

# **The New Table Stakes for Triple Play Deployment: Basic Performance + Unprecedented Customer Quality of Experience**

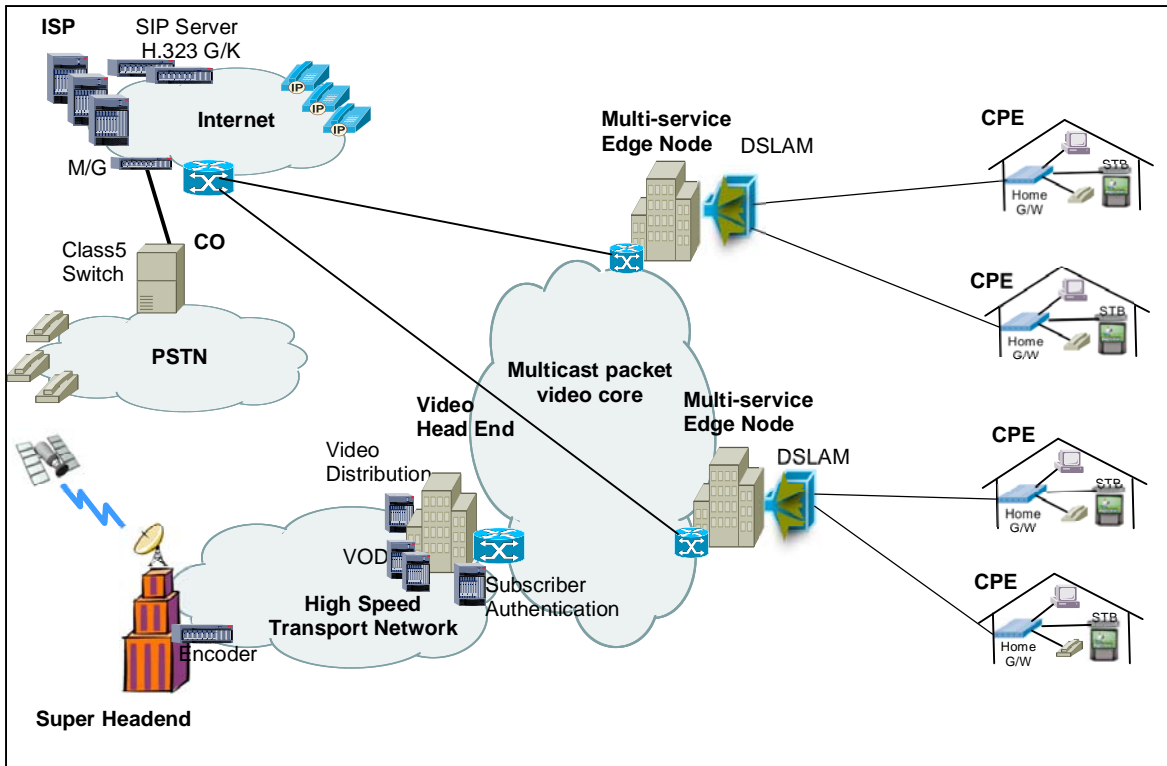
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Offering video, voice and data as a combined service (triple play) is a growing trend in the telecommunications service market. Telcos and service providers are eager to generate new revenue from triple play services; however, adding video service to the IP infrastructure creates a huge demand in bandwidth. In today's customer-driven environment, qualifying the physical layer and testing to ensure Quality of Service (QoS) for triple play deployments are basic expectations. QoS ensures services function properly from an objective, technical perspective: the equipment works properly, services are delivered, and features are fully operational. To win and keep customers, service providers must deliver unprecedented Quality of Experience (QoE), a customer's subjective perception that they *experiencing* triple play services as they anticipated. For example, crisp, clear television pictures, fast Internet connections and downloads, and high quality uninterrupted telephone service. To this end, testing plays an entirely new role, and field equipment must enable technicians to ensure both QoS and QoE simultaneously.

## **Triple Play Service Architecture**

In a multi-service IP network, video, voice and data traffic normally originate from different sources. Different networks are interconnected to form an infrastructure which supports multiple services to be delivered from sourcing nodes to subscribers. The figure below represents a typical triple play service network infrastructure.



In a subscriber network, typically the first hop is to a DSL modem that terminates the DSL line and connects the subscriber’s home network to the service provider’s access network. A standard triple play subscriber environment consists of a home gateway (residential gateway), which converts digital voice to analog voice for common phones and supports the network connections of other devices like video set-top boxes (STB) and PCs. Currently, Ethernet cable is the primary home network medium, but other technologies such as WiFi and HomePNA (HPNA) installations are growing steadily. These new technologies and the mix of legacy and emerging technologies deployed in a single environment make it difficult for service personnel to anticipate the home network situation they will encounter and to ensure QoE when installing or troubleshooting triple play services at the customer’s site.

**Challenges of Supporting High Bandwidth**

Supporting time-sensitive triple play service applications presents a host of challenges for IP-based networks, especially for access and subscriber networks. In an access network, the first challenge is the service provider's ability to support the high bandwidth requirements for video service. A Standard Definition Television (SDTV) channel consumes three to four Mbps using MPEG2 compressed video and audio. A High Definition Television (HDTV) channel, however, requires 12 to 30 Mbps with the same codec. Fortunately, higher compression rate codec such as H.264/AVC (MPEG4, part 10) addresses this issue by reducing IPTV bandwidth to a range that allows carriers to offer HDTV and other media services using an ADSL2+ line.

Data service, while not as time sensitive as video and voice services, can consume a large amount of bandwidth when a user downloads large files from an upstream server. This often unexpected reduction of bandwidth may degrade the video and voice services being transported over the same access link simultaneously. Therefore it is necessary to allocate a minimum amount of bandwidth for video and voice so that acceptable service levels are guaranteed at all times. Achieving this goal requires a QoS policy between the home gateway and the DSLAM.

IPTV installation problems are related to the quality of the copper wire more than 50% of the time. In general, digital signals work until they can no longer resolve data from background noise. Past this point the picture may freeze, sounds may disappear, or the image may suffer from pixilation or tiling. This results in repeat truck rolls where customers must endure the troubleshooting process, all of which leads to a negative customer experience. Some carriers chose to push the transport network edge closer to subscribers by installing FTTN or by laying fiber all the way to the home.

### **Delivering Exceptional Quality of Service**

Even though the customer's QoE has become the primary metric for market success, the basic rules of network transport and how they impact video quality still apply. Video, voice and data are all carried by IP packets; therefore jitter, latency and packet loss in packet switching networks are basic measurable factors that provide an indication to the overall quality of the service.

### Physical Layer Testing

Since a majority of the installation and troubleshooting problems are related to the physical layer, it is essential to pre-qualify before a triple play service is installed. There are two parts to the physical layer testing – the outside plant copper pairs and the inside wiring of a customer's home.

As mentioned previously, the subscriber network consists of a connection between the DSLAM and the customer modem or residential gateway. Copper pairs that were previously acceptable for either Plain Old Telephone Service (POTS) or Internet DSL may no longer be adequate for IPTV, as IPTV services require more bandwidth and are less tolerant of any type of noise or impairments. As a result, outside plant copper pairs must be re-qualified to a higher standard.

A series of tests are required to check the DSL, including testing to determine the loop length and insertion loss. Longer loops have lower DSL rates, which affect the overall bandwidth. If the loop is too long, the customer will not receive the service. Insertion loss testing identifies whether or not bridge taps exist that could disrupt service or, depending on the length of the bridge tap, prevent the DSL connection. Technicians must remove existing bridge taps using a Time Domain Reflectometer (TDR).

After these copper tests are completed, a modem emulation test should be performed. This test establishes a link between the Customer Premise Equipment (CPE) and the DSLAM and provides essential performance information such as actual data rate, maximum attainable rate, signal-to-noise margin and the attenuation of the link.

### In-home Installation

Once the outside plant is verified for IPTV service, technicians must install the service inside a customer's house. This could be a technician's worst nightmare as often there are no records or blueprints, and various home owners may have changed the in-home wiring using cascading splitters or connectors that are unacceptable for IPTV. These simple changes can lead to pixilation or tiling, and an undesirable QoE for the customer. To avoid future problems, a careful inspection and loss testing should be

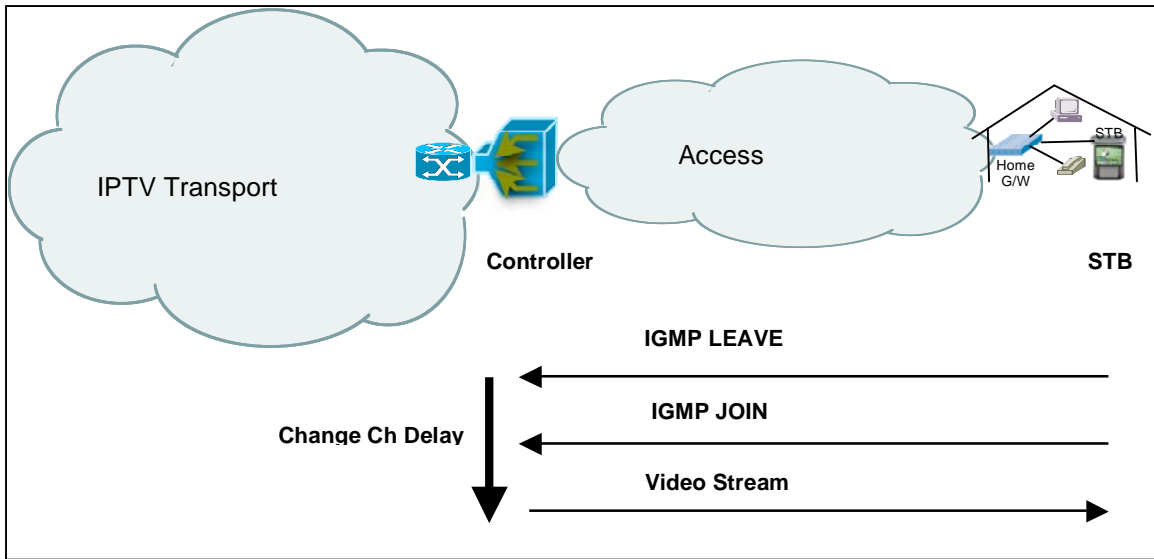
performed on the in-home wiring. If a tech sees one coax cable going into the house and two televisions connected inside, he or she can conclude that at least one splitter exists on the cable run. All the in-house wiring and connectors should be inspected for damage or alternations. In doing so, technicians should ensure the appropriate types of connectors are in place. Cable loss testing will indicate the existence of splitters or any other impairment that may prevent a signal from reaching its destination.

Finally, technicians should complete a proof of performance test for the home networking method used whether Ethernet, HomePNA, MoCA, WiFi, HomePlug or another home networking technology. This proof of performance test stresses the entire home network to verify that it is capable of supporting IPTV. Diligence in qualifying the physical layer will reduce future problems and eliminate repeat truck rolls, which in turn will increase the customer's QoE.

### **Quality of Experience**

Covering the basics only meets part of today's requirements for ensuring a high QoE. From the IPTV user's perspective, a good QoE with IPTV service goes way beyond a set of network performance figures such as lost video packets, jitter, delayed video packets, etc., and encompasses the overall quality experienced when using new services.

Change channel delay, for example, may impact the basic performance of the service and the customer's QoE. IPTV uses IP multicasting technology to deliver the requested TV channel. Unlike traditional broadcast TV where all the channels are available via the airwaves, IPTV service only delivers one channel to a STB at a time in order to keep network bandwidth requirements to a manageable level. When a user changes from one channel to another, the STB sends two multicast control messages to the upstream controller to get the new channel video stream. The diagram below shows change channel delay and Internet Group Management Protocol (IGMP) control messages.



The network latency between a STB and video stream controller is affected by several factors including the access network transport delay and the video controller traffic loading. Peak loading projections are required for the video controller in order to prevent long zapping delays during worst case scenarios, such as the commercial breaks during a popular TV show.

Another service that is sensitive to latency is voice. Low jitter and end-to-end latency are very important in maintaining an interactive phone conversation. Normally, a carrier grade voice service must maintain end-to-end latency below 150ms. While voice service is extremely sensitive to latency, it is more tolerant of packet drops since state-of-the-art VoIP endpoint digital-to-analog conversion includes a concealment mechanism to “hide” dropped packets. This concealment function can handle up to 30 ms of digital voice loss in the conversion to analog voice without generating an impairment that can impact the customer’s QoE. Specific requirements for ensuring QoE in triple play service have been defined by the DSL Forum in Technical Report TR-126 (see sidebar).

In addition to QoE metrics, a technician may also want to see a live video feed played on a second device, other than a TV, as an additional reference of the video quality.

Customer expectations for QoE are a growing challenge for service providers. As such a single, suitable tool, which provides physical plant qualification, in-home network testing, QoS and QoE measurements, is critical as triple play service providers face both high growth and an increasingly competitive landscape. Such a tool will significantly increase customer retention by ensuring service is turned up properly the first time.

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**Sidebar:****From DSL Forum Technical Report TR-126 Guidelines for Quality of Experience***Service Layer*

Service layer QoE metrics are typically measurements of user opinion of the service quality such as Mean Opinion Score (MOS) or objective estimates of viewer ratings.

*Application Layer:*

The application layer defines parameters of video content such as resolution, frame rate, encoder and decoder settings, transcoding, bit rate, etc. at the head end. In addition, corresponding audio track recommendations are made. At the receiving end, application layer parameters mainly defines loss concealment and user controls. Key areas of the data plane and control plane fall within the application layer.

The data plane addresses the various settings and parameters selected for digitization and compression of video and audio source materials, such as codec, bit rate, encoding settings and noise reduction etc. The control plane is mainly concerned with the responsiveness of user control and user interface in video service, such as change channel delay, control of video on demand, Electronic Program Guide navigation and startup time of the STB.

*Transport Layer:*

Transport layer requirements are typically expressed using network performance metrics with appropriate targets and limits to meet the desired Service layer QoE. Within

this layer, the key criteria for the data plane include loss, latency and jitter. In general, reasonable end-to-end delay and jitter values are not problematic due to STB dejitter buffers, provided that the dejitter buffer size is provisioned to match network and video element performance. Video streams, however, are highly sensitive to information loss so packet loss will have a direct impact on the video quality. The impact of packet loss is dependent on which type of frame is carried by the lost packet.

Within the control plane, it is critical that the channel zapping delay remains below two seconds to ensure interactivity and satisfactory QoE. The total channel zapping delay includes IGMP Join/Leave time on the wire, time for IGMP processing and time for the new stream to reach the STB.