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Title

SEI 0: Embedded Network Approaches to Multiscale Seismic Networks Overview

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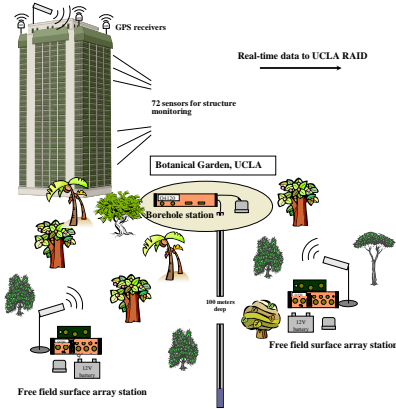et al.

Publication Date

2006

CENS — Center for Embedded Networked Sensing

Embedded Network Approaches to Multiscale Seismic Networks-Overview

Paul Davis, Monica Kohler, Deborah Estrin, Richard Guy, Ramesh Govindan, Igor Stubailo, Allen Husker, Martin Lukac, Sam Irvine

Factor Building Seismic Test Bed : Structure Monitoring, Free field and Borehole sites, GPS

GPS receivers
Real-time data to UCLA RAID
72 sensors for structure monitoring
Botanical Garden, UCLA
Borehole station
100 meters deep
Free field surface array station
Free field surface array station

Goal

• Make high resolution unaliased measurements of the seismic wavefield for scientific and engineering purposes, with rapid visualization and analysis of data using network technologies.
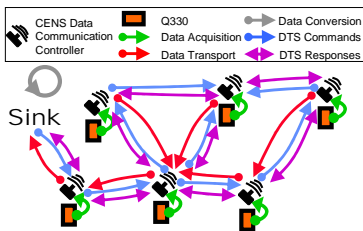
Approach

• UCLA Factor building network provides a great resolution of the area. The high dynamic range of the 24-bit digitizers allows both strong motions and ambient vibrations to be recorded with reasonable signal-to-noise ratios.

• It has 72 2G sensors wired throughout the structure (4 sensors on every floor), 3 channel borehole seismometer, 3 station Free field ground array, 3 GPS receivers on the roof.

• Serves as a test bed for state-of-health monitoring using Wireless mote seismic array managed by 'Tenet'.

Wireless Mote Network

Mexico 50 station long term deployment: Success of CENS hardware and software engineering

Seismic System Software

CENS Data Communication Controller — Q330 — Data Conversion
Data Acquisition — DTS Commands
Data Transport — DTS Responses

Sink

Disruption Tolerant Shell (DTS)

– Asynchronous remote shell interface to all nodes simultaneously
– Provides node management capabilities when end to end connections are unavailable or fail
– DTS reaches 100% of the nodes faster in the absence of high availability end to end connections
– Uses a reliable and efficient publish-subscribe mechanism to disseminate shell commands and responses "epidemically" and reliably hop by hop

Network Characteristics

– Station location constrained by sensor placement needs
– Erratic link qualities and intermittent node disconnections
– Unpredictable environmental conditions
– Difficult to obtain end to end connections
– End to end connection may fail at critical times

Mexico Network

• Managed by 'Disruption Tolerant Shell' with Duiker data acquisition software and 'filemover' data delivery tool.

• Designed and constructed a 50 station wireless seismic network currently installed in Mexico (green dots on the map)

• Collect data along with 50 autonomous stations run by Caltech

• Mexico multihop wireless 802.11b network taps into internet at various sinks, and is controlled from UCLA using newly designed CENS systems software DTS (Disruption Tolerant Shell) that supports rerouting, reconfiguration of instruments and data transfer.

• Data is coming to the UCLA RAID array in real time and available for processing almost immediately after an event happen.

Results

• Achieved a great resolution of 100 times better than it was before.

• Allows scientists to visualize the upper mantle and the subduction process from the coast to coast across Mexico.
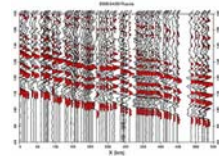
Future development: Peru, developing Geonet, power efficient data acquisition.

Geonet (a low power high resolution wireless seismic array)

– Geophone network (100 nodes)
– Ultra low power (200 mWatts)
– Rapid deployment of RF footprint in aftershock zones
– Self configuring network
– Rapid central data recovery, visualization, processing, and reconfiguration to optimize science
– Expandable to 1000 nodes using DTS

Current system, requires ~4 Watts

Geonet prototype, uses ~0.2 Watts.
LEAP Technology (Aevena)

Peru Network

• Plans to install wireless 50 station network in Peru for comparison with Mexico results looking at the flat slab subduction.

• A chain of high mountains, the Andes, rises on the continental side of the collision boundary of two plates, a deep-sea trench lies just off the coast. Slabs provide information about the mechanics of plate tectonics.

Peru-Chile Trench
Nazca Plate
South American Plate

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