



5G integrated Fiber-Wireless networks exploiting existing photonic technologies for high-density SDN-programmable network architectures



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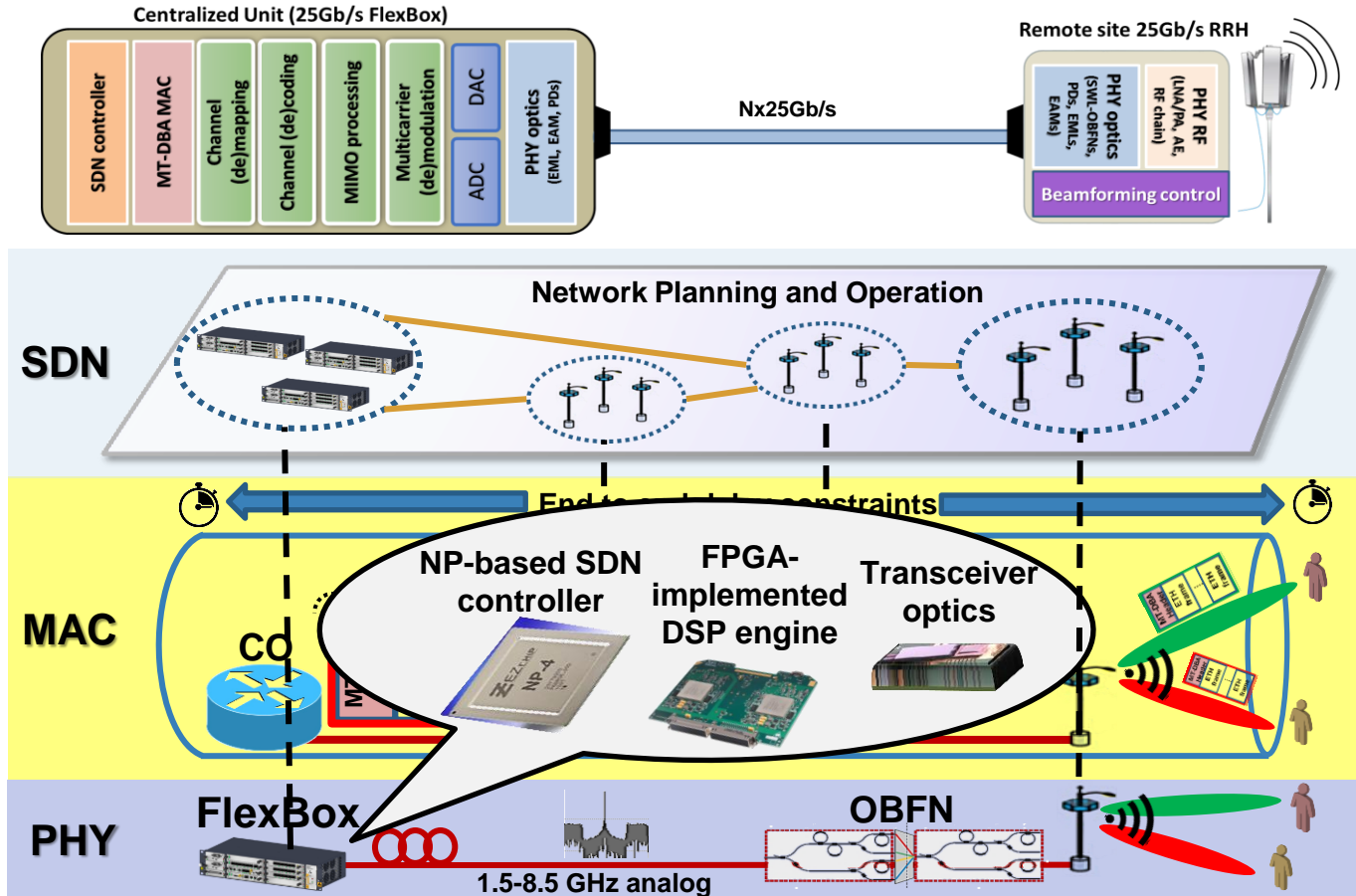
Overall goal

- V-band packetized C-RAN Fronthaul.
- Analog RoF w/ massive MIMO.
- Innovation Action: Close to market solutions.

Field Trials: **MTN Cyprus** **Orange Labs** **P.A.O.K. F.C.**

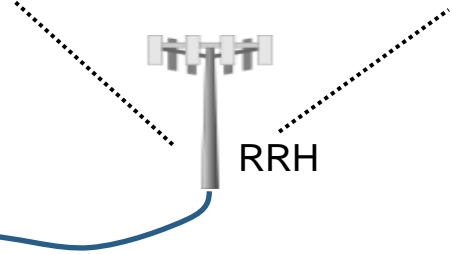
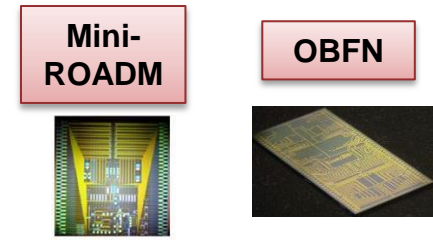
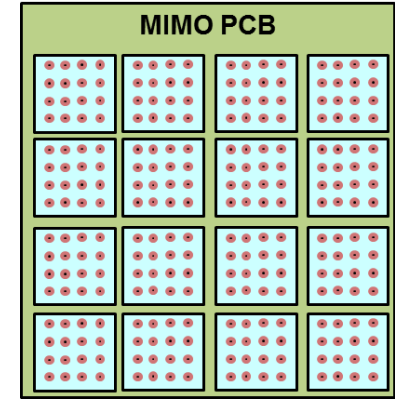
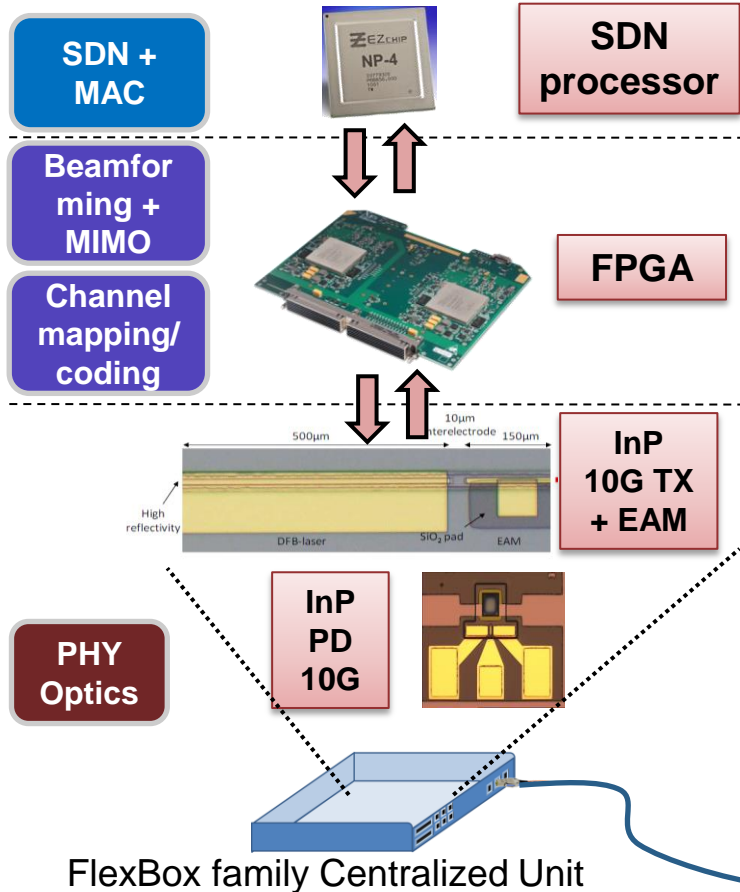


Solution Approach





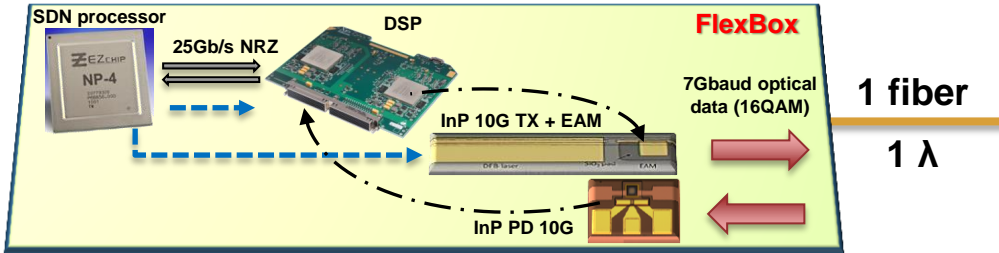
Technologies





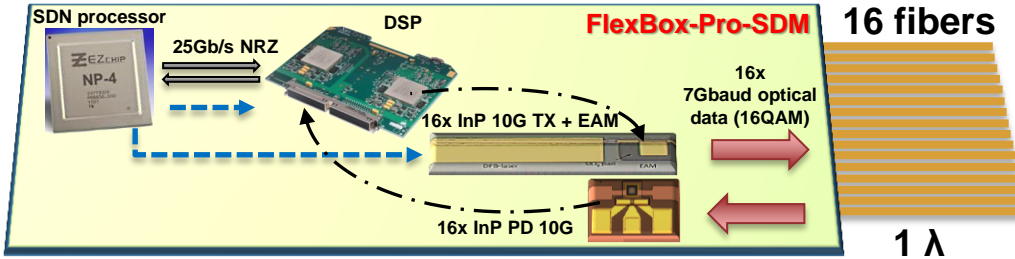
FlexBox family Centralized Units

- 25 Gb/s FlexBox for 25 Gb/s PON-overlaid networks



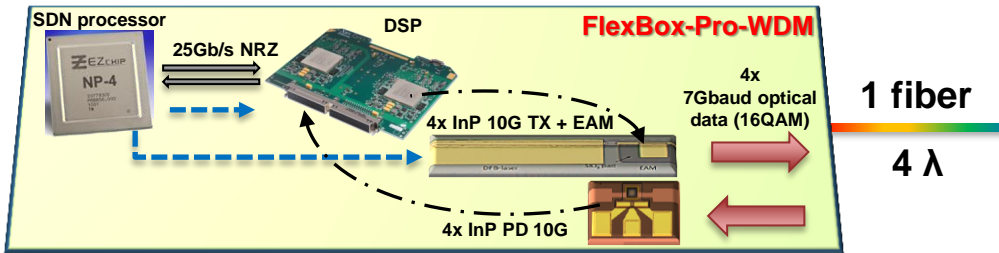
To 25Gb/s V-band MIMO RRH

- 16x25 Gb/s FlexBox-Pro-SDM for 400 Gb/s p2p SDM FiWi links



To 400Gb/s V-band MIMO RRH

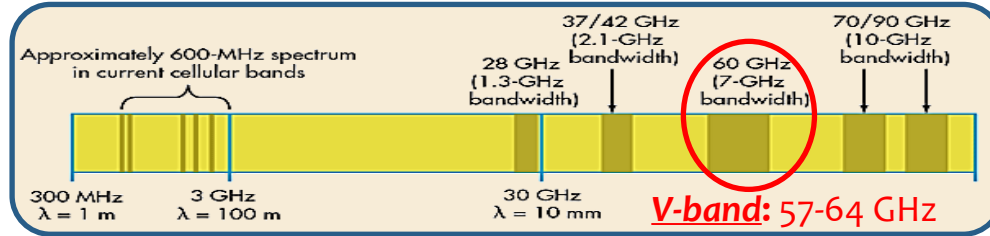
- 4x25 Gb/s FlexBox-Pro-WDM for 100 Gb/s TWDM FiWi links



To 100Gb/s V-band MIMO RRH



mmWave antennas for 5G networks



Massive MIMO layout
64x64 antenna elements

High-capacity

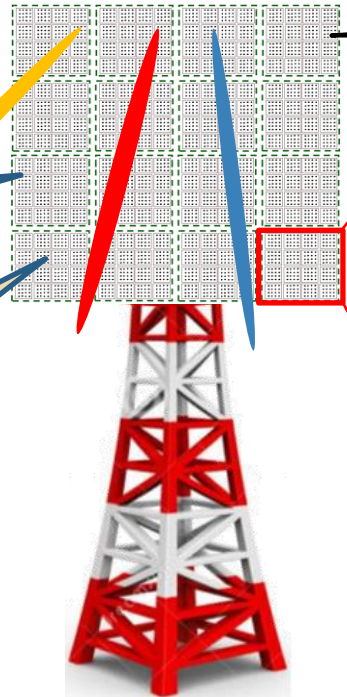
- ✓ 25 Gb/s
- ✓ 100 Gb/s
- ✓ 400Gb/s

Beamforming technology

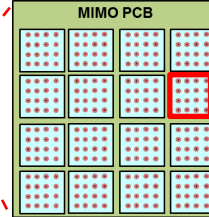
- ✓ Single- λ (25 & 16x25 Gb/s)
- ✓ Multi- λ (4x25 Gb/s)

OBFN-based RRHs

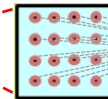
4096 antenna elements!
Not possible by 1 OBFN!



MIMO module (16x16)



Tile module (4x4)



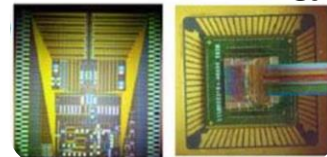
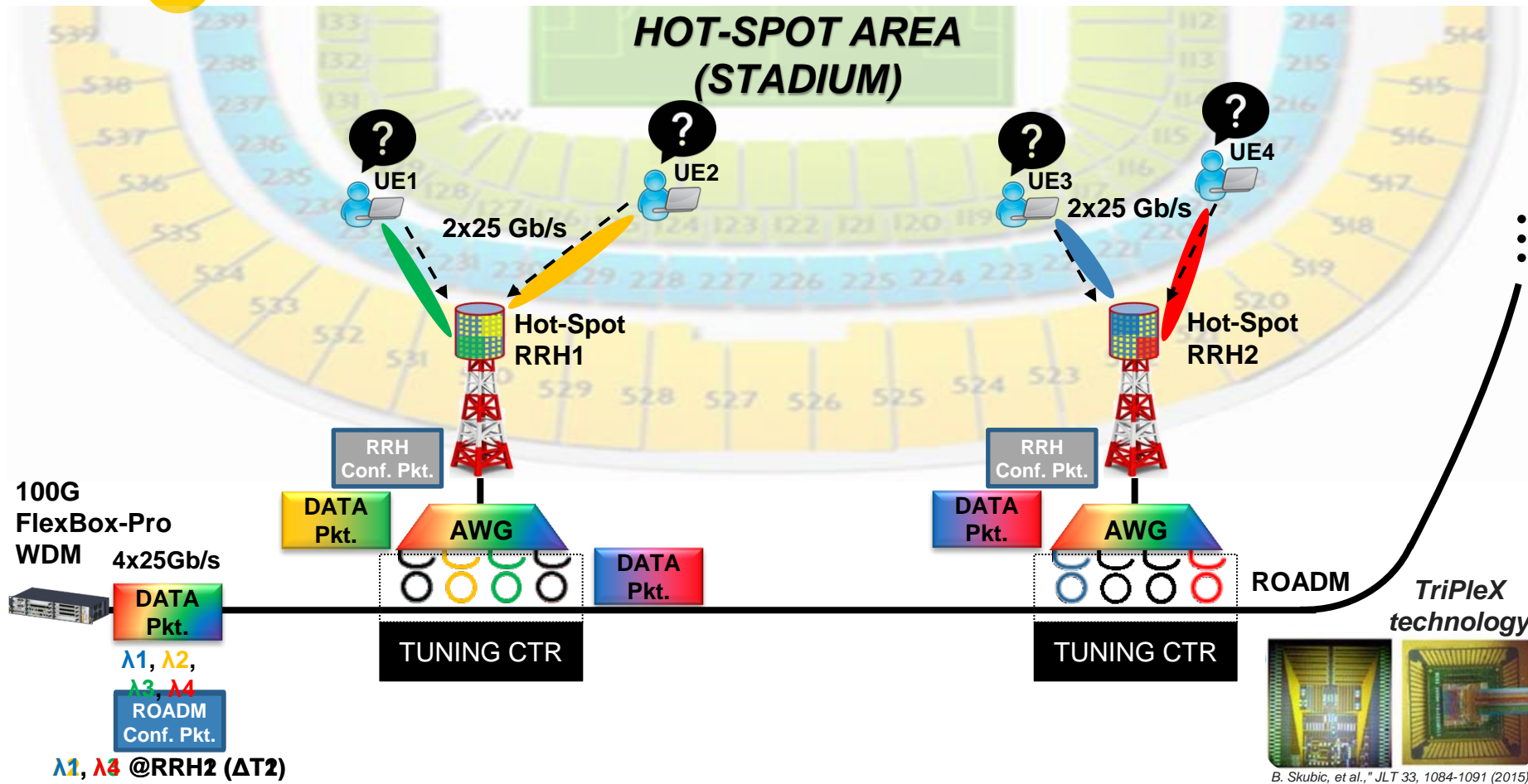
RF beamforming of 16 AEs & down-convert to 5GHz

SOLUTION

Modular technology path
+
Hybrid beamforming

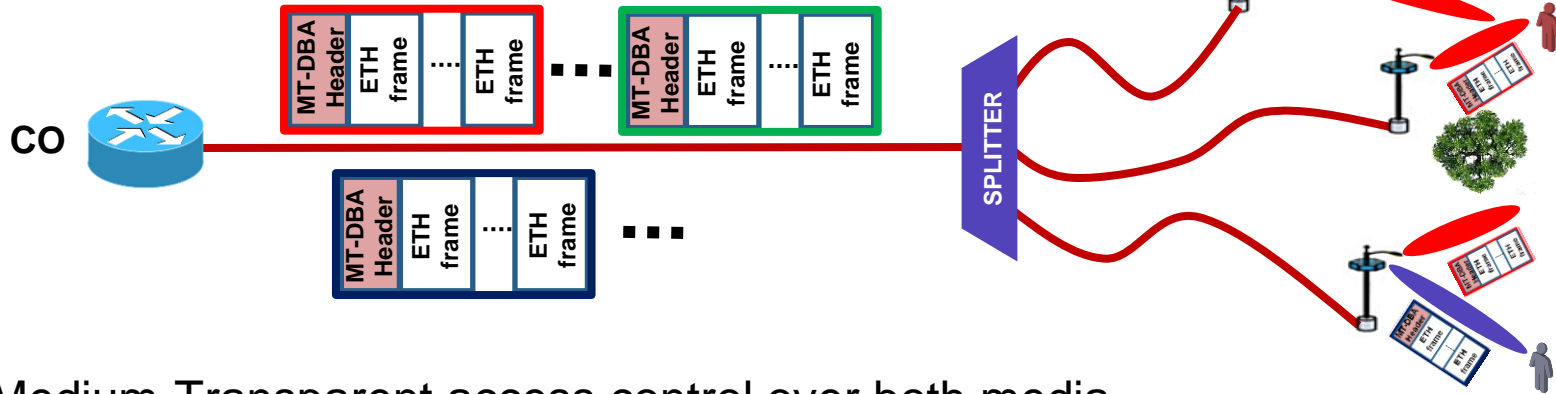


Mini-ROADM





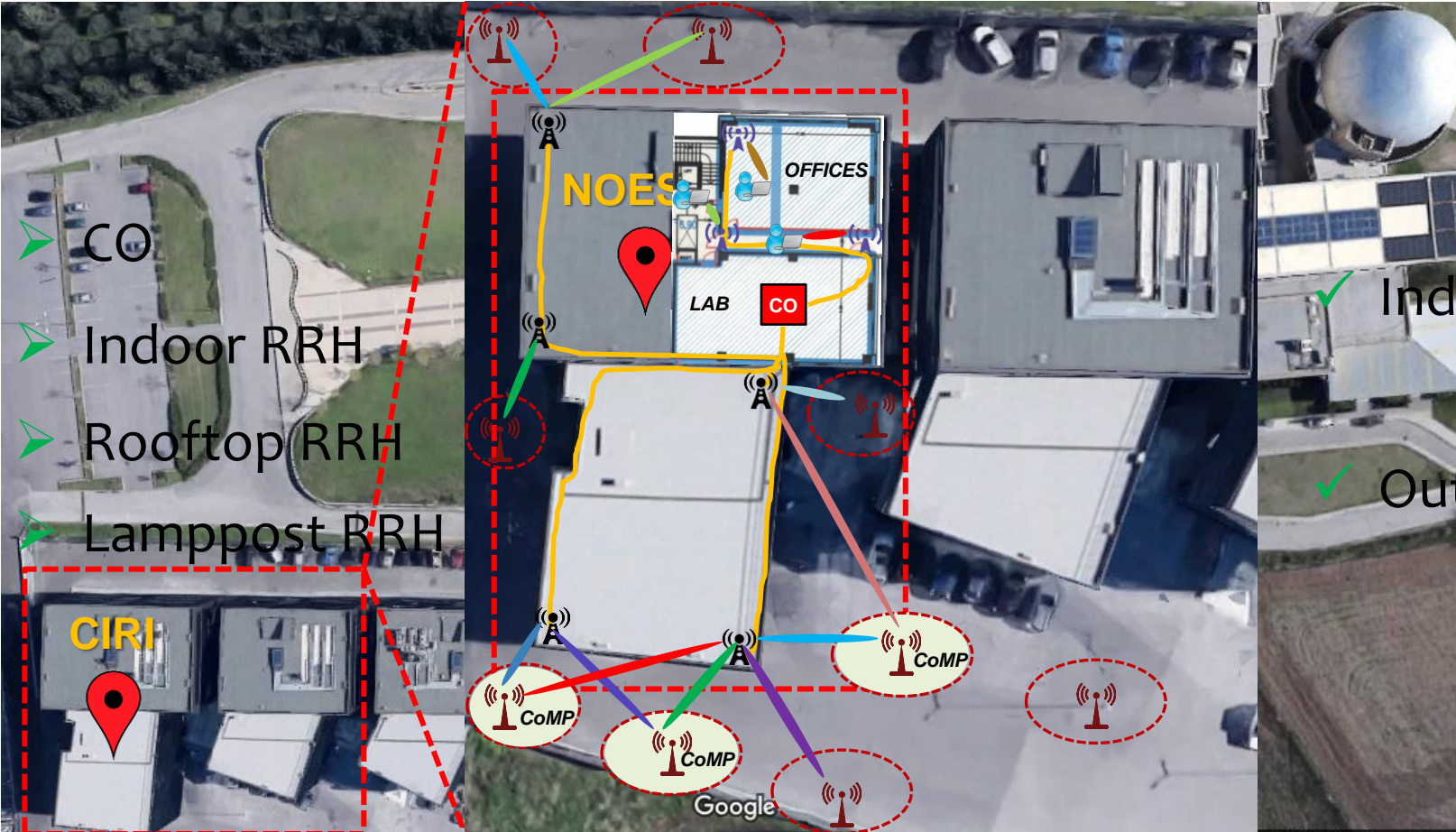
Packetized Fronthaul & CoMP



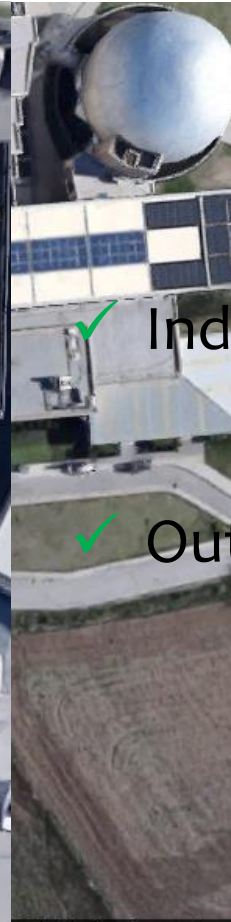
- Medium-Transparent access control over both media
- Ethernet payload compatible
- Cooperative Multipoint communications
- Centralized architecture enables re-routing of traffic



Testbed location in CIRI, Thessaloniki



- CO
- Indoor RRH
- Rooftop RRH
- Lamppost RRH



Indoor

Outdoor



Partners

- ✓ 9 countries
- ✓ 16 partners
- 2 research centers
- 3 operators
- 2 equipment vendors
- 3 universities
- 5 SMEs
- 1 football club

TU/e
Lionix
INTERNATIONAL

COSMOTE
Incelligent
Machine learning – powered Networks
ΠΑΦΚ

meec

Fraunhofer
IZM

orange™
III-V lab

ERICSSON

MTN

i q

Siklu
Mellanox
TECHNOLOGIES



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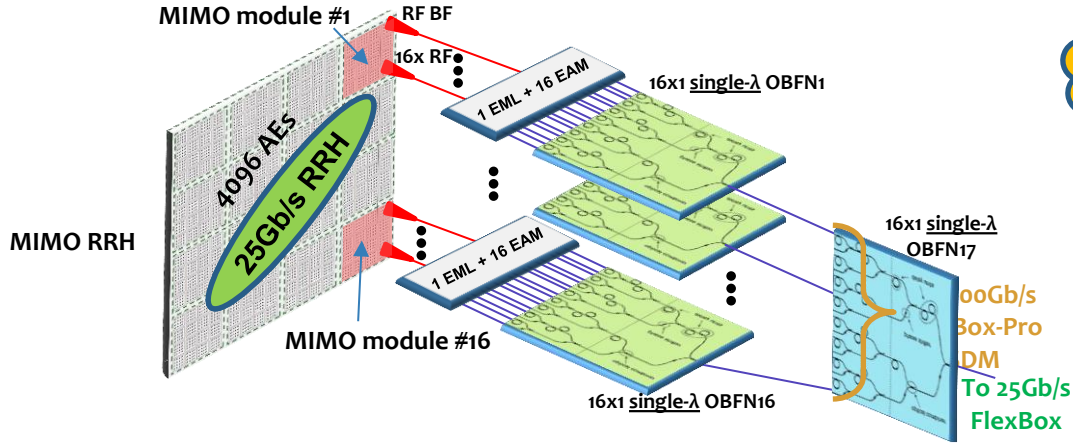
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Thank you for your attention!

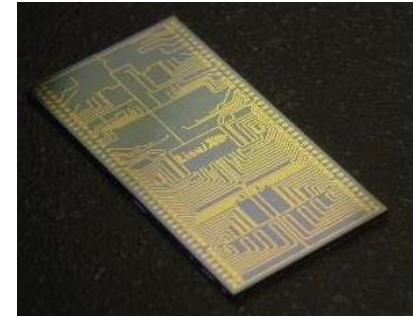


OBFN



(Ultra) Dense Areas

Single- λ OBFN



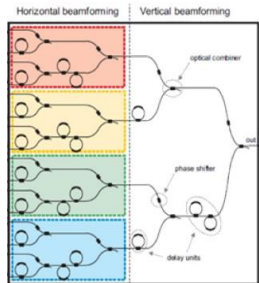
C. Roeloffzen et al., 34th ESA Antenna Workshop, (2012)

WDM: Exploit the frequency periodicity of RRs

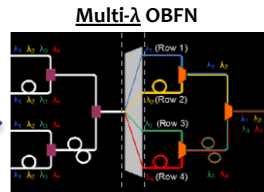
- ✓ Fewer RRs
- ✓ Cost & energy savings
- ✓ Reduced footprint

Hot-Spot Areas

- ✓ TriPleX waveguide technology
- ✓ 7 GHz instantaneous bandwidth
- ✓ > 1 ns tunable optical delays



Single- λ OBFN



M. Burla et al., JLT 32, 3509-3520 (2014)

To 100Gb/s FlexBox-Pro WDM

Multi- λ OBFN



M. Burla et al., JLT 32, 3509-3520 (2014)