Beyond IPTV: Multi-play and its Network Requirements

A new architecture for Triple Play over Broadband Ethernet networks

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Agenda

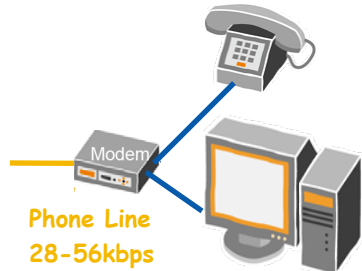- **Multi-Play Broadband Architecture Concept**
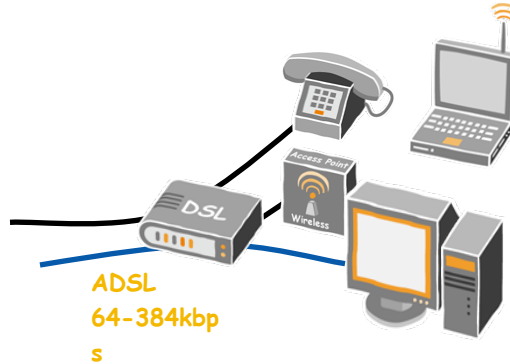
- **Multi-Play Broadband Requirements**

- **Summary**

The Evolution of Broadband Services......
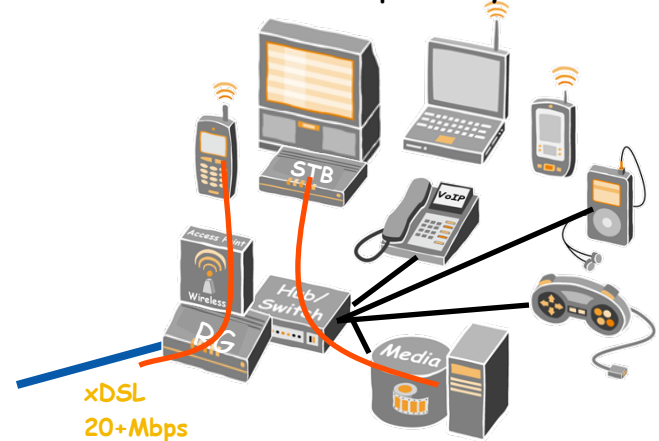
1980's-90's:
A new world called the Internet

Phone Line
28-56kbps

- The Start of the Internet for masses using Dial up:
  Phone line is shared between the PC and the phone – big rush to sell 2nd phone lines

  Emergence of the ISP concept with AOL,…

- New concept:
  Content available to everybody
  "New economy concept"

2000-'04:
The always-on concept w/ broadband

ADSL
64-384kbps

- The Emergence of ADSL and DOCSIS technology
  Higher bandwidth than dial-up:
  ADSL typically 64k to 1.5Mbps

  "Always on" concept i.e. no busy signal

- No need for a unique phone line, Same physical link into the home For multiple services

First look at Convergence!!

2005-200x
The emergence of Home Networks and Triple Play Services
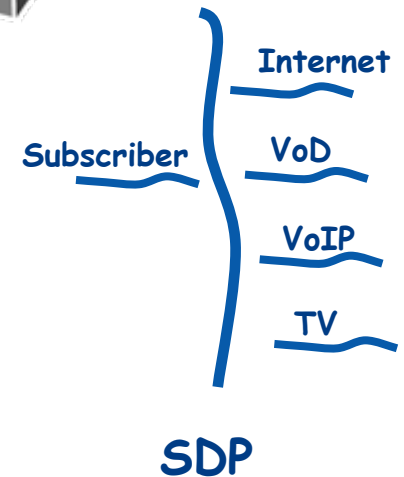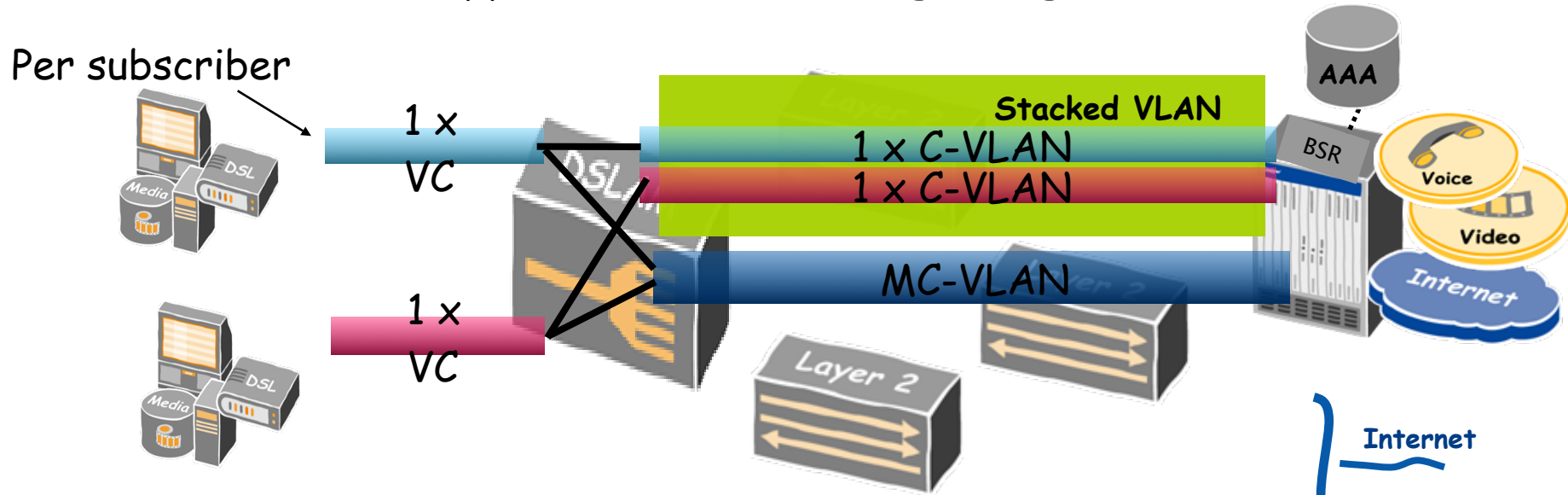
xDSL
20+Mbps

- The Emergence of the new DSL, DOCSIS, And xPON technologies:
  Higher bandwidth than ADSL: typically 20+ Mbps per home

- First signs of home networks with Digitalization of the home:
  Digital Camera, Camcorder, Playstation, DVD, iPOD

Proposed BSR architecture (TR-101, TR59):

Subscriber-centric approach based on Single Edge / C-VLAN model

Per subscriber

AAA

Stacked VLAN

1 × VC

1 × C-VLAN

1 × C-VLAN

BSR

Voice

Video

MC-VLAN

Layer 2

Internet

1 × VC

DSL

Media

DSL

Media

All subscriber and service provisioning in BSR
C-VLAN per subscriber for all unicast services
Shared MC-VLAN for IPTV broadcast services
Per-subscriber policy and QoS centralized in BSR
Access and aggregation focus is on connectivity/transport

Internet

Subscriber { VoD

VoIP

TV

SDP

Alternative architecture (TR-101, TR59):
Service-centric approach based on Multi Edge / Service-VLAN model

Per subscriber

VC - Internet
VC -
V6ice
WOD
BCTV

VC - Internet
VC -
V6ice
WOD
BCTV

Layer 2

DSLA

Service VLAN - Internet

Service VLAN - Voice

Layer 2

Service VLAN – VOD

MC - VLAN

Layer 2

AAA

BSR

Voice

Internet

Video

Video PE

**SDP
?**
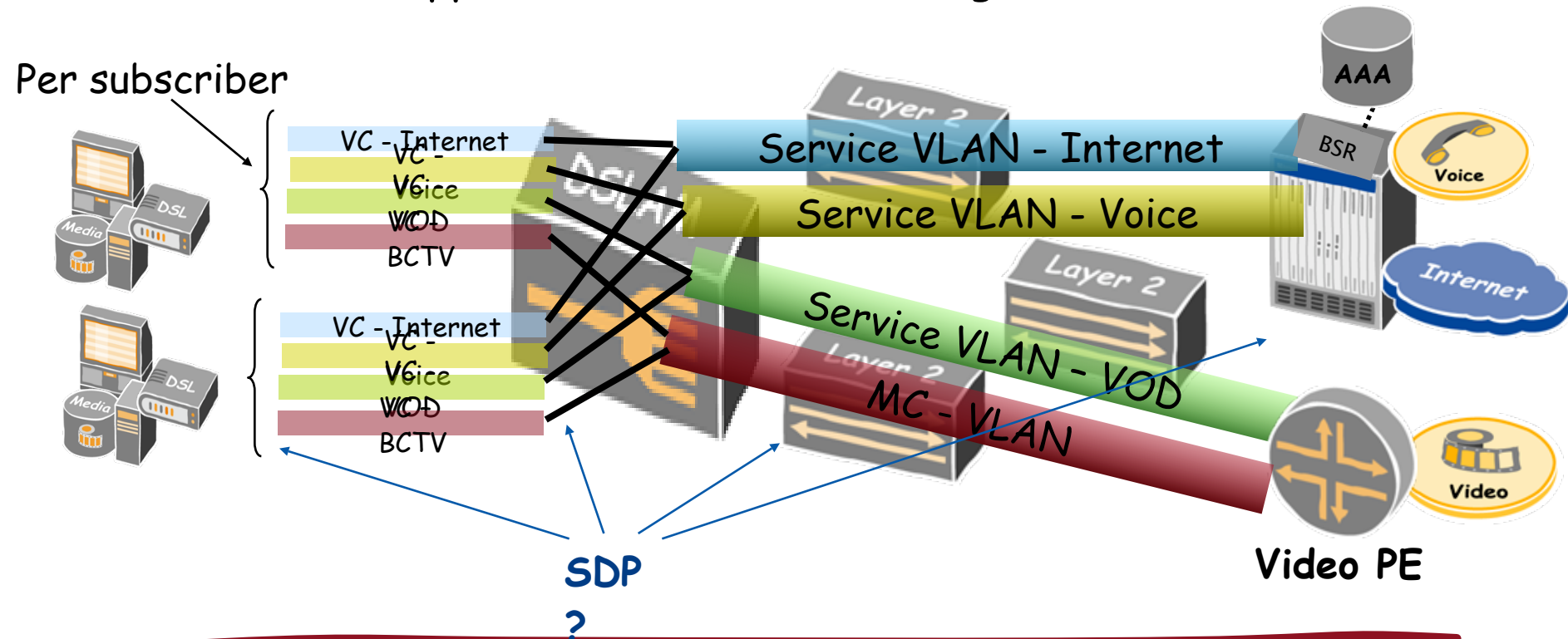
**Subscriber and service provisioning in access/aggregation
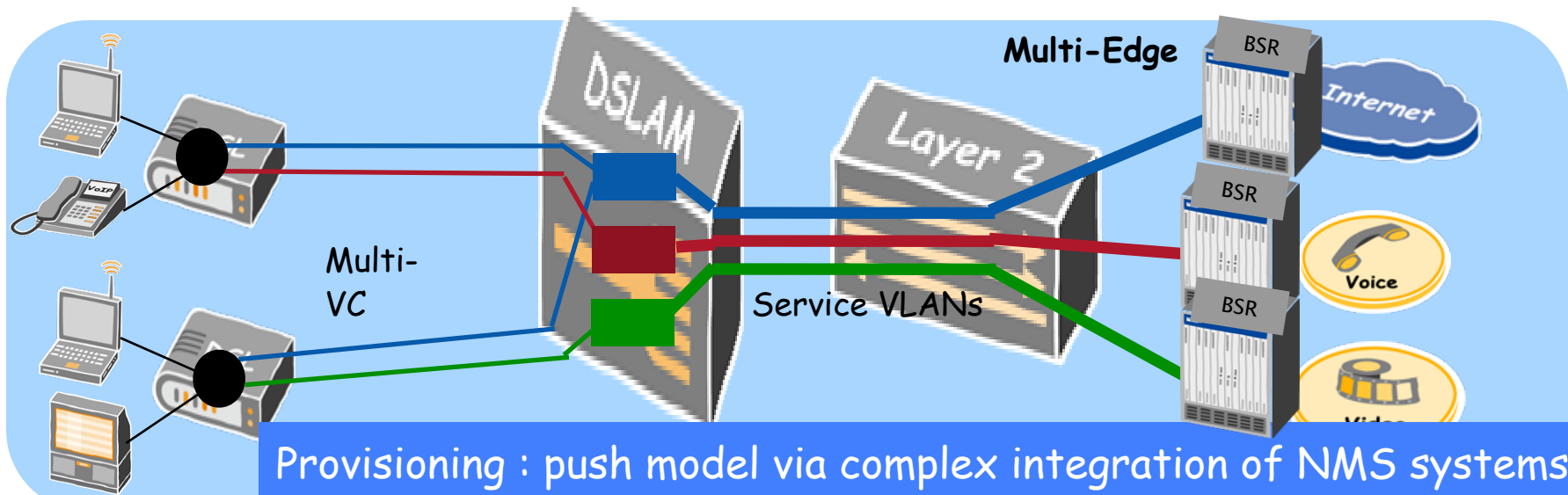Shared VLAN per service for all unicast services
Shared MC-VLAN for IPTV broadcast services
Per-subscriber policy and QoS distributed over access/aggregation/BRAS
Access and aggregation is now 'service-aware'**

Single Edge vs. Multi Edge model (TR-101, TR59)

Multi-Edge

DSLAM

Layer 2

BSR

Internet

BSR

BSR

Voice

Multi-VC

Service VLANs

Provisioning : push model via complex integration of NMS systems at subscription time on a per subscriber basis

DSLAM

Layer 2

BSR

Internet

Single-VC

Customer VLANs

Voice

Video
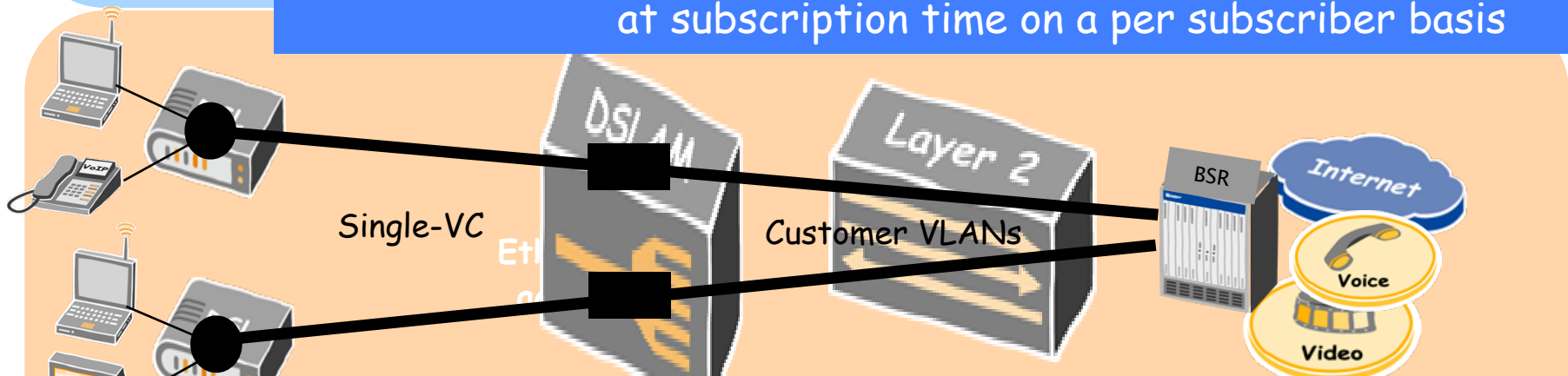
Provisioning : batch pre-provisioning at DSLAM commisioning time and pull model via Radius at subscriber connection time

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Options for the aggregation network

- Layer 1 backhaul (*)
  - Direct connect between DSLAM and BSR
- Carrier Ethernet Switches
  - Bridging / MAC-based forwarding
  - VLAN switching (without MAC learning)
- MPLS Switches
  - Pseudo wire Services
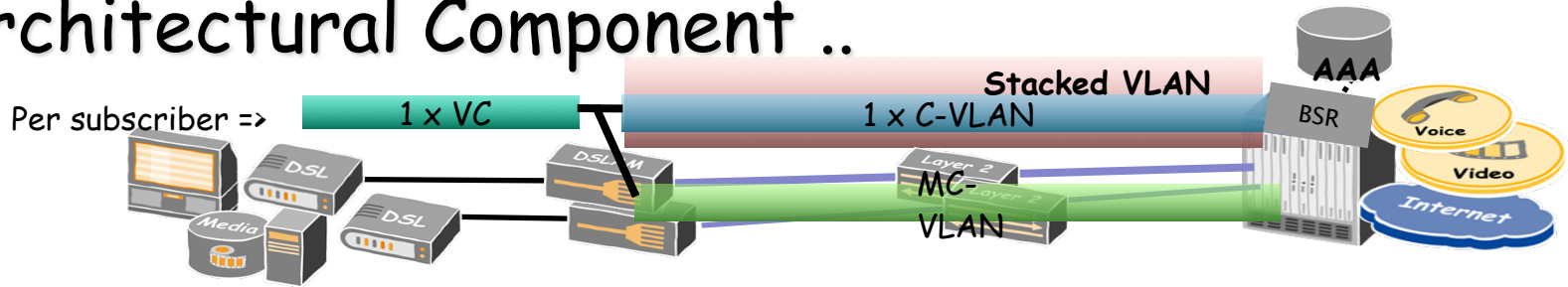 - Point-to-Multipoint LSPs
  - Virtual Private LAN Services

(*) Only applies to single edge BSR architecture

Agenda

- Multi-Play Broadband Architecture Concept

- **Multi-Play Broadband Requirements**

- Summary

BSR Architectural Component ..

Per subscriber => 1 x VC   Stacked VLAN   AAA
1 x C-VLAN   BSR   Voice
Video
Layer 2   MC-VLAN   Internet

Operational simplicity	Provisioning & Operations Toolkit
Quality of experience	QoS and Policy Toolkit
Network & Service security	Security Toolkit
Service availability	Redundancy Toolkit
Network efficiency	Multicast Toolkit

Provisioning & Operations Toolkit

Network provisioning between CPE and BSR

- Based on mass pre-provisioning using standard EMS tools
- Is about connectivity, not about services
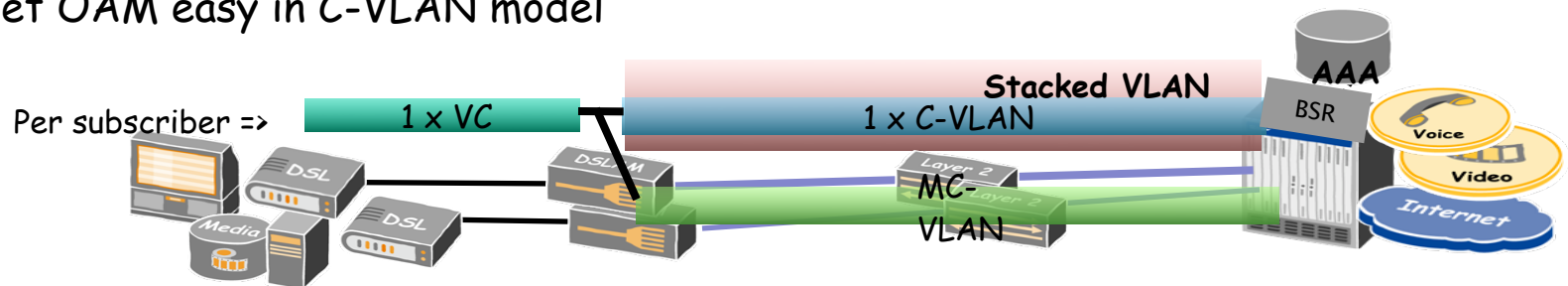- No need for expensive integrated e2e NMS

TR–68, TR–69

Service provisioning on the BSR

- Auto-sensing VLAN / DHCP / PPPoE
- Single SDP for 'subscriber-centric' service provisioning
- Using standard broadband provisioning tools (Radius, Policy Engine)

Operations

- Single SDP eases operational procedures for troubleshooting
- Troubleshooting starts from perspective of subscriber, not service
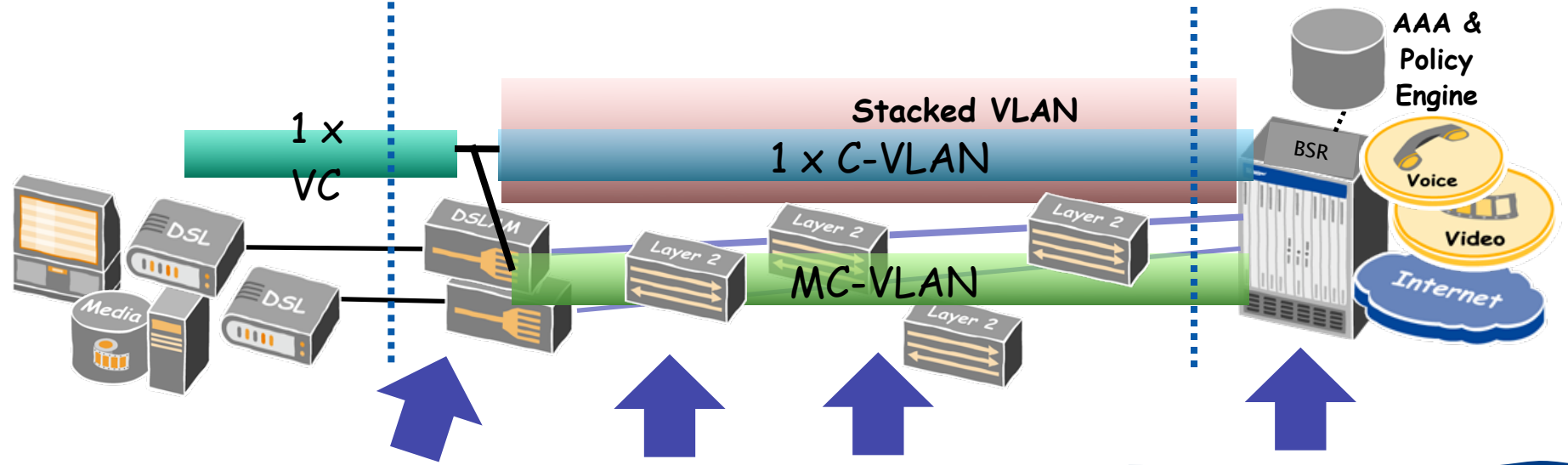- Ethernet OAM easy in C-VLAN model

Per subscriber =>

1 x VC

Stacked VLAN
1 x C-VLAN

AAA

BSR

Voice

Video

Internet

MC-VLAN

DSL

DSL

Media

DSLAM

Layer 2

Layer 2

End-to-end provisioning

Service Provisioning

Non service-aware provisioning Connectivity only

Service Provisioning

AAA & Policy Engine

Stacked VLAN
1 x C-VLAN

1 x VC

BSR

Voice

Video

Internet

MC-VLAN

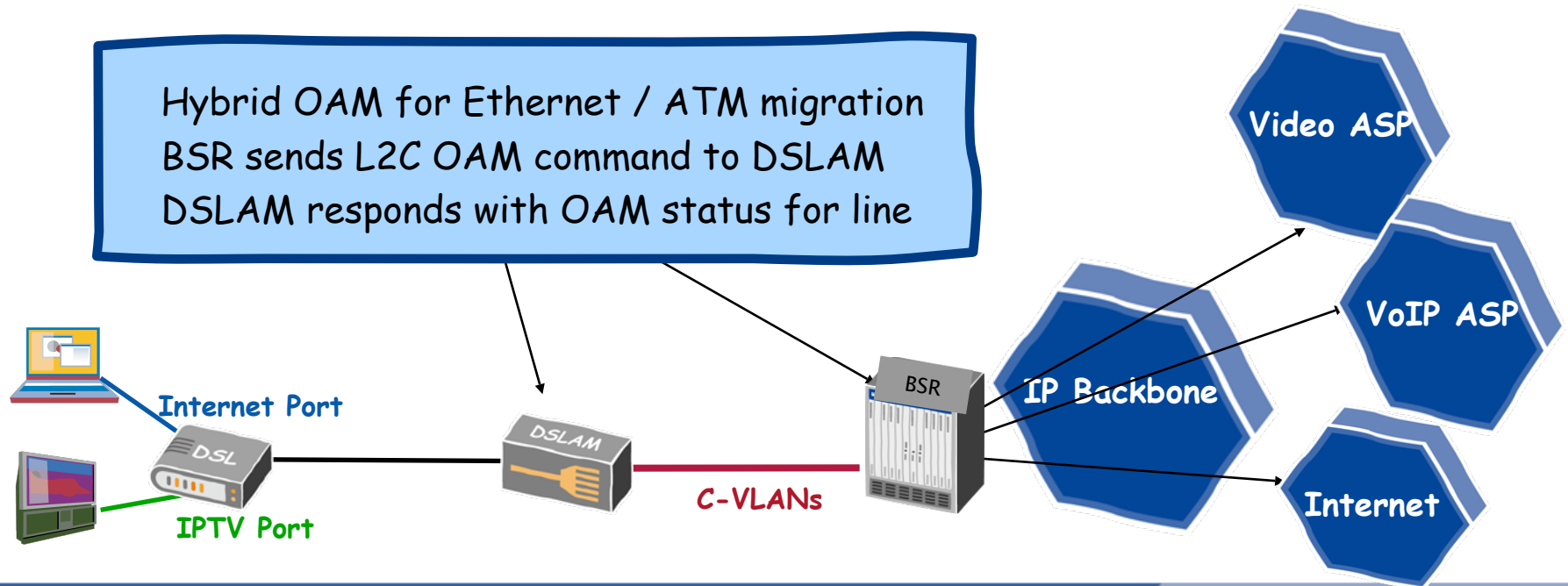Template configuring ATM-VC to C-VLAN cross-connections (can be done when DSLAM gets commissioned)

Configure L2 backhaul for S-VLANs between DSLAM and BSR (can be done when DSLAM gets commissioned)
… or use L1 backhaul

Auto-configuration of VLANs
Auto-detection of sessions (PPPoE or DHCP)
Auto-provisioning of sessions (Radius, Policy Engine)

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L2C to automate provisioning and operations
L2C OAM use case

- Lightweight protocol between access node and BSR
- All major DSLAM vendors working on implementation

Hybrid OAM for Ethernet / ATM migration
BSR sends L2C OAM command to DSLAM
DSLAM responds with OAM status for line

Internet Port

IPTV Port

DSL

DSLAM

C-VLANs

BSR

IP Backbone

Video ASP

VoIP ASP

Internet

QoS and Policy Toolkit

DSLAM
- DSL line should not experience congestion thanks to BSR per-subscriber QoS (no need for multi-VC)
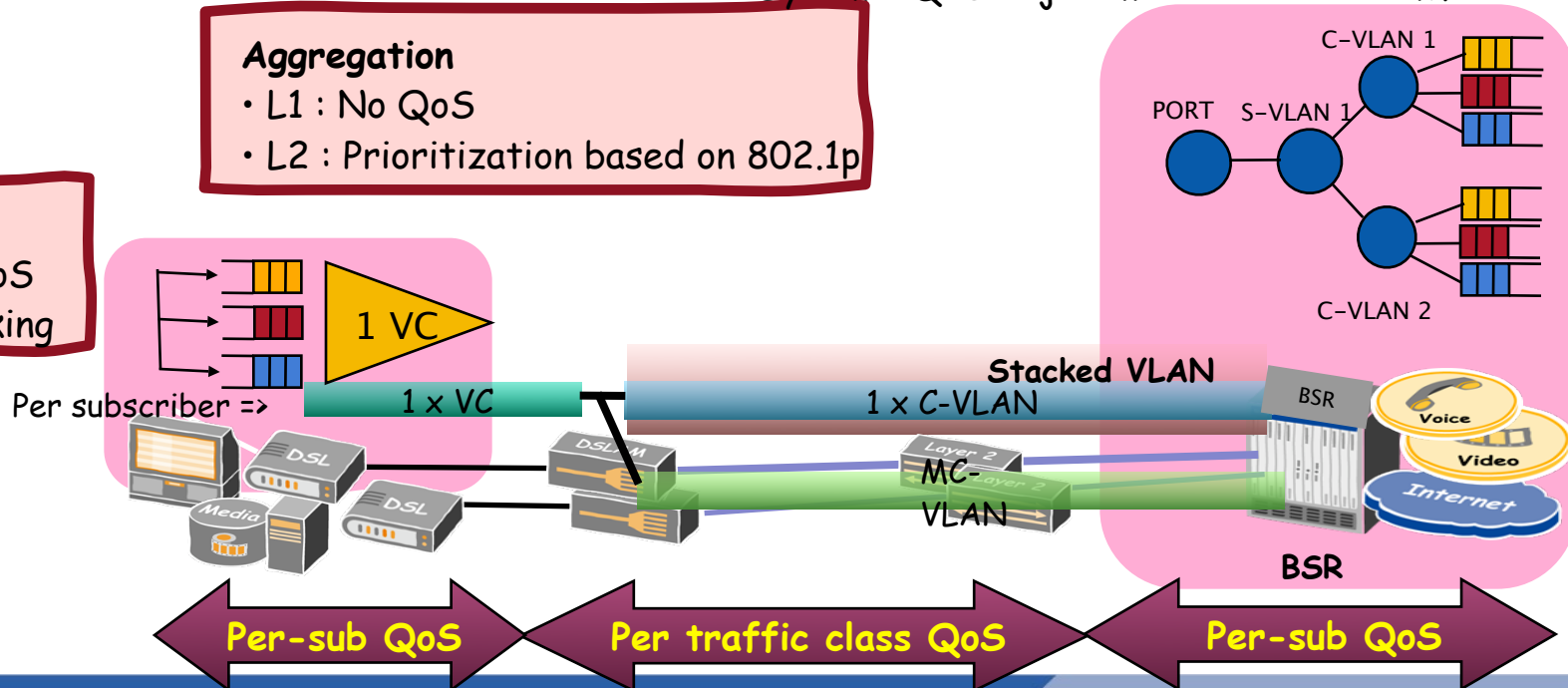- 802.1p / IP TOS-DSCP (re)marking

BSR
- Per-subscriber per service QoS
- Per-subscriber advanced packet processing
- Multi-level hierarchical scheduling
- Shared shaping in oversubscribed networks
- Shape C-VLAN to DSL line speed (L2C RAM)
- Marking 802.1p / IP TOS
- Dynamic QoS adjustment based on IGMP

Aggregation
- L1 : No QoS
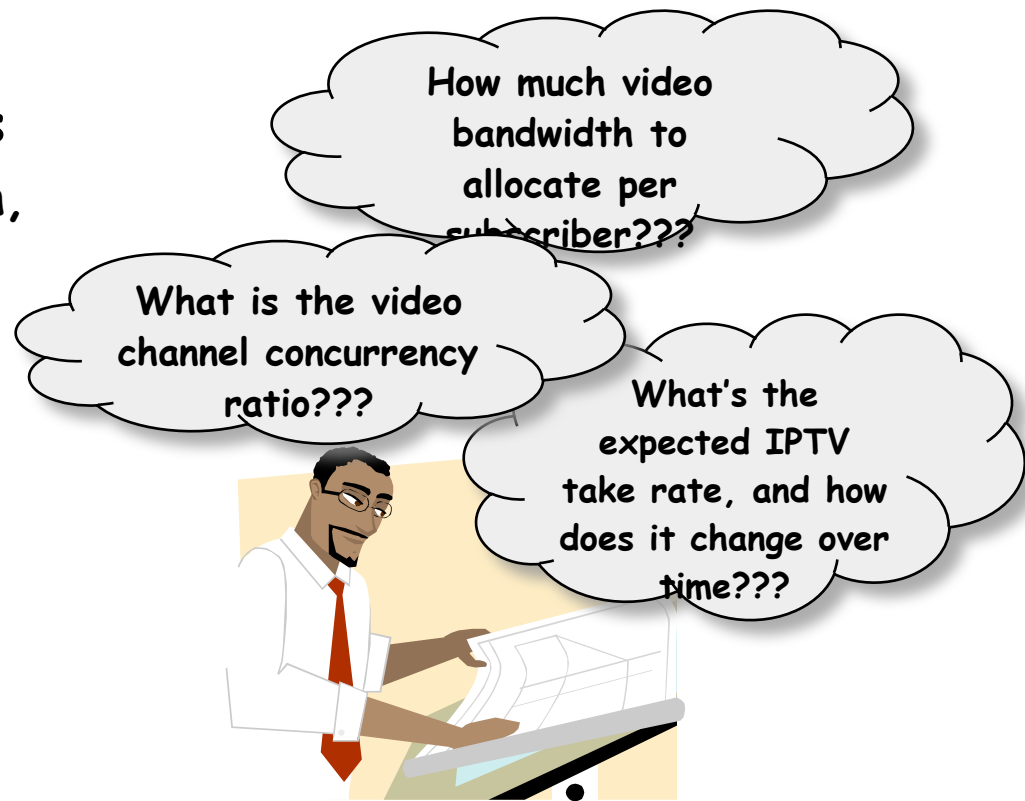- L2 : Prioritization based on 802.1p

CPE
- Upstream QoS
- IP TOS marking

C-VLAN 1

PORT   S-VLAN 1

C-VLAN 2

1 VC

Per subscriber =>

Stacked VLAN
1 x C-VLAN

1 x VC

BSR

MC-VLAN

Voice

Video

Internet

BSR

Per-sub QoS   **Per traffic class QoS**   **Per-sub QoS**

Multi-Play Challenges

- **Diverse Delivery Requirements**
  - **VOIP needs minimal bandwidth, but requires priority handling to minimize delay and jitter**
  - **IP Video requires high bandwidth with low loss**
- **Carve outs are inefficient**
- **Forecasting is inaccurate**

How much video bandwidth to allocate per subscriber???

What is the video channel concurrency ratio???

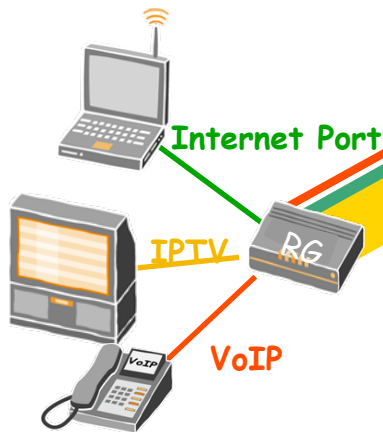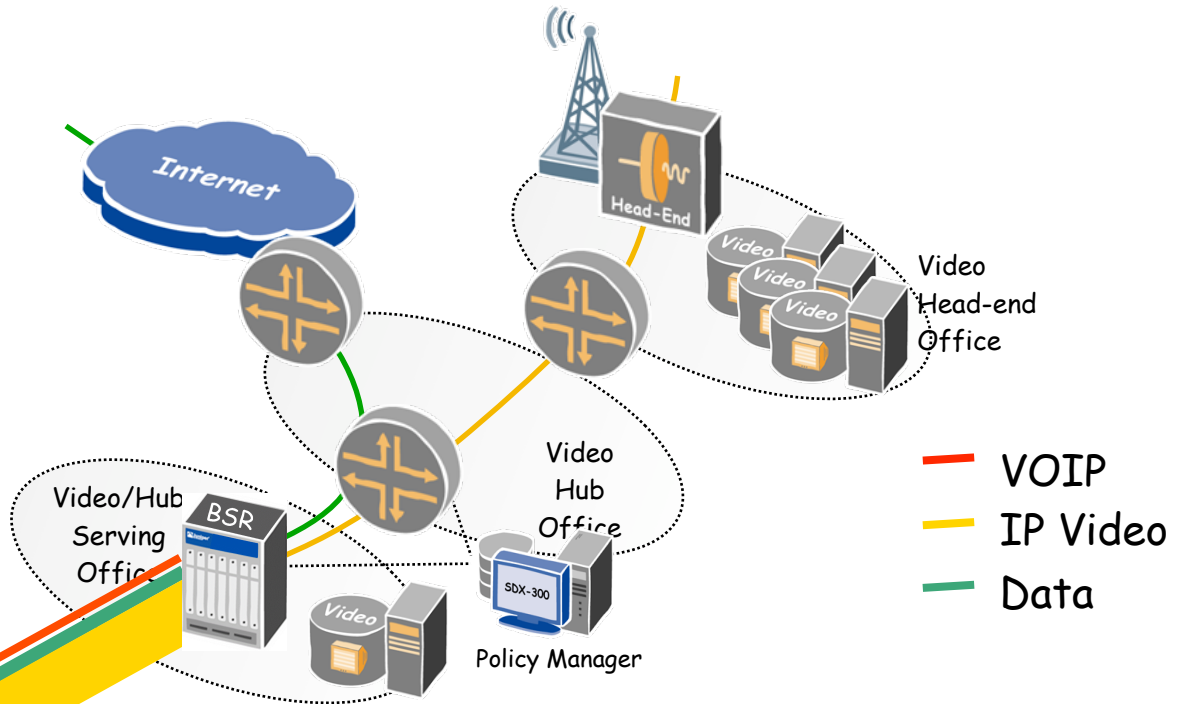What's the expected IPTV take rate, and how does it change over time???

Service Providers are challenged to accurately forecast new triple play service acceptance, making design decisions difficult

Solution: Dynamic Bandwidth Allocation
Bandwidth, Where and When it's Needed

Upon IPTV activation – Broadband Services Router adjusts BW to ensure IPTV QoE, Voice / Data allocated remaining bandwidth
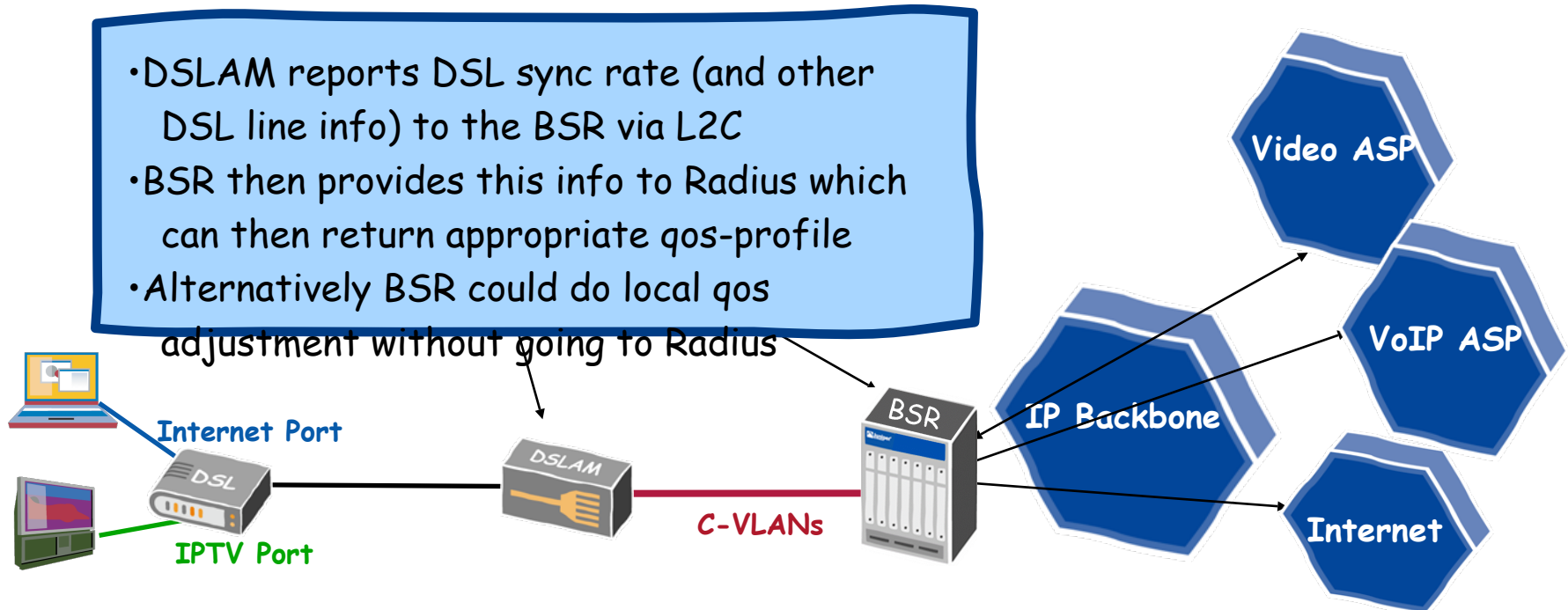
Be
or
al

Internet

Head-End

Video Head-end Office

Video Hub Office

Video/Hub Serving Office

BSR

Video

SDX-300

Policy Manager

— VOIP
— IP Video
— Data

Internet Port

IPTV

RG

VoIP

Customer VLAN shaped to 10Mbps service

Subscriber Benefits
- Full access to all available bandwidth
- QoS for all services

Provider Benefits:
- Eliminates need to statically partition bandwidth per service
- Minimizes planning and provisioning associated with rollout of IPTV

L2C to automate provisioning and operations
L2C Rate Adaptive Mode (RAM) use case

- How to copy the DSL sync rate to the C-VLAN shaping rate ?

- DSLAM reports DSL sync rate (and other DSL line info) to the BSR via L2C
- BSR then provides this info to Radius which can then return appropriate qos-profile
- Alternatively BSR could do local qos adjustment without going to Radius

Internet Port

IPTV Port

DSL

DSLAM

C-VLANs

BSR

IP Backbone

Video ASP

VoIP ASP
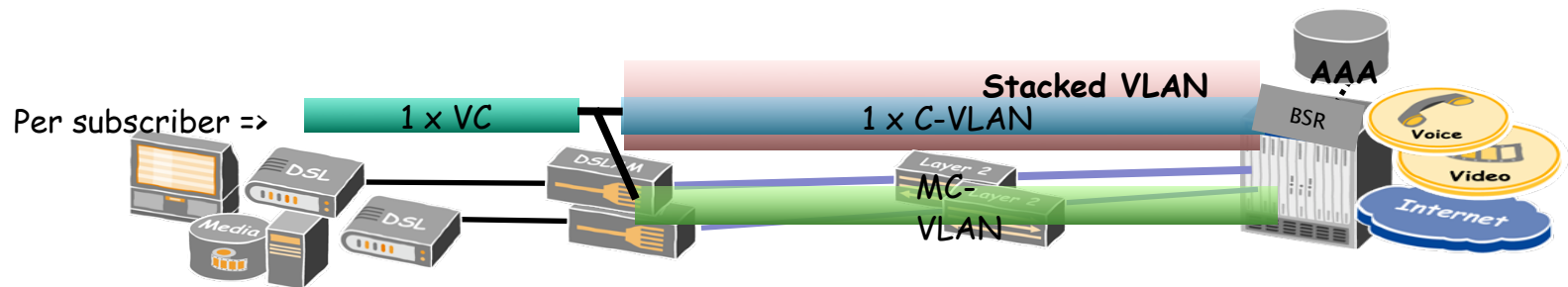
Internet

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Security Toolkit

C-VLAN backhaul to BSR (using CVLAN switching or MPLS PWE) addresses:

- No MAC learning required
- Broadcast domain restricted per user
- No user-to-user communication
- MAC spoofing (MAC table corruption)
- IP spoofing
- ARP tampering
- Theft of service
- PPPoE / DHCP DOS attacks

BSR security at single enforcement point (SDP)

- Simplicity
- No need for proprietary security mechanisms
- No out-of-sync issues
- Central manageability
- Lawful interception (Radius controlled)

Per subscriber =>   1 x VC   Stacked VLAN   1 x C-VLAN   AAA

DSL   DSLAM   Layer 2   MC-VLAN   BSR   Voice   Video

Media   DSL   Internet

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Redundancy Toolkit

Increasing availability in the platform, eliminating ANY single point of failure :

- Stateful Switch Over
- Switch Fabric redundancy
- Line module redundancy
- Port redundancy
- In Service Software Upgrade

Increasing availability in the network

- Protocol Graceful restart
- MPLS FRR
- VRRP

Per subscriber =>   1 x VC

Stacked VLAN
1 x C-VLAN

AAA
BSR
Voice
Video
Internet
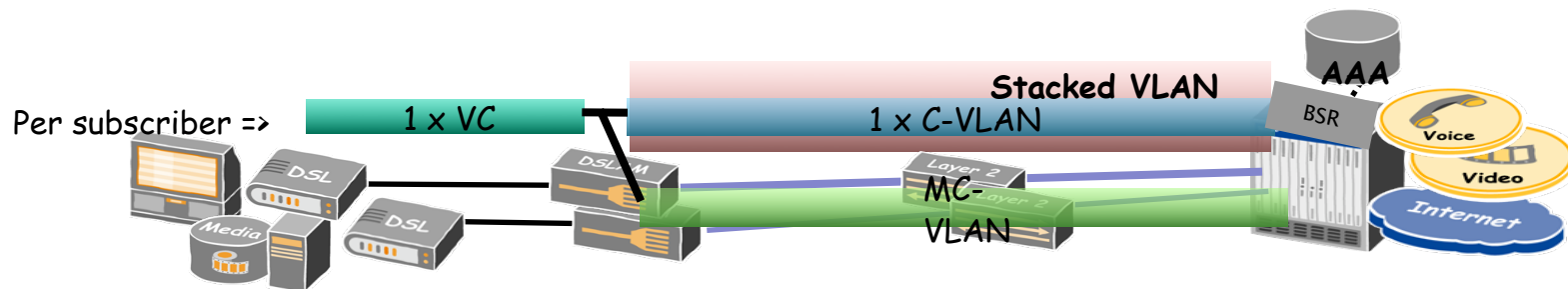
MC-VLAN
Layer 2

Multicast Toolkit
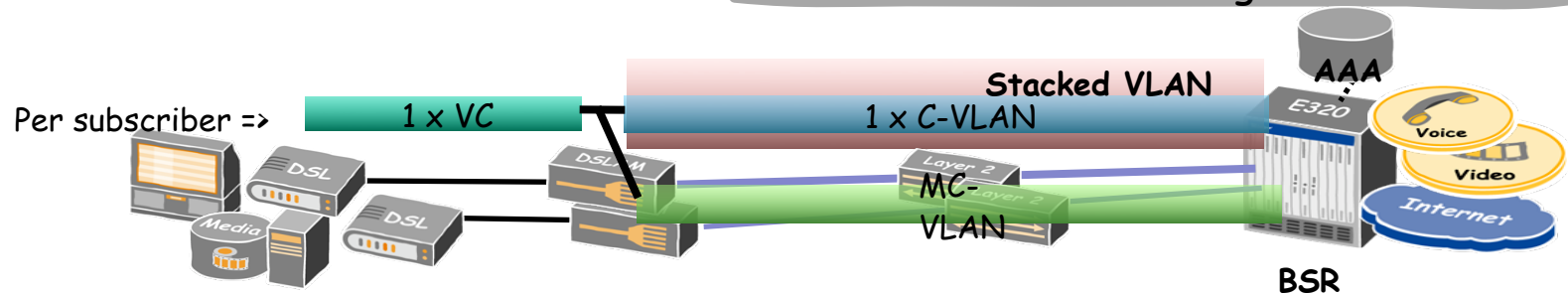
Best-in-class multicast routing protocols

- IGMPv2, IGMPv3
- PIMv2 SM, DM, SM-DM
- DVMRP, M-BGP
- SSM mapping
- MC optimization in software
- MC join state dynamically adjusts
  C-VLAN shaping rate

Scaling and Availability

- IGMP scaling
- MC redundancy solutions in access
  layer based on PIM-SM

Multicast Control & Tracking

- Per-subscriber IGMP statistics
- Control MC bandwidth utilization
- Prevent subscriber-originated MC traffic

Per subscriber =>

1 x VC

Stacked VLAN
1 x C-VLAN

AAA

E320

DSL

DSLAM

Layer 2

MC-
VLAN

Voice

Video

Internet

BSR

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Layer 2 backhaul
Multicast optimization in access network

- Optimization 1 : IP edge (BSR) should not send unnecessary channels into the ethernet aggregation network

  Desirable

  - BSR receives IGMP joins from subscribers across the entire metro aggregration area that is managed by that BSR

- Optimization 2 : further optimize/filter channels on a per CO/DSLAM basis

  Optional

  - IGMP snooping in aggregation switches

- Optimization 3 : only replicate requested channels to end user

  Required

  - DSLAM does IGMP snooping (or proxy)

Agenda

- **Multi-Play Broadband Architecture Concept**

- **Multi-Play Broadband Requirements**

- **Summary**

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Summary of BSR architecture for IPTV

- Addresses the key requirements to facilitate rapid broadband service deployments over ethernet based access networks
  - Subscriber & service provisioning + Operations
  - Security
  - QoS and Policy
  - Redundancy & Availability
  - Multicast Optimized
- Service-independent infrastructure allowing to move beyond the traditional triple play service offering
- Access-independent infrastructure allowing to move beyond ADSL (to VDSL, PON, Wimax, etc.)
- A A TCO-optimized solution (taking both CAPEX and OPEX into account)

Thank You