Title
Mote Herding for Tiered Wireless Sensor Networks

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Mote Herding: A system architecture for Tiered Wireless Sensor Networks

Mote Herding

Tiered systems: Collections of motes and microservers working together

Mote Herding explores guidelines to clarify how services should be developed in tiered systems

Architectural abstractions
- **Flock**: a collection of motes that connects to a microserver via a multihop tree
- **Shepherd**: a microserver responsible for a single flock. Shepherds connect to each other using IP-based routing over 802.11
- **Herd**: the collection of flocks and shepherds that forms the entire mote/microserver network

Design Principle
Shift system complexity from motes to microservers for those operations that require distributed decision making on the motes

Corollaries:
- **Centralize** decision making on a microserver to make decisions based on a complete set of information
- **Reduce** volatile state required for system functionality on motes
- **Utilize** computational and communication resources on microservers to support more complex functionality
- **Program** a significant part of the system in a familiar and resource-rich 32-bit environment

Mote Herding Services

**Flock Services**
- Operate on a **flock** under supervision of a **shepherd**
- Hybrid: code resides on motes and microserver
- Can use other services in the same flock but cannot interact with motes on other flocks
- Emphasize master-slave relationship between microservers and motes

Flock Foundation service: Mote Routing
- Provides bi-directional routing from motes to their shepherd
- Centralized protocol: shepherd makes all routing decisions
- Lack of distributed decision making on motes improves stability and consistency

**Herd services**
- Operate on the entire network
- Code resides only on microservers
- Interface to the mote network via appropriate flock services
- Allow for distributed and collaborative decision making between microservers

Herd Foundation service: Microserver State Replication
- StateSync: a reliable state synchronization protocol
- Allows state sharing on the microserver level for information pertaining several flocks
- Provides each microserver with a global state view

Service Details and Performance

**CentRoute**
- **Centralized** routing protocol based on source routing
- Motes broadcast beacons only when they wish to join a tree
- Any motes attached to the tree forward join beacons towards shepherd via unicast
- Shepherd picks best path using an ETX metric and sends a unicast reply to the mote
- Mote attaches to shepherd and uses the last mote on the reverse path as its parent
- Multi-shepherd ambiguities resolved on microserver network

**DataRel**
- **End-to-end** mote data reliability protocol
- Can deliver 100% to the data at up to 30% link failure rates
- Low buffer usage and complexity compared to hop-by-hop protocols (mDTN)

**ResDisc**
- **Resource Discovery** herd service based on three subservices
- **Registration protocol** registers mote resources with shepherd
- **Resource caching export** local flock resources and imports remote flock resources
- **Query resolution** replies to client queries based on information from resource caching

**Future Work**
- Implementing more services (data replication, tasking, system monitoring)
- Implement a coordinated imaging application using Cyclops and larger more powerful cameras

**The CentRoute phased-join operation**