MOB course problem A.
Cost reduction using network sharing

Problem background:

Two operators will deploy new wireless networks for there customers in an area and they want to investigate the potential benefits of network sharing of two different types

1. Geographical split
2. Shared sites

About coverage and deployment strategies

Coverage
The whole area 1km *1km should be covered at year 1.

Own network
Each operator builds its own network over the full area in order to serve own users only.

Geographical split
Each operator builds half of network, i.e. 50% of the sites that are fully equipped in order to the serve the demand of both operators. The users of one operator will then be "roaming" users of the other operator. .

Shared sites
The operators jointly build base station sites which are used by both operators but each deploys and uses own radio equipment.

Your problem:

Calculate the total cost of investments and the potential cost savings using the two types of network sharing, "geographical split" and "common shared network".

Provide answers for both "low" and "high" demand predictions; see below.

Part 1:
Do the calculations for year 1 using the RAT technology "COMA-1"

Part 2:
Repeat the calculations assuming that the operators start the deployment year 2 when the RAT "COMA-2" with enhanced performance is available.

Demand predictions

The user distribution is assumed to be homogeneous in the area. The operators have 50% market share in the area. Two levels of demand predictions are considered ("low"/"high")

Type of demand prediction	Number of active users in the whole area	average user demand during "busy hours"
"Low"	2000	20 kbps per user
"High"	4000	100 kbps per user

RAT descriptions

The operators have agreed to use the highly modular COMA technology (Corner Optimized Molto-Accesso) with the good property to produce coverage areas shaped as perfect squares. The micro base station can be configured with a number of carriers.

Type of Radio Access Technology	Coverage (square km)	Number of carriers	Capacity per carrier	Availability
COMA-1	0,01	1 – 4	1 Mbps	Year 1
COMA-2	0,01	1 – 8	2 Mbps	Year 2

Price list

	Price
Deployment and Site build out	
Non-telecom equipment	9 k€ per site
Construction	5 k€ per site
Installation	6 k€ per site
Radio equipment	
COMA-1 TRX, the first carrier	10 k€ per carrier
COMA-1 TRX, additional carrier	10 k€ per carrier
COMA-2, the TRX first carrier	10 k€ per carrier
COMA-2 TRX, additional carrier	10 k€ per carrier
Running costs (per year)	
Site leases	6 k€ per site
O & M	4 k€ per site
Electric power	1 k€ per carrier per site
Leased lines	1 k€ per carrier per site

Solution

Demand

Low level demand: 2000 * 20 kbps = 40 Mbps (20 Mbps per operator)
High level demand: 4000 * 100 kbps = 400Mbps (200 Mbps per operator)

Deployment for coverage and capacity

The coverage of the COMA base stations is 0,01 sqkm (100m*100 m)
For 1 km * 1km area 100 base stations are needed to ensure coverage.

The solution strategy

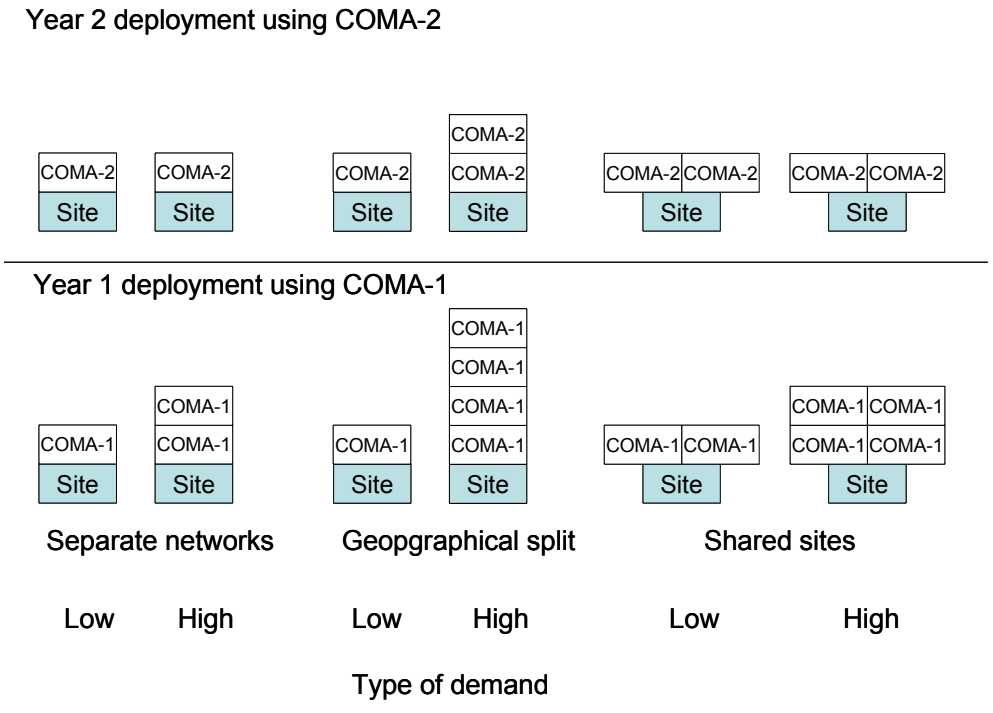
The building blocks used for the dimensioning and capacity are

- COMA-1 carriers (year 1 case)
- COMA-2 carriers (year 2 case)

The building blocks used for the cost structure analysis and comparison are

- The site related costs, 1 per site
- Radio related costs, 1 or more carriers of type COMA-1/COMA-2

The key aspect is to find the base station configurations for the different cases.
Then the total cost for all base stations and the sharing of costs is straight forward



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Separate networks (reference case)
Each operator deploys 100 base stations.
The minimum COMA-1 configuration is with 1 carrier, 100 *1*1 Mbps = 100 Mbps
The minimum COMA-2 configuration is with 1 carrier, 100 *1*2 Mbps = 200 Mbps

Demand level "low" (20 Mbps are needed)
=> OK with 100 sites with COMA-1 or COMA-2 (excess capacity is deployed)

Demand level "high" (200Mbps are needed)
=> For COMA-1 another 100 Mbps need to be deployed.
Add one additional carrier per base station; 100 *(1+1)*1 Mbps = 200 Mbps; OK
=> For COMA-2 the capacity of the deployed 100 sites offers 200Mbps

Geographical split
In this case each base station shall serve the demand of both operators, i.e. 40 Mbps for "low" and 400 Mbps for "high" demand. Each operator deploys 50 base stations.
The minimum COMA-1 configuration with 1 carrier=> 100 *1 Mbps = 100 Mbps
The minimum COMA-2 configuration with 1 carrier=> 100 *2 Mbps = 200 Mbps

Demand level "low"(Requirement 40 Mbps)
=> OK with 100 sites with COMA-1 or COMA-2 (excess capacity is deployed)

Demand level "high" (Requirement is 400Mbps)
=> For COMA-1 another 300 Mbps need to be deployed.
Add 3 additional carriers per base station; 100 *(1+3)*1Mbps = 400 Mbps; OK
=> For COMA-2 another 200 Mbps need to be deployed.
Add 1 additional carrier per base station; 100 *(1+1)*2 Mbps = 400 Mbps; OK

Shared sites
The operators jointly deploy 100 base stations to be shared. Each operator needs to deploy radio equipment in order to satisfy "own" demand (20 Mbps and 200Mbps).

Demand level "low" (Requirement is 20 Mbps)
Each operator deploys one carrier; OK for COMA-1 (100Mbps), COMA-2 (200Mbps)

Demand level "high" (Requirement is 200Mbps)
=> For COMA-1 another 100 Mbps need to be deployed.
Add 1 additional carrier per base station; 100 *(1+1)*1Mbps = 200 Mbps; OK
=> For COMA-2 200 Mbps is already supported with the first carrier: OK as is

Cost analysis and comparison

Cost structure
Only investments are to be considered in the analysis.
Site related costs = 9 + 6 +5 k€ = 20 k€; called (S)
Radio equipment = 10€ per carrier (for both COMA-1 and COMA-2), called (R)

Cost per operator - Separate networks (reference case)
Demand level "low"
COMA-1. Cost per site: S + R = (20 + 10) = 30 k€; Cost per op. 100*30 k€ = 3 M€
COMA-2. Cost per site: S + R = (20 + 10) = 30 k€, Cost per op. 100*30 k€ = 3 M€
Demand level "high"
COMA-1. Another carrier needed => Cost per site: S + 2*R = (20 + 2*10) = 40 k€
COMA-2. Capacity OK with 1st carrier=> Cost per site: S + R = (20 + 10) = 30 k€
COMA-1: Cost per op. 100*40 k€ = 4M€,
COMA-2: Cost per op. 100*30 k€ = 3M€

Cost per operator -Geographical split
Demand level "low"
COMA-1. Cost per site: S + R = (20 + 10) = 30 k€; Cost per op.100*30 k€ *0,5 = 1,5M€
COMA-2. Cost per site: S + R = (20 + 10) = 30 k€, Cost per op.100*30 k€ *0,5 = 1,5M€
Demand level "high" (Requirement is 400Mbps)
COMA-1. 3 more carriers needed => Cost per site: S + 4*R = (20 + 4*10) = 60 k€
COMA-2. 1 more carrier needed => Cost per site: S + 2*R = (20 + 2*10) = 40 k€
COMA-1: Cost per op.100*60 k€ *0,5 = 3M€,
COMA-2: Cost per op.100*40 k€ *0,5 = 2M€

Cost per operator - Shared sites
Demand level "low"
COMA-1. Cost per site: S + 2*R = (20 + 2*10) = 40 k€;
COMA-2. Cost per site: S + 2*R = (20 + 2*10) = 40 k€,
=> Cost per op.100*40 k€ *0,5 = 2 M€ (For both COMA-1 and COMA-2)
Demand level "high" (Requirement per operator is 200Mbps)
COMA-1. Another carrier needed per op
=> Cost per site: S + 2*2*R = (20+2* 2*10) = 60 k€, Cost per op.100*60 k€ *0,5 = 3M€
COMA-2. Capacity OK with 1st carrier per operator
=> Cost per site: S + 2*R = (20+ 2*10) = 40 k€, Cost per op.100*40 k€ *0,5 = 2M€

Summary: Cost (savings) per operator

Demand / RAT	Dedicated network	Geographical split	Shared sites
"Low"/COMA-1	3 M€	1,5 M€ (1,5)	2,0 M€ (1,0)
"High"/COMA-1	4 M€	3,0 M€ (1,0)	3,0 M€ (1,0)
"Low"/COMA-2	3 M€	1,5 M€ (1,5)	2,0 M€ (1,0)
"High"/COMA-2	3 M€	2,0 M€ (1,0)	2,0 M€ (1,0)