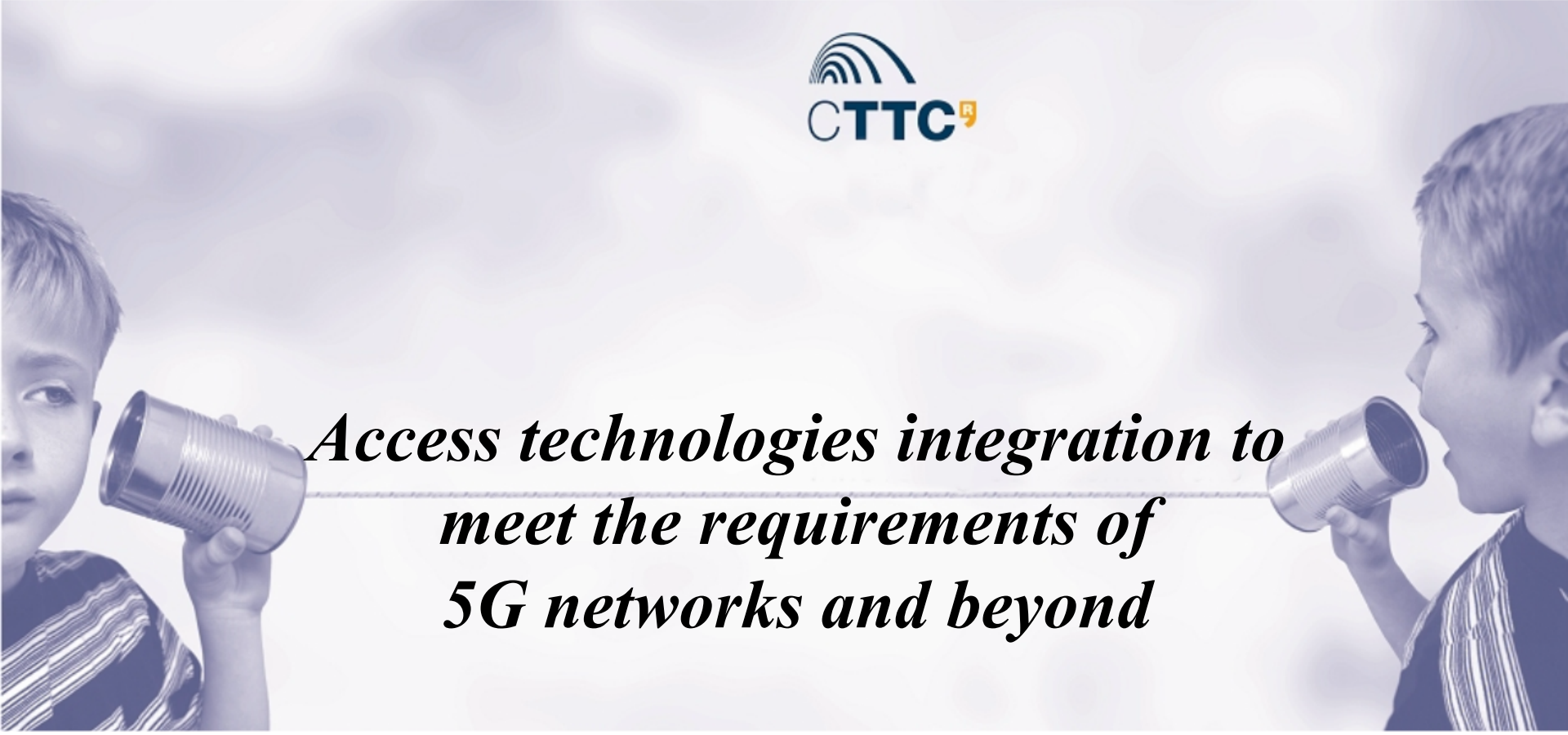

Access technologies integration to meet the requirements of 5G networks and beyond

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Event: Visions for Future Communication Summit (VFCS)
Venue: ISCTE, Lisbon University Institute, Lisbon, Portugal
Dates: 23-24 Oct., 2017

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HR EXCELLENCE IN RESEARCH

Centre Tecnològic de les Telecomunicacions de Catalunya (CTTC)

- Non-profit research institution based in Castelldefels (Barcelona), resulting from a public initiative of the Regional Government of Catalonia
- Both **fundamental** and **applied research activities**, with focus on technologies related to the physical, data-link, and network layers of communication systems
- **Mission:** Provide response in range of pre-competitive research and engineering demonstration models
- More info: http://www.cttc.es

Budget	6,1M€
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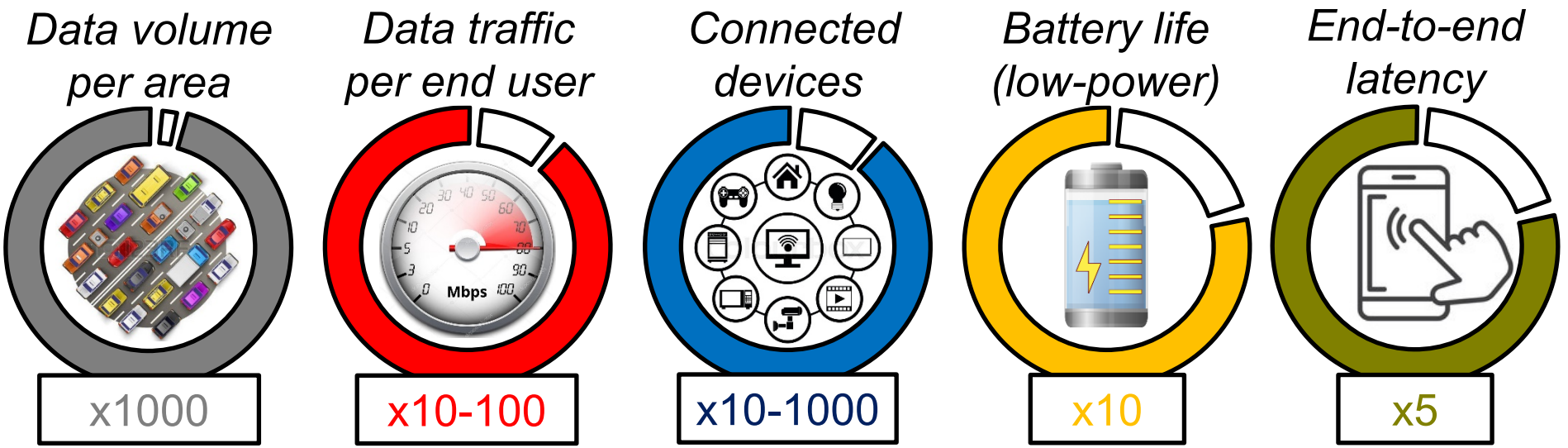
PhD Students	15
Labs	
Facilities	9
M² Space	280
TESTBEDS	
ADRENALINE Testbed ®, EXTREME Testbed ®, GEDOMIS ®, GESTALT ®, GEMMA NAVIGATION ®, IoTWORLD, CASTLE	
R&D Projects	187
Active research projects	78
Granted Patents	65
Publications	1892
Journals (ISI Indexed)	470
Int'l Conferences	1328
Books & Chapters	94
EU FP7 ranking performances*	
ICT Objective 1.1 in Spain	3rd
ICT in Spain	13th
ICT Objective 1.1 in EU	20th
Spin off**	1
Events / Seminars	420
Awards	37

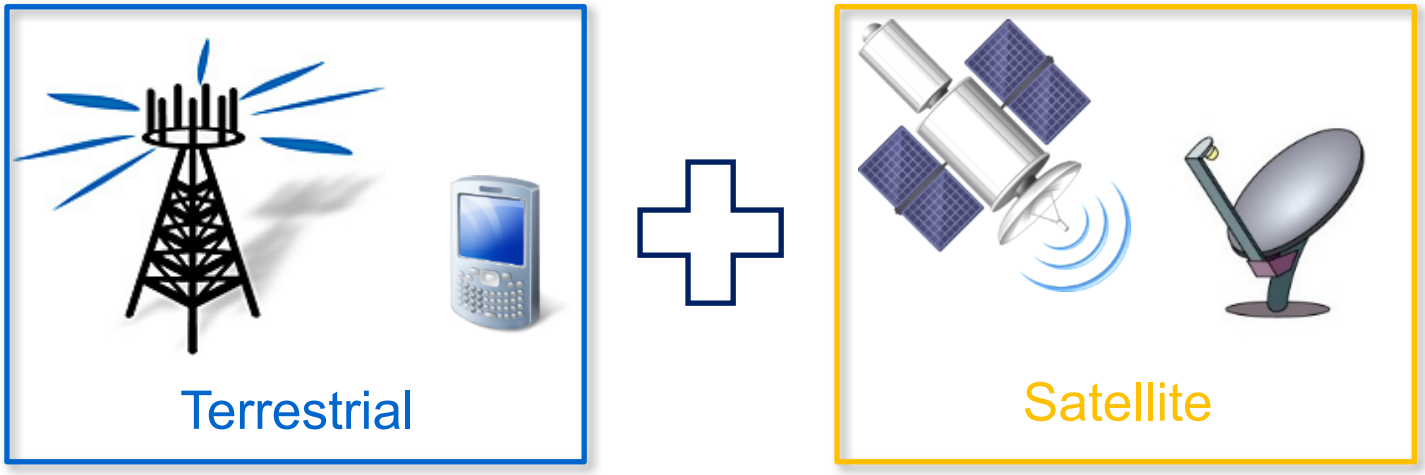
*Ranked among academic institutions in EU and Spain.

Ideas and concepts beyond 5G

- Technical goals set for 5G are very diverse
- Innovative solutions that integrate different access technologies into a common framework will be required
- Two examples of technology integration are presented:
  1) **Satellite-Terrestrial** communication technologies
  2) **Optical-Wireless** communication technologies



(1) Integration of terrestrial and satellite communication technologies



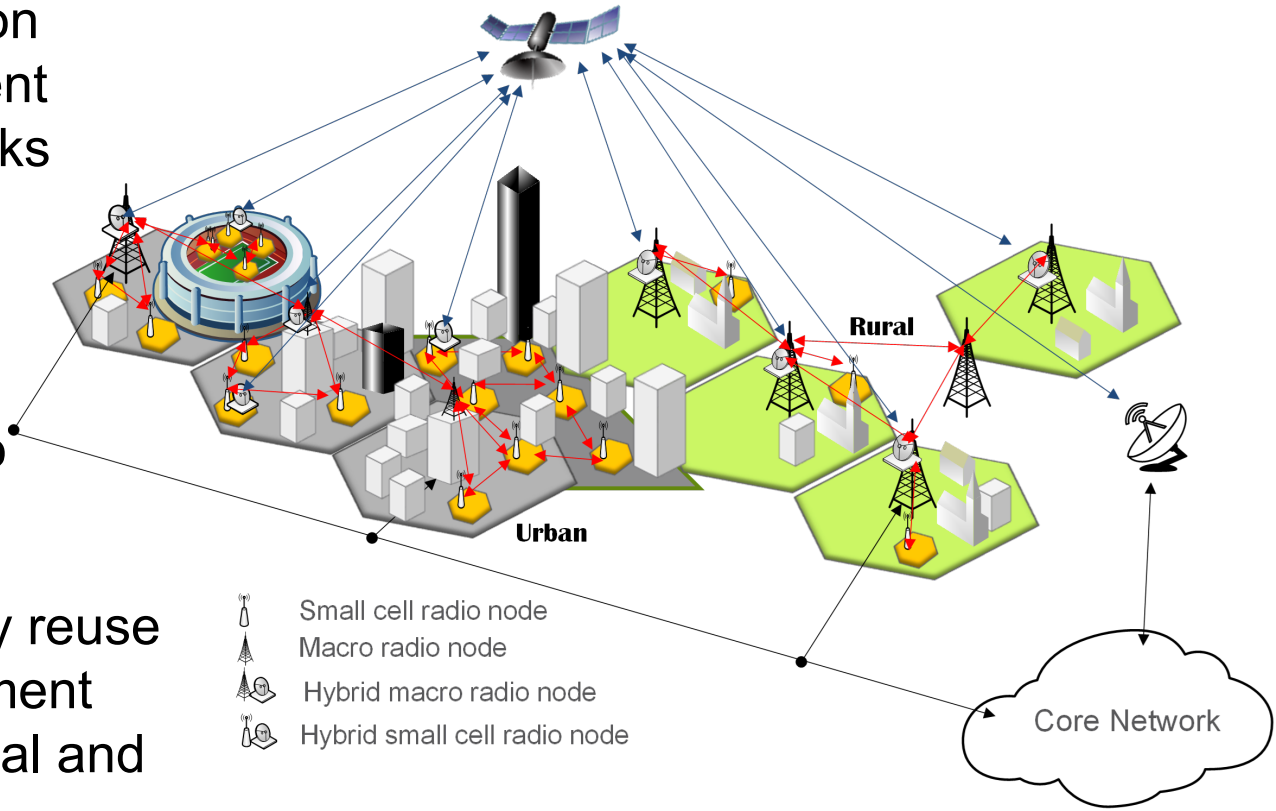
Satellite-Terrestrial integration

- Future networks should support anytime and anywhere communication with a wide range of QoS requirements

– A seamless integration of the satellite segment into terrestrial networks

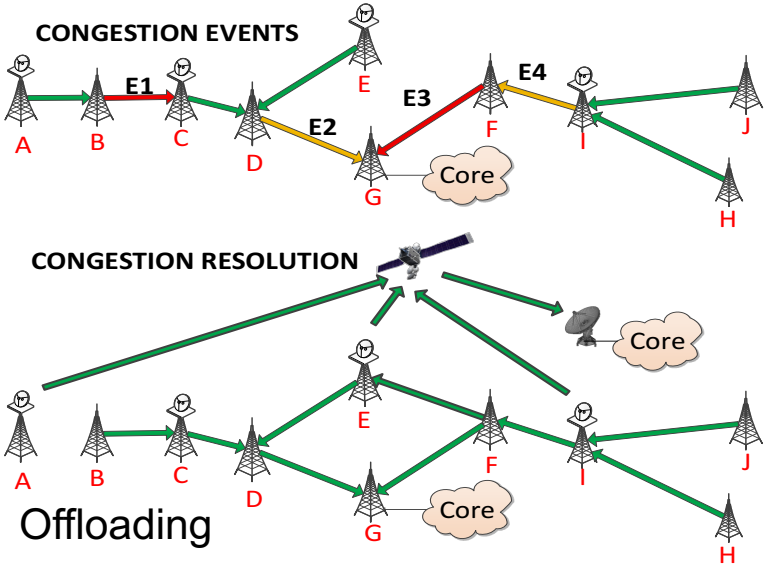
– A terrestrial wireless network capable of reconfiguring its topology according to traffic demands

– Aggressive frequency reuse within terrestrial segment and between terrestrial and satellite segments

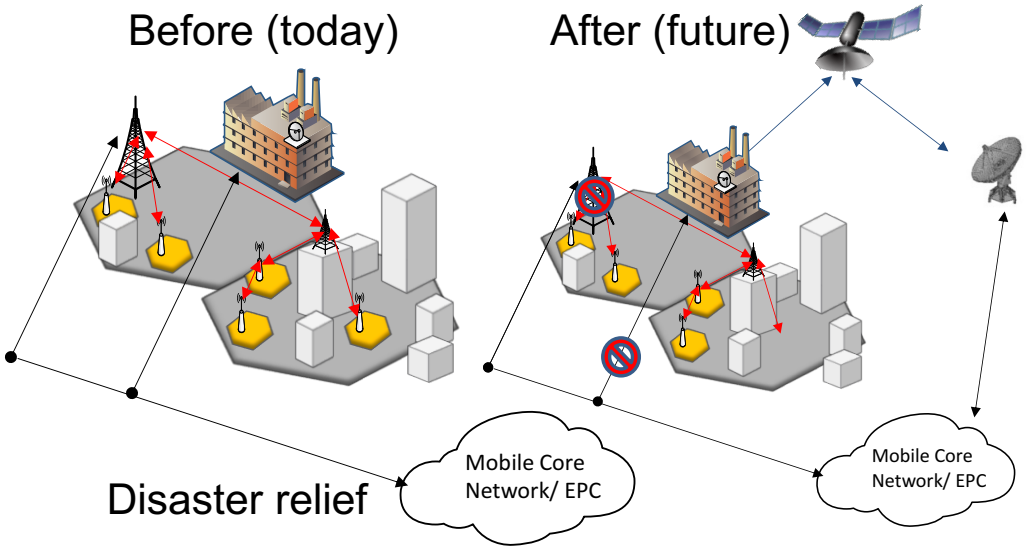


Can SatCom do more for us?

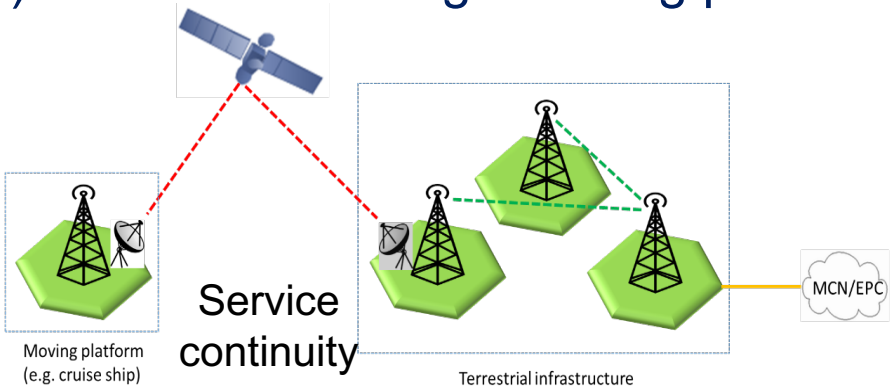
(1) Dynamic operation



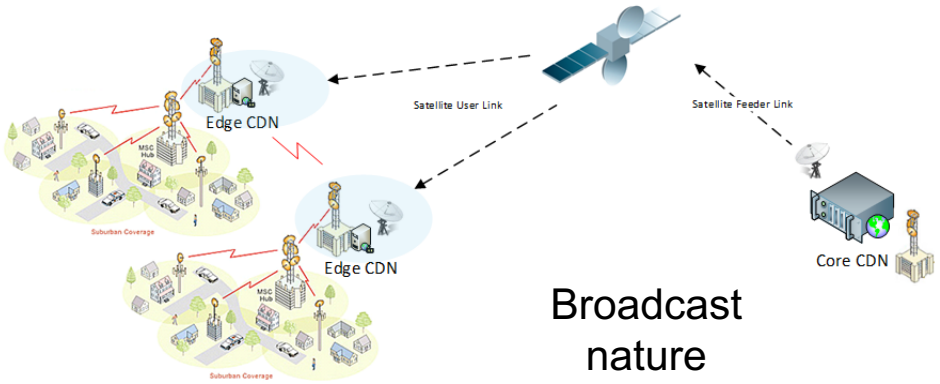
(2) Network Resiliency



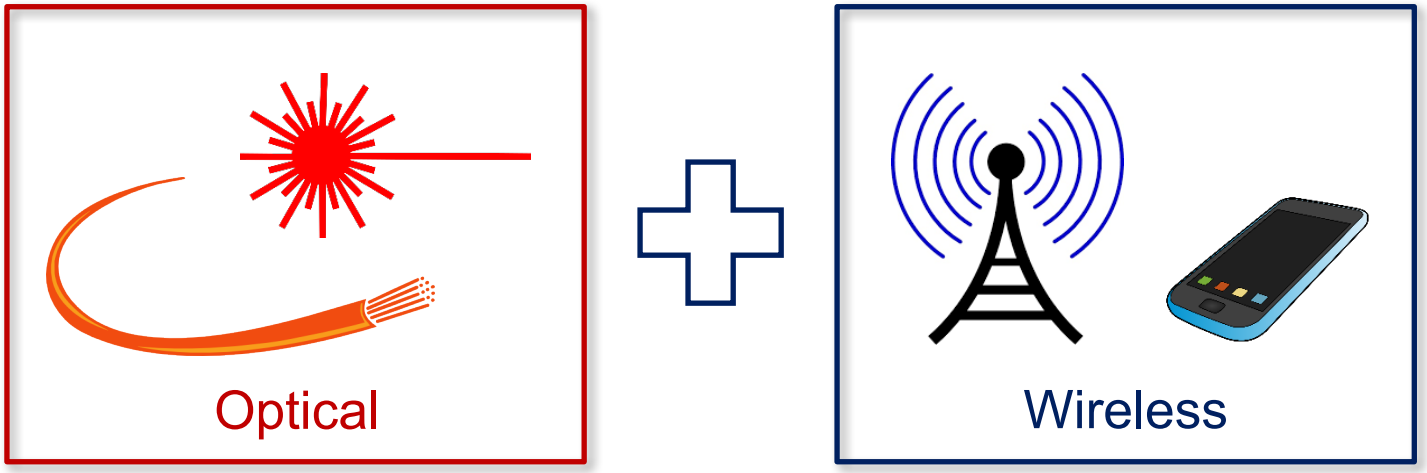
(3) Extended coverage/Moving platforms



(4) Content Delivery Network (CDN)

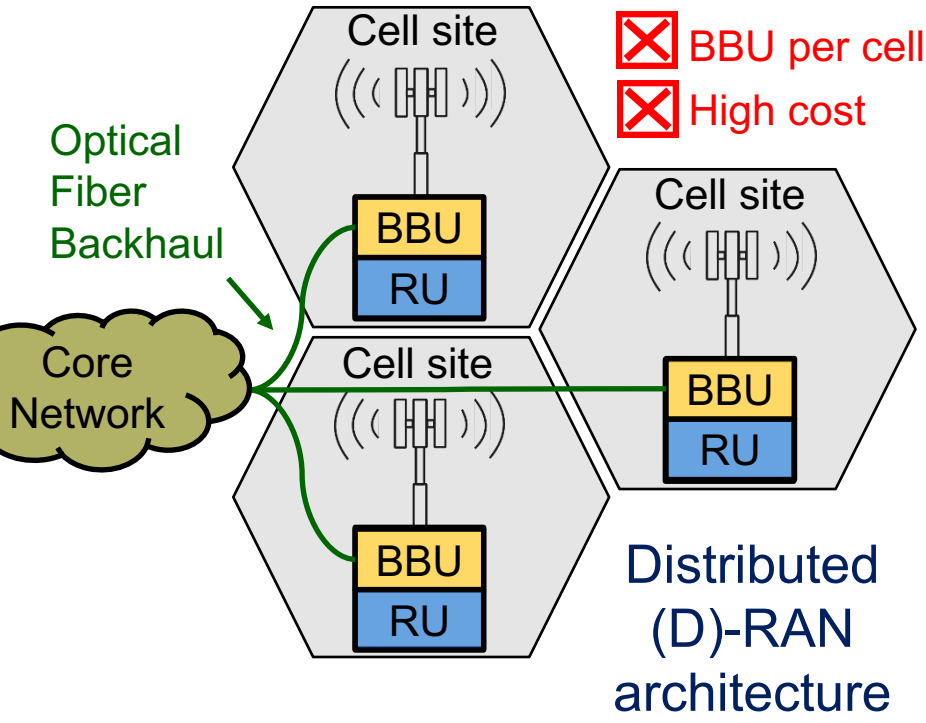


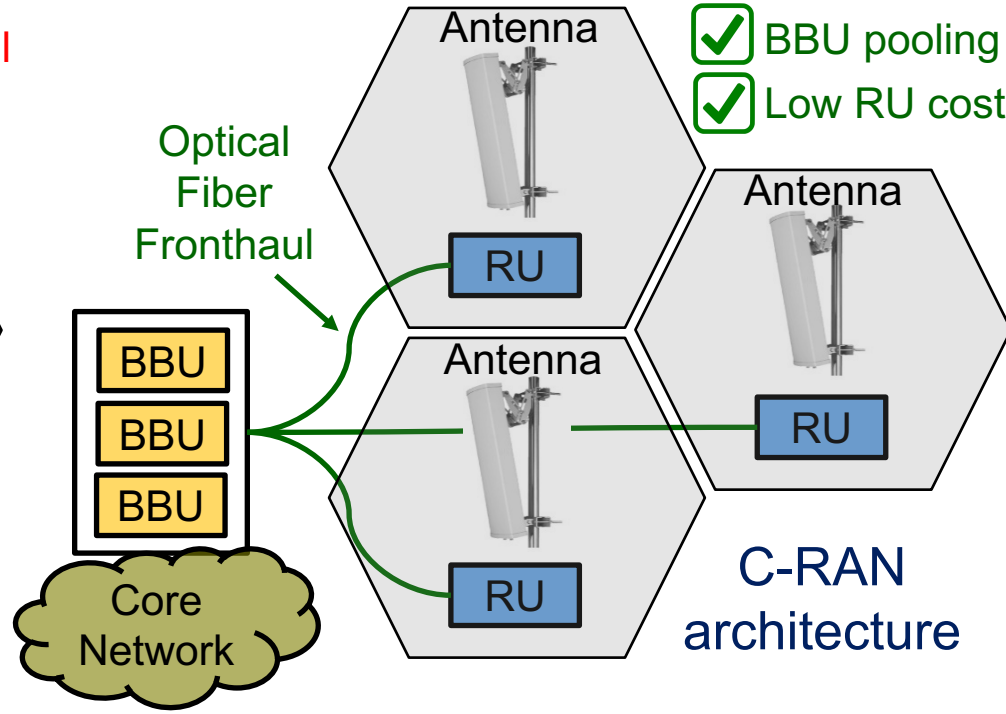
(2) Integration of optical and wireless communication technologies



Fronthaul in C-RAN architecture

- The **‘fronthaul”** is the network segment that appears in a C-RAN, where ‘C’ may mean “Centralized” or “Cloud”





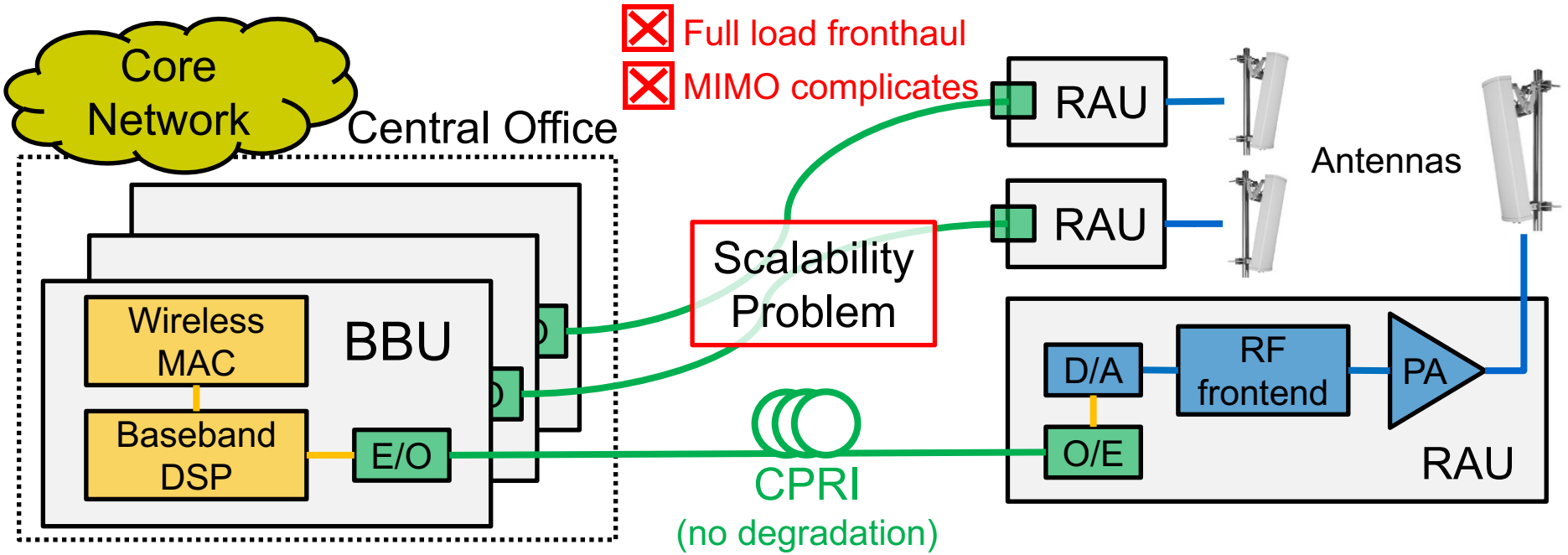
RU = Radio Unit (Analog signal processing)

BBU = Baseband Unit (Digital signal processing)

C-RAN: Base station is split into two parts connected with a fronthaul interface

Baseline C-RAN architecture (Today)

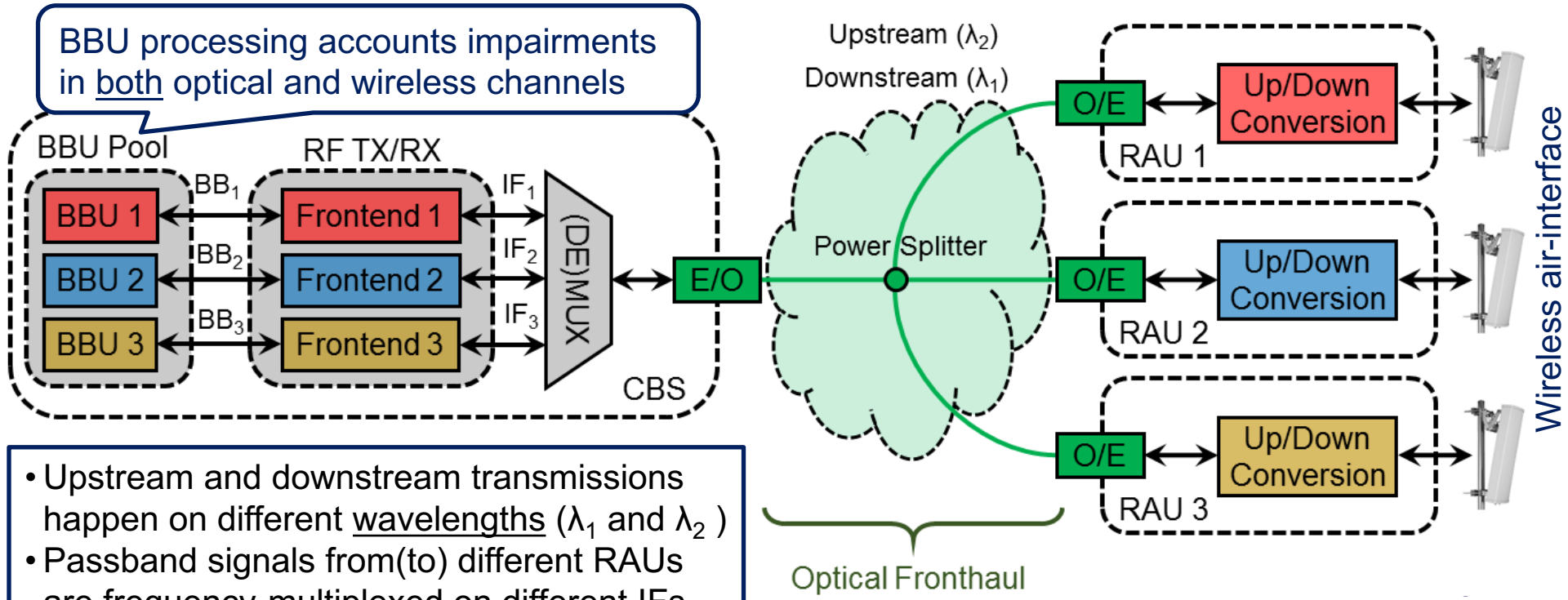
- Digital units of few cell sites co-located at Central Office (CO)
- Common Public Radio Interface (CPRI) used in fronthaul



- CPRI transports digitalized I-Q samples (plus sync, control and management) that <u>expand</u> the data rate and introduce <u>delay</u>

Proposed C-RAN architecture (Vision)

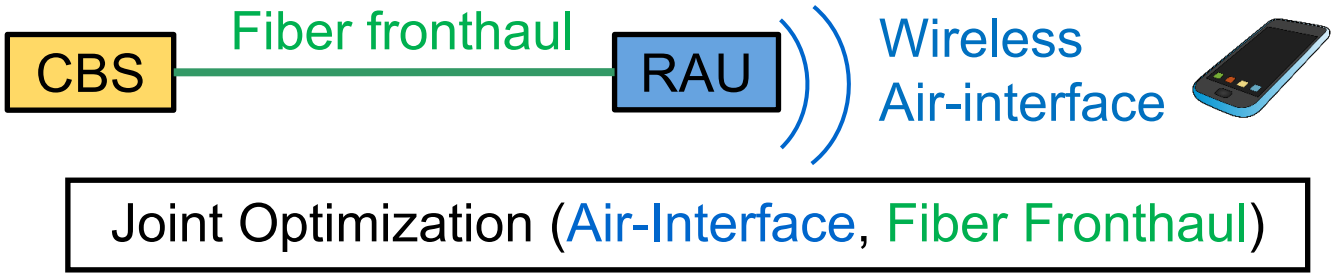
- RAU with low-cost analog hardware (ultra-dense deployments)
- Analog RoF fronthaul that introduces "*ideally*" only propagation delay and does not expand the wireless signal bandwidth over the fiber
- Fronthaul composed by single-fiber tree-like passive optical network architecture, which must be shared among all distributed RAUs



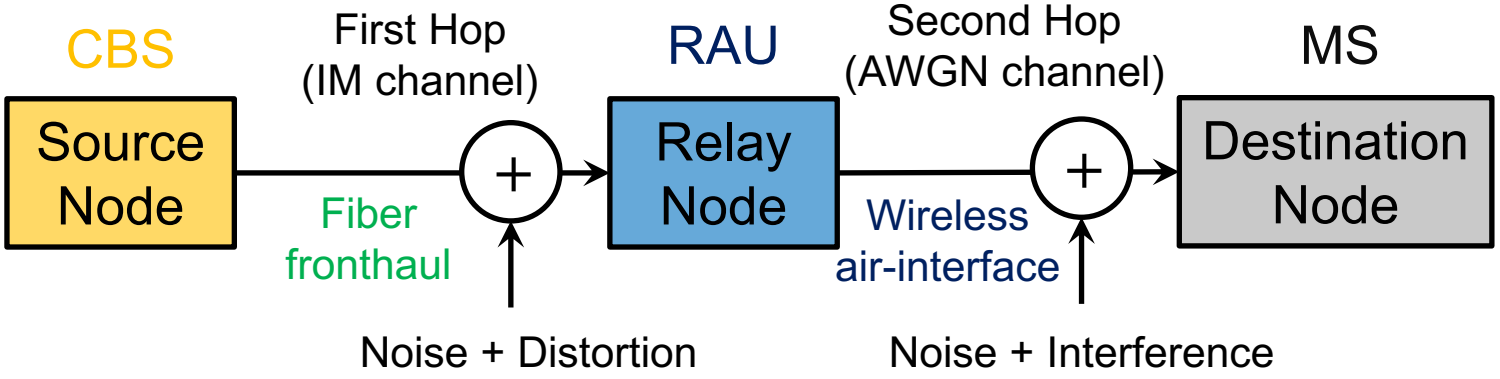
- Upstream and downstream transmissions happen on different wavelengths (λ_1 and λ_2)
- Passband signals from(to) different RAUs are frequency-multiplexed on different IFs

Can things be done in a better way?

- Traditionally, the modulation and coding scheme of a wireless system is selected based on the channel gain of radio channel



- The hybrid optical-wireless link that is configured when cascading the fibre fronthaul and air interface becomes and Amplify-and-Forward (AF) relaying system



Summary

- Two illustrative examples of communication technology integration beyond 5G were presented, namely:
  1) Satellite-Terrestrial integration (Access and backhaul)
  2) Optical-wireless integration (Access and fronthaul)

- The integration of satellite and terrestrial technologies is needed to support a wide range of QoS requirements (*e.g.*, (coverage extension, data offloading, and service continuity)

- In a C-RAN architecture, the use of an all-analog fronthaul enables the joint design of optical and wireless segments, providing key advantages to address 5G goals (*i.e.*, extremely low-delay, low-cost, multi-point cooperation, …)

Thanks for your kind attention!

Questions and/or comments?

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GOT A QUESTION?
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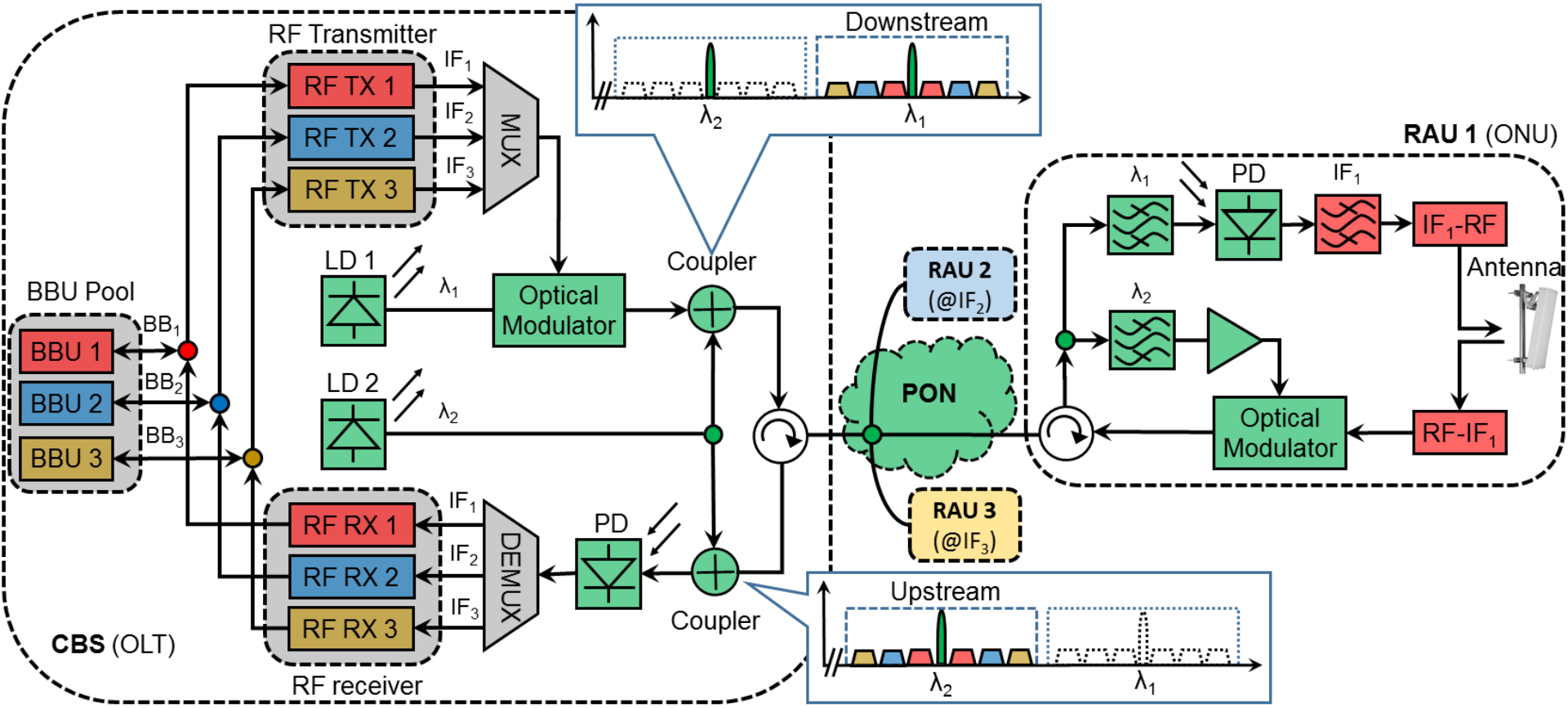
Proposed C-RAN for 5G



- **Downstream:** Intensity modulation (IM) of composite IF-mux signal
- **Upstream:** Electrical-field modulation with carrier supresssion