MIDDLEWARE IN WIRELESS SENSOR NETWORKS (WSNs)

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OUTLINES

- Introduction
- The Major Components of WSN-Middleware
- Reference model for Middleware in WSN
- Middleware common services
- Conclusion
Middleware is a bridge between small in size, complex in architecture and unique in characteristic sensors and high level systems with high quality and concise by nature demands.
The Major Components in WSN-Middleware

WSN-Middleware Component

- Programming Abstraction
  - Abstraction Level
- System Services
- Runtime-Support
- QoS Mechanism
  - Interface Type. e.g. XML, Rule based, RDF...
REFERENCE MODEL FOR MIDDLEWARE IN WSN
REFERENCE MODEL FOR MIDDLEWARE IN WSN
MIDDLEWARE SERVICES

- Code management
- Data Management
- Resource and information discovery
- Resource management
- WSNs Integration
CODE MANAGEMENT

Task (e.g., Fire detection)
**CODE MANAGEMENT**

64 bit long

**Pros and Cons**
1. Complex but small in size
2. Communication cost is high
3. Resource dissipative
4. Requires homogeneity
DATA MANAGEMENT

Data Acquisition

- Event based data model: eg, Mire
- Query Based Model: eg, TinyDB

Data Processing

- Centralized processing
- Node Level processing
- In-Network processing

Data Storage

- External storage
- Internal storage
- Data-Centric storage
DATA PROCESSING

Middleware uses three approaches for data processing:

- Centralized Approach
  - *All data sent to the sink for processing*
  - *High communication requirements*

- Node Level Approach
  - *Data is, primarily, processed in nodes then sent to the sink for further processing.*
  - *High communication requirements*

- In-network distributed Approach
  - *Data transmitted whenever the need necessitate so*
  - *Data Fusion/Aggregation*
  - *Data Calibration*

- Concerns:
  - *Communications within the network*
  - *Aggregation module update*
DATA ACQUISITION/PROCESSING/STORAGE: PUB/SUB PARADIGM “MIRES”

Middleware Layer

Sink

Sensor I

Sensor II

Sensor III

Aggregation

Aggregation policy/
Maintaining Routing
tables/
Data storage
chosen scheme
DATA STORAGE

Middleware uses three approaches for implementing data storage:

- **External storage**
  - ✓ *Negligible inquiry cost*
  - ✗ *High communications*

- **Local storage**
  - ✓ *Reduce communication cost*
  - ✗ *High inquiry cost*

- **Data centric storage**
  - ✓ *Trade-off between the two previous approaches*
Resource and Information Discovery

- Resource Discovery: The resource discovery returns the data type a discovered node can provide, the modes it can operate in, and the transmission power level of a sensor node.

- Information Discovery: Returns information about the network topology, the network protocols, and the neighbours and the locations of the discovered node.
RESOURCE AND INFORMATION DISCOVERY

Two main functions:

1. Providing underlying network information to applications that are required to be reflective or adaptive.
2. Providing the underlying network for the purpose of supporting adaptive resource management services.
RESOURCE MANAGEMENT SERVICES

- Resource management services
  - Cluster service
    - Provides member re-allocation service that redefine the cluster. eg. EnviroTrack, MiLAN, SINA, etc.
  - Schedule service.
    - Provides node wakeup/sleep scheduling.
  - Data routing service
    - Implementing multi-hop routing protocol at the middleware level.
    - Overlay maintenance and routing mechanism support. eg. Use Pub/Sub mechanism.
    - Switching/adaption “between” different routing protocols. Impala, MiLAN.
WSNs Integration

- WSN needs to be integrated into other network infrastructure, such as the Internet.
- For WSN middleware there are two related tasks:
  - Task coordination
  - Data sharing.
- Proxy server is a common mechanism for integration implementation.
  - Client access non-standardized services in WSN by inquiring a proxy server which translates the standardized protocol to the proprietary protocol, and vice versa.
WSNs Integration

Format Conversion

Packet

Application/sensors

MiLAN API

MiLAN

Data channels
Remote network control
Bluetooth-specific local network control
L2CAP
HCI
Bluetooth stack
Bluetooth network

Data channels
Remote network control
802.11-specific local network control
TCP/UDP
IP/Ad Hoc routing
802.11 MAC
IEEE 802.11 network

Data channels
Remote network control
Network-specific local network control
Transport
Routing
MAC
Physical
Generic network
Example of Middleware: Mires
EXAMPLE

- GSN
- SensorMap

CONCLUSION

- As the gap is increasing between the WSNs and the application attempting to access it, the need for a way to glue them increases.
- The research on middleware in WSNs is a green field as no solution thus far is satisfactory at all levels.
- Any attempt to have full use of any given WSNs will not be completely successful without a well designed middleware.
THANKS

Q&A