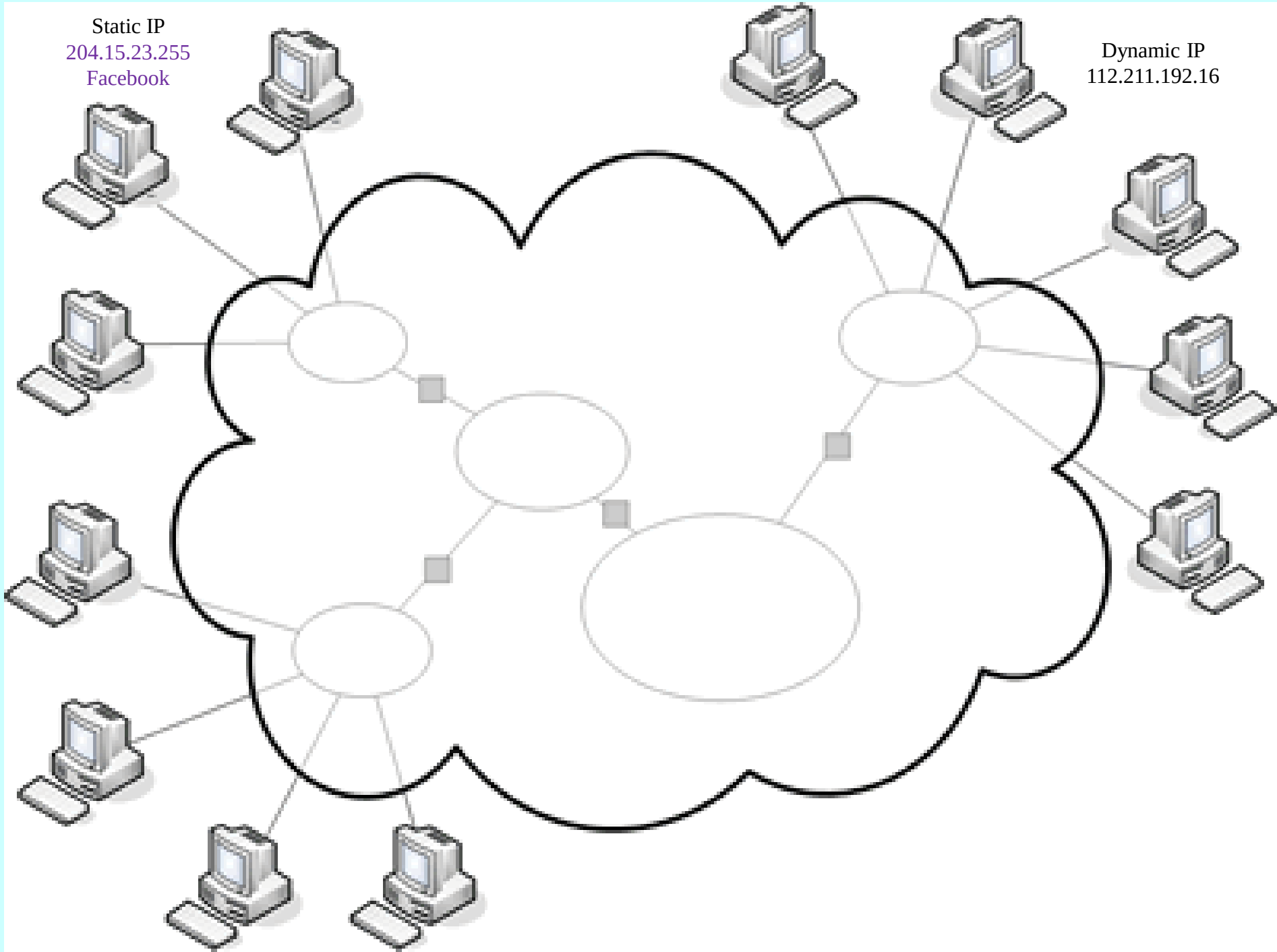
(2) Static IP Users

(3) Internet Service Providers for Internet

(4) Corporate/Entrepreneurs for Intranet

(5) Networking Engineers

(6) Research & Development


Static IP
204.15.23.255
Facebook
Dynamic IP
112.211.192.16

IP ADDRESSES

- Hostname gmail.com have IP Address 74.125.79.83
- The following IP address ranges belong to Facebook:
- 66.220.144.0 - 66.220.159.255
- 69.63.176.0 - 69.63.191.255
- 204.15.20.0 - 204.15.23.255
- All IP addresses belonging to "WhatsApp Inc", that were looked up on this site.
- 50.22.210.151 3/06/2015 1:01:23AM
  208.43.244.170 3/06/2015 12:49:46 AM

Ver mi IP

In order to know what the IP internet connection address is and if you are connected via a proxy cache server

Ver mi IP | Show my ip | Il mio ip | IP-ul meu | O meu IP | La meva IP | Mon IP | Mijn IP | Meine IP

Your public IP is: 117.197.217.225

Your connection does **NOT** operate via a proxy cache server.

Name of your connection: **117.197.217.225**
REMOTE_ADDR: **117.197.217.225** | HTTP_X_FORWARDED_FOR: **117.197.217.225** | HTTP_CLIENT_IP:

USER_AGENT: **Mozilla/5.0 (Windows NT 6.1) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/47.0.2526.80 Safari/537.36**
REFERER: **https://www.google.co.in/**

To find out if your IP is **dynamic** or **static** follow these steps:

Close all the windows of your browser (Firefox, IExplorer, etc.)
Disconnect your PC from internet (in the case of some connections this is not necessary)
Turn off and restart the modem or router (according to the connection)
If the modem or router is internal (or usb) restart your PC
Re-connect to internet and open a window in your browser
Open this page again (http://www.vermiip.es/show-my-ip)

Date/Time of the server: **17/12/2015 01:05** CET
Date/Time of your PC: **17/12/2015 05:35**

W3C XHTML 1.1 | W3C CSS 2.0 | VALID ROBOTS.TXT | GET FIREFOX | PR 0/10

If I have many more Systems in a larger area

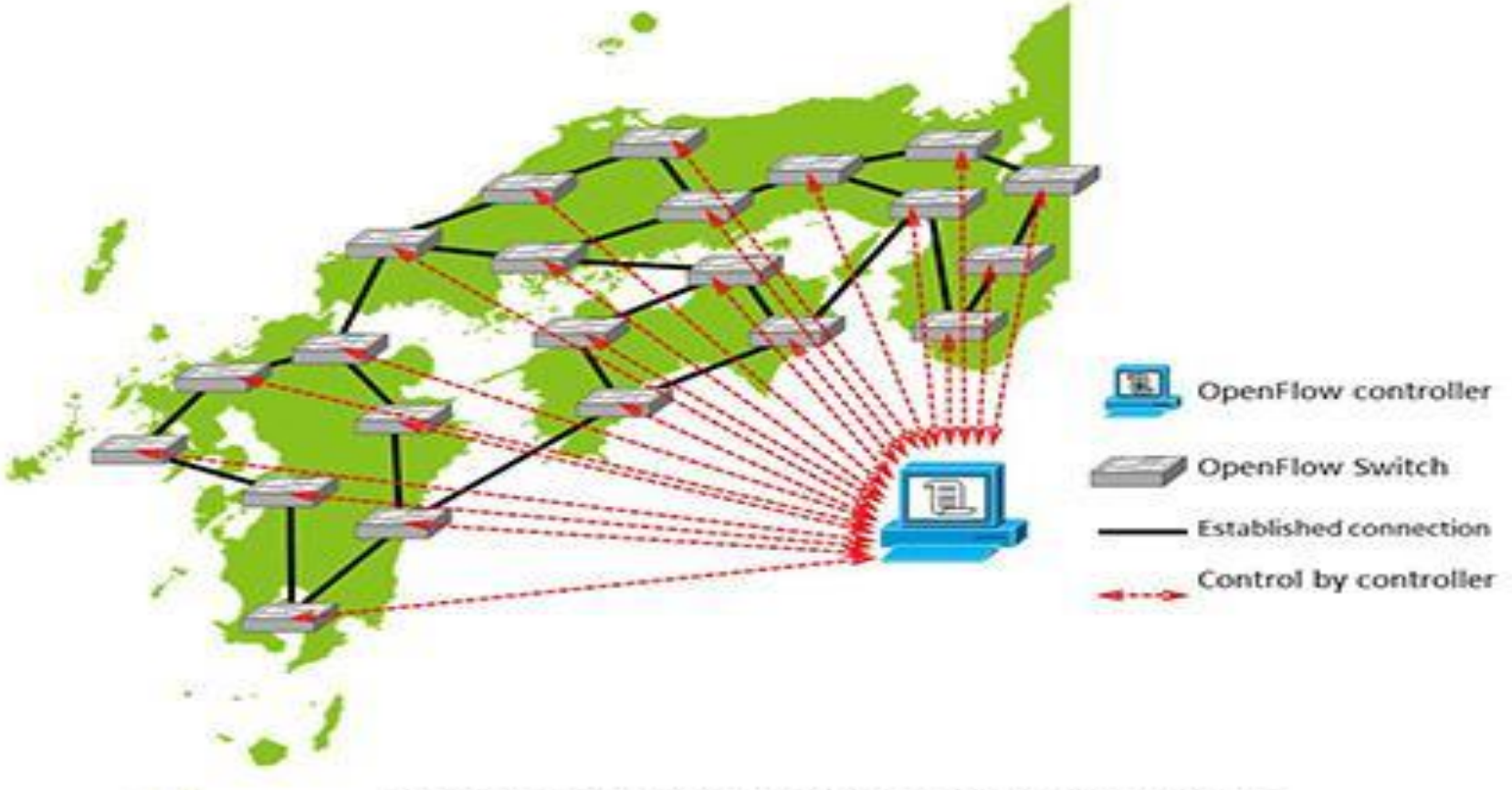
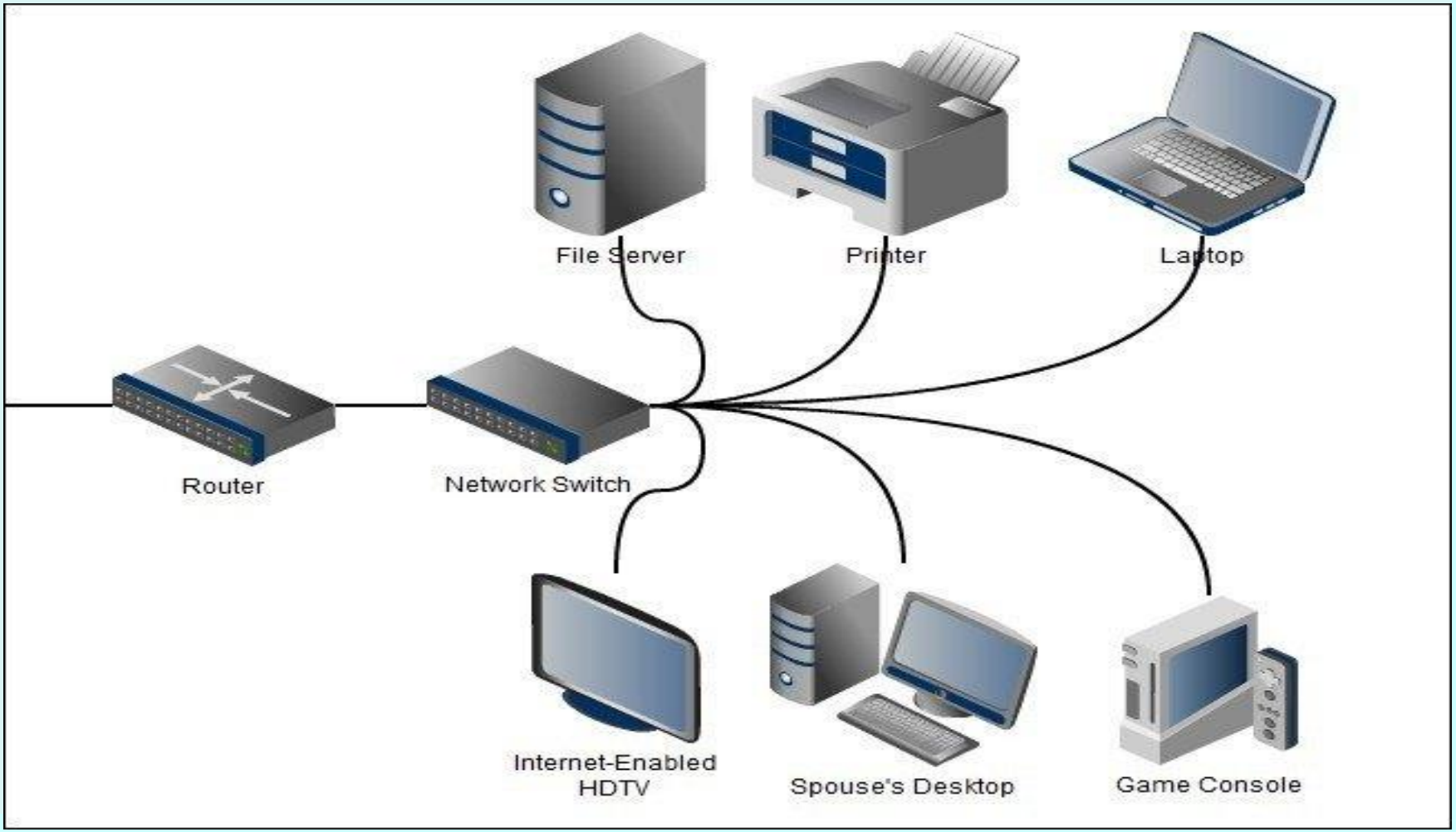


Fig: Key map of a network which affects a demonstration experiment
（This key map is different from actual wiring.）

Limited Hosts



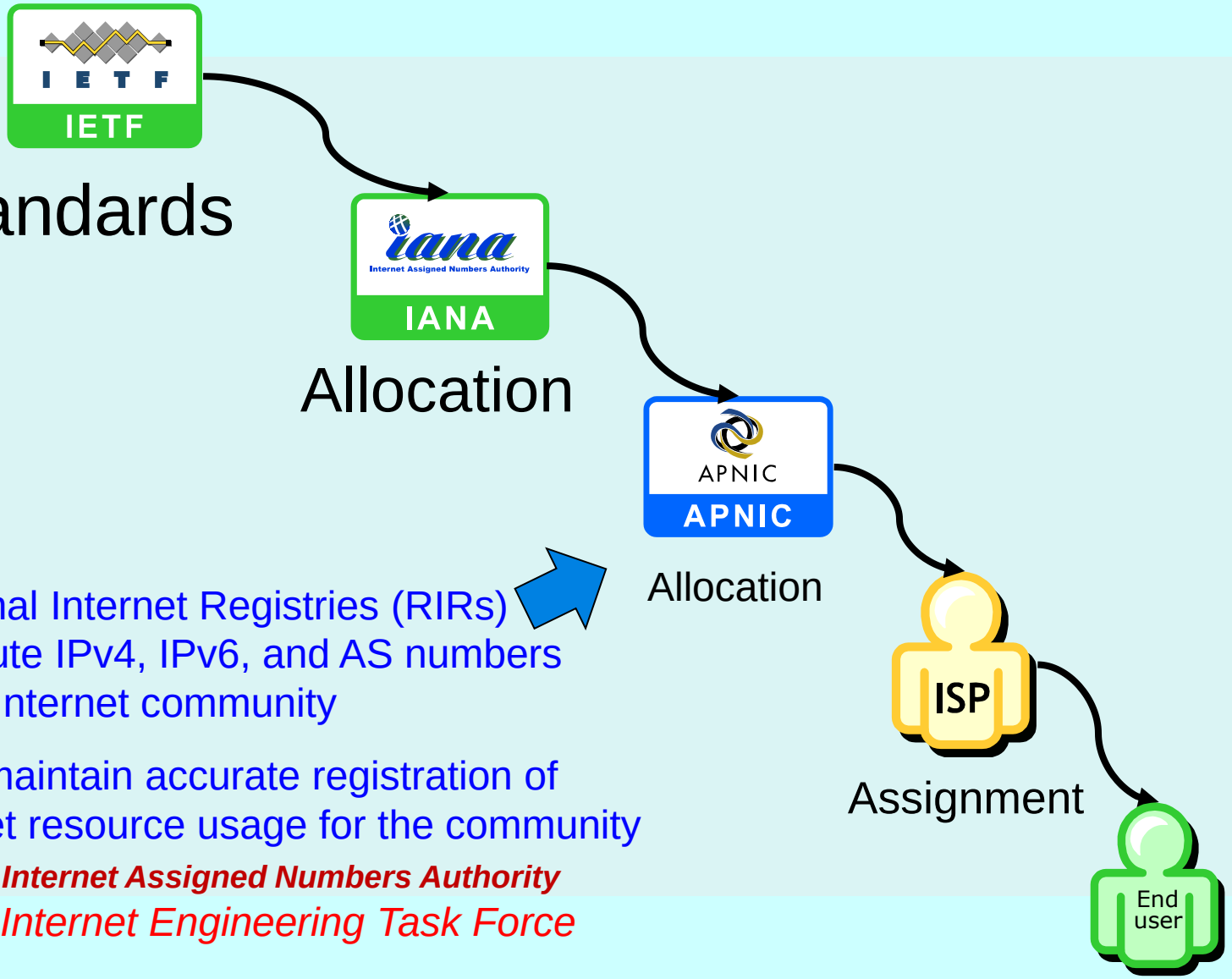
What is an IP address?

- **Each host on a TCP/IP network is uniquely identified at the IP layer with an address.**
- **The IP address is also known as Protocol address**
- **The IPv4 address is 32 bits long**
- **2^32=4294967296=429Cr**

India's IPv4 Address Status

Country	Country Code	Addresses(million)	Per Capita
United States	**US**	**1474.319**	**5.297**
China	**CN**	**194.425**	**0.152**
Japan	JP	153.327	1.210
European Union	EU	114.103	-
Germany	DE	85.300	1.038
Canada	CA	76.197	2.446
South Korea	KR	72.239	1.542
United Kingdom	GB	70.795	1.187
France	FR	68.385	1.155
Australia	AU	37.378	1.979
Italy	IT	32.344	0.561
Brazil	BR	29.755	0.175
Russian Federation	RU	24.919	0.170
Taiwan	TW	24.681	1.109
Netherlands	NL	21.249	1.339
Sweden	SE	18.998	2.144
India	**IN**	**18.312**	**0.018**

Where do IP addresses come from?



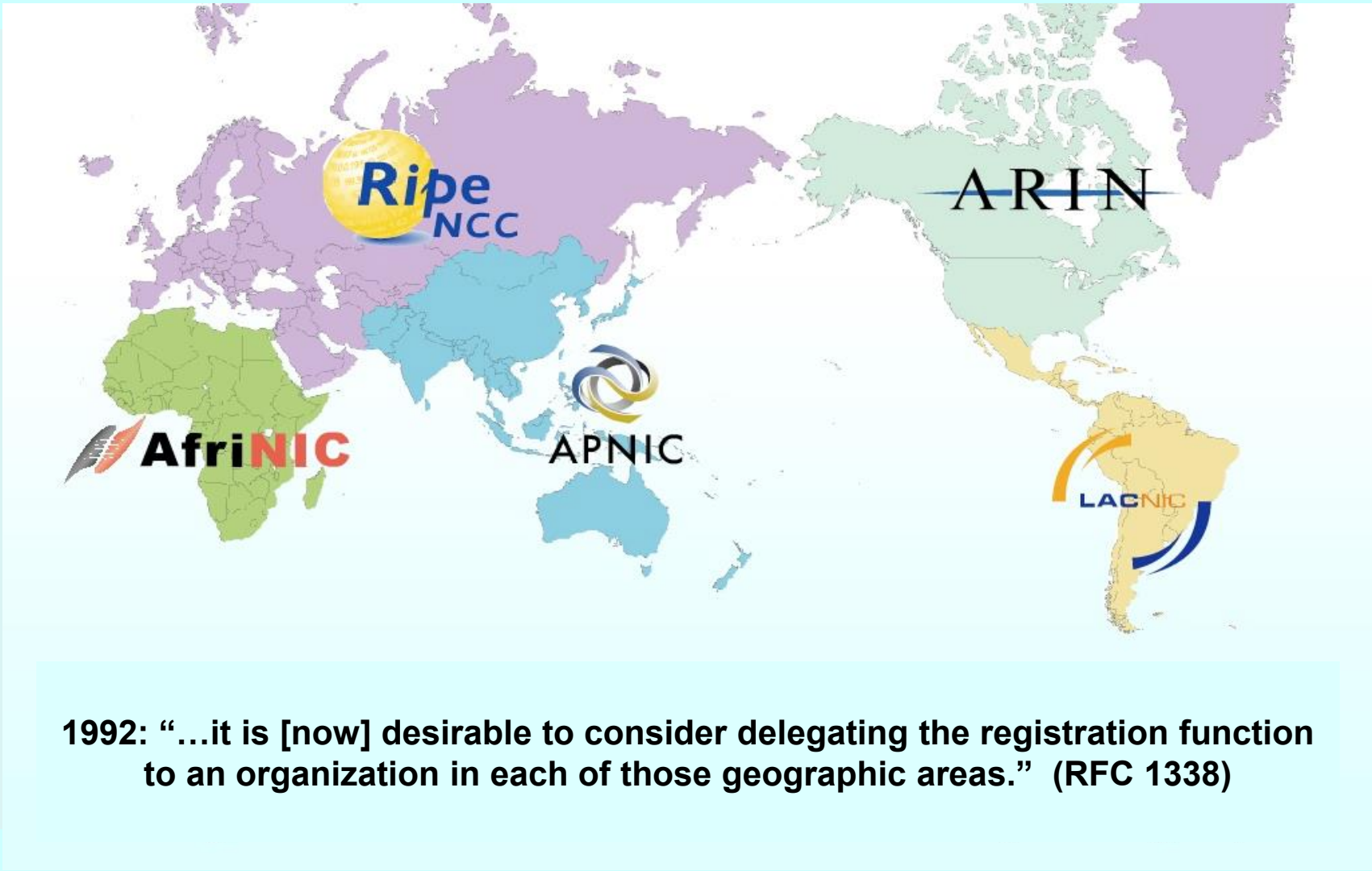
Regional Internet Registries (RIRs) distribute IPv4, IPv6, and AS numbers to the Internet community

RIRs maintain accurate registration of Internet resource usage for the community

IANA : ***Internet Assigned Numbers Authority***

IETF : Internet Engineering Task Force

Regional Internet Registries



1992: "…it is [now] desirable to consider delegating the registration function to an organization in each of those geographic areas." (RFC 1338)

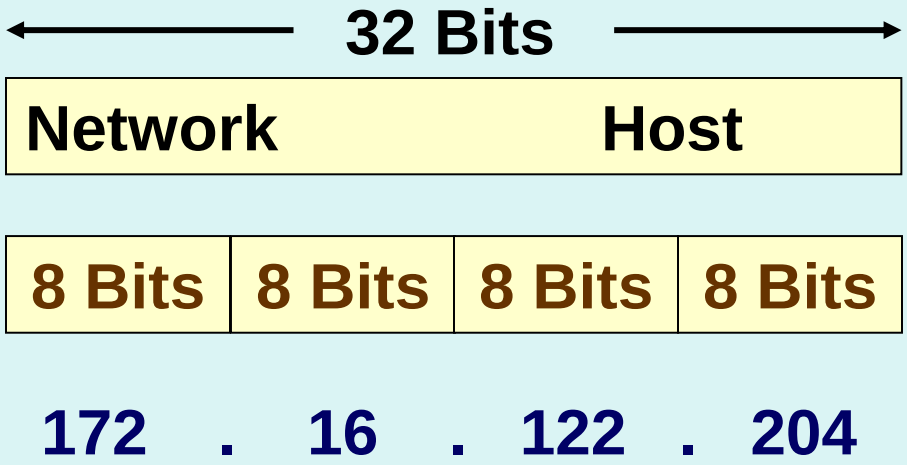
Who Are the IP Address Provisioning Organizations?

ICANN IANA	• Allocate to RIRs =Regional Internet Registries •**Internet Corporation for Assigned Names and Numbers (ICANN)** •***Internet Assigned Numbers Authority [IANA]***
RIR AFRINIC, APNIC, ARIN, LACNIC, RIPE NCC	• Allocate to Service Providers • Assign to Enterprises •*The Asia Pacific Network Information Centre*
NIR/LIR/ISP	• Reallocate to Service Providers • Reassign to Enterprises

IPv4 Address Scheme

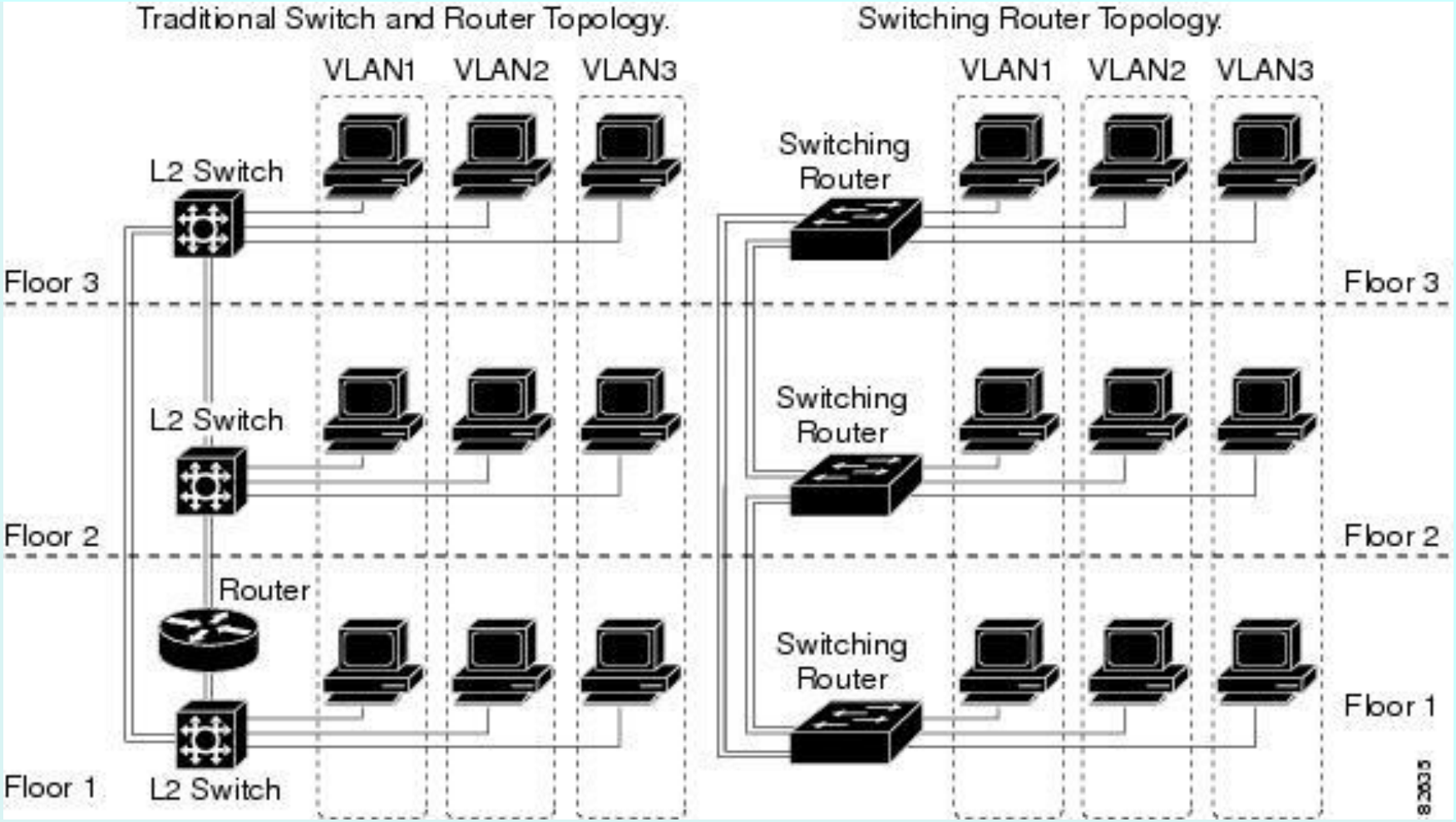
- **How we see an IP address? 140.179.220.220**
- **What the Internet machines see an IP address? 11001010000011100100000000000001**
- **For human understanding the 32 bits of IP address are separated into 4 bytes of 8 binary digits**
- ***Each binary byte is converted into decimal and is separated by a dot hence also known as Dotted Decimal Notation***

IPv4 Address Scheme



- In decimal the address range is 0.0.0.0 to 255.255.255.255
- The IP address is of the form <networkID,hostID>

If there are many systems in a Company?



IPv4 Address Scheme

- **There are five classes of addresses A, B, C, D & E.**
- **A, B & C classes are used to represent host and network address.**
- **Class D is a special type of address used for multicasting.**
- **Class E is reserved for experimental use.**

IPv4 Address classes

Class-A:	N	H	H	H
Class-B:	N	N	H	H
Class-C:	N	N	N	H

Class-D: **For Multicast**

Class-E: **For Research**

- **N=Network number assigned by IANA**
- **H=Host number assigned by network administrator.**

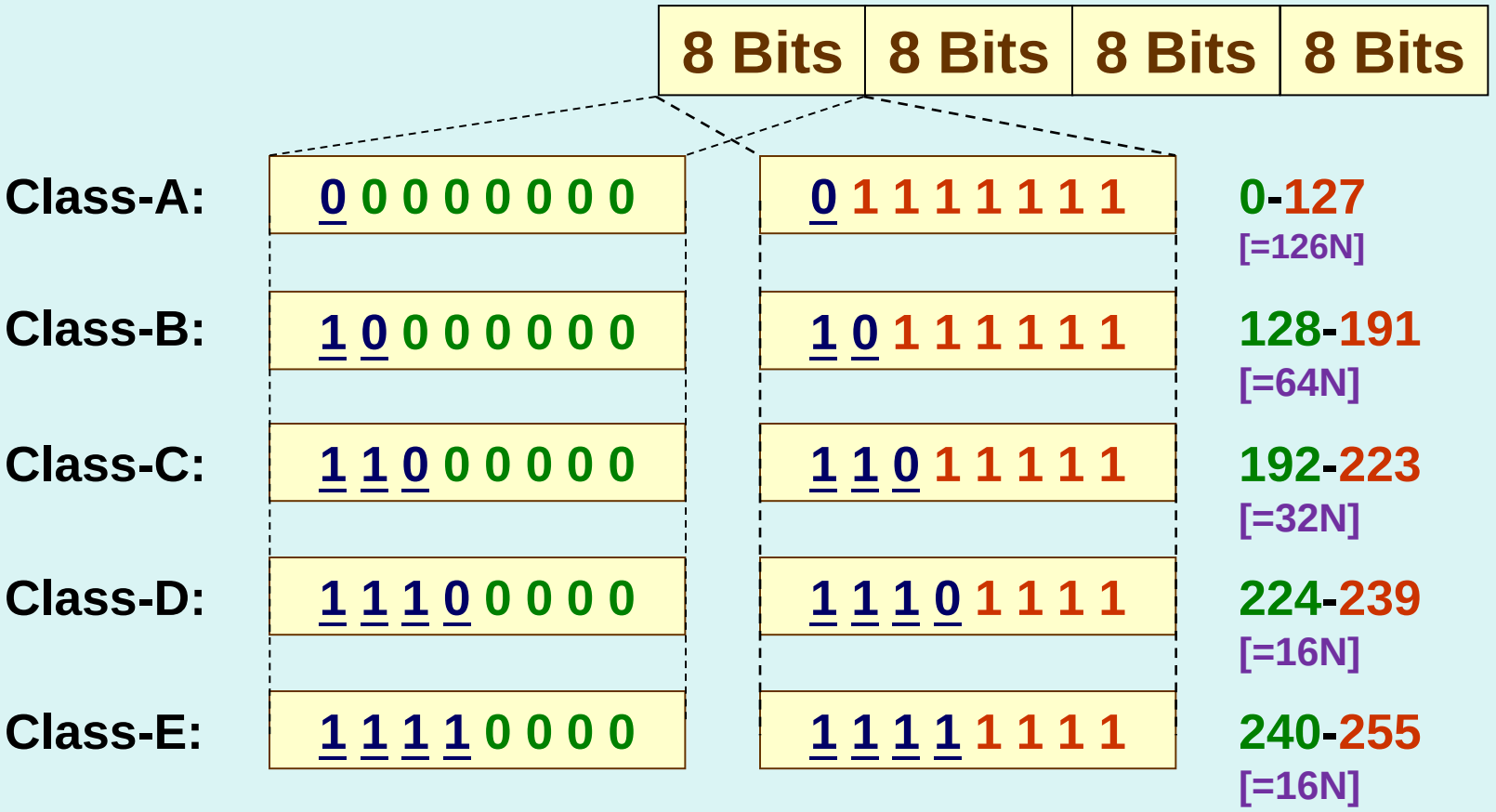
IPv4 Address Scheme

	8 Bits	8 Bits	8 Bits	8 Bits	
Class:A	**:**	**0-127**	**. 0-255**	**. 0-255 . 0-255**	**0-127 [=126N]**
Class:B	**:**	**128-191**	**. 0-255**	**. 0-255 . 0-255**	**128-191 [=64N]**
Class:C	**:**	**192-223**	**. 0-255**	**. 0-255 . 0-255**	**192-223 [=32N]**
Class:D	**:**	**244-239**	**. 0-255**	**. 0-255 . 0-255**	**224-239 [=16N]**
Class:E	**:**	**240-255**	**. 0-255**	**. 0-255 . 0-255**	**240-255 [=16N]**

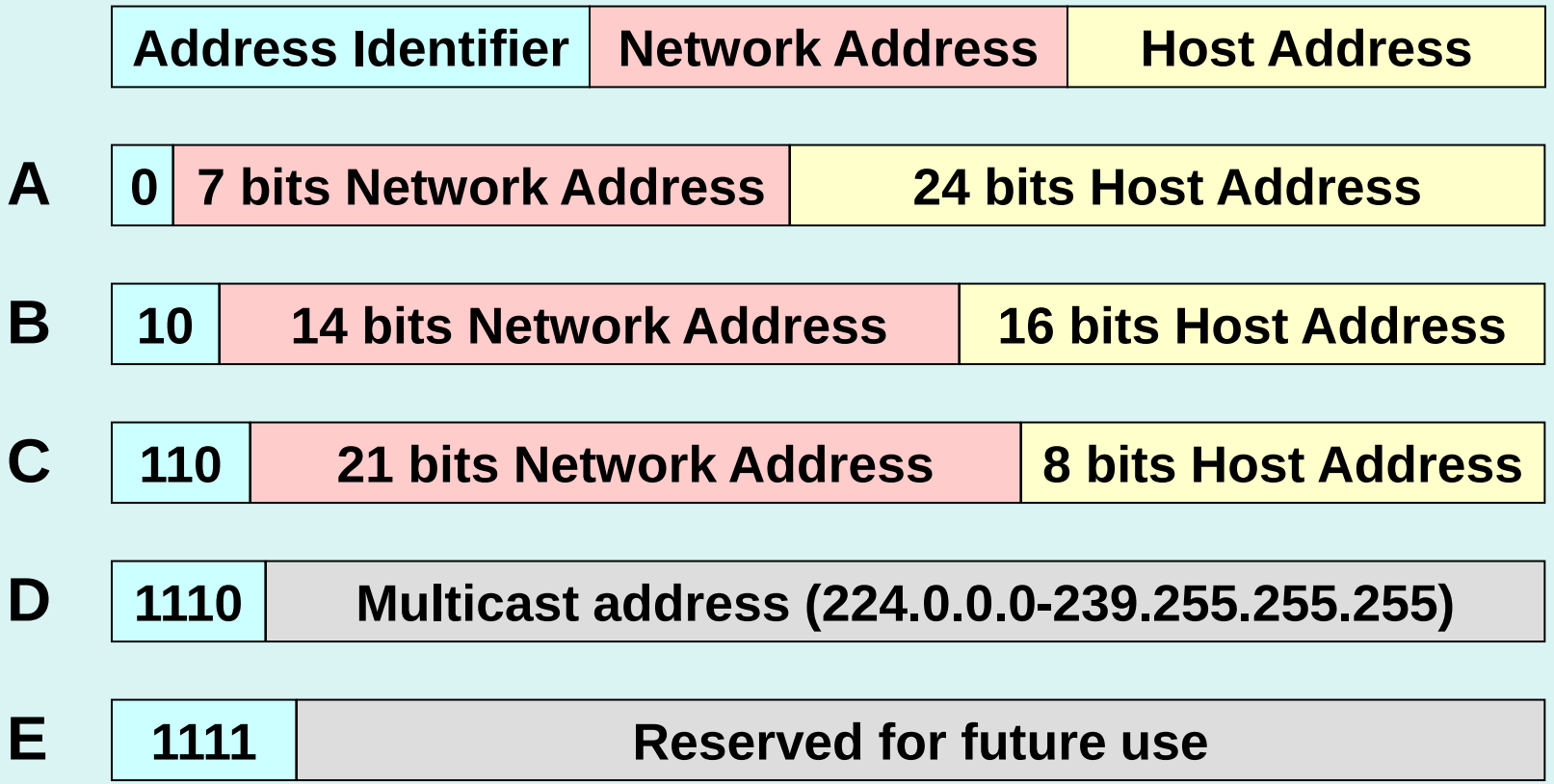
The IP address is of the form

<networkID,hostID>

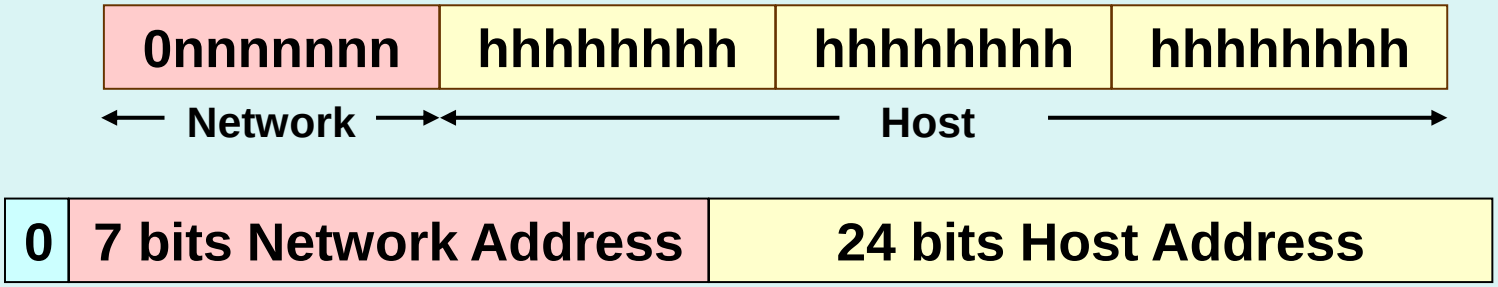
IP Address Bit Patterns



Identifying a class of address by a machine

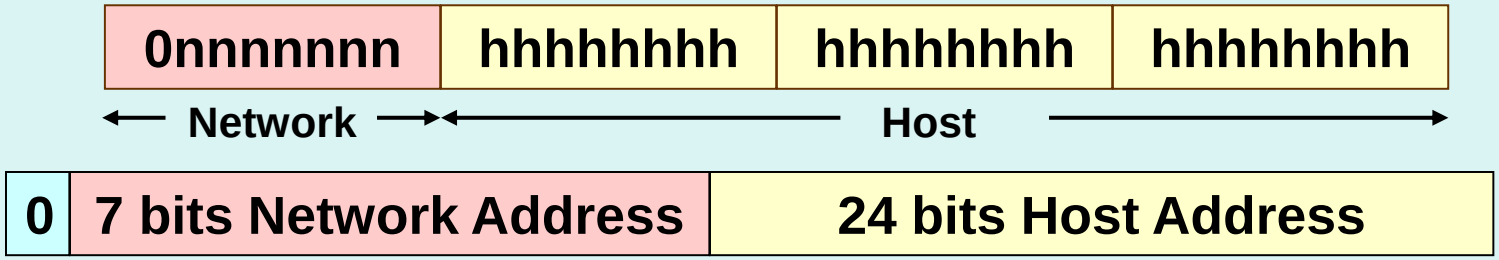


Class-A address (Networks)



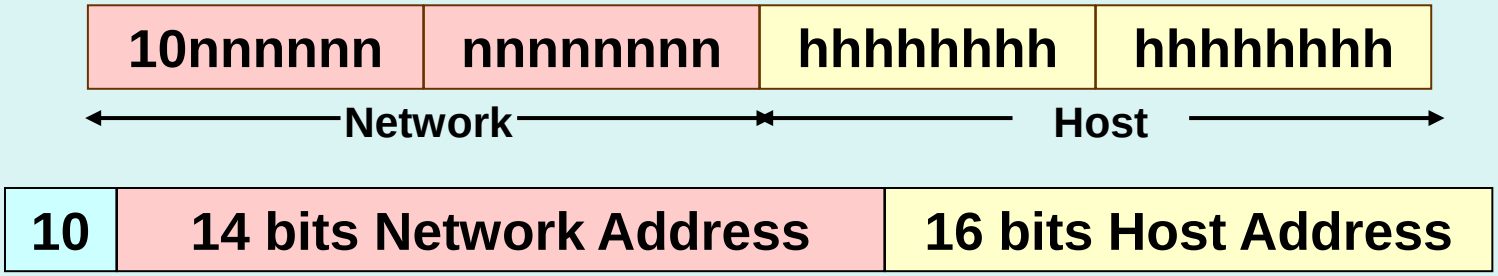
- Number of Networks = 2^7 i.e.128 (0-127)
- Network ID ‘0’ is not used.
- Network ID ‘127’ is reserved for loop back and is used for internal testing.
- Number of Networks = 126
- Network IDs = 1-126

Class-A address (Hosts)



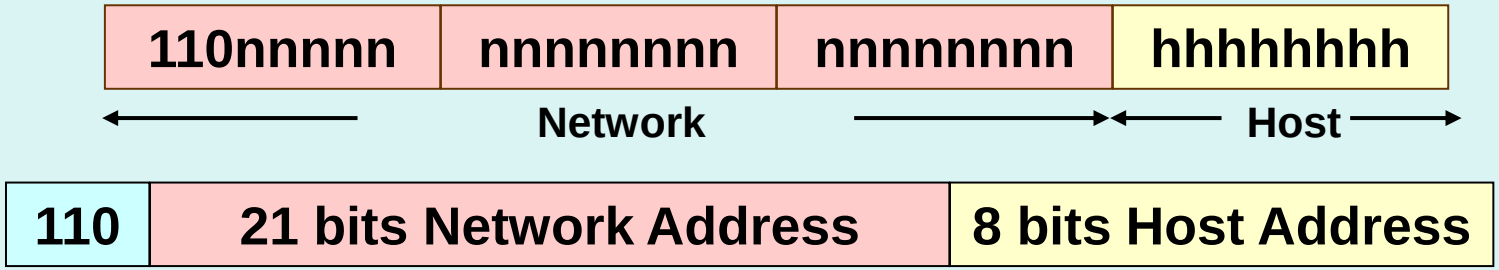
- Number of Networks = 2^7 i.e.128
- Number of Hosts=2^{24}=16777216
- No Host ID can have all zeros
  i.e. 0.0.0 and specifies network address.
- No Host ID can have all ones
  i.e. 255.255.255 and specifies the broadcast address.
- Number of Hosts per network= 2^{24} -2=16777214

Class-B address



- Number of Networks = 2^{14} i.e.16384
- Number of Hosts = 2^{16} i.e. 65,536 (0-65,535)
- No Host ID can have all zeros
  i.e. 0.0 and specifies network address.
- No Host ID can have all ones
  i.e. 255.255 and specifies the broadcast address.
- Number of Hosts per network= 2^{16} -2=65534

Class-C address



- Number of Networks = 2^{21} i.e. 2097152
- Number of Hosts = 2^{8} i.e. 256 (0-255)
- No Host ID can have all zeros
  i.e. 00000000 and specifies network address.
- No Host ID can have all ones
  i.e. 11111111 and specifies the broadcast address.
- Number of Hosts = 2^{8}-2 = 254

Class-D & E addresses

1110	Multicast address (224.0.0.0-239.255.255.255)

- **Class D are special addresses are known as multicast addresses**
- **This address is assigned to a group of networks and not to represent a unique address**
- **This address is used to send IP datagrams to a group but not to all the hosts on the network**
- **This address is also used to address router update messages**

1111	Reserved (240.0.0.0-255.255.255.255)

Networks Vs Hosts

- In Classless environment we can have 2^{32}=4294967296 Hosts

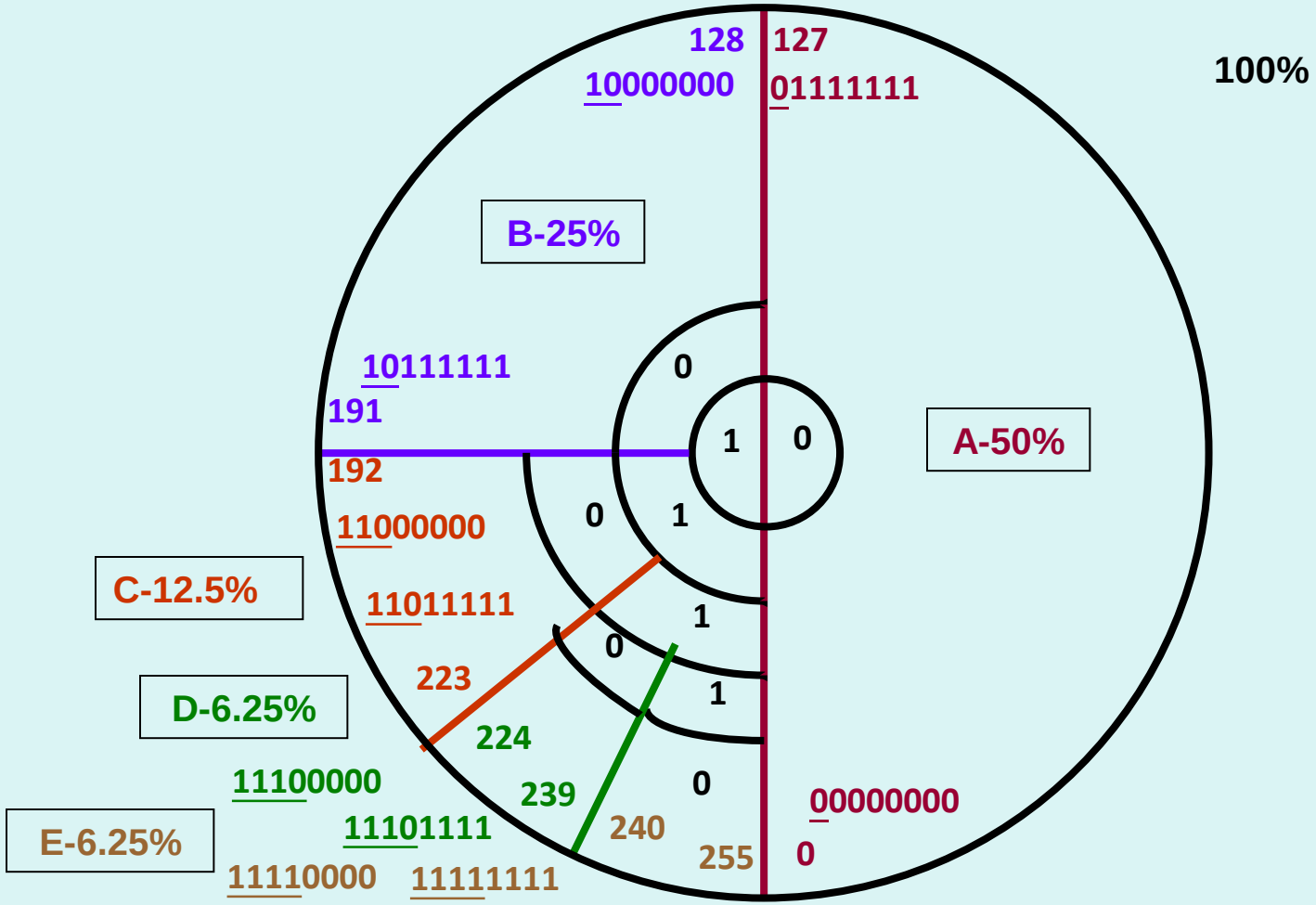
Class	Networks	Hosts/Network
A	126 [128-2]	16777214 [256x256x256(-2)]
B	16382 [=64x256(-2)]	65534 [256x256(-2)]
C	2097150 [32x256x256 (-2]	254 [256-2]

So, In Cl-A : [Appr 211 cr]

In Cl-B : [Appr 107 cr]

In Cl-C : [Appr 53 cr] Total = 371 Cr

Address space utilisation



- Classes of IP addresses are identified by the decimal number of the 1st octet

Class A address begin with a **0** bit

Range of class A addresses = 0.0.0.0 to 127.255.255.255

Class B address begin with a **1** bit and a **0** bit

Range of class B addresses = 128.0.0.0 to 191.255.255.255

Class C addresses begin with **two 1** bits & a **0** bit

Range of class C addresses = 192.0.0.0 to 223.255.255.255.

High Order Bits

Class	High Order Bits	Start	End
Class A	0	0.0.0.0	127.255.255.255
Class B	10	128.0.0.0	191.255.255.255
Class C	110	192.0.0.0	223.255.255.255
Multicast	1110	224.0.0.0	239.255.255.255
Experimental	1111	240.0.0.0	255.255.255.255

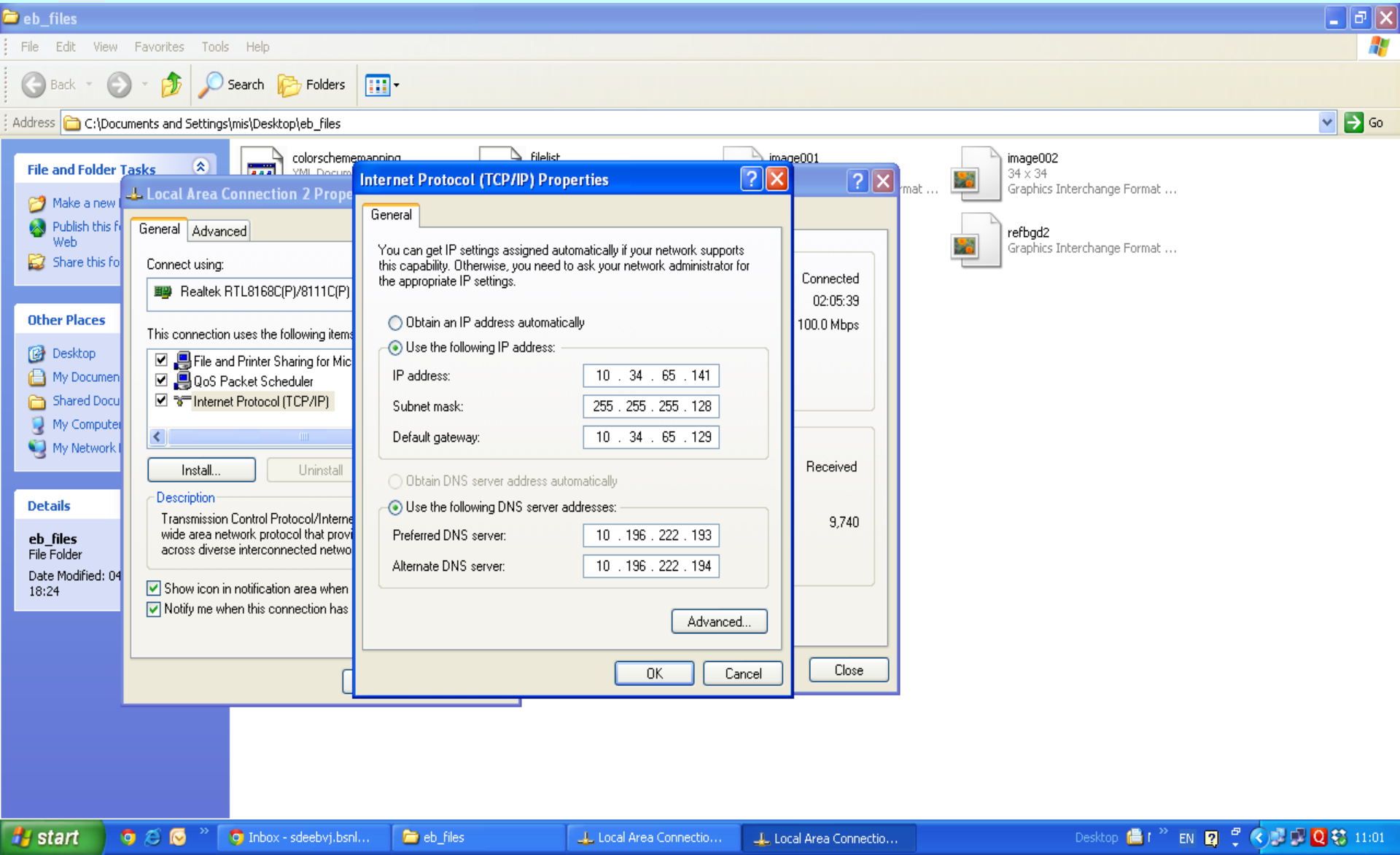
Reserved Addresses

- **Network address**: It is used to identify the network itself.
- **Broadcast address** :Used to broadcast packets to all devices on a network.

Private IP addresses

- Class A - 10.0.0.0 to 10.255.255.255
- Class B - 172.16.0.0 to 172.31.255.255
- Class C - 192.168.0.0 to 192.168.255.255

AP BSNL INTRANET IP ASSIGNING



SUB NETTING

Subnetting

- •**Creating Multiple independent Networks from a Single Network.**
- •Converting Host bits into Network Bits
- **i.e. Converting 0's into 1's**
- •Subnetting can be performed in two ways.
- –FLSM (Fixed Length Subnet Mask)
- –VLSM (Variable Length subnet mask)

- •Subnetting can be done based on requirement .
  - – Requirement of Networks ?
  - –Requirement of Hosts ?

Default subnet mask

- •Subnet Mask differentiates Network portion and Host Portion
- •Represented with all 1’s in the network portion and with all 0’s in the host portion.

Default subnet mask

- **Class A : N.H.H.H**
- **11111111.00000000.00000000.00000000**
- **Default Subnet Mask for Class A is 255.0.0.0**
- **Class B : N.N.H.H**
- **11111111.11111111.00000000.00000000**
- **Default Subnet Mask for Class B is 255.255.0.0**
- **Class C : N.N.N.H**
- **11111111.11111111.11111111.00000000**
- **Default Subnet Mask for Class C is 255.255.255.0**

How Subnet Mask Works ?

- **IP Address:192.168.1.1**
- **Subnet Mask:255.255.255.0**
- **ANDING PROCESS:**
- **192.168.1.1 = 11000000.10101000.00000001.00000001**
- **255.255.255.0 = 11111111.11111111.11111111.00000000**
- **==========**
- **192.168.1.0= 11000000.10101000.00000001.00000000**
- **==========**
- **Hence, 192.168.1.0 is the Network Address.**
- **The output of an AND table is 1 if both its inputs are 1.**
- **For all other possible inputs the output is** 0

Requirement of Networks is 4 ?

- **Class C : N.N.N.H110xxxxx.xxxxxxxx.xxxxxxxx.xxxxxxxx**
  Class C : 192.168.1.0
- **•No. of Subnet=2^n >=4**
- **Req. of Subnet=2^2 >=4**
- n=2
- **No. of Host=2^h –2**

  [“-2” is for Network ID & Broadcast ID]
- **=2^6 –2=64 –2=62 Hosts/Subnet**

- Actual Octet Format in Class-C:
- N.N.N.00000000
- => N.N.N.ΦΦ000000 [Since, n=2]
- There are 6 Zeros,
- No. of hosts=2^6-2=64-2=62 Hosts/Subnet
- So, There are 4 subnets and 62 Hosts per each subnet.

If Subnet Mask is 255.255.255.192 , Then New Networks and respective hosts are :

- 192.168.1.00000000= 192.168.1.0 [I Subnet]
- 192.168.1.01000000= 192.168.1.64 [II Subnet]
- 192.168.1.10000000= 192.168.1.128 [III Subnet]
- 192.168.1.11000000= 192.168.1.192 [IV Subnet]

Ranges : 192.168.1.0 to 192.168.1.63=>64 IDs

192.168.1.64 to 192.168.1.127 =>64 IDs

192.168.1.128 to 192.168.1.191 =>64 IDs

192.168.1.192 to 192.168.1.255 =>64 IDs

Now subnet Mask :

- N.N.N.ΦΦ000000
- =>11111111. 11111111. 11111111.11000000
- =>255 .255 .255 . **(128+64)+0+0+0+0+0+0+0**
- =>255 .255 .255 .192

- **[It can be understood like this:**
- **NID = All 1’s, SID= All 1’s, HID=All 0’s]**

[For, 9 subnets, 128+64+32=224]

In 192.168.1.0 to 192.168.1.63

192.168.1.0 is Network ID & 192.168.1.63 is Broadcast ID

Hence, there are 62 IDs for host in First Subnet

In 192.168.1.64 to 192.168.1.127

192.168.1.64 is Network ID & 192.168.1.127 is Broadcast ID

Hence, there are 62 IDs for host in Second Subnet

In 192.168.1.0.128 to 192.168.1.191

192.168.1.128 is Network ID &192.168.1.191 is Broadcast ID

Hence, there are 62 IDs for host in Third Subnet

In 192.168.1.192 to 192.168.1.255

192.168.1.192 is Network ID &192.168.1.255 is Broadcast ID

Hence, there are 62 IDs for host in Fourth Subnet

Range of IP addresses

- 192.168.1.0 -- 192.168.1.63 /26
- 192.168.1.64 – 192.168.1.127 /26
- 192.168.1.128 – 192.168.1.191/26
- 192.168.1.192 – 192.168.1.255 /26

Similarly in Class – A and Class – B also.,

Now subnet Mask :

- N.N.N.Φ0000000
- =>11111111. 11111111. 11111111.10000000
- =>255 .255 .255 . **(128)+0+0+0+0+0+0+0+0**
- =>255 .255 .255 .128

- **[It can be understood like this:**
- **NID = All 1’s, SID= All 1’s, HID=All 0’s]**

[For, 9 subnets, 128+64+32=224]

Now subnet Mask :

- N.N.N.ΦΦΦ00000
- =>11111111. 11111111. 11111111.11100000
- =>255 .255 .255 .128+64+24+0+0+0+0+0+0
- =>255 .255 .255 .224

- **[It can be understood like this:**
- **NID = All 1’s, SID= All 1’s, HID=All 0’s]**

[For, 9 subnets, 128+64+32=224]

[For, 16 subnets, 128+64+32+16=240]

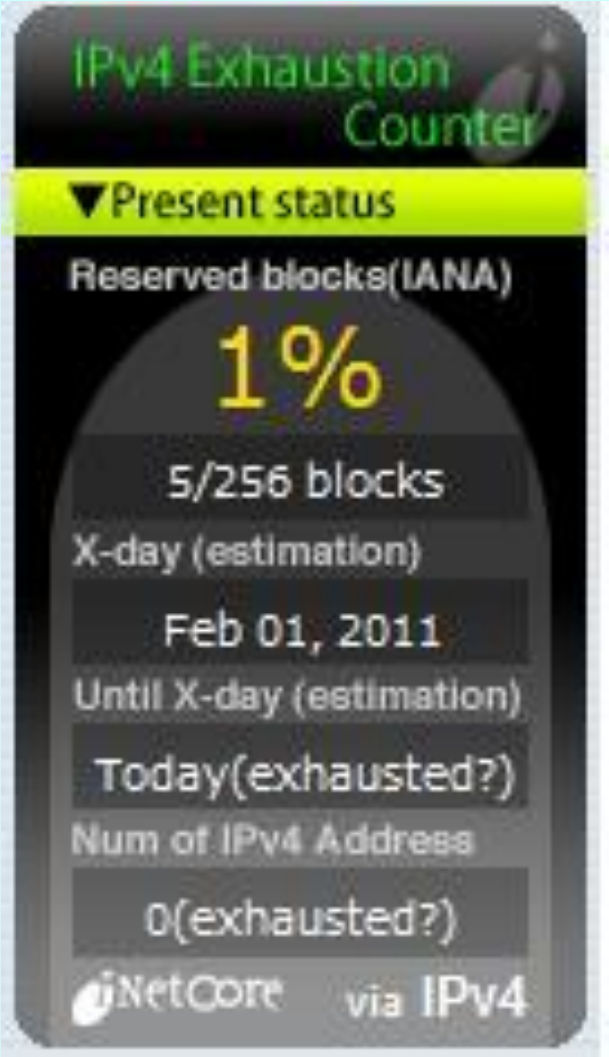

I.P. V6

IPv6

- To meet the continual growth of the Internet, IETF has proposed a set of specifications commonly known as the next generation IP protocol ("IPng" or IPv6").
- IPv6 increases the address size from 32 bits to 128 bits, supporting up to $3.4X10^{38}$ nodes.
- It is represented using hexadecimal values separated by colons using the format X:X:X:X:X:X:X:X:, where each X refers to a four digit hexadecimal integer (16 bits each).
- One such address could be BA98:7654:3210:FEDC:BA98:7654:3210:0043.

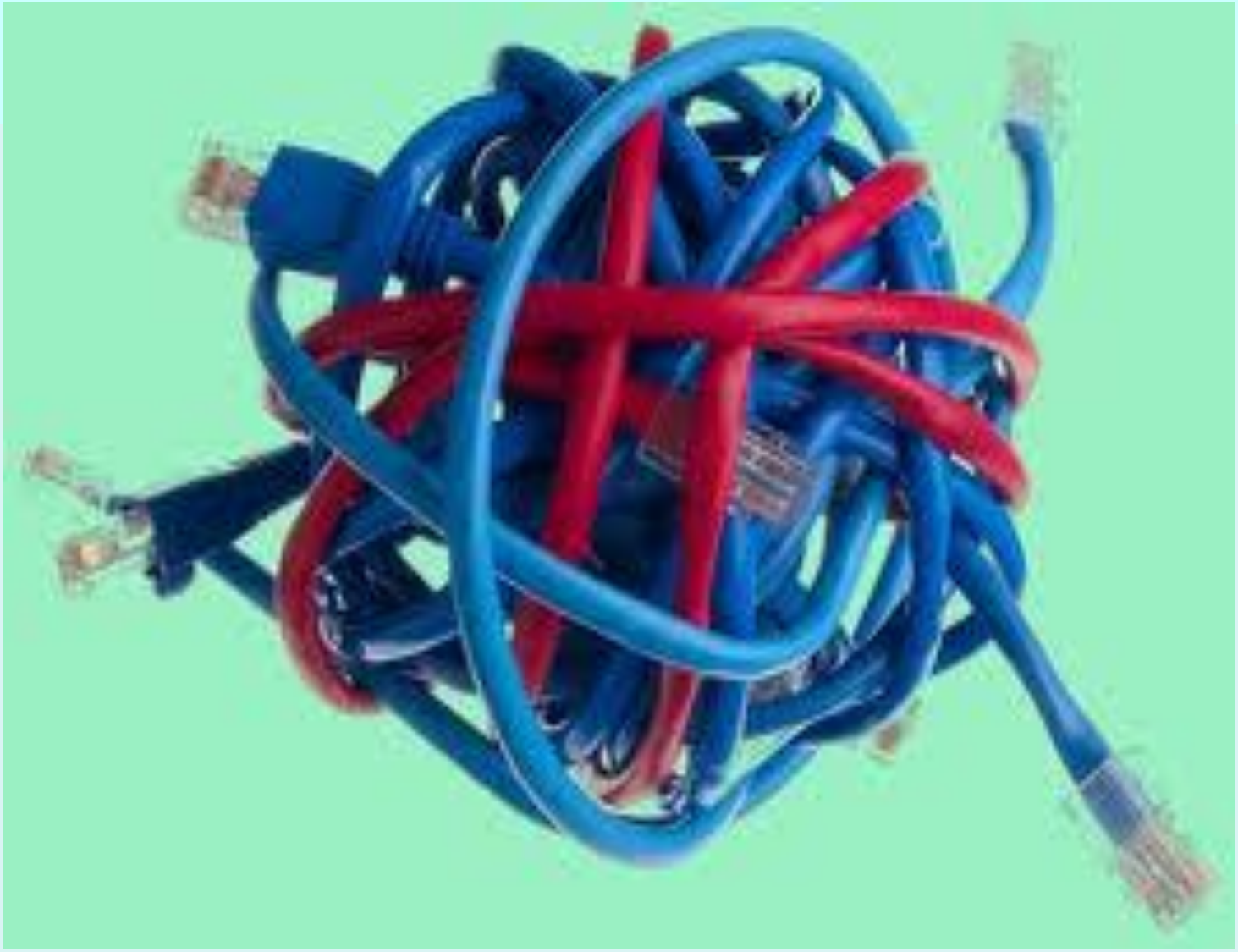
Problems of IPv4

- Addressing problem
- Routing Crisis
- End to End problem
- Security
- Mobility
- Performance
- Cost



Address Crisis

Routing Crisis



End to End problem

Mobility

Security Problem

IPv6 Features

1. Larger address space
2. Global reachability
3. Flexibility
4. Auto-configuration
5. Aggregation
6. Multi-homing
7. Efficient Routing
8. Scalability
9. Easy Mobility
10. Better security

IPv6

No more room in IPv4

Quite empty in IPv6

Larger Address Space

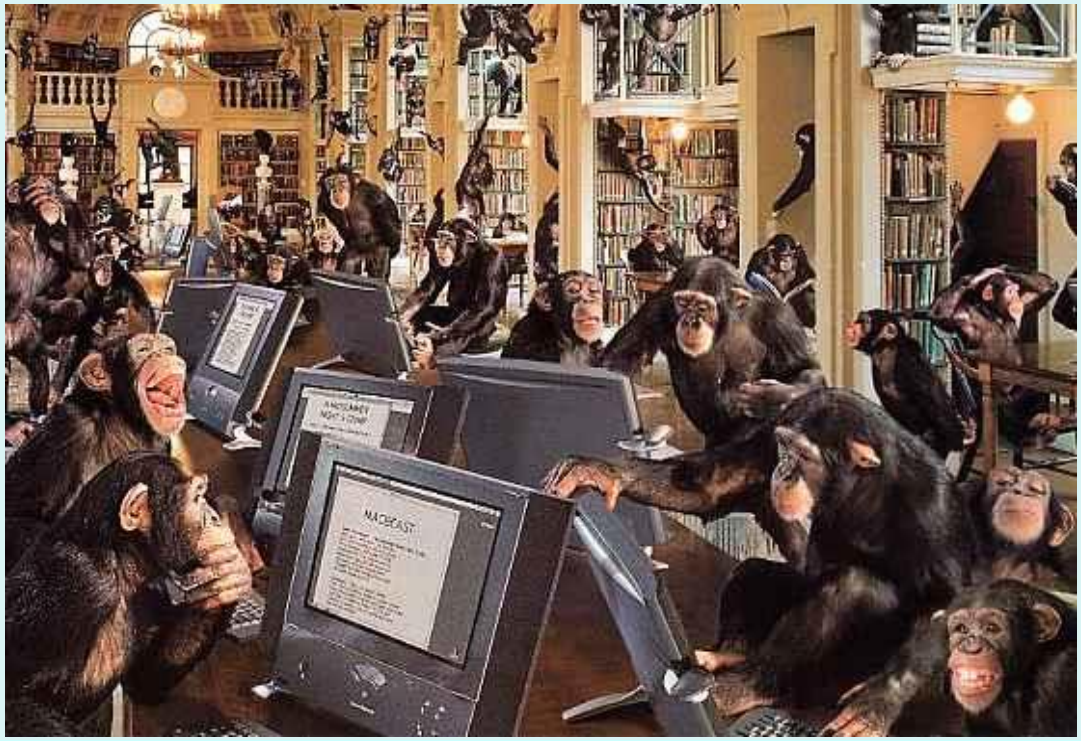
Global Reachability

From 32 bits to 128 bits addresses enables:

– Global reachability:

• No hidden networks, hosts

• All hosts can be reachable and be "servers"



Flexibility

From 32 bits to 128 bits addresses enables:

– Flexibility

Auto-Configuration

- "Plug and play"

– By autoconfiguration

Aggregation

- Aggregation

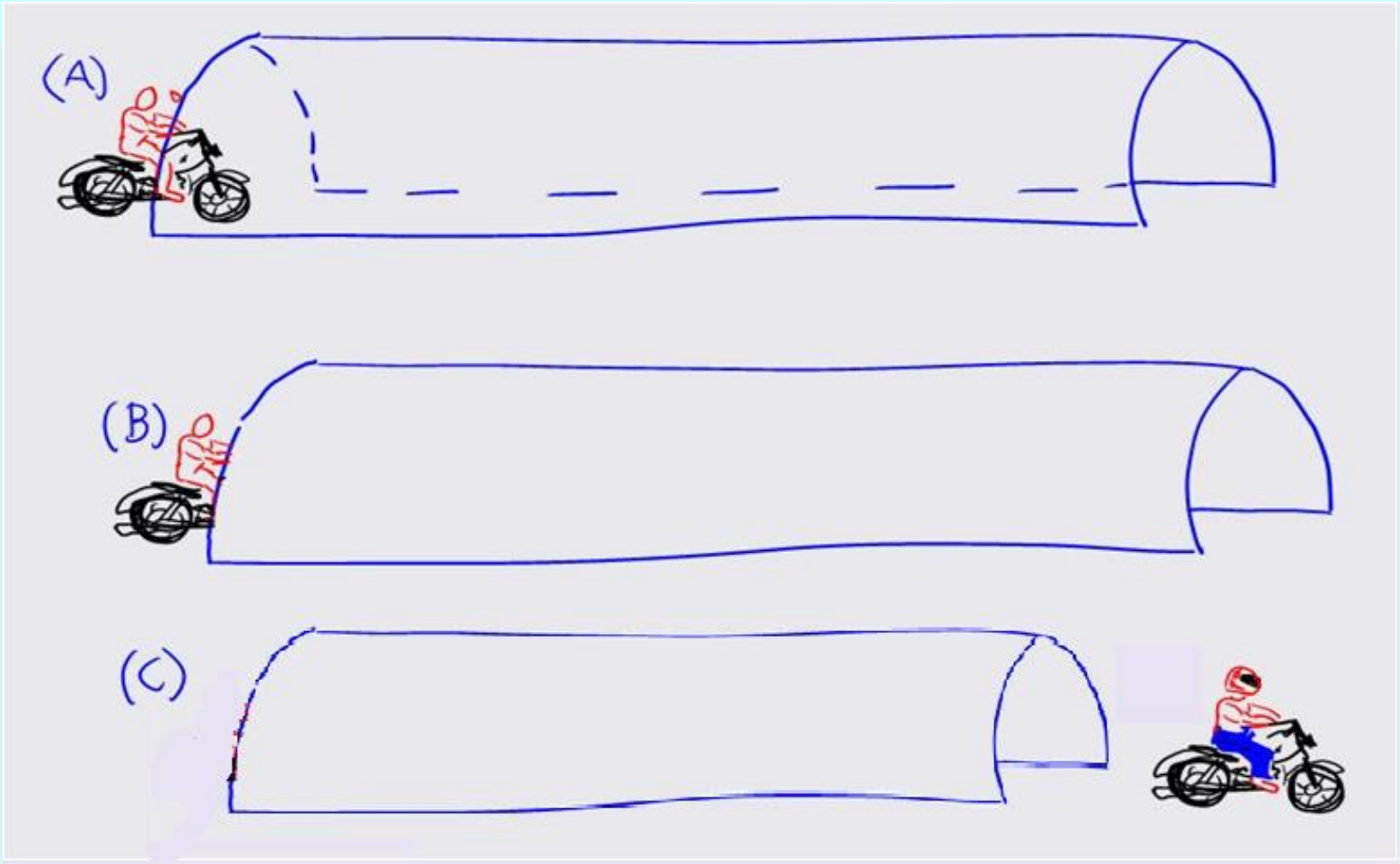
Multi-homing

Efficient Routing

Scalability

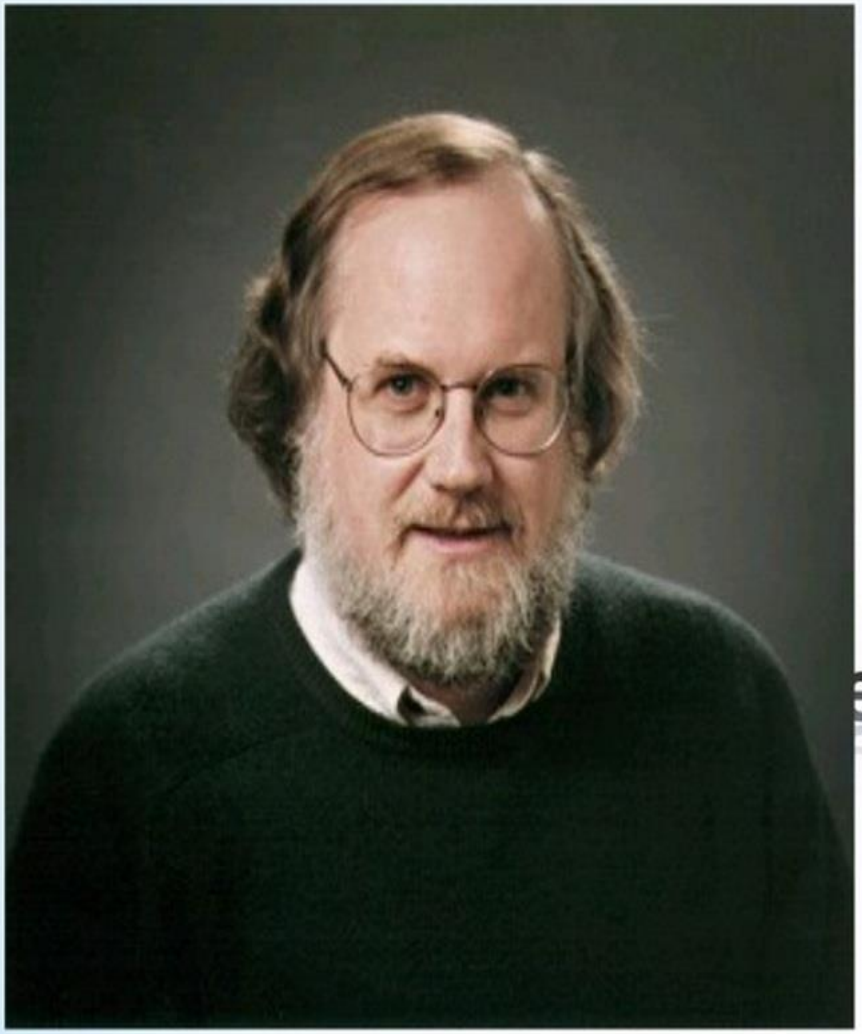
Easy Mobility

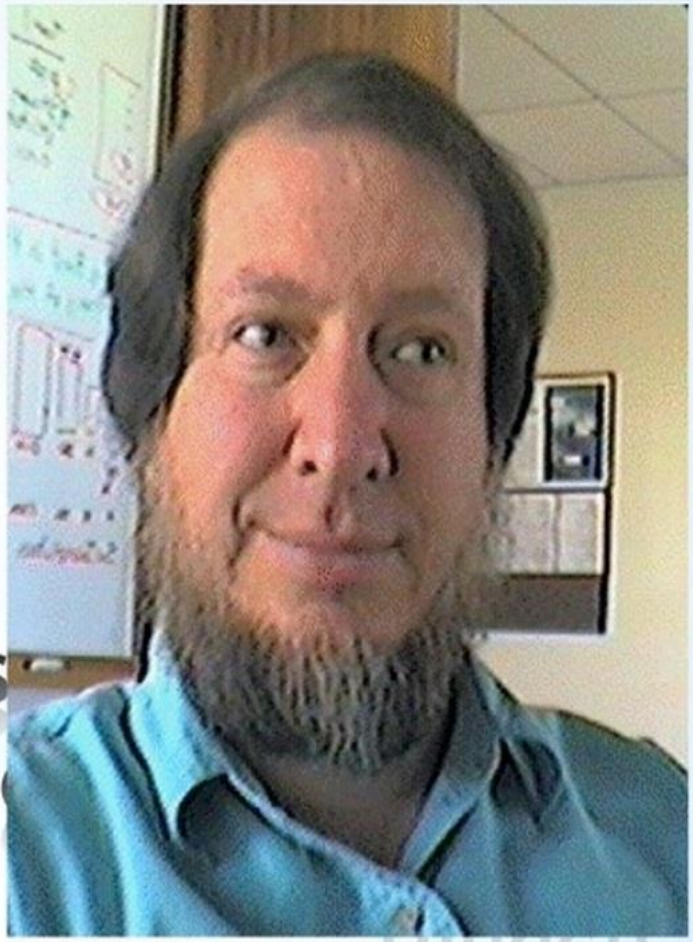
End to End Security



Better Security

* Architects of IPv6 Protocol
Steven Deering and Robert Hinden





4 digit Hexadecimal Integer

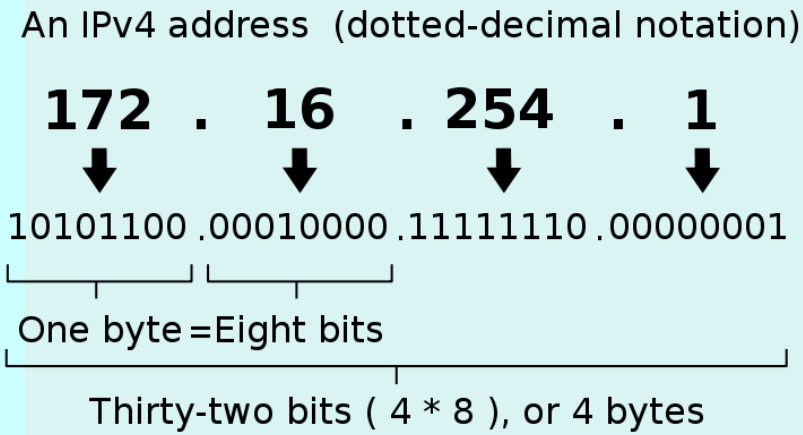
Minimum : $0000_{16} = 0_2 = 0_{10}$

Maximum : $ffff_{16} = 1111\ 1111\ 1111\ 1111_2$

$= 65535_{10}$

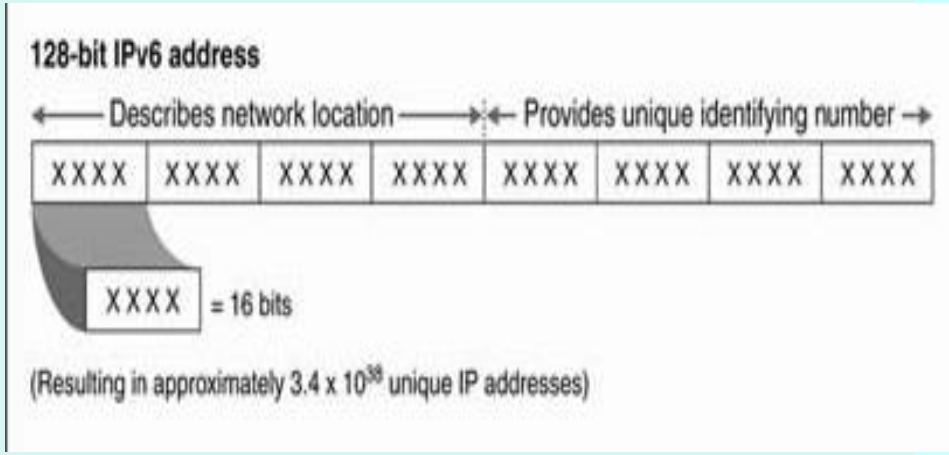
IP Address Schemes

IPV4 Address (Present)



- **Total Addresses = 2^32 = 4 billion**
- **Some addresses are reserved for special purposes like private networks or multicast addresses. However practically only 250 million addresses are usable.**

IPV6 Address (Future)



Total Addresses = 2^128 = 340 billion, billion, billion, billion

Working of IPv6 addressing...

* IPv6 addresses are 128 bits long, compared to 32 bits for IPv4 addresses. IPv6 addresses are represented as 8 chunks of 16 bits in hexadecimal separated by colons, compared to 4 chunks of 8 bits in decimal (dotted-quad) for IPv4. For example, IPv4 addresses looks like:

*
  128.255.1.3
  209.85.225.106
  38.100.128.10

* whereas IPv6 addresses looks like:

*
  2620:0:e50:2::1
  2001:4860:800b::67
  2001:550:1::cc01

* In IPv6, leading 0s in each chunk can be omitted, & a single instance of consecutive 0s can be replaced with "::". For example, the following IPv6 addresses are equivalent:

*
  2620:0000:0e50:0002:0000:0000:0000:0001
  2620:0:e50:2:0:0:0:1
  2620:0:e50:2::1

* Finally, IPv6 addresses use the same prefix/length notation which is now used for IPv4 to specify blocks of address space. The "prefix" is the base address of the block. The "length" is the number of bits from the left which are the same for all addresses in the block. This is often called "CIDR notation" because it was created when Classless Inter-Domain Routing was employed in the IPv4 Internet. For example:

How does IPv6 addressing work? -

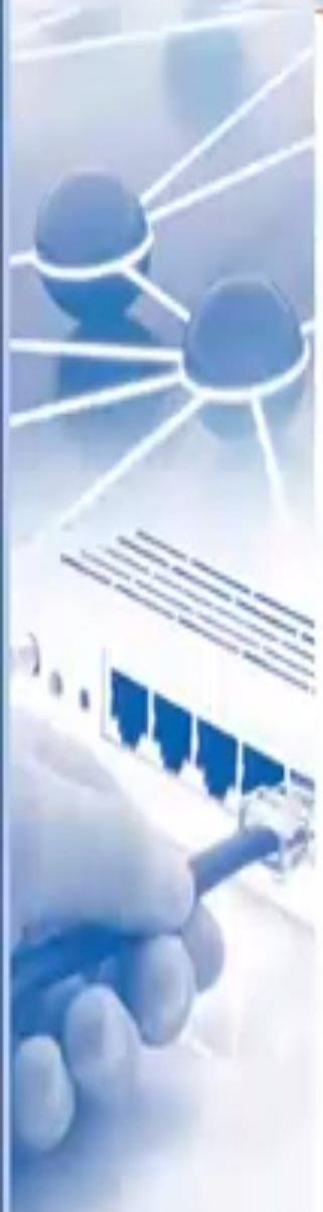
Block	Addresses in Block
128.255.56.0/24	128.255.56.0 - 128.255.56.255
128.255.116.0/22	128.255.116.0 - 128.255.119.255
129.255.0.0/16	129.255.0.0 - 129.255.255.255
2620:0:e50:2::/64	2620:0:e50:2:0:0:0:0 - 2620:0:e50:2:ffff:ffff:ffff:ffff
fd9a:2c75:7d0c::/48	fd9a:2c75:7d0c:0:0:0:0:0 - fd9a:2c75:7d0c:ffff:ffff:ffff:ffff:ffff

- Decimal equivalent of ffff is 65535
- So,
- 65535x65535x65535x65535x65535x65535x65535x65535
- = 3.4×10^{38} = 340×10^{36}
- = 340 Trillion Trillion Trillion

Networked Computer Growth

- Networked Computer Growth
  - 1981 : 2 million
  - 1991 : 65 million
  - 2000 : 360 million
  - 2010 : 1.7 billion (thousand million)
  - 2020 : 5 billion ?

How Many IPv6 Addresses Are There?



IP version 6 :

- 48 billion billion billion addresses for every person
- 340 trillion trillion trillion addresses in total
- that's … 340 000 000 000 000 000 000 000 000 000 000 000 000

Introduction to Routers

Router fundaments

- The router is a device that connects two networks
- A router accepts packets on at least two network interfaces and forwards packets from one interface to another.

A router works at network layer.

- Each router maintains a database called routing table of the router
- This routing table contains network addresses.
- Routers do not talk to remote computers

Router fundamentals

- Router is like a PC and has
  - Mother board
  - CPU
  - Memory
  - Ports & interfaces to hook peripherals
  - May have a monitor to serve as a console

Types of routers

- Hardware routers

  Cisco, juniper, nortel , dlink, DAX

- Software routers

  Microsoft server , LINUX server

CISCO's HIERARCHICAL DESIGN MODEL

Access Layer : Small organization

Ex:1600,1700,1800,2500 series

Distribution Layer: Medium size organization

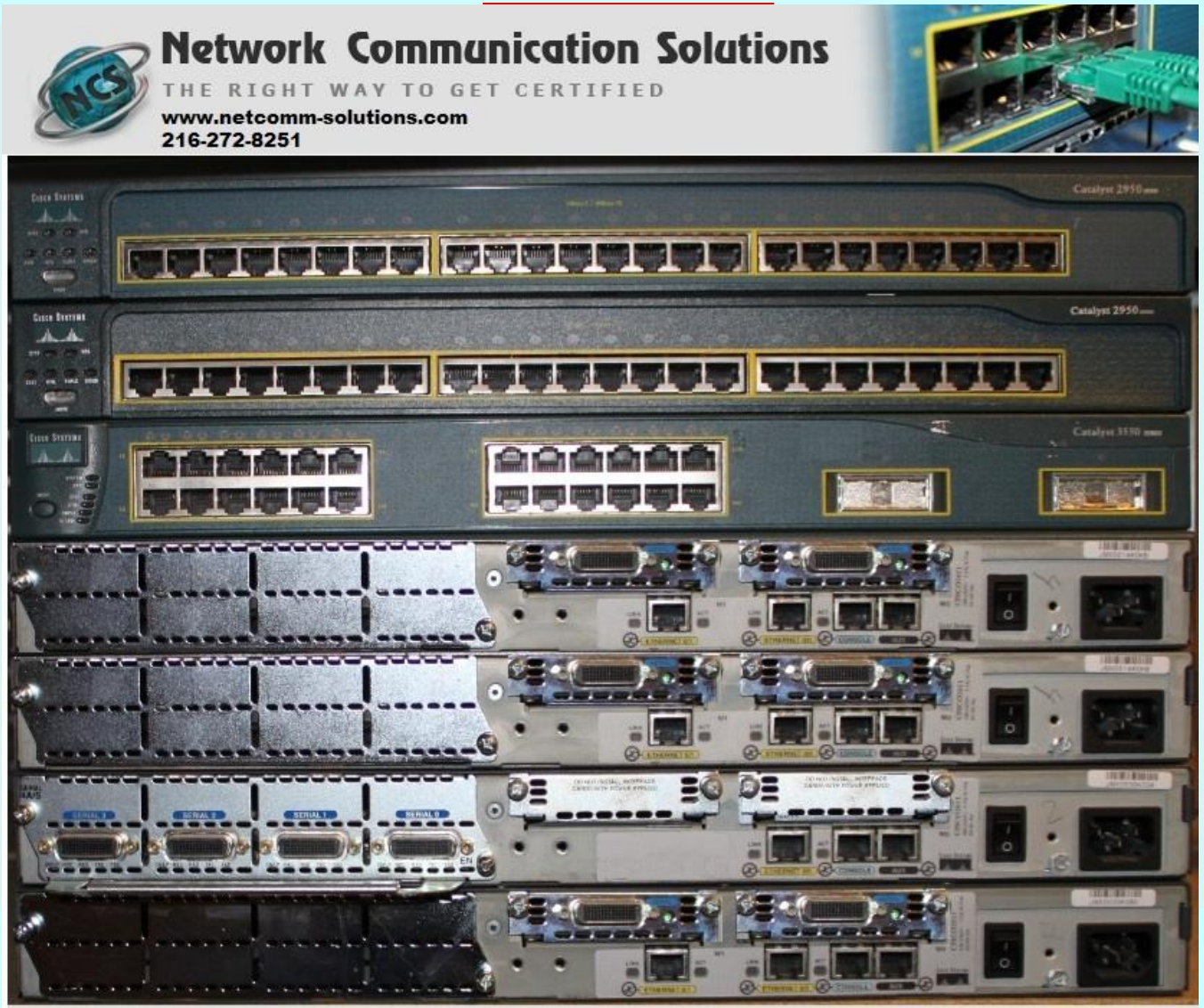
ex: 2600,2800,3600,3700,3800

Core layer : Very large organizations and ISPs.

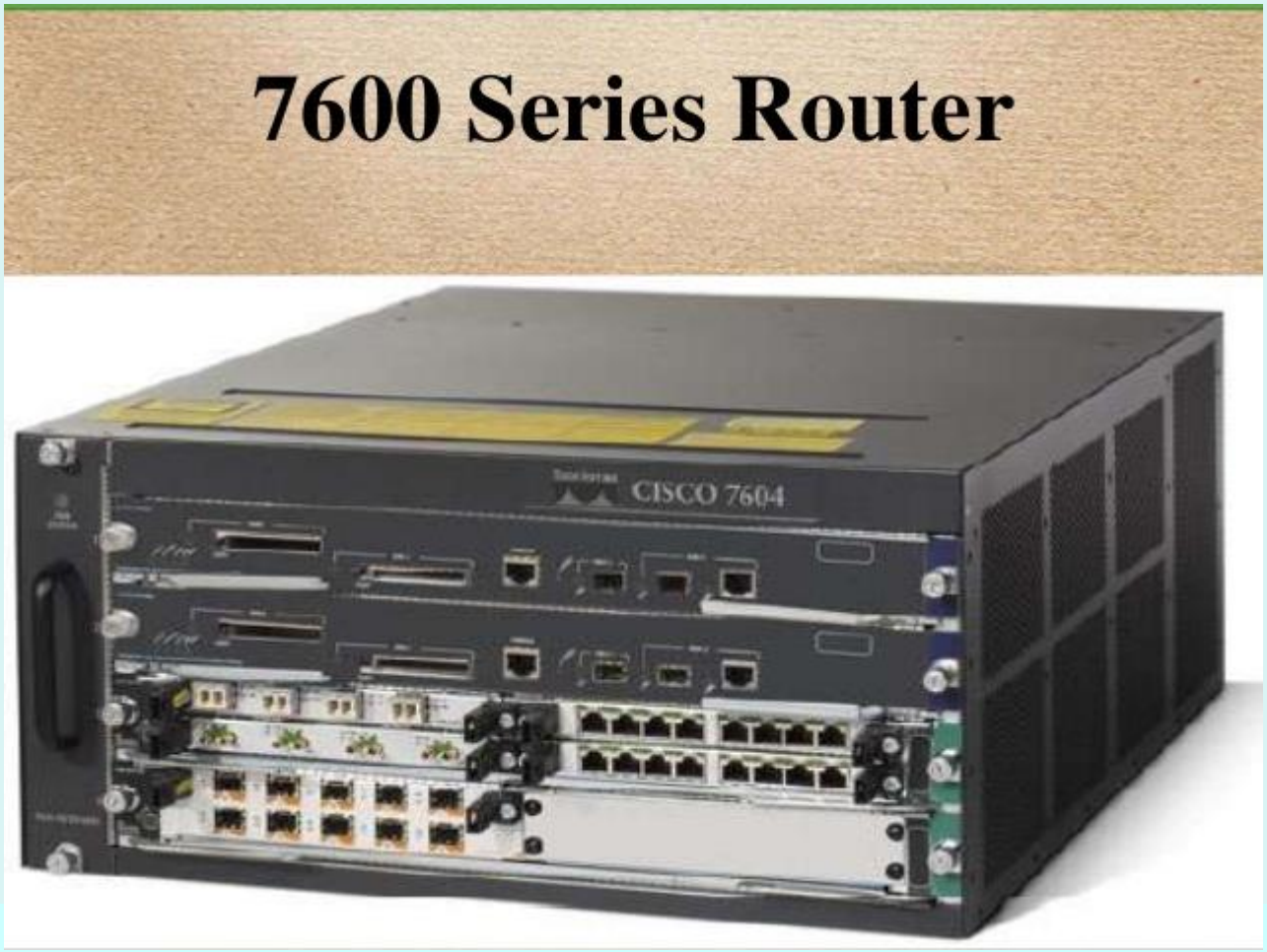
ex:7200,7600,10000,12000

Cisco 1600,1700,1800,2500 series Routers

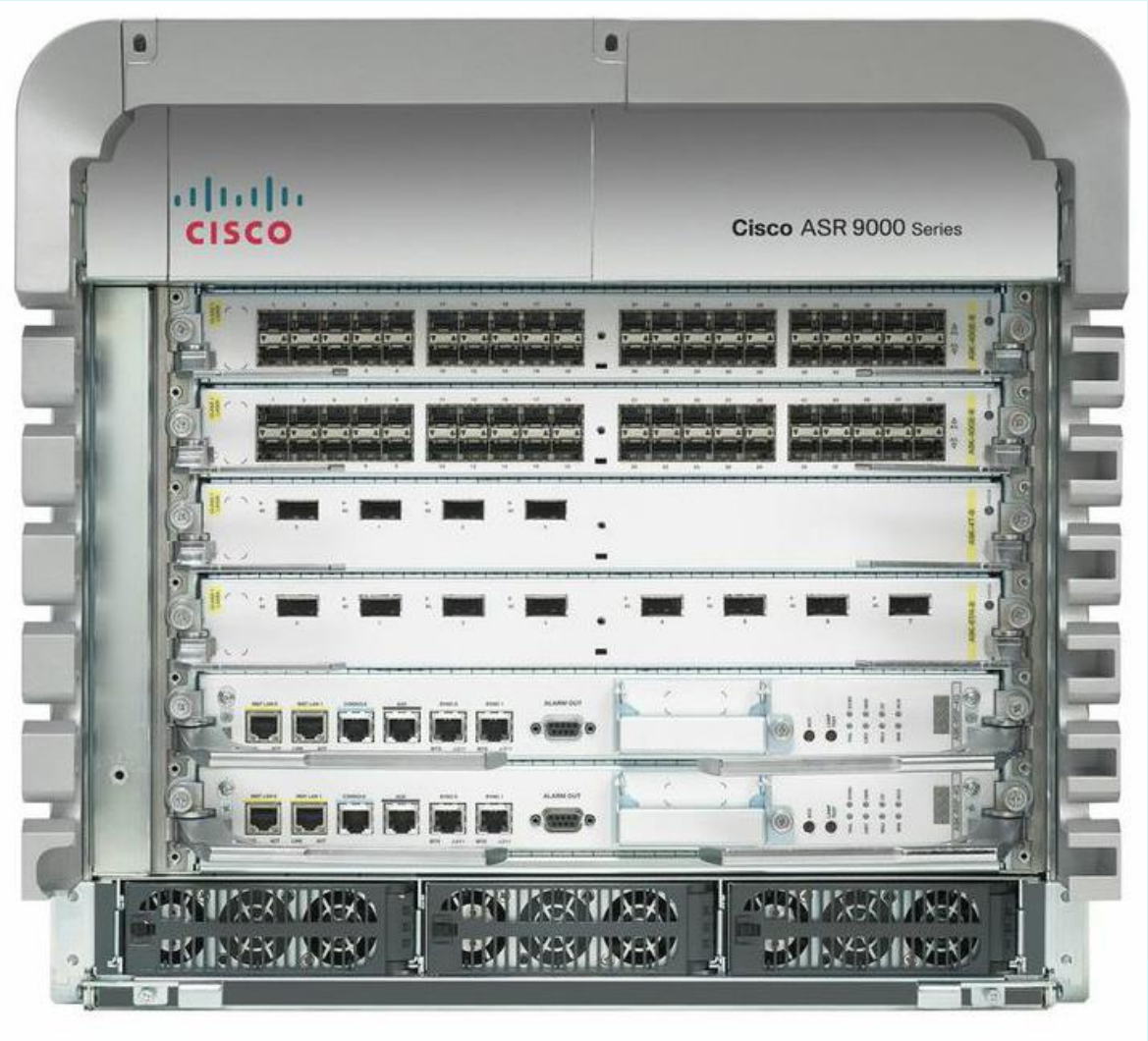
2600,2800,3600,3700,3800 series routers



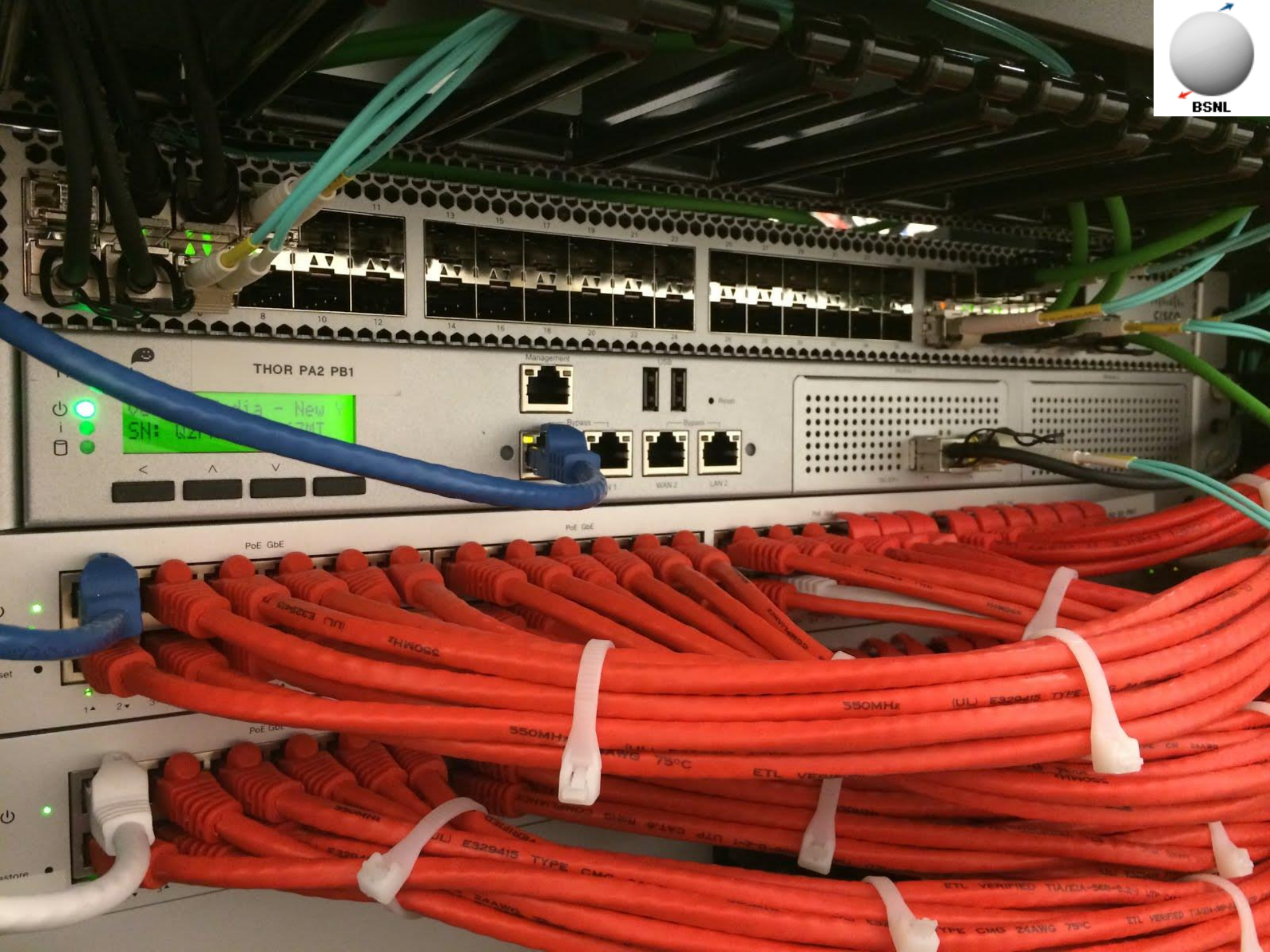
:7200,7600,10000,12000 routers



7200,7600,10000,12000 routers



EDGE ROUTER


BSNL
THOR PA2 PB1
Management
Bypass
WAN 2
LAN 2
PoE GbE
550MHz
75°C

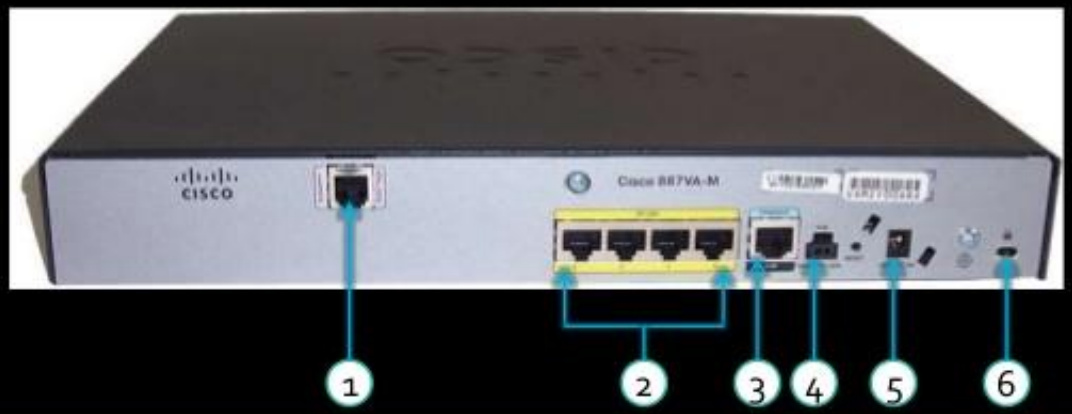

Ethernet
1000BASE-X SFP
ONLINE/OFFLINE
ACTIVITY
LINK
PORT 3
PORT 2
Ethernet
1000BASE-X SFP
BSNL

Interfaces of routers

- LAN Interface to connect to the switch
- WAN Interface to connect to the next router (serial port)
- Administrative port (console port)
- Auxiliary port

DIFFERENT PORTS

Ports Description 800 series



1	WAN port	2	LAN ports
3	Console port	4	USB port
5	Power Connector	6	Security Lock

Types of WAN technologies

- Leased Line
- MLLN(Managed leased line network)
- ISDN
- MPLS
- Broadband

Introduction to Static Routing

ROUTING AND ROUTING PROTOCOLS

ROUTING METHODS

- Routers must learn the direction to remote networks in order to forward packets.
- Two ways to learn this information:
  - DYNAMICALLY
    - Information is learned from other routers
      - Often through RIP, OSPF, or EIGRP routing protocols
  - STATICALLY
    - Configured manually
      - Requires the network administrator to add and delete static routes when topology changes
      - In large networks it requires a tremendous amount of administrative time
      - On small, or unchanging networks, it requires very little maintenance

Static Routing

- Routes for each destination network has to be manually configured by the administrator.
- Used in small networks.
- Route may be up or down but static routes will remain in the routing tables and traffic would still be sent towards the route
- Not suitable for large networks

STATIC ROUTE OPERATION

- Static route operations can be divided into 3 stages:
  - A network administrator manually configures the static route on the router
  - The router installs the route in its routing table
  - Packets are routed using the static route

CONFIGURING STATIC ROUTES

Send traffic through an interface:

```
Router(config)#ip route 192.168.0.0 255.255.255.0 Serial 0
```

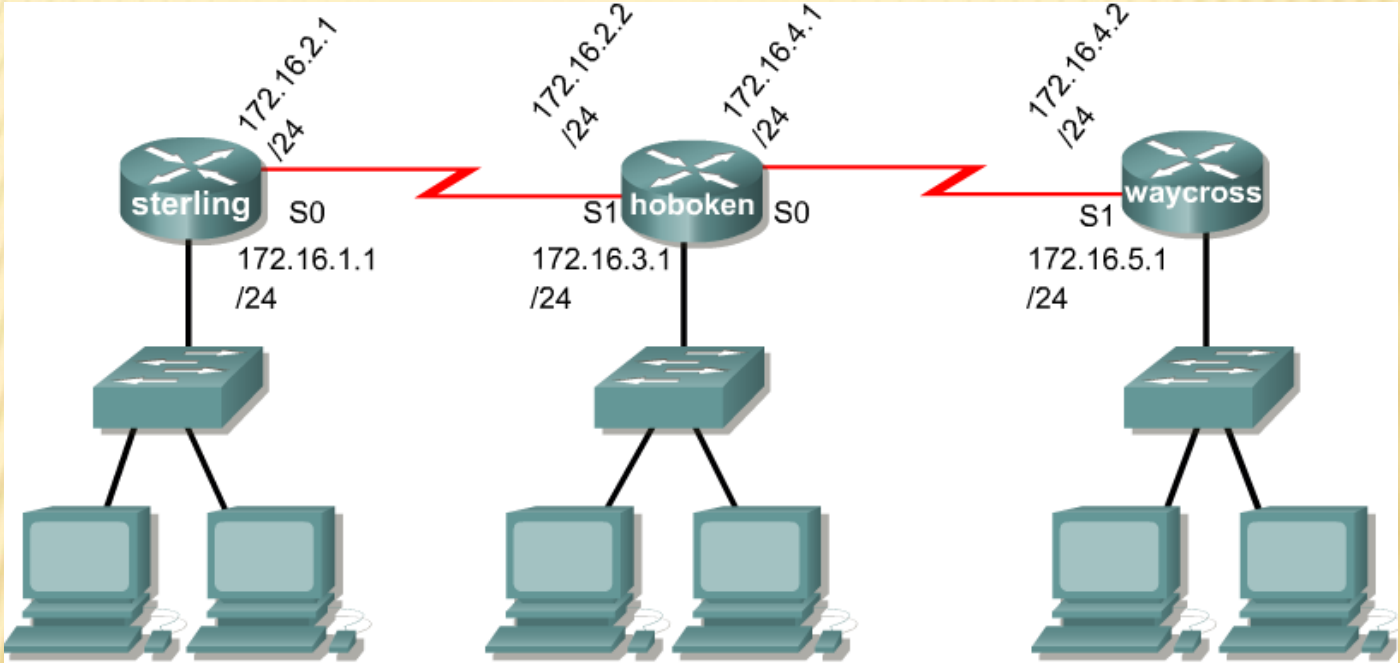
Destination Network — **Subnet Mask** — **Local Router's Outgoing Interface**

Send traffic to the next router's address:

```
Router(config)#ip route 192.168.1.0 255.255.255.0 192.168.1.2
```

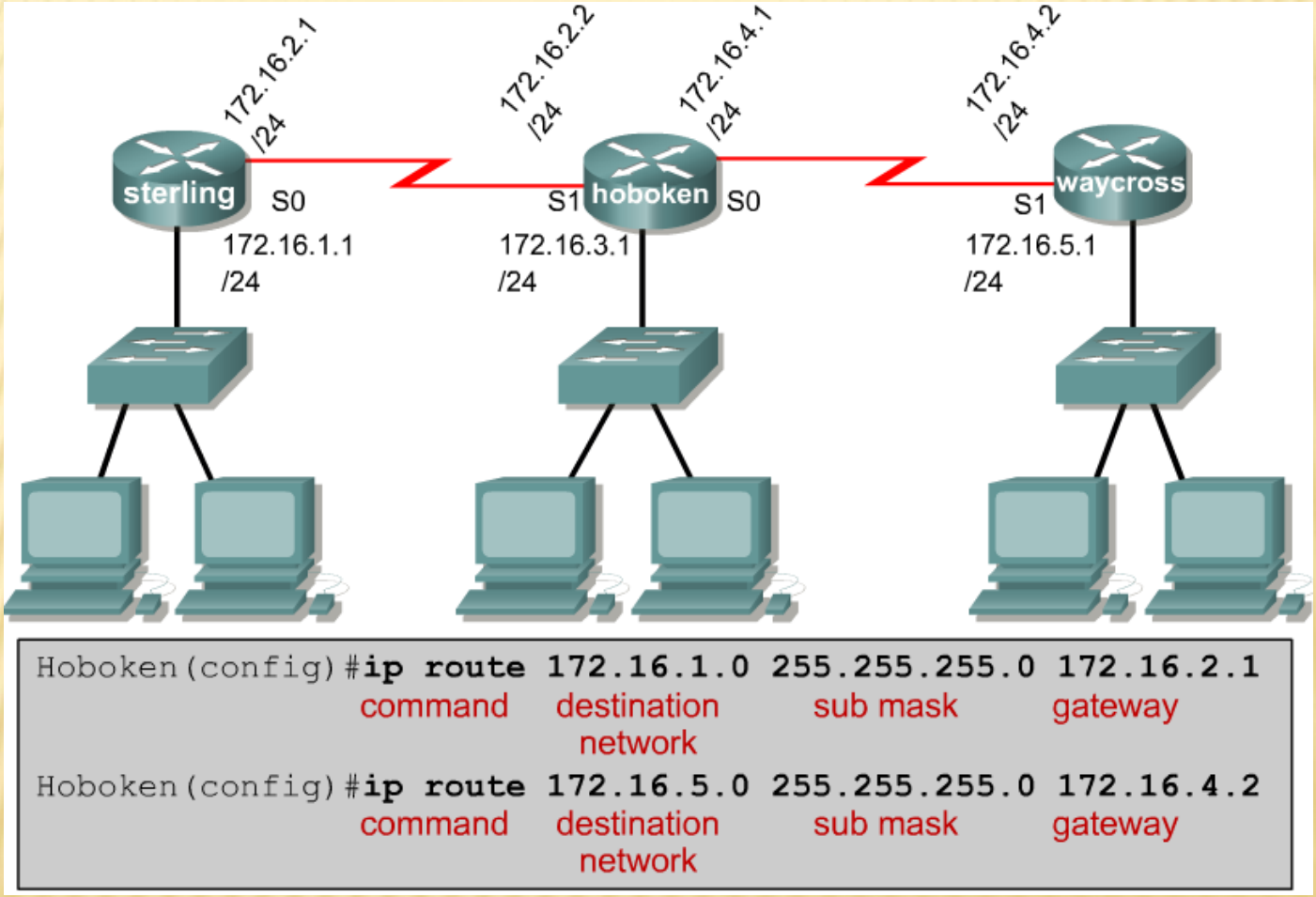
Destination Network — **Subnet Mask** — **Next Hop IP Address (address of next router)**

CONFIGURING THE OUTBOUND INTERFACE




```
Hoboken(config)#ip route 172.16.1.0 255.255.255.0 s1
                   command destination   sub mask    gateway
                           network
Hoboken(config)#ip route 172.16.5.0 255.255.255.0 s0
                   command destination   sub mask    gateway
                           network
```

CONFIGURING THE NEXT-HOP ADDRESS



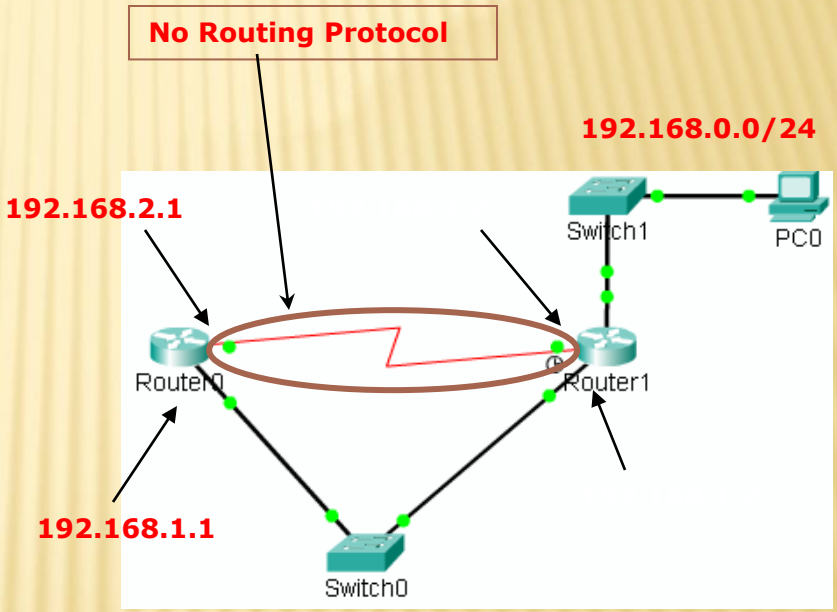

```
Hoboken(config)#ip route 172.16.1.0 255.255.255.0 172.16.2.1
                    command destination   sub mask     gateway
                            network
Hoboken(config)#ip route 172.16.5.0 255.255.255.0 172.16.4.2
                    command destination   sub mask     gateway
                            network
```

STATIC ROUTES AS BACKUPS

- Often static routes are used for backup purposes, such as when the dynamically learned route fails.

BACKUP ROUTE EXAMPLE

- For Router0, the preferred path to the 192.168.0.0 network is through the switch.



Dynamic Routing

- Changes in the network topology are updated dynamically.
- Only the directly connected networks information is required for configuration.
- Administrative work is reduced.
- It is used in medium and large networks.

RIP & OSPF are routing protocols

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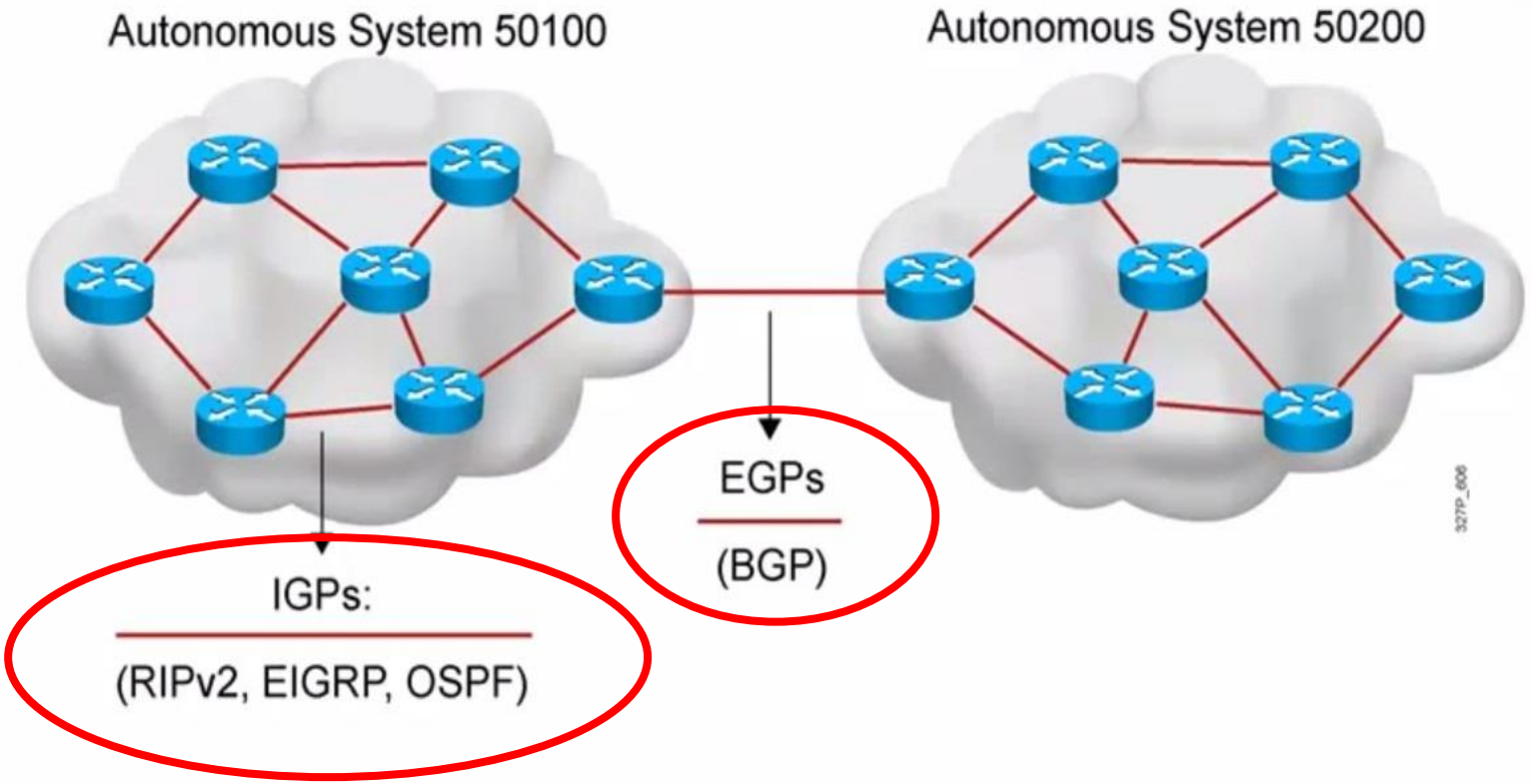
Static vs. Dynamic Routes

- Static Route
  - Uses a route that a network administrator enters into the router manually

- Dynamic Route
  - Uses a route that a network routing protocol adjusts automatically for topology or traffic changes

Autonomous Systems: Interior and Exterior Routing Protocols

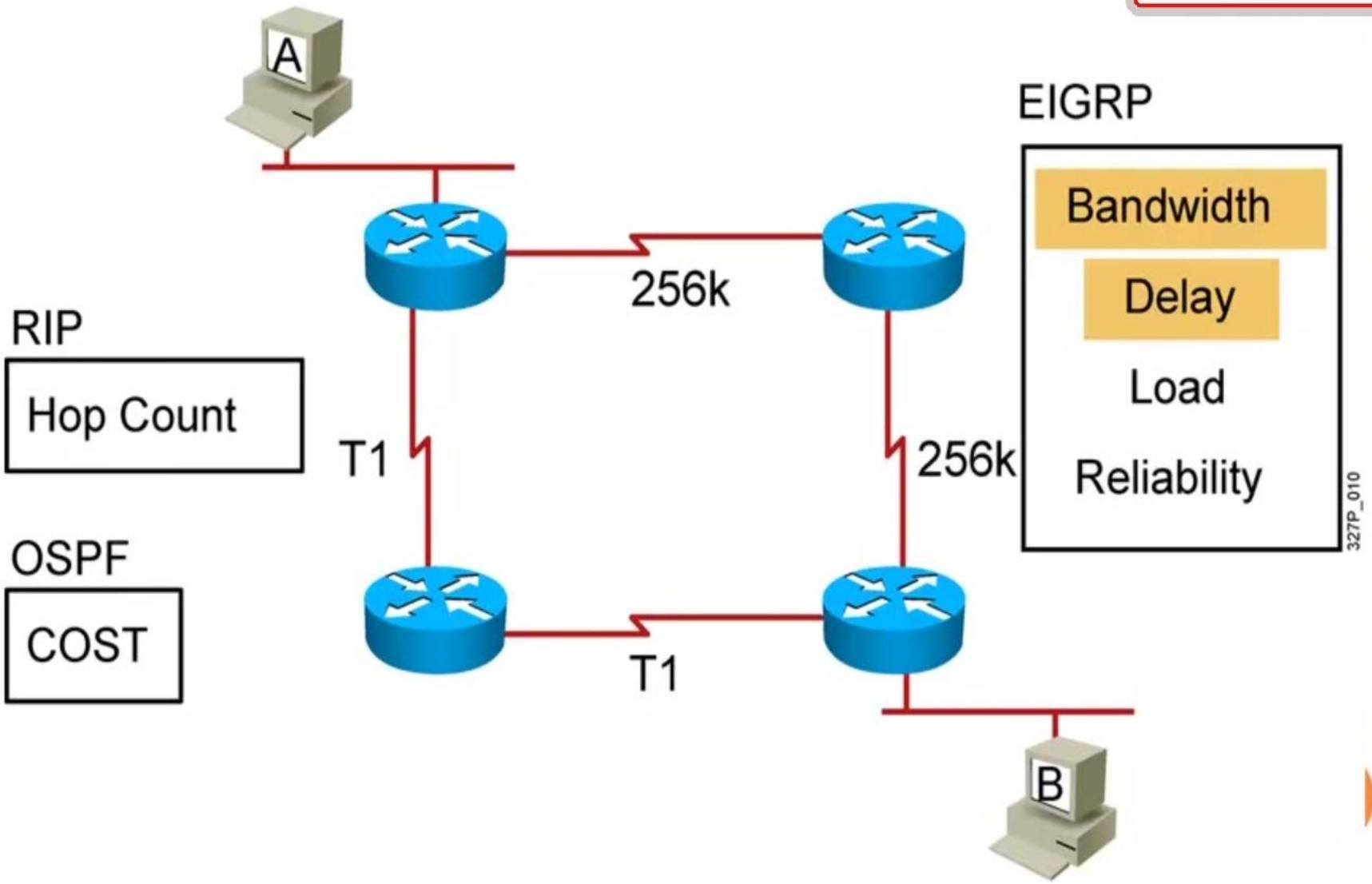


- An autonomous system is a collection of networks within a common administrative domain.
- Interior gateway protocols operate within an autonomous system.
- Exterior gateway protocols connect different autonomous systems.

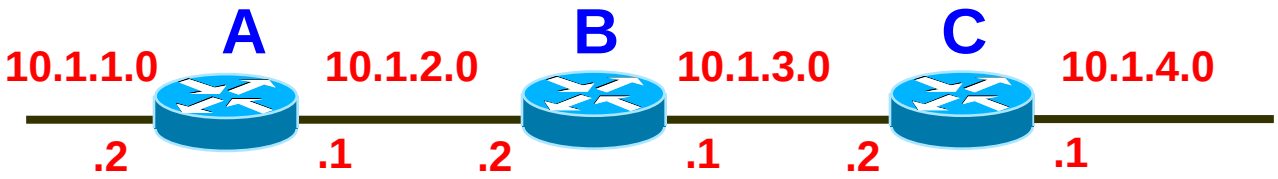
Intra-AS Routing

- Also known as Interior Router Protocols (IRP) or Interior Gateway Protocols (IGP)
- Most common:
  - RIP: Routing Information Protocol
  - OSPF: Open Shortest Path First
  - IGRP: Interior Gateway Routing Protocol (Cisco proprietary)

Selecting the Best Route Using Metrics



Routing Updates



Routing Table-A

NW	VIA	HOP
10.1.1.0	----------	0
10.1.2.0	----------	0
10.1.3.0	10.1.2.2	1
10.1.4.0	10.1.2.2	2

Routing Table-B

NW	VIA	HOP
10.1.2.0	----------	0
10.1.3.0	----------	0
10.1.1.0	10.1.2.1	1
10.1.4.0	10.1.3.2	1

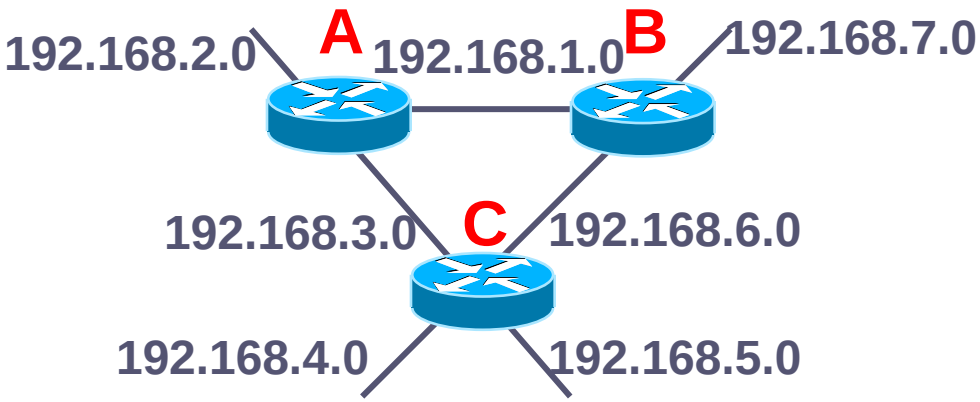
Routing Table-C

NW	VIA	HOP
10.1.3.0	----------	0
10.1.4.0	----------	0
10.1.2.0	10.1.3.1	1
10.1.1.0	10.1.3.1	2

- After exchanging 2 periodic updates, the network is converged.

Hop Count

- A hop count metric simply count router hops.
- From router-A it is 1 hop to network 192.168.5.0 if packets are sent out interface 192.168.3.0 and 2 hops if sent out 192.168.1.0

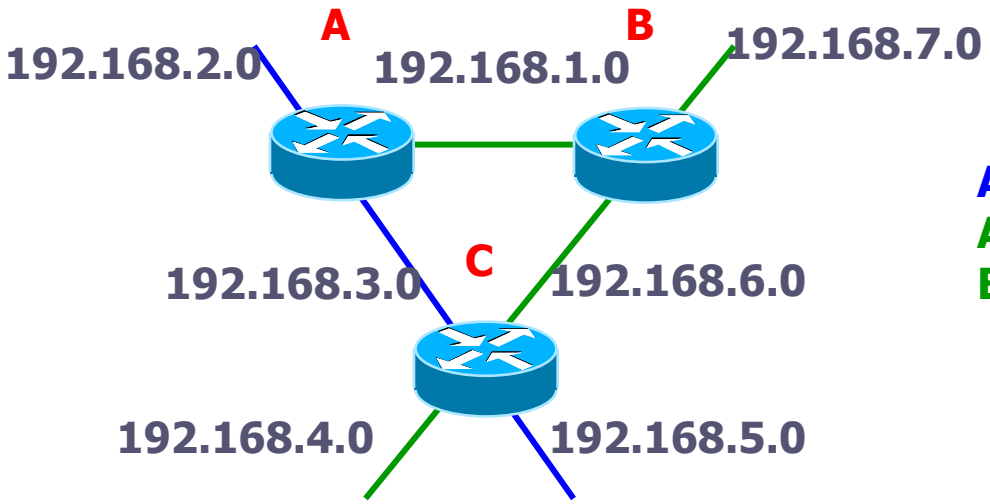


OSPF "ADVANCED" FEATURES (NOT IN RIP)

- Selects high Bandwidth route
- Security: all OSPF messages authenticated (to prevent malicious intrusion); TCP connections used
- Multiple same-cost paths allowed (only one path in RIP)
- For each link, multiple cost metrics for different Type Of Service (e.g., satellite link cost set "low" for best effort; high for real time)
- Integrated uni- and multicast support:
  - Multicast OSPF (MOSPF) uses same topology data base as OSPF
- Hierarchical OSPF in large domains.

Bandwidth

- A bandwidth metric would choose a higher bandwidth over a lower bandwidth.
- A packet from router A to C will follow path A-B-C.



A-C: 64kbps
A-B: 2mbps
B-C: 2mbps

IGRP
(Interior Gateway Routing Protocol)

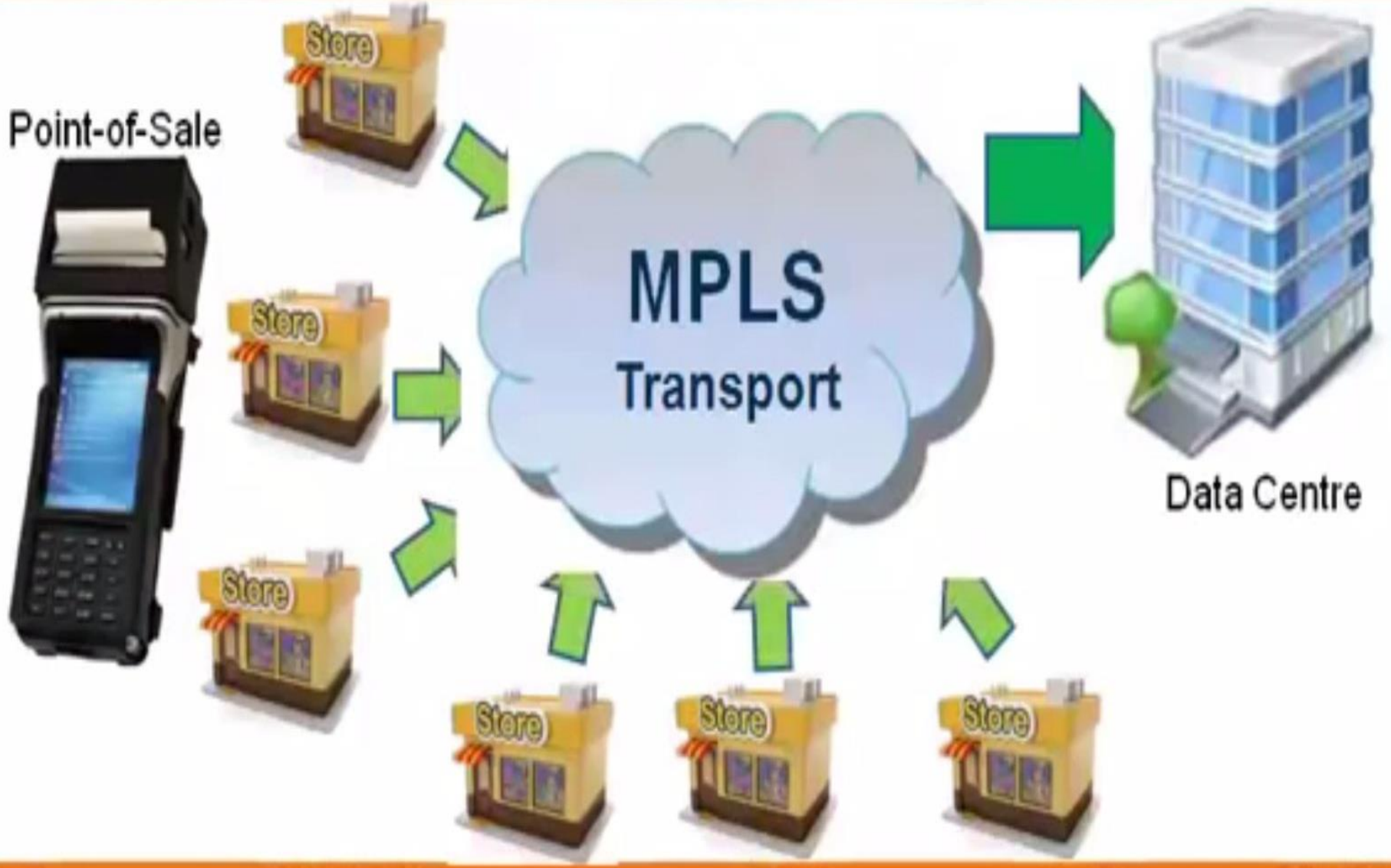
- CISCO proprietary; successor of RIP (mid 80s)
- Distance Vector, like RIP
- Several cost metrics (delay, bandwidth, reliability, load etc)
- Uses TCP to exchange routing updates
- Loop-free routing via Distributed Updating Alg. (DUAL) based on *diffused computation*

MPLS

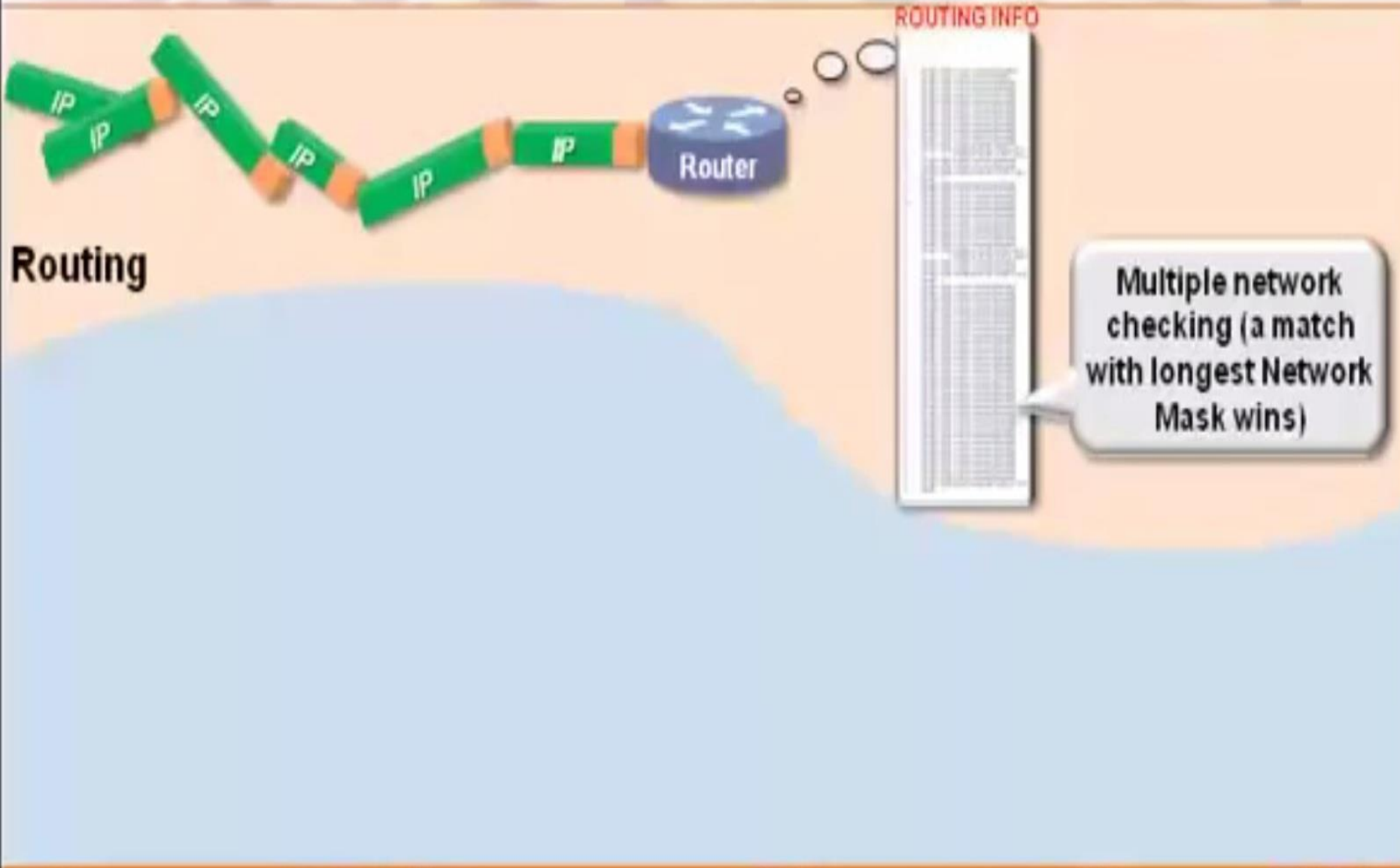
What is MPLS?

- Defined by Internet Engineering Task Force (IETF) in 1998
- **M**ulti-**P**rotocol **L**abel **S**witching
- Provides a combination of:
  - A high-performance forwarding mechanism
  - Connection establishment
  - Mapping onto various lower layer technologies
  - Data path protection
  - OAM functions (Operations, Administration and Maintenance)

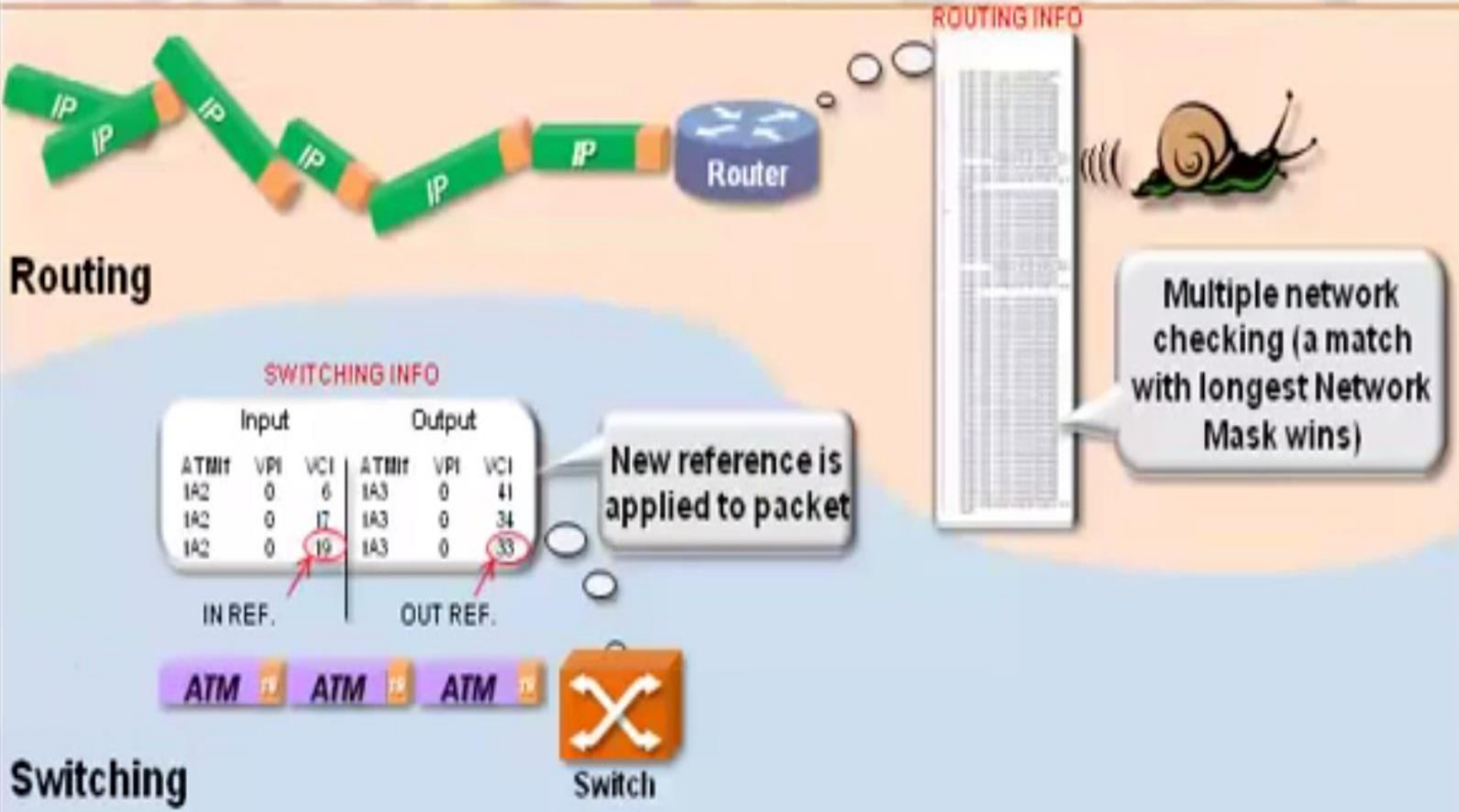
Rapid Forwarding of Transaction Data



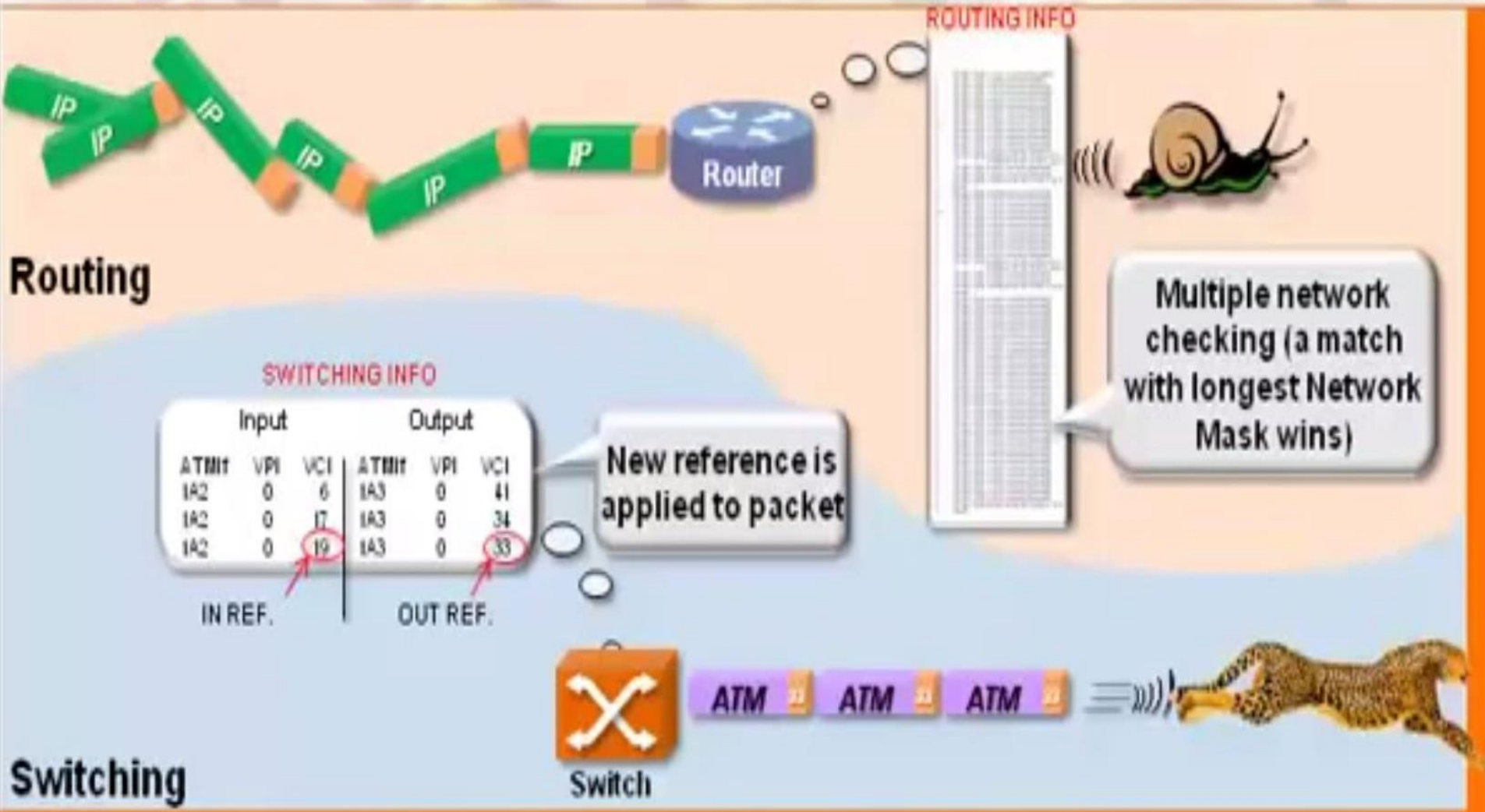
Routing and Switching : A Comparison



Routing and Switching : A Comparison

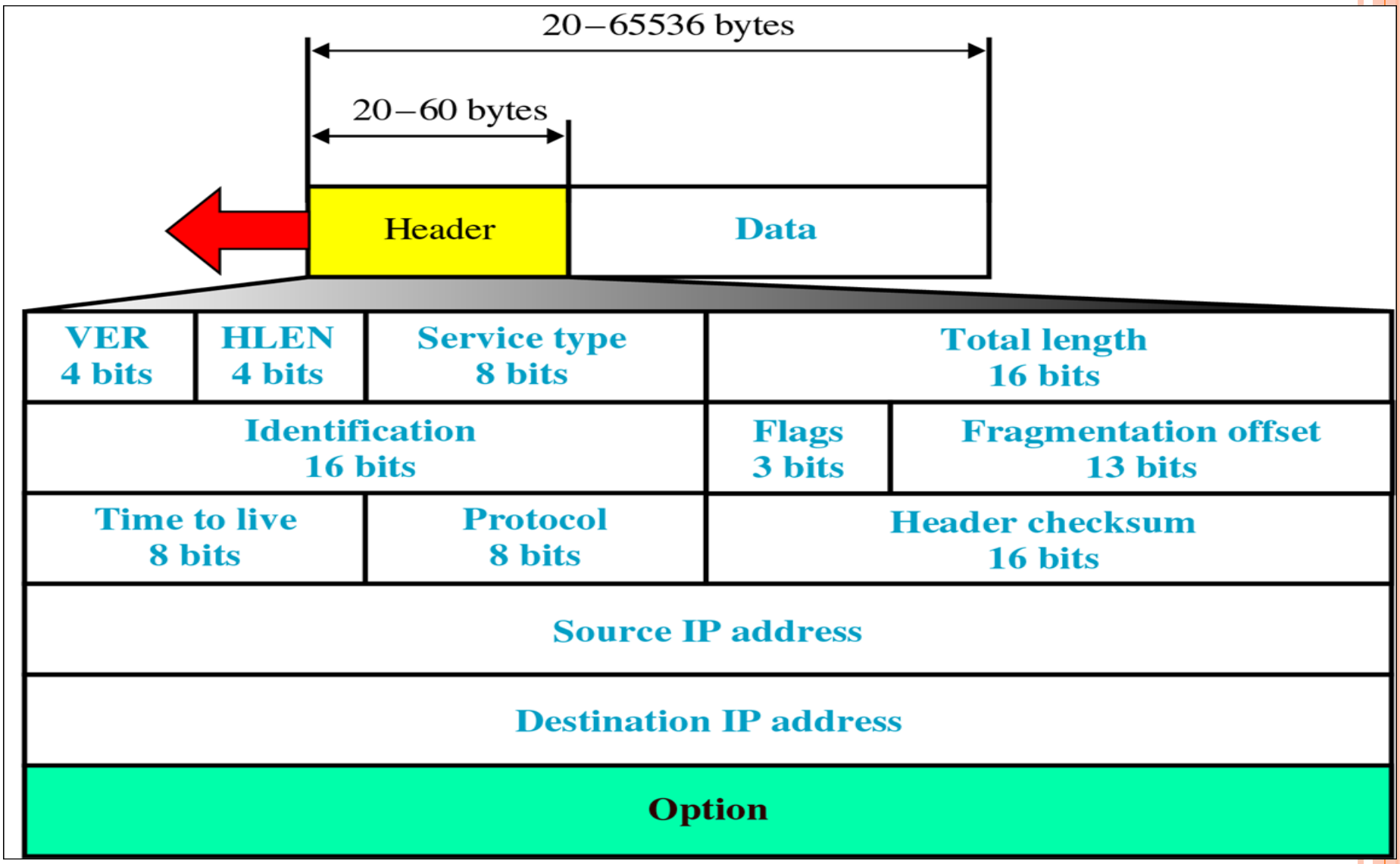


Routing and Switching : A Comparison

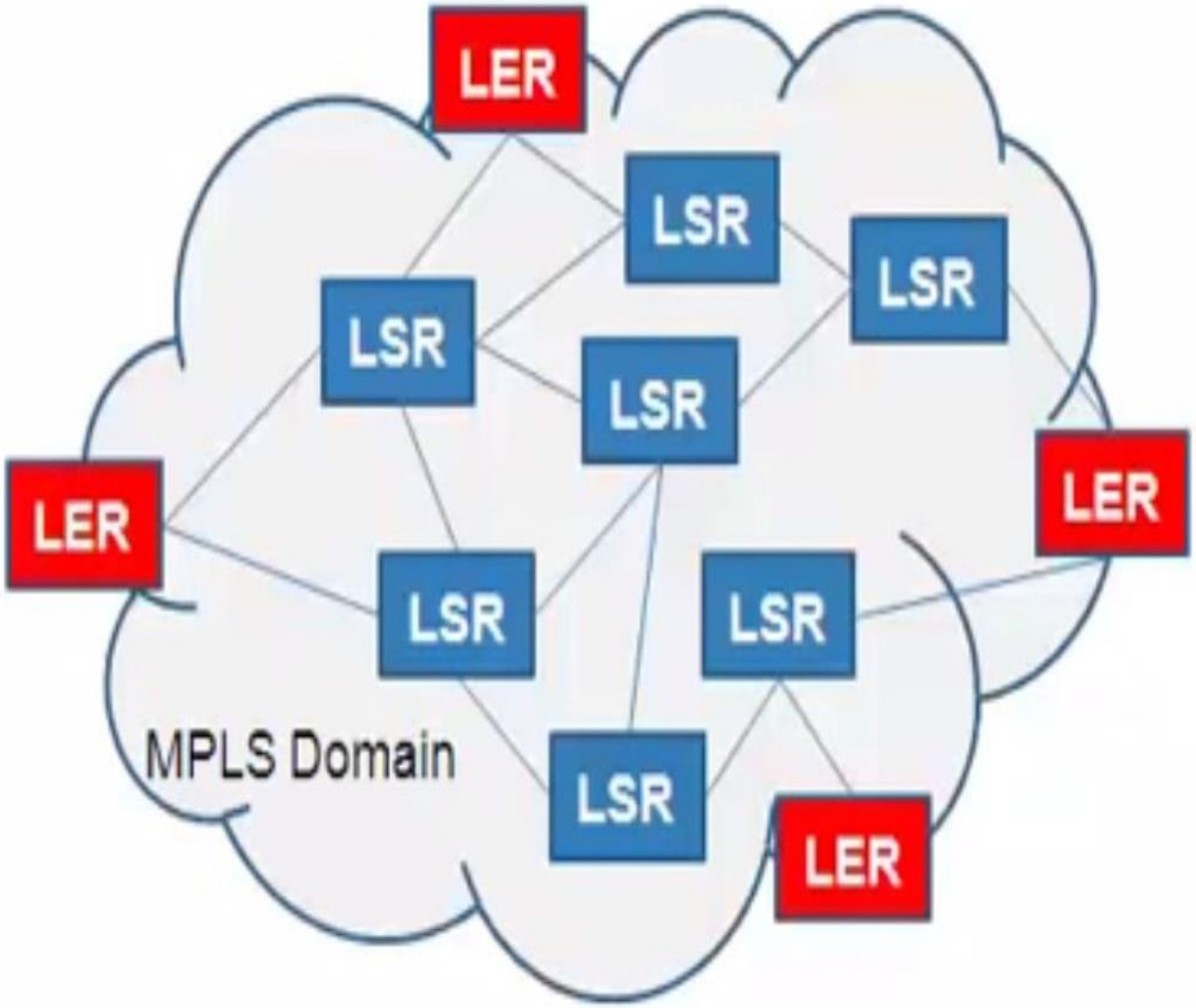


MPLS uses Best of Both Worlds: "Switch if possible, Route if necessary"

PACKET FORMAT



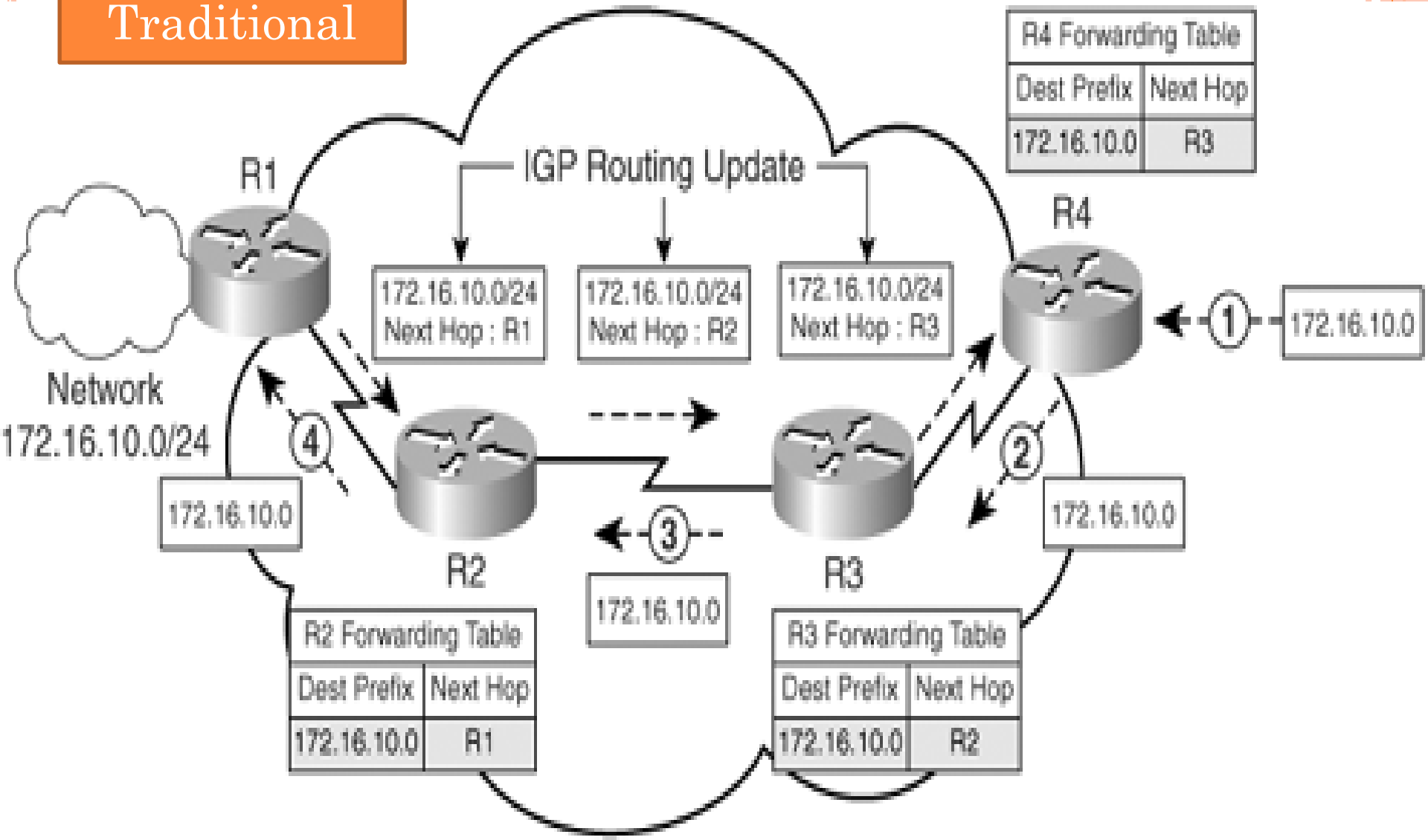
MPLS Domain Routers



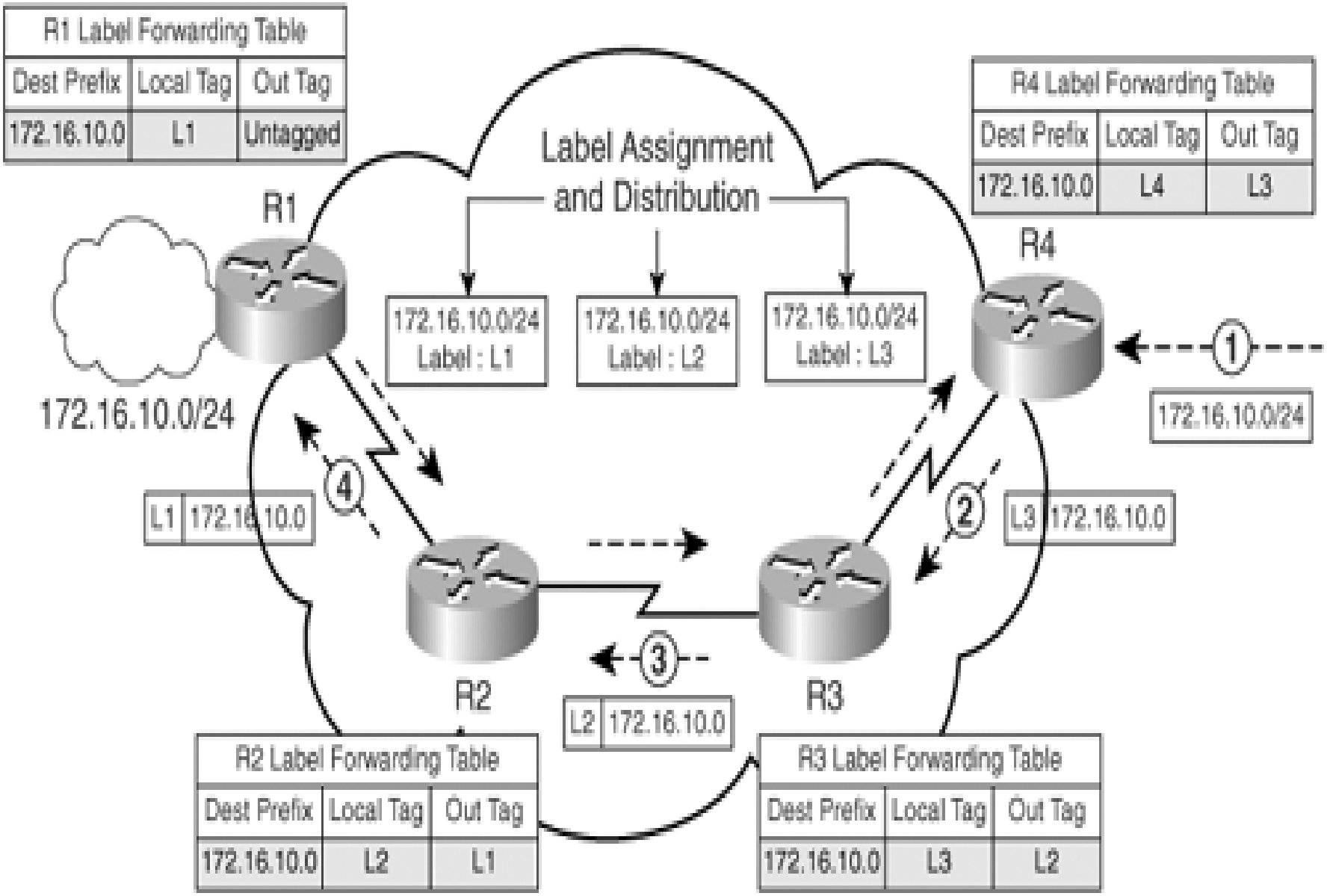
Label Switch Router
(LSR, Provider Router, P Router)

Label Edge Router
(LER, Edge LSR, Provider Edge Router, PE Router)

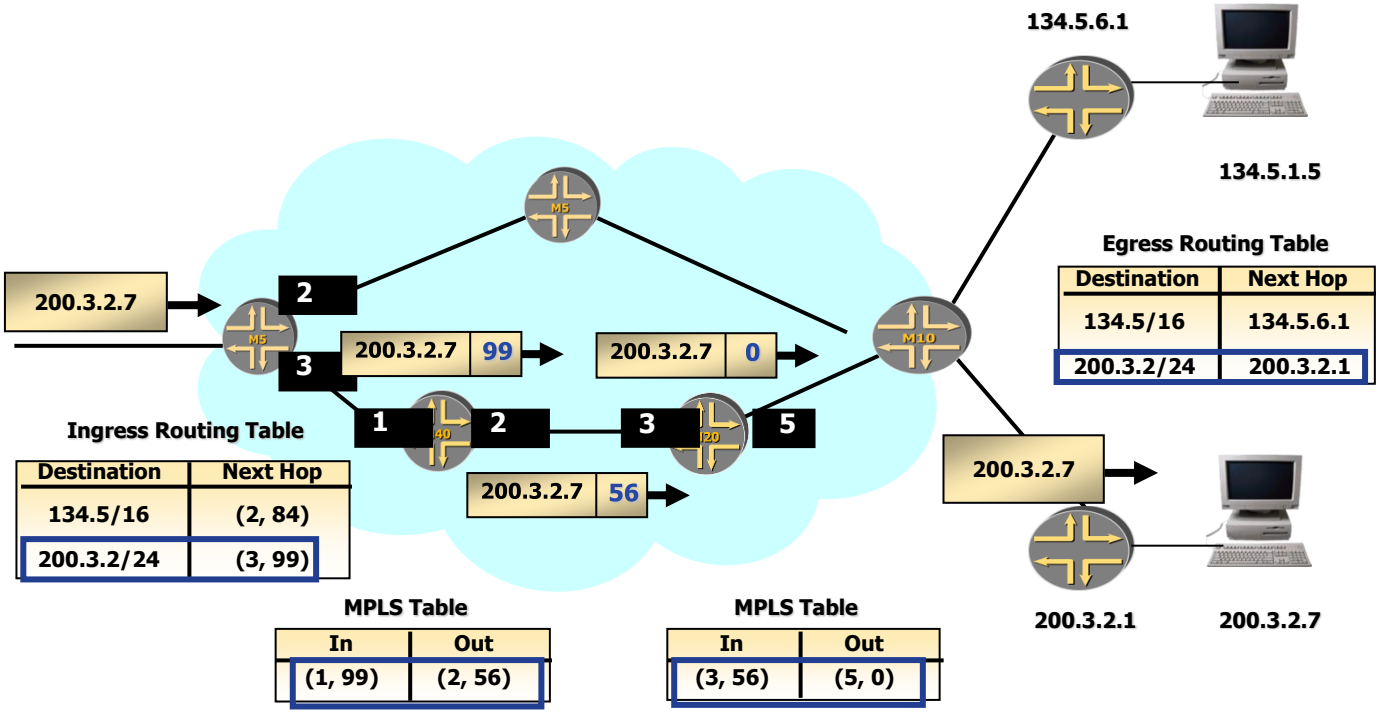
Traditional



Overview of MPLS Forwarding



TYPICAL EXAMPLE OF MPLS



The Ingress Label Edge Router : Adding a Label

IP Domain

MPLS Domain

Label is 'Pushed'

17

INGRESS LER

Table of Forwarding Equivalence Classes

Check F.E.C.

IP Header Info	Label
xxx.xxx.xxx.xxx	17
yyy.yyy.yyy.yyy	18
zzz.zzz.zzz.zzz	19

The Ingress Label Edge Router : Adding a Label

IP Domain

MPLS Domain

Label is 'Pushed'

INGRESS LER

Table of Forwarding Equivalence Classes

Check F.E.C.

IP Header Info	Label
xxx.xxx.xxx.xxx	17
yyy.yyy.yyy.yyy	18
zzz.zzz.zzz.zzz	19

The Label Switch Router : Swapping a Label

MPLS Domain

Label is 'Swapped'

LSR

CHECK L.I.B.

Label Info Base

Old	New
17	26
18	35
19	47

MPLS Domain

The Label Switch Router : Swapping a Label

MPLS Domain

Label is 'Swapped'

LSR

CHECK L.I.B.

Label Info Base

Old	New
17	26
18	35
19	47

MPLS Domain

The Egress Label Edge Router : Removing a Label

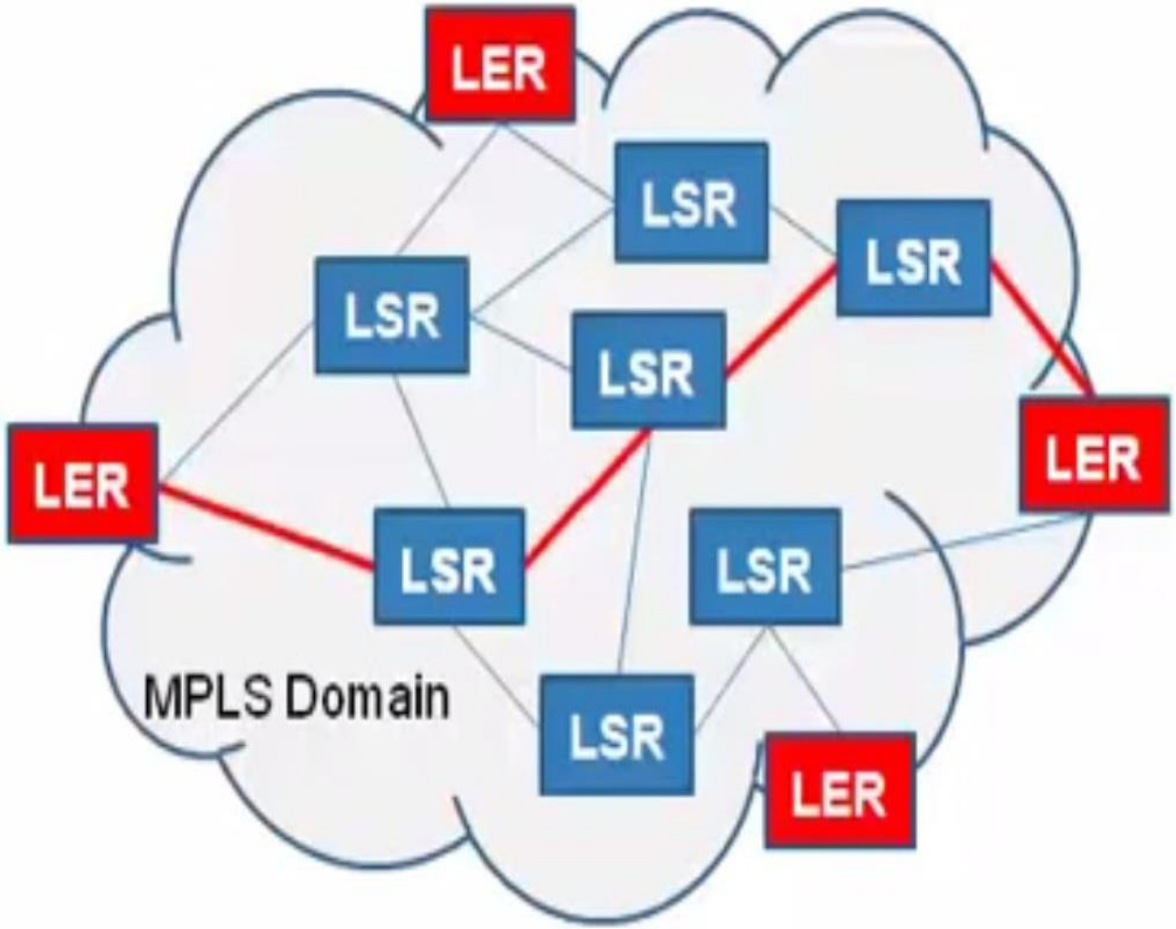
MPLS Domain

Label is 'Popped'

EGRESS LER

IP Domain

Label Switched Path



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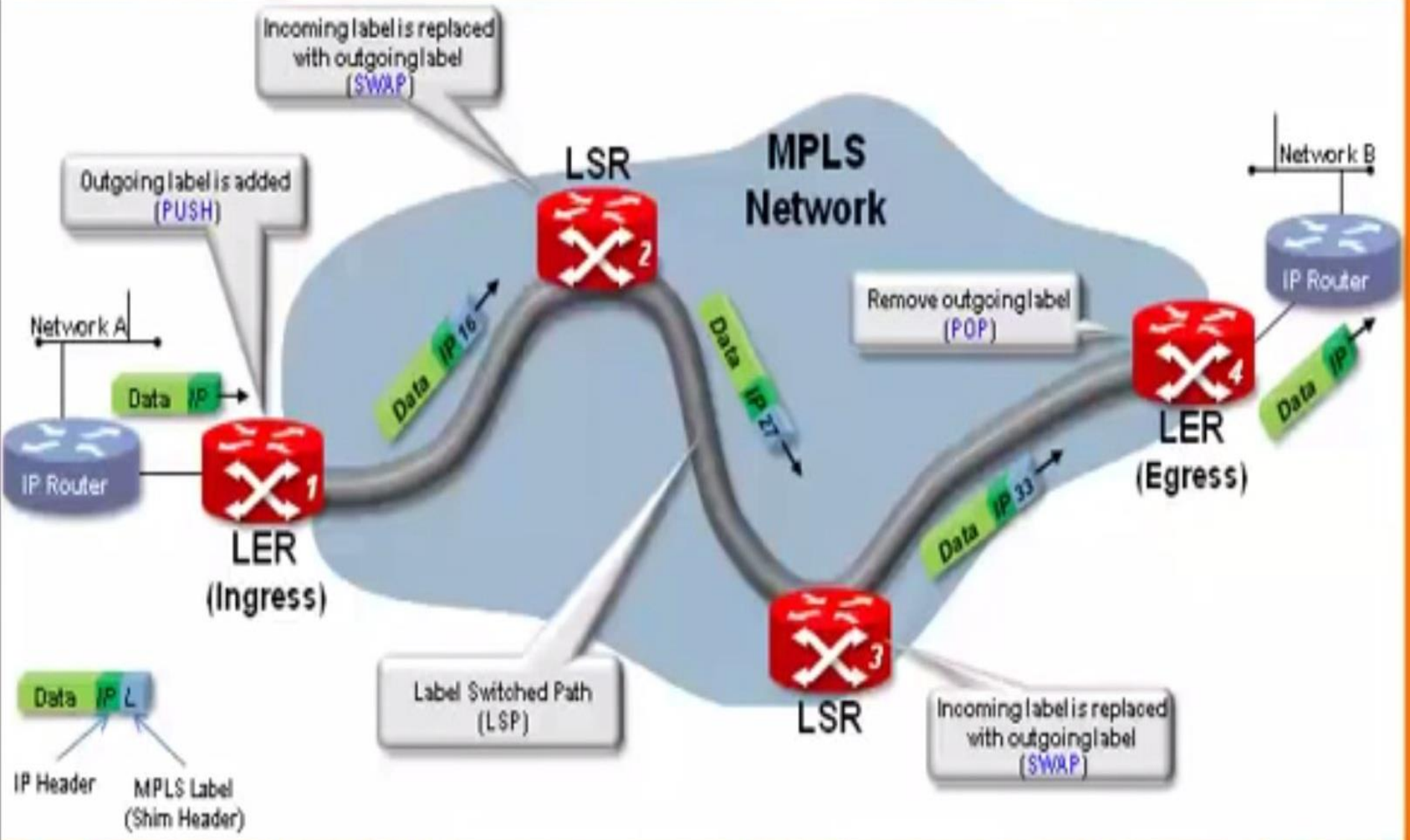
Label Switched Path
(LSP)
established by
LDP
(label distribution protocol)
or
RSVP-TE
(Resource Reservation Protocol – Traffic Engineering)

LSPs are Uni-Directional, the return path is a separate LSP!

Label Operations – (Push, Swap & Pop)



MPLS Terminology

Forwarding Equivalence Class (FEC)— The group of packets are forwarded in the same manner over the same path with the same forwarding treatment.

LER (Label edge router)---Boarder routers of MPLS domain where the adding or removing of the label will be taking place. These are also called as edge routers.

LSR (Label switched router)---These are the high speed routers in the core of the MPLS N/W. These are also called as core routers. These routers will swap the labels.

Any Doubts Please.....!

THANK YOU