

# Evolution of Cell Networks

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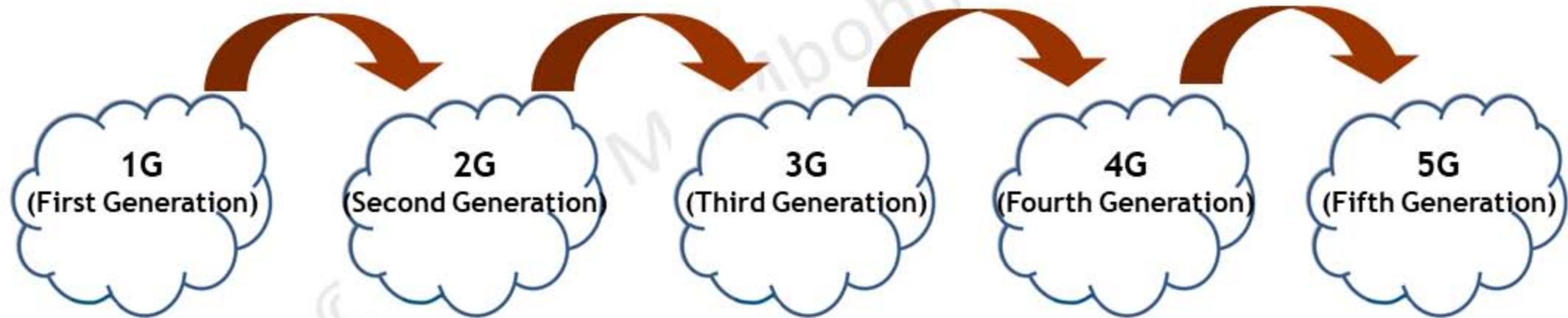
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# Evolution of Cellular Networks

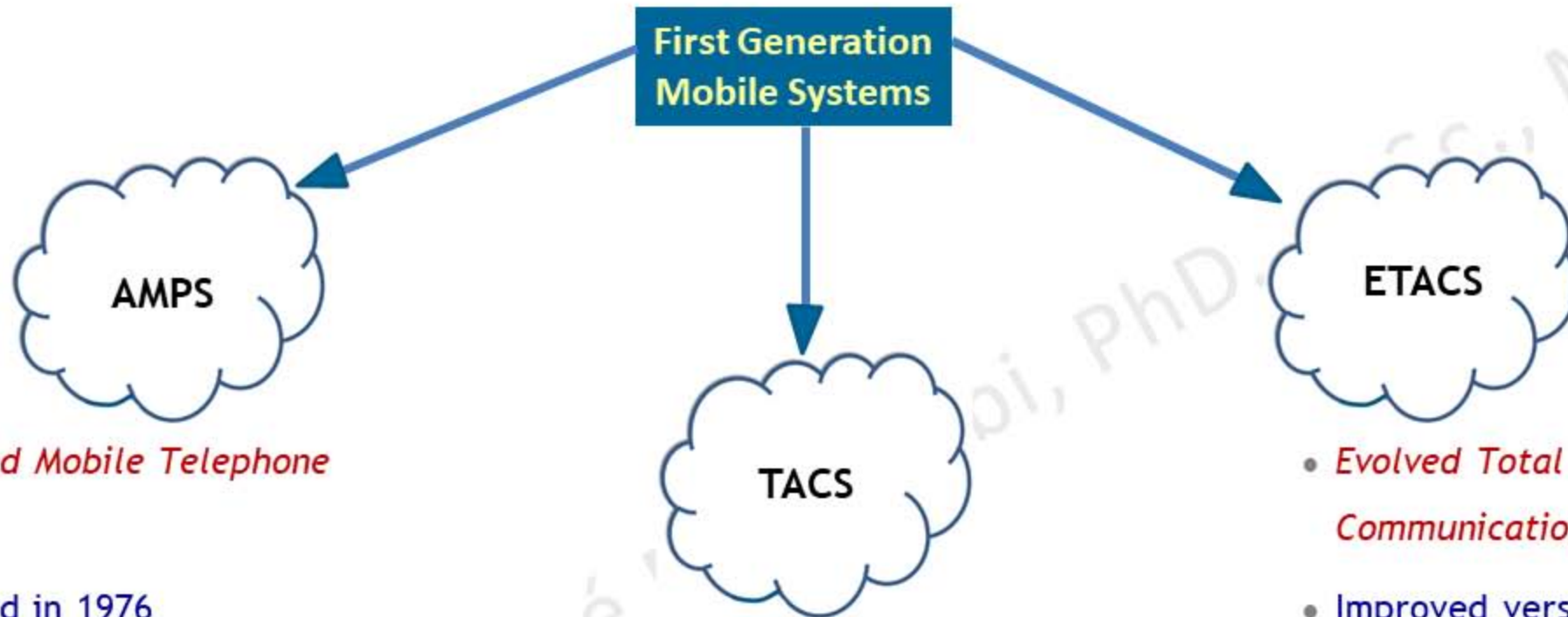
- Cellular mobile networks have been evolving for many years



# First Generation Mobile Networks (1G)

Eng.

# First Generation Mobile Systems



- *Advanced Mobile Telephone System*
- Appeared in 1976
- First implemented in the USA, Russia and Asia
- Used by Télécel and Comcell D. R. Congo



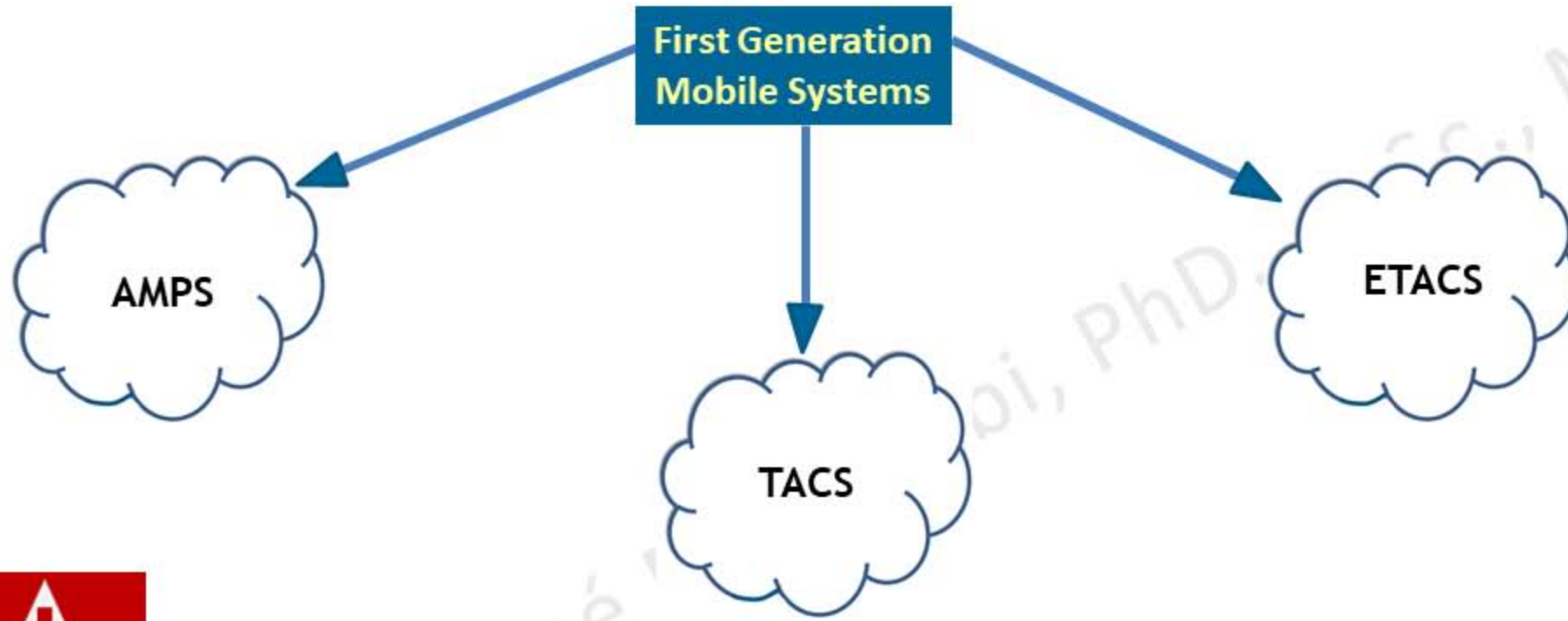
- *Total Access Communications System*
- European version of AMPS with operations in different frequency bands
- Mainly used in the UK, and Asia



- *Evolved Total Access Communications System*
- Improved version of TACS
- Enables greater number of channels to facilitates more users



## Issues of First Generation Mobile Systems



- The pressure for greater capacity, more security, and roaming capability brought about the replacement of 1G Networks by 2G Networks

# Second Generation Mobile Networks (2G)

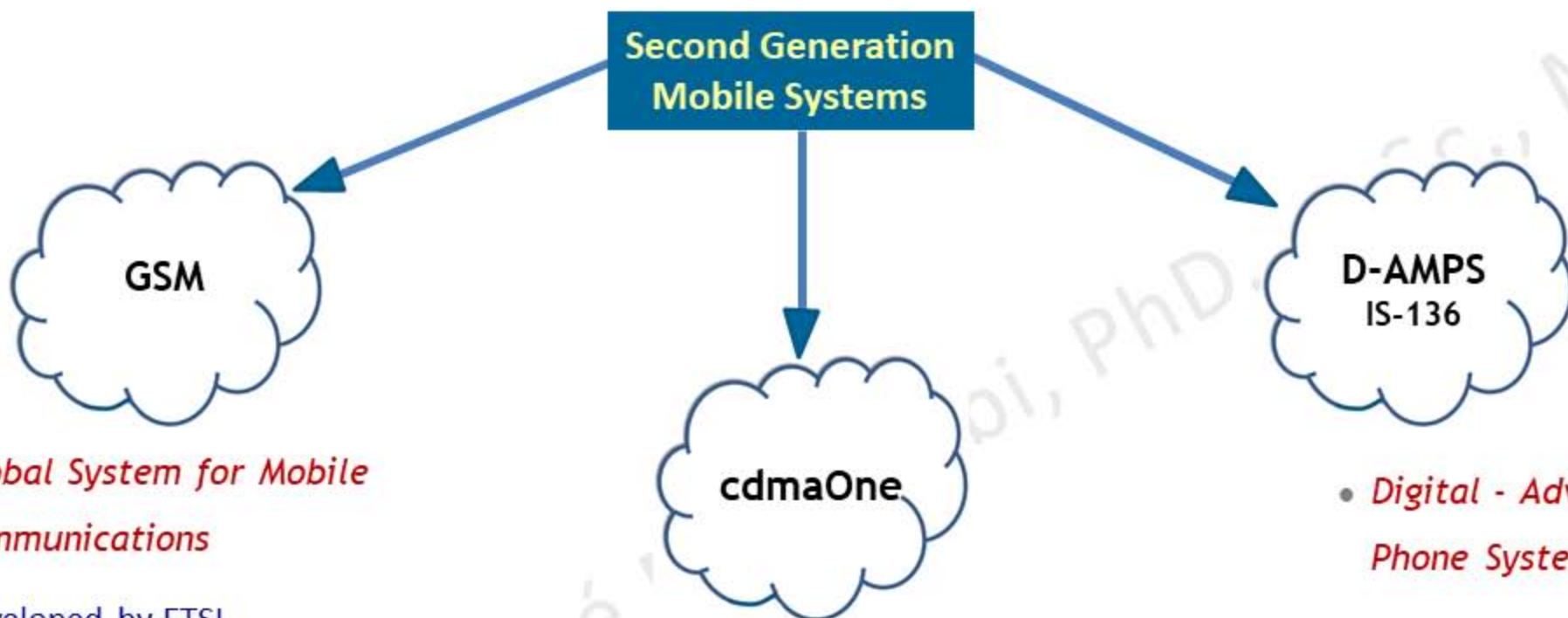
Eng.

## Second Generation Mobile Systems

- 2G systems utilize digital multiple access technology (TDMA and CDMA)
- *As digital systems, they provide improvement in terms of **capacity**, **security** and **roaming**.*



## Second Generation Mobile Systems

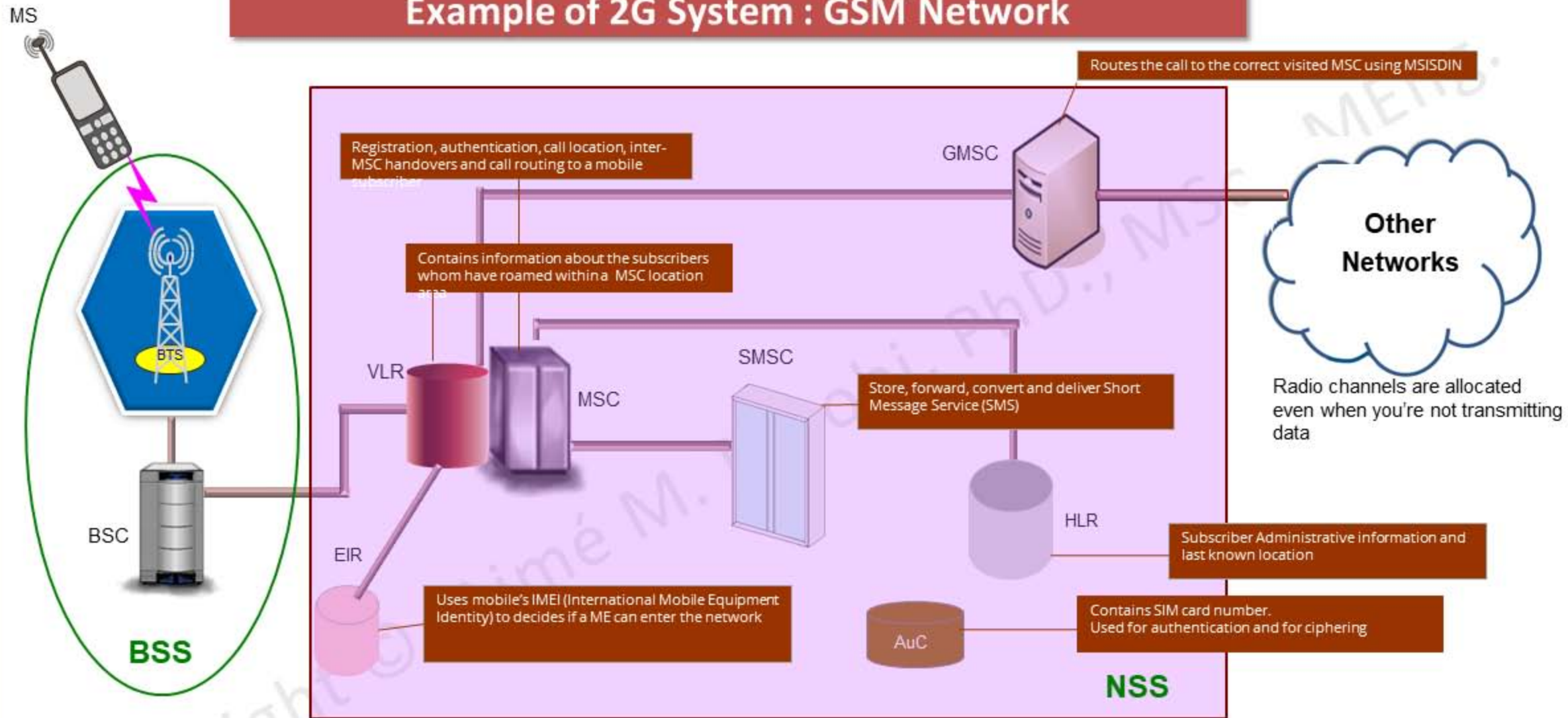


- *Global System for Mobile communications*
- Developed by ETSI
- Worldwide support
- Uses TDMA
- Employs 8 timeslots on a 200kHz wide carrier

- *Code Division Multiple Access Based on IS-95*
- Uses a spread spectrum technique which incorporates codes and timing for cells and channels identification

- *Digital - Advanced Mobile Phone System Based on IS-136*
- Enhancement to AMPS
- Uses TDMA
- Used in North America, New Zealand, APAC region

# Example of 2G System : GSM Network

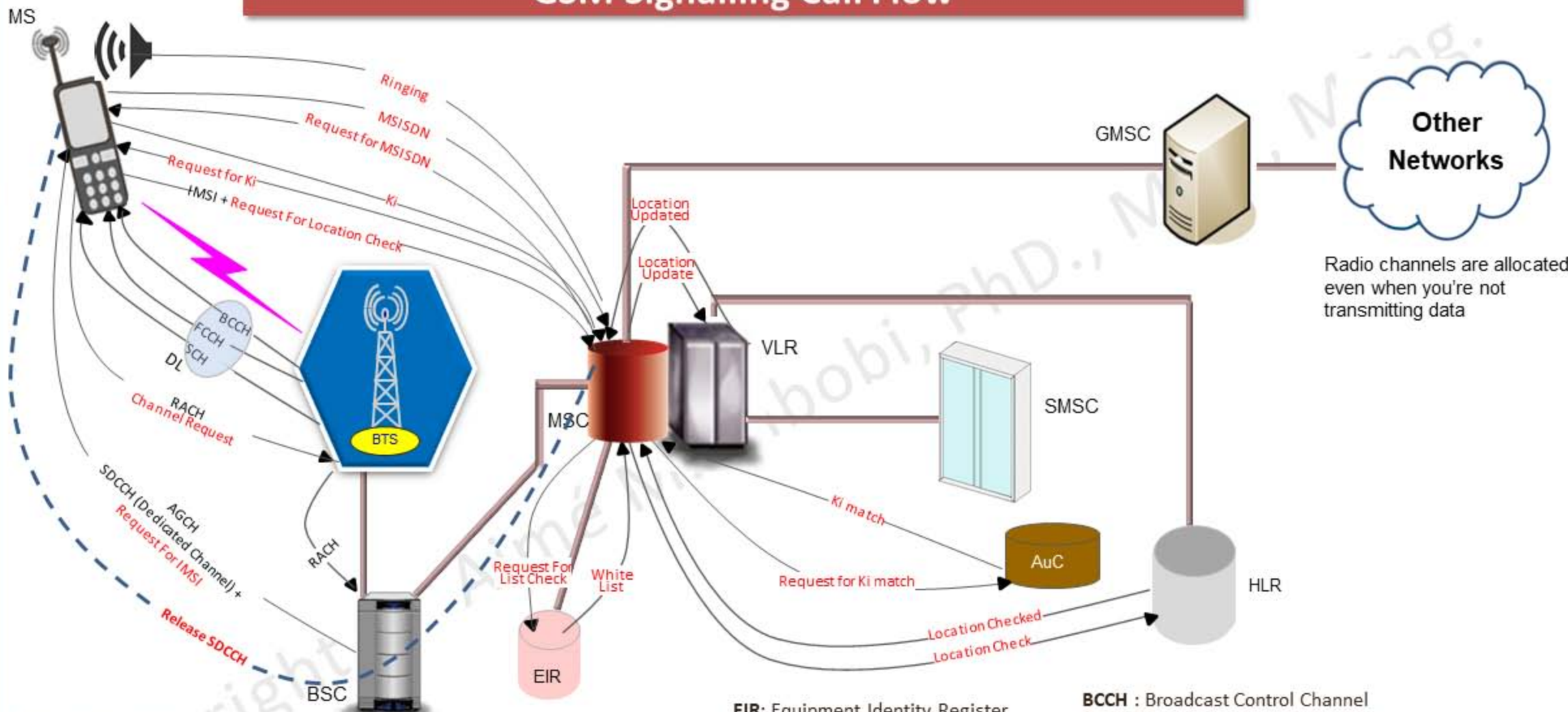


**MS** : Mobile Station  
**BTS**: Base Transceiver Station  
**BSC** : Base Station Controller  
**MSC**: Mobile Switching Centre

**GMSC**: Gateway Mobile Switching Centre  
**HLR** : Home Location Register  
**VLR**: Visitor Location Register  
**SMSC**: Short Message Service Centre

**EIR**: Equipment Identity Register  
**AuC** : Authentication center  
**BSS** : Base-Station Subsystem  
**NSS** : Network and Switching Subsystem

# GSM Signalling Call Flow



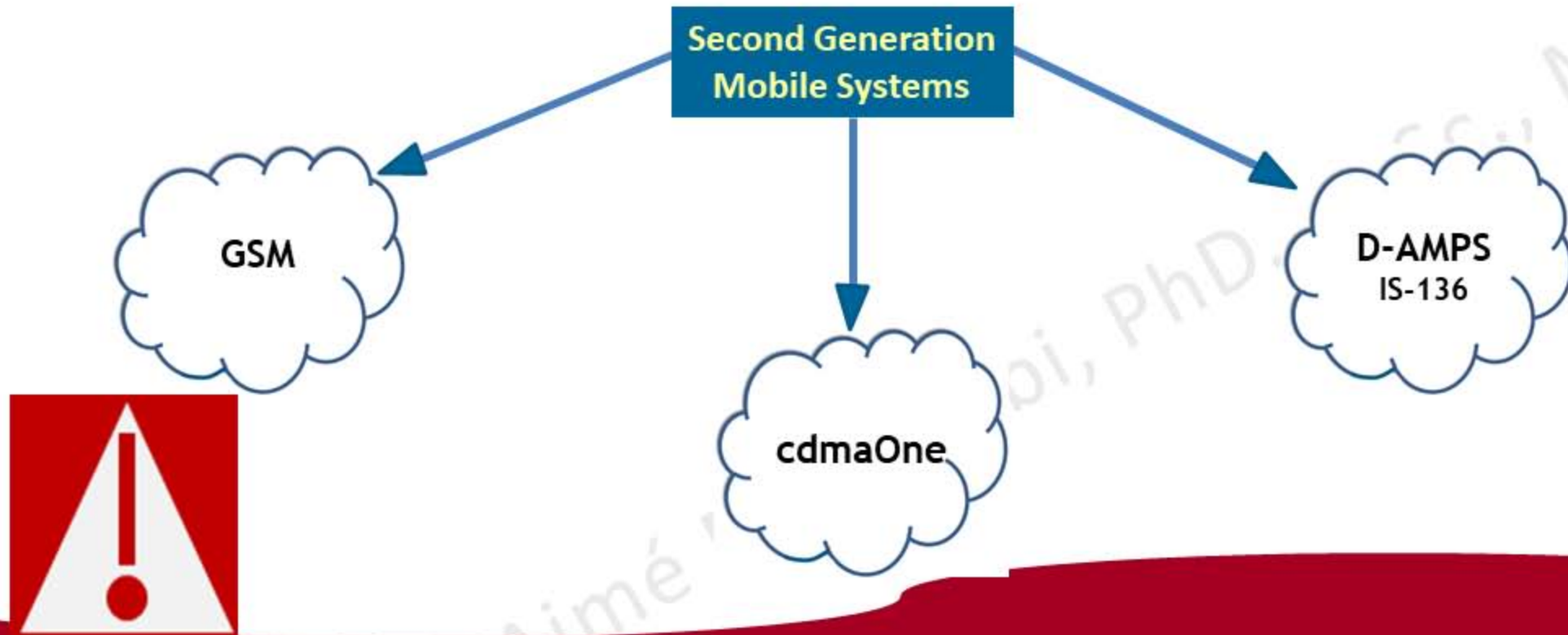
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**SMSC** : Short Message Service Centre

**EIR** : Equipment Identity Register  
**AuC** : Authentication center  
**Ki** : 128-bit Individual Subscriber Authentication Key used as a secret key between the MS and the HLR of the subscriber's home network

**BCCH** : Broadcast Control Channel  
**FCCH** : Frequency Correction Channel  
**SCH** : Synchronization Channel  
**AGCH** : Access Grant Control Channel  
**SDCCH** : Stand-alone Dedicated Control Channels  
**IMSI** : International Mobile Subscriber Identity

## Issues of Second Generation Mobile Systems



- Circuit Switched Systems : Low Capacity for Multimedia and Broadband Services
- The market demand for **multimedia** and **broadband** services led the ITU to define the 3G concept in **IMT2000 Recommendation** (International Mobile Telecommunications 2000)

# **Third Generation Mobile Networks**

## **(Universal Mobile Telecommunications System – UMTS)**

### **(3G)**

## Key Features of ITU IMT 2000

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## Key Features of ITU IMT 2000

- High degree of worldwide **similar functionality**
- **Flexibility** to support range of services and applications in a **cost efficient** manner
- **Compatibility** of services **within IMT and with fixed networks**, and High quality mobile services.
- Capability of **interworking with other RA** systems and **Worldwide roaming capability**.
- **Enhanced peak data rates** to support advanced services and applications.

**3rd Generation Partnership Project (3GPP) to develop the Specifications**

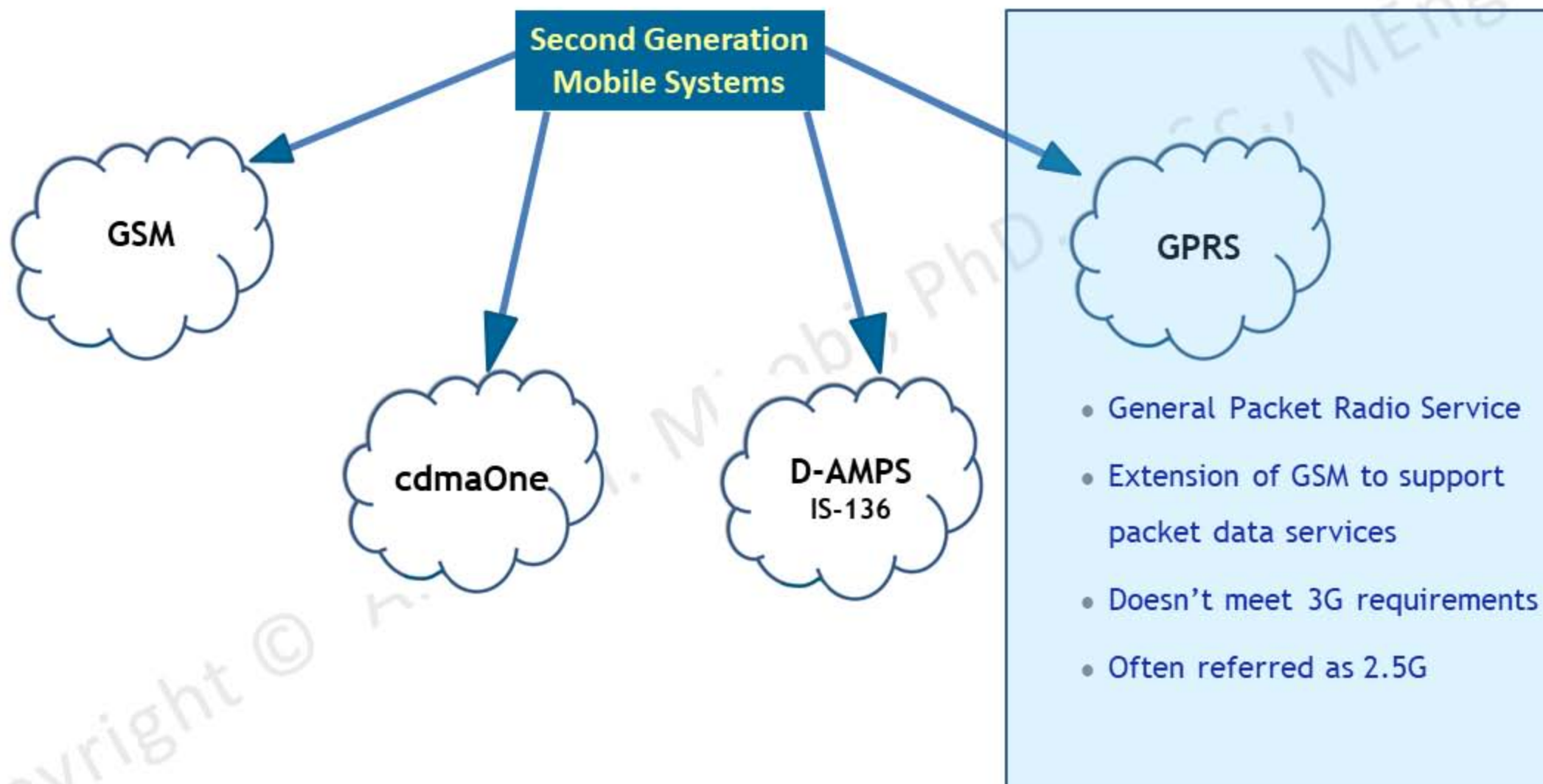
## 3rd Generation Partnership Project (3GPP)

- Collaboration between groups of telecommunications associations (Partners)
- Partners are:
  - ▶ **USA** : Alliance for Telecommunications Industry Solutions (ATIS)
  - ▶ **Europe**: European Telecommunications Standards Institute (ETSI)
  - ▶ **Japan** : Telecommunication Technology Committee (TTC)
  - ▶ **Japan**: Association of Radio Industries and Businesses (ARIB)
  - ▶ **China** : China Communications Standards Association (CCSA)
  - ▶ **Korea** : Telecommunications Technology Association (TTA)

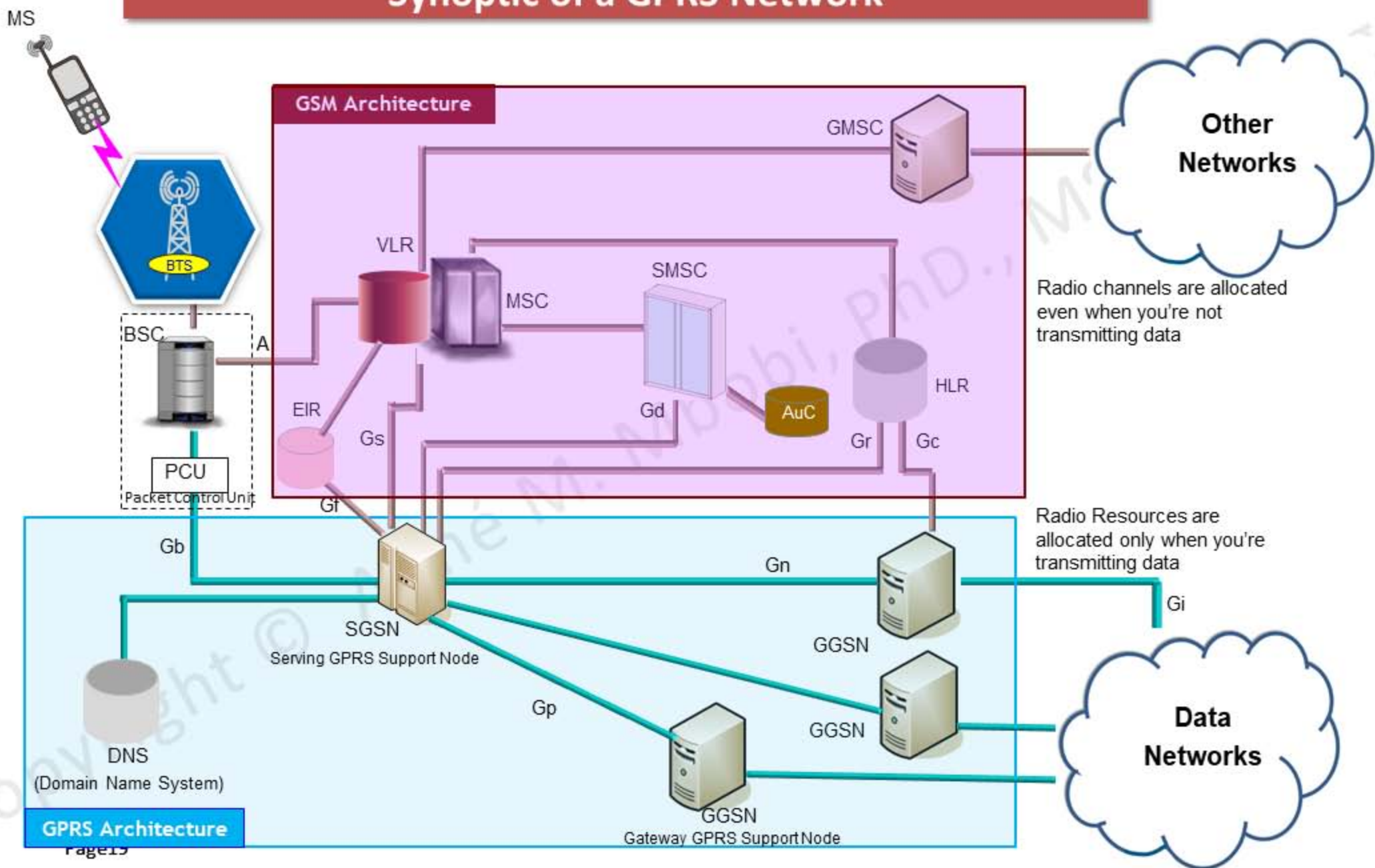


# General Packet Radio Service (GPRS -2.5G) As Intermediary Path to 3G

## GPRS (2.5G) as Intermediary Path to 3G



# Synoptic of a GPRS Network

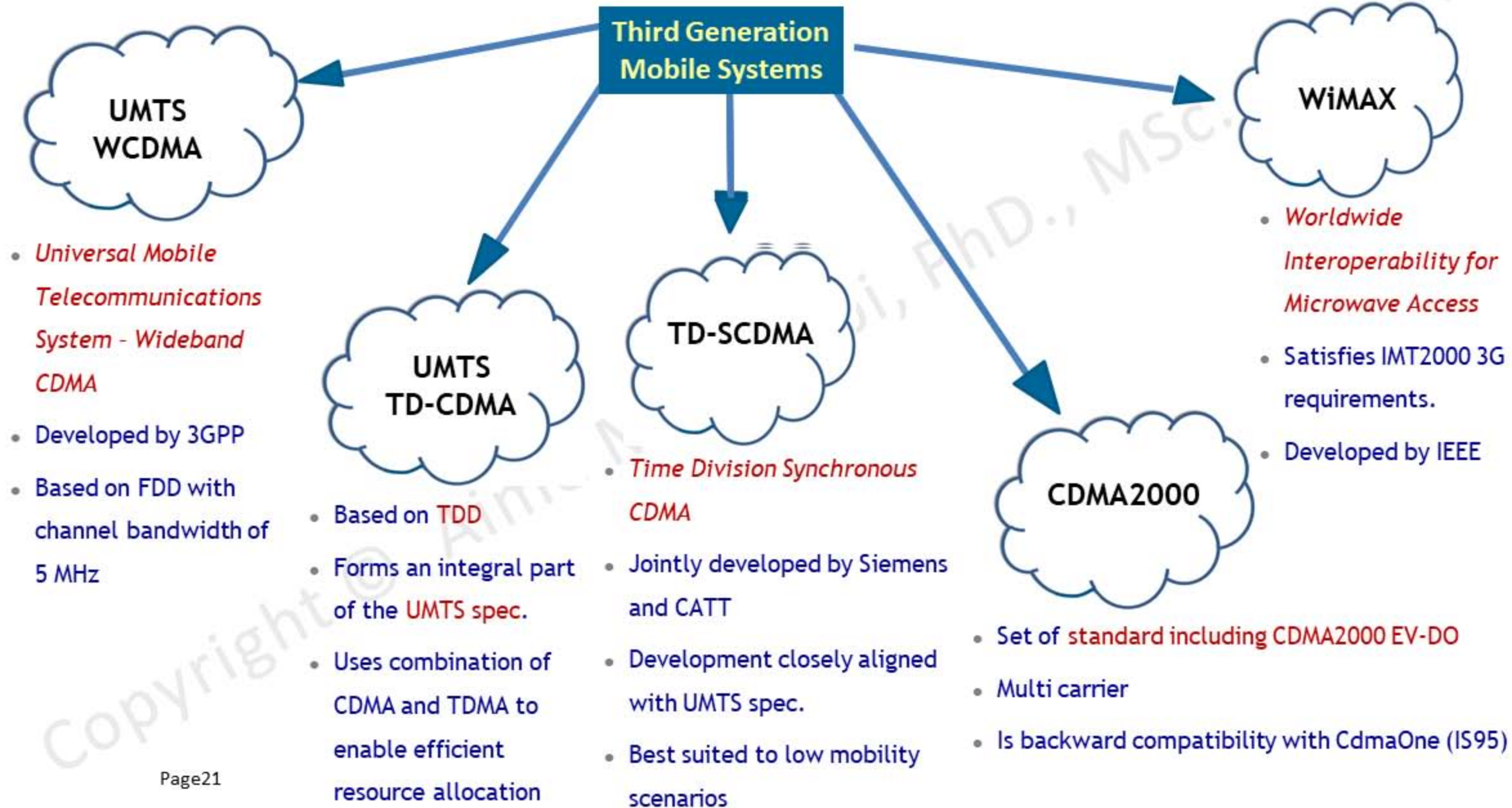


# Full 3G Network

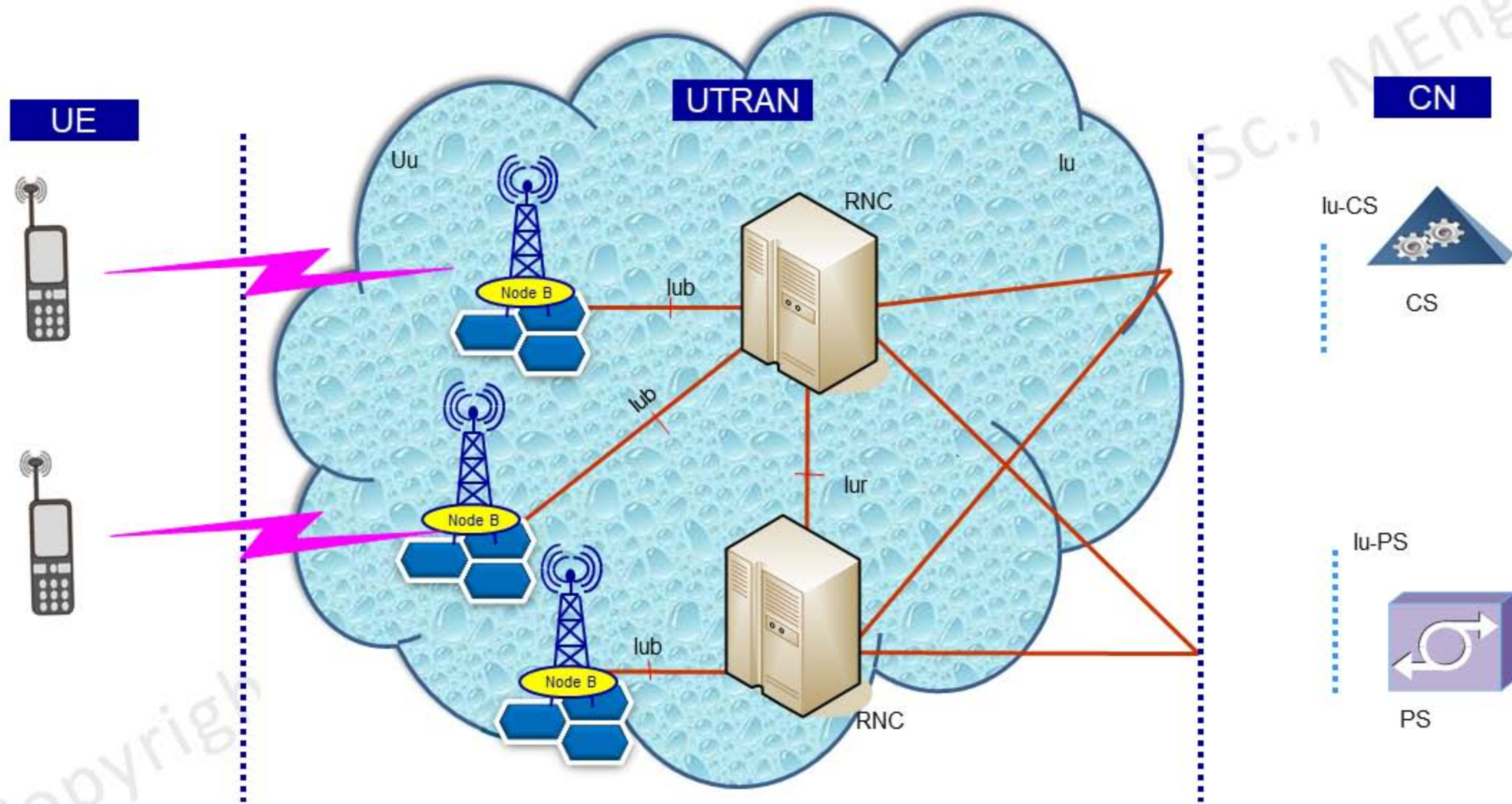
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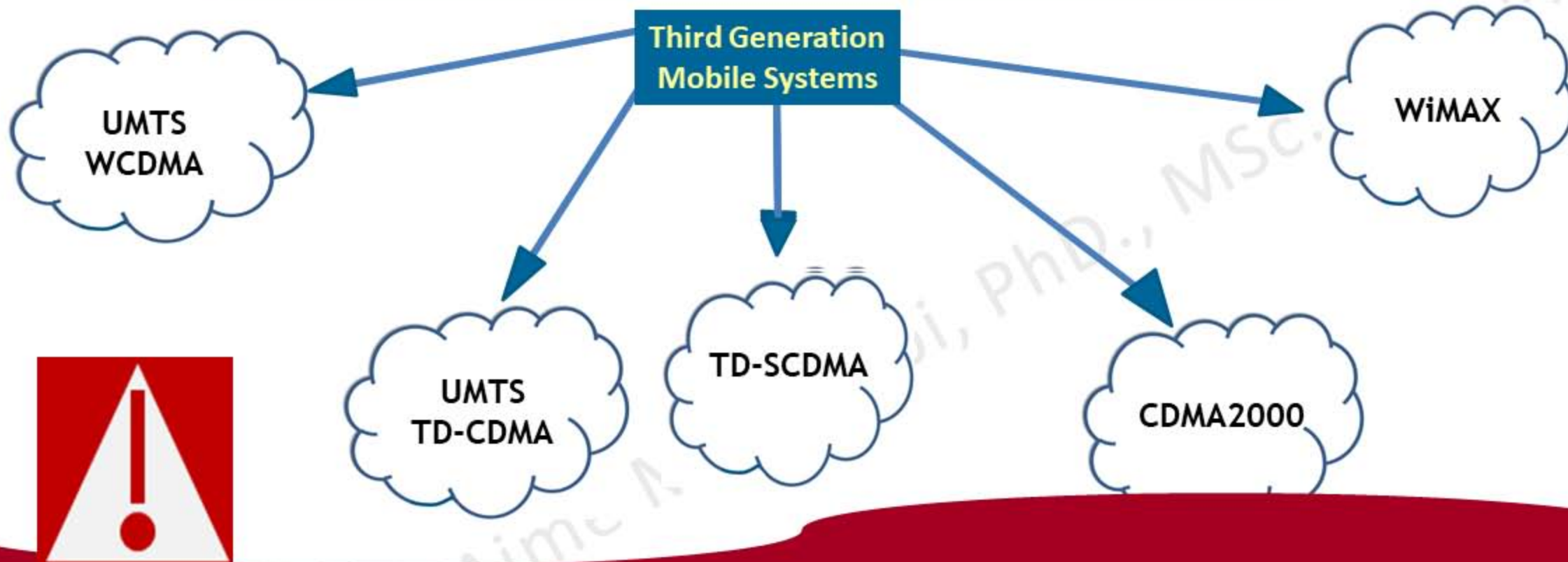
## Third Generation Mobile Systems



# Example of 3G Network : UMTS



## UMTS Issues



- Could not support the growth in Mobile Broadband
- This limitation led the ITU to define the 4G concept in IMT Advanced Memorandum

# Fourth Generation Mobile Networks

(Long Term Evolution – LTE)  
(4G)



# 4G-LTE Concept

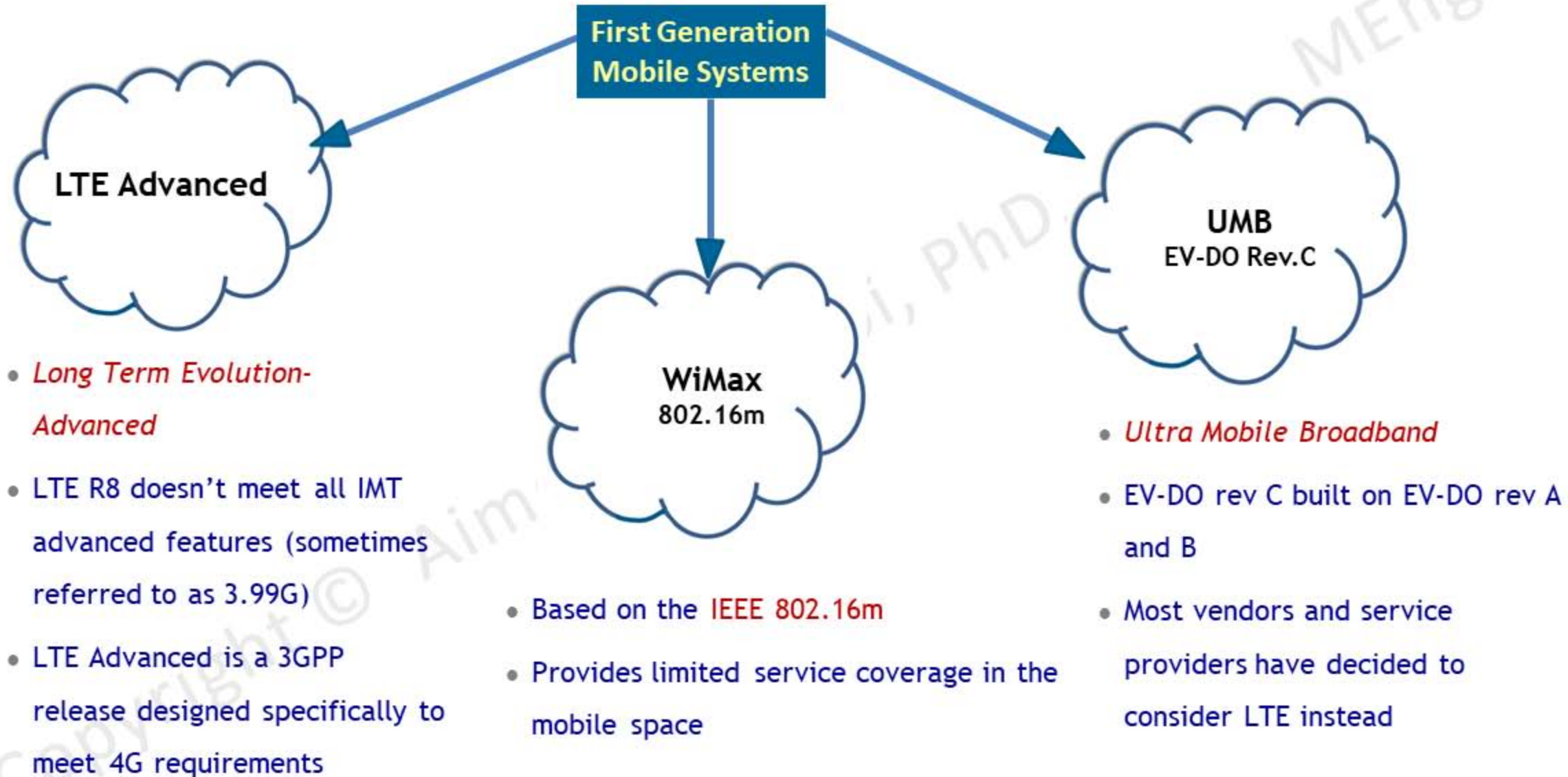
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## Fourth Generation Mobile Systems

- The ITU memorandum (IMT Advanced) paved the way of the Fourth Generation Networks (LTE)
  1. Worldwide interoperability
  2. Fixed and mobile compatibility
  3. Low cost per bit
  4. Extremely high data rate

## Fourth Generation Mobile Systems



# IN CLASS ACTIVITY 1

1. Provide the technology related to the following networks

Network	Technology (1G, 2G, 3G)
GSM	2
ETACS	1
CDMA2000	3
CDMAOne	2
UMTS	3
TD-SCDMA	3
GPRS	2.5

## IN CLASS ACTIVITY 1

2. Which of the following statements best explains why first generation mobile systems were replaced by second generation systems:
- a. First generation systems had poor coverage
  - b. First generation systems provided poor quality voice
  - c. First generation systems had low capacity and did not support security and roaming
  - d. First generation systems were expensive to maintain

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## IN CLASS ACTIVITY 1

3. While GSM supported data services through features such as SMS, which network architecture was overlaid onto GSM to offer packet data services across the air interface?

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GPRS

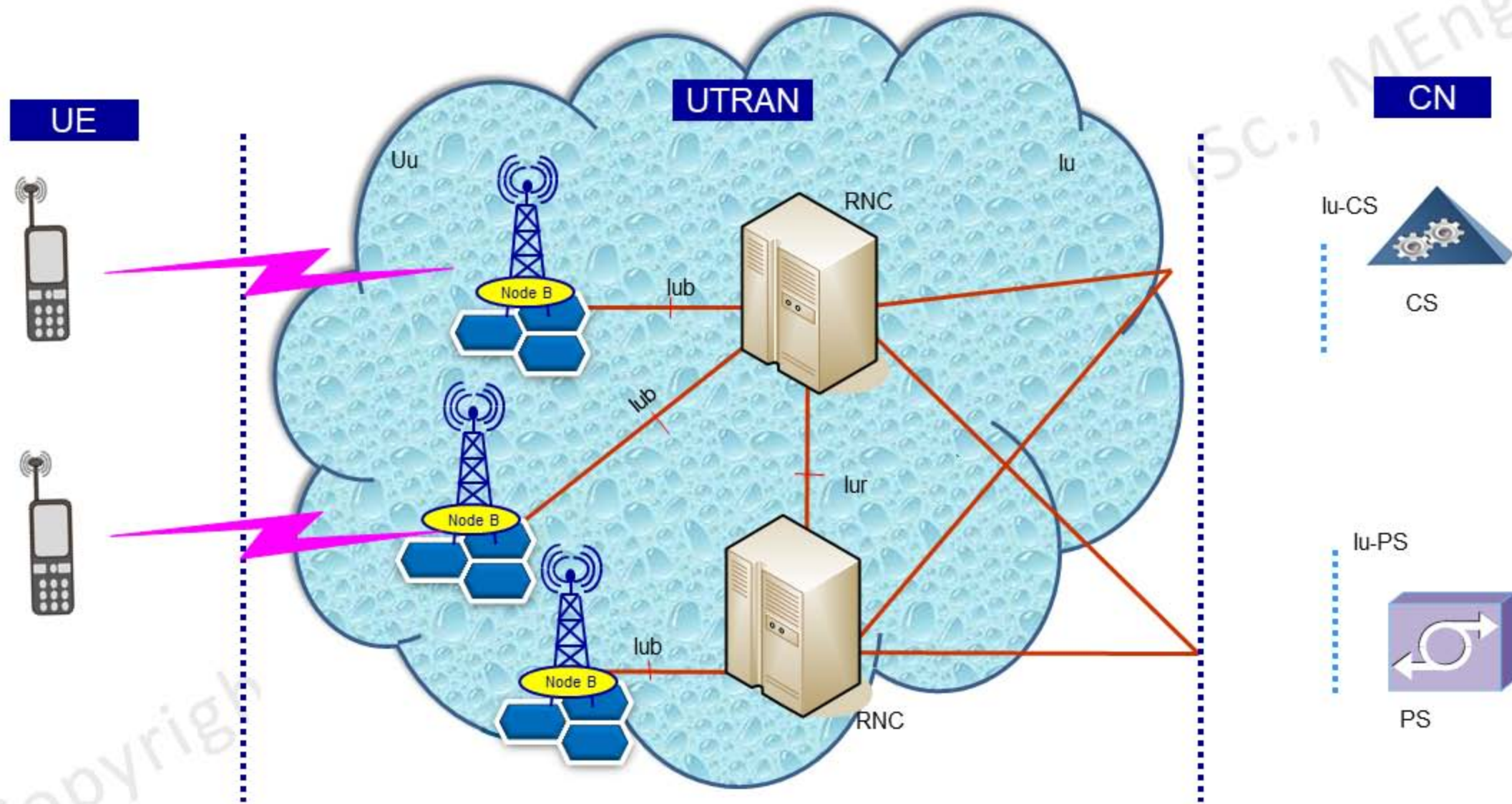


# LTE Network Architecture

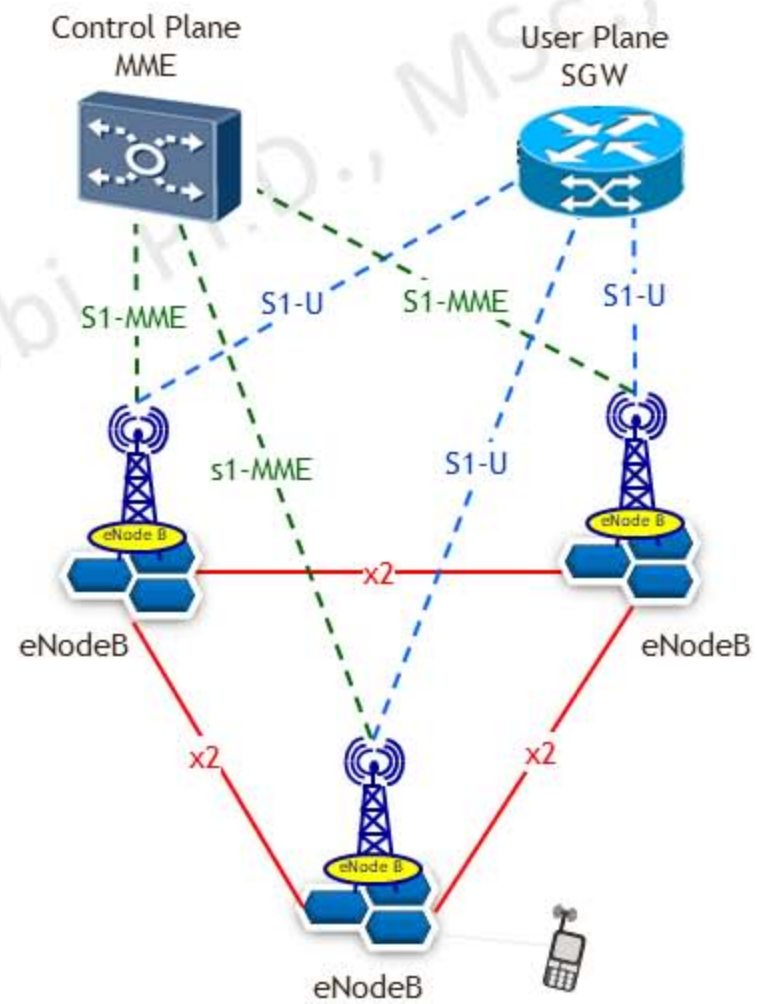
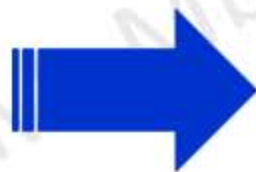
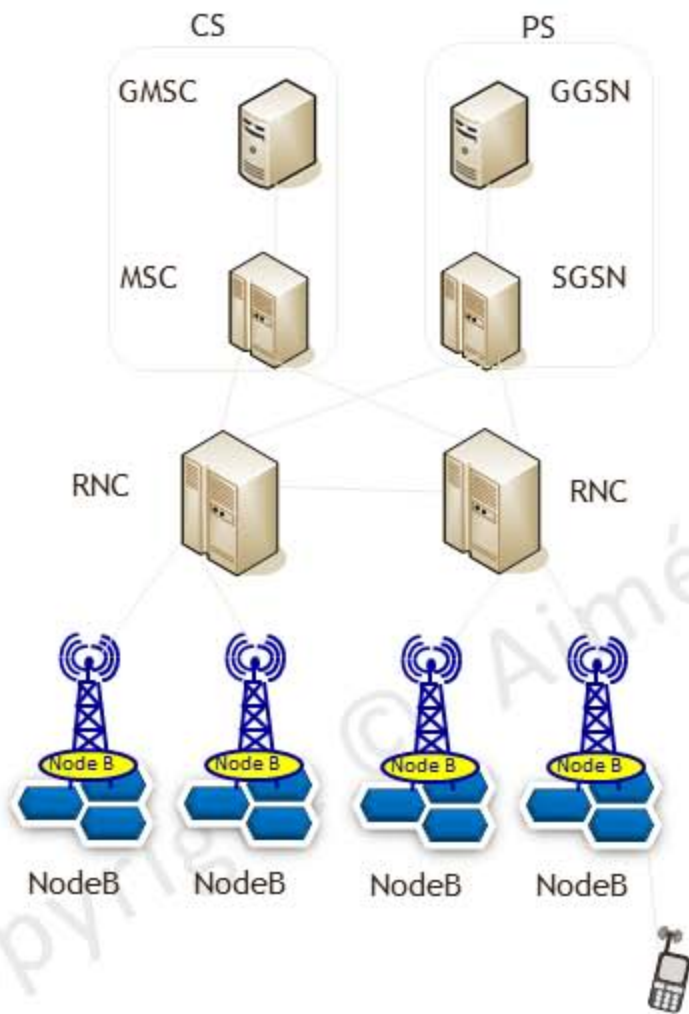
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# From UMTS to LTE

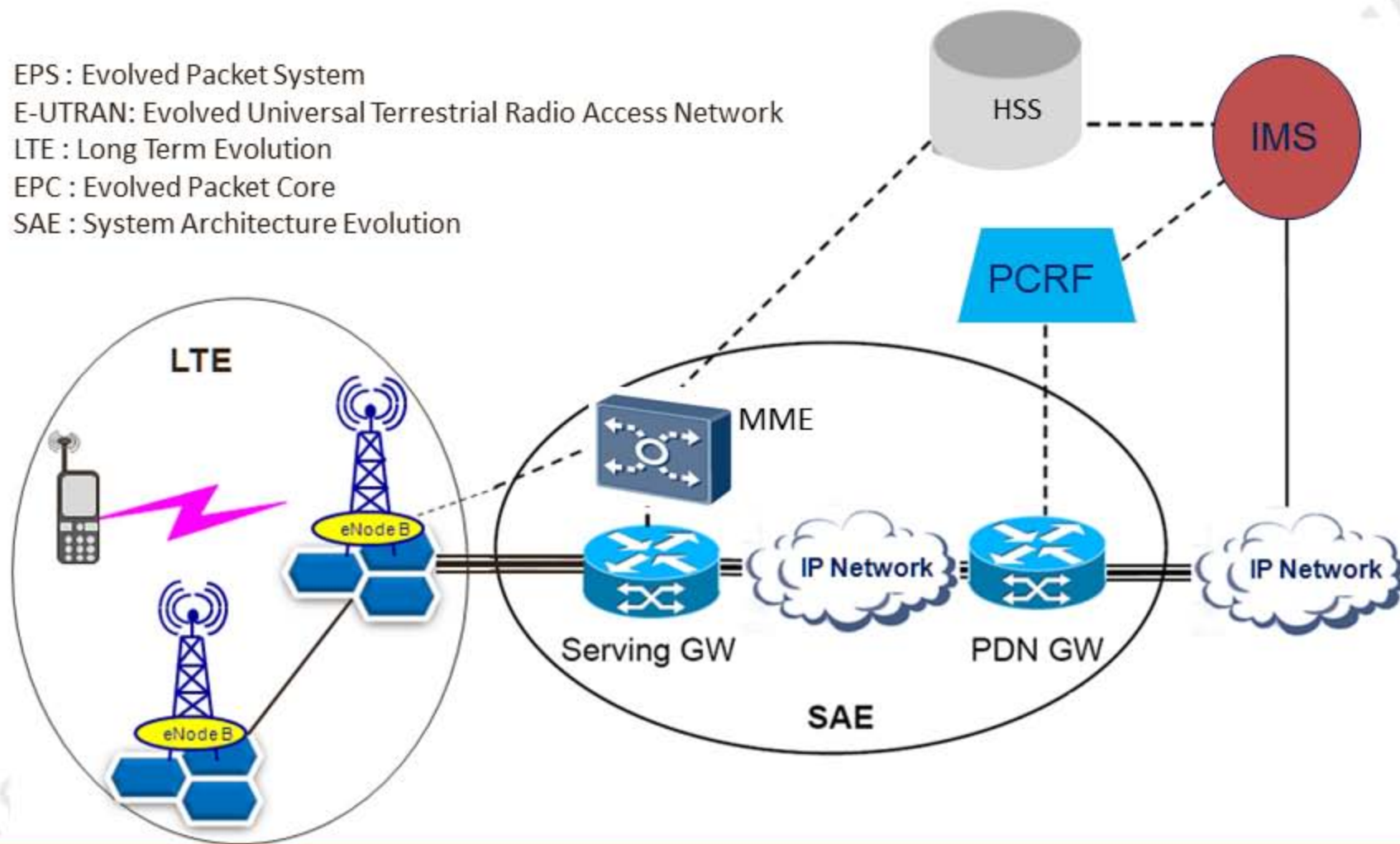


# LTE Network Architecture



# LTE Network Architecture

EPS : Evolved Packet System  
 E-UTRAN: Evolved Universal Terrestrial Radio Access Network  
 LTE : Long Term Evolution  
 EPC : Evolved Packet Core  
 SAE : System Architecture Evolution



**EPS = E-UTRAN (LTE) + EPC (SAE)**

--- Control Plane

==== User Plane

# Fifth Generation Mobile Networks (5G)

Eng.

# 5G-Concept



- 5G is Revolution, not Evolution

END