Back-Bone Transmission Structures

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Introduction

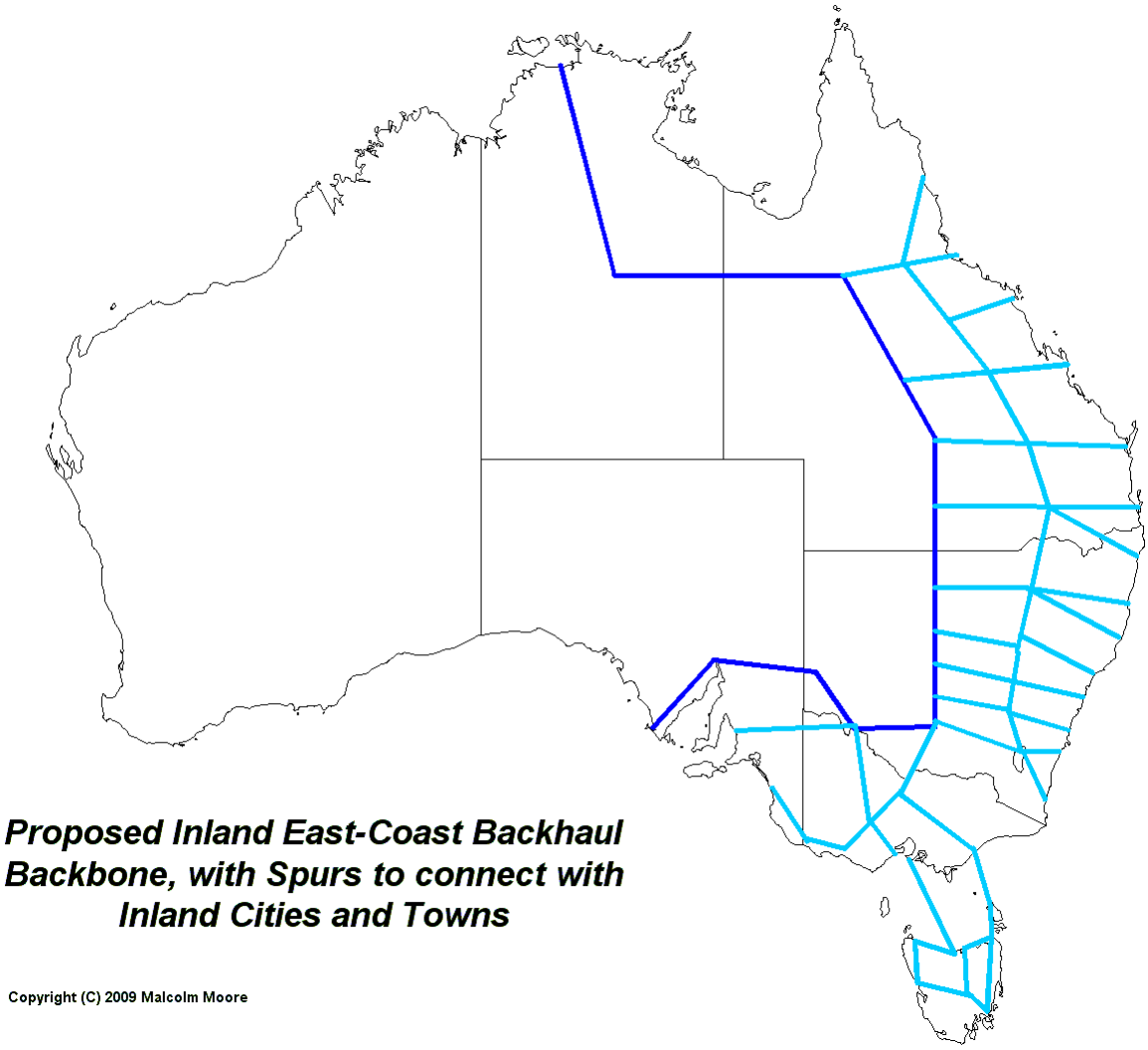
Backbone Transmission structures are like major road freeways, with multiple lanes and the traffic travelling at fast speeds. Backbones generally use Wave Division Multiplexing, so that several light wavelengths can pass down the one fibre, and each of these wavelengths will be carrying at least 10 Gb/s, so carrying capacities per fibre is often 40Gb/s (2009) and a fibre can for example carry 14 wavelengths using Wave division Multiplexing (WDM) so 140 Gb/s is possible (and practical), and considering that a cable may carry say 10 fibres can be transporting 1.4 Tb/s (1,400Gb/s).

The fibre cables used for Backbones are usually identical to those used for CAN applications except that the number of fibre strands is significantly less in Backhaul situations (typically less than 80 strands), where fibre cable used in metro CAN situations is typically 320 fibres, or 120 fibres. Special attention is applied to the construction and Single Mode Optical Fibres (SMOF) is the normal, with Non-Zero Dispersion Fibres (NZDF) being a special class of SMOF that has an overall lower attenuation per unit length of about 0.25 dB / km where SMOF has an attenuation per unit length of about 0.43 dB / km. This means that NZDF cables can span a considerably longer distance than SMOF cables before the signal needs amplification and/or regeneration.

With NZDF Optical Fibre cables, backbone transmission links need amplification about every 100 km (or slightly shorter), and regeneration by about 400 km. The reason is that even though the cable may well be DZDF (for low attenuation loss per unit length), the wave fronts and tails tend to flatten out over distance and the signal becomes prone to systemic error, so by about 400 km the flattened out light pulse signals needs to be synchronised with a system timing cock and the signal regenerated as fresh light pulses with sharp wave fronts and tails.

In some instances, where IP is distributed over several light wavelengths, the light velocity is different at different wavelengths, and consequently this causes what is called Group Delay Distortion (difference in through-speed of the various light spectrum frequencies in WDM), and special synchronising techniques need to be implemented to minimise transmission problems caused by Group Delay.

Backbones are usually positioned between major capital cities to carry the bulk of the traffic (just like a road or rail highway), and just like major road and rail highways, there are wayside points where local traffic can be dropped off and picked up. Because Optical Fibre is a very cheap and highly efficient method of electronic signalling transmission, the old method of finding the shortest direct link between major centres is no longer the obvious geographic choice of route, and major backbones can have very significant advantages both in security and robustness, if many of the traditional backbone routes are removed from the Australian coastal border and re-positioned inland. An example of establishing an eastern inland Backbone is shown in the diagram below:



In this case, the Royal Blue line represents a Proposed major Backhaul Backbone, and the Cyan (Light Blue) lines represent Backbones that connect between major centres. This structure forms a grid, so that a number of highly reliable network Rings can be intersected, so that traffic can be automatically bypassed if any of the Backbone routes or Spurs suffer damage.

Note that the inland routs is considerably shorter than the coastal route, because the inland is far flatter, making the points of connection almost straight lines. Also the inland route Sydney - Darwin cuts off about 500 km compared to the coastal route via Brisbane, and/or the route via Adelaide.

Cable Internet and Pay TV

For Cable Internet; this same local router that feeds to the DSLAM also feeds to the IP side of the Universal Broadband Router (uBR) to create a series of equivalent Internet TV channels and these then mix with the CATV feeds in the local Broadband Multimedia Services (BMS) Aggregation Rack; before connecting to the local Headend, that feeds the Hybrid Fibre Coax (HFC) CAN to the CPN. The practical demarcation point is the equipment side of the Ethernet Panel that connects from the local router to the uBR. This makes the entire uBR and all downstream equipment including the (remote) Headend as part of the CAN.

The local routers feed to a pair of geographically diverse Regional Routers via geographically diverse Optical Fibre cables, each with a transmission rate of 1 Gb/s. The Regional Router pairs connect to a mesh of peer Regional Routers pairs (just

like the telephony Backhaul Network) connecting at 40 Gb/s and these have 10 Gb/s feeds to Interconnect Routers (just like telephony Backhaul Network).

3G Mobiles and Internet

For non-capital city Internet, there are considerable limitations in the transmission systems but these have been addressed (July 2007) in synergy with the development of the "3G" mobile (CAN) that requires a very substantial Backhaul Network structure to support complex signalling and switching processes along with high capacity / throughput transmission channels.

In Regional and Remote areas over the past few years a considerably large network of Optical Fibre cables have been trenched in, ready to take high capacity transmission equipment that will connect with Node Switch sites to Regional and Main / Core network sites. It is this infrastructure that will make the positioning of (CAN) 3G Mobile Base Stations to this Backhaul Network so that both 3G Mobiles and Internet connections can happen in these areas.

Internet Speed Limitations

Every Internet Connection has a valid reason for not going fast. In most cases: The big limitation in download speed is the bandwidth capacity of internationally connected Trans-Ocean Optical Fibre cable transmission systems.

Not all locally managed and installed Websites have high upload speeds, and some are deliberately limited to 64 kb/s, while others deliberately have a throttle control to minimise the upstream data flow rate - which will appear as your download data flow rate.
Depending on the 'Grading' of your service providers network, your download rate can be severely compromised if the network is working near full capacity. You get what you pay for: If your Broadband contract is comparatively cheap then understand that you and thousands of other people on that same contract will all be connected to a 'thin pipe' that simply cannot provide fast Broadband downloads!

High speed Broadband in non-capital city (read 'non-metropolitan') areas simply cannot get high speed Broadband Internet until a very substantial Optical Fibre network with high capacity SDH intersecting rings as the prime infrastructure is firstly installed and commissioned into the country areas. This then needs a similar Internet (Routers / Switches) structure to what is currently (2007) being installed in the metropolitan areas; and then Routers / Switches need to be installed at the Local / Terminal exchange sites so that Digital CAN can be installed. The Digital CAN of the future will be Optical Fibre.

When considering using Internet for a video link - the slowest Upload rate will be the determining factor! (Strange this is not openly advertised.)

Network Management

The Out Of Band (OOB) Network

The Out Of Band Network (OOB) is a non-switched transmission network that connects to all the switches and routers in the Backhaul Network and brings these connections back to a common interface point (usually as a Global Operations Centre). At the GOC, operators can see the state of all the network switches and they can communicate with the switches / routers as desired to set their parameters. This means that network switching faults can be analysed and maintenanced from a common location – with vastly reduced operating costs.

The SDH Control Network (SCN)

This is another Out Of Band non-switched transmission network that connects to all the Synchronous Digital Hierarchy transmission equipment elements in the Backhaul Network and brings these connections back to a common interface point (usually as a Global Operations Centre). At the GOC, operators can see the state of all the SDH equipment elements and they can communicate with these network elements as desired to set their parameters. This means that Backhaul Network transmission faults can be analysed and maintenanced from a common location – with vastly reduced operating costs.

The CSS7 Network

This Common Channel Signalling System Number 7 (CCS7) network sits on the telephony based switches and reports on the health of the switches, network occupancy, bearer occupancy, provides data on the whereabouts of cellular mobile phones, passes the small messages between customers and provides the data for metering. Apart from that it also controls the switches telling them what to connect and when and when and how to clear down calls. Without this little network running in the background the IDN simply could not run and calls could not be charged.

Comments and Corrections are welcome