

COMVERGE

CREATING INTELLIGENT NETWORKS

Guidelines For FTTH Deployment In Greenfield Developments

COMVERGE

CREATING
INTELLIGENT
NETWORKS

Comverge Networks
26 Jellico Drive, Scoresby
Victoria 3179 Australia
Phone +61 3 8706 0000
Fax +61 3 8706 0066
ABN 43 125 517 553
www.comverge.com.au

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GLOSSARY OF TERMS

Abbreviation	Description
AC	Alternating Current
ACA	Australian Communication Authority
ACMA	Australian Communications and Media Authority
ACIF	Australian Communication Industry Forum
AS	Standards Australia
CCTV	Closed Circuit Television
CATV	Cable Television
DC	Direct Current
EPON	Ethernet Passive Optical Network
EPON-ONU	Ethernet Passive Optical Network – Optical Network Unit
FTA	Free-to-Air
FTTH	Fibre to the Home
GPO	General Power Outlet
IP	Ingress Protection
IP	Internet Protocol
MATV	Master Antenna Television
NAP	Network Access Point
NTD	Network Termination Device
ONT	Optical Network Termination
ONU	Optical Network Unit
PC	Personal Computer
PSTN	Public Switched Telephone Network
PSU	Power Supply Unit
PVC	Poly Vinyl Chloride (plastic)
RF	Radio Frequency
SATV	Satellite Television

1. OBJECTIVE

The objective of this document is to provide builders and telecommunications cabling providers with basic guidelines for cabling of new residential dwellings for connection to Comverge Networks Fibre-To-The-Home (FTTH) network architecture & services.

2. SCOPE

Comverge Networks will use FTTH technology to supply telecommunications services to the residents of Greenfield Developments, including high-density developments such as villas and town houses. Such services may include, but not limited to:

- (a) Voice - Telephony services, at a level of service comparable to that provided by a PSTN network (as offered by Incumbent provider).
- (b) Data - High speed data connections to the Internet or to other private networks.
- (c) Video Services – including free-to-air terrestrial & satellite services, subscription television (pay television) and demand-based video services.
- (d) Other value-added services --- many other value-added services for an FTTH can be envisaged, such as:
 - Online Gaming
 - Online Home Security
 - Online Learning
 - Teleconferencing
 - Community Portal
 - Telemedicine, Medical Imaging
 - Remote Radiology and Specialty Consulting etc.

3. INTRODUCTION

3.1 What is FTTH?

FTTH, or Fibre-to-the-Home, refers to fibre optic cable that replaces the standard copper twisted-pair wire of the local Telco running to the home. The optical fibre cable that runs to the building is similar to twisted pair cable in physical size but contains no metallic components. Also, only one such cable is required to supply voice, data and video services instead of two or more separate cables.

Optical fibre cable is less robust than twisted pair cable in terms of physical abuse, i.e., it must not be folded back, kinked or trampled on or the fragile glass fibre it contains may be permanently damaged and render it unusable.

3.2 Why Fibre & Fibre-to-the-Home?

There are a number of reasons to consider deploying optical fibre rather than copper:

- The lifetime costs for fibre are less than for copper-based systems, even though fibre may require a larger upfront investment. Typical aging lifespan of fibre cables is over 50 years.
- It's transparent with regard to data formats and data rates; therefore, to increase bandwidth the fibre does not have to be replaced, just replace the terminal equipment. This is a very important issue from the point of view of life cycle costs as well as persistence of the technology.
- Only fibre can “truly” reach the 50-1000 Mbps and beyond to support a full-range of applications:
 - ❖ Copper supports voice and data services, but cannot “adequately” support Cable TV/Video services.
 - ❖ Wireless can support data services, and voice services that are compromised in quality – but cannot support Cable TV services.
 - ❖ Coax can support Voice over IP services, data, and Cable TV services – but that's it. No other additional service is able to run on it.
- Fibre is less susceptible to electrical interference from power lines and spurious radio signals and immune from lightning-induced surges.
- Attenuation (or signal loss) for fibre is several orders of magnitude less than any other broadband technology, thereby significantly reducing the need for expensive signal regeneration equipment and/or amplifiers.
- Fibre offers
 - Higher Bandwidth
 - Lower Latency (i.e., delay)
 - Lower Bit Error Rate

3.3 What Services are available via FTTH?

Initially, the equipment described in this Guideline can supply the following services:

- up to four (4) telephone services;

Each telephone service will support narrowband dial-up modems and most dialup alarm units (eg. security, panic button, medical, smoke).

- a data service

The data service does not require a modem but may be connected directly to a 10 Base-T or 100 Base-T (Ethernet) port on a personal computer or an Ethernet router, switch or hub.

- a digital video service.

3.4 Equipment required at the Customer's Premises

3.4.1 Network Termination Equipment

The optical fibre lead-in cable from the street terminates within a unit (box) that converts the optical (light) signals into electrical signals. This unit is called an Optical Network Termination (ONT) or Optical Network Unit (ONU). ONU/ONT is preferably located inside an enclosure.

The enclosure (along with the customer premise equipment) is installed on the wall of the building by Comverge Networks installers.

3.4.2 Power Supply Unit & Battery

A power supply unit (PSU) is required at the customer's building to provide power for the ONU. This requires a 240 V socket-outlet into which the PSU cord is plugged.

The PSU contains a rechargeable battery to ensure continuity of telephone services during electricity outage.

3.4.3 Optional Video Splitter/Amplifier

Where the customer requires more than one video outlet but no more than three video outlets, it will be necessary to install an RF splitter.

Where the customer requires more than three video outlets, an RF video amplifier will be required to boost the video signals to support the extra outlets. Where an RF video amplifier is to be installed, an extra 240 V socket-outlet is required next to one of the video outlets to power the amplifier.

The splitter and amplifier, if required, may be installed inside the enclosure. The amplifier may be powered via the coaxial cable from a 240 V power pack at the video outlet location, otherwise the power pack may be located beside the amplifier (if internal), in which case an extra 240 V socket-outlet will be required at this location.

4. THE VARIOUS COMPONENTS OF FTTH DEPLOYMENT

The different components of a Fibre to the Home solution are:

- **Pit & Pipe**
- **Fibre Reticulation**
- **Satellite Farm**
- **Head-end Equipment**
- **Head End Facility**
- **Connection of Home & Service Activation**
- **In-Home Wiring**

5. GREENFIELD DEVELOPMENTS

5.1 Pit & Pipe Deployment

In Victoria, Whittlesea City Council started exploring options for equipping the developments in its jurisdiction with better communications infrastructure in 2000. The Council recognised that once areas were developed, the opportunity to economically fit new cabling underground would be effectively lost. As a result, it introduced a policy in July 2004 requiring developers to install a spare communications duct (with suitably spaced access pits) at the time of construction. So, pit & pipe architecture must be in place before builders move into the estate to build houses. Other city councils in Victoria, for example, Casey, Cardinia, Melton etc. are expected to follow suit soon. So, it is very important these days to have a suitable pit & pipe architecture planned for a Greenfield Development.

Figure 1 shows a typical pit and pipe deployment in a Greenfield estate.



Figure 1: Greenfield Pit and Pipe Deployment

Points to note are:

The “trunk” pipes (i.e. the pipes that run along the streets) typically have internal diameters of 100mm (outside diameter 110mm). The conduits shall be heavy duty, rigid UPVC in accordance with AS 2053. Standards Australia (AS) and the Australian Communication Industry Forum (ACIF) mandate that these pipes be made either from white PVC or orange PVC with a white stripe along the pipe length. In most cases white PVC is used. In

1. **Figure 1**, these pipes are shown as dark black lines.

The “drop pipes” (i.e., the pipes from the pits to the homes for carriage of the “drop” fibre cable from the pits to the homes) typically have an internal diameter of 27mm (outside diameter 32mm). As with the “trunk” pipes, the “drop” pipes must be made either from white PVC or orange PVC with a white stripe along the pipe length. In all cases, white PVC is used. In

2. **Figure 1**, these pipes are shown as blue lines.
The lead-in trench must be deep enough for the conduit to be laid on suitable bedding material, and for the minimum top cover to be applied. In urban areas within private property, the minimum depth of cover required is 300 mm. The depth of cover should not exceed 500 mm. This means that the depth of the trench needs to be between about 400 mm and 600 mm below the finished ground, path or driveway level. The trench may be a dedicated one for fibre only or it can be a shared one with another service (electricity, water, sewerage/sanitary, stormwater, gas etc.).
3. Large radius bends (100mm or more) are required on all pipes where there is a need for pipes to change direction.
4. As a general rule the pipes need to be buried to a minimum depth of 300mm or, where installed under a trafficable area, to a minimum depth of 500mm below the open drain invert or road low point. For precise details please refer to AS/ACIF S009:2001 standard and the AS HB29:2000 Communication Cabling Manual.
5. P6 pits are used at the junctions of the “trunk” pipes (100mm conduits). They will generally house a fibre service loop and may also house an underground closure, which contains the passive optical splitter(s). A fibre service loop is a loop in the “trunk” fibre cable (i.e. either feeder or distribution cable) that can be unwound to provide slack for repairing a future break in the fibre cable. This reduces operating costs over the life of the network.
6. P5 pits are used at the “drop” points along the “trunk” pipes. They house the NAP (Network Access Point) and are also used to take up the slack in the “drop” cables.
7. Pits can be located on one side of the road or both sides of the road with appropriate road crossing (using 50mm ID conduit or enveloper conduit etc.). The lead-in conduits run from the nearest pit to the property boundary (it can be extended up to a metre or so into the property). The minimum depth of cover for these conduits is usually 300mm, or 450mm if the conduit runs parallel with the property boundary for some distance before it enters the property. Conduit bends should have a bend radius of 100mm or more (a bend radius of 300mm is usually recommended). Please see **Figure 2**.

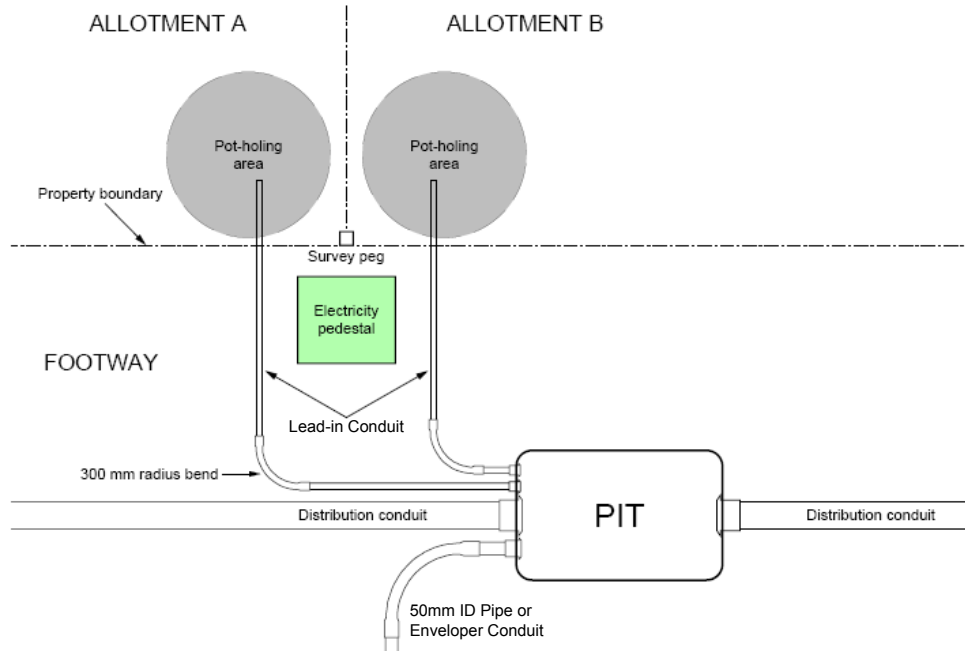


Figure 2: A Typical conduit arrangement for a Greenfield Development

Figure 3 shows the appearance and dimensions of the P5 and P6 pits (the lids are not fitted in these pictures). The lids can be made of heavy duty plastic or concrete with suitable locking system.



Figure 3: P5 and P6 Pits – Appearance and Dimensions

5.2 Fibre Reticulation

Once the pit and pipe conduit has been completed and as the first home nears completion a crew will be sent out on site to haul the fibre through the pits and pipes ready to connect the head end and homes to each other.

The Fibre reticulation takes a couple of days per stage and can be done once the roads and landscaping has been completed as the splice vans and hauling trailers are low impact.

Figure 4 shows a P5 pit with fibre coiled ready to be pulled through the lead-in pipes.

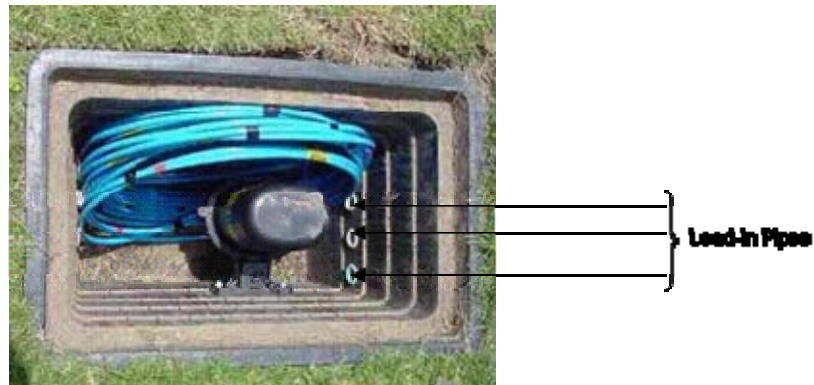


Figure 4: P5 Pit with fibre loop

5.3 Satellite Farm

- If the developer is mandating an Antenna and Satellite dish free environment in the Greenfield Development, a suitable site needs to be allocated to locate the Master antenna and 3-4 90cm-120cm satellite dishes.
- Ideally, this could be on the roof or adjacent to the building where the head end is located.
- If this facility is not available a suitable Satellite Farm needs to be provided.
- All the satellite dishes (FTA or Pay TV) can be located at a place “almost invisible” from the residential area.
- Fibre will be used to connect the Satellite Farm to the Head-end equipment for distributing various channels throughout the estate.
- The Satellite Farm can be with a single dish for a specific service or multiple dishes for multiple services as shown in the following figure. Typically you would have a dish each for FoxTel/Austar & SelecTV one for free to air satellite such as BBC World or an ethnic channel and one for initial internet broadband if required.

A typical Satellite Farm is shown below (Figure 5):



Figure 5: Satellite Farm

5.4 Head-end Facility

- Ideally, the Head End Equipment would be located in a suitable room (4m x 3m x 3m) in a fixed structure such as a Club House or Community Centre.
- If this facility is not available or will not be available until later in the project, a Comms Shelter (a transportable walk-in shelter) needs to be provided by the developer to house the head-end equipment. The recommended room dimensions are 4m x 3m x 3m
- If a Comms Shelter is used, relevant council permit needs to be obtained by the developer.
- With either the Comms room or Comms Shelter the developer needs to provide suitable Mains Power, Air Conditioning, Uninterruptible Power Supply (UPS) and Generator, if required.
- Fencing may also need to be considered for security and aesthetics.

A typical Comms Shelter is shown here (Figure 6):



Figure 6: External View of a Comms Shelter

5.5 Head-end Equipment

In a typical development of 1,000 homes, the equipment in the racks will look similar to the racks shown in the following figure (Figure 7):

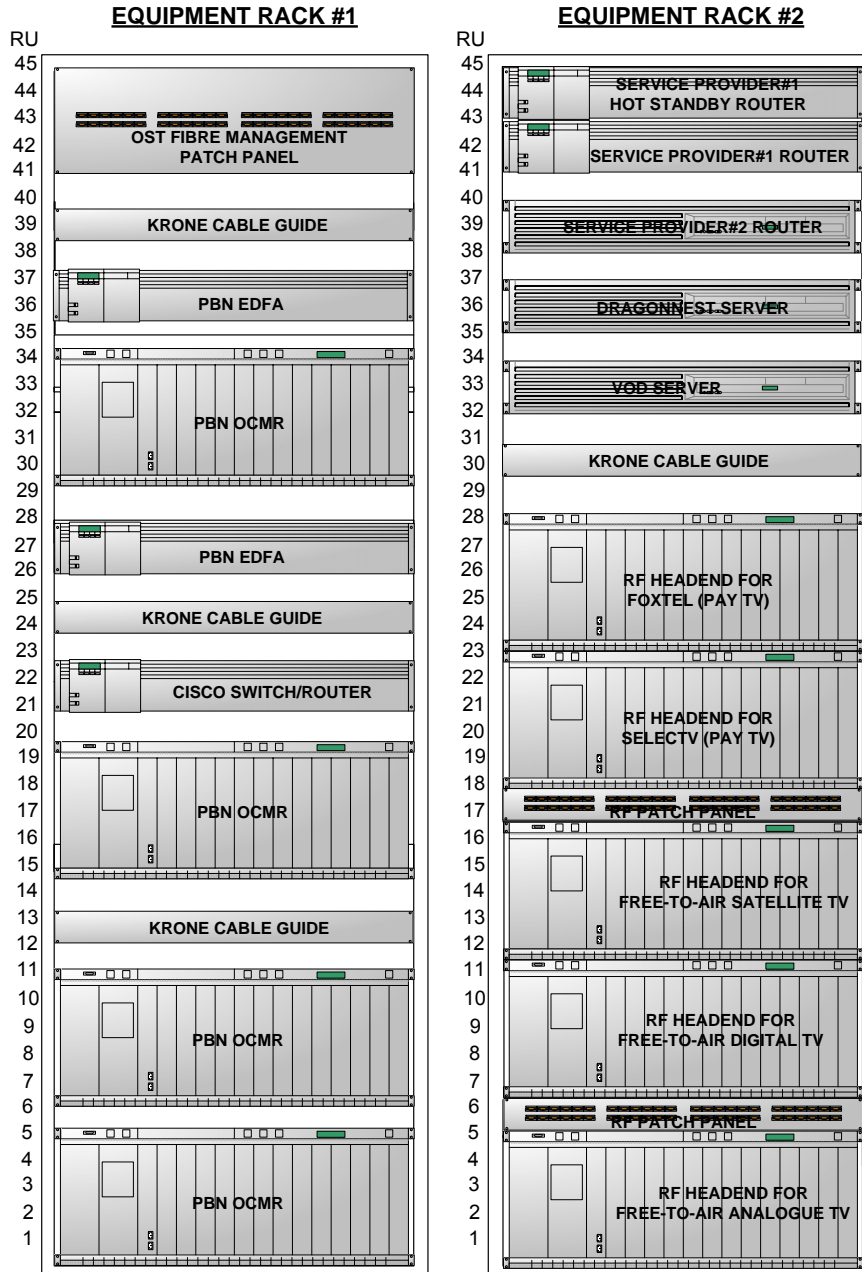


Figure 7: Equipment racks with appropriate equipment

6. STANDARDS TO FOLLOW

Comverge Networks recommends that any pit & pipe architecture and trenching follow industry regulations as detailed in various documents. Some of them are given below:

Document Number	Title
AS/ACIF S009:2006*	ACA Wiring Rules
AS HB29:2000	Communication Cabling Manual
AS/NZS 2053	Conduits and Fittings for electrical installations
AS/NZS 3000	Electrical Installations (known as the Australian/New Zealand Wiring Rules)

* comes into force as a mandatory Standard on 1 July, 2006.

7. INSTALLATION OF EXTERNAL EQUIPMENT

7.1 Location of the Equipment

Optical Network Unit (ONU) or Optical Network Terminal (ONT) along with other equipment is installed inside an enclosure (see **Figure 8**). The enclosure will also house General Power Outlet (GPO), back-up battery etc. (GPO is to be supplied by the home owner). To ensure accessibility and avoid tampering with the equipment, Comverge Networks suggests that the lockable metal enclosure be located in the garage, which is protected by a zone of the in-house alarm system. Since the enclosure is located inside the garage, there is no need to use IP (Ingress Protection) rated enclosure. The enclosure should be 380mm wide to fit between the typical studs in an internal wall.

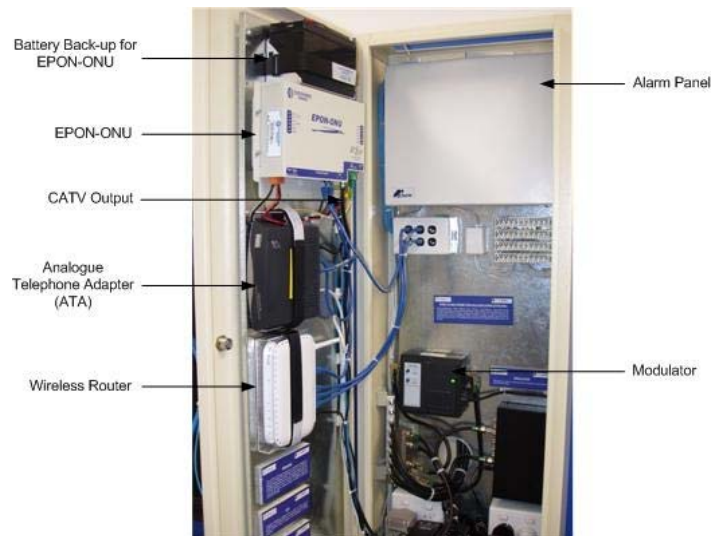


Figure 8: Enclosure with Equipment inside (located in the garage)

7.2 Lead-in Conduit

The lead-in trench must be deep enough for the conduit to be laid on suitable bedding material, and for the minimum top cover to be applied. In urban areas within private property, the minimum depth of cover required is 300 mm. The depth of cover should not exceed 500 mm. This means that the depth of the trench needs to be between about 400 mm and 600 mm below the finished ground, path or driveway level. The trench may be a dedicated one for fibre only or it can be a shared one with another service (electricity, water, sewerage/sanitary, stormwater, gas etc.).

The builder shall extend the 32mm (27mm internal diameter; AS/NZS 2053) white PVC conduit and its draw wire from the network pit in the street or easement to the enclosure in the garage (preferably via the wall cavity). The conduit shall have only long radius bends and it shall have a suitable draw wire from the pit (mostly P5 pit) to the enclosure (see **Figure 9**).

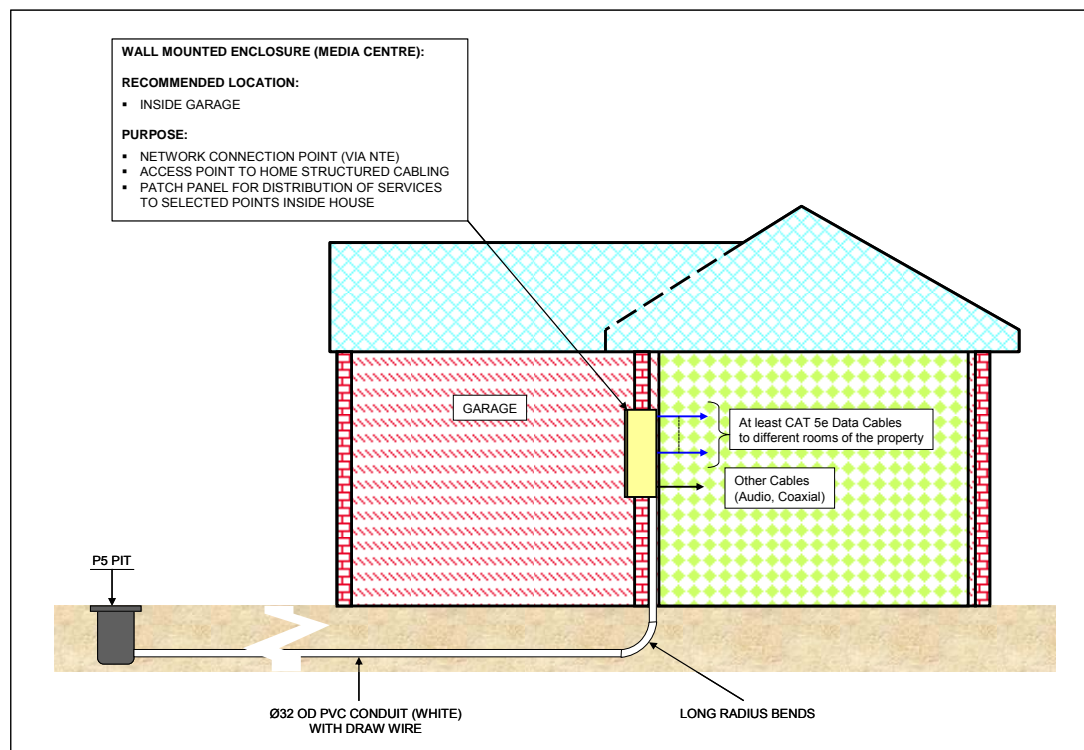


Figure 9: Lead-in Conduit to Home

Flexible or corrugated conduit should not be used in building cavities due to the difficulty in drawing cables through such conduit. Conduit bends should have a bend radius of 100 mm or greater.

8. IN-HOME STRUCTURED CABLING

8.1 Introduction

A structured / smart cabling system should be installed in each and every home on the estate by the builder during the home construction phase. Such a cabling system provides a uniform cabling infrastructure that is the foundation to implementing current and future network technologies within the home environment. Properly installed, a structured / smart cabling system will provide expected performance and agility to adjust with the growth of the system. Several factors are contributing to the growth and mainstream acceptance of structured / smart cabling:

- Builders are more familiar with structured / smart cabling and recognize that it gives them a competitive edge. Furthermore, if they do not install a structured / smart cabling system, they run the risk of building new homes that will quickly become obsolete.
- Homebuyers are recognizing that the lifestyle benefits of a structured / smart cabling system are worth the amount that a system adds to the cost of a new home.
- The real estate industry is recognizing that the resale value of new homes could be adversely affected if a home does not have the proper infrastructure installed for delivering various broadband services.

A Structured / Smart Cabling System is comprised of three major components:

- ◆ **A Structured Media Centre** comprising a wall mounted enclosure that is usually installed in the garage as shown in **Figure 8**.
- ◆ **High Performance Cabling** - Category 5e telecommunications cables & RG6 Quad shield coaxial cables that provide the "highways" for voice, data, and video to travel over.
- ◆ **High Quality Outlets** - specifically designed to support advanced information services, outlets are designed for quality, performance, and aesthetics.

8.2 Who Does What?

8.2.1 Telephone, Data and Video Outlet Cabling

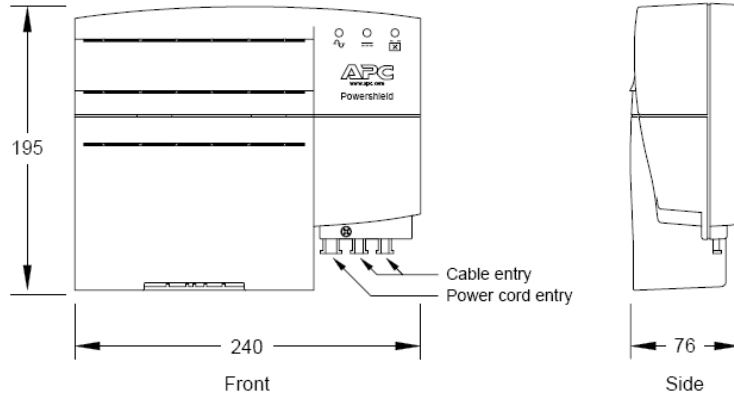
Comverge Networks Optical Network Unit (ONU) is designated as a Network Termination Device (NTD) and is the network boundary for services supplied by FTTH. Cabling between the ONU and the telephone, data and video outlets is customer cabling, to be provided by the builder's or customers chosen "Cabler". Options and guidelines for installation of this cabling are provided in Sections 8.3.

8.2.2 Power Supply Unit

The Power Supply Unit (PSU) and the cabling between it and the ONU belong to the Network Operator and are provided by the Comverge Networks installer. However, the builder or customer must provide the 240 V socket-outlet required to power the PSU.

The PSU provides the power for the Comverge Networks ONU. It converts the domestic 240 V AC to 12V DC. to operate the electronics in the ONU. Initial supplies of the PSU contain a sealed, lead-acid 12V, 7.2 a.h. battery that form part of the ripple filtering circuitry and also maintains

operation of the telephone lines for a limited time (nominally up to 8 hours) during power outage. A standard PSU dimensions are shown in the following figure (**Figure 10**).



Note: The dimensions include the battery, where provided. The battery is housed inside the PSU.

Figure 10: Power Supply Unit (PSU)

However, the customers may decide to install any battery that meets the following specifications (they are available at most consumer electronic and battery specialty stores):

Battery Type	Sealed Lead Acid
Voltage	12 Volts
Amp-Hours	7.0Ah ~ 7.2Ah

The PSU is connected to the domestic power via a plug and cord. A dedicated, standard 240 V socket-outlet is required within 1 metre of the PSU. The socket-outlet is to be provided by the builder or customer.

8.2.3 Earthing Issue

The builder's or home owner's electrician is responsible for any earthing required for the power cabling.

8.3 Basic Cabling

8.3.1 Introduction

Basic telecommunications cabling will provide the occupant with access to telephone and video services at one or more rooms of the dwelling (depending on the number of outlets installed) plus access to the data service at a single, predetermined location.

A certain amount of flexibility will be built into the cabling system, but changes will need to be made by a registered/licensed telecommunications cabler (e.g. If access to the data service is required in a different room).

This cabling system will suit customers who have basic telecommunications needs. Basic cabling will not support networking of personal computers (PCs) via the cabling system — but limited PC networking may be achieved by such means as wireless network cards and adaptors.

8.3.2 Cabling Scenarios

A typical basic cabling system is illustrated in **Figure 11**. With this cabling system, to provide maximum flexibility:

- All telephone and data outlets are star-wired from the ONU, subject to a maximum of six (6) cables at the ONU.
- Additional telephone outlets may be cabled from other telephone outlets where more than 6 outlets are required, as long as they are not likely to be used for data (e.g. kitchen wall phone or two bedside telephones in the master bedroom). See **Figure 12**.
- Data-grade (category 5/5e) cable is used for all telephone and data cabling.
- If there is a need for more than 6 telephone/data cables to be connected at the ONU, a distributor is required to provide additional connection facilities.
- Where only one video outlet is required, this is cabled directly from the ONU.
- Where more than one video outlet is required, these are star-wired from an RF splitter (up to 3 outlets) or RF amplifier (more than 3 outlets), which will be installed inside the enclosure. See **Figure 12**.

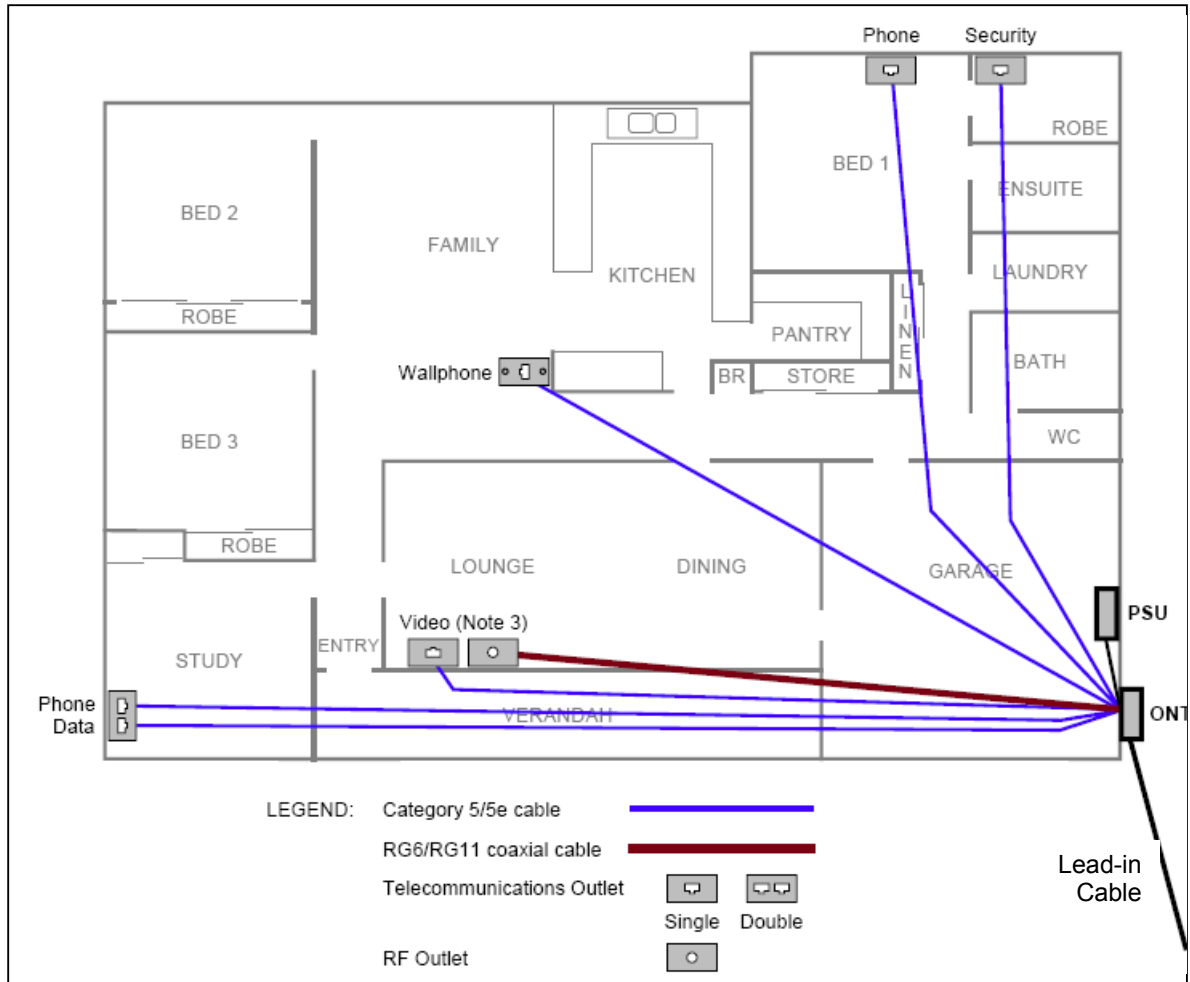


Figure 11: Basic Telecommunications Cabling

Notes:

- (a) With this cabling arrangement, any telecommunications outlet may be used for telephone or data, depending on how it is connected in the ONU. This provides maximum flexibility at low cost.
- (b) A maximum of six (6) category 5/5e cables and one (1) coaxial cable may be run to the ONU.
- (c) Each video outlet requires a telephone socket for access to digital video services. See **Figure 12** if more than one video outlet is required.

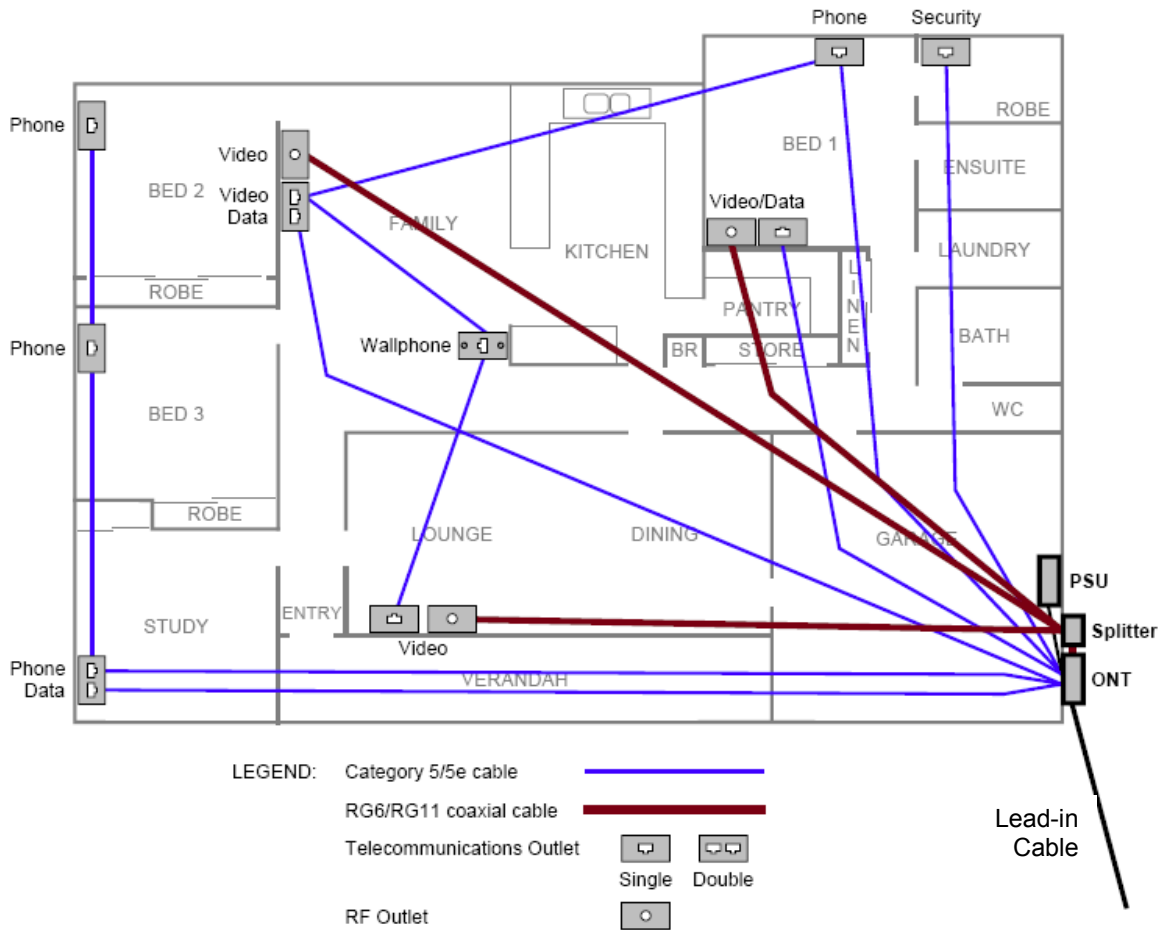


Figure 12: Cabling Scenario where the number of outlets required exceeds the number of cables that may be connected to ONU

Notes:

- (a) A maximum of six (6) category 5/5e cables may be run to the ONU. If more than one (1) video outlet is required, a second conduit will be required between accessible roof space and an external splitter box.
- (b) With this cabling arrangement, outlets that are only ever likely to be used for telephone or access to digital video services are bus-wired. Outlets that may be used for data or security are star-wired from the ONU. This provides some flexibility without the need for an internal distributor.
- (c) Each video outlet requires a telephone socket for access to digital video services.

8.3.3 Telephone & Data Cabling

ACA-compliant, 4-pair, unshielded, category 5 or 5e, 100Ω cable with 0.50 mm (24 AWG) solid conductors should be used. Any cable with stranded conductors should not be used.

The use of higher performance cable (e.g. category 6 or 7) is not necessary.

The length of any cable between the ONU and any telephone or data outlet should not exceed 90 metres (cable runs this long are unlikely in most dwellings).

When installing category 5/5e cables, take care to avoid stretching, kinking or crushing of the cable and in particular:

- Avoid excessive tension when drawing cable through building cavities, conduits, etc.
- Don't allow any kinks or knots to form in the cable.
- Ensure any bend in the cable has a bend radius greater than 25 mm (5 times cable diameter).
- Ensure the cable is evenly supported, protected from crushing or trampling during and after installation, and that the cable sheath is not appreciably distorted by mechanical protrusions, cable ties, clips or other securing devices.
- Keep at least 50 mm away from power cables and appliances whether or not there is an interposing barrier. Where it is necessary to cross power cables, cross at right angles.
- Make each run of cable as short and direct as possible while ensuring the above requirements are met. Allow for at least 200 mm of slack cable to be left at each end after termination of the cable.
- Don't joint/splice the cables. If any cable is damaged or too short, replace the full length of cable rather than repairing with a joint/splice.
- Don't tee or tap off any cable except for additional telephone sockets provided in accordance with **Figure 12**.

Marking of Cables

All category 5/5e cables will be connected the same at the outlets. In general, it will only be necessary to mark the cable intended for the data service at both ends. All other cables need only be marked at the ONU end with mnemonic coding, e.g., "FAM" (for family room), "BED 1", "BED 2", "KIT" (for kitchen), "STU" (for study room), "SEC" (for security), etc. This may be done either by use of permanent ink felt pen markings on the cable sheath or an adhesive label. Such marking will make it easier to connect the cables at the ONU and for subsequent alterations or fault finding.

8.3.4 Telephone & Data Outlets

8-position (8P) modular sockets (commonly called “RJ45” sockets) should be used for all telephone and data outlets. Use 8-contact (8P8C), category 5/5e sockets for all telephone and data outlet to provide maximum flexibility, i.e., so that any outlet can be used for either telephone or data without the need to change the socket.

Don't use 6-position modular sockets (“RJ11”/“RJ12”) or 600 series sockets. **Figure 13** and **Figure 14** illustrate typical 8P modular sockets and plates, surface-mount boxes and plugs. **Figure 15** shows 8P8C socket connections and **Table 1** shows the cable colour code for 8-position modular sockets.

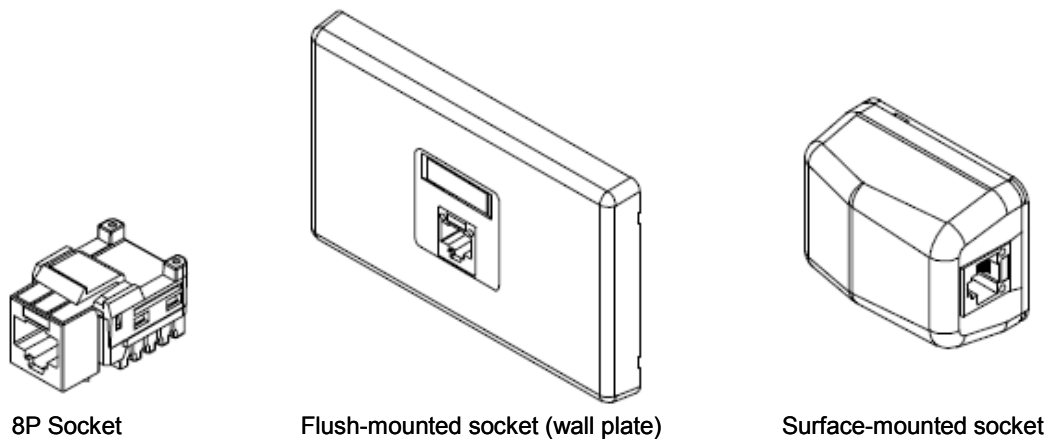


Figure 13: Typical 8-position modular socket hardware

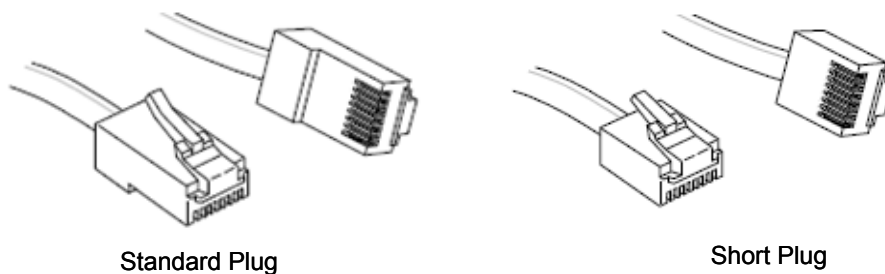


Figure 14: 8-position modular plugs

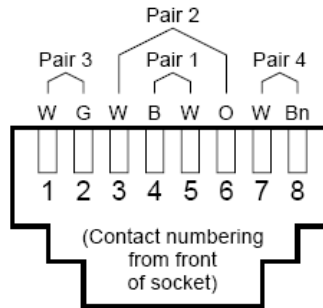


Figure 15: 8P8C socket

Notes:

- (a) Pairs 1 & 2 may be used for telephone connections.
- (b) Pairs 2 & 3 are used for Ethernet (10 Mbps) or Fast Ethernet (100 Mbps) data connections.
- (c) Pair 4 is rarely used. If necessary, pair 4 could be terminated on contacts 4 & 5 of a second, adjacent socket to connect telephone equipment. However, this should not be designed into the cabling system but should only be used as a last resort option subsequent to the initial installation.

Table 1: Cable Colour Code for 8-position modular sockets

Contact no.	Pair no.	4-pair cable colour code variations		
5	1	White	White-blue	White-blue*
4		Blue	Blue	Blue-white*
3	2	White	White-orange	White-orange*
6		Orange	Orange	Orange-white*
1	3	White	White-green	White-green*
2		Green	Green	Green-white*
7	4	White	White-brown	White-brown*
8		Brown	Brown	Brown-white*

* The first-named colour is the predominant colour. This colour code is in accordance with AS/NZS 3080 and AS/NZS 3086 (coloured mate to the even-numbered contact).

No telecommunications outlet should be located in a damp area restricted zone as defined in the ACA Wiring Rules. The installation of outlets in bathrooms or shower rooms, or near saunas, spas, fountains or swimming pools, is not recommended.

If an outlet is to be located outdoors, it must be protected from the weather either by location in a covered area (e.g. verandah or patio) or installation in a suitable weatherproof enclosure. Securing the outlet against unauthorised access should also be considered, e.g., by means of a control switch located indoors or by installation of the outlet in a lockable enclosure.

It is recommended that a 240 V power outlet (socket-outlet) be located within 1 metre of each telecommunications outlet for powering of such things as cordless or hands free telephones, fax machines, modems, personal computers, telephone answering machines, security or medical alarm equipment, etc.

8.3.5 Video Cabling

Single Video Outlet

Where only one video outlet is required, run a single RG6 coaxial cable between the ONU and the outlet (see Figure 11). Allow for 300 mm of RG6 cable to be stored in the wall cavity where the video outlet is to be located. At the proposed location of the ONU, allow enough cable to reach the ground.

Any cable left unterminated at the external wall of the building should be capped to prevent the ingress of moisture which may adversely affect cable performance.

Multiple Video Outlets

Comverge Networks ONU has only one video output port. Multiple video outlets may be provided using a separate RF splitter or RF video amplifier, as appropriate.

Where more than one video outlet is required, the coaxial cables must be star-wired from an RF splitter. Where two or three video outlets are to be provided and are within the cable distance limits, a single 2-way or 3-way splitter may be used.

An RF Video amplifier is required where more than three (3) video outlets are to be provided or where the ONU to video outlet distances exceed the limits. The amplifier must have a forward path frequency operating bandwidth of 85 MHz – 860 MHz.

RF Splitter or RF Video Amplifier should preferably be installed inside the enclosure located in the garage. However, it can be located in a separate insulated (e.g., plastic) video wall box as well.

Combining with Other Video Signals

The video cabling must not be combined with any free-to-air (FTA) or master antenna television (MATV) cable. A separate cable must be installed to each room where access to the digital video service is required. The FTA or MATV system will require a separate cable and connection within each room.

Suitability of Video Cabling

Before connecting digital video services to the premises coaxial cabling, Comverge Networks technicians will visually inspect and test the pre-wired video cabling to ensure that it meets installation standards.

If it is apparent that the pre-wiring does not meet existing standards, the technician will not connect the video service to the pre-wired video cabling and report to the customer/builder.

If the pre-wiring meets the required standards, the connection to digital video services will proceed. Once a connection has been made, the pre-wiring may be comprehensively tested to ensure the appropriate signal quality is present at each video outlet. If the wiring does not pass these tests, the installation technician will advise accordingly. The necessary changes can be made by the customer/builder (and re-connect at a later date) or the Comverge Networks technician (if requested by the customer/builder) can make the changes at a charge.

Choosing the Correct Cable

Use **Table 2** below to determine which cable should be used for your application.

Table 2: Suitability of Coaxial Cables for Various Applications

Application Type	Coaxial Cable Type	Suitable for
Analogue TV	RG6/U	<ul style="list-style-type: none"> Gives superior performance on cable runs <225 metres. Used for cable runs >225 metres but <545 metres.
	RG11/U	For cable runs greater than 545 metres.
CCTV	RG6/U	<ul style="list-style-type: none"> Gives superior performance on cable runs <225 metres. Used for cable runs >225 metres but <545 metres.
	RG11/U	For cable runs greater than 545 metres.
DTV, CATV, SATV, MATV	RG6/U	Standard cable for these applications
	RG11/U	Recommended for long cable runs and for backbone cabling.

RG6/U Quad shield cable is the minimum requirement under the latest Australian Standard for digital TV antenna cabling and for all TV antennas cabling for apartments/units (MATV). It is also used for the distribution of Cable TV (CATV) and Satellite TV (SATV) in residential or commercial premises. It features a copper-clad-steel inner conductor. Single-shield, dual-shield and tri-shield versions of RG6/U are available but do not provide adequate EMI shielding.

RG11/U Quad-shield is used for the same applications as RG6/U for either backbone cabling or for long distribution runs. It features a copper-clad-steel inner conductor.

The total length of cable between the ONU and any video outlet should not exceed 25 metres where RG6 cable is used. Distances up to 35 metres from the ONU to a video outlet can be achieved if RG11 cable is used for all of the cabling from the ONU to the video outlet. Note that this maximum distance is reduced proportionally if RG6 cable is used for part of the Cabling. Extending the cabling limit to the furthest video outlet or to support more than 3 outlets is to use a 4-port RF video amplifier.

The minimum bend radius for installed coaxial cable is as follows:

- RG6 Quad shield 40 mm
- RG11 Quad shield 55 mm

A larger bend radius must be maintained when pulling cable around bends, e.g., through conduits.

Video Connector Type

“F” type connectors must be used for the video cable connections, i.e., at the ONU, RF splitter, RF video amplifier and video outlet. These connectors have a threaded connection. F connectors provide the necessary shielding to prevent RF signal ingress or egress. F connectors should be installed using the proper tools, which must be in good working order. Both “thru” connectors and right-angled connectors can be used for the installation of internal coaxial cabling (see **Figure 16**). The thru connector uses the centre conductor of the cable as the centre pin. The right-angled connector has the pin built in.

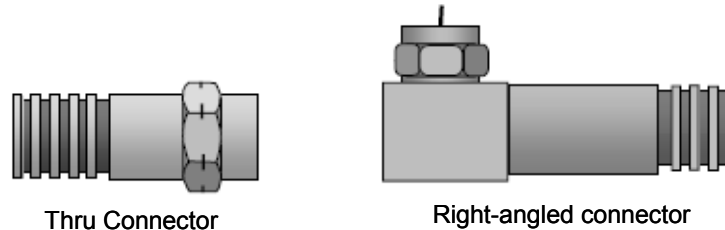


Figure 16: Typical F Connector

Safety with Coaxial Cabling

Care should be taken when installing or repairing coaxial cabling due to the nature of the cable itself and the appliances that may be connected to it. Once VCRs, TVs, hi-fi systems etc. are connected to the video coaxial cabling, an electrical hazard may be present on the video cabling due to leakage currents or faulty customer equipment.

To avoid potential electrical hazards when handling video coaxial cables, connectors or components:

- (a) switch off all electrical appliances connected to the video cabling system (eg., VCR, TV, hi-fi) and remove their power plugs from the 240V AC sockets before handling any video cabling system components; or
- (b) wear 240V AC rated electrical protective rubber gloves when handling any video cabling system components.

8.3.6 Video Outlets

Each video outlet requires a telephone socket for access to digital video services. The telephone outlet should be located within 300 mm of the video outlet — or use a combined telephone/video wall plate as shown in **Figure 17**.

Video outlets may consist of a single-purpose outlet that only has a female F connector, or may be a combined outlet with a telephone (8P modular) socket or FTA TV socket (which is usually a Belling Lee type).

The female F connector must be captive within the wall plate to prevent it from rotating when a male F connector is tightened onto it. Only manufactured F connector outlets are to be used, i.e., don't fabricate a video outlet by drilling a wall plate and fitting a female F connector. F connectors must not be mounted on the same wall plate as a power switch or power outlet.

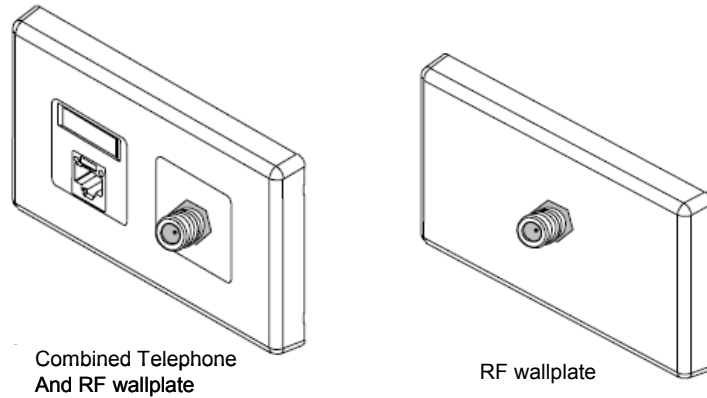
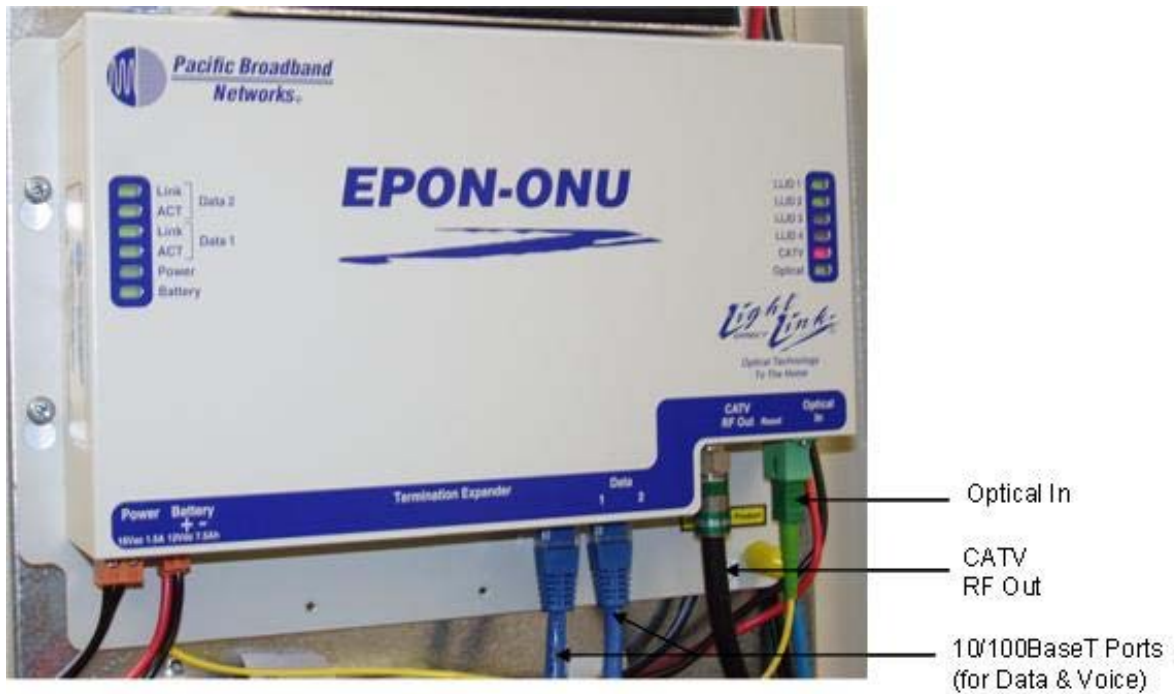
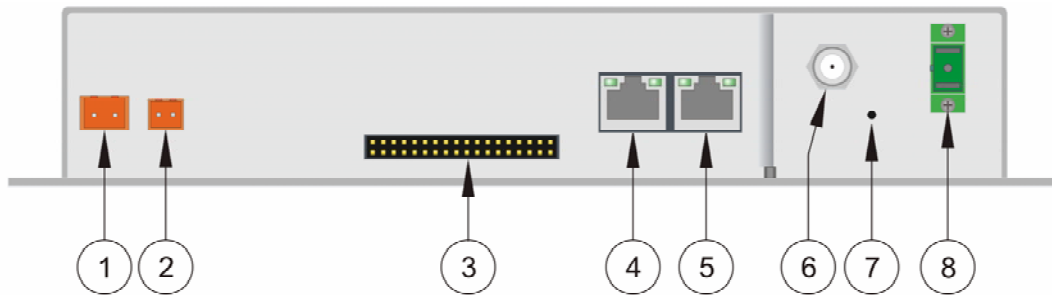


Figure 17: Typical Video Outlets

8.4 Connection of Customer Cables to ONU

The Comverge Networks ONU has two 10/100BaseT port and one CATV Subscriber port (see Figure 18).



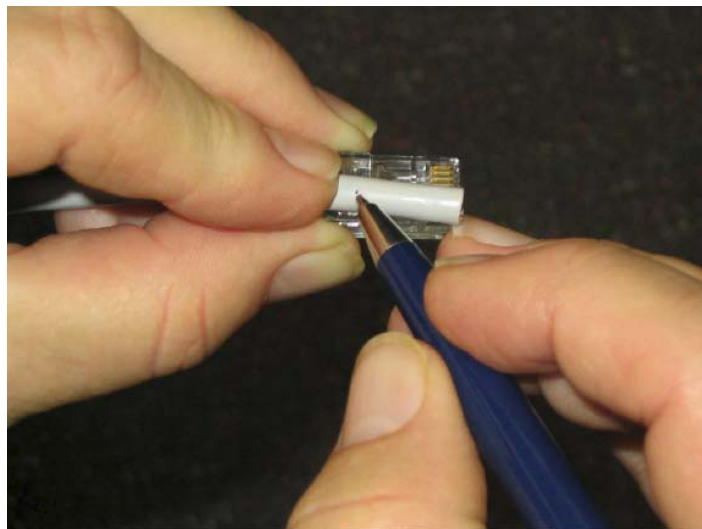


- 1 - **POWER 16Vac** - Input power port, AC.
- 2 - **BATTERY IN** - Terminal for connecting external back-up battery.
- 3 - **TERMINATION EXPANDER** - Allow Terminal Block style punch down.
- 4 - **DATA 1** - RJ 45 port for 10/100 Base-TX connection.
- 5 - **DATA 2** - RJ 45 port for 10/100 Base-TX connection.
- 6 - **RF OUT** - RF output, F-type female connector, 75Ω.
- 7 - **RESET** - Reset Unit Firmware.
- 8 - **OPTICAL INPUT** - Single optical port for fibre to the home cable.

Figure 18: EPON-ONU

Data Cable

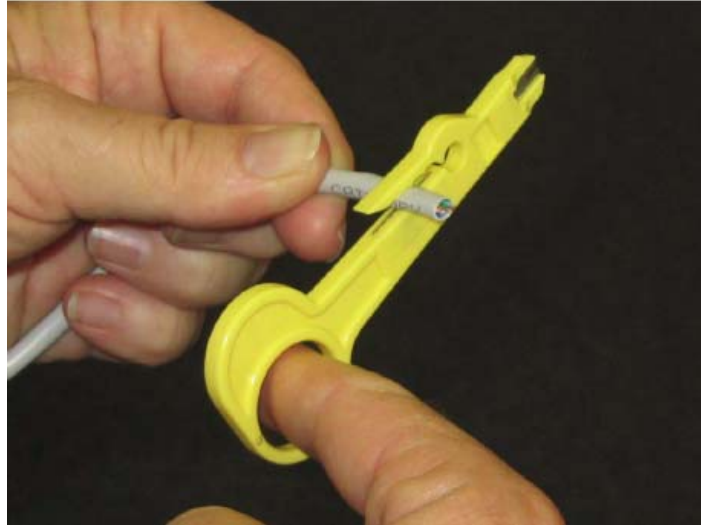
The cable to the data outlet must be connected via an 8P8C plug to the Ethernet socket in the ONU. The plug must be connected to the data cable on site using a modular plug crimping tool in accordance with **Figure 19** through **Figure 23**.



Notes:

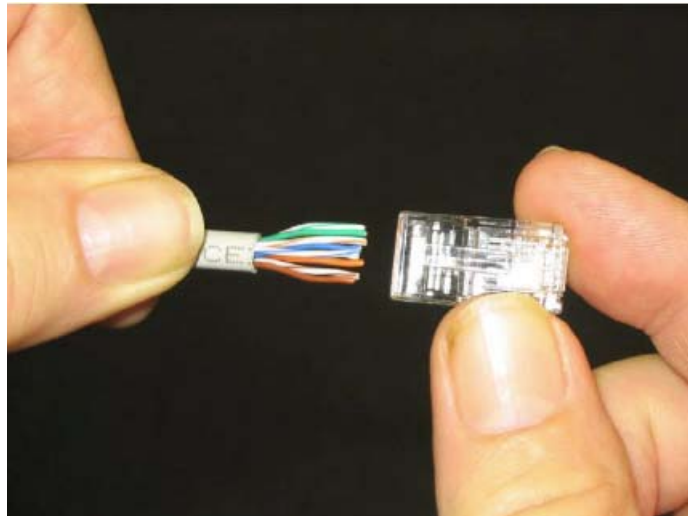
- (a) Cut the end of the cable neatly and squarely using side-cutting pliers.
- (b) Mark the cable sheath at 12 mm from the cut end of the cable, either by measuring it with a rule or against the depression in the 8P8C plug.

Figure 19: Cable Sheath Marking



Note: Cut the cable sheath back at the 12 mm mark using a category 5 cable sheath cutting tool and remove the 12 mm length of sheath.

Figure 20: Removal of Cable Sheath



Notes:

- Untwist, fan out and line up the conductors ready for insertion into the plug, in accordance with the colour code shown in **Figure 15** and **Table 1**.
- Insert the conductors into the plug, ensuring that they feed correctly into the correct slots.
- Push the conductors firmly into the plug and ensure they extend all the way to the end of the plug.

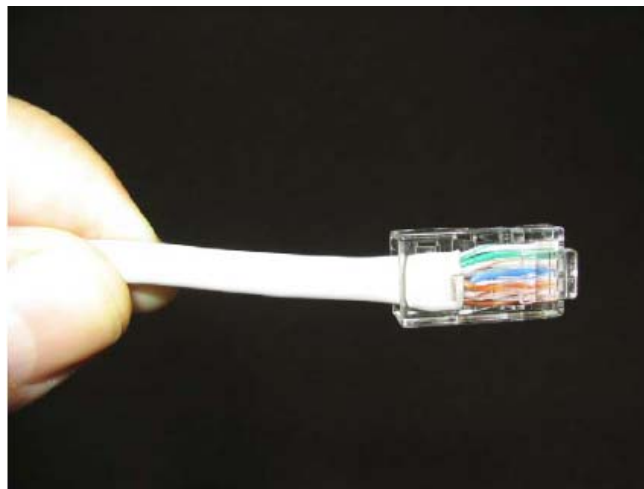
Figure 21: Preparation and insertion of conductors



Notes:

- (a) Double-check the colour coding of the plug conductors and that the conductors are properly located in the plug.
- (b) Seat the plug in the 8P receptacle of the crimping tool, support the cable at right angles to the tool, and crimp the plug.

Figure 22: Crimping the plug



Note: Visually inspect the plug to ensure the contacts are recessed in the plug, the cable sheath is properly restrained, and that the conductors appear to be properly seated within the plug.

Figure 23: Visual Inspection

Video Cable

Connect the coaxial cable that feeds the customer’s video outlet(s) to the video port on the ONU using an external-rated F connector (see **Figure 18**). If RF Splitter or Amplifier is used, ONU RF output will be fed to that. It is not possible to leave any slack coaxial cable in the ONU. However, leave sufficient length in the cable to allow the F connector to be connected and disconnected without exerting any strain on the cable.

8.5 Testing the Services

As a minimum, simple continuity testing should be conducted on all cables between the point of network demarcation, i.e., ONU and the user outlets. In particular, the data cable should be tested using a 4-pair cable continuity tester that tests for open circuits, short circuits and mis-wiring between the 8P8C plug terminated on the cable at the ONU and the standard data socket (8P8C). A typical continuity tester (from Clipsal) used in such tests is shown below (see **Figure 24**).

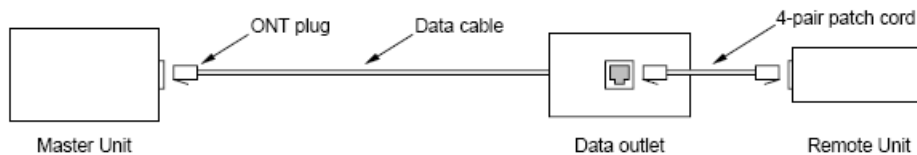


Figure 24: Data Cable Testing

Each Cat 5e cable shall be in-situ capacity tested to ensure a minimum of 100Mbps data transfer. Certification to this capacity shall be provided to the property developer in advance of issue of the Certificate of Occupancy.

8.6 Home Networking

“Home Networking” describes a cabling system designed to support flexible distribution and interconnection of telecommunications services and equipment within the home.

Home networking can be provided to varying levels of sophistication for:

- connection of multiple telephone lines and equipment
- interconnection of PCs and peripheral equipment (printers, scanners, etc.)
- intercom/paging
- music distribution
- voice monitoring (eg. nursery)
- remote control of audio or video equipment
- closed circuit television (CCTV)

Note that home networking does not provide a “total cabling solution”. For example, separate cabling systems are usually required for home automation (i.e., electronic control of electrical lighting and other electrical appliances), security and/or fire/smoke alarm systems. However, such systems may be linked to the home network at various points for remote control or monitoring over the FTTH network. A typical home network cabling solution is shown in **Figure 25**.

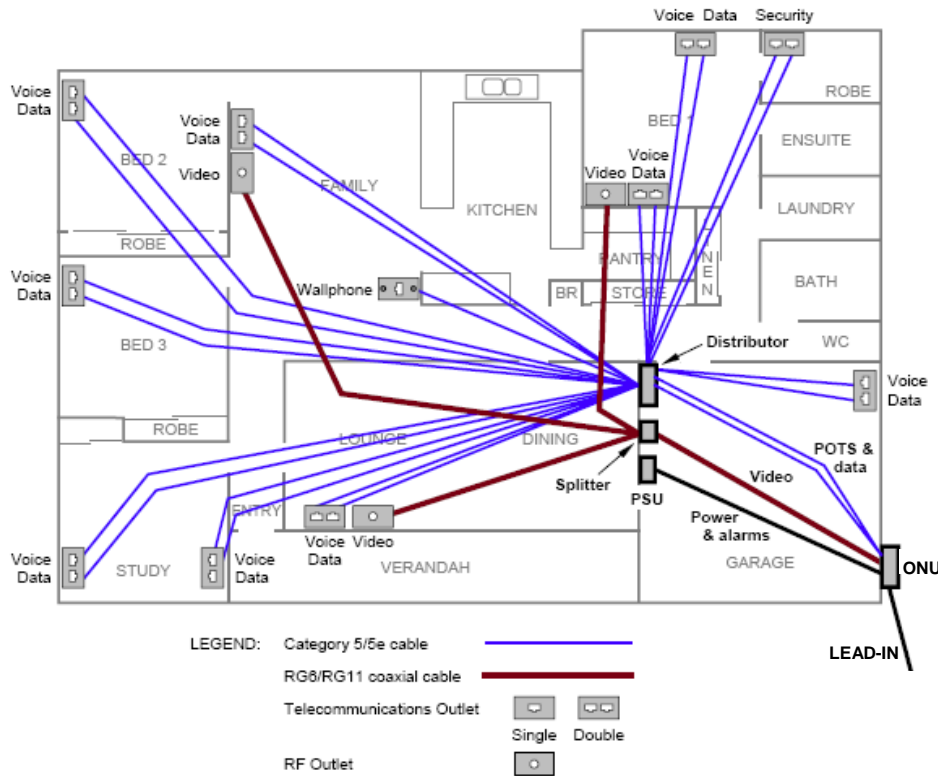


Figure 25: A Typical Home Network Cabling

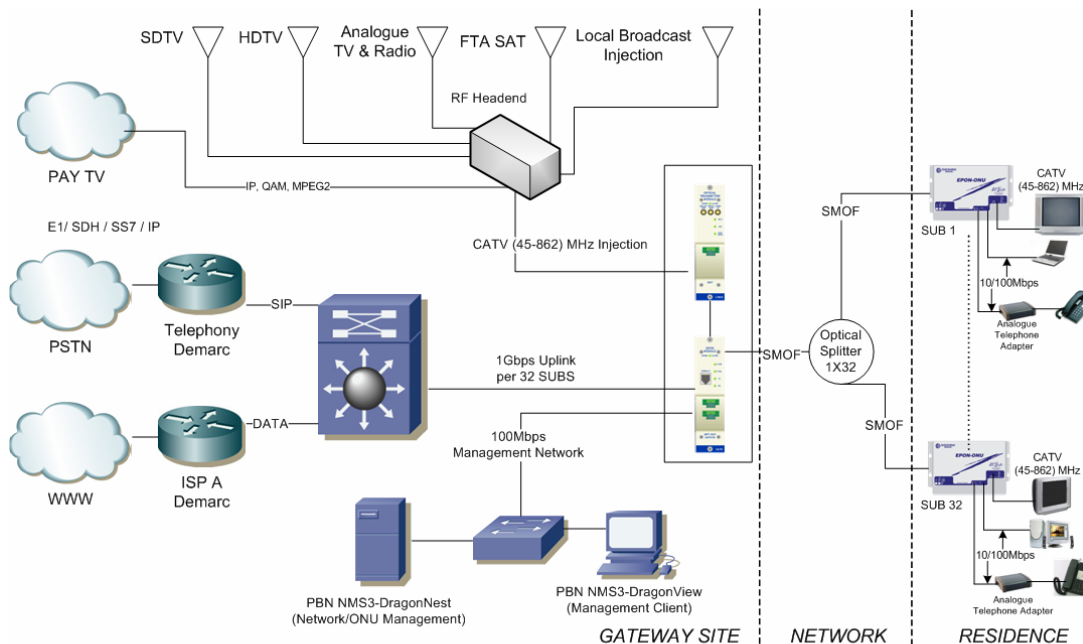
Appendix A: Solution Topology & Technology Overview

Comverge Networks proposed Light Link® Direct range of products provides operators with true “triple play” services over a single fibre network with the ability to manage the active equipment over a TCP/IP network. The proposed products offer high degree of flexibility as it can be used to deploy an “IP only” network or “IP with RF Overlay” network. This helps the operators in deploying services for residential as well business customers.

Comverge Networks is proposing an **EPON Point-to-Multi Point (P2MP)-based solution** as the primary offer (most suitable for single dwelling units). This network topology is compliant with the leading industry standard of Ethernet in the first mile (EFM) published as IEEE802.3ah. However, since Comverge Networks proposed base equipment (chassis & power supply) can also be used to offer a Point-to-Point (P2P) Fibre to the Home (FTTH) optical network, which may be suitable and cost-effective for multi dwelling units, Comverge Networks has provided brief information on **P2P solution** as well.

EPON Point-to-Multi Point (P2MP) Solution

The EPON P2MP solution delivers a point-to-multi point “Triple play” bouquet of services to the subscriber. Symmetrical 1 Gbps bandwidth is directed to 32 subs for voice and data, RF cable television to transmit digital and analogue television and radio services (CATV in RF format) via only one fibre core to an optical network termination unit located at each home (preferably in the garage).

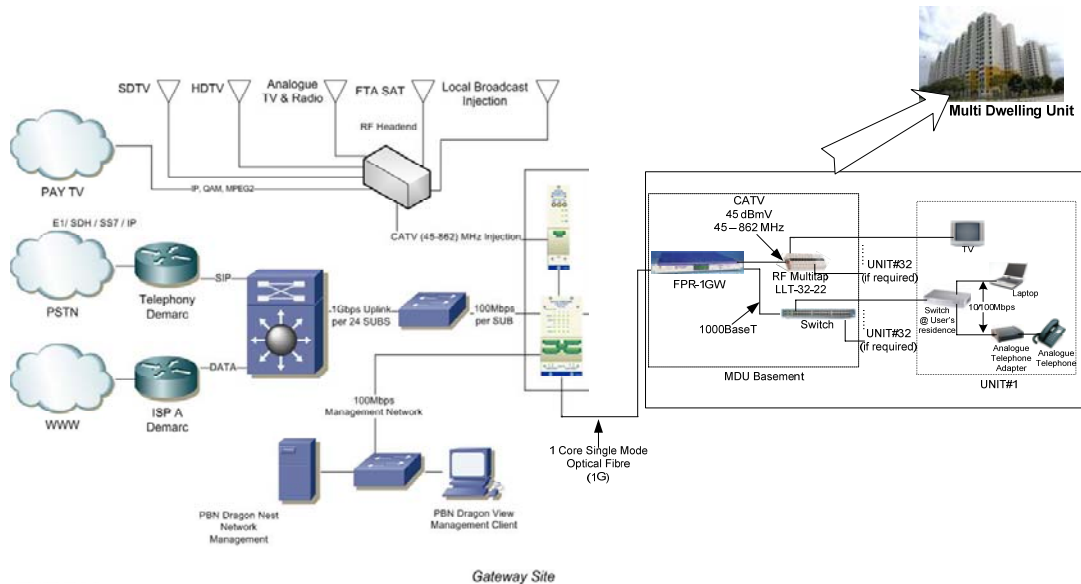


EPON-based Point-to-Multipoint FTTH Architecture

In the “last mile”, a 32-way optical splitter is used to split the light inside the feeder fibre into 32 distribution fibres. Each distribution fibre is routed to an individual house using drop cable and inside the house, it is terminated on a Customer Premise Equipment (CPE) or Optical Network Terminal (ONT). The CPE/ONT converts the light signal to electrical signal and provides two 10/100BT auto-sensing Ethernet ports (Cat 5e minimum) for use by the end-user. Each of the two ports can deliver a unique service. Existing analogue phones can be used for Voice over Internet Protocol (VoIP) service, but an Analogue Telephone Adapter (ATA) will be required (can be offered as optional offer). In that configuration, the remaining Fast Ethernet (RJ45) port is available for data service (broadband Internet) and can be expanded to multiple Ethernet ports via a commodity priced Layer 2 switch if required. Comverge Networks proposed ONT has the advantage of having a built-in CATV interface, which means that RF overlay broadcast video service can be provided to home without using any other additional equipment.

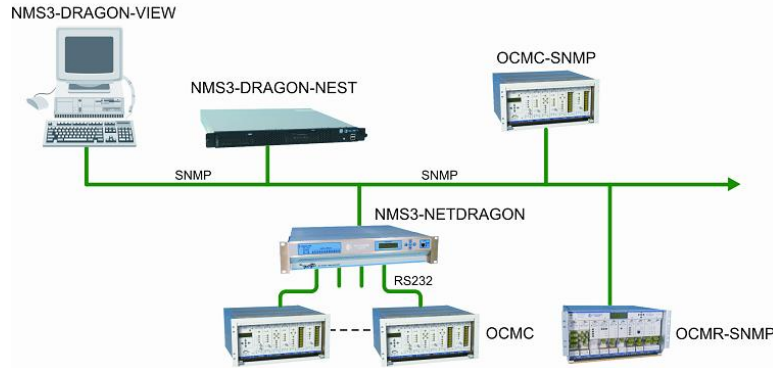
Point-to-Point (P2P) Solution

As mentioned earlier, Comverge Networks can also offer P2P solution using the base equipment (chassis & power supply) of our P2MP solution along with some additional suitable modules at the head-end and customer premise equipment at the end-user location. This solution would be particularly useful in reaching multi-dwelling units residents.

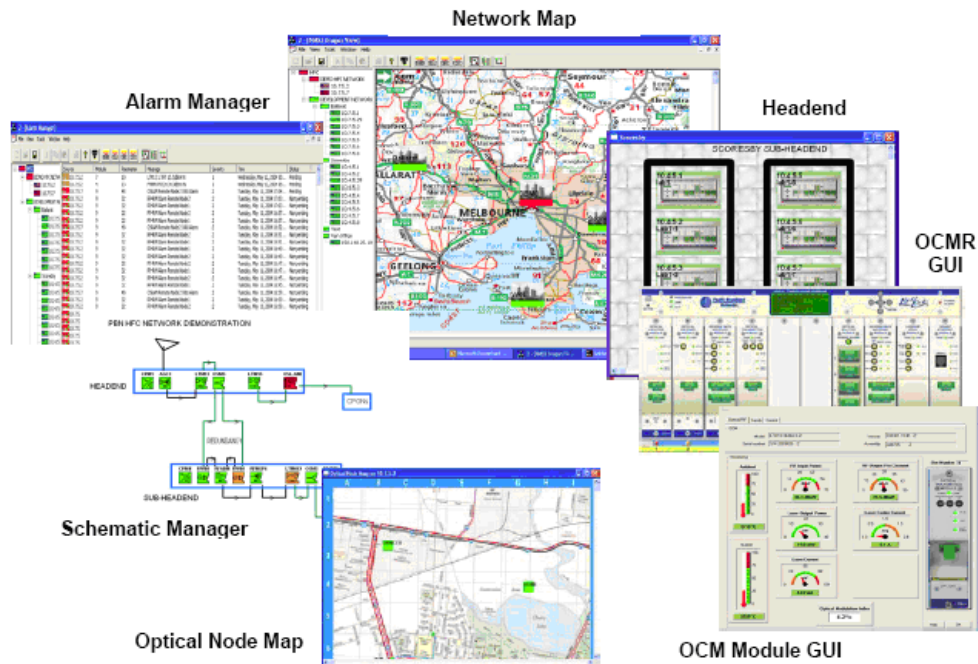


Point-to-Point (P2P) FTTH Optical Network

In addition, Comverge Networks offers PBN's NMS3-DragonView & NMS3-DragonNest for efficient management of the total solution. DragonNest is an application server, which is required for using DragonView. DragonView provides a unique management concept allowing an operator to remotely monitor and control all PBN broadband optical transmission equipment and nodes in an entire network. The heart of the NMS3 DragonView is its network overview, providing effective tools for alarm management, system configuration, network schematics, performance management and security management.



NMS3 Architecture



Appendix B: Telecommunications Cabling Advice (TCA1 & TCA2)

Telecommunications cabling advice (TCA2)



This form is an optional addition to the TCA1 Telecommunications Cabling Advice form. It may be used by registered cablers to alert the customer or building manager of any non-compliant cable installations that are outside the contracted scope of work.

- Pre works advice
- Post works advice

Outstanding matters

While undertaking the contracted cabling work, the following issues have been identified with the pre-existing cable installation, which may require your attention:

<input type="checkbox"/> Inadequate separation of communications and electrical cabling	<input type="checkbox"/> Urgent safety hazard <input type="checkbox"/> Attention required – non-urgent <input type="checkbox"/> Long term – low safety risk
<input type="checkbox"/> Inappropriate or inadequate support provided to cables	<input type="checkbox"/> Urgent safety hazard <input type="checkbox"/> Attention required – non-urgent <input type="checkbox"/> Long term – low safety risk
<input type="checkbox"/> Cables not secured or fixed	<input type="checkbox"/> Urgent safety hazard <input type="checkbox"/> Attention required – non-urgent <input type="checkbox"/> Long term – low safety risk
<input type="checkbox"/> Non-compliant cabling product used	<input type="checkbox"/> Urgent safety hazard <input type="checkbox"/> Attention required – non-urgent <input type="checkbox"/> Long term – low safety risk
<input type="checkbox"/> Non-compliant customer equipment installed	<input type="checkbox"/> Urgent safety hazard <input type="checkbox"/> Attention required – non-urgent <input type="checkbox"/> Long term – low safety risk
<input type="checkbox"/> Non-compliant earthing	<input type="checkbox"/> Urgent safety hazard <input type="checkbox"/> Attention required – non-urgent <input type="checkbox"/> Long term – low safety risk
<input type="checkbox"/> Wrong colour conduit used	<input type="checkbox"/> Urgent safety hazard <input type="checkbox"/> Attention required – non-urgent <input type="checkbox"/> Long term – low safety risk
<input type="checkbox"/> Records are missing or out of date	<input type="checkbox"/> Urgent safety hazard <input type="checkbox"/> Attention required – non-urgent <input type="checkbox"/> Long term – low safety risk
<input type="checkbox"/> Pre-existing cables are worn or frayed	<input type="checkbox"/> Urgent safety hazard <input type="checkbox"/> Attention required – non-urgent <input type="checkbox"/> Long term – low safety risk
<input type="checkbox"/> Pre-existing cabling is not compliant (other)	<input type="checkbox"/> Urgent safety hazard <input type="checkbox"/> Attention required – non-urgent <input type="checkbox"/> Long term – low safety risk

Appendix C: FTTH Installation Checklist



CREATING INTELLIGENT NETWORKS

Comverge Networks
26 Jellico Drive, Scoresby, Victoria, 3179
Tel: 03 8706 0000 Fax: 03 8706 0066
www.comverge.com.au

FTTH
Installation checklist

JOB NO: _____

Part A - Customer

Lot No: _____ Customer Name: _____
Street Address: _____

Part B - Pre Installation Checklist

Table with 4 columns: No., Description, YES, NO. Rows include items like '1 x 32mm conduit from Telecommunications Pit to Wired Services cabinet', 'Luca Box Installed', etc.

If items above comply with the wiring rules (AS/ACIF S009 & The Carriers Specifications) proceed to part C and part D, If installation does not comply proceed to part E.

Part C - Installation Checklist

Form with fields for Phone Number, VoIP MAC Address, Unit MAC Address, Unit Serial Number, Optical Level, RF output levels, and FTTH Unit Installed (CPON, EPON, 4100VT).

Part D - Confirmation of Installation

I hereby certify that the cabling work described in this advice complies with the wiring rules (AS/ACIF S009 & The Carriers Specifications). I am satisfied that the works are complete.
Please print clearly.
Copy required for retention by Customer, Cabler and Employer
Customer Signature: _____
Technician Signature: _____
Registration Number: _____
Date: ____/____/____

Part E - Installation can not proceed

I confirm that this installation does not conform with the wiring rules (AS/ACIF S009 & The Carriers Specifications) and the works cannot proceed.
For further information on specific requirements please refer to:
Telephone Number:
Customer Signature: _____
Technician Signature: _____
Registration Number: _____
Date: ____/____/____