The Technologies of (Broadband) Access

Peter Darling
Pondarosa Communications

CPRF, September 2006

What is “Broadband”?

A technical definition:

- **Multiple streams of data sharing the one medium?**

To the ITU-T:

- **Data at rates greater than ISDN Primary Rate (1.54 Mbit/s or 2.048 Mbit/s)?**

To the marketer:

- **Anything above 56 kbit/s?**

(For this presentation, data at rates [well] over 1 Mbit/s)

What is “Broadband”?

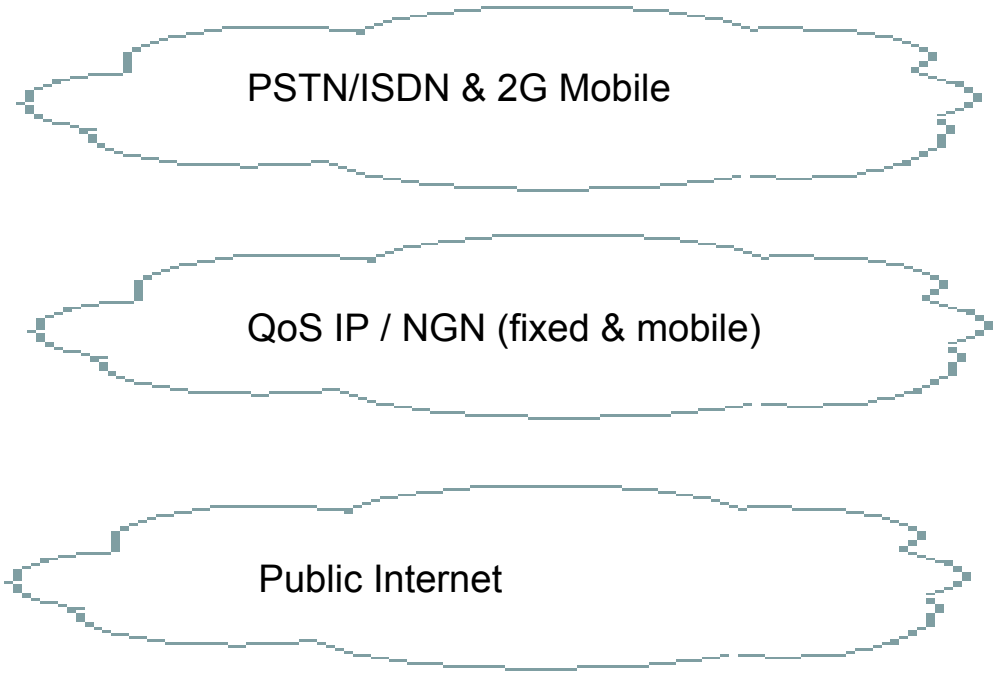
For the user:

- **An access speed at least twice the speed currently available!**

(For this presentation, data at rates [well] over 1 Mbit/s)

Broadband Access needs to support….

….the full range of services, not just Internet access (and, maybe, the famous triple play).

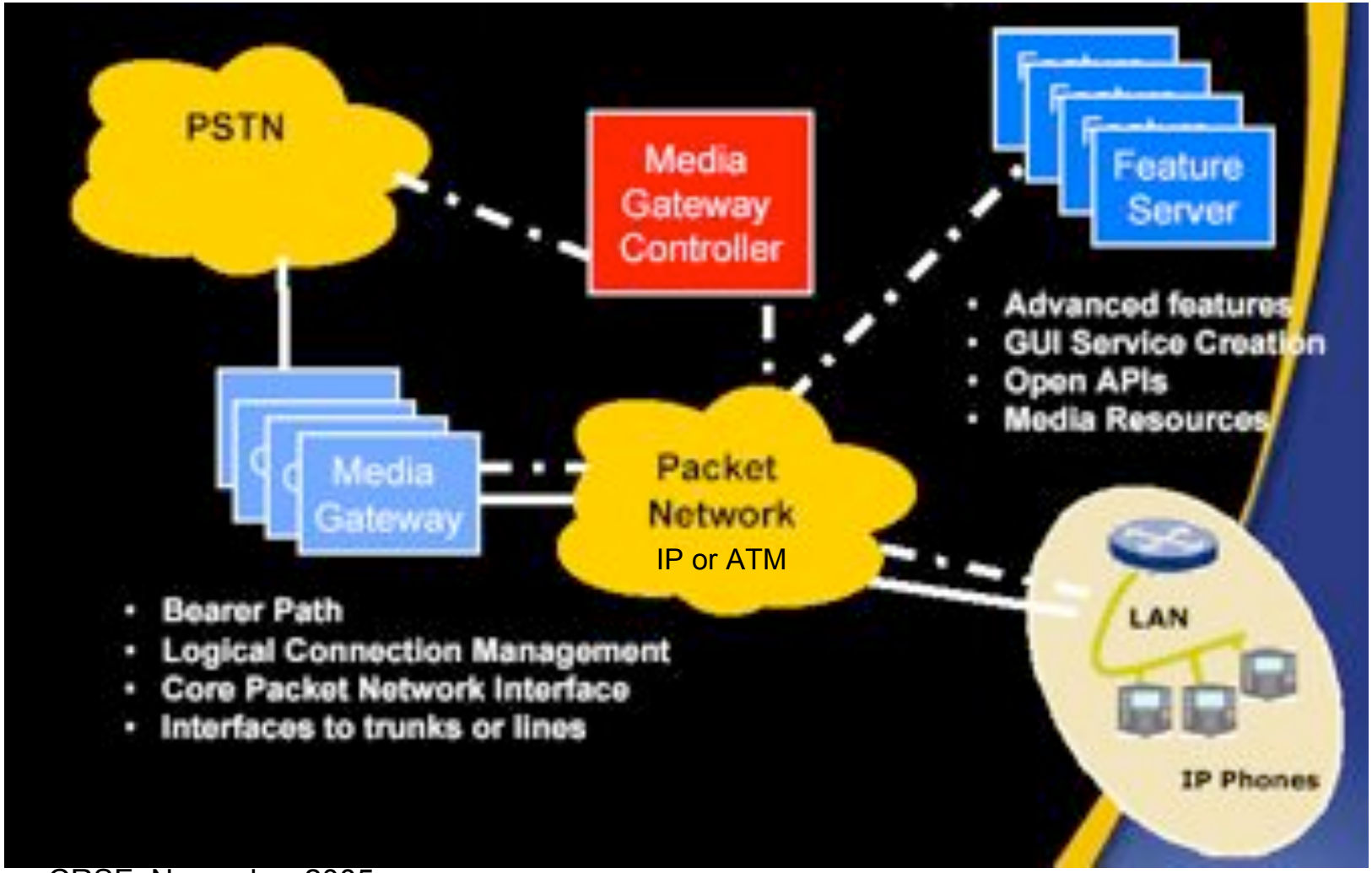


Quality of Service

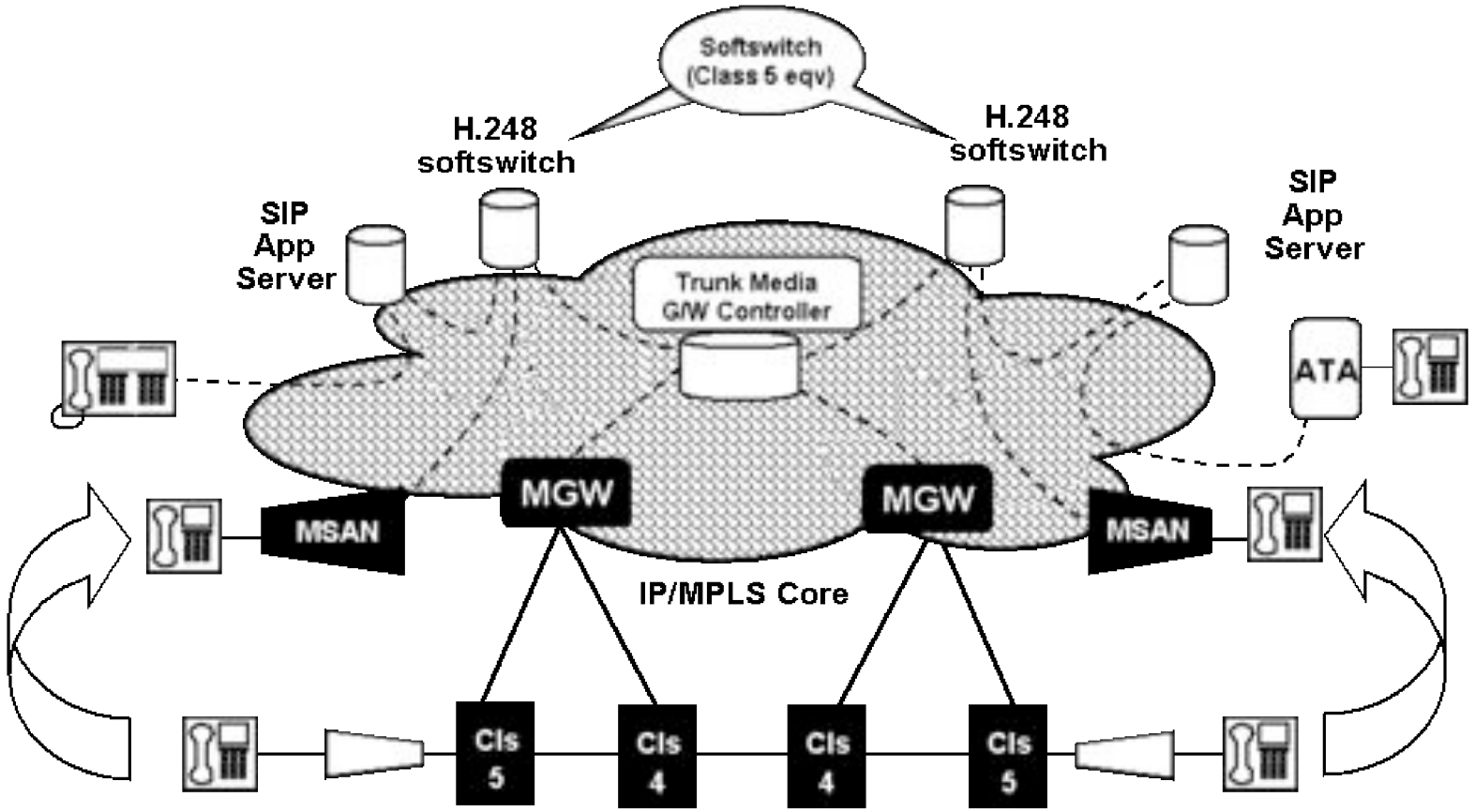
ITU-T Recommendation Y.1451

QoS Class	Applications (Examples)	Node Mechanisms	Network Techniques
0	Real-Time, Jitter sensitive, high interaction(VoIP, VTC)	Separate Queue with preferential servicing, Traffic grooming	Constrained Routing and Distance
1	Real-Time, Jitter sensitive, interactive (VoIP, VTC)		Less constrained Routing and Distances
2	Transaction Data, Highly Interactive, (Signaling)	Separate Queue, Drop priority	Constrained Routing and Distance
3	Transaction Data, Interactive		Less constrained Routing and Distances
4	Low Loss Only (Short Transactions, Bulk Data, Video Streaming)	Long Queue, Drop priority	Any route/path
5	Traditional Applications of Default IP Networks	Separate Queue (lowest priority)	Any route/path

The Next Generation Telephone Network



Telstra's Realisation



Access & Core Networks

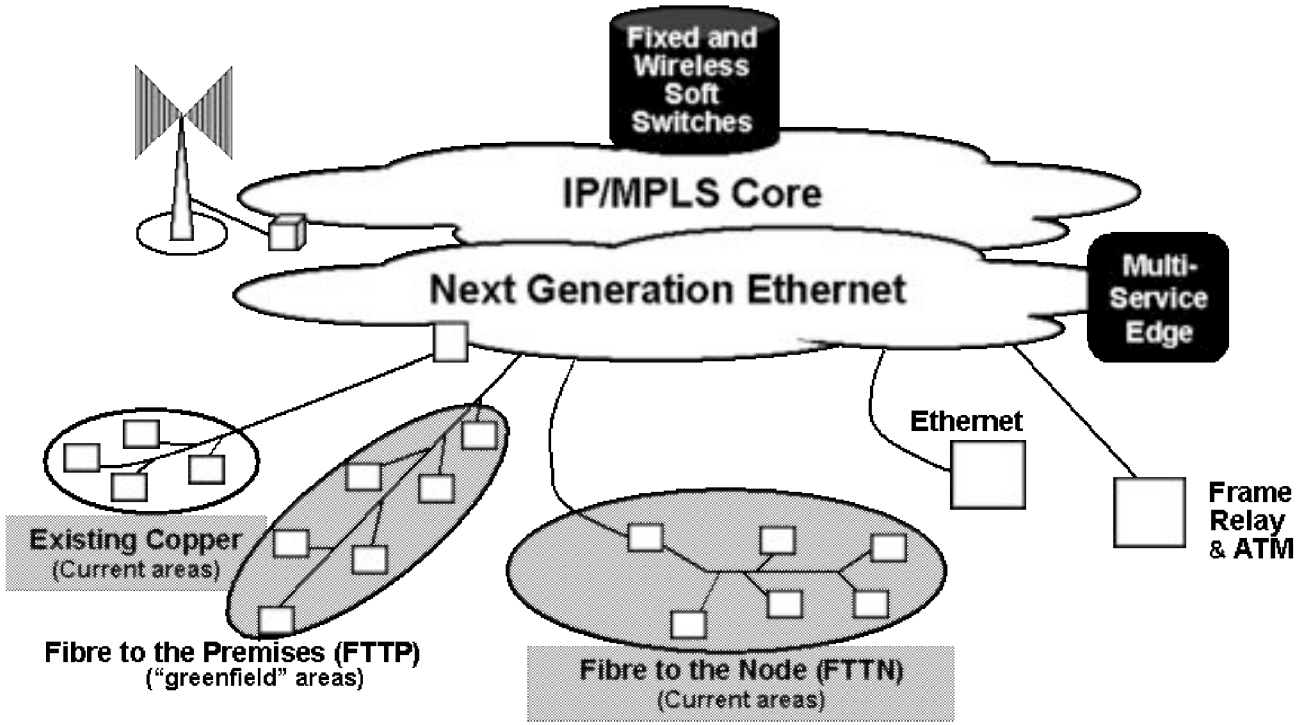
The Core Network:

- Traffic from multiple users combined, allowing economies of scale.

The Access Network:

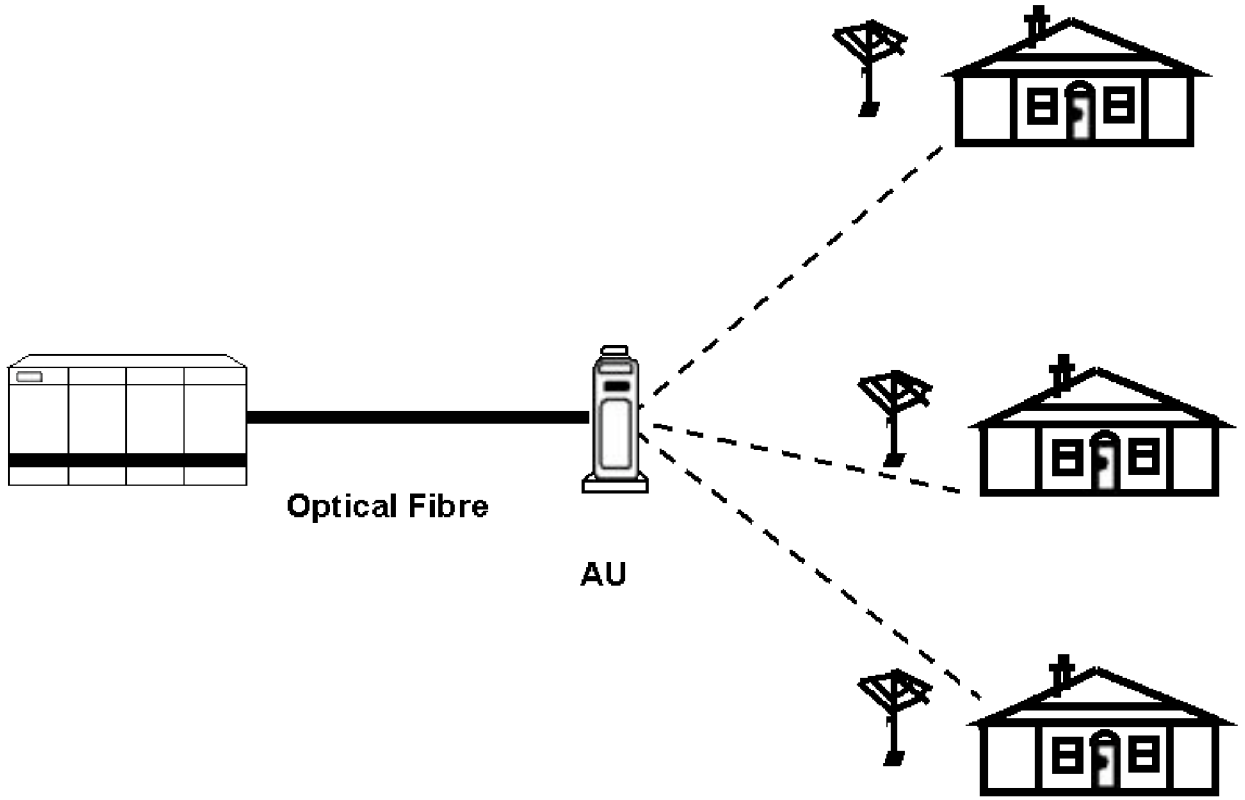
- Provision of access to the core network for individual users;
- Always on, but supporting low average levels of traffic

Telstra's Proposed Network



The “Access Unit”

At the point of separation between the Core Network and the Access Network



This could be…..

- The subscriber stage of a telephone exchange;
- A remote node (RIM or CMUX) in the telephone network;
- A mobile base station;
- A wireless data access point, or
- An Internet router/server/access point

Optical Fibre

The prime broadband transmission technology:

- **Very high data-carrying capability;**
- **Low cost for high data rates, but**
- **Higher cost for lower data rates.**

The technology of choice for the core network, but

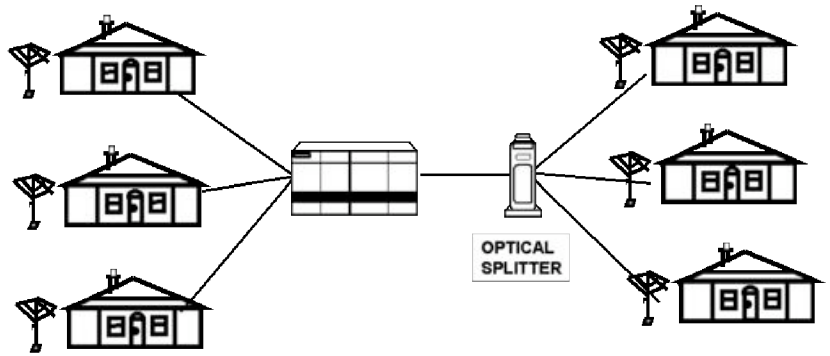
The economics for the access network are less certain.

Optical Fibre to the User?

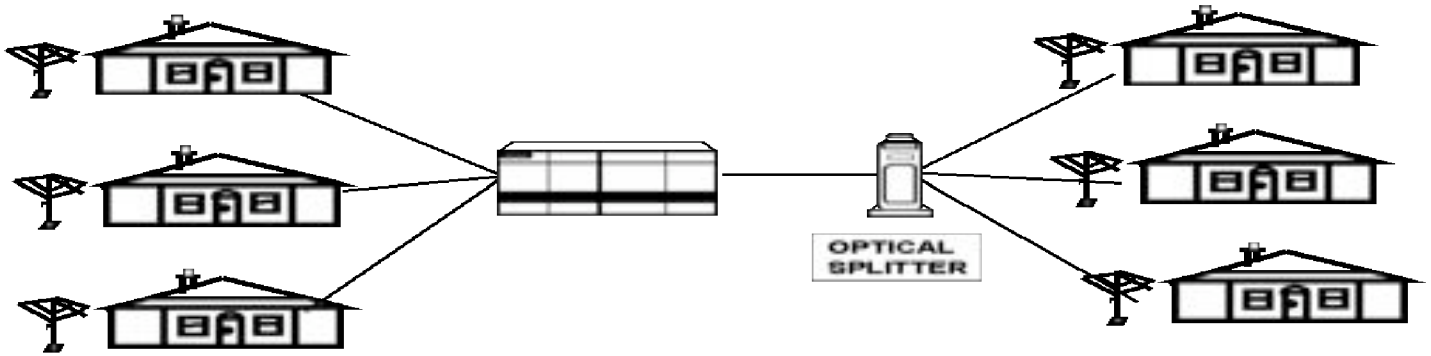
- The technology is available (and becoming relatively cheaper);
- Able to deliver hundreds of Mbit/s to each user.

Do users want high data rate services?

How much are users willing to pay?



FTTH Technologies



Point to Point

- Based on IEEE 802.3ah (Ethernet in the First Mile)
- Cost high, but reducing

Passive Optical Networks

- Standardised by the ITU-T
- Optical splitters at Access Unit
- Current technology

OF in the Access Network

- **Cost now close to (or below) traditional copper access *for new installations;***
- **There have been several trials of Fibre to the Home (FTTH) in Australia, and Verizon is offering FTTH commercially in the USA.**
- **Recent initiatives by Governments in Victoria, NSW and Tasmania are designed to encourage FTTH as standard for new housing developments.**

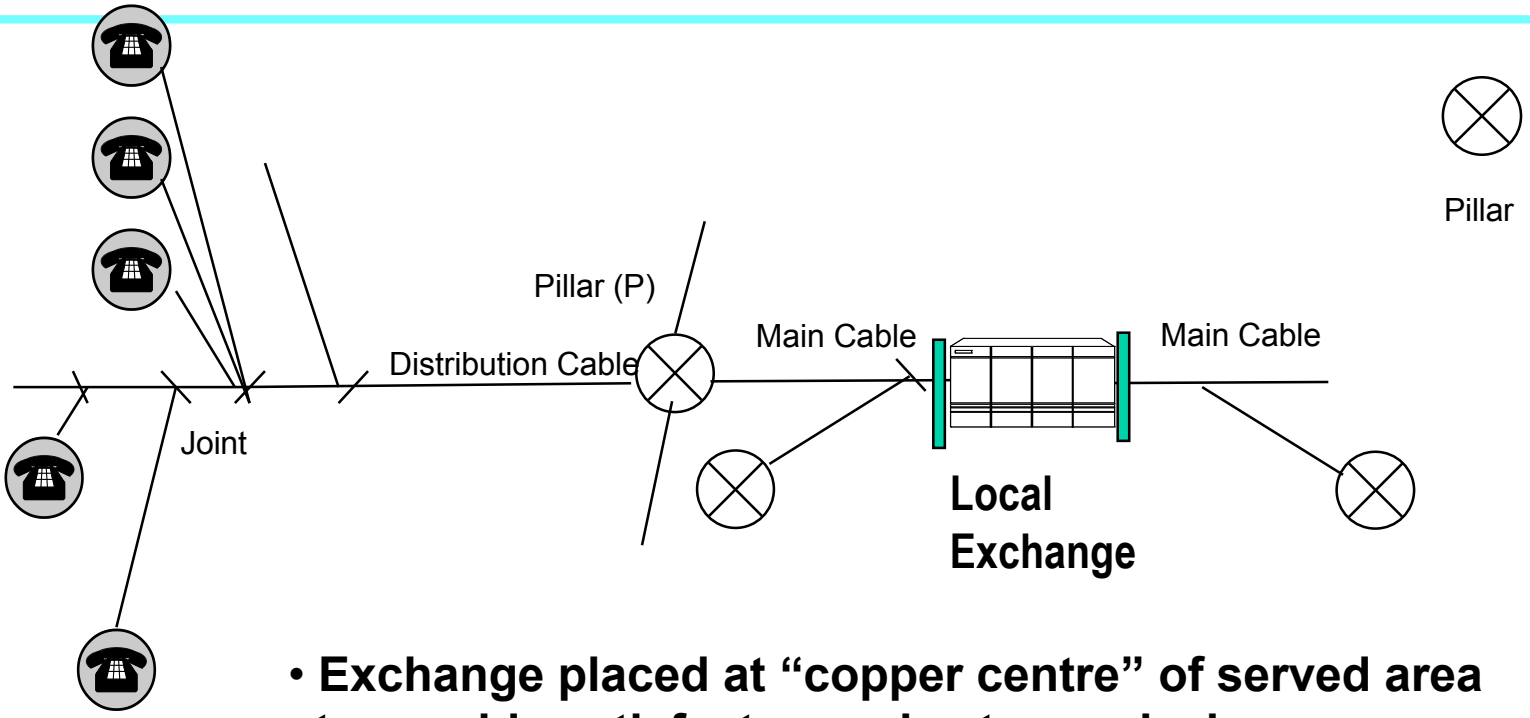
OF Closer to the User

- For areas where copper telephony access is already in place, and there is no strong demand for high-bandwidth services, FTTH is not economic (unless supported by other drivers such as Government policy);
- The key to broadband access is to move OF (the access unit) close to the user, and use another medium for the final link.

Use of the Telephony Copper Network

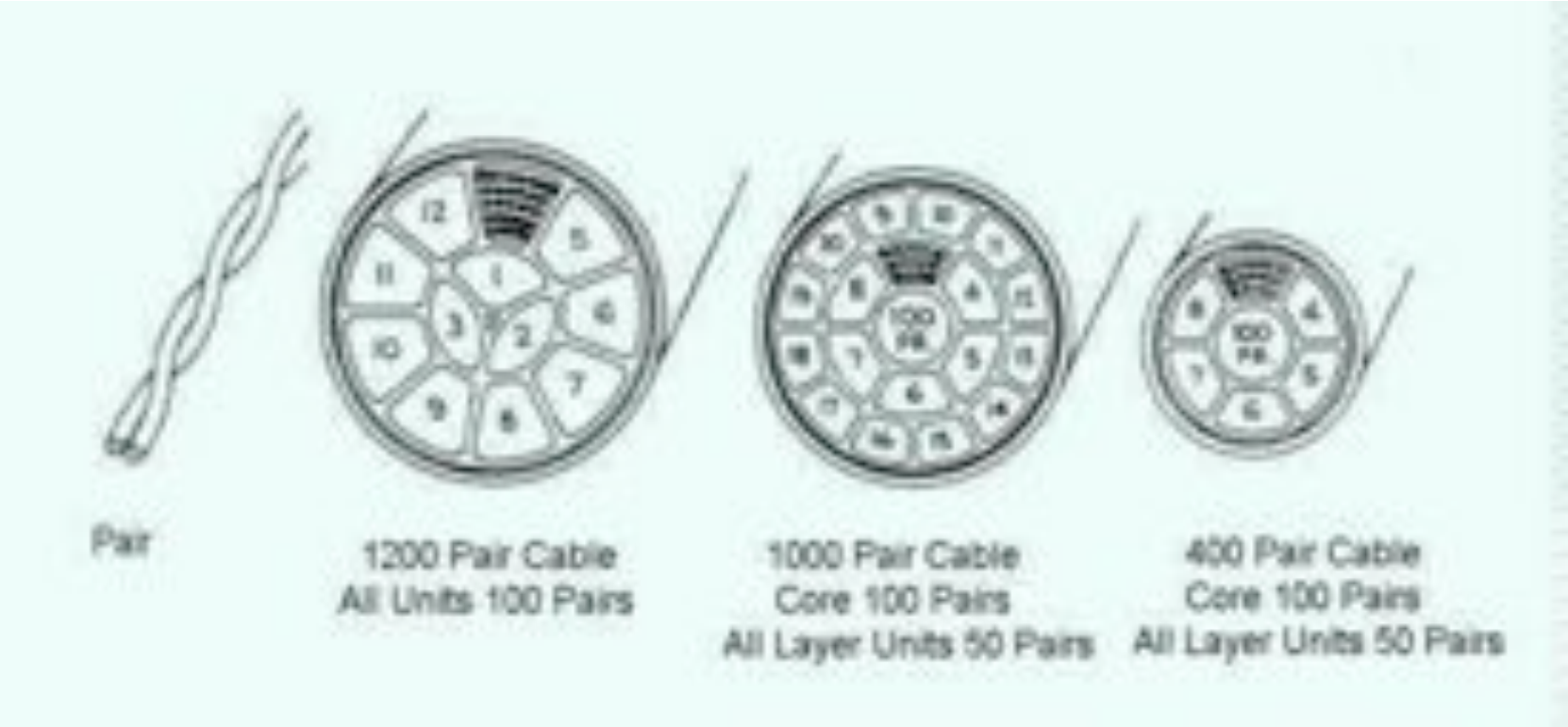
- The telephony CAN was designed to carry 4 kHz voice;
- The copper cables can also carry higher frequencies;
- DSL (digital subscriber line) technologies use these higher frequencies to support data access.
- Because the network was not designed for higher frequencies, there are limits to use.

Traditional CAN Structure

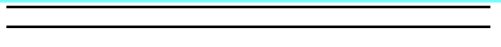


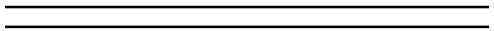
- **Exchange placed at "copper centre" of served area to provide satisfactory voice transmission**
- **One copper pair physically connected for each customer from premises to exchange, via a number of cables**
- **Multiple spurs/taps generally used**
- **Large number of exchanges**

CAN building blocks - Cables



Crosstalk - Twisted Copper Pair

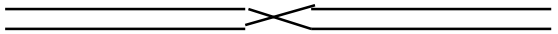




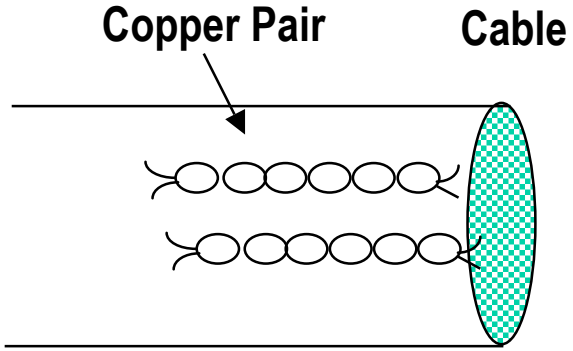
"Crosstalk"

Electric and magnetic fields overlap between pairs

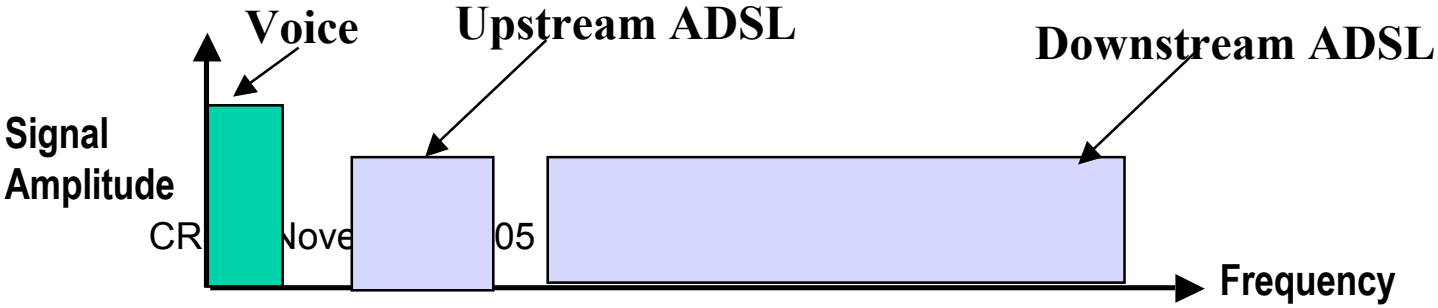
Twist



Crosstalk (at voice frequencies) cancelled by twisting wires



Crosstalk (at higher frequencies) not cancelled by twisting wires
INTERFERENCE

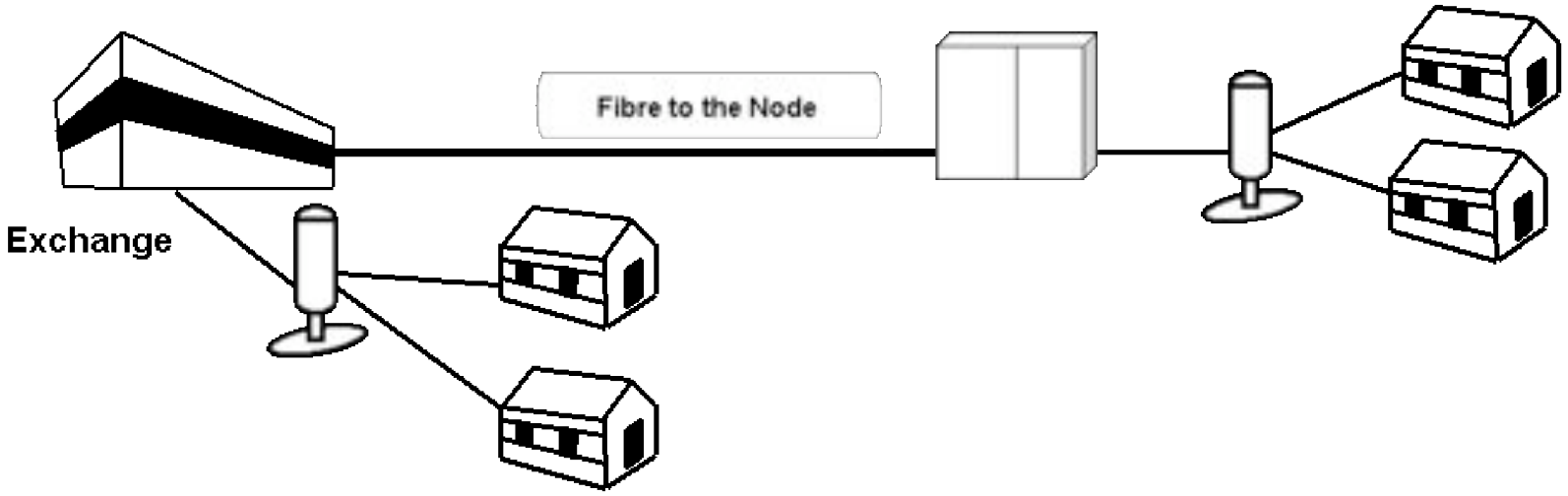


ADSL Limits

- **The speeds available in a real-life network are limited by interference, reflections and attenuation.**
- **Initial Australian operational standards allowed for the use of ADSL to approximately 4 km from the exchange at typical speeds up to 1 Mbit/s 'down' and 256 kbit/s 'up'**
- **The industry has also agreed on network and operational standards for the next generation of DSL, ADSL2 and ADSL2+, providing speeds of up to 10 Mbit/s at distances of 1 to 1.5 km from the exchange.**

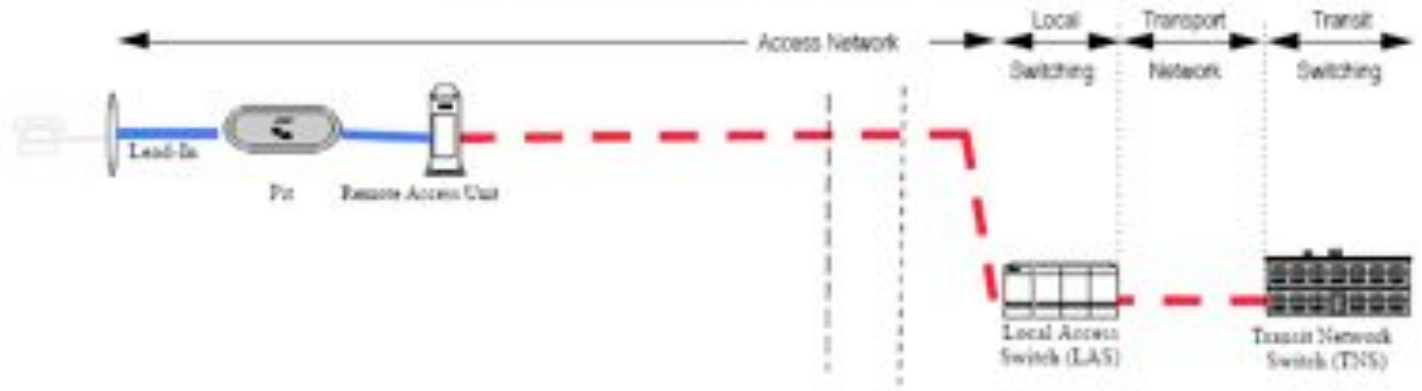
High speeds only possible over short distances.

DSL Access Units – Fibre to the Node



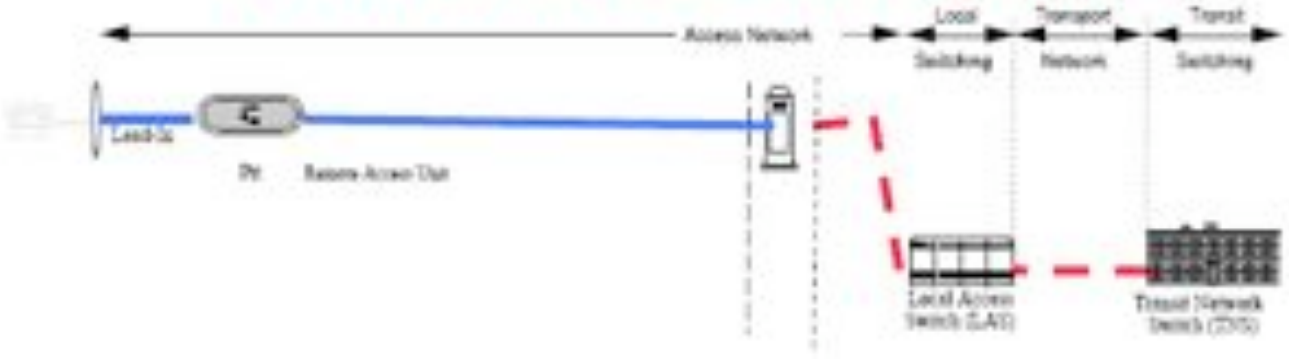
- To get higher speeds, the Access Unit can be moved closer to the User;
- Telstra (and G9) proposed putting nodes within 1.5 km of users to get 12 Mbit/s download speeds

The CAN is Changing



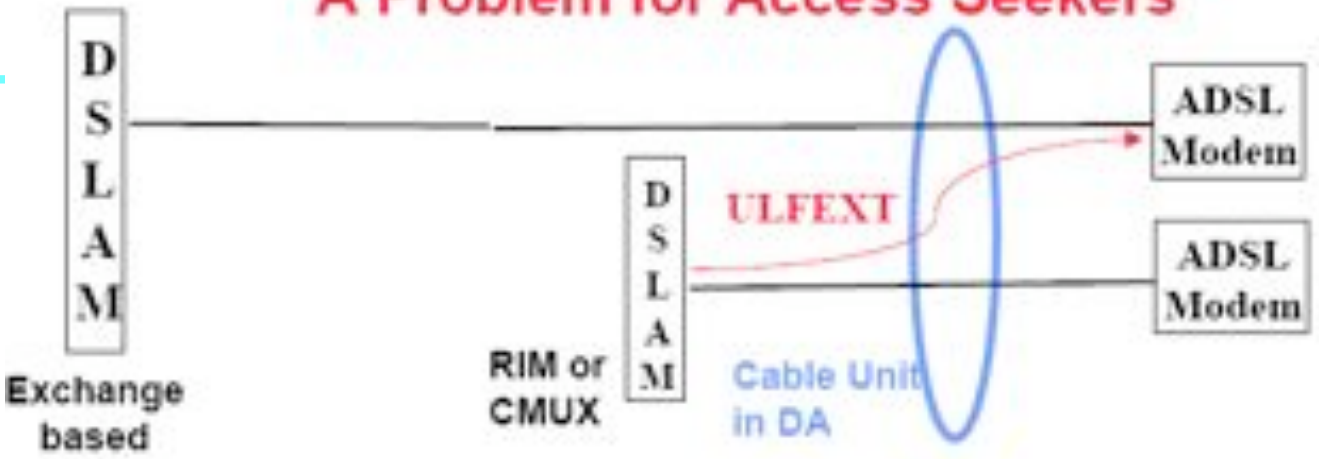
- **Telstra is already using remote units (RIMs) to**
  - Open up new distribution areas and
  - Provide relief/replacement for existing main cables
- **Overseas, similar units have been used to close exchanges and recover the valuable real estate**
- **Telstra's announced DMO plans call for extensive use of a "Customer Multiplexer". If this is located close to the user, then it will be easy to provide VDSL very high speed access.**

A Problem for Access Seekers



- **If copper extends to the old exchange site**
  - An access seeker can provide xDSL service across the exchange area, with a Business Case based on winning part of the market (for example, provide service to 5% of 10,000 customers, with equipment for 500 users in Telstra's exchange)

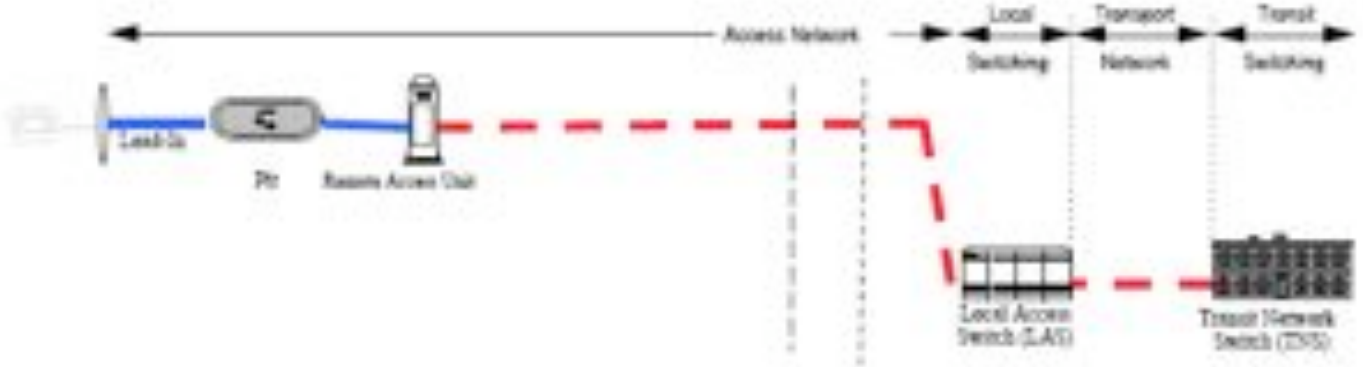
A Problem for Access Seekers



- If RIMs or CMUXs are used
  - Higher speed VDSL as well as ADSL could be provided from the new site
  - If Telstra provides ADSL or VDSL from the remote unit, the stronger signal will interfere with the weaker signal
- An access seeker is forced to co-locate with the Telstra unit

CLL IMPACTS JUNE 2000 Page 49

When Remote Units Are In Place



- **An access seeker must provide its own remote unit**
  - Telstra RIMs and CMUXs are densely packed, with no provision for other users
  - The Access Seeker would have to gain Local Government permission
- **The Access Seekers would have a doubtful Business Case**
  - If a 10,000 line ESA was served by ten remote units, each with 1000 users, an Access Seeker with a 5% penetration would only have 50 customers at each site, making provision much more costly

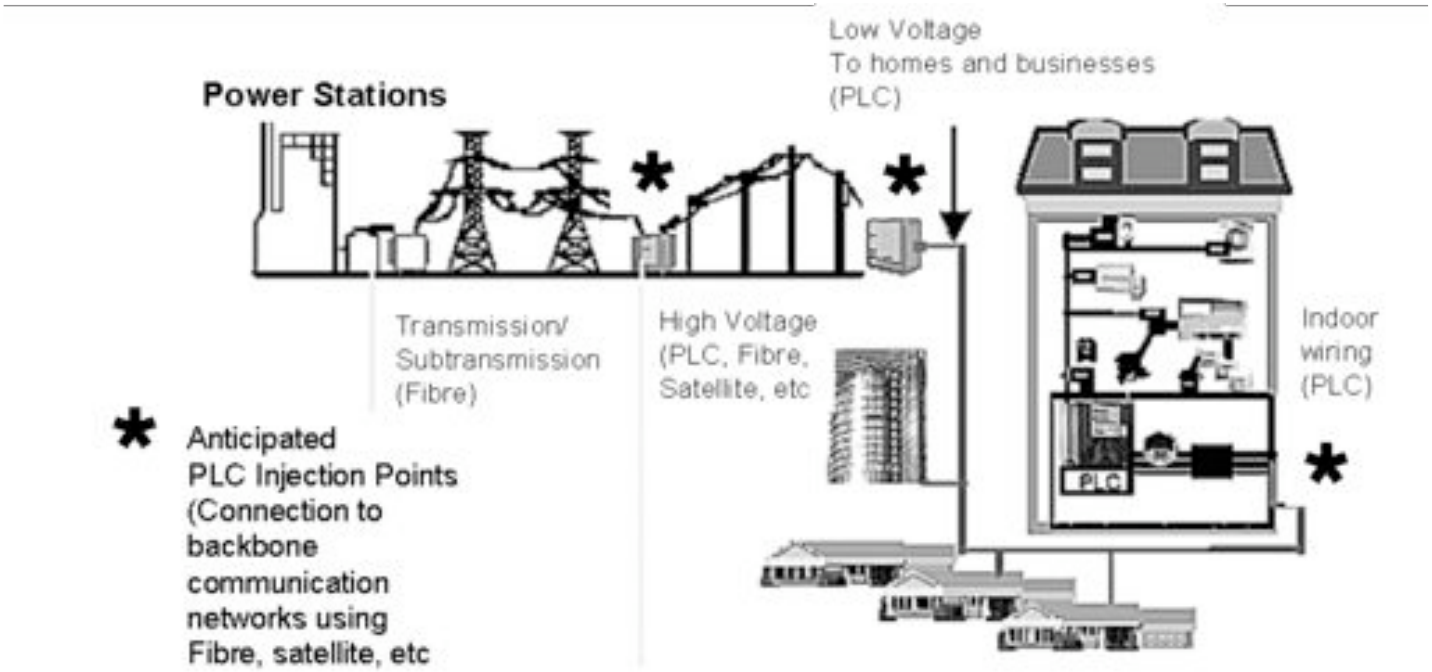
All modelling suggests Remote Units are Best Practice!

CLL IMPACTS JUNE 2000 Page 50

Powerline Communications

- The AC power distribution network (or CAN) rivals the copper telephone access network in size.
- The electricity access network is able to carry higher frequencies than the 50 Hz power distribution for which it was designed.
- Two potential uses:
  - Within a dwelling, for distribution over the internal power wiring (In-house); and
  - For access to a dwelling, to provide delivery of broadband Internet and other services (Access).

Powerline Communications



[from Report prepared for DCITA by PB Associates]

Main injection point would be at “Low Voltage” point

Possible Problems

- Power lines are not designed to carry high frequencies, and act as radiators;
- There may be interference to radio services in HF, VHF and UHF bands.
- The ACMA has authorised commercial trials, with strong restrictions;
- The outcome of these trials will determine possible use.
- Power infrastructure can be used to support OF delivery to near premises.

Radio-based Access

- Solution of choice for mobile and nomadic users;
- Broader application in areas of high density limited by available spectrum;
- Line of sight SHF radio links may be used from access unit to premises;
- May be preferred solution for rural and remote areas.

Alternatives

- Cellular Mobile Services, in particular 3G systems with latest enhancements
- Local Area Services, in particular “WiFi” services based on IEEE 802.11 standards
- Wide Area Services, in particular WiMax based on IEEE 802.16
- Satellite Services, using satellites in geo-synchronous orbit

Cable TV Delivery

Existing cable TV networks, using OF to an access point, then coaxial cable to the user, are major broadband delivery alternatives in many countries;

Better use could be made of current Australian networks, but the previous decision to move to satellite pay TV delivery limits network reach.

Options

Low Hanging Fruit

- Medium speed DSL over telephony copper;
- Broadband access over HFC Cable TV;

Possibly Poisoned

- Access over existing power lines.

Expensive

- Fibre to the node, then DSL

Niche

- Radio based systems

Conclusion

Technology is available to support:

- **Medium speed broadband access at low cost using the current telephony copper network, the existing HFC network and (possibly) the power supply network;**
- **High speed broadband access at significant cost, providing access units close to the user, for example by fibre to the node; and**
- **Very high speed, at considerable cost, by Optical Fibre to the user's premises**

The Choices to be Made

Economic, based on presumed demand and cost of service provision, albeit entangled in current telecommunications regulation;

Policy, based on presumed national benefits of "universal" broadband access.