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SYS5: Sympathy for the Sensor Network Debugger

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Sympathy for the Sensor Network Debugger

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Problem: Debugging Sensor Networks is Difficult

Challenges

- WSN debugging is challenging
 - Minimal resources, limited visibility, & unpredictable environmental interactions
- Sympathy is deployed at **James Reserve** and in the lab, and has detected many **hard to track down** failures; e.g.
 - Detected a **routing loop** caused by bug in routing layer
 - Detected **congestion** caused by dense neighborhoods

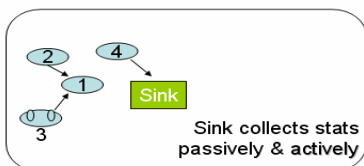
Contributions

- Identified **metrics** and **analyses** that help programmers detect failures and correlate events into the **root causes of bugs**
- Insight:** Insufficient data delivery => Failure
 - For a large class of applications (defined below)
- Small step towards autonomous robustness
 - What are the limits to system self repair?
 - How can we **generalize** across conditions, deployments, and systems?

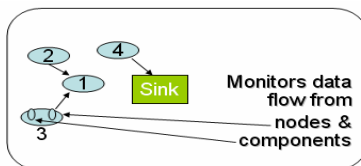
Proposed Solution: Sympathy collects metrics to identify and localize failures

How It Works

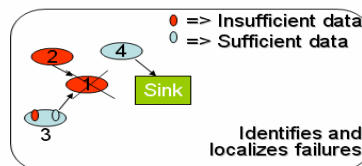
1) Nodes periodically send selected metrics to a sink



2) Sink identifies failures in data throughput, and

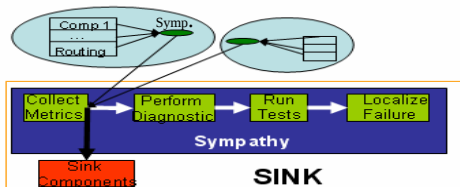


3) Sink analyzes the metrics to determine the cause for data interruption



Identifying Failures

- Initial model: Applications that collect node data at a sink
 - “Regular” data exchange required; interruptions are unexpected
 - Generalize for future work
- Insufficient data delivery => Failure**
 - “Insufficient” defined by components
 - Detect by continuously monitoring collected metrics and data



Statistics Collected

Node Statistics	
Routing Table	(Sink, next hop, quality) tuples.
Neighbor List	Neighbors and associated ingress/ egress
Time awake	Time node is awake
#Statistics tx	Number of statistics packets transmitted to the sink
#Pkts Routed	Number of packets routed by the node
Component Statistics (tx for each component on a node)	
#Pkts comp rx	Number packets component has received
#Pkts comp tx	Number packets component transmitted
Last timestamp	Timestamp of last data sample stored by comp

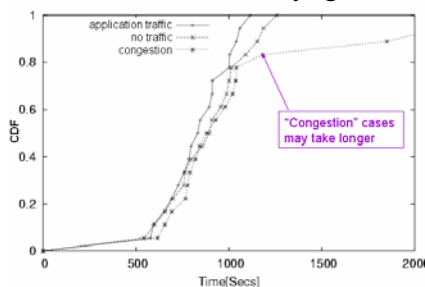
Localizing Failures

- Determining **why** data is missing
- Physically narrow down cause
 - E.g. Where is the data lost

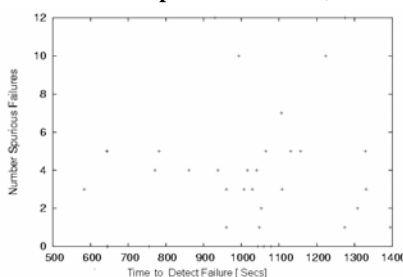


Results

Time Detect Failure, Varying Traffic



Number of Spurious Failures, No Traffic



Sympathy Added Overhead, Varying Statistics Period and Traffic

