Numbering systems

1 Hex digit = 4 binary bits

Hexadecimal	Binary	Decimal
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
A	1010	10
B	1011	11
C	1100	12
D	1101	13
E	1110	14
F	1111	15
1 0	0 0 0 1 0 0 0 0	1 6

Octal

0
1
2
3
4
5
6
7
10
11
12
13
14
15
16
17
20

Number	0	1	2	3	4	5	6	7
Binary	0000	0001	0010	0011	0100	0101	0110	0111
Hexadecimal	0	1	2	3	4	5	6	7

Number	8	9	10	11	12	13	14	15
Binary	1000	1001	1010	1011	1100	1101	1110	1111
Hexadecimal	8	9	A	B	C	D	E	F

LSD is on the right

Convert Binary to Decimal

Make the digit "1" to give it the decimal value.
The total sum of all the decimal values of digits with a "1" is equal to the decimal number.

0 + 64 + 0 + 16 + 0 + 0 + 0 + 1

64 + 16 + 1 = 81

1 2 3 4

XXX.XXX.XXX.XXX ← Octets

Octet 1 determine the IP class

IPv4

32 bits

Octets

Classes

Max = 255

Pvt Range

APIPA

Loopback

CLass	First Octet Range	Default Subnet Mask	Max Hosts	Format
A	1-126	255.0.0.0	16M	NETID: Network (1 Octet) . HOSTID: Host . Host . Host (3 Octet)
B	128-191	255.255.0.0	64K	NETID: Network . Network (2 Octet) . HOSTID: Host . Host (2 Octet)
C	192-223	255.255.255.0	254	NETID: Network . Network . Network (3 Octet) . HOSTID: Host (1 Octet)
D	224-239	N/A	N/A	Multicast Address: . . .
E	240-255	N/A	N/A	Experimental: . . .

Multicast

IP address Classes

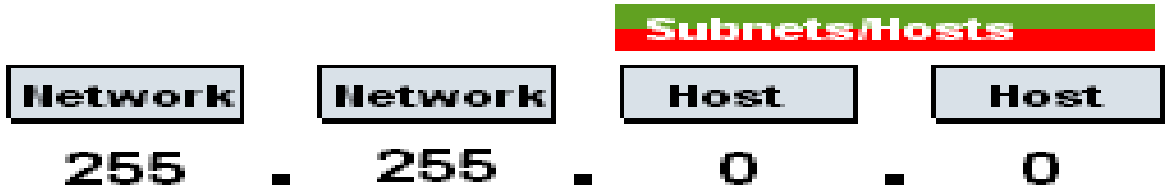
Class	# Network Bits	# Hosts Bits	Decimal Address Range	Subnet mask
Class A	8 bits	24 bits	1-126	N H H H 255.0.0.0
Class B	16 bits	16 bits	128-191	N N H H 255.255.0.0
Class C	24 bits	8 bits	192-223	N N N H 255.255.255.0
Class D	Reserved for Multicasting		224-239	N/A
Class E	Reserved for R & D		240-255	N/A

CLASS A (1-126)

Default subnet mask = 255.0.0.0

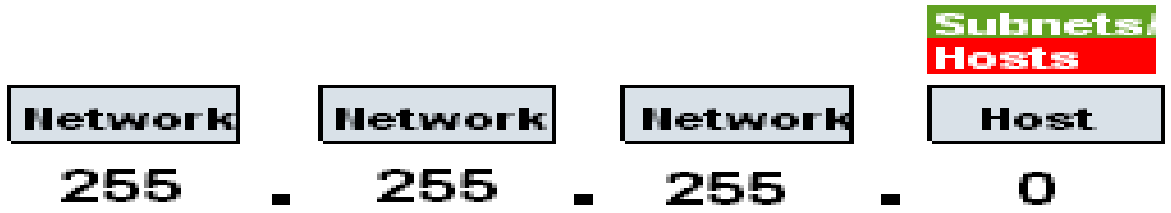
CLASS B (128-191)

Default subnet mask = 255.255.0.0



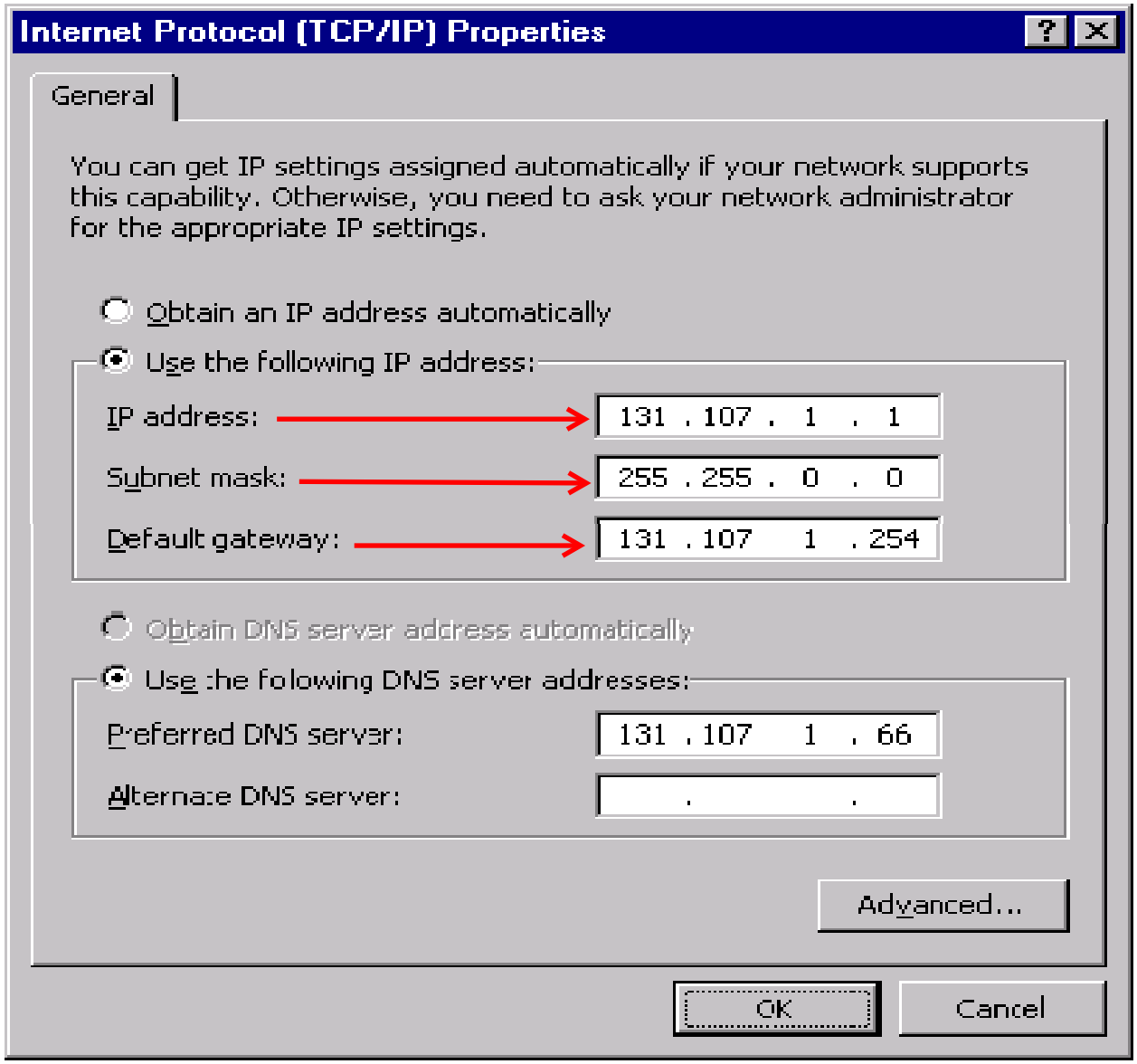
CLASS C (192-223)

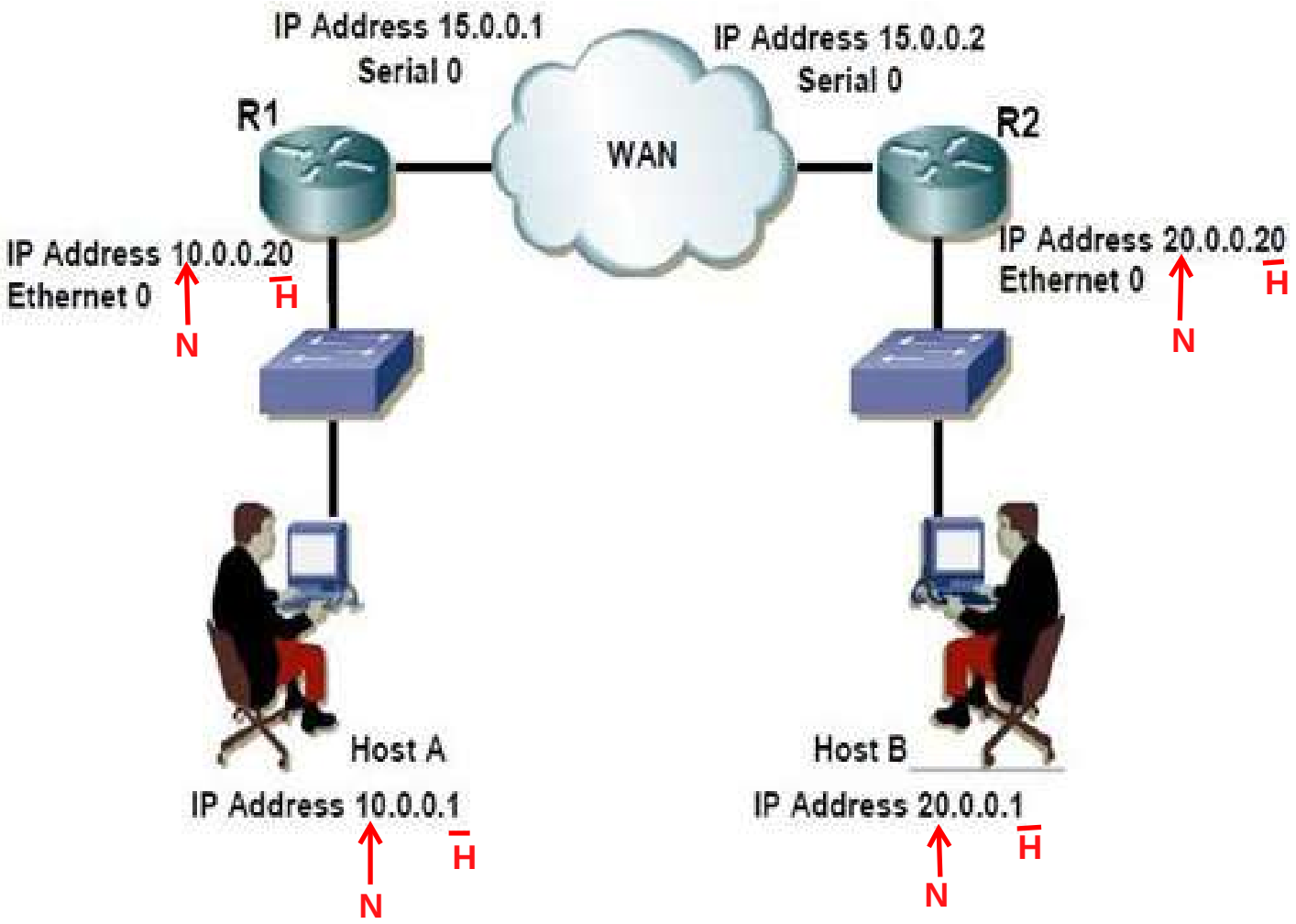
Default subnet mask = 255.255.255.0

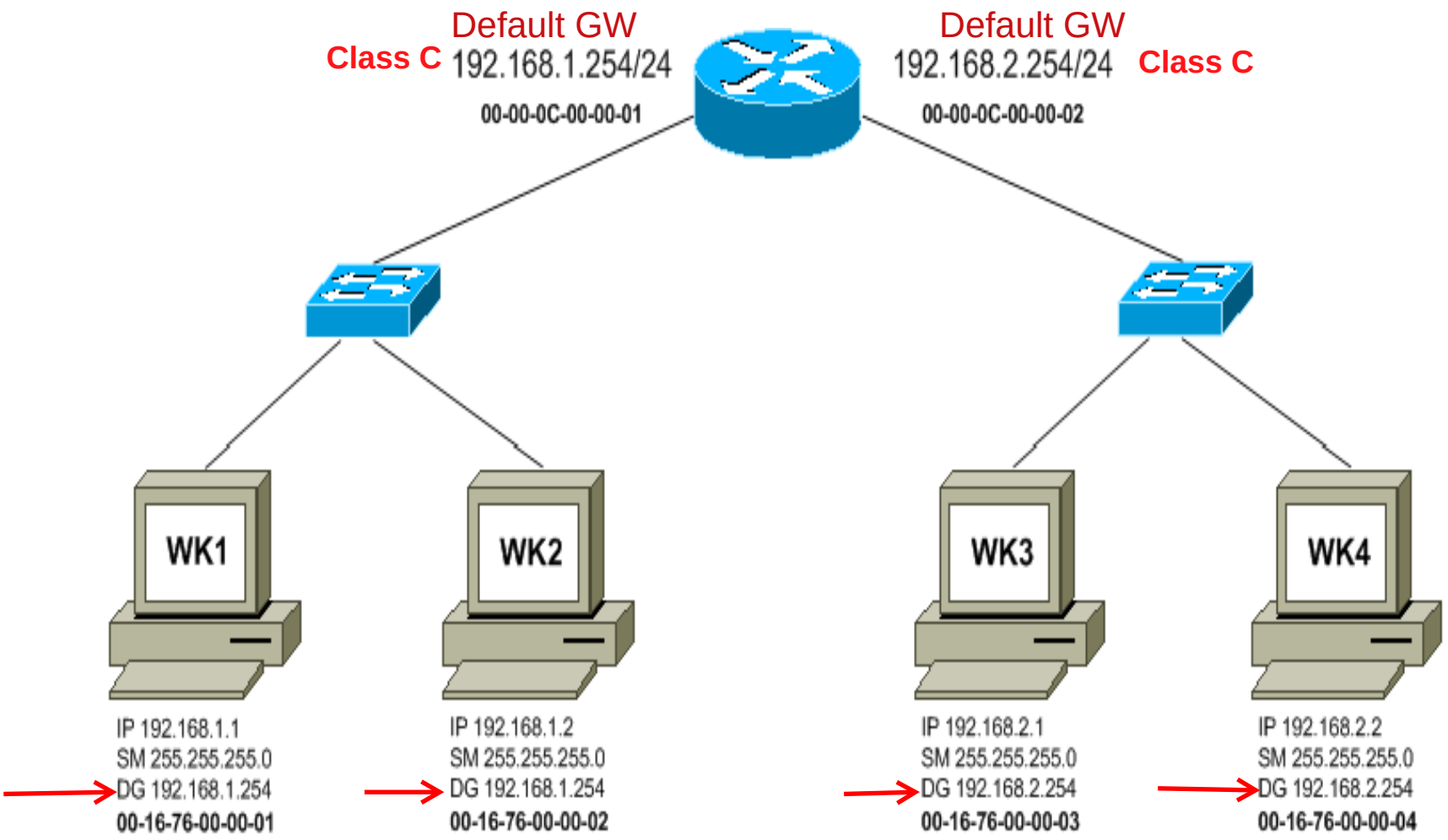


3 requirements for network access

1 - IP address
2 - Subnet mask
3 - Default GW

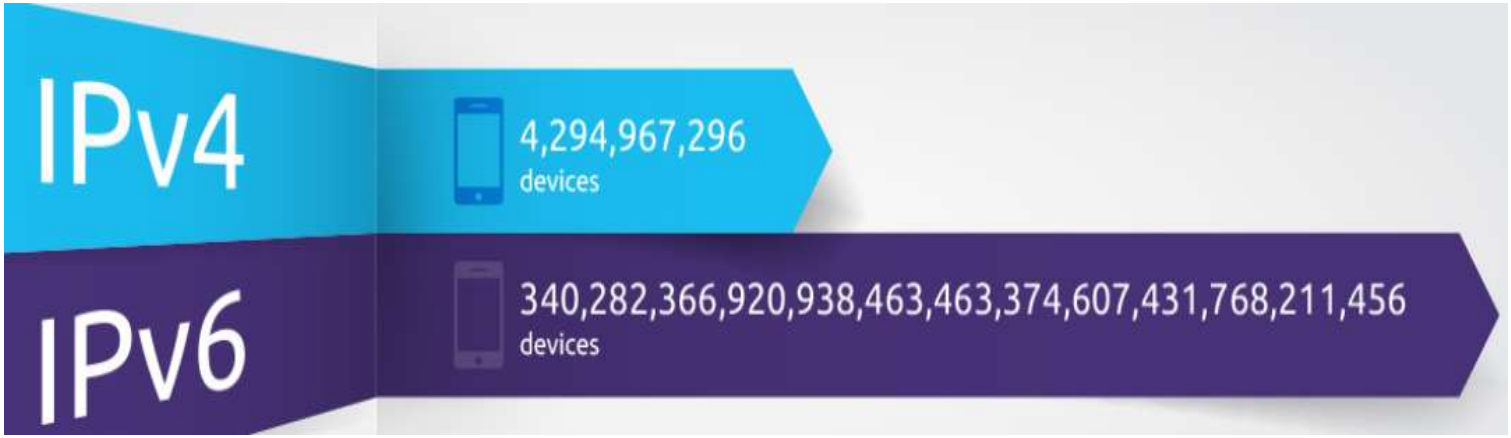


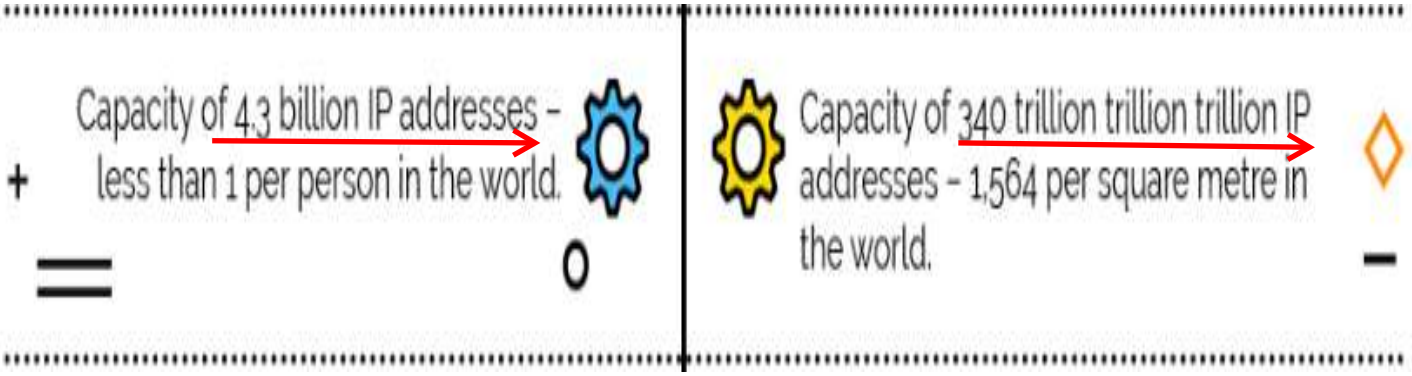

IP Address 15.0.0.1
Serial 0
IP Address 15.0.0.2
Serial 0
R1
R2
WAN
IP Address 10.0.0.20
Ethernet 0
N
H
IP Address 20.0.0.20
Ethernet 0
N
H
Host A
IP Address 10.0.0.1
N
H
Host B
IP Address 20.0.0.1
N
H


Default GW
Class C 192.168.1.254/24
00-00-0C-00-00-01
Default GW
192.168.2.254/24 Class C
00-00-0C-00-00-02
WK1
WK2
WK3
WK4
IP 192.168.1.1
SM 255.255.255.0
DG 192.168.1.254
00-16-76-00-00-01
IP 192.168.1.2
SM 255.255.255.0
DG 192.168.1.254
00-16-76-00-00-02
IP 192.168.2.1
SM 255.255.255.0
DG 192.168.2.254
00-16-76-00-00-03
IP 192.168.2.2
SM 255.255.255.0
DG 192.168.2.254
00-16-76-00-00-04

255	.	255	.	255	.	0
1 1 1 1 1 1 1 1	.	1 1 1 1 1 1 1 1	.	1 1 1 1 1 1 1 1	.	0 0 0 0 0 0 0 0
128 64 32 16 8 4 2 1	.	128 64 32 16 8 4 2 1	.	128 64 32 16 8 4 2 1	.	128 64 32 16 8 4 2 1

	Internet Protocol version 4 (IPv4)	Internet Protocol version 6 (IPv6)
Deployed	1981	1999
Address Size	32-bit number	128-bit number
Address Format	Dotted Decimal Notation: 192.149.252.76	Hexadecimal Notation: 3FFE:F200:0234:AB00: 0123:4567:8901:ABCD
Prefix Notation	192.149.0.0/24	3FFE:F200:0234::/48
Number of Addresses	2^{32} = ~4,294,967,296	2^{128} = ~340,282,366, 920,938,463,463,374, 607,431,768,211,456


IPv4
4,294,967,296
devices
IPv6
340,282,366,920,938,463,463,374,607,431,768,211,456
devices


Capacity of 4.3 billion IP addresses – less than 1 per person in the world.
Capacity of 340 trillion trillion trillion IP addresses – 1,564 per square metre in the world.

1 2 3 4 5 6 7 8
FE80:0000:0000:0000:00AB:0000:0000:0001
FE80 :: AB 0 : 0 : 1

IPv6: Address Compression

- Drop leading 0s in each group

  2001:0db8:0000:0000:0000:0053:0000:0004

  becomes

  2001:db8:0:0:0:53:0:4

- Replace the first group of 0s with ::

  2001:0db8:0000:0000:0000:0053:0000:0004

  becomes

  2001:db8::53:0:4

- Only one set of :: can exist in an address

WEP Replacement

➢ WPA

- Intermediate solution by Wifi-Alliance
- Use TKIP (Temporal Key Integrity Protocol)
  - Based on WEP
- Hardware change not required
- Firmware update

Personal — PSK

Enterprise — 802.1x + Radius

➢ WPA2

- Long Term Solution
- Use CCMP (Counter Mode Cipher Block Chaining Message Authentication Code Protocol)
- Based on AES
- Hardware Change Require

Personal — PSK

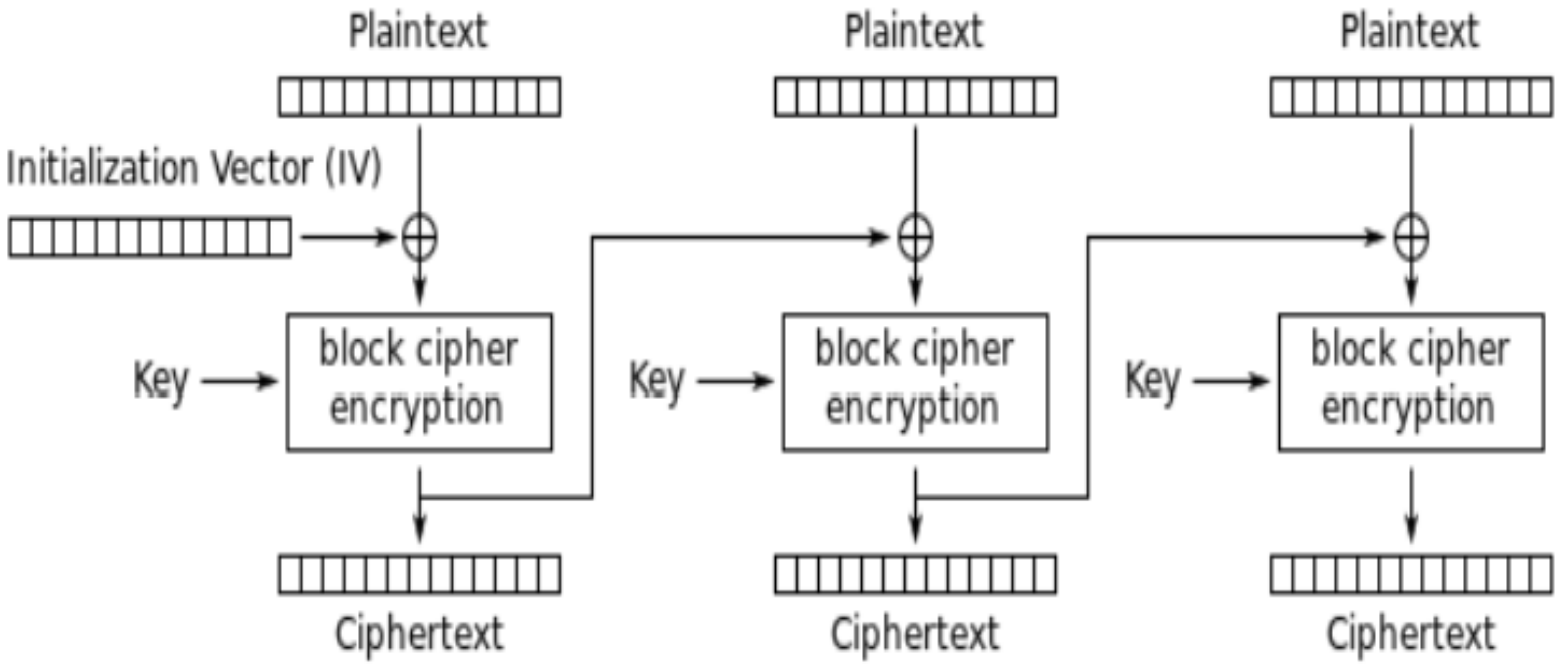
Enterprise — 802.1x + Radius

802.11 Wireless Standards

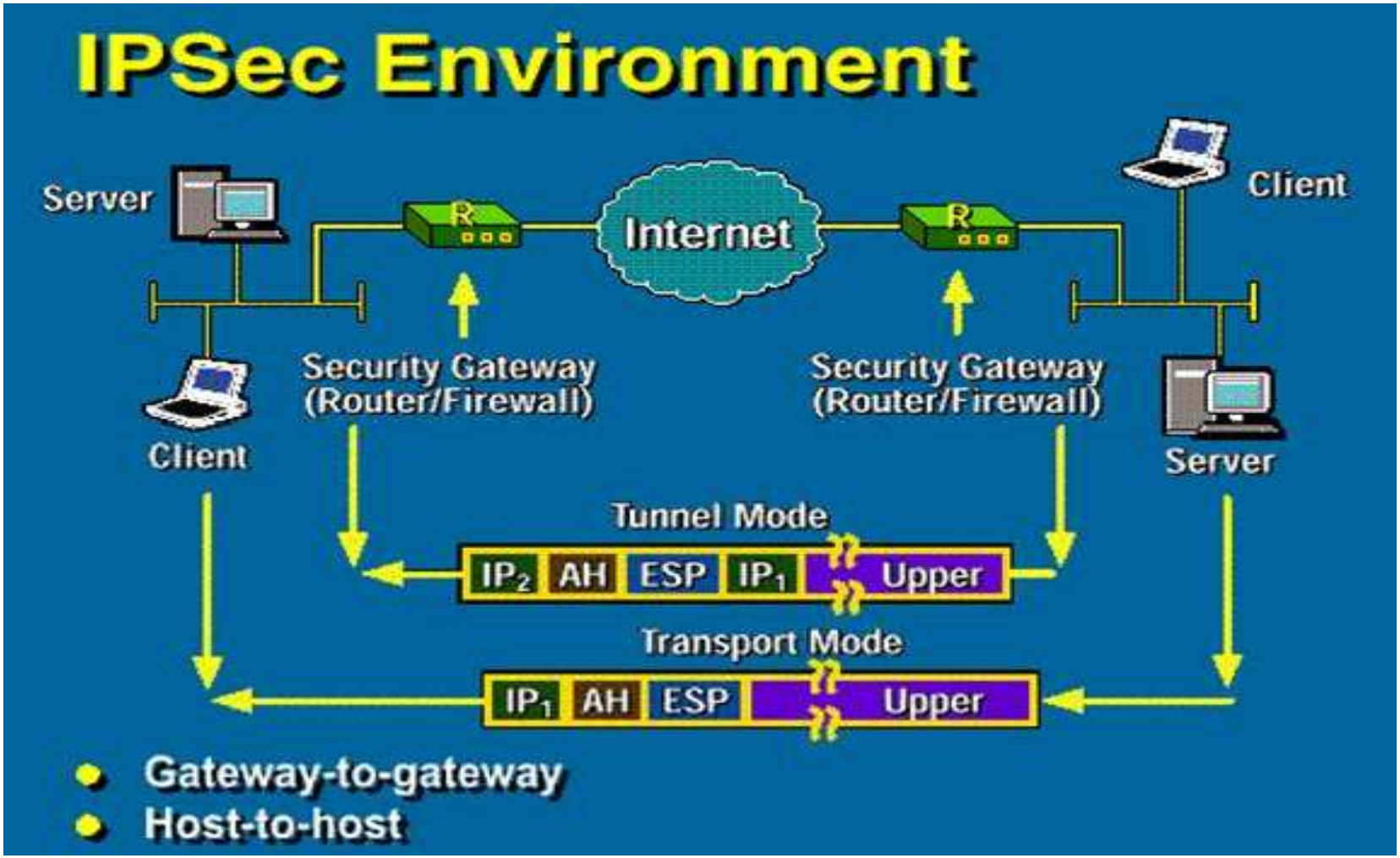
IEEE Standard	802.11a	802.11b	802.11g	802.11n	802.11ac
Year Adopted	1999	1999	2003	2009	2014
Frequency	5 GHz	2.4 GHz	2.4 GHz	2.4/5 GHz	5 GHz
Max. Data Rate	54 Mbps	11 Mbps	54 Mbps	600 Mbps	1 Gbps
Typical Range Indoors*	100 ft.	100 ft.	125 ft.	225 ft.	90 ft.
Typical Range Outdoors*	400 ft.	450 ft.	450 ft.	825 ft.	1,000 ft.

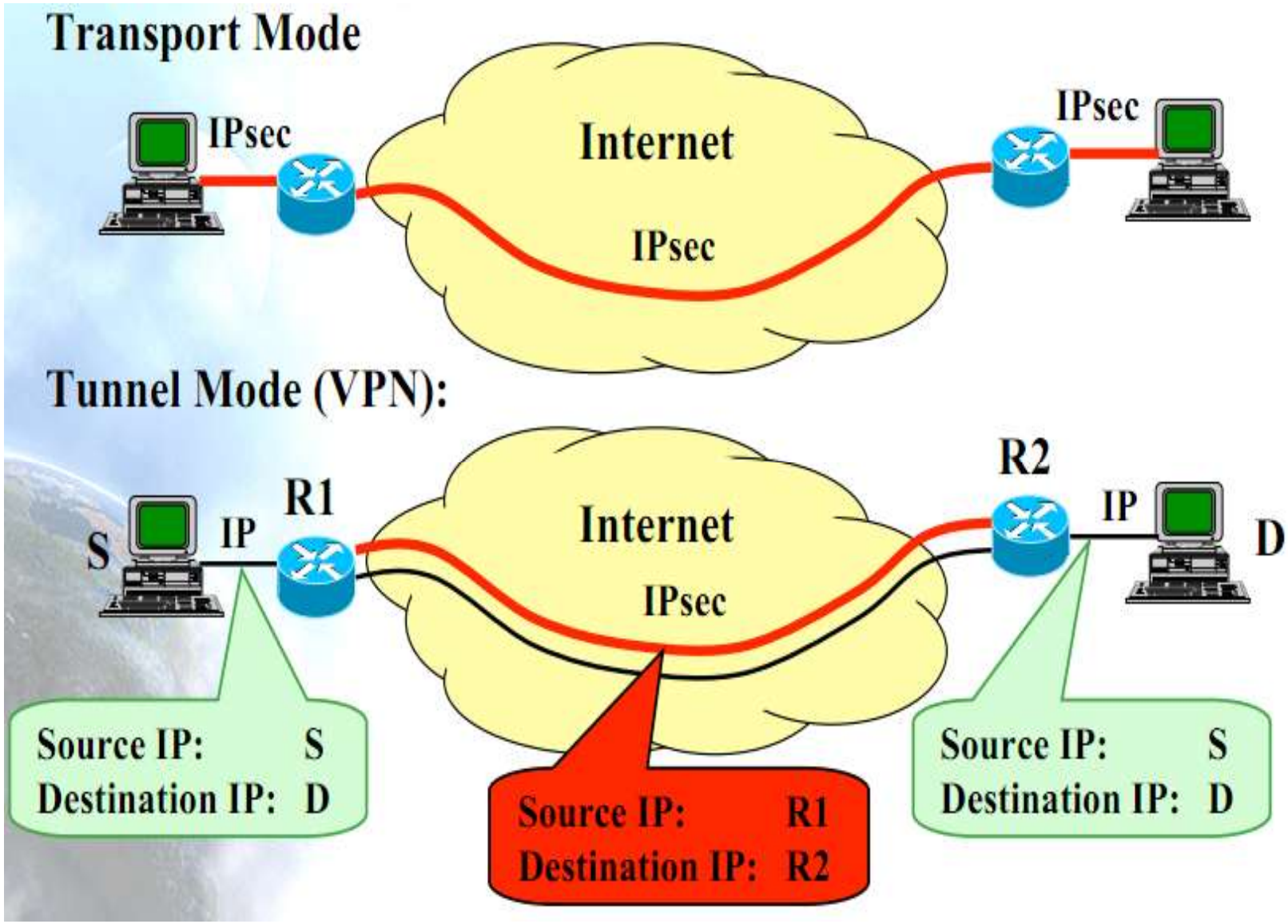
	Authentication	Encryption	Suitable for corporate WAN	Suitable for home and small business WLAN
WEP	none	WEP	poor	less than good
WPA (PSK)	PSK	TKIP	poor	best
WPA2 (PSK)	PSK	AES-CCMP	poor	best
WPA (full)	802.1x	TKIP	better	good (expensive)
WPA2 (full)	802.1x	AES-CCMP	best	good (expensive)

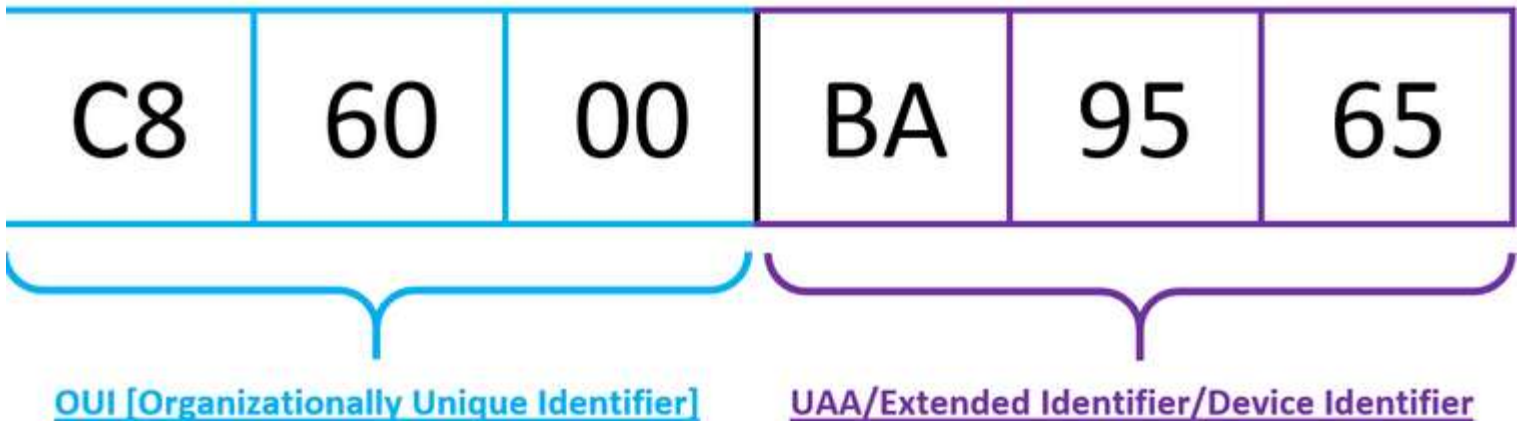
Cipher Block Chaining



Cipher Block Chaining (CBC) mode encryption


IPSec Environment
Server
Internet
Client
Client
Security Gateway
(Router/Firewall)
Security Gateway
(Router/Firewall)
Server
Tunnel Mode
IP2 AH ESP IP1 Upper
Transport Mode
IP1 AH ESP Upper
Gateway-to-gateway
Host-to-host


Transport Mode
IPsec
Internet
IPsec
IPsec
Tunnel Mode (VPN):
S
IP
R1
Internet
IPsec
R2
IP
D
Source IP: S
Destination IP: D
Source IP: R1
Destination IP: R2
Source IP: S
Destination IP: D


C8
60
00
BA
95
65
OUI [Organizationally Unique Identifier]
UAA/Extended Identifier/Device Identifier