

## Solutions to Exam IK2514 - December 13, 2012

### Problem 1 - Value of spectrum

This question deals with the value of spectrum assets and can be considered from a cost saving perspective and a revenue perspective. Since it is about auctions prices it is also related the market situation and competition.

Q1.1)

Lower frequencies (700-900 MHz) provide better coverage, i.e. less number of sites are need to cover an area which makes these bands very attractive from a cost perspective. In addition "less" bandwidth is available below 1 GHz than above

Q1.2)

The EUR/MHz/pop normalizes the value with respect on potential revenues. More MHz means higher capacity and more users that can be served. Higher population means a larger market and potential revenues.

In the same way the revenues for operators depend on the time period (the license period) and the willingness (ability) to pay by end-users ( how wealthy the country or users are). Hence, two aspects could be the GDP per capita and the length of the license period.

### Problem 2 - Spectrum and spectrum efficiency

Demand per user 21,6 GB/month = 0,4 Mbps

Q2.1)

The femtocells support max 20 users,  $20 * 0,4 = 8$  Mbps need to be supported  
With a spectral efficiency of 4 bps/Hz this means that 2 MHz is needed.

Q2.2)

The macro sites can support 300 users => site capacity  $300 * 0,4 = 120$  Mbps  
Spectral efficiency = Site capacity / (Bandwidth\*No sectors) =  $120/(20*3) = 2$  bps/Hz

### Problem 3 -Termination charges, traffic balance, profitability and CAPEX

Q3.1)

In order to calculate the relation between termination revenues and voice revenues a number of calculations have to be made as the table shows. The termination balance is calculated by taking termination revenues minus termination cost. The numbers are a result of a series of calculations on total minutes as the table exhibits.

Q 3.2)

EBITDA is calculated by taking the average number of customers for each year multiplied with EUR 80, adding Opex, which is calculated by taking the Opex ratio multiplied with total revenues. EBITDA is then the resulted of revenues minus total cost, and the EBITDA margin is the ratio between EBITDA and total revenues.

Q3.3)

Capex is a combination of maintenance capex and capex for new installations. The accumulated capex is developed as the table shows and the annual maintenance is the ratio of 5% which should be multiplied with the accumulated capex. Capex for new installations is the relation between the capex ratio and total revenues for each year. Finally, the free cash flow is the sum of EBITDA minus total capex for each year.

The table below shows all the necessary calculations to answer the three questions.

	2007	2008	2009	2010	2011
Subscribers	3 900 000	4 000 000	4 200 000	4 410 000	4 630 500
Change y-o-y			5%	5%	5%
ARPU EUR		20	19	17	16
Change y-o-y			-7%	-7%	-7%
Non-voice services as a share of revenues		15%	17%	19%	21%
Minutes of Use (incoming and outgoing)		200	210	221	232
Change y-o-y			5%	5%	5%
Traffic balance voice calls					
Outgoing from mobile to fixed networks		15%	15%	13%	10%
Outgoing from mobile to mobile networks		15%	17%	20%	23%
On-net-traffic		30%	33%	37%	40%
Incoming from fixed networks		30%	25%	20%	15%
Incoming from mobile networks		10%	10%	10%	12%
Termination rates per minute					
Mobile termination rates EUR		0,030	0,020	0,015	0,010
Fixed termination rates EUR		0,009	0,007	0,006	0,005

**Calculations to answer the questions**

Question Calculation formula

	20	19	17	16	
ARPU					
Revenues	948 000 000	915 120 000	893 614 680	872 614 735	ARPU * average number of subscribers per year * 12
Non-voice	142 200 000	155 570 400	169 786 789	183 249 094	Share non-voice revenues * revenues
Voice revenues	805 800 000	759 549 600	723 827 891	689 365 641	
Total minutes	9 480 000 000	10 332 000 000	11 391 030 000	12 558 610 575	MoU * average number of subscribers * 12
Outgoing from mobile to fixed networks	1 422 000 000	1 549 800 000	1 480 833 900	1 255 861 058	Share of calls mobile to fixed networks * total minutes
Outgoing from mobile to mobile networks	1 422 000 000	1 756 440 000	2 278 206 000	2 888 480 432	Share of calls mobile to mobile networks * total minutes
Incoming from fixed networks	2 844 000 000	2 583 000 000	2 278 206 000	1 883 791 586	Share of calls fixed to mobile networks * total minutes
Incoming from mobile networks	948 000 000	1 033 200 000	1 139 103 000	1 507 033 269	Share of calls mobile to mobile networks * total minutes
Total minutes	6 636 000 000	6 922 440 000	7 176 348 900	7 535 166 345	
Termination cost					
Outgoing from mobile to fixed networks	12 798 000	10 848 600	8 885 003	6 279 305	Termination rate * outgoing minute to fixed networks
Outgoing from mobile to mobile networks	42 660 000	35 128 800	34 173 090	28 884 804	Termination rate * outgoing minute to mobile networks
Net outgoing	55 458 000	45 977 400	43 058 093	35 164 110	
Incoming from fixed networks	25 596 000	18 081 000	13 669 236	9 418 958	Termination rate * ingoing minute from fixed networks
Incoming from mobile networks	28 440 000	20 664 000	17 086 545	15 070 333	Termination rate * ingoing minute from mobile networks
Net incoming	54 036 000	38 745 000	30 755 781	24 489 291	
<b>Termination revenue as a share of voice revenues</b>	<b>5,7%</b>	<b>4,2%</b>	<b>3,4%</b>	<b>2,8%</b>	<b>Q1a Net incoming termination / voice revenues</b>
<b>Termination balance</b>	<b>-1 422 000</b>	<b>-7 232 400</b>	<b>-12 302 312</b>	<b>-10 674 819</b>	<b>Q1b Net incoming - net outgoing</b>
Direct cost per customer per year	80	80	80	80	
Opex (excluding direct customer cost)	50%	49%	48%	45%	
Total cost for customers	316 000 000	328 000 000	344 400 000	361 620 000	Average number of subscribers * 80
Opex	474 000 000	448 408 800	428 935 046	392 676 631	Opex margin * revenues
Total cost	790 000 000	776 408 800	773 335 046	754 296 631	
EBITDA	158 000 000	138 711 200	120 279 634	118 318 104	total cost - total revenues
<b>EBITDA margin</b>	<b>16,7%</b>	<b>15,2%</b>	<b>13,5%</b>	<b>13,6%</b>	<b>Q2 EBITDA / revenues</b>
Capex-to sales new installations	8%	8%	9%	9%	
Capex	75 840 000	73 209 600	80 425 321	78 535 326	Capex-to-sales ratio * revenues
Accumulated capex	1 500 000 000	1 500 000 000	1 575 840 000	1 729 474 921	Maintenance capex ratio * accumulated capex
Maintenance capex ratio	5%	5%	5%	5%	
Maintenance capex	75 000 000	78 792 000	82 452 480	86 473 746	
<b>Total capex</b>	<b>150 840 000</b>	<b>152 001 600</b>	<b>162 877 801</b>	<b>165 009 072</b>	<b>Q3a Capex + maintenance capex</b>
<b>Total capex-to-sales</b>	<b>15,9%</b>	<b>16,6%</b>	<b>18,2%</b>	<b>18,9%</b>	<b>Q3b</b>
<b>Free cash flow</b>	<b>7 160 000</b>	<b>-13 290 400</b>	<b>-42 598 168</b>	<b>-46 690 968</b>	<b>Q3b EBITDA - Total capex</b>
Cash flow yield	1%	-1%	-5%	-5%	

#### **Problem 4 - Operator strategies**

Q 4.1)

The main challenge for DTAC is to decide if the 3G deployment should be made in the own and new 2.1 GHz network to be built - with no revenue sharing, or in the existing 850 MHz network with existing sites and better coverage – but with the revenue sharing

Q 4.2)

Any well motivated strategy that applies to the DTAC situation provides some points. Examples are: to focus on deployment of 2.1 GHz or 850 MHz depending on demand, Key issue is that customers have to be moved to the new 2.1 GHz network

Q 4.3)

Any well motivated strategy that applies to TOTA and CAT provides some points.

If the state owned operators TAT and CAT do not get new spectrum they can:

- Use existing spectrum and offer capacity on a whole sale basis to other MNOs and/or offer end-user services, marketing needed since low market share
- Start network sharing business for wholesale or consumer business
- Start tower companies and offer services to other MNOs
- Sell everything and withdraw from the market

#### **Problem 5 – Dimensioning of data and voice capacity**

##### Data services

Site capacity for data: 3 sectors\*3 MHz\*1,67 bps/Hz = 15 Mbps per site

Consumers 16 hours per day => ~ 25 kbps (23 kbps) => ~600 users (653)

Business users 8 hours per day => ~100 kbps (92 kbps) => ~150 users (163)

##### Voice services

1,8 MHz => 9 carriers, with re-use factor 3 => 3 carriers per sector

=> 24 voice channels (3 carriers\*8 time slots) per sector (blocking occurs in sectors)

Consumers: 25 mE with 5% blocking => ~19 Erlang

19Erl/25mErl => 760 users per sector => 2280 users per site

Business: 100 mE with 1% blocking => 15,3 Erlang

15,3 Erl/1000 mErl => 153 users per sector => 459 users per site

Answer Q5.1)

Number of consumers per site = min (653, 2280) = 653

Number of business users per site = min (163, 459) = 163

Answer Q 5.2) Choose consumer service

Revenues from consumers = 653 \* 30 € = 19 590 €

Revenues from business users = 163 \* 80 € = 13 040 €

Answer Q5.3)

The dimensioning based on the assumptions indicates more voice users than data users. It implies un-used voice capacity. Hence allocate more spectrum to data services, then more data users (and total number of users) can be served meaning larger revenues.