



Mobile Data Management Issues



What is Pervasive Computing?

- **“Pervasive computing is a term for the strongly emerging trend toward:**
 - Numerous, casually accessible, often invisible computing devices
 - Frequently mobile or embedded in the environment
 - Connected to an increasingly ubiquitous network structure.”
 - NIST, Pervasive Computing 2001
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Party on Friday



- Update Smart Phone's calendar with guests names.
- Make a note to order food from Dinner-on-Wheels.
- Update shopping list based on the guests drinking preferences.



- Don't forget to swipe that last can of beer's UPS label.
 - The shopping list is always up-to-date.
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Party on Friday

- AutoPC detects a near Supermarket that advertises sales.



- It accesses the shopping list and your calendar on the Smart Phone.
- It informs you the soda and beer are on sale, and reminds you that your next appointment is in 1 hour.
- There is enough time based on the latest traffic report.

Party on Friday



- Smart Phone reminds you that you need to order food by noon.
 - It downloads the Dinner-on-Wheels menu from the Web on your PC with the guests' preferences marked.
 - It sends the shopping list to your CO-OP's PC.
 - Everything will be delivered by the time you get home in the evening.
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Mobile Applications

- Expected to create an entire new class of Applications
 - new massive markets in conjunction with the Web
 - Mobile Information Appliances - combining personal computing and consumer electronics
 - Applications:
 - Vertical: vehicle dispatching, tracking, point of sale
 - Horizontal: mail enabled applications, filtered information provision, collaborative computing...
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Mobile and Wireless Computing

- Goal: Access Information Anywhere, Anytime, and in Any Way.
- Aliases: Mobile, Nomadic, Wireless, Pervasive, Invisible, Ubiquitous Computing.
- Distinction:
 - Fixed wired network: Traditional distributed computing.
 - Fixed wireless network: Wireless computing.
 - Wireless network: Mobile Computing.
- Key Issues: Wireless communication, Mobility, Portability.

Terminologies

- **GSM - Global System for Mobile Communication**

- GSM allows eight simultaneous calls on the same radio frequency and uses narrowband TDMA. It uses time as well as frequency division.

- **TDMA - Time Division Multiple Access**

- With TDMA, a frequency band is chopped into several channels or time slots which are then stacked into shorter time units, facilitating the sharing of a single channel by several calls

- **CDMA - Code Division Multiple Access**

- data can be sent over multiple frequencies simultaneously, optimizing the use of available bandwidth.
- data is broken into packets, each of which are given a unique identifier, so that they can be sent out over multiple frequencies and then re-built in the correct order by the receiver.

TDMA

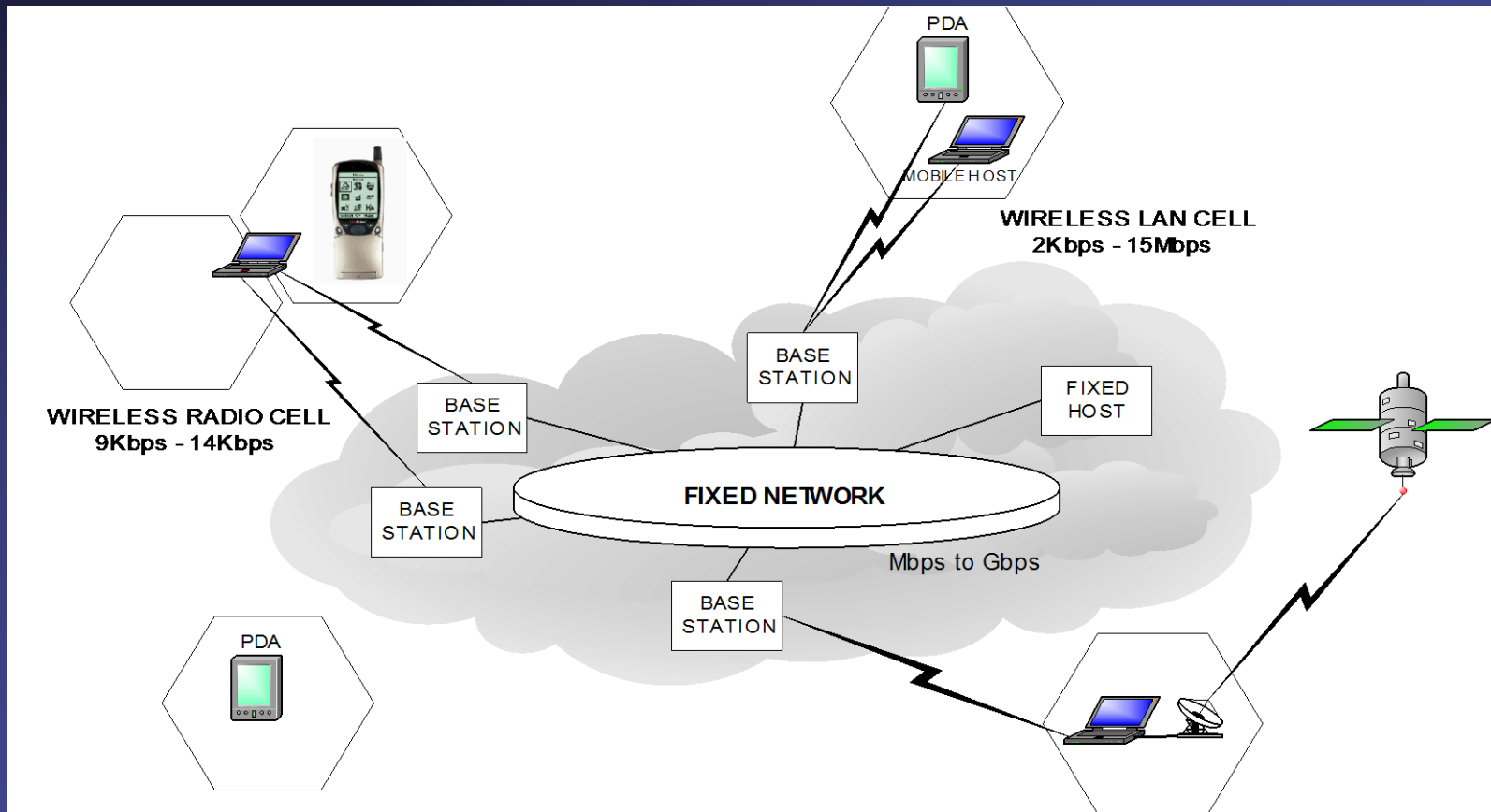
Conversation	A	Mary had a little lamb.
	B	Hickory Dickory Dock – the mouse ran up the clock.
	C	There was an old woman who lived in a shoe.
	D	Jack and Jill ran up the hill.

RF Ch.	Mary had a	Hickory, dickory,	There was an	Jack and Jill
Freq. 1	Slot 1	Slot 2	Slot 3	Slot 4

Wireless Technologies

- **Wireless local area networks** (WaveLan, Aironet) – Possible Transmission error, 1.2 Kbps-15 Mbps
 - **Cellular wireless** (GSM, TDMA, CDMA)– Low bandwidth, low speed, long range - Digital: 9.6-14.4 Kbps
 - **Packet radio** (Metricom) -Low bandwidth, high speed, low range and cost
 - **Paging Networks** – *One way*
 - **Satellites** (Inmarsat, Iridium(LEO)) – Long Latency, long range, high cost
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Mobile Network Architecture



Wireless characteristics

- Variant Connectivity
 - Low bandwidth and reliability
 - Frequent disconnections
 - predictable or sudden
 - Asymmetric Communication
 - Broadcast medium
 - Monetarily expensive
 - Charges per connection or per message/packet
- Connectivity is weak, intermittent and expensive

Portable Information Devices

- PDAs, Personal Communicators
 - Light, small and durable to be easily carried around
 - dumb terminals, palmtops, wristwatch PC/Phone,
 - will run on AA+ /Ni-Cd/Li-Ion batteries
 - may be diskless
 - I/O devices: Mouse is out, Pen is in
 - Wireless connection to information networks
 - either infrared or cellular phone
 - Specialized Hardware (for compression/encryption)
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Portability Characteristics

- Battery power restrictions
 - transmit/receive, disk spinning, display, CPUs, memory consume power
 - Battery lifetime will see very small increase
 - need energy efficient hardware (CPUs, memory) and system software
 - planned disconnections - *doze mode*
 - Power consumption vs. resource utilization
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Portability Characteristics Cont.

- Resource constraints
 - Mobile computers are resource poor
 - Reduce program size – interpret script languages (Mobile Java?)
 - Computation and communication load cannot be distributed equally
 - Small screen sizes
 - Asymmetry between static and mobile computers
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Mobility Characteristics

- Location changes
 - location management - cost to locate is added to communication
 - Heterogeneity in services
 - bandwidth restrictions and variability
 - Dynamic replication of data
 - data and services follow users
 - Querying data - location-based responses
 - Security and authentication
 - System configuration is no longer static
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What Needs to be Reexamined?

- Operating systems - TinyOS
 - File systems - CODA
 - Data-based systems – TinyDB
 - Communication architecture and protocols
 - Hardware and architecture
 - Real-Time, multimedia, QoS
 - Security
 - Application requirements and design
 - PDA design: Interfaces, Languages
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Mobility Constraints

- CPU
- Power
- Variable Bandwidth
- Delay tolerance, but unreliable
- Physical size
- Constraints on peripherals and GUIs
- Frequent Location changes
- Security
- Heterogeneity
- Expensive
- Frequent disconnections but predictable

What is Mobility?

- A device that moves between
 - different geographical locations
 - Between different networks
 - A person who moves between
 - different geographical locations
 - different networks
 - different communication devices
 - different applications
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Device mobility

- Laptop moves between Ethernet, WaveLAN and Metricom networks
 - Wired and wireless network access
 - Potentially continuous connectivity, but may be breaks in service
 - Network address changes
 - Radically different network performance on different networks
 - Network interface changes
- Can we achieve best of both worlds?
 - Continuous connectivity of wireless access
 - Performance of better networks when available

Mobility Means Changes

- Addresses
 - IP addresses
 - Network performance
 - Bandwidth, delay, bit error rates, cost, connectivity
 - Network interfaces
 - PPP, eth0, strip
 - Between applications
 - Different interfaces over phone & laptop
 - Within applications
 - Loss of bandwidth trigger change from color to B&W
 - Available resources
 - Files, printers, displays, power, even routing
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Bandwidth Management

- Clients assumed to have weak and/or unreliable communication capabilities
 - Broadcast--scalable but high latency
 - On-demand--less scalable and requires more powerful client, but better response
 - Client caching allows bandwidth conservation
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Energy Management

- Battery life expected to increase by only 20% in the next 10 years
 - Reduce the number of messages sent
 - Doze modes
 - Power aware system software
 - Power aware microprocessors
 - Indexing wireless data to reduce tuning time
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Why Mobile Data Management?

- Wireless Connectivity and use of PDA's, handheld computing devices on the rise
 - Workforces will carry extracts of corporate databases with them to have continuous connectivity
 - Need central database repositories to serve these work groups and keep them fairly upto-date and consistent
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Mobile Data Applications

- **Sales Force Automation** - especially in pharmaceutical industry, consumer goods, parts
 - **Financial Consulting and Planning**
 - **Insurance and Claim Processing** - Auto, General, and Life Insurance
 - **Real Estate/Property Management** - Maintenance and Building Contracting
 - **Mobile E-commerce**
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Mobility – Impact on DBMS

- Handling/representing fast-changing data
 - Scale
 - Data Shipping v/s Query shipping
 - Transaction Management
 - Replica management
 - Integrity constraint enforcement
 - Recovery
 - Location Management
 - Security
 - User interfaces
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DBMS Industry Scenario

- Most RDBMS vendors support the mobile scenario - but no design and optimization aids
 - Specialized Environments for mobile applications:
 - Sybase Remote Server
 - Synchrologic iMOBILE
 - Microsoft SQL server - mobile application support
 - Oracle Lite
 - Xtnd-Connect-Server (Extended Technologies)
 - Scoutware (Riverbed Technologies)
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Query Processing

- **New Issues**
 - Energy Efficient Query Processing
 - Location Dependent Query Processing
 - **Old Issues - New Context**
 - Cost Model
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Location Management

■ New Issues

- Tracking Mobile Users

■ Old Issues - New Context

- Managing Update Intensive Location Information
 - Providing Replication to Reduce Latency for Location Queries
 - Consistent Maintenance of Location Information
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Transaction Processing

- **New Issues**
 - Recovery of Mobile Transactions
 - Lock Management in Mobile Transaction
 - **Old Issues - New Context**
 - **Extended Transaction Models**
 - Partitioning Objects while Maintaining Correctness
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Data Processing Scenario

- One server or many servers
 - Shared Data
 - Some Local Data per client , mostly subset of global data
 - Need for accurate, up-to-date information, but some applications can tolerate bounded inconsistency
 - Client side and Server side Computing
 - Long disconnection should not constraint availability
 - Mainly Serial Transactions at Mobile Hosts
 - Update Propagation and Installation
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