

# FUSECO



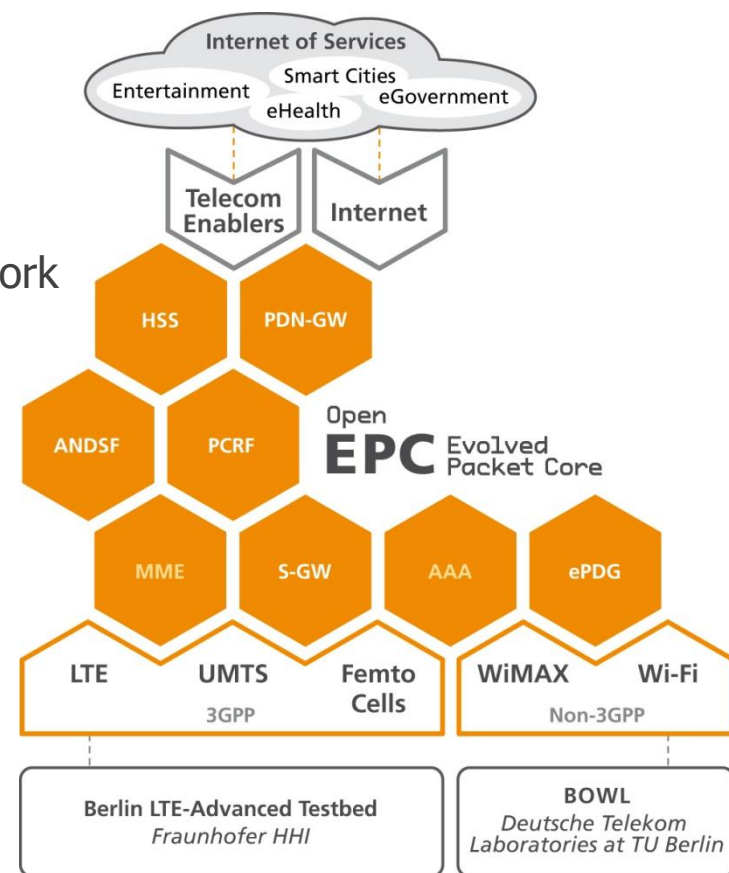
playground

**FUTURE SEAMLESS COMMUNICATION**



# The Future Seamless Communication (FUSECO) Playground

- State of the art testbed infrastructure as a cooperation of Berlin's Next Generation Mobile Network expertise for
  - **EPC** from Fraunhofer FOKUS
  - **LTE-Advanced** at the Fraunhofer HHI
  - **WLAN** networks at the Berlin Open Wireless Network from the Dt. Telekom Labs @ TU Berlin
- Enabling to prototype application support for
  - handover optimization across heterogeneous networks
  - support for Always Best Connected (ABC)
  - subscriber profile based service personalization
  - QoS provisioning and related charging
  - controlled access to IMS-based services
  - controlled access to Internet/Mobile Clouds
- More information: [FUSECO-playground.org](http://FUSECO-playground.org)



## FUSECO Playground – R&D Topics

- Goal is to **cover the entire technology spectrum for communication for vertically integrated research in the area of future mobile communication** from mobile devices to applications

### Network Support for Future Mobile Applications

- Mobile Cloud Computing
- Remote management of smart home environment
- M2M communication / sensor network integration
- Ambient Aware Applications /Future Internet Network Enablers



### Mobility Management

- Harmonization of mobility layers
- Scalability of Next Generation Mobile Networks
- Multi-access and IP flow mobility
- Traffic steering
- Optimized Access Network Discovery and Selection
- Mobile device support for mobility

### Resource Management & Security

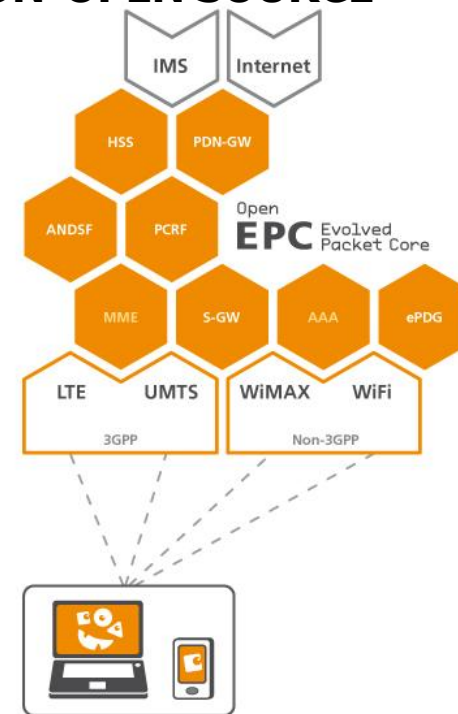
- Convergence for fixed and mobile QoS and AAA topics
- Packet classification mechanisms
- Evolution of PCC & QoS support for all-IP data services
- Aspects of Femtocell integration to EPC



# What is the FOKUS OpenEPC Platform ?



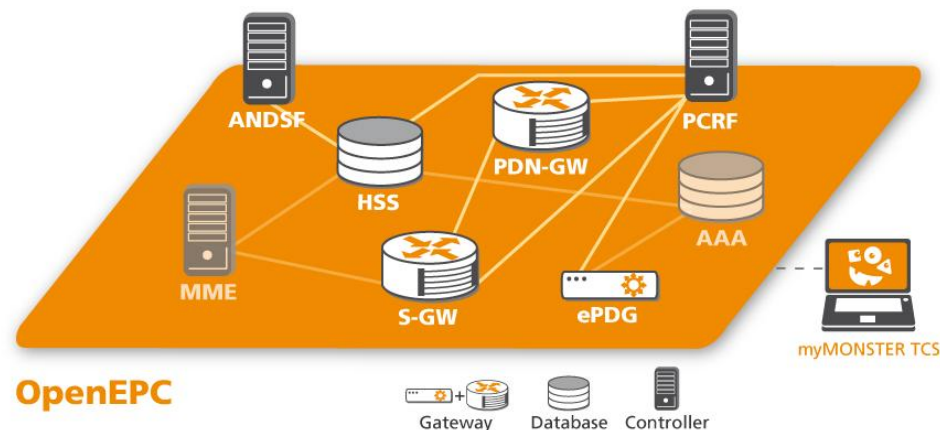
- In NGN/Next Generation Mobile Networks multi access network support (fixed, mobile, cable) and multi application domain support (OTT, P2P, IMS, etc.) will become key for multimedia service delivery
- Based on the Open IMS Core success, FOKUS is developing a **NON-OPEN SOURCE** EPC platform, enabling academia and industry to
  - integrate various network technologies and
  - integrate various application platformsinto a single local testbed, lowering development costs
- This platform can be used to perform R&D in the fields of
  - QoS, Mobility, Security, Management
- OpenEPC is aligned with 3GPP specifications (Rel 8)
  - high performance
  - adaptable to different deployments
  - extensible to specific research needs
  - configurable
- More information: [www.OpenEPC.net](http://www.OpenEPC.net)



# OpenEPC Architecture



- OpenEPC includes the main functionalities of 3GPP's Evolved Packet Core
- The principles of standard conformance, configurability and extensibility have been respected in the overall architecture and the specific components
- In Release 1, a subset of functionalities and features is available as depicted below
  - Subscription based procedures for
    - Always Best Connected
    - Resource Reservation
  - Mobility Support
  - Mobile Equipment support for EPC



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





## OpenEPC Home Subscriber Server (HSS)

- OpenEPC HSS provides storage and provisioning facilities for subscriber profile as defined in the EPC technical specification. It also performs the non-standard Subscriber Profile Repository (SPR) functionality described in the Policy and Charging Control (PCC) architecture documentation. For this, it offers an implementation of the not yet standard interface Sp. This interface permits the support of personalization through profiles.
- The definition of the OpenEPC interface has been developed based on the Open IMS Core Sh interface used between HSS and an IMS Application Server with the addition of some specific Attribute Value Pairs (AVPs). Concretely, the Data-Reference AVP has been extended to include parameters which are fetched from HSS and are used for policy control and for access network discovery and selection.
- Interfaces provided:
  - Sp with ANDSF or PCRF
  - IMS Interfaces: Cx, Dx, Sh
- *The S6a, S6b and S6c will be added in later releases of the OpenEPC.*





## OpenEPC PCRF

- The Policy and Charging Rules Function (PCRF) implementation of the OpenEPC is an evolution of the PCRF included in the FOKUS PoCCA component set which was released in January 2008. This new PCRF aligns with the Release 8 requirements on interfaces (Gxx and S9 new interfaces) and functionality.
- The PCRF permits the application function (e.g. P-CSCF, DPI system etc.) to request resources and priority treatment from OpenEPC, through Rx interface, to consult the subscriber profile downloaded from the HSS/SPR via Sp interface and to make the policy decision to be enforced in network gateways using Gx and Gxx interfaces.
- The PCRF also subscribes to modifications in subscriber profile that may affect the policy decision or require it to be modified.
- Towards gateways the PCRF implements Gx and Gxx interfaces to the PCEF deployed in a PDN-Gw and to BBERF of an S-Gw or an ePDG.
- The behavior of PCRF is controlled through XML described policies which can be provisioned from a GUI dynamically as well as stored in a file. The policy description language complies with OMA Policy Expression Language extending it to support the necessary tags for the functionality of PCRF.





## OpenEPC PCRF - II

- The development of interfaces of PCRF has been done as loadable modules; therefore a specific deployment of OpenEPC PCRF is not forced to include all of them.
- The OpenEPC PCRF is suitable of performing TISPAN Resource and Admission Control Subsystem (RACS), Service based Policy Decision Function (SPDF). It provides the Gqprima interface to application function and it is planned that it will be extended for next releases to support the Ia and Rq interfaces of RACS. In a further extension modules to include the Re interface and the e4 interface can be deployed to complete the overall RACS functions.
- PCRF Interfaces:
  - Rx with Application Function
  - Gqprima (ETSI) with Application Function
  - Gx with PCEF in PDN-Gw
  - Gxx with BBERF in S-Gw or ePDG
  - Sp with SPR/HSS
  - S9 with another PCRF
- *Charging functionality is not currently part of the OpenEPC PCRF and it will be supported in a future release of OpenEPC.*





## OpenEPC PDN Gateway (PDN-Gw)

- OpenEPC PDN-Gw includes a PMIPv4 or PMIPv6 stack configured as a Local Mobility Anchor (LMA). It allocates IP addresses from a provisioned pool. It also supports Policy and Charging Enforcement Function (PCEF) module for Policy and Charging Control.
- PCEF module permits to allocate default QoS values upon attachment of a new subscriber to the PDN and service specific rules when a user accesses a service. The enforcement of these rules is done through standard Linux network tools accessed through shell scripts, and therefore fully configurable.
- Current interfaces offered:
  - PMIP based S5/S8 with Serving-Gw
  - SGi with services domain
  - S2b with the ePDG
  - S2c with the UE
  - Gx from co-located PCEF to PCRF
- In future releases, there is targeted support for other mobility protocols specified in the 3GPP EPC: Dual Stack Mobile IP (DSMIP), Mobile IP Foreign Agent Care of Address (MIP FCoA) and GRPS Tunneling Protocol (GTP). Charging interfaces for the PCEF
- *Support for S6a interface to AAA server will also be supported in the next release.*





## OpenEPC Serving Gateway (Serving-Gw)

- OpenEPC Serving-Gw includes a PMIPv4 or PMIPv6 Mobility Access Gateway (MAG) function. It also includes a module integrating with a standard DHCP server. The attachment of the user to EPC is detected in network level through the request of IP address and configuration parameters over DHCP.
- The OpenEPC Serving-Gw can also include a Bearer Binding and Event Reporting Function (BBERF) for policy control. This function permits to request QoS and priority parameters for IP flows associated with a subscriber. Resulting QoS rules are enforced in the gateway by the standard Linux network tools (e.g. iptables, traffic classes etc.) through shell scripts that permit customization.
- Current interfaces offered are:
  - PMIP based S5/S8 to PDN-Gw
  - Gxx from co-located BBERF to PCRF
- *Support for GPRS Tunnelling Protocol (GTP) will be included in subsequent releases of OpenEPC*





## OpenEPC evolved Packet Data Gateway (ePDG)

- OpenEPC ePDG includes a PMIPv4 or PMIPv6 Mobility Access Gateway (MAG) function. It includes a module integrating with a standard DHCP server. Attachment of the user to EPC is detected in network level through the request of IP address and configuration parameters over DHCP.
- OpenEPC ePDG can also include a Bearer Binding and Event Reporting Function (BBERF) for policy control. This function permits to request QoS and priority parameters for IP flows associated with a subscriber. Resulting QoS rules are enforced in the gateway by the standard Linux network tools (iptables, traffic classes etc.) through shell scripts that permit customization.
- Current interfaces offered:
  - Gxx of collocated BBERF with PCRF
  - S2b between ePDG and PDN-Gw
- *Future releases will support SWu interface and IPSec requests as an attachment trigger as well as SWm interface to AAA Server for authentication.*





# OpenEPC Access Network Discovery and Selection Function

- Access Network Discovery and Selection Function (ANDSF) is a new Release 8 feature of 3GPP that has not yet been fully standardized. At this point, the OpenEPC ANDSF includes several non-standard functionalities necessary to provide a demonstrative usage of its functionality.
- On its current status the description of ANDSF is included in 3GPP TS 24.302
- ANDSF has a S14 interface with User Equipment (UE) used to provide information on access networks available in the vicinity of the subscriber and information on operator's preference on these access networks.
- This information is provided in an XML format specified by 3GPP under TS 24.312.
- The OpenEPC ANDSF includes an interface with the HSS based on the Sh interface between the AS and HSS which provides personalization based on subscribers' profiles.
- The interfaces offered by the OpenEPC ANDSF are:
  - Sp to HSS
  - S14 to UE
- A GUI is included for configuring the behavior of the ANDSF for demonstration of different Always Best Connected (ABC) scenarios.
- *In further releases the ANDSF will include other interfaces and features as soon as they are standardized.*





## OpenEPC Technical Aspects

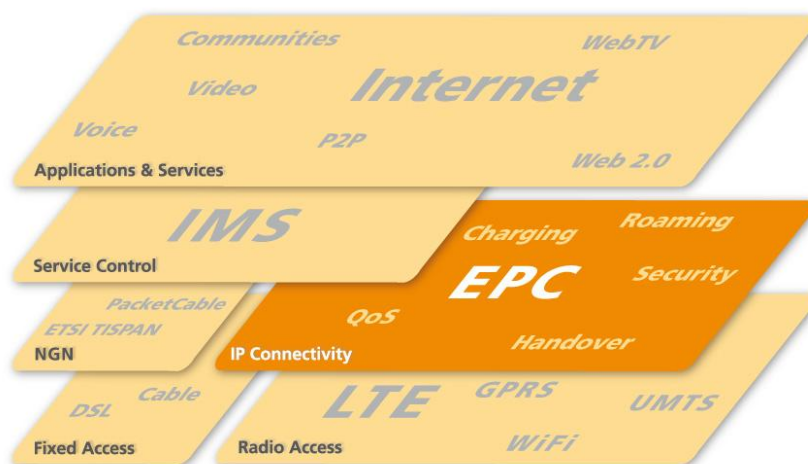
- OpenEPC is a **software implementation of a set of standard EPC** components which permits the cost efficient establishment of testbeds to prototype, measure, test and perform research developments in the area of future wireless networks.
- OpenEPC is both **IPv4 and IPv6 compatible** and its components have been developed in C under Linux for high performance.
- The specific components that are part of the current release 1 of OpenEPC are:
  - a S-Gw and ePDG (including a BBERF from PCC Release 8), PDN-Gw (including a PCEF from PCC Release 8), PCRF, HSS, ANDSF and a corresponding EPCclient.
- All these components have been designed to be:
  - **Configurable** – allowing easy modification of the behavior of components and the inclusion of optional features.
  - **Customizable and extensible** – permitting the set-up of different environments and adapting to new requirements that may appear within standardization process
  - **Reliable** – based on the know-how gained in previous component development like the Open IMS Core project
  - **Aligned with standards** - can be used for testing other commercial EPC components as well



# OpenEPC Usage Scenarios

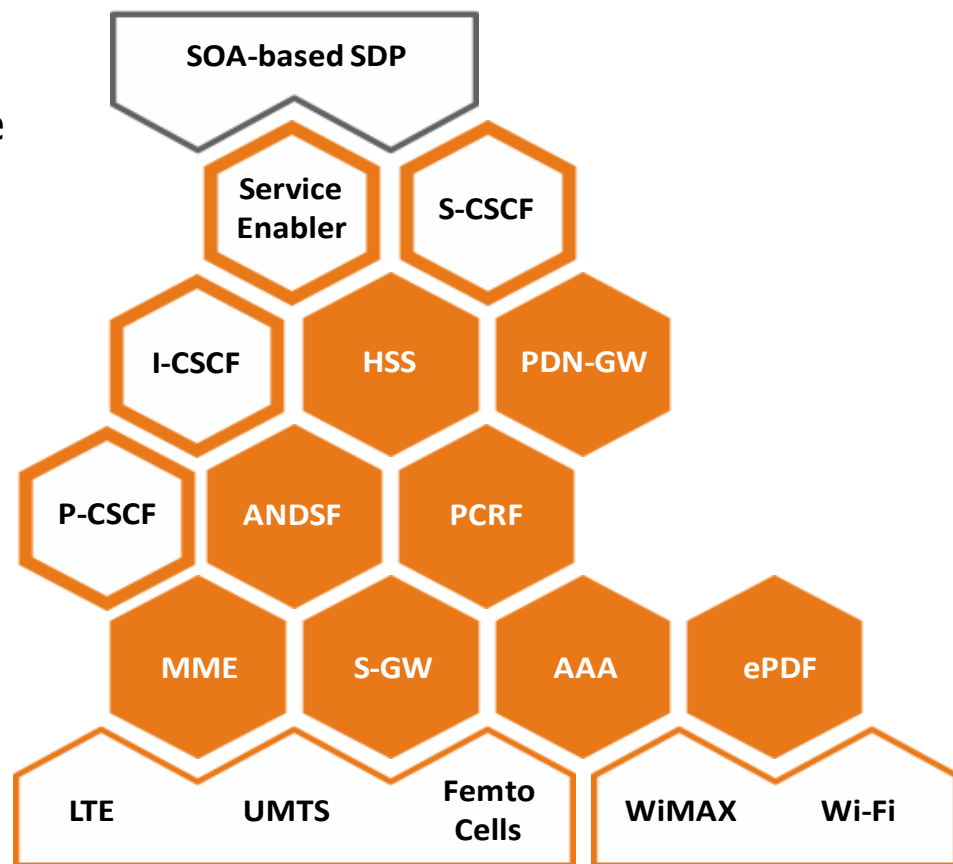


- Handovers in Heterogeneous Networks
- Support for Always best connected (ABC)
- Access Control and QoS provisioning
- Service Adaptation to Network Context
- Access to IMS services through OpenEPC
- Access to Internet through OpenEPC



# Service-controlled Network selection & QoS EPC, IMS, and SDP

- Interworking of EPC, IMS and SOA-based SDP allow on-demand functionalities of the network layer triggered by the service layer:
  - Dynamic network selection providing the best-suited network connectivity according to service / media parameters
  - QoS enforcement for specific bandwidth requirements
  - Configuration of network routes (e.g. emergency communications, enforcement of optimised routing for high-bandwidth or low-delay streaming services)



# OpenEPC Releases and Roadmap






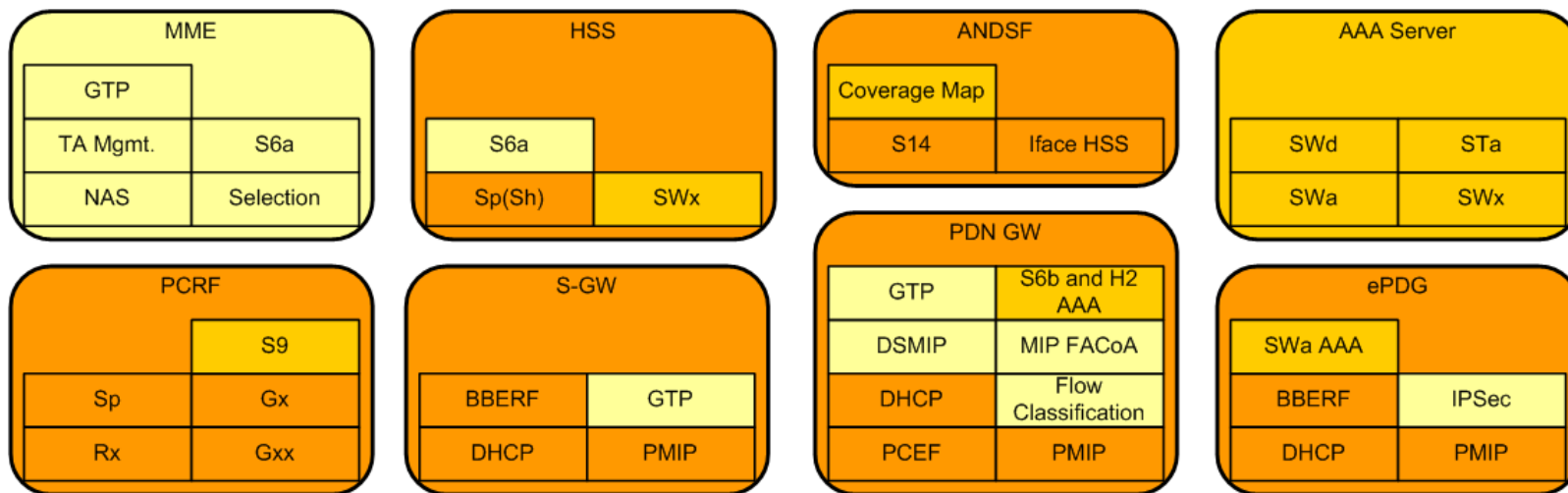
- OpenEPC is available under license either as a complete testbed or as individual components for research and development purposes. OpenEPC integrates with various access networks and different services platforms to provide a complete prototype solution.
- The planned releases of OpenEPC are as follows:
  - **November 2009:** First demonstration of OpenEPC and availability for partners at 5th FOKUS IMS Workshop
  - **April 1<sup>st</sup> 2010: Release 1** of OpenEPC will include more mobility options, roaming configurations support, and support for security procedures
  - **November 2010: Release 2** and full OpenEPC
- We are able to provide on-site coaching, local deployment and integration activities, support, as well as extensions to OpenEPC components to meet specific customer requirements.
- In the same way Fraunhofer FOKUS and TU Berlin are interested in setting up joint R&D projects based on the OpenEPC platform.



# OpenEPC Releases and Roadmap - II

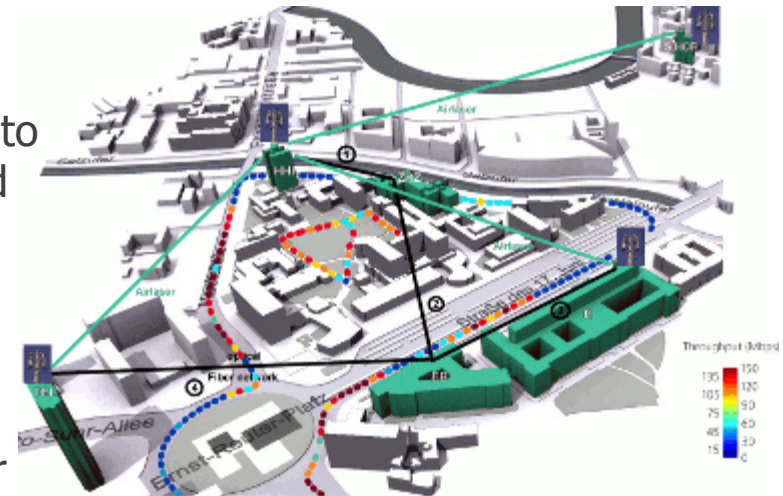


-  **Release 1:** Complete Base Functionality (April 2010)
-  Internal Release: Secure Access and Roaming (August 2010)
-  **Release 2:** Mobility Management Enhancements (November 2010)



# Berlin LTE-Advanced Testbed

- Serves for the early evaluation of LTE-Advanced concepts in a realistic cellular environment
- For the demonstration of key technology features to increase spectral efficiency, range, throughput and quality-of-service
- Challenges
  - Reducing inter-cell interference
  - Cooperation between adjacent base stations (promises a higher performance in the cellular network)
  - Distributed cooperative signal processing
- operated from Fraunhofer HHI, Deutsche Telekom Laboratories and Technische Universität Berlin
- More information: [www.hhi.fraunhofer.de/bm](http://www.hhi.fraunhofer.de/bm)



# Berlin Open Wireless Lab (BOWL)

## Reconfigurable Wireless Research Network

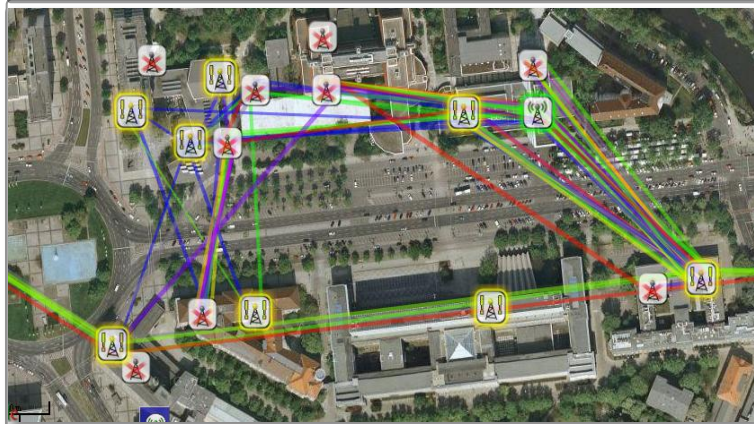


### Goals

- Bring research results to a semi-productive environment
- Allow for easy setup of arbitrary experiments with real users and live traffic
- Coherent infrastructure from physical layer and radio transmission through network to services

### What is BOWL

- Wireless research network
- 46 rooftop nodes on TUB Campus
- Accessible by *all* students of TUB for Internet access
- Authentication: currently VPN, 802.11x since the beginning of the Summer semester 09



<http://bowl.net.t-labs.tu-berlin.de>



### Outlook

- Wireless research: Mobility management, wireless communications and networking algorithms, measurements ...
- Open beyond networking: Testing of IP-convergent services, location based services ...
- Open for new technologies
- Open to TU students: Most playful user base



## The FUSECO Playground – Partner Offering



- **Operators** can prepare for the upcoming all-IP NGN and Next Generation Mobile Network world in an open and vendor independent end-to-end test-bed infrastructure
- **Manufacturers** of individual EPC components can use the OpenEPC to test their products in concert with a standards aligned Next Generation Mobile Network environment
- **Application developers** can use the FUSECO Playground APIs to certify that their applications are tailored for Next Generation Mobile Networks
- **Research institutions and universities** can use the setup for practical research in an open lab environment
- General offers to all partners
  - **customized access** to parts or the whole infrastructure
  - **local distribution/deployment of parts of the EPC infrastructure** within the partner environment
  - customization of the infrastructure for **application trials, IOP testing** or for use within R&D projects
  - **product validation**
  - **tutorials and consultancy**



# The FUSECO Playground - Roadmap



## **Phase 1 - Interconnection of OpenEPC with access networks** (January-March 2010)

- IP address through OpenEPC DHCP
- Forwarding of data traffic to OpenEPC

## **Phase 2 – Initial Demonstration Cases** (March-May 2010)

- Always Best Connected
- Scalable video broadcasting H.264/Scalable Video Coding (SVC)

## **Phase 3 - Open lab to be used in research projects**

(Starting May 2010)



# Coming up ...

## TridentCom 2010

The 6th International Conference on Testbeds and Research Infrastructures for the Development of Networks & Communities

18-20 May 2010, Berlin, Germany

Sponsored by:	Technically co-sponsored and supported by:
	         

- **TridentCom 2010 is devoted to “Testbeds and Experimental Facilities for the Future Internet”.**
- This three-day event features 4 keynotes about the German G-Lab, the European FIRE initiative, the US GENI program and the Japanese New Generation Network project framework, 5 tutorials, and 41 technical papers from 20 countries presented in 11 technical sessions
- **Also featured:** 2nd Open NGN and IMS Testbeds (ONIT) Workshop [www.onit-ws.org](http://www.onit-ws.org)
- **Also featured: free EPC tutorial** [www.FUSECO-playground.org/epc-tutorial](http://www.FUSECO-playground.org/epc-tutorial)
- **More details on Tridentcom 2010 can be found at:** [www.tridentcom.org](http://www.tridentcom.org)



# EPC Tutorial - Towards the Wireless Future Internet

Understanding the Role of Next Generation Mobile Networks and the Evolved Packet Core



- **May 17th 2010, 14:00h – 17:30h**
- **Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute, Einsteinufer 37, 10587 Berlin**
- This half-day tutorial will provide an overview of Next Generation Mobile Networks and the corresponding 3GPP standards related to the Long term Evolution (LTE) and the Evolved Packet Core (EPC), which form together the Evolved Packet System (EPS). Major focus of this tutorial is on the EPC concepts, architecture, components, interfaces and functional capabilities. As the EPC provides a unified control platform for linking different IP application platforms with various broadband wireless access networks, the tutorial also addresses potential EPC application domains, namely the IP Multimedia Subsystem (IMS), as well as potential open internet service architectures.
- The tutorial terminates with an introduction to the TU Berlin / Fraunhofer FOKUS OpenEPC ([www.openepc.net](http://www.openepc.net)) software toolkit enabling rapid prototyping for applied academic and industry research. In particular, it introduces the new open Future Seamless Communication (FUSECO) Playground ([www.fuseco-playground.org](http://www.fuseco-playground.org)) established in Berlin, Germany in the beginning of 2010.
- **Register for free under [www.FUSECO-playground.org/EPC-tutorial](http://www.FUSECO-playground.org/EPC-tutorial)**



*Coming up*

## ***1st FOKUS FUSECO Forum***



- ***„Business and Technical Challenges of Seamless Service Provision in Converging Next Generation Fixed and Mobile Networks“***
- Follow up of the famous FOKUS IMS Workshop Series
- Event date: **October 14-15, 2010**
  - Day One: **LTE and EPC Tutorials and FUSECO Playground Demos**
  - Day Two: **Interactive Workshop with Operator Talks and Vendor Panel**
- **More at: [www.FUSECO-Forum.org](http://www.FUSECO-Forum.org)**



*Coming up*

## ***IEEE Globecom FUSECO Workshop***



Friday, 10 December  
Miami, Florida

### **IEEE Globecom 2010 FUSECO Workshop**

Future Seamless Communication: Packet Core Evolution  
and Seamless Multimedia Application Platforms

- **Follow up of Globecom 2009 Next Generation Mobile Network/EPC Business Developing Forum**
- **Paper Submission due: July 2, 2010**
- **Conference date: December 10, 2010**
- **More at [www.FUSECO-workshop.org](http://www.FUSECO-workshop.org)**



## Recent FUSECO Publications



- Corici M., Gouveia F., Magedanz T., Vingarzan D., "OpenEPC: A Technical Infrastructure for Early Prototyping of Next Generation Mobile Network Testbeds", in Proceedings of TRIDENTCOM 2010, 6th International Conference on Testbeds and Research Infrastructures for the Development of Networks and Communities, Berlin, Germany, accepted for publication
- Diez, A., Gouveia, F., Corici, M., Magedanz, T., "Evolution of QoS control in Next Generation Mobile Networks", chapter 26 in S. Adibi (Ed.), "Quality of Service Architectures for Wireless Networks: Performance Metrics and Management", published by Information Science Reference, ISBN: 978-1-61520-680-3, release date January 2010
- M. Corici, D. Vingarzan, A. Diez, T. Magedanz, C. Pampu, Q. Zhou. "Enhanced Access Network Discovery and Selection in 3GPP Evolved Packet Core", IEEE LCN, October 2009
- Fabricio Gouveia, Sebastian Wahle, Niklas Blum, Thomas Magedanz, "Cloud Computing and EPC / IMS Integration: New Value-added Services on Demand", in MobiMedia 2009, 5th International Mobile Multimedia Communications Conference Proceedings. ACM/ICST, 2009, accepted for publication in 2009
- Good, Richard; Gouveia, Fabricio; Magedanz, Thomas; Ventura, Neco, "Policy-Based Middleware for QoS Management and Signaling in the Evolved Packet System" In: Bonnin, Jean-Marie (Hrsg.) u.a.: Mobile Wireless Middleware, Operating Systems, and Applications : Second International Conference, Mobilware 2009, Berlin, Germany, April 28-29, 2009 Proceedings. Berlin [u.a.]: Springer, 2009, S. 115-128 (Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering 7)
- Diez A., Gouveia F., Corici M., Magedanz T., "The PCC Rule in the 3GPP IMS Policy and Charging Control Architecture", IEEE Global Telecommunications Conference (Globecom), New Orleans, ISBN: 978-1-4244-2324-8, December 2008
- M. Corici, F. Gouveia, T. Magedanz, "A Network Controlled QoS Model over the 3GPP Evolved Packet Core", Chapter 12, pp. 255-275 in "Advances in Broadband Communication and Networks", Editors: J.I. Agbinya, et.al., River Publishers Series in Communications; ISBN: 978-87-92329-00-4 (c) 2008 River Publishers, Denmark, September 2008
- Corici, M. I.; Gouveia, F. C.; Magedanz, T., "A Network Controlled QoS Model over the 3GPP System Architecture Evolution", Second Australian Conference on Wireless Broadband and Ultra Wideband Communications - AusWireless 2007, Crowne Plaza Hotel, S H



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[www.FUSECO-Playground.org](http://www.FUSECO-Playground.org)