CPET 565/CPET 499
Mobile Computing Systems

Lecture 7
Data Dissemination and Management
1 of 3

Based on the Text used in the course: Fundamentals of Mobile & Pervasive Computing, 2005, by Frank Adelstein, et. al, from McGraw-Hill

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Data Dissemination and Management - Topics

- Introduction
- Challenges
- Data Dissemination
- Mobile Data Caching
- Mobile Cache Maintenance Schemes
- Mobile Web Caching
- Summary

Data Dissemination and Management – Topics (cont.)

- Introduction
  - Pull (On-Demand) Mode
  - Push (Publish-Subscribe) Mode
  - Information Caching
- Challenges
  - Architecture-based
  - Architecture-less
- Data Dissemination
  - Bandwidth Allocation for Publishing
  - Broadcast Disk Scheduling

Data Dissemination and Management – Topics (cont.)

- Mobile Data Caching
  - Caching in Traditional Distributed Systems
  - Cache Consistency Maintenance
  - Performance and Architecture Issues
- Mobile Cache Maintenance Schemes
  - A Taxonomy of Cache Maintenance
  - Cache Maintenance for Push-based Information Dissemination
  - Broadcasting Invalidation Reports
  - Disconnected Operation
  - Asynchronous Stateful (AS) Scheme
  - To Cache or Not to Cache
- Mobile Web Caching
  - Handling Disconnections
  - Achieving Energy and Bandwidth

Data Dissemination and Management - Introduction

- Mobile Information Content and Applications
  - Email, Messaging, News
  - Public Transportation, Traffic, Flight Status
  - Business Info, Financial Info, Banking, Stock quotes, Sales
  - Events, Parking
  - Tourism, Hotel, Restaurants, Weather
  - Medical
  - Consumer Services, Yellow pages

Data Dissemination and Management – Introduction (cont.)

- Mobile Information Servers
  - Email
  - Web Portal
  - Calendar, Tasks, and Contacts
  - etc
- Possible Combinations
  - Hardware
  - Network Protocols (Wireless Access Protocols, GSM/Circuit, TDMA/CDPD, TDMA/Circuit)
  - Browsers
  - Gateways

Data Dissemination and Management

- Mobile Application Consumers
  - Wireless Sync and Go connectivity & Mobile web services
  - PIM: contacts, calendar, tasks, email, and notes
  - Desktop cradle synchronization

Data Dissemination and Management - Introduction (cont.)

- Mobile Application Server Architecture (Data & Information)
  - 1st Tier – Thin clients
  - 2nd Tier – Communications & Business Applications
  - 3rd Tier – Applications Systems (ERP, CRM, etc)
- Mobile Application Servers, http://www.mobileinfo.com/application_servers.htm

Data Dissemination and Management - Introduction (cont.)

- Wireless Communication Problems
  - Physical Medium
    - Signal Fading
    - Path Loss
    - Interference
    - Time dispersion
  - Lower bandwidth
  - Higher error rates
  - Higher communication latency

Data Dissemination and Management – Introduction (cont.)

- Mobile Communication Infrastructures
  - Wi-Fi
  - Wi-Max
  - CDMA (Code Division Multiple Access)
  - GPRS (General Packet Radio Service; for data packet service on GSM network)
  - EDGE (Enhanced Data GSM Evolution, up to 384 Kbps)
  - 3G (3rd Generation Wireless Technology include enhanced multimedia, and upwards of 2 Mbps throughput)
  - 4G, LTE
  - Bluetooth, IrDA, IrFM, OMA (Open Mobile Alliance) Device Management

Data Dissemination and Management - Introduction (cont.)

- Mobile Application Servers (Data & Information)
  - Enterprise Resource Planning (ERP)
  - Customer Resource Management (CRM)
  - Sales Force Automation
  - Financial Accounting System
  - Manufacturing Systems
  - Field Services

Data Dissemination and Management – Introduction (cont.)

- Examples of Mobile Application Servers
  - AT&T Mobile Applications, http://www.business.att.com/enterprise/Family/mobility-services/mobile-applications/
  - IBM WebSphere Application Server
  - Oracle Mobile Application Server
  - Sybase Mobile Application Server
  - Microsoft Mobile Application Server
  - Nokia Mobile Web Server, discontinued 2010, http://www.developer.nokia.com/Community/Wiki/Archived:Mobile_Web_Server_Tutorial_for_custom_applications
  - Mobile Web Application Architecture, http://www.asp.net/mobile/2514A_01A001.swf

Data Dissemination and Management – Introduction (cont.)

- Other Related Tasks and/or Modules
  - Mobile Data/Information Integration
  - Global Mobile Information System
  - Mobile Information Protection & Security
  - Mobile Information Center
  - Unified Data Model
  - Middleware for Mobile Information Access

Data Dissemination and Management – Introduction (cont.)

- Mobile Information Delivery Methods
  - Push (Publish-Subscribe) Mode
    - Information broadcasting when its available
    - Resource-efficient
    - Scalable
  - Pull (On-Demand) Mode
    - User send query for particular information to an information source (server or peer)
    - Reply
  - Information Caching
    - Document, files

Data Dissemination and Management – Introduction (cont.)

- Issues of Mobile Information Services
  - Publication Content: Which items
  - Publication Frequency: How often
  - Bandwidth Allocation:
    - Uplink channels
    - Downlink channels
  - How can mobile users access services transparently?

Data Dissemination and Management – Introduction (cont.)

- How can mobile users access services transparently?

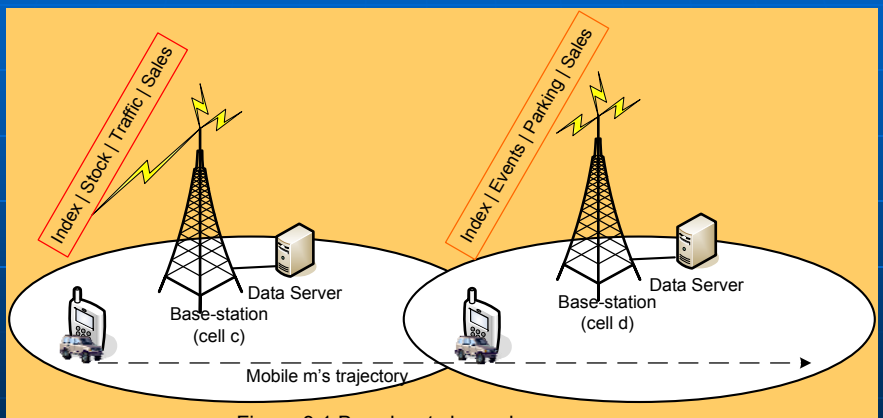

Figure 3.1 Broadcast channel

Adapted from the Text: Fundamentals of Mobile and Pervasive Computing, 2005, by Frank Adelstein, et. al, McGraw-Hill

Data Dissemination and Management – Introduction (cont.)

- How can their energy consumption be minimized? (Energy efficient Info services)
  - Low-power radio circuit – matching a predefined set of packet address
  - Store data in a low-energy buffer
  - Wake-up the CPU after a certain time interval
  - Run CPU clock in a low-power mode

Data Dissemination and Management – Introduction (cont.)

- Publish-subscribe
  - Conserves battery power since no uplink query is needed
  - More scalable – access time independent of the number of mobile hosts requesting the data
  - More useful in asymmetric environments

Data Dissemination and Management – Introduction (cont.)

- Information caching
  - Caching to avoid frequent access
  - Replenish on an as-needed basis or in a predictive manner
  - Hoarding items that are in short supply and become available only occasionally
  - How to guarantee the consistency of cached information

Data Dissemination and Management - Challenges

- Challenges
  - Architecture-based
  - Architecture-less
- Environment Challenges
  - Intermittent Power
  - Intermittent Connectivity
  - Long Travel Times
  - Variable Population Density
  - Lack of Secure Storage
- User Challenges
  - Mobile Workforce
  - User Education Levels

Data Dissemination and Management - Challenges

- Architecture-Based Cellular Mobile Networks
  1. Weak Connectivity
  2. Severe Resource Constraints
  3. Asymmetric Communication Links
  4. Location and Time (context) Dependent
- Architecture-less Mobile Ad Hoc Network (MANET)
  1. Weak Connectivity
  2. Severe Resource Constraints

Data Dissemination and Management - Challenges

- 1. Architecture-Based Cellular Mobile Networks - Weak Connectivity

- How to ensure high data availability in mobile computing environment where frequent disconnections may occur because the clients and server may be weakly connected?

Data Dissemination and Management - Challenges

- 2. Architecture-Based Cellular Mobile Networks - Severe Resource Constraints
- How to minimize resource consumption (e.g. energy and bandwidth) for data management while ensuring a desired level of data consistency?

Data Dissemination and Management - Challenges

- 3. Architecture-Based Cellular Mobile Networks - Asymmetric Communication Links
- How can the asymmetric nature of wireless connectivity be exploited to ensure low data access latency and resource consumption?

Data Dissemination and Management - Challenges

- 4. Architecture-Based Cellular Mobile Networks - Location and Time (context) Dependent
  - A mobile user ↔ Query database periodically to retrieve location dependent and time-dependent information
  - Traveler ↔ restaurants, hotels
  - Salesman ↔ up-to-date product price
- Caching and pre-fetching can be an effective technique to reduce the impact of
  - Low-bandwidth
  - Intermittent wireless links

Data Dissemination and Management - Challenges

- 4. Architecture-Based Cellular Mobile Networks - Location and Time (context) Dependent
  - The decision to cache or replace a data item also depends on the context (location) of the mobile node in addition to the temporal or spatial locality
- How do you enhance existing cache management technique for context-dependent data?

Data Dissemination and Management - Challenges

- Architecture-less Mobile Ad Hoc Network (MANET)
  1. Weak Connectivity
  2. Severe Resource Constraints
- Data availability and bandwidth/energy efficiency still need to be addressed
- Can the data management schemes used developed for an Cellular Mobile Networks be used directly to solve problems in a MANET?

Data Dissemination and Management - Challenges

- Gateways of MANET/Cellular Mobile Networks
  - Gateways (MANET) – unreliable mobile computing devices
  - Base Stations – reliable dedicated networking devices
  - MANETs Remote Communication Links
    - Unreliable, Low Bandwidth Links: Radio Frequency Wireless Links
    - High-latency, unreliable Links: Satellite channels
  - Base Stations Remote Communication Links
    - High-speed wired networks

Data Dissemination and Management - Challenges

- Network Architectures of MANET/Cellular Mobile Networks
  - Peer-to-peer (P2P) networks – MANETs
  - Client-Server – Cellular Mobile Networks
  - Data Management Approaches
    - Cooperative Caching
    - Caching hierarchy – backbone caches
    - Hyper Text Transfer Protocol (HTTP)
    - Internet Caching Protocol (ICP)

Data Dissemination and Management - Challenges

- Internet Cache Protocol, RFC 2187
- Hypertext Transfer Protocol, http://www.w3.org/Protocols/