Unified Access and Aggregation Network Allowing Fixed and Mobile Networks to Converge: The COMBO project

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Agenda

- INTRODUCTION
- COMBO TARGET & KEY QUESTIONS
- NETWORK EVOLUTION TRENDS
- CONVERGENCE - NG-POP
  - FUNCTIONAL CONVERGENCE
  - STRUCTURAL CONVERGENCE
- SUMMARY
<table>
<thead>
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<th>Key facts</th>
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<tr>
<td>• COnvergence of fixed and Mobile BrOadband access/ aggregation networks</td>
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<td>• Work programme topic: ICT-2011.1.1 Future Networks</td>
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<td>• Type of project: Large scale integrating project</td>
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<td>• Project start: 1st January 2013</td>
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<td>• Project duration: 36 months</td>
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<th>Partners</th>
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<td>ERICSSON</td>
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<td>ADVA Optical Networking</td>
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<td>Alcatel-Lucent</td>
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In the past, fixed and mobile access networks have been optimized and evolved independently, with partly contradicting trends.

Access infrastructures represent long term investments (> 50% of total ICT) and about 90% of network energy consumption: a sustainable network evolution strategy is required for the next decade.

Level of integration and functional distribution needs to be investigated and optimized.
# Main target and objectives

**Main target**

**COMBO** targets a **unified access and aggregation network** by **converging fixed and mobile networks** (Fixed / Mobile network convergence), enabling:

- optimal and seamless quality of experience for the end-user
- optimized network structure ensuring reduced **cost** and **energy consumption** while **bandwidth is increasing**

**Objectives**

- Define optimised FMC architectures
- Assess multi-operator FMC scenarios
- Demonstrate experimentally FMC in lab tests and field trials
- Drive standardization bodies with respect to FMC architectures
COMBO key questions and requirements

Key questions

- Which are the optimum levels of convergence?
- Which network functions and equipment should be centralized or distributed?
- How will convergence impact handover mechanisms?
- How will convergence impact data traffic?

Key requirements

- Increasing traffic and changing applications
- Reduced network cost and energy
- Openness of network interfaces
- Seamless performance monitoring and management
- Multi service flexible network to cope with future services
Evolution of fixed access network

On the way to the Gigabit Society. Replacing of copper network with FTTH enabling real Gigabit access.
Total Cost of Ownership optimized access/aggregation network by structural changes (node consolidation).
Evolution of mobile access network (1)

- **Pure packet-based high performance 4G networks**
  - VoIP necessary on 4G networks
  - Bandwidth up to 20 MHz / 100 Mbps typically
  - Reduced latency (~10 ms)

- **Towards more capacity and performance (>4G)**
  - higher bandwidth and spectral efficiency
  - carrier aggregation, generalized MIMO, relaying, Inter-Cell Interference Coordination (ICIC), Coordinated MultiPoint (CoMP)

![Relaying](Image)

![CoMP](Image)
Evolution of mobile access network (2)

- A larger data rate uniformity for users
  - Cf. ARTIST4G European project results

- Capacity increase through densification of base stations (small cells)
Network evolution trends

Concentration of functionalities in access and distribution of functionalities from core

- Virtualization, In-networks processing
- Optical node concentration
- Network Cooperation
- BBU hostelling
- Content to the edge, CDN, Infrastructure cloud, Applications distribution
- Distributed Core Nodes

Home
- Business services

Access
- OLT

Backhaul
- S/P-GW DMM

Core
- S-GW, P-GW
New concept of Next Generation Point of Presence (NG-POP):

- **Functional convergence**, i.e. the convergence of fixed and mobile network functions
- **Structural convergence**, i.e. the convergence of fixed and mobile infrastructures and equipment
Example of functional convergence

Functional convergence targets a better localization of key network functions.
Functional convergence

Set of functions which needs to be considered

Enablers

- Virtualization will allow flexible integration of fixed and mobile network functions
- Common handover mechanisms between fixed and mobile networks (e.g. WiFi and 3GPP)
- Common set of CDN functions for fixed and mobile networks
- Unified control of heterogeneous networks and technologies
- Homogenization of authentication and subscriber management
- Openness of infrastructure at NG-POP level
- Convergence on policy mechanisms for seamless fixed and mobile QoS and QoE
Structural convergence

- Usage of the same location (NG-POP)
- Usage of the same infrastructure/transport
- Usage of the same technologies
- Integration of mobile and fixed access equipment
Structural convergence in a multi-operator environment

**Structural convergence** targets a mutualization of fiber and equipment through e.g. BBU hostelling and fixed/mobile equipment integration and enabling a multi-operator usage in an *open architecture*.

- **OP1**: Mobile operator sharing NG-POP and tower but using its own equipment.
- **OP2**: OP2 provides converged network to the other operators and hosts co-location point at NGPOP and tower.
- **OP3**: OP3 uses the co-location points of OP1 and also the FMC network resources and functions of OP2.
Making fixed and mobile networks converge is a desirable though very complex target for network operators and vendors.

- Better integration of fixed and mobile networks would result in both:
  - an optimal and seamless quality of experience for the end user
  - an optimized network infrastructure ensuring increased performance, reduced cost and also reduced energy consumption

COMBO is designing a unified access and aggregation architecture leading to Fixed-Mobile Convergence:

- Based on Next Generation Point of Presence
- With a better distribution of all essential functions, equipment and infrastructures of convergent networks and will thus
- Enable a network with better services at lower operational costs
COMBO consortium
Expected COMBO impacts on the delivery model for convergent services

Enhanced quality of experience for access to multimedia contents:
• Adequate distribution of content closer to the user, thanks to network openness, thus lowering network transport cost and making available broader range of contents.
• NGPOP concept will benefit from processing capacity available at the access/aggregation node level, e.g. to adapt when needed the distributed content to devices and access resource capacity.

Improved control of heterogeneous access resources:
• Unified control of heterogeneous access technologies allowed by FMC architectures.
• Real-time dynamic resource allocation to service/traffic demand and terminal capacity.
• Advanced load balancing and scheduling techniques between access links.
• Handover and service continuity schemes over various technologies will be provided in a dynamic way, avoiding un-necessary tunnelling and traffic indirections.

Unified user’s authentication and access scheme:
• Native homogenization of identification, authentication and reachability of the user over heterogeneous terminals and access technologies.
• Easier service provision in multiple operators scenarios, avoiding issues faced today in fixed (generally “access line” based) and mobile (“SIM card” based) networks.
## Client device scenarios versus COMBO solutions

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<th>Client Device Scenario</th>
<th>Network requirements</th>
<th>COMBO solutions</th>
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<tr>
<td>Mobile Client devices and applications with high bandwidth requirements</td>
<td>Increased capacity in both access and metro networks</td>
<td>Very good scalability by adding more wavelengths and capacity per wavelength</td>
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<td>Easy to manage due to Self Organized Network properties</td>
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<td>Enable Peer to Peer connections</td>
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<td>Programs and data stored in the cloud, Terminals have only I/O functionality</td>
<td>Access capacity need determined by video streams (HD and 3D HD TV)</td>
<td>Centralized concept (e.g. BBU hotels) able to handle the traffic demands from data storage close to end users</td>
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<td>Increasing number of always connected smart phones, Personal Area Networks and M2M devices</td>
<td>Low data capacity demand per device but very high control traffic</td>
<td>The NG-POPs will be higher in the network than the traditional central offices, thanks to optical node concentration, and will be able to host advanced control functions</td>
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<td>Unified control mechanisms with a better and possibly dynamic distribution of control functions</td>
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Convergence layers

FMC will enable higher energy efficiency both at the level of:

a) Structural convergence
   • BBU resource pooling (20%)
   • Small cells, decreasing RAN energy consumption (up to 40%)
   • Decreased number of central offices/equipment (50%)
   • Optimized location of video/content servers (10-15%)
   • Increased utilization of low-power optical technologies for backhauling (up to 50%)

b) Functional convergence
   • Energy aware path engineering (multi-hop mobile provides flexibility) (up to 50%)
   • Combined idle modes management in the converged fixed-mobile network
   • Equipment sharing in multi-operator scenarios (20%)