Transhumance

A power-sensitive middleware for data sharing on mobile ad hoc networks

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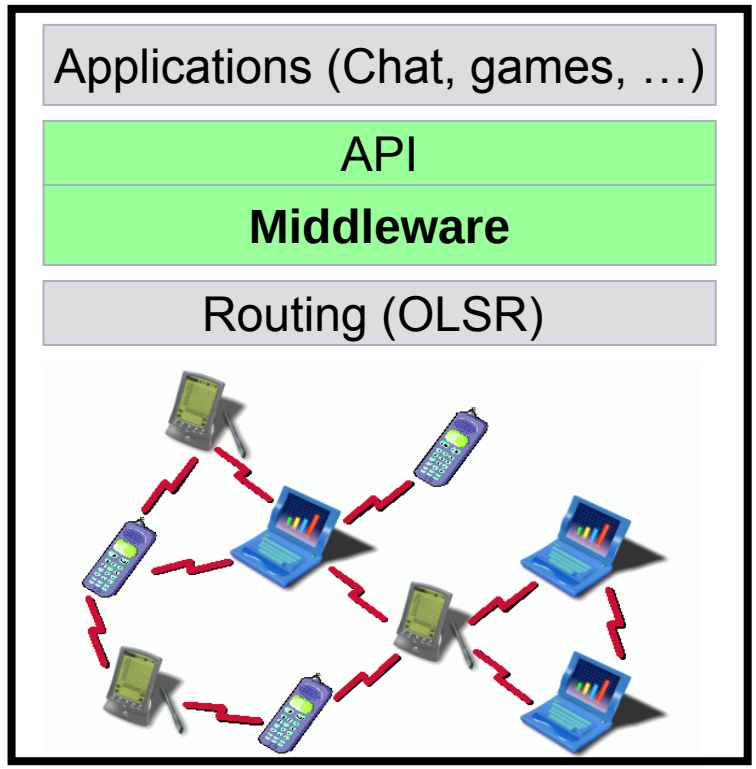
Outline

- Context
- Related work
- Middleware architecture
- Groups
- Communication
- Data sharing
- Security
- Power awareness
- Conclusion

Context

- Mobile Ad hoc NETwork (MANET)
  - Wireless multi-hop communication
  - No pre-existing infrastructure
  - Spontaneity
  - Dynamic topology
- Need for a middleware
  - Facilitate application design and deployment
    - APIs
  - Provide high-level functionalities
    - Event, group, presence
  - Hide MANETs complexity
    - Mobility, topology
  - Data sharing
  - Security features
  - Energy-awareness
- The middleware relies on the routing layer
  - Numerous existing protocols
- More specifically …
  - Small MANET (20 nodes)
  - Pedestrian mobility
  - Pocket PC devices
  - Only peer-to-peer applications



Related work

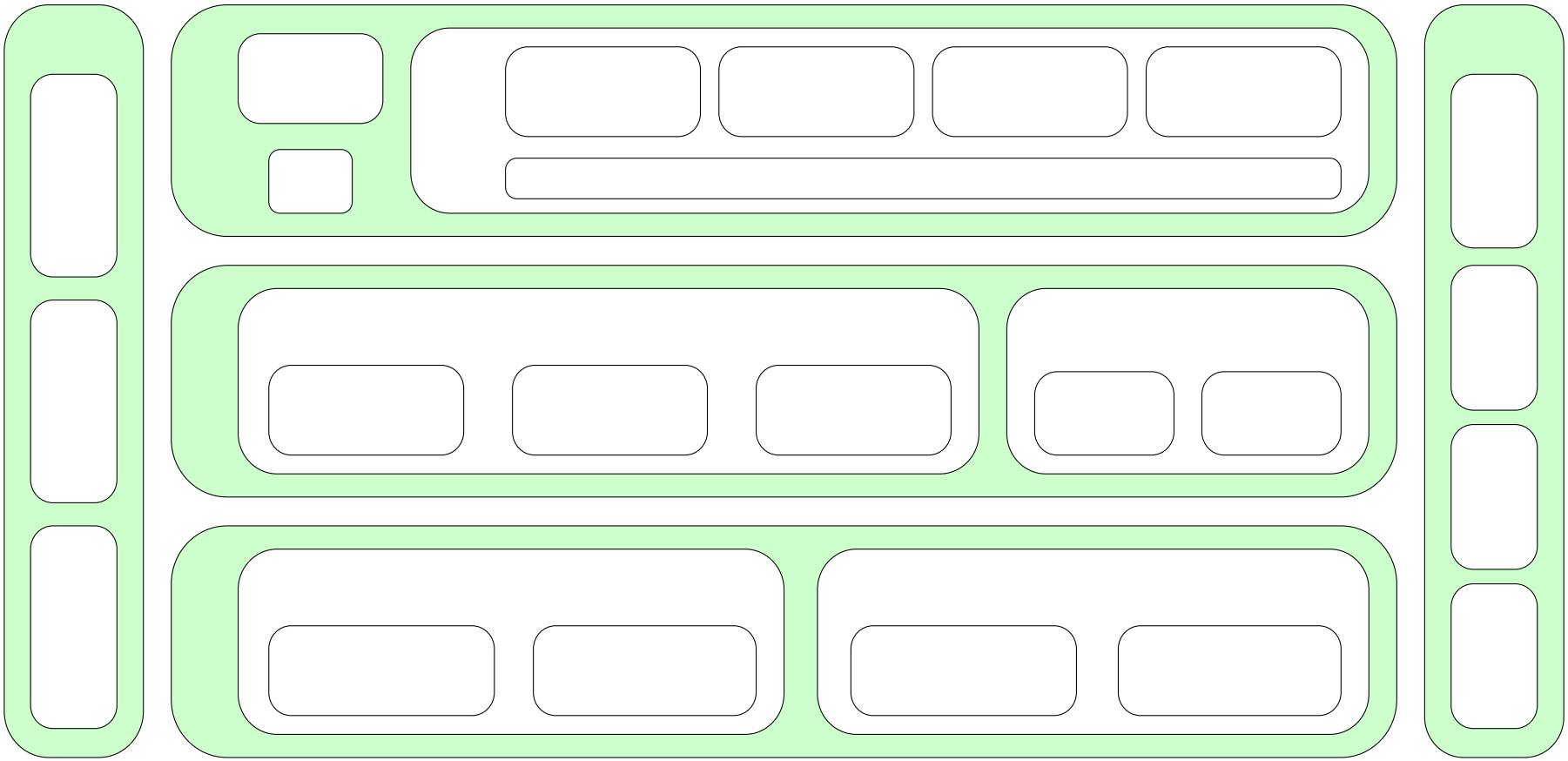
- Existing middleware for MANETs
  - Proem (focuses on Personal Area Networks)
  - Steam (focuses on Event-based communication)
  - JMobiPeer (JXTA extension for MANETs)
  - XMiddle (structured data sharing over MANETs)
- We also studied about 10 other middleware

- Missing critical functionalities
  - Security
  - Energy-awareness
- These two features are clearly identified by existing middleware but are not addressed

- Transhumance addresses these missing functionalities

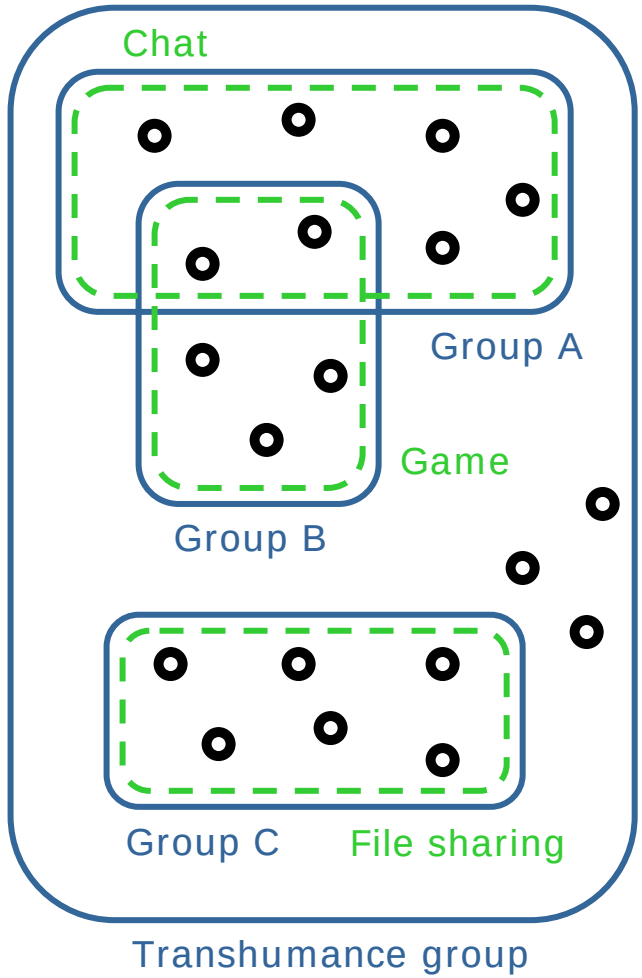
Middleware architecture

Transhumance



Groups

- Basic entities of Transhumance
- Communities of users sharing common interests
  - Interest = service, topic
  - No geographical limitations (proximity)
- Each application is associated to a group
  - Application users automatically belongs to the associated group
- Secured groups
  - Access rights
  - Cooptation for new member
- A peer may belong to multiple groups
- Group discovery mechanism

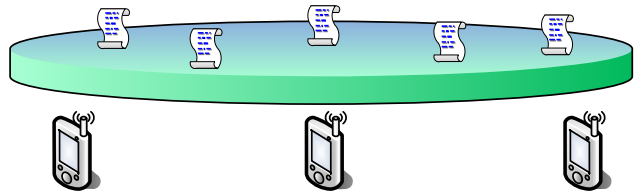


Communication

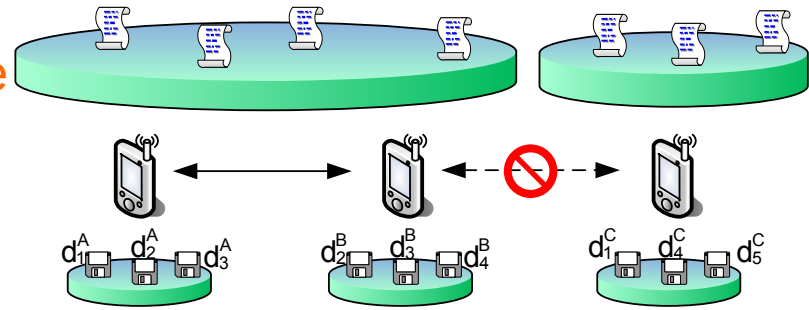
- Routing protocol is not part of the middleware
  - Relies on OLSR - Exploits topology information
- Transport protocol
  - Non-connected protocol
  - 3 modes
    - Simple: UDP-like, no delivery guarantee
    - Acknowledged: not connected but messages are acknowledged
    - Secured: messages are ciphered and acknowledged
- Event management
  - Event = structured message
    - Fields = Type, subject, ID, SenderID, destination, content
  - Publish/subscribe model
    - Filtering mechanisms for subscribers
  - Emulate multicast
    - Multiple destinations, support group communication
  - Persistent events
    - Delivery guarantee and persistence during a determined period

Data sharing: motivations

- Data sharing definition
  - Collaborative work on common data
  - Data shared on a virtual storage space accessible by all users → sharing space
  - Sharing space ≡ Transhumance group



- Challenges in MANET
  - We choose to use no server
    - The sharing space is split up amongst nodes
    - The view of the sharing space may be partial
  - Network partition & unpredictable node disappearance
    - Data must be replicated
      - Persistency
      - Accessibility
    - Replicas must be kept consistent
  - Protocols must be energy aware



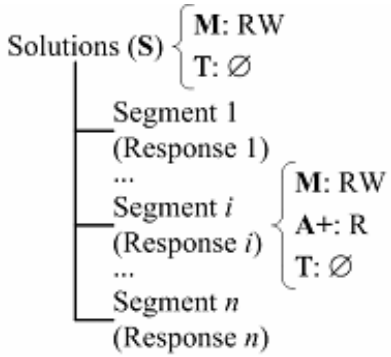
Data sharing: main features

- Replication
  - Transhumance combines 2 replication approaches:
    - Selfish: Users replicate data they access → good accessibility
    - Collaborative: Manage the replicas for each data in neighborhood
      - More efficient usage of limited resources
      - Analysis of user behavior (evaluation of user needs)
      - Replication criteria: local needs, neighbor needs, number of existing replicas and level of energy
  - Data persistency settings:
    - Sharing space level: Lifetime (*temporary*, *group-linked* or *persistent*)
    - User level: A user may demand to keep permanently a local replica
- Consistency
  - Optimistic approach
    - Allow concurrent modifications → divergences
    - Require reconciliation → potentially expensive operation
  - Transhumance improvement
    - Spilt data into semantically independent parts called segments
    - Avoid easy-to-detect conflicts (with 1 hop neighbors)
    - Begin/end of data modifications are noticed to neighbors that should not modify the same data during this period

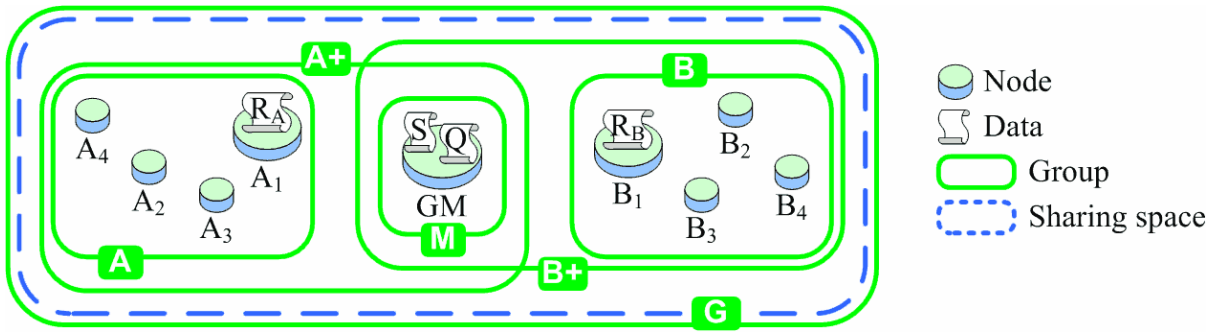
Security

- Authentication
  - Deal with the admission of new members in a group
    - Cooptation principle
    - Several modes of secret transmission depending on the context
  - Verify the membership of the node to a group
    - A group key identifies the group
    - The group key is defined by the group creator
    - Once in a group, all the members are considered as trustful
  - Innovations
    - Decentralized model
    - Group authentication

- Access Control
  - Access rights definition
    - For the groups known by the user
    - For each data segment
    - Inheritance in the segment tree



  - Scenario
    - A_1 shares the data R_a in G
    - A_1 defines R_a access rights (for A, A+ and G)
    - A signature preserves data and access rights integrity

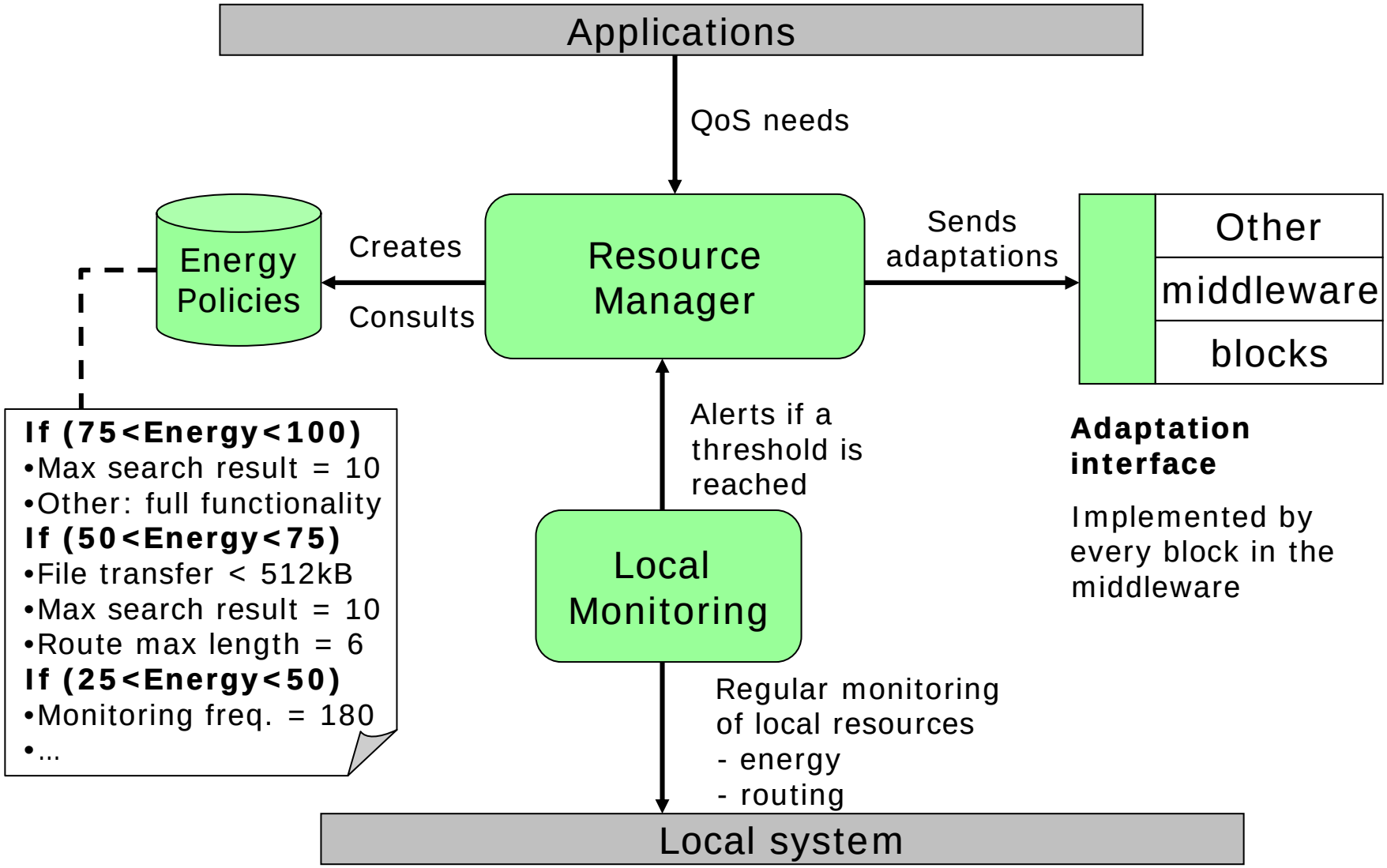


  - Innovation
    - Proposal of a non-binary access control system

Power awareness

- Motivations
  - Handheld mobile devices have limited battery capacities
  - Middleware = additional source of energy consumption
- Objectives
  - Control the middleware energy consumption
    - And increase the peer network lifetime
  - Preserve QoS provided to the applications
    - Reliability, performance, security
- **Control the middleware consumption by adapting it to the application needs and to available resources**
- Approach: adaptability
  - Each middleware block is adaptable
  - Adaptation levers: alternative algorithm, parameters, behavior
    - Discovery depth, number of results/query, update rate
  - Policy-driven
    - Set of conditions/adaptations based on energy level
  - Adaptations meet QoS needs
    - Attempt to minimize the impact on QoS

Power awareness



Conclusion

- Contributions
  - Complete middleware for MANETs
    - Communication features, group structure, API for applications
  - Data sharing oriented
    - Support for data replication, discovery, consistency
  - Improve the existing middleware by adding
    - Security features: authentication, access control
    - Power-awareness: adaptation of the middleware behavior to the available energy
- State of development
  - The middleware has been completely specified
  - It is now under development (~ 40% accomplished)
  - Environment: Nokia 770, Linux OS, C++
  - Some tests are carried out on a MANET emulator
- Perspectives
  - Tests under the MANET emulator the different functionalities
  - Tests in real conditions in November
    - About 20 participants

Thank you for your attention

Do you have some questions?