



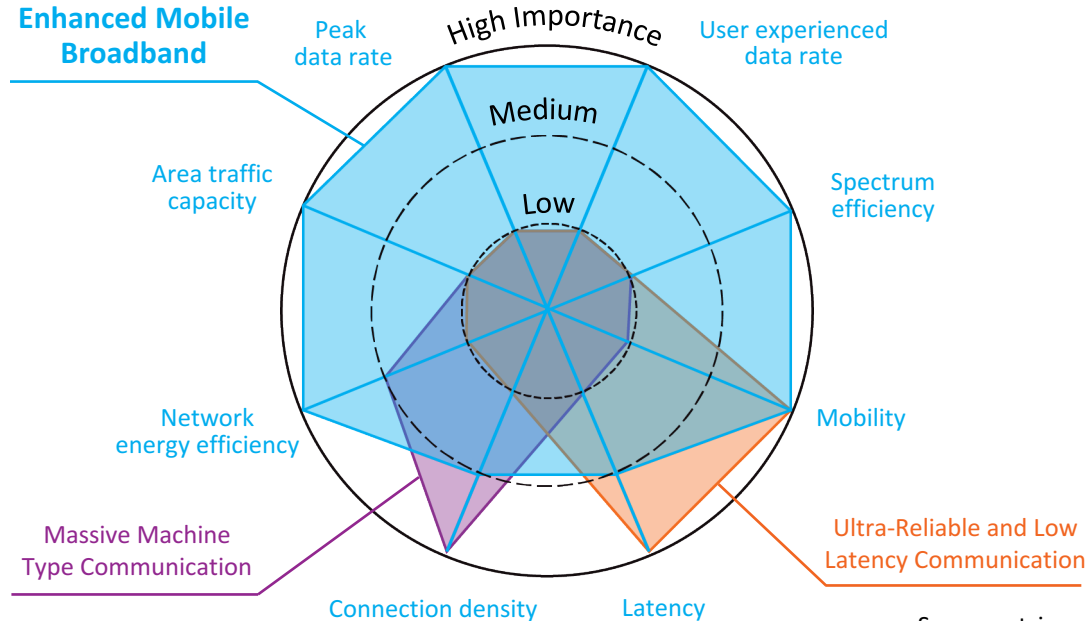
CREATING
THE LIVING NETWORK.
TOGETHER.

Edge Technology Innovation in a 5G World

Edge Computing Congress, Berlin

September 18-20, 2018

5G is Now! & Flexibility May Be Its Key Defining Attribute

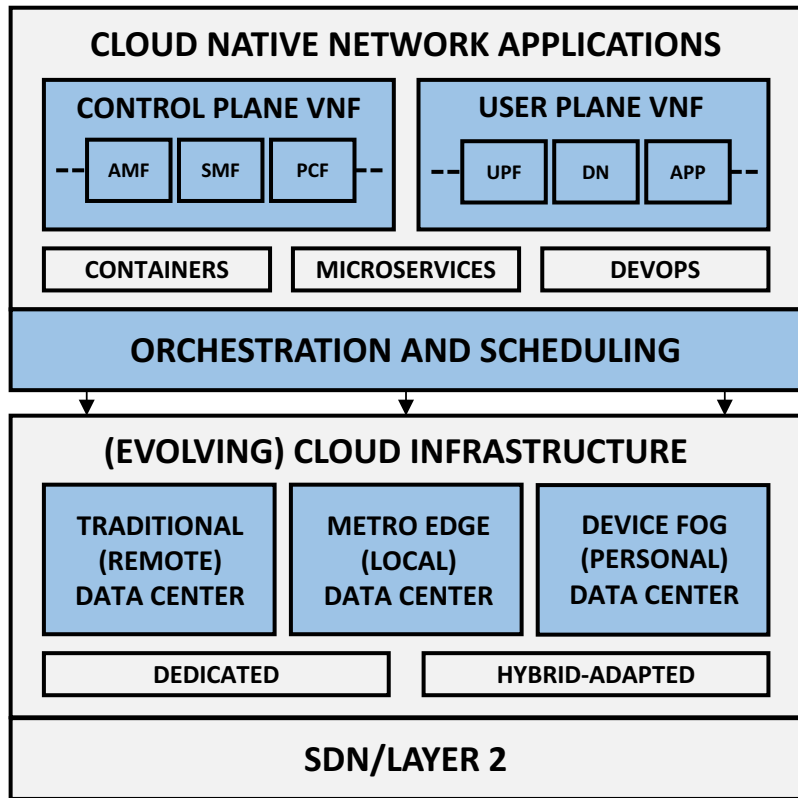


Source: etsi.org

5G is Being Shaped with All These Diverse Requirements in Mind



5G is Pushing the Frontiers of the Cloud Native Design



- To meet needs of 5G services network is steadily evolving away from legacy P2P
- NOT a new trend in Internet space but new and defining in 5G Wireless world!
- Embrace of a SBA in Release 15 means 5G Core will be “Cloud Native” by design
- Release 16 focus is on Control Plane and limited set of User Plane Functions
- Beyond this, how broad and how deep this push will go (& when) is not yet clear
- One thing that is clear, where this road leads is the ***future of Edge Computing...***

InterDigital is Holistically Exploring This Future in 2 Projects

Current + Historical Partners (38)

Platform providers	InterDigital, ATOS
Vendors	Huawei, NEC, Intracom, Thales
Content	Disney Research, VRT Belgium
Operators	Deutsche Telekom, Orange, Telenor Guifi.net, Avanti, Primetel
SMEs	CTVC, Ell.i, Martel Consulting, Ubitech B-COM, Eurescom, Nextworks
Municipalities	Barcelona, Bristol-is-Open
Academia & Research Institutes	Athens University of Economics & Business, Aalto University, RWTH Aachen, TU Munich, Cambridge University, University of Essex, TU Kaiserslautern, i2CAT, iMinds, King's College London, Fraunhofer Fokus, IT Aveiro, IT Innovation, University of Bristol, ETH Zurich



EUH2020 funded under grant #731677
<http://www.ict-flame.eu>



Unfunded effort in the 5G Private Public
Partnership Programme
<http://www.5g-control-plane.eu>



EUH2020 funded under grant #643990
<http://www.point-h2020.eu>



EUH2020 funded under grant #644663
<http://rife-project.eu>



13.5MIL EURO
Combined H2020 Funding



Showcased as **ETSI MEC PoC**
Successful **5G network trial in 2017**
World first **5G CP demo in 2018**

Current Partners (10)

Vendors	Ericsson (Sweden) InterDigital (United Kingdom) ADLINK (Taiwan) AZCOM (Italy)
Operators	Telecom Italia (Italy)
SMEs	Telcaria (Spain)
Academia & Research Institutes	ITRI (Taiwan) University Carlos III of Madrid (Spain) National Chiao Tung University (Taiwan) RISE (Sweden)



EU H2020 funded under
grant #761586

<http://www.5g-coral.eu>

*A 5G Converged Virtualised Radio Access Network
Living at the Edge*

Project Coordinator: Dr Antonio De La Oliva (UC3M, Spain)
Technical Manager: Dr Alain Mourad (InterDigital, UK)
Innovation Manager: Dr Chenguang Lu (Ericsson, Sweden)



4MIL EURO
Combined EU-Taiwan Funding



1st Showcase at **Edge Congress Sep'18**
1st Trial in a **Shopping Mall in Taipei (Taiwan) Oct-Nov'18**

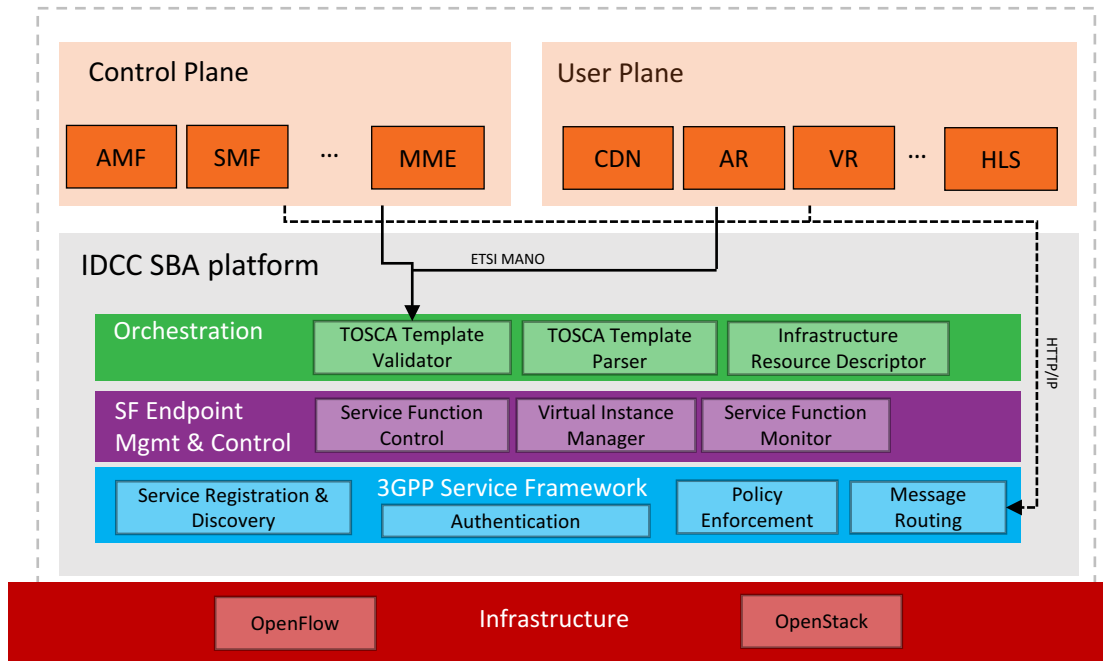
FLAME Project Family Deeper Dive (Our SBA Platform)

Pioneering Project Family that has Helped Drive the 5G Core Move to a SBA Today

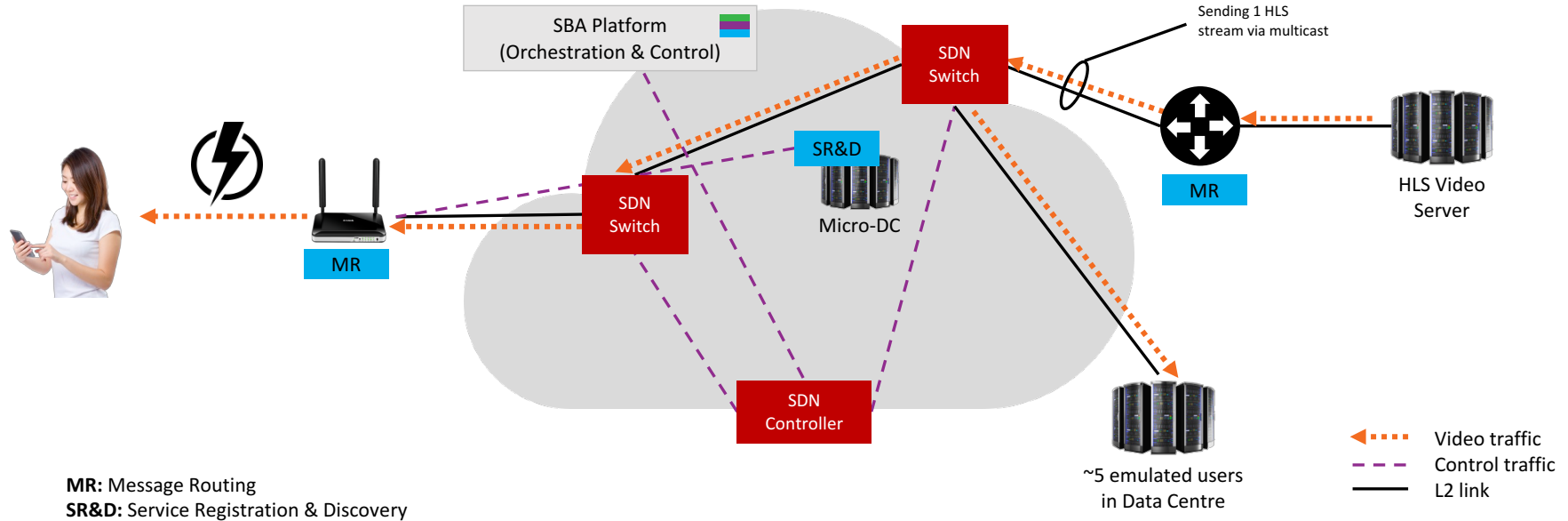
5G compliant service delivery platform that has proven MEC services & capabilities can be delivered in minutes or less over managed cloud-native operator infrastructures

- **We have also proven** an array of other capabilities are possible through this technological approach:
 1. **Linear cost increases of HTTP based streaming can be capped through an easily enabled L2 multicast method**
 2. **E2E latency can be reduced significantly by dynamic end point selection nearest to end users in less than 20ms**
 3. **Recovery from service & network failures can be reduced to <1 sec. compared to DNS based failovers in minutes**
 4. **Device battery performance can be increased 50% by offloading device functions in real time to edge resources**
- **Experimental** solution, deployed in 5G UK test bed in Bristol & Bath (in UK) by end of September 2018
- **Trials** planned for 2018 and 2019 in Bristol, Bath and Barcelona

InterDigital 3GPP Compliant SBA Development Platform

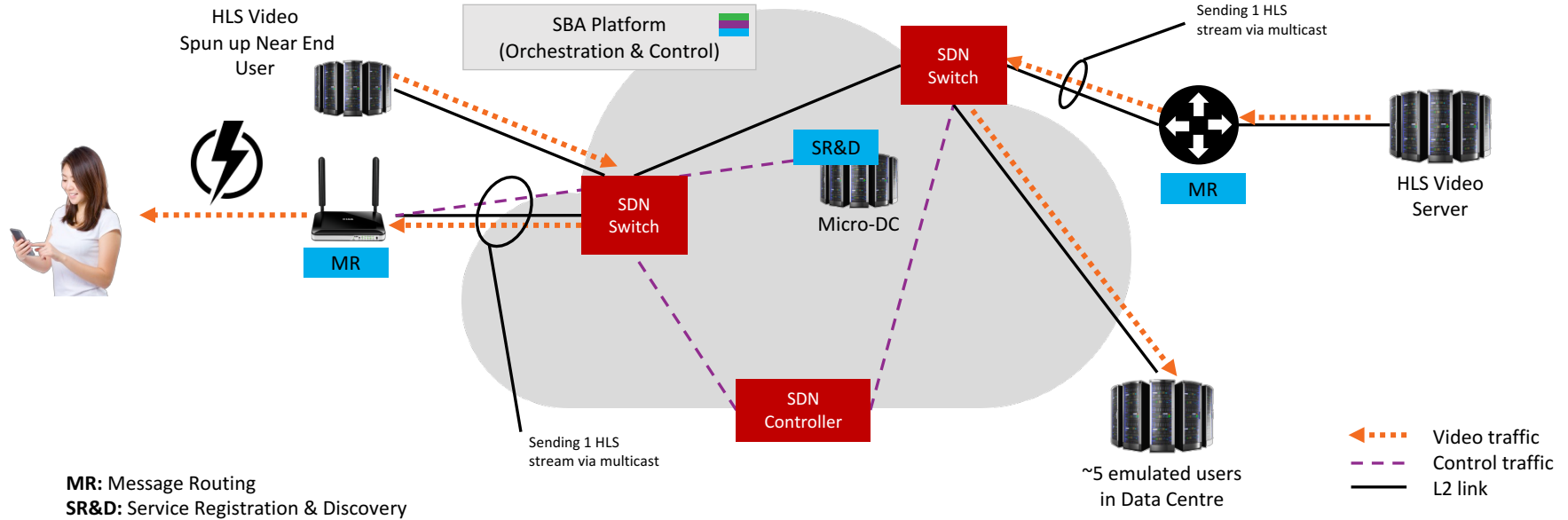


Berlin Demo Aspect 1: Multicast Gain Equals Number of Users



Aspect 1 demonstrates the multicast gain as well as the reduced server load through multicast delivery of HTTP responses in HLS video streaming scenario.

Berlin Demo Aspect 2: Spin up HLS at Edge or Latency Reduction with Switch-Over Times of <1s

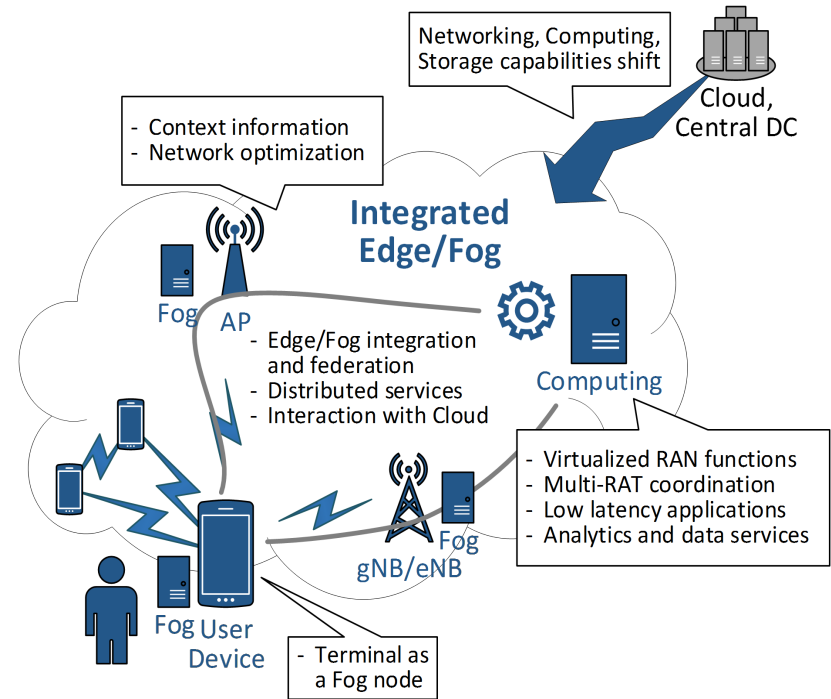


Aspect 2 demonstrates the latency reduction and video quality improvement through spun up edge server at Edge Congress.

CORAL Project Deeper Dive

Exploring Service Based Design in a Deep and Volatile Edge-Fog Infrastructure model

- CORAL stands for “**A 5G COnvergent Virtualized Radio Access Network Living at the Edge**”
 - An H2020 international EU-Taiwan project from Sep 2017 to Aug'19 (2 years)
- Targets an **integrated virtualized edge and fog** RAN solution, aka a **FogRAN** notion
- Focus on the deep edge and fog tiers of the distributed computing infrastructure, along with their interactions with the higher tiers (regional cloud/data centers)
- Mobile and Volatile Fog nodes are also key focus area, for example a user terminal (e.g. smartphone, car, drone, AR/VR unit)

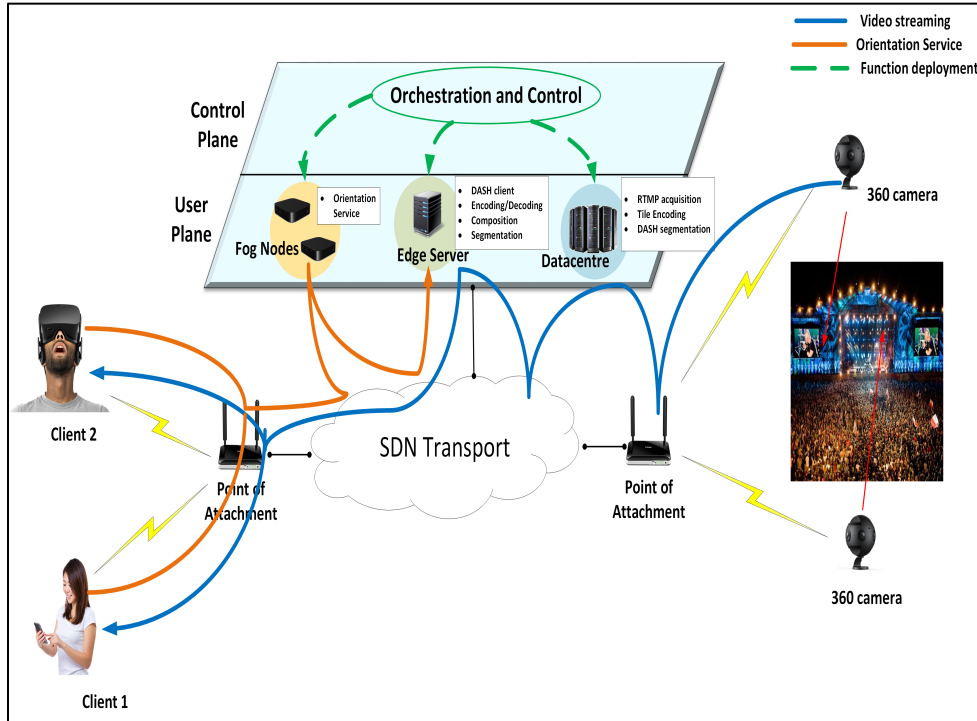


Some of the Unique Challenges Virtualizing the Deep Edge

- **Orchestration** of resources, noticeably volatile & mobile in nature, requiring special handling for volatility & mobility management
- **Integration and federation** of heterogeneous resources belonging to different Business domains and possibly different owners
- **Distribution, synchronization & chaining** of applications, functions and services across this dynamic resource fabric
- **Authentication, authorization, and accounting (AAA)** for smartly controlling access to deep edge resources
- **Timely provisioning, abstraction and fusion** of measurement and context data for fog analytics

Our Demo. Here in Berlin

Use Case: Viewport Adaptive 360 Video over Distributed Intelligence System



Demonstrating:

- 360 immersive experience with End-to-End video service distributed across hierarchy of Edge/Fog Nodes
- An integrated system of heterogeneous compute entities (low → high end nodes)
- A microservice architecture that aligns completely with larger trend towards fully cloud native system design
- Bandwidth and deployment cost saving through the leveraging of hybrid mix of higher and lower cost compute facilities

Some Quick Takeaways

- The emerging 3GPP Service Base Architecture will implicitly bring with it a new capability to realize all the benefits of edge computing
- More, forward looking research in large scale test bed initiatives are proving many other performance benefits are possible too
- How deep our industry is prepared to take this vision (and when) is still unclear but distributed compute trend would seem hard to stop
- Ongoing research in the deep edge are revealing the many unique challenges (e.g. volatility, heterogeneity) that need to be resolved
- Early research results would seem to be proving the feasibility and value of realizing a fully distributed virtual resource model in time



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Thanks For Your Attention!
Please Come by our Booth to Learn More