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Title
Developments on the CENS Structural Health Monitoring Front

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CENS
Center for Embedded Networked Sensing

Developments on the CENS Structural Health Monitoring Front

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Introduction: Structural Health Monitoring (SHM) Systems

SHM: Process of assessing state of health/damage of instrumented structures from their measurements

Objectives: To improve scientific understanding of the dynamic behavior of large structures as well as safety and reliability of infrastructure by damage detection and rapid post-event assessment

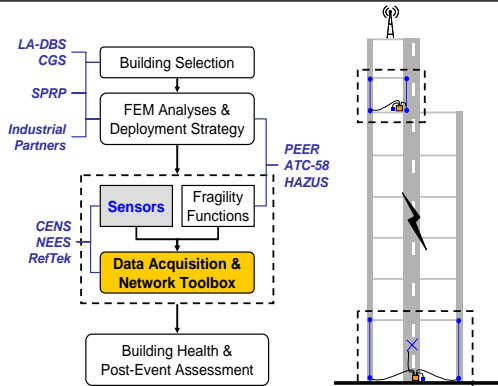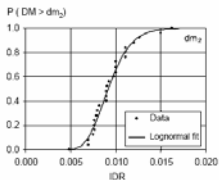**Requirements:** Rapid Deployment, low power, robust DAS & sensors, damage detection algorithms

Two distinct but related systems: SHMnet & ShakeNet

I-35W Bridge Collapse

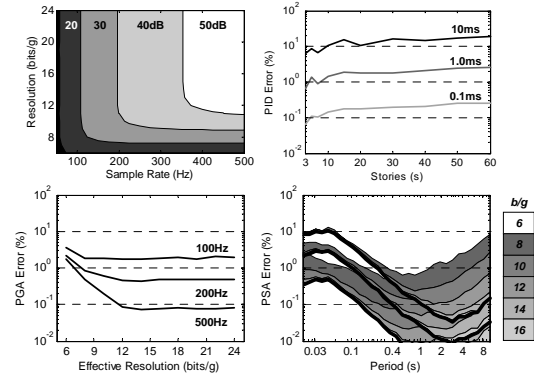## SHMnet: Instrumentation Requirements for Permanent Deployments

System Components

- Probabilistic post-event assessment based on fragility functions
- New sensor for direct measurement of IDR

LA-DBS CGS / SPRP / Industrial Partners → Building Selection → FEM Analyses & Deployment Strategy

CENS NEES RefTek → Sensors / Fragility Functions → Data Acquisition & Network Toolbox

PEER ATC-58 HAZUS

Building Health & Post-Event Assessment

$P(DM > dm_2)$

Tall Buildings

- LA-DBS update code and instrumentation specifications
- Increase quantity and quality of channels per structure for tall buildings

Stories	Channels
10 – 20	15
20 – 30	21
30 – 50	24
> 50	30

- Results published in *An Alternative Procedure for Seismic Analysis and Design of Tall Buildings Located in the Los Angeles Region,* by the Los Angeles Tall Buildings Structural Design Council, 2008
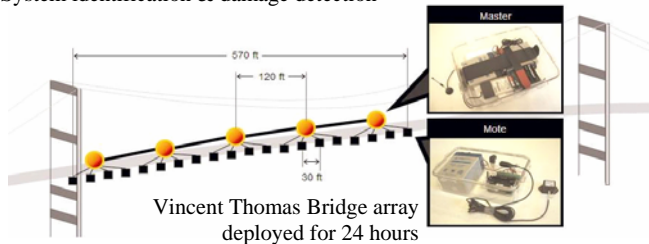
Instrumentation Specifications

- SHMnet leverages partnerships with SMIPs (CSMIP, ANSS, and LA-DBS) for building access and instrumentation requirements
- Building instrumentation specifications of major SMIPs are not-uniform and are based on experience
- A quantitative basis for key specifications is established by analyzing signal errors associated with DAQ processes (resolution, sample rate, time-synchronization) and sensitivity analyses of engineering quantities

PGA, PGV, PSA | PFA, PID → R ≈ 15mg   S ≈ 200Hz   Ts ◔ 1ms

ShakeNet: Rapid Post Event Deployments and Real-Time Analyses

System Components

- Portable, low-power vibration sensor network
- Multi-tier wireless sensing system
- Rapid deployment enables aftershock monitoring
- System identification & damage detection

Vincent Thomas Bridge array deployed for 24 hours

Test Deployments

- Mote sensors and stargate backbone
- CENS Tenet multi-tier software
- Deployment time: 2.5 hours
- Reliability: 100% data reception
- Planned: alongside existing wired networks (e.g., Factor Building)
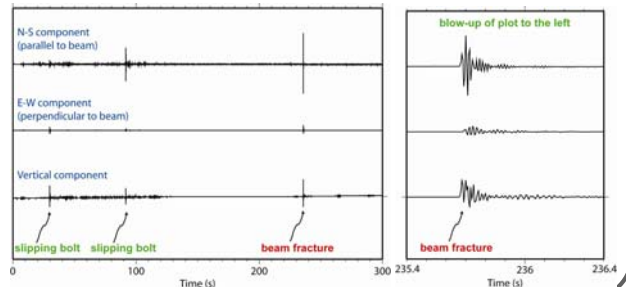
Factor Bldg

Weld Fracture Detection

- Preliminary experiment at UCSD on March 8, 2007
- Accelerometer installed near plastic hinge of moment-frame connection
- CENS CDCC box used to collect vibration data
- High frequency range data

Cyclical Loading

Fracture Event

Acceleration data recorded on CENS CDCC Box