Traffic Network System

OKANISHI Shogo, KON Mutsumi, CHIKU Shintarou, SUGIYAMA Masao, SAKURAI Hitoshi

Abstract

This paper discusses the characteristics and applicability of various terminals installed at the roadsides of expressways and driveways, including sensors for collecting road management information and information boards for providing road information, and the network dedicated for the communications between the terminals and central offices.

Keywords

traffic network, road management, dedicated communication network, integrated IP/optical network

1. Introduction

The communications network systems of roads administrators are built as dedicated systems for use in the management and maintenance of the roads as well as for secure crisis control systems to be used in case of disasters or accidents. These dedicated communications network systems are reliable and rugged and are adequate for the support of local social infrastructures. They are managed and administered independently without being entrusted to other networks, including those of the carriers.

As the rapid diffusion of IP devices thanks to recent technological innovations has tended to make the communications network systems more economical, many of the existing equipment centers and terminals are being replaced with IP devices and their applications are also advancing among the dedicated communications network systems.

These IP devices are constantly expanding the data transmission bands so wide that the processing capacity of existing networks is often exceeded; this trend causes an increase in the demand for the band enhancement of existing networks.

In addition the ITS (Intelligent Transport Systems, which is the generic name given to new road traffic systems aimed at improvements in road traffic safety, comfort and transportation efficiency) is attracting attention as the new service to arrive in the near future. As ITS should be built as a system integrating humans, roads and vehicles, it needs the most advanced information communications technology.

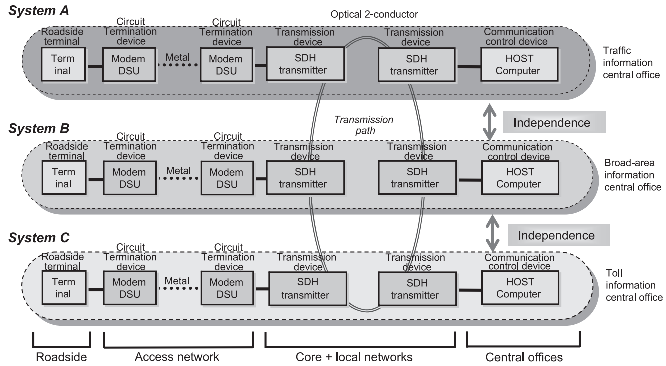
The above conditions make it necessary for the dedicated communication network systems to transfer data traffic efficiently and to offer band flexibility according to both demand and economic considerations.

This paper describes the "Integrated IP/optical network" compatible network solutions based on the latest optical technology that is capable of fulfilling the above conditions.

2. Dedicated Communication Network Systems, Their Present Status

The legacy systems have been used as narrow-band (64kbps) service based mainly on circuit switching. These network systems are built independently in accordance with management targets and system management categories (**Fig. 1**).

After more than ten years have elapsed since the start of optical migration of legacy systems, the dedicated communication network equipment is entering the period in which updating is required to deal with ageing.



The legacy networks were built as individual network systems that are independent of other networks. Each system is divided in the physical layer (L1) according to its management target and system management category, and this strict independence has contributed to the strong reliability of the system.

Fig. 1 Administration mechanisms and management of existing networks (Legacy systems).

If an entire dedicated communication network is updated all together into an IP network, it becomes necessary to migrate all of the components including the central processing unit (server), the network and various terminals into IP-based ones and the costs required for this work would be enormous. Also, since it is a social infrastructure that should not be shut down completely, it would be necessary to build an entirely new system while operating an existing system, and switch the existing system to the new system simultaneously but this is not a practical proposition.

Therefore, the system updating of dedicated communication network into an IP network is performed by introducing legacy/IP hybrid multiplexing devices (ADM nodes), and by switching each subsystem sequentially to the IP-compatible subsystem (**Fig. 2**). This makes the coexistence of the legacy and IP systems possible.

Following the rapid spreading of IP migration of networks, the demand for terminals and servers for the legacy systems has decreased significantly. As most of the new systems succeeding the previous systems are now IP-based, the demand for updating into IP-compatible systems has been increasing at an accelerating speed.

Based on the above background, the introduction of IP technology has shifted from the initial phase to the present massive diffusion phase. What is required now is to optimize the systems from the perspective of the use of all-IP systems from the growth period to the maturity period.

The course of development expected in the future is a spiral one, in which broad-band services that were previously beyond reasonable expectation (such as the IP data communication of a few Mbps) are now able to promote enhancement of the network environment. This leads to other new broadband services (such as the ITS service using IP images). As the demand for these services tends to increase rapidly once they enter the cycle of spreading, it is expected that their traffic will expand more rapidly in the future.

The network should be capable of dealing quickly with the demands and therefore provide flexible extendibility and economy.

3. "Integrated IP/Optical Network" Solving the Issues

With the previous system, the central equipment and terminals have been connected through dedicated interfaces, and their 1-to-1 connection resulted in an individual network with solid reliability based on firm independence.

When the IP becomes the *de facto* standard, convergence of all processing operations into IP processing leads to media fusion by Ethernet as an integrated interface and accommodation of multiple services of the subsystems makes possible the provision of advanced composite services (**Fig. 3**).

It should be noted that the IP network should be a managed network in order to maintain the same reliability as previously. The integrated IP/optical network is equipped with security and quality assurance functions in order to ensure solid reliability. The bandwidth extensions and flexible connections are thereby implemented according to sudden changes in demand in the optical layer and the comfortable access is

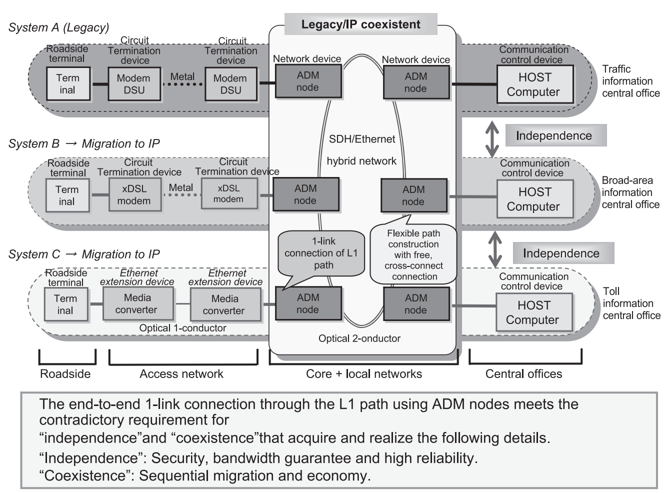


Fig. 2 Mechanism of IP migration per subsystem (Legacy/IP hybrid).

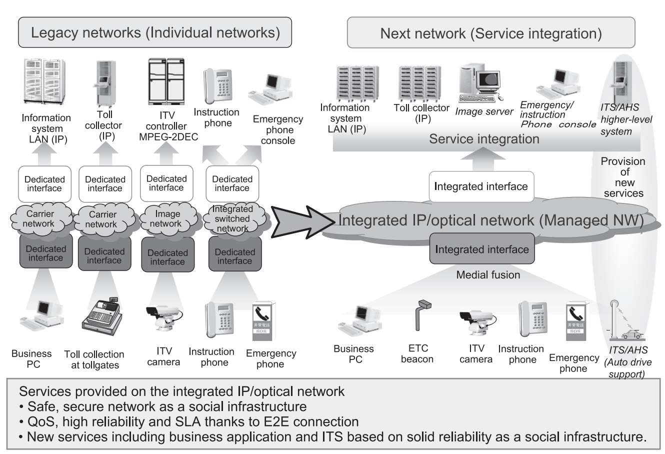


Fig. 3 Provision of composite services by accommodating multiple services (From media fusion to service integration).

provided seamlessly for the core network, local networks and roadside network terminals (**Fig. 4**).

Use of IP-based roadside terminals will accelerate the all-IP migration with the FTTH system (GE-PON) of roadside access networks. The FTTH system concentrates the IP networks of roadside terminals in the 1Gbps band and accommodates them in a local network (**Fig. 5**).

Since the local network should accommodate various terminals that use a large variety of traditional interfaces, it is integrated into an all-IP based network via accommodation of multiple IFs by migrating the legacy IFs into TDM over IP (**Fig. 6**).

A flexible editing function that can allocate the concentrated legacy IFs to the respective destinations is also required. It should give an IP address to each destination and perform transparency on the IP network.

Over a gigabit-class broadband is also required to accommodate the transmission capacity of the roadside access, but this is hard for the traditional time-division multiplexing (TDM) technique from the viewpoint of economy.

To solve this problem, optical ADM nodes that feature wavelength division multiplexing (WDM) technology in the optical layer are used to perform bit-free, format-free, protocol-free multiplexed transmission.

The functions described above makes possible the migration into an all-IP based "integrated IP/optical network" that features both a high transmission performance economically and the implementation of the optimum system configuration for the period of all-IP network (**Fig. 7**).

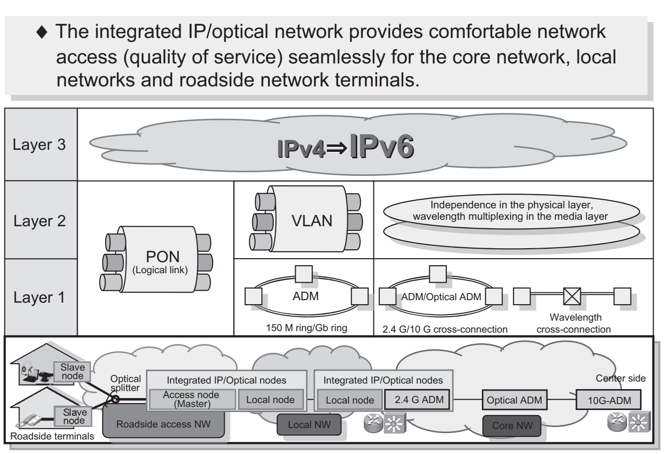


Fig. 4 Configuration of integrated IP/optical network (Core, local and roadside access networks).

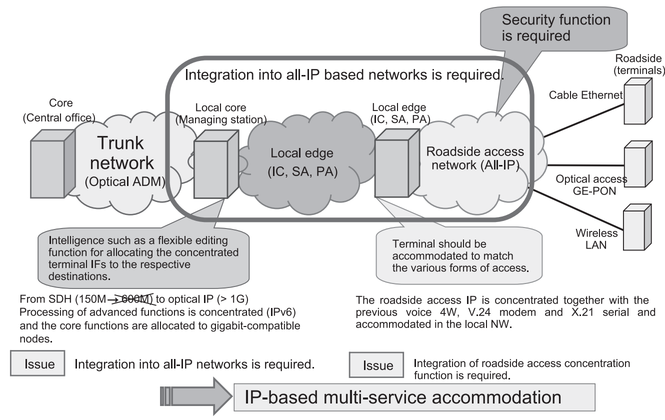


Fig. 5 Functional requirements for integrated IP/optical network (Progress of IP migration of roadside terminals).

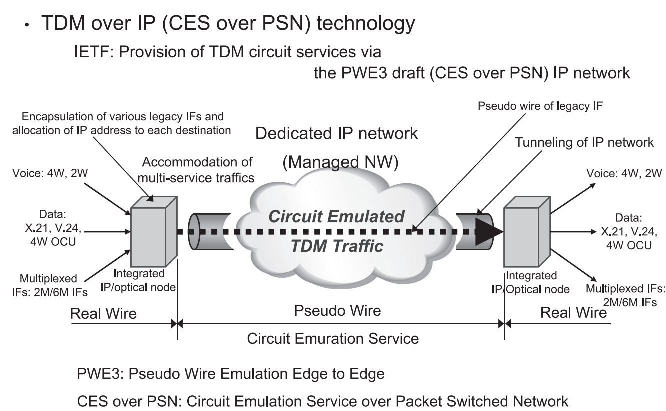


Fig. 6 IP migration of legacy IF (TDM over IP).

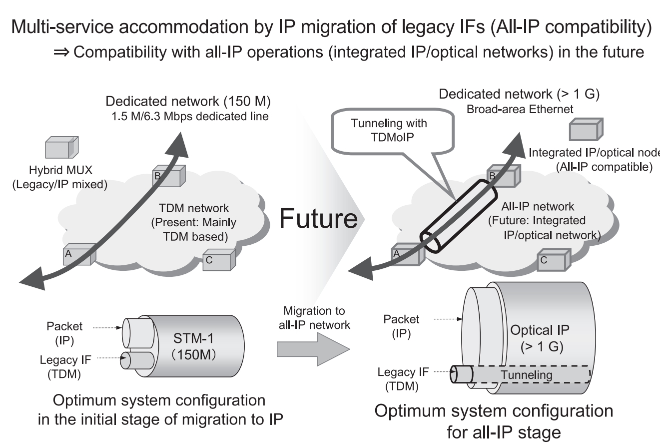


Fig. 7 Migration to an All-IP Network (Integrated IP/Optical nodes).

4. Progress of “Integrated IP/Optical Network” and Its Applications

Mixed accommodation of a variety of interfaces and integration of multiple services into an integrated IP/optical node and single optical fiber enable downsizing of the system. In addition, these can also make radical reform possible, thus improving the utilization efficiencies of current communication facilities including the floor space, power capacity, air conditioning equipment, number of optical fibers and optical channels.

This policy not only doubles the values of the owned assets but also provides them with new value because they can be used in the provision of additional services (**Fig. 8**).

ITS is one of the most anticipated new services and its implementation requires it to be constructed as a system for handling humans, roads and vehicles in an integrated manner. Its road-to-vehicle and inter-vehicle communications necessitate the installation of roadside access networks, and the ITS network should provide a ubiquitous communications environment (**Fig. 9**).

Completely new installation of a national level network is very difficult from the viewpoints of environmental conditions, work scale and economy. However, if existing facilities can be utilized effectively by introducing the integrated IP/optical network, it would be possible to build a broad-area, large-scale network quickly and reliably. In addition, the installation of a national-level network is also facilitated by ensuring security by means of the complete isolation of the confidential data using the optical layer.

The utilization of the various information services of the traffic control system is expected to support the implementation of existing services such as VICS (Vehicle Information and Communication System), AHS (Automated Highway System) and ETC (Electronic Toll Collection system), and also to promote the development of ITS services with higher added values.

The mechanism for providing advanced ITS services based on road-to-vehicle linkage at the national level will be able to be implemented by active utilization of the seamless nationwide communication environment based on the “integrated IP/optical network” as the network platform and by conducting road-to-vehicle communications based on wireless technology such as DSRC as the access platform (**Fig. 10**).

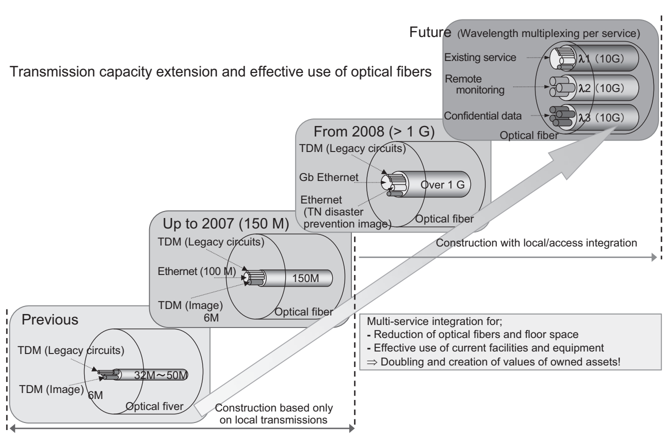


Fig. 8 Progress and efficient use of integrated IP/optical network.

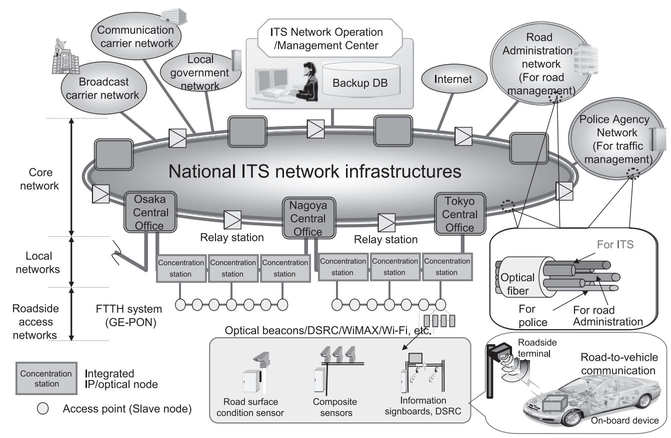


Fig. 9 Application examples of the provision of new services (ITS network).

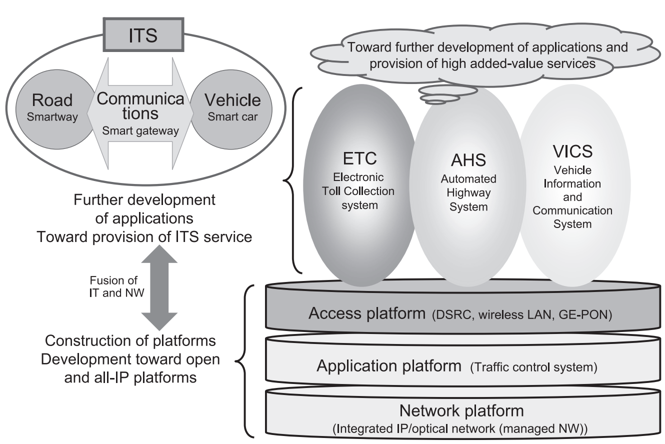


Fig. 10 Development of ITS services (Toward provision of high-value-added services).

The expansion of networks compatible with the "integrated IP/optical network" that employs the-state-of-the-art optical technologies is expected to promote further development of traffic networks as social infrastructures in the future.

5. Conclusion

In the above, we introduced the characteristics and applicability of the network for dedicated use in expressways and driveways.

As the demands for various information and services are expected to increase in the future, introduction of IP technology in terminals and construction of an integrated IP/optical network are regarded as being indispensable.

At the NEC Transportation and Public Network Division, we have been endeavoring to provide various systems for the road administrators. In the future, too, we are determined to continue our studies, proposals and development of next-generation network systems and traffic control systems by forecasting emerging needs.

Reference

1) TANAKA Kumeshiro: "KOSOKU DORO KOTSU KANSEI HANDOBUKKU (Expressway Traffic Control Handbook)," Denkishoin Co., Ltd., 2005.

Authors' Profiles

OKANISHI Shogo
Assistant Manager,
Transportation and Public Network Division,
Broadcast and Control Systems Operations Unit,
NEC Corporation

KON Mutsumi
Assistant Manager,
Transportation and Public Network Division,
Broadcast and Control Systems Operations Unit,
NEC Corporation

CHIKU Shintarou
Staff,
Transportation and Public Network Division,
Broadcast and Control Systems Operations Unit,
NEC Corporation

SUGIYAMA Masao
Manager,
Transportation and Public Network Division,
Broadcast and Control Systems Operations Unit,
NEC Corporation

SAKURAI Hitoshi
Department Manager,
Transportation and Public Network Division,
Broadcast and Control Systems Operations Unit,
NEC Corporation