An Extensible Sensing and Control Platform for Building Energy Management

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Anthony Rowe
Assistant Research Professor
ECE Department
Carnegie Mellon University

Mario Bergés
Assistant Professor
CEE Department
Carnegie Mellon University

Chris Martin
Senior Manager
Bosch Research and Technology Center
Pittsburgh

Partners

The Team

Anthony Rowe
ECE - CMU

Chris Martin
Bosch

Mario Bergés
CEE - CMU

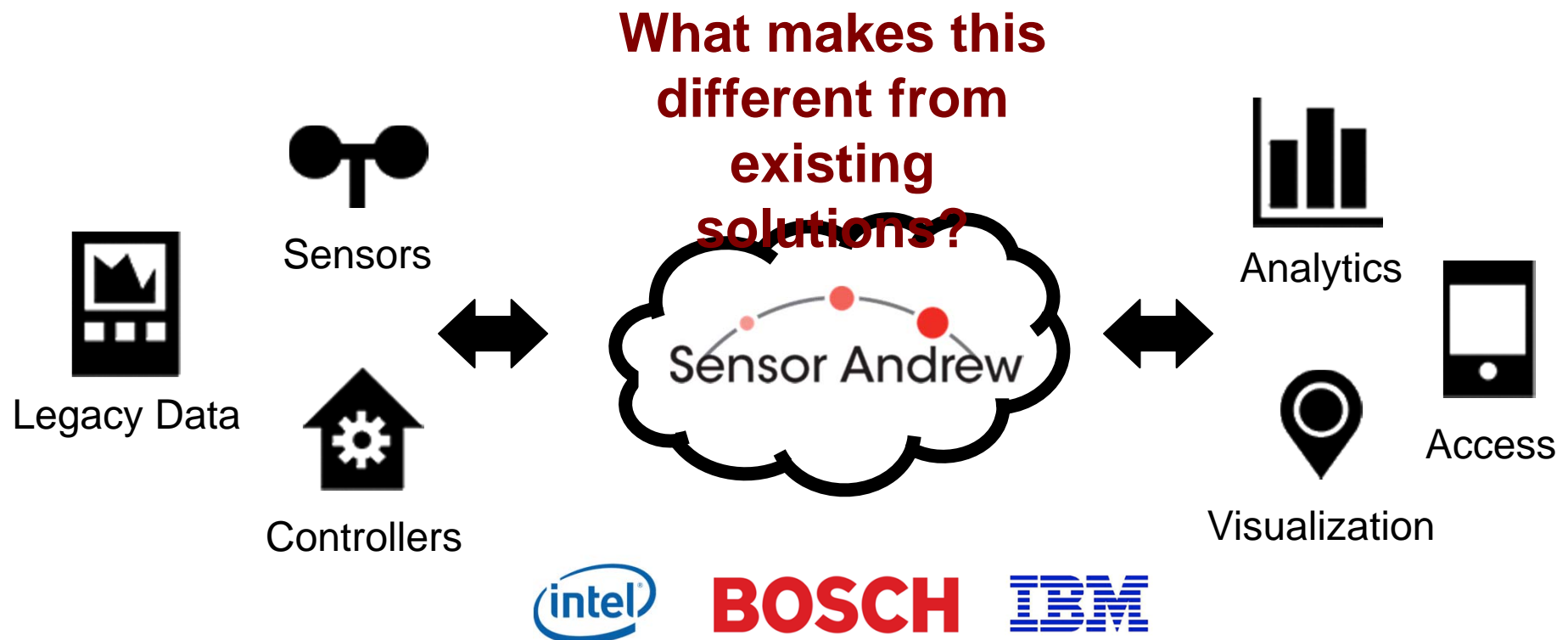Patrick Lazik
ECE

Max Buevich
ECE

Emre Kara
CEE

Jingkun Gao
CEE

Sensor Andrew

- Infrastructure to help connect the *virtual* and *physical world*
- Access, store, control, describe and search sensor data while maintaining security and privacy
- Internet-scale performance and Extensibility

What makes this different from existing solutions?

Legacy Data

Sensors

Controllers

Sensor Andrew

Analytics

Visualization

Access

(intel) **BOSCH** **IBM**

Some Differences

- Open source, community driven and hacker-oriented (SDK)
- Reuses existing solutions for:
  - Access control / Privacy
  - Internet-scalability
- Separates measurements from meta-data.
- Minimalistic meta-data schemas

Sensor Andrew Highlights

- **Networking**
  - Publish-Subscribe Architecture
  - Device-Level Access Control
- **Storage**
  - Multi-Resolution Time Series Database
  - Cloud-to-Edge Hand-off
    - High-resolution data stored at routers
    - Aggregates intelligently pushed to server side
- **Device Interfaces**
  - FireFly Wireless Sensing Platform, BACnet, Android@Home, NEST thermostat, Web Services, ModBus, PUP, Zigbee, Zwave

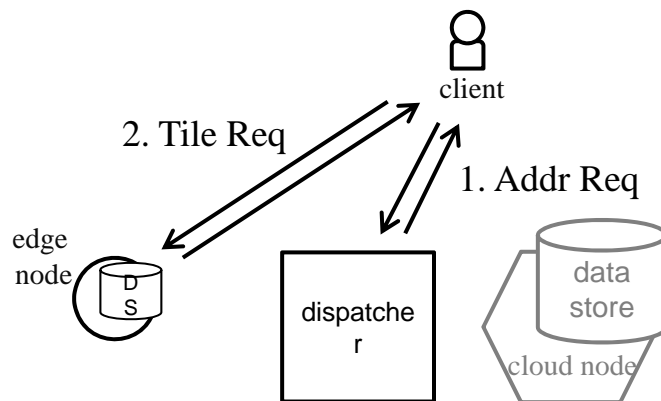# Respawn Distributed Datastore
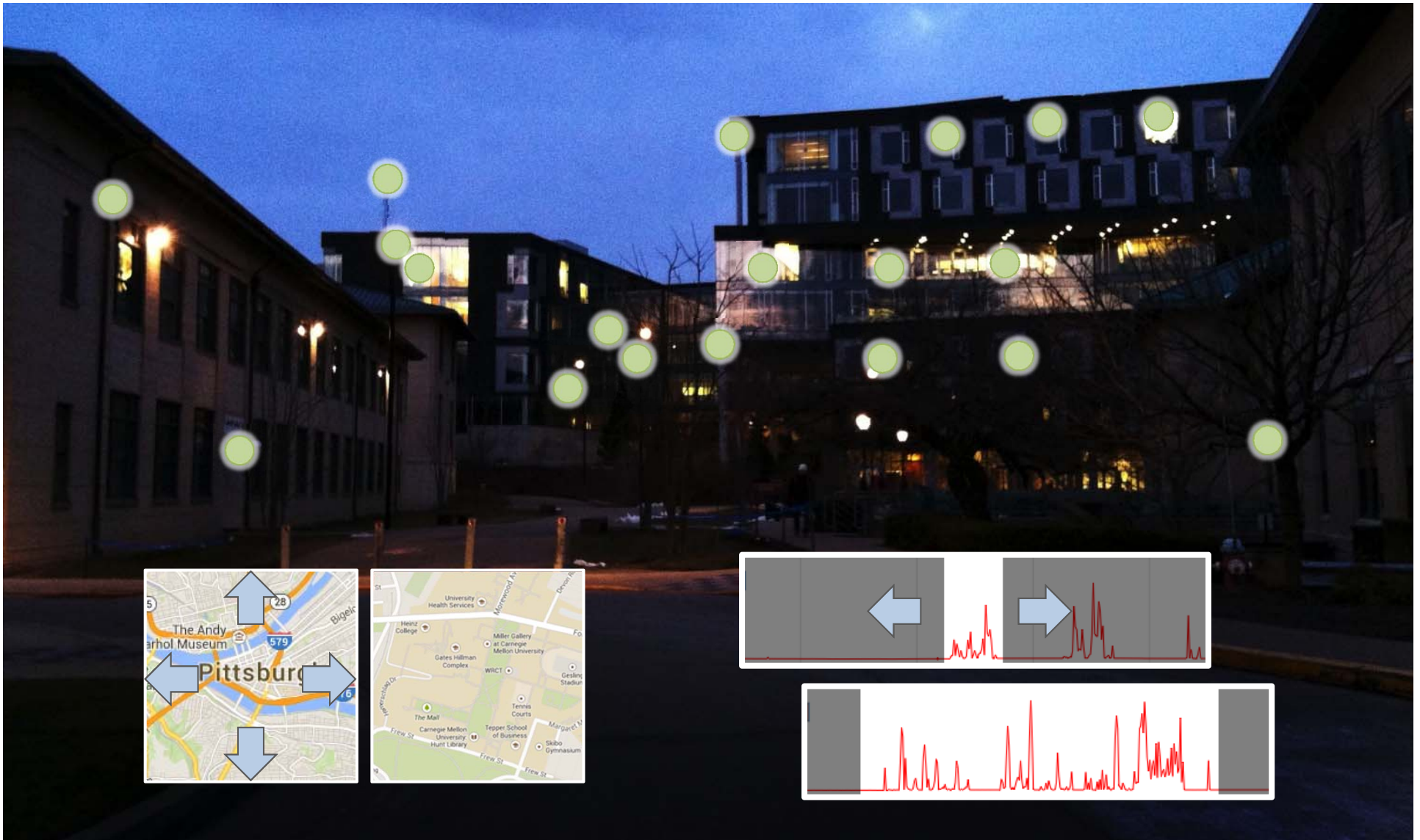
Respawn Approach

- Key techniques:
  - multi-resolution tiling / lossless compression
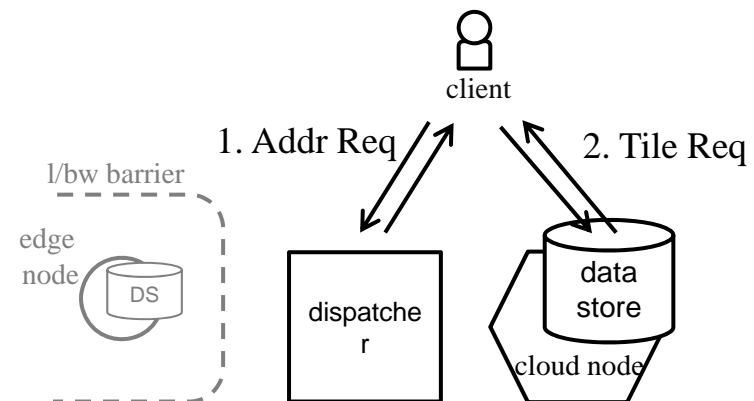 - cloud-to-edge partitioning

1.
2.
3.
4.

$f(x)$

$f(x)$
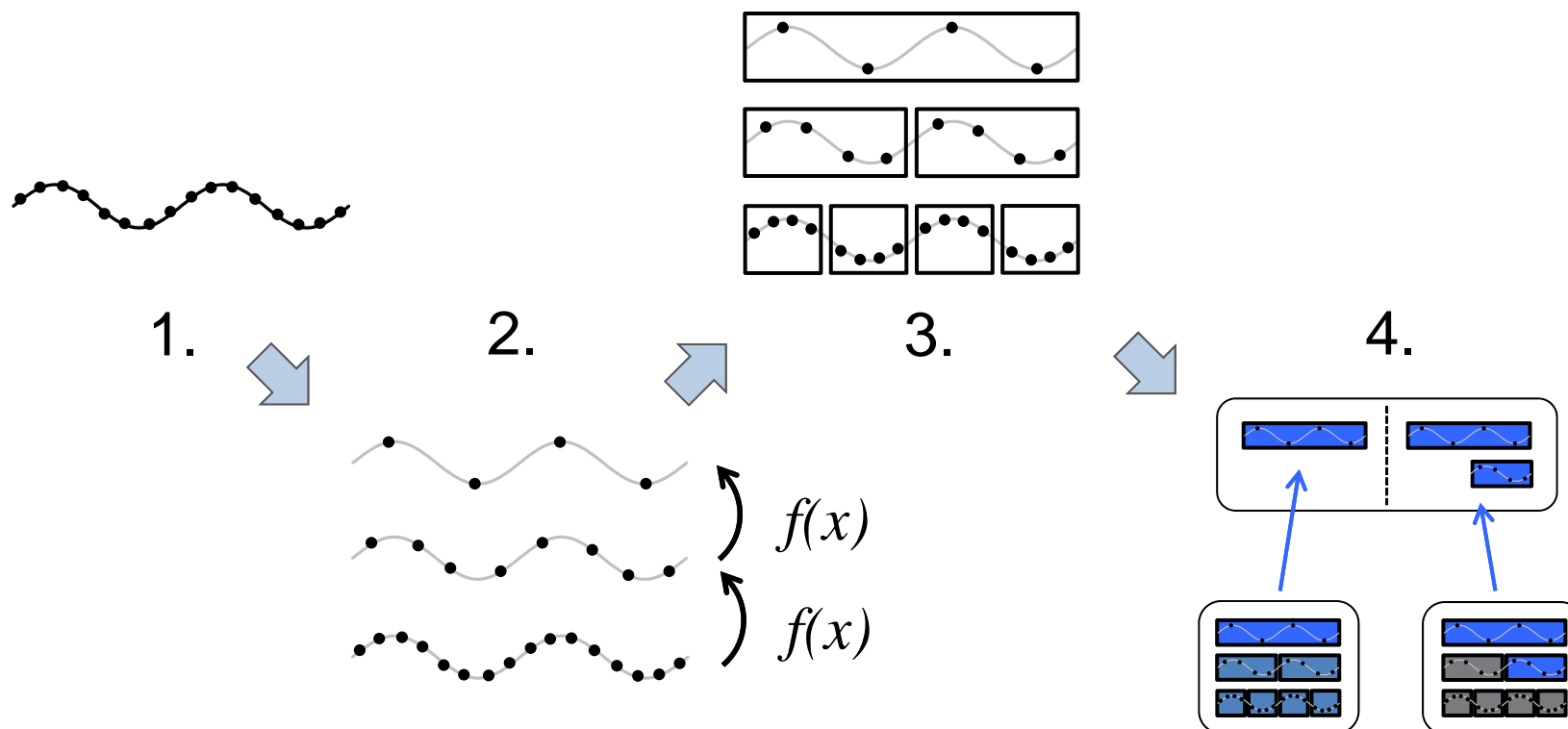
Request Handling

- Dispatcher redirects client requests to edge/cloud.
- **REQUEST:** (device, channel, level, offset)
  - *"HTTP/1.1 GET /tile/sensor.temperature/10.2609.json"*
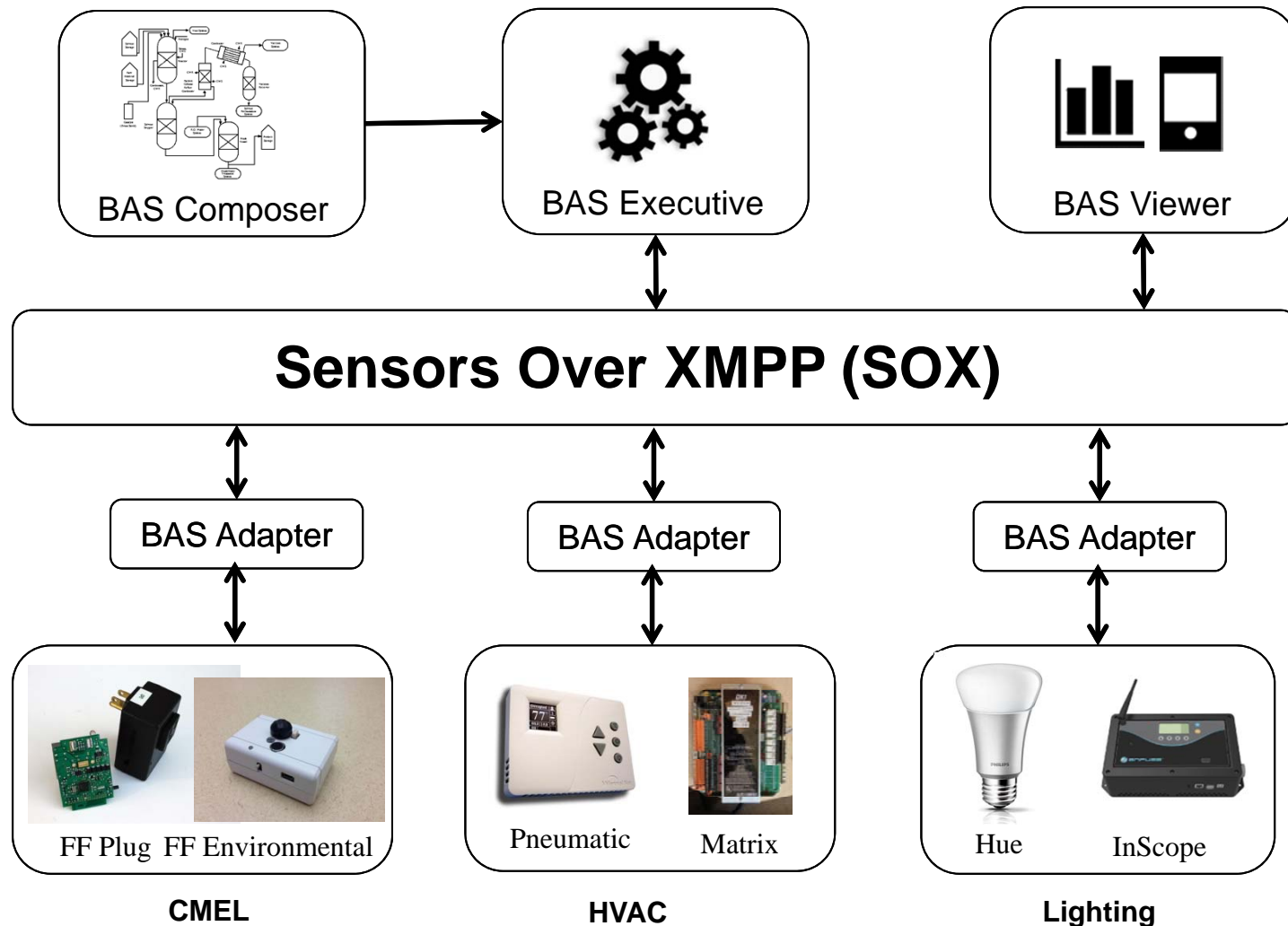- **RESPONSE:** JSON object

Edge Query   **Cloud Query**

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Sensor Andrew Applied to Building Automation Systems (BAS)

Scaife Hall Deployment

40,000 sq ft, 5 story, 140 room, 8 hallway, academic building built in 1962 with classrooms, auditorium, offices and labs.

Instrumentation Roadmap

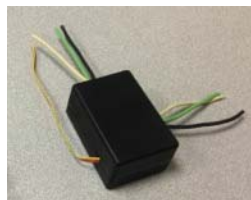### EnFuse Panel Meters
Electricity usage
11 x 48 = 528 feeds

AutoMatrix PUP Controller
HVAC
30 x 6 (inter-building) x 24 = 4320 feeds

Thermostat
802.15.4 Pneumatic thermostat with branch pressure monitoring
70 feeds

Fan Control Units
802.15.4 units for heat exchangers in each room
Control and power metering
170 feeds

OSRAM Lighting Controller
277 VAC lighting control
15 x 2 = 30 feeds

FireFly Environmental
Light, temp, humidity, sound, motion, vibration, pressure
120 feeds

Chilled Water and Steam
Temperature and flow-rate
2 x 2 = 4 feeds

Localization
ALPs + VLC Localization
Feed per person

Conclusions

- Existing Buildings
    - Rapid / low-cost deployment
- Leverage Open Standards
    - XMPP, IFC, BIM Surfer
- Scalable Backend
    - Storage, Communication, Analytics