Submission to the Inquiry into Broadband Wireless Technologies

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1. Introduction

The Inquiry into Wireless Broadband Technologies has been asked to consider the following:

- "The benefits and limitations on the use of wireless broadband technologies compared with cable and copper based broadband delivery platforms" and
- "The potential for wireless broadband technologies to provide a "last mile" broadband solution….."

These items reflect a growing shift to broadband access for residential subscribers. While "broadband access" has many definitions (as submissions to the inquiry have shown), common denominators include "always on" capability, and data rates substantially higher than voice grade modems. This submission addresses the following two aspects of broadband access:

1. To discuss the applicability of multi-hop wireless networks for wireless broadband access in regional areas, and
2. To show how broadband wireless backhaul may be used to increase ADSL market diversity.

2. Multi-hop Wireless Broadband Networks

The major spectrum that is available for broadband wireless access networks (such as the spectrum generally used for LMDS, MMDS, MDS, and 802.16, as well as the 2.4GHz and 5 GHz ISM bands) are generally considered to limited to line of sight transmissions. Many architectures designed to provide broadband wireless access networks consist of subscriber stations that require line of sight to a base-station connected to an optical fibre back-haul. In densely populated areas, the demand for broadband wireless access may be sufficient to enable the required number of base stations to ensure line of sight access to all customers overcoming mountains, large buildings etc. However, in smaller regional cities and towns, the presence of geographical features (such as hilly terrain) may significantly increase the number of base-stations required to cover a particular area resulting in a non-commercially viable network. There are several mechanisms under development to overcome the requirement for line of sight transmissions including multi-hop (or Mesh) networks and smart antennas that exploit multi-path distortion [2]. This section will discuss the use of mesh networks to overcome line of sight problems and reduce infrastructure costs in regional towns.

Mesh networks introduce relaying nodes between the base station and the subscriber. Examples of such networks include:

1. The mesh topology of the 802.16ab standard [3],
2. Nokia's Wireless Router[1]
3. SkyPilot[2]
4. CoWave[3]

Mesh networks operate in both unlicensed and licensed bands. The Nokia, SkyPilot and CoWave solutions are proprietary complete solutions. A standard mesh solution is currently being developed by the 802.16ab working group that operates in the 5 GHz ISM band [3]. Nokia's wireless router can operate in many bands including: PCS (1.8GHz), ISM (2.4GHz, 5GHz), MMDS and LMDS[1]. CoWave operates in the PCS, MMDS, 3.5 GHz and UNII bands[3].

A scenario where mesh networks can be used to connect several communities in hilly terrain is illustrated in Figure 1. The base station/aggregation point connects the mesh networks to the optical backhaul to the Internet. Each mesh network has at least one node/subscriber with line of sight to the base station for the wireless back-haul. Other subscribers only require line of sight to another house that is part of the mesh. The equipment at each house (which may be, for example, Nokia wireless routers) receives packets destined for the house and forwards packets, if required, to other nodes in the mesh or to the base station/aggregation point on behalf of a node in the mesh. Within the mesh, only low power transmissions are required. However, the wireless backhaul links may require higher power, higher frequency, and/or directional transmitters.

[1] www.wbs.nokia.com
[2] www.skypilot.com
[3] www.cowave.com

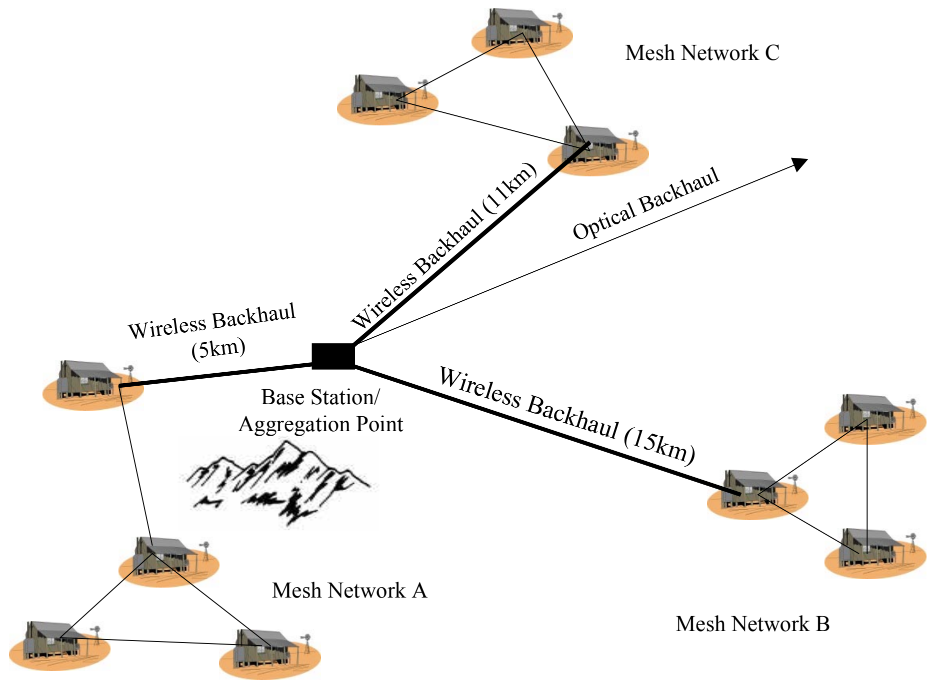

Figure 1 Mesh Network

The major advantages of the mesh network in this scenario include:

1. Nodes in mesh network A (in Figure 1) get access to broadband even though they are on the other side of a mountain from the base station,
2. A large area can be covered with significantly reduced infrastructure costs (when compared to a single-hop point to multipoint scenario) since only low power transmitters are required for a majority of subscribers within the multi-hop access network.
3. Infrastructure costs could be further reduced, for best effort services, by using commodity 802.11 equipment for the mesh network (similar to a community network). However, this solution may have significant performance problems due to interference and uncooperative behavior and is not likely to be viable in a commercial network. This problem may be minimised by the use of highly directional antennas, however, the use of licensed bands (such as PCS, MMDS) may be a more appropriate choice for commercial networks.

The performance of mesh networks is still a research issue. In particular, from a networking perspective, it is important to determine optimal sizes for the mesh networks, dimensioning techniques, routing protocols, and mechanisms to optimise network performance as new nodes are added. If these issues can be solved mesh networks may be a potential cost effective solution for providing broadband access to medium to low density regional areas.

3. Wireless ADSL Back-haul

Despite its relatively short history, Internet access is becoming akin to telephone and free to air TV, namely a standard household service. Voice grade modems have established a benchmark maximum data rate of 56 kbps downstream (i.e. from network to user). However popular Internet applications, such as video and audio streaming, generally require higher rates than this. ADSL commonly provides maximum downstream rates of 512 kbps (higher data rates are available, however at prices generally beyond the reach of residential subscribers). These individual maximum rates may reduce when aggregate ADSL demand rises, due to backhaul limitations (i.e. the bandwidth of links provided for ADSL traffic aggregates).

Cable is an alternate broadband access technique; however cable rollout has largely halted, with coverage being far from ubiquitous. Commercial broadband wireless access is not yet widely available, although this may change. In particular, AAPT are trialling LMDS broadband services in regional Victoria, with Unwired planning voice and data service delivery over the 3.4-3.5 GHz band. Unwired are trialling services in Newcastle, and claim to have spectrum to cover of 95% of the Australian population. If successful, they will become a major competitor to Telstra for local loop provision. Despite these alternate techniques, ADSL is likely to remain the key broadband access method. Hence a competitive ADSL market is desirable.

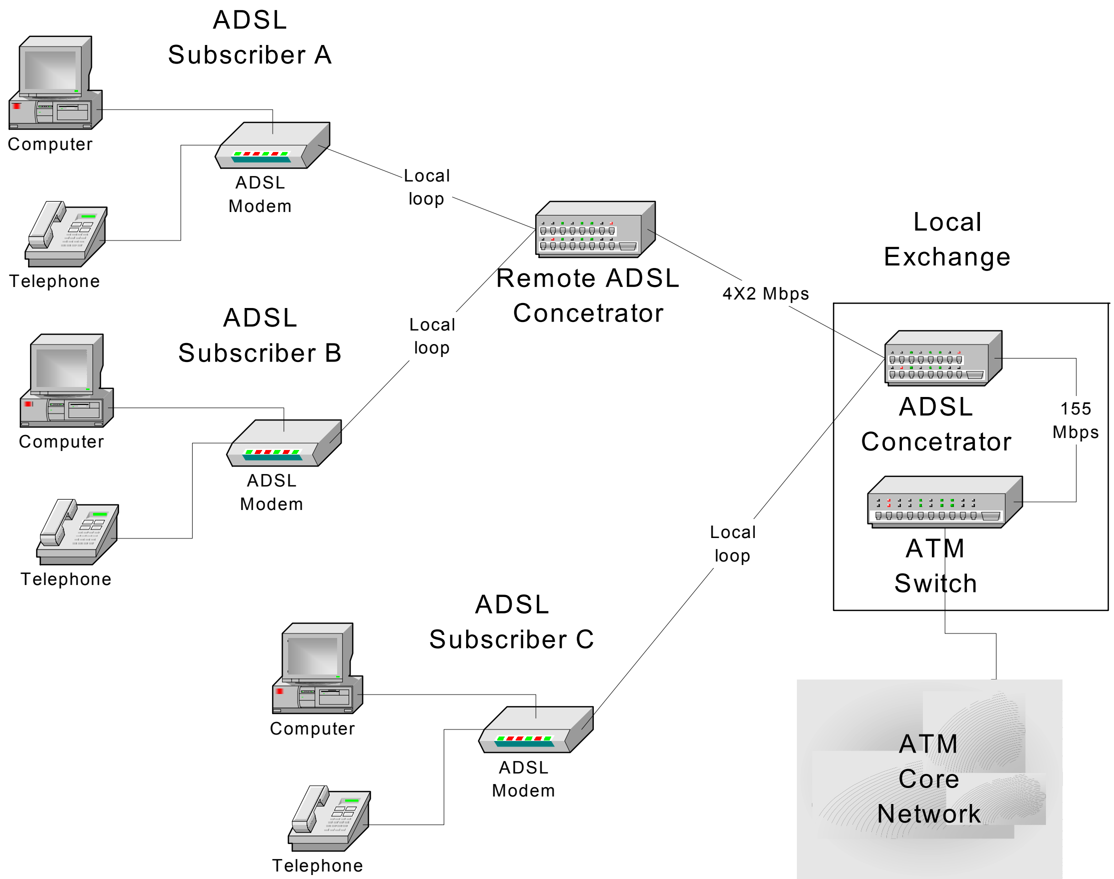

Figure 1: ADSL Network Architecture

We now examine ADSL architectures, to identify areas where broadband wireless technologies may assist competitive 3rd party ADSL service provision.

A key technical feature of ADSL is the use of the local loop for high speed data transmission. Rates up to 8 Mbps can be achieved, depending on line condition and distance. ADSL service provision therefore requires access to the local loop, which is not always feasible for 3rd party service providers, due to the ADSL network architecture. Figure 1 shows typical ADSL configurations. Subscribers A and B connect to a remote ADSL concentrator. This device is generally housed externally (i.e. outside the exchange), and supports telephone and ADSL services. As shown in the figure, the combined ADSL traffic is transmitted to the exchange over an 8 Mbps interface (i.e. four 2 Mbps links). Due to the architecture of the remote concentrator, it is not possible to split the ADSL traffic, as would be required if a third party were to provide ADSL service. Also it is generally not feasible to extend the local loop to a remote 3rd party exchange, where, for example, a competitor's ADSL concentrator may be located.

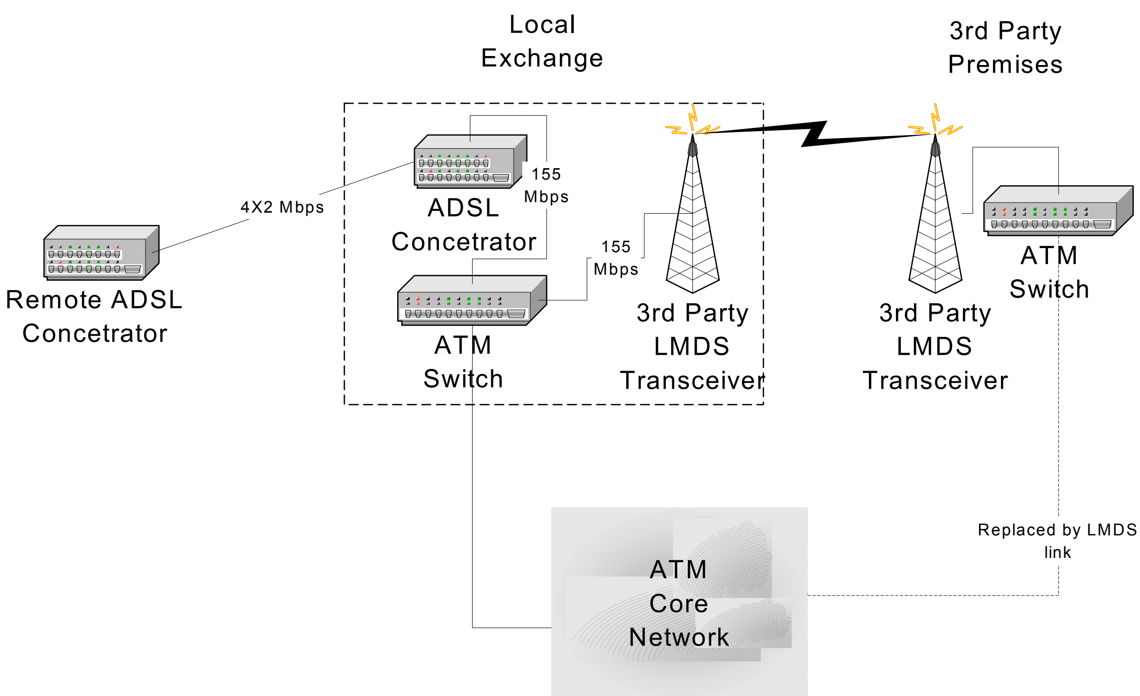

Figure 2: Broadband Wireless Backhaul

For 3rd party ADSL service provision, the configuration used by subscriber C is required. Here the local loop terminates at the exchange, as shown in the figure. Hence alternate ADSL equipment can be installed in the exchange, thereby allowing competitive service provision. However, to reach Subscribers A and B, 3rd party providers are obliged to resell the Telstra ADSL service. Minimizing this wholesale cost is a key requirement for a competitive ADSL market.

There are four key components contributing to this resale cost: the local loop, the remote ADSL concentrator, the bandwidth to the local exchange, and the ATM core network bandwidth. In particular, the ATM core network would be used to deliver ADSL traffic to a 3rd party exchange, and hence the ATM bandwidth costs would figure in the ADSL wholesale price. Broadband wireless could potentially be used to bypass the ATM core network leg, which may in turn reduce the Telstra cost for wholesale ADSL. Any savings would depend on the relative costs of broadband wireless infrastructure and spectrum, compared to Telstra ATM bandwidth costs.

Figure 2 shows potential configurations using broadband wireless for ADSL backhaul. Here the local exchange (i.e. Telstra) hosts a 3rd party wireless transceiver, which transmits the ADSL data stream to the 3rd party premises. This bypasses the ATM network (however a port is required in the ATM switch in the local exchange). Figure 2 shows an LMDS wireless infrastructure. While LMDS is generally considered for point to multipoint operations, it can also be used for point to point ADSL backhaul, as outlined in [1]. LMDS has a maximum range of around 5 km, which would limit these deployments to major urban centers, with closely spaced infrastructures. LMDS provides asymmetric bandwidth (e.g. higher data rates on downlinks), and is hence well matched to ADSL. The broadband wireless backhaul alternative outlined here also requires LMDS spectrum, which is currently owned by potential ADSL competitors.

There is a clear and growing demand for broadband access for residential subscribers. Despite alternate offerings, ADSL remains the dominant broadband access technique in urban areas. This submission has outlined potential means by which broadband wireless backhaul, particularly using LMDS, can lower costs for 3rd party ADSL providers, hence providing a more competitive ADSL market.

References

[1] www.alcatel.com "Multi-tenant Unit Distribution Solutions"
[2] B. Schrick, M, Riezenman, "Wireless Broadband In a Box", IEEE Spectrum, June 2002, pp 38-42
[3] D. Beyer, C. Eklund, M. Kasslin, N. Waes, "Mesh Overview Changes", Contribution to IEEE 802.16 Broadband Wireless Access Working Group, C802.16a-02/30r1