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DEPLOYMENT CHALLENGES OF LTE NETWORKS

Network Upgrade Issues Towards full LTE Deployment

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Increased mobile broadband bandwidth is undoubtedly today's most pressing requirement in the telecom industry. The 3GPP Long Term Evolution (LTE) is the latest technology to address the need for increased mobile broadband performance. LTE standardization is complete and approved by 3GPP within Release 8 and is the basis for the initial LTE deployments worldwide. But as witnessed too many times, every new networking technology comes with its own particular set of deployment challenges and issues.

Deployment Challenges of LTE Networks

IS LTE REACHING GLOBAL CONSENSUS?

The short answer is yes – there is unanimous industry agreement on the strategic significance of LTE to operators and equipment vendors alike. The world's first publicly available LTE-service was deployed by TeliaSonera in the two Scandinavian capitals Stockholm and Oslo on the 14th of December 2009. A number of highly publicized technology demos have since convinced the skeptics including:

- **December 2006** - Transport of HDTV streaming (>30 Mbit/s), video supervision and Mobile IP-based handover between the LTE radio demonstrator and the commercially available HSDPA radio system was shown during the ITU trade fair in Hong Kong in.
- **September 2007** - LTE data rates of 200 Mbit/s with power consumption below 100 mW during the test.
- **April 2008** - EVDO to LTE hand-off - handing over a streaming video from LTE to a commercial EVDO network and back to LTE.
- **February 2009** - Mobile World Congress: Infineon demonstrated a single-chip 65 nm CMOS RF transceiver providing 2G/3G/LTE functionality.
- **February 2009** - Successful handoff between CDMA and LTE networks.
- **February 2010** - Complete the first LTE call in Italy with commercial hardware and software. During the call a throughput of about 70 Mbit/s downlink and 19 Mbit/s uplink was reached.

A major concern with LTE is its lack of support for circuit switched applications such as voice and SMS. These services account for 85% of the services revenue currently, and according to Heavy Reading (Mobile Services Report – Sept. 09), they are expected to still account for around 77% of the revenue by the time LTE gains mass adoption.

This issue had previously received limited attention as initial LTE deployments are expected to be data-only, based on USB dongles and data cards, with voice services planned for much later – by which time IMS networks are expected to be ready and deployed. However, as operators commit to LTE deployment, it is quite clear that these networks will need to co-exist with legacy 2G/3G networks in the short and medium terms.

MAJOR DEPLOYMENT CHALLENGES

LTE is a very complex technology – which is not surprising given the throughput, latency, and IP-interworking requirements placed on it. However, given the unprecedented industry push, the technology is set to mature at a very rapid pace.

Various models of LTE deployment are under consideration, with using LTE Femtocells coverage to overcome the limitations of indoor coverage in the 2 GHz+ spectrum receiving much attention. Major wave of LTE deployments is expected to start in 2011 with increasing number of field trials this year. These deployments have significant impact on a number of areas some of which have been outlines below:

Interworking with current networks - Unlike previous versions of technology, which needed to interoperate with only its predecessor technology, LTE needs to coexist with all major mobile standards. The combinations of devices, network equipment and network interfaces that can exist in LTE deployments increase the complexity of both Interoperability Testing (IOT) and end-to-end functionality testing. This is further exacerbated by the lack of availability of products and devices to test these various network elements.

The problem of IOT and end-to-end testing is very real. To avoid disruption to live services and to optimize deployment time, it is advisable to try as much as possible to use simulators or third party labs. However, using simulators and protocol analyzers, in the pilot network, can help address only a subset of the issues. End-to-end testing is critical for any successful rollout, and even more so in an LTE scenario, which spans multiple networks that were never really designed to work together. To effectively address this challenge, testing interoperability with equipment from different vendors, and across different network elements is essential.

Introduction of an all-IP networking architecture – Apart from the deployment of new LTE related network elements including MME (Mobility Management Entity), SGW (Serving Gateway) and PGW (PDN Gateway), LTE's Evolved Packet Core needs to be dimensioned to support:

- Higher throughput and lower latency radio access networks (RANs).
- Interworking between networks, multiple heterogeneous RANs, including legacy systems as GPRS, but also non-3GPP systems (e.g. WiMAX).
- Reduce round trip delay – This can only be achieved if the Operator's legacy Core IP is also upgraded with interface speeds to support expected network traffic. Network and traffic dimensioning will need to be carried out based on transit time of <10ms and call setup times of <100ms.

Spectrum and impact on number of Sites - One of the key features of LTE is utilization of OFDMA to handle multipath propagation without complex receivers. The drawback, however, is that the signal has high amplitude variability, so-called Peak-to-Average-Power Ratio (PAPR), which typically reduces the efficiency of the transmitter power amplifiers – putting more emphasis on installation quality and accuracy.

Radio planning of OFDMA networks is similar to GSM RF planning rather than WCDMA, because intra-cell interference is basically eliminated due to the orthogonal property. Scalable OFDMA also offers frequency reuse with capability of moving capacity from one cell to another based on traffic utilization.

The most commonly considered spectrum allocation is at a carrier frequency of 2.6 GHz, which is available in large parts of the world and can serve as harmonized spectrum. However, at this carrier frequency, there are problems with poor propagation characteristics and high capital cost for deployment. As a general rule, it takes nearly ten times as many sites to deploy at 2.6 GHz than at 1 GHz.

Other emerging options for spectrum utilization is the use of the 700 MHz band, as intended by Verizon, deploying single 10 MHz allocation, or the use of the 800 MHz bands which is being pushed by European countries. Finally there is the option of 2G/3G spectrum re-farming such as 2.1 GHz for 5 MHz allocations, or the GSM 900 MHz band for 5 MHz or less allocation.

Impact on Transmission and Radio Access Network – The perception in 3GPP is that IMS should be used for LTE voice. While IMS is recommended, at least by 3GPP, to be the end-goal, the lack of maturity and proven deployments in large-scale networks are the biggest hurdle to adoption and deployment of IMS by operators.

This brings us to a more practical solution for supporting voice on LTE. Circuit switch fallback is an alternative, where the mobile is forced off the LTE network to a legacy 2G/3G network to support voice calls. This approach is cumbersome and also results in sub-optimal utilization of resources (e.g. spectrum) because resources for both legacy and LTE technologies need to be retained.

On the transmission side the major areas concerned will be:

- An Operator's SDH strategy – What are the replacement options?
- Impact of fully meshed approach with tunneling - mechanism over IP transport network
- Economic usage of backhaul capacity; simplified and unified transport (IP)

IN CONCLUSION

The reality is that multi-technology hybrid networks will coexist well into the foreseeable future. Operators will have to interwork a multitude of technologies, protocols and network resources for many years to come.

LTE deployments will likely be rolled out in phases with densely populated areas served first. As operators begin to transition their networks, subscribers will demand uninterrupted coverage; seamless mobility between legacy 2G/3G and LTE networks will be critical for successful deployment. Interworking diverse networks will require operators to support a variety of technologies – each with its own protocols and interfaces – as well as interconnections between multiple domains.

To deliver a seamless service experience, operators have to interwork a staggering array of personal devices, access technologies and network resources. Providing end-to-end service assurance across multiple domains requires appropriate deployment strategy that needs to be carefully thought and executed.