

Validating IPTV service quality under realistic Triple Play network conditions

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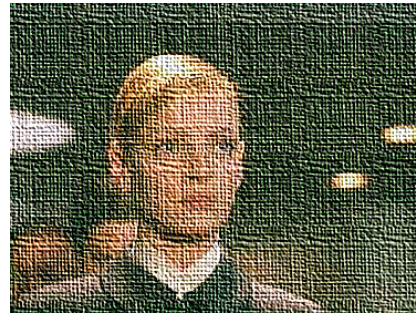


Agenda

- **What is IPTV “Quality of Experience”?**
- Measurement techniques to improve IPTV QoE
 - Channel-Changing (Zapping) Delay
 - IPTV Video (Media) Quality
 - Network Reliability (High Availability Mechanisms)
 - Network Security
- Microsoft TV – Key features & challenges
- Conclusion

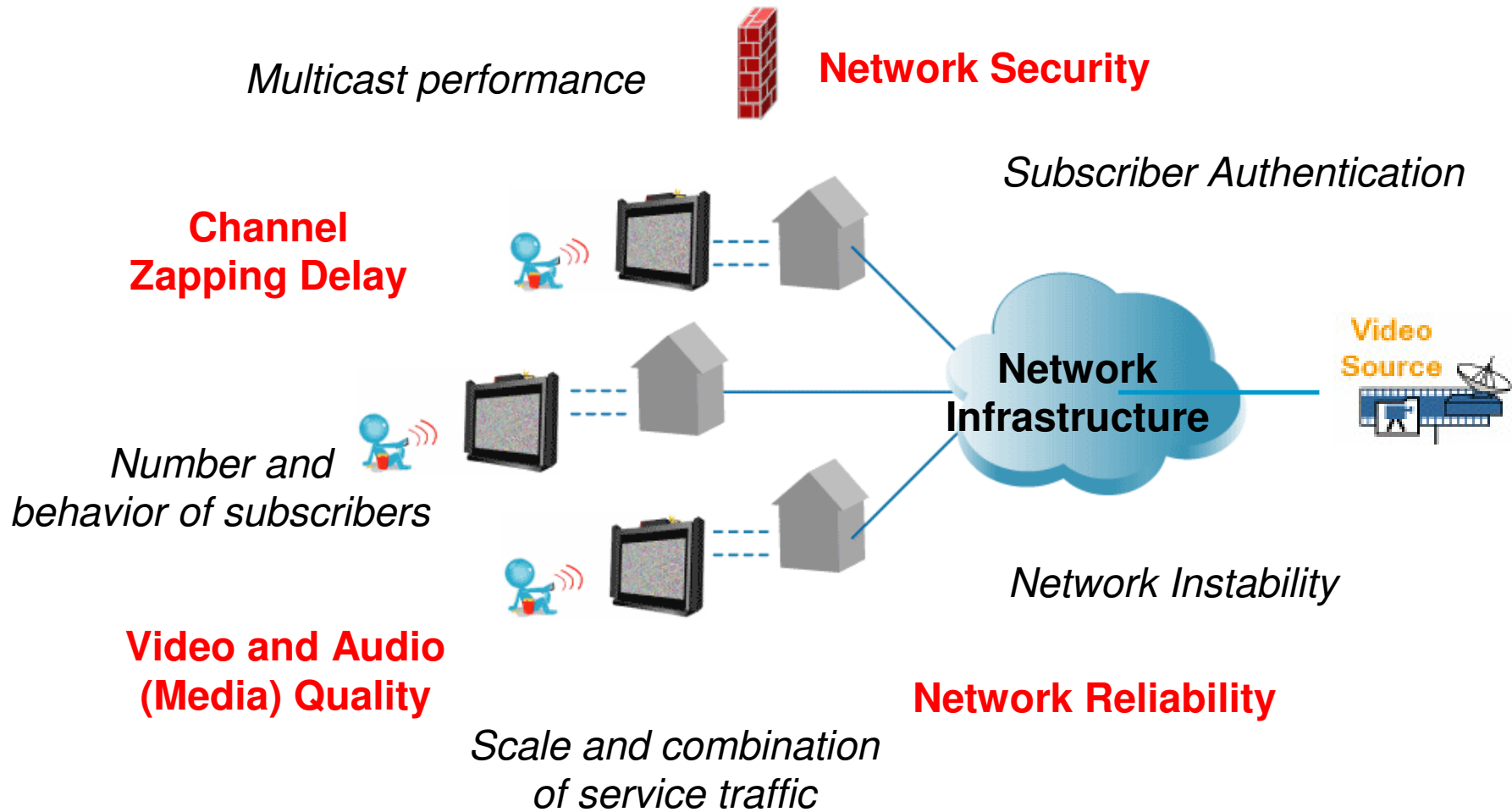
What is IPTV Quality of Experience (QoE)?

- QoE describes how well a **service** satisfies **user expectations**
 - A rating of service performance from the user perspective
- The IPTV quality experienced by subscribers (IPTV QoE) must be equal or better than today's cable and satellite TV services
 - Acquisition costs are estimated at \$1k per subscriber
- Commercial factors (content, pricing, usability) will attract new subscribers... but QoE is the critical factor in retaining customers
- IPTV QoE can be compromised by many factors
- Must be able to test network equipment under realistic conditions

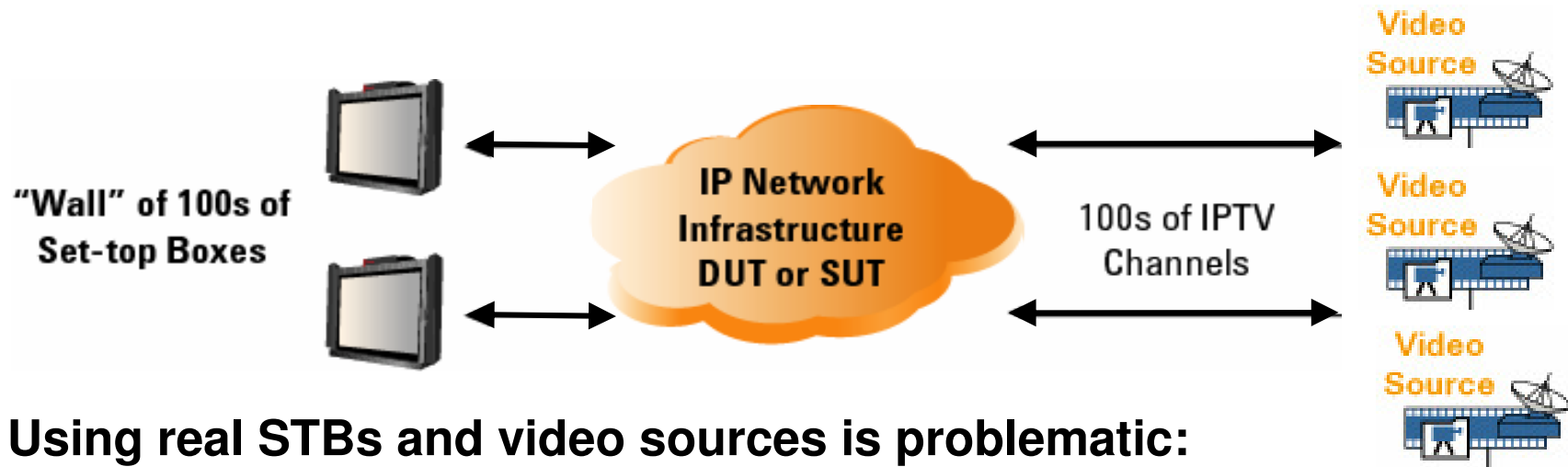


Can network equipment meet quality expectations from day 1?

Components of IPTV QoE



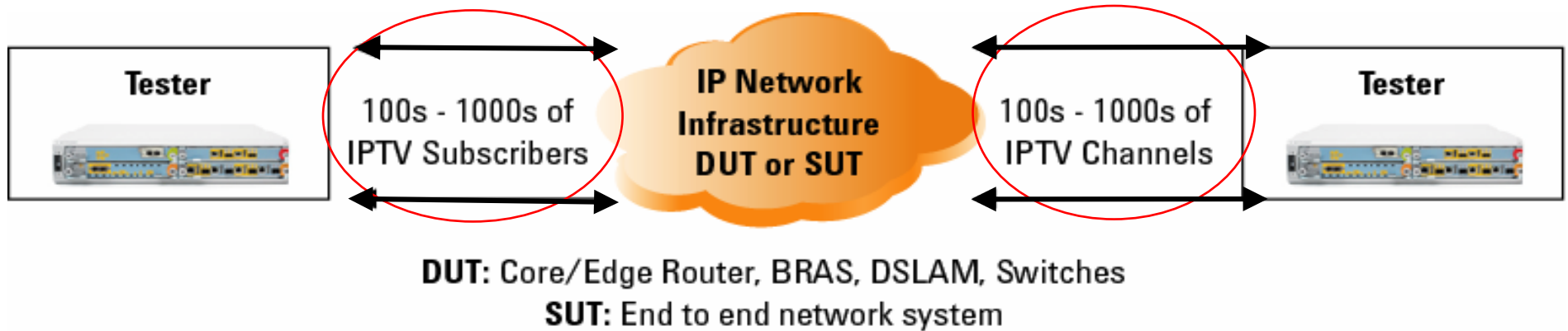
Testing IPTV QoE Today...



Using real STBs and video sources is problematic:

- Expensive
- Difficult to control and run tests (labor-intensive)
- Space-consuming
- Unreliable (set-tops overheat, need rebooting, etc)
- Doesn't scale to real-world levels (hundreds of thousands of subscribers)

Emerging IPTV Test Methodology



IPTV Subscriber Emulation

- Simulate tens of thousands of subscribers

Video Source Emulation

- Simulate hundreds of video sources

Replace an expensive & complex test bed with an industrial strength test solution

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IPTV QoE: Channel Zapping Delay

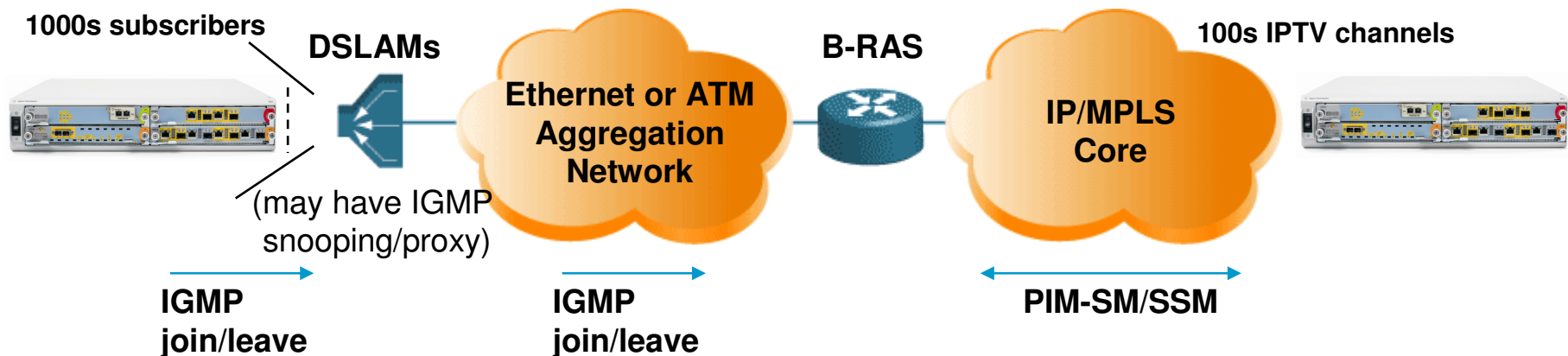


- Part of the users' QoE is how quickly/reliably they can change channels
 - Often called “channel zapping delay”
- Key measurement: “Multicast leave/join latency”
 - With **IGMP** (IPv4) or **MLD** (IPv6)
- Service providers and equipment vendors must measure channel zapping time through individual DUTs, as well as through networks (end to end)
- Channel Zapping Delay Challenges:

Network Infrastructure

1. B-RAS, IP DSLAM, Switch: Channel zapping performance for large numbers of subscribers (scalability, capacity)
2. Core/edge routers: Multicast routing performance

Improve Channel Zapping Delay by Testing IGMP/MLD Leave-Join

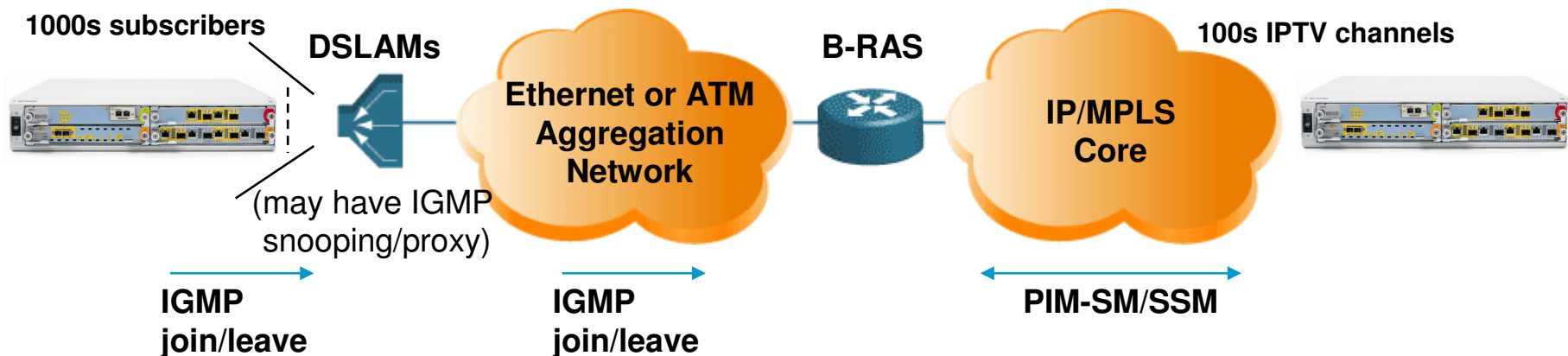


DUT: B-RAS, IP-DSLAM, or Ethernet Switch

Test emulation/variables

- Emulate traffic of 100s IPTV channels and 1000s of subscribers
- Define a unique channel zapping profile for each subscriber
- Simulate thousands of subscribers requesting the same channel
- Simulate thousands of subscribers cycling through multiple channels in sequence

Improve Channel Zapping Delay by Testing IGMP/MLD Leave-Join



DUT: B-RAS, IP-DSLAM, or Ethernet Switch

Key Measurements

- Identify how changing channel behaviors impacts the DUT/SUT
- Analyze accurate channel zapping delay statistics **per subscriber** & avg/min/max delay of subscriber groups
- Evaluate, troubleshoot and optimize the DUT/SUT

Agenda

- IPTV Overview
- “Quality of Experience” and IPTV Test Challenges
- Measurement Techniques to Improve QoE
 - Channel-Changing (Zapping) Delay
 - **IPTV Video (Media) Quality**
 - Network Reliability (High Availability Mechanisms)
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Video & audio
(media) quality

IPTV Video Media Quality

- **Perceived quality** of IPTV is sensitive to network impairments
- **Network Impairments** can cause video/audio quality problems
 - Packet loss, latency, jitter, bit errors and out-of-sequence packets
- **Video Impairments** like blocking, blurring, edge distortion, judder, visual noise...
- **Audio Quality** and media synchronization (lip-sync)

Testing IPTV Video Media Quality...

- Delivery System *Our focus today*
- Video Encoder/Decoder
- Human Factor



Impaired Video (Tiling)

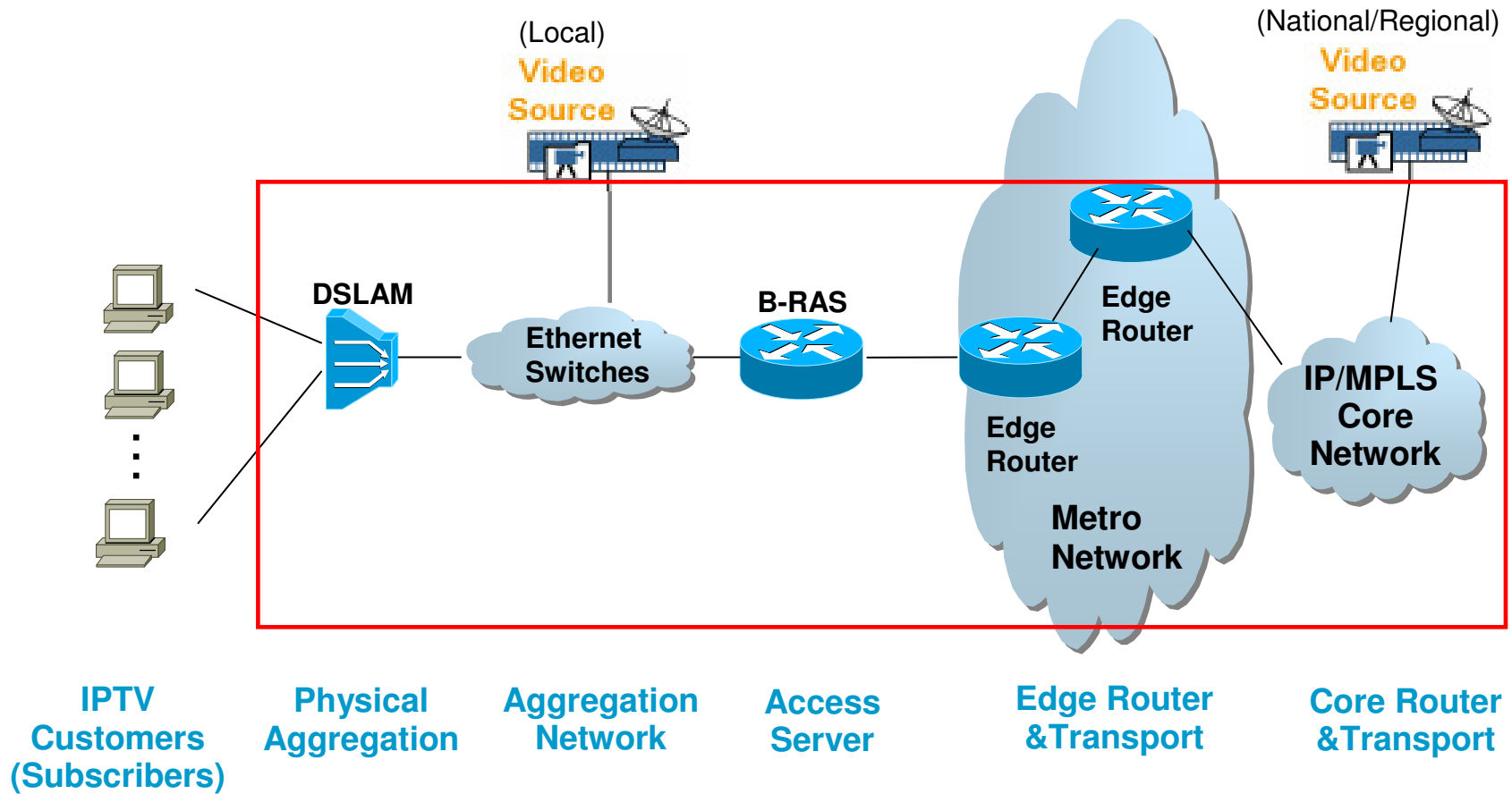


Noisy audio

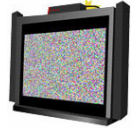


IPTV Delivery System

(Network Infrastructure Equipment)



Media Quality Test Challenges



Video & audio
(media) quality

Network Infrastructure	<ol style="list-style-type: none">1. Video stream forwarding<ul style="list-style-type: none">• Performance of Unicast traffic forwarding (VoD)• Performance of Multicast traffic forwarding (IPTV)• Subscriber scalability2. Bandwidth management<ul style="list-style-type: none">• QoS control – ensure video packet priority• P2P rate limiting – file-sharing bandwidth usage
Video Source	<ol style="list-style-type: none">1. Performance and scalability of IPTV encoder and VoD server

To improve media quality, CSPs and NEMs need to understand the challenges in each network section as well as in end-to-end networks

Testing under 'realistic' conditions

Network Infrastructure Equipment



Video & audio
(media) quality

Test Challenges

- Reflecting dynamic subscriber behaviors
 - Channel zapping, DHCP session flapping (new Internet connection request), etc. for tens of thousands of individual subscribers
- Combining video, voice and data traffic
 - Thousands of streams
 - Multicast 'broadcast' IPTV and Unicast 'VoD' traffic
 - Different video traffic profiles (MPEG-2 SD and MPEG-4 AVC/H.264 SD/HD traffic, Windows Media® 9/VC-1)
- Achieving scalable and relevant video quality metrics
 - IPTV subscriber growth is estimated at 133% per year
 - Network equipment can delay packets, introduce jitter, and drop packets which degrades actual visible video quality
 - **Video quality metrics for network equipment should be in relevant terms!**

“Video QoE can't be tested in isolation. It's constantly effected by other services.”

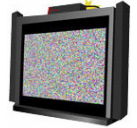
Video Quality Metrics



Video & audio
(media) quality

- Subjective testing (ITU BT.500) is most accurate. But time consuming, not scalable, impractical for network equipment testing
- PSNR (Peak Signal-to-Noise Ratio) is simple, but poorly correlates with perceived video quality and subjective testing.
- Objective Mean Opinion Score (MOS) test developed by ITU VQEG (MPQM), other 'proprietary' metrics like V-factor...
 - Not very scalable, coupled with video encoding technologies
 - Doesn't support MPEG-4 QoE Analysis
- Media Delivery Index (MDI)
 - Industry standard endorsed by IP Video Quality Alliance & defined in RFC 4445
 - Not coupled with encoding technology so can scale measurements over thousands of video streams at once
 - The returned values (metrics) are actually useful and relevant

Components of Media Delivery Index (MDI)



Video & audio
(media) quality

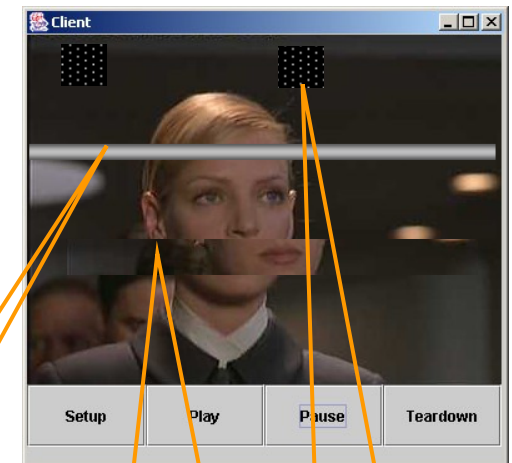
Delay Factor (DF)

- The network can introduce jitter into the media packet stream
- Buffers are used to de-jitter video before it is presented to the decoder
- Buffers are of finite size and can overflow; decoder buffers can underflow
- In the presence of jitter, the DF gives an indication of how much buffer space (in ms worth of data) is required to avoid packet loss
- **DF can be used to establish margins and warn of impending packet loss!**

Media Loss Rate (MLR)

- The number of lost media packets per second
- Loss indicates that the network is not delivering the video properly

MLR indicates video quality problems



Jitter

Out-of-order

Packet loss



MDI Values

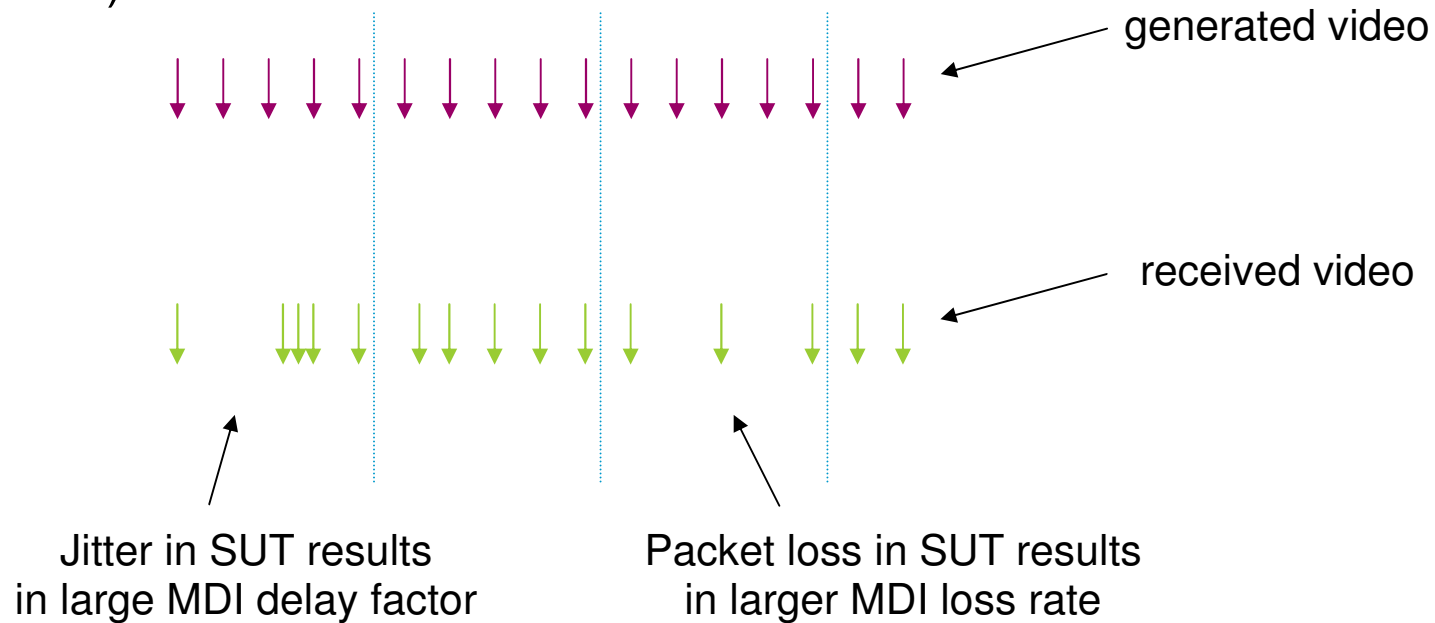


Video & audio
(media) quality

MDI is expressed as a Delay Factor (in millisecond) and a Media Loss Rate (packets/sec)

DF:MLR e.g. 4.22 : 1

Defined in IETF RFC 4445, and endorsed by the IP Video Quality Alliance (IPVQA)



MDI quality metrics relate to actual visible quality

Loss of a single IP Packet (7 MPEG packets)



Single B-frame IP packet loss
(at 3.1 seconds, 1 frame affected)



Single I-frame IP packet loss
(at 2.4s, 14 frames affected)

Since networking equipment can't distinguish MPEG frame types, networks must be engineered for very low packet loss.

Typical target: 1 packet dropped per 30 min.

Ideal: Zero packet loss.

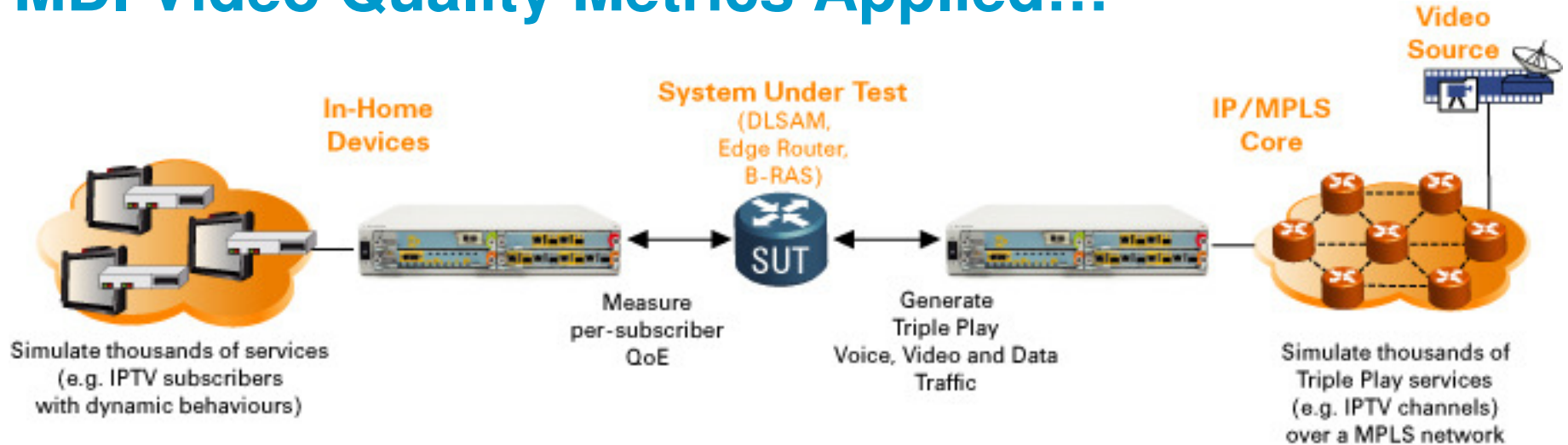
DSL Forum recommends 99.94% packet loss in WT-126

Benefits of MDI over other video quality metrics

	MDI	V-Factor, MPQM, Video-MOS, and other perceptual metrics
Highly scalable (QoE metrics for thousands of subscribers; hundreds of channels)	Yes	No
Directly indicative of network problems relating to video quality	Yes	No
CODEC agnostic	Yes	No
Can be used with any encrypted media payloads	Yes	No
Results independent of encoding and decoding	Yes	No
Suitable for variable bit rate (VBR) video quality testing	Yes	Yes
Defined in an Internet RFC	Yes	No
Correlated to user MOS scores	Yes	Yes
Suitable for real-time evaluation of video quality	Yes	Yes
Useful for establishing network margins	Yes	Yes
Support for MPEG-4 QoE analysis	Yes	No

MDI overcomes the scalability limitations of other video quality metrics

MDI Video Quality Metrics Applied...



Per-subscriber measurements for tens of thousands of subscribers

- Measure impact of protocol stress & instability on QoE
- Measure impact of 'other' services (voice, data...) on QoE
- Measure impact of channel zapping on video quality
- Correlate network impairments with video quality
- Identify scalability limitations

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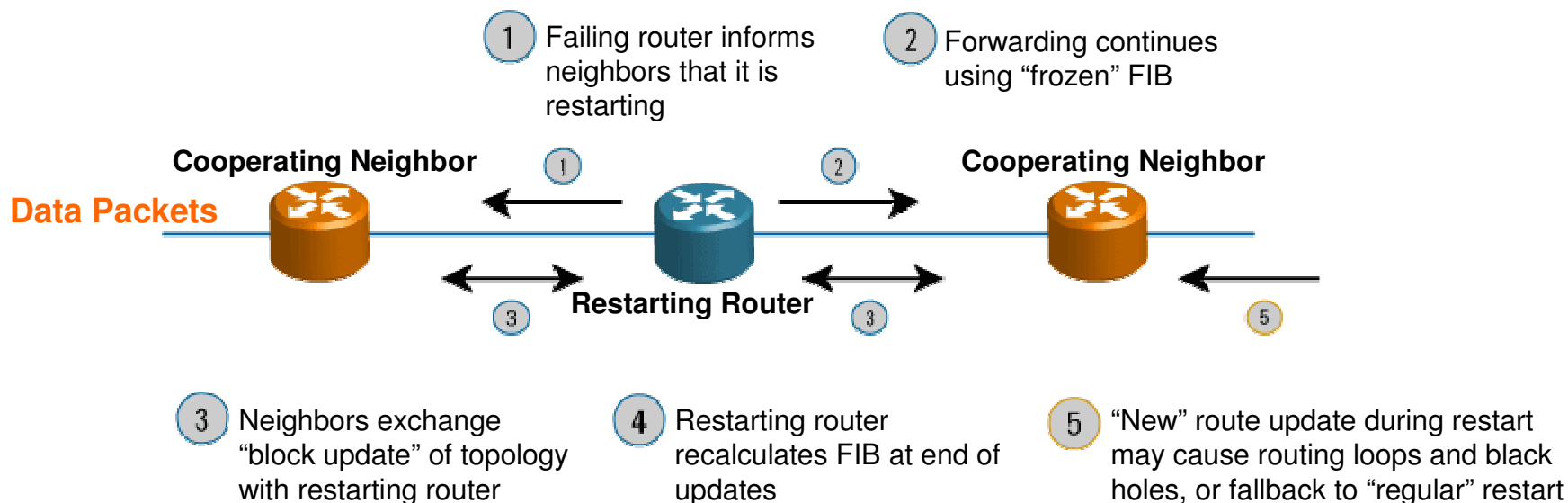
IPTV QoE: Reliability



- Subscribers expect reliable IPTV service that CSPs must guarantee
- Reliable IPTV service need High Availability (HA) networks
- High Availability (99.999%) implies only 5 minutes service outage per year
- Hardware redundancy and HA routing protocols improve network reliability
- Reliability Challenges:

Network Infrastructure	<ol style="list-style-type: none">1. Implement HA routing protocols in network<ul style="list-style-type: none">• Graceful Restart• Non-Stop Forwarding• MPLS Fast Reroute2. Hardware redundancy, hot-swap modules, etc
Video Source	<ol style="list-style-type: none">1. Reliable IPTV encoder, VoD server

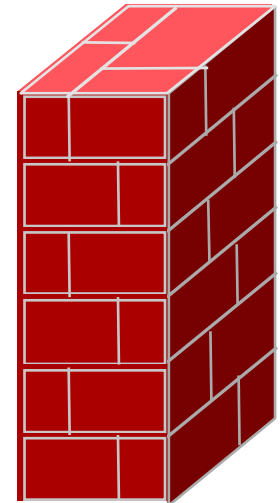
Improve Reliability by Testing Graceful Restart (HA Testing)



- Core and Edge Routers need to be tested for High Availability
 - e.g., Graceful Restart
- Detailed HA test methodologies are available (Archived LightReading Webinar)
 - http://www.lightreading.com/webinar_archive.asp?doc_id=27597
- HA white paper is available on the Agilent website
 - <http://advanced.comms.agilent.com/n2x/technologies/highavail.htm>

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IPTV QoE: Security

Security

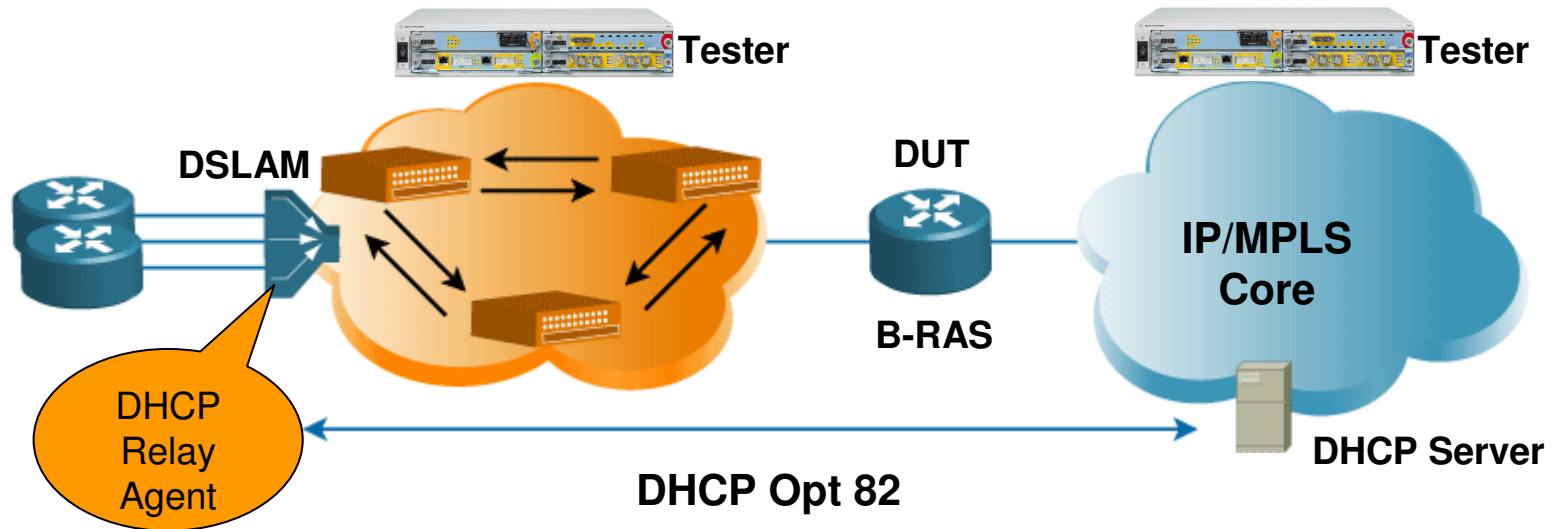


- **Denial of Service** (DoS) attacks, not an issue for traditional TV, are a threat to IPTV
- Protect networks and video sources with **firewalls** or **Application Layer Gateways**
- **Authenticate** subscriber identity to prevent ‘stealing’ of IPTV service
- Security Challenges:

Network Infrastructure	<ol style="list-style-type: none">1. User Authentication for subscriber connections<ul style="list-style-type: none">• PPPoX : need username and password for PPP session• DHCP : Option 82 validates subscribers by location2. Protecting services from attacks and malicious traffic
Video Source	<ol style="list-style-type: none">1. Use firewall to protect VoD server from DoS attacks and other threats

Improve Security by testing DHCP Option 82 for subscriber authentication

Security



- The DSLAM acts as a **Relay Agent**, adds DSL line identification information to the DHCP requests coming from the clients
- 10s of 1000s of DSL clients are simulated by tester to test **address assignment** and **authentication** via DHCP with Opt 82
- Measure max DHCP session capacity, session setup rate, session setup latency, and validate sessions established via traffic through B-RAS
- Measure throughput, latency and loss of IP traffic over established DHCP sessions

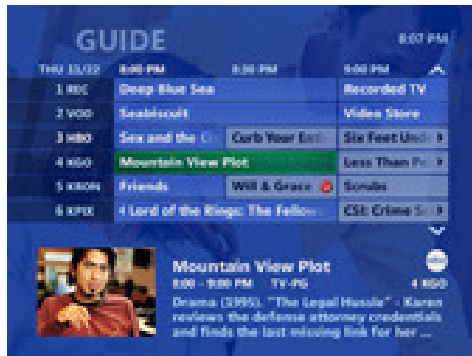
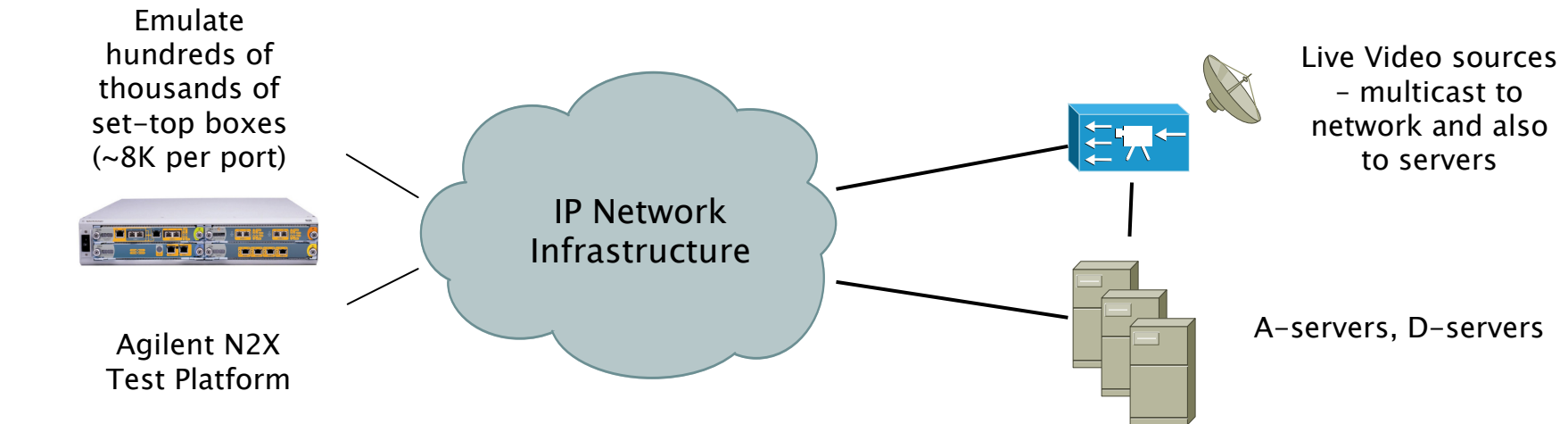
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- Microsoft IPTV is a middleware platform and IPTV architecture being used by several Service Providers worldwide
- Most deployments are in trial phase or early rollout to a small number of subscribers
- Testing with a large # of subscribers is currently expensive and tedious – requires a large number of ‘real’ MSTV clients

Test scenario: Testing a real MSTV system



Allow service providers to:

- Measure channel zapping performance and scalability of a real MSTV system
- Assess the impact of ICC bursts on the video, voice, and data services
- Measure service quality via MDI and R-UDP retries

MSTV – *Instant Channel Change*

- Key feature of MSTV is the **Instant Channel Change** (ICC) technology that allows fast channel changes:
- Video content is distributed via IP Multicast as in regular IPTV, but
- When the user changes a channel a short **unicast** burst of video traffic is sent from the “D-server” (Distribution Server) to the set-top box to enable a faster channel change
- This unicast burst causes an increase in network bandwidth
- 100s or 1000s of users simultaneously changing channels causes an even larger increase in traffic
- This increased traffic can cause problems, ranging from quality issues (packet loss/jitter/latency) to full service outage

MSTV – Challenges of Instant Channel Change

Instant channel change creates a subscriber-driven network load that is not entirely predictable. This presents link and server provisioning difficulties. Consider:

- High number of simultaneous ICC requests place a heavy load on the D-server for ICC unicast bursts
- Aggregation link load increases due to ICC unicast traffic, increasing the likelihood of packet loss.
- Retransmit requests from STBs (after detection of packet loss) place further demands on D-server and further load on aggregation network.
- The **video server needs to be scalable** – capable of generating unicast bursts of video traffic whenever a user changes channels
- The IP network needs to be able to **handle these bursts of unicast video traffic** without degrading the performance of the multicast video traffic and other service traffic (data, VoIP)

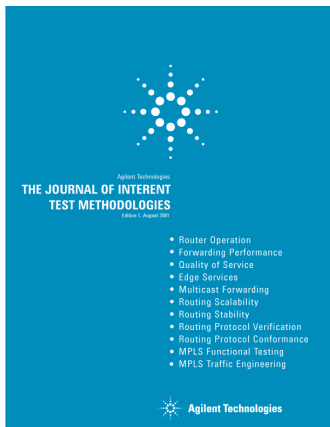
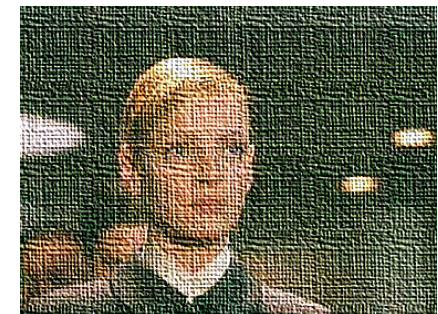
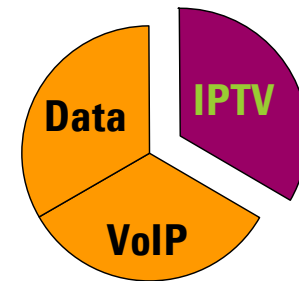
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Conclusion

- Triple Play is changing the Telecom landscape
 - New challenges for traditional carriers
- QoE is paramount for IPTV market acceptance
- Service Providers and NEMs must test network equipment and video source to ensure IPTV QoE
 - Routers, B-RASs, DSLAMs, Ethernet Switches, Firewalls/ALGs, IPSs, RTSP servers

Copper Pair Triple Play



- Agilent's Journal of test Methodology
www.agilent.com/comms/thejournal

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