

Delay Tolerant Networking for Sensor Networks

Andrew Parker, Athanasios Stathopoulos, Jeremy Elson, Lewis Girod, Ning Xu, Alberto Cerpa
Ramesh Govindan*, Deborah Estrin

CENS Systems Laboratory, UCLA - <http://www.cens.ucla.edu/>

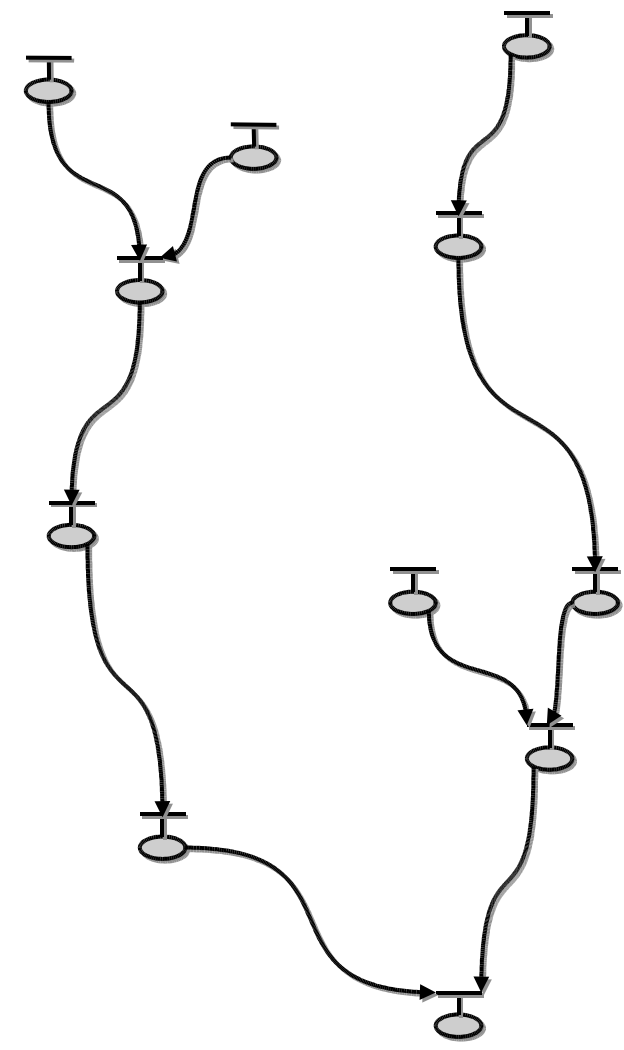
*Embedded Networks Laboratory, USC - <http://www.enls.usc.edu/>

Delay Tolerant Networking Technologies Are Key to Many Sensor Network Applications

Seismic Array

- Reliable delivery despite *long, lossy paths*

Nodes can be hundreds of meters apart.

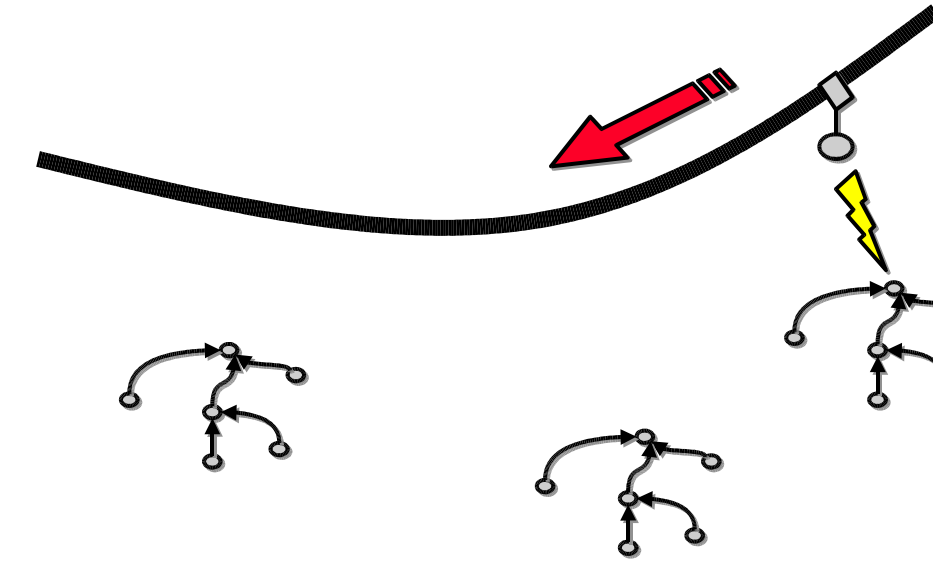


CENS Application Drivers

Data Mule / NIMS

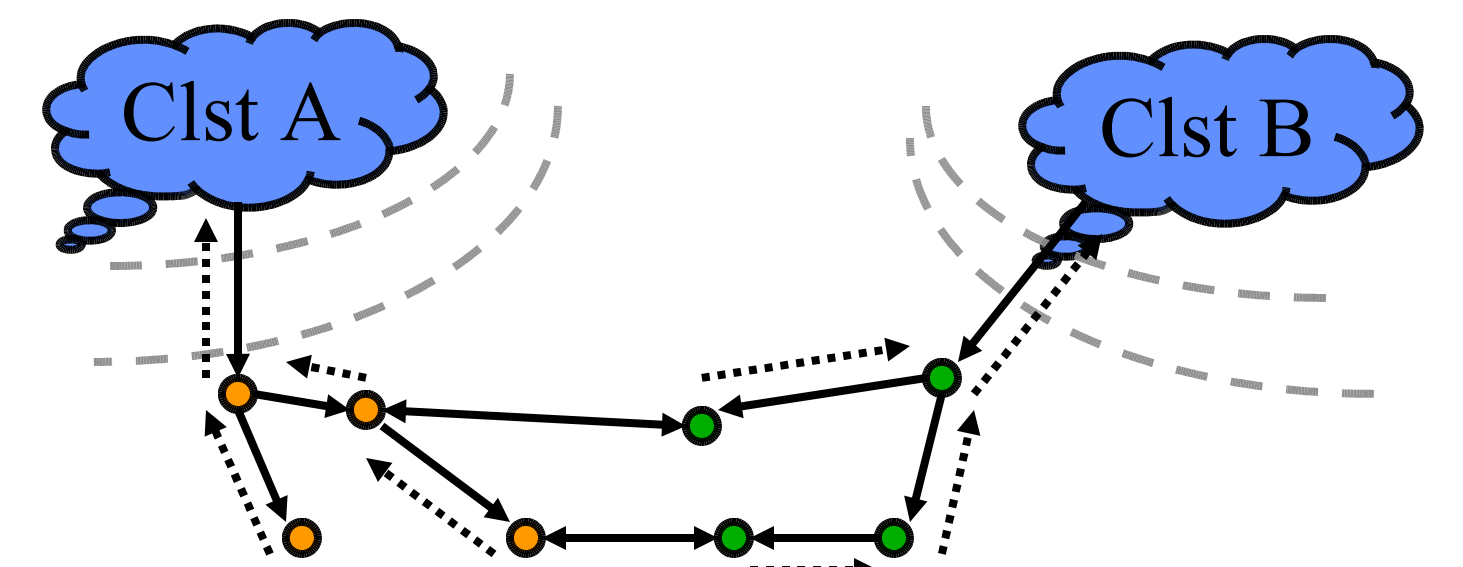
- Reliable deliver despite *mobility based link disruption*

Connectivity to other clusters only via Data Mule / NIMS node.



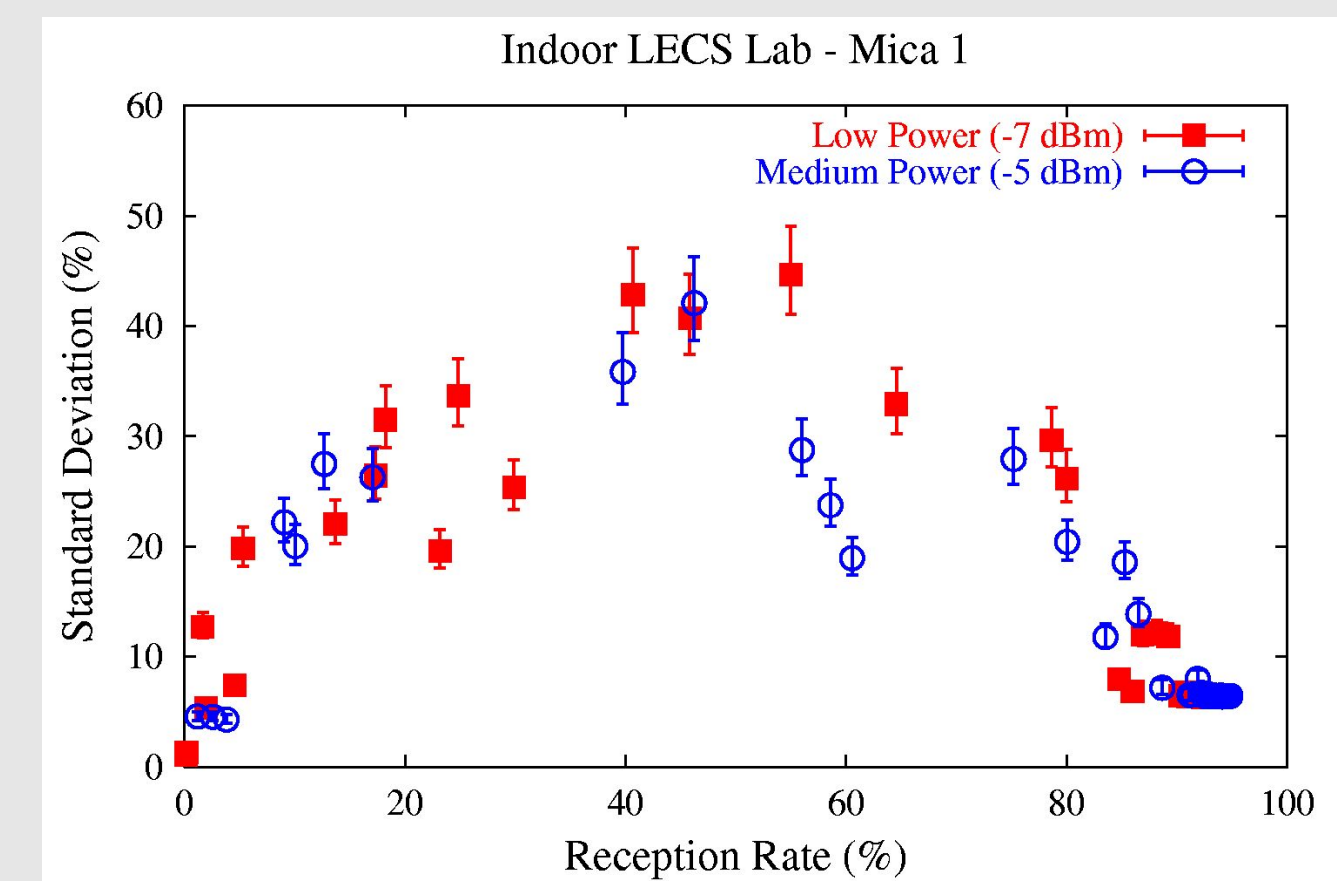
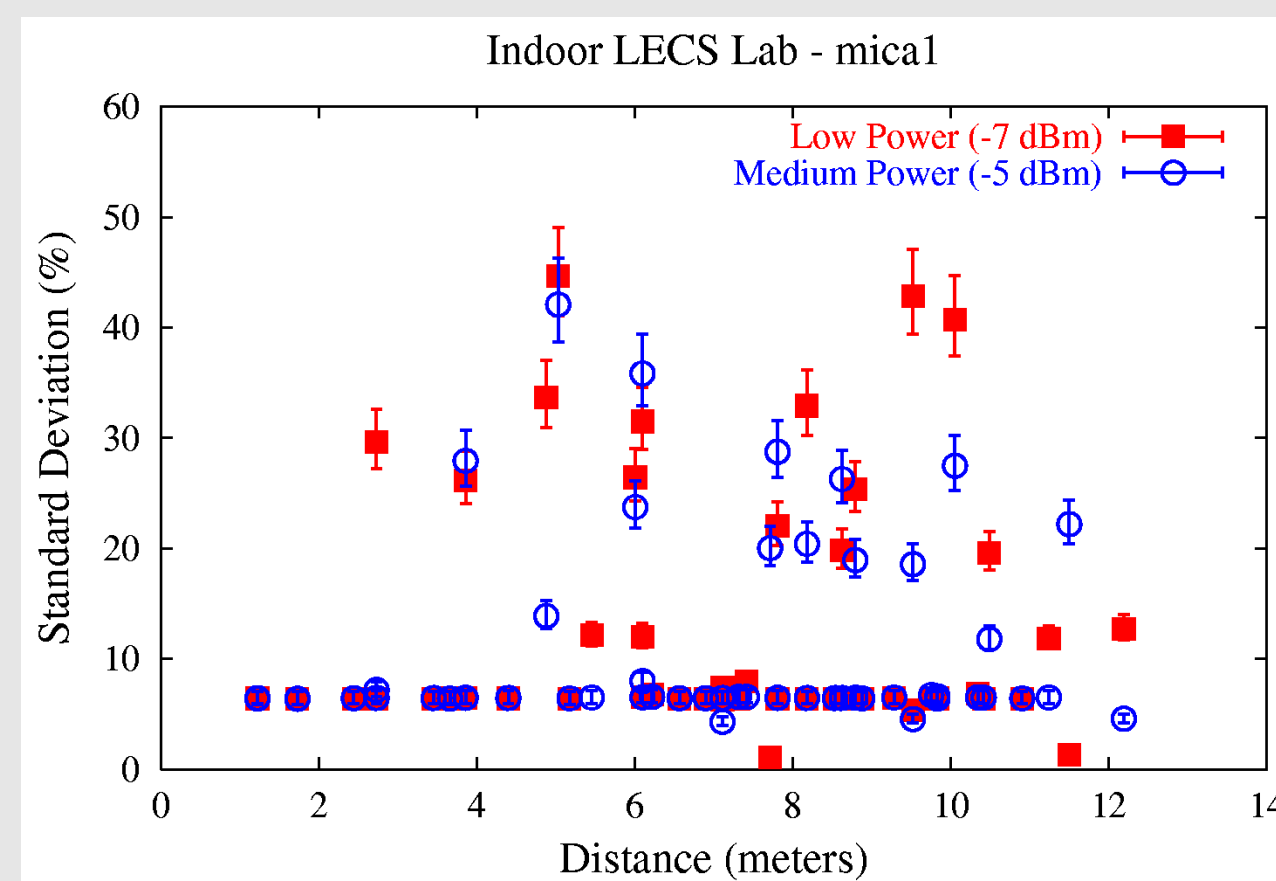
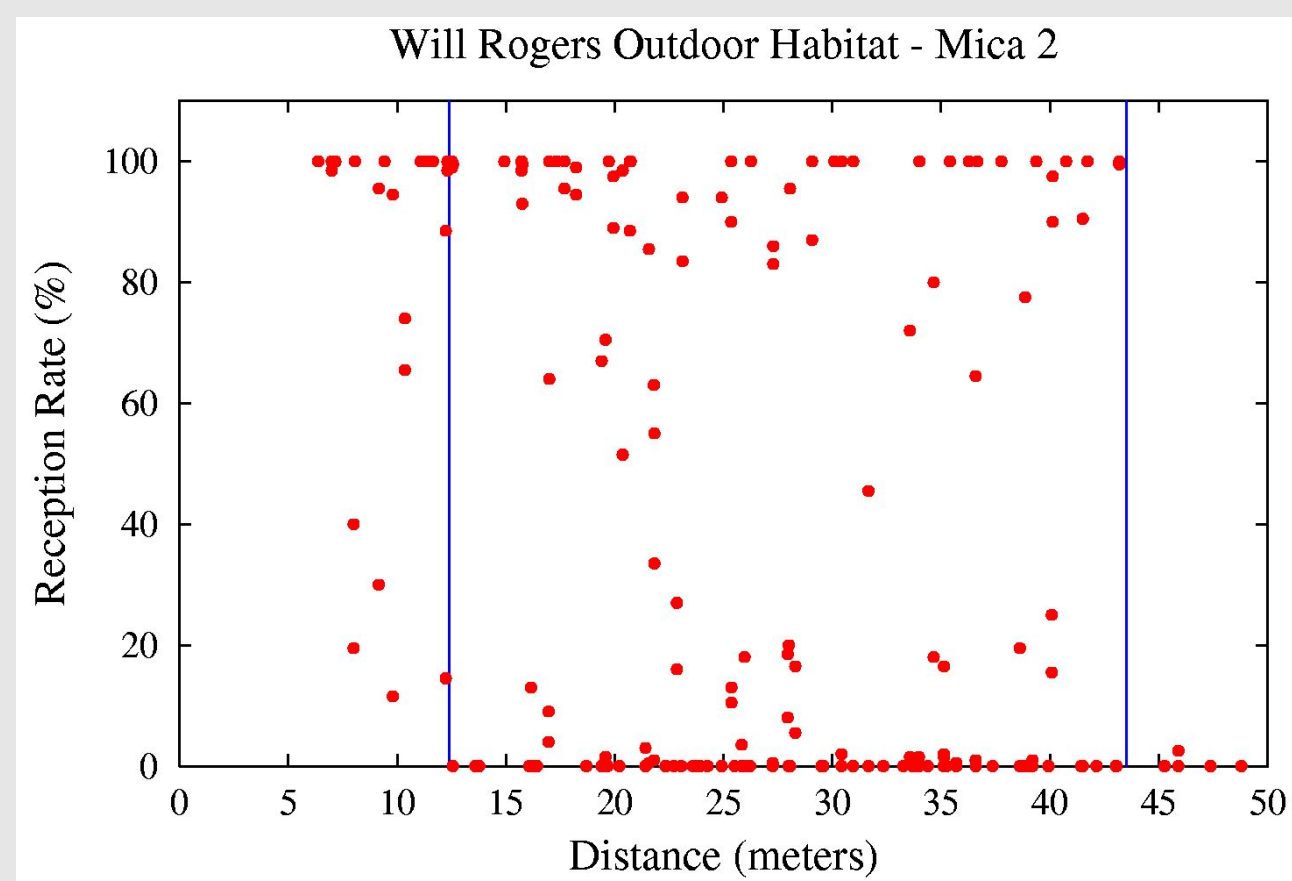
Extensible Sensing System

- Reliable delivery despite *moderately long lossy paths, low bandwidth links*



Majority of Links Are Highly Variable

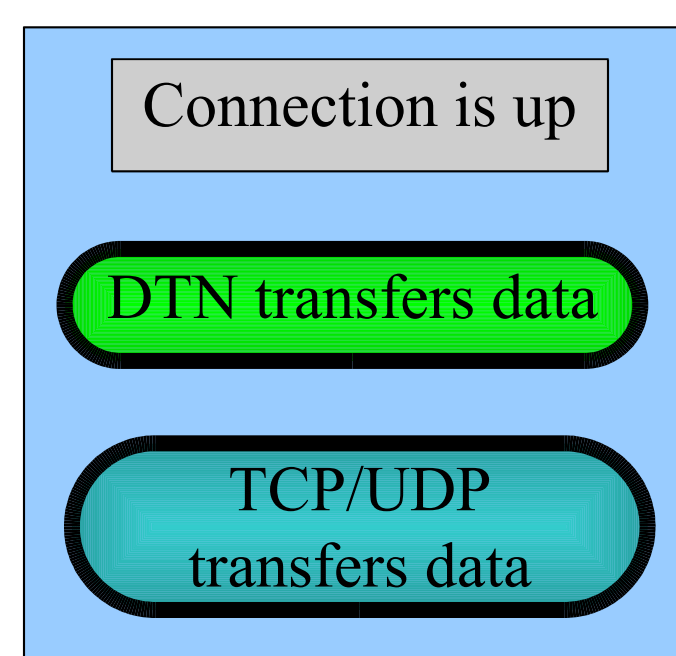
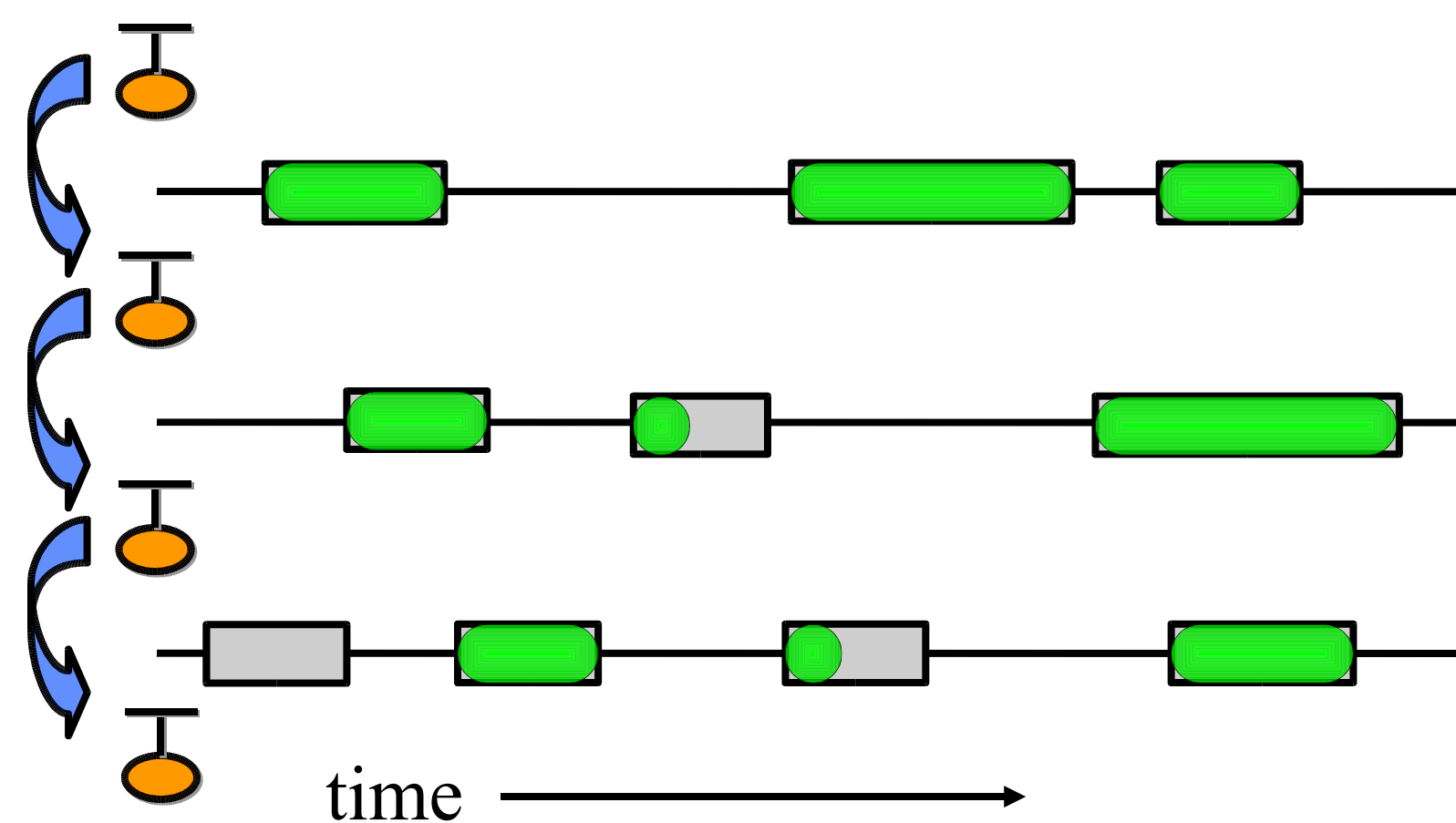
A Significant Percentage of Links in Sensor Networks Suffer from High Variance of Reception Rate



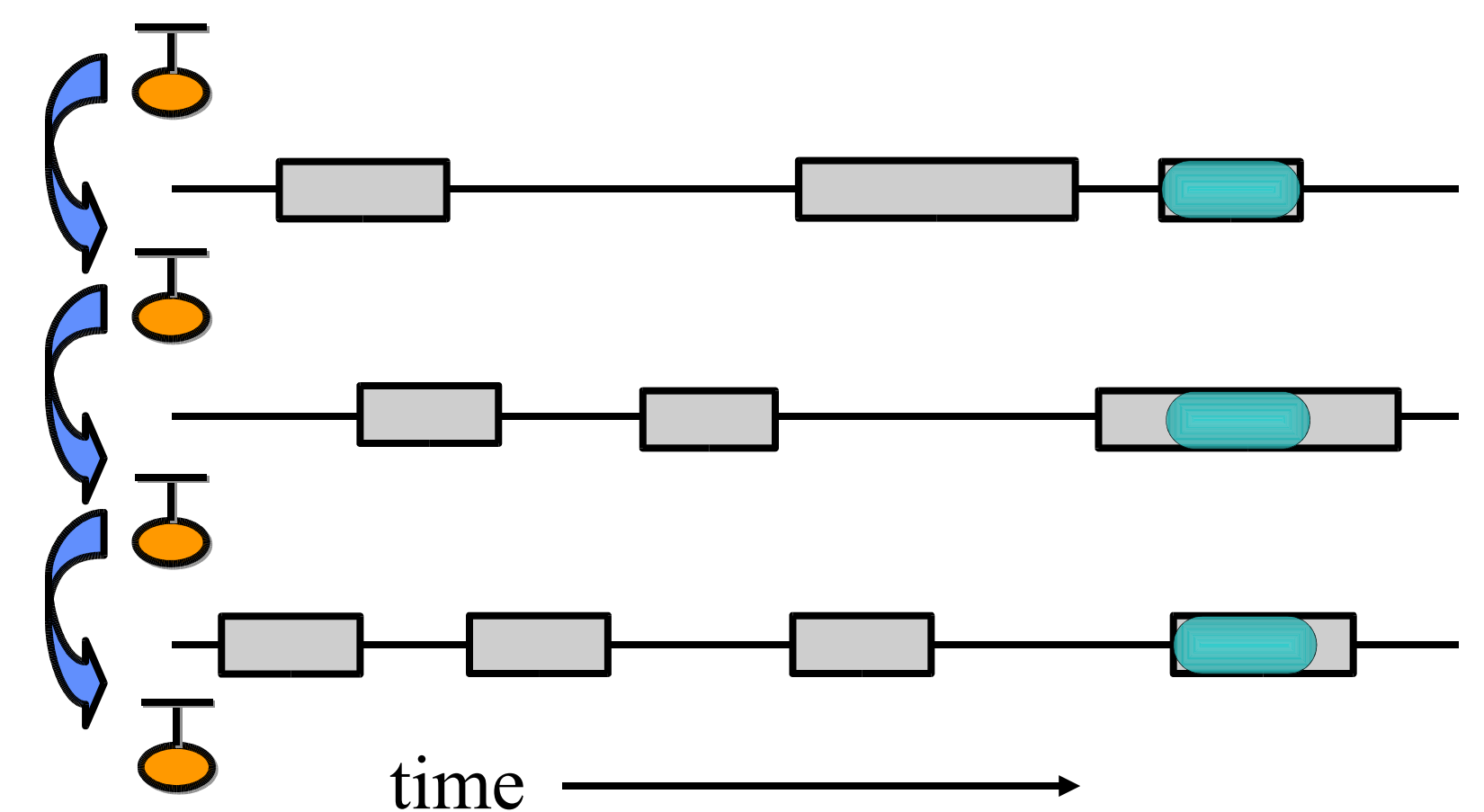
* Graphs from Cerpa et. al. 2003

Delay Tolerant Networking Will Let Us Utilize Transient Links

Delay Tolerant Networking Performance



TCP/UDP Performance



Important DTN Features

- Store and forward of bundles with custody transfer between intermediate hops
- Reactive Fragmentation
- End-to-end Acknowledgement

Plan of Work

* In collaboration with Scott Burleigh et. al. at JPL

- Support DTN functionality for *tiered sensor network architectures*
- Build EmStar based bundle server
- Gradient routing of bundles based on directed diffusion
- Reliability scheme
 - Stargate \Leftrightarrow Stargate: TCP hop-by-hop
 - Mote \Leftrightarrow Mote and Mote \Leftrightarrow Stargate: Wisden

CENS Ad hoc Seismic Array: First Target Application

* In collaboration with Paul Davis et. al. at UCLA



- Extend two parallel lines of seismometers across San Andreas Fault (shown in white)
- Network of approximately 50 nodes, displaced approximately 2 km
- Each node equipped with a parabolic antenna about six feet off ground
- Tested to 8 km



Proposed Topology: Braided String of Nodes

