PUBLIC VERSION

TELSTRACLEAR

TelstraClear's Use of Wireless

Overview

1. Telecom asserts in its Response that:

   - TelstraClear's deployment of fixed wireless network using Alvarion technology would allow it "to extend the availability of .service to a large number of customers – potentially up to 200,000 (depending on the costs of deploying their sites)– and to do so in a targeted way, aimed at the highest value business customers"[1]; and

   - TelstraClear's proposed deployment of a UMTS (3G) platform would allow TelstraClear "to substitute fixed voice services as well as potentially offer cost-competitive high-bandwidth broadband plans, where a 20 per cent discount on business data would be feasible, using marginal costing"[2].

2. Telecom:

   - understates the costs of deployment and therefore overstates the potential customer reach of the FWA network being deployed by TelstraClear, by up to 10 times;

   - overestimates the capabilities of the Alvarion technology, and wireless in general, to support business grade data services which are competitive with those which Telecom can offer over its copper network (and which competitors could offer using LLU and bitstream); and

   - misleadingly implies that UMTS can provide broadband services which are competitive with Telecom's xDSL services.

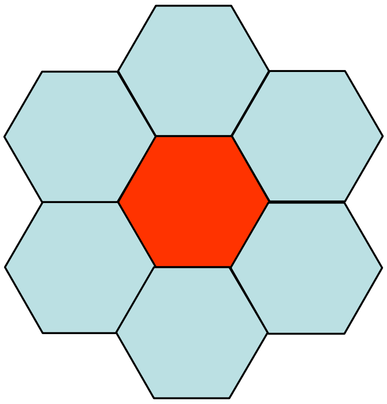
3. TelstraClear's FWA network, as with other radiocommunications networks, faces technical limitations, such as line of sight requirements, and capacity and contention limitations, which make it uneconomic for provision of business grade data services. TelstraClear is deploying its FWA as an interim measure to provide POTS and medium speed, internet grade broadband access pending resolution of access to unbundled access services which can support the high quality, high bandwidth services. TelstraClear is also deploying the FWA to bypass the high costs of Telecom local tails, which result from an absence of cost based regulatory requirement for data tails.

[1] para 185, Telecom Response to Commission's Draft Report, 29 October, 2003.
2 para 187, Telecom Response to Commission's Draft Report, 29 October, 2003.

Fixed Wireless Deployment

4. TelstraClear has the management rights to 27 MHz of spectrum at 3.5 GHz. As Telecom notes, TelstraClear has publicly announced that it will be deploying a limited radiocommunications network using Alvarion's BreezeAccess technology[3]. BreezeAccess operates with 1.75 or 3.5 MHz channels and has a spectrum efficiency of 2.5 bit/Hz[4]. It uses coherent orthogonal frequency division multiplexing to achieve this high modulation efficiency.

5. First, Telecom overstates the geographic coverage possible using this technology. The arrangement for delivery of broadband wireless access is cellular (but with no inter-cell handover). To allow for frequency re-use in adjacent cells, the frequency reuse is 7. This can be pictured as a hexagon surrounded by six other hexagons – each must use a different channel.



Each cell can use a 3.5 MHz channel to cover the area where services are supplied. There is a little better efficiency if adjacent cells are not required. The area covered by each cell is theoretically the area of a hexagon, which is given by:

$$\frac{\sqrt{3}}{2} \times W^2$$

The maximum value for W will be a maximum of 14 km, because customer premises greater than a radial distance of 7 km from the base station consumes a disproportionate amount of capacity. Realistically, the normal cell size is likely to have a diameter of 3 – 4 km. Even at four kilometres, the area covered is 13.85 km2. Even if 80 sites were built, as Telecom claims, the total area covered would be 1,100 km2, rather than the 5,000 – 10,000 km2 suggested by Telecom. TelstraClear, as discussed below, is building only a maximum of [ ][**TelstraClear designated Restricted Information**] cell sites, which would cover an area of only 277 km^2.

6. Second, Telecom overestimates the number of sites TelstraClear is deploying for the $14 million investment. TelstraClear is deploying fixed wireless infrastructure in limited zones within the following urban areas (number of separate zones specified):

3 Alvarion press release of 11 June 2003 at http://www.alvarion.com/Runtime/CorpInf_30130.asp?fuf=342&type=item.
4 Alvarion specifications at www.alvarion.com.

Figure 1: TelstraClear Planned FWA Deployment Areas [table contains TelstraClear designated Restricted Information]

urban area	no. of separate zones
[	
	]

7. Telecom overestimates the coverage of the TelstraClear wireless deployment because it fails to take into account the costs of the fixed network infrastructure required to support each base station. These costs fall into three categories:

- intra-city fibre to reach the base station site;

- "skeletal" fibre ring in the base station area. The FWA network is not suitable to connect customers with more than 8 lines or with high speed or committed rate data requirements (usually mid-sized SMEs and larger businesses with 20 or more employees) because their service requirements consume disproportional amounts of the limited spectrum available. TelstraClear's experience is that it is impracticable to target marketing in an area only to those SMEs which would be suitable to connect to the wireless network: we do not accurately know the number of lines which customers have or their data requirements until we knock on their door and TelstraClear risks damaging its marketing efforts and profile if its receives a large number of responses to its campaigns which have to be refused. Accordingly, we deploy a limited fibre ring in the cell area of each base station to connect customers with more than 8 lines or more sophisticated data requirements; and

- transmission backhaul to the TelstraClear network. This may involve the construction of new network, such as in the case of Nelson. Other areas already have backhaul, but it may have to be upgraded (e.g. Rotorua, Napier) while in yet other areas there is already sufficient capacity and the backhaul costs are limited (e.g. Auckland).

The costs are set below:

Figure 2: FWA Deployment Costs [table contains TelstraClear designated Restricted Information]

Base station:	[
Base station installation and fit out:	
Fibre links, including skeletal ring to support direct fibre (larger) customers :	
Backhaul:	
CPE including install	]

8. TelstraClear has recalculated the "cost curve" Telecom plots for the TelstraClear FWA network, as set out in figure 3: **[contains TelstraClear designated Restricted Information]**

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This cost curve does not take account of the inverse relationship between the number of customers which can be connected and the quality of the service provided, which is discussed below.

9. Third, Telecom overestimates the number of customers within each cell area which can be connected to the TelstraClear. About half of the sites for which customers request service turn out to be unsuitable because of the inherent problems of radio communications networks, including building shadow and line of sight. Telstra informs us that it experienced problems at a similar level with a FWA they deployed in Australia. A "mis-connect" costs approximately [ ][**TelstraClear designated Restricted Information**] for wasted "truck roll" to the customer premises, which is an overhead to be met from the sites which are successfully connected.

10. Fourth, and most importantly, Telecom overestimates the number of customers which can be served using TelstraClear's FWA network. Telecom suggests that TelstraClear could supply a wide range of voice and data services to over 200,000 customers. The network has been designed to serve a maximum of 20,000 Lines providing a limited number of narrowband POTS lines and medium speed 256 kbit/s internet grade data services (i.e. data services with no quality of service or capacity commitments). As discussed below, the number of customers which can be supported by a base station drops steeply if higher bandwidth services or committed rate (business grade internet) data services are offered. If business grade services were provided over the TelstraClear FWA network, the number of customers who could be supported on the network would fall to fewer than 10,000 lines

11. The number of customers which TelstraClear can connect to the FWA network it is deploying, and the type of services they can be offered, is constrained by the characteristics of radiocommunications networks. As Dr Milner from Telecom pointed out in his technical presentation on Monday 10 November, radiocommunications networks are shared medium networks, which means that the available capacity must be shared by customers within the coverage area, unlike fixed direct connect copper and fibre networks which give each customer the exclusive use of the capacity which can be provided over the line. The ratio of customers to available spectrum is called the "contention ratio": the higher the contention ratio, the lower the grade of service which can be guaranteed by the operator because more customers are competing for the limited capacity.

12. Operators count on connecting substantially more customers to their radiocommunications networks than the available spectrum can support (called "over-subscription") because they count on customers not all wishing to use their services at the same time. Oversubscription ratios also can be much higher for narrowband services, such as POTS lines, and lower grade data services, such as broadband access to the Internet, where the impact of high simultaneous usage does not significantly affect the customer's perception of the service or the customer is prepared to tolerate it ("my internet access seems slow today"). Hence, although the customer may be supplied with a 256 kbit/s internet broadband service, the actual speeds which are available may vary from time to time, and the operator accordingly will only provide the service on a "best efforts" basis (internet grade data service). FWA operators supplying broadband internet access design their networks with an oversubscription ratio of up to 100.

13. If customers want service guarantees on capacity or a committed bit rate service, contention ratios must be much lower. In effect, the customer has to be provided with a "nailed up" circuit through the air which dedicates a slice of the available spectrum to that customer. Data services delivered over FWA will not be competitive with fixed network services such as DDS or Frame Relay unless it can offer committed

bit rate services. As the examples below show, a small number of customers with committed bit rate services will soon consume the radiocommunications capacity available at each base station and the costs per customer rapidly escalate.

14. In the "pre-IP world", the higher revenue which could be achieved from committed bit rate services such as Frame Relay may have justified connecting the customer (usually a large corporate) by wireless, even though only a few customers could be supported with the available spectrum in each area (in any event, a point to point wireless solution is usually adopted for large customers). However, IP services can now be provided with quality of service and capacity commitments which bring higher quality data services (business grade Internet) within the reach of SMEs for whom "traditional" committed bit rate services were too expensive. But radio, which may have been suitable for provision of narrowband POTS and Internet grade data services to SMEs, is not feasible to deliver these business grade services to SMEs because so few of them can be supported with the available capacity per cell whilst maintaining the level of quality customers demand. Other connection options, such as building fixed network facilities, are even less economically feasible.

15. Telecom mainly offers internet grade services to SMEs over its DSL services, mainly to protect its "traditional", higher services from cannibalisation[5]. However, as TelstraClear has previously submitted, IP services are likely to be extended (and technologically can) support quality of service levels which are comparable to the committed bit rate services. As this occurs, wireless networks will not be competitive against Telecom's business grade IP services over DSL.

16. Turning to the capacity of the TelstraClear FWA network, each base station can support a maximum of 28 mbps. Each base station is divided into 4 sectors which operate separately to support customers within its 90 degree arc and each sector can support 6.5 mbps (capacity has to be bothways and consumes spectrum for uplinks and downlinks to each customer). Each cell of 13.85 km2 (about the area of the Wellington CBD) could only support the equivalent of 3 customers in each sector with committed rate 2 Mbit/s services. As set out in figure 3, if capacity is mainly used to provide narrowband POTS lines and 256 kbps internet grade broadband services, a maximum of 100 lines balanced between POTS and internet access can be provided per sector (or 400 POTS or Internet access lines per base station). A few committed rate data services such as frame relay also can be provided (and this allows TelstraClear to replace some high priced Telecom tails – see below):

5 see separate paper by point-topic on SHDSL.

Figure 3: Service Capabilities [Table contains Telecom designated Restricted Information]

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17. As the loading of each base station shifts to a higher number of data services requiring more capacity or committed bit rates, the number of lines which can be supported falls steeply. TelstraClear has provided in electronic form a spreadsheet which allows the Commission to vary the number of lines to see the impact of different ratios between internet grade data services and business grade data services. For example, if TelstraClear wanted to offer its IPVPN 200 service (which provides guaranteed bandwidth of 200 kbps) to 15 customers and its IPVPN 500 service (which provides bandwidth of 500 kbps) to 20 customers, all available capacity in the sector would be utilised and TelstraClear would have to cease providing every other service listed in table 3 (the IPVPN services cannot tolerate a contention ratio of more than 4). The number of lines would drop from 91 to 35 or from approximately 400 across the base station to approximately 150. The base station costs (including site and backhaul) per line would increase by nearly 3 fold, from approximately [ ] [**TelstraClear designated Restricted Information**] to approximately [ ][**TelstraClear designated Restricted Information**], a level which is likely to prove unsustainable given the revenues which can be generated from IPVPN services.

18. TelstraClear can deploy an upgraded version of the Alvarion technology (v.4), which will provide approximately twice the capacity at each base station. However, even with V4, base station capacity would be exhausted by 30 IPVPN 200 lines and 40 IPVPN 500 lines. 16. As base stations near their maximum capacity levels, substantial additional investment is required to expand capacity. The cell has to be split and a new base station has to be installed at a new site and up to half of the customers on the existing base station must have their antenna "repointed" to the new base station, which will involve a visit (truck roll) to the customer premises. The costs of expanding capacity can be [ ][**TelstraClear designated Restricted Information**] per site.

19. As Telecom currently is not required to supply local data circuits on a cost basis, data tails which TelstraClear acquires from Telecom are highly priced. TelstraClear currently acquires over [4,500] **[TelstraClear designated Restricted Information]** data circuits from Telecom at a total annual cost of [ ] **[TelstraClear designated Restricted Information]**. The cost savings from replacement of Telecom tails offsets some of the costs of the TelstraClear FWA network: for example, in Rotorua, these

cost account for [ ] **[TelstraClear designated Restricted Information]** of the gross margin.

UMTS

20. UMTS or 3G will provide customers with access to higher bandwidth mobile data services. But the hype over 3G has obscured the bandwidth capacities of 3G. A 3G cell may be able to offer high data rates to users, but this is limited by the number of concurrent users and the services that they are using. Further, the current UMTS specifications call for the design data rate to be 2.048 Mbit/s at the centre of the cell and 384 kbit/s at the cell perimeter.

21. According to the practical experience gained by Orange in France[6], the coverage of a cell designed for the maximum data rate will yield 2.048 Mbit/s over 60% of the cell and 384 kbit/s (minimum) over the balance. The cell size varies with use (the phenomenon of "cell breathing") and in an urban cell supplying 64 kbit/s services at 50% of design throughput, the cell diameter reduces by 20%[7].

22. Work completed on the mixture of voice and data services using EDGE (which is a reasonable proxy for UMTS) yield the theoretical (that is, best case) results[8] set out below:

Figure 4: Broadband Services achievable with mobile technologies

Erlangs/Sector	Data Throughput/Sector (Kbit/s)
42.1	0.0
36.5	208.3
31.9	416.7
27.3	625.0
22.8	833.3
18.4	1041.7
13.2	1250.0
9.0	1458.3
5.1	1666.7
1.7	1875.0
0.0	2083.3

That is, a single data user in a cell with no voice calls could achieve a data throughput of 2 Mbit/s. However, 10 data users in a cell that was supporting 600, three minute mobile voice calls per hour (the equivalent of 30 users making calls at any one time) would achieve a data throughput of about 100 kbit/s. This is about twice the rate of a dial-up modem service but not broadband.

6 Presentation by M Marzoug to esprit on 10 October 2003.
7 Presentation by M Marzoug to esprit on 10 October 2003.
8 Mixed voice and data capacity estimation for 3G Wireless Networks, Y. S. Rao and Prof. M. N. Roy, Qualcomm, 2003.

23. There is speculation that mobile may substitute for fixed voice. However, the limited bandwidth capabilities of UMTS make it difficult for competitors to use UMTS to offer substitutes for the Telecom IP voice and data services provided over DSL.

Wireless in an NGN World

24. Telecom has presented an image of a multi-service environment in which users in customer premises, including residential dwellings, can simultaneously access a range of "data rich" services, including video from the web, gaming, video conferencing, surfing the internet using broadband access, remote working, file sharing and personal web hosting[9]. As Dr Milner noted (with his "entrant CTO hat on"), this multi-services access vision is shared by entrants as the way of the future.

25. Wireless cannot support this multi-service access vision, other than for a limited number of customers in a cell site. As Telecom's Network Investment Manager said of Telecom's plans to update its copper network, the challenge for a multi-service access model is "getting enough bandwidth in place and of high enough quality[10]". Wireless, given it is a shared medium, cannot provide the amount and quality of bandwidth required to support the multiple bandwidth hungry services in multiple homes, in much the same way as wireless has difficulty supporting business grade internet services. This means that:

- the number of concurrent activities in wireless homes in any area is limited by the access network (finite resource issue);
- the number of wireless homes in any area is limited by access to the shared air interface; and
- the number of concurrent activities in wired homes in any area is limited by the core network.

The last issue is, as discussed below, common to DSL networks but the first two are specific to wireless.

26. Networks providing broadband Internet access (internet-grade services) are designed with average usage rates and bursting rates in mind. The average usage rate is the bandwidth capacity an end user requires when browsing the Internet, such as while reading a web site or switching between web sites. This capacity requirement is relatively limited. When an end user wishes to download a document, the service will "burst" to a higher speed to allow the document to be downloaded quickly. Therefore, the network needs to be designed, to accommodate the average user rates for the number of customers forecast to be using the broadband network, usually at the busiest time, plus capacity for a subset of those customers to simultaneously burst. In terms of the contention rates discussed above, the higher the contention rate lower the burst rate.

[9] Telecom's Next Generation Network, Murray Milner, slide 10, Monday 10 November, 2003.
[10] Russell Locke, afternoon session, Monday 10 November, 2003.

27. The dynamics and consequences of bursting are very different on fixed DSL networks and wireless networks. As Dr Milner explained, DSL services can burst to the maximum rate of the DSL access service provisioned to each customer – the access service is not shared between customers and each customer therefore has available the maximum bandwidth which can be achieved with the "flavour" of DSL service provided to that customer. However, as the DSL network uses a shared IP core, the bursting rates have an impact at the network core and, as Dr Milner explained, impact on the dimensioning of the core.

28. As wireless networks, unlike fixed DSL networks, are a shared access network, bursting rates affect both the wireless access component and the core of a wireless broadband network. The greater the number of customers connected to the wireless network (and therefore the larger the number of customers whose services may be bursting at the same time), the lower the burst rate which can be made available to each customer because the available spectrum has to be shared (including with those at the average user rate). As customers are added to a wireless network, the bursting rate quickly approaches the average usage rate. Figure 5 shows the relationship between the number of customers and the bursting rate, with the bursting rate quickly falling to the average usage rate as customers are added. Figure 6 provides the comparison with the bursting rate on a fixed DSL network.

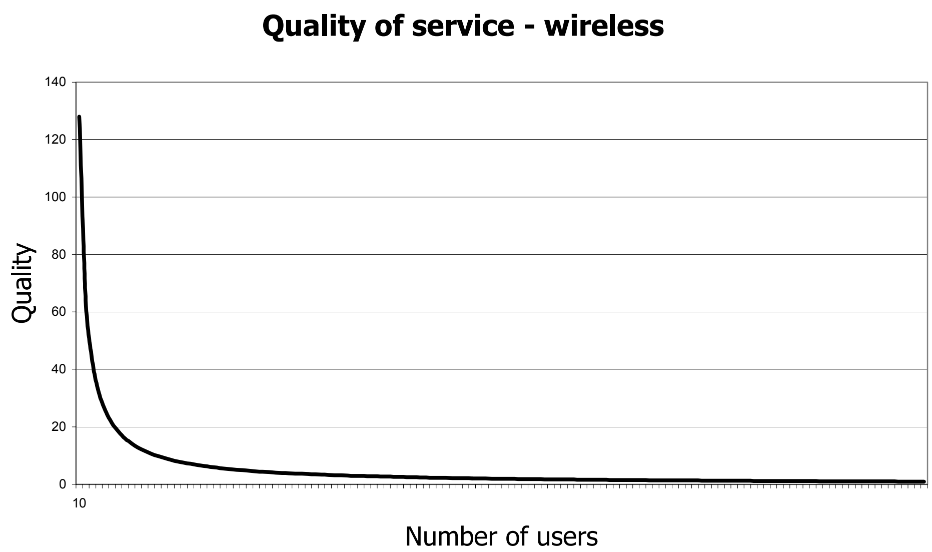

Figure 5: Bursting Rates on Wireless

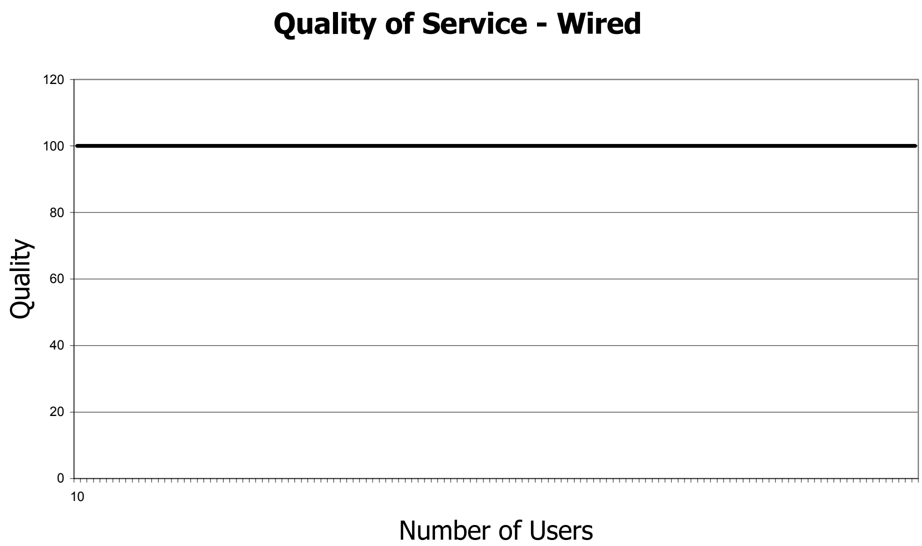

Figure 6: Bursting Rates on DSL

29. The following example shows the differences between using fixed and wireless network over which to provide the multi-service access future painted by Telecom:

Case Study: Multi-user, multi-service intelligent home

Consider a home where there are two adults and three children. Each of the members of the household uses the features of the multi-service home to enjoy their own pursuits. The children are Anne (17), Brian (16) and Charlotte (14). Their parents, David and Elizabeth both work and keep in touch with friends and relatives by e-mail.

It is a weekday evening and each of the members of the household is involved in a connected activity:

Anne is doing her History homework and is studying the impact of the ANZAC in twentieth century New Zealand history. To help, she is investigating who attends contemporary ANZAC day commemorations using the resources available at http://www.teawamutu.co.nz/tv/index.shtml to view the 2003 ANZAC memorial service as a streaming video service.

Brian has abandoned his homework and has decided to use his Xbox games console instead. Brian has subscribed to the Xbox Live service, which allows him, because of his broadband connection to play against or with friends and cyber enemies from around the world. Microsoft recommends[11] that Brian have a capability to connect at 512/128 kbit/s or better for this service.

Charlotte has discovered that chatting to her "pen" friend in Sydney using Microsoft NetMeeting is a perfect complement to the SMS and MMS that she sends during the day. Charlotte uses Microsoft Messenger to check that her pal Zoë is on line and then connects up the camera. Zoë has a cable modem so the video is really quite impressive.

[11] http://www.bigpond.com/broadband/access/games/.

David is catching up with work and has just completed the presentation that is due for tomorrow. He is sending it to the office server and will then send it by e-mail to his colleagues for that one final review. The presentation is media rich and includes a video of the existing problem and an animation of the proposed solution.

Elizabeth has just completed a video of the (very reluctant) kids, David and her on holiday in Christchurch. She has spent the last few days with the editing software and is burning the results to DVD. Elizabeth's mother (who unlike Murray's Milner's mum is a broadband fan) always loves pictures of the grandchildren and Elizabeth has decided to allow the video to be streamed from her (hosted) website. She is just in the process of sending the file to the website by file transfer protocol (**ftp**).

Figure 7: Summary of bandwidth used:

User	**Activity**	**Bandwidth used**
Anne	Streaming video	256 kbit/s
Brian	Xbox *live*	128 kbit/s
Charlotte	Video conference	256 kbit/s
David	E-mail and ftp	Maximum available
Elizabeth	ftp	Maximum available
Total	-	Maximum available (2 Mbit/s)

Now consider that this activity is being duplicated in 30% of all homes. If the homes are wired, the limit to the bandwidth provided occurs in the core network and will have an effect on the speed of the file transfer and e-mail services. That is, those services which are least affected by delay will be limited.

In the case of a wireless access network, only three homes in the cell site could perform these functions simultaneously as the maximum available bandwidth is 6.5 Mbit/s (using the current Alvarion technology being using by TelstraClear). If more homes were attempting to use this bandwidth, then all services would receive less bandwidth (and not just e-mail and file transfer.

Clearly, not all homes use 2 Mbit/s simultaneously. However, using the typical concentration rates that are applicable to residential Internet use for wireless (50), then the number of users that could be supported is 144 (equivalent to 480 homes with a 30% penetration rate). These figures assume a committed information rate of 64 kbit/s and a maximum information rate of 2 Mbit/s – comparable to Telecom's DSL offering.