LTE Perspectives and Challenges for the 2.5GHz Expansion Band

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Abstract— **This poster paper is dedicated to the analysis of the new improved platform, provided by 3GPP Long Term Evolution and its possible integration solutions. It offers a general image regarding the overall architecture, performance and typical deployment scenarios focusing on the needs of a mobile operator. The purpose is to establish to what degree LTE serves the efficiency and high capacity requirements of an active telecommunications network. Given the variety of possible applications, macro scenarios, as well as micro-femtocell based ones, the operator is backed-up in his attempt to deliver high quality services to customers in all types of environment.**

Index Terms—**LTE, femtocell, backhaul, Mobile WiMAX**

I. LTE Guidelines

LTE is a completely new radio technology, backwards incompatible with WCDMA and HSPA (High Speed Packet Access). The new radio interface is entirely re-designed, upgrading 3G to an **optimized PS (Packet Switched) system**, supported by a simplified and unified transport level, which is IP.

In order to ensure higher average throughputs for data transmitted within the cells (both at the inner level and at „cell edges", with the use of MIMO – Multiple Input Multiple Output - techniques) and spectral efficiency, LTE operates in all WCDMA supported frequency bands, using **scalable system bandwidth for improved spectrum flexibility** (1.25 up to 20 MHz channels). Also, LTE access technology focuses on both paired FDD (Frequency Division Duplex) and unpaired TDD (Time Division Duplex) spectrum.

Gradual passing from 3G deployment to LTE is implemented using a 5MHz LTE carrier at first, followed by increased bandwidth as the transfer to the new technology takes place. Peak data rates are estimated to reach 100 Mbps (DL - downlink) and 50 Mbps (UL - uplink) using a 20 MHz channel, with guaranteed high performance for cell radius up to 5 km (first commercial release).

Improving the QoS considers maintaining the performance – cost trade-off, as operational expenses, determining the degree of financial efficiency in the case of a mobile operator should be kept at a minimum. The necessity for a **strong QoS** (Quality of Service) is followed by **reduced user and control plane latency and delay demand** (user plane: less than 5ms, measured on the IP layer as the time it takes for a mobile terminal to send a small IP packet to the RAN – Radio Access Network - edge node; control plane: less than 100ms, with at least 200 active state terminals supported).

In point of **mobility**, the Evolved packet based RAN will be optimized for various speeds (up to 300km/h, using fast handover schemes), supporting high quality voice and real-time services.

All efforts would be in vain without a flexible, simple cheap modular architecture (reduced number of network elements). Coexistence with legacy 3G, as well as cost effective migration can only be provided within a unified EPC (Evolved Packet Core), which is SAE (System Architecture Evolution), built on a full IP infrastructure, supporting an advanced service platform (including VoIP – Voice over IP).

II. The 2.5GHz Spectrum

As a result of the competition between WiMAX supporters and 3G operators in Europe, who felt they had essentially "prepaid" for the 2.5 GHz spectrum when they bought 2.1 GHz spectrum for 3G, in October 2007, the ITU Radio communication Assembly finally approval, by consensus, **a new sixth radio interface**, **"IMT-2000 OFDMA[1] TDD WMAN[2]"**, based on a normative reference to IEEE Std 802.16. In other words, ***IEEE Std.802.16 became part of the IMT-2000 family*** and is now a viable candidate for deployment in all IMT-2000 bands, including the 2.5GHz band.

So, there are 2 opposing technologies competing for the 2.5 spectrum (FDD paired - UL: 2.5-2.57GHz, DL: 2.62-2.69GHz; TDD unpaired – 2.57-2.62GHz): Mobile WiMAX (802.16e) and 3GPP LTE. This paper focuses on LTE access.

III. LTE Architecture Integration Perspectives

The LTE interconnection with existing technologies is provided via several new interfaces regulated in the 3GPP LTE TS 36.000 family of specifications under development (inter-technology handover one of the targets of this set of specs). Several aspects need to be taken into account when deploying new technologies in the existing Romanian market:

1. spectrum related issues: the 2.5 GHz band is available for mobile operators but no auction has been organized correlated with the lack of full – feature equipment for Mobile WiMAX; LTE equipment is yet unavailable; this spectrum should become available for broadband communications, but the license expense is a factor to be taken into account, together with the availability of paired FDD or unpaired TDD band;

2. customer demand for high capacities is greater, but still

[1] OFDMA – Orthogonal Frequency Division Multiple Access
[2] WMAN – Wireless Metropolitan Area Network

insufficient to justify investing in short term solutions such as equipment upgrades.

Theoretically speaking, possible scenarios from the operator's point of view include 3G/HSPA/LTE femtocell over WiMAX link, WiMAX backhaul for Mesh Access Network – the convergence between IEEE 802.16 ('d', 'e', 'm'), 802.11a (linking the AP's in the mesh) and 802.11g (client access to AP), a mixed FTTH (Fiber-To-The-Home) + WiMAX femtocell scenario, as well as mixed FTTH + 3G/LTE femtocell targeting the business and residential areas.

The design is very simple: any mobile operator seeks to deploy **low cost local loop solutions** (cost effective equipment for reducing costs and optimizing the available radio resource usage), in point of access. As such, given the complex architecture resulted from overlapping GSM and UMTS technologies, by adding WiMAX implementations a hybrid "crowded" network architecture emerges, which is most of the time saturated. In this case, the new BSs (viable for integration in the existing infrastructure) should be capable of handling and managing combined technology interfaces.

A promising solution in this respect is provided by mixed Mobile WiMAX – 3GPP LTE femtocells (benefiting from FMC – Fixed-Mobile Convergence), relieving the macro outdoor load while transferring it to the indoor coverage. The backhaul for indoor femtocells is provided via Internet IP tunnels securing connectivity with the operator's core.

The macro network is expensive in point of maintenance, as the largest investments are related to **leased line backhaul** for the BS – Base Station and **power supply**. For a newly installed femtocell, backhaul is ensured over the Internet and electricity becomes the customer's concern. In this case, only installation generates reduced OPEX (Operational Expenses).

Hence, the femto has to sustain multiple interconnection solutions: WCDMA voice and data, Ethernet LAN interfaces, ADSL[3] connectivity, WiFi and Mobile WiMAX 802.16e, LTE interface as well as modem functionality.

From the operator's point of view, the benefits include increased voice revenues, vast typology of broadband services offered via the same interface at low implementation costs, reduced CAPEX (Capital Expenses) and OPEX, remote area coverage, unique access equipment.

IV. LTE Metro Solution

Mobile WiMAX cannot substitute the existing 3GPP macro network (GSM and UMTS) even if it sustains VoIP, remaining a Metro NLOS access solution for the classical customer services (IP VPN[4], Voice VPN, DIA[5], Leased Line, PABX[6]).

Metro 802.16e backhaul cannot compete with existing FO ring topology infrastructure (with WDM – Wavelength Division Multiplexing), with SNCP (Sub-network Connection Protection) protection. Even if the cost are higher for optical metro architecture, wireline solution offer the advantage of **high order scalability**, something no wireless broadband access technology can provide.

In the case of metro LTE, as it follows the HSPA+ upgrade of existing networks, it should be easily integrated within a multi-standard multi-service platform facilitating the transfer of PS and CS (Circuit Switched) traffic while using existing limited physical resources (e.g. LTE in the 900MHz band). Additional resources are to be provided by the 2.5GHz spectrum, mainly in point of maximum achievable throughput.

In order to backhaul the high capacity provided by the LTE system, IP transport must be provided over different types of wireless connectivity, like Free Space Optics (FSO) or E-band links (millimeter wave radio exploiting the 71/76 GHz and 81/86 GHz frequency bands). FSO sustains data throughputs ranging from 1 STM-1 (Synchronous Transfer Module) to 2.5 Gbps for low distance hops and generates license free possible deployments, high available data rates, low radiation levels and short implementation time with reduced interference.

Also, the LTE femtocell can turn out to be a very important solution for high capacity demanding residential eccentric customers, the bandwidth limitation being overcome in the new spectrum.

V. Rural Area Solutions

In this case, it is highly unlikely that LTE will enter this market very soon. The implementation costs exceed the requirements of the local population.

As a result, UMTS will continue to dominate this segment in the next couple of years, together with HSPA. Spectrum is less of an issue, as the demand focuses on coverage, better achieved for lower frequencies and not on throughput as for urban environments.

VI. Conclusions

All in all, LTE remains a promising macro high capacity deployment technology, striving to substitute the already overloaded access infrastructure. It faces many obstacles, including incomplete standardization and mobile operators having already largely invested in HSPA technology.

In order to relieve the pressure of transporting high capacity over the operator infrastructure, LTE femtocells can implement IP tunneling over an Internet customer provided connection and using a gateway as a point of entry in the core network. In this way access is not backhauled by the mobile operator, therefore the service connectivity is not guaranteed.

Future developed network architecture prototypes must take into account the corresponding transmission technologies implied, to generate relevant deployment scenarios.

References

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[3] ADSL – Asymmetric Digital Subscriber Line
[4] VPN – Virtual Private Network
[5] DIA – Dedicated Internet Access
[6] PABX - Private Automatic Branch eXchange