Designing a Novel Unlicensed Nomadic Access Relay Station in IEEE 802.16-based Wireless Access Networks

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Introduction

- Broadband wireless access network (BWAN) technologies provide mobile high-speed services in recent years
  - WiMAX – IEEE 802.16
  - WiBro – IEEE 802.16 based
- BWAN service providers expect WiBro provide service with much ***lower cost*** and ***higher data rate*** than 3G
- However, BWAN is not likely to totally replace the existing wireless technology, such as WiFi
  - Due to lower cost and high-speed in LAN

Introduction

- WiFi mesh (802.11s) is developed to build a wireless mesh network using WiFi
  - Extends the service coverage of Wi-Fi network
  - Backhaul links is still a issue

- Some of studies lately goal to build a wireless mesh network using WiFi for user access link and WiMAX for backhaul link
  - Satisfy user in terms of data rate and cost

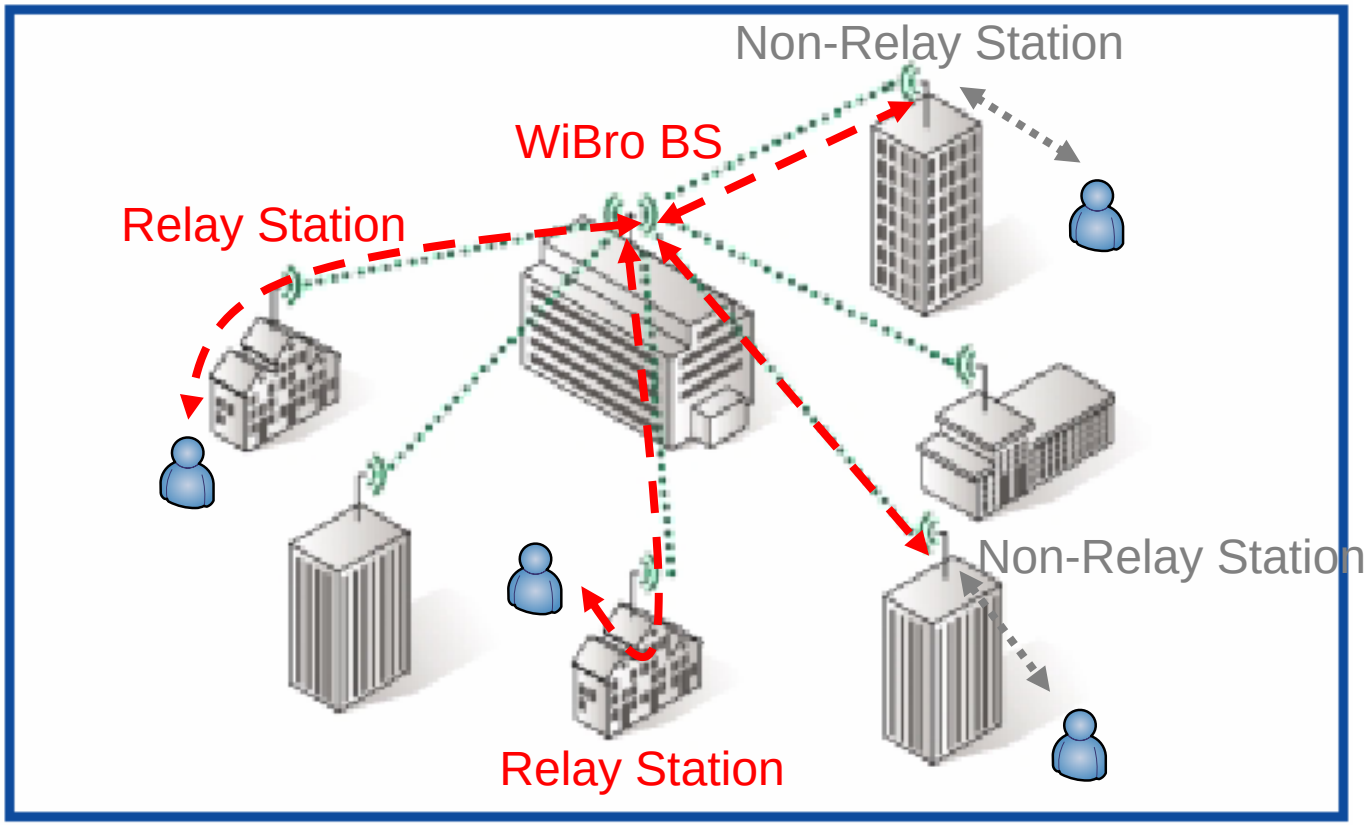
Motivation

- BWAN and WLAN Coexistence
  - WLAN and BWAN are developed for different service usage models
    - Alternative wireless solution to Ethernet cables and xDSL/cable modems
  - Compared with 3GPP Unlicensed Mobile Access (UMA) technology, BWAN coexisted with WLAN can provide lower cost service
    - Single mode vs dual mode
    - Service provider-oriented vs user-oriented

Motivation

- A novel ***service provides-oriented*** unlicensed nomadic access (UNA) relay station is proposed in WiBro access network
  - Individual unlicensed user can be visible and managed at the core network side
    - For QoS, access control, and billing
  - The relay station connects unlicensed band user terminal and core network using connection ID (CID)
    - CID is defined to manage each of service (traffic) flow within WiBro system
  - WiNNERS
    - ***Wi***Bro u***N***licensed ***N***omadic acc***E***ss ***R***elay ***S***tation

Motivation



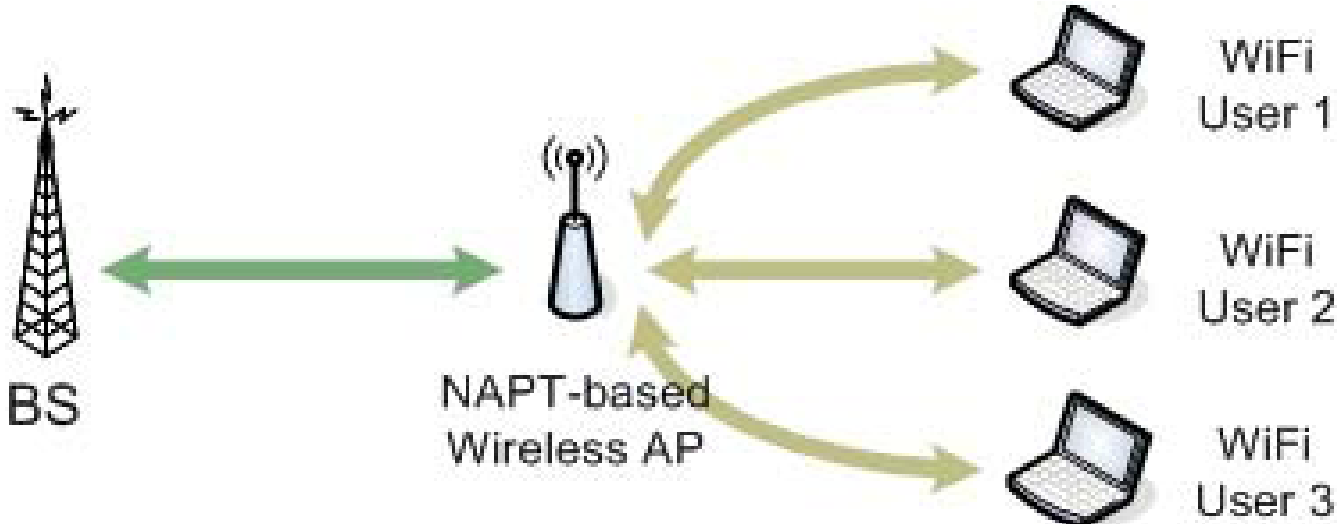
Point-to-Multipoint Network

Related Works

- Connection sharing using NAPT
  - NAPT is a popular technique to avoid the lack of public IP address
  - In WLAN-BWAN coexisted network, service flows form individual users are not manageable for access control, QoS, and billing
  - The network system should be modified to recognize each of the WiFi user at core network side
    - The NAPT basically is not designed to distinguish each of users at external network side

Related Works

NAPT-based WiFi user Traffic Forwarding Concept

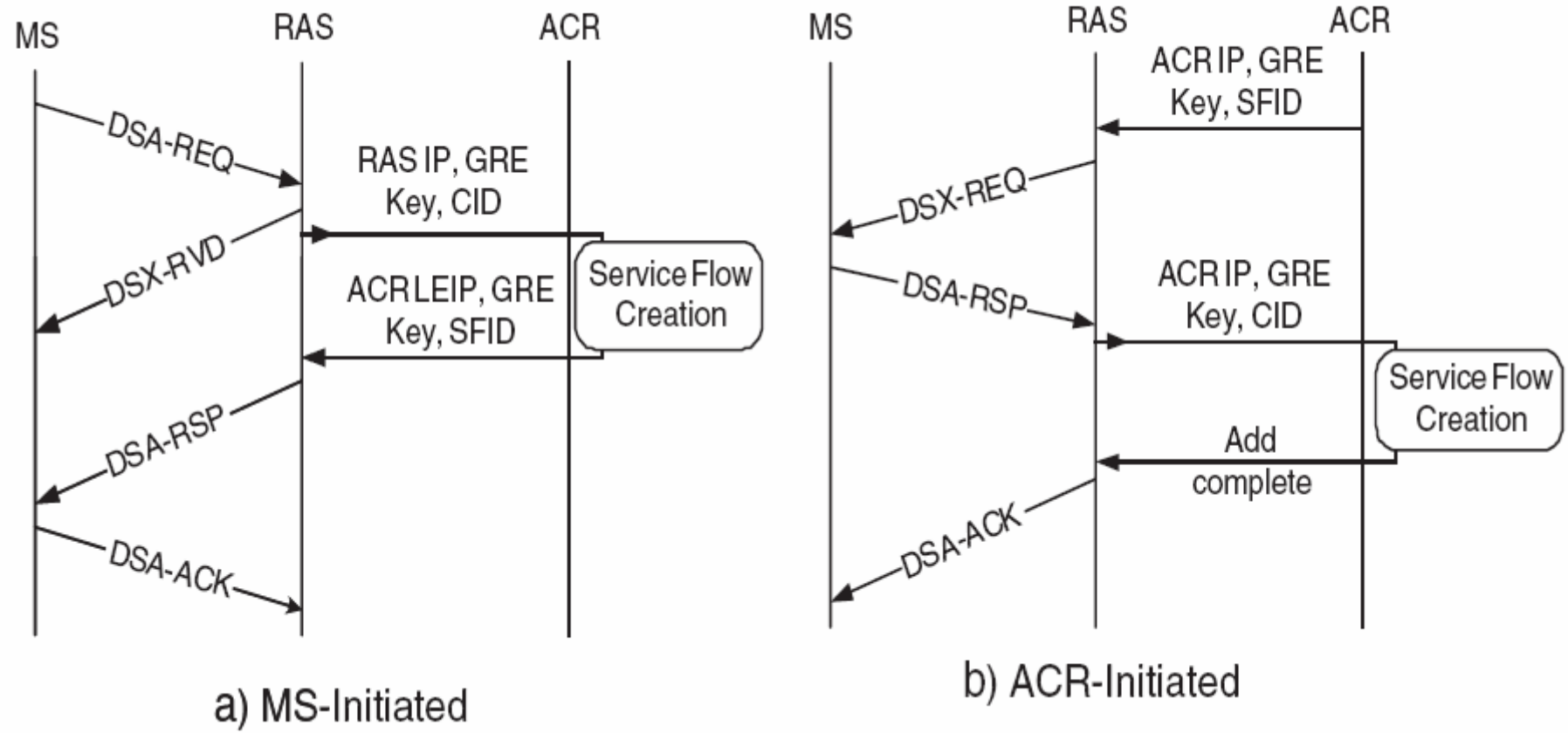


Issues:

1. NAPT-based access router needs to report the internal address associated with each of user's service flow – ***signaling overhead***
2. Core network needs to setup a table of identification given by NAPT router dynamically – ***maintenance overhead***
3. Every incoming and outgoing packet will be inspected to find out where it belongs – ***processing overhead***

Related Works

WiBro Dynamic Service Addition Flow Sequence

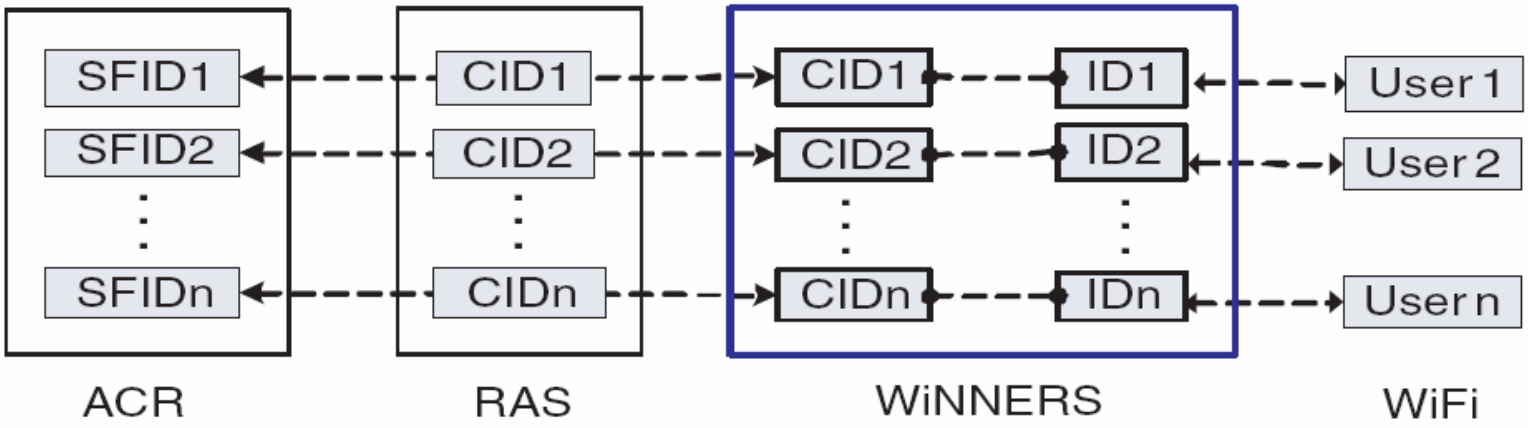


CID : Connection Identification
SFID : Service Flow Identification
DSA : Dynamic Service Addition

RAS : Radio Access System
ACR : Access Control Router

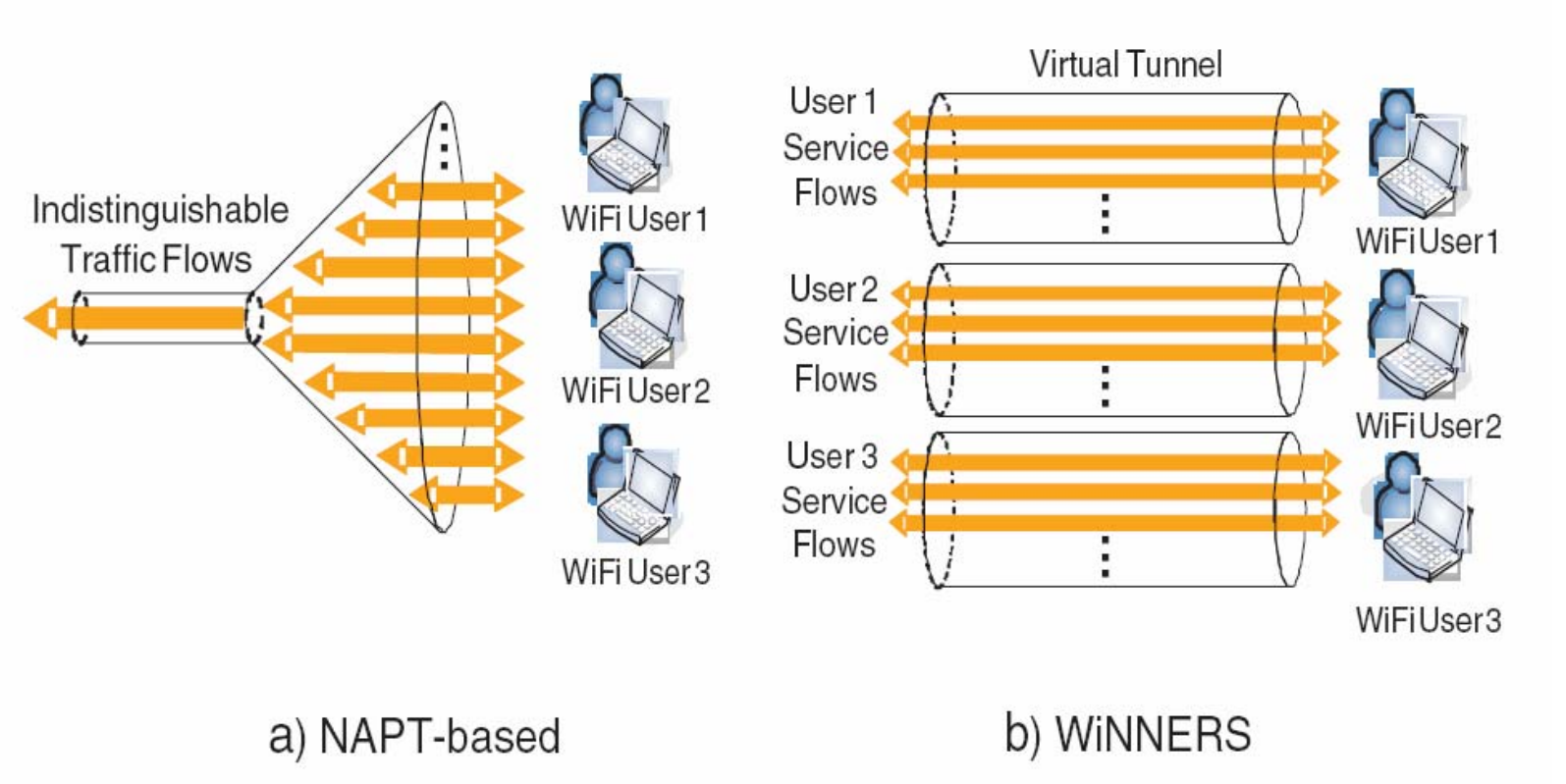
Description of WiNNERS

- Concept
  - Design and implement a service provider-oriented relay station
    - Equipped with at least two radio interfaces

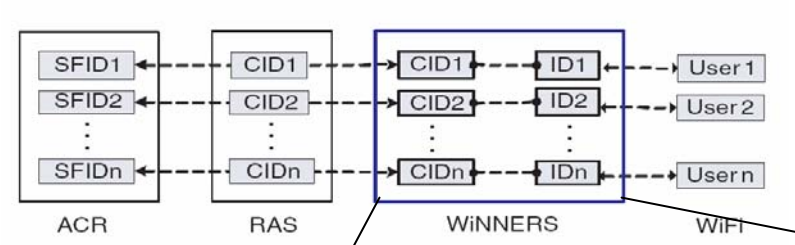


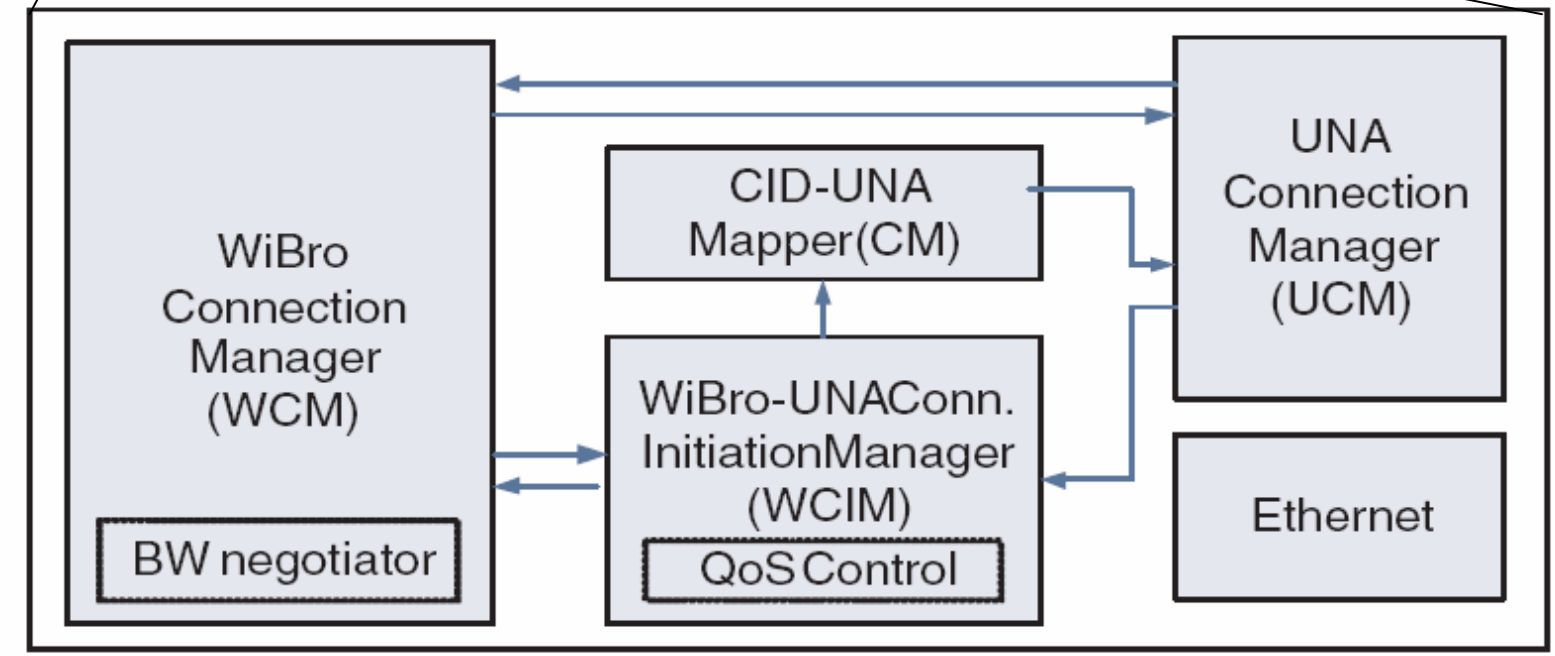
Description of WiNNERS

WiNNERS constructs a virtual tunnel from ACR at the core network side to individual user terminal



Description of WiNNERS





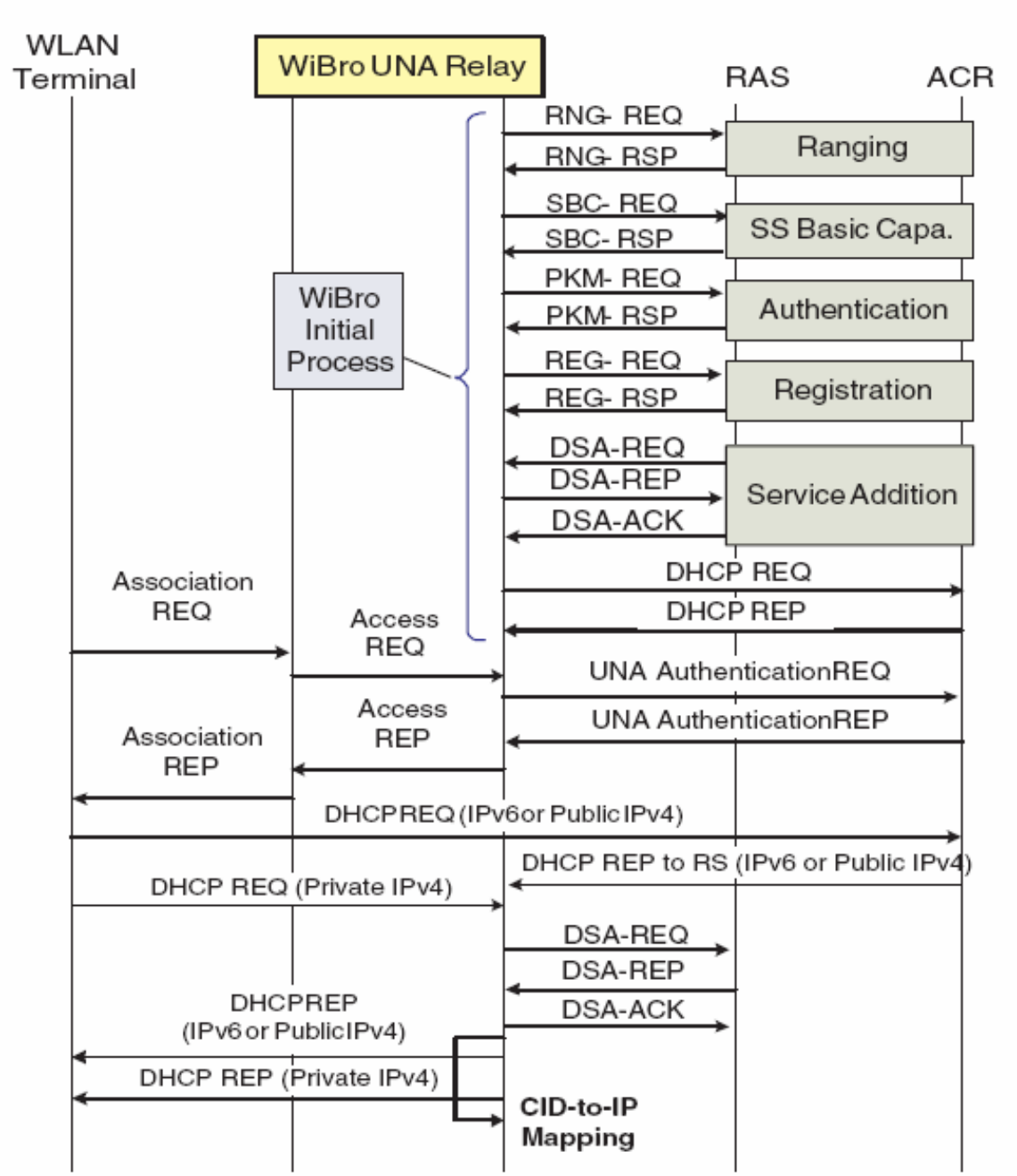
WiNNERS Functional Block Diagram

Description of WiNNERS

- UNA Connection Manager (UCM)
  - Serves as an WiFi AP and WiBro connection initiation requester
  - Takes care DHCP
- WiBro-UNA Connection Initiation Manager (WCIM)
  - Relays WiBro connection request to WCM
  - Asks for CID reply
- WiBro Connection Manager (WCM)
  - Takes care WiBro connection setup process
  - Passes requested CID to WCIM
- CID-UNA Mapper (CM)
  - Maintains 1-to-1 mapping table of ***CID*** and ***each WiFi user terminal***

Description of WiNNERS

- In WiNNERS, each WiFi user can be registered as a new WiBro network subscriber
  - QoS level can be offered based on service level agreement



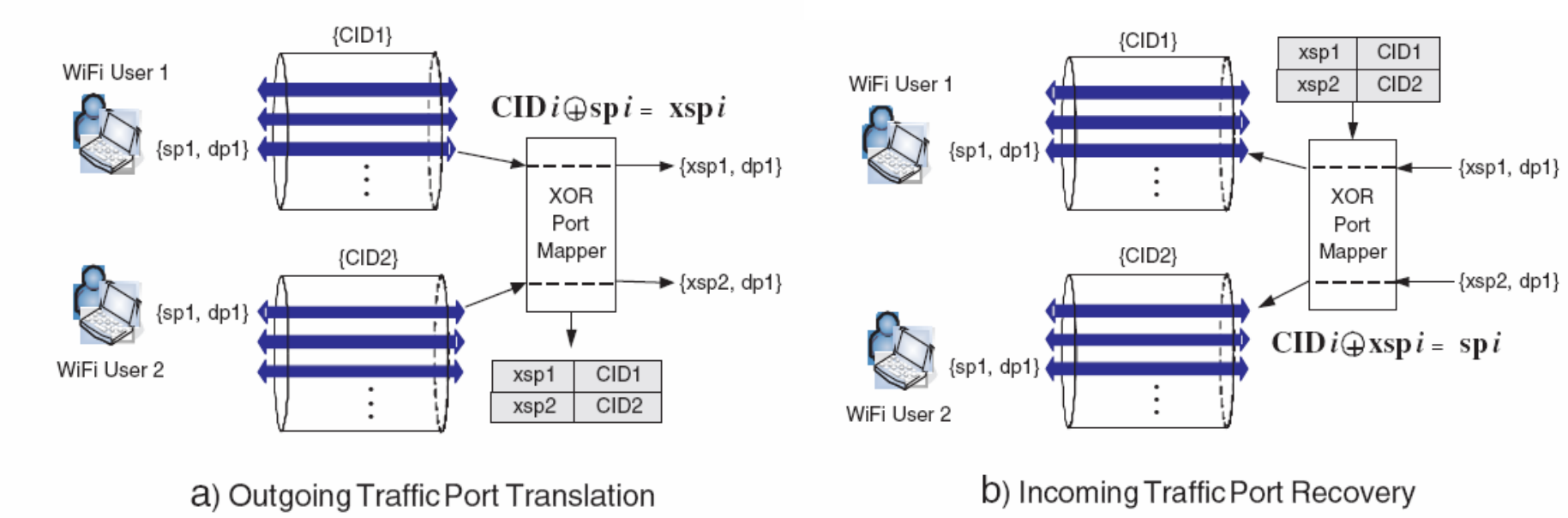
Inter-connection Setup Flow in WiNNERS

Description of WiNNERS

- CID-to-ID Mapping for the use of Private IP Address
  - Unlike the NAPT-based router, port translation is done on the ACR side
  - XOR operation
    - $x \oplus y = y' \rightarrow x \oplus y' = y$
  - Proposed operation
    - $CID_j \oplus sp_i = xsp_i \rightarrow CID_j \oplus xsp_i = sp_i$

      Where sp_i is source port i given to a service flow at user side and xsp_i is a new port number generated for sp_i by XOR port translation

Service Flow Management in WiNNERS (in case of Private IPv4)



- ACR maintains an *xspi* –to-CIDi mapping table without including the original port number
- ACR uses *xspi* as a key to find out which CID to be used

Discussion for Proposed Relay System

- Samsung are currently developing WiFi wireless mesh network gateway with a WiBro backhaul link and WiFi user access link

Discussion for Proposed Relay System

- Mobility
  - When MS moves to an adjacent cell, the system transfer all transport CIDs belonging to the MS to the adjacent cell
    - MS does not have to reinitiate network entry process
- Multicast
  - Multicast service is also based on CID management in WiBro and can be also applied

Conclusions

- A service provider-oriented relay system is developed
  - Called WiBro unlicensed nomadic access relay station (WiNNERS)
  - Goals to provide the service providers with the capability to directly manage individual unlicensed band users
  - Makes WiFi business model more lucrative
  - Realize WiBro-WiFi interworking with minimum modifications