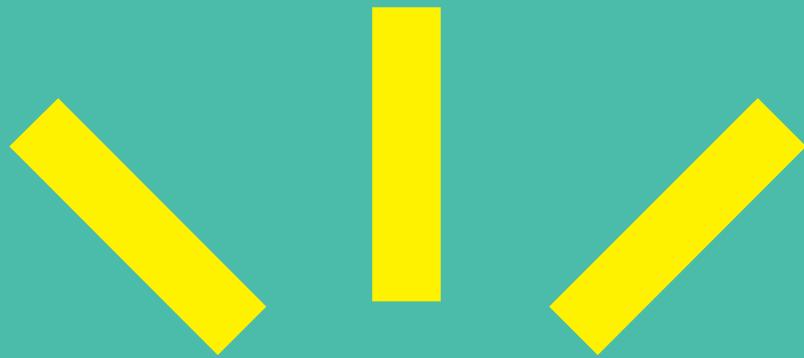


521150A

Introduction to Internet

Lecture 1 – Introduction & motivation to the course



Lecture 1 part I

– Introduction



Teaching personnel



Asst. Prof. Erkki Harjula



Bilgehan Akdemir

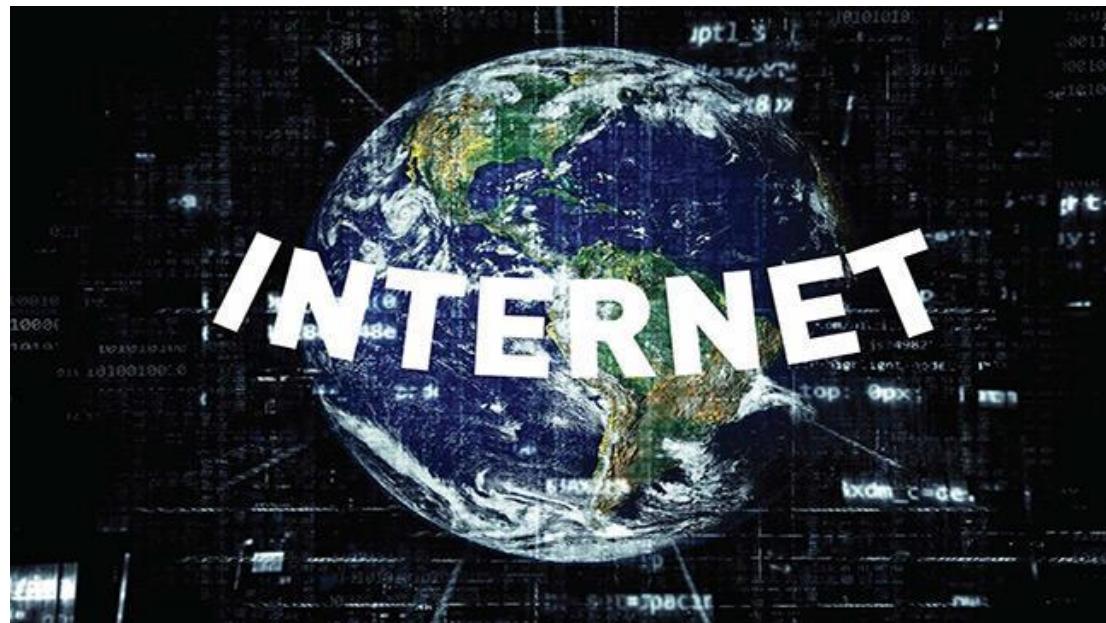


Faheem Shahid

- Responsible Teacher: **Erkki Harjula**
 - Main organization of the course, lectures, preparation and grading of exams
 - erkki.harjula@oulu.fi; 050 3030478
 - Office: TS427, weekly office hour: Thursdays at 13-14.
- Teaching Assistant: **Bilgehan Akdemir**
 - Exercises, labs, course work
 - bilgehan.akdemir@oulu.fi, TS430
- Teaching Assistant: **Faheem Shahid**
 - Labs, exercises, course work
 - hafiz.shahid@oulu.fi, TS430
- **Please tag your emails as follows:**
 - [II] <title of your matter>



Welcome to Introduction to Internet course



- On this course, you will learn the basics of networking and the Internet
- On the course you will learn both theoretical and practical skills
- The course builds upon the Internet reference model and TCP/IP protocol stack
- **The main content includes:**
 - The basic concepts on networking,
 - Key terminology,
 - Design principles of the Internet,
 - Main layers of operation and key protocols on each layer,
 - Basics of network security and multimedia networking,
 - Future directions



Objectives and learning outcomes

- Upon completion of this course, students know and understand the basic concepts, know the key terminology and can write clearly with justifications about the following key areas of the course, which are:
 1. The design principles of the Internet, its architecture, functionality and challenges
 2. The role of the data link layer and the most important access network technologies
 3. The structure and the most important protocols of the TCP/IP protocol stack
 4. The most important internet applications and their protocols
 5. The basic principles of internet security and multimedia applications
- Additionally, students who have attained grades 2 or 3 have demonstrated:
 - Satisfactory capability to perform practical software implementation work AND/OR solving Internet-related problems relevant to most centric course key areas.
- Students who have attained grades 4 or 5 have demonstrated:
 - Solid capability to perform practical software implementation work AND analytical skills for solving technical and research problems relevant to the course key areas.



Contents of the course

- **Course part 1**
 - Motivation
 - Architecture, design principles, performance
 - Data link layer - Wired and wireless access networks
- **Course part 2**
 - TCP/IP protocol stack
 - Network layer
 - Transport layer
- **Course part 3**
 - Networking applications
 - Network security
 - Multimedia
 - Challenges and future trends



Schedule of the course

PART I: Basics of networking and Internet, data link layer

Mon 13.3.
10-12 L6/Zoom

Lecture 1: Introduction & motivation

Tue 14.3.
10-12 L6/Zoom

Lecture 2: Architecture & design principles

Wed 15.3.
10-12 L5/Zoom

Lecture 3: Data link layer – basics part I

Thu 16.3.
10-12 L4/Zoom

Exercise session 1A

Mon 20.3.
10-12 L6/Zoom

Lecture 4: Data link layer – basics part II

Tue 21.3.
10-12 L6/Zoom

Exercise session 1B

Tue 21.3.
14-18 AT122/Zoom

Lab exercise 1 – group 3

Wed 22.3.
10-12 L5/Zoom

Lecture 5: Data link layer – Wired networks

Wed 22.3.
14-18 AT122/Zoom

Lab exercise 1 – group 4

Thu 23.3.
14-18 AT122/Zoom

Lab exercise 1 – group 2

Fri 24.3.
12-16 AT122/Zoom

Lab exercise 1 – group 1

Mon 27.3.
14-16 L5/Zoom

Exercise session 1C

Tue 28.3.
10-12 L6/Zoom

Lecture 6: Data link layer – Wireless networks

Wed 29.3.
10-12 Moodle

Theory exam 1

PART II: Network and transport layers

Thu 30.3.
8-10 L5/Zoom

Lecture 7: Network layer part I

Mon 3.4.
14-16 L5/Zoom

Exercise session 2A

Tue 4.4.
10-12
L6/Zoom

Lecture 8: Network layer part II

Wed 5.4.
10-12 L5/Zoom

Lecture 9: Transport layer part I

Course work intro

Tue 11.4.
10-12 L6/Zoom

Lecture 10: Transport layer part II

Tue 11.4.
14-18 AT122/Zoom

Lab exercise 2 – group 3

Wed 12.4.
10-12 Moodle

Theory exam 2

Wed 12.4.
14-18 AT122/Zoom

Lab exercise 2 – group 4

Thu 13.4.
8-10 L5/Zoom

Exercise session 2B

Thu 13.4.
14-18 AT122/Zoom

Lab exercise 2 – group 2

Fri 14.4.
12-16 AT122/Zoom

Lab exercise 2 – group 1

Course work (independent work)

PART III: Application layer, network security and multimedia

Fri 14.4.
10-12 L5/Zoom

Lecture 11: Networking applications

Mon 17.4.
14-16 L5/Zoom

Lecture 12: Network security

Tue 18.4.
10-12 L6/Zoom

Exercise session 3A

Wed 19.4.
10-12 L5/Zoom

Lecture 13: Multimedia and QoS

Mon 24.4.
14-16 L5/Zoom

Exercise session 3B

Tue 25.4.
14-18
AT122/Zoom

Lab exercise 3 – group 3

Wed 26.4.
10-12 L5/Zoom

Lecture 14: Challenges&Future Internet trends

Wed 26.4.
14-18 AT122/Zoom

Lab exercise 3 – group 4

Thu 27.4.
14-18 AT122 /Zoom

Lab exercise 3 – group 2

Fri 28.4.
12-16 AT122 /Zoom

Lab exercise 3 – group 1

Wed 3.5.
10-12 Moodle

Theory exam 3

Thu 25.5.
16-19 L1

Final exam



Schedule highlights

- **Detailed schedule in Moodle:**
<https://moodle.oulu.fi/course/view.php?id=17413>
- **Theory exams:**
 - 1st: Wednesday March 29th at 10-12 in Moodle
 - 2nd: Wednesday April 12th at 10-12 in Moodle
 - 3rd: Wednesday May 3rd at 10-12 in Moodle
- **Final exam:**
 - Thursday May 25th at 16-19, L1



Main structure and Grading of the course

Lectures (14 x 2h)

Basic knowledge evaluation

Mandatory demonstration of basic knowledge through either of the following:

- 1) In-lecture mini-exams (6-7x randomly organized electronic exams);
- 2) Exams in Moodle (for those who have not passed the needed mini-exams).

(problem solving) Exercises	Advanced exam questions	Laboratory exercises	Course work
<ul style="list-style-type: none">• 7 x 2h sessions• Pre- and post-assignments• Non-mandatory• Grading: 0–15p (0–2.5p/session)	<ul style="list-style-type: none">• Demonstration of advanced knowledge through intermediate exams• Cover basic and advanced lecture material, and problem solving exercises• Require ability to apply the gathered knowledge to different situations.• Non-mandatory• Grading: 0–15p.	<ul style="list-style-type: none">• 3 x 4h sessions• In groups or alone (no effect to grading).• Non-mandatory• Grading: 0–15p (0–5p./session)	<ul style="list-style-type: none">• Programming exercise• In groups or alone (group size slightly affects the grading).• Non-mandatory• Grading: 0–15p.

Grading:

Grade 1 can be completed by passing the mandatory part: basic knowledge evaluation

Grades 2 – 5 are based on points gathered from four non-mandatory areas described above.



Grading

Grade	Points	Verbal	Description
0	basic part failed	Fail	Does not have sufficient knowledge on the basic parts.
1	basic part passed, points: 0-14	Sufficient	Knows and understands the basics and can write clearly with justifications about the course key areas.
2	basic part passed, points: 15-24	Satisfactory	In addition, has capability to either perform practical implementation work or solving problems relevant to centric course key areas.
3	basic part passed, points: 25-34	Good	...with good results.
4	basic part passed, points: 35-44	Very good	In addition, has capability to perform practical implementation work and shows analytical skills to solve relevant technical/research problems.
5	basic part passed, points: 45-60	Excellent	...with excellent results!



Lectures



- **The main course material is taught on 14 two-hour lectures**
 - Organized as hybrid (F2F/online) sessions
 - Flipped classroom –type lectures
 - Lectures are recorded and will be made available in Moodle
- **Non-mandatory**
- However, **participation is strongly recommended**, since the primary method to pass the mandatory basic part of the course is through in-lecture miniexams
 - More information on passing the basic part of the course at pages 14-15 of this slide set
- **Lecture content is divided to three categories:**
 - 1) Basic content (mandatory content)
 - 2) Advanced content (non-mandatory content)
 - 3) Practical content (non-mandatory content)



Structure of the course material

The contents are divided to different categories

Application layer

Transport layer

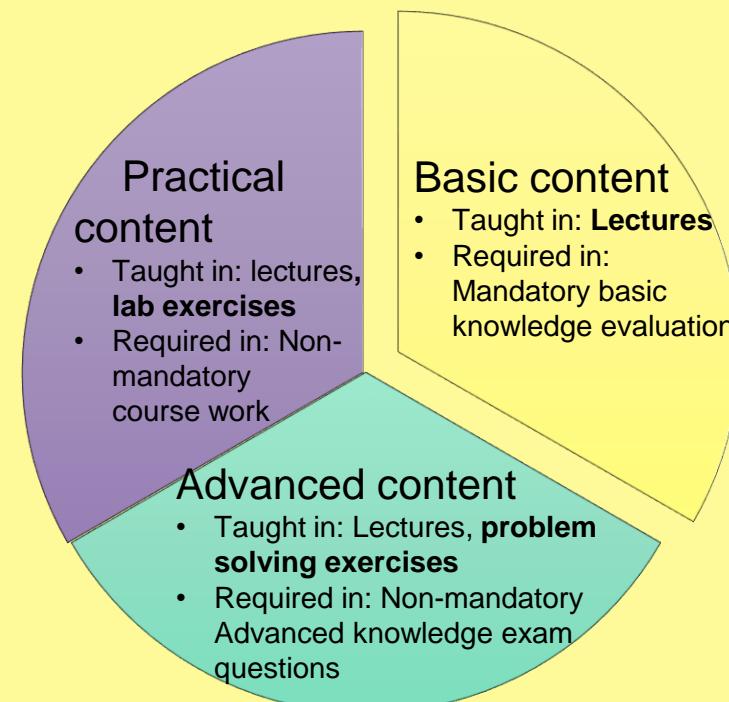
Network layer

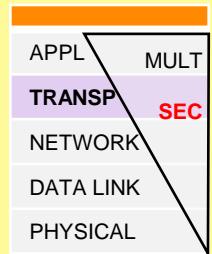
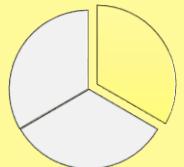
Data-link layer

Physical layer

Multimedia,
Security

The contents are divided into three types





The type and category of the content of each slide is indicated in upper left corner

– Slide content type:

- Yellow (in example on the left): mandatory material required in basic knowledge evaluation
- Green: more advanced material required in advanced exam questions
- Purple: practical material needed in problem solving & lab exercises, and advanced advanced exam questions

– Slide content category:

- Internet model layer/category is highlighted
- In the example, the slide would focus on transport layer security
- In case none is highlighted, the content is general, and applies to all categories



Basic knowledge evaluation



- **Mandatory part of the course**
- What is required: **for each of the three course parts**, you must show you know the basics, by either:
 - In-lecture mini-exams (Kahoot):
 - Primary method to pass the course
 - 2-3 in-lecture mini-exams per each course part
 - 3 out of 4 questions must be correct to pass each exam
 - All mini-exams need to be passed
 - **OR Electronic exam in Moodle:**
 - "Backup" method, meant for those who did not pass a course part by mini-exams
 - Will be available after the course part has been taught
 - 5 out of 7 questions must be correct to pass an exam
 - One basic exam per each course part, all three need to be passed
 - **OR Final exam basic part in Moodle**
 - "Last resort" – should never be the primary choice
 - Wider set of questions from the whole course content
 - 75% of the basic questions must be correct to pass
 - Accepted basic part from previous years is valid
 - However, partial basic part accomplishments from previous years are not accepted
 - **Grading: Pass/fail**



In-lecture Mini-exams



- **There will be 6-7 randomly organized in-lecture mini-exams during the course** in order to encourage students to participate the lectures.
- Questions:
 - Multi-choice questions based on the lecture content and preliminary videos between the current and past mini-exam
 - Simple "must-know" questions related to basic lecture material
 - For those who master the basics, questions are relatively easy
- Obs! Course can be passed by successfully passing all mini-exams (=> grade 1).
- Kahoot application will be used for these tests:
<https://kahoot.com/>
- **Student needs to have a smartphone or a laptop with Internet connectivity** to participate a mini-exam.
- Student must use their student number (NOT NAME) to join the game.
- Similar questions in the Examinarium exams, but there are more questions
- **Grading: Pass/Fail (Pass: >75% correct answers)**



Advanced exam questions



- Questions from basic, advanced and practical parts of the lecture material
 - Organized as Moodle exams
- Non-mandatory
- In intermediate exams: three advanced questions, max 5p/exam (max 15p/3 exams).
- In final exam: five advanced questions, max 15p/exam.
- The points from intermediate exams and final exam cannot be combined
 - If you do both, higher points are used for final grading.
- The advanced exam points from previous years are valid for 2021 course
 - The advanced exam points from 2019-2020 are valid as is
 - The exam points from years before 2019 (8-24pts) are converted to new system by subtracting 8 points.
 - Obs! Please tell about your previous accomplishments to the lecturer
- **In total, maximum 15p.**



Exercises

$$\begin{aligned}
 & \int_{x_1}^{x_2} \int_{y_1}^{y_2} f(x, y) dx dy = \int_0^a \int_0^a g(x, y) dx dy \\
 & \text{where } x = t, y = \sqrt{t}, \quad t \in [0, 1] \\
 & \text{Jacobian: } \frac{\partial(x, y)}{\partial(t)} = \begin{vmatrix} 1 & 0 \\ \sqrt{t} & \frac{1}{2\sqrt{t}} \end{vmatrix} = \frac{1}{2\sqrt{t}} \\
 & \text{Volume element: } dt dy = \frac{1}{2\sqrt{t}} dt dy \\
 & \text{Transformed integral: } \int_0^a \int_0^a g(x, y) dx dy = \int_0^a \int_0^a g(t, \sqrt{t}) \frac{1}{2\sqrt{t}} dt dy \\
 & \text{Final answer: } \boxed{\int_0^a \int_0^a g(t, \sqrt{t}) \frac{1}{2\sqrt{t}} dt dy}
 \end{aligned}$$

- **Each section of the course has 2-3 problem solving sessions**
 - Organized as hybrid (F2F/online) sessions
 - **Non-mandatory**
 - **For each session, there is an introductory exercise in Moodle**
 - You can earn 1p by solving the exercise before the problem solving session.
 - These exercises are relatively easy.
 - **In each session:**
 - The introductory exercises are revisited
 - A set of more demanding exercises are introduced. Solve up to three of them and return your solution in Moodle for 0,5p each
 - Additionally there is time to ask questions and receive guidance
 - **In total 7x2,5p., maximum 15p.**



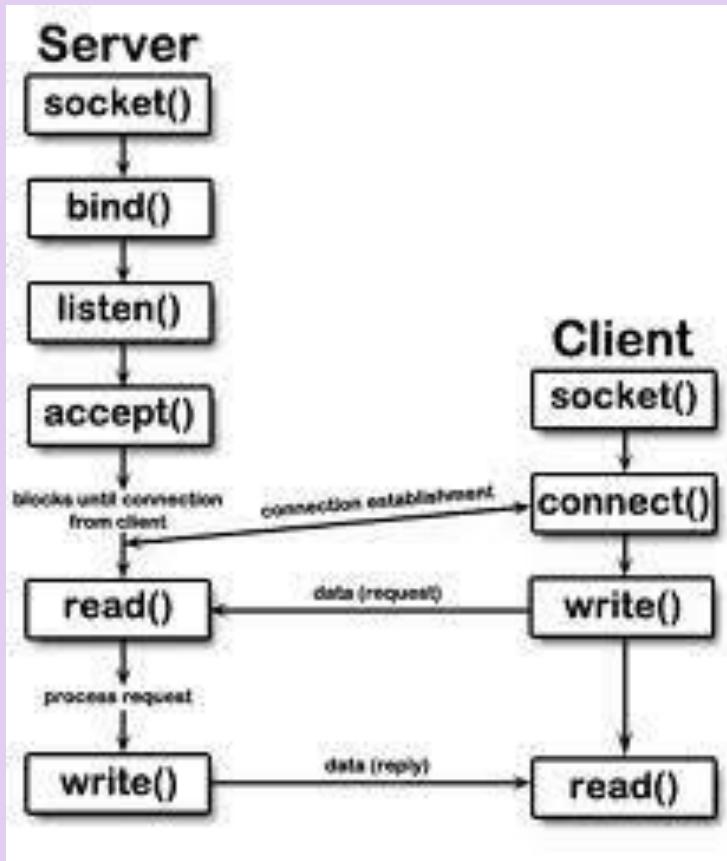
Lab exercises

```
81     self.color = colors
82     def on_key_press(self, symbol, modifiers):
83         """Delegate key press"""
84         if self.context_index == -1:
85             if symbol == key.UP and not self.active_index == 0:
86                 self.menu_labels[self.active_index].color = [255, 255, 255, 255]
87                 self.active_index -= 1
88                 self.mags_dt = self.get_act_color_mag()
89             elif symbol == key.DOWN and not self.active_index == 3:
90                 self.menu_labels[self.active_index].color = [255, 255, 255, 255]
91                 self.active_index += 1
92                 self.mags_dt = self.get_act_color_mag()
93             elif symbol == key.ENTER:
94                 if self.active_index == 3:
95                     pyglet.app.exit()
96                 else:
97                     self.context_index = self.active_index
98             elif symbol == key.ESCAPE:
99                 if self.context_index == -1:
100                     pyglet.app.exit()
101                 else:
102                     self.context_index = -1
103             elif self.context_index == 1:
104                 if symbol == key.ESCAPE:
105                     self.context_index = -1
106                 else:
107                     self.cur_game.on_key_press(symbol, modifiers)
108             else:
109                 if symbol == key.ESCAPE:
110                     self.context_index = -1
111
```

- Lab exercises consist of three hands-on exercise sessions
 - Organized as hybrid (F2F/online) sessions
- Non-mandatory
- Labs are on weeks 2, 4 and 6. They are organized 4 times a week but you only have to attend one of the sessions.
- Three laboratory sessions, 0-5p each, depending on quality of work
- See moodle for more details
- The lab exercise points from earlier years are counted as 2 points
- In total 3x5p., maximum 15p.



Course work



- Hands-on programming assignment
- Consists of two parts:
 - Basic part (simple TCP&UDP client)
 - Additional parts:
 - Encryption
 - Parity
 - Multipart messages
- Depending on completed additional parts and timely completion, 0 – 15p can be earned
- Course work can be done alone or in groups of 2-3. If you do the work in groups you are expected to implement one extra feature in order to pass the mandatory part.
- Details can be found from Moodle and more detailed course work description will be announced 14.4 on a lecture
- The course work points from 2019-2021 are valid for this year's course as is
- The course work points from years before 2019 are converted to new system by multiplying them by 3 (max 15p).
- In total, maximum 15p.



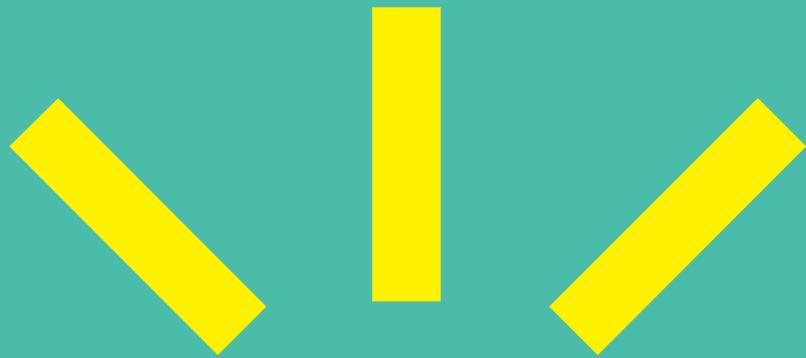
Course materials

- **Lecture slides are sufficient for passing the course**
- **Course book not required, but e.g. following books give more details on the course topics (also used in generating the lecture material):**
 - Kurose & Ross, Computer Networking: A Top-Down Approach Featuring the Internet (6th edition), 2013
 - Stallings, Data and Computer Communications (9th edition), 2011
 - Tanenbaum & Wetherall, Computer Networks (5th edition), 2011
 - Comer, Computer networks and Internets with Internet applications (5th edition), 2009
 - Peterson & Davie, Computer Networks – A Systems Approach (4th edition), 2007
 - Halsall, Computer Networking and the Internet (5th edition), 2005
 - Comer, Internetworking with TCP/IP, Vol. 1 (5th edition), 2005
- **Materials of following experts have been borrowed: Henning Schulzrinne, Geoff Huston, Scott Shenker, Pekka Nikander, Tanja Zseby, Van Jacobson**
- **Selected additional texts, detailed on slides (e.g. RFC's)**



Online course content

- Course registration in **Peppi**
- Course description, material, announcements, results and discussions in **Moodle**:
<https://moodle.oulu.fi/course/view.php?id=17413>
- Electronic exams in **Moodle**:
<https://moodle.oulu.fi/course/view.php?id=17413>



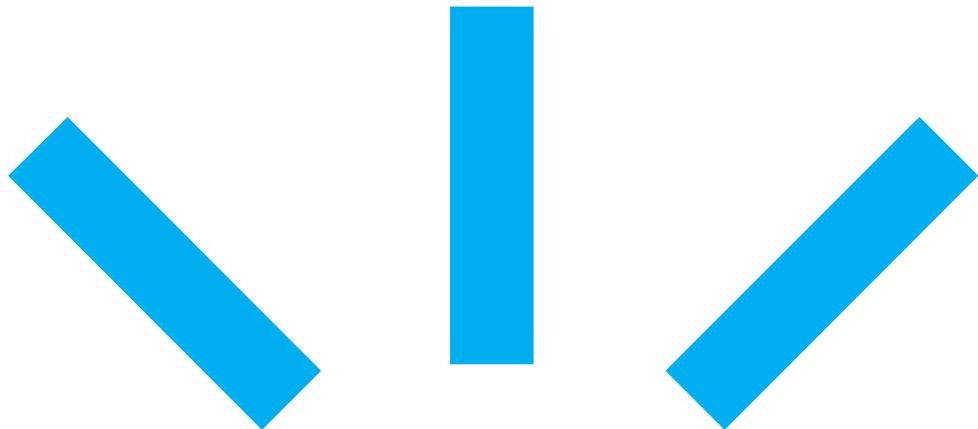
Lecture 1 part II

Motivation

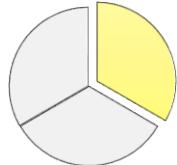


Main learning objectives of this lecture

1. Understanding the Internet's role as a part of the core civil infrastructure
2. Know the basic concepts of networking and main application areas of the Internet
3. Be aware of the the history and global importance of the Internet
4. Understand the importance of the Internet standardization



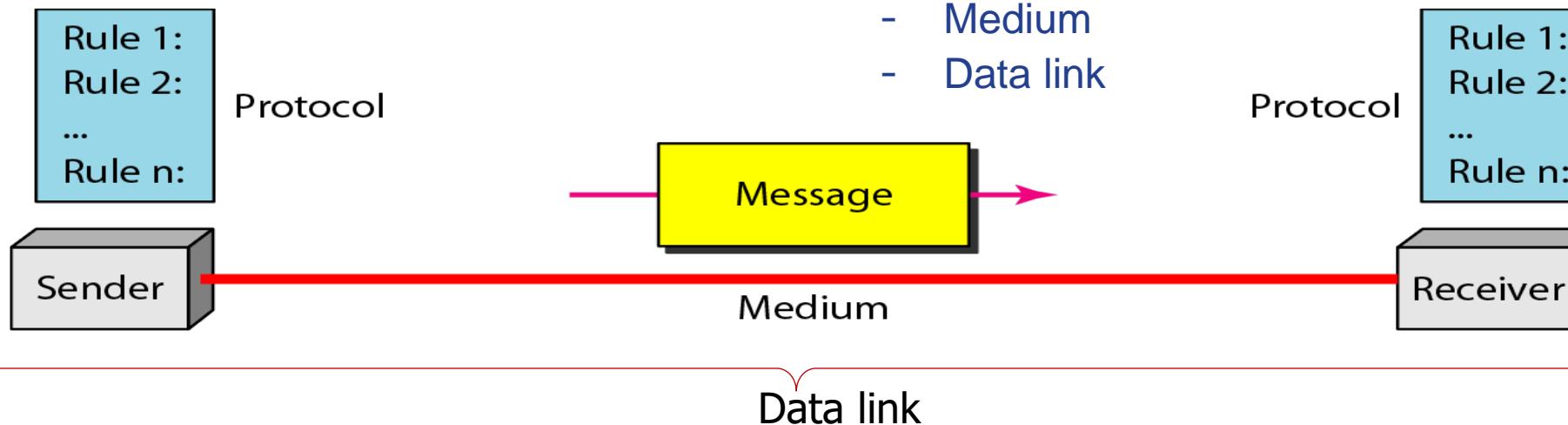
Overview of data communication and computer networks



Introduction to Data Communication

– What is data communication?

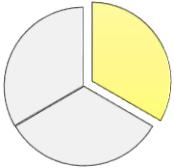
- Electronic transmission of information that has been encoded digitally with some standard from one network (systems) to another network (systems).
- Elements of Data Communication:
 - Data
 - Protocol/encoding
 - Message
 - Sender and receiver
 - Medium
 - Data link



https://www.slideshare.net/zafar_ayub/data-communication-and-network-11903853

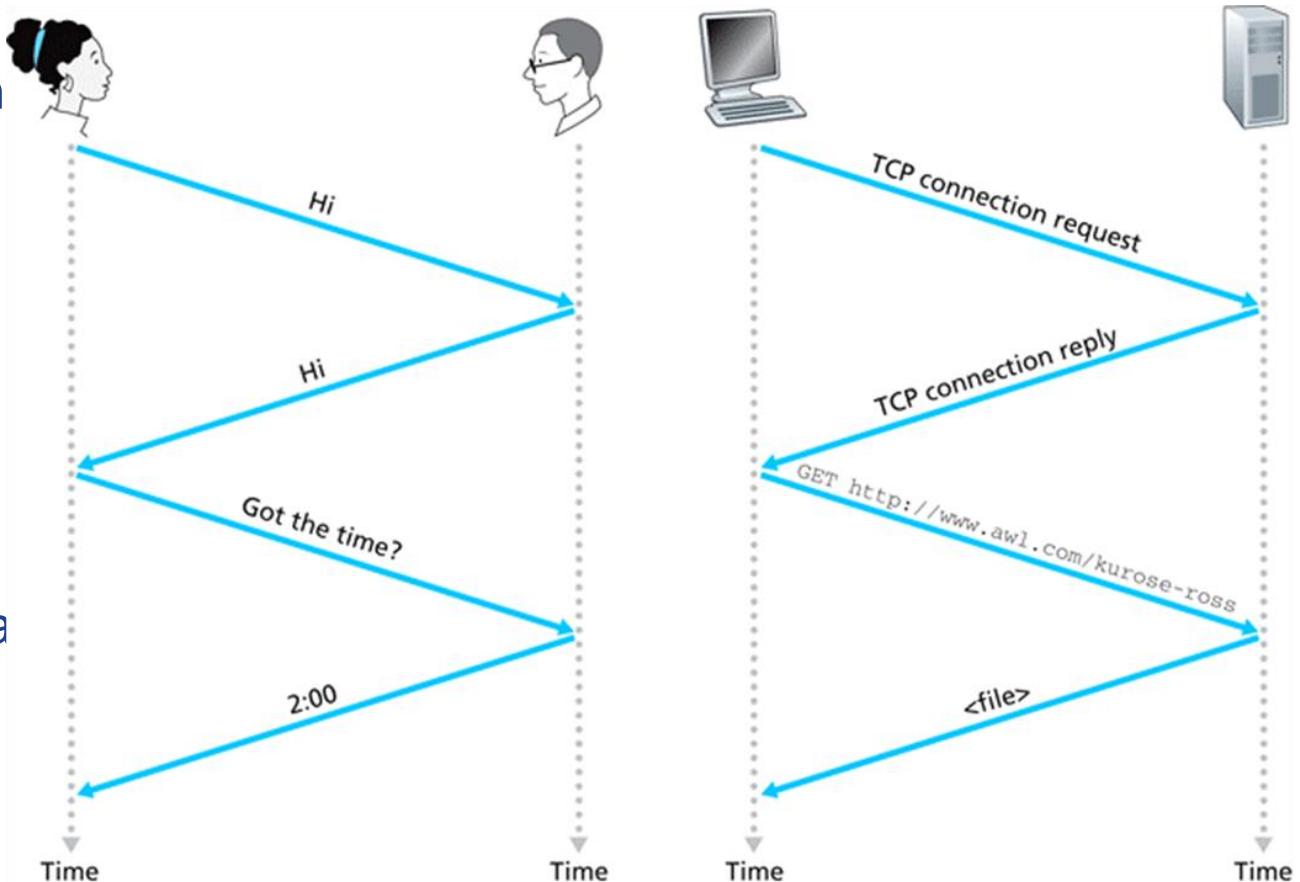


Protocol



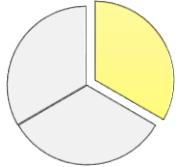
– Protocol defines

- The **format** and the **order** of messages exchanged between two or more communicating entities
 - Message (PDU, protocol data unit) comprises of application data (payload) and protocol control information (header)
- The actions taken on the transmission and/or receipt of a message or other event
 - Protocol is a state machine

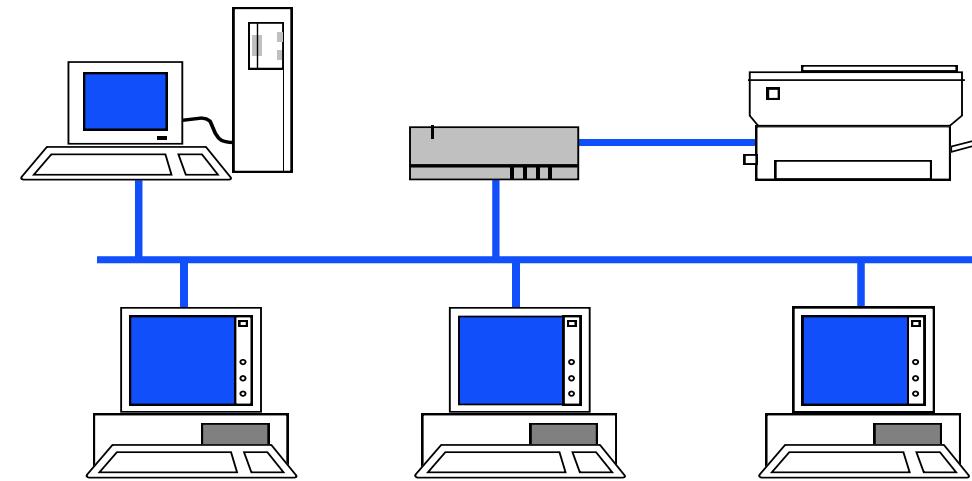




Computer network



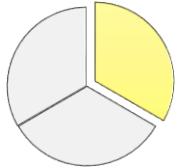
- Computer network (Tanenbaum) ~ "A collection of autonomous computers interconnected by a single technology"
- Network = **collection of data links**



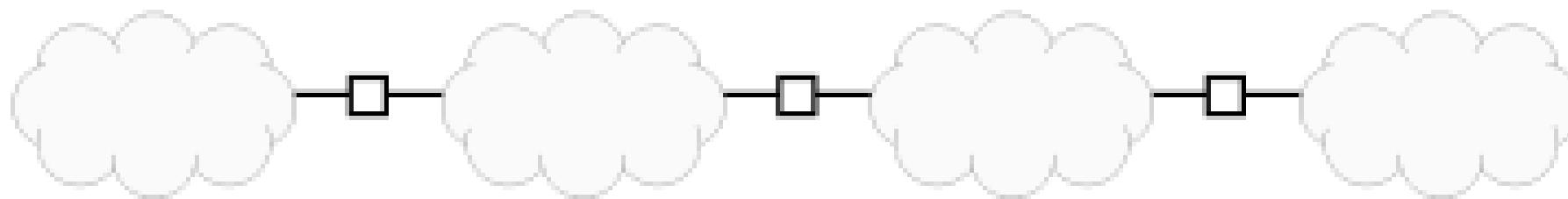
- Obs! Distributed system ~ "A collection of independent computers appearing to its users as a single coherent system, e.g. WWW."



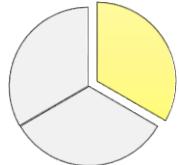
Internetwork



- Set of computer networks interconnected by routers.
- Internet scheme allows organizations to choose:
 - The **number** of and **type** of networks,
 - The number of **routers** to use to interconnect them, and
 - The interconnection **topology**.



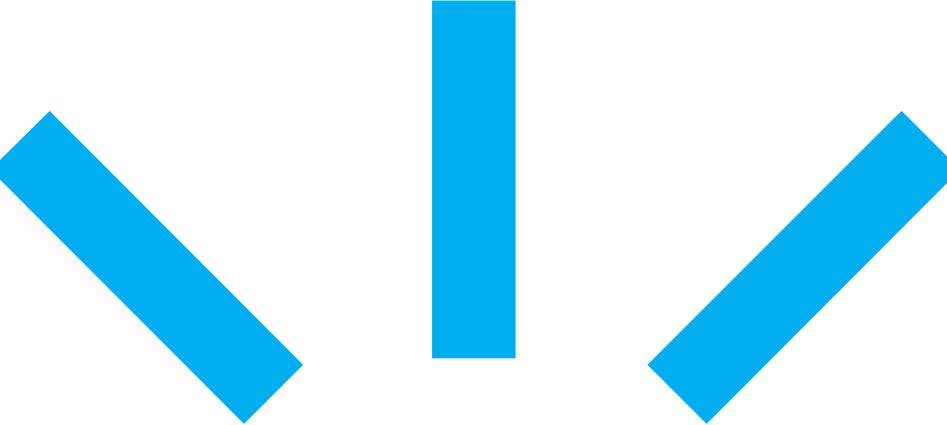
An internetwork formed using three routers to interconnect four physical networks.



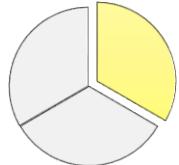
Classification of networks by scale

Interprocessor distance	Processors located in same	Example
1 m	Square meter	Body area network
10 m	Room	Personal area network
100 m	Building	Local area network
1 km	Campus	
10 km	City	
100 km	Country	Metropolitan area network
1000 km	Continent	
10,000 km	Planet	

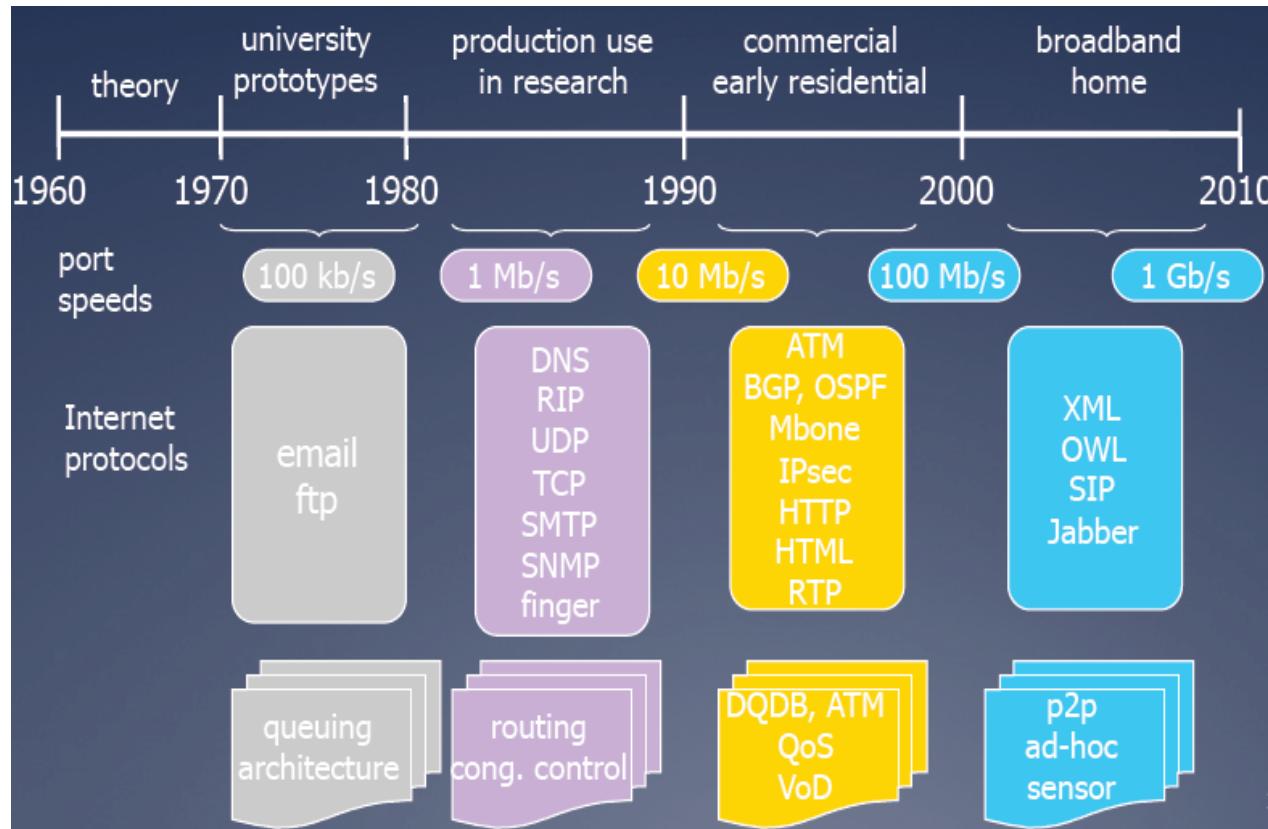
- **Body area networks (BAN)**
 - Connects **wearable** computing **devices** (e.g. gaming headsets, smartwatches, wristbands, smart rings, etc.)
- **Personal area networks (PAN)**
 - Connects **devices in proximity** "nearables" (e.g. wireless keyboards, mice, sensors, etc.)
- **Local area networks (LAN)**
 - Connects **devices at a site**, such as a building or a limited outdoor area (e.g. PCs, mobile phones with WiFi, servers etc.)
- **Metropolitan area networks (MAN)**
 - Connects **devices at larger areas than LAN** (e.g. mobile phones with cellular connection, broadband routers, cars, etc.)
- **Wide area networks (WAN)**
 - Connects together LANs and other types of **networks over a large geographical area**
- **Internet**
 - Connects together WANs and other types of **networks globally**



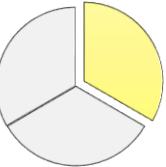
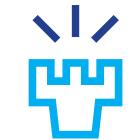
History of the Internet, significance in modern society



Evolution of data communication and Internet (1)



- **1961-1972:** The **packet switching** services were introduced for communication between computers
- **1972-1980:** Local networks (**LAN/Ethernet**) and internetworking between them (**Arpanet**) were introduced
- **1980-1990:** Internet protocols (TCP/IP, DNS, FTP) and wide-area networks (**WAN**) were introduced
- **1990=> WWW, namespace and mobility extensions (IPv6, Mobile IP, NAT extensions, HIP, ...)** have emerged during the new millennium
 - Gradual evolution towards **All-IP** (Internet Protocol) communications
 - Data centers, cloud storage, web-based services are now commonplace and accessible with mobile terminals (still called mobile phones).



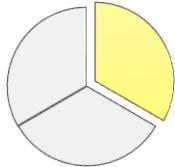
Evolution of data communication and Internet (2)

Internet is getting into middle age:

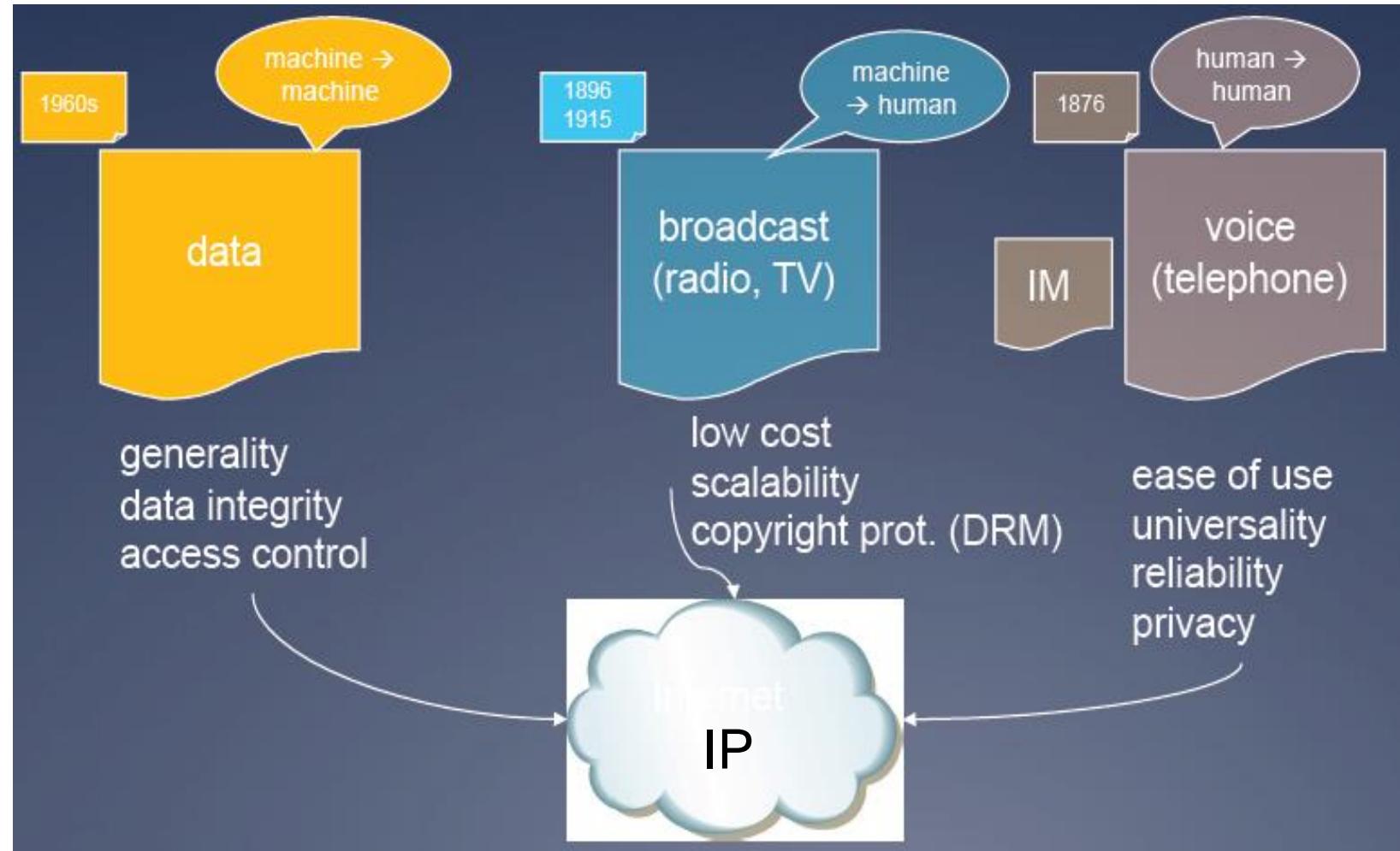
Protocol	Idea	Current implementation
IP	1969 (v4), 1980 (v6?)	1981
TCP	1974	1981
TELNET	1969	1983
FTP	1980	1985

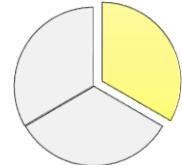


Convergence of networks

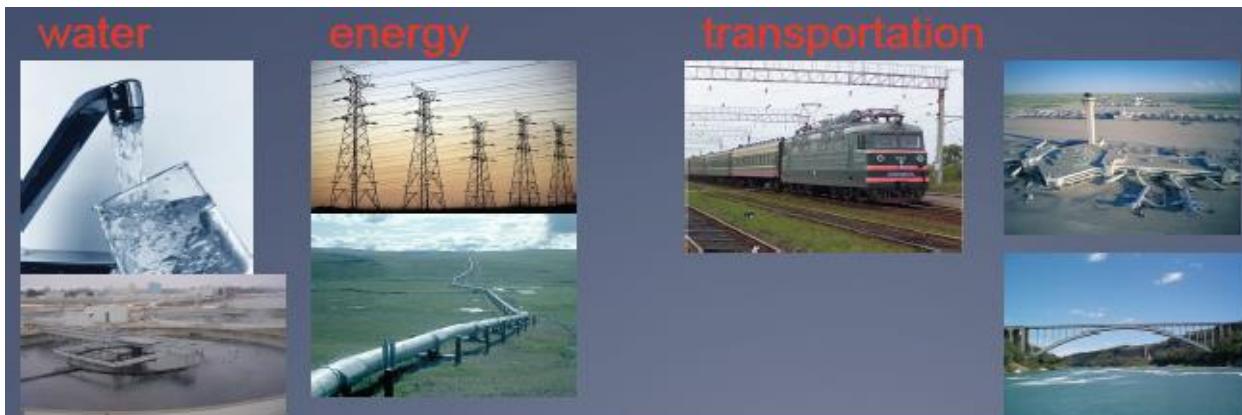


**Convergence
from
application
specific
networks
towards “all IP”
network
architecture**

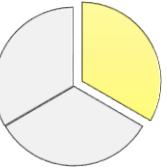




Internet as part of the core civil infrastructure (1)



- **Civil infrastructure ~ Technical structures supporting society**
 - Large
 - Constructed over generations
 - Not often replaced as a whole system
 - Continual refurbishment of components
 - Interdependent components with well-defined interfaces
 - High initial cost

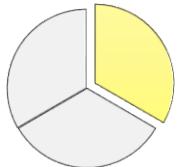


Internet as part of the core civil infrastructure (2)

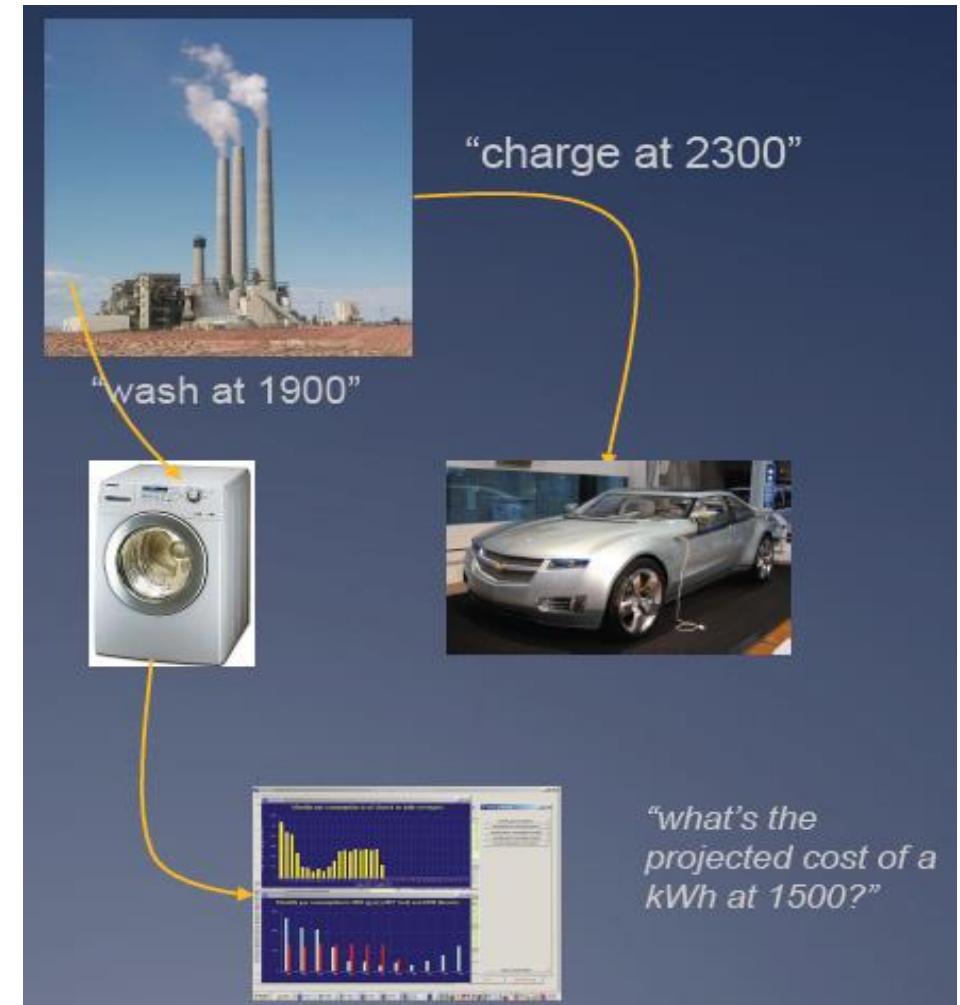
- **Internet is the information infrastructure**
 - Involved in all information exchange
 - Crucial to commerce, governance, coordination, inter-personal and machine-to-machine communication
 - Assumed to just be there like (“plumbing & piping”)
- **Extrapolating from history**
 - **IP is the data interface**
 - **IP is packet-switched**
 - Compared to traditional circuit-switched systems:
 - ≥ 10 times cheaper
 - ≥ 10 times more functionality
 - ≥ 10 times more secure
 - IP replaced traditional phone system due to **generality**, not performance
 - IP offers general channel
 - **We're stuck with IP**
 - Except for niche applications (car networks, military systems, ...)

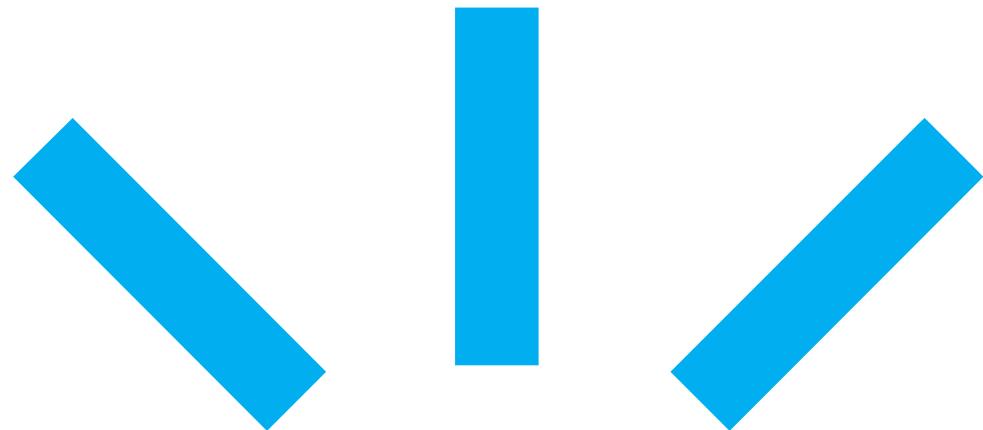


Internet as part of the core civil infrastructure (3)



- Much of the improvement in civil infrastructure needs networks
- information networks complement other networks
 - Transportation
 - Energy
- Example: smart grid
 - Cost optimization and energy demand equalization
 - Plug-in hybrid car is notified when it should charge
 - Dishwasher, water heater run after Midnight
 - Utility requests load reduction “Please reduce load by 1 MW”
 - Information exchange
 - “Dear fridge, how many kWh’s have you used?”

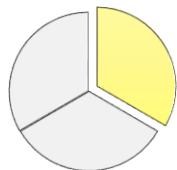




Internet applications



Evolution of the Internet applications

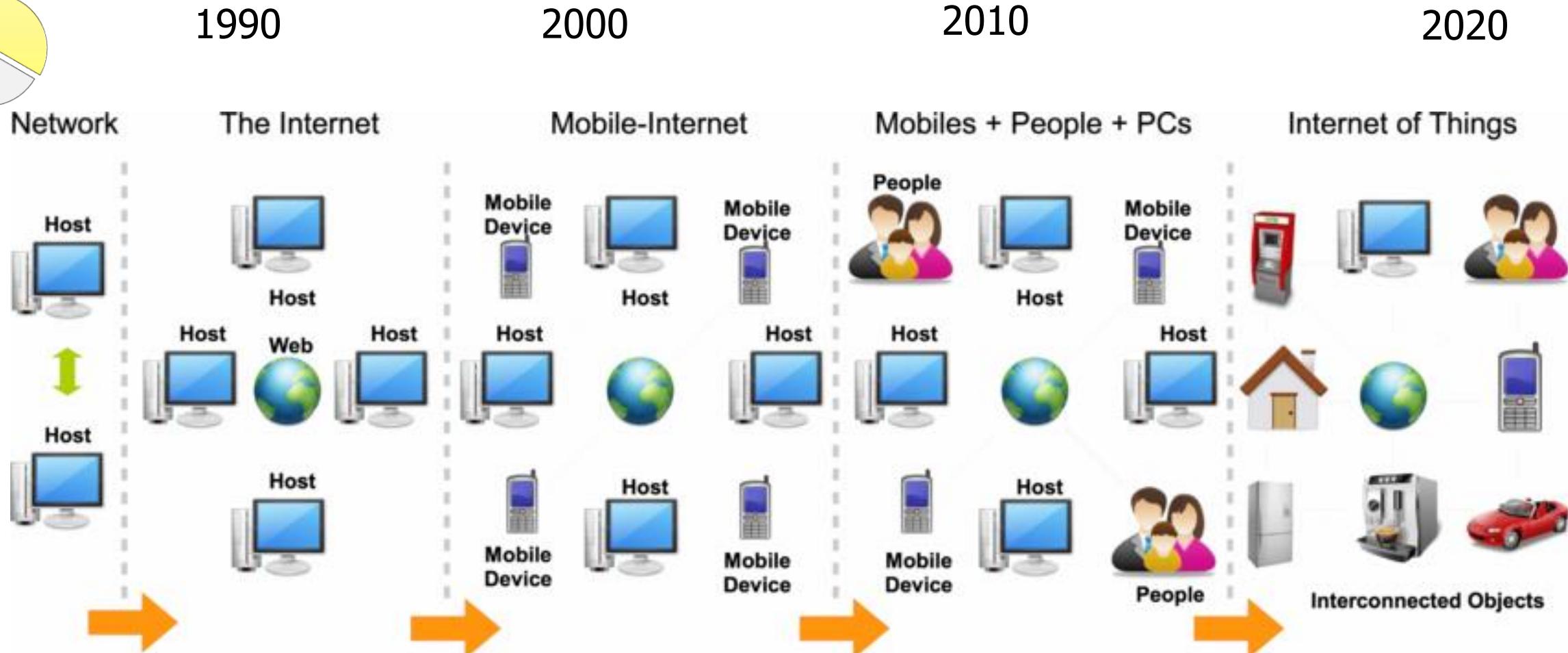


1990

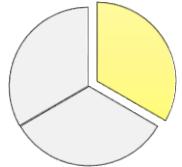
2000

2010

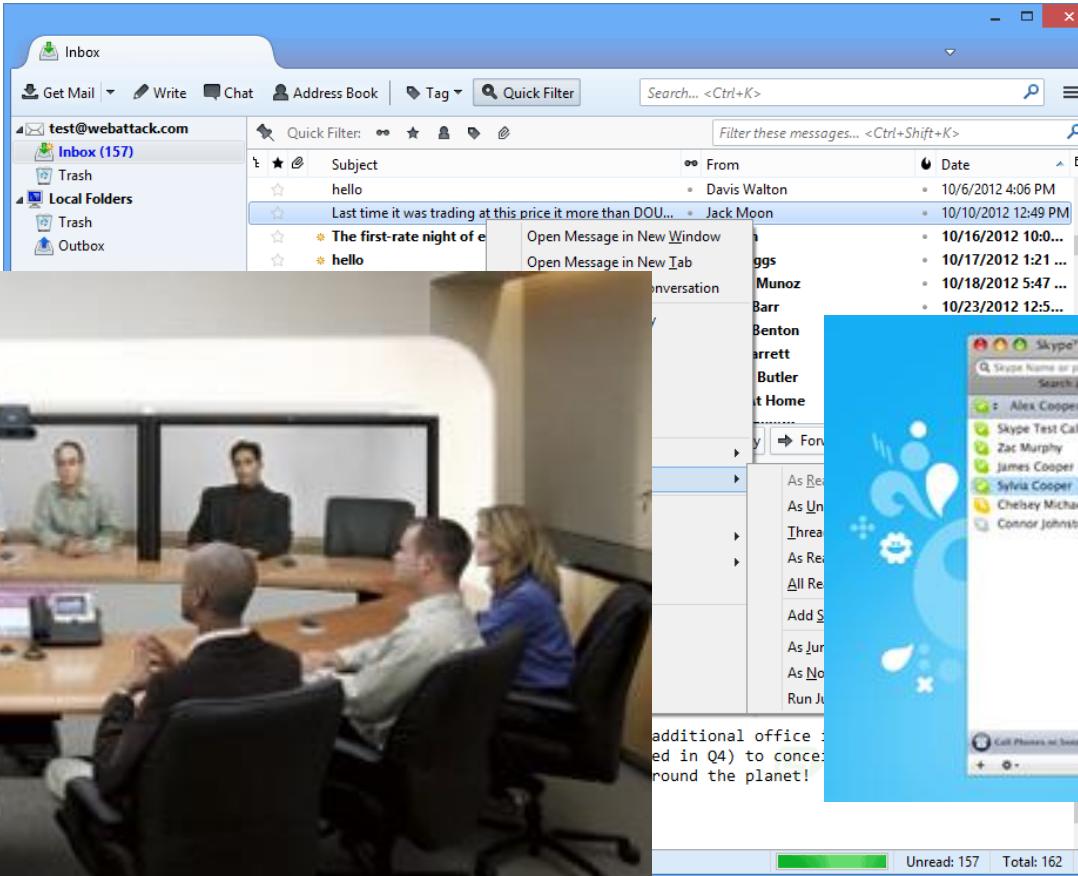
2020

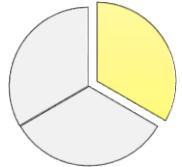


https://www.researchgate.net/publication/271585522_A_Survey_on_Internet_of_Things_From_Industrial_Market_Perspective



Applications: Communication (email, IM, VoIP, video)

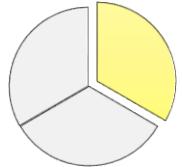




Applications: Information browsing

The image displays two examples of information browsing applications. On the left, a web browser window shows the University of Oulu's website (www.oulu.fi/university/) with three students sitting together. On the right, Google Earth shows an aerial view of a city street with buildings labeled 'Oulun tuomiokirkko' and 'City or Town Hall Uleåborgs stadshus'.

WWW (web) was originally an information browsing system



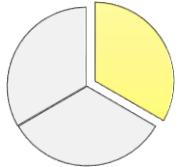
Applications: Information sharing & virtual communities (“social media”)

This composite screenshot illustrates several key components of social media and information sharing:

- Facebook Interface:** Shows a user's news feed with posts from friends like Josephine Williams, Tom Russo, Betty Chen, Dennis Han, and Cynthia Lopez. It includes sections for "What's on your mind, Josephine?", "Photo/Videos", "Tag Friends", and "Feeling/Activity".
- Instagram Profile:** Displays a profile for "dark_emeralds" with 1,242 followers and 398 following. It shows posts related to "Global citizen", "Red Table Talk Group", and "Best Hidden Hiking Trails".
- Instagram Grid:** Shows a grid of posts from users like samanthapoet, detch, gregmarr, jeffreygerson, drellew, and ericafahr.
- Instagram Story:** A vertical strip showing a series of images related to flowers and arrangements.
- Wikipedia Sidebar:** A sidebar for the Wikipedia page on Rubik's Cube, providing links to featured articles, news, and recent changes.

This composite screenshot highlights the integration of different digital communication and learning environments:

- YouTube Home Screen:** Shows a search bar for "Blues rock music" and a list of recommended videos including "TOP SONGS 2021" and "MOODLE Part 1 Flipped Classroom course".
- YouTube Video Player:** A video titled "Build a Flipped Classroom Course in Moodle-Step by step pt1" by Russell Stannard, showing a man in a suit.
- Wikipedia Main Page:** The homepage of Wikipedia with a welcome message, featured articles (e.g., "Group (mathematics)"), and news sections about political figures like Yoon Suk-yeol and Shane Warne.
- Moodle Course Page:** A screenshot of a Moodle course titled "MOODLE Part 1 Flipped Classroom course" with a thumbnail of the instructor.
- YouTube Video Preview:** A preview of a video titled "Best Jazz Blues Music | Greatest Blues Rock Songs Of All Time |..." with a thumbnail of a woman.

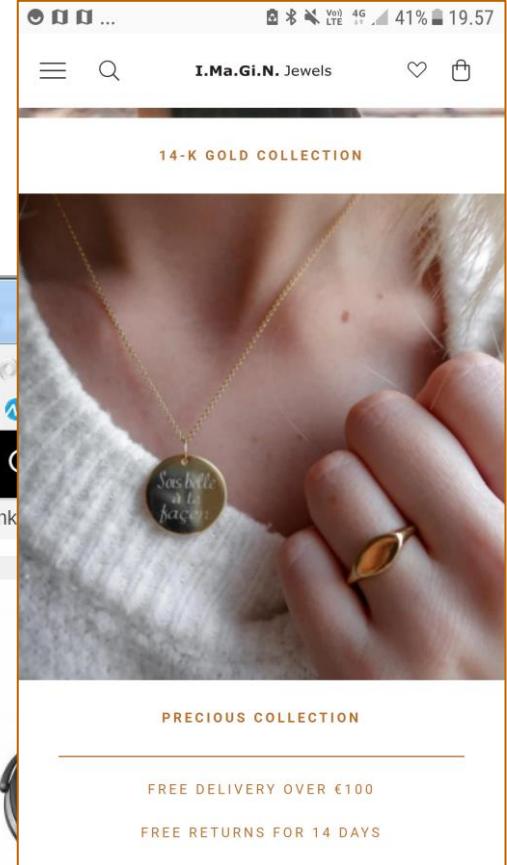


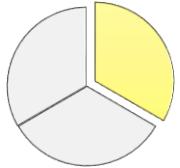
Applications: e-commerce

The screenshot shows a web browser window with the eBay homepage. The address bar displays the URL <https://www.ebay.com/rpp/moda-en-womens>. The main content area shows a search bar with the placeholder "Search for anything" and a category dropdown set to "Shop by category". Below the search bar, the breadcrumb navigation shows "eBay > Fashion > Women's". The main heading is "Women's Clothing". The page features a grid of product thumbnails, with one item clearly visible: a "fire HD8 with Alexa" tablet.



The screenshot shows a web browser window with the Verkkokauppa.com website. The address bar displays the URL <https://www.verkkokauppa.com/tod...>. The main content area displays a product listing for the "Philips 55PUS7502 55" Smart Android 4K Ultra HD LED television. The product image shows a sleek black TV with a vibrant screen. The listing includes a price of 799,90 €, a 4.5-star rating from 95 reviews, and a brief description mentioning "Core i5-7200U, 8 Gt, 256 Gt SSD". Below the main listing, there are other product cards for a Lenovo laptop and a Sennheiser HD 4.50 BTNC headphones.

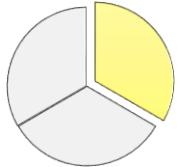




Applications: Gaming

The image displays three separate windows from different video games and applications:

- WPT Online Poker Lobby - 8:14am**: A screenshot of the World Poker Tour online lobby. It shows a list of active poker tables and tournaments, including Sit and Go, Private Tournaments, WPT Satellites, and Freerolls. The interface includes player names like Zambezi, Magdelena, and Donets, and their respective stakes. Below the lobby is a screenshot of a Warcraft III game showing two characters, Holy Light and Doomsyth, in a stone-paved area.
- Internet Backgammon**: A screenshot of a backgammon application. It shows a board with pieces for Brown and White. The score is 167 for Brown and 0 for White. The interface includes buttons for "Roll", "Double", and "Resign". A chat window on the right shows messages between Brown and White.
- World of Warcraft Interface**: A screenshot of the Warcraft III user interface. It shows the character Holy Light in the center, with health and mana bars. The minimap at the bottom left shows the map of The Eventide. The bottom right corner displays a gear score list for the event.



Applications: Broadcasting & multimedia on-demand

The screenshot shows the Yle Areena homepage with several sections:

- Suosittelemme**: Includes a thumbnail for "Vuoroin vieräissä" and a video player for "Perjantai".
- Uusi päivä**: Includes a thumbnail for "Uusi päivä" and a video player for "Yle Uutiset Häme".
- Katsomiesi perusteella**: Includes a thumbnail for "Katsomiesi perusteella".
- NRJ CLIPS**: A red banner featuring "NRJ CLIPS" and "donkeyboy TRIGGERFINGER".
- NRJ VIIHDEUUTISET**: A video player showing a person's face.

At the bottom are social sharing icons for Facebook, Twitter, and Google+.

The Netflix interface displays:

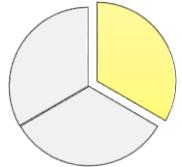
- New Releases**: Shows thumbnails for "sleepwalk with me", "how I met your mother", "JIRO DREAMS OF SUSHI", "DOCTOR WHO", "JEFF AT HOME", "GHOST PROTOCOL", "THE LORAX", "SMART LAUGHS TED TALKS", and "TopGear".
- Available Offline**: Shows a list of movies and TV shows including "Best Friend", "Pumpkin Blood", and "Burn".
- Magic**: A currently playing track by Coldplay.

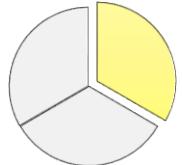
The screen shows a user profile for "RICHARD TOLMAN CARRION" with "9 FOLLOWERS". It includes a "SHUFFLE PLAY" button and a list of tracks:

- Best Friend - Foster The People - Supermodel
- Pumpkin Blood - NONONO - Endless Love (Original Motion Picture Sou...
- Burn - Ellie Goulding - Halcyon Days
- Magic - Coldplay

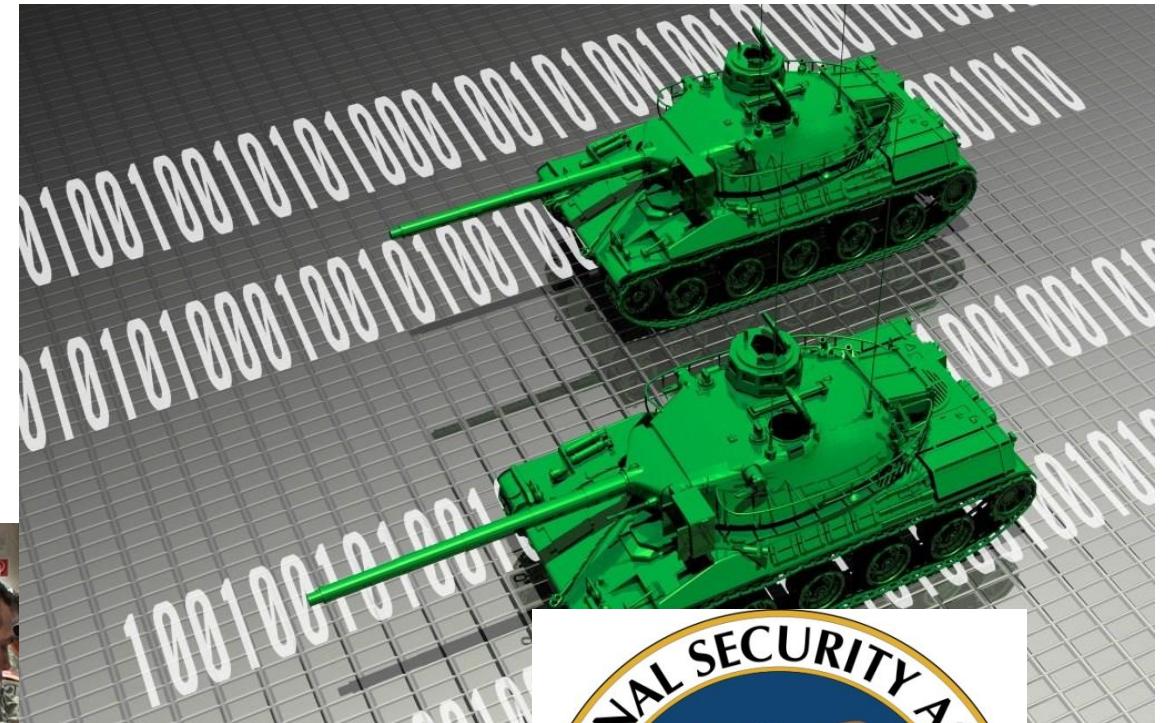


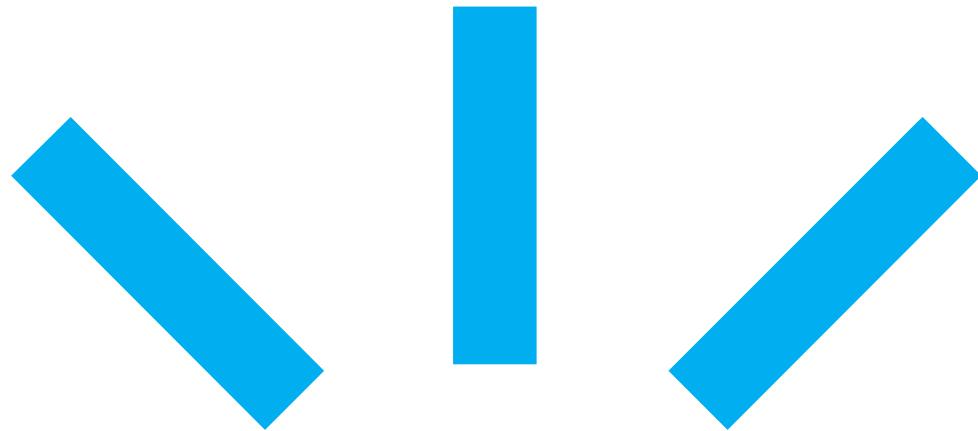
Applications: 3D Internet (VR & AR)





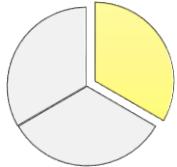
Applications: Cyber warfare



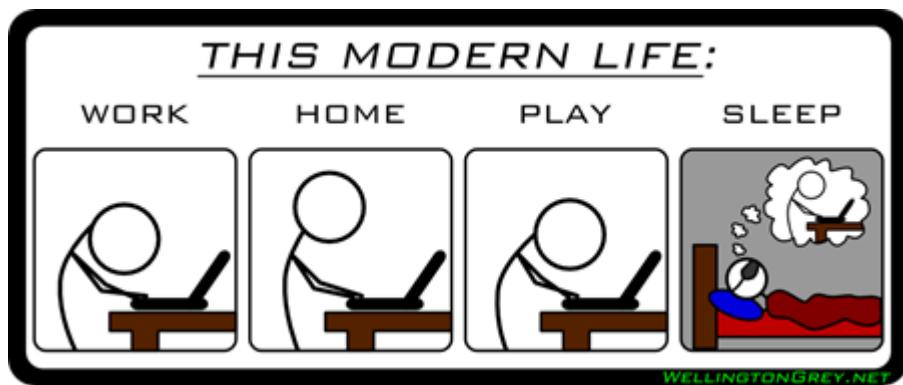


Societal effects of the Internet

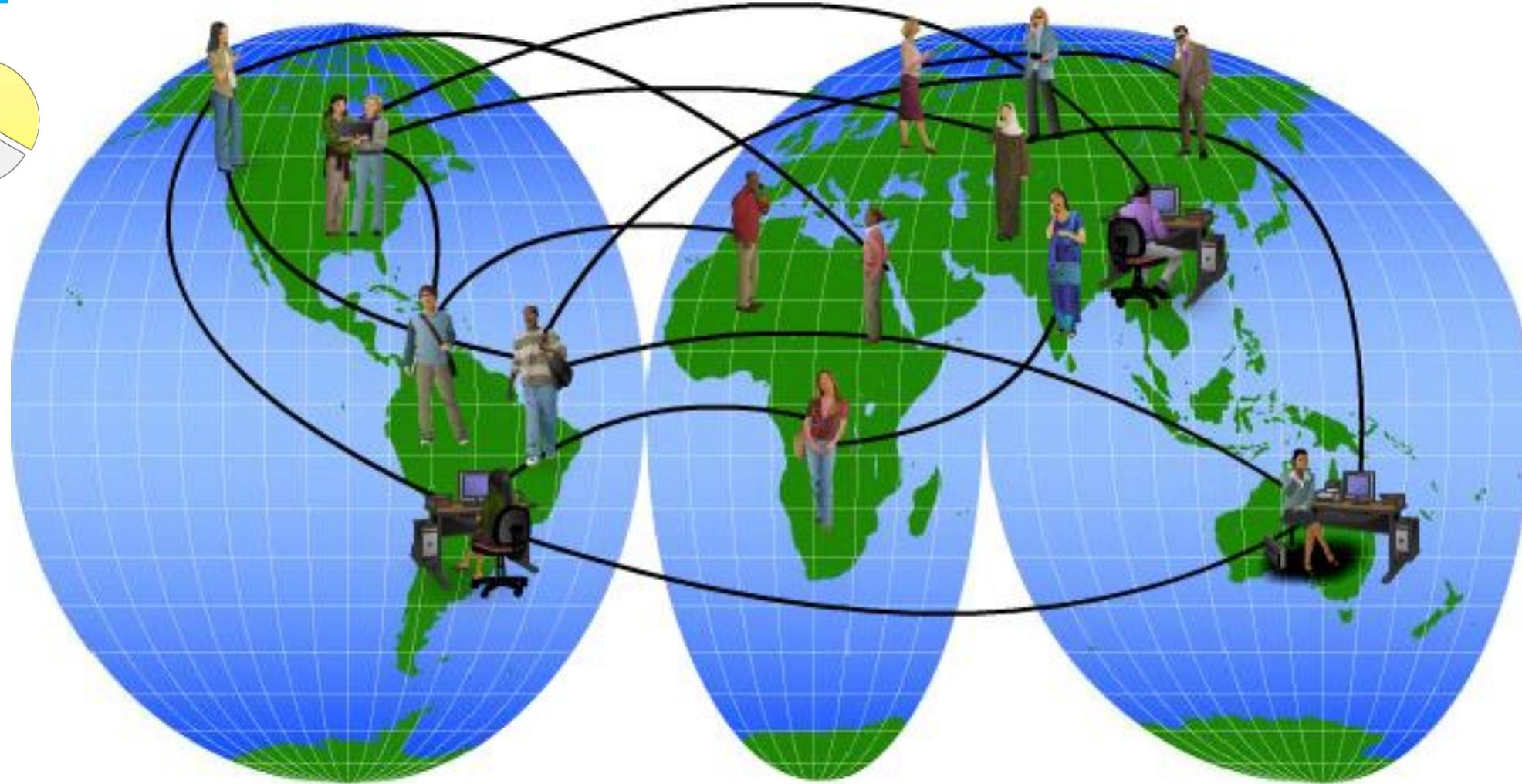
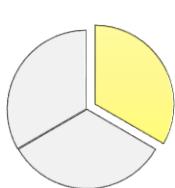
Internet has created a network-centric world (1)



- “**Everything is connected**”
 - Civil infrastructure
 - Economy
 - Services
 - Social life
 - ...



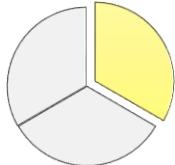
Internet has created a network-centric world (2)



In particular, social networking (social media) services built atop the web have played a crucial role in this development



Internet has created a network-centric world: Opportunities



Anyone can make it big!



14 March 2022

Ukraine USA Russia Syria Select regions

News Live Api About Tweet us

Updated on 14/03/2022 10:42:09

an hour ago Source Kharkiv, Kharkivs'ka Oblast'(09:50). Red Alert: aerial threat. Sirens sounding. Take cover now!

Comments Tell friends

an hour ago Source At least 2 killed after missile strike on Kramatorsk

Comments Tell friends

an hour ago Source Energotam: no transport connection between Enerhorod and Zaporizhie as bridge in Kamyanske destroyed

Comments Tell friends

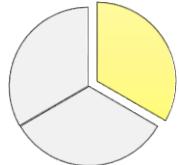
Get live map App Store Google Play

Power of crowdsourcing!



Oppressed have voice!

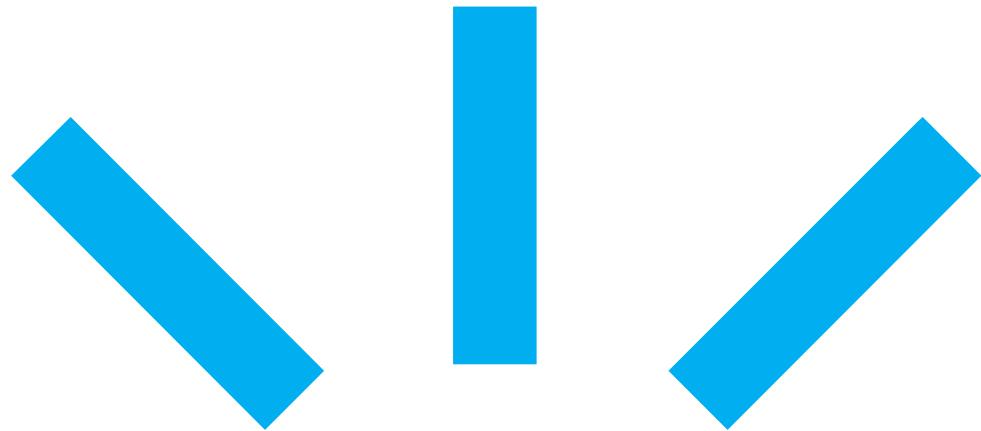
Internet has created a network-centric world: Threats



- Technology dependency
- Privacy issues
- Cyber-crime
- Cyber warfare

...

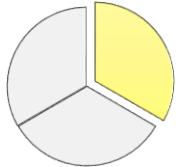




Internet standardization



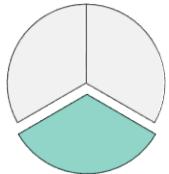
Internet standardization (1)



- Standards are needed to provide guidelines for interoperable software, hardware, data formats and communication protocols for the Internet
- Standards are essential in creating and maintaining an open and competitive market for manufacturers, vendors, government agencies, and service providers
- Data communication standards fall into two categories:
 - De facto: standards that have not been approved by an organized body but have been adopted as standards through widespread use are de facto standards
 - De jure: standards that have been legislated by an officially recognized body are de jure standards



Internet standardization (2)



- **ISOC (Internet Society)**
 - ↳ IAB (Internet Architecture Board)
 - ↳ IETF (Internet Engineering Task Force)
 - Internet Drafts
 - RFC (Request For Comments)
 - ↳ IRTF (Internet Research Task Force)
 - **W3C (World Wide Web Consortium)**
 - Web standardization in cooperation with IETF

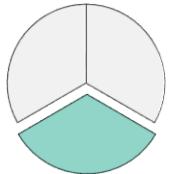


I E T F®





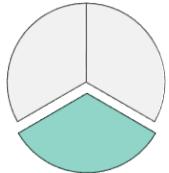
Internet standardization (3)



- **IEEE (Institute for Electrical and Electronic Engineers)**
 - E.g. IEEE 802.x standard family (Ethernet, WLAN, WiMAX)
- **ISO (International Organization for Standardization)**
- **ITU (International Telecommunication Union)**
 - E.g. xDSL
- **ETSI (European Telecommunications Standards Institute)**
 - E.g. GSM
- **EIA (Electronic Industries Association)**
 - E.g. RS-232-C



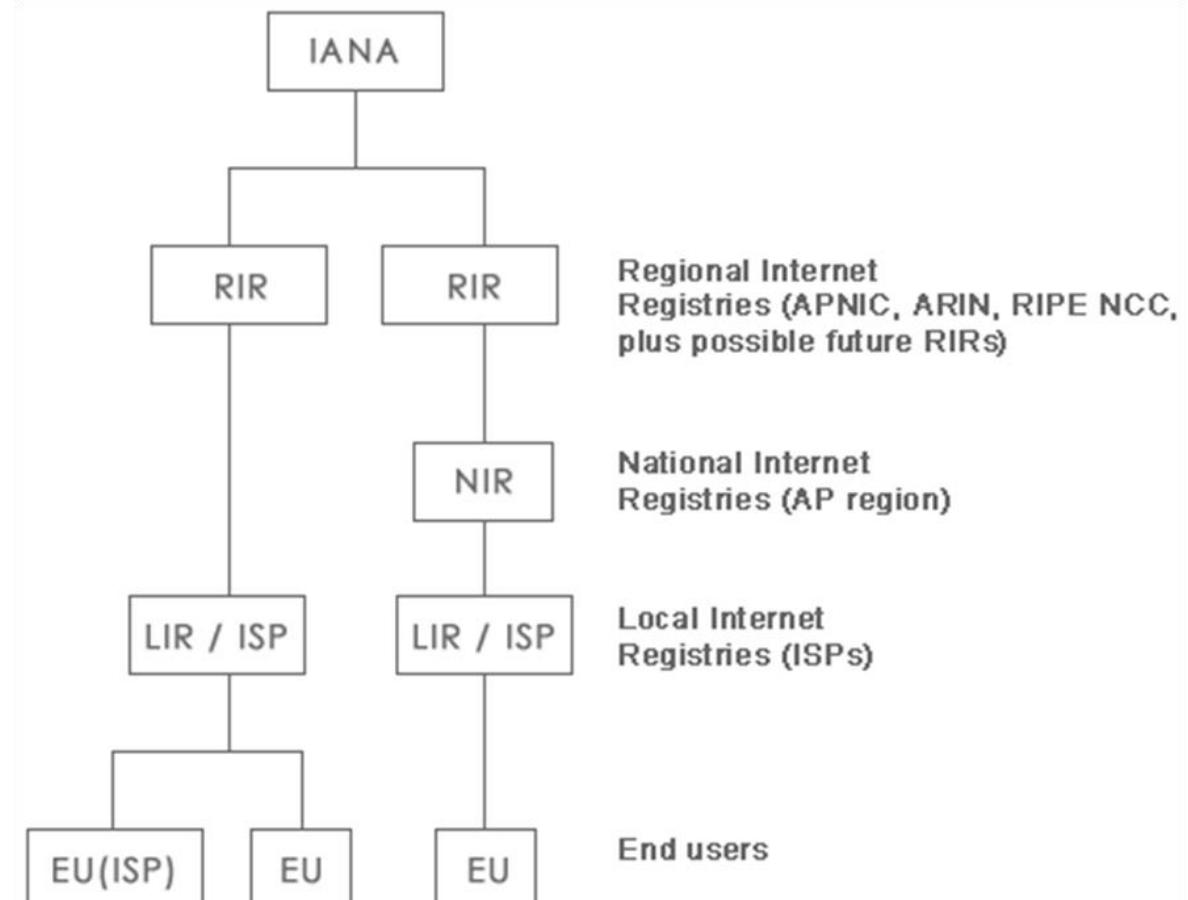
Internet administration



- IANA (Internet Assigned Numbers Authority) operated by ICANN (Internet Corporation for Assigned Names and Numbers)
 - Global IP address allocation
 - DNS root zone management
 - Other Internet protocol assignments

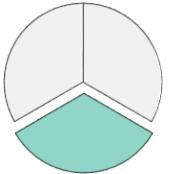


also LACNIC, AfriNIC

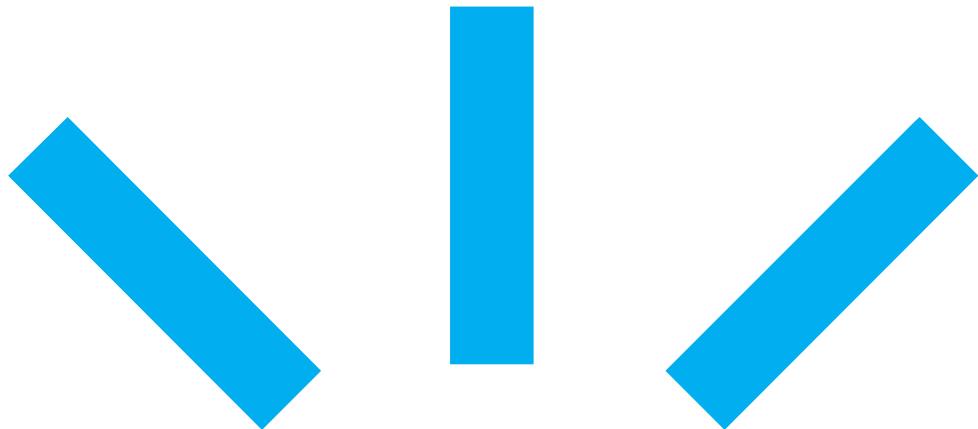




Internet legislation and regulation



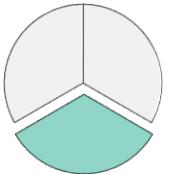
- **National legislation and regulation in Finland**
 - Government sets acts and decrees
 - Communications Market Act
 - Act on the Provision of Information Society Services
 - Act on the Protection of Privacy in Electronic Communications
 - Radio act
 - Etc.
 - FICORA (Finnish Communications Regulatory Authority) supervises enforcement of legislation and regulation
 - Issues supplementary guidelines, recommendations and regulations
- **Global radio regulation: WRC (World Radiocommunication Conferences) by ITU-R**
 - Europe: ETSI
 - USA: FCC



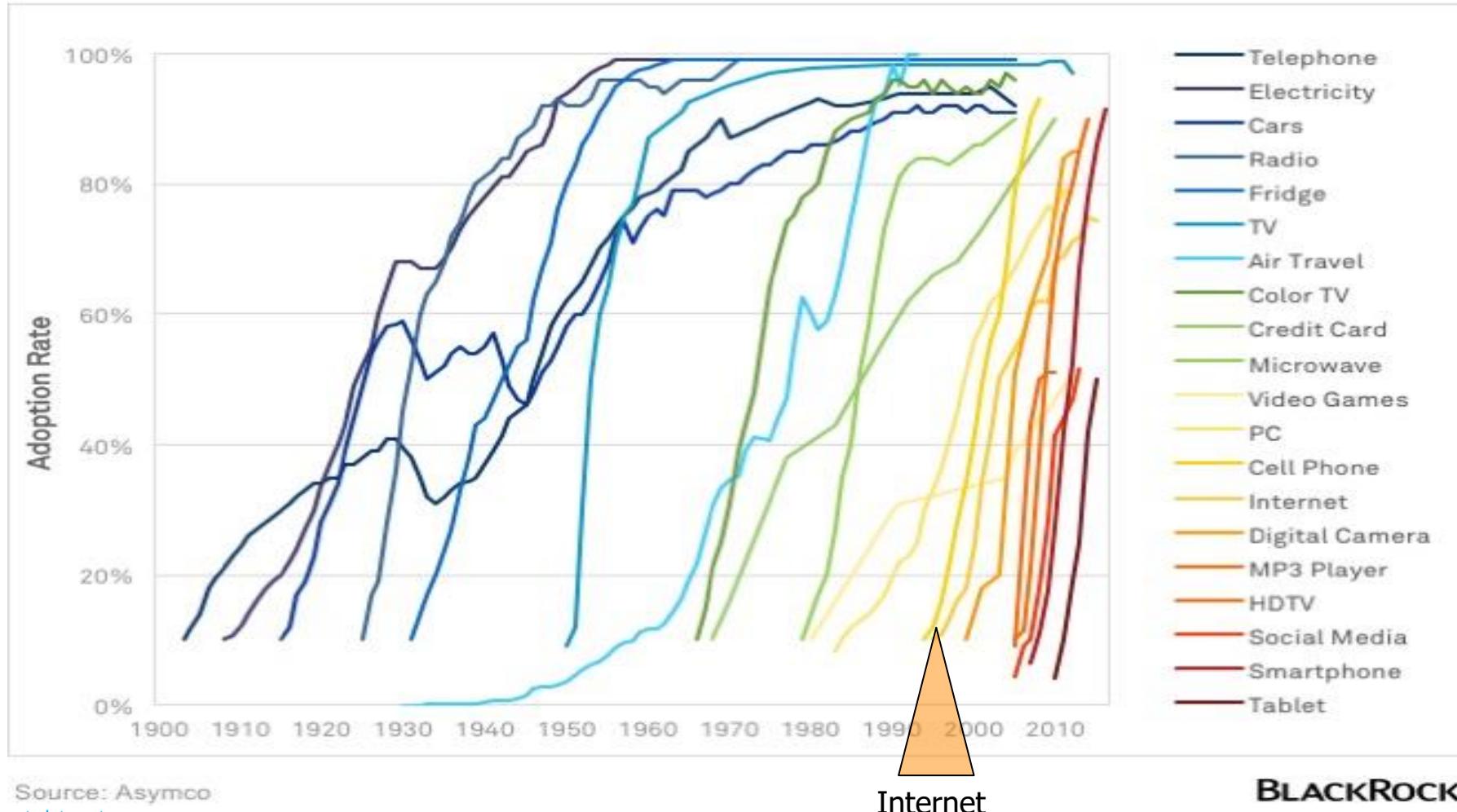
Growth of the global network traffic

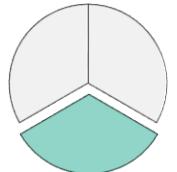


Rapid growth of the Internet (1)



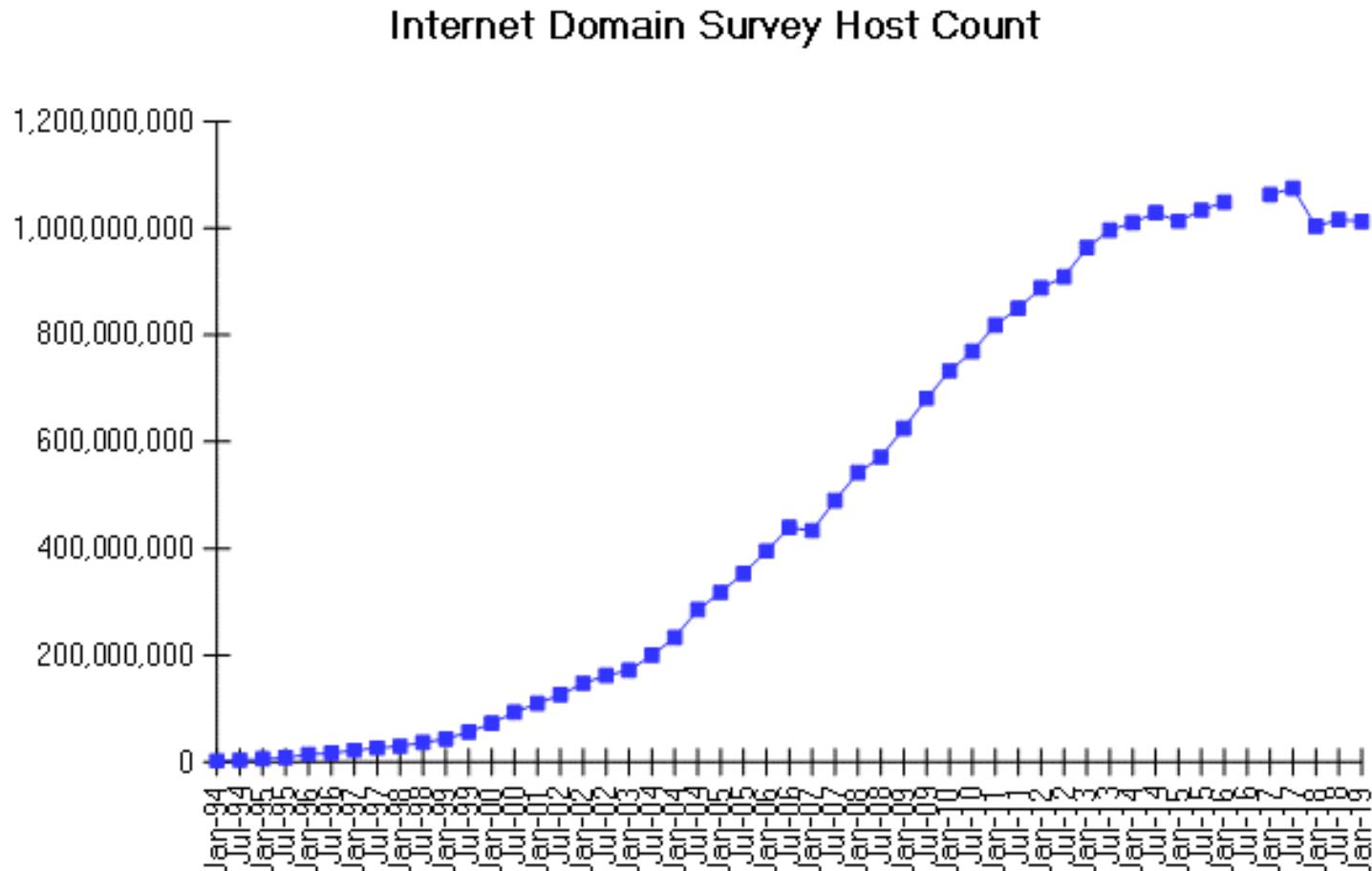
Internet is one of the fastest growing technologies ever introduced.





Rapid growth of the Internet (2)

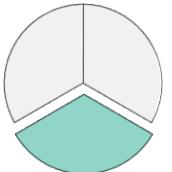
- Number of hosts advertised in DNS (IPv4)
 - Source: ISC: <https://www.isc.org/network/survey/>



Time	Count
8/1981	213
10/1984	1,024
12/1987	28,174
7/1989	130,000
10/1992	1,136,000
7/1996	12,881,000
1/2001	109,574,429
7/2012	908,585,739
7/2013	996,230,757
1/2014	1,010,251,829
1/2015	1,012,706,608
1/2016	1,048,766,623
1/2017	1,062,660,523
1/2018	1,003,604,363

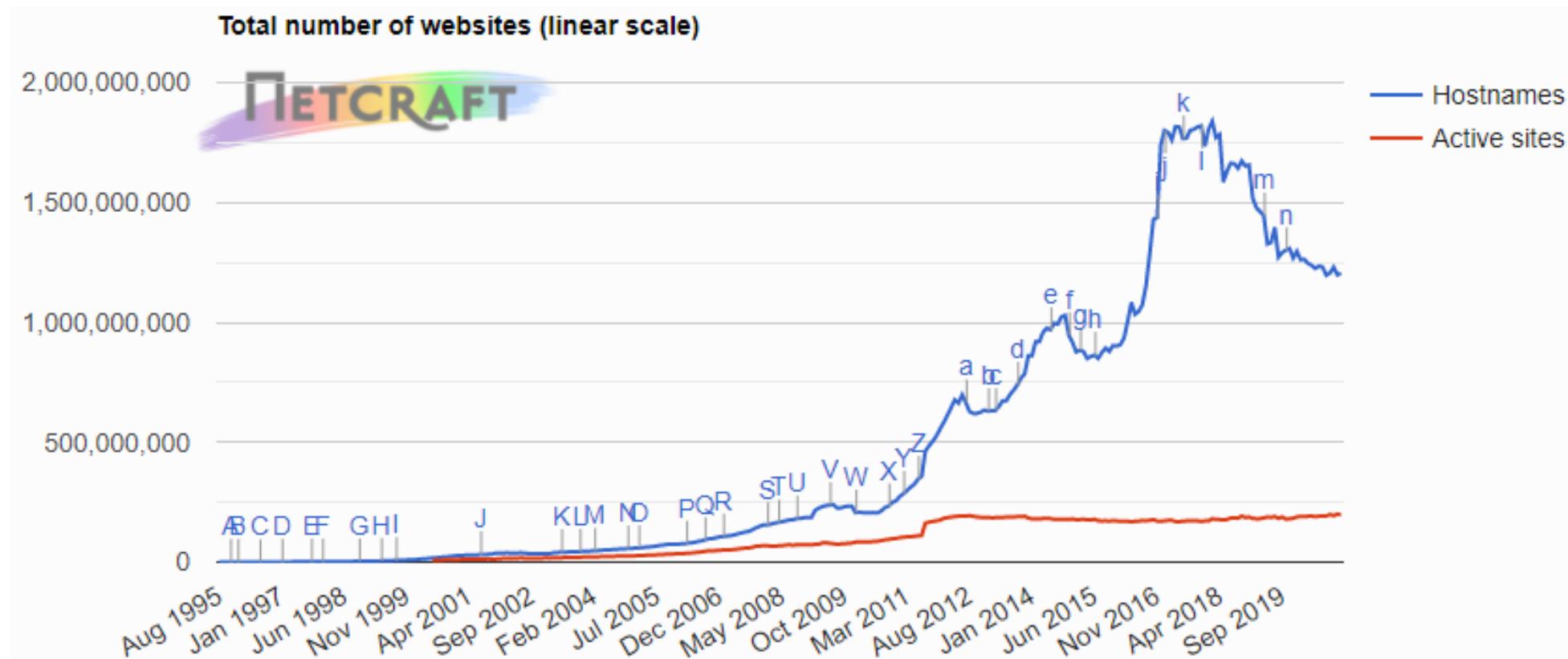


Rapid growth of the Internet (3)



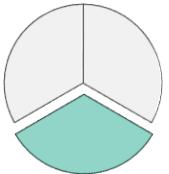
- Number of websites

- Source: Netcraft: <https://news.netcraft.com/archives/category/web-server-survey/>



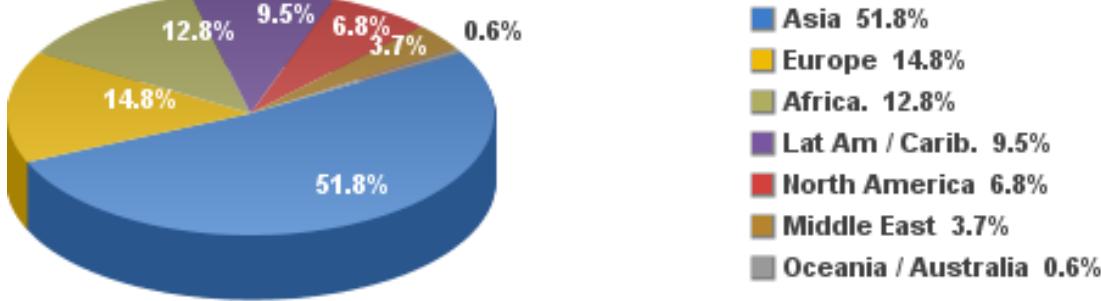


Global Internet penetration (1)



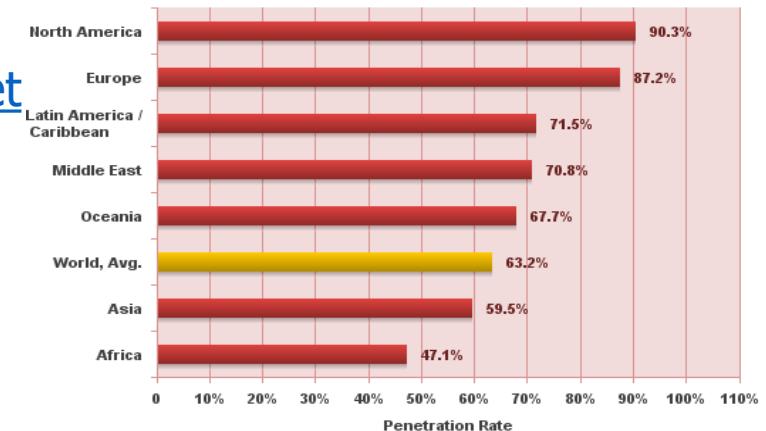
Sources: <http://www.internetworldstats.com/stats.htm>
<http://www.internetlivestats.com/internet-users/>
<https://www.oberlo.com/statistics/how-many-people-use-internet>

**Internet Users Distribution
in the World - 2020 Q3**



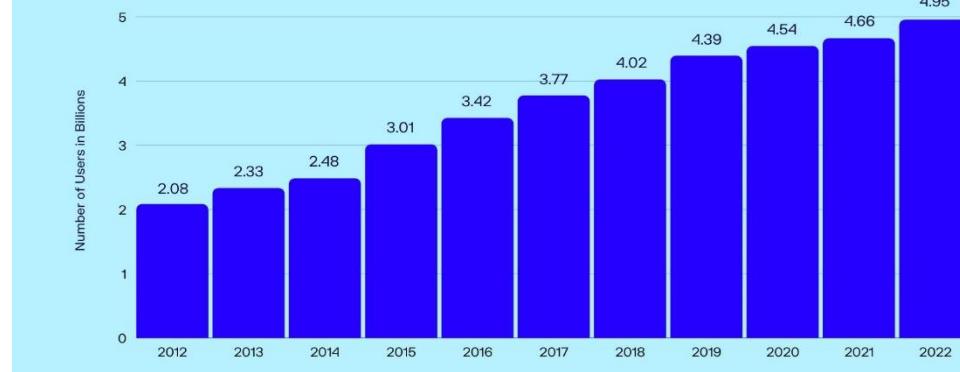
Source: Internet World Stats - www.internetworldstats.com/stats.htm
Basis: 4,929,926,187 Internet users in Sept 30, 2020
Copyright © 2020, Miniwatts Marketing Group

**Internet World Penetration Rates
by Geographic Regions - 2020 Q3**

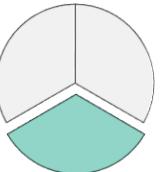
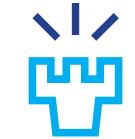


Source: Internet World Stats - www.internetworldstats.com/stats.htm
Penetration Rates are based on a world population of 7,796,615,710
and 4,929,926,187 estimated Internet users in October 27, 2020.
Copyright © 2020, Miniwatts Marketing Group

Number of Internet Users Worldwide (2012-2022)



OBERLO



Internet penetration in Finland and Europe (2017)

YEAR	Users	% Population	Facebook %	Source
2000	1,927,000	37.1		ITU
2006	3,286,000	62.3		ITU
2012	4,703,480	89.4	43.5	IWS
2021	5,225,678	94.0	65.0	IWS

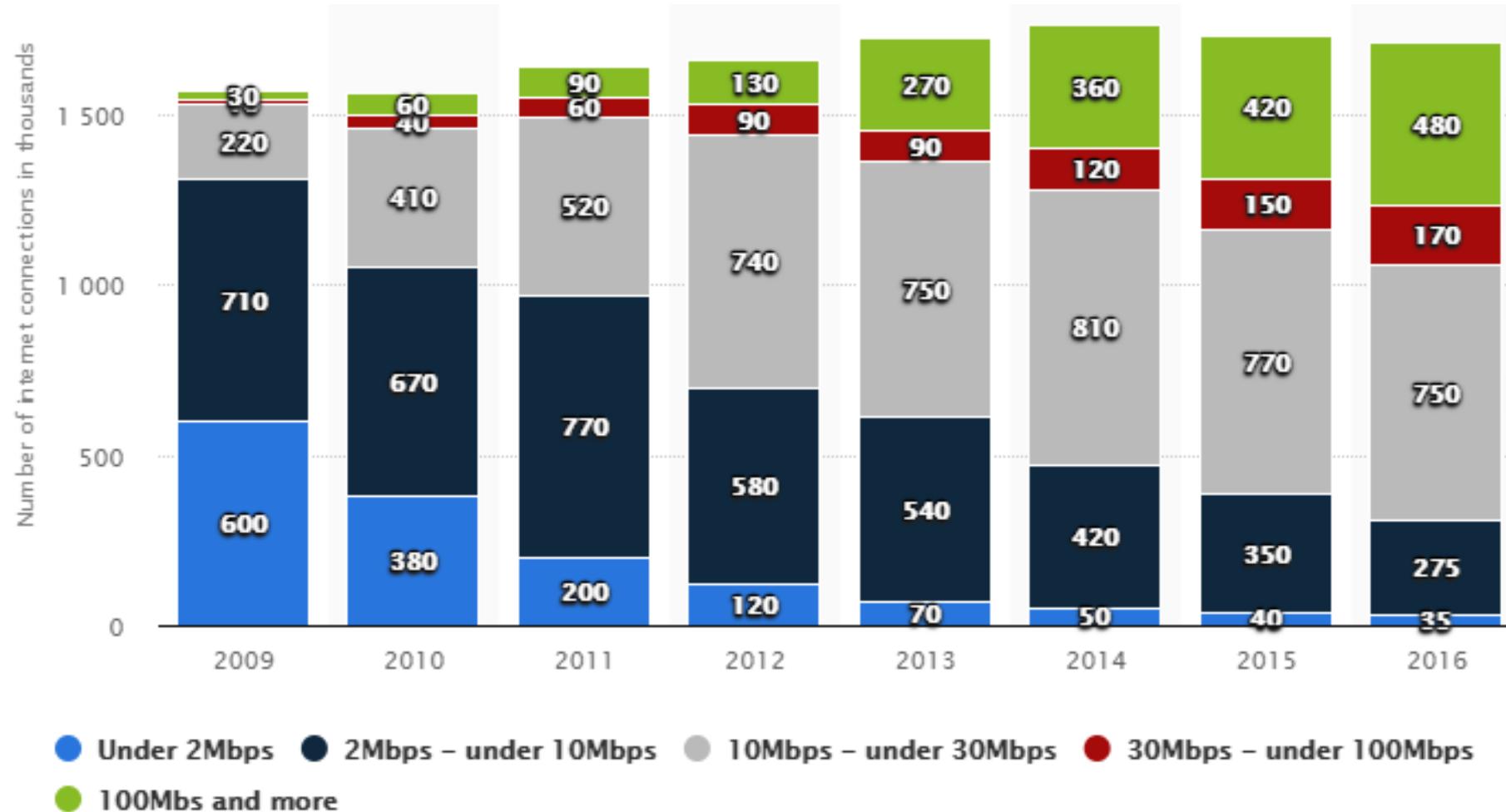
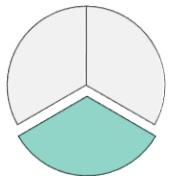
Source: <http://www.internetworldstats.com/>

- **For comparison, Internet penetration elsewhere in Europe (2021)**

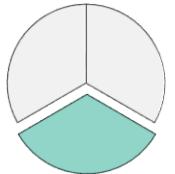
- Denmark 97.8 %
- Netherlands 95.6 %
- Luxembourg 97.8 %
- Sweden 96.4 %
- UK 94.9 %
- Germany 96.0 %
- Ukraine 93.4 %
- Europe average 87.7 % (51.8 % in 2008)



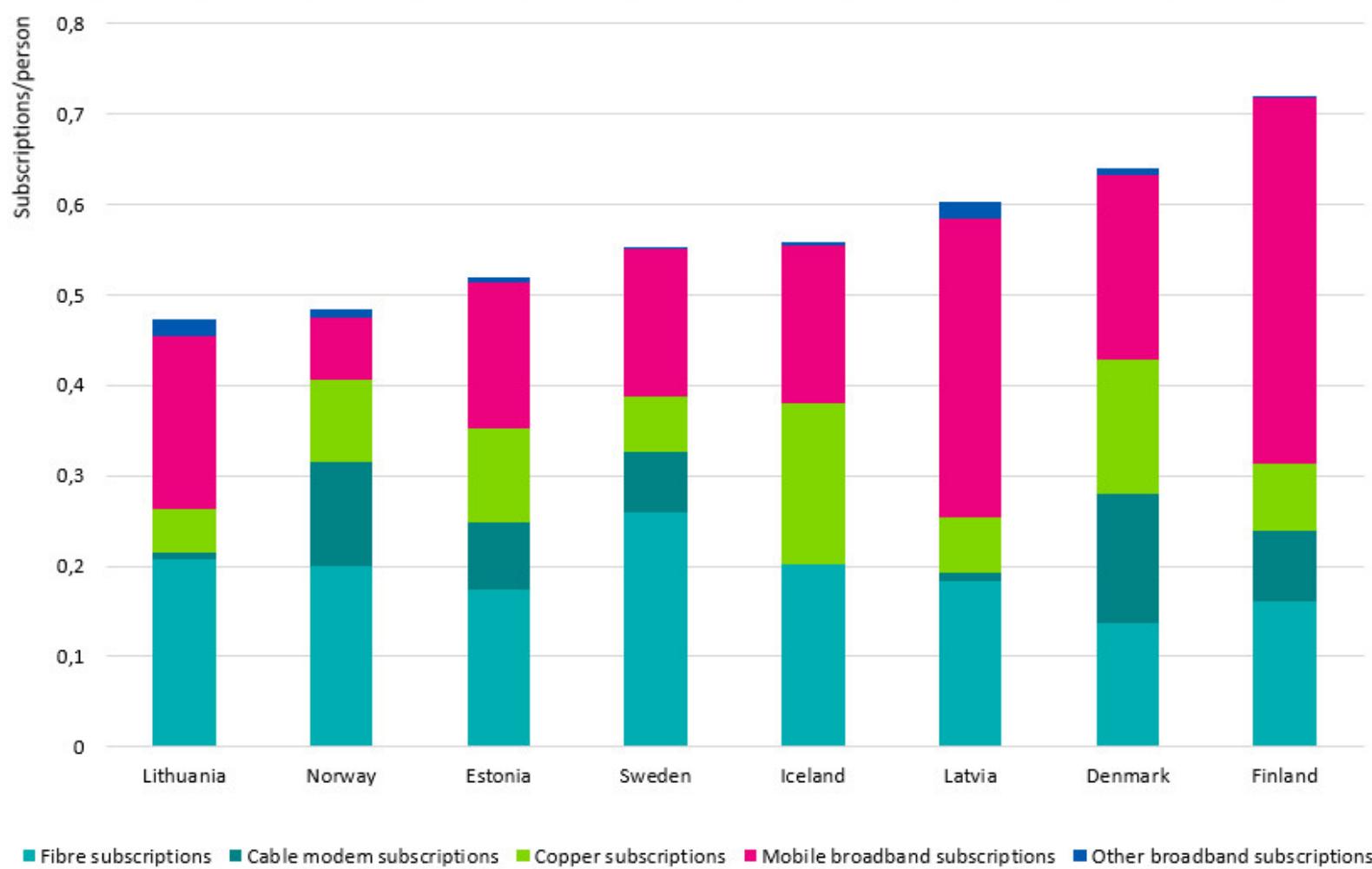
Internet household market in Finland



Source: Statista <https://www.statista.com/statistics/551196/number-of-fixed-internet-connections-in-finland-by-speed/>



Mobile vs Fixed broadband subscriptions – North Europe



Source: Traficom <https://www.traficom.fi/en/news/finland-nordic-mobile-services-leader-fixed-network-falling-behind>



Key points to remember

1. Understanding the Internet's role as a part of the core civil infrastructure
2. Know the basic concepts of networking and main application areas of the Internet
3. Be aware of the history and global importance of the Internet
4. Understand the importance of the Internet standardization



Thank you!