



# ***FINe: Future (Inter)Net(works)***

The day by day of the course:

what we did  
what we learned  
what we will do today

# September 23, 2020 (I)

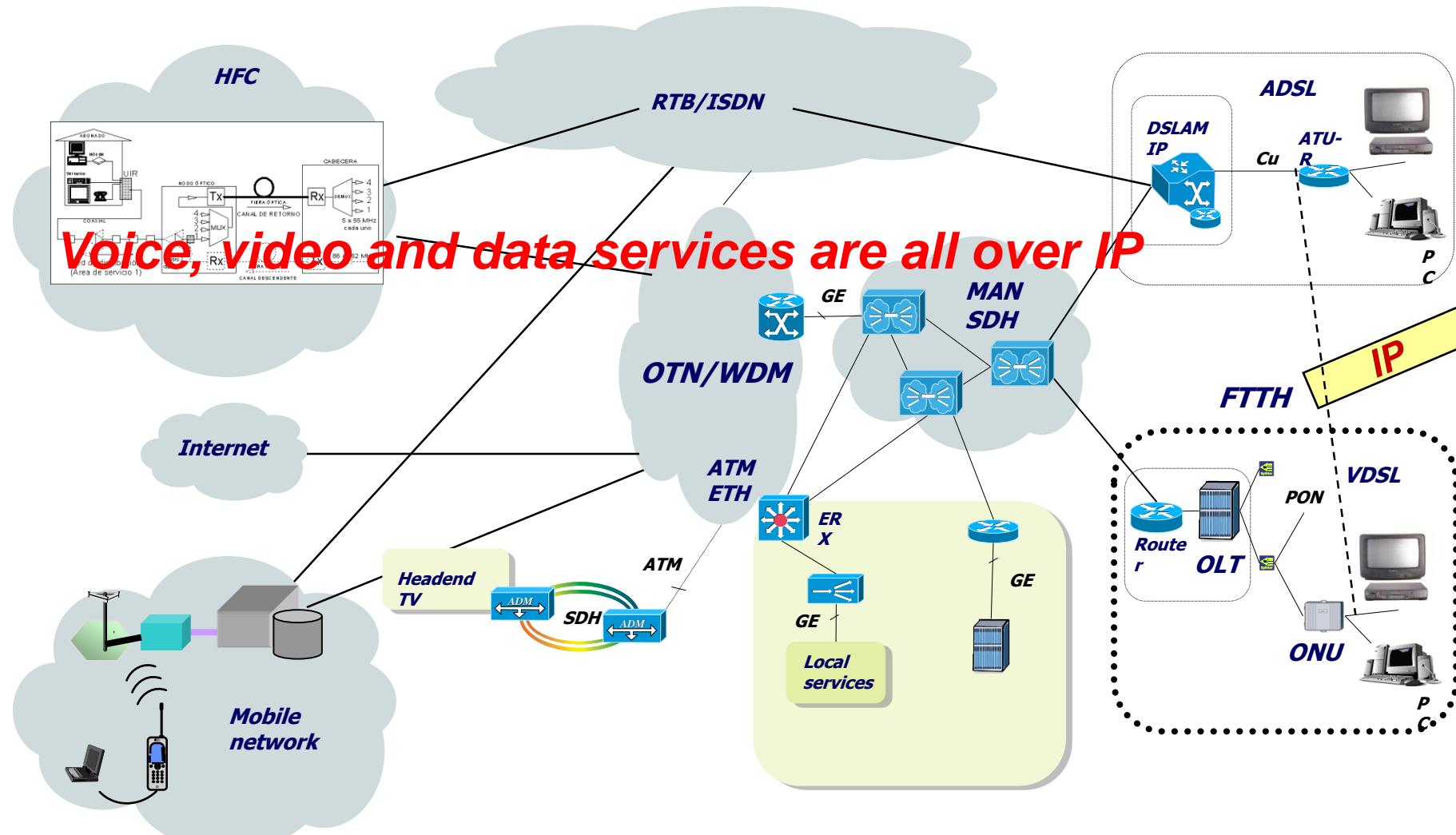
- ✓ What did we do last week (on September 16)?
  - We introduced the course
  - Launched the first Panel session
  - Launched the first set of questions
  - We started Chapter 1: Review of the statistical figures provided by ITU:
    - ICT facts and figures

# September 23, 2020 (ii)

- ✓ What did we learn/review/understand?
  - We learned what to do for passing the course
  - We revised the concept of Internet\*:
    - The Layer 3 (IP) being the glue for interconnecting different network technologies
      - An IP network is packet switched
      - An IP network is connectionless
      - The IP packet is the universally accepted format for transporting data (either PDUs or streaming)
      - The Backbone (Transport) Network is usually connection oriented, and is in charge of transporting IP packets from source to destination

\* Internetworking, Interoperable/International Network  
Future (Inter)Net(works)

# Internet became the Public Network



# September 23, 2020 (III)

- ✓ What did we learn/review/understand? (cont.)
  - Revising the statistical figures provided by ITU, we knew that:
    - Internet usage keeps growing, but barriers lie ahead
      - Lack of ICT skills a barrier to effective Internet use
      - Most of the offline population lives in least developed countries
      - The digital gender gap is growing in developing countries
    - Mobile-broadband subscriptions continue to grow strongly
      - Computers no longer needed to access the Internet at home
    - Bundled mobile broadband prices, compared with the PPP\$ (Purchasing Power Parity) of 2019
      - Broadband still expensive in LDCs
    - Almost the entire world population lives within reach of a mobile network

# September 23, 2020 (iv)

- ✓ What did we learn/review/understand? (cont.)
  - We learned about the existence of...
    - Two organizations providing the main Internet standard documents, namely ITU and IETF
    - CIS (Commonwealth of Independent States), a very powerful political and economic organization, in the orbit of the United Kingdom, whose head currently is the Queen of UK (Elizabeth II)
      - [https://en.wikipedia.org/wiki/Commonwealth\\_of\\_Nations](https://en.wikipedia.org/wiki/Commonwealth_of_Nations)

# September 23, 2020 (V)

- ✓ What will we do today?
  - Continue with Chapter 1: Review of the statistical figures provided by:
    - Mary Meeker in her 2019 Internet Trends report
  - Explore one of the main concerns of the EU in the ICT arena:
    - joining efforts to shape the Digital Single Market ...
  - Go through the Networking Infrastructure models, in particular, commons versus private
    - Lecturer: Roger Baig

# September 30, 2020 (i)

- ✓ What did we do last week (on September 23)?
  - Review the statistical figures provided by:
    - Mary Meeker in her 2019 Internet Trends report
  - Explore the main concerns and active policies of the EU in the ICT arena
    - Technology that works for people
    - A fair and competitive digital economy
    - An open, democratic and sustainable digital society
    - Europe as a global digital player
  - The lecture on Infrastructure models, commons versus private (Lecturer: Dr. Roger Baig)

# September 30, 2020 (II)

## ✓ What did we learn/review/understand?

- From the Mary Meeker's 2019 Internet Trends report, we knew that:
  - The number of Internet users comprises more than half the world's population, but *Internet user growth is slowing*
  - E-Commerce continues to gain share vs. physical retail, but *growth rates are slowing*
  - Global innovation & competition continue to drive product improvements
    - New types of usage & monetization – especially in areas of digital video, voice, wearables, on-demand + local services & traditionally underserved markets
  - Internet advertising growth is solid & innovation is healthy, but *there are areas where customer acquisition costs may be rising to unsustainable levels*
  - The rapid rise of gathering digital data is often core to the success of the fastest growing & most successful companies of our days
  - As Internet systems become increasingly sophisticated, data-rich & mission critical, so has the opportunity for cyber attacks
    - We are in a new era of cyber security where technology issues are increasingly intermixed with international diplomacy & defense

# September 30, 2020 (III)

- ✓ What did we learn/review/understand?
  - We learned that the European Digital Strategy is focused in the development, deployment and uptake of digital technologies to achieve:
    - A real difference to enhance people's daily lives
    - A strong and competitive economy that masters and shapes technology in a way that respects European values
    - A frictionless single market, where companies of all sizes and in any sector can compete on equal terms, and can develop, market and use digital technologies, products and services at a scale that boosts their productivity and global competitiveness, and consumers can be confident that their rights are respected
    - A trustworthy environment in which citizens are empowered in how they act and interact, and of the data they provide both online and offline
    - A European way to digital transformation which enhances our democratic values, respects our fundamental rights, and contributes to a sustainable, climate-neutral and resource-efficient economy

# September 30, 2020 (iv)

- ✓ What did we learn/refresh/understood?
  - With Roger Baig, we went into the concepts of property and management for the Internet/network infrastructures
    - We learned that the dominant models for building and managing the telecommunication infrastructures are three:
      - Public
      - Public-private partnerships (PPP)
      - Private
    - We discussed about the opportunities of an alternative model: The Commons

# September 30, 2020 (V)

- ✓ What will we do today?
  - Run the first panel
    - Panel chaired by the members of Group #2
  - First item of the Chapter 2 (Lecturer: Prof. Josep Solé-Pareta):
    - Review the Transport Network Concept
    - Review the Control Plane Concept
    - Review GMPLS<sup>1</sup>: The control plane technology installed in current Backbone transport networks

<sup>1)</sup> GMPLS: Generalized MultiProtocol Label Switching

# October 7, 2020 (I)

- ✓ What did we do last Tuesday (September 30)?
  - Run the first Panel on:
    - Democratizing the Digital Economy
  - Start with Chapter 2:
    - Review the Transport Network Concept
    - Review the Control Plane Concept
    - Introduced MPLS and GMPLS: The control plane technology installed in current Backbone transport networks

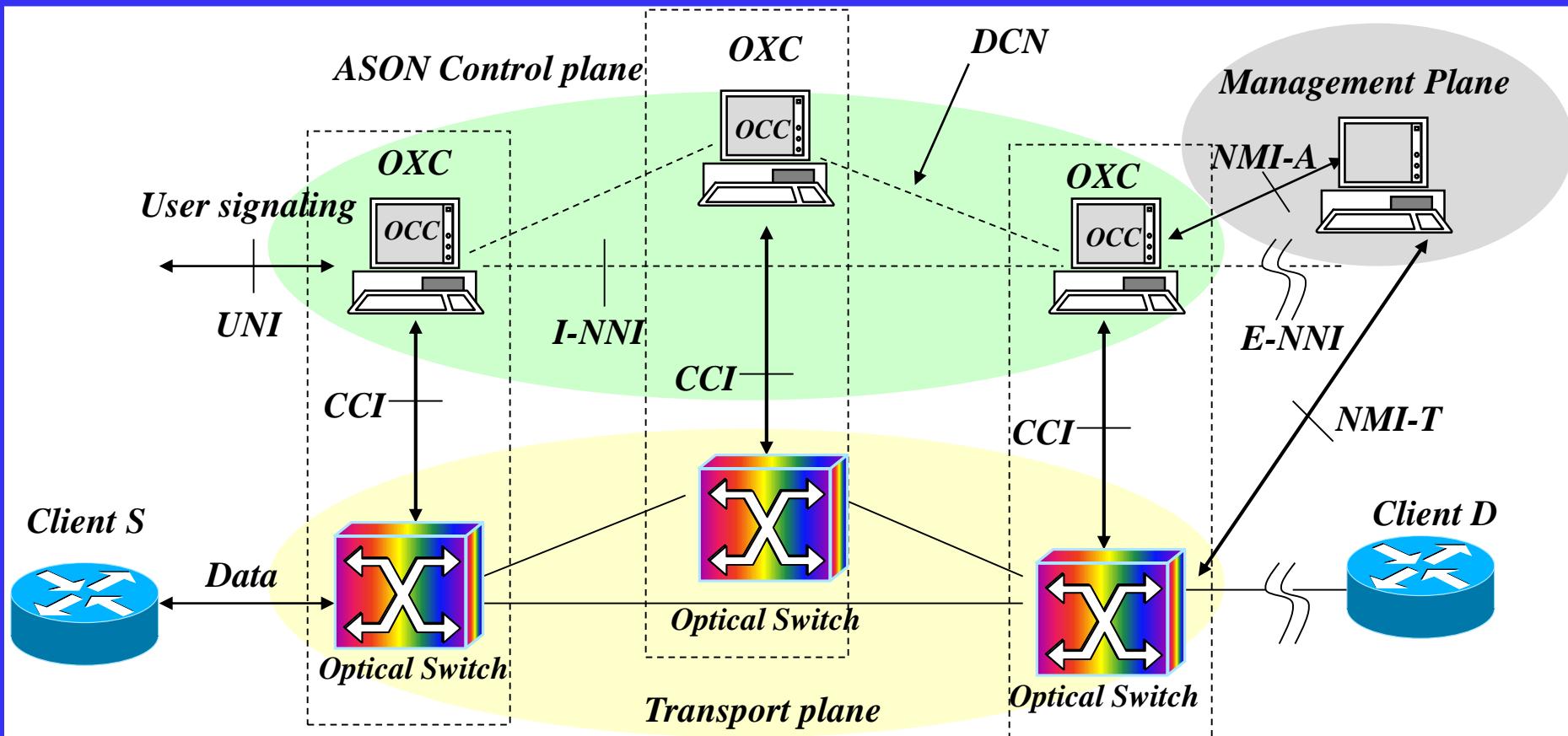
# October 7, 2020 (II)

- ✓ What did we learn/refresh/understood?
  - From Evgeny's Morozov talk we learned how accumulation of power over user data by giant tech companies will lead to very difficult problems
    - Promises by big tech companies are lies
    - Their behavior just enhances their profit
    - Companies control what and how we access information
  - Potential solutions:
    - Subscription-based: not clear
    - Competition-based: not clear
    - Legal framework to regulate access to data: difficult, since depend on governments... they usually react at the last minute
    - Educating and informing well the people. Also difficult, but seems the most effective

# October 7, 2020 (III)

- ✓ What did we learn/refresh/understood?
  - About the Transport Networking technology existing below Internet, we knew that
    - Its features are key for a fast and reliable transport of the IP traffic
    - It uses Optical transmission and switching
    - It is circuit-switched based, currently supporting flexible Bw allocation
      - A Tutorial on the Flexible Optical Networking Paradigm: State-of-the-Art, Trends, and Research Challenges:  
<https://ieeexplore.ieee.org/abstract/document/6824237>
  - We learned the main elements of an ASON architecture

# ASON architecture



CCI: Connection Control Interface

OCC: Optical Connection Controller

UNI: User to Network Interface.

NNI: Network to Network Interface

DCN: Data Communication Network

Future (Inter)Net(works)

OXC: Optical Cross Connect.

# October 7, 2020 (IV)

- ✓ What did we learn/refresh/understood?
  - We introduced the MPLS protocol, and we learned that
    - it allows for **traffic engineering**, QoS provisioning, tunnelling, etc.
    - its generalization (GMPLS) is the Control Plane standard protocol installed in the core of current transport networks

# October 7, 2020 (V)

- ✓ What will we do today?
  - Second item of Chapter 2  
**(Lecturer: Prof. Jordí Perelló)**
    - Introduce SDN<sup>1</sup> the Emerging technology for implementing the control plane of the future networks
    - Introduce the OpenFlow Architecture
    - Introduce the NFV<sup>2</sup> concept
  - Start with the third item of Chapter 2  
**(Lecturer: Dr. Fernando Afgraz)**
    - SDN on Optical Networks and Data Centers: Two case studies

<sup>1</sup>) SDN: Software Defined Networking

<sup>2</sup>) NFV: Network Functions Virtualization

# October 7, 2020 (Vi)

- ✓ What will we do today?
  - Launch the second panel session
    - On a Tutorial paper on ASON Automatically Switched Optical Networks
      - Deadline for posting the report in ATNEA: October 14 (11:00 am.)
      - To be run on October 14 and Chaired by Working Group #3
      - Evaluation period: From October 14 to October 21 (11:00 am.)

# October 14, 2020 (I)

- ✓ What did we do last Tuesday (October 7)?
  - Second item of Chapter 2  
**(Lecturer: Prof. Jordi Perelló)**
    - Introduced SDN<sup>1</sup> the Emerging technology for implementing the control plane of the future networks
    - Introduced the OpenFlow Architecture
    - Introduce dthe NFV<sup>2</sup> concept
  - Started the third item of Chapter 2  
**(Lecturer: Dr. Fernando Afgraz)**
    - SDN on Optical Networks and Data Centers: Two case studies
  - Launched the second panel session
    - On a Tutorial paper on ASON Automatically Switched Optical Networks

<sup>1</sup>) SDN: Software Defined Networking

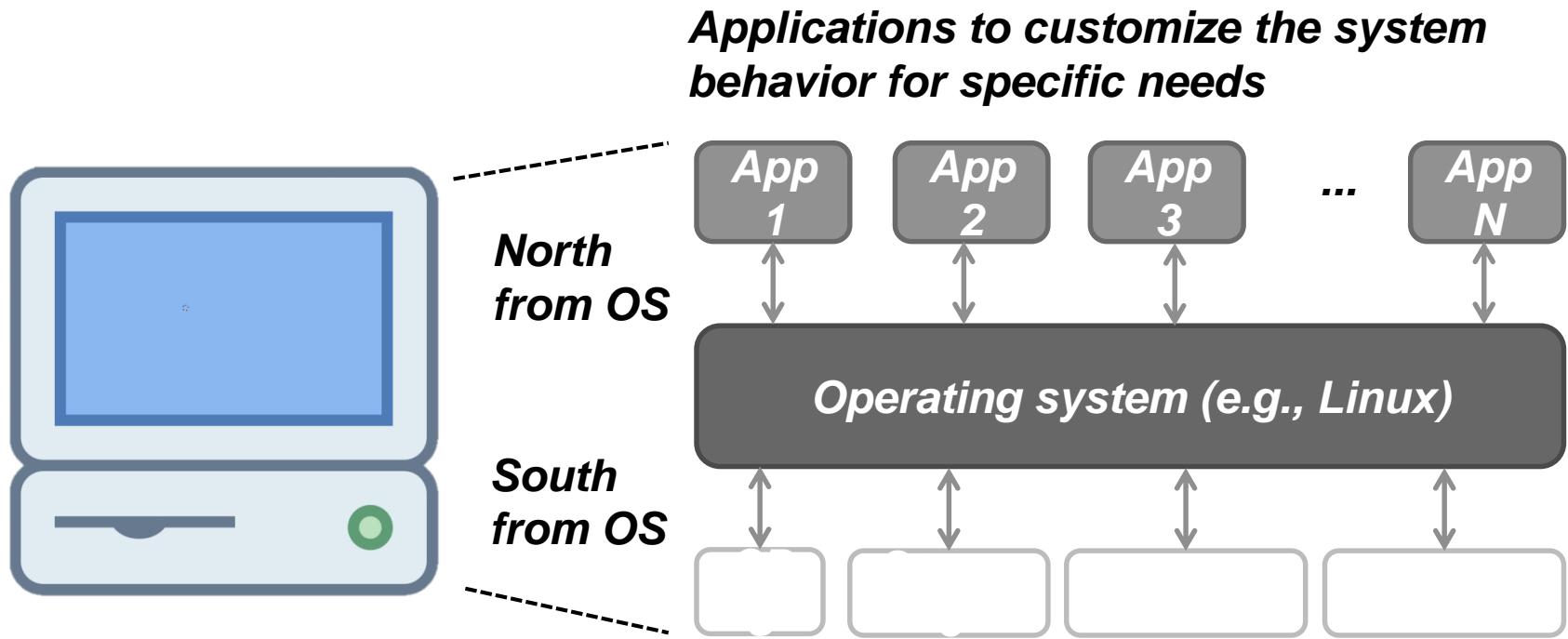
<sup>2</sup>) NFV: Network Functions Virtualization

# October 14, 2020 (II)

- ✓ What did we learn/refresh/understood?
  - About SDN and OpenFlow
    - SDN aims to counteract some limitations current networks operation
      - Problematic vendor-specific configuration procedures
      - Inconsistencies of distributed control protocols
      - ...
    - SDN can be seen as an analogy of a computer OS, but operating over a network domain
    - OpenFlow is the most widely used standard protocol for communicate the SDN controller and the Network Devices
      - Initial OpenFlow main goal was to make Ethernet networks, which are native connectionless, able to operate in connection oriented mode.
      - ... as MPLS do with IP networks

# ***SDN in analogy with a computer OS***

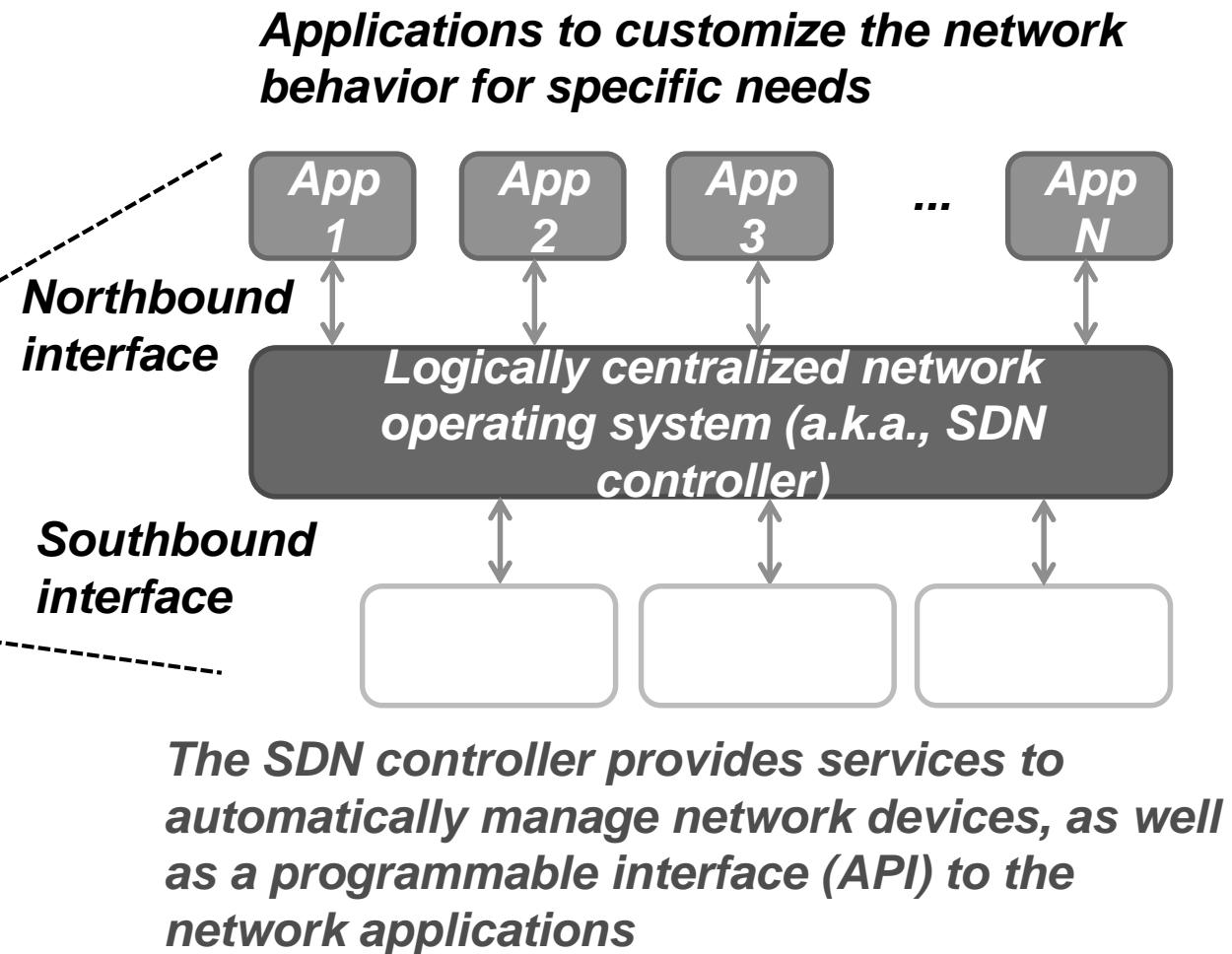
- The computer operating system model can be drawn in three basic layers: hardware, operating system and applications



*The OS can be seen as a middleware permitting applications to access HW resources, based on policies*

# SDN in analogy with a computer OS

- Similarly, the SDN model can also be split into 3 different layers:



# October 14, 2020 (III)

- ✓ What did we learn/refresh/understood?
  - About NFV
    - NFV consists of replacing specialized network appliances (like firewalls, load balancers, routers, etc.) with software running on VMs
    - SDN and NFV complement each other:
      - VNFs running on VMs in different servers can be connected over an SDN network to build an end-to-end service chain
      - Orchestrator is then required to coordinate both SDN and NFV
  - That the LIGHTNESS project was about designing a novel interconnection network architecture for **intra** data center network (DCN)
    - Based on both Optical Circuit Switching and Optical Packet Switching technology
    - Leveraging SDN and OpenFlow solution/specs

# October 14, 2020 (IV)

- ✓ What will we do today?
  - Finishing the third item of Chapter 2  
**(Lecturer: Dr. Fernando Afgraz)**
    - SDN on Optical Networks and Data Centers: Two case studies
  - Run the second panel session
    - On a Tutorial paper on ASON Automatically Switched Optical Networks
    - Erlang B Calculator
  - Launch the second set of questions
    - Devoted to Chapter 2
      - Deadline for posting the questions in ATENEA: October 21 (11:00 am.)
      - Evaluation period: From October 21 to October 28 (11:00 am.)
  - Technical reports assignment (tentative)

**Note:** I have extended the assessment period for the 1<sup>st</sup>. set of questions until midnight, today

# October 14, 2020 (V)

- ✓ Tentative assignment of the technical reports
  - TOPIC for Group#2:  
(Group members: David Carrera Casado, Lauréline Le Godec, Axel Washington)
    - Can GDPR protect the privacy rights of citizens?
      - <https://gdpr-info.eu/>
      - <https://ec.europa.eu/info/law/law-topic/data-protection>
  - TOPIC for Group#3:  
(Group members: Ayoub Bellouk, Dinis Falcão Leite Moreira, Francesc Roy Campderros, Juan Pablo Royo Sales)
    - Solutions to secure the 5G system
      - <https://www-sciencedirect-com.recursos.biblioteca.upc.edu/science/article/pii/S138912861830817X>

# October 14, 2020 (VI)

- ✓ Tentative assignment of the technical reports
  - TOPIC for Group#4:  
(Group members: Paulina jedrzejewska, Julien Labarre, Adrian Manco Sanchez,  
Jorrit Wolfgang Palfner)
    - Towards the 6G Network era: New IP architecture
      - <http://jultika.oulu.fi/files/isbn9789526226842.pdf>
      - <https://www.oulu.fi/6gflagship/>
  - TOPIC for Group#1 (sponsored by DAMM):  
(Group members: M Ros Gauthier, Kacper Szymula, Mar Vidal Segura)
    - Augmented traceability for food or its state (inclosing nanosensors inside the food / drink). Also applicable to control the beer fermentation process?
      - <https://www.rentokil.com/blog/five-examples-iot-food-supply-chain/>

# October 21, 2020 (I)

- ✓ What did we do last Tuesday (October 14)?
  - Finished with Chapter 2
    - Second case study: a SDN-based control plane and an Orchestration plane for provisioning coordinated IaaS (*Lecturer: Dr. Fernando Afgraz*)
  - Run the second panel session
    - On a Tutorial paper on ASON Automatically Switched Optical Networks
      - Evaluation period was until today at 11:00 am. → extended until midnight!
  - Launched the second set of questions
    - Devoted to Chapter 2
      - Deadline for posting the questions in ATENEA: October 21 (11:00 am.)  
→ extended until midnight!
      - Evaluation period: From October 21 to October 28 (11:00 am.)
  - Assigned the topics for doing the Technical Reports to the different working groups of the course
    - Date for the appointment? Pending for groups 2 and 4

# October 21, 2020 (II)

- ✓ What did we learn/refresh/understood?
  - While the LIGHTNESS project was about designing a novel interconnection network architecture for **intra** data center network (DCN)
    - Based on both Optical Circuit Switching and **Optical Packet Switching** technologies
  - The COSIGN project was about a novel architecture with a SDN-based control plane and an Orchestration plane for provisioning coordinated **IaaS**
    - We learned that Data Centers Orchestrator can provide network and IT virtualization allowing service programmability and complex service provisioning. The so called Virtual Data Center (VDC) provisioning
      - VDCs emerged as a service to cope with the multi-tenancy requirements faced by the DC operators

# October 21, 2020 (III)

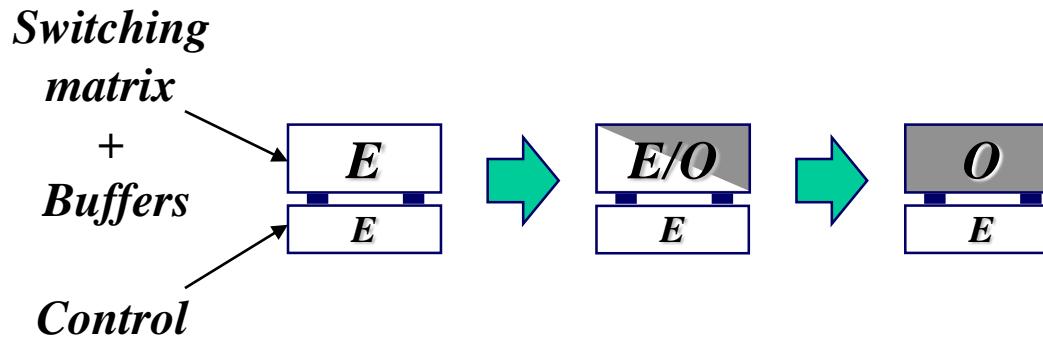
- ✓ What did we learn/refresh/understood? (cont.)
  - About the tutorial paper on ASON, we learned/debated about:
    - The issues to operate the core transport networks in Internet
    - The main mechanisms and requirements for enabling the ASON architecture
      - Which are also applicable to new schemes, such as SDN
    - The benefits of using ASON architecture
      - Matching client-network operator needs (Bw on Demand Service plus resource optimization)
      - Easy network operation
      - Facilitate network reliability
      - ... among others

# October 21, 2020 (IV)

- ✓ To do list from the pass class
  - Review the last slides of Fernando's presentation on
    - Providing 5G services over an optical infrastructure
    - ... and send an e-mail to Fernando ([agraz@tsc.upc.edu](mailto:agraz@tsc.upc.edu)), with Cc to me, if you have doubts
  - Play with the Erlang B calculator
    - Erlang B Calculator
      - A free online Erlang B calculator, which can be used to estimate how many lines are needed in the trunk groups of a network, once the traffic that will be offered to the target system is known. This is specifically for Circuit Switching Networks
  - Review the generic slides on Optical Packet Switching of the pass version of the diary of the course

# Packet Switching vs. Optical Packet Switching

- Electronic to optical packet switching evolution:



- Optical Packet Switches main characteristics:

- Both switching matrix and buffers are optical
- Bit rate independent payload (transparent bit rate)
- Headers still processed electronically

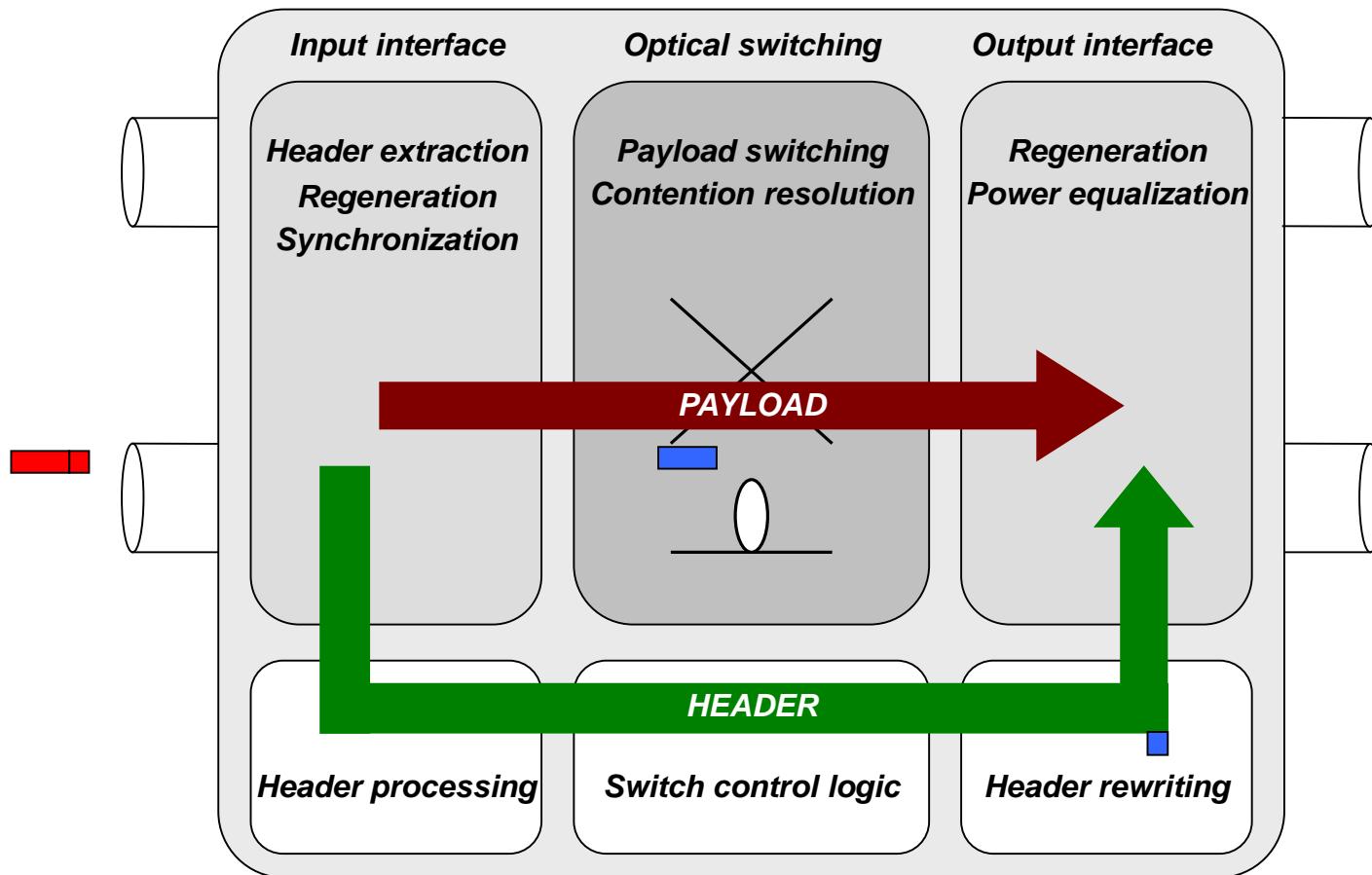
	Elec	Elec-Opt	Opt
Sw. Capacity	low	medium	high
Complexity	high	medium	low
Memory Dim.	high	high	low
Transparency	no	no	yes

# **Packet Switching vs. Optical Packet Switching**

- Electronics are reacting to fill the opto-electronic capacity GAP:
  - > 1 Tbps throughput is reachable
- Photonic technology is also evolving fast
  - Solves the opto-electronic capacity GAP
  - Three dimensions: Space, Time, Wavelength

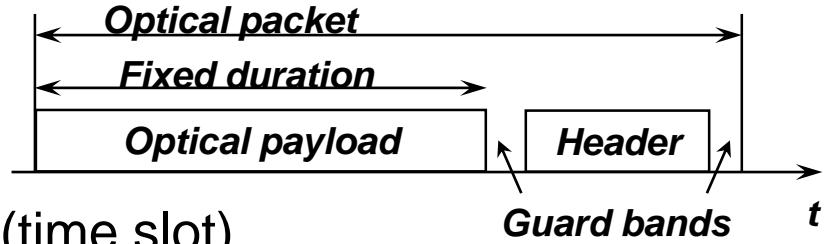
<i>Dimension</i>	<i>Space</i>	<i>Time</i>			<i>Wavelength</i>	
<i>Function</i>	<i>Switch</i>	<i>Mux</i>	<i>Syn/Asyn</i>	<i>Storage</i>	<i>Mux</i>	<i>Conv.</i>
<i>Electronic</i>	●	●	●	●	●	●
<i>Optical</i>	●	●	●	●	●	●

# *Optical Packet Switching operation*

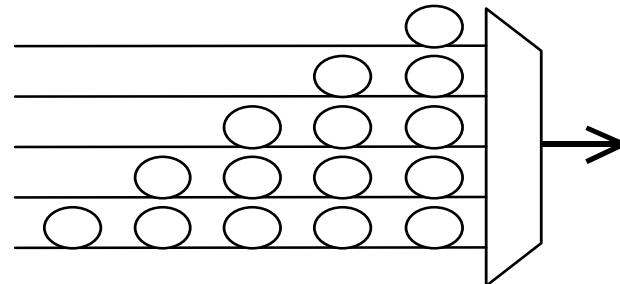


# Optical Packet Switching operation

- Optical packets:
  - Electronic header
  - Optical transparent payload (time slot)
    - Because what is switched are very short light beams



- Optical buffers? Fiber delay lines



# October 21, 2020 (iv)

- ✓ What will we do today?
  - Start with Chapter 3 (Lecturer: Prof. Pere Barlet)
    - Traffic Monitoring and Analysis
      - Internet Measurements: Algorithms and Challenges

# October 28, 2020 (i)

- ✓ What did we do last Wednesday (October 21)?
  - Reviewed the concept of Optical Packet Switching (OPS)
  - Started Chapter 3 (Lecturer: Prof. Pere Barlet)
    - Traffic Monitoring and Analysis
      - Internet Measurements: Algorithms and Challenges

# October 28, 2020 (II)

- ✓ What did we learn/refresh/understood?
  - We reviewed the concept of Optical Packet Switching (OPS)
    - OPS networking was a top research topic some years ago. Nevertheless, the attention of the scientific community to this topic strongly reduced due to the evolution of WDM networking technology (moving from rigid fixed-grid to flexi-grid), which leaded to the Flexible or Elastic WDM (optical) networks
      - Two papers on Elastic Optical Networks for those who want to learn more about it:
        - <http://www.enggjournals.com/ijet/abstract.html?file=17-09-03-022>
        - <https://ieeexplore.ieee.org/abstract/document/6824237>

# October 28, 2020 (III)

- ✓ What did we learn/refresh/understood?
  - About Traffic Monitoring & Network Measurements, we learned that
    - It is crucial for network operation and management
      - Estimation of traffic volume, type, topological distribution
      - Traffic engineering, network planning, BW management, QoS provisioning
      - Fault diagnosis, troubleshooting, performance evaluation
      - Accounting, billing, security...
    - It is important for networking research
      - Design and evaluation of protocols, applications, etc.
      - Traffic modeling and characterization (for network devices performance evaluation, analytical or by simulations)

# October 28, 2020 (iv)

- ✓ What did we learn/refresh/understood?
  - We also learned that traffic monitoring/measuring is (another) scalability problem
    - The more the traffic demand grows, the more difficult is capturing the whole traffic
    - The more the network bitrate increases, the more challenging is computing the data captured in real time
    - Resort to sampling is commonly needed
      - Due to that, a gap between the obtained traffic measurements and its accuracy (accurate estimate traffic measurements) can appear
    - Some algorithms and techniques helping to reduce such a gap
      - Proper sampling techniques
      - Bloom Filters
      - Direct Bitmaps
      - Bitmaps over Sliding Windows (Timestamp and Countdown vectors)
      - Count-Min Sketch data Structures

# October 28, 2020 (V)

- ✓ What will we do today?
  - Continue with Chapter 3
    - Traffic Monitoring and Analysis in SDN based networks  
*(Lecturer: Dr. José Suárez)*
      - Traffic Measurements in SDN environments
      - Traffic Classification in SDN environments
    - Privacy and security implications on the Internet: Web tracking  
*(Lecturer: Ismael Castell, PhD student)*
  - Launch the third set of questions
    - Devoted to the first part of Chapter 3 on Traffic Monitoring and Analysis
      - Deadline for posting the questions in ATENEA: November 4 (10:00 am.)
      - Evaluation period: From November 4 to November 11 (11:00 am.)
  - Launch the third Panel session
    - On the Self-similar Nature of Ethernet Traffic
      - Scheduled by November 11, to be chaired by Group #4

# October 28, 2020 (Vi)

## ✓ What will we do today?

### • Important!

- The assessment period for the 2<sup>nd</sup>. set of questions has been extended until today at midnight
- The first midterm exam is next Wednesday (November the 4th.)
  - If in person, at room A5-103, from 10 to 11:30 am.
  - If virtual, I will send you a message through Atenea

# November 11, 2020 (I)

- ✓ What did we do in our last lecture (October 28)?
  - We concluded the topic on Traffic Monitoring and Analysis:
    - We had Dr. José Suárez who gave a lecture on "Traffic Monitoring and Analysis in **SDN based networks**" dealing with
      - Traffic Measurements in SDN environments
      - Traffic classification in SDN environments
  - We started a new topic about the dangers and risks of the use of Internet
    - Ismael Castell (PhD student) introduced the privacy and security implications on the Internet talking about
      - Web tracking: Definition, mechanism and antidotes
  - We launched the third Panel session
    - On the Self-similar Nature of Ethernet Traffic

# November 11, 2020 (II)

## ✓ Notice

- The topic on dangers and risks of the use of Internet **will continue** in the class of November 25 with a lab session on:
  - Fighting Cyber Crime: An application of network analysis
    - Ransomware, network scanning, and general use of exploits and vulnerabilities
    - Practical look at malware behavior from a network perspective
    - Exercises on the offensive side of things using a virtual hacker lab
  - To be given by a special guest:
    - Prof. Jens Myrup Pedersen (University of Aalborg)

# November 11, 2020 (III)

- ✓ What did we learn/refresh/understood?
  - We learned
    - How to perform Flow-level traffic aggregation in SDN environments
    - How to perform sampling in SDN environments
    - How to classify the traffic, in particular web traffic, in SDN environments
    - Different ways of tracking our activity in Internet
    - Several methods to counteract them and preserve our privacy

# November 11, 2020 (IV)

- ✓ What will we do today?
  - Run the third Panel
    - "On the Self-similar Nature of Ethernet Traffic"
      - Evaluation period: Starts today and will last until November 18 (11:00 am.)
  - Continue with Chapter 3 dealing with "Inter-domain Routing" scalability and security issues
    - lecturer: Prof. Albert Cabellos

# November 18, 2020 (i)

- ✓ What did we do in the last lecture (November 11)?
  - We run the third Panel
    - "On the Self-similar Nature of Ethernet Traffic"
  - Prof. Albert Cabellos gave his lecture on the "Inter-domain Routing". He discussed about:
    - The inter-domain routing protocols, in particular, the case of BGP (Border Gateway Protocol)
      - The BGP Scalability problem
      - The BGP Security problem

# November 18, 2020 (II)

- ✓ What did we learn/refresh/understood?
  - We again learned that:
    - Networks are becoming faster than computers, which creates Internet scalability problems
      - For the network monitoring (traffic capturing and analyzing)
      - Due to the Inter-domain routing function (BGP)
  - After all we have discussed about Network Monitoring, we should have learned that what network managers need to find out is:
    - What network users do?
    - What is happening to the network?
    - How traffic load the network?

# November 18, 2020 (III)

- ✓ What did we learn/refresh/understood?
  - And, we can answer the following question:
    - The main purposes (applications) of Network Monitoring are Traffic Classification, Anomaly Detection and Traffic Characterization.  
Why is each of these applications useful for?
      - Traffic classification is useful for determining what network users do
      - Troubleshooting or Anomaly Detection is useful for determining what is happening in the network
      - Traffic Characterization allows for synthetizing the statistical behavior of the network traffic
    - Let us put an example to illustrate each of case:
      - Controlling users behavior, Engineering the network (network dimensioning & planning), Billing and Charging...
      - Is the network fully or partially attacked? Is the network (connectivity, devices, etc.) failing? Is there a too high BER or too low S/N?...
      - How traffic load the network? How new network devices and protocols will perform under realistic traffic conditions?...

# November 18, 2020 (IV)

- ✓ What did we learn/refresh/understood?
  - We also learned that:
    - The main causes of BGP scalability problems are the procedures of Reachability advertisement and Multihoming
  - We refreshed the concept of Peering
    - This concept already appeared in one of our introductory videos... who has watched it?

# November 18, 2020 (V)

- ✓ What did we learn/refresh/understood?
  - Then, we went to the BGP security issues, and we learned that
    - BGP was not designed with security in mind. So then, BGP introduces critical security threats, namely:
      - Prefix Hijack
      - Path Hijack
      - Route Leak
    - Current solutions to fix such a security threats are
      - Resource Public Key Infrastructure (RPKI)
      - BGP-SEC
    - More advanced solutions
      - Decentralized Distributed Infrastructure (DII) and beyond

# November 20, 2019 (VI)

- ✓ What will we do today?
  - Complete the discussion of the paper "On the Self-similar Nature of Ethernet Traffic" with
    - An example of the importance of traffic characterization for the performance evaluation of network devices
  - Finish with Chapter 3 dealing with the "Recursive Internet Architecture" (RINA)
    - Invited Lecturer: Prof. Jordi Perelló

# November 20, 2019 (VII)

- ✓ About RINA?
  - The problem:
    - Internet needs to continuously be updated, how to do this?
  - Evolutionary solutions:
    - "Put patches in the IP network
      - Example: To cope with the BGP security problem (discussed in class by Prof. Cabellos)
  - Disruptive (clean state) solutions:
    - Designing a brand new architecture for the IP network
      - Content Centric Networking
      - RINA (today's lecture by Prof. Perelló)
      - The Technical Report of Group #4 will also illustrate us about this topic...

# November 20, 2019 (VÍII)

✓ Today we will also:

- Launch the fourth set of questions
  - Devoted to inter-domain scalability and security problems, and RINA
    - Deadline for posting the questions in ATENEA: November 25 (11:00 am.)
    - Evaluation period: From November 25 to December 2 (14:00 pm.)
- Launch the fourth Panel session
  - Towards the Internet of 2030
    - Scheduled by December 9, to be chaired by Group #1