Development of Service-area Expansion Technologies for Wireless IP Access System

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Abstract

This article presents service-area-expansion technologies that increase the applicability of the wireless IP (Internet protocol) access system (WIPAS), which enables the rapid provision of broadband access by combining wireless technology with optical technology.

1. WIPAS

The wireless IP (Internet protocol) access system (WIPAS) is a 26-GHz-band fixed wireless access (FWA) system based on the combination of optical and wireless technologies ("optical + wireless") and provides broadband access rapidly at low cost [1]. We believe that WIPAS is an efficient way to solve the regional-based digital divide problem and overcome the difficulty of installing optical fibers in apartments in metropolitan areas.

The concept of WIPAS services is shown in **Fig. 1** and the main specifications are given in **Table 1**. WIPAS comprises an access point (AP) attached to a telephone pole and a wireless terminal (WT) attached to the user's home. The AP is connected to an IP network via an optical fiber. The maximum radio transmission rate is 80 Mbit/s (maximum Ethernet frame transfer rate is 46 Mbit/s) and an adaptive modulation scheme is used to maintain the radio link by control-

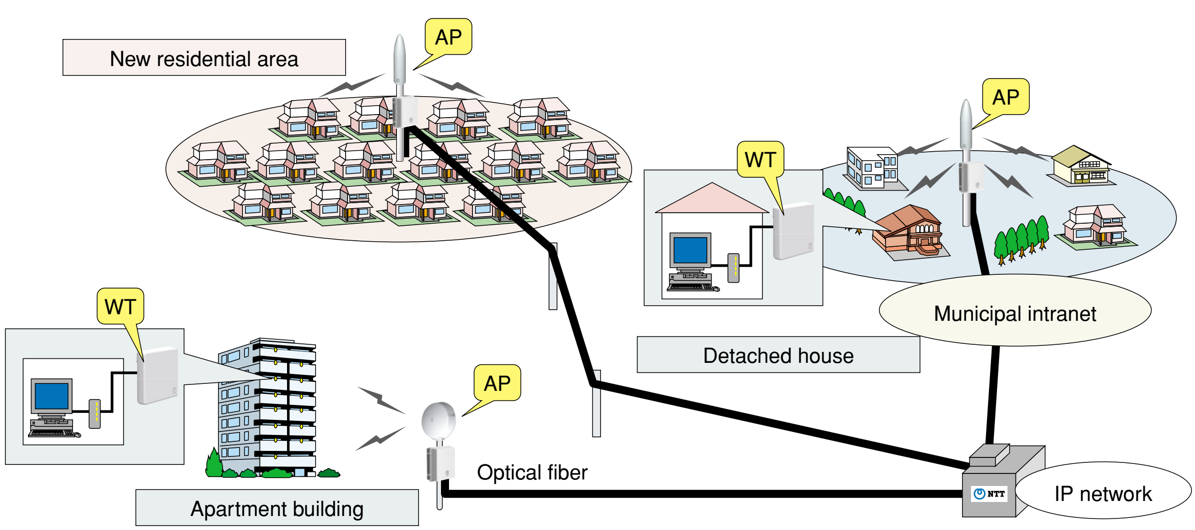

Fig. 1. Service concept.

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ling the transmission rate. We are now promoting the application of WIPAS to multi-dwelling housing such as apartments, detached houses in new residential areas, and municipal intranets that take advantage of local expansion.

2. Current development

This section introduces technologies that have been developed to expand the service area of WIPAS.

2.1 Service area expansion based on "optical + wireless + wireless"

To expand service areas based on "optical + wireless" technologies, we improved the wireless access scheme and developed service-area-expansion technologies based on "optical + wireless + wireless" that can be used to construct inexpensive access circuits quickly. These technologies can provide broadband services relatively efficiently in areas where optical fiber has not yet been installed. When WIPAS is applied to areas where optical fibers cannot be laid for reasons related to the installation environment (rural areas, rivers, main roads, railways, etc.), the construction needed to extend the optical fiber to the AP is often expensive and takes time. One alternative is to construct a wireless backhaul circuit using WIPAS equipment. This lets us expand the coverage economically and quickly to an area with the same circumference as current service areas, as shown in **Fig. 2**.

There are two types of the wireless backhaul schemes in WIPAS. In one, an AP is set opposite the WT, as shown in **Fig. 3**. In the other, two WTs are set opposite to each other. By using a highly directional Cassegrain-type antenna at the master station, we can increase the system gain and achieve a transmission range of approximately 2 km rapidly at low cost. These options let us plan the expansion of WIPAS service areas.

Service-area-expansion technologies based on "optical + wireless + wireless" can also be applied to public wireless LAN (local area network) service, as shown in **Fig. 4**. They enable the service area of public wireless LANs to be expanded to wider open areas such as event halls (possibly on a temporary basis), where there are no LAN cables or optical-cable-based devices, providing abundant flexibility. In addition, by setting two WTs opposite to each other, we can construct an economic and simple wireless backhaul circuit and provide services to remote places.

We aim to use these "optical + wireless" service area expansion technologies in future to apply wire-

Table 1. Main specifications.

Frequency band	26-GHz band
Modulation scheme	QPSK/16QAM adaptive
Transmission scheme	TDM/TDMA/TDD
Ethernet frame transfer rate	QPSK: 23 Mbit/s 16QAM: 46 Mbit/s
Maximum number of WTs accommodated per AP	239
QoS control	Fairness assignment among WTs

QPSK: quadrature phase shift keying
QAM: quadrature amplitude modulation
TDM: time division multiplexing
TDMA: time division multiple access
TDD: time division duplex

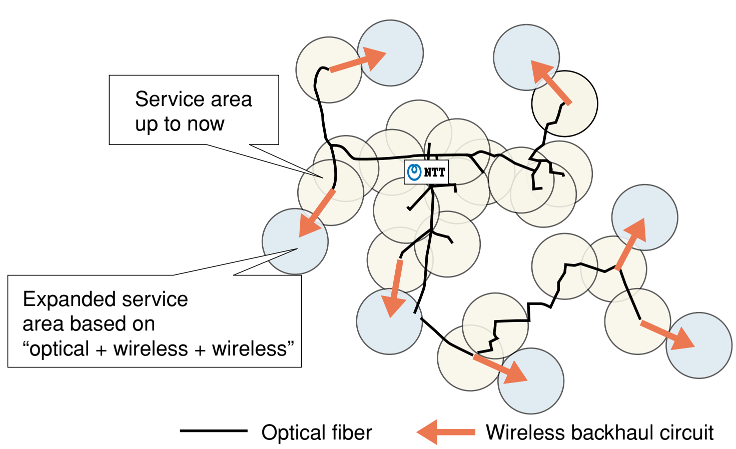

Fig. 2. Area expansion based on "optical + wireless + wireless".

less access to indoor information terminals and provide broadband services to the terminals that can be freely carried anywhere inside the home. The application of WIPAS is illustrated in **Fig. 5**.

2.2 Service area expansion based on simplified internal wiring

Since some rooms do not have a hole in the outer wall, such as an air conditioner duct, that can be used

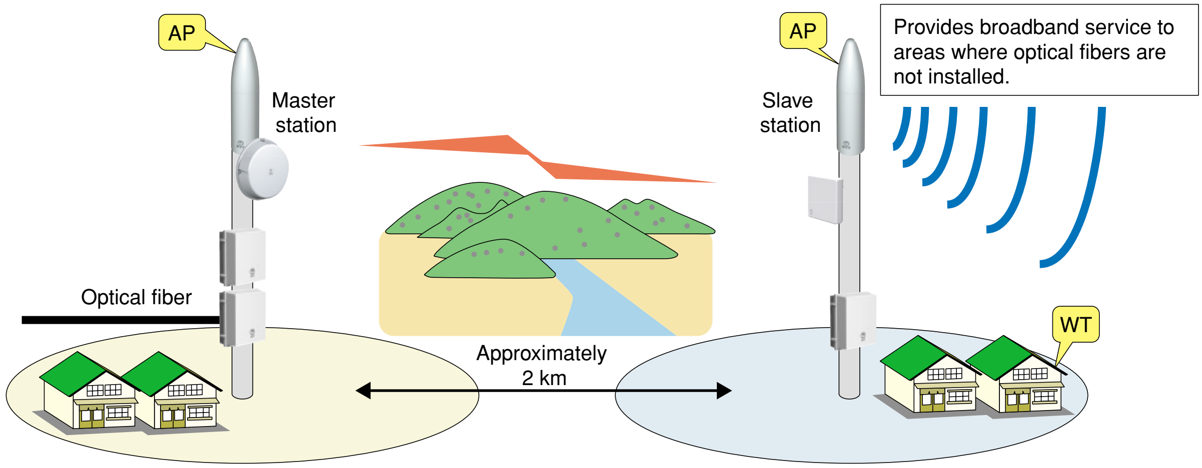

Fig. 3. Technology for expanding the service area based on “optical + wireless + wireless”.

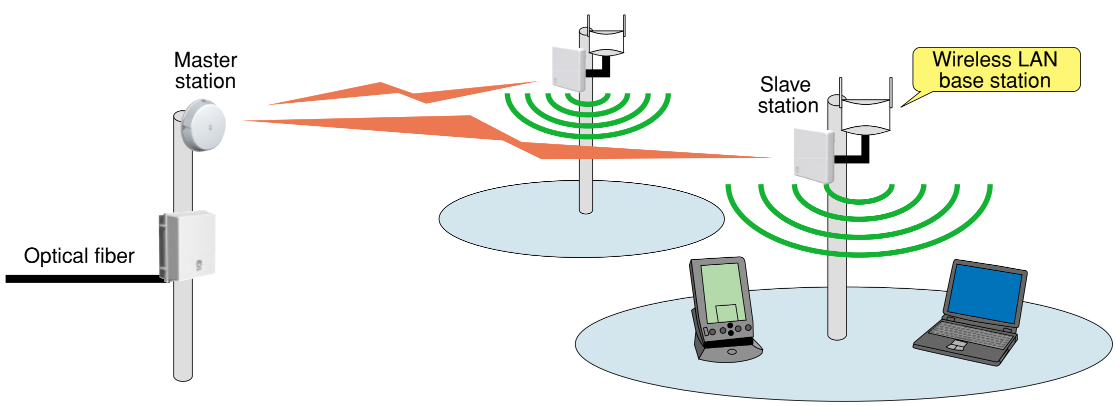

Fig. 4. Expansion of public wireless LAN service areas based on “optical + wireless + wireless”.

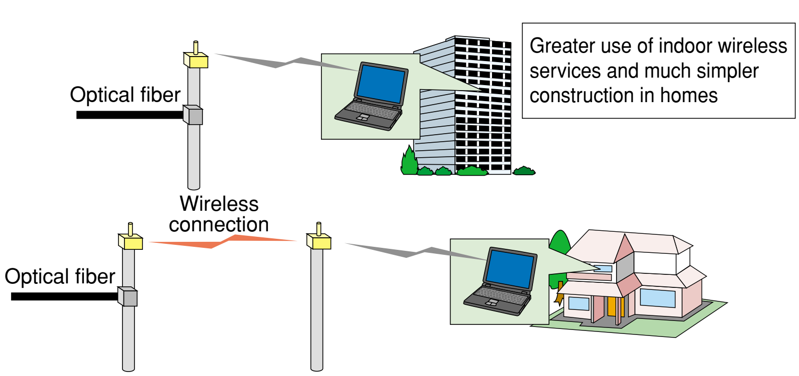

Fig. 5. Application to indoor wireless services.

for wiring, we developed a unit for traversing the gap of a window frame (**Fig. 6**). This makes WT installation easy. Initially, a straight-pair cable was used for the signal lines. However, it was vulnerable to physical impacts and electromagnetic noise, so we developed a new twisted-pair cable (**Fig. 7**) that solves this problem. This wiring design can also be used to connect internal LANs based on the generic category 5 standard cable [2].

2.3 Service area expansion using an extension pole to raise the WT

We are also developing poles to support service area expansion by enabling line-of-sight communication between the AP and the WT attached to a customer's house. Currently, WTs are attached to veranda railings or set under the eaves of a house, so line-of-sight communication cannot be guaranteed because of the obstructions posed by buildings or trees. The newly developed pole solves this problem, enabling us to guarantee service provision to homes. To handle various different attachment situations, we developed three types of poles. Their specifications are given in **Table 2**. The pole designed to be attached underneath the house eaves has an adjustable support arm. We chose to construct it from aluminum to make it lightweight and use alumite processing to provide rust and corrosion resistance (**Fig. 8**). The poles designed to be attached to metal or concrete fences are constructed from stainless steel, which is as thin as possible (1.5 mm) considering weight and durability (**Figs. 9** and **10**). We intend to investigate ways of adjusting the antenna direction after the antenna has been fixed to the pole and will also pursue plans for commercialization.

Fig. 6. Example of the installation of the window-frame-gap traversing unit.

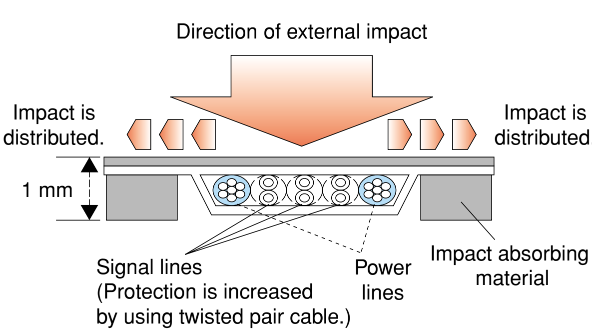

Fig. 7. Design for handling impacts.

3. Future plans

WIPAS based on "optical + wireless" and on "optical + wireless + wireless" provides an effective solution to the digital divide and can handle various communication environments. We are developing and promoting WIPAS to expand service areas further and achieve wireless access networks including indoor wireless access.

Table 2. Pole specifications.

	Length (m)	Weight (kg)	Material
Under eaves	1.2	0.9	Aluminum
On metal fence	3.25	5	Stainless steel
On concrete fence	3.25	5	Stainless steel

Fig. 8. Pole mounted under eaves.

Fig. 9. Pole mounted on metal fence.

Fig. 10. Pole mounted on concrete fence.

References

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[2] http://www.ntt-at.co.jp/news/2004/release43.html (in Japanese).

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