

# IK2514 WIDE Exam December 13, 2012

## Problem 1 - Value of spectrum

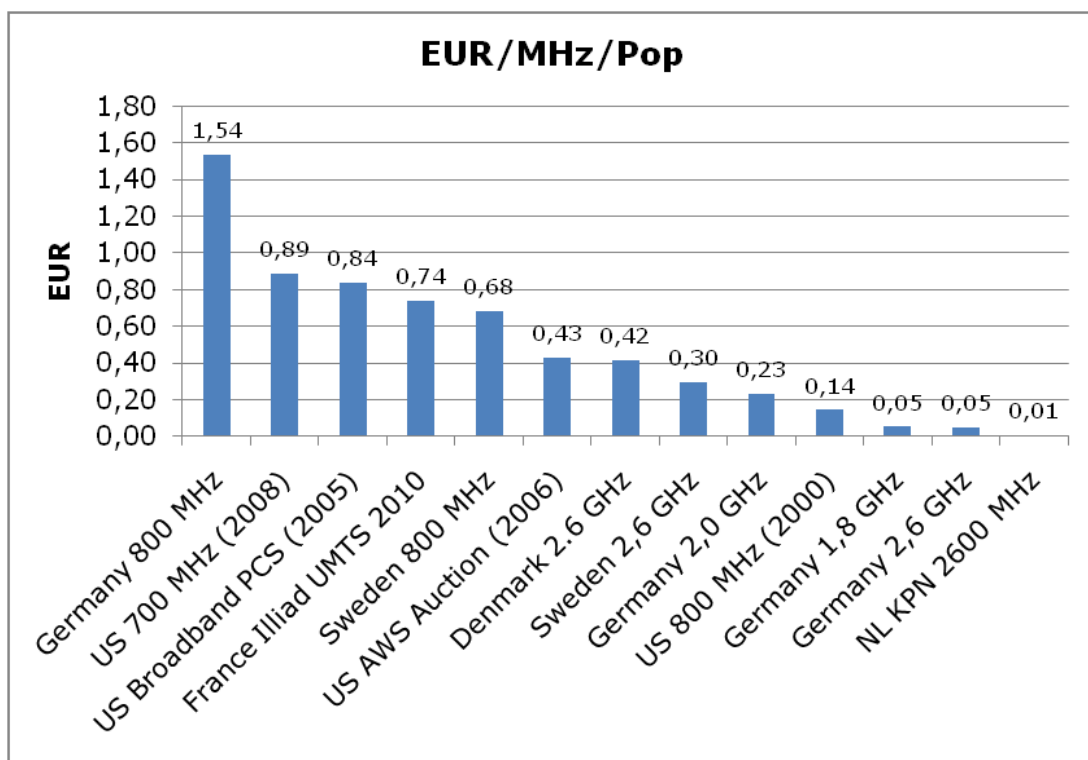
One way to estimate and to compare the value of spectrum is to normalize the auction prices with the amount of spectrum (# MHz) and the population in a country or region, this leads to the “spectrum value metric” (EURO/MHz /pop) shown in the figure below.

Question 1.1 (1point)

Why do auctions for “lower” frequency bands usually result in higher prices than auctions for “higher” frequency bands?

Question 1.2 (2 points)

Propose at least two other aspects or parameters that can be included in a “spectrum value metric” in order to make a more detailed and fair comparison between different spectrum auctions? Motivate your answer.



## Problem 2 - Spectrum and spectrum efficiency

Operator A offers wide area data services in the 1800 MHz band where the operator has 20 MHz. With a 100% utilization factor three sector base stations can support 300 users.

Operator A consider offloading to local femtocell networks in the 2,6 GHz band, However, operator A has no own 2,6 GHz spectrum but can buy (or lease) from another operator B that offers its frequency bands, in blocks of 1 MHz, to other operators.

Question 2.1 (1point)

How much spectrum should operator A buy in order to be able to deploy a femtocell network assuming the same demand per user as for the macro base station users?

Question 2.2 (1point)

What is the average spectral efficiency of the radio access technology used for the macro base stations operating at the 1800 MHz band?

Input data and assumptions

- The re-use factor for macrocell and femtocell deployment is 1.
- The femtocell base stations can support a peak data rate up to 40 Mbps using a bandwidth of 5 MHz
- The average capacity femtocell corresponds to a spectral efficiency of 4bps/Hz.
- Each femtocell can serve at most 20 users
- Each user consumes 21,6 GB per month.
- Dimensioning is made where the data is assumed to consumed during 4 busy hours per day during 30 days of the month

### Problem 3 -Termination charges, traffic balance, profitability and capital expenditures

Operator Star is a leading operator in a small European country and it has grown its operation nicely the last couple of years. But the European Commission has forced the national regulator to gradually lower termination charges. This has motivated Operator Star to modify its price plans and marketing strategy, which has had an impact on the traffic profile of its customer base.

	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

#### About the data

- The subscriber base has grown with 5% per annum during the last couple of years. The table shows the total number of subscriber by December 31, 2007-2011 which implies that the average customer base for a single year should be calculated for June 30.
- The ARPU (average revenue per user) has declined with 7% per year during the last couple of years. ARPU includes all relevant revenues for the operator.
- Minutes-of-use, total minutes used per subscriber (in and outgoing) have increased with 5% per year 2008-2011.
- The traffic balance has changed during the period 2008-2011 as the share “on-net traffic” (traffic handled within the Operator Star’s network) has increased gradually.
- The level of the termination charges for mobile and fixed networks (the price that an operator are allowed to charge another operator to terminate a voice call per voice minute) have decreased according to the figures in the table.

Question 3.1 (1,5 point)

Given that there is a lot of concern regarding lower termination charges the question is what termination revenues are in relation to voice revenues. Secondly, the question is how the termination balance (net outgoing termination minus net ingoing termination traffic) has developed in absolute terms expressed in EUR during 2008-2011.

Question 3.2 (1 point)

Operator Star's management has been concerned over the profitability for the operation and one investor wonders how the EBITDA margin (earnings before interest, taxation, depreciation and amortization) has been during 2008-2011. EBITDA is in this context defined as total revenues minus Opex and direct customer costs. The direct cost per subscriber is EUR 80 per year, and the Opex (excluding direct customer cost) is set to 50% of revenues in 2008, 49% in 2009, 48% in 2010 and 45% in 2011.

Question 3.3 (1,5 point)

Operator Star had invested EUR 1.5 bn in accumulated capex by December 31, 2007. The management set capex-to-sales for new installations (excluding maintenance capex) to 8% in relation to sales in 2008, and 2009, and increased it to 9% in relation to sales in 2010 and 9% in 2011. Added to capex for new installations Operator Star has been doing maintenance capex with 5% in relation to accumulated capex (the figure for accumulated capex for December 31 for the preceding year). How large has the total capex been and what is the relation to sales during 2008-2011? Given that management want to distribute a dividend to the shareholders the question is how free cash flow has developed (free cash flow is in this context defined as EBITDA minus total capex) in absolute term expressed in EUR during 2008-2011?

#### **Problem 4 – Operator strategies**

In Thailand the telecom market consists of two types of operators, two state owned enterprises (TOT and CAT) and a number of private owned mobile operators. The private mobile operators operate under concessions and a so called “BTO contract”. BTO stands for Build, Transfer and Operate meaning that the private operators have to invest and build the networks, transfer the ownership to TAT or CAT, and operate the network commercially, i.e. to acquire customers and provide services. In addition, the private operators have to share the revenues (20-30%) with TAT or CAT, see attachments for more information and overview.

Recently the regulator NBTC has initiated a transformation of the telekom market from the “concession” and BTO approach described above to a licensed spectrum approach. With the new approach the operators will build and OWN the networks and NO revenues will be shared with the state owned operators. The first networks to be deployed and operated using the new approach will be 3G networks operated by the operators AIS, True and DTAC (a Telenor company).

DTAC will offer 3G services using both 10 MHz in the 850 MHz band (BTO contract) and 15 MHz in the 2.1 GHz band (using the “new” approach and own licensed bands). Currently around 3G at 850 MHz is deployed at around 3000 sites. These sites (and other new sites build under BTO contract) will be handed over to CAT year 2018 when the BTO contract ends. DTAC plan to deploy new sites for the 2.1 GHz band from 2013.

Question 4.1 (1 point)

What challenges and open issues are DTAC facing when it comes to the deployment of 3G networks and services?

Question 4.2 (1 point)

Identify and describe two 3G network strategies for DTAC.

The state owned operators TAT and CAT plan to bid in upcoming spectrum auctions. IF they get licensed new spectrum they can offer services on a wholesale basis or provide services directly to consumers.

Question 4.3 (1 point)

IF the state owned operators TAT and CAT do NOT get new spectrum what kind of business strategies can then be feasible for these companies? Describe briefly two such strategies.

## Problem 5 – Dimensioning of data and voice capacity

Operator Blue in the country T has acquired a competitor with an already build-out 2G and 4G network and 5 MHz of spectrum in the 1800 MHz band. Operator Blue plans to use this band to launch a service package for smartphone users with GSM voice services and 4G data services. Market surveys shows that there is a very large unmet demand for this kind of service offers in the country T. Two options are to be investigated: a consumer offer and an offer for business users.

The initial approach and plan is that the consumer service should be offered for 30 €per month, including up to 5 GB of data traffic per month and 300 voice minutes.

The business user service is to be offered for 80 €per month, including up to 10 GB of data traffic per month and 600 voice minutes.

When the network planning group and consumer behavior group meets to discuss the new offers the following guidelines are recommended for dimensioning of the two offers:

\* Assumptions for the consumer service

- data usage during 16 hours per day for 30 days of the month.
- voice usage 25 mE per user during busy hour to be dimensioned for blocking rate 5%

\* Assumptions for the business user service

- data usage during 8 hours per day for 30 days of the month.
- voice usage 100 mE per user during busy hour to be dimensioned for blocking rate 1%

The network planning group starts to compare these options and make the following initial assumptions:

- 3 MHz is allocated for the LTE data services and 1,8 MHz for GSM voice services
- The base station site equipment support 3 sectors
- For LTE a reuse factor 1 is assumed and for GSM the reuse factor is 3
- The average spectrum efficiency for LTE is 1,67 bps/Hz

Question 5.1 (2 points)

What is the number of users for the two types of offers that can be supported by a base station site where both the data and voice requirements are met? Calculate and explain!

Question 5.2 (1point)

With these assumptions should operator Blue go for the consumer or business service? Motivate!

Question 5.3 (1point)

Is the spectrum used in an optimum way or should operator Blue consider another relative allocation of spectrum resources for voice and data services? Motivate!

Note:

The GSM carriers are 200 kHz and consist of 8 time slots (voice channels). Assume that all GSM time slots can be used for voice traffic ( i.e. neglect control channels)

Use attached Erlang Traffic table

## Telecom industry 1990-2004 “BTO Contract”



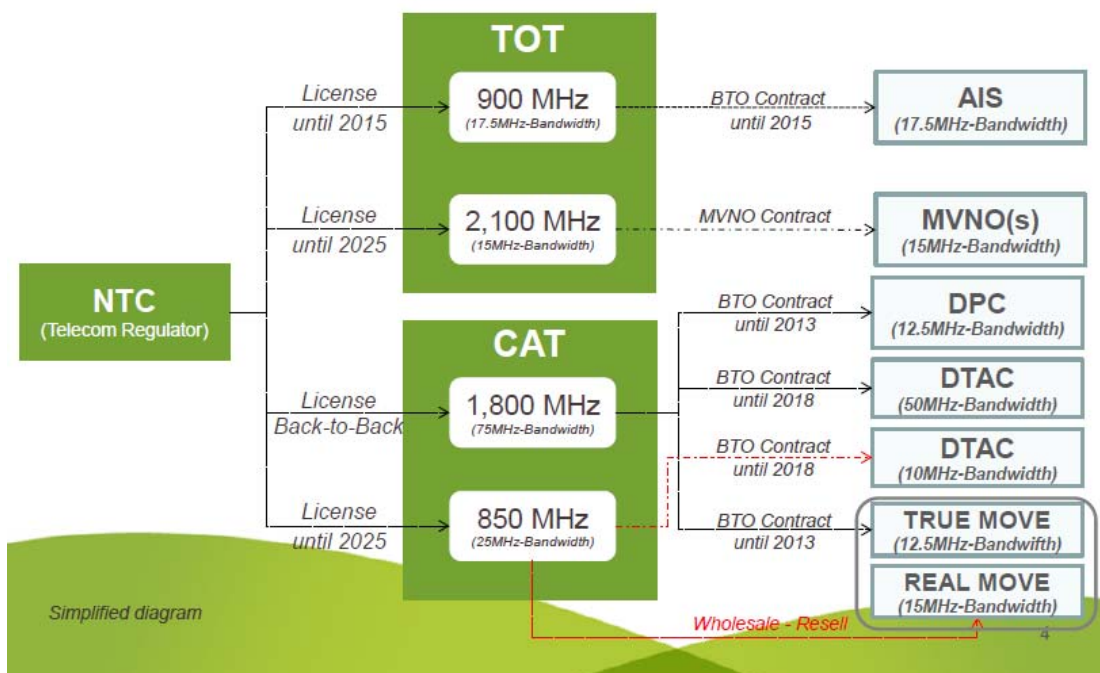
- ✓ In the past, telecommunications services in Thailand were provided exclusively through two state enterprises, i.e. TOT and CAT. The TOT's primary responsibility was to provide domestic telephone service while the CAT focused on international services. The private sector could only operate within the industry if they worked in conjunction with one of the state enterprises through collaborated partnership in form of Build-Transfer-Operate (BTO) Contract.
- ✓ Mobile operators in Thailand including AIS, DTAC, True Move, DPC all operates under this type of contract, started during early 1990s with the terms of 25-27 years (ended during year 2013-2018)

Under BTO contract, mobile operator is entitled to

- ✓ **Build** and raise capital for investment in the cellular network
- ✓ **Transfer** the network ownership to agreement's grantor (TOT/CAT)
- ✓ **Operate** the network and service commercially
- ✓ **Share revenue** with the grantor of 20-30%

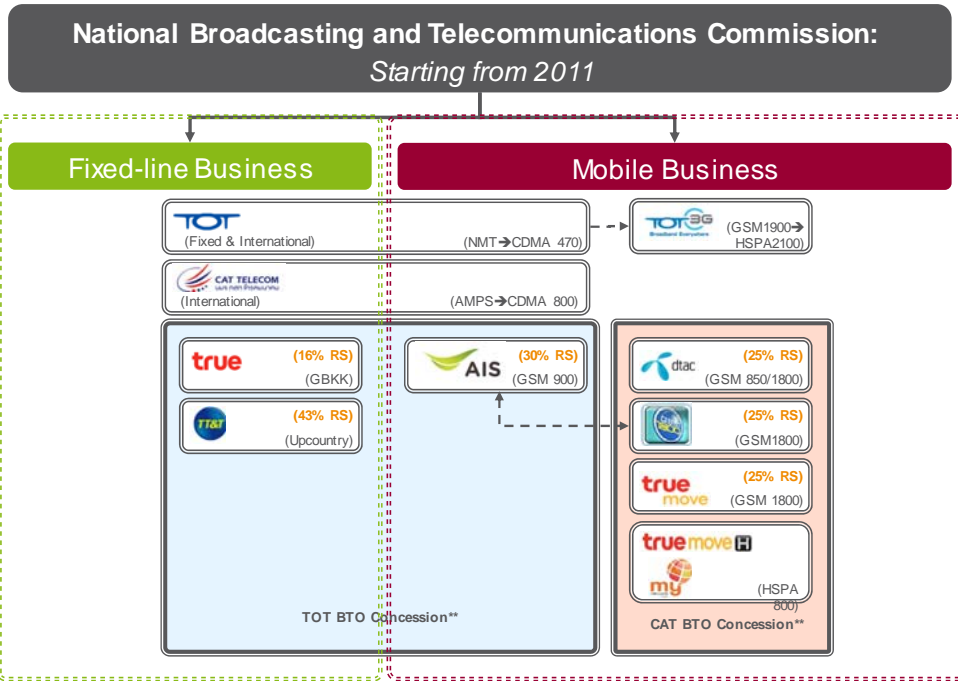
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## Mobile spectrum allocation





# Thailand Telecommunication Structure



## Mobile network providers



Five active operators, but three dominate the market:



- › AIS (43.5 % MS): (BTO concession with ~25% revenue sharing till 2015)

– Operating at 900 and 1800 MHz bands with GSM/GPRS/EDGE/HSPA technologies.



- › DTAC (30.2% MS): (BTO concession with ~25% revenue sharing till 2018)

– Operating at 850 and 1800 MHz bands with GSM/GPRS/EDGE/HSPA technologies.



- › True Move (23.7% MS): (BTO concession with ~25% revenue sharing till 2013)

– Operating at 1800 MHz band with GSM/GPRS/EDGE technologies.



- › “MY by CAT” and “True Move H” (1.5% MS): (joint marketing and investment partnership between True with CAT-State-owned enterprise)

– Operating at 850 MHz band (migrating from CDMA to HSPA)



- › TOT (1.1% MS): (State-owned enterprise)

– Operating at 1900/2100 MHz band with HSPA technology