ANCOM
National Authority for Management and Regulation in Communications of Romania

Planning a Spectrum Auction

an introduction in spectrum auctioning

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CEE Regional Working Group meeting,
9 May 2013, Bucharest, Romania

Agenda

1. Spectrum auctioning - pros and cons
2. Types of auctions
3. Mobile communications spectrum valuation
4. Valuation and reserve prices for the Macedonian LTE auction
5. Hiring a consultant
6. Preparing for the LTE auction

1. Spectrum Auctioning - pros and cons

Auctions in Telecommunications

A well designed auction is the method most likely to allocate resources to those who can use them best

- Rather than relying on authorities to assess the merits of competitors' business plans, an auction **forces businessmen to put their money according to their understanding** of the future business.
- An **auction can** therefore **extract and use information** (valuation) otherwise unavailable to the authorities

Auctioning spectrum for mobile communications

- Economists had been advocating auctioning spectrum at least since Ronald Coase (1959). William Vickrey had been pushing the use of auctions in such contexts for many years, but was left to sing unheard for most of his career.
- The U.S. Federal Communications Commission (FCC) turned to auctioning radiospectrum for phone licences in **1994**. The FCC used the "simultaneous ascending auction" design, that had first been sketched by Vickrey (1976) and whose details were independently developed by McAfee, Milgrom and Wilson. This auction is much like a standard "ascending" auction used to sell a painting in Sotheby's or Christies, except that several objects are sold at the same time, with the price rising on each of them independently, and none of the objects is finally sold until no-one wishes to bid again on any of the objects. The FCC auctions worked fairly well in practice, and the fact that $20 billion was raised, twice the original estimate, attracted much favourable media attention.
- The U.K. embraced auctions later than the U.S.A., and the U.K.'s 2G mobile-phone licences were awarded using a "beauty contest", in which firms submitted business plans to a government committee which awarded the licences to those candidates it judged best met a set of published criteria.

3G auctions

- **UK** 3G spectrum auction, 6th March-27th April 2000. The auction, designed by Paul Klemparer, was described as the "biggest ever". The British government raised £22.5 ($34) billion in an auction for five telecom licences. The exact total raised was £22,477.4 million, or about £22,477.3 million after deducting the cost of the economic consultants - primarily on programming simulations, running experiments etc. **About $7 bn/licence!** The U.K. auction yielded about 2.5% of GNP, or enough money to build 400 new hospitals. The winners of the U.K.'s previous 2G licences original payments were in the region of just £40,000.
- **German** auction, August 2000 - Germany raised the record amount of DM98.8bn (€50.5bn, $46bn) in a 3G mobile phone licences auction for six licenses. **About $7 billion per licence**!
- France, Spain, etc awarded 3G licenses via beauty contests
- **Context** - Manufacturers, consultants, banks, cellcos, etc. considered 3G a "bonanza". Only "killer application" was missing.

Objections to Auctions

Auctions are unfair to competitors – they make investments decrease, and tariffs increase!

- Auctions are unfair - **forcing cellcos to attend them and to make bids**. Cellcos should compete for a new licence, **for their business future**, but in no European 3G auction have there been fewer licences than incumbents, so the prices of licences were set by the new entrants who had nothing to lose if they failed to win a licence.
- The companies are taking **huge risks in bidding in an auction**, just as, for example, firms take huge risks when they invest in developing a new aircraft, a new drug, or a new car. They know that they are buying into a lottery that might result in huge losses or huge gains.
- In the U.K., Germany, Italy and elsewhere, some licences were won by companies who had no previous presence in those markets (3 - HW), took the risk. In the U.K., one winner quickly re-sold a share of its licence at a 37% profit. În Romania, a 3G license winner was sold - for the 3G license!
- For the first time - an auction (Czech auction) was stopped because of too high prices!

Investments effect

- Decrease in investments? Theoretically possible, but it seems unlikely that very many highly profitable investments are being foregone because of the difficulty in raising funding for them. Cellcos, looking for investment recovery, will launch their business as good as possible (coverage, time to market, etc.)
  - Telefonica paid in Germany US$7 billions for a 3G license and very little in Spain, while investments did not take this into consideration. Markets are becoming global!
  - Were investment in mobile communications in UK and Germany less than in Spain?
  - Why government in UK and Germany insisted on auctions, if investments are decreasing?

Transfer of license cost to the end users!

- Like any other company, the cellcos will establish tariffs to maximize their profit, no matter of what the spectrum cost them in the past. Their shareholders ask for dividend!
  - Ex. Houses: a houses developer which buy cheaper the land, will not sell houses cheaper!
  - But, big amount of money paid for licenses will influence cellcos's finance - huge costs of 3G licenses was written down ...
- A few of economists are considering licenses fee 'sunk cost', (sunk costs are retrospective (past) costs that have already been incurred and cannot be recovered regardless of future events), not affecting services tariffs

Arguments in Favor of Auctions

Auctioning eliminates competitors with poor financing and expertise

- Higher probability on developing a profitable business for society, shareholders, end users, etc.
- No doubt on favoring of any competitor
- Could permit a new comer.

Auctions results are higher and could support specific projects developed by regulatory body or government in: telecommunications (**universal service, broadband coverage**, etc.) or could decrease tax burden supported by citizens

- UK: 3G auction - £22.5 billion or 2,5% of GNP, or 400 hospitals,
  2G beauty contest - £40,000

Auction vs. beauty contest:

- **Beauty contest**
  - BC - an easier way to fulfill other policy goals, such as broadband penetration, through roll-out and coverage conditions, but from an economist's view point this could be a poor way to meet such objectives.
  - Beauty contests are typically time consuming to define and analyse,
  - Decisions are vulnerable to legal challenge, which may lead to huge legacy costs and delays
  - May expose the regulators to hidden costs
  - **Difficulty of specifying and evaluating the future in a beauty contest**
  - Nicholas Negropontes: '3G licenses should be alocated to those which guarantee the lowest prices for end user'. How could anybody to guarantee prices for 10-20 years for products and services hard to imagine when selling spectrum?
  - How to evaluate the most creative competitor?
  - How to monitor and implement competitors promises?
  - How to penalize an operator not enough creative?
  - How to proceed with a creative operator developing a product/service with valuable characteristics unforseen before, but with prices higher than promised/guaranteed (before) value?
- **Auctions**
  - Auctions are ideal if main focus is on **efficient assignment** and/or ensuring a **transparent process** which is **not vulnerable to legal challenge**
  - In current economic conditions, auctions can bring extra revenues, but this depends on the level of competition and how one sets reserve prices
  - Auction costs and timing are fairly predictable once the auction format is defined ;
  - These costs could be recouped from auction results (eg. Danemark asked winners to share the costs of auction organizing, beside the fees).
  - Advantages of an auction over a beauty contest increase with the level of competition

2. Types of Auctions

Auction Types

- **Sealed bid** (one-shot) vs. **open auction** (multiple rounds leading to price discovery)
- **Single item** vs. **multiple items** (substitutes and complements might matter)
- **Package bidding** - where there are multiple bids, are bids across items linked or independent?
- **First price** (pay what you bid) vs. **second price** (winning price determined by losing bids)

- **Ascending-bid auctions**, also called **English auctions**. These auctions are carried out interactively in real time, with bidders present either physically or electronically. The seller *gradually raises the price*, bidders drop out until finaly only one bidder remains, and that bidder wins the object at this final price. Oral auctions in which bidders shout out prices, or submit them electronically, are forms of ascending-bid auctions.
- **Descending-bid auctions**, also called **Dutch auctions**. This is also an interactive auction format, in which the *seller gradually lowers the price* from some high initial value until the first moment when some bidder accepts and pays the current price. These auctions are called Dutch auctions because flowers have long been sold in the Netherlands using this procedure.
- **First-price sealed-bid auctions**. In this auction, bidders submit simultaneous “sealed bids” to the seller. The terminology comes from the original format for such auctions, in which bids were written down and provided in sealed envelopes to the seller, who would then open them all together. The highest bidder wins the object and pays the value of her bid.
- **Second-price sealed-bid auctions**, or **Vickrey auctions**. Bidders submit simultaneous sealed bids to the sellers; the highest bidder wins and pays the value of the second-highest bid. These auctions are called Vickrey auctions in honor of William Vickrey, who wrote the first game-theoretic analysis of auctions. Vickery won the Nobel Memorial Prize in Economics in 1996.

Auction Types for Spectrum Awarding

Sealed bid

In the 800MHz band, if a symmetric 2x10MHz lot structure is used, it may be feasible to implement a simple sealed bid based on the approach used for the Danish 3G auction. Bidders submit a single bid for one lot each. Lots are awarded to the three bidders that bid the most. A key aspect of this format is the pricing rule. In the Danish 3G auction, winning bidders paid the price of the lowest winning bidder, which created incentives for bid shading below value. This approach may act to encourage participation, as weaker bidders know they have a better chance of winning because incumbent rivals may shade their bids too much. The main drawbacks of this format are the lack of price discovery and possible outcome inefficiency if strong bidders bid too low relative to their value. C

Simultaneous Multiple Round ascending Auction (SMRA) - German auction in 2010! E-Plus!

The most common multiple-round format used for spectrum awards, pioneered by the FCC in the 1990s. In each round, bidders submit bids for individual lots and may shift their demand across lots from round-to-round. This format is ideally suited to auctions where bidders are limited to buying one lot. In more complex settings where bidders are pursuing multiple lots, they may be exposed to aggregation risk, and this may also create gaming opportunities. There is great scope for varying the detailed rules to manage such risks, but they cannot typically be eliminated.

Clock auction (forward or reverse)

A simpler alternative to the SMRA, in which lots are grouped into categories on an **abstract basis**. In each round, buyers indicate how many lots of each band they want to buy at the new, higher prices. Buyers can change the distribution of their bids among the various products at each round, although an "activity rule," designed to stimulate participation throughout the auction, prohibits a buyer from increasing the value of its total quantity demanded, as prices rise. The auction ends, and final prices are established, when the total number of lots bid upon equals the total number available. The clock format may provide a way to remove aggregation risk without the complexity of a full combinatorial process. This format can be vulnerable to so-called 'overshoot', in which demand falls suddenly in response to rising prices, leading to unsold lots. Given the limited number of lots in this auction it should be possible to design rules that eliminate this problem. **Romanian auction**!

Combinatorial Clock Auction (CCA)

This format, used for the 2010 Danish 2.6GHz auction, provides a practical design for implementing package bidding in a multi-round format. A clock auction is used to induce price discovery. This is followed by a sealed bid combinatorial bidding round in which bids are constrained by previous behaviour in the clock rounds. This approach eliminates aggregation risk and also offers effective price discovery.

The Danish 2.6GHz award was implemented using a Vickrey-nearest core-pricing rule. (Vickrey auction, also known as *sealed-bid second-price auction* is identical to the sealed first-price auction except that the winning bidder pays the second highest bid rather than their own) **Seems to be the most appropriate for multi-packages!**

The auction type should be selected together with the consultant!

Combinatorial Clock Auction

Part 1 - the allocation stage determines how much spectrum each bidder wins. It has two phases:

a. Primary rounds (clock phase)

The primary rounds are intended to provide information to all bidders about the market value of the spectrum. The lots of spectrum to be sold are divided into a number of categories of identical generic items. Each category has an individual price 'clock' and the price increases on each individual clock at different speeds according to the level of interest within each category.

Each bidder is allowed to make a bid for a package of lots across multiple categories. In each clock round, bidders will bid for the package of lots they are most interested in acquiring at the current round prices.

The primary rounds conclude when there is no excess demand for any of the lots in any category.

b. Supplementary round (sealed-bidding round)

The supplementary round allows bidders to make their best and final offers for all the different combinations of spectrum they want. It is a sealed bid round held after the primary rounds.

A bidder cannot place bids in the supplementary round that are inconsistent with their preferences revealed through their bids in the primary rounds. This is designed to ensure bids in the primary round are truthful.

Determining winners

The winners are those that make the highest value combination of bids. All bids are considered from either phase of the auction, but each bidder can only win one of its bids.

Determining the price to be paid by the winners

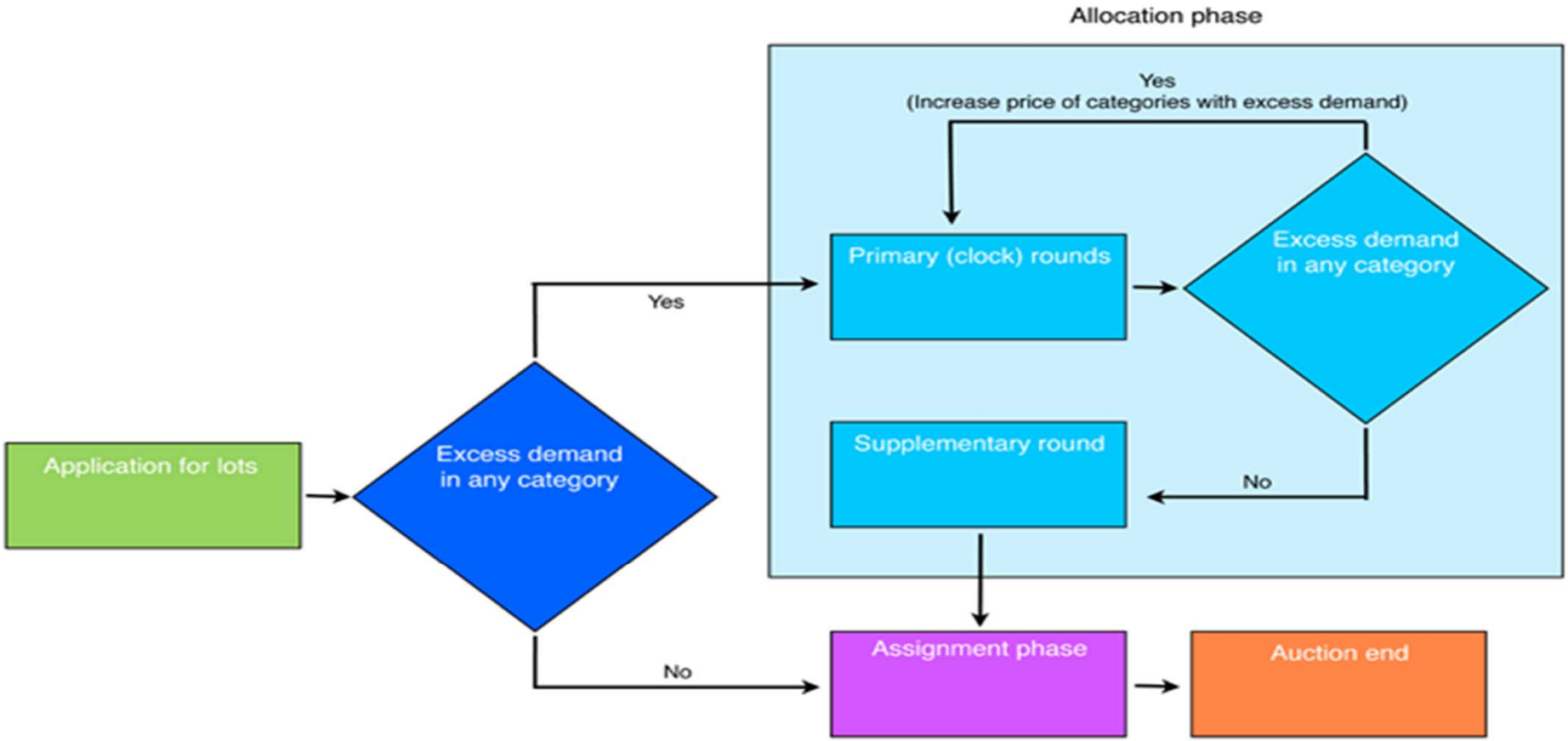
The price paid by each winning bidder will be based on others' bids, with safeguards to ensure winners pay a competitive price. **Reserve prices** will be used as a further measure to ensure appropriate prices are paid setting a minimum amount, below which the spectrum will not be sold.

Part 2 – the assignment phase (sealed bidding round)

Once the auction has identified the winners and how many generic lots they have purchased in each category, the assignment phase determines which lots each winning bidder will obtain. This stage consists of a single, sealed bidding round, where the winners can offer to pay extra money to secure specific lots. This addresses the issue that bidders may have reason to prefer some lots over others.

It is a relatively complex format for bidders to understand and to implement.

Combinatorial Clock Auction



SMRA vs. CCA

- **Duration - SMRA is more simple, but could last more and seems to be more spectacular (UK and German 3G auctions, German 4G auction)**
- **Eficiency**
  - **SMRA seems to encourage weaker competitors to 'strategic demand reduction' (E-Plus in German auction)**
  - **Suplimentary round in CCA (final offer) has potential inefficiencies**
    - **Complex rules to be auctioned all the offered blocks**
    - **Bidders should be more responsible in preparing the offers, creating sometimes uncertainty. Sometimes, the winners could be the most aggressive competitors rather those valuating the most spectrum – ineficient spectrum allocation**
    - **Bidders could not change the offer.**
  - **Implementation costs – low for SMRA and medium to high for CCA**
  - **Financial result - CCA seems to be more efficient (Danemarca vs. Germania) than SMRA in lower competitive conditions**

3. Spectrum Valuation

The German Auction (12 April-20 May 2010)

Auktionsrundenergebnis

Ende der Auktion

Frequenzbereich	Block	Ausstattung	Höchst-bieter	Höchstgebot (€ in Tsd)
0,8 GHz (gepaart)	0,8 GHz A	2x5 MHz konkret	To2 GER	616.595
	0,8 GHz B	2x5 MHz abstrakt	To2 GER	595.760
	0,8 GHz C	2x5 MHz abstrakt	Telekom D	570.849
	0,8 GHz D	2x5 MHz abstrakt	Telekom D	582.949
	0,8 GHz E	2x5 MHz abstrakt	Vodafone	583.005
	0,8 GHz F	2x5 MHz abstrakt	Vodafone	627.317
1,8 GHz (gepaart)	1,8 GHz A	2x5 MHz abstrakt	Telekom D	20.700
	1,8 GHz B	2x5 MHz abstrakt	Telekom D	20.700
	1,8 GHz C	2x5 MHz abstrakt	Telekom D	19.869
	1,8 GHz D	2x5 MHz konkret	E-Plus Grp	21.550
	1,8 GHz E	2x5 MHz konkret	E-Plus Grp	21.536
2,0 GHz (gepaart)	2,0 GHz A	2x4,95 MHz konkret	Vodafone	93.757
	2,0 GHz B	2x4,95 MHz konkret	E-Plus Grp	103.323
	2,0 GHz C	2x4,95 MHz konkret	E-Plus Grp	84.064
	2,0 GHz D	2x4,95 MHz konkret	To2 GER	66.931
2,0 GHz (ungepaart)	2,0 GHz E	1x5 MHz konkret	To2 GER	5.731
	2,0 GHz F	1x14,2 MHz konkret	To2 GER	5.715

Frequenzbereich	Block	Ausstattung	Höchst-bieter	Höchstgebot (€ in Tsd)
2,6 GHz (gepaart)	2,6 GHz A	2x5 MHz abstrakt	Telekom D	19.096
	2,6 GHz B	2x5 MHz abstrakt	Telekom D	19.025
	2,6 GHz C	2x5 MHz abstrakt	To2 GER	17.364
	2,6 GHz D	2x5 MHz abstrakt	To2 GER	17.364
	2,6 GHz E	2x5 MHz abstrakt	Vodafone	18.948
	2,6 GHz F	2x5 MHz abstrakt	Vodafone	19.025
	2,6 GHz G	2x5 MHz abstrakt	Telekom D	19.069
	2,6 GHz H	2x5 MHz abstrakt	Telekom D	19.038
	2,6 GHz I	2x5 MHz abstrakt	To2 GER	18.948
	2,6 GHz J	2x5 MHz abstrakt	E-Plus Grp	18.931
	2,6 GHz K	2x5 MHz abstrakt	E-Plus Grp	17.739
	2,6 GHz L	2x5 MHz abstrakt	To2 GER	17.739
	2,6 GHz M	2x5 MHz abstrakt	Vodafone	17.739
	2,6 GHz N	2x5 MHz abstrakt	Vodafone	17.752
2,6 GHz (ungepaart)	2,6 GHz O	1x5 MHz abstrakt	Vodafone	9.130
	2,6 GHz P	1x5 MHz abstrakt	Vodafone	9.130
	2,6 GHz Q	1x5 MHz abstrakt	Telekom D	8.598
	2,6 GHz R	1x5 MHz abstrakt	Vodafone	8.598
	2,6 GHz S	1x5 MHz abstrakt	Vodafone	9.051
	2,6 GHz T	1x5 MHz abstrakt	Vodafone	9.051
	2,6 GHz U	1x5 MHz abstrakt	E-Plus Grp	8.273
	2,6 GHz V	1x5 MHz abstrakt	To2 GER	8.229
	2,6 GHz W	1x5 MHz abstrakt	To2 GER	8.229
	2,6 GHz X	1x5 MHz abstrakt	E-Plus Grp	8.229

Ausgeschiedene Bieter:

Summe aller gehaltener Höchstgebote (€ in Tsd)	4.384.646
Zahlungsverpflichtung aufgrund zurück-genommener Höchstgebote (€ in Tsd)	0
Summe	4.384.646

The German Auction - €4,385 billion, under analysts predictions of €6 - €8 billion

- Offer – four bands:
  - Digital Dividend band - 800MHz: 6x2x5=60MHz
  - 1.8 GHz: 5x2x5MHz = 50MHz
  - 2.0 GHz: 4x2x4.95+(1x5+1x14.2) = (39.6 + 19.2) MHz
  - 2.6 GHz: 14x2x5 + 10x1x5 = (140 + 50) MHz
- Duration 12 April-20 May 2010, 29 working days for auctioning, 224 rounds, 4 competitors
  - Too small reserve prices
- Simultaneous Multiple Round ascending Auction
- Bidders located in the authority headquarters during the bidding process
- Total revenues €4.385 bn, out of which €3.577 bn from Digital Dividend - 81.6% from total
  - Four competitors for 60MHz. Only **here it was a real competition!**
- €4.385 billions - less than analysts predictions €(6 - 8) billion – not very competitive
  - The German auction was not actually very competitive - just the four incumbent operators. The true value of the spectrum was probably rather higher than the prices paid, even for 800MHz. It appears that prices were depressed because E-Plus engaged in 'strategic demand reduction', i.e. reducing its spectrum demand so that prices would be lower. The auction format chosen tends to encourage weak marginal bidders to behave in this way. (RM)

The Digital Dividend band seems to be vital for a cellco future

E-Plus future seems to be uncertain after the failure to buy a licence in 800MHz band (Reuters, 10 June 2010)

- Germany's statistics:
  - Population: 81.76 million
  - GDP: €2,380 billion
  - PIB per capita: €29,355
  - SIMs: 107.8 million

Statistics of the German Auction

Frequency band	Bandwidth offered (MHz)	Revenues (€mn, %in total)	**€ per MHz/pop (GSA - gsm.org, 21 May 2010)**	€ per €1 mn in PIB; € per €1 mn in PIB & MHz
800 MHz (Digital dividend), paired	60	**3576,475** **81,6%**	**0,729**	**1.502,7** **€25/MHz/€1mn**
1800 MHz, **paired**	50	**104,355** **2,4%**	**0,0255**	43,85 0,9
2100 MHz, **paired**	39,6	**384,075** **7,9%**	**0,107**	146,25 3,7
2100 MHz,	19,2	**11,446** **0,26%**	**0,00727**	4,81 0,25
2600 MHz, **paired**	140	**257,777** **5,9%**	**0,0225**	108,3 0,77
2600 MHz,	50	**86,518** **2,0%**	**0,0211**	36,35 0,7

How to Evaluate Spectrum for Mobile Communications

How to Evaluate Frequency Bands

- No precise and unique formula. Results - statistical behaviour.
- Band value = **K*(MHz*Pop)** - simplest methodology.
  - **Benchmarking** - reviews the other European countries that had already made a spectrum auction and had made public their own prices, to find out **price per population and MHz**.
  - **Adust** these prices for country's data based on two methodologies because countries are different:

- **Methodology A: Population** and **GDP** - **one compares GDP per capita at ppp**
  Use the price per MHz per Population of a Country and multiply this with country's population.
  Further adjustment with GDP per capita @ ppp (from Eurostat) - divide the implied price per MHz per population for Macedonia with country's GDP per capita @ ppp and multiply it with Macedonia's one
  Example: Germany obtained for 60MHz in 800MHz band €3576 million, resulting the price per MHz and Population of €0.729.
  Population Adjustment: This is multiplied with Macedonia's population (2.08) resulting €15.1 million for a 2x5MHz bloc in 800MHz band.
  Population & GDP Adjustment: A Macedonian is different from a German. > The GDP per capita in purchasing power terms adjustment is calculated: €15.1 *8.600 (= Macedonia's GDP per capita in ppp) / 29.000 (= Germany's GDP per capita in PPP) = **€4.49 million**) (Eurostat - GDP at ppp or index).
- **Methodology B: Users** and **Revenues per User/ARPU - compares revenues from mobile com** (data from 15th Implementation Report of the EU Commission) Same methodology as per above.
  Example: Germany obtained for 60MHz in 800MHz band €3576 million, which means that the price per MHz and User is €0.566 (mobile penetration is 132%)
  Users Adjustment: Price per MHz per user (€0.566) is multiplied with Macedonia's sold SIMs (2.045 mn) resulting €11.6 million for a 2x5MHz bloc in 800MHz band
  ARPU Adjustment: €11.6 *81.6 (= Macedonia's ARPU in 2010) / 248 (= Germany's ARPU in same year) = **€3.81 million**) (data from 15th Implementation Report of the EC) .
- First methodology compares GDP per capita at ppp of countries, while the second compares mobile communications revenues (SIMs x ARPU) - consumers desire to pay for mobile services. The second methodology seems to be more adequate because refers to mobile communications.

- **More precise method: long term business plan:** revenues, expenses (capex, opex, licenses) ...

4. Valuation and Reserve Prices for the Macedonian LTE Auction

LTE Auction in Macedonia

- Using the two methodologies (Pop & GDP and SIMs & ARPU) one calculates values for considered bands using results of the auctions in other countries.
- The lowest and highest value, for each methodology, defines **intervals** in which one could find out the value of the considered band.
- The intersection of these two intervals gives a new interval, with higher probability to find out the value of the band.
- Bands
  - 800 MHz band - 60 MHz
  - 2600MHz band - 140 MHz
- Competitors
  - T- Mobile - 52%
  - ONE - 22.4%
  - VIP – 25.6%
- Macedonia statistics
  - Population - 2,077 million
  - GDP - €8,600 per capita
  - SIMs - 2.045 million (2010)
  - ARPU - €81.6/SIM/year (2010)
  - 2.045 x 81.6 = €169 million paid the Macedonians for mobile communications

800MHz band Macedonia

	Population	2,077		€ million
	€/MHz/Pop	x Pop	x GDP ratio	Price for 2x5MHz
Germany	0,7290813	1,51	0,449	4,5
Sweeden	0,4115750	0,85	0,243	2,4
Spain	0,4726358	0,98	0,340	3,4
France	0,6682395	1,39	0,454	4,5
Average				3,7
Midle				3,5
Interval	2,4	4,5		
	SIM	2,045		€ million
	€/MHz/SIM	x SIM	x ARPU/ARPU	Price 2x5MHz
Germany	0,565618	1,16	0,381	3,8
Sweeden	0,340426	0,70	0,210	2,1
Spain	0,401901	0,82	0,176	1,8
France	0,740842	1,52	0,285	2,8
Average				2,6
Midle				2,8
Interval				
Interval	1,8	3,8		
Interval	2,4	3,8		

- Two intervals for 2x5MHz value - (€2.4 - €4.5) million and (€1.8 - €3.8) million
- Highest probability interval (**€2.4 - €3.8**) million
- The reserve prices could be in the upper part of interval (>3.0), if only three competitors
- Macedonia could raise over **€20 million** by auctioning 60 MHz in 800MHz band

2600MHz band Macedonia

	Population	2.077		€ million
	€/MHz/Pop	x Pop	x GDP ratio	Price 2x5MHz
Germany	0.02252	0.04678	0.01387	0.14
Sweeden	0.15680	0.32568	0.09267	0.93
Austria	0.02490	0.05171	0.01448	0.14
Danemark	0.12852	0.26693	0.07534	0.75
Finland	0.00310	0.00643	0.00194	0.02
Spain	0.02356	0.04893	0.01696	0.17
France	0.10159	0.21100	0.06902	0.69
Average				**0.41**
Midle				**0.47**
Interval	**0.02**	**0.93**		
	SiM	2.045		€ million
	€/MHz/SIM	x SIMs	x ARPU ratio	Price 2x5MHz
Germany	0.017472	0.0357	0.0118	0.12
Sweeden	0.129696	0.2652	0.0799	0.80
Austria	0.018649	0.0381	0.0093	0.09
Danemark	0.101998	0.2086	0.0438	0.44
Finland	0.002403	0.0049	0.0013	0.01
Spain	0.020033	0.0410	0.0088	0.09
France	0.112624	0.2303	0.0433	0.43
Average				**0.28**
Midle				**0.41**
Interval	**0.01**	**0.80**		
Interval	**0.02**	**0.8**		

- Two intervals for the value of 2x5MHz - (€0.02 - €0.93) million and (€0.01 - €0.8) million
- Highest probability interval (€0.02 – €0.8) million
- The reserve prices could be in the upper part of interval (>0.4), if only three competitors
- Macedonia could raise over **€6 million** by selling 140 MHz in 2600MHz band

Criteria for Choosing Reserve Prices

Reserve prices and auction results depends on:

- **National context**
  - Macroeconomics (GDP, inflation, unemployment, etc.) - present and long term outloock ->
  - Industry (cellcos, users, etc.) - present and long term outloock->
  - Financing - unfavorable now
- **Market evolution**
  - Mobile data access in increasing - attractive market!
  - Weak competitors - vulnerable during economic turmoil
  - Possible market concentration on medium term (economic crisis, market saturation)
  - Network sharing - EverythingEverywhere could be *everywhere. Also* in our region.
  - **New entrants**
    - Cable operators -> 5 plays package: Holland – set aside spectrum for cablecos
    - National Post (distribution network) & national broadcaster (technical expertise) > setting aside spectrum
- **Seting aside spectrum for a new entrant**:
    - Setting aside spectrum - separate auction for a newcommer. Cable Tv operators! Holland.
    - Decrease the offer (remaining spectrum) and increase competition and the price (Canada, Hungary, etc.)

✓ The reserve price could be in intervals previosly calculated and could be determined taking into consideration auction format, conditions, competitors, national interest, etc.

- **Low reserve prices** (values in the lowest part of interval)
  - Extends auction process: Germany - auction last about two months
  - Not for any type of auction - sealed bid
  - Poor results in low competitive conditions
- **High reserve prices** (values in upper part of intervals)
  - Reduces rounds numbers
  - Recommended for poor competition - reserve prices in middle or upper part of the interval!
  - If too high - risk of failure!

Setting Aside Spectrum - Canadian Auction

- On July 21, 2008 spectrum auction was completed. The auction lasted 331 rounds in which 282 of the 292 licenses offered were attributed, generating revenue of **CAD4.26 billion, three times** than the CAD1-1.5 billion forecasted by analysts!
- **The offer: 105MHz block of spectrum in the 2GHz band, including 40MHz set aside exclusively for new entrants,**
- Rogers Communications won 59 licences worth CAD999.3 million, whilst its nationwide rivals Telus Mobility and Bell Mobility won, respectively, 59 licences worth CAD879.8 million and 54 licences worth CAD740.9 million.
Globalive won 30 spectrum licences worth CAD442 million. Quebecor bid a total of CAD554.5 million for 17 licences. Another cableco, Shaw Communications spent CAD189.5 million on 18 spectrum concessions, whilst EastLink won 19 licences for CAD25.6 million. Data&Audio-Visual Enterprises Wireless won spectrum worth CAD243.2 million in ten urban zones.
- **Auction objectives**
  - To maximize economic and social beneffits resulting for the Canadians from the usage of frequency spectrum
  - To award frequency licenses correct, efficient and effective. Not revenues maximization!
  - To increase competition level taking into account lower competitive level (comparing with USA) which resulted in higher tariffs, lower innovation, lower users and usage
  - Opportunities for new entrants (including operators with <10% market share). Not Rogers, Telus and Bell Canada!
    - Eliminating the spectrum entrance barrier: auction design was favorable to small operators - regional, cablecos, new entrants - 40MHz in bloks B, C, D in 59 zone sets aside. This spectrum is not for sale for 5yrs!
    - Commitment to share towers
    - Incumbents commitment to provide national roaming:
      - In licensed areas at commercial tariffs for five years while the newcomers are building their network
      - Outside of the areas of the new comers on the whole license life
    - Licenses are flexible – could be transferred, resold, shared
  - One considered the license fee as a 'sunk cost' (Cost already incurred which cannot be recovered regardless of future events.) - not influencing the retail tariffs for end users
- **NERA findings**

- Overpayment was due to the auction design
- Outcome of the Canadian auction is a repeat of the 3G auction outcome in the UK and other European countries as the **cost of the licenses is the cost of staying in business**
- Preferential treatment given to new entrants carries a significant risk, can lead to inefficient market entry
- Main component of the preferential treatment was the set-aside spectrum reserved for entrants - 40MHz or 40%!!!
- Setting aside spectrum increased competition for spectrum resulting too much higher revenues.
- Any benefits awarded to entrants should not come at the expense of other operators!!!

5. Hiring a Consultant

Hiring a Consultant

- **Why hire a consultant?**
  - **Consultancy for the best approach for 'spectrum packaging' and auction design**
    - **Analyzing all auctions format**
    - **Comparing pros and cons for a specific country**
    - **Implementing an auction format and organizing the auction**
  - **The consultant should not 'sell' a specific type of auction, but help determine the proper auction format for a specific market!**
  - **Because mobile operators will hire a consultant ! Orange Romania!**
- **How to hire a consultant according to NERA Consulting**
  - **understanding country's situation and authority policy goals (10%)**
  - **quality of approach to spectrum packaging (10%)**
  - **quality of approach to auction format and rules (20%)**
  - **quality of approach to auction implementation (10%)**
  - **quality of auction software solution (15%)**
  - **expertise of consultants (20%)**
  - **price (15%)**
- **Consultant payment**
  - **From auction results**
  - **By the auction winners**

The Cost of Organizing an Auction

A

Activities

1. Study on **auction rules**
2. Drafting of the part of the **public consultation document** which deal with auction rules
3. **Assessment of responses to public consultation document** with regard to auction rules and review of auction rules, if required.
4. **Assisting the software company** during the implementation of auction rules into the software.
5. Drafting of a **manual for bidders**.
6. **Bidders training**.
7. **On-site advise to the auctioneer** with regard to the determination of relevant auction parameters during auction phase. The work involved in the last phase depends on the length of the auction, which cannot be predicted at this point in time.

Cost estimation

The team would involve a Team Leader, a principal consultant and a senior consultant, as well as, an academic advisor in auction theory, with a total work input of roughly 400 days. This may amount to a budget of **€**600-**€**700 ths., depending on the mix of the Team (this excludes stage 7.) These figures are very preliminary. The actual amounts will depend on the exact terms of reference and the particular circumstances of the auction.

Software company

Activities

- Modification of the existing software to English language and adaptation of country licence packages: 15 days
- Installation of software on NRA computers in your country: 10 Days
- Optional: Documentation of the software (Installation Manual, Configuration Manual, User Manual): 15 days
- Optional: Training of NRA Staff to perform the auction: 10 days
- Optional: Training of bidders to perform the auction: 5 days
- Optional: support (hotline or on site) during the auction: based on time used

Cost estimation

One calculates a day by 8 hours and based on 8 hours a daily rate of **€**1.000, plus travel expenses to country, if necessary. Therefore the modification of the software an the installation at NRA will cost around **€**25.000 plus travel expenses for two consultants on site in country for 5 Days.

Total costs **less than €50.000.**

The Cost of Organizing an Auction (contd)

- **B**

Depending on many factors**, the cost could be anywhere in the range of €300.000 - €1 milion.** Cost depends on the **auction format** and **associated software** provision, and how much help NRA requires with items such as marketing, defining licence conditions and drafting the information memorandum.

A secure system is essential, so as to prevent outsiders from hacking into the network and changing bids. Also, bidders must be confident that their bids will be safe and not seen by rivals. This is true for both local networks and the Internet, although it obviously matters more for auctions over the public Internet. In a proposal, NRA can ask what approach the contractor will take on security. At a miminum, the system should be run on a secure server and have controlled password access

An important way to keep costs below the one million euro level is to **run the auction online** using a secure system.

- **C**

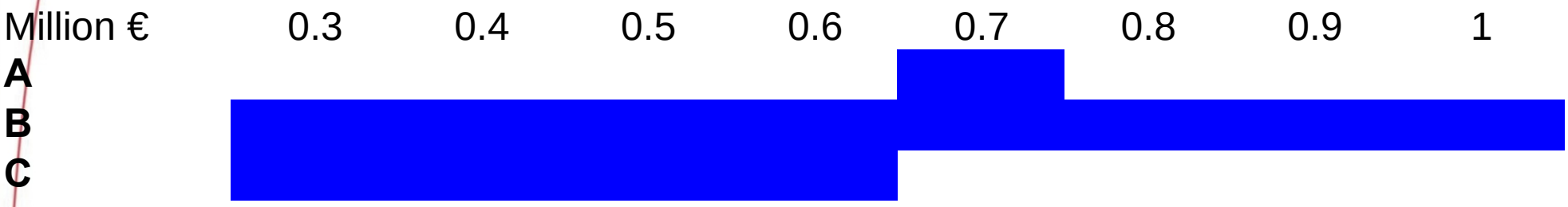
The cost of auction design (including drafting of the **detailed auction rules**) for a simple auction ranges from £30,000 to £70,000. Complex auctions may require further work and therefore costs more.

The cost of implementing the auction (including provision of software, training of the auctioneer team, bidder training sessions and real-time support during the auction) would range between £100,000 and £250,000. One could therefore expect to have design and implementation of a **simple auction** process for a total of around **£250,000**.

If the **structure of the lots for the auction is complex**, or if *one requires extensive support for consultation on the auction rules* and substantial engagement with industry stakeholders during the design and pre-auction process, the **total cost could increase to typically between £250,000 and £500,000.**

- **These values were for Romania! Probably, for smaller markets, smaller values, despite of same volum of work!**

The Cost of Organizing an Auction (contd)



Romanian auction raised €682 million
Auction cost - about €0.5 million, or 0.07% of auction proceedings
In a real contest, the cost of organizing an auction could be lower

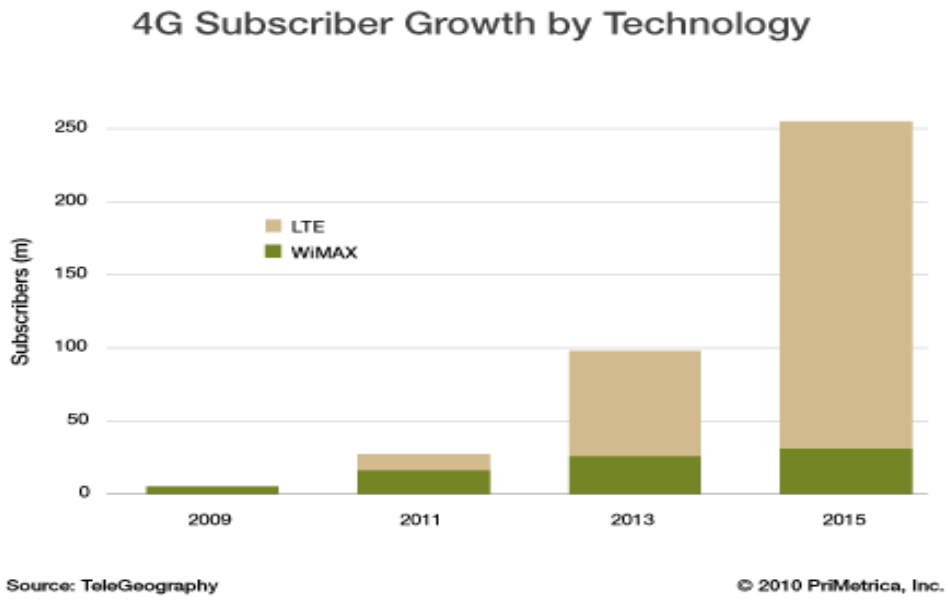
Bidding Place and System

- **Bidding place**
  - **In authority HQs (Germany, Romania)**
  - **From the competitors HQs**
- **Software needed in both cases.** In the second case there is a need for a very secure and reliable system
- **Logistics -** auctioning in authority HQs involves more complex logistics, meaning higher costs, as well as, a little bit higher security (competitors could talk at the end of the day)
- **Security -** Bidding from competitors HQs seems to involve higher risks
  - **Transmission reliability and security**
  - **Collusion risk – higher: discussions between competitors - easier**

6. Preparing for the LTE Auction

LTE in the World and our Region

- First commercial launch in Dec 2009 - only for data. In April 2013 - 163 commercial networks in about 70 countries. In Europe - the most networks in west and nordic parts
- 3G networks in our region - still permit development but for very few years
  - Traffic not too high, no capacity problems, yet.
  - Coverage in increasing
  - Portable PCs, smartphones, end of economic turmoil and decrease in mobile data tariffs would lead to traffic increase, making **mobile access to enter mass market** phase (2015!) and asking for the new technology - LTE.
- LTE networks
  - First networks - 2013
  - Commercial launches - 2014



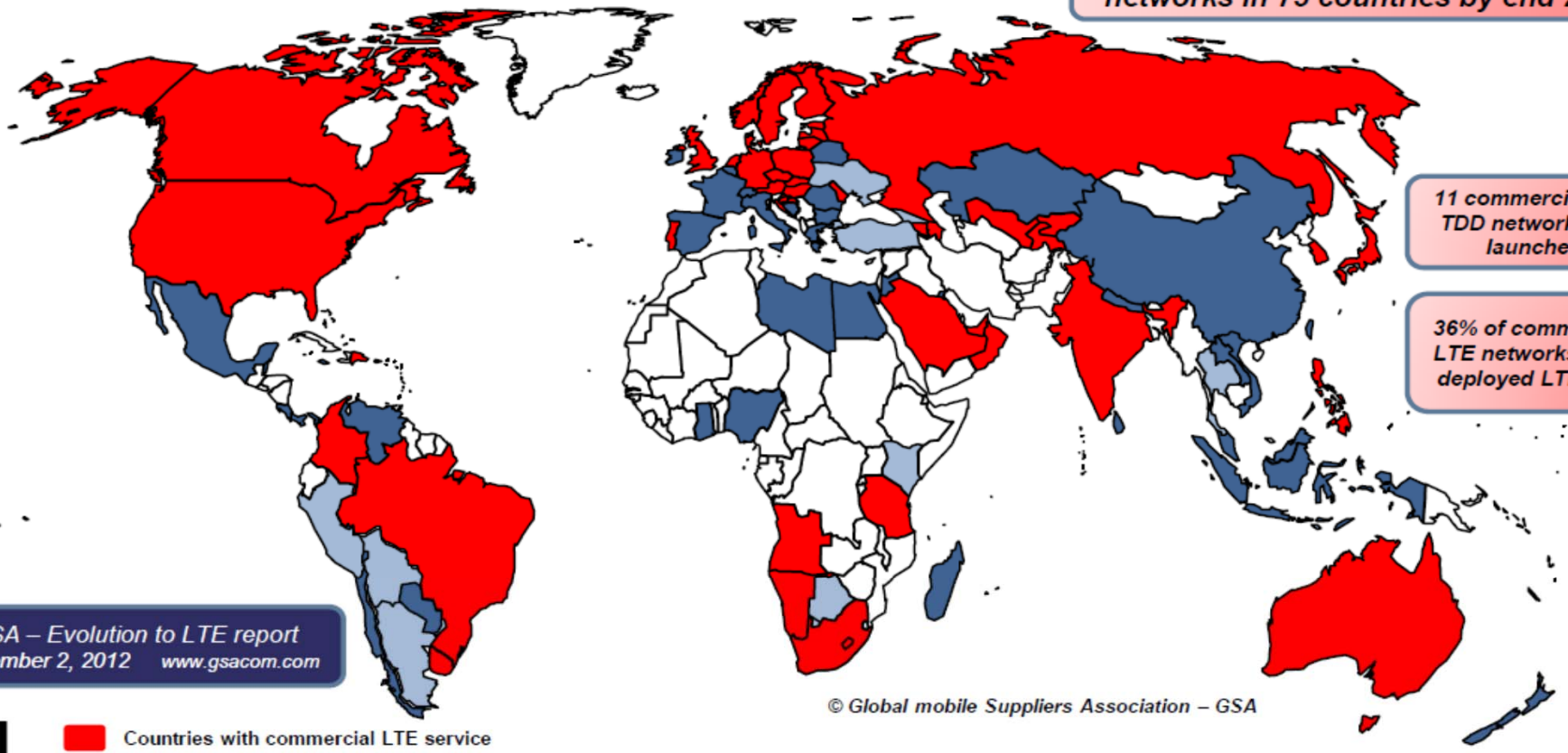
LTE in the World and our Region

360 operators in 105 countries are investing in LTE

- 308 commercial LTE network commitments in 94 countries
- *52 pre-commitment trials in additional 11 countries*
- ***113 commercial LTE networks launched in 51 countries***

GSA
www.gsacom.com

GSA forecasts 209 commercial LTE networks in 75 countries by end 2013



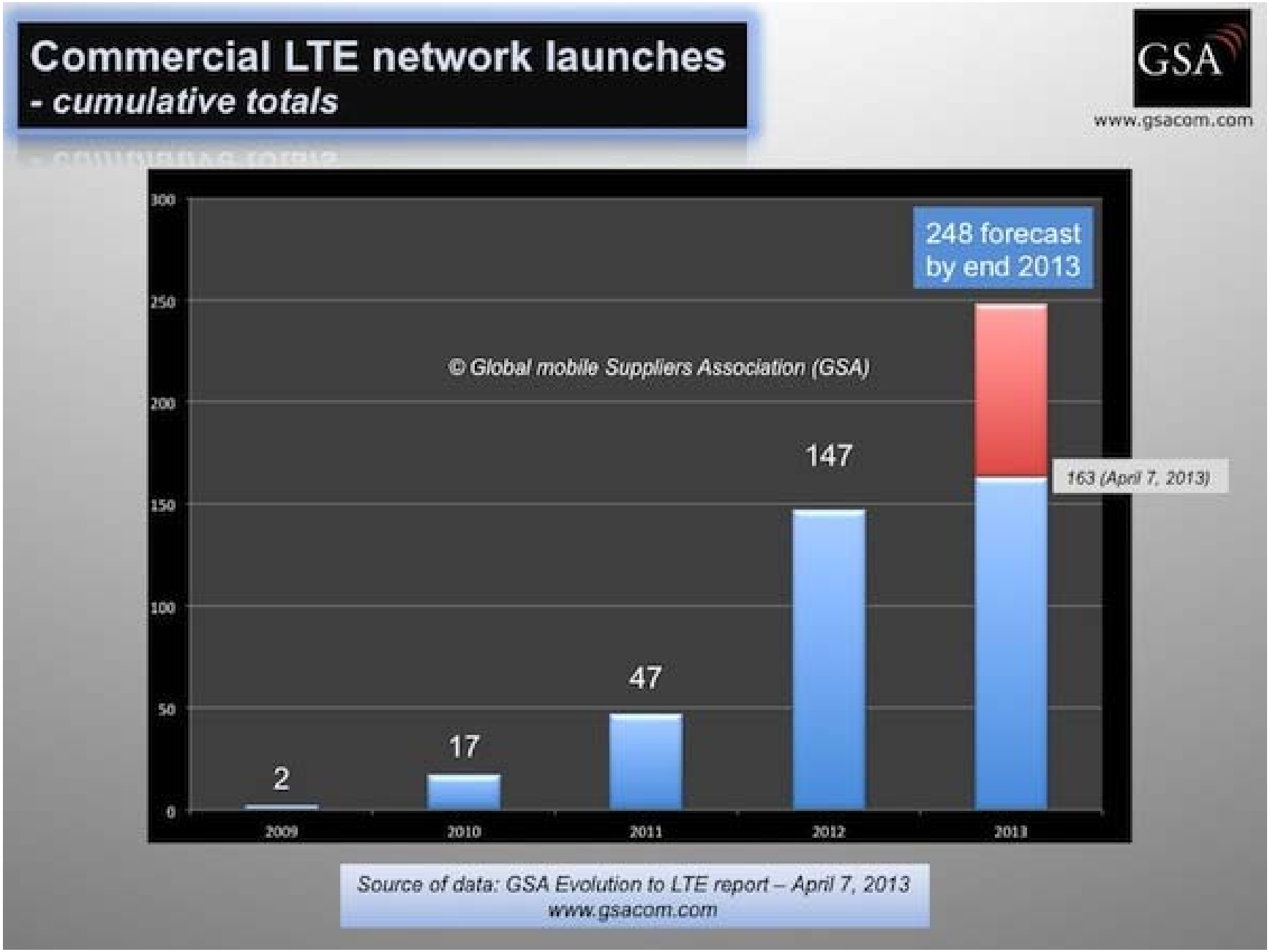
11 commercial LTE TDD networks are launched

36% of commercial LTE networks have deployed LTE1800

GSA – Evolution to LTE report
November 2, 2012 www.gsacom.com

Countries with commercial LTE service
Countries with LTE commercial network deployments on-going or planned
Countries with LTE trial systems (pre-commitment)

LTE in the World and our Region



Auction Objectives

- **Efficient spectrum assignment**
  - 800MHz - 6*2*5MHz
    - Set aside for a new entrant (!)
    - Spectrum caps to avoid hoarding - 2x10MHz, and 2x20MHz under 1GHz?
  - 2,6GHz - x (14)*2*5 MHz
- **Preserve or increase competition**
  - Mature markets
  - Market consolidation during economic crisis, network sharing (EverythingEverywhere)
  - As many as possible competitors, eventualy a newcomer
    - National roaming for the new entrant - Romania
  - MVNOs - Romania
- **National strategic objectives:** efficient country coverage with broadband access
  - Germany - coverage started with smallest rural villages and ended up with large cities:
    - Four zones depending on villages dimensions
    - Next phase only after 90% coverage
  - Romania - coverage of uncovered villages
- **Eficiency - a good auction economic outcome**
  - Licenses to those which valuates most the frequencies
  - Money from auction to be used to finance national broadband strategy
- **Preventing collusion**
- **Auction team** with experts in:
  - IT
  - Legal
  - Logistics and acquisitions
  - Telecommunications economics
  - Telecommunications engineering - frequency spectrum, measurement, etc.

Activities - Steps

- Auction team - IT, Legal, Logistics & acquisitions, telecommunications economics telecommunications engineering
- Consultant hiring - time consuming, public acquisition procedure
- Public consultation to see interest for the offered bands
- Auction model, including the use of IT tools for implementing the auction, specification of terms for participating in the auction, how to deal with bids submitted, etc
- Promoting the auction - ensuring interest in participation, including meetings with the industry, ...
- Draft documents for the auction, including a detailed time schedule for the auction process
- Public consultation of draft documents
- Publication of the auction final documents
- Training cellcos for auction - mock auction
- Auction
- Licenses award

Thank you for your time and attention!

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References

- Putting auction theory to work: the simultaneous ascending auction, Paul Milgrom, Journal of Political Economy, 2000, vol. 108, no. 2
- The Biggest Auction Ever: the Sale of the British 3G Telecom Licences, Paul Klemperer, September 2001
- Introduction to spectrum auctions, Richard Marsden, DotEcon, 29 April 2009
- Regulatory Policy Goals and Spectrum Auction Design, a statement by Christian Michael Dippon, NERA Economic Consulting, 14 July 2009
- European Workshop on Spectrum Auctions, BNetzA, 29 October 2010
- The ANCOM auction, 2012