5Growth

Network architectures for 5G and beyond

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Beyond 5G Evolution Webinar

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Abstract

5Growth sets a solid and tangible ground towards beyond 5G network architectures
5Growth Vertical pilots
**Implications to the network architecture**

<table>
<thead>
<tr>
<th>Trends</th>
<th>Result</th>
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<tbody>
<tr>
<td>Vertical-orientation</td>
<td><strong>Complex network</strong></td>
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<tr>
<td>Disaggregated network equipment / Softwarization</td>
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<tr>
<td>• Increasing number of interfaces</td>
<td>• Multiple providers</td>
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<td>• Increasing number of stakeholders</td>
<td>• Multiple technology domains (incl. RAN)</td>
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<td>Ubiquitous computing</td>
<td>Dynamic adaptation to varying demands and network conditions</td>
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<tr>
<td>• Distribution/Decentralization in general brings heterogeneity</td>
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<td>Deployment heterogeneity</td>
<td>• AIML platform</td>
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<td>• Different nature of verticals</td>
<td>• Monitoring platform</td>
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<td>• Access and transport network variety</td>
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Extending Baseline Architecture

Baseline Architecture Leveraging on 5G-TRANSFORMER

**Vertical Slicer (5Gr-VS)**
- Common entry point for all verticals
- Definition of vertical services and SLAs
- Network Slice (NS) to NFV Network Service mapping (NFV-NS)
- Arbitration

**Service Orchestrator (5Gr-SO)**
- End-to-End (E2E) service & resource orchestration
- NFV Network Service Management
  - Creation, instantiation, scaling, termination, update, query
- Federation and Inter-domain

**Resource Layer (5Gr-RL)**
- Resource abstraction

**Monitoring Platform (5Gr-VoMS)**
- Centralized Monitoring Engine

**AI/ML Platform (5Gr-AIMLP)**
- Centralized AI/ML model management

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AI/ML Platform (5Gr-AIMLP)
- Centralized AI/ML model management
Support for Multiple domains
NPN-PN integration
5Gr-Vertical Slicer

Request of services based on VSDs with optional RAN parameters

VSMF

Vertical Service Catalogue

NSMF/NSSMF

VS

NST

Admin

VSB and NST with RAN extensions

5GR-VS

5Gr-SO
Service heterogeneity
Inter-service arbitration at the VS (I)

Service heterogeneity
Inter-service arbitration at the VS (II)
What’s next?

Putting more intelligence in intra-slice interaction handling (i.e., services inside the same slice)
  • Including decision-making based on vertical application metrics

Putting more intelligence in inter-slice handling (from the same vertical customer of between customers)

Dynamic slice composition
Technological heterogeneity
Resource abstraction

APPLICATION PLANE
CONTROL PLANE
HIERARCHICAL 5G-CROSSHAUL
CONTROL INFRASTRUCTURE

Resource Management Application (RMA)
E2E Transport Orchestrator (pABNO)
Multi-layer Optical Orchestrator (cABNO)
SDN Controller
Active Stateful PCE
SDN Controller

mmWave/Wi-Fi transport network
Multi-layer optical transport network

User
Server

Technological heterogeneity
Resource abstraction (II)

5GT-SO

5GT-MTP

DB

GUI

Users

NfV PoPs

Domain

Servicelid

LLs

Stitching

Virtual Links

Resource Attributes

MTP Core

Orch

Abs Logic

DomRes Logic

RO

WIM plug-in

SBI

VM plug-in

Log

PA

PA Engine

NFV PoP2

(CPU, RAN, storage)

NFV PoP1

(CPU, RAN, storage)

Logical Link 1 (BW, latency)

Abstraction/Deabstraction

Detailed View (internal to 5Gr-RL)

Abstracted View (exposed to 5Gr-SO)

What’s next?

AIML-based virtual infrastructure provider optimizations
Joint access and backhaul optimizations
Towards RAN integration and abstraction
  • Smooth integration of O-RAN-like based approaches
Handling of CUPS and cell-less architectures
Dynamic deployment of vertical services

Slicing support

3GPP TR28.801. Study on management and orchestration of network slicing for next generation network

NGMN. Description of the network slicing concept.
Slicing support
Composite Network Service

ETSI NFV IFA012. Report on Os-Ma-Nfvo reference point - application and service management use cases and recommendations

Network service federation (NSF) in 5Growth

E2E network service catalog
Built through composite network services
5Gr-SO as the central component because

- E2E service view
  - Integrated nested NSs from other domains
- Resource view
  - Local
  - Remote (partially)
- Enables federation of domains with heterogeneous MANO platforms (e.g., Cloudify, OSM)
The NSF has been included on top of available single-domain orchestration thanks to two modules: the SOEp and CROOE. The proposed NSF is inspired in ETSI IFA 028/030 work but extending it to deal with resource orchestration operations enabling the interconnection between nested NSs in different ADs.

In the NSF process, we distinguish between consumer domain (CD) and the provider domain/s (PD/s).


Federation in action
eHealth use case

eHealth Monitoring service
Service Creation Time Profiling

The biggest contribution to SCT comes from resource allocation operations:

- VNF allocation (yellow), configuration of LL (blue), creation of IntraPoP Network (green)
- 98.5% for Composite Multi-Pop (245s)
- 92% for Federation (257s)

A polling operation (grey) impacts in the SCT of Federation

- 7% of total SCT
- Time to process, decompose, interaction between sub-modules and ADs is on the order of ms

What’s next?

Enabling all sorts of multi-stakeholder interaction
Dynamic service composition
Dynamicity and trust in multi-stakeholder service discovery
Intelligence in selection of provider of discovered services
Dynamic SLA management

Layer 1: Data Stream Ingestion

Layer 2: Data Analytics

Layer 3: Data Storage

Monitoring Platform (5Gr-VoMS)

AI/ML Platform (5Gr-AIMLP)

5Growth Management Platform

5Growth Infrastructure

Model Evaluate
- Precision, Recall
- Accuracy, MSE, etc.

Accept or Optimize Model

5a. Compute Reward

5b. Train model

2. Request orchestration of monitoring probes

4a. Get perf metrics

4b. Send perf metrics

3b. Send Context and data

3a. Get Context (parameters)

0. Expose Model Catalog

1. Select Model (parameters)

6. Return Output (Model Deployment)
   (e.g., initially sending a binary file, such as pickle, HDF5, YAML, JSON, etc, file formats, and from then on, updating just the params of the model)


AIIML-based SLA management
Experimental Setup

Best fast track paper award
IEEE NFVSDN 2020

AIML-based SLA management
Time Profiling

Instantiation time is increased by \( \approx 1 \text{s.} \) (much lower than resource-oriented deployment)

Interaction with kafka is the most time consuming step in instantiation and at runtime

Spark job deletion is long if running when deletion requested
What’s next?

AIMLaaS

- Generic model definition and management
- Real-time model updates
- Smooth integration with monitoring platforms and data engineering pipeline in general
In brief

Future networks come with demanding requirements
  • Support for diverse virtualized services with stringent requirements
  • Shared and diverse infrastructure
  • Multi-technology
  • Multi-stakeholder
  • NPN-PN integration

Modularized and adaptable architecture with clear demarcation of functionalities

5Growth sets a solid ground for 5G (and beyond) network architectures
Periodically revisit “What’s next” slides considering the implications of:

- Much higher data rates
- Much higher densification
- Cell-less architectures
- Much higher technological diversity
- New coverage areas (e.g., sky, underwater)
- Energy efficiency requirements
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Open Source code available @ GitHub  https://github.com/5growth