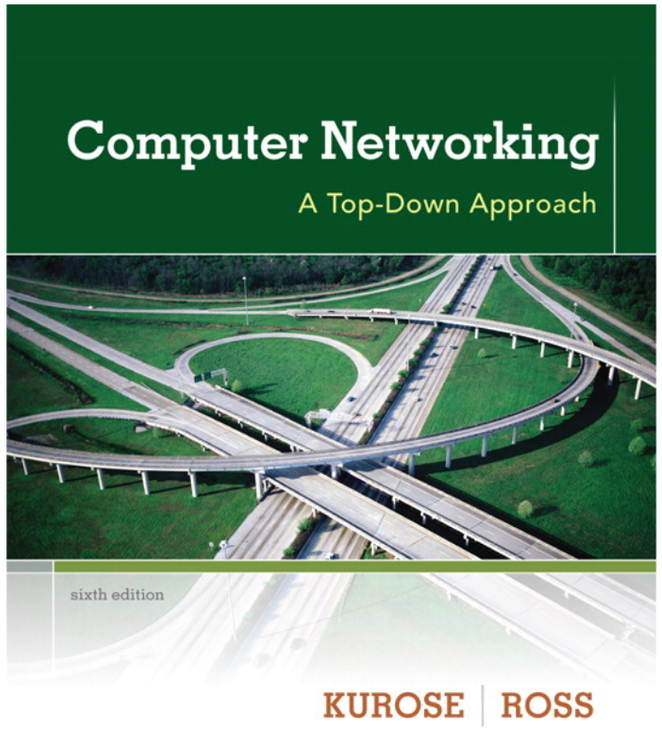
CN-Advanced
L40

Cellular Internet Access

Dr. Ram P Rustagi
rprustagi@ksit.edu.in
http://www.rprustagi.com
https://www.youtube.com/rprustagi

Resources Acknowledgement

Chapter 6 Wireless and Mobile Networks



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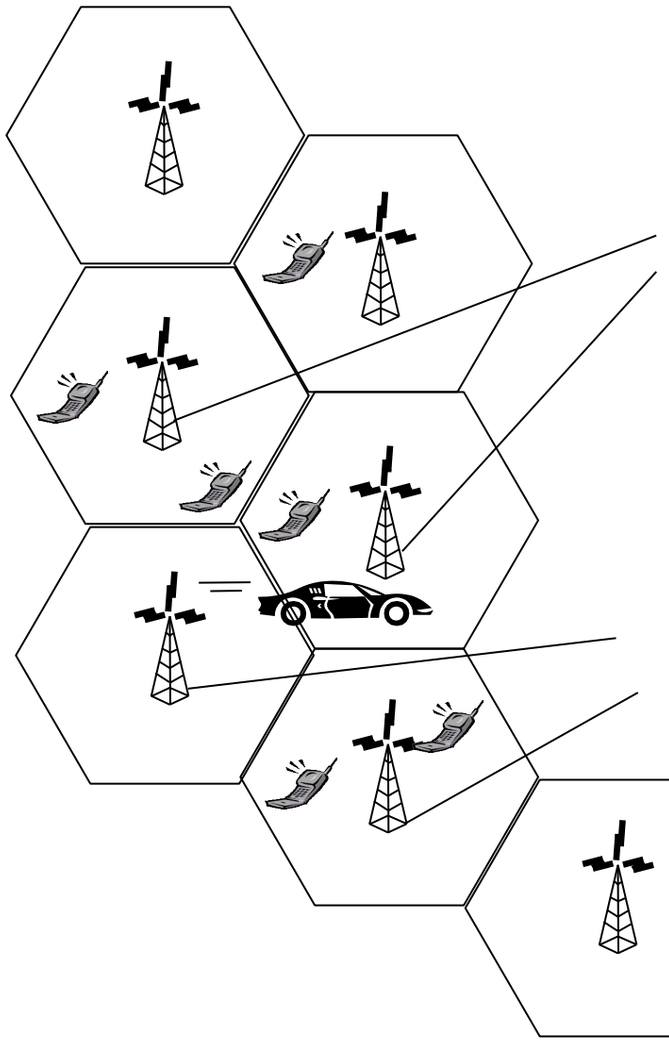
Data Comm Standards

- GSM
  - Frequencies
    - Uplink: 890.1 - 914.9 MHz, Downlink: 930-956MHz
    - Each channel 200KHz, 124 channels, 8 timeslots/channel
- Generations
  - 1G - Voice only
  - 2G: GPRS - 14.4kbps
  - 2,5G/2.5+G :Enhanced GPRS : 100kbps
  - 3G: 2Mbps, both voice and data simultaneously
  - 4G:All IP
- CDMA: IS-95, CDMA2000, IMT-2000, WCDMA
- UMTS: CDMA for efficiency, GSM for compatibility

Cellular Networks Structure

- Adjacent cells in various directions
- Distinct freq. in adjacent cells
  - Avoids frequency interference
- Base stations connect among themselves
  - Guided
  - Wireless networking
- Allows handover
  - Phone moves from one cell to another
  - Connection moves to neighbor base station



GSM Network...

- Supplementary (Other than Voice) services
  - Code description
    - **http://portal.etsi.org/hf/brochure/servicer l.pdf**
  - Common patterns
    - *service# Activate
    - **service# Register and activate
    - *#service# Check Status
    - #service# Unregister
    - ##service# Unregister and deactivate
- **To know your IMEI**
  - ***#06#**

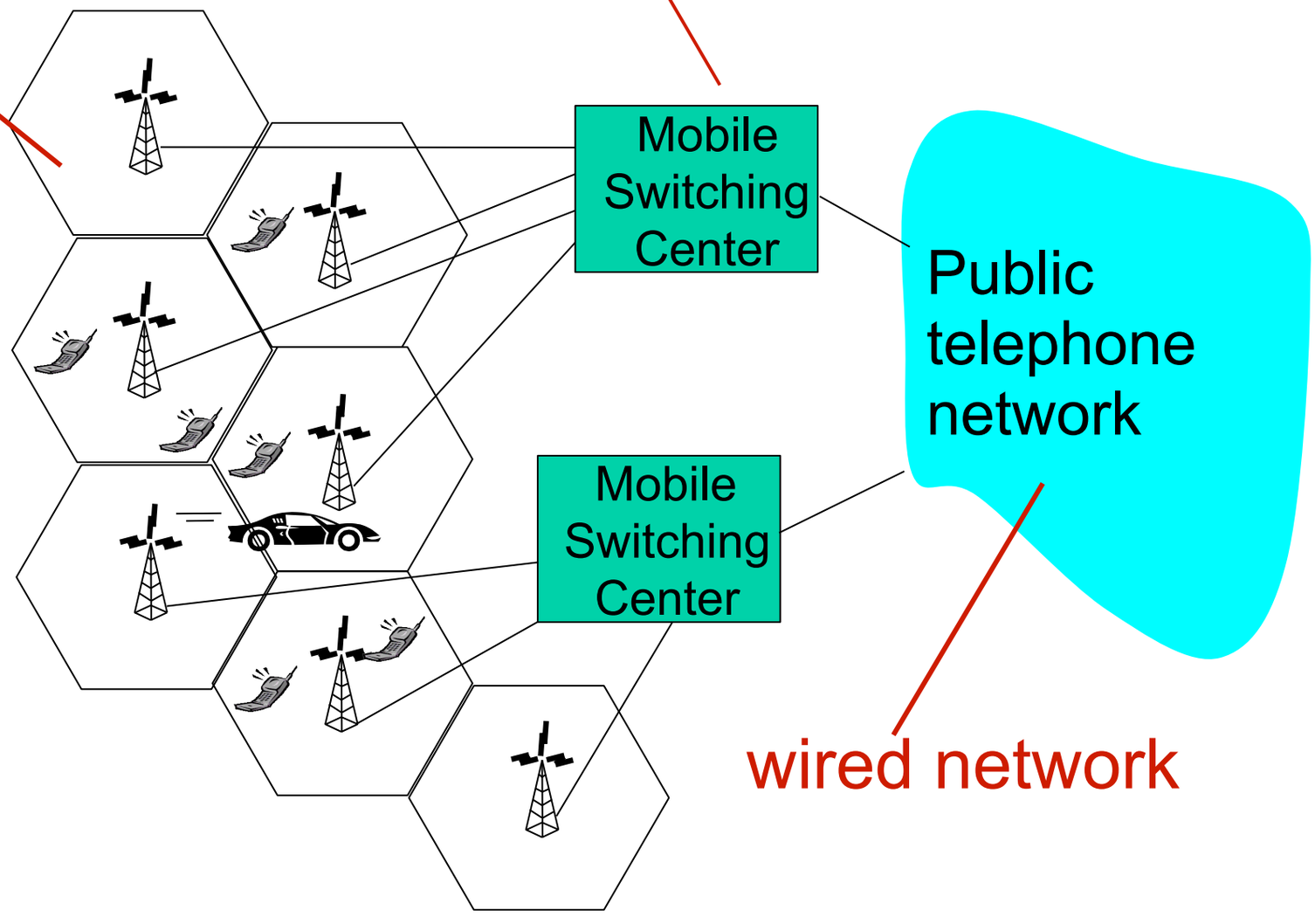
Components of cellular network architecture

cell

- covers geographical region
- *base station* (BS) analogous to 802.11 AP
- *mobile users* attach to network through BS
- *air-interface:* physical and link layer protocol between mobile and BS

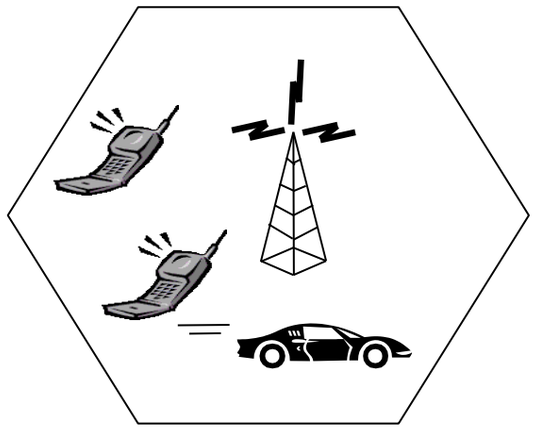
MSC

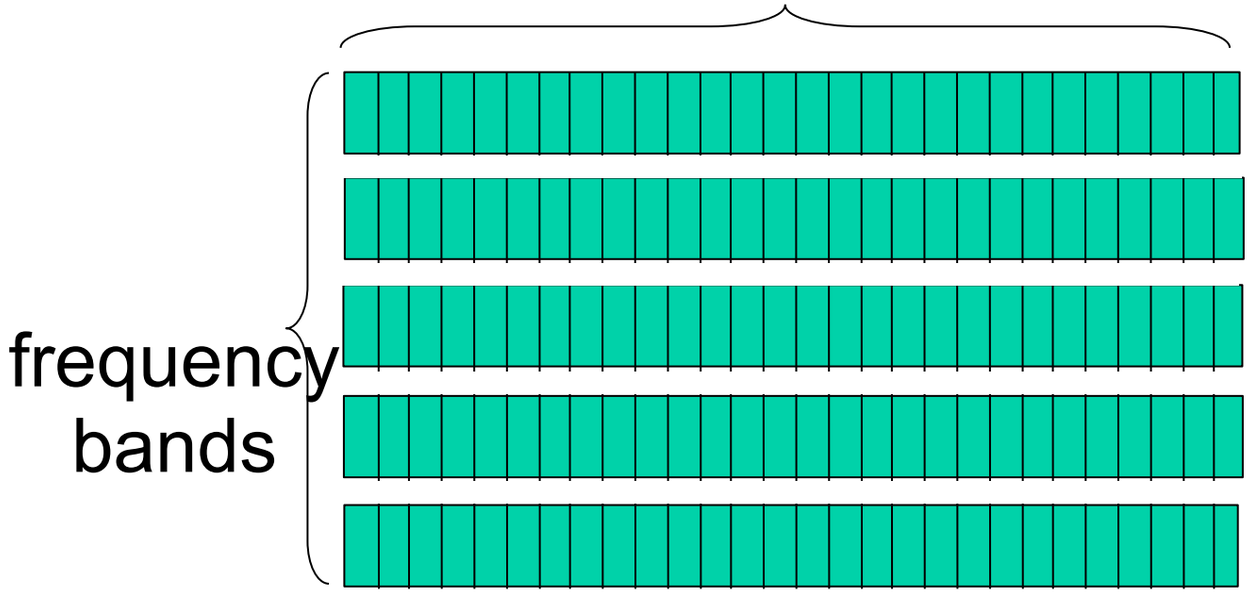
- connects cells to wired tel. net.
- manages call setup (more later!)
- handles mobility (more later!)



Cellular networks: the first hop

- Two techniques for sharing mobile-to-BS radio spectrum
- combined FDMA/TDMA: divide spectrum in frequency channels, each channel into time slots
  - channel: 200KHz
  - 8 Timeslots/channel
- CDMA: code division multiple access

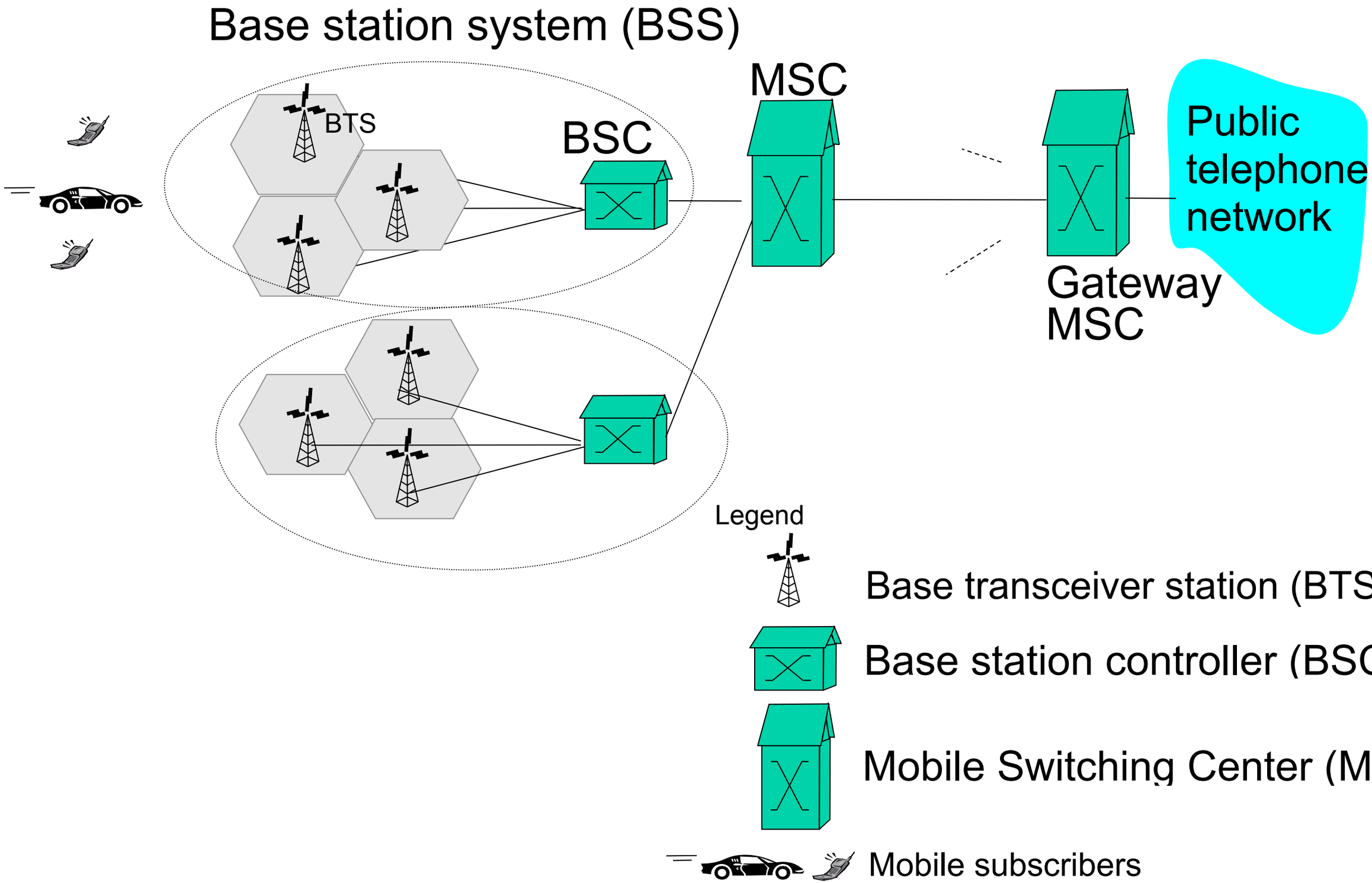




BTS...

- GSM Channels
  - Total 124
    - Permitted to use Ch02 to Ch123
      - (thus total of 122)
    - 32 channels are reserved for data transmission of operator
- Total channels assigned to a BTS is 11
  - One for transmission to MS or BSC
  - 10 for users
  - All BTS taken together can communicate over 90 channels

2G (voice) network architecture



BSS

- BTS
  - Like an AP in WiFi network
  - Covers one cell
    - Area depends upon transmitting powers
      - BTS, user devices, height of tower antennaes
    - Initially at the center of hexagon cell, now directional
- BSC
  - Services several BTS
  - Allocate radio channels to mobile subscribers
  - Perform paging (finding the cell where the user is)
  - Perform handoff when user moves

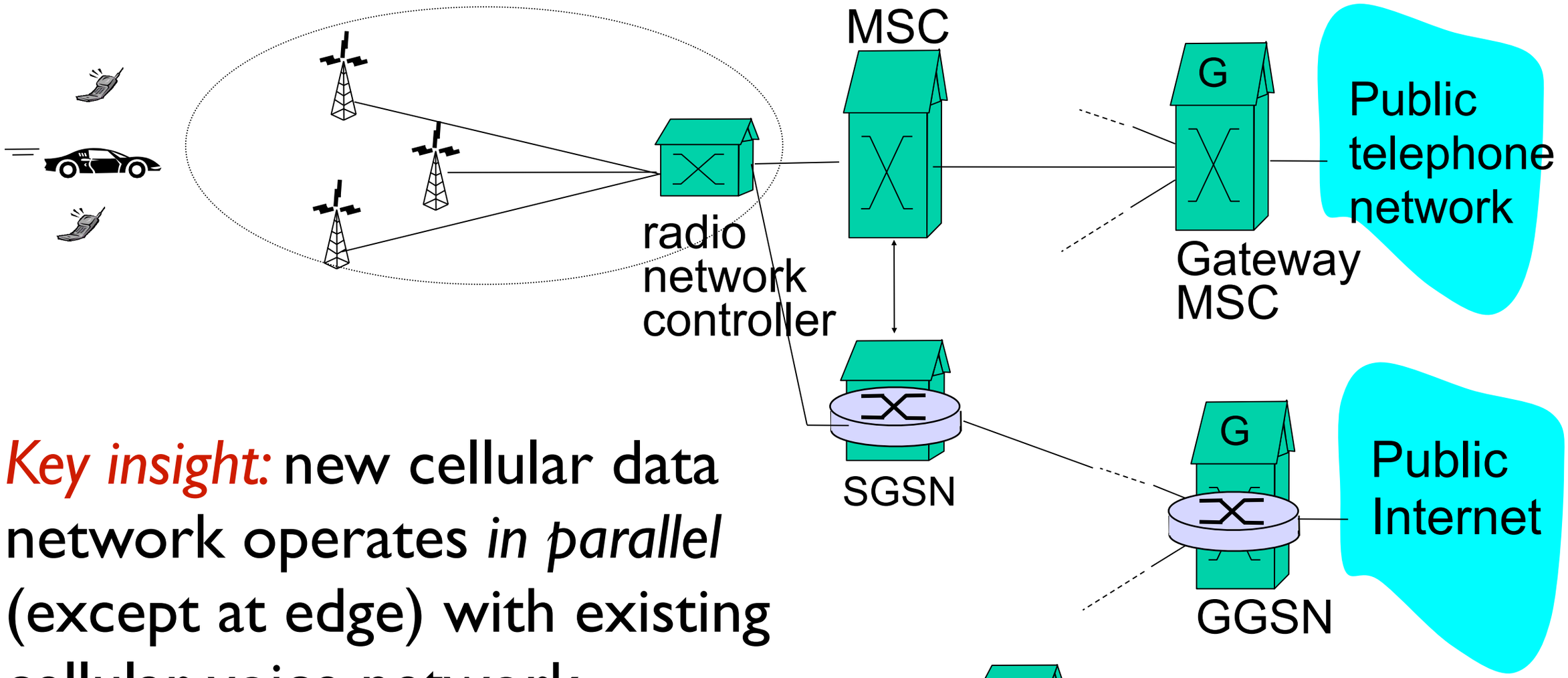
MSC

- MSC
  - Central role in user authentication and accounting
    - Decides if user can connect to cellular network
  - Provides call setup, teardown and handoff
  - Typically contains up to 5 BSCs, about 200K users
  - Call monitoring, charging
  - Multi-way calling, supplementary services
- Special MSC : Gateway MSC (GMSC)
  - Connects to public telephony network
- HLR/VLR
  - Subscriber's data base

Localization and Calling

- Numbering schemes to locate and address MS
- MSISDN: A personalized number for user
  - Follows E.164 ITU standards
  - CC+NDC+SN
- IMSI: Uniquely identifies the SIM
  - MCC+MNC+MSIN
  - TMSI is used to hide the IMSI
- MSRN (Mobile Station Roaming Number)
  - Temp. number hides the identity/location of subscriber
  - VLR generates this number
    - VCC+VNDC+VSN
  - Helps finding of MS by an HLR for incoming call

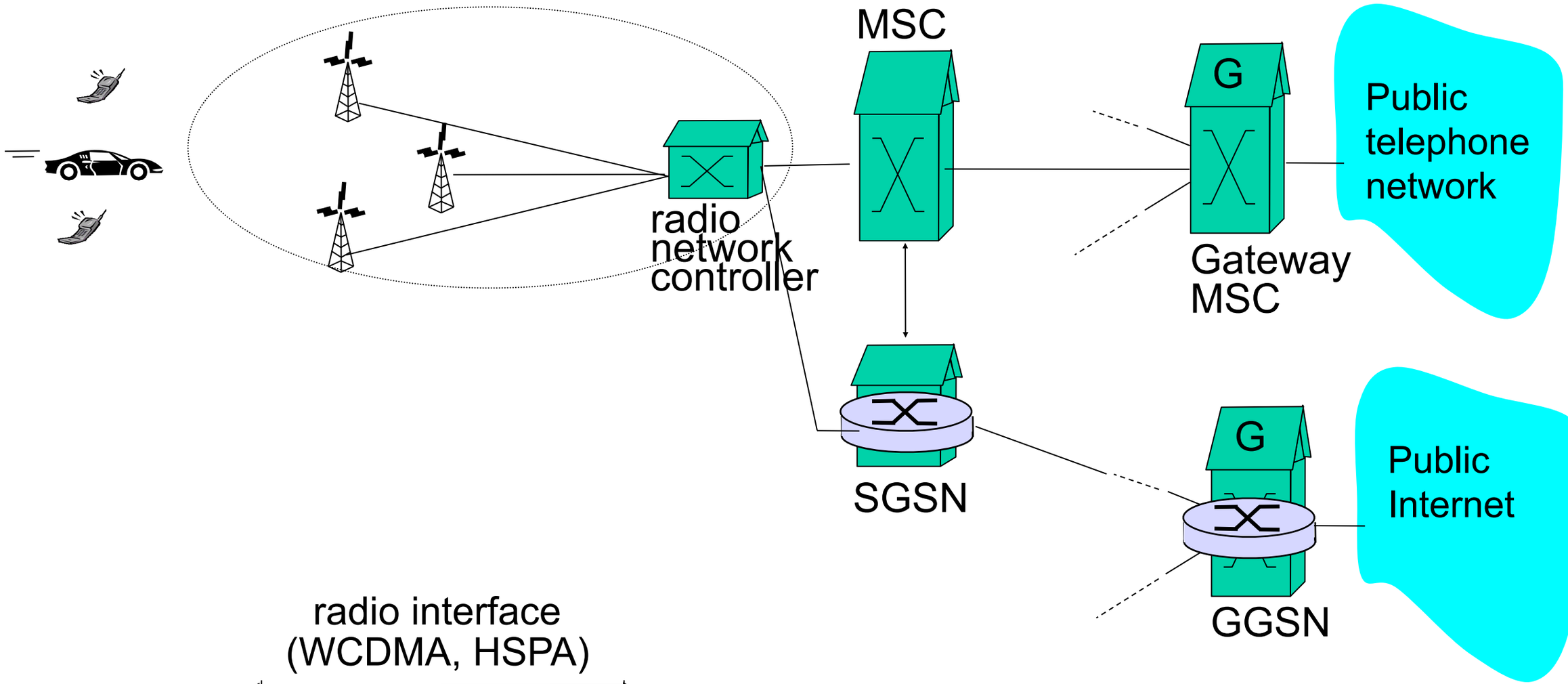
3G (voice+data) network architecture



Key insight: new cellular data network operates *in parallel* (except at edge) with existing cellular voice network

- voice network unchanged in core
- data network operates in parallel

3G (voice+data) network architecture



On to 4G

- 2 important innovations over 3G (by 3GPP)
  - Evolved Packet Core (EPC),
  - LTE (Long Term Evolution)
- EPC
    - Simplified all IP core network
    - Carries both voice and data in IP packets
    - IP is best effort, not very well suited for voice
      - Can it provide QoS for telephony
    - EPC needs to manage network resources for QoS
    - Allows multiple types of RAN (Radio Access Networks)
      - Includes legacy 2G and 3G as well

On to 4G

- LTE Radio Access Network
  - Uses combination of FDM and TDM with OFDM
    - Orthogonal: signals on 2 freq channel don't interfere
  - Each MS is allocated one or more 0.5ms timeslot
    - One or more frequency channels
  - To achieve higher bandwidth, more timesltos allocated
  - Slot reallocation can be performed once every ms
  - Uses MIMO antennas
    - Takes care of multipath, reflections etc.
  - Downstream : 100 Mbps; upstream: 50 Mbps
  - Allocation of time slots:
    - Implementation as per vendors equipment
    - Also based on user priorities (Gold, Silver, platinum)

Summary

- Overview of Cellular Architecture
  - BSS
    - BTS
    - BSC
  - MSC
  - GMSC
  - 3G
    - SGSN
    - GGSN
  - 4F
    - LTE