Turning the Cellular System into a Distributed Cloud

First Experiences in Realizing a Paradigm Shift in Mobile Network Design

CW Virtual Networks SIG
December 11, 2018

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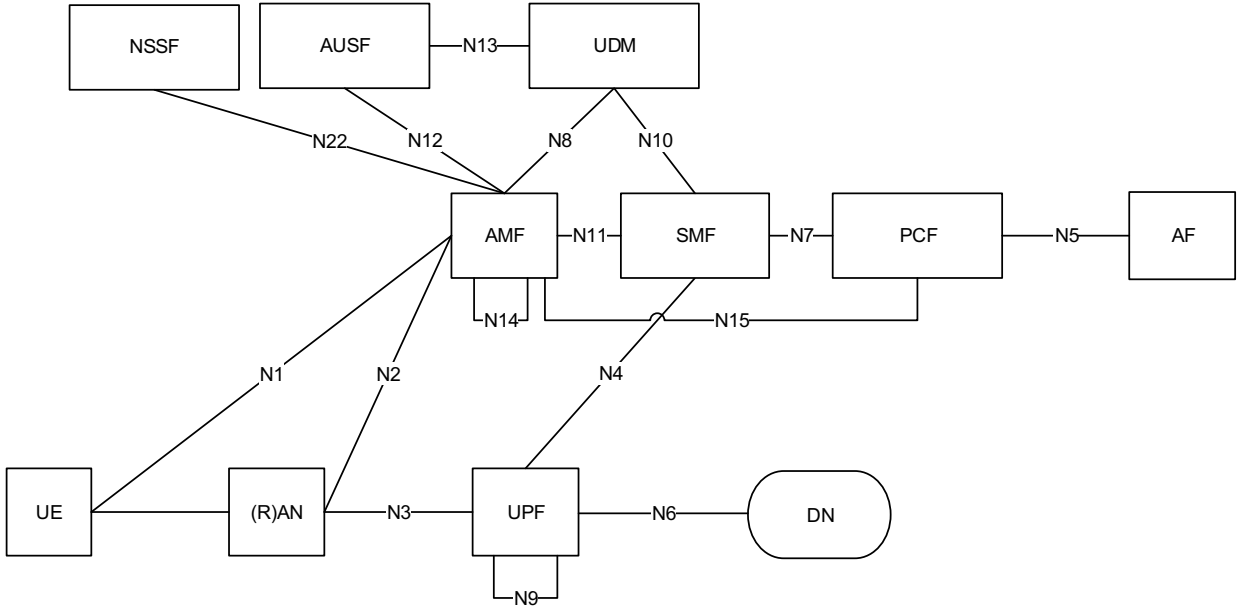
Pre-Rel 15 Way of Doing Things



A purpose-built Cellular Service Architecture

- Point-to-Point interfaces
- Long lived bindings between generally monolithic network functions
- Sticky functions

Alternative: Further Evolution of the Evolved Packet Core

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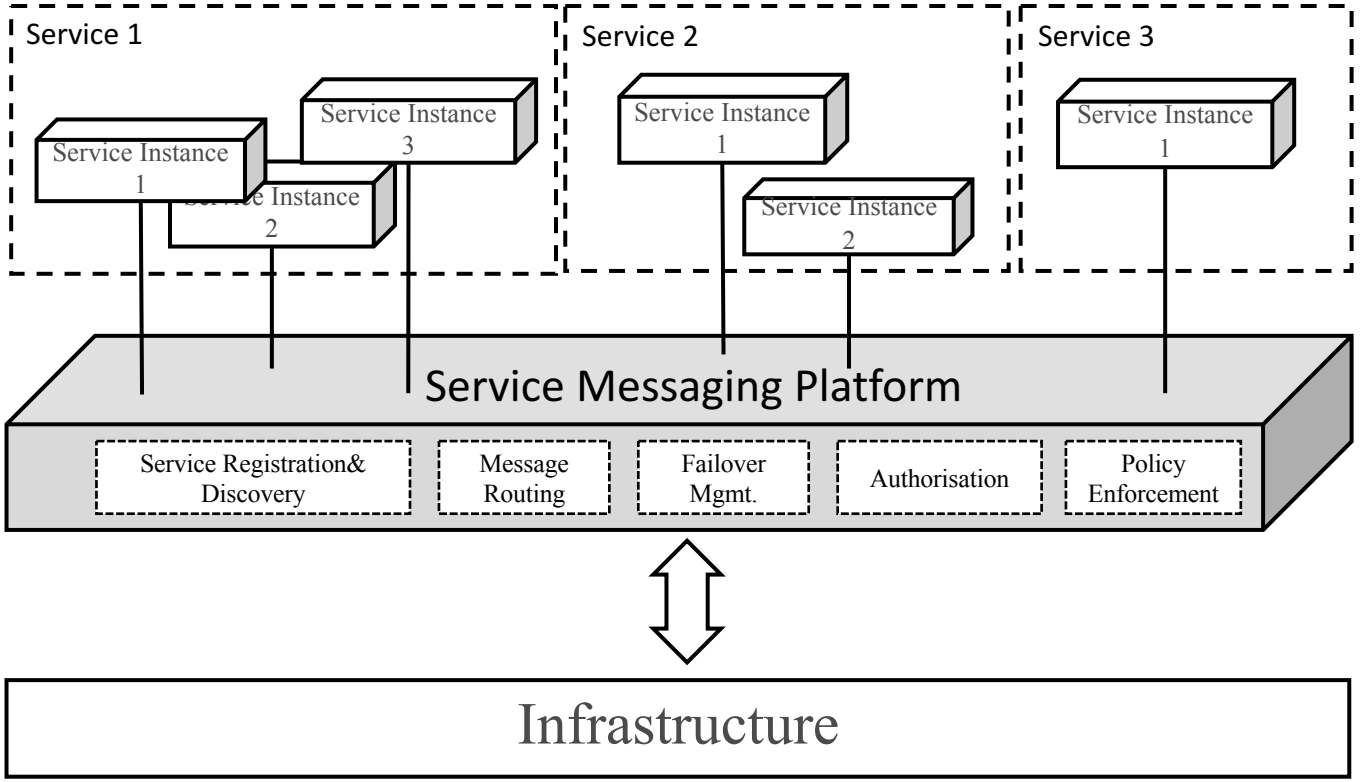
A Paradigm Shift in Rel16 through Service-Based Architecture based Design

Service logic
- self-contained
- Non-sticky
- Stateless

Message routing substrate
- Messages are HTTP-based
- Interfaces standardized

Cloud-native
- micro- data centres
- Connected via SD-WANs



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What is SBA in a Nutshell?

Service-Based Architecture for 5G means integrating mobile networks into the existing large-scale cloud-native Internet service architecture, exemplifying the phrase "IT meets Telecom", i.e., apply the principles that made major Internet players successful and scale to compete with and complement them towards improved QoE for end users

-> real winners will be **operators** with increased flexibility for new business models over a single cloud-native architecture

-> possibility for **new entrants** in the SW-driven services market, enabled by slicing and exchangeable control & user plane!

-> possibility for **new applications** beyond pure client-based ones, e.g., true mobile edge computing, distributed immersive experiences, …

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Two Flavours of SBA

- Control plane SBA
  - Regional and micro data centres, executing control plane services
  - Interconnected via software-defined WAN (SDWAN), e.g., SDN-based

- User plane SBA
  - Micro-services in UEs (and edge as well as DC compute resources) for scenarios such as multi-user VR/AR and any other UE-centric services
  - Interconnected over 5GLAN (3GPP FS_Vertical_LAN)

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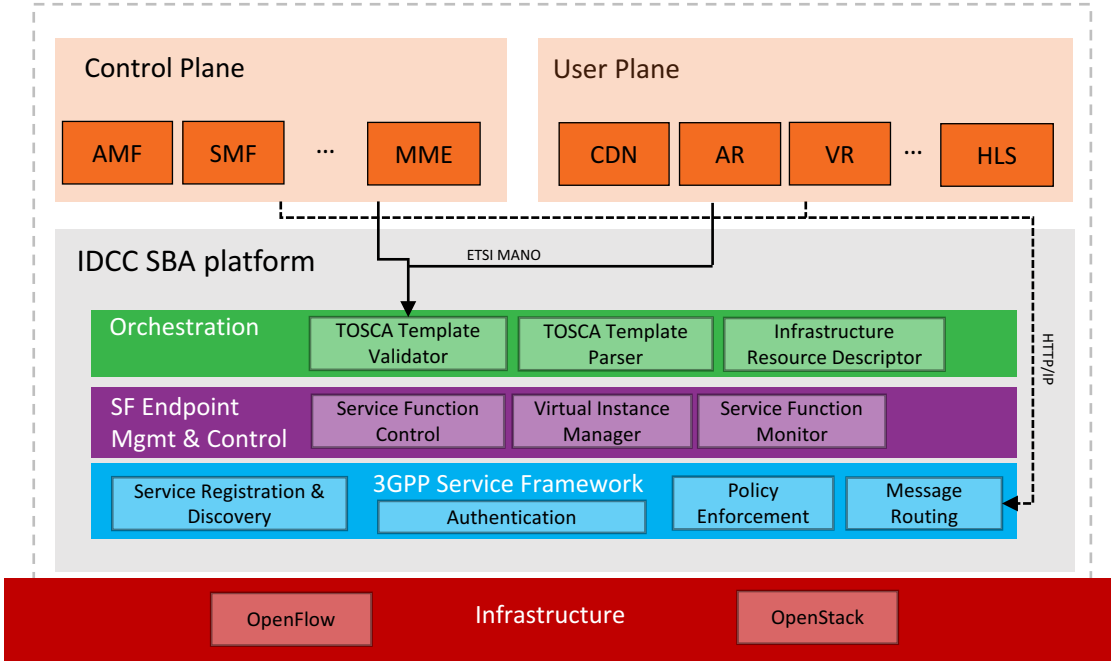
Our 5G Service-Based Architecture Platform

Pioneering 3GPP to Help 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



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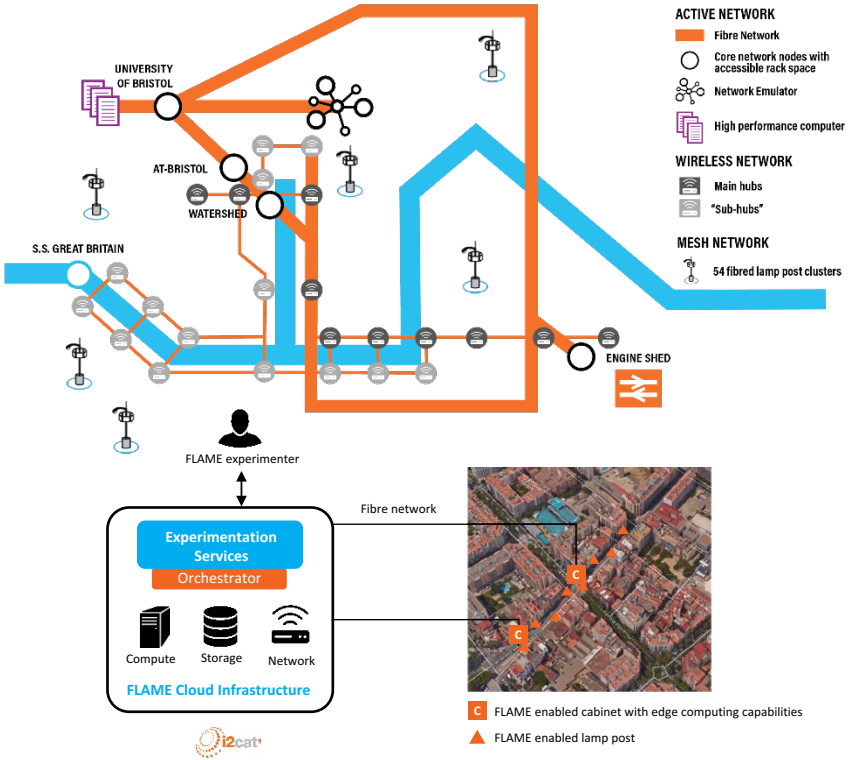
Validation through Urban Scale Trials & Experiments

- Validate platform capabilities by trials conducted by ecosystem partners
  - 5 operator infrastructures
  - 25+ customer trials
- New media formats (AR, VR, 360) and distribution channels
- Engagement with media service providers, content providers, infrastructure operators and beyond
- Trials will be conducted in 3 waves from October 2018 to March 2020
- Public funding available through H2020 FLAME project



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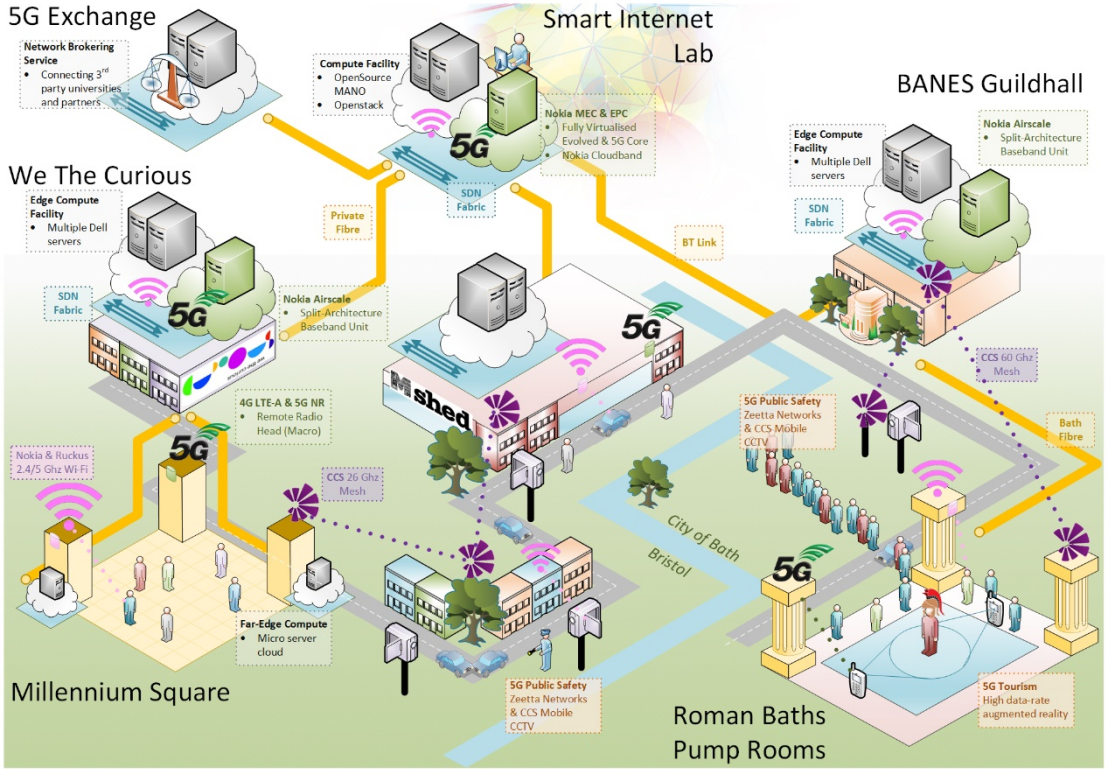
Deployed Across Two UK Cities for Large-Scale Trials in 2019



Technology Highlights

- Multi-RAT
  - 5G NR & 5G mmW
  - LTE-A
  - Wi-Fi
- Micro-data centers in
  - Roman Baths & Guildhall
  - We The Curious
  - Smart Internet Lab

  providing MEC services
- Use cases in guided VR tours, AI-assisted image recognition & public safety

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Working with Partners Across Horizon 2020

	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

POINT

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

RIFE

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

FLAME

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

5G CONFIG

Unfunded international research and innovation project http://www.5g-control-plane.eu

13.5MIL EURO
Combined H2020 Funding

Showcased as **ETSI MEC PoC**
Successful **5G network trial in 2017**
Won **CSI Award 2018**

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Conclusion

- Major **paradigm shift** for deploying (and designing) networks occurring
  - SBA extends up the design of the Internet to the cellular sub-system
- Control plane services only the first front
  - Enable business **flexibility** and reduce deployment **costs**
- User plane services are the new frontier
  - **Efficiency** benefits could be huge
  - Bringing true mobile edge computing
  - New **form factors** for future devices by enabling micro-services across far-edge devices
- Action taking place in **3GPP** right now
  - IETF picking up pace on key technologies and protocols

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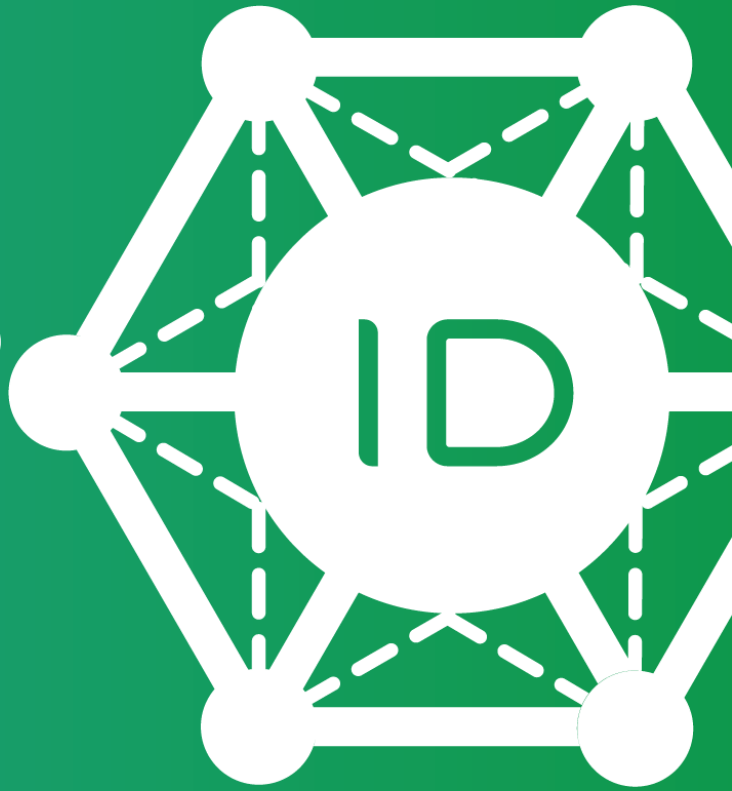
SBA Control Plane Demo



Use Case

- Simple scenario that attaches UE for consumption of 5G services
- UE is part of interaction through HTTP-based message with CP services
- New control plane services instances are created at runtime across one or more data centres

Showcased Benefits

- Integration with container-based lifecycle management
- Control of CP instances at runtime, based on policy constraints
- Support for multiple data centres
- Flexible routing of requests to any instance (policy-based)
- Support for more than one service framework

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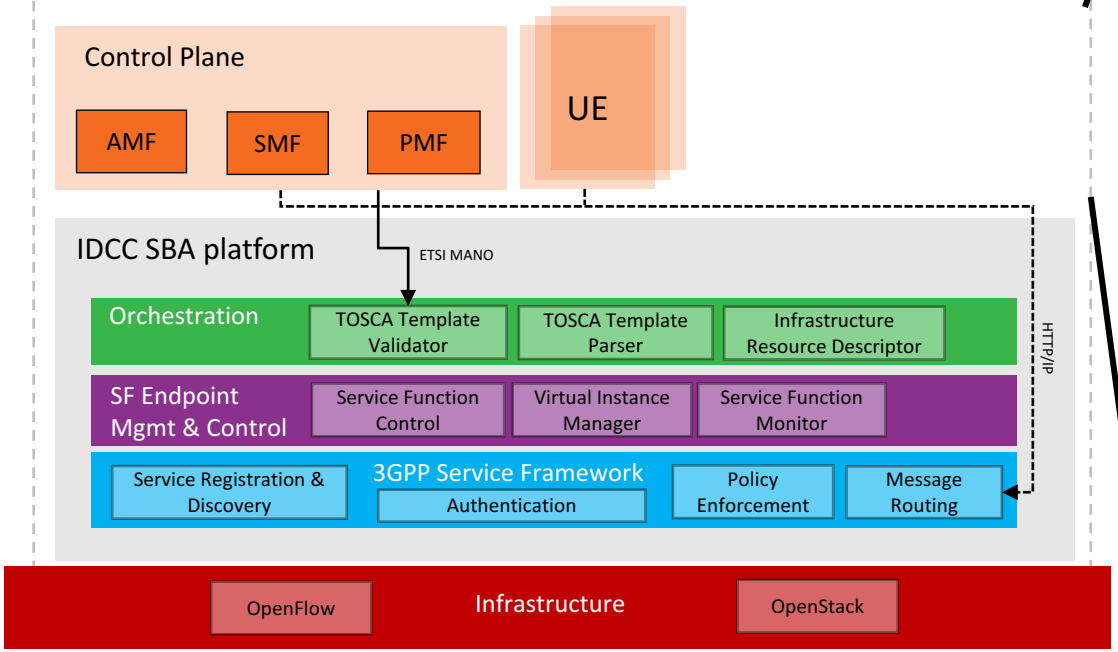
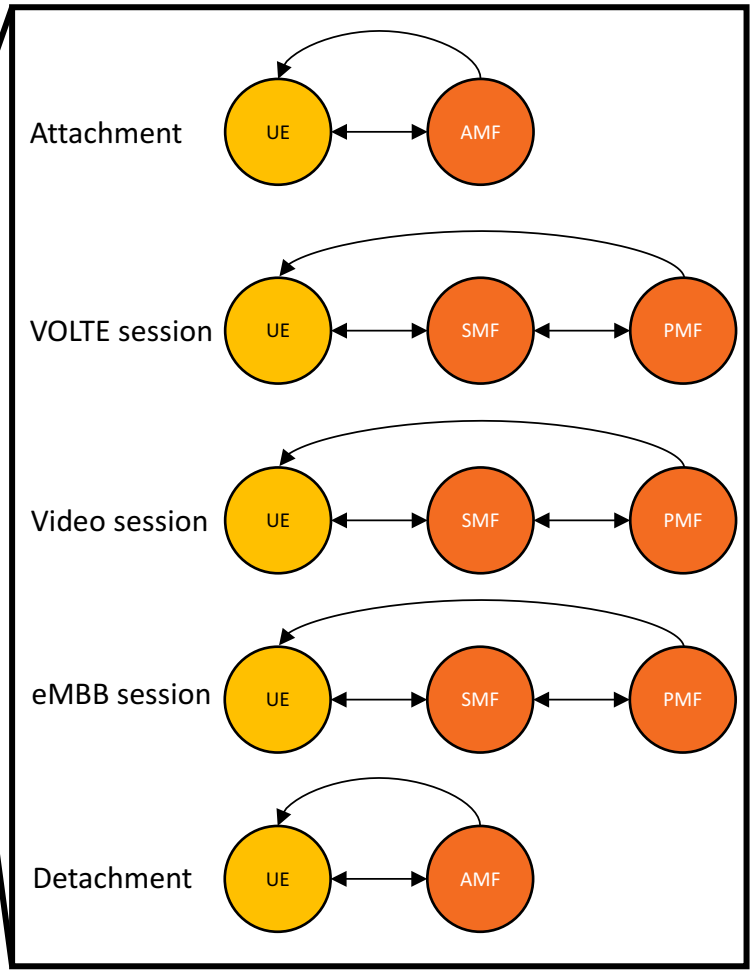
Service Interactions





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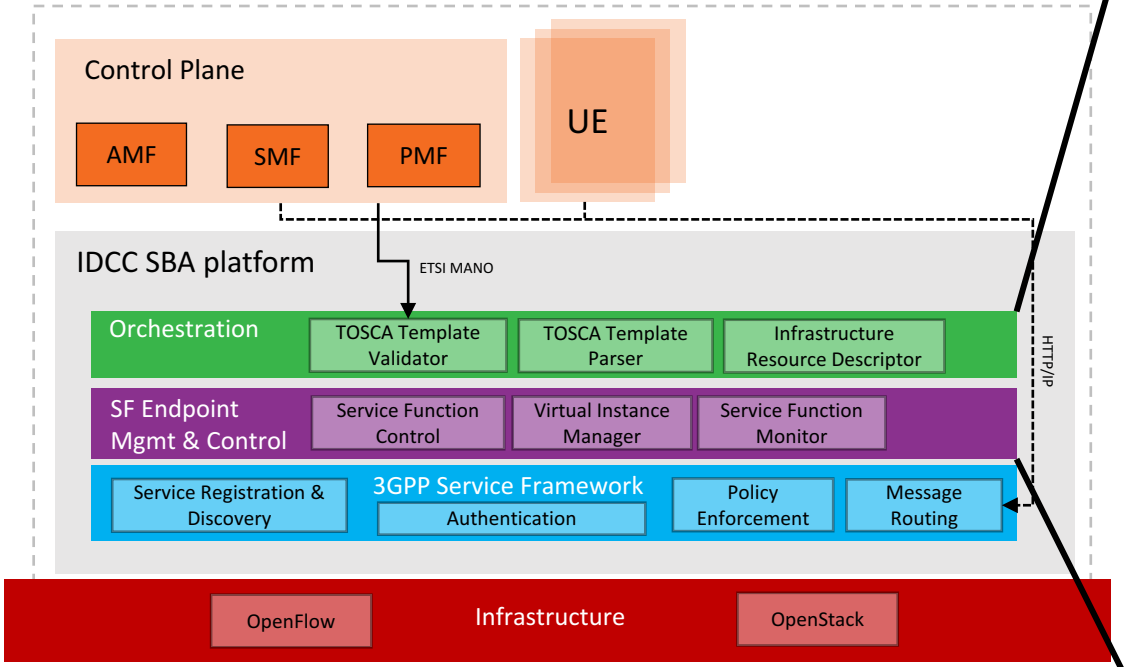
Lifecycle Management




```
tosca_definitions_version: tosca_simple_profile_for_nfv_1_0_0
description: Template for deploying the Control Plane Service use case.
...
imports: - flame_definitions-0.1
## Topology
topology_template:
  # CPS Nodes plus Influx
  node_templates:
    authentication:
      type: eu.ict-flame.
      capabilities:
        host:
          properti
            num_
            mem_
            disk_s
          properties:
            hy
            im
            fqdn
            - authentic
...
policies:
  Another
  it is only
  s
  init_
  con
  co
  actio
  auth
  clus
  cluster2: eu.ict-flame.sfe.state.lifecycle.booted
```

This defines a service function for

Defi… properties of the ser…

…but with own extensions to accommodate our policies

Def… virtua… the URL for the packaged image

funct… …entifier, i.e. the URI, …der which to reach the AMF

We allow for policies that control the service function state at runtime!

…OT …vice functions since routing is done via the 3GPP service framework!

One AMF instance is deployed in Cluster1 in c…nected state, ready to serve UEs

Always define the initial state through an explicit policy, also defininig in which cluster the service function will be deployed!

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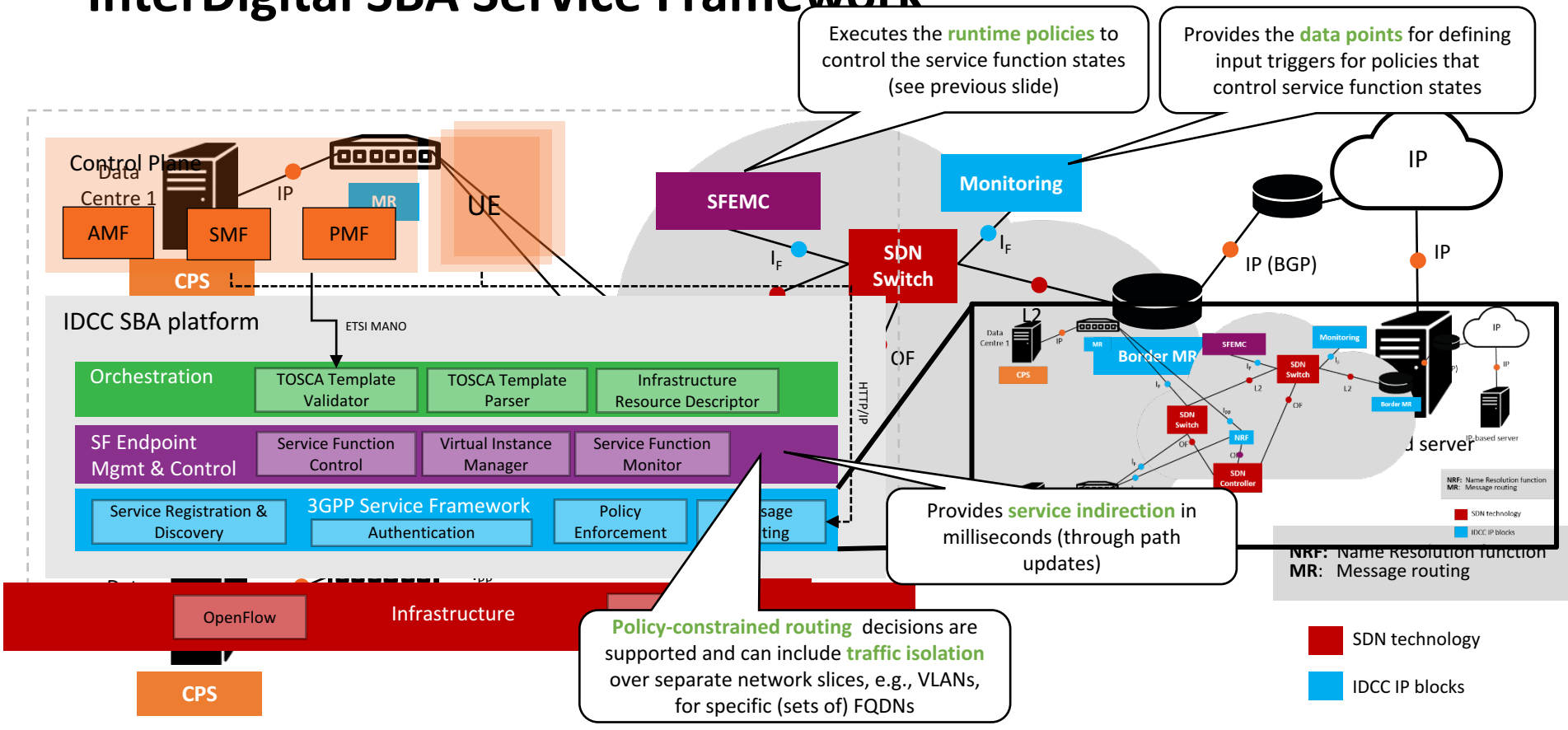
InterDigital SBA Service Framework



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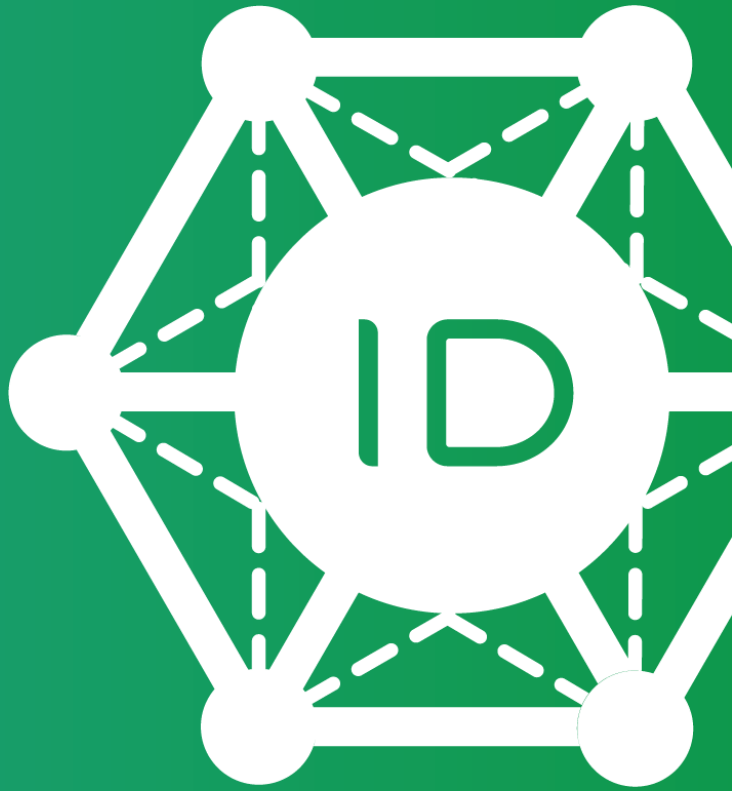
SBA User Plane Demo

Preview



Use Case

- Three users watch a virtual reality stream in two locations
  - Users are somewhat synchronized in viewing
- Bristol (UK) trial in Jan 2019 will showcase a scenario where stream is controlled by storyline according to tourist guide

Come to our MWC 2019 booth for a Extended Connected Home scenario!

Showcased Benefits

- End-to-end delivery of LAN-based end-to-end network
  - WLAN instead of 5GLAN for now
- Multicast of HTTP content over Layer 2
  - Gain is linear to number of users!
- Multicast over radio link
  - Assumes broadcast capability on radio link!
- Reduction of E2E latency through fast re-routing of service requests to local server

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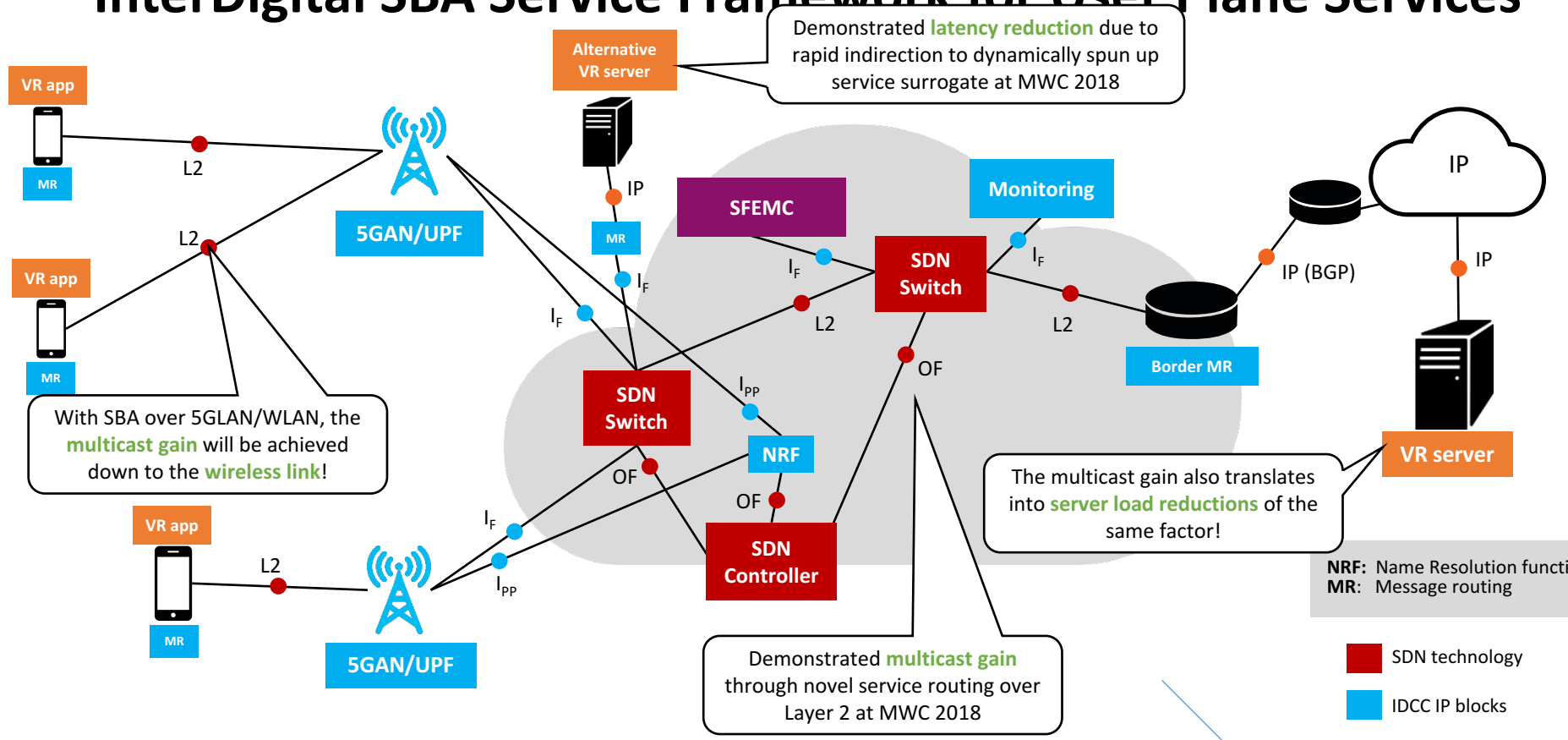
InterDigital SBA Service Framework for User Plane Services



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