Synchronization with Guarantees

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Goal and Motivation in the Context of Ad-Hoc Networks

Goal: Find efficient algorithms that provide tight and deterministic time bounds in ad-hoc networks

Use of synchronization
- fusion of distributed sensor data
- coordination among distributed actuators
- energy-efficient communication

Peculiarities of ad-hoc networks
- no configuration or infrastructure
- stable connectivity cannot be assumed
- energy is a scarce resource

Advantages of guaranteed bounds
- unambiguous combination of time information
- guaranteed data-fusion results
- fail-safe state if bounds drift too far apart

Results

Scenario

Network of heterogeneous nodes

GPS receiver
NTP server

Model

Corresponding event chart

Path-based analysis

Basic principle

Duration 1800s, 50 nodes in a square with edge length $x$
- each node has constant clock drift $p \in [−100ppm, 100ppm]$,
- nodes communicate with all reachable neighbors $c$ times
- $x$ source events occur at randomly chosen times and nodes
- we are interested in the average gain of using backward paths

<table>
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<tr>
<th>$x$</th>
<th>$c$</th>
<th>average # of comm</th>
<th>average gain</th>
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Simulation

Path-based analysis

Work in Progress

- investigate whether the improved algorithm is generally optimal
- extend simulation framework: varying drifts, node mobility, and communication patterns
- adapt simulation framework to internal synchronization
- show worst-case optimality of simple algorithm for internal synchronization and find generally optimal algorithm
- implement and compare the algorithms on the BNode platform

Related Work