Fraunhofer FOKUS

MCN Mobile Cloud Networking

44. Treffen der VDE/ITG-Fachgruppe 5.2.4, Mobilität in IP-basierten Netzen

Mobile Network (Function) Virtualization and Software Defined Networking

Mobile Cloud – Combining EPC, SDN and NFV

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About the Speaker

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Scientific work and PhD focus on:

- Evolved Packet Core (EPC)
- Software Defined Networks (SDN)
- Policy Control and Flow Based Charging
- Cross-Layer Composition within NGNs and FI

Technical University Berlin

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Chair Architekturen der Vermittlungsknoten / Next-Generation-Networks

Fraunhofer Institute FOKUS

Competence *Center Next Generation Network Infrastructures (NGNI)*

Agenda

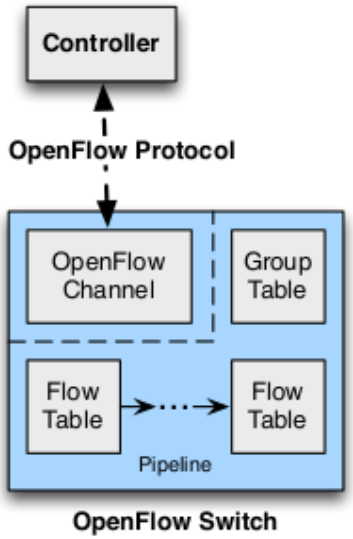
- Introduction and Problem Statement
- Virtualization Trends: SDN and NFV
- Telecommunication Core Network Evolution
- Project OpenSDNCore
- Concept, Implementation and Validation
- Conclusion and Future Work

Introduction and Problem Statement

- Main trends in today (mobile/fixed) telecommunication networks
  - Heterogeneous and partially RAN deployment (WiFi, 4G, Femto Cells, …)
  - Limited spectrum and radio capacity (800, 1.800 and 2.600 MHz for LTE in DE)
  - Increasing number of mobile devices (smartphones, tablets, laptops, …)
  - Always on - quasi permanent connection between the device and the network
  - High bandwidth demands – large variety of apps and multimedia services
  - Cheaper flat-rate tariffs offered by the network operator
  - Strong grows in IP data and 3GPP Diameter protocol signaling
- Key research challenges:
  - Handling the IP data and Diameter signalling traffic grows efficiently, QoS, mobility, security, Network-as-a-Service (NaaS), elasticity and flexibility on the data path, etc.
- Today's approaches: Access- and core network congestion handling approaches
  - TR 22.805 FS_UPCON Study on "User Plane Congestion Control"
  - TR 22.806 FS_ACDC Study on "Application specific Congestion control for Data Connectivity"
  - TR 23.843 FS_CNO Study on "Core Network Overload solutions"
  - 3GPP Policy Control and Charging (PCC) architecture (TS 23.203)

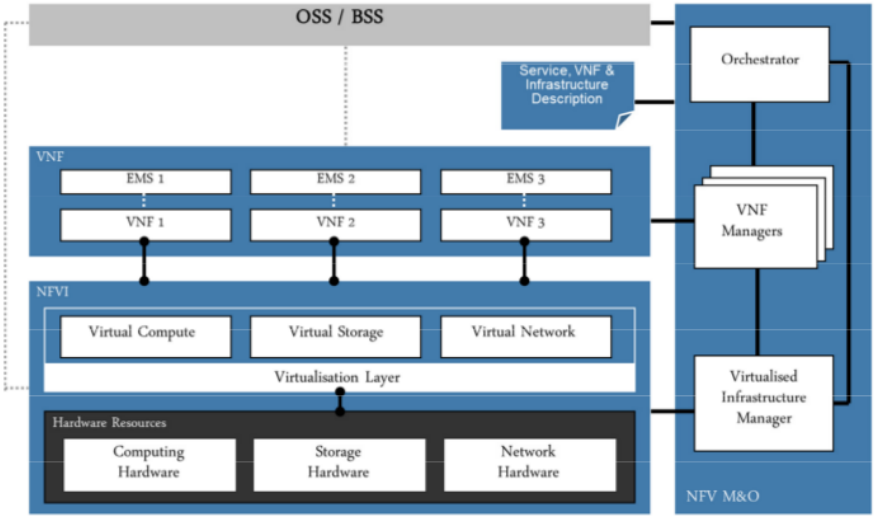
SDN & NFV Definitions and Concepts

- Software Defined Networks (SDN)
- Definition: ‘Physical separation of the network control plane from the forwarding plane’ (ONF)
- Open Networking Foundation (ONF)
- https://www.opennetworking.org/index.php



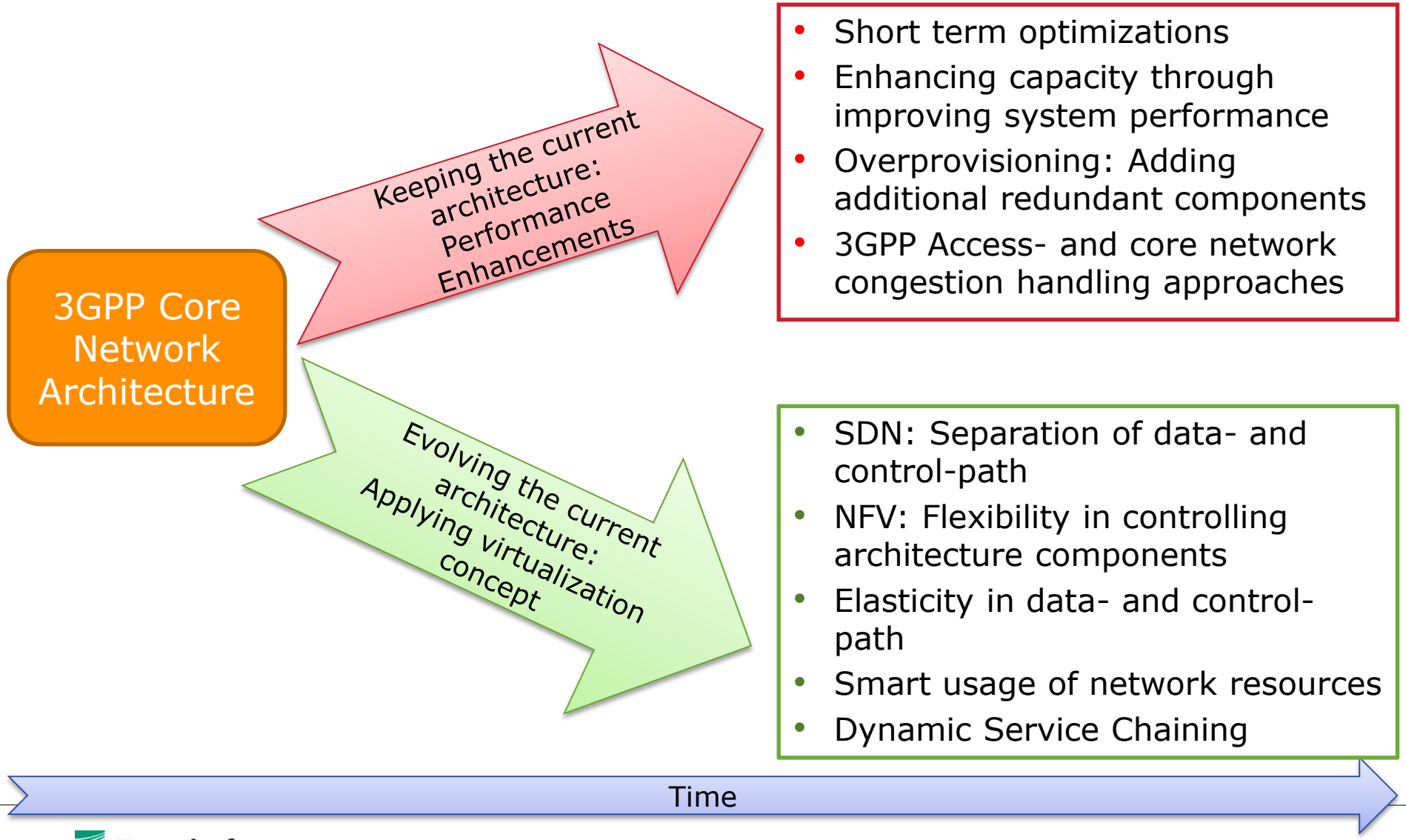
- Source: ONF Spec. OpenFlow v1.4.0

- Network Function Virtualization (NFV)
- Definition: ‘Decouple software from dedicated hardware. Modular Virtual Network Functions (VNF) run on COTS hardware.’
- ETSI Industry Specification Groups (ISG)
- http://portal.etsi.org/portal/server.pt/community/NFV/367

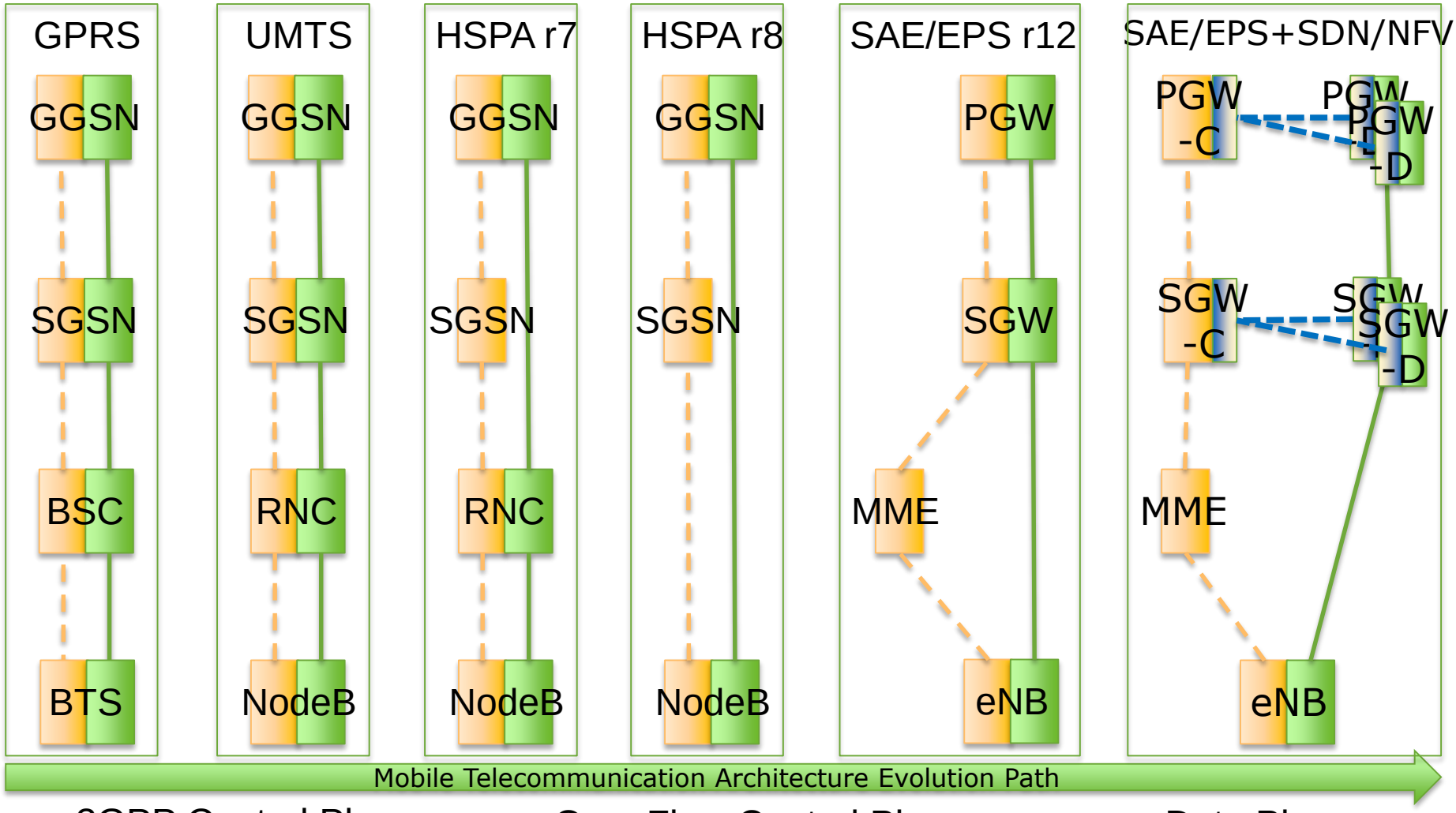


- Source: Network Functions Virtualisation – Update White Paper 2

Core Network Evolution Strategies

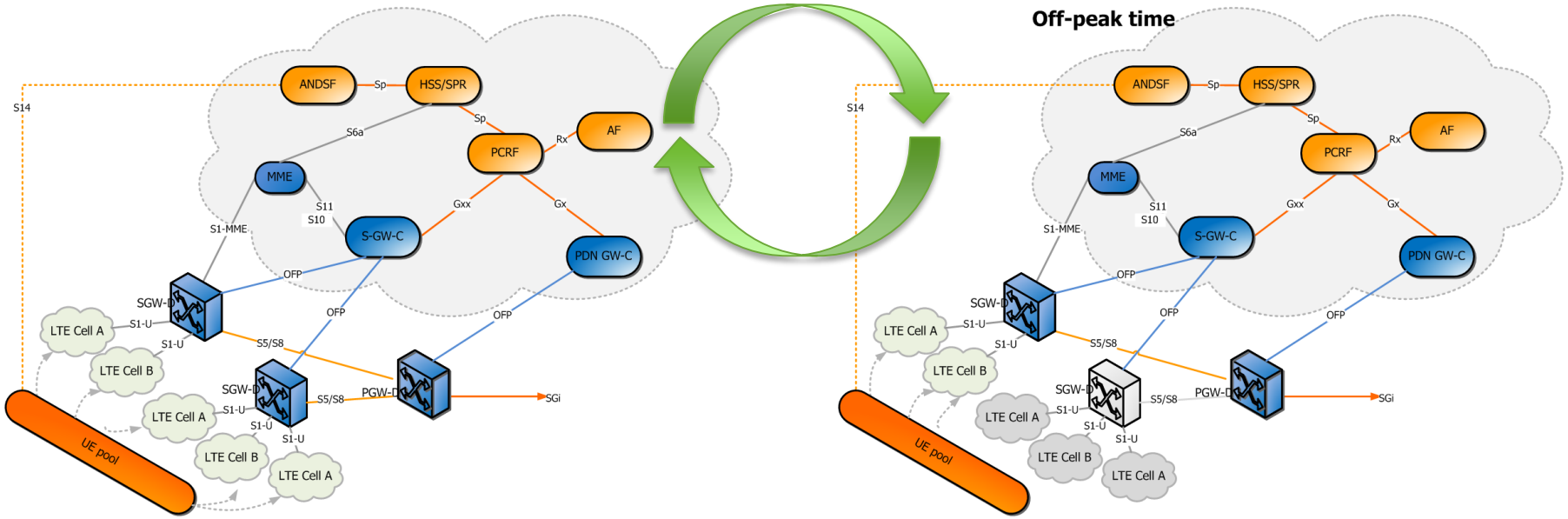


Mobile Core Network Architecture Evolution Path



Business Driver: Elastic and Flexible Network Design - Example EPS

- Other Business Driver: Multi Tenancy, Redundancy, Efficiency, Service Chaining



- Elastic network design aligned on real-time network load situations
- Enablement and disablement of redundant access- and core-network elements
- Optimized energy consumption of the access- and core-network
- Network Resources as a Service (NRaaS) and on demand

IEEE ICCCN'13

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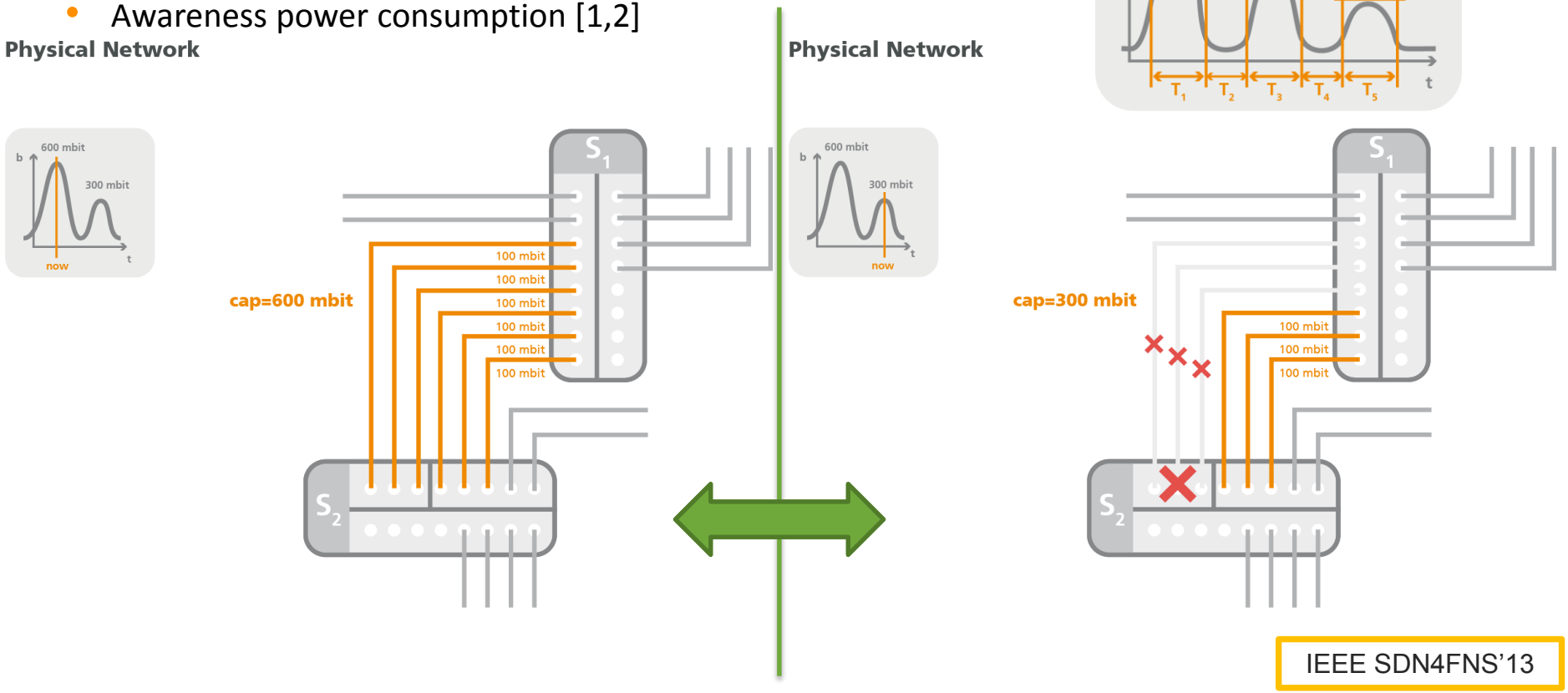
Traffic Pattern, Traffic Demands and Line Cards

- Definition of a “Traffic Pattern”
- Definition of a “Traffic Demand” as capacity requirements
- Awareness power consumption [1,2]



IEEE SDN4FNS’13

[1] J. Chabarek, J. Sommers, P. Barford, C. Estan, D. Tsiang, and S. Wright, Power awareness in network design and routing, INFOCOM 2008. The 27th Conference on Computer Communications. IEEE, april 2008, pp. 457 –465.

[2] GreenTouch Green Meter Research Study: Reducing the Net Energy Consumption in Communications Networks by up to 90% by 2020, A GreenTouch White Paper, Version 1.0, June 26, 2013

Routing Formulation as Mixed Integer Program (MIP)

- ***Goal***: Definition of an ***optimization schema*** that ***minimizes the weighted operational costs*** arising in each of the ***traffic pattern and active network element*** that we need to support.
- Fat tree network topology design of physical network model: G = {V, E}
- Enriching topology model G with meta data
  - Physical line cards per switch/node
  - Physical interconnection as links between line cards (connectivity map)
  - Edge with maximal capacity of each physical link {u,v}
    - Active links have costs
- Approach: Dantzig-Wolfe reformulation as Mixed Integer Program

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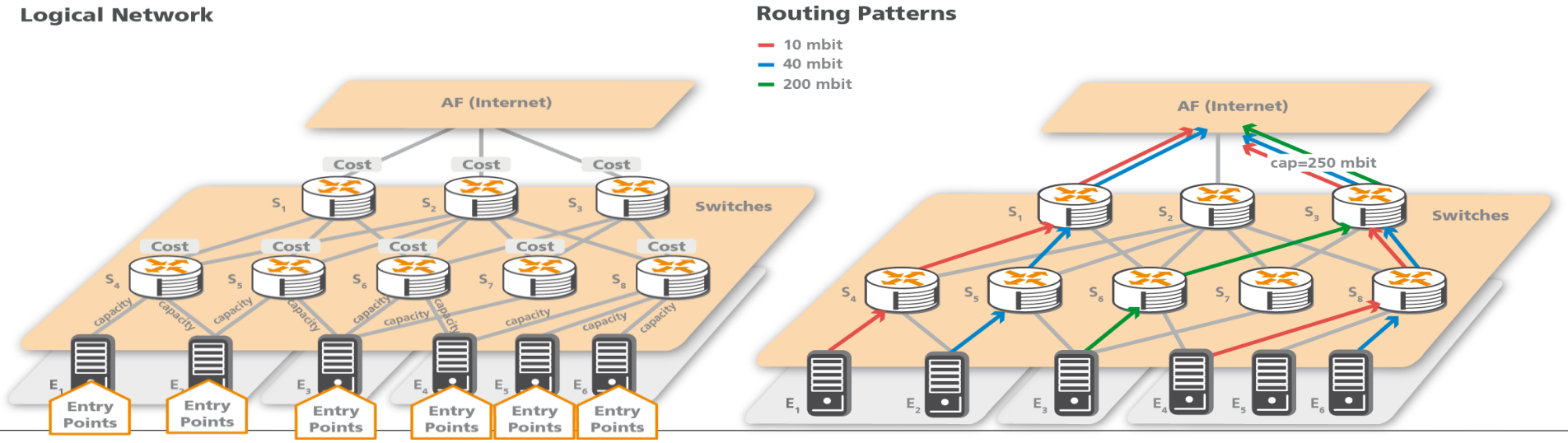
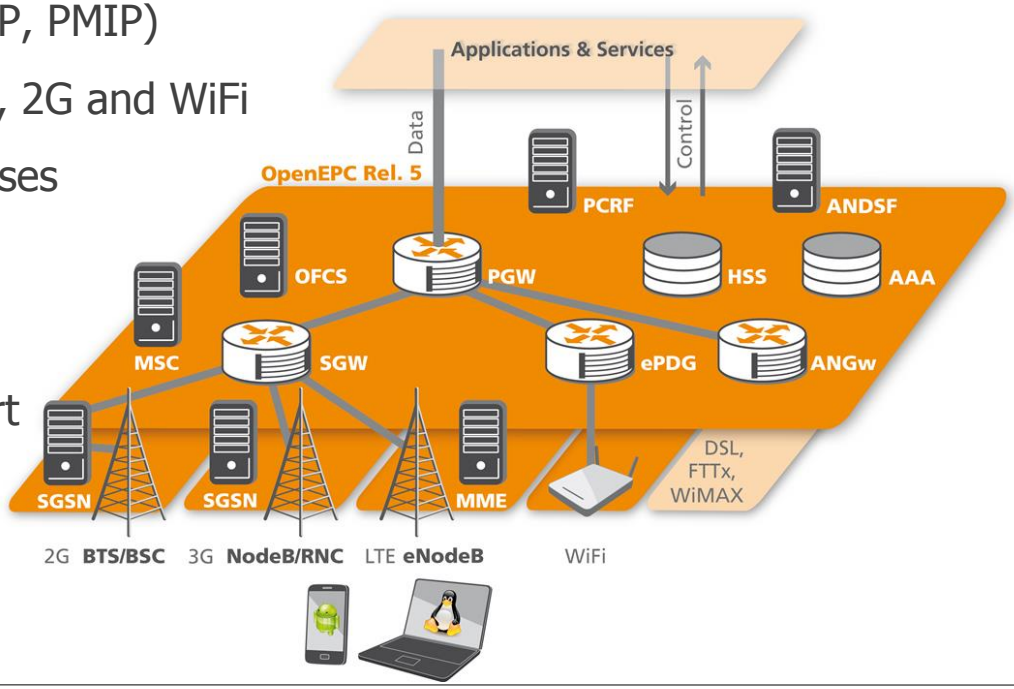


OpenEPC Rel. 5: Mirroring the Future Operator Core Network

open epc++
core net dynamics

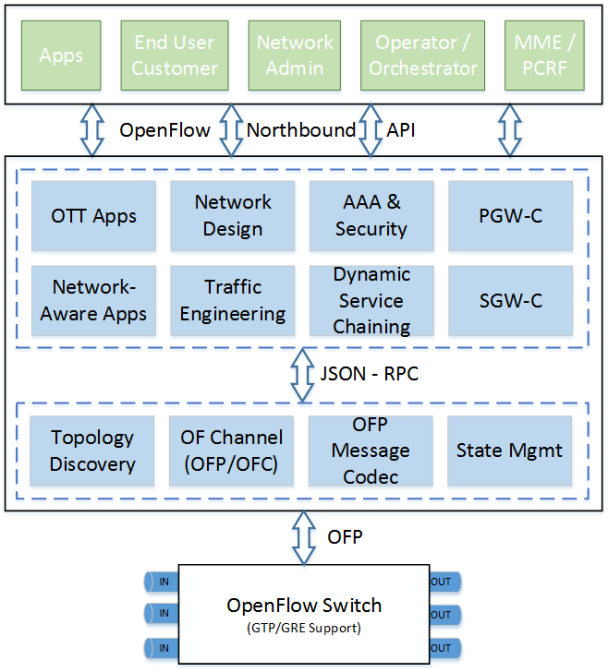
- OpenEPC includes the main functions of 3GPP Evolved Packet Core (3GPP Release 8→12)
- The principles of standard alignment, configurability and extensibility have been respected in the overall architecture and in the specific components implementation
- OpenEPC Rel. 5 enables the establishment of small operator network testbeds including
  - Core network mobility support (GTP, PMIP)
  - Deep integration with real LTE, 3G, 2G and WiFi
  - AAA for 3GPP and non-3GPP accesses
  - Policy and Charging Control
  - Access network selection
  - Common mobile equipment support

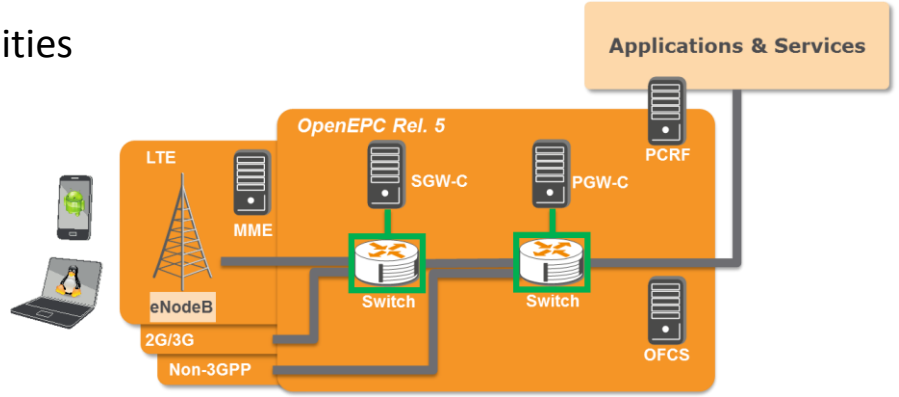


PLEASE NOTE: OpenEPC does not claim 100% standard compliance, but allows for early prototyping

User Plane Realization – SDN with OpenFlow 1.4.0

- For user plane handling, OpenEPC Rel. 5 includes the development of an initial SDN solution
  - Splitting of gateways into Control and multiple Switches
  - Communication via OpenFlow protocol 1.4.0
  - Flexible deployment of control components
  - Flexible data traffic management through elastic network design
- SDN Controller:
  - OpenFlow 1.4.0 protocol support
  - JSON-RPC API for OpenFlow Controller Applications
  - Integration with SGW and PGW control entities
- Integration with OpenSDNCore Switch (www.opensdncore.org)
  - Support for GTP and GRE encapsulation
  - Metering Tables extensions





OpenSDNCore

- OpenSDNCore is a practical implementation of a future core network based on the latest network evolution paradigms:
  - Software Defined Networks (SDN) – flexible data plane
    - Separation of control and data plane
    - Flexible forwarding mechanisms
    - Aggregated control plane
  - Network Functions Virtualization (NFV) – flexible service plane
    - Self-orchestration of network components
    - Network topology awareness

open sdn core

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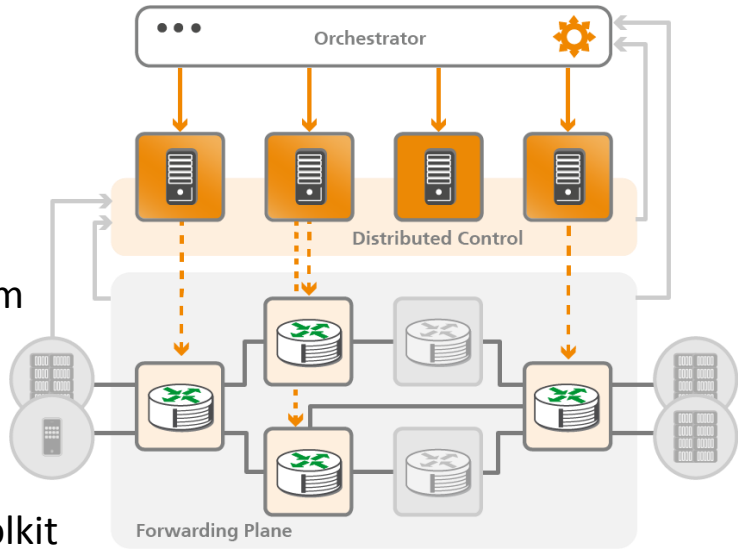
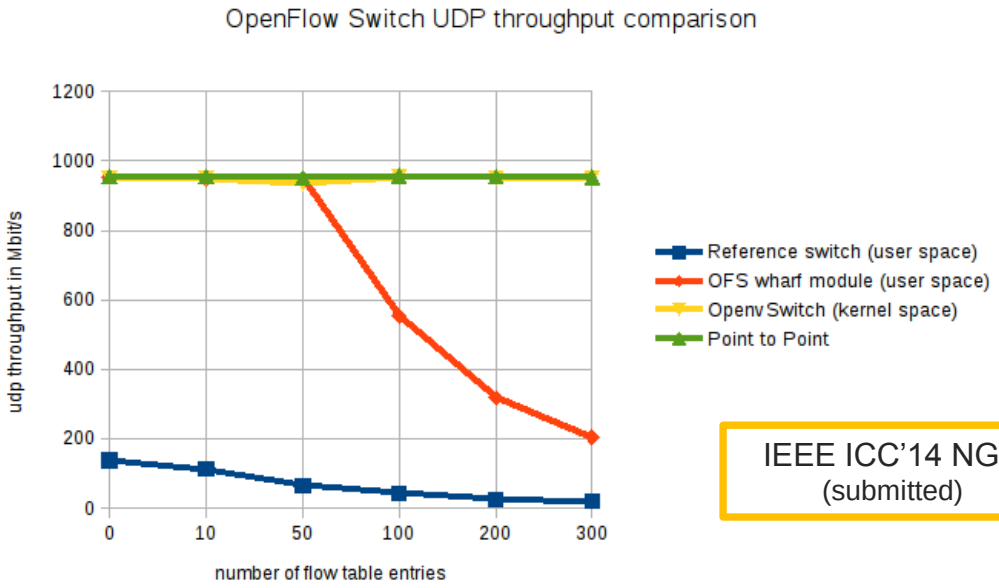


- Self-adaptable connectivity on different levels and scopes
  - Orchestrator – service life cycle mgmt. and control
  - Control Plane – integrating novel Internet and Telecom principles in a simplified modular manner
  - Data Path – plane data plane forwarding functions

- OpenSDNCore is a non-open source, standards inspired toolkit designed for adaptable deployments

Evaluation of Wharf based OpenFlow Switch Implementation

- Four types of measurements have been performed.
- (1) A none-OpenFlow maximum point-to-point link connection without any involvement of a switch.
- (2) The latest OpenVSwitch kernelspace implementation version 1.9.3.
- (3) The latest OpenFlow reference switch implementation version 1.3 (last commit 08/09/13).
- (4) Our OFS implementation based on the Wharf platform.



IEEE ICC'14 NGN
(submitted)

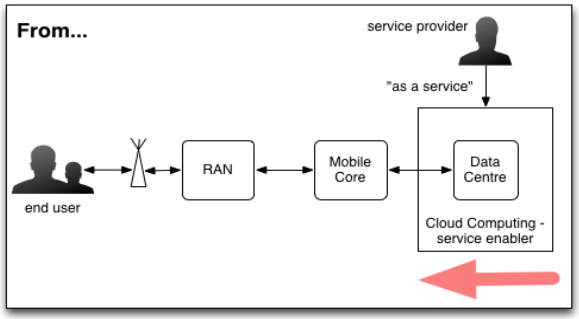
(Each measurement has been performed four times and the mean value is presented in the evaluation above)

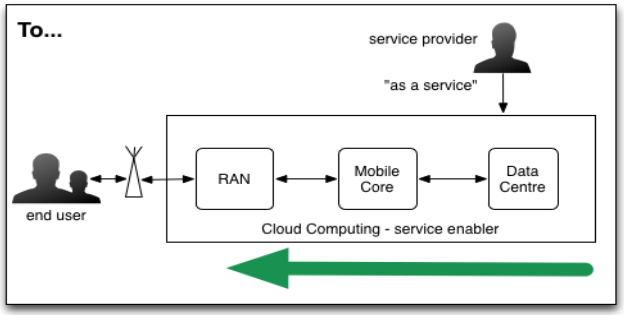
Switch: Dell manufactured motherboard (0TP412), an Intel Core2 Quad processor and 4 Gbyte of DDR2 667 MHz RAM. Network connectivity is provided by one Intel 82571EB dual port 1 Gbit/s and one Intel 82575GB quad port 1 Gbit/s NICs plugged into PCI-Express bus. The operating system is Linux Ubuntu 12.04.3 LTS, kernel version 3.8.0-29-generic.
Traffic generators: are ASUSTeK Eee Boxes with an Intel(R) Atom(TM) CPU N270 @1.60GHz CPU

Mobile-Cloud Networking (MCN)

MCN
Mobile Cloud Networking

- MCN project high level objectives
  - develop a novel mobile "network" architecture and technologies, using proof-of-concept prototypes, to lead the way from current mobile networks to a fully cloud-based mobile communication system
  - extend cloud computing so as to support on-demand and elastic provisioning of novel mobile services
- Extend the Concept of Cloud Computing Beyond Data Centres Towards the Mobile End-User
- Start November 1st, 2012 for 36 month
- Website: http://mobile-cloud-networking.eu/site/





Summary and Outlook

Summary

- Business Driver: Elastic and Flexible Network Design, Flexible data path, Network as a Service
- Telco Network Evolution – influences of SDN and NFV
- Project OpenSDNCore
- Concept, Implementation and Validation

Outlook

- Service placement / location algorithm
- Validation on large scale physical networks

TUB and FOKUS Publications on SDN, Traffic Engineering and Network Management

- Mueller J., Wierz A., Magedanz T., '***Scalable On-Demand Network Management Module for Software Defined Telecommunication Networks***', accepted for IEEE SDN4FNS'13, Trento, Italy, Nov 11-13, 2013, http://sites.ieee.org/sdn4fns/
- Mueller J., Wierz A., Vingarzan V., Magedanz T., ***'Elastic Network Design and Adaptive Flow Placement in Software Defined Networks***', accepted at International Conference on Computer Communications and Networks ICCCN 2013, Nassau, Bahamas, July 30 - August 2, 2013, http://www.icccn.org/icccn13/
- Mueller J., Magedanz T., ***'Towards a Generic Application Aware Network Resource Control Function for Next-Generation-Networks and Beyond***', IEEE ISCIT 2012, International Symposium on Communications and Information Technologies (ISCIT), DOI:10.1109/ISCIT.2012.6381026, ISBN:978-1-4673-1156-4, Page(s): 877 - 882, Gold Coast, Australia, October 2–5, 2012, www.iscit2012.org/
- Mueller J., Magedanz T., ***'Generic-Adaptive-Resource-Control (GARC) in Next-Generation-Networks and the Future Internet***', Demonstration, 12th Würzburg Workshop on IP: ITG Workshop "Visions of Future Generation Networks“ (EuroView2012), Würzburg, Germany, July 23rd - July 24th 2012, http://www.g-lab-deep.de/
- Further publications on SDN and OpenFlow http://www.openflow.org/wk/index.php/OpenFlow_based_Publications

References

- OpenEPC, http://www.openepc.net
- OpenIMSCore, www.openimscore.org
- OpenSDNCore, www.opensdncore.org
- NGN to Future Internet Evolution, NGN2FI, www.ngn2fi.org/
- TU-Berlin – AV, http://www.av.tu-berlin.de/
- Fraunhofer FOKUS – NGNI, www.fokus.fraunhofer.de/go/ngni/
- FP7 IP Project Mobile-Cloud Networking, https://www.mobile-cloud-networking.eu/

4th FOKUS „Future Seamless Communication“ Forum (FFF) Berlin, Germany, November 28-29, 2013

FUSECO Forum 2013
FUTURE SEAMLESS COMMUNICATION

- **Theme: „Smart Communications Platforms for Seamless Smart City Applications – Fixed and Mobile Next Generation Networks Evolution towards virtualized network control and service platforms and Seamless Cloud-based H2H and M2M Applications“**

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  - FFF 2010 attracted 150 experts from 21 nations
  - FFF 2011 was attended by around 200 experts from 30 nations
  - FFF 2012 was attended again by around 200 experts from 30 nations

- See **www.fuseco-forum.org**

Workshop 3:
"Evolution of the Operator Networks beyond EPC: SDN and NFV"

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Questions ???

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