

Replication in Mobile Environments

Heinz Faßbender

Research Establishment for Applied Sciences

Research Institute for Communication, Information Processing, and Ergonomics

E-Mail Address: fass@fgan.de

UNCLASSIFIED – APPROVED FOR PUBLIC RELEASE

Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE 01 DEC 2007		2. REPORT TYPE N/A		3. DATES COVERED	
4. TITLE AND SUBTITLE Data Replication Over Disadvantaged Tactical Communication Links: Replication in Mobile Environments				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Research Establishment for Applied Sciences Research Institute for Communication, Information Processing, and Ergonomics				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited.					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 10	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

What is the Problem?

Data replication among distributed databases occurring over disadvantaged (unreliable, low bandwidth or energy constrained) mobile wireless military communication networks

- extremely limited and highly variable **data throughput**
- **energy constraints**
- **inconsistent** databases

UNCLASSIFIED – APPROVED FOR PUBLIC RELEASE

Different Ways of Solving the Problem

Nr: 3

- Developing a solution in the described environment without considering existing solutions
- **here:**
 - Studying existing solutions
journals, conferences, dissertations, ...
 - Check whether those solutions are applicable in our environment
- **Example:**
 - Dissertation David Howard Ratner:
“Roam: A Scalable Replication System for Mobile and Distributed Computing”

UNCLASSIFIED – APPROVED FOR PUBLIC RELEASE

- **Master - Slave**
one replica: master, all others: slave
slaves are read-only
modifications are only performed with the master
- **Client - Server**
functionality (modifications / updates) of clients improved
multiple inter-communicating servers permitted
no intercommunication between clients
- **Peer - to - Peer**
all replicas are equal
any replica can synchronise with any other replica

- **Master - Slave and Client - Server**
no intercommunication between clients
-> don't get replica from the nearest partner
important position of server
-> if server down, no update for clients
- **Peer - to - Peer**
storing all necessary replication knowledge at every site
-> exceedingly large data structures
-> scaling problems

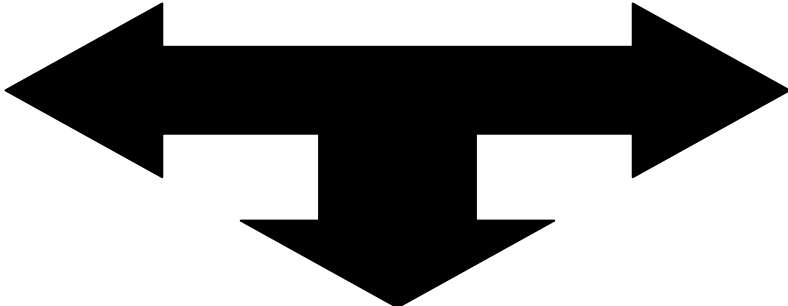
Ward Model [David Howard Rattner]

Nr: 6

- **Wide Area Replication Domains**
- based on a hybrid between client-server and peer-to-peer
- one **ward master** representing the group
- Ward Grouping depends on:
 - Geographic location
 - Expected bandwidth
 - Connection latency
 - Expected network connectivity
 - Network cost
- All ward members are peers

UNCLASSIFIED – APPROVED FOR PUBLIC RELEASE

Ward Example



UNCLASSIFIED – APPROVED FOR PUBLIC RELEASE

Military Application

Nr: 8

- Low-level units, like battalions or companies, that communicate via wireless communication systems, are modelled as a ward.
- Higher-level units, like brigades,... are modelled out of wards.

UNCLASSIFIED – APPROVED FOR PUBLIC RELEASE

Two approaches to achieve global **consistency**:

- **Conservative Approach**

locking, voting, primary-site techniques to prevent conflicting updates

not viable because of disconnection and partitions

- **Optimistic Approach**

concurrent updates and conflicts are rare

allows updates to be performed independently

improving availability, but conflict resolution needed

Application in the Military Environments

Nr: 10

- **Combination** of conservative and optimistic approach?
- Do we need **global consistency**?
- Is the described solution **applicable in military environments**?
- Are the advantages of **Broadcasting** integrated?
- Can **Selective Replication** be applied to reduce the number of replicated information?
ATCCIS: replication by contracts

UNCLASSIFIED – APPROVED FOR PUBLIC RELEASE