Orthogon Systems

Comparison of OS-Gemini with WiMAX

N. J. R. King

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1 Introduction

Figure 1 illustrates a deployment of a typical wireless network, the red dots represent the subscribers, the thicker blue lines (BC, BD, BE, BF, and BG) represent the back-haul from the base-stations to the fibre point of presence, and the black line (AB) represents the fibre.

As can be seen from this diagram, the value of each of the links increases as you move from a single subscriber up the network to the fibre. At each part of this hierarchy there are differing optimisations to be made.

Standards are very important to ensure that this network will work well with a minimum of maintenance; however, the standards appropriate to one part of the network, are not necessarily the same standards as will be appropriate for another part of the network. This paper assesses the suitability of the WiMAX standard for the back-haul portion, and compares this with the OS-Gemini.

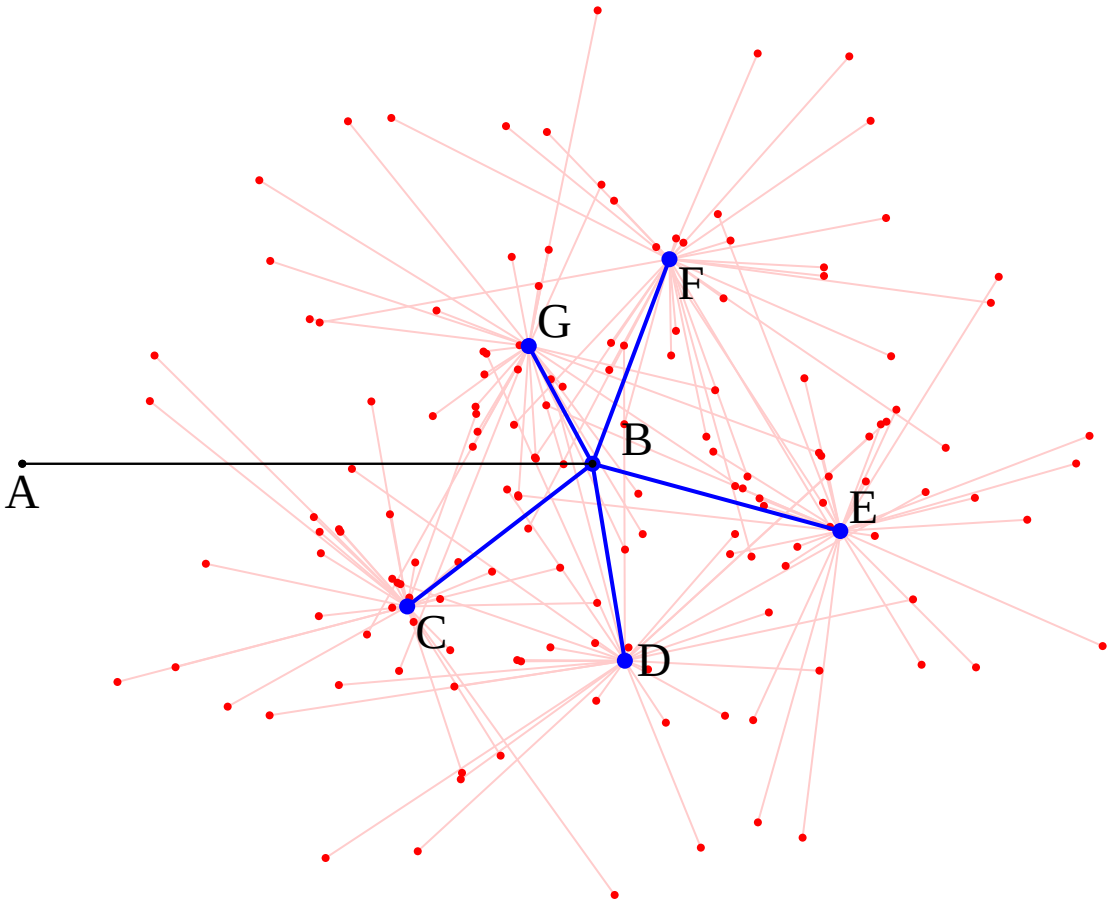

Figure 1 Typical area deployment

2 Requirements for Back-haul Point to Point and Access Systems

The requirements of the access portion of the network are very different to those of the back-haul. This is because of the differing value of the communications which take place over them, and the quantity of each component that will be used in the network. For instance, it is much more important to place a base-station in the best position for subscriber coverage, than to place the base-station in the best position for the back-haul.

The next two subsections deal with the specific differences in these requirements for the access portion and the back-haul.

2.1 Access

The access portion of the network is characterised by there being a large number of terminations. Typically there will be between 100 and 3000 of these per base-station (access point) and thus the traffic carried by the back-haul is typically 100 to 3000 times as important as the traffic on the individual access. Of course the back-haul does not need to be 3000 times the data bandwidth, since the laws of large numbers comes into play and the traffic per subscriber does not usually average more than 28 kbps, despite the requirement for bursts which are much higher. The requirements for the access portion of the network are;

- A network of a large number of similar devices sometimes but not exclusively connected to base-stations,
- Expansion of the network using similar protocols needs to occur over many years,
- Cost of the devices needs to be very low,
- There needs to be multiple sources for devices in the access network, and
- Replacements for compatible network components must be available for many years.

These requirements lead one to the conclusion that the air interface and termination must be standardised, since the requirement is for the replacement of the terminal with a terminal from another manufacturer.

2.2 Back-haul

In figure 1 it can be seen that there are a small number of these links in comparison to the access network. Since many terminals may be dependant upon the Point to Point links, the performance must be very high. Requirements for the back-haul network can be summarised as;

- High reliability,
- High link capacity,
- Low latency,
- Install anywhere,
- High spectral efficiency,
- Multiple sources for links, and
- Replacements for compatible network components must be available for many years.

Note that it is the links that need to be available from multiple suppliers rather than each end of a link.

Standardisation of the network interfaces for this back-haul is very important and that is why OS-Gemini uses Ethernet 100baseT as the termination with IP for the management interface using SNMP, Web or Telnet.

3 Comparison OS-Gemini with WiMAX

There is often a call for WiMAX compliance from Point to Point equipment. There is an assumption that WiMAX will provide the lowest cost and highest reliability for this connection. There is no dispute that WiMAX would provide the lowest individual cost for a link however a single link may not then do what is required of it. A WiMAX device will have been optimised for lowest cost. With up to 3000 subscribers depending upon one back-haul it is not difficult to imagine the larger data rates will be required on the back-haul components. The Access network will often make very large demand upon the spectrum, the back-haul has to make use of it's narrow beam antennas and use it's better signal to noise to enable higher speeds. It will often also be a requirement that the back-haul must use larger ranges.

Table 1 compares OS-Gemini with WiMAX. Remember that WiMAX is a Point to Multi-Point or Mesh protocol. It is not defined for Point to Point operation. In some cases it is not specifically defined yet for 5.8 GHz operation which is why in certain cases there is more variability in the WiMAX specification.

Innovation is required in the back-haul to enable greater speeds from smaller amounts of spectrum. OS-Gemini's software defined radio is well placed to take advantage of these innovations and we expect OS-Gemini to increase Ethernet delivered data rates up to 7 bits/second/Hz of RF bandwidth.

4 Shared Spectrum

In many deployment cases WiMAX will be deployed in the same band as OS-Gemini, in this condition it is important to ensure that the systems do not interfere with one another and also that the best use is made of the available spectrum.

OS-Gemini works in the 5.8 GHz band using Time Division Duplex (TDD). There are a number of Point to Multi-Point systems that also use TDD. WiMAX recommends TDD in this spectrum. Interference can occur when a high power transmitter is operating in the vicinity of a sensitive receiver. The causes of this interference can be because the transmitter actually transmits the interference or because of some nonlinearity or lack of selectivity of the receiver.

Aspect	WiMAX	OS-Gemini	Comments
OFDM	OFDM with 256 point FFT	OFDM with 1024 point FFT	1024 point offers greater efficiency and higher dispersion capability
Modulation	6 modes from QPSK 1/2 to 64QAM 2/3	8 modes BPSK 1/2 to 64QAM 7/8	Greater sensitivity of BPSK 1/2 assists in the NLoS operation while 64QAM 7/8 allows greater data rates.
Pilots	8	128	Enables fast recovery from fade giving instantaneous demodulation
FEC	Concatenated Reed-Solomon and Convolutional	Concatenated Reed-Solomon and Convolutional	Almost Identical
Cyclic Prefix	1/4, 1/8, 1/16 and 1/32	1/8	The dispersion for NLoS operation is fully accommodated.
Bandwidth	20 MHz	11 MHz	Spectrum efficiency of providing 33.6 Mbps in 11 MHz of RF bandwidth is class leading. A smaller bandwidth can be provided if necessary to provide the spectrum utilisation required.
MAC	Polling	Point to Point	It is unnecessary to provide the complexity and inefficiency of a Point to Multi-Point Mac for a Point to Point product.

Table 1 Comparison of OS-Gemini with WiMAX

The mitigation of this interference can be by higher performance components, avoidance by synchronisation or avoidance by strategic placement of components. The following subsections provide more detail about each.

IEEE 802.16 generates the specification which WiMAX follows. An ad-hoc subgroup of 802.16 is in the process of being formed which is to study the problem of interference between the various components. It expects to optimise the coexistence of the various technologies using the unlicensed bands. We expect to contribute to this study.

4.1 High Performance Components

While this might be an option for the higher value Point to Point links, it is unlikely to be an option for the lower cost access components.

4.2 Synchronisation

In the access network sometimes synchronisation is employed in order to ensure that the base-stations do not interfere with one another. Some improvement in network efficiency can also arise if the back-haul also is also synchronised to the same timing. Network topology can sometimes stop this from being possible. Consider the case in figure 1 of an access base-station being located at the junction between the fibre and the back-haul. If this was the case there would be a conflict between the base-station timing synchronisation and the back-haul synchronisation.

4.3 Strategic Placement

This is always an option when the performance is reasonably good. Placement of the Point to Point link below the base-station antennas is usually recommended and the spacing will often need to be 10 feet.

5 Conclusion

Standards are very important in telecommunications but standards must be used appropriately. The back-haul links should comply with standards at it's external interfaces. It should also comply with coexistence standards for the shared medium (the radio spectrum). There is however no need for the back-haul to comply with the air interface standard of WiMAX because there is no requirement to inter-operate at this level with the access equipment, indeed compliance with WiMAX would reduce the performance of the back-haul and thus would be undesirable.