Enabling Concepts for 5G
14th International Conference on Frontiers of Information Technology (FIT'16)

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Highlights of what we do in Telenor Research

Provide **LPWA infrastructure** and drive innovation and research in the fields of big data **analytics** and **AI**.

**FierceWireless**

Telenor seeks to secure Norway’s place in AI, big data, and IoT sectors

Telenor to invest €5m in IoT networks and AI lab in Norway

How to use Big Data for Social Good

1st Nordic Conference on ICT - 5G: Expected Impact - Oslo 5-6 April 2016
What is 5G

2G 1990 **Mobile** Voice & SMS

3G 2000 **Mobile** Internet

4G 2010 **Mobile** broadband
5G is Integrating the verticals

- **2G** 1990: **Mobile** Voice & SMS
- **3G** 2000: **Mobile** Internet
- **4G** 2010: **Mobile** broadband
- **5G** 2020: Every “Vertical” Connected
5G needs to incorporate different characteristics and requirements of the verticals

![Graph showing the proportion of values for M2M and Smartphone](image-url)
5G needs to incorporate different characteristics and requirements of the verticals.
5G empowering the verticals

**Factories of the Future**
- Time-critical process control
- Non time-critical factory automation
- Remote control
- Intra/Inter-enterprise communication
- Connected goods

**Energy**
- Grid access
- Grid backhaul
- Grid backbone

**E-health**
- Assets and interventions management in Hospitals
  - Robotics
  - Remote monitoring
  - Smarter medication

**Media & Entertainment**
- Ultra High-Fidelity Media
- On-site Live Event Experience
- User/Machine Generated Content
- Immersive and Integrated Media
- Cooperative Media Production
- Collaborative Gaming

*Source: 5GPPP white paper 2016*
5G empowering the verticals

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FACTORIES OF THE FUTURE

*Source: 5GPPP white paper 2016*
5G empowering the verticals

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**Use-cases**

- Automated driving
- Share My View
- Bird’s Eye View
- Digitalization of Transport and Logistics
- Information Society on the road

*Source: 5GPPP white paper 2016*
Verticals have diverse requirements

*Source: 5GPPP white paper 2016*
Conceive and develop technology enablers to design a network adaptable to verticals.
Current Mobile Network Architecture

(a) Current Mobile Network Architecture

Coupled hardware and Software

Infrastructure

Coupled Control and Data Planes

Legend:
- CP: Control Plane
- DP: Data Plane

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Enabling concepts

- Network softwarization
- Network slicing
- Architectural modularization
- ...
Network Softwarization propelled by NFV and SDN

(a) Current Mobile Network Architecture

(b) Softwarized Mobile Network Architecture

Coupled hardware & Software

Coupled Control and Data Planes

NFV – Network Function Virtualization
SDN – Software Defined Networking

Enabling Concept: network softwarization
Network Function Virtualization (NFV) decouples network functions from hardware so they can run in software.

Classical Network Function approach

- Function A
- Function B
- Function C
- Function D
- Function E
- Function F

NFV

- Function A
- Function B
- Function C
- Function D
- Function E
- Function F

Virtualization Layer

Commodity Hardware
(compute, storage, network)

Enabling Concept: network softwarization
NFV: An Example

Classical Network Function approach

- EPC
- SBC
- IMS
- Router
- DPI
- CDN

NFV

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Virtualization Layer

Commodity Hardware
(compute, storage, network)

Enabling Concept: network softwarization
Software Defined Networking (SDN) decouples the control and data planes to enable logically centralized network control.
Key Drivers for Network Virtualization using NFV and SDN

• **Flexible and fast service delivery** through automated deployment and operation of network and functions.

• **Operational efficiency** using common potentially centralized platform with network functions from multiple vendors.

• **Software-oriented innovation** to rapidly prototype, test and introduce new services and generate new revenue streams.

• **Reduced CAPEX** over time through opening of the ecosystem and COTS IT HW.

*NFV – Network Function Virtualization*  
*SDN – Software Defined Networking*
Use case 1: Network Virtualization enabled vEPC enables new Opportunities

Enabling Concept: network softwarization
Use case 2: Cloud-RAN can increase performance and cost efficiency

Enabling Concept: network softwarization
Use case 2: Cloud-RAN can increase performance and cost efficiency

Benefits
- Spectral efficiency (SON, COMP)
- Resource utilization & energy consumption
- Management and operation - OPEX
- Faster time-to-market
- Enables edge computing and services

Challenges
- Fronthaul capacity and latency
- Performance of virtual resources (e.g. compute)

Enabling Concept: network softwarization
Test-bed setup – Field figure with 2 iRRH sites

Enabling Concept: network softwarization
Enabling concepts

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Network Slicing to provide flexible services and infrastructure to verticals

A network slice is an independent logical network, made by the interconnection of a set of network functions and which can be independently instantiated and operated over a set of physical or virtual infrastructure to support the communication service requirements of a multiple use cases from the verticals.
Enabling concepts

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Modularization to build a flexible network architecture
Modularization natively supports Network slicing

- IoT Network slice with no mobility and relaxed security requirements
Modularization natively supports Network slicing

- Mobile Broadband Network slice

5G control
Architecture modularization is an agreed concept in 3GPP

11 - 15 July 2016, Vienna, Austria

Source: Orange, NEC, Telenor, Interdigital
Title: Solution for Key Issue 7: The Interconnection of Modular Network Functions
Document for: Approval
Agenda Item: 6.10.7
Work Item / Release: FS_NextGen/Rel-14

Abstract of the contribution: This contribution provides a solution for the Key Issue #7 based on a model for Network Architecture Modularisation.
Security in 5G

- HaaS

- Will security be the biggest show stopper in adaption towards softwarized, sliced, modularized architecture?
Conclusion

- 5G is integrating the verticals
- Conceive and develop **technology enablers** to design a network adaptable to verticals.
- Current architecture poses a lot of challenges
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  - Virtualized EPC leveraging virtualization enables new opportunities
  - Cloud-RAN can increase performance and cost efficiency
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- Current architecture poses a lot of challenges
- **Network softwarization** propelled by NFV and SDN can enable dynamic network for flexible and fast service delivery enabling software oriented innovation.
  - Virtualized EPC leveraging virtualization enables new opportunities
  - Cloud-RAN can increase performance and cost efficiency
- Network slicing and modularization will enable network as-a-service paradigm for multiple verticals (e.g. MBB, IoT, V2V)
- Security is of paramount importance

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