Are Device Response Times a Neglected Risk of IoT?

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About me: Balwinder Kaur

• Architect and Software Engineer
  – IoT since 2014 ([Delivered a Video Development Kit](#))
  – Android Camera Stack
  – Mobile (pre-smart phone era)
  – Enterprise Software
• Emerging Technologies @ AppDynamics
• @bkaurca
• #OpenIoT
• balwinder.kaur@appdynamics.com
Why This Talk?

HOUSTON...

WE HAVE A PROBLEM
Agenda

- The Ecosystem
- The Problem
- The Solution
- Best Practices
The Ecosystem

The Problem

The Solution

Best Practices
The Changing Consumer
I WANT IT ALL
AND I WANT IT NOW...
Millennials

- Digital Native
- Impatient
- All services working 24x7
- Seamless Access from all devices
- Multi-Taskers
- Short Attention Span
Response Time Expectation

2000
10 sec

2015
1 second

Goal
0.1 second

Source: WirelessWeek Article
The Changing Enterprise
Growing Complexity

- Web
- Mobile
- IoT
- Network
- Microservices
- Async
- Agile
- Cloud
- Web Server
- Messaging Queue
- App Platform
- No SQL DB
- SQL DB
- No SQL DB
- APACHE
- Application Server
- NOSQL
What’s Becoming More Complex?

1. More access points
What’s Becoming More Complex?

1. More access points
2. Finer Grained Services
3. More external Services
What’s Becoming More Complex?

1. More access points
2. Finer Grained Services
3. More external Services
4. Extremely Async
What’s Becoming More Complex?

1. More access points
2. Finer Grained Services
3. More external Services
4. Extremely Async
5. Ephemeral Services
Latency Management

Uptime = $$\$\$

Ultimately, Uptime = Success of the IoT Business

- Voluminous Scale
- Highly Distributed
- Cross Organizational Transactions
Launching an IoT Solution
**Top IoT Concerns**

*What are your top 2 concerns for developing IoT solutions?*

- Security: 47.4%
- Interoperability: 29.4%
- Connectivity: 22.3%
- Integration with Hardware: 20.9%
- Cost: 18.6%
- Performance: 16.3%
- Privacy: 15.7%
- Complexity: 13.2%
- Maintenance: 12.1%
- Data Analytics: 11.3%
- Certification/Conformance: 6.7%
- Other: 2.5%
- I don't know: 2.5%
Risk Assessment - After Deployment

**Organizations that have IoT Solutions Today**

What are your top 2 concerns for developing IoT solutions?

<table>
<thead>
<tr>
<th>Concern</th>
<th>Organizations that have deployed an IoT solution</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security</td>
<td>48.3%</td>
<td>47.4%</td>
</tr>
<tr>
<td>Interoperability</td>
<td>31.9%</td>
<td>29.4%</td>
</tr>
<tr>
<td>Connectivity</td>
<td>19.7%</td>
<td>22.3%</td>
</tr>
<tr>
<td>Integration with Hardware</td>
<td>19.3%</td>
<td>20.9%</td>
</tr>
<tr>
<td>Cost</td>
<td>16.4%</td>
<td>18.6%</td>
</tr>
<tr>
<td>Performance</td>
<td>16.3%</td>
<td>21.0%</td>
</tr>
</tbody>
</table>

Note: Performance becomes #3 issue.
MTTR
Mean Time To Resolution

KPI for Success
Performance Impact

Backend Services

Devices
The Ecosystem

The Problem

The Solution

Best Practices
Teresa

Director, IT Services
Inventory Management Company

• Manage web applications on the cloud for customers to fulfil their orders from mobile and web.
• Recently launched an RFID based automated inventory management system
• It is now possible to track and manage inventory in real time.
• The backend applications see an unexpected load that is bringing down her systems
Ivan

Head, Operations
White Goods Company
• Recently Launched a connected washer dryer system
• Getting complaints of unresponsive control panels.
Where can problems happen?

- Devices Unavailable
- Devices Unhealthy
- Network Lags
- Third Party Cloud Services
- Backend Service Problems
Deep Dive - Problems Originating from Devices

- Power
- Connectivity
- UI
- Mobility
- CPU
- RAM
- Storage
- Version mismatch
Deep Dive - Problems Originating from Aggregation of Devices

- Scale of Devices
- Volume of Data
- Velocity of Data
- Variety of Data

Highly Distributed
Hybrid Environments

User Response Time Expectations
1.0 second
0.1 seconds

1 wirelessweek
Poor MTTR

- Trapped Metrics
- Manual Correlation
- Manual Remediation
- Organizational Gaps
End to End Monitoring Solution

Availability

Performance

Correlation

Remediation

Analytics
Device Side Instrumentation

Capture and report Device Metrics

Capture and report Device Events
Enterprise Grade Performance Monitoring Solution

- Instrument all kinds Apps
- Aggregate Data at Scale
- Correlate
- Single Pane View of the Enterprise
Enterprise Grade Performance Monitoring Solution (contd)

- Deep instrumentation
- Diagnose Problems Quickly
- Provide Alert Mechanisms
- Measure the Business Impact
Recap
The business services see an unexpected load bringing down the systems

Problem
• The RFID reader was updating the GPS coordinates every minute whether the value changed or not!

How it was detected
• Both the backend Java Webservice and the RFID reader were instrumented for performance metrics
• The Application Monitoring Solution was able to correlate that the traffic from the RFID reader was very high

Solution: An OTA update to the RFID reader solved the problem.
Ivan

Recap
Connected Washer Dryer had unresponsive panels

Problem
• The HTTP Endpoint was upgraded w/o informing the device team

How it was detected
• Both the backend java webservice and the Washer Dryer were instrumented for performance metrics
• The Application Monitoring Solution was able to correlate that the traffic from the Washer Dryer was ending up in timeouts

Solution: The Webservice team rolled back their change until Ivan’s team was ready with a patch.
The Ecosystem

The Problem

The Solution

Best Practices
Best Practices – For the Device Manufacturer and Embedded Application Developer

• Runtime performance instrumentation is now a Must-Have, not a Nice-To-Have
• Allocate CPU/Memory Budget for it. – 2 ~5% overhead is a good estimate
Guidelines to choosing an agent

Choose an agent with following attributes:
• Configurable
• Controllable
• Small Footprint
• Secure
• Available in your favorite programming language
  – Languages that support Auto instrumentation like Java, post compile time auto agents is an option.
• Collect and send Crash Information
• Supports Offline mode
Best Practices – For the IoT Cloud Service Provider

• Make runtime performance instrumentation agent on the device as part of your acceptance plan
• Ensure it provides a heartbeat.
• Ensure it provides
  – Device health metrics
  – Application transaction health
  – Application crash info
  – Customizable to tag w/ Business Metrics
• Understand that requirements for Embedded Agents differ than those on the Backend
Choosing Instrumentation Agents for IoT Devices

<table>
<thead>
<tr>
<th></th>
<th>Web Agent</th>
<th>Embedded Agent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Message Payload Format</td>
<td>JSON</td>
<td>ProtoBuf, CBOR, BSON</td>
</tr>
<tr>
<td>Application Layer</td>
<td>HTTP/HTTPS</td>
<td>MQTT/MQTT-SN, CoAP</td>
</tr>
<tr>
<td>Security</td>
<td>TLS</td>
<td>DTLS</td>
</tr>
<tr>
<td>Transport Layer</td>
<td>TCP/UDP</td>
<td>UDP</td>
</tr>
<tr>
<td>Network Layer</td>
<td>IPv4/IPv6</td>
<td>IPv6/6LowPAN</td>
</tr>
<tr>
<td>Link Layer</td>
<td>Ethernet, 802.11</td>
<td>802.15.4</td>
</tr>
</tbody>
</table>
Guidelines to choosing a Management Console

• Ensure it can display both time series data and events
• Correlates instrumentation data in near real-time from different data sources
  – Mobile, Browser, Webapps, Databases
• Provide Alerts, Configurable dashboards
• Provide a single pane view of the entire system
• Analyze crashes
• Nice to have: Ability to ingest custom data (performance or business)
Open Source Solutions

- Plethora of open source tools to monitor performance or Device Health
  - top, vmstat, ls/of, tcpdump, htop, iotop, monit, nagios, vmstat, perf_events
- Tracing Tools like dtrace, LTTng (Open source tracing framework for Linux.)

- **Prometheus.io**: Open-source service monitoring system & time series database
- **Influxdata.com**: Platform for managing, storing and visualizing time series data
- **Graphite**: Real-time graphing system for numeric time-series data.
- **Graphana**: Popular visualization library for multiple Time Series backends.
Questions or Comments?

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Thank you