



Proactive data replication using semantic information within mobility groups in MANETs

Hoa Ha Duong & Isabelle Demeure
Telecom ParisTech – Institut Telecom



Mobilware 09
April 28-29 2009
Berlin, Germany



Motivation & context

- **MANET (Mobile Ad-hoc NETWORK):**
 - Self configuring network of mobile terminals also acting as routers
- **Network infrastructure may not be present**
 - Too expensive to deploy / to use
 - Travel situation / Unpractical
- **Objective: support data sharing among MANET participants**



■ Illustrative scenario

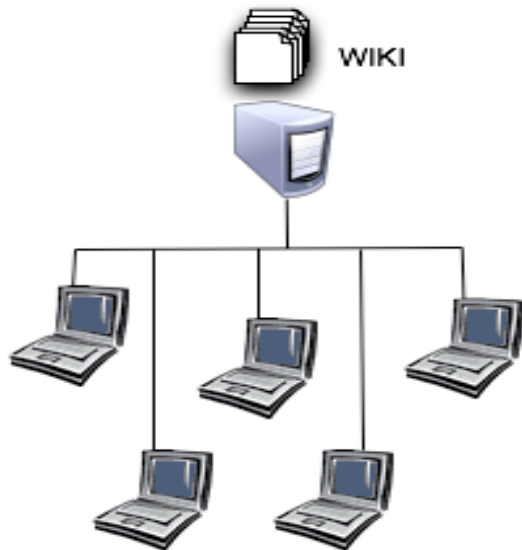
- In a school,
 - Kids have mobile terminals
 - Collaborative edition of a Wiki
- Kids leave on a field trip
- On site
 - They edit the wiki
- Upon return
 - Modifications are integrated



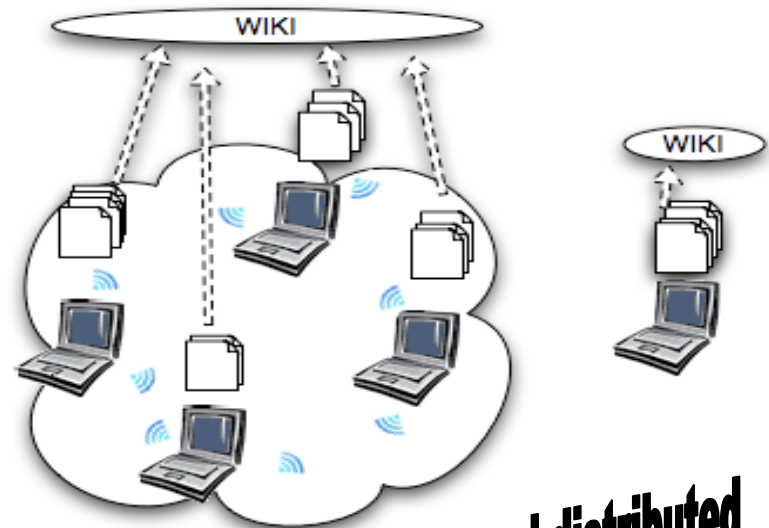
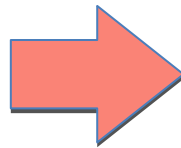
Context and challenges

■ Challenges:

- mobile and volatile terminals,
- limited capacities (battery, bandwidth),
- better adapted to P2P than to client/server



From fixed and centralized



To mobile and distributed

ISSUES

•Functionalities

- Data Sharing
- Data Edition
- Data Search

•SEMANTICS

- Search Service
- Location service

•Properties

- Persistency
- Avallability
- Fault Tolerant
- Efficiency

•REPLICATION

- Replication Algorithm
- Coherence Model
- Coherence Algorithm

•COLLABORATION

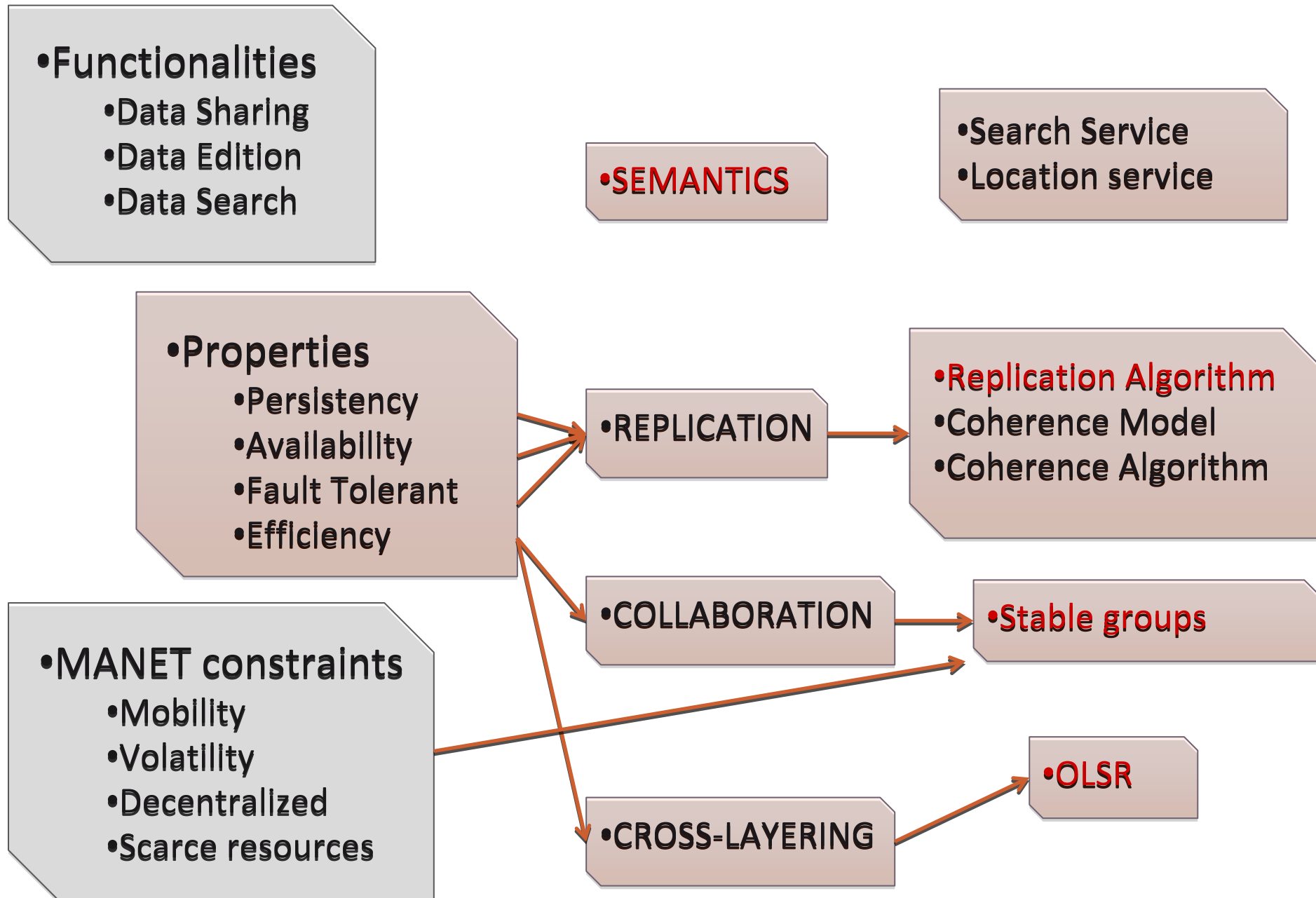
- Stable groups

•MANET constraints

- Mobility
- Volatility
- Decentralized
- Scarce resources

•CROSS-LAYERING

•OLSR





Related work

■ P2P Wiki

- Distriwiki
 - 2007, Ball State University, USA
 - No coherence
- Wooki
 - 2007, Loria, France
 - Large scale with nomadism
- Swooki
 - 2008, Loria, France
 - Large scale with nomadism
- Xwiki Concerto
 - 2007, ANR project, France
 - Large scale with nomadism
- These systems do not address MANET specificities

■ Data sharing for MANET

- adHocFS
 - 2003, Inria Rocquencourt, France
 - Distributed unix like file system
 - Ocaml, non available
- Xmiddle
 - 2002, University College London, UK
 - XML data shared
 - Java, not maintained

■ Data replication:

- work from Hara that is most similar to ours
- but strong assumptions on data access frequency and patterns (suited to sensor networks with cyclic data exchanges)

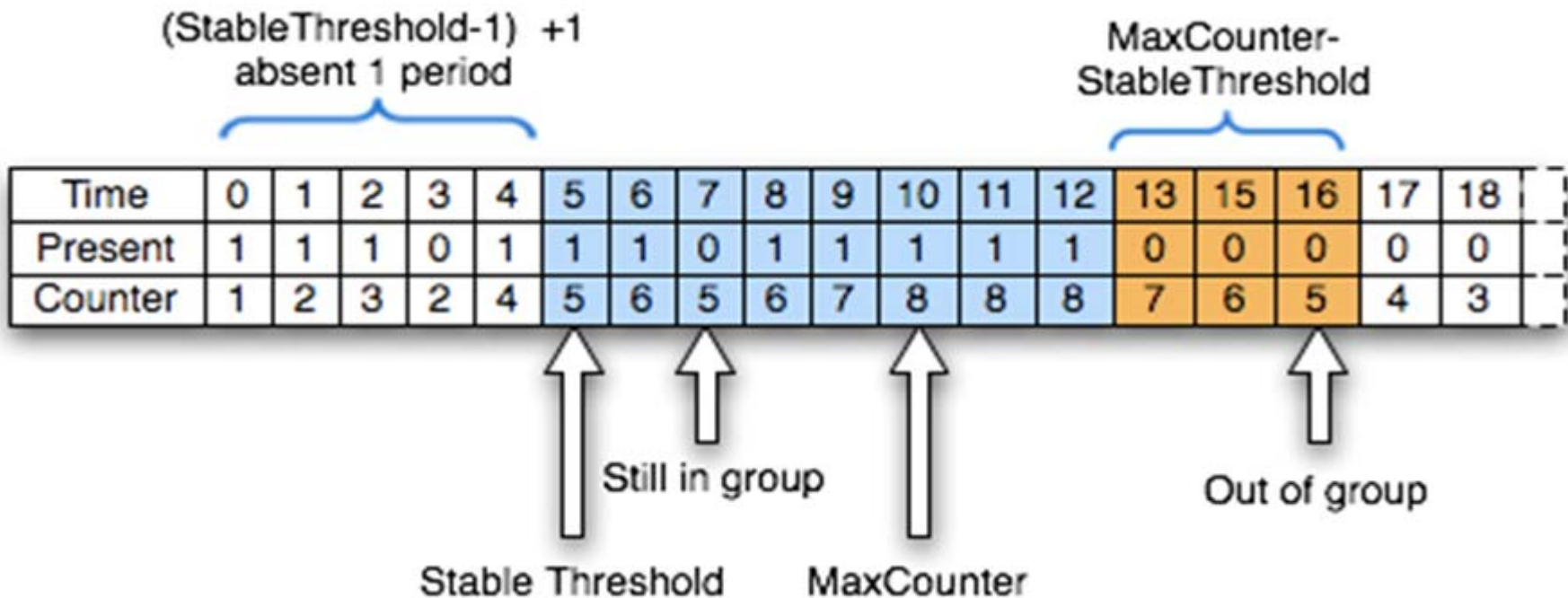
■ While they suit their purposes these systems do not fulfil our requirements



Proposal: Stable Group Creation

- **Cross-layering: routing table from OLSR**
- **Based on past presence**
 - Peer A looks at routing table
 - Associates counter to each other peer P
 - If P present : counter increases, else counter decreases
 - If counter > stableThreshold, P is in stable neighbour

Here: StableThreshold=5. maxCounter = 8





How does it compare to existing algorithms?

■ GPS based

- Predict accurate trajectory: computation heavy
- Centralized: scales?
- GPS dependent

■ Multiple route based

- N broadcast messages to advertise neighbours: scales?
- Must maintain graph

■ Distance based

- Based on routing graph => 0 message if proactive routing
- Does not deal with disconnections

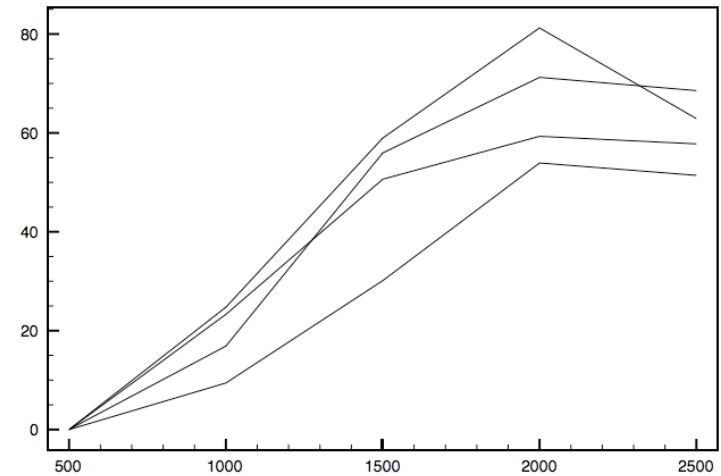
■ Our proposal

- 0 message exchanged
- Scales
 - As much as OLSR
 - No extra messages
 - Simple computation
- Thresholds depend on the network dynamicity
- OLSR dependent
 - Would work with other proactive routing protocol

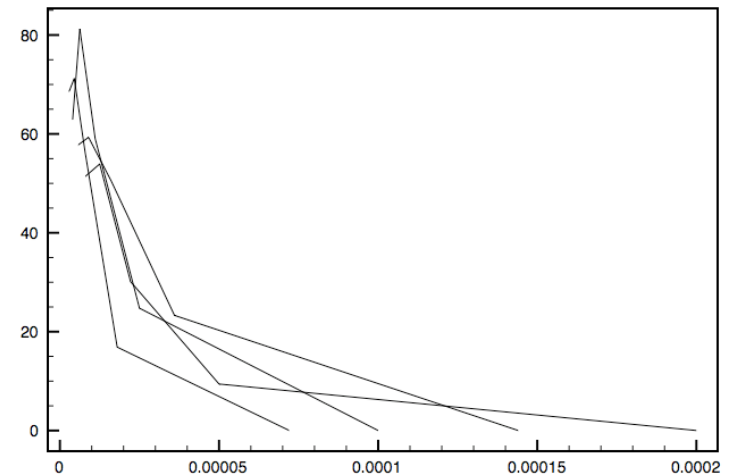


Evaluation

- **Nb message = 0**
- **We evaluate accuracy, in NS3**
 - Create simulated mobility group
MBG: nodes sticking together
 - Execute algorithm to create group
SNG
 - Accuracy: do the 2 groups match?
- **Observation:**
 - Accuracy = F(size of simulated area, node density)
 - Small area: sustained connectivity even if peers not walking together
 - **We detect all the prearranged neighbours**
 - If density high, we detect nodes that are not part of the MBG (because of high connectivity)



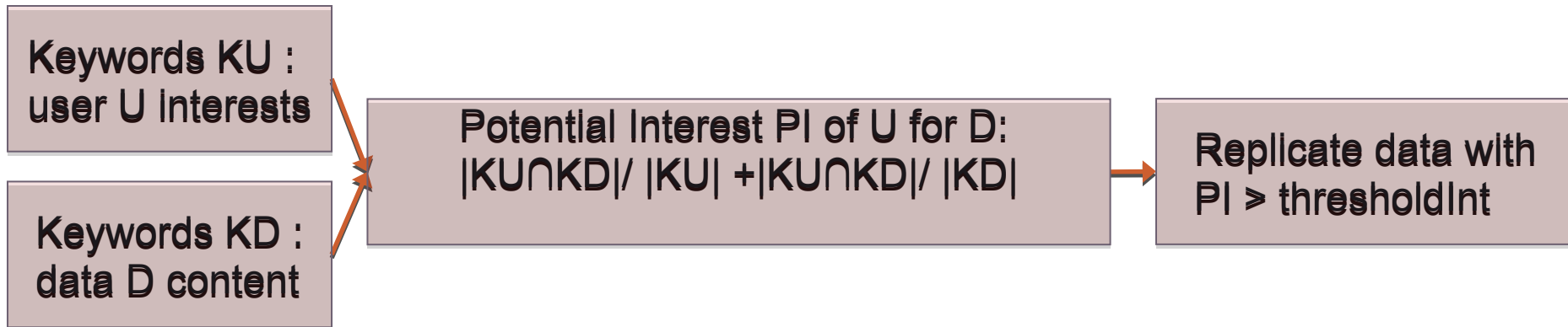
X= area length, Y=accuracy



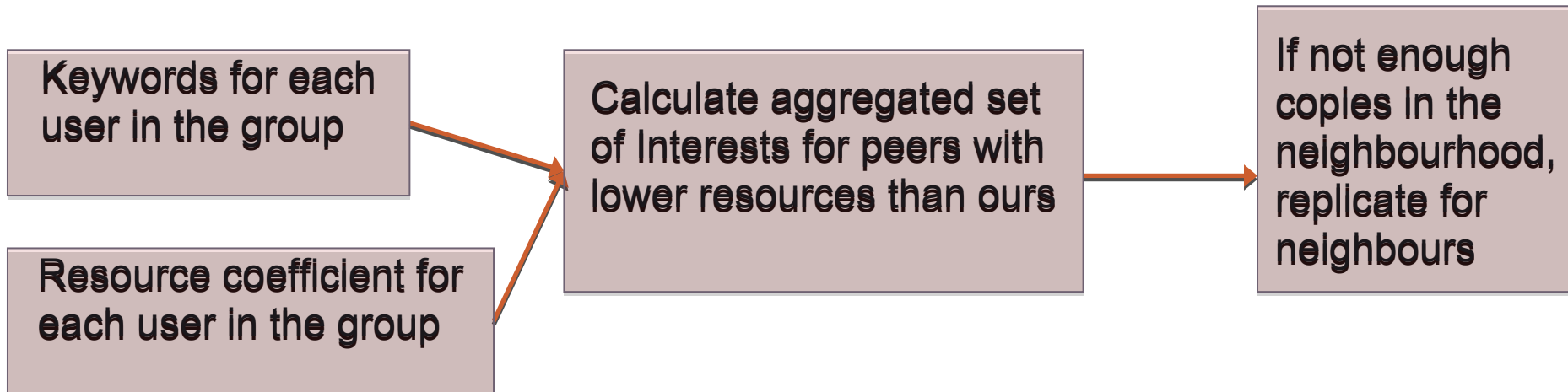
X=node density, Y=accuracy

Proposal: Collaborative Data Replication (1/2)

Match user to data, based on interests



In a stable group, replicate for neighbours





Proposal: Collaborative Data Replication (2/2)

■ Within a stable neighbourhood

- Interests and resource coefficient are exchanged
- Aggregated interests are computed

■ When a new data is created

- It is advertised through the network with its keywords
- 2 phases algorithm:
 - Peers compute their Potential Aggregated Interest PAI
 - If $PAI > \text{threshold}$, peers replicate the data
 - If not enough replicas
 - Other replicas are created in the neighbourhood



Evaluation

- **Reasonable messages cost: if size of network= M , size of stable group= N**
 - $N(N-1)$: to exchange interest & resources info within stable group
 - $M-1$ msg: (or 1 broadcast) to advertize creation of data
 - $N(K+1)$ msg: if K replicas created within a stable group

- **The algorithms were tested in the prototype of the IST-POPEYE project.**

- **Difficulties to proceed with simulations**
 - Replay traces?
 - Traces from distributed files system: do not log semantics
 - Traces of wiki (eg: wikipedia dump): do not log read accesses
 - Simulate random accesses?
 - Proposal based on predicting non random accesses
 - Simulate non random accesses?
 - Use interests & metadata to decide which data the simulated user accesses
 - Done by our system
 - Biased results
 - Solution: collect our own traces ?



Proposal - other issues not adressed in this paper

■ Coherency

- Open/close within reach, eventual consistency overall
- Coherency algorithm: commutative replicated data type Treedoc
 - Designing a commutative replicated data type for cooperative editing system, N. Preguiça and M. Shapiro, 2008

■ Interests learning

- Based on access patterns
- Memorize each time a keyword is accessed
- Keywords accessed often become new interests

■ Search service

- Keyword based: associates set of keyword to data ID
- Fully replicated on OLSR MPR (cross-layering)

■ Location service

- Associated data ID to host ID
- Fully replicated on OLSR MPR (cross-layering)



Conclusion

■ We have proposed:

- An algorithm to build stable neighbourhoods based on past stability, rather than on proximity.
- The use of semantic information to manage data and calculate
 - interests and do proactive replication.
 - aggregated interests and do collaborative replication.
- The use of accesses patterns to automatically gather semantic information:
 - Automatic learning is not new but we have not found any use of it in data caching.

■ Ongoing work

- Algorithms validation
 - Test on prototype
 - Simulation with NS3
- Implementation
 - A nomadic wiki taking into account the specificities of MANETs
 - On top of Transhumance
 - Middleware for MANet, available on sourceforge
 - Built on top of OLSR



Transhumance middleware for MANETs

- **Supported by the ANR (French national Research Agency)**
 - Partners: Orange Labs, Thales Communications, 3iE, CODETIC, Telecom ParisTech
- **Prototyped on Nokia 770 under Linux OS**
- **Source code**
<http://sourceforge.net/projects/transhumance/>
- **More (including video clip of demo) at**
<http://www.infres.telecom-paristech.fr.fr/~demeure/TRANSHUMANCE>



Thank you ! Questions ?



<http://www.telecom-paristech.fr/~demeure/TRANSHUMANCE>