LECTURER: TAI LE QUY

INTRODUCTION TO COMPUTER SCIENCE

UNIT 6

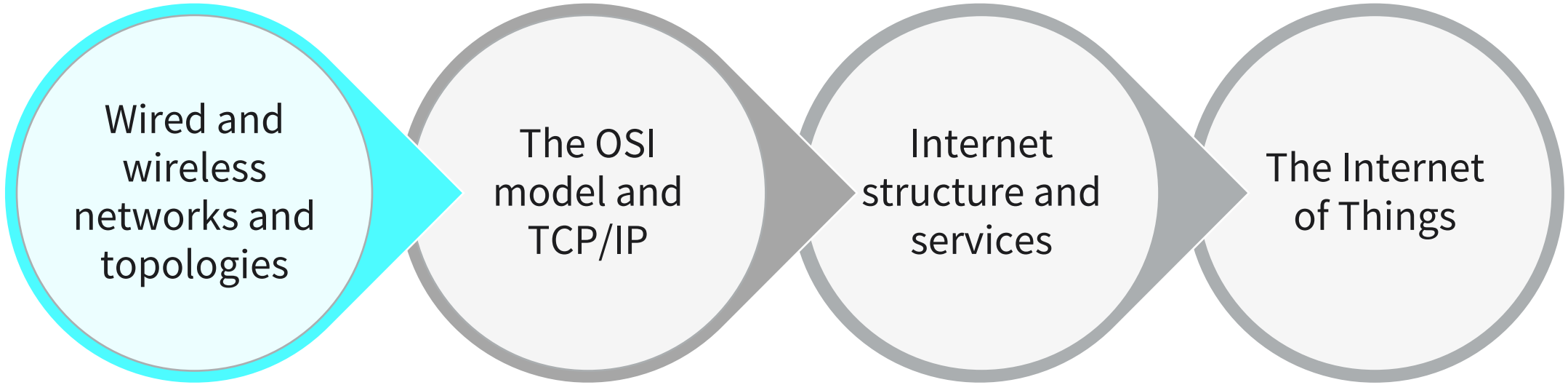
NETWORKS AND THE INTERNET

On completion of this unit, you will have learned …

- … about standard network topologies.
- … about the hardware devices used in a network.
- … how TCP/IP and the internet work.
- … about wireless and wired network technologies.
- … about the Internet of Things (IoT).

EXPLAIN SIMPLY

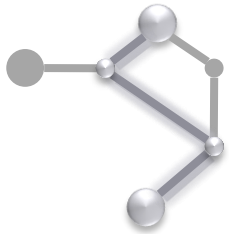
1. What is a switching network?
2. What is the difference between a switch and a router?
3. What is a URL?


Wired and wireless networks and topologies
The OSI model and TCP/IP
Internet structure and services
The Internet of Things

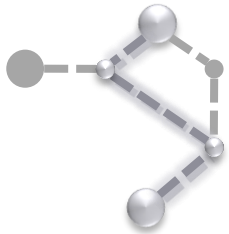
COMPUTER NETWORK TYPES

Criterion	Examples
Area Type	Personal area network (PAN), Local Area Network (LAN), Campus Area Network (CAN), Metropolitan Area Network (MAN), or Wide Area Network (WAN)
Media	Optical fiber, Ethernet, Wireless LAN, Power line communication
Connectivity	Client-server, Peer-to-peer
Topology	Bus, Star, Ring, Mesh, Tree
Technology	Modem, Wireless, Bluetooth, Parallel, Serial, Integrated Services Digital Network (ISDN), Digital Subscriber Line (DSL)

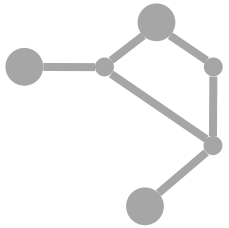
Area Types	Abbr.	Typical Distance	Example
Personal Area Network	PAN	1 - 10 m	Home net, Bluetooth
Local Area Network	LAN	1000 m	Company, Campus net
Metropolitan Area Network	MAN	20 km	Cable TV net
Wide Area Network	WAN	1000 km	Country-wide net
Internet	-	40,000 km	World-wide net



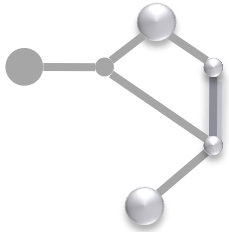
Circuit Switching
Sender and receiver are connected by dynamic nodes that are switched on demand.



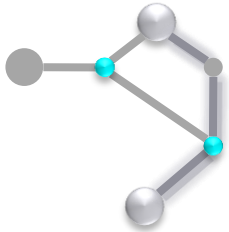
Packet Switching
Data is dissected into packets and provided with a header including transport information.
Intelligent nodes read the header and decide for the route.



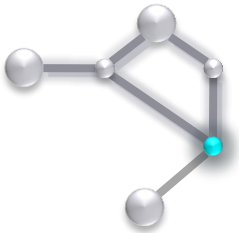
Topology
Layout and connection of components



Switching
Transfer between adjacent nodes or components



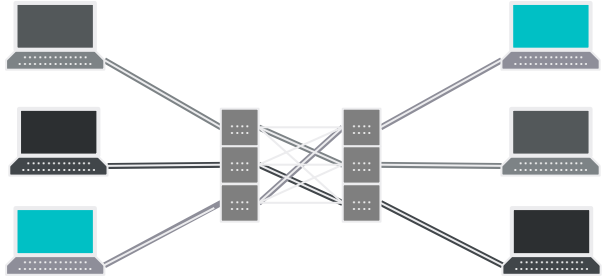
Routing
Path from sender to receiver



Flow Control
Handling congestion, loss or other exceptions

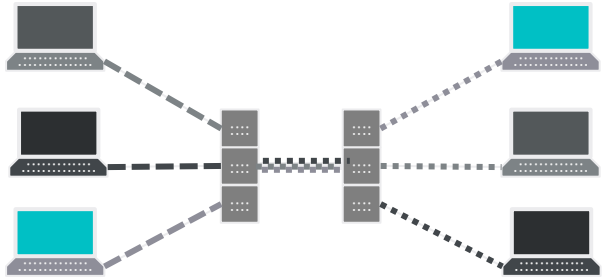
Circuit switching: Dedicated communication channel

+ Single overhead for setup and termination
+ No buffer required; full bandwidth
– Deadlock: line blocked even if unused
– No interleave possible



Packet switching: Dynamic communication channel

+ Resource is occupied only when needed
+ Alternative routing possible
– Buffer required; partial bandwidth
– Creation of packets required
– Flow control required
– Packet may be lost or delayed
– Depending on number of nodes

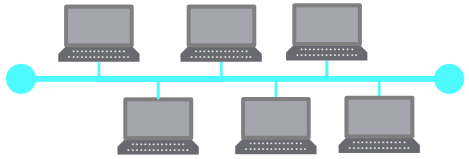


TOPOLOGIES

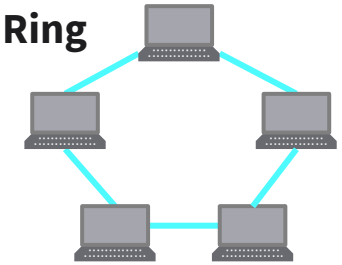
Point-to-Point

Virtual Point-to-Point

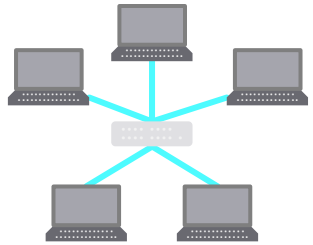
Bus



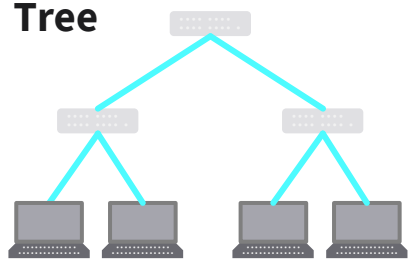
Ring



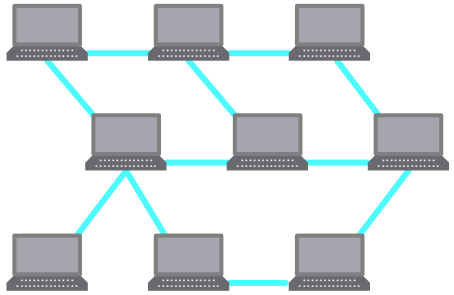
Star



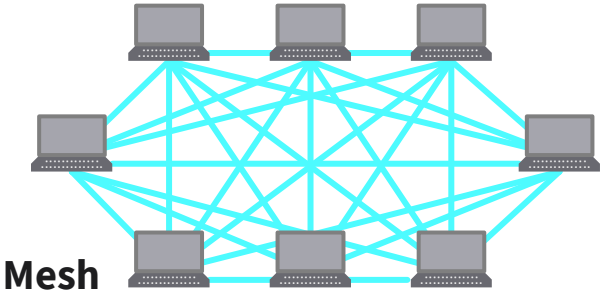
Tree



Partial Mesh



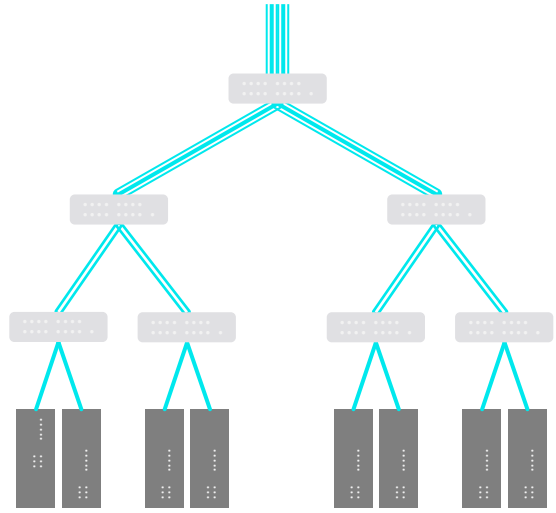
Complete Mesh

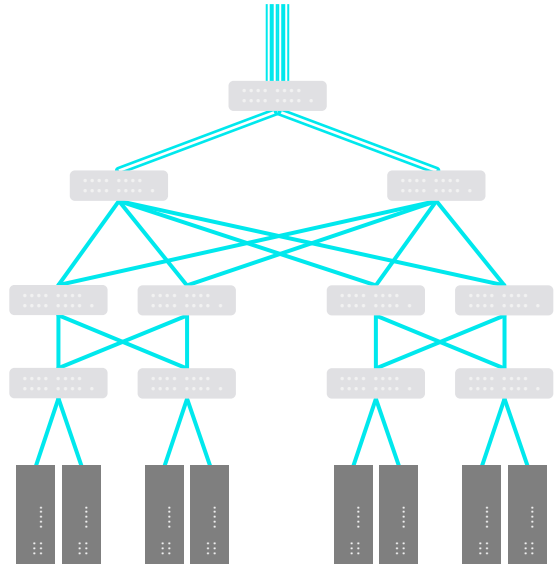


The main goal in a data center is to connect a large number of endpoints (processors or servers) by using switches that only have a limited number of ports.

Fat-Tree networks consist of a tree in which any switch has the same number of connections in both directions.

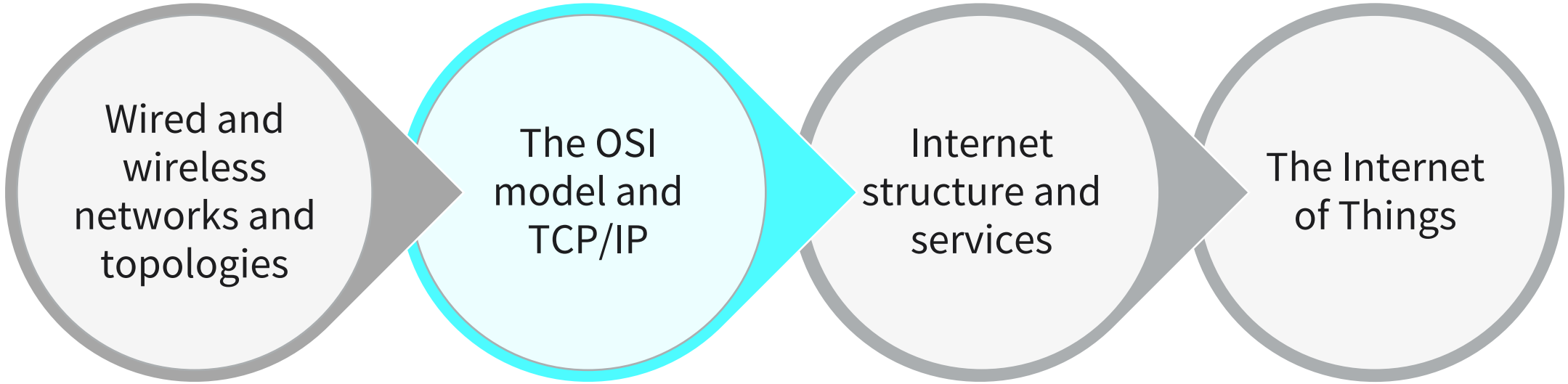
- Connections closer to the root switch have a higher bandwidth.
- Higher redundancy: multiple paths are possible to connect between servers.
- Power consumption is lower compared to other topologies.





WIRED VERSUS WIRELESS

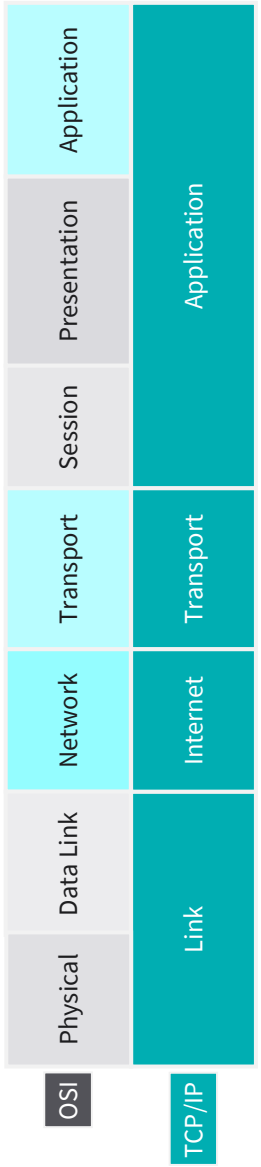
Wired network 	Wireless network 
Devices physically limited by cable	Devices can move more freely within range
Easier to troubleshoot	Can be difficult to troubleshoot
Fastest data speeds	Medium data speeds
Much more secure	Easy to intercept signal
Must purchase cabling	Only wireless access point must be purchased


Wired and wireless networks and topologies
The OSI model and TCP/IP
Internet structure and services
The Internet of Things

OSI MODEL

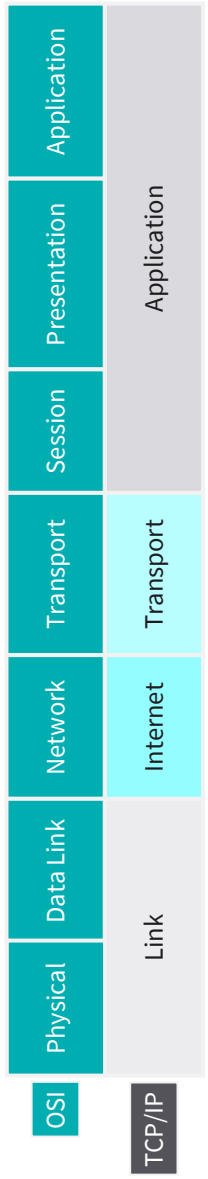
Video: https://youtu.be/LANW3m7UgWs

CONCEPTUAL OSI MODEL



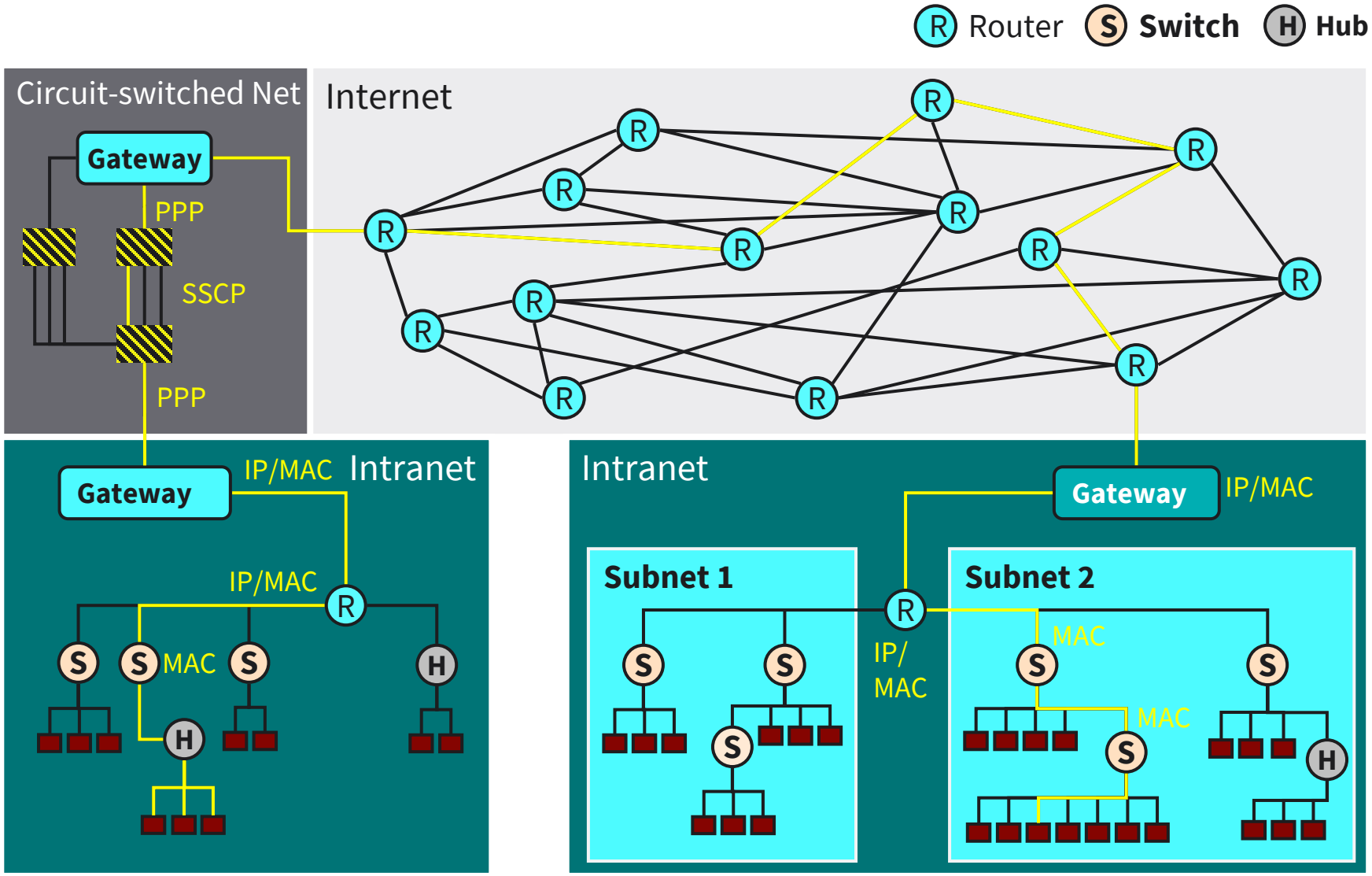
7	Application	Function call	Software Layer-4/7 Switch	**Data**	A Data
6	Presentation	Data conversion Compression Encryption			P A Data
5	Session	Synchronization Session control			S P A Data
4	Transport	Segmentation Sequencing Flow control, Congestion notification	Gateway Layer-4 Switch	**Segment Datagram**	T S P A Data
3	Network	Addressing, Routing	Router Layer-3 Switch	**Packet**	N T S P A Data
2	Data Link	Logical Link Control Media Access Control	Bridge Layer-2 Switch	**Frame**	D N T S P A Data
1	Physical	Interface specification	Hub NIC	**Bits**	P D N T S P A Data

INTERNET PROTOCOL SUITE



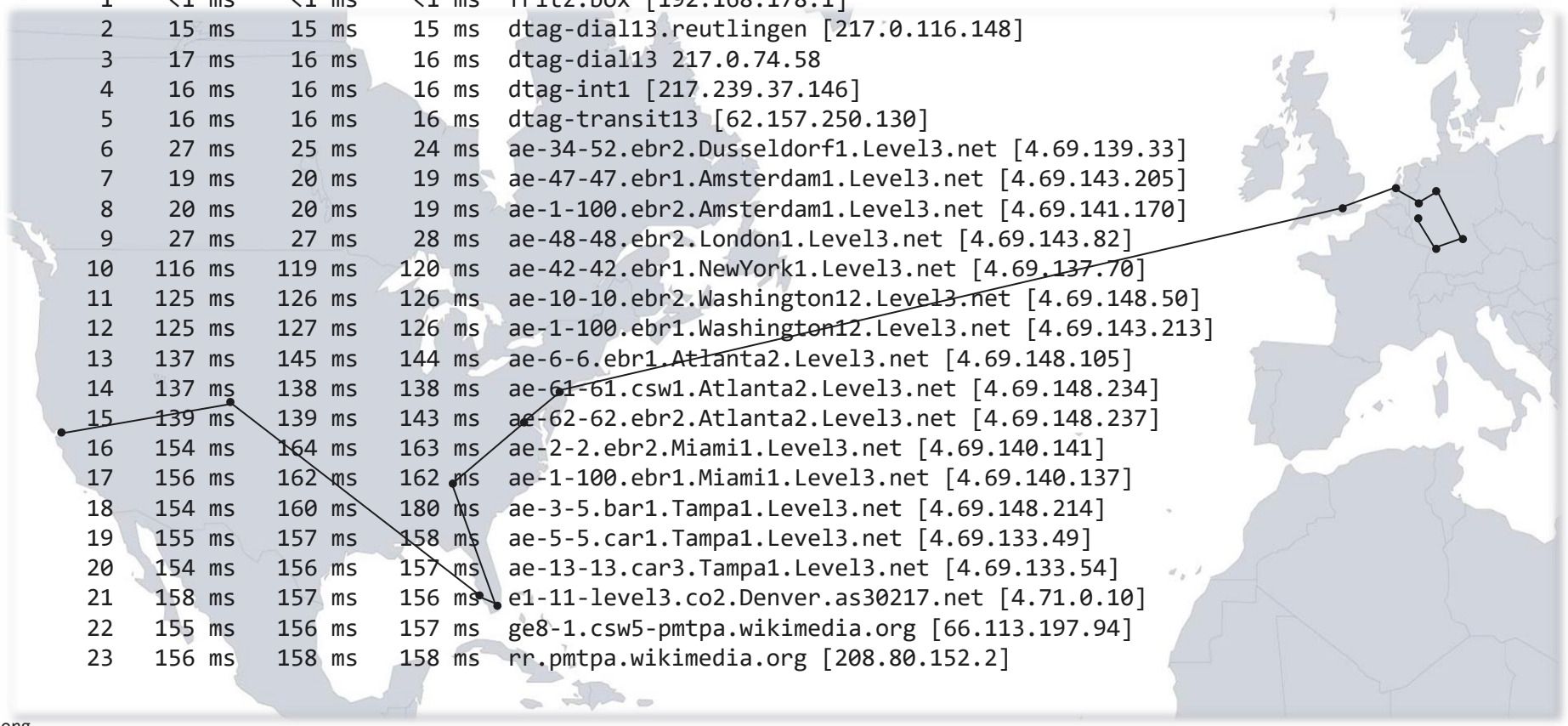
TCP/IP Layer	Typical Services	Typical Protocols
Application	Name and Directory Services Transmission Communication Encryption	DHCP, DNS, LDAP FTP, HTTP, HTTPS IRC, POP, IMAP, SMTP SSH TLS/SSL
Transport	Flow control Error control Port addressing	TCP, UDP DCCP, SCTP
Internet	Logical addressing	IPv4, IPv6, ICMP, ICMPv6, IPsec
Link	Physical addressing Interfaces Topology	ARP, NDP, OSPF, Tunnels, L2TP, PTPP, MAC (Ethernet, DSL, ISDN)

ROUTING


R Router
S Switch
H Hub
Circuit-switched Net
Gateway
PPP
SSCP
PPP
Internet
Gateway
IP/MAC
Intranet
IP/MAC
MAC
Intranet
Gateway
IP/MAC
Subnet 1
Subnet 2
IP/
MAC
MAC
MAC

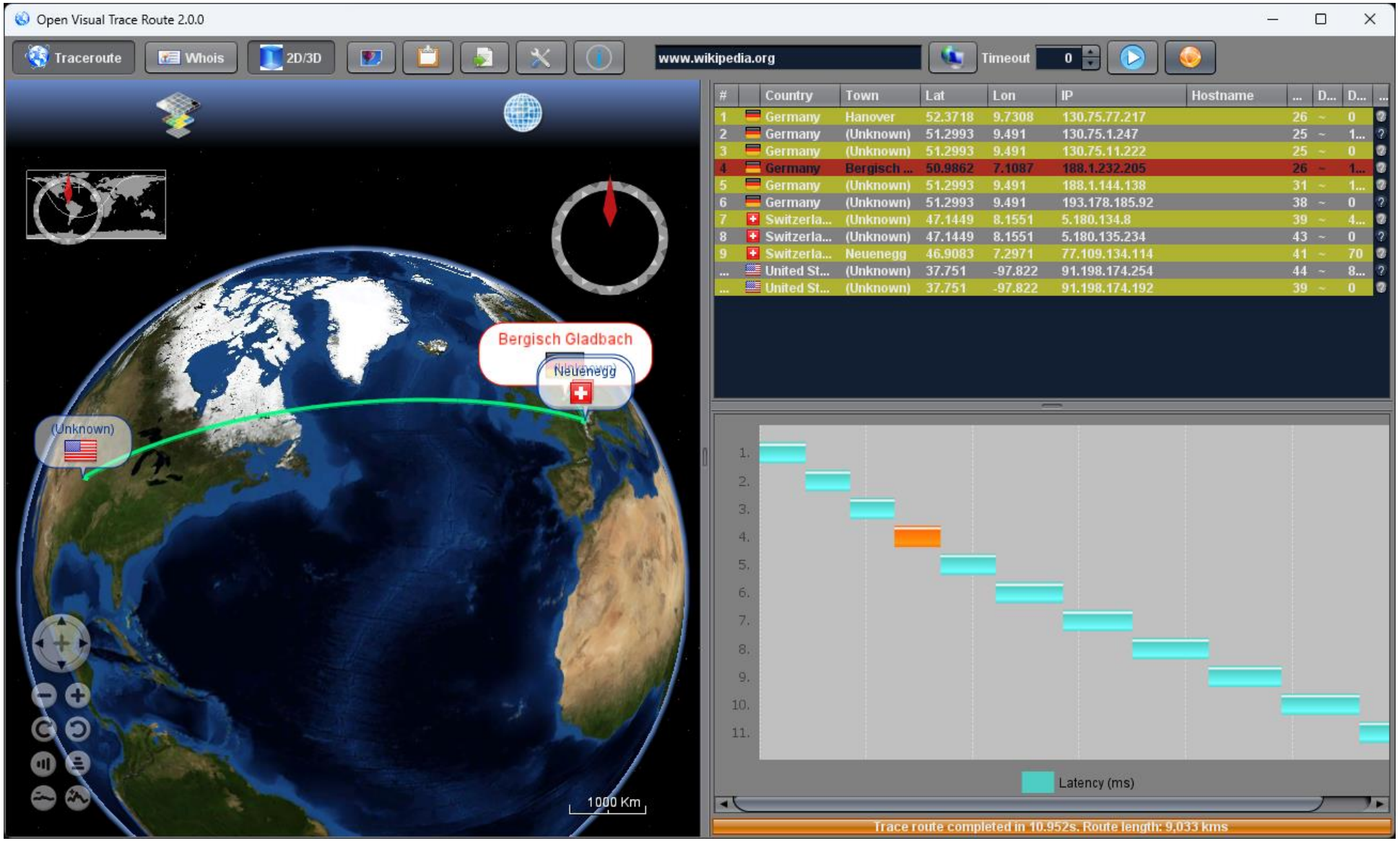
ROUTE TRACING

The software tracert.exe (trace route) can be used to identify the nodes that are used to connect to the target computer.

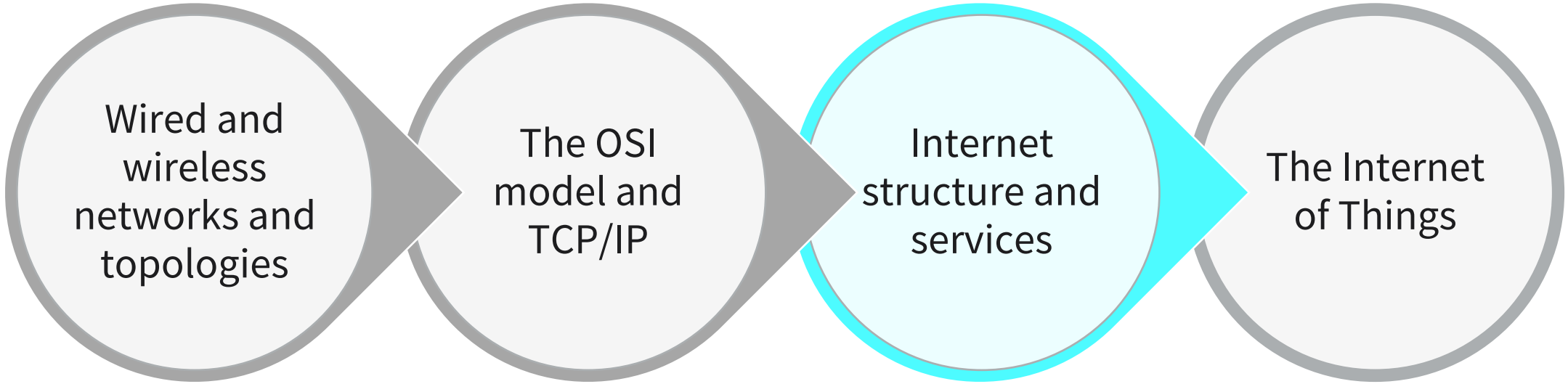


tracert www.wikipedia.org

VISUAL TRACEROUTE



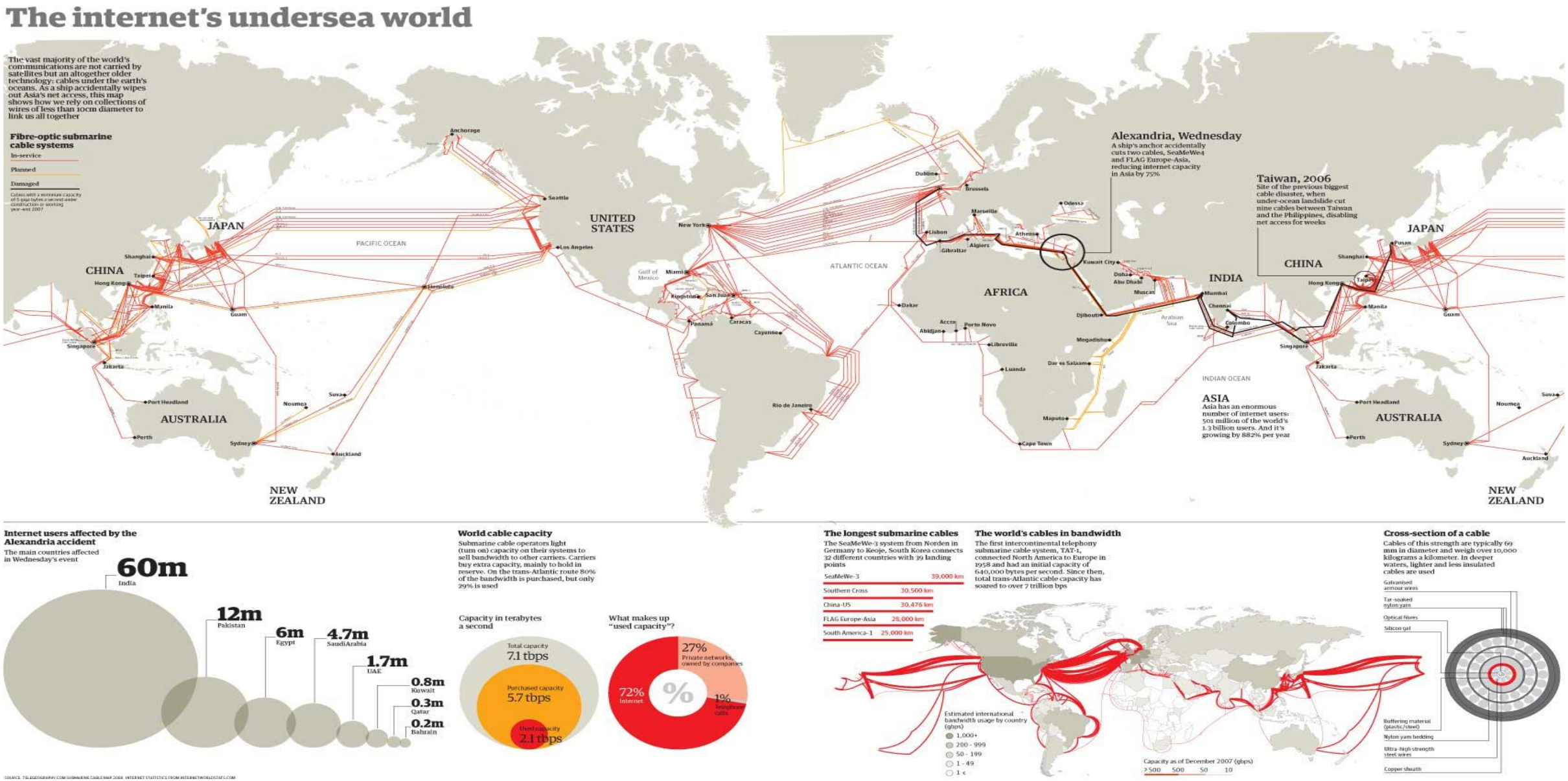
Source: https://visualtraceroute.net/


Wired and wireless networks and topologies
The OSI model and TCP/IP
Internet structure and services
The Internet of Things

INTERNET

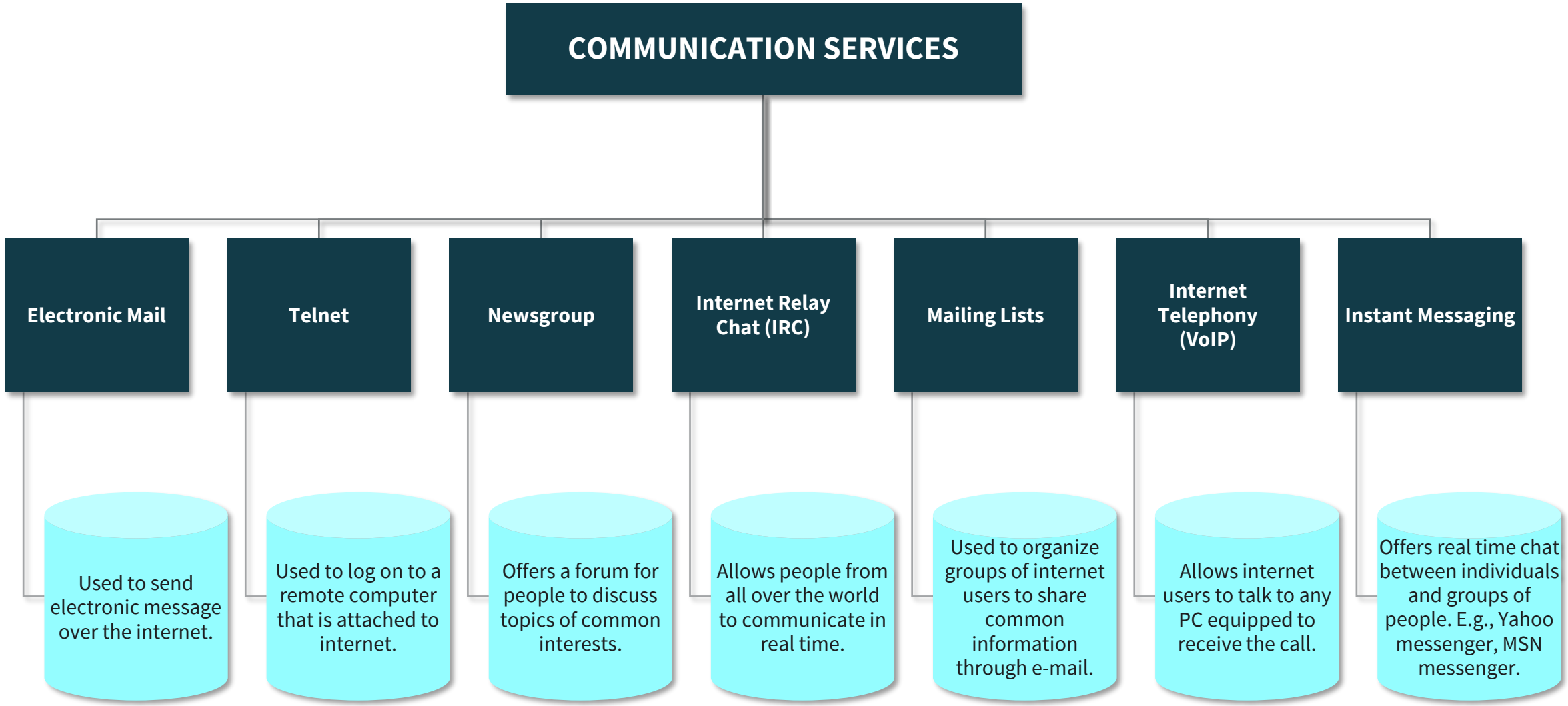
- Is defined as an information super-highway to access information.
- Internet is a global system of interconnected computer networks.
- Internet uses the standard Internet Protocol **(TCP/IP)**.
- Every computer is identified by a unique IP address IPv4 or IPv6.
- IP Address is a unique set of numbers (such as 110.22.33.114) which identifies a computer location.
- A special computer DNS **(Domain Name Server)** is used to give name to the IP Address so that user can locate a computer by a name.
  - For example, a **DNS server** will resolve a name **http://www.tutorialspoint.com** to a particular IP address to uniquely identify the computer on which this website is hosted.
- Internet is accessible to every user all over the world.

INTERCONTINENTAL INTERNET

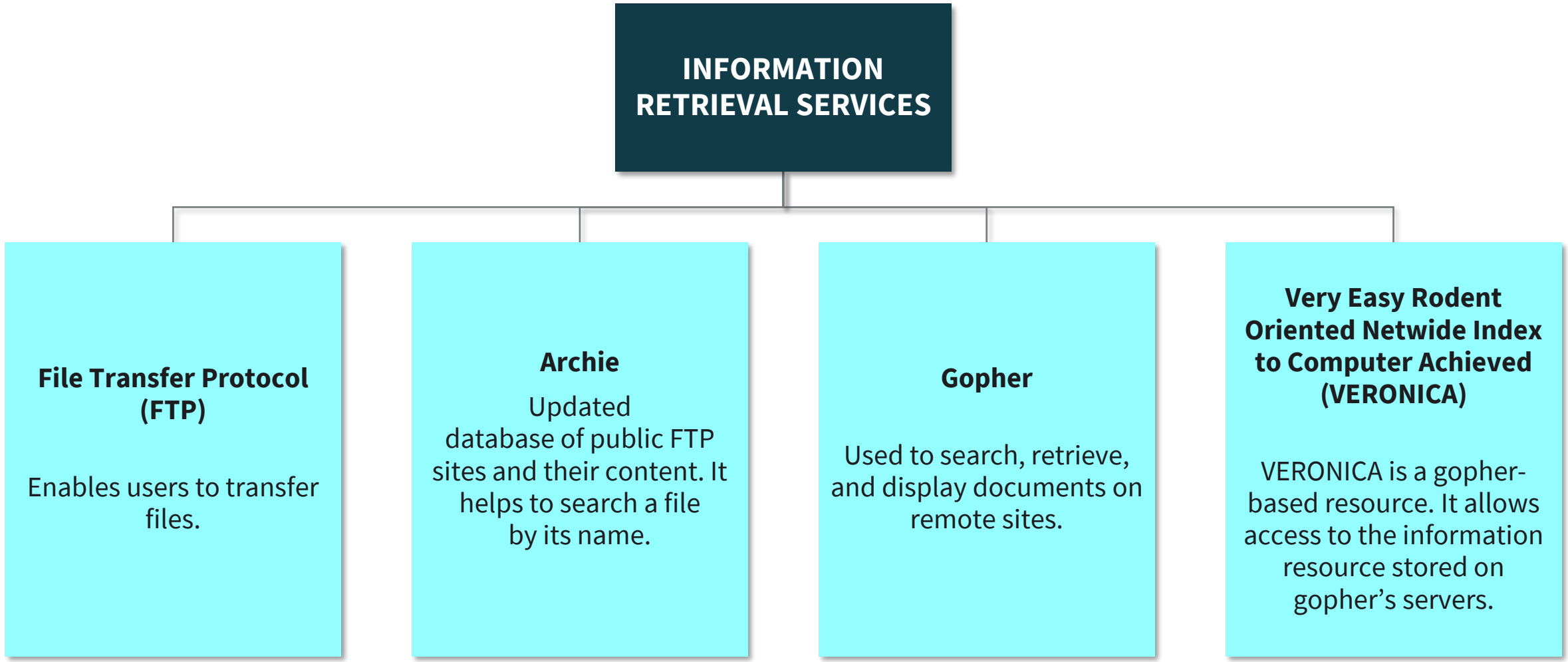


Source of the image: https://www.theguardian.com/business/2008/feb/01/internationalpersonalfinancebusiness.internet

INTERNET SERVICES



INTERNET SERVICES



INTERNET SERVICES

Web Services

Web services allow exchange of information between applications on the web.

Using web services, applications can easily interact with each other.

World Wide Web (WWW)

WWW is also known as W3.

It offers a way to access documents spread over the several servers over the internet.

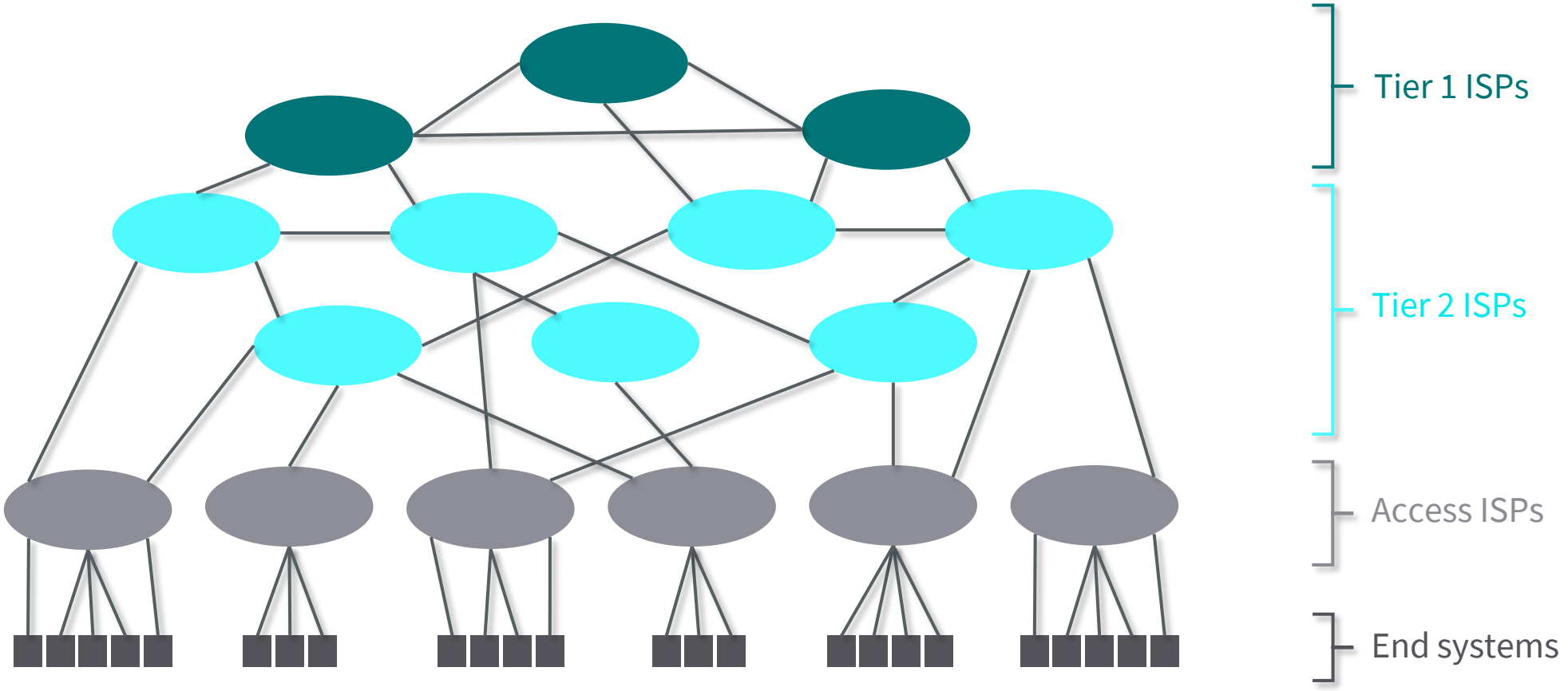
These documents may contain texts, graphics, audio, video, hyperlinks.

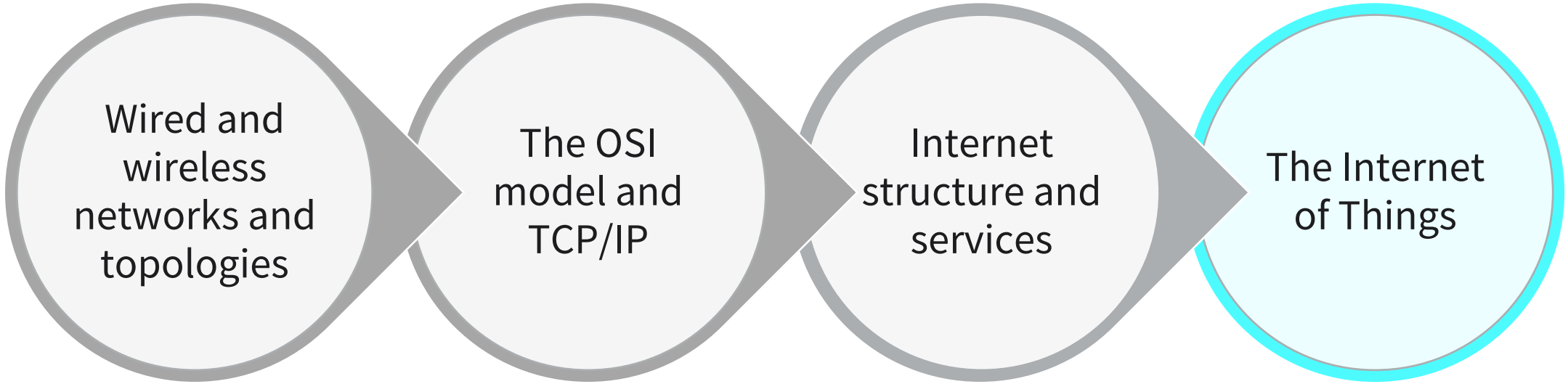
The hyperlinks allow users to navigate between the documents.

Video Conferencing

Video conferencing or video teleconferencing is a method of communicating by two-way video and audio transmission with help of telecommunication technologies.

INTERNET COMPOSITION




Wired and wireless networks and topologies
The OSI model and TCP/IP
Internet structure and services
The Internet of Things

IIOT

Video: https://youtu.be/LlhmzVL5bm8

INTERNET OF THINGS (IOT)

IoT is a **network of** physical objects or people called **“things”** that are embedded with software, electronics, network, and sensors that allow these objects to collect and exchange data.

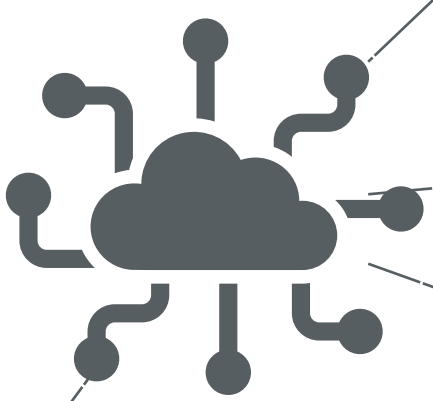
The goal of IoT is to extend to internet connectivity **from standard devices** like computer, mobile or tablet **to relatively dumb devices** like a toaster.

Source of the image: GREGOR, Pixabay

ADVANTAGES OF IOT

Technical Optimization:

IoT technology helps a lot in improving technologies and making them better.



Improved Data Collection:

Traditional data collection has its limitations and its design for passive use. IoT facilitates immediate action on data.

Improved Customer Engagement:

IoT allows you to improve customer experience by detecting problems and improving the process.

Reduced Waste:

IoT offers real-time information leading to effective decision making & management of resources.

DISADVANTAGES IOT

SECURITY

IoT technology creates an ecosystem of connected devices. However, during this process, the system may offer little authentication control despite sufficient security measures.

PRIVACY

The use of IoT exposes a substantial amount of personal data in extreme detail without the user's active participation. This creates lots of privacy issues.

FLEXIBILITY

There is a huge concern regarding the flexibility of an IoT system. It is mainly regarding integrating with another system as there are many diverse systems involved in the process.

COMPLEXITY

The design of the IoT system is also quite complicated. Moreover, it's deployment and maintenance are not very easy.

COMPLIANCE

IoT has its own set of rules and regulations. However, because of its complexity, the task of compliance is quite challenging.

CHALLENGES OF INTERNET OF THINGS (IOT)

At present IoT is faced with many challenges, such as:

- insufficient testing and updating
- concerns regarding data security and privacy
- software complexity
- data volumes and interpretation
- integration with AI and automation
- devices require a constant power supply which is difficult
- interaction and short-range communication

You have learned …

- … about standard network topologies.
- … about the hardware devices used in a network.
- … how TCP/IP and the internet work.
- … about wireless and wired network technologies.
- … about the Internet of Things (IoT).

SESSION 4

TRANSFER TASK

TRANSFER TASK

Dial-In via Internet Service Provider

You are at home and your local IP address is 192.168.178.0. You want to reach Wikipedia from your browser. You have the following network components available:

- Internet
- Homenet
- Home PC
- Your ISP (Internet service provider) (IP 80.45.4.9)
- Routers
- Gateways
- Wikipedia.org Server
- DSL connection Switches
- Hubs

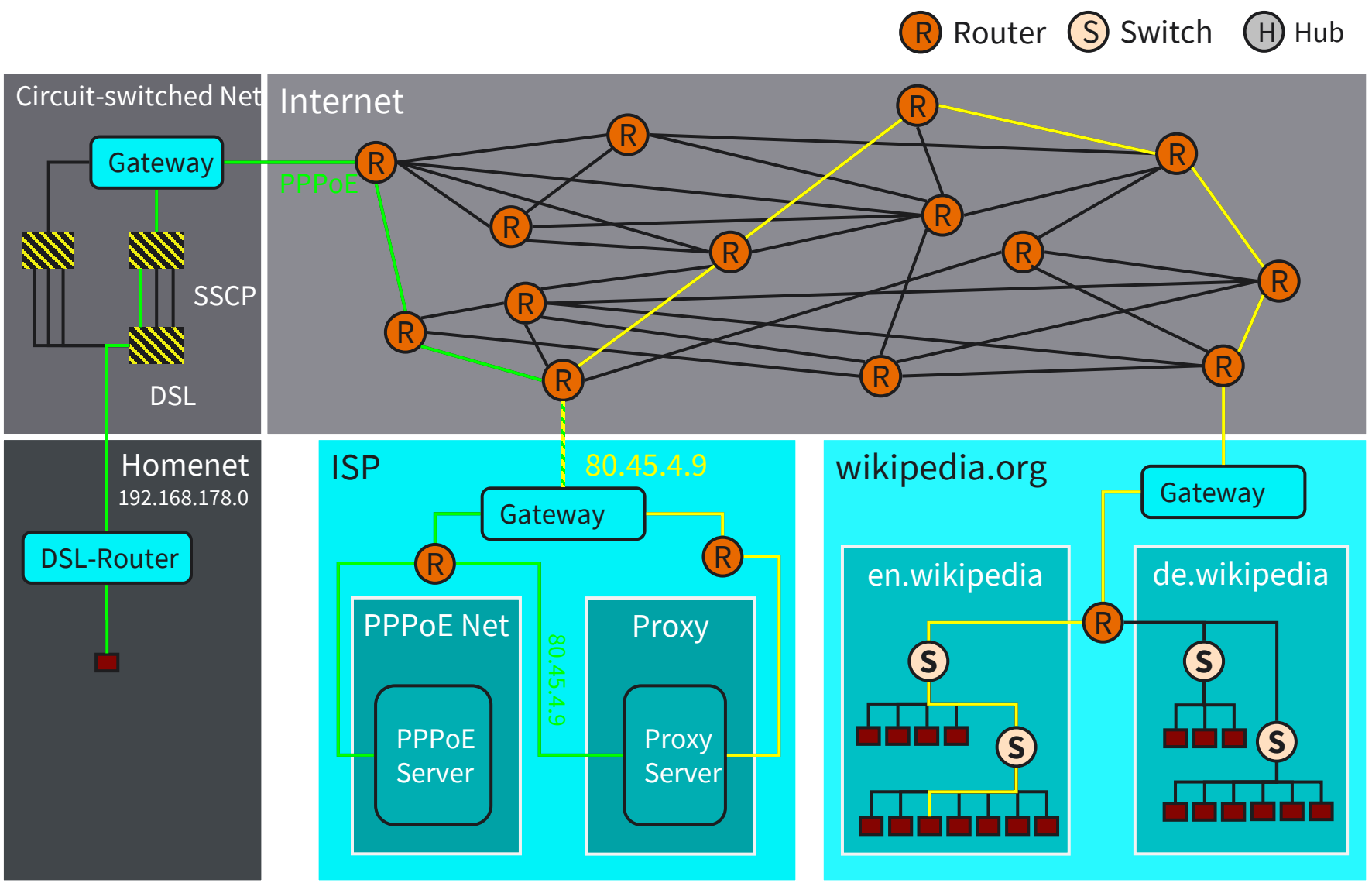
Draw a schema of the network by using the above components to reach Wikipedia form your Home PC.

TRANSFER TASK
PRESENTATION OF THE RESULTS

Please present your results.

The results will be discussed in plenary.

SAMPLE SOLUTION



1. Which of these is found at the data link layer of the OSI model?
   a) packets
   b) Ethernet
   c) encoding
   d) routing

2. Which of these devices does not filter network traffic?
   a) switch
   b) router
   c) hub
   d) firewall

3. Which layer of the OSI model is responsible for encryption?
   a) application
   b) session
   c) transport
   d) presentation

4. IoT stands for:?
   a) Interweb owner Transfer
   b) Internet of Things
   c) Intelligent on Throughput
   d) Interleaving of Technology

5. A router is used as part of what network topology?
   a) hub
   b) star
   c) ring
   d) bus

LIST OF SOURCES

Brookshear, G. & Bylow, D. (2011). *Computer Science: An Overview* (11th ed.). Pearson.

Dale, N. & Lewis, J. (2020). *Computer Science Illuminated* (7th ed.). Jones & Bartlett Learning.

Downey, A. B. & Mayfield, C. (2020). *Think Java: How to Think Like a Computer Scientist*. O'Reilly.

Filho, W. F. (2018). *Computer Science Distilled: Learn the Art of Solving Computational Problems.* Code Energy LLC.

Petzold, C. (2000). *Code: The Hidden Language of Computer Hardware and Software.* Microsoft Press.

Weizenbaum, J. (1966). *ELIZA—a computer program for the study of natural language communication between man and machine.* Communications of the ACM, 1966. dl.acm.org

Whitington, J. (2016). *A Machine Made this Book: Ten Sketches of Computer Science.* Coherent Press.