IK2514 WIDE Exam December 21, 2011

Problem 1 Operator business – financial aspects

Operator Edge is the leading operator in Eurostan, and it has a growing mobile broadband business. However, voice is still driving the business and makes up the majority of revenues. The business was developing positively during 2008-2010, with a growth of the subscriber base of 8% per year generating a EBITD margin of 35%.
But during 2011 a number of negative developments occurred.

- The total subscriber base grew with only 5% compared to 8% in 2010
- SMS revenues declined with 90% as applications in smart phones provided a more appealing way to communicate and chat
- VOIP made a dramatic inroad reducing voice ARPU to EUR 10
- The ARPU for all customers dropped to EUR 11 as a consequence of the deteriorating voice business
- The EBITDA margin for voice decreased slightly to 28%

But a number of key parameters remained unchanged

- The ARPU for mobile broadband (MBB) was unchanged at EUR 15
- The EBITDA margin for SMS remained at 90%
- The EBITDA margin for mobile broadband increased to 6%

Question 1 (1,5p):
Calculate the numbers in order to be able to insert figures in the empty boxes

	2008	2009	2010	2011
Subscribers	4 000 000	4 320 000	4 665 600	
of which mobile broadband subcribers	400 000	518 400	653 184	
Growth of subscriber base y-o-y		8%	8%	5%
MBB customer as a share of total subscrib	10%	12%	14%	14%
ARPU average for all customers	20,0	19,0	18,0	11,0
Revenues	960 000 000	948 480 000	970 444 800	
Non-voice services as a share of revenues	15%	22%	25%	
Voice subs				
Voice revenues	816 000 000	739 814 400	727 833 600	
Voice ARPU	18,9	16,7	15,5	10,0
Non-voice revenues	144 000 000	208 665 600	242 611 200	
SMS share of revenues	12%	14%	14%	
SMS revenues	115 200 000	132 787 200	135 862 272	
SMS growth		15%	2%	-90%
MBB revenues	28 800 000	75 878 400	106 748 928	
ARPU MBB	6,0	13,8	15,2	15,0
EBITDA total	336 000 000	331 968 000	339 655 680	
EBITDA-margin total	35%	35%	35%	
EBITDA SMS	103 680 000	119 508 480	122 276 045	
EBITDA-margin SMS	90%	90%	90%	90%
EBITDA MBB	1 440 000	3 793 920	5 337 446	
EBITDA margin MBB	5%	5%	5%	6%
EBITDA voice	230 880 000	208 665 600	212 042 189	
EBITDA-margin voice	28%	28%	29%	28%

Question 2 (1,5p):
The ratio of capex to sales was 13% in 2008, 14% in 2009, and 14% in 2010.
But in 2011 operator EDGE was forced to make an additional investment (capex) of 67,9m on top of the regular capex in order to upgrade the network.
The regular capex was unchanged (in absolute numbers) in 2011 compared to 2010.
Capex related to mobile broadband was as a share of total capex 50%, 75%, 75% and 90% during 2008-2011.

a) How much was the capex in absolute numbers per year during 2008-2011?
   What was the capex-to-sales in 2011 for the total operation?

b) How has cash flow developed for the total business and for mobile broadband?

c) How has cash flow per mobile subscriber developed?
   How has cash flow per mobile broadband subscriber developed?

	2008	2009	2010	2011
Capex				
Capex-to-sales				
Capex MBB				
Capex MBB share of total				
Cash flow				
Cash flow MBB				
Cash flow per subscriber				
Cash flow per MBB subscriber				

MBB= Mobile broadband
ARPU = Average Revenue per User per month
EBITDA = Earnings before interest, tax, depreciation and amortizations
Capex = Capital expenditures
Currency is EUR

Problem 2 Telecom markets, interconnection and operator strategy

Year 2007 the Swedish operators TDC and TeliaSonera had a conflict regarding interconnection fees for fixed telephony. At that time Telia had a market share ~70 % and TDC < 5%. Other background information from newspapers is found below.

Questions:

a) What was the main driver for the TDC interconnection fee strategy?
In what way could they benefit from the strategy? (1p)

b) How do you think TDC did motivate the higher prices? (1p)

c) What is meant by “SMP”?
Provide one example from your HW1 + HW2 country.

Headlines:

Telia stops traffic of competitor (Veckans affärer Oct 2, 2011)

TDC: “Telia uses maffia strategy” (Computer Sweden, Oct 3, 2007)

Quotes:

“On Monday TeliaSonera will shut down the traffic from its own customers to the (fixed line) customers of TDC, the reason is a conflict about interconnection fees.**”**

“The background of the conflict is that TDC, according to TeliaSonera, charges too high fees for interconnection. TDC wants to charge 10,4 öre per call (~ 0,01€) while Telia only wants to pay 5 öre per call”

“The conflict has been going on for some time. TDC wants to charge twice the interconnection fee compared to all other operators” (Telia laywer)

“According to the CEO of TDC the Telia actions threatens critical societal functions and swedish telecom services in general. A major part of the Swedish healthcare sector will be paralyzed. The subscribers will not be able to call some hospitals and the county councils.”

“..many hospitals, the Swedish aviation authority and *Sveriges Radio* (the Swedish public broadcaster) that are customers of TDC will be cut off from the rest of the world and they cannot be reached through the public fixed network”

Problem 3 Deployment of mobile broadband services

Problem background:
A facility owner will build a new office area called Kista 2.0 with an estimated number of 2500 office workers from start. The facility owner wants to investigate the possibility to offer Internet over wireless connections and needs to estimate the cost for deploying a new radio access networks. The facility owner has been in contact with two different operators offering different solutions. From the initial discussions the facility owner has some information from the two operators and now wants to get an initial cost estimate.

The problem to solve (3p)
Your task is to help the facility owner and make this initial cost estimate for the estimated low and the high demand levels based on the information provided below.
Which operator will most likely be able to offer the services at the lowest cost?

The demand
2 500 workers are to be served from year 1 in the 1 km2 area.
Two levels of demand are of interest; 2,88 GB and 14,40GB per month and user for low and high level respectively. The demand is assumed to be the same for years 1 - 5.
For the dimensioning assume that the data is consumed during 4 busy hours (all equally busy) for 20 work days per month.

Data for deployment by Greenfield operator G
Operator G has no base stations sites at all in the area. New sites are needed and operator I has all necessary building permits. Operator G has access to 20 MHz of spectrum in this frequency band and will use the radio access technology WAD suitable for wide area deployment, see table 1.

Data for deployment by Incumbent operator I
The incumbent operator I has 4 macro base station sites in the area that can be re-used. In case new macro base station sites are needed the operator I has all necessary building permits. Operator I has access to 10 MHz of spectrum in this frequency band and will also use the radio access technology WAD, see table 1

The radio access technology
The technical data and performance are shown in table 1. WAD has a re-use factor of 1. One WAD TRX module supports a three sector site and system bandwidth up to 20 MHz. The link budget for WAD is calculated to allow for 20 dB wall penetration losses which are sufficient for all locations in all buildings in the area.

Table 1: Technical data for the radio access technology

Type of deployment	Radio access technology	System bandwidth	Spectral efficiency	Max cell range (for all bandwidths)
Outdoor macro site	WAD	5–20 MHz	1,67 bps/Hz	700 m

Cost calculation
Estimate the total cost as the CAPEX plus the OPEX for years 1 to 5 assuming a discount rate of 0 %. All network deployment and build out is made year 0. Do the network dimensioning and derive the total CAPEX from the data in table 2.
For the macrocell deployment the annual OPEX is estimated to be 10 % of the total CAPEX including radio equipment, installation and all *new* macro base stations sites.

Table 2: Estimated cost and prices

WAD Radio equipment and installation	**Costs**
TRX supporting 3 sectors and up to 20 MHz, first TRX	10 k€
TRX supporting 3 sectors and up to 20 MHz, additional TRX	10 k€
Installation of the first TRX	10 k€
Deployment and macro site build out	
Site construction	70 k€ per site
Non-telecom equipment	20 k€ per site
Transmission costs	10 k€ per site

Problem 4 Deployment of Voice services

About 80 000 people live at Kungsholmen. Assume that 40% of them have operator T.
Question (3p):
- Estimate the minimum number of base station sites that operator T would need build to cover the required voice capacity with GSM?

Assumptions and background data
- Operator T has 10MHz of spectrum in the GSM band
- Each radio channel is 200 kHz wide and contains 8 time slots (traffic channels). (Ignore pilot signals, handover capacity etc)
- All GSM radio channels are planned in a static pattern with a frequency reuse of 4 (one fourth of all the available channels can be used in each cell)
- Each site covers 3 cells
- Each user requires 25mErl in the peak hour:
- 2% blocking

Erlang table is attached

Problem 5 – Telecom markets, spectrum and operator network strategy

Background – spectrum availability

Future demand for more capacity can be met by allocation of more bandwidth and new spectrum bands to mobile communication. But spectrum is a scarce resource and allocation of new licensed bands will only partly satisfy the growing demand. The take-off for mobile broadband underscores the essential role spectrum plays for operators, as it enables operators to provide coverage and capacity in their mobile networks.
However, the conditions for the operators varies considerable as operators in Pakistan and India in average have access to just around 2 x 15 MHz while operators in Germany and Sweden in average have access to 2 x 70 MHz, see figure 1.

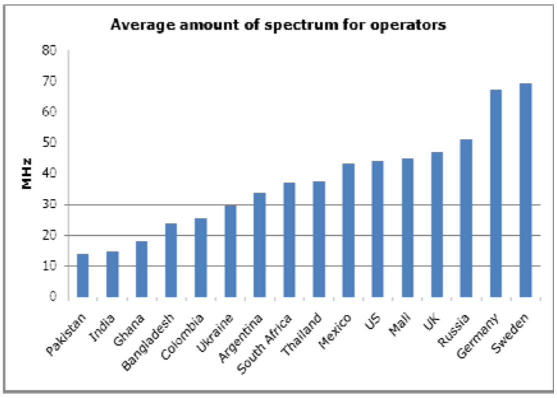

Figure 1 Average amount of spectrum for mobile operators in different countries (compilation of data by B.G. Mölleryd)

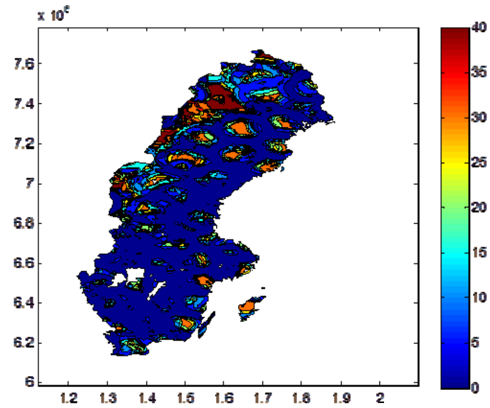

Figure 2 Example of spectrum availability the number of available TV channels in Sweden (from Quasar deliverableD5.1)

Background – Secondary access of spectrum

Another possibility besides licensing of new bands is called secondary access of spectrum bands. This means that bands that primarily have been allocated for other services, e.g. TV or traffic control radars are used by a "secondary user" e.g. a mobile operator. . The secondary use exploits un-used spectrum in frequency, time or physical location. Such un-used spectrum in the TV bands is called TV white space (TV WS).
An example of TV WS spectrum availability is shown in Figure 2. The number of "un-used" TV channels is very low in most part the country. "Many" TV channels are available in rural areas in northern Sweden, areas where the population density (and demand) is low. Please note that the availability of spectrum for secondary use depends on the type of services and the type of network deployment that is used. If TV white space is to be used for mobile broadband access there is a difference how it can be used depending on how the mobile broadband network is deployed. By using macro base stations with high towers the mobile broadband services will cause interference over large distances, hence the spectrum availability is low.
Drivers for secondary use of spectrum can be:

- that an operator has not got (bought) licensed spectrum,
- that it is cheaper to re-use sites using TV WS than deployment of new sites
- licensed spectrum is too expensive (see next page)

Background – Price for spectrum

Sometimes it is claimed that one driver for secondary use of spectrum is that the cost of spectrum can be avoided. However, this is only partly true since it depends on the paid spectrum price in relation to other network costs. Consider the prices paid at recent spectrum auctions in different countries. Using the metric "spectrum price normalized to number of MHz and the population", we can identify large differences between auctions in different countries, see Figure 3.

The Swedish operators in average paid EUR 0.68 per MHz/pop for the 800 MHz band, while prices for spectrum in the 2.6 GHz band reached EUR 0.30 per MHz/pop in Sweden, EUR 0.05 in Germany and just 0.01 in the Netherlands. Interestingly enough, prices paid at the Indian 3G auction in 2010 for spectrum in the main two cities are not far off from the very high prices paid at the 3G auctions in the years 2000-2001.

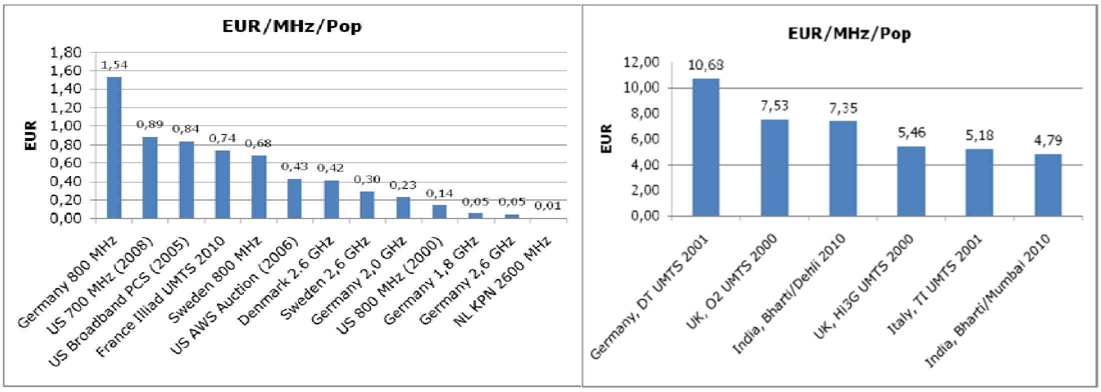

Figure 3 Prices paid per MHz/Pop in spectrum auctions and for 3G licenses in India and Europe

The problem to solve (3p)

Consider the four generic cases of rural and urban mobile broadband deployment in Sweden and India respectively. Taking into account the *total amount of spectrum* and other available information in the table below identify the deployment case (cases) where use of TV white space would be worthwhile to investigate more - motivate your answer.

<u>Assumptions</u>

Assume three sector sites and an average cell spectral efficiency of 0,67 bps per Hz for rural and 1,67 bps for urban deployment. The operators have existing GSM sites that can be re-used for mobile band deployment, the coverage areas are indicated in table 1.

A TV channel is assumed to have an efficient bandwidth of 7 MHz.

The data consumption is distributed equally over 8 hours per day 30 days per month.

Deployment case	Number of operators	Bandwidth per operator	Spectrum price € /MHz/pop	No available TV channels	Max No users /km2	Demand Per user	Coverage per site
Sweden Urban	4	40 MHz	~0,10	0 – 5	2 000	5,4 GB/month	0,2 km2
Sweden Rural	3	10 MHz	~0,50	15 – 20	10	5,4 GB/month	100 km2
India Urban	8	5 MHz	~5	0 – 10	16 000	2,7 GB/month	0,1 km2
India Rural	6	5 MHz	~1	10 - 15	400	2,7 GB/month	50 km2

Table 1. Deployment cases to compare