Raul Muñoz, Research Director, Head of Packet Optical Networks and Services, Centre Tecnològic de Telecomunicacions de Catalunya (CTTC), Spain



Raul Muñoz (PhD 2005) is the Research Director and Head of Packet Optical Networks and Services at CTTC in Barcelona, Spain. He has contributed to over 50 R&D projects related to optical networks and 5G/6G, including coordinating two European projects (STRAUSS and ONFIRE). He served as elected academic member of the Steering Board for the 5G Infrastructure Association, Wireless World Research Forum, and Networld2020 from 2015 to 2017. He is serving as editor of the optical networks chapter in the NetworldEurope strategic research and innovation agenda (SRIA) in 2016, 2022 and 2024. He also served as general Chair for NoF2024 and ONDM 2020 conferences, and TPC chair for ECOC 2015. His research focuses on network control, and service management for packet-optical networks, and he has published over 100 journal papers and 300 conference papers.



ITU Workshop on "Evolution of Optical Networks for IMT2030 and Beyond"

Charles K. Kao Auditorium, Hong Kong Science and Technology Park (HKSTP) 20 November 2024, 15:00 - 18:00

Towards Optical Network 2025/2030: ETSI F5G-A PoC and Networld Europe SRIA

Raul Muñoz CTTC



ETSI ZSM & F5G POC:

Enabling Cloud AR/VR Gaming Services by an Open-Source and Standards-Based Network-as-a-Service Platform for Control and Management of Optical Networks



PoC Use Case: CAMARA+F5G for Cloud VR Gaming







PoC Demo Lab Equipment



OCN: Optical Cloud Network (See ETSI DGS/F5G 018)

fgOTN: fine grain OTN (see ITU-T G.709.20)

Performed PoC Demos

- MWC, February 26-29, 2024 in Barcelona, Spain
- IEEE, 24–28 June 2024, St. Louis, USA
- ICTON, July 14-18, 2024, Bari, Italy
- ECOC, 22-26 September 2024, Frankfurt, Germany.
- CNSM, 28 31 October 2024, Prague, Czech Republic.







Demo use-case for PoC phase two: cloud VR service differentiation and service assurance

- More advanced QoD features:
 - App-flow service classification and differentiation through network slicing,
 - service status monitoring and telemetry,
 - closed-loop operations for service assurance.



Lab setup for PoC phase two





NETWORLD EUROPE ETP:

Strategic research and innovation agenda (SRIA) 2024

"NetworldEurope is the new incorporation of the European Technology Platform (ETP) for communications networks and services, which gathers players in the communications systems sector: industry leaders, innovative SMEs, and leading academic institutions, thus reaching out to a significant part of the European ICT community. The NetworldEurope has currently **973 members**, including 142 "Industry" members, 322 "Research" members, 363 "SME" members, and 146 "Cooperation" members."



NETWORLD EUROPE SRIA 2024: Optical research challenges

- Networld Europe ETP is defininig the Strategic Research and Innovation Agenda 2024, including a chapter on optical networks:
 - Introduction and Vision (Editor: Raul Muñoz, CTTC, Andrew Lord, BT and Philippe Chanclou, Orange).
 - Sustainable capacity scaling (Editor: Sébastien Bigo, Nokia Bell Labs France)
 - New switching paradigms (Editor: Colja Schubert, Fraunhofer HHI)
 - Deterministic networking (Editor: Jörg-Peter Elbers, ADTRAN)
 - Optical technologies for radio networks and systems (Editor: Fabio Cavaliere, Ericsson)
 - Optical network automation (Editor: Ramon Casellas, CTTC)
 - Security for mission critical services (Editor: Helmut Griesser, ADVA Network Security)
 - Ultra-high energy efficiency (Editor: Antonio Napoli, Infinera)
 - Optical integration 2.0 (Editor: Benjamin Wohlfeil, ADTRAN)
 - Optical access beyond FTTH (Editor: Rene Bonk, Nokia Bell Labs Germany)
 - Optical wireless (Editor: Ernesto Ciaramella, SSSA)
 - Other contributors: HUAWEI, U. Patras, POLITO, TCD, UPC



NETWORLD EUROPE SRIA 2024: Optical key performance indicators (KPIs)

	Target KPI		Current	Short-term Evo	Mid-term Evo	Long-term Evo
			2024	~2027	~2030	~2033
Metro/Core Networks	Aggregated Spectrum ¹		10 THz	20 THz	40 THz	100 THz
	Port speed ²		800 Gbps	1.6 Tbps	3.2 Tbps	6.4 Tbps
	Bandwidth ³		<150 GHz	<300 GHz	<600 GHz	<1.2 THz
	Line capacity ⁴		50 Tbps	200 Tbps	600 Tbps	2 Pbps
	Node capacity ⁵		300 Tbps	1.2 Pbps	3.6 Pbps	12 Pbps
	FSO Feeder capacity ⁶	НАР	N/A	50 Gbps	100 Gbps	200 Gbps
		LEO sat.	N/A	100 Gbps	400 Gbps	800 Gbps
		GEO sat.	N/A	1 Tbps	2 Tbps	5 Tbps
Access Networks	PON line rate		Combo : G-PON & XGS-PON & 25G- PON	50G-PON in combo with G-PON and XGS- PON	100 or 200G-PON (preliminary)	100 or 200G-PON (mature) 0.5T-PON (preliminary)
	User data rate ⁷ (consumer)		Up to 5Gbps	Up to 10Gbps	Up to 10Gbps	Up to 50Gbps
	User data rate ⁷ (business)		Up to 8Gbps	Up to 25Gbps	Up to 50Gbps	Up to 100Gbps
	Latency ⁸		Downstream < 50µs	Downstream < 30 μs	Downstream < 25 μs	Downstream < 20 μs
			Upstream < 1ms	upstream < 500 μs		
	FSO speeds		1-10 Gb/s	100 Gbs	200 Gbs	400 Gbs

NETWORLD EUROPE SRIA 2024: Optical key performance indicators (KPIs)

	Targat KDI	Current	Short-term Evo	Mid-term Evo	Long-term Evo
	larget KPI	2024	~2027	~2030	~2033
Building Networks	PON capacity, latency	<= access networks offer for consumers	<= access networks offer for consumers	<= access networks offer for consumers	<= access networks offer for consumers
	LIFI capacity, latency, footprint	Gb/s, large footprint and high power consumption	5 Gb/s, <100 cm3		10 Gbs, 1 cm3
	Position accuracy	none	4 cm	2 cm	1 cm
	Power consumption ⁹	100%	40%	30%	20%
	Service provisioning ¹⁰	Under 1hour	O(10min) Partially limited by hardware configuration delays	Under 1min Limited by hardware configuration delays	O(10s) Limited by hardware configuration delays. O(k x 100ms) in specific scenarios O(k x 10ms) with optimized systems
	Network operations ¹¹	Operator-controlled, reactive. Manually triggered, automated via control & mgmt	Intent-based, proactive. Selected autonomous operations Half-closed loop network operation	Self-diagnosing	Self-optimizing

Conclusions and synergies



Conclusions and synergies

- ETSI ISG F5G is working / will work on F5G-A E2E system and beyond
 - The joint ETSI ZSM/F5G PoC requires to validate the F5G Advanced network from E2E (access, aggregation, core, cloud).
 - ITU-T SG15 covers all the aspects of the E2E system, but it would be preferable to have more coordination and do some related standards for E2E.
- Networld Europe is defining the Strategic Research and Innovation Agenda 2024, including the Optical KPIs for short, medium and long-term evolution (2033) :
 - It is a joint effort of the main European vendors and operators.
 - Similar as IMT-2030 defines the KPI of wireless, ITU-T SG15 may define optical version IMT2030 and the KPI of Networld Europe SRIA could be a useful input.
- It will be great if ITU-T, ETSI, Networld Europe and other SDOs/Academic groups can work together for the Optical Network 2030: defining the UC, KPI, architectures; organization workshops/symposiums...



Thank you !

