Response to the ACA discussion paper

The Management of Interference from Broadband over Power Line Applications

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1 Introduction

1.1 Broadband over Power Lines

Recent developments in technology have delivered chipsets designed for transmission of high speed data at Broadband speeds over existing power line infrastructure in a range of scopes including existing premises power wiring, the low voltage (LV) distribution network, and high voltage (HV) transmission network.

Power Line Communications (PLC) is not new; it has been in use for a very long time for electricity network protection, control, telemetry, voice and data communications, and demand side load management. Some of these applications are more broadly captured by the term Power Line Telecommunications (PLT).

Broadband over Power Lines (BPL) is a specialised form of PLT, it is designed to deliver high speed data services at Broadband speeds (greater than 256Kbps), usually delivered to the customer with an Internet Protocol (IP) interface and principally for access to the Internet.

It is a combination of the growing demand for Broadband data services and development of powerful digital signal processing capability on silicon chips that has encouraged BPL.

BPL achieves the high data rates by modulation of carriers at radio frequencies with the data, and transmission of that radio frequency energy on the power line media. BPL does not depend on radiation of radio frequency energy for its operation; BPL uses conduction on the metallic power line conductors to carry the modulated data signals from the sending BPL modem to the receiving BPL modem.

Power lines in their various forms are almost universally unsuitable media for transmission of radio frequency energy for a number of reasons, but most importantly to users of radiocommunications services, because of the leakage of substantial radiocommunications energy from the power lines and in-building wiring and the consequent risk of interference to radiocommunications services.

Current BPL technologies mainly use the radio spectrum from about 2MHz up to 30MHz to 80MHz (HF and VHF radio spectrum). BPL signals that leak from infrastructure are quite unlike any other form of radio frequency radiation, they are wideband (typically several MHz wide for individual links) with almost uniform power density across that bandwidth when in traffic, and they have the potential to interfere with a very large number of radiocommunications services used for diverse purposes.

1.2 Broadband in Australia

Australia has a range of installed infrastructure that can be and is used to deliver broadband services. That includes traditional in-street telephone cabling, ISDN,

traditional Pay-TV cable (eg Optus, Telstra), purpose built digital networks (eg Transact), Satellite (eg Optus).

Existing Broadband delivery methods provide 100% geographic coverage of the Australian mainland and Tasmania, and most nearby islands.

Satellite Broadband access, particularly full two-way satellite access is more expensive that other methods, but a current federal government scheme (HBISS) assists rural and remote consumers with the costs.

Several carriers have aggressive rollout programs to widen the coverage of their lowest cost delivery methods (DSL over telephone lines), increasing competition in the process.

Effective competition exists despite ownership of most of the Customer Access Network (CAN) by the dominant carrier. Competition does not require diverse ownership of infrastructure. The regulatory environment makes the existing CAN, mostly owned by Telstra for historical reasons, available to other carriers.

Notwithstanding the significant progress in Broadband rollout, some people do not yet have access to Broadband at affordable rates, and some of those are likely to support any delivery mechanism that brings forward affordable Broadband Internet access without due regard for adverse impacts of the access technology.

Some individuals possess a well developed hatred for the dominant carrier (rightly or wrongly) and may support any other delivery technology again without due regard for adverse impacts of the access technology

1.3 Radiocommunications

Radiocommunications in Australia is controlled by the Radiocommunications Act (Cth) 1992 (RA) and subordinate regulations. Australia is also a signatory to a number of international agreements on radiocommunications that have treaty status (eg the Radio Regulations).

Radiocommunications uses electromagnetic fields that travel as a wave to convey energy over great distances without requiring a conducting medium. Although the waves do not require a medium, the capability to transfer the energy in this way is a unique and valuable natural resource that can easily be spoiled by pollution of the space around us with high-level radio frequency energy that masks desired signals.

Reflection of radio waves by the ionosphere permits propagation of radio waves beyond line of site without any intervening infrastructure.

It is the ability of radio to communicate between two terminal equipments without intervening infrastructure and over short or very great distances that makes it a most valuable tool, especially in the event of a disaster where fixed telecommunications infrastructure is disabled.

The possibility of conflict where EMP weapons might be used to specifically target telecommunications infrastructure without major collateral damage in order

to permit invasion with minimal resistance creates a strategic need to maintain a working radiocommunications capability.

Recent natural disasters, including the 2004 Tsunami in Indonesia, have demonstrated the importance of radiocommunications as a first-in technology for remote communications.

The propagation of radio waves across international boundaries has meant a need for careful international cooperation and administration for a shared approach to management of the resource to the benefit of all.

The expectation of would be BPL operators that they can establish and operate equipment (as they have done) that has been demonstrated to have unintended wideband radio frequency leakage that is 60dB (or a million times) or more above the spectral power density of the background or ambient noise level on mid to low HF frequencies is totally inconsistent with existing regimes for careful coordination and management of radiocommunications nationally and internationally.

1.4 Competition

Australia, like many countries, had a monopolist telecommunications provider that was state owned. Australia set down the path of creating effective competition in telecommunications for a number of reasons. By and large that has been successful in reducing prices, improving values, encouraging new services and service levels that match consumer's needs.

In opening up the telecommunications market to competition, the government had a challenge in that the existing monopoly owned the entire installed infrastructure. The government opened that infrastructure up to competition by a number of determinations made under competition law that were intended to provide access to other carriers and carriage service providers under equitable terms. There has been manoeuvring and delay, but progressively there is more and more competition. Some analysts believe that the monopoly should have been split into two entities, one to own the infrastructure and wholesale it to any carrier, and the other separate entity to assume the existing retail business. It is a long time down the track, and that separation of Telstra's business may yet happen.

The key point is that even though the dominant carrier may own most of the infrastructure today, there is competition because of a government strategy to facilitate competition.

The claim by some that Australia needs BPL to permit competition is phoney, competition exists today including on Telstra's infrastructure.

Some of the proponents of BPL are already supplying bundled energy (gas, electricity), telecommunications (LD phone calls, Internet access). One of the benefits of bundles is to obscure the value of the deal, to make it harder to compare competitive offerings because they are different and it is like comparing apples and oranges - to "muddy the waters". Another key aspect of bundles is that

it is harder for the customer to exercise competitive choice when they are locked in to a product set with complex service, billing, discounting, payment, and minimum term options. These enterprises might not be the champions of competition that they at first appear.

2 Comment on the ACA discussion paper

2.1 General

2.1.1 Management of Interference

The title of the discussion paper seems to concede that BPL and the high level of radio frequency energy radiation proven from existing technologies is inevitable, and the future is about "management" of the interference rather than "prevention" of interference.

2.1.2 Leakage of energy from underground power lines

The ACA in its Executive Summary states "Leakage of the signal occurs as a radiofrequency electromagnetic emission from the power lines and has the potential to cause interference to radiocommunications services, particularly where power lines are above ground."

That implies that leakage from underground power lines is not an issue.

There is no doubt that radiation direct from buried lines is reduced by the attenuating effects of the soil, the amount of attenuation varies with soil types ranging from light dry sandy soils which would have very little attenuation to heavy wet clays which would have more attenuation.

Dependence on attenuation by the soil of buried cables might be sound if the houses were also buried. It should not be overlooked that in most cases, buried power lines come to the surface and most building wiring is above ground level. Radio receiver antennas will more commonly be closer to building wiring than to underground or overhead distribution.

It should not be overlooked that residential estates with underground power often have associated restrictions in pavement openings and, in concert with the lack of power poles, often require extensive expensive directional boring operations for installation of alternative wired telecommunications infrastructure. This type of estate and similar are potentially attractive for BPL deployments, and radiation can be expected from the building wiring as well as the power distribution network.

2.1.3 The ACA's challenge

The ACA in its Executive Summary states: "The challenge for the ACA is to develop regulatory arrangements that do not unnecessarily inhibit BPL deployments but, at the same time, protect radiocommunications services from harmful interference."

The ACA appears to take a position that its first priority is to develop regulatory arrangements that enable BPL, and to some extent relegating protection of radiocommunications to a lesser priority. The statement later in the document

reinforces this: "If it just affected one household cordless telephone or one amateur radio operator then the cost to the community might be small".

With respect, the ACA as Australia's radiocommunications regulatory authority has a primary responsibility to protect radiocommunications under international treaty and for Australia's own reasons, and the challenge for the ACA is to protect radiocommunications services at least from harmful or substantial interference (as applicable) and, at the same time to develop regulatory arrangements that do not unnecessarily inhibit BPL deployments.

2.1.4 Radiocommunications interference

In discussing radiocommunications interference, the ACA lists four factors that influence the probability of interference; one of those factors is receiver sensitivity.

The ambient noise environment is a significant limitation on successful reception of radio signals in many situations, and is very dependent on the radio frequencies involved, and may effectively prevent realisation of the full receiver sensitivity. The ambient noise consists of three main components, galactic noise (noise from stars and other radio sources in space), atmospheric noise (noise caused by natural phenomena on earth such as lightning) and man made electrical noise. The contribution of each of these components varies with frequency, and we can do little about the noise from two of these categories.

It is important that the community, through its radiocommunications regulator, ensures that the contribution of man-made noise to the ambient noise environment does not creep to render radiocommunications less and less effective.

The ambient noise floor (as it is known) is a real limit on radiocommunications, and is relevant to determination of whether radiation of radio frequency energy has the capacity to, and is likely to cause interference.

Other factors also contribute to the probability of interference, for example a continuous service like BPL is more likely to cause interference than an infrequency intermittent service all other things being equal.

2.1.5 Part 4.2 of the Radiocommunications Act (Cth) 1992

Part 4.2 of the RA contains offence provisions relating the emissions.

The most general of them is S.197, which makes it an offence for a person to engage in conduct and to be reckless as to whether the conduct will result in substantial interference with radiocommunications; or substantial disruption or disturbance of radiocommunications.

Though S.197 seems wide in its coverage, it depends on the meaning of the terms "substantial interference" and "substantial disruption or disturbance" which are not defined in the Act. The terms are not mentioned in the House of Representatives Second Reading Speech given on 26 November 1992, or in the Explanatory Memorandum to the 1992 Act.

The predecessor to the RA, was the Radiocommunications Act (Cth) 1983 (the 1983 Act). The second reading speech for the 1983 Act on 18 October 1983 indicates that the 1983 Act intended to address interference problems for which the Wireless Telegraphy Act (Cth) 1905 (WTA) did not provide a remedy. The 1983 Act included standards and controls (see S.9 of the 1983 Act) designed to prevent interference such as industrial interference to radio and television reception. However, these standards were limited to technical standards for devices (transmitters, receivers and radiosensitive equipment). The standards did not include any definition of the meaning of "substantial disruption" or "substantial interference".

This paper suggests that the meaning of these terms is important to the effectiveness of this in S.197 which has it roots in the 1983 Act, and was clearly intended to provide a remedy for interference problems that were not dealt with adequately under the WTA.

It is suggested that the meaning of "substantial" should be something that is of substance, that is it is a material fact that can be identified and measured to prove its existence.

Establishing the materiality of interference or disruption or disturbance would then be a matter of reliably identifying / measuring some phenomena that was a valid indicator of the existence of the interference or disruption or disturbance. Reliability would require a sufficient margin for error in any quantitative measurements. For instance, one measure of substantial interference might be radiation that results in an increase in noise floor by sufficient margin to be confident that measurement artefacts were not significant in the outcome. So it might be that while increases in noise floor of 0.1dB are detectable, an increase of 2dB could be material evidence of substantial interference to any radiocommunications service than is intended to operate down the noise floor as a lower limit.

ITU-R recommendation P372-8 (Radio Noise) provides guidance on expected noise levels for design of radiocommunications services. It indicates higher ambient noise levels at HF than are commonly experienced in residential areas and should not be relied upon as an indicator of the actual ambient noise levels. Clearly, if ambient noise is material to proving "substantial interference" it needs to be measured reliably in each case of interference, or alternatively in a risk managed approach, a realistic profile established for actual ambient noise in different environments in Australia to serve as a ceiling for permitted emissions.

2.1.6 Harmful interference

The discussion paper uses the term "harmful interference" without definition.

The ITU-R Radio Regulations use the term "harmful interference" to define circumstances which endanger the functioning of a Radionavigation Service or of other safety services, or which seriously degrades, obstructs, or repeatedly interrupts a radiocommunications service operating in accordance with ITU-R Radio Regulations. Australia is a Member State of ITU-R. The RA does not

reflect the ITU-R definition of "harmful interference" although Australia is a Member State of ITU-R.

2.1.7 The need for a carrier licence

The discussion paper suggests that a BPL operator may be exempt from the requirement to hold a carrier licence under S.49 of the Telecommunications Act (Cth) 1997 (TA). It is arguable that when the communications crosses the demarcation point for electricity delivery (that being well defined) that the communications should be regarded as a normal telecommunications service, whether the other endpoint of a session is the electricity meter on the customer switchboard or any other service outside the customer's physical boundary.

In any case where a BPL operator delivers a generalised telecommunications service that supports for example any of Internet access, Telephony (whether or not it is bundled with other products such as energy services,) that they should be subject to the same laws, and operate within the same licencing regime as other telecommunications providers.

2.1.8 Economic rationale

The discussion paper mentions economic rational and bringing to book externalities of BPL. Concern is held for the validity of any attempt to convert all of the competing factors to a dollar value to tot up on a balance sheet.

How does the ACA assign economic values to the strategic value of HF communications in the event of a hostile attack on satellite and fixed communications infrastructure?

How does the ACA assign economic value to maritime safety, remembering that for many years the government charged a substantial licence fee on maritime stations, how does the ACA offset the opportunity for spectrum charges against peoples lives or just the cost of search and rescue?

The discussion already raises the point that economic value of one person's use of a cordless phone, or another's pursuit of Amateur Radio might be small in community terms. This seems to assume that individuals need to make an accommodation for BPL rather than the onus being on the BPL product developers to develop a product that in compatible with the existing environment.

There is a well established practice of auctioning off spectrum resources to the highest bidder, but this is no great windfall for the people, it might be paid initially by carriers (who have the greatest capacity to pay), but the cost is born be each and everyone of us who use services directly or indirectly derived from that spectrum.

2.1.9 No-interference clauses

Many radiocommunications users operate under class licences. Reference is often made to unlicenced services, when in fact, the service operates under a class licence with clear statement of entitlement to operate and terms and conditions specific the class licence. The only real difference with a class licence is that the

licence is not granted on an individual basis by the ACA, but is granted to all persons for their use.

Class licences are sometimes thought of as unimportant or less important services. This is not true, for example aviation operates under the Radiocommunications (Aircraft Station) Class Licence 2001, and VHF maritime operates under the Radiocommunications (Maritime Ship Station - 27 MHz and VHF) Class Licence 2001. These are services that are vital to safety of life.

The conditions of some class licences include a clause that the service is not entitled to protection from interference. There are radiocommunications services operating under such services that are vital to safety of life (eg Personal Emergency Response Systems) and that the community should expect to be protected from interference.

The community might not accept the fine print of no-interference clauses in class licences as acceptable if interference to radiocommunications prevented or delayed timely access to life saving care.

2.2 Section 2

2.2.1 Notification of the risk interference by BPL operators

BPL systems should not be deployed where there is a significant risk of interference to radiocommunications services.

Notification of the risk of interference only becomes necessary, and it is necessary, where BPL systems that are known to have emissions that are above the noise floor are operated at any location where a person may operate a radio receiver.

Notification at the start-up of a service does not address situations where subsequent to that notice at a later time, a person commences using a radiocommunications service without knowledge that it may be affected by the BPL system. An example might be where a resident's health fails and they commence a Personal Emergency Response System overlooking a warning in the past that radiocommunications devices in the neighbourhood might be adversely impacted by interference from a BPL deployment.

2.3 Section 3

2.3.1 Regulatory certainty

It is in the interests of both telecommunications industry and radiocommunications users, and indirectly, the entire community that there is certainty in moving forward.

Clearly, investors in telecommunications need to be confident of returns on their investment to encourage investment in infrastructure and services that are vital to the growth and prosperity of the Australian economy.

Equally, radiocommunications users need to know that their radiocommunications services will continue to operate in the manner that has been accepted and relied upon.

The community is not well served by financial failure or waste of failed telecommunications start-ups, nor is it well served by trashing of the unique and valuable spectrum resource for parallel delivery of telecommunications services.

2.3.2 Allowing the BPL industry to make its own arrangements

The BPL industry should not be allowed to make its own arrangements about how it deals with stakeholders outside the industry. The industry would have a vested interest and would not be seen to act fairly and impartially.

The BPL industry is really about provision of telecommunications services. Although the industry claims benefits that include management of the electricity network, it is a medium capacity telecommunications service that is much higher in capacity than needed for electricity network management and is principally for providing Broadband Internet access to the public. As such, they are in the telecommunications industry, and as pointed out in the discussion paper, subject to the TA and subordinate regulation. Participation in Australian Communications Industry Forum (ACIF) would seem not only appropriate, but essential to the smooth operation of interconnected networks.

The role of ACIF or an organisation like ACIF, or the Telecommunications Industry Ombudsman (which was established to arbitrate service related issues between contracted parties) should not be extended to dealing with or arbitrating cases of interference to radiocommunications services.

The ACA (and any organisation that substantially assumes the role of the ACA) has a role to act in an impartial manner, and to balance the needs of all stakeholders, and remains the obvious agency for management of complaints of interference to radiocommunications.

2.3.3 Standards based approach

The existing EMC standards have the effect of reducing the risk of interference, but not necessarily preventing interference. For example, inverter air conditioners that comply with the relevant standards may still emit sufficient radio frequency energy to cause interference, or a power line that complies with the relevant standards may still emit sufficient radio frequency energy to cause interference.

Whilst the existence of the standards reduces the risk and level of interference it does not ensure no-interference.

Nothing in the RA suggests that compliance with EMC standards gives any relief from the provisions of S.197.

Anecdotal evidence is that equipment suppliers and electricity network operators conveniently assert that if their equipment is compliant with the relevant EMC standards, then the matter is closed and the complainant is not entitled to protection from interference.

If the standards based approach proposed is a risk managed one, ie that the standards reduce the likelihood of interference rather than preventing interference, there will still be occurrences of interference, and the public should be afforded protection from such interference.

Whilst there might not currently exist a standard that applies to BPL, if a BPL emission standard did exist that was similar in levels to existing EMC standards, FCC Part 15, European standards (eg NB30), or proposed standards, the standard would not prevent interference, only reduce the risk of interference. Any administrative action to deem that equipment compliant with a standard does not cause interference is just denial of the reality and does not resolve the problem of disruption of the affected radiocommunications services.

Standards that are tight enough to prevent interference will drive the cost of goods up substantially, and may deny access to "world products". It is not practical to go-it-alone with stringent standards that prevent interference. It is appropriate that standards reduce the risk of interference, that they evolve, and that standards compliance is not a waiver of the requirement to not cause interference.

The preferred approach is appropriate standards that evolve in a timely way to reduce the risk of interference, and at the same time legislated protection from interference for radiocommunications services and an independent agency for resolution of interference complaints.

2.3.4 Appropriate body to develop a code

As discussed in 2.3.2, to the extent that the BPL industry should be permitted self-regulation in matters regarding interoperability within the BPL / telecommunications industry, which is really the telecommunications industry, the appropriate body would seem to be ACIF.

2.3.5 Licencing fee for use of spectrum by BPL

Charging licence fees for BPL spectrum use implies acceptance of radio frequency energy radiation that is material in nature.

It is, in a sense, authorising BPL as a radio transmitter, albeit within specified limits. It may have the benefit of better identification and cataloguing of emission sources and more enforceable limits, with fees to reasonably recover the cost of management (including interference resolution).

If licencing and licence fees are used as an economic rationalist's tool for auctioning off radio spectrum to the highest bidder, it is likely that BPL operators would outbid any other user of the spectrum because of their capacity to pay, and to the detriment of almost all users of radio spectrum.

2.4 Section 4

2.4.1 General

The discussion paper suggests that in-house BPL is less likely to be an interference problem mainly because of the "symmetrical construction of the power cable with its closely spaced conductors". Whilst some wiring of residential premises uses a topology where the active conductor is close spaced in the same sheath as the neutral and earth it is the common mode current that gives rise to radiation, and where the BPL signal is injected only on the Active conductor, or where there is any unbalance at radio frequencies of the cable (eg an open switch in the active only) or connected appliance to ground, then there will be common mode current. Note also that whilst GPO final sub-circuits and single appliance final sub-circuits (eg stoves, water heaters etc) may use symmetric cabling, lighting final sub-circuits are usually free and easy about the wiring of the switches which often use single core cable in a shortest path topology.

The fact remains that power wiring, whether in the transmission, distribution or utilisation segment, is not suitable for carrying radio frequency energy from point to point. Of all of the reasons for the lack of suitability, the most relevant to radiocommunications interference is the radiation of radiofrequency energy from conductors where the fields due to current in one conductor do not balance fields due to currents in other conductors, whether because of the amplitude or phase of the currents, or the geometry of the conductors.

The manufacturers of BPL chipsets have visions of them being embedded in many household appliances. The vision includes that modular entertainment systems would not be cabled to carry video and audio, rather the DVD player would for example, send a digital stream to the television display using embedded BPL. The modular flexibility, portability, and lack of cable clutter have a certain appeal. There is a prospect that in-house BPL might expand significantly beyond the computer LAN.

2.4.2 Strategy

Experience has been that consumers have purchased equipment that is compliant with certain standards, but at the same time has the potential to cause interference to radiocommunications. For instance, consumers are often not aware that when they acquire a device that operates under the LIPD Class Licence, they may be unable to use it because it causes interference through no fault of the equipment or their own. They may reasonably see this as unfair, and obtain little comfort after purchase with the fine print in the ACA's Class Licence.

Consumers should be made aware that some products have some risk of causing interference to radiocommunications, and that if they are shown to cause interference, they may be required to cease using the product. The ACA should consider extension to its C Tick scheme to ensure adequate product disclosure to consumers.

It would appear that standards are formative, and must be balanced with similar standards. For example, standards for in-house BPL should not permit emission levels in a neighbouring property (which could be just a wall thickness away) that would not be permitted of access BPL. Similarly, though not currently regulated, traditional line telecommunications and power lines should be subject to similar emission limits. If this balance was to be achieved, then it is likely to be some time before standards for in-house or customer premises equipment is settled.

3 Conclusions

BPL has been trialled in Australia in a number of locations, the most notable the ongoing trials in Queanbeyan, NSW (pictured on the cover) which commenced in November 2004 and appears from Country Energy's recent press release to be extended to around March 2006.

The BPL operator ought to have known before deploying the equipment of the radiation levels, and must now know that the radiation is so high as to be likely to impact radiocommunications in that area on the frequencies affected by each of the links, and yet the Queanbeyan trial continues beyond its initial trial period.

The ACA's published measurement data for the Queanbeyan trial showed radiation of radio frequency energy that is 40 to 60dB above the expected lowest ambient noise levels set out in ITU-R recommendation P372-8 (Radio Noise) in the residential area where the trial was deployed. The ACA has the knowledge and skills to measure and analyse the measurements, to know of the risk of interference to radiocommunications, and yet the Queanbeyan trial continues.

The suggestion by the BPL industry that the equipment trialled and measured in Queanbeyan is obsolete technology with known high levels of radiation, and that new generation chipsets will resolve all problems is an appalling attestation of their reckless approach, and raises concerns for their credibility.

BPL technology is undergoing rapid development, though it has a long way to go to achieve operating radiation levels that are safely no worse than the ambient noise floor. We should expect that in the future, it is likely that safe BPL technologies will be available, and that many of the benefits of BPL, especially in-premises will be available without the attendant interference risk that has been demonstrated.

The ACA should act now to protect radiocommunications under existing laws, subordinate regulations, international agreements, and treaties as a first priority, even if that means shutting down existing trials. They should explore additional regulatory options (legislative change, regulations, standards, licencing etc) to ensure that BPL systems are unlikely to cause interference to radiocommunications. In cases where BPL does cause interference to radiocommunications, the ACA should act to prevent the interference continuing and recurring.

4 Glossary

Terms used in the document have the meanings set out in Table 1.

Table 1: Glossary

Term	Meaning
ACIF	Australian Communications Industry Forum
Bit	Binary Digit
BPL	Broadband over Power Lines
Broadband	High-speed data, generally accepted as above 256Kb/s in at least the downstream direction. More importantly, Broadband is characterised by "always-on" access that supports multiple concurrent applications, though at this point in time not to imply suitability for real time-traffic such as telephony as we experience it on the POTS network.
Byte	An octet or 8 bits.
CAN	Customer Access Network
DSL	Digital Subscriber Line, technology for transmission of high speed data on telephony or better grade copper lines.
HF	High Frequency (3MHz to 30MHz)
HV	High Voltage (higher than LV)
Interference	Interference to, or with radiocommunications that is attributable, whether wholly or partly and whether directly or indirectly, to an emission of electromagnetic energy by a device (from the Radiocommunications Act (Cth) 1992.
ISDN	Integrated Services Digital Network. Available in two access interfaces, Basic Rate at 144Mbps aggregate, and Primary Rate at 2Mbps aggregate.
ITU	International Telecommunications Union
LV	Low Voltage (below 660V to 100V)
Mbps	Mega Bits Per Second.
PLC	Power Line Communications
PLT	Power Line Telecommunications
POTS	Plain Old Telephone Service

Term	Meaning
RA	Radiocommunications Act (Cth) 1992
VHF	Very High Frequency (30MHz to 300MHz)