

Course IK2514, Wireless Infrastructure Deployment and Economics. Description of Home Work 3

Dimensioning and cost structure analysis of wide area data service network

Objectives and task

You will dimension and design a radio access network and analyze the cost structure for different deployment options and types of used Radio Access Technologies (RATs). The task will be done and reported individually for a specific user, traffic and deployment scenario using a specified set of RAT's.

General description

We will consider deployment of radio access network for wide area data services ("mobile broadband"). The network will be deployed in a region or small country, e.g. "Republic of Skåne" or "Little Belgium".

The deployment will be done for one of two types of areas with different population densities; Urban and Rural. There are two types of operators; i) an incumbent operator with an existing voice service network, and ii) a Greenfield operator that starts business in the region.

Requirements for the deployment are described in terms of coverage and capacity.

The capacity (Mbps per area unit) is to be calculated using estimates of average data usage per user and the number of users.

For the dimensioning of the radio access network parameters for different RATs are provided describing coverage, capacity and cost. The cost structure analysis shall include

- Investments (CAPEX) e.g. radio and transmission equipment, sites and installation
- Running costs (OPEX) e.g. site leases, fees for leased lines and O&M

The dimensioning and analysis shall be done for years 1 to 5 taking into account the network build out, price erosion and discounted cash flow.

Analysis steps

- i. Calculate the user demand in your type of area for years 1 – 5
- ii. Make a cost structure description for your deployment options and RATs
- iii. Model the RAT's in terms of coverage, capacity and cost
- iv. Do the network dimensioning for years 1 – 5, and estimate network costs expressed as CAPEX, OPEX and according to a Net Present Value (NPV) model
- v. Compare the different options and make a recommendation

References

- [1] J. Markendahl, B. Mölleryd, Ö. Mäkitalo, J. Werding; "Business Innovation Strategies to Reduce the Revenue Gap for Wireless Broadband Services" Communications & Strategies, No. 75, p. 35, 3rd quarter 2009, pp 45-55 Available at SSRN: <http://ssrn.com/abstract=1559116>
- [2] G. Blennerud, "Don't worry, Mobile Broadband is profitable ", Ericsson Business review, http://www.ericsson.com/us/ericsson/corpinfo/publications/ericsson_business_review/pdf/209/209_BUSINESS_CASE_mobile_broadband.pdf
- [3] Klas Johansson, "Cost Effective Deployment Strategies for Heterogeneous Wireless Networks", PhD dissertation, KTH 2007, <http://www.cos.ict.kth.se/>

Individual case for each student

Each student will analyze a specific case described by

- Urban or Rural environment
- Greenfield or Incumbent operator
- A specified user demand and traffic scenario
- A set of deployment options and types of RATs

The cases will be defined and announced at KTH Social latest 12:00 December 2

Reporting and reviewing, time plan

The report shall describe the analysis steps above so that the “line of reasoning” is clear. The used assumptions and motivations shall be included together with the calculations.

Prepare and hand in a draft homework report before 10.00 December 8, 2011.

See instructions below for review, preparation of final report and oral presentation.

Oral presentations are done individually 15 minute per student

December 13, 13.00 – 15.00, Room Motala or Hörby, Electrum, Elevator C, Floor 4

– You will be assigned a time slot December 12

Activity	Homework 3
Home work is assigned to each student	11-12-02, 12:00
Distribution of draft versions to reviewers and teachers	11-12-08, 10:00
Send review comments to teacher and students	11-12-09, 16:00
Oral presentation	11-12-13 individual 15 min 13:00-15:00
Send final version to teacher	11-12-13, 07:59
Feedback and HW grading send to student	11-12-16, 12:00
e-mail address of teacher(s)	janmar@kth.se claesb@kth.se

Input data and assumptions

1. Radio access network

RAT number	RAT Deployment	Maximum cell range [km]	
		Urban	Rural
1	EDGE	1,00	8,00
2	WLAN	0,03	0,08
3	UMTS Macro	0,60	4,00
4	UMTS Micro	0,15	0,50
5	HSDPA Macro	0,4	2,00
6	HSPA Micro	0,1	0,50

2. Type of operator

I. Incumbent operator

An incumbent operator has an existing GSM network with a number of sites that can be re-used. The distance (D) between existing sites is 10 km in rural areas and 0.5 km in urban areas, the cell radius $R = D / \sqrt{3}$. The GSM TRX's can be upgraded to EDGE

G. Greenfield operator

All sites are to be deployed from scratch

3. Population density

U. Urban

The density of users is 2000 per square kilometer.

R. Rural

The density of users is 100 per square kilometer.

4. Coverage

The urban area is 1000 km² and the rural area is 10 000 km².

The area to be covered is according to the table below.

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Area to be covered each year	0	20%	40 %	60 %	80 %	100 %

5. Usage and Demand

Usage per user (GB/month)

Type of user	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
MBB as complement	1.0	1.2	1.4	1.6	1.8	2.0
MBB as substitute	5	6	7	8	9	10

Penetration (% of population)

Type of development	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Complement_1	5 %	10 %	15 %	20%	20 %	20%
Complement_2	20 %	30 %	35 %	40 %	45 %	50 %
Substitute_1	1 %	2 %	3 %	4 %	5 %	6 %
Substitute_2	4 %	6 %	8 %	10 %	12 %	14 %

6. Dimensioning

The dimensioning shall fulfill the coverage requirements and meet the estimated user demand for each year. The traffic is assumed to be concentrated to 4 hours per day

The figures on penetration and coverage are for each of the operators and describe the demand over the whole area. The coverage numbers 20%, 40% etc are decided by the operator and in the covered area the demand should be satisfied

The RAT "cell" capacity is the capacity for one carrier for one omni cell or for one sector

You can use omni, 2 or 3 sector systems, with 1 or 2 carriers, i.e. maximum 6 cells per site

7. Financials

Calculate the CAPEX and OPEX for years 1 – 5 based on your dimensioning. The price erosion of all equipment is assumed to be 5 % and the discount rate for Net Present Value calculation is 10%.

8. Capacity and Cost

Equipment	Cost [kEuro]	Capacity [Mbps]
EDGE Macro BTS, 3 TDMA carriers	10	0,7
EDGE Macro BTS, additional sector	5	0,7
EDGE upgrade for existing GSM Macro	5	0,7
WLAN AP (1 AP per site)	1	10
UMTS Macro BTS, first cell at site	20	1
UMTS Macro BTS, additional cells (sectors or carriers)	10	1
UMTS Micro BTS, one cell only (i.e. no build out)	10	1
HSDPA Macro BTS, first cell at site	25	3
HSDPA Macro BTS, additional cells (sectors or carriers)	15	3
HSDPA Micro BTS, one cell only (i.e. no build out)	15	3
Installation and buildout costs		
EDGE/UMTS/HSDPA Macro BTS site installation	30	
UMTS/HSDPA Micro BTS site installation	20	
EDGE/UMTS/HSDPA Macro BTS site buildout RURAL	70	
UMTS/HSDPA Macro BTS site buildout URBAN	40	
UMTS/HSDPA Micro BTS site buildout URBAN	20	
WLAN AP installation + buildout	3	
Data line installation per EDGE site	5	2
Data line installation per UMTS/HSDPA site RURAL	10	10
Data line installation per UMTS/HSDPA site URBAN	5	10
Running costs (annual cost per unit)		
	k€per unit	
Site lease, Macro BTS, RURAL	6	
Site lease, Macro BTS, URBAN	8	
Site lease, Micro BTS, URBAN	4	
Site lease, WLAN AP, URBAN	1	
Leased line, E1 or Ethernet type RURAL	2	2
Leased line, E1 or Ethernet type URBAN	1	2
Operation & Maintenance costs are 10 % of all CAPEX		
Electricity EDGE/UMTS/HSDPA site Macro - RURAL	4	
Electricity UMTS/HSDPA site Macro - URBAN	2	
Electricity UMTS/HSDPA site Micro	0,2	
Electricity WLAN AP	0,02	