End to End IPTV Design and Implementation, How to avoid Pitfalls

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Agenda for the IP TV Design Tutorial

1. IP TV Business Models and Challenges
2. Key IP TV Design Considerations
3. Delivering IP TV Services and Quality of Experience
4. Testing Considerations
5. Future Directions
6. Finally – Key Messages

1. IP TV Business Models and Business Case Challenges

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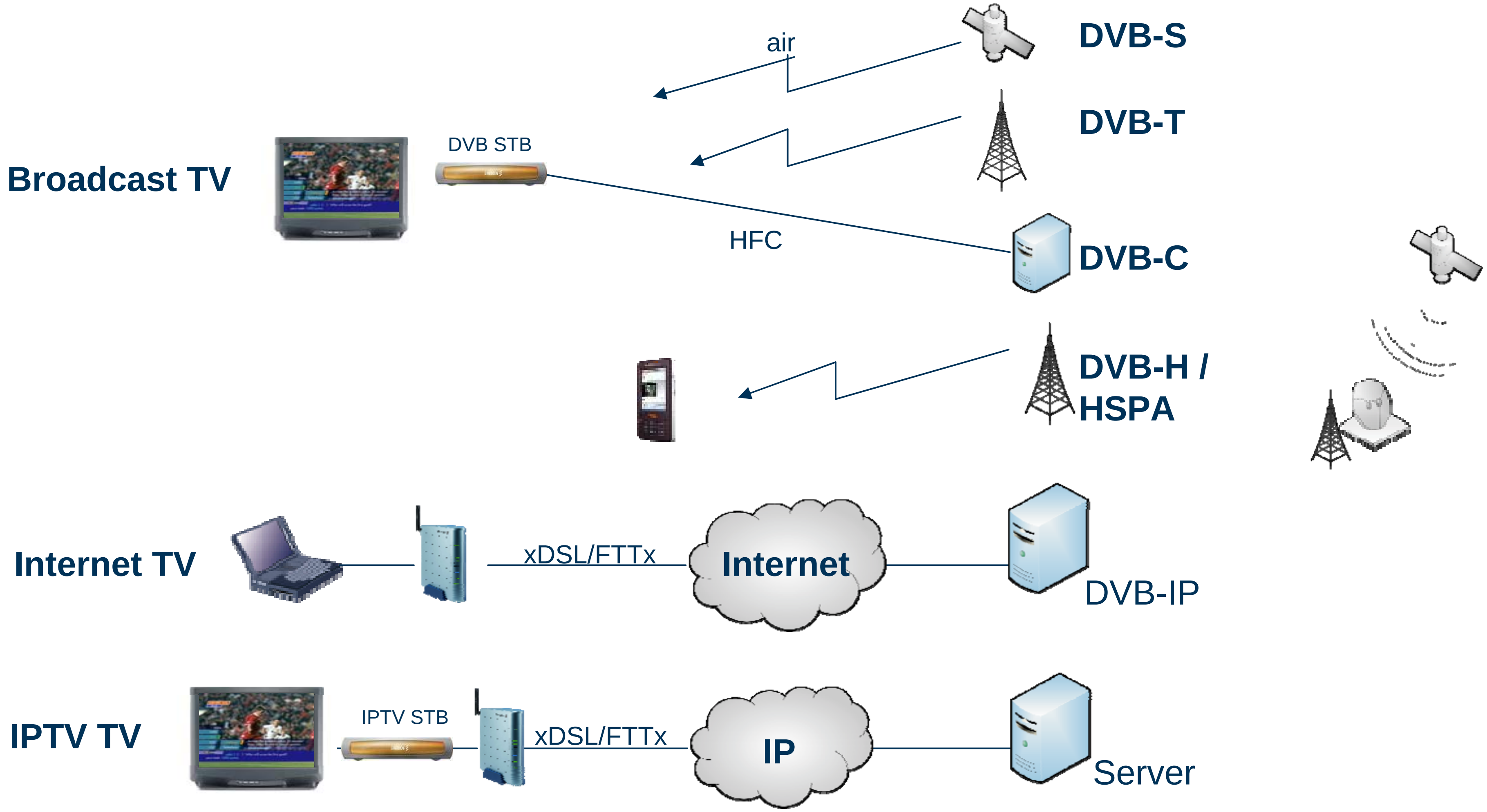
What is IP TV ?

- It is “TV anytime” with no strict dependency on the fixed program guide
- Can replace cable and satellite based video and TV broadcast services
- It is broadband TV, video on demand and interactive TV
- It offers triple play service bundling – voice, video and data on FTTP and ADSL 2+ and VDSL access
- Viewers would expect a predictable <u>or better</u> service quality, when comparing IP TV with Broadcast FTA, cable and Satellite TV services

What is TV?
(Broadcast, Internet TV, IPTV)



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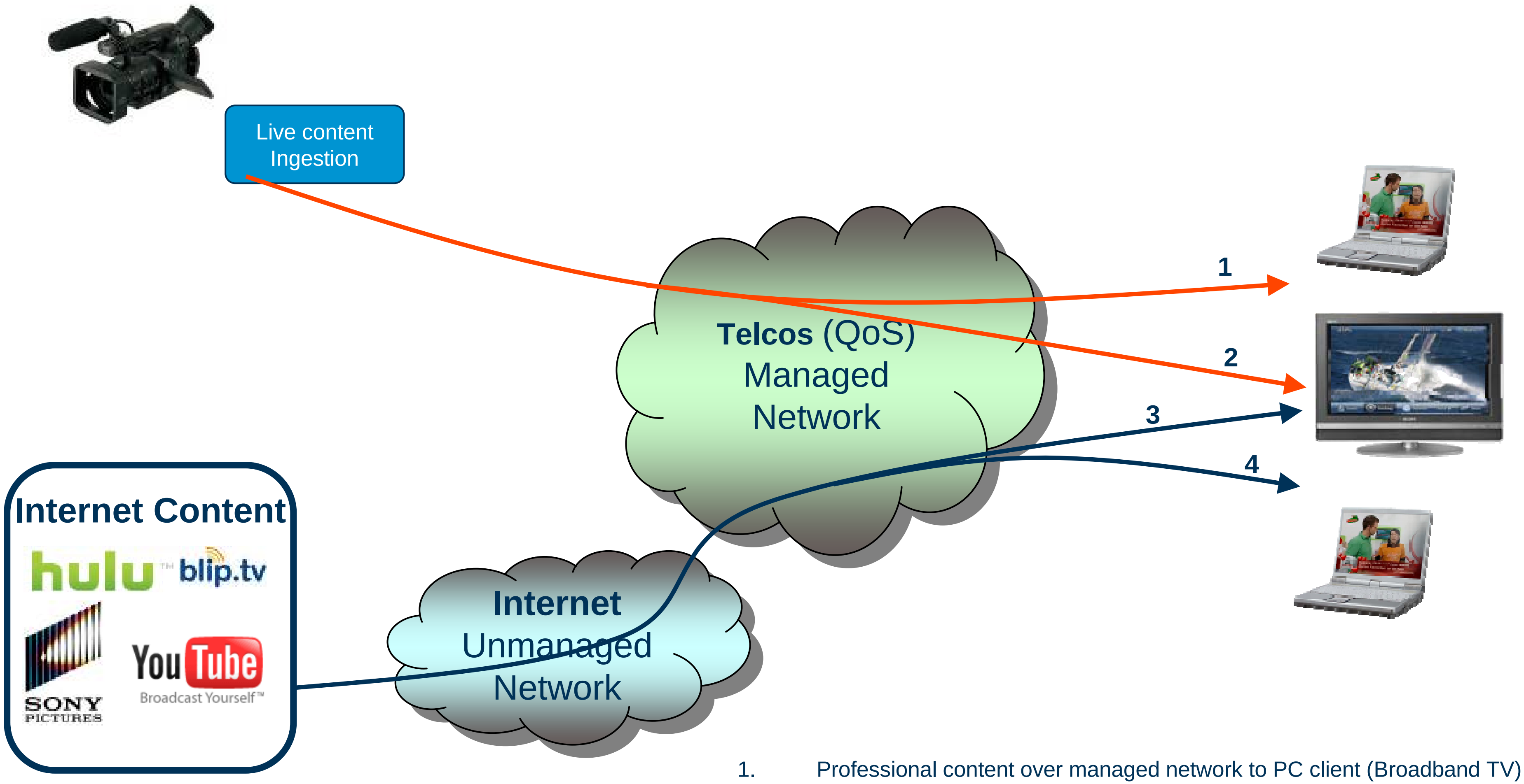
IPTV Scenarios

Managed vs Unmanaged



1. Professional content over managed network to PC client (Broadband TV)
2. Professional content over managed network to STB (IPTV)
3. Internet originating content to STB (Internet TV = Web TV)
4. Internet orientating content to PC (Internet TV = Web TV)

IP TV Scenario Analysis

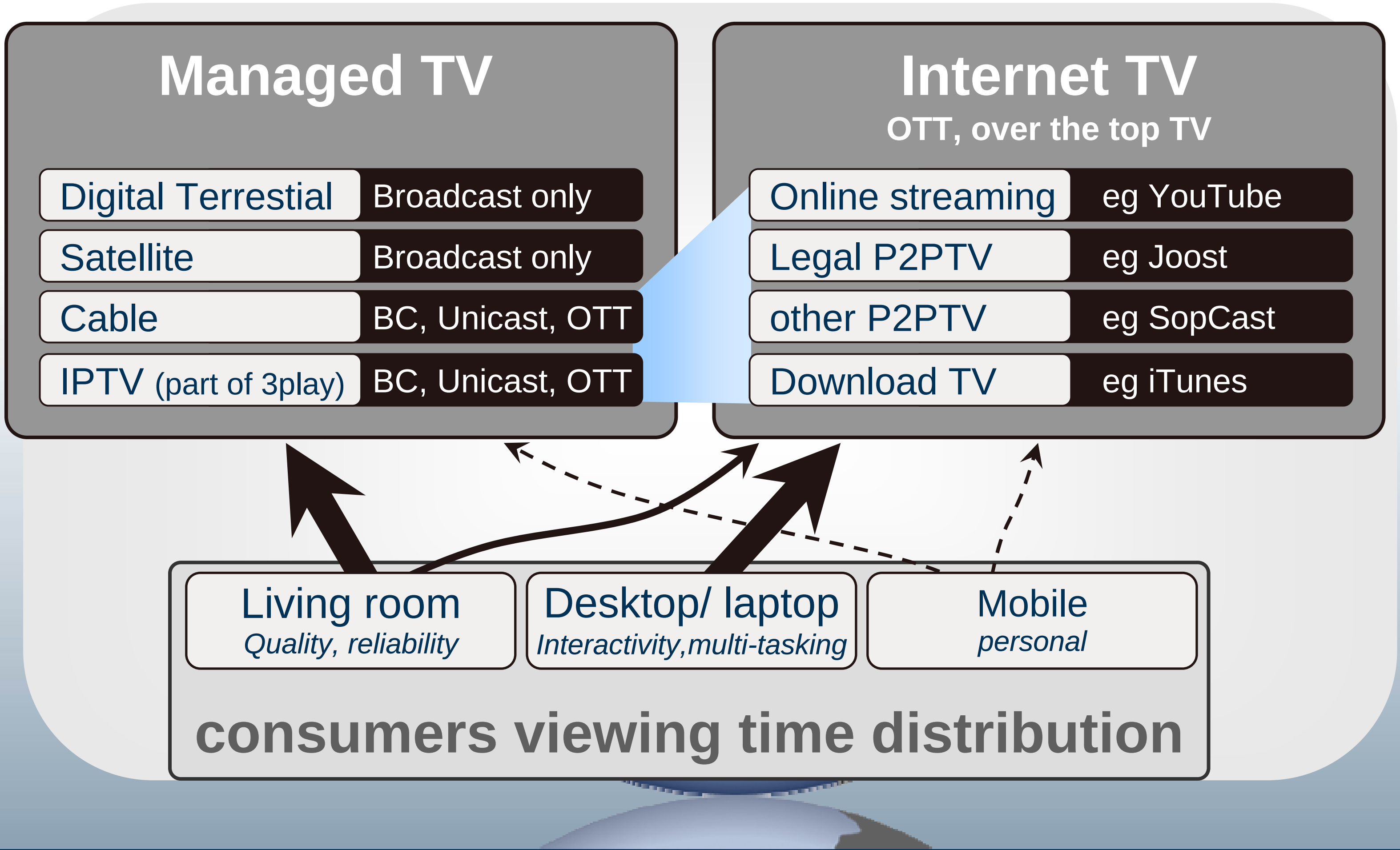
PC Based Internet TV Model

- A pure Video On Demand Approach
- Primarily portal based as extensions to broadcaster's linear digital channels
  - Commercial Broadcasters - NBC in the US, Channel 4 and BBC in the UK have launched their own video on demand portals
- Connectivity via Internet only
- Leveraging existing content from digital channels funded through a combination of revenue sources including
  - Advertising
  - Pay-per-view
  - Subscription based
  - Download to own
- User generated content from Portals such as YouTube and MySpace
- Video and music On-Demand Portals such as iTunes and Joost

IP TV via Set Top Box (STB) Model

- Combination of both Linear Broadcast and Video on Demand Approach
- Connectivity via Operator's Closed Broadband Network
- Standard Pay-TV distribution model
- Revenue model is a combination of
  - Subscription based
  - Pay-per-view
  - Advertising
- Broadcasters, content providers, advertisers or disintermediators have a revenue sharing arrangement with the Telco

Open the network to internet TV



Internet and IPTV over same networks, filling different needs

IP TV Business Model Examples

Virtual Video Store

- A little VoD infrastructure and not own access network
- Convenient access to video library at a user's preferred time
- Premium VoD –Hot, Exclusive, large choices and speciality content for specific target segments
- Pay per view or certain number of films per month
- Brand name and easy content navigation is essential

Value-Added Internet Service Provider

- Broadband Internet Access and rich value added services included IP TV and VoD
- PC centric users and own customer base
- Internet Protal services including information services, music downloads, online gaming
- Flat broadband Access and IP TV Services and pay-per-view for VoD

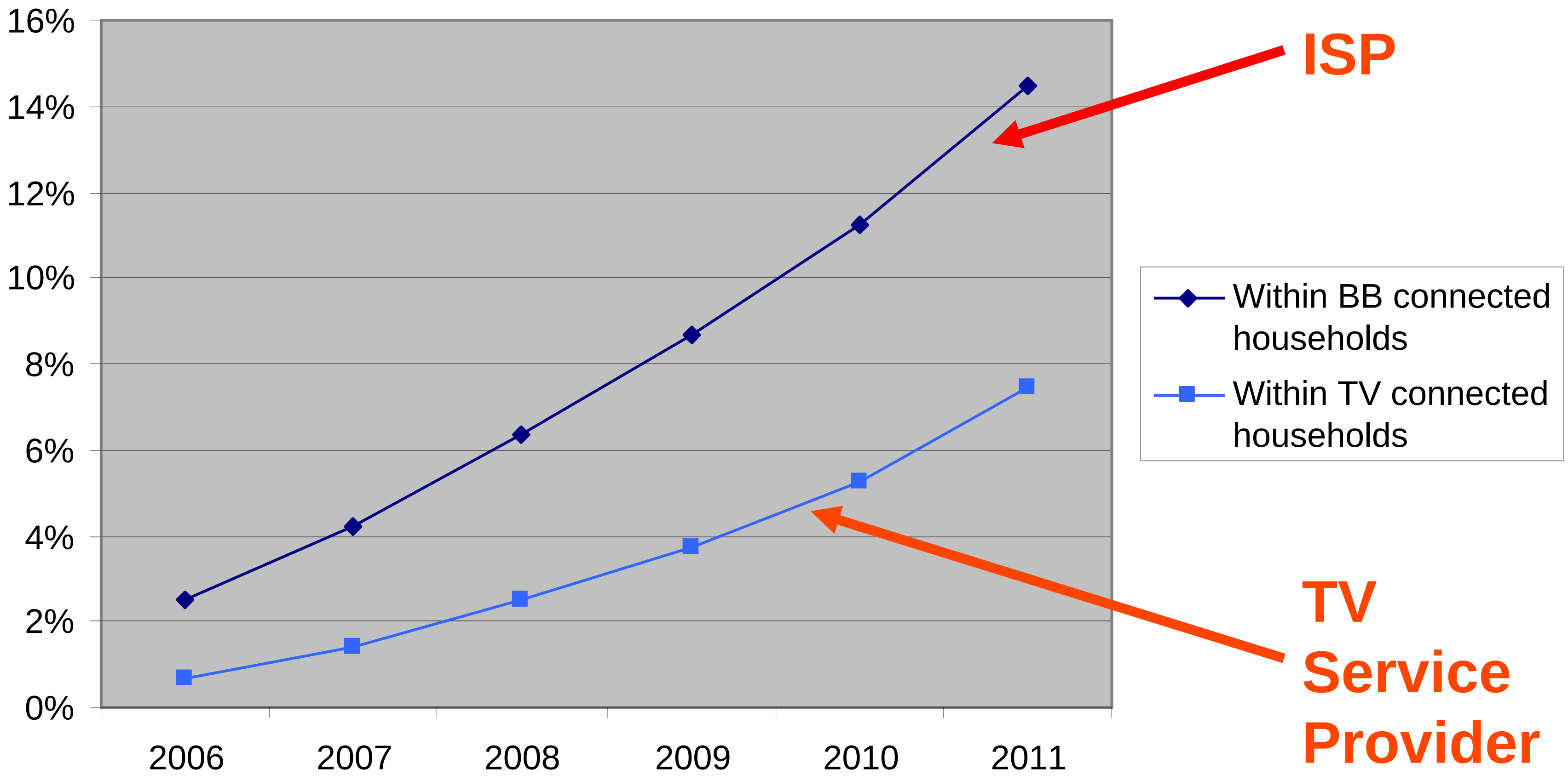
Enhanced TV Service Provider

- Advanced TV services at competitive price
- TV centric users with often own broadband customer base or registered IP TV subscription users
- IP TV services including rich and varied bundles of channels , EPG, PVR, NPVR and Interactive services
- Subscription and additionally pay per view for VoD

Triple Play

- Combined video, telephony and broadband internet services for mass market
- TV centric users, telecommunications customers requiring to subscribe to triple play bundles
- IP TV services including rich and varied bundles of channels, EPG, PVR, NPV, interactive services, VoIP and other IP services.
- Subscription Triple Play bundles, plus pay per view charges for VoD

IPTV Penetration at Connected Households



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IP TV Business Case Challenges

Business Model

- The new service and the absence of business experiences at scale and the important size of the required investments (eg. Content and technology)
- The important trade-off between service and content offerings
- The Cost of content and Service
- ARPU, the life time customer value

Content and Media Management

- Setting up a dedicated team for content selection and program schedule management
- Developing expertise in content negotiation, cross-selling, promotional offer management and defining the content refreshment policies
- Quality assurance and compliance process for content providers

Service Control

- Supporting new services such as network PVR, VOD Distribution scheme
- Limit access to certain services in case of network and service infrastructure overload eg. Video servers
- QoS Management and service control architecture to handle load peaks and service mixes

End to End Service Assurance

- Strong need for real time troubleshooting
- Monitor all the end to end architecture (CPE, TV, STB)
- Proactive segment status analysis and start automated trouble management and recovery process if required
- Identity the customers who could be affected by the service and network problem
- Proactively managing new challenging areas such as video quality management and conditional access management

Customer Care and Billing

- Integrating the IP TV billing processes with the existing billing processes
- Design new billing processes and build interfaces with external payment GWs
- Customer self modify subscription
- Managing he peak for customer care during prime time hours (8:00 PM to Midnight)
- Building attractive commercial offer by bundling TV services with Voice and Data

Product Technology Choices

- Use of off-the -self products to be integrated in Telco’s infrastructure or define architecture and standards and ask suppliers to adapt their solutions to this scenario
- Cost effective STBs with high video quality, GUI and interactive services
- Ability to offer high scalable title search for on-demand movies and contents

IPTV study – Consumer Behaviors

Only 30% satisfied with service

- People are referring to old technology
  - Features not living up to expectations/old technology are irritating

1. Improve service reliability (73%)
2. Would like to be able to choose their own channels (69%)
3. Having the service available on more than one TV (60%)
4. Most of all, care about the content and its quality! (75%)
5. It must be very easy to get something showing what viewers want to watch (75%)

Most households experience this problem on a daily or weekly basis. It has now become a "oh no, not again" feature.

Source: Web survey with users

No need to fine tune the details until the basics are in place!

Critical Success Factors for IP TV

The Right Content

- Having the right movies
- Releasing content in a competitive time windows
- Exclusive premium content eg. Broadcast sports or new series
- Providing speciality and local content customised to targeted group

High Quality of Service

- Quality of Service in IP networks to deliver constant quality in transmission
- MPEG4 compression
- Video Call Admission control

Positive User Experience

- Improved ICC for immediate viewing
- Automatic system requirement checks
- Easy STB installation
- Easy payments for pay-per-view services

Tight Operational and Cost Control

- Extendable content environment
- Require tight cost control as competition for IP TV customers is fierce between Telecom service providers, traditional broadcasters, Energy and Media companies
- In the case of VoD there is competition from neighbourhood video store

Interactivity

- Major differentiator compared to traditional broadcast TV where there is no back channel
- As a lever to accelerate application convergence on three screens PC, Mobile and TV
- Opportunity for personalised Ad selection

Low Priced Set-Top Boxes

- Operator will have to subsidize or pay for STBs
- Require close partnership with STB vendor to deliver IP TV client capabilities at a lower cost
- Volume purchase should be used to lower STB procurement costs

Summary Of IP TV Business Model and Challenges

- Telco's QoS managed network is a vehicle to deliver both managed TV and Internet TV with high Quality of User Experience
- For IP TV Services, Content is the key, but operators need to be mindful of important commercial trade-offs between content and services
- IP TV offers a new, more compelling model for advertisers to reach and influence consumers. Ability to target adverts more accurately by time viewed, by programme and via viewer profile could deliver new revenue opportunities for both Telco's and the advertisers
- Product and technology choices are critical to ensure that, features delivered must meet the user expectations and preferences
- Organisational realignment is necessary to develop User Centric IP TV value Delivery Model in a cost effective fashion
- The IP TV business model could vary from operator to operator. Whilst an incumbent Telco would like to own the entire network and services infrastructures, content providers, aggregators and wholesale ISPs would look for a collaborative approach to the deployment of IP TV via a separate white label or wholesale entity

Designing an IP TV Network

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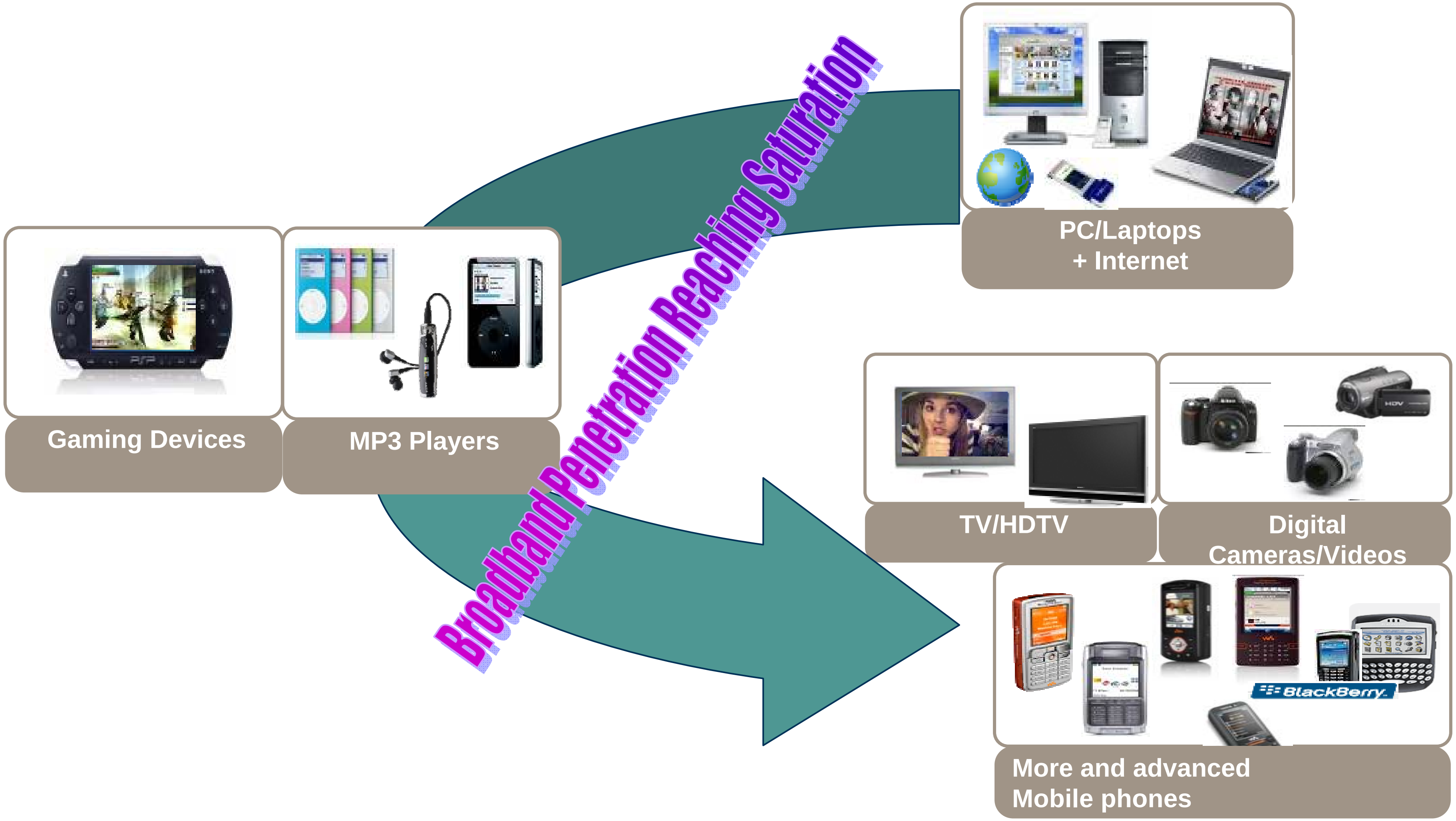
Service Transformation - Triggers



Video is at the forefront of driving Service Transformation, which has triggered new network requirements, new services, content types and Expectations

Consumer View of Services

User selects what services they subscribe to :

Services	Subscription	Volume	
Voice	✔	3	Voice Lines
IP TV	✔	2	SD Channel
		1	HD Channel
Streaming VoD	✔	1	1 Video Streaming
Interactive Apps e.g gaming	✔	1	1 Gaming
HSI	✔	Default	

- Key Observation

Users are in total control of full service mixes

Flexible subscription based on volume purchased

How Operator Handles Service Mixes ?

Operator translates customer subscriber to Bandwidth and IP QoS Profile at the Downstream Direction

Services	Subscription	Volume	CIR	PIR
Voice	✔	3	0.5M	0.5M
IP TV SD	✔	2	4M	4M
IP TV HD	✔	1	8M	8M
Streaming VoD	✔	1	2 M	2 M
Interactive Apps e.g gaming	✔	1	0.1 M	0.5 M
HSI	✔	Default	0.05M	12 M
Total Line BW			14.65M	26 M

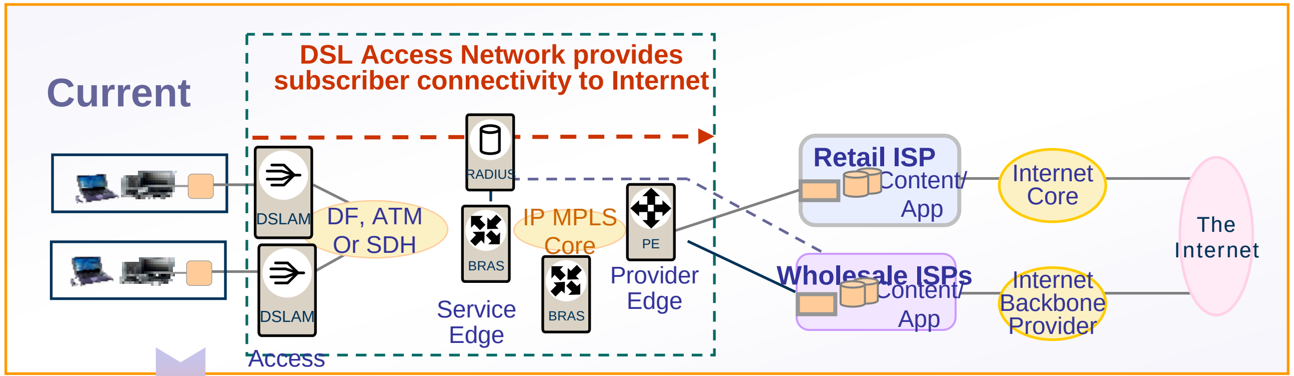
- Key Observation

Voice and IP TV require Constant Bit Rate (CBR) performance

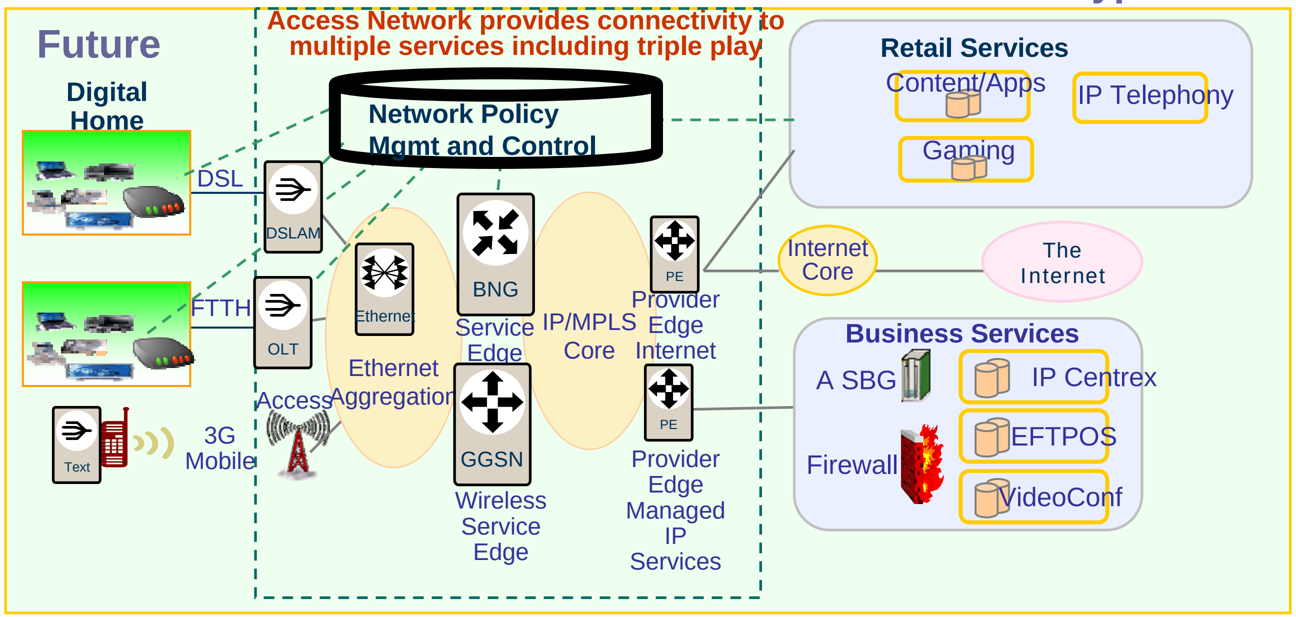
Voice and IP TV Services are highly sensitive to packet loss and delay

Note : CIR Commited Information Rate
PIR Peak Information Rate

Network Transformation – A Journey towards Services World



Industry Direction – Revenue growth stimulation, IP Network Rationalisation for all Access Types

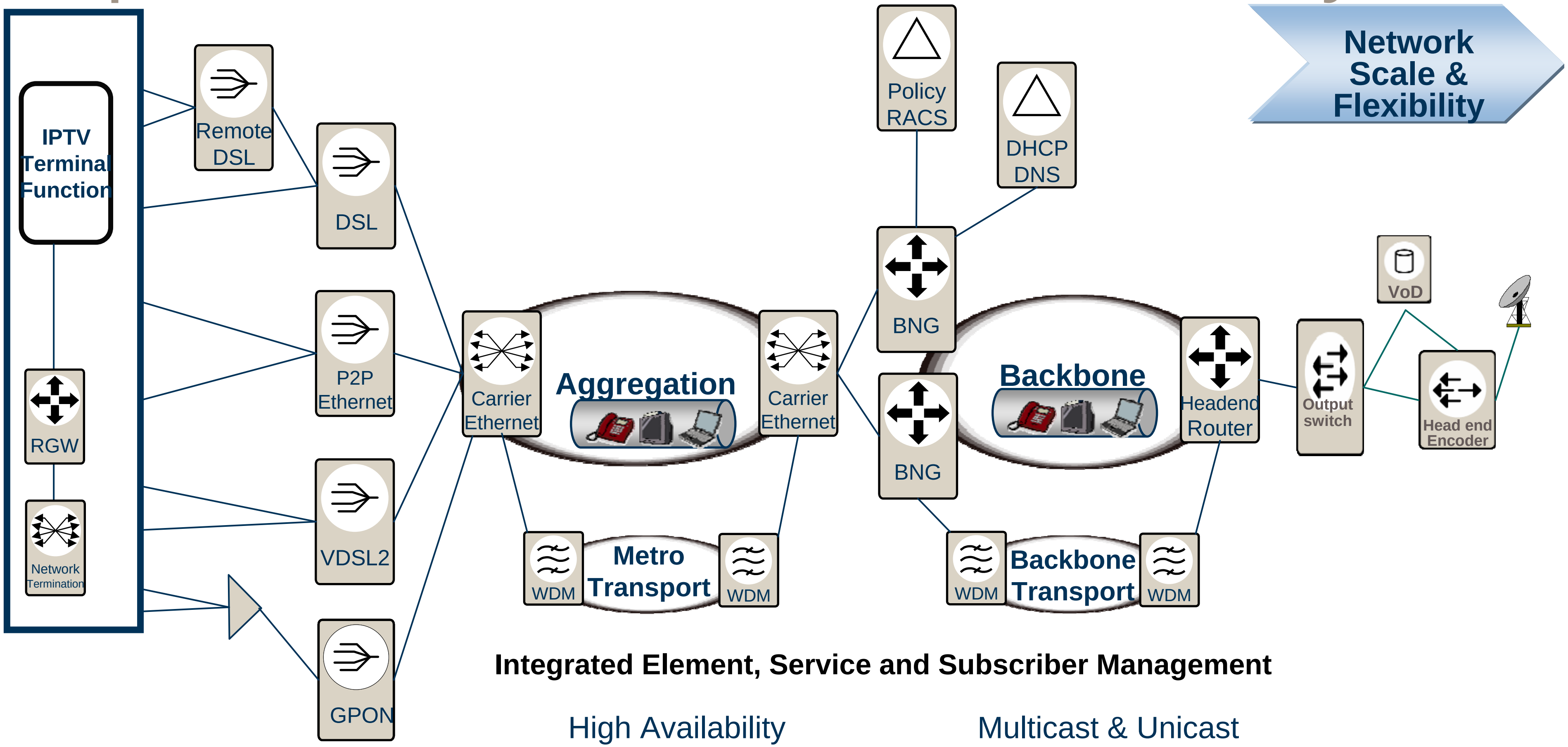


- **Access** Evolution
  - –Higher speeds (ADSL2+, VDSL2, xPON)
- **Aggregation** Evolution
  - –Ethernet elements provide higher capacity at lower cost
  - –A common Ethernet Aggregation for Residential and Business services
- **IP Edge** Evolution
  - –Consolidate platforms for business (L2/L3) and residential services
  - –BNG as the IP Edge to support Service aware Routing with L3 policy management

Key IP TV Network Design Considerations

Network Scale & Flexibility	Network Security & Reliability	Network Operations & Platform Mgmt
• **Bandwidth Planning in access and edge** • Designing for 100% VoD • **Optimized multicast delivery** • **Service-aware QoS** • Subscriber QoS to deliver service bundles • **Single Network for Business & Residential subscribers**	▪ **Always on Service** ▪ **Network Availability** ▪ **Node Availability** ▪ **Non Stop Service and Non-Stop Routing** ▪ **Anti-spoofing and DOS attack prevention**	▪ **Service-aware OAM diagnostic tools** ▪ **Network Op Tool** ▪ **OSS Integration** ▪ **Service-aware accounting and billing for innovative service models**

Requirement for IP TV Service Delivery



Massive Bandwidth Scaling

- 20Mb/s to more 100Mb/s per subscriber

Subscriber Level QoS for Multiple Services

- Scale QoS mechanisms, enforce service interaction per-sub, per-service

High Availability

- Per-path, per-link, per-node high availability, across the network

Policy scaling

- Scale security, anti-spoofing, accounting, filtering, policing etc.

Multicast & Unicast

- Any mode of operation & optimize architecture for BTV as well as 100% VoD

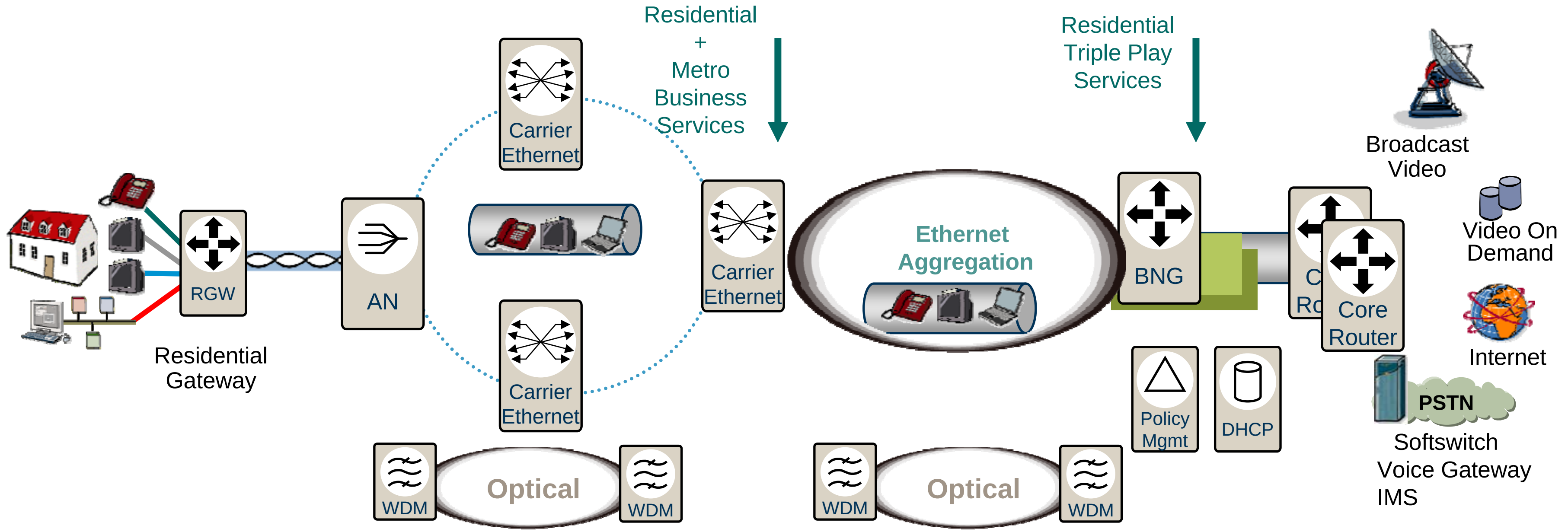
Optimized Cost Structure

- Linear, predictable (non-exponential)
- Streamlined network & service operations

AN (Access Node); EAS (Ethernet Aggregation Switch); BNG (Broadband Network Gateway)

Ethernet Aggregation Design Goals

Network Scale & Flexibility

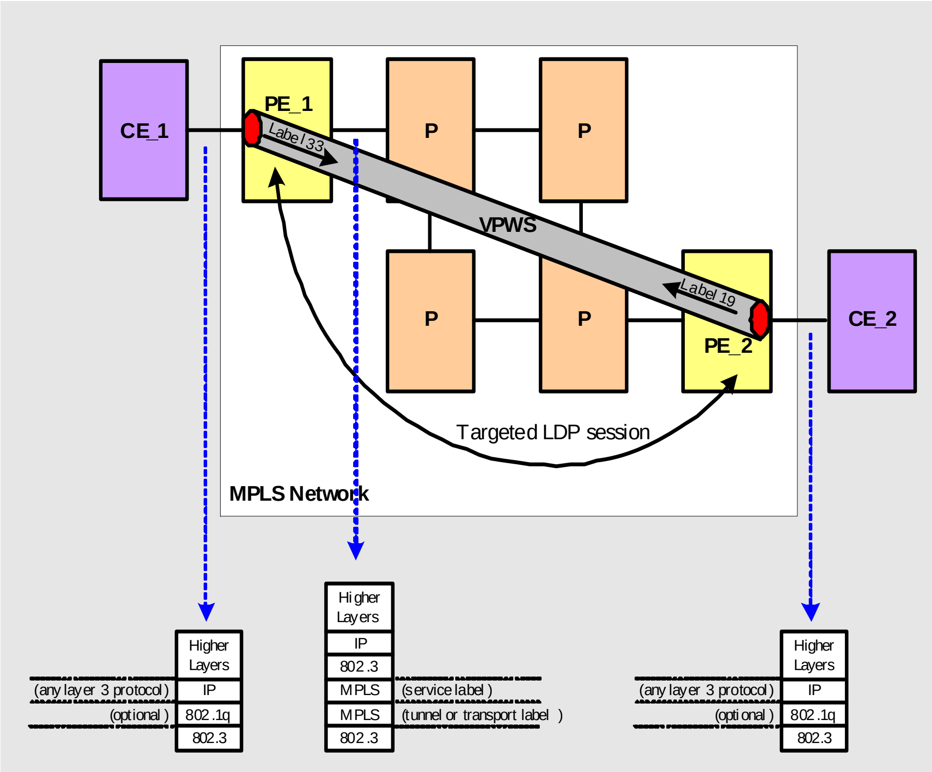


- Increase Ethernet scalability
  - –Works equally with VLANs and 802.1 Q circuits
  - –VLAN translation and VLAN aggregation
- Improves Resiliency for Ethernet
  - –Sub-50ms Fast-reroute with MPLS
  - –No spanning tree for loop prevention
- Simplifies multicast with IGMP proxy/snooping

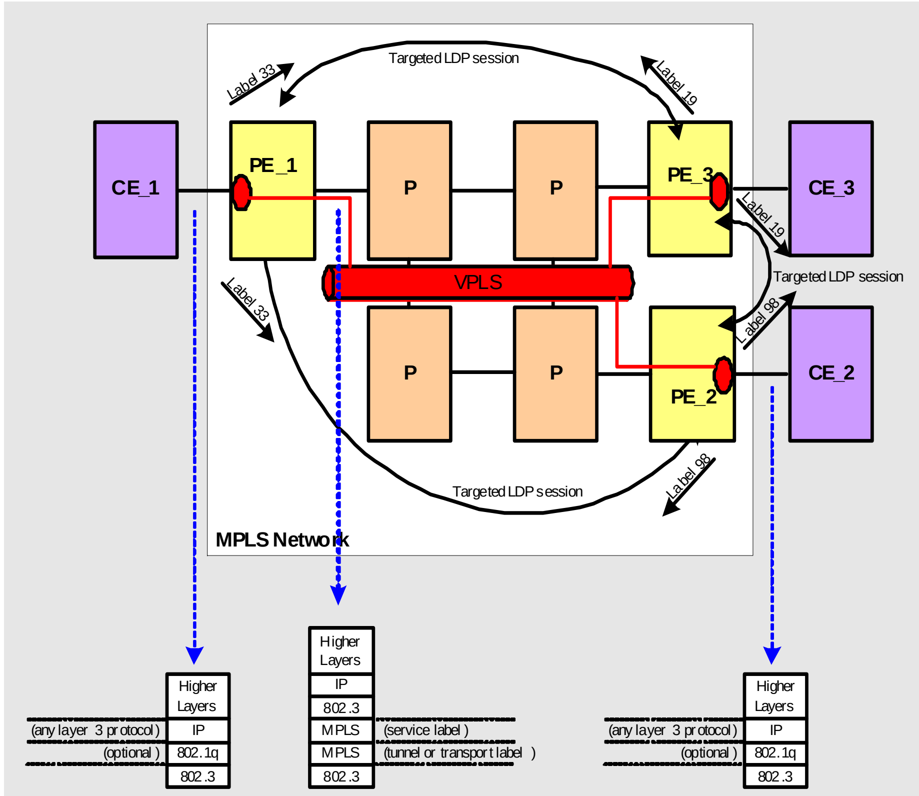
- Conserves VLAN and IP addresses – subnet can span multiple DSLAMs
- Standardised OAM capabilities and tools
- Service ping, MAC ping, MAC trace-route tools
- Offers LSP ping & Traceroute

MPLS Technologies In The Ethernet Aggregation Network

Network Scale & Flexibility



Virtual Private Wire Service (VPWS)



Virtual Private LAN Service (VPLS)

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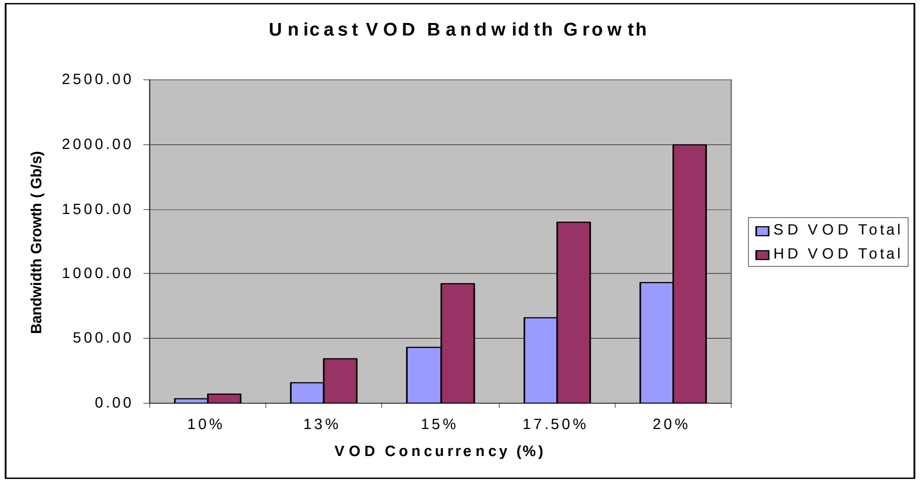
Unicast VoD will be the main driver for Network Capacity Growth

Network Scale & Flexibility

- **Scaling of Unicast Video Requires:**
  - 1000s of GE capacity per CO
  - Services and Policy enforcement at wire-speed



Services	Subscription	Volume	CIR	PIR
Voice	✓	3	0.5M	0.5M
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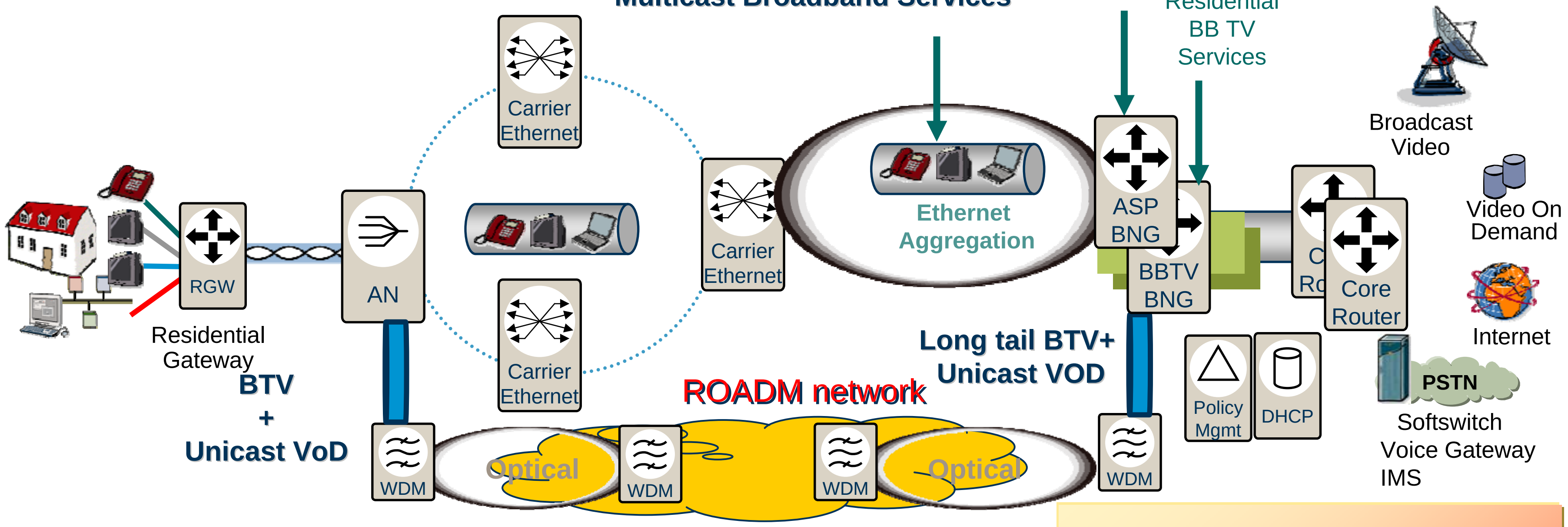
Interactive Apps e.g gaming	✓	1	0.1 M	0.5 M
HSI	✓	Default	0.05M	12 M
Total Line BW			13.65M	26 M

			Year 1	Year 2	Year 3	Year 4	Year 5
Subscriber Baseline	in K		90	340	770	1000	1250
Contention Ratio	in %		10%	13%	15%	17.50%	20%
Total BW	in Gbps						
SD Bandwidth	in Mbps	3.75	33.75	159.38	433.13	656.25	937.50
HD Bandwidth	in Mbps	8.00	72.00	340.00	924.00	1400.00	2000.00

BB TV Alternate Architecture

Network Scale & Flexibility



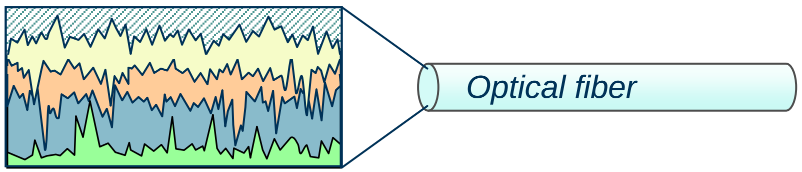
- **Low Cost Broadcast TV Architecture Optical Bypass**
  - Video Broadcast is delivered via Ethernet Service aware Optical Transport
  - BBTV VLAN can be mapped onto a 10 G optical λ reserved for Video
  - Automatic rerouting of video traffic if designated main and protection points fail
  - High capacity scalable DWDM transport with reconfigurable optical mesh provides flexible capacity per node and optical express capability optimising traffic path and cost

- **BNG Architecture Simplification**
  - Services interactions are complex on a common BNG architecture
  - One single BNG for all services could increase both architectural and operational complexity
  - BBTV service requirements are different from VoD and HSI, Hence it would make sense to segregate BBTV service on a separate BNG
  - Distributed BNG options
  - Ethernet aware Optical Transport

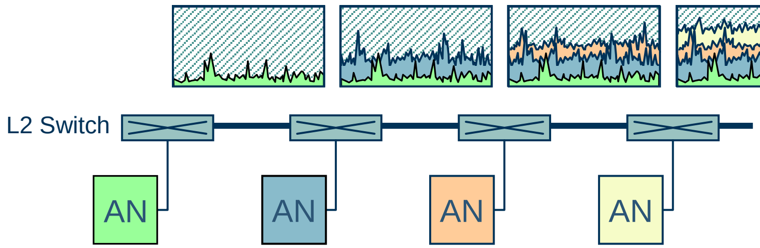
Changed Orientation

L2 oriented Metro

- Traditional way of aggregating access
- Scalability by increasing Ethernet rate
- Besides Ethernet Switching, complementary VPLS & MPLS is used
- 1st gen Multicast IPTV manageable, Unicast growth is a challenge

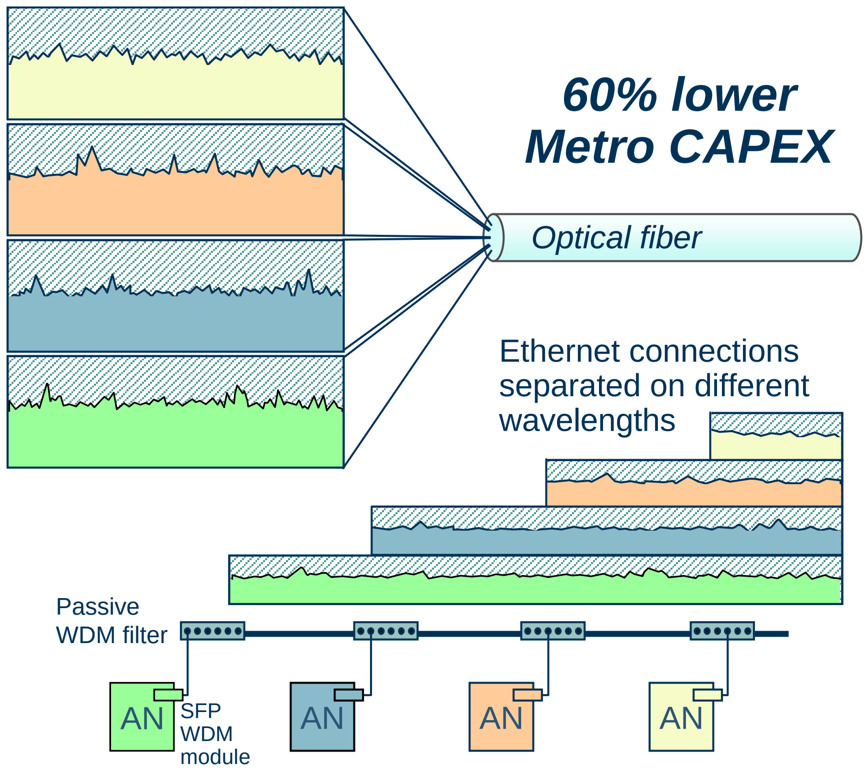


Ethernet sharing of common capacity through L2 traffic processing



WDM oriented Metro

- Scalability by adding wavelengths
- Efficient use of fiber resource
- Significantly less power per bit
- Low cost optical components used
- More efficient for evolved IPTV with Unicast and ”long tail” Multicast



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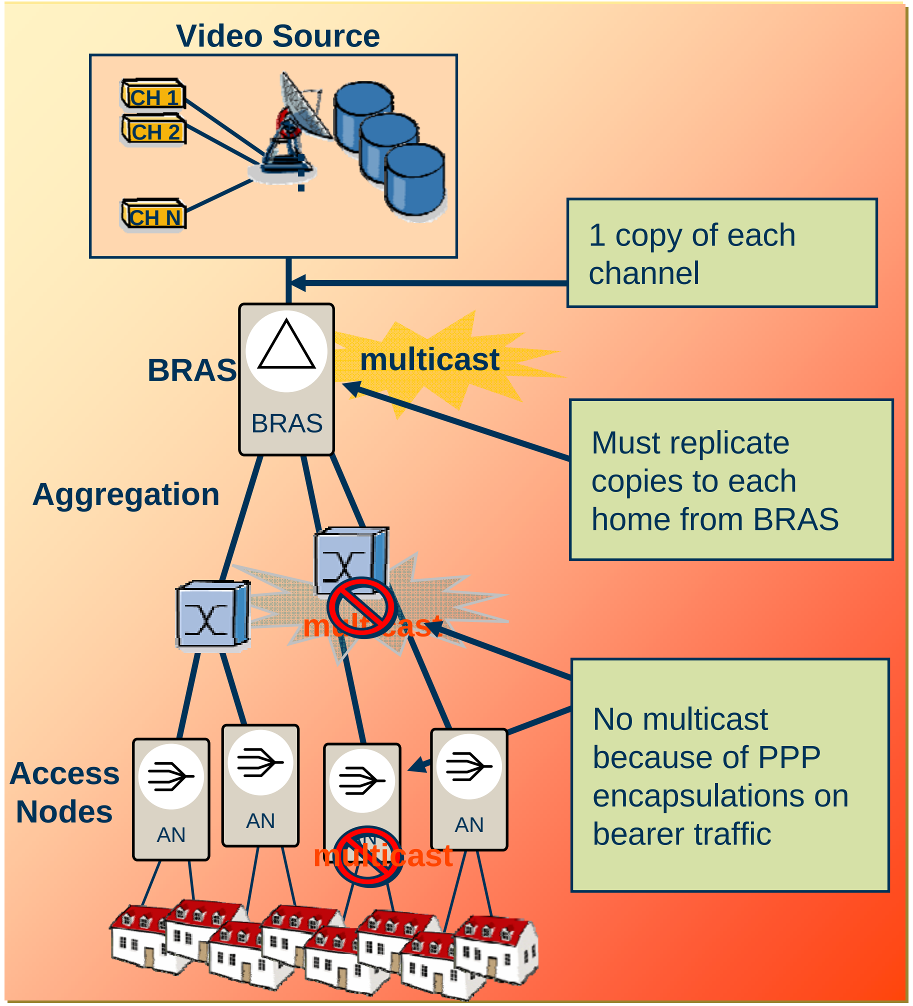
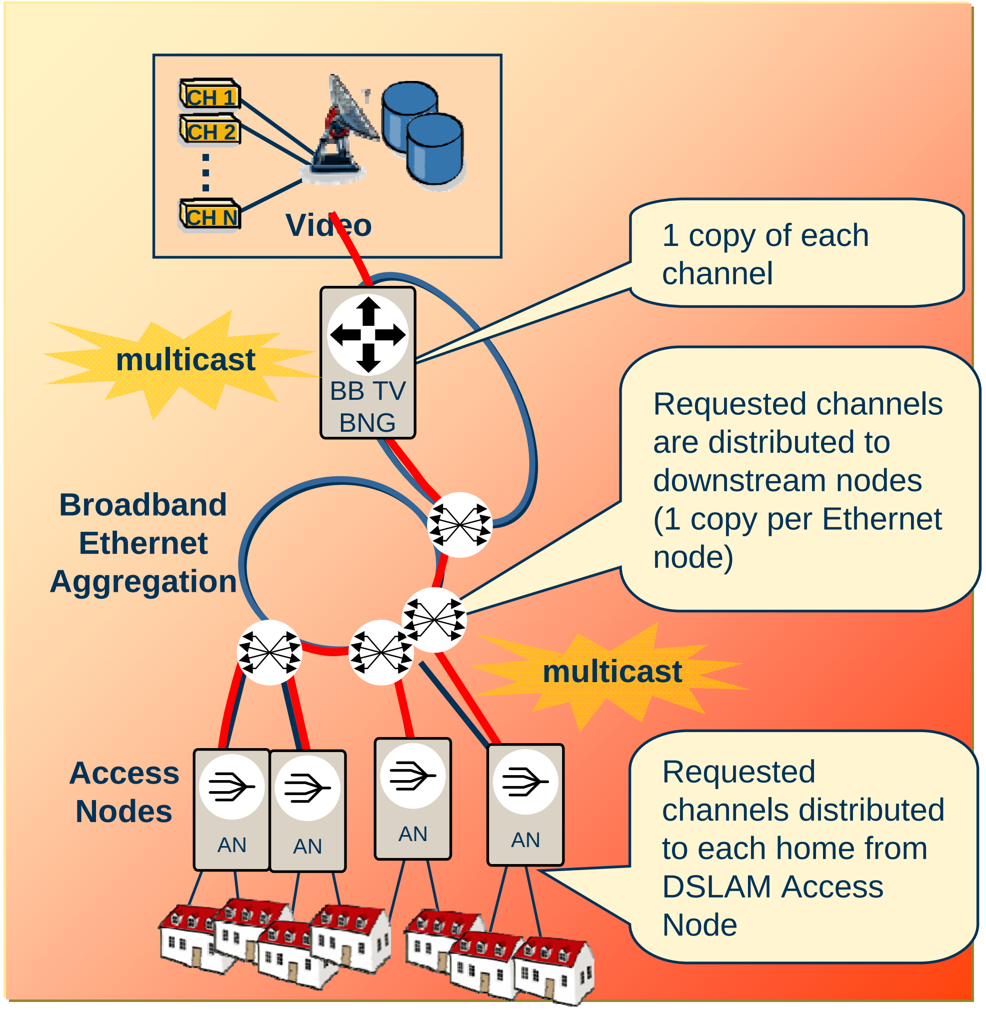
Optimised Multicast Network For Efficient Video Delivery

Network Scale & Flexibility





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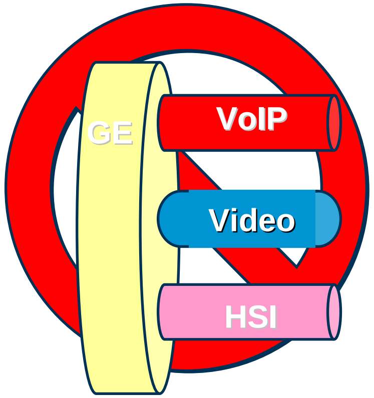
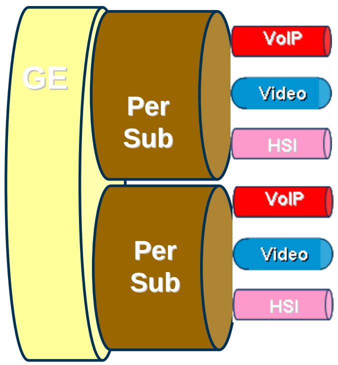
Subscriber QoS to meet Multi Services Requirements

Network Scale & Flexibility



Subscriber -Unaware IP Edge (BRAS)



Subscriber-Aware

IP Edge (BNG)

- **QoS for High-speed Internet is about service differentiation**
  - –Service works at different bandwidths
- **Video Service requires bandwidth to be available**
  - –QoS for video and VoIP requires admission control, prioritization, delay/loss guarantees
- **Triple-play requires per-service, per-subscriber queuing and shaping**
  - –Subscriber Isolation
    - Prevents one user from taking too much shared bandwidth
  - –Bandwidth Efficiency
    - Controls bursts to optimize use of buffers downstream resulting in better quality video due to lower loss
  - –User differentiation
    - Enforces each subscriber's independent policy

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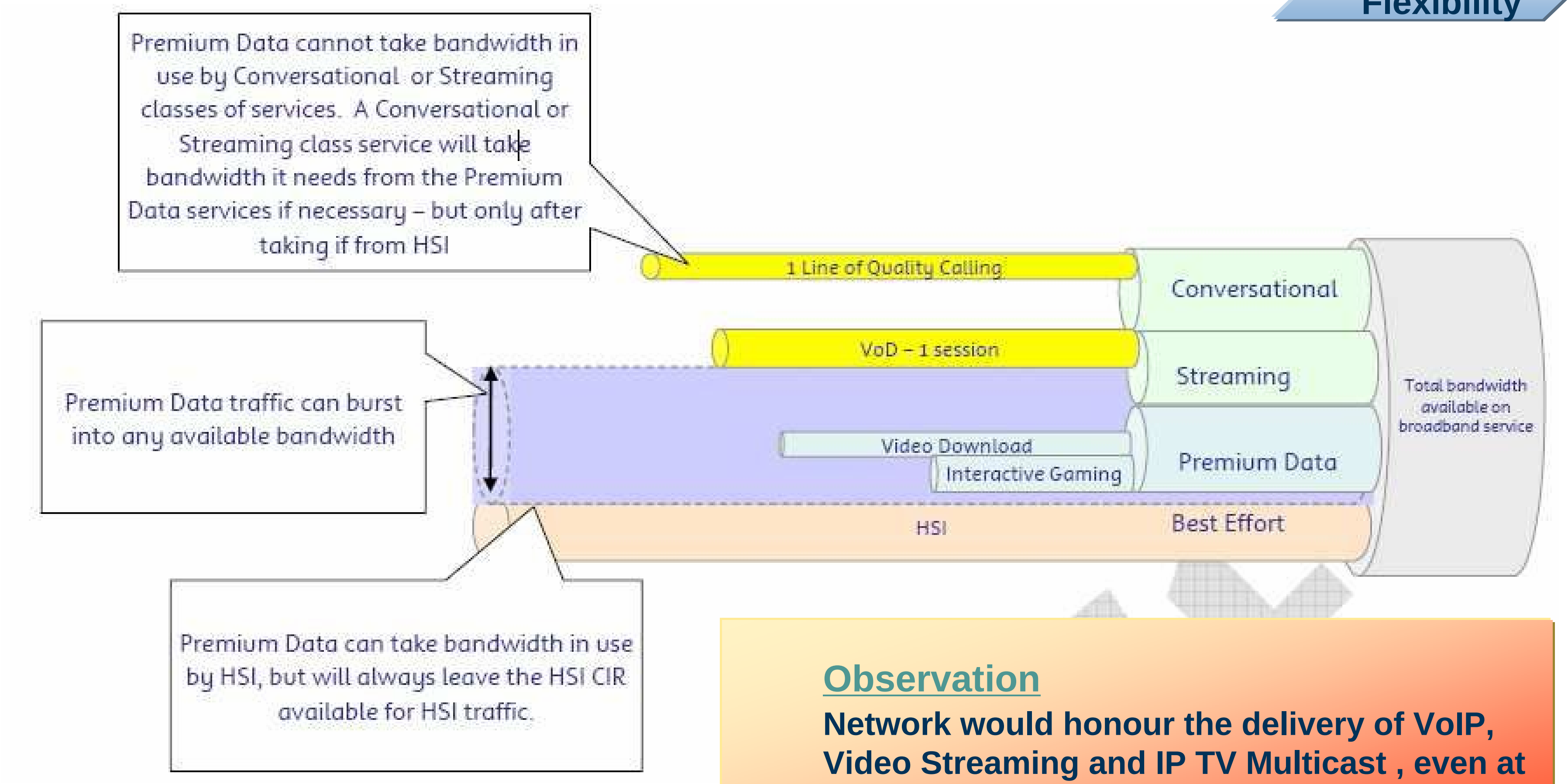
Subscriber Bandwidth Model

Network Scale & Flexibility



Observation

Network would honour the delivery of VoIP, Video Streaming and IP TV Multicast , even at the expense of Premium Data and High Speed Internet Data flows not the other way around

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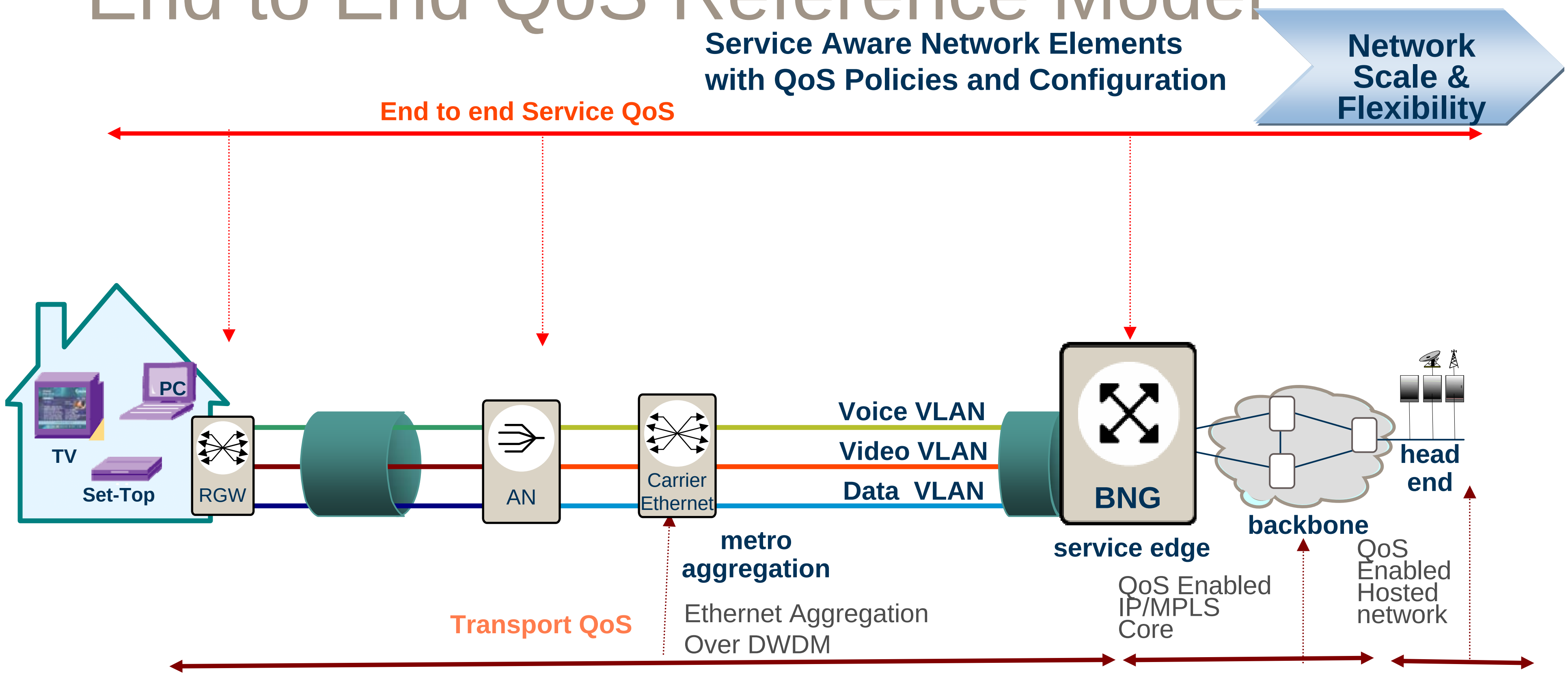
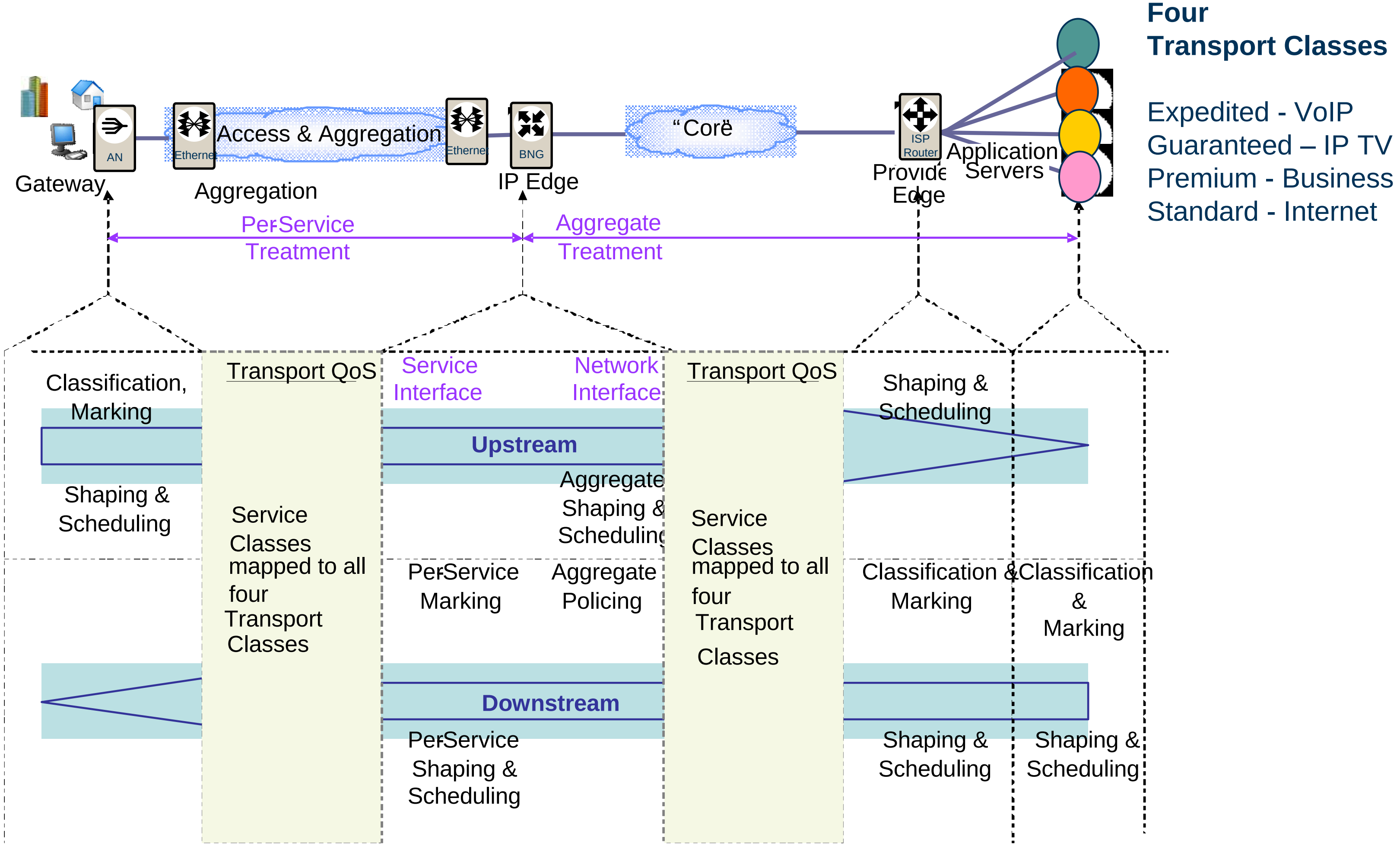
End to End QoS Reference Model



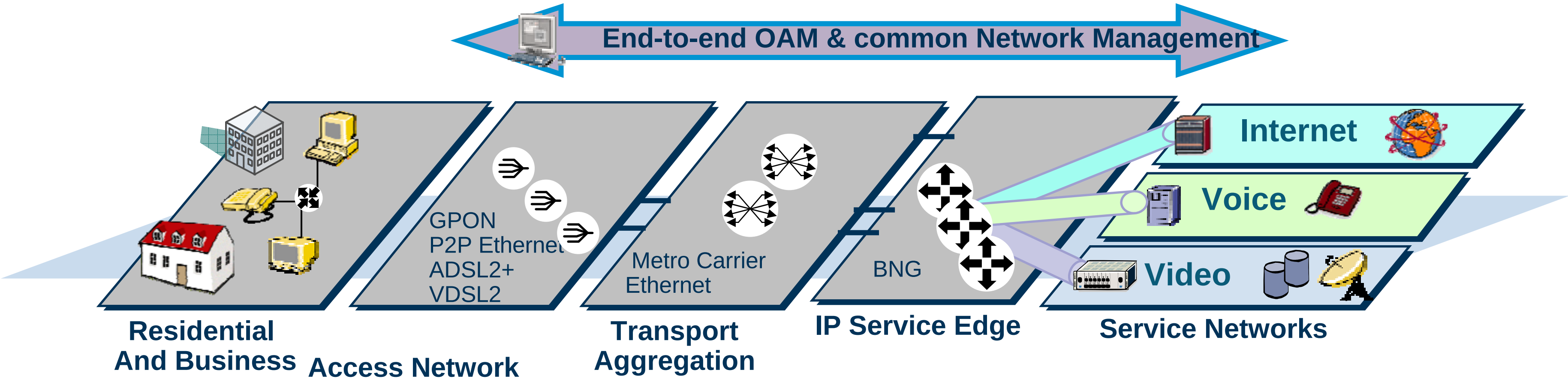
Transport QoS Priority	Traffic type
7	Control & management
5	Voice (residential & business)
4	IPTV, multicast services
3	IPTV, unicast services (VoD)
2	Business data services
0	Best effort Internet access

Location of QoS Functions for Service Mixes



One Network for All Services:
Business & Residential

Network Scale & Flexibility



- **Common architecture across all access types for residential services**
  - VoIP, VoD, HSI, IP Multimedia
- **One Network for business and residential service delivery**
  - Point-to-point services, L2 VPNs (VPLS), Layer 3 IP-VPNs, etc
- **Without business services, Residential IP TV service delivery could use light-weight Ethernet Protocols eg. PBB-TE, T-MPLS (with GMPLS Control)**

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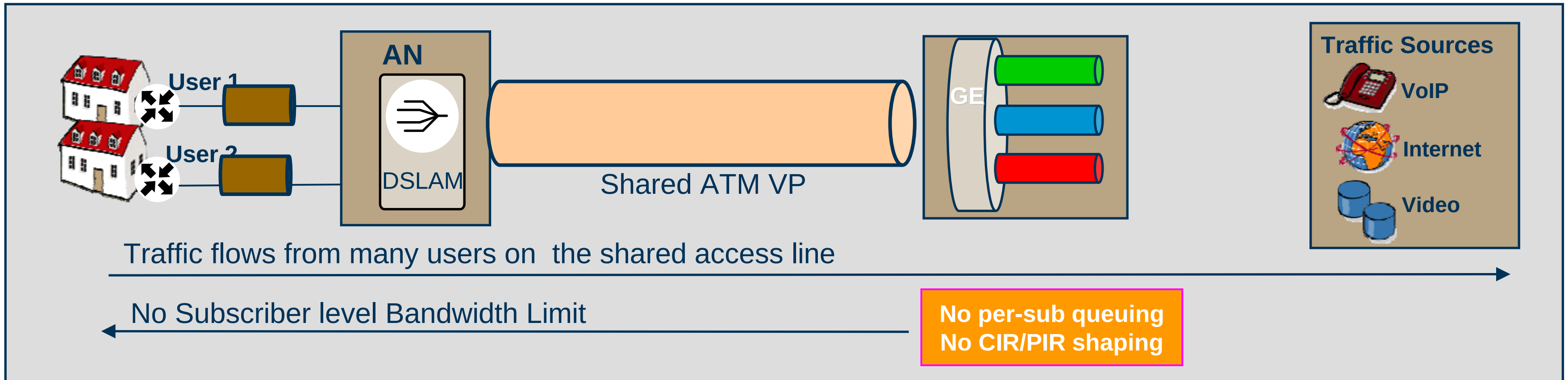
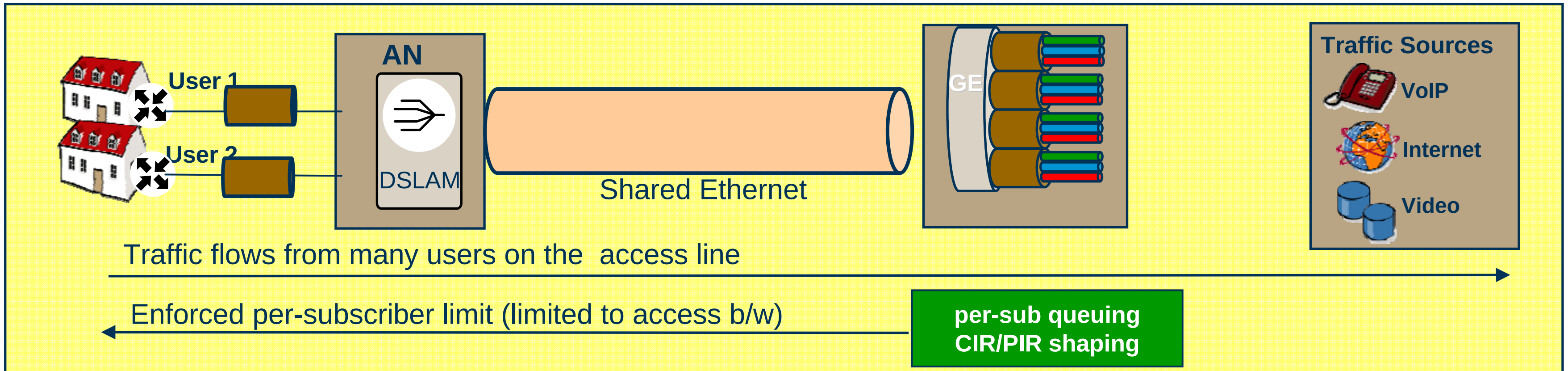
Subscriber QoS for Fairness in Service Bandwidth Allocation

Network Security & Reliability



Possible DoS attack – users can consume disproportionate amounts of shared bandwidth



Protects shared bandwidth with CIR and PIR shaping per subscriber

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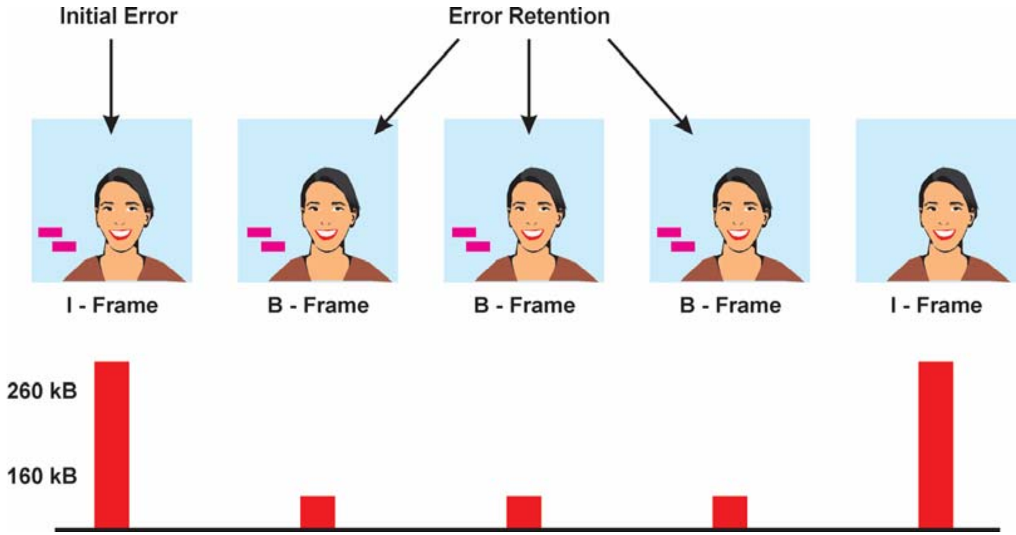
MPEG Error Retention

Network Security & Reliability



- **Objective**
  - –Keep error as low as possible
- **Implications**
  - –Bad quality : Degradation of picture quality, more noticeable on fast moving picture
- **Answer**
  - –MPLS Fast Re-route
  - –High Availability
  - –MPEG Error Performance Testing

Always On Experience : Packet Loss Expectations

Network Security & Reliability

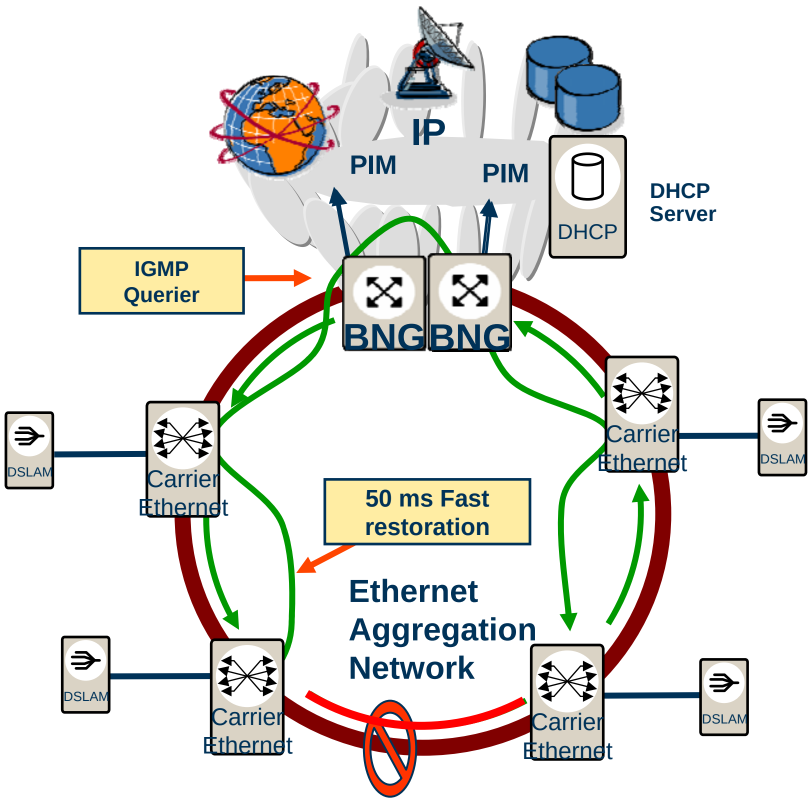
Single B-frame IP packet loss (1 frame affected)

Single I-frame IP packet loss(14 frames affected)

- **Objective**
  - –Keep outage as short as possible
- **Implications**
  - –Bad quality : 1 IP packet loss (Bframe/Iframe)
- **Answer**
  - –MPLS Fast Re-route
  - –High Availability
  - –End To End Packet Loss Testing

High Availability: Network Resiliency (1/2)

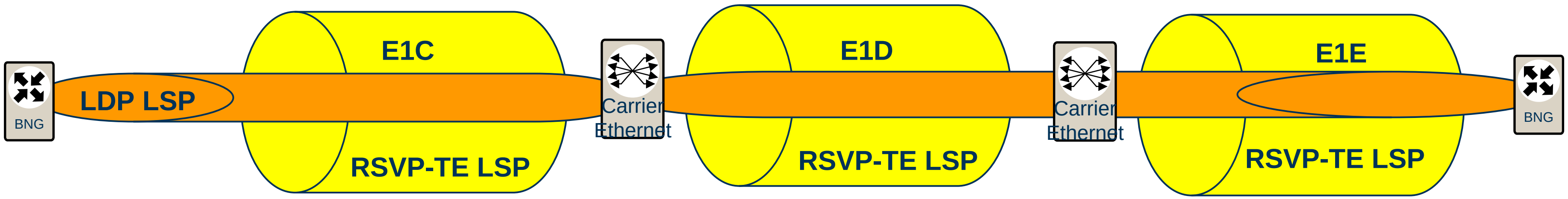
Network Security & Reliability



–In case of link failure on ring between aggregation nodes, recovery is via MPLS FRR on Individual RSVP Tunnel
LDP over RSVP TE is the Protocol Of the choice

–Sub 50 ms recovery

Traffic Flow Through LDP tunnels within one or more RSVP-TE LSPs



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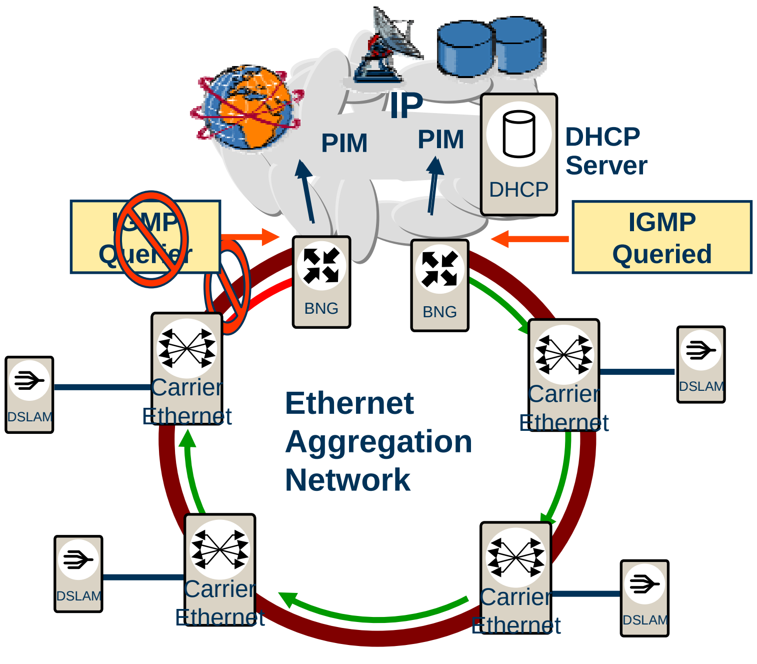
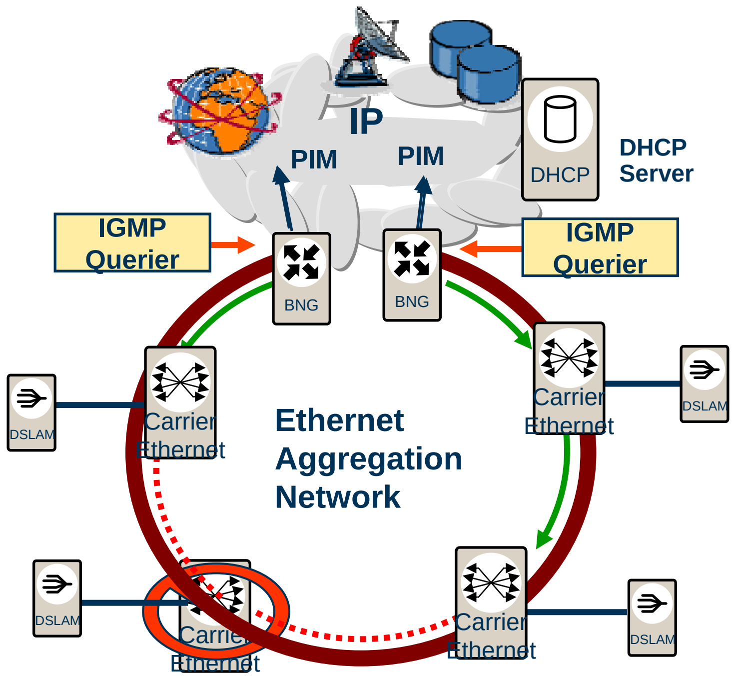
High Availability: Network Resiliency (2/2)

Network Security & Reliability



•In case of link failure to multicast router, IGMP election process will cause switchover of multicast router, recovery in seconds (IGMP timers).



•In case of Aggregation node failure, the ring is broken and both multicast routers become active

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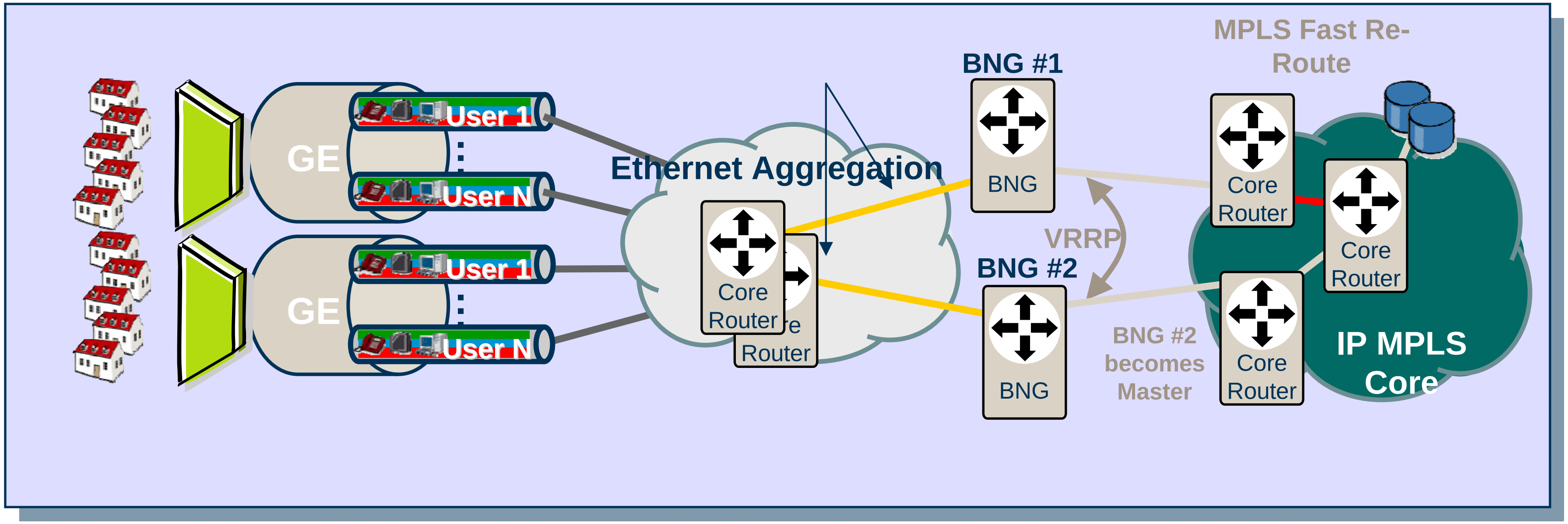
High Availability: MPLS FRR and VRRP

Network Security & Reliability



- MPLS Fast Reroute OR Hot-standby secondary LSPs protect failure between BNG's
- Use LDP over RSVP - TE
- Use Virtual Router Redundancy Protocol
  - Provides transparent (subscriber unaware) switchover to secondary router in case of failure of primary

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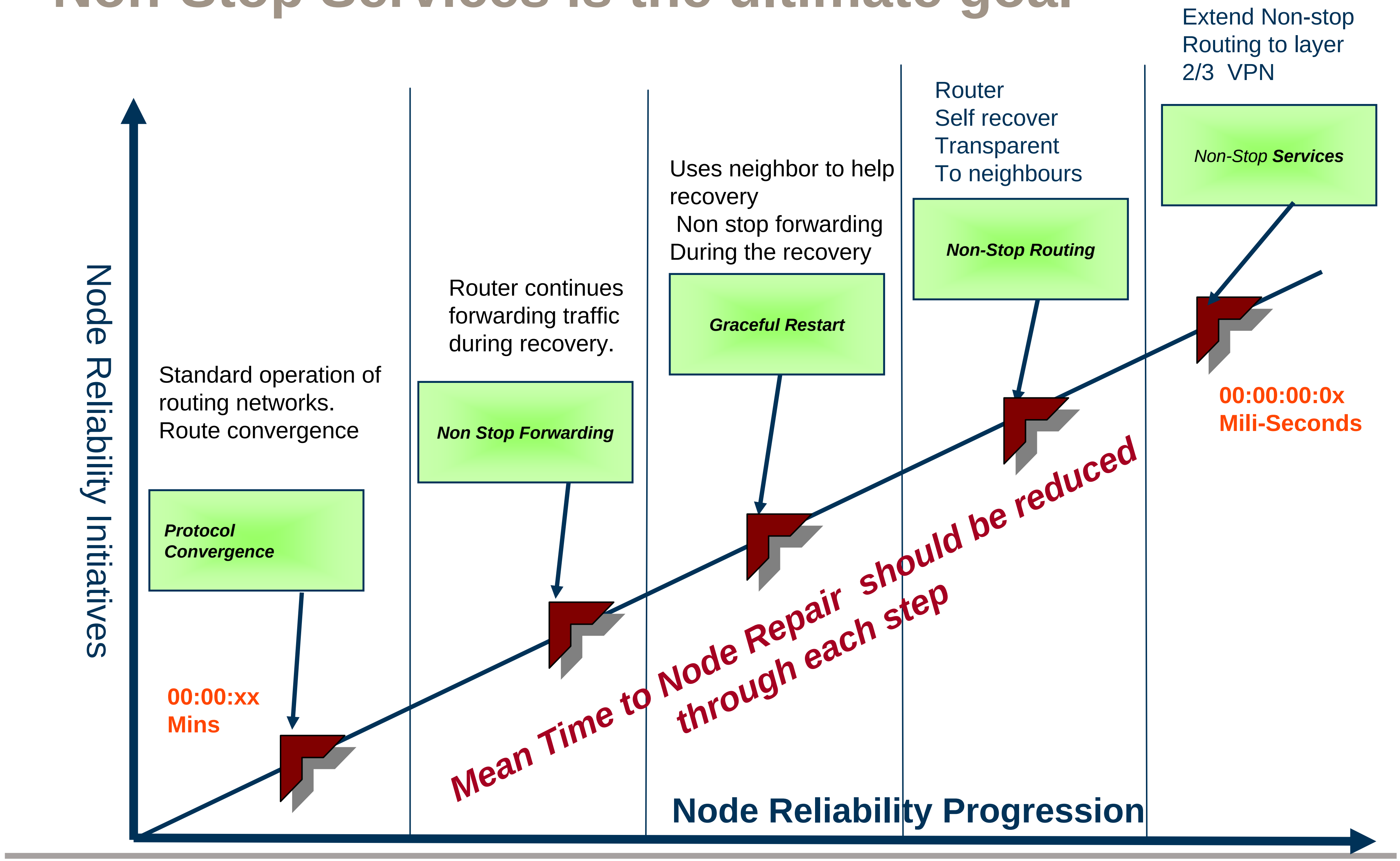
Network Security & Reliability

High availability: **Node Reliability**
Non-Stop Services is the ultimate goal



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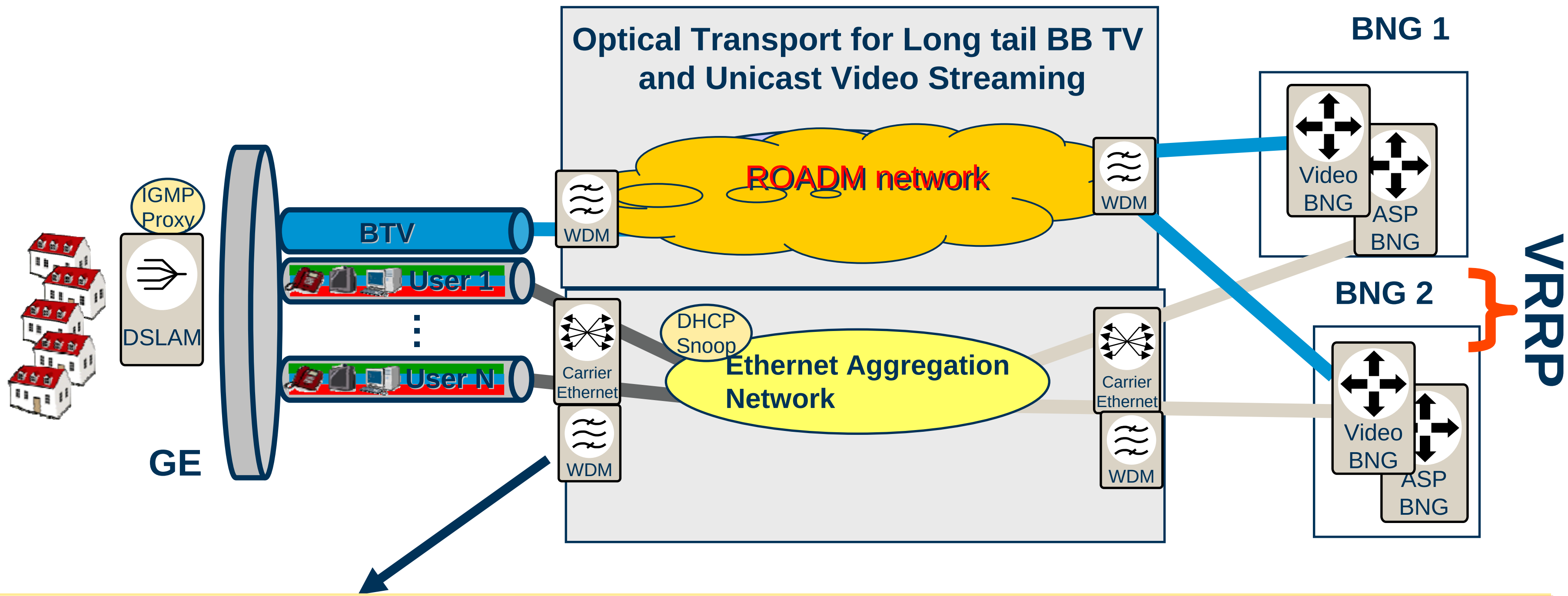
Security & Traffic Control

Network Security & Reliability



■**Prevent theft of Service**

Only valid SRC-IP/SRC-MAC combination allowed based on auto installed filter policy by snooping DHCP Ack

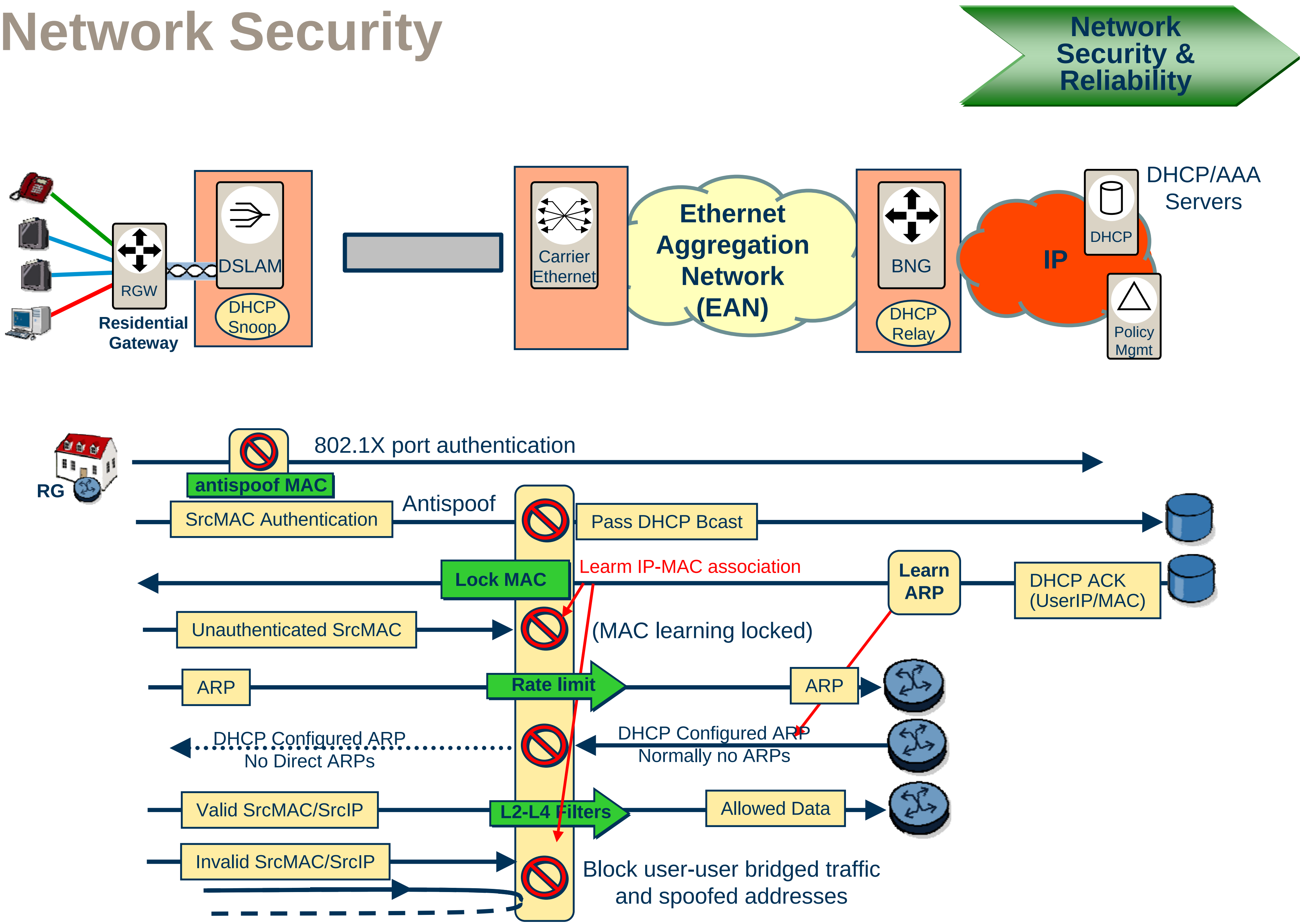
⑩**Subscriber Activation**

Subscriber associated with purchased service dynamically based on examination of DHCP ACK msg OR as part of user-RADIUS authentication

⑩**Disallow user-to-user communication in L2 network**

Example : Blocked in the Aggregation Switch using VPLS Split Horizon

Network Security



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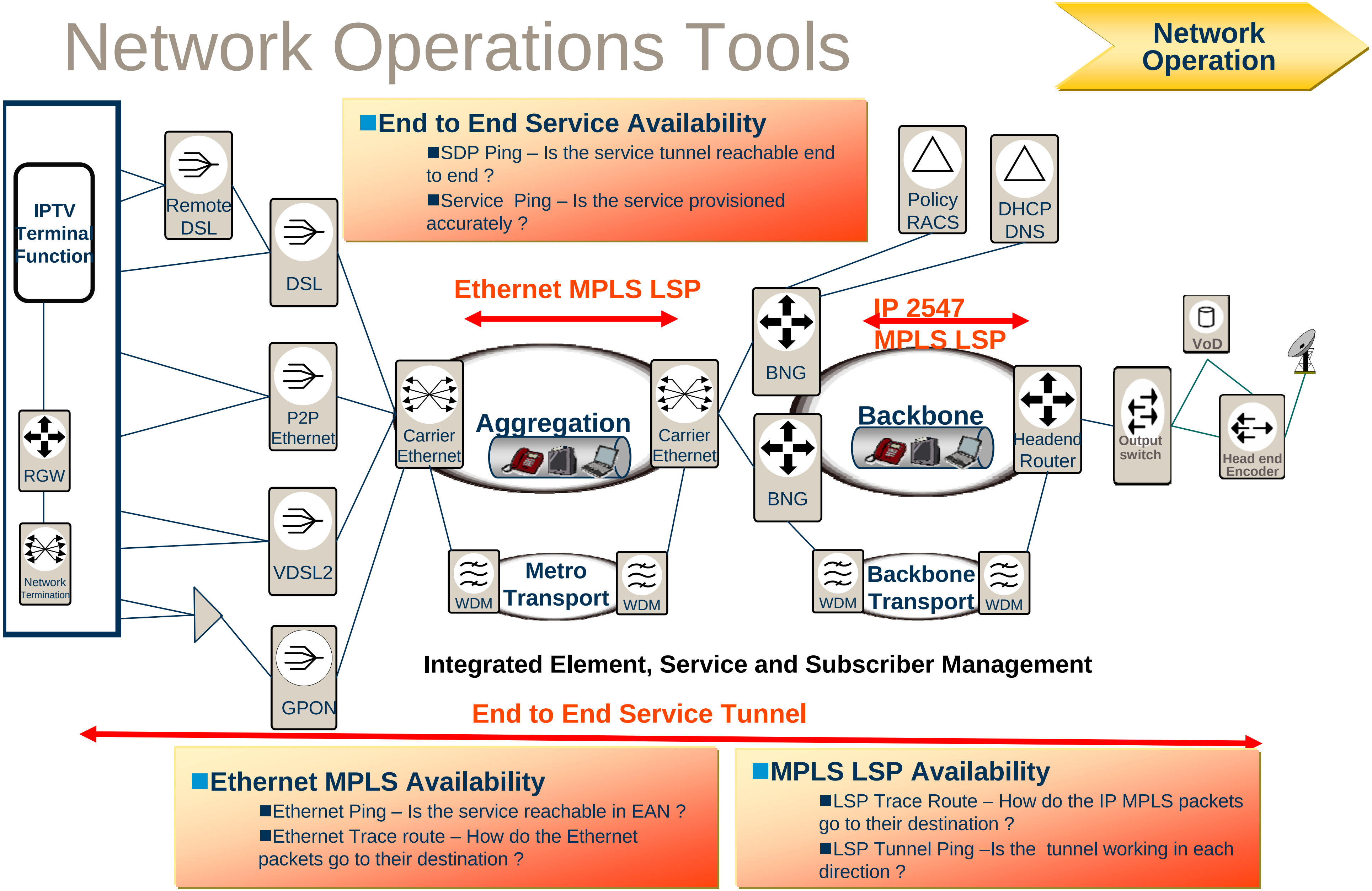
Network Operations Tools



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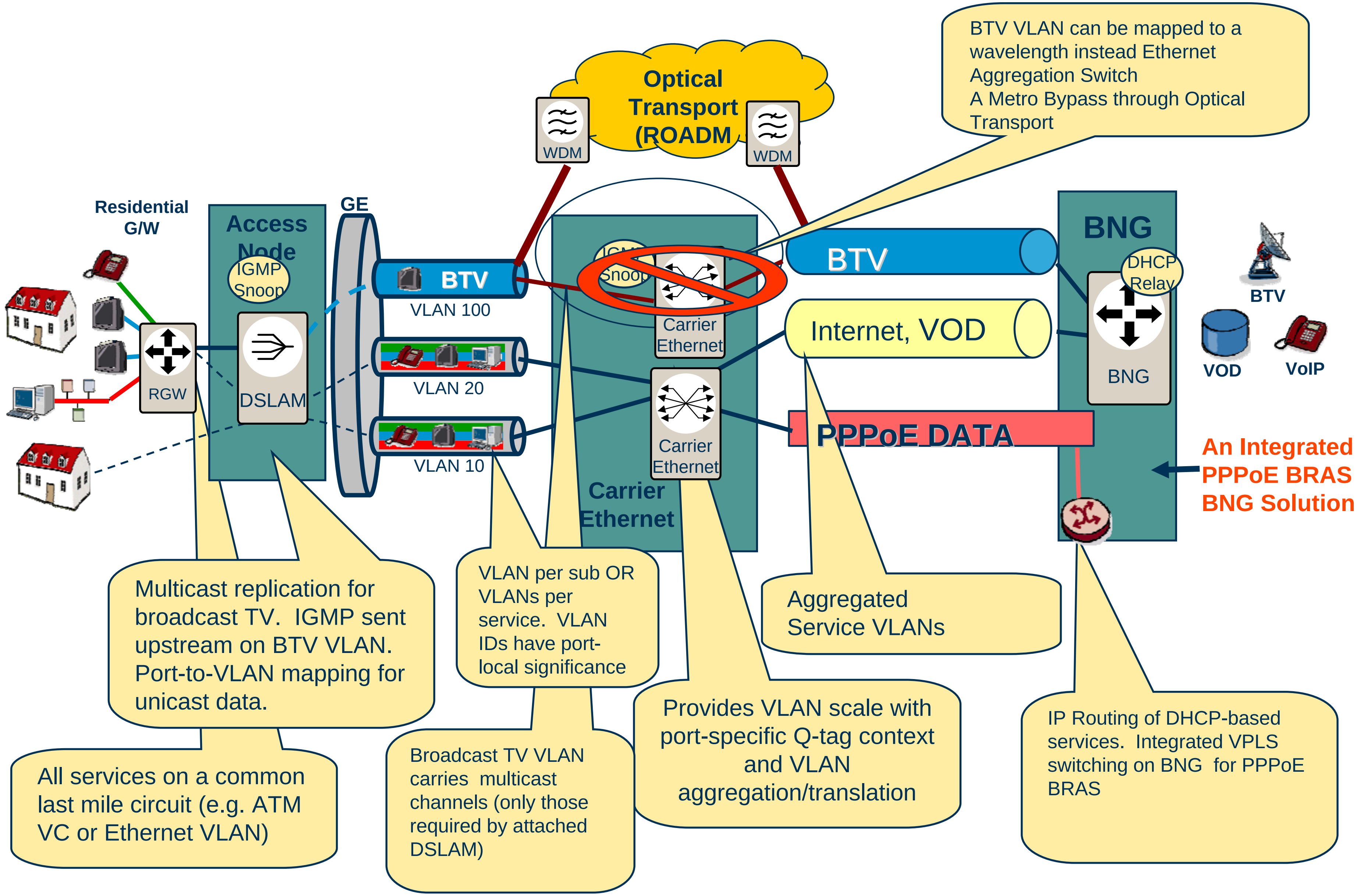
IP TV Network Architecture Options



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Summary - Key Design Considerations

- Unicast VoD is the main driver for network bandwidth growth
- Ethernet technologies (VPLS, VPWS, T-MPLS) have matured enough to offer higher scalability, increased security and improved resiliency at the aggregation layer. Any specific choice of technology however would depend on the operator's products and service offerings (eg, Business or residential)
- The delivery mechanism of Broadcast TV requires careful consideration. A possible solution is to deliver long tail BTV and unicast VoD streaming via the optical transport bypass
- MPLS FRR could be implemented to support 50 ms network failover – a key performance requirement for voice and video
- Network operations and management tools are the key considerations, while making a choice about network technologies and systems
- Subscriber level QoS and network policy control will be required to control the fairness in bandwidth allocation and resource usage
- End to End QoS management is the key to meeting Real time multimedia application performance

Delivering IP TV Services with Quality of Experience

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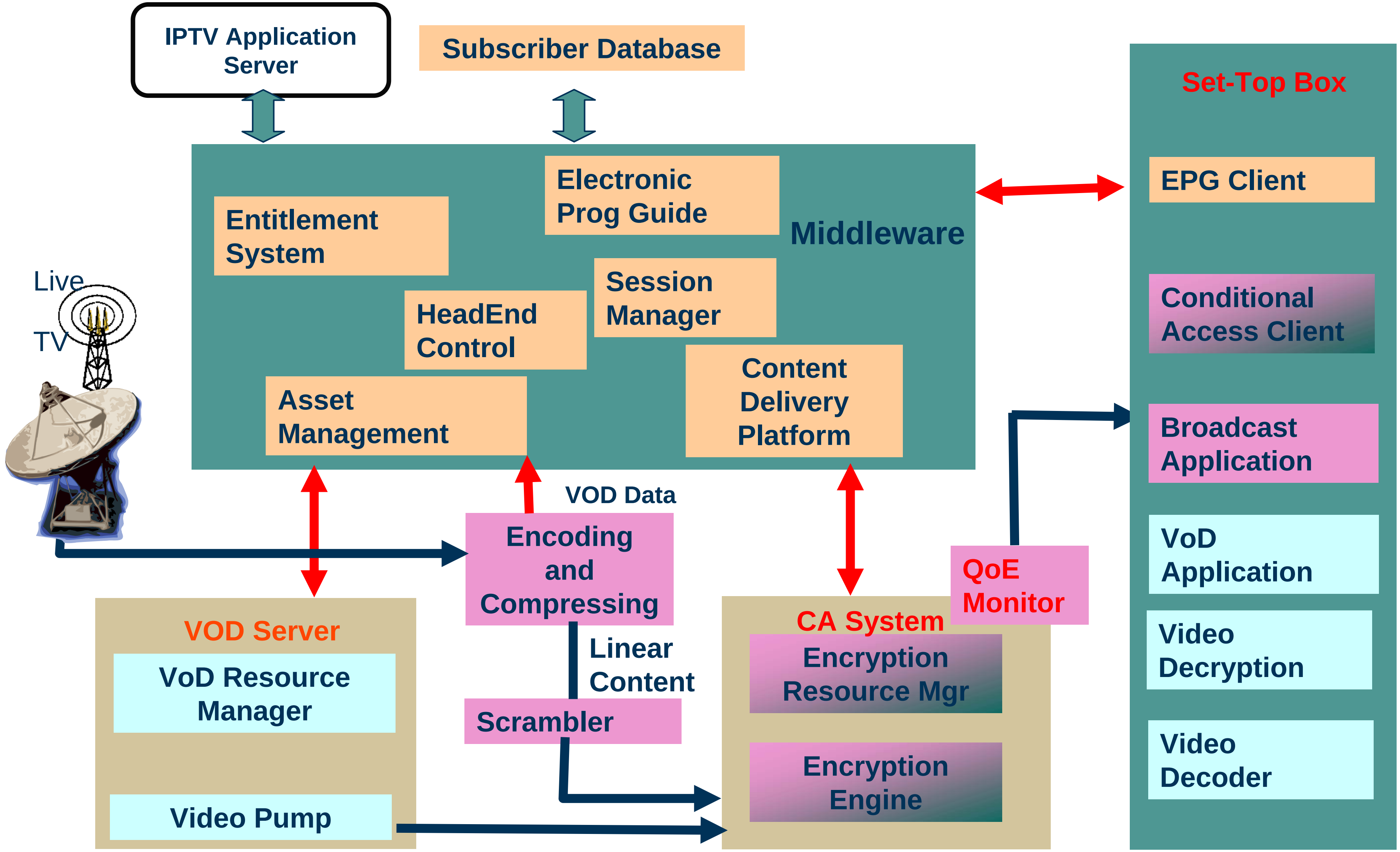
TAKING YOU FORWARD

A Simplified IP TV System



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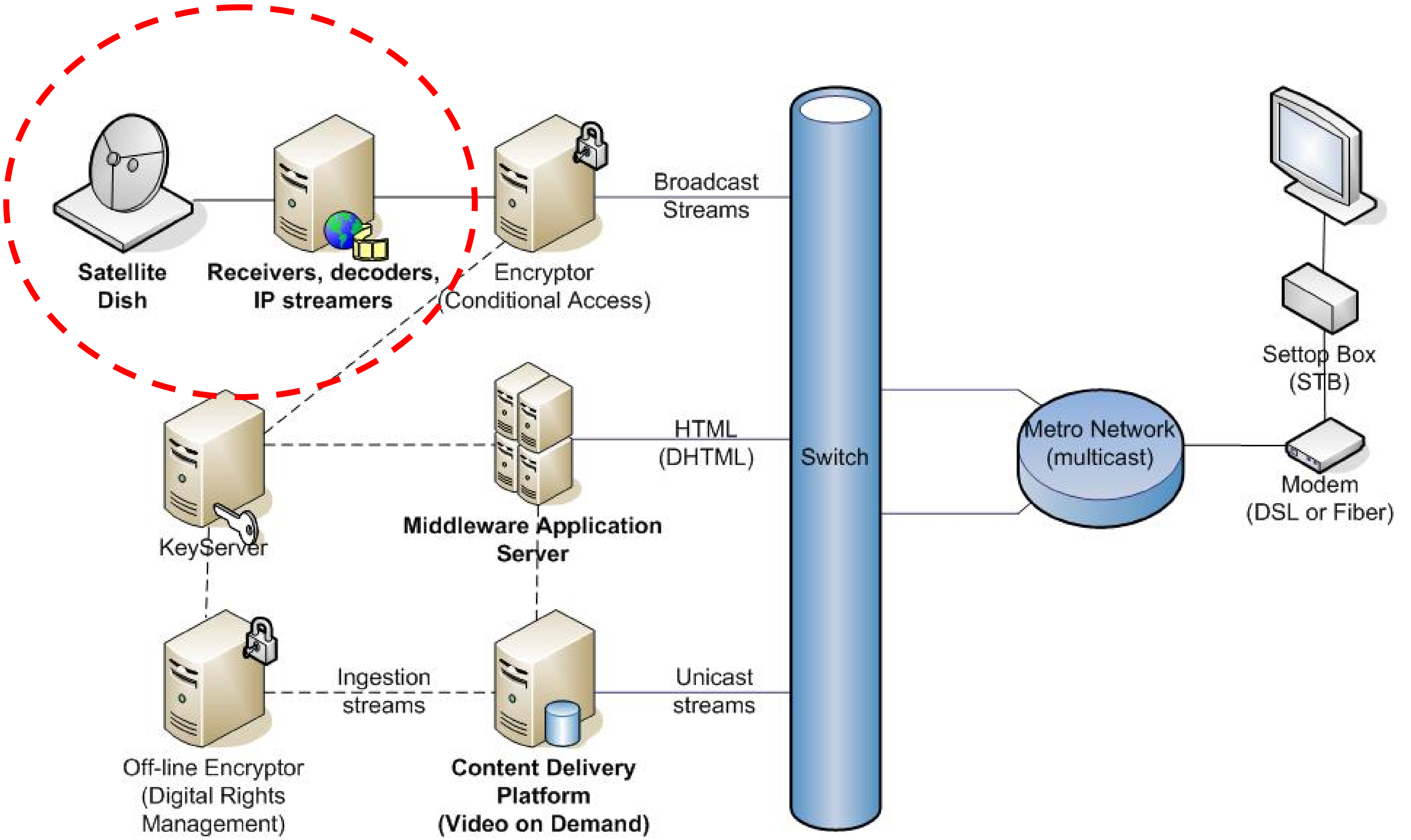
Head-end in an IPTV Solution



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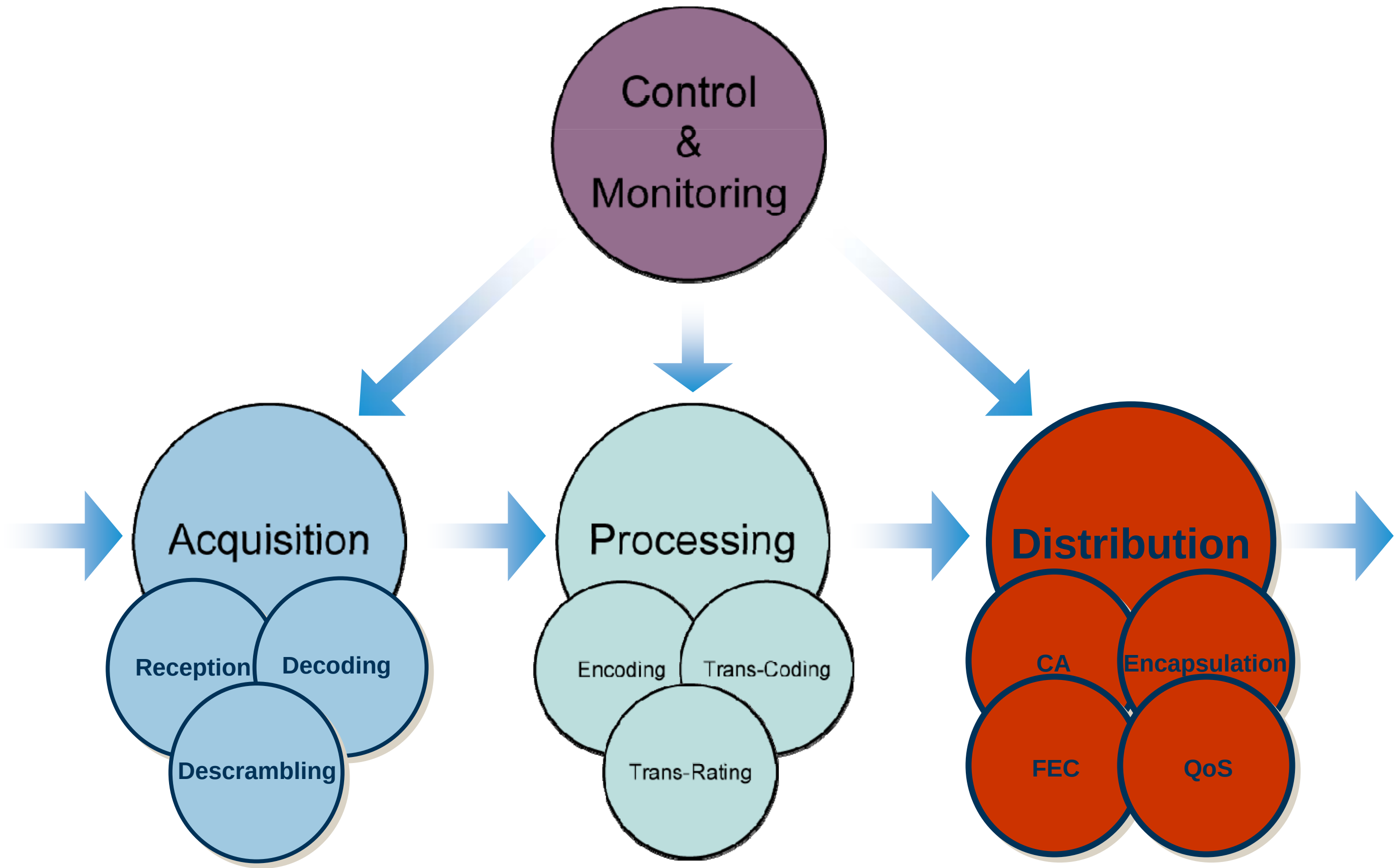
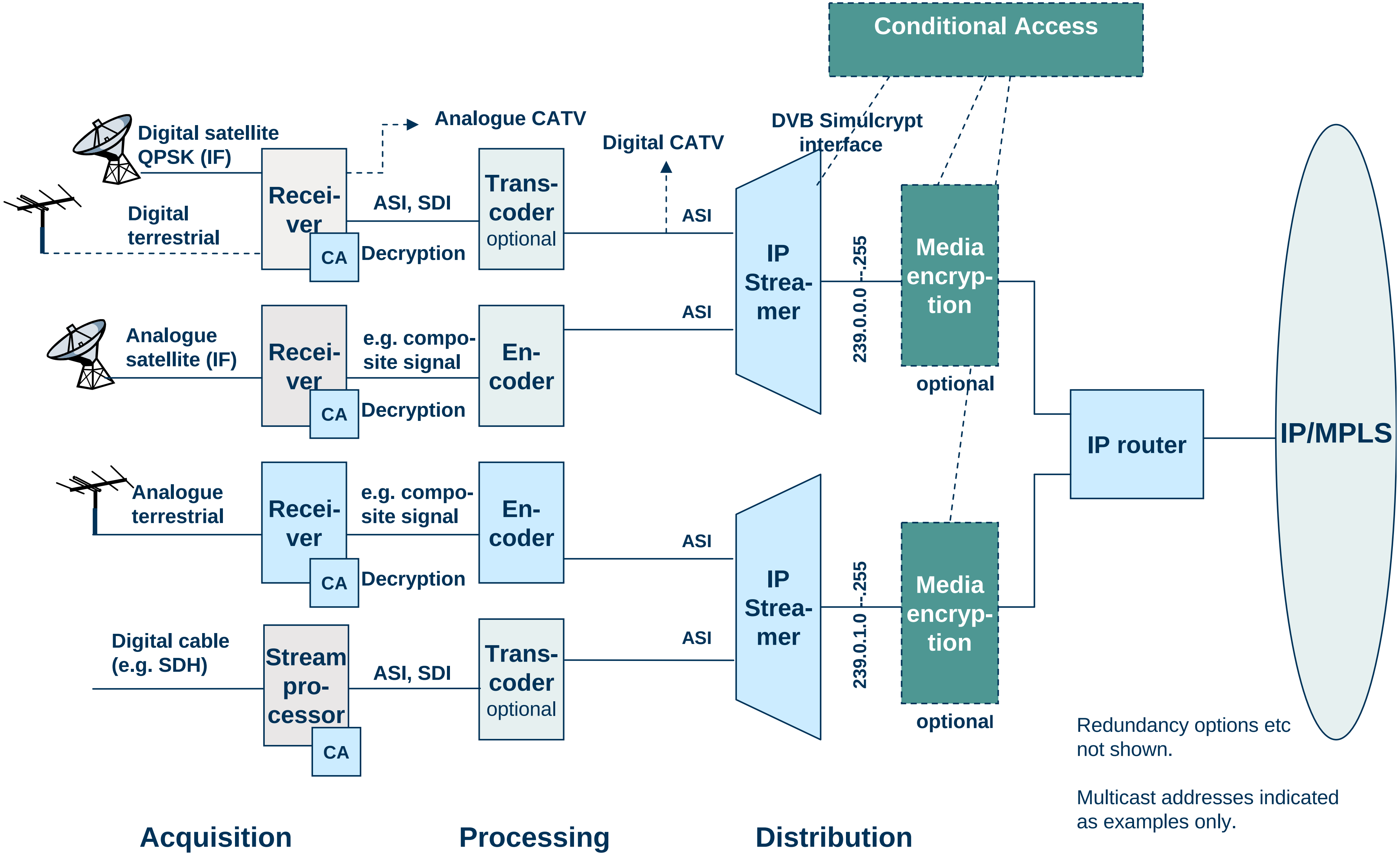
Concept of IP-Headend



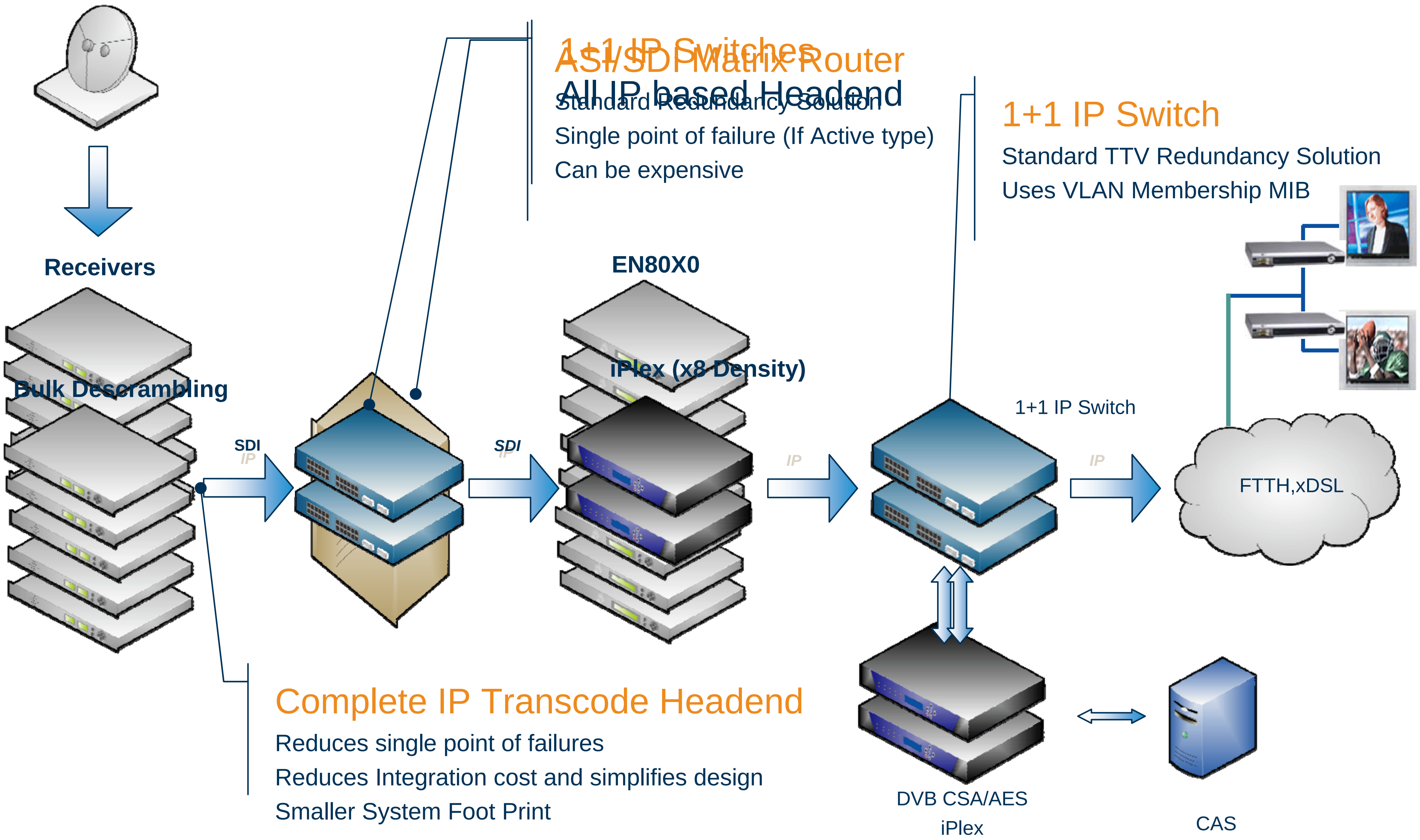
Head-end Building Blocks.



Redundancy options etc not shown.

Multicast addresses indicated as examples only.

IPTV Headend Architecture



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IP TV Head End System Considerations

Satellite L-Band Inputs

The number of satellite dishes?
The number of satellite transponders?
The number of TV and Radio services from each transponder?
The number of SD MPEG-2/4 TV services?
The number of HD MPEG-2/4 TV services?
The number of services to be Transrated?
The number of services to be Transcoded?
The number of services that require re-encoding?

Terrestrials DVB-T Inputs

The number of TV and Radio services?
Details on the method of DVB-T transmissions?
The number of SD MPEG-2/4 TV services?
The number of services to be Transrated?
The number of services to be Transcoded?
The number of services that require re-encoding?

ISP Input via Ethernet And IP

The number of TV and Radio services?
The peak bit-rates of the services if VBR
What type of interface?
The number of SD MPEG-2/4 TV services?
The number of HD MPEG-2/4 TV services?
The number of services to be Transrated?
The number of services to be Transcoded?
The number of services that require re-encoding?

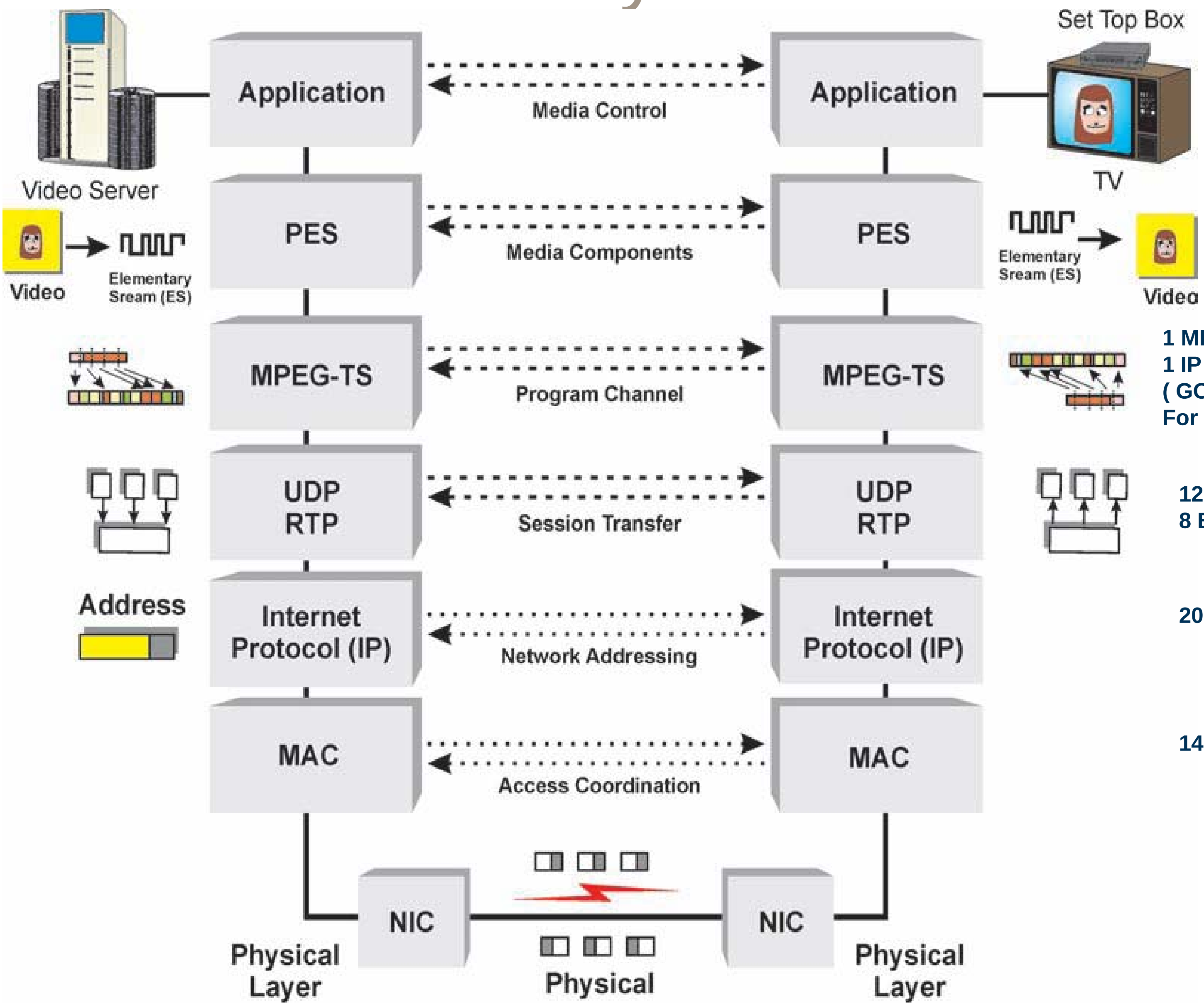
Other Considerations

Locally Encoded Programmes
- The number and type of TV service SD MPEG-2/4 or HD MPEG-2/4
- What type of interface ?

MPEG2 MPTS supply Considerations

Video Bandwidth Consideration
- Channel bandwidth per service – CBR and VBR services
- For pass through channels, service is VBR ranging typically from 1 to 5 Mb/s

IP TV Protocol Layer



1 MPEG TS = 188 Bytes
1 IP Packet - 7 MPEG TS approx.
(GOP Length is Variable
For MPEG 4)

12 Bytes of RTP Header (op)
8 Bytes of UDP Header

20 Bytes of IP Header

14 Bytes of MAC Header

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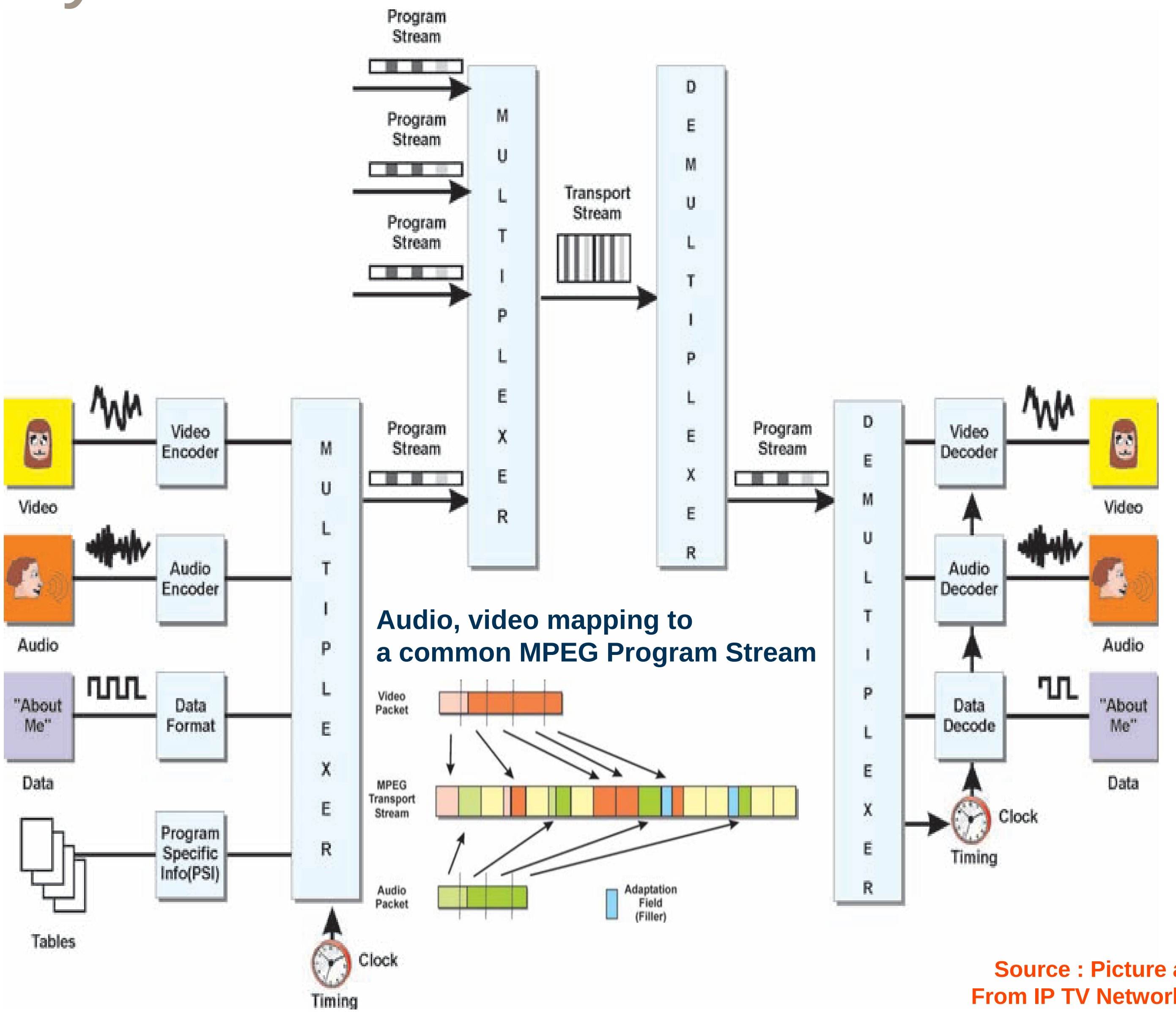
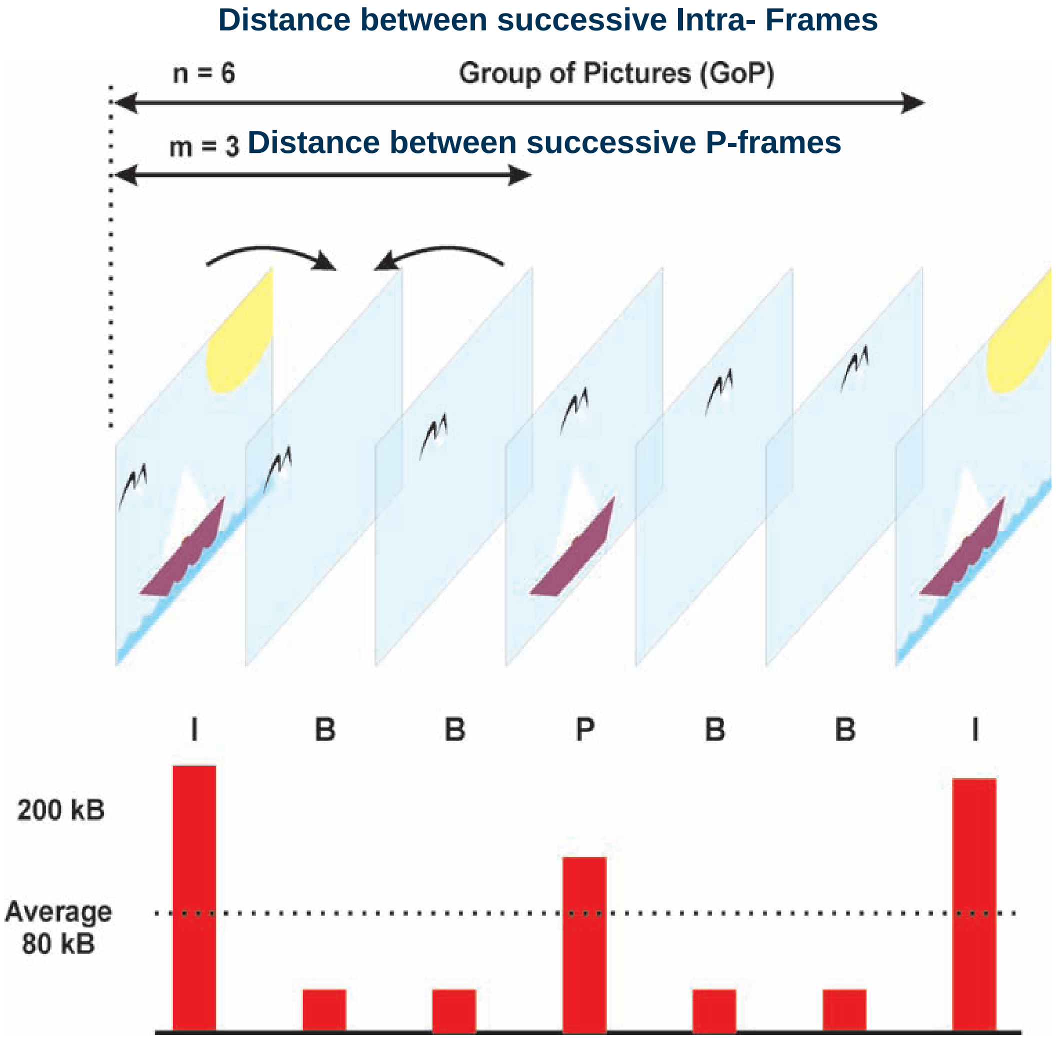
MPEG System



Audio, video mapping to a common MPEG Program Stream

Source : Picture adopted From IP TV Network Testing, ALTHOS Inc 2008

MPEG GOP Pictures



What is Group of Pictures (GOP) ?

Frames can be grouped into sequences called a group of pictures (GOP). A GOP is an encoding of a sequence of frames (I-frame, P-frame, and B frames) that contain all the information that can be completely decoded within that GOP. Each Image frame is segmented into 16x16 Macro blocks

How GOP Length could impact network ?

The longer the GOP length, the lower the bandwidth that is used (higher video compression). However, the longer the GOP length, the longer it takes for a video error to be corrected as errors are propagated over the P and B frames until the next I frame occurs.

MPEG 4 encoding allows for longer GOPs, containing a greater number of P-and B-frames between I-frames, making it more susceptible to video errors and packet loss

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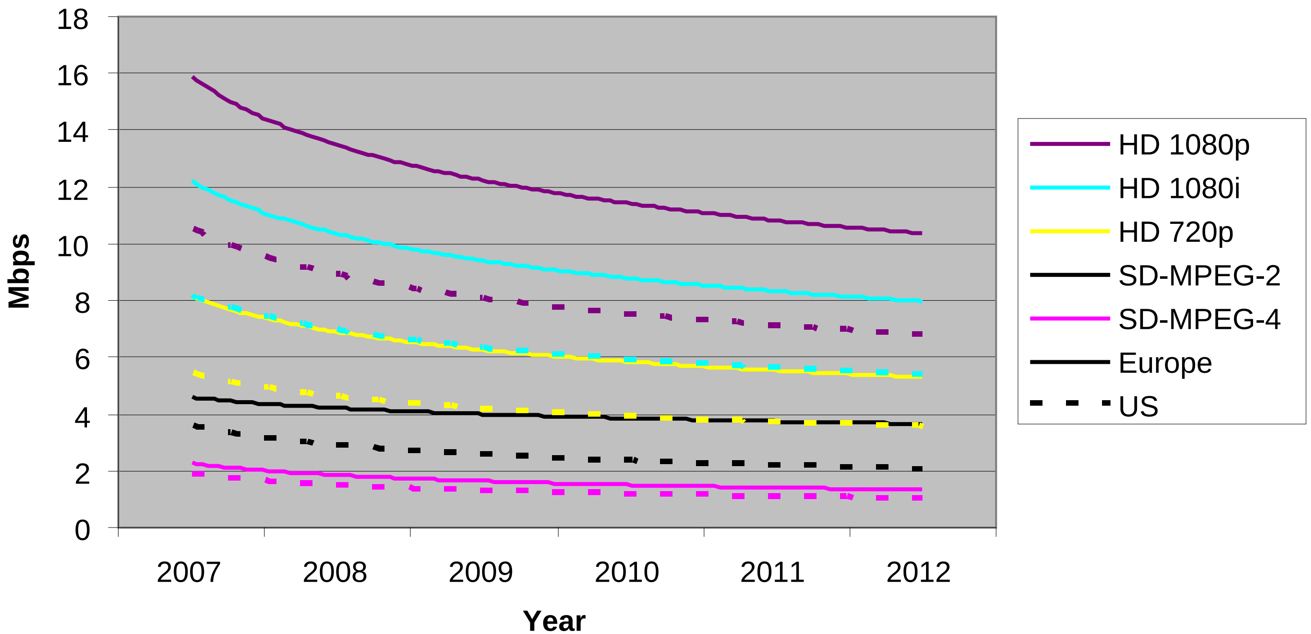
IPTV Codec Rate Evolution



Codec		Real Time Encoded Bit Rate				Non Real-Time Encoded Bit Rate			
		(e.g. Broadcast TV)				(e.g. VoD)			
		SD TV		HD TV		SD TV		HD TV	
H.264		1.8 -2 Mbps		8-10 Mbps		1.8-1.8 Mbps		7-9 Mbps	
VC-1		1.8-2 Mpbs		8-10 Mbps		1.6-1.8 Mbps		7-9 Mbps	
MPEG-2		2.5-3 Mbps		15-20 Mbps		2.3-2.7 Mbps		13-17 Mbps	
MPEG-4		1.8-2 Mpbs		6-8 Mbps		1.8-2 Mbps		6- 7 Mbps	

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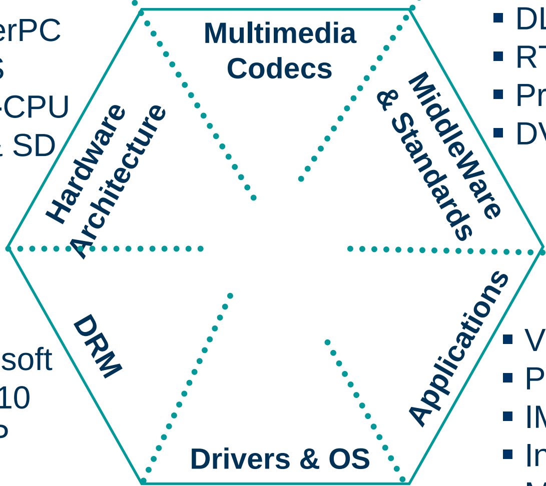
Set Top Box - IPTV Key Challenging Area



- MPEG2, MPEG-4 AVC/H.264
- AAC, AC3, MP3, G.7xx
- WMV, WMA
- FLAC, Ogg Vorbis

- Intel
- PowerPC
- MIPS
- Dual-CPU
- HD & SD

- DLNA / UPnP AV
- RTP/RTSP
- Proprietary protocols
- DVB, ATSC Hybrids

- Microsoft DRM10
- DTCP

- VOD
- PVOD
- IMS
- Internet Browser
- Media Player
- Plays For Sure
- Sync from PC
- Photo Viewer
- Games

- Flash
- E-net
- IDE
- USB
- 1394
- Serial

- Linux
- WinCE
- Embedded XP

Glossary of Terms

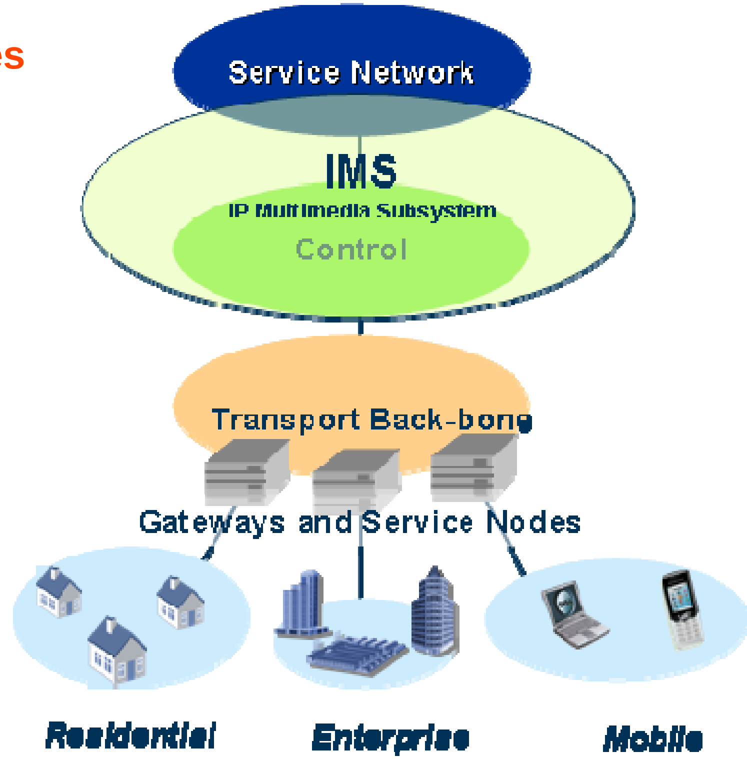
ATSC – Advanced Television Standards Committee Standards
RTP- Real Time Transport
RTSP – Real Time Stream Protocol
FLAC – Free Lossless Audio Codec
Ogg Vorbis – Free Lossy Audio Code as replacement To MP3
MPEG – Standards for compression of Audio and Video Media
WMV –Windows Media Video
WMA– Windows Media Audio
H.264- Video Compression Part in MPEG 4
DLNA – Digital Living Network Alliance
DTCP- Digital Transmission Content Protection
Windows Media DRM10
IMS – IP Multimedia System

IMS Home GW

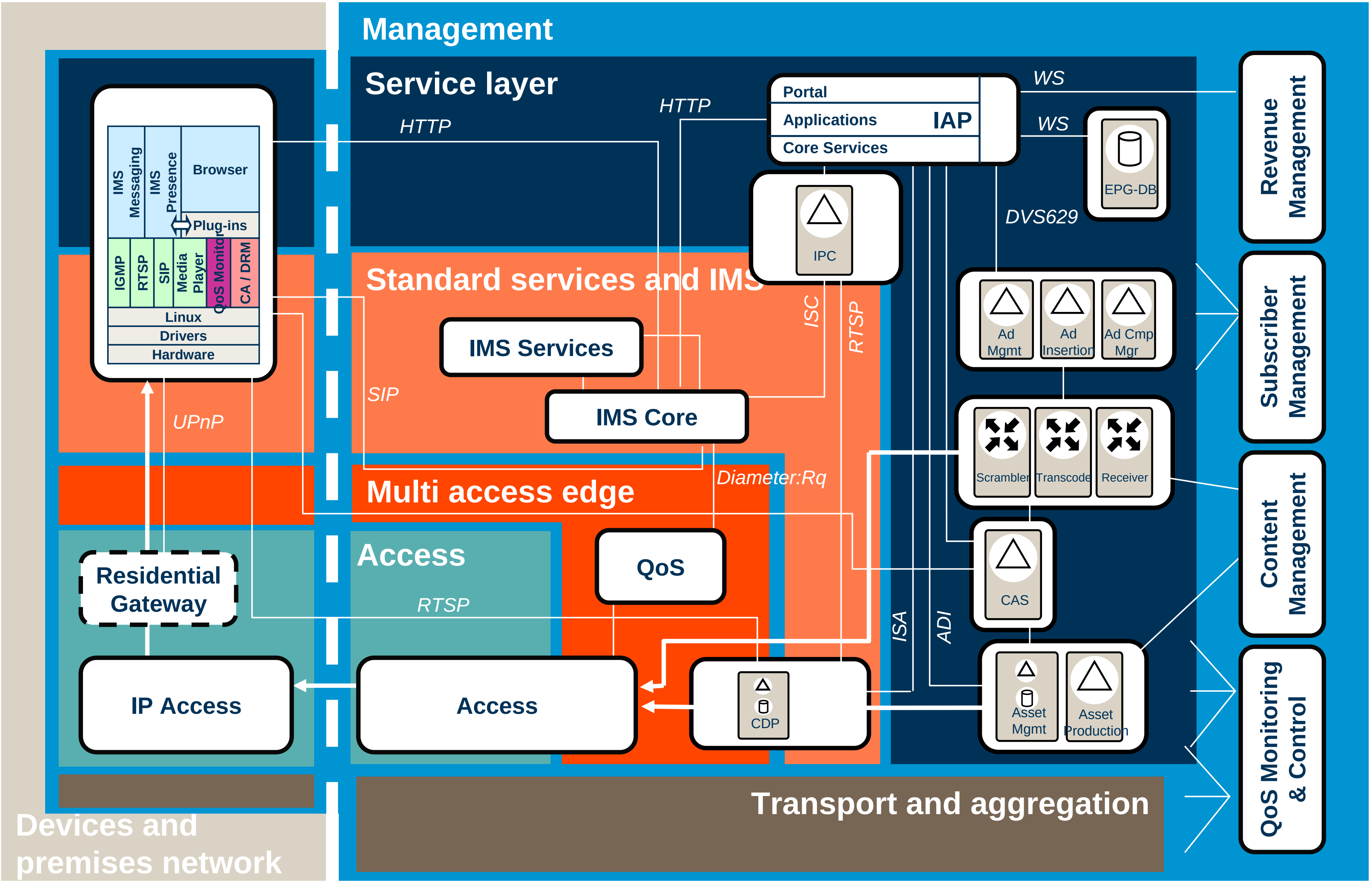
Key Message : Require STB Standardisation

Why IMS?

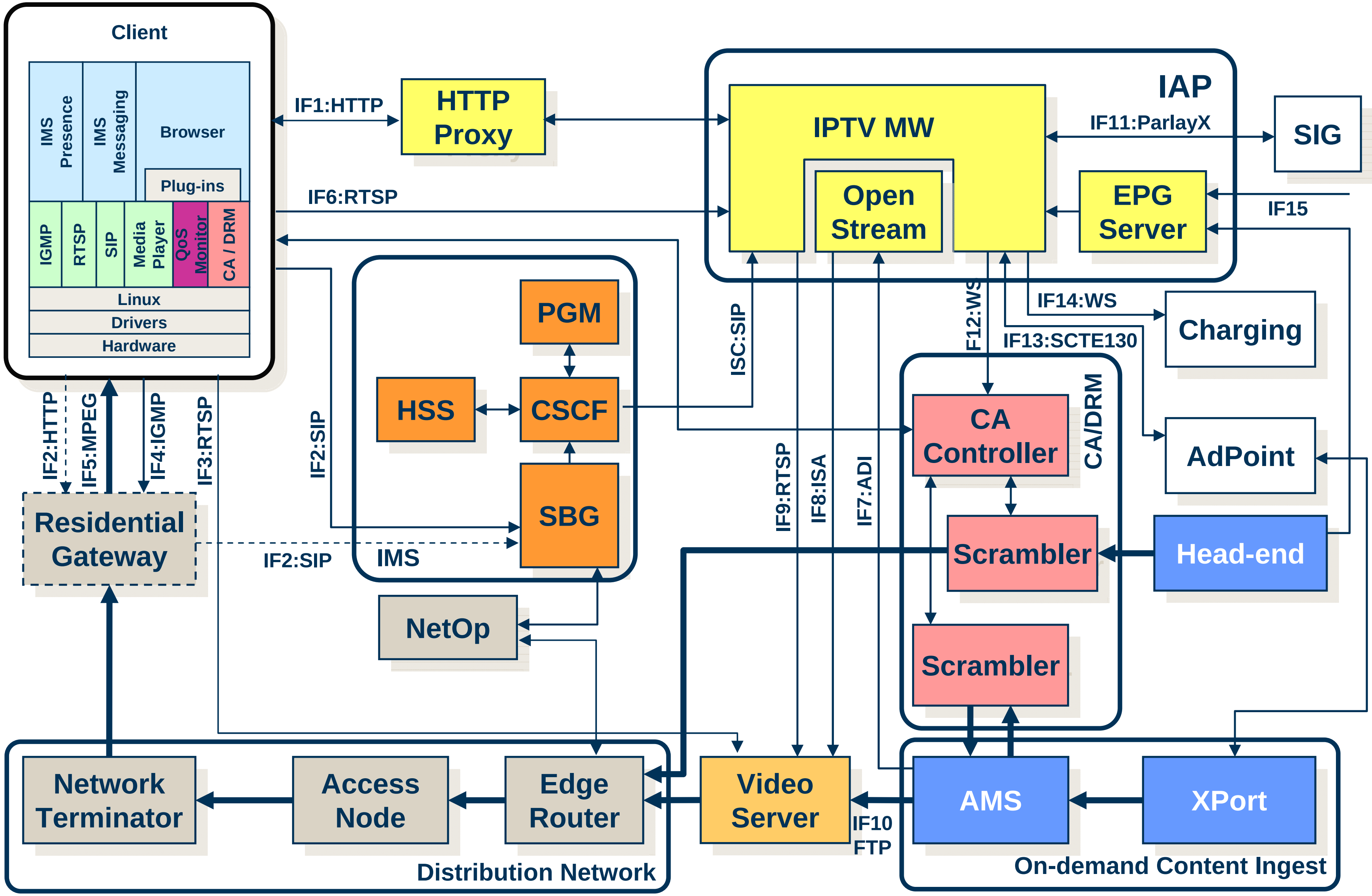
- Core service network independent of access technology
- Same application is available from any Access method.
- Migrate and deploy across fixed and mobile users
- **Standards allow scalable deployment of new services**
- **Evolution to combined services for enhanced user experience (presence, messaging, address book)**
- Security through IMS built in Identity management, authentication, authorization and service access
- Centralized user profiles shared between apps
- Architecture designed for scalability and redundancy
- Common solution to achieve Quality of Service
- Flexible Charging of multimedia services
- Common Provisioning



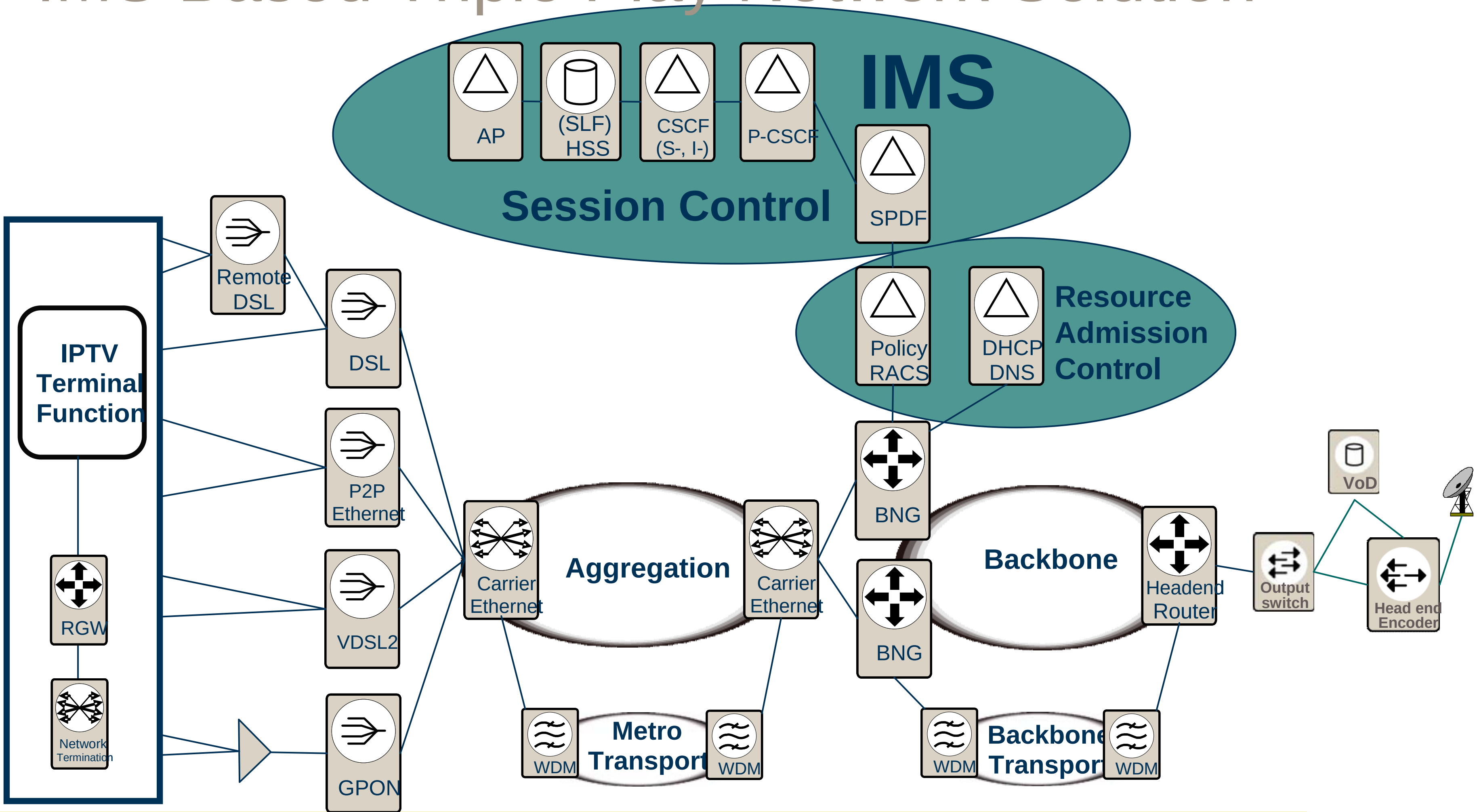
IMS IP TV Services – A Functional View



IMS IP TV Services Architecture

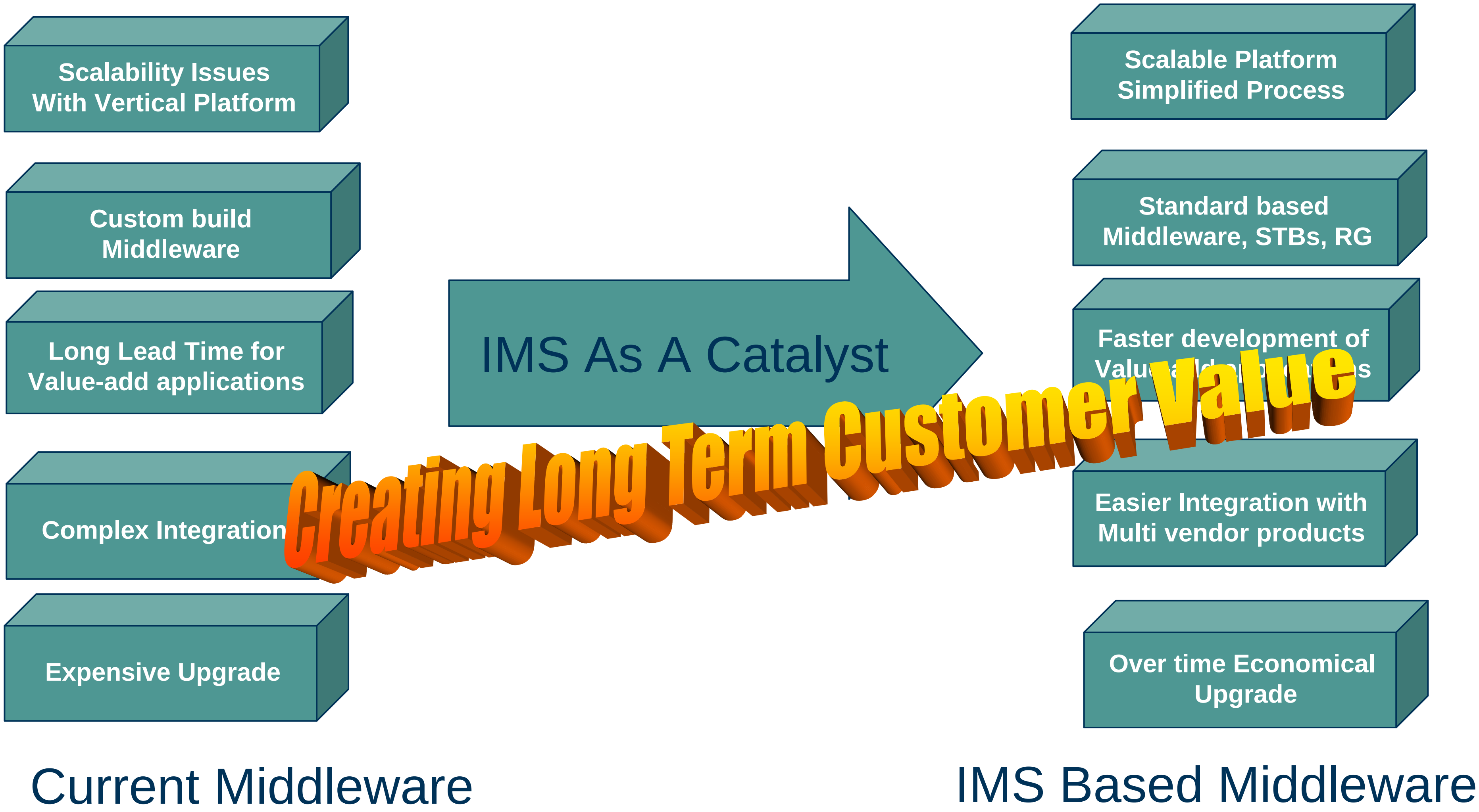


IMS Based Triple Play Network Solution



New IMS Enabled RG supporting SIP and RTSP control signalling to RACS and IMS Core
Simplify the STB configuration and client functionality
A Standard based approach for Video Admission Control and BW Management
Simplifying IP TV Middleware through Standard based value-add application creations
A Scalable network solution for future converged services in an access agnostic fashion

IMS As a Transformation Catalyst for IP TV Middleware



IP TV Performance Measures

Quality of Service (QoS)

QoS is one or more measure of desired performance and priorities through the IP TV Communication System

Key Measures Include-

- service availability,
- maximum bit error rate (BER), minimum committed bit rate (CBR)
- packet Loss and Latency Performance

Quality of Experience (QoE)

QoE is one or more measure of the total communication and entertainment experience from the perspective of end users

Key Measures Include -

- service availability
- service integrity
  - –audio and video fidelity
- Types of programming,
- ability to use the system easily
- The value of interactive services.

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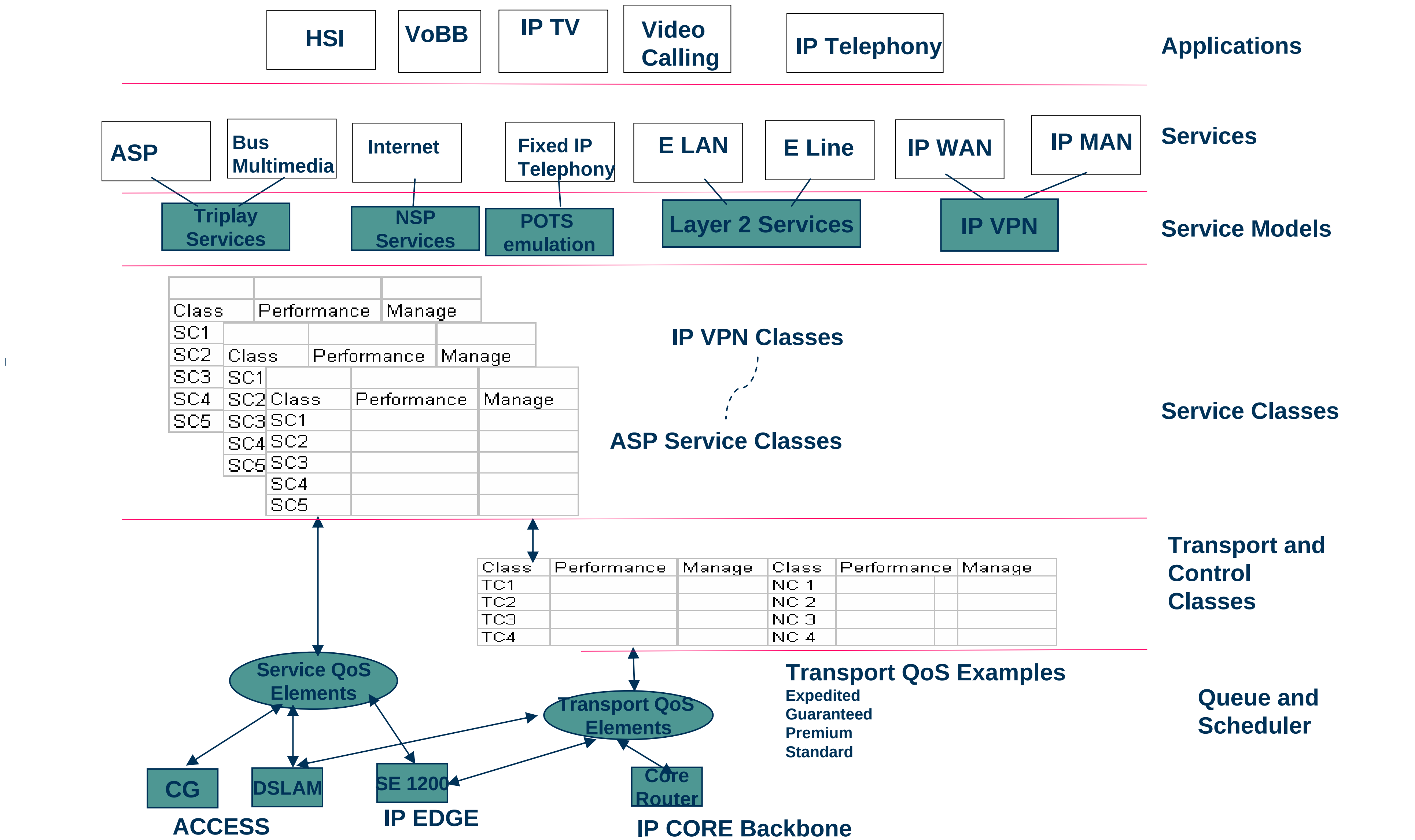
Service and Transport QoS Model



Transport Class Application Mapping

Transport Class Markings	Common Name	Application	FC	Relative Priority	802.1p or DiffServ
TCexpedited/NCexpedited	Expedited	BFD, Voice	EF		5
NCguaranteed	Network Control & Management	Network Control and Management Flow	NC	2	CS6
TCguaranteed	Guaranteed	Unicast & Multicast IPTV	H2	3	4
TCpremium/TCpremium	Premium	Business Premium & Premium Residential	AF	4	3 or 2
NCgeneral	Network Control and General	Device software maintenance, FTP, TFTP, HTTP	L2	5	CS2
TCstandard/TCstandard	Standard	Internet	BE	6	1 Or 0

BE= Best Effort

EF= Expedited Forwarding

AF= Assured Forwarding

NC= Network Control

FC = Forwarding Class

H2 = High

L2 = Low

Transport Classes Example

Common Name	Transport Class	Primary Characteristics	Indicative Performance targets per Node		
			Delay	**Loss**	**Jitter**
Expedited	$TC_{expedited}$	Very Short Queue Highest Customer Priority Strictly Enforced Rates	<1ms	<0.1% in bytes	<1ms
Guaranteed	$TC_{guaranteed}$	Medium Queues Reliable delivery even if delayed	<200ms	<0.1%	<200ms
Premium	$TC_{premium}$ Hi	Small Queues Latency Sensitive Apps Low Discard Preference	<100ms	<0.5%	<50ms
	$TC_{premium}$ Lo	High Discard Preference		<5%	
Standard	$TC_{standard}$ Hi	Deep Queues Low Discard Preference	<500ms	<1%	<200ms
	$TC_{standard}$ Lo	High Discard Preference		<5%	

Some Key Design Considerations to Deliver QoE

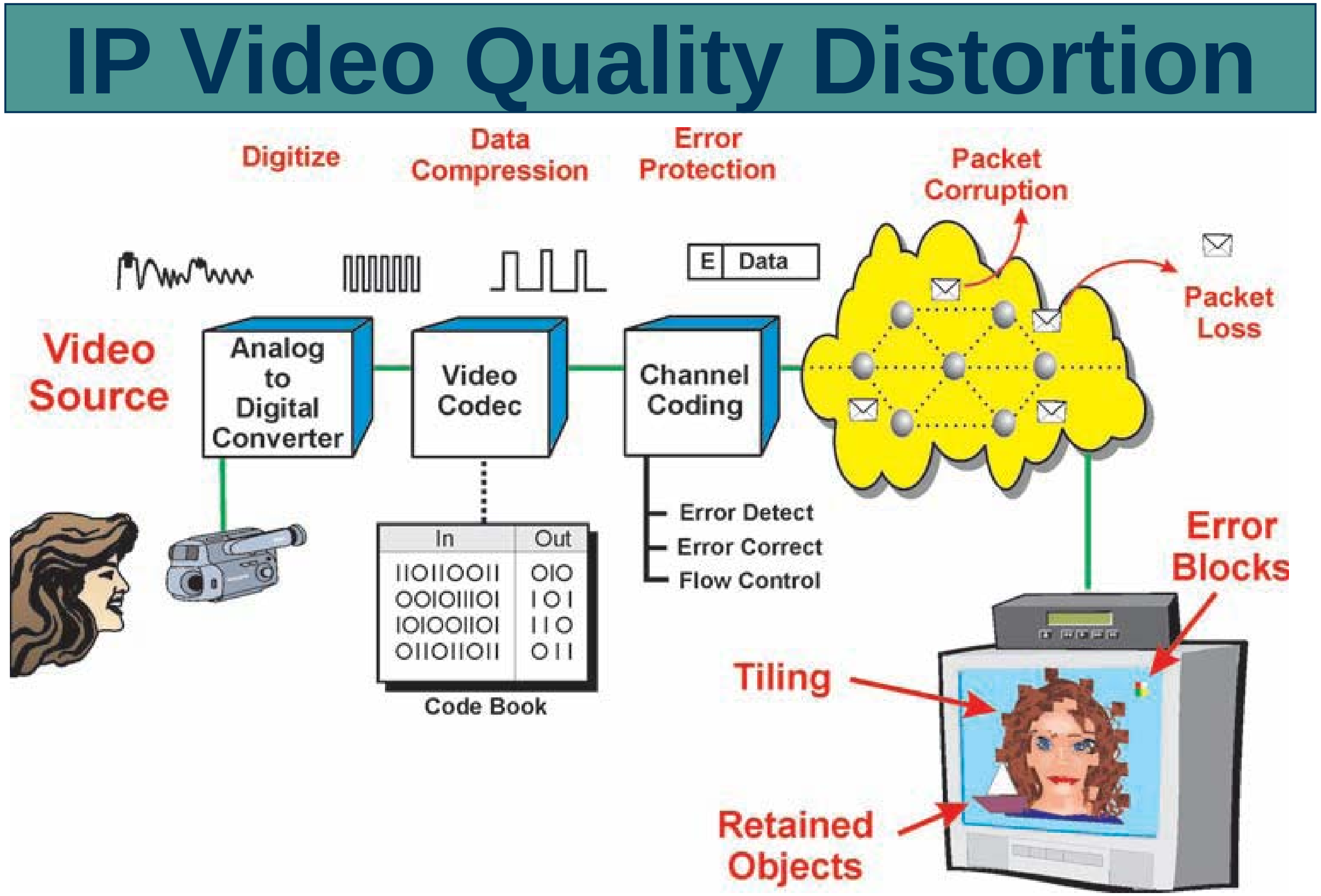
Service Availability and Useability

- **Channel Change Performance**
- **Video Resource Optimisation**
  - Subscriber Aware Resource management
- **Distributed VOD to reduce core network congestion**
- **Fast Routing Convergence**
  - **Speeding up IGP**
  - **Dual PIM Joint**

Service Quality Guarantee

- **Improving Service Satisfaction for the User**
  - Reducing Packet Loss
  - Reducing Retransmission
    Fixing video frame errors
- **Video Application Quality Monitoring**
  - Objective
  - Subjective
- **Video Quality Metrics**
  - Media Delivery Index (MDI)
  - V Factor
- **IP TV Performance KPIs**

Example A : When QoE is not Met



Source : Picture adopted From IP TV Network Testing, ALTHOS Inc 2008

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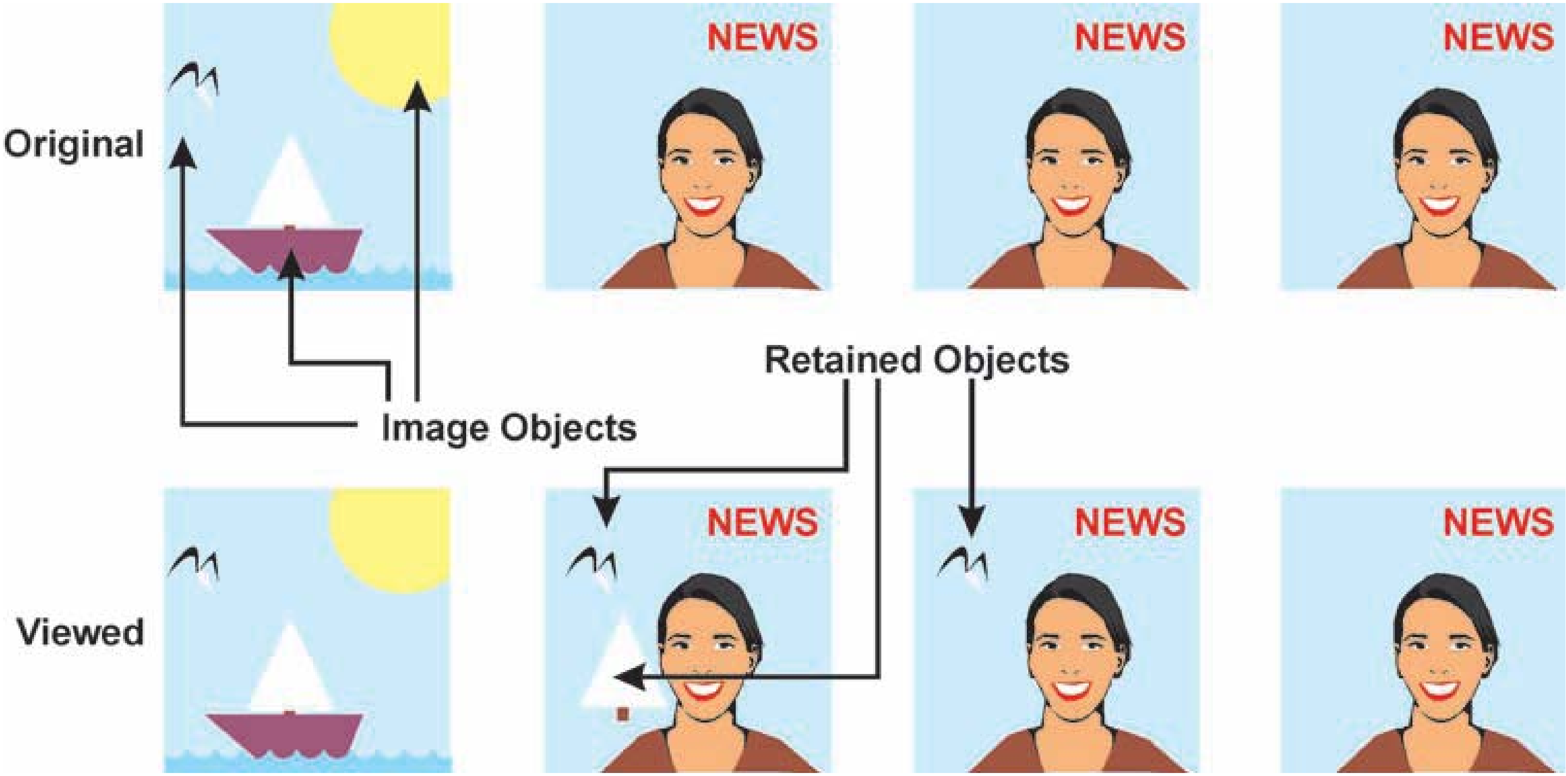
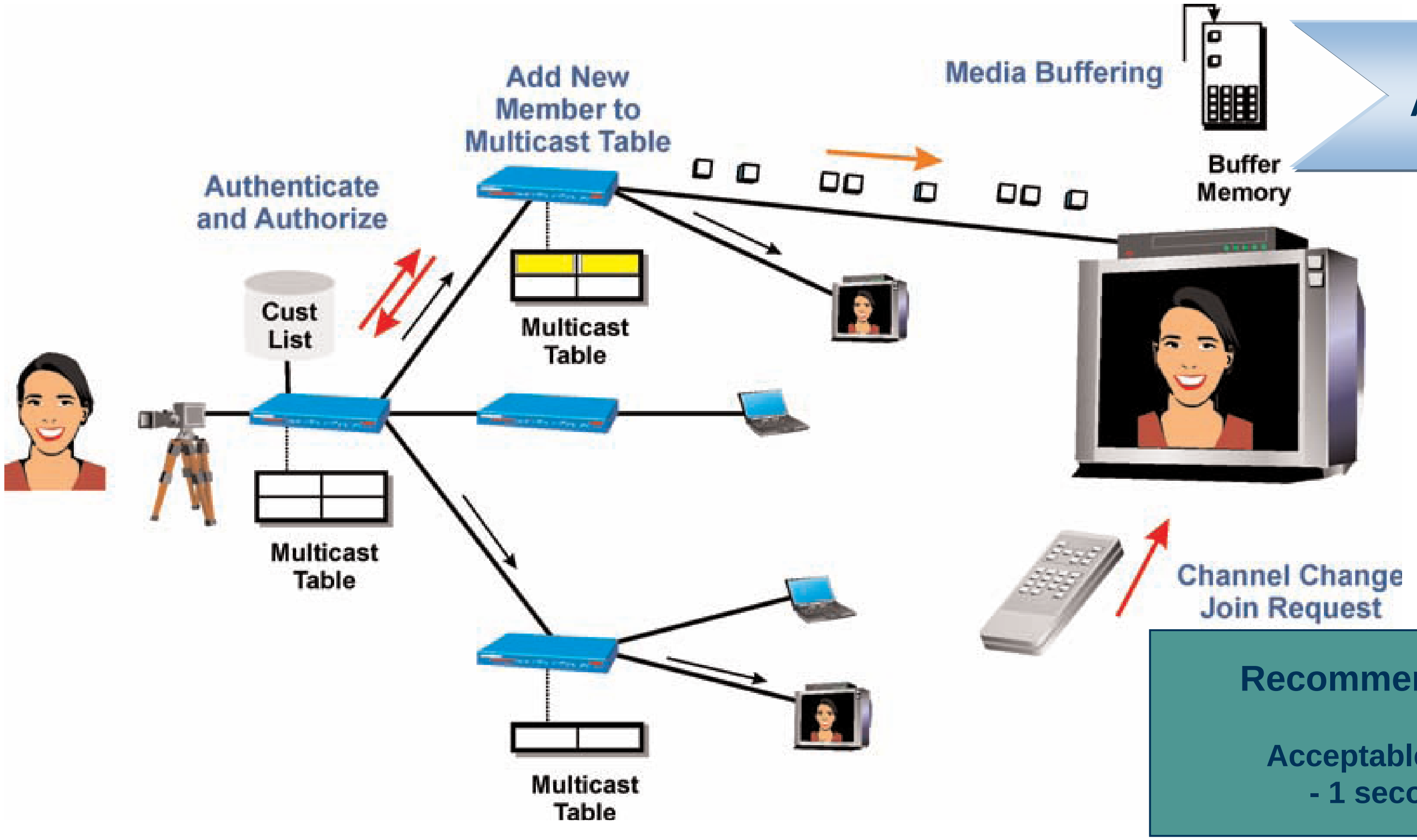
Example B : When QoE is not met

Video Object Retention



Source : Picture adopted
From IP TV Network Testing,
ALTHOS Inc 2008

User Channel Change Performance



Service Availability and Useability

Recommended Values

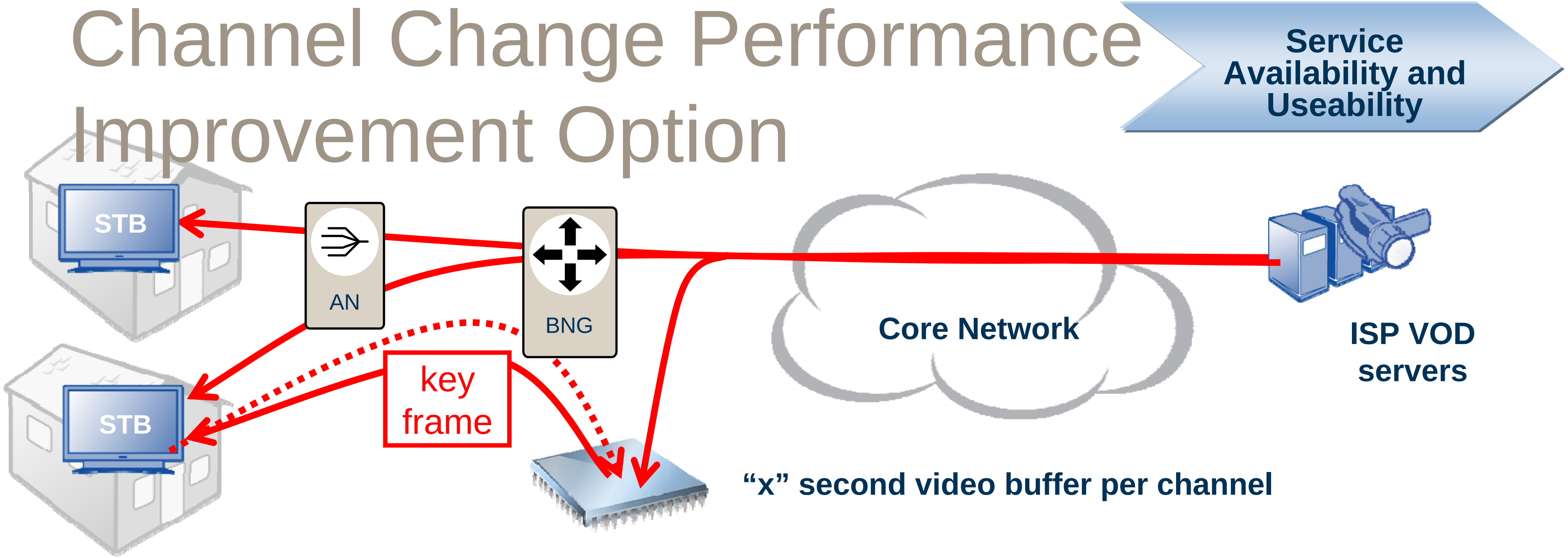
Acceptable E2E Delay
- 1 second total,

Key Contributors to channel change delay

- Processing the channel change request in the set top box,
- Sending a IGMP join message to the nearest multicast router that is carrying the channel,
- Channel rights validation,
- Adding the device to the multicast routing table,
- Filling up the channel buffer for the new channel,
- Presenting the media to the viewer

Source : Picture adopted
From IP TV Network Testing,
ALTHOS Inc 2008

Channel Change Performance Improvement Option

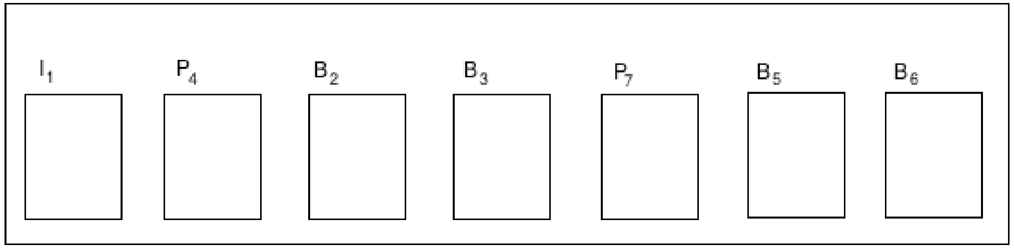


- **How to improve channel change delay performance ?**
- **Enhanced IP Edge IGMP handling can bring down channel change delay latency in the order of 10 ms**
- **But at the application level video codec typically needs to wait for the next I-frame before displaying a full picture (intermediate frames or delta frames does not convey the full picture info)**
- **The Edge Router or Access Node can provide an accelerated unicast delivery starting with a recent I-frame for rapid decoding.**

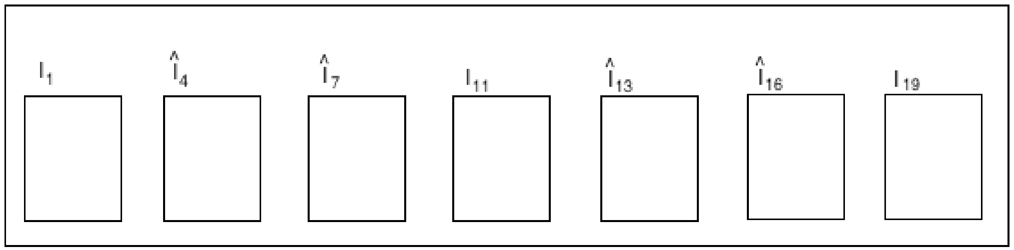
“Alternative Packet” Stream for Low Network-Impact Instant Channel Change

Service Availability and Useability

Standard MPEG Transport Stream



"Alternative Packet" Transport Stream



■Two Options

■Create Alternate Stream at the encoder

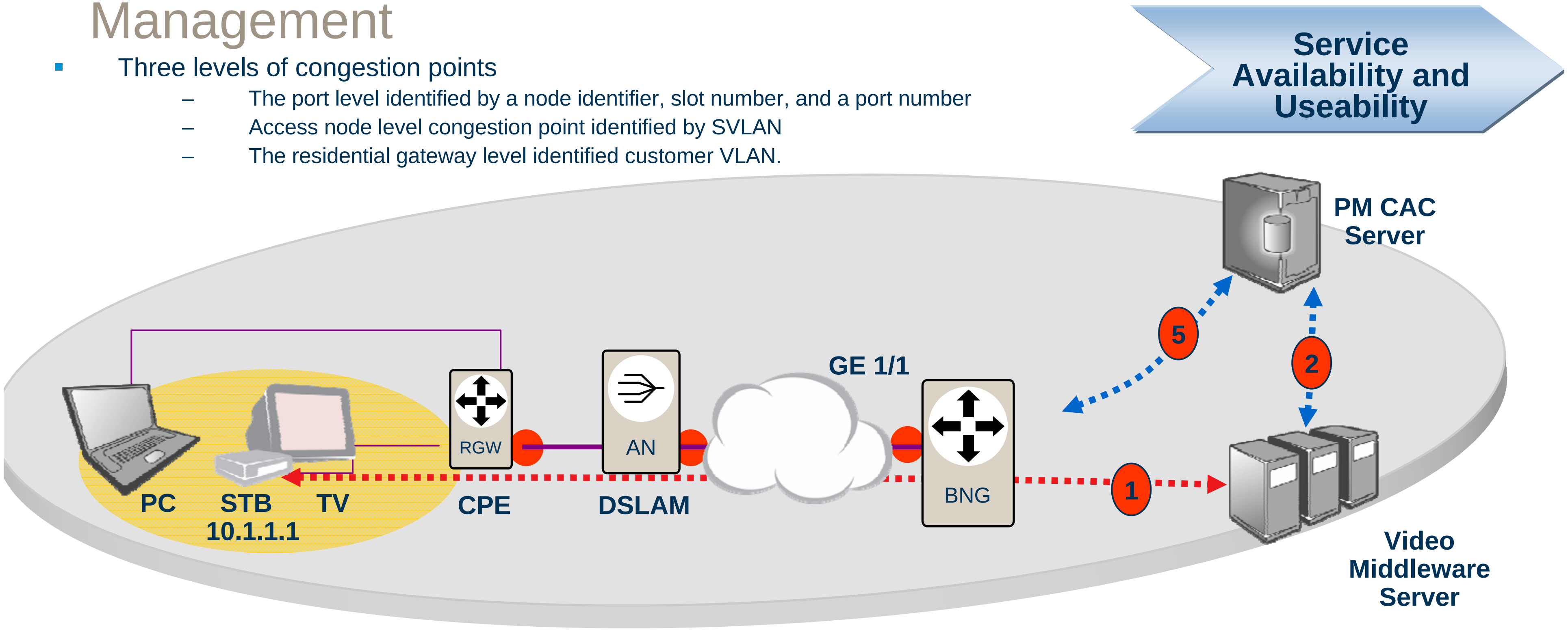
-Higher quality source from which to build key frames
-More bandwidth used through the core network
-Less computationally intensive

■Create Alternate Stream at the IP Edge

-Less traffic is used through the core network
-Much more computationally intensive.

Video Resource Optimization - Subscriber Aware Resource Management

- Three levels of congestion points
  - The port level identified by a node identifier, slot number, and a port number
  - Access node level congestion point identified by SVLAN
  - The residential gateway level identified customer VLAN.



1. VOD request from set-top box at 10.1.1.1 to Middleware
2. Middleware requests from CAC server VOD bandwidth for 10.1.1.1
3. CAC server accepts stream if requested bandwidth does not cause total VOD traffic bandwidth to exceed the maximum traffic bandwidth for GE 1/1 port
4. CAC server denies request if bandwidth exceeded
5. On accept, PM configures QoS policies on BNG
6. When VOD complete, middleware informs CAC server to release bandwidth reservation

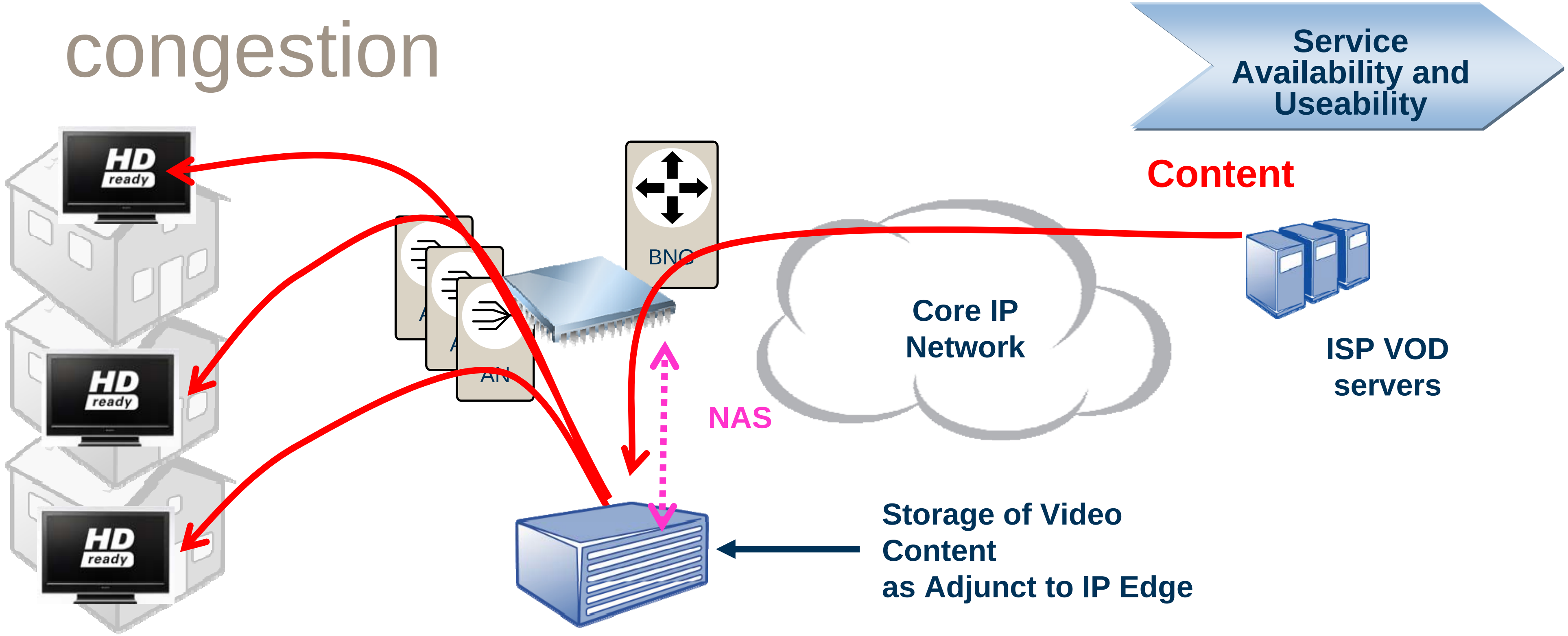
Current Video On Demand Services

- **Current On Demand Services Limited by Existing Network Capabilities**
  - No Real Time Return Channel; Return Based on Dial Up
  - On Demand Content + Metadata Delivered Via Broadcast Infrastructure
  - Content Authorisation Based on Broadcast Conditional Access
- **Pay TV Operator Box Office (Current NVoD Service)**
  - Current Implementation = Staggered Broadcast Delivery
  - Content Metadata Delivered to STB using EPG / Carousels
  - Authorization Implemented using Broadcast Pay Per View Model
  - Advantages: Works with non IP Enabled STBs
  - Issues: Staggered Delivery Means Delay from Order to Viewing
- **Push VoD (Current On Demand Service)**
  - Current Implementation = Broadcast via Hidden Channels to STB Hard Drive
  - Content Metadata Delivered to STB using Carousels
  - Authorization Implemented using Broadcast Pay Per View Model
  - Advantages: Works with non IP Enabled STBs
  - Issues: Additional STB Hard Drive Space Required for Movie Storage
    - Does not scale to Large Numbers of Titles

Future VoD Delivery Model

- **Next Gen On Demand Services can Leverage IP Delivery**
  - Real Time Interactive Signaling Via IP
  - Content Can be Browsed Interactively
  - Vod Unicast Model for Content Delivery
- **PayTV Operator's Box Office (Current NVoD Service)**
  - Use IP Enabled Content Distribution Service :
    - Implement as VoD Based Movies on Demand Service
  - Advantages:
    - No Delay from Order to Viewing
    - Consistent Interface / User Experience for All On Demand Services
    - Single Infrastructure For All On Demand Services
- **Push VoD (Current On Demand Service)**
  - Use IP Enabled Content Distribution Service :
    - Implement as VoD Based MoD / SVoD Service
  - Advantages:
    - Cost Savings over Unicast VoD + Push VoD Hybrid
    - Single Infrastructure For All On Demand Services

Distributed VOD to reduce network congestion

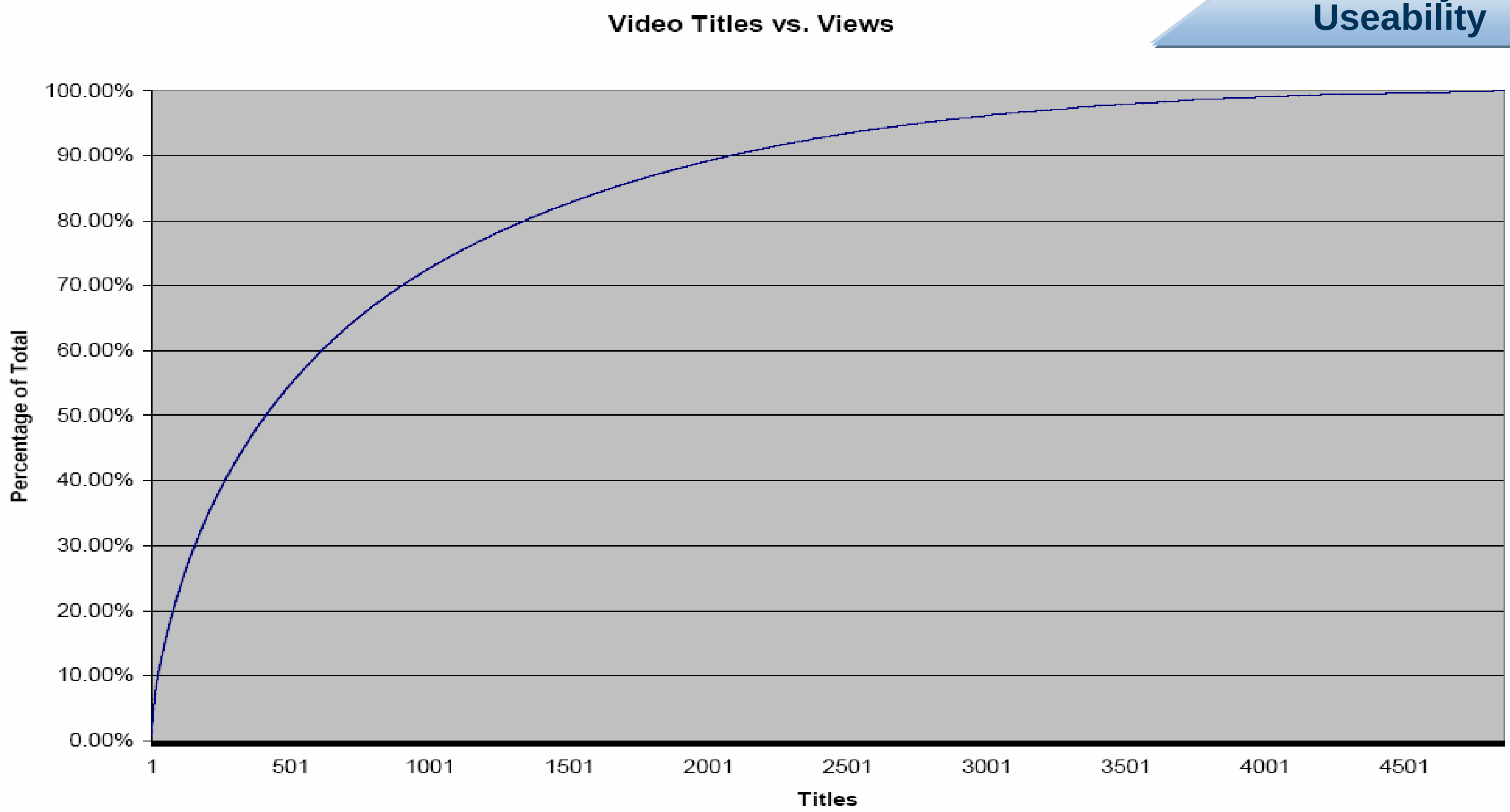


Architecture Synopsis-

To help mitigate the effect of large amounts of unicast traffic on the network, popular content may be stored at the IP edge. Content may be actively pre-delivered or transparently cached.

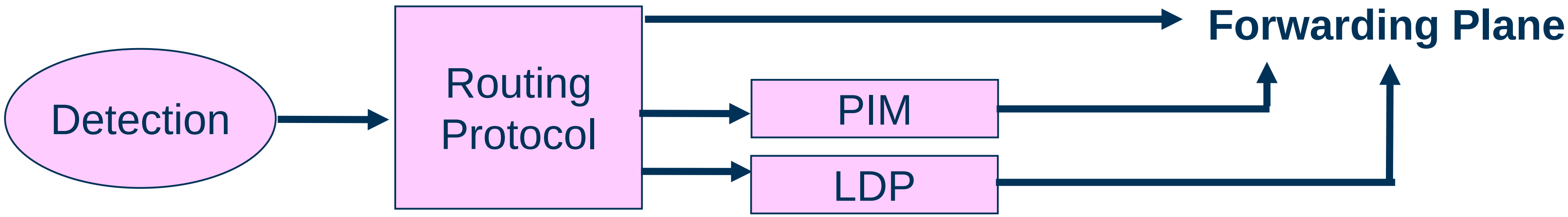
A Movie Title Distribution Example

Service Availability and Useability



- **20 Titles = 10% of all views, 60 Titles = 15%, 100 Titles = 25%**
- **500 Titles = 50% of all views**
- **10% VoD Peak Concurrency**

Fast Routing Convergence for Failure Detection

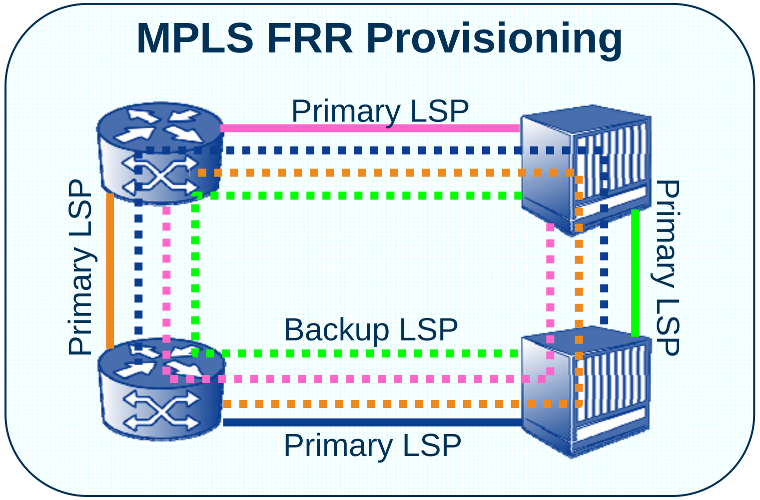


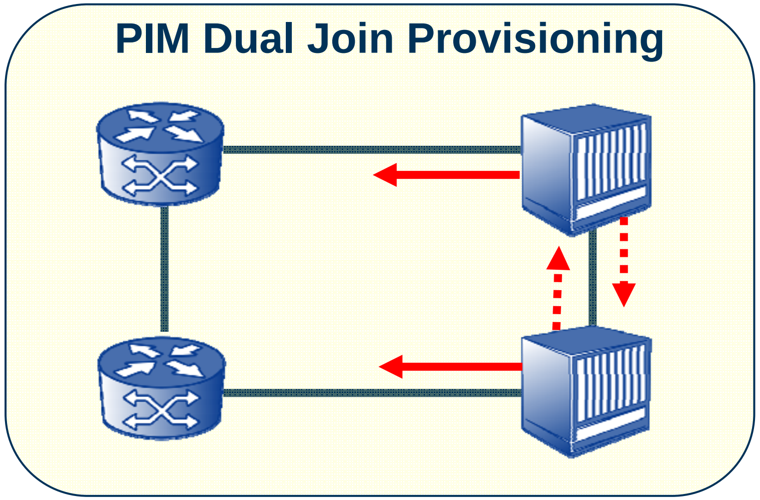
Key IGP Features to support fast convergence of the Routing Protocols

- IGP (OSPF & ISIS) is implemented with a ”fall back” to timer SPF calculation in case of network instability
- IGP (OSPF & ISIS) is implemented in a ”event driven” mode to allow for immidiate SPF calculation
- PIM is implemented in an enhanced mode to remember join & leave messages from unexpected interfaces in a ring topology
- LDP implementation enhanced to advertise all labels to everybody, and make it the responsibility of the receiver to discard labels.

PIM Dual Join Summary

Service Availability and Useability





MPLS FRR

PIM DUAL JOIN

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PIM Dual Join

Service Availability and Useability

- PIM Dual Join Strategy
  - Reuse lessons learned from multicast high-availability financial networks
  - Receivers join the multicast stream from 2 different places
  - Move this responsibility to the IP Edge, the last IP aware replication point before the multicast receiver.
  - Keep IP Edge network as is from a routing & provisioning perspective, no need for MPLS just to transport multicast.
- Key Benefits
  - Static PIM Join for low latency channel join
  - Dynamic ASM to SSM conversion
  - Easy provisioning; the configuration is local to the IP edge
  - Will NOT increase traffic on any links in case of failure
  - Fast channel switchover in case of failure, due to local decision
  - Will be 50msec. or better in both Link as well as Node failure.

Signalling Protocol Choice for MPLS FRR

Service Availability and Useability

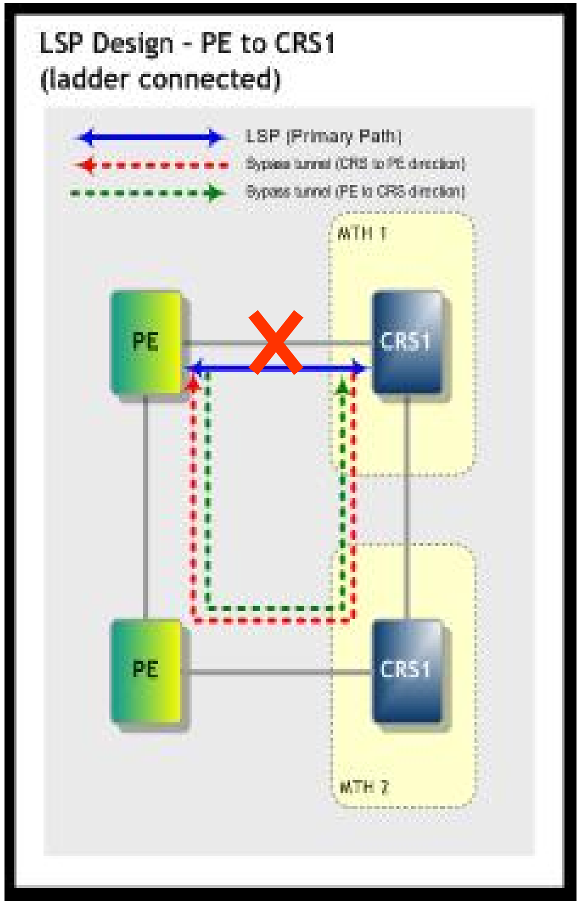
Signalling Protocol	Pros	Cons
LDP	▪ Simple protocol requiring simple configuration ▪ Label distribution happens automatically	▪ Relies on IGP for routing information convergence in order of a few seconds (jeopardising 99.999% availability) ▪ No recovery mechanisms for 50ms link failure recovery ▪ No support of traffic-engineering paths
RSVP-TE	▪ End-to-end traffic-engineered paths ▪ End-to-end LSP protection using MPLS-TE Fast Re-Route (MPLS FRR) features providing 50ms failover ▪ Ability to use bandwidth reservation along paths	▪ With large number of LSPs required for a full mesh with LSRs bearing brunt of RSVP signalling traffic ▪ Administrative burden with LSP configuration on each Router
Protocol of Choice		
LDP over RSVP-TE	▪ **To achieve available targets, neither RSVP or LDP can be used in isolation** ▪ Hybrid solution of LDP tunnelling over RSVP tunnels is to be used ▪ Reduction/elimination of LSP mesh requirements ▪ Reduced provisioning requirements ▪ MPLS FRR can be used on individual RSVP tunnels ▪ More scalable than using RSVP tunnels only	

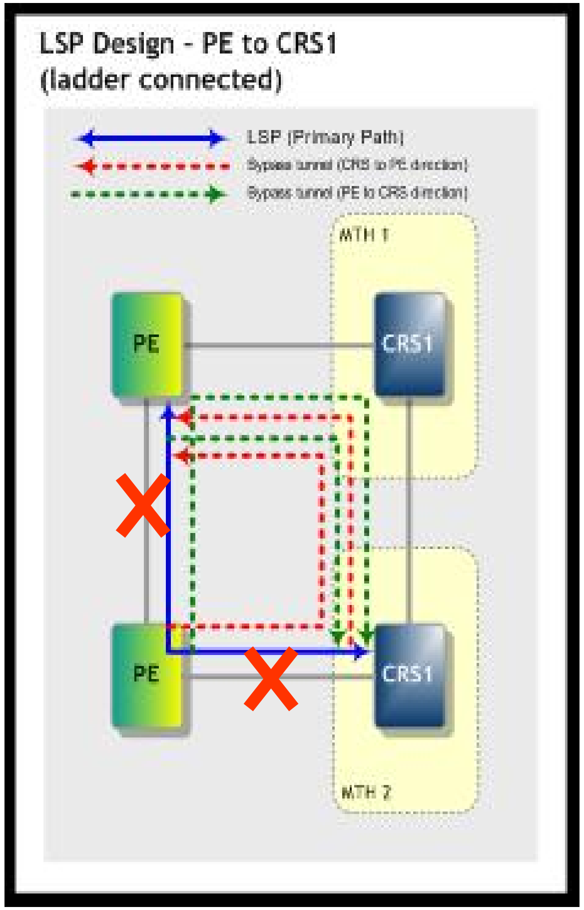
Biggest Benefit of Multicast over MPLS P2MP delivery is High Availability with MPLS FRR
To Compete with this Multicast delivery based on PIM need to be able to recover in less than 50msec

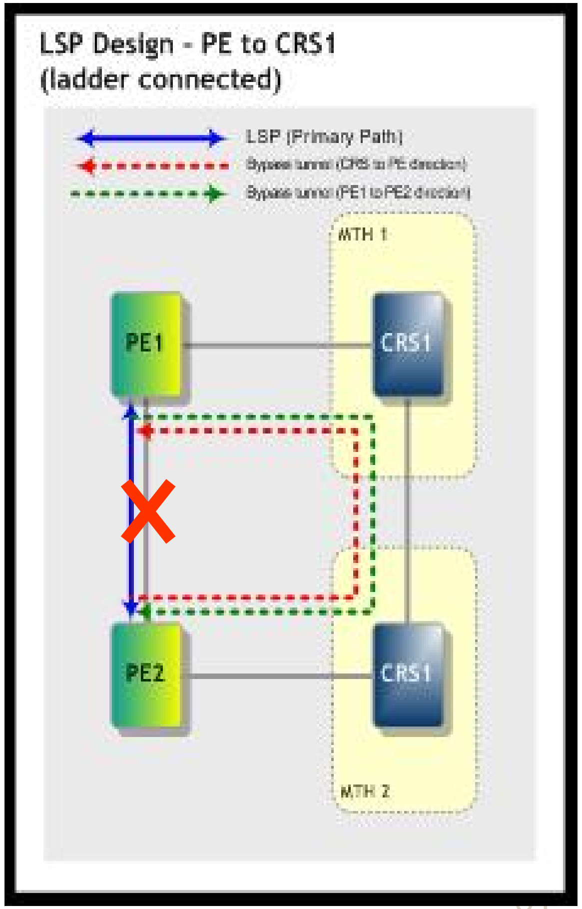
LSP Design – PE to Core Router (Ladder)

Service Availability and Useability

- Failure Scenarios – LSPs originating from PE
- Example using CRS-1 IP Core







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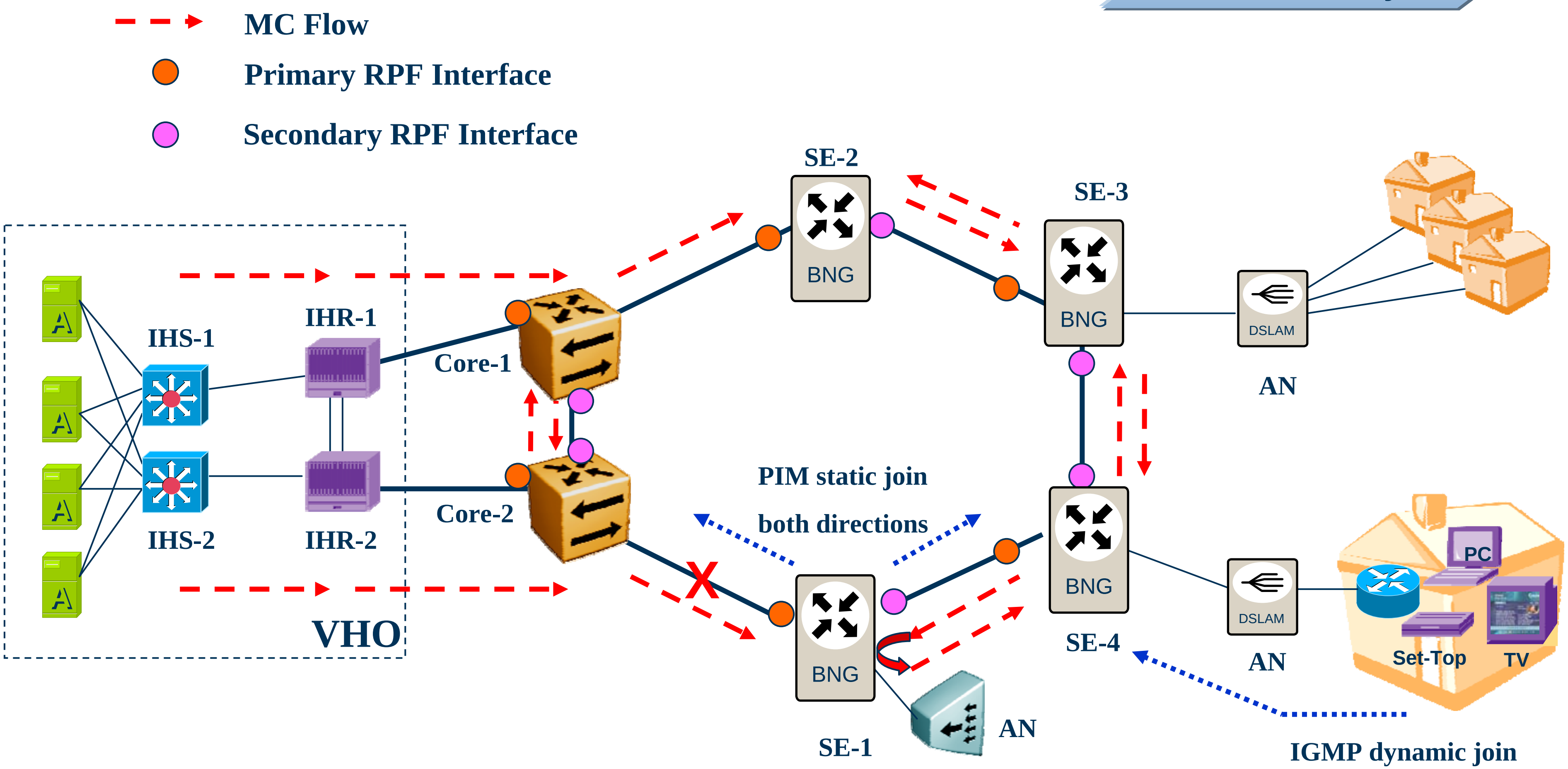
PIM Fast Convergence w. Dual Joins

Service Availability and Useability



- Multicast Recovery is unrelated to IGP Fast Convergence
- Multicast Recovery is now a matter of a local repair time.

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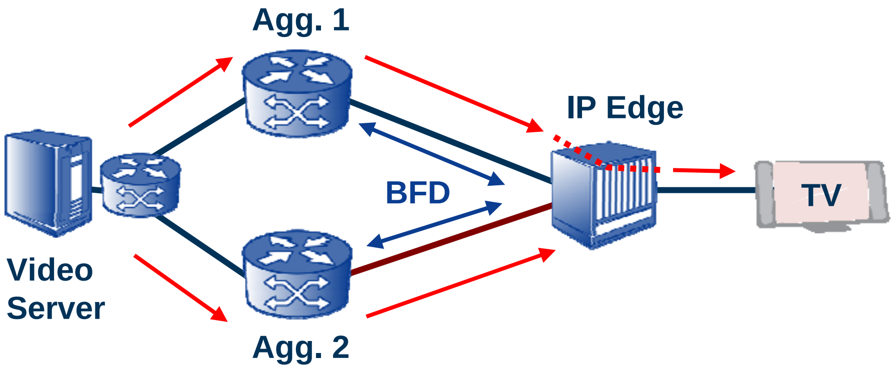
PIM Dual Join – Test Results

Service Availability and Useability



Test Setup:

- Test done with "Static" PIM Join, IGMPv2 & IGMPv3
- IGMP ASM to PIM SSM translation
- BFD: multiplier = 3, Tx & Rx = 10msec
- Multicast traffic rate: 10,000 packets/sec
- IP Edge send "primary" (S,G) PIM join to Agg. 1
- IP Edge send "secondary" (S,G) PIM join to Agg. 2

Test Failure:

- Introduce link failure between IP Edge & Agg. 1
- Introduce Agg. 1 Node failure

Test Measurement:

- Monitor the Multicast traffic switchover when failure
- Monitor the Multicast traffic switchover when recovery

	LoS	BFD
Static Join	F: 11.6msec R: 0msec	F: 48.7msec R: 0msec
IGMPv.2	F: 8.0msec R: 0msec	F: 43.7msec R: 0msec
IGMPv.3	F: 12.2msec R: 0msec	F: 46.2msec R: 0msec

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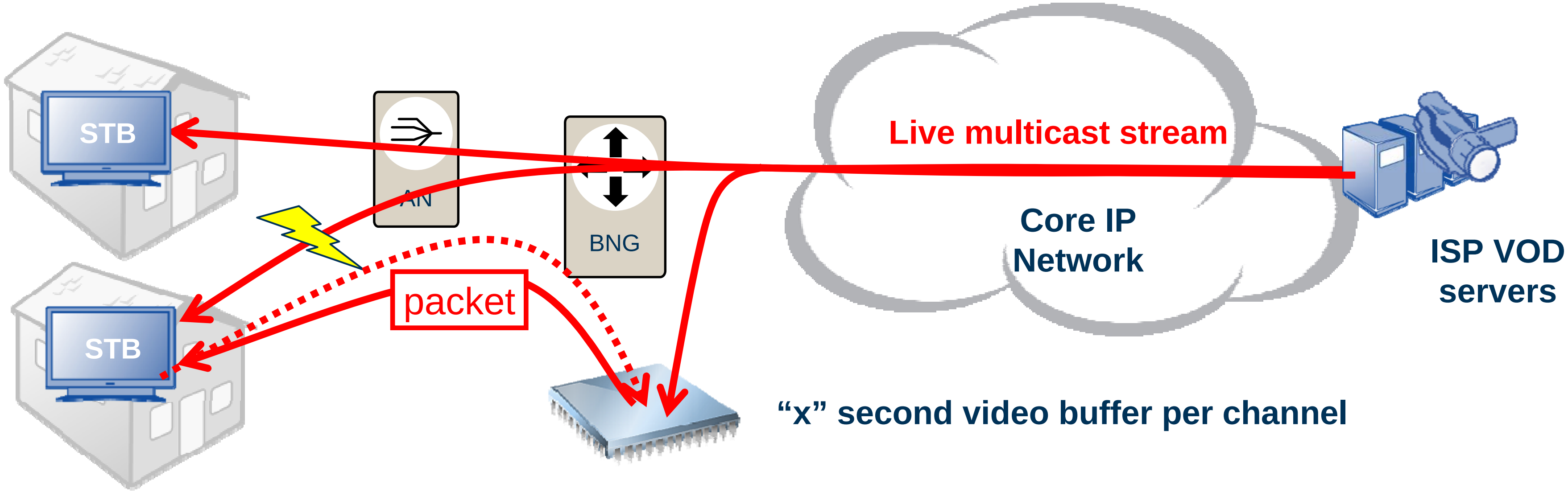
Reducing Video Packet Loss

Service Quality Guarantee

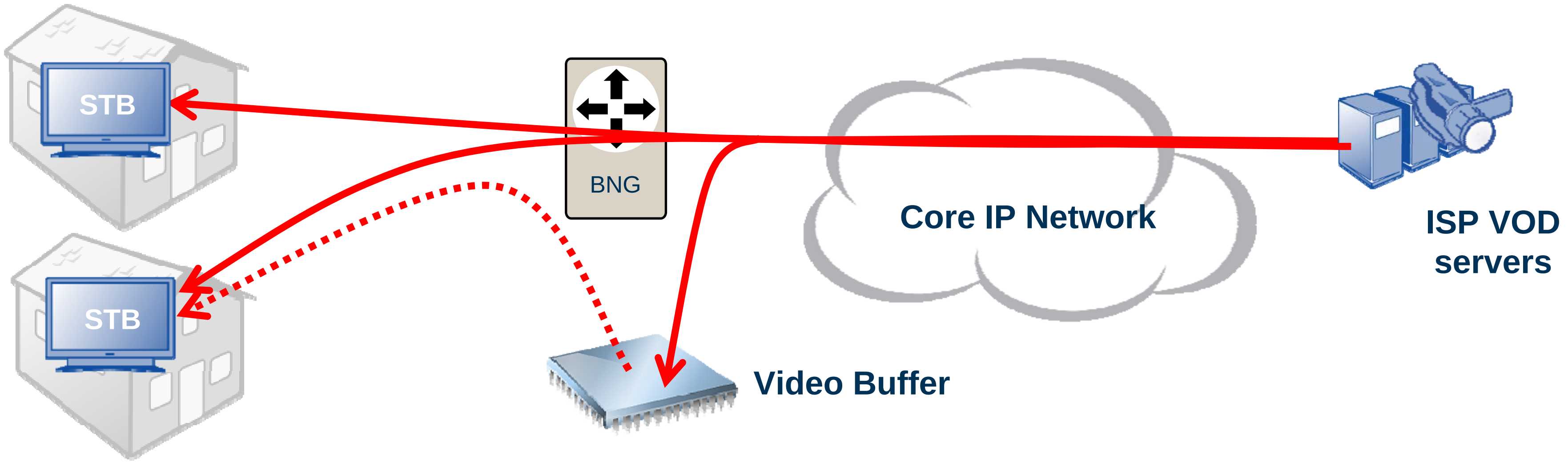


Why there could be Packet loss and what is the best way to handle this ?

- **DSL lines are prone to intermittent interferences that can cause significant packet drop over a period of time that can not be compensated by FEC (especially when optimized for throughput)**
- **Enhance the IP Edge Router to maintain a sliding window of video buffer for each multicast video channel.**
- **The IP Edge Router can retransmit dropped packets in unicast to the STB without impacting network bandwidth and with a low latency to accommodate short buffers at STB**

Packet Retransmission

Service Quality Guarantee



What is the most efficient way to handle packet retransmission ?

- The Set-top box implements an R-UDP protocol that utilizes a negative acknowledgement (N-ACK) or RTP Retransmission Extensions to indicate lost packets
- The IP Edge (BNG) receives the retransmission request from the set-top box and retransmits the indicated packet or range of packets from the video buffer via unicast

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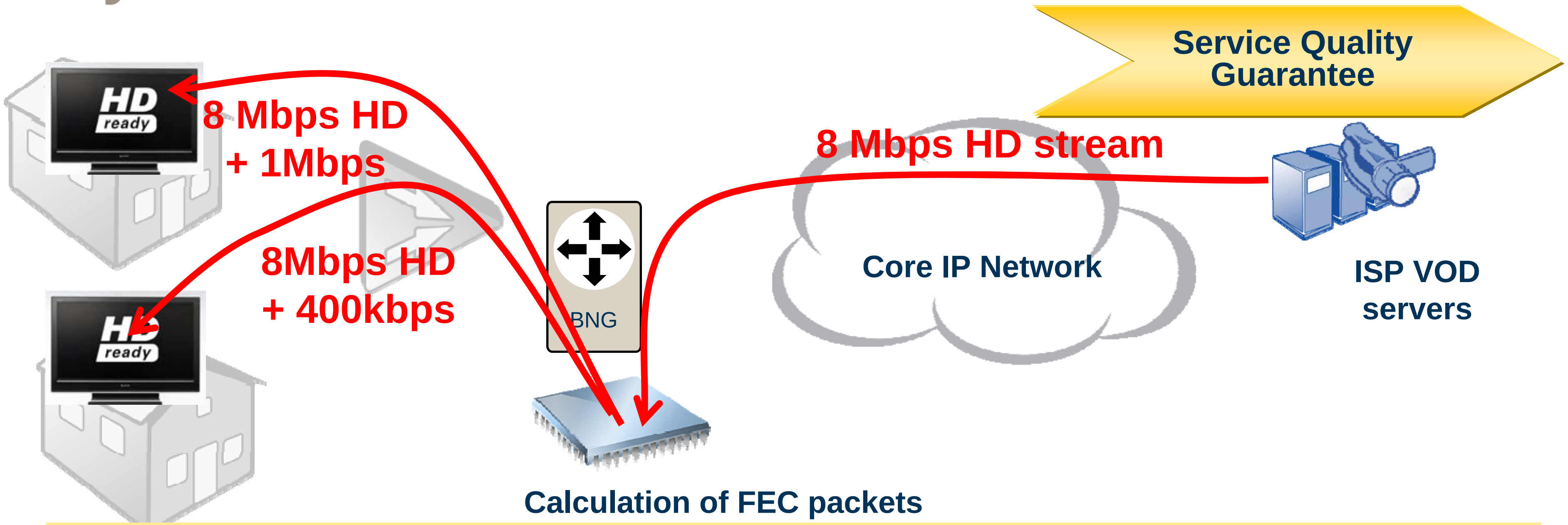
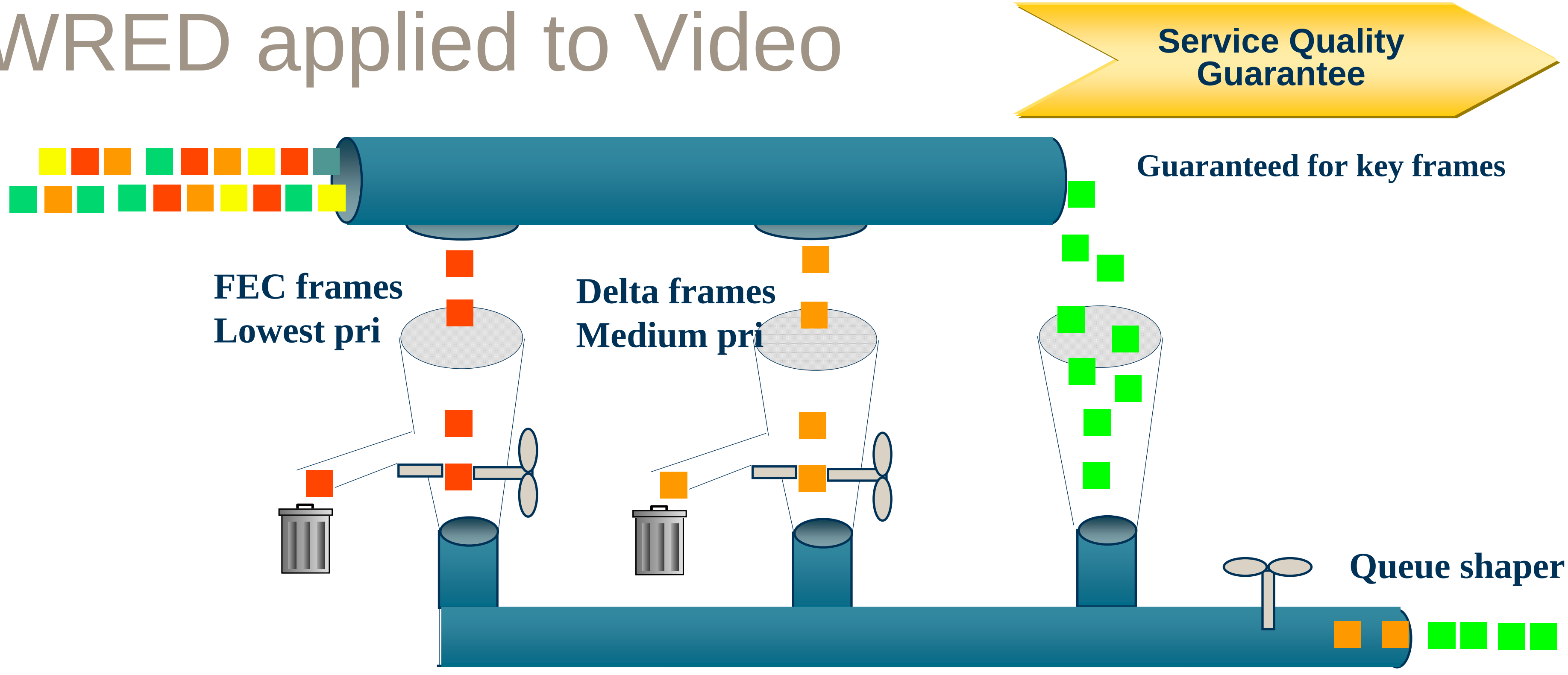
Dynamic Forward Error Correction



What is the most efficient way to handle Packet Loss ?

- FEC is method for generating redundant packets, to be used in the event of packet loss. Depending on line conditions and available bandwidth, different amounts of FEC may be appropriate for different residences.
- FEC can be layered, but optimal FEC for video is un-equal (some frames are more protected than others).
- Generated FEC at IP Edge can save up to 30% of core bandwidth
- QOS tagging can also be used to mark less important packets

WRED applied to Video



What is the best way to handle video congestion ?

- All frames of the same flow (Ordered Aggregate) will remain in the same queue to avoid out of order issues
- WRED allows for differential treatments of the frames in the same video flows if congestion happens
- Allows to max out resolution and FEC but trim to the minimum when line condition degrades

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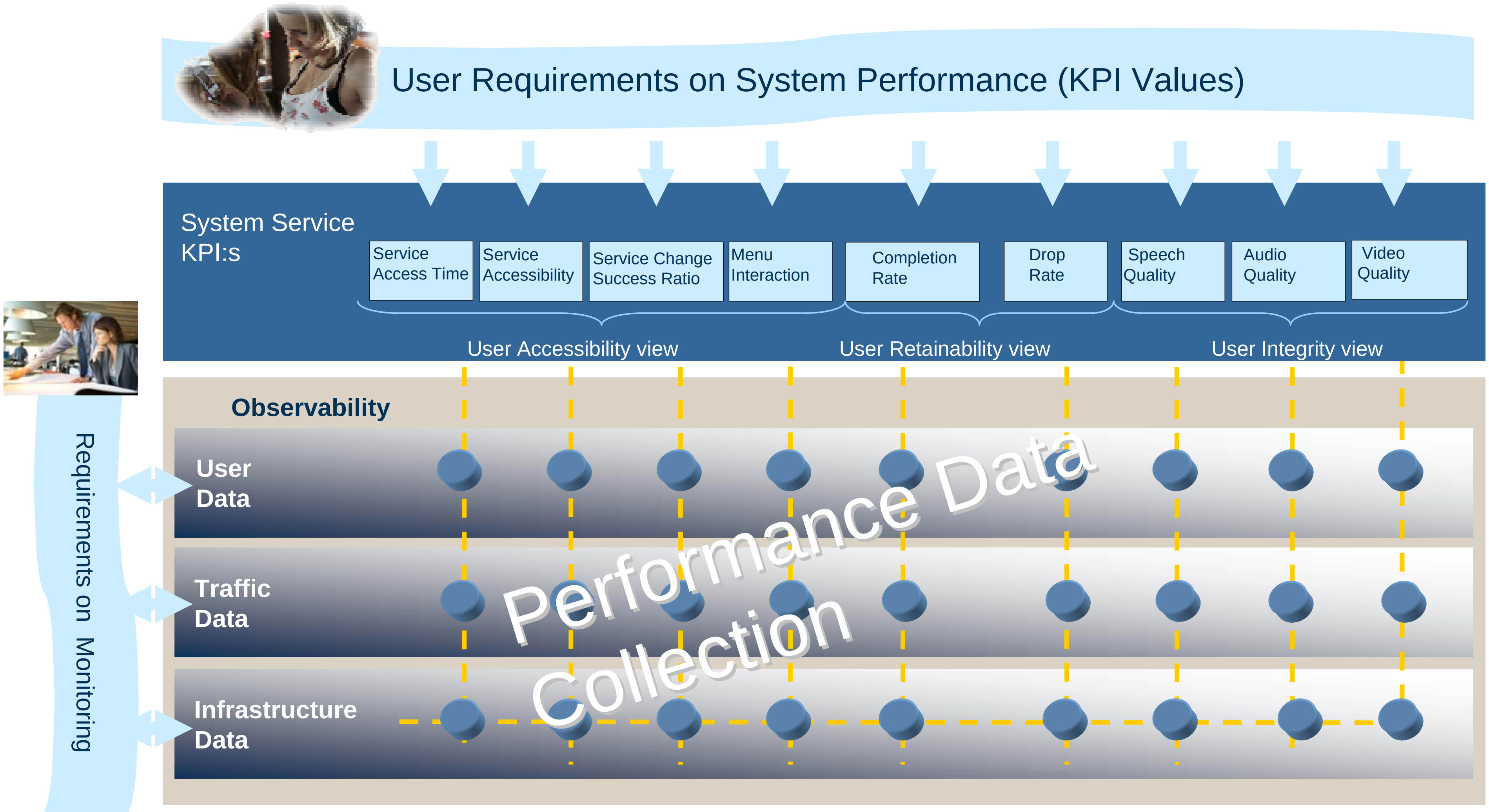
IP TV Performance KPIs

Service Quality Guarantee



IP TV KPI Examples

Service Quality Guarantee

IP TV Media Quality

Media Quality Metrics can be measured using Media Delivery Index (MDI) Industry Standard (RFX 4445) endorsed by IP Video Quality Alliance. MDI has two parts :

- Delay Factor (DF) : Used establish jitter buffer margins and warn of impending packet loss
- Media Loss Rate (MLR) : The number of media packets could be lost or misordered per second

Key KPI Values-

- Service (All Codecs) - Maximum acceptable Delay Factor 9 to 50 ms and Minimum acceptable 0
- Codec Services - Maximum acceptable average MLR per second
  - SDTV 0.004
  - HDTV 0.004
  - VOD 0.005
  - Typical target for SD TV 1 packet dropped per 30 mins

IP TV Channel Change

The parameter IPTV Channel Switching Time describes the time it takes (in seconds) to switch from one TV channel to another (aka channel zapping). The duration is measured from the request to change the channel is sent by the client until the channel switch request is completed.

Key KPI Values –

- Acceptable delay 1 second total, end to end
- Target multicast leave/join delay 10 -200 ms

Other KPIs

- IPTV Portal Information Retrieval Time [s]
- IPTV Service Access Time [s]
- IPTV Content on Demand Access Time [s]
- IPTV Content on Demand Access Success Ratio [%]
- IPTV Content on Demand Completion Ratio [%]
- IPTV Content on Demand Control Response Time [s]

Summary – Delivering IP TV Services with QoE

- The integrated IP transcoded solution at the Head-End would reduce equipment footprint and improve compression performance compared to the equivalent decode/re-encode solution. Important data elements such as Teletext, close captioning, active format descriptions and wide screen signalling are preserved in the Integrated Transcoding case

- Variable GOP length in MPEG 4 could be a significant challenge to deliver deterministic IP TV channel change performance. A standard based solution is recommended to expedite frame processing at the encoder and the set top box

- A standard based IMS IP TV middleware solution could solve today's middleware scalability, performance and vertical integration issues

- MPLS FRR using RSVP TE in LDP Tunnel and/or PIM Dual Join could meet 50 ms failover requirements in a triple play network

- IP TV Services and network infrastructures must be benchmarked against a set of IP TV performance KPIs to meet user accessibility, retainbility and integrity requirements

- A distributed VOD architecture with strategic placement of content caching in the network could ensure optimised network resource usage in a triple play deployment

IP TV Network Testing

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Why IP TV Testing ?

To Deliver Customer Satisfaction

- Content offered of very high quality
- Quality of Service (QoS) Delivered
- Feature working as per customer expectations
- Reduce Operational Costs in managing services

To Ensure Efficient Network Utilisation

- Network bandwidth usage is Optimised
- Identify key engineering and scaling limits
- Forward planning of network and services elements

To be able to Predict Service/Network Faults

- Determine the design pitfalls with networks and services
- Estimate the occurrence of unwanted conditions
- Find potential workarounds to avoid known faults

Identify Opportunities for Future Revenues

- Develop of awareness of services and products that could earn more revenues
- Reduce Opex by improving service delivery and rollout processes
- Determine ways to increase customer satisfactions
- Determine specific customer needs and buying patterns

Deliver on Service Level Agreements (SLAs)

- Define key terms and conditions of SLAs with the customers
- Deliver User Quality of Experience (QoS) as per SLAs
- Provide feedback to improve on SLAs

Monitor and Adjust Services for Continual Improvement

- Measure customer satisfactions with service offerings
- Determine what improvements will be required
- Adjust services to ensure they deliver higher customer satisfaction

IP TV Test Challenges

- Mixed Media
  - Video and Audio signal processing functions can result in different amounts of delay or loss quality resulting in acceptable quality of one type of signal, while other type of signal has unacceptable quality
- Content Dependent
  - Some types of content look good, while other types of content look bad given the same level of network impairments
- Multiple Conversions
  - Content may be converted multiple times between its high quality format and when the media is received by the viewing device eg. Set-top box
- Content Protection
  - Content may be scrambled and encrypted as part of the End to End Encryption system
- Error Concealments
  - Codec may generate information that replaces the data with error

IP TV Testing Considerations

Performance Testing

- Test and measure operational parameters during specific modes of operation.
- Determine if the device or service is operating within its designed operational parameters.
- Can be performed over time to determine if a system is developing operational problems.

Interoperability Testing

- Perform measurements and observations of a device or service or system with other devices of a similar type or with devices that have been designed with industry standards spec
- Example of middleware and STB client

Multilayer Testing

- Perform measurements or observations of a network or system with different functional levels such as physical, link, transport , session and service layers
- Example IMS interface to network and service layer

Load Testing

- Test the services at defined rates such as near or at maximum designed capacity limits.
- Verify, whether a system will meet or exceed its performance requirements during high-capacity operating conditions.

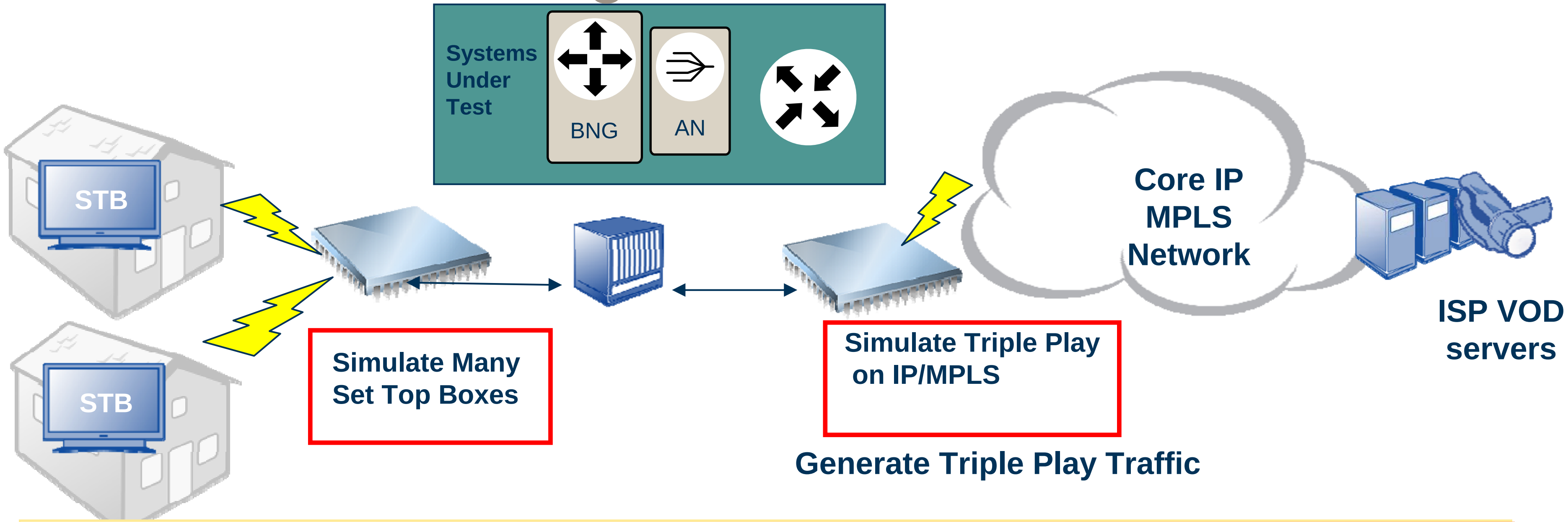
Stress Testing

- Test engineering limits of devices or services under operational conditions that are near or above their design limitations.
- Determine how a network or system will operate under loaded or failed conditions.

Service Capacity Testing

- Test the maximum amount of resources that can be effectively used for transmission of functions within a system and network
- Example a data network may be monitored for several days to determine the capacity and transmission delay of routers and switches in the network.

IP TV Stress testing - Realistic Conditions



Measure Per Subscriber QoE

Scale Testing

- Simulate many thousands subscribers and hundreds of multicast and unicast IP TV channels concurrently
- Different Video Traffic profiles MPEG2, MPEG4, SD and HD Traffic

Subscriber interactivity simulation Testing

- Support Various subscriber profiles – Channel changing, HTTP VOD requests

Combining Multi Services ASP Triple Play Traffic

- Generate Thousands of concurrent VoIP, IP TV, High Speed Internet and Interactive Gaming traffic

IP TV Video Server Testing

- Generate Thousands of concurrent SD and HD videos on demand subscribers at a certain peak load to
- Verify performance characteristics of the VoD Servers

IP TV Quality Performance Parameters

Content Quality Measurements

Media Delay Factors
Frame Counts
Frame Loss Rate
Media Loss Rate
Buffer Time
Rebuffer Events
Rebuffer Time
TS Rate
PS Rate
Clock Rate Jitter
Jitter Discards
Compression Ratio
Image Entropy
Missing Channels
Channel Map
PTS Error
PCR Error
TS Error
Program Clock Errors

How accurately the Media is displayed to the user ?

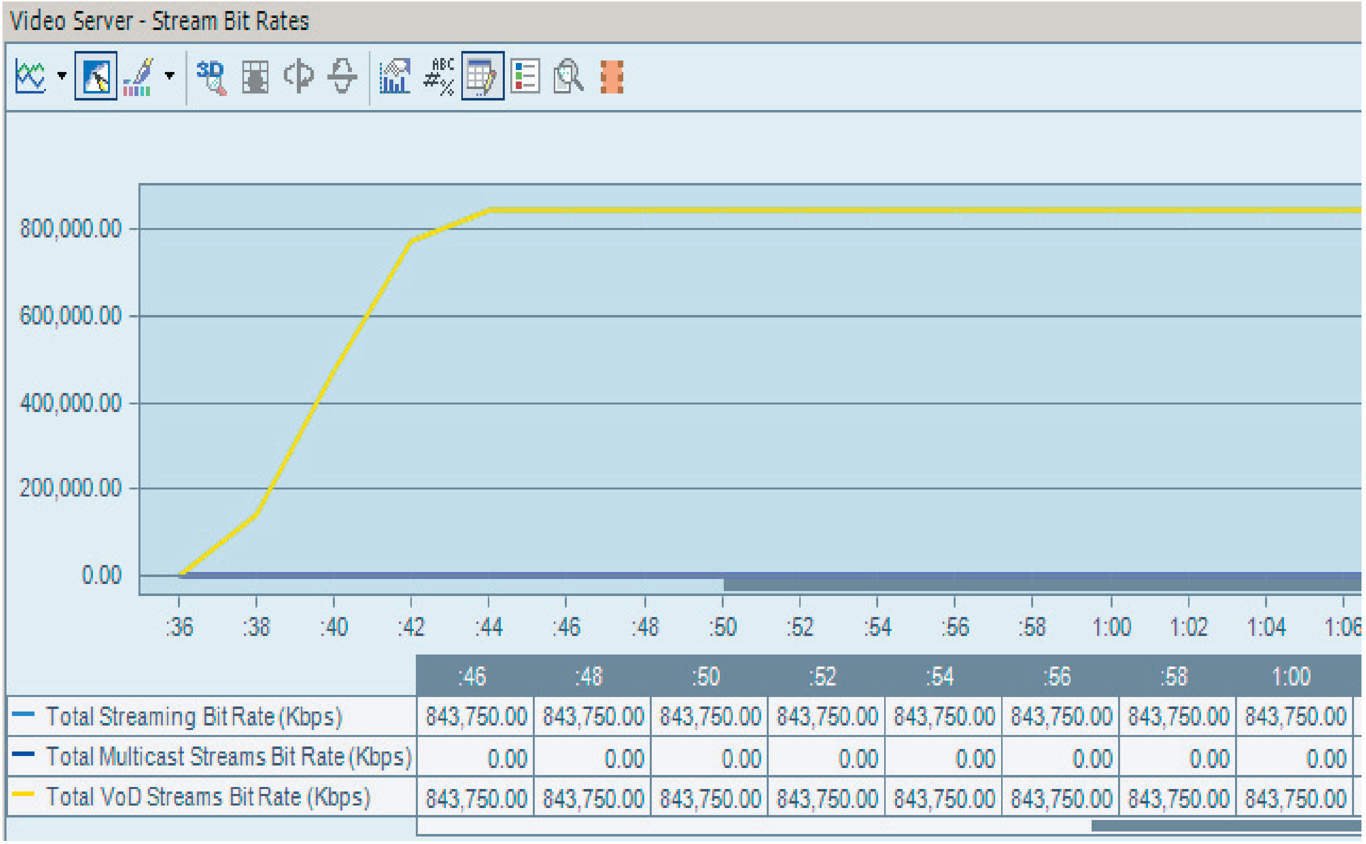
IP TV Network Measurements

Packet Loss Rate
Packet Discard Rate
Packet Latency
Packet Jitter
Packet Delay Variation
Out of Order Packets
Gap Loss
Packet Gap
Route Flapping
Loss of Signals
Bit Error Rate
Connection Success Rate
Line Rate
Streaming Rate

How IP TV stream is affected by the performance and operations of the network?

MDI – Media Delivery Index to measure Content and Network

VoD Server Testing Using MDI Method



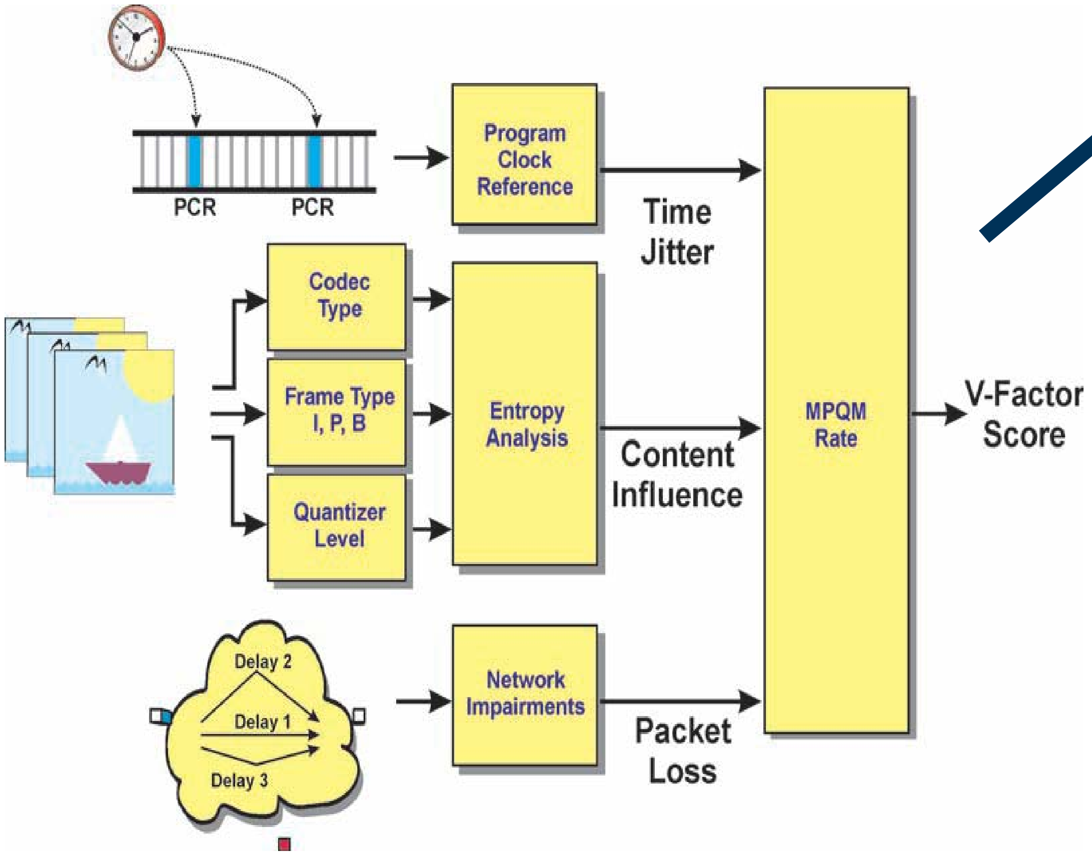
Key MDI Measurement Parameters –
MDIDF- Media Delay Factor
MDR -Media Loss
as Defined in RFC 4445

Maximum Video Server Throughput – 225 X 3.75 Mbps = 845.75 Mbps

Stream Name		Stream Bit Rate (Mbps)		MDI-MLR(us)	Min MDI-MLR (us)	Max MDI-MLR (us)	MPEG2 TS Loss (us)	Jitter (ns)	Min Inter pkt arrival (ns)	Max Inter Pkt arrival (ns)	Min Pkt Latency (ns)	Max Pkt Latency (ns)	Join Latency (ms)
user0_201_100.01		3750002		0	2832	2841	0	564	2790180	2825400	37120	40240	1103
user2_201_100.01		3750002		0	2832	2842	0	516	2786460	2828920	37160	40200	1103

Per Stream Statistics

Video Quality Measurement Using V-Factor



A score of 1 to 5 used to measure Video Quality

Content influence Enhancement In VQ Testing

Include MPEG Stream Type (I, P, B)

Quantizer Level

Codec Type

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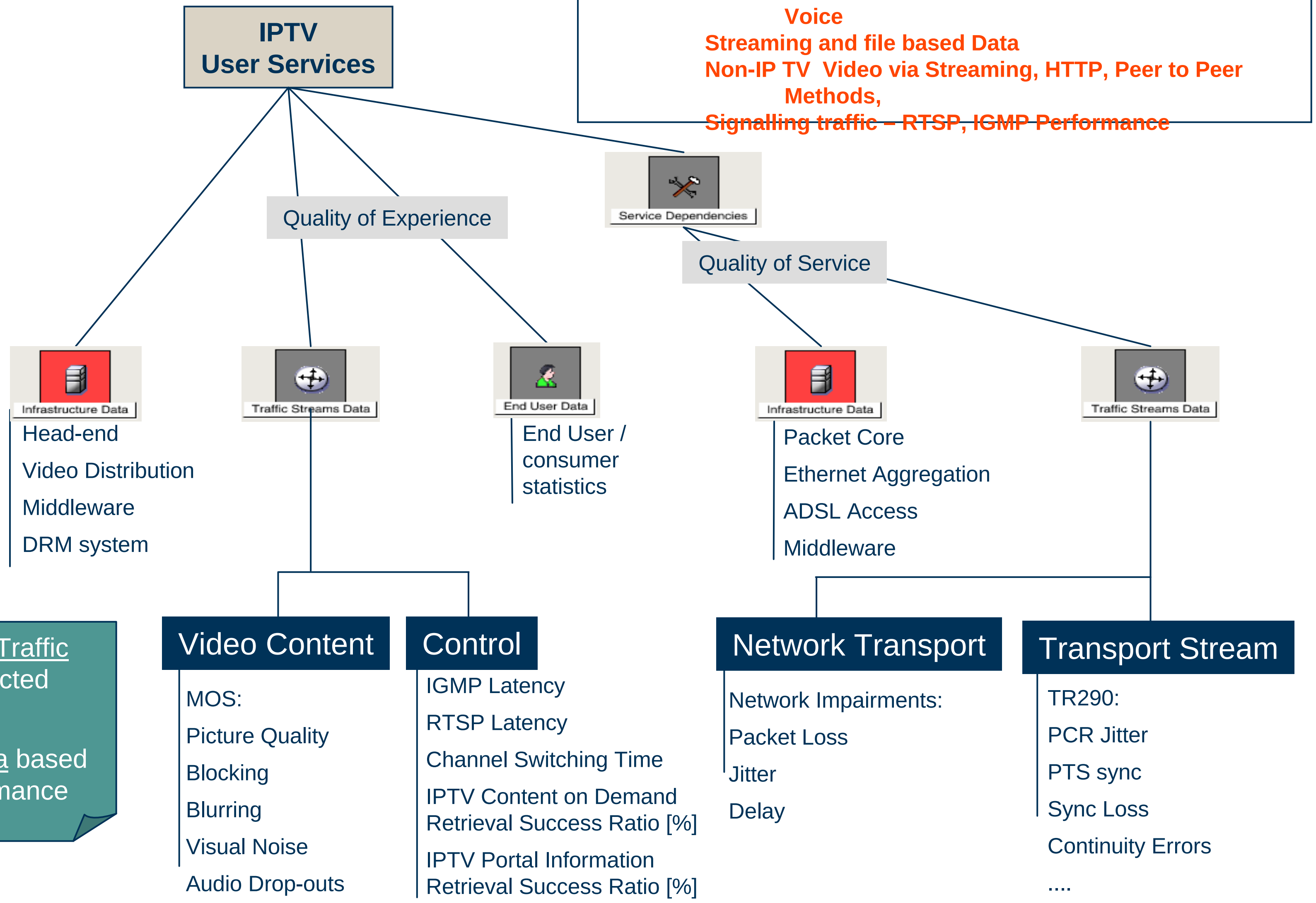
Service Model based approach

Test Measurement and Monitoring (TM&M) equipment will be used to measure performance of all types of services delivery
- **Video – Linear and VoD**
  - **Voice**
- **Streaming and file based Data**
- **Non-IP TV Video via Streaming, HTTP, Peer to Peer Methods,**
- **Signalling traffic – RTSP, IGMP Performance**



End User Data & Traffic Stream Data collected with probes

Infrastructure Data based on Fault & Performance information

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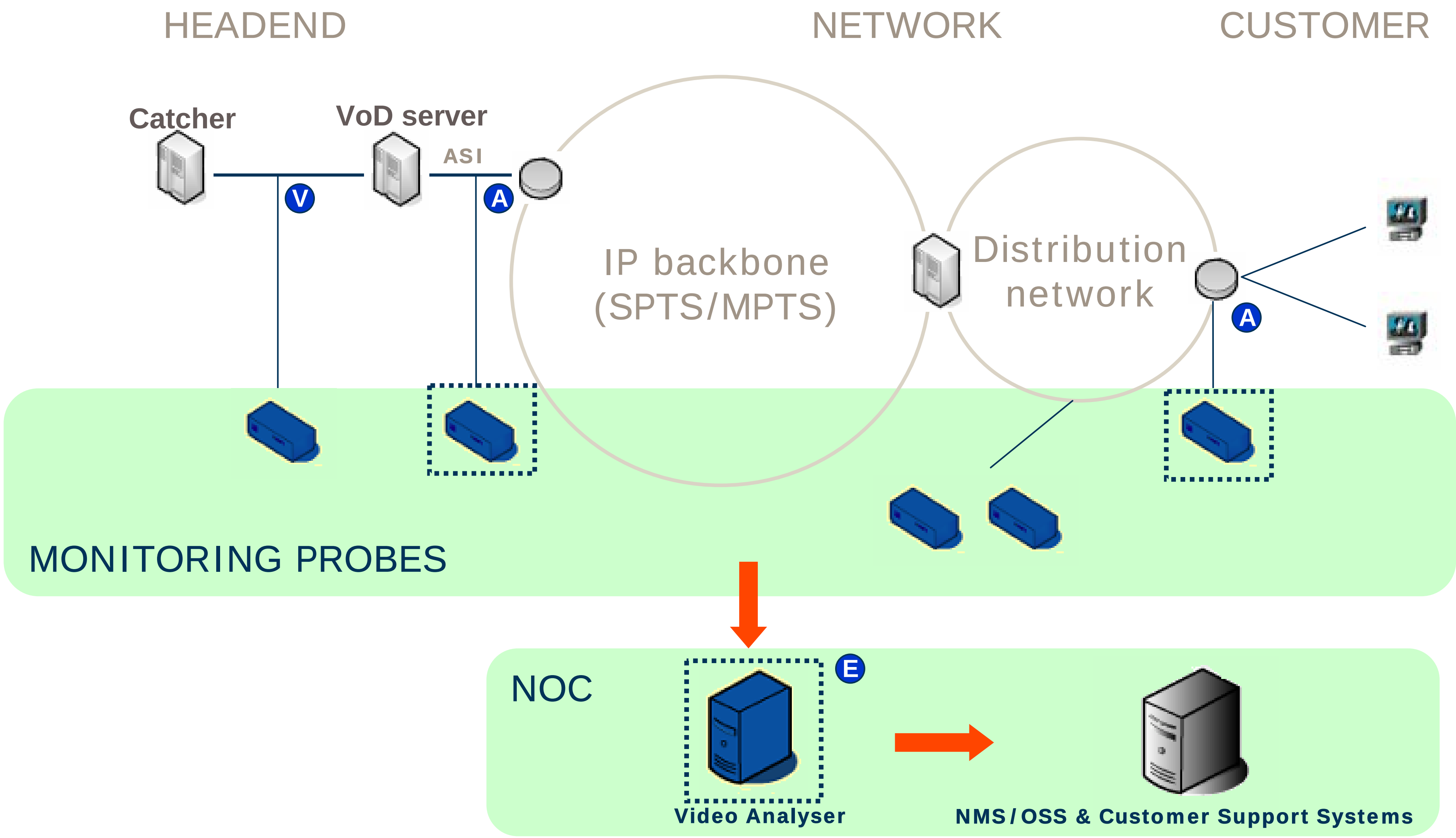
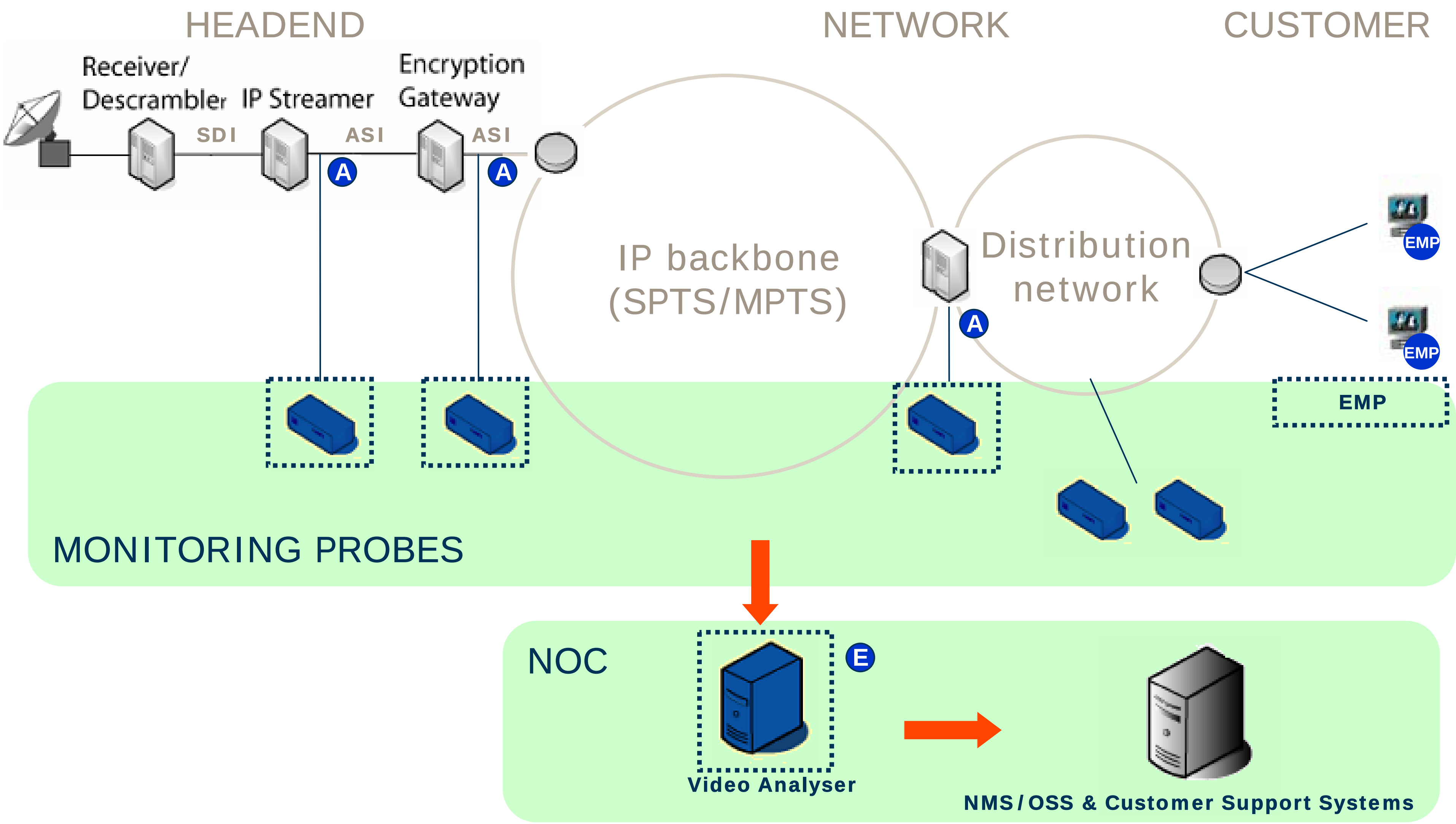
Basic VoD Monitoring



Basic Live Monitoring



IP TV Test Equipment Choices

Video Analyser

- Receive and evaluate video signals
- Capable of evaluating multiple types of media formats such as MPEG2, MPEG4, VC-1, VC-6
- Analyse the stream rates, bit rates, display motion vectors, quantizer values, frame rates, frame counts
- Measure various types of errors such as bit rate, frame loss rate

MPEG Generator

- Create signals to simulate the source (headend) of a Broadcast TV
- Create SPTS or MPTS
- Insert or adjust the error rate to simulate common network impairments

Network Impairment Monitor

- Create or simulate operational or communication impairments for the device under test
- Produce jitter, latency, burst loss, packet loss, out of order packets, route flapping and link failures to simulate fault conditions

Protocol Analysers

- Analyse protocol data in promiscuous and listening mode
- Used for problem determinations
- Analyse packets independent of destination address

Network Monitoring Tools

- Analyse network alarms and performance data
- Can detect trouble in interoffice, loop and switching systems

Test Clients

- May be installed on the STB to monitor performance conditions
- can determine packet losses, monitor packet jitter, and analyze their impact on the display of the video

IP TV Test Considerations

- How Lab testing could model the real world deployment ?
  - Service Emulation for application layer QoE testing
    - Voice and Video services emulated with data
    - Testing could include channel change, a broad mix of motions, colour ranges, scene changing and special effects
    - Emulate different TV users behaviours
    - Interactive simulation of VoD and Web TV
  - Multiple Consumer Use Cases in normal and stressed simulated environments
    - Too many subscribers are requesting for video titles from the VoD servers
    - Testing of Video Call Admission Control performance
    - Network behaviour under video congestion
    - Client software download performance on hundreds and thousands of STBs from Middleware server
    - Simulate real subscriber behaviour by automated simulated button presses from a physical remote control
- How IP TV Service could be measured and monitored in post deployment period ?
  - Place Monitoring Equipment at various points of the IP TV network
    - At the Head End- Demux, Decode, Transcode, rate conversion, A-D Conversion, Encoded MPEG in Storage
    - At the Storage – Video Server, Ad Server
    - At the Content Processing Point – Encryption, Live MPEG Video &Audio for IP Multicast
    - At Network Domain – Core, IP Edge, Aggregation, DSLAMs, STBs
  - When and Where Video Quality Be Measured ?
    - At the Headend, At the Acquisition
    - As Content enters the Distribution Network
    - At the Core, IP Edge and Aggregation Network
    - At the CPE Devices- Home GW, STBs

IP TV Testing Summary

- IP TV Test Challenges are significant due to mixed media, multiple conversion, error concealments and from content protection
- IP TV Testing must conform with established standards and best practices. Testing will be required
    1. At a Video Quality Level, through Signal Testing (OSI L7-L8)
    2. At a network, QoS Level, through data testing (OSI L1-L4)
    3. At a QoE Level through Application Performance Testing (OSI L4-L7)

- Lab testing must model the real world deployment. Equipments used are Video Analysers, MPEG Generators, Protocol Analysers and Network Impairment monitors

- IP TV Services must be measured and monitored by placing network probes at various parts of the IP TV network in a post deployment period.

IP TV Future Direction

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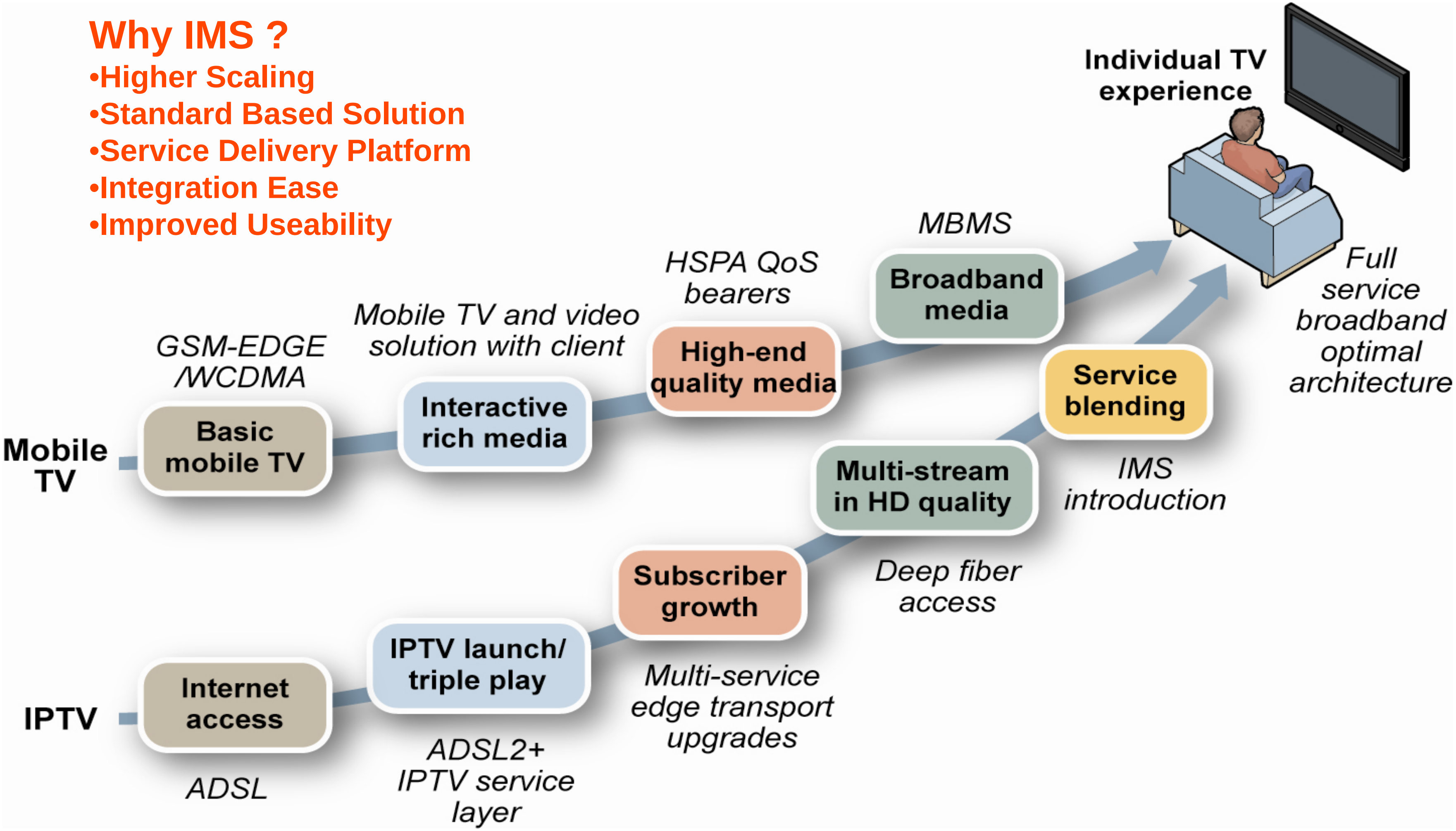
Ericsson's TV Vision of Converged Services and Service Creations

Why IMS ?

- **Higher Scaling**
- **Standard Based Solution**
- **Service Delivery Platform**
- **Integration Ease**
- **Improved Useability**



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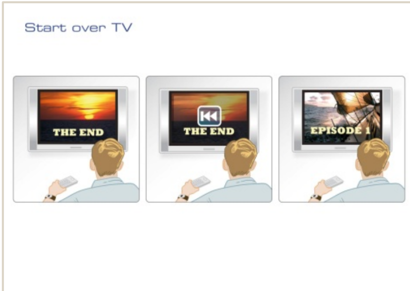
The different IPTV concepts

More than one TV

The possibility of using Time Shift and/or Video on Demand on more than one TV device in the home

Start over TV



The viewer can rewind a TV program approx 15 min and watch it from the beginning.

TV on demand

All programs broadcast by the eight most common TV channels are stored for up to five days by the service provider.

HDTV

HDTV brings much more picture clarity and detail, plus a wider picture and better sound.

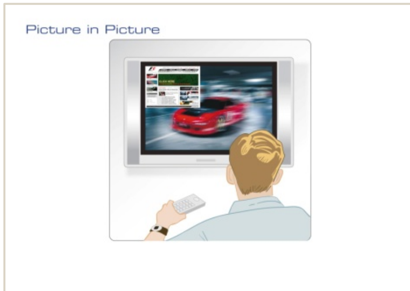
NPVR

The film/program is stored by the service provider and the viewer is able to access it whenever he/she chooses.

Time Shift

The viewer can pause a TV program and continue viewing it later. Also possible to rewind and fast-forward.

Picture in Picture



The possibility of viewing two separate windows on the TV screen: e.g. TV in one and surf/chat in the other, two different TV channels etc.

The Personalized TV Roadmap

Towards a Converged World

Step 0

IPTV

Step 1

Multi-play

Step 2

Multi-access

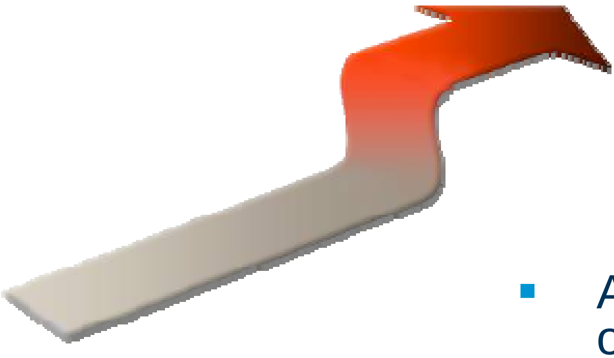
Step 3

Full Convergence

Broadband – QoS and Scalability
IMS enabling communications and end user services
IPTV Standardization – future proof migration

Opening the access to multi-devices

Shift from manage closed environment to open access



- 1st generation Integrated IPTV IAD Proprietary
- Access content from a larger set of devices (multi-STB, PC, Console, Mobile) => Need standard

1st generation IPTV often restricted to single stream SDTV

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Expand TV service offerings

- More than one TV
- Start over TV
- TV on demand
- NPVR
- HDTV
- Time Shift/VOD

The market is ready

- Picture in Picture
- Cost control
- Personalization
- Voting
- Messaging & presence

Could include TV Program and Internet Surfing in two screens

"Moving to Future"
(IMS as a key technology Enabler)

IMS Value Proposition

Presence Services

1. Identity the users based on post-code, demography profile and group preference.
2. Insert targeted ads to personalize customer experience with IP TV.

Enrich Call

1. Extend multimedia conference such as Video sharing, file sharing, white board on TV.
2. Extend TV viewing experience with picture in picture by offering TV Widgets and Sidebars

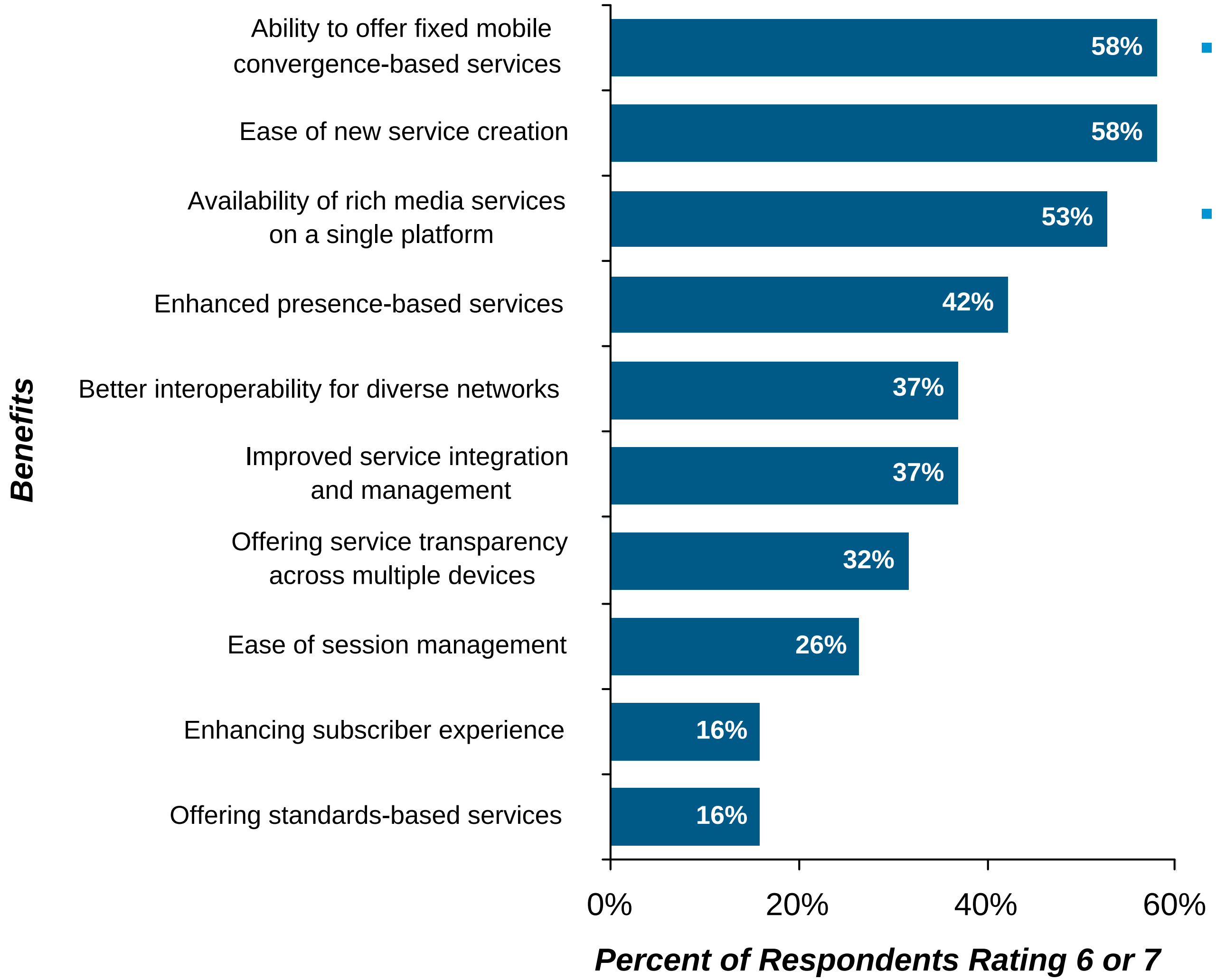
Enhanced Messaging

1. Ability to handle Multimedia messaging from TV
2. supporting instant messaging, text, image, sound, video and other multimedia files on the TV screen.

Personal Phone book

1. Ability to create a personal phone book for each customer linking all subscribed services and calling preferences.
2. Services included but not limited to : Fixed and Mobile access, broadband data and TV services.
3. Allow search and calling capabilities based on multimedia ID and destination calling ID on both fixed and mobile access

Convergence and Ease of Service Creation Seen as Key IMS Benefits



- Being a natural feature of IMS, ease of service creation has been topping the list for some time
- Our respondents—some of whom are offering UMA-based FMC voice services—see FMC services as going beyond voice
  - Multimedia FMC services

Source : Adapted from Infonetics Service Provider Plan for IMS August 2008 Study Highlights

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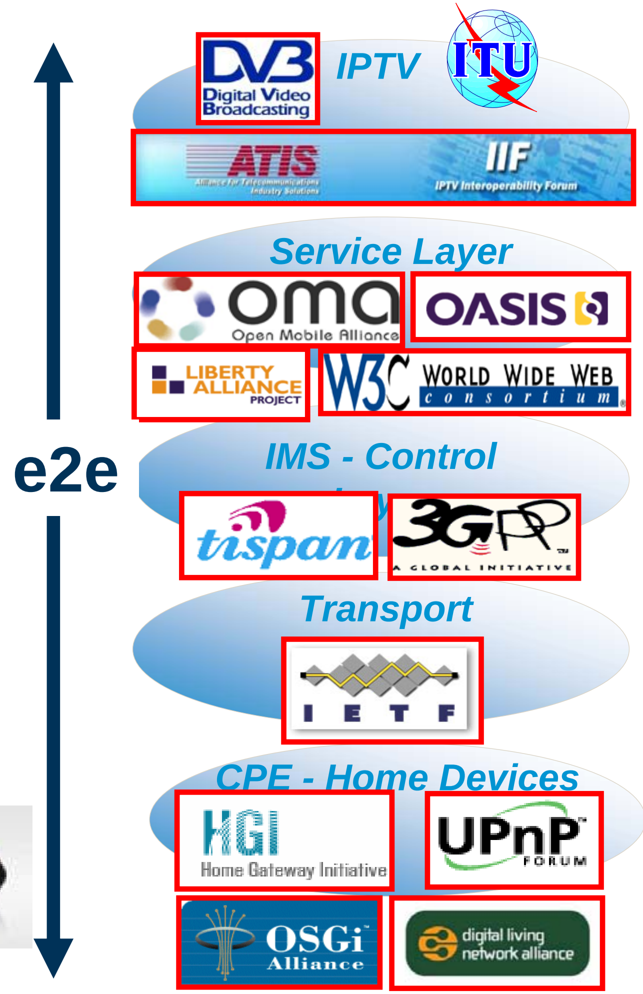
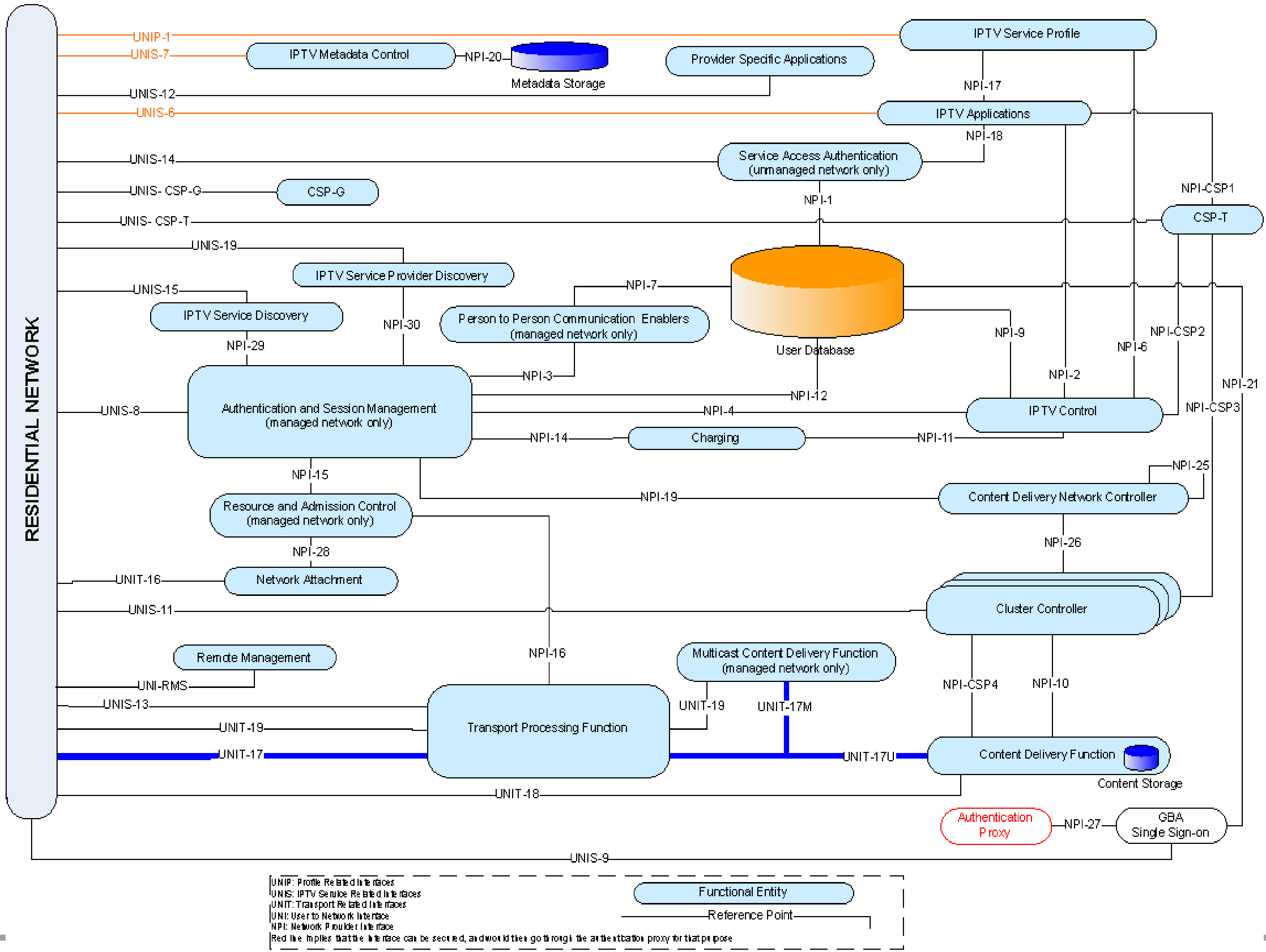
Key Standardization Drivers for IP TV

- Today the market is characterized by: Fragmented Standards, Fragmented Market and Proprietary Solutions
- Convergence will enable new and innovative consumer experiences
- Open Standards will drive down Costs and consumer Complexity, it will also promote Volume of capable devices and Innovations
- http://www.openiptvforum.org/docs/OpenIPTV-Functional_Architecture-V1_1-2008-01-15_APPROVED.pdf



Ericsson’s IMS IP TV- A Standard Based Solution



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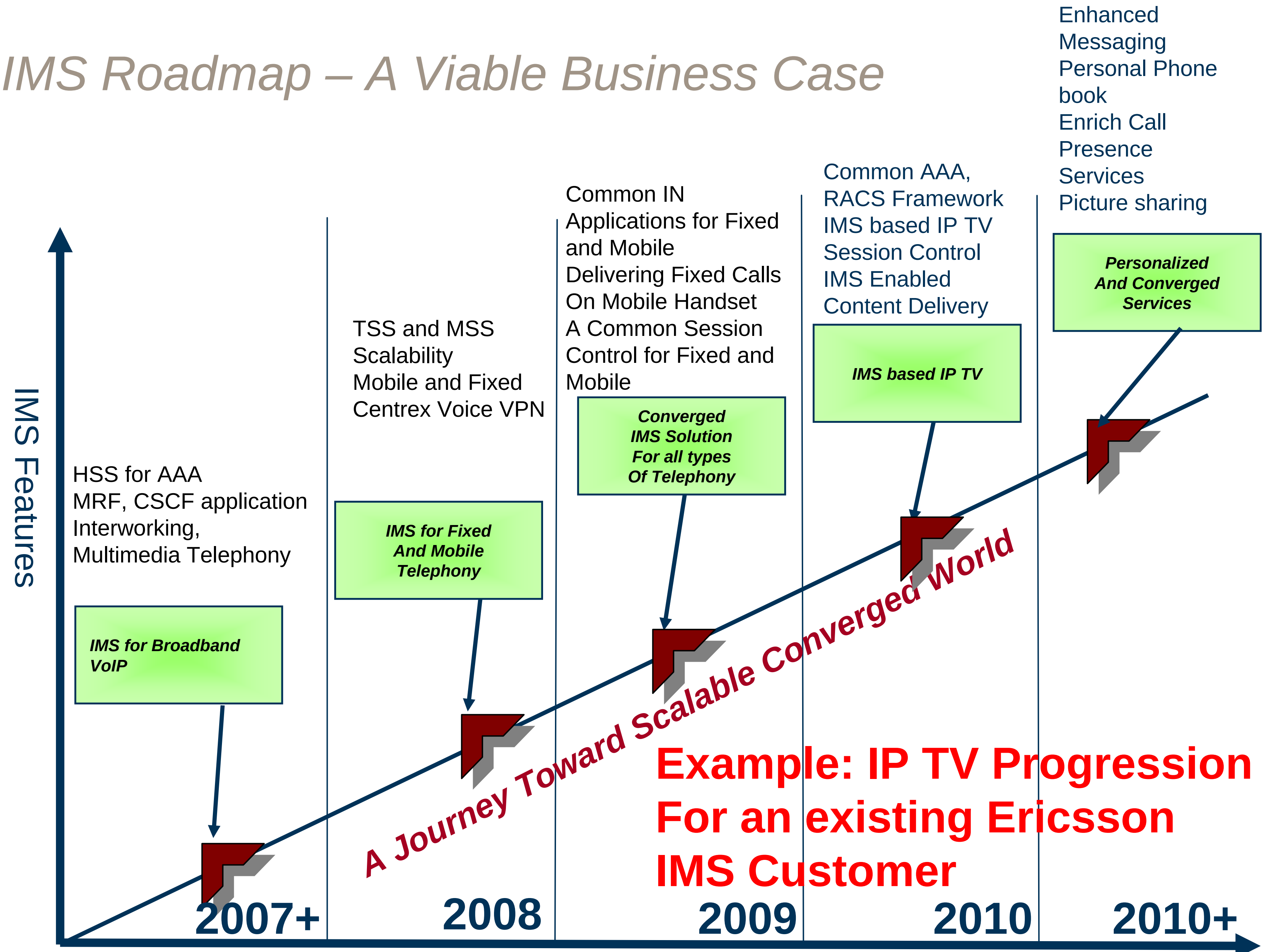
IMS Roadmap – A Viable Business Case



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Future Direction Conclusions

- IMS Platform Evolution for All Types of Telephony
  - Make sure IMS works for Broadband VoIP and Fixed IP Telephony First!
  - Develop VoIP siganlling, conferencing, Presence and Location services to decommission legacy IN and PSTN infrastructure rapidly
  - A common IMS based Session Control for Fixed and Mobile Telephony

- Upgrade IMS Platform to Enable IP TV Applications
  - IMS IP TV Platform must scale up with the service build up
  - Make sure IMS IP TV Middleware is scalable and deployed in a cost effective way
  - Ensure that, IP TV Applications are developed based on Open TV Standardisation
  - Simplify Set Top Box functionality using IMS enabled RG
  - Demonstrate an echo-system with efficient multi vendor environment
- The future : A Converged World
  - Personalization➔ Your content, Adverstivement
  - Time and place shift will be key

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Finally …. The Key Messages

- Operators' business model Emerging – 1) Incumbent owned, 2) A collaborative approach with infrastructure managed by a white label infrastructure entity
- High Availability and Resilient Triple Play Network Design Consideration
- User Quality of Experience with Mixed Media is equally dependent both on Services and Network Parts
- End to End QoS Management and Network control is a necessity for service differentiation in the network
- IMS as the IP TV future to deliver middleware scalability and service convergence

Abbreviations

- ASI Asynchronous Serial Interface
- ATIS Alliance of Telecommunications Industry Solutions (USA)
  http://www.atis.org/
- DVB Digital Video Broadcast
  http://www.dvb.org/
- DVB-C Digital Video Broadcast for Cable
- DVB-H Digital Video Broadcast for Handheld
- DVB- S Digital Video Broadcast for Satellite
- DVB-T Digital Video Broadcast for Terrestrial
- FC-Fast Convergence
- FEC – Forward Error Correction
- FRR- Fast Re-Routing
- IRD Integrated Receiver/Decoder
- SDI – Serial Data Interface
- ETSI – European Telecommunication Standard Interface
  http://www.pda.etsi.org/pda/queryform.asp/
- HGI – Home Gateway Initiative
  http://www.homegatewayinitiative.org
- IPI – IP Protocol Infrastructure
- IRD- Integrated Receiver/Decoder
- IMS- IP Multimedia Services
- MDI – Media Delivery Index
- MLR- Media Loss Rate
- MPLS – Multi Protocol Level Switching
- MPTS- Multi-Programme Transport Stream
- NGN- Next Generation Network
- QoE – Quality of Experience
- RTP- Real Time Protocol
- RSVP – Resource Reservation Protocol
- RTSP – Real Time Transport Protocol
- SDI –Serial Data Interface
- SPTS- Serial Program Transport Stream
- TS – MPEG Transport Stream
- TE – Traffic Engineering
- UDP- User Datagram Protocol

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TAKING YOU FORWARD