A World Leading SFI Research Centre

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CONNECT
Centre for Future Networks

OpenIreland: end-to-end testbed for network disaggregation using open source and open hardware

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CONNECT and IPIC research centres

Cork Smart Gateway webinar on 5G, 17th June 2021

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Ireland's European Structural and Investment Funds Programmes 2014-2020
Co-funded by the Irish Government and the European Union

European Union
European Regional Development Fund

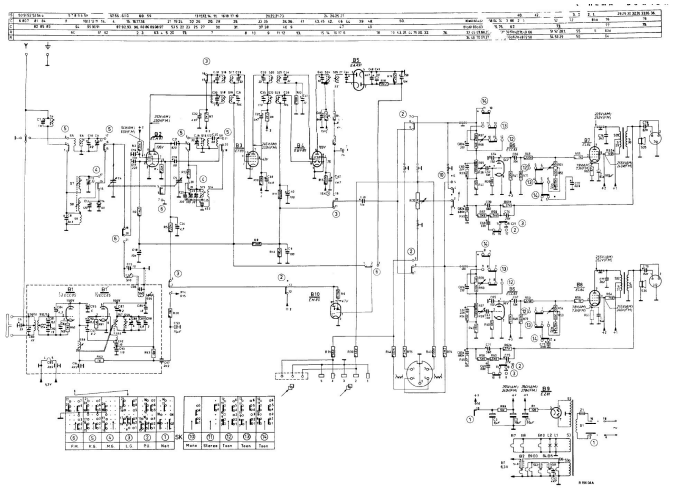
Science Foundation Ireland sfi For what's next

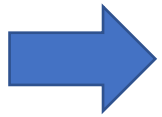
IPIC
BRINGING PHOTONICS TO LIFE

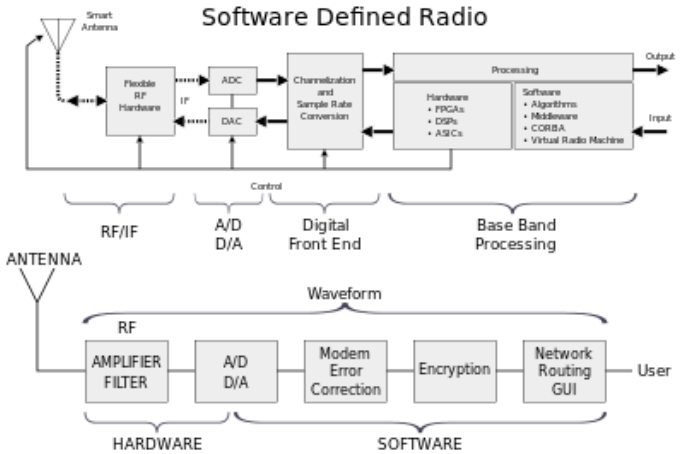
The Open Movement

- Software Defined Radio introduced in 1992 by Mitola in IEEE journal

1. Moving from hardware to software is the first step for opening up a system
   - Software can be copied, downloaded, etc. and can be worked on by anyone.

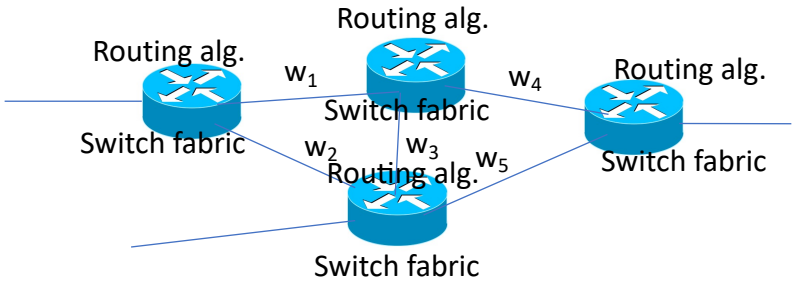


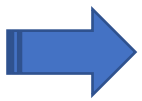


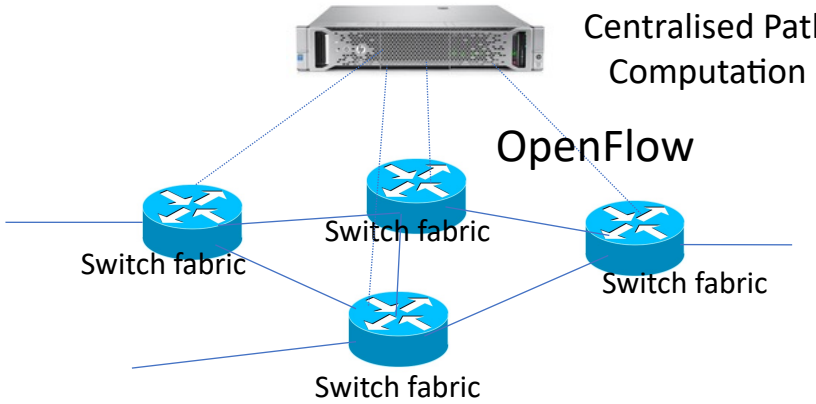


2. The second innovation in 2008 was the separation of control and data planes.

➔ It means providing an open interface (OpenFlow / SDN) so that the hardware and software could communicate across a distance







Opening the base station

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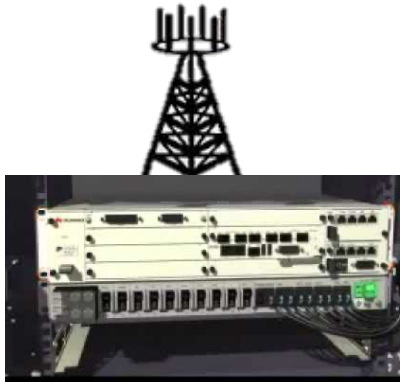
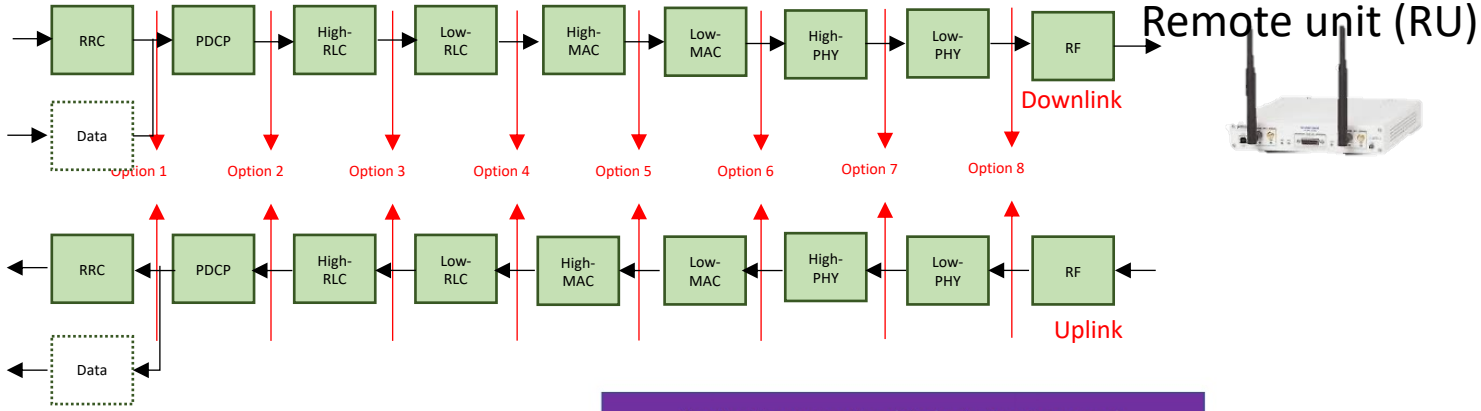
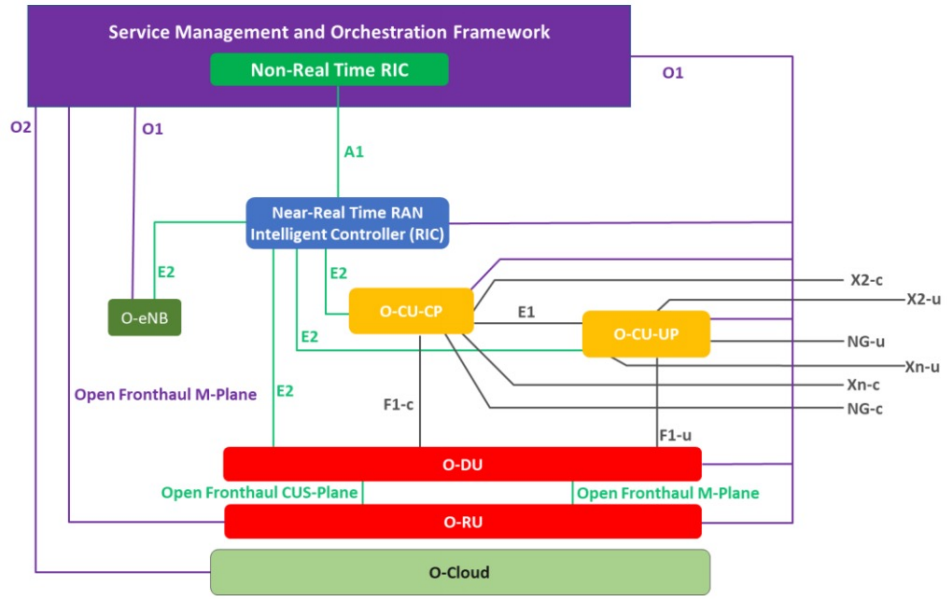
- For over 10 years we have been able to do this: run a 4G (now 5G) base station from a server or laptop





- Next step is to bring this concept to proper commercialization (actually replacing current large vendor base stations)
- Define one one specific split (called 7.2) and start defining interfaces so that vendors can start producing the different parts



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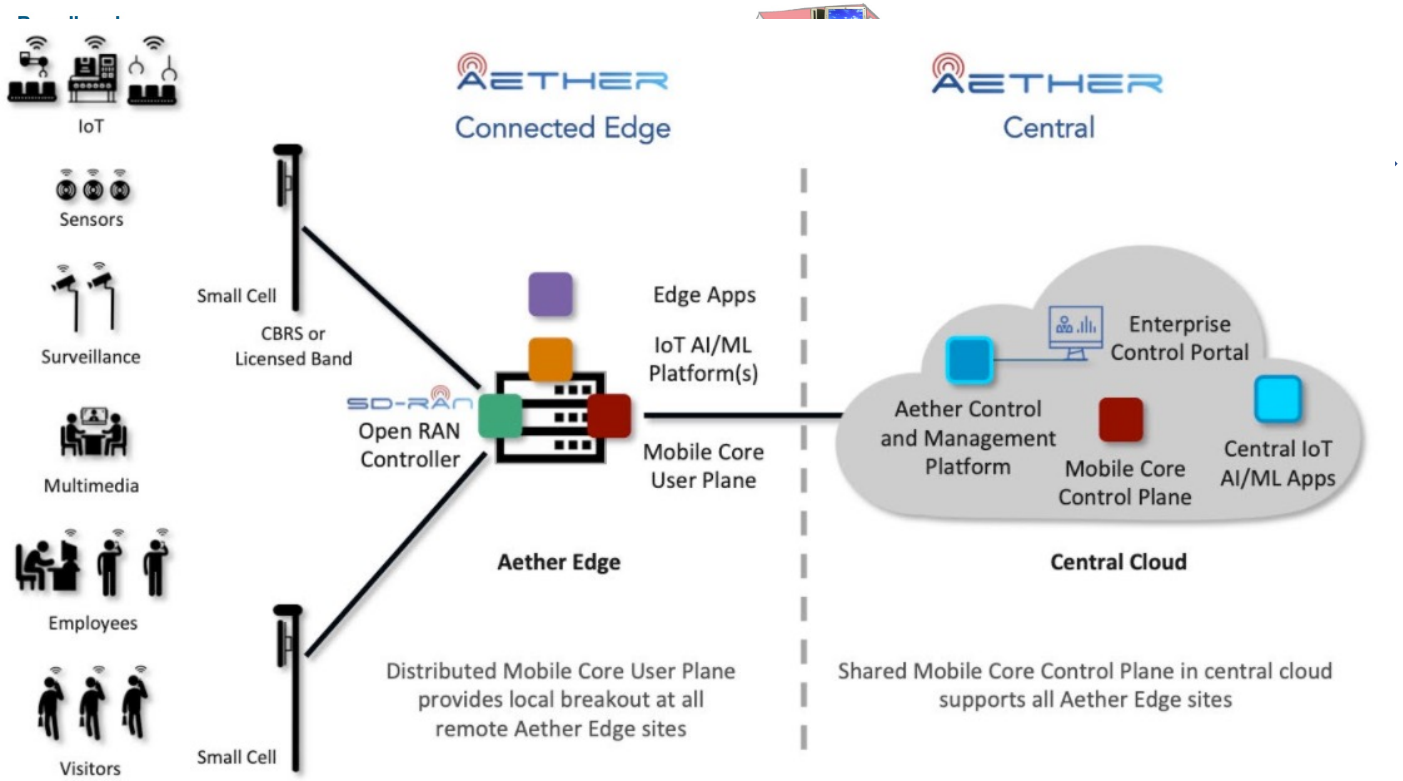
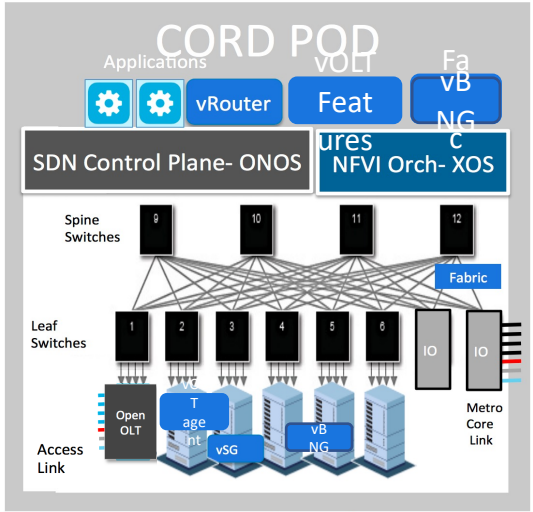
Opening the central office

- Over the past 10 years the concept has evolved from academic research and individual devices, to telecoms network scale.
- The central office is being “Softwarised” or “Cloudified”. Started in 2015 with the Central Office Rearchitected as a Data Centre (CORD), from Stanford and AT&T, then turned into the Open Networking Foundation (ONF).





Commodity Hardware

Most recently evolving to AETHER to integrate with edge cloud

Opening the optical layer

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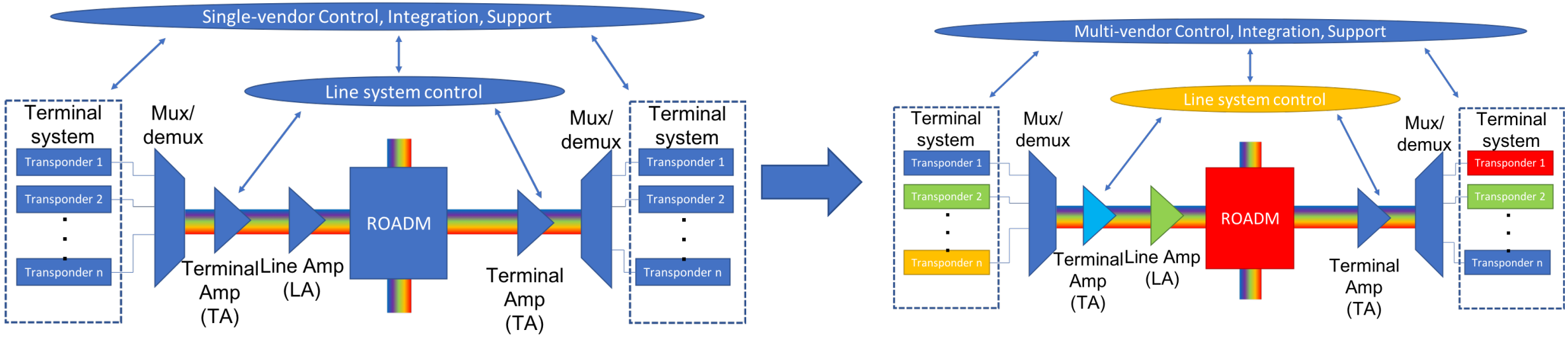
- This is a difficult one!
- Optical transmission is analogue, meaning that different devices have different behavior (unlike digital)
- Nonetheless now there are SDN-controlled ”whitebox” devices, like ROADMs, amplifiers and transponders..



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Advantages of Open Interfaces

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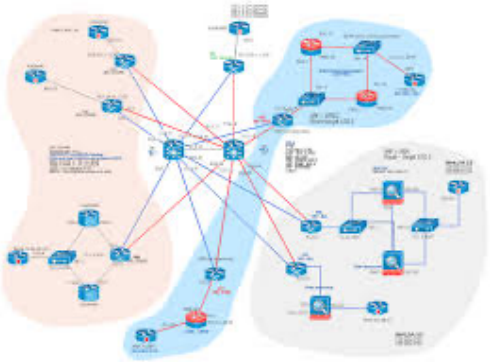
- Open networking has created a physical separation between the silicon and the software. **And it has standardised and opened the interface between the two**.

Open interface



- Now vendors are producing low-cost whitebox switches (just hardware, no software): a 3.2 Tb/s switch costs less than €7k! (the same as an entry level iMAC Pro)
- Also.. avoid vendor lock in and enable improved programmability and higher innovation

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Open source and research opportunities

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- Disaggregation enables anyone to get involved in real system development.
- Open source real enabler for low cost testbed setup/maintenance and ability to develop new ideas… create new startups
  - SONiC for control of switching hardware; Goldstone for control of optical transponder hardware
  - OAI or SRS (coming soon) for 5G RAN; OAI, Magma, Open5GS for 5G Core
  - ONOS for network control plane
  - OpenStack for cloud control
  - OSM for orchestration
  - CORD/SEBA for central office virtualisation
  - AETHER for edge cloud…

- Opens up many research opportunities:
  - Intelligent (AI-based) network control for both wireless and optical systems
  - Network customisation
  - Telemetry for monitoring quality of transmission and quality of service to meet Service Level Agreements
  - Use of distributed ledger technology to implement smart contracts

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Open Ireland: Ireland's Open Networking Testbed

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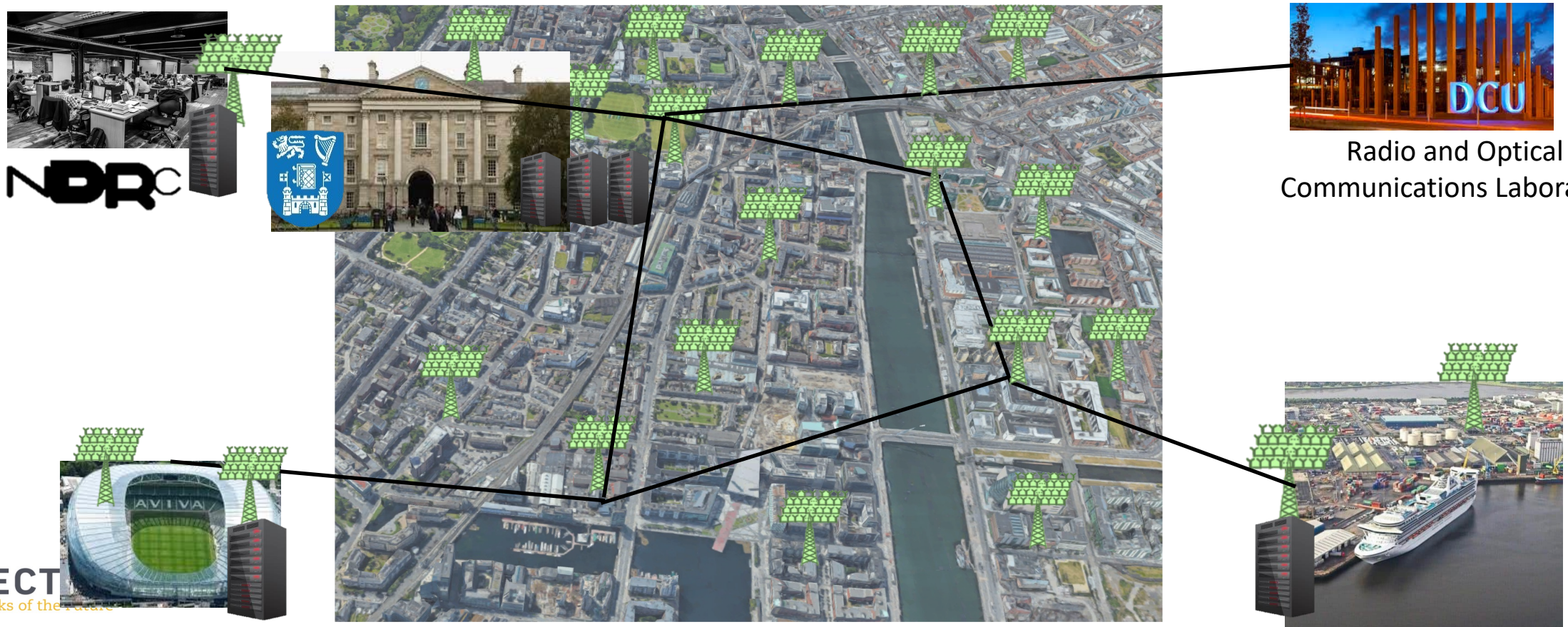
- Testbed for research on end-to-end: wireless-optical-cloud based on **open interfaces** and **open source**
  - **Investigate** end-to-end operation of OpenRAN, Cloud Central Office and Disaggregated optical systems.
- Investigate intelligent control plane, technology and protocols and to enable 100X scalability:
  - Capacity, Latency, Availability, Energy, Automation…



Radio and Optical Communications Laboratory

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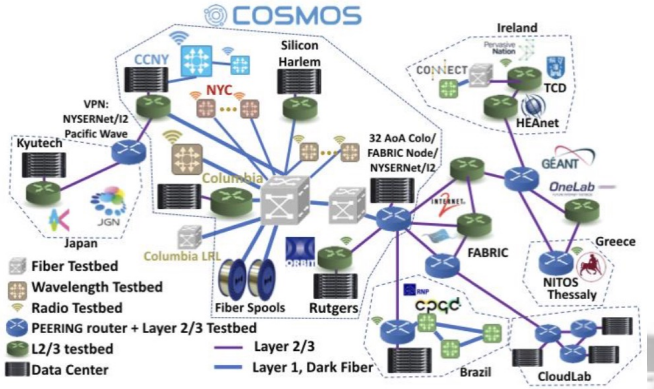
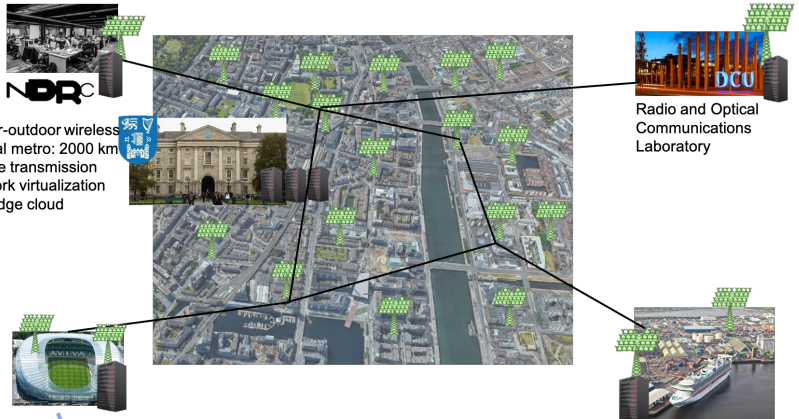
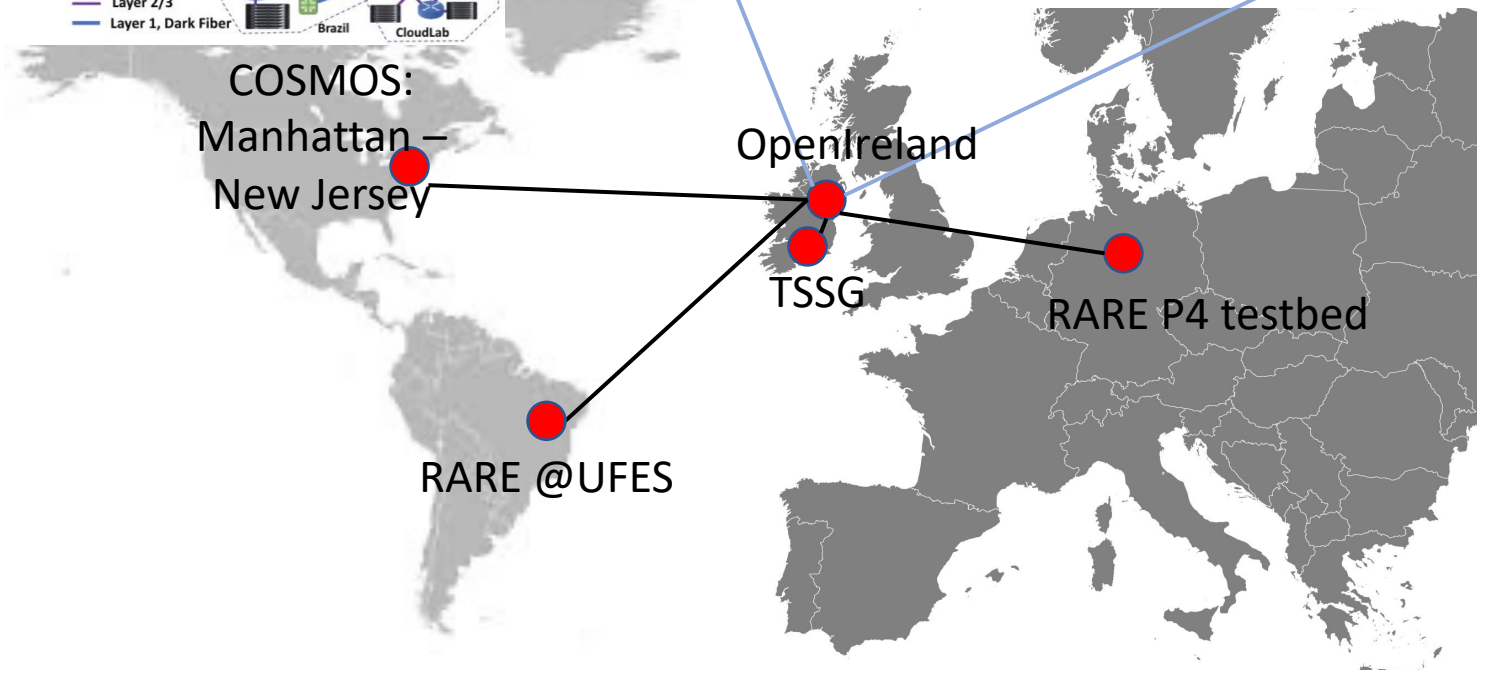
Worldwide reach of our testbeds

COSMIC: COSMOS international connectivity (Europe, Brazil, Japan…)







OpenIreland offers fully reconfigurable topology including:

- Metro transmission (ROADMs, Coherent transponders, amplified links ~2000km, channel loading)
- SDR Wireless, including laboratory USRPs and OpenRAN indoor and outdoor small cells)
- Edge computing and networking (including P4, etc.)

- **<u>Key feature: only based on open systems and open source!</u>**

Disaggregated control planes with Mininet-Optical

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We developed Mininet for the optical layer **(Mininet-Optical)**

➔ Test your optical control plane (routing algorithms, ML-based) in large scale emulated networks

Key for Access-Metro Convergence

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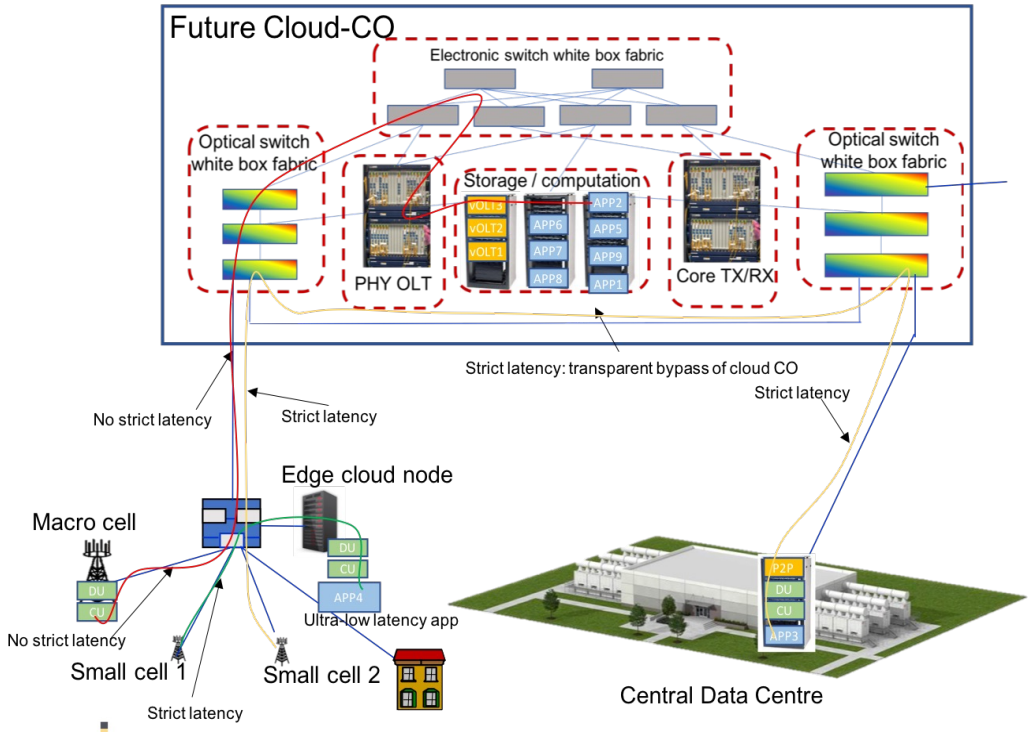
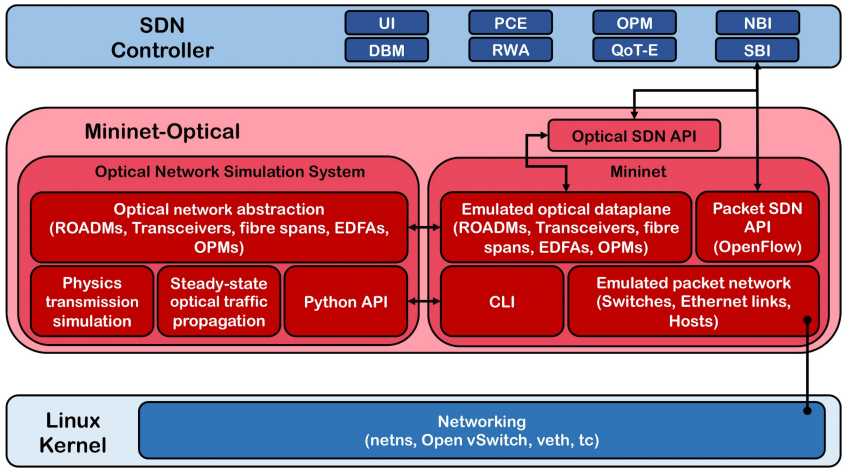
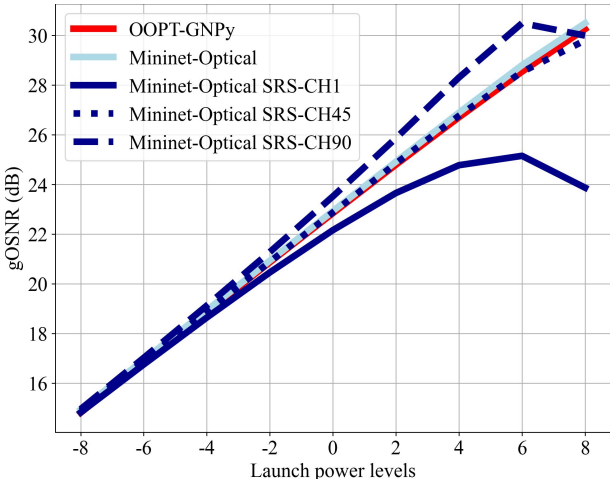
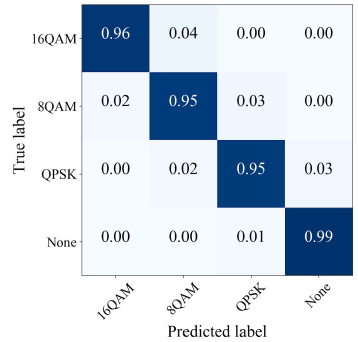






Example: Machine Learning for quality of transmission estimation



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Published at OFC, ICC, ONDM, ACP, PTL.

Development plan

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Today

- Optical disaggregation
- ML-QoT experimentation
- EU and Brazil connectivity

October 2021

- Multi-node optical system
- Remotely reconfigurable topology
- Indoor SA 5G
- DCU dark fibre
- COSMOS connectivity

April 2022

- Remotely controlled testbed
- Outdoor 5G SA

Future Extensions

- Free Space Optics
- Open Source mmWave and above
- Quantum communications

Hardware technology	OpenSource Software Technology
Coherent 200G transmission	Goldstone
P4 programmable data plane	SONiC
SDR indoor radio	OpenAir Interface (and SRS)
ORAN outdoor radio	OpenAir Interface (and SRS)
FPGA PON	Intel-TCD virtual PON
Edge/Cloud servers	OpenStack / AETHER

Bring your own technology!

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Thank you

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