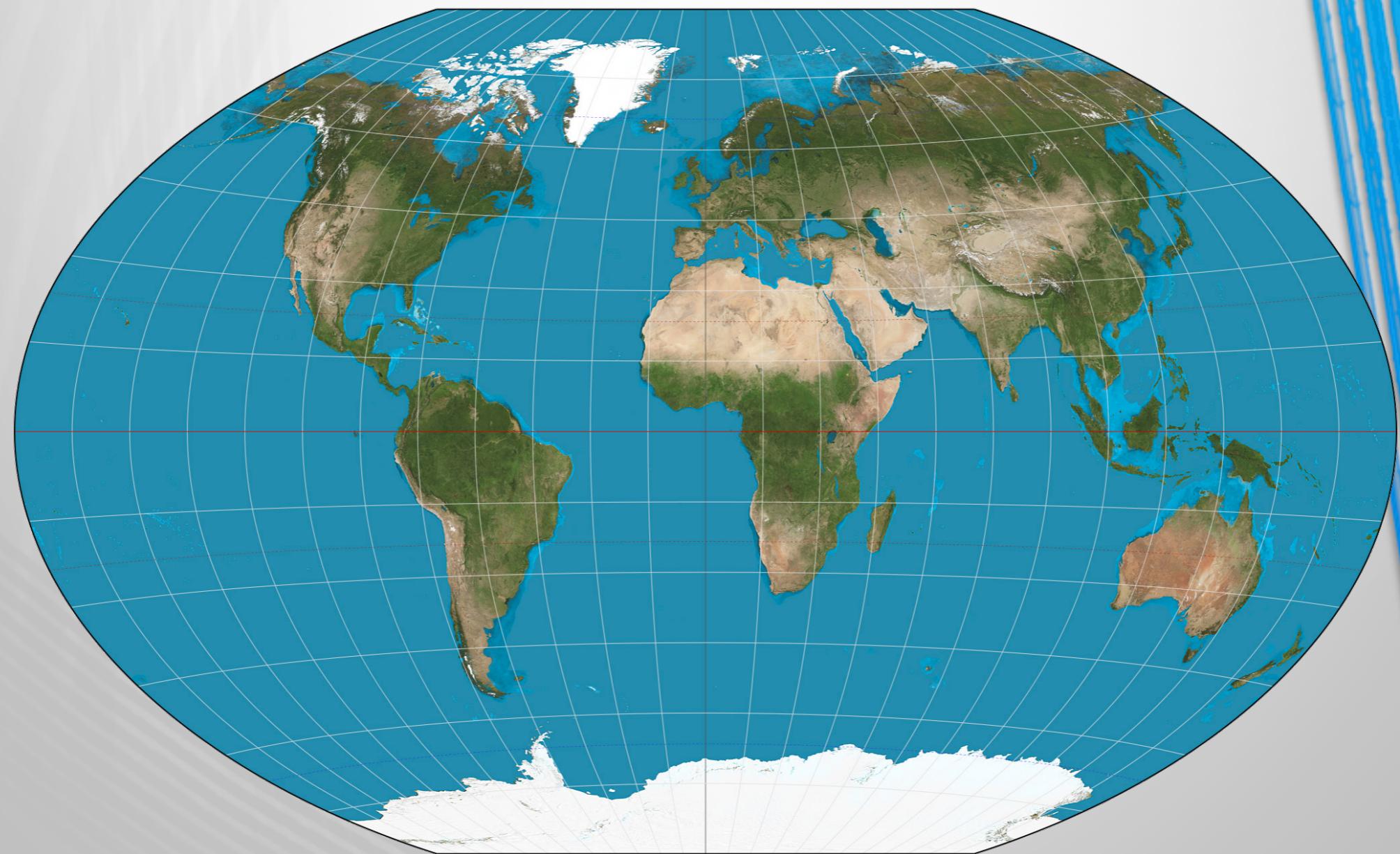


Distributed Real-Time Sensor Network

Ehsan Khamespanah
Fall 2022

Collaboration of Three Institutions





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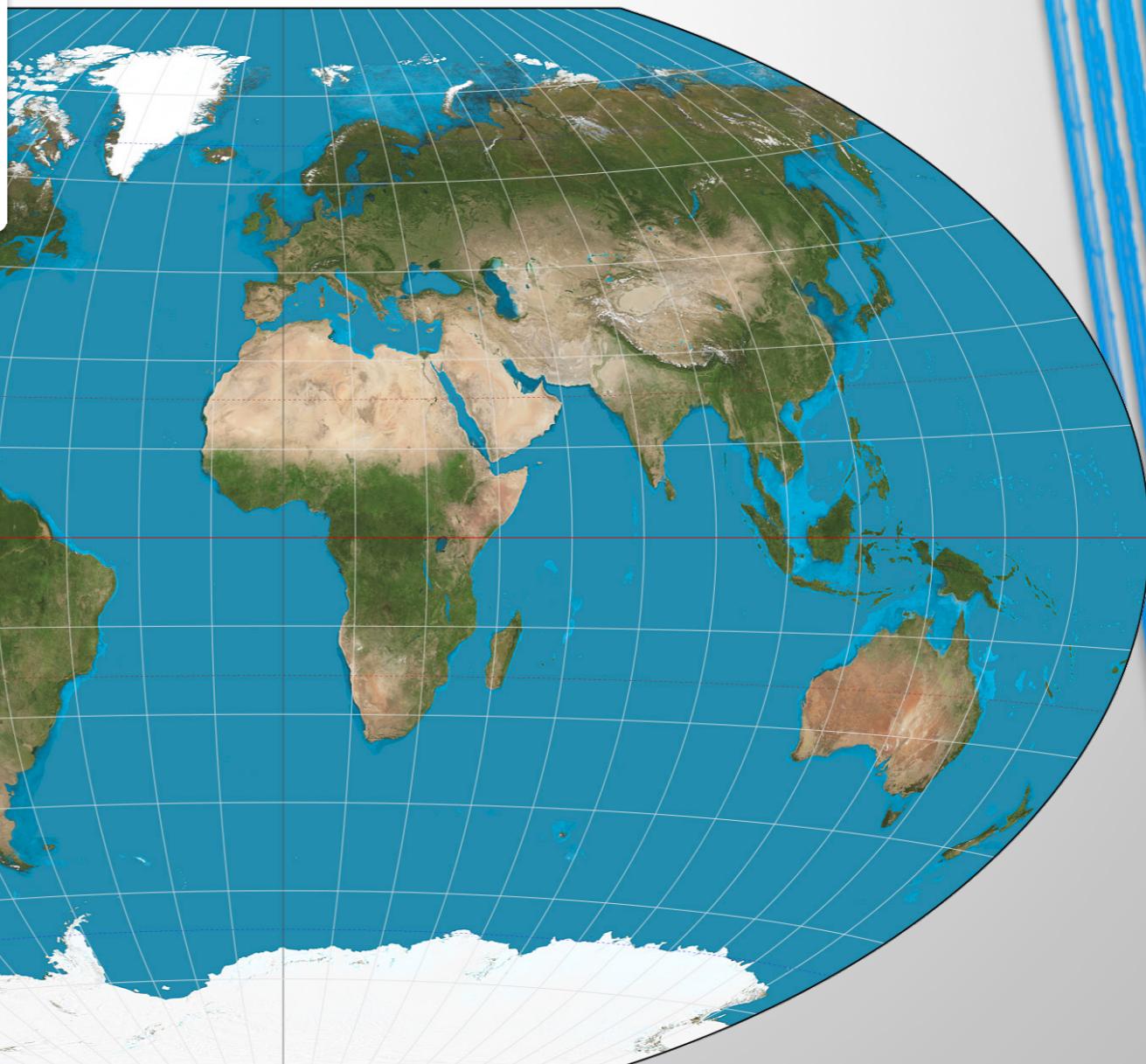
ILLINOIS SHM PROJECT



The *Illinois Structural Health Monitoring Project* (ISHMP) is developing hardware and software systems for the continuous and reliable monitoring of civil infrastructure using a dense network of smart sensors. The project has released an open source toolsuite containing a library of services for, and examples of, SHM applications. This toolsuite has been validated on laboratory-scale bridge structures; full-scale validation is currently underway.

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ILLINOIS STRUCTURAL HEALTH MONITORING PROJECT

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
OPEN SYSTEMS LABORATORY & SMART STRUCTURES TECHNOLOGY LABORATORY

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پردیس دو دانشگاه های فنی



The Problem Domain

- The condition of civil infrastructures is in poor shape



- **Structural health monitoring** (SHM) intends to help make infrastructure safer while reducing

Smart Structures

“... one highly **intelligent bridge** knows what to do when trouble arises: send [the engineers] an e-mail.”

The New York Times



Using Networks of Sensors

- The basic building blocks



Challenges

- Real-time
 - Physical process keeps on going regardless of what the computational part is doing.
- Location
 - Often an integral part of CPS computations/ functionality.
- Robustness
 - Unexpected things happen. Pretty much all the time.
- Energy
 - Computational elements need it.

Imote2 Specification

ISHMP provides **hardware** and **software** for continuous and automated structural health monitoring using a dense network of **Imote2** smart sensors

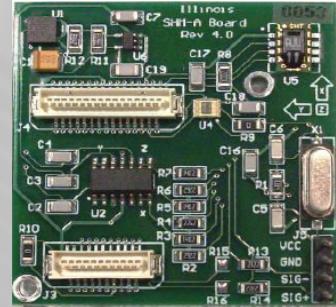
Imote2 wireless smart sensor platform

- **CPU**: variable-speed processor 13 – 416MHz
- **Memory**: 256KB SRAM, 32MB SDRAM, 32MB Flash
- **Wireless communication**: 802.15.4 Radio (2.4GHz)
- **Small size**: 48mm × 36mm
- **Low power consumption**: 0.4mA (sleep) ~ 66mA (active)



Imote2

SHM sensor board series (developed by SSTL)

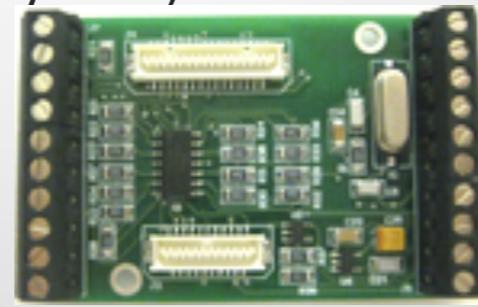


(1) SHM-A



(2) SHM-H

3-axes acceleration
(Temp., Hum., Light)



(3) SHM-DAQ

High-sensitivity acc.
(0.02mg res.)



(4) SHM-S

Strain sensor
(0.5us)



(5) SHM-P

Illinois SHM Services

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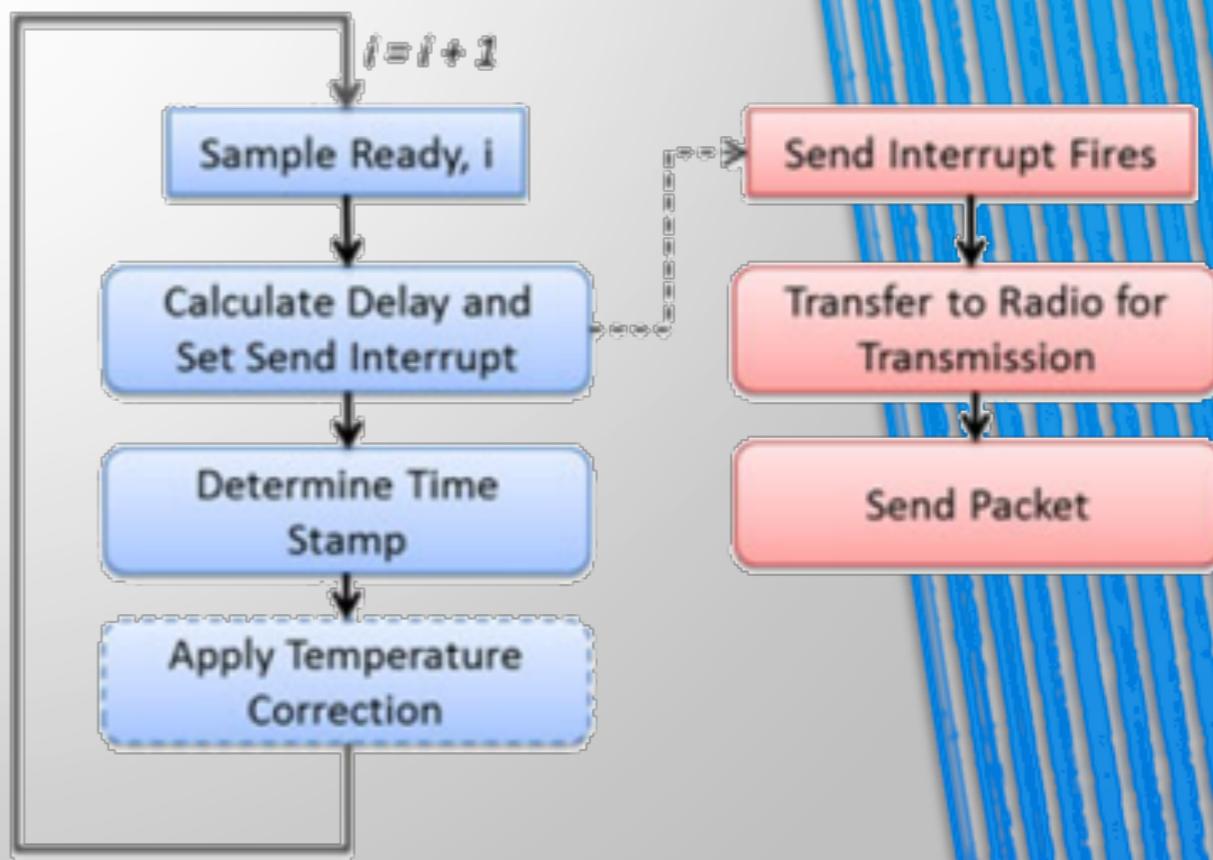
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- 200,000+ LOC
- Modular
- Robust
- Autonomous

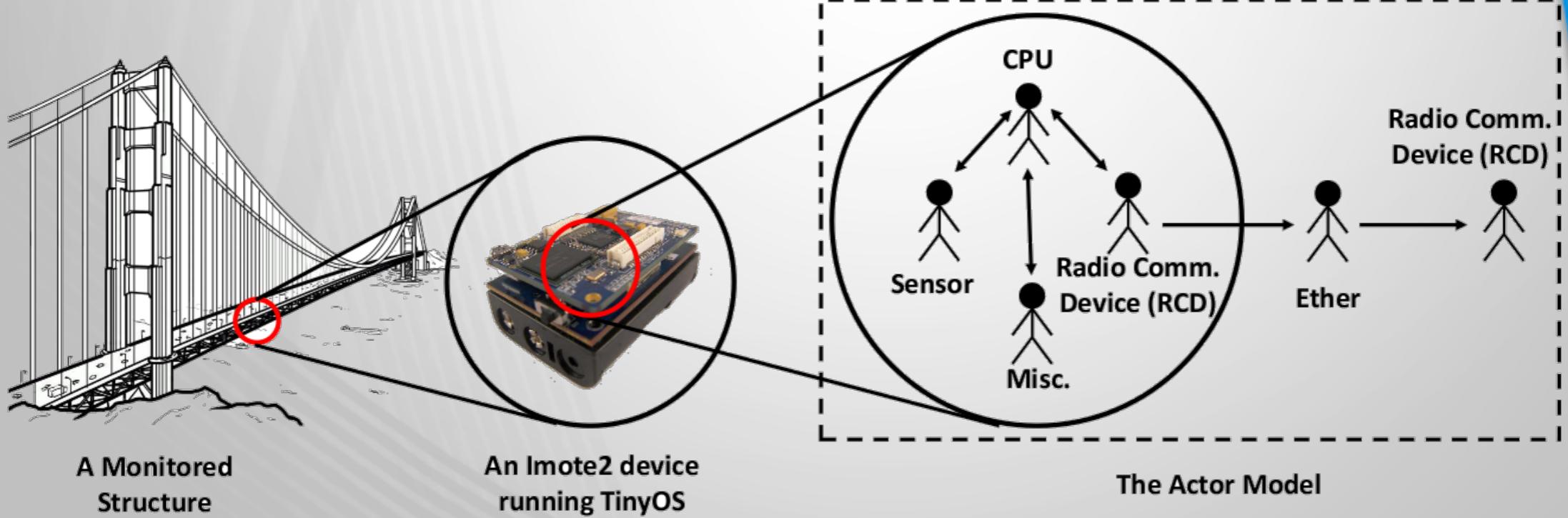
The Problem

- Sensing (left) and radio transmission (right) have their own deadlines, and a dependency relationship
- Finding the best configuration is crucial
 - Try and error (simulation)
 - Worst case analysis
 - Model Checking



The Actor model

- An actor model for WSAN applications



The Model of a Node

- Only four actors must be considered
- Communication between nodes of WSAN and the central server is omitted

