CS 525M – Mobile and Ubiquitous Computing Seminar

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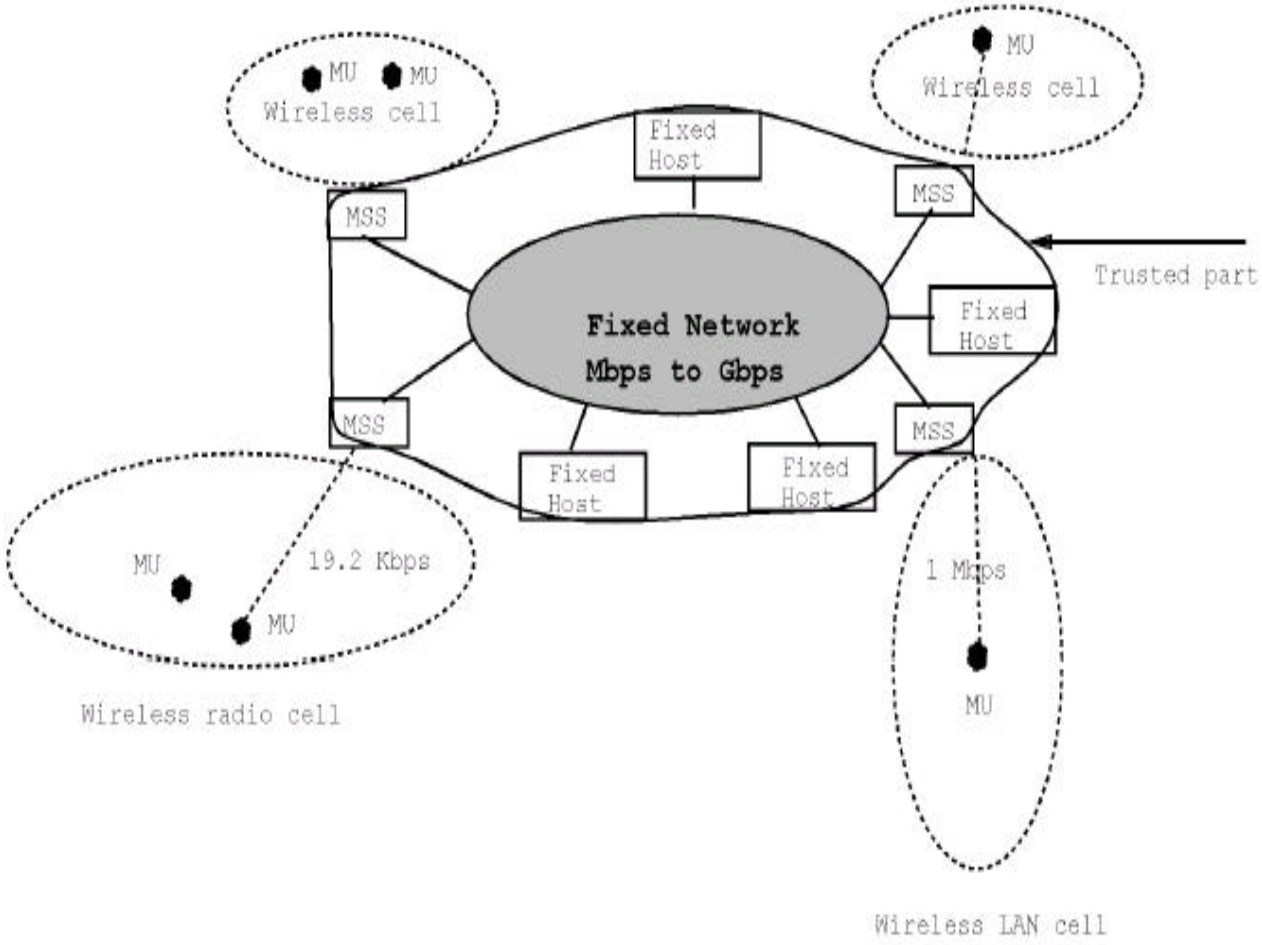
Outline

- 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.

Introduction Cont'd



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.

Interfaces

- 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.

Interfaces

Interfaces

- 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.