

## Seamless Multimedia over Heterogeneous Wireless Networks (4G)

Abolfazl Nazari



### Outline

- “Seamless multimedia over heterogeneous...” what does it mean?
- 4G networks
  - Technologies
  - network architecture
- Multimedia services in 4G
- Seamless mobility literature review
- Steps ahead: (5G?)

## Seamless multimedia over...

### ■ Seamless:

- Uninterrupted multimedia session, even during handoff to another network with different technology

### ■ Multimedia:

- we only focus on real-time applications (voice+video)

### ■ Heterogeneous:

- integration of different wireless technology over an IP-platform (4G)



## 4G: technologies

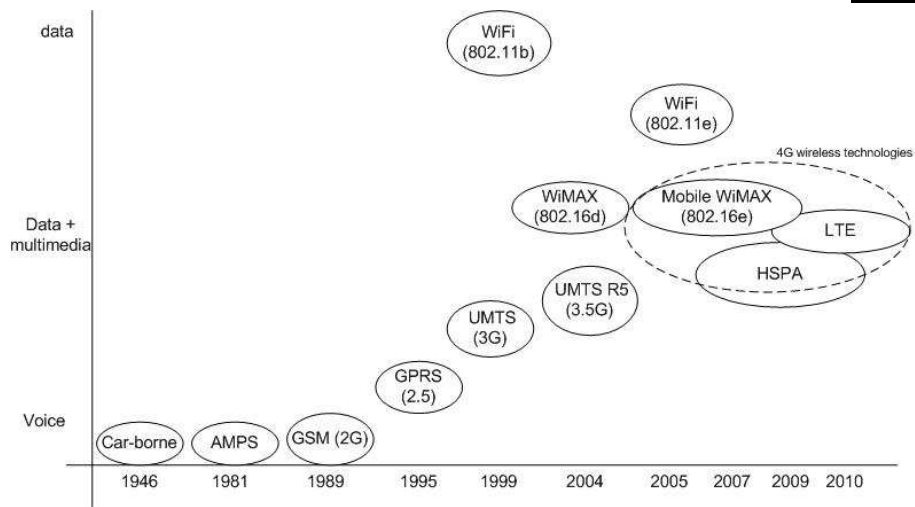
### ■ Is 4G only one wireless technology? No

### ■ Why different technologies?

- Different origins: IEEE and ETSI (3GPP)
- Different characteristics: bandwidth, mobility, cost
- Backward compatibility: ex. HSPA is 3G compatible
- Evolution of wireless networks

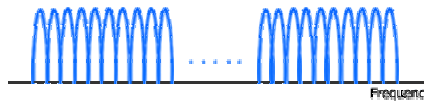


# 4G: technologies



# 4G: wireless techniques

■ OFDMA



■ MIMO

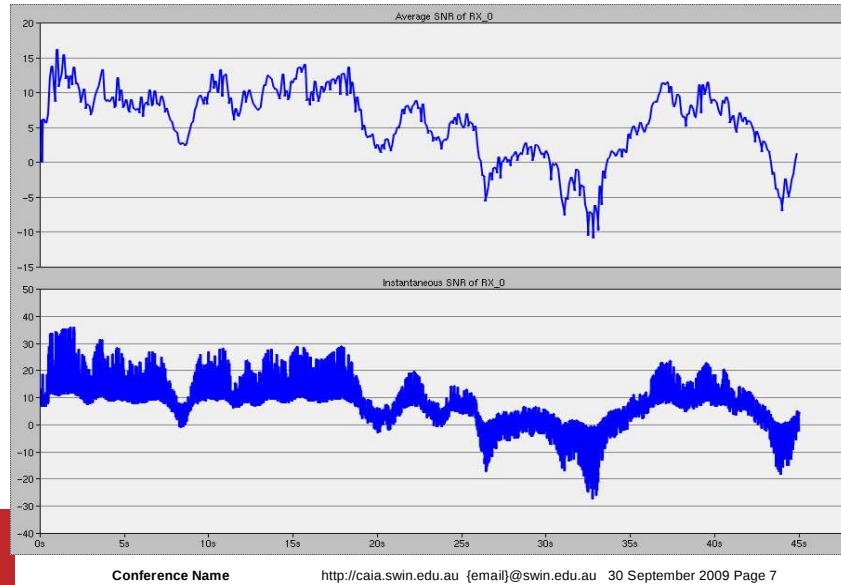
■ Multi-stream data transfer

■ HARQ with soft-combining

■ Multiuser diversity

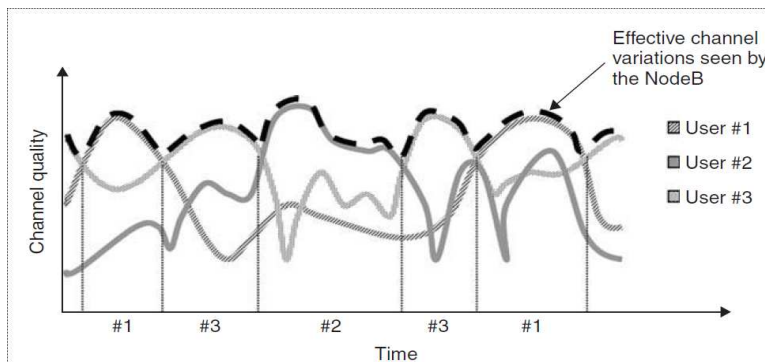
## 4G: wireless techniques

### Receiver SNR



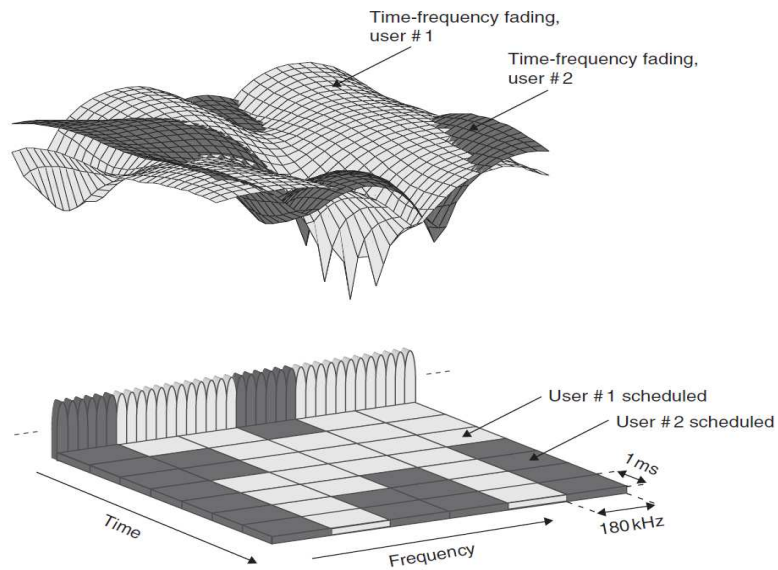
## 4G: wireless techniques

### Multiuser diversity for HSPA (channel-dependent scheduling) [1]

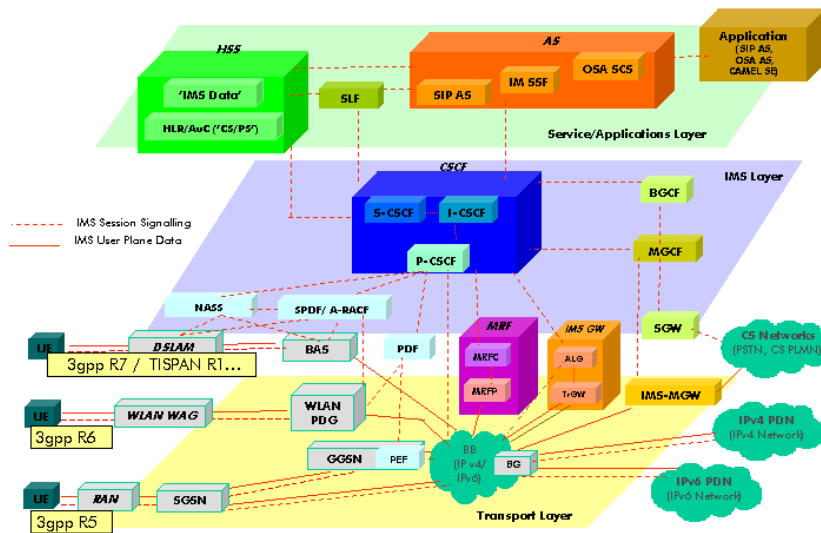


# 4G: wireless techniques

## Multiuser diversity for LTE [1]



# 4G: Architecture

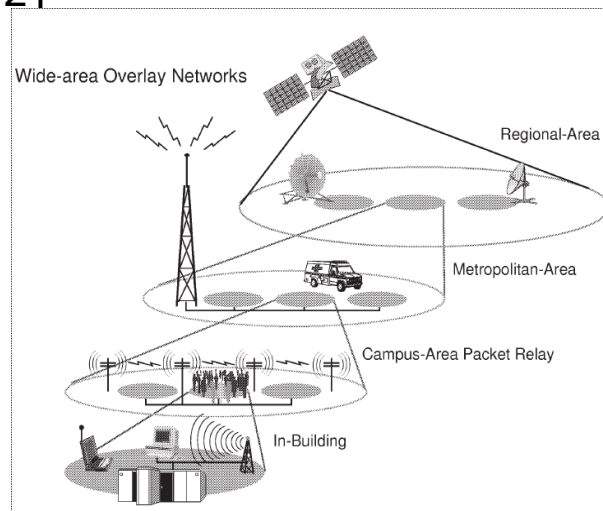


## Multimedia services

- IMS is the standard platform for multimedia and VoIP.
  - Introduced in UMTS R5 (2002)
  - Pros: security, QoS, charging, lawful interception, open API, message compression
  - Cons: cheap “naked SIP” services are already there
- IMS is access-agnostic:
  - uses access information for better service delivery

## Seamless mobility

- The term “vertical handoff” first was used in 1998 [2]
- Why vertical?



## Seamless mobility

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- vertical handover: the MN moves between point of attachments of **different link** types [802.21]
- Pahlavan et. al. in 2000 [3]: UMTS/WLAN integration (impressive!)
  - UMTS/WLAN main force behind 4G
  - UMTS R6 (2005) added WLAN integration
- Gustafsson in 2003 introduced the concept of Always Best Connected (ABC) [4]

## Seamless mobility: protocols

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- Changing the network results in change of IP address
  - Some how packets should be redirected
  - We need a network information repository
- End-to-end solutions
  - mSCTP [5]: transport layer
  - SIP [6]: application layer
- Network solutions:
  - Mobile IP [7]: IP layer solution

## Seamless mobility: process

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- Redirecting the packets is only one part of the solution
- Handoff process:
  - Starting the HO
  - scanning and discovering target networks
  - network selection
  - authentication and authorization
  - obtaining an IP address
  - redirecting the data packets



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## Seamless mobility: reducing delay

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- Reducing the handoff delay
  - Be proactive
    - Use phy info to trigger HO: Mohanty [8] in 2006 for MIP
    - **Predicting RSS: Change [9] in 2008**
  - Make-before-break (Soft Handoff)
    - **Park et. al. [10]:** for IPTV
    - Koh and Hyun [11]: bicasting for SIP
    - The effect of shadow fading can be reduced



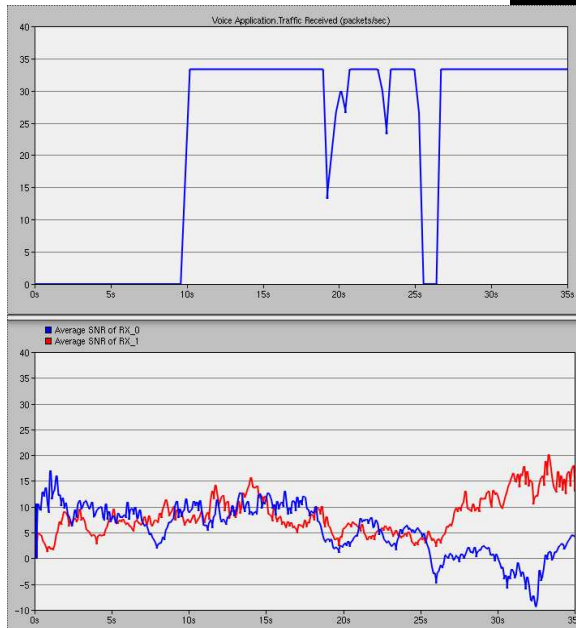
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## Seamless mobility: reducing delay

- Hard handoff



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## Seamless mobility: reducing delay

- Soft handoff

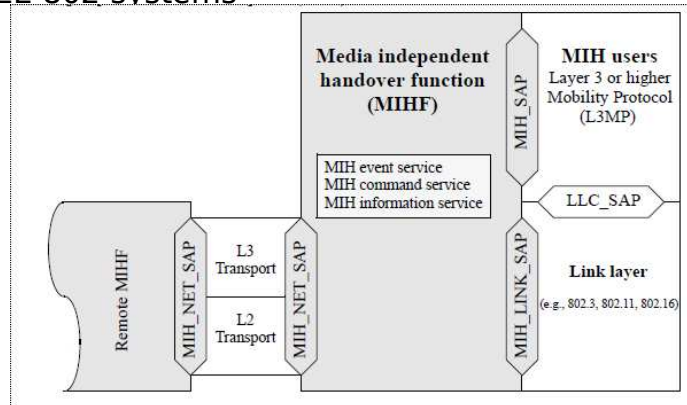


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## Seamless mobility: reducing delay

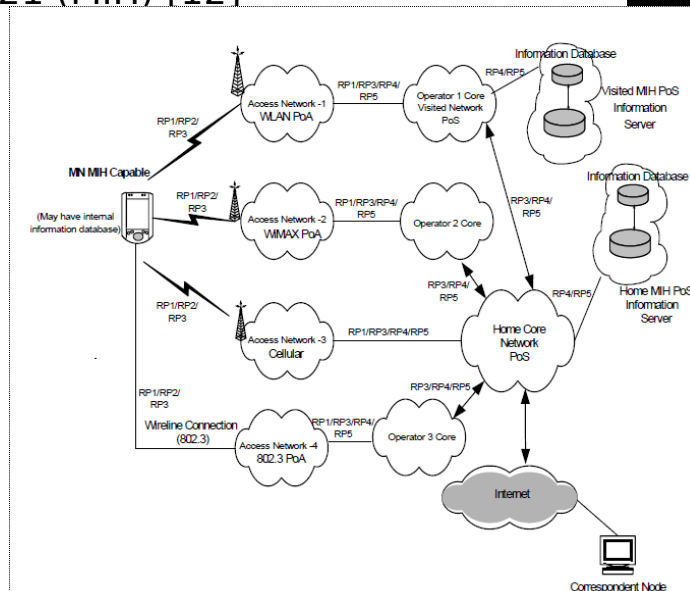
- IEEE 802.21 (MIH) [12]
  - A framework for handoff
  - Like 802.1X introduced a framework for security for IEEE 802 systems



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## Seamless mobility: reducing delay

- IEEE 802.21 (MIH) [12]



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## Seamless mobility: reducing delay

- IEEE 802.21 (MIH) [12]
  - MS is informed link is going down
  - MS asks for handoff information from MIH information server
  - MS asks for information from PoS in the access network
  - MS request MIHF to start handoff
  - A variety of scenarios can be imagined



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## Steps ahead

- Fast network switching to use shadow fading
  - Shadow fading correlation distance is 20 m
  - Network dwell less than a second
  - Fast loss less handoff is required
  - Push it further: can we have a “network diversity” to use fast fading?
    - Millisecond dwell time
    - Joint channel based scheduling



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## Steps ahead

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- Do we have a 5G? Do we need it
  - 4G is extensible: open IP architecture, core and access separation, service and transport separation
  - A change in networking scenario
    - Traditional “one network many clients” model
    - New “one client many networks” model.



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## Steps ahead

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- Do we have a 5G? Do we need it
  - A change in network traffic
    - Traditional definition of real time application, human brain limitation
    - New definition of real time: machine to machine communication
  - A change in the network architecture
    - Traditional infrastructure-based network, mobile users
    - New mobile network, mobile users



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