

UKNOF: Broadband Forum Overview with Focus on Next Generation Access

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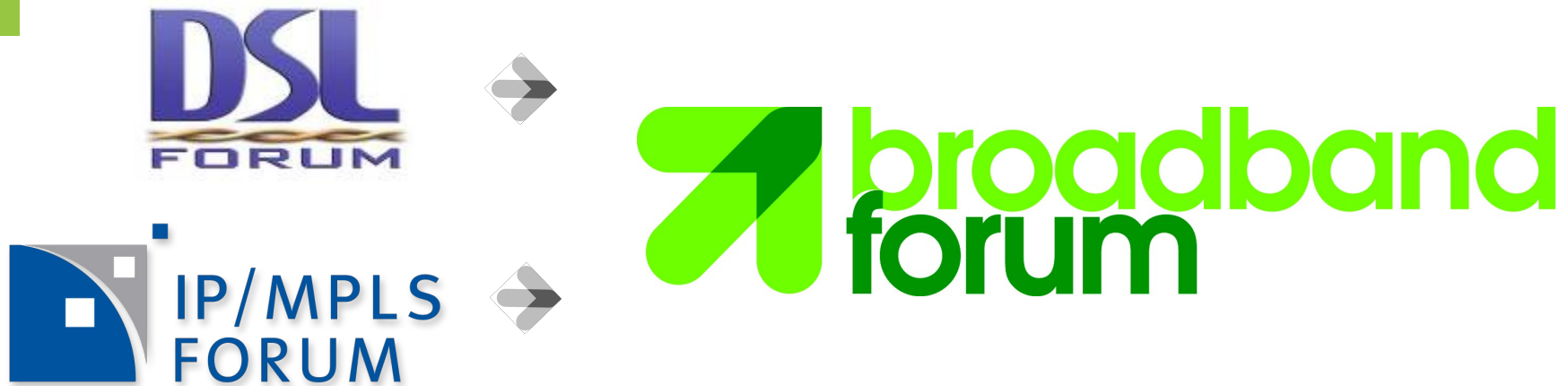
September 11th 2009



OVERVIEW

- **Broadband Forum Overview**
- Drivers & Requirements for Next Gen Access
- BBF Ethernet Architecture – TR-101 & TR-156
- NGA CPE – Management & Interop/Testing
- BBF Specifications – NGA Summary & Roadmap

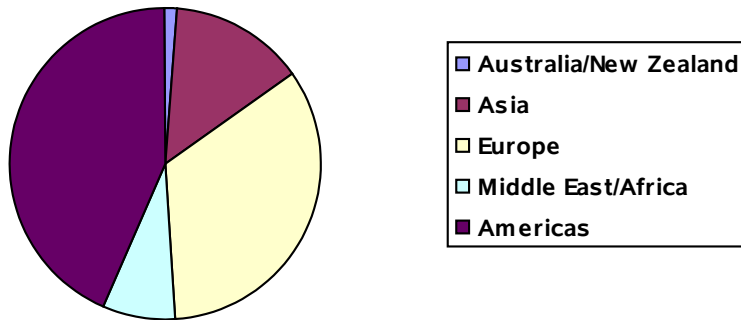
The Broadband Forum



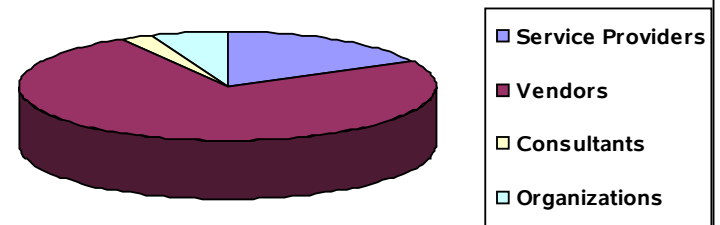
- The Broadband Forum mission is to develop the full potential of broadband.
- We develop multi-service broadband packet networking specifications addressing interoperability, architecture and management.

Who is in the Broadband Forum?

Regional Membership



Industry Segment Breakdown



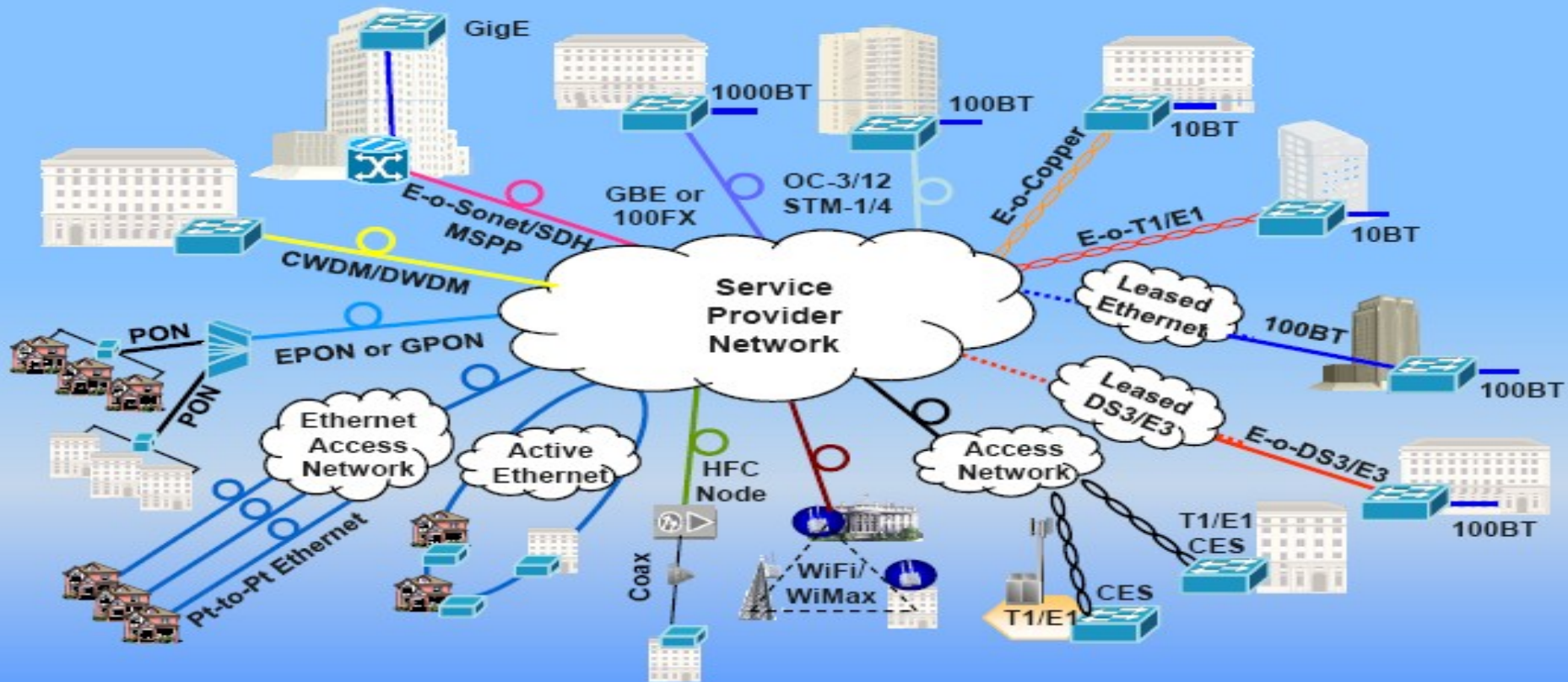
- 205 members (Dec 2008): Global membership- every region represented
 - Service Providers: Incumbent Telcos, CLECs, ISPs, consultants
 - Vendors: Systems, chip-sets, test equipment, management software ...
 - Others: Test labs, universities, regulators
- Active Service Provider Action Council
- Committed to developing real world solutions for today's broadband service providers' requirements
 - Release Program
 - Surveys and membership polls for specific requirements

BroadbandSuite™ Scope

OVERVIEW

- Broadband Forum Overview
- **Drivers & Requirements for Next Gen Access**
- BBF Ethernet Architecture – TR-101 & TR-156
- NGA CPE – Management & Interop/Testing
- BBF Specifications – NGA Summary & Roadmap

The Access Challenge: Reduce Options & Costs, Increase Speed



Source: Stan Hubbard, Heavy Reading, Ethernet Expo Europe May 20

Focus on Ethernet as the “Base Currency” for Access Interconnects (NNIs)

Physical Interconnect will increasingly be 1G or 10Gbit/s Ethernet

Support IP, MPLS or L2TP for more scalable aggregated interconnects, traffic engineering

Next Generation Access (NGA) Evolution

- Cost-effective Bandwidth & Transport Infrastructure Scaling
- Faster Interconnects (1 Gbit/s & 10 Gbit/s) at NNI
- Increasing use of Fibre to Increase Speed & Reduce Opex Compared to Copper
- Easy to Integrate with Modern 'Ethernet' DSL Architectures



- Passive Line Access (duct, fibre, wavelength unbundling)
 - Outside the scope of current Broadband Forum work)
- Active Line Access (ALA) - Based Around Ethernet

Key Requirements for Wholesale Access to Next Generation Broadband

- **Functionality:**
 - QoS, security, multicast, flexible CPE & interconnect
 - Management & diagnostics capabilities across the NNI to CPE
- **Integration:**
 - Leverage existing broadband platforms, systems & processes as much as possible (for both residential and business applications)
- **Standardisation:**
 - Multiple entities will build Next Generation Access infrastructure in different geographies (localised infrastructure monopoly)
 - Commonality of network technology and architecture reduces integration costs for service providers to get national coverage
- **Differentiation:**
 - Need scope for differentiation & competition at retail level
 - Hence layer 2 Ethernet approach of ALA – transparent to IP layer
- **Future Proof:**
 - Be able to evolve to accommodate IPv6, WDM PON etc

OVERVIEW

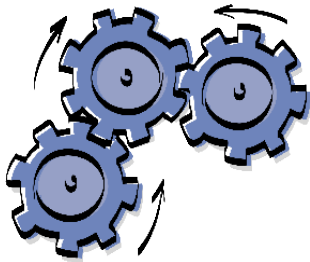
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Broadband Architecture

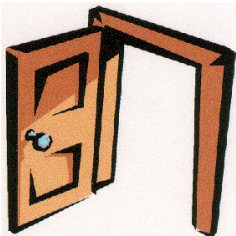
Why Standardize the Architecture?



Shape **broadband evolution** according to the views and needs of all players involved

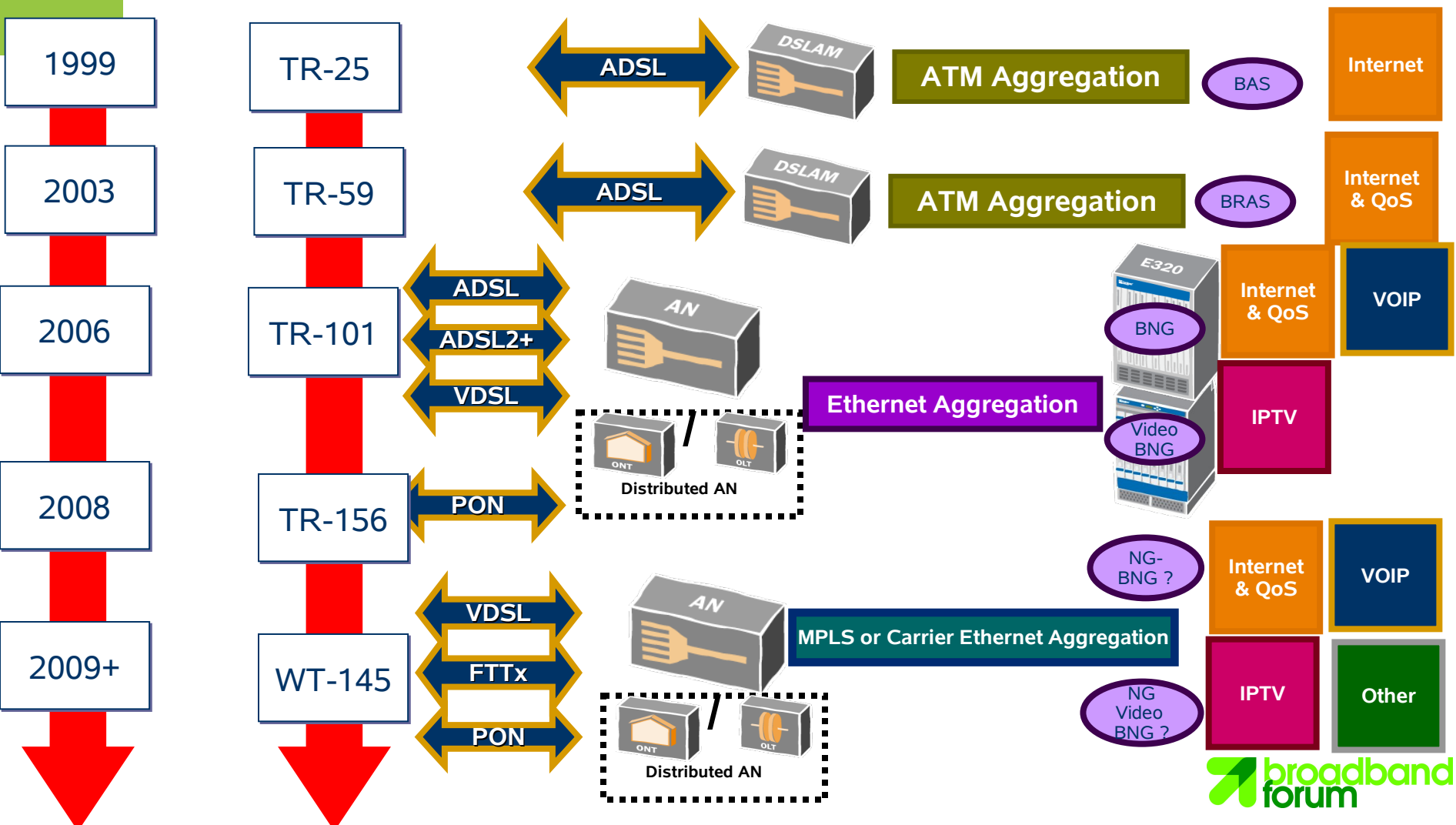


Enable regional and global **interoperability** of network equipment



An **open access architecture** is crucial for the easy adoption of new services such as HD IPTV

Access and Network Evolution at the Broadband Forum



Broadband Forum TR-101: Next Generation Broadband Architecture

NSP – Network Service Provider
ASP – Application Service Provider

- Blue print for QoS and Multicast in Ethernet architecture
- Support for business services and higher access speeds

Wholesale Access within Broadband Forum TR-101

Wholesale Access:
L2TP, IP-QoS & Ethernet



Broadband Forum TR-101 Key Features

- **Protocol adaptation functions** for legacy services
 - PPPoA to PPPoE
 - IPoA to IPoE
- **Security features** in the Access Node
 - Protect against MAC address spoofing & DoS attacks
 - Protect against broadcast / multicast storms
 - ARP processing and IP spoofing prevention
- **Access Loop Identification and Characterization**
 - PPPoE and DHCP extensions to communicate the DSL loop status, syncrate and encapsulation to the BNG
- **End-to-end Ethernet OAM model for broadband access**
 - Based on IEEE 802.1ag and ITU-T Rec. Y.1731

Broadband Forum TR-101

Multicast Architecture

- **N:1 VLAN** structure **for delivery of multicast** data
 - “multicast VLAN”
- **IGMPv3** processing for resource efficient IPTV support
 - Proxy routing on the RG
 - Transparent snooping on the Access and Aggregation Nodes
 - Source Specific Multicast support (source IP address matching)
 - IGMP router and PIM/SSM on the BNG
- **Multicast access control** (enabled by TR-101, TR-147 & TR-156)
 - White/black lists per subscriber line
 - Provides an additional level of security
 - Reinforces the channel access control done by IPTV middleware
 - Important to protect content from “channel hacking” and within the home network
- Coordination of access loop state with the BNG(s)
 - Gathering statistics
 - Dynamically adjusting Hierarchical Schedulers in BNG
 - Access loop to Multicast domain mapping within TR-147 is a key capability for wholesale multicast

TR-101 Network Requirements

Access Node



- ATM-Ethernet interworking
- VLAN handling (1:1, N:1)
- Ethernet QoS
- Multicast replication / IGMP snooping

Aggregation switch



- Ethernet/VLAN aggregation
- Ethernet QoS
- Resiliency
- Multicast replication / IGMP snooping

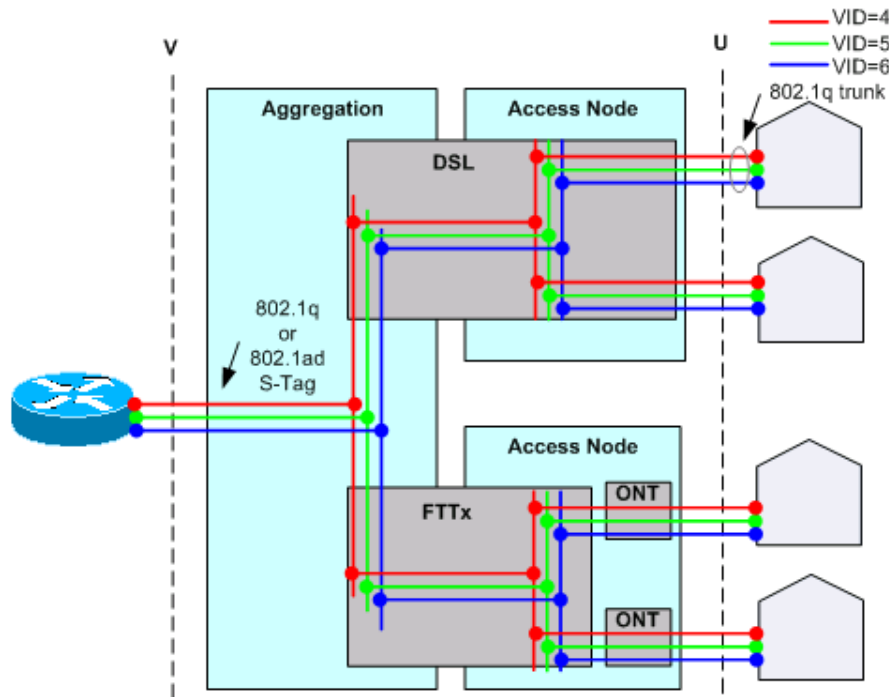
Broadband Network Gateway (BNG)



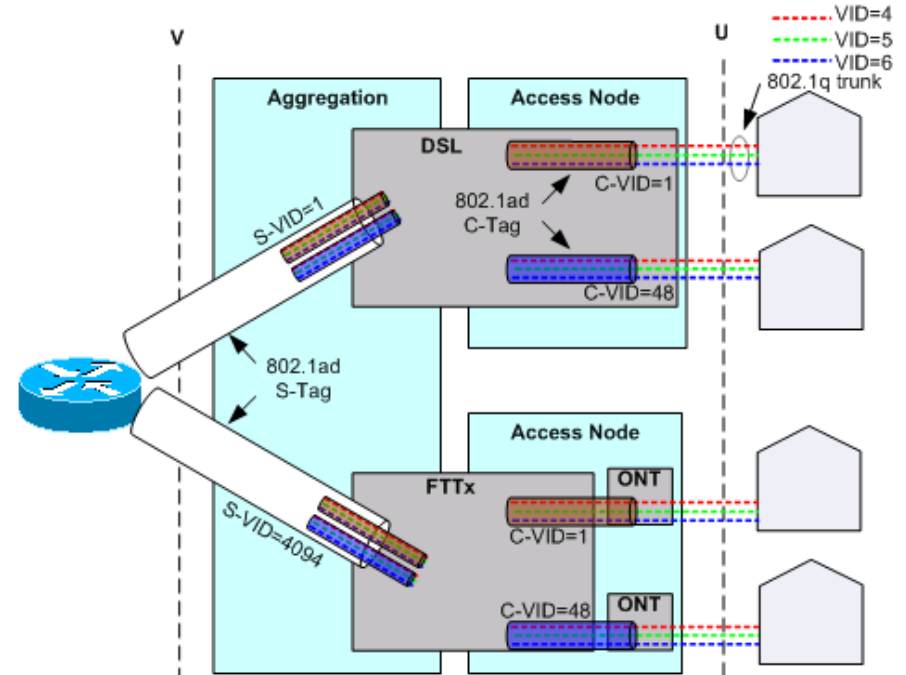
- PPPoE and/or IP/DHCP services
- Bandwidth and IP QoS policy enforcement
- Multicast traffic control

TR-101 Ethernet Aggregation Explored

VLAN Per Service (N:1)



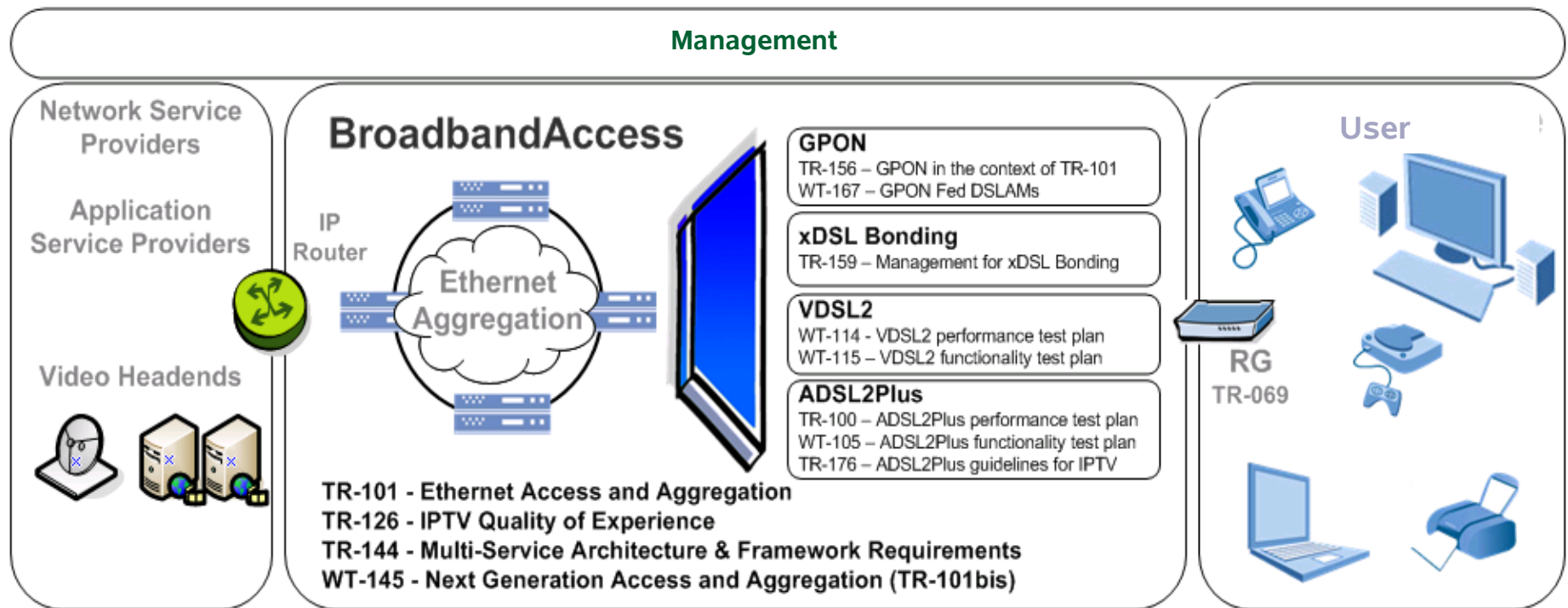
VLAN Per Subscriber (1:1)



Ethernet Aggregation Summary

- VLAN Per Service (N:1)
 - “Virtual Circuits” via Mac Forced Forwarding
 - Simplified provisioning
 - BNG/BRAS Shaping, Policing, etc achieved by Classification on IP Address. DHCP Option-82 facilitates this
- VLAN Per Subscriber
 - Analogous to ATM VPI/VCI
 - “Virtual Circuits” via VLANs
 - BNG/BRAS Shaping, Policing, etc based on C-VID &/or IEEE 802.1p markings
 - Access Node & Aggregation Nodes can use 802.1p for CoS

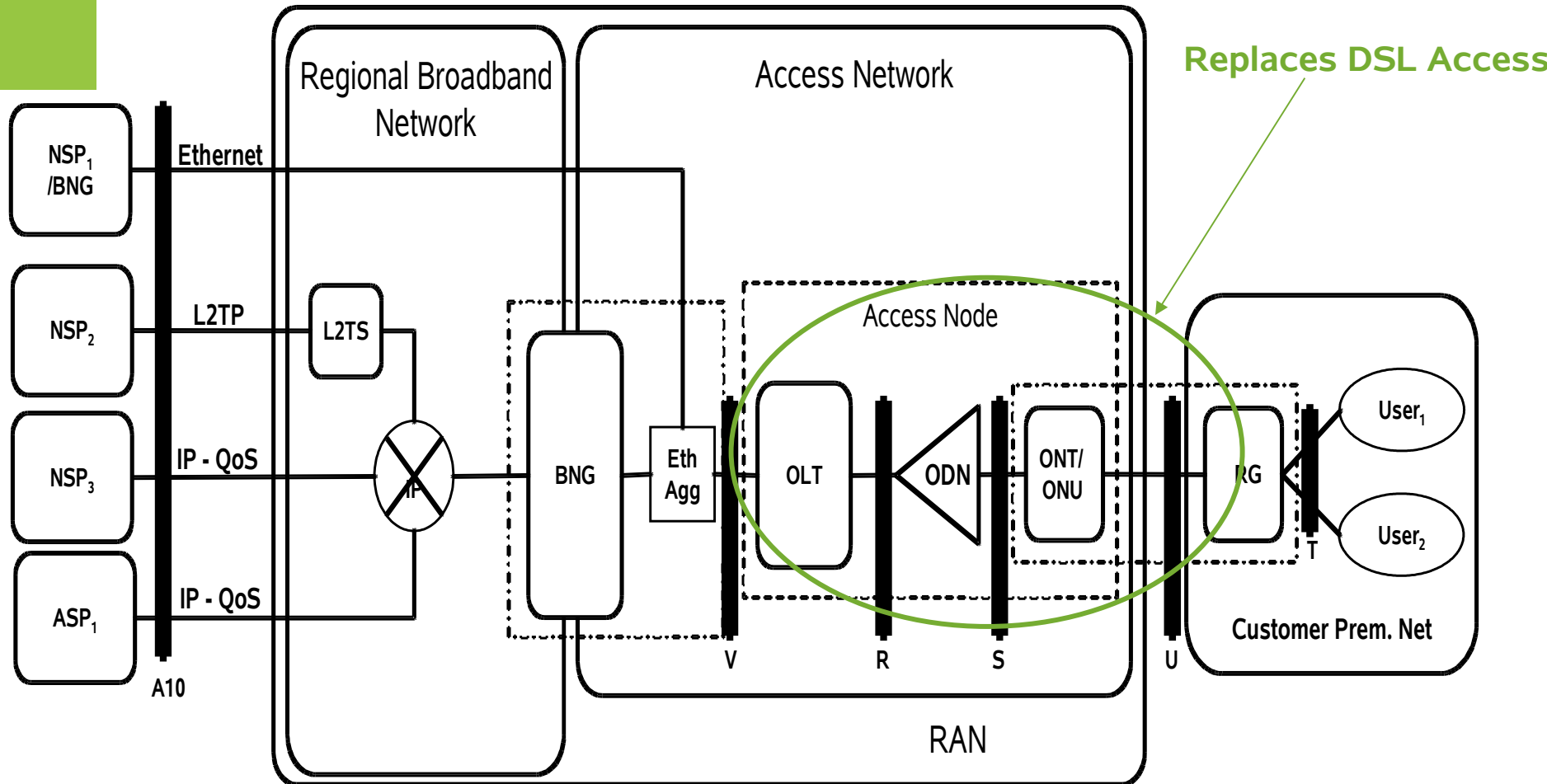
The Broadband Network Architecture must be able to handle all types of access options



Fiber related Broadband Forum architecture specifications

TR-156 extends the IP Ethernet access aggregation in connection to a PON last mile
WT-167 provided the common method for establishing fiber fed DSLAMs

Broadband Forum TR-156 : GPON within TR-101 Ethernet Architecture



TR-101 and TR-156

- TR-101 addresses:
 - Enables E-FTTx (Active/Point-to-Point/EFM)
 - Aggregation, Access Node and RG requirements
 - VLAN Per Service (N:1) and VLAN Per Subscriber(1:1)
 - Multicast support for IPTV
 - Security
- TR-156 Enables GPON to work in a TR-101 network
 - Resolves FSAN/ITU's many GPON constructs to better establish OLT vs ONU responsibilities in support of security, QoS, IPTV and other service oriented capabilities

<http://www.broadband-forum.org/technical/download/TR-101.pdf>

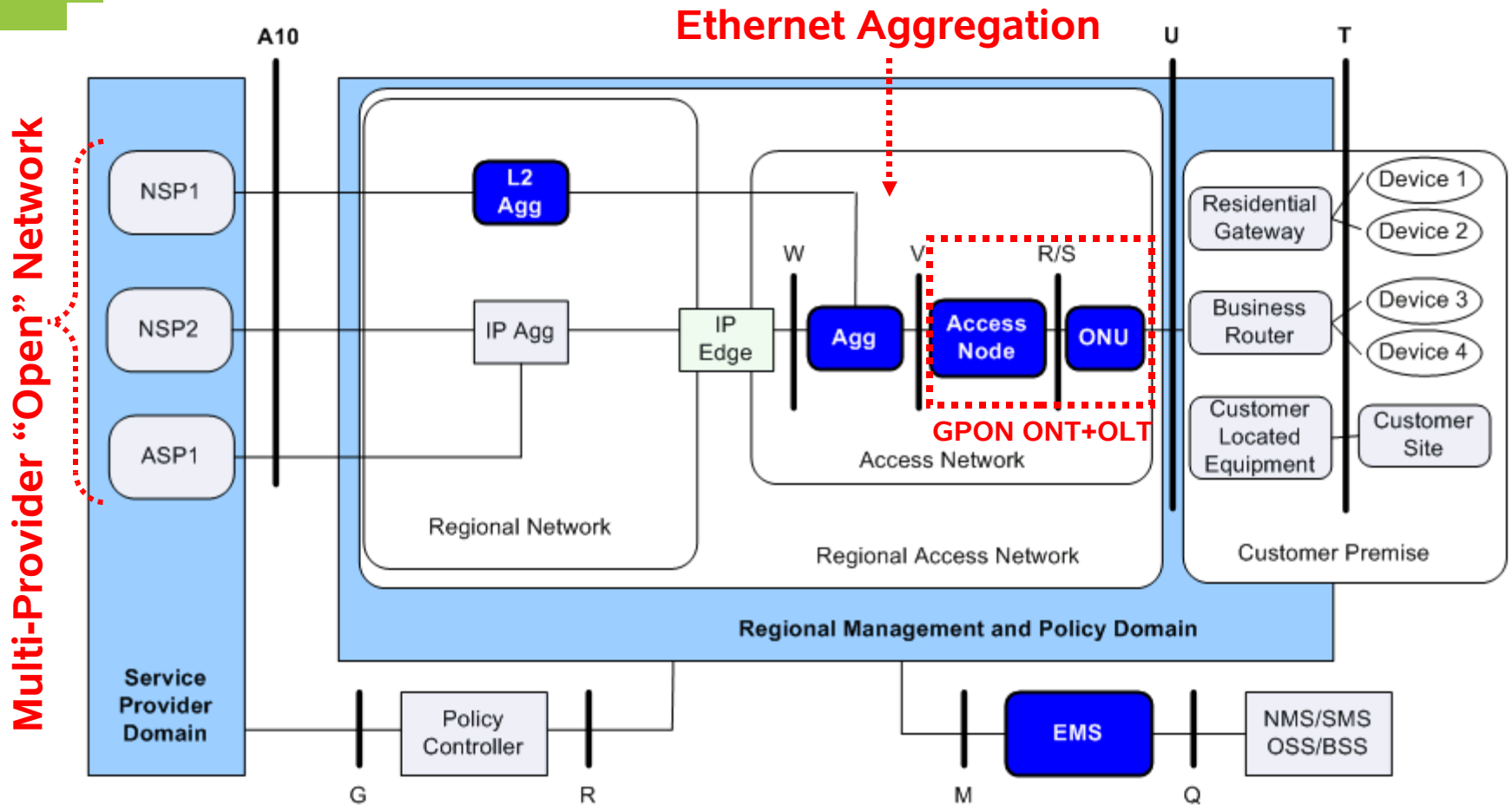
<http://www.broadband-forum.org/technical/download/TR-156.pdf>

Future Evolution Considerations

“SUPER PONS”

- Higher speed e.g. 10Gbit/s & higher, possibly via WDM overlay
- Longer range: 60 -100km
- 1024 or 2048-way split
- More customers per PON, hence resilience is more important
- Even greater bandwidth gains from multicast
- As the path forward is standardized the BBF will evaluate the impact on broadband architectures

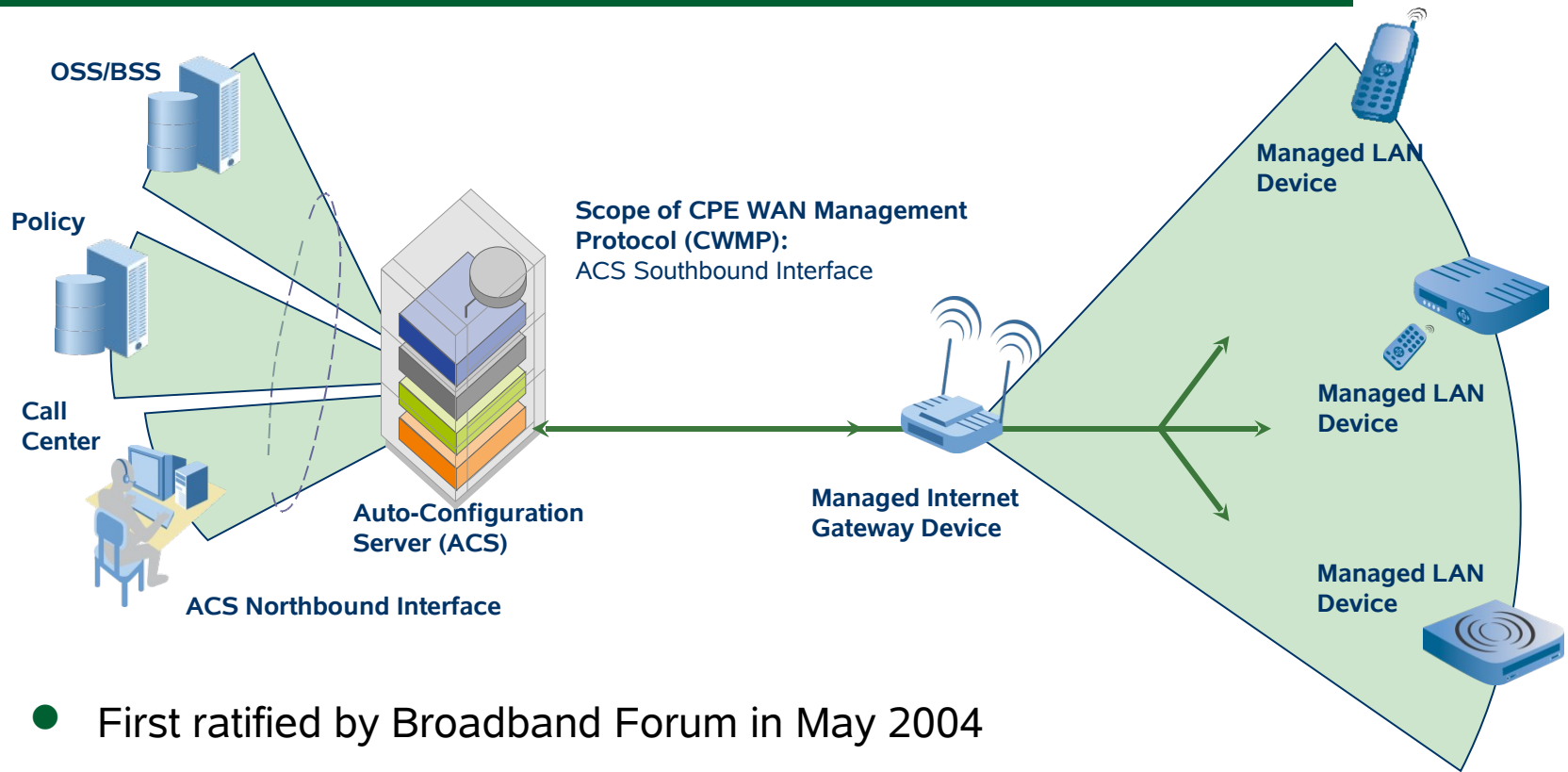
Ethernet Fibre Access Continues in New Multi-Service Architecture Work (WT-145)



OVERVIEW

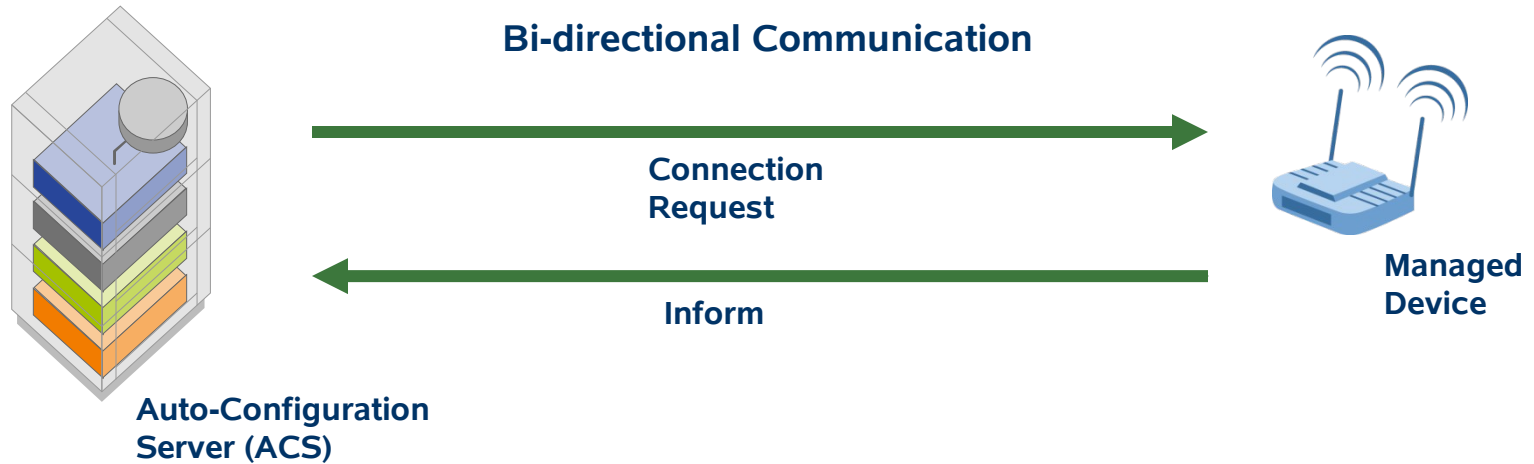
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TR-069 CPE WAN Management Protocol (CWMP) Architectural Framework



- First ratified by Broadband Forum in May 2004
- Management Functions
 - Auto Configuration
 - Service Provisioning
 - Firmware Management
 - Diagnostics
 - Fault and Performance Monitoring

TR-069: CWMP Protocol



ACS Discovery

CWMP Connection Initiation

- Bi-directional SOAP/HTTP-based messaging
- Bootstrap – first connect to network
- Requested by ACS – Scheduled or immediately
- Asynchronous Notifications
 - > Active – as soon as value changes
 - > Passive – report value next inform

Device Control

- Get, Set Parameter Values and Attributes
- Add, Delete Objects
- Reboot, Reset to Factory Defaults
- Initiate Firmware Download
- Initiate diagnostic tests

Broadband Forum TR-069: Supports the entire service lifecycle

Remote CPE troubleshooting

- Improve problem resolution abilities
- Shorten support calls
- Eliminate unnecessary CPE replacement
- Reduce truck rolls
- Enhance current customer support process

Web-based integration

- Service selection
- Customization
- Provisioning
- Eliminates subscriber need to access CPE GUI

support

deploy

install

manage

New service establishment

Remote CPE management

- Automate management of millions of devices
- Firmware upgrades
- Enable new services
- Database of all installed CPE

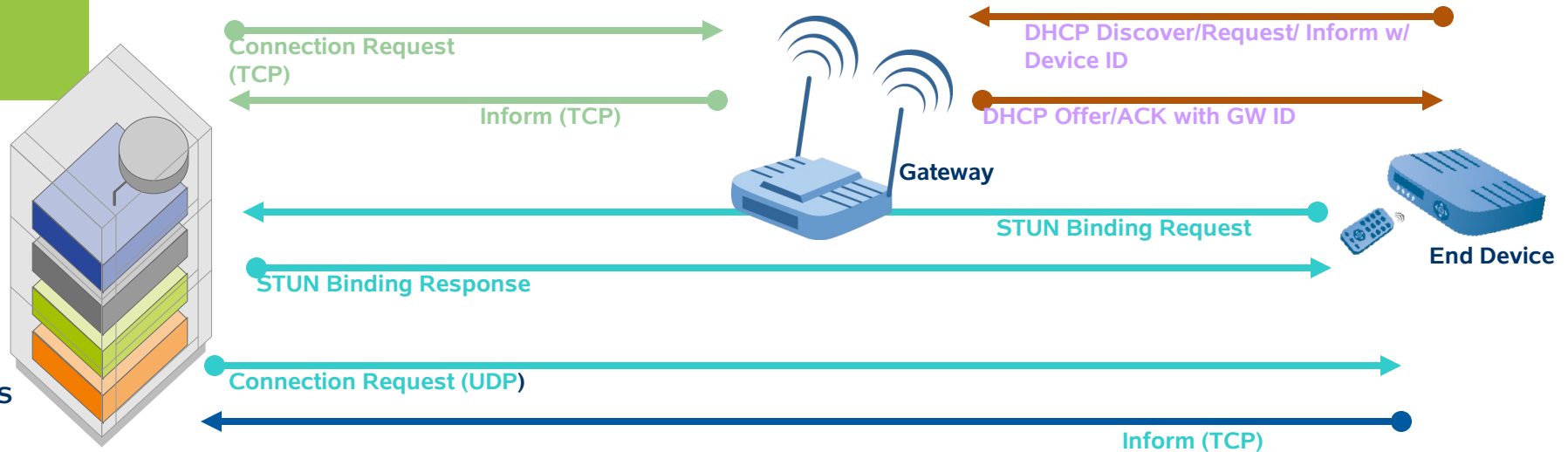
Touch-less installation

- Auto-detection and configuration of CPE
- Automatic firmware downloads
- Download latest revisions of 3rd party software
- No need to modify or maintain CD's

Summary of TR-069 (CWMP) Benefits

- Profitable and seamless service deployment
 - Reduce costs
 - Enable services
 - Improve customer experience
- Higher layer protocol – network (and device) agnostic
- Robust functionality
 - Granular device and service control
 - Flexible, policy-based management
- Well-defined extensibility mechanisms
 - New devices and services
 - Vendor differentiation
- Standard web technologies
 - Scalable
 - Secure
 - Widespread
- Applicable to full range of devices on home network
 - Annexes F (device/gateway association) and G (NAT traversal)

Applying CWMP to Home Network End Device



Device/Gateway Association

- End Device and Gateway exchange DeviceID via DHCP
 - > Independent of device address assignment
- Populate relevant objects in data model
 - > ManagedDevices table in GW
 - > GatewayInfo object in end device
 - > ACS can perform optional cross-check

STUN – Simple Traversal of UDP through NAT (RFC 3489)

NAT traversal for ConnectionRequest

- ACS enables STUN client on device
- Device creates STUN binding with STUN server
 - CPE uses STUN protocol to determine NAT type and public address and communicates to STUN server
 - Uses STUN to maintain UDP binding through NAT gateway
- ACS sends UDP ConnectionRequest to address communicated to STUN server
- CPE responds with TCP Inform

Service Support Use Case with TR-069

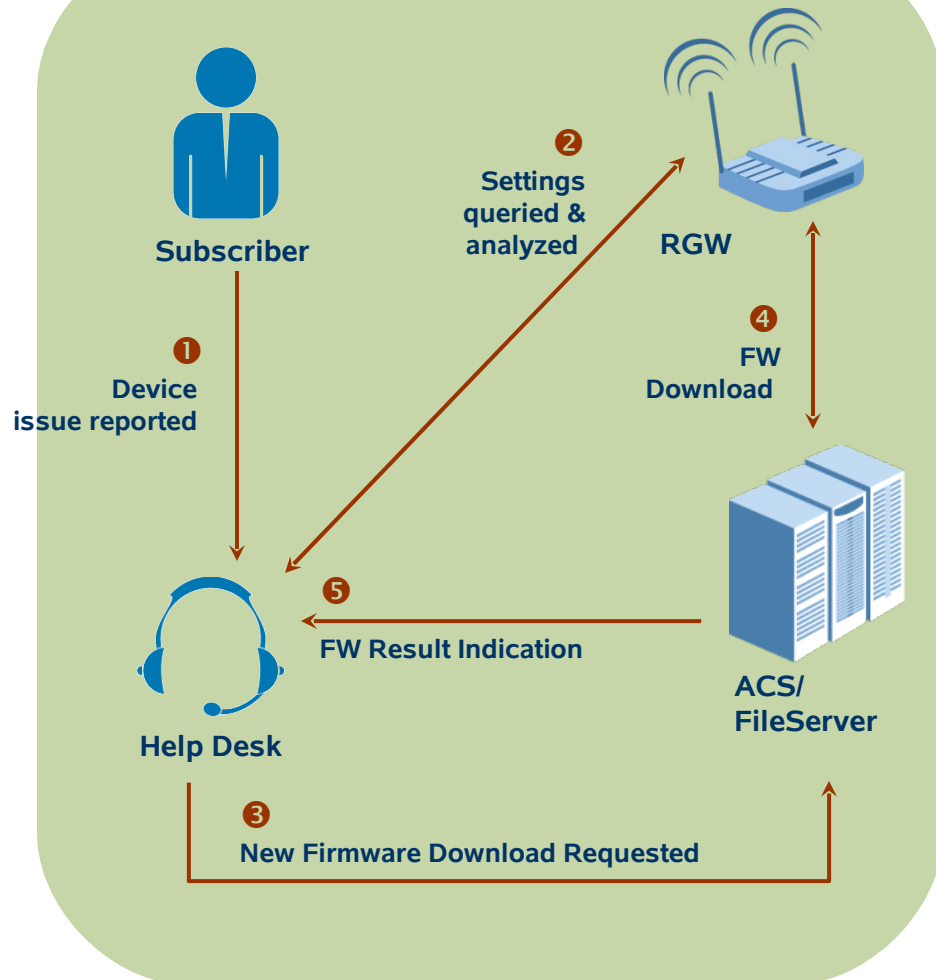
Use Case: Device Troubleshooting

Features

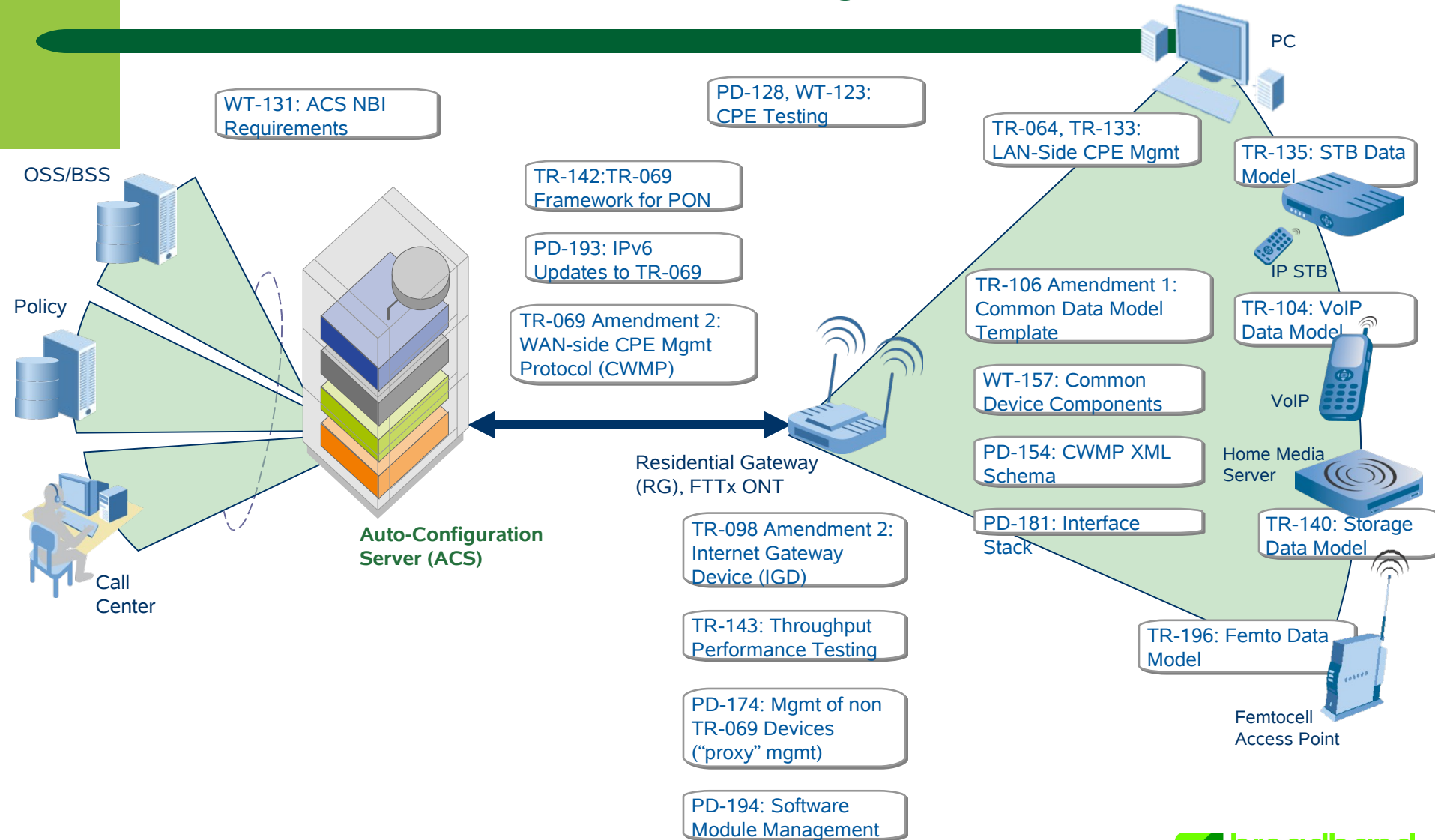
- Subscriber calls Service Provider call center to report device problem
- Through the ACS, CSR can query device settings
 - CSR notes that firmware out of date, contains known bug
 - Requests ACS to initiate file download/upgrade
- RGW reports to ACS when download complete; ACS indicates results to Help Desk
 - ACS could also change configuration settings as appropriate
 - Firmware upgrades could also be managed proactively

Benefits

- Reduces call center escalation costs
- Reduces AHT, increases FCR
- Streamlines CSR processes
- Reduces RMA, equipment upgrade costs
- Enables new device capabilities



BroadbandUser Remote Management Framework



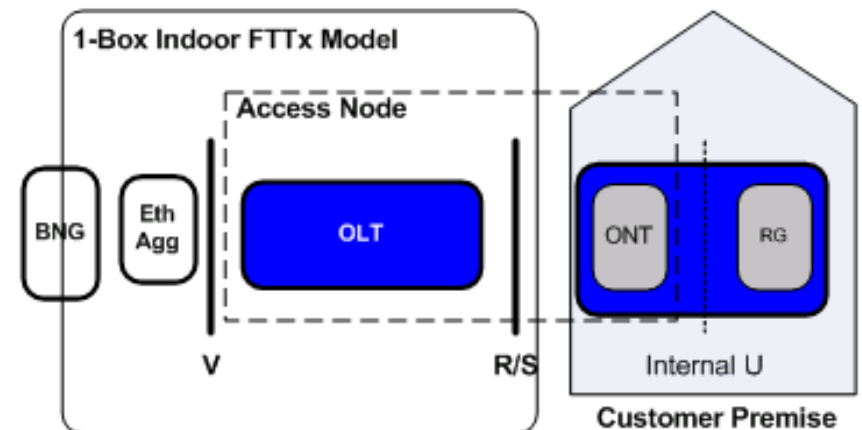
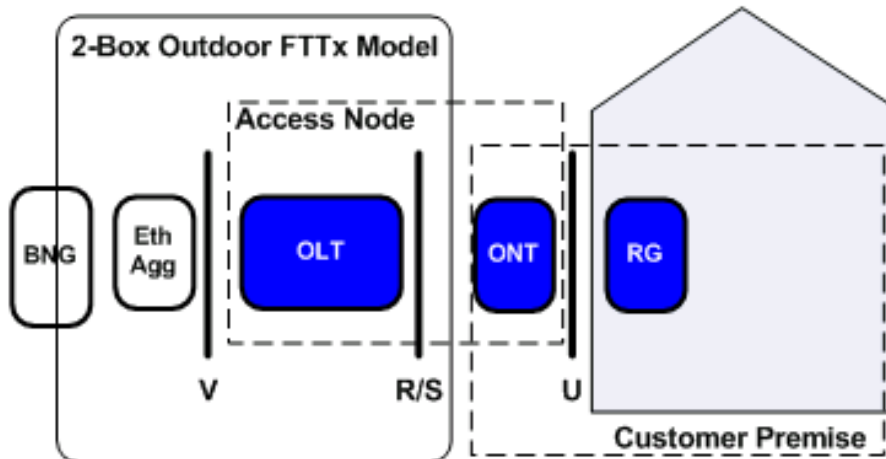
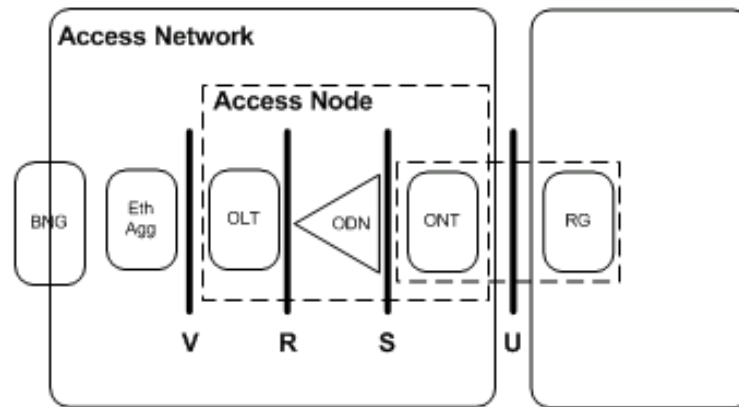
TR-069 Supported Functionality

- Auto-configuration and dynamic service provisioning
 - Initial CPE configuration
 - Re-provisioning at any subsequent time
- Software/firmware image management
 - Version identification
 - File download initiation
 - Notification of the success or failure of a file download
- Status and performance monitoring
 - Log file, and dynamic notification
- Diagnostics
 - Connectivity and service issues

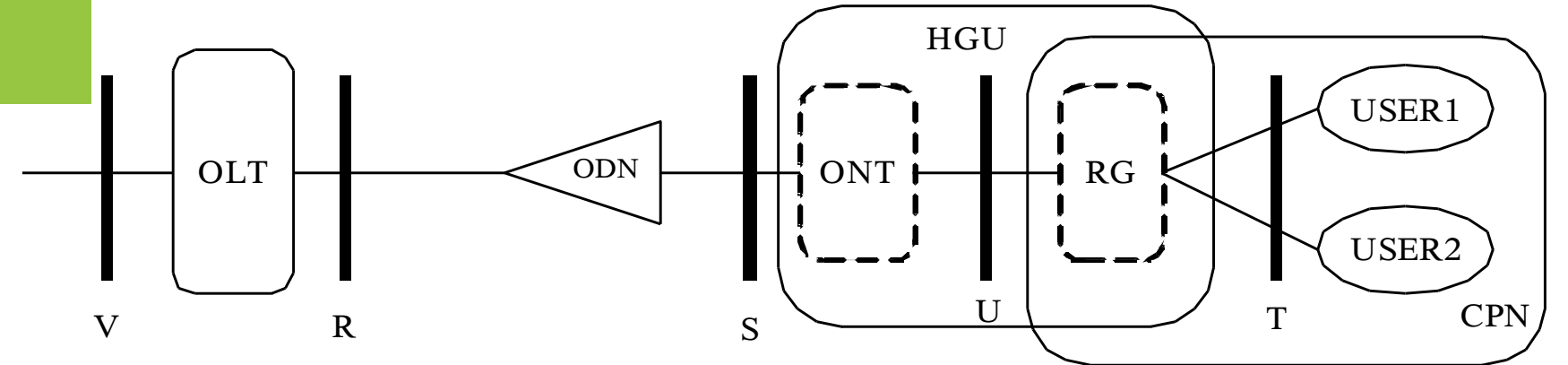
NGA CPE: A Key Domain for Service Differentiation & Branding

- Flexibility for future wholesale “wires-only” approach required (in some countries) so retail service provider can select price/functionality and innovate (has been a key differentiator in many DSL service offerings)
- In future, GPON CPE (ONU/ONT) & VDSL2 CPE could be provided by the retail service provider
- Interoperable, self-installable, plug & play!
- OAM features are key for assurance
- Requires interface & management standards for vendor interoperability

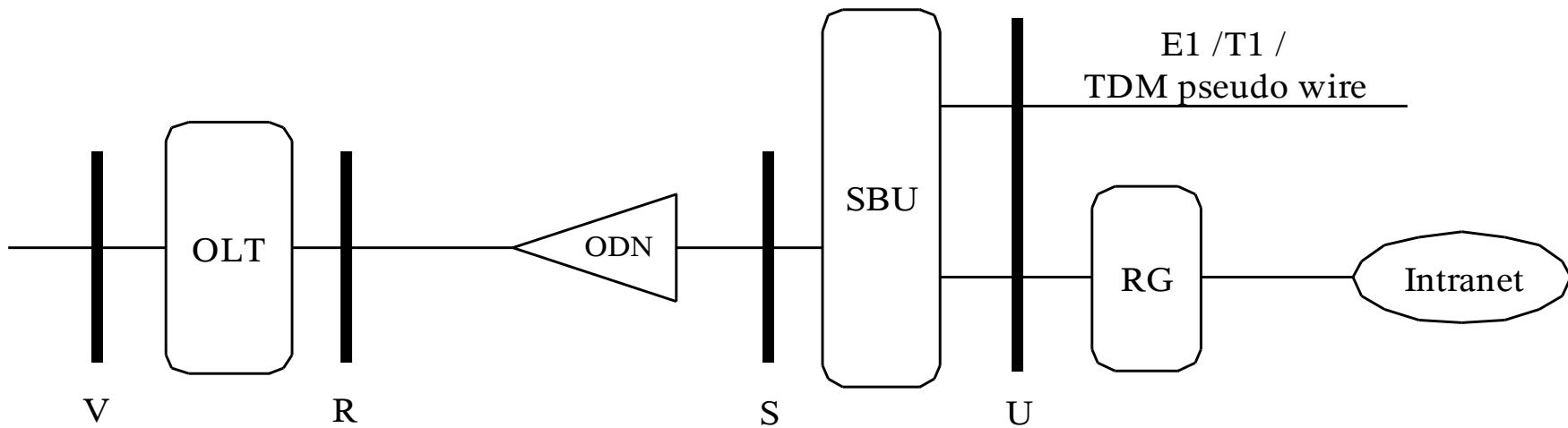
Architecture of GPON ONTs and Residential Gateways



GPON CPE EXAMPLES OF INTEGRATED FUNCTIONALITY - one size does not fit all



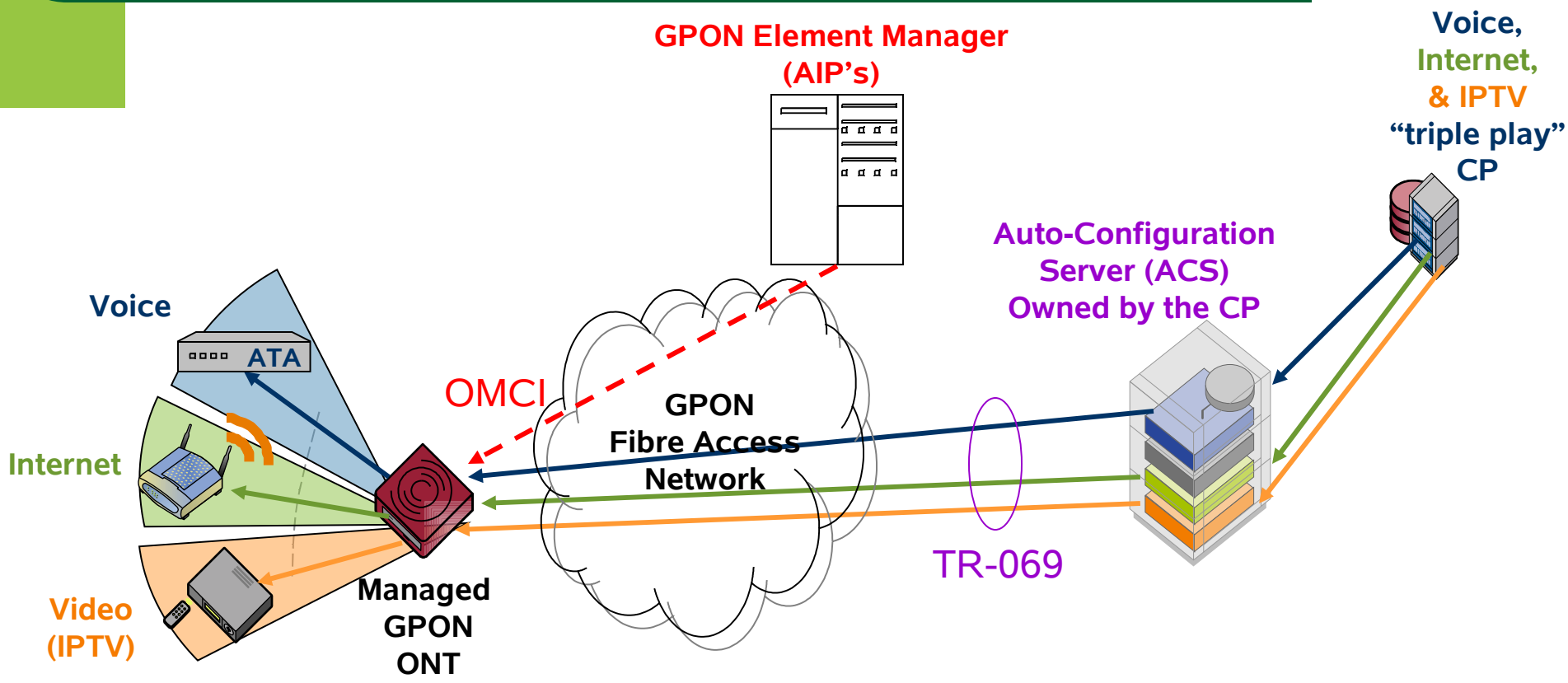
HOME GATEWAY UNIT



SINGLE BUSINESS UNIT

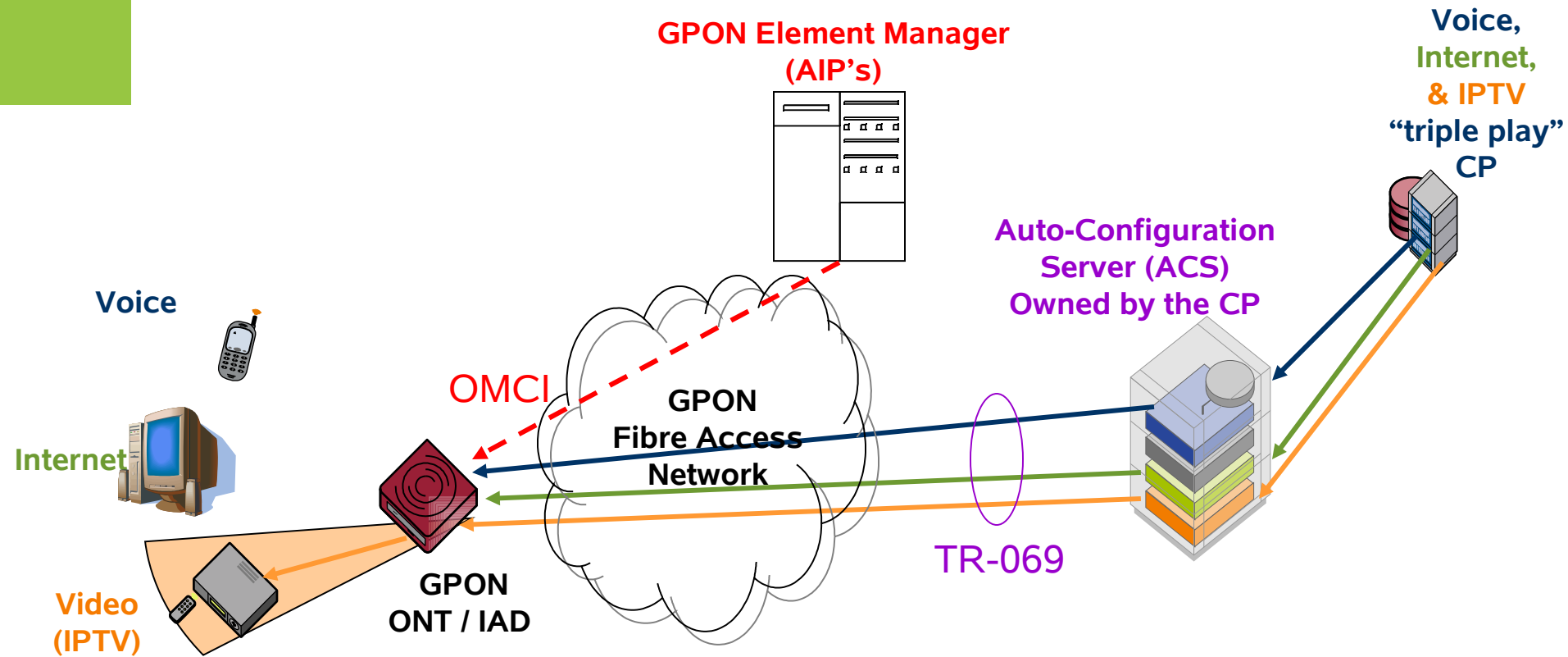
AIP = Access Infrastructure Provider (of GPON wholesale/bitstream product)
CP = "Communications Provider" e.g. ISP Providing & Managing the Service

Use Case: Separate Multi-box CPE



CP uses its own ACS with TR-069 to configure the various "service" CPE boxes
AIP uses OMCI to configure GPON PHY & Ethernet layers

Use Case: Integrated single-box CPE



CP uses its own ACS with TR-069 to configure the "service" aspects of the ONT/IAD plus the STB

AIP uses OMCI to configure GPON PHY & Ethernet layers

CPE Functions Required for Triple-Play

DSL CPE FUNCTIONS

1. DSL Router or IAD
2. Set Top Box

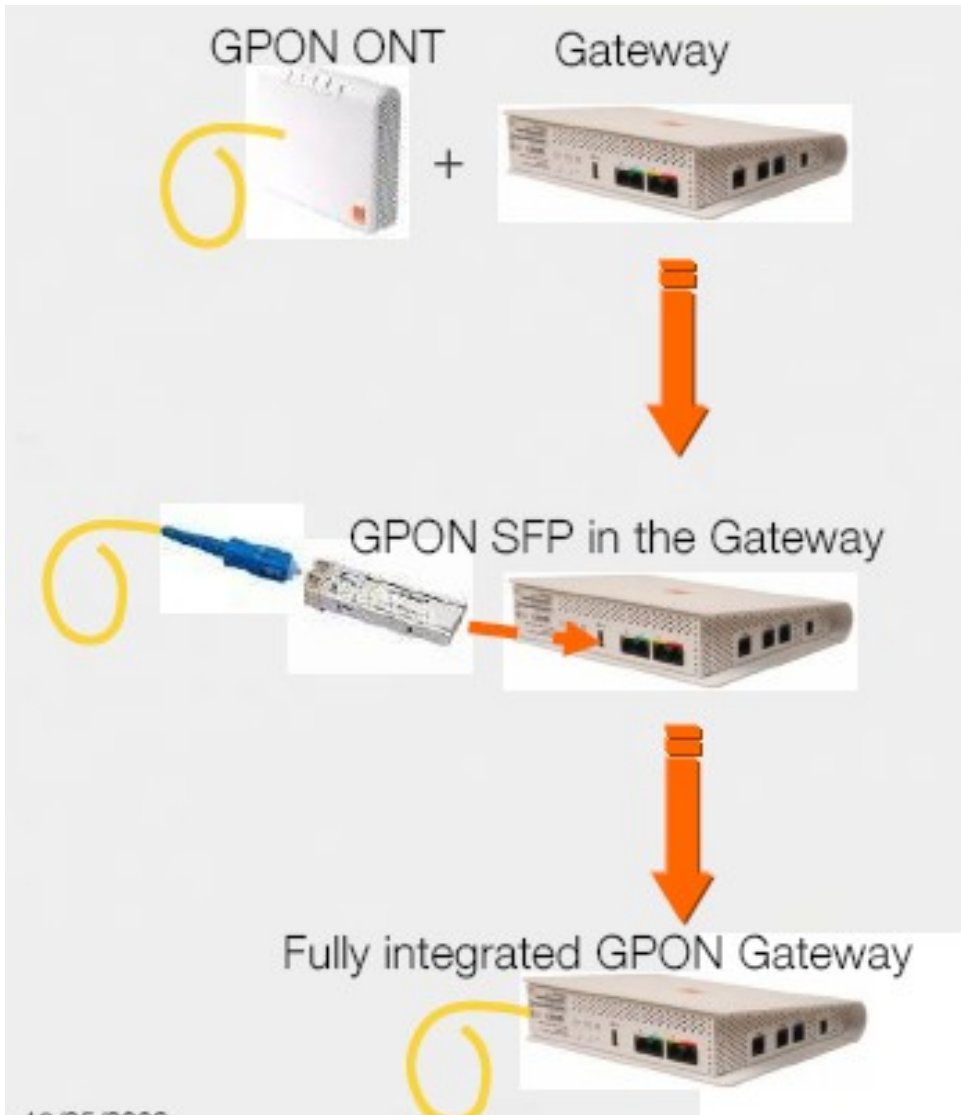
FTTP CPE FUNCTIONS

1. ONU/ONT
2. Battery Back-Up Unit
3. Router (Data)
4. ATA (Voice)
5. Set Top Box

GPON Triple-Play CPE Vision

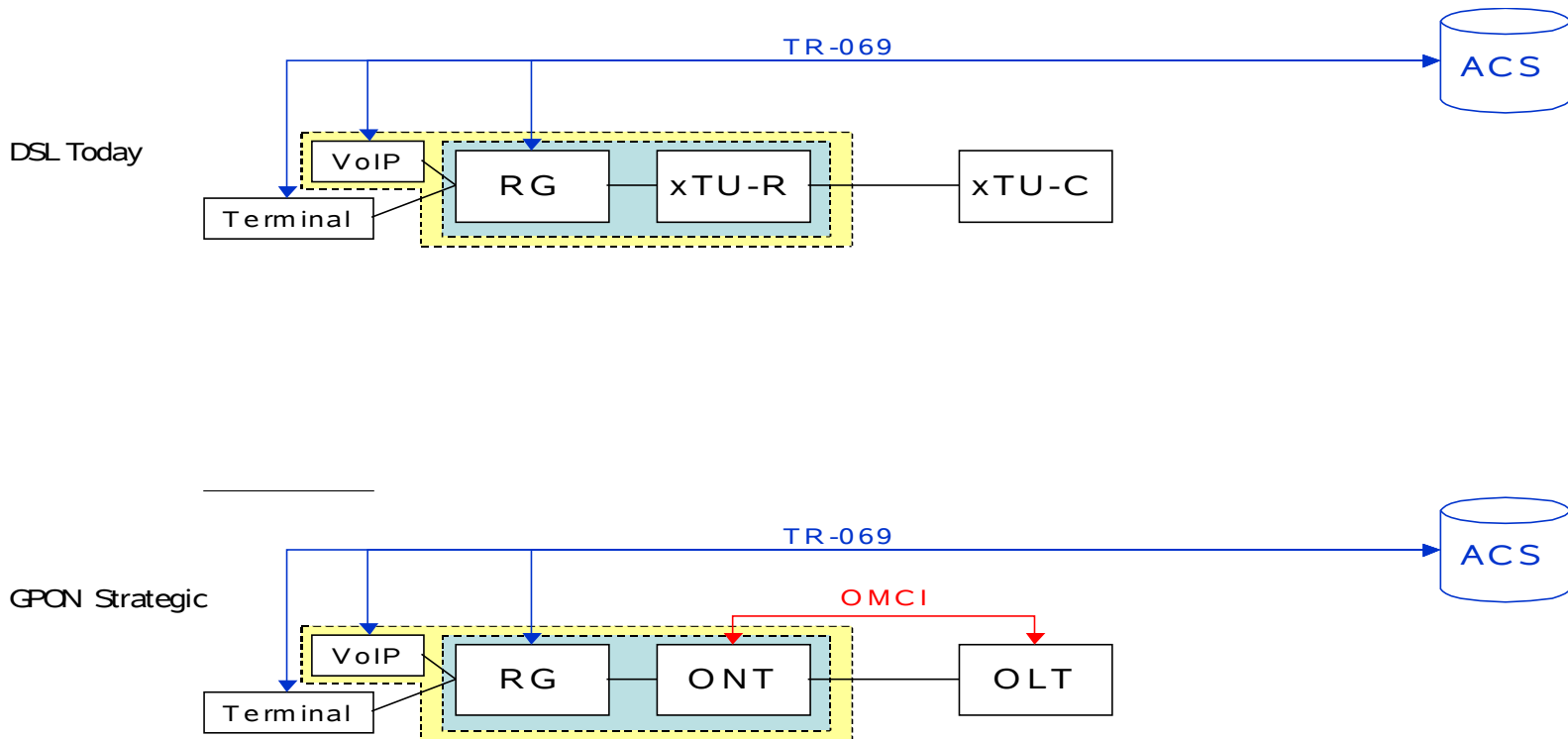
- Instead of lots of boxes, aim for two:
GPON Gateway (integrated ONT/IAD/battery back-up) + STB
- Benefits:
 - Reduce complexity
 - Easier install
 - Reduced power consumption
 - Reduced cost (overall Bill of Materials)

Integrated GPON Gateway

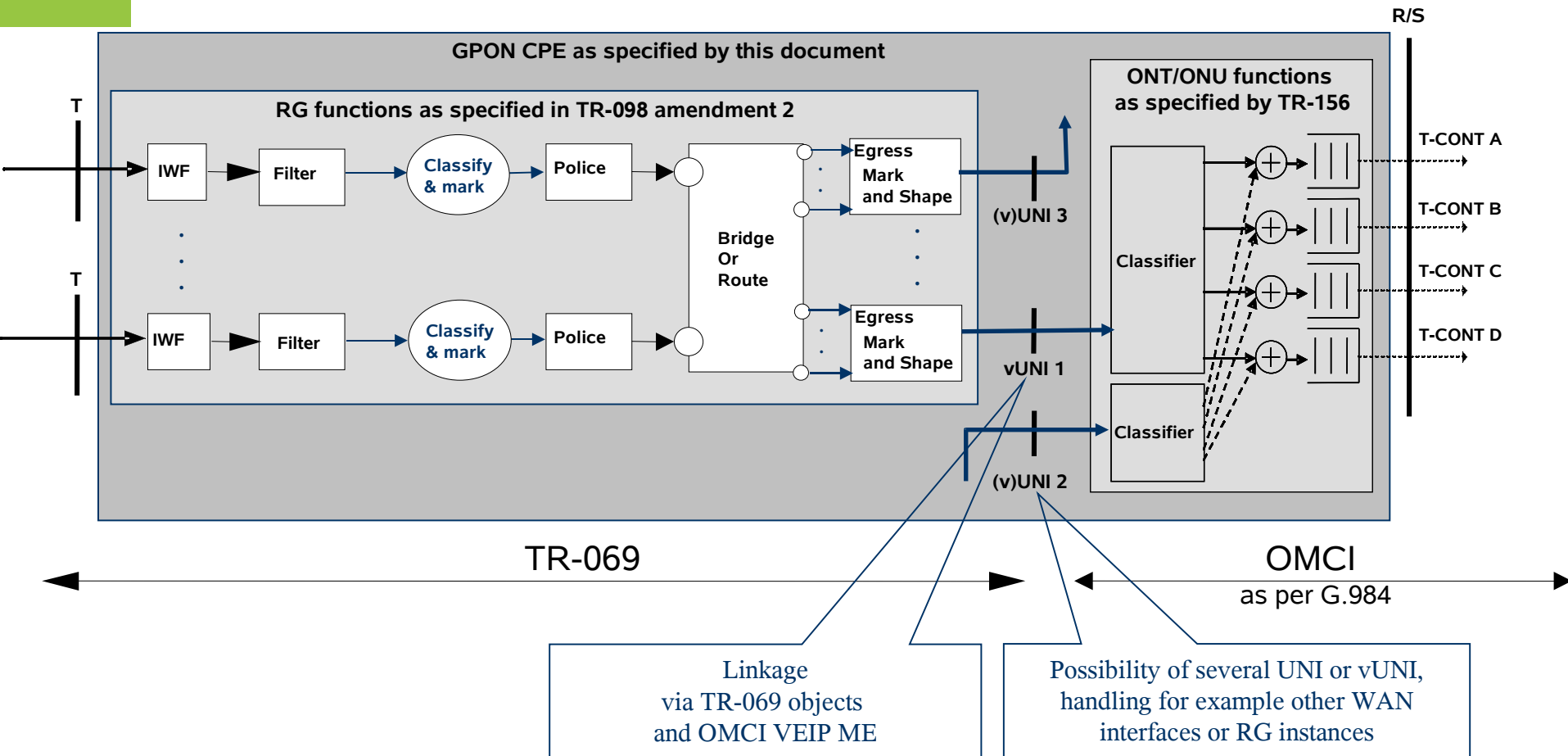


Source: Phillipe Lucas (FT/Orange)
BBF Key Note May 2009

Partitioned Management : TR-069 Compliments OMCI (See Broadband Forum TR-142)



Concept of a Virtual UNI for OMCI-TR069 domain of management responsibilities



Broadband Forum Test and Interoperability To Support FTTC/VDSL2 Variants of NGA

- Focus on data rate performance of VDSL2 Access under various loop and noise conditions
- Guidelines and test suites for interoperability (performance) and functional testing
 - WT-114: VDSL2 performance testing
 - WT-115 VDSL2 functional testing
- VDSL2 “Plugfest” events at both chip and system level
 - 11 chipset only plugfests held
 - Allowing participants to test their low-level implementations and fine-tune mandatory and optional features
 - 6 system integrator plugfests held
 - Bringing DSLAM, CPE, and chipsets together to test and debug the final products, fine-tune performance issues, and solve any implementation issues with APIs, etc.

OVERVIEW

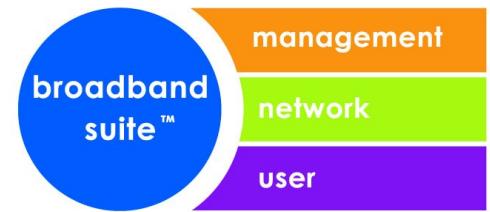
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Broadband Forum Key Work of Relevance to Active Line Access (ALA) Form of NGA

- Ethernet Architecture for QoS & multicast (TR-101)
- GPON Architectures (TR-156, WT-167)
- New Architecture work for Wholesale models to address some efficiency, scaling and multicast aspects of Ethernet ALA type services (WT-145)
- GPON CPE management (TR-069, TR-142)
- GPON CPE specification (WT-155)
- VDSL2 interoperability (WT-114, WT-115)
- Access Node Control Protocol (TR-147)

BroadbandSuite™ Scope

The BroadbandSuite Goals and Focus



The Release Plan is broken down into three major domains:

- **BroadbandManagement**

- **Goal** – enhance network management capabilities and enable an intelligent, programmable control layer that unifies diverse networks
- **Focus** - empower service providers to deliver and efficiently maintain personalized services that enhance the subscriber experience

- **BroadbandNetwork**

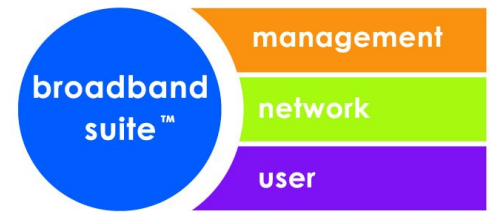
- **Goal** - establish network architecture specifications to support current and emerging services and applications
- **Focus** - deliver access, aggregation and core specifications that provide inherent interoperability, quality, scalability and resiliency capabilities from end-to-end

- **BroadbandUser**

- **Goal** - Define unified networking standards by establishing a common set of CPE capabilities within the business, home and mobile environments
- **Focus** - Simplify the service delivery process by developing common devices' identification, activation, configuration and maintenance specifications

BroadbandSuite™

Release Plan Overview



- **BroadbandSuite 1.0**

Internet access via ADSL or SHDSL over a QoS-enabled ATM architecture. Supports VoIP transport & VoDSL

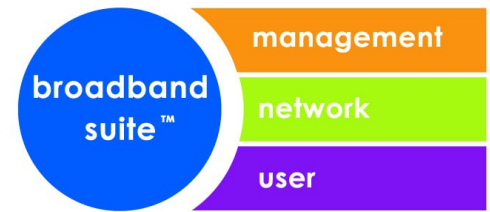
- **BroadbandSuite 2.0**

Triple-play access via ADSL2plus (or ADSL) over a QoS-enabled Ethernet architecture. Full support for multicast to enable IPTV streaming

- **BroadbandSuite 3.0**

Triple-play access augmented via GPON or bonded DSL over a QoS-enabled Ethernet architecture. Provides full support for multicast to enable IPTV streaming. Integrated remote management of Set-Top Box & storage devices

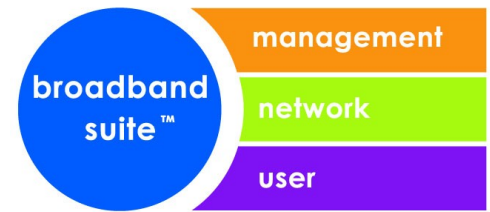
BroadbandSuite 3.0



Management R3.0	Network R3.0	User R3.0
TR-117 : Broadband Trouble Reporting	TR-101 : Ethernet-centric multicast-capable architecture	TR-135 : Residential Data Model for a TR-069 Enabled Set Top Box
TR-141 : Protocol Independent Management Model for TR-101 Compliant Access Node	TR-156 : Extending TR-101 to GPON fibre access systems	TR-140 : Data Model for a TR-069 Enabled Storage Device
TR-147 : Layer 2 Control Mechanism		TR-142 : Framework for use of TR-069 with PON Access
TR-159 : Management Framework for xDSL Bonding		TR-143 : CPE Throughput Performance Test Mechanism
TR-176 : ADSL2plus Configuration Guidelines for IPTV		TR-98 Amendment 2 : Internet Gateway Device Data Model version 2 (includes bonded DSL)
TR-169 : EMS-NMS Functional Reqs for Access Nodes Supporting for TR-101		TR-106v2 (PD-154) : XML Data Model Descriptions and Object Library

Each Release builds on past releases

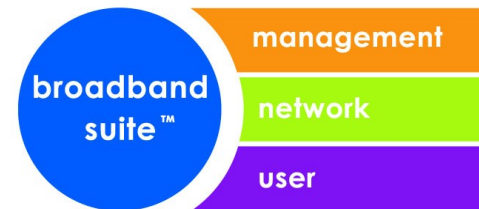
Benefits of BroadbandSuite 3.0



- Allows providers to seamlessly integrate fiber and bonded DSL into their current network architecture and management procedures
 - Enabling interoperability
 - Efficient management
 - Single architecture based on TR-101
- Simplifies management of the latest devices coming into the home- STB, storage devices and PON devices
 - Easily recognized/provisioned by the TR-069 adherent ACS
 - Easily managed and updated remotely
- Optimizes Multimedia performance
 - ADSL2plus profiles set the bar for network performance
 - Multimedia device object models simplifies customer experience, and improves service provider's bottom line
 - Better troubleshooting techniques
- Overall, this provides a roadmap to ensure Quality of customer Experience (QoE) in today's multimedia environment.

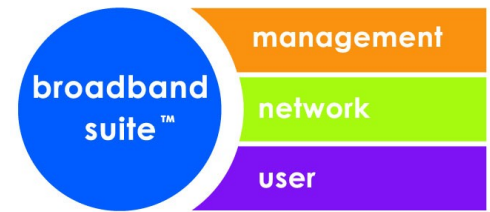
What's next?

BroadbandSuite 3.1



MANAGEMENT R3.1	NETWORK R3.1	USER R3.1
TR-165 : Vector of Profiles	WT-114 : VDSL2 Performance Test plan	TR-157 Amendment 1: Supported Data Model Table
	WT-115 : VDSL2 Functionality Test Plan	TR-196: Femto Access Point Data Model
	TR-127 : Dynamic Testing of DSL Transceivers with Splitters	TR-106 Amendment 3: CWMP Data Model Schema (adding use cases)

Benefits of BroadbandSuite 3.1



Management related specifications

- Defines a Vector of Profiles (VoP) based object model for DSL configuration that allows for great flexibility of configuration without an undue burden of data storage in DSL Element Managers or DSLAMs. This is particularly important for VDSL2+FTTx deployment scenarios
- Helps service providers implement efficient and cost effective network operation processes such as network creation, service delivery, service assurance and troubleshooting

Network related specifications

- Establishes an industry agreed test suite, ensuring common VDSL2 global standards- thereby expediting VDSL2 adoption, and helping manufacturing cost and ultimately price reductions
- Offers whole house splitter specifications that enhance IPTV delivery and ensure consistent customer satisfaction

User related specifications

- Extends TR-069 provisioning and maintenance to ensure quality Femto Access Point mobile service and coverage
- Provides the framework to continue building recognizable object models for emerging online devices- adding to the family of products and services easily managed via TR-069
- Establishes TR-069 use cases, expediting this management platform adoption

Future Release Roadmap

- Build on BroadbandSuite 3.0 with minor releases-
 - BroadbandSuite 3.1- including VDSL2 interoperability testing, TR-069 objects and data models (2009/early 2010)
 - IPTV best practices
 - DSL Quality Management
- Next Major Release (BroadbandSuite 4.0) will establish network and CPE IPv6 transition specifications (2010)
- Future Releases expected to address-
 - Multi-service architecture based on TR-144 and anchored by work such as WT-145 and the MPLS in Mobile Backhaul Initiative (MMBI)
 - Energy efficient broadband
 - Fixed/Mobile Convergence
 - G.hn-based home networking

Thank you

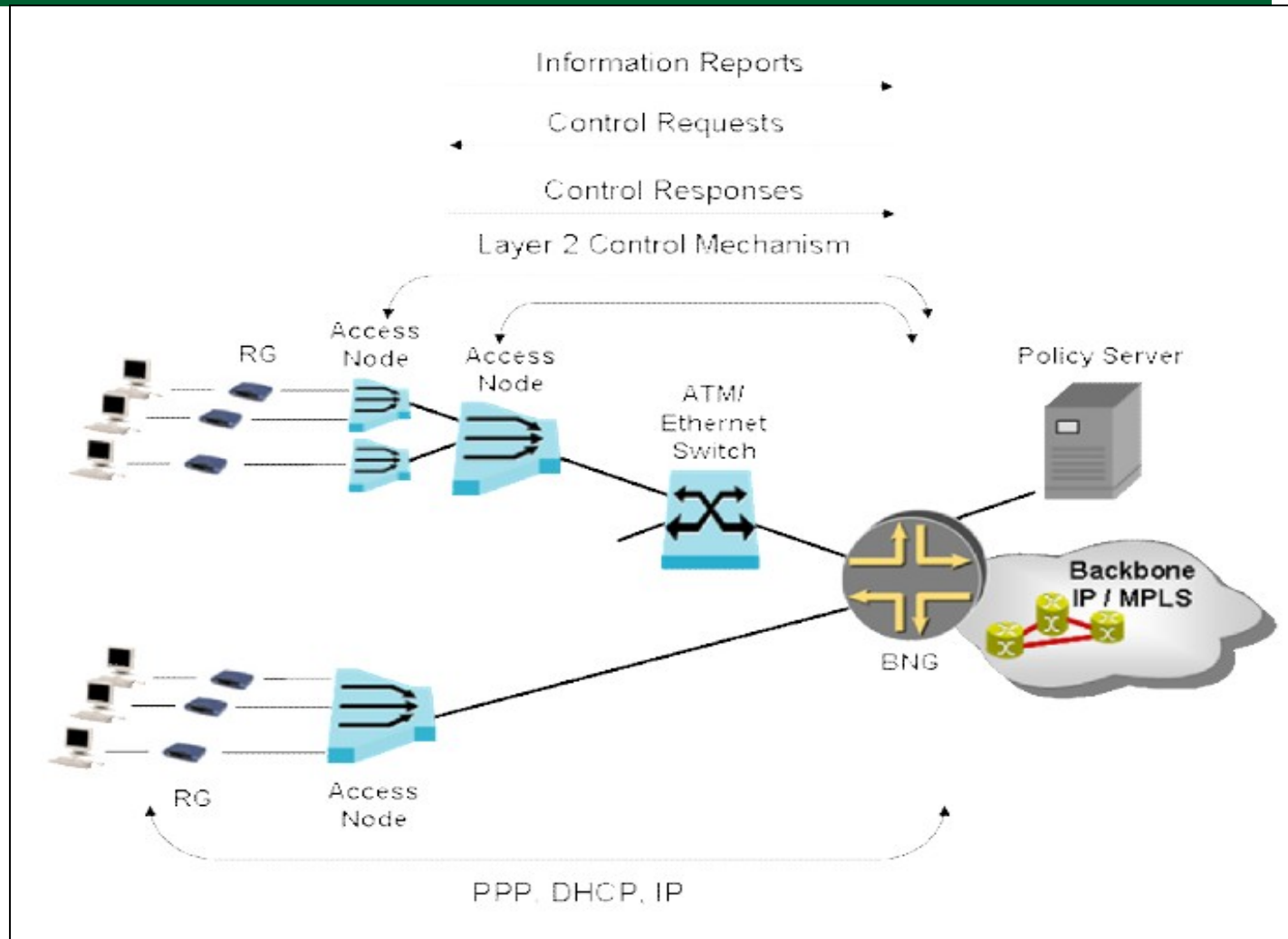
For more
information:

www.broadband-forum.org



BACK-UP SLIDES

L2C General Architecture



On going Policy related work

WT-134 More details

- **Section 4 – Business Level requirements for Policy**
 - Session-Based Policies
 - Non Session-Based Policies
 - Wholesale Sessions
 - Session Resource Request initiation sources
 - Application Admission Control
 - Relations between NSP's and ASP's
 - Bandwidth
 - QoS
 - Security
 - Network Threat Detection
 - Multicast
 - Routing
 - Auditing, Service monitoring and Accounting
 - Charging
 - Deep Packet Inspection

On going Policy related work

WT-207

- TR-207 LAYER 2 CONTROL MECHANISM FOR BROADBAND MULTI-SERVICE ARCHITECTURES PART II
Co-Editors Bill Welch Juniper Networks and Hongyu Li Huawei Technologies
- The purpose of this Working Text is to extend Layer 2 Control Mechanism to include additional access technologies, new devices and support new services.
- This Working Text defines the network element requirements and describes information flows for the following use cases:
 - Application of L2C Mechanism in GPON/EPON networks
 - Application of L2C Mechanism with wholesale and retail business arrangements.
 - Application of L2C Mechanism in Multi-Edge Architectures.
 - Application of L2C Mechanism in a redundant and resilient access network Architecture
 - L2C use case for Unified unicast and multicast Resource Control.
 - L2C use cases for PON based and Ethernet base Remote OAM messages
 - Additional use cases that spring forth from business requirements found in TR-144, the functional module discussion in WT-145 and nodal requirements specification found in WT-178

On going Policy related work

WT-203

- **TR-203 Interworking between Next Generation Fixed and 3GPP Wireless Access**
Co-Editors Kalyani Bogineni Verizon and Alan Kavanagh Ericsson
- The purpose of this document is to develop architecture and requirements that facilitate FMC between BBF and 3GPP architecture
- The scope of this work targets defining the architecture framework for the underlying functions and interworking protocols necessary to support the outlined scenarios. The use cases will define the services which are within the scope of this document. This document focuses on the convergence and interworking of networks to provide services over both fixed and wireless networks and considers the following aspects:
 - A Single service provider offering both fixed and 3GPP wireless accesses and services.
 - A fixed SP and 3GPP SP collaborating to deliver services across both networks