

- White Paper
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WiMAX network quality
of service
White Paper based on
User bit rate assumption

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1.- INTRODUCTION

Dimensioning a WiMAX network needs to keep in mind the user traffic demand and the applications he/she shall use so that the density of Base Stations and backbone network dimensioning can fulfil the demand.

Each Base Station will be parameterised to offer a maximum bit rate for both downlink and uplink, and where it can be expected that downlink provides higher throughput (like ADSL). Bit rate depends on C/I ratio, and thus on modulation spectral efficiency.

Typical modulation spectral efficiency – PHY – Physical Layer

Down Stream Throughput (8MHz Channel)

Modulation	Bits per sub-carrier	code rate	Net bit rate (Mbps) for different Guard intervals			
			1/4	1/8	1/16	1/32
QPSK	2	–	4.98	5.53	5.85	6.03
	2	2/3	6.64	7.37	7.81	8.04
	2	–	7.46	8.29	8.78	9.05
	2	5/6	8.29	9.22	9.76	10.05
	2	7/8	8.71	9.68	10.25	10.56
16-QAM	4	–	9.95	11.06	11.71	12.06
	4	2/3	13.27	14.75	15.61	16.09
	4	–	14.93	16.59	17.56	18.10
	4	5/6	16.59	18.43	19.52	20.11
	4	7/8	17.42	19.35	20.49	21.11
64-QAM	6	–	14.93	16.59	17.56	18.10
	6	2/3	19.91	22.12	23.42	24.13
	6	–	22.39	24.88	26.35	27.14
	6	5/6	24.88	27.65	29.27	30.16
	6	7/8	26.13	29.03	30.74	31.67

Let's assume guard interval 1/16,
 QPSK 2/3: $7,81/8 = 0,97$ b/s/Hz
 16 QAM 2/3: $15,61/8 = 1,95$ b/s/Hz
 64 QAM 2/3: $23,42/8 = 2,92$ b/s/Hz

Users will be modelled regarding their demanded bit rate for both downlink and uplink, and parented/attached to base stations.

As the customer base is growing, there must be a measure of the simultaneity of users requesting bit rate from the Base Stations because most users won't demand data at the same time and many of those connected will demand data whose packets can be delivered assuming some latency or jitter (best effort data applications as web browsing).

Example of Voice/IP Data Link Layer performance - MAC

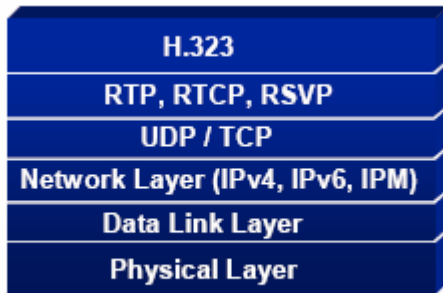


Figure 4: VoIP Protocol Structure

End-to-end delay is a significant issue when voice data is transported across IP networks. Delay can cause two types of problems echo, and speaker (talker) overlap. Echo becomes a problem if the delay exceeds 50 ms. Delay induced echo can be overcome by the use of echo cancellation technology. Speaker overlap, a problem of one talker stepping on the other talker's speech, becomes a problem if delay exceeds 250 ms and cannot be corrected.

Delay is introduced from several parts of the signal chain and has three major components algorithmic (accumulation) delay, processing delay, and network delay. Algorithmic delay comes primarily from the voice coding algorithms ranges from 125 is to 30 ms. Processing delays are primarily due to packetization and can be up to 30 ms. Network delay itself has three primary components and includes transmission time due to signal propagation (for example 15 ms for New York to Los Angeles), delays through routers (on the order of 10 is each), and the jitter buffering performed at the receiving end (70 to 100 ms).

Jitter is a variable inter-packet timing caused by the network packet transverses. Jitter can be removed by collecting packets and holding them long enough. This allows the slowest packet to arrive in time to be played in the correct sequence—but this causes delays. For VoIP to be successful, a system must minimize delay and remove jitter.

Packet loss is another QoS issue for packetized voice. IP networks cannot provide a guarantee that packets will be delivered at all or in an order. Packet losses greater than ten are generally not tolerable, as packets will be dropped under peak loads and during periods of congestion. Normal TCP-based retransmission schemes are not suitable due to the time sensitivity of voice transmissions. Some approaches for compensating packet loss is by the interpolation of speech by replaying the last packet and by sending of redundant information.

This user simultaneity is defined by a parameter we call **contention ratio**. For example, BT IPStream products have 2 contention ratios for ADSL 50:1 and 20:1. The contention ratio means that you could be sharing the bandwidth you have with up to that many users.

As an example, a user who contracted 512 kbps will be downloading data along 1 hour comprising bursts of data 512 kbps, let's say that these bursts have 1 minute length in time and happen every 5 minutes. Then this user is having a real demand of a fifth of the contracted bit rate, that is 102.4 kbps and contention ratio would be 5:1.

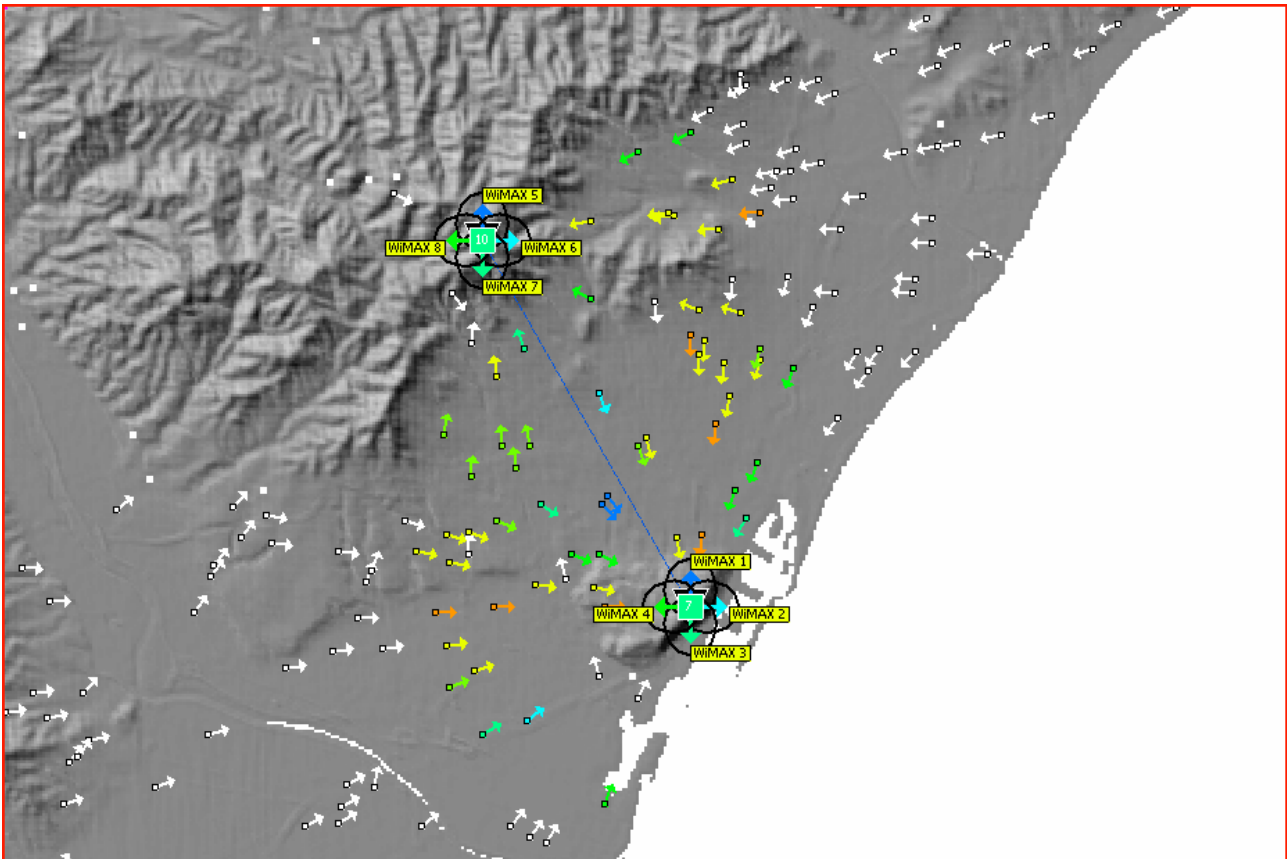
<p>ATDI Ibérica C/ Manuel González Longoria, 8 28010 Madrid – España Telf.: +34 91 44 67 252 / Fax: +34 91 44 50 383 NIF: N0013090-F</p>		
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Typical values for contention ratio can be about 30:1 for residential users (less priority) up to 10:1 for business users (higher priority and throughput).

Note: We already know that each user's radio link from/to base station is guaranteed after radio link planning by ICS Telecom.

2.- TRAFFIC ANALYSIS IN ICS TELECOM

Once on the planning tool, ICS Telecom, we will create the scenario of our planned network where Base Stations are already set on their location and parameterised regarding equipment configuration (frequency, EIRP, etc.) and users have also been located and parameterised. This scenario could come from a complete planning process: search for sites regarding existing or random users, selection of best station located on existing sites, frequency assignment, etc.



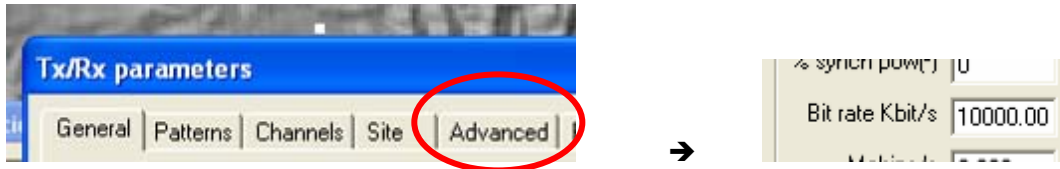
Now we must face the final test of the network, that is, analysis its capacity to satisfy the user traffic demand.

For this purpose we will model traffic parameters as bit rate both at Base Stations side and customer CPE premises.

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For Base Stations we will set the highest bit rate it can provide in a peak hour, this is just its maximum technical configurable bit rate offered. Let's say it is 10 Mbps for a single sector:

► Menu Tx/Rx parameters/advanced



For users we will set a bit rate according to user type and contention ratio. For example we can have two kinds of users:

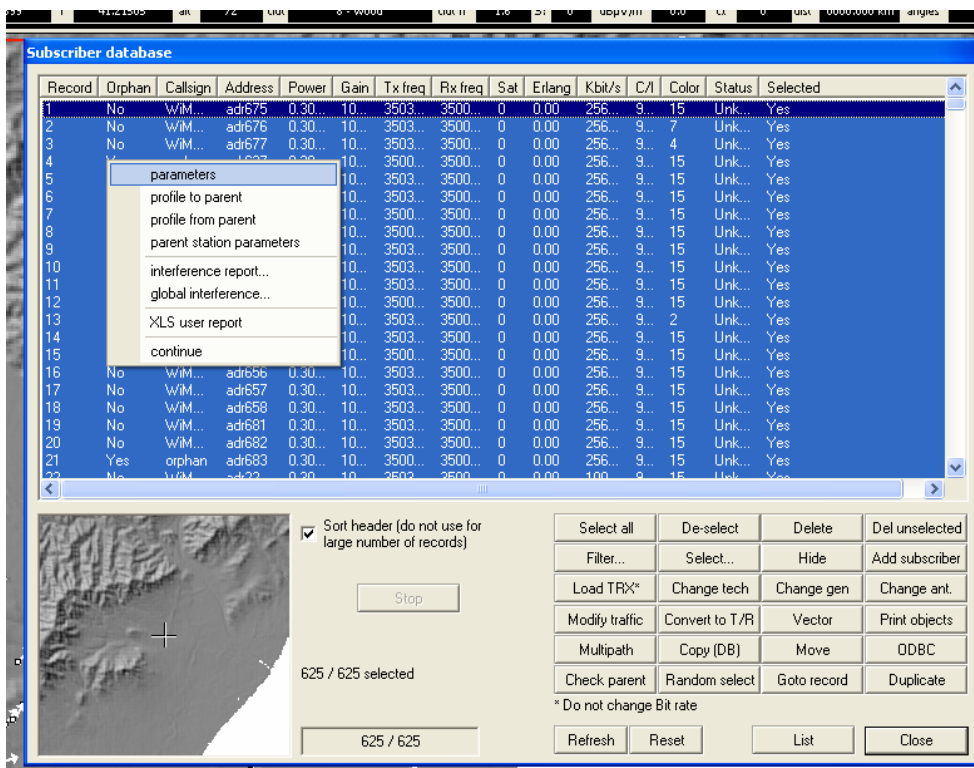
- .- Business: bit rate = 2 Mbps DL / 512 kbps UL contention ratio -> 10:1
- .- Residential: bit rate = 512 kbps DL / 128 kbps UL contention ratio -> 30:1

Then traffic parameter at users will be:

- .- Business: $2000/10 = 200$ kbps DL / **51** UL
- .- Residential: $512/30 = 17$ kbps DL / **4.2** UL

And this is the value we will use for customers.

► Menu Base/DB Subscriber:

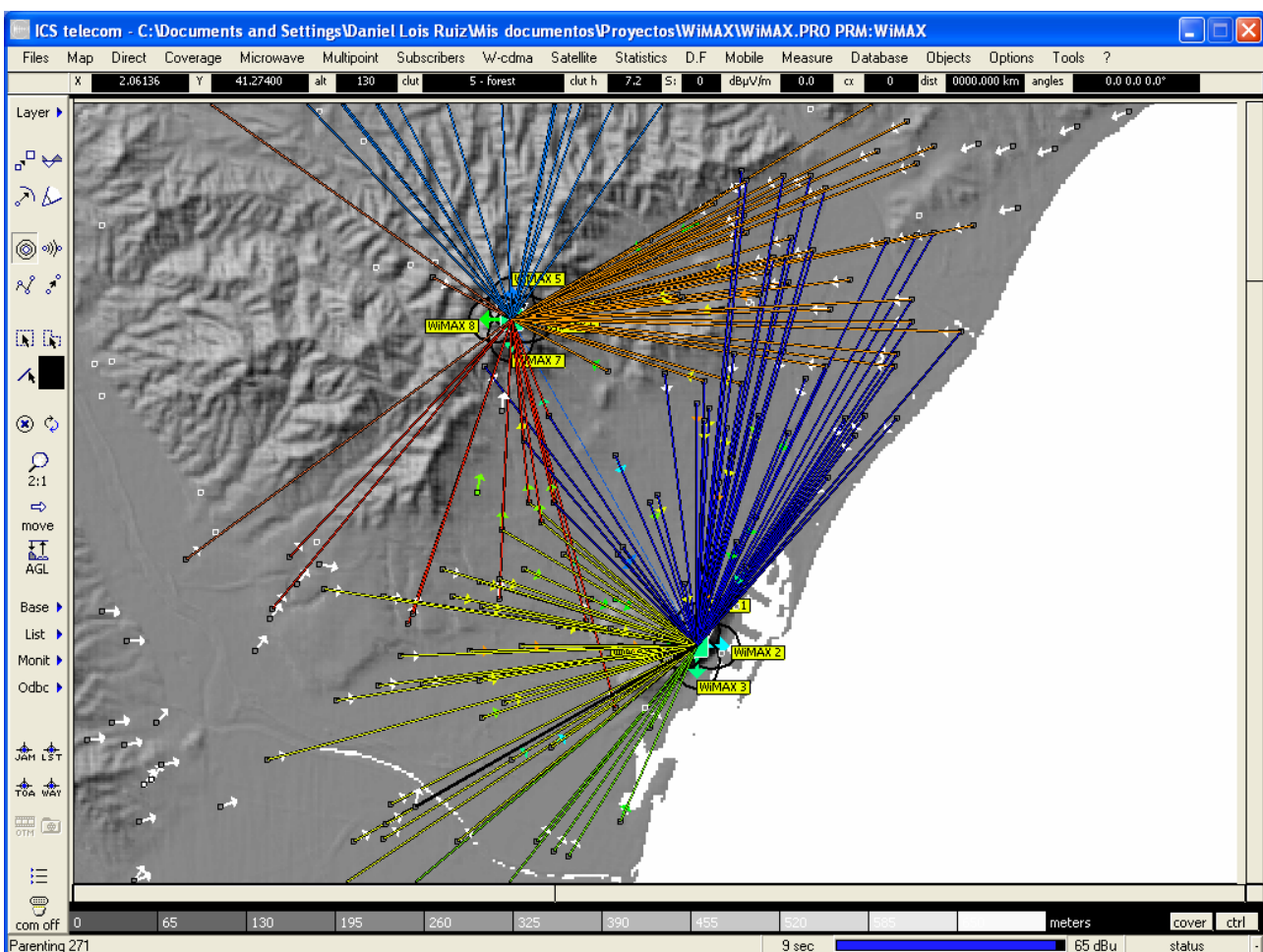


Kbit/s (down/up)	200.00	51.00	and	Kbit/s (down/up)	17.00	4.00
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Then after parenting analysis, ICS Telecom will measure the integration of bit rate demand on each base station, when a base station has already been demanded all its available bit rate, no other user will be connected to that base station, even though the new user may have a good radio link and connectivity is possible.

► Menu Subscribers/Parenting

Gain diffusion
 Connecting to best server - control bit rate*2
 Connecting to nearest server - control bit rate*2
 Sort sub adaptive mod... site dispatch (trig)



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Station	BST	Subscribers	D
WIMAX 1	1	63	
WIMAX 5	2	31	
WIMAX 2	5	0	
WIMAX 3	6	14	
WIMAX 4	7	69	
WIMAX 6	8	73	
WIMAX 7	9	25	
WIMAX 8	10	6	



	Mbits ul	Mbits dl
00	0.25	1.07
00	0.12	0.53
00	0.00	0.00
00	0.06	0.24
00	0.28	1.17
00	0.29	1.24
00	0.10	0.43
00	0.02	0.10

Total parented subscribers (selection): 281 (44.96 pc)

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