

Reti di Elaboratori

Corso di Laurea in Informatica
Università degli Studi di Roma “La Sapienza”
Canale A-L Prof.ssa Chiara Petrioli

Parte di queste slide sono state prese dal materiale associato al libro
Computer Networking: A Top Down Approach , 5th edition.
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Thanks also to Antonio Capone, Politecnico di Milano, Giuseppe Bianchi and
Francesco LoPresti, Un. di Roma Tor Vergata

Internet History

1961-1972: Early packet-switching principles

- ❑ 1961: Kleinrock - queueing theory shows effectiveness of packet-switching (MIT)
- ❑ 1964: Baran - packet-switching in military nets
- ❑ Davies at the National Physical Laboratory, UK was also developing ideas on packet switching
- ❑ 1967: ARPAnet conceived by Advanced Research Projects Agency
- ❑ 1969: first ARPAnet node operational

Packet switches dubbed
Interface Message
Processors (IMP)

- ❑ 1972:
 - ARPAnet demonstrated publicly by Robert Kahn
 - NCP (Network Control Protocol) first host-host protocol
 - first e-mail program
 - ARPAnet has 15 nodes



- Leonard Kleinrock with first IMP

Kleinrock's students:
Vinton Cerf
John Postel...

Network measurement
center UCLA

Internet History

1972-1980: Internetworking, new and proprietary nets

- ❑ 1970: ALOHAnet satellite network in Hawaii (Abramson)
- ❑ 1973: Metcalfe's PhD thesis proposes Ethernet
- ❑ 1974: Cerf and Kahn - architecture for interconnecting networks
- ❑ late70's: proprietary architectures, e.g. IBM SNA (Schwartz)
- ❑ late 70's: switching fixed length packets (ATM precursor)
- ❑ 1979: ARPAnet has 200 nodes

Cerf and Kahn's internetworking principles:

- minimalism, autonomy - no internal changes required to interconnect networks
- best effort service model
- stateless routers
- decentralized control

define today's Internet architecture

Internet History

1980-1990: new protocols, a proliferation of networks

- ❑ 1983: deployment of TCP/IP
- ❑ 1982: SMTP e-mail protocol defined
- ❑ 1983: DNS defined for name-to-IP-address translation
- ❑ 1985: FTP protocol defined
- ❑ 1988: TCP congestion control
- ❑ new national networks: Csnet, BITnet, NSFnet, Minitel
- ❑ 100,000 hosts connected to confederation of networks

Internet History

1990, 2000's: commercialization, the Web, new apps

- ❑ Early 1990's: ARPAnet decommissioned
- ❑ 1991: NSF lifts restrictions on commercial use of NSFnet (decommissioned, 1995)
- ❑ early 1990s: Web
 - hypertext [Bush 1945, Nelson 1960's]
 - HTML, HTTP: Berners-Lee
 - 1994: Mosaic, later Netscape
 - late 1990's: commercialization of the Web

Late 1990's - 2000's:

- ❑ more killer apps: instant messaging, peer2peer file sharing (e.g., Napster)
- ❑ network security to forefront
- ❑ est. 50 million host, 100 million+ users
- ❑ backbone links running at Gbps

Significant late developments: P2P, broadband access, wireless Internet

Recent trends (2000-2016)

- ❑ Intense evolution
- ❑ Aggressive deployment of broadband Internet access to homes
 - enabler of distribution of user generated videos, on demand streaming videos, multi-person video conferencing services
- ❑ Ubiquitous deployment of high speed wireless access
 - number of wireless devices connected to Internet > wired devices from 2011
- ❑ Development of social networks
- ❑ Companies such as Google and Microsoft have developed extensive private networks
- ❑ Internet commerce companies and institutions run their applications on the cloud

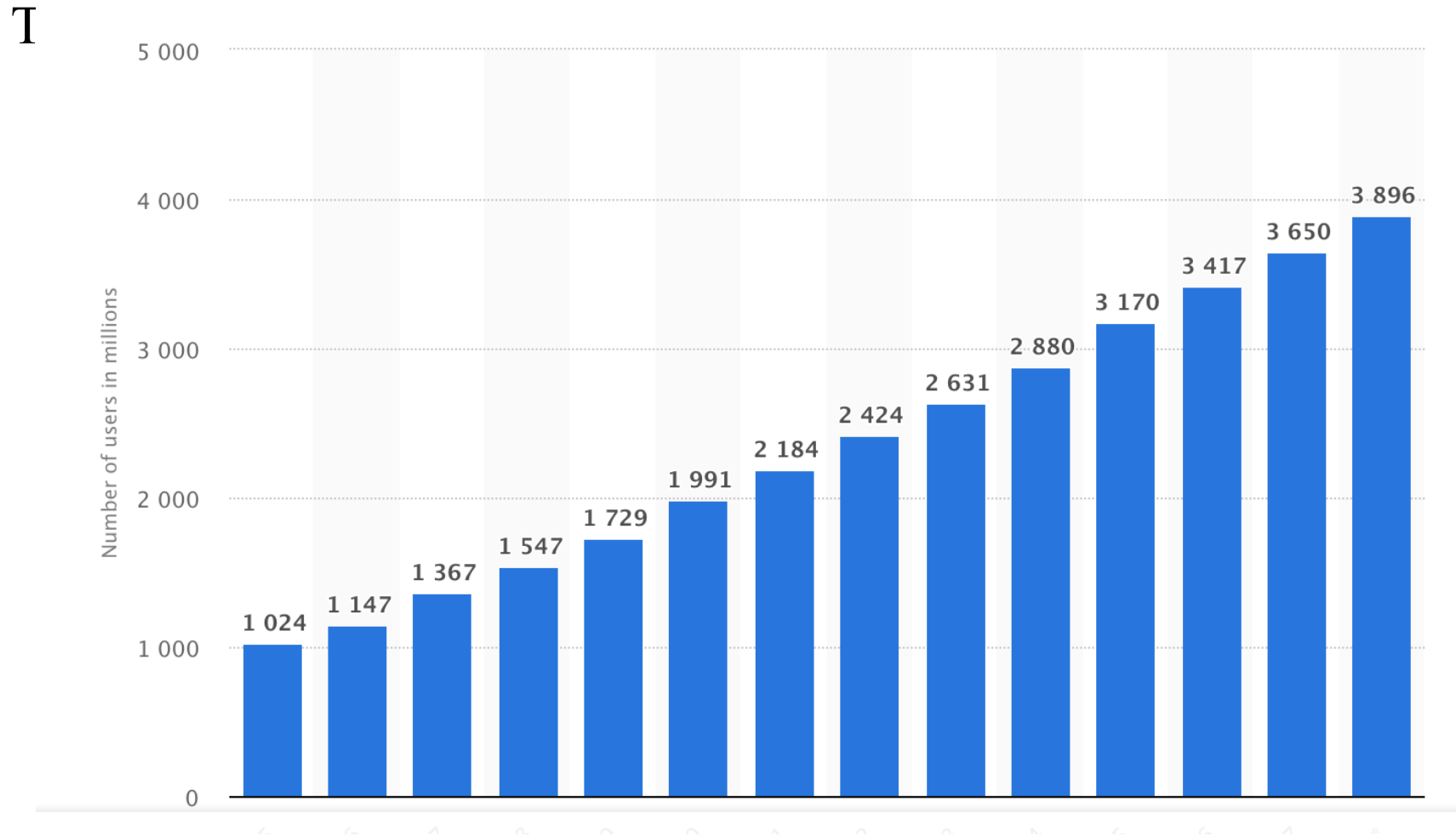
A short digression:

where is Internet standardized?

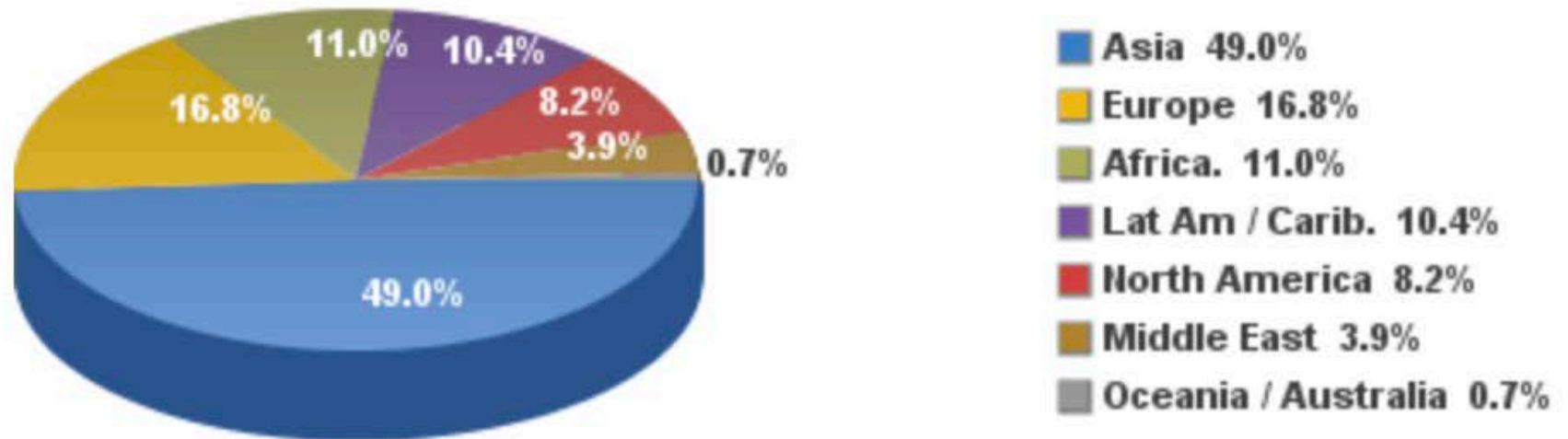
Who controls the Internet?

- ❑ No single administrative organization
- ❑ IETF - Internet Engineering Task Force (since 86)
 - Developement of current protocols and specifications for standardization.
 - International community, open to everyone
 - Most of the work via mailing lists
 - Meets three times/year
 - organized in areas and working groups
 - Dynamically activated & deactivated on need
 - group coordination: IESG (Internet Engineering Steering Group). Area directors are members of the IESG. Responsible for the actions associated with entry into and movement along the Internet "standards track," including final approval of specifications as Internet Standards.
- ❑ Industry also preemptively determine standards

To conclude general introduction: Why is Internet So Important-- Some Statistics



Internet Users in the World by Regions - June 30, 2018

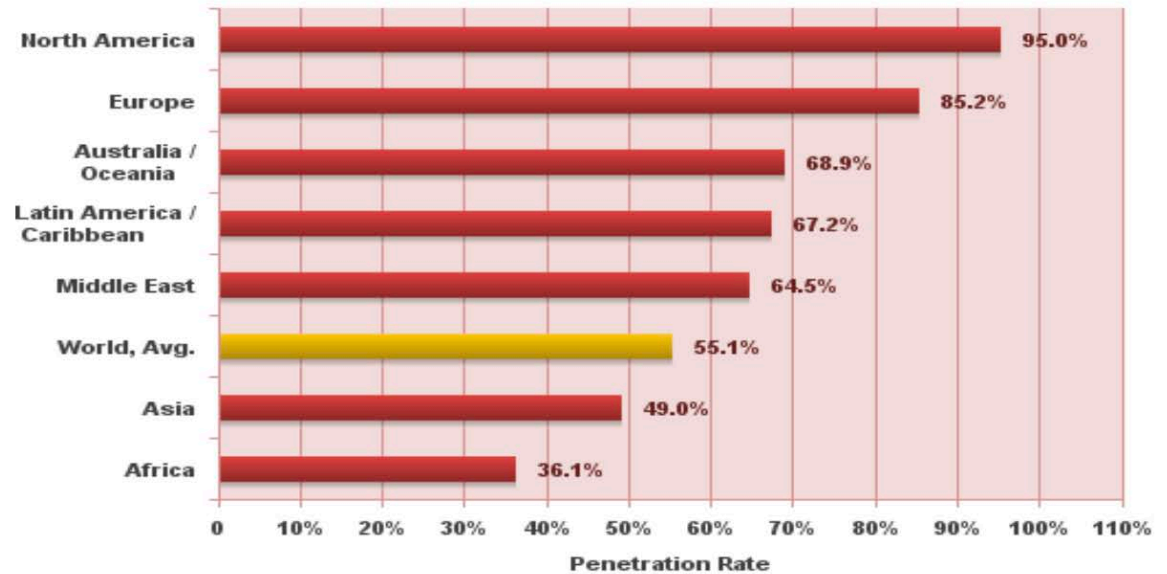


Source: Internet World Stats - www.internetworldstats.com/stats.htm

Basis: 4,208,571,287 Internet users in June 30, 2018

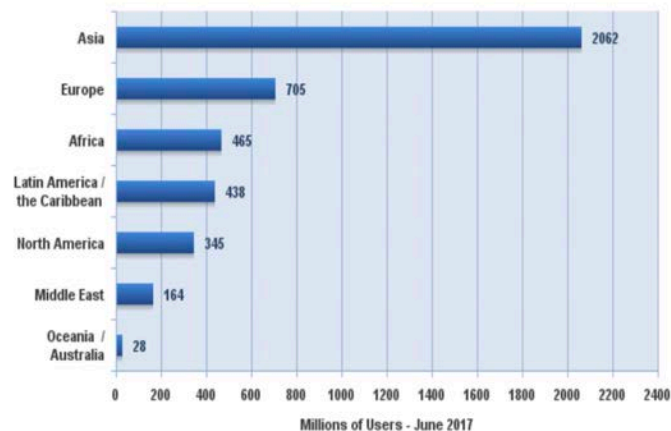
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Internet World Penetration Rates by Geographic Regions - June 30, 2018



Internet World Stats - www.internetworldstats.com/stats.htm
 Penetration Rates are based on a world population of 7,634,758,428
 08,571,287 estimated Internet users in June 30, 2018.
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Internet Users in the World by Geographic Regions - June 30, 2018

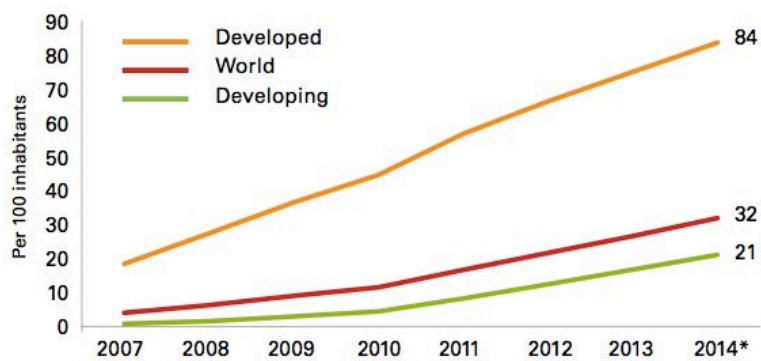


Source: Internet World Stats - www.internetworldstats.com/stats.htm
 Basis: 4,208,571,287 Internet users estimated in June 30, 2018
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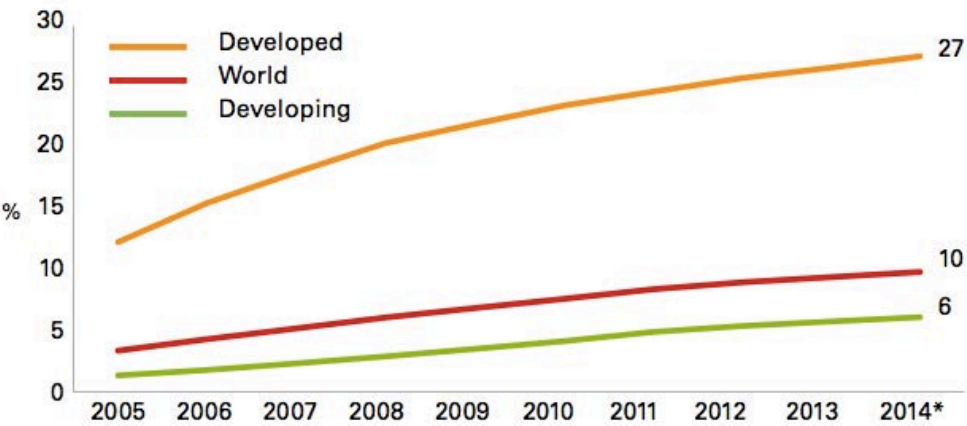
A changing Internet...

Wired broadband subscription (for 100 users)

Active mobile broadband subscription

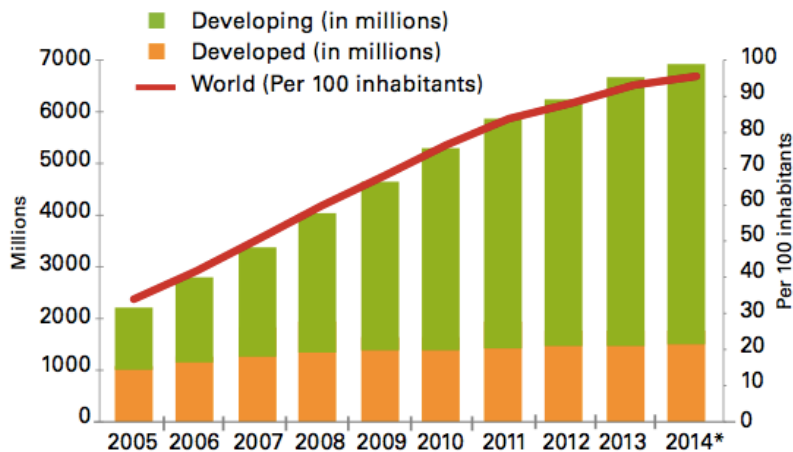


Note: * Estimate
Source: ITU World Telecommunication/ICT Indicators database



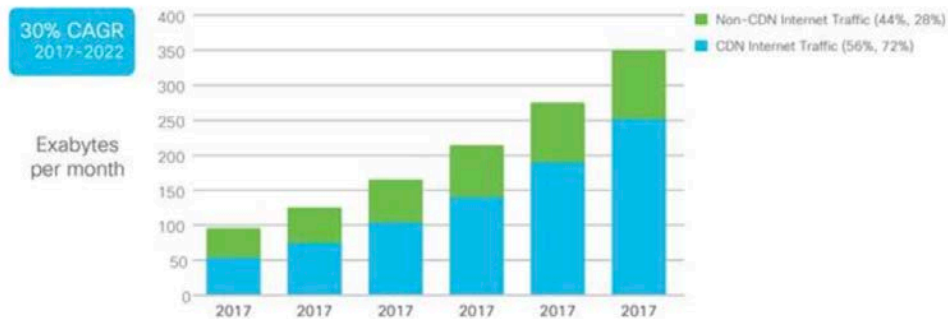
Note: * Estimate
Source: ITU World Telecommunication/ICT Indicators database

Mobile cellular subscription



Note: * Estimate
Source: ITU World Telecommunication/ICT Indicators database

Figure 24. Global content delivery network Internet traffic, 2017 and 2022



* Figures (n) refer to 2017, 2022 traffic share
Source: Cisco VNI Global IP Traffic Forecast, 2017-2022

A changing Internet...

CISCO forecasting

Consumer Internet Traffic,2017-2022	2017	2018	2019	2020	2021	2022	CAGR 2017-2022
By Network (EB per Month)							
Fixed	67	86	111	141	179	225	27%
Mobile	10	16	25	36	50	68	47%
By Subsegment (EB per Month)							
Internet video	56	77	105	140	184	240	34%
Web, email, and data	12	15	19	23	27	31	22%
Online gaming	1	3	4	7	11	15	59%
File sharing	8	7	7	7	7	7	-3%

A changing Internet...

CISCO forecasting

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Changes in trends:

IoT

Multimedia support

Network devices reconfigurability and
virtualization

Cloud vs. Edge computing

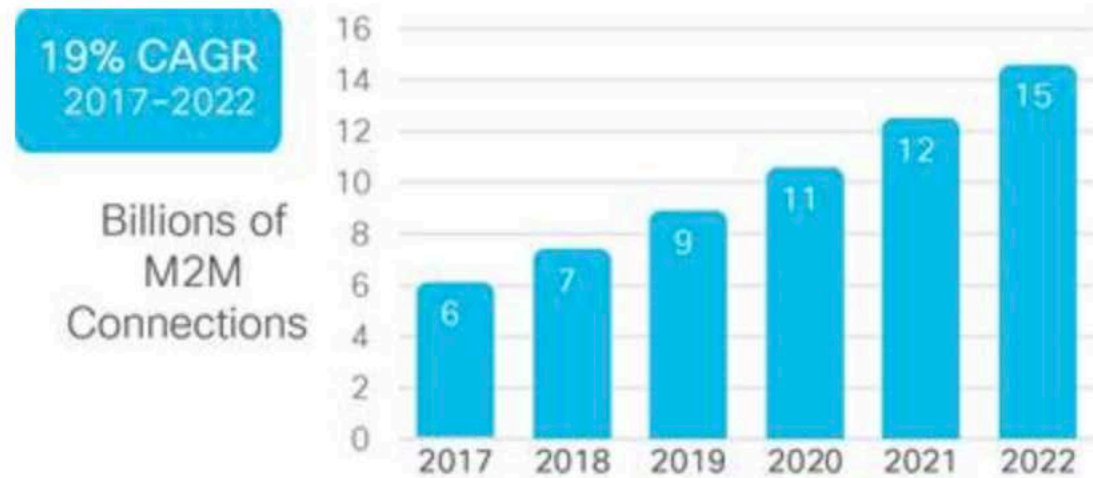
240 34%

31 22%

15 59%

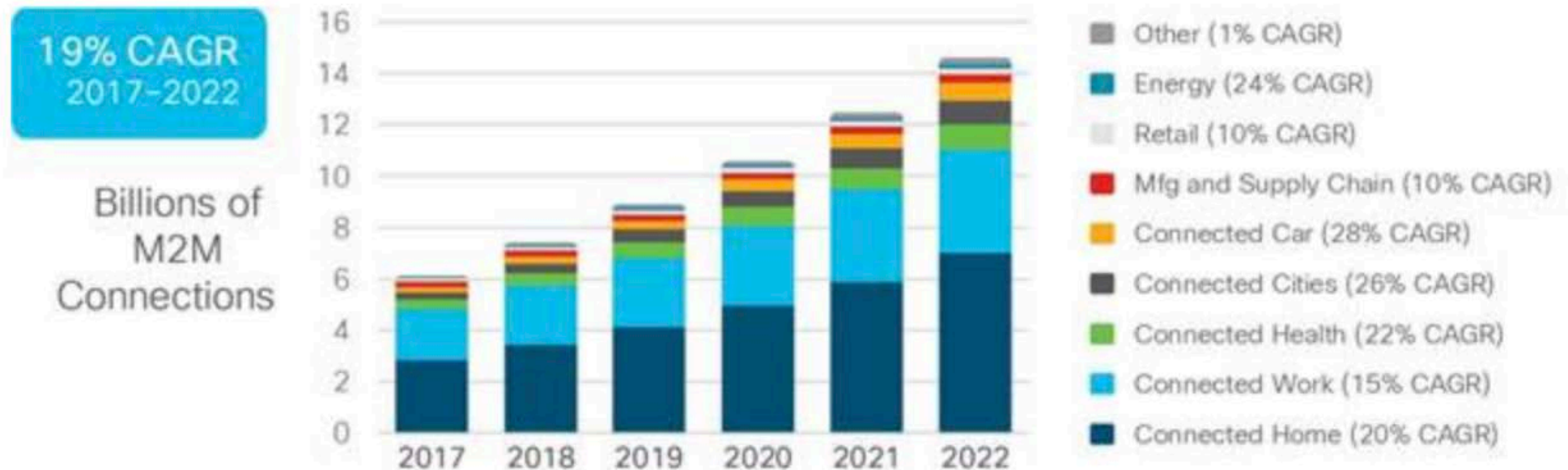
7 -3%

Figure 10. Global M2M connection growth



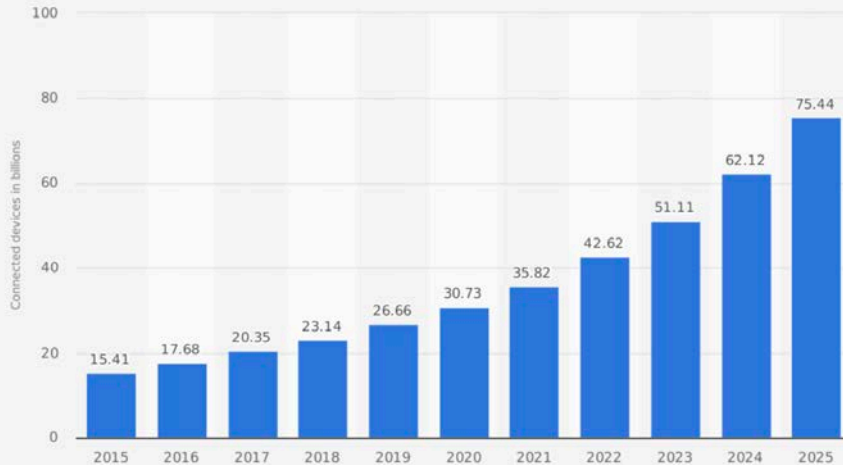
Source: Cisco VNI Global IP Traffic Forecast, 2017-2022

Figure 11. Global M2M connection growth by industries



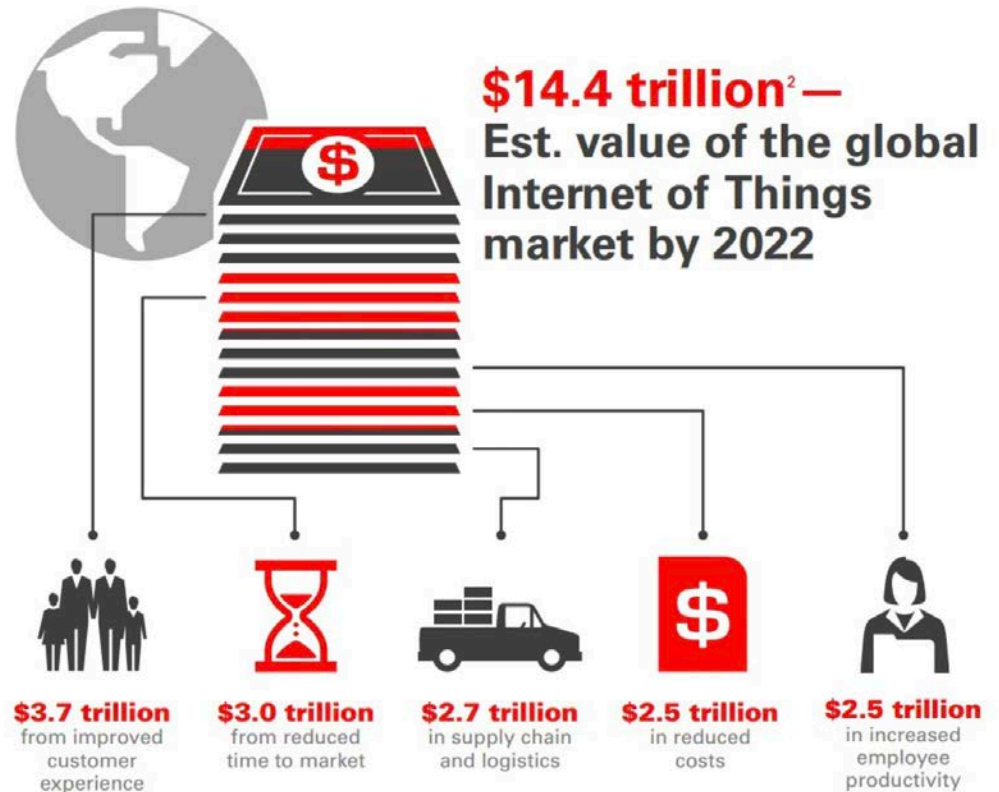
Il mondo dell'IoT

Internet of Things (IoT) connected devices installed base worldwide from 2015 to 2025 (in billions)



Source
IHS
© Statista 2018

Additional Information:
Worldwide; IHS; 2015 to 2016



SENSES lab: IoT & Systems for Smarter City/Smarter Planet



Smart Cities



Smart Environmen



Smart Water



Smart Metering



Security & Emergency



Retail



Logistics



Industrial Control



Smart Agriculture



Smart Animal Farming



Domotic & Home Automation



eHealth



Underwater monitoring & control systems



Structural health monitoring



Cultural Heritage



Tra triennale e e magistrale in informatica in Sapienza
è possibile un percorso di specializzazione su IoT

College experience



+

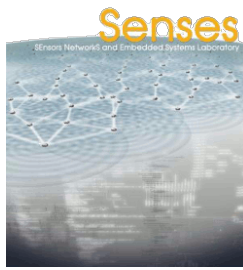


Collaborazione con lab scientifici
Seminari di esperti internazionali

Internship
Spinoff

Opportunità

<http://senseslab.di.uniroma1.it>



1. Grant per iscrizioni per partecipare a conferenze

2. TIROCINI (Borse di studio per attività di ricerca durante la tesi alla magistrale)

3. Percorso di eccellenza

http://www.studiareinformatica.uniroma1.it/sites/default/files/L_31_Informatica.pdf

Opportunità

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