Resonant Communication Network Architecture (RENA)

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Abstract

This article gives an overview of NTT's resonant communication network architecture (RENA), which provides superior usability—a key aspect of NTT's vision of a new optical generation—and opens the way to a genuinely realistic communication environment, which was impossible with the narrowband transmission capabilities of the past.

1. Concept of a resonant communication network

Based on NTT's vision of a new optical generation, the NTT Group committed itself in November 2002 to a major new initiative to develop and deploy technologies to support broadband-based resonant communications [1], [2]. The initiative, which is to be implemented over the next five years, aims to make a resonant communication network environment with exceptional usability and create diverse feature-rich new services and business opportunities based on it. The network must satisfy several advanced requirements to create such a public infrastructure. The most important ones are given below:

- Support for tens of millions of broadband subscribers: The number of IP network users will continue to increase, and there will be a vast increase in the number of terminals (including information appliances, radio-frequency ID tags, and sensors) connected to the network.
- Ability to accommodate changing patterns of network use: It must support access by a diverse range of different types and modes of communication including end-to-end and multipoint communications.
- Quality of Service (QoS) assurance: It must offer a range of reliability conditions and QoS options from best-effort to assured-quality services.
- Assured network security and reliability: Users must have total confidence that their privacy will be fully protected when they use the network.
- Good usability: The network must support safe, secure communications without requiring any technical knowledge or difficult setup procedures on the part of users.
- Platform functions that support and promote business opportunities: It must support authentication and other shared functions so that anyone can easily set up a new business using the network.

To meet all of these requirements, we are developing a resonant communication network concept that provides reliable end-to-end communications and supports the creation of diverse feature-rich services and new business opportunities, and we are striving to continually upgrade and enhance its usability (Fig. 1).

2. Benchmark services

The concept of the resonant communication network can be understood more clearly in terms of the following reference services and capabilities. Once we have achieved the cost-effective implementation of these capabilities, we will have met our goals for the network.

(1) Interactive real-time end-to-end communications: Ability to support interactive real-time voice, high-quality video, and other media between users

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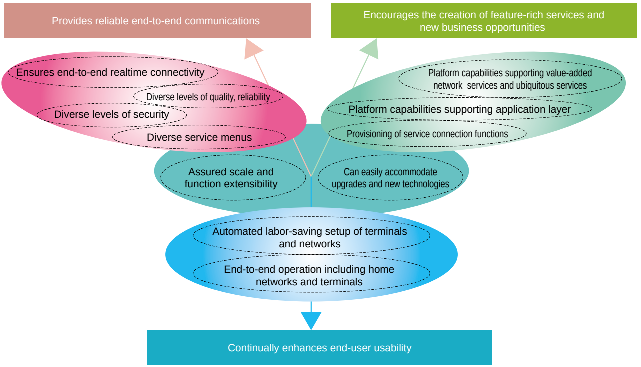


Fig. 1. Concept of the resonant communication network.

in 1-to-1, N-to-N, and other distribution arrangements.

(2) IP telephony services: Support for end-to-end voice over Internet protocol.

(3) Virtual private network (VPN) services: Ability to configure secure VPNs connecting any number of specified points over the public network.

(4) Content delivery services: Ability to deliver video and other media securely with appropriate quality to large numbers of users.

(5) Nomadic services: Support for seamless user/terminal mobility even for different network connection environments.

(6) Sensor network services: Support for a ubiquitous environment using network-ready sensors and radio-frequency identification tags.

(7) Data communication services: Support for home control, customer support, and other remote equipment control environments.

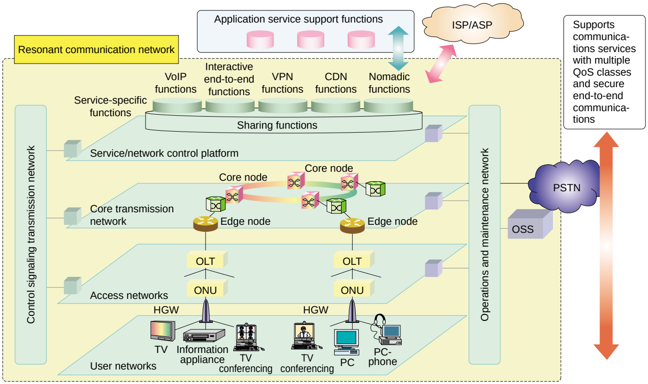
(8) Public Internet interface: Ability to access the global Internet.

3. Network architecture

Going beyond the benchmark services listed above, the resonant communication network must also support end-to-end connectivity, security, quality classes, and usability for the many new services that will emerge in the future. We call the network architecture that will provide this support the Resonant Communication Network Architecture (RENA). As shown in Fig. 2, it consists of user networks, access networks, a core transmission network, a control signaling transmission network, and an operations and maintenance network, which are integrated through the centralized control functions of a service/network control platform. One notable feature of RENA is its ability to support a range of QoS levels. Starting with the top-tier service, RENA can provide a premium bandwidth-guaranteed service comparable to a leased-line, a second-tier priority service that provides guarantees involving various factors (e.g., bandwidth, latency, delay variation, and packet loss ratio), and a best-effort economy service that provides Internet-like quality but with no service quality guarantees. Note that to ensure stable traffic so that these guarantees can be made, several differentiated classes of end-to-end connection reliability must also be provided.

3.1 Components of RENA

The user network provides the point of access for a diverse range of user devices and equipment. For example, telephones, personal computers and printers, audio-visual digital equipment such as TVs and DVD players, and information appliances can be connected



OLT: optical line terminal, ONU: optical network unit, OSS: operation support systems, CDN: contents delivery networks

Fig. 2. Resonant communication network architecture.

to home networks; IP Centrex systems and mail and web servers can be connected to corporate networks; and other kinds of devices such as sensors and RFID (radio frequency identification) tag readers can also be connected. It is essential that all these various types of terminal equipment can be connected via the user network regardless of the interface and can take full advantage of RENA's powerful features. We are now developing a home gateway (HGW) that will provide a point of access to the resonant communication network. Its functions include IPv4/IPv6 protocol termination, multicast protocol termination, SIP signal termination, IP telephony termination, quality control through Layer 2 VLAN (virtual LAN) tags and Layer 3 traffic class, compensation of quality degradation, security control that prevents unauthorized assess, packet routing control, address management, and remote operation.

The access network is implemented as either a dedicated or shared line connecting a user network to the edge of the core transmission network, the control signaling transmission network, and the operations and maintenance network. It supports a range of QoS classes at Layers 1, 2, and 3 and robust security. The access network for RENA will provide throughputs ranging from 10 to 100 Mbit/s for general users and ranging from 10 Mbit/s to 10 Gbit/s for corporate users including SOHO (small office home office) customers. The actual physical network could be implemented as a passive optical network (PON), as a media converter, or as a hybrid optical and fixed wireless access line, and it is assumed that these different facilities would complement the existing ADSL (asymmetric digital subscriber line), whose bandwidth and QoS performance are easily influenced by external factors.

Turning next to the core transmission network, considering the growing demand for the benchmark services described above, we can anticipate a need for terabit-class networks in only a few years. Therefore, we are developing a cost-effective, flexible network that combines the high-speed delivery capability of photonics and the practicality of IP technology. More specifically, we have taken an approach called "multi-layer pass-through" that identifies the destination of packets at the edge node of the core transmission network and routes the packets across the network at high speed using the best path available: the lightwaves simply pass through intermediate core nodes. To ensure quality parameters are maintained across the service, the packets are mapped to a QoS level and an IP packet flow control level from edge to edge of the core transmission network, so the specified quality is maintained without QoS control processing at any of the intermediate nodes.

The RENA interface supports both IPv4 and IPv6 protocols, while a dual stack IPv4/IPv6 transmission scheme is used for the core transmission network. To enable interconnection between terminals dedicated to only IPv4 or IPv6, the network also supports automatic conversion between these protocols.

Even though multicasting can be used on the same networks as unicasting, authentication-enabled multicasting protocols are supported for content delivery (the Internet Group Management Protocol for user authentication (IGMP) and the Multicast Listener Discovery Authentication (MLDA) protocol).

Finally, a robust security technology called Moving Firewall (MovingFW) [3] is being implemented to protect RENA against denial-of-service (DoS) and distributed denial-of-service (DDoS) attacks, and to provide a reliable, secure network environment. When an attack is detected, this firewall technology effectively protects large portions of the network by tracing back and stopping the attack near its source.

The service/network control platform also supports end-to-end connectivity, quality control, security, usability, and service control functions. Moreover, the platform provides service connection capabilities that enable corporate users and service providers to easily link their applications to the network and take full advantage of RENA's features. Its functions are listed in Table 1 on page 58. They are all implemented on servers, and to promote better reliability for a large-scale network, clustering and multi-homing techniques are employed across multiple servers.

The control signaling transmission network is a dedicated network that carries control signals supporting the service/network control platform, the user networks, and the transmission network. Its basic roles are to prevent the loss of signals used for control functions, to minimize transmission latency, and to ensure proper sequencing, and security.

The operations and maintenance network is a dedicated network supporting end-to-end operations. It provides immediate intelligence about traffic conditions in the access, core transmission, and control signaling transmission networks, and about the working status of equipment, thus enabling continual smooth end-to-end operations. It also enables remote maintenance for the home gateway.

4. Conclusion

Inspired by the original vision of communications as a means to overcome time and distance, we are moving quickly to put in place a network that, through video and other capabilities, supports genuine more natural communications fostering the emergence of the *multiplizing* of individuals (a coined term meaning that one individual simultaneously plays several roles to fulfill potential "intelligence") and Web-chain behavioral models.

References

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