White Paper
July 2008

Over Subscription Ratio as a planning criterion

Software solutions in radiocommunications

The purpose of this white paper is to give a methodology to manage Over Subscription Ratio (OSR) as a criterion for the design of a network.
The OSR is the ratio of the total subscriber's demand over the reference capacity of the base station when taking into account the adaptive modulation.
The reference capacity of the base station corresponds to the available bit rate of the lowest modulation.

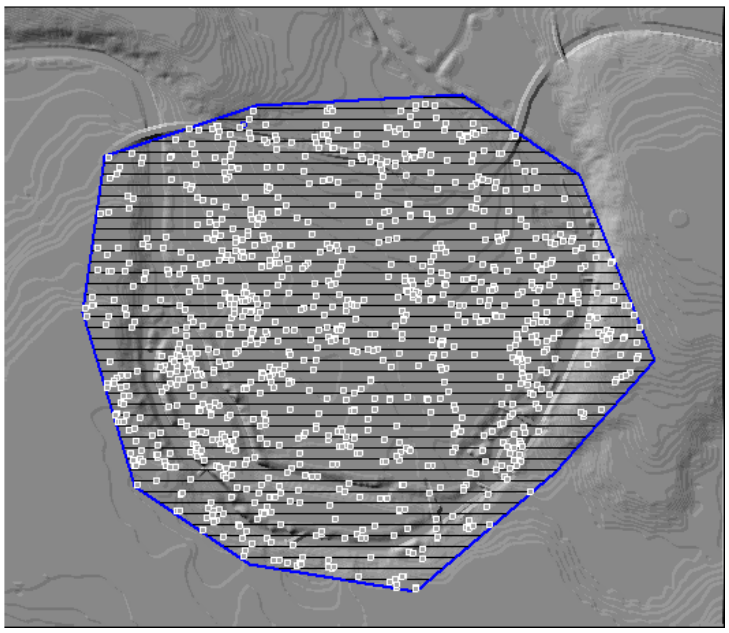
During this white paper we will assume that we start from scratch and that an average OSR comprises between 1 and 2 is expected to do the pre-design of the network.

You start by creating your area of interest or service area, where the different types of services will be provided to the subscribers.
The different types of services will be taken into account through the traffic parameters of the subscribers.

Then you generate inside the service area the subscribers according to a repartition/distribution for each type of service that you have already pre-defined.
For example:

- 60 subscribers at 1 Mbit/s;
- 120 subscribers at 512 Kbit/s;
- 240 subscribers at 256 Kbit/s;
- 600 subscribers at 128 Kbit/s;

This repartition of subscribers per type of service is the key element to take into account the OSR as a planning criterion. The more the repartition is unbalanced the more the OSR criterion will be difficult to achieve.



Once the subscribers have been generated a prospective planning can be launched.
The prospective planning will allow to create automatically sites according to different criteria and the OSR is one of them.

If we want to be sure to obtain an average Over Subscription Ratio comprises between 1 and 2, it means that it is necessary to have a total traffic demand at least equal to the reference capacity and at the most equal to two times the reference capacity.

We know that the reference capacity of the base station corresponds to the available bit rate of the lowest modulation. So if we assume the following scheme of adaptive modulation, it gives a minimum traffic demand of 2820 Kbit/s and a maximum traffic demand of 5640 Kbit/s.

Modulation	**Threshold (dBm)**	**Required C/(N+I) (dB)**	**Bit rate (Kbit/s)**
QPSK 1/2	-97	3	2 820
16 QAM 1/2	-91	9	5 640
16 QAM 3/4	-88	12	8 545
64 QAM 2/3	-83	17	11 280
64 QAM 3/4	-82	18	12 818

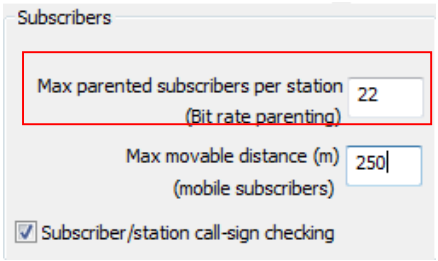
Now, if we look at the subscriber distribution we defined, we can infer an average traffic demand of:

(60*1000 + 120*512 + 240*256 + 600*128)/1020 = 254 Kbit/s

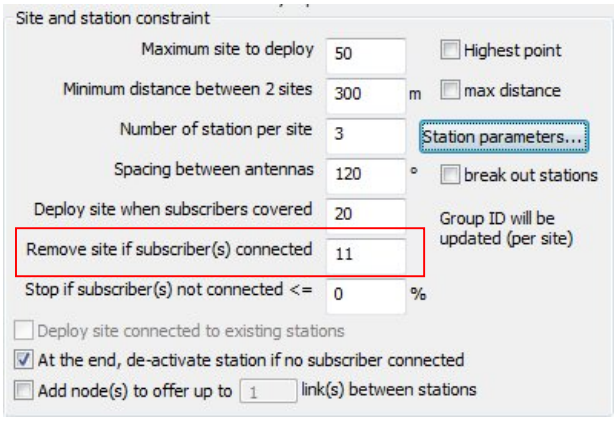
Thereby we can say that in order to respect the OSR criterion each sector will have to connect at least 2820/254 = **11** subscribers and at the maximum 5640/254 = **22** subscribers.

These minimum and maximum values of allowed parented subscribers per sector can be then set:

- In the window *Preferences*, for the maximum parented subscribers per station:

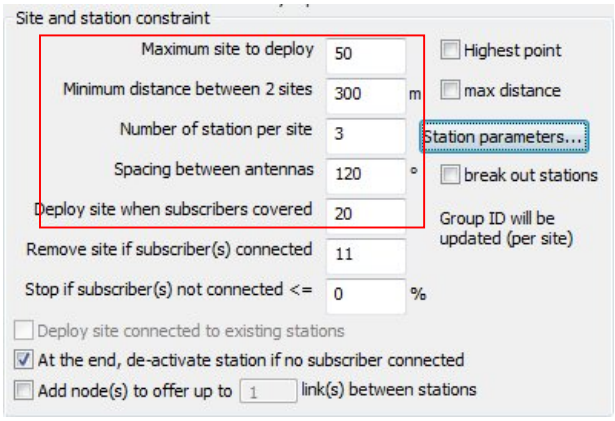


- In the *sites and stations constraints* part of *prospective planning* window for the minimum parented subscribers per sector:

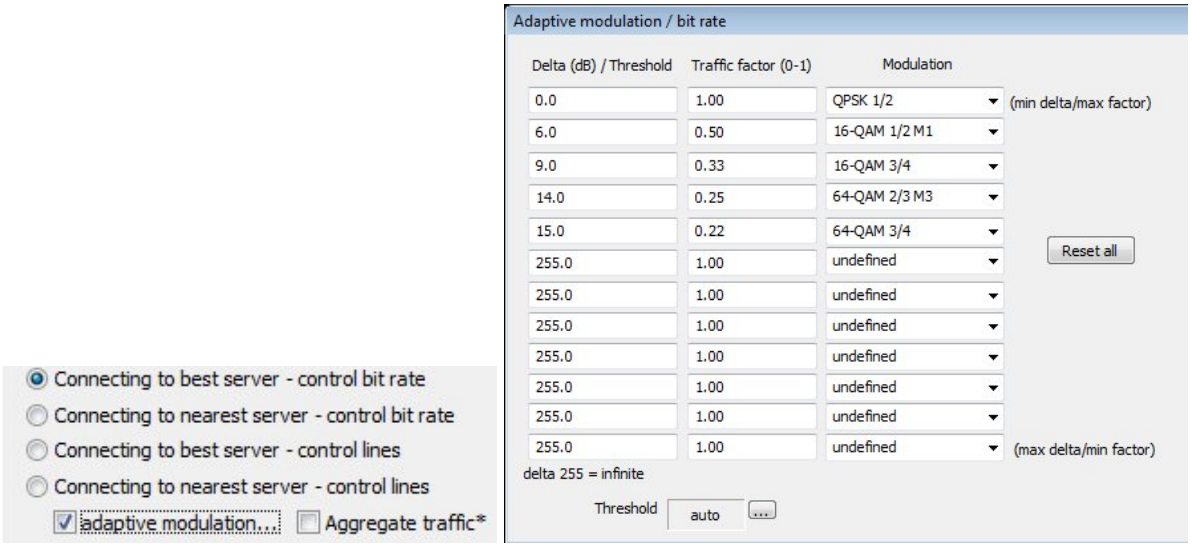


The other criteria that have to be set are:

- The locations of the sites,
- The maximum number of sites to deploy;
- The number of sector per site;
- The number of subscribers that must connected to deploy a site;



- And the type of connection that must be applied:



At this stage none interference is considered since no frequency plan has been yet defined.
A traffic report can then launched to check the average OSR obtained:

BST	Ref. mod.	Ref cap DL	Ref cap UL	Demand DL	Demand UL	OSR DL	OSR UL	CPE(s)	CPE ratio
(#)		(Mbits/s)	(Mbits/s)	(Mbits/s)	(Mbits/s)	(ratio)	(ratio)	(nb)	(%)
address 1	QPSK 1/2	2.82	2.82	3.97	3.97	1.41:1	1.41:1	22	2.33
address 2	QPSK 1/2	2.82	2.82	6.69	6.69	2.37:1	2.37:1	22	2.33
address 3	QPSK 1/2	2.82	2.82	6.66	6.66	2.36:1	2.36:1	22	2.33
address 4	QPSK 1/2	2.82	2.82	3.58	3.58	1.27:1	1.27:1	22	2.33
address 5	QPSK 1/2	2.82	2.82	3.58	3.58	1.27:1	1.27:1	22	2.33
address 6	QPSK 1/2	2.82	2.82	7.89	7.89	2.80:1	2.80:1	22	2.33
address 7	QPSK 1/2	2.82	2.82	5.25	5.25	1.86:1	1.86:1	22	2.33
address 8	QPSK 1/2	2.82	2.82	2.82	2.82	1.00:1	1.00:1	22	2.33
address 9	QPSK 1/2	2.82	2.82	2.82	2.82	1.00:1	1.00:1	22	2.33
address 10	QPSK 1/2	2.82	2.82	5.86	5.86	2.08:1	2.08:1	22	2.33
address 11	QPSK 1/2	2.82	2.82	11.42	11.42	4.05:1	4.05:1	22	2.33
address 12	QPSK 1/2	2.82	2.82	4.22	4.22	1.50:1	1.50:1	22	2.33
address 13	QPSK 1/2	2.82	2.82	12.19	12.19	4.32:1	4.32:1	22	2.33
address 14	QPSK 1/2	2.82	2.82	10.48	10.48	3.72:1	3.72:1	22	2.33
address 15	QPSK 1/2	2.82	2.82	11.94	11.94	4.23:1	4.23:1	22	2.33
address 16	QPSK 1/2	2.82	2.82	6.10	6.10	2.16:1	2.16:1	22	2.33
address 17	QPSK 1/2	2.82	2.82	6.27	6.27	2.22:1	2.22:1	22	2.33
address 18	QPSK 1/2	2.82	2.82	8.68	8.68	3.08:1	3.08:1	22	2.33
address 19	QPSK 1/2	2.82	2.82	8.63	8.63	3.06:1	3.06:1	22	2.33
address 20	QPSK 1/2	2.82	2.82	3.82	3.82	1.35:1	1.35:1	22	2.33
address 21	QPSK 1/2	2.82	2.82	2.82	2.82	1.00:1	1.00:1	22	2.33
address 23	QPSK 1/2	2.82	2.82	2.43	2.43	0.86:1	0.86:1	19	2.01
address 24	QPSK 1/2	2.82	2.82	0.13	0.13	0.05:1	0.05:1	1	0.11
address 25	QPSK 1/2	2.82	2.82	6.58	6.58	2.33:1	2.33:1	22	2.33
address 26	QPSK 1/2	2.82	2.82	5.46	5.46	1.93:1	1.93:1	22	2.33
address 27	QPSK 1/2	2.82	2.82	6.89	6.89	2.44:1	2.44:1	22	2.33
address 29	QPSK 1/2	2.82	2.82	2.82	2.82	1.00:1	1.00:1	22	2.33
address 30	QPSK 1/2	2.82	2.82	2.82	2.82	1.00:1	1.00:1	22	2.33
address 31	QPSK 1/2	2.82	2.82	3.33	3.33	1.18:1	1.18:1	22	2.33
address 32	QPSK 1/2	2.82	2.82	7.99	7.99	2.83:1	2.83:1	22	2.33
address 33	QPSK 1/2	2.82	2.82	7.35	7.35	2.61:1	2.61:1	22	2.33
address 35	QPSK 1/2	2.82	2.82	2.94	2.94	1.04:1	1.04:1	22	2.33
address 36	QPSK 1/2	2.82	2.82	6.97	6.97	2.47:1	2.47:1	22	2.33
address 37	QPSK 1/2	2.82	2.82	3.58	3.58	1.27:1	1.27:1	22	2.33

In this example the average OSR is equal to 2.01.

The average OSR can be improved by removing the useless sectors and/or by adapting the maximum parented subscribers allowed per sector (iterative way).

Once the OSR has been validated the classical steps of design of network can be applied:

- Coverage calculations;
- Automatic frequency assignment;
- Interference analyses;
- Traffic analyses.

For more details on these steps please refer to the WiMAX tutorial.

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