CS 525M – Mobile and Ubiquitous Computing Seminar

Damian Robo
Outline

- Introduction
- Data Dissemination
- Data Consistency
- Location Dependent Queries
- Interfaces
- Challenges
- Conclusions
Introduction

• Advances in wireless networking and powerful portable devices (laptops/palmtops/PDA-s etc.) have made mobile computing a reality, and in some cases a necessity.
• Mobile Computing has had and still has an impact on many areas of Computer Science such as networking, software developing, hardware, graphics etc.
• Here we will survey the impact Mobile Computing has on the area of Data Management.
• Wireless Networks, a breakthrough in technology, display some unique features not found in wired environments.
MU  Mobile unit (can be either dumb terminals or walkstations)
MSS  Mobile Support Station (has a wireless interface)
Fixed Host  (no wireless interface)
Features of a Wireless Distributed System

• **Asymmetry in the Communications**
  - Bandwidth in the downstream direction is much greater than the one in the upstream direction.

• **Frequent Disconnections**
  - Users often switch their devices on/off.

• **Power limitations**
  - Often devices are limited on the amount of energy they can use (batteries).
  - New solar powered devices are emerging (Casio, Fujitsu, Grundig Deutsche S.A.).

• **Display/Screen Size**
  - Small screens often display problems using graphics.
  - Samsung has presented a folding screen which solves some of the problems.
Data Dissemination

• Communication asymmetry and restrictions in power make the model of broadcasting data to the clients a nice solution.

• Data Dissemination
  – Delivery of data from a set of producers to a larger set of clients.

• In a Push based system the data is broadcasted/sent to clients without a request being done.

• Pros:
  – Servers avoid interruptions.

• Cons:
  – Relevance of broadcasted data.
  – Periodic or non-periodic?
Data Dissemination

• Broadcast Disks
  – Periodic Dissemination Architecture.
  – Provide a multilevel mechanism that permits data items to be broadcast non-uniformly relative to importance.
  – Mechanisms for managing the storage in the clients are devised to tailor caching and pre-fetching designed to perform efficiently.

• Memory hierarchy comes into play
  – Few items broadcasted more often on the top layer and more items broadcasted less often in the other layers.

• Clients do caching and pre-fetching to compensate for mismatches.
• Often servers do not “guess” right.
Data Dissemination

- There are options to combine push and pull systems using two channels (backchannel and frontchannel).
- A study has showed that pure pull or pure push systems are the best choice.
- IPP (Interleaved Push and Pull)
  - Clients use the backchannel to request items not appearing in the Broadcast channel.
  - Suffers from bottleneck issues found in Pull techniques.
    - Either adjust pull bandwidth at the expense of pull band.
    - Or apply a pull threshold.
    - Or cut off the least frequent broadcasted material.
- All the above techniques work on the expense of each other.
Data Dissemination

• Invalidation Reports
  – Server notifies clients about changes on the data being cached by them using a limited bandwidth channel.

• Several options exist to make these IR-s shorter.
  – Quasicopies.
  – Rate of cache purging.
  – Groups are introduced.

• AIDA (Adaptive Information Disposal Algorithm)
  – Flat organizations.
  – Rate monotonic organizations
  – Slotted rate monotonic organizations.
Data Dissemination

• IDA (Information Dispersal Algorithm)
• A file F is divided in n pieces
• Then there is a m<=n such that from these m pieces the whole file can be reconstructed.
• Directories group together data of interest for clients (requires less uptime)
• Indexing on air. Transmitting indexes along with data.
• Distributed Indexing Techniques (Best latency and tuning)
• Temporal and broadcast addresses
Data Consistency

- The limited bandwidth and frequent disconnections have a major impact on the consistency of data.
- One idea is to provide a view of the database that is consistent with the user’s actions.
- Session guarantees are introduced:
  - Read your writes
  - Monotonic reads
  - Writes follow reads
  - Monotonic writes
- Implemented in the Bayou project
Data Consistency

• Escrow methods divide the total number of available instances among the number of sites in the system.
• Ease transactions when a client is on the move, help servers identify next set of transactions.
• Another technique is the split of large objects and assigning each part to different clients.
• Tentative transactions. While clients are offline transactions are applied on the cached data.
Data Consistency

• Isolation Only Transactions (IOT)
  – A transaction is executed on the mobile client.
  – It then enters a committed or pending state based on the connection with the server.

• Data Replication
  – Important since mobile clients are often not connected.
  – Can process files locally. Files are updateable.
  – Core copies. Several techniques exist to manipulate core copies.
  – Referees are responsible to track core update information.
  – Directories can be replicated in the same way.
Location Dependent Querying

- Clients in a mobile network change locations. Queries have to be answered in a way that is dependent on the current position of the client.
- Integration of GPS and IP enable the creation of location dependent services.
  - E.g. telling user if some information is available at that location.
- Advanced Traveler Information System (ATIS)
  - Provides trip information to travelers.
Location Dependent Querying

- Genesis is based upon ATIS in Minnesota.
- Contains data collector services from different departments, a database server and also data dissemination techniques for alerting users.
- Mobisaic is an extension of WWW to support mobile users.
  - Uses Dynamic URL-s, and active documents.
- Spreitzer and Themer proposed another architecture with User Agents and Location Query Service.
Location Dependent Query

• User Agents manage personal information
• Agents get information by infrared, GPS, sensors etc.
• Local Query Service is used to manage local-based services.
• QBI Query by Icons
  – Iconic visual image allowing users to make queries by using a pointing device.
  – A semantic data model that captures most aspects of databases.
  – Metaquery tools that help create queries during offline periods.

• All of the above are reflected in University of Berkeley InfoPad.

• Light Projection Keyboard PDA’s are into play.
• Alonso and Mani present a pen based database access tool.
• Uses a cell phone to connect to databases by using schemas.
• In this case user can perform joins and other relational database tools using a pen.
• Often referred as the Universal Relation concept. It aids in automatic generation fo queries based on the attributes chosen by the user.
Challenges

- **Prototyping**
  - A full scale prototype that encompasses all of the above issues is still missing.

- **Bandwidth Utilization**
  - More work is needed to optimize tradeoffs between certain techniques.

- **Transactional properties.**
  - Not enough real cases are taken in consideration.

- **Optimization of Location Based Query Processing.**
  - A little has been done to enhance this.

- **Data Visualization**
  - Need more effective ways to use the scarce display space
Conclusions

• The nature of mobile computing itself presents a challenge in the area of database management, as well as in other areas.

• Need of
  – Better Protocols in data sharing.
  – Better Displays.
  – Clever Algorithms.

• More research is very likely to emerge in order to deal with the above issues.