

# *IEEE 802.11u Interworking & Vertical Handover*

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## ◆ Evolution in Communication Systems

### ◆ WLAN Interworking with Other Networks

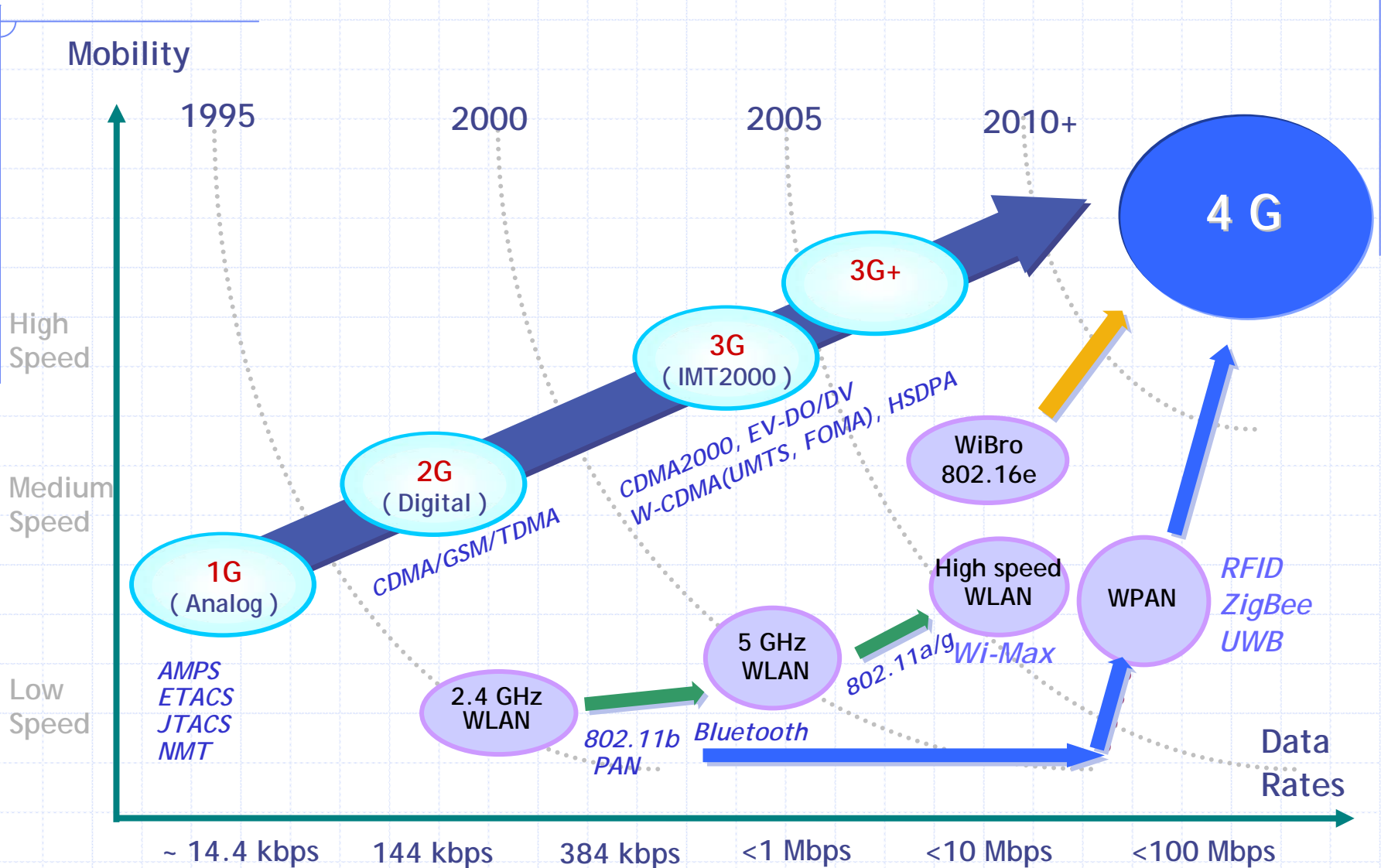
- WLAN vs. 3G
- Goal of WLAN & 3G Integration
- Architectural Issues for WLAN & 3G Integration
- Scenario of WLAN & 3G Integration
- WLAN/WMAN Handover Scenarios

### ◆ IEEE 802.11u Standardization

- Introduction & History
- Expected Technical Results

### ◆ Research Trends & Conclusions

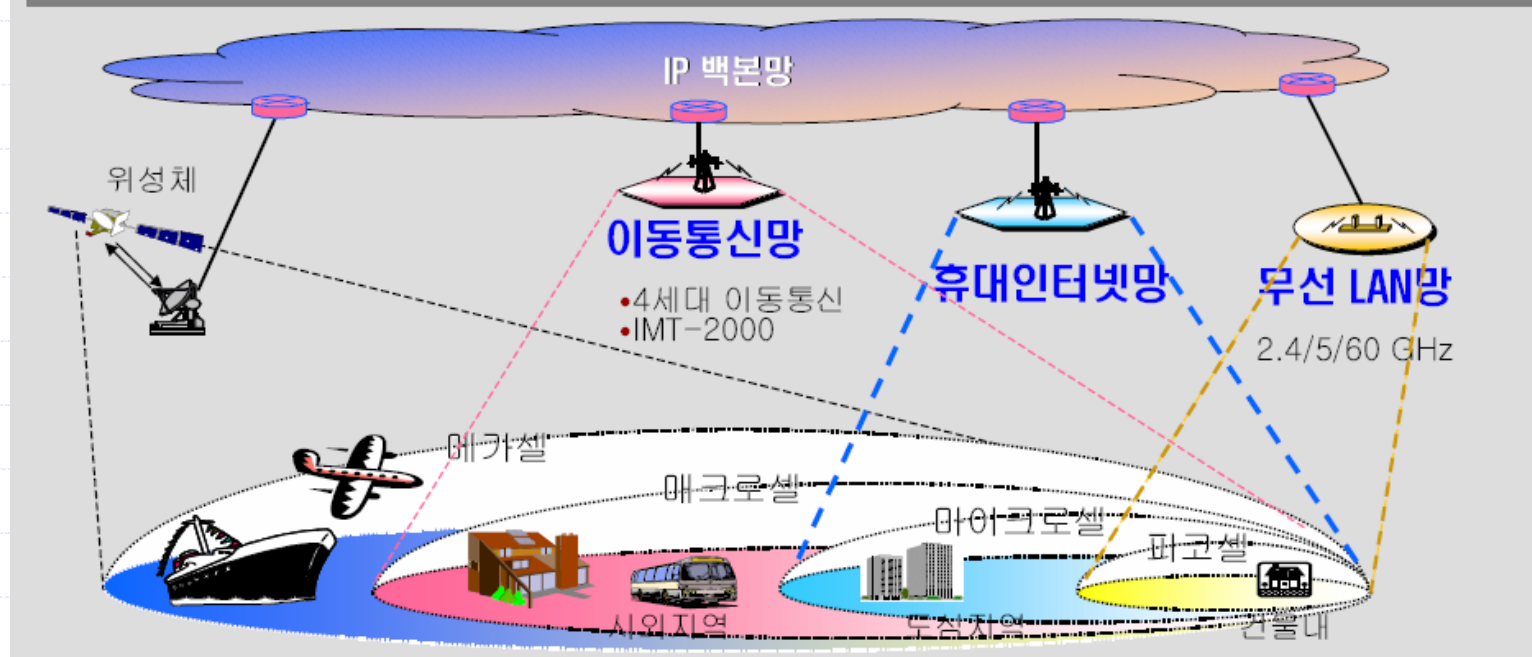
# Mobile Communication Roadmap



# 4G Mobile Communication Network

● 정지 및 이동 중에 다양한 형태의 정보를 다양한 망을 통하여 고속, 고품질로 송수신

● 차세대 이동통신은, 휴대 인터넷, IMT-2000 고도화, 초고속 무선 LAN, 이동통신을 포함하는 개념으로 2010년경 서비스 제공 예정



# Heterogeneous Network Operation

*Fast, Reliable and QoS Guaranteed  
Seamless Active Handoff*

**CDMA2000  
1X/DO/DV**

**WCDMA/  
HSDPA**

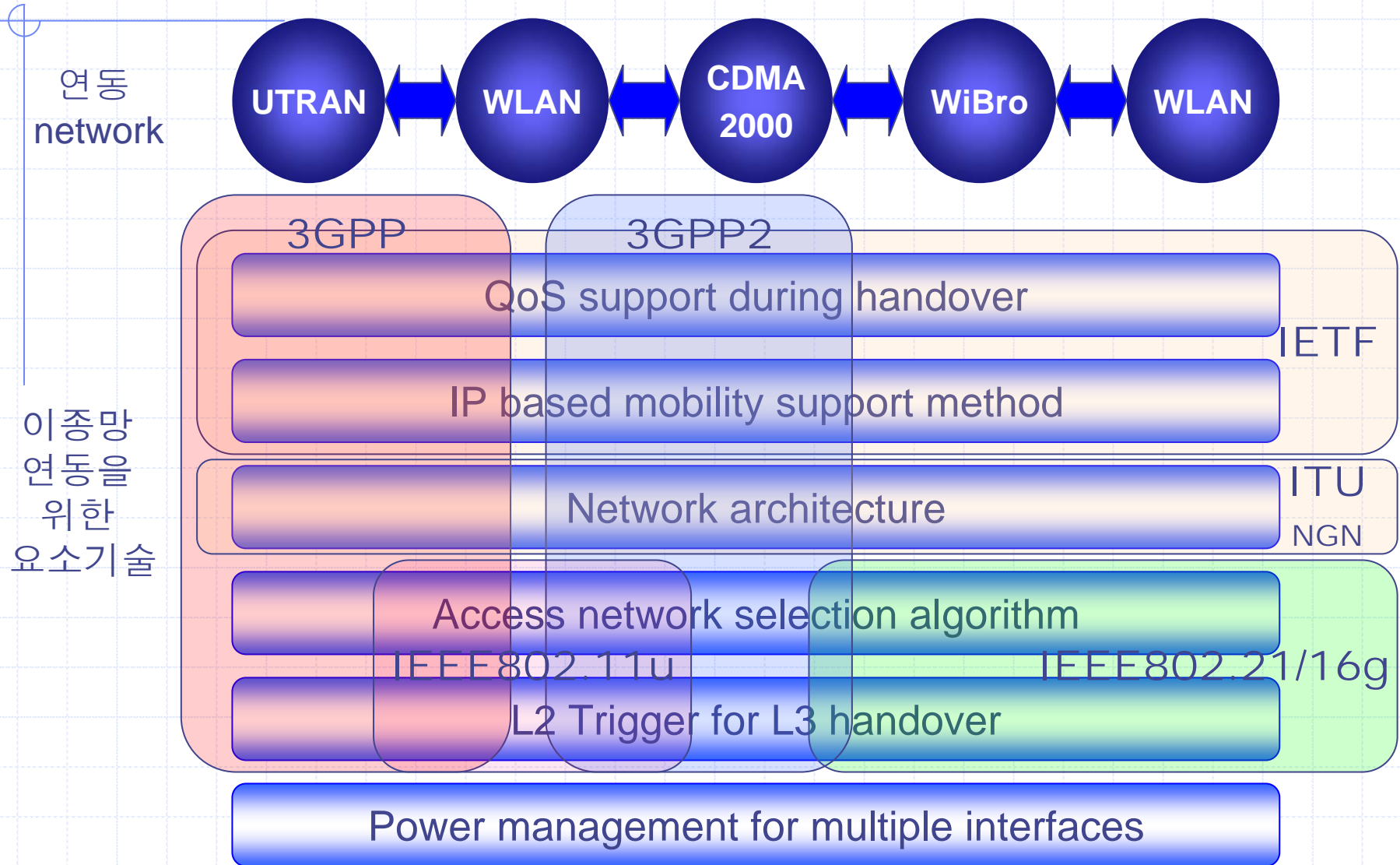
**WLAN**

**WIBRO**

**Bluetooth  
UWB**

*Always Best Connected  
Ubiquitous Network*

# Standardization Organization



- ◆ Evolution in Communication Systems
- ◆ **WLAN Interworking with Other Networks**
  - **WLAN vs. 3G**
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# Goal of WLAN & 3G Integration

## ◆ WLAN

- **Low cost, high data rate, small coverage**
- Designed for low terminal velocity (non-contiguous spots)
- Office, Stations, Department store, Subway etc.

## ◆ 3G Cellular Network

- **High cost, medium data rate, large coverage**
- Even a fast moving vehicle can use on-line browser

| Characteristics                  | 3G                        | 802.11b (WiFi)             | 802.11a (WiFi5)            |
|----------------------------------|---------------------------|----------------------------|----------------------------|
| Typical end-user Bit-rate        | < 2 Mbps                  | < 5 Mbps                   | < 10 Mbps                  |
| Typical range of stationary user | 3-5 Km (dense urban area) | 50-60 m                    | 10-20 m                    |
| Handover                         | Yes                       | Limited                    | Limited                    |
| Security                         | High                      | Low – being improved       | Low – being improved       |
| Coverage                         | Wide area - contiguous    | Hot spots – non contiguous | Hot spots – non contiguous |
| Mobility                         | High speed                | Stationary, Nomadic        | Stationary, Nomadic        |
| Service                          | Voice and data            | Primarily data (VoIP)      | Primarily data (VoIP)      |



# Goal of WLAN & 3G Integration

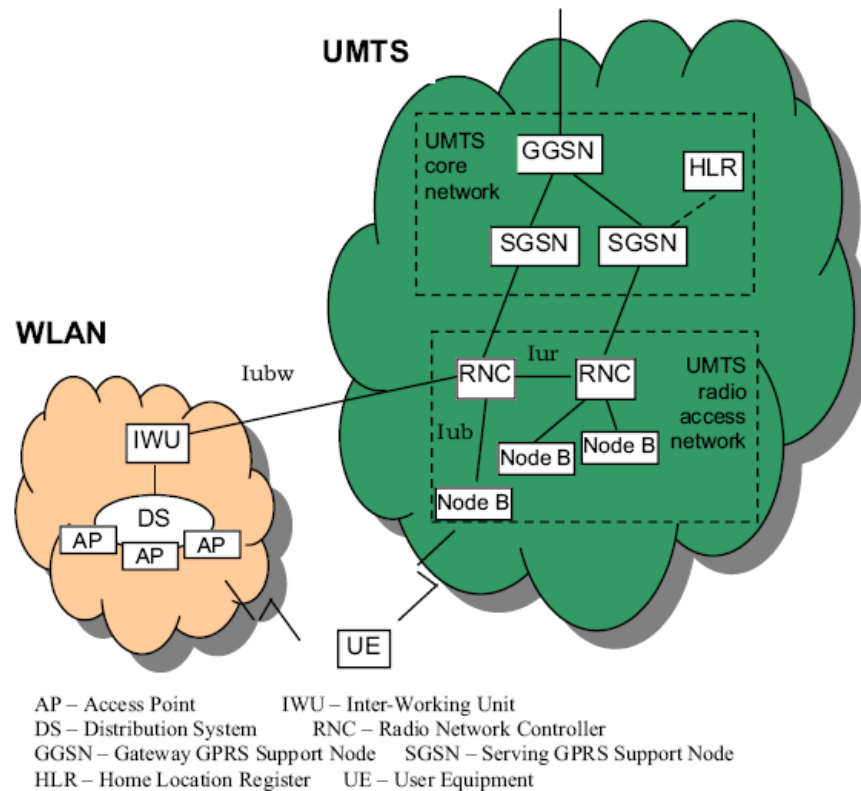
## ◆ 이종망 연동의 동기

- '높은 이동성 + 낮은 전송속도 vs. 낮은 이동성 + 높은 전송속도' 두 가지 방향으로 기술 발전 (e.g. Mobile network vs. Nomadic network)
- 단일 접속망 기술로는 다양한 환경 및 다양한 서비스 요구 (e.g. 이동성 정도, QoS 요구량, 전력 소모량 등)에 대해 효율적으로 지원이 불가능하다.
- 최근 활성화 되고 있는 무선랜 망을 통한 3G 서비스의 확대 제공
- 향후 General heterogeneous network 사이의 연동을 위한 기반 제공

## ◆ 목적

- 사용자 및 service 요구사항과 상황에 맞는 최적화된 접속망을 사용.
- 3G 사용자 정보 및 인증 방법을 이용한 무선랜 서비스 이용
- 3G 서비스 (e.g. VoIP, Multimedia Service)의 무선랜을 이용한 제공
- 이종 접속망 간의 이동성 (Handover) 지원

# Architectural Issues for WLAN & 3G Integration

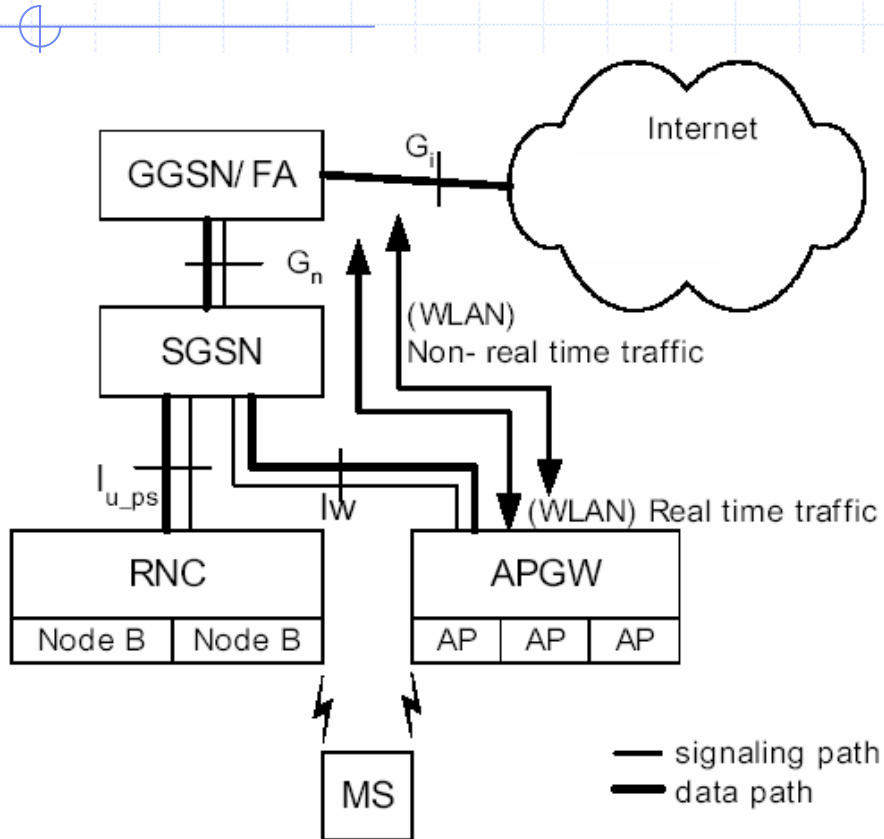


**Very Tight Coupling**

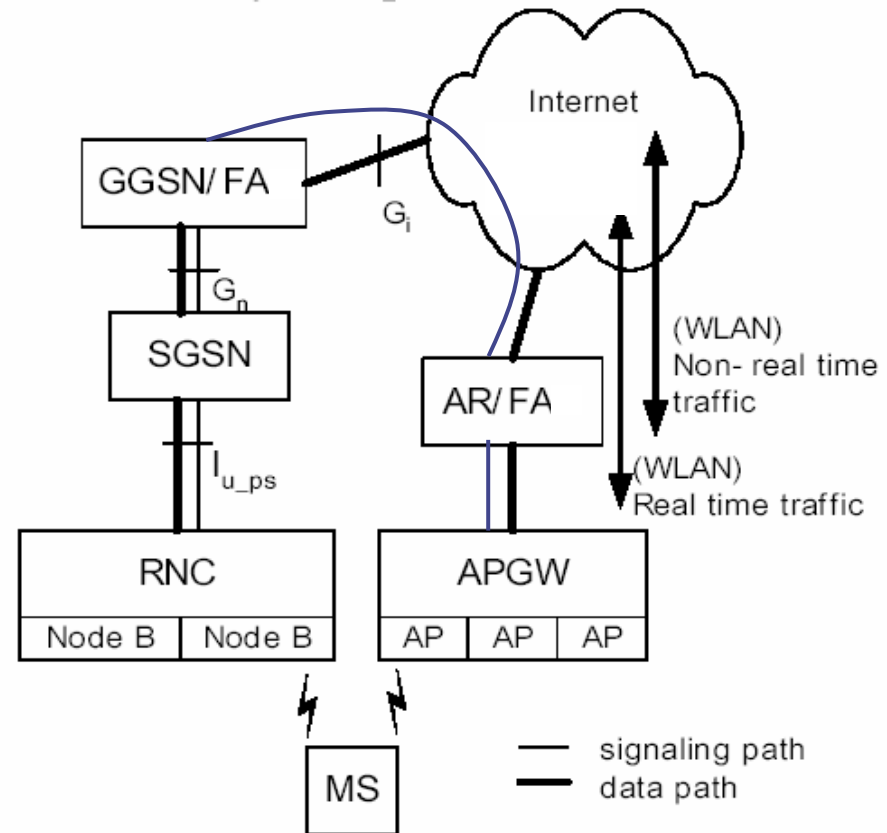
Figure 1. WLAN integration into the UMTS radio access network

[K. Salkintzis, et. Al., "Common radio resource management for WLAN-UMTS integration at radio access level," Proceedings of the IST Mobile & Wireless Communications Summit 2005, Dresden, Germany, June 19-23, 2005]

# Architectural Issues for WLAN & 3G Integration



**Tight Coupling**



**Loose Coupling**

[K. Salkintzis, et. Al., " WLAN-GPRS Integration for Next-Generation Mobile Data Networks," IEEE Wireless communications, Vol. 9, Issue 5, pp. 112-124, Oct. 2002.]

# Architectural Issues for WLAN & 3G Integration

|              | Tight Coupling   | Loose Coupling   |
|--------------|--|--|
| Features     | WLAN access network and 3G access network <b>share same core network</b>   | 3G Core network and WLAN core network <b>have each individual core network</b> . Both core networks are connected by gateway |
| Advantage    | <b>Easy and Vertical Handover</b> (Paging, Billing, etc.)<br>& Improved handover performance   | Both access providers can save money by using the other's network <b>without changing their own network</b>                  |
|              | 3G Access Provider don't need to build another core network for WLAN.<br><b>Just build WLAN hot-spots</b>                                | <b>Suitable for all WLAN technologies</b>  |
| Disadvantage | <b>Technically difficult to merge</b> tunneling based (or switching based) complex 3G Core network and packet-routing based WLAN network | Gateway can be a <b>bottle-neck</b> to the whole system performances   |
|              | <b>Only feasible if a single operator</b> runs both networks   | User profile might be transferred by network for billing and roaming, which might <b>be serious problem for security</b> .   |

# Scenario of WLAN & 3G Integration

|  | Scenario 1: | Scenario 2: | Scenario 3: | Scenario 4: | Scenario 5: | Scenario 6: |
|--|-------------|-------------|-------------|-------------|-------------|-------------|
| Common billing   | X           | X           | X           | X           | X           | X           |
| Common customer care   | X           | X           | X           | X           | X           | X           |
| 3G-based Access Control  |             | X           | X           | X           | X           | X           |
| 3G-based Access Charging   |             | X           | X           | X           | X           | X           |
| Access to 3G PS-based services   |             |             | X           | X           | X           | X           |
| Access to 3G PS-based services with service continuity                 |             |             |             | X           | X           | X           |
| Access to 3G PS-based services with <i>seamless</i> service continuity |             |             |             |             | X           | X           |
| Access to 3G CS-based services with seamless mobility                  |             |             |             |             |             | X           |

[3GPP TR 22.934, Sep. 2003.]

# Scenario of WLAN & 3G Integration

## ◆ 시나리오 1

- 3GPP 시스템 변경 요구 사항 전혀 없음
- 인증 및 보안 관련 기능은 두 시스템 별로 독립적으로 수행한다.
- 고객 입장에서는 WLAN 혹은 3G 중 어느 서비스를 사용하건 간에 단일화된 요금관리 및 고객관리 서비스를 받는다.

## ◆ 시나리오 2

- 3GPP 시스템에서 제공되는 Authentication, Authorization, Accounting 서비스를 WLAN에서 같이 사용하는 형태
  - ◆ 3GPP 시스템의 재사용으로 WLAN 가입자는 자신의 USIM 카드를 사용한 인증으로 WLAN을 사용할 수 있게 됨
- 시스템 운영자나 가입자 모두 시스템의 큰 변화 없이 최소한의 노력으로 3G/WLAN 서비스를 연동
- WLAN, 3GPP 각각에 대하여 세션 서비스를 동시에 독립적으로 지원

# Scenario of WLAN & 3G Integration

## ◆ 시나리오 3

- 운영자가 **3GPP** 시스템 **PS (Packet Switching)** 기반의 서비스를 **WLAN** 환경의 가입자에게 제공
  - ◆ **IMS (IP Multimedia Subsystem)** 기반 서비스, 위치기반 서비스, **Instant messaging** 등이 포함
- **3GPP** 접속망과 **WLAN** 망과의 서비스 로밍은 지원
- **3GPP** 접속망과 **WLAN** 망 사이의 서비스 연속성은 보장되지 않는다.
  - ◆ 이용 서비스에 대하여 사용자가 직접 단말기에 대한 재설정 필요

## ◆ 시나리오 4

- 시나리오 3에서 제공되는 서비스가 **WLAN**과 **3GPP** 시스템 사이에 핸드오버를 하더라도 계속 유지되게 하는 것이다.
  - ◆ 이용 서비스에 대하여 사용자가 직접 단말기 재설정 필요 없음
- 적절한 레벨의 이동성 지원 기술 요구 (e.g. **Mobile IPv4/v6**)
- 접속망의 변경을 사용자가 알 게 됨 (**Seamless** 성 보장 안됨)
- 세션 연속에 대한 서비스 품질 보장은 받지 못한다.

# Scenario of WLAN & 3G Integration

## ◆ 시나리오 5

- 시나리오 4에서 제공되는 서비스에 대해 끊어짐이 없는 서비스 연속성을 제공하는 것이다.
- 끊어짐이 없는 서비스 연속성 (**Seamless**)은 접근 기술들이 바뀌는 동안에 데이터의 손실이나 정지 시간 등이 최소화되는 것을 의미
- 이때 사용자는 이런 중요한 변화를 알아차리지 못하게 된다.

## ◆ 시나리오 6

- **WLAN** 시스템에서 **3GPP Circuit-switched service**(예, 일반적 음성 전화)를 이용할 수 있도록 함
- **WLAN** 시스템에 음성 전화의 **Quality-level** 또한 **3GPP** 에서 제공하는 것과 비슷해야 함

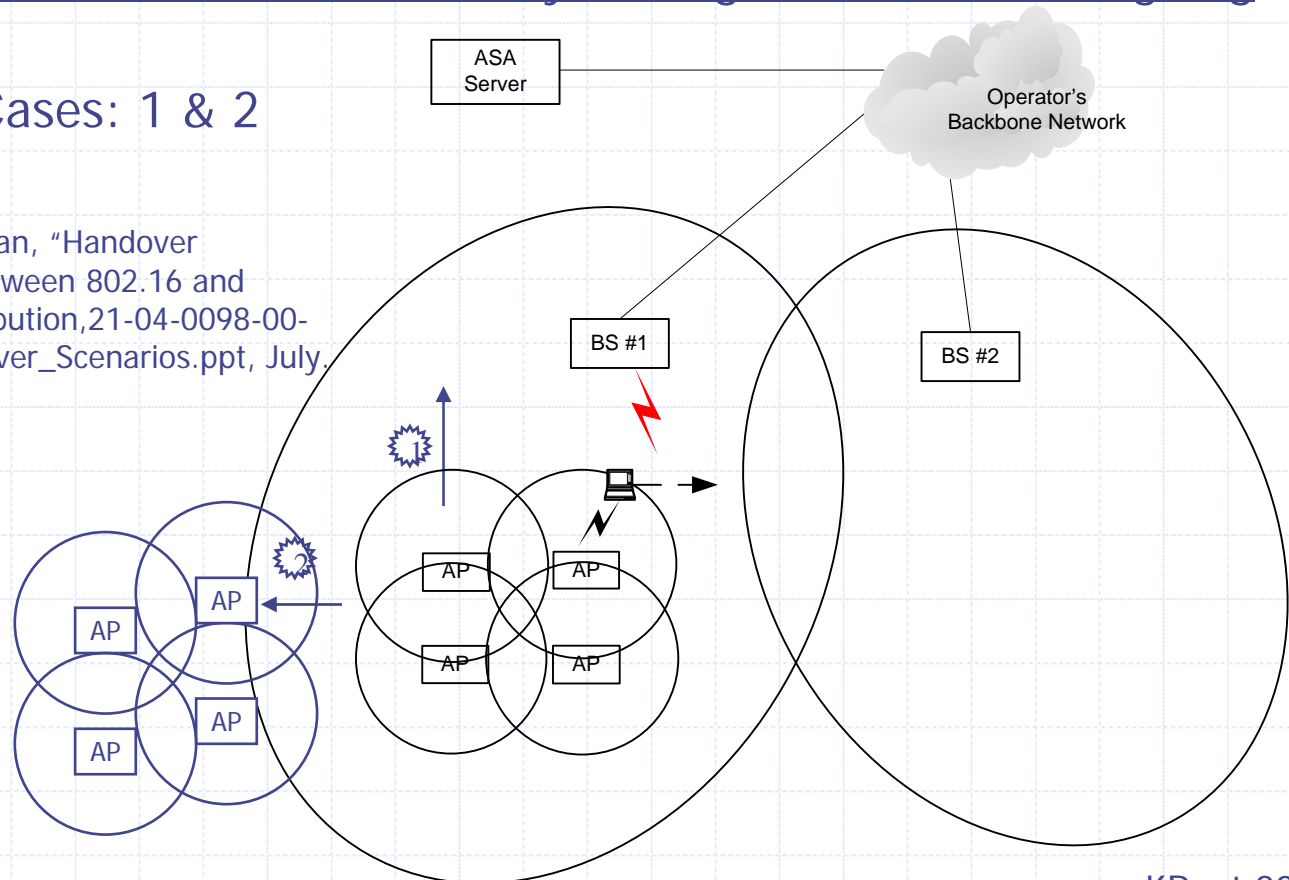


# WLAN/WMAN Handover Scenarios

## ◆ Enforced Service Continuity

- When one interface is (or will be) disabled, another connection is established to keep session continuity
- VHO Events initiated from lower layers: e.g. link down / link going down
- H/O Use Cases: 1 & 2

[Xiaoyu Liu and Youn-Hee Han, "Handover Scenarios and Use Cases between 802.16 and 802.11," IEEE 802.21 Contribution, 21-04-0098-00-0000-802.11\_802.16\_Handover\_Scenarios.ppt, July, 2005.]

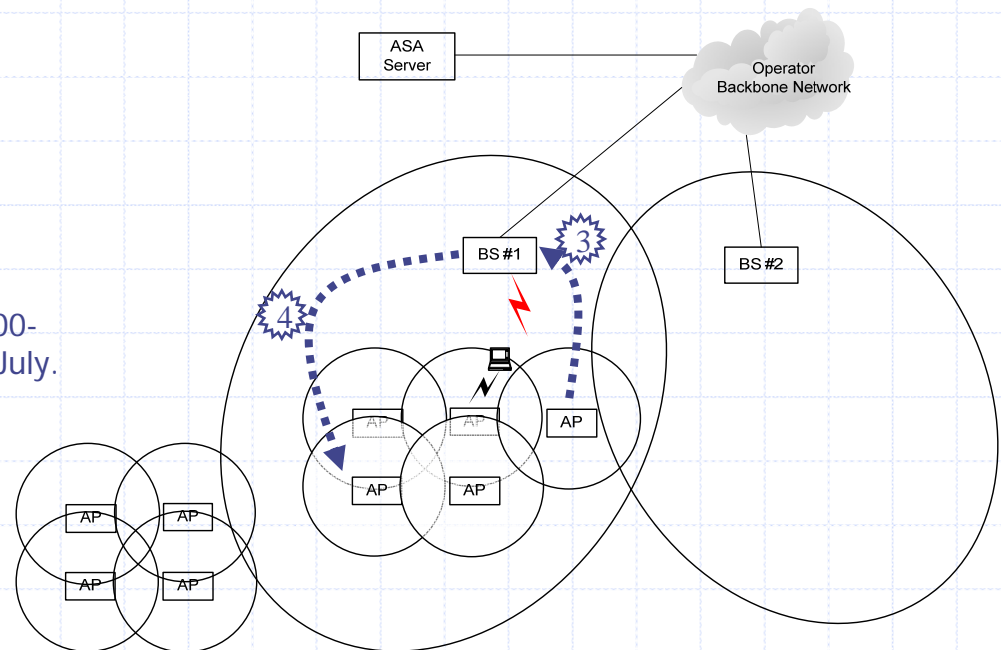


# WLAN/WMAN Handover Scenarios

## ◆ Policy Driven Selection

- The current interface is qualified while other interfaces are available, active session is switched from one interface to another driven by policies or smart decision makers
- A smart decision maker selects the optimal one based on user preferences and a set of policies.
- VHO Events initiated from upper layers or a policy engine module: e.g. link switch
- H/O Use Cases: 3 & 4

[Xiaoyu Liu and Youn-Hee Han, "Handover Scenarios and Use Cases between 802.16 and 802.11," IEEE 802,21 Contribution, 21-04-0098-00-0000-802.11\_802.16\_Handover\_Scenarios.ppt, July, 2005.]



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  - **Expected Technical Results**
- ◆ Research Trends & Conclusions

# IEEE 802.11u - Introduction

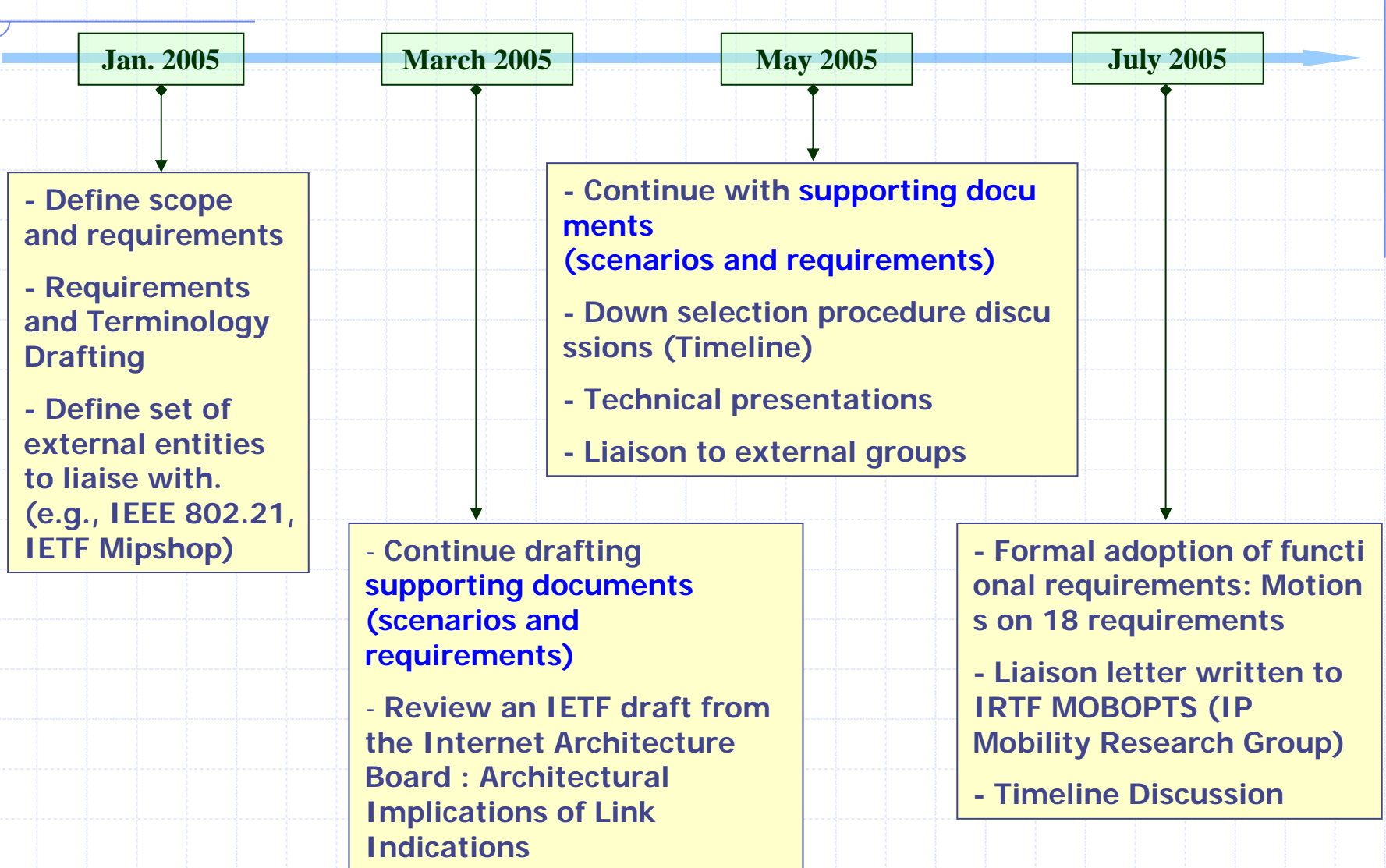
## ◆ Study Group

- IEEE 802.11 WIEN (Wireless Interworking with External Networks)
- 2004.05 ~ 2004.11
- About 20~30 Participants
- Goal
  - ◆ Creation of PAR (Project Authorization Request) and 5Criteria with the objective of producing an output document

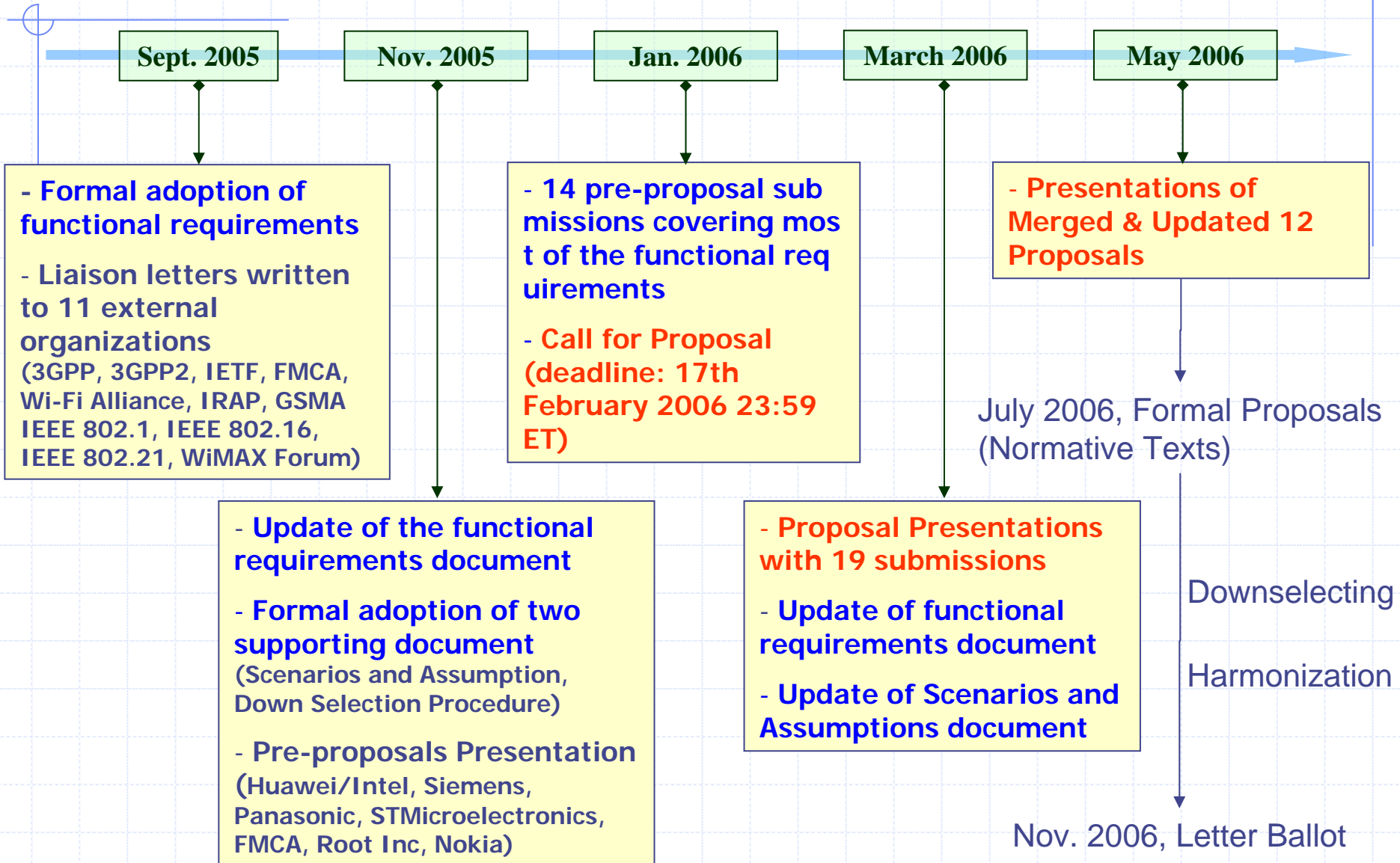
## ◆ Working Group

- IEEE 802.11u
- 2005.01 ~ present
- About 30~40 Participants
- Chair : Stephen McCann (Siemens)
- Goal (of PAR)
  - ◆ The goal of IEEE 802.11u is to produce an amendment to the IEEE 802.11 standard to allow a common approach to interwork IEEE 802.11 access networks to external networks in a generic and standardized manner.

# IEEE 802.11u - History



# IEEE 802.11u - History



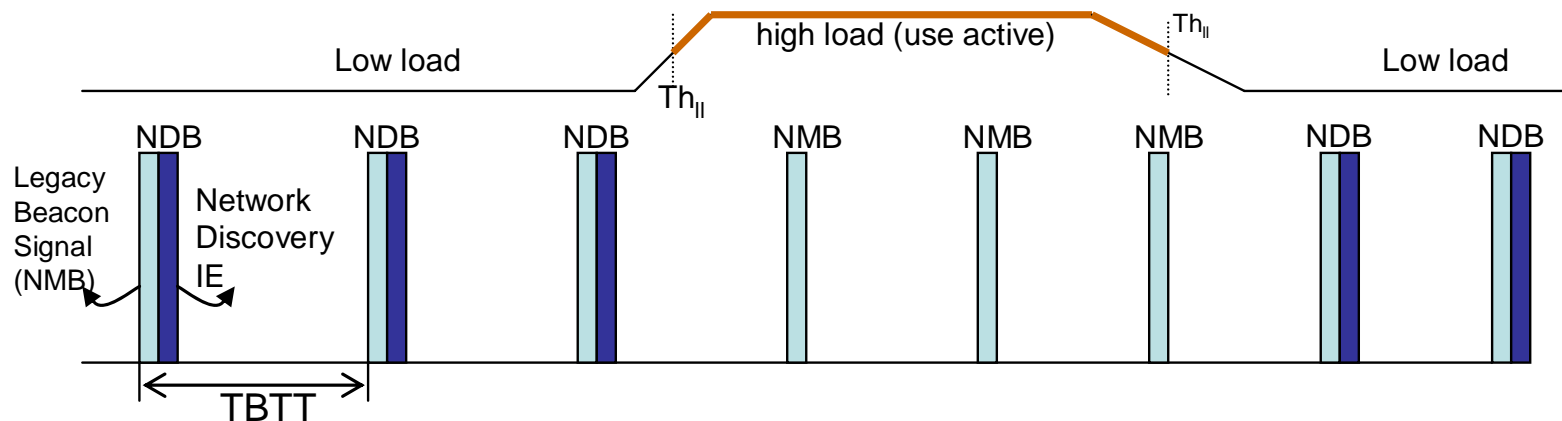
# Expected Technical Results

## ◆ Multiple authentications

- STA can be authenticated with multiple service provider networks through a single AP
- Expected Solution: Virtual Link Concept (by Huawei)

## ◆ Additional Info. Availability for Network Selection

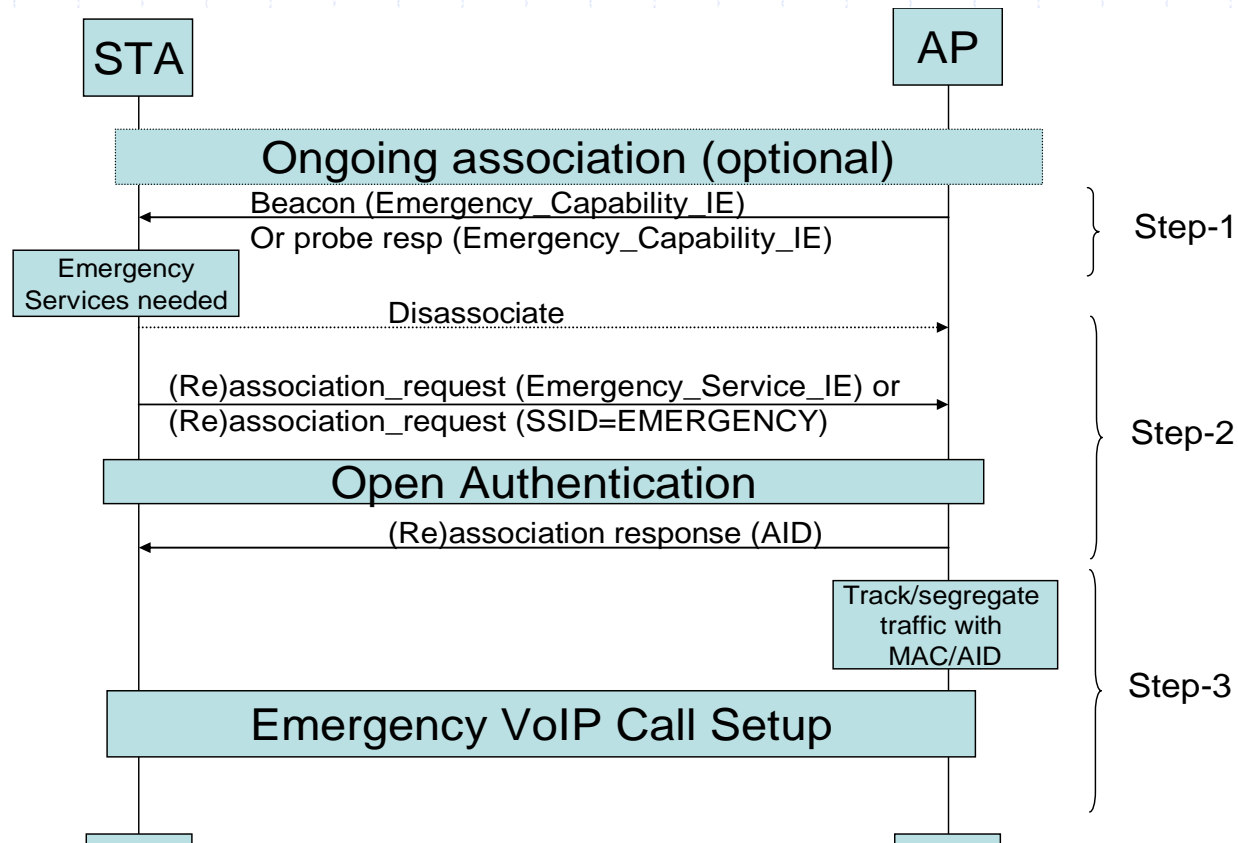
- STA can discover whether the WLAN hotspot has a roaming agreement with their service provider
- Expected Solution (by Siemens, Nokia, LG...)
  - ◆ Passive: ESSID, Hashing, and Layered Beacon
  - ◆ Active: New MAC Management Messages (Service Request/Response)



# Expected Technical Results

## ◆ Emergency Call Service via WLAN

- Define IEEE 802.11 functionality which would be required to support an Emergency Call (e.g. E911) service.
- Expected Solution: New Signal Flow (by Interdigital, Siemens, Nokia)





# Expected Technical Results

## ◆ MAC Address Anonymity

- It's a standard feature of modern cellular networks that observers can not determine the real identity of a phone.
- The same level of protection should be extended to IEEE 802.11.
- Expected Solution (by Nokia, LG, British Telecommunications)
  - ◆ ESS MAC Identifier (EMID), Association MAC Identifier (AMID)

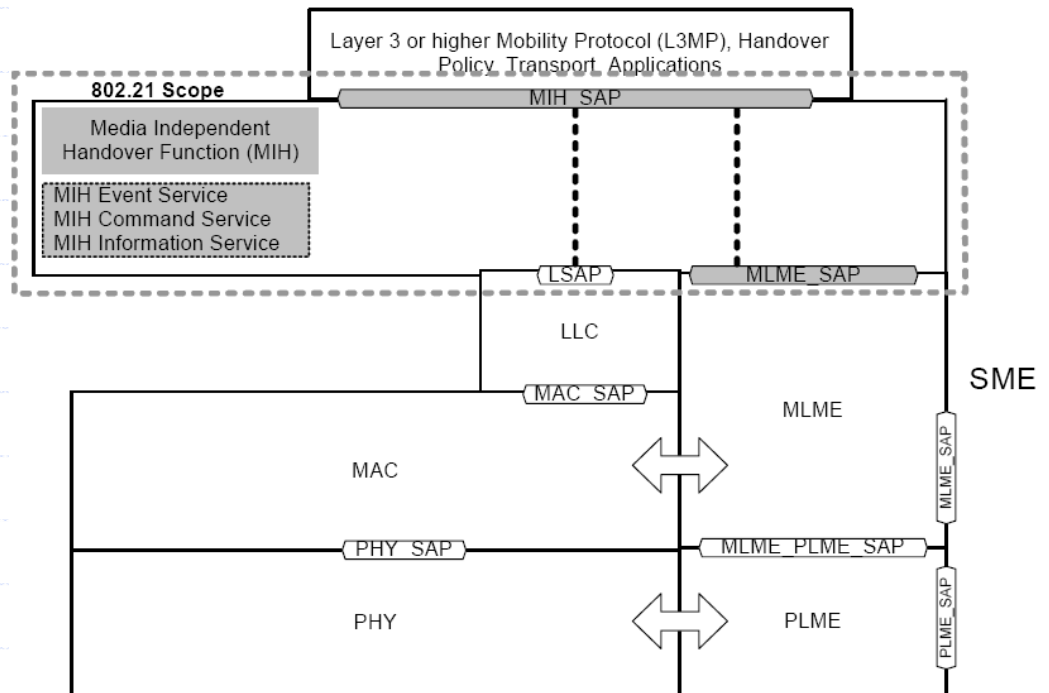
## ◆ QoS Mapping

- Provide mapping from external QoS information, e.g. DSCP, to IEEE 802.11 specific parameters
- Expected Solution (by Siemens, Panasonic, T-Mobile...)
  - ◆ New field, QoS Mapping Set, in Association Response
  - ◆ Traffic Segregation
    - TRAFFIC-SEG Request/Response frame

# Expected Technical Results

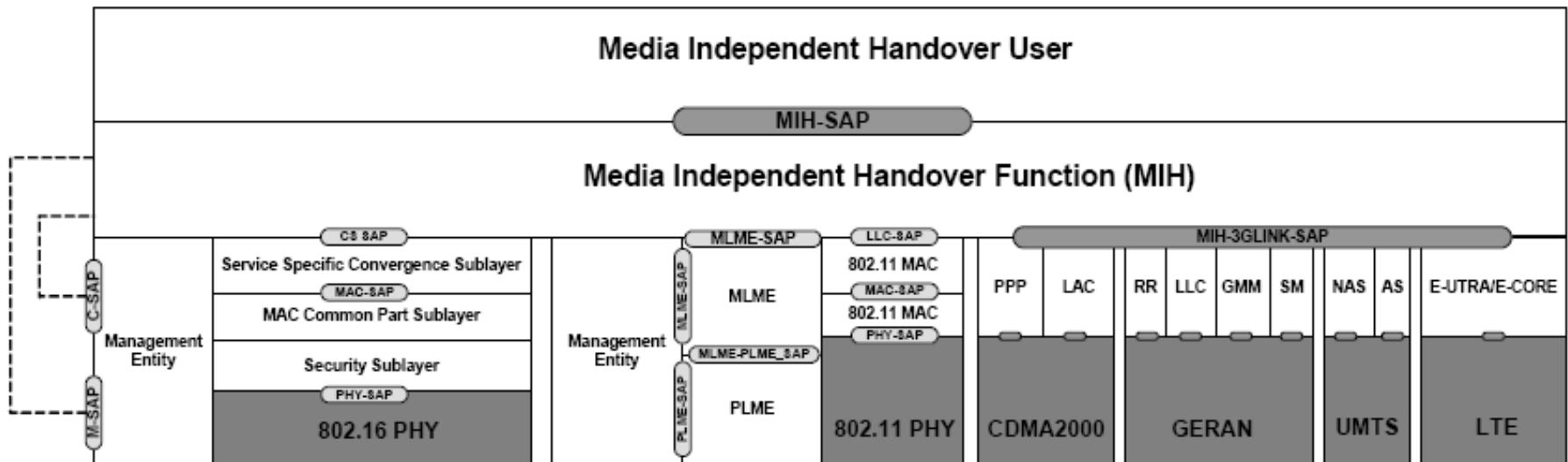
## ◆ New Primitives for MIH (Media Independent Handover) Service

- Input from IEEE 802.21
  - ◆ Link\_Up, Link\_Down, Link\_Going\_Down, Link\_Going\_Up...
- Event
  - ◆ Link\_Status\_Polling, Link\_Switch, Link\_Power\_Up/Link\_Power\_Down...
- Command
  - ◆ Link\_Status\_Polling, Link\_Switch, Link\_Power\_Up/Link\_Power\_Down...



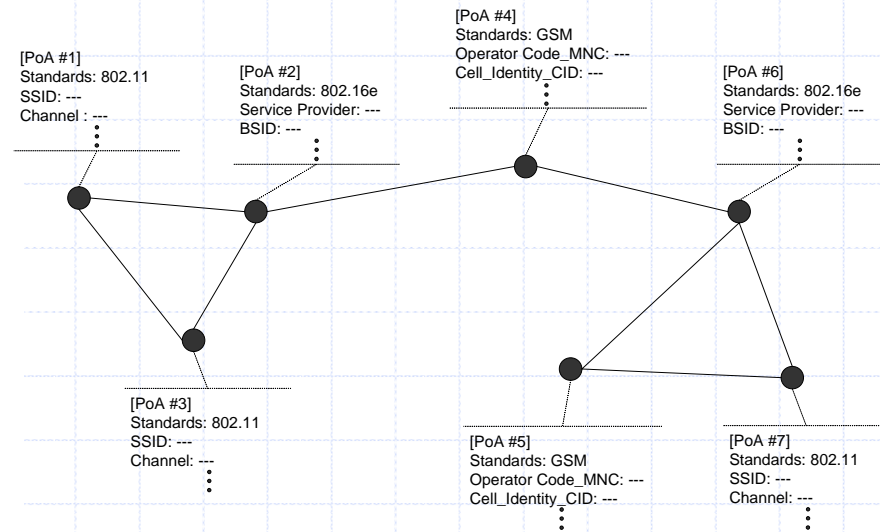
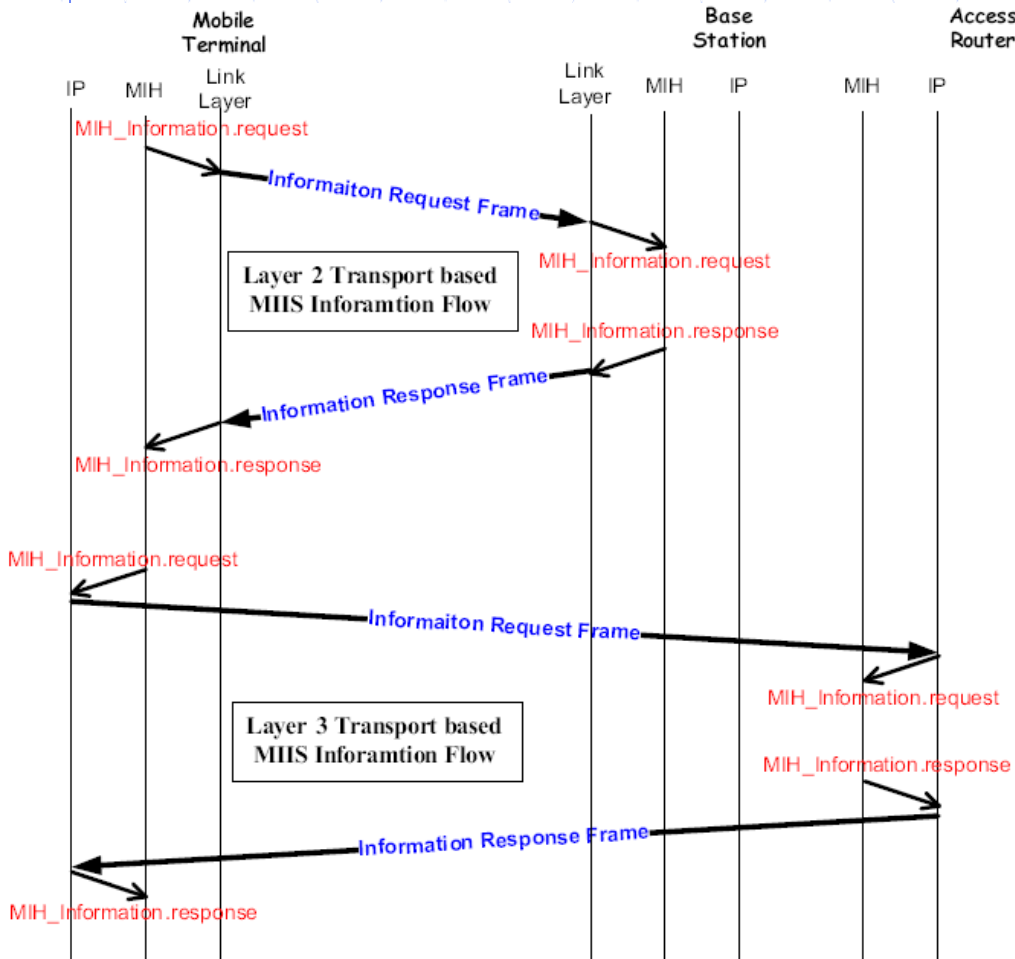
# IEEE 802.21 - Reference Model

## ◆ MIH Reference Model for Mobile Stations with Multiple Protocol Stacks



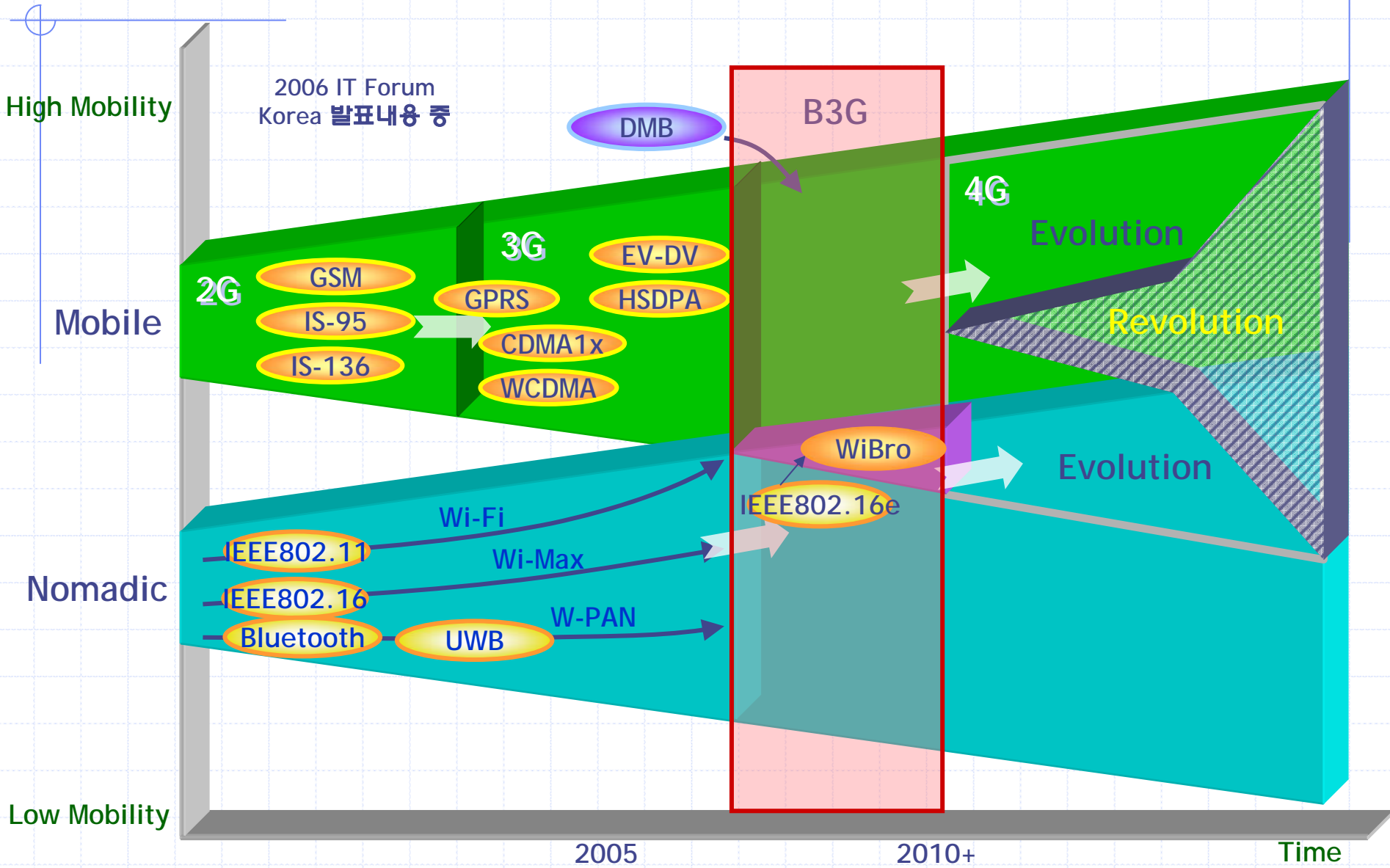
- **MIH Key Service**
  - ◆ Event Service
  - ◆ Command Service
  - ◆ Information Service

# MIH Function Key Service – Information Service

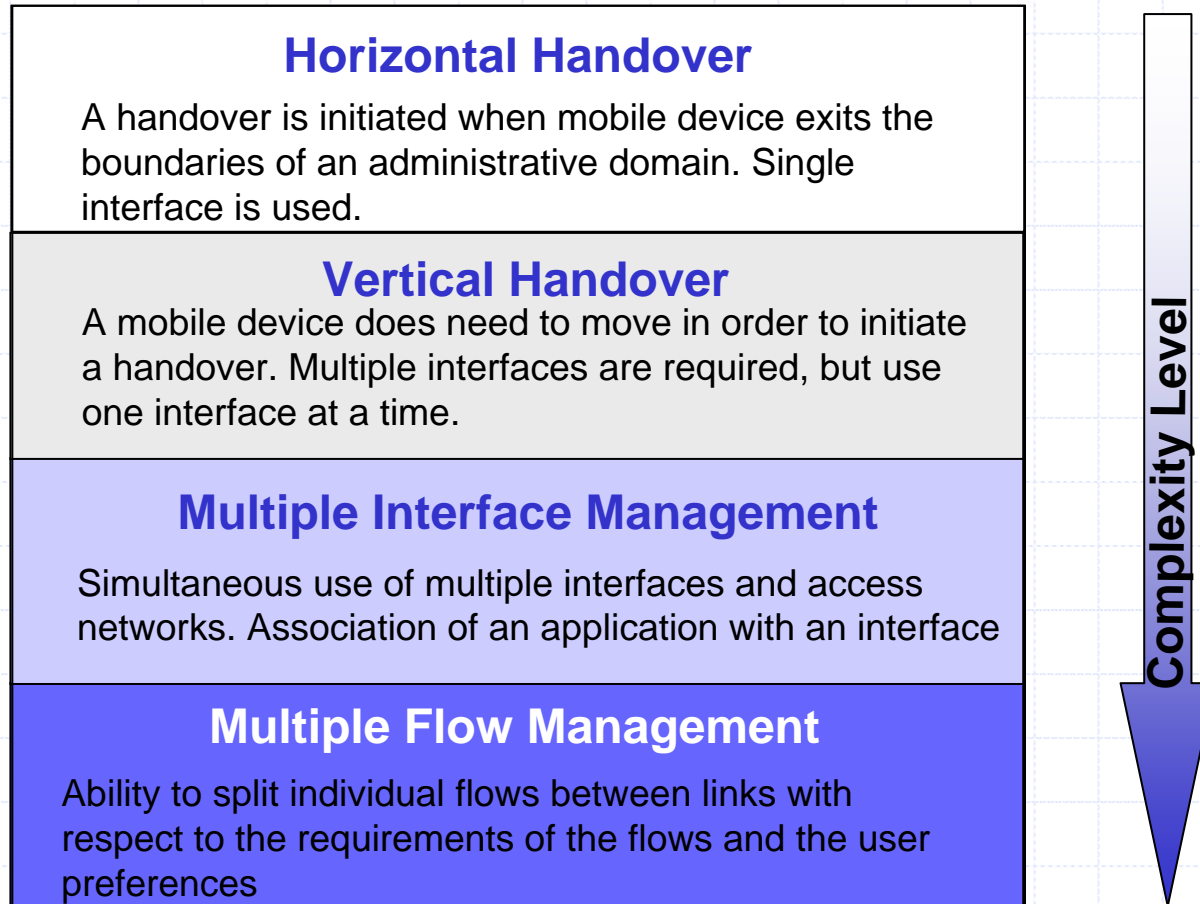


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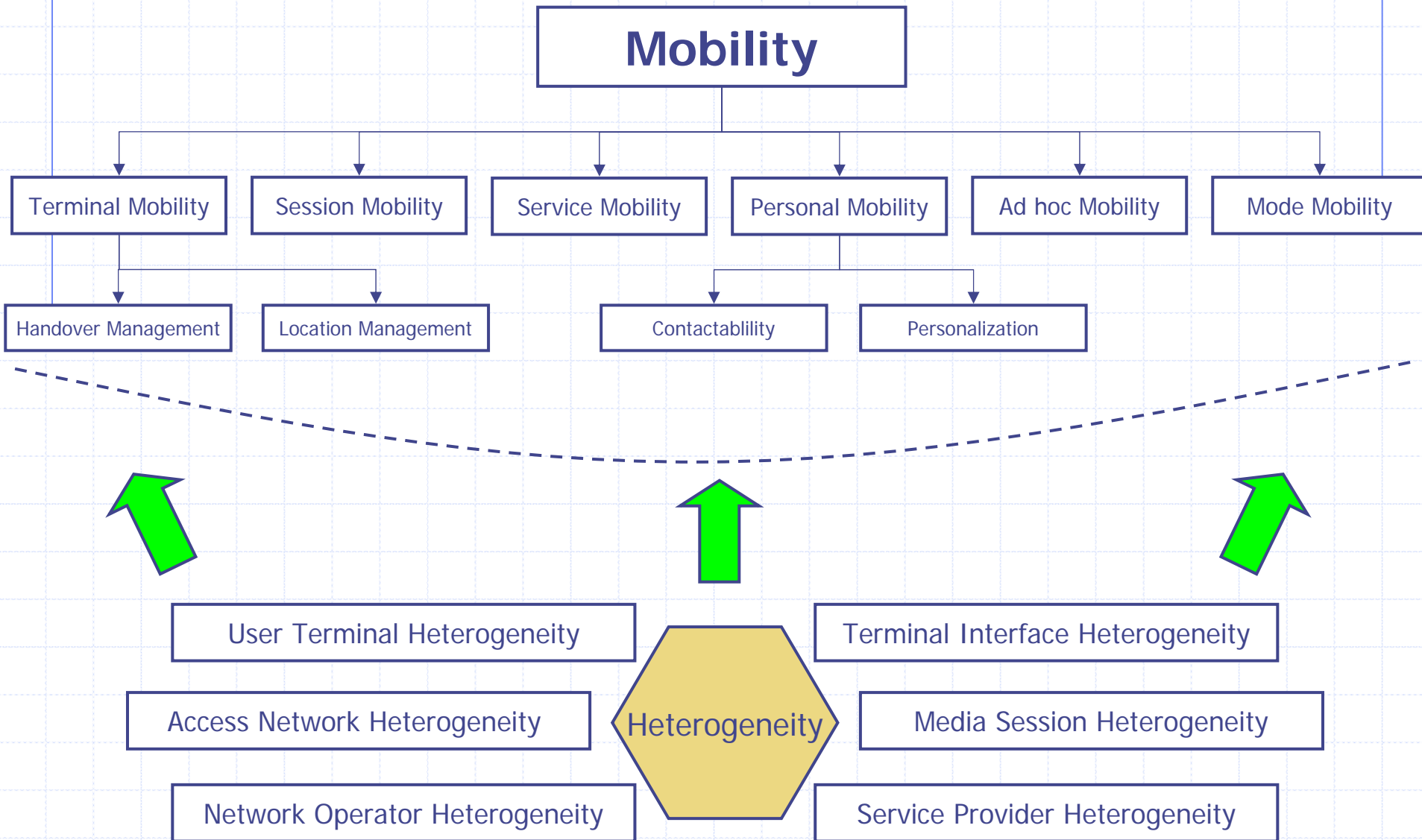
# Samsung's View on B3G and 4G



# Mobility Granularity



# Mobility and Heterogeneity Problem Space





# Key Challenges

## ◆ Scalability

- Roaming from any access network to any other access network (2G, 3G, 4G, Wi-Fi, Wi-Max, Bluetooth, Satellite, Ethernet)

## ◆ Cross-layer solutions

- Extensions to layer 1 & layer 2 functionalities in order to optimize higher layer mobility architectures (MIPv4, MIPv6, SIP).

## ◆ QOS guarantees during handover

- No disruption to user traffic
  - ◆ extreme low latency, signaling messages overhead and processing time, resources and routes setup delay, near-zero handover failures and packet loss rate

## ◆ Security

- User maintains the same level of security when roaming across different access networks.