CPS:TTP Option: Synergy: Collaborative: Internet of self-powered sensors - Towards a scalable long-term condition-based monitoring and maintenance of civil infrastructure

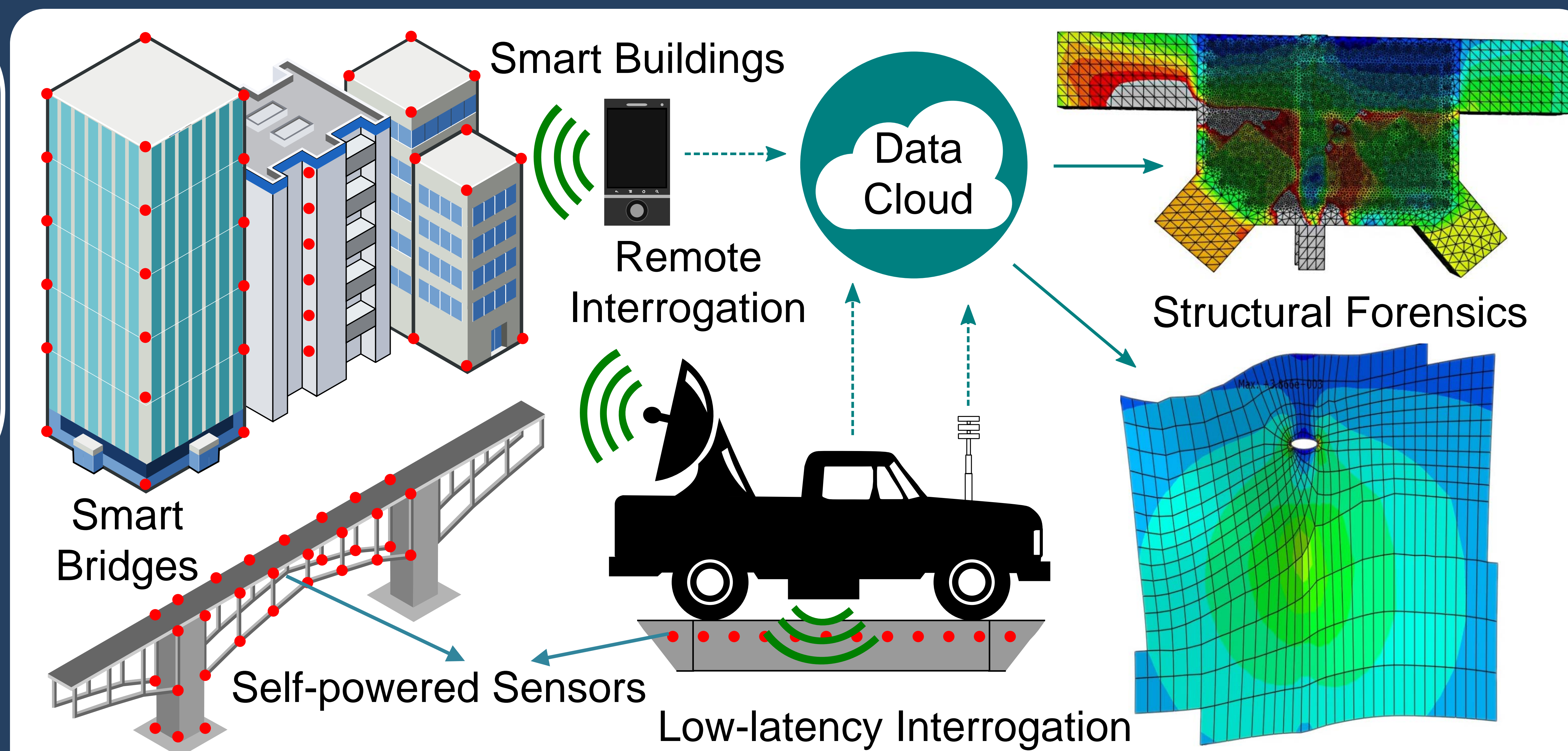(**CNS** 1646380, 1645783, 1646420; **Award Date**: 09/01/16)

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Challenge

- **Smart civil infrastructure** *that can predict any impending failures and in the cases of extreme events diagnose itself.*
- **Continuous monitoring using embedded sensors** *that do not require any maintenance and can monitor rare events.*
- **Actionable intelligence** *from sensor data to prioritize structural areas for immediate maintenance.*

Solution

- **A framework of infrastructural internet-of-things (i-IoT)** *using a network of self-powered, embedded health monitoring sensors.*
- **Novel variants of embedded self-powered piezo-floating-gate (PFG) sensors** *that provide accurate spatial resolution in structural imaging.*
- **Low-latency wireless interrogation** *using a novel variance based logic processor combining energy harvesting, memory, computation and communications on a single platform.*
- **Novel structural failure prediction and structural forensic algorithms** *based on historical data collected from self-powered sensors embedded at different spatial locations.*

Smart Buildings
Remote Interrogation
Data Cloud
Structural Forensics
Smart Bridges
Self-powered Sensors
Low-latency Interrogation

PFG Chipset
Highway Sensors
Bridge Sensors
Seismic Testing @ UNR Sep 2017
Mackinac Bridge, May 2017
Nantes, France Aug 2017

Scientific Impact

- **Multi-physics optimization** *of energy scavenging, transduction, rectification and logic computation to improve the system's energy-efficiency and reduce the system latency.*
- **Kernel based machine learning algorithms** *that combine domain specific structural information with real-world sensor data to identify and localize anomalies signifying onset of failure or vulnerabilities.*

Broader Impact

- *Condition based maintenance will lead to a* **significant reduction in costs** *for maintaining and upgrading civil infrastructure, like bridges and highways.*
- **Post-disaster forensics** *(for example earthquakes or hurricanes) of civil structures to quickly isolate vulnerable regions for repair.*
- *Cross-disciplinary* **undergraduate and graduate student projects**. *Outreach to stakeholders in the state and federal governments.*
- **Deployed sensors**: *Mackinac Bridge, Michigan, Earthquake Engineering Laboratory at UNR and Bio-pave European union test facility.*
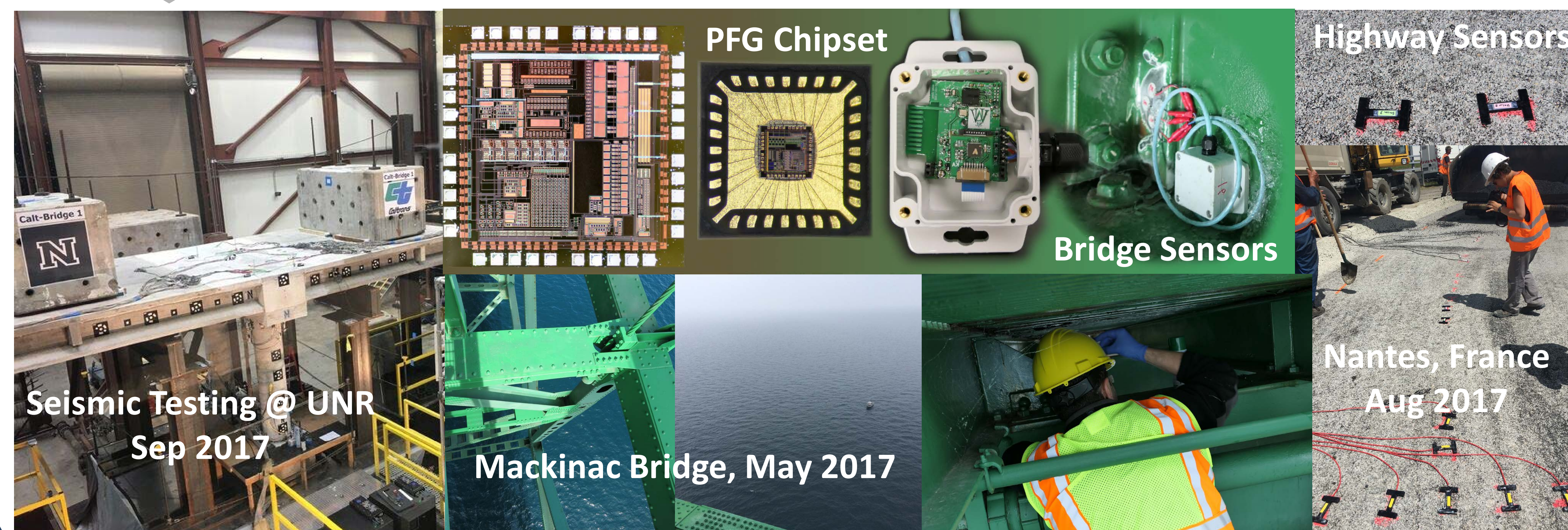
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