Towards Smart City Service Delivery and Control Platforms - Putting SDP, IMS, MTC, and EPC into a single context

Prof. Dr. Thomas Magedanz
TU Berlin, Germany

thomas.magedanz@tu-berlin.de
www.av.tu-berlin.de
The Role of IP Multimedia Subsystem, Machine Type Communication, Evolved Packet Core and related Open APIs within emerging Smart City SDPs

- FOKUS Toolkits and practical examples
- Summary
A déjà vu - From NGN towards SDPs for Future Internet / Smart Cities

Main Idea: A Core Platform provides reusable capabilities (⇒ Enablers) for multiple applications hiding the details of underlying technologies
Evolution of Telecommunication Platforms toward Smart Communications

- IT Impact on Telecoms
  - Intelligent Network (IN)
  - Open APIs
    - OSA/Parlay/JAIN
  - Telecom APIs
    - Parlay X, GSM One, OMA NGSI, etc
- Service Delivery Platform (SOA based)
  - Open Service APIs (Enablers)
- Network Abstraction
  - IP Multimedia System (IMS)
  - IP Networks (NGN)
    - DSL
    - UMTS
    - WLAN
    - Cable
    - LTE
    - WiMAX
    - WLAN
  - Circuit Switched Networks
    - PSTN
    - GSM
  - VoIP / SIP
  - All-IP

Future Internet Research

- SC Cloud Applications:
  - RCS, UC, eGov, eHealth, eTransport, eUtilities
- Smart Core (EPC)
- Cloud Applications:
  - RCS, UC, eGov, eHealth, eTransport, eUtilities
- Network of the Future
- Internet of Services
- Internet of Things
- MTC
- IN Overlay Architecture
- IN Services based on SIBs
- Circuit Switched Networks
  - PSTN
  - GSM
- Service Delivery Platform (SOA based)
  - Open Service APIs (Enablers)
The Notion of Enablers within the European Future Internet Initiative

Maximising the Common enablers

- Examine the basic enablers in each area
- Determine the common enablers
- Determine the enhanced enablers
- Work out how to provide a core platform that supports the enablers
- Build it and show the world
- Use it in large scale trials and tests
- Use existing advanced infrastructures to test future Internet function
Agenda

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- FOKUS Toolkits and practical examples
- Summary
Future Internet ... to make our cities smart
A Smart City is a huge Future Internet Show Case

- E-Living
- E-Health
- Education
- Culture
- Urban Production
- Signal Transmission & Networks
- Transport & Traffic
- Politics & E-Government
- Communications
- Energy
- Security
- Mobility
- Culture
- Urban Production
- Signal Transmission & Networks
- Transport & Traffic
- Politics & E-Government
- Communications
- Energy
- Security
- Mobility

www.fokus.fraunhofer.de/go/ngn2fi
A Smart City relies on Integration & Federation of Systems
Convergence will lead to a Common SC Service (ICT) Platform

Enablement of “Smarter Applications” by allowing these to make use of common/open data and common service capabilities provided by a Smart City service platform

Common SC Service (ICT) Platform

Federation & Integration of different fixed and mobile Network Technologies to interconnect different machines (sensors, actuators) and people and for providing applications seamless
Fraunhofer FOKUS – Activity Domains

Public Innovation Management

System Quality Engineering
- eGovernment
- eHealth
- Public Security
- Smart Mobility
- Smart Energy

Smart Communication

- Interoperability
- Critical Infrastructure
- Identity Management
- Virtualization
- Process Orientation
- Linking Legislation and Technology
- Business Analytics/Big Data
Research Agenda of Fraunhofer: Smart City Vision

Environment
Cities that produce almost no more CO₂-Emissions.

Quality of life
Cities that provide the best life quality for all residents.

Smart City
Cities that intelligently interlink all its potentials and city systems.

Energy
Cities that are greatly energy-efficient.

Climate Change
Cities that can easily adapt to the effects of climate change.

Resources
Cities that are profoundly resource-efficient.

Society
Cities that represent a post-fossil society.

E-Mobility
Cities that offer a medium for the change towards electromobility.
Solutions made by FOKUS
FOKUS labs on ICT in Smart Cities

- Secure eIdentity-Lab
- Cloud/SOA-Lab
- Open/Closed Source-Lab
- Protocol Conf. and Interop Lab
- eGovernment Lab
- Politics and Administration
- Communication
- Energy
- Smart Metering Lab
- Urban Security
- eHealth Interop Lab
- Health
- Public Services Urban Management
- Transport and Traffic
- Automotive Lab
- Smart Communications Lab
- FUSECO
- eHealth Interop Lab

Fraunhofer FOKUS
Smart City ICT
Tools & Testbeds

www.fokus.fraunhofer.de/go/ngni
Related FOKUS Testbed Evolution

IT Impact on Telecoms

Intelligent Network (IN)

Open APIs

OSA/Parlay/Java API

Telecom APIs

OSA/Parlay

OSA/Parlay Playground

IN Services

based on SIBs

IN Overlay Architecture

Circuit Switched Networks

(iptel.org)

PSTN

GSM

IP

DSL

UMTS

WLAN

IP Networks (NGN)

Evolved Packet Core (EPC)

WiMAX

Core Platform

Network Abstraction

Evolved Packet Core (EPC)

FUSECO

playground

People & Things

FI Applications

Smart Cities, eGov, eHealth, eTransport, eUtilities

Smart Communications Playground

IP Multimedia System (IMS)

Telecom APIs

Parlay X, GSM One

OMA NGSI, etc

Telecom APIs

OSA/Parlay

Open APIs

OSA/Parlay/Java API

Open IMS Playground

Open SOA telco Playground

FI Applications

Smart Cities, eGov, eHealth, eTransport, eUtilities

Smart Communications Playground

People & Things
Stakeholders

Operators
- Be prepared for all-IP mass mobile broadband world
- Validate new technologies

Manufacturers
- Validate their products against standard compliant EPC
- Looking for the missing pieces

Application developers
- Validating wireless applications
- Direct access to core functionalities

Research institutions and universities
- R&D on real network conditions
- Innovating new concept and algorithms
Commercial FOKUS NGN/IMS/EPC/SOA Testbed Deployments around the world
Fraunhofer Testbeds / Playgrounds

Smart Communications Playground

FUSECO Playground

Over-The-Top Services

Communication

Communication Server

OpenMTC

LTE

eEnergy

OpenIMS

WiBack

2G/3G

eGovernment

OpenEPC

OpenCTK

WiFi

eHealth

M2M & RCS

DSL, FTTx

Entertainment

Telco Communicator Suite

Network Access & Control

Bit-Pipe Access

WiBack

LTE

WiBack

OpenEPC

OpenCTK

OpenIMS

OpenMTC

FUSECO playground

www.FUSECO-Playground.org

www.SC-playground.org
FOKUS Smart Communication Research
A Generic Smart Communication Architecture

- Connecting Smart City objects across application domains
- Enabling the Internet of Things by using M2M gateways and network middleware to communicate efficiently
- Enabling multimedia communication services by integrating Telecoms APIs and platforms.
- Enable rapid application development using M2M and H2H network APIs and software development kits (SDK)
- Enable cross domain data analytics and fusion to serve the need of Smart Cities

visit: www.sc-playground.org
Future Seamless Communication (FUSECO) Playground

- State of the art testbed infrastructure as a cooperation of Berlin’s Next Generation Mobile Network expertise for
  - Open IMS for H2H communications
  - OPenMTC for M2M communications
  - OpenEPC for seamless access
  - Various access network technologies

- 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
The Start: Open Source IMS Core

- Global reference for IMS test-beds
- In November 2006 the FOKUS Open Source IMS (OSIMS) Core System - the core of the Open IMS playground - has been officially released to the general public via the BerliOS Open Source portal: www.openimscore.org
- OSIMS allows industry and academic institutions to setup own testbeds (with or without FOKUS support and components)
- Since then OSIMS has been downloaded many thousand times from all over the world

See also www.open-ims.org

Note: IMS Client shown is MyMonster – see www.opensoaplayground.org/tcs
FOKUS joyn App for Deutsche Telekom
Extending RCS for Facebook Image sharing

- App uses Deutsche Telekom RCS network gateway to provide mobile image sharing for Facebook images
- Extends Facebook network with mobile operator RCS network
Introducing the FOKUS OpenMTC Platform

- Based on the success of the Open IMS Core and OpenEPC Fraunhofer FOKUS has developed a **NON-OPEN SOURCE** Machine Type Communication platform, enabling academia and industry to:
  - integrate various machine devices with operator networks
  - integrate various application platforms and services
  into a single local testbed, thus lowering own development costs
- OpenMTC is an intermediary layer between multiple service platforms, the operator network, and devices
- This platform can be used to perform R&D in the fields of machine type communication
- OpenMTC implemented features are aligned with ETSI M2M specifications:
  - Adaptable to different M2M scenarios (e.g. automotive)
  - Extensible to specific research needs
  - Configurable
  - Performant

- For more see www.open-MTC.org
OpenMTC Architecture – Release 1

- OpenMTC consists of the two main components
  - Network Service Capability Layer (NSCL)
  - Gateway Service Capability Layer (GSCL)
- Both SCLs contain several modules
  - e.g. NGC: Network generic communication, GSEC: Gateway security, etc.
  - Some of them are optional
- OpenMTC allows interworking with
  - OpenEPC (Evolved Packet Core)
  - OpenIMS (IP Multimedia Subsystem)
  - FOKUS Service Broker
- OpenMTC supports:
  - Various sensors and actuators (e.g. ZigBee, FS20 devices)
  - Multiple Access networks (e.g. fixed, mobile, xDSL, 3G, etc.)
  - Various Applications (e.g. Smart Cities, Smart Home, etc.)
OpenMTC Architecture
OpenMTC Application Enablement

- Exposes functionalities implemented in the service layers (N/GSCL) via the reference points
  - mIa
  - dIa

- Single contact point for
  - Network Applications (NA)
  - Gateway Applications (GA)
  - Device Applications (DA)

- Performs routing between applications and capabilities in the N/GSCL

- Routing is defined as the mechanism by which a specific request is sent to a particular capability
Integration and Interworking on all layers  
**Supporting Interoperability**

- Heterogeneous Application Integration
- Heterogeneous System / Platform Integration
- Heterogeneous Device Integration
OpenMTC Releases and Roadmap

First Demos
Nov 2011
- IMS based demos
- Sensor integration in Telco world

OpenMTC Rel. 1
May 2012
- Generic communication
- Application enablement
- ETSI resource tree
- Remote management
- Integration with Telco Services

OpenMTC Rel. 2
Nov 2013
- New use case demos
- NSCL APIs & SDK
- Android D/GSCL
- Integration with 3GPP core network – EPC, PRCF/ANSDF, MTC-IWF
- Full REM SC, OMA DM
Smart City Services for Facilities and Campuses

- OpenMTC hides heterogeneity across a wider facility infrastructure (i.e. sensor and actor networks), communications (i.e. wireline or wireless, fixed or mobile), and services (i.e. M2M or proprietary) enabling data fusion and joint control.
Smart City Services for Early Warning and Emergency Management

- OpenMTC aggregates sensor information and environmental warnings, implements application logic and policies, and can automate counter-measures (e.g. multi-channel hazard warning, facility management, and traffic control) via dedicated application logic.
KATWARN – An example for cost-effective solutions
An adaptable combination of existing technologies for public alerting
KATWARN-App
Smart City Services for eHealth and Support of Elderly People

- OpenMTC supports various eHealth devices and can communicate health information to hospitals and first responders. In conjunction with traffic & location information and data about medical staff occupancy, critical time savings and cost reduction can be achieved.
Fl-star as one of the Phase 2 Use Case project of FI-Ware

https://www.fi-star.eu
http://fistarblog.com/
## Fi-Star budget and partner structure

<table>
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<th>FiStar</th>
<th>Budget €</th>
<th>EU contribution €</th>
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<tbody>
<tr>
<td>Total</td>
<td>16,830,394</td>
<td>13,499,000</td>
</tr>
<tr>
<td>26 partners, of which:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fraunhofer FOKUS</td>
<td>634,561</td>
<td>488,934</td>
</tr>
<tr>
<td>TU Berlin, AV</td>
<td>835,204</td>
<td>654,228</td>
</tr>
</tbody>
</table>

The table shows the budget and EU contribution for the Fi-Star project. The total budget is €16,830,394, with the EU contributing €13,499,000. This is achieved through contributions from 26 partners, including Fraunhofer FOKUS and TU Berlin, AV, with contributions of €634,561 and €835,204, respectively.
AV/FOKUS Components in FI-Star

Applications and Services

Transport Network

IoT

Data Handling

OpenMTC Gateways

OpenEPC

Cloud Proxy

I2ND

QoS/Mobility

Sense/Act
Smart City Services for End Customer Domotics and Smart Metering

- OpenMTC provides a unified API to M2M client applications while hiding heterogeneity of end-customer premises equipment (i.e. domotics and smart meter) and the communication links between customer premises and M2M service center.
Current Research

TRESCIMO | Testbeds for Reliable Smart City Machine-to-Machine Communication

- **Context:** FP7 FIRE STREP: EU/SA collaboration
- **Motivation:** Urbanization issues in South Africa
- **Goal:** Reliable Smart City Communication Platform
- **Approach:**
  - Smart Technologies
    - CSIR: Smart Platform
    - i2CAT: Smart City Platform
    - Fraunhofer/TUB: OpenMTC / FITeagle
  - Smart Sensors
    - Eskom: Utility Load Manager
    - AirBase: Smart City Air Pollution Wireless Sensors
  - Evaluation
    - Pilots: San Vicenç dels Horts and Johannesburg
    - Testbeds: TUB and University of Cape Town
- **Web:** [http://trescoim.eu](http://trescoim.eu)
Approach | Main Roles

Project Management.

OpenMTC developments. Testbed interconnection.

OpenMTC developments.

Smart device developments. Testbed setup.

Experimentation and evaluation.

Scenarios and requirements. Smart City platform developments.

Testbed setup.

Smart device developments. Testbed setup. These partners are not funded by the EC.
Approach | Collaboration between Europe and South Africa
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, enabling:
  - 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:
  - Configurable to different deployments
  - Customizable to the various testbed requirements
  - Extensible to specific research needs
  - Reliable & highly performant
  - Based on 3GPP standards

- More information: www.OpenEPC.net
OpenEPC Scales for different deployments

- OpenEPC components can be deployed in almost any configuration possible
  - Large testbeds – each component on a separate machine
  - Smaller testbeds – components are grouped in same servers
  - Single box testbed – components are virtualized on the same machine
  - Minimized testbed – the OpenEPC components run as parallel programs on the same box
OpenEPC is highly modular and easy to extend

- Development of a new interface using a protocol
- Creating a new component
- Modifying an existing one
- Re-creating state
- Remote Procedure Calls
- Using the interfaces in new contexts
- Replacing Interfaces with Proprietary Ones
OpenEPC Roadmap

- Integration of 3GPP
- Offline Charging
- Non-3GPP AAA
- Extended UE function
- Dynamic node selection
- Full NAS, GTP stacks
- S1AP with APER, X2AP

Core Network Mobility
Client Mobility
Policy and Charging Control
Subscription Management
Mobile Device support

Preview Nov. 2009
Rel. 1 April 2010
Rel. 2 Feb 2011
Rel. 3 Nov 2012
Rel. 4 Feb 2011
Rel. 5/6...

First demo of the OpenEPC at the 5th IMS Workshop

Extended Mobility (GTP, MME etc.)
Extended AAA
More Access Networks
Integration
Support for specific applications

OpenFlow and SDN-EPC
VoLTE with SRVCC
Network Functions Virtualization
UE/eNodeB-emulation-with-WiFi
Self Organized Networks Features...

LTE RAN integration
2G and 3G RAN integration
Android Mobile Devices Support
Multiple APN Support
Radio conditions based handover
Traffic Shaping for QoS
Agenda

- The Role of IP Multimedia Subsystem, Machine Type Communication, Evolved Packet Core and related Open APIs within emerging Smart City SDPs
- FOKUS Toolkits and practical examples
- Summary
NGN2FI Evolution is a Challenge

Information Technologies
(Service Oriented Architectures & Cloud Computing)

Smart Cities

VoIP and Instant Messaging
Fixed and Mobile Telecommunications
Cable Networks

Future Internet

Network Virtualization
Self Organising Networks
Internet of Things
Internet of Services
Clouds

EPC
IMS
MTC
OTT

IMS
3/4 Play
IPTV
FMC
RCS
PES

Evolution
Revolution

Telecommunications

Next Generation Network
UNIFI Workshop @
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