

Mobile and Ubiquitous Computing

Cellular Mobile and Implications of Mobility

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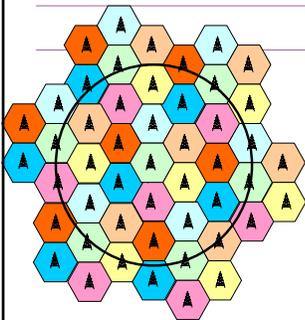
Session Overview

- How cellular mobile systems work
 - Elements
 - Methods
- Implications of mobility for computing
 - Wireless
 - Mobility
 - Portability





Cellular Architecture



- Research in 1960's and 1970's at Bell Labs led to the concept of "cells"
- Basic concept of frequency re-use applied in a smaller area by the use of several low power transmitters instead of a single high power transmitter
- Each transmission range called a CELL
- A set of cells that do not share the frequency form a "cluster"
- The cluster is then replicated throughout the desired communication area



Cellular Techniques

- Trick: reuse spectrum
- Separating users:
 - FDMA: Frequency Division Multiple Access – one user, one frequency
 - TDMS: Time Division Multiple Access – one user, one time slot (time interval within a radio frame) (GSM: every 8th time slot)
 - CDMA: Code Division Multiple Access – one user, one code

Architecture of GSM

- GSM system consists of three major interconnected sub systems
 - Base station Subsystem
 - Mobile station (MS)
 - Base Transceiver Station (BTS)
 - Base Station Controllers (BSC)
 - Network Switching Subsystem
 - Mobile Switching Center (MSC)
 - Home Location Register (HLR)
 - Visitor Location Register (VLR)
 - Authentication center (AU)
 - Operation Support Subsystem
 - Operation Maintenance Centers

Mobile Station

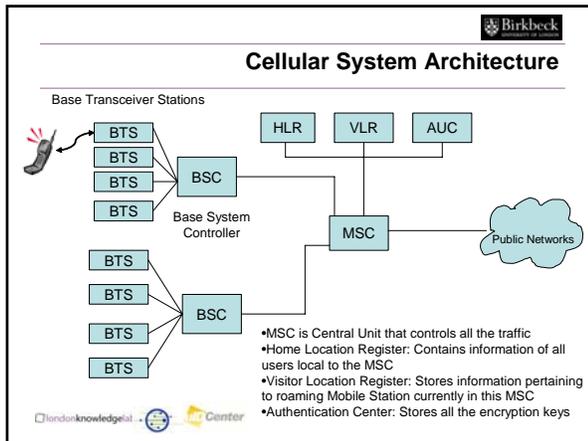
Mobile Terminal

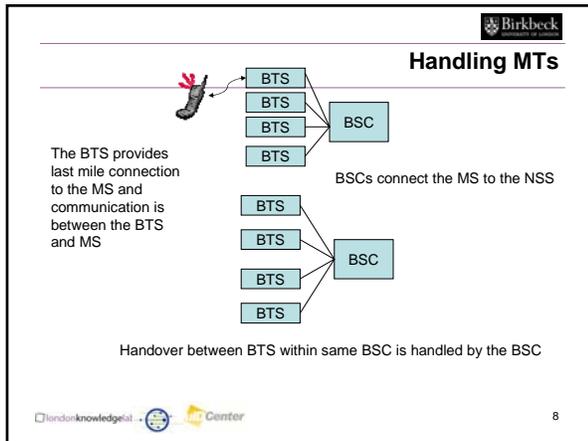
Terminal Equipment:
User Interaction applications

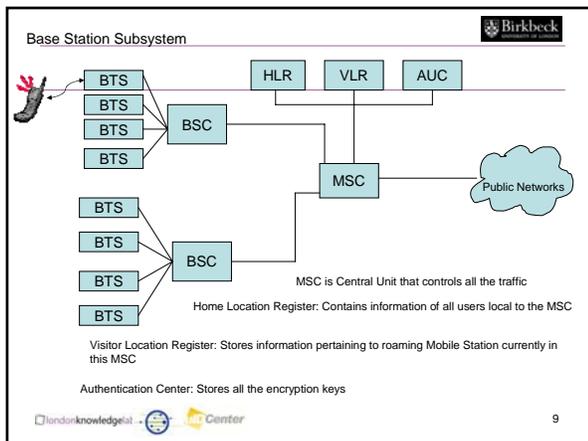
Mobile Terminal:
Connection to the Network

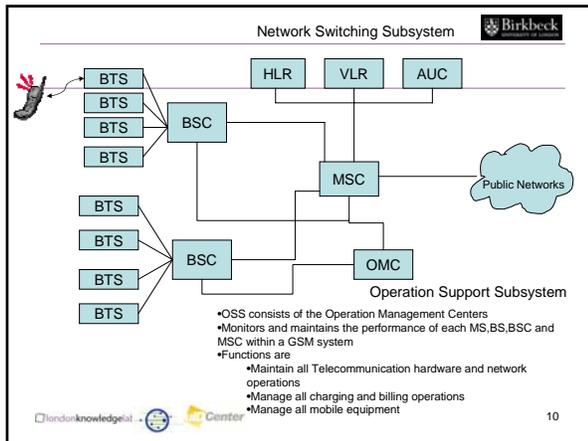
Subscriber Identity Card:
User Data

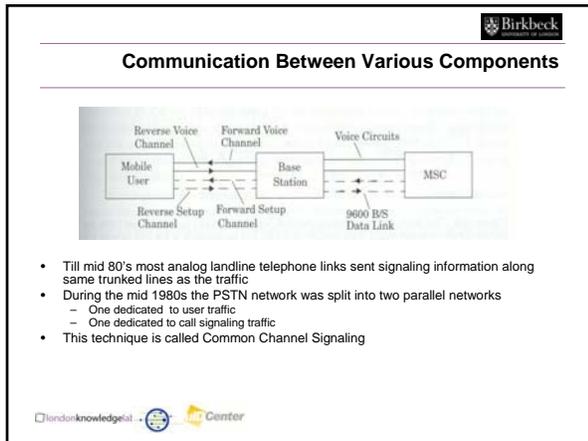


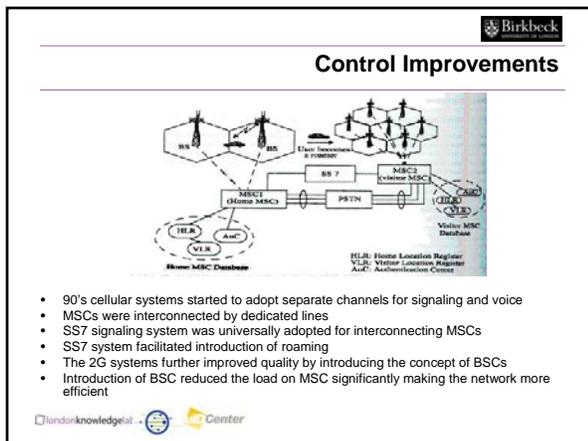














Mobile Computing in More Depth

- Wireless communication
 - Disconnection
 - Low bandwidth
 - High bandwidth variability
 - Heterogeneous networks
 - Security
- Mobility
 - Addressing and routing
 - Location based information
 - Migration
- Portability
 - Low power
 - Small interface
 - Restricted storage
 - Security



Wireless Characteristics

- Wireless is primary network interface, may attach via cable on and off
- Implication: signal interacts with the environment
 - noise, echoes (multi-path, timing), blocking
 - objects, walls, other sources, weather
- Implication: network topology very dynamic
 - hosts come and go, loss of connectivity, variable density
- Result: degradation/variability of capability to communicate, errors
- Networks and applications must deal with this



Communications Challenges 1

- Disconnection
 - autonomy of operation vs. centralized operation
 - delay tolerance: asynchronous operation, pre-fetching, lazy write-back, caching
 - execution quality guarantees
- Low bandwidth
 - cellular 9-14 kbits, GPRS 171 kbits (theory), 40-60 kbits (real), infrared 1Mbits, Bluetooth 1-10 Mbits, Wi-Fi 2-57 Mbits
 - shared between users!
 - limited transmission range!



Communications Challenges 2

- High bandwidth variability
 - adaptation
 - move from area with GPRS to simple cellular
- Heterogeneous networks
 - different (physical) interfaces
 - different network structure (e.g. cellular vs. ad-hoc)
- Security
 - eavesdropping on the air
 - easy to move between security domains
 - may have limited access to resources (e.g. software updates)






Mobility: Addressing and Routing

- Moving from access point to access point
 - How do you handle the change
 - How do you reroute data to the new location
 - Who is responsible for maintaining correct operation
- These actions are mostly taken by persons on wired networks
- One solution: Mobile IP
- Will discuss in detail






Mobility: Location Based Computing

- How to take into account the location of the host and the user
 - to access resources nearest to you
 - more relevant, better performance
 - local restaurant, closer data servers
 - to modify the operation of software e.g. discover new services available locally
- Technology: many different depending on
 - wireless system used, indoor-outdoor, type of location needed
 - GPS, location tags, vision, triangulation etc
- A whole session will be on this!




Mobility: Migration

- Device
 - start work on a PDA and continue on a phone
 - processes, data, state
- Location
 - start work on the train and continue at home
 - security, resources, preferred attachment
- Context
 - use the same resource to work and then to entertain
 - cost, security, resources, identity

Low power

- Mobile power source = battery
- Reduce processor and network power consumption
 - on/off cycles
 - reduce frequency
- Adaptation
- New: data harvesting
 - solar power, vibration, thermal power

Small Interface

- Small display/screen size
 - need for interaction alternatives
 - need for summarization
- Restricted input device
 - no mouse, no full keyboard
 - keypad or less, voice recognition
- Eternal devices
 - Bluetooth headphones, printers, interaction with external displays



Restricted Storage

- Non-volatile storage is very expensive in terms of power (e.g. mechanical components)
- Local vs. network storage
 - Restricted in size, speed and availability
 - Frequent disconnections!
- Old techniques to the fore
 - Compression, shared code, compressed code in memory, surrogates
- Issues with synchronization

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Security

- “The protection of information systems against unauthorized access to or modification of information, whether in storage, processing or transit, and against the denial of service to authorized users or the provision of service to unauthorized users, including those measures necessary to detect, document, and counter such threats” US INFOSEC
- Integrity, confidentiality, availability, non-repudiation
- Hostile environment
- Implications

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Experimental Systems Research

- The scientific method
 - hypothesis, **experiment**, **validation** and replication
- How to formulate a hypothesis
 - What is the basis for your hypothesis?
 - What are the implications of your hypothesis?
- What is the expected result
- Design experiment to show the causal effect
- Ensure correctness and replication

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