DRAFT

IoT – Sensors for Data Center Management

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Topics

- Relationship of sensors and IoT

- Data Center Management (DCM) at LBNL
  - Extending the life of a legacy data center

- Alignment of Data Center sensor networks and the IoT

- Conclusion

Relationship of sensors and IoT

- IoT isn't a new concept
  - *In a few decades time, computers will be interwoven into almost every industrial product* - Karl Steinbuch, German computer science pioneer, 1966
- "Smart" objects play a key role in the Internet of Things vision[1]
  - Using sensors, they are able to perceive their context, and via built-in networking capabilities <u>they would be able to communicate with each other</u>, access Internet services and interact with people
- The *Things* in this talk are sensors used for Data Center Management

1. Friedemann Mattern and Christian Floerkemeier. 2010. *From the internet of computers to the internet of things*. In From active data management to event-based systems and more, Kai Sachs, Ilia Petrov, and Pablo Guerrero (Eds.). Springer-Verlag, Berlin, Heidelberg 242-259.

Data Center Management at LBNL:
Extending the Life of a Legacy Data Center

- In 2007 the IT Division began to work on a data center efficiency project[1]

- The data center:
  - Many years old
  - Approximately 5000 square feet
  - Raised floor
  - Approximately ½ MW power consumption
  - Cooled air forced under the floor and supplemented by overhead chiller system

1. Gregory Bell. 2008. *Towards a Greener Data Center: Tools & Techniques.* Presented at UCCSC 2008, UC Santa Barbara.

Data Center Management at LBNL

- Why bother with this old Data Center?
- Space is the final frontier at the Lab!
  - Limited for a number of reasons
    - Building ages range from many decades old to new
    - Challenging to get adequate power, cooling
    - Expensive to convert space to data center
- This old Data Center served two purposes
  - Space for clusters used for scientific computing
  - Space for servers supporting business systems
- Running out of power
  - Nowhere to move

Data Center Management at LBNL

- IT and Energy Experts got together to work on the problem
  - Measured, Analyzed and documented major systems in the data center
  - Performed Computational Fluid Dynamics analysis
  - Determined efficiency – established a reference point
- The assessment revealed:
  - Data Center was being over-cooled
  - Humidifying and Dehumidifying simultaneously
  - Lots of perforated floor tiles
  - Lots of panel blanks missing
  - Ineffective air-flows

Data Center Management at LBNL

- Improvements:
  - Several steps taken to improve air-flow:
    - Install panel blanks and curtains
    - Adjust the number and placement of perforated floor tiles
    - Converted the overhead plenum to hot-air return
    - Redirected the supplementary cooling to under-floor
  - Visualization of air-flow
  - Water cooling
- Deployed a wireless sensor system to measure and monitor efficacy of changes

Data Center Management at LBNL

- Wireless sensor system measured
  - Temperature
  - Pressure under the raised floor
  - Current
  - Humidity
- 200 monitors installed
  - Wireless sensors used 802.15.4; self-organizing
- System provided historical and real-time plots, enabling IT Data Center staff to see the impact of changes such as maintenance, system failures, etc.

Data Center Management at LBNL

- What was the outcome?
  - Increased IT load by more than 50% [1]
    - No increase in infrastructure energy use
    - Shut down unnecessary cooling systems

- This is just one small example, but the benefits are obvious.

- The techniques and tools referenced here have become best-practices and included in specifications

- How does this affect the trend of sensor deployment in Data Centers?

1. David Edgar and Ray Pfeifer. 2011. *Power Management in a Legacy Data Center*. UptimeInstitute Symposium, Santa Clara, CA.

Data Center Sensor Network Trend

- The same vendor used by the LBNL Data Center published 5 case studies[1]:
    - Sensors deployed in nearly 300,000 sq. ft. of various Data Center space
    - 14,235 sensors
- Project Genome
- More Sensor Trend data
- Transition

1. www.synapsense.com
2. *Semiconductor Wireless Sensor Internet-of-Things IoT Market Shares Strategies and Forecasts Worldwide 2014-2020, WinterGreen Research, February 2014*

Alignment of Data Center sensor networks and the IoT

- These wireless sensor networks align with the vision of the IoT
  - The vision of the IoT is that these networks:
    - Are able to perceive their context
      - E.g. a temperature sensor in a data center monitoring system
    - Are able to communicate with each other
      - Automatically connect in a mesh network
    - access Internet services
      - Probably not as much as other IoT devices
    - interact with people
      - Probably not as much as other IoT devices

- Transition

Conclusion

- Environmental sensors in Data Centers are essential to maintaining efficient operation
- The life of a legacy data center was extended by
  - Conducting an analysis of the data center systems
  - Documenting these systems and calculating the efficiency of the data center
    - Establish the reference
  - Making improvements
  - Continually measuring and monitoring the environment
    - This was done with a wireless sensor system
- The techniques used in this Data Center have become best-practices in Data Center Management

Conclusion

- Data Center Management is one use-case for the Internet of Things
- Given the numbers and sizes of Data Centers, DCM will contribute to the growth of the IoT
- Open question:
  - Are there use-cases that could benefit through standardization?
- Still need more information
  - Many other DCM use-cases
  - Many other use-cases
  - Please contribute!