LTE Spectrum and Network Strategies

Strategic Options for Mobile Operators in Dynamic 4G Mobile Markets

The LTE spectrum auctions across Europe are the start of LTE becoming market reality. Operators are focusing on one of two spectrum strategic options: major investments into 800 MHz or smart hybrid multiband solutions with >1GHz spectrum on 1800, 2600 FDD and TDD bands. These options are linked to their network deployment strategies and are increasingly implemented via network cooperation agreements. By choosing smart spectrum and network deployment strategies, operators can improve their position in dynamic 4G markets.

Spectrum auctions in Europe indicate LTE will quickly have a significant impact on market dynamics

In reaction to the explosion in mobile data traffic and to improve access in rural areas, the European Union ensured that the Digital Dividend, 800 MHz spectrum previously used by analogue terrestrial TV, would be used for mobile data networks. Most countries are auctioning off new 2600 MHz spectrum at the same time, and also enable operators to refarm 900 and 1800 MHz bands for usage via UMTS/HSPA or LTE. The availability of this new spectrum is creating a range of opportunities for incumbent and challenger operators alike to improve their competitive market position.

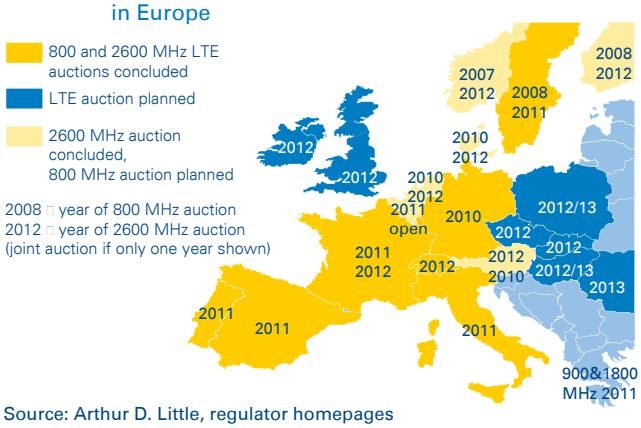
Arthur D. Little has identified auction patterns and a variety of smart network deployment strategies. In this Viewpoint, we will review the lessons learned and assess possible auction and network deployment strategic options for mobile operators in 4G markets.

Auction results indicate operators highly value 800 MHz spectrum, but alternative auction and spectrum strategies have also emerged

LTE auctions have already been completed in Germany, France, Spain, Portugal, Italy, Sweden, the Netherlands, Belgium, and Switzerland (see Figure 1). Competition for the 800 MHz spectrum has dominated auction results, especially in markets in which four mobile operators compete for three licenses of 10 MHz each on the 800 MHz band. While prices for 800 MHz skyrocketed in Germany, Italy and France bidders in other countries managed to keep the auction fee rather low.

In Germany, e-plus chose not to acquire 800 MHz spectrum due to the demanding obligations to cover remote areas, as well as the high price. Deutsche Telekom, Vodafone and Telefónica Germany (O2) paid €1.2 billion for 10 MHz paired

Figure 1: Concluded and planned LTE spectrum auctions in Europe



Source: Arthur D. Little, regulator homepages

800 MHz spectrum each. €3.6 billion of the total auction proceeds of €4.4 billion was paid for just the 800 MHz band – which means that 82 percent of the auction proceeds were paid for just 60 MHz (18 percent) of the 335 MHz of auctioned spectrum.

In Italy, H3G pursued a similar strategy as e-plus. After initially also bidding for 800 MHz, H3G chose to stop bidding for 800 MHz once the price reached the very high level of €0.81/MHz/capita. Instead, H3G then focused on bidding for 1800 and 2600 MHz spectrum. The three largest Italian mobile operators, Telecom Italia Mobile, Vodafone and Wind, ended up paying a total of close to €3.0 billion for the three licenses of 10 MHz each in the 800 MHz band, i.e. 75 percent of the total auction proceeds of €3.9 billion.

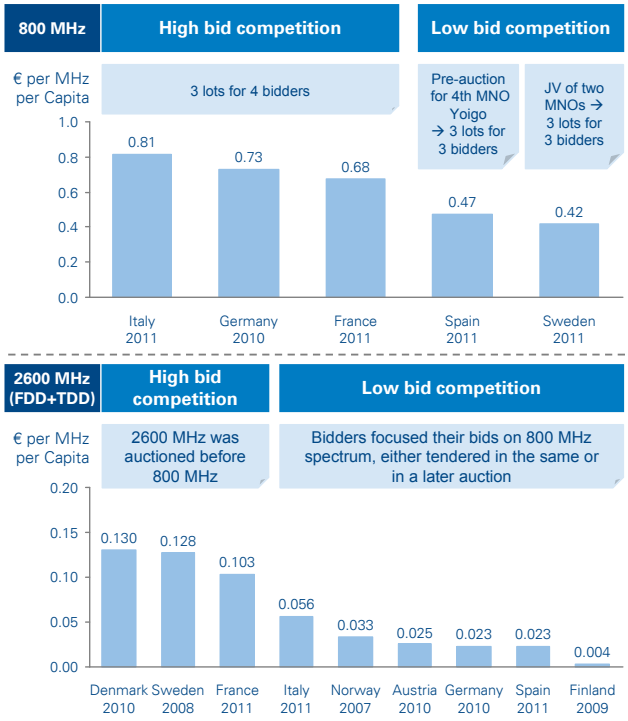
In France, Orange, SFR, Bouygues and Free competed for 800 MHz spectrum, until Free dropped out knowing it could roam

on one of the operator's 800 MHz networks. The bidders ended up paying €2.6 billion, or €0.68/MHz/capita for 800 MHz spectrum.

In contrast to Germany, Italy and France, competition for the 800 MHz band was much lower in Spain and Sweden. In each of these countries, special circumstances resulted in only three bidders for the three 800 MHz licenses. In Spain, overall LTE auction fees reached €2 billion, which was less than expected. A pre-auction phase ensured spectrum for the fourth player, Yoigo, leaving three bidders for the three 800 MHz licenses in the main auction. In Sweden, Telenor and Tele2 bid via their joint venture, Net4Mobility, leaving three bidders for the three 800 MHz licenses.

Austria has so far auctioned 2600 MHz spectrum with auction proceeds of €39.5 million, or €0.025/MHz/capita, at the lower end of benchmarks. The country plans to auction 800 MHz spectrum in 2012.

Figure 2: Benchmark of LTE spectrum auctions



Source: Arthur D. Little, regulator homepages

Figure 2 details the results of 800 and 2600 MHz auctions in markets with high and low bid competition. In Switzerland, the regulator just completed an auction of all frequencies already owned by operators, as well as on 800 and 2600 MHz spectrum. Prices per band cannot be derived as the auction followed a combinatorial clock methodology, bundling spectrum from various frequencies into packages.

Two LTE strategies: acquire 800 MHz + 2600 MHz LTE spectrum or go for a hybrid multiband 1800/2600 MHz FDD/TDD approach

Depending on the competitive situation, auction rules and spectrum availability in the particular market, there have been two primary operator strategies in the auctions thus far (see Figure 3): push aggressively for 800 MHz spectrum or side-step, go for bands above 1 GHz and develop smart hybrid multiband solutions. Operators without 800 MHz spectrum can deploy LTE 1800 in urban and semi-urban areas if they have free spectrum and add an LTE 2600 MHz layer for capacity reasons.

Figure 3: Common spectrum / deployment strategies

800 + 2600 MHz approach	
800 MHz deployment for rural outdoor and for indoor coverage + urban 2600 MHz deployment for LTE capacity reasons, complementing existing nationwide GSM 900/1800 MHz and UMTS 2100 MHz networks	■ Germany: Vodafone, T-Mobile and Telefónica ■ France: Orange, SFR & Bouygues Télécom ■ Italy: TIM, Vodafone & Wind ■ Spain: Telefónica, Vodafone and Orange
Hybrid multiband 1800/2600 MHz FDD/TDD approach	
a) 1800 MHz only: deploy LTE only on 1800 MHz, possibly before other operators have free spectrum	■ Poland: Polkomtel ■ Spain: Yoigo
b) Hybrid 1800 MHz + 2600 MHz strategy: get as much 1800 MHz as possible plus 2600 MHz. Then deploy LTE 1800 MHz in semi-urban areas and cities (for indoor coverage). Deploy LTE 2600 MHz as a capacity overlay in cities	■ Germany: e-plus ■ France: Free (2600 MHz only) ■ Italy: H3G

Source: Arthur D. Little

The 800 + 2600 MHz approach needs to take 800 MHz deployment obligations into account

The auction results are a strong indication of the value of 800 MHz, which can be explained by two of its physical features. Firstly, it carries farthest, so that wide rural regions can be covered with fewer sites. Secondly, it enables the best indoor coverage, which is critical as people will mostly be using LTE-based data connections indoors on their smartphones, notebooks or tablet PCs. Operators with 800 MHz spectrum will also have the only nationwide LTE networks, and be able to provide the best customer experience; large cell overlap areas of 800 MHz antennas ensure continuous data connections while moving in cars or on trains. As good coverage remains key to customer satisfaction, most operators long for 800 MHz spectrum, which explains the high price paid at auctions. However, coverage obligations have decreased the attractiveness of the 800 MHz spectrum in several countries:

- In Germany, each federal state has been divided into four "priority stages". Stage 1, for example, consists of towns and districts with less than 5,000 inhabitants ("white spots"). Operators have to cover 90 percent of each stage before they can start to deploy 800 MHz in more attractive rural, semi-urban and urban regions. Operators are in a hurry to meet these obligations, and 800 MHz networks are already being deployed in more densely populated areas in some states
- In Spain, owners of 800 MHz spectrum must jointly cover 90 percent of villages of less than 5,000 inhabitants with a speed of at least 30 Mbps by the end of 2019
- In France, each LTE 800 MHz license holder has to cover 40 percent of priority areas, which are mostly rural areas, by the end of 2016, 90 percent by the end of 2021 and more beyond

- In Italy, there is no obligation on the first 800 MHz block, but each owner of the other five blocks has to fulfill rural coverage obligations. Those operators have to start deploying networks from the beginning of 2013, by when analog terrestrial TV is expected to have been switched off, and have to cover 30 percent of a specified list of towns of less than 3000 inhabitants three years later (by the end of 2015), 75 percent five years later (by the end of 2017), and 100 percent 7 years later (by the end of 2019).

The hybrid 1800/2600 MHz approach drives a new evolution: 1800 MHz is becoming a strong LTE ecosystem

Rather than waiting for the 800 MHz spectrum to become available, several operators have begun to deploy 2600 MHz or 1800 MHz in cities. As 1800 MHz has better outdoor and indoor coverage propagation parameters, operators with 10 or 20 MHz of free 1800 MHz spectrum are deploying LTE 1800 MHz networks.

LTE 1800 MHz deployments are becoming a key trend. World-wide over 20 operators have committed to deploy LTE on 1800 MHz, either on newly acquired spectrum or on spectrum freed via refarming strategies. Examples of mobile operators pursuing an LTE strategy on 1800 MHz include Yoigo in Spain, Telstra as first operator to offer LTE services in Australia, e-plus in Germany and H3G in Italy. Polkomtel in Poland is using the 1800 MHz spectrum of smaller sister mobile operators, Aero2 and Mobyland, to offer LTE services nationwide, well before any of the other mobile operators, which have to wait for LTE auctions to be held early in 2013.

LTE will have an impact much faster than UMTS – myths of LTE skeptics are being refuted

LTE is becoming a market reality much faster than UMTS did a decade ago. At that time, operators invested into UMTS assuming it would push customer demand for better connectivity, but demand initially remained low. In contrast, today mobile operators need to deploy the LTE spectrum in order to cope with the already existing rapid growth in demand for mobile data. This, in addition to operators' and suppliers' need to show that LTE can become a much needed growth area, has resulted in significant pressure on all market players to ensure that LTE will be adopted more rapidly than UMTS.

Still, the buzz around LTE has included several myths arguing that there will be a slow deployment of LTE. Our reality check indicates that these myths do not hold true.

- Myth #1: LTE will not provide sufficient indoor coverage for data services
  Reality: Indoor coverage on 800 MHz has proven to be strong, and 1800 MHz can also provide reasonable coverage in urban and suburban areas. Femto-/Pico- and Microcells can also resolve indoor coverage concerns

- Myth #2: There will be a lack of LTE devices, as was the case in the early days of UMTS
  Reality: LTE devices are already available and the premium compared to handsets without LTE is shrinking rapidly due to intense competition among smartphone device suppliers such Apple, Nokia, Samsung, Huawei and HTC. A range of LTE-compatible smartphones, dongles, tablets and modems were already presented at the International Consumer Electronics Show (CES) 2012 and at the Mobile World Congress 2012 in Barcelona

- Myth #3: LTE tariffs will be very expensive, limiting uptake on the consumer side
  Reality: UMTS tariffs were more expensive than GSM tariffs for many years. We expect that the price premium for LTE vs. UMTS-only data tariffs will rapidly decline, fostering LTE uptake. In Sweden, for example, LTE data tariffs were already substantially revised downwards

- Myth #4: LTE is only suitable for mobile, not fixed, broadband services
  Reality: LTE is also used to provide fixed broadband services via stationary LTE modems as promoted by Vodafone Germany, for example

- Myth #5: LTE is not suited for mobile voice
  Reality: Solutions enabling voice for LTE are in the making. Yoigo plans to introduce VoIP for LTE in Spain this year. Qualcomm and Ericsson announced the first successful test of VoIP over LTE to WCDMA handover. Voice over LTE, in particular IMS-based, is now strongly pushed by the industry. Additional solutions will be available soon.

The five hurdles often put forward as likely to slow LTE uptake are hence being overcome by infrastructure and device suppliers, as well as by operators.

Utilizing network innovations: Enabling better capacity and coverage on 1800 and 2600 MHz bands

Suppliers and their network innovations are the enablers of smart network solutions for the efficient use of >1 GHz bands for LTE, making up to a certain extent for the coverage limitations of these bands compared to 800 MHz spectrum:

- Macro-cells are intended for all LTE bands (800, 1800, 2600 FDD and TDD)
- Micro and Picocells can be deployed as an underlay network to a macro-cell network, possibly in another spectrum band – leading to hybrid macro/micro-cell networks with improved indoor coverage
- Femtocells are also an option to increase LTE indoor coverage and can help to substitute fixed broadband with mobile broadband
- TDD is now back on the agenda of mobile operators deploying 2600 MHz networks in a hybrid FDD/TDD approach – TDD spectrum is used as a capacity overflow buffer and/or for applications using massive downlink, but no or limited uplink capacity

Network cooperation can be a game changer as reduced Opex & Capex can lead to a competitive advantage

While numerous network cooperation agreements exist to share 3G active radio network infrastructure, there is so far only one 4G network cooperation – the Net4Mobility joint venture between Tele2 and

Telenor in Sweden. We expect to see more 4G network cooperation agreements, as they can enable savings of up to 40 percent of LTE network investment and operating costs for each partner operator. Such cooperation agreements can also help to overcome three operational hurdles of LTE deployment:

1. *Installing LTE antennas on existing sites* – Sites need to be re-enforced, landlords may require higher rental payments as additional antenna are being installed, residents may complain, electro-radio-magnetic emission limitations may be a restriction
2. *Installing high-capacity backhaul networks required to transport the LTE data traffic* – In rural areas, new high capacity microwave links have to be installed, requiring costly civil works for most sites, and fibre links have to be deployed to some 10-15 percent of sites serving as traffic concentrator sites. Network cooperation can lead to 40-50 percent savings on required backhaul upgrade investments and backhaul operating costs
3. *Identification of additional site locations, especially in cities, for LTE 2600 MHz deployments* – It is increasingly difficult to identify new, especially rooftop, locations to cover major cities well with dense LTE 2600 MHz networks. Network cooperation can help to reduce the need for new locations

Operators with a smart spectrum auction, network deployment and network cooperation strategy can improve their market position

Results of recent LTE spectrum auctions and early deployments have highlighted the impact that the availability of LTE spectrum will have on market dynamics. LTE spectrum auctions, the speed of network deployment and the availability of LTE devices will lead to a much faster LTE uptake than was the case with UMTS. In order to maximize LTE potential, mobile operators need to have smart LTE strategies in place along three elements:

- *Auction strategy* – Push for either a mix of LTE 800 MHz, LTE 1800 MHz and 2600 MHz spectrum – or, if no 800 MHz can be acquired, ensure the acquisition of significant spectrum on 1800 MHz and 2600 MHz FDD and TDD bands
- *LTE network deployment strategy* – Carefully optimize LTE and UMTS/HSPA network deployment on various available bands and make smart use of hybrid Macro & Micro/Pico/Femtocell solutions
- *Network cooperation* – Use a smart approach to possibilities of network cooperation and TowerCo deals

Mobile operators with the right LTE strategy have an opportunity to use the rise of fourth generation networks to improve their overall market position.

Contacts

Dr. Karim Taga
Managing Partner
Global Practice Leader TIME
taga.karim@adlittle.com

Christian Niegel
Principal
TIME Practice
niegel.christian@adlittle.com

Giancarlo Agresti
Partner
TIME Practice
agresti.giancarlo@adlittle.com

Andrea Faggiano
Principal
TIME Practice
faggiano.andrea@adlittle.com

Contributing author

Dr. Nicolas Racz

Arthur D. Little

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