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Broadband Over Existing Cable in Hotels

VDSL2 vs DOCSIS

Telephone wire and coaxial cable is found in every hotel guest room. At the most basic, these cables are used to deliver guest room entertainment to a television, and communications to a bedside phone. With the advent of Internet delivered content and ubiquitous smartphones, the guest expectations have far exceeded the ability of basic television and telephony communications. Additionally, the all-wireless nature and convenience of mobile devices has made 802.11 wireless networks preferred.

There are four methods to deploy 802.11 wireless into hotel guest rooms to service higher quantities of low power wireless devices.

Ethernet

Ethernet networks use category rated cable to connect 802.11 wireless APs inside hotel guest rooms. Unfortunately, Ethernet is not common in all hotel rooms and is tightly constrained by wire length and type.

802.11 MESH

802.11 MESH technology can be used to bridge the gaps between guest room APs and centrally located root APs. This attractive technology can reduce, but not eliminate, the need for new Ethernet cabling. The topic of MESH is not covered in this document, but is worthy of consideration.

VDSL2

VDSL2 uses point-to-point telephone wire already in the hotel to deliver dedicated broadband into the guest room for guest accessible Ethernet at the desk, and high capacity 802.11 wireless. VDSL2 is transparent to analog telephone signals. Originally designed for residential broadband, VDSL2 can be used as the foundation of a purpose-built hotel technology.

DOCSIS

DOCSIS uses the coax cable already in the hotel to deliver up to 300Mbps (optimal speed of DOCSIS 3.0) of shared broadband to a cable modem located inside the hotel guest room. DOCSIS operates at frequencies above those used for television and VOD. Originally designed for residential broadband, small DOCSIS head-ends and low-cost modems are attractively priced.

Structured cable requirements for Ethernet are well understood and are not discussed further in this paper. When a hotel can afford the downtime and potentially high expense to install a structured cable infrastructure that supports Ethernet – they should do so.

Not every hotel can afford the high cost of re-cabling for Ethernet. In North American hotels, the cost to re-cable can vary from \$300 USD per room to over \$1000 USD per room. This direct cost does not include lost room revenue from idle floors, disturbed guests, and postponed conferences. Due to these negatives, some hotels are interested in leveraging the existing telephone wire or coax cable already in the hotel room to deliver broadband into hotel guest rooms for a high density 802.11 wireless network.

Coax Cable Plant for MATV or Broadband

Coax cable plant is never the same from one hotel to another. Each property requires a uniquely engineered network to accomplish the end goal. When initially built, the coax plant in the hotel was designed for a master antenna TV system (MATV). Adding DOCSIS on top of this network requires re-engineering the cable plant and may involve replacing amplifiers, or pulling new cable to split the network into smaller segments.

When evaluating a site for a DOCSIS deployment, check for the following:

In the Central Wiring Closet

- Type of riser cable used
- Space to install equipment

In the Guest Room

- Measure signal levels to determine loss “stacking”
- Check for RF leakage at f-connector (DOCSIS is very high frequency and leaks are common)
- Check for evidence of corrosion on the f-connectors. May require changing the jack

In the Cable Plant

- Topology and number of rooms per amplifier
- Type and frequency response of amplifiers; check both forward and return path loss
- Frequency response of the system as a whole. DOCSIS 3.0 uses frequencies above the analog TV signals and requires eight bonded channels to reach the theoretical speed of 300Mbps.

Before selecting a vendor, it is highly recommended to evaluate an existing property using standard test tools such as iPerf to test TCP throughput using standard PCs with Ethernet ports.

The following information describes hotel coax systems and illustrates the various topologies used for coax distribution networks.

System Frequency Allocation

Broadband systems over coax are designed by starting at the end of the cable and working back toward the headend. Each component in the system subtracts RF signal from the total available. If the losses are too great, amplifiers can be added to boost the signal. However, amplifiers amplify noise as well as signal, so there is always a trade off. One extra factor to consider is that signal loss is greater at high frequency than it is at lower frequency. Lower frequency = less signal loss = greater range and tolerance of deployment mistakes.

MATV systems in hotels were designed to carry analog television channels into each hotel room. Each analog channel is 6Mhz wide. Channel 2 starts at 54MHz. If we assume 30 channels at a particular hotel, a simple calculation shows that a MATV system needs 234MHz for FTG (free-to-guest) content. $(6\text{Mhz} * 30 \text{ channels}) + 54\text{Mhz} = 234\text{Mhz}$. If VOD is offered, the remaining frequencies are allocated for use as VOD channels and management channels. The typical cable plant found in hotels is 550MHz or 750MHz to support FTG, VOD, barker channels and system management.

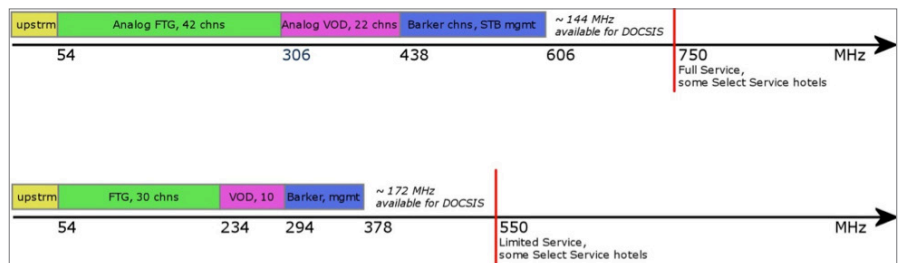


Figure 1: Diagram of frequency allocation for Full, Select, and Limited Services Hotels. Not all hotels are the same – different combinations of channels and technology will result in a different frequency allocation. Site evaluation is required.

The diagrams above show the overall system level frequency allocation. For a distributed coax system, each leg, tap, amplifier and termination affects the overall system performance. For an analog MATV system, mistakes are often masked by the cable capacity itself, but for high frequency DOCSIS deployment, any mistake in the topology must be found and corrected.

Coax Cable Topology

The primary coax cable topologies are home-run, drop-tap, hybrid fiber-coax, and hybrid splitter-tap. By a wide margin, the hybrid splitter-tap topology is the most common in hotels for its low cable cost. Three types of coax cable may be used; RG59, RG6, and RG11. RG59 has the most loss per 100ft of cable, so the rest of this document will assume RG6 cable is used. RG11 has the least amount of signal loss, but it is 0.4 inches diameter and inflexible. RG11 is commonly used for riser trunk cable.

To better understand the splitter-tap topology, first review a pure home run and pure drop-tap topology.

Pure Home Run

Pure home run cable is not common in hotels due to the high cost of dedicated coax cables run to each room and large diameter of the coax cable itself. The best way to illustrate a pure home run network is a single family residence. The cable company typically delivers up to 15dB of signal to the home. If we assume there are eight television jacks in the home, the pure home run topology would look like this.

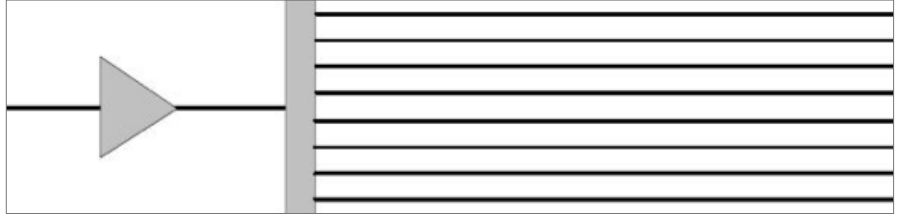


Figure 2: In this diagram, ► is an amplifier used to compensate for the splitter losses and | is an eight-port splitter. One television could be connected on each end of the long home run cable.

Signal loss in a splitter is 3.5dB for a two-port, 7dB for a four-port, and 12dB for an eight-port. Signal loss for each 100ft of RG6 cable is about 6dB (to keep this simple, we will only use the signal loss at the high frequency. Is that making this any easier?). In the topology above, if each leg off the splitter is 100ft, the loss to any single TV would be 12dB + 6dB = 18dB. Since most residential cable companies deliver about 15dB to the home, we have to install an amplifier in this network. A hotel installed MATV system will have more signal than what is sourced in a residential system, but a hotel also has more than rooms than a single family home.

For hotels, there are three reasons this is not a common topology:

1. High cost of dedicated coax cable to each room
2. Large cable diameter makes installation costly and requires extra riser space
3. Each leg of the splitters must be nearly equal. An unbalanced splitter (for example if one port has 50 rooms and one port has 2 rooms) will lead to signal starvation on the overloaded leg. This requires more thought when laying out the cable topology.

Pure Drop-Tap

This might be used in a school where a single coax cable runs through the ceiling with a “drop-tap” placing one TV in each classroom. In contrast to the nice clean splitter diagram above, a drop-tap has to avoid “end of line” starvation. This occurs when the nearest drop-tap siphons off more signal than it needs, causing massive signal loss at the end of the line. To avoid this situation, the MATV system will use a different value drop-tap at each location. Note how this is illustrated.

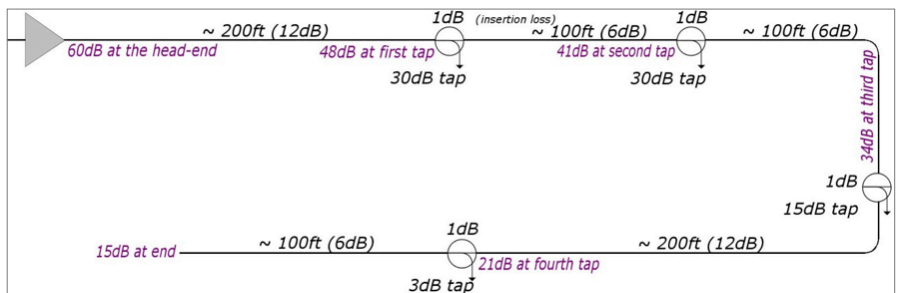


Figure 3: In this diagram, ► is the combiner output at the headend and ⊖ is a one port drop-tap. The end of the cable must be terminated with a 75ohm termination ⊖.

A drop-tap is not the same as a two-port splitter. The difference being a two-port splitter splits the incoming signal equally on each port; whereas a drop-tap is unbalanced, allowing more signal to pass-through to the next tap. This comes with the additional complexity of using the correct drop-tap at each location.

For hotels, there are four reasons this is not a common topology:

1. One cable would have to snake its way to every room on all floors
2. A true single point of failure (cable systems suffer from this in general)
3. RF leakage at the near-end TVs. High frequency and high amplitude signals will leak from a poorly terminated cable. Energy is sapped from the remainder of the line.
4. Insertion loss works both ways; forward path and return path. The combined insertion loss and cable attenuation would impair upstream signal and limit the length of the cable.

Hybrid Splitter-Tap

This is the most common topology used in hotels and other MTU such as hospitals and dormitory housing. The diagram below is from a real hotel with over 700 rooms on a single RG11 trunk. Splitters, amplifiers and four port drop-taps are used to feed TVs in hotel guest rooms.

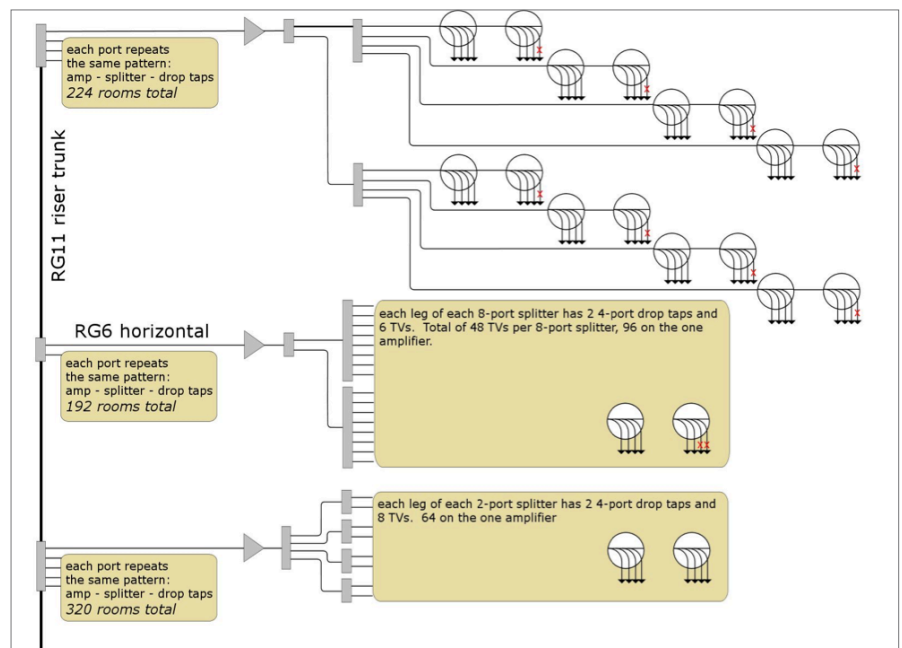


Figure 4: In this diagram, ► is an amplifier, | is a 2-port, 4-port, or 8-port splitter, ○ is a 4-port drop-tap, and ○ with a red X is a 4-port drop-tap with some ports terminated and not used.

DOCSIS Summary

Cable plant can be any one of three topologies; with variations within the topology. For example, the Hybrid home run/tap topology can vary within the same property as different parts of the building were erected.

In nearly every case, DOCSIS will require extensive site prep that may include changing components (splitters, taps, and amplifiers) or even re-cabling the riser or horizontal RG6 cables to split up the rooms into smaller service groups.

VDSL2 over Telephone Wire for Dedicated Broadband

Like the coax distribution system, telephone infrastructure can vary from hotel to hotel. Unlike coax, the topology is always a point-to-point connection between the PBX in the central wiring closet and the telephones in the room.

VDSL2 is designed to accommodate variations in wire length and wire type. Since all telephone wires are home-run to the central wiring closet, VDSL2 provides dedicated broadband, isolation from issues elsewhere on the property, and no single point of failure.

(A common misconception is that VDSL2 requires Cat-3 rated cable. In fact, the only requirement is UTP wire (unshielded twisted pair))

When evaluating a site for a VDSL2 deployment, check for the following:

In the Central Wiring Closet

- Space to install equipment and telco cross connects
- Available AC power for the VDSL2 DSLAM (aka concentrator or Switch)
- Additional HVAC may be required for larger properties

In the gGest Room

- Inspect the RJ11 jacks in a few rooms to look for corrosion. This may be required in areas with high humidity and would require changing the RJ11 jack

In the Cable Plant

- The only requirement is UTP (unshielded twisted pair) cable

For most Limited and Select service hotels, the evaluation criteria can be performed by a telephone interview with the property engineer or other person that can answer basic questions. The best person may be the contracted PBX maintenance company.

Before selecting a vendor, it is highly recommended to evaluate an existing property using standard test tools such as iPerf to test TCP throughput using standard PCs with Ethernet ports.

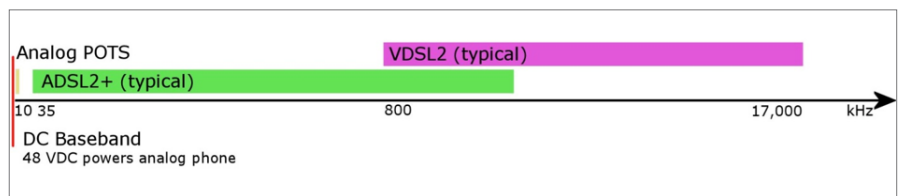


Figure 4: Diagram of spectrum allocation with analog POTS and ADSL2+ or VDSL2 Drawing is not to scale.

Cable Topology

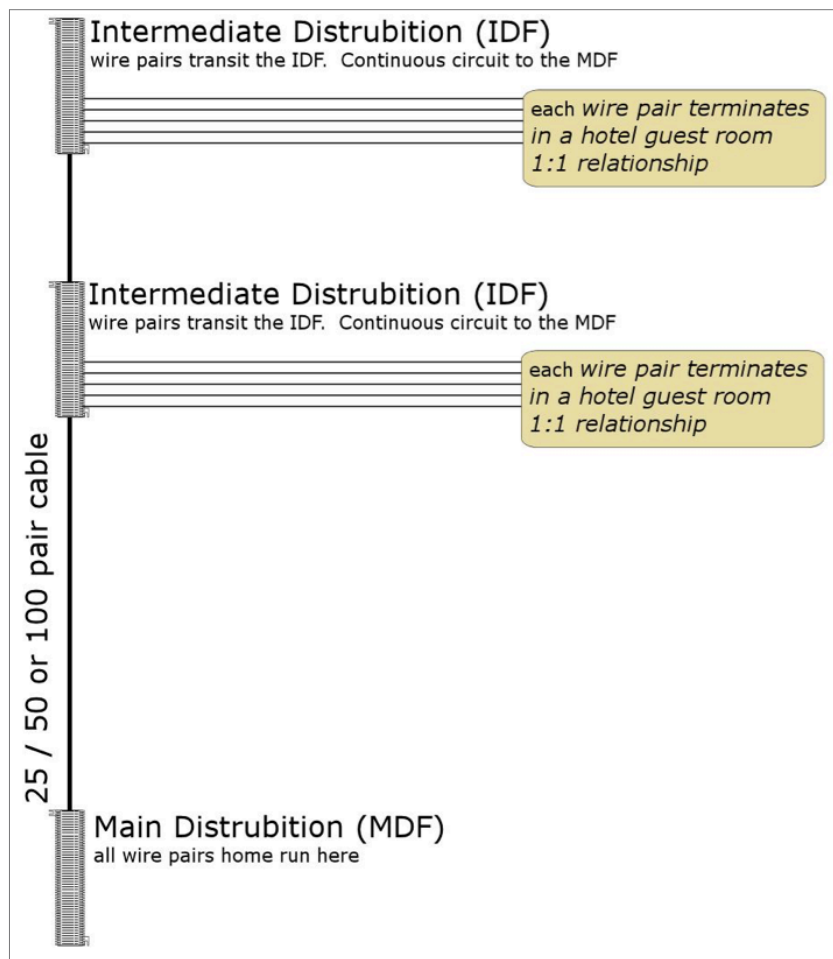
All telephone cable is home-run from the guest room to the main distribution frame (MDF) and terminated at the PBX. In larger hotels, Intermediate distribution frames (IDF) are located about one every three to five floors to facilitate adds/moves/changes to individual guest rooms. In smaller hotels, often there are no IDFs and each guest room has a dedicated two-pair cable home-run to the MDF.

There is no deployment or functional difference if the wire pairs transit an IDF on the way back to the MDF. A deployment of a VDSL2 system does not require installing equipment in an IDF. For the Extreme Networks' T5 system with Adaptive Line Power, it may be desirable, but not required, to locate equipment in an IDF for very large properties with cable lengths that exceed 1000ft. This is rare.

Topology Diagram of a Telephone Cable Plant

The following illustrates how telephone cable can be routed through an IDF on the way to the MDF. Every wire pair in the guest room terminates in the MDF on a telco cross connect field.

The 1:1 topology scales from a small 25 room Boutique Hotel to large hotels such as the 5,004 room MGM Grand in Las Vegas. Small hotels will typically skip the IDFs, but they are immaterial to a VDSL2 deployment.



VDSL2 Summary

Telephone cable is always a home run from the guest room to the central wiring closet. Installation is always a repeat of the same process. Site prep is the normal network preparation (ensure adequate power in the closet) and re-terminating the phone room wires onto a cross-connect block in the central closet.