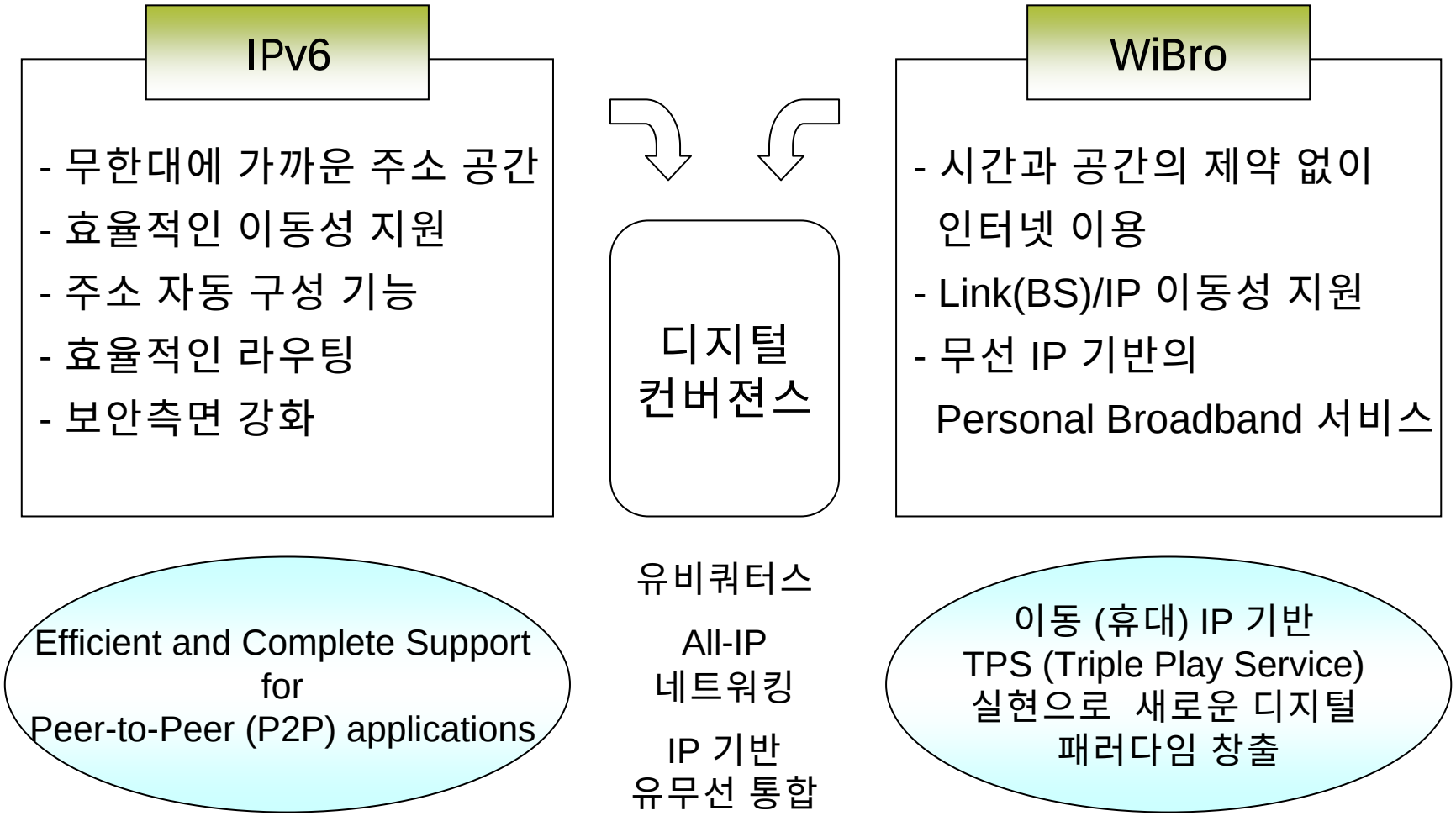
IEEE 802.16/와이브로 ISP 액세스 망 적용 시나리오 및 IPv6 링크 표준 모델

한국기술교육대학교
한연희
yhhan@kut.ac.kr
2006.03.30

Table of Contents

Introduction

Why IPv6 over WiBro?



TPS: 초고속 인터넷, 전화(VoIP), 방송(IP-TV)

국내외 표준화 Trends

- **IETF**
  - **16ng (BoF) – IPv6 over IEEE 802.16**
    - **2005년 11월에 새롭게 신설 – 100여명 참석 (WG화 56명 찬성, 2명 반대)**
    - **한국 연구자들이 주도적으로 참여**
  - **MIPSHOP**
    - **FMIPv6 over WiBro 제안건(삼성, ETRI) WG Item 채택 유망**
- **WiMAX**
  - **NWG**
    - **Release 2에는 IPv6 및 Mobile IPv6 관련 기술을 넣는 계획 수립**
      - **IPv6 Subteam 구성**
    - **IETF 16ng 의 결과를 WiMAX에서 활용하려고 함**
- **IEEE**
  - **IEEE 802.16g**
    - **네트워크 측면에서의 관리 및 제어 평면 규격 정의**
- **TTA**
  - **IPv6 over WiBro WG** (IPv6 PG – PG210)
    - **2005년 10월경 신설 - 2006년 국내 고유 표준 제정 목표**
- **IPv6 Forum Korea**
  - **Mobility WG**
    - **IPv6 over IEEE802.16 연구**

The 64th IETF 16ng BoF Agenda (2005.11)

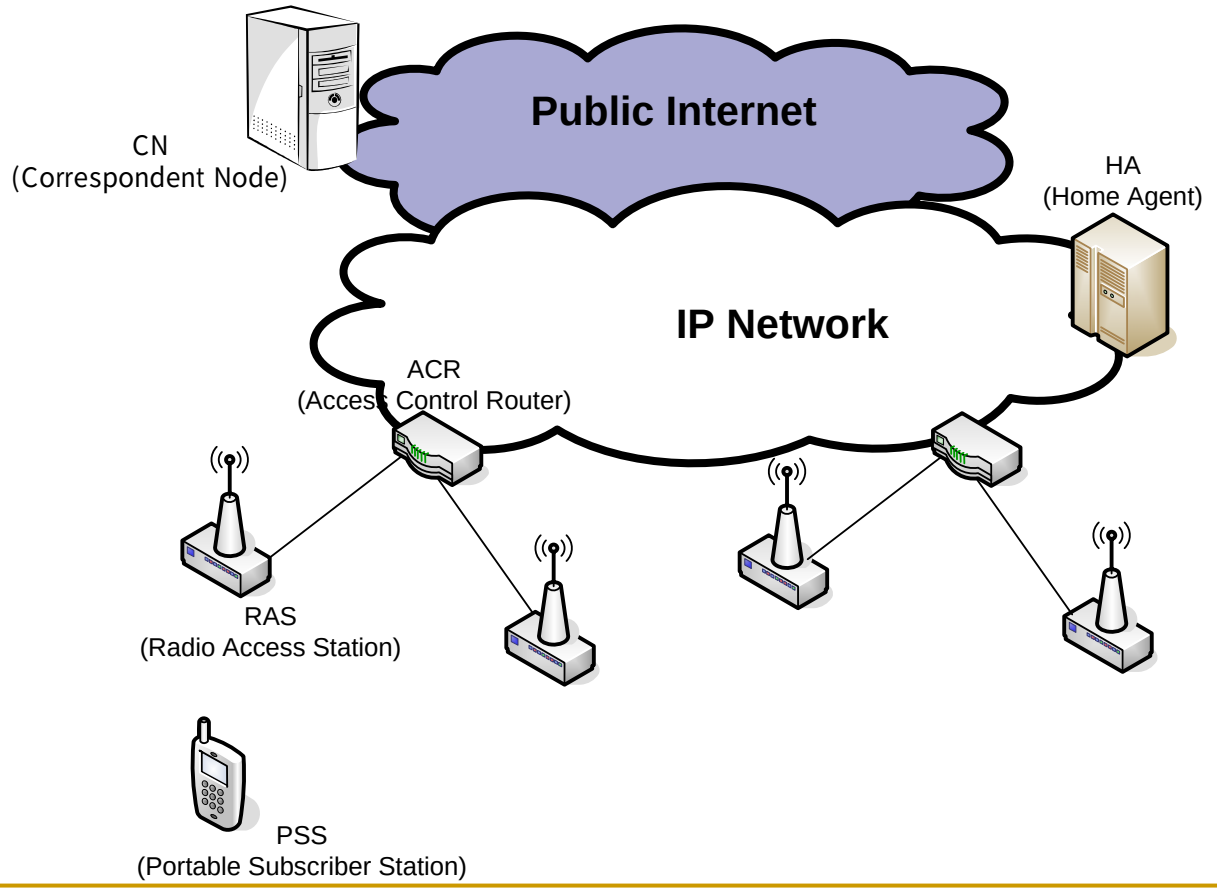
- **IETF 16ng Agenda – 11월 8일 (의장: 박수홍-Samsung DM, Gabriel-Microsoft)**
  - **An Introduction to IEEE 802.16(e) (15 minutes)**
    - **presenter: Hannes Tschofenig <hannes.tschofenig@siemens.com>**
  - **WiMAX Forum Network Working Group Overview, (15 minutes)**
    - **presenter: Parviz Yegani <pyegani@cisco.com>**
  - **IEEE 802.16 and NETLMM Overview, (5 minutes)**
    - **presenter: James Kempf <kempf@docomolabs-usa.com>**
  - **IPv6 Deployment over IEEE 802.16, (5 minutes)**
    - **presenter: Yu-Seon Kim <yseonkim@kt.co.kr>**
  - **Transport of IP over IEEE 802.16, (10 minutes)**
    - **presenter: Jeff Mandin <jeff@streetwaves-networks.com>**
  - **Scenarios and Considerations of IPv6 in IEEE 802.16 Networks, (10 minutes)**
    - **presenter: Myung-Ki Shin <mkshin@pec.etri.re.kr>**
  - **IPv6 NDP Implications in IEEE 802.16, (10 minutes)**
    - **presenter: Syam Madanapalli <syam@samsung.com>**
  - **Fast Mobile IP Handovers over IEEE 802.16e Networks, (10 minutes)**
    - **presenter: Rajeev Koodli <rajeev@iprg.nokia.com>**
  - **16ng Problem Statements, (5 minutes)**
    - **presenter: Junghoon Jee <jhjee@etri.re.kr>**
  - **Overview of proposed charter, (5 minutes)**
    - **presenter: chairs**
  - **Charter discussion, (25 minutes)**
    - **presenter: chairs**

The 65th IETF 16ng BoF Agenda (2006.03)

- **IETF 16ng Agenda – 3월 22일 (의장: 박수홍-Samsung DM, Gabriel-Microsoft)**
  - **16NG Problem Statement, (20 minutes)**
    - **Presenter: Junghoon Jee<jhjee@etri.re.kr>**
  - **WiMAX Forum NWG Stage 3 work for IPv6, (10 minutes)**
    - **presenter: Basavaraj Patil <Basavaraj.Patil@nokia.com>**
  - **IPv6 over IEEE 802.16 Solution Framework, (10 minutes)**
    - **presenter: Syam Madanapalli <syam@samsung.com>**
  - **Charter discussion, (50 minutes)**
    - **presenter: Yu-Seon Kim <yseonkim@kt.co.kr>**
  - **IPv6 NDP for Common Prefix Allocation in IEEE 802.16, (5 minutes)**
    - **presenter: Hongseok Jeon**
  - **IPv6 Packet Tramsmission over 802.16 Networks, (5 minutes)**
    - **presenter: Myungki Shin <mkshin@pec.etri.re.kr>**
  - **Real-Time usage of IEEE 802.16: Problem Statement, (5 minutes)**
    - **presenter: Pedro Neves**
  - **QoS Aware Real-Time Support for IPv6 in IEEE 802.16 Backhaul scenarios, (5 minutes)**
    - **presenter: Pedro Neves**

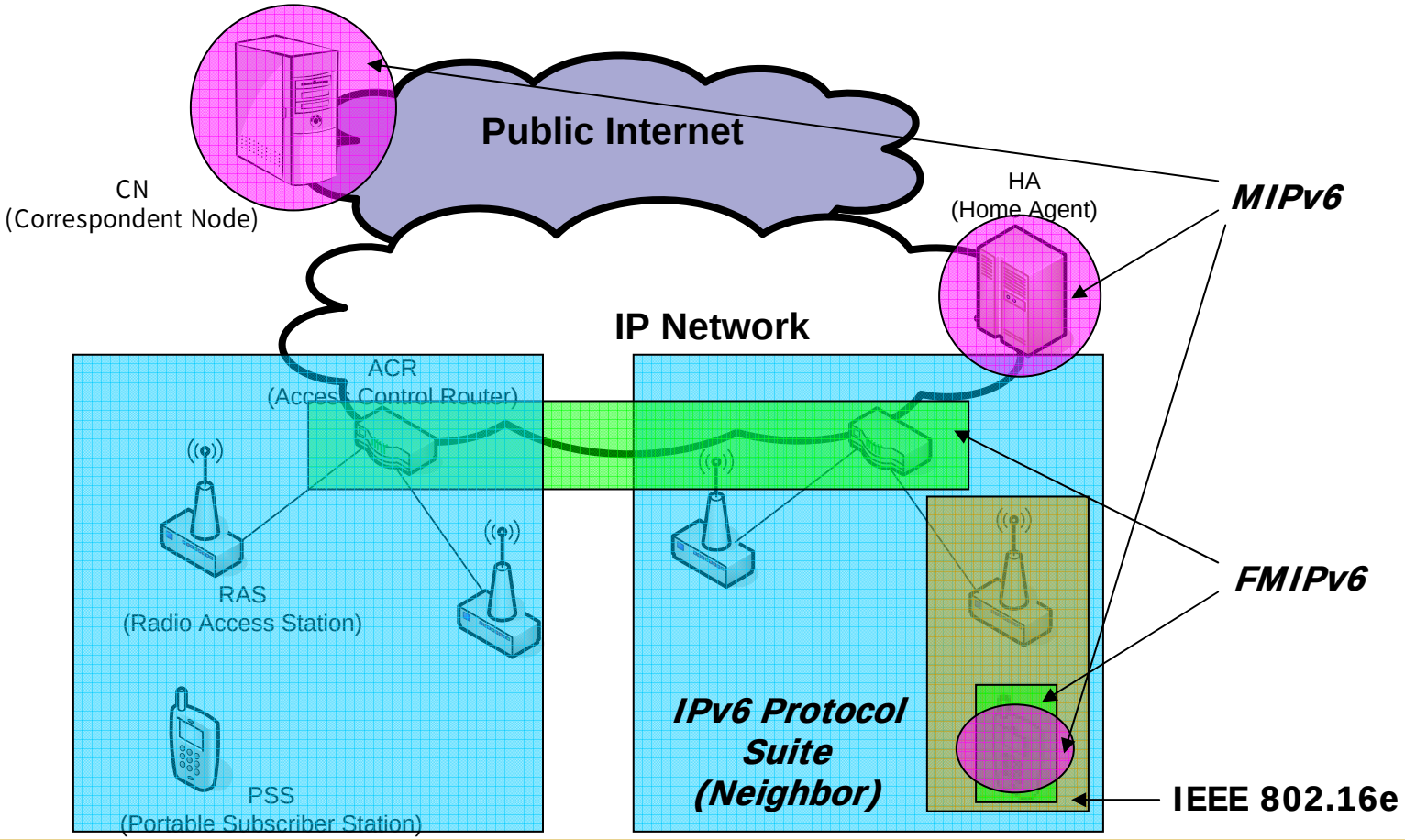
IEEE 802.16/WiBro

- Network Model in WiBro



IPv6 over IEEE 802.16/WiBro

- IPv6 & Network Model in WiBro



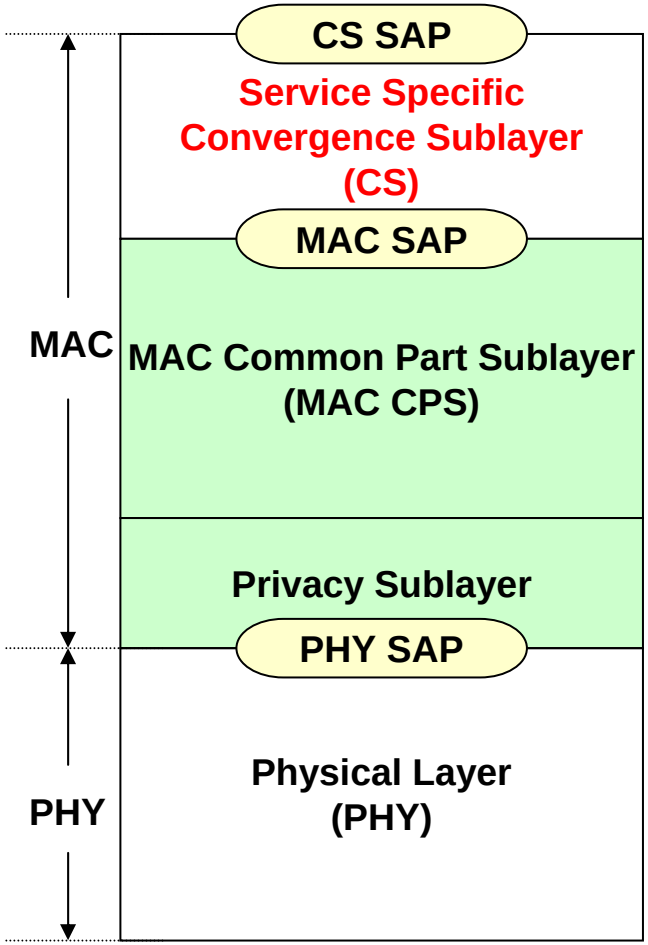
IPv6 Technical Issues over WiBro

- **IPv6 Link Model Determination (Packet Transport)**
- **IPv6 Multicast Address Mapping**
- **IPv6 Neighbor Discovery Service**
- **IPv6 Mobility Service**
- **Fast IPv6 Mobility over WiBro**

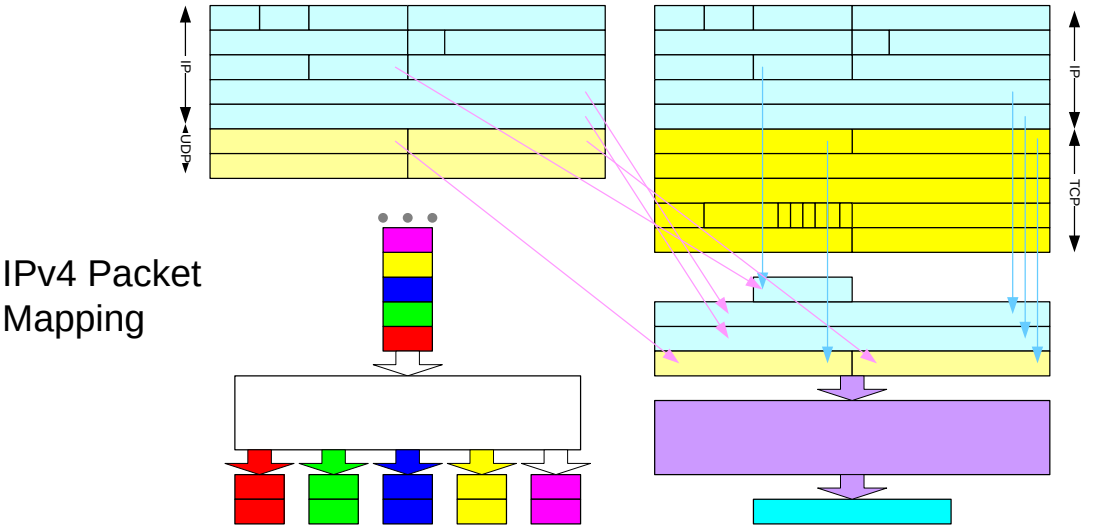
IPv6 Link Model Determination (Packet Transport)

Link Model Determination

- **Convergence Layer & IPv6 Packet Transport**

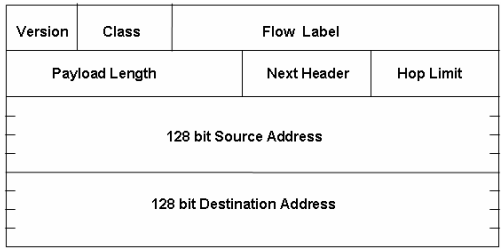


1) Transformation or mapping of external network data
2) Classifying external network SDUs and associating them to the proper MAC service flow and Connection ID



IPv4 Packet Mapping

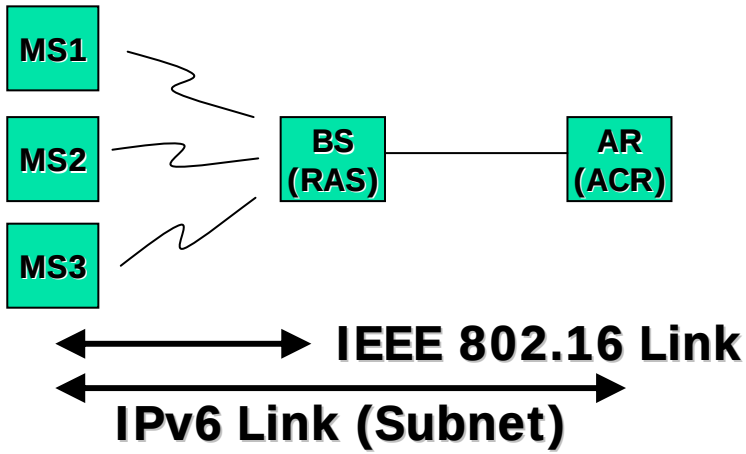
IPv6 Packet header



How to efficiently map ?

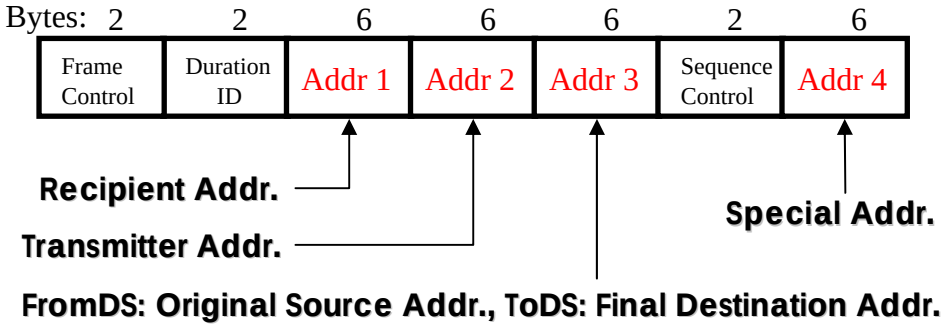
Link Model Determination

- **IEEE 802.16 Link vs. IPv6 Link (Subnet)**

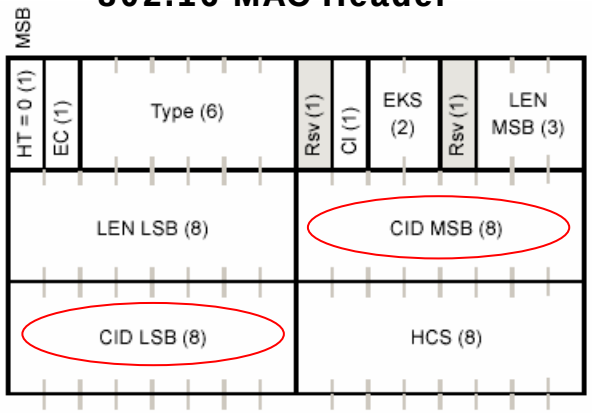


From the viewpoint of IPv6 ND, BS is just link-level bridge. Unlike IEEE 802.11, however, IEEE 802.16 BS is always acting as the termination point for a communication by using Connection ID instead of MAC address

802.11 MAC Header



802.16 MAC Header

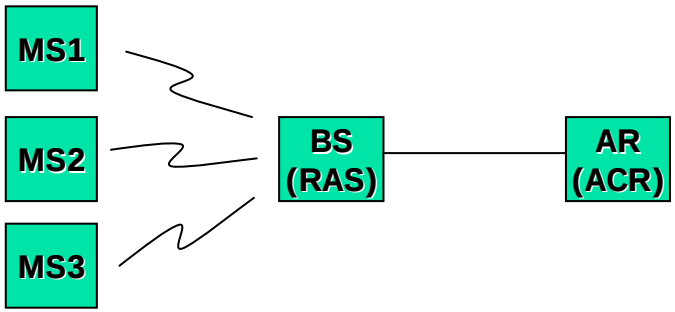


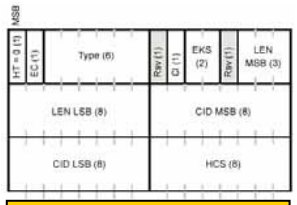
Link Model Determination

- **A Recipe for IP transport over IEEE 802.16**
  - **Determine an IP Link(subnetwork) model**
    a. **Can view the PMP (Point-to-Multipoint) network as a collection of point-to-point links (WiBro)**
    b. **Can create an "emulated broadcast network" at layer 2 which the IP layer then regards as a regular IEEE 802-style broadcast network**
  - **Implement the subnetwork model in the 802.16 PMP network via the following steps:**
    1) **Determine an "appropriate" 802.16 CS**
       a. **Ethernet CS**
       b. **IP CS (WiBro)**
    2) **Define how to configure the classifier tables in the CS (either statically or dynamically) to support the subnetwork model**
    3) **If necessary, place additional (and hopefully simple) functional elements into the protocol stack between the IP layers and the 802.16 MAC (WiBro에서는 고려 안함)**

Link Model Determination

Ethernet CS





Ethernet Header (Source MAC, Destination MAC)

IPv6 Header (Source IP, Destination IP)

DATA Payload

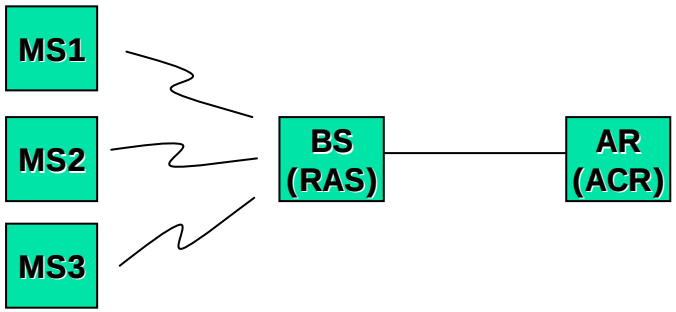
Ethernet Header (Source MAC, Destination MAC)

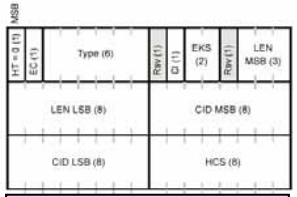
IPv6 Header (Source IP, Destination IP)

DATA Payload

Overload on Wireless Links

IP CS / GRE Tunnel





IPv6 Header (Source IP, Destination IP)

GRE Header

IPv6 Header (Source IP, Destination IP)

DATA Payload

IPv6 Header (Source IP, Destination IP)

DATA Payload

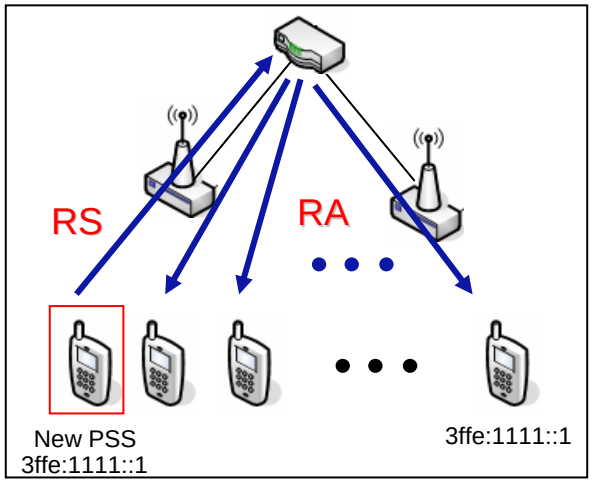
WiBro's approach. But the followings happen:

1) Stateful network monitoring
2) Unsolved problems with IPv6 autoconf.
3) Difficult to support for control plane protocols
4) Difficult to support for peer-to-peer communication in a IPv6 link

IPv6 Multicast Address Mapping

IPv6 Multicast Address Mapping

- IPv6 Signaling Multicast may put heavy loads on the wireless link



[접근방법]

Option 1: RS/RA를 내보내지 않음

- MAC Singling Message 내에 RS 및 RA를 Embed 함

Option 2: RS/RA를 Unicast로 보냄

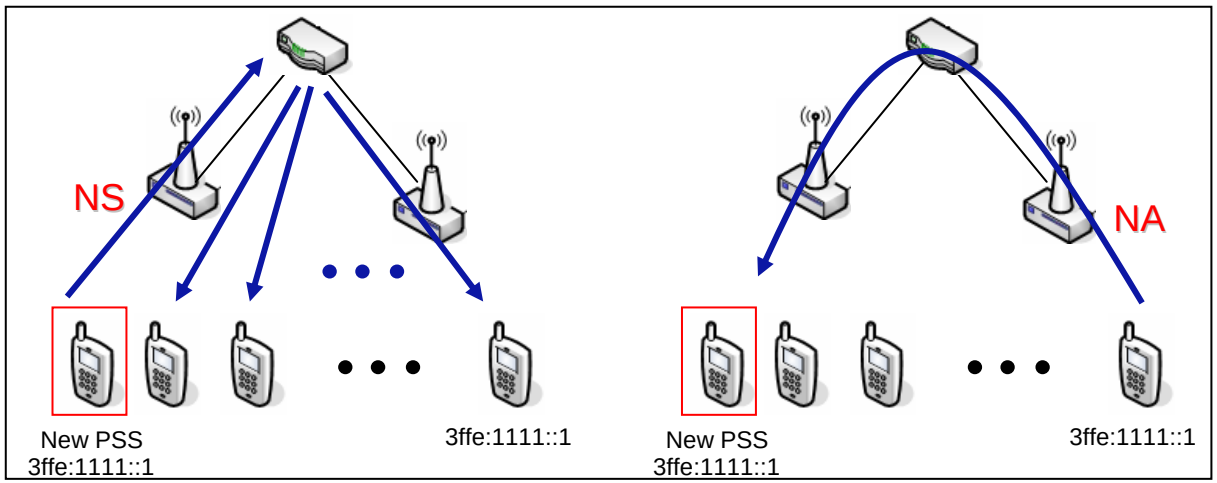
-Router의 주소를 미리 단말에게 알려주어야 함

Option 3: Simulated Multicast using Unicast

-무선구간에 부하가 심함

Option 4: IP Signaling 위한 New Multicast

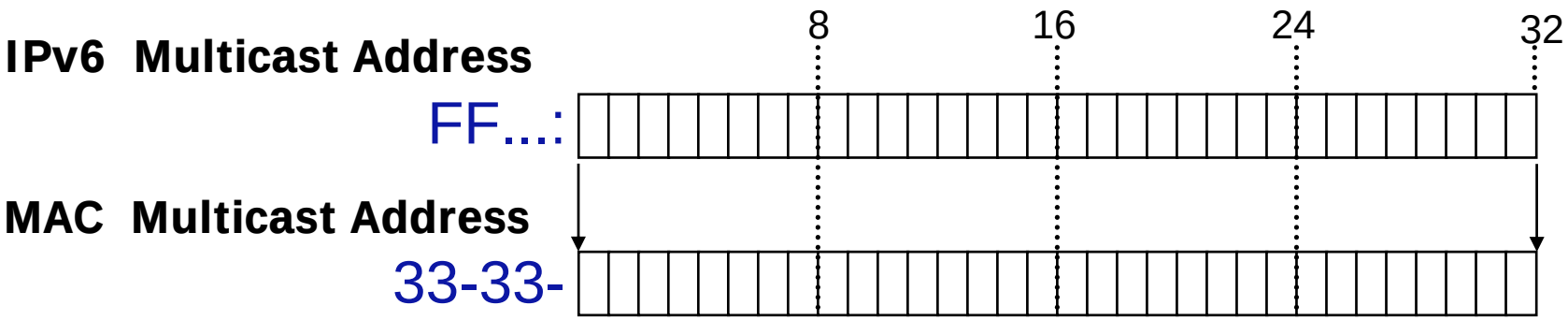
- CID 할당 및 효율적 Multicast 방법 구현



IPv6 Multicast Address Mapping

- IPv6 Multicast Address (IPv6 link scope)
  - all-nodes multicast address – FF02::1
  - all-routers multicast address – FF02::2
  - solicited-node multicast address – FF02::1:FFxx:xxxx
  - Specific-purpose multicast address

- Mapping: IPv6 ↔ IEEE 802 MAC



Transmission of IPv6 packets over Ethernet (RFC 2464)

IPv6 Multicast Address Mapping

- How to map into Connection ID?
  - Case of IP CS
    - IPv6 Multicast Address ⇔ Connection ID
  - Case of Ethernet CS
    - IPv6 Multicast Address ↔ Ethernet MAC ⇔ Connection ID
- It seems to be a standardization item in “IETF”
  - WiMAX will use the result.
  - SAIT will submit a draft
- 기타
  - MLD (Multicast Listener Discovery) 를 어떻게 Deployment 할 것인가?
  - IEEE 802.16 MBS 서비스와 어떻게 연동할 것인가?

IPv6 Neighbor Discovery Service

IPv6 Neighbor Discovery Service

- Why IPv6 ND ?
  - Address Autoconf. and Duplicate Address Detection
  - Peer-to-peer communication in a IPv6 link

- Specific Protocols for IPv6 ND Services

	RS	RA	NS	NA	Redirect	Notes
Router Discovery	✓	✓				**Adaptation to WiBro**
Prefix Discovery	✓	✓				**Adaptation to WiBro**
Parameter Discovery	✓	✓				**Adaptation to WiBro**
Address Autoconfiguration						**What Policy? (Whether or not stateless address aucoconf in WiBro)**
Address Resolution			✓	✓		**Ethernet CS, IP CS (Adaptation to WiBro)**
Next-hop determination						**Adaptation to WiBro**
Neighbor Unreachability Detection			✓	✓		**Adaptation to WiBro**
Duplicate Address Detection			✓	✓		**Whether or not stateless address aucoconf in WiBro**
Redirect					✓	**Adaptation to WiBro**

IPv6 Neighbor Discovery Service

- Router (ACR)/Prefix/Parameters Discovery
  - Router (ACR), On-link Preifx, Link MTU 정보들을 어떻게 단말기에 알려주는가?
  - Original Method (in multicast manner)
    - RS/RA Exchange or
    - Receipt of (Periodic) Unsolicited RA
  - Alternatives
    1) 망 접속시에 한번의 Unsolicited RA를 보낸다.
    2) Network Entry 과정 시 IEEE 802.16 MAC Management 메시지 내에 위 정보를 넣어서 보내준다.

IPv6 Neighbor Discovery Service

- Stateless Address Auto-configuration & DAD
  - Stateless Auto-conf를 지원해야 하나?
  - 만약 지원한다면…
    - 어떻게 DAD (Uniqueness Test)를 할 수 있나?
    - 어떻게 제어국쪽의 CS Layer에게 생성된 IPv6 주소를 통보하는가?
  - Original Method
    - 단말이 On-link Prefix와 자기 자신의 ID를 Combine 하여 구성
    - NS/NA Exchange for DAD in multicast manner
  - Alternatives
    1) 각 단말에게 고유의 Prefix를 할당하면 각 단말이 스스로 주소를 생성하여도 DAD 를 수행하지 않아도 되게끔 한다.
    2) Network Entry 과정 시 IEEE 802.16 MAC Management 메시지를 통하여 고유의 주소를 할당한다. (DHCP와 다름)

IPv6 Neighbor Discovery Service

- Next-hop Determination & (Neighbor) Address Resolution
  - Next-hop Determination
    - Mapping: Destination IPv6 Address → A Neighbor or A router?
  - Address Resolution
    - Mapping: A Neighbor or A router → Link-layer Address (MAC)
  - 단말 입장에서 Neighbor 는 누구인가?
    1) Only ACR (BS)?
    2) Include other terminals
  - IP CS를 사용한다면 구현 필요성이 없음
  - 단말에서 필요한가? 필요하다면 어떻게?
    - Neighbor 에게 직접 패킷을 보낼 수 있는가?
    - ACR 이 여러 개 일 수 있는가?
    - 위 2 기능이 필요 없다면 Next-hop Determination 은 필요 없음

IPv6 Neighbor Discovery Service

- Neighbor Unreachability Detection
  - 어떻게 Neighbor Node가 Reachable 한지 아닌지 알 수 있나?
  - 단말에서 필요한가? 필요하다면 어떻게?
  - 단말 입장에서 Neighbor 는 누구인가?
    1) Only ACR (BS)?
    2) Include other terminals

- Redirect
  - ACR이 더 좋은 Next-hop을 단말에게 알려주는 기능.
  - 단말에서 필요한가? 필요하다면 어떻게?

IPv6 Mobility Service

Mobile IPv6 over WiBro

- RFC 3775 (June 2004)
- MIPv6 over WiBro
  - Easy Deployment
  - No More Issues will remain if “IPv6 over WiBro” technical issues are resolved.

- Issues of Mobile IPv6 over WiBro
  - Movement Detection
    1) RS/RA exchange (Original Method)
    2) Using router/prefix information embedded in L2 frame
  - Address Configuration and Confirmation (DAD)
    1) Terminal configures it and DADs it? (End-to-End Approach)
    2) Network allocates it?
  - Return Routability
  - Location Registration

- Mobile IPv6 is not handover management protocol but location & path update protocol.

FMIPv6 (Fast Mobile IPv6) over WiBro

- RFC 4068 (July 2005) - Fast Handover over Mobile IPv6
  - 약 5년여 동안 걸쳐서 Update된 프로토콜
  - It can be the next step IP-handover solution for WiBro
  - IETF Official Standardization Item
    - FMIPv6 over IEEE 802.16e
      - SAIT, Samsung DM, ETRI Collaboration
      - http://www.ietf.org/internet-drafts/draft-jang-mipshop-fh80216e-00.txt
  - Some optimization technique needed for WiBro

IPv6 Deployment Scenario over IEEE802.16/WiBro Networks

IPv6 Deployment Scenario in IEEE 802.16 Networks

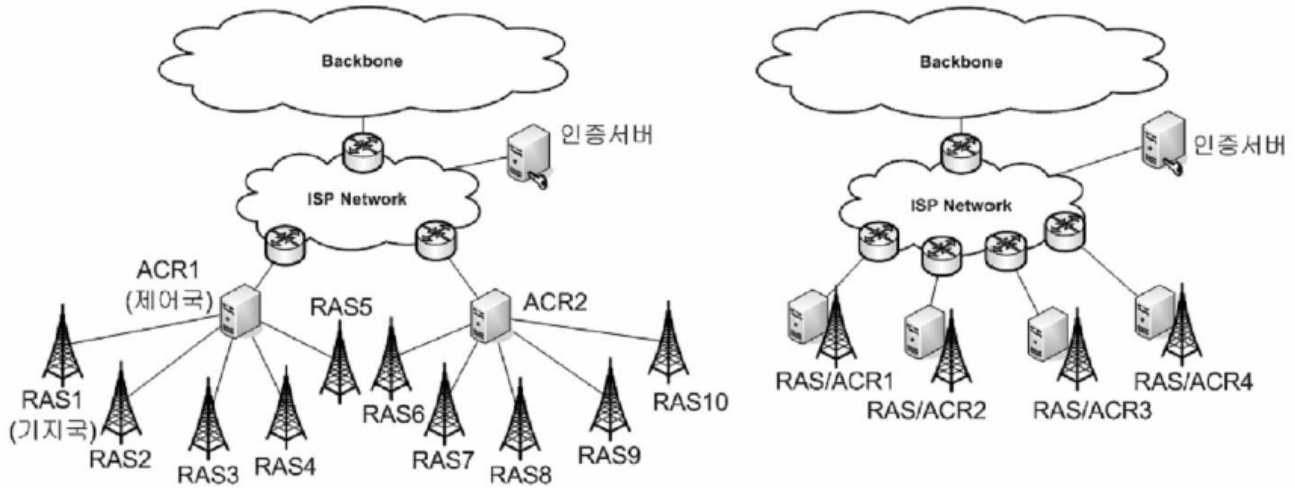
- How to provide the service?
  - Cellular-like
  - Hot-zone
- How to define system architecture?
  - Router separation from BS
  - BS and Router in one Box
- How to allocate prefix?
  - A unique prefix to a SS
  - A single prefix to attached SSs
- How to make Convergence Sub-layer?
  - IP CS
  - Etehrent CS

How to provide the service?

- Cellular-like (e.g. WiBro)
  - BS might be deployed with a proprietary backend managed by an operator
  - All standard IPv6 functionalities may not survive and some of them might be compromised
- Hot Zone
  - An area served by one BS is usually termed ‘Hot Zone’
    - Use unlicensed (2.4 & 5 GHz) band as well as licensed (2.6 & 3.5 GHz) band
  - Department store, Campus, Factory…
  - BS will be deployed using an Ethernet (IP) backbone rather than a proprietary backend like cellular systems.
  - Thus, many IPv6 functionalities will be preserved.

How to define system architecture?

- Router separation from BS (e.g. WiBro)
  - A simple or complex network equipments may constitute the underlying wired network between BSs and router.
  - IPv6 adoption to IEEE 802.16 may depend on the underlying network architecture
- BS and Router in one Box
  - Only IEEE 802.16 link will be taken into consideration for IPv6 adoption.



How to allocate prefix?

- A unique prefix to a SS
  - RFC 3314 recommends that 3GPP terminals generate multiple IPv6 address using the unique prefix per terminal without the concerns of address confliction.
  - Many IPv6 functionalities can be implemented without difficulty.

- A single prefix to attached SSs
  - 'Hot zone' scenario would not allow RFC 3314 recommendation
  - There will be more issues for adopting IPv6 to IEEE 802.16.

How to make Convergence Sub-layer?

- IP CS (e.g. WiBro)
- Ethernet CS

Conclusions

Conclusions

- IPv6 over WiBro 기술
  - Wibro 시스템에 최적화된 IPv6 Protocols의 Adaptation 기술 개발
    - Transport, Multicast Address Mapping, Neighbor Discovery, Mobility
  - 국내 고유 표준 개발
    - TTA 표준 & IPv6 Forum 표준
  - 국내 표준에 대한 국제 표준화
    - IETF 16ng, WiMAX 등
- IPv6 over IEEE 802.16 Hot Zone Service
  - Compatibility to the existing IPv6 devices
  - Efficiently keep the all IPv6 features
- Development of IP-based Service & Application over WiBro

Q & A?