

Standardization Trend of Home Networking in the Broadband Forum

Yoichi Maeda[†] and Tatsuhiko Yoshida

Abstract

This article gives an overview of the standardization of home-network-related topics in the Broadband Forum, a global consortium of approximately 200 leading industry players covering telecommunication equipment, computing, networking, and service provider companies. Established in 1994, originally as the ADSL Forum and later the DSL Forum, the Broadband Forum united with the IP/MPLS Forum in May 2009 to become the central body for next-generation Internet protocol (IP) network specifications.

1. Introduction

Broadband Internet access is a dynamic market all around the world and is the fastest growing area of the telecommunications sector. The leading broadband technology in the world is digital subscriber line (DSL), which holds approximately 66% of the broadband market share and is available in every region of the world. However, optical fiber deployments are increasing rapidly and they are a key component of IPTV (Internet protocol television) services, business services, and mobile backhaul of the future.

The Broadband Forum [1] is a global consortium of approximately 200 leading industry players covering telecommunication equipment, computing, networking, and service provider companies. Established in 1994, originally as the ADSL Forum and later the DSL Forum, the Broadband Forum united with the IP/MPLS Forum in May 2009 to become the central body for next-generation IP network specifications (IP: Internet protocol; MPLS: multiprotocol label switching).

Since 1994, the forum has developed more than 100 specifications ranging from DSL technology definitions to ways of delivering maximum effectiveness in broadband deployment and management. To show that it embraces work on all forms of DSL, not only

asymmetric digital subscriber line (ADSL), the forum changed its name to the DSL Forum in 1999. Over the years, it expanded its work to address fiber architecture and management and digital home support to ensure that service providers can effectively deploy and manage their hybrid networks from a single IP-centric platform. To better represent this expanded scope, it changed its name to the Broadband Forum in 2008. Its logo is shown in **Fig. 1**.

Prior to uniting with the Broadband Forum in May 2009, the IP/MPLS Forum had a long parallel history of industry leadership. The IP/MPLS Forum started initially as three distinct forums—the ATM Forum, Frame Relay Forum, and MPLS Forum—and grew out of the evolution of IP transport technology (ATM: asynchronous transfer mode).

2. Broadband Forum activities

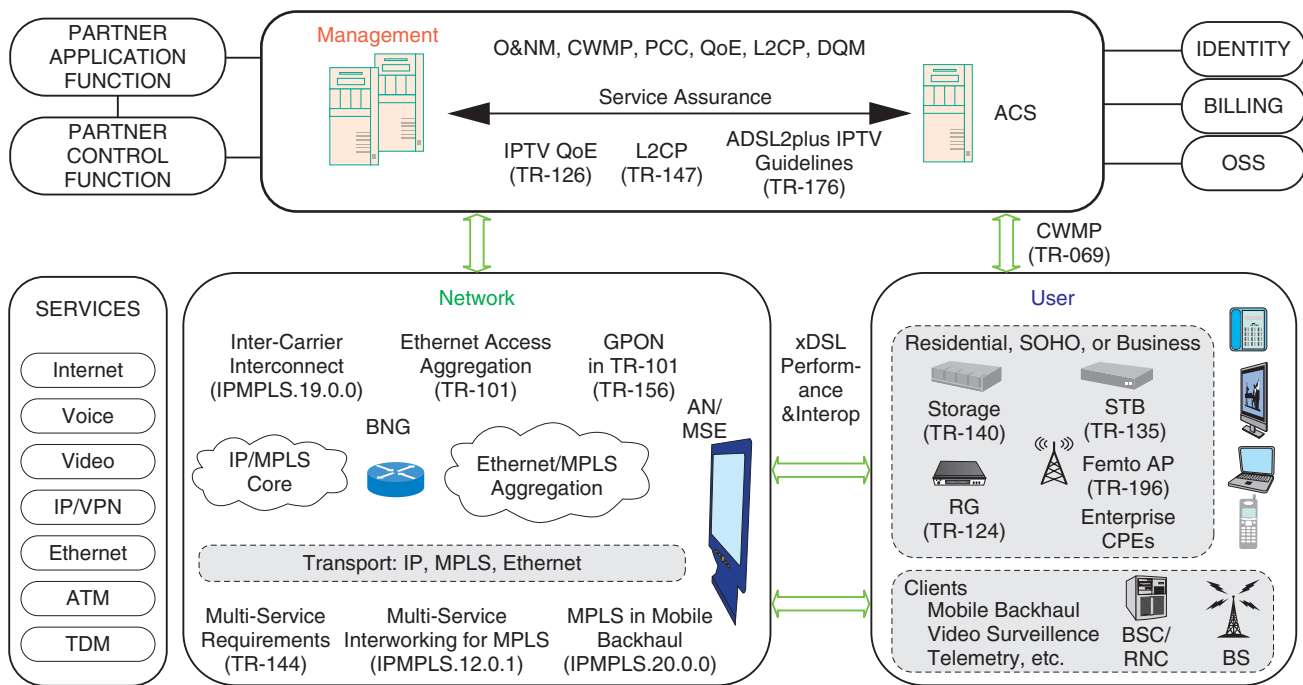
The Broadband Forum launched the BroadbandSuite™ in 2005, which grouped the technical work into solution sets, covering not only transport but also network management and digital home support. The current BroadbandSuite covers the three main solution sets of the Broadband Forum: network, management, and user-oriented specifications. The vision of the Broadband Forum is depicted in **Fig. 2**.

Some of the key network specifications to date are global test suites for ADSL, SHDSL (single-pair high-speed DSL), and ADSL2/2+. The performance/

[†] NTT Advanced Technology Corporation
Shinjuku-ku, 163-0431 Japan



Fig. 1. Logo of the Broadband Forum.

Source: <http://www.broadband-forum.org/about/mission.php>

ACS: auto-configuration server
 AN/MSE: access node/multiservice edge
 AP: access point
 BNG: broadcast network gateway
 BS: base station
 BSC/RNC: base station controller, radio network controller
 CPE: customer premises equipment
 CWMP: customer premises equipment wide area network management protocol
 DQM: data quality management
 GPON: Gigabit capable passive optical network

L2CP: Layer 2 control protocol
 O&NM: operations and network management
 OSS: operations support system
 PCC: policy and charging control
 QoE: quality of experience
 RG: residential gateway
 SOHO: small office, home office
 STB: set-top box
 TDM: time division multiplexing
 VPN: virtual private network

Fig. 2. Key areas in the Broadband Forum's vision.

functional test suite for VDSL2 (very-high-speed DSL 2) should be completed by the end of 2009. These, along with bonding, will provide a complete portfolio of DSL technologies, and new work is looking at passive optical network access systems and end-to-end Ethernet standards. Work addressing energy efficiency test plans will assist the industry in

establishing measurable adherence to global energy reduction commitments. Finally, new work around core and backhaul enhancements will ensure effective broadband convergence.

Management work includes specifications for network management, policy control, and the operations support system. Some of the key areas that have been

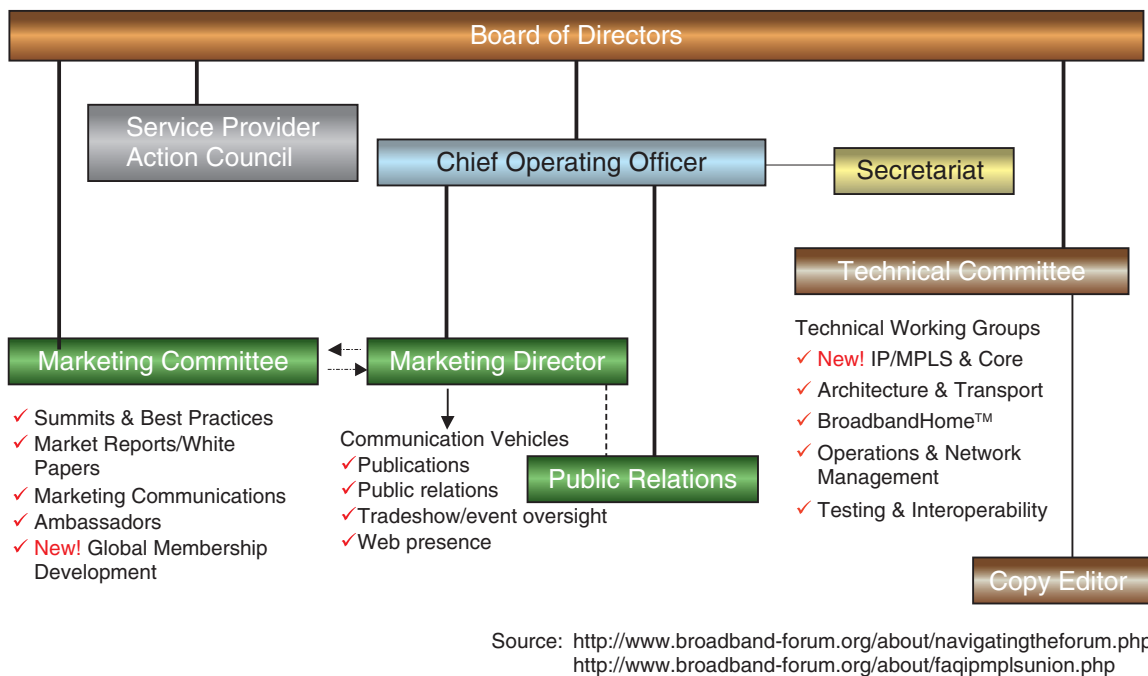


Fig. 3. Organization of the Broadband Forum.

addressed are protocol-independent management models, broadband troubleshooting best practices, ADSL2+ profiles, Layer 2 control mechanisms, and current work on developing the policy control framework for fixed-line operators.

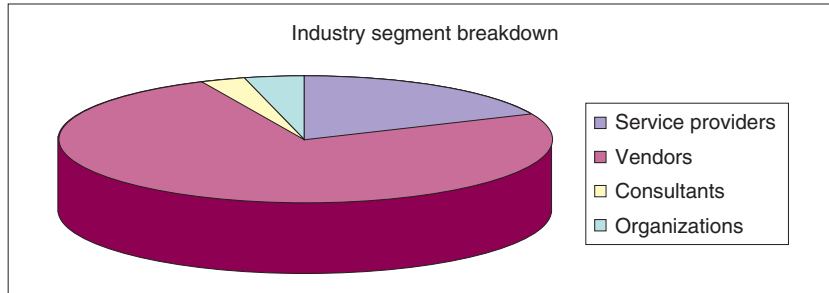
In user-related work, establishing the remote management protocol for the digital home (TR-069 family of technical reports) was a major milestone because it is not biased toward any particular access method (known as being access agnostic). This is now broadly referenced by other organizations as the de facto standard protocol for global remote management. Adding object models for new device types as they emerged has empowered service providers to effectively provision and maintain the host of new applications and devices that come online. Current work moves beyond the home to address business service/device management as well as fixed mobile convergence requirements including femtocell access points.

The organization of the Broadband Forum is shown in **Fig. 3**. A Service Provider Action Council provides an opportunity at each meeting for the providers to meet separately and discuss best practices, issues, and opportunities as well as to come together as a collective voice to identify the top initiatives for each year. With this input, the Broadband Forum stays

aligned with real-world requirements and the Technical Reports (TRs) that are released have immediate application.

Each member company contributes to the work of the Broadband Forum by participating in technical and marketing working groups (WGs), sharing their knowledge, experience, and expertise to create common, agreed protocols, processes, and best practice recommendations for use by the industry and for standards and other related industry bodies. This work takes place at quarterly, week-long meetings and through the continuous activity of working groups. Through its marketing activities, which is an extensive, continuous global public and industry education campaign, the Broadband Forum also ensures a growing international understanding of the benefits of broadband.

In meeting its core objectives, the Broadband Forum continues to establish essential and proven processes for broadband delivery that accelerate the delivery of broadband to the mass market and optimize the quality of service and customer's experience. Technical Reports, Marketing Reports, and past IP/MPLS specifications are all available for use throughout the global industry and can be downloaded free of charge from the Broadband Forum's website [1].



Source: <http://www.broadband-forum.org/about/navigatingtheforum.php>

Fig. 4. Membership breakdown for the Broadband Forum.

The Broadband Forum contributes to global industry standards by developing Technical Reports and through formal liaisons with global standards bodies such as ATIS (Alliance for Telecommunications Industry Solutions), ANSI (American National Standards Institute), ETSI (European Telecommunications Standards Institute), and ITU (International Telecommunications Union). Broadband Forum Technical Reports cover the technology itself, network operations and management, interoperability, and the integration of broadband technology into existing infrastructures.

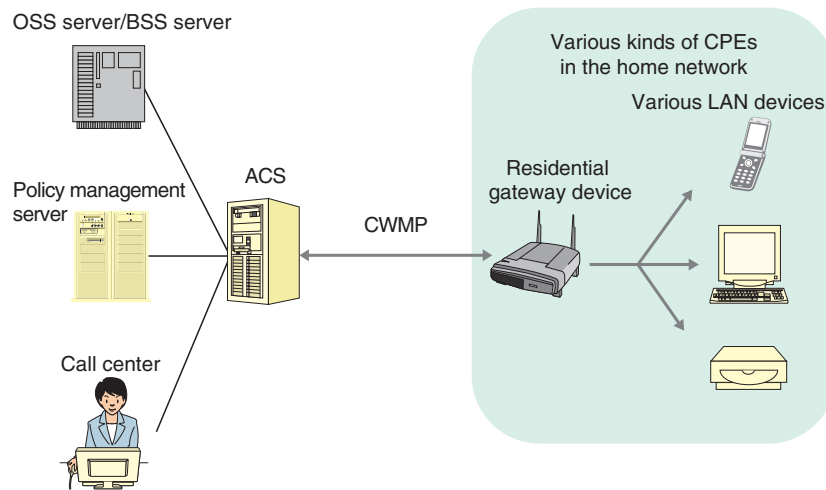
A breakdown of the Broadband Forum membership is shown in **Fig. 4**. Besides the approximately 200 leading companies covering the telecommunications, equipment, computing, networking, and service provider sectors, there are Associate members, which include academics and nonprofit organizations with an interest in broadband. The membership categories include Principal, Small Company Principal, Auditing, and Associates with annual membership fees of \$9500, \$4500, \$3500, and \$1000, respectively. Principal members have full rights to 1) attend all annual, general, and committee meetings of the Forum, 2) cast one vote each on all Forum issues, technical reports, and marketing reports, 3) access all working documents, contributions, technical reports, and meeting minutes, 4) run for the Board of Directors and Committee officer positions, 5) submit Technical Committee and Marketing Committee contributions, and 6) subscribe to all Broadband Forum email mailing lists. Small Company Principal Members must have had annual revenues under US\$10 million; they get all the privileges of a Principal member. Auditing and Associate members have limited voting rights, officer position eligibilities, and contribution submis-

sion rights.

3. BroadbandSuite release program

Over the last 15 years, the Broadband Forum has forged industry best practices and standards that have empowered service providers with the tools they need to optimize their broadband networks. Maturing from defining basic physical layer transport parameters to facilitating multimedia service delivery across broadband, the Forum's work continues to be aligned with real-world broadband development and service provider requirements. Today, the Broadband Forum packages Technical Reports into distinct BroadbandSuite Releases that provide a roadmap for broadband solutions. Each new release builds on the earlier releases. Ultimately, the release program offers the industry a toolkit for broadband achievement.

- BroadbandSuite 1.0 provides the technical reports needed to deliver basic high-speed Internet access over ADSL. The key capabilities of this release are Internet access via ADSL or SHDSL over a QoS-enabled ATM architecture that supports VoIP transport and VoDSL (QoS: quality of service, VoIP: voice over IP, VoDSL: voice over DSL).
- BroadbandSuite 2.0 increases the speed by including ADSL2/2+ specifications and addressing the remote management requirements of the networked home. The key capabilities of this release are triple-play access via ADSL2+ over a QoS-enabled Ethernet architecture and full support for multicasting to enable IPTV streaming.
- BroadbandSuite 3.0 brings fiber and bonded options into the mix and provides specifications that ensure quality IPTV deployment and man-



Source: http://www.broadband-forum.org/technical/download/TR-98_Amendment_2.pdf

Fig. 5. Home network management architecture.

Table 1. Data models for managing typical CPEs.

Document number	Document name	Managed CPE
TR-098 Amendment 2	Internet Gateway Device Data Model for TR-069	Residential gateway
TR-106 Amendment 2	Data Model Template for TR-069 Enabled Devices	LAN-side devices behind residential gateway
TR-104	Provisioning Parameters for VoIP CPE	VoIP device
TR-135	Data Model for TR-069 Enabled STB	Set-top box
TR-140 issue1.1	TR-069 Data Model for a Storage Service Enabled Devices	Network attached storage
RT-196	Femto Access Point Service Data Model	Femto access point

agement. The key capabilities of this release are triple-play services augmented via GPON (Gigabit capable passive optical network) or bonded DSL over a QoS-enabled Ethernet architecture, full support for multicasting to enable IPTV streaming, and integrated remote management of set-top boxes and attached storage devices.

BroadbandSuite 3.1 will add VDSL2 specifications soon.

4. Topics related to the home network

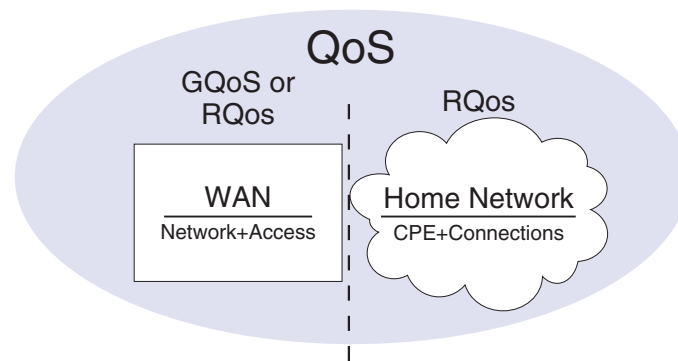
The main study items related to the home network in BroadbandSuite are management for various kinds of customer premises equipment (CPE) and QoS control.

4.1 CPE management in the home network

As shown in Fig. 5, the BroadbandHome Technical

WG is studying the management interface between an auto-configuration server, which manages various kinds of CPEs in the home network, and CPEs. The CPEs to be managed include routers, such as a residential gateway, as well as various kinds of devices in the local area network (LAN). Lots of specifications are being produced for their configuration management, service provisioning, software/firmware management, state/performance monitoring and diagnostics. The auto-configuration server can be accessed by the OSS/BSS (operations support system, business support system), policy management server, and call center. It helps service and network providers to offer home network services.

The management protocol called CWMP (customer premises equipment wide area network management protocol) shown in Fig. 5 is specified by TR-069. Moreover, lots of data models are specified over this protocol to manage various kinds of CPEs. Data mod-



WAN/home network QoS interface

Source: <http://www.broadband-forum.org/technical/download/TR-094.pdf>

Fig. 6. QoS model for the home network.

els for managing typical CPEs are listed in **Table 1**.

Of particular note, is the completion of the data model for Femto access points (Femtocell service) in April 2009 in the cooperation with the Femtocell Forum. One more feature is that the BroadbandHome Technical WG is studying ways to reflect IPv6 (Internet protocol version 6) requirements into TR-124 (Functional Requirements for Broadband Residential Gateway Devices), based on the IPv6 architecture being studied by the Architecture & Transport Technical WG. The data models for IPv6 are planned to be produced in the future, considering these activities.

As shown in Fig. 5, CPEs can be categorized into two types: the residential gateway and LAN-side devices, such as a set-top box, that operate behind the residential gateway and communicate with WAN-side servers (WAN: wide area network). The residential gateway is directly managed by the auto-configuration server on the basis of TR-069. However, how to manage LAN-side devices behind the residential gateway remains a study item. TR-111 (Applying TR-069 to Remote Management of Home Networking Devices) specifies how to manage CPEs via the residential gateway where the network address translation function resides. Moreover, for the case where universal plug and play (UPnP) and so on are used between the residential gateway and the LAN-side devices, studies are in process to determine how to specify the managed devices' proxy data model in the residential gateway.

TR-069 as well as the data model documents of the Broadband Forum are well accepted by various standards bodies. Besides the Femtocell Forum, bodies such as the WiMAX Forum, HGI (Home Gateway

Initiative), and ATIS are also planning to utilize these documents.

4.2 QoS control in the home network

The service providers are studying how to provide QoS-guaranteed IPTV and/or VoIP. One of the reference documents for offering QoS over the end-to-end network is TR-101 (Migration to Ethernet-Based DSL Aggregation) produced by the Architecture & Transport Technical WG. This document specifies the whole architecture for providing IPTV services by multicasting and QoS functions in the IP/Ethernet-based network. Another reference document is TR-126 (Triple-Play Services Quality of Experience (QoE) Requirements), which specifies QoE requirements.

On the other hand, TR-094 (Multi-Service Delivery Framework for Home Networks) should be referred to for QoS control in the home network, where the WAN-side traffic is merged with the LAN-side traffic. The QoS model for the home network depicted in TR-094 is shown in **Fig. 6**. Assuming that guaranteed QoS (GQoS) or relative QoS (RQoS) is used in the WAN, while RQoS is used in the home network, it describes the QoS mapping necessary for connecting the two networks. One should keep in mind that although the current TR-098 already specifies the QoS management in the residential gateway, the BroadbandHome Technical WG is studying it further in cooperation with HGI and the UPnP Forum for the purpose of incorporating detailed QoS management specifications into the next versions of TR-098 and TR-124.

Reference

- [1] <http://www.broadband-forum.org/technical/trlist.php>.



Yoichi Maeda

Executive Manager, Standard Strategy, Network Technology Center, NTT Advanced Technology Corporation, NTT Senior Adviser on Standardization, ITU-T SG15 Chairman.

He received the B.E. and M.E. degrees in electronic engineering from Shizuoka University in 1978 and 1980, respectively. Since joining Nippon Telegraph and Telephone Public Corporation (now NTT) in 1980, he has been engaged in R&D of access network transport systems for broadband communications including SDH, ATM, and IP. From 1988 to 1989, he worked for British Telecom Research Laboratories in the UK as an exchange research engineer. He moved to NTT Advanced Technology Corporation in 2006 and currently leads its standardization promotion and is also NTT's Senior Adviser on Standardization. In October 2008, at WTSA-08, he was appointed to the chair of ITU-T SG15 for the 2009–2012 study period for his 2nd term. He is a member of IEEE and a Fellow of the Institute of Electronics, Information and Communication Engineers (IEICE) of Japan. He has been a feature editor on the Standards Series in IEEE Communications Magazine since 1999.



Tatsuhiko Yoshida

Senior Engineer, Network Systems Business Headquarters, NTT Advanced Technology Corporation.

He received the B.E. degree in electronic engineering from Tokyo University in 1977. He joined Nippon Telegraph and Telephone Public Corporation (now NTT) in 1977 and moved to NTT Advanced Technology Corporation in 2000. Since joining NTT, he has been studying and developing metallic transmission systems, synchronous transport equipment, leased-line systems, ATM operation systems, and so on. He was also involved in the standardization activities, such as ITU-T, the TM Forum, and the Broadband Forum, while he was the network management interoperability committee chair of INTAP during 1995–1997 as well as the TMN committee chair of TTC (Telecommunications Technology Committee) in Japan during 1996–2001.
