Networks, History & Bandwidth Net Neutrality Imaging Ethics

NBAY 6120

Lecture #6

March 15, 2018

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Required Reading

- "Uncle Sam, Ma Bell and Her Babies: A Timeline," The New York Times. December 22, 1994. (link posted on website)

- Barbara Kantrowitz. The Birth of the Internet, Newsweek, August 8, 1994, vol. 124, Is. 6, pg. 56.

- "Oral Statement of Chairman Ajit Pai," December 14, 2017.

- "Oral Dissenting Statement of Commissioner Mignon Clyburn," December 14, 2017.

Recommended Reading

- Klint Finley. "Tech Giants to Join Legal Battle Over Net Neutrality," January 5, 2018. Wired

Networks, History & Bandwidth

Comparison between auditory and visual sensory systems

The human auditory channel is serial.

All of the different frequencies are condensed into a single channel at a given point in time.

The human visual system is parallel.

Many pieces of information (e.g. electrical impulses, pixels) are received at the same time.

Both systems are time dependent.

Pictorial Data vs. Text

- Text

  1 character = 8 bits

  1 word = 8 characters

  1 page = 300 words

  2.4 Kilobytes

- Picture

  1280 x 1024 x 3 bytes/pixel = 3 ¾ Mbytes

Dynamic Information (Bandwidth Required)

- Voice   44,000 bits/second

- Video   512 x 480 x 8 bits x 30 fps = 7 1/2   Mbytes/second = 60 Mbits/second (1363x)

- HDTV   1920 x 1280 x 3 bytes x 60fps = 420   Mbytes/second (76,328x)

*Statistics represent uncompressed data.*

Internet & Computer Networks

Internet - History & Growth Chronology

1973 - Vinton Cerf & Robert Kahn - designed Internet architecture based on TCP/IP

1979 - Configuration Control Board - contracted parts of infrastructure

1980 - U.S. Department of Defense - adopted TCP/IP, MILNET designed to withstand atomic attack - becomes ARPANET

Early 1980's - ARPANET becomes known as Internet researchers enticed to use CSNet (paid by NSF)

ARPAnet (Circa 1980)
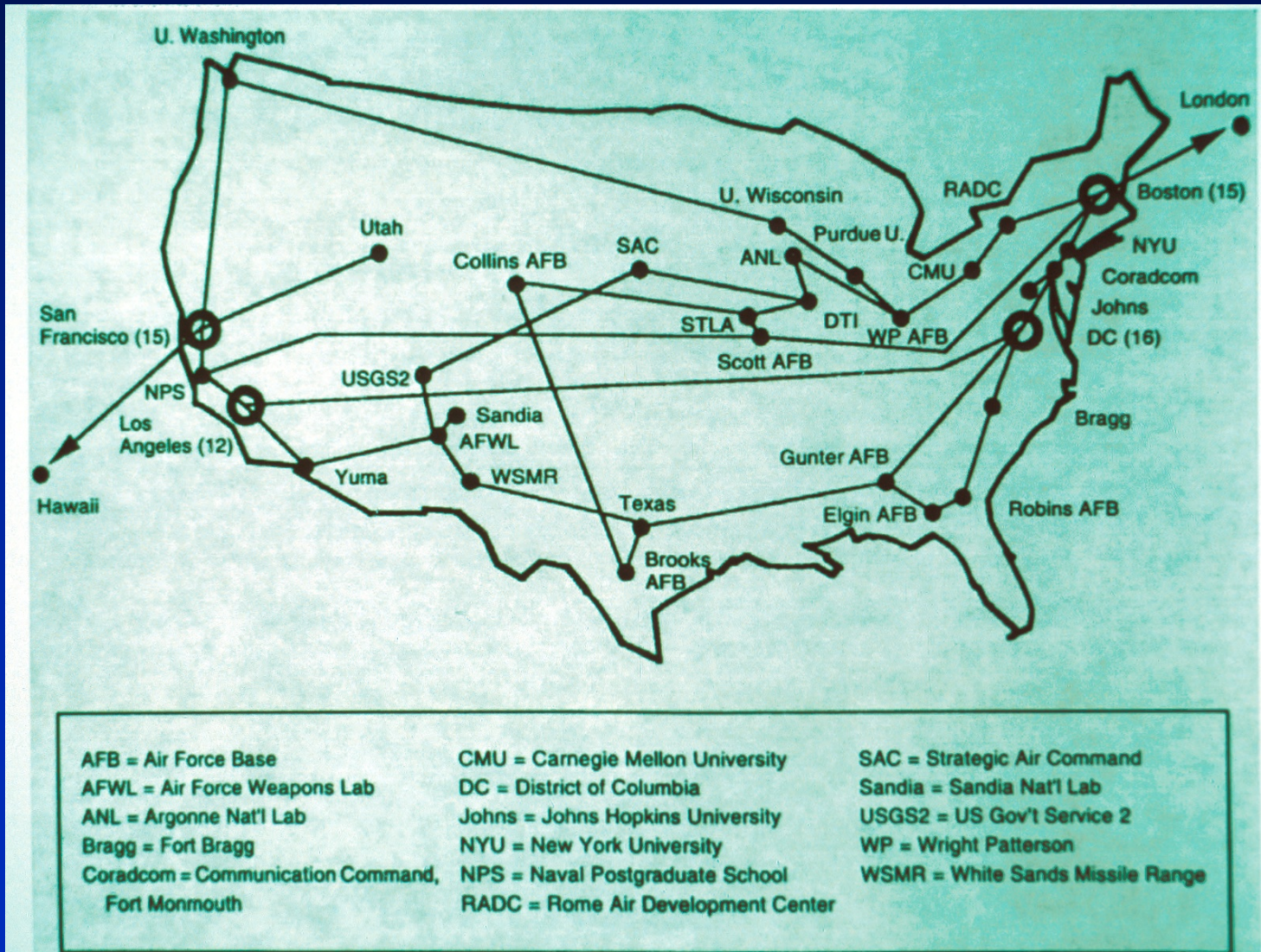
The Telecommunication Bill of 1996

What The Telecommunication Bill Will Do

LONG-DISTANCE PHONE SERVICE

Seven regional Bell's can enter into the long-distance phone business, must open their local phone networks

LOCAL PHONE SERVICE

Local phone markets open to new competitors (AT & T, MCI and cable TV companies) without specifying how much they pay

What The Telecommunication Bill Will Do

BROADCAST

Raises the national TV-station ownership cap. Requires TV sets to block violent or sexual programs.

CABLE

Lifts all rate regulations in three years for big cable systems.

What The Telecommunication Bill Will Do

INTERNET

Transmission of indecent material is a crime without restricting minor's access.

SPECTRUM

TV Stations get valuable new broadcast spectrum for advanced TV free of charge. (To be revisited)
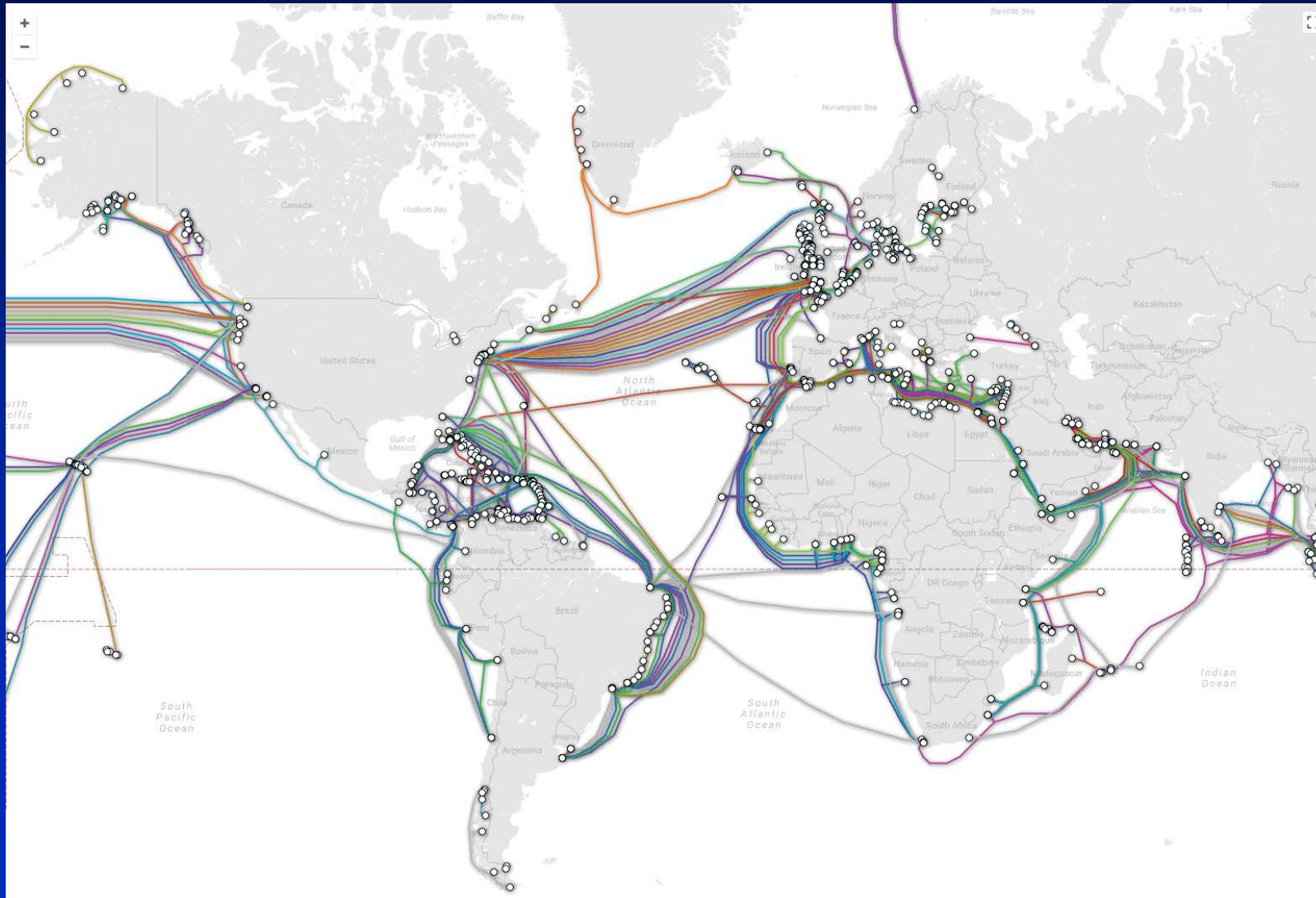
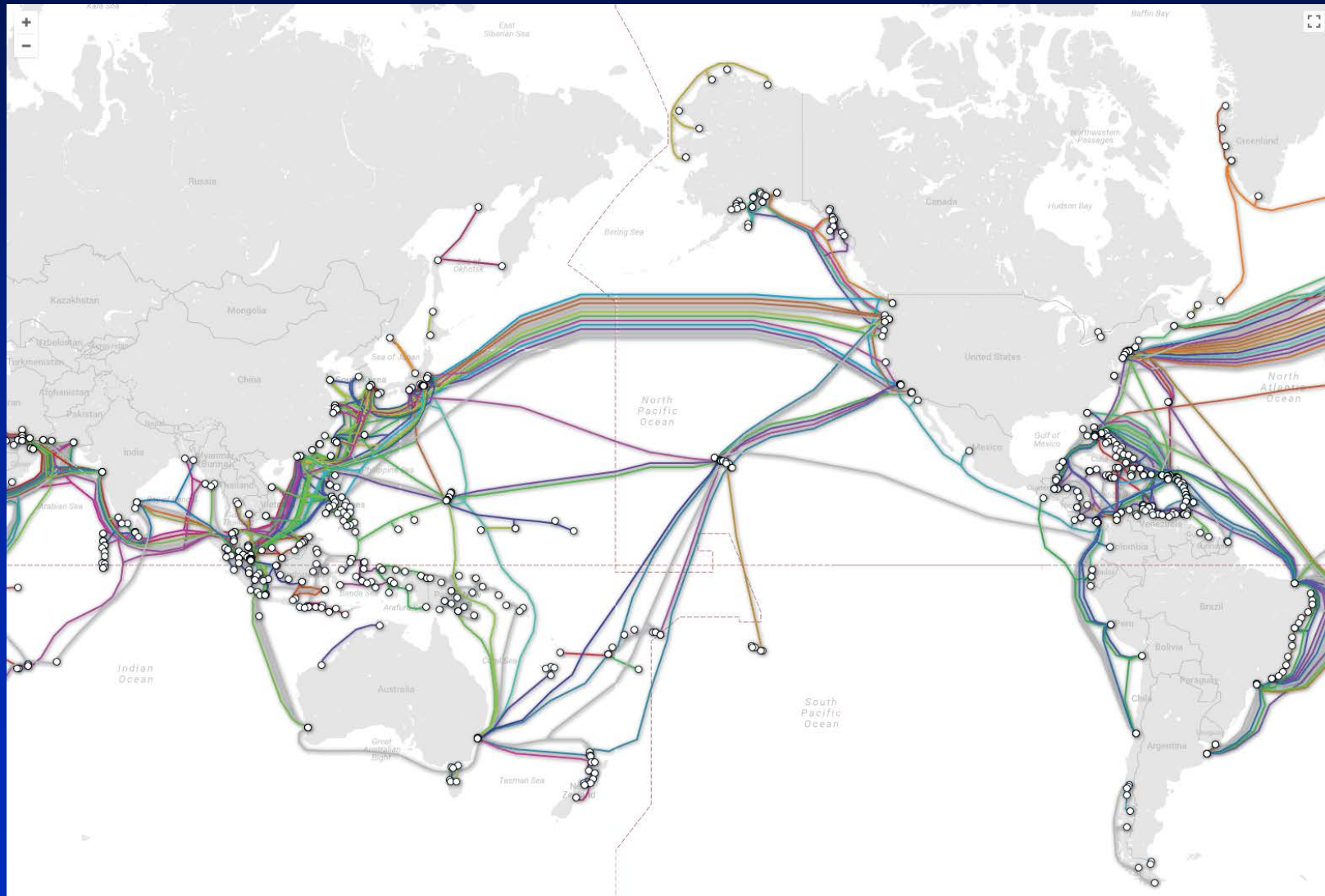# 100Gb/s Internet2   2007

Submarine Cable Map   2018
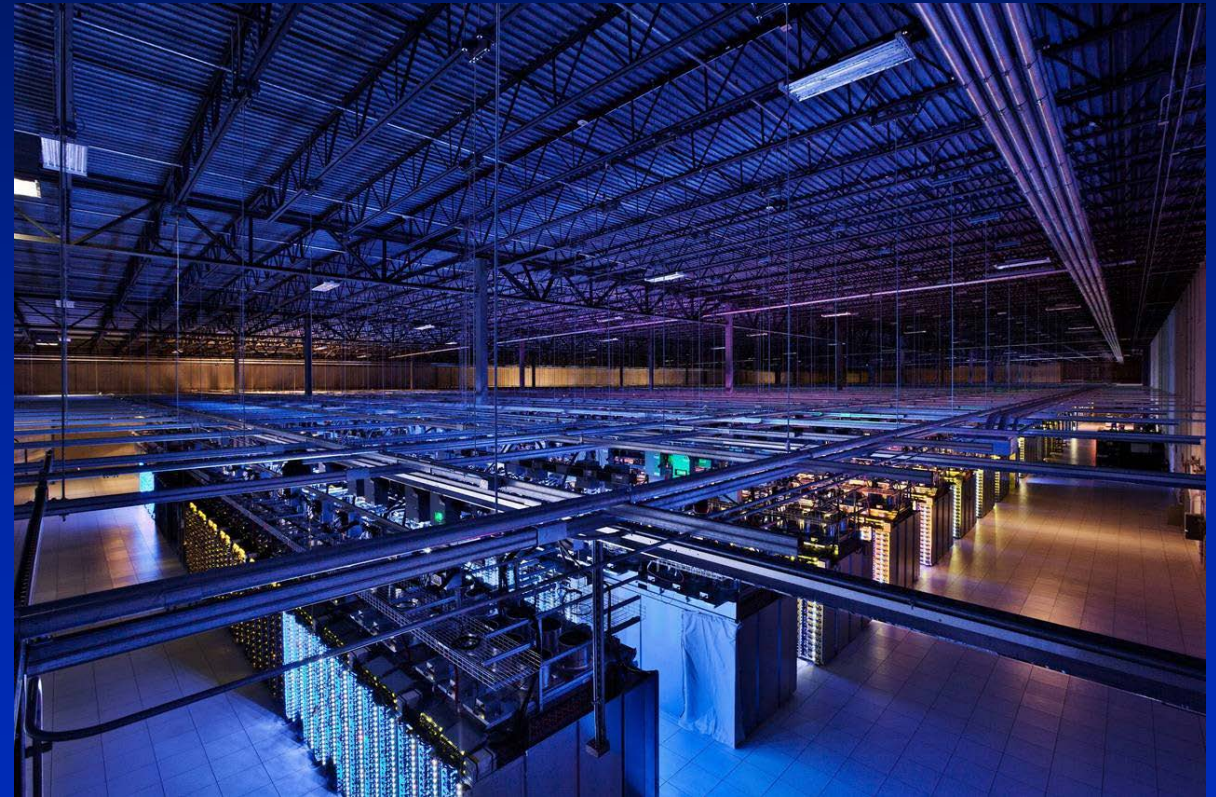
Submarine Cable Map   2018

https://www.submarinecablemap.com/

Google & Amazon Transpacific Submarine Cable

Network Typologies

Wired Networks –

Copper wires (telephone companies, DSL)

Fiber/coaxial cables
(cable television companies)
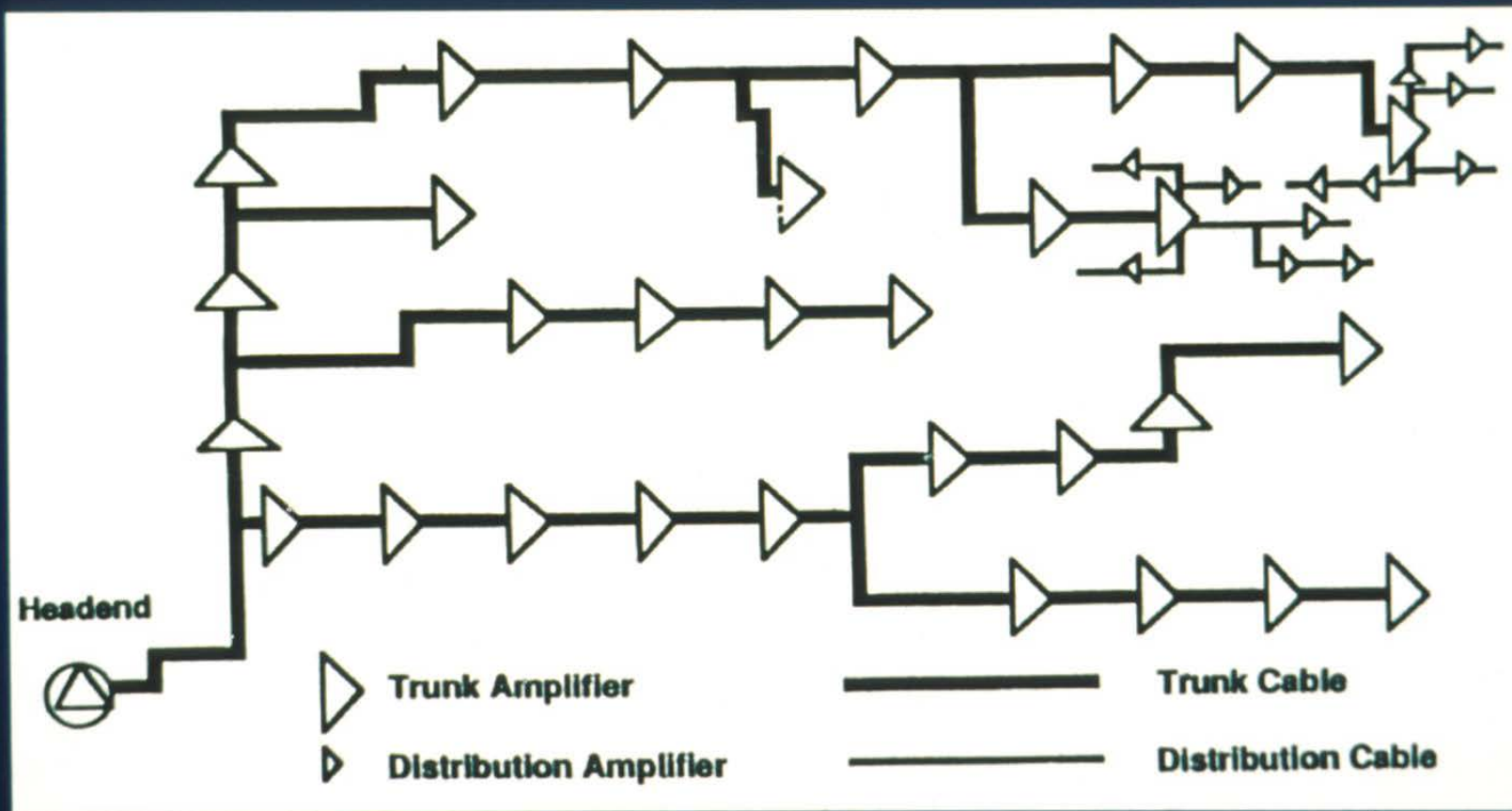
Fiber to the home (everybody)

Wireless Networks –
Satellites

Hybrid Networks –

Coaxial Cable Network

Sources: Time-Warner, Goldman Sachs

Fiber Optic Cable Network
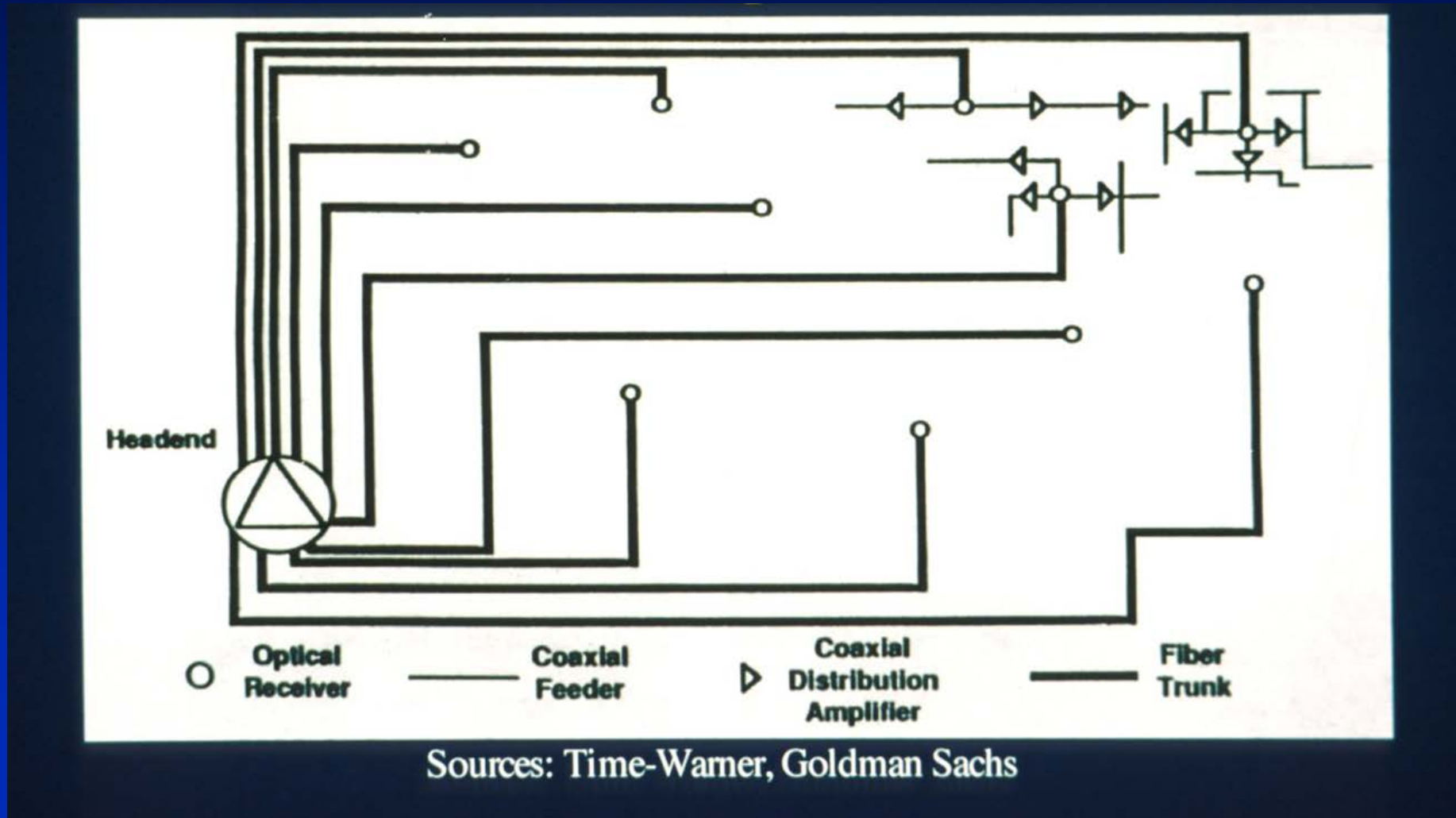
Sources: Time-Warner, Goldman Sachs

A Less Expensive Way To Bring Fiber To The Home

OPTICAL POWER SPLITTER

2 - The optical power splitter divides the light signal equally among 16 to 32 fibers that run to the customers.

1 - Service provider encodes data in laser light. The data for 16 to 32 homes is sent along an optical fiber to an optical power splitter.

A Less Expensive Way To Bring Fiber To The Home

OPTICAL POWER SPLITTER

3 - Optical transceivers at each home convert that home's data to electrical signals.
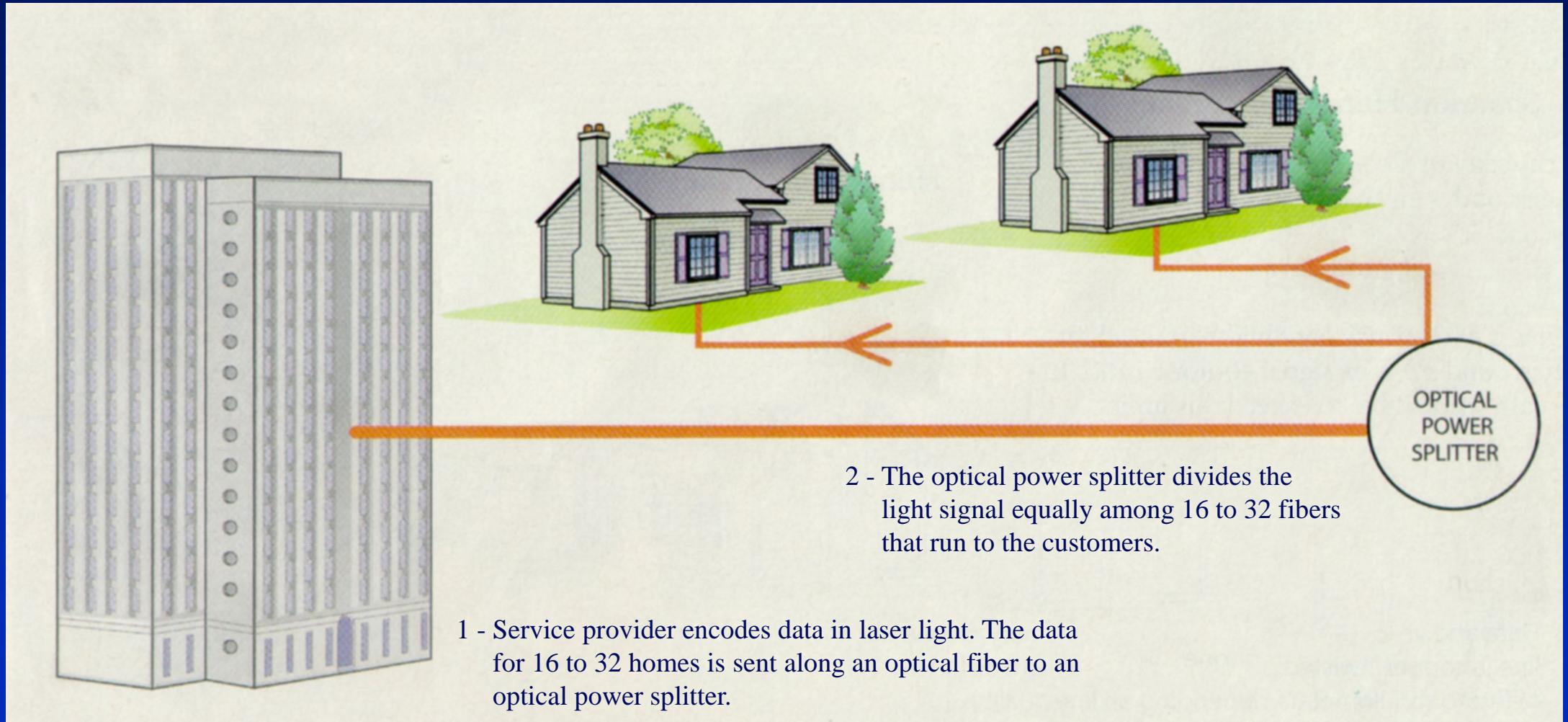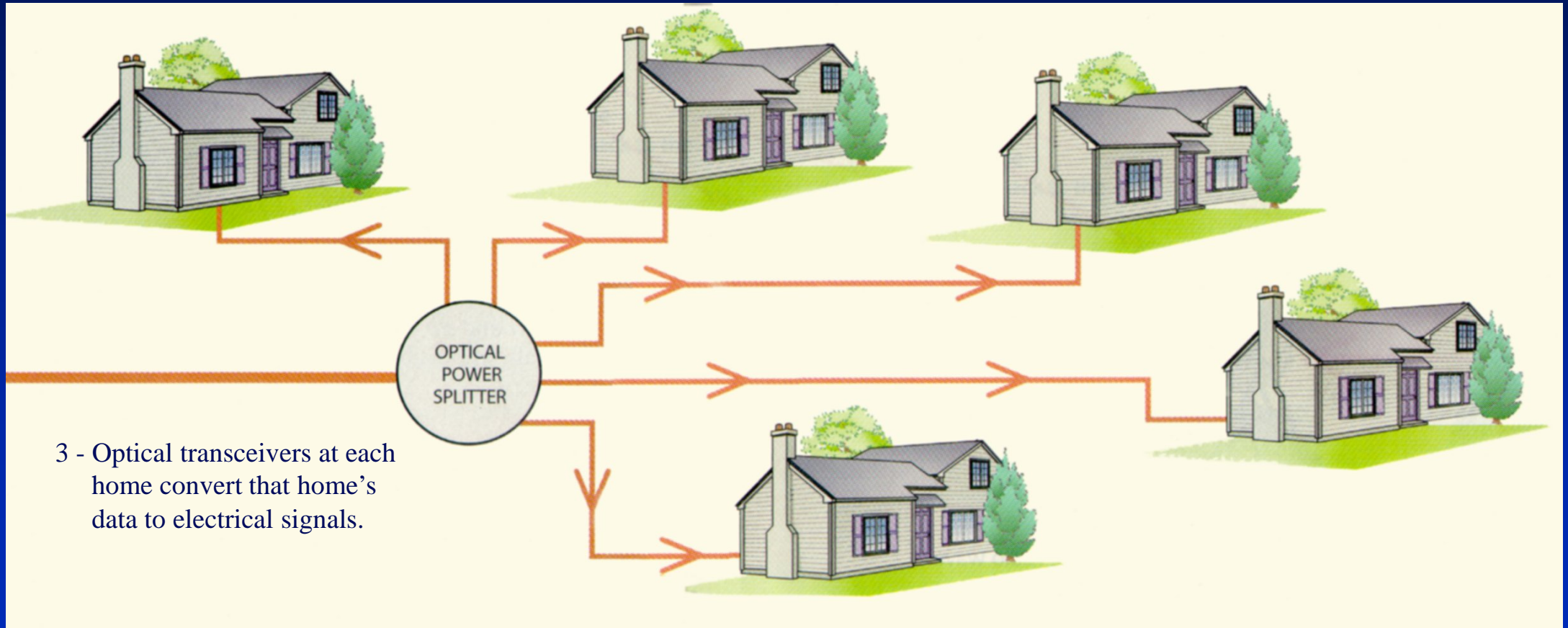
Advantages of Optical Fiber

- High bandwidth capacity

- Light within fiber can be "bent"

- Cheap and abundant raw material

- Low signal deterioration reducing need for amplification

- Multichannel capacity (WDM)

Frequency Spectrum
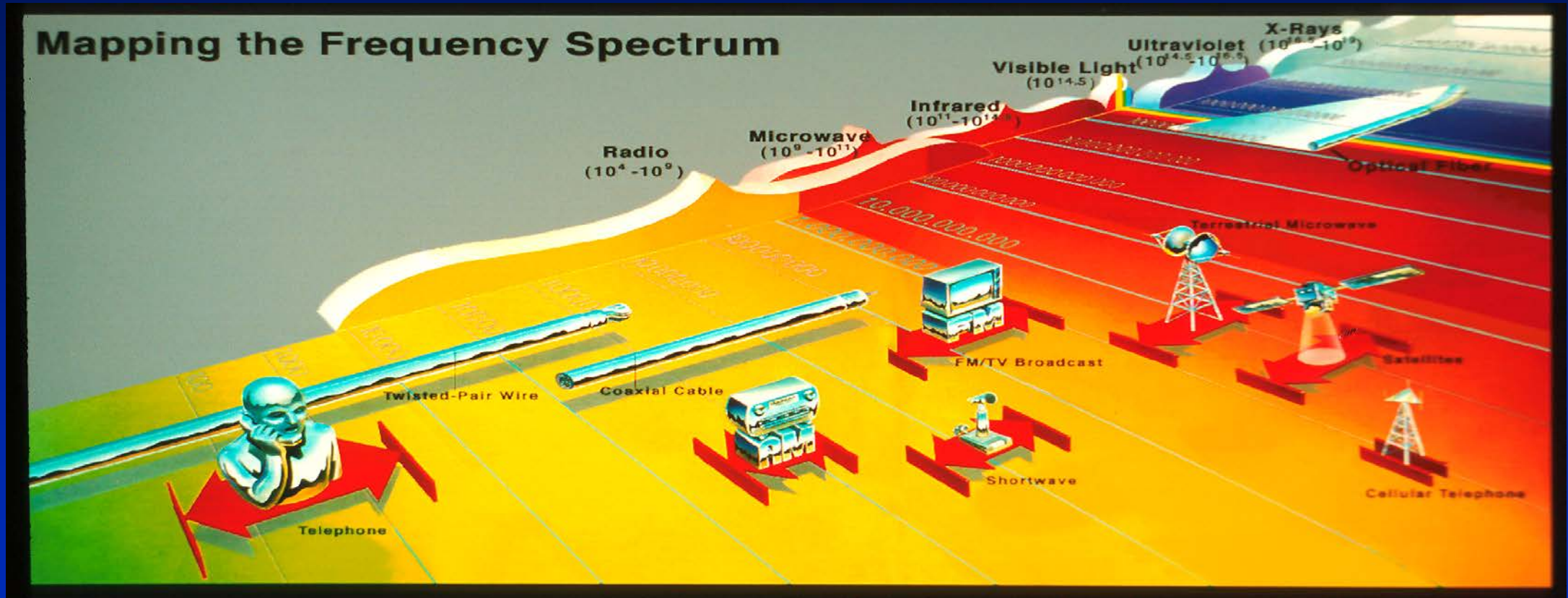
Wireless Coding Technologies

First Generation (Analog)

Early 1980's - 2000

AMPS (Advanced Mobile Phone System)

FDMA (Frequency Division Multiple Access)

CELL PHONES

CELL TOWER
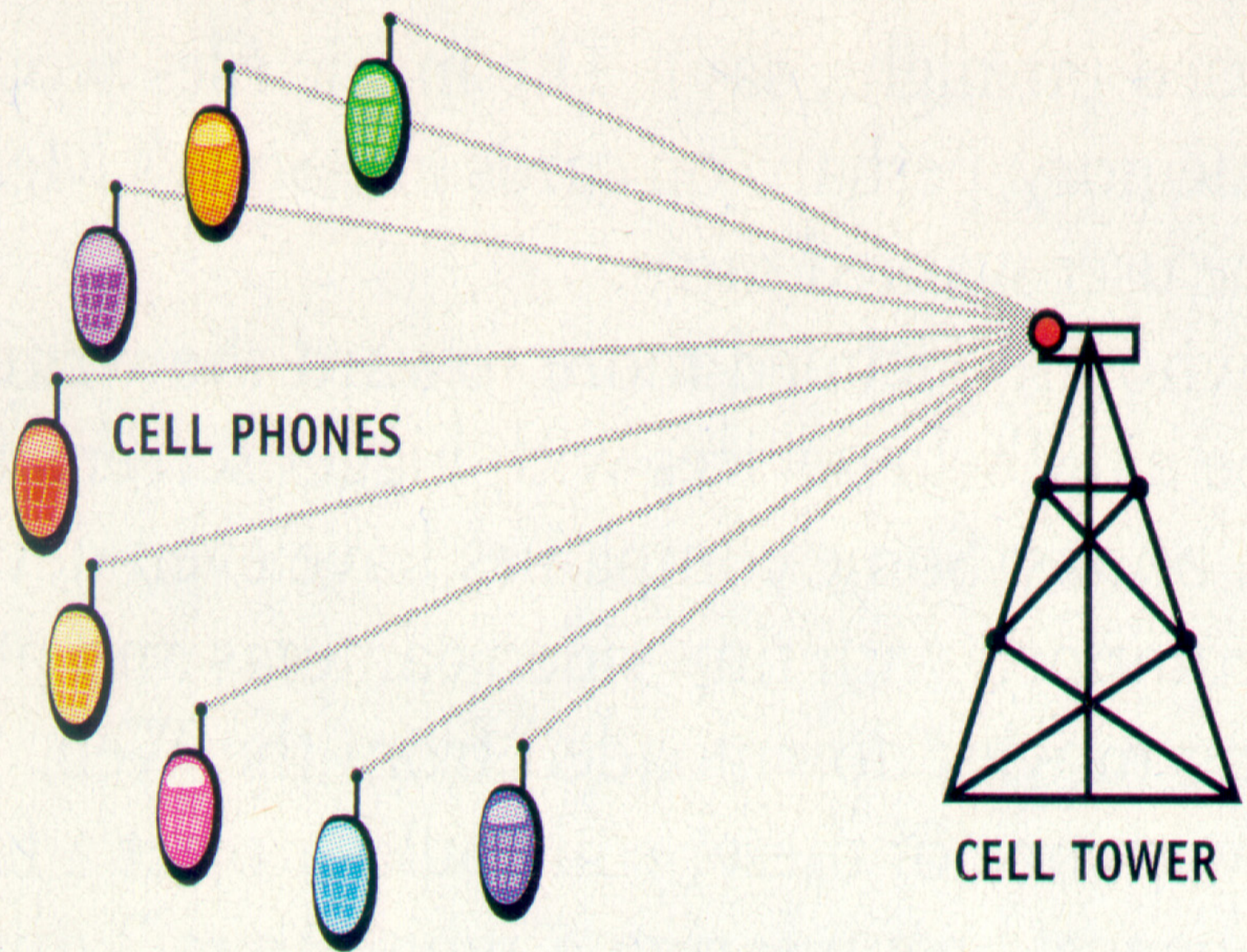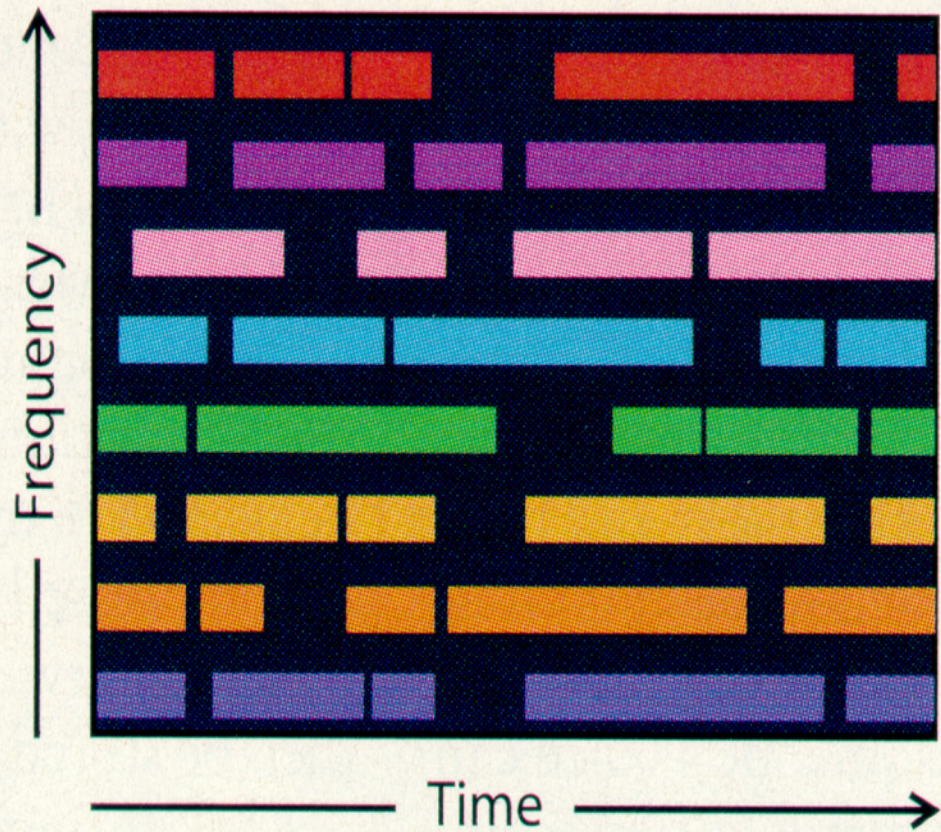
FREQUENCY DIVISION MULTIPLE ACCESS allows many cell phones to communicate with one base station (*left*). Each caller is assigned a different frequency channel (*above*). Breaks in the colored bars indicate that the channels are not in constant use.

Second Generation (Digital)

Early 1990's - 2000

TDMA (Time Division Multiple Access)

> Original GSM (Global System for Mobile Communication)
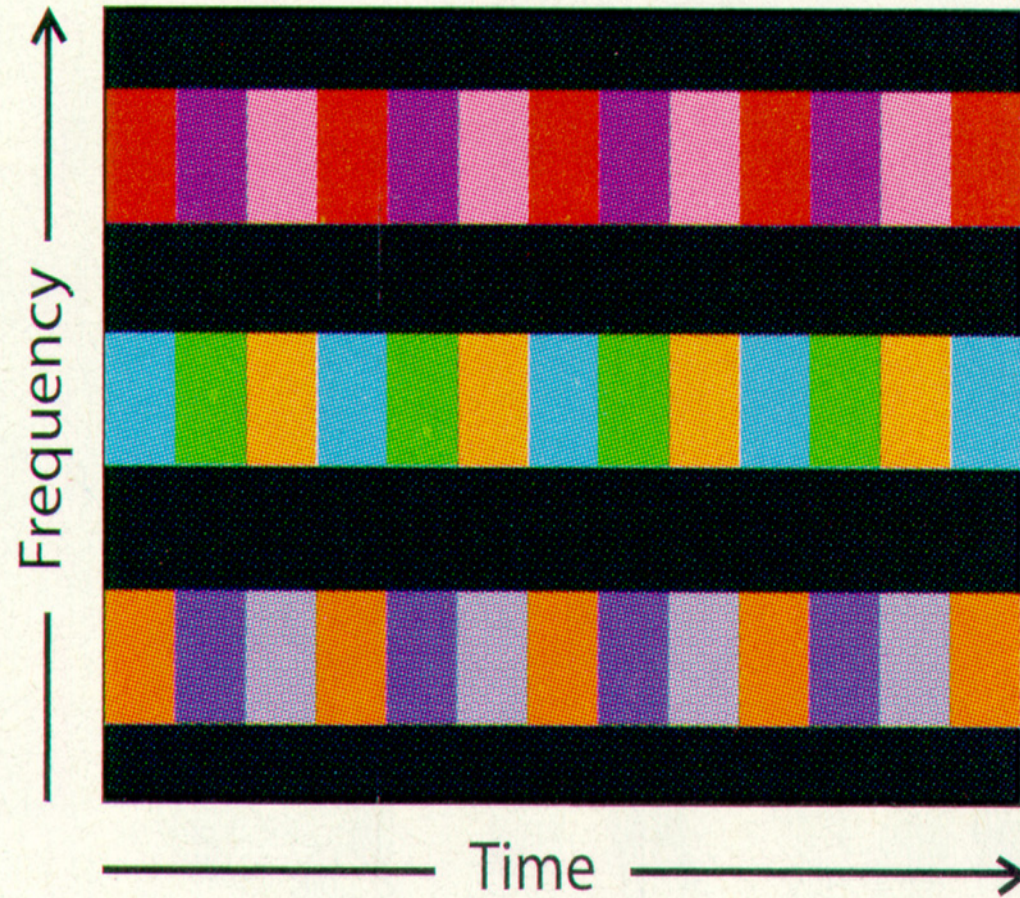
TIME DIVISION MULTIPLE ACCESS allows many users to share a frequency channel. Each wireless call is assigned a repeating time slot (*colored bands*) in the channel.

Second Generation (Digital)

Early 1990's - 2000

TDMA (Time Division Multiple Access)

      Original GSM (Global System for Mobile Communication)

CDMA (Code Division Multiple Access)

      PCS (Personal Communications Service)
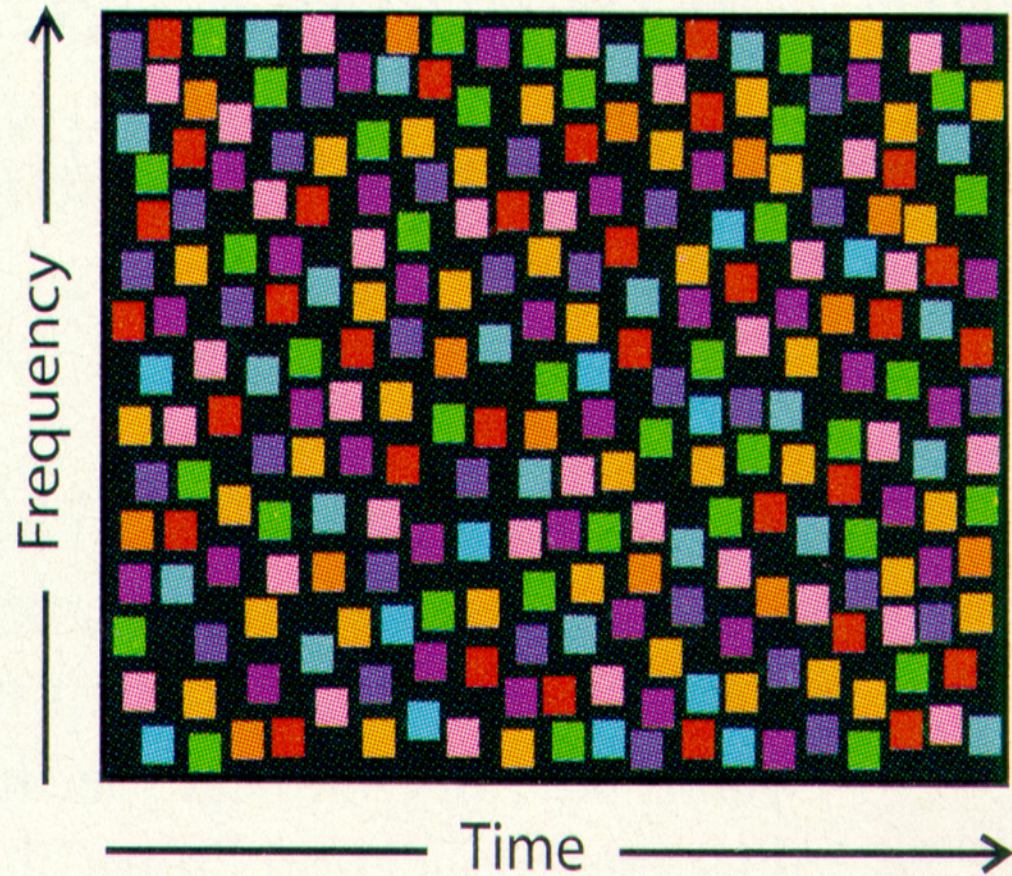
CODE DIVISION MULTIPLE ACCESS breaks each wireless signal into many chips of data (*colored squares*). The chips are transmitted over a band of frequencies and then reassembled at the receiving end.

Third Generation (Broadband Digital)

W-CDMA (Wideband Code Division Multiple Access)

Refinement of CDMA technology

Minimum data rate for stationary users is 2Mbs

Flash - OFDM

Flash – OFDM (orthogonal frequency division multiplexing)

Breaks images into small packets
Send info over many frequencies (FDM)
But only when others are in a trough (orthogonal)
(reducing noise)

4-5x faster than 3G
Requires less bandwidth

Flarion
Red Herring
October 2002

How Flash-OFDM Works
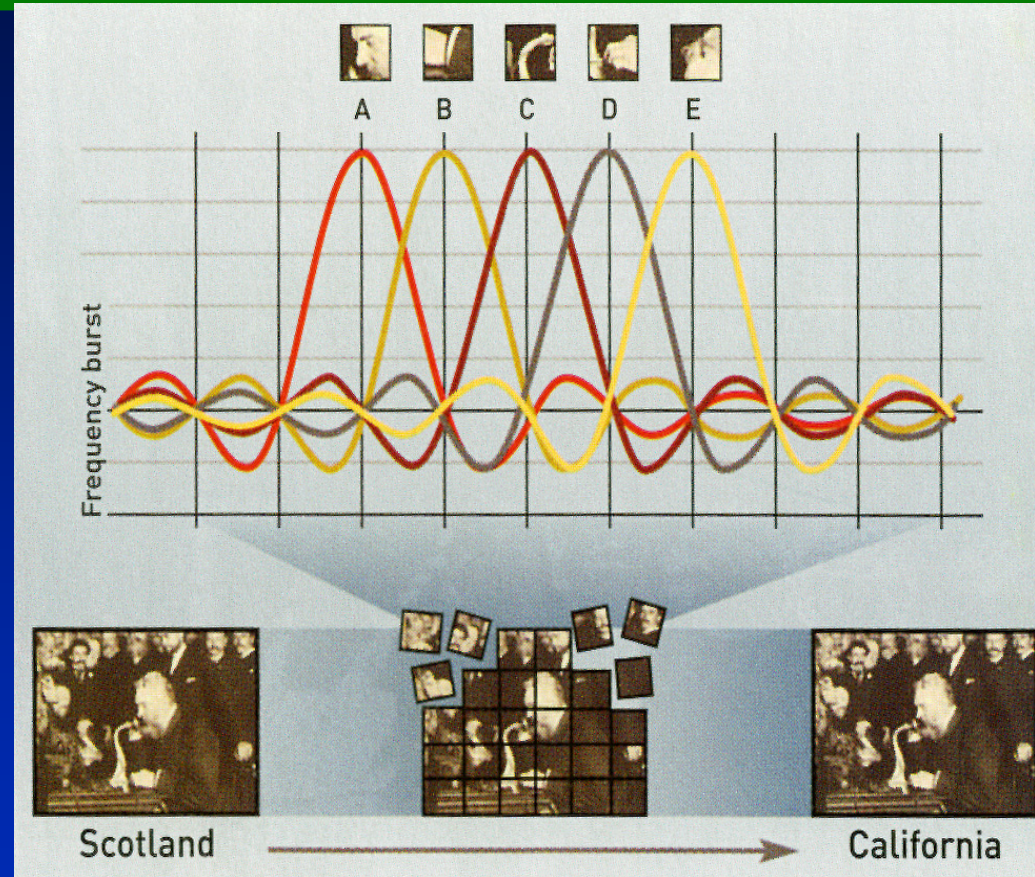
Each of these packets is sent on a short frequency burst. Each burst, A to E, occurs while the others are in a trough, which keeps the signals from canceling each other–a problem with other wireless technologies, like CDMA.

Josh McHugh. "A High Wireless Act," Red Herring, October 2002, p. 36.

What is 4G?

- 4G mobile technology is the name given to the current generation mobile technology (approximately 10x 3G)

- There is not an industry standard, but the **goals** include enhanced security measures, and smoother transition of data when a device moves across areas covered by different networks.

- Includes IP telephony, ultra-broadband internet access, gaming services, and Internet TV, at least 100Mbs when client is moving at high speeds, 1 Gbs when client is stationary.

4 G Systems

- Two competing systems, WiMax (Clearview and Sprint Nextel) and Long Term Evolution (LTE) backed by Verizon, AT&T, and Qualcomm

- Target peak data rates

  - 100 Mbits/second for high mobility
  - 1 Gbit/second for low mobility

Wireless Technology Progression

5G Technologies   2018
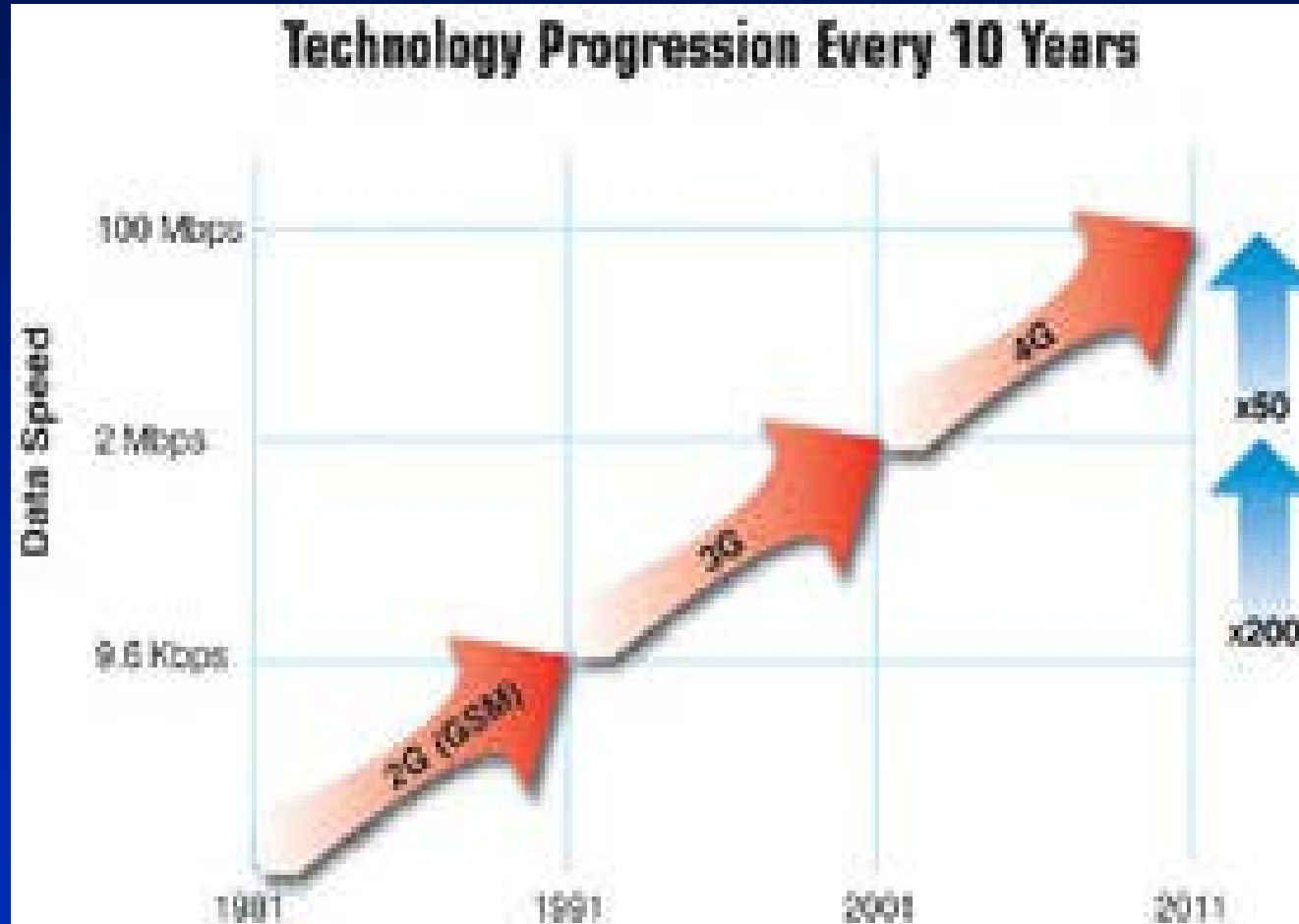
How 5G Could Work

While the final specifications for 5G, or fifth-generation mobile service, are still being finalized, here are technologies likely to play a role:

4G

Signals broadcast in all directions

All data sent to and from the network
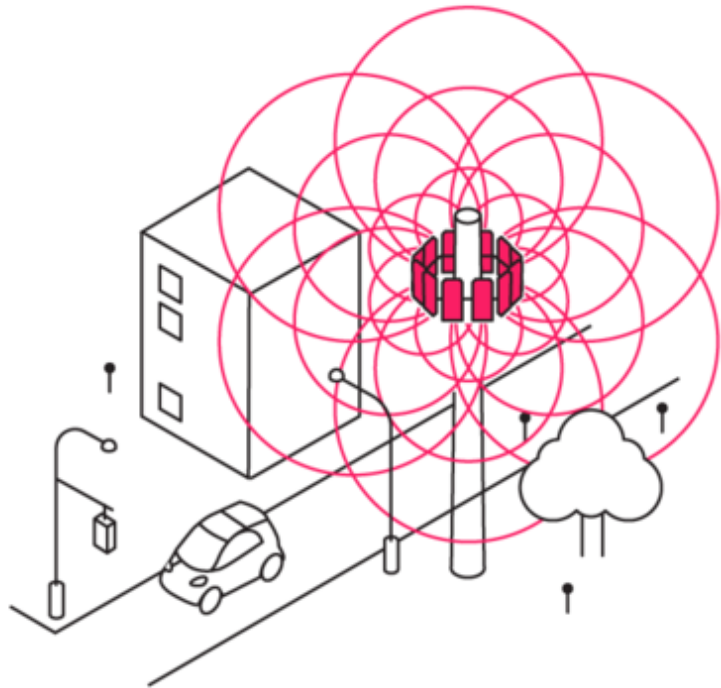
5G

Focused signals

Small base stations extend reach and handle some exchanges directly

Device-to-device communication
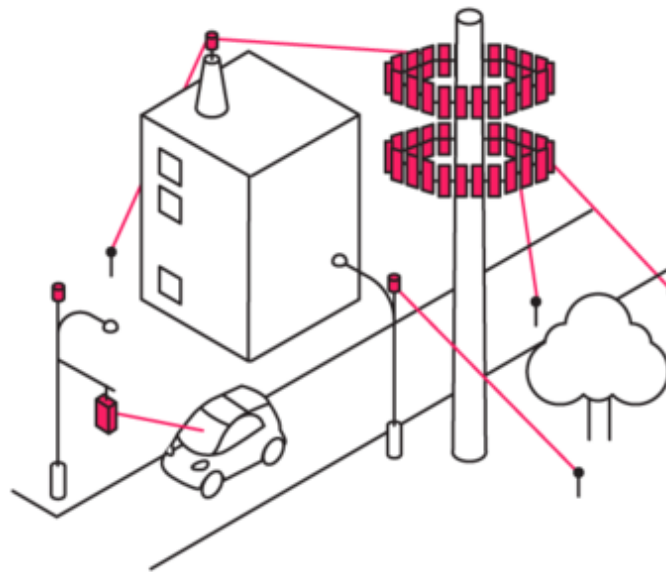
Source: Institute of Electrical and Electronics Engineers

Bloomberg QuickTake

The Negroponte Switch

$\rightarrow$ 1990's   Voice communication sent through wires
Video programs sent through air

2010 $\rightarrow$ Voice communication sent through air
Video programs sent through cable

Note exception: Satellite direct broadcast TV

5G Goes for the Gold   February 2018

- Korea telephone announced plans to demonstrate 5G (100x with delays < 1ms) at the winter Olympics

- Anticipated to be available in 2019

Bluetooth

- More than just cable replacement

- Scans the area for other Bluetooth devices

- Can perform background operations
  (e.g., identification, security, checking e-mail, stock prices, etc.)

Bluetooth

Initial Specifications

Originally conformed to standards 802.11a & 802.11b. A 10-meter radio signal (through walls)
bandwidth of close to megabit/second

Cost to manufacture was estimated at $5/chip with mass production in 2008. Now it is much, much cheaper.

Later versions have longer distances (20+ meters) and higher bandwidth

Comparing Wireless Technologies (Roughly)

TECHNOLOGY	DATA RATE (Mb/s)	OUTPUT POWER (mW)	RANGE (meters)	FREQUENCY BAND
Bluetooth	1-2	100	100	2.4 GHz
IrDA	4	100 mW/sr[1]	1-2	Infrared
Ultrawideband	100-500	1	10	3.1-10.6 GHz
IEEE 802.11a	54	40-800	20	5 GHz
IEEE 802.11b (Wi-Fi)	11	200	100	2.4 GHz
IEEE 802.11g	54	65	50	2.4 GHz

[1] Eye safety determines the infrared power density, which is measured in milliwatts per steradian

Table page 26, IEEE Spectrum, Sept. 2003

Global Consumer Internet Traffic

Global consumer Internet traffic (2006-'14)

2014 SHARE

42,070 petabytes/month

PROJECTED

ACTIVITY
- ■ VoIP
- ■ Online gaming
- ■ Video calling
- ■ Web/data
- ■ File sharing (P2P)
- ■ Internet video to TV
- ■ Internet video to PC

12,684

40%

37%

2,280

'06 '07 '08 '09 '10 '11 '12 '13 '14

15%

27%

10%

46%
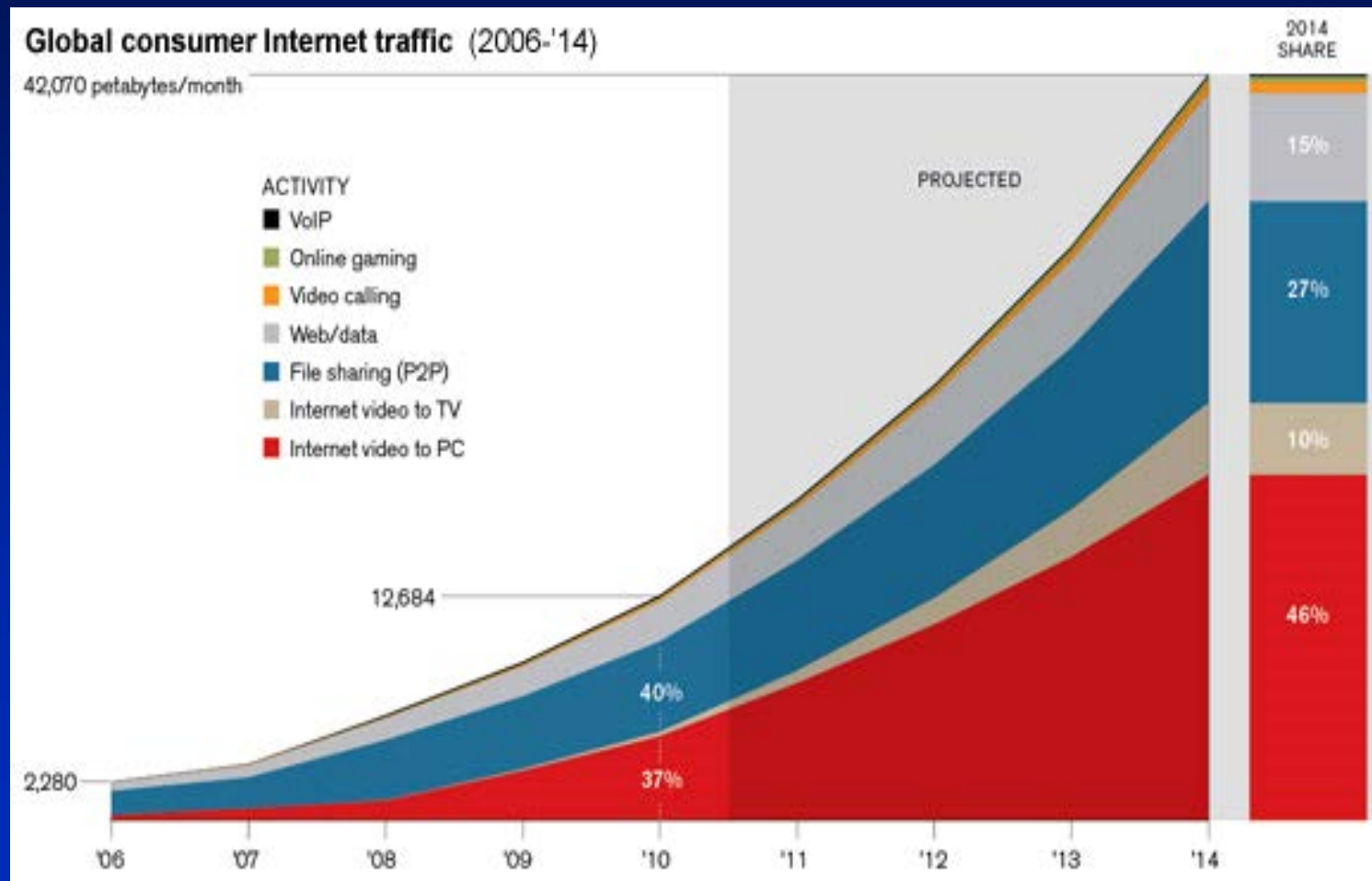
Prediction of Demand   Cisco

- Global IP traffic will increase nearly threefold over the next 5 years, and will have increased 127-fold from 2005 to 2021.

- Broadband speeds will nearly double by 2021. By 2021, global fixed broadband speeds will reach 53.0 Mbps, up from 27.5 Mbps in 2016

Prediction of Demand   Cisco

- Globally, mobile data traffic will increase sevenfold between 2016 and 2021

- The number of devices connected to IP networks will be three times as high as the global population in 2021

- Traffic from wireless and mobile devices will account for more than

  63 percent of total IP traffic by 2021

Prediction of Demand   Cisco

- Globally, IP video traffic will be 82 percent of all consumer Internet traffic by 2021, up from 73 percent in 2016.

- Virtual reality and augmented reality traffic will increase 20-fold between 2016 and 2021, at a CAGR of 82 percent

Net Neutrality
Freedom of Speech, Privacy, and National Security

The First Amendment

"Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof; or abridging the freedom of speech, or of the press, or the right of the people peaceably to assemble, and to petition the Government for a redress of grievances."

The Fourth Amendment

"The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no warrants shall issue, but upon probable cause, supported by oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized.

FISA warrant requests for electronic surveillance September 2013

Year	# Requests Submitted	# Requests Modified[b]	# Requests Denied	Cumulative # Warrants Issued
1979–1999	12,082		0	12,090
1979	199	0	0	207[7]
2000	1,005	1	0	13,102[c]
2001	932	2	0	14,036
2002	1,228	2 [d]	0	15,264
2003	1,724	79	4 [e]	16,988
2004	1,758	94	0	18,742
2005	2,074	63	0	20,814
2006	2,181	77	1	22,990
2007	2,371	86	4	25,360
2008	2,082	2	1	27,443
2009	1,329	14	1	28,763
2010	1,511	14	0	30,342
2011	1,676	30	0	32,087
2012	1,789	40	0	33,942
TOTALS	33,949		11 [f]	33,942

a. ^ Excludes physical searches

Facial Recognition

Original Goals of the Internet

- The goals of the original Internet were to provide:

    – Permission-less innovation

    – Open access

    – Collaboration

Original Rules of the Internet

- Free

- First come, first serve

- Anyone can say anything (Legal)

Privacy and Security: Challenges of the new Internet Regulations

- Freedom of Speech vs. Security vs. Privacy?

- Maintenance of net neutrality and a free Internet?

Ajit Pai   Trump's FCC Chairman

SOPA and PIPA   2012

- Stop On-line Piracy Act (SOPA)

  Protect Intellectual Property Act (PIPA)

- Both of these bills were introduced to Congress, supported by major media and entertainment companies

- Intent was to shut down foreign websites that distribute unauthorized copies of software, videos and music

SOPA and PIPA   2012

- Tech industry maintained the "language was too broad" and could threaten free speech and stifle innovation

- Sites could be responsible for "all content and links posted by their users"

- Tough job for social networks

SOPA and PIPA – What Happened?

- An Internet Groundswell

  Initiated by Tumblr, Reddit, et al.,

  Helped by Twitter

  Followed by Wikipedia (went dark 1/25/2012)

- The bill was withdrawn

Imaging Ethics and Photojournalism

Moon and Half Dome by Ansel Adams

Dodging (Ansel Adams)
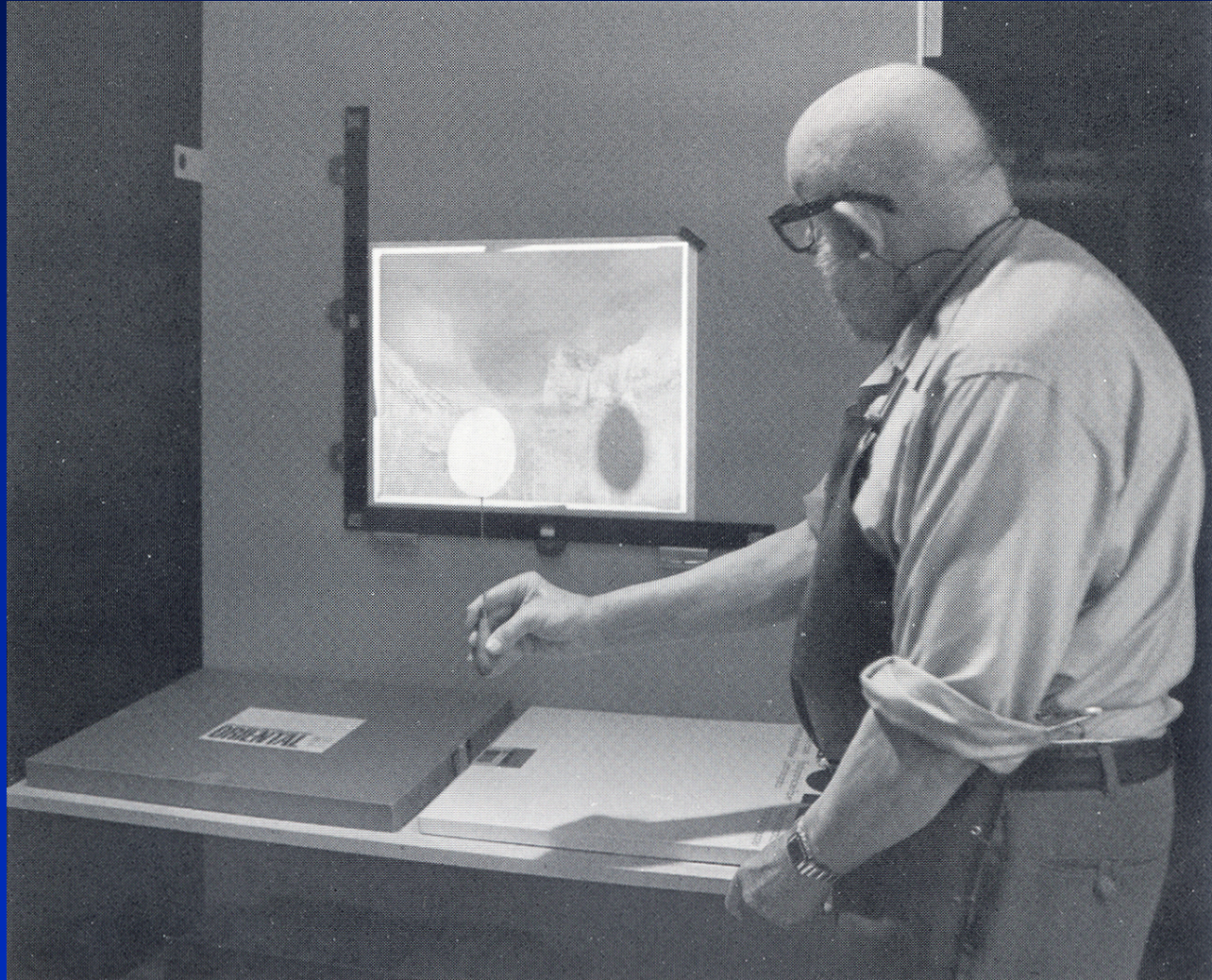
What should be the ethics and rules in this age of digital photography?

Magnum Photographers

Robert Capa
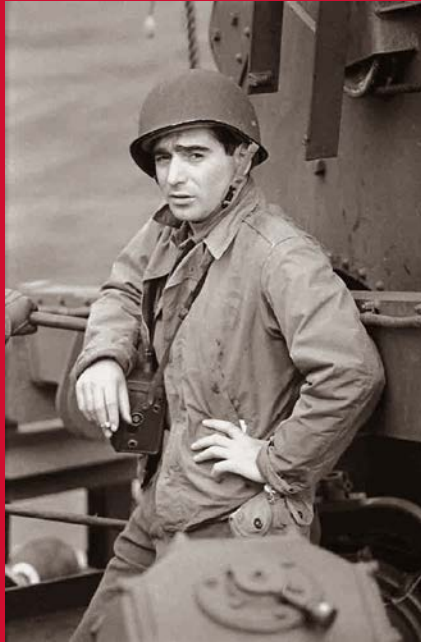
Henri Cartier-Bressone

- Organization was founded on the ideal that photographs must not be altered, cropped, or manipulated in any form.

Stalin & Trotsky

Original

Margaret Thatcher and George Bush
(*New York Times, Scientific American,
Museum of Modern Art*) *1994.*

English Version

U.S. Version

Margaret Thatcher and George Bush (*New York Times, Scientific American, Museum of Modern Art*). 1994.

Kerry and Fonda

The picture of Senator Kerry was captured by photographer Ken Light as Kerry was preparing to give a speech at the Register for Peace Rally held in Mineola, New York, in June 1971. The picture of Jane Fonda was captured by Owen Franken as Fonda was speaking at a political rally in Miami Beach, Florida, in August 1972.

Kerry and Fonda

Fonda Speaks To Vietnam Veterans At Anti-War Rally

Actress And Anti-War Activist Jane Fonda Speaks to a crowd of Vietnam Veterans as Activist and former Vietnam Vet John Kerry (LEFT) listens and prepares to speak next concerning the war in Vietnam (AP Photo)

February 2004: This digital composite of Senator John Kerry and Jane Fonda sharing a stage at an anti-war rally emerged during the 2004 Presidential primaries as Senator Kerry was campaigning for the Democratic nomination.

The journey of a fake news story that begins with a single tweet

SF Gate

Fake News Onslaught Targets Pizzeria as Nest of Child Trafficking

New York Times

Comcast/BitTorrent

- BitTorrent has many legitimate uses and is part of the future of high quality Internet video

- It is widely used by:

  – Major Hollywood studios for legal distribution of movies, TV shows, and music

  – Software makers to develop and distribute software

  – In 2007, testing by MIT professors and others confirmed that Comcast was secretly blocking and degrading particular applications

- Comcast has incentive to degrade BitTorrent because Internet TV can compete with cable television

Comcast/BitTorrent - Lawsuit   2008

- In the summer of 2008, the FCC ruled that Comcast violated Internet open-access guidelines by blocking BitTorrent P2P traffic

- Comcast's Appeal to the U.S. Court of Appeals (Washington D.C.) was set for January 8, 2010

- In December 2009, after two years of legal fighting, Comcast settled out of court

Comcast/BitTorrent – Settlement

- Comcast agreed to put $16M into a fund to pay BitTorrent users effected by their "network management"

- Those who want a refund will have to state that they were not violating copyright law

- The company "still refuses to admit its wrongdoings"

AI Generated Images 2018

Wired vs. Wireless
The Physics of Sound & Light

Basic Physics
Speed (velocity) Of Sound & Light

Sound (air)	1100 ft/second
	335 meters/second
Light (vacuum)	186,000 miles/second
	300×10^6 meters/second
(fiber)	200×10^6 meters/second
Electricity (copper)	225×10^6 meters/second

Physics 101

Relationship between distance, velocity and time

Distance = velocity x time

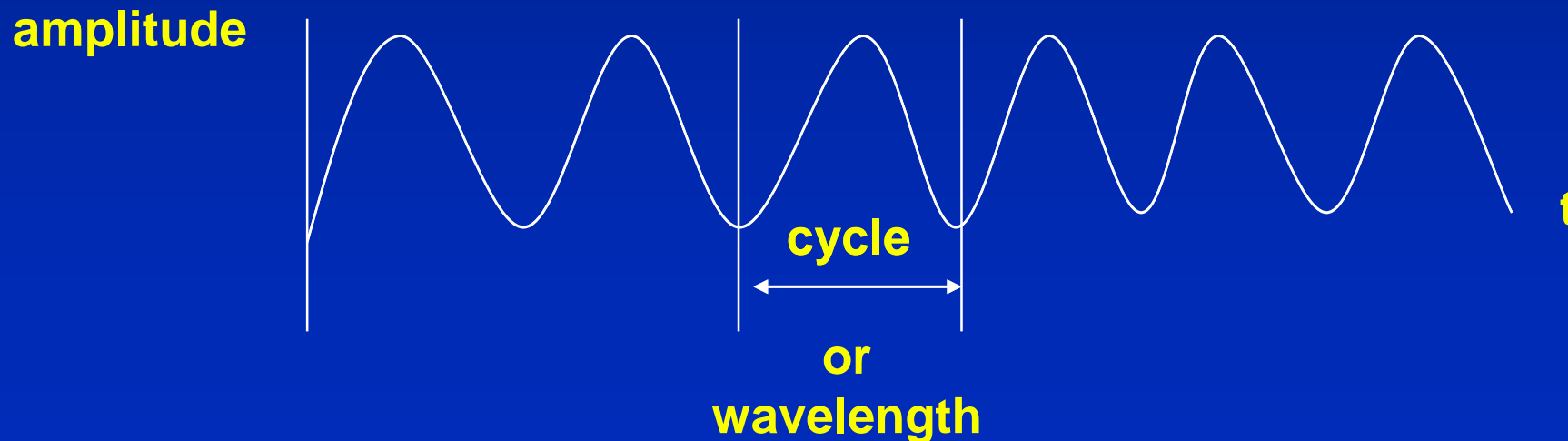$$d = vt, v = d/t, t = \frac{d}{v}$$

d = distance

v = velocity

t   = time

Physics 101

Relationship between velocity, wavelength and frequency

Velocity (v) = frequency (f) x wavelength (λ)

$$v = f\lambda, \quad f = \frac{v}{\lambda}, \quad \lambda = \frac{v}{f}$$

amplitude

t

cycle

or
wavelength

Physics 101

Velocity of sound in air $= 1100$ ft/second

Frequency $= 300$ cycles/second

$$\lambda_{300} = \frac{1100\,ft/\sec}{300\,cycles/\sec} = \frac{11}{3}\,ft = 1.1\,Meters$$

Frequency $= 33000$ cycles/second

$$\lambda_{3300} = \frac{1100\,ft/\sec}{33000\,cycles/\sec} = \frac{11}{330}\,ft = \frac{1}{30}\,ft \approx 0.01\,Meters$$

Light vs. Sound

- Human ear
  - Hears between 300-33,000 cycles/sec.

- Human eye
  - Sees at wavelengths between 400nm-700nm (blue to red)

Comparison Between Wavelengths Of Sound And Light

Short Wavelengths

Long Wavelengths

Sound   0.01 M

1.1 M

Light   400nm

700nm

Ratio

$$\frac{\lambda_s}{\lambda_1} = \frac{0.01}{400 \times 10^{-9}} = 25,000x$$

$$\frac{\lambda_s}{\lambda_1} = \frac{1.1}{700 \times 10^{-9}} = 1,570,000x$$