A Novel Radio Multiservice adaptive network Architecture for the 5G era based on Network Slicing

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Introduction

• Goal & Motivation
  – Enabling new 5G business through a network architecture that efficiently supports services with very different or even contradicting requirements
  – “one fits all” not efficient

• Approach
  – Flexibility through 3 key Innovations
    • Adaptive (de)composition and allocation of NFs, Joint optimization of RAN and CN, SW-defined Mobile Control
    – Apply ETSI/ONF NVF to Mobile RAN & core
    – Define control and data layer as set of functions
    – Implement network slicing
The 5G NORMA consortium: Going to enable 5G business

5G NORMA in a nutshell
EU funded R&D project within 5GPPP Initiative, aiming on building consensus on E2E mobile network architecture and rapid implementation

Duration
July 1st, 2015 – Dec 31st, 2017

Connect to 5G NORMA
Webpage: https://5gnorma.5g-ppp.eu/
Twitter: 5G NORMA project @5G_NORMA
5GPPP: https://5g-ppp.eu/

Contact 5G NORMA
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Multi-service and multi-tenancy

Dedicated networks contained in slices can meet the need of different services and tenants:

• Service quality and performance
• Service-specific functionality
• Adaptation to available infrastructure
Key Ingredients for 5G

3 layers are needed

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How 5G Architecture should look like?

- e2e perspective of a network service

**Service orchestrator**: owned and operated by the tenant or the service provider

- **SDM Controller** is a key function in 5G NORMA. It controls the performances of PNFs and VNFs through its SBI. It exposes a NBI for ‘inserting/reconfigure’ functions and resources assigned to the network slice. Time scale can be in the order of tens of milliseconds. In case that QoE/QoS targets cannot be met, the SDM-C may request re-orchestration SDN-C and NF are owned and operated by service provider

- **ETSI- NFV MANO** seems sufficient in this simple case

- What about Network Slicing?
Network Slicing: The key enabler for new business with 5G

“Definition of Slicing from NGMN” - NGMN, White Paper

5G NORMA
- aims to develop a novel mobile network architecture that provides the necessary adaptability
- to support native multi-service and multi-tenant
- in a resource efficient way able to handle fluctuations in traffic demand
- resulting from heterogeneous and dynamically changing service portfolios and to changing local context

Network Slicing
- satisfies service-specific demands by mapping different services to separate slices
- utilizes resources efficiently by mapping tenants to separate slices and sharing resource dynamically between slices.
Network Slicing based architecture

- **Service orchestrator**: owned and operated by the tenant or the service provider
- **Slice orchestrator (NFV-O)**: owned and operated by the service provider that operates the slice for the tenant (tenant and service provider may be the same)
  
  There is one instance per slice

- **The VNF Manager** is owned and operated by the service provider.
  
  There are multiple VNF-M instances per slice (typically per vendor)

- **The Virtual Infrastructure Manager (VIM)** is owned and operated by the infrastructure provider.
  
  One VIM per cloud (e.g. one for the edge and one for the central cloud)
Network Slicing ‘requirements’

Network Slicing

- The infrastructure resources should be shared across many network slices
- Some functions may be common to more than one network slice: RAN, HSS, mobility management ...
- Network slices isolation
**Service orchestrator:** instantiate an e2e slice instance

**Orchestrator Manager:** for handling the infrastructure allocation across network slices. Kind of 'dispatcher'

**NFV Orchestrator (NFV-O):** There is one instance per the dedicated and one per the common VNFs
The “5 Innovations” of 5G NORMA
1. Adaptive function (de)composition and flexible placement
2. Joint optimization of access/core functions
3. Software defined mobile network control and orchestration (SDM C+O)
4. Multi-service and context-aware adaptation of network functions
5. Mobile network multi-tenancy

Different architectural views for clarity
– each highlighting specific aspects of 5G NORMA architecture and innovations
Deployment view

- Illustration of...
  - Function placement and SDM C+O
  - Mapping of functions to mobile network elements
  - Decomposition of functions and their flexible allocation
  - Network slice specific set of functions
Resource View

- **Software libraries**
  - functions
  - services

- **Hardware resources**
  - computing, storage, networking
  - virtualized and physical NF

- **Edge and network clouds operate according to ETSI NFV principles**

- **Physical network functions**
  - SW and HW cannot be decoupled
  - SW highly embedded in the HW
Topological view

- Concrete illustration of network deployment and function placement
- Shows mapping of functions to geographical locations
- May be used to display per instance/per location properties
  - functions allocated
  - space demand
  - link capacity and latency
Project Outcomes

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- October 2015: use cases, requirements and scenarios relevant for the architecture design
- August 2016: Performance 5G NORMA architecture & socio-economical analysis – first release
- December 2016: 5G NORMA reference architecture
- February 2016 (MWC ’16): Multi-service architecture demos – first release
- September 2017: 5G NORMA architecture – final release
- January 2017: 5G NORMA architecture – first release
- October 2016: Software Defined Mobile network Control (SDMC) demos – first release
- December 2017: Performance 5G NORMA architecture & socio-economical analysis – final release
- November 2017: Multi-service architecture & Software Defined Mobile network Control (SDMC) demos – final release
Expected 5G NORMA Impact

Manufacturers: novel products
- Enhanced and flexible 5G base stations: light, flexible and efficient
- Software-based centralized controllers: based on software and hence easy to modify and to adapt to different scenarios and services

End-users and society
- Support for more and better services

Operators: novel and flexible services
- Flexibility to adapt network operation as desired
- Reduction of the cost of operating the network
- Support for new and diverse services, thereby increasing revenue

Vertical markets
- Network able to adapt to their needs in terms of latency, reliability, security, QoS, etc.

Standardization
- Novel architecture contributions: 3GPP
- Interfaces with the software-design controller: ONF
- Network-related protocols: IETF

Prototypes
- Multi-Service and Multi-Tenant support
- SW Defined Mobile Network Control
Conclusions

• Inspired by concepts from the NGMN Whitepaper, 5G NORMA will develop an innovative E2E network concept
• allowing to support multiple services and tenants according to their specific needs,
• with great flexibility and adaptability
• to meet the demands of the 5G future
• based on network sharing.
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Resource View cont’d

• Library of functions
  – function itself (code) and its characterization to allow orchestration
  – specifies resource requirements, supported interfaces and reference points, orchestration and configuration parameters

• Library of services
  – service blueprint
  – service description, i.e. QoS parameters
  – ordered graph of functions ("forwarding graph") that implements service
  – may reference basic graphs (services) as subgraphs

• Hardware resources
  – compute (general purpose and specialized hardware) incl. memory, storage, network
  – virtualized as well as non-virtualized ("bare metal"/physical network functions)
3 Innovations enabling flexibility

Adaptive (de)composition and allocation of NFs
Joint optimization of RAN and CN
SW-defined Mobile Control

create the flexibility to

• adapt dynamically to daily fluctuations in traffic demand
• adapt to rapid load variations in small cells
• introduce new services and business models quickly

Joint optimization of mobile access and core network functions when located together in the network or edge cloud

Controller

Software Defined Mobile network Control (SDMC) applies SDN principles to mobile network functions

Network Cloud

Adaptive (de)composition and allocation of mobile network functions (c-plane and u-plane) between network and edge cloud that depends on the service and deployment

Edge Cloud

RAN c-plane

RAN u-plane

Network Cloud

5G NORMA interface

CN c-plane

CN u-plane

5G NORMA interface

RAN c-plane

RAN u-plane

Software Defined Mobile network Control (SDMC) applies SDN principles to mobile network functions