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# Towards Multitechnology seamless access for 5G: a first approach with very tight coupling

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- Introduction : Fixed Mobile Convergence and overview of COMBO project
- Very Tight Coupling between LTE and Wi-Fi
- Beyond very tight coupling



# Credits

- Slides xx to yy are extracted from a tutorial on Fixed Mobile Convergence given in IEEE IPSR Conference, Budapest, 2015 July 1-4
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# The COMBO consortium





- COnvergence of fixed and Mobile BrOadband access/aggregation networks
- Large scale integrating project
- Work programme topic: ICT- 2011.1.1 Future Networks
- Web page: <a href="http://www.ict-combo.eu">http://www.ict-combo.eu</a>

# **COMBO FMC: Network Convergence is in focus**

#### Today's network architecture

Fixed and mobile networks -

- developed independently
- limited joint usage of infrastructure
- independent network operation, control and management
- convergence only at service level (e.g. IMS)



#### Potential converged architecture

Common architecture requires -

- Structural convergence
  - Common use of infrastructure, technology, interfaces, transport mechanisms
- Functional convergence
  - Unification of fixed and mobile network functions and services



# Why network convergence is needed

#### Drivers

- Increasing number of users and connected devices
- Access any content any time anywhere from any device
- Demand for video streaming for fixed and mobile customers
- Increasing Wi-Fi traffic
- Tight price pressure on telcos: Reduce CAPEX/OPEX, Generate new revenue, Improve user experience

#### Expected benefits

- Unified hardware resources for both fixed and mobile services
- Cost and energy savings
- Increased revenue
- Improved customer experience
- Network infrastructure with end-to-end management and orchestration capabilities

Broadband subscribers Connected devices Video contents Online services New technologies Traffic increase



- Converged network control and operation → functional convergence
- Converged transport for mobile and fixed network  $\rightarrow$  structural convergence

# Network convergence reference framework



# Target benefit: Converged access and aggregation technologies



#### Objective:

- universal access and aggregation technology
- scaling for traffic growth
- scaling for number of user equipment

# Target benefit: Universal access bundling for residential gateway



- Integrated hybrid access to residential end-users
- Dynamic bandwidth using fixed and mobile technologies
- Benefits:
  - One authentication for the customer not per technology
  - More efficient network management for the operator
  - Improved network performance and user experience

# Definition of a "Universal Access Gateway"



UAG's data plane is IP edge for all access networks

- it includes a SGW/PGW for mobile traffic
- It includes the BNG for fixed traffic
- it may include a MPE (with MPTCP)
- it may interface with content caches

#### UAG's control plane

- Interfaces with the uAUT
- Includes the MME
- Includes security and policy control
- May interface with content distribution functions

## Very Tight Coupling between LTE and Wi-Fi



## The observation

- Very dense deployment of Wi-Fi access points in cities
- Generalisation of community networks
- All smart-phones have Wi-Fi and cellular interfaces
- Wi-Fi is already an offload solution for 3G/4G
- But
  - The attachement and security procedures should be made on Wi-Fi
  - The decision to use Wi-Fi is taken by the terminal
  - For reliability reasons, moving terminals are kept on the cellular network
- Wi-Fi is not fully used (as it could be) to offload cellular networks

#### Need for mechanisms :

- where the decision to use Wi-Fi can be taken by the network (with assistance by the terminal) which can have a better global view of the current load
- that have fast Wi-Fi link set up procedures
- that can be used for moving terminals



Very tight coupling between LTE and WiFi: objectives

- Session continuity when connecting to WiFi beside LTE
  - Dual WiFi/LTE connection
- The decision to set up a WiFi connection is taken by the network ;
  - Can be assisted by the terminal (measurement reports, GPS,...)
  - Compatible with ANDSF ;
- Very fast attachment to WiFi access points (APs) : WiFi can be used even by fast moving UEs;
  - Take advantage of WiFi APs already widely deployed :
  - No WiFi APs new deployments are needed ;
- Target : no modification of the hardware and minimum modification of the software of RGWs ;





- RGWs are connected to eNBs → Only 1 IP address for the two interfaces → session continuity provided
- Reuse of LTE security procedures (PDCP layer) on WiFi → Very fast handover WiFi attachement and connection while keeping LTE connection (dual connectivity)
- Compatibility with EPC offload solutions (SIPTO,...)



# Example of implementation in a decentralized universal access gateway



- X2 and S1 are internal interfaces
- PGW can be inside or outside the UAG





- BBU hotels cannot be in the UAG  $\rightarrow$  delay constraints (0.4µs ~ 40km)
- RGW/BBU connectivity provided by both the access and the aggregation network (VLANs configuration to ensure isolation between users and between services and QoS management)



# Very tight coupling: protocol stack (user plane only)



• Path decision taken by the UAG

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- Interface selection done by the sender: UE in the uplink and UAG in the downlink.
- Very simple Adaptation layer: includes only essential information (RNTI, LCID,...)

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# Very tight coupling: eNB building blocks

























## **Performance analysis**

### Wi-Fi offloading is efficient on borders of LTE cells

- Due to shadowing, the serving base station is not always • the same at the same location
- Offloading capacity when
  - the CEAP is connected to only one (the closest) or more base 1



## **Implementation test**

### **On-progress work**

- Implementation on **OpenAir Interface**
- Step 0 : simulation
- Next step : emulation then full radio link with USRP





# **Beyond Very Tight Coupling**



# **Conclusion : beyond very tight coupling**

- Very tight coupling can be extended
  - To fixed networks
- Convergence has been identified as an important issue for 5G
- Needs for a really seamless multi-technology access network



# Thank you ! Questions ?

