Wireless LAN as Mobile Radio Access Networks

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Introduction

- WLAN technology has been maturing (for over 15 years)
- Standards development (IEEE 802.11, ETSI-BRAN, MMAC) ongoing for well over a decade
- Standards-based product implementations are now a reality (many 802.11 vendors)
- Enjoying widespread adoption for use in different environments, e.g., Enterprises, Homes, Factories, Hotspots (airport, hotel, conference room, plane, train, public safety), …

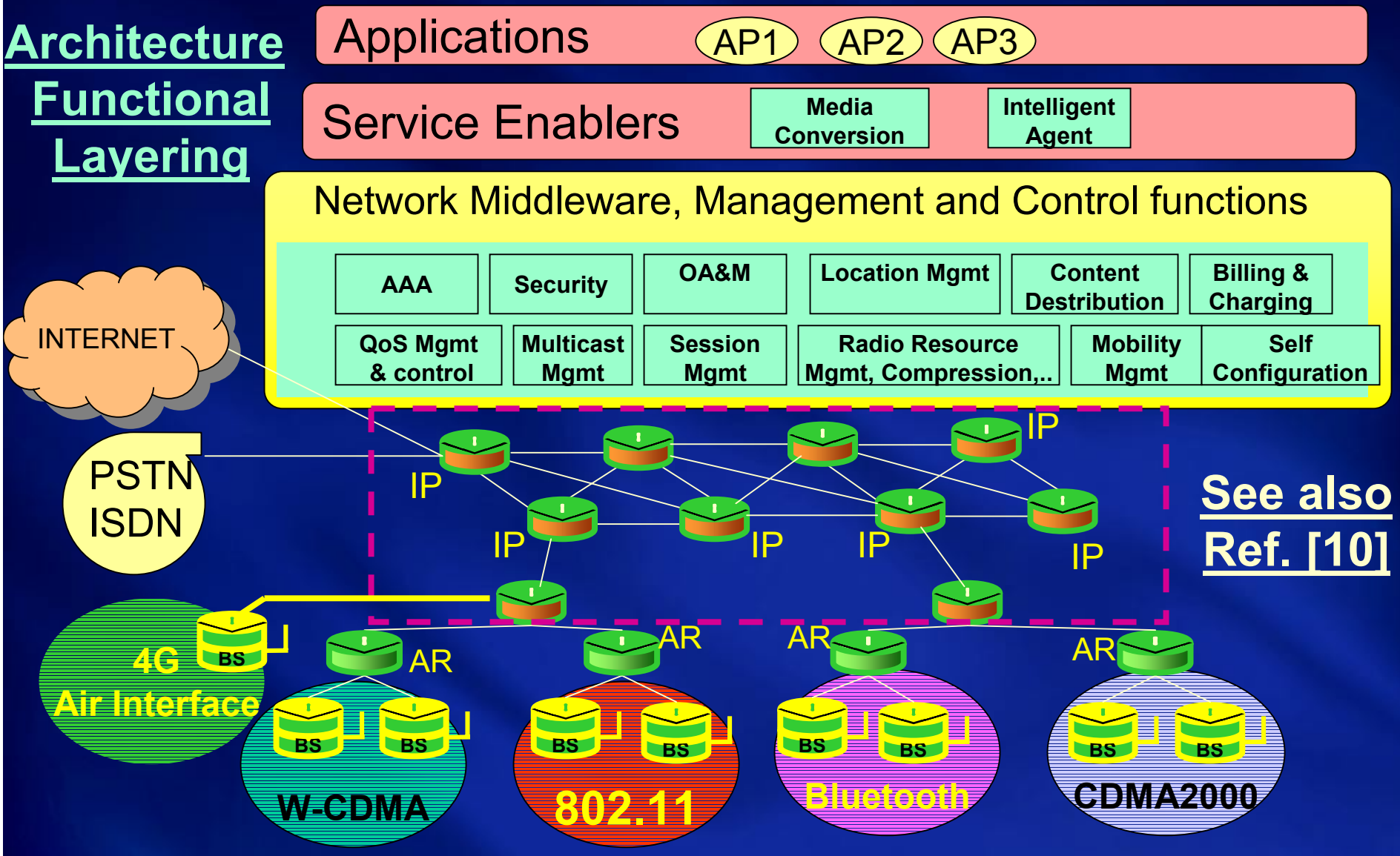
A Qualitative Assessment:

WLAN relative to Wide-Area Cellular

- Significantly higher bit rates (50x and more)
- Based on unlicensed spectrum (regional 900MHz, 2.4 GHz, global 5 GHz)
- Ease and low cost for setup and use
- Faster pace of technology evolution (in PHY layers)
- Limited range (per cell)
- Limited mobility (stationary, pedestrian but without vehicular speeds)
- QoS and Security issues are no less critical

- Evolving business models (many kinds of WLAN players)
- Can uniquely compliment IMT-2000 access technologies (a competition to cellular only if not embraced in a timely manner)

Architecture Functional Layering



See also Ref. [10]

Expectations for Systems Beyond IMT-2000

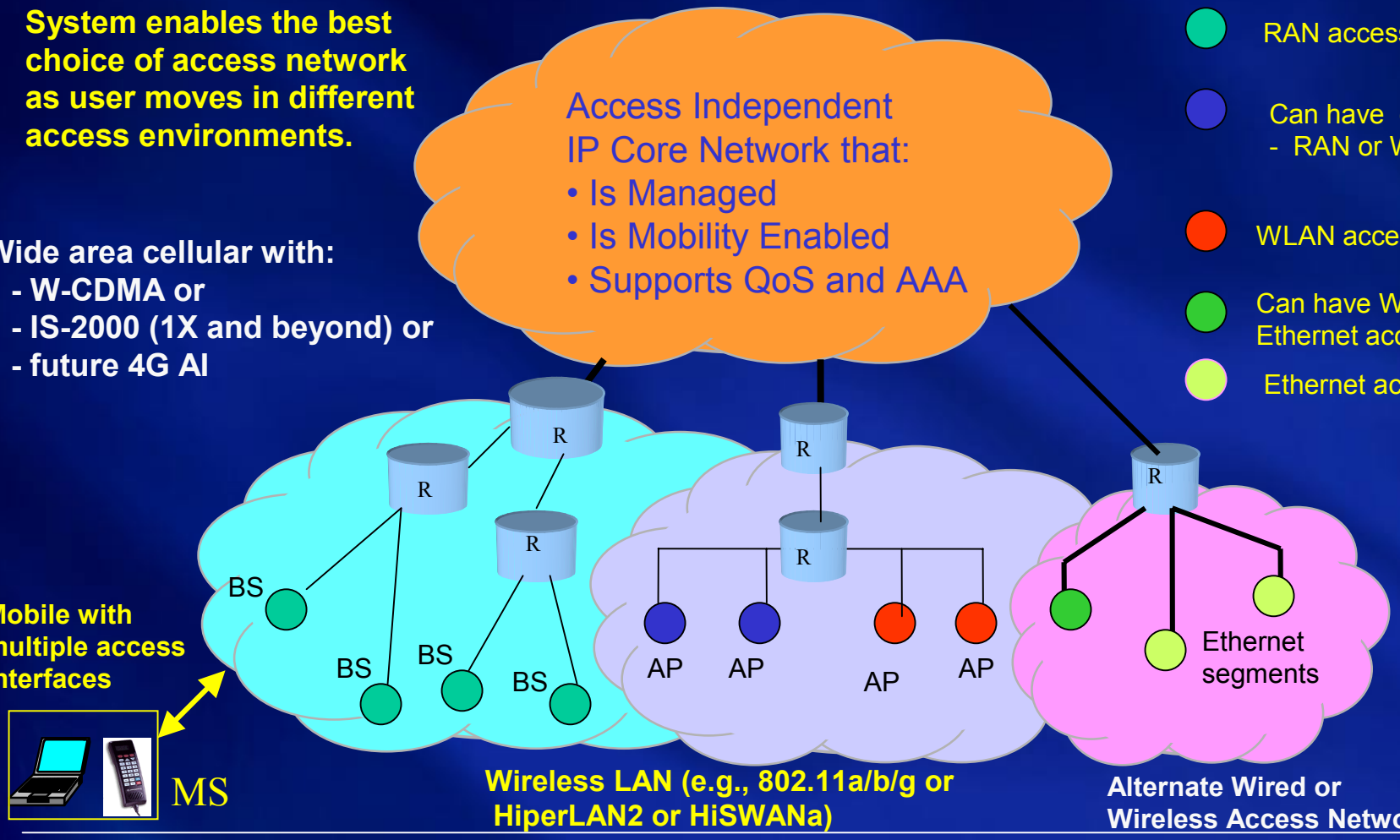
- Provide flexible support for a wide range of user needs with respect to speed, coverage and mobility
- Support a diverse set of radio access technologies including:
  High speed Wireless LAN (>100 Mbps), evolution of 3G air interfaces, and new 4G air interfaces
- Provide seamless mobility support for mobile devices with multiple access technologies that will become commonplace
- Seamless support for mobile networks (i.e., a closed group of users that moves collectively with respect to a fixed network)

Seamless Mobility

As the user moves, different access choices become available.

System enables the best choice of access network as user moves in different access environments.

Wide area cellular with:
- **W-CDMA or**
- **IS-2000 (1X and beyond) or**
- **future 4G AI**



Facets of Seamless Mobility

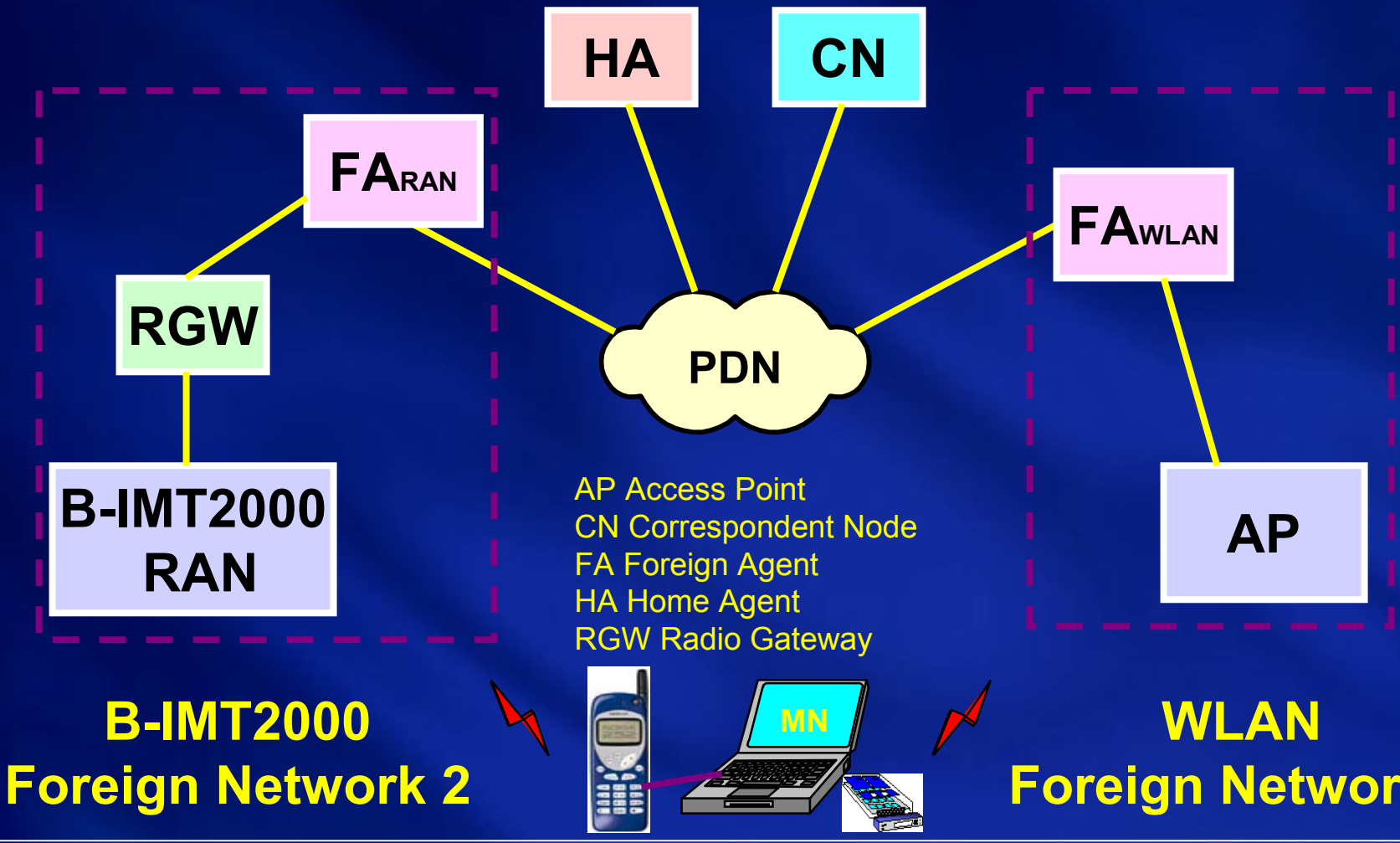
- Mobility between wide-area cellular network and Wireless LAN
- Handoff design must account for:
  - Intra-access versus Inter-access technology movement
  - Intra-domain versus Inter-domain movement
  - Type of service (real-time or non-real-time)
  - Flexible QoS needs of mobile users
- Seamless Mobility from the User perspective –
  - Unified authentication / security, billing and ease of access to applications from all locations with acceptable QoS at all times

Architectural Approaches to Mobility

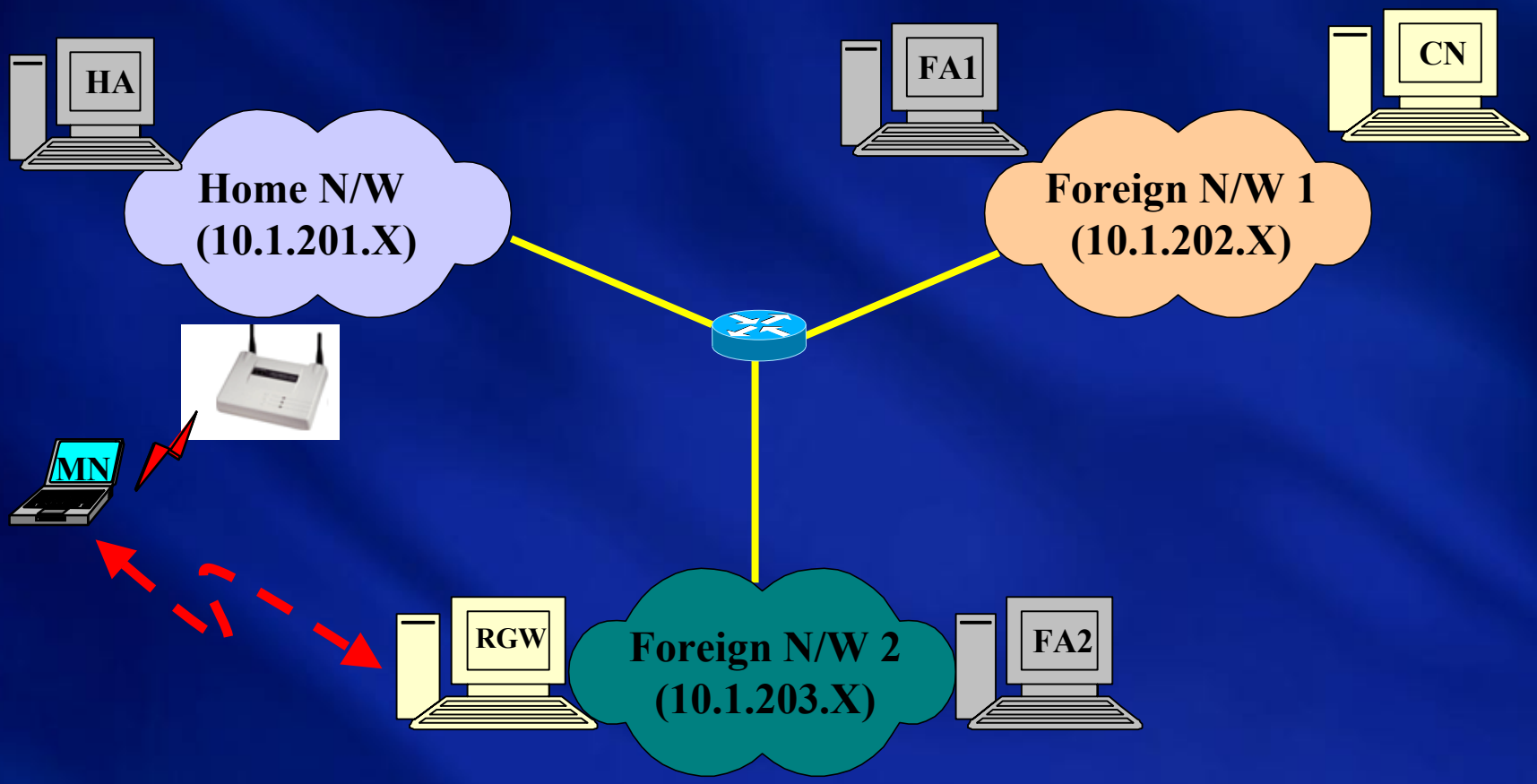
Two approaches have been proposed for coupling WLANs with Cellular Systems

- Loosely coupled architecture
- Tightly coupled architecture

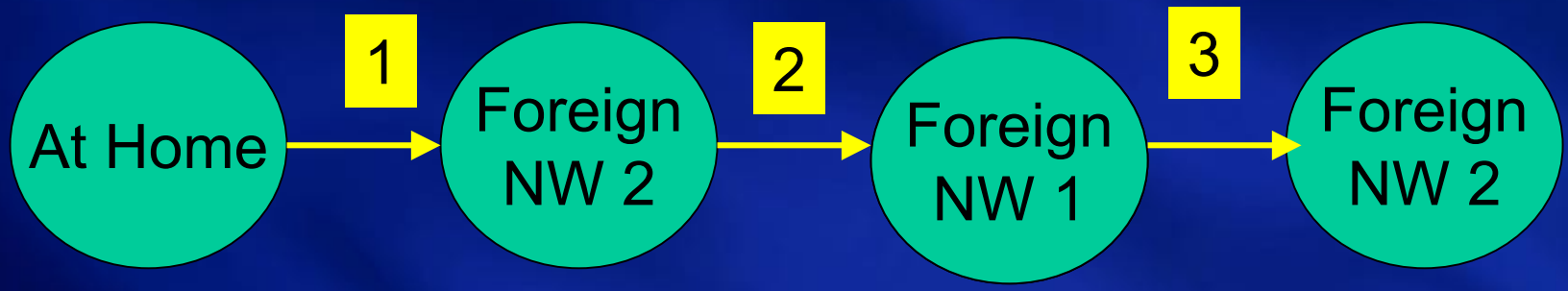
Loosely Coupled Functional Architecture



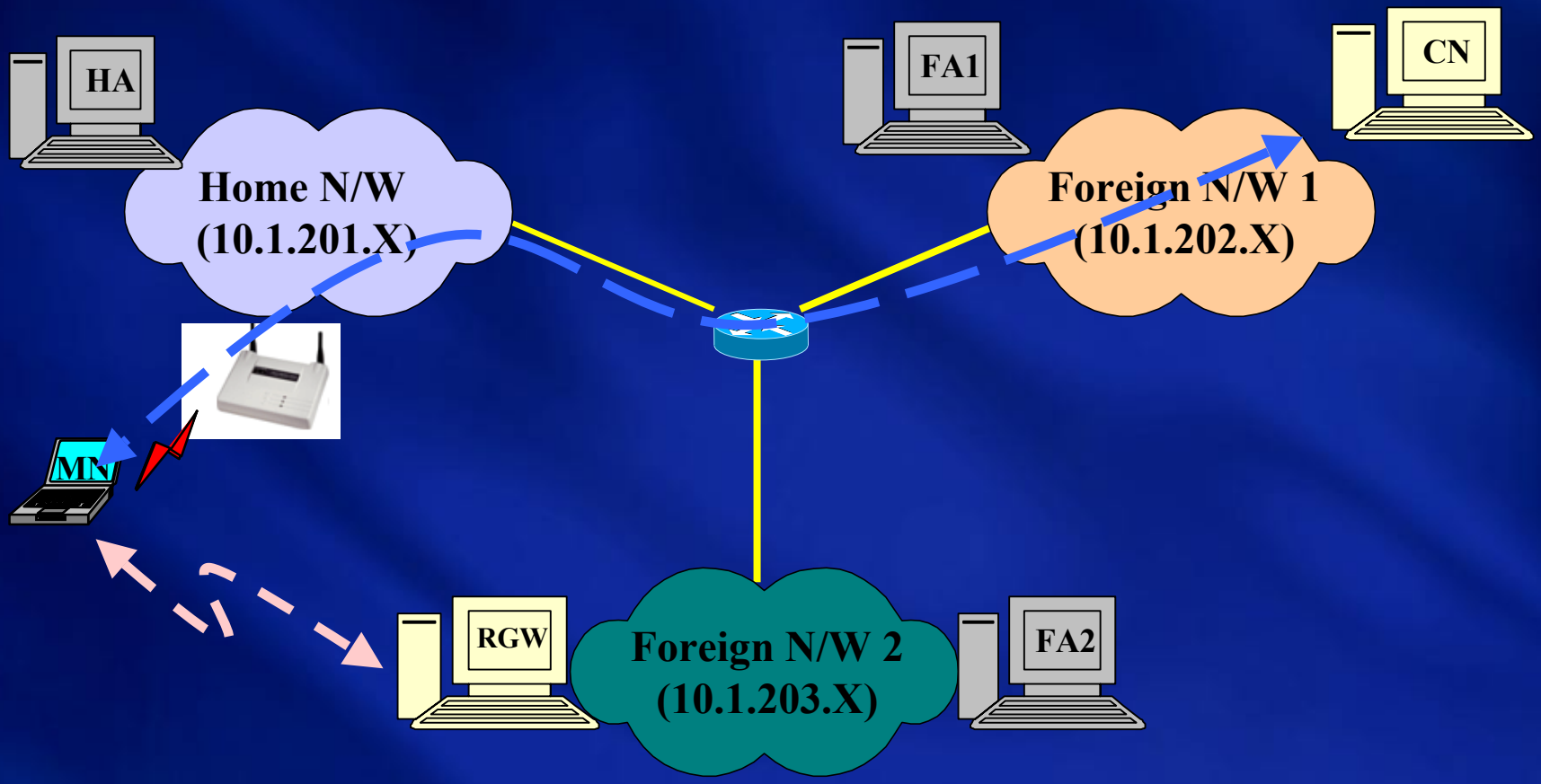
An Example Network



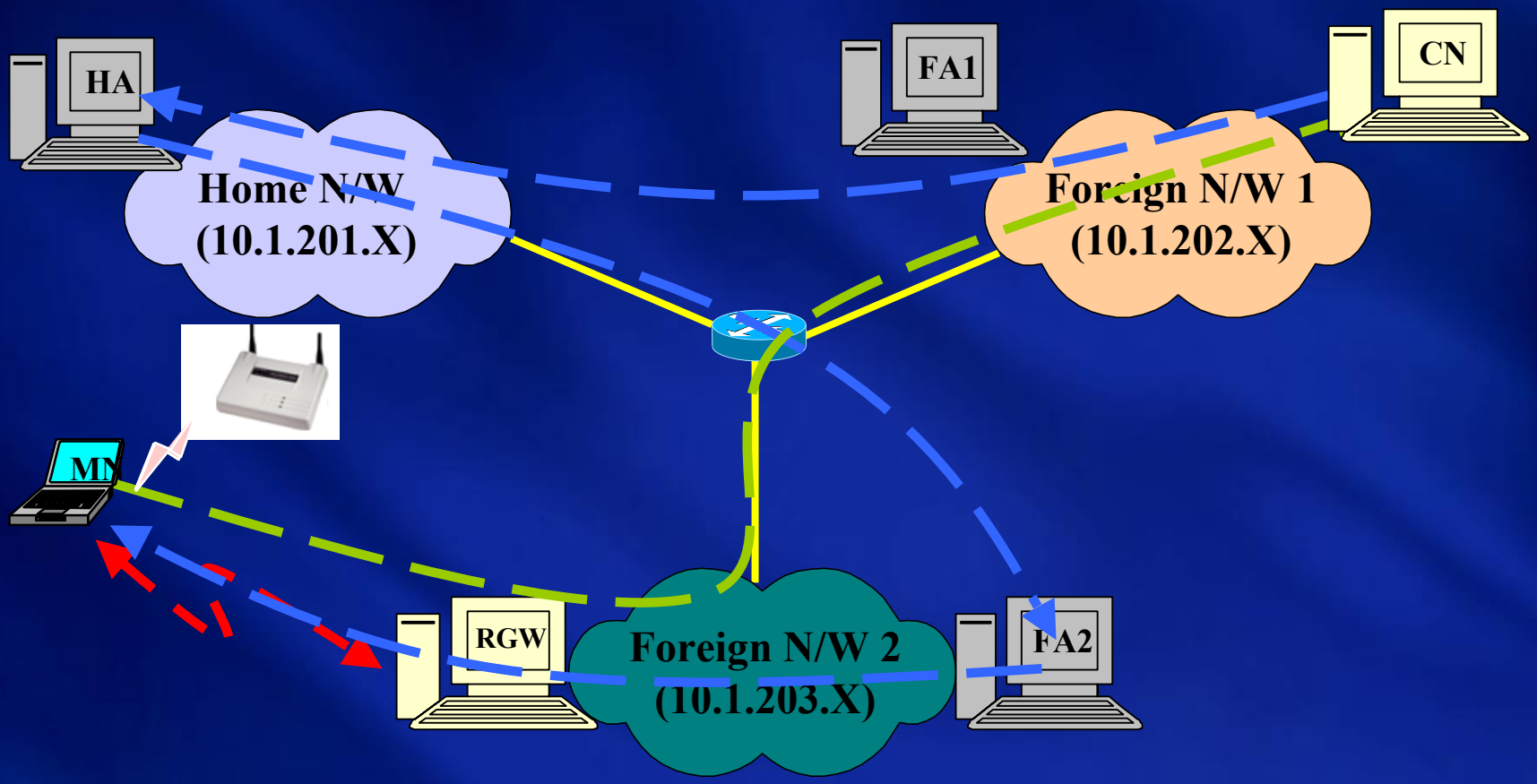
Consider a Mobile Station that moves from its Home to Foreign Networks as shown below.



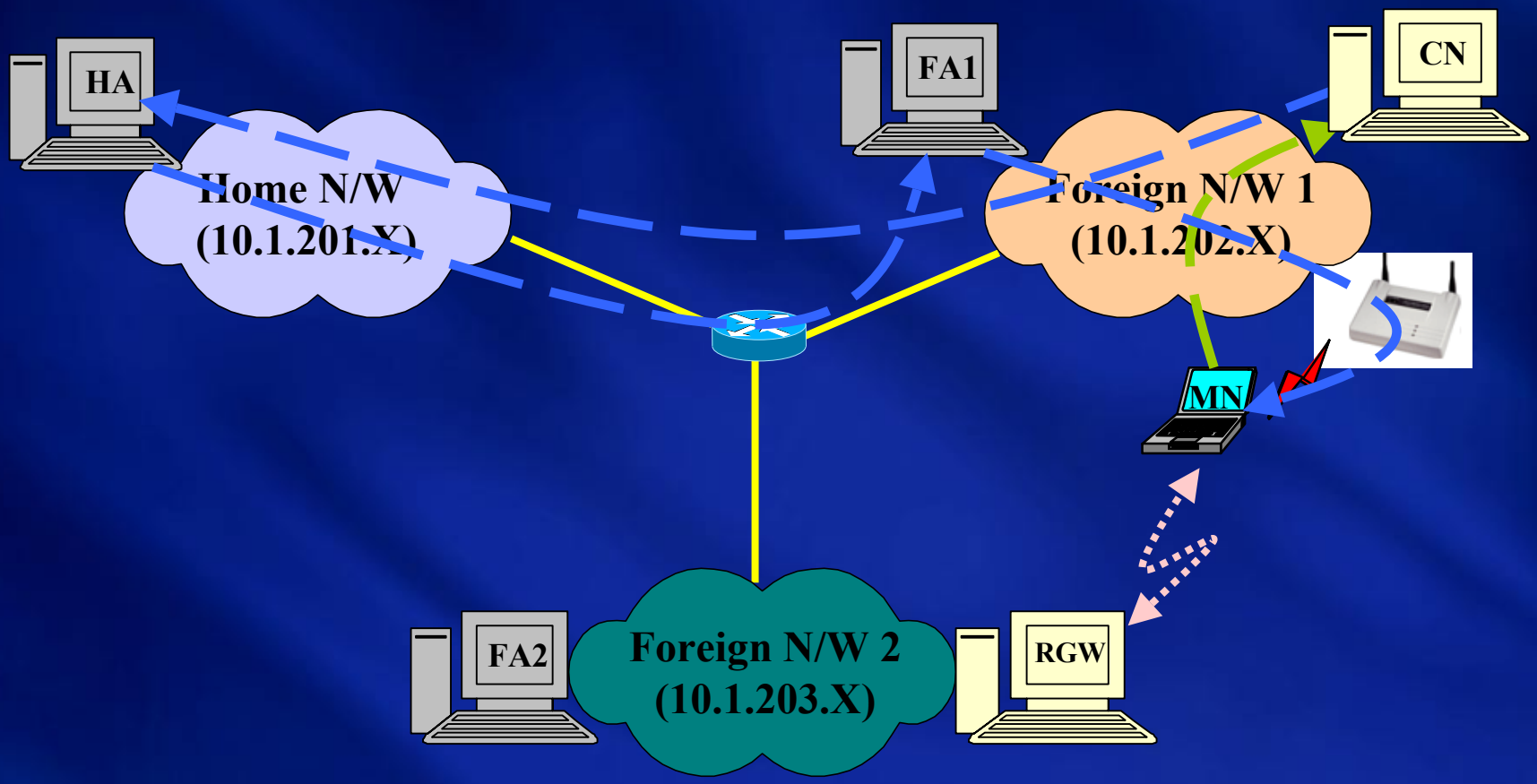
On Home NW (via WLAN)



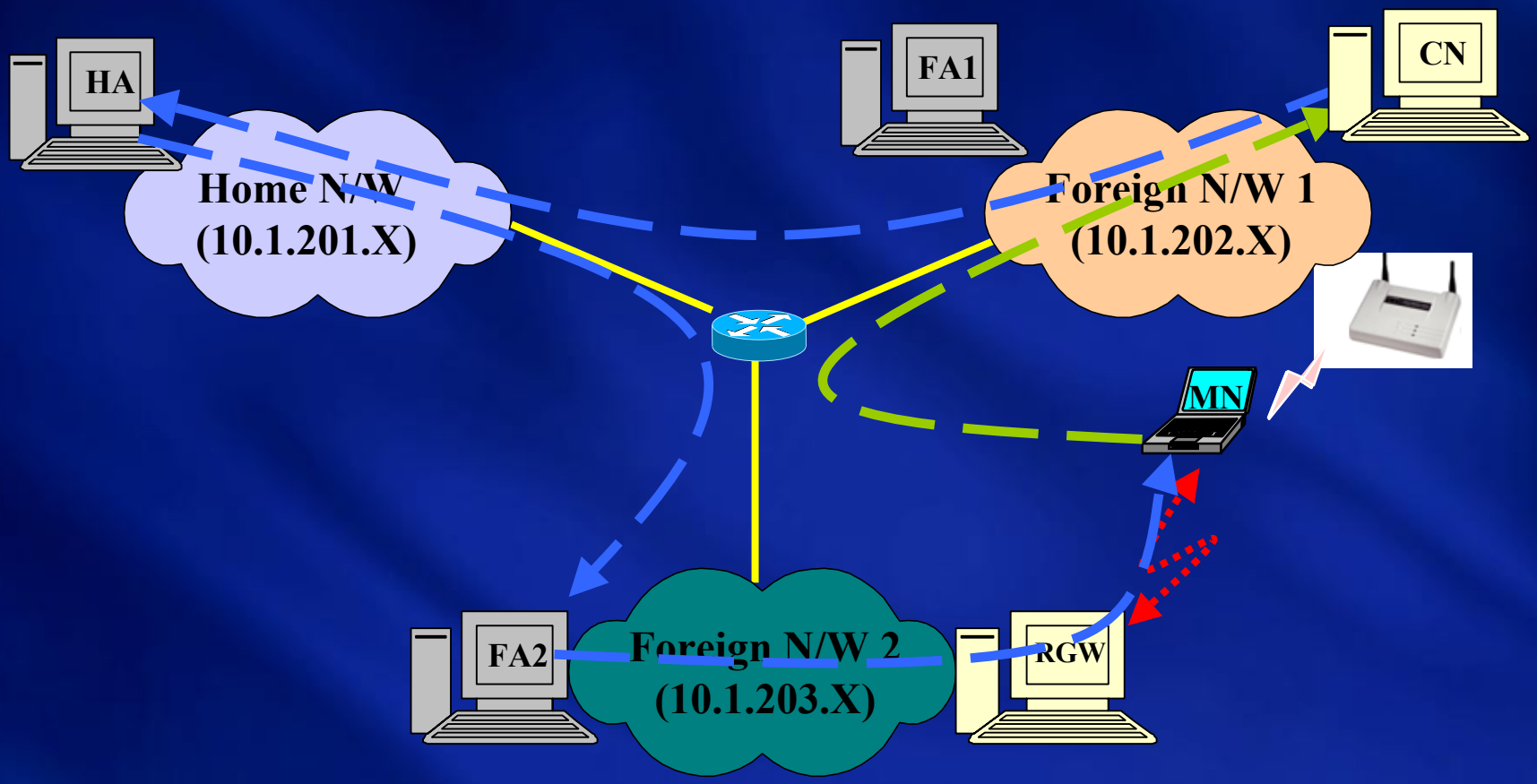
Move 1: Home NW to Foreign NW 2 (B-IMT2000 RAN)



Move 2: Foreign NW 2 to Foreign NW1 (WLAN)



Move 3: Foreign NW 1 to Foreign NW 2 (B-IMT2000 RAN)

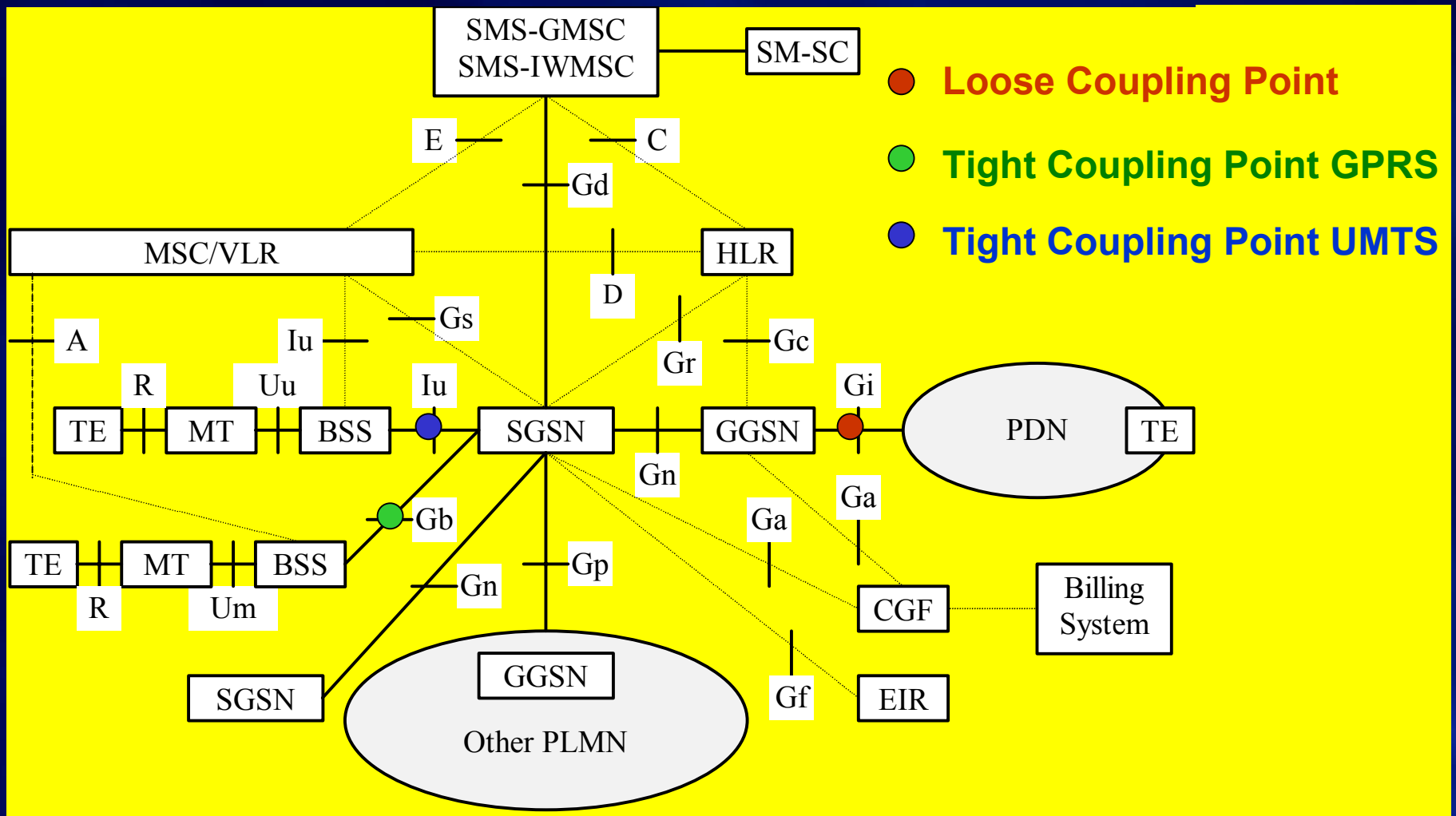


Loosely Coupled Architecture

- Access technology independent
- Widespread support in Standards Development Organizations
- Links together existing hotspot and enterprise network environments
- Implementation based on existing / proven technology

Tightly Coupled Architecture

- Access technology dependent
- WLAN appears subservient to Mobile RAN
- Lack of support due to high level of standardization effort
- Higher complexity for cellular interworking
- Longer time to develop


SMS-GMSC
SMS-IWMSC
SM-SC
Loose Coupling Point
Tight Coupling Point GPRS
Tight Coupling Point UMTS
E
C
Gd
MSC/VLR
HLR
D
Gs
A
Iu
Gr
Gc
R
Uu
Iu
Gi
TE
MT
BSS
SGSN
GGSN
PDN
TE
Gn
Ga
Gb
Ga
TE
MT
BSS
Gp
Gn
CGF
Billing
System
R
Um
GGSN
SGSN
Gf
EIR
Other PLMN
Signalling Interface
Signalling and Data Transfer Interface

Wireless LAN Standards & Choices

Attribute	802.11	802.11a	802.11b	802.11g	HiperLan/2	MMAC
Frequency range	2.4 - 2.4835 GHz (100 mw max)	U-NNI (USA) bands 5.15 - 5.25, 5.25 - 5.35 and 5.725 - 5.825 GHz	2.4 - 2.4835 GHz (ISM band in N. America, Europe & Asia)	2.4 - 2.4835 GHz	5GHz	5GHz (HiSWANa) 25/27GHz (HiSWANb)
Physical Layer	FHSS DSSS Infrared	OFDM 52 carriers @ 300 KHz BPSK/QPSK/16QAM/64QAM combined with FEC coding	Barker (mandatory) CCK (mandatory) PBCC (optional) DSSS	Barker, CCK, OFDM (mandatory) PBCC-22 (optional) CCK-OFDM (optl.)	OFDM BPSK,QPSK, 16QAM,64QAM	Coded OFDM BPSK, 16QAM, 64QAM
Channel Width	1 MHz 3 without overlap	8 channels each 22 MHz	22 MHz 3 without ovedrlap	22 MHz 3 without ovedrlap	22 MHz	4 channels 20MHz each
Throughput (Mbps)	1, 2	6,12,24 (mandatory) 9,18,36,48,54 (optional) (speed varies as distance from Access Point)	1,2, 5.5,11 Mbps using Dynamic Rate Shifting 7 Mbps (expected)	1,2, 5.5,11, 6,12,24 5.5,11,22,33 6,9,12,18,24,36,48,54	6,9,12,18, 27,36,54	6 to 54 Mbps 27 Mbps nominal
Medium Access Control protocol	Same as 802.11b	Same as 802.11b	CSMA/CA with Distributed Coord. func (mandatory) Optional Point CF	Same as 802.11b	Reservation TDMA w/ TDD 2 ms frame	TDMA-TDD, central control + dynamic slot assignment
Comments	Standard in 1997	Completed in 1999 Not compatible with 802.11b	Approved in '99. Not compatible with 802.11a	1st draft Nov. '01. Standard expected in 2H02. Compatible with 802.11b	Completed in '00. Dynamic Freq. Selection, Transmit Power Control	Carrier Sense functions at AP, Inter AP Synchronization

Additional WLAN standards

802.1X	Completed in 2001	Comprehensive security framework for all IEEE 802 LANs including wireless. Includes authentication (EAP and Radius) and key management.
802.11i	Expected in 2002	Wireless specific security functions that work in conjunction with 802.1x
802.11d		Protocol to let 802.11 device to receive regulatory information for self-configuration
802.11e	Expected in 2002	QoS mechanisms in support of all IEEE 802.11 PHY interfaces
802.11f	Expected in 2002	Defines protocols for communication between APs (Inter-Access Point Protocol)
802.11h	Expected in 2002	Spectrum and Transmit Power management extension techniques (5GHz in Europe)
802.11 WNG	Started 1/2002	WLAN Next Generation study group (peak rate > 100 Mbps)

Conclusions

- Wireless LANs will continue to become faster, cheaper, reliable and ubiquitous
- Useful compliment to the wide area cellular access technologies
- Market evolution will likely result in multiple access technologies supported by seamless mobility solutions

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