Seismic Array Software System
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Motivation: Long-term Deployment of a Portable Broadband Seismic Array

About
• Part of the Middle America Subduction Experiment (MASE)
• Partnered with Caltech and UNAM

Goals
• Map the subducted slab beneath Mexico
• Examine slow earthquakes observed at this subduction zone
• Examine volcanic earthquakes observed at this subduction zone
• Study the propagation of seismic waves in Mexico City

Needs
• Line of seismic stations: Acapulco to Tampico through Mexico City
• 100 Stations total, 5-20 km apart
• 100 Hz broadband seismometers

The Setup: High Powered 802.11b Connect 50 Stations to Mexico City

Physical Topology Characteristics
• Non-uniformity in Topology
• Variable Spacing: many factors in choosing a site
  – Terrain and vegetation
  – Policy – need local permission for each site
  – Cable length and antenna height
  – Seismic Noise
• Distance between stations: 100m to 20km
  – Relays fill in critical gaps
  – Some stations have internet connections and hard drives
• Network topology is the physical topology
  – Each node only has a single downstream neighbor
• Not completely linear – local clusters and star topology
• Max hops is 15 - largest cluster of nodes is 20
• End-to-end connections are unreliable, unstable, and slow
• Data is multi-hopped delivered to a sink
  – Need EVERY bit – cannot lose any data

Dualer: Software for end to end system autonomous seismic data collection

October 2005 Status
• 40 of 50 sites completed
• Additional relays required to connect paths to sinks
• Duiker completed
  – Instrumentation underway

Purposed Measurement Instrumentation
• Transport component will keep track of:
  – When it first tried to send a bundle
  – Each time it begins to send the same bundle
  – When it successfully completes sending a bundle
  – The disk space used on the node on send and receive
• Compare with simulation and testbed results

Storage Estimates
• Data generated at 1-3MB per hour
• 1 GB CF card: 14 days worth of data from a single node at 3MB per hour
• For a 12 node path: 27 hours of data / 1 GB

Minimum Bandwidth Estimations
• Assume worst-case:
  – 3MB per hour = 6667 bits per second per node
  – Last hop connection to sink requires most bandwidth
• For 12 nodes, ~ 80-kbps at last hop:
  – 6,667 bits/node * 12 nodes = 80,004 bps

Latency Measurements
• Latency will be measured through simulation
• Instrumentation will report actual latency
• Depends on node uptime
  – Nodes going down means data can get lost
  – CF Cards fill up and data is delayed or lost

Duiker components
• Acquisition: runs on microservers
  – Collects data from Q330 over ethernet
  – Bundles contain raw Q330 packets, state information configuration info, and an md5sum
  – < 1% of CPU and < 1MB of RAM on Stargate
• Transport: runs on microservers
  – Moves bundles hop-by-hop to a sink
  – Bundles transferred over tcp using scp
  – Storage priority given to local bundles
• Data Acknowledgement
  – Initiated at the sink
  – List of received files at sink updated throughout network
  – Each node uses list to delete files
  – Old local bundles that are not ack’ed are resent
• Data Conversion runs at the sink
  – Converts bundles into minised format
  – No conversion happens on Stargate
  – Allows recovery from conversion errors since all raw packets from Q330 are saved