

LTE – When the Time’s Right

Northstream White Paper

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Operators on the Path to LTE

Mobile broadband based on HSPA has been an astonishing success in many countries, even in geographical regions where DSL and cable internet are widely available. According to statistics by the GSM Association, the number of HSPA users has

surpassed 100 million, served by more than 230 network operators. Additionally, many CDMA2000 operators have launched EV-DO Rev A services, selling laptop data devices and internet-enabled mobile phones. Expectations on future market growth are high, which is reflected in analyst forecasts of the continued take-up of mobile broadband services:

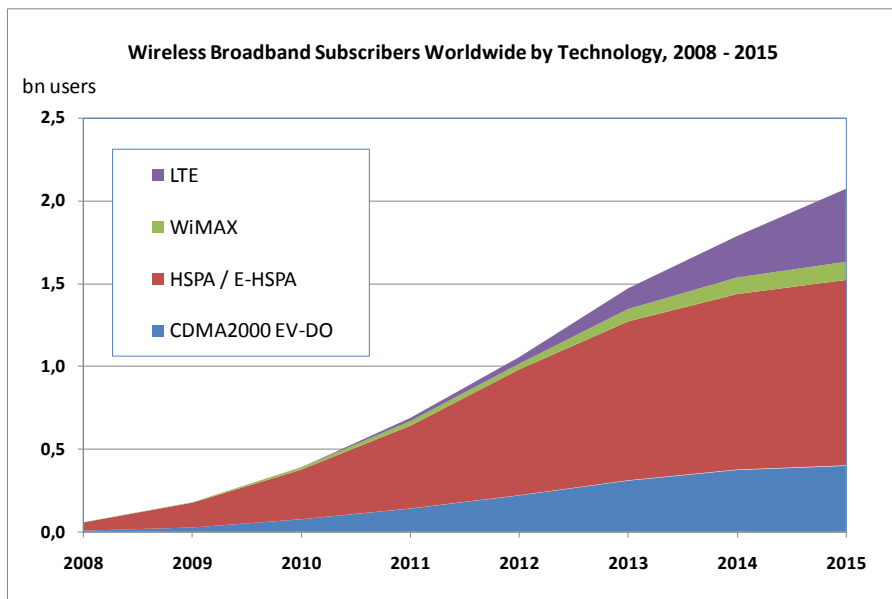


Figure 1: Mobile Broadband Subscriber Forecast, Sources: GSM Association, Analysys Mason

The success of mobile broadband services using flat-rate pricing raises the question of if and how operators can profitably continue on this path. Operators are pondering subscriber and traffic forecasts, pricing, applications, terminal aspects and the resulting technology and network strategy.

The next evolution step of mobile broadband technology has already appeared on the horizon: Long Term Evolution, or LTE. The technology is expected to deliver a better service experience to

end users and lower cost to operators. Many industry experts believe that a number of commercial LTE launches will take place as early as 2010 - 2011. Is this a realistic expectation?

Northstream sees various reasons suggesting that these expectations are overoptimistic. In order to validate our own hypothesis we have discussed with a number of leading industry players and analyzed different operators' motivation and timing regarding an LTE launch.

Deciding to deploy LTE within the next few years is by no means an obvious choice: Technology readiness is often overestimated, and every market and operator has its unique situation and challenges which must be considered for a launch.

Operators face growing external pressure to cut investment levels – at the same time, they need to

manage mobile broadband profitability in the light of growing usage and low service prices.

This whitepaper examines key aspects that operators should take into account for their radio technology roadmap.

Fact Box: LTE – The Lowdown

Specified in 3GPP Release 8, Long Term Evolution (LTE) is a standard for Pre-4G mobile communications. LTE networks provide an upgrade to today's UMTS & HSPA networks, delivering improvements in areas such as speed, capacity and spectrum efficiency. These benefits will be delivered through two key elements:

- a) A new **radio interface** called Evolved UMTS Terrestrial Radio Access (E-UTRA). Its advantages include carrier bandwidth flexibility (supporting spectrum slices between 1.25 MHz and 20 MHz, as opposed of fixed chunks of 5 MHz for WCDMA networks), higher spectrum efficiency, data rates of over 100 Mbit/s in the downlink, and latencies below 10 ms.
- b) An **All-IP core network** based on the System Architecture Evolution (SAE) specification that has evolved from today's GPRS core network. SAE brings a simplified architecture (reducing the number of nodes and interfaces and thereby operating costs), supports radio access networks (RAN) with higher throughput and lower latency (notably LTE), and provides mobility between heterogeneous RAN including legacy systems such as GPRS and non-3GPP RAN such as WiMAX. For reasons of simplicity, the mentioning of LTE in this whitepaper will also include SAE.

LTE networks are expected to operate on a variety of **frequency bands**, such as 2.6 GHz in Europe, 700 MHz in North America, or "digital dividend" spectrum that has become available due to the switchover from analogue to digital TV. As HSPA, also LTE provides operators with the possibility of frequency **refarming**, allowing the usage of, for instance, HSPA on 900 MHz and LTE on 1800 MHz spectrum.

A frequently mentioned advantage of LTE over its predecessors is its **data rates**: For every 20 MHz of spectrum, LTE is theoretically capable of delivering speeds in excess of 300 Mbit/s in the downlink, and over 50 Mbit/s in the uplink. This is achieved through "Multiple Input, Multiple Output" (MIMO, using up to four antennas each at transmitter and receiver) and the usage of advanced modulation processes, namely Orthogonal Frequency-Division Multiple Access (OFDMA) for the downlink, and Single Carrier FDMA (SC-FDMA) for the uplink.



The Reasoning for Launching LTE

In order to get a full overview of the steps to an LTE launch let us take a high level look at the stages to go through when introducing new telecommunication technologies in general:

1. Standardization & Development
2. Lab testing (covering performance, stability and interoperability between different vendors' infrastructure and devices)
3. Friendly user trial & pre-commercial launch (service launch with no major marketing efforts, not aimed at the mass market)
4. Commercial operation, build-out to mass market penetration

5. Maintenance status (investments only made for keeping the network operational)
6. Decommissioning.

The following chart illustrates these phases, together with a typical uptake curve. The uptake curve shows how operator demand for supporting network infrastructure and services develops over time.

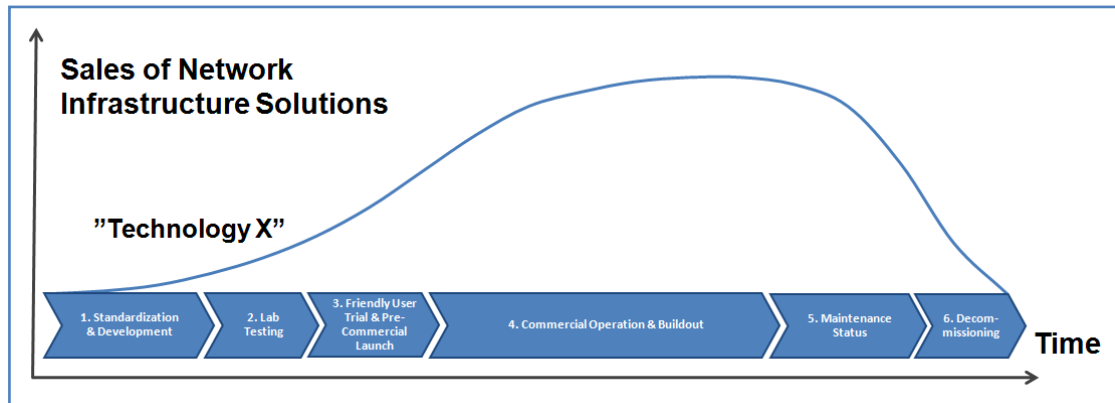


Figure 2: Phases of Telecoms Technology Introduction and Associated Uptake Curve

Looking at this curve raises the question of where LTE stands today, and how long it will take to reach the next uptake phases. Northstream sees various reasons why one can expect LTE to be available to end users much later than often suggested:

- **Exhaustion of HSPA capacity**

It is argued that mobile broadband usage and customer expectations grow so fast that HSPA networks would be congested within the next few years. Transporting the high amount of expected traffic would be more cost-effective using LTE networks.

A full capacity and cost analysis comparing both technologies, and including availability of HSPA and LTE devices will often lead to a different result: Northstream believes that WCDMA operators still have major potential for improving performance and capacity in their HSPA networks, following the evolution path towards Evolved HSPA (E-HSPA).

Devices are another aspect to consider. Using LTE networks as a capacity relief would require deploying a large number of devices to the user base. This is however unlikely to happen within the first few years after launch, as the choice of HSPA and E-HSPA terminals will be superior both from a portfolio and from a pricing viewpoint. The next wave of mobile data growth will likely come from the mass market launch of HSPA-enabled smartphones rather than first generation LTE products.

- **Straightforwardness of LTE migration**

Introducing LTE is sometimes compared to the migration from R99 (UMTS) to HSDPA, arguing that the step from HSPA to LTE is less of a challenge than going from R99 to HSDPA.

This argument underestimates the complexity of an LTE deployment: Vendors indeed provide multi-standard base stations, but the need for site solutions remains, with special

requirements in areas such as antennas, feeders, cabling or backhaul.

Introducing HSPA in a UMTS network was to a large extent a software upgrade, but launching LTE means designing and implementing a new radio network using a new air interface, and in most cases in a new frequency spectrum, implying new radio design.

- **Availability of laptop devices**

Proponents of an early LTE launch argue that the availability of LTE-enabled modems and laptops provides a sufficient launch portfolio.

This depends on the operator strategy: Relying on a data-centric portfolio means settling for data revenues. Although mobile data grows fast, it contributes less than 15% to a typical operator's sales. Mobile broadband is far less profitable than voice, making a data-only based LTE investment decision less than obvious.

Launching LTE with a data-only portfolio will only be accepted by operators that are in urgent need of LTE capacity, or that want to use LTE peak rates as a marketing argument. Others will first focus on HSPA smartphones and await the availability of voice-centric LTE devices and underlying service architectures, launching once the issues with first-generation LTE products are remedied and prices of HSPA/LTE dual-mode devices have fallen.

- **New applications create the need for LTE**

Some operators refer to applications that require peak data rates so high that only LTE could provide them; examples being healthcare services, IPTV and other media services.

The expectation that early LTE deployments will deliver significantly higher peak rates than mature HSPA network may not be realistic. Although LTE does promise higher data rates, its key advantages lie in other areas such as

capacity and spectrum flexibility. As long as LTE remains a niche technology, any widely adopted mobile broadband applications will need to work on HSPA as well.

methods, or that implementation and testing efforts would be lower compared to previous technologies.

- **OFDM as a proven technology**

The fact that LTE uses Orthogonal frequency-division multiplexing (OFDM) as a modulation method is regarded as beneficial for an early launch, referring to the fact that OFDM has been deployed in other technologies such as WiMAX, WLAN and DVB. It is argued that both TDMA and CDMA were proven technologies before being applied in the cellular world.

It is true that OFDM has a track record of successful deployments. However, that does not provide reassurance that its implementation in LTE is smoother than other modulation

LTE – A Beacon Technology in the WCDMA World

Following these arguments and looking at previous experiences in the telecoms industry, we have plotted the positioning of the main cellular technologies on the above-shown life cycle curve, showing the status as of 2009 for a typical mature market such as North America or Western Europe.

The charts below show how Northstream expects the situation to change by 2012 and 2015, respectively. These figures also include “LTE-A” or LTE Advanced, the planned technology providing the evolution path of LTE into 4G.

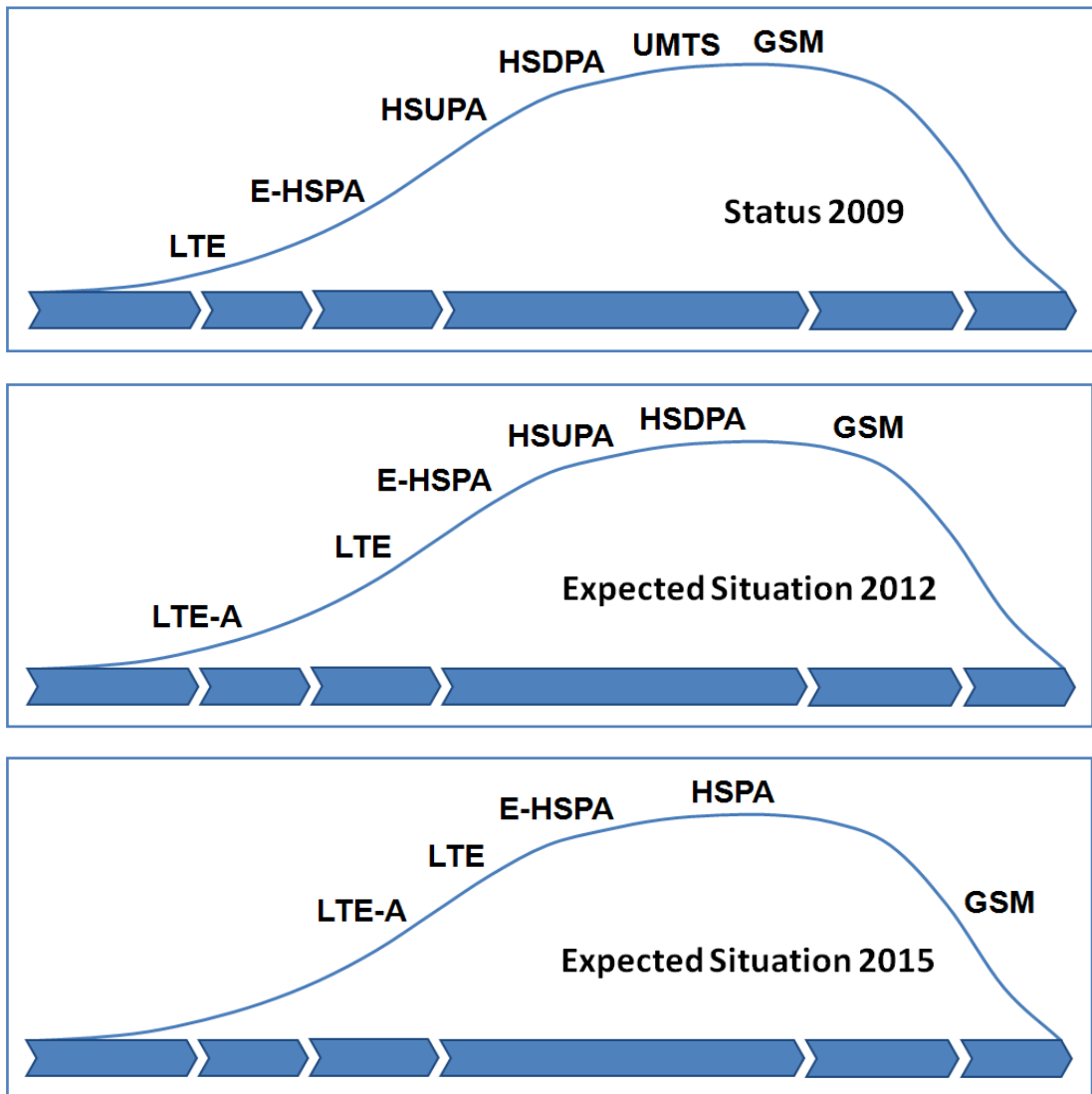


Figure 3: Uptake of Wireless Telecommunications Technologies 2009, 2012 and 2015

Based on this, a pre-commercial LTE launch by 2012 appears to be a realistic ambition for most HSPA operators in mature markets. However, different time lines may apply for other players, including an even more aggressive timeline in some cases.

Many 3G operators in emerging markets have not yet implemented HSDPA, and will still rely on the HSPA evolution path for the next 5 – 10 years. Other operators do not possess sufficient amounts of own spectrum and rely on other players' 3G capacity – this situation calls for an early LTE launch. Players in Japan or Korea tend to follow an early adopter strategy for new technologies; those operators are also expected to implement LTE at an early stage.

However, one group of operators that is of particular significance when looking at the general development of LTE is CDMA2000 operators providing EV-DO services.

CDMA2000 Operators – First Movers, but no First Mover Advantage

Compared to their WCDMA counterparts, CDMA2000 operators in mature markets find themselves in a situation where a “natural” network evolution path is no longer available.

CDMA2000 Rev B provides improvements over Rev A, but operators do not see the case for investing into a technology that is not future-proof. With Ultra Mobile Broadband (UMB) being discontinued, the choice rests between WiMAX and LTE as air interfaces.

WiMAX has lost momentum and is these days more perceived as a solution for wireless DSL or operator backhaul, used in frequency bands above 2 GHz. Mobile operator preferences are therefore shifting towards LTE as a long-term radio interface technology, supporting the operators' transformation into internet service providers.

LTE provides the perspective of scale benefits leading to lower prices, more choice and more attractive features in the areas of network infrastructure and devices. The potential of wider international roaming adds to the customer proposition and operator bottom line.

Thus, CDMA2000 operators have various reasons to launch LTE as soon as feasible, with commercial launches planned as early as 2010. However, specific challenges apply – hence we believe that early launches are unlikely to yield a first mover advantage. For example:

- **Technology maturity:** Early LTE players will find it challenging to compete against other operators running stable and mature HSPA networks. It will take a number of development

cycles before the LTE customer experience is on par with HSPA.

- **Infrastructure and service rollout:** EV-DO operators rolling out LTE need to work with new vendors, new standards and new products and align their organization. Challenges include network design, site installation, testing, training, and vendor management.
- **Device portfolio:** Operators pursuing an early LTE launch cannot count on a wide choice of devices. The offering will be restricted to form factors such as USB modems and high-end laptops with in-built LTE. Only a subset of devices will support dual-mode CDMA2000 and LTE; a feature that also pushes up price and subscriber acquisition cost.
- **Fixed vs. mobile positioning:** Many mobile operators are part of organizations that also offer fixed-line services. These players need to ensure that mobile and fixed-line broadband are clearly positioned and packaged. Internal politics must also be addressed, avoiding competition between both services.

Despite these challenges, CDMA2000 players may turn out to be the first operators launching large-scale LTE networks. Their aggressive moves to bring LTE to the market will benefit WCDMA players, who can enjoy the increased availability of infrastructure, devices and applications once the market has moved to a more mature stage.

Prerequisites for an LTE Launch

This paper has focused on the intricacy of LTE timing for mobile operators. Key aspects have been highlighted, but every operator must assess its specific situation and identify the particular prerequisites to be met before a commercial LTE launch can take place.

Considerations about LTE timing will revolve around questions such as market demand, service portfolio, device offering, spectrum availability and competitive situation. In Northstream's view this translates into five key areas where certain prerequisites must be gauged and met before a successful launch of LTE can be achieved:

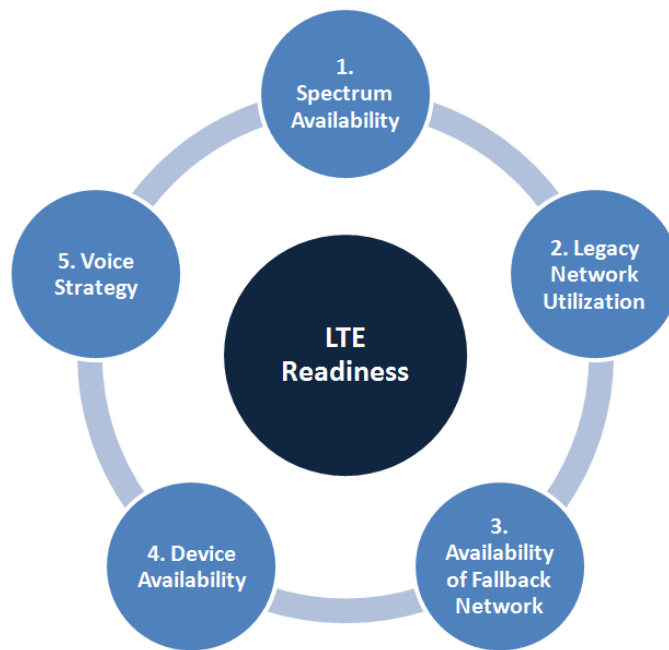


Figure 4: Operator Prerequisites for an LTE Launch

1. Spectrum availability

Sufficient spectrum and compliant infrastructure are needed in order to leverage LTE's potential. Without owning more than 5 MHz of bandwidth, LTE may not significantly improve mobile broadband economics compared to HSPA.

2. Legacy network utilization

The data traffic in the high density zones of the current HSPA network should constantly be monitored. At a certain stage, traffic may be so high that shifting parts of it to an LTE network will improve the business case. Other options include a further build out of the HSPA network, delaying the LTE launch until the economics have improved (prices of LTE infrastructure have fallen, efforts to grow ARPU have led to results).

3. Availability of fallback network

Even in hot spot zones where LTE will initially be deployed, a fallback network (e.g. for providing indoor coverage) will be required. Launching LTE is not a decision of "HSPA versus LTE", but about establishing complementary networks: HSPA coverage is a success enabler for LTE.

Different conditions apply in so-called "white spot" areas where fixed-line broadband is not available. Covering white spots with mobile broadband would allow the deployment of

LTE as the only broadband infrastructure, enabled by different user expectations and service positioning.

4. Device availability

Devices supporting the planned voice and data services must be available. Operators should verify that the terminals' user experience and value for money are at least on par with HSPA devices. Differences in price and resulting subsidies between HSPA and LTE terminals must be considered as part of the business plan.

Operators should also monitor whether the experience made with previous technologies is repeated with LTE: First generation products are seldom competitive, followed 12 – 18 months later by the second generation which provides full feature sets but substandard processing power and battery life. Two to three years after the initial launch, commercially attractive products tend to be available from the third generation onwards.

5. Voice strategy

Launching LTE will mean establishing a new radio network that does not support circuit-switched voice as the key revenue generating service, at least for the first few years of operation. This has to be verified against the corporate strategy. Topics of network handover and international roaming

must be addressed as well in order to manage VoIP revenues and user experience.

Operators should review and constantly monitor these five areas in order to ensure LTE readiness when the time is right.

In the long run, LTE and LTE Advanced will be the next GSM, but with a wider focus – paving the way for ubiquitous mobile voice and internet services. LTE provides the chance to reduce the technology fragmentation that has long plagued the telecoms industry in many areas.

LTE will be the first truly global radio access technology – a major step towards promoting scale and lowering the costs of mobile internet for hundreds of millions of new users. In the short term though, the key challenge for operators is to understand when the time is right for taking the first steps towards LTE.

Northstream – Strategy and Sourcing

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- Strategic sourcing of systems and services
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- Operational review, optimization and support
- Investment analysis and due diligences

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