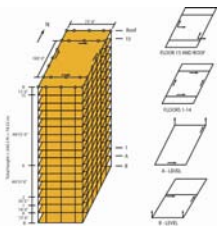
Developments on the CENS Structural Health Monitoring Front

M. Kohler, J. Wallace, D. Skolnik, R. Govindan, O. Gnawali, J. Paek, P. Davis, and I. Stubailo

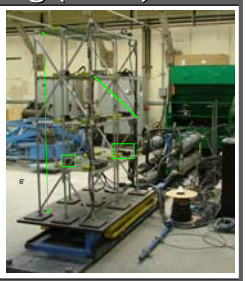
Introduction: Existing field deployments and laboratory experiments have set the stage for further development of a meaningful framework for structural health monitoring (SHM).

Test-Beds: Wired Networks in the Field and in the Laboratory



The broad range of wireless vibration/structural response recording requires integration of different types of complementary systems being developed and tested by the CENS seismic group.

Wired network in the field and laboratory serve as test-beds for predictive modeling and sensor applicability. Wireless untethered devices whose design is guided by the data analysis can significantly increase the spatial resolution of structural response to earthquakes. Networks deployments can be optimized using a model-driven approach

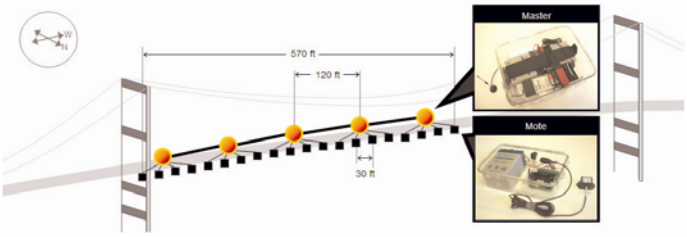


Problem Description: Developing Robust Wireless Systems for SHM

- For structural monitoring deployments, systems need to be able to handle multiple spatial scales, flexible node placement with easy and rapid installation, multiple sensor types, and sophisticated tools for such as rapid data visualization and assessment.
- Geonet is being developed and tested in large-scale, long-term deployments for weak motions such as the MASE project in Mexico and for strong motions in model driven network designs such as that being developed for the tall and important building monitoring project.
- The multi-tier net would be used for the fine-scale, multi-scale structural monitoring deployments that require quick, easy, short-term installation.
- Remaining hardware needs to remove current limitations
  1. higher signal-to-noise MEMS accelerometer, especially for low frequencies
  2. 3-component recordings at 500 sps
  3. 24-bit data acquisition system for recording low-amplitude signals

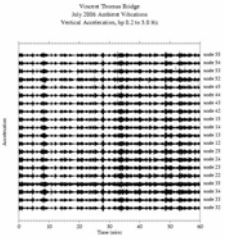
Proposed Solution: Utilize Novel CENS Tools to Develop More Robust SSHM Toolboxes.

Multi-Tier Acceleration Sensor Arrays

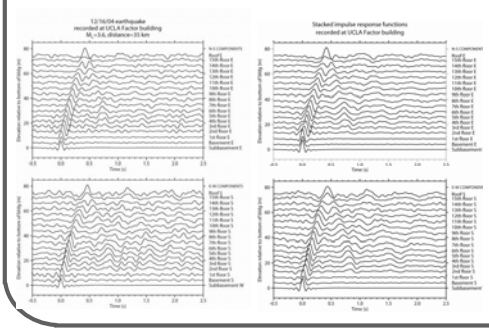


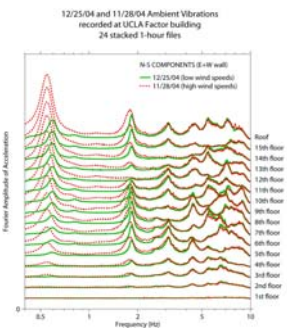
Mutli-tier wireless array deployed for 24 hours on Vincent Thomas Bridge

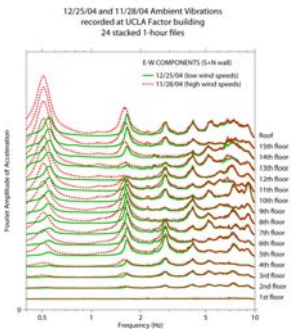
- Mote sensors and stargate backbone
- CENS Tenet multi-tier programming software
- Deployment time: 2.5 hours
- Reliability: 100% data reception



Ambient vibration and small event signals are best recorded at resolution levels afforded by high-resolution systems. For example, Stacking of small-to-moderate size earthquake data produces wave propagation observations that can be used to validate 3D numerical models and 1-hour stacking of 24 hours of ambient vibration vs. wind gust data illustrate change in dynamic properties due to small and moderate level shaking.







Tall and Important Buildings

70+ New Tall Buildings in Los Angeles using Alternative Designs

RC Core Wall

Model-Driven Networking
Sophisticated 3D models developed by collaborating engineering firms

LA-DBS Requires Seismic Instrumentation!

Current Systems
- Accelerometers only
- Cumbersome
- Wired or GPS
- No data
- No damage probability

Proposed SHM Framework
- Various sensors
- Model driven network
- Network time synch
- Real-time visualization
- Rapid/easy deployment