

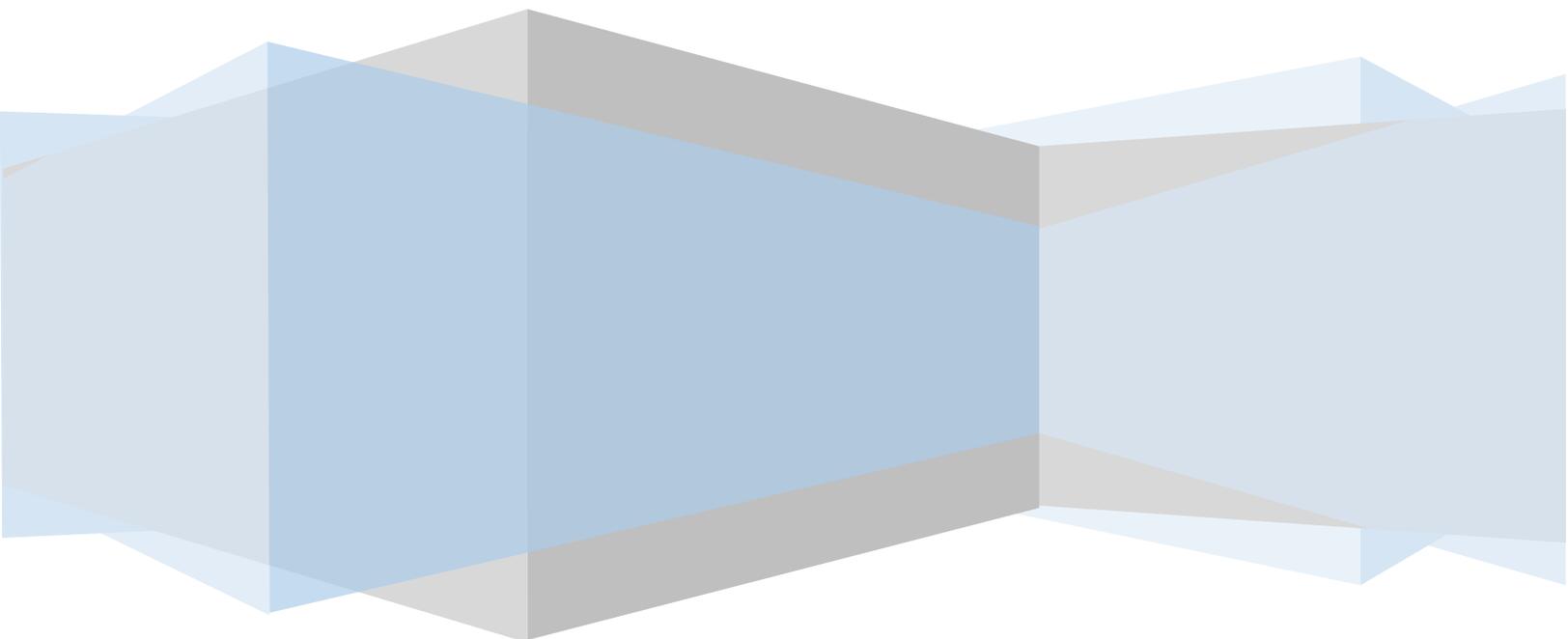


UNIVERSITY OF
ALBERTA

Implementation of Physical layer of a network via practical analysis

Capstone Project MINT 709

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Abstract

Telecommunications is world's largest industry, bringing people together. Its establishment took a long time and it is in continuous improvement till date. The telecommunication state of art infrastructure in present day is the combined result of hard work that the network engineers and field technicians put in over the past century. I can guarantee that this infrastructure will be far more advanced in the future than we can imagine. The network is growing with each passing day and it is all attributed to the people who are building it. This is the main reason which inspired me to take this course in the first place. The fascination for networking started as a kid when I wondered how my computer was connected to a world wide web. Data being sent and received from one computer to other fascinated me.

Looking at the vast network of cables and wires laid underground and aurally, it is not hard to estimate the effort which goes into the repair and maintenance of these things. If we have to remain one day without internet at our homes due to a faulty wire it is a disaster. And it would mean a financial loss for any enterprise running today if their networks went down. As such the toughest part is the maintenance of the networks. For the physical medium of a network, this job is done by Field Technicians who are working at the physical end ; installing and repairing all the telecom connections.

This project majorly revolves around the implementation of physical layer of a network. The project stems from the fact that as internetworking graduates, one can have a future job prospect as a field technician but there are critical aspects of the nature of this job, which need to be studied and practically analyzed. I have given my best efforts to discuss the various aspects of the work a field technician might be involved with and the various tools used by them.

*Submitted to:
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Acknowledgement

This project is incomplete without expressing my gratitude to the people whose supervision and guidance made it possible. First and foremost I would like to thank Mr. Mike Agouros(CEO, Dialtone MD Inc) my mentor in personal as well as professional life. He has greatly influenced me and his constant feedback & guidance has made this project worthwhile the effort. My entire training for the install and repair is attributed to Mr. Jim Brouwer who taught me the practical usage of most of the tools discussed in this project. Mrs. Karen Ehrenholz(IT Administrator, Dialtone MD Inc) is my friend at the workplace who has always encouraged me and her positive vibes have kept me going.

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1. Install and Repair of Telecom Lines

Telecommunication is the most developing juncture from past 200 years, from drum & smoke signals to satellite & internet networks. This boom of technology has gone through many phases such as electrical telegraph, telephone, radio & television, video telephony to mobile (cellular) and computer networks. In this section, we will cover install and repair for putting up a telephone connection from Central office to a residential or business place. We will cover its network setup describing each component in detail. In order to understand what a field technician do, we will go through some basic fundamental principles and methods.

Sound Waves

- When you speak, air is forced from your lungs through your vocal cords, and out your mouth. The result, of course, is your voice.
- Much the same way that a pebble, when thrown into a pool, will create waves of water, the vibration of your vocal cords produces waves of air. It is these sound waves that make your voice audible.
- The sound waves have various “frequencies” and “amplitudes” that are the result of your vocalization.

Frequency and Amplitude

- Frequency and amplitude are two characteristics that you use to describe a signal. When you listen to music, or carry on a conversation, you are experiencing both frequency and amplitude, although those terms are not usually the first ones that come to mind.
- People generally interpret frequency as higher or lower tones or pitches. A higher frequency sound, such as a small dog’s yip, has a “higher” pitch than a lower frequency, such as a big dog’s growl.
- We perceive amplitude in terms of how loud or soft a sound is. An ocean liner’s horn has a large amplitude, where as a whisper is a much lower amplitude.
- When you speak, sound waves travel outwards, and will leave an impact on the ear of your listener, causing their eardrum to vibrate with the same frequencies and amplitudes that were spoken. As a result of this vibration, your listener will hear what you have said.
- As the frequencies and amplitudes of your voice are continuously variable, your voice is considered to be an analog signal. This fact will become important later on as we discuss how your analog voice is carried in the telephone circuit.
- Frequency is measured in terms of cycles per second. That is, the number of times per second that the signal will complete a transition from its lowest to highest amplitude and back again. This is known as oscillation.

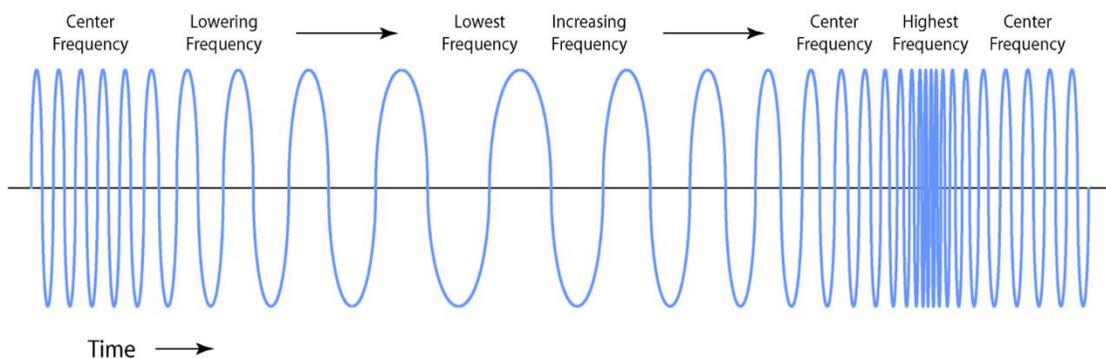


Figure 1: Oscillation

- The unit of measure for a cycle is 1 Hertz (Hz), and is measured relative to 1 second. A signal that oscillates 10 times per second would have a frequency of 10 Hz. A signal that oscillates 60 times per second would have a frequency of 60 Hz.
- When speaking of high frequencies, it becomes cumbersome to use the unit Hz. Instead, multiples of the following units are used -
 - 1 Kilohertz (kHz) 1,000 Hz
 - 1 Megahertz (MHz) 1,000,000 Hz
 - 1 Gigahertz (GHz) 1,000,000,000 Hz
 - For example, 1,500 Hz is the same as 1.5 kHz.
- Amplitude is typically measured with the relative unit called the decibel (dB). It is a relative unit because it does not indicate the exact amplitude of a signal. Rather, it indicates how much louder or softer (stronger or weaker) one signal is compared to another.

Voice Frequency

- Most of the energy in your voice is centered around 400 Hz. The frequencies of the vowel sounds are contained in the range of 100 to 2,500 Hz (2.5 kHz), while the consonants are in the range of 2 kHz to 3.4 kHz.
- Depending upon their age, a human is able to detect sounds in the frequency range of about 10 Hz to 20 kHz. However, the frequency range required for voice communications is quite narrow; between 300 Hz and 3 kHz is all that is necessary for conversations to be intelligible.

Sound Wave to Electrical Energy

In order to deliver your voice across the telephone circuit, the sound waves must be converted from “air energy” to electrical energy. This is done with “transducers” in the handset of the telephone.

A transducer is simply a device that converts one form of energy to another.

The transducer, or microphone, in the mouth-piece of your telephone handset vibrates (much like a listener’s eardrum) in response to the frequencies and amplitudes of your voice and creates corresponding “waves” of AC (Alternating Current) electrical energy.

These electrical signals are carried across the telephone network to the receiver’s telephone, where the transducer in the ear-piece (speaker) of their handset converts them back, from an AC signal, to sound waves.

Delivering electrical signal from your telephone to the destination requires two things to happen –

- The destination for the call.
- The path to take to reach the destination.

In order to indicate to the telephone system what telephone you want to be connected to, you must send the destination phone number to the telephone system **Central Office (CO)**. In other words, you need to dial the phone number.

When you dial the phone number, you are “signaling” the destination address to the telephone system. This signal is communicated to the CO by a series of known frequencies, or tones, that represent the individual numbers and symbols on a telephone keypad. When you touch the keys on the keypad, their corresponding tones are generated and sent to the CO. This is commonly known as touch-tone dialing.

DTMF Dialing

- The formal designation for touch-tone is **DTMF**, which stands for Dual-Tone Multi-Frequency.
- With DTMF, each number or symbol on the telephone keypad is represented by a specific combination of two tones.
- Whenever you press a key on your telephone keypad, the combination of tones is chosen from a set of fixed frequencies. This combination of two, or dual, tones from multiple frequencies is where the DTMF name is derived.
- For example, when you press the “5” key, the frequencies 770 Hz and 1336 Hz are sent to the CO. This process is repeated for each key you press.

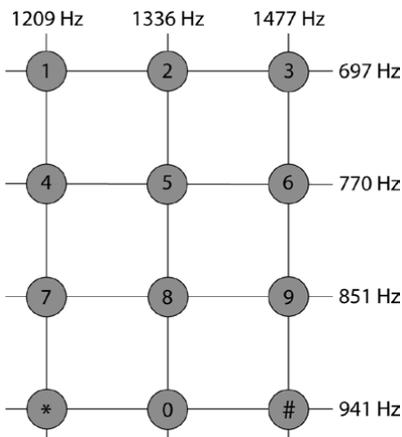


Figure 2: DTMF dialing

1.1 Transmission Lines

The signal between your telephone, the Central Office, and the person you are calling, flows along a transmission line of some kind. A transmission line is any medium over which the signal can flow. This could be copper wiring, such as twisted Pair (TP) or Coaxial cable (COAX). It could be fiber optic cable or even wireless. We will focus mainly on copper wiring and you will generally be dealing with one or more pairs of copper wire. COAX is used by CATV companies to transmit their service to their customers. 2 conductor makes 1 pair. 1 pair of wire is the transmission pathway for your dial tone service.

Types of Cable

There are different types of cables. In general, all cables serve to complete a circuit so that a signal may flow. However, each cable type has certain characteristics that make it more or less suitable for a given application. Twisted Pair (TP) cable is widely used in data and telecommunication installations.

- PRO – TP is light-weight, easy to work with, relatively inexpensive and is capable of supporting high-capacity data networks over relatively short distances.
- CON – TP is quite susceptible to interference (although the twists in the cable help alleviate this to some extent) and external monitoring, making it unsuitable in high security environments.

Signal from Central Office

We require 2 things to happen before the signal can deliver to the Central Office.

- The device at the CO that receives the tones is called the Switch, Line Equipment (LE), or Office Equipment (OE). The term changes by area.
- The common types of switches you would find in a CO would be DMS 100 developed by Nortel, 5ESS developed by Lucent and The GTD-5 EAX developed by GTE Automatic Electric Laboratories.

Nortel DMS 100

DMS-100 Switch (Digital Multiplex System).

- It was designed during the 1970's and released in 1979 and can control 100,000 telephone lines.
- To provide local service and connections to the PSTN public telephone network.
- It is designed to deliver services over subscribers' telephone lines and trunks.



Figure 3: Switches in CO, Nortel DMS 100 (Left) & Lucent 5ESS (Right)

Lucent 5ESS

5ESS (Class five Electronic Switching System).

- First appeared in 1982 and was developed by Western Electric and now sold by Western Electric's descendant, Alcatel-Lucent.
- Approximately half of all US telephone exchanges are serviced by 5ESS switches.

1.1.1 Powering the Telephone System

To enable the functioning of your telephone, power must be supplied by the CO (which also supplies the dial-tone that indicates that the system is available). We have already discussed the fact that your voice is converted into an AC electrical signal, which is the carrier of your voice, from your phone to the CO. But that is not the only electrical signal required by the telephone system. All electrical circuits have three basic characteristics in common. They are:

- Voltage
- Current
- Resistance
- **Voltage** is the difference of electrical potential between two parts of a circuit. As you would expect, voltage is measured in Volts.
- **Current** is defined as the amount of electrical charge flowing on a conductor over time. You measure this flow in units called Amperes (amps, for short) or milliamps when measuring small current flows.
- **Resistance** is any impedance that serves to restrict the flow.

AC vs DC Circuits

- Alternating Current (AC), as the name implies, is an electrical current where the direction of the current flow changes cyclically.

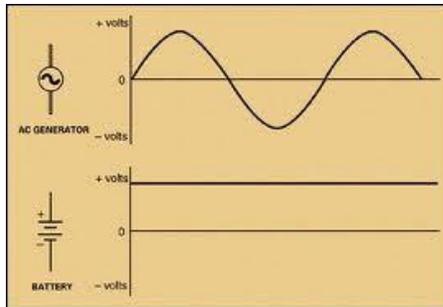


Figure 4: AC vs DC Circuit

- You will be most familiar with AC circuits as those that deliver 120 or perhaps 240 volts, AC, to power the appliances, lights and electrical outlets in your home.
- The direction of electron flow in Direct Current (DC) circuits is constant at all times. DC voltages are always trying to find a path to ground.

Telephone Circuit Electrical Requirement

- Your phone's components, including the DTMF key pad, tone generator, and transducers, require that a Direct Current (DC) voltage be present. To be precise, the CO must provide a DC voltage of anywhere between -48V and -52V, at a minimum current of 23 milliamps (mA), in order for your phone to function.
- The -48 to -52 volts are supplied on the ring side of the circuit, and the tip side is at ground potential (0V DC).
- There is one other electrical component of the telephone system that needs to be mentioned. It is called **Ring Voltage**, which is an AC signal, and causes your telephone to ring. This ring voltage is approximately 85V AC (must be no less than 40V), with a frequency of 20 Hz. When your phone senses this particular voltage, it causes the ringer to activate, indicating that you have a call.
- The reason that the ring voltage is AC in nature is illustrated in the following diagram.

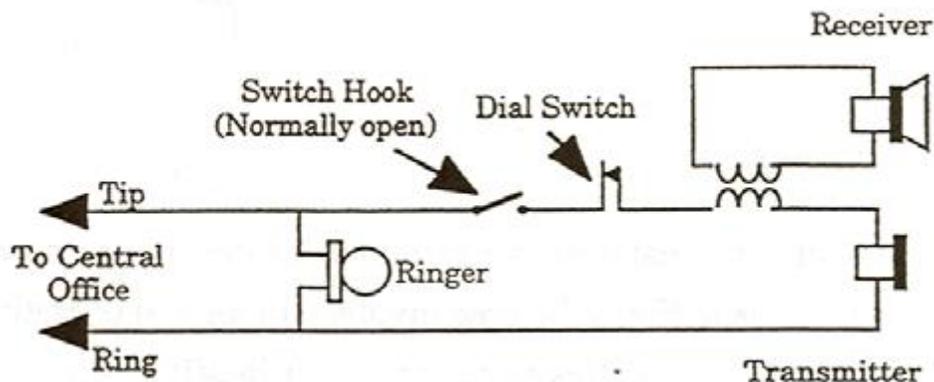


Figure 5: Telephone electrical Circuit

- As you can see, when the telephone is in the on-hook state, and waiting for a call to come in, there is no connectivity on the cable pair (between Tip and Ring). Therefore, the DC signal path is incomplete.
- However, the ringer can still be operated by an AC signal, which does not require continuity through Tip and Ring on the cable pair.

1.2 Cable Characteristics

All cable has certain characteristics which will determine its operational parameters. In this section, you will learn of the most important characteristics of copper cable.

Balance

- A balanced cable is one in which both conductors are of the same type and have equal impedance to ground or other circuits. Twisted Pair cabling are balanced cables whereas coax is usually unbalanced.

EMF Shielding

- In an attempt to eliminate or at least reduce the effects of noise and interference from outside electrical sources, many cable types use some kind of shielding around the cable or even around individual conductors.
- This shielding is often in the form of aluminum foil, which is wrapped around the cable or around individual pairs.
- In Coax cable, the outer conductor, which is comprised of a cylinder of braided copper or aluminum strands, serves as the shield
- The twists in twisted pair cable serve as shielding, reducing the effect of Electro Magnetic Field (EMF) interference, which is caused by the electrical field of nearby conductors such as electrical wires, or even other telephone or data cables.

Attenuation

The reduction in signal strength along the length of a conductor. As the strength of a signal declines, the ability for a receiver to distinguish between the signal and the noise on the cable is impaired. At some point, the signal and the noise will be indistinguishable.

Noise

- Caused by unwanted electrical impulses on the conductor as well as by the metallic nature of the conductor itself.
- Metallic or Gaussian Noise
 - Is caused by the constant movement of electrons in a copper conductor or idle electrical circuit. This is the noise you will hear if you turn up the volume on a stereo that has no signal. Metallic noise is typically disregarded in telephone circuits.
- Impulse Noise
 - Is created by spurious electrical signals that are typically short lived. A lightning strike, the start of a furnace, or even turning on a light switch, can all cause a short lived electrical impulse to effect a conductor. In a telephone circuit, this is often perceived as a “pop” or “crackle” that comes and goes in a short time period.
- Electro Magnetic Interference (EMI)
 - Is noise that is of longer or even constant duration, and which is caused by EMF interference from other electrical sources.

Cross Talk

- EMI from other conductors, whether from the same cable pair or adjacent pairs.
- The twists, in twisted pair cable, help to reduce the effects of crosstalk.
- Each pair in a 25 pair cable has a different twist so this eliminates the crosstalk greatly.
- Other Digital circuits, special circuits and/or DSL circuits in the same cable will affect each other. Some having greater affects than others.

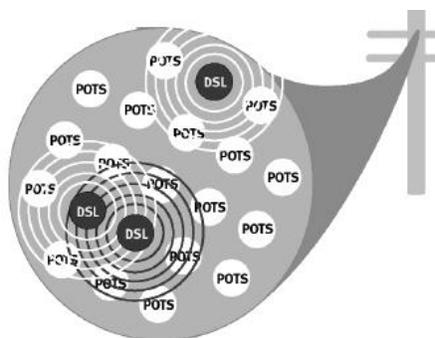


Figure 6: Single Line with POTS and DSL connection

Resistance

- The degree to which a conductor or an electrical circuit opposes an electrical current flowing through it. It is somewhat analogous to the idea of friction, which in mechanical systems opposes the movement of equipment. In electrical circuits, resistance is measured in Ohms. Ohms law serves to describe the relationship between resistance, voltage and current in an electrical circuit.
- Ohms law states that Resistance = Voltage / Current ($R=V/I$).
- We typically speak of resistance in DC circuits whereas in AC circuits the term impedance is used.
- While all cable has a characteristic amount of resistance built into it, which resistance is taken into account, when a circuit is designed, and it does not adversely affect the function of the circuit.
- Typically speaking, the shorter the cable, the less resistance.
- For example, you wouldn't hook up your CD player to your speaker with 1000 meters of speaker wire. You would use the shortest wire possible.
- Less Resistance = Less Attenuation = Better Signal
- However, there are many things that can cause the resistance to either increase or decrease, thus causing problems. Items and situations to be aware of include:
 - Connections to equipment and within equipment (i.e. hang up-switch) may become loose, dirty, wet, broken, old (corroded). In fact, anything less than an ideal connection can increase or, in the case of a short, decrease the resistance.
 - Using the CD player analogy again, you wouldn't connect your player to your speaker with ten chunks of speaker wire or various gauges twisted together.
 - Fewer Connections = Less Resistance = Better Signal
 - Improper resistance can throw off the cable balance, increase susceptibility to noise, cause crackling, static, grounds, shorts and other problems.

Frequency Response

- The characteristic of a cable that will determine how closely the signal that is input to the cable will resemble the signal that is output after having traveled along the cable. Ideally, each frequency transmitted on the cable will be received with identical attenuation. However, the reality is that not all frequencies arrive equally attenuated. The frequency response of the cable will tell you what the attenuation for a set of frequencies will be.
- Lower frequencies travel farther distances than higher frequencies because of their wavelengths, but higher frequencies can hold more information.
- Example: AM radio (typically lower fidelity, mono) vs FM radio (higher fidelity, stereo).

Capacitance

In electrical circuits, refers to the mutual capacitance between two conductors. The result of capacitance is that each conduct can impact the other, electrically, causing degradation of the signal.

Inductance

- The generation of a magnetic field, in a conductor, due to the fact that an electrical current is flowing along it. Inductance raises the resistance of a conductor, thus increasing attenuation.
- A given length of cable will have a certain amount of inductance, and this fact is taken into account when circuits are created. This is the “specification” of the cable.
- Short cable runs will have too much inductance and will be said to be “over loaded”, when compared to the specification, and long cable runs can have too little inductance and are said to be “under loaded”.

1.2.1 Type of Cables

- Cable can range from 25 pairs to 2400 pairs.
- Imagine to have 2400 subscribers on 1 cable.
- If you miss count by 1, you would be on the wrong path to the subscriber.
- Understand and know your color code, it is the basic language to counting the pairs.

CABLE NAME	CABLE TYPE	RANGE OF SIZES
CELFIL	Grease filled Fully color coded, binder groups and pairs	6 - 2400 Pair
ALPETH (ALP)	Air Core Fully color coded, binder groups and pairs	6 - 2400 Pair
CELSEAL (CEL)	Grease filled Fully color coded, binder groups and pairs	6 - 2400 Pair

1.2.2 Color Codes

A standard color code system enables you to identify specific cable pairs. Each numbered pair in a 25-pair binder group always has the same colored wires. Ten colors are used: 5 for the tip and 5 for the ring. We typically call the pairs by TIP-RING like a red-green pair. But binder colors we call by RING-TIP colors like ORANGE – BLACK. This way we know if someone is referring to the pair or binder.

Tip and ring

The terms “tip” and “ring” come from an earlier time when telephone operators connected calls using phone plugs. The tip is connected to ground, while the ring is connected to –48 to –52 volts. Tip is positive and ring is negative. Although the technology has evolved since then, “tip” is still used to denote the positive grounded wire of a twisted pair and “ring” still refers to the negative wire connected to –48 to –52 volts.

Ring Colors

Pair numbers ending in	Ring colour
1 or 6	Blue
2 or 7	Orange
3 or 8	Green
4 or 9	Brown
5 or 0	Slate

Each color is used for rings of 5 different twisted pairs in a 25-pair binder group. These are the ring colors for pairs 1 through 5. The sequence repeats for every 5 pairs.

Tip Colors

Pair number	Tip colour
1 to 5	White
6 to 10	Red
11 to 15	Black
16 to 20	Yellow
21 to 25	Violet

Each color is used for tips of 5 twisted pairs in a 25-pair binder group. The color changes for each new set of 5 pairs.

- 25 pair cable is comprised of a wire bundle of 50 conductors, providing a total of 25 pairs or individuals circuits.
- Cables are categorized by their ability to transmit data. Specifications include: Frequency Response, Maximum Data Rate, Crosstalk, Length Limit and Attenuation.

Binder groups



Bundles of 25 pairs

Each bundle of 25 pairs is called a binder group. Each binder group is wrapped in a two-colored Mylar ribbon. The sequence of binder group colors is the same as the sequence of twisted pair colors.

So the first binder group (pair numbers 1 to 25) is wrapped in a white and blue ribbon. The second binder group (pair numbers 26 to 50) is wrapped in a white and orange ribbon. There are 24 binder groups (or

600 pairs).

1.3 PSTN (Public Switched Telephone Network)

- PSTN is known as the “world’s most complex machine”. It is the world’s public telephone network and is consist of copper wires, fiber optic cables, microwave transmission links, communications satellite, cellular networks and telephone sets.
- This is all inter-connected by switching centers that is located within your city allowing any telephone to dial anywhere in the world.
- The PSTN is almost entirely digital in its core but the telephone line going into individual homes are mostly analog using copper wires.
- Since the invention of the telephone, the PSTN has grown proportionately with the increased demands to communicate. Switching services beyond metropolitan areas were soon developed, increasing the size and complexity of the central office.
- Before we discuss what PSTN is, first you need to understand what makes PSTN function, POTS!
- Plain Old Telephone Service – Offered by your Telecommunications provider as a phone line.
- Many POTS network connected together makes up the PSTN.

We will discuss all the components one by one which comprises a part of PSTN with POTS network in it. Also we will discuss what types of wires and specific tools are used in different departments which enable us to say HELLO and stay connected with our family and friends.

Central Office

As we discussed in the previous unit, the device in the CO that receives the signal from the telephone is called the Switch (also known as Line Equipment, Office Equipment).

It is responsible for –

- Supplying power to the telephone circuit.
- Responding to signals sent from the telephone
- Sending the ring signal to your telephone when a call is made to you
- Communicating information, such as caller ID, to your telephone
- Getting your call on the path from your telephone, to the telephone of the person you are calling
- Maintaining and delivering the features of your phone service (i.e. name/number display)

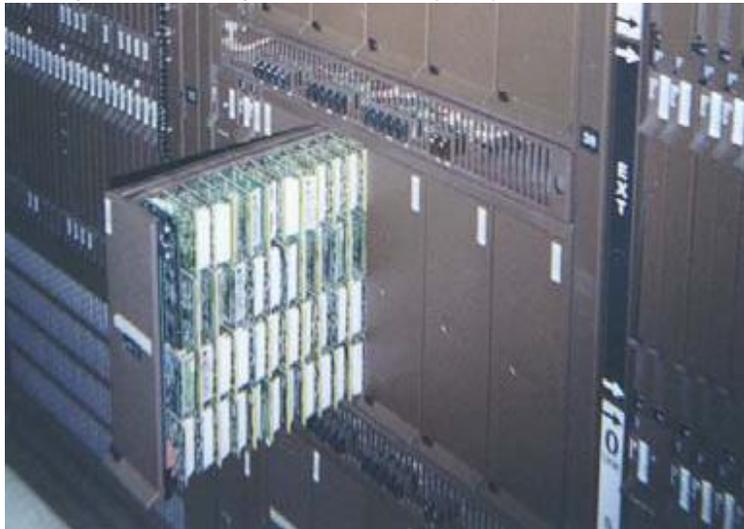


Figure 7: Office Equipment

Switch Signaling

In order for you to make a phone call, you would need to signal the CO switch and the CO to signal back to your telephone and vice versa. This communication back and forth is known as Signaling. There are several types of signaling the telephone system can handle but the most common one is known as Supervisory Signals which occur before and after a conversation has been established. These signals are known as –

- On-Hook - Known as the Normal or Inactive State and exists when your telephone is “on-hook” and not connected to a talk path in the CO.
- Off-Hook - Known as the Calling State, this signal indicates your intent to make a call but, as yet, there is no talk path connected through the CO.
- Talking - Known as the Talking State, where your phone is off-hook and a talk path exists through the CO.
- Release/Disconnect - Indicated by an on-hook signal while connected to a talk path through the CO.
- Information signal –
 - Dial Tone - Informs the subscriber that they may start to dial.
 - Ringing - Indicates that the called line has been reached and ringing has started.
 - Line Busy - Called line was reached but was already in use.
 - All Trunks Busy - Local switch paths are busy.
- Control signal – inform the CO of the call destination and are indicated by interrupting the DC current flow on the line (pulse dialing) or by the generation of tone signals (DTMF or tone dialing.).
- Data Burst: To send information such as caller ID from the CO to your telephone. Your telephone interprets this data and displays the appropriate information on its display. You can hear this data burst by using your Buttset (Butt-in) and this signal is typically sent after the first ring.

1.3.1 Connections at CO

MDF, RACK or Frame

- Main Distribution Frame or Rack - The rack where a jumper cross connects from the LE/OE to the Feeder cable going out the SAC/JWI.
- HDF
 - Horizontal Distribution Frame is connected to the Switch/LE/OE. You may also find ADSL connections blocks on this side of the Rack.

FRAME – HORIZONTAL SIDE



Figure 8: HDF Horizontal Side

- VDF

Vertical Distribution Frame is the cable going out to the SAC/JWI or directly to the Demarcation point. A component at the VDF is the protection unit: fuses or other devices that protect the switch from lightning, shorts with electric power lines, or other foreign voltages coming from the Outside Plant (OSP).

FRAME – VERTICAL SIDE

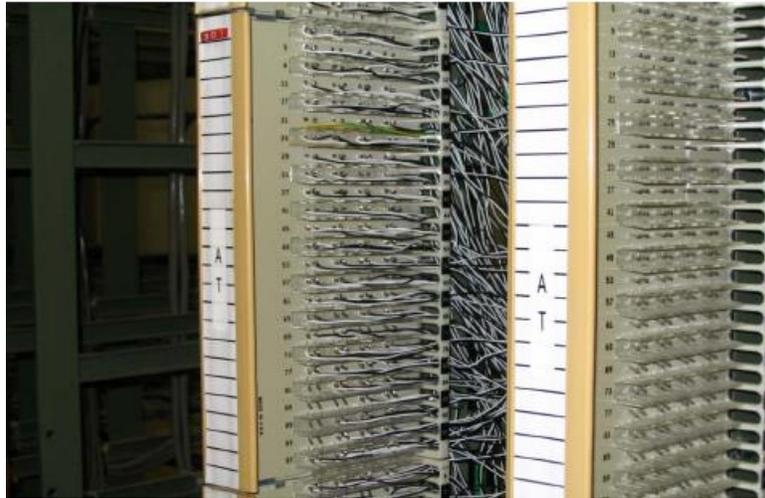


Figure 9: VDF Vertical Frame

- The cable leaving the Central Office to the SAC/JWI is known as the Feeder Cable, some areas call it F1.



Figure 10: Central Office Horizontal Frame (Left) & Vertical Mounted IDF frame in CO (Right)

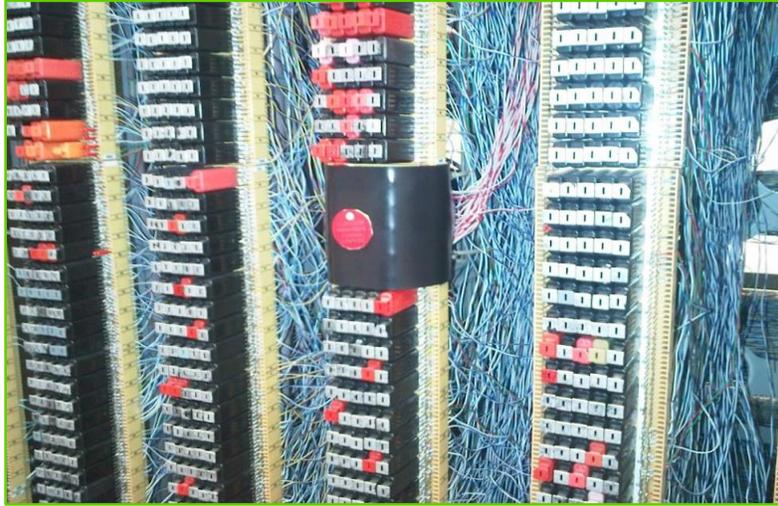


Figure 11: MDF – Wire wrap Blocks

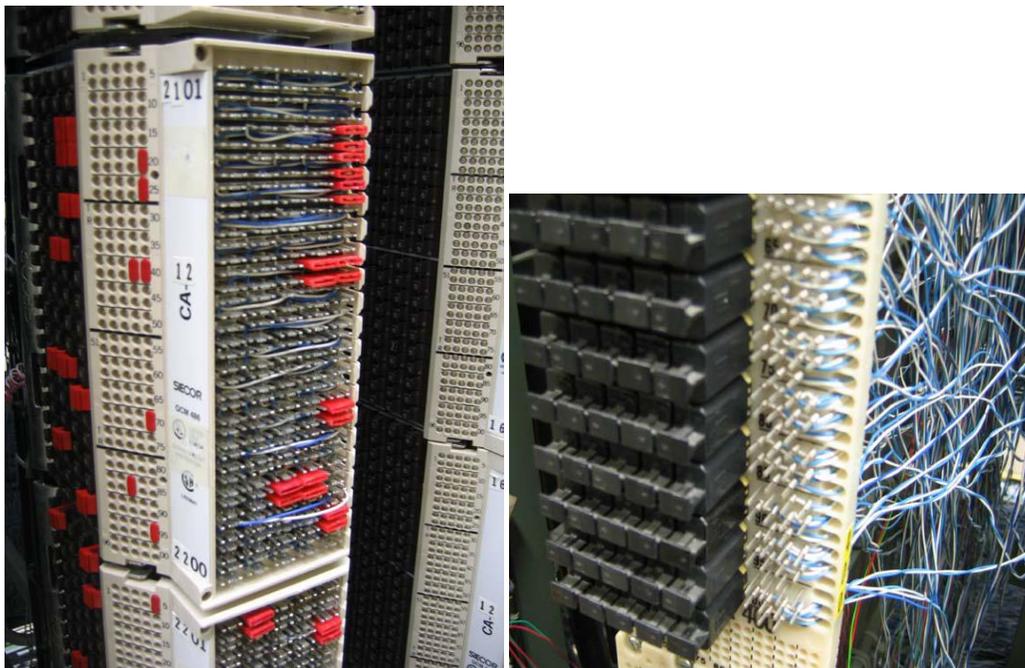


Figure 12: Protector (Left) & MPC Mainframe Connector (QCM486) 100-Pair Connector (Right)

Jumper Wires

Jumper wire is a short wire which is used at both CO and SAC boxes to complete an electric circuit or bypass a break in a circuit.

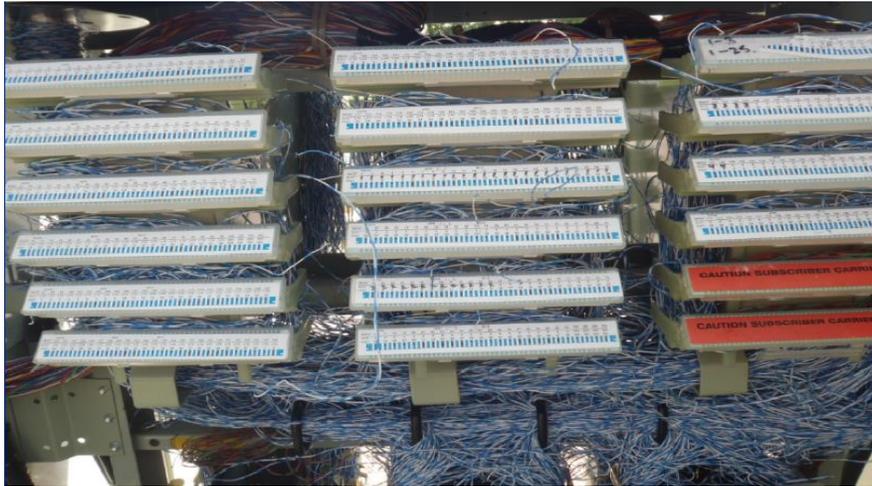


Figure 13: Jumper Wires

Color code for jumper wire used are as follows:

- Yellow/blue or blue/yellow - BC for most circuits
- White/blue or blue/white - Alberta for SAC Boxes, UMC's
- Red/green – Alberta for Power Pairs
- White/black – Alberta frames
- Red/black – Express Power pairs for RDSLAMs, T1 & CLEC circuits with high voltage.
- Red/green – Special Services

Working with Jumper wires

- Never remove jumpers through the connecting block fanning strips
- Remove jumpers from the horizontal side
- Remove all clearance jumpers
- Do not leave dead jumpers in the rack
- Leave 3 to 6 inches of slack
- Measure from tip of thumb to tip of little finger with fingers spread

1.3.2 CO Tools

1. Northern Telecom QTH 38b - QTH38B tool used for terminating, bridging, and removing wires from 2-beam or 3-beam, insulation-slicing, quick-clip terminals found on QCM486 (MPC) and 391Q connectors, and on Versa blocks with quick-clip pins. Quick connect tool lets you install and/or remove jumpers quickly.



- No need to strip jumper wire prior to terminating.
- Push out the wire holder. Put the wire in it. Have the loose end of the wire – the end to be cut off – hanging out of the yellow side of the tool. Punch down the wire over the block pins.
- Use the take-out-hook to remove old jumpers.

2. Wire Wrap Tools –



Figure 14: Wire Wrap gun & Wire Stripper tool

- Strip the wire to the correct length 3.8 cm (1.5 inches).
- Pull back gently on the gun during the wrap.
- Turns must be tight.
- Wraps must not be bunched in a pile on top of each other on the pin.
- A correct wrap will have 7 turns.
- To remove, turn a Removal Tool counter clockwise on the pins.



Figure 15: Example for a good wrap and Bad Wrap

Wrap is 7 times around pin but has a tail sticking up -

- The cause is that too much wire is being stripped and a tail is left.
- Use the stripping tool to strip 3.81 cm (1.5 inches) of insulation only.

Wrap is all bunched up at the bottom of the pin -

- The cause is incorrect technique
- Remember to pull back gently as the gun is pulled.

Wire comes in from different directions to the pin -

- Follow the pattern on the other pins and have the wire all come in from the same direction
- Insulation must be ¼ wrap on base of pin

1.3.2 Connector Terminations

3M termination

The 3M SLIC terminals uses Raychem's DTerminator 2IIDC (Inverted Insulation Displacement Connector) block. The connector accommodates 18 – 24 AWG drop wires without stripping the conductors. Gel-filled test ports in the top of each drive module accept standard butt-in clips for easy testing to the CO. In the field, you may encounter these in 5-pair, 10-pair, or 25-pair blocks.

BIX blocks

BIX blocks are used to interface between inside and outside cables in multi-tenant or commercial buildings. They are also common in large homes with many inside wire runs to a “star connection” point. In these environments, they represent the demarcation point. They are designed to be installed in a business entrance terminal (BET), metal inside terminal (MIT) box, an indoor closet or equipment room. They are also used occasionally in pedestals.

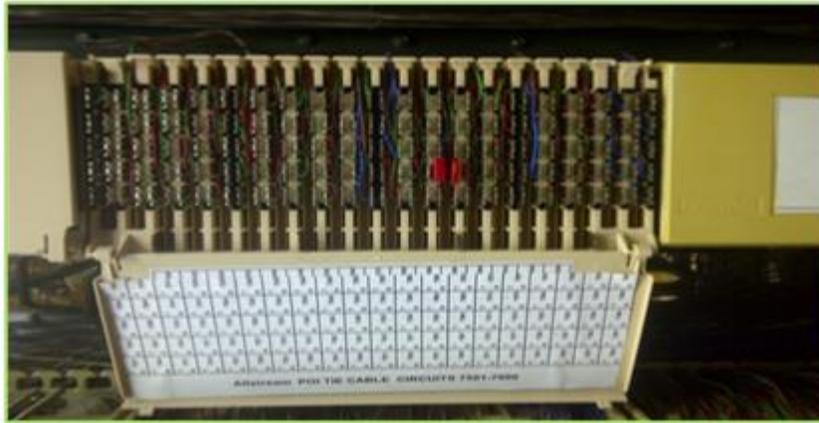


Figure 16: Quick Connector

BIX blocks replace legacy **R66 Quick connect terminations**. They are laid out to count from left to right. Connectors have a slip-in fitting that automatically strips wire as it is punched down. Cables can enter the mount from either the top or the bottom. BIX blocks feature back to back connections.

The standard identification for BIX blocks is green labels for feeder pairs and blue labels for distribution or house pairs; however, this standard is not always followed. If your work changes their designation, you should be sure to update these circuit labels.

Pair 1 is always on the extreme left side and pair 25 is on the right side. The tip is the left side of the protrusion and the ring is the right. There are different types of BIX blocks, single pair and multiplied strips, so it is important to use the correct type for the application.

110 blocks

The 110 block is a type of punch block used to connect sets of wires in a structured cabling system. The “110” designation is also used to describe a type of insulation-displacement connector that terminates twisted pair cables. It uses a punch-down tool, similar to that used for BIX blocks.

110 blocks are laid out to count from left to right, like BIX blocks.

On the 110 block, wires are fed from the front, and (like BIX blocks) the 110 features back to back connections.

R66 blocks / Quickconnect

The R66 is a legacy block that you may see in multi-tenant or commercial buildings, although it has been increasingly replaced by the BIX block. The R66 uses a special tool to punch in wires. The pins are connected together in either horizontally or in a two-level fashion.

R66 blocks are laid out to count from top to bottom.

The 66 block is designed with contact accessibility from the front, and wires are fed in from the side.

- Accepts 50 pairs to be terminated.
- 25 pair on one side and 25 pair on the other side.
- Starting from top to bottom.
- 110 impact tool is used to terminate pairs.



Figure 17: R66 Block (Left) and 110 tool used to terminate R66 (Right)

1.3.3 BIX Installation



Figure 18: BIX installations

- BIX blocks are normally associated with inside wire cable, they also are used to interface between inside and outside cables, as well as occasionally in pedestal terminals.
- BIX blocks have replaced Quick Connect blocks.
- The basic termination is 1A connector that will terminate 25 pairs.
- Cables can enter the mount from either the top or the bottom.
- Pair 1 is always on the extreme left side, pair 25 on the right side.
- The tip is the left side of the protrusion, the ring on the right.
- The 1A connector only accommodates one jumper per circuit.
- Other connectors accommodates multiple connections per circuit (e.g. 2A up to 2 pair of jumpers per circuit, 5A up to 5 pair of jumpers per circuit and 7A up to 7 pair of jumpers per circuit).
- BIX 10A mounts can be joined with distribution rings for horizontal and vertical jumper channels. A 2-connector mount (BIX 10c) with cover (BIX 31A) can be used for smaller applications.
- A green label identifies feeder cable
- A blue label identifies distribution cable at terminal
- A white labels indicate house runs
- A yellow labels indicate Enter-phone terminations
- A single pair test probe is used to access any pair on the bix connector. Its fits on either side of the plastic protrusion on the block.



Figure 19: BIX Impact Tool is used to terminate BIX blocks.

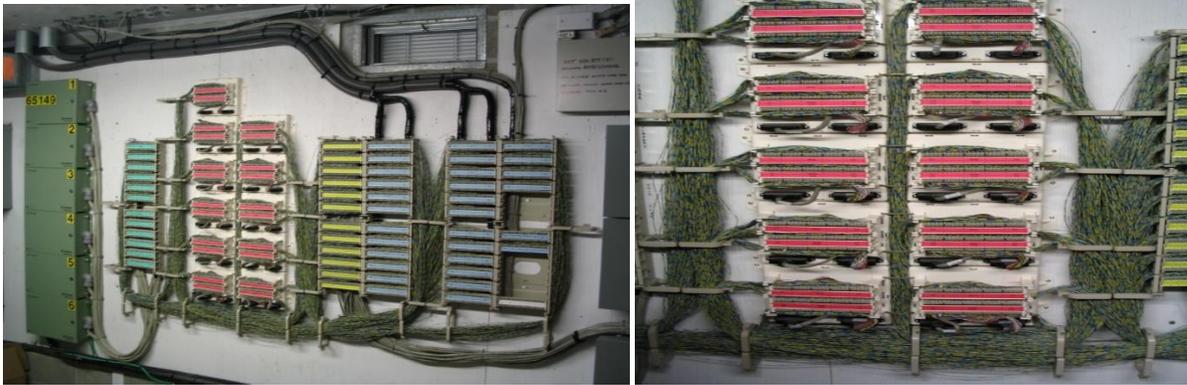


Figure 20: Cut over Buried to BIX & ADSL/POTS Splitter used today in all high rises

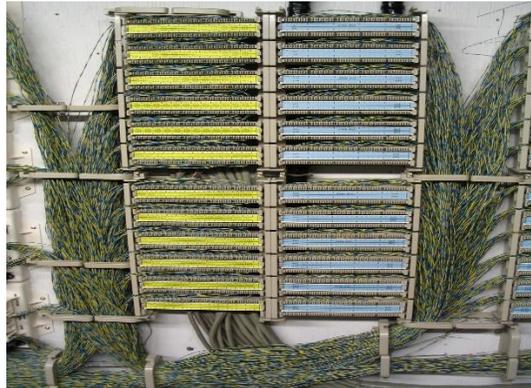


Figure 21: Jumper wires running to closets and suites from the P1 level enter phone

Feeder Cable

A feeder cable is a large cable that runs from the CO and carries individual cable counts of different sizes of up to 3900 copper pairs. Feeder cables connect to SAC boxes which then feed distribution cables out to the Ready Access (RA) or SLIC terminals.

The feeder cable is usually placed in a conduit, accessed by manholes and sometimes referred to as underground cable.



Figure 22: Feeder Cable running

Distribution cable

The distribution cable is a smaller version of a feeder cable. It contains a smaller number of twisted pair wires.

The wrapping or sheath that covers a cable varies based on where it is located for example, buried versus aerial. Distribution cables connect SAC boxes to the RA or SLIC terminals.

1.4 Serving Area Concept Box/JWI/XCONN

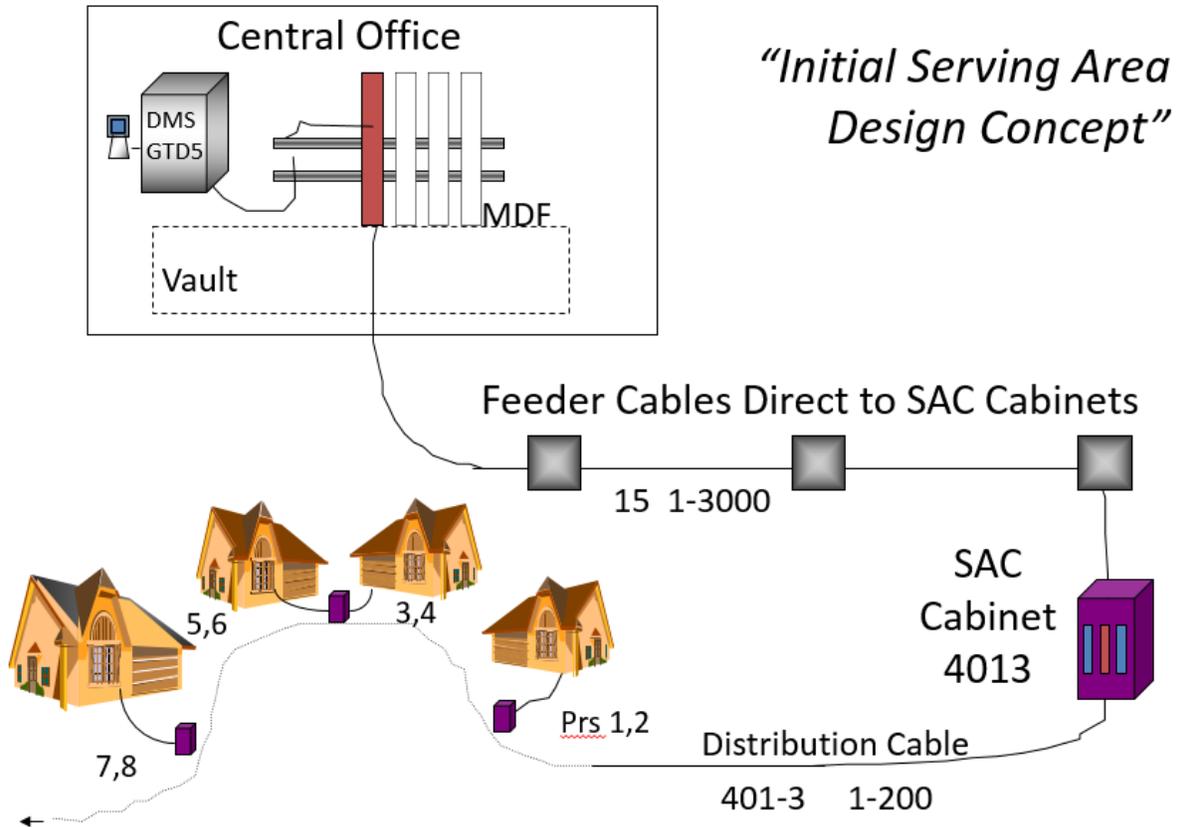


Figure 23: Serving Area Design Concept

- Serving Area Concept Box and Jumper Wire Interface Box is referring to the same service box.
 - A cabinet that houses the feeder cable pairs (IN pair) and distribution cable pairs (OUT pair). The Green Cover Modules (usually in the center) is the cable from the Feeder. The Blue Cover Modules (usually on each side) is the cable to the Terminals, which will cover more in detail in the next few sides.
- Cross-connect box - XCONN box is a smaller version of the SAC/JWI box.
- These cabinets are designed for easy access so the Telecom personnel can easily change the cable route from any IN pair to any OUT pair.
- You may not notice these cabinets in the field but they are usually located at the side of streets, back alleys, inside buildings, or mounted at poles.

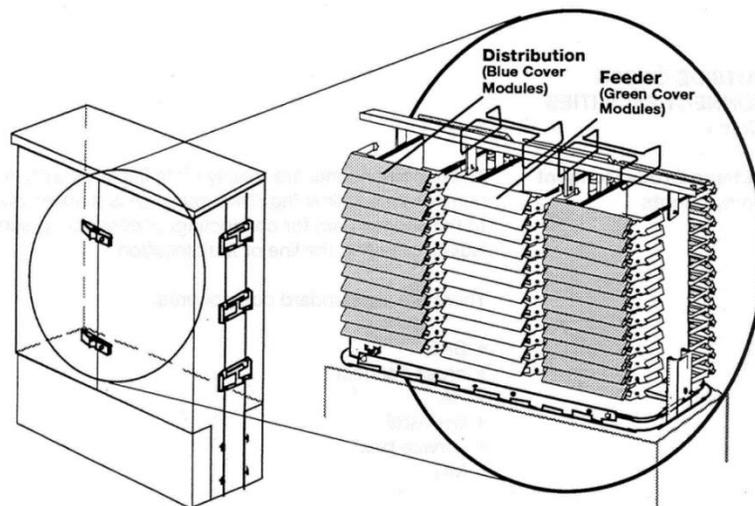


Figure 24: Inside of a SAC Box

- For Telecommunications, these Cabinets are green and depending of your Telecom, they may decorate them to blend in with the neighborhood.

SAC/JWI with ADSL

- DSL service has become very common over the years to provide the consumer with high bandwidth.
- In order to achieve these high bandwidth for consumers, DSL equipment have to be install closer to their home.
- Dial tone have to go through the DSL connections for both service to work over 1 pair.

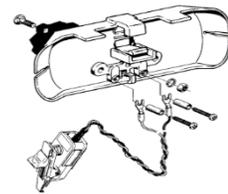


Figure 25: ADSL Connection Block on top of Feeder/Distribution

Test Clip at the SAC

- MS2 4047A Pair Test Plug Assembly (with tool dish).
- Every SAC should have a test plug for you to use to monitor or test the individual pairs.
- You would simply insert this test plug into the binding post on the block.

- Note – due to the years of usage, this plug may become defective. The leads on the clip becomes corroded and may give you noise on the line resulting in false readings. Your instructor will show you alternative way to test the MS2 modular blocks.



Cross Connect Box

- Normally inside we would only find 1 row for Feeder and 1 row for Distribution.
- These can be pole mounted to service a smaller neighborhood.

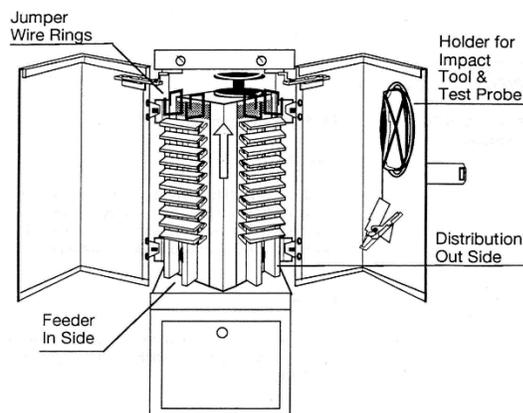


Figure 26: Cross Connect Box

MS2 Impact Insertion tools

- 3M™ Impact Insertion Tool.
- The only tool approved for use in connecting jumper wire to MS2™ Quick-Connect modules.

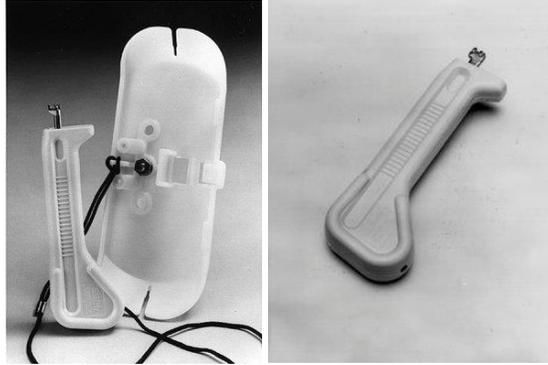


Figure 27: Impact Tools

Running Jumpers in the SAC/JWI

- Insert the jumper from top of MS2 modular block and run it straight down.
- Ensure tip color is at the left of marking and ring color is at the right of marking.
- Using the MS2 impact tool you can punch down the jumper by lining up with the binding post.
- Follow the existing path as other jumpers.
- Do not splice or use existing jumper, run a new one instead.
- **DO NOT MAKE YOUR OWN PATH!!**
- Ensure jumpers are ran through the rings inside the SAC.
- Binding post 1 to 12 must enter and exit from the Left.
- Binding post 13 to 25 must enter and exit from the Right.
- Match the MS2 impact tool with the MS2 modular block.
- Angle the MS2 impact tool 45 degree, the way the MS2 modular block is.
- Punch down 1 conductor at a time.
- The wire will be cut off.
- If there is a cap on there, please ensure it is closed after you are done.
- Some SAC boxes you will find red caps on a pair, these are special circuits and should not be touched unless you are the special circuits technician.
- Special circuits can be – ISDN T1, PRI, Channel banks, etc.

1.4.1 SAC to House components

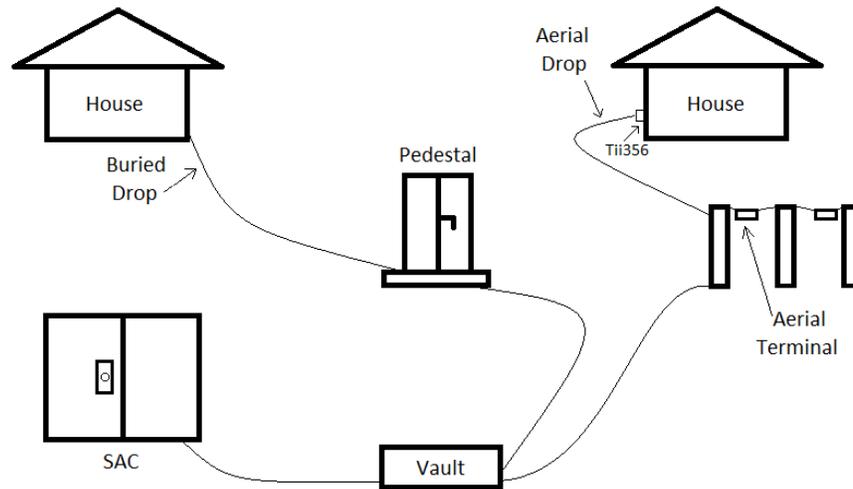


Figure 28: Basic Flow from SAC to house components

- After you have done your work in the Central Office, and Serving Area Concept box, you would head to the Ready Access Terminal (RAT).
- The RAT is terminal that is located close to the customer premise where the Drop cable is ran into the customer home.
- In some areas, RAT refers to both Aerial outside Plant and Buried outside Plant service.
- In others, RAT only refers to the Aerial outside Plant. Buried outside Plant is call Pedestals (PED) or Encapsulated (ENC).

Terminals: Ready Access (RA)

Aerial terminals are normally either Ready Access (RA) or SLIC terminals. The Ready Access terminal is a legacy terminal. It was the standard aerial terminal for plastic insulated cable since the late 1960s.

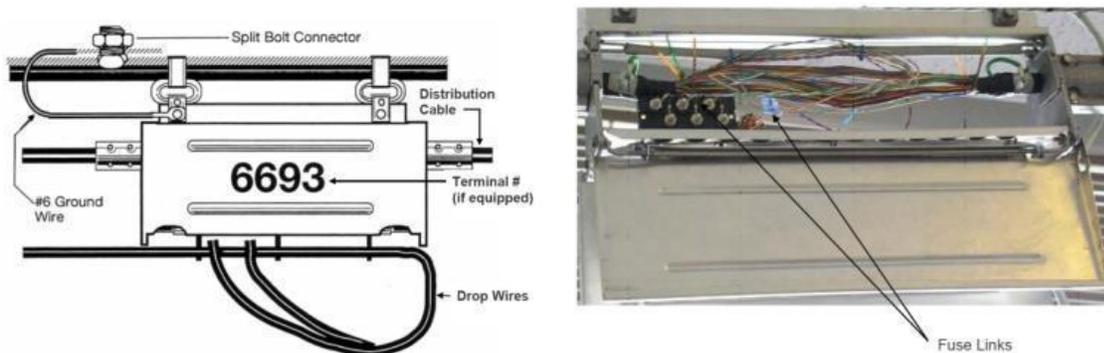


Figure 29: RA Terminals

The RA contains binding post blocks that allow the terminal to be expanded from the standard 6 customers to a maximum of 24 in multiples of 6.

Hazards for the all aerial terminals include jammed lids, bee nests, cobwebs, bugs and grease from cable and voltage.

The binding post block used in the RA is the 145B. The binding posts can be random access (technician chooses a free binding post) or in some cases, dedicated. When dedicated, the technician is told by assignment which binding post to use.

The binding posts are connected to the cable pairs with fuse links, shown here. The standard termination connector is the **Scotchlok**.

Terminals: SLIC

The current company standard terminal for plastic insulated cable is the SLIC terminal.

The SLIC contains binding post blocks that allow the terminal to be expanded from the standard 10 customers to a maximum of 25 using 5, 10 and 25 pair blocks.



Figure 30: SLIC Terminals

1.4.2 Binding post blocks

Binding posts are used to connect a drop to the assigned cable pair through a fuse link. This provides an easy point for opening the circuits for the purposes of isolation testing.

There are 3 primary terminal binding post styles used are:

1. 145B block

This block is obsolete, and may only be used in rural areas without HSIA.

2. Tii 67-2 IDC block

This block is designed to replace the 145B block. It has an IDC connector, so it provides a superior electrical connection between 22 – 26 gauge drop wire, the fuse link and the cable pair.

This block must be used with all xDSL installations or repairs where the customer's service comes from an RA or other 145B equipped terminal.

3. SLIC terminal block

The block used for the SLIC terminal comes in 3 configurations: 5, 10 and 25 pairs. The binding posts are Insulation Displacement style connectors (IDC).

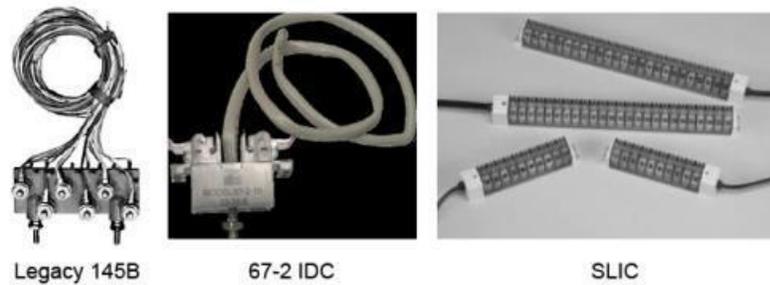


Figure 31: Binding Post Blocks

The binding posts can be random access, where the technician chooses a free binding post and attaches it to the assigned cable pair. Or in most urban centers/districts, they are dedicated, which means that a splicer has attached the binding posts to the cable pairs in advance and the Assignment Group assigns the binding post on the order.

Fuse Links

Binding posts are connected to the pair with fuse links.

A fuse link is a piece of wire that acts as a fuse between a binding post and a cable pair in case of high voltage contacts on the cable pair. It is composed of a different alloy than that of the cable pair, and it is typically of a different gauge as well. A fuse link must always be used for electrical protection.

When terminating a fuse link to a cable pair, the assigned cable pair should be identified and UB **Scotchlok** should be used to connect the fuse link to the pair using the proper Scotchlok tool. Pliers should never be used here.

Pedestals

A pedestal is similar to the RA or SLIC in application and can be metal or plastic. Pedestals are used as terminals where there is underground cable.

Pedestals come in many styles and shapes. Some are designed to look like the landscape (like the large rock you see on the right) and others are in the base of city lampposts, sharing space with Cable TV. The non-shared side is often the electrical utility.

Most pedestals, however, are metal boxes of various shapes that are smaller than SAC/JWI's.

Some older pedestals have no binding posts and the drop is attached directly to the cable pair. More modern pedestals have binding posts, insulation displacement connectors and even BIX 1A water resistant blocks.



Figure 32: Pedestals

Underground drops are run to pedestals either in conduit or as direct buried cable.

Pedestals may or may not have identification numbers visible from the road.

Rural Alberta numbers translate as follows:

Example 90902

- 9 means rural
- 09 means I route (I is 9th letter)
- 02 means pedestal number 2

Most pedestals are not locked.

In Rural applications in Alberta a pedestal called an RJP or Rural Junction Point is used. This is where the “Exchange” cable or urban cable transitions to the rural cable designations. Numbered like RJP -1
Hazards include jammed lids, overgrown shrubbery, bee nests, cobwebs, bugs, snakes, grease from cable and voltage.

The binding posts in pedestals are not standard and may include 145B blocks, IDC blocks, BIX 1A blocks and other binding post blocks. Some also have the underground drop spliced directly into the cable.

Shared Pedestal



Figure 33: Shared Pedestal with EPCOR

Other Access Points (AP)

- A splice, pull or service box are tubs made of concrete or plastic.
- Used as access points, they serve as protection for smaller cables that are run in conduit, primarily in subdivisions.
- These boxes may contain cablevision wire along with the telephone cable.
- The cover can sometimes be pried off with a screwdriver, however, a lid-lifting tool is available (splice box lifter).
- There is no security.
- Hazards include jammed lids, bee's nests, cobwebs, bugs, grease from cable and water, overgrown bushes, shrubs, grass, and bark mulch.
- Snow may make these boxes hard to locate.

1.4.3 Tools Used

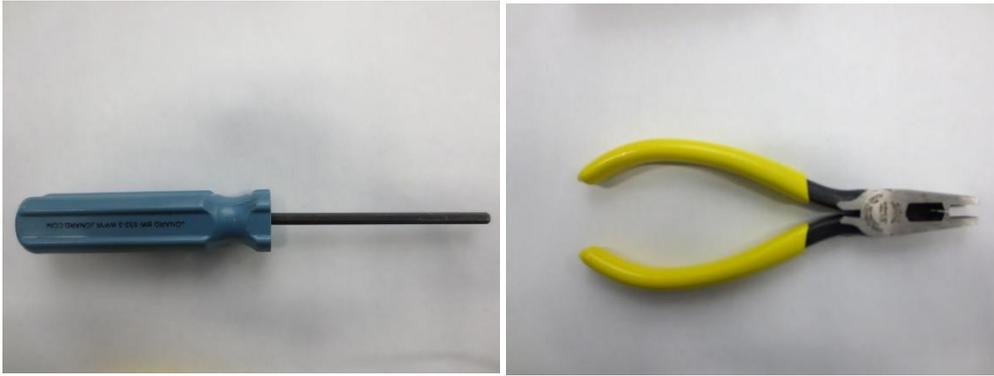


Figure 34: NIB/NID Security Driver (Left) & Scotlock Clippers (Right)



Figure 35: Can Wrench (Left) and SAV Impact Tool (Right)



Robertson #3



Robertson #2



Robertson #1



Philips Head



Flat Head

Figure 36: Screw Drivers



Figure 37: Spudder Probe (Left) & Butt Set (Right)

1.5 Terminal Types

Terminals fall into 3 main categories:

Aerial

Aerial terminals include Ready Access (AC) and SLIC terminals. The Ready Access terminal is a legacy terminal that is increasingly being replaced with the 3M SLIC terminal.

The RA contains binding post blocks that allow the terminal to be expanded from the standard 6 customer's to a maximum of 24 in multiples of 6. Historically, it contains 145B binding post blocks that allow the terminal to be expanded from the standard 6 customers to a maximum of 24 in multiples of 6. However, for all new installs and repair visits for xDSL and TELUS TV circuits, the 145B block must be replaced with the Tii 67-2 IDC block. The 145B block may still be used in rural areas without HSIA.

The SLIC terminal is the current company standard terminal for plastic insulated cable. (PIC cable). The SLIC contains Raychem DTerminator 2IIDCbinding post blocks that allow the terminal to be expanded from the standard 10 customers to a maximum of 25 using 5, 10 and 25 pair blocks. They are connected to the pair with fuse links. Access to the fuse links is by releasing three metal snaps across the top of the terminal. A fuse link must always be used for electrical protection. A drop should never be connected directly to a cable pair without a fuse link.

Buried

For underground drops, if there is a terminal it will be a pedestal, although many underground drops are fed from service boxes and encapsulated buried splices. Pedestals are similar to the RA or SLIC in application and can be metal or plastic. They can be random access or dedicated. Underground Drops are run to pedestals either in conduit or as direct buried cable. The wiring in pedestals is very similar to that of RAs and SLICs.



Figure 42: Buried Terminals

In Alberta the drop is normally direct buried from the pedestal to the house. The technician runs the drop up the side of the house in a conduit and attaches a NIB. Encapsulated splices are splices where typically 2 pairs are dedicated from the SAC to the house. So when the tech runs the jumper in the SAC, dial tone will be at the demarc location.

In BC, usually the customer places a conduit and the technician pulls in the drop from the Pedestal (or Pull Box) to the NIB.

Premise

Inside wire at most houses terminates at a protector like the Tii 356, which has two gel-filled IDC rockers. In commercial and multi-tenant building, the BET (business entry terminal) box or MIT (metal inside terminal) were historically used on the customer side of protection equipment or to house the protection equipment. They are also used for house terminals, satellite terminals or building cross connect points. BET / MIT boxes can contain BIX blocks.

In some areas a Supra "S" vault key unlocks the BET / MIT and the cover lifts up and out at the bottom. After work is completed, the cover must be replaced and all knockout holes must be sealed (using sealing compound – Duxseal) to eliminate any fire hazard.

BET / MIT boxes are no longer standard and have generally been replaced with self-enclosed CIRCA protectors.

1.5.1 Binding Post Counting

Binding post counting needs to be done in order to determine how many usable pairs are in a terminal.

If binding posts are labelled, they just need to be counted. If they are not labelled, then you need to use what you learned about color coding. You need to correlate the pair count to where the color codes would be.

On typical 145B aerial terminals, use odd – even counting. On one side, the binding posts(BP) will count BP 1,3, 5 and the other BP 2,4 6. In terms of color coding, this will be White – Black, White – Green, White – Slate on the odd side and White – Orange, White – Brown and Red-Black on the even side. It is good to know what side of the terminal your BP is on when you set up a ladder on a pole.

Feeder and distribution SAC modules will be marked in 25-pair increments.

1.5.2 Clear Capping

Clear capping helps maximize the stability and speed capabilities of the circuit. A bridged tap is a portion of a cable pair connected to a circuit that is not part of the useful path.

Clear capping is the removal of bridged taps going to the field side of the customer’s drop pedestal or aerial terminal. It is the technician’s responsibility to clear cap on all repairs and installs for (HSIA and IPTV).

When the field side of the cable is removed (clear capped) and tests still show a bridged tap, then these are BEFORE the drop pedestal. A tech should email CAST ACE with the particulars so they can analyze the counts to look for opportunities to cut out large groups of bridged taps.

Clear capping the cable pair and removing all bridged taps before the drop pedestal or aerial terminal removes any reflection of the signal caused by the extra cable. A reflection on the line is similar to that of an echo of the signal, and a modem cannot tell the difference between the original and echoed signal. The modem cannot sync or creates errors. The longer the bridged tap, the fainter the echo. Our modems are powerful enough to accurately use the closer signal and ignore the echo. Short bridged taps will create service outages very quickly. This cable grooming is required on both aerial and buried terminals.

To clear cap, identify the C.O. side carrying the dial tone and the pair going to the terminal block or fuse link. Use Scotchlok connectors and correct tool to connect these two pairs, not pliers. Cut off the remaining field side pair(s) going to terminals past yours. There may be more than one field side pair. You should endeavor to keep the cut-off pair visible while keeping the terminal neat and tidy.

Do NOT connect the wires of the field side pair together with an electrical connection (eg Scotchlok™ UY) as the practice has the potential to impact higher data frequencies.

In some compounds, the Red Scotchlok™ UCC connector is available. It is designed to hold the pair together but not make an electrical connection. It is acceptable to use this connector instead of simply twisting back the opened wires.

When you write off the order or trouble on completion, note in FITS that you have clear capped the pair and in which terminal it was done. This helps technicians who may have to fix or recover the pair in the future.

1.5.4 Protectors, Bonding and Grounding

Protectors

The station protector is the last connection point for drop wire when you install a single line service. Station protection provides a path to ground in case of excess voltage. It is important to install a protector properly in order to protect the safety of telephone users and employees, as well as to prevent damage to property.

Protection is designed to provide a path to ground if a voltage over the rating occurs as it will bleed off excess current to ground. If the protection is not functioning correctly, the increased current flow may cause the wires to overheat, which may be a fire hazard.

Protection is provided on the tip and the ring, both at the CO and at the customer's premise. Always determine whether the existing protection and grounding is correctly done and sufficient to support any additional services that you are installing.

BET / MIT grounding

BET and MIT grounding is normally done by the outside build (construction), so you will not normally need to do this. But you will need to verify that the terminal is grounded if you are working with it. In the event that you notice a missing ground, you will need to repair it only if trained and equipped to do so. Otherwise, notify your manager.

All BETs and MITs need to be grounded from the ground lug on the terminal to the premise power ground. The minimum gauge for this is a #6 AWG.

Older style business entrance terminals are also grounded with #6 AWG wire to a copper strap that runs behind all the terminals into which the individual modules are attached.

BET bonding

When two BET's are placed together they need to be bonded with a #6 AWG wire between the two.

Tii 356

The Tii 356 is a fuse less protector; a NIB with a Tii 356 protector is the company standard. A fuse less protector must be used if the customer has a power company multi-grounded neutral (MGN) or a known grounded community metallic cold water supply.

The Tii 356 is the demarcation point between outside plant and inside wiring, and between Central office and the customer. The test jack on the Tii 356 enables the customer to check their line themselves. Being able to find out that the trouble is in their home can save them the expense of a service call.

The 356 module is entirely self-contained and consists of:

- a Tii heavy duty three-electrode gas tube surge arrester
- a fail short mechanism
- Insulation displacement connections (IDC) for Telco and customer wiring
- an RJ-11 jack as a demarcation

The Tii 356 must be used for all xDSL and TELUS TV installations.

For all new installs and repairs, the existing protector must be upgraded to the Tii 356.

Installing the Tii 356

The Tii 356 should be installed in a network interface box (NIB).

Do not strip the wire before inserting into IDCs.

Using the Mini Rocker tool, follow this connector termination procedure:

- Open contact actuator by simply pulling back on caps with thumb or finger. Do not over open.
- Insert wire into color coded ports.
- Visually inspect for full wire insertion through the transparent body.
- Close firmly.
- Make sure that all contact actuators are left in the “down” or locked position.
- Gently tug to make sure connections are made.

Ensure the placement of the ground wire does not interfere with the test jack. If existing wire is to be reused, cut off at least ¼” (6 mm) before re-termination.

1.5.5 Terminal Wiring

Aerial terminals

For both RAs and SLICs, ensure that both cable bonds to the messenger are securely attached at each end of the terminal.

Replace wire wrapped binder group identification with the appropriate colored zap strap (plastic cable ties colored in the same colors as the pair colors).

RA: The drop is to be run into the terminal on the extreme right hand side of the terminal (the side without binding posts). This is to allow the multi pair drops less congested access to both the odd and even side of the binding posts.

1. When using duplex, split conductors 5 centimeter’s (2 inches) using a wire splitter, but do not strip the insulation from the conductors.
2. Back driver module off until it clicks in the “up” position.
3. Insert pair into wire entry port until it passes over the white or colored insert inside the module and stops.
4. Hold conductors in place while tightening the drive module to the “down” position.

SLIC: The drop is to be run into the terminal directly under the binding post to be used. The terminal block accommodates 18 to 24 AWG drop wires without stripping the conductors. Gel-filled test ports in the top of each driver module accept standard butt-in clips for easy testing to the CO.

For both RA and SLIC, ensure a drop lock is used and that no more than 1” of drop jacket is left beyond the drop lock. Enough length on the drop pairs should be provided to reach all possible binding posts in the terminal.

Terminate the fuse link to the pair with a UB Scotchlok if it has not already been terminated or follow the clear cap procedure, when appropriate.

Underground terminals

Underground drops are either run to pedestals or spliced directly into a cable. Either way, they can either be routed to the customer’s home in conduit or as direct buried cable. Where drops are run to a pedestal, ground at both pedestal (if possible) and NIB. Where underground drops are spliced directly into a cable, they are direct buried in a service box or pull box, or they are connected to a drop tail spliced into a cable. Ground at the NIB.

While it is the customer’s responsibility to provide a conduit from the foundation level to the height of the NIB, it is not uncommon that the drop is attached directly to the home.

1.6 NID (Network Interface Device)

Network interface devices (NIDs) have been developed to deal with interconnect. The interface device provides the following:

- Electrical protection for the subscriber loop.
- Test point for Field Technician.
- Test and access point for the customer.

NID consist of –

- Plastic body-base, lock hole for subscriber
- A Protector – with or without a RJ11 test jack
- Ground bar
- Ground wire



PT6IX with optional additional protectors.

Figure 43: NID

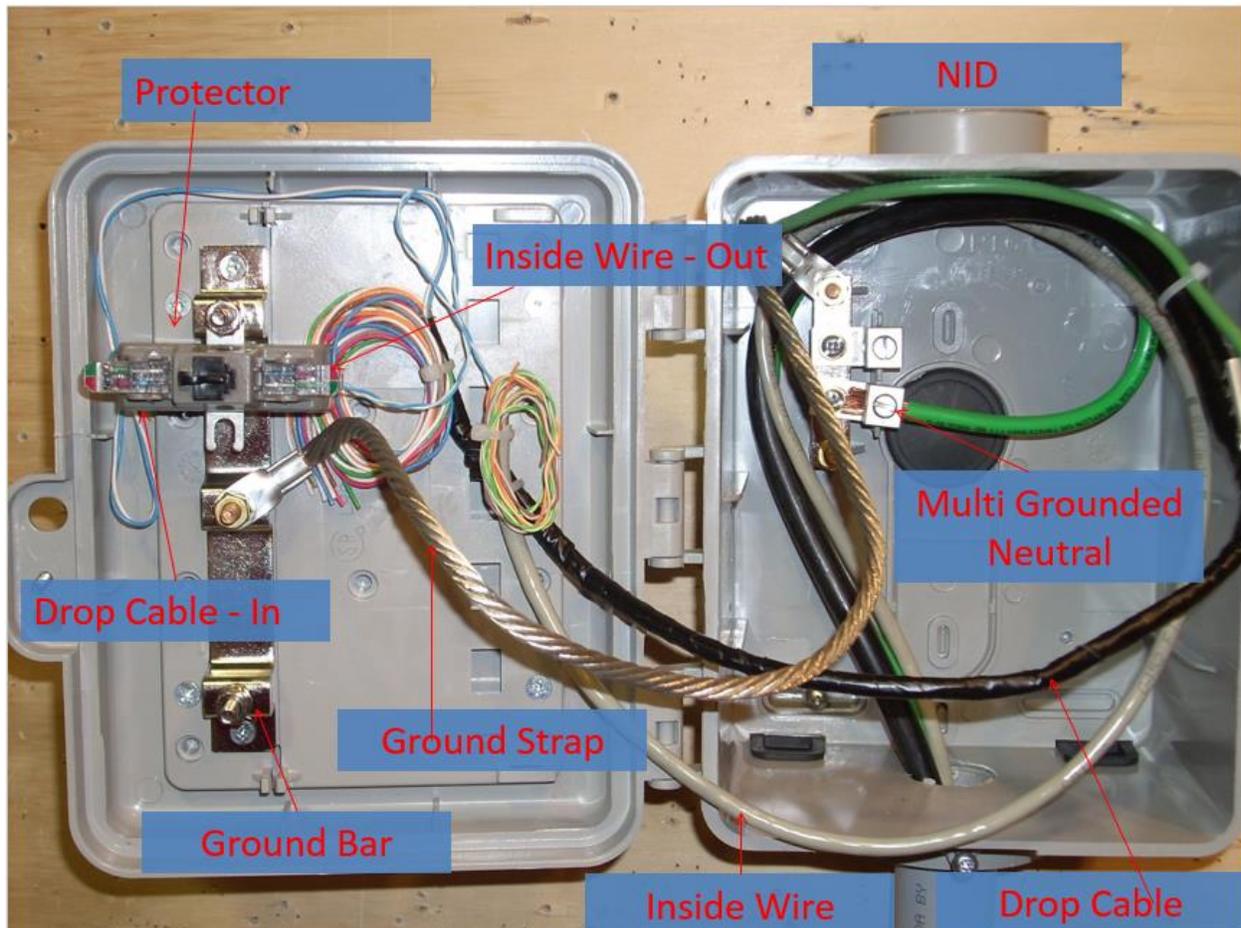


Figure 44: Components of NID

Surge Protector



- Communication systems are vulnerable to electrical damage from lightning or other surges thus requiring a surge protector at the customer premise to prevent from injuries, fires, and damages.

- What is a Surge?
 - A “surge” is a short-term increase in voltage or current. Both lightning and the AC power distribution system cause surges, but of very different magnitudes and durations.
 - These events can either be via direct contact or by field or resistive coupling from events close to the telephone system, resulting in a wide variety of threats.
 - For example, the effects of a power line fault caused by lightning may even be more threatening to the telephone system than the original lightning.

Grounding

- Grounding is the process of removing the excess charge on an object by means of the transfer of electrons between it and another object of substantial size (i.e. the Earth).
- A proper ground serves two purposes. It allows our circuits to perform properly and it allows us to properly protect our services and facilities, including those of the subscriber.



Figure 45: Grounding

Bonding

- The Canadian Electrical Code require all grounds, i.e. telephone, electric power, lightning rod and TV antenna ground rods, to be bonded (interconnected) by a copper ground wire to prevent hazardous voltage differences between such grounds in the event of a lightning surge or accidental power contact on one of the systems.
- Bonding is required regardless of the distance between electrodes.
- Bonding of the drop cable should be done at the NID and PED/ENC.
- Use your company approved bonding clip for bonding the drop cable to ground.
-

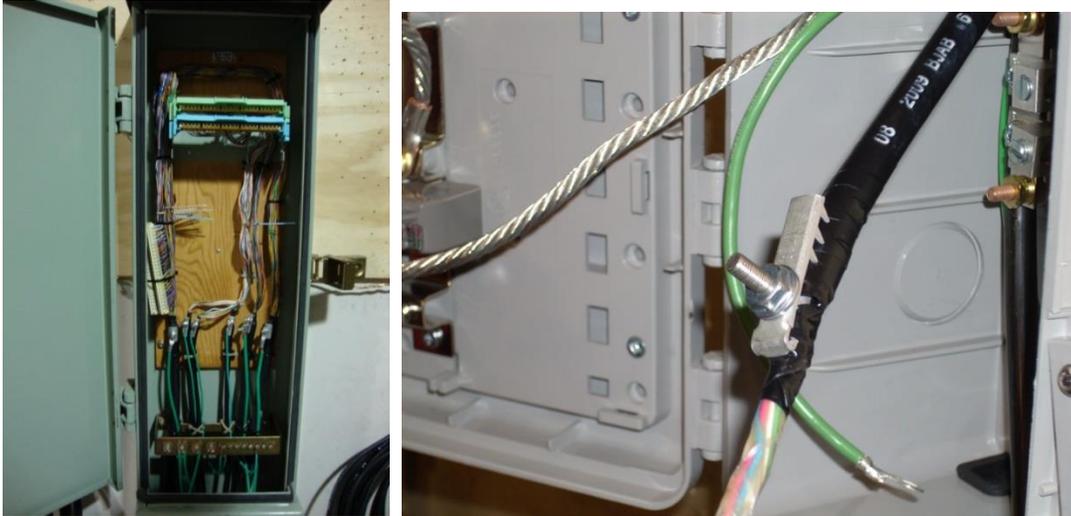


Figure 46: Bonding

1.6.1 NID Install and Upgrade

Step 1. Attaching the NID to the house

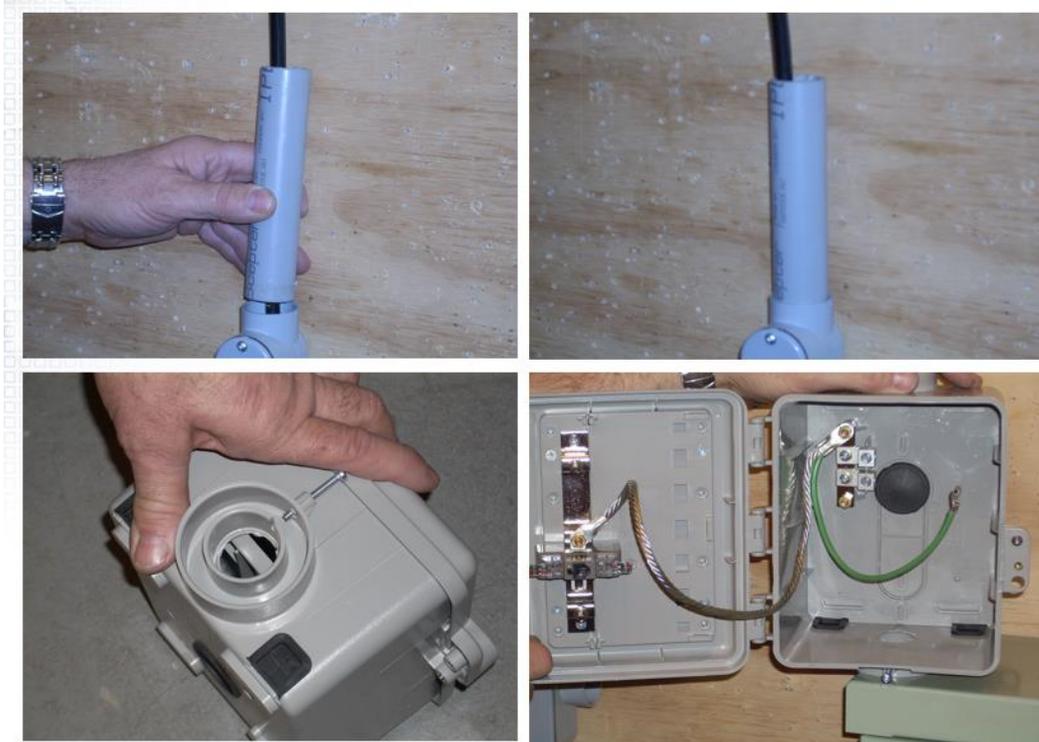
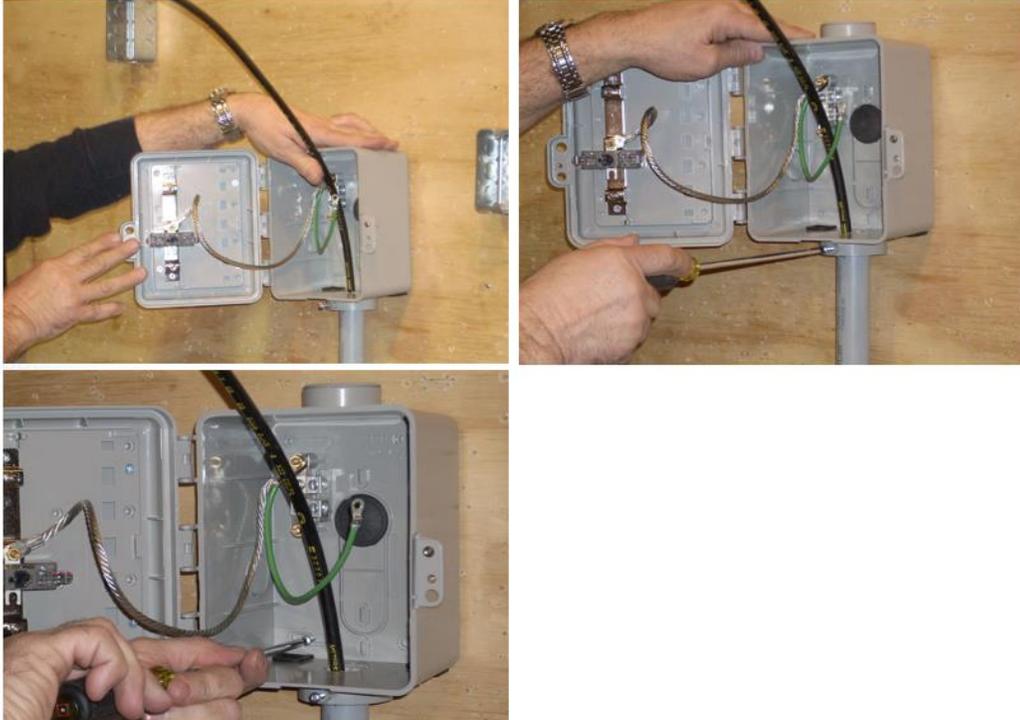


Figure 47: Attaching the NIB to the house

- Make sure to fasten NIB with correct screws.
- Be sure to add sealant to any areas where the NIB does not make a tight seal.
- Over tightening will cause the NIB to warp.
- Use correct conduit sleeve to ensure a tight seal.



Step 2. Dressing your cables and connecting your ground

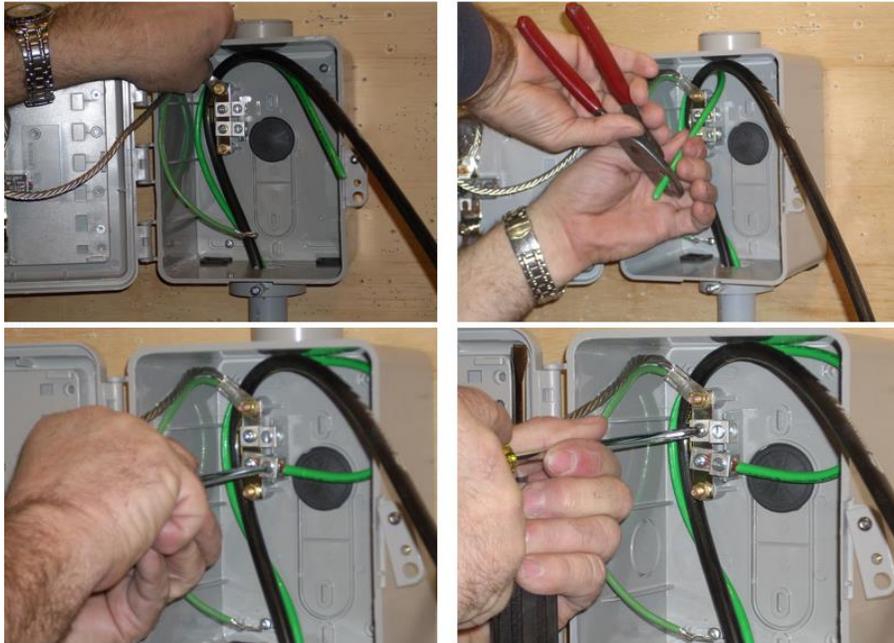


Figure 48: Dressing your cables and connecting your ground

Step 3. Butting and unsheathing, buried drop

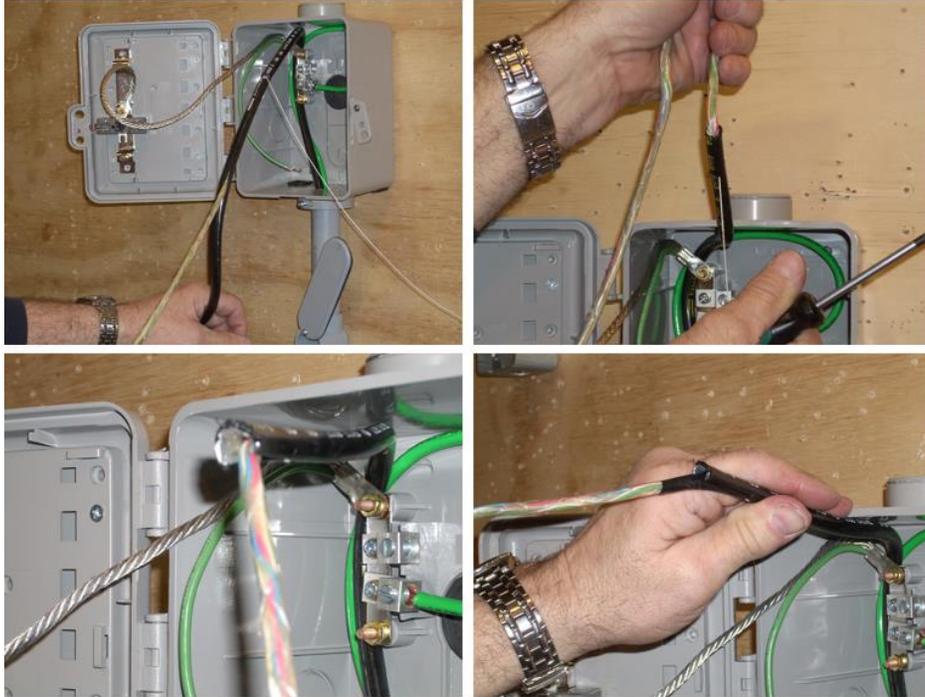


Figure 49: Butting and unsheathing, buried drop

Step 4. Bonding

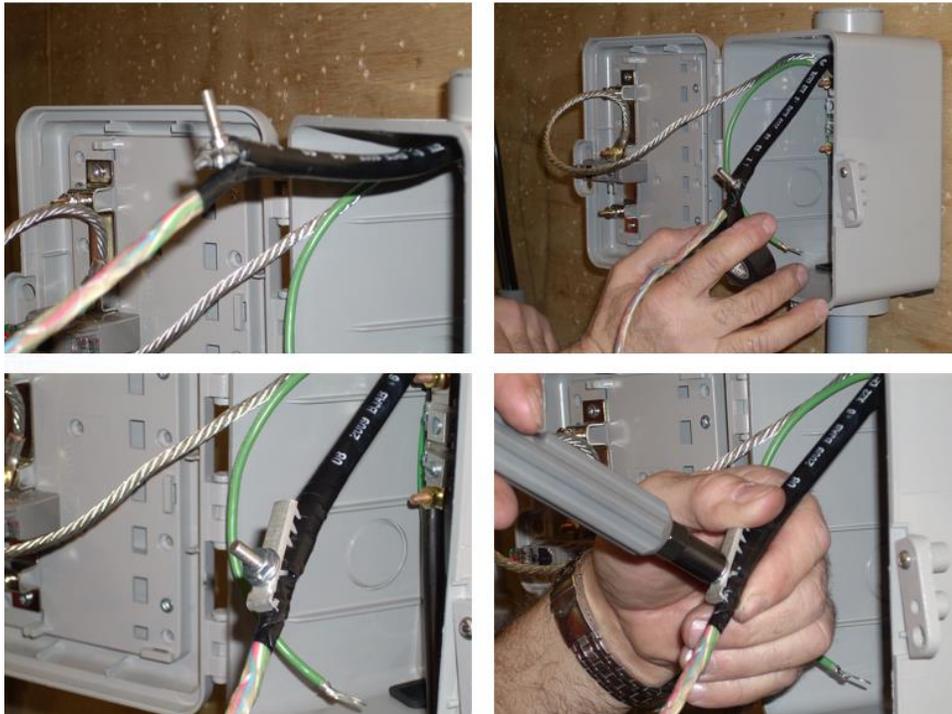


Figure 50: Bonding

Step 5. Dressing Cables

- Butting should be added prior to alligator.
- Alligator clip must be fastened tightly.
- All ground connections must be tightened.

- #6 ground should have slack.

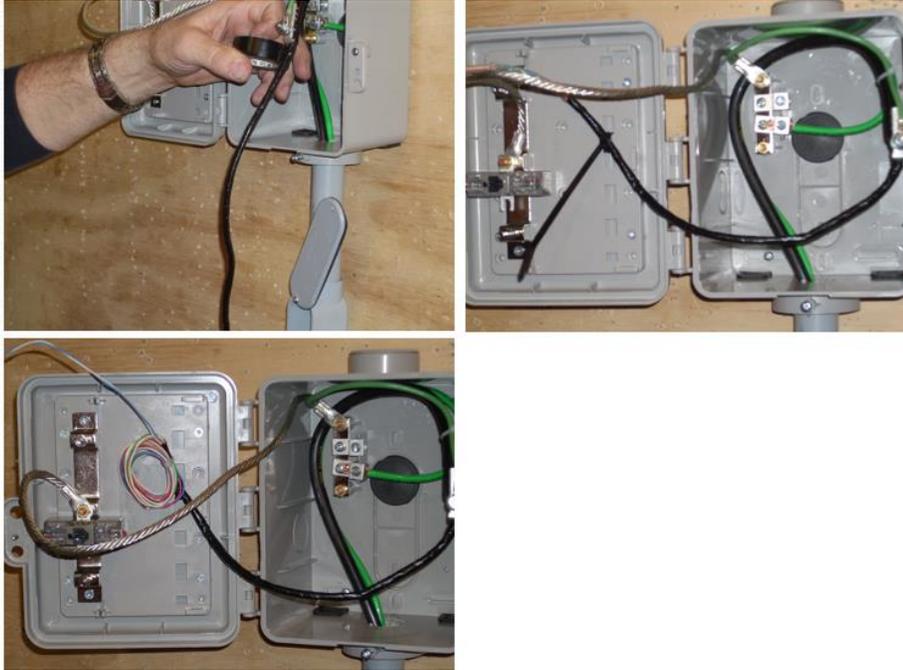


Figure 51: Dressing Cables

Step 6. Protection

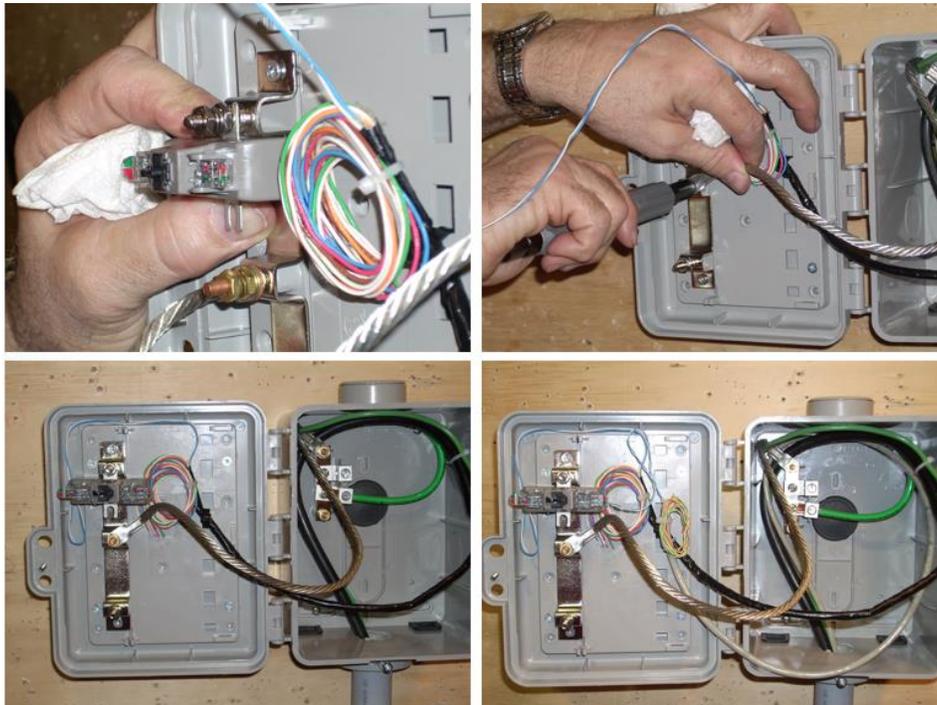


Figure 52: Protection

Step 7. Securing NID upon Completion



Figure 53: NID Completion

1.7 Drops

A drop (also known as a network service wire or NSW) can be either aerial or buried.

Aerial drops:

There are 2 main styles of aerial drop used:

- The black 2 & 6 pair drop, used primarily in Alberta. These are rectangular.
- The grey 4 pair drop, used primarily in BC. These are round.

Underground drops:

- Underground drops are installed in 3 ways.
- Directly buried from a pedestal, pull box or encapsulated splice
- Placed in conduit from a pedestal or pull box

Run down a pole from an aerial terminal. This is known as a lateral

Today, developers are expected to provide a conduit, at least from the foundation level to the NIB location.

The customer must pay the cost of installing additional underground drops.

In Alberta, the drop is normally direct buried from the pedestal to the house. The technician runs the drop up the side of the house in a conduit and attaches a NIB. In BC, usually the customer places a conduit and the technician pulls in the drop from the pedestal (or pull box) to the NIB.

In subdivisions where pedestal terminals are not in place, the drop is spliced directly into the cable. The splice is either permanently encapsulated or closed with a heat shrink sleeve. Splices that are designed to be reopened are protected by service or pull boxes. The current standard underground network service wire is Cat 5, although some 6 pair is still used in rural Alberta. In Alberta, until recently, the Cat 5 network service wire also included a tube with 4 fiber optic fibers (called composite cable).

Closures

The underground drop is now usually either spliced directly into the cable or is connected at pedestal terminals. Occasionally it is run up a pole, and in the past in BC, it has been connected in pull boxes to stubs using Klick-it, Zebra or preformed closures.



Figure 38: Types of Closures

Installation and Repair technician must always ensure that the Under Ground drops shield is connected at the NIB and if possible, at the pedestal.

Tii 356

The most common type of station protection is the gas filled fuse less protector. This style replaces legacy devices that used carbon modules, rods or wafers in their protection circuits. These carbon module arrestor units are no longer used because they have a tendency to pit or get dusty over time, causing noisy circuits. Also, once they have been tripped by a high voltage incident they must be replaced.

A fuse less protector must be used if the customer has a power company multi-grounded neutral (MGN) or a known grounded community metallic cold water supply.

The module is placed between the tip and ring of the drop and the tip and ring of the inside wire. The module is marked accordingly, and it will provide a path to ground for voltages over the rating occurring from lightning strikes or power line contact with cable pairs. The ground connection remains open on the tip and ring until the over voltage condition causes the modules to trip and direct dangerous current to ground.



Figure 39: TII 356

Loading coils

Loading coils are coils that do not provide coupling to any other circuit, but are inserted in a circuit to increase its inductance.

Loading coils are still used in long cables.

A common application of loading coils is to improve the voice-frequency amplitude response characteristics of the twisted balanced pairs in a telephone cable.

Loading coils inserted periodically in series with a pair of wires reduce the attenuation at the higher voice frequencies up to the cutoff frequency of the low-pass filter formed by the inductance of the coils.

With loading coils of exactly the right inductance, neither capacitance nor inductance dominate: the response is flat, waveforms are undistorted and the characteristic impedance is resistive up to the cutoff frequency.

Loading coils prevent xDSL frequencies, which are higher than voice frequencies, from passing. This is a common fault for new areas getting DSL or TV, and loading coils are normally only used in rural applications.

DSLAM integration

In a multiple dwelling unit (MDU), you may encounter a rack-mounted DSLAM. If so, it should be treated in the same way as a DSLAM at a SAC cabinet, with the feeder coming in and distribution going to individual customers.

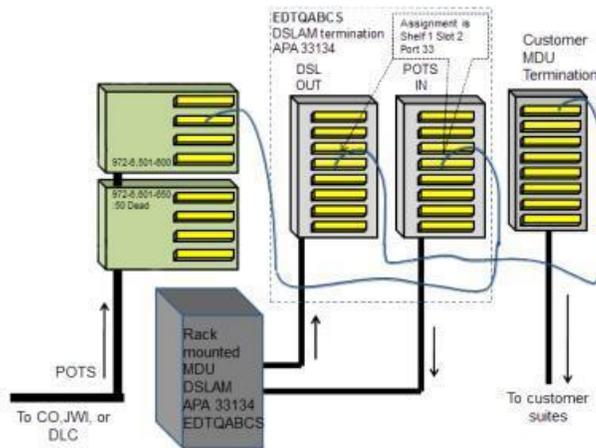


Figure 40: Multiple Dwelling Unit

Vaults

A vault is a concrete enclosure that is normally underground and in the basement of central offices. This is where the outside cables are connected to the inside cables on the frame.



Figure 41: Vaults

Vaults can be anywhere from the size of a small box to a large room. Vaults have been designed for the housing and easy access to telephone and cable-TV splices. Vaults can be very dangerous because of lack of oxygen and their tendency to accumulate carbon monoxide, natural gas and other hazardous gases.

1.7.1 Attaching Drops

Aerial drop types

There are following kinds of drops:

- The black 2 & 6 pair drop – Used mostly in Alberta
- The grey 4 pair drop – Used mostly in BC

For special situations such as small business applications, there are an additional 2 styles that require more lines than can be carried by a normal drop.

Legacy 18.5 AWG black single pair drop, often called old black or liquorish drop, will be encountered across Alberta and BC in legacy neighborhoods. It is not to be used except under specific situations, for instance when customers have only POTS service with no splices. It must be replaced with black 2 or 6 pair or grey 4 pair drops when installing xDSL or TELUS TV circuits. Legacy 18.5 AWG black single pair drop should not be connected directly to SLIC terminals.

2 & 6 pair black drops



Figure 54: 2 & 6 Pair black drop

The black 2 & 6 pair drop is used primarily in Alberta. The color code is the same as the PIC outside plant color code. It uses a wedge type hanger. The jacket can be stripped with the pull string, a stripping can wrench or by "banana peeling".

The wedge type drop hanger (or drop wire clamp) is installed with the cap of the hanger up. This is to minimize moisture collection and subsequent failure due to freezing. A ram's horn type house hook is usually used with the wedge type drop hanger.

Note that the rough side of the spacer tab goes on the drop side of the assembly.

Color Code for 2 & 6 Black pair

Tip colours	Ring colours				
	Blue	Orange	Green	Brown	Slate
White	1 Drop Pair 1	2 Drop Pair 2	3 Drop Pair 3	4 Drop Pair 4	5 Drop Pair 5
Red	6 Drop Pair 6	7	8	9	10
Black	11	12	13	14	15
Yellow	16	17	18	19	20
Violet	21	22	23	24	25

4 Pair Grey Drops

4 pair drop with wrap hanger and “P” style house hook



Figure 55: 4 Pair Grey Drop

The grey 4 pair drop is used primarily in BC. The color code is based on the PIC code (e.g. 1 ring & tip colors, second ring and tip colors). It uses a “wrap on” hanger. It is stripped either with the pull string or by “banana peeling”.

The wrap-on drop hanger is installed by first wrapping on one side of the wire wrap. The second side wrap starts where the black mark on the first side is met with the black mark on the second side.

A “P” type house hook is generally used with the wrap-on style drop hanger.

Color Code for 4 pair Grey

Tip colours	Ring colours					
	Blue	Orange	Green	Brown	Slate	
White	1	Drop Pair 1	2	3	4	5
Red	6	7	Drop Pair 2	8	9	10
Black	11	12	13	Drop Pair 3	14	15
Yellow	16	17	18	19	Drop Pair 4	20
Violet	21	22	23	24	25	

Splicing drop wire

While the legacy 18.5 AWG drop wire was designed to be spliced, modern multi pair drop wire is not. In circumstances where an existing modern multi pair drop has to be extended and replacing the entire drop is not an option (e.g. upgrading a NIB box) the wire may be spliced as long as:

- UY Scotchlok™ connectors are used
- The splice is in a dry weather protected location (e.g. in the NIB) uses “dry spots” from 3M. These are 5 cm x 5 cm (2 inches x 2 inches) black splice points that are attached to a pole.
- The wire used to extend the drop is the same kind as the drop taking care to retain the twist of the extended wire. Do not use jumper wire.

Span Clamp

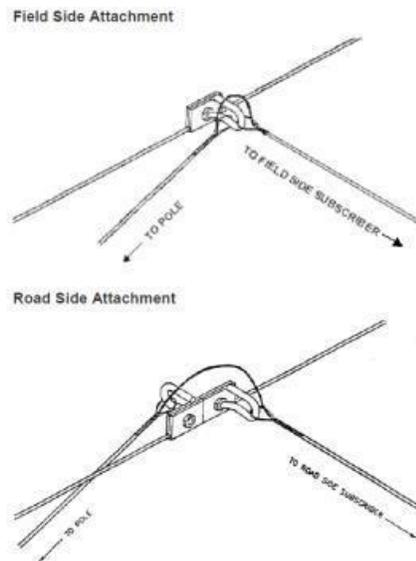


Figure 56: Clamps

Aerial attachment is usually to the messenger. (A messenger is a wire that does not carry signal, but supports signal wires.) This helps ease pole replacement when it becomes necessary as well as reduces climbing hazards.

All network service (drop) wire placed from pole to building will be distributed from span clamps when a messenger is in place.

The network service wire is secured to the messenger at the pole by a span clamp. The span clamp is attached a minimum of 10 cm (4") from the span side of the aerial terminal and 38 cm (15") from the pole on the opposite side of the pole. Bridal rings will be used at the pole.

Drive hooks will only be used where proper road clearance cannot be met using a span clamp. Customers can either be on the field side or the road side of the messenger.

If the proper method is not followed to place the drop, it will get twisted into the messenger and cable when construction crews "over spin" the cable. If this happens, the construction crews will be forced to cut the drop.

Network service wire from a span clamp going to a building on the field side must be attached as shown here in the top diagram.

Network service wire from a span clamp going to a building on the road side must be attached as shown in the bottom diagram. This is achieved by looping the network service wire over the cable before attaching network service wire to a backward facing span clamp.

Drop Placing Caution

Care must be taken when placing drops, particularly over or across roads. If a potential traffic hazard exists, discuss traffic control options with your manager.

Never attach a drop to your body or equipment. Use a break-away clip or better still a hand line to raise a drop.

Always attach and sag the drop to the messenger or drive hook before doing any other work aloft.

Always perform voltage hazard tests when working aloft and before ascending the pole.

Drive Hooks

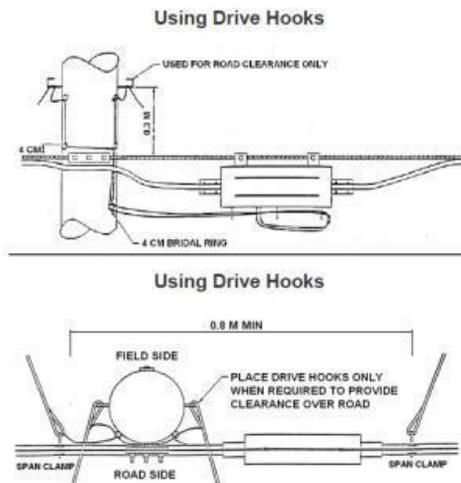


Figure 57: Drive Hooks

The only time a pole is contacted with the network service wire is when additional height is required for road clearance or no messenger exists on which to attach a span clamp. Use drive hooks to contact pole.

1.7.2 Aerial drop routing

Five things need to be considered when routing aerial drops:

- Ground clearance
- Power separation
- Pole to pole spans
- Terminal to premises spans
- Stringing sag

Ground clearance

Aerial trespass over private property must be avoided. In order to avoid aerial trespass, route the wire to the mid-span and put on span clamps. Downhill slopes may cause the customer to be required to provide a clearance pole or mast. Do not sacrifice clearances when running in a service. There are specific clearances for airports, railway crossings, trolley wires and swimming pools.

Power separation

Aerial crossings under power conductors should be as close to right angles as possible.

Telephone plant is never to be placed above power conductors.

It is not permissible to place drop wire directly under primary power; it must be placed below a messenger. Cable clearances are measured from the lowest power conductor at maximum sag and a straight line between telephone supports.

It is recommended that you follow the electrical utility sag and keep at least 0.6 m (2 feet) separation from power at the pole and 0.3 m (1 foot) at the premises, while maintaining ground clearances.

A span of wire can be placed temporarily to the terminal; call facilities and have a new RA terminal installed.

Pole to pole spans

Where no cable, messenger or electrical utility exists, pole-to-pole spans of drop wire must not exceed 60 m (200 feet).

Pole to pole spans of drop wire on private property must not exceed 50 m (164 feet).

Terminal to premises spans

Use of existing drop wire is acceptable. Two, four and six-conductor drop wire should not be spliced. Use a drop wire guard or reroute the drop if trees are in the way. Trimming trees on private property should be limited. The owner is responsible for removing any limbs and large branches.

New drop wire span length between the pole and building must not exceed 45 meters (148 feet). 100 meters (328 feet) of drop wire is provided to the customer with a new installation.

Stringing sag

If a drop already exists, hang the new drop with the same amount of sag, as long as it meets clearance standards. Sagging will depend on the time of year; the warmer the weather the more the drop will sag. Sag clearance is measured at the point in the span closest to the ground. In mid span situation where a ladder is placed on the messenger. The weight of the technician on the messenger will bow the distribution cable towards or from the house slightly. This is important to know if attaching the drop at the house first or cutting and existing drop. The sag will changed once the ladder is removed, either tighter or looser. Caution must be taken if cutting a drop under tension as the tech may get "shot" backwards off the ladder.

Aerial Building Attachment

This particular application is easier to apply since an existing service like the electrical utility can be followed in many instances.

This particular application is easier to apply since an existing service like the electrical utility can be followed in many instances.

Attachment to wood-sided buildings is done with either a “P” style or “Rams Horn” house hook. Attachment to an electrical or telephone mast is done with a mast clamp.

Factors affecting the house contact are telephone location, protector location, wire runs, existing drop wire and electrical service location.

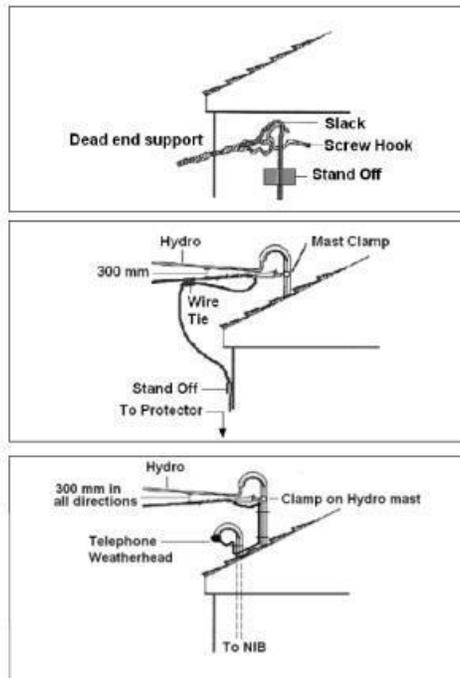


Figure 58: Building attachment

A small amount of slack, which acts as a water drip loop, of 75-100 mm (3-4 inches) should be left and the drop wire secured to the building with a standoff.

Wood, aluminum, vinyl, stucco, brick and stone are all examples of material used for house siding. The difficulty in attaching to some material has led to today's standard request for conduit to be placed when the house is being built.

1.7.3 Attaching Underground Drops

Underground drops or are installed in 3 ways.

- Directly buried from a pedestal, pull box or encapsulated splice
- Placed in conduit from a pedestal or pull box
- Run down a pole from an aerial terminal

Developers normally provide a conduit from the foundation level to the NIB location. The builder should also supply a #6 ground wire and Cat 5 wire from the STB or LB to the customer's power panel. (The STB and LB are 19 or 25 millimeter connectors that protect wire and allow it to be routed at a 90-degree angle.)

The customer must pay the cost of installing additional underground drops. The I&R technician must always ensure that the underground drop shield is connected at the NIB and if possible, at the pedestal.

Underground Drop Installation

You will need to connect 3 wires to the NIB and protector: drop, ground and Cat 5. They run from an STB or LB connector to the customer's power panel. (STB and LB connectors are access fittings that protect wire and allow it to be routed at a 90-degree angle.) If there is no ground wire, either the technician will need to install it. If there is no access available or if the basement ceilings are drywalled, the owner or builder will have to install a ground.

Whenever possible, the CO end of the drop cable should be bonded to the terminal ground.

To install an underground drop, follow these steps:

1. Bring the three wires up through the hole in the bottom of the NIB.
2. Attach the NIB straight and level to the siding. Stucco and brick siding will need special attachments.
3. Attach #6 AWG ground wire to the ground lug in the NIB.
4. Cut down the drop and attach the sheath bond to the sheath. (This will be demonstrated a little later in this course.)
5. Attach the proper #10 AWG ground strap or the green wire from "Y Braid" found on pre assembled NIBs to the sheath bond of the drop. This should be attached to one of the ground lugs in NIB
6. Make sure other end of "Y Braid" is attached to a ground lug on the NIB door.
7. Terminate drop pair to the "CO-IN" side of the Tii 356 protector.
8. Terminate the Cat5 pair to the "Cust" side of the Tii 356 protector.
9. If not already done by builder, use split bolt to connect #6 ground from NIB to customers #6 AWG ground from power panel. Always verify.
10. Dress all wiring neatly and be aware of pinch point of door closing. Sometimes a loose fitting Ty-Wrap is recommended to keep the wires in alignment.

Types of Underground drops

1. Direct buried underground

Direct buried drops are run from pedestals, pull boxes and from encapsulated splices. In direct buried situations, care must be taken to ensure that 30 cm (12 inches) of bonded cable is in the NIB before the bond, to allow for ground bumps and frost heaves, which potentially can pull off the ground connection at the NIB.

2. Conduit enclosed buried drop

Conduit enclosed underground drops run from pedestals and pull boxes. In pull box situations (in BC), the splicer will splice the underground drop into a cable, close the splice, and leave a coil of underground drop for the I&R technician to pull through the conduit to the NIB.

In conduit situations, for new houses you may just have an empty conduit and will have to pull in your own drop at the time of installing. Sometimes the contractor will pre-pull the drop, but this is not always the case. Once the drop is in place, you will have to bond and ground both ends and terminate at the pedestal and NIB.

3. Composite fiber drop

Composite fiber underground drop is a standard cat 5 grease filled drop, with bonding sheath, wrapped together with a 4-fibre tube.

Bond the Cat 5 cable to ground as normal

- Always leave at least 2 meters of the fiber tube coiled in the NIB (6 meters in the pedestal)
- Always place a cap over the fiber tube before working on the cable
- Always place a yellow fiber tag in the NIB when completing your work
- Always follow safe fiber procedures, including:
 - Always wear safety glasses
 - Never touch the fibers with bare hands
 - Always contain fiber trimmings in a "sharps" container

1.7.4 Repair a Buried Drop

There are many scenarios where cable is cut, in these circumstances buried drop repair is required. In this section we'll simulate the buried drop repair experience. Splice kits are used for physical damage, in particular they can be used to extend temporary buried drops (above ground) or repair cut and damaged drops. In this demo we will take a look at splicing 6 pair buried drop using a splice kit.

Process – 6 Pair drop splicing

1. Ring the cable approximately 6" from end. Bend to break the sheath and pull off sheath.

Note – Items 1,2,3 and 5 to be performed on both free ends of drop.

2. Locate the pull string and with needle nose pliers pull open the sheath approximately two inches.

3. Gently pull the wire out of the sheath and with the pliers' flair the sheath to expose the metallic shield.

4. Punch a hole in the sheathing of the drops and attach a "coin stud" or bond clamp between the two flared sheath ends. Tighten with a standard "can" wrench securely.

Note – Brace the connector with your thumb on the opposite side to the turning can wrench, to help prevent the metal cable sheaths from cracking.

5. Remove the plastic shield (Mylar) and string from around the cable pairs, clean and wrap the pairs with electrical tape to provide protection from chaffing against the clamp. Continue to wrap the electrical tape around the end of the cables to keep the tape in place on the pairs and seal the end of the cable. Ensure the coin stud/bond clamp is taped over to prevent possible ground faults

6. Splice the 6 pairs of wires with Scotchlok connectors. Take care not to "split" the pairs. Fold spliced wires towards the bond clamp, but not touching.

7. Insert the two free drop ends into the guide slots of the base of the splice kit. Fillers are supplied for smaller gauge drops. Cut off the clamp arrangement atop the base and discard. Slide the base towards the bond clamp to about one inch or until tight.

8. Screw the top gel filled cap on to the base ensuring it reaches the end of the cap. It is normal and desired for the gel to be displaced and "ooze" from the holes at the bottom of the base.

9. Bind the two drops together below the splice base with electrical tape to keep base in place.

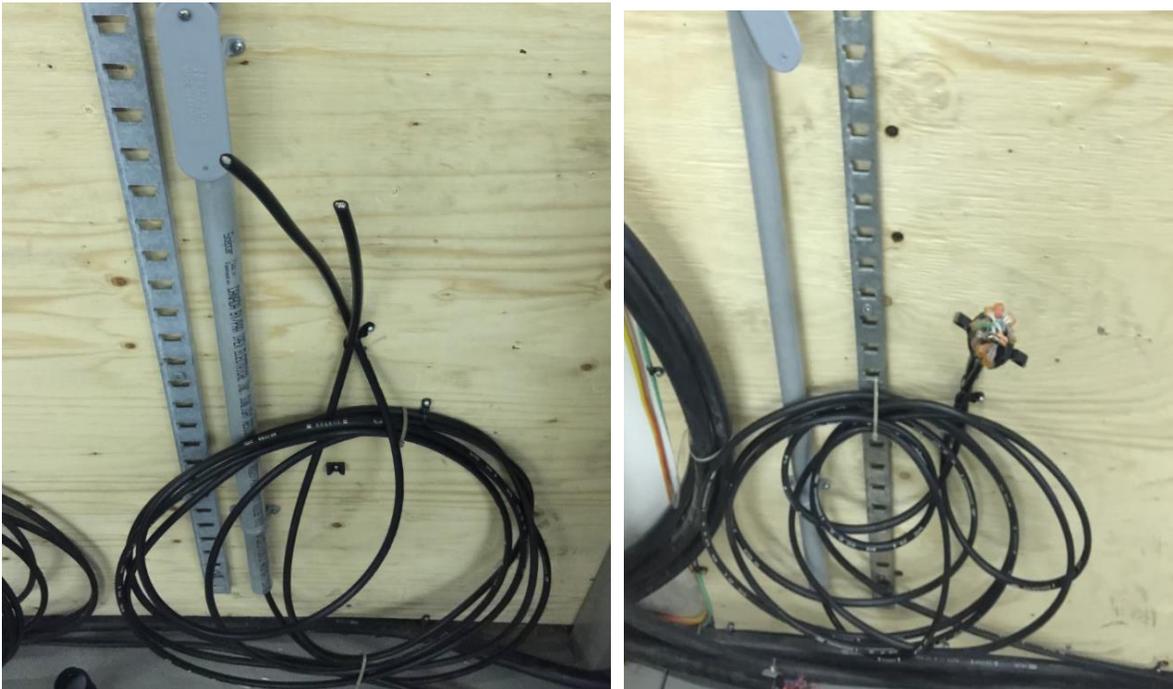


Figure 59: 25 Pair CELFIL Buried wire for BDO Conduit fitting



Figure 60: Series of process for Buried drop



Figure 61: 2 Buried wires spliced for further connectivity

1.8 POTS Splitter

POTS splitters are one of the components used in a basic single-line installation. Although they are only used when a customer has HSIA or TTV service, you may encounter them at POTS-only customer's premises, if the previous tenant did have those services. These are the two currently used by technicians for single-family dwellings:

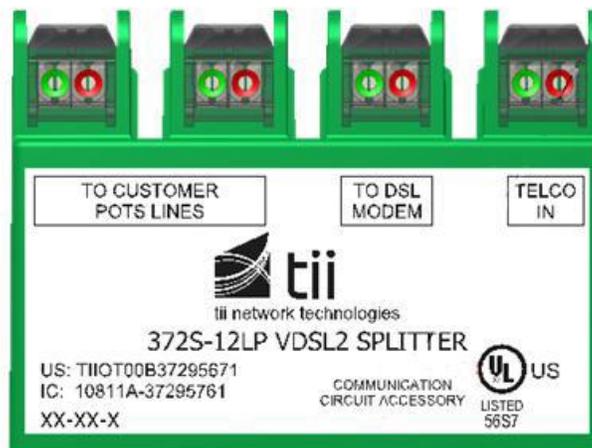


Figure 62: Tii 372S-12LP

Primarily used where the Star Configuration Point is in the NIB.
It is also used in trailer park installations where the NIB is placed on a 4 x 4 post, and the Star Configuration point is at the post.

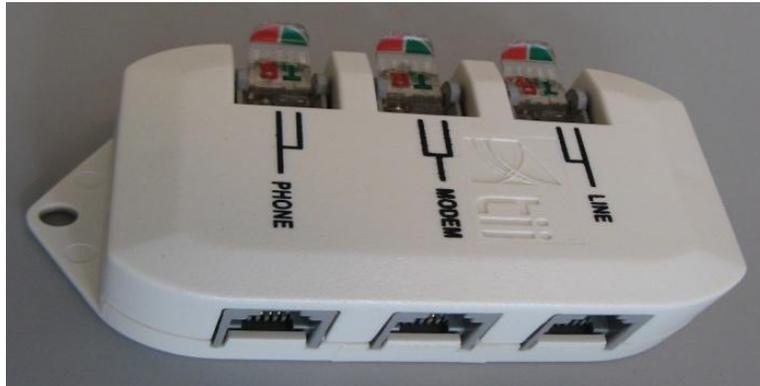


Figure 63: Tii 80-410V-11

1. Used inside the home
 2. Can also be used in small MDUs
- Both are VDSL2 compliant and use insulation displacement connection technology.

1.9 Alarm Jacks

Residential alarms also need to be taken into account for single-dwelling installations.

8 pin shorting jacks in an RJ45 configuration are usually installed by the alarm company. Sometime they will be installed, but not wired. The alarm company may leave a note asking us to wire this for them. They go between the telephone service and the residential alarm equipment.

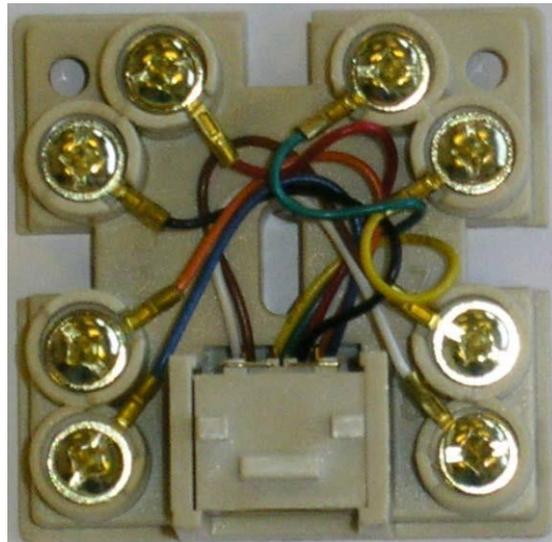


Figure 64: RJ 45 Style alarm Jack

Basic alarm jack wiring

This diagram shows basic alarm jack wiring:

1. Dial tone is on the pair from the protector.

The 8-position RJ45 has shorting bars to complete the circuit even if there is no cord plugged into the jack. This assures that if there is an alarm condition, the alarm panel can have exclusive access to the phone line by cutting off the remaining inside jacks.

2. The alarm jack must be installed after any POTS splitter in the circuit, as seen here.

3. For POTS only service, the circuit bypasses the splitter (as shown by the red dotted line) and continues directly to the alarm jack.

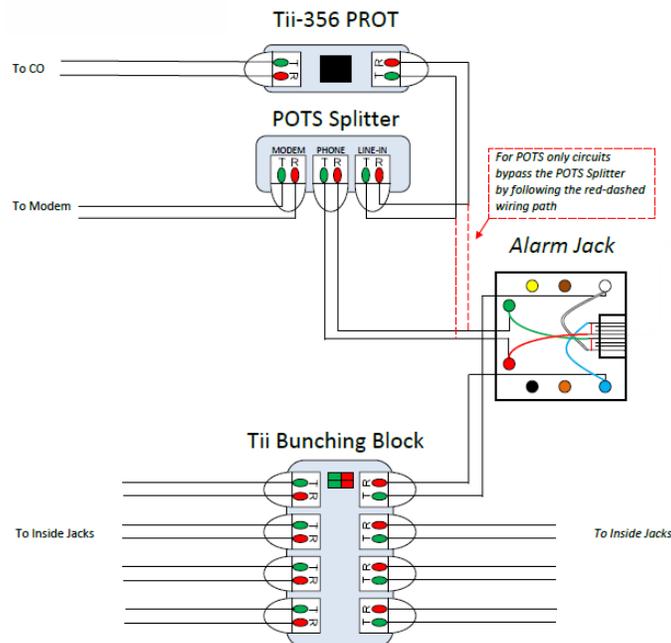


Figure 65: Circuit from POTS to Alarm Jack

Let's take a more detailed look at the alarm jack wiring as shown below.

The alarm jack is the demarcation point between the telephone service and the alarm equipment.

It should be placed before the star connection point.

In some cases, an alarm company may require it in another location; this is not recommended since it may require inside wire to be run back to the star connection point. The greater the length of wire used, the greater the potential for damage, rendering the alarm inoperative.

Alarm demarcation allows service to remain uninterrupted. Dial tone is on the pair from the protector. An internal shorting bar loops the circuit to inside set runs. An alarm plug removes the short and loops the circuit through an alarm dialer. When the dialer activates, it opens a circuit that removes the telephone sets from the circuit, so that any burnt set runs or phones that are off the hook do not prevent the outgoing alarm call. Since xDSL is often impaired by alarm equipment, the xDSL splitter is placed between the 356 protector and the alarm jack, which means the set run to the xDSL modem does not go through the alarm jack. Never plug a telephone jack or banjo into an alarm jack.

MDU 25 in multi-dwelling unit

It can be used as a single module or in multiples of 25 and is located in the MDU main terminal room, or MTR, as seen here.

The MTR, is the cross-connecting point of incoming cables from the telecommunications external network and the MDU cabling system. You will also hear it referred to as the main telephone room.



Figure 66: MDU 25

Tii ISB

The Tii Intercom System Bypass (ISB) module, or ISB, is a solution for interrupt style Enterphone systems, where the customer premises is serviced by a single riser pair, and they subscribe to services such as TELUS TV or xDSL.

The mounting plate, which holds up to 12 modules, is mounted with the entrance protectors and should be mounted as close to the incoming CO, house and Enterphone cables as possible, where enough plywood space is available to accommodate a foot print of 8" (20 cm) wide x 13" (33 cm).

The Tii ISB uses insulation displacement connectors.

When using an ISB, the POTS splitter is placed in the suite. The connections are:

1. Input line – Jumper to the CO Cable
2. Line output – Jumper to riser pair
3. To enter system – Jumper to intercom system input
4. From Enter system – Jumper from intercom system output



1.9.1 Jack Terminations – OLD and NEW

RJ11 Jack

We're going to take a look at some jack terminations now, both old and new. You need to be familiar with the old style jacks as well since you will encounter them in the field.

At one time, RJ11 jacks like the one shown here, were the standard telephone jacks used with all residential telephones. This is the inside wiring of the jack.

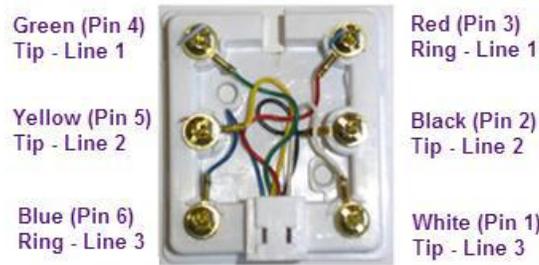


Figure 67: RJ11 Jack

RJ11 mounts

The RJ11 came in flush mount (also referred to as a wall jack) with the profile of an electrical plug plate, and in surface mount (also called base board jacks).

The flush mount was installed in a wall box, “caddy fastener”, or a “mud” ring.

Normally these jacks were installed at the level of the electrical plugs, with the top of the plate about 35 cm (or 14 inches) from the floor.

These jacks also came in “duplex” versions (2 RJ11 jacks) used for xDSL.

Leviton jacks

Leviton jacks are one of the termination types currently used. The jacks are inserts that “clip” into the faceplates shown here. They are considered flush mounted since they mount to an 1104 box installed in the wall during the construction of the building. They can also be surface mounted, using the same inserts as flush mounts.



Figure 68: Leviton Jacks

Wiring standards

For residential data purposes, the standard is T568A. The cat 5 color code and plug pin configuration for this standard are shown below.

You can also see the color code for older wire. In both cases the dial tone goes to the back pair of connectors.

Wire is relatively cheap. Opening walls is expensive.

As a result, it is often best to pull more wire than will immediately be required. This provides the capacity and flexibility for the future needs of the home.

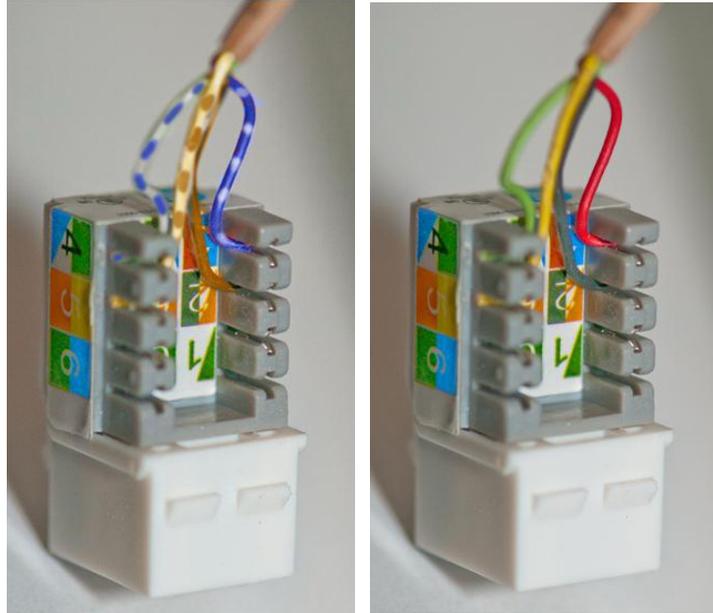


Figure 69: Wiring Standards

1.10 Reviewing Different types of Order

Now that we've covered the components required for installing residential service, we'll move along to the types of orders you'll be working with. But before we do that, to interpret orders correctly, you need to understand the following:

- Class of service codes
- Local number portability

Class of service codes

Various services are offered to customers, but the basic ones are residential and business.

Residential Service is primarily used for normal household, domestic and family purposes. This includes non-profit group homes. Home-based business customers can also have Residential Service as long as the account is not in a business name, the service location is a private residence and the company name is not advertised in the white or yellow pages.

Business Service is used for commercial, industrial, professional, institutional, vocational, governmental, charitable or any other purpose other than that covered by Residential Service.

Common Class of Service codes include:

1. R – Residential Service
2. B – Business Service (Individual & Multiline) not terminating on a key system or PABX (Private Area Branch Exchange)
3. BK – Business Service (Individual & Multiline) terminating on a key system, regardless of supplier
4. PX – Business Service (Individual & Multiline) terminating on a PABX, regardless of supplier

Local number portability

There are three types of LNP:

1. Servicer Provider Portability allows the customer to move from one service provider to another and retain the same phone number.
2. Location Portability allows a customer to keep their phone numbers, when they move outside the exchange area covered by their current central office.

Service Portability allows customers to obtain services that are not available through their central office by securing these services through another switch without changing numbers.

Port out

“Porting Out” refers to a customer moving their service and number to a Competitive Local Exchange Carrier (CLEC).

Port in

- On a port in, the customer retains their number when moving from one location to another within the same exchange (rate centre)
- It allows the customer to have a number that doesn't reside in the host switch serving the customer's address
- Known also as a location port
- The order is assigned with a Location Routing Number (LRN)

Each “portable” switch has an LRN.

Service order types

Service orders contain the customer, plant and equipment information you require for each job assignment. There are different types of service orders for installations, moves, adding jacks, equipment changes and equipment deletions.

As I&R field technicians, your main concern will be with the following order types:

- Installation – a new installation where the client does not presently have service in their name with company
- Change – a change to an existing service
- Repair – a repair to an existing service
- Move – the installation or “to” portion of an order for an existing customer who is moving to a new address
- Batch – an in and out order in the CO; a visit to the customer's premises is not required

These orders are either “fielded” or “non-fielded”.

Fielded and non-fielded orders

With a Fielded Order, an INR Technician must be dispatched to connect the service path; for example:

- No service has existed before at the location
- A second line is be added to the location
- The previous assignment to the location was disconnected for some reason, such as a trouble cut
- A non-fielded order does not work
- To install TELUS TV

Non-fielded orders result when all of the outside service path is still in place from a previous customer or is at a location that is serviced by dedicated plant.

For example, if the following conditions are in place, it is a non-fielded order:

- Only the CO software needs to be updated to provide service
- Only the CO software needs to be updated along with CO jumper work

A Non-fielded order will become fielded as a trouble if for some reason the circuit doesn't work.

2. ADSL

Asymmetric Digital Subscriber Line (ADSL) is a standard for digital communications between client and remote network host. It is asymmetric because the transmission rates for downstream and upstream are different with the downstream rate higher than the upstream rate. The downstream direction is from the service provider to the customer, and the upstream direction is from the customer to the service provider. ADSL generally offers downstream rates of about 512Kbps to 6Mbps. ADSL modems are in widespread use in homes and small businesses for high-speed access to the Internet.

The need for speed at a lower cost is the basic requirement for web connections today due to which ADSL is the way to go. ADSL meets both these requirements offering amazing speed increase at a relatively low cost, to both provider and consumer. ADSL has brought future entertainment to the computer at the same quality and speed as your television and it has paved the way for digital video conferencing and other such applications. However, ADSL does suffer from one major weakness; signal attenuation in the copper, which increases with increasing line length, increasing signal frequency, and decreasing line gauge.

ADSL modems rely on discrete multitone modulation (DMT). DMT divides a broadband channel into many narrowband sub channels and modulates encoded signals onto the narrowband sub channels by using the fast Fourier transform (FFT). In ADSL standards, the lowest sub channels are not used for data transmission so as not to interfere with voice and ISDN signals, and one sub channel is often reserved for a pilot tone. Either each of the other sub-channels carry a QAM signal, or no message, depending on the bit allocation determined by the receiver and sent back to the transmitter. A bit allocation is determined during modem initialization. During data transmission, the receiver can request small changes to the bit allocation table, e.g. as a response to changes in the channel.

ADSL receiver does the following two equalizations:

- Time-domain equalization (TEQ) to shorten the effective duration of the channel impulse response
- Frequency-domain equalization (FEQ) to compensate for magnitude and phase distortion.

The above equalizations are done before a bit allocation table is created.

The various ADSL standards support training sequences during initialization for the purpose of training an equalizer and transmission of synchronization symbols during data transmission which can be used to adapt the equalizer. The bit allocation table can be derived from the equalizer. Equalizer design is the key to maximizing bit rate in an ADSL modem.

The new generation of DMT-based wireline modems has been defined by three standards: ADSL+, ADSL2, and Very High Speed DSL (VDSL) standards. These three standards were approved in 2002 and 2003. VDSL is essentially a higher speed version of ADSL. VDSL provides training sequences to train the equalizer, and uses a cyclic prefix length that is 1/16th the symbol length. VDSL experiences interference from AM radio stations and amateur radio. A VDSL tutorial is available under tutorials. As in ADSL modems, equalizer design is the key to maximizing bit rate in an VDSL modem.

History:

ADSL was started up by telephone company's as a way to compete with cable TV by delivering both TV and phone service on the plain old copper phone line. ADSL was originally designed so that it could still be used as a regular phone line if the power happened to go out. At the beginning only a tiny uplink of 16 or 64kbps was supported now ADSL can support up to ten times that much. The idea for ADSL was spawned by Joe Leichter in 1987, he was a Bellcore researcher and the first idea for it was analog to digital conversion at the subscriber end of an advanced transmission technology over a twisted pair copper line. ADSL was designed to provide megabit access for interactive video (video on demand, video games, delayed TV segments, etc.) and high speed data communications (Internet access, remote LAN access, other network access) but it is also perfect for surfing the web.

In the 1990s, ADSL emerged as a winner for web surfing at home. The only thing missing was the telephone line, so frequency-division multiplexing (FDM) was added to ADSL to reserve a separate 4-kHz POTS (plain old telephone system) channel below the higher frequency data band. ADSL uses a single wire pair. Speeds on

Loop Class	Description	Rate
Class I	6000ft, 26 gauge	6.176 Mbps
Class II	8000ft, 26 gauge	4.632 Mbps
Class III	12000 ft, 24 gauge	3.088 Mbps
Class IV	18000 ft, 26 gauge	1.544 Mbps

Key Points

- A technology that converts existing twisted pair phone line into a high-speed transmission path for data communications
- POTS operates in the 300 – 3400 Hz frequency band
- Simply stated, ADSL is an access technology for services that require high-speed digital transmission. It only supplies access to the Telco’s high-speed network. Where your data goes from there is determined by the SERVICE you subscribe to.
- To achieve high speed though, ADSL modems use all the available bandwidth inherent in twisted pair copper wires, while a dial up modem will stay within the small band of frequencies regular phone lines use.
- Divided into two unequal size bands (Asymmetric)



Figure 71: Upstream and Downstream

How it Works?

- The fundamental of ADSL uses Quadrature Amplitude Modulation (QAM)
- Four points (constellation) in each quadrant
- Uses sine or cosine wave to transmit data as it hits each constellation
- The sine and cosine waves varies in phase and amplitude

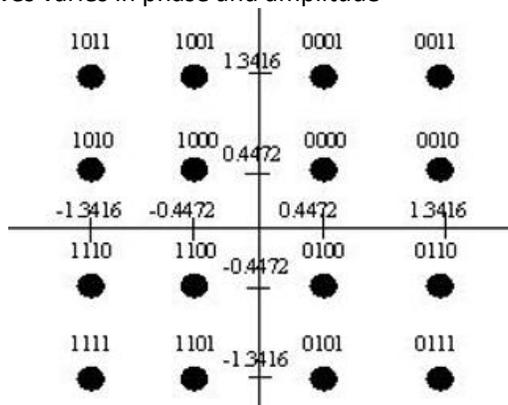


Figure 72: Quadrature Amplitude Modulation

How ADSL Achieve its High Speed

- Efficient Bit Encoding schemes that match the transmission medium and the available bandwidth of the medium is what ultimately determines the speed of a delivery system.
- If you have ONE MILLION CYCLES PER SECOND of bandwidth available and you can vary each one in some manner, you can transfer information on each cycle.
- There are two type of ADSL line encoding schemes, CAP and DMT. DMT has recently been ratified as the standard scheme but there are manufactures who still make CAP systems. Current chipsets now incorporate both schemes as well as G.lite (a derivative of DMT).

2.1 DMT (Discrete Multi-tone Modulation)

- ADSL uses Discrete Multi-Tone modulation which divides the frequency range of copper and divides it into many bins / channels
- DMT modems use QAM encoding. One channel will be designated as a Pilot channel which serves as a reference point carrier for all the other channels to measure received phase angles.

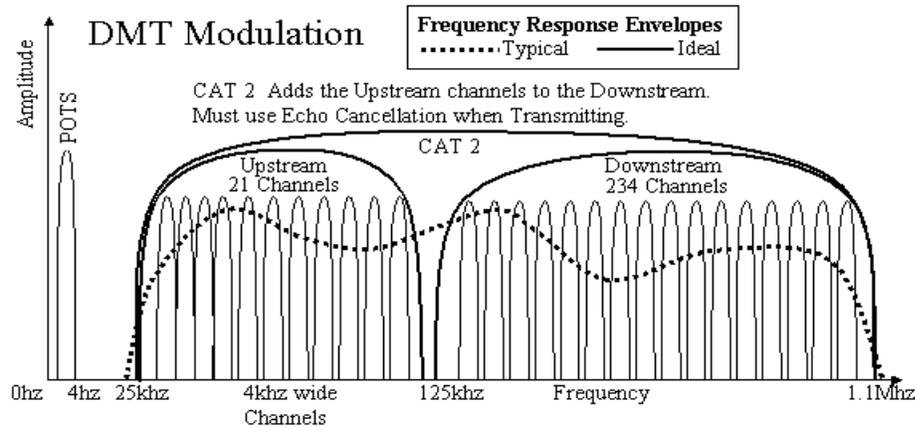


Figure 73: DMT modulation

2.1.1 DMT2

- DMT2 operates from 25 kHz to 1.1 MHz (above POTS band)
 - 255 bins across this frequency band (each bin is 4 kHz wide)
 - 21 bins for upstream
 - 234 bins for downstream
 - Max 15 bits per bin
- DMT2 has a max rate of 10 Mbps

DMT2 Modems are to be replaced with ADSL 2+ modems i.e. DLink 300i, DLink 300g, 3Com Modem to be replaced by Thompson Speedtouch – Modem, Siemens Gigaset SE567 – Gateway, 2Wire – Gateway or D-Link 3810 – Gateway.

2.1.2 ADSL 2+

- ADSL2+ operates from 25 kHz to 2.2 MHz
 - Add another 255 bins for downstream

- 512 bins in total
- 21 bins for upstream
- ADSL2+ max rate is 24 Mbps

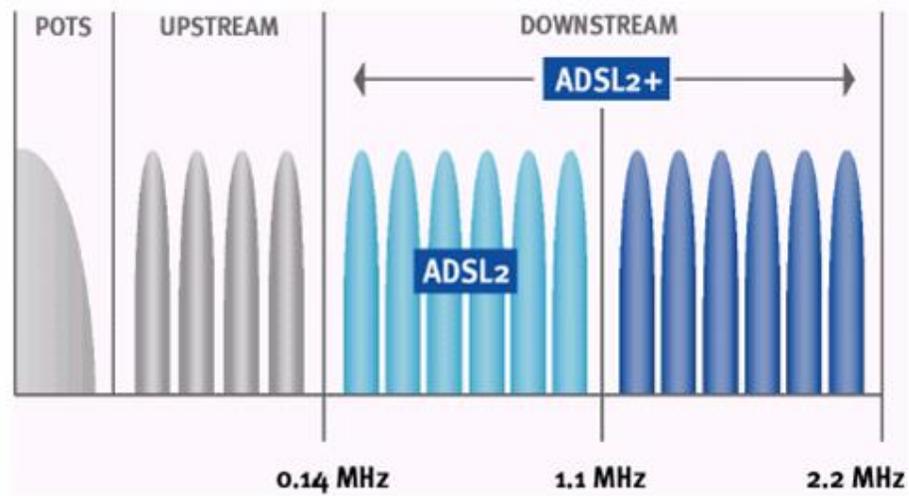


Figure 74: ADSL2+

2.1.3 VDSL2

- Very high bitrate Digital Subscriber Line operates from 25 kHz to 30 MHz
 - More bins
 - 3479 bins in total
 - Each bin is 8 kHz wide
- VDSL2 max rate is 100 Mbps

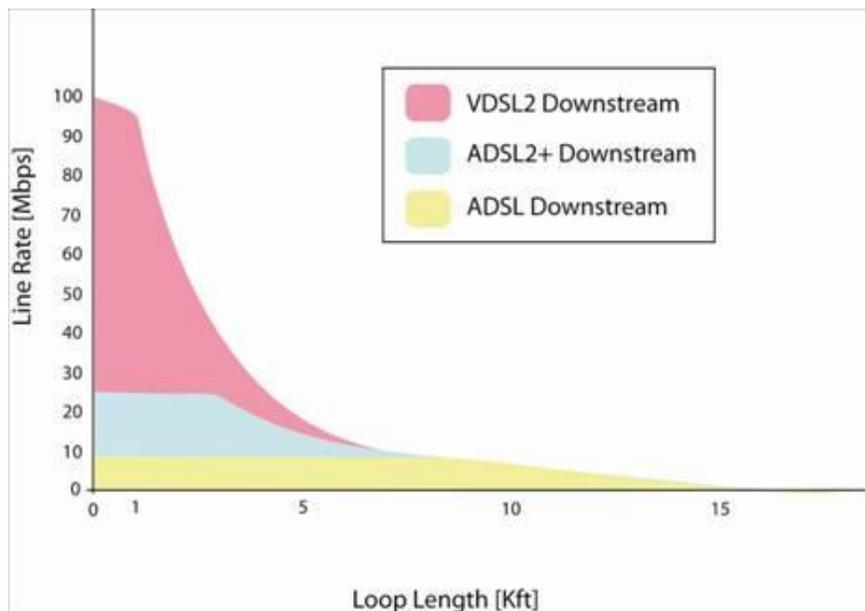


Figure 75: VDSL2

VDSL2 modems are Alcatel Lucent Cellpipe – Modem & Actiontec V1000H – Gateway.

Bandwidth Comparison

	ADSL	ADSL2	ADSL2+	VDSL2 30a profile
Standard	G.992.1	G.992.3	G.992.5	G.993.2
Bandwidth	1.104 MHz	1.104 MHz	2.208 MHz	30 MHz
Line coding	DMT	DMT	DMT	DMT
Bins	256	256	512	3479
Tone spacing	4.3125 KHz	4.3125 KHz	4.3125 KHz	8.625 KHz
Max downstream	8 Mbit/s	15 Mbit/s	24 Mbit/s	100 Mbit/s

Ports

- DMT2 port uses Bay and Unit.
 - Example – Bay 2345 and Unit 5678.
 - If you look in E-fulfillment, then you can find where it is located in the In-Frame/Out-Frame.
 - DMT2 port can be located in the SAC box and these are referred to as Stingers. They would be read as AP3011, unit 12345 (AP stands for access point and 3011 would be your SAC number)
- ADSL2+/VDSL2 port uses Shelf, Slot, and Port.
 - Example – AX3456, Shelf 1, Slot 1, Port 1.
 - If you look in E-fulfillment, then you can find where it is located in the In-Frame/Out-Frame.\
 - AX3456 means the port is located in the Central Office.
 - ADSL2+/VDSL2 can be located in the SAC box and these are referred to as RDAC. They would be read as APA3011, Shelf 1, Slot 1, and Port 1. (AP “A” is one side of the SAC and sometimes you would see AP “B”, and it is the other side of the SAC)

2.2 Inside of an RDAC (Remote Data Acquisition and Control)

- These DSLAM ports inside the RDAC are fed by a Fiber Optic connections from the Central Office.
- Each APA can support 4 SLOTS cards.
- Each Slot can have 48 ports.
- So each APA, APB, or APC can have 192 ports.



Figure 76: RDAC

- There are “In” ports and “Out” ports in the DSL block.
- You must connect Dial Tone to the “In” port.
- Then connect “Out” port to FX/customer.
- The “In” port on the DSL takes the dial tone then injects the DSL (Frequency) on the “Out” port to your customer.
- If you connect the jumpers incorrectly, your DSL will not sync.
- DSL doesn’t require dial tone to work as it is transmitting a signal by itself.
- Blue DSL Ports = Voice
- Green DSL Ports = data
- CO feeds(Green) goes to DSL Voice(Blue)
- DSL data(green) goes to SAC distribution(Blue Modules)



Figure 77: DSL Voice and Data

2.3 Inside of SAC

- To power these DSL equipment in the SAC are powered by DC voltage.
- These Red/Black jumper are coming from the CO and they should NEVER BE TOUCHED!!



Figure 78: High Voltage Red Modules

2.4 Factors affecting ADSL

Crosstalk

Whenever a current flows through a conductor, a magnetic field is set up around the conductor in a direction given by the right-hand corkscrew rule.

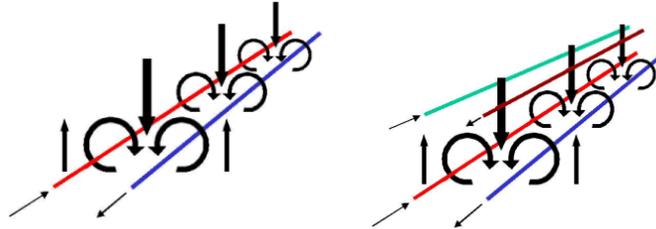


Figure 79: Crosstalk

If we now bring another pair of conductors close to the first, the re-enforcing field created by the currents flowing in the first line cuts through the plane of the new line, and this has the effect of inducing current into the new line.

Attenuation

- Reduction of signal strength during transmission (measured in dB)
- Factors that affect attenuation
 - Distance of cable
 - Temperature
 - Wire gauge
- Attenuation < 65 dB = OK
 - Clear capping helps reduce attenuation

Signal to Noise ratio (SNR)

- Signal to Noise Ratio is the difference between the signal and noise floor
- Measure of usable space between the signal and noise floor across the spectrum (upstream & downstream)
- SNR > 6 dB = OK
- Excellent SNR, Upstream of 13.0 dB and Downstream 29.5 dB

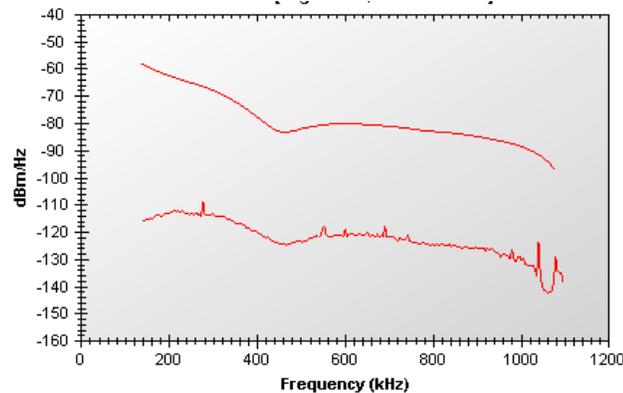


Figure 80: Excellent SNR

- Very poor SNR, downstream 7.5dB, upstream 4.0dB

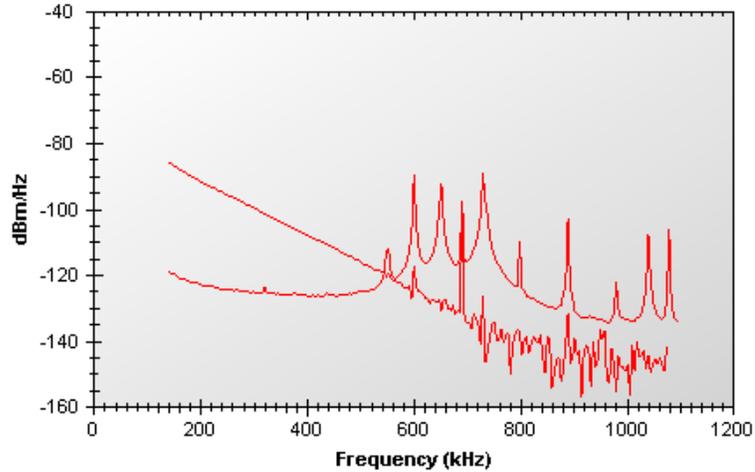


Figure 81: Poor SNR

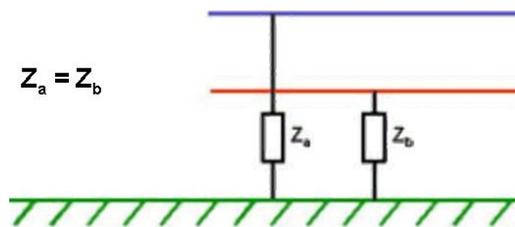
Power Influence

- The measurement of the electromagnetic field from AC power induced into a cable pair
- $PI < 90 \text{ dBrc} = \text{OK}$

Longitudinal Balance

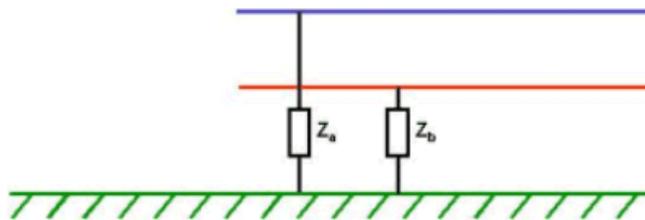
For efficient transmission, the *impedance* (Z) to earth of each conductor must be as near to equal as possible. This is called the longitudinal balance of the line. Any imbalance will cause noise as the “cancelling effect” of a twisted pair is reduced.

$PI - N = LB > 60 \text{ dB} = \text{OK}$

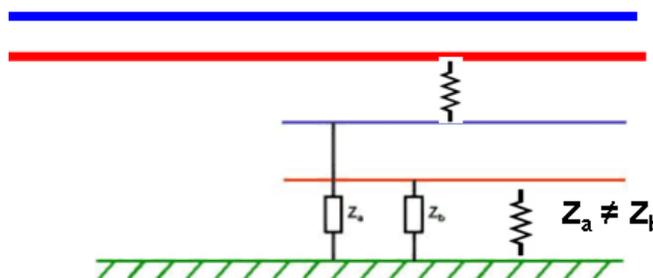


Typical causes of an Imbalanced Cable Pair

- One side of the pair is longer than the other



- One side of the pair is crossed with another wire, or ground



Error Packets

- FEC – Forward Error Correction allows the receiver to detect and correct errors without asking for more data
 - FEC < 500 (after 2 minutes) = OK
- CRC – Cyclic Redundancy Check detects accidental changes to raw data
 - CRC < 10 (after 2 minutes) = OK
- HEC – Header Error Control is a bit error detection and correction
 - HEC < 10 (after 2 minutes) = OK

ERRORS

- FEC'S < 500 Forward Error Correction
- HEC'S < 10 Header Error Correction
- CRC'S < 10 Critical Error Correction

ATTENUATION

- ADSL < 50
- TTV < 32
- HD < 24

SNR

- ADSL > 6 Db
- TTV > 9 Db

Copper Loop Characteristics

- The composition of copper loops may include various elements such as bridge taps (shown below), gauge of the loop, & gauge changes. Each can have an effect on the ADSL signal.
- Bridge Taps and gauge changes may attenuate and/or reflect ADSL signals, and can reduce the rates of the DSL line.

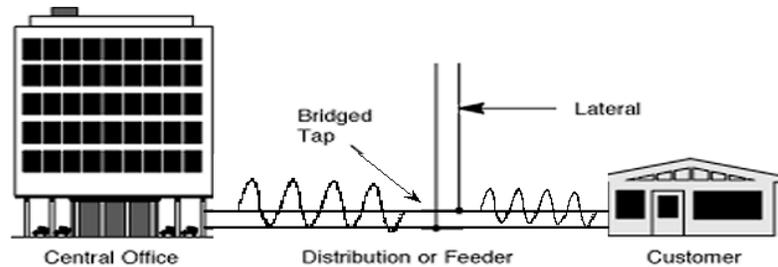


Figure 82: Bridge Tap

2.7 Installation

- All drop cable running from RA/SLIC/QTD terminals must be twisted pair.
- Liqourice cable and Green/Red/Black/Yellow drop MUST be replaced.
- ALL ADSL installs/repairs has to be Clear Cap.
- Pots splitter must be installed for ADSL jobs.
- Bonding and grounding requirements to NIB and underground TM.
- Any customer with an Individual Line account, Residence or Business, new or existing can qualify (some restrictions apply) for the service. When all the qualifying conditions have been met, an installer will be dispatched to the subscribers' premises on an agreed date.
- One modem will be placed inside the customer premise, the other is placed in the Central Office (Rack Mounted).

2.7.1 Loop Bonding

It is the logical bond between two VDSL2 signals or VDSL ports.

- Based upon the ITU-T Recommendation G.998.2 Ethernet-based multi-pair bonding.
- Not restricted to VDSL2 technology.
- Some companies only bond to VDSL2 ports.
- VDSL2 Bonding = loop bonding.

Regardless of where the DSLAM is located, the network requirements are the same.

The primary network requirements for loop bonded installs are:

- Requires two VDSL2 locations within a single DSLAM at the C.O.
- Connected via two copper pairs to the customer's residence.
- VDSL2 signals combined into a modem with a bonding capacity of two telephone signals.
- Actiontec Gateway V2000H.
- Bandwidth management is controlled by the modem
- Both loops must meet minimum requirements.
- Works even if line performance is not identical.
- Important to groom both lines for optimal performance.
 - Certain line impairments cannot be repaired equally.

Basic diagram:

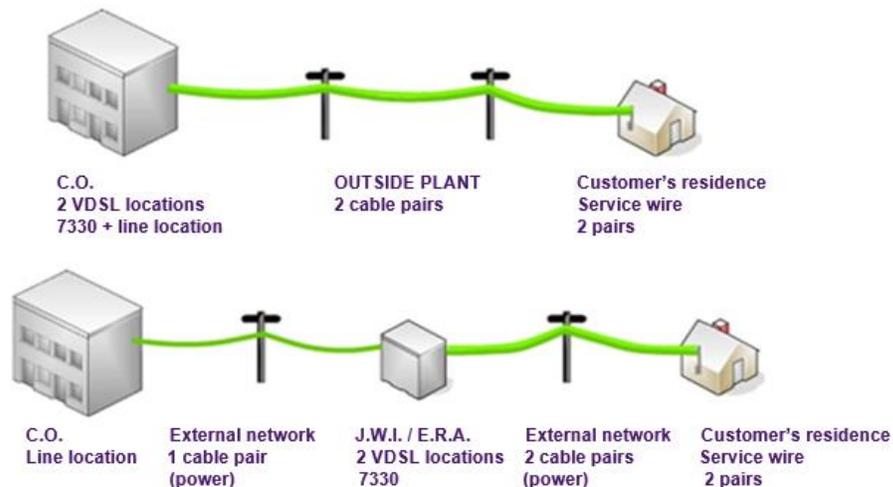


Figure 83: CO to Customer premises

Examples:

ingress, cross talk, impulse noise

The primary network requirements for loop:

- Two VDSL connections be on the same card in a DSLAM.
- If possible, the two pairs of cables should be within the same 25-pair binder.
- The QoS will always be applied to the VDSL master port, which should always be connected to the first/primary line.

The distinction is there to tell you which of the two has the bridge port assigned to it (and thus can't be removed). Yes the master port technically has the bridge port (and thus at the ERX the service profile) attached to it, but at the DSLAM everything references the bonded *group*, not either port, when it comes to the overall service. It just so happens the group is named after the primary port. Therefore, QoS is applied

by the DSLAM at the *group*, not at either port. So if the “master” port goes down, the *group* is still up via the slave port, and thus service continues to work, albeit at a reduced rate.

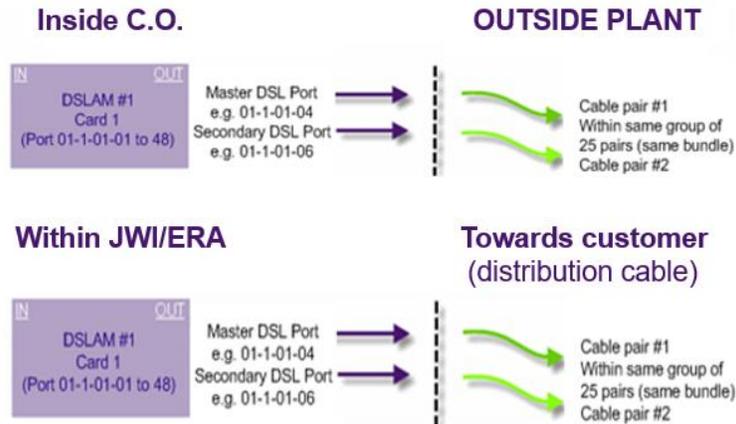


Figure 84: DSLAM Connection

Benefits of Loop Bonding

- Customers who would normally qualify for a 1 HD 2 SD profile will now qualify for a 3 HD 1SD profile
- The increase to the available HD streams that our customers can enjoy greatly enhances the customer experience

The primary network requirements for loop bonded installs

- Optik footprint has expanded significantly.
- Bandwidth restrictions prevent services in some areas.
- Excessive distance from C.O. may require VDSL2 bonding, for a bandwidth of 15 Mbps or more.

List the primary network requirements for loop bonded installs. We will bond customers that qualify with 1HD to get them to 3HD.

Bonding Criteria:

- Customers qualifying for 1HD+2SD will automatically be bonded to 3HD+1SD
- Bonded service qualification is VDSL2 speed 13.8Mbps
- Customers qualifying for 2 HD 1 SD profiles will not be bonded

DSLAM to customer Premise

- Ensure both ports are on the same card in the same DSLAM
- Where available keep both pairs in the same 25 pair binder
- Groom the line for VDSL specification - removing bridge taps where possible and clear capping.
- Make appropriate connections to the terminal. Change the service wire if necessary.
- Inside the residence, install the two VDSL2 lines on two protectors at the demarcation point.
- Correctly label the Master (Primary) and Secondary line numbers at the demarcation point (the connection numbers as noted in the service request).

2.7.2 Premise Equipment



VDSL POTS Splitter



Actiontec V2000H

A VDSL2 POTS splitter and an Actiontec V2000H gateway will need to be installed.

- Install the Actiontec V2000H Gateway and follow this order: VDSL Master Phone Jack #1 / Dry VDSL Phone Jack #2.

During the customer installation, a secondary Comtest POTS splitter is required as a best practice. Correctly label both telephone numbers at the POTS splitter.

Note: The Actiontec V1000H is not compatible with bonded lines as it does not have the input for a second phone line.

Installation Diagram

Installation diagram (inside the customer's residence):

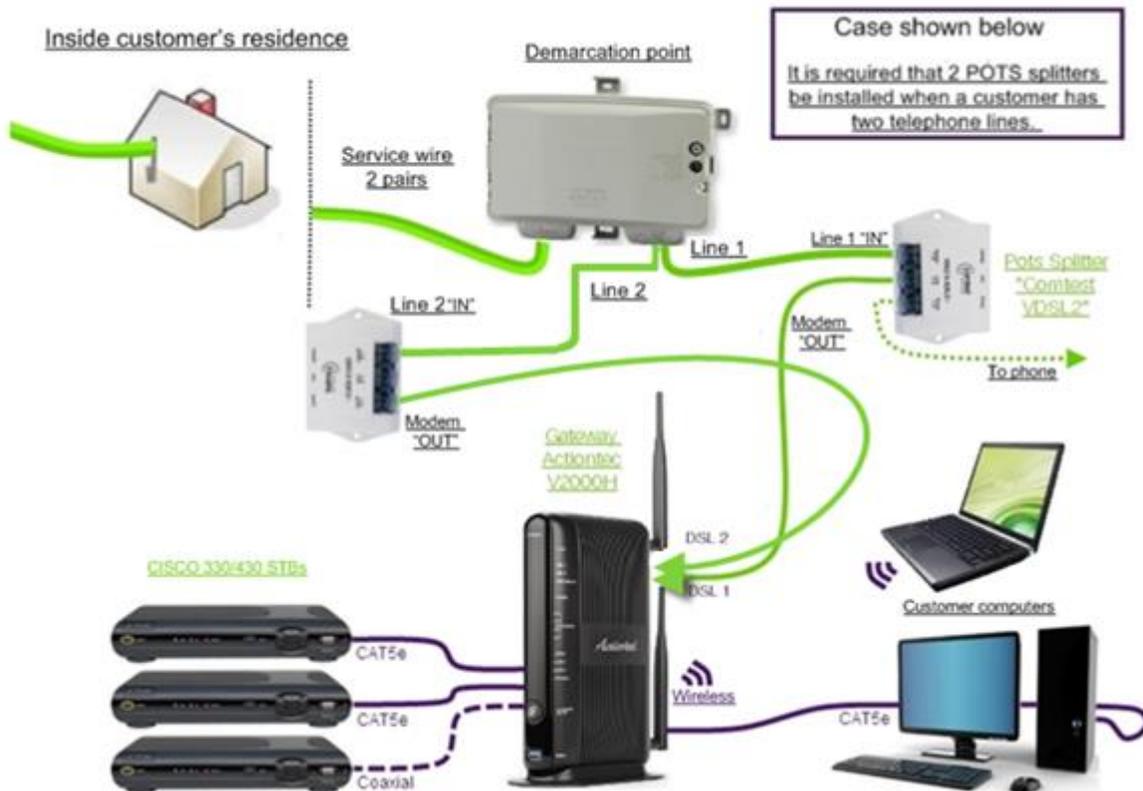


Figure 85: Architecture for POTS, ADSL and IPTV

- Connect the V2000H Gateway's power supply and wait for both VDSL2 connections to sync.
- Once the sync has completed, the modem will restart.
- When both VDSL lights have synched and stabilized, connect customer peripheral equipment (computer, STB) to the LAN.

- Emphasize, if the power light flashes red once the modem is synced, the technician must not unplug the Actiontec device because an internal firmware update will be in progress. Unplugging the device might “brick it” (i.e. it’s as good as a brick).

Insert Image of sync or Image of light status indicators (DSL 1 & 2)

- If one of the two connections fail, Optik TV and internet services will not be completely cut.
- If one of the two lights go off, Internet bandwidth will be greatly reduced (possibility of pixelization)
- Remember: A grouped- pair (bonded) service requires sync on two VDSL2 ports. Therefore both indicator lights (VDSL) on the Actiontec V2000H must be lit for the service to work properly.

Model NO.V2000H 	UPC Code:  0 789286 807878
SN:SVGA2301303957 	H/W Ver: 1A F/W Ver: 31.30L.55 Made In China
MAC: 207600DF23F1 	
Installer Code:  1266188	

Figure 86: Actiontec details

- The Actiontec V2000H boxes are identical in every way to the Actiontec V1000H boxes, other than the model number noted on the labels.
- When stocking your truck, make a notation on the outside of each box to help track your stock.
- Always ensure that you are using the correct model, V2000H for Bonding and V1000H for single line installations and troubleshooting.
- The V1000H model cannot replace the V2000H and vice-versa.

2.7.3 Testing a Bonded connection

- Plug both lines into the Actiontec V2000H Gateway.
- Wait for both lines to sync up (both VDSL1 and VDSL2 lights on the Actiontec will be lit).
- Remove the first line from the Actiontec Gateway and plug it into the NCI-465 tool, keeping the second line plugged into the Gateway.
- Run diagnostics on the first line.
- Plug the first line back into the Gateway.
- Now remove the second line from the Actiontec Gateway and plug it into the NCI-465 tool, keeping the first line plugged into the Gateway.
- Run diagnostics on the second line.
- Testing is complete, ensure both lines are connected back to the Gateway.



Figure 87: NCI – 465 tool

Testing the Modem

Our V2000H modem provides B/G/N in mixed mode, but the customer's PC/MAC wireless card may understand only one of these modes, and thus the speed subscribed to will not be attained.

- B: ~11 Mbps
- G: ~54 Mbps (~30 actual)
- N: ~600 Mbps (~100 actual)



Figure 88: Speed test

Reboot and Verify

1. Perform a system reboot starting with the gateway and working out to all of the STB's and peripherals.
2. If the customer has, POTS ensure there is proper dial tone.
3. Ensure the Internet is working, your connection is hard wired, perform your speedtest then verify with the customer.
4. Set up wireless for/with your customer and ensure peripheral devices are connected.
5. Run KIT, ensure that the 430 and STB's are pulling the correct number of streams based on the customer's profile.
6. Complete the Whole Home Checklist and review with the customer.

In addition, the python script below will reboot the ADSL modem via telnet library

```
import sys
import telnetlib
HOST = "1"
USER = "admin"
PASSWORD = "yourdevicepasswordgoeshere"
telnet = telnetlib.Telnet(HOST)
telnet.read_until(b"Username : ", 8)
telnet.write(USER + "\r\n")
telnet.read_until(b"Password : ", 4)
telnet.write(PASSWORD + "\r\n")
telnet.write("system reboot" + "\r\n")
telnet.close()
```

3. TELUS OPTIK TV

What is IPTV?

IPTV is the transmission of TV signals through packet data networks that use IP addressing. It also comprises of TV and Multimedia Content in Digital Format, IP Distribution Networks and IP Viewing Devices.

Services provided by them are:

- Single Video Connection per TV
- STB Similar to Cable Box
- Media Servers - Unlimited Number of Channels
- Subscription Services
- Pay Per View (PPV)
- TV Advertising - IPTV advertising is the communication of messages or media content to one or more potential customers who use IPTV enabled devices.

IPTV View Devices

- IP Set Top Boxes (IP STBs)
- Multimedia Computers
- IP Television Sets
- Multimedia Mobile Telephones

3.1 TELUS Optik TV Service

- Is delivered to TELUS subscribers over xDSL:
 - Full-rate ADSL 2+ (15Mbps/19.2Mbps) or
 - VDSL (19.4Mbps/26Mbps)
- It is also delivered over GPON and ETTS in selective areas (37.25Mbps)
- Is 100% digital distribution (picture and sound)
- Delivers a maximum of 4 TV streams concurrently
- Can support up to 6 Set Top Boxes
 - each set top box can display one of the 4 streams
 - each set top box can be linked to multiple televisions

OPTIK TV includes:

- Standard Definition Television broadcasting
- High Definition Television broadcasting
- Personal Video Recorder (PVR)
- Pay Per View (PPV) programs
- Video On Demand (VOD) services
- Music services
- Local radio stations
- Interactive Programming Guide



Figure 89: HD STB CIS 330(Left) and HD PVR CIS 430(Right)

The Cisco CIS430 HD / PVR Set Top Box has both SD and HD as well as PVR capabilities:

The Cisco CIS430 HD / PVR Set Top Box offers customers the convenience to record their favourite shows to watch on their time and at their convenience.

Allows customers the ability to pause, rewind and fast forward live TV without needing additional hardware.

3.1.1 Optik TV STB

- A digital set top box is required for each TV in the customer's home in order to access the TELUS TV service.
- For OPTIK TV, a maximum of 3 streams are available on a circuit using an ADSL 2+ or VDSL port on a 15/19.2/ or 19.4 Meg service,
- 4 streams are available for VDSL 26Meg or GPON and ETTS.
- In all applications a maximum of 6 STB's can be supported on each circuit
- Additional TVs may be linked to each STB that would be able to view the same channel which is called multicasting.

3.1.2 Optik TV Features

- IPTV solution using various access technologies (ADSL, ADSL 2+, VDSL, GPON, ETTS)
- 100% Digital distribution: All channels and services are in digital format.
- Customer flexibility: Customers choose the channel packages they want to subscribe to.
- Order PPV and VOD directly from your TV.
- Parental Control: Ability to manage what your children view on TV whether you're there or not.
- 48 Hour Access: TELUS VOD enables you to watch what you want when you want.
- View content from the time zone of your choice.

3.1.3 Optik TV Content

TELUS OPTIK TV receives content from the following types of providers:

- Local television stations
- Local radio stations
- Satellite & fiber feeds from bulk providers like Bell Express Vu
- Galaxie music stations from CBC
- Required Content: The CRTC and economics dictate what must be included in the basic package. (Essentials package)

- Discretionary Content: Customers have the choice of TV channels that appeal to them. TELUS offers packages (pre-selected groups of channels) that allow customization based on customers desires.

3.2 Wireless settings

Coverage Conditions

Use the following coverage considerations to ensure all customers receive excellent wireless coverage in their homes.

- Wherever practical, locate wireless gateways near where customers use their devices the most.
- Avoid locating wireless gateways inside metal smart panels, or where large metal objects will block the signal (furnaces, water tanks, duct work, metal support beams, other appliances)
- Avoid locating wireless gateways near devices that cause a lot of wireless interference (Television sets, microwave ovens, other wireless transmitters)
- Wireless signals propagate outward from the sides of the antennas, ensure that the sides of the antennas, and not the ends, are pointed towards the wireless devices trying to use the network. Signal strength decreases significantly just by turning an antenna sideways. For best signal radiation and the best chance of matching the receiving antenna's orientation, orient the antennas on the gateway 90 degrees off from each other. (for a gateway in horizontal orientation, angle the antennas upwards and off to each side at 45 degrees from the vertical, for gateways in the vertical orientation place one antenna vertical and the other horizontal)
- Verify network coverage using a tool such as InSSIDer in each of the locations the customer uses their wireless devices the most and aim for a signal strength of >-70db in each of those locations. Relocate the gateway, or adding extender as required.
- Wherever possible, hardwire stationary devices (desktop computers, IPTV devices, smart TVs, etc)

Settings

- The default wireless mode is "compatibility mode (802.11b/g/n)" unless customers have very old wireless devices they probably do not require the "b" mode, a better setting is "balanced mode (802.11g+n only)"
- AES encryption is faster, and more secure, than TKIP, setting to "AES" rather than "TKIP" or "both" can improve speeds and security
- WMM Power save has some compatibility problems with certain specific devices. Disable this feature to help with wireless reliability
- Always ensure that the gateway has the latest firmware (v31.121L.13 or newer for V1000)
- Leave the gateway set to automatically choose the best wireless channel; this will help the gateway better deal with future changes to wireless conditions in the area. The exception is if it is proven that it is not selecting the best channel, or if the best one at the gateway location is not the best one where the customer's devices are located. Verify this with InSSIDer before making any changes to this setting.

Customer Expectations

During the installation, it is necessary to set some expectations with the customer. Educate the customer to ensure they understand the potential limitations of wireless Internet.

- Inform customers that wireless speeds cannot be guaranteed, and will often be lower, and less consistent, than hardwired speeds. TELUS will make best effort to ensure speeds are 75% or more of the plan rate. (test using the TELUS server at <http://www.speedtest.net> on the customer's device in a commonly used location where possible)
- Advise customers that wireless is susceptible to interference from many things, including, but not limited to:
 - Baby monitors

- Cordless phones
- Wireless alarm systems
- Microwave ovens
- Other wireless networks (even those in other buildings up to a block away)
- Where a wireless extender has been installed, customers should be aware that using the 5GHz network will generally enable higher speeds than the 2.4GHz connection, especially for those on higher speed plans
- Devices may not automatically switch between the Gateway and the Wireless Extender if the customer moves after connecting to the device. If they move to a new location within the house they may need to disconnect, And re-connect to the network to get the best signal.

3.3 Configuring the Actiontec Wireless Network Extender

This document will outline the initial set up for the Actiontec WCB3000N Wireless Network Extender; this includes connecting to the gateway, logging into the extender and configuring the extender.

3.3.1 Connecting the WCB3000N

There are two primary ways to connect the Wireless Network Extender. The methods below are listed in preferred order:

- Zero-touch auto-configuration with an Actiontec V1000H/V2000H/T1200/T2200 gateway (only available with Phase 2 firmware v31.121L.12 on the V1000H gateway or v31.122L.11 on the V2000H). Phase 2 firmware is now available in SyNOPsis so you can manually push the latest version of the software to the gateway using the “Update Firmware” button in the Modem Details section prior to connecting the extender
- WPS configuration with Actiontec Gateways

Process – Zero-touch auto-configuration with an Actiontec V1000H/V2000H/T1200/T2200 gateway

1. Before plugging the power into the Extender, use an Ethernet/Cat5 cable to connect one of the LAN ports on the back of the Extender to a LAN port on the back of the Actiontec gateway.
2. Plug one end of the power supply in the power port of the Extender, and the other into an available electrical outlet.
3. Wait approximately 90 seconds, during which time the Extender performs an “automatic configuration” and acquires the same wireless SSID and password settings as the Actiontec gateway.
4. If applicable, scan for networks with the wireless device, or log in to the GUI of the Extender to confirm that the settings have been configured correctly.

Note - When the “Auto-Configure” checkbox is active on the Extender, any changes made to the Actiontec gateway will automatically propagate to the Extender. If “Auto Configure” is left unchecked, the Extender can be manually configured with any desired SSID or password

Process – WPS configuration with Actiontec gateways

The WCB3000N Wireless Network Extender is designed to automatically configure itself with the user’s existing wireless settings, however if this is not successful you can force the automatic configuration using WPS.

1. With the gateway plugged in and operational, place the Extender in close proximity to the gateway and power it up by plugging in its power cord.
2. Connect the Extender and gateway via an Ethernet cable.



Figure 90: Steps for configuring wireless extender

3. Press the WPS button on the side panel of the Extender for more than 8 seconds. Once you release the button, it will start flashing with a red ring.



4. Within 2 minutes of performing step 3, press the WPS button the front of the gateway for two seconds. It will start flashing.



Note - Actiontec V1000H WPS button flashes green and red; V2000H flashes green only

5. Wait for the process to complete. If the pairing is successful, the WPS button on the Extender will be illuminated with a green ring.



Note - If unsuccessful, the WPS button on the Extender will continue to flash with a red ring for two minutes then it will be illuminated with a red ring. If this occurs, unplug the devices from each other and perform this procedure again.

If the two above methods fail, the Wireless network extender can be configured by logging into the extender's GUI. Using this method the WCB3000N Wireless Network Extender is powered up and connected to a gateway via Ethernet cable, allowing the device to receive a dynamically assigned IP address from the gateway. Using this IP address, the technician will then be able to access the Extender's GUI.

1. Plug in the Extender's power cable and power up the device.
2. Connect the Extender to the gateway via an Ethernet cable.

3.3.2 Telus Actiontec V1000H/V2000H/T1200/T2200 GUI:

Navigate to the Gateway's Home screen by entering "192.168.1.254" in the address box of a web browser. In the Home screen, the Extender's IP address will appear under "Home Network." You can identify the extender by the "WECB-XXXX" name in the list of devices.



Figure 91: Web browser Login

Open a new tab in the web browser and enter the Extender's IP address in the address box. The Extender's Password screen appears. See the "Logging In to the WCB300N" section of this guide to determine the Extender's password.

3.3.3 Logging into the WCB300N

To log in to the GUI of the Extender (firmware 0.16.2.3 or higher) for the first time:

1. Open a new tab in the web browser and enter the Extender's IP address in the address box.
2. The Extender's "Login" screen appears. Enter the Extender's username (default is "admin") and password in the appropriate text box. To find the password, locate the label on the back of the Extender.

GUI Username:admin
 GUI Password:XXXXXXXXX
 2.4G Wi-Fi Network Name: TELUS0005-2.4G
 2.4G Wi-Fi Network Key: WWWWWWWWWWW
 5G Wi-Fi Network Name: TELUS0005-5G
 5G Wi-Fi Network Key: WWWWWWWWWWW

S/N: CWGA3190100001 MAC: 00180100254A

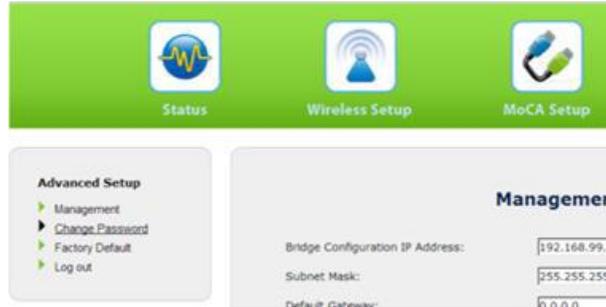
Figure 92: Logging into WCB300N

3. Click OK. The Extender's Home screen appears.

3.3.4 Changing the default Username and Password

After logging in to the Extender with its unique 8-character password for the first time, the GUI username and password can be changed.

1. From the Extender's Home screen, click Advanced Setup.
2. The Advanced Setup screen appears. Select "Change Password" from the menu on the left.



3. The "Change Password" screen appears. Enter the current password and new password in the appropriate textboxes, and then click Apply.

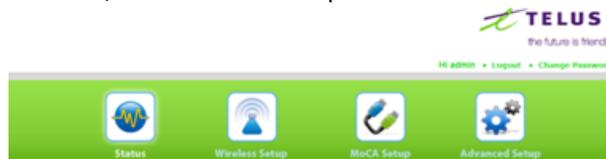


4. Make sure to write the new username and password down and keep it in a safe place. They will be required when logging in to the Extender's GUI in the future.

3.3.5 Configuring the WCB3000N

After accessing the Wireless Network Extender's GUI, the Extender must be set up to provide a seamless wireless network extension. To do this:

1. From the Extender's Home screen, click Wireless Setup



2. The first "Wireless Settings" screen appears. From the menu on the left, select "Wireless Security."



3. The wireless security screen will appear

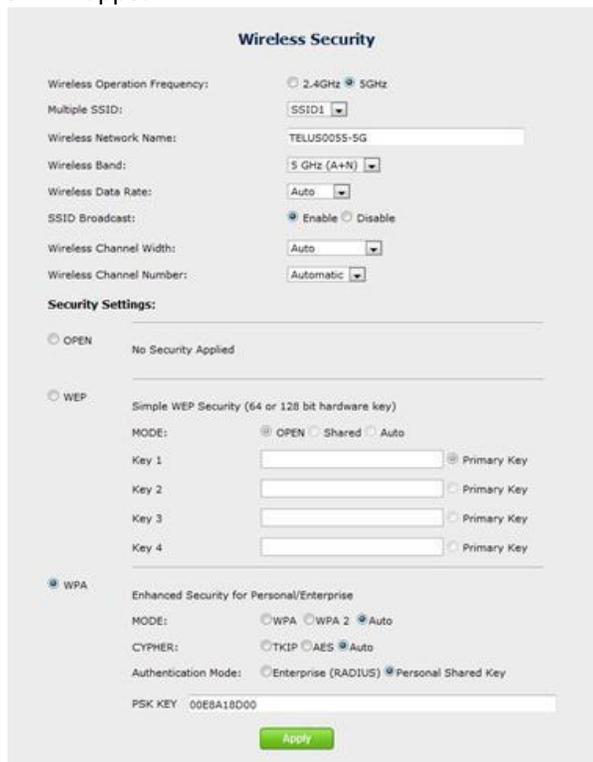


Figure 93: Wireless security screen

4. Enter the SSID name of the gateway's wireless network name in the "Wireless Network Name" text box. It is important that you use the same wireless network name and passphrase on both the extender and gateway to ensure seamless roaming between the two 2.4GHz wireless access points.

5. If applicable, click in the "5GHz" button next to "Wireless Operating Frequency" and enter the SSID name of the gateway's wireless network name in the "Wireless Network Name" text box. You should add "-5G" to the end of the SSID so the customer can differentiate this network from the 2.4GHz range network when looking at a list of available networks on their wireless devices.

6. Click Apply to save changes.

3.4 Wireless STB Setup

The Wireless Set Top Box allows for a flexible setup for a client as well as a way to bypass chronic inside wired issues. The Wireless stb has the same features and functionality as a wired stb.

Key Considerations

1. A wired PVR is required for home functionality
 2. Maximum Wireless STBs per household: 4
 3. Maximum Access Points per household: 1
 4. STBs IP viewable in Gateway GUI
 5. Wifi diagnostics can be run on each STB
- Menu >Settings > General > System Information> enter wifidiag (94343424) on your remote
6. XvU/KIT/TV Tools functions are the same as wired STB's

When setting up the Wireless set top box please follow these steps:

1. Determine the best placement scenario for the access point. Use inSSIDer: Target: <-73dBm.
2. Connect access point to power and wait for the solid light. Then connect access point to gateway. Acceptable Gateways: Actiontec V1000 / T1200 / V2000 / T2200.
3. Ensure Toggle behind Access Point is set to AP not CL.
4. Connect STB to power and connect STB to TV. Wait for connect screen. Press OK button on STB and then wait for single gear splash screen.
5. Press WPS pairing button on Access point within 2 minutes
6. Validate signal strength of STB through RSSI indicators on front of STB. Wireless Signal indicator is located directly right of the Power button. Ensure minimum threshold -73dBm (3 green level indicators). If RSSI is low, check 5GHz band using inSSIDer to ensure it's on highest power band. Reboot Access Point to switch bands if applicable.



3.5 Coax and IPTV

Coax, especially HPNA on coax, can be very susceptible to interference and is a key driver of repeats for TELUS, causing poor video quality and a negative customer experience. With thorough coax troubleshooting and by following best practices, coax is still an effective delivery medium for Optik TV.

Coax should be treated like fiber optic cable or “pipes” used to carry water in a home, sharp bends should be avoided and the coax should never be crushed or dented. If a connector is not installed properly, the signal can be negatively affected, causing signal to flow poorly, just like water flows poorly thru pipes not connected properly.

Avoid the Top 5 Coax Quality Issues

1. Replace all non-compression “F” connectors.
2. Ensure ALL connectors are wrench-tight.
3. Replace suspect barrel connectors – the center must be blue (not clear or white). Remember that connectors will wear out after years of use.
4. Locate hidden splitters and/or splices:
 - A mismatch in cable color and/or type (i.e. white/black, RG59/RG6) between the modem and the jack is clear indication that there is a splice or splitter somewhere. However, this is not definitive, and Coax Clarifier tests should be done on all runs to attempt to identify hidden splitters, or bad splices. Visual checks of the entire cable should also be done wherever the coax cable is accessible (surface runs, unfinished basements, etc.)
5. Run CAT5 to the PVR whenever possible; This reduces HPNA traffic.

Coax Connectors

- Never remove aluminum braid or foil from the coax when installing connector.
- Replace all non-compression “F” connectors. They are the leading cause of issues.
- Ensure the right type of connector is used – RG59 or RG6.
- Connectors with significant ‘air-gaps’ should be changed.
- Connectors should be wrench-tight everywhere in home (except customer’s equipment).
- The F-81 splice (or barrel connector) should never be “spun” on to connector; the connector should be threaded on to the F81 splice to prevent the center conductor from being scratched.
- The signal is transported on the outside of the center conductor. If scratched, it can cause significant signal degradation and will cause some of the signal to reflect back on itself.
- Replace suspect barrel connectors at wall plates. Most are worn out after years of use.
- Ensure length of center conductor is neither too long nor too short. It should be approx. 1/8”-1/4 past the end of the connector.



Figure 94: COAX examples

Coax Ends

Ensure the ends are fully compressed. If the connector isn’t compressed enough, the coax cable is free to move around inside the connector resulting in a loose connection and pixelization.

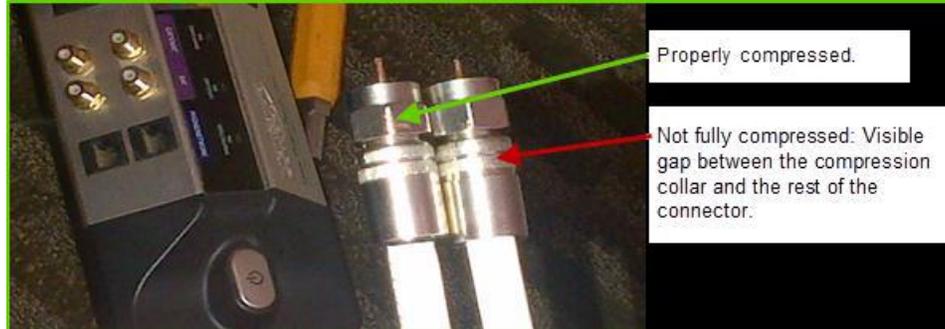


Figure 95: COAX Compressions

Coax Splitters / Splices

- Check for hidden splitters and splices. Investigations into attics and crawlspaces may be necessary. Trace the coax from the modem to the jack (if possible) and look for splices.
- A mismatch in cable color/type (ie. white/black, RG59/RG6) between the modem and the jack is a clear indication that there is a splice or a splitter somewhere.
- Avoid secondary splitters. If a secondary splitter is necessary, don’t install any more than 2 splitters between the STB and the gateway.
- You must use Holland HPNA splitters.
- Use the smallest splitter possible.

Coax Cable

- Consumer/Retail, coax without compression connectors or coax with a clear nylon core should be replaced with anRG-6 foam core.
- Any other coax type is not usable: antenna wire is RG11 w/ 50-ohm impedance.

- Ensure no extreme bends or crushing of coax.
- When toning out a coax line, ensure there is no continuity on the line and when using a toner ensure “tone” is loud & clear.
- Make necessary repairs and retest to check for improvement.
- If a run cannot be improved to a usable condition, replace with cat5e.
- If investigating/repairing the coax will be too time-consuming or impractical, replace with cat5e.
- If the customer indicates they want to move STB locations, ensure the runs are cat5 or the customer is charged for wireless STB.

3.6 BLAST Test (Broadband Loop and Service Testing)

BLAST testing will test the copper loop, frame and network layer components & check the spectrum for interference.

- 2000 test heads installed to date.
- 3 types of test Sync, Non-Sync and DSL Expert
- Sync Test (Green Light): Connects to DSLAM and Customer's modem, tests the frame & network, Obtains IP address, pings address on TELUS network
- Non-Sync (Red Light): Connects to DSLAM & modem, tests the copper loop.
- DSL Expert (Completion Test): Combination of Sync & No-Sync tests.

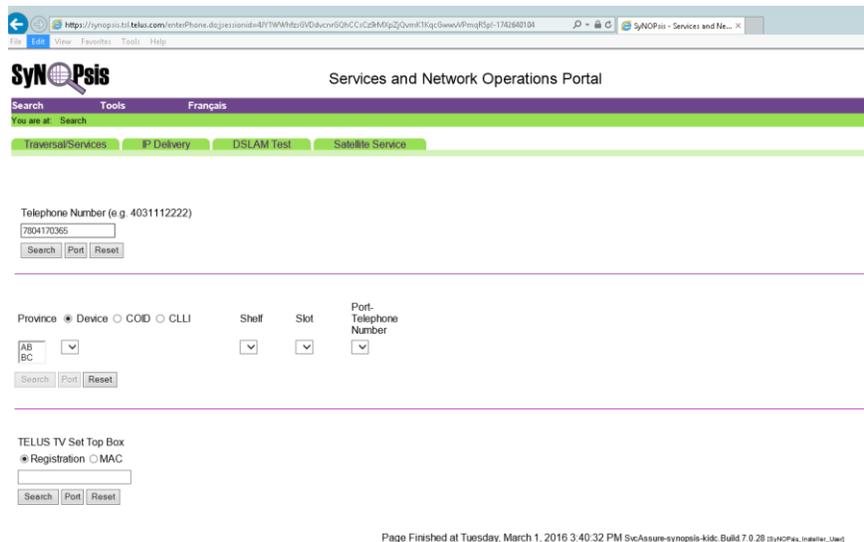


Figure 96: logging into Synopsis

Customer Information				
First Name	James	Last Name	Smyth	
Status	Working	Class of Service	R	
Province	AB	City	SHERWOOD PARK	
Service Info				
HSA Resource Id: 27851135 ADSL Service: TTV HSA 3HD 1SD 15HS Order submitted date: Unavailable Order due date: Unavailable Order Completed Date: 2015-09-05T11:34:33		Service Type Service Id: 7804170365 Service Status: Working Port assigned to ISP: TELUS Order Number: Unavailable Access/Network Type: Copper/CE		
		Trouble Tickets Display Open Tickets Display Closed Tickets Display All Tickets		
Inventory Traversal View				
Element Type	Element Info	Element Details	Trouble Tickets	Alarms / Status
Modem	Model: Actiontec - V1000H	View Details <ul style="list-style-type: none"> View Wireless Settings View Connections View Performance 	N/A	N/A
Access Device	Device Name:SWPKABU0042DS02 Device Type:A7330_ISAM CLLISWPKABU0042 Card Type:EVLTK Port Name:XDSL-1-1-4-16 Port Interface:VDSL VLAN:416 VPI/VCI:Unavailable/Unavailable Trunk Port:null-null-null	The line is stable with good rates Ave. Stability Last 10 days: VERY_STABLE Port Status: IS Modem Type: Unknown Modem Current Speed (Kbps): 51229.0 / 7167.0 Attainable Speed (Kbps): 75112.0 / 14629.0 Output: 9.7 / 9.4 Attn: 14.1 / 15.2 SNR: 18.1 / 13.0 Obtained: 2016-02-29 20:41:37 MST Circuit Tests Check / Display Train Rate	Display Open Tickets Display Closed Tickets Display All Tickets	Display Alarm Information
Routed Edge Device	Device Name:SWPKAB01RE01 Type:Model:A7750 Lag ID:49 Port Interface:GigE VLAN:416 VPI/VCI:N/A / N/A	N/A	Display Open Tickets Display Closed Tickets Display All Tickets	N/A

Figure 97: Inventory Screen

The screenshot shows the Synopsis Services and Network Operations Portal. The main content is a table of test results for DSL Expert Tests. The table has columns for Date/Time, Circumstance, Cable Pairs (CO, Cable, Pair, AP, Type), Test Result Summary, Tested By, and Final Test. The tests are performed by SWPK 12 and SWPK 3013. The results are generally successful, with some failures noted in the Test Result Summary column.

Date/Time	Circumstance	Cable Pair(s)					Test Result Summary	Tested By	Final Test
		CO	Cable	Pair	AP	Type			
2014-10-24 08:19:38 MST	Dsl Expert Test - CSD Repair User	SWPK 12	00384	3013	XCONN	Loop test succeeded, sync to CPE modem was successful, but one or more of the CPE modem sync threshold tests failed. Engage CSD.	x112993	Y	
2015-09-23 11:00:48 MST	Dsl Expert Test - CSD Repair User	SWPK 3013	01079	8531	BUR	All tests passed. If trouble still exists, troubleshoot CPE and customer configuration. Please check detailed results for Bridged Taps.	x179483	N	
2014-10-24 08:06:36 MST	Dsl Expert Test - CSD Repair User	SWPK 12	00384	3013	XCONN	All tests passed. If trouble still exists, troubleshoot CPE and customer configuration. Please check detailed results for Bridged Taps.	x112993	N	
2014-10-24 07:49:30 MST	Dsl Expert Test - CSD Repair User	SWPK 3013	01079	8531	BUR	All tests passed. If trouble still exists, troubleshoot CPE and customer configuration.	x112993	N	
2014-01-27 12:02:11 MST	Dsl Expert Test - CSD Repair User	SWPK 12	00384	3013	XCONN	Loop test succeeded. CPE detected but BLAST unable to sync to CPE modem. Investigate and power reset (do not factory reset!) modem and retest. If error repeats, engage CSD.	x134054	N	
2012-04-02 11:10:57 MST	Dsl Expert Test - CSD Repair User	SWPK 3013	01079	8531	BUR	All tests passed. If trouble still exists, troubleshoot CPE and customer configuration.	x134054	N	
2012-01-03 12:53:38 MST	Dsl Expert Test - CSD Repair User	SWPK 12	00384	3013	XCONN	DSLAM sync test failed using service mode of ADSL2P. Engage CCO Tier II to verify provisioning and/or dispatch to DSLAM	x134054	N	
2011-08-11 09:35:37 MST	Video Quality Testing - CSD Install User	SWPK 12	00384	3013	XCONN	TOK - All tests Passed. Execute Poor Video Quality test strategy	x119591	N	
2011-08-11 09:27:34 MST	Dsl Expert Test - CSD Install User	SWPK 12	00384	3013	XCONN	All tests passed. If trouble still exists, troubleshoot CPE and customer configuration.	x119591	N	

Page Finished at Tuesday, March 1, 2016 3:42:43 PM SvcAssure-synopsis-kidd: Build 7.0.28 [SynOpsis_Installer_User] sedm3216 ent.agt.ab.ca

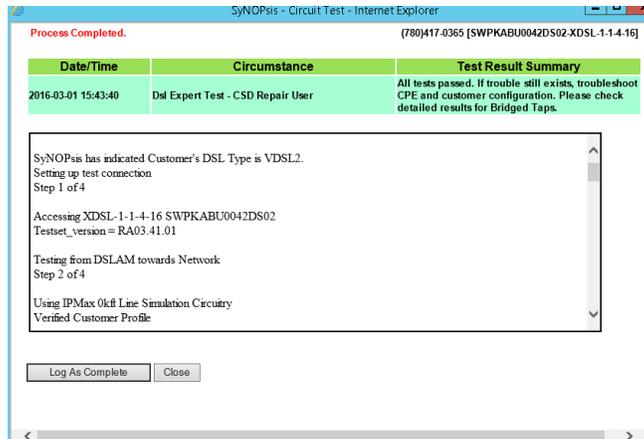


Figure 98: Blast test done in Synopsis

Example of Blast Test done

Telus 3577C DSL Expert System - Revision 1.122
 Test Start Time: 03/01/16 15:50:12

SyNOPsis has indicated Customer's DSL Type is VDSL2.
 Setting up test connection
 Step 1 of 4

Accessing XDSL-1-1-4-16 SWPKABU0042DS02
 Testset_version = RA03.41.01

Testing from DSLAM towards Network
 Step 2 of 4

Using IPMax Okft Line Simulation Circuitry
 Verified Customer Profile

DSL Type = G9932
 Downstream SNR Margin = 13.5
 Downstream Actual Data Rate = 51024
 Downstream INP = 2.0
 Downstream Actual Interleaving Delay = 8
 3577c_profiles_8ms_INP_2_8B_12DB.data

DSLAM Port test passed
 DHCP authentication OK

Testing from DSLAM towards Customer
 Step 3 of 4

NOTE: Uncapped or Unknown DSLAM Port profile was detected during port sync!
 Default 31MB profile will be used for IPMax-to-Subscriber's modem sync test.
 Please check downstream Actual and Max Attainable Data Rates in results.

IPMax-to-Subscriber's Modem sync test was successful.
 Actual Data Rates (Kbps) = 3072 31492
 Max Attain. Rates (Kbps) = 11629 58328
 SNR Margin (dB) = 27.1 15.0
 Actual INP (symbols) = 1.1 3.7

Actual Delay (ms) = 7 8
Line Attenuation (dB) = 13.7 15.3

Loop Estimate

Equivalent Gauge = Generic26AWG
Equivalent Loop Length (meters) = 395
Number of Bridged Taps = 0
Bridged Tap 1 (meters) = N/A
Bridged Tap 2 (meters) = N/A
Tap Search Range (meters) = 5.0 - 261.0
Confidence level (%) = 100

Data Rate Reduction (Downstream Actuals)

Crosstalk (kbps) = 12500
AM and NB (kbps) = 1500
Bridged Tap (kbps) = 0

Estimated Data Rates

(using loop estimate above and -122 dBm/Hz noise floor):

DownStream @ VDSL2 DERQ (kbps) = 65616
IPMax-to-Subscriber's Modem DS SNR Margin of 15.0, is greater than or equal to the threshold of 6db
IPMax-to-Subscriber Modem DS Attenuation of 15.3, is less than or equal to the threshold of 26db
IPMax-to-Subscriber Modem sync rate passed

Metallic Loop Test

Step 4 of 4

DC-Voltage TG -0.0 Volts
DC-Voltage RG -0.0 Volts
DC-Voltage RT -0.3 Volts
DC Voltage okay.

AC-Voltage TG -1 Volts
AC-Voltage RG -1 Volts
AC-Voltage RT -1 Volts
AC Voltage okay.

Resistance TG OR Kohms
Resistance RG OR Kohms
Resistance RT 599.637 Kohms
Resistance okay.

Capacitive Loop Length = 477.3226 m
Capacitive Balance 92.9%
Loop Capacitive Balance okay.
Loop length okay.

No load coils detected.
Subscriber's Modem detected.

Summary Statement=All tests passed. If trouble still exists, troubleshoot CPE and customer configuration. Please check detailed results for Bridged Taps.

Sommaire=Tous les tests complétés avec succès. Si le problème persiste, investiguer le CPE et la configuration chez le client.

Benefits of Blast Test

- Testing can be completed remotely
- Consistent testing approach
- Automated testing using test sequenced dialogs
- Part of service testing roadmap (Reactive > Proactive > Preemptive)
- Results are stored for future reference/ Proactive analysis
- VDSL2 compliant & backward compatible
- MS Media Room Profile compliant; INP & Delay
- DELT (Double Ended Loop Test – AKA Dr. DSL) Blast test results have been implemented to assist in identifying Bridge Taps and / or Crosstalk impairments and to report the data rate reduction caused by these impairments (via Insight).

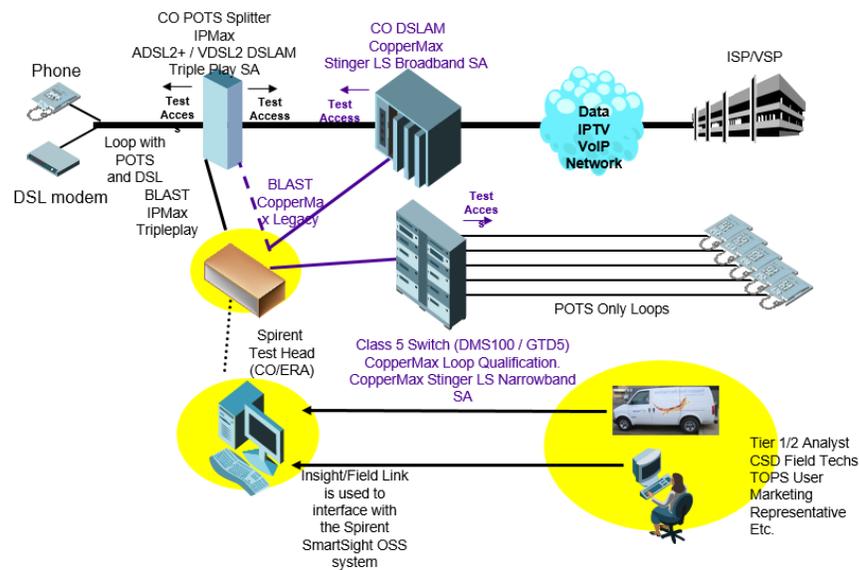


Figure 99: Blast test Architecture

Blast SA Dialogs:

- Provides automation to Spirent Test System via InSight/FieldLink:
- Sync Test Dialog – Broadband Tests
- Non-Sync Dialog – Narrowband Tests
- DSL Expert Dialog – Service Acceptance Tests
- DSLAM Port Acceptance/ Port Recovery (via InSight)
- Video Channel Change Dialog
- Video Quality Dialog – No Audio / No Video
- Video Quality Dialog – Chronic / Intermittent

Video Quality Test Dialogs

Network Broadband & Network Video Diagnostics Tests :

- Emulates Customer's CPE Modem and supports ADSL, ADSL2+ & VDSL2
- Modem Synchronization, Train-up, Rate Adaption and Tone Detection
- DSLAM Vendor Information
- DSLAM Port Test / Sync using Internal IPMax 3kft Line Simulation Circuitry
- DHCP Authentication

- Site IP Pings & Trace-route
- Network Video Channel Change ZAP Time Test
- Network Video Quality MDI Test; Media Loss Rate & Delay Factor

IPMax Facility Broadband & Narrowband Tests:

- Emulates DSLAM Port and supports ADSL, ADSL2+, and VDSL2
- Modem Synchronization, Train-up, Rate Adaption and Tone Detection
- CPE Vendor Information
- Customer’s CPE Modem Sync (Using the Customer’s Profile obtained in DSLAM Port Sync Test; Cap Rate, INP & Delay)
- OAM Test Cells To Customer’s CPE Modem
- DC Loop Current Measurement for ROH Detection
- AC/DC Voltage R/T, T/G, R/G
- Resistance R/T, T/G, R/G
- Capacitance, Loop Length, Balance R/T, T/G, R/G
- Load Coil Detection

3.7 Technician Responsibilities

Basic Phase (before reaching premise)

- If existing customer, run InSight(Telus Metaframe application) and check Last mile and customer profile.
- Make any modifications to the line to maximize the xDSL signal.
- Activate the TTV Port in FITS



Figure 100: FITS Screen (Telus Metaframe)

Phase 1

- Clear Cap the pair
- Replace older, non-twisted drop
- Replace the Protector with the latest standard (TII)
- ALWAYS install a VDSL pots splitter
- If necessary, install new Cat 5 wire from the protector to the router location.
- Perform a Blast test on your circuit and log it as complete.

- Use TELUS provided power bar only - directly to duplex receptacle
- Label ADSL / TV jacks
- Have customer accept "User Agreement"
- Run Speed Test

Phase 2

- Preview the Customer's Existing TV Quality, If customer has a Home Theatre system you will want to check the sound quality as well
- Install STB in first location. (you may want to give the subscriber a brief instruction on the OPTIK TV remote and have them practice)
- Install additional STB's (if required)
- Make sure STB volume is maximum
- Program the remote for TV and Audio Receiver if applicable
- Note Registration numbers on "MY TTV" stickers, place stickers on the STBs and copy into the user manual
- Give Customer basic training and introduce the welcome KIT / PVR manual

Phase 3

- Close with the customer
- Write off the order in Fieldlink (enter work done in comments field)
- Test all services before departure
- (POTS / DSL / TV call display/ Wireless connectivity/ Enterphone etc.)
- Perform Blast (in InSight)
Insight Tool
- A reporting tool providing valuable feedback by CSD technicians regarding TTV Installation and repair activity.
- To reduce the effort required by CSD technicians in providing this feedback on customer, technical and process issues encountered in TTV work that will be accessible to other CSD technicians, Tier II and others as required.
- CSD technicians will fill out checklist on all OPTIK TV Installations and repairs when closing off work upon completion of Installs or Repairs.
- This site can only be accessed via the TELUS Intranet (VPN).
- You can also access InSight from a WRENCH button in Fieldlink right from your service order.
- When accessing the InSight login screen, login with your LDAP User Name and Password



Figure 101: Insight Screen

-

- Session Progress

Session Progress

DSM Status	20:35:59	✔
Connection Health Status	20:35:59	✔
DSM Profile Optimization	20:35:59	✔
Bridge Tap Check	20:35:59	✔
FEC Error Check	20:35:59	✔
CRC Error Check	20:35:59	✔
Outage Check	20:35:53	✔
Migrations Check	20:35:53	✔
IPD Status	20:35:53	✔
IPD IP Status	20:35:53	✔
TISAA Acceptance Test	20:35:53	✔
QoS Check	20:35:53	✔
Lynx Assets TT Check	20:35:53	✔
Abuse Suspension Check	20:35:53	✔
LoopQual Test	20:35:53	✔
Address Comparison	20:35:53	✔
DSL Tone Check	20:35:53	✔
TTV Service Info	20:37:03	✔
Headroom Upstream Status	20:36:54	✔
Physical Disturber Check	20:36:54	✔
Sync Connection Status	20:36:54	✔
Train Rate Status	20:36:54	✔
Headroom Downstream Status	20:36:54	✔
IPD IP Status	20:36:54	✔
Modem Plan Check	20:36:54	✔
Modem Code Check	20:36:54	✔
HDM Connectivity Status	20:36:54	✔
Modem Managed By HDM Check	20:36:54	✔
Modem Firmware Status	20:36:54	✔
MAC Address Filter Check	20:36:54	✔
Gateway IP Address Check	20:36:54	✔
Wi-Fi On/Off Check	20:36:54	✔
SSID Broadcast Check	20:36:54	✔
Gateway Serial Number Check	20:36:54	✔

DSL Equipment

In Frame	Out Frame	Bay/RR	Shelf	Slot	Port	Unit	Model
MDF 001AH	MDF 001AH	APB3013	1	4	16		ADSL2/FIELD

Line Equipment

In Frame	LOC	SWU
MDF 082FH	HOST 05 0 02 21	001

[Click here to view DSL Express for this account \(opens in new window\)](#)

Modem Details

General Information		Wireless Information		Performance Information	
Service Plan	TTV H5IA 3HD 1SD 15HS	Wireless On/Off	Enabled	Current Stability	VERY_STABLE
Modem Type	Actiontec - V1000H	SSID Broadcast	Enabled	Ave. Stability Last 10 days	VERY_STABLE
Firmware Version	31.121L.13	SSID	TELUS4545	Retrains (24 hr total)	0
Serial Number	CVGA1451114545	Security Method	WPA/WPA2-PSK AES	Line Code Violations DS (24 hr max spike)	0
Attainable Rates (kbps)	73340 / 14745	Wireless Channel	1	Line Code Violations US (24 hr max spike)	0
Current Speed (kbps)	56318 / 7167	MAC Address Filtering	Disabled	FEC Corrections DS (24 hr max spike)	38
Min Train Rate Threshold (kbps)	9999	Registered MAC	a8:39:44:e4:7f:61	FEC Corrections US (24 hr max spike)	0
Line Attenuation (dB)	14.2 / 15.2	IP Address	108.181.95.249	Errored Seconds (Last Hour)	-1
SNR Margin (dB)	15.9 / 11.9	Theoretical dB Loss	10.32312	Current Speed (kbps) Bonded Port	N/A / N/A
Device Uptime	31 days, 4 hours, 19 minutes, 11 seconds				
Date	2014-11-24 12:21:47				

Figure 102: Insight session with all details

4. Gigabit Passive Optical Network

- Gigabit Passive Optical Network (GPON) is the common name for the ITU-T G.984 standard for bridging the access gap from a customer's home to the CO with fibre.
- GPON is a Point to Multi-Point (P2MP) type of architecture. A single fibre leaves the CO and is passively split in the Outside Plant to feed 32 homes or small businesses.
- GPON provides for throughput capabilities as high as 80 Mb/s downstream – 40Mb/s upstream, and bursting up to a Gigabit per second.
- All services are provided via IP over a high quality of service and secure Ethernet connection.

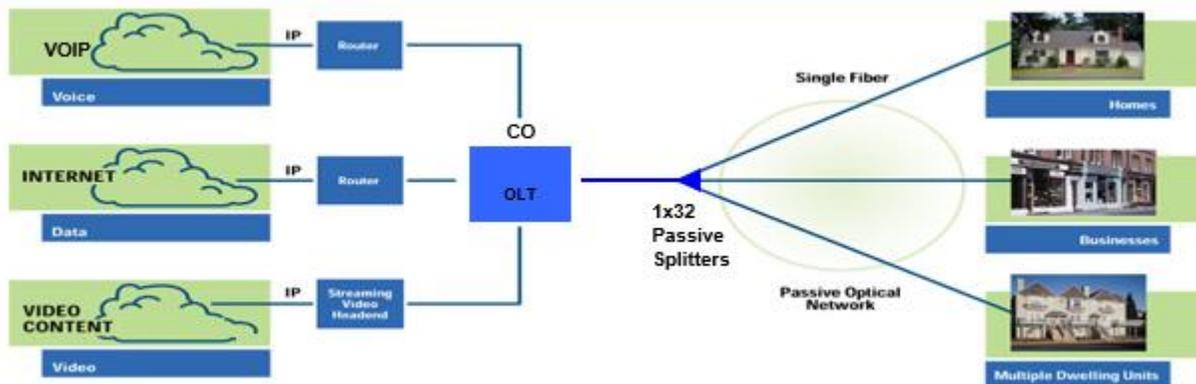


Figure 103: Passive optical network

Access area

- The generic architecture consists of four key locations and three cable sections. The Central Switch Point (CSP), is usually a Central Office, Head End or remote terminal. It may be located on a metro ring or other redundant link to the “core”. The CSP, which serves on the order of thousands of subscribers, contains the electronics that form the provider side of the access network. The feeder cable originates in the CSP and connects to the Local Convergence Point (LCP). The LCP is located in a neighborhood or business park and serves many subscribers. Multiple distribution cables originate from the LCP and radiate into the surrounding service area. Each distribution cable services many Network Access Points (NAPs). The NAP is a closure or pedestal that access some of the fibers in the distribution cable so that drop cables can be joined. The NAP typically serves 4-8 subscribers (but can range up to 24). A drop cable is connected in the NAP and the routed to a Fiber Network Interface (FNI) on the subscriber's premise. The FNI may contain electronics that interface with the subscriber's premise wiring (fiber, copper, coax) or may be a passive interconnect used as a demarcation point (in which case a short cable would run from the FNI to the subscriber's electronics, which may be inside the building).

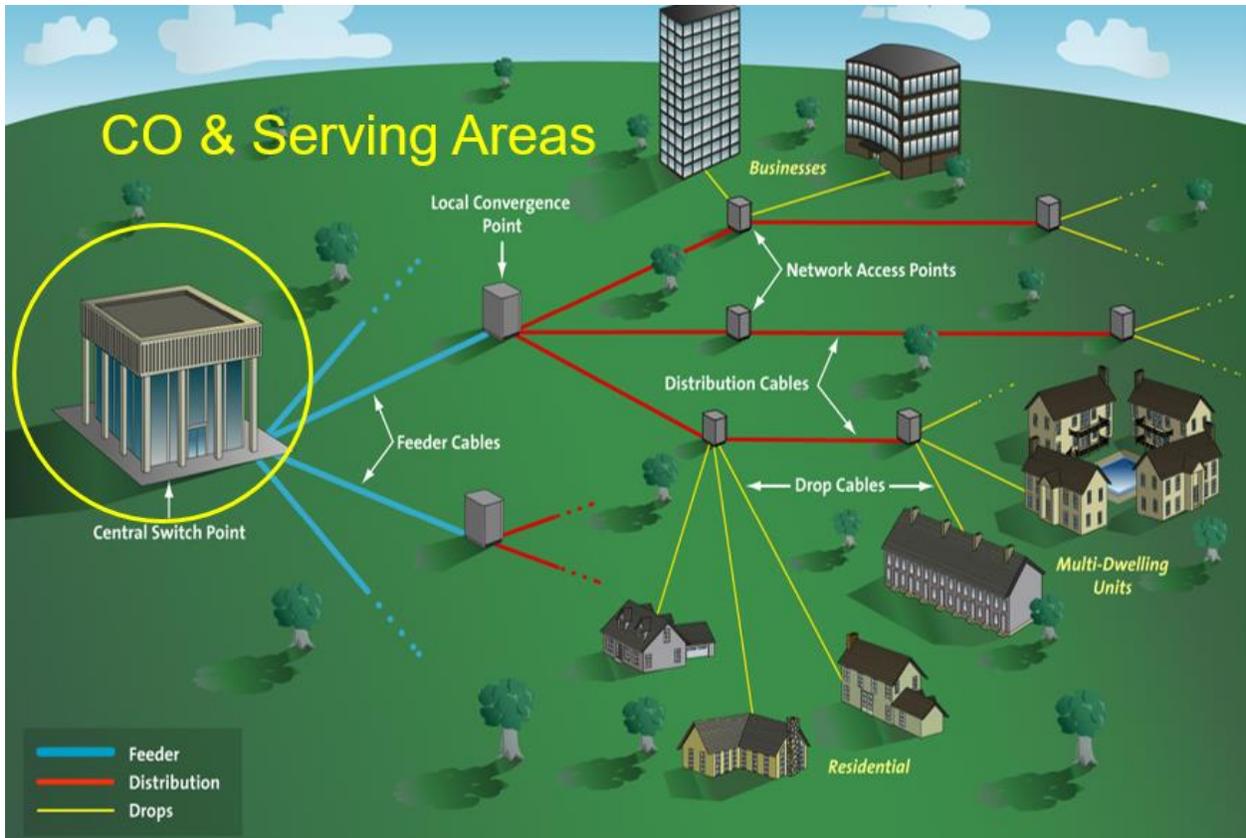


Figure 104: Architecture

4.1 CO – OLT (Optical Line Termination)

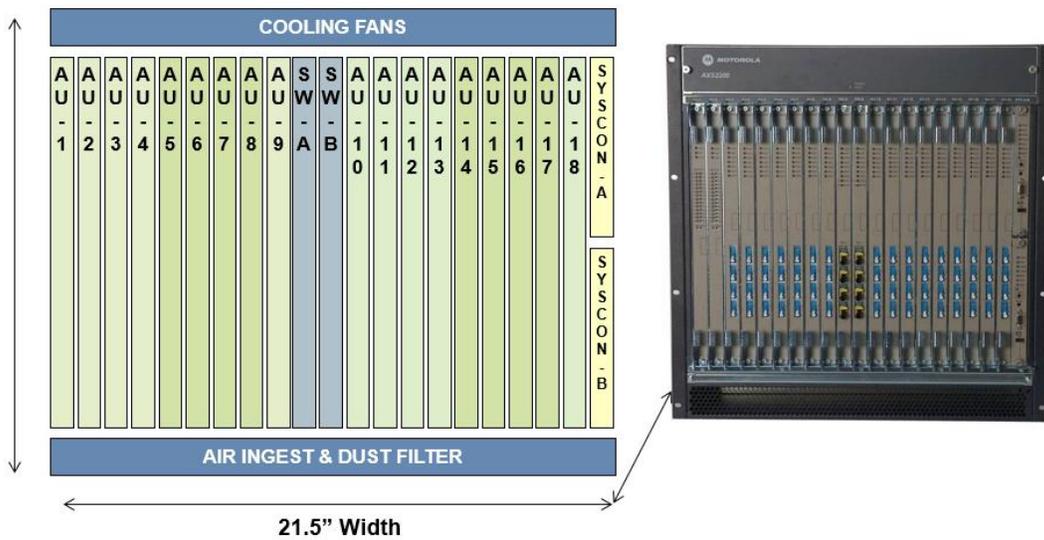
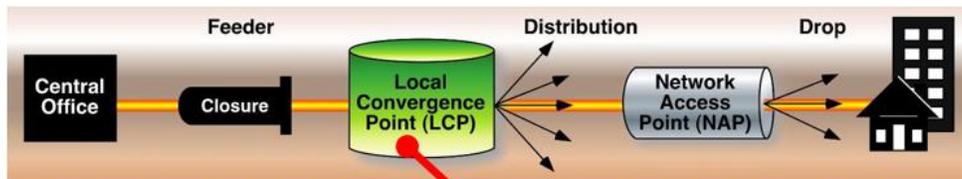


Figure 105: Optical Line Termination

Local Convergence Point (Splitter Cabinet)



OptiTeC Gen III Cabinet - Splitter Module (288 fibers) | Photo CC0112



OptiTeC Gen III Cabinet (432 fibers) | Photo CC0130

Figure 106: Local Convergence Point

Strands distribution

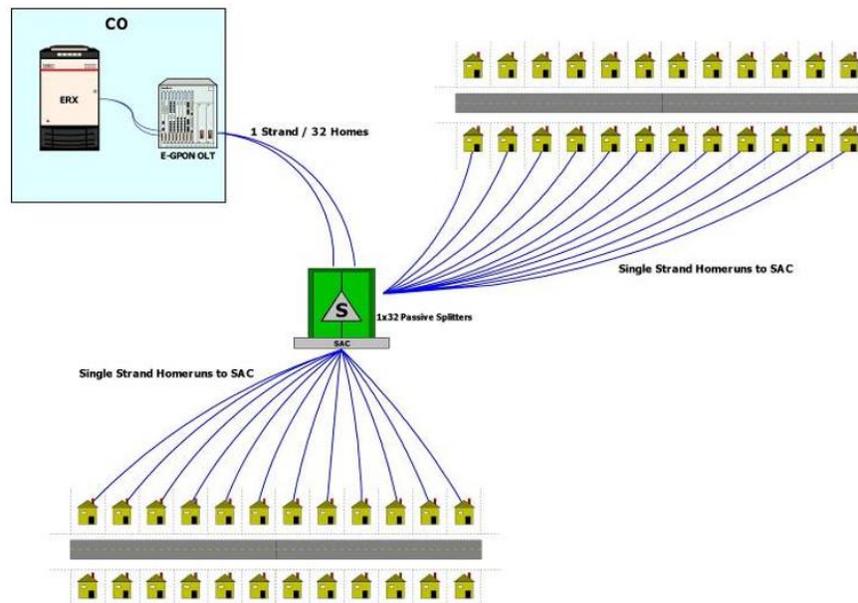


Figure 107: Strands Distribution

FlexNap

- **FlexNAP** = Flexible Network Access Point
- A **Terminal Distribution System** (often referred to as “Pre-Term” or “FITS” in its copper life) is a fiber optic distribution cable with network access point’s pre-connectorized at customer-specified locations along the length of the cable.
- The **Terminal Distribution System** ships as a complete solution (cable & terminals) on a standard cable reel.

- **FlexNAP** is compatible with both aerial and below-grade distribution applications.
Distribution – Opti Tap on Splice Closures

- Distribution cable fibers are terminated to factory installed pigtails.
- Pigtails are routed to environmentally sealed OptiFit adapters
- OptiFit drop cables are pre-terminated to connect to sealed adapter
- No re-entry of terminal required
- Integrated drop cable strain relief and grounding
- Capability to integrate splitters or CWDM

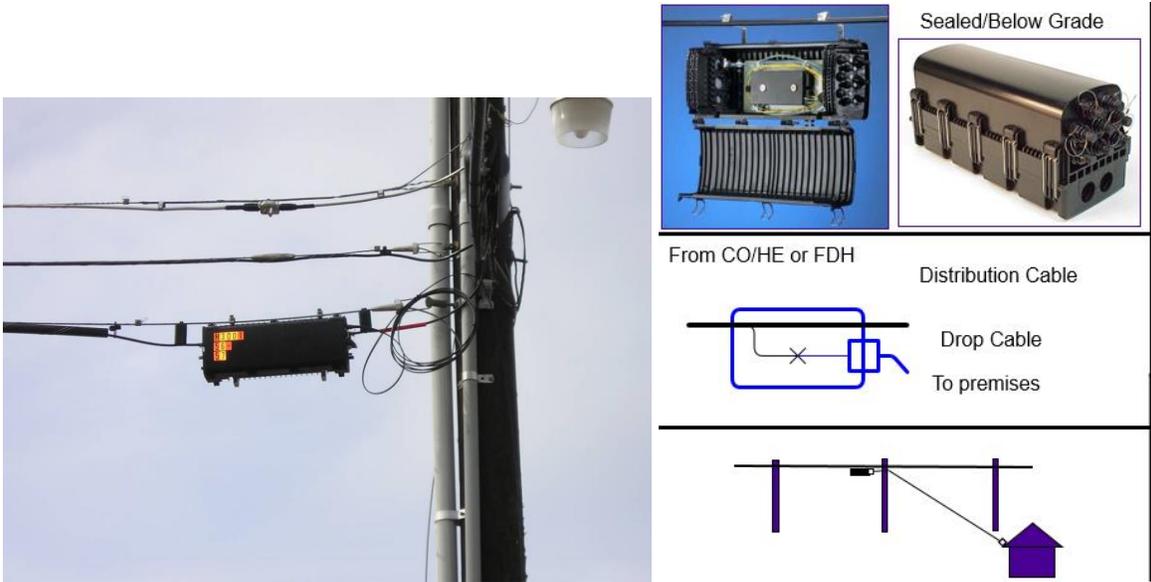


Figure 108: Distribution – Traditional Cables and Splice Closures (Left) & OptiTap on Splice Closure (Right)

4.1.1 Drop Cables

- Single-fiber, single-mode SC UPC drop cable assemblies
- Available with one or both ends that can be connected
- Cable design for aerial, direct-buried or duct installation
- Standard lengths available in 15 feet increments from 90 to 180 feet and in 50 feet increments above 200 feet
- Environmentally-sealed connector housing permits rapid connection to external flush-mounted bulkhead adapters on terminals or closures (terminal or closure entry is not required for drop cable installation).
- Robust design keeps connector intact during installation
- Can be pulled through 1.25-in conduit
- Integral pulling eye/connector cap designed for 100 lb maximum pulling tension

4.1.2 ONT (Optical Network Terminator)

- Replaces residential customers “NID” box
- Converts light information to electrical information
- Can operate up to 20 Km from OLT

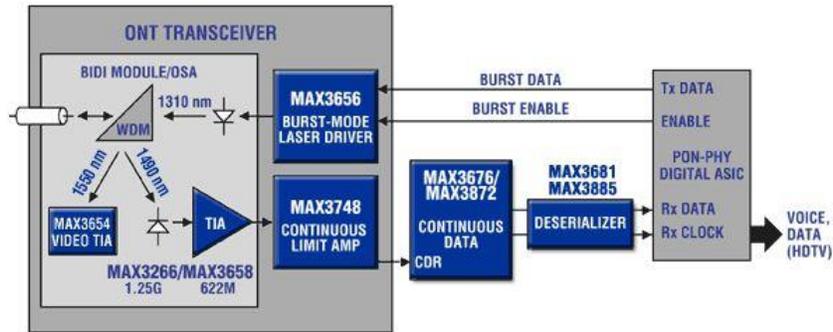


Figure 109: Optical Network terminator

4.1.3 ALU ONT

The ALU GPON fibre to the home deployment will enable higher BW HSIA plans and will support multiple SD and HD STB's, as well as Derived Voice, at the customer premise. The ALU I-220A indoor ONT is installed in the customer premise with a single fibre SC connector running back to the passive splitter cabinet in the field. The ONT's Ethernet port will provide HSIA and TTV service, while the POTS port will provide DV service.

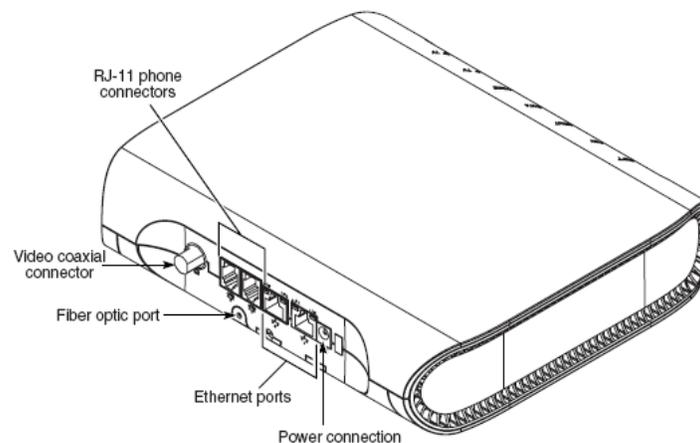


Figure 110: ALU ONT

4.2 Three Types of Fiber Drop

- Corning Clear Curve
- Composite Cable (4-strand fiber & 6 pair buried copper)
- Fujikura Fiber

All drops require one loop of slack for the pedestals and tubs & are tagged with the house number using an orange fiber tag (orderable in the GPON order form).

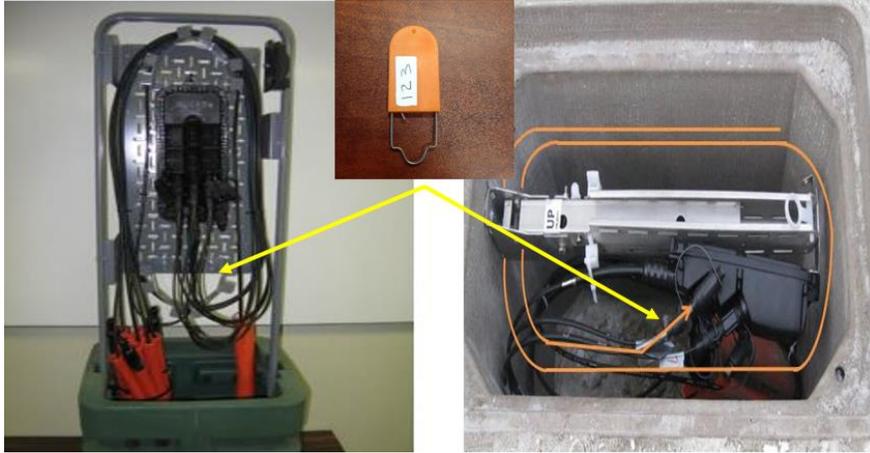


Figure111: Loop of stack at pedestal and orange tag

Proper amounts of slack allow the conduit to shift in the ground (as the ground settles) without putting excess stress on any bend points within the NAP. The same rationale is applied to leaving slack in the NID and/or conduit at the premise.

- Both Corning drop are used for aerial and buried, the fibers are 900um. The dual-strand drops have a blue and orange colored end for identification in the NAP and remove the need for running an additional fiber drop.



Figure 112: Single drop and dual strand drop for multiplex

- Jonard Stripper is used strip the entire shield, the stripper can be reversed to get extra usage of the blades. If your blades become dull, you need to replace the blades.
- Dual strand drop has copper tracer (toning wire) that must be removed with an LTS-approved knife prior to using the Jonard stripping tool. Attempts to use only the Jonard stripping tool will cause one of the blades in the tool to become damaged and potentially too dull for future use.

Fiber drop NIB's



Figure 113: Fiber drop in NIB

- All aerial drops must have a transition or NIB box installed outside the house.
 - All LBs must be secured with screws on all Falcon Drops.
 - In Mass Market areas (Calgary/Edmonton, etc.) an outside Transition Box or NIB is not required **when using a Clear Curve fibre drop** but all drops must be stripped and have 1m+ of slack fibre coiled up inside the LB.
 - **Composite Drops** must have a NIB or Transition box installed, as the cables are not fire rated to be used inside the home.

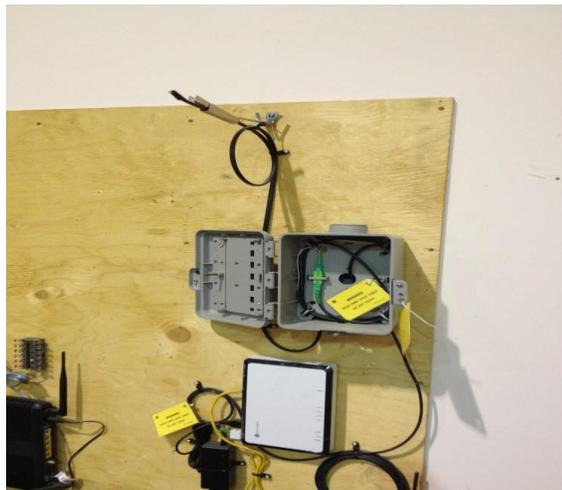


Figure 114: All buried drops should be stripped before entering premises and NIB with Fiber Drop

- The enclosed NAP is only accessible by Cable Repair and the blue strand is spliced through.
- The other strands (orange/green/brown) can be used for additional services to the premise but must be prepared by Cable Repair.
- Composite cable is not fire rated and an outside NIB is required with a Clear Curve patch cable run into the house.
- All copper materials should be removed or tucked behind the fibre tray (NIB) to avoid making contact with the fragile fiber strand and tape up unused strands



Figure 115: Enclosed NAP and TRANSITION BOX INSTALLED ABOVE AN EXISTING NIB

- Due to co-existing copper services, a transition can be added above the NIB
- If the composite fiber becomes too short to be terminated at the LB (and the LB is high enough off the ground) the conduit can be cut into and a transition box or second NIB installed below the LB (Cable Repair will not extend the composite drop if there is enough space to install a box below the LB)

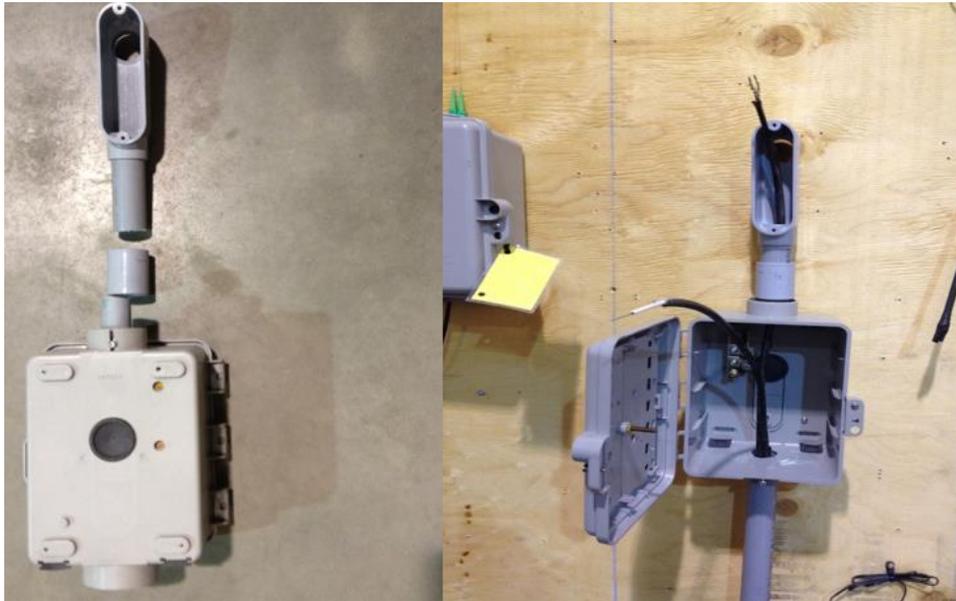


Figure 116: NIB Installation below the LB

- Especially in cold weather composite fiber cable is extreme stiff and fragile.
- Hardening bending causes the white tube to snap and breaking off the fiber strands inside.



Figure 117: Cut the white tube at the middle of the NIB, cutting the tube at the corners will put stress on the fiber strands (Left) & as composite fiber is much smaller, a sleeve must be used (Right)

Fujikura fiber drop aka AFL, it is exclusive to AFL built aerial overlay in Calgary Hillhurst and major part of Crescent Heights communities.

- 250um single blue strand in loose gel filled tube, requires a sleeve for termination like composite fiber,
- AFL supplies a 900um protective tube for their own techs.
- Unlike Composite fiber, it is more durable and more resistant to breaking or shattering
- A transition box or NIB is required
- Both Corning FDH and IDEAA are being used for Fujikura Fibre areas
- The Fujikura IDEAA cabinet is essentially “backwards” from a Corning FDH – the “tails” are now your distribution and the splitters have the female end you plug the tail into.
 - If you can’t find your distribution in the cabinet simply use your “Ruby Red” to trace it back to the cabinet.

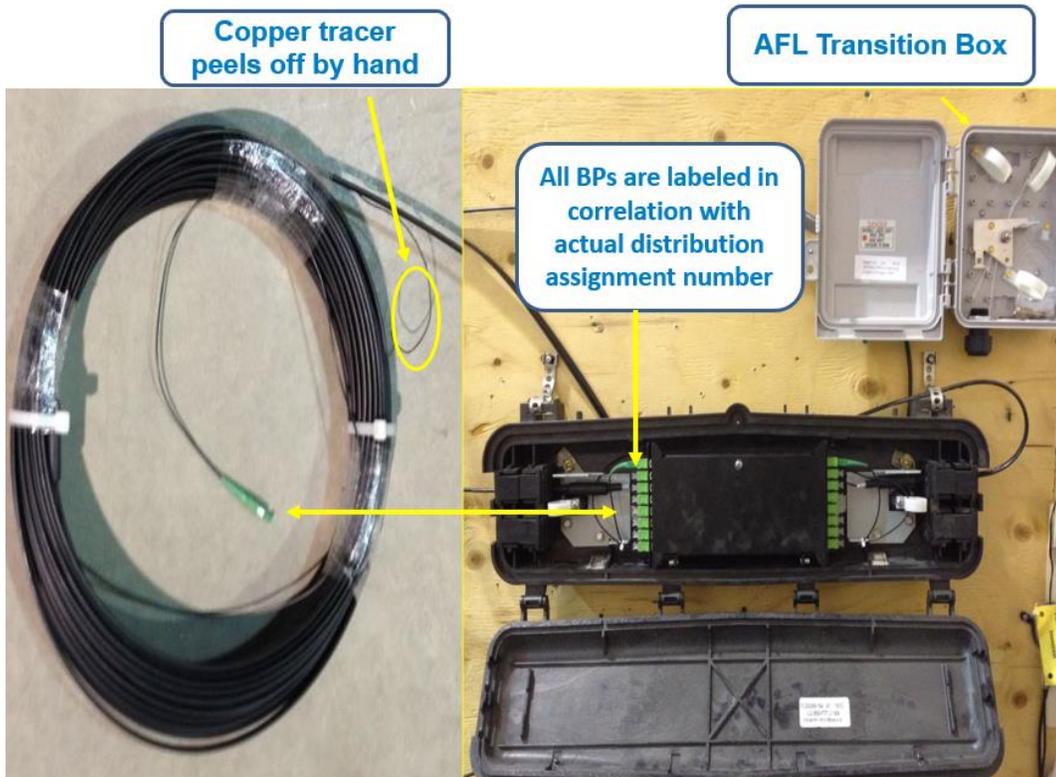


Figure 118: Fujikura Fiber Drop

4.3 Static IP over GPON

Now we will discuss the configurations and order flow process for setting up Internet and Internet + TV for small businesses upgrading from copper to fiber, and includes procedures for SMB customers that have also requested a static ip. Additional information is provided below on registering the device and obtaining a static ip.

NOTE: CUSTOMERS WITH CURRENT STATIC IP ON COPPER WILL GET A NEW STATIC IP ON GPON AND MUST ENGAGE THEIR IT PERSONNEL BEFORE THE CONVERSION TAKES PLACE.

Set Up Configuration

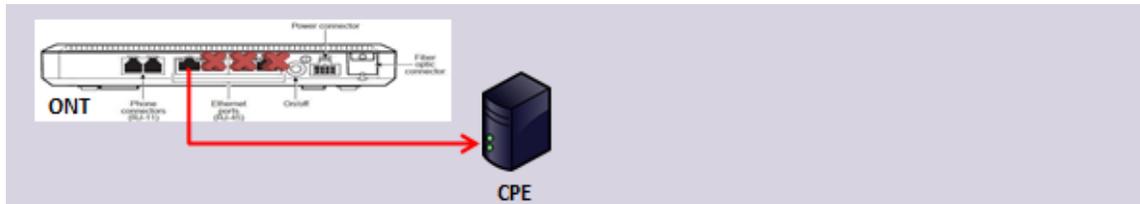
I) DYNAMIC IP: HS



II) DYNAMIC IP: HS + TV



III) STATIC IP: HS



IV) STATIC IP: HS + TV



PROCESS

STEP 1: Once your ONT is installed and registered and you have an acceptable light level on your fiber path (maximum loss -26db) initiate an order flow (go/rof) on the copper circuit. Then initiate the order flow on your GPON circuit. This process will ensure the smoothest migration to the GPON path.

STEP 2: Plug your Fiber into the ONT. The ONT will receive the customer profile and any firmware upgrade if required. This process may take up to 5 minutes during which time the ONT may reboot. The process is complete once the ONT management light turns green.

If this step fails, engage Tier 2 for assistance, 310-3344 option 4 3 3 to resolve any provisioning issues.

STEP 3: Always factory reset gateways during GPON installations to prevent gateways from going into bridged mode.

STEP 4: Ensure the TISSA agreement has been accepted and speedtest your circuit to verify the provisioning is correct.

STATIC IP REGISTRATION

To obtain the static ip, the user name and password supplied in the gpon order is required to log into the Registration Portal. Ensure that the customer is provided a copy of the gpon user name and password! The customer is also supplied a separate user name and password for e-mail and TELUS internet security. This is different from the copper process as the user name and password are the same for static ip, e-mail and security.

Note 1: The customer's existing static ip on copper cannot be migrated over to gpon. This is because the static ip for copper and gpon are from two different and separated ip pools.

Note 2: If the customer's equipment is already registered with a static ip on our copper network, then their equipment has to be de-registered (i.e. mac address deleted from the static ip Registration Portal) and then register the equipment with the gpon user name and password. Follow the steps outlined below.

Step 1: Obtain the customer's copper user name and password.

Step 2: If customer does not know their copper user name and password, call into NFS to have the user name and password reset.

Step 3: If customer is ready to connect up to the gpon service, then go into the Registration Portal with the COPPER credentials and delete their equipment with a static ip.

Step 4: Exit Register Device Portal.

Step 5: Log back into the Register Device Portal with the GPON user name and password.

Step 6: Add the customer's equipment (mac address) to obtain a static ip.

Step 7: If the customer is not ready to switch their equipment from copper to gpon, ensure that you leave them the copper and gpon user name and passwords and the instructions to delete equipment with the copper credentials and then register equipment with the gpon credentials.

Additional Information for Static IP Plan Subscribers

Static IP addresses are assigned by TELUS; you cannot hard code the information in the TCP/IP settings. Static IP addresses are location-dependent and are subject to change in the event of a move or a TELUS Network Upgrade.

If you change or replace your computer equipment or device, you MUST re-register. Return to the device registration page (<https://registerdevice.telus.com>) and follow the steps above.

If the available slots are filled in and you see the new MAC address associated with a dynamic IP address (rather than a static IP address) you MUST change the IP address to the assigned Static IP address and update the old MAC address. You can find the MAC address on the device itself (on a sticker on the device) or by logging into the device.

*Your MAC address is a unique value identifier for a network adapter on your computer. It allows your computer to communicate with other devices and networks on the web.

**Your Static IP address is a unique identifier for your computer that is assigned to you by TELUS.

4.4 COAX Clarifier

The Coax Clarifier is a coax-specific hand-held tool used for:

- Identifying runs
- Testing quality of a run or network
- Detecting faults such as shorts, opens, or splitters
- Measuring the length of runs
- Generating tones



Difference between Coax Clarifier and Copper gate

Coax Clarifier

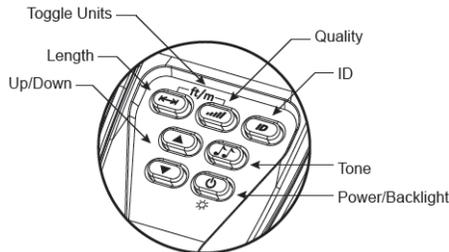
- Tests the physical integrity of the coax in the home
- Tests for cable faults, splitters, etc.
- Identifies cable runs
- Measures length of individual runs
- Generates tracing tones
- Live quality testing

Copper Gate

- Tests packet loss between boxes
- Netinf test: sends packets between all HPNA devices in a network and looks for lost/corrupt packets
- Netinf is a snapshot test and may not detect an existing fault
- Netper test: Monitors traffic between HPNA devices and looks for lost/corrupt packets
- Coppergate can confirm the existence of a fault but not necessarily its location

ID Test

The ID Test is used to identify specific runs during an installation.



until all IDs are found.

1. Place an RF remote on each run to be used for install.
2. At the Coax NIB, etc. connect Coax Clarifier™ to the first run to be ID'd.
3. Press the *ID* button. The Coax Clarifier™ will check the run for IDs and display the results at the top on the screen.
4. Repeat steps 2 and 3 for remaining runs

Quality Test

The Quality Test will measure the return loss from 0 – 40 dB. Higher numbers are better.



Quality of Cable Run

1. Place 75 ohm terminator on far end of run to be tested.
2. Connect the Coax Clarifier™ to the other end and press the *Quality* Button.
3. The return loss in dB will be displayed in the bottom right hand corner of the screen.
4. A low return loss number could indicate a splitter, damaged cable, bad barrel connector, etc.

The Quality Test measures Return Loss in dB

- Return loss is a measure of how much signal is lost in a cable.
- The Coax Clarifier sends a signal down the coax run where it gets absorbed by the 75ohm terminator. Ideally all of the signal is absorbed by the 75ohm terminator.
- Faults, i.e. a splitter, will reflect some of the signal back to the Coax Clarifier™ where it's measured in dB.
- Signal that's reflected back is signal that won't make it to an STB.
- The lower the dB measured the worse the fault.
- The Coax Clarifier™ can measure Return Loss from 0 - 40dB with 0dB being the worst and 40dB being the best.

Return Loss Guidelines:

- Generally, any runs that test below 40 dB should be inspected.
- After inspection and repair, any runs that test between approx. 30dB and 35dB should be avoided, while runs testing below 30 should be abandoned and replaced with Cat5, etc.
- On a pixelization trouble, when all other factors have been ruled out, any suspect runs that cannot be repaired should be replaced with Cat5, etc.

Length Test



The Length Test is used to measure the length of a coax run.

1. Connect Coax Clarifier to coax run to be tested. Ensure cable is open on far end.
2. Press the *Length* Button.
3. Use the *Up* and *Down* buttons to select the cable type (RG6 or RG59).
4. Read the measured length value from the lower right hand corner of the screen.
5. A cable fault (or splitter) can cause inaccurate measurements.
6. Briefly press the *Length* and *Quality* buttons simultaneously to switch between meter and feet measurements.

Tone Generation

The Coax Clarifier can generate tones on coax runs

1. Connect Coax Clarifier™ to coax run to be toned.
2. Press the *Tone* button.
3. Use the *Up* and *Down* buttons to select the *HL1*, *HL2*, *Hi*, or *Lo* tones.
4. Press the *Tone* button to select whether the tone is placed on the Pin (*P*), the Shield (*S*), or both (*PS*)
5. A standard tone probe can be used to detect the tone.

When doing a TV install with the Coax Clarifier

1. Place RF remotes on all coax runs being used for TV service.
2. Use the ID Test mode (at NID, etc) to find all runs being used. Note any possible splitters or bad runs.
3. Bring all runs up to standard (i.e. change non-standard ends, remove splitters, etc.).
4. Place 75 ohm terminators on all coax runs being used for TV service.
5. Use the Quality Test mode (at NID, etc.) to check the quality of all the runs being used.
6. Replace any poor quality runs with Cat5, etc.

When doing a TV repair with the Coax Clarifier

7. Place 75 ohm terminators on all coax runs being used for TV service.
8. Use the Quality Test mode (at NID, etc.) to check the quality of all the runs being used.
9. Investigate and repair any poor quality runs.
10. Retest any repaired runs. If a run still tests poorly, replace the run with Cat5, etc.

Limitations

Like any tool, the Coax Clarifier™ has some limitations

- In Quality Mode, it is possible to test using the RF Remotes instead of 75ohm terminators. However, this will give inaccurate results, especially when testing a single run.
- Over time the barrel connector in the meter as well as in the RF Remotes will wear out. Replace worn-out barrel connectors with new ones as needed.
- In ID Mode, the ID Only Remotes cannot be detected through splitters. However, the RF Remotes can be detected through splitters.
- In ID Mode, if the Return Loss (Quality) is less than 17dB remotes cannot be detected and the test will stop.
- For most tests, if a short is detected the SHORT icon is displayed and testing cannot continue.
- The Coax Clarifier™ cannot detect all possible faults, especially when the fault is intermittent.

5. Telus Metaframe

Telus has developed many applications so that it can be a help for the field technicians and dispatch to track all the services from Central offices to House and Business premises.

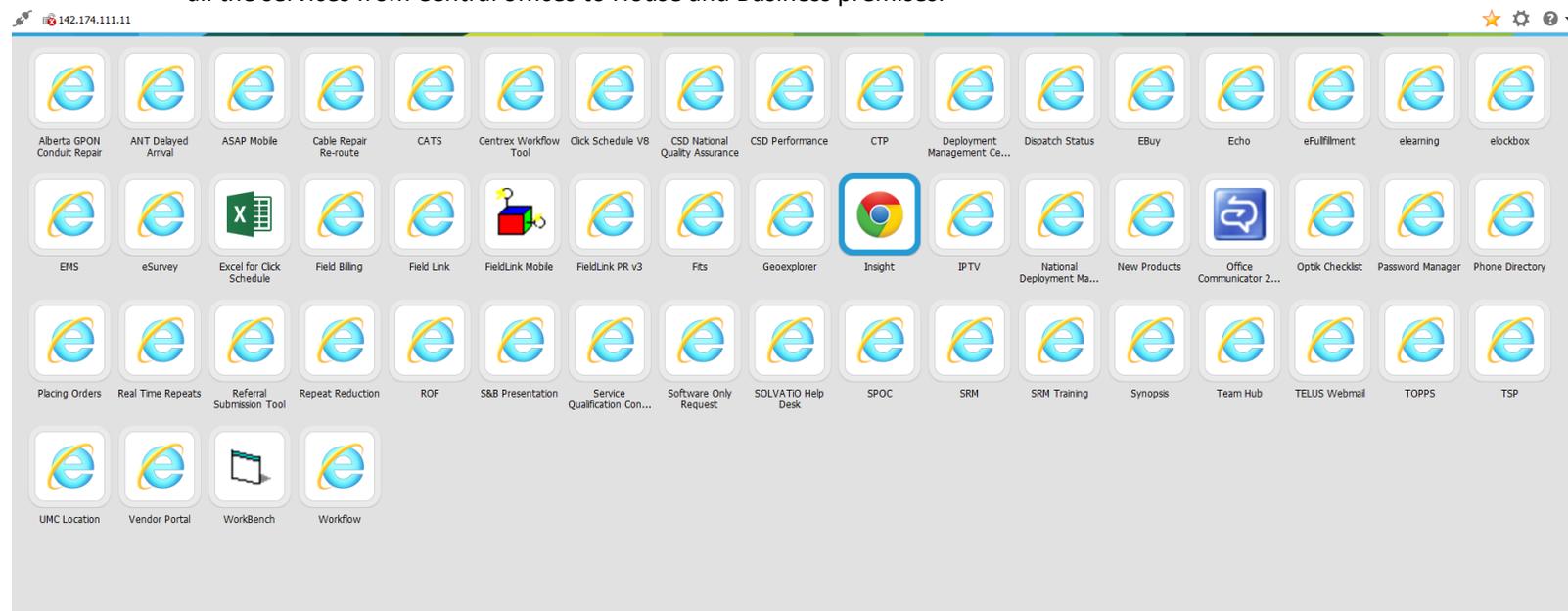


Figure 119: Telus Metaframe

We will discuss major applications which help a technician to assign jobs, see their work orders, know the cable pairs and in prior perform some tests before reaching the premises.

5.1 Field Link

It is an application, which let a technician know which jobs he/she has been assigned for the day.

When is a job mine?

Tentative jobs are dispatched to a technician one hour before their scheduled time. Scheduled time is where the system has placed work on your day, NOT the appointment time. Until a job is dispatched, it is on your board and can be seen on the 'Future' tab, but cannot be picked up. This allows the system to optimize the workload throughout the day.

Status	Tentative
Pinned	No
Appointment Window	2011-04-05 08:00 PDT - 17:00 PDT
Due Date	2011-04-05 17:00 PDT
Scheduled Time	2011-04-05 08:00 PDT - 09:15 PDT
Customer Name	CONCERT PROPERTIES LTD

Figure 120: Job Designation

Is pinned work mine?

A pinned status indicates a job is locked to your board and cannot be moved by the system. In some cases, jobs must be pinned because of glitches in Click, but might still be moved by a dispatcher. WIPs are pinned to your day and will not be moved. Never work on a tentative job, even if it is pinned, unless you are asked to do so by a dispatcher.

Status	Tentative
Pinned	Yes
Appointment Window	2011-04-05 08:00 PDT - 17:00 PDT
Due Date	2011-04-05 17:00 PDT
Scheduled Time	2011-04-05 08:00 PDT - 09:15 PDT
Customer Name	CONCERT PROPERTIES LTD

Figure 121: Pinned Designation

En Route and On Site

'En Route' and 'On Site' are job statuses that help the Click system determine where you are in your day. The colors in the figure are the colors that jobs will display to indicate their status.

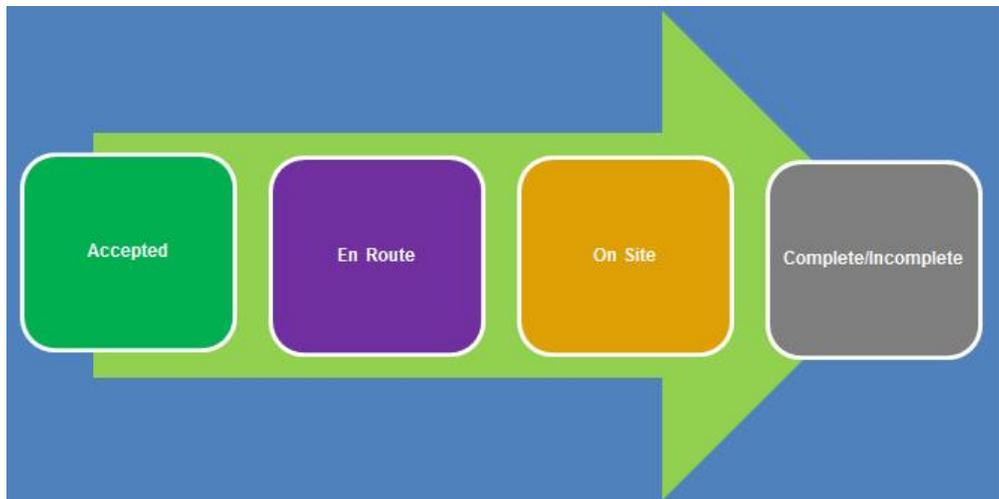


Figure 122: Status Color code

Dispatchers monitor these statuses to track workload and day progression. You are required to update your status whenever possible. When writing work off, 'En Route' and 'On Site' times will display as:

- En Route = Job Started
- On Site = On Site

Incomplete Trouble Ticket 1029876098 (Satellite TV) - Call ID 1/10000

Reason *

Workforce *

Job Started * (yyyymmdd)

On-site Arrival Time * (yyyymmdd)

Incomplete Time * (yyyymmdd)

Meal Break Included? Yes

Correct Job Type? (Change only if incorrect)

Figure123: Enroute and onsite display

How to use En Route and On Site?

If you use the 'En Route' or 'On Site' buttons, you will NOT be able to adjust 'Job Started' and 'On Site' times when you write off the ticket. When you select 'On Site', the scheduled time changes to the current time. This could open up more space for work in your day. For example, if you go 'On Site' at 10:00 am for a job that is 1.25 SWT and scheduled for a 2:00 pm start time, that job will move and open up 1.25 hours in your day starting at 2:00 pm. This can overbook you as shown in the figure.

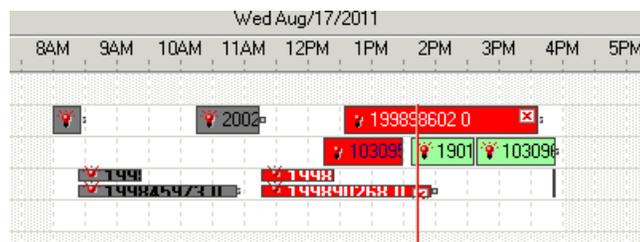


Figure 124: Double Plays

Technicians working in BULK Dispatch (rural) areas must be careful when going 'On Site' to a job. In the figure below, the technician has accepted all work. If he/she was to go on site for the last job in the day, it would move to where the time bar currently is (current time). This would open up 2:15 pm to 4:00 pm for a new job to fall in.

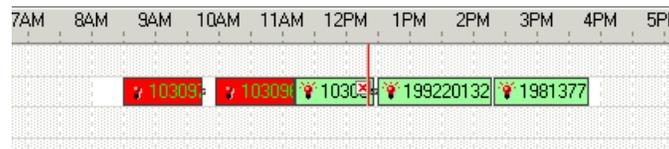


Figure 125: Bulk Dispatch Warning

As a general rule, if the job is scheduled in the future, regardless of appointment time, do NOT go on site until the scheduled time for the job arrives. If you must, leave the job as 'Accepted' and write it off later. Only go 'On Site' if you want to open up your day for more work. All technicians are asked to use 'En Route' and 'On Site' as accurately as possible. Any time you have multiple jobs dispatched, you must decide how to handle them. Triple plays are lined up consecutively so the SWT time for all pieces added is blocked out of your day. If you go 'On Site' to all three pieces, the jobs all stack, which means that only the longest SWT time is now blocked.

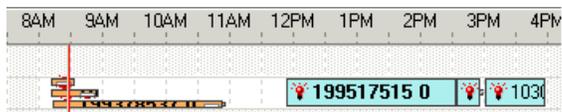


Figure126: Triple Stacking

If you do not want to cause triple or double-play jobs to stack, only update 'En Route' and 'On Site' using the buttons for the first scheduled piece. Any time you go 'On Site' to a job that is scheduled in the future, you may be opening up your day for more work. You can go 'En Route' to a job without causing this issue as the scheduled time only changes when you select 'On Site'. If a job is scheduled in the future and you do not want to open up your day for more work, do NOT use the 'On Site' button. You will be able to choose the 'On Site' time when writing off work.

For example, you are BULK dispatched (all work dispatched at 8:00 am) and you arrange to go to a job that is scheduled for 2:00 pm as your first due to an escalation. If you go 'On Site' before 2:00 pm, you are opening up your afternoon for more work by 'stacking' the job on top.

Remarks sections are now limited to 1000 characters. Any time you see a remarks screen, you may enter information about the job. Start all remarks with your X-ID, the date, and the time. These are critical for dispatchers to handle WIPs and reroutes properly and to ensure your WIPs are returned to you if they become lost or assigned to another technician.

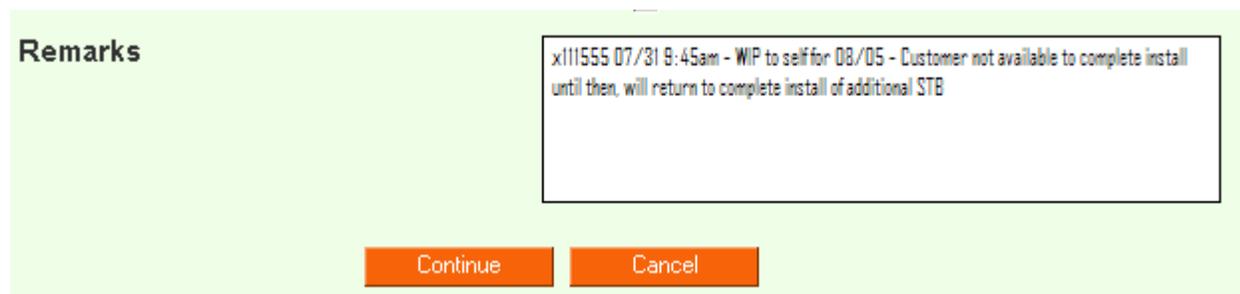


Figure 127: Remarks

Reroutes (Incomplete with Continuation)

Reroutes do NOT go directly to the TELUS Queue. They must be transferred to TELUS by the dispatchers.

The following is critical to every reroute:

- Add detailed remarks as to why the ticket is being rerouted and where it needs to go.
- Add the date, time, and your X-ID in case dispatch needs to ask questions. Cable Repair requests are NOT rerouted. Orders are WIPed for 2 days and 310-CUTS is called. Once Cable Repair confirms their job is done, the technician can complete his/her work orders.

Jobs Tab

When logging into FieldLink, the 'Jobs' tab and 'Current' sub-tab are displayed first.



Figure 128: Job Tabs

The orange 'Accept' button will be lit up if there are any jobs you have not yet accepted. (For example, jobs in dispatched status.) Whether you accept them or not, dispatched jobs will stay on your board. The 'Future' tab can be used to view tentative work, and completed or incomplete jobs will show up on the 'Cleared' tab. Note: Any time you change sub-tabs, the date will reset to today and you will need to use the < and > symbols to go to past dates. The circuit number, as shown below, is a hyperlink that will take you into the job details.



Figure 129: Circuit Number

Multiple jobs can be accepted directly from the 'Current' list by checking the boxes at the upper-left of each job and clicking 'Accept'. Alternatively you can click the circuit number in a job heading to load the full job details and accept the job. Once you click into the 'Job Details' screen, you will see the 'Reject' button appear.

While the ability to reject jobs exists in FieldLink, NEVER reject jobs without the approval of your Manager or Dispatcher. This is the same as the rules for refusing work in AWAS. Your manager or dispatchers will reject jobs if necessary by logging into FieldLink as the technician in question. Technicians who reject jobs without approval will be referred to their managers for a review of the job rejection policy. If your manager or a dispatcher asks you to reject a job, enter their name in the remarks section. Any time you are accepting a job in FieldLink, you will see the 'Accept' confirmation dialog box. Clicking 'No' will return you to the 'Current' tab of your job list. The job will remain dispatched to you.

Clicking 'Yes' will then require you to make one of the two following choices:

- Incomplete (No Access, Reroutes, WIP)
- Complete (Writing off the work as done)

Incompleting a Job - No Continuation

Reasons for a No Continuation on an incomplete include:

- Customer Cancelled
- Customer Not Ready

- Incorrect Customer Information (This is only if the issue cannot be resolved like when an order is in the wrong province.)
- No Access (Legitimate No Access with ANT confirmation.)
- Safety Customer Fault

To Incomplete a Job...

1. Select 'Incomplete'.
2. Select the appropriate reason from the drop-down menu.

Note: "Job Started" and "On Site" times will be pre-populated if you used the "En Route" or "On Site" buttons. If these times are pre-populated, they cannot be changed.

3. Fill out remarks.
4. Select 'Continue'

Figure 130: In completing a job

5. After clicking 'Continue', enter your function codes for the job on the 'Timesheet' screen that appears. Note: Function codes should always add up to the SWT time spent on a job. Once you have hit the '+' symbol, the function code is added and you can assign time to it and add a code-specific remark. Once one code is added, the 'Continue' button becomes active.
 6. Select 'Continue' to either incomplete the job or bring up a form.
 7. If a form appears, fill out the required form. (For example, Blast Test if no blast test was performed in the last 12 hours, Optik Checklist, Field Billing if you selected Customer Billable)
 8. Select 'Save' or 'Continue' button.
- Note: In some cases scroll bars do NOT appear in the forms that load, which may prevent you from seeing the 'Save' or 'continue' button. If you do NOT see this on any forms, use the 'Tab' key to workaround the screen until you do.

Job Didn't Complete/Incomplete

Unless you are returned to the job list with a message indicating the job is now incomplete, the job may not have been successfully written off. If your job did not incomplete, you may have missed a required form or may not have clicked the 'Save' or 'Continue' button in a form that loaded. You will need to go through all the past steps again. When you get to the timesheet screen, you will notice that the function codes are already populated. The 'Continue' button will be grayed out, but you can trick the system into allowing you to continue. Click the red 'x' to unselect any function code and then click on the red 'x' again to reselect the function code. This will make the system think you have made a change and let you continue with the process. You can now complete the form and incomplete/complete the job.

Incomplete with Continuation

Some examples of No Continuation on an incomplete include:

- Other Workforce Required - Reroute
- Tech Additional Skills - Reroute

- Route to AWAS - Reroute
- Customer Work in Progress - WIP
- TELUS World in Progress - WIP

Note: You can see more examples in the drop-down menu after selecting 'Incomplete' on any active job.

Signing off a WIP

The following example will walk you through signing off a WIP. A WIP contains the most complicated steps for writing off any work. By showing you this example you will be able to apply the steps to most other operations.

Note: TELUS WIP is used the most. It allows the most flexibility for rebooking and allows you to FORCE appointments even for your days off or if you already have a full day of work.

CUSTOMER WIP will not allow you to force an appointment and is used mainly for rebooking an order for the customer when no work has been performed.

1. Select 'TELUS Work in Progress' in the drop-down menu and the WIP options will populate.
2. Select 'Myself' which will look for appointments in your day, 'Someone else' which will search all other deployed technicians in the area, or 'None'.

Note: The 'Continue' will only appear if you select a drop-down reason that warrants completing with continuation, so you wouldn't see it if you selected 'No Access'.

3. Choose the accurate time to complete the job so the system is looking for the right amount of time in your day. When you complete the WIP, the job will re-size itself to the time picked.

4. After filling out all the previous options, select 'Get Appointments'. The system will search the next two weeks and show you all possible appointments where the duration you selected is available. If you did not select 'Myself', these are other technicians' appointments.

5. Use the 'Customer Request' field to force an appointment to a day off. If you do not see appointments for days, it means you are either scheduled off or the amount of time you are seeking is not available.

6. Once you select 'Customer Request', you will be presented with a 'Calendar' to select the day you will return to the job. Select the closest standard appointment time to when you plan to return to the job.

7. Enter the X-ID, date, time, and description of the WIP in case it does not appear on your board.

Note: Forced WIPs are expected to be performed before or after a day's work. New jobs always take precedence.

Job Details

Job Identification: Lists the circuit number, job type, and job location.

Job Milestones: Lists the created date, appointment, due date, scheduled time, and current status.

Customer Details: Lists the customer's name, address (which hyperlinks to Google Maps), the site contact name and contact number.

General Remarks: Displays the general comments and information contained in each job.

Dispatcher Remarks: Displays any specific remarks left on a job left by LTS Dispatch

Trouble: Displays the circuit number, priority, trouble ticket type and issue

Line_Test_Results: Displays a summary of the line test results.

Activity: Displays the activity of the job while in FieldLink and shows timestamps and comments.

History: Displays a Trouble Tickets history in greater detail and displays previous customer experiences.

5.2 Fits and E.Fulfillment

- The goal is to reduce calls into Assignment that can be done via self serve tools – FITS & e.Fulfillment
- By reducing calls that can be done via the self serve tools Assignment will be able to improve answer times for CSD for calls where an Assignor is the only method of resolution.

In one week Assignment gets:

- Over 2000 calls to provide basic order/ticket information
- Over 1000 calls to change a cable
- Over 600 calls to release a switch hold code.

In order to reduce Assignment wait times for CSD we need to substantially reduce calls for:

- Basic ticket and order information
- Cable changes and
- Releasing switch hold codes.

Main Inquiry Functions within e.Fulfillment:

- Telephone number inquiry
- Order number inquiry - CRIS or Netcracker Orders
- Terminal Info
- Cable/Pair Capacity totals & details for cable & pair ranges
- Line Equipment details

Telephone Number Inquiry – TN Lookup Tab

The TN Lookup will provide you with the most commonly required information about a number and its associated facilities.

Status	Class	Type	DueDate	Address	COID	Cable	Pair	CRIS Order	PWL Status
N	B	IND	20030109	130-195 W 2ND AVE, VAN BC	TRTY	61	470		N/A
N	B	IND	20051004	202-3310 FRASER ST, VAN BC	TRTY	40	1410		N/A

Figure 131: TN lookup Tab

Order Inquiry – CRIS Tab

- Any CRIS or Netcracker Order can be looked up
- An order can be queried using the hyperlink either on the TN lookup page or by entering an order number on the CRIS tab.

Order #	Sequence	OMS Order Action Reference #	Status	Purpose	Clearance #	Class	Req. Date	Date Data
3700982	05	69296277C	P	U	7507714030	R	20090102	

Figure 132: CRIS Tab

Access Point Inquiry – Terminal Tab

- Terminal information can be looked up using the COID & the Access Point number
- This query will provide the Terminal address along with the counts.
- This query also shows binding post information for each range.

Figure 133: AP inquiry

Cable Pair Inquiry – Cable Capacity Tab

- This tab gives information on a range of cable pairs within a CO with relevant capacity totals for that range.
- This includes the percentage of pairs used, damaged, and available.
- Enter the COID, the cable number, start and end pair for the range, and province.

Figure 134: Cable Pair Enquiry

- In addition detailed information for each pair in the specified range is also shown, including the address and line equipment attached to that pair.

Cable	Pair	AP	LE	Address	Circuit	Status	ADSL	Type	Details
1	2			-		Spare	-	-	-
1011	1	5084	HOST 03 1 15 12	230 COTTONWOOD AV	780-464-5435	Working	-	ADSL	RES -
	3	5084		230 COTTONWOOD AV	780-417-2910	Spare	-	RES	-
1011	4	5084	HOST 03 1 16 12	232 COTTONWOOD AV	780-449-6810	Spare	-	RES	-
1011	5	5090		226 COTTONWOOD AV	780-449-3913	Spare	-	RES	-
1011	6	5082	HOST 13 0 02 00	234 COTTONWOOD AV	780-467-4300	Working	-	RES	-
1011	7	5082		234 COTTONWOOD AV	780-410-9489	Spare	-	ADSL	RES -
1011	8	5081	HOST 03 1 00 13	104 LARCH CRT	780-464-1787	Working	-	ADSL	RES -
1011	9	5090	HOST 03 1 01 13	226 COTTONWOOD AV	780-449-3960	Working	-	TTV	RES -
	10			-		Spare	-	-	-
	11			-		Spare	-	-	-
	12			-		Spare	-	-	-
	13			-		Spare	-	-	-

Figure 135: Spare Pair Information

Line Equipment Inquiry – LE & SE Tab

- By entering the COID, line equipment and switch unit number, you can obtain the location, status, and attached TN, if applicable, of the requested Line Equipment.

TN Lookup	Lynx & Addr	CablePair	CRIS	CRIS Special	Terminal	LE & SE	CLEC	Cable Capacity	FITS	Links	Address Inquiry	Field Specs
COID Province												
SWPK AB												
Line Equip.		Switch Unit										
HOST 03 1 01 13		001		Lookup LE								
Bay/RR		Unit		SHLF SL		PT		Model		List		Pos
												Lookup SE
<p>ACTIVITY: SP FUNCTION: SPI DUE DATE: 20080711 SO/TT/CUT#: C780449396001</p> <p>TELF: 780 449 3960</p> <p>WORKING, RESIDENCE TELUS TV, TOUCH</p> <p>ADDRESS: 226 COTTONWOOD AV, SHERWOOD PARK AB T5A 1Y2</p> <p>TRANSPORT,FR/CH DP EXC AP EXC TYPE BGC/PC/BP TN</p> <p>1011 ,PAIR: 9 D 5090 AER BLW_R_BR PI PT</p> <p>10 ,PAIR: 606 D 1011 SAC BP# 6 N N</p> <p>LE: HOST 03 1 01 13 001 DB SPECIAL EQUIP ASSIGNED PIC: 00323</p> <p>Could not get additional LE info.</p> <p>NOT701U E4108 013 SWITCHING UNIT RECORD NOT FOUND</p>												

Figure 136: Line Equipment Information

Cable Change

Cable Changes can be done in FITS or e.Fulfillment

- It will depend on why you are changing the cable as to what tool you choose
- Trouble Cuts – start with FITS
- If you know the pair you want to cut to use e.Fulfillment

In Fits

- To do a trouble cut start with FITS
- Click on Get Spares in FITS
- Fill in Province, COID, Cable, Pair and select a Defective Code
- FITS will return up to 3 spares if they are available

Get Available Spares for a Trouble Cut	Trouble Cut Pair Processing																															
Province BC COID WHRK Cable 2171 Pair 446 Defective Code Cut On Spec Options: <input type="checkbox"/> Choose Defectives Only <input type="checkbox"/> Different Binder Group Retrieve 3 spares. <input type="button" value="Get Spares"/>	Details COID WHRK Status Working Class Residence Service Type Individual Teho (604) 531-8417 Address 16809 24 AVE, SURREY BC V4B 5E7 Cutting From <table border="1"> <thead> <tr> <th>Cable</th> <th>Pair</th> <th>Access Point</th> <th>B/P Pr Colour</th> <th>Load Coils</th> </tr> </thead> <tbody> <tr> <td>7</td> <td>PAIR: 1878</td> <td>2171</td> <td>BP# 78</td> <td>Yes</td> </tr> <tr> <td>2171</td> <td>PAIR: 446</td> <td>363</td> <td>O_W_V_EL</td> <td></td> </tr> </tbody> </table> Available Spares <table border="1"> <thead> <tr> <th>Cable</th> <th>Pair</th> <th>Disposition</th> <th>Defective Code</th> </tr> </thead> <tbody> <tr> <td>2171</td> <td>PAIR: 448</td> <td>Release</td> <td></td> </tr> <tr> <td>2171</td> <td>PAIR: 449</td> <td>Release</td> <td></td> </tr> <tr> <td>2171</td> <td>PAIR: 450</td> <td>Release</td> <td></td> </tr> </tbody> </table> <input type="button" value="Submit for Processing"/>	Cable	Pair	Access Point	B/P Pr Colour	Load Coils	7	PAIR: 1878	2171	BP# 78	Yes	2171	PAIR: 446	363	O_W_V_EL		Cable	Pair	Disposition	Defective Code	2171	PAIR: 448	Release		2171	PAIR: 449	Release		2171	PAIR: 450	Release	
Cable	Pair	Access Point	B/P Pr Colour	Load Coils																												
7	PAIR: 1878	2171	BP# 78	Yes																												
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Cable	Pair	Disposition	Defective Code																													
2171	PAIR: 448	Release																														
2171	PAIR: 449	Release																														
2171	PAIR: 450	Release																														

Figure 137 : Finding Spares

- Cable Change in FITS
- Click on Cut/Release Spares
- Select a pair you want to cut to
- Select a disposition code
- For the pair you are cutting to &
- For all pairs that need to be returned select release
- If FITS does not return any spares you can try e.Fulfillment

In e.Fulfillment

- If FITS does not return any spares and to want to look further or get a specific pair go into e.Fulfillment – Cable Capacity Tab
- After you have figured out what cable are going to cut to
- Scroll to the bottom of the Cable Capacity Tab to update Cable Pairs.

Update Cable Pairs

COID	HMLK		
Telephone #	6044351077	<input checked="" type="radio"/> Residential <input type="radio"/> Business	
Old Cable	1062	Old Pair	228
New Cable	1062	New Pair	223
Exception Code	A - Short	CO Rackwork	
Remarks			
<input type="button" value="Inform Assignment"/>			

Figure 138: Cable Change in e.Fullfilment

Releasing Switch hold Codes

- Use FITS to release the switch-work hold codes for an order
- FITS can be used to release single Line switch work held orders
- Standard Process applies to co-ordinated, held orders. Please ensure that all comments on the order are reviewed prior to removing a hold to ensure that it is not a co-ordinated for some reason.
- In the Order Number field enter the CRIS order number or the NC order you wish to release. Please note this is not the AWAS order number.
- Click **Release Hold Codes**
- FITS will locate any related orders to the one you entered and release those hold codes also.
- Watch the messages returned as there may have been a trouble while processing your request.
- FITS will warn you if it encountered a trouble, In these cases contact the NFS Assignment queue to have your order run

5.3 DSL Exprese

- A testing tool that reads past and real-time data from the DSLAM to the modem.
- A tool (used by TELUS) to optimize the port profile of a DSL circuit to maximize the bandwidth (train rate) to the modem.
- Dsle (DSL Exprese) is a backend system that automatically adjusts the training rate and optimizes the profile by opening up the port to the maximum with very little downloading head room or the line simply can't handle, in some cases it creates a havoc with huge CRC (AKA CV's or coding violation) and FEC (forward error Correction) errors. We can call into T1 or T2 to have the profile capped, or set to the "standard" profile of 31.5 Mbps down stream.
- By providing excellent first time customer satisfaction will increase your scorecard and ultimately your pay.

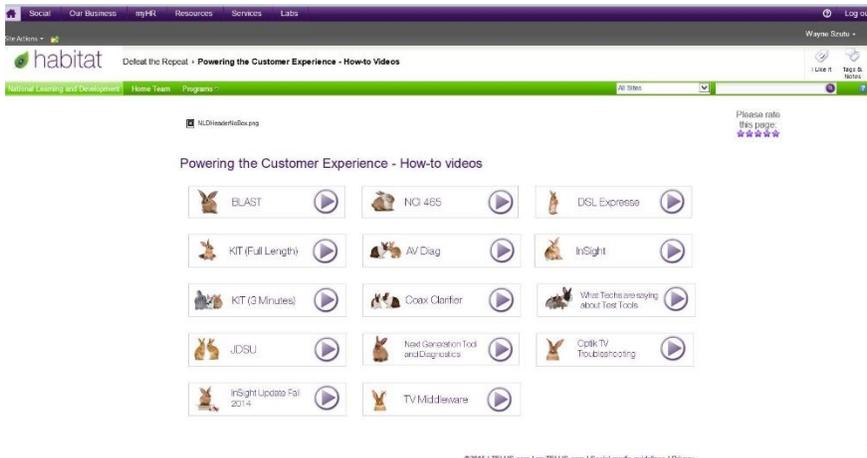


Figure 139: DSL Expresse

Using DSLe will reduce repeats by identifying problems relating to Outside Plant that may not be captured by other testing tools (i.e.: KIT/BLAST)

Using DSLe properly will allow us to provide excellent service on the first visit with no repeats.

When to use it?

- Every TV/DSL trouble where Insight indicates a failure on the cable pair or modem
 - Using DSLe does not replace the requirement to run Insight, BLAST, or KIT on any job but will limit the drive time by identifying possible areas for repair outside the customer's home
- Any time you need to diagnose a Bonded DSL trouble
 - BLAST tests cannot be run on a Bonded circuit, but DSLe can analyze the data on both lines and see any errors on the modem.

Modem Details		Communication problem	
Click here to continue			
Modem Type	Actontec - V1000H	IP Address	205.206.79.115
Firmware Version	T1200H-31.120L.05	Registered MAC	4c:0b:30:37:40:31
Serial Number	SVUA4371903339	Device Uptime	1 days, 1 hours, 54 minutes, 37 seconds
Service Plan	HSIA 50		49-23 14:48:25
Wireless Information		A2-PSK AES	
Wireless On/Off	Enabled		abled
SSID Broadcast	Enabled		
SSID	TELUS3339		
Performance Information			
Current Speed (Mbps)	46841 / 17396	Theoretical dS Down	10.364
Attainable Rates Reported (Mbps)	47750 / 17416	SNR Margin (dB)	6.1 / 5.8
Attainable Rates Estimated (Mbps)	52628 / 17416	Average Stability in Last 10 days	STABLE
Current Stability	STABLE	FEC Corrections DS (24 hr max spike)	119.873
Line Code Violations DS (24 hr max spike)	674	FEC Corrections US (24 hr max spike)	51
Line Code Violations US (24 hr max spike)	42		
Retrans (Last 24 Hours)	11		

Figure 140: Red flags indicating a likely issue with the distribution pair. Excess errors on the modem will cause modem instability (11 retrains in 24 hours in the bottom example) leading to poor service quality for the customer.

- If you are dealing with a chronic synch loss issue where the actual train rate and maximum attainable rate (head room) is less than 5 to 10 Mbps, you should call T1 to disable the profile optimization function of DSL Express for that port. A “standard profile” of 31.5 Mbps downstream is sufficient to support 3HD/15HS service

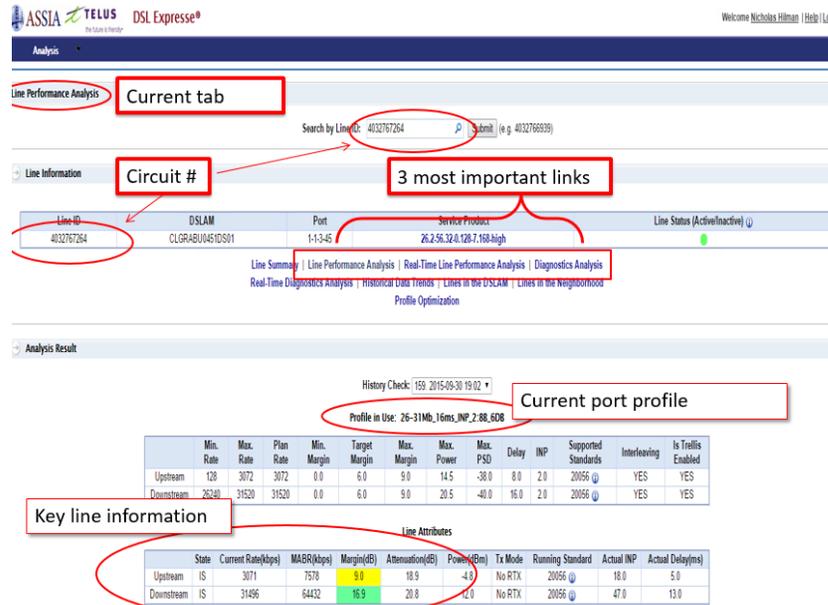


Figure 141: Important areas to look at within DSL Express

- It is important to run BLAST Test on all copper DSL and TV Installs, and to run BLAST Test, Insight, Dsle (DSL Express) and xVu with all DSL and TV Troubles to identify any faults before starting the repair, and afterwards to ensure the fault is resolved.
- Be proactive! Do the right thing to troubleshoot and resolve the problems on the first visit. Spending time to diagnose the problem will increase the actual repair accuracy and efficiency, eliminating your frustration and unnecessary equipment swapping, reducing callbacks and repeats.
- The biggest modem sync loss problem and train rate reduction with aerial and enc copper circuits are Bridge Taps, if you have cleared any BT within your terminal, you must send a request to CAST-ACE@TELUS.COM for possible BT removal further down the line. Typical distances (can vary with size of customer home and/or distance to pedestal) are:
 - BT @ < 20m= Customer's Home
 - BT @ 20 - 65m = Pedestal or Aerial Terminal
 - BT @ > 65m = requires BT Removal Request

Example

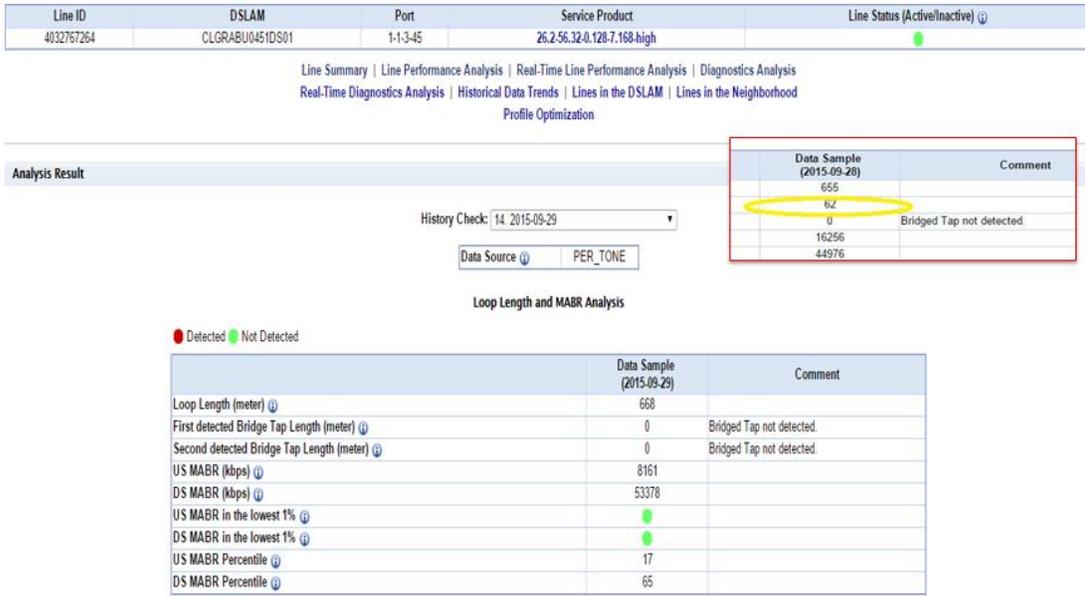


Figure 142: Example of DSL Express diagnostic test

Our Example circuit shows a pretty clean line. The inserted picture includes an example of a circuit with a 62m Bridge Tap detected.

Bonded Circuits:

Both ports will be selectable under the “port” column (see top of picture) to compare the health and status of both lines. Some indicators of bonded instability are:

- Loop Length: Should be relatively the same for both pairs
- Bridge Tap(s)
- Imbalanced MABR between both ports (i.e.: 50Mbps on primary, 22 on secondary)
 - Any detected faults (high attenuation, impulse noise, cross talk, etc.) once removed can balance the lines without needlessly changing distribution pairs.

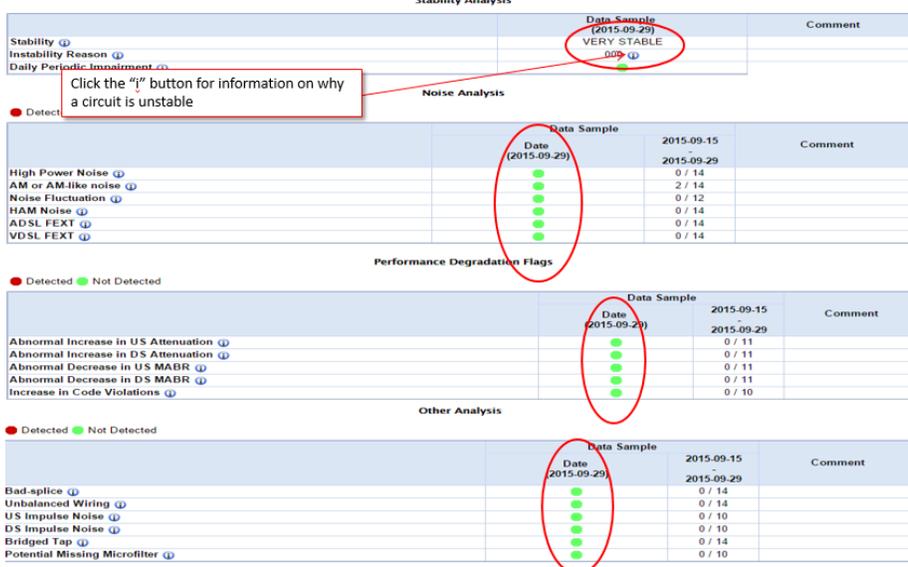


Figure 143: Results of the Test

Highlighted sections are color-coded areas that indicate problem areas with a circuit. Red denotes an issue with that section, and the comments section provides information as to what could be the cause (i.e.: AM or AM-like noise will likely have “possible cable grounding fault” in the comments)

5.4 Insider Office

InSSIDer is an Wi-Fi analyzer provides information on all networks in the proximity of the client modem, including signal strength in dBm (some tools refer to this as RSSI), channel, security, MAC address of each access point and multiple graphs to display information.

InSSIDer also calculates a *Link Score* (designed for use with a Wi-Spy device) based on information such as channel overlap and signal strength for each wireless network. You can see how tweaking channel settings or even relocating an access point or router influences the score.

- Wireless speed expectations in their homes
 - Large homes might require one (or more) Wireless Extenders
- Possible sources of Interference
 - More on slide 7
- Bandwidth usage and the subsequent effect on wireless speeds
 - Internal network usage (including TTV) can impact internet speeds wireless and wired
- Variance of wireless performance on different devices
 - Age/type of devices can have a huge impact on download speeds and network utilization
 - 5GHz networks are not even visible to older devices like the iPhone 4S – testing must be done with the technician laptop
 - Typical rule of thumb is that newer = better, and that larger devices have more consistent speeds over Wi-Fi due to a larger wireless antenna

2.4 GHz has three non-overlapping channels to work with, while 5 GHz has twenty four. In high-density MDU environments it is very important to look at the severity of congestion on the 2.4GHz frequency and run a speed test (www.speedtest.net) to verify quality service. Lower frequencies travel through materials much better than high frequencies which is why 2.4GHz networks have a greater effective range than 5GHz. Think of a neighbor playing loud music; all you hear is the lower frequencies (bass) and not the high frequencies that are absorbed by building materials.

2.4 GHz	5 GHz
802.11b/g/n	802.11a/n/ac
Greater Range (~300 ft)	Lower Indoor Range (~90 ft)
Universal Compatibility	Limited Compatibility (a/n/ac devices only)
3 non-overlapping channels	24 non-overlapping channels
Congested with Wi-Fi	Little Wi-Fi congestion
Plagued by non-Wi-Fi interference	Very little non-Wi-Fi interference

Why Channel 1, 6 or 11?

Customers spend good money for high speed internet, yet they can’t get the speeds they expect. Why are they experiencing slow Wi-Fi data rates? Selecting the proper Wi-Fi channel can significantly improve your Wi-Fi coverage and performance.

In the 2.4 GHz band, 1, 6 and 11 are the only non-overlapping channels. Selecting one or more of these channels is an important part of setting up your network correctly. Currently, many wireless routers

automatically select the channel for you upon initial setup but, depending on your wireless environment, it could lead to slow Wi-Fi speeds and interference.

Non-Overlapping Channels

Each channel on the 2.4 GHz spectrum is 20 MHz wide. The channel centers are separated by 5 MHz, and the entire spectrum is only 100 MHz wide total. This means that the 11 channels have to squeeze into the 100 MHz available, and in the end, overlap. There are three channels that don't overlap: 1, 6 and 11.

Main causes of WiFi Interference

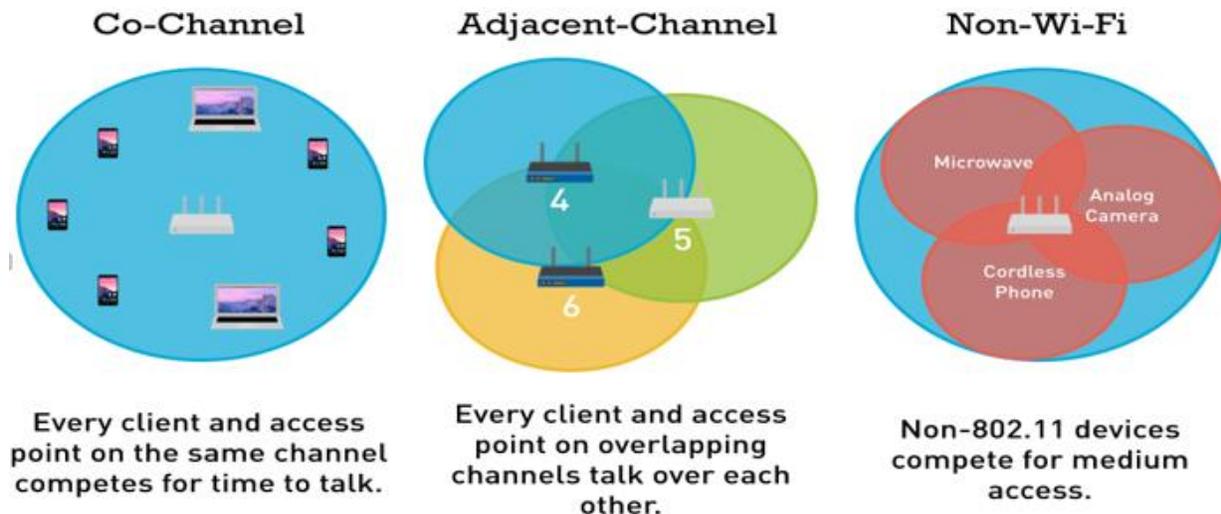


Figure 144: Cause of Wi-Fi Inference

Baby monitors are also a common source of Non-Wi-Fi interference.

InSSIDer will only pick up devices that **broadcast** a wireless data network such as:

- Modems
- Wireless Access points
- Wireless network printers (running a print server)
- Devices that **use** the network (laptops, phones, etc.) or that communicate on non-Wi-Fi wireless frequency (baby monitors, cordless phones, etc.) **do not** show up on InSSIDer without the use of a spectrum analyzer.

The following is a guideline to gauge how different materials in your home affect the signal strength of Wi-Fi.

Every **3 dB** drop is equivalent to a **50% reduction** in power:

Dry Wall: 3 dB

Hollow Wood Door: 4 dB

Brick Walls: 6 dB

Concrete: 8 dB

Refrigerator: 19dB

A good fix for this example would be to place a Wi-Fi Extender in the opposite corner of the customer's home

There are three filter types for InSSIDer Office: Physical, Logical and Channels.

With **Physical Grouping**, all virtual SSID's on the same radio are grouped together. Each line item then

represents one physical radio on an access point that is the host of more than one SSID (i.e.: Guest networks)

With **Logical Grouping**, all access points with the same SSID are grouped together.

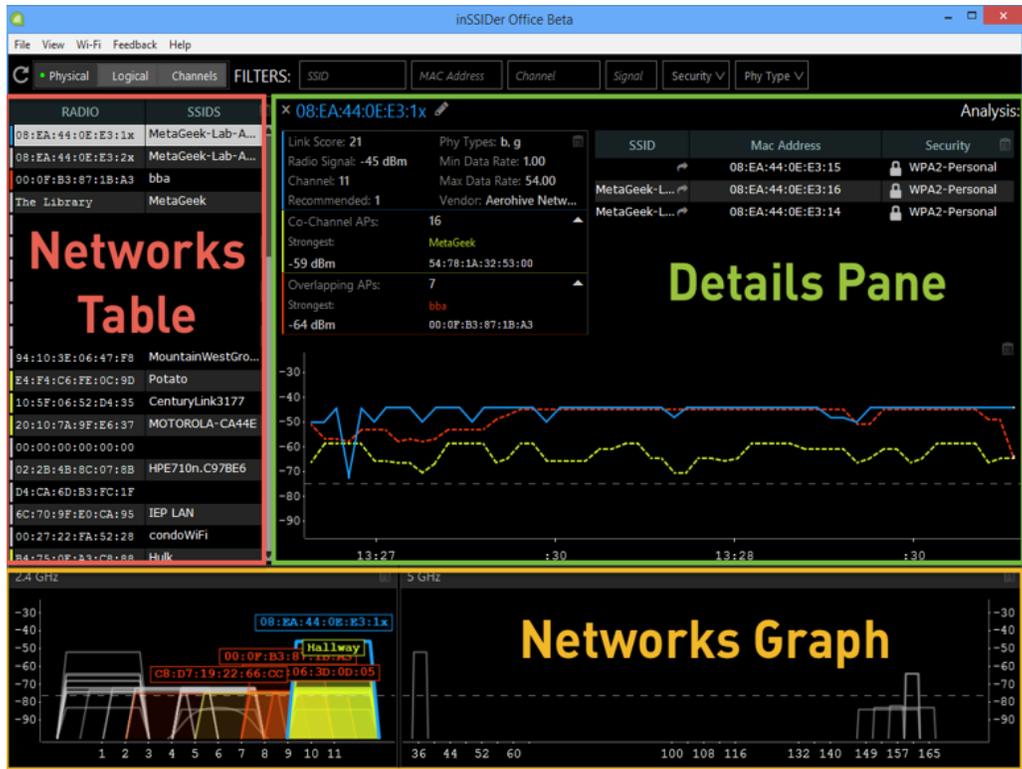


Figure 145: InSSIDer details

Signal strength is indicated in $-dBm$ and the closer to 0 the better.

The dotted line in InSSIDer is set standard at $-75dBm$ and for TELUS installations can be deemed as an unreliable signal strength. **TELUS aims for $-50dBm$ in all areas of the customer's home.**

Using the recommended channel from InSSIDer, move the modem broadcast channel accordingly and re-test the download speeds (i.e.: www.speedtest.net). You can also see a direct result on the signal strength graph as interference is avoided.

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4. GPON training in INR course