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“Understanding the Quality of Experience for IPTV”

by

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INFOSYS TECHNOLOGIES LIMITED

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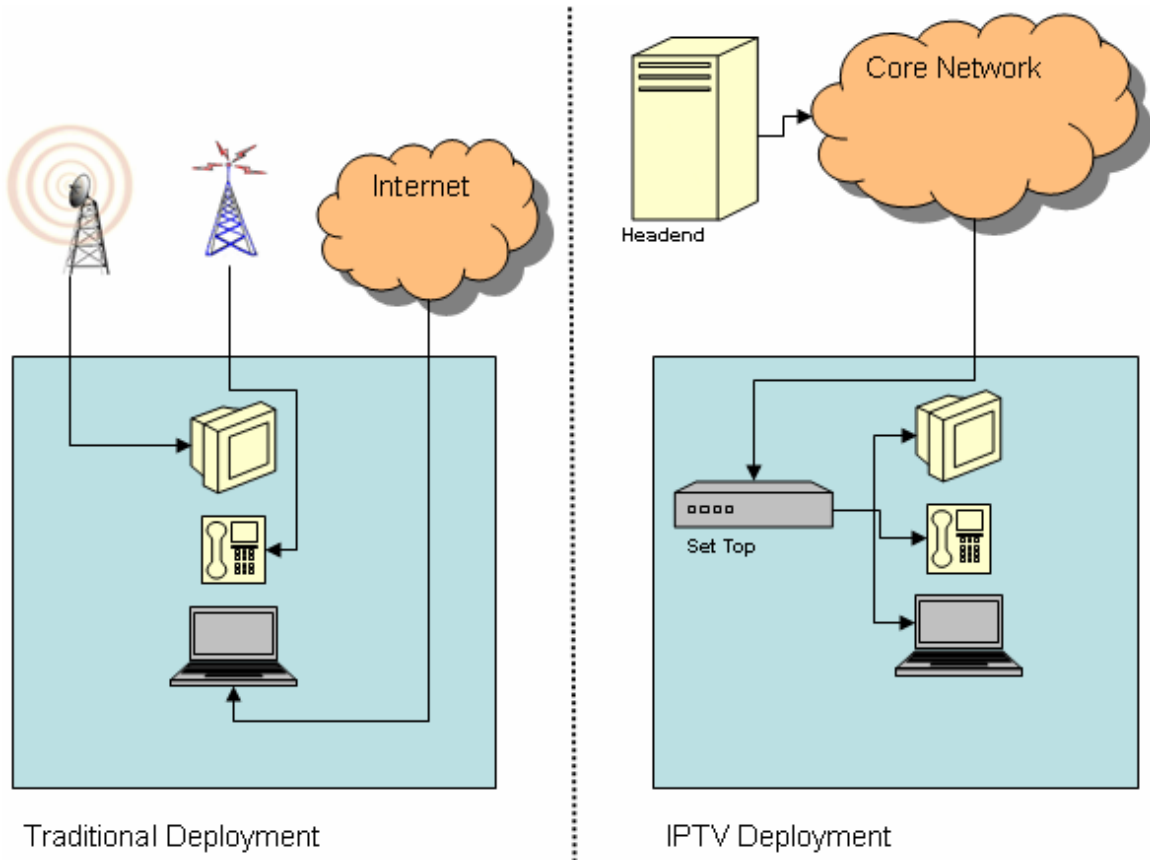
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Introduction to IPTV

With the advent of more and more Internet usage, come various opportunities to expand and diversify the Internet based businesses. One of the rapidly picking areas in this direction is IPTV service provided by the Telco drivers over the same Internet network. With more commoditized voice (both landline and mobile) and data services, limiting the growth opportunities it becomes imperative for them to diversify into the delivery of video over the Telecom networks. Coupled with the technical drivers, the technological enablers have improved a lot in the last one-decade. The core networks can now deliver content with the speed of light with the fiber technologies and the video compression technologies help in reducing the size of the individual packets over the same network increasing the bandwidth further.

IPTV is a system where a digital television service is delivered by using Internet Protocol over a network infrastructure used for computer networks. IPTV is often provided in conjunction with Video on Demand and may be bundled with Internet services such as Web access and VoIP. The commercial bundling of IPTV, VoIP and Internet access is referred to as "Triple Play" service. The services offered include Television, Voice over IP (Telephone), Internet access and online games.

IPTV vs Traditional Broadcasting



❖ Advantages

- Interactivity
- VoD
- Triple Play
- Digital Video
- Efficient Bandwidth utilization (compared to broadcast and unicast)
- Cost

❖ Disadvantages

- High initial cost of setup
- Dedicated bandwidth provided to each customer

Services Offered

- Television
- Video on Demand
- Music over IP
- Voice and Video Conference
- Online Games
- Converged Services

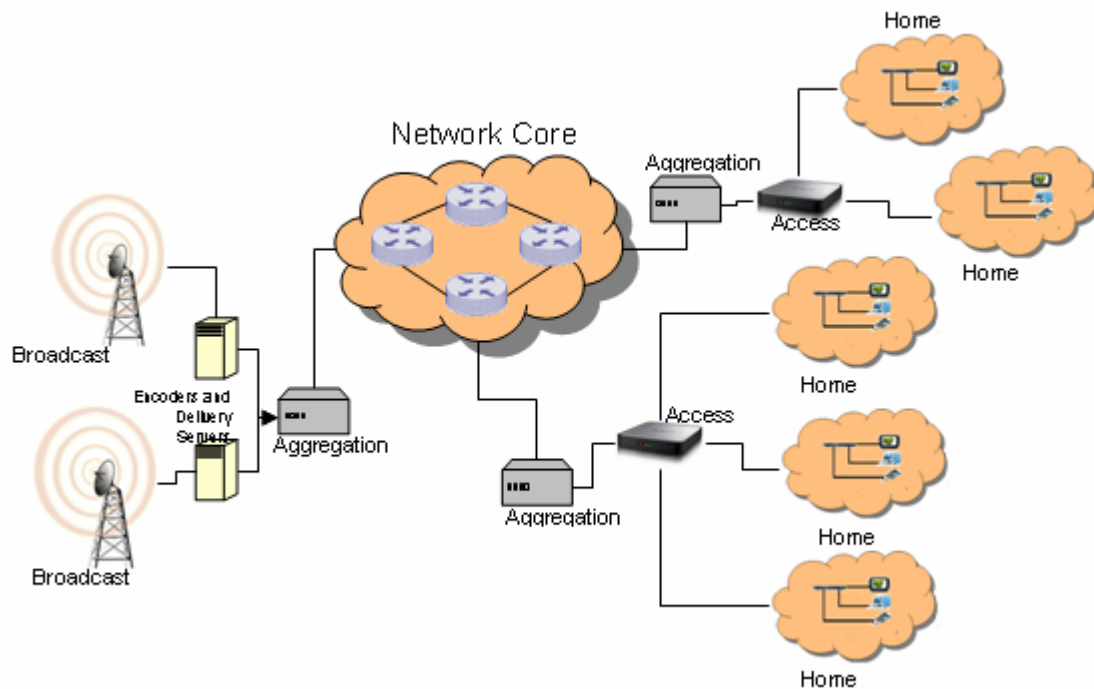


Figure representing IPTV Architecture

A typical IPTV architecture consists of a **Headend** which include Content Servers, Encoders, Middleware, **Core Network** composed of routers, switches and the **CPE** (Customer Premise Equipment) having a Home Gateway and STB (Set Top Box). Traffic from the headend is either in the form of Multicast (television channels) or Unicast traffic (VoD).

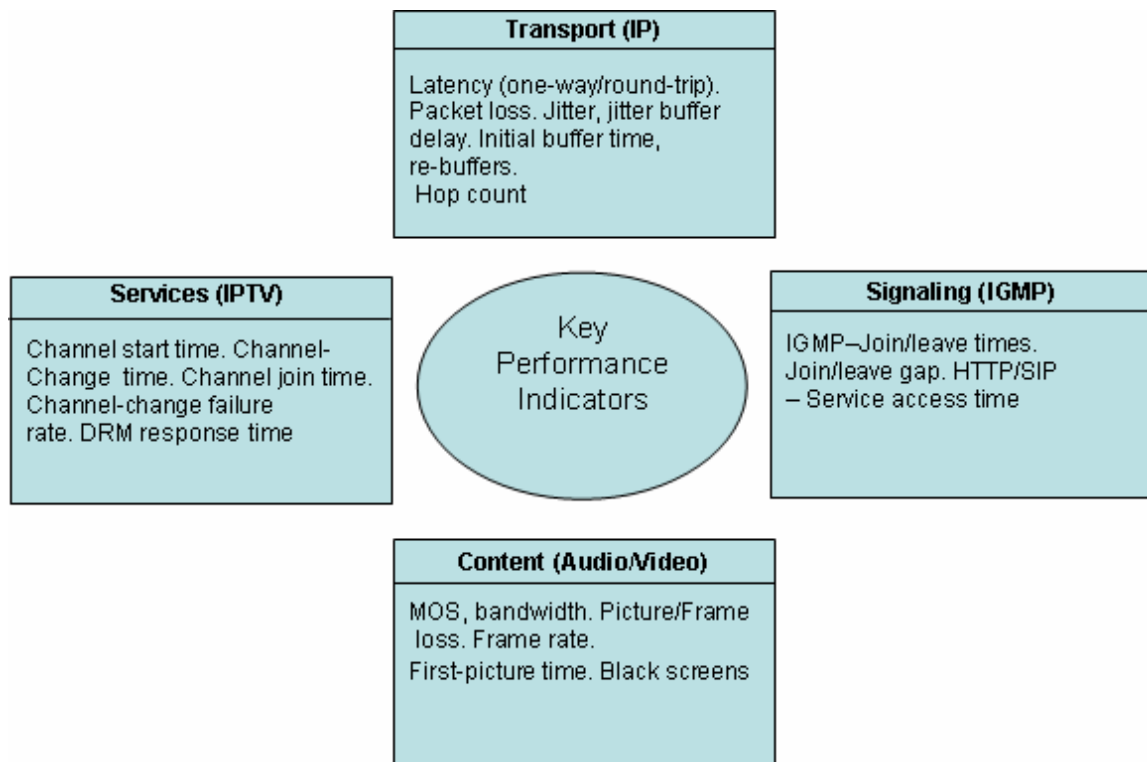
Performance Issues

Unlike internet where the performance of a particular application is concentrated at the head-end, in IPTV performance issues may arise anywhere between head-end to the CPE. Since the internet traffic pass through networks provided by different service provider(s), network is considered as out of scope most of the time. But in IPTV, network testing plays a very important role. Bottlenecks can be at Core Network like latency, delay and packet loss, Signaling issues like IGMP join/leave may also have an impact on the QoE. Customer satisfaction also depends on the quality of content delivered which depend on the bandwidth, frame rate, frame loss. Issues at the head-end like Channel start time, Channel change time and high DRM response time can leave a customer unsatisfied with the service.

❖ Typical Performance Issues

- Channel Zap Delay
- Traffic quality degradation during triple play
- Unwanted packet retransmissions
- Packet Loss
- Latency
- Inefficient switching and routing
- Slow Encoders (eg. Encoder Servers/STB)
- Frequent connection breakdown
- Network/Device scalability
- Unexpected inter packet delay

Key Performance Indicators



Ensuring High Quality IPTV Offering

If proper testing is not performed to uncover potential QoE issues, a number of service impairments can rear their ugly heads. From the user's perspective, such impairments can manifest themselves as grainy pictures, blurred images, banding across the screen, frozen frames, and painfully slow channel change times. Worst case user scenarios can involve situations where channel change requests are not performed at all to completely blank screens.

Ensuring high quality experience to the end user is one of the major challenges faced by the Telcos providing IPTV service. Thus it becomes imperative for these providers to test the IPTV system for the Quality of Experience (QoE) when the traditional broadcast systems have already set the high expectations of this experience. Having a defined QoS to meet the QoE expectations is extremely important in IPTV system. QoE can be impacted either at the Service Layer or the Transport Layer. For eg. problems may exist at the source itself even before the packets are submitted for transmission. The service layers exist above the Transport (RTP/UDP) layer and the transmission layers extend from the Transport (RTP

UDP) layer to the Physical layer. Bandwidth provided to the end user also plays an important role in quality experienced.

To ensure a high quality delivery the service provider must ensure that every entity in IPTV system perform as expected under real conditions. The core network which is mainly concerned with packet forwarding should be free from network impairments like packet delay, packet loss, more than expected jitter. Proper testing with real time load before deployment can give a level of confidence to the service provider as to what should be the maximum load that the core network can handle before it start losing packets or before the latency exceeds expected level. Determining optimal QoS setting poses another challenge in setting up the system. For eg. having a very low packet timeout value will have many unwanted retransmissions resulting in unnecessary overloading of the network. Also having a very high value for this flag will result in packet retransmission delays.

Allocating adequate bandwidth ensure timely delivery of packets avoiding jitter buffer delays. Service related signaling like IGMP (Internet Group Management Protocol) join/leave can also have a significant impact on the end user. Delays may also occur due to authenticating services. Authorization and authentications are basically to check if a user is authorized to view the content. Scalability can be another issue that can haunt the service provider. The system should be scalable up to pre-tested value without any quality degradation. Triple play can also have an impact on the user. Some traffic type may affect the delivery of other packets.

Importance of Quality of Service testing

Computer networks initially was used for carrying internet data, but with improvement in network technologies the same network, with little enhancement, is used to deliver media traffic. The TOS (Type of Service) required for media traffic, like voice and video, are quite different from conventional TOS required for Internet data. For eg. Video packets require higher priority, low packet loss rate than data packets. This TOS is also known as QoS (Quality of Services). In short, QoS is the way different kind of traffic is handled by the network entities to ensure a smooth flow of IP packets. Any discrepancy in QoS may lead to a bad user experience. This customer experience is measured in terms of QoE (Quality of Experience). Some of the factors that affect QoE are latency and packet loss rate. Encoding and decoding algorithms employed has a serious impact on the quality of content delivered.

QoS Parameters

- Bandwidth
- Availability
- Delay
- Packet loss
- Jitter
- Packet error ratio

Measuring QoE

QoE is a subjective measure of a customer's experiences with a vendor. For applications such as streaming media, MPEG video, Voice over IP, or other information sensitive to arrival time and packet loss Media Delivery Index (MDI) measurement can be used as a diagnostic tool or a quality indicator for monitoring a network. However MDI does not solely provide QoE diagnosis. It can be used as network evaluation metric and not user-oriented video assessment metric. A subjective scoring called V-Factor (Video Quality Factor) and MOS (Mean Opinion Score) is used to evaluate the quality of the video and audio received. These metrics are based on properties of human vision and accurately predict the quality of video delivered. The score ranges from 1 to 5, where 5 stands for “excellent quality” and 1 representing “poor quality”.

QoE can also be measured analyzing the packets transmitted for delivery and the ones that are transmitted to the end user. This type of analysis is known as Active and Passive. Active Video Analysis is the most accurate of all video analysis systems since the measurement is conducted on a frame by frame, ‘pixel by pixel’ basis. Users perform analysis which compares a received stream against a generated source stream. Comparing the received stream frame versus the source frame enables providers to determine high end issues such as brightness, chrominance, pixelization and luminance. Passive Video Analysis will not consider the actual payload but runs analysis on the encapsulating video frame headers. Passive Analysis enables multiple parallel packet inspection. Parallel Packet Inspection provides greater detail and diagnostic capabilities.

Keys Areas to Test

Scalability – How scalable is the system under increased load.

Session Termination Rate – How often do session timeout and how often connections have to re-established.

QoS – QoS across multiple network entities.

Channel Join/Leave latency – Time taken to join a leave a channel.

Channel Validation – Is the correct channel being delivered?

Availability – Ensure 100% availability.

Triple Play – Does voice affect the video?

Bandwidth – Is the network capable of handling multiple channels?

Conclusion

Based on one of the report “IPTV subscribers could reach 66 million by 2011, and generating over \$20 billion in revenues“. To cater to the need of such high volume of service over the net, it’s imperative to plan, build and test keeping QoE as the target for the success of IPTV domain. Quality of Experience is a mix of various Quality of service parameters. A good QoE can only be achieved with the good QoS system. Like any other performance testing, it’s important to ensure that the end user experience is targeted for the testing and not just the systems which deliver it. An unsatisfied customer can always switch to alternative source thus directly affecting the market share of the IPTV service provider. The future of IPTV resides on how effectively the service can be delivered to its end customers. Understanding the QoE to plan for good overall testing is the key in this emerging market.

Speaker profile

Name: Amit Dixit

Education: 1998: B.Tech. Production Engineering and Management N.I.T
Jamshedpur

Total Experience: 9 years

Software Testing Experience: 7 Years

Experience:

Amit Dixit is a Performance Test Manager currently leading the R&D and training department of Enterprise Performance Testing Solution at Infosys Technologies Ltd. He has extensive experience and knowledge in software testing in banking and retail domains. His current interest includes solutionizing and improvising the existing way of doing system performance testing. He has been instrumental in defining the innovative ways of making system efficiently reliable, scalable and available to its user. He is in-charge and anchor for R&D on IPTV testing, one of the evolving areas in Telecom domain.

Amit completed his graduation with distinction from a reputed NIT and eventually gained varied experience in manufacturing and aircraft industry before he moved into the software industry, having those experiences has helped him bring in the diverse, innovative and the business view to his unit. In the software testing, Amit has worked on Macintosh based applications, Oracle financial applications, Retek data warehousing, high end technology domain and Banking domains.

Amit has extensive exposure in the testing domain and has been instrumental to the various high quality project deliveries as a team member and the lead during his 7 years of experience in this field. Amit has received several accolades from various clients through appreciations and excellence awards. Amit has also developed many models, solutions in the performance testing during his tenure in the performance testing group in the last 2.5 years.

Amit Dixit has published "Performance testing of Cash Management applications" in HSBC magazine as a technical editor. Also for Standard Charter bank, his article "Ensuring High Availability of Corporate Treasury Applications in South East Asian countries" is undergoing publishing.

Interests: Team organization and Project Management

Specialty: (Optional) Performance Testing and Performance Engineering

Name: Meekey Khati

Education: BCA, Shree Bhagawan Mahaveer Jain College, V.V Puram Bangalore

Total Experience: 3 years in IT Industry.

Software Testing Experience: 3 years in Performance Testing

Experience:

During the 3 years of my career in IT industry, I have been engaged in different testing projects. Working in Infosys Technologies Ltd. from past 2.5 yrs till date. I am associated with Enterprise Performance Testing Solutions which is a part of Independent Validation Solutions unit at Infosys. After completing my college studies I started my career in the field of testing and over the years got interested in performance related issues. From the start of my career I have been dedicated to the performance-testing domain. My exposure to the world of testing and validation services has been through performance testing projects that I have participated in and managed.

Working as a Performance Testing Engineer, I have developed keen interest in identifying and fixing performance related issues. Being the last leg of the development cycle, though performance testing has times been stressful and demanding, it has offered me a challenging a fulfilling opportunity.

Over the past two years I have been engaged for large performance testing engagements in the Banking, Retail and Financial services industry. Currently I am handling the Research and Development of the IPTV testing. Earlier to this I was handling the responsibilities of training the new joinees. I am well versed in HTTP and Web services in LoadRunner also worked on WebLoad, Winrunner, Test Director, Performance Centre, Quality Center and Wily Introscope.

With the advent of more and more Internet usage, come various opportunities to expand and diversify the Internet based businesses. One of the rapidly picking areas in this direction is IPTV service provided by the Teleco drivers over the same Internet network.

Certifications done:

Mercury LoadRunner 8.1 and Oracle SQL Certification

Interests: QoE in IPTV