MIDDLEWARE GROUP
COMMUNICATION MECHANISMS IN M2M ENVIRONMENTS

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OUTLINE

- General problems to address in M2M
- Requirements to fulfill addressing these problems
- Goal definition
- Specific problem to attack
- Proposal
- Future works
GENERAL PROBLEMS TO ADDRESS IN M2M

- **Base-station overload**
  - In M2M communication a huge number of M2M devices may try to connect at the same point in time [1]

- **Energy consumption of devices**
  - M2M communication involves resource-constrained devices, which have low power resources

- **Heterogeneous applications**
  - M2M applications must be aware about the events detected by other applications

Avoid the base-station overload

- If overload occurs, the communication with all requested devices will not be possible, damaging the M2M communication as well as the traditional Human-to-Human (H2H) communication

Prolong the lifetime of the constrained-resource devices

- Without an appropriate use of the devices’ energy, these devices will need human maintenance, which increases operational costs and reduce the network lifetime
Reduce the application programming complexity and enable high level of abstraction

- Reduce the costs with programming and enabling the interaction of different applications from different stakeholders

Manage multiple (heterogeneous) application interests

- The M2M heterogeneity implies in multiple data types
- Applications with different amount of traffic, frequency of transmissions and delay tolerance

Be adapted dynamically according to the level of resources available in the devices involved in the communication
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<td><strong>R5</strong>: Reduce the application programming complexity and enable high level of abstraction</td>
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Main goal:
“Design a dynamical middleware component to satisfy multiple application interests, managing mechanisms that save energy and avoid base-station overload”

The potential mechanisms to be used:
- Data-aggregation
- Sleep-schedule
- Uplink-schedule
- Signaling-aggregation

The management of these mechanisms:
- Takes into account the heterogeneous applications requests, the base-station overload indicators and the M2M devices’ status
SPECIFIC PROBLEMS TO ATTACK

- A solution involving these four mechanisms should consider how each mechanism affects the others

- Data-aggregation vs Sleep-schedule
  - The delay problem
    - Delay is a special issue considering the following applications: real-time monitoring, including e-healthcare, smart grids, environmental monitoring, industrial automation, and so on [10].
    - The delay caused by the sleep added to the delay caused by the data-aggregation can break the application tolerance
  - The multi-hop problem
    - In a multi-hop scenario, the sleep-schedule mechanisms can break the data-aggregation path

SPECIFIC PROBLEMS TO ATTACK

- Data-aggregation and sleep-schedule versus Signaling-aggregation and uplink-schedule
  - Synchronization problem
    - Without synchronization the next transmission could be scheduled to a period that the device is in sleep mode, which means that no transmission will occur and no signaling message will be sent
Input parameters

Resource descriptors

Overload indicators

Mechanisms
- Data-aggregation
- Sleep-schedule
- Uplink-schedule
- Signaling-aggregation

Configuration profile assignment

Base-stations

Set of devices

Cluster

Configuration Profile

Communication Manager Component

Application

Requests and description Module

Request Resolver

Semantic Device Description Directory

Multiple Request Control

Data requests
Queries and preferences
Data type, aggregation function (max, min, avg), delay tolerance

Hardware and data characteristics
Wireless interface, battery level, position, memory and CPU capacity

Traffic load
Number of traffic sessions, number of devices attached

Resource descriptors

Overload indicators

Base-stations

Mechanisms
- Data-aggregation
- Sleep-schedule
- Uplink-schedule
- Signaling-aggregation

Configuration profile assignment
Verify the compatibility level between the received request and the active older ones

Receive a data request and filter the S3D, returning a temporary set of nodes able to satisfy the data request

Maintain the consistency of information about the M2M devices
Tasks:
1) Definition of the definitive set of devices;
2) Selection of the configuration profile that will be assumed by the communication mechanisms.
Group definition metrics and profile configuration

- Several metrics can be used to select the devices that will communicate
  - E.g.: Best level of energy, best location, best sensor accuracy, best bandwidth

- Several configuration profiles can be assigned to the mechanisms
  - E.g. 1: Configure the data-aggregation to have low energy consumption and high delay. Simultaneously, the sleep-schedule can be configured to generate high energy consumption and low delay.
  - E.g. 2: Configure both mechanisms to have low energy consumption and high communication delay
FUTURE WORKS

- Study other mechanisms that could be added to the 4 mechanisms

- Design of the rules/polices for the decision tasks

- Study the overhead impact of the proposed component versus the benefits