Network Technology 2 –

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Slides are based on Chapters 6 and 7 in Accessing the WAN[6].

Introduction

- Teleworker Services,
- Broadband
- VPN
- DHCP
- NAT
- IPv6

Definition – Teleworker

"Teleworker is when an employee performs his or her job away from a traditional workplace, usually from a home office."[6]

Benefits

Teleworking Benefits

Teleworker Benefits:

Organizational benefits:

- Continuity of operations
- Increased responsiveness
- Secure, reliable, and manageable access to information
- Cost-effective integration of data, voice, video, and applications
- Increased employee productivity, satisfaction, and retention

Social benefits:

- Increased employment opportunities for marginalized groups
- Less travel and commuter related stress

Environmental benefits:

- Reduced carbon footprints, both for individual workers and organizations

Figure 1 : Benefits of being able to work remotely[6]

Technologies for remote connection

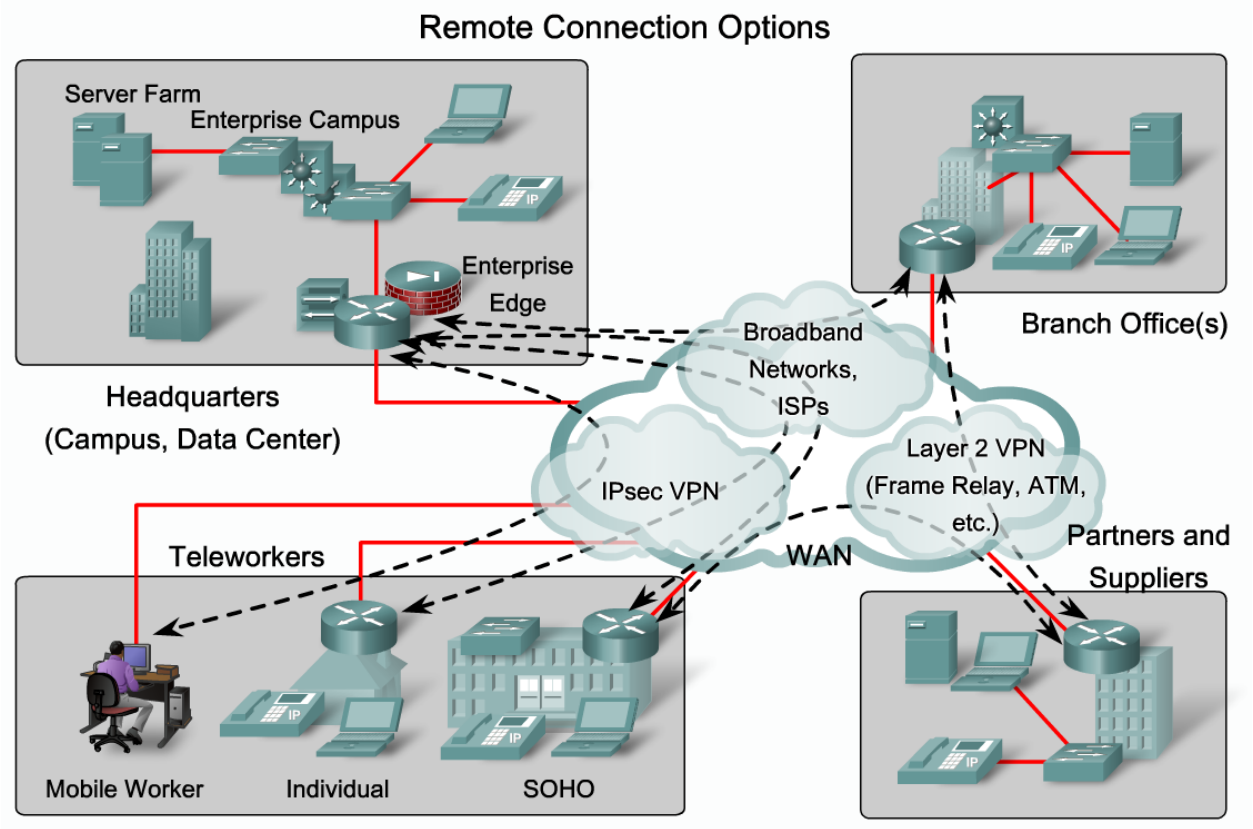


Figure 2 : Multiple ways to connect remotely. [6]

Broadband Services

Definition - Broadband

"A type of high-speed data transmission in which the bandwidth is shared by more than one simultaneous signal. " [3]

Broadband Technologies

- DSL.
- Fiber-optic.
- Coaxial Cable.
- Wireless.
- Satellite.

Components

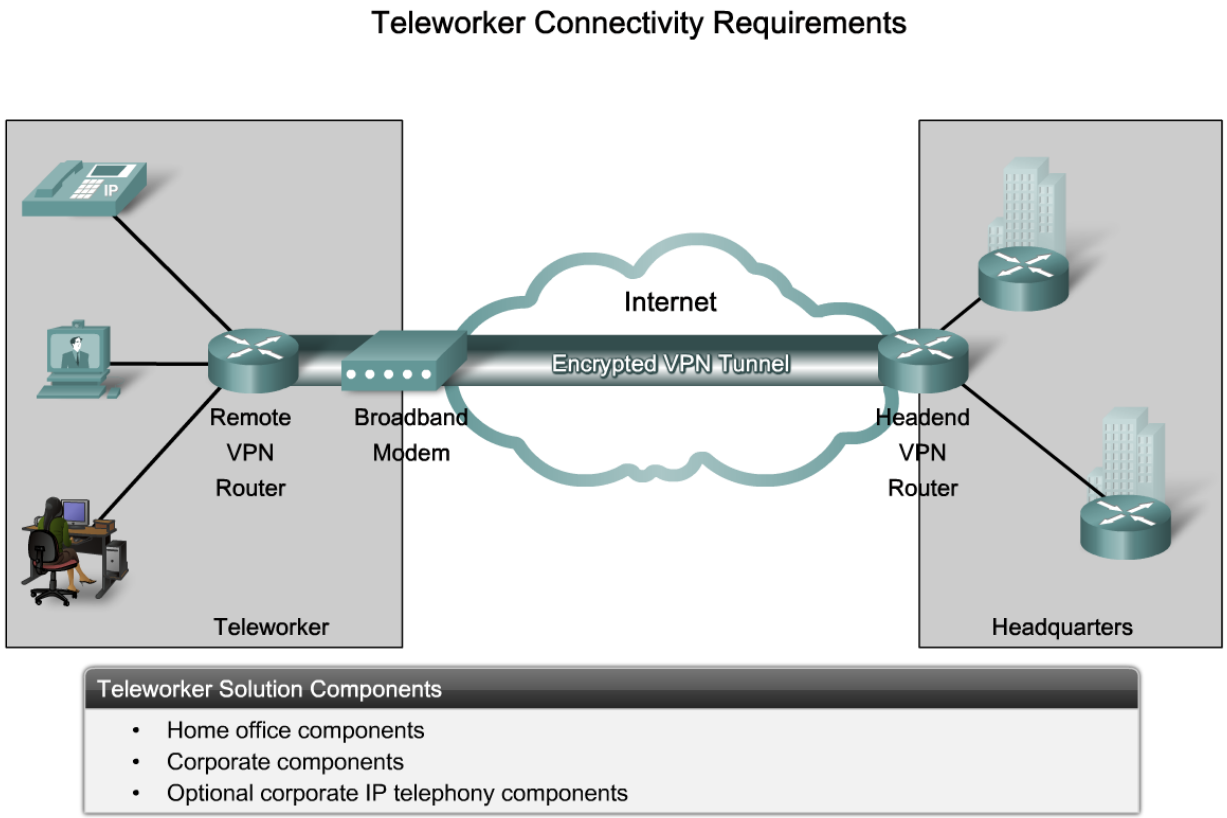


Figure 3 : Requirements for remote connections [6]

Connecting teleworkers

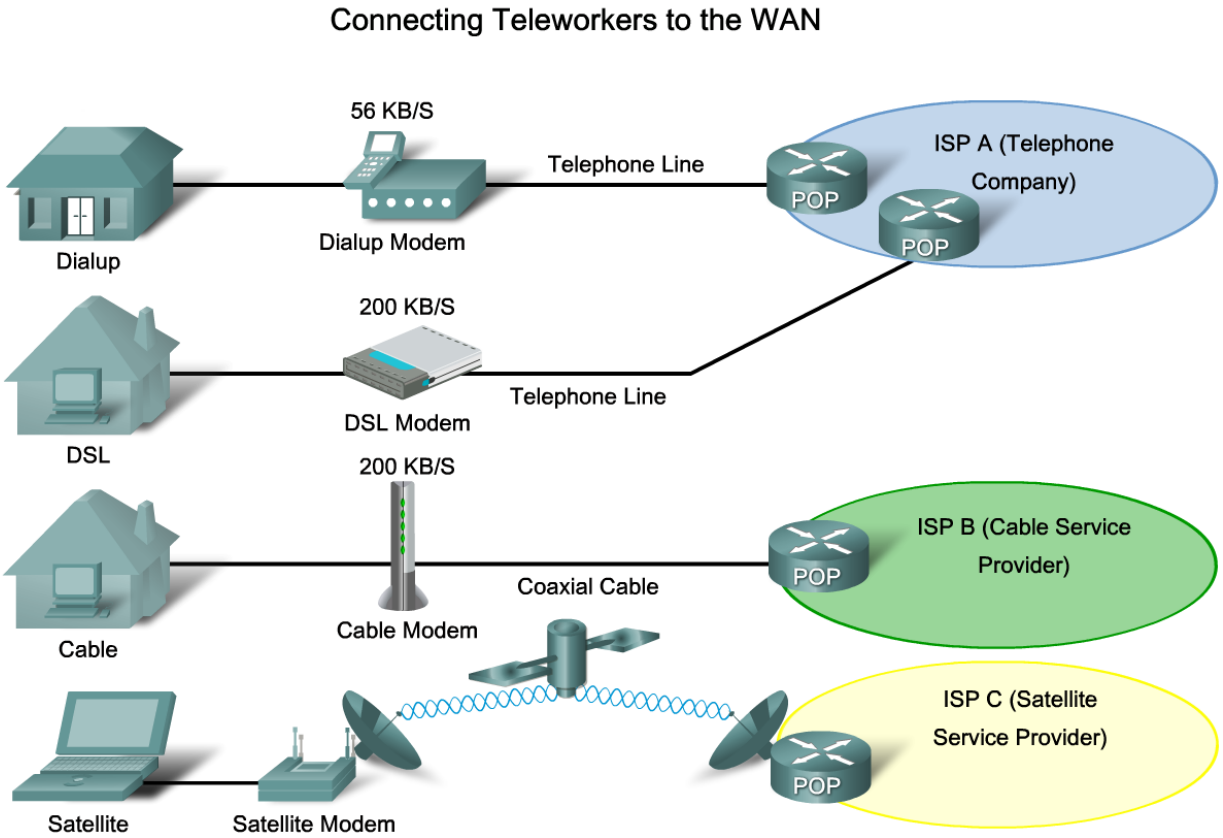


Figure 4 : Technologies to connect to a network [6]

Digital Subscriber Line

DSL

Digital Subscriber Line

DSL

- Provided by phone operators (Telia).
- Use the telephone lines.
- Cables support up to 1.1 Mhz (later 2.2 Mhz ADSL2+)
- More expensive than dial-up, but supports higher bit-rate.
- Speed vary based on distance to Central Office (CO).
- 200 Kb/s and higher.

DSL

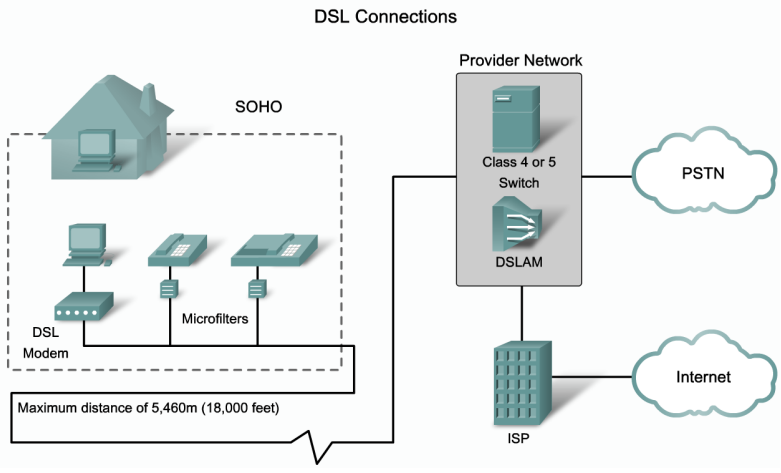


Figure 5 : Connecting DSL [6]

DSL

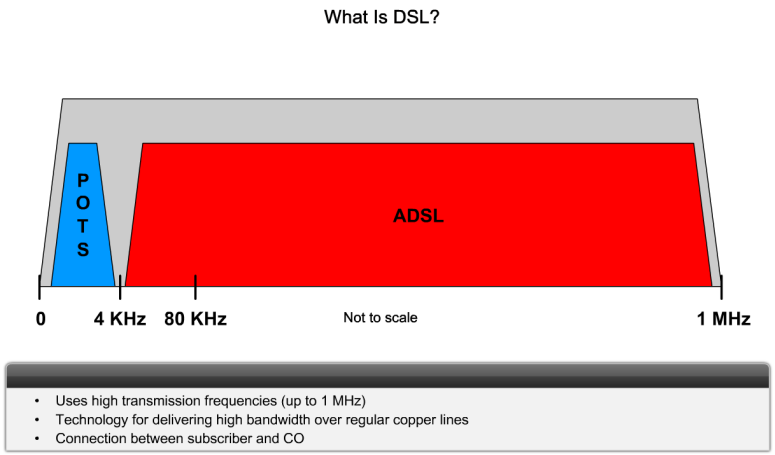


Figure 6 : DSL Bandwidth use [6]

- 256 channels.
- Each channel is 4kHz
- Channel 0 used for POTS.
- Channels 1-5 are unused.
- Usually around 25 channels used for upstream (one for control).
- The rest is for downstream (one for control).

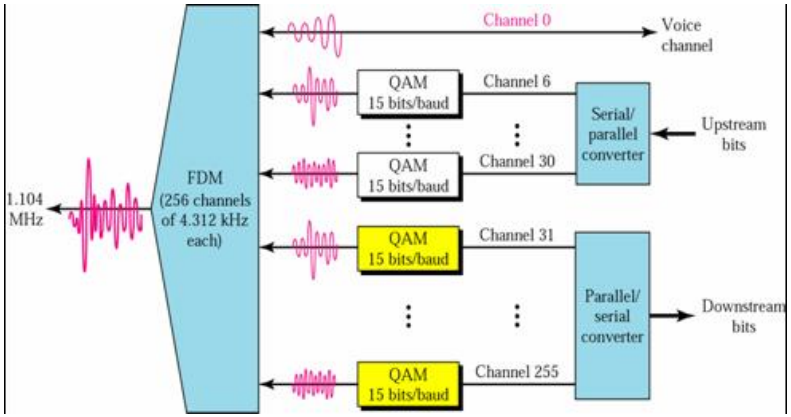


Figure 7 : Discrete Multitone Technique [4]

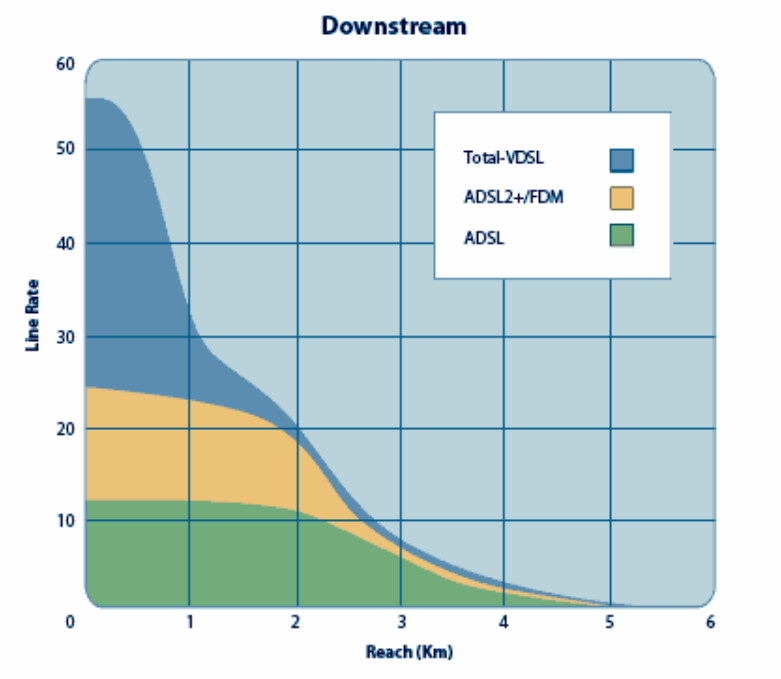


Figure 8 : Graph showing bandwidth versus distance in DSL [1]

Channel separation

Microfilter

Microfilter is a passive low-pass filter, One end connects to the phone, the other connects to the wall jack.

Splitter

A splitter separates the DSL-traffic from the POTS traffic. Located at the Central Office and at the customer.

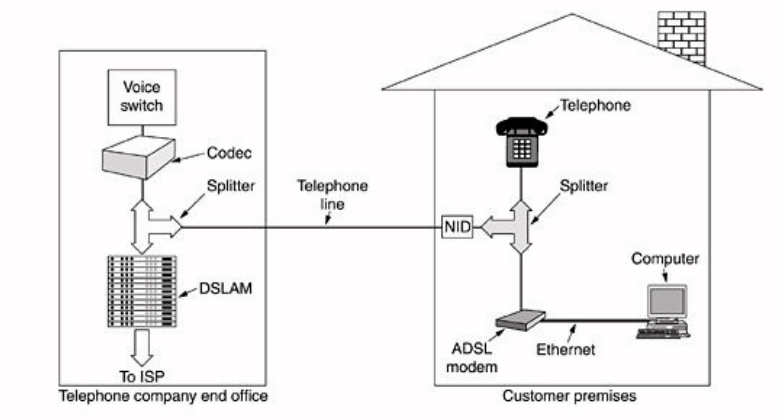


Figure 9 : A typical ADSL equipment configuration [5]

Cable Modem

Internet over Cable TV network

DMAs

TDMA

Time Division Multiple Access – Share the same frequency channel using timeslots.

FDMA

Frequency Division Multiple Access – Media is shared using different frequencies.

CDMA

Code Division Multiple Access – Share the same frequency channel using by using different codes.

Cable Modem

Internet access through coaxial cables.

- Usually provided through a Cable TV provider (Com Hem).
- Same cable as used to provide TV.
- Cable usually handles 750Mhz up to 1Ghz.
- Speeds from 200Kb/s and higher.
- Not affected by distance to ISP.
- Affected by number of subscribers.

CATV

Community Antenna Television

- Invented by John Walson in 1948.
- Poor TV reception.
- Erected an antenna at local mountaintop and connected the antenna to his store using a cable and signal boosters.

Community Antenna Television (CATV)

Components in Cable-TV network

- Antenna site – Placed for optimum signal reception. 7
- Headend – Receives the signals from the Antenna, and then distributes the signal.
- Distribution Network – Network to distribute the signal to all subscribers.
- Subscriber drop – Connects the subscriber to the distribution network.

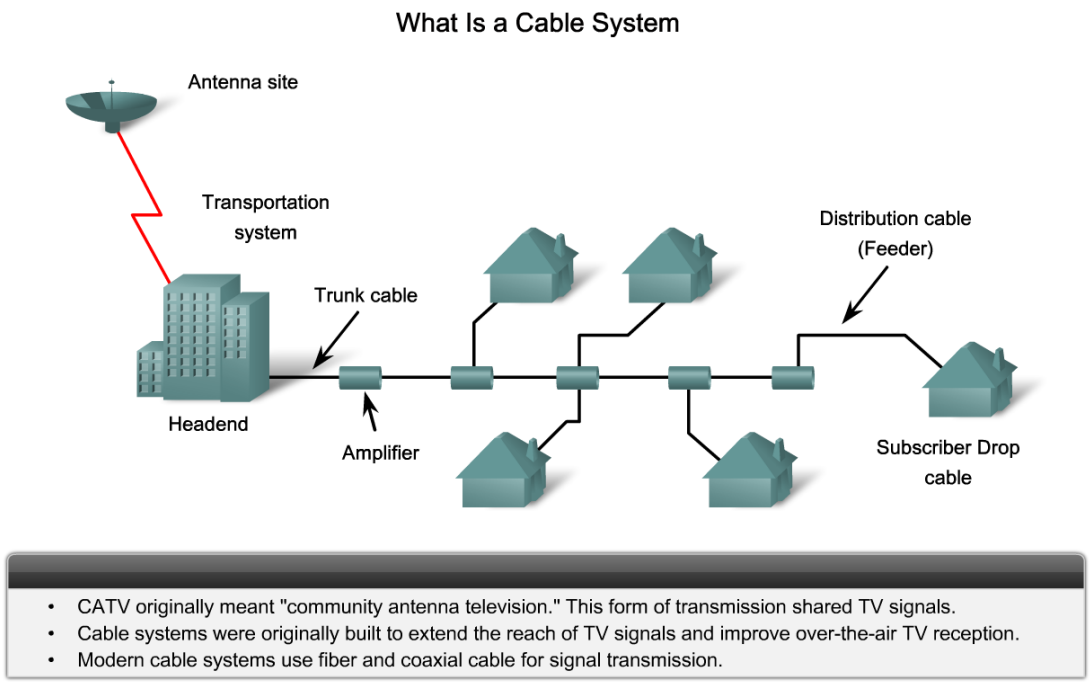


Figure 10 : Cable TV connection [6]

Hybrid Fiber-Coaxial network (HFC)

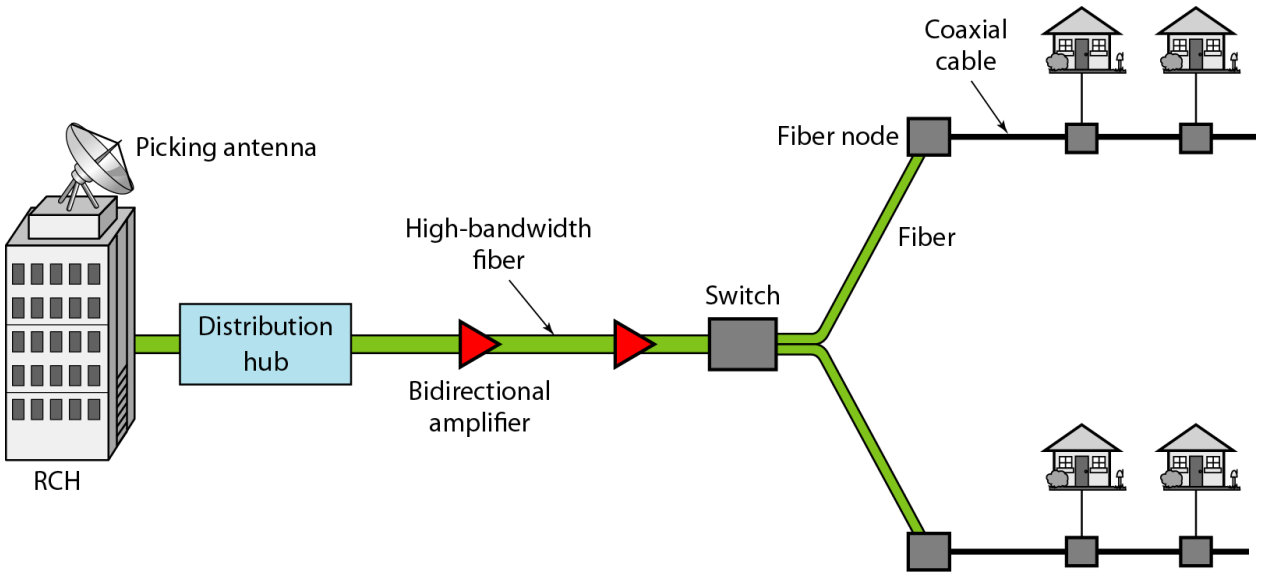


Figure 11 : Hybrid Fiber-Coaxial Network [4]

Cable TV for Data transfer

Cable TV companies started using the same network to distribute internet access.

Data over Cable TV network

- TV only needed 496Mhz out of 750Mhz.
- The rest of the frequency band could be used for data transfer.

Spectrum Allocation

Channels

- Each channel occupy 6-8 Mhz.
- Downstream – 6bits/baud.
  - 1 bit for FECN.
  - 5 bit data/baud.
  - The standard specifies 1 Hz for each baud.
- Upstream – 2 bits/baud.
  - Lower frequencies means more susceptible to noise. Other modulation technique.
  - The standard specifies 1 Hz for each baud.

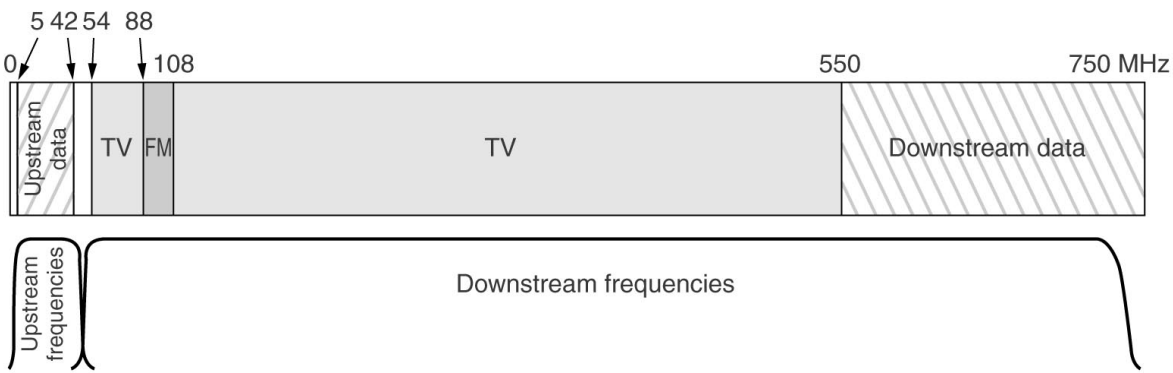


Figure 12 : Frequency allocation in coaxial network [5]

Sending data over Cable TV Network.

Equipment

- CMTS – Cable Modem Termination System
  - Placed in the distribution hub.
  - Receives data from the internet and sends it to a combiner.
  - Receives data from the subscriber and send it out to the internet.
- CM – Cable Modem.
  - Placed at the subscriber.
  - Modulates and demodulates the signal, same as an ADSL modem.
  - A filter is needed at the subscriber to separate Video from Data.

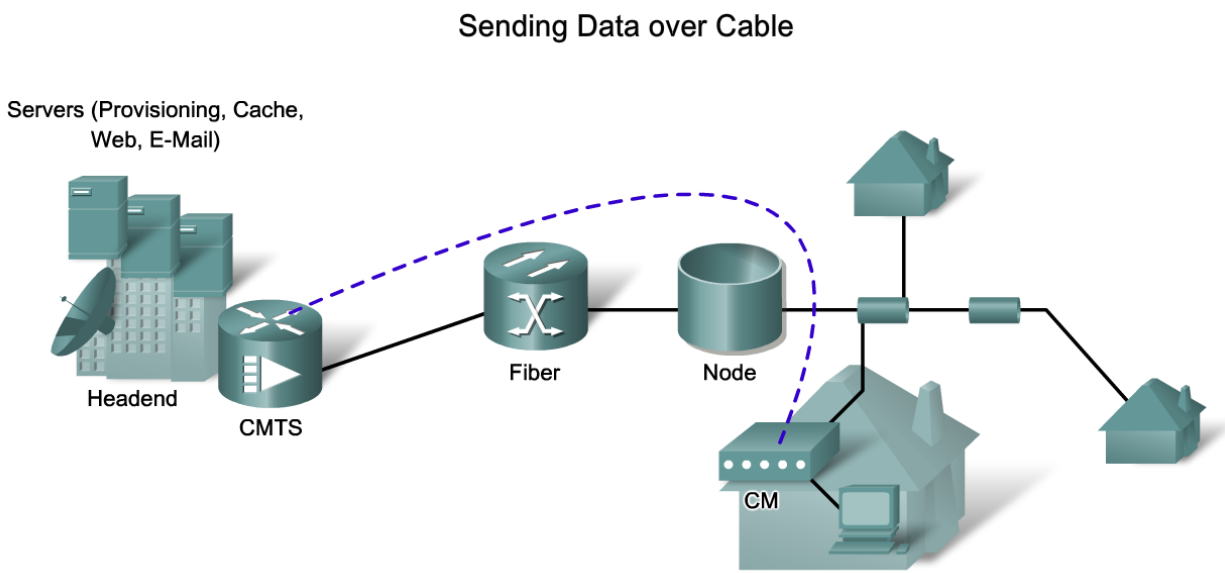


Figure 13 : Sending data over cable [6]

Sharing

Sharing upstream bands

- Upstream data band is 37Mhz = 6 Channels upstream.
- Upstream data band is divided into channels using TDM.
- Each subscriber is given a mini-slot (usually 8 bytes).
- A timeslot can be shared, then a CDMA scheme can be used.

Sharing downstream bands

- Downstream data band is 200Mhz = 33 Channels downstream.
- Only one sender, no contention.
- 204 bytes packet (184 bytes payload)

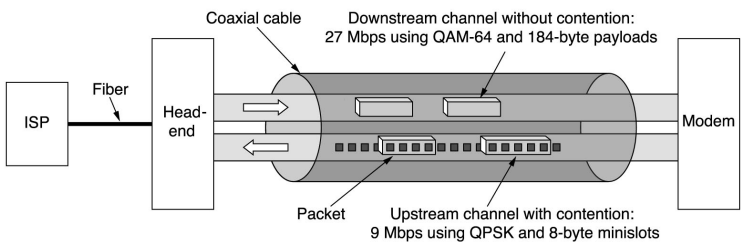


Figure 14 : Upstream and Downstream channels (North America) [6]

VPN

Virtual Private Networks

Public versus private network infrastructure

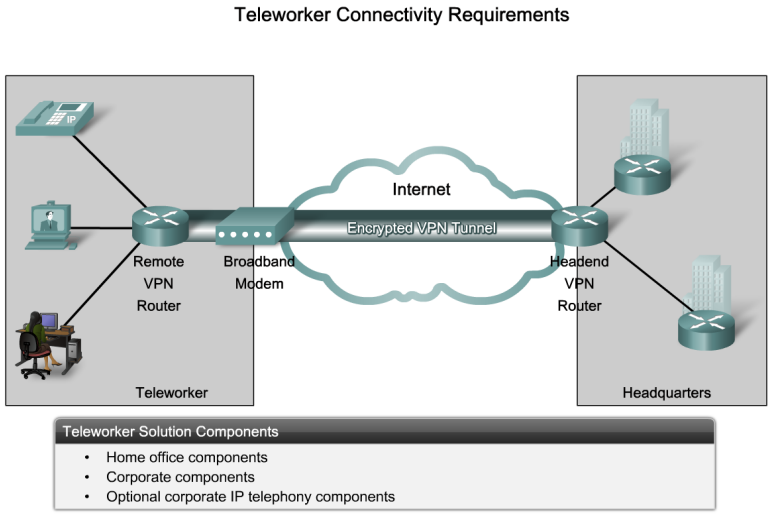


Figure 15 : Private and public network infrastructure [6]

VPN

Virtual Private Network

Allows us to securely connect to a remote network over a public network.

Virtual and Private

- Virtual
  - A virtual network is established over the public network, usually with the help of tunneling.
- Private
  - Measures are taken such that the data sent over this virtual network is kept secret from the public network, usually with the help of an encryption technique.

Benefits of VPNs

- Cost – A simple internet connection can be used to establish a WAN-connection.
- Security – Privacy is ensured using strong encryption and authentication mechanisms.
- Scalability – Allows use over existing infrastructure.

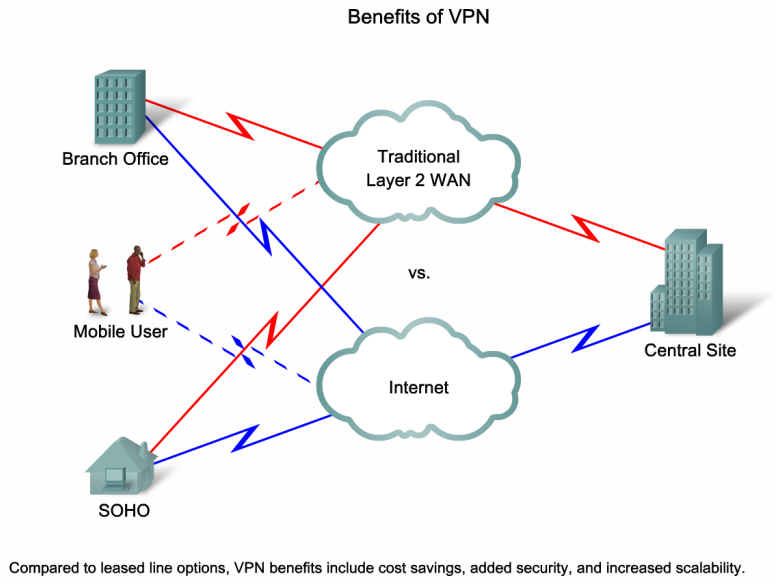


Figure 16 : Benefits of VPNs [6]

Types of VPNs

Site-to-Site

Provides access between two sites.

Remote-access VPNs

Provides remote users a connection to the company or organisations intranet.

Site-to-Site VPNs

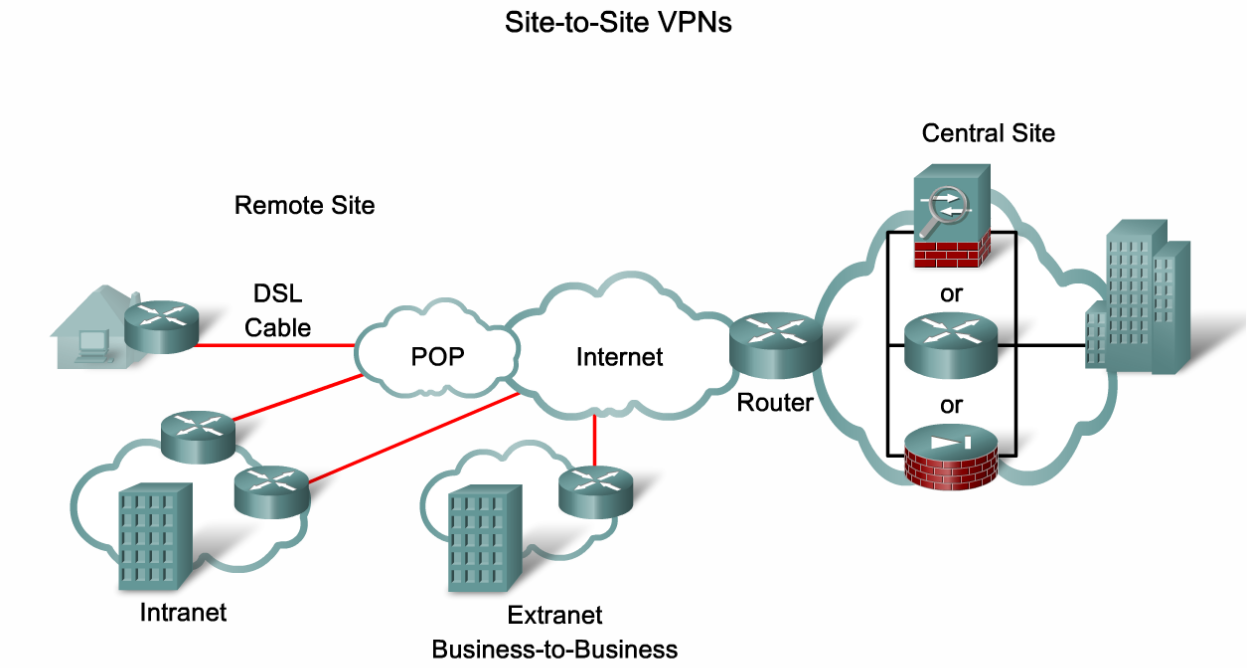


Figure 17 : A Site-to-Site VPN [6]

Remote-access VPNs

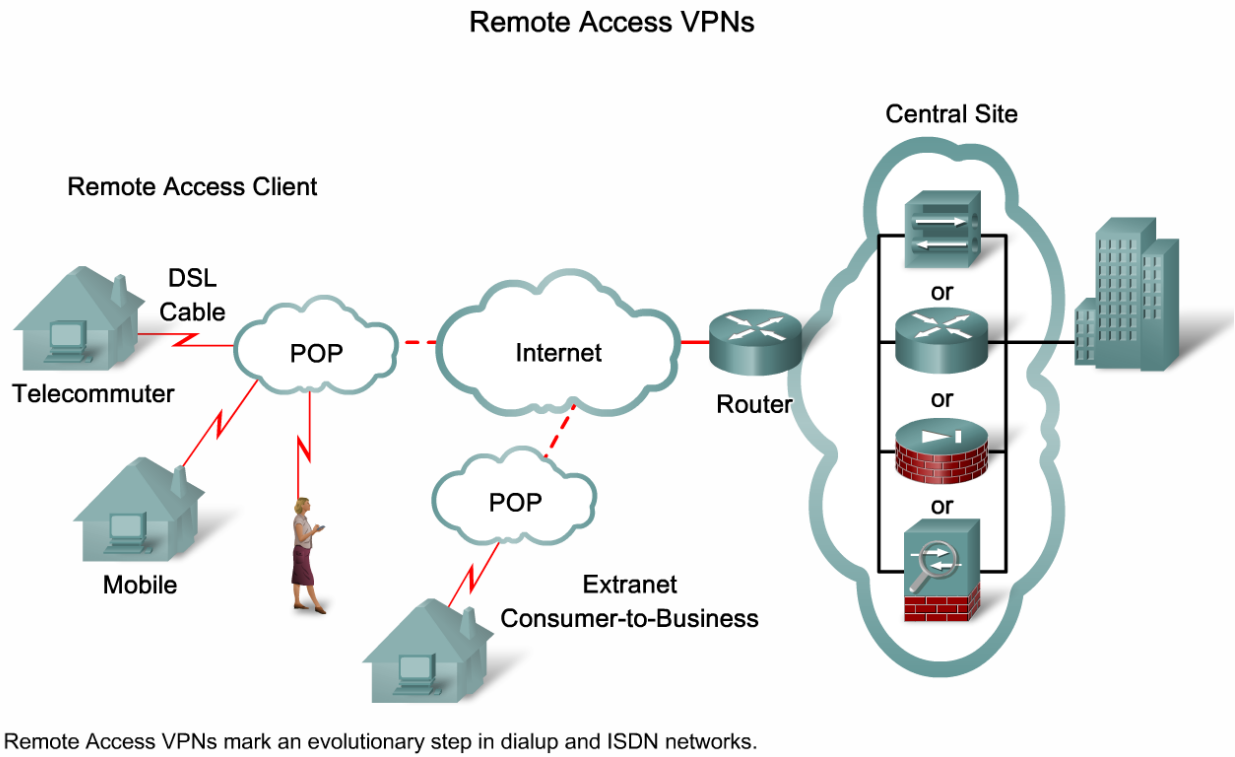


Figure 18 : A Remote-access VPN [6]

VPN Components

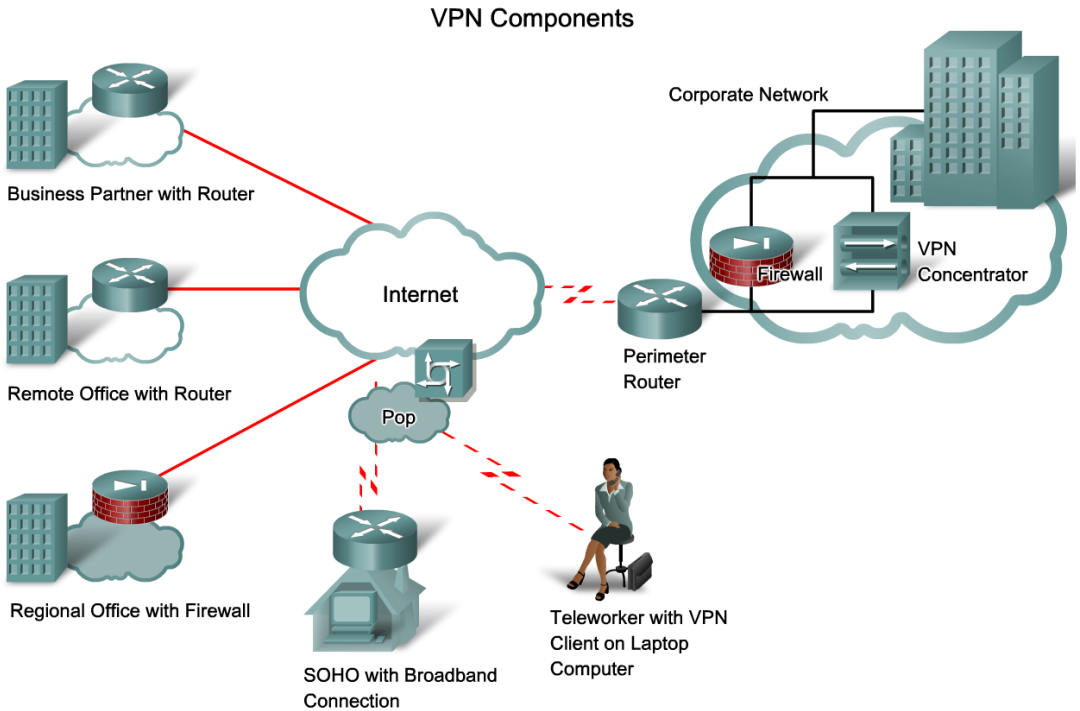


Figure 19 : Components of a VPN [6]

Characteristics

Characteristics of Secure VPNs

Characteristic	Purpose
Data Confidentiality	Protects data from eavesdroppers (spoofing).
Data Integrity	Guarantees that no tampering or alterations occur.
Authentication	Ensures that only authorized senders and devices enter the network.

Figure 20 : Characteristics of a VPN [6]

Tunneling Protocols

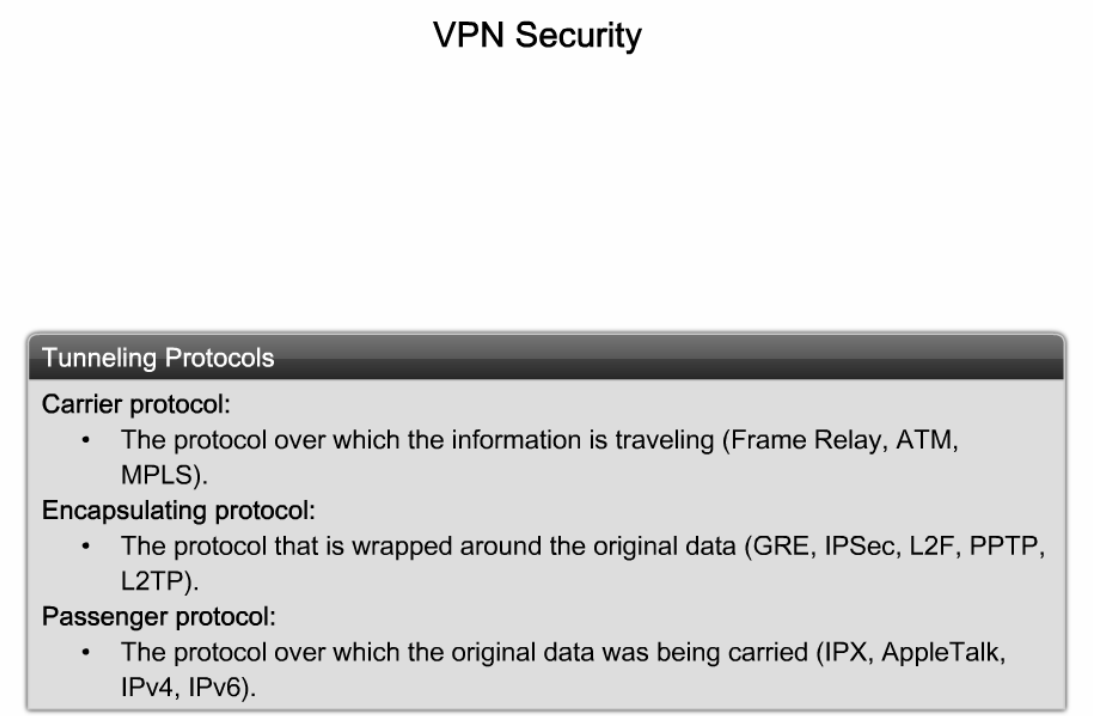


Figure 21 : Tunneling protocols [6]

VPN Encryption techniques

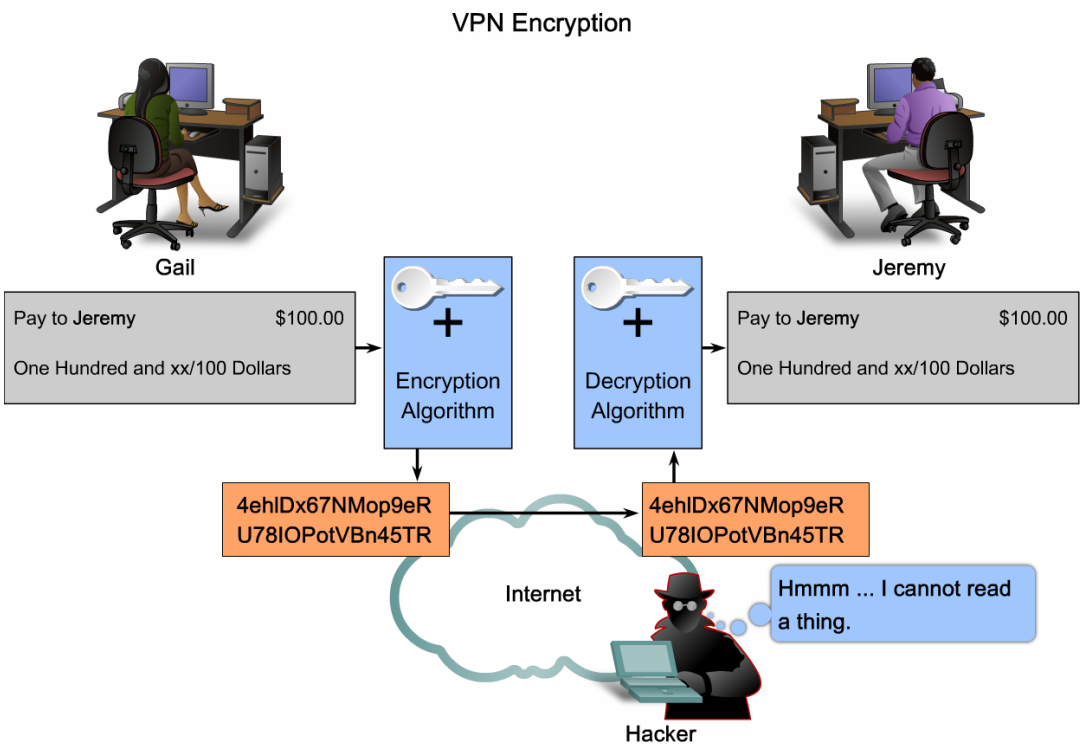


Figure 22 : VPN Encryption [6]

IPsec

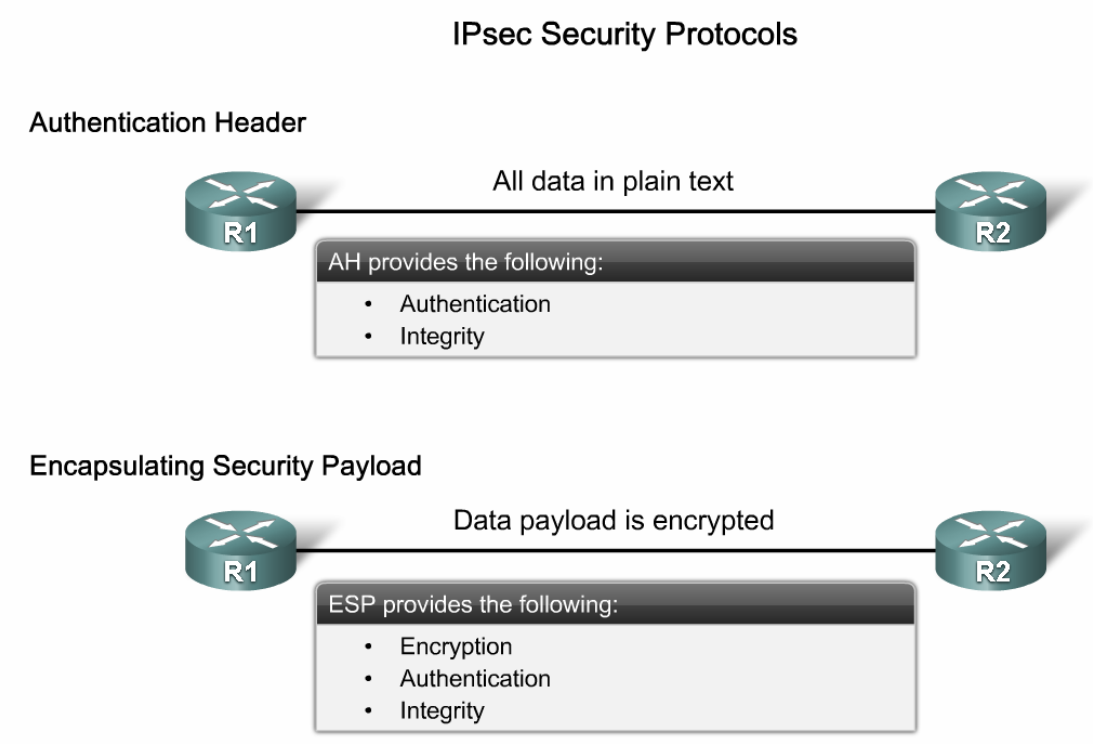


Figure 23 : IPsec [6]

IP Addressing Services

IP Addressing Services and Issues

IP addressing issues

IP addresses

- IP addresses are depleting.
- Services such as DHCP and NAT helps prolong the usage of IPv4.
- IPv6 is meant as a replacement for IPv4.

DHCP

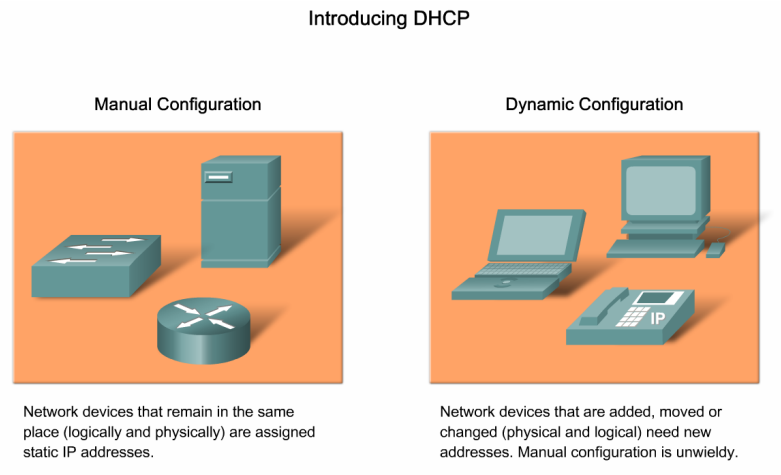


Figure 24 : Purpose of DHCP [6]

DHCP

DHCP

- Allows us to specify a pool of available addresses.
- Information such as default gateway and DNS can also be included.

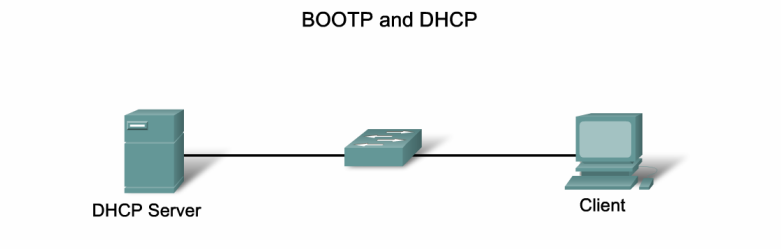
Assigning IP addresses

- Manual Allocation
  - Preallocate the IP address.
- Automatic Allocation
  - DHCP server allocates automatically an IP-address from a pool.
  - No lease time.
  - Permanently assigned to the host.
- Dynamic Allocation
  - DHCP server allocates automatically an IP-address from a pool.
  - Limited period of time.

BOOTP

BOOTP

- Designed for manual pre-configuration.
- Limited amount of information.



BOOTP	DHCP
Static mappings	Dynamic mappings
Permanent assignment	Lease
Only supports four configuration parameters	Supports over 20 configuration parameters

Figure 25 : Bootstrap Protocol [6]

DHCP

DHCP process

- DHCP discover – Client broadcasts a discover message to find a DHCP-server on the network.
- DHCP offer – A DHCP server responds with a DHCP offer message containing an IP address for the client.
- DHCP request – Client responds with a DHCP Request message. Sent as broadcast.
- DHCP acknowledgement – DHCP server verifies with an acknowledgement.

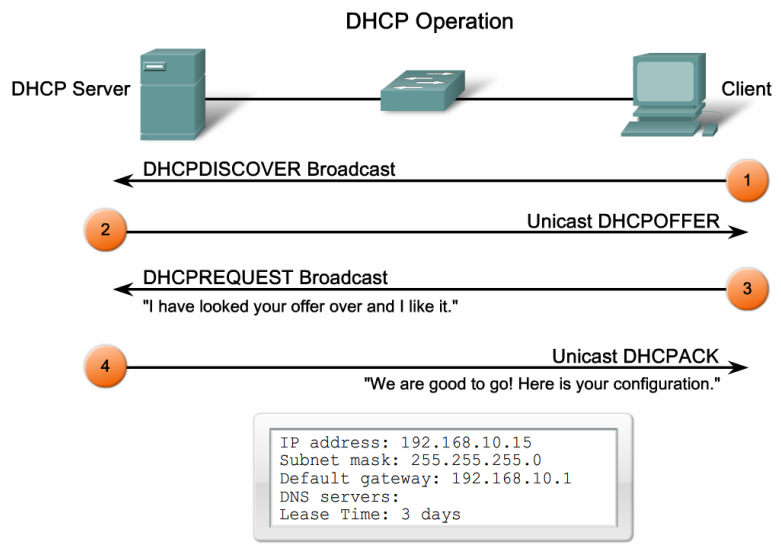


Figure 26 : DHCP address allocation process [6]

DHCP Relay

- Problem if DHCP server is located on another Subnet.
- `Router(config-if)#ip helper-address`
- Relays DHCP messages (amongst other things)

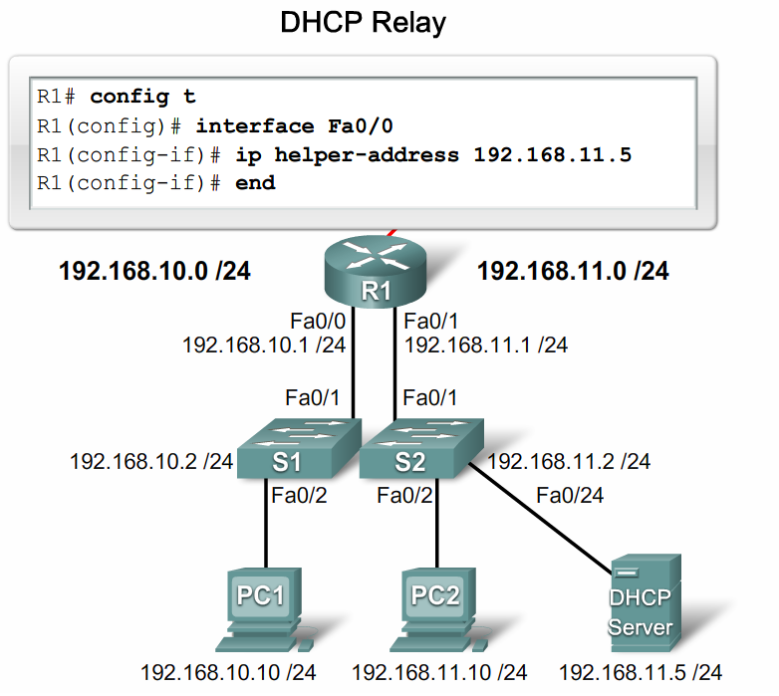


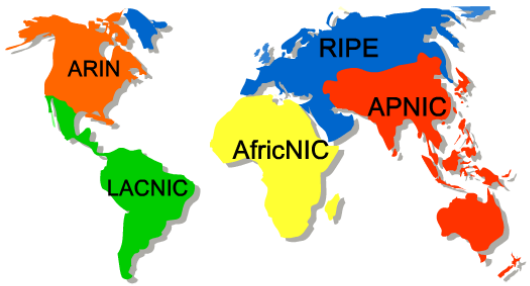
Figure 27 : Relay DHCP messages [6]

NAT

Network Address Translation

NAT

Public and Private Internet Addresses



Public Internet addresses are regulated by five Regional Internet Registries (RIRs):

- ARIN
- RIPE
- APNIC
- LACNIC
- AfriNIC

Private Internet addresses are defined in RFC 1918:

Class	RFC 1918 Internal Address Range	CIDR Prefix
A	10.0.0.0 - 10.255.255.255	10.0.0.0/8
B	172.16.0.0 - 172.31.255.255	172.16.0.0/12
C	192.168.0.0 - 192.168.255.255	192.168.0.0/16

Figure 28 : Regional Internet Registry (RIR)

Native Address Translation

NAT

- Allows us to use *private* IP addresses in a local network.
- Only need a few *public* IP addresses.

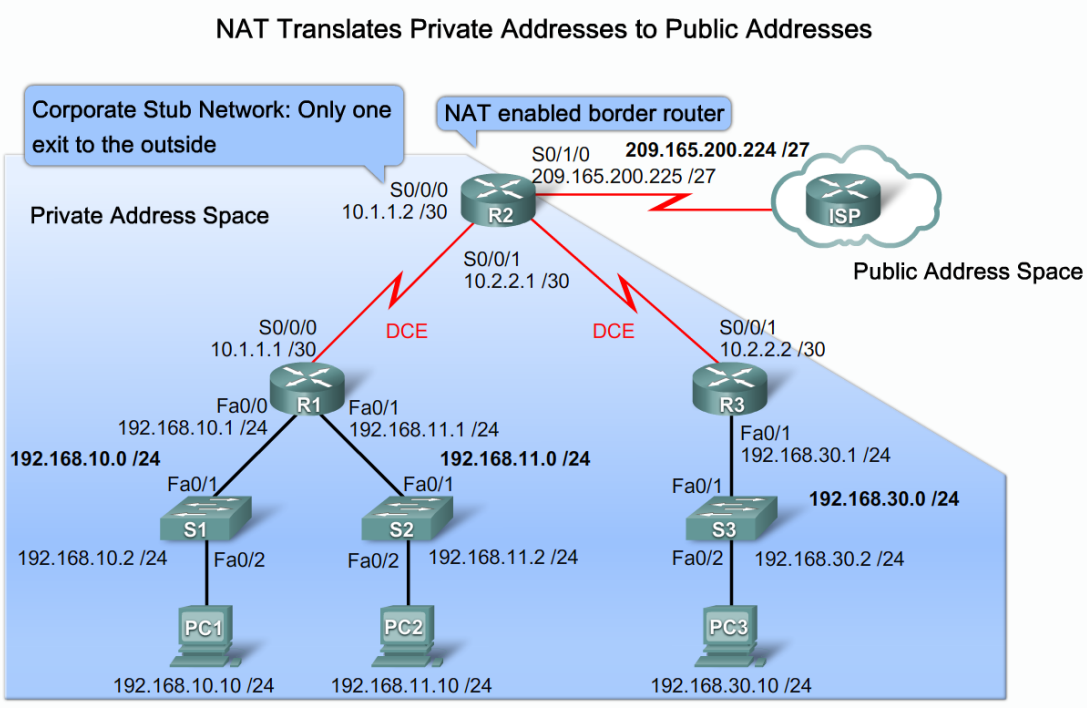


Figure 29 : NAT purpose [6]

NAT Addresses

NAT Table

- Inside Local Address – The Local IP address on the sending host.
- Inside Global Address – The public IP address that have been assigned to that host.
- Outside Global Address – The public IP address of the receiving host.

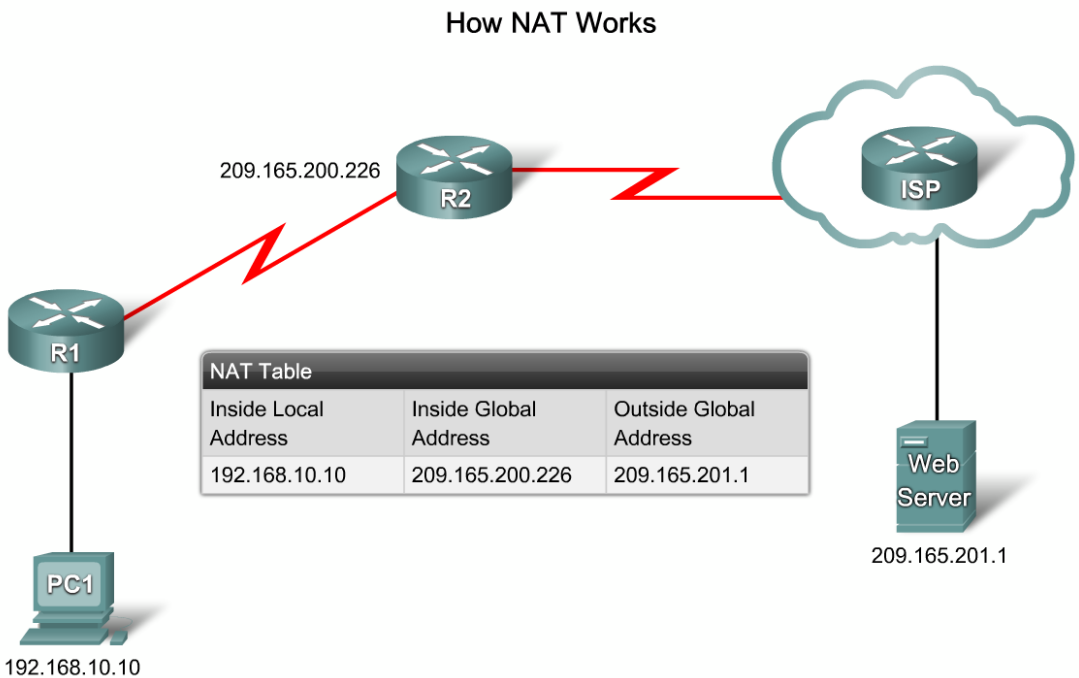


Figure 30 : NAT Address types[6]

NAT IP Mapping

Dynamic IP Mapping

- Dynamic IP Mapping have a pool of inside global addresses
- Assigns them according to a first-come-first-served scheduling scheme.

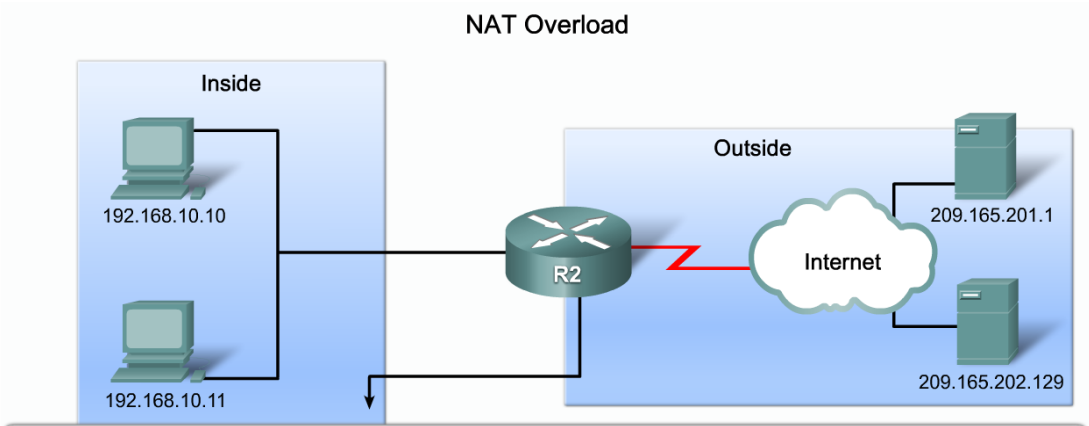
Static IP Mapping

- Use a one-to-one mapping between local and global inside addresses.
- Used for servers that needs to be constantly available to the outside.

Port Address Translation (PAT)

PAT

- NAT Overload
- Commonly used if only a few Inside Global Addresses are available.
- Use L4 address to map inside local address to outside global address.



NAT Table with Overload

Inside Local IP Address	Inside Global IP Address	Outside Global IP Address	Outside Local IP Address
192.168.10.10:1555	209.165.200.226:1555	209.165.201.1:80	209.165.201.1:80
192.168.10.11:1331	209.165.200.226:1331	209.165.202.129:80	209.165.202.129:80

Figure 31 : NAT purpose [6]

Benefits and Drawbacks with NAT

NAT Benefits [6]

- Conserves the legally registered addressing scheme.
- Increases the flexibility of connections to the public network.
- Provides consistency for internal network addressing schemes.
- Provides network security.

NAT Drawbacks [6]

- Performance is degraded.
- End-to-end functionality is degraded.
- End-to-end IP traceability is lost.
- Tunneling is more complicated.
- Initiating TCP connections can be disrupted.

Carrier-Grade Network Address Translation

CGNAT

- Allows a service provider to use NAT, so that multiple of their subscribers will share the same Inside Global IP-address.
- RFC6598 have assigned the 100.64.0.0/10 address space.

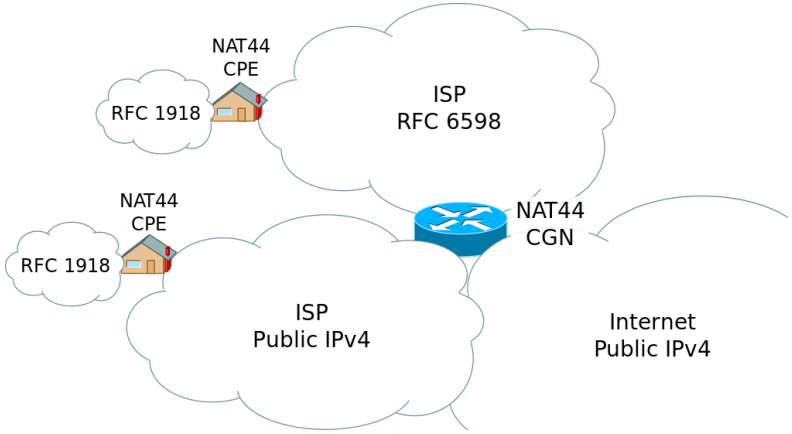


Figure 32 : Carrier-Grade Network Address Translation [2]

IPv6

Internet Protocol Version 6

IPv6

Address space depletion

- IPv4 supports 2^{32} addresses.
- Most of these addresses have been allocated now.
- Transitions have started, but it goes extremely slow.

IPv6 Transision methods

- Dual stack
- Manual Tunnel
- 6to4 tunnel
- NAT-PT

Dual stack

Dual stack

Running both IPv4 and IPv6 at the same time, and gradually phase out IPv4.

Manual tunnel

Set up an IPv6-over-IPv4 tunnel.

Dynamic 6to4 tunneling

Automatically setup a tunnel to a IPv6-"island". The packets will be allocated a valid IPv6 address within that Island.

Proxying and translation

Allows a router to translate between IPv4 and IPv6.

References

[1] Adsl line rate reach, November 2005. URL http://en.wikipedia.org/wiki/File:ADSL_Line_Rate_Reach.gif.

[2] File:cgn ipv4.svg, June 2010. URL http://en.wikipedia.org/wiki/File:ADSL_Line_Rate_Reach.gif.

[3] Dictionary.com unabridged. May 2013. URL http://dictionary.reference.com/browse/broadband.

[4] Behrouz A. Forouzan and Sophia Chung Fegan. *Data communications and networking*. McGraw-Hill, Boston, 4. ed. edition, 2007. ISBN 0-07-125442-0 (International ed.).

[5] Andrew S. Tanenbaum and D. Wetherall. *Computer networks*. Pearson, Boston, 5th ed. edition, 2011. ISBN 978-0-13-255317-9 (hft.) (International ed.).

[6] Bob Vachon and Rick Graziani. *Accessing the WAN : CCNA exploration companion guide*. Cisco Press, Indianapolis, Ind., 2008. ISBN 978-1-58713-205-6 (hardcover w/cd).