Ubiquitous Computing (CS60055)

Satellite Systems

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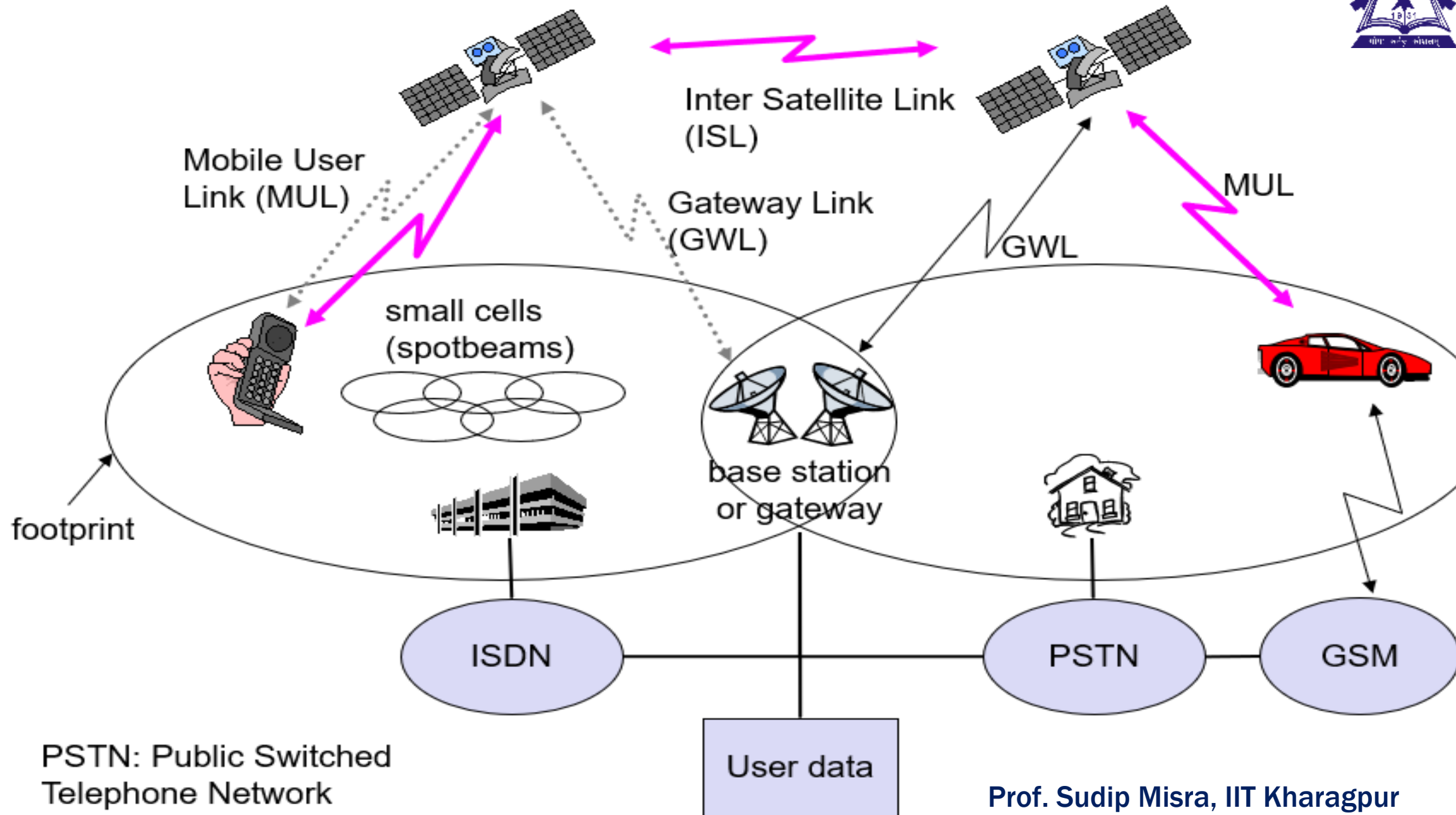**Research Lab: cse.iitkgp.ac.in/~smisra/swan/**

Overview

❑ Communication Satellite can be looked upon as a large microwave repeater.

❑ It contains several transponders which listens to some portion of spectrum) amplifies the incoming signal and broadcasts it in another frequency to avoid interference with incoming signals.

Satellite System:

Mobile User Link (MUL)

Inter Satellite Link (ISL)

Gateway Link (GWL)

GWL

MUL

small cells (spotbeams)

footprint

base station or gateway

ISDN

User data

PSTN

GSM

PSTN: Public Switched Telephone Network

Types of Satellite Based Networks

GEO – Geostationary Orbits
36000 Km = 22300 Miles, equatorial, High latency

MEO – Medium Earth Orbits
High bandwidth, High power, High latency

LEO – Low Earth Orbits
Low power, Low latency, More Satellites, Small Footprint

VSAT - Very Small Aperture Satellites
Private WANs

Satellite Orbits

GEO – Geostationary Orbits
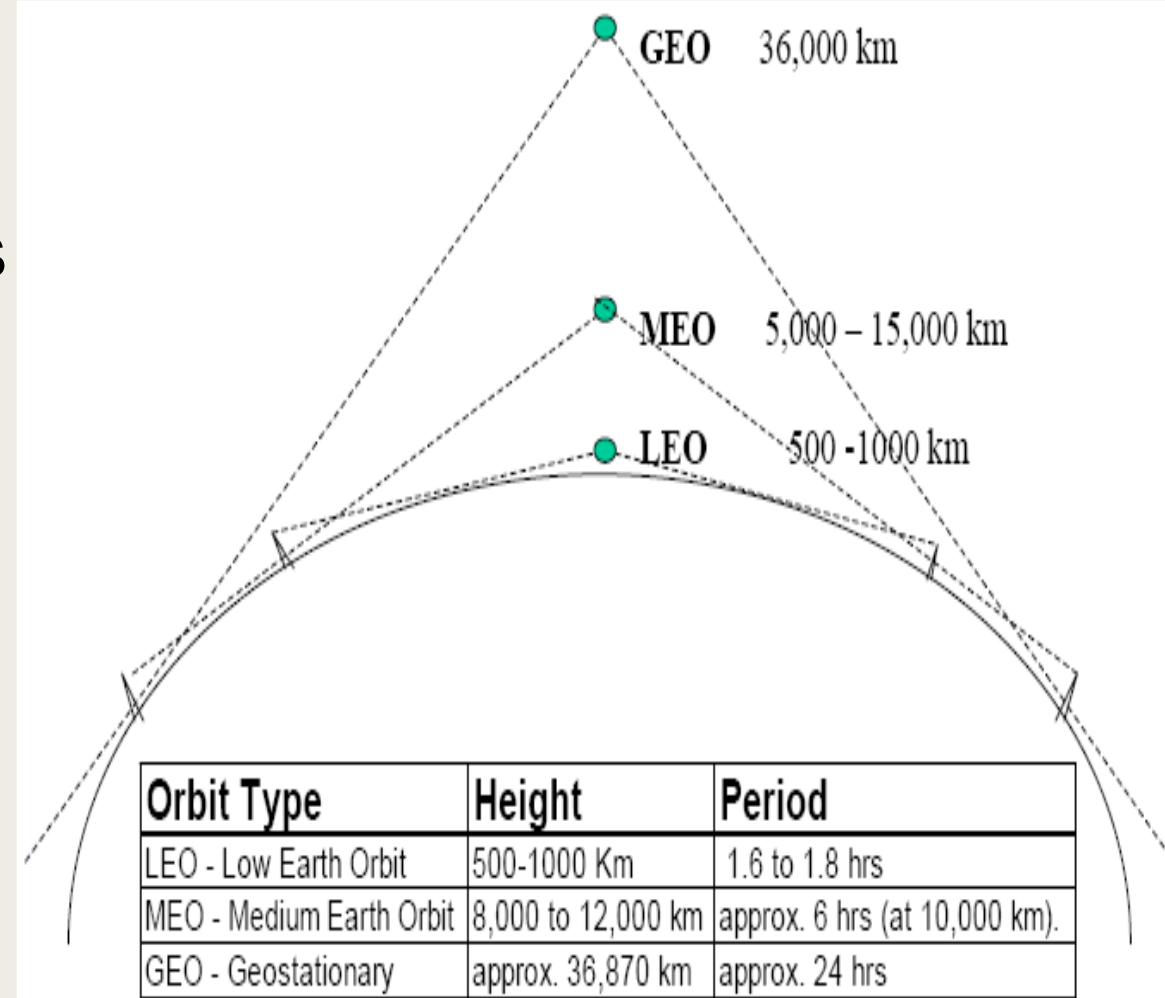36,000 km above Earth, includes commercial and military communications satellites, satellites providing early warning of ballistic missile launch.

MEO – Medium Earth Orbits
5000 to 15000 km, they include navigation satellites (GPS, Galileo)

LEO – Low Earth Orbits
500 to 1000 km above Earth, includes military intelligence satellites, weather satellites.

Orbit Type	Height	Period
LEO - Low Earth Orbit	500-1000 Km	1.6 to 1.8 hrs
MEO - Medium Earth Orbit	8,000 to 12,000 km	approx. 6 hrs (at 10,000 km).
GEO - Geostationary	approx. 36,870 km	approx. 24 hrs

GEO   36,000 km

MEO   5,000 – 15,000 km

LEO   500 -1000 km

Advantages of Satellite Communication

❑ Can reach over large geographical area

❑ Flexible (if transparent transponders)

❑ Easy to install new circuits

❑ Circuit costs independent of distance

❑ Can reach over large geographical area

❑ Flexible (if transparent transponders)

❑ Easy to install new circuits

❑ Provision of service to remote or underdeveloped areas

Routing

- One solution: inter satellite links (ISL)
  - ❑ reduced number of gateways needed
  - ❑ forward connections or data packets within the satellite network as long as possible
  - ❑ only one uplink and one downlink per direction needed
- Problems:
  - ❑ more complex focusing of antennas between satellites
  - ❑ high system complexity due to moving routers
  - ❑ higher fuel consumption
  - ❑ thus shorter lifetime

Localization of Mobile Stations

- Mechanisms similar to GSM

- Gateways maintain registers with user data
  - HLR (Home Location Register): static user data
  - VLR (Visitor Location Register): (last known) location of the mobile station
  - SUMR (Satellite User Mapping Register):
    - satellite assigned to a mobile station
    - positions of all satellites

- Registration of mobile stations
  - Localization of the mobile station via the satellite's position
  - requesting user data from HLR
  - updating VLR and SUMR

- Calling a mobile station
  - localization using HLR/VLR similar to GSM
  - connection setup using the appropriate satellite

Handover in Satellite Systems

- Several additional situations for handover in satellite systems compared to cellular terrestrial mobile phone networks caused by the movement of the satellites
  - *Intra satellite handover*
    - handover from one spot beam to another
    - mobile station still in the footprint of the satellite, but in another cell
  - *Inter satellite handover*
    - handover from one satellite to another satellite
    - mobile station leaves the footprint of one satellite
  - *Gateway handover*
    - Handover from one gateway to another
    - mobile station still in the footprint of a satellite, but gateway leaves the footprint
  - *Inter system handover*
    - Handover from the satellite network to a terrestrial cellular network
    - mobile station can reach a terrestrial network again which might be cheaper, has a lower latency etc.

Thank you!