Standardization Trends in 3GPP Related to IP Interconnect Specifications

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Abstract

NTT Network Service Systems Laboratories has been working over a decade on the standardization of the specifications of migrating from public switched telephone networks to Internet protocol (IP) networks and inter-operator IP interconnection of telephone services due to the expanding use of voice over IP. Thanks to this effort, IP interconnection in Japan will start in 2021. In this article, we describe the trends and NTT's activities in international and domestic standardization of IP interconnection.

Keywords: SIP, IMS, IP interconnection

1. Introduction

To enable users served by different telecommunication operators to talk with each other, the network of each operator needs to be interconnected with one another. With conventional voice over Internet protocol (VoIP) services, each telecommunication operator's network is connected to the public switched telephone network (PSTN), and phone calls between VoIP users are provided through the PSTN. However, telecommunication operators in Japan and the Ministry of Internal Affairs and Communications are planning to change the via-PSTN interconnections to direct VoIP interconnections due to the inefficiency of IP-to-STM (Synchronous Transport Module) conversions and maintenance limits of some PSTN nodes (**Fig. 1**).

The conventional interconnection through the PSTN is achieved with the mature signaling protocol called Integrated Services Digital Network User Part (ISUP), but direct IP interconnection needs to be achieved with the Session Initiation Protocol (SIP), which is excessively complex for telephone services and has a wide variety of usage. NTT Network Service Systems Laboratories has worked on developing new SIP common interface specifications to ensure interoperability of IP telephone networks through domestic and international standardization activities.

2. Standards developing organizations for IP interconnection

Today, SIP is widely used as a protocol for VoIP session control (e.g., connecting and disconnecting communications with the other party). The basic specification of SIP is defined in Request for Comment (RFC) 3261 developed by the Internet Engineering Task Force (IETF), an organization that develops technical standards for the Internet. In addition to the basic specification of RFC 3261, many extensions to the basic SIP have also been developed. RFC 5411, which is a guide for understanding SIP-related RFCs, indicates that there were over 100 related RFCs even in 2009. Telecommunication operators need to select technical specifications among the numerous RFCs to be implemented for providing their VoIP services. To solve this problem, international standards developing organizations, such as the International Telecommunication Union - Telecommunication Standardization Sector (ITU-T) and the 3rd Generation Partnership Project (3GPP), have deliberated service requirements and the network architecture for telecommunication operators to provide their services and published profiles of

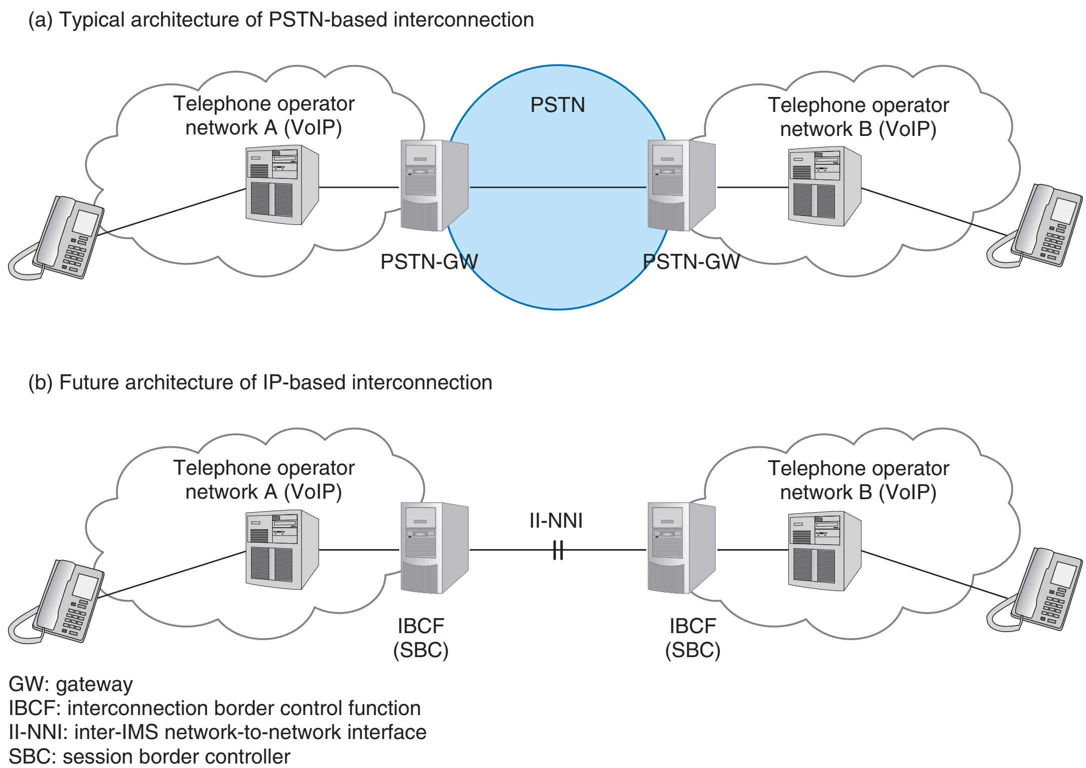


Fig. 1. Architecture of interconnection for VoIP services.

signaling protocols as international standards. Currently, the IP Multimedia Subsystem (IMS) specified by 3GPP is the global standard for telecommunication operator networks using SIP.

3. Latest trends in 3GPP standardization

3GPP was organized to promote the standardization of 3rd-generation and later mobile communications and related technologies (e.g., 3G, 4G, 5G, IMS). The 3GPP specifications are implemented by mobile operators.

3GPP is now vigorously developing technical specifications related to 5G and studies the progress in units called Releases. The goal of Release 15 was developing the basic specification for 5G (Phase 1), that of Release 16 was the completion of the 5G specification (Phase 2), and that of Release 17 is additional enhancements related to 5G. The "5G" referred to here consists of the 5G radio network and 5G core network (5GC), and the IMS nodes are interconnected with the 5GC. The IMS nodes are interconnected with the 4G core network using the Diameter protocol, so achieving interconnection between the IMS nodes and 5GC using this protocol was the goal of Release 15. Achieving interconnection between the IMS nodes and 5GC using HTTP (Hypertext Transfer Protocol) was defined in Release 16 to follow the latest technical trends (e.g., cloud computing). In Release 17, 3GPP is working on the use of 5GC specific features (e.g., network slicing and mobile edge computing) for IMS. As well as 5G enhancements, 3GPP is continuing to introduce new IMS supplementary services. For example, restricted local operator services that enable unauthenticated devices to be given a specific service and multi-device and multi-identity services have been specified. We are proposing many contributions based on the analysis of the impact of these new features and specifications to incorporate them into existing national services and domestic standards with no negative effects.

4. IP interconnection standardization trends

We have worked on standardization at 3GPP, IETF, and the Telecommunication Technology Committee (TTC) (**Fig. 2**), and the outputs are reflected in

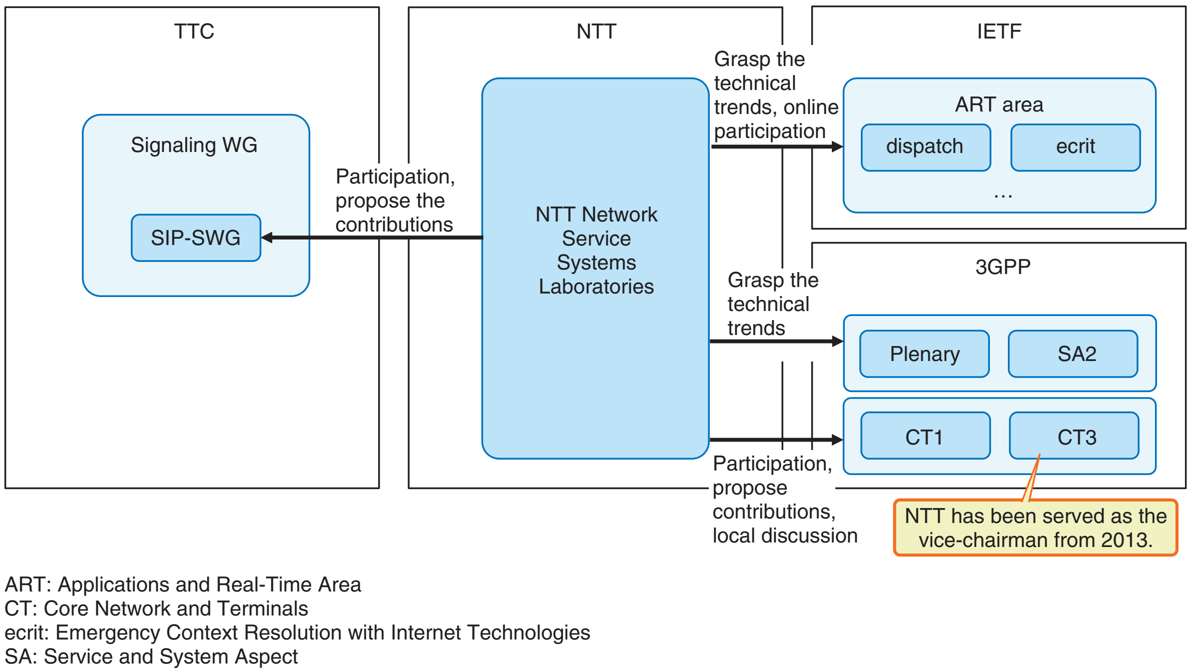


Fig. 2. Standards developing organizations in which NTT participates.

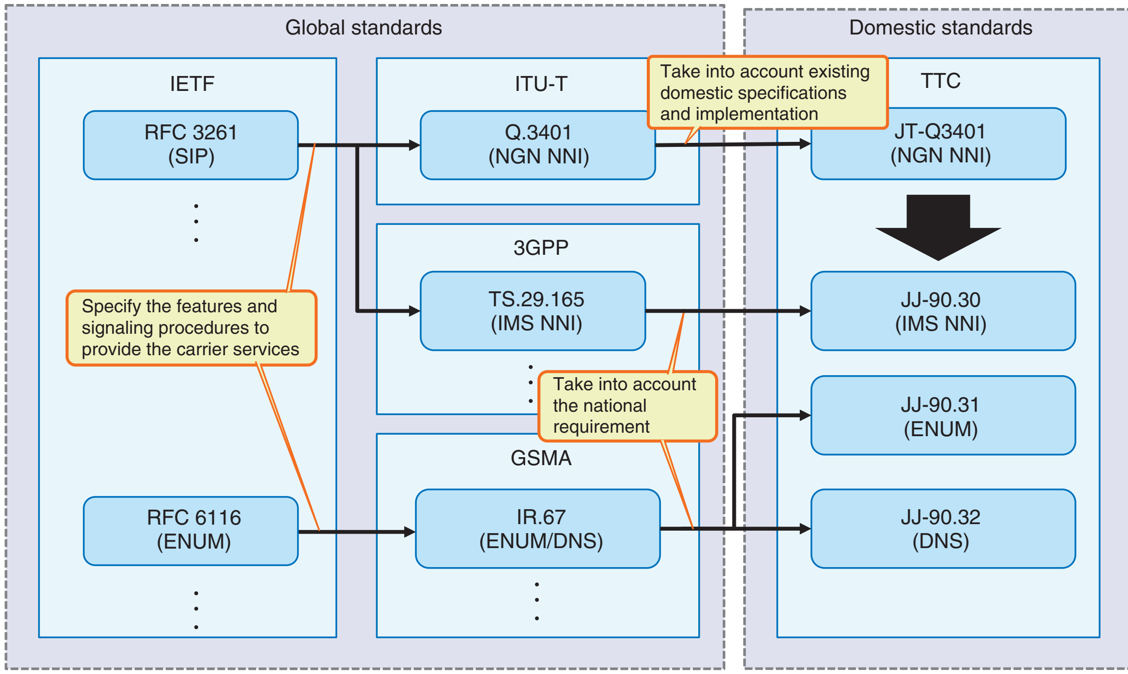
domestic standards for IP interconnection (e.g., TTC JJ-90.30) and global standards (e.g., 3GPP TS 29.165) endorsed by the domestic ones (**Fig. 3**).

The interface of NTT's Next Generation Network (NGN) was originally designed based on the NGN specifications of ITU-T. The domestic network-to-network interface/user network interface (NNI/UNI) specifications of NGN (TTC JT-Q3401/JT-Q3402) were published based on ITU-T Q.3401/Q.3402 considering the national requirements and services in 2007. 3GPP created a new NNI specification between IMS networks in 2008, which is known as Technical Specification (TS) 29.165. We expect that TS 29.165 will become the basis of future domestic NNI specifications for IP interconnection instead of ITU-T ones because the interconnection between fixed and mobile networks needs to be addressed. We began analyzing the differences between ITU-T specification JT-Q3401 and 3GPP specification TS 29.165 and came to the conclusion that it would be feasible to make TS 29.165 compatible with JT-Q3401. We then began work in 2010 on incorporating all stipulations included in JT-Q3401 but not in TS 29.165 and that are not Japan-specific into TS 29.165.

We also proposed two work items to 3GPP as the rapporteur for clarifying the setting condition of the header fields/parameters on inter-IMS NNI (II-NNI) and option items facilitating the inter-operator agreements on the interface, which were accomplished in 2013. This means we completed the preparation for migration from JT-Q3401 to the new domestic II-NNI standard based on TS 29.165 [1]. Moreover, we have successfully reflected the emergency call service [2], which was a Japan-specific requirement, in 3GPP documents, so making a specification of domestic emergency calls based on 3GPP standards also became feasible.

We are proposing contributions related to the feedback from the developments of session border controller (SBC) or other IMS nodes for IP interconnection and commercial operations, e.g., addition of the II-NNI condition for new supplementary services, clarification of the methods of restoration detection on the SIP layer, correction in setting conditions of the SIP header fields used for inter-operator charging, and amendments of descriptions related to the handling of calling party number in ISUP-SIP interworking. Restoration detection on the SIP layer is explained below as an example of our proposals.

Operators will set up gateway nodes called SBCs, which are equivalent to the interconnection border control function (IBCF) in the IMS architecture, at the point of interconnection of their IP telephone networks. In domestic standards, a method using the



DNS: domain name system
ENUM: E.164 number to uniform resource identifier mapping
GSMA: GSM Association

Fig. 3. Relation between standard documents of IP interconnection.

OPTIONS request is specified for detecting restoration of SBCs on the SIP layer after detecting faults in the SBCs. With this method, an SBC detecting the fault of the opposite SBC sends OPTIONS requests periodically and detects the restoration by receiving a successful response from the peer. This method uses the OPTIONS request only in the inter-SBC hop; however, 3GPP specifications define only end-to-end procedures for the OPTIONS request. Because the restoration detection method in domestic standards is useful for reducing downtime and operational errors and is being used for private IP interconnection in some operators, we proposed that the inter-SBC method be allowed explicitly. The proposal was agreed, so the TTC standards could maintain consistency with the 3GPP standards.

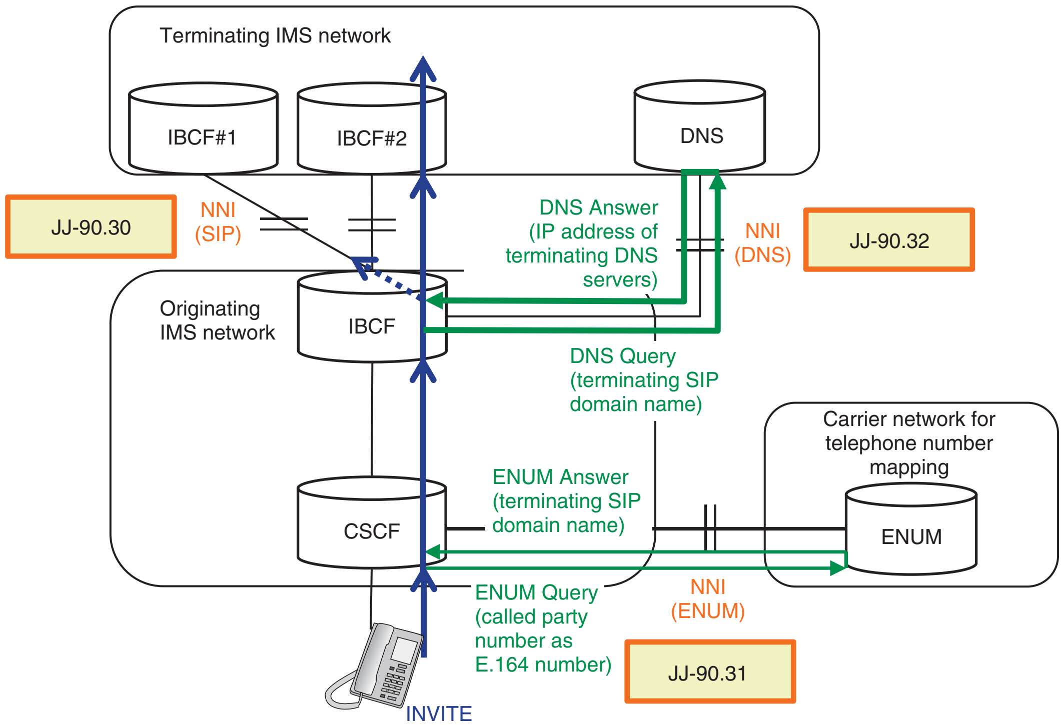
NTT has also contributed to the 3GPP Core Network and Terminals (CT) Working Group (WG) 3, which considers interworking with external networks, as a vice chair since 2013. The activities have resulted in the increasing presence of NTT.

5. Overview of NNI technical specifications in Japan

TTC has published JJ-90.30 as the common interconnection interface specification among IMS operator networks in Japan. This document specifies the II-NNI SIP signaling conditions based on 3GPP TS 29.165. In addition to JJ-90.30, TTC has published JJ-90.31 as the common interconnection interface specification for carrier ENUM (E.164 number to uniform resource identifier mapping), JJ-90.32 as the common interconnection interface specification for SIP domain name resolution with domain name systems (**Fig. 4**), JJ-90.27 as the interconnection interface specification for call transfer and diversion, and JJ-90.28 as the interconnection interface specification for emergency calls. JJ-90.31 and JJ-90.32 are specified based on GSM Association IR.67, and JJ-90.27 and JJ-90.28 are based on 3GPP specifications.

6. Future prospects

Since current TTC standards refer to 3GPP Release



CSCF: call session control function

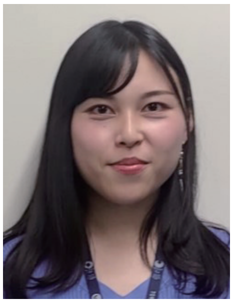
Fig. 4. Relation between domestic standard documents of IP interconnection.

15, we are working on updating the reference to 3GPP Release 16. The progress of 3GPP Release 16 was delayed due to the impact of the COVID-19 pandemic but was finally completed and the specification was frozen in July 2020. We have examined all the changes in Release 16 and applied necessary updates to TTC standards including JJ-90.30. The revised TTC standards will be published in November 2020. Our work at 3GPP is reflected in domestic standards such as this process. Inter-operability testing (IOT) of IP interconnection between domestic operators based on the revised TTC standards is planned to start at the end of this year, and commercial IP interconnection will start in 2021. We will continue to clarify the specifications and make them more practical by taking into account the feedback from IOT.

References

[1] S. Sakaya, K. Arai, and S. Kanegae, "Standardization Efforts in IP Interconnect Specifications" NTT Technical Review, Vol. 12, No. 9, Sept. 2014.
https://www.ntt-review.jp/archive/ntttechnical.php?contents=ntr201409gls.html

[2] M. Ogawa and T. Jocha, "Standardization Trends of the Emergency Call and Standardization Efforts for IP Interconnection," NTT Technical Journal, Vol. 30, No. 2, pp. 57–61, Feb. 2018 (in Japanese).
https://www.ntt.co.jp/journal/1802/files/JN20180257.pdf



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She received an M.S. in physics from Kyushu University, Fukuoka, in 2017. In the same year, she joined NTT Network Service Systems Laboratories, where she researched interconnection between IMS networks. She has been contributing to standardization efforts in 3GPP CT WG1 and CT WG3 since 2018. She is currently researching interconnection between IMS networks.