## Problem 1 Operator business – financial aspects

Question 1

Calculate the numbers in order to be able to insert figures in the empty boxes.

Answer: See table below

| | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|
| Subscribers | 4 000 000 | 4 320 000 | 4 665 600 | 4 898 880 |
| of which mobile broadband subcribers | 400 000 | 518 400 | 653 184 | 685 843 |
| Growth of subscriber base y-o-y | | 8% | 8% | 5% |
| MBB customer as a share of total | 10% | 12% | 14% | 14% |
| ARPU average for all customers | 20 | 19 | 18 | 11 |
| Revenues | 960 000 000 | 948 480 000 | 970 444 800 | 627 625 843 |
| Non-voice services as a share of revenues | 15% | 22% | 25% | 21% |
| Voice subs | | | 4 012 416 | 4 213 037 |
| Voice revenues | 816 000 000 | 739 814 400 | 727 833 600 | 493 527 168 |
| Voice ARPU | 19 | 17 | 16 | 10 |
| Non-voice revenues | 144 000 000 | 208 665 600 | 242 611 200 | 134 098 675 |
| SMS share of revenues | 12% | 14% | 14% | 21% |
| SMS revenues | 115 200 000 | 132 787 200 | 135 862 272 | 13 586 227 |
| SMS growth | | 15% | 2% | -90% |
| MBB revenues | 28 800 000 | 75 878 400 | 106 748 928 | 120 512 448 |
| ARPU MBB | 6 | 14 | 15,19 | 15,0 |
| | | | | |
| EBITDA total | 336 000 000 | 331 968 000 | 339 655 680 | 157 645 958 |
| EBITDA-margin total | 35% | 35% | 35% | 25% |
| EBITDA SMS | 103 680 000 | 119 508 480 | 122 276 045 | 12 227 604 |
| EBITDA-margin SMS | 90% | 90% | 90% | 90% |
| EBITDA MBB | 1 440 000 | 3 793 920 | 5 337 446 | 7 230 747 |
| EBITDA margin MBB | 5% | 5% | 5% | 6% |
| EBITDA voice | 230 880 000 | 208 665 600 | 212 042 189 | 138 187 607 |
| EBITDA-margin voice | 28% | 28% | 29% | 28% |

Comment: In order to correctly calculate voice revenues, MBB revenues the average number of subscribers during the year has to be applied.

Question 2

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

Answer:
Capex was 124.8 m in 2008, 132,8 m in 2009, 135.9 m in 2010 and 203.8m in 2011. Capex-to-sales was 32% in 2011. See table below for the numbers

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

Answer:
EBITDA – Capex = Cash flow. This means that cash flow for the entire operation was 211.2m in 2008, 199.2 m in 2009, 203.8 in 2010 and a negative -46.1 m in 2011. Cash flow for mobile broadband has developed negatively with -61.0 in 2008, -95.8 in 2009, -96.6 m in 2010 and – 176.2 in 2011

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

Answer:

Cash flow per subscriber has developed negatively during the period 2008-2011. Going from 53 in 2008, 48 in 2009, 45 in 2010 and reaching a negative -10 in 2011. Cash flow per mobile broadband subscriber has fluctuated from a negative -152 in 2008, -209 in 2009, -165 in 2010 and -263 in 2011.

The numbers are found in the following table.

| | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|
| Capex | 124 800 000 | 132 787 200 | 135 862 272 | 203 762 272 |
| Capex-to-sales | 13% | 14% | 14% | 32% |
| Capex MBB | 62 400 000 | 99 590 400 | 101 896 704 | 183 386 045 |
| Capex MBB share of total | 50% | 75% | 75% | 90% |
| Cash flow | 211 200 000 | 199 180 800 | 203 793 408 | -46 116 314 |
| Cash flow MBB | -60 960 000 | -95 796 480 | -96 559 258 | -176 155 298 |
| Cash flow per subscriber | 53 | 48 | 45 | -10 |
| Cash flow per MBB subscriber | -152 | -209 | -165 | -263 |

Comment: In order to correctly calculate cash flow per subscriber voice revenues, MBB revenues the average number of subscribers during the year has to be applied.

## Problem 2 Telecom markets, interconnection and operator strategy

Questions:

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

Answer:

Since TDC had many large and public organizations as customers the incoming traffic was larger than the outgoing traffic. Hence TDC would benefit from the unbalanced system even if the other operators would have increased their interconnection charges.

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

Answer:

One possibility was that TDC claimed that their production cost was higher since they had fewer customers than the other operators. Hence, the other operators could benefit from “economy of scale” leading to a lower “production cost” than TDC.

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

Answer:

SMP = Significant Market Power is used for actors that have a dominant position at one or several telecom markets in a country.

Usually the former state owned “monopoly operator” has a SMP status at some market. Examples are Telia in Sweden and Telenor in Norway for the fixed telephony market.

In Sweden all mobile operators have SMP status when it comes to “termination of mobile calls”, the mobile operator is the only one that “can” terminate calls in the own network.

## Problem 3 Deployment of mobile broadband services

**Demand**

Compute demand as kbps per person (4 busy hours and 20 days per month) and total demand for all 2500 persons

Low level: 2,88 GB per month => 80 kbps per person => 0,20 Gbps in total

High level: 14,40 GB per month => 400kbps per person => 1,00 Gbps in total

**What can the solutions offer?**

Coverage not a problem since one WAD can cover > 1 sqkm, i.e. the total area

One WAD TRX supports a 3 sector site for bandwidths up to 20 MHz, implications:

- capacity = 3*1,67*bandwidth
- just one TRX per site since just 10 or 20 MHz of spectrum available for operator
- cost 10 k€ for TRX and 10 k€ for TRX installation

Capacity of WAD with 10 MHz: 10*1,67*3 sectors = 50 Mbps per site

Capacity of WAD with 20 MHz: 20*1,67*3 sectors = 100 Mbps per site

**How many base station sites are needed?**

Operator G (WAD with 20 MHz):

Low demand (0,2 Gbps) is met with 2 base station sites => 2 new sites are needed

High demand (1,0 Gbps) is met with 10 base station sites => 10 new sites are needed

Operator I (WAD with 10 MHz):

Low demand (0,2 Gbps) is met with 4 base station sites => already have 4 sites

High demand (1,0 Gbps) is met with 20 base station sites => 16 new sites are needed

**Cost analysis**

Deployment cost for one new macro site: 100 k€ (70k€+20k€+10k€)

Cost for one WAD TRX with installation: 20 k€ (10k€ +10 k€); just one TRX per site

| Solution | No sites = existing + new sites | Costs for new sites (M€) | No TRX | Costs TRX (M€) | CAPEX year 0 (M€) | OPEX year1-5 (M€) | Total cost (M€) |
|---|---|---|---|---|---|---|---|
| WAD 10 MHz Low demand | 4 = 4 + 0 | 0 | 4 | 4*0,02 = 0,08 | = 0,08 | 5*0,008 = 0,04 | 0,12 |
| WAD 10 MHz High demand | 20 = 4+16 | 16* 0,1 = 1,60 | 20 | 20*0,02 = 0,40 | = 2,00 | 5*0,20 = 1,00 | 3,00 |
| WAD 20 MHz Low demand | 2 = 0 + 2 | 2* 0,1 = 0,20 | 2 | 2*0,02 = 0,04 | = 0,24 | 5*0,024 = 0,120 | 0,36 |
| WAD 20 MHz High demand | 10 = 0+10 | 10* 0,1 = 1,00 | 10 | 10*0,02 = 0,20 | = 1,20 | 5*0,12 = 0,60 | 1,80 |

**Conclusions and recommendations**

If the demand is believed to remain at the low level Operator I (with 10 MHz and 4 existing sites) can be chosen. Lowest costs since no new sites need to be built.

If the demand is believed to be close to or larger than the “high” level Operator G (20 MHZ and 10 new sites) provides the lowest cost due to less number of new sites.

## Problem 4 Deployment of voice services

**Required capacity**

40% of population 80 000 => 32 000 users,

Required voice capacity: 25 mErl * 32 000 = 800 Erlang

**Number of base station required**:

Reuse of 4, 10MHz of spectrum => 2.5MHz/cell

200kHz radio channels in GSM => 2.5/0.2 = 12.5 => 12 radio channels/cell

12 radio channels, each with 8 time slots/traffic channels=>8*12= 96 traffic channels/cell

2% blocking, 96 channels => 84 Erl (according to table)

No of cells needed: 800/84= 9.5 cells

3 cells/site => 3 sites equals 9 cells. This is not enough, but 4 sites will do!

**Answer**: 4 Sites=12 cells will do the job

## Problem 5 – Telecom markets, spectrum and operator network strategy

**Approach**

This problem includes a lot of information, the challenge is to see what is important and not - and what kind of analysis that can be made based on the available data.

1. Start to look what kind of data and information that is available – and not!
    a. There are no ARPU figures -> hence we cannot estimate any revenues.
    b. There is no information about the total spectrum cost for the operators, the number of sites or the cost structure in terms of sites, radio, transmission -> we have no clue about spectrum costs related to other costs
    c. There are no performance or cost figures for solutions using TVWS -> we cannot make any comparative analysis
2. The information we have are *total* user demand and network capacity expressed per area unit (Mbps per km2) =>*Estimate total demand and supplied capacity* and see what can be learned from comparison of these numbers for the different cases. In what cases can we see a clear shortage of capacity (spectrum)?

| Deployment case | Total available bandwidth | Site capacity (Mbps) using all spectrum | Capacity per km2 | Demand per km2 | Supply vs demand |
|---|---|---|---|---|---|
| Sweden Urban | 4*40 = 160 MHz | 1.67*3*160 =800Mbps | 4000 Mbps | 100 Mbps | S >> D |
| Sweden Rural | 3*10 = 30 MHz | 0.67*3*30 = 60 Mbps | 0,60 Mbps | 0,50 Mbps | S ~ D |
| India Urban | 8*5= 40 MHz | 1.67*3*40 = 200 Mbps | 2000 Mbps | 400 Mbps | S >> D |
| India Rural | 6*5= 30 MHz | 0.67*3*30= 60 Mbps | 1,20 Mbps | 10 Mbps | S << D |

**Table 1. Deployment cases to compare with solution guideline**

**Conclusion**

We can see that for the urban cases the total supplied capacity is much larger than the demand. For these cases there is no lack of capacity or spectrum. The same is true for the rural case in Sweden where the demand is roughly the same as the offered capacity. However, for the case of rural deployment in India the demand is much higher than the offered capacity. Hence, this would be a case to investigate further for use of TV WS.

In addition, the situation in India is characterized by: i) low amount of licensed spectrum allocated to operators (figure 1), and ii) high spectrum prices (figure 3).