An aerial night photograph of a city. A large, modern building is the central focus, illuminated with blue light. On its roof, the word 'LINKOM' is visible in white capital letters. The surrounding city is dark, with various lights from other buildings and streets visible. The text 'TK35303' and 'Computer Networks' is overlaid on the image in large, bold, black font.

TK35303

Computer Networks

#Convergence Networks

Susmini Indriani Lestariningati, M.T

Rules in Class

- Hadir tepat waktu, toleransi keterlambatan 15 menit
- HP dimatikan/silent-mode dan disimpan di dalam TAS. Tidak boleh menerima telpon atau SMS selama perkuliahan.
- Tidak melakukan kecurangan pada saat ujian (Quiz, UTS maupun UAS)
- Bekerja secara maksimal dan memiliki kesungguhan dalam belajar.
- Minimal kehadiran adalah 80% (Maksimum ketidakhadiran 3 kali)
- Menanyakan perihal akademik pada jam kantor. (Baik berupa email, sms, maupun telepon)
- Berbahasa Indonesia yang baik dan sopan.



Steve Jobs (1955 -2011)



Jaringan Komputer

Silabus

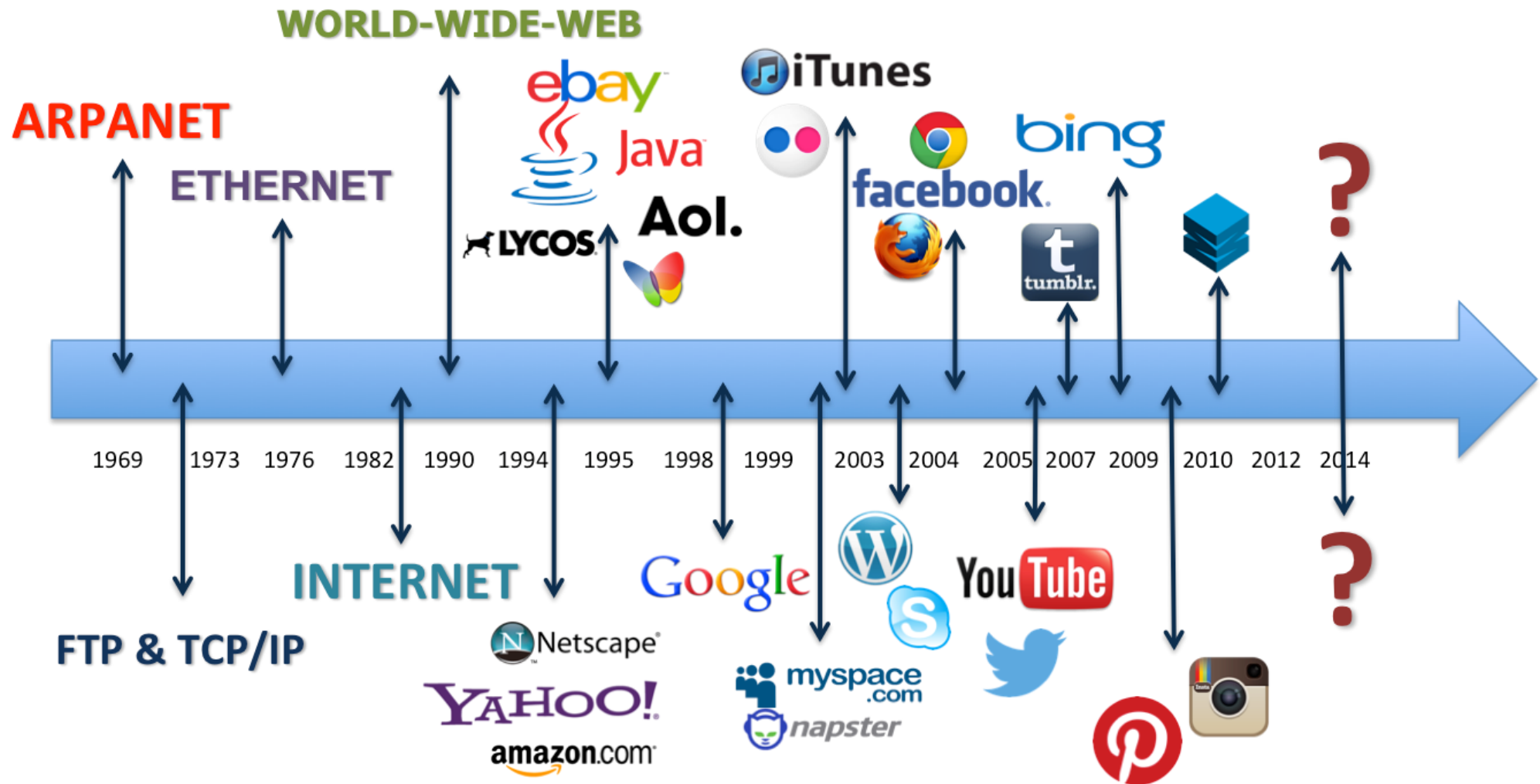
Jaringan komunikasi data membahas proses komunikasi data antar komputer melalui jaringan komunikasi data. Proses komunikasi melibatkan arsitektur protokol OSI & TCP/IP yang didalamnya dijelaskan aturan, mekanisme dan kemampuan protokol setiap layer. Jaringan komunikasi disusun atas berbagai media transmisi dan perangkat jaringan yang memiliki karakteristik tersendiri

Jaringan Komputer

Course Learning Outcome (CLO)

- Mahasiswa memahami prinsip kerja komunikasi data dalam arsitektur protokol OSI dan TCP/IP
- Mahasiswa memahami kemampuan perangkat dan elemen jaringan penyusun komunikasi data
- Mahasiswa mampu merancang sebuah jaringan skala LAN dengan parameter efektifitas pengalamatan, routing dan penggunaan perangkat jaringan
- Mahasiswa mampu mensimulasikan hasil rancangan jaringan LAN

History of Internet



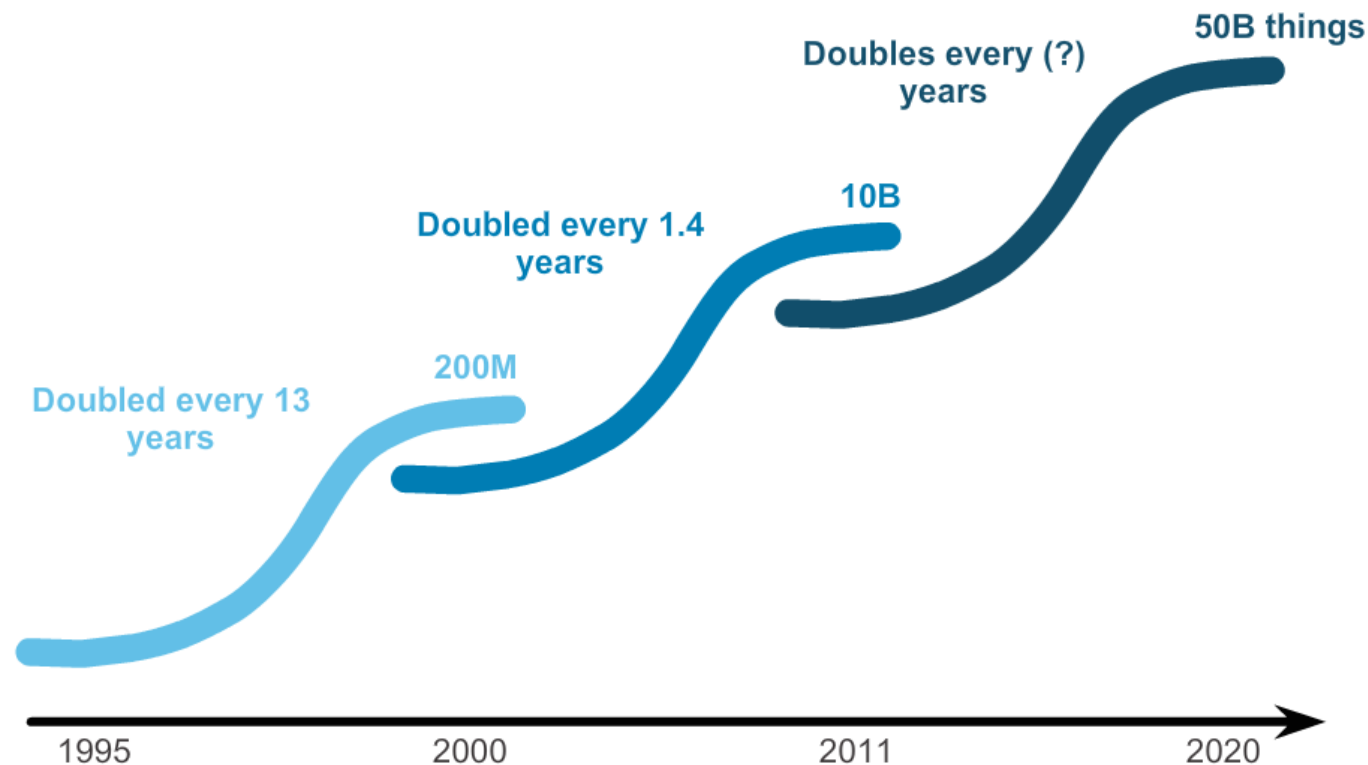
Technology Now and Then

"Fixed" Computing
(You go to the device)

Mobility/BYOD
(The device goes with you)

Internet of Things
(Age of Devices)

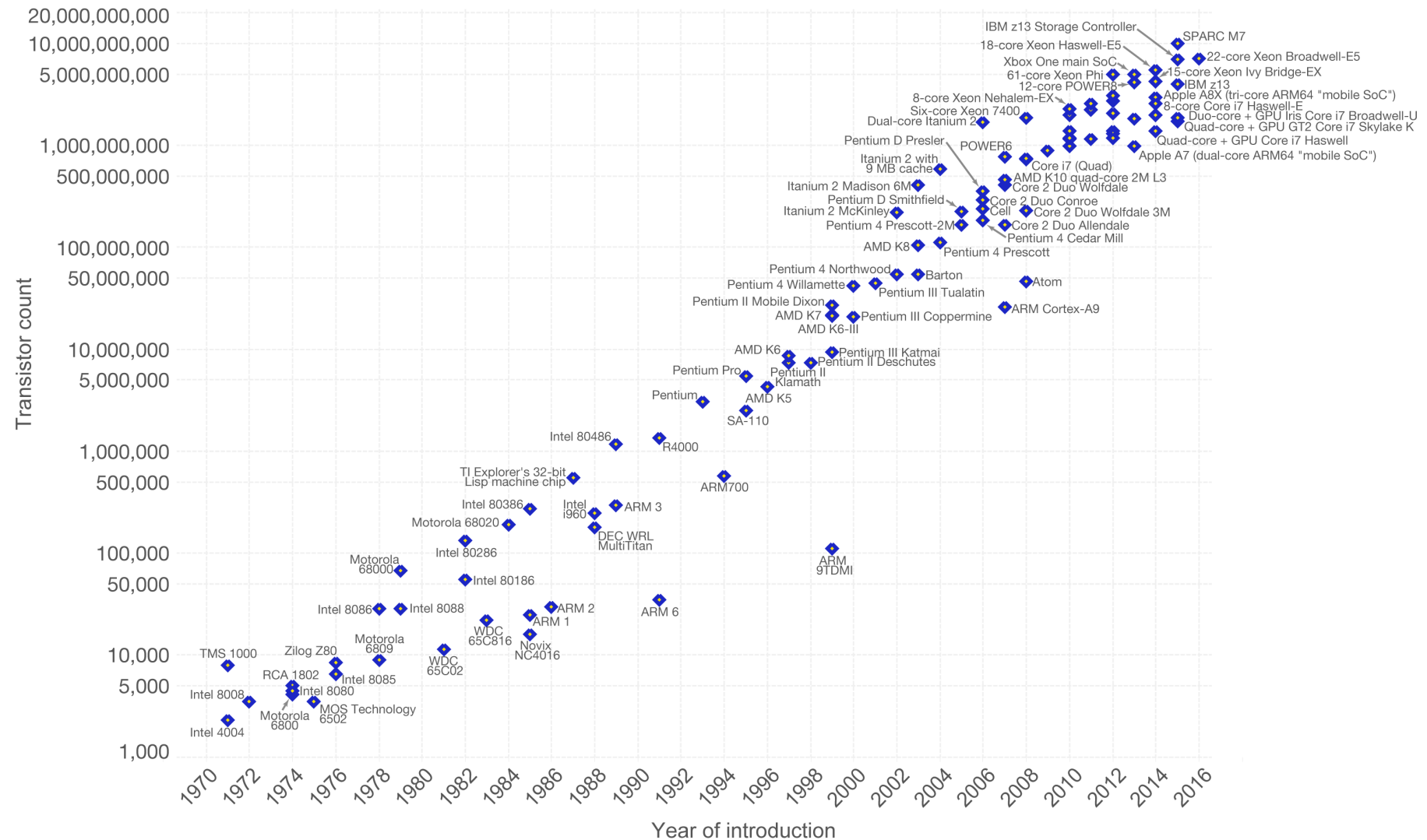
Internet of Everything
(People, Process, Data, Things)



Moore's Law – The number of transistors on integrated circuit chips (1971-2016)



Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years. This advancement is important as other aspects of technological progress – such as processing speed or the price of electronic products – are strongly linked to Moore's law.

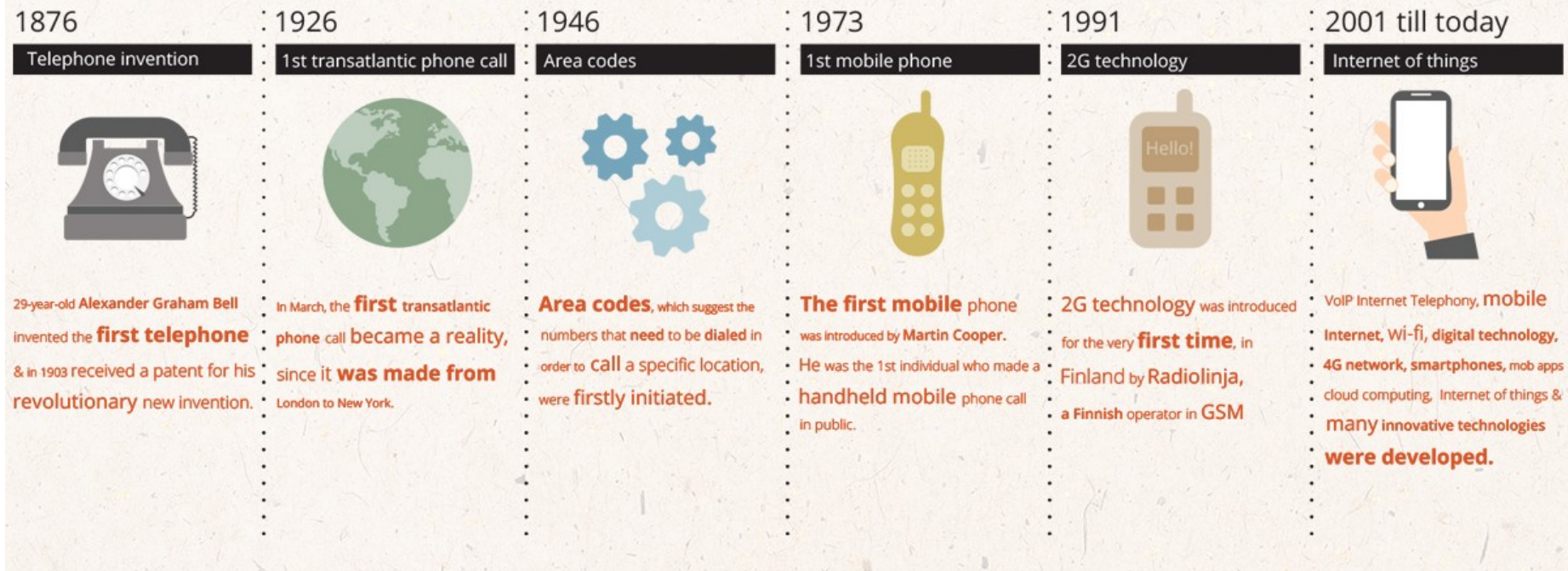


Data source: Wikipedia (https://en.wikipedia.org/wiki/Transistor_count)

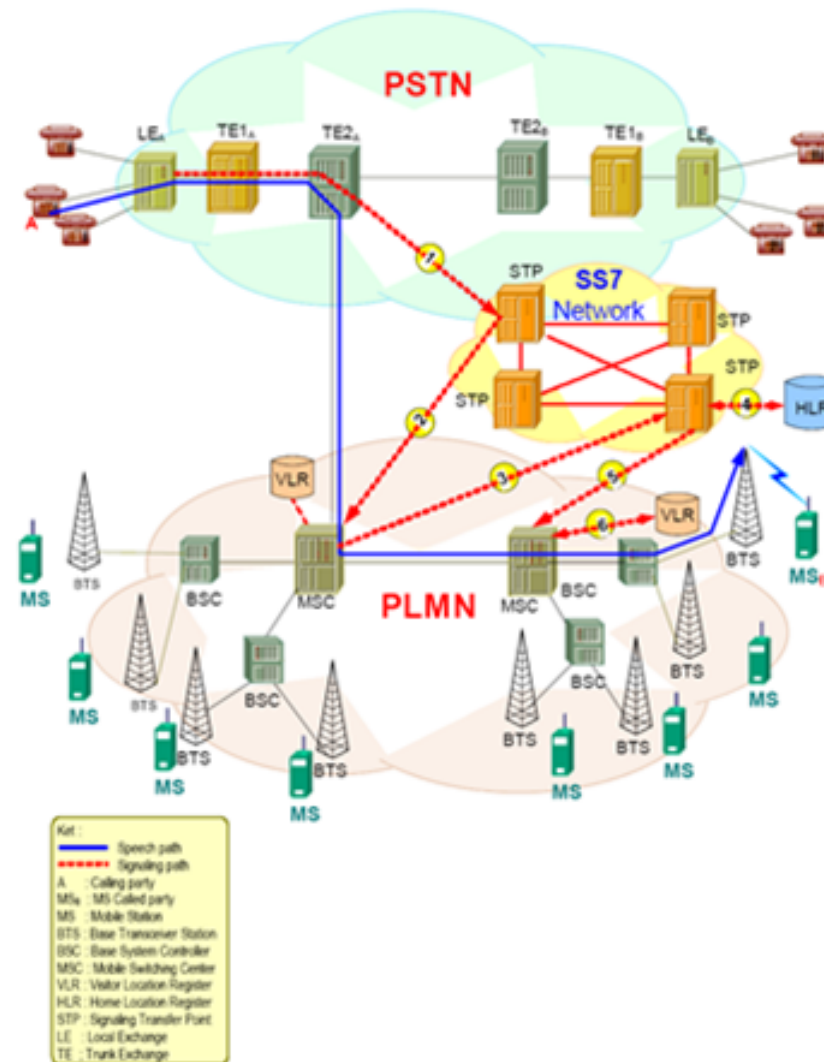
The data visualization is available at [OurWorldinData.org](https://ourworldindata.org). There you find more visualizations and research on this topic.

Licensed under [CC-BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) by the author Max Roser.

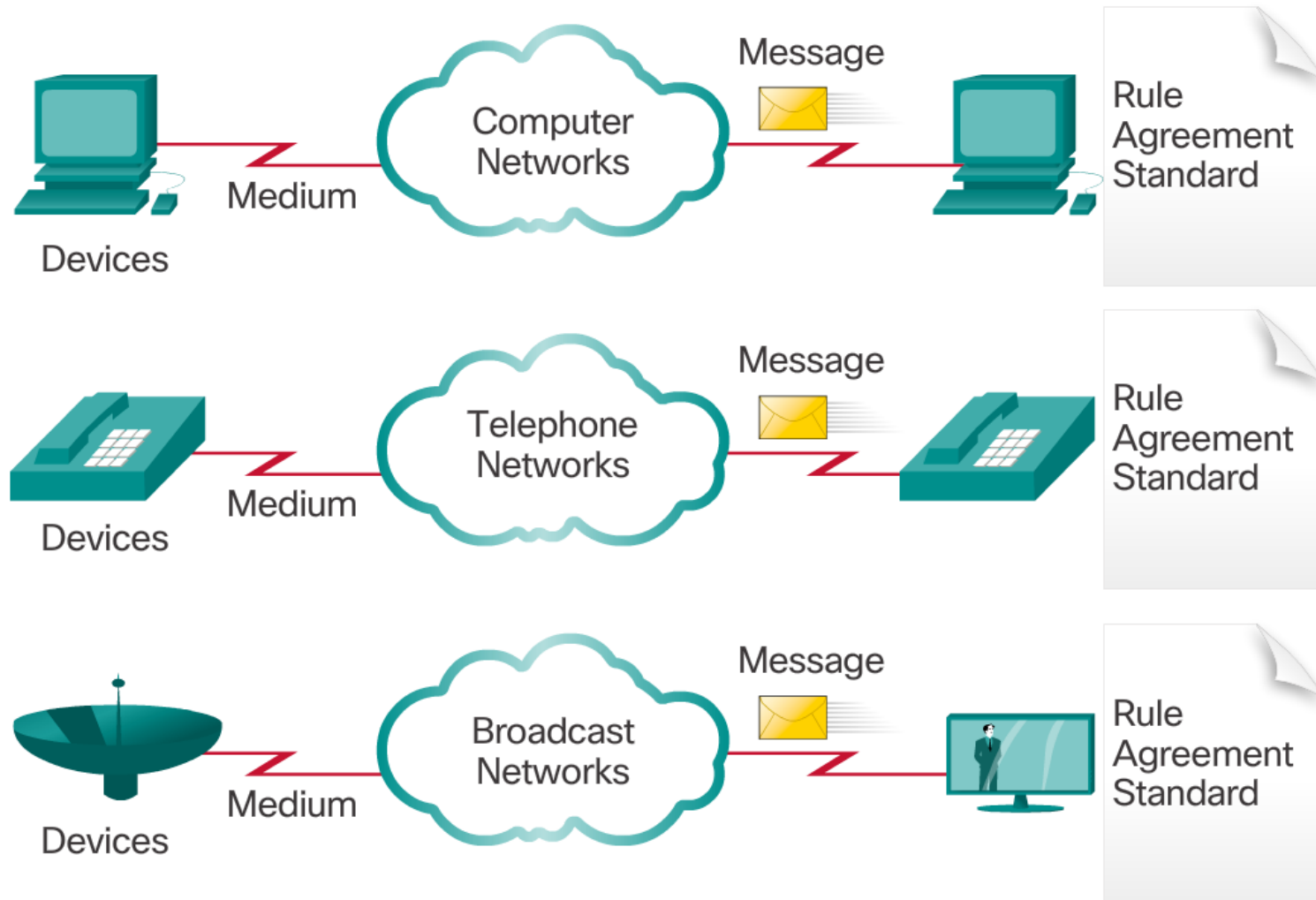
The Evolution of Telecommunications



Network Growth

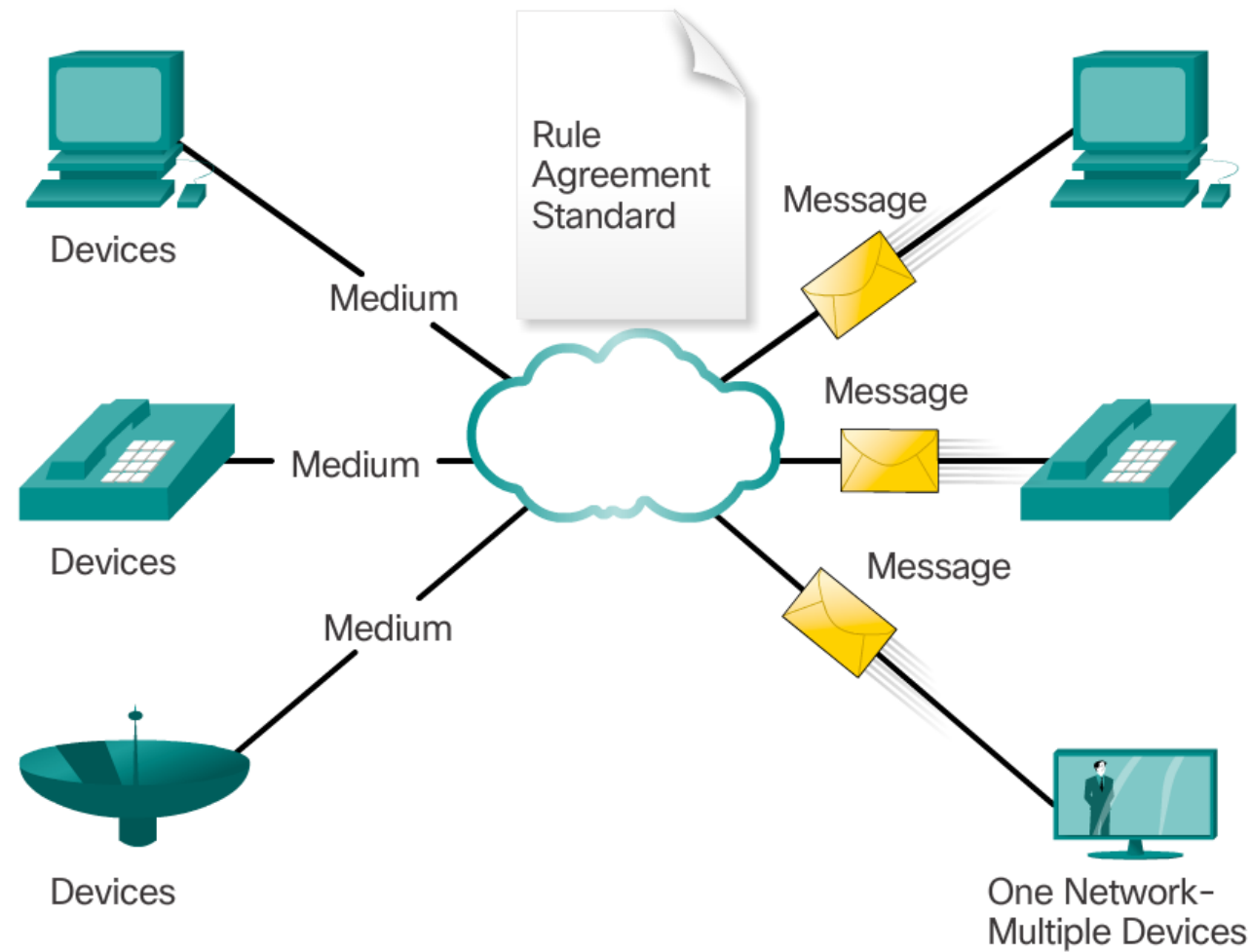


Multiple Networks



Multiple services are running on multiple networks.

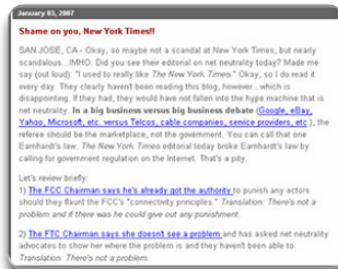
Converged Networks



Converged data networks carry multiple services on one network.

How Networks Impact Our Daily Life

Online Interest Groups



Online Gaming



Online Entertainment



Virtual Classrooms



Collaborative Learning Spaces



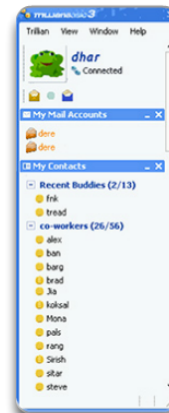
Online Shopping



Onboard Data Networks



Instant Messaging



Networks support the way we learn ...



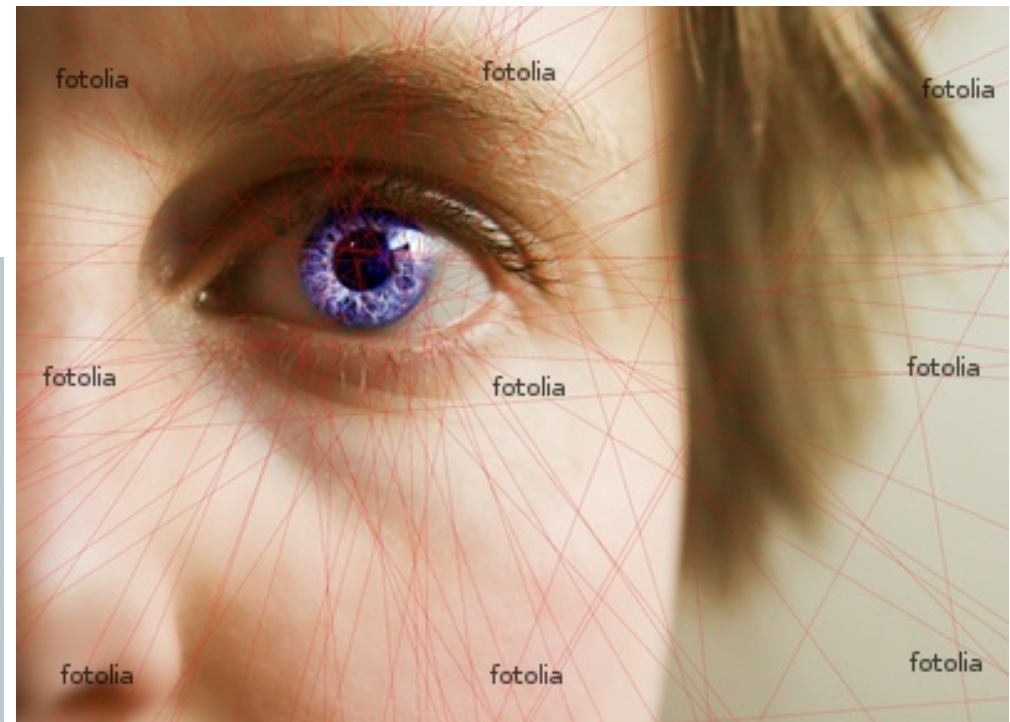
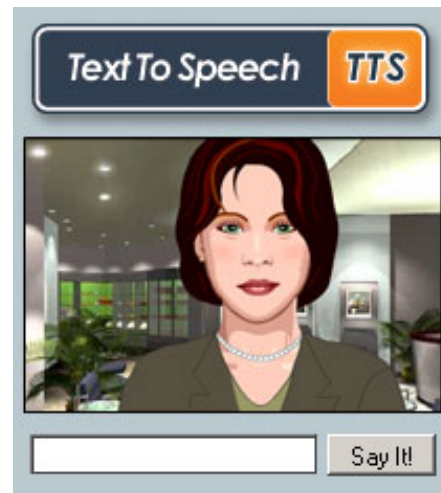
On-demand Video



Mobile Learning

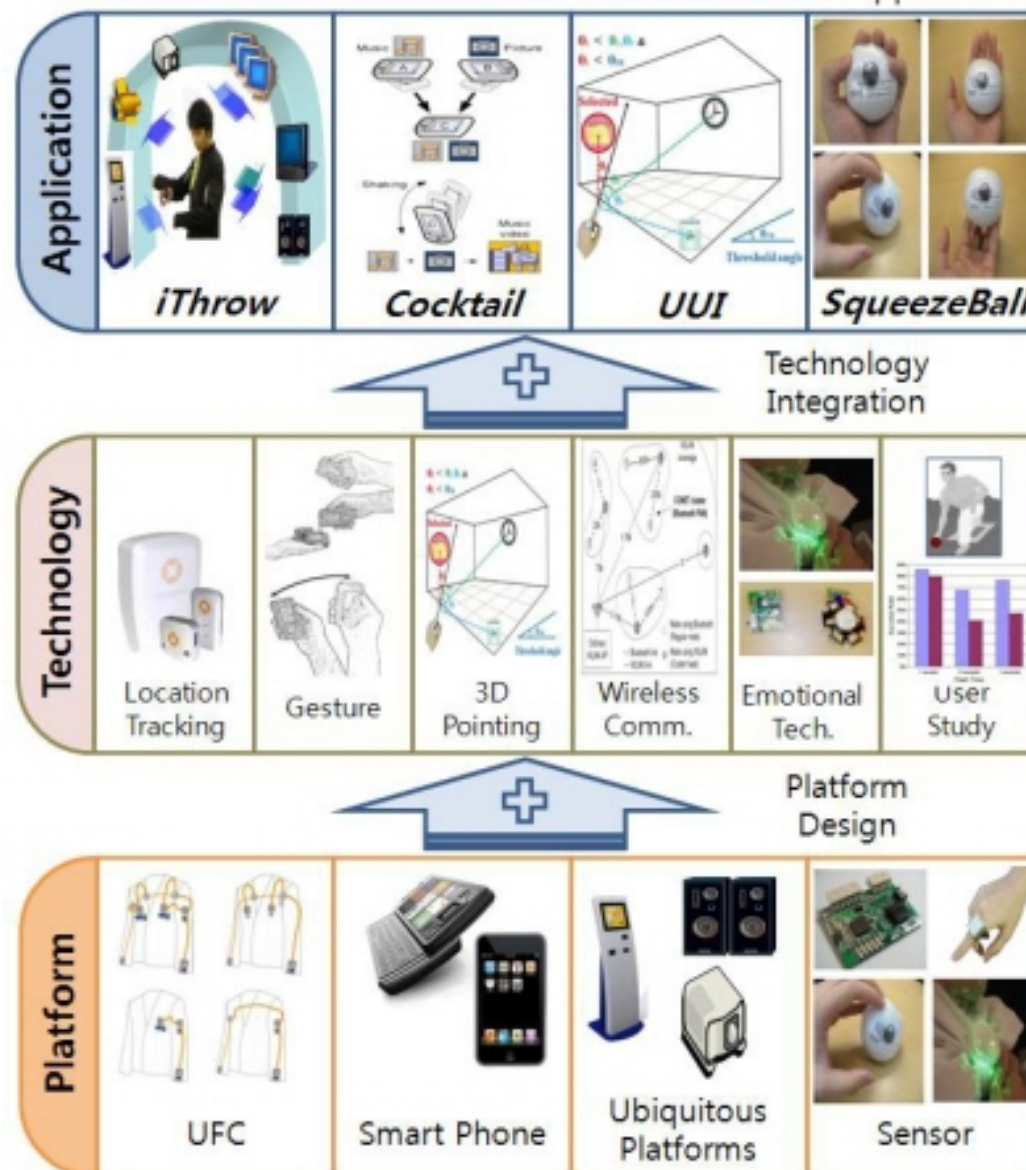
The way we play is supported by services delivered by the data network.

Application Growth



Human-Computer Interaction Research

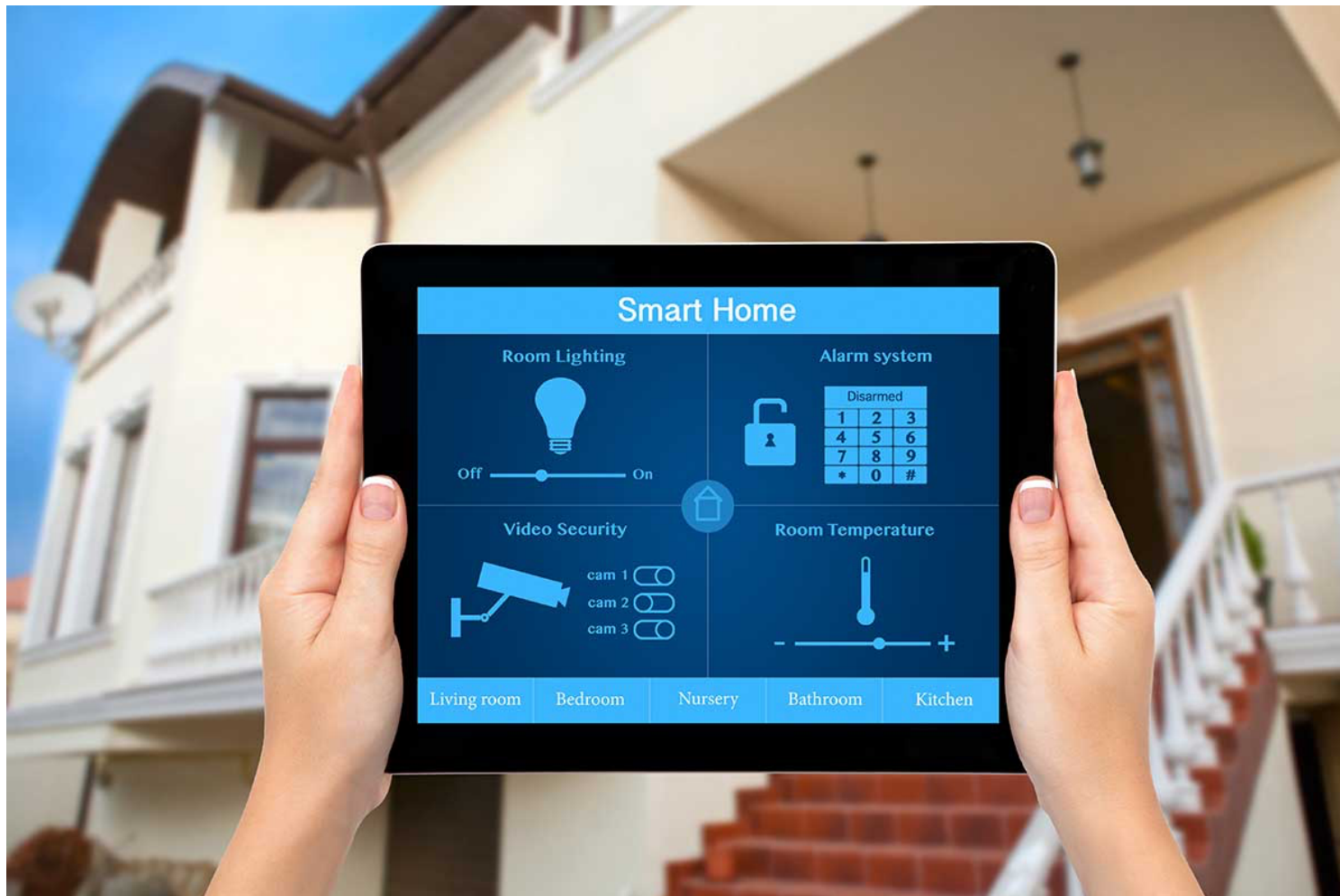
Next Generation Mobile Applications



Video Conference



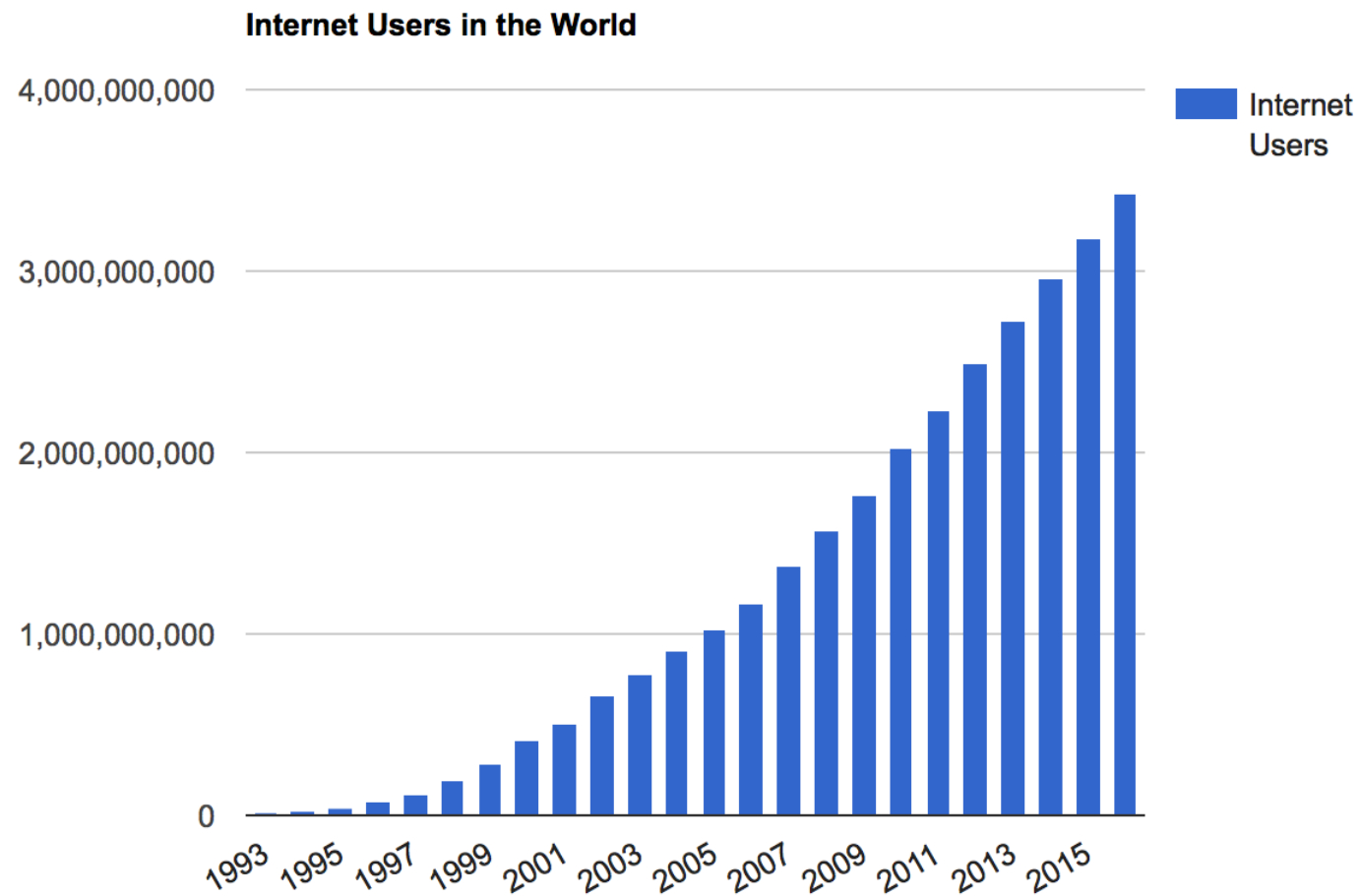
Smart home



Smart Home



Internet Users Growth in The World



Source: www.internetlivestats.com

Internet Users by Country

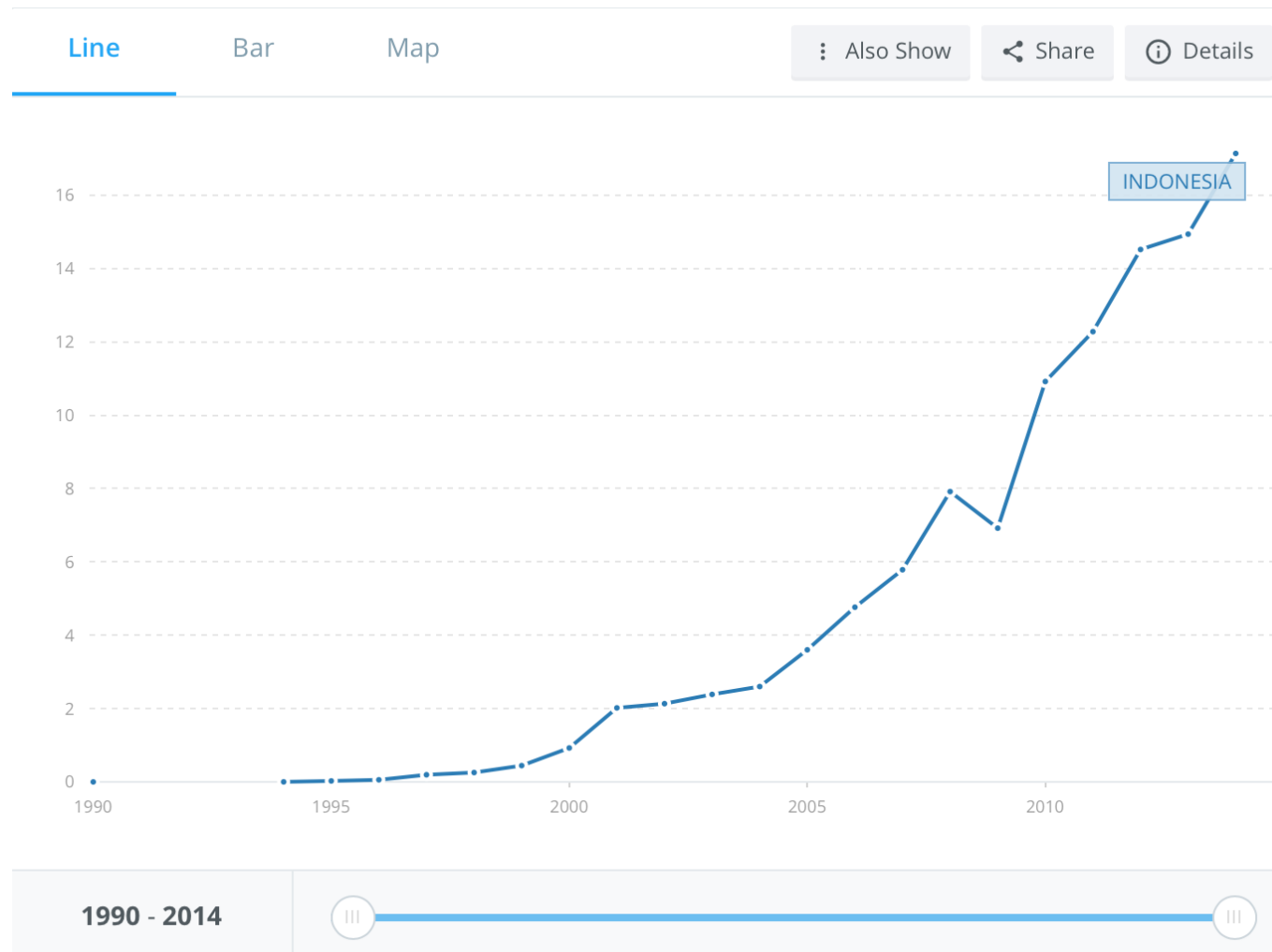
Internet Users by Country (2016)

See also: [2015 Estimate](#) and [2014 Finalized](#)

#	Country	Internet Users (2016)	Penetration (% of Pop)	Population (2016)	Non-Users (internetless)	Users 1 Year Change (%)	Internet Users 1 Year Change	Population 1 Y Change
1	China	721,434,547	52.2 %	1,382,323,332	660,888,785	2.2 %	15,520,515	0.46 %
2	India	462,124,989	34.8 %	1,326,801,576	864,676,587	30.5 %	108,010,242	1.2 %
3	U.S.	286,942,362	88.5 %	324,118,787	37,176,425	1.1 %	3,229,955	0.73 %
4	Brazil	139,111,185	66.4 %	209,567,920	70,456,735	5.1 %	6,753,879	0.83 %
5	Japan	115,111,595	91.1 %	126,323,715	11,212,120	0.1 %	117,385	-0.2 %
6	Russia	102,258,256	71.3 %	143,439,832	41,181,576	0.3 %	330,067	-0.01 %
7	Nigeria	86,219,965	46.1 %	186,987,563	100,767,598	5 %	4,124,967	2.63 %
8	Germany	71,016,605	88 %	80,682,351	9,665,746	0.6 %	447,557	-0.01 %
9	U.K.	60,273,385	92.6 %	65,111,143	4,837,758	0.9 %	555,411	0.61 %
10	Mexico	58,016,997	45.1 %	128,632,004	70,615,007	2.1 %	1,182,988	1.27 %
11	France	55,860,330	86.4 %	64,668,129	8,807,799	1.4 %	758,852	0.42 %
12	Indonesia	53,236,719	20.4 %	260,581,100	207,344,381	6.5 %	3,232,544	1.17 %
13	Viet Nam	49,063,762	52 %	94,444,200	45,380,438	3.3 %	1,564,346	1.07 %
14	Turkey	46,196,720	58 %	79,622,062	33,425,342	5.1 %	2,242,750	1.22 %
15	Philippines	44,478,808	43.5 %	102,250,133	57,771,325	4.4 %	1,855,574	1.54 %

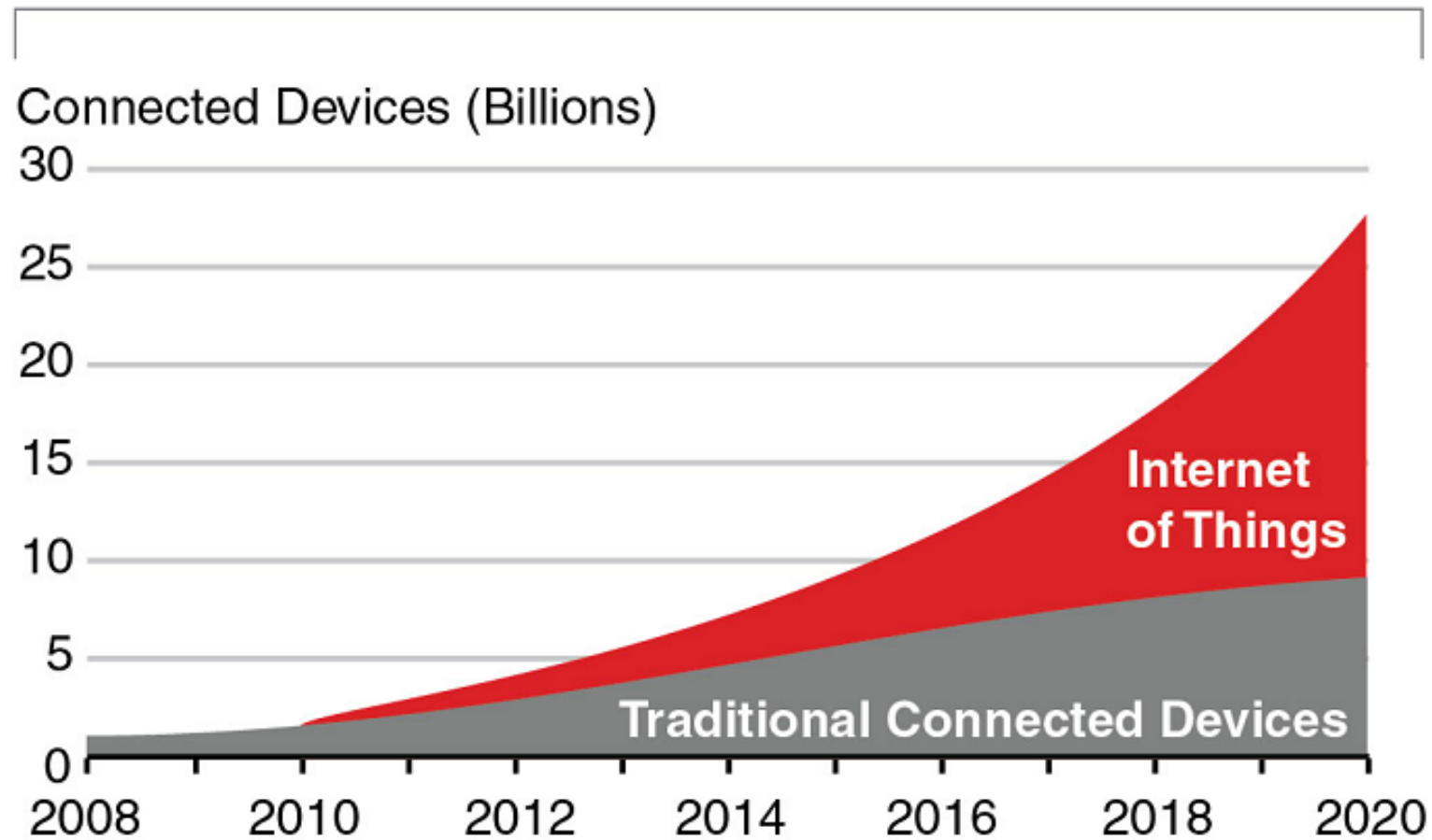
Source: www.internetlivestats.com

Internet Growth in Indonesia



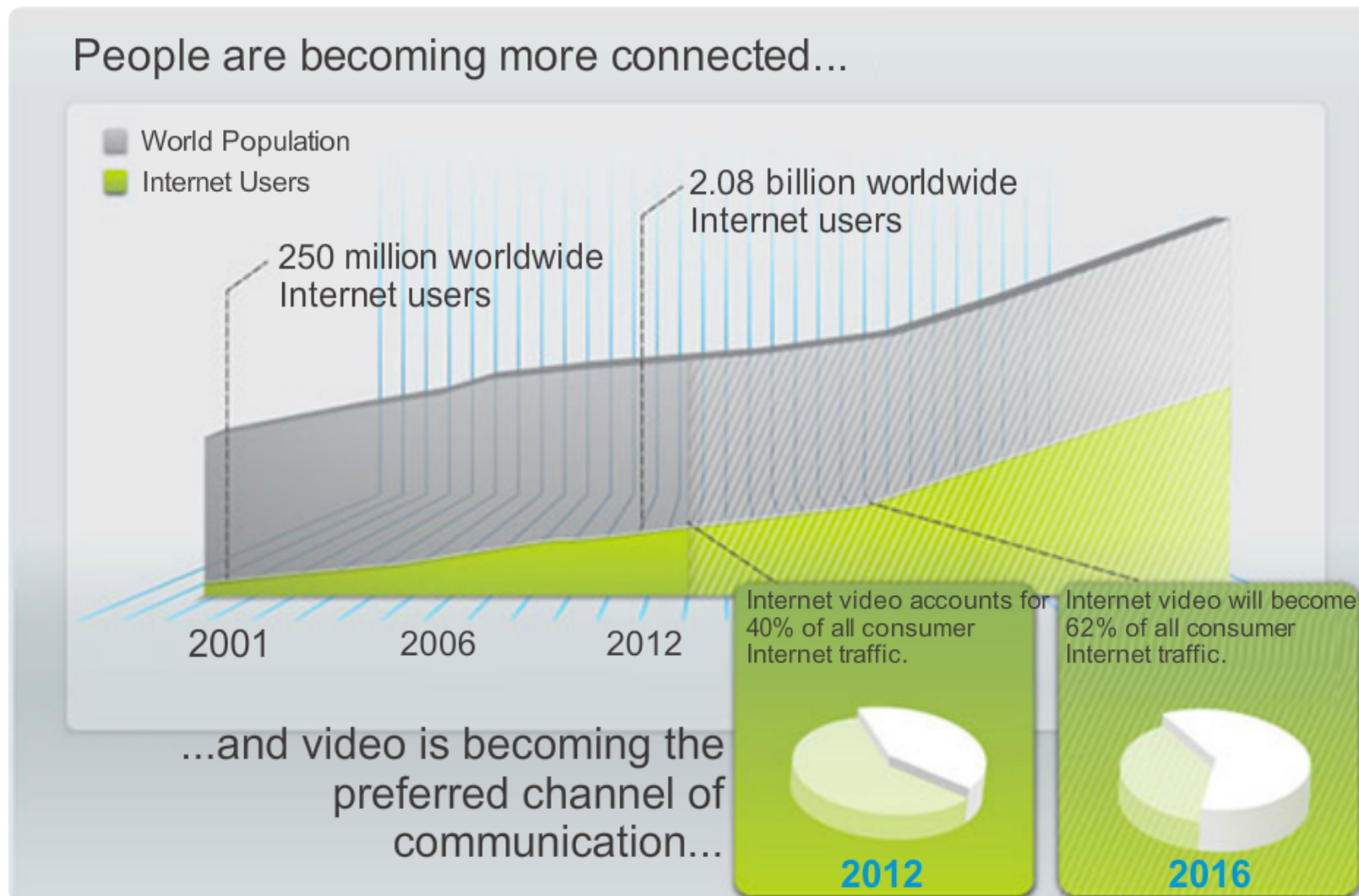
Source: www.data.worldbank.org

Estimated Worldwide Growth of Traditional Connected Devices and IoT

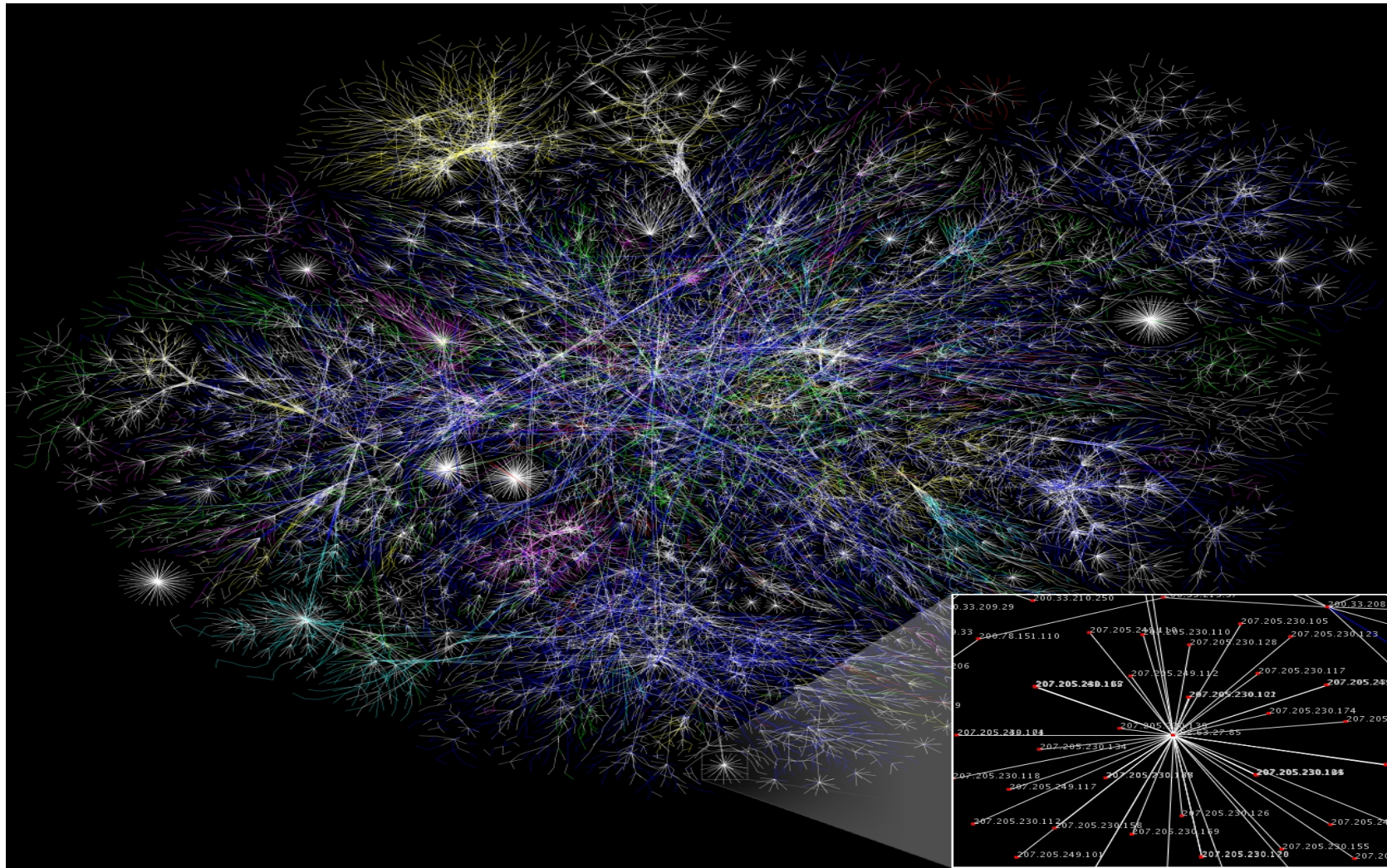


Source: A.T. Kearney

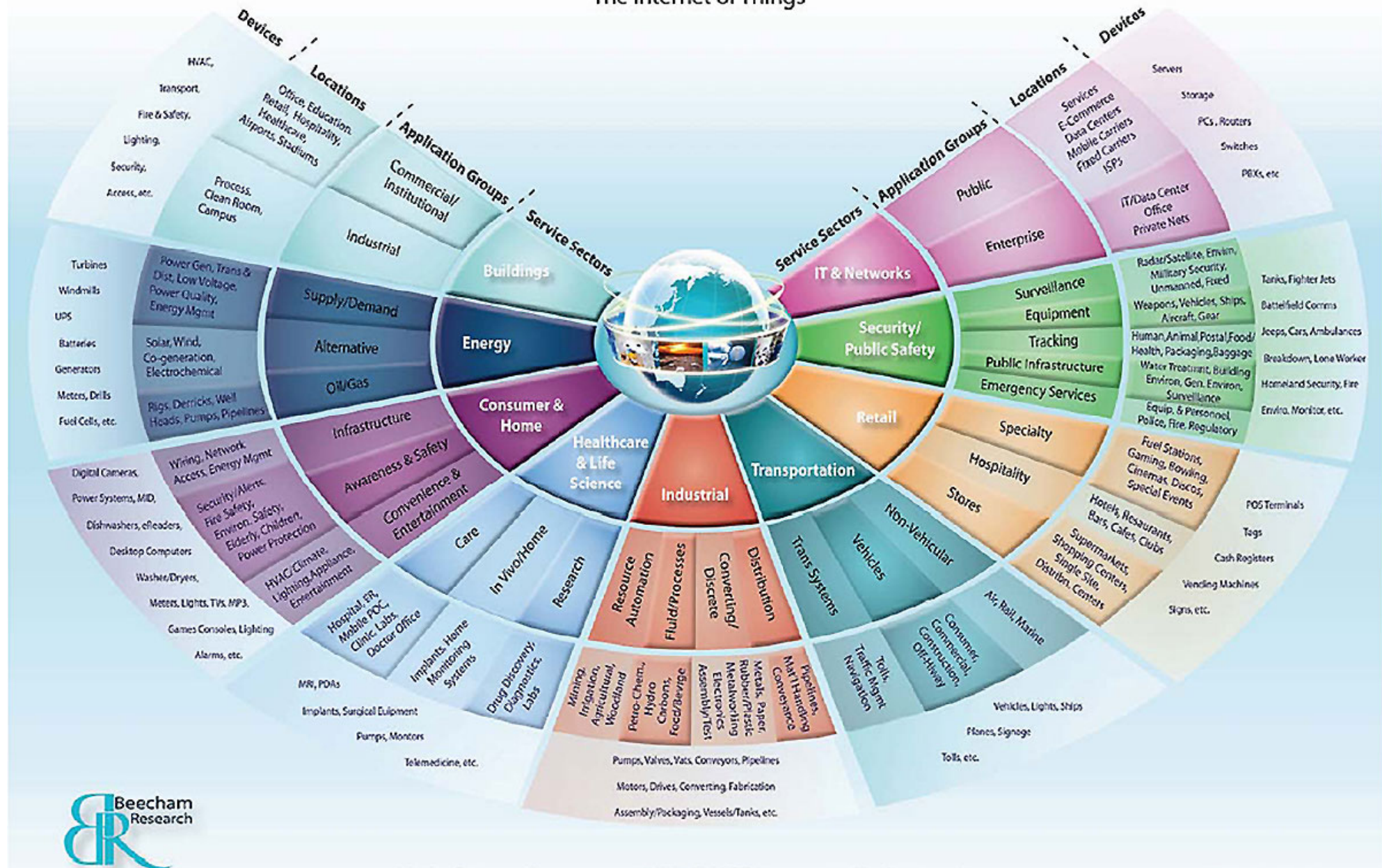
IoT ripples through advanced industries.

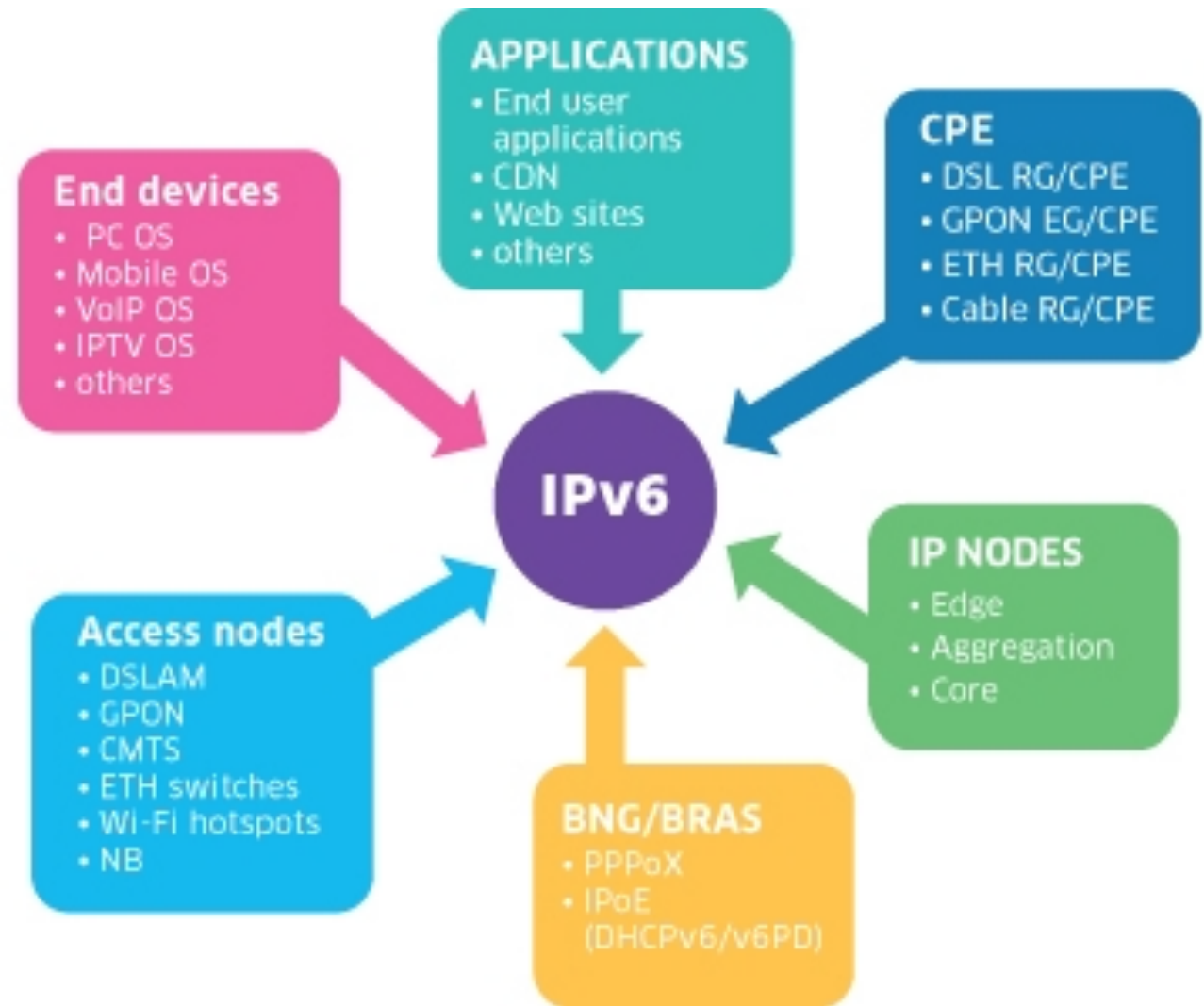
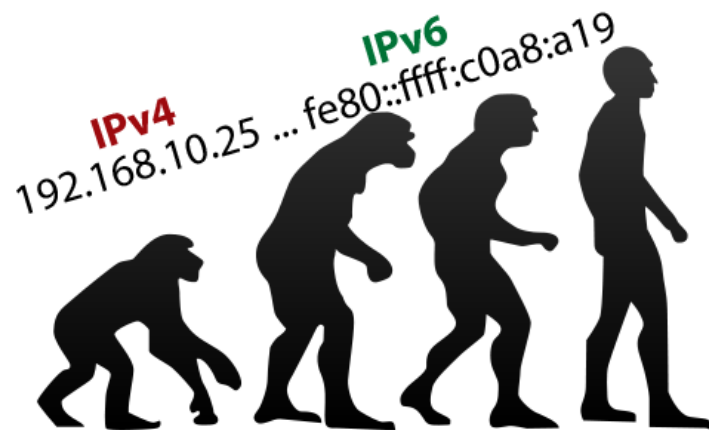


Data Growth

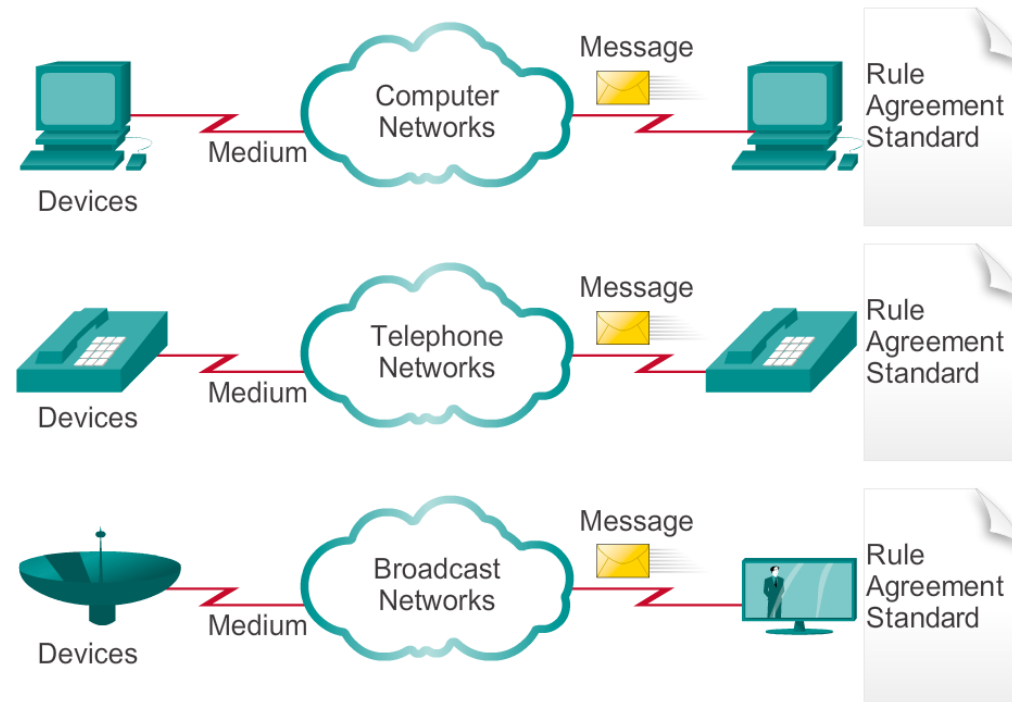


The Internet of Things





Data Networking Role, Components, and Challenges



Various elements make up a network :

- **Devices:** These are used to communicate with one another
- **Medium:** This is how the devices are connected together
- **Messages:** Information that travels over the medium
- **Rules:** Governs how messages flow across network

Network Architecture - Reliable Networks

- Networks must support a wide range of applications and services, as well as operate over many different types of cables and devices, which make up the physical infrastructure. The term network architecture, in this context, refers to the technologies that support the infrastructure and the programmed services and rules, or protocols, that move messages across the network.
- There are four basic characteristics that the underlying architectures need to address in order to meet user expectations:
 - ***Fault Tolerance*** (Figure 1)
 - ***Scalability*** (Figure 2)
 - ***Quality of Service (QoS)*** (Figure 3)
 - ***Security*** (Figure 4)

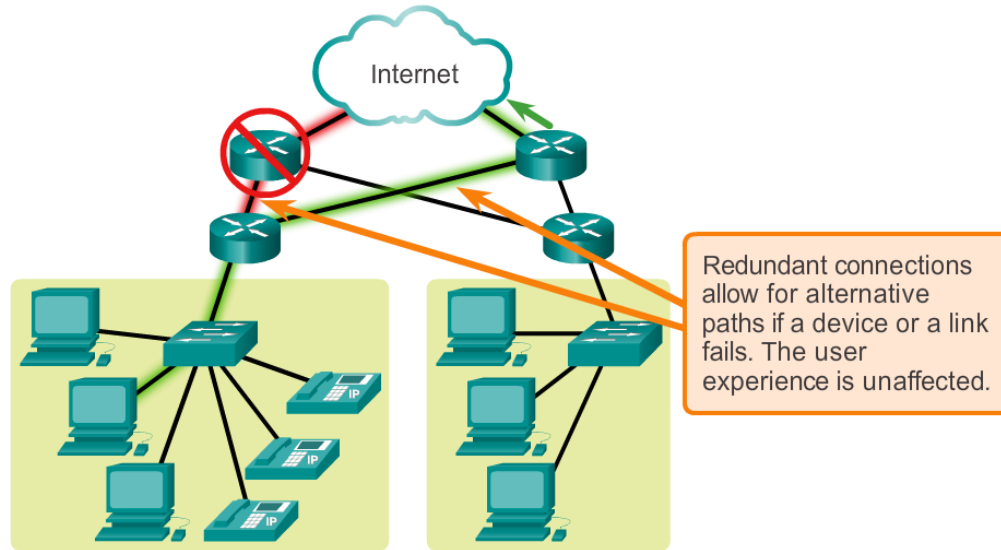


Fig 1 Fault Tolerance

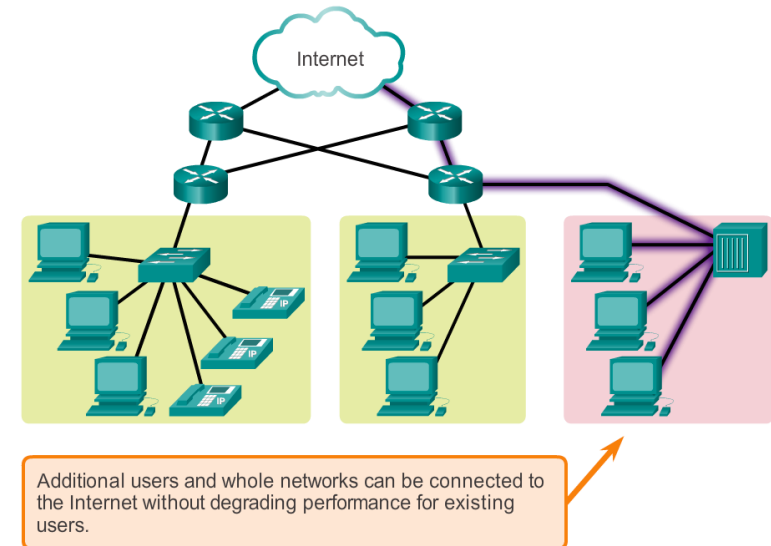


Fig 2 Scalability

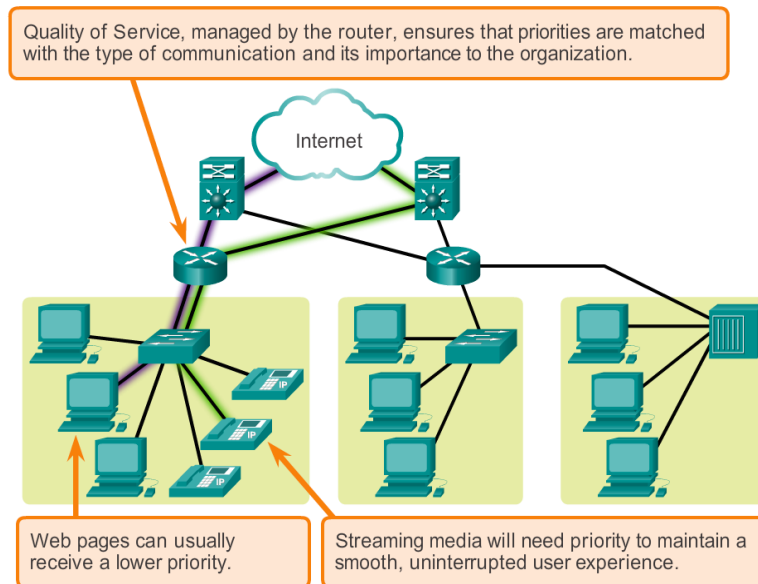


Fig 3 Quality of Service

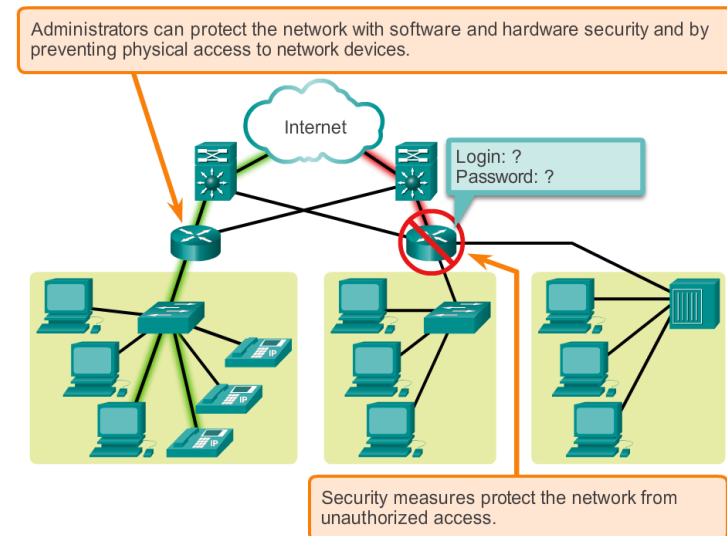
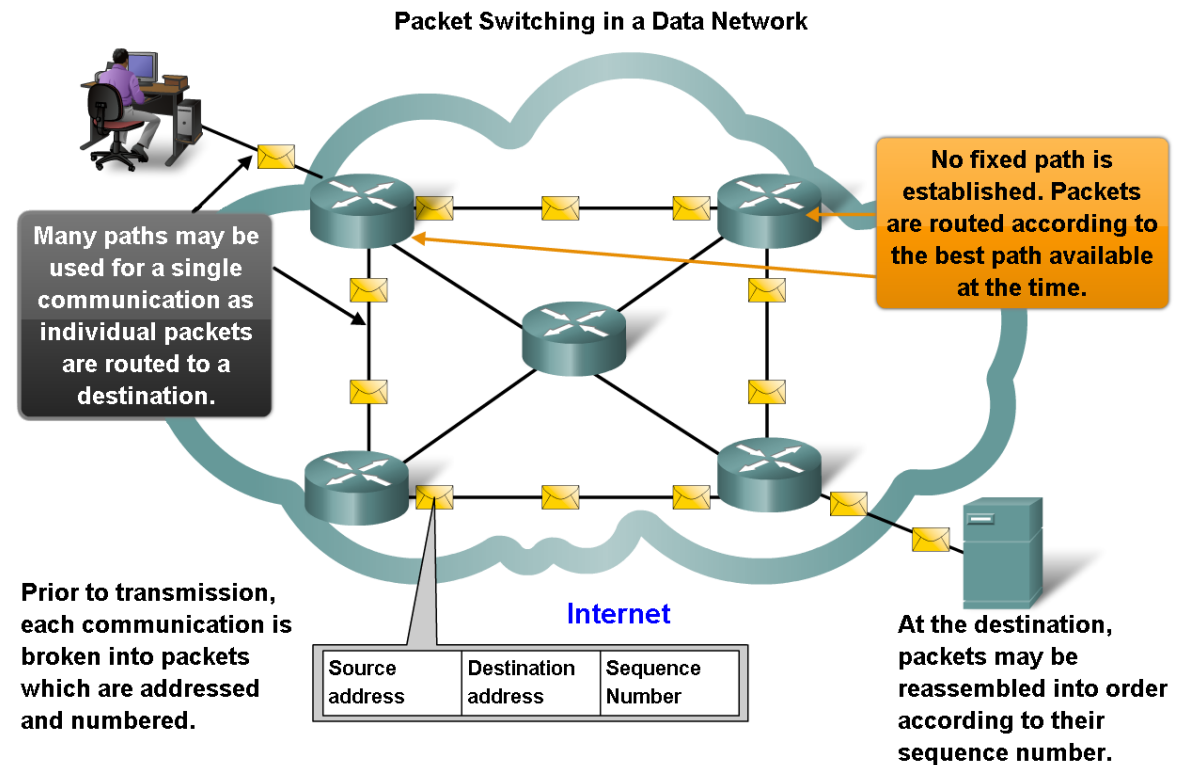


Fig 4 Security

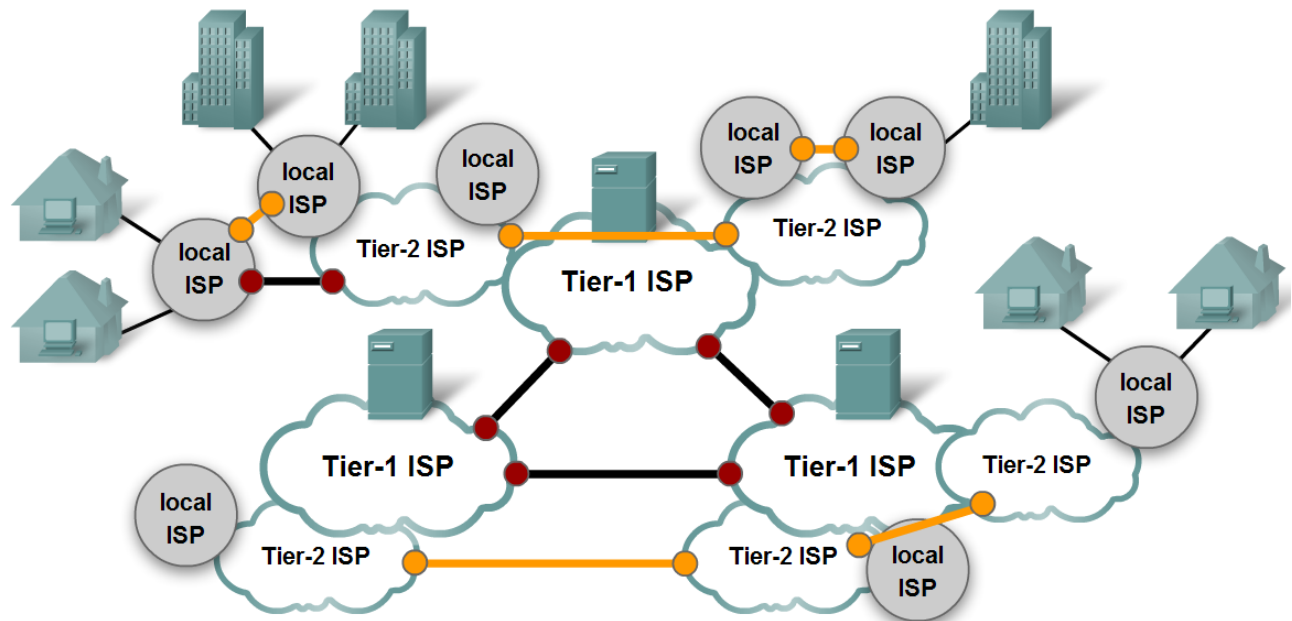
Fault Tolerance

- Packet switching helps improve the resiliency and fault tolerance of the Internet architecture



Scalability

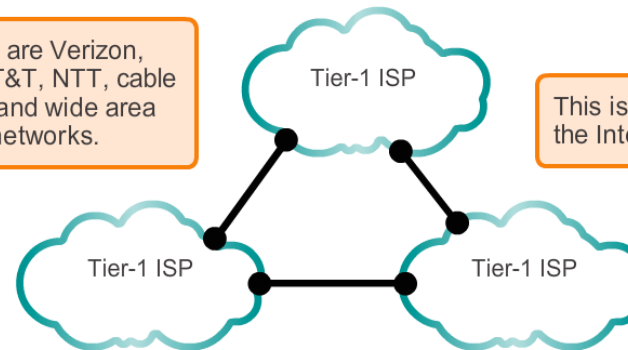
- Characteristics of the Internet that help it scale to meet user demand
 - Hierarchical
 - Common standards
 - Common protocols



Tier 1

Examples are Verizon, Sprint, AT&T, NTT, cable systems, and wide area wireless networks.

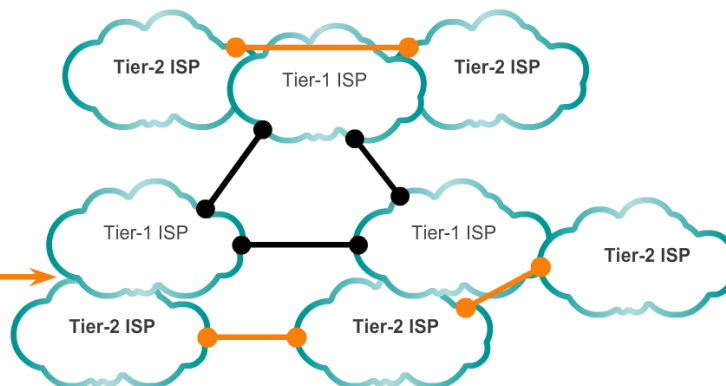
This is the backbone of the Internet.



At the center of the Internet, Tier-1 ISPs provide national and international connections. These ISPs treat each other as equals.

The point where ISPs interconnect is often called a border.

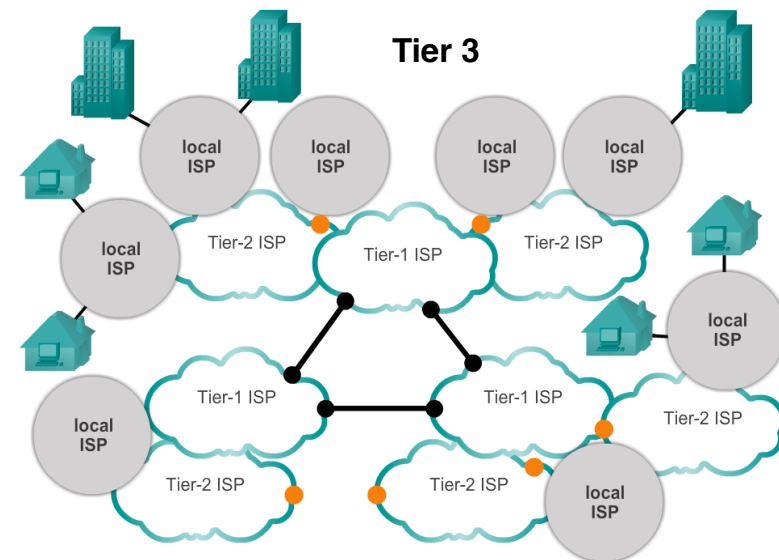
Tier 2



Tier-2 ISPs are smaller and often provide regional service. Tier-2 ISPs usually pay Tier-1 ISPs for connectivity to rest of the Internet.

Peer connections between networks at the same level provide direct connections, bypassing longer routes and preventing congestion on the backbone.

Tier 3

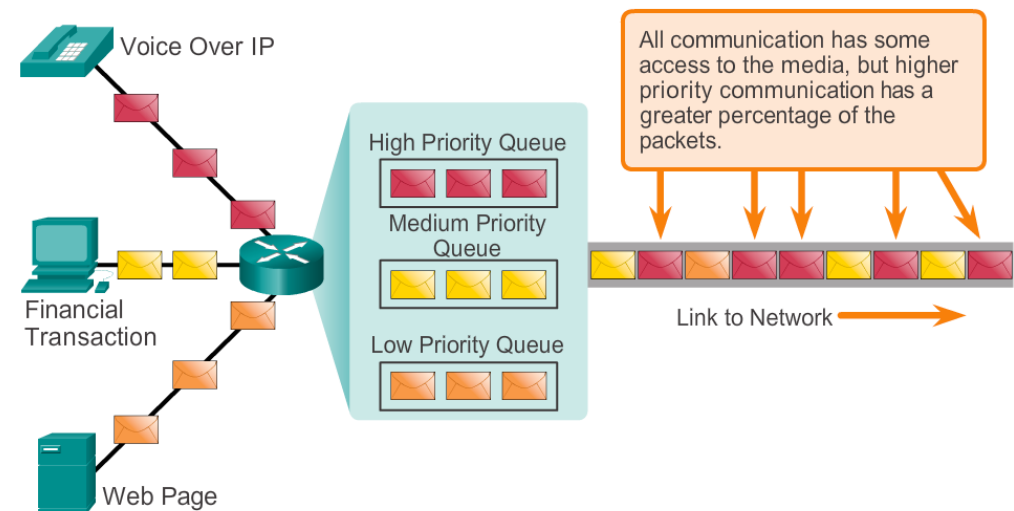


Tier-3 ISPs are the local providers of service directly to end users. Tier-3 ISPs are usually connected to Tier 2 ISPs and pay Tier 2 providers for Internet access.

Quality of Services (QoS)





- Networks also need mechanisms to manage congested network traffic.
- Network bandwidth is the measure of the data carrying capacity of the network. In other words, how much information can be transmitted within a specific amount of time? Network bandwidth is measured in the number of bits that can be transmitted in a single second, or bits per second (bps).
- When simultaneous communications are attempted across the network, the demand for network bandwidth can exceed its availability, creating network congestion.

Using Queues to Prioritize Communication



Queuing according to data type enables voice data to have priority over transaction data, which has priority over web data.

Quality of Service Matters

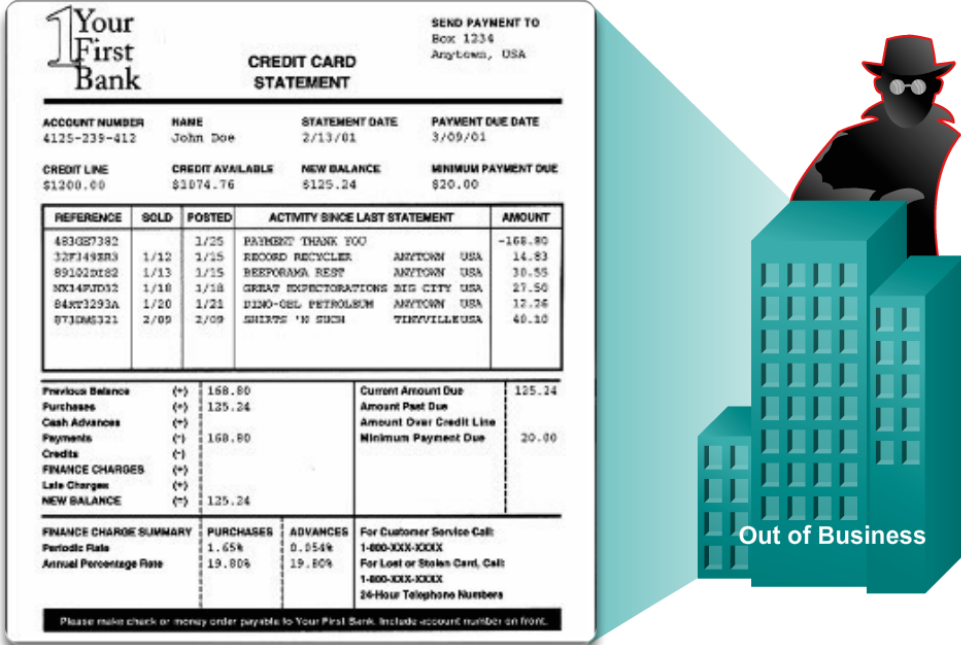
Communication Type	Without QoS	With QoS
Streaming video or audio	 <p>Choppy picture starts and stops.</p>	 <p>Clear, continuous service.</p>
Vital Transactions	<p>Time : Price</p> <p>02:14:05 : \$1.54</p> <p>Just one second earlier...</p>	<p>Time : Price</p> <p>02:14:04 : \$1.52</p> <p>The price may be better.</p>
Downloading web pages (often lower priority)	 <p>Web pages arrive a bit later...</p>	 <p>But the end result is identical.</p>

Security

- There are two types of network security concerns that must be addressed: network infrastructure security and information security.
- Securing a network infrastructure includes the physical securing of devices that provide network connectivity, and preventing unauthorized access to the management software that resides on them.
- Security measures taken in a network should:
 - Prevent unauthorized disclosure
 - Prevent theft of information (Figure 1)
 - Prevent unauthorized modification of information
 - Prevent Denial of Service (DoS)

Security is Important for How We Use a Network

Unauthorized Transactions



SEND PAYMENT TO
Box 1234
Anytown, USA

1 Your First Bank

CREDIT CARD STATEMENT

ACCOUNT NUMBER	NAME	STATEMENT DATE	PAYMENT DUE DATE
4125-235-412	John Doe	2/13/01	3/09/01

CREDIT LINE	CREDIT AVAILABLE	NEW BALANCE	MINIMUM PAYMENT DUE
\$1200.00	\$1074.76	\$125.24	\$20.00

REFERENCE	SOLD	POSTED	ACTIVITY SINCE LAST STATEMENT	AMOUNT
483087382		1/25	PAYMENT THANK YOU	-168.80
327349283	1/12	1/15	RECORD RECYCLER ANYTOWN USA	14.83
89102182	1/13	1/15	BEEPORAMA REST ANYTOWN USA	30.55
303149102	1/18	1/18	GREAT EXPECTORATIONS BIG CITY USA	27.50
84XT3293A	1/20	1/21	DINO-OL PETROLEUM ANYTOWN USA	17.76
8730MS321	2/09	2/09	SHIRTS 'N SUCH TINYVILLEUSA	40.10

Previous Balance	(+)	168.80	Current Amount Due	125.24
Purchases	(+)	125.24	Amount Paid Due	
Cash Advances	(+)		Amount Over Credit Line	
Payments	(-)	168.80	Minimum Payment Due	20.00
Credits	(-)			
FINANCE CHARGES	(+)			
Late Charges	(+)			
NEW BALANCE	(=)	125.24		

FINANCE CHARGE SUMMARY	PURCHASES	ADVANCES	For Customer Service Call:
Periodic Rate	1.65%	0.054%	1-800-XXX-XXXX
Annual Percentage Rate	19.80%	19.80%	For Lost or Stolen Card, Call:
			1-800-XXX-XXXX
			24-Hour Telephone Numbers

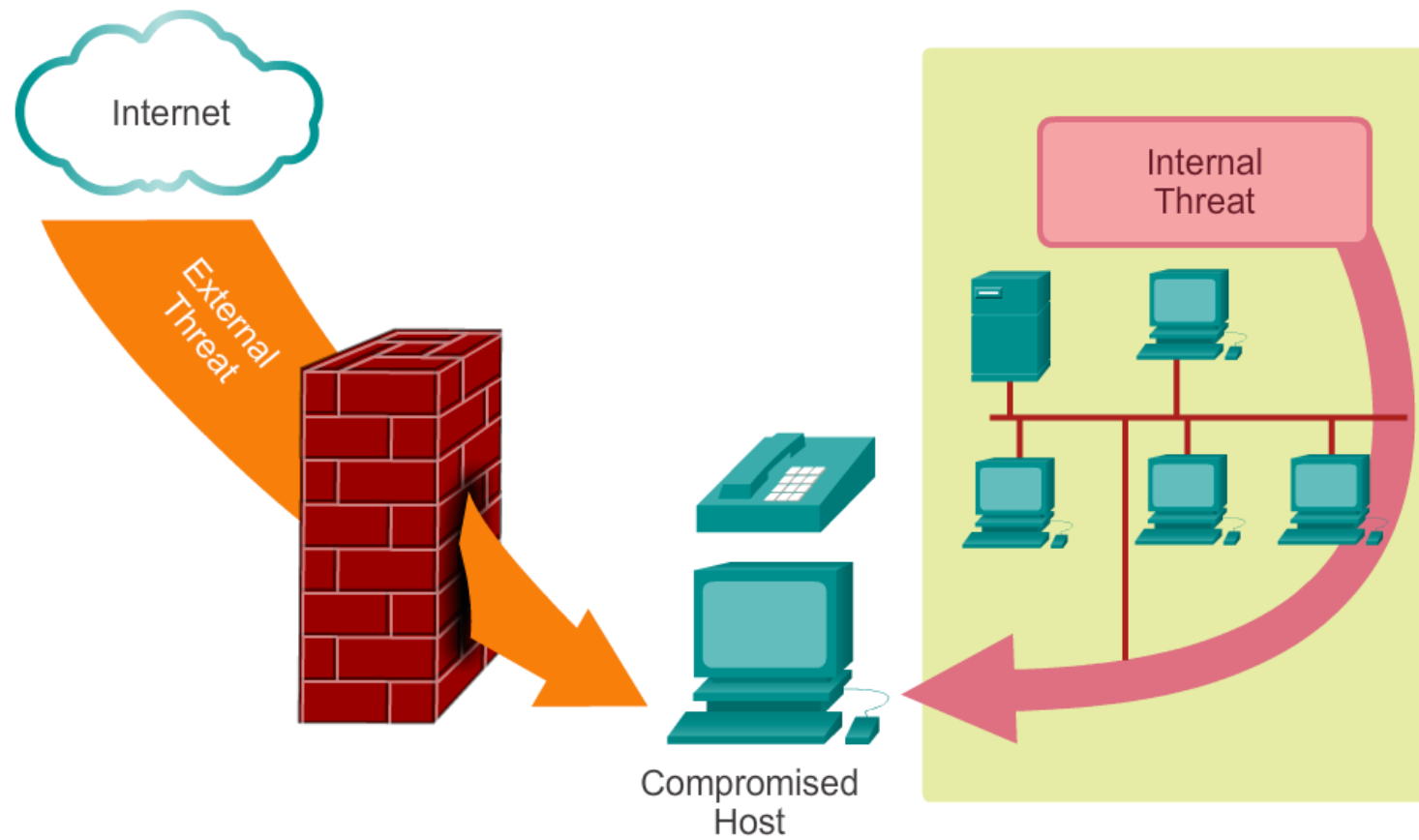
Please make check or money order payable to Your First Bank. Include account number on front.

Out of Business

Unauthorized use of our communications data can have severe consequences.

- No single solution can protect the network from the variety of threats that exist. For this reason, security should be implemented in multiple layers, using more than one security solution. If one security component fails to identify and protect the network, others still stand.
- Network security components for a home or small office network should include, at a minimum:
 - **Antivirus and antispyware** - to protect user devices from malicious software
 - **Firewall filtering** - to block unauthorized access to the network. This may include a host-based firewall system that is implemented to prevent unauthorized access to the host device, or a basic filtering service on the home router to prevent unauthorized access from the outside world into the network.
- In addition to the above, larger networks and corporate networks often have other security requirements:
 - **Dedicated firewall systems** - to provide more advanced firewall capability that can filter large amounts of traffic with more granularity
 - **Access control lists (ACL)** - to further filter access and traffic forwarding
 - **Intrusion prevention systems (IPS)** - to identify fast-spreading threats, such as zero-day or zero-hour attacks
 - **Virtual private networks (VPN)** - to provide secure access to remote workers

Firewall



Data Networking Role, Components, and Challenges

- The role of converged networks in communications
- Converged network
 - A type of network that can carry voice, video & data over the same network



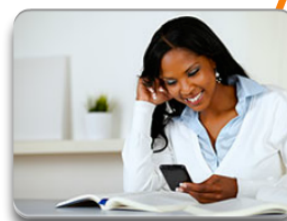
Intelligent networks allow handheld devices to receive news and emails, and to send text.



Video conferencing around the globe is in the palm of your hand.



The Human Network is everywhere.



Phones connect globally to share voice, text, and images.



Online gaming connects thousands of people seamlessly.

Communicating Over The Networks

Model Komunikasi

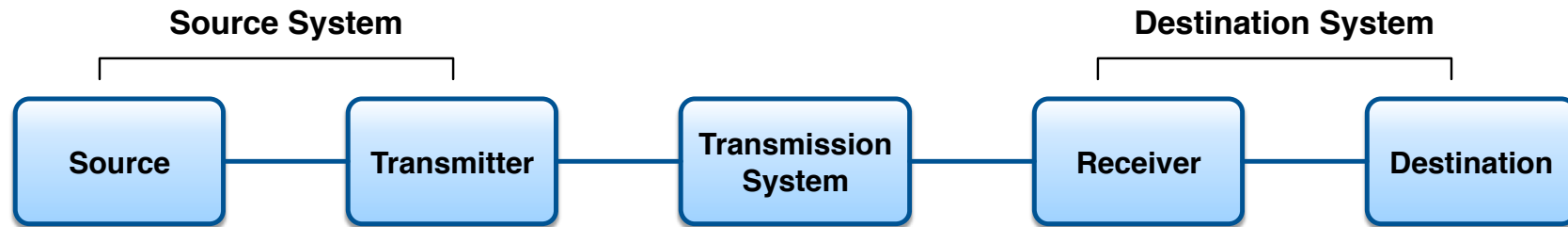


Figure 1. General Block Diagram

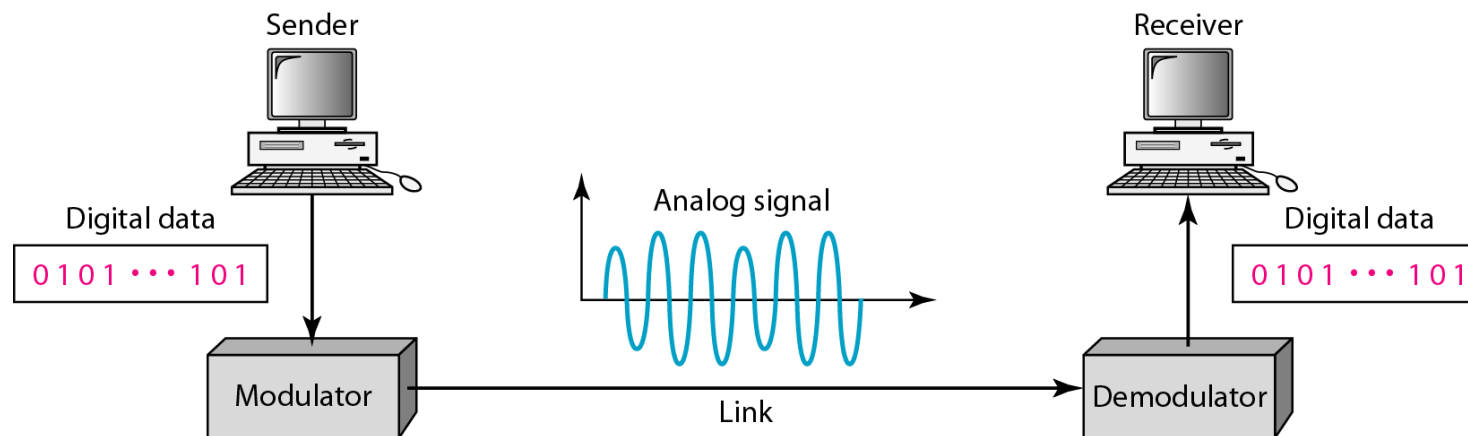
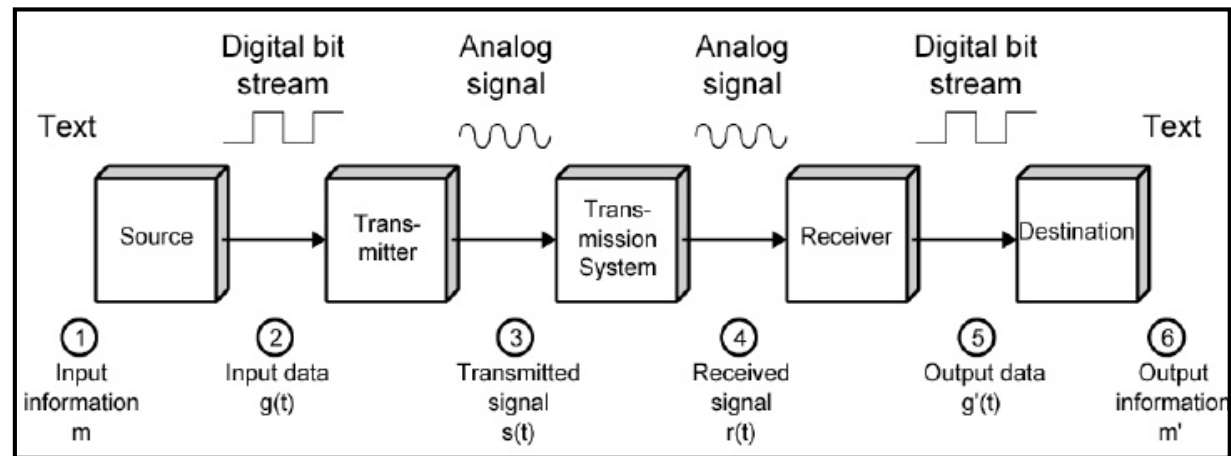


Figure 2. Example

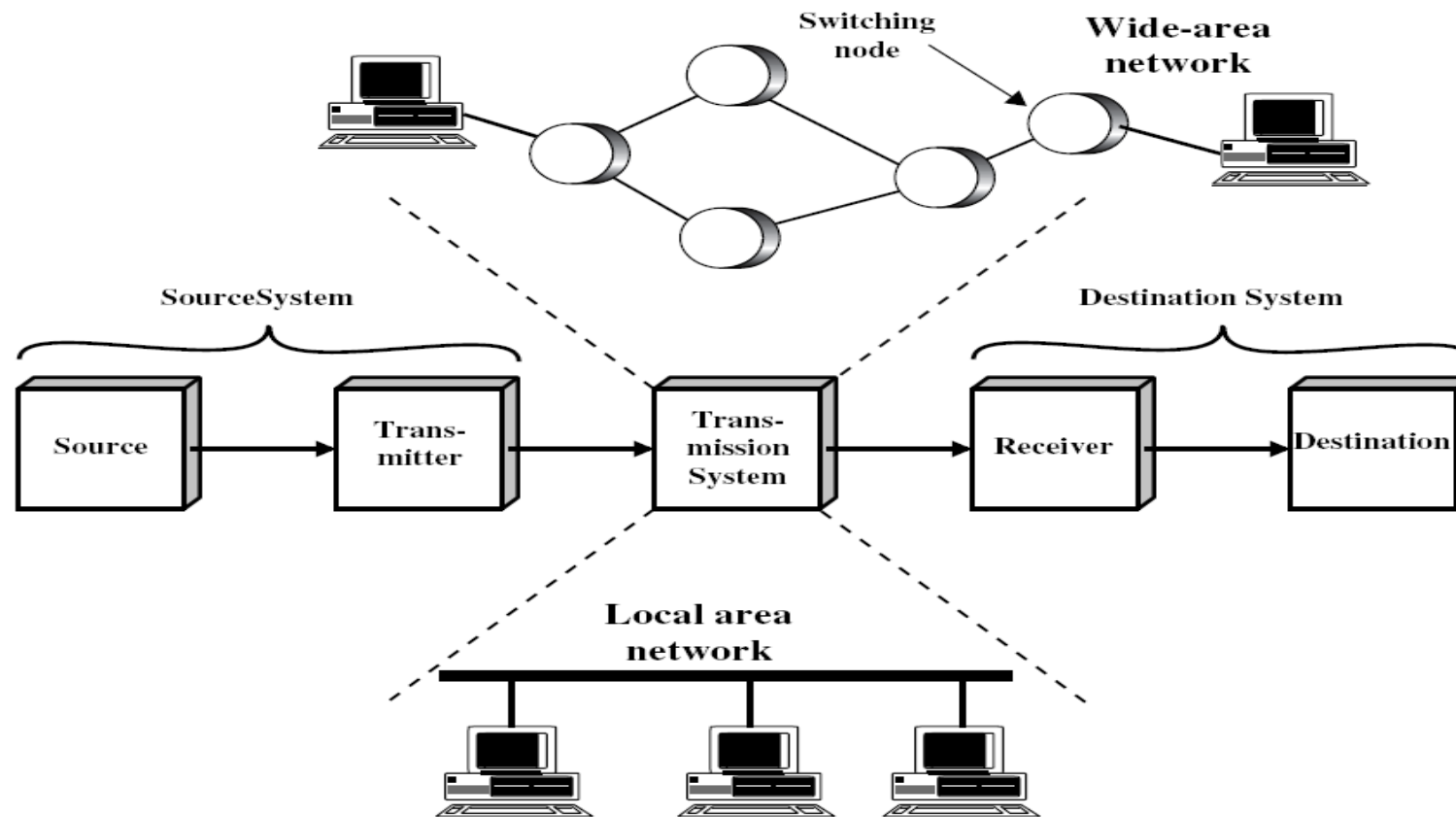
Elemen Sistem Komunikasi

1. Source (Sumber)
2. Transmitter (Pengirim)
3. Transmission System (Sistem Transmisi)
4. Receiver (Penerima)
5. Destination (Tujuan)

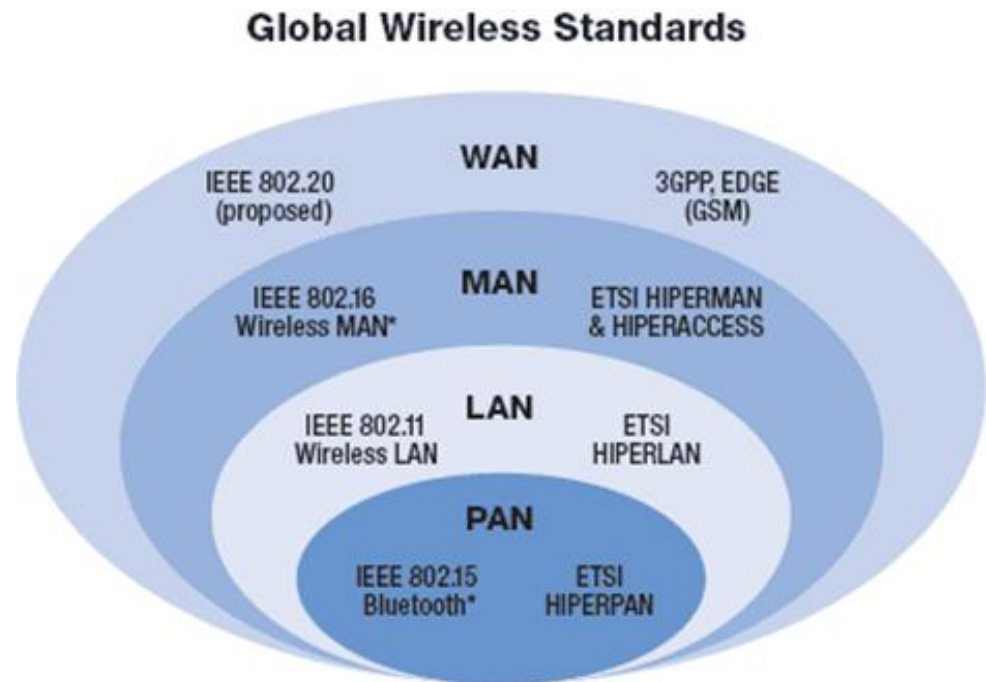
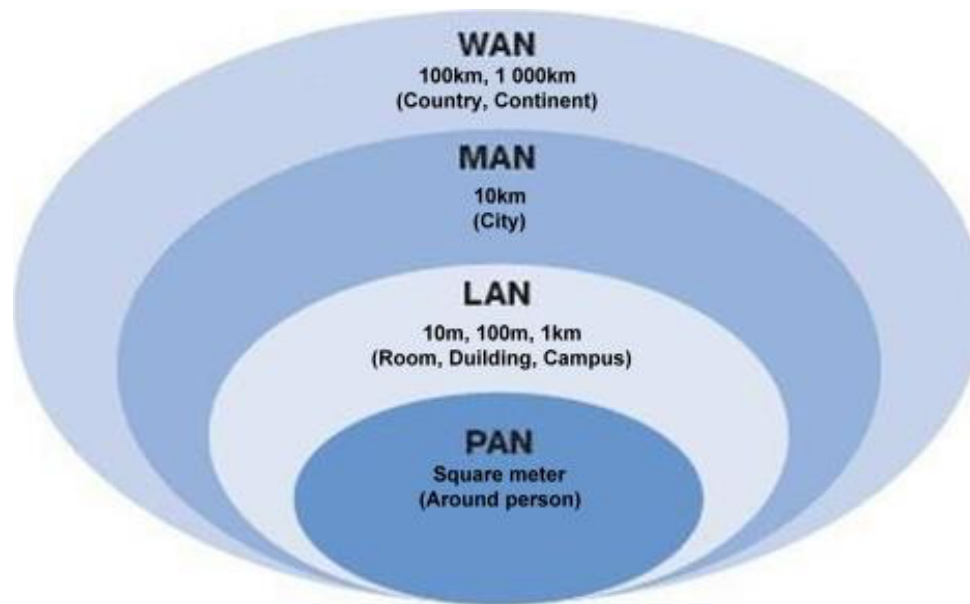
Komunikasi Data



Jaringan Komunikasi Data



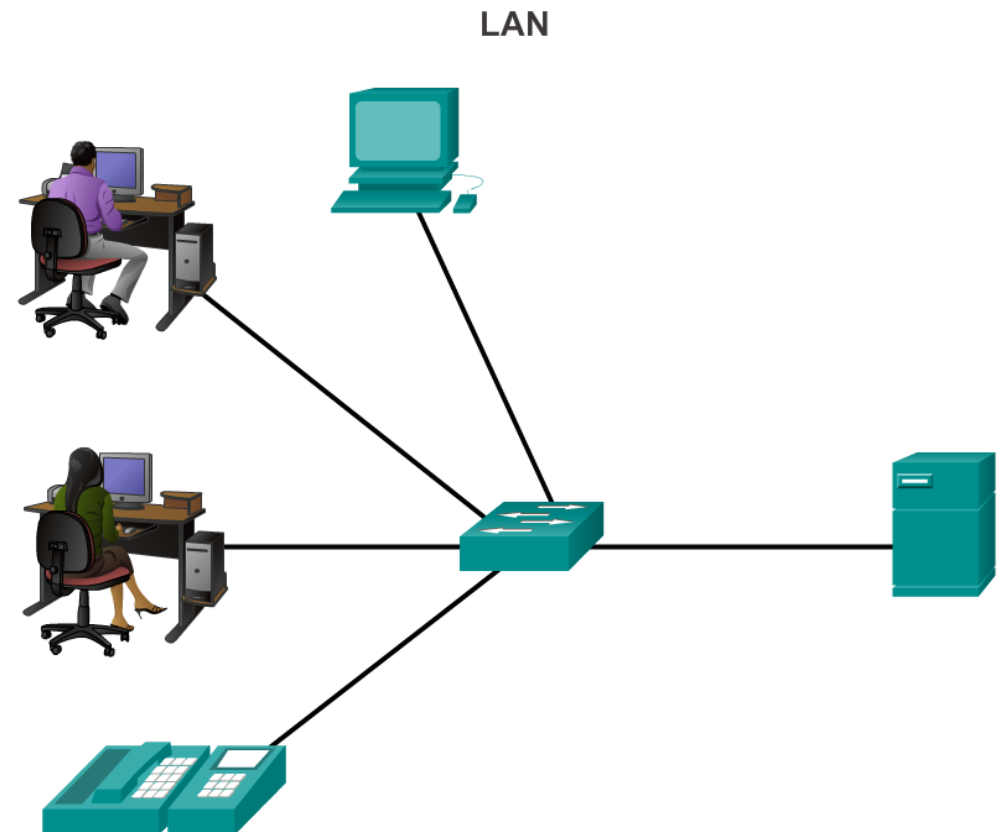
Types of Networks



CRITERIA	LAN	MAN	WAN
Cost	Low	High	Higher
Network Size	Small	Larger	Largest
Speed	Fastest	Slower	Slowest
Transmission media type	Twisted-pair	Twisted-pair and fibre-optic cables	Fiber optic, radio wave and satellite
Number of computers	Smallest	Large	Largest

Local Area Network (LAN)

- **Local Area Networks (LANs)** are a network infrastructure that spans a small geographical area. Specific features of LANs include:
 - LANs interconnect end devices in a limited area such as a home, school, office building, or campus.
 - A LAN is usually administered by a single organization or individual. The administrative control that governs the security and access control policies are enforced on the network level.
 - LANs provide high speed bandwidth to internal end devices and intermediary devices.



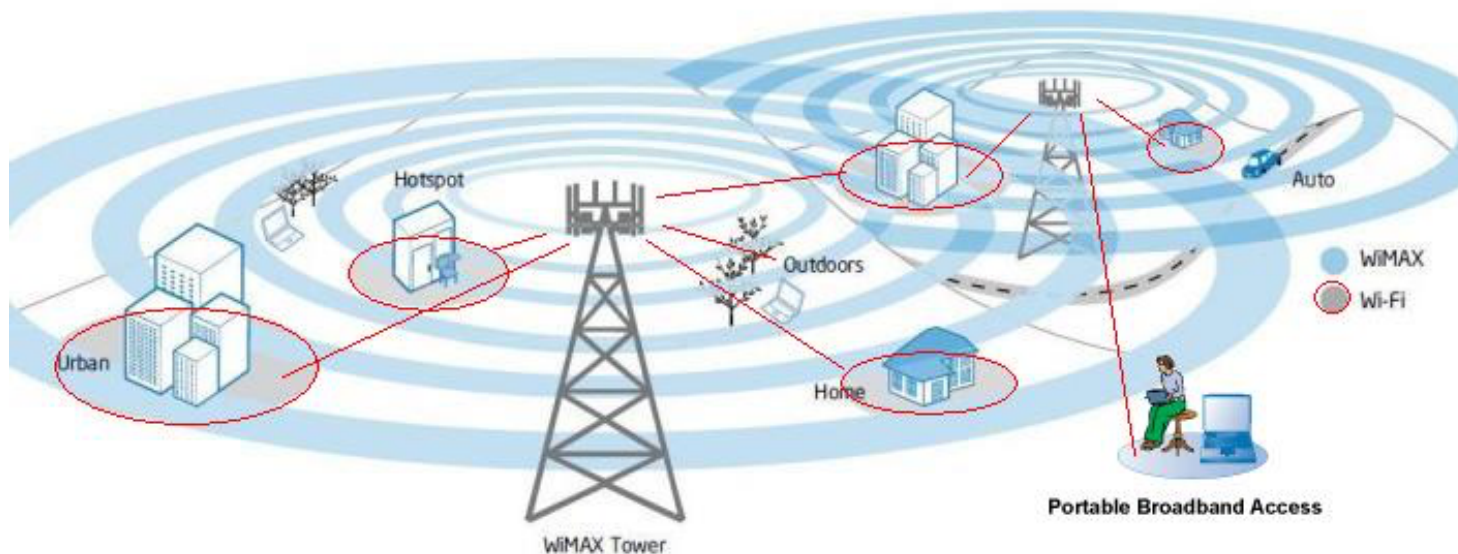
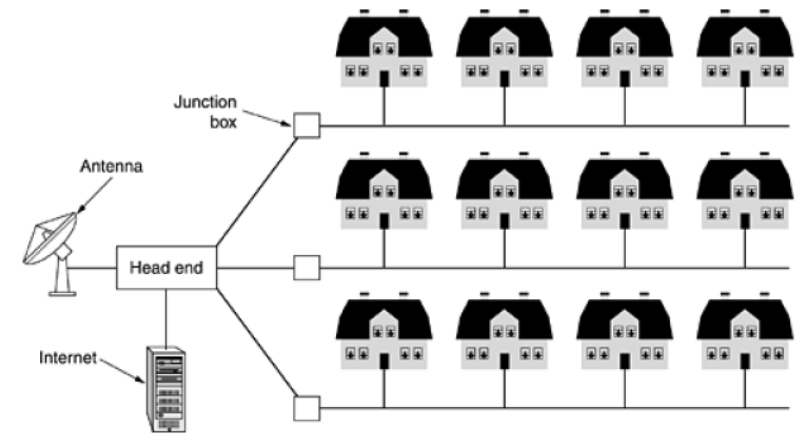
A network serving a home, building, or campus is considered a LAN.

Metropolitan Area Network (MAN)

- **Metropolitan Area Network (MAN) -**

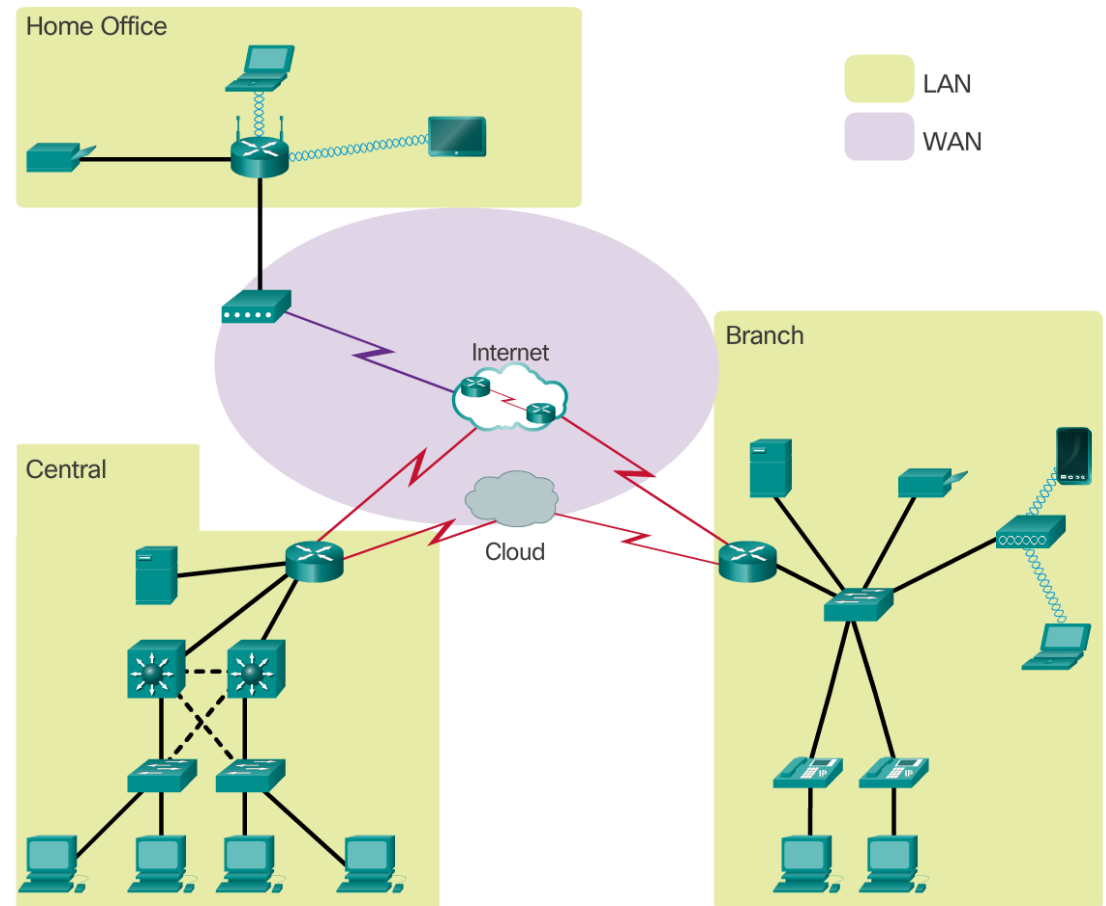
A network infrastructure that spans a physical area larger than a LAN but smaller than a WAN (e.g., a city). MANs are typically operated by a single entity such as a large organization.

Figure 1-8. A metropolitan area network based on cable TV.



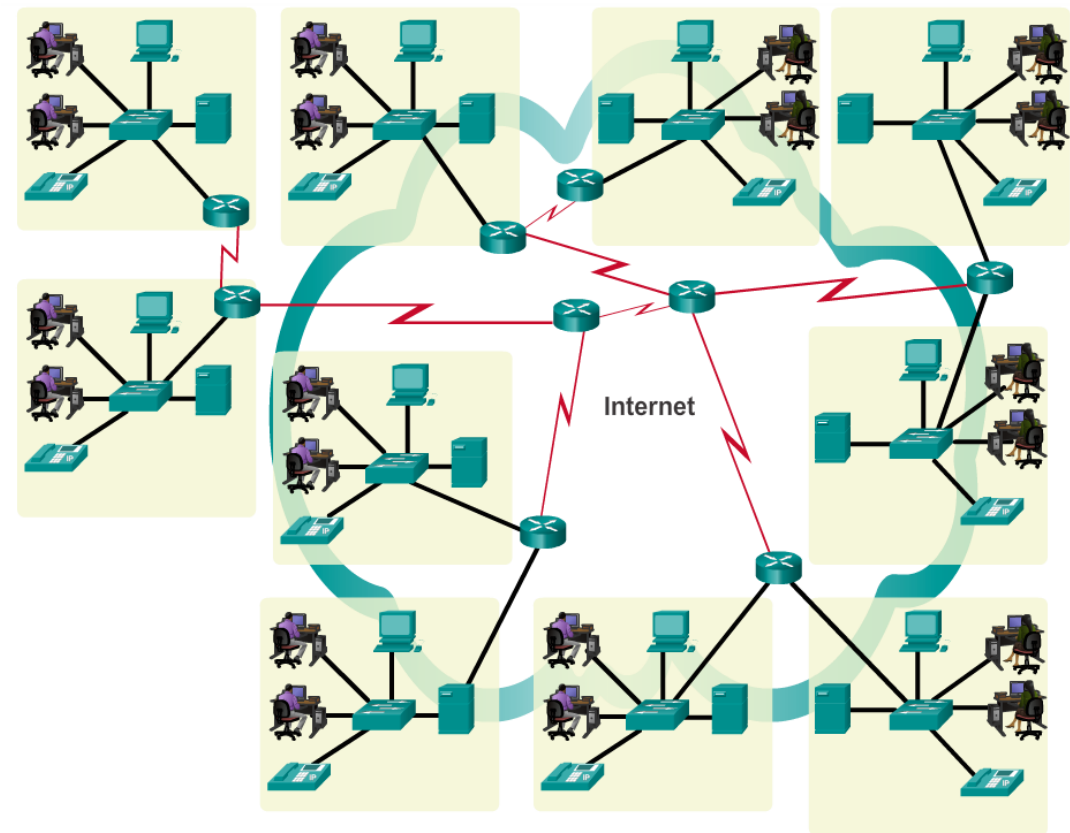
Wide Area Network (WAN)

- **Wide Area Networks (WANs)** are a network infrastructure that spans a wide geographical area. WANs are typically managed by service providers (SP) or Internet Service Providers (ISP).
- Specific features of WANs include:
 - WANs interconnect LANs over wide geographical areas such as between cities, states, provinces, countries, or continents.
 - WANs are usually administered by multiple service providers.
 - WANs typically provide slower speed links between LANs.

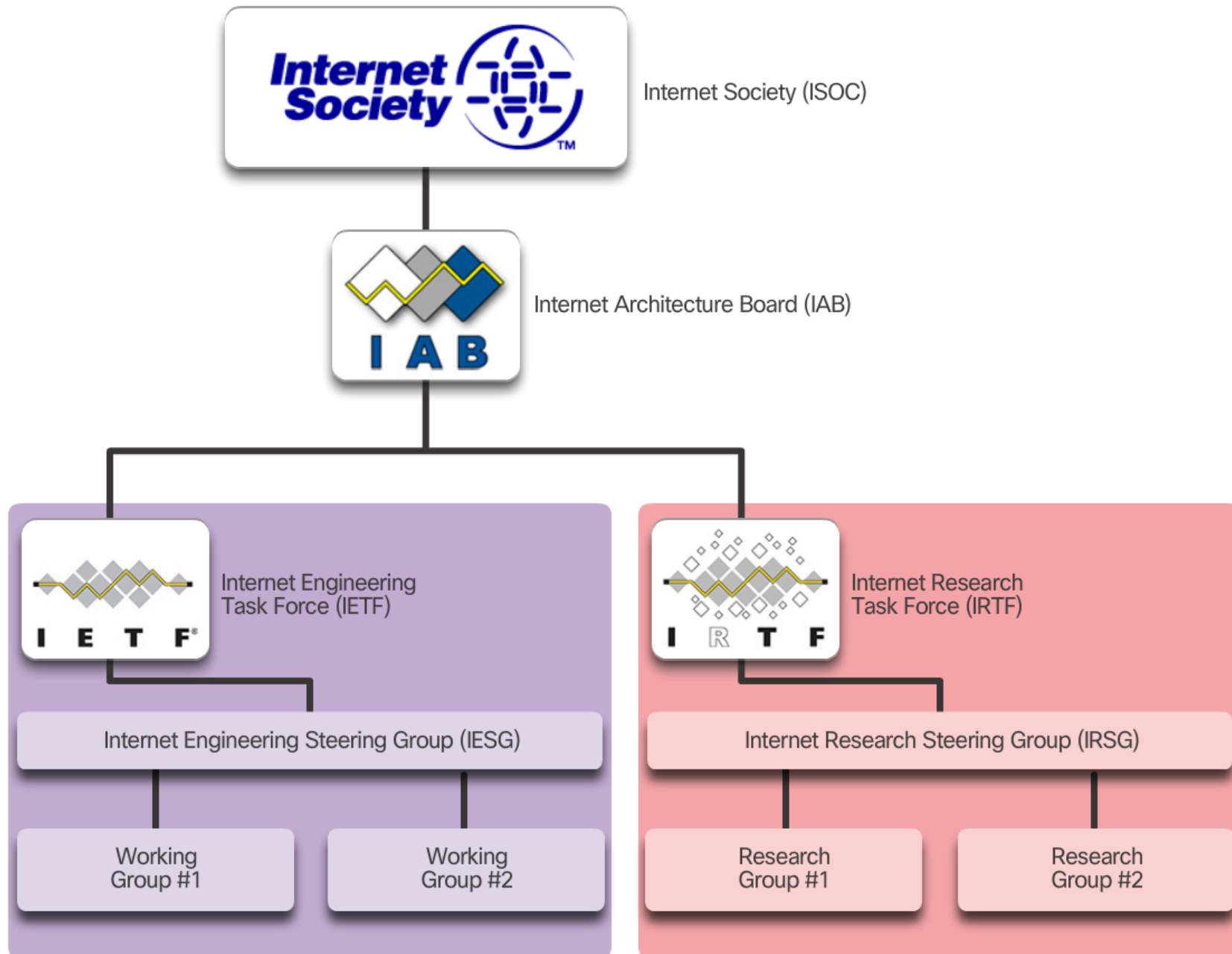


Internet

- The Internet is a worldwide collection of interconnected networks (internetworks or internet for short), cooperating with each other to exchange information using common standards. Through telephone wires, fiber optic cables, wireless transmissions, and satellite links, Internet users can exchange information in a variety of forms.

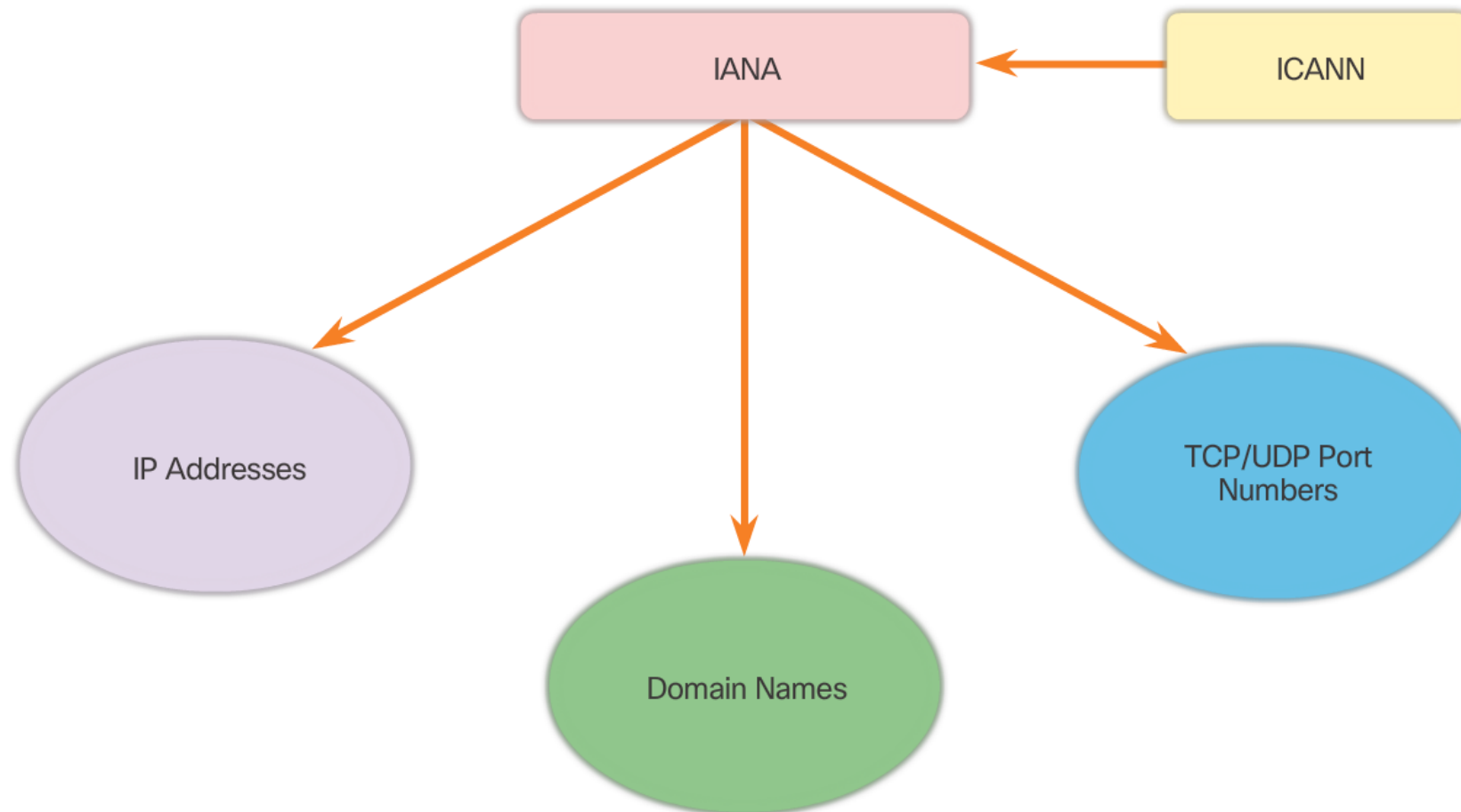


LANs and WANs may be connected into internetworks.



Standards Organizations

- **Internet Society (ISOC)** – Responsible for promoting the open development and evolution of Internet use throughout the world.
- **Internet Architecture Board (IAB)** - Responsible for the overall management and development of Internet standards.
- **Internet Engineering Task Force (IETF)** - Develops, updates, and maintains Internet and TCP/IP technologies. This includes the process and documents for developing new protocols and updating existing protocols known as Request for Comments (RFC) documents.
- **Internet Research Task Force (IRTF)** - Focused on long-term research related to Internet and TCP/IP protocols such as Anti-Spam Research Group (ASRG), Crypto Forum Research Group (CFRG), and Peer-to-Peer Research Group (P2PRG).



- **Internet Corporation for Assigned Names and Numbers (ICANN)** - Based in the United States, coordinates IP address allocation, the management of domain names, and assignment of other information used TCP/IP protocols.
- **Internet Assigned Numbers Authority (IANA)** - Responsible for overseeing and managing IP address allocation, domain name management, and protocol identifiers for ICANN.

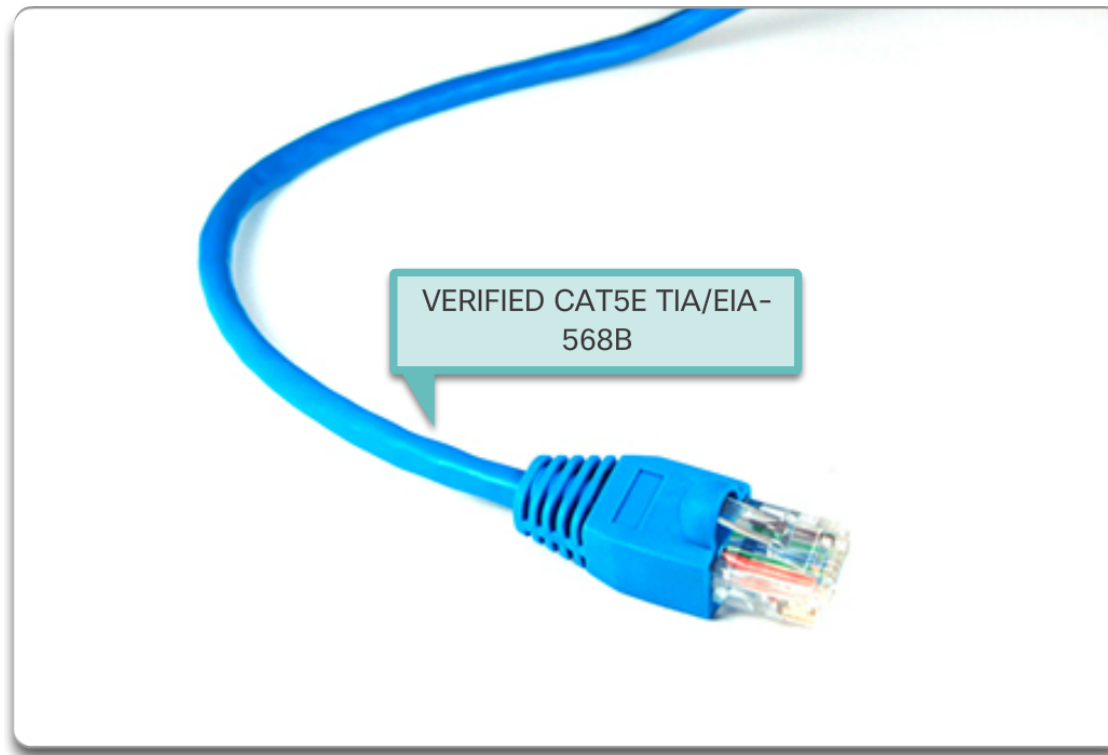
Electronics and Communications Standard Organizations

- **Institute of Electrical and Electronics Engineers** (IEEE, pronounced “I-triple-E”) – Organization of electrical engineering and electronics dedicated to advancing technological innovation and creating standards in a wide area of industries including power and energy, healthcare, telecommunications, and networking.
- **Electronic Industries Alliance** (EIA) - Best known for its standards related to electrical wiring, connectors, and the 19-inch racks used to mount networking equipment.
- **Telecommunications Industry Association** (TIA) - Responsible for developing communication standards in a variety of areas including radio equipment, cellular towers, Voice over IP (VoIP) devices, satellite communications, and more.
- **International Telecommunications Union-Telecommunication Standardization Sector** (ITU-T) - One of the largest and oldest communication standard organizations. The ITU-T defines standards for video compression, Internet Protocol Television (IPTV), and broadband communications, such as a digital subscriber line (DSL).

IEEE 802 Working Groups and Study Groups

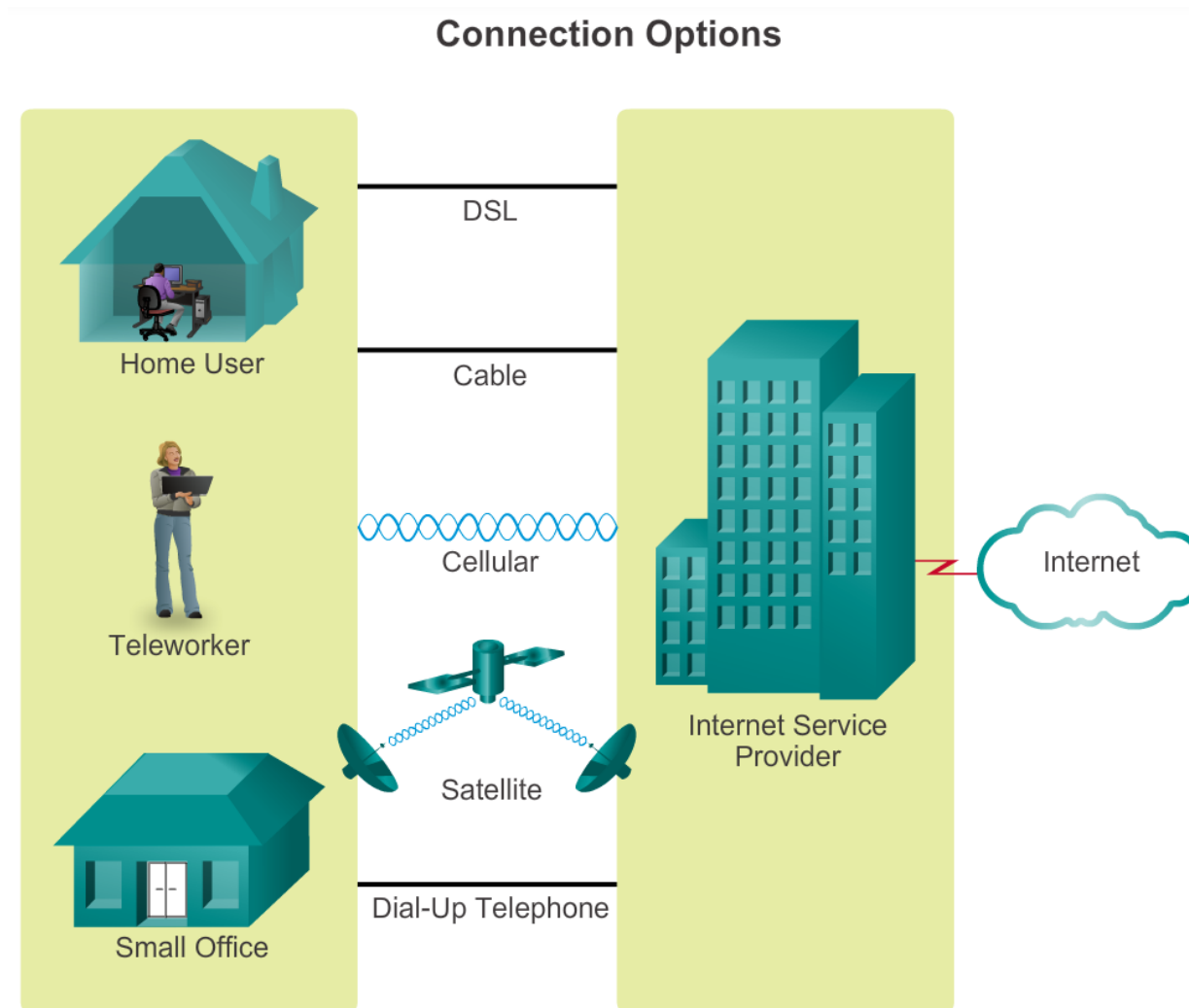
Standard	Name	Topic
802.1	Internetworking	Routing, bridging, and network-to-network communications
802.2	Logical Link Control	Error and flow control over data frames
802.3	Ethernet LAN	All forms of Ethernet media and interfaces
802.4	Token Bus LAN	All forms of Token Bus media and interfaces
802.5	Token Ring LAN	All forms of Token Ring media and interfaces
802.6	Metropolitan Area Network (MAN)	MAN technologies, addressing, and services
802.7	Broadband Technical Advisory Group	Broadband networking media, interfaces, and other equipment
802.8	Fiber Optic Technical Advisory Group	Fiber optic media used in token-passing networks like FDDI
802.9	Integrated Voice/Data Networks	Integration of voice and data traffic over a single network medium
802.10	Network Security	Network access controls, encryption, certification, and other security topics
802.11	Wireless Networks	Standards for wireless networking for many different broadcast frequencies and usage techniques
802.12	High-Speed Networking	A variety of 100 Mbps-plus technologies, including 100BASE-VG
802.14	Cable broadband LANs and MANs	Standards for designing networks over coaxial cable-based broadband connections
802.15	Wireless Personal Area Networks	The coexistence of wireless personal area networks with other wireless devices in unlicensed frequency bands
802.16	Broadband Wireless Access	The atmospheric interface and related functions associated with Wireless Local Loop (WLL)

EIA/TIA Standards

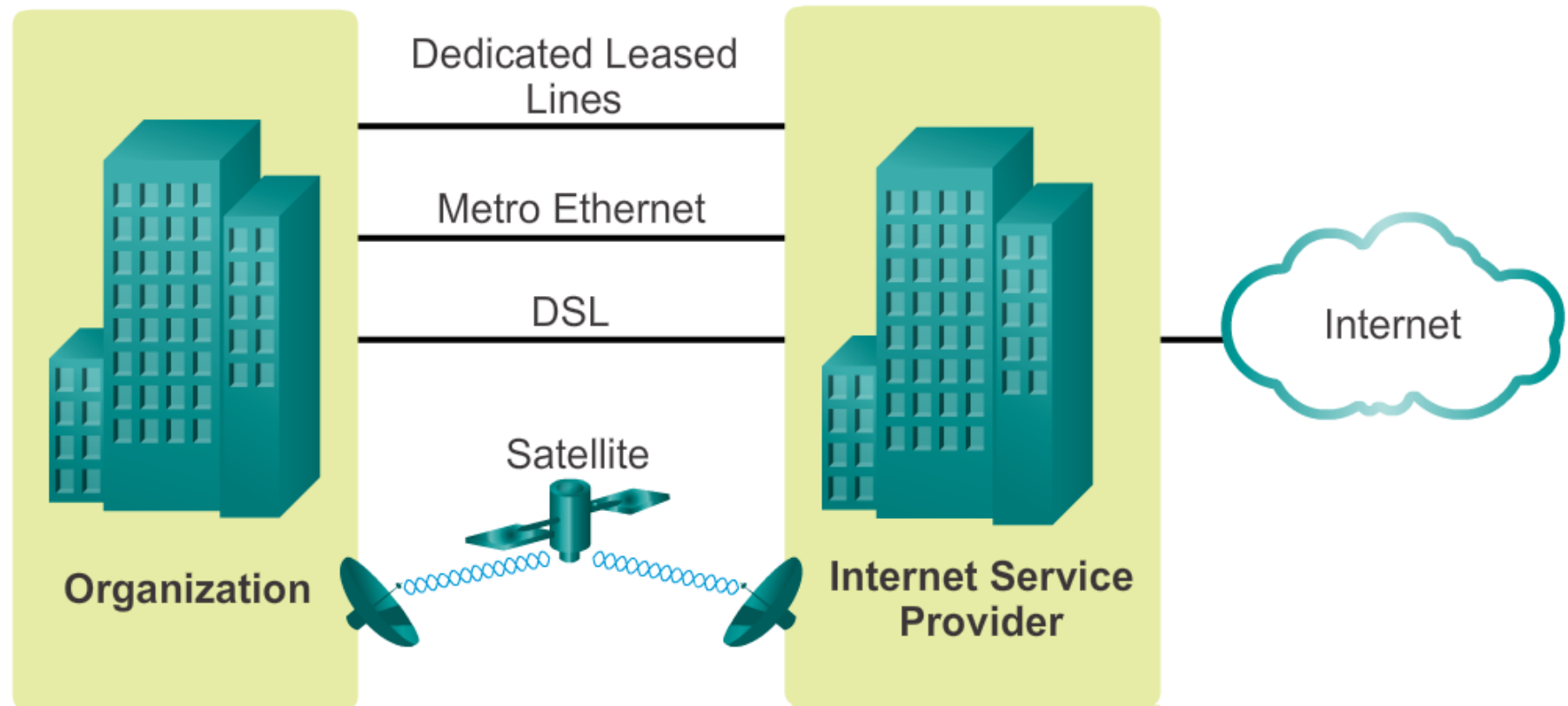


How to connect to Internet?

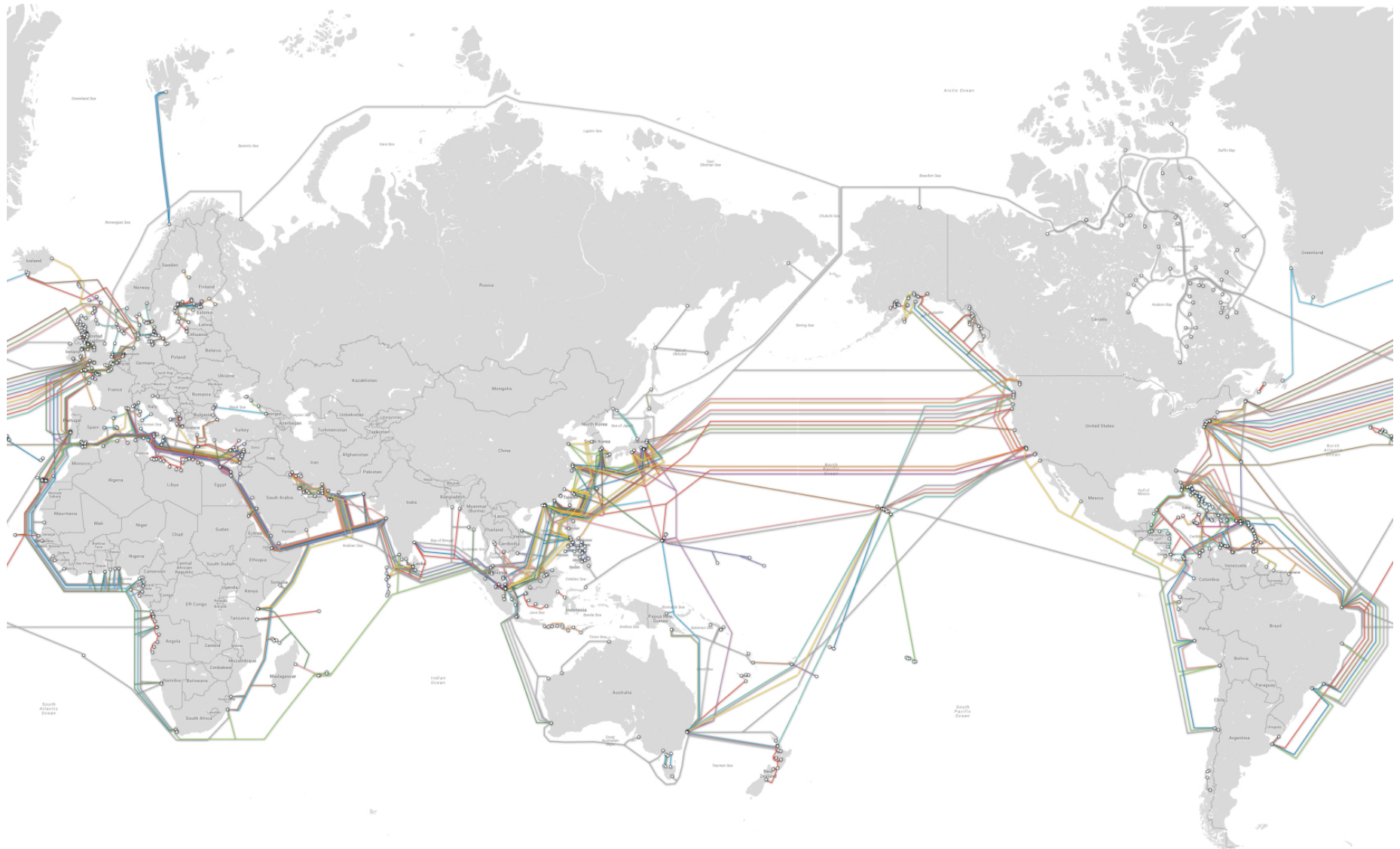
Home and Small Office Internet Connections



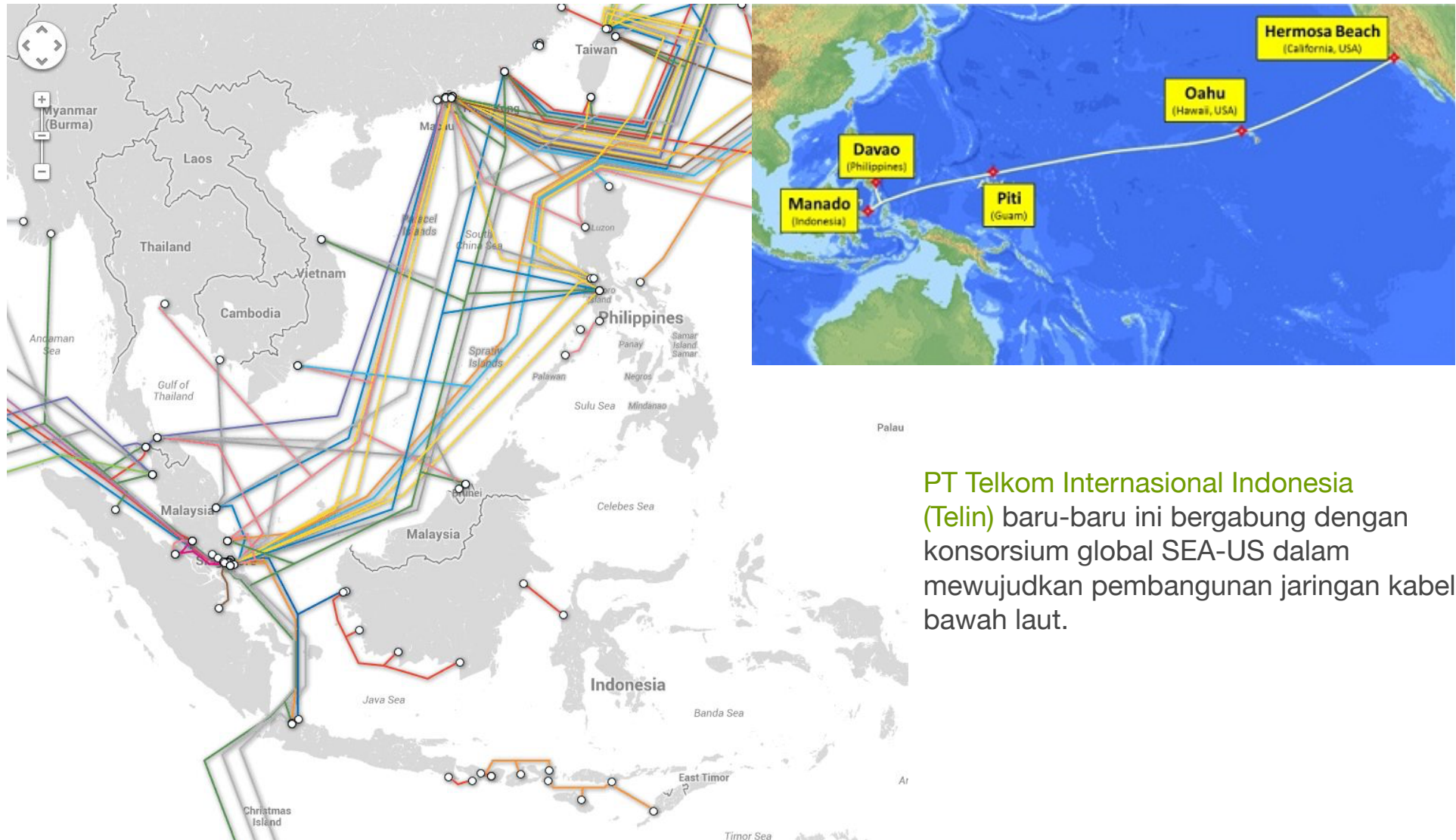
How to connect to Internet? Business Internet Connection



Submarine Cable



Indonesia Submarine Cable



PT Telkom Internasional Indonesia (Telin) baru-baru ini bergabung dengan konsorsium global SEA-US dalam mewujudkan pembangunan jaringan kabel bawah laut.