VOD: LIFE ON THE STREETS

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ABSTRACT

A Video on Demand (VOD) deployment is easy. All you have to do is drop a server into a headend, connect it, and lean back. Right? Of course not. Successful VOD deployment is complex. There are many issues to consider, many tasks to complete, and unanticipated hurdles to overcome.

What are these details? What pitfalls must be avoided? What practices are important to follow in order to insure a successful deployment?

There are three general areas to consider in a VOD deployment:

- Overall project management for the deployment
- Pre-installation preparation
- Site-specific configuration and service testing

Quality overall project management is critical to a successful rollout. There are many parties involved with a VOD rollout — the MSO, the VOD vendor, and the network infrastructure / set-top vendor. It is essential that a single project manager be identified and placed in a position of authority and responsibility to bring all of these parties together. This helps to build a team, fosters a “get-the-job-done” attitude, and helps avoid finger pointing when problems arise. Often a separate, dedicated systems integrator is worth employing to provide the project management role because of its objectivity and multi-vendor neutrality.

Once the project manager is in place, it is important to have good up-front planning for each headend. Quality site surveys are required. All issues need to be considered. Among them are power requirements, sufficient HVAC, allocated rack space, operational IP network connectivity, and comprehensive wiring diagrams. Also, site surveys must be allocated sufficient time. A quality site survey - where all issues are physically verified -

often takes two days and requires full participation from MSO headend personnel.

Before installers are dispatched to the headend, the project manager needs to make sure that all the necessary preparations are made: power lines are run, HVAC is increased, racks are installed and plants are tested. Installers have often arrived at a headend only to sit on their hands. The necessary infrastructure wasn't in place to even plug the VOD server in. The project manager helps to solve this expensive and wasteful problem.

Plant configuration is the second major area to focus careful effort. Most people are surprised to hear this. After all, the plant has been working just fine for broadcast video. It's been working for years - even decades - and so it should work for VOD, too. Right? Unfortunately, this is often not the case.

The problem arises with the connectivity between the QAM modulators and the fiber nodes. When new QAM channels are added for VOD services, they are often connected to the wrong outgoing fiber. It is easy to do. In VOD, the directed, personalized nature of the service requires that different video go to different nodes. If the node connectivity is incorrect, then the VOD service will not work. Also, the return path must be engineered, sized and tuned for proper VOD operation.

Finally, configuration of the headend gear is obviously critical to successful operation. The headend controller and the VOD server both need to be properly configured in order to utilize the correct bandwidth to work properly. Billing systems need to be integrated for purchasing and revenue generation. This process often proceeds very slowly simply because the configuration procedure is new. Also, it is important for this phase of the installation to have zero impact on the operation of the MSO's existing services.

The answer is a well-trained and well-informed installer both on the network controller and the VOD server. High-quality personnel can get this phase done in hours; poorly trained personnel may require days and many Excedrin. As a result, large rollouts may require a good training program for all personnel involved with operating the system.

If these issues are handled well, everyone will reach the final phase of the VOD deployment quickly and efficiently — to lean back and enjoy a movie.

INTRODUCTION

You've all probably seen something like this happen:

- Marketing agrees to deploy VOD service.
- President inks deal with VOD vendor, and
- Lets the Chief Engineer know in the hallway.
- The Chief Engineer is a busy person.
- Proper follow through on the installation falls through cracks.

Then, later, just before the deployment date:

- The VOD servers are shipped, complete with installation technicians.
- The headend personnel are completely surprised.
- The installation technicians twiddle their thumbs.
- The headend personnel make some phone calls.
- There's maybe some yelling and cursing…

…Then, things slowly get figured out.

We've all had similar experiences. The cable TV business is growing and changing rapidly. All MSOs are adding services and customers. They're consolidating facilities, especially after the recent spate of mergers and acquisitions. And, of course, there are all the "regular" services and operations that must be dealt with on a daily basis.

Video on Demand (VOD) is just another service to be stirred into the mix. Given the hectic nature of our business, there's a good chance the launch of this critical service will experience difficulties unless it is handled thoughtfully and carefully. As with the launch of any new service, VOD deployments are most successful when they are implemented in a systematic, thoughtful and disciplined manner. The following elements are important parts of this process:

- Establish Project Management
- Prep, Prep, Prep
  - Documentation
  - Site Surveys
  - More Documentation
  - Order and Ship Equipment
  - Training
  - Site Prep
- Install Servers and Test
- Install Content Delivery System
- Sit Back and Enjoy the Popcorn!

The remainder of this paper will detail each of these important topics.

CHOOSE A PROJECT MANAGER

Solid project management is the primary key to a successful VOD launch. VOD systems and the process necessary for their deployment are complicated. Project

management provides the structure necessary to keep the project moving forward on a predetermined schedule. The project manager leads the VOD deployment team.

A good project manager (PM) for a VOD deployment has several important qualities. He or she must have a good technical knowledge of the system and its technologies. A solid technical foundation allows the project manager to quickly get to the heart of a problem, to identify charlatans, and, most importantly, gain proper respect from the team.

The PM's knowledge must be fairly broad and well-rounded. It should encompass not only the VOD system itself, but also a good understanding of a network's operation. In addition, the PM must be a good people person, as he/she will be working with a wide assortment of folks during the course of the deployment. Of course, skill at jockeying Microsoft Project files is a bonus. In the final analysis, a good project manager is a good team leader.

Ideally the MSO supplies project management. The MSO is the ultimate customer for the VOD system. It is the MSO who benefits from properly stitching together all the equipment and software supplied by a variety of vendors. Since this is also the primary responsibility of the PM, having them work strictly on behalf of the MSO insures proper direction and motivation. An MSO can directly supply project management from its internal resource, or it can outsource this function to a qualified integration outfit that specializes in providing this function. Often outsourcing is a better alternative, since it matches the natural rise and fall of this type of project based work.

In many deployments, the VOD vendor supplies this project management. This approach does work, but it's not the best. A PM that is directly linked to the MSO can get the attention of the necessary vendors when problems arise. After all, the MSO is the ultimate customer – and they're often a BIG one, too! So when an MSO calls, the vendor responds. An employee of a VOD vendor doesn't have this kind of clout.

A final word on project management: If at all possible, keep the same project manager constant across the overall project. This consistency prevents confusion, maintains a single purpose for the team and, generally, provides the consistent leadership every successful team requires.

DEPLOYMENT KICKOFF

ESTABLISH THE TEAM

The first step in a VOD deployment is to identify the correct team. Team selection must balance inclusion against the necessity of smallness and efficiency. The team must include representatives from all the necessary groups, but must not grow ponderous and slow. Where possible the project manager should participate in selection of team members. Representatives should be included from each of the following groups:

- Project Management
- Engineering Staff
  - Network Architect
  - IT/Billing system/Addressable Controller Expert
- Headend Staff
- MSO Marketing
- VOD Vendor

- Content Vendor

Although it may not be intuitively obvious, marketing must be represented on the team. Marketers need to review the architecture and the plan for the VOD deployment for one simple reason: They are (usually) responsible for meeting an MSO's revenue targets. They have a specific service they want to offer. They have a specific method of billing for this service. They have a timeframe they've often committed to for establishing this new revenue stream. Therefore, they need to review the architecture and plan to assess whether or not it will meet their needs. And, if it doesn't, they can make the necessary adjustments – either to the VOD system, or to their business plans, or to a little of both – in order bring expectations closer to reality.

KICKOFF MEETING

The kickoff meeting has a couple of goals. First, it provides a forum for the team members to meet each other. Often team members haven't met prior to this, especially if they work in different companies. Second, it establishes and communicates the team's goals. Third, it lays out the basic process and strategies the team will use to reach their goals. Finally, the meeting communicates each team member's role in the overall process. When the meeting finishes, each team member will understand what they're heading for, how they'll get there and what their role is.

PRE-INSTALLATION TASKS

Have you ever seen a good tile guy work? They spend days getting ready, even for a small job. They level and measure and square and calculate and ask questions and prep the sub-surface and take care of dozens of other details. Then, just when you're ready to fire them for being so slow – BOOM! – they lay the tile like a cat runs from a kid with a garden hose. They finish up fast and the job looks great. The tile lines match from floor to wall, overlaps are perfect and lines are all straight. And they don't have to redo anything. The pre-installation period of a VOD deployment is exactly like the prep period of a good tiling job.

Pre-installation tasks fall into five categories:

- Architecture Document
- Site Surveys and Site-Specific Documentation
- Equipment Ordering and Shipping
- Training
- Site Preparation

ARCHITECTURE DOCUMENT

The general architecture of the VOD system must be well documented. It provides the technical foundation for all work done in the deployment. The architecture document includes all the general architecture information about the VOD system. It does not cover site-specific details. Those are covered during each site's survey and the subsequent documentation.

The general architecture system includes:

- **Signal Flow:** The architecture document diagrams the basic signal flow from the content receiver to the server, and, the two-way flow between the server and the subscriber's set-top box. The signal flow diagram(s) must show every piece of equipment involved in a VOD system, in both the downstream and upstream paths.

  The signal flow diagram should include the content delivery network, too. It should show the overall network topology, whether it's a distributed or centralized network, and the components of the distribution network.

- **Per Node Channel (Frequency) Allocation:** The architecture document provides guidelines for frequency allocation for the VOD service in conjunction with pre-existing guidelines for services already offered by the MSO.

- **Sizing:** The document should include general sizing policies for the VOD system. For the downstream network, it should give rules of thumb for each of the following:

  - Assumptions for digital subs, VOD subs and simultaneous sessions as a function homes passed.
  - Number of homes per service group
  - Number of VOD channels per service group
  - Number of QAM modulators per service group
  - Number of IP switches (if IP distribution is used)
  - Number of any other pertinent pieces of equipment as a function of either homes passed or service group, as appropriate.
  - Size guidelines for the server complex as a function of homes passed

  Of course, the specific numbers for each site will vary.

  For the return channel, it should provide rules of thumb for each of the following.

  - Number of homes passed per return path demodulator
  - Size guidelines for Interactive Gateway (if necessary) as a function of simultaneous sessions
  - Size guidelines for other participants in the VOD session, such as DSM-CC network functionality

  For the backend network, the architecture document provides sizing information on the following:

  - WAN connectivity
  - Internal network connectivity
  - Connectivity between a server complex and the content receiver

  The architecture document should take into account any existing services such as broadcast video (analog and digital), cable modems, telephony and status monitoring when detailing the sizing guidelines.

- **Wiring and Level Diagram:** The architecture document should include generic wiring diagrams that are as detailed as possible. MSOs generally like to utilize a consistent wiring approach across headends in order to increase operational efficiency and ease troubleshooting. Full connectivity between each subsequent piece of equipment should be shown with as much details as possible. It includes wire type, color, and any other pertinent details.

  The wiring diagram also details the location of desired insertion/extraction points. These are absolutely necessary for proper testing and troubleshooting.

  In addition to connectivity, the diagram should also calculate signal levels at each pertinent stage of the network. Transmit and receive specifications on each the equipment should be checked carefully. Many of these "new" pieces of equipment transmit at a different level than many of their more traditional predecessors.

- **Equipment Specifics:** The architecture document gives general recommendations/requirements for the following:

  - *Location recommendations:* Any general recommendations for locating the equipment. Any physical security issues are included here.
  - *Rack Space requirements:* Includes physical size requirements for each piece of equipment, as well as any specific racking requirements (such as the inclusion of baffles) required by each piece of equipment.
  - *Power requirements:* Includes number and sizing of outlets required per piece of equipment.
  - *HVAC requirements:* Includes heat removal requirements for each rack of equipment.

- **IP Network:** The architecture document gives guidelines for supplying WAN and internal network (usually Ethernet) to the server complex. This includes:

  - IP address guidelines. Always reserve extra IP addresses for use during the installation period.
  - Network security guidelines, including firewalls.

- **Basic Material:** The architecture document also suggests guidelines for the amount of basic material, such as raw cable, connectors, etc. to have available during the installation.

SITE SURVEY

A good site survey is probably the most important part of a successful VOD deployment. If done well, the survey catches the big surprises early, when they're still easy to fix. Here are a few example situations we have found ourselves in that could have easily been prevented by a proper site survey:

- **Extension-Cord-a-Rama:** The VOD servers arrive at the headend. The installers un-crate them, rack them, but can't plug them in. There are no

available power outlets. The only options available are to wait for proper power outlets to be installed or to unroll the long, orange snake.

- **The Shoe Horn:** The VOD servers arrive at the headend. After uncrating, the installers notice that they are much larger than anticipated. They are so large, that they won't fit in the space between the target rack and the wall behind it. They extend out too far. The only options available are to move the rack or to find another rack with the necessary open space.

- **The Pole Polka:** The VOD servers have been installed and they're ready to test. However, the installers find that there are no available test points at the fiber transmitter with which to exercise the system. The installers have to get in a truck and drive to an outside plant location (probably a pole) where they can access the signal for each transmitter/receiver pair. This is a lot of expensive work that could have been eliminated by making sure test points are available.

Site Checklist

The checklist is based largely on the architecture document. The site survey engineer takes the guidelines found there and adapts them to the specifics of this site. It covers all of the issues addressed in the architecture document, including sizing, wiring, level setting, IP network connectivity, equipment location and racking, power, HVAC, and equipment quantities. The checklist forms the foundation for a good site survey.

Survey Execution

The site survey is done on site. In close conjunction with the site's engineering personnel, the surveyor works down the site checklist, point-by-point. He or she should check on every item. In addition, anything special about the site should be noted. All sites are unique. There is always something not covered on the general checklist. A good site survey often takes a couple of days.

In addition to its documentation of the site's specific configuration data, the site survey is a key communication vehicle for the team. Proper use and distribution of the site survey to all associated personnel helps avoid mis-communications, mistakes and delays.

Site Specific Documentation

Upon completion of the survey, two documents are prepared:

- **Site survey results:** This is a filled-in version of the checklist, with all site-specific comments included.
- **Site-specific BOM (Bill of Materials):** This is a tabulation of all equipment required at the site. Site-specific BOMs form the basis of the over all equipment order from all vendors.

ORDER AND SHIP EQUIPMENT

Once site surveys are completed – or even before all surveys are complete – equipment and supplies can be order and scheduled for delivery. The site-specific BOMs

form the basis for order lists to specific vendors. Vendors can be grouped into the following categories.

- **MSO:** The MSO is not usually considered a "vendor." However, it is usually responsible for supplying all the basic materials, such as combiners, splitters, amps, cables, etc., as well as test video content. The MSO has the contract with the content provider and they, therefore, usually provide content for testing the system.

- **Transport Vendors:** These vendors provide all the gear for hauling information on the backend network as well as between the subscriber and the server. It includes the encryption/QAM gear, IP switches, GigE transport, etc.

- **VOD Vendor:** The VOD vendor supplies servers, server managers, and software.

  To save time during installation, servers can be pre-staged by the vendor. If pre-configured correctly, they can plug-and-play directly into the network without further configuration as soon as they arrive at the site. This is a huge help for installers, since it eliminates a lot of the tedious, error prone work from the often high-pressure environment of a VOD installation site. However, pre-staging of servers is only as good as the configuration data given to the vendor. If this data – which is probably based on the site survey – is inaccurate, or becomes inaccurate due to change after the site survey, pre-staging the server loses its value. In some cases, depending on what data is inaccurate, the server may have to be reconfigured from scratch after it arrives at the site.

  Each VOD vendor can supply the necessary configuration data for their server. Configuration of each vendor's server is unique. They each require a different set of configuration data.

- **Content Vendor:** The content vendor supplies the content receivers and related software. Often these have only to be powered on and connected to a network. The vendor can then log on remotely to complete configuration and initiate proper operation.

Once BOMs are completed, orders can be placed with each vendor. This is an area where the project manager is critical. Since on-time shipment and arrival is critical to the smooth and timely completion of a VOD deployment, vigilance over these orders pays big dividends.

TRAINING

There are a couple of training options to be considered. First, the MSO personnel can be trained on the VOD equipment at the VOD vendor's site. This is the way training is typically done. In this case, training is often isolated from the actual installation sites, making it tough to quickly apply the learner's new skills. As a result, the knowledge is quickly forgotten. Often, a second option – on-site training – may provide better results.

This method is a lot like teaching the baby to swim by tossing it in the pool. It's very tough at first, but the knowledge is not forgotten.

A third option, which we suspect would work very well, is to train the MSO personnel in the operation of the VOD server complex *after* the installation. By having the training after installation, the learner is fully motivated to learn operation of the server. He or she is already acquainted with the server, undoubtedly generated a number of questions, and is ready and motivated to learn.

SITE PREPARATION

There are several important steps in preparing the site for a VOD installation. This paper assumes that any site construction, HVAC expansion, power system wiring and other infrastructure issues have been taken care of. Methods for addressing these issues are well understood. Instead, the paper focuses on issues that are specific to VOD installations. These include:

- Transmitter Wiring
- Receiver Wiring
- VOD Forward Path Wiring
- VOD System Test

Recommended Transmitter Wiring

Figure 1 recommends a method for wiring sources to a fiber transmitter. Broadcast services are introduced separately from non-broadcast services via an isolated amp or a transmitter with a high-isolation input to prevent cross talk. Interactive, non-broadcast services, such as cable modem data, VOD, telephony and status monitoring, are introduced to the transmitter through a single combiner. Each service is on a well-labeled color-coded cable, and each combiner is wired exactly the same. Such consistency makes the operation and troubleshooting of the network much easier.

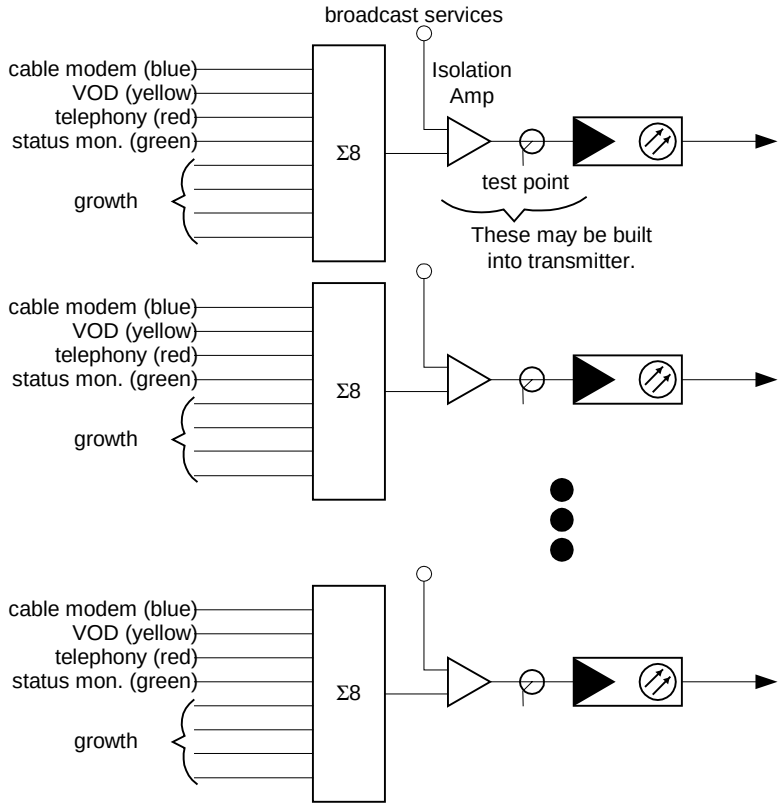

Figure 1: Recommended Transmitter Wiring

Each transmitter also has a separate insertion point. This point provides access to test and troubleshoot all interactive services, including VOD. It is critical to have this test point in order to efficiently and cost-effectively test the VOD installation.

Recommended Receiver Wiring

The recommended wiring for a fiber receiver is similar to the transmitter. It is diagrammed in Figure 2. All non-broadcast services are split out at a common splitter. Once again they are wired on well-labeled, color-coded cable, and are wired consistently across all splitters.

The test point is again critical to easy testing and maintenance of the VOD system. Keep it open and available at all times.

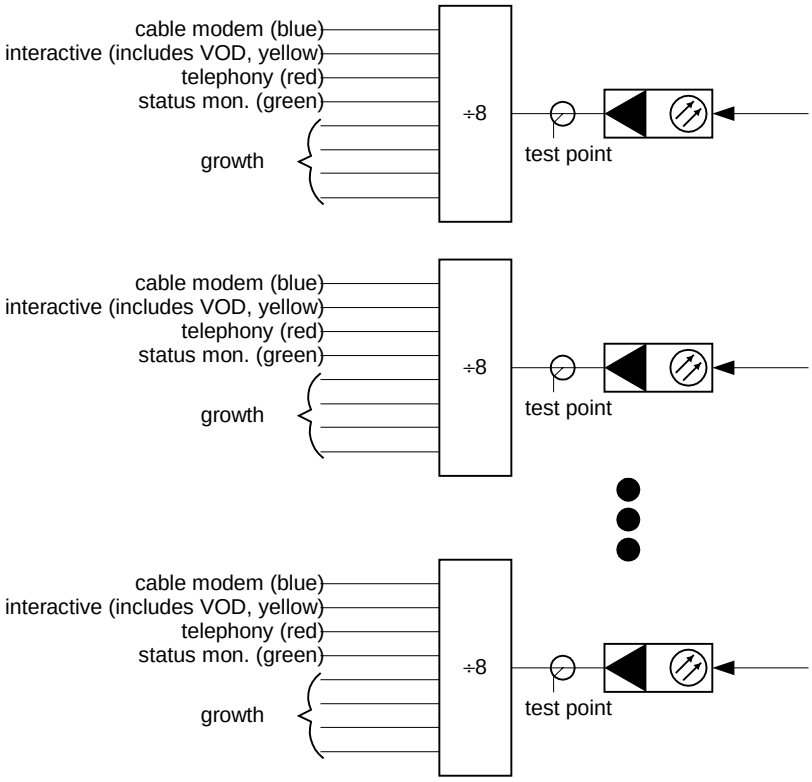

Figure 2: Recommended Receiver Wiring

Typical VOD Forward Path Wiring – ASI Based

Figure 3 shows the recommended wiring for the forward path network of an ASI-based VOD system. Signals flow from the server complex to the QAM modulators over an ASI link. After modulation they are routed through a fixed wiring matrix, through a combiner-splitter network and then to a group of transmitter/nodes. The purpose of the combiner-splitter network is to group a stack of channels carrying VOD services together for transport to a group of nodes. The group is commonly referred to as a *service group.* Grouping several common VOD channels together for delivery to a group of nodes helps spread out peaks of subscriber load across several channels. A common service group size is about 2000 homes passed.

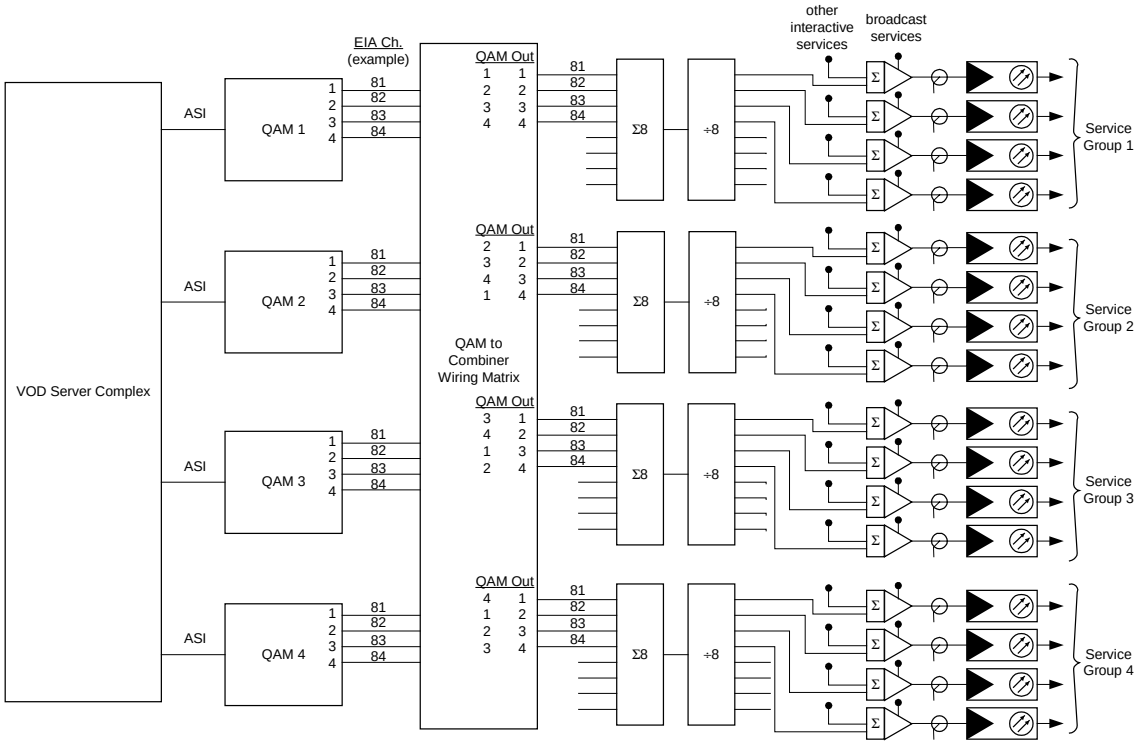

Figure 3: Typical VOD Forward Path Wiring - ASI Based Distribution

The wiring matrix is the key to this network. As shown, it routes one output from each QAM to each service group. This minimizes the failure of a single QAM by limiting its impact to a single channel on each service group. A QAM failure on a more straightforward wiring matrix, might bring down an entire service group. The matrix also allows each of the QAMs to be configured exactly the same. Each output is at the same frequency, regardless of QAM. This attribute is desirable since spare QAMs can be pre-configured and swapped in quickly to replace a failed QAM. Finally, this matrix also places the same frequencies at each combiner port, so that all the combiners are identical. Again, consistency helps ease the operation and troubleshooting of this network.

The wiring matrix is complex, but it only has to be done once. And, once it's done it makes operation of the rest of the network much easier.

The matrix and the full wiring network – from QAM to transmitter – needs to be tested prior to server installation. Testing is straightforward. Insert a continuous wave signal at an input and check every output port for the presence of the signal. The signal should be seen where it IS wanted and NOT where it isn't. For instance, to test the matrix, insert a signal where each QAM output would be connected. Then check each of the matrix outputs. The signal should be detected only on the specified ports. In addition, test the full network inserting a signal on each QAM output and checking at each transmitter's test point. Again, the signal should be seen only on the desired transmitters.

Typical VOD Forward Path Wiring – IP Based

Figure 4 shows the typical forward path wiring for an IP based VOD system. It is basically the same as with the ASI approach, only the VOD servers deliver their content over an IP based network (usually GigE) to an IP switch and then to an EdgeQAM.

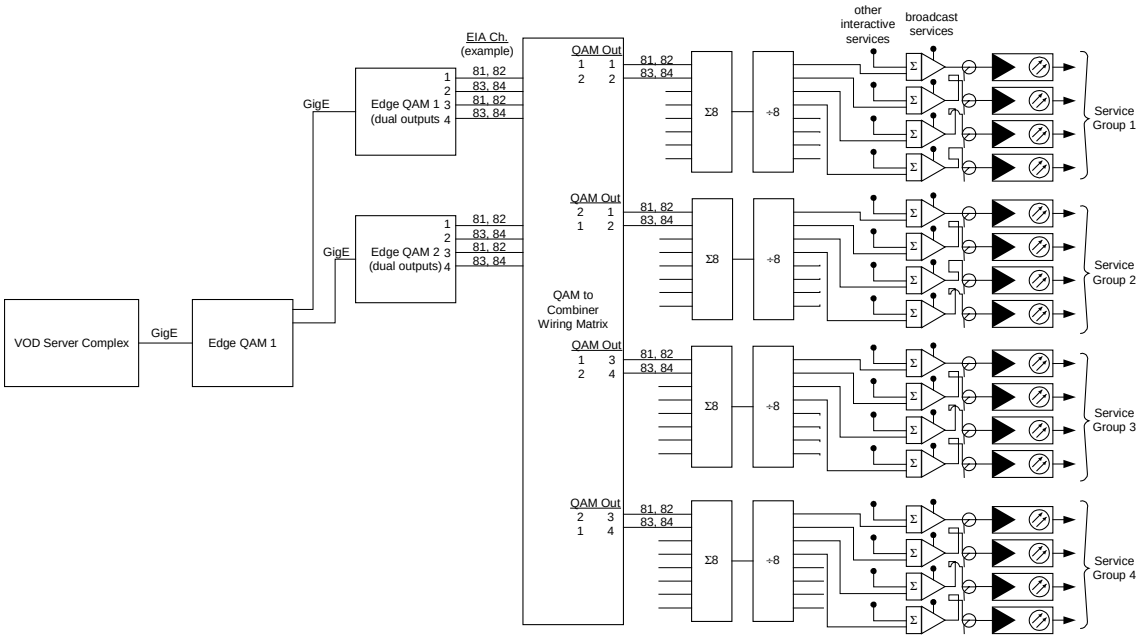

Figure 4: Typical VOD Forward Path Wiring -- IP Based Distribution

One common difference in this network is that IP-based QAMs often have dual channel outputs. This reduces the wiring matrix to ¼ of the ASI's matrix size. (½ the inputs multiplied by ½ the outputs.) The impact of a failed QAM is higher, though, because of the dual channel outputs. Now, when a QAM fails, two channels are impacted in each service group. Output levels of the EdgeQAMs should be planned for carefully. They are often lower than their traditional counterparts due to the internal combining required to produce a dual-channel output.

Example Wiring Mistake

To emphasize the importance of proper wiring, Figure 5 shows a common wiring mistake and its consequences. A wiring mistake has been made in the matrix: two wires have been crossed. In the diagram, correct paths are solid and incorrect paths are dotted.

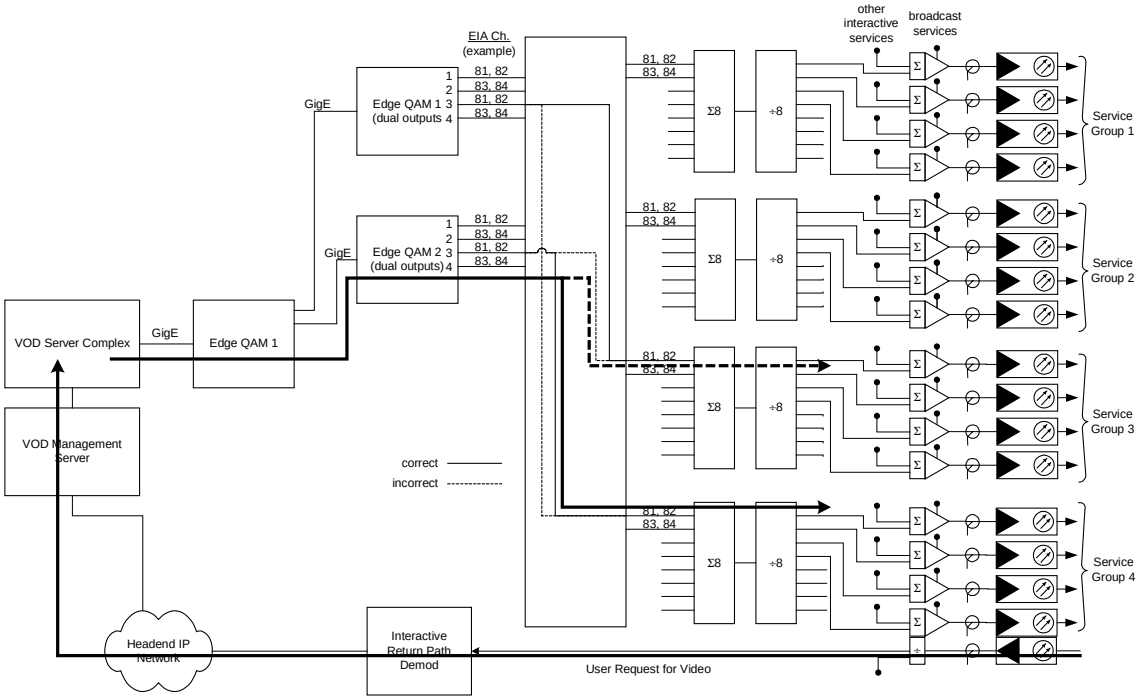

Figure 5: Typical VOD Wiring Mistake and Its Consequences

When the user on service group 4 requests a video, the server sends the video to QAM2, output 3. If wired correctly the video would be delivered to service group 4, as desired. However, due to the wiring mistake, the video ends up on service group 3, and the subscriber sees only the dreaded blank screen.

Wiring mistakes can also produce other effects like frequency overlaps, such as would occur if two outputs with channels at the same frequencies were combined together. Obviously, this won't work well.

VOD SYSTEM INSTALL AND CONFIGURATION

There are several physical components to a VOD system. They include:

- VOD Servers
- VOD Management Servers
- Content Receivers
- VOD Staging Servers (optional)

Installation of this equipment is straightforward, as long as the site preparation has been thorough. It's basically a matter of racking, cabling and powering the equipment. If the racks power outlets, video cabling and network cabling are in place, the job is easy. If not, a significant amount of last minute work is required to complete the installation. To make sure this happens, the project manager should check that the site has been properly prepared before dispatching any installation personnel. This saves time, money and frustration.

The configuration of equipment is the most complicated part of the system's installation. It can encompass some or all of the following items.

- **Set Top Software Download:** The VOD vendor typically supplies this software. However, the cable equipment vendor installs the software on their system controller and sets the download running. Later, the MSO enables the desired set-top boxes via their billing system.

- **VOD Server:** The VOD server must be configured for many different items, including:

  - IP addresses
  - Network Topology
  - Billing system type and interface
  - Content Installation, including movement and any content tagging.

  Every VOD server is unique. The installation personnel should be well trained and experienced in each specific server.

- **Content Receiver (from Satellite):** Set up of the content receiver is typically straightforward. Once it's racked and powered on, the installer makes sure it is connected to the WAN. The vendor can then remotely log on and configure the receiver.

- **Staging Server:** The staging server is the "server's server." It is used in large systems to cache content locally and then distribute it to the local server complex. This allows the local servers to operate more efficiently.

VOD SYSTEM FINAL TEST

Figure 6 diagrams the typical configuration for testing a VOD system once installation and configuration is complete. The test is done with a cart of set-top boxes on each transmitter/receiver pair. One set-top box is used for each channel carrying VOD service. The set-top boxes are connected at the test points of the transmitter and receiver and then, one-by-one the tester invokes a VOD session. Assuming the server distributes service uniformly across the available frequencies, each new session will be on a new frequency. If all four set-top boxes are successful in bringing up a VOD session, then that service group is operating correctly.

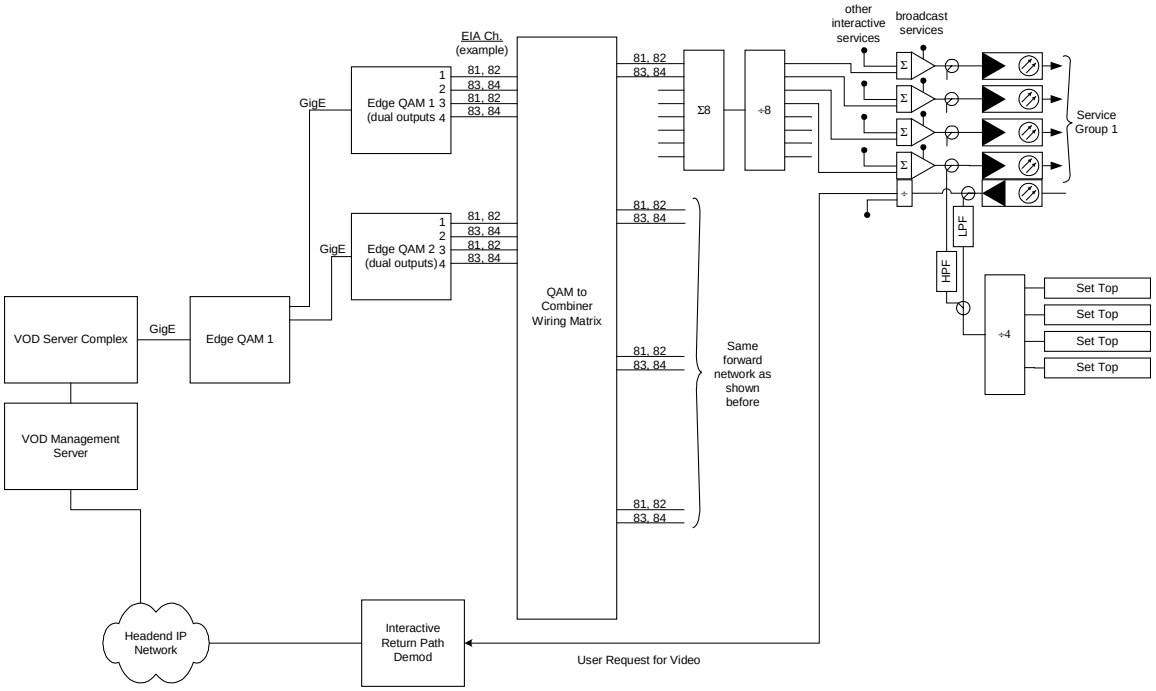

Figure 6: VOD System Final Test Configuration

This is another place where the transmitter/receiver test points are absolutely necessary.

CONCLUSION

A successful VOD deployment depends on:

- Good Project Management
- Good Preparation
  - Proper Team
  - Well Planned and Communicated Project Flow
  - Documentation
  - Site Surveys
  - Equipment Ordering and Shipping
  - Site Preparation
  - Training
- Good Installation and Test

The bottom line is obvious: Any good service deployment – including VOD – is based on a well thought out plan, good communication of the plan and controlled, rigorous technical execution.