CenSCIR & Sensor Andrew

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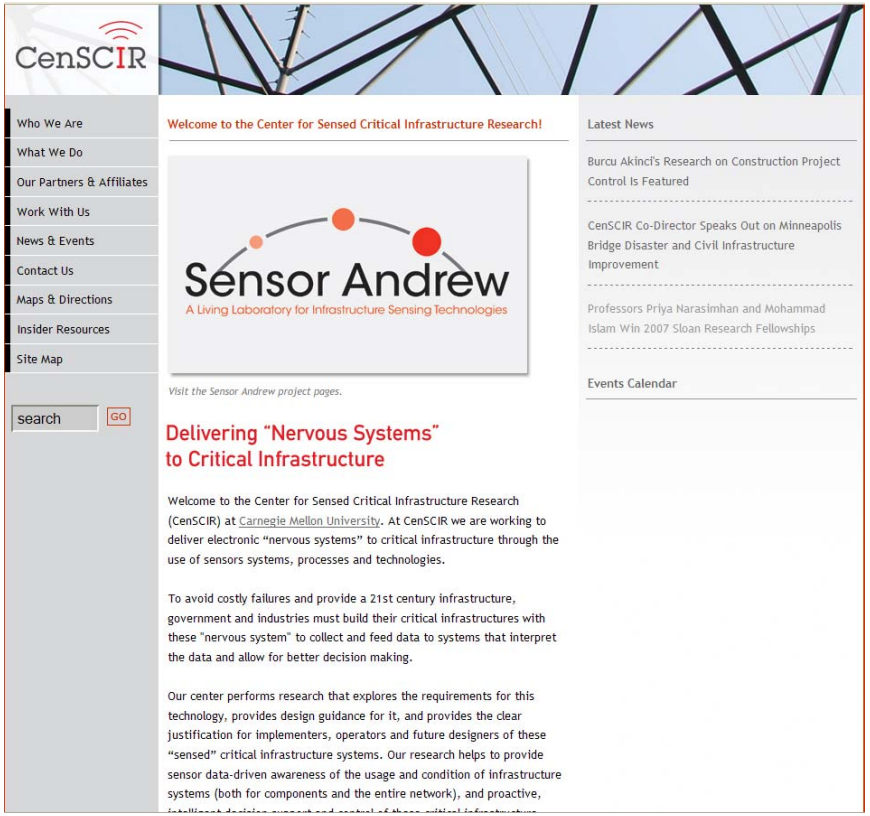
Several faculty members and students

CenSCIR

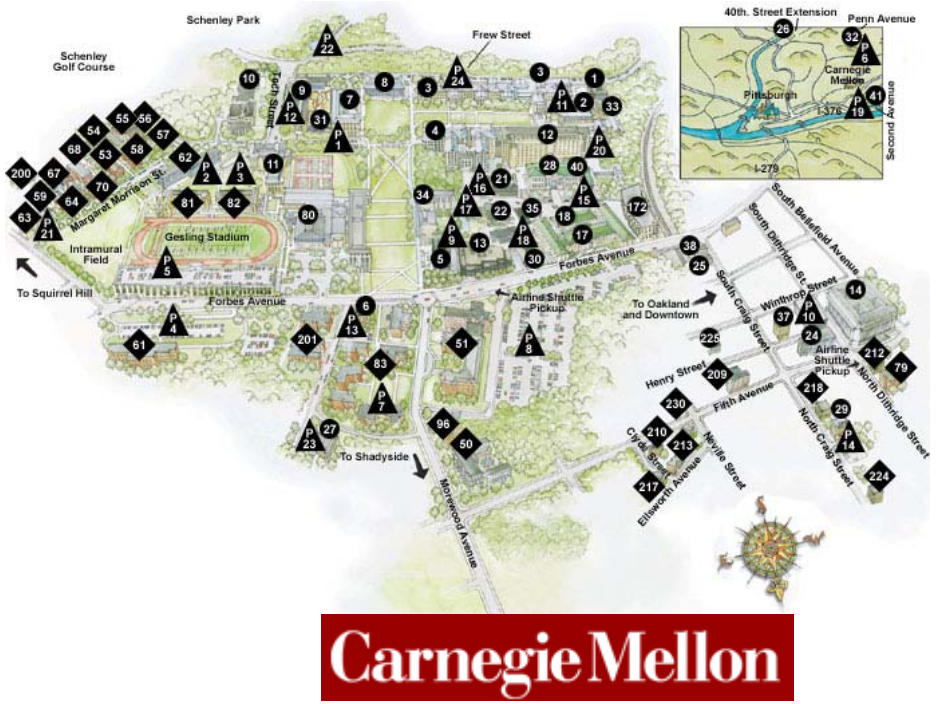
- **Center for Sensed Critical Infrastructure Research**
- The focus of **CenSCIR** is to
  - perform research on pro-active and intelligent, sensor data-driven awareness of the usage and condition of critical infrastructure systems.
- Hosted by ICES (Institute for Complex Engineered Systems)



http://www.ices.**cmu**.edu/**censcir**

Sensor Andrew

- **Campus-wide infrastructure for sensing *and* control**
- **Goals**
  - Ubiquitous large-scale monitoring and control
  - Easy to manage, configure and use
  - Scalable and extensible
  - Secure and private
  - Evolves
    - Evaluate different computational paradigms for sensor networks
    - Rapidly prototype applications at scale
    - Demonstrate utility, deployability and practical usage



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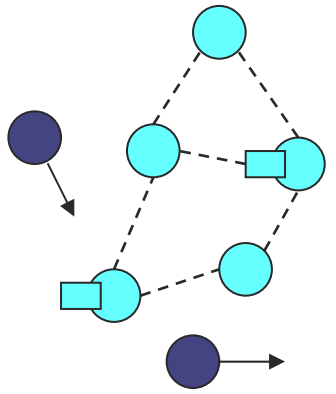
Challenges

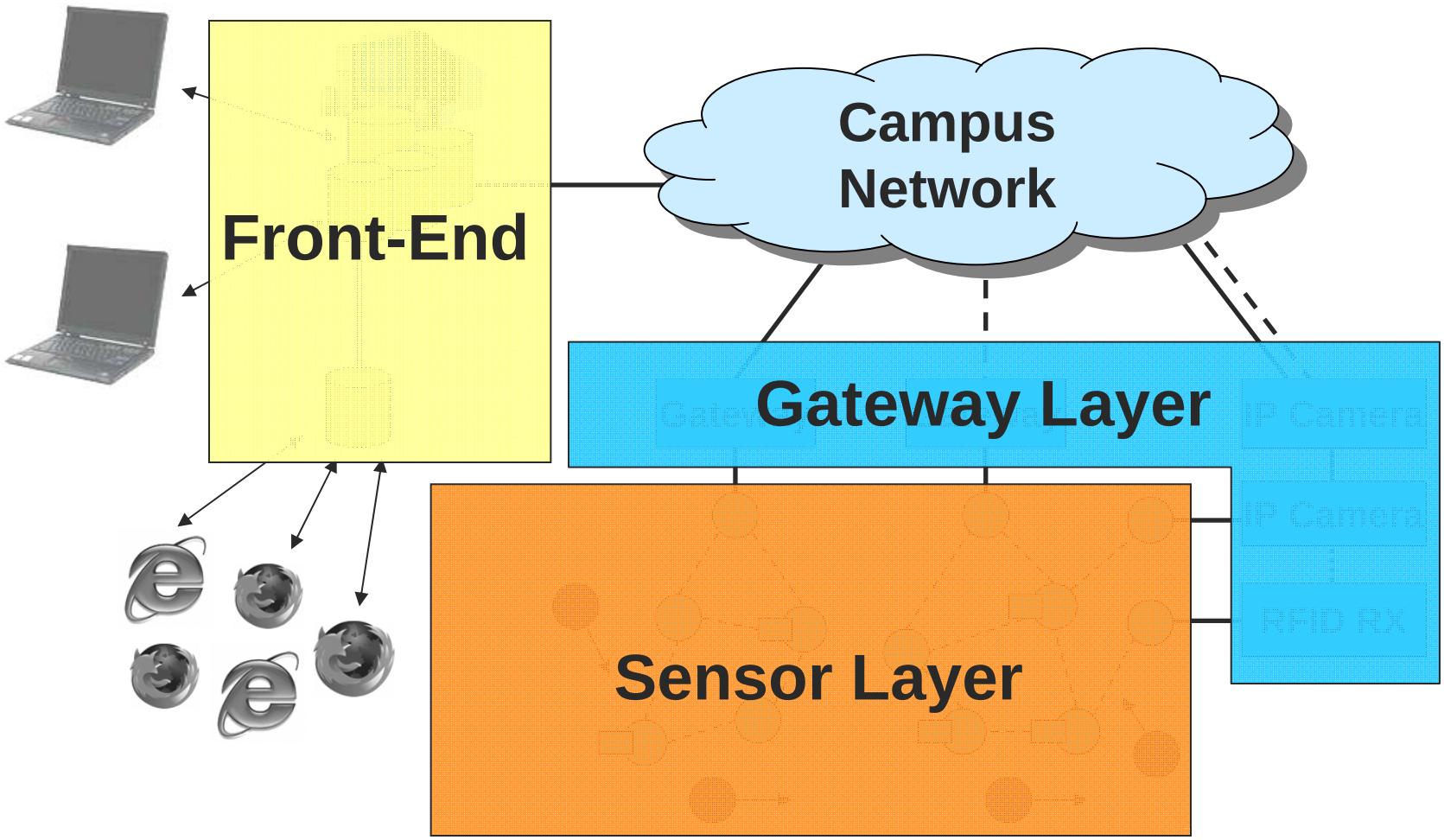
- Data → Information → Knowledge → Action → Control → Optimization
- Upgradability
- Security and Privacy
- Filtering, Aggregation and Archival
- Self-healing topologies
- Real-time tracking of personnel and assets

Current Application Families

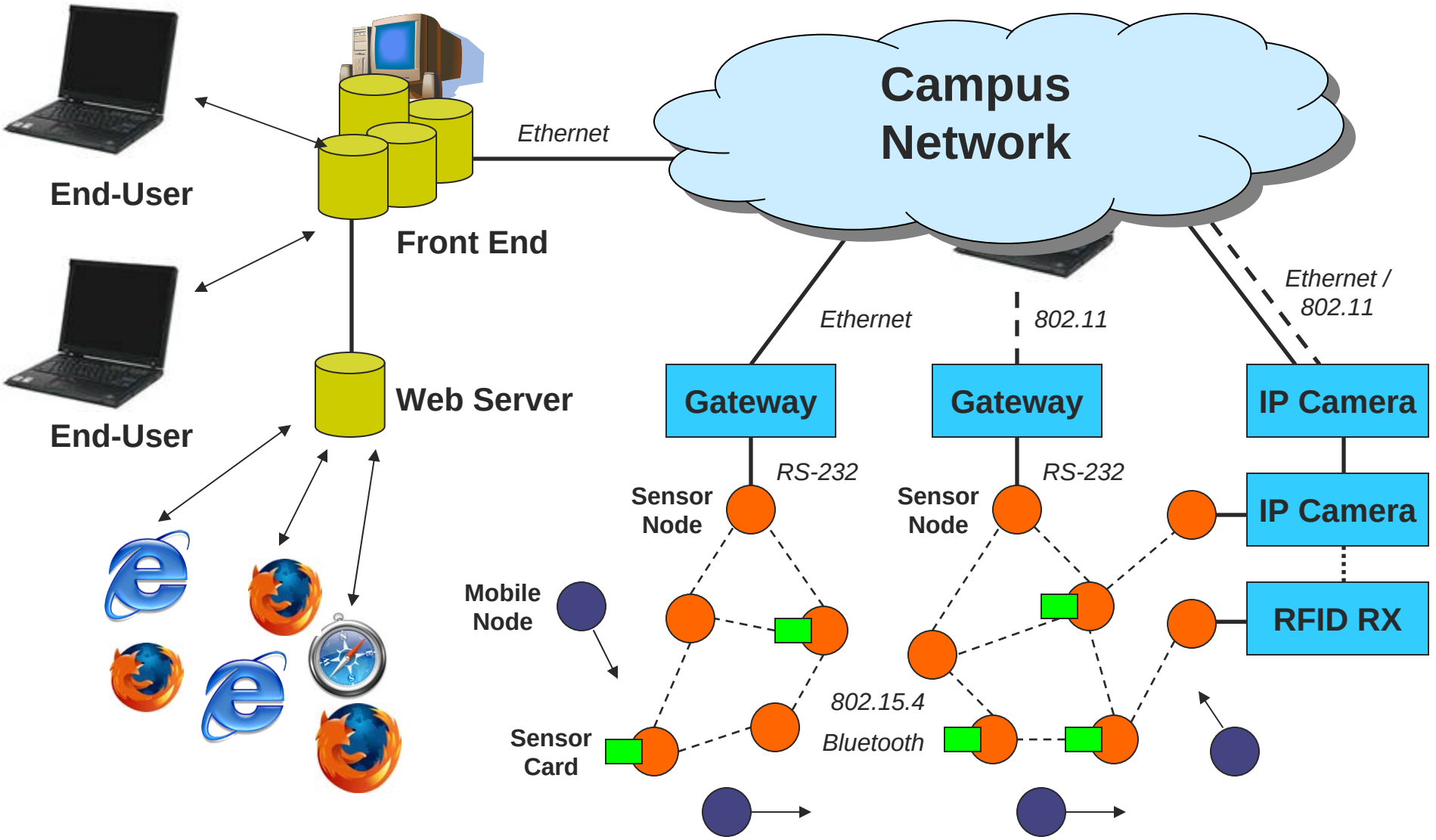
- **Physical Infrastructure monitoring and control**
  - Stress on pipes + humidity monitoring, temperature control, energy control
  - Data Center monitoring
  - Inventory tracking (RFID)
- **Access Control to Physical Areas**
  - Entry/exit point access control
- **Social Networking**
  - People tracking and notification with privacy constraints



Sensor Andrew Layers



SA Detailed Architecture



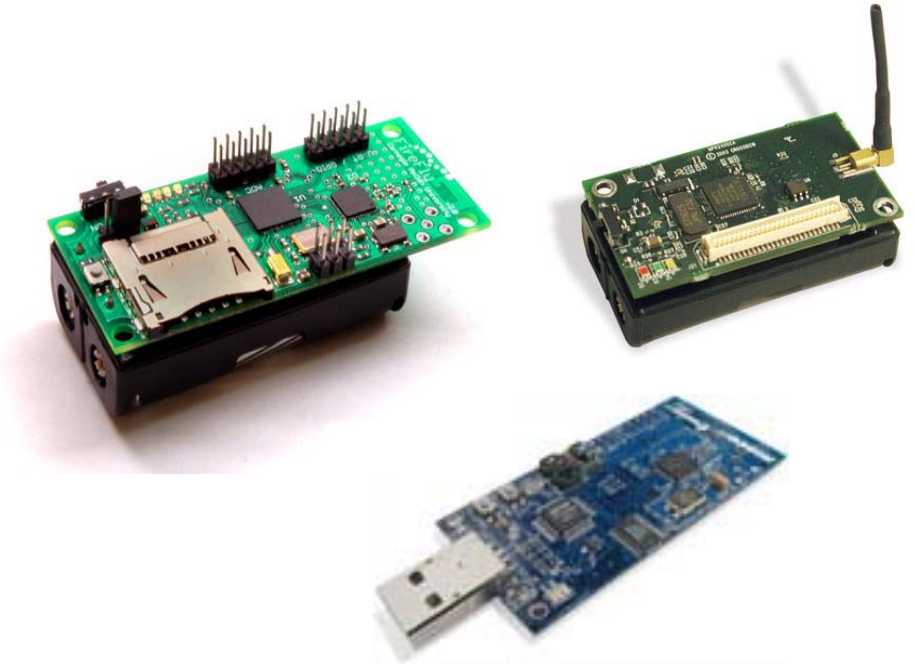
** Protocols listed are examples*

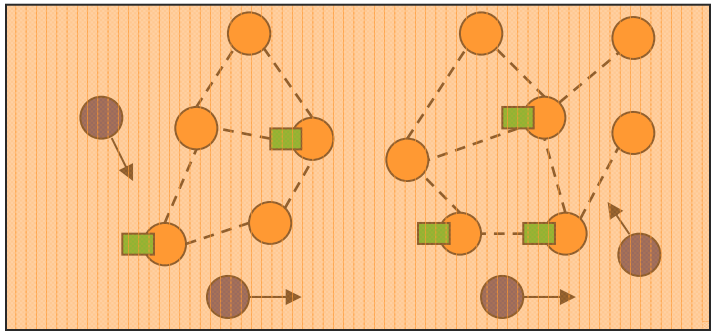
Some Sensor Andrew Projects

- **Sensor Platforms/Environments**
  - FireFly
  - Critters
- **Middleware**
  - Maples
  - Eddy
- **Video Processing**
  - Safe Campus Surveillance
  - Camera Face Detectors
- **Applications**
  - Social Networking
  - Distributed Pipeline Monitoring
  - RFID Based Guidance For First Responders

Sensor Layer Component Examples

- **Infrastructure nodes**
  - FireFly nodes
  - MicaZ/Tmote Sky Motes
  - RFID readers/tags
  - EnerSure
- **Mobile nodes**
  - Battery Operated Nodes
  - RFID Readers/Tags
  - Cellphones (w/ Bluetooth, Wifi, …)
- **Critters**
- **…**



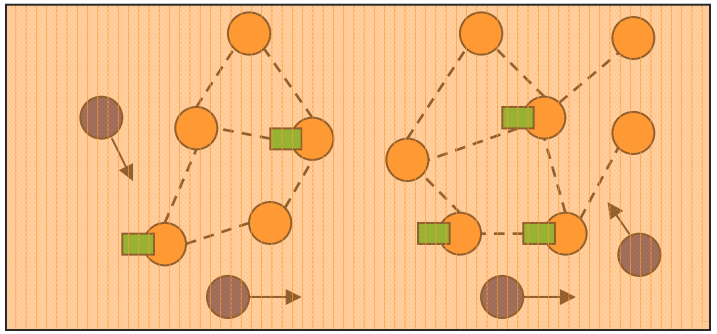


Example Sensors / Actuators

- **FireFly**
  - Light, Temperature, Sound, Acceleration (default)
  - Motion, Humidity, Ultrasound, Line Voltage Power Control, Image Processor (expansion)

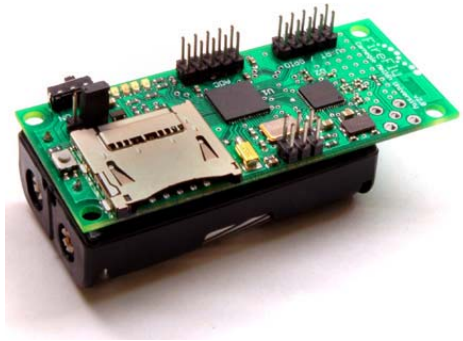
- **Smart Camera**
  - Blackfin-based DSP Camera
  - Wireless IP Camera

- **PZT Transducer**
- **Motes**
  - Light, Temperature, Humidity (default)
  - Magnetometer, Ultrasound, Acceleration (expansion)



- **Critters**

Hardware



FireFly sensor nodes

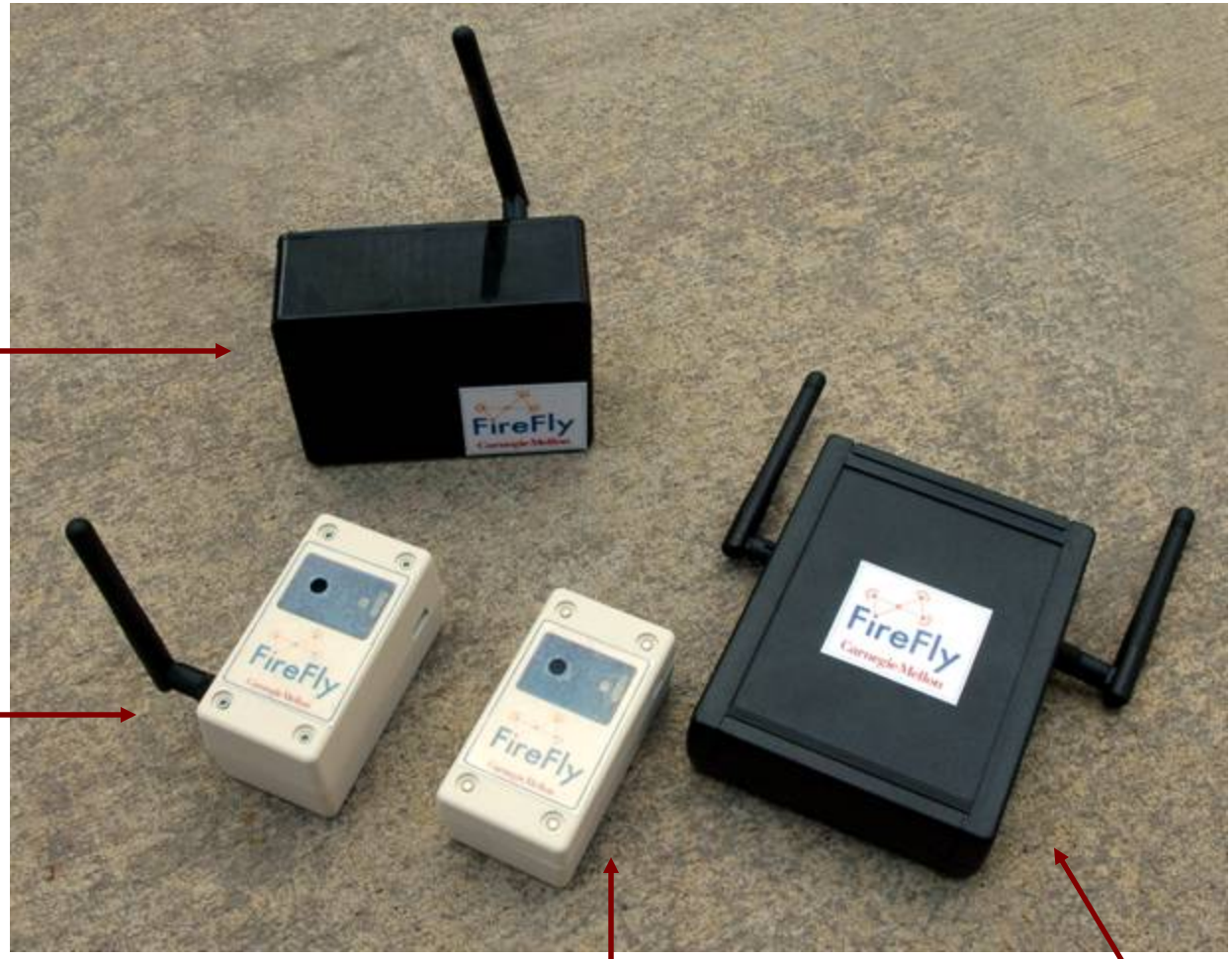
Time Synchronization

Smart Camera Nodes

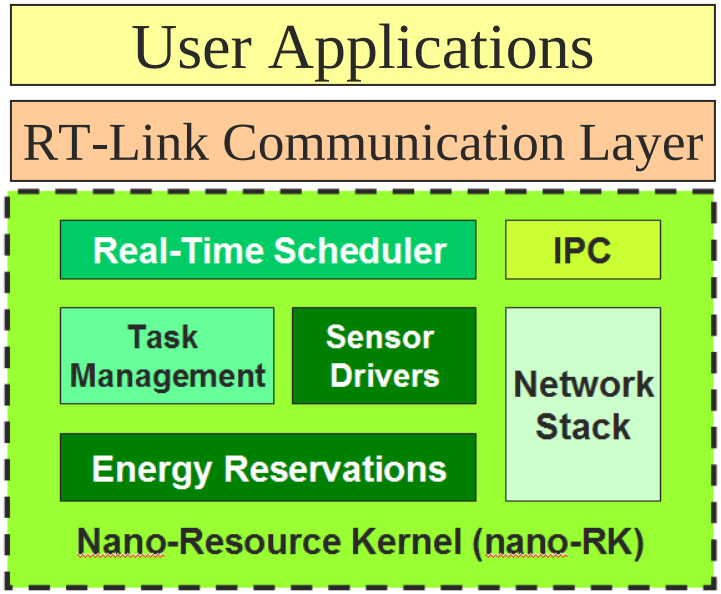
Line Voltage Control

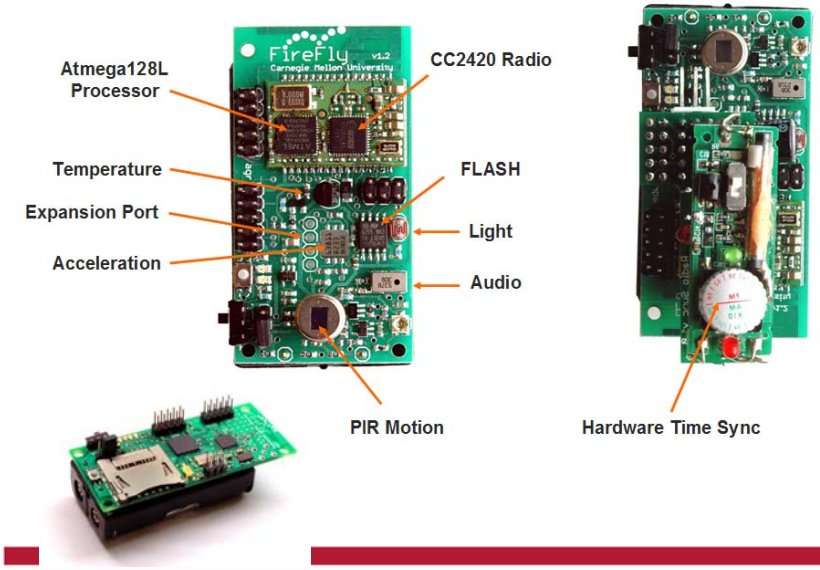
eWatch

FireFly Hardware



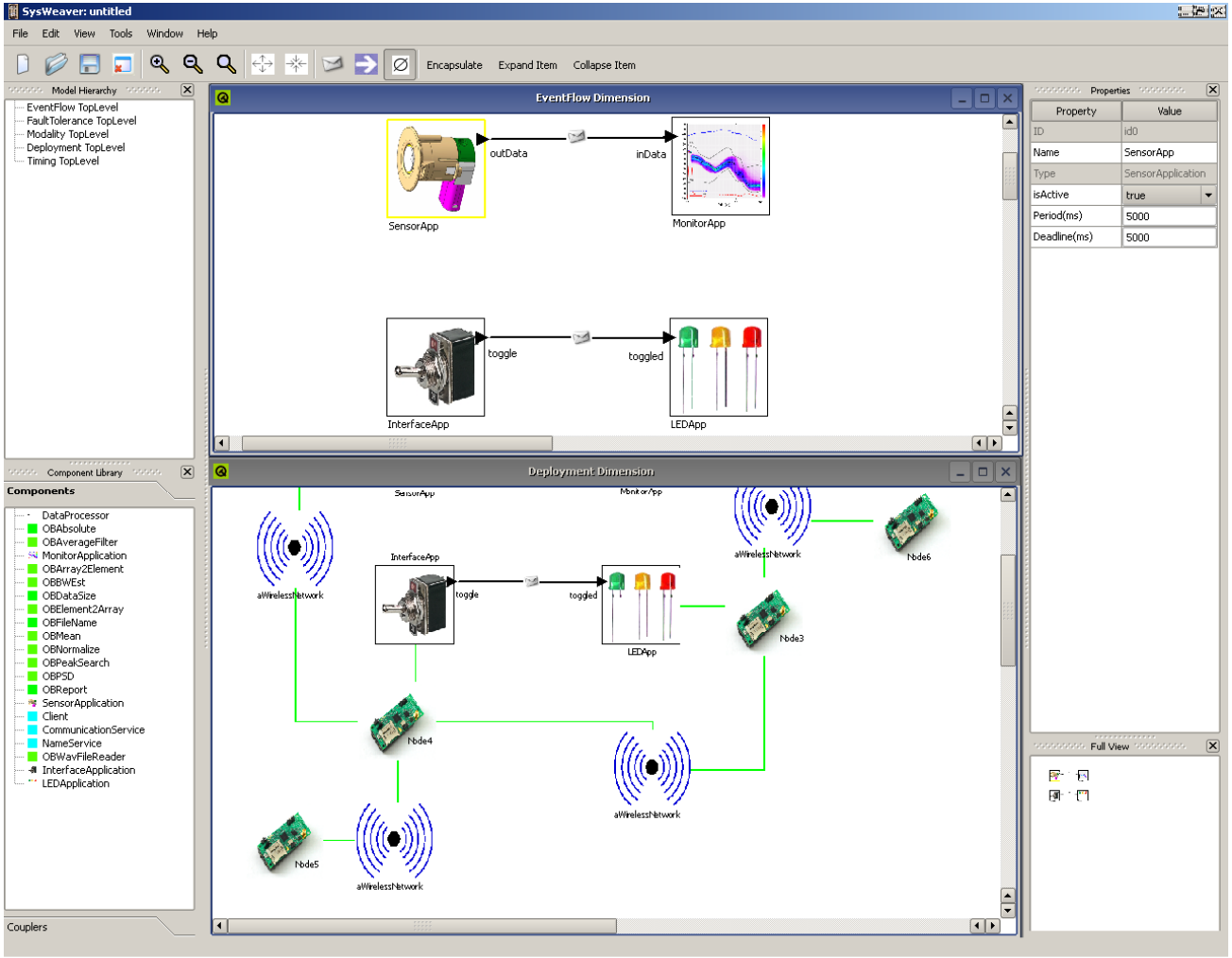
CMU FireFly Sensor Node





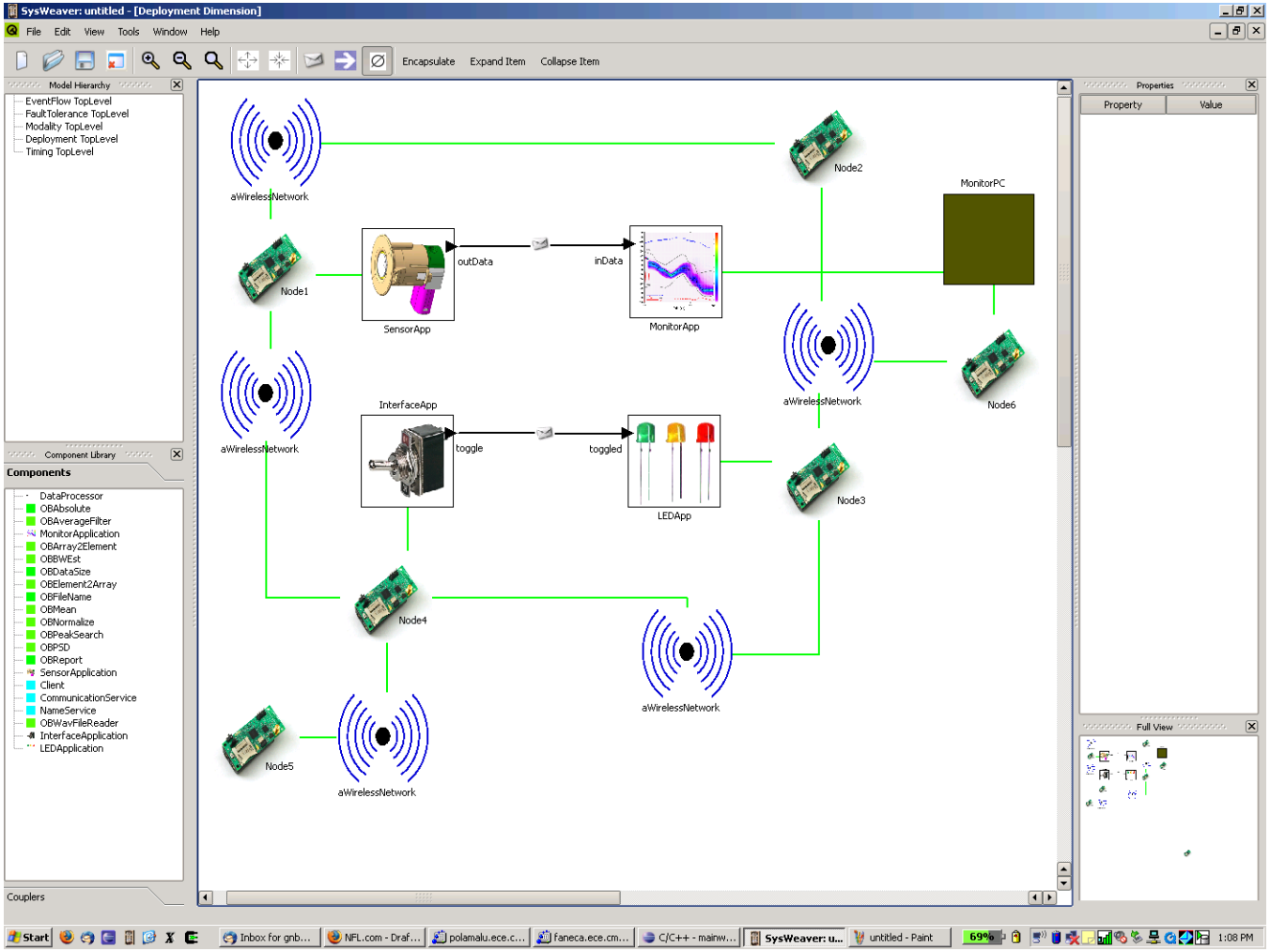
- Sensor Andrew deployment
- IEEE SECON (Best Paper)
- Multi-hop TDMA
- Download source code, documentation and tutorials from http://www.nano-rk.org
- Version 2.2 available in large quantities

SysWeaver Model



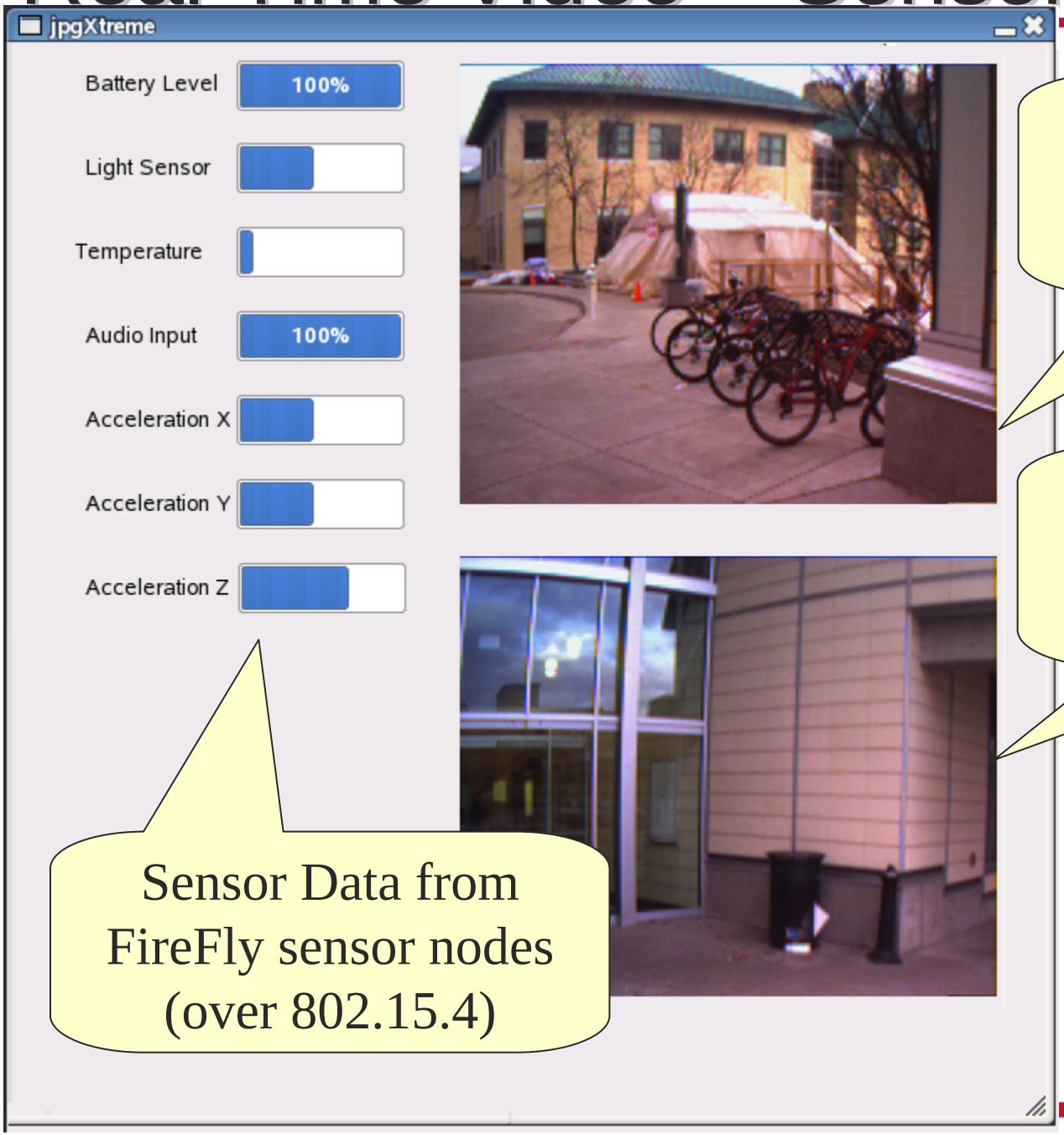
- Model consists of a Sensing Application sending data to a Monitor Application, and a Switch Interface toggling LEDs
- Software View is modeled separately from Deployment View

Deployment Model



- Deployment view consists of deployment of software components to Firefly nodes
- Wireless Network Couplers give an indication of which Nodes are within “hearing” distance of each other

Real-Time Video + Sensor Data



View from FireFly DSPcam A (through 802.15.4)

View from FireFly DSPcam B (through 802.15.4)

Sensor Data from FireFly sensor nodes (over 802.15.4)

JPEG compression performed locally on FireFly DSPcam's

Building Energy Monitoring

- Goals:
  - Detect trends and predict values of various energy efficiency investments.
  - Understand current building operation
  - Discover knowledge from existing conditions
  - Manage sensor and sensor networks
  - Develop tools for diagnosis.

Line Voltage Control

RFID Tags (long and short range)

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Sensor Placement

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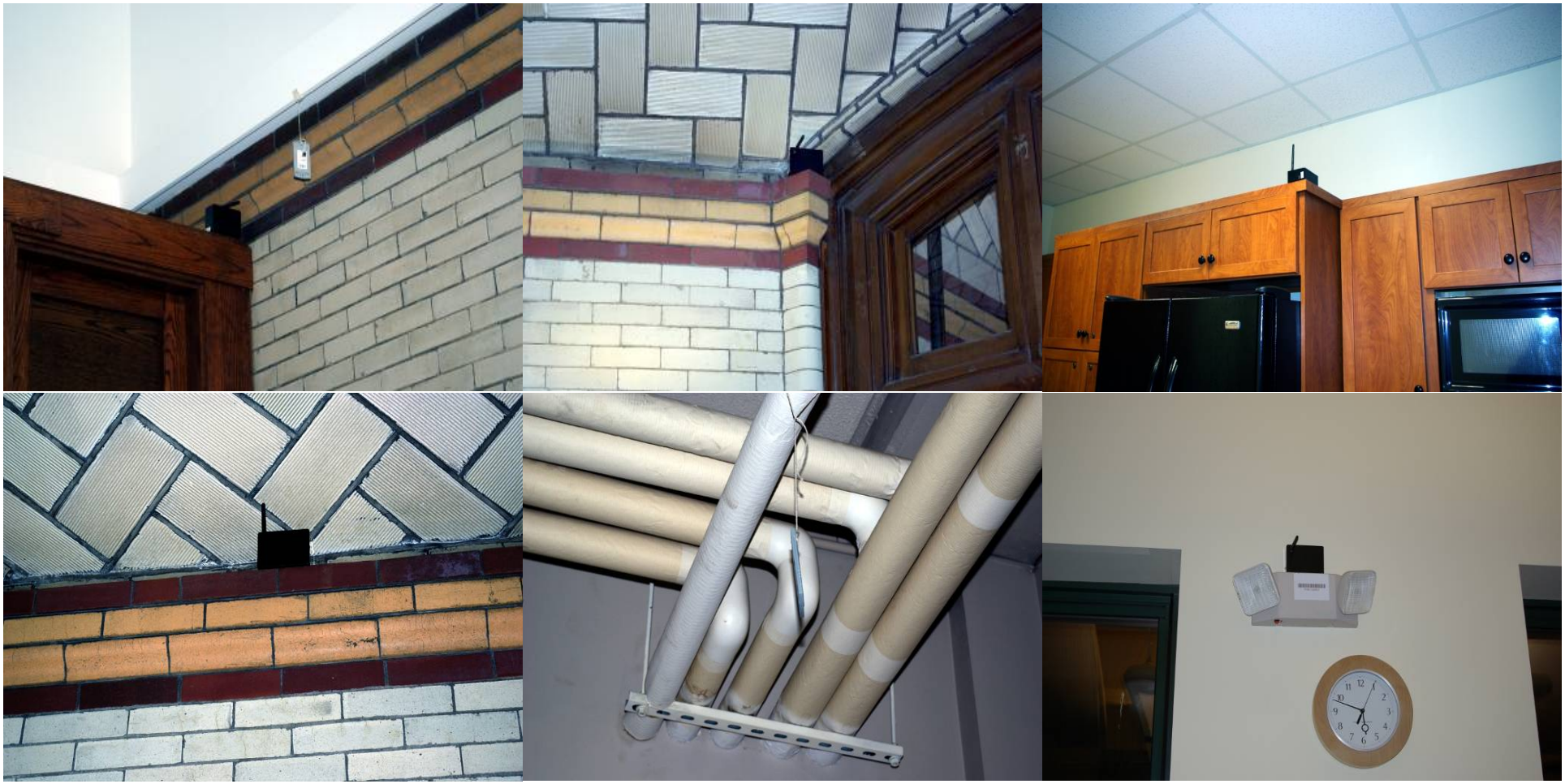
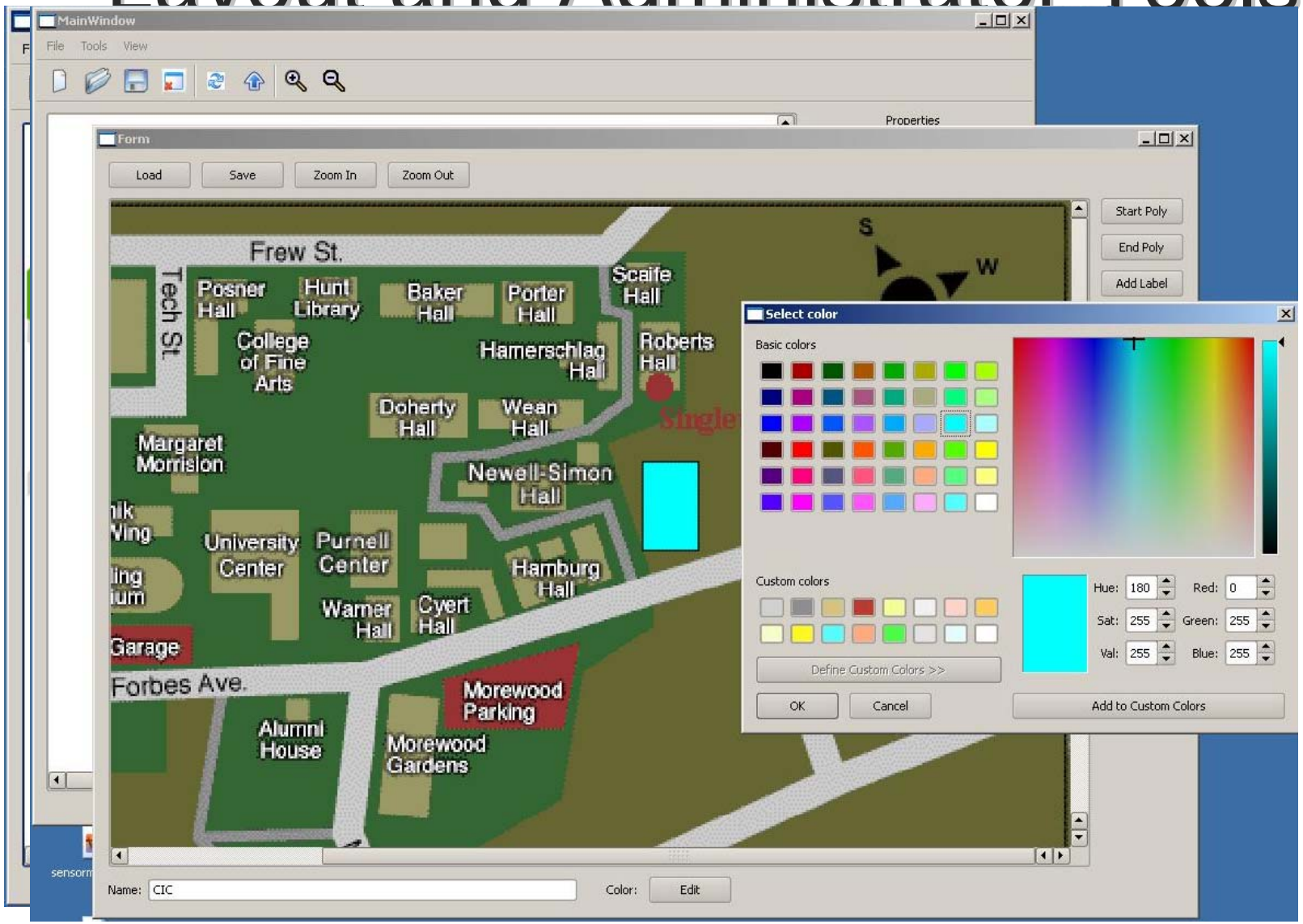


Layout and Administrator Tools



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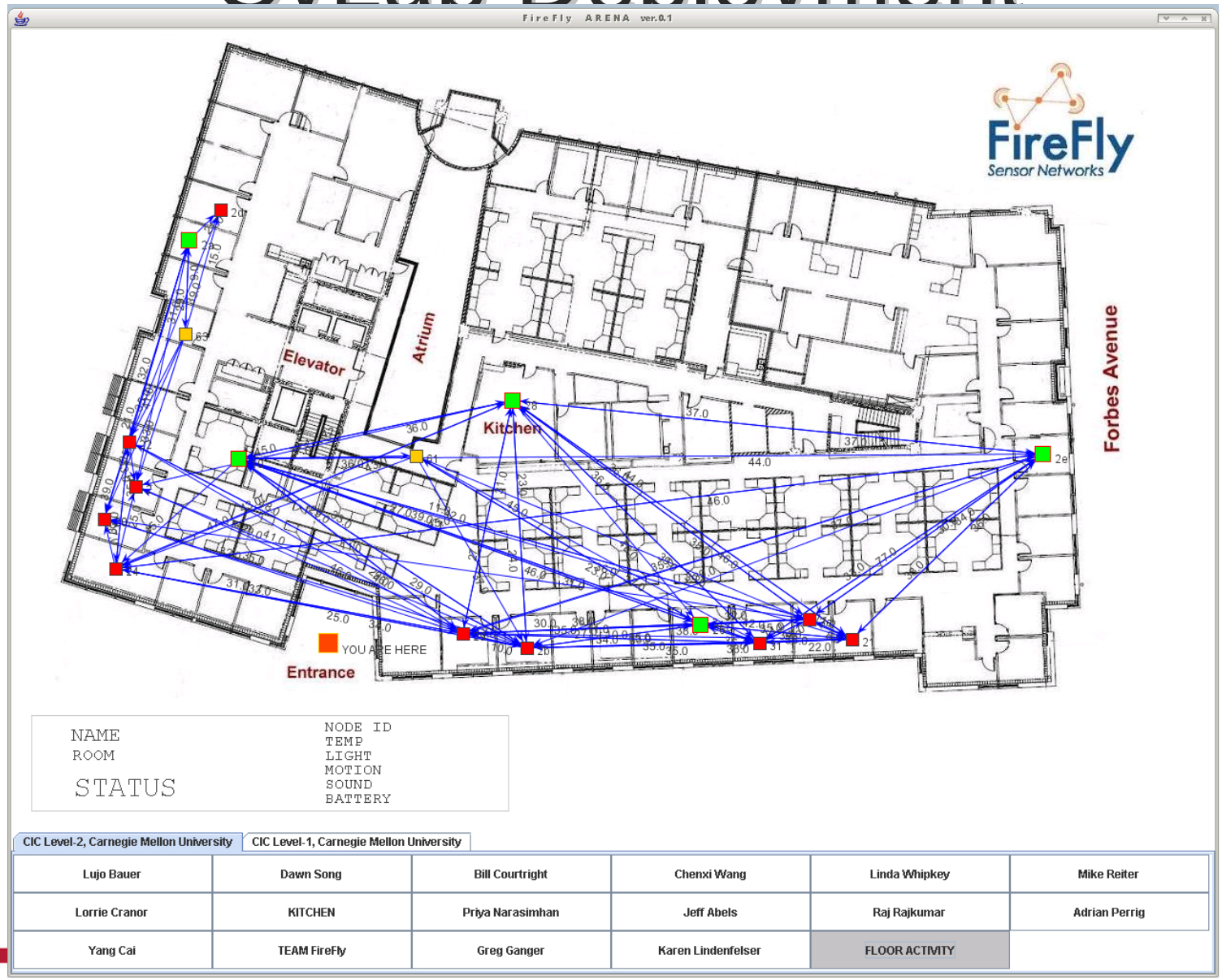
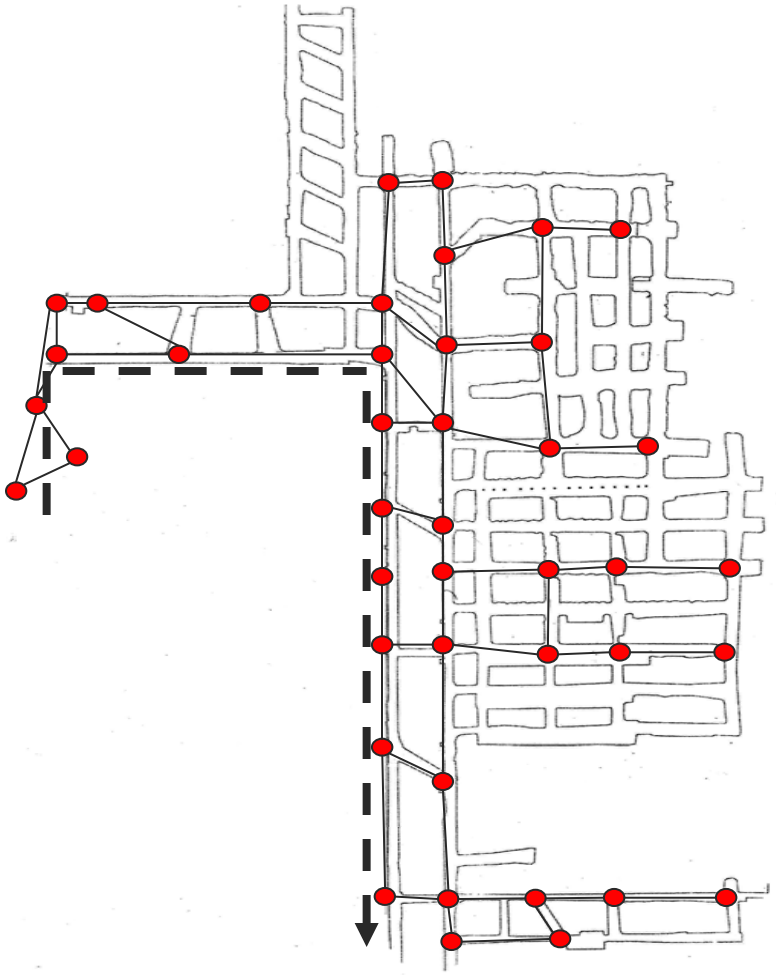
CyLab Deployment



Miner Tracking



Coal Mine in South Hills Test Deployment

Status

- Multiple faculty members and researchers working together
  - A platform and environment for true multi-disciplinary research
- Prototype deployment across 2 buildings
  - 2 other buildings in the process of being added
- Multiple applications in the process of being integrated

Large-Scale Real-Time Sensor/Actuator Network

- Wide range of sensors, actuators, tools and applications
- Security and privacy requirements
- Large-scale user base and deployment