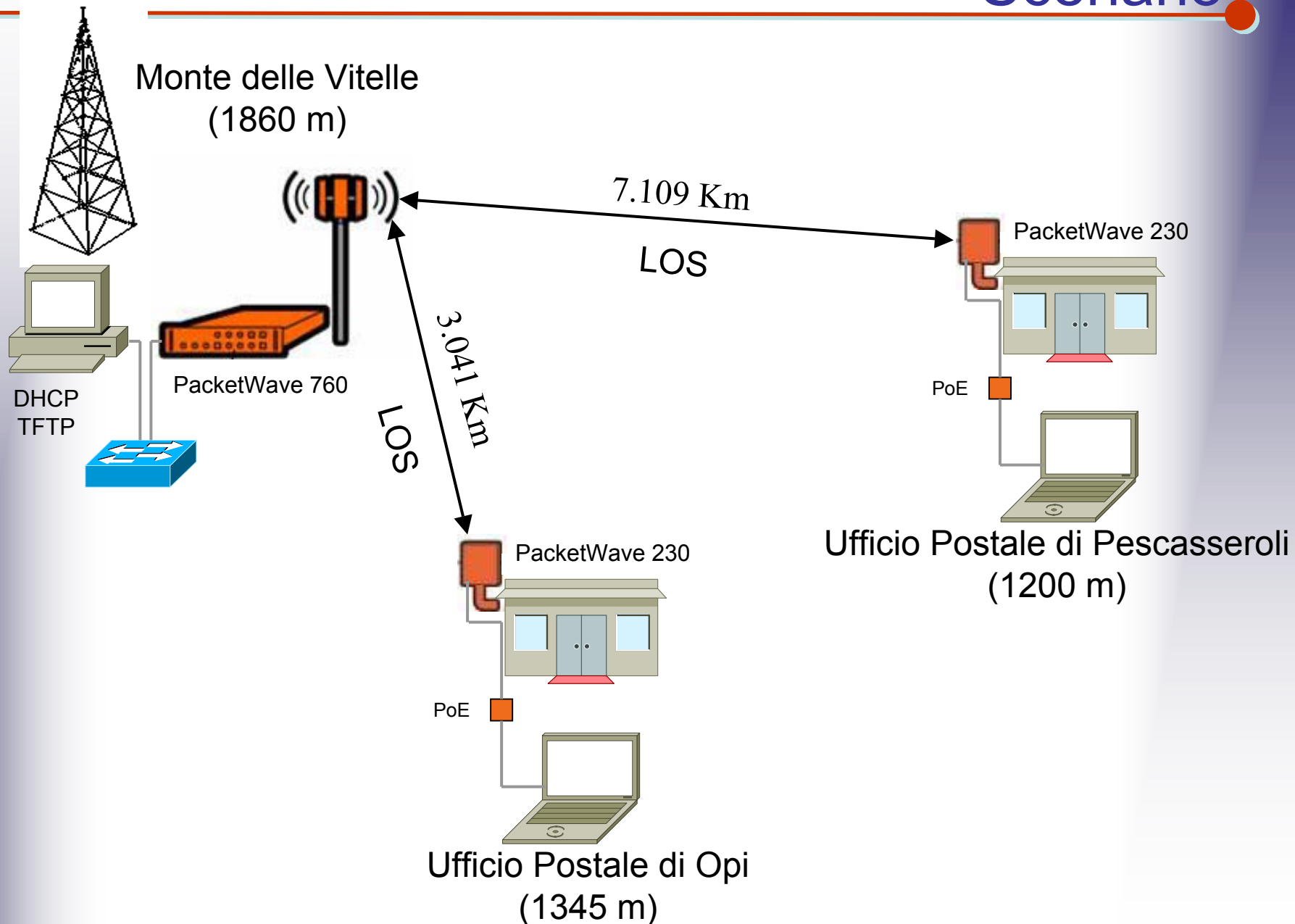


i n f o t e l

Giornata di Studio sul WiMAX

- Infotel S.p.A. in qualità di partner ha sperimentato la tecnologia Aperto Network
- La sperimentazione è stata condotta in Abruzzo (ambiente montuoso).
- Infotel ha ottenuto la disponibilità da parte di Poste Italiane ad utilizzare i propri uffici postali.
- Poste ha contribuito alla sperimentazione.





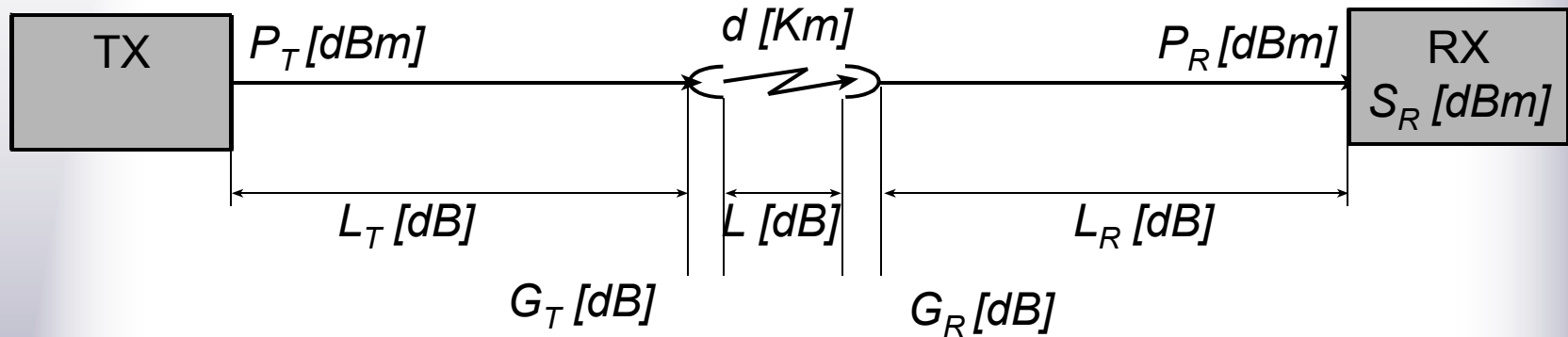


- Base Station = **PacketWave 760**
- Subscriber Unit = **PacketWave 230**
 - Frequency band: ETSI 3.5 GHz (3.410 – 3.800 GHz)
 - Channel width (MHz): 1.75, 3.5, 7
 - Tecnica di duplexing utilizzata: TDD
 - Tecniche di modulazione utilizzate: QPSK e 16-QAM (64-QAM già disponibile)
 - Sensibilità in ricezione:

	CPE	Base Station
High Symbol Rate (4.8 Mbauds)		
16QAM	-83.7 dBm	-83.7 dBm
QPSK	-90.7 dBm	-90.7 dBm
Low Symbol Rate (2.4 Mbauds)		
16QAM	-86.7 dBm	-86.7 dBm
QPSK	-93.7 dBm	-93.7 dBm

SNR requirements (BER = 10^{-6}) for High Symbol Rate:
 Downstream: 18.5dB/16QAM; 12.0dB/QPSK
 Upstream: 18.5dB/16QAM; 12.0dB/QPSK

- Service classes: CBR, CIR and Best Effort
- Differentiated scheduling:
 - CBR \Leftrightarrow Unsolicited Grant Scheduling
 - CIR \Leftrightarrow Real Time or Non-Real Time Polling
 - Best Effort \Leftrightarrow Round Robin
- Up to 16 service flows for intra-QoS
 - Up to 13 for traffic
 - Up to 3 for management
- Classifiers at layer 2, 3 and 4
 - MAC addresses, VLAN, 802.1p
 - IP addresses, IP ToS
 - Port numbers, etc.



$$f = 3443,50 \text{ MHz}$$

$$\lambda = \frac{300}{f} = 8,71 \text{ cm}$$

$$d = 7,109 \text{ Km}$$

$$L = 10 \log_{10} \left(\frac{4\pi d}{\lambda} \right)^2 = 120 \text{ dB}$$

$$G_T = 16 \text{ dBi}$$

$$G_R = 17 \text{ dBi}$$

cavo RF utilizzato RG58 (-1,3 dB/m)
lunghezza di collegamento = 10 m

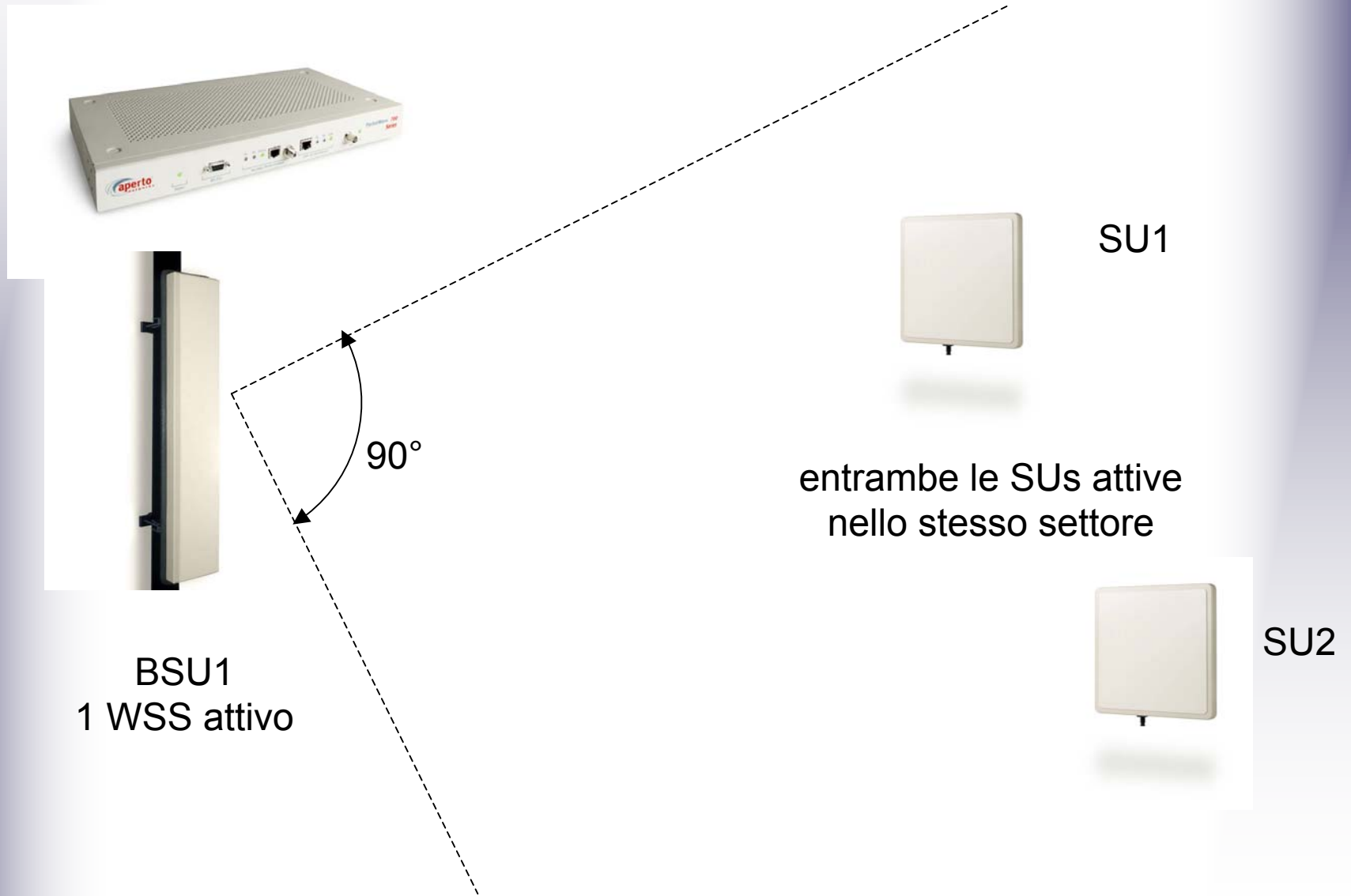
$$L_T = 14 \text{ dB}$$

$$L_R = 3 \text{ dB}$$

$$P_R = P_T - L_T + G_T - L + G_R - L_R = -84 \text{ dBm}$$

System Variables	
Frequency Band [GHz]	3,5
Channel Bandwidth [MHz]	7,00
Distance [m]	7109
Path Loss Exponent [n =]	2
Availability [%]	99.99
Noise BW [MHz]	4,8
16QAM SNR Threshold [dB]	18,50
QPSK SNR Threshold [dB]	12,00
Calculated Fade Margin [dB]	16,84

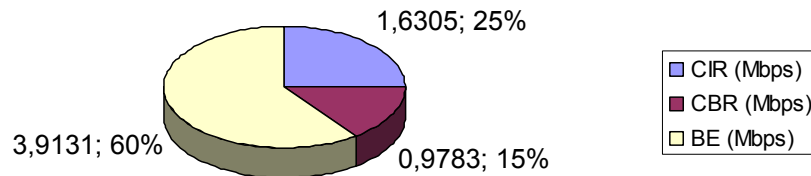
Link Budget				
Tx Power	20	dBm	100	mW
Tx Antenna Gain	16	dBi		
Tx Cable Loss	13	dB		
Tx Connector Loss	0,37	dB		
Tx EIRP	200	mW	22,63	dBm
Path Loss	120	dB		
	-97,71	dBm		
Fade Margin	16,84	dB		
			-114,55	dBm
Rx Antenna Gain	17	dB		
			-97,55	dBm
Rx Noise Power	-114,5	dBm		
Rx Noise Figure	5,5	dB		
SNR			16,95	dB
Link Margin for QPSK	4,95	dB		
Link Margin for 16QAM	-1,55	dB		



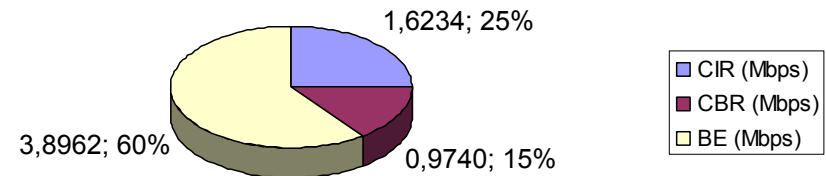
- Throughput
- Statistiche di traffico
- Qualità del segnale

- Banda Netta = 14 Mbps
- Rapporto Upstream/Downstream = 50/50
- Allocazione della banda
 - Best Effort (0 – 100 %) = 60%
 - CIR (0 – 100%) = 25%
 - CBR (0 -100%) = 15%

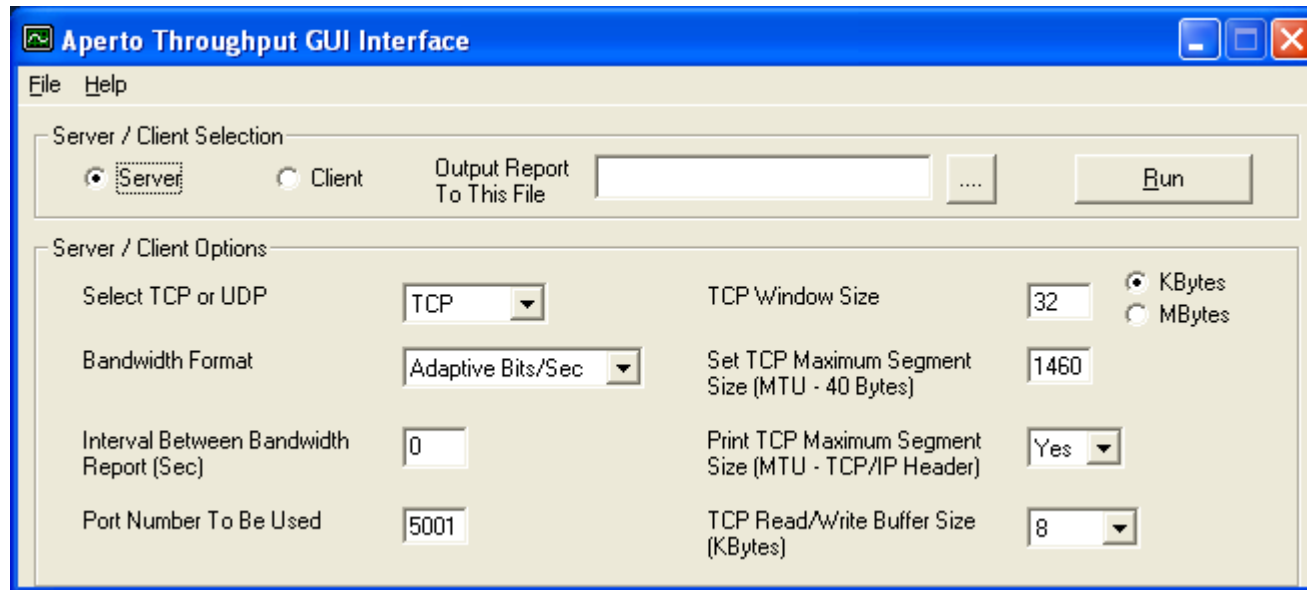
Allocazione Upstream



Allocazione Downstream



- Ogni CPE è stata configurata con un Service Flow di tipo BE senza Data Peak Rate
- La banda max loro riservata è:
 - 3.9131 Upstream
 - 3.8962 Downstream



- TCP Windows Size = 256 Kbyte
- TCP Maximum Segment Size = 1460 Byte
- Number of Parallel Connection = 24
- Duration of the Test = File Length & Time
- Throughput effettivo rilevato = **2,83 Mbps.**

Total packets seen in the last 3600 sec

<i>Service Flow Detail</i>	
WSS Tx Packet Count	146555
WSS Rx Packet Count	147182
WSS Tx Byte Count	138227367
WSS Rx Byte Count	138067812
WSS Tx PPS	AVG: 40; MAX: 227
WSS Rx PPS	AVG: 40; MAX: 227
WSS Tx Bytes PS	AVG: 38396; MAX: 222968
WSS Rx Bytes PS	AVG: 38352; MAX: 223352
Average WSS Tx Packet Size (Bytes)	943
Average WSS Rx Packet Size (Bytes)	938

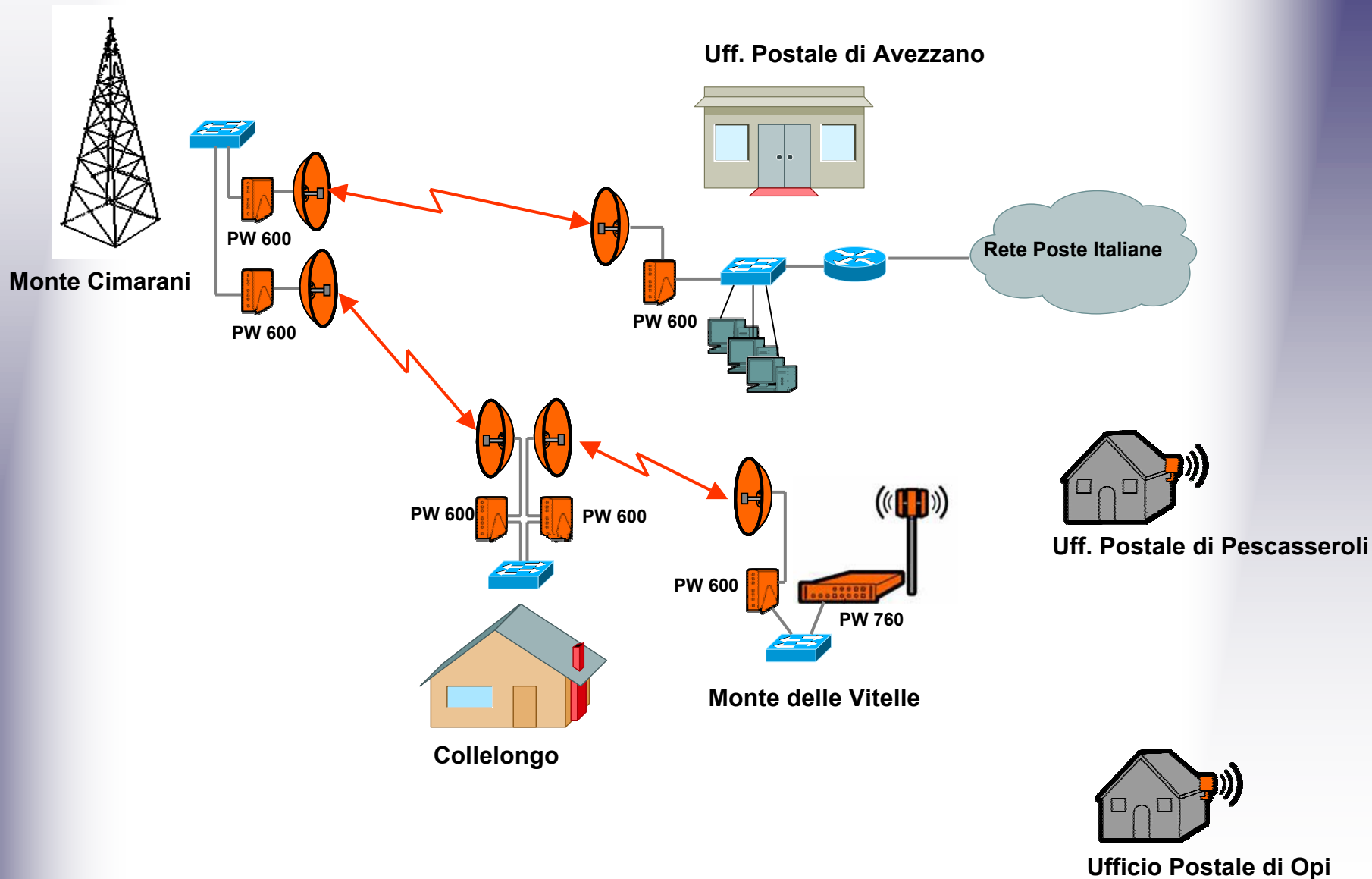
<i>Signal Quality</i>	
Bursts	1489186
Burst with Energy	1488015
Errors	11205
No Unique Word Detected Count	9879
Collided Burst Count	0
No Energy Count	1171
Payload Length Err. Count	0
CRC Err. Count	1326
Burst Error Rate	0,75%

- Possibili sviluppi futuri prevedono la realizzazione di un collegamento radio tra la stazione base della sperimentazione WiMAX attualmente in corso e l'ufficio postale di Avezzano

Collelongo –
Mte Cimarani

M.te delle Vitelle-
Collelongo





- Analizzare il comportamento del sistema in un ambiente di esercizio simulato
- Misurare le prestazioni in presenza di 4 hops:
 - throughput
 - latenza
 - jitter
 - BER, PER, ecc.
- al fine di validare il sistema per il trasporto dei dati “time sensitive”.