

8th KuVS Fachgespräch NGSDP – "Competitive Service Delivery Infrastructures"
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TU Berlin Chair for Next Generation Networks (AV)
FOKUS Center for Next Generation Network Infrastructures (NGNI)

SDN / Openflow Impacts on EPC Evolution

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Agenda for this talk

- Introduction
 - Idea and Motivation
 - SDN Concept
 - OpenFlow Overview
- OpenFlow Impacts on Telecommunication Networks
 - Telecommunication Network Evolution Path
 - Applying SDN Concepts on 3GPP Evolved Packet Core
 - New Policy and Charging Models
 - Showcase OpenEPC and OpenFlow
- Summary and Future Work



Trends on Telco Networks

Overall Data Traffic Forecast

- IP data and 3GPP Diameter protocol signaling dominated
 - Dominating factors: Video, file transfer, M2M and downloads

Envisioned Mobile Network Architecture

- Towards simple and flat IP architecture
 - low complexity, low latency, lower costs, higher performance, higher throughputs, less costs (CAPEX and OPEX)
- Further separation of control and user (data) plane
 - Scalability, flexibility, reliability of the system components through SDN & NFV

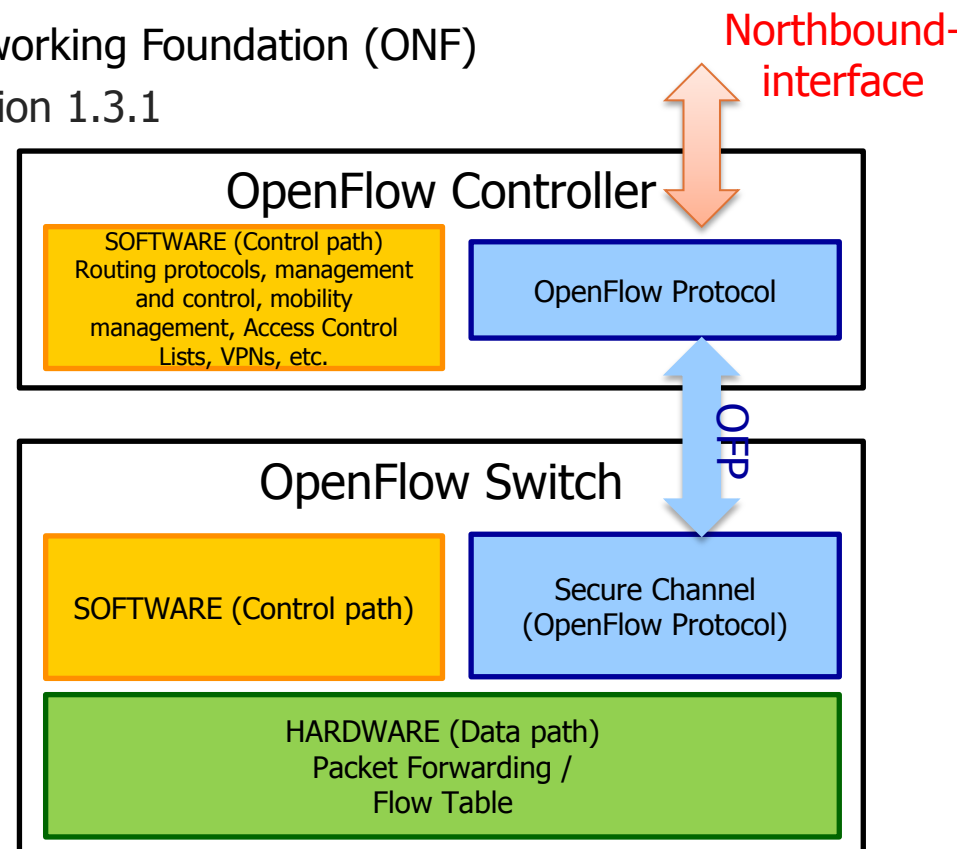
New Services Models

- MVNO support for a shared physical network
- Application based traffic prioritization
- QoS on demand per service data flow or network slice

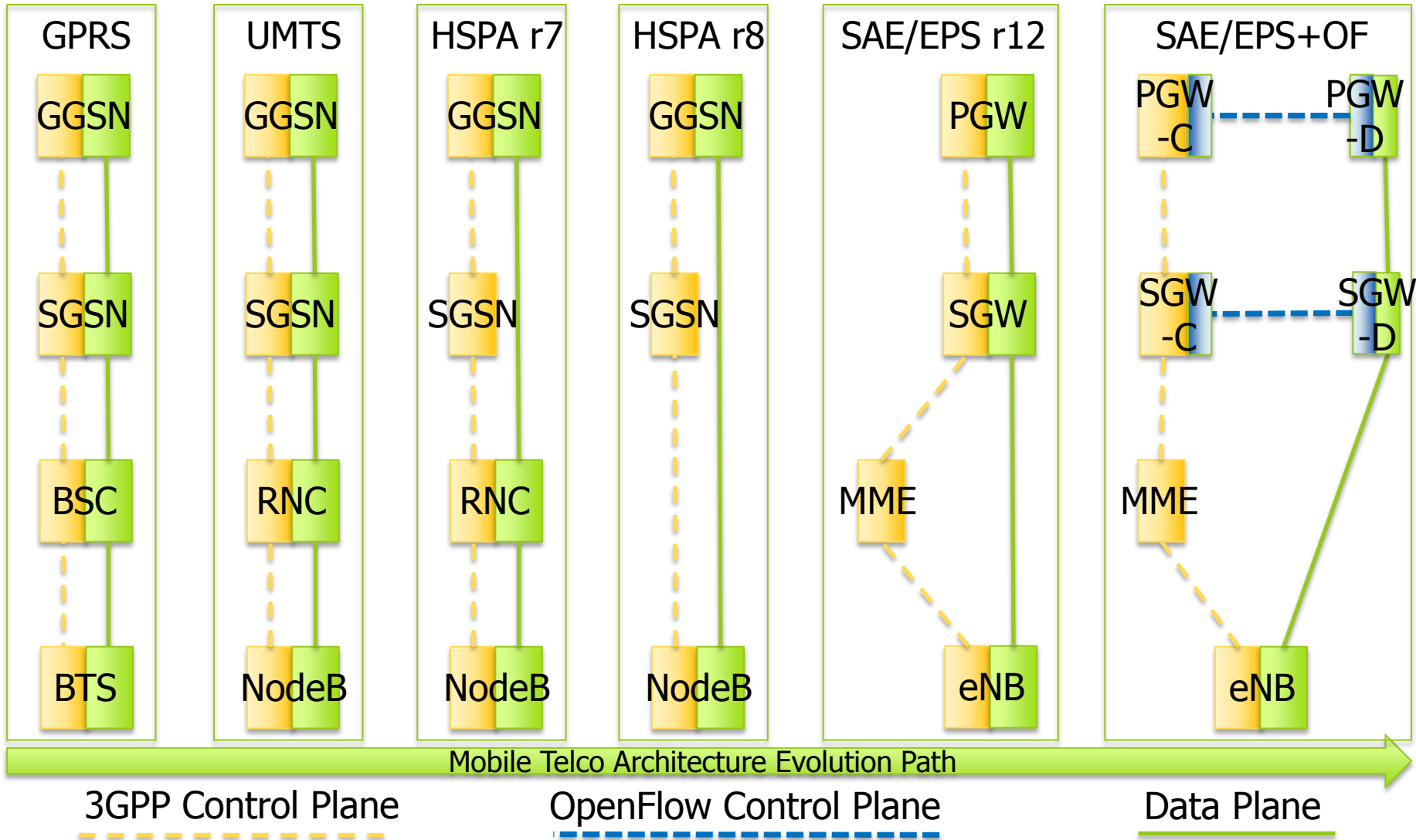


Software-Defined-Networks (SDN) / OpenFlow Overview

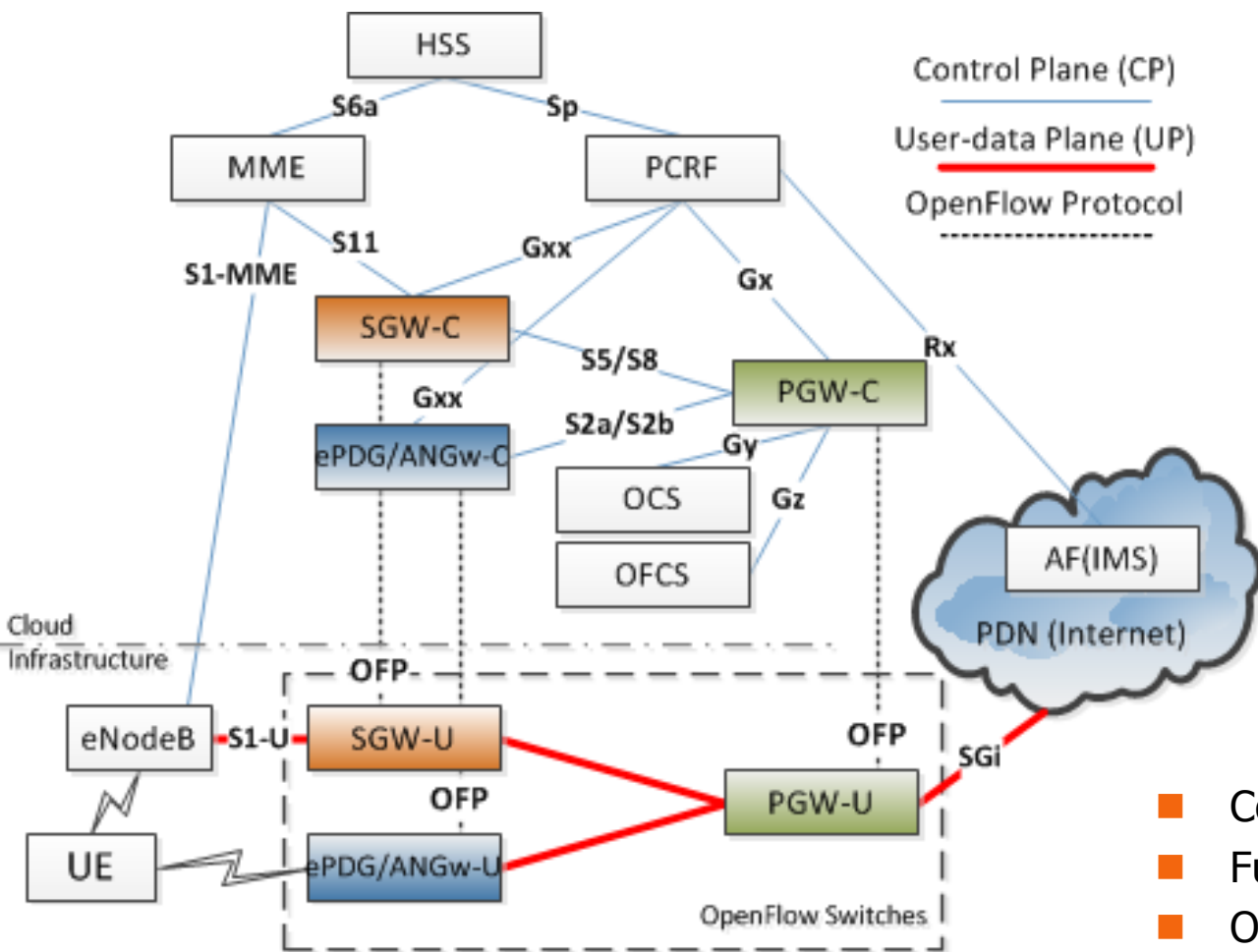
- The concept of SDN separates forwarding and control from switches and routers into OpenFlow controller.
- OpenFlow Protocol specified by Open Networking Foundation (ONF)
 - Control of layer 2-4, Specification version 1.3.1
- Implementations and Specifications
 - OpenFlow Protocol, OF Config
 - OpenVSwitch, OpenFlow switch, etc.
 - POX, NOX, Beacon, Trema, etc.



Mobile Telco Architecture Evolution Path



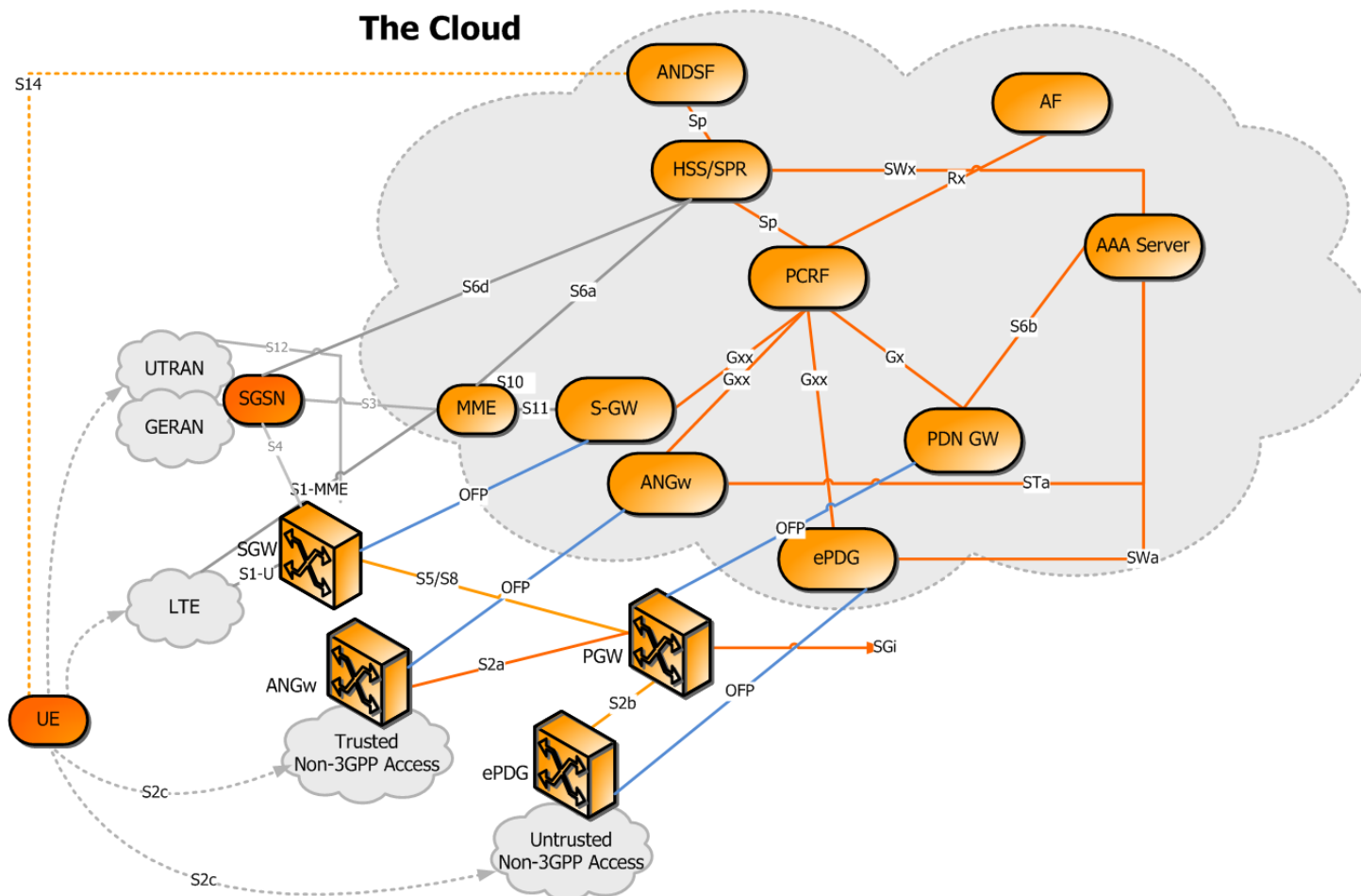
3GPP EPC and OpenFlow



- Control and User Plane Split
- Functional Split of Gateways
- OFP communication protocol



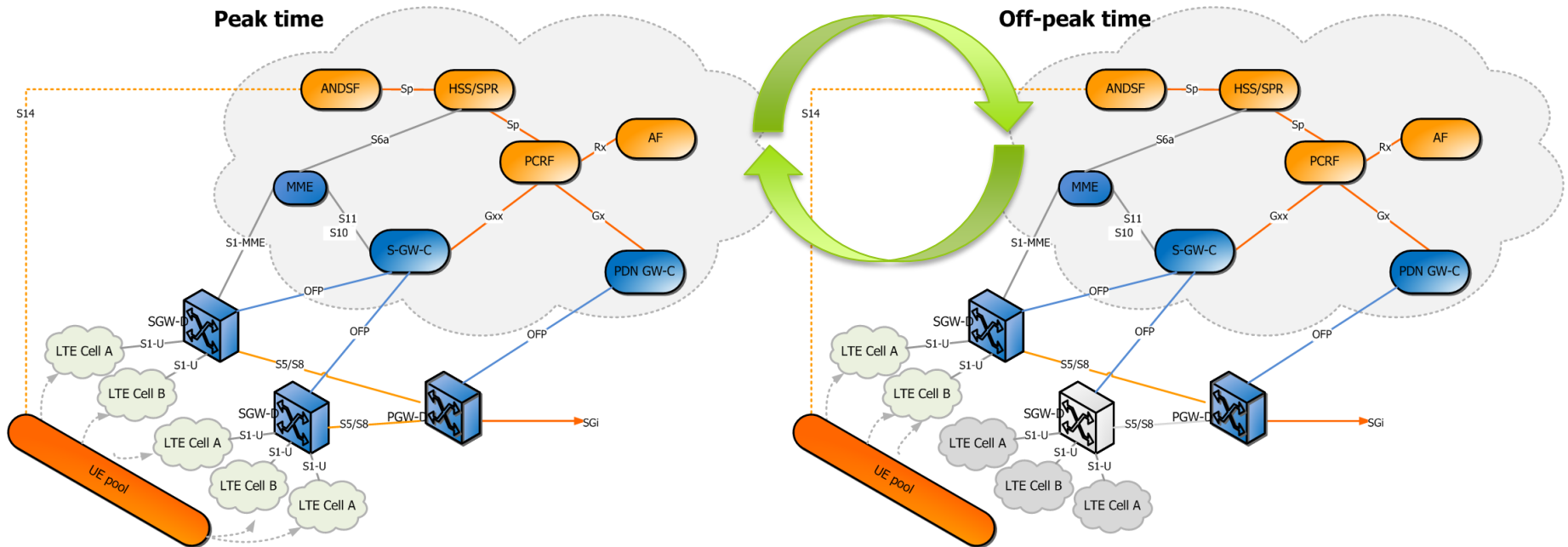
OpenFlow Enhanced EPC Architecture



Challenges of Combining OpenFlow and EPC

- Backwards compliance and interoperability against standard conform 3GPP SAE/EPS solutions.
- GTP and GRE control in OpenFlow switches.
- Delay constraints between core network OpenFlow switches and cloud telco control components.
- Translation from Diameter into OpenFlow Protocol.

Elastic and Flexible Network Design - Example EPS



- 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 Recourses as a Service (NRaaS) and on demand



Applying SDN Concepts on Telco Networks? Pros and Cons!

Pros	Cons
Efficient data plane control	Additional complexity in the architecture
Efficient centralized control components	Additional delay for OFController and OFSwitch communication
Cost aware networking: Flexible data path topology control/mgmt and faster topology re-configuration	Additional costs for supporting 3GPP protocols
Data path elasticity + flexible and optimized service data flow placement	New dimension in complexity for compliance testing
Support for shared network / MVNO concepts	
Performant QoS control on the data path	
New policy models enable more fine granular service charging for additional revenue streams	
Standard-based Solution	

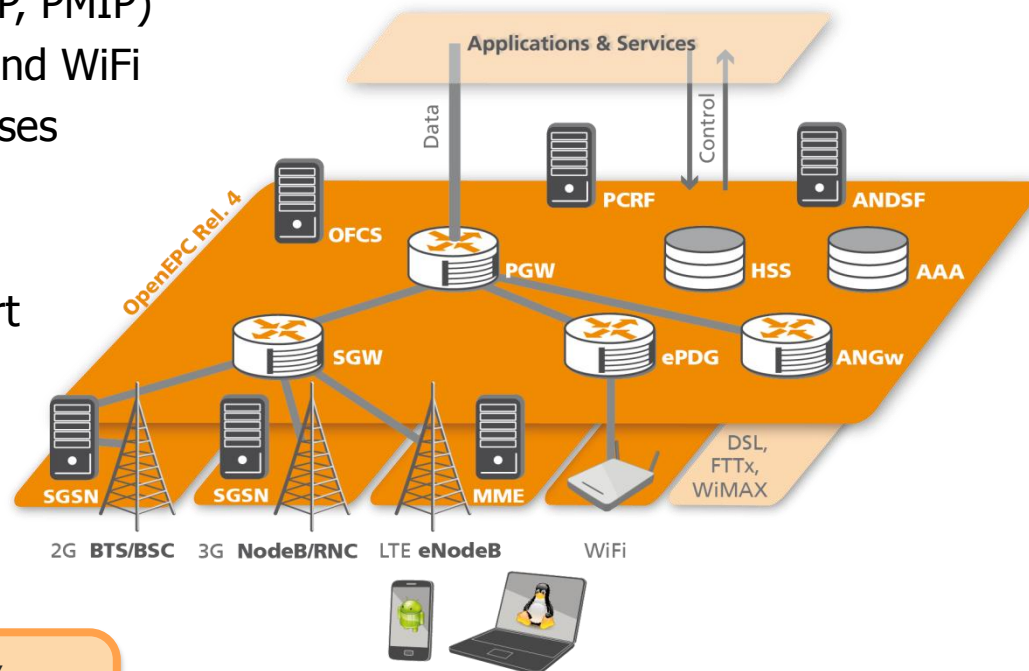
What is FOKUS OpenEPC Platform?

- Future massive broadband communications will be realized through multi-access support (LTE, 3G, 2G, WiFi, fixed networks ...) and multi-application domains (OTT, IMS, P2P, M2M, Cloud, ...)
- Fraunhofer FOKUS is developing the **NON-OPEN SOURCE** OpenEPC toolkit, enabling to:
 - integrate various network technologies and
 - integrate various application platforms
 - into a single local testbed, thus lowering own development costs
- This platform can be used to perform R&D in the fields of
 - QoS, Charging, Mobility, Security, Management, Monitoring
- OpenEPC represents a software implementation of the 3GPP EPC standard addressing academia and industry R&D:
 - Based on 3GPP standards
 - Configurable to different deployments
 - Customizable to the various testbed requirements
 - Extensible to specific research needs
 - Reliable & highly performant
- More information: www.OpenEPC.net



OpenEPC Rel. 4: Mirroring the Future Operator Core Network

- OpenEPC includes the main functions of 3GPP Evolved Packet Core (Release 8,9, 10, 11,...)
- The principles of standard alignment, configurability and extensibility have been respected in the overall architecture and in the specific components implemented
- OpenEPC Rel. 4 enables the establishment of small operator network testbeds including:
 - Core network mobility support (GTP, PMIP)
 - 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



Summary and Future Work

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Future Work

- Implementation of OFController and OFSwitch in version 1.3.1 within OpenEPC
- GTP and GRE support in OpenFlow
- Scalability and Interoperability use case validation



Abbreviations

- ADC Application Detection and Control
- AF Application Function
- BBERF Bearer Binding and Event Reporting Function
- BBF Bearer Binding Function
- CSG Closed Subscriber Group
- CSG ID Closed Subscriber Group Identity
- DRA Diameter Routing Agent
- H-PCEF A PCEF in the HPLMN
- H-PCRF A PCRF in the HPLMN
- HRPD High Rate Packet Data
- HSGW HRPD Serving Gateway
- IP-CAN IP Connectivity Access Network
- MPS Multimedia Priority Service
- OFCS Offline Charging System
- OCS Online Charging System
- PCC Policy and Charging Control
- PCEF Policy and Charging Enforcement Function
- PCRF Policy and Charging Rules Function
- QCI QoS Class Identifier
- vSRVCC video Single Radio Voice Call Continuity
- SPR Subscription Profile Repository
- TDF Traffic Detection Function
- UDC User Data Convergence
- UDR User Data Repository
- V-PCEF A PCEF in the VPLMN
- V-PCRF A PCRF in the VPLMN



Related Publications (selected list)



- Mueller, J.; Carella, G.; Corici, M.; Magedanz, T.; Corici, A.; Vingarzan, D.: "Applying Cloud Principals on Next Generation Mobile Broadband Networks", 7th Workshop (Fachgesprach) on Next Generation Service Delivery Platforms, 'Cloud-based Service Platforms for the Future Internet', of the GI/ITG specialist group on Communications and Distributed Systems "Kommunikation und Verteilte Systeme (KuVS)", Winterthur, Switzerland, November 29, 2012. <http://www.kuvs-ngsdg.org>
- Mueller J., Magedanz T., 'Towards a Generic Application Aware Network Resource Control Function for Next-Generation Networks and Beyond', in the proceedings of IEEE ISCIT 2012, International Symposium on Communications and Information Technologies (ISCIT), Gold Coast, Australia, October 2–5, 2012, www.iscit2012.org
- Mueller J., Magedanz T., Corici M., Vingarzan D., 'UE & Network Initiated QoS Reservation in NGN and Beyond', IEEE Network of the Future (NOF), 2011 International Conference on the Future Internet, Issue Date : 28-30 Nov. 2011, On page(s): 62 - 67, Print ISBN: 978-1-4577-1605-8, DOI: 10.1109/NOF.2011.6126684 Paris, France, 28-30 Nov. 2011, <http://www.network-of-the-future.org/>, <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6126684>
- J. Mueller, T. Magedanz, 'Der Evolved Packet Core', Handbuch der Telekommunikation, Arnold (Hrsg.), 150. Erg. Lfg, Kap. 3.6.0.0, S. 1-52, Wolters Kluwer Deutschland GmbH, April 2012, ISBN: 978-387-156-096-5
- L.Lange, T.Magedanz, J.Mueller, D.Nehls, D.Vingarzan. 'Evolutionary Future Internet Service Platforms Enabling Seamless Cross Layer Interoperability', Baltic Congress on Future Internet and Communications BCFIC, Riga, Latvia, Feb. 2011, Digital Object Identifier: 10.1109/BCFIC-RIGA.2011.5733228, Publication Year: 2011 , Page(s):1-6, Issue Date:16-18 Feb. 2011, Location: Riga, Print ISBN: 978-1-4244-8511-6, INSPEC Accession Number: 11875803, DOI: 10.1109/BCFIC-RIGA.2011.5733228, Date of Current Version: 17 March 2011, <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5733228>
- J.Mueller, M.Kleis, A.Siddiqui, M.Becke, 'Evaluating a Future Internet Cross-Layer Composition Prototype', 7th International ICST Conference on Testbeds and Research Infrastructures for the Development of Networks and Communities, TridentCom, Shanghai, China, April 2011, ISBN: 978-1-936968-04-6, Vol. 90, On page(s): 11-27, <http://www.tridentcom.org/>, <http://dSPACE.icsy.de:12000/dSPACE/bitstream/123456789/324/1/2010-09-Measurements.pdf> T. Korakis et al. (Eds.): TridentCom 2011, LNICST 90, pp. 11--26. Institute for Computer Sciences, Social Informatics and Telecommunications Engineering (2012)



References

- OpenEPC, <http://www.openepc.net/>
- OpenIMSCore, www.openimscore.org/
- FOKUS Open SOA Telco Playground, www.opensoaplayground.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/



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



- **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“**
- FUSECO FORUM is the successor of the famous FOKUS IMS Workshop series (2004-09)
 - 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**



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Questions ???

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