SNIA DSI DATA STORAGE INNOVATION CONFERENCE

Leveraging Ubiquitous Sensors to Predict Failures and Discover Data Center Flaws

Teague S Algie

Cleversafe

SNIA

Purpose and Motivation

The Possibilities:

- Decreased cost of deployment
- More information to correlate with and predict failures
- Help find datacenter cooling inefficiencies

The Roadblocks:

- Insulation of sensors
- More work involved to use collected data
- Limited only to sensors which are built into devices

Presentation Overview

- What are some of the ways sensors are generally used in a datacenter?
- How can we use onboard sensors as stand-ins for external sensors?
- How can we learn to leverage this sensor data more effectively?

Available Sensors

- Water leak detector
- Humidity

Available Sensors

- Motion Detector
- Smoke Detector

Available Sensors

- Power Availability
- Switches

Available Sensors

- Airflow
- Accelerometers

Available sensors: Temperature

Air conditioning

Available sensors: Temperature

Room

Available sensors: Temperature

Rack

Onboard Sensors

- CPU thermal sensors
- Hard Disk and Solid-State Drive thermal sensors
- Chassis internal temperature sensors

Other Available Information

- Fan speed
- Power use
- IO and device load stats

Candidates for Replacement?

- Water Leak Detector
- Humidity Sensor
- Motion Detector
- Smoke Detector
- Power Use/Availability
- Airflow Sensor
- Accelerometer
- Temperature

Candidates for Replacement?

• Water Leak Detector	NO
• Humidity Sensor	NO
• Motion Detector	NO
• Smoke Detector	NO
• Power Use/Availability	YES
• Airflow Sensor	YES
• Accelerometer	NO
• Temperature	YES

Candidates for Replacement

Power Use/Availability

- Metrics are available
- Best to use dedicated device

Candidates for Replacement

Airflow Sensors

- No outside-rack information available inside the rack
- Fan speeds indicate target airflow rate
- Limited usefulness

Candidates for Replacement

Temperature Sensors

- Most available sensor
- Most direct readings
- Problems with sensor insulation

Problems using internal sensors

- Physical insulation
- Sensitive to individual device failure
- Device locations must be known

Load vs. Temperature

- Higher CPU loads, disk activity, will cause temperatures to increase if unchecked
- Higher core/memory voltages and clock speeds contribute to increased temperatures
- Fan speeds increase in an effort to bring temperatures down

External Influences to Temperature

- Other local devices
- Intake temperature
- Airflow obstructions

Model for Normalizing Temperatures

(CPU*i + HDD*j – Fans*k) = Thermal Contribution (T)

(Intake Temperature) + (T) = (Measured Temperatures)

(Measured Temperatures) – (T) = (Intake Temperature)

More Data Matters

- Polling frequency and device load
- Know your history
- More data results in a better model

What Sensor Interpolation Provides

- Intake/exhaust temperatures
- Hot/cold aisle estimates
- Limited air flow information

Using Internal Sensors

Air conditioning and room focused

- Temperature rises over entire datacenter
- Temperatures are in a gradient
- Multiple racks with heat issues
- Average temperatures at specific heights/regions

Using Internal Sensors

Rack and Machine focused

- Temperature rises only in a specific rack
- Temperatures gradient inside the rack
- Match best practices for rack sensors
- Relationship between neighbor machines

Findings

- Temperature variations by height
- Device internal temperature variations
- Rack temperature accuracy
- Variations in temperature by device type

Taking It To The Limit

- Throttling and overclocking
- Load balancing
- Active zone management (air management)

The Future

- Data indicates support for the hypothesis
- More data collection! (also stuff we can't get yet)
- Datacenter and device heat visualizations
- Obtain negative test data(blck vents)

Q&A

Questions?