Towards Self-Conscious Buildings through connected products

Oct. 27th 2015
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Including nearly 90% of the world’s tallest buildings
And some of the most iconic spaces and places
We create efficiency for the life of buildings
A historical note on the IoT

1999 - A big year for the IoT and MIT

The Internet of Things term is coined by Kevin Ashton executive director of the Auto-ID Center:

"I could be wrong, but I'm fairly sure the phrase "Internet of Things" started life as the title of a presentation I made at Procter & Gamble (P&G) in 1999. Linking the new idea of RFID in P&G's supply chain to the then-red-hot topic of the Internet was more than just a good way to get executive attention. It summed up an important insight which is still often misunderstood." - Full article

Hype Cycle for Emerging Technologies, 2011
Connectivity is table-stakes now, but is it a box to be checked or a way to create value?

https://twitter.com/pmarca/status/562149152948113408
Role of Connectivity in Enabling New Business Models

- Provide product differentiation as we know more on how customers use products
- Broaden the value proposition beyond the physical product – include valuable data and value-added services
- Allow us to develop closer relationships with customers and contractors
- Accelerate adoption of customer support and merchant services
Products connect to ???

- Product to Infrastructure
  - Building structure integrity data aggregator (e.g., a gateway) talks to infrastructure
- Product to Environment
- Product to Human
  - Adjust airflow for person X
  - Thermostat talks to occupant
- Product to OEM and/or service provider
- Product to Enterprise
- Product to Product (within the same industry)
  - E.g., BAS Controller talks to other BAS controller
- Product to other internet connected products from X (across industries)
  - A building automation gateway offers data brokerage service to personal health insurance industry, assisted living care provider, and remote security monitoring service provider.
The Smartest Building in the World

Inside the connected future of architecture

By Tom Randall | Sept. 23, 2015
Connected product will change

- Manufacturer
- Distributor
- Reseller/Service Provider
- Owner or End user
- Reseller/Service Provider
- Manufacturer
- Distributor
- Owner or End user

Customer Relationship
**Architecture (Current JCI’s IoB technology stack)**

<table>
<thead>
<tr>
<th>Data Producers</th>
<th>Aggregation</th>
<th>Ingestion (distributed)</th>
<th>Transformation</th>
<th>Storage &amp; Compute</th>
<th>Visualization &amp; action</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAS</td>
<td>Cloud Gateways (APIs)</td>
<td>Scalable event Brokerage Service</td>
<td>Real-time analytics (Storm/Orleans, NRT)</td>
<td>Storage</td>
<td>Web/thick client dashboards</td>
</tr>
<tr>
<td>Equipment</td>
<td>Field Gateways</td>
<td></td>
<td></td>
<td>External data sources</td>
<td>Search and query</td>
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<td></td>
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<td></td>
<td></td>
<td>Data analytics (R/Spark..)</td>
</tr>
</tbody>
</table>
Connected Offering Platform, 1.0

OT (Operational Technology)

IT (Information Technology)

JCI Connected Offering Platform

Connected Offering IoT Platform

Microsoft Azure

JCI BE Data Lake

ERP

CRM

PLM

Financial
Things I’m not going to talk about

- Use of IoT in our manufacturing enterprise
- “IT” data ingestion – streaming data of database changes
- In-depth algorithms we use for fault detection on mechanical systems
- Security – especially authorization
- HVAC
- *Too* much about our business models
Typical Streaming Data Analytics

- “Cleaning” data
  - Bad sensor readings, meter rollovers or resets, missing data

- Online Modeling
  - Based on regression model, predict next few hours of energy spend
  - Update model with new data

- Signal extraction
  - Transform data streams onto a new basis to better describe features

- Anomaly and Fault Detection
More Streaming Data Use Cases

- **Aggregation**
  - More independent than many Time Series databases assume, less server-farm focused
  - Rollup of a single series rather than vertical slices across all

- **General algebra on streams**
  - “Virtual” meters - Meter C is the sum of Meter A and Meter B
  - Incorporate external data sources, e.g. weather, schedules
Things that keep me up at night: Deployment
Sometimes we can’t get the cloud!
Where’s the SQLite of Streaming?

https://twitter.com/codinghorror/status/347070841059692545
More things that keep me up at night: Transactional Handoff

- Updates either need to be idempotent or coordinated
  - If my Actor Model is pushing to a stream and crashes, how do I recover?
- One missing link and we have to build a whole workaround ourselves
Things that we really like: **Python + Pandas**

- **What’s Good?**
  - We’re a big MATLAB shop and will continue to be, but easy to pickup
  - Rich library to talk about timeseries – especially dates and times
  - General purpose programming language with great ecosystem
  - Fast, but expressive.

- **What’s the worry?**
  - Not so good with streaming.
  - Maybe Ibis will fix? Spark Streaming/PySpark?
Things that we really like: **Portable Format for Analytics**

- **What’s Good?**
  - Declarative/intermediate representation of computation
    - Useful functions, abstract representation of computation that seems reasonable
  - “Compiles”/has runtimes for multiple systems, from single node to big clusters

- **What’s the worry?**
  - Not clear that it’s efficient.
  - Very Early Days

- [http://dmg.org/pfa/index.html](http://dmg.org/pfa/index.html)
Things that we really like: Google Cloud Dataflow

- **What’s Good?**
  - Rich windowing
  - Restatements

- **What’s the worry?**
  - Embedded in a language and hard to reason about outside of system
  - Early days
Things that we really like: **Streaming Storage Systems & Platforms**

- **What’s Good?**
  - Kinesis, Cloud PubSub, Azure Event Hub: solve a real problem
  - Amazon IoT, Azure IoT Hub: one level up, also solving real problems

- **What’s the worry?**
  - For non-cloud, Kafka it is, I guess?
  - IoT platforms, build out our own?
Thank You!