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# HSDPA-to-WiFi Access Point 구현 -HSDPA CPE

## Implementation of HSDPA-to-WiFi Access Point -HSDPA CPE

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**요약** 본 논문은 HSDPA 무선망에 접속하여 WiFi 단말에게 무선 인터넷 서비스 제공이 가능한 HSDPA-CPE 시스템 구현에 관한 것이다. 이 시스템은 상향 인터페이스로 HSDPA를 지원하며 하향 인터페이스로 WiFi 및 100Mbps 이더넷 인터페이스를 지원하는 것을 목표로 한다. 이 시스템은 지하철, 자동차, 선박 등에서 다수의 인터넷서비스 가입자에게 WiFi 단말을 이용하여 무선 인터넷 서비스를 제공할 수 있으며, HSDPA에 가입한 Wi-Fi 단말들이 인터넷에 접속할 수 있다.

**Abstract** This paper is to implement HSDPA-CPE that can provides WiFi terminal with wireless Internet service through the connection to HSDPA wireless network. This system aims to support HSDPA interface in upstream, and WiFi and 100Mbps Ethernet interface in downstream. So, this system can provide multiple Internet customers with wireless Internet service by using WiFi terminal in subway, car, ship, and so on, and WiFi terminals that be registered in HSDPA service can be connected to Internet.

**Key Words** : HSDPA, CPE, WiFi, Ethernet, WCDMA, Access Point

### 1. Introduction

As WiFi is connected to wire network, it provides WiFi terminal with wireless Internet service only at the specific location. So, it can't provide the mobile subscriber on the moving vehicle with WiFi service. As the use of diverse IT (Information Technology) equipments in the moving vehicle such as bus, train, and subway, has been increased, mobile wireless AP is appeared to allow these equipments to connect to Internet.

These days, as mobile communication technologies for high-speed wireless Internet has been developed,

they can support fast mobility and high-speed data communication. As WiFi that provides the existing hot spot with Internet service already has many subscribers and supports low-price high-speed service, it will be made the best use of. But as this WiFi can't support high-speed mobility, new service markets will be created by supporting mobility through Wibro or HSDPA and allowing WiFi subscriber to use Internet service in the mobile vehicle.

Wibro and HSDPA is wireless Internet service, and has the similar characteristics in mobile Internet connection. Wibro is the technology developed for wireless Internet, and HSDPA is the technology based on cell phone. HSDPA is the high-speed packet connection specification that expands WCDMA. As HSDPA provides more fast transmitting and receiving

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rate than one of WCDMA and CDMA, it is called 3.5 generation mobile communication method. if using this technology, it can communicates more fast over five times than WCDMA, and it's downlink speed is the maximum 14.4Mbps. it also has another advantages by providing services through the improvement of WCDMA system without additional investments on the base station.

In this paper, we has developed HSDPA-CPE(wireless AP) that has HSDPA interface in upstream, and Wi-Fi and 100Mbps Ethernet interface in downstream. So, wireless AP based on HSDPA, that is not fixed in specific location but installed in the vehicle, has to provide WiFi terminal with wireless Internet service.

## II. High-Speed Broadband Wireless Access Technologies

<Figure 1> shows the mobile communication technology road map. There are two main series in mobile communication technology, such as synchronous IMT-2000 series and asynchronous IMT-2000 one based on GSM. Third generation service is defined by ITU from CDMA-1x in synchronous series and WCDMA in asynchronous one.

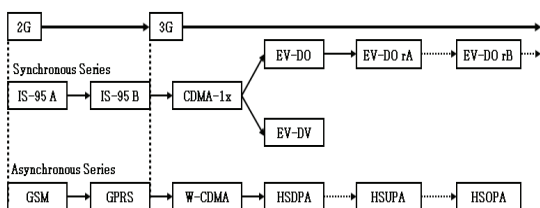


그림 1. 이동통신 기술  
Fig. 1 mobile communication technology

WCDMA(Wide Code Division Multiple Access)/HSDPA(High Speed Downlink Packet Access) is superior to the existing CDMA service technical and service side. WCDMA/HSDPA provides the diverse services, such as video communication, global roaming

function, high-speed data service, service based on USIM (Universal Subscriber Identity Module).

HSDPA is the connection method only for packet added to downlink for high-speed transmission in 3GPP. The first HSDPA standard was established through WCDMA FDD(Frequency Division Duplexing) one, and provides maximum 10Mbps transmission rate in FDD mode using 10MHz transmission bandwidth. Later, HSDPA standard for TDD (Time Division Duplexing) method was established. There are two 3GPP TDD modes, such as HCR (High Chip Rate) TDD mode having 3.84Mcps chip rate at 5MHz bandwidth and LCR (Low Chip Rate) TDD mode having 1.28Mcps chip rate at 1.6MHz bandwidth. As TDD method can assign the resources for up/downlink asynchronously, in the case of assigning the downlink channel maximumly, it maximums the transmission efficiency by introducing HSDPA, and supports maximum 10.2Mbps for HCR TDD mode, 2.8Mbps for LCR TDD mode.

표 1. HSDPA 기술  
Table 1. HSDPA Technology

item	description
<b>General</b>	<ul style="list-style-type: none"> <li>- Mobile communication telephony service that improves the downlink rate of WCDMA</li> <li>- Improve of uplink rate through HSDPA</li> <li>- use of OFDMA MIMO smart antenna</li> </ul>
<b>bandwidth</b>	5MHz
<b>Rate</b>	Maximum 10Mbps for downlink
<b>speed</b>	within 300km/h
<b>QoS</b>	Guarantee
<b>Service</b>	Voice (Basic), Data
<b>data service</b>	Data with high-quality and less than medium capacity <ul style="list-style-type: none"> <li>- video telephony, MMS, M-Commerce</li> <li>- Internet connection</li> </ul>
<b>Terminal type</b>	<ul style="list-style-type: none"> <li>- Cell/Smart phone, PDA, PMP</li> <li>- hand-held PC and note book</li> </ul>

## III. Implementation of HSDPA-to-WiFi Access Point (HSDPA-CPE)

These days, as mobile communication technology

that can support high-speed Internet has been developed, it can support mobility and high-speed data communication. WiFi, which provides the existing hot spot with Internet service, already has secured many subscribers, and also has the merit of low price high-speed service. So it will be expected to be used largely in the future. But this WiFi can not support mobility. if this WiFi supports the mobility through interworking with HSDPA, the existing WiFi subscriber can use Internet service in vehicle, such as bus, train, and subway. So this will create the new service market through the integration of merits in two technologies.

<Figure 2> shows HSDPA-CPE Deployment. HSDPA-CPE for service provider use HSDPA as uplink interface, and connects to Internet through that interface. This part is service provider area, and network has to provide many functions of WiFi terminal, such as authentication, address assignment, and mobility.

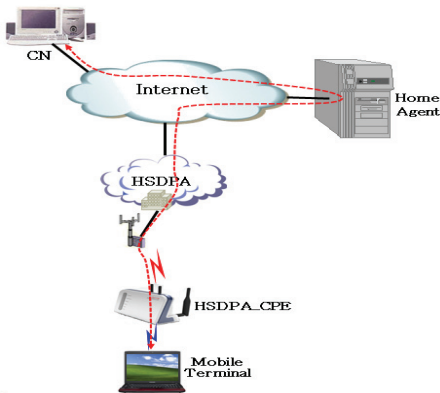


그림 2. HSDPA-CPE 배치  
Fig. 2 HSDPA-CPE Deployment

The connection between many subscriber terminals and HSDPA-CPE can be established through the interfaces that ISP provides, such as WiFi, and Ethernet. Subscriber terminal can receive authentication, address assignment, and mobility that ISP provides through these interfaces. In this figure, home agent is a kind of router. One of routers on home

link has the registration information of mobile node. if mobile mode goes out home link, home agent delivers the packet to the current location of mobile node. if mobile node is in home link, mobile node registers its own current address to home agent. And when mobile node is in home, home agent is a node on home link that does not perform any forwarding function. CN(Correspondent Node) is a kind of node that mobile node communication with.

The existing wireless LAN AP is fixed at the specific location, but HSDPA-CPE platform is moveable. HSDPA-CPE platform supports Ethernet, WiFi, and HSDPA interfaces. So, along with the integration of wire and wireless communication, it can provide the Internet service in moving vehicle, such as bus, train, subway, and so on, through interworking with base station. <Figure 3> shows HSDPA-CPE architecture. it has two HSDPA interfaces for uplink, and WiFi and 100Base-Tx interfaces for downlink. And as option, it supports VoIP telephony interface as option, which is used for Internet telephony service. Additional, it has flash memory to store S/W image and various parameters, and SDRAM for operation

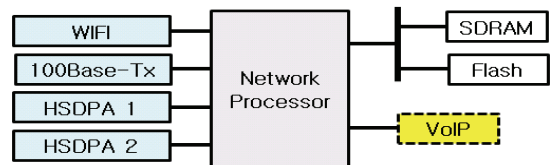


그림 3. HSDPA CPE 구조  
Fig. 3 HSDPA CPE Architecture

<Figure 4> shows the board configuration of HSDPA-CPE. HSDPA-CPE consists of network processor, SDRAM, Flash ROM, Fast Ethernet PHY Chip, RF module, HSDPA interface module, 100Base-T Ethernet port. In left side of <Figure 4>, There are two USB ports for HSDPA module, one Ethernet interface, antenna port, and input power.

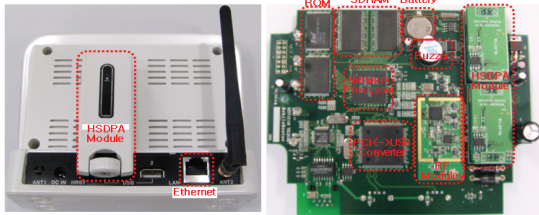


그림 4. HSDPA-CPE의 보드 구성도  
Fig. 4 The board configuration of HSDPA-CPE

<Figure 5> shows the interface architecture of HSDPA-CPE. HSDPA-CPE is implemented to support WiFi and HSDPA interfaces. This architecture consists of user and kernel areas. User area performs the connection management function for user to connect to Internet. Kernel area is responsible for the driver to drive WiFi and HSDPA through the interworking with kernel IP stack, and the outer interfaces for WiFi and HSDPA.

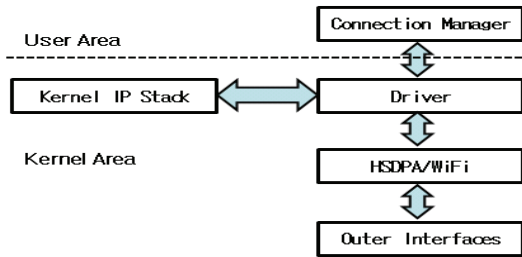


그림 5. HSDPA-CPE 인터페이스 구조  
Fig. 5 The Interface architecture of HSDPA-CPE

<Figure 6> shows the protocol stack of HSDPA-CPE. HSDPA-CPE consists of the interface based on IPv6 and the control protocol for HSDPA service.

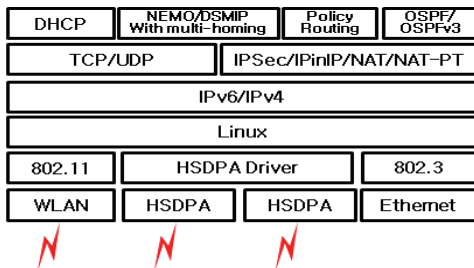


그림 6. HSDPA-CPE의 프로토콜 스택  
Fig. 6 The Protocol Stack of HSDPA-CPE

HSDPA-CPE can support IPv6 basic functions, such as RFC2461 (Neighbor Discovery for IPv6), RFC2462 (IPv6 Stateless Address Auto-configuration), and RFC3587 (IPv6 Global Unicast Address Format) through Linux kernel. Also, HSDPA-CPE can support RFC2740 (OSPF for IPv6) routing protocol through OSPF/OSPFv3.

Mobility in NEMO (Network MObility) network is done by the gateway called MR (Mobile Router). NEMO network is the environment having more than one IP subnet and the specific type of one having the characteristics that part of network or one subnet can be moved.

#### IV. Performance Test of HSDPA-to-WiFi Access Point

<Figure 7> shows the basic test configuration of HSDPA-CPE based on commercial HSDPA network. In this configuration, HSDPA uses IP address assigned after authentication through server. In downstream, Ethernet (LAN) or WiFi (WLAN) is used, and in upstream, private network is established through HSDPA-CPE and DHCP (Dynamic Host Configuration Protocol). The communication performance between server and client for uplink and downlink are measured using NAT and port forwarding function within HSDPA-CPE.

<Figure 7> a) shows HSDPA to LAN (Ethernet) configuration. <Figure 7> b) shows HSDPA to WiFi one. In this configuration, HSDPA-CPE goes through authentication process and then receives IP address from HSDPA server. And bandwidth, RSSI (Received Signal Strength Indication), and CNIR (Carrier to Interface Ratio) are measured using TCP traffics.

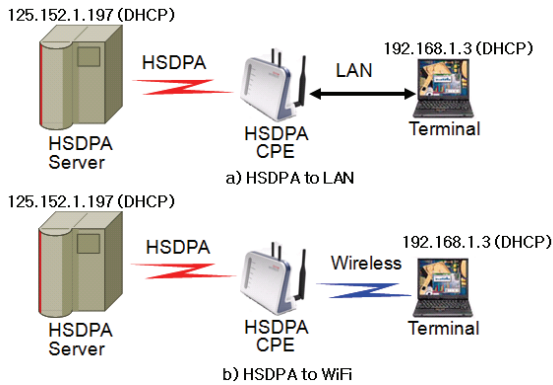


그림 7. HSDPA-CPE의 기본 시험 구성도  
Fig. 7 The basic test configuration of HSDPA-CPE

<Figure 8> shows the downlink/uplink bandwidth of HSDPA-CPE. The downlink bandwidth is about 1.34Mbps, and the uplink bandwidth is about 581kbps. HSDPA can receive data in maximum 14Mbps theoretically, but in fact, it can receive data in 2~3Mbps. As HSDPA has been commercialized in earnest, the mobile data communication environment of maximum 2Mbps level has been leveled up to maximum 14Mbps. So multimedia service, such as mobile video phone, will be implemented in stable.

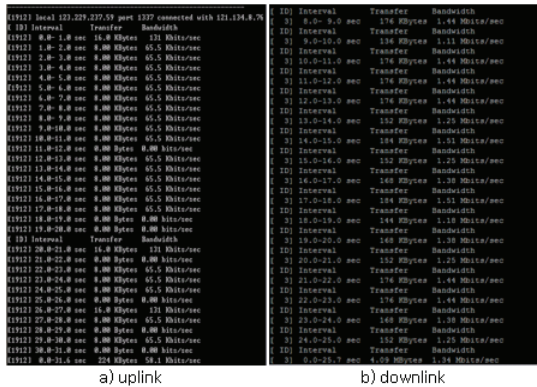


그림 8. HSDPA-CPE의 대역폭  
Fig. 8 The bandwidth of HSDPA-CPE

<Figure 9> shows the downlink/uplink bandwidth of HSDPA-CPE measured at various points.

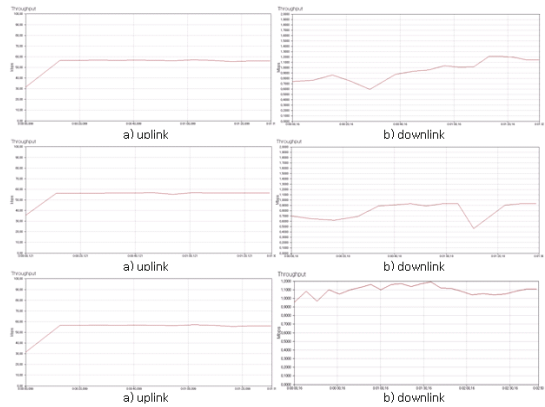


그림 9. 여러 포인트에서 HSDPA-CPE 대역폭  
Fig. 9 HSDPA-CPE bandwidth at various points

in the case of uplink, it shows average 53Kbps. in the case of downlink, it shows the different characteristics at each location because of signal strength variation. In the case of installing the base station for indoor, communication rate is 14Mbps rightly under the base station having good quality, 7~8Mbps in the vicinity of the base station having comparative good quality, and 2Mbps in cell boundary. This is why modulation method and coding rate are controlled per 2ms according to the radio signal state. Also, even though maximum rate is 14Mbps, if there are multiple users in same cell, the average rate is less than 4Mbps because of sharing the rate. So, HSDPA has the characteristics that its rate varies with communication traffic.

## V. Conclusion

In this paper, HSDPA-CPE has been developed that supports HSDPA interface for uplink, and WiFi or 100Mbps Ethernet interface for downlink. This system supports HSDPA interface in upstream, and WiFi or 100Mbps Ethernet interface in downstream. This system can be used for business and user. For business, this system can provide multiple Internet users with wireless Internet service using WiFi terminals in vehicles, such as subway, car, and ship.

For individual user, general users buy this system, and then they install this system at the specific location. So, multiple WiFi terminals that registers to HSDPA service can connect to Internet simultaneously.

In near future, this test result will be used for implementing mobile access point having multiple interface, such HSDPA and Wibro.

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