Mobile Transactional Coordination

Can Türker

ETH Zurich / U Konstance

"Mobile Datenbanken und Informationssysteme", GI-Arbeitskreis-Gründungstreffen, Jena, 23.11.2001

... towards Pervasive Computing

- Gartner Group: *"by 2003 more than 137 million business users will be involved in some form of remote work"*
- Accenture: *"by 2005 over 500 million mobile devices will offer Internet access"*

- *Conclusions*
  - mobile hosts (MH; laptops, palmtops, smart phones, etc.) outstrips fixed hosts (FH; personal computers, desktops, etc.)
  - the way information is created and processed will change within this increasingly ubiquitous network

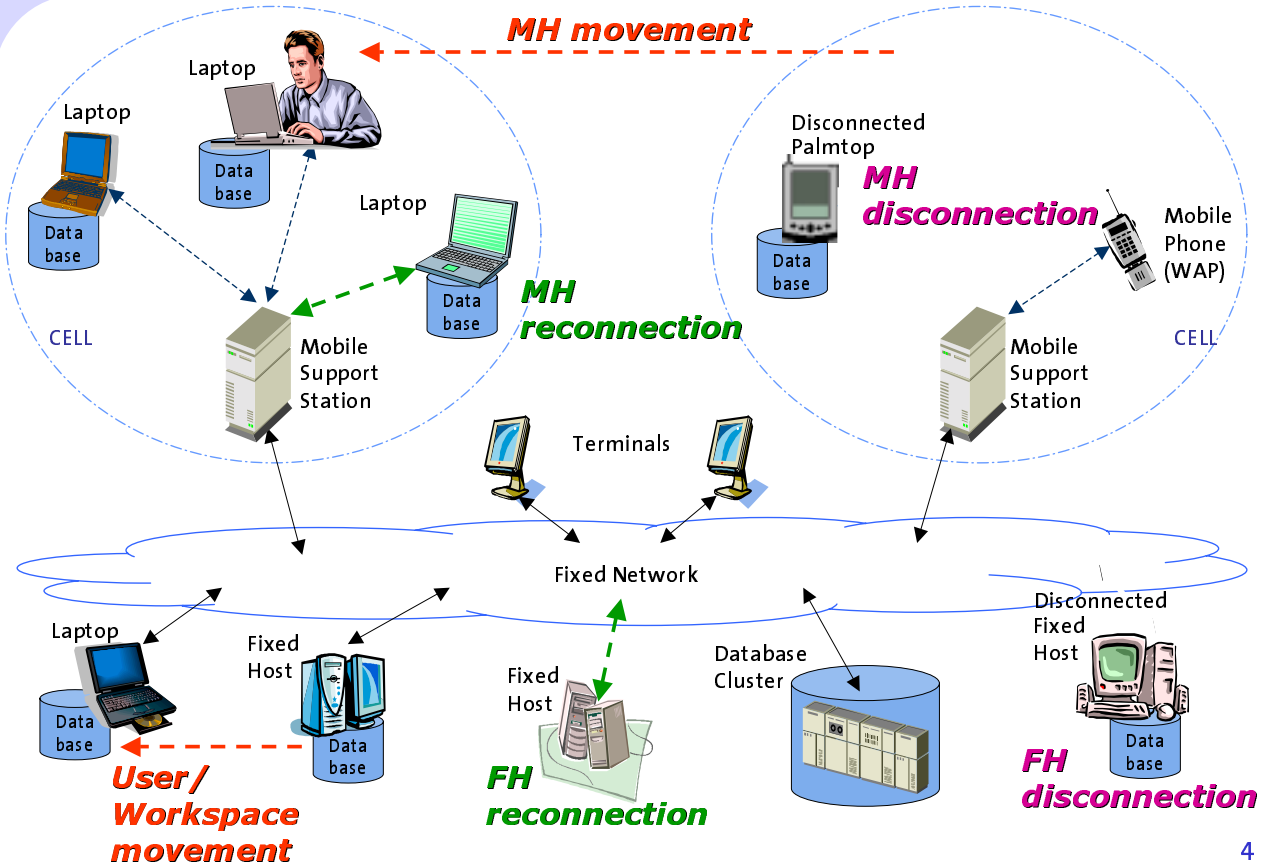
- *Need*
  - infrastructure to coordinate concurrent information access and processing in the presence of mobile hosts and users

Characteristics of Mobility

- Mobile information sources and consumers
  - physical access point to the network may change: sources as well as consumers may move
  - sources as well as consumers may be disconnected
- User and Context Awareness
  - tracking/monitoring information sources and consumers
  - consumer's information needs may shift with location change
- Data management techniques have to be revisited

Resource Limitations (Bandwidth, Memory, Computing Power, ...)	Optimization + Careful Resource Sharing
Scalability	
Correctness Concerns	Transactional Guarantees
Combining Many Sources	Data Integration

Movements and Disconnections



Abstractions

Abstraction of Data Storage	(Relational) DBMS
Abstraction of Concurrency & System Failures	DBMS & TP-Monitors with Concurrency Control & Recovery
Abstraction of Method Implementations	Object-relational DBMS with Object Methods, Triggers & Stored Procedures
Abstraction of Distribution, Heterogeneity & Autonomy	Distributed & Federated DBMS, Data Integration, Conflict Resolution
Abstraction of Movements & Disconnections	Mobile DBMS, Context Maintenance, Replication & Synchronisation, Profiling

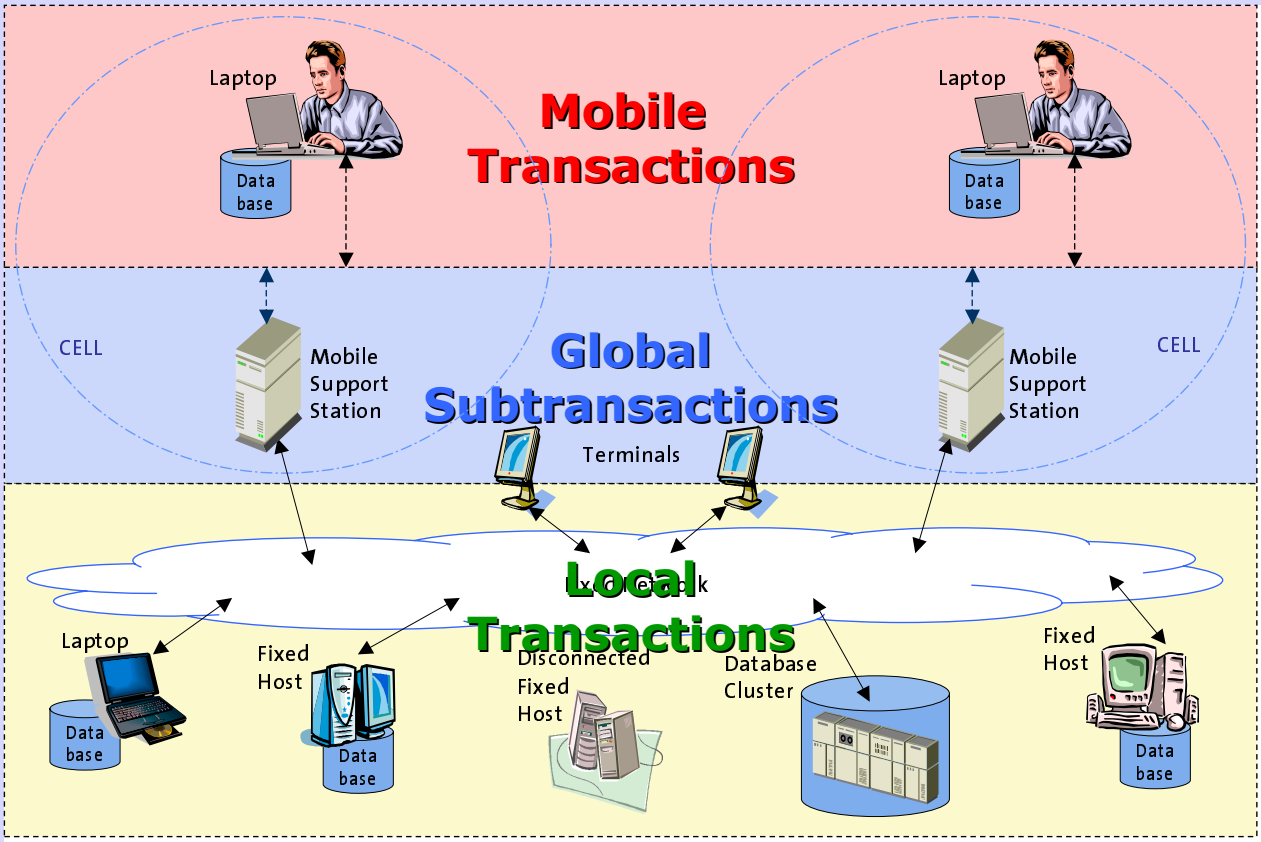
Transparency of Mobility

- Challenge: information access and processing everywhere and at anytime while supporting
  - *transparent disconnections* and
  - *transparent movements of users and information components*

  up to a certain degree

- How much transparency is indeed needed and reasonable?

Transaction Tiers



Disconnections

- "The flight worker": Working in the "intended" disconnected mode requires some lazy replication techniques
  - updates are precommitted locally **transparent to the user?**
  - precommitted updates are propagated asynchronously when reconnected to the network
    - conflicts may occur
    - run conflict resolution when a conflict arises
- Conflict detection via timestamps, version vectors, etc.
- Conflict resolution (during global commitment)
  - optimistic (resolution): function-based, manual
  - pessimistic (avoidance): primary copy, ROWA, quorum

Movements

- "The train/tram/bus worker": Working while physically moving requires transparent support of cell migration and "unintended" disconnections
  - create subtransactions on several mobile support stations
  - coordinate these substranactions correctly
  - wireless communication and cost issues

transparent to the user?

- "The home worker": Resume and/or continue work at another host (mobile or fixed)
  - continue transactions
  - create new subtransactions (within the existing workspace / transaction sphere)

Mobile Transaction Models

- Mobile Transactions involve execution/initiation on MH
  - ACID cannot be supported generally
  - nevertheless, certain transactional guarantees shall be ensured always and everywhere
- MH may or may not have transaction processing capabilities
  - MH initiates a mobile transaction on a FH where the complete processing is done
  - MH can also run transactions locally
- MH may change its location and network connection while transactions are being executed (transaction movement)
- MH may disconnect while transactions are being executed

Overview of Mobile Transaction Models

Subtransaction Types & Mobility Support	Open	Closed	Vital	Non-vital	Dependent	Independent	Substitutable	Compensatable	Temporal	MH Disconnection	MH Movement	MH Usage	User Profiling
Reporting-/Co-Txs Chrysanthis 93	✓	✓	✓		✓		✓	✓			✓	H	
Isolation-Only Txs Lu & Satyanarayanan 94		✓	✓		✓					✓		H	
MDSTPM Txs Yeo & Zaslavsky 94	✓	✓	✓	✓	✓		✓	✓		✓		L	
Weak/Strict Txs Pitoura & Bhargava 94	✓	✓	✓	✓	✓		✓	✓		✓	✓	H	
Kangaroo Txs Dunham et al. 97	✓		✓		✓			✓		✓	✓	L	
Pro-Motion Walborn & Chrysanthis 97	✓	✓	✓		✓		✓	✓	✓	✓	✓	H	✓
Toggle Txs Dirckze & Gruenwald 98	✓		✓	✓	✓		✓	✓		✓	✓	L	
Moflex Txs Ku & Kim 00	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	L	

Overview of Commercial Mobile DB Approaches

Subtransaction Types & Mobility Support	Savepoints	Tx Nesting
IBM DB2 Everyplace		
Informix Cloudspace		
Microsoft SQL Server CE	✓	✓
Oracle Lite	✓	
Sybase Anywhere	✓	✓

- only a few supports nested Txs (closed, vital, dependent)
- no compensating / alternative Tx
- "basic" data replication and synchronization techniques
- no transaction mobility

Conclusion

- Mobile transactional coordination has to deal with
  - weak connectivity and frequent disconnections
    - asynchronous, dynamic replication with profiling
    - publish & subscribe for data recharging & propagation
  - large-scale replication
  - user interaction / feedback
  - long-running tasks and decentralized commitments
  - real-time constraints
- Commercial approaches mostly neglect these issues
- Main open question: Where to implement the abstraction of disconnections and movements?
  - Do we really need extensions to transaction models or can we model these issues as additional steps of an overall process?
  - How we express costs?