SPECIAL TOPIC

Applications of TR069 in Home Networks

Abstract:
The complexity of terminal equipment and diversity of services in a home network have more requirements for terminal management. The Digital Subscriber Line (DSL) forum has defined a special protocol for terminal management. This is the TR069. The TR069 uses the client/server model of Hypertext Transfer Protocol (HTTP) for architecture design and fully use the mature Web technologies for reference. Therefore, it supports simple protocol fulfillment and has good scalability. Moreover, the management parameters the TR069 defines are totally aimed at the characteristics of terminal services. A TR069-based network management system helps greatly simplify the configuration and management work at the user side, and makes the equipment easier to use and manage. Accordingly, the TR069 may help a home network deploy equipment and launch services quickly.

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Broadband access for home is more popular, and Voice over IP (VoIP) and IPTV services are growing quickly. For this reason increasing number of IP terminal devices are being introduced to the home network, and the traditional Simple Network Management Protocol (SNMP) manages the numerous terminal devices more difficultly.

Operators have to consider how to implement the effective management of home network equipment.

The Customer Premises Equipment Wide Area Network Management Protocol (CWMP) is a terminal-oriented network management protocol defined by the Digital Subscriber Line (DSL) forum with the file number of TR069. It defines brand new network management architecture, including the management model, interactive interfaces, and basic management parameters.

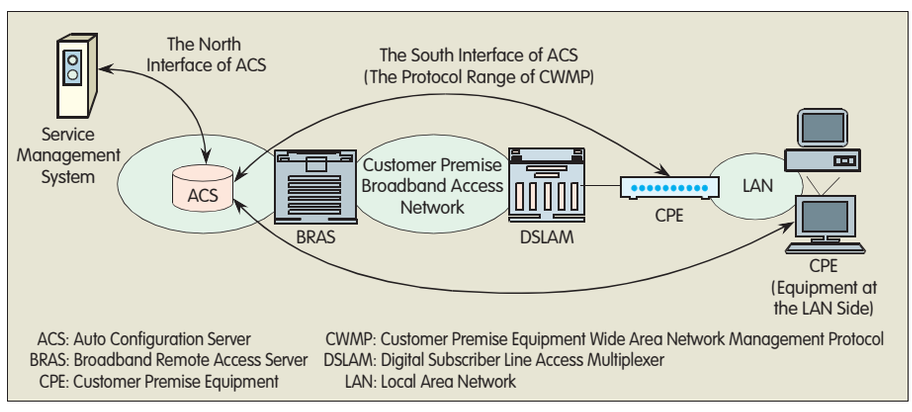
1 Introduction of TR069

1.1 The Characteristics of TR069

In the network model defined by TR069, the management server is called Auto Configuration Server (ACS), which is responsible for the management of Customer Premise Equipment (CPE). The interface between ACS and CPE is called the south interface. The interface between ACS and other network management systems, service management systems and billing systems is called the north interface. The TR069 defines the standards for the south interface[1].

The TR069 is an application-layer protocol above IP. Therefore, it has wide application with no restrictions on access modes. All the CPE based on Asymmetric Digital Subscriber Line (ADSL), Ethernet, and Passive Optical Network (PON) can use this protocol. The TR069-based network management architecture is shown in Figure 1.

The TR069 fully absorbs the strengths of Web technologies. Transmission is based on the Transport Control Protocol (TCP). The interaction between ACS and CPE is based on Hypertext Transfer



▲Figure 1. TR069-based network management architecture.

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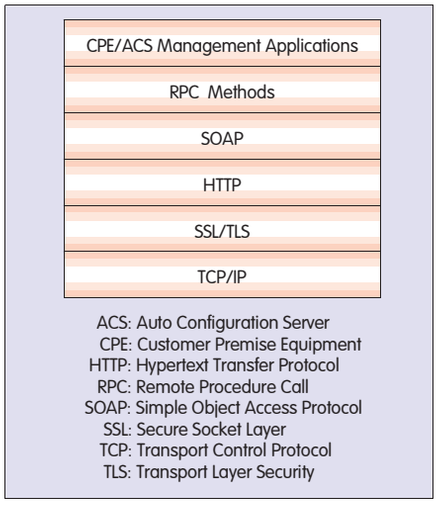
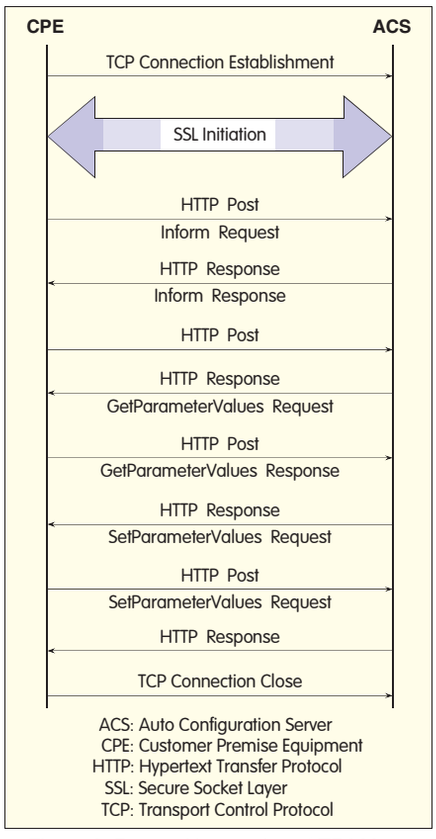


▲Figure 2. The TR069 layers.



▲Figure 3. Protocol interaction of TR069.

Protocol (HTTP) with ACS as the HTTP server and CPE as the client. Remote Procedure Call (RPC) based on the Extensible Markup Language (XML) fulfills the practical management operation. The current version of TR069 defines nine basic and six optional RPCs for CPE, and two basic and two optional RPCs for ACS. Figure 2 shows the layered structure of TR069. Using a number of mature Web technologies, TR069 is easy to be fulfilled. This reduces the difficulty in development and deployment of terminal products.

In the interaction process defined by TR069, all the management interactions are initiated by CPE, that is, CPE "requests" ACS to conduct management, in order to adapt to numerous terminals and unfixed addresses (as shown in Figure 3). When ACS wants to initiate the CPE management, TR069 defines a reverse trigger mechanism as the following.

- CPE first establishes and maintains an HTTP port for detection, and the message about this port is sent to the ACS at the time of initial connection of CPE;
- ACS will establish a TCP connection to this port and send an empty POST message if it wants to manage the CPE;
- CPE will initiate a forward HTTP/HTTPS connection to request the management of ACS once it receives the message.

1.2 Network Management Functions Based on TR069

The network management functions based on TR069 include:

(1) Configuration Management

ACS initiates the configuration management defined by TR069, and Get/SetParamerterValue RPC implements the comparison and configuration of CPE parameters. The ACS that implements configuration management strategy and the CPE that actively requests management simplify equipment configuration.

(2) Version Management

The TR069 allows CPE to take the initiative in requesting version/firmware upgrade, and ACS to conduct version upgrade coercively as well. The ACS makes decision of version upgrade for both upgrade models. This function may not only fulfill the traditional version upgrade, but also works with the configuration function. Together these functions implement the control of dynamic download of services, which offers deployment means of value-added services for operators.

(3) Performance Monitoring and Control

The ACS may use GetPramerterVal RPC to inquiry real-time equipment state. Moreover, it uses log files obtained by upload to analyze the history states of CPE.

(4) Diagnosis

The TR069 doesn't define special RPC for diagnosis. It uses Set/GetParamterVal RPC to fulfill the diagnosis function. Using SET to setting diagnosis parameters triggers a diagnosis process, and the diagnosis results are read by operating GET.

(5) Warning

The CPE takes the initiative in sending event reports to implement real-time warning.

1.3 Other Standards of TR069 Protocol Family

With TR-069 and other protocols, the TR069 is a complete protocol family of network management. Its matching protocols TR-098 and TR-104 define management parameters of data services for CPE and management parameters of VoIP services respectively. The WT-135 protocol defines management parameters of the set-top box and TR-111 defines mechanism of deploying TR069 network management to internal home devices. The WT-121 collects protocol modifications various vendors have made during fulfillment and deployment of TR069.

2 Applications of TR069 in Home Networks

A triple-play home network includes the home gateway, VoIP terminals, and the Set-top Box (STB), as shown in Figure 4.

The home gateway allows ADSL access and uses four Permanent Virtual Connections (PVCs) to offer voice, data, and IPTV services respectively. In a home network, the analog phone line, Ethernet and Wireless Local Area Network (WLAN) are used to connect POTSes, IP telephones, PCs, and IP STBs respectively. As the core of a home network, the gateway is responsible for providing addresses management, Network Address Translation (NAT), data forwarding, QoS, security, and other services.

Numerous devices are involved in the

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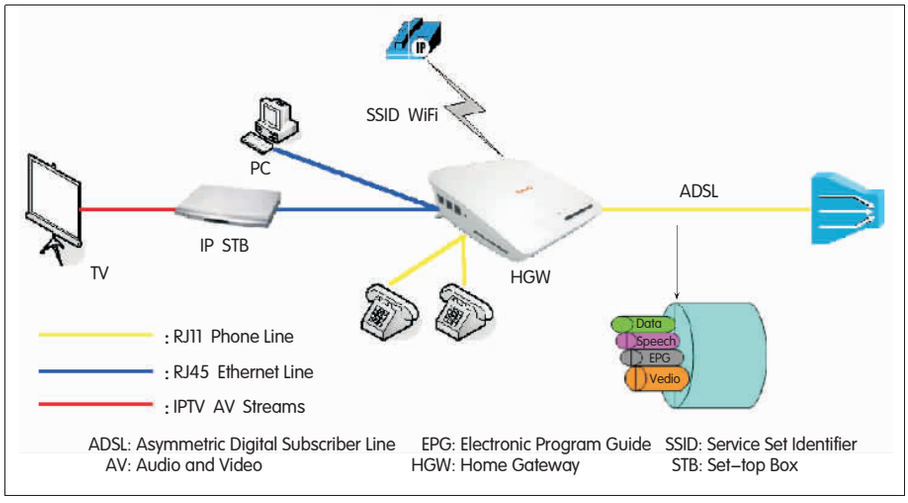

▲Figure 4. Structure of a home network.

networking, therefore, the equipment configuration and management is troublesome for the operators as well as for the users. Fortunately, the TR069 network management system greatly simplifies the maintenance/management work.

The TR069 is IP-based network management protocol. Therefore, the IP-layer authentication and access of users is a must at first if a home network should be a manageable element of the network management system, based on which registration of the network elements on the network management system will be then fulfilled. There are three significant steps in the available terminal deployment process.

(1) Initial Equipment Configuration

Before a home device is given to a user, the operator needs to pretreat it and configure some basic parameters for access the home network. Since the home gateway is a key device, it requires preparations and parameter configuration. The parameters include access information at the WAN side and access information of ACS. However, it is unnecessary to pre-configure devices at the LAN side such as STB.

(2) Initialization of Home Network

The home gateway is the port of a home network for connection with Internet, and the initialization of a home network begins at the gateway. The gateway, by pre-configuring its internal basic parameters (such as PVC, user name, and password), first establishes an Internet connection and gets the basic network parameters (such as IP addresses and domain name). With regard to networking, this is to establish an Internet connection on the PVC used for data services. Then the gateway uses the pre-stored URL message to access ACS. The ACS uses TR069 to get user information from the gateway, the north interface to get service parameters of a user from service system, and the TR069 to fulfill configuration of the gateway (setting parameters for IPTV and VoIP connection, routing messages, VoIP parameters, QoS strategy, and security strategy). Based on gateway initialization, devices in a home network begin to be initialized. In order for ACS to make unified management of home devices, it is necessary for the gateway and home devices to use the interaction mechanism defined by TR-111. The gateway uses Dynamic Host Configure Protocol (DHCP) to notify home devices of the ACS address, and the home devices use the datagram protocol and Simple Traversal of UDP over NAT (STUN) mechanism to establish a port mapping that interactive with ACS. In this way, ACS makes the configuration of home devices through the gateway (setting encoding/decoding features of the STB and EPG address[2]). With the process mentioned, the initialization of a home network is completed and various services the user applied can be used.

(3) Routine Management

In the network shown in Figure 4, ACS may directly manage the home gateway and the devices below the gateway. The parameter configuration, equipment diagnosis, warning, and version upgrade can all be handled by TR069. This realizes the unified management of a home network.

3 Conclusions

The management of home network devices is becoming increasingly complex with the large-scale launching of triple-play services. It is a popular problem for operators to meet users' demand of "zero configuration" and simplify equipment maintenance and management. The deployment of TR069 helps reduce network maintenance cost greatly. Therefore, operators have deployed the TR069 based terminal management system one by one since the DSL forum released the protocol in May 2004. As the case stands, TR-069 is still in improvement. The service parameter model needs to support more terminal services and features, and the modification and detailing of several processes are necessary for protocol inter-working.

References

[1] CPE WAN management protocol[R]. TR-069. Builder, UK: Jungo Software Technologies Co. 2004.
[2] Applying TR-069 to remote management of home networking device[R]. TR-111. Builder, UK: Jungo Software Technologies Co. 2004.

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Biographies

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