

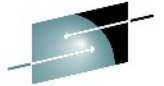
Connectivity for the Smarter Planet

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IBM

August 4, 2010
Session Number 7056



SHARE in Boston

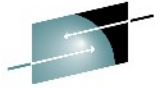


SHARE
Technology • Connections • Results

- **Context**
- **Technology**
- **Case studies**



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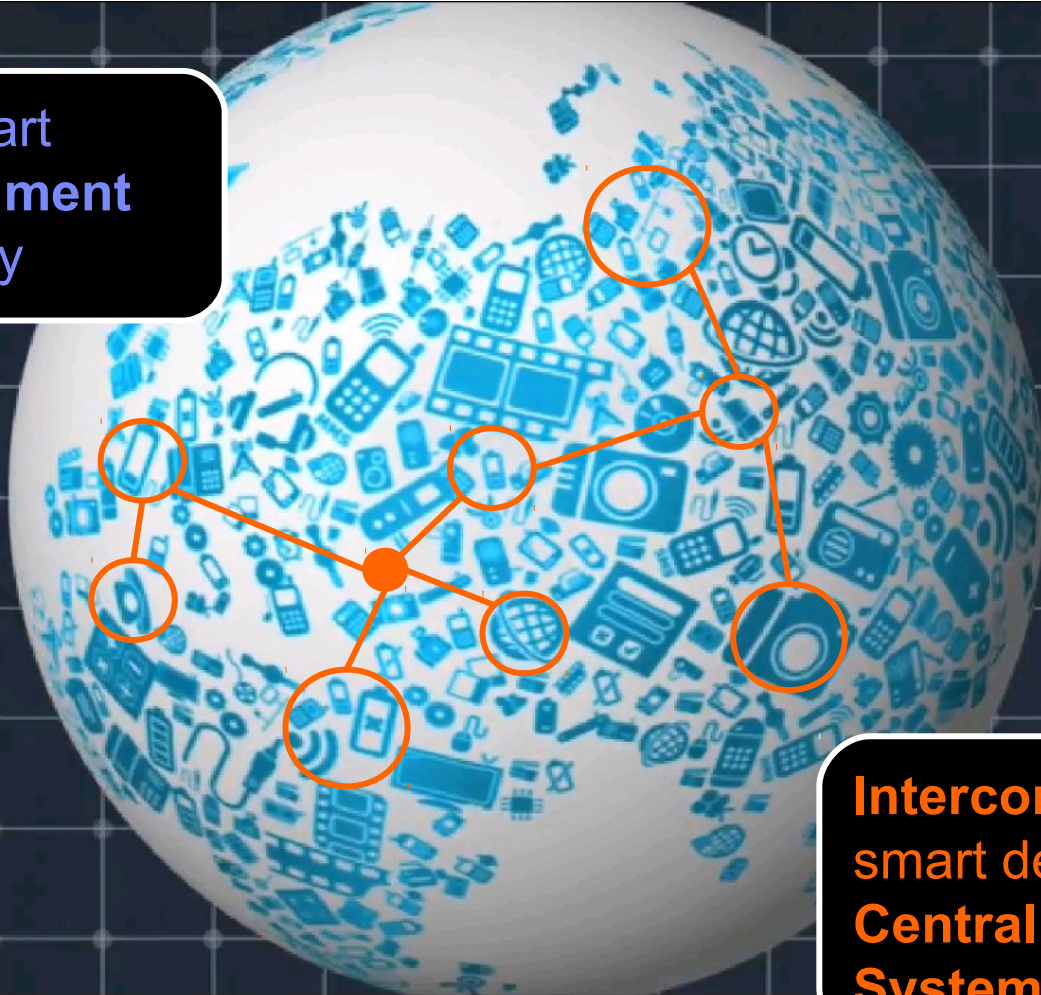
Context



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The Internet of Things

Trillions of smart devices **instrument** our world today



Interconnecting these smart devices creates a **Central Nervous System**

Our World is Filling with Devices

Pop Quiz



Grains grown each year 1,000,000,000,000,000 (1 quadrillion)



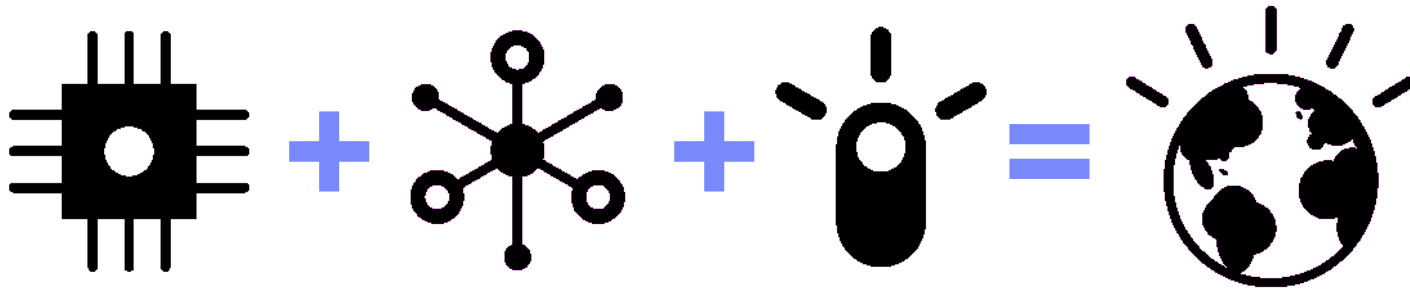
Crawling the earth 100,000,000,000,000,000 (100 quadrillion)



Manufactured each year 10,000,000,000,000,000,000 (10 quintillion)

**1 billion transistors
for every one of us**

Building a Smarter Planet



An opportunity to **think and act in new ways**—
economically, socially and technically.

Trends & Objectives



Business

Discover insights that enable innovation

- Achieve savings with better decisions using real-time data
- Innovate with new business models
- Win loyalty through personalized incentives

Maximize value of business interactions

- Proactive response to current situations and predicted events
- Apply analytical techniques like systems thinking, scenario planning, game theory, value network analysis

Optimize productivity and resources

- Improve management of remote resources
- Maximize utilization of fleet or inventory
- Coordinate operations more efficiently by advanced planning



IT

Achieve increased IT flexibility

- Increased recognition of value of event-driven architecture
- Increasing use of event-driven concepts e.g. pub/sub

Leverage connected smart devices

- Smarter devices enabling more intelligence at the edge
- Increased cross-over of technologies, tools and standards between enterprise and device worlds

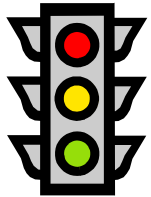
Encourage re-use

- More strategic approaches to IT architecture
- Focus on reducing time to value
- Service orientation enabling multi-channel re-use

Business Scenarios



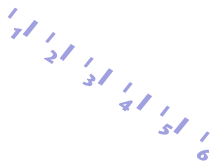
predict



alert



track



measure

| Scenario | Key Industries | Example |
|--|---|---|
| Automated Metering | Chemical & Petroleum Energy & Utilities | <i>Solution provider enables smart metering of home energy by using MQ Telemetry technology</i> |
| Distribution Supply Chain and Logistics | Retailers Distributors Consumer products Transportation | <i>Shipping company improves customer loyalty by providing up-to-the-moment detailed tracking information for cargo</i> <i>Transportation company improves customer safety and satisfaction with improved tracking of fleet</i> |
| Industrial Tracking & Visibility | Automotive Industrial manufacturing Aerospace Defense | <i>Manufacturing company automates inventory checking to improve management of stock and optimize production rates</i> |
| Healthcare Personal & Resource Tracking | Pharmaceutical companies Health trials Hospitals Nursing Homes | <i>Medical organization uses MQ Telemetry to track health of at-risk patients to increase safety and quality of patient care</i> <i>Hospital uses MQ Telemetry to track expensive surgery equipment to maximize utilization and reduce waiting lists</i> |
| Location Awareness and Safety | Chemical & Petroleum Energy & Utilities Homeland Defense | <i>Gas company uses MQ Telemetry to monitor gas pipeline operations</i> <i>Government monitors dams and flood-risk areas to increase early-warning detection and prediction capabilities</i> |
| Executive Alerting | Insurance Banking | <i>Bank alerts Personal Account Managers when new clients open accounts >= \$2M improving customer satisfaction</i> |

Connectivity for a Smarter Planet

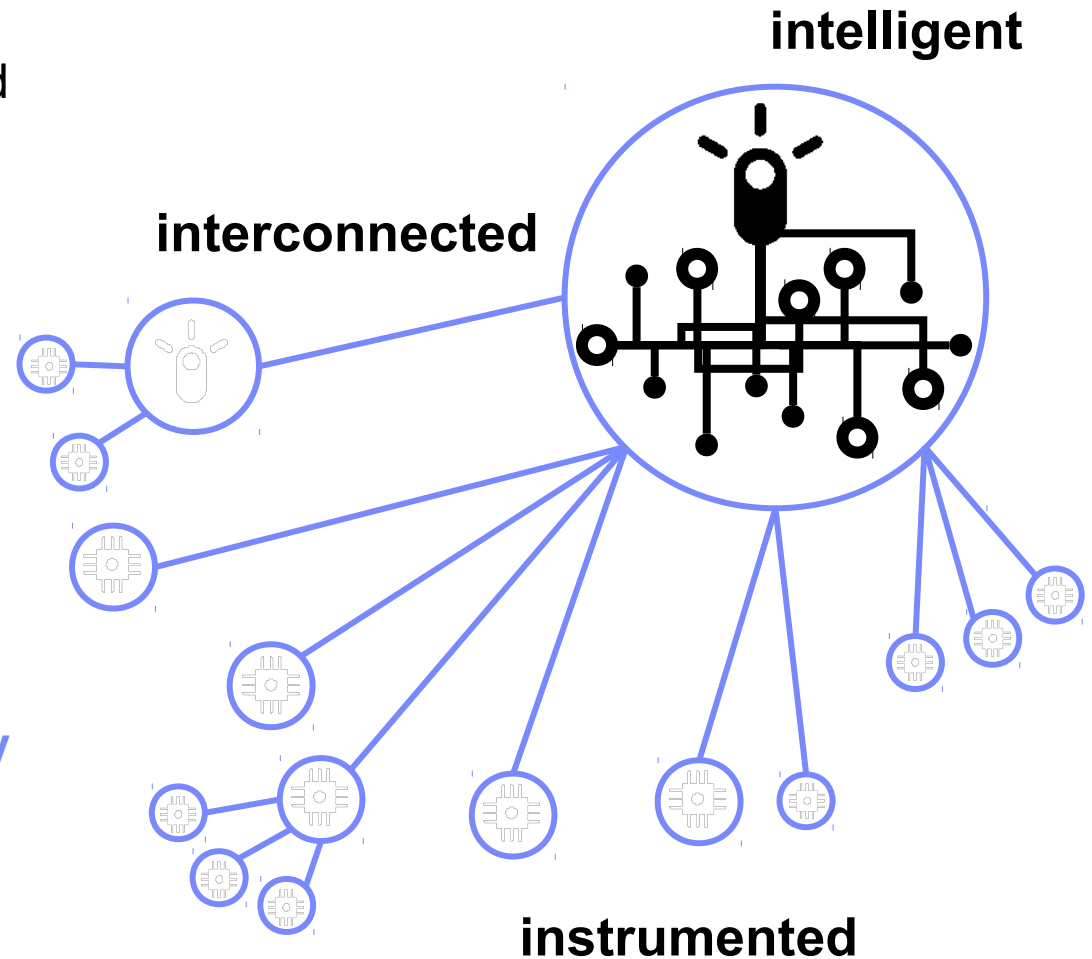
Extend connectivity beyond enterprise boundaries to smart devices

Offer connectivity capabilities **optimized** for sensors and devices

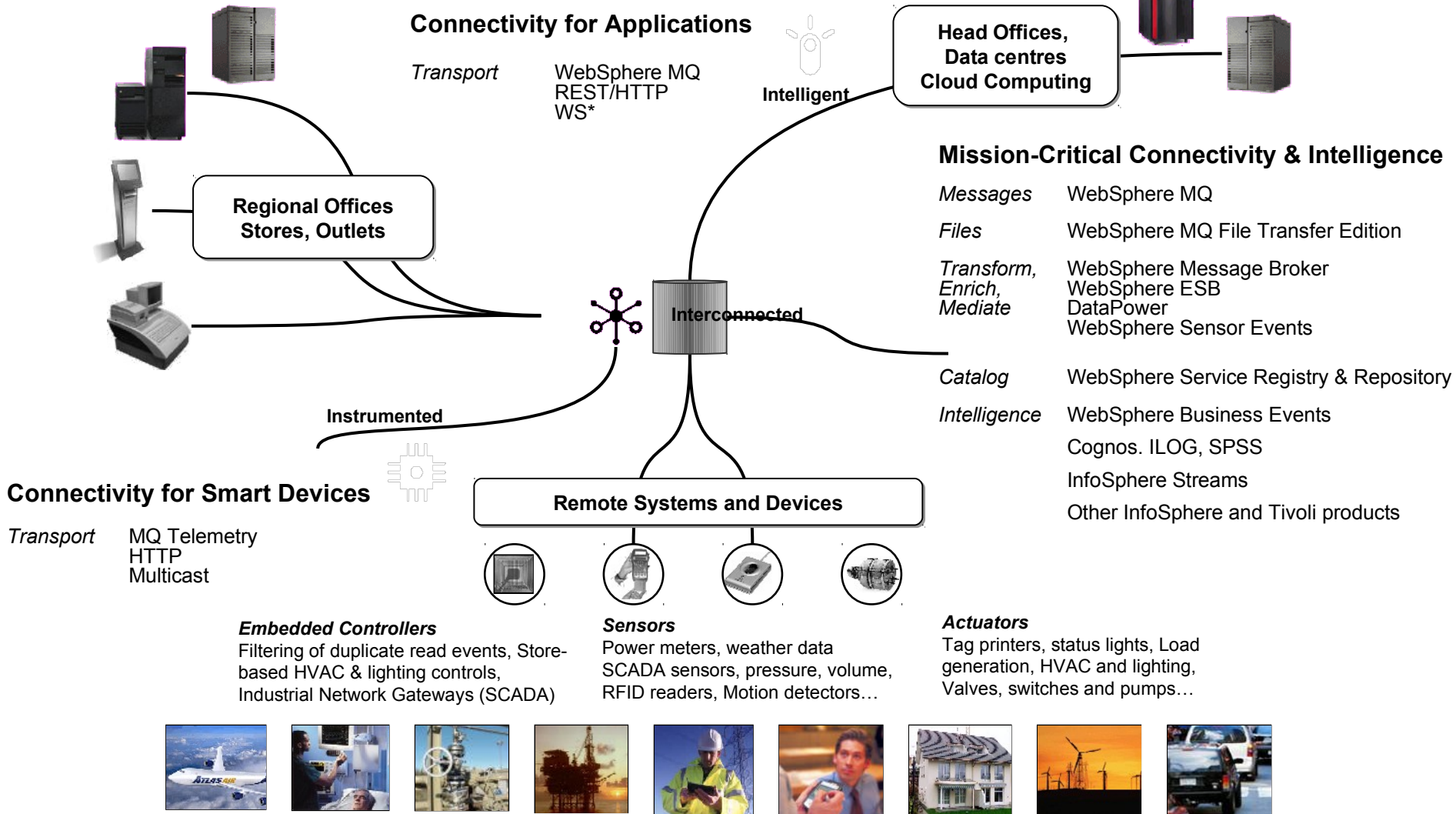
Deliver **relevant data** to intelligent decision making assets

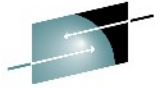
Enable **massive scalability** of deployment and management of solutions

Create **self-managing** device networks



Blueprint for Edge Connectivity





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Technology



SHARE in Boston

Introducing key technologies in the IBM messaging family

- MQTT
 - Specialist protocol for low powered devices and fragile networks
- WebSphere MQ Telemetry
 - High-scale connectivity from the edge into the enterprise
- WebSphere MQ
 - The world's leading enterprise messaging provider
- WebSphere Message Broker
 - Enterprise Service Bus providing any-to-any transformation and connectivity



Introducing MQTT

- The challenges of industrial control systems (supervisory control and data acquisition, or SCADA) well-suited to a messaging solution
 - Loose coupling, multi-protocol, separation of concerns...
- IBM developed a protocol for the MQSeries Integrator product designed for the constraints of the SCADA world.
 - MQ Integrator SCADA Device Protocol (MQisdP)
- Later renamed MQ Telemetry Transport – (MQTT) due to broader telemetry adoption
- Support has been available via SCADA nodes in WebSphere Message Broker from version 2.0 through version 6.1



Design principles of MQTT

- Publish/subscribe messaging paradigm as required by the majority of SCADA and sensor applications.
- Minimise the on-the-wire footprint.
- Expect and cater for frequent network disruption – built for *low bandwidth, high latency, unreliable, high cost* networks
- Expect that client applications may have very limited processing resources available.
- Provide traditional messaging qualities of service where the environment allows.
- Publish the protocol for ease of adoption by device vendors and third-party client software.



Key facts about MQTT

- Reduced complexity and footprint
- Simple, minimal pub/sub messaging semantics
 - Asynchronous (“push”) delivery of messages to applications
 - Simple set of verbs: connect, publish, subscribe, disconnect
- Minimised on-the-wire format
 - Plain byte array message payload
 - No application message headers
 - Protocol compressed into bit-wise headers and variable length fields
 - Smallest possible packet size is 2 bytes
- In-built constructs to support loss of contact between client and server
 - “Last will and testament” to publish a message if the client goes offline
 - Stateful “roll-forward” semantics and “durable” subscriptions



Qualities of Service

Three qualities of service for both publishing *and* subscribing:

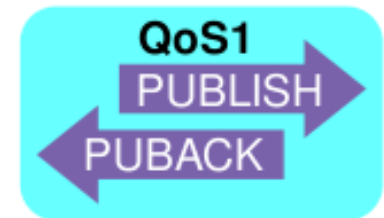
QoS 0: At most once delivery (non-persistent)

- No retry semantics are defined in the protocol.
- The message arrives either once or not at all.



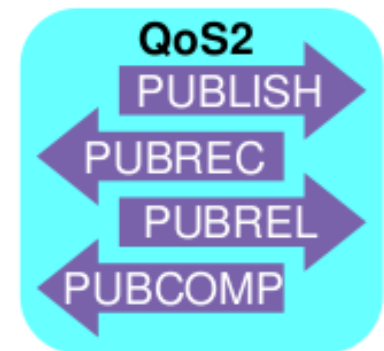
QoS 1: At least once delivery (persistent, dups possible)

- Client sends message with Message ID in the message header
- Server acknowledges with a PUBACK control message
- Message resent with a DUP bit set if the PUBACK message is not seen



QoS 2: Exactly once delivery (persistent)

- Uses additional flows to ensure that message is not duplicated
- Server acknowledges with a PUBREC control message
- Client releases message with a PUBREL control message
- Server acknowledges completion with a PUBCOMP control message



Example: connect and send an MQTT message

```
public void sendAMessage() throws MqttException {
    MqttProperties mqttProps = new MqttProperties();
    mqttProps.setCleanStart( true );
    MqttClient client = MqttClientFactory.INSTANCE.
        createMqttClient("testClient",
            "tcp://localhost:1883", mqttProps);
    client.registerCallback(this);
    client.connect();
    client.publish("abc/123",
        new MqttPayload(("Hello World!").getBytes(),0),
        (byte) 2, false);
    client.disconnect();
}
```

← Create a connection using the connection factory, this time for a clean starting client

← Register the class as a listener and connect to the broker

← Publish a message to the given topic and disconnect

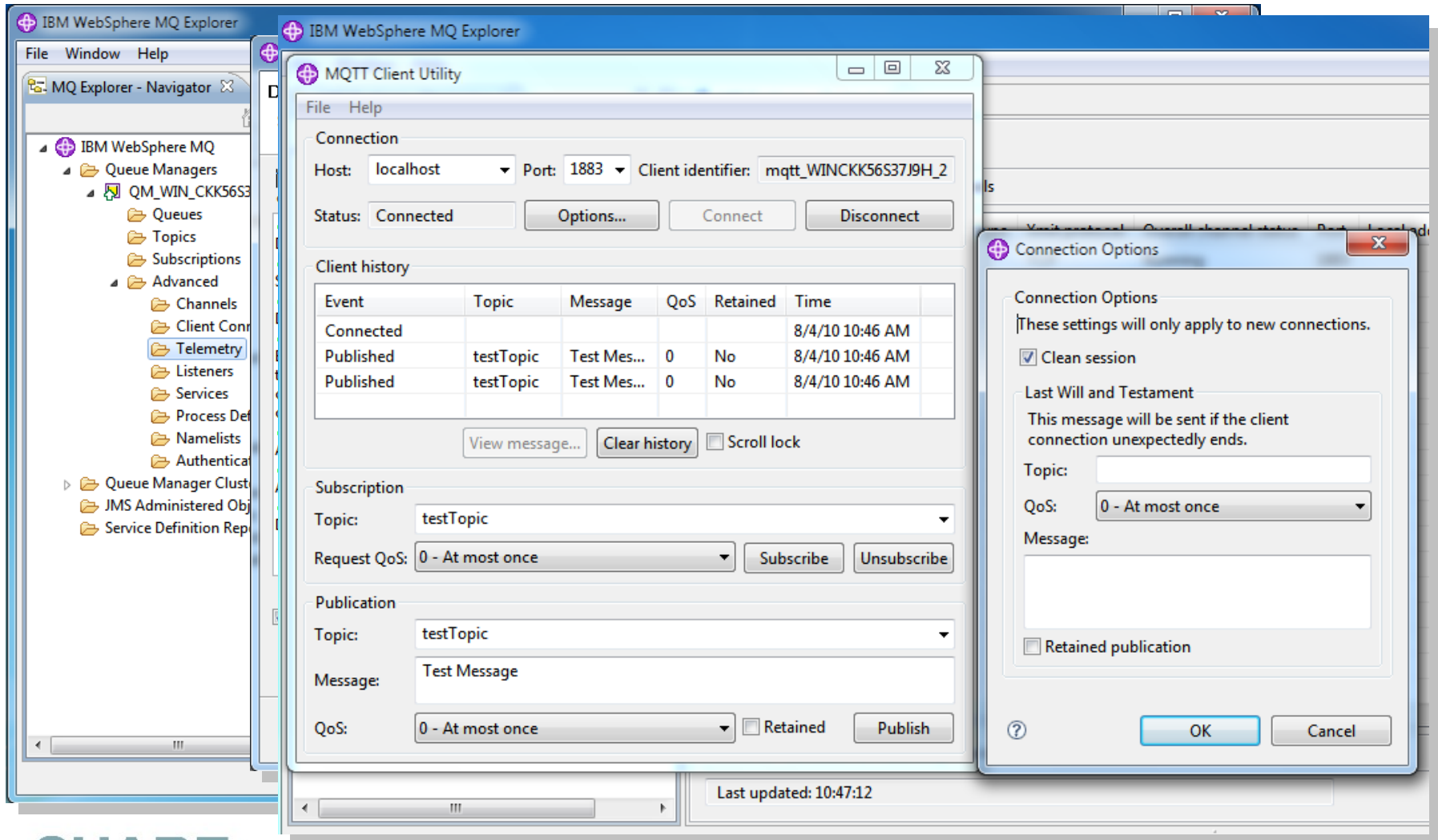
```
public void publishArrived(String topicName,
    MqttPayload payload,
    byte qos, boolean retained,
    int msgId) {
    System.out.println("Got it!");
}
```

← On receipt of a publication, simply spit out a message to the console to say we received it

WMQT Implementation

- New MQ service – MQXR ('eXtended Reach')
 - Separate purchasable extension
 - Available on Windows and UNIX
 - eGA 27 August 2010
- Fully integrated / interoperable with MQ
 - Publishers and subscribers can exchange messages
- Telemetry channels enable MQTT connections to Qmgr
- Supports MQTTv3 protocol (most common in use)
- Ships with reference Java (for MIDP upwards) and C clients
 - other APIs and implementations available via 3rd parties

MQ Explorer integration



The screenshot displays the IBM WebSphere MQ Explorer interface. The main window shows a tree view of Queue Managers, with 'Telemetry' selected under 'Advanced'. Overlaid on this is the 'MQTT Client Utility' window, which shows a 'Connected' status and a table of client history. A 'Connection Options' dialog box is also open, showing settings for a new connection.

MQTT Client Utility - Connection

Host: localhost Port: 1883 Client identifier: mqtt_WINCKK56S37J9H_2

Status: Connected [Options...] [Connect] [Disconnect]

MQTT Client Utility - Client history

| Event | Topic | Message | QoS | Retained | Time |
|-----------|-----------|-------------|-----|----------|-----------------|
| Connected | | | | | 8/4/10 10:46 AM |
| Published | testTopic | Test Mes... | 0 | No | 8/4/10 10:46 AM |
| Published | testTopic | Test Mes... | 0 | No | 8/4/10 10:46 AM |

[View message...] [Clear history] Scroll lock

MQTT Client Utility - Subscription

Topic: testTopic

Request QoS: 0 - At most once [Subscribe] [Unsubscribe]

MQTT Client Utility - Publication

Topic: testTopic

Message: Test Message

QoS: 0 - At most once Retained [Publish]

Connection Options

These settings will only apply to new connections.

Clean session

Last Will and Testament

This message will be sent if the client connection unexpectedly ends.

Topic: []

QoS: 0 - At most once

Message: []

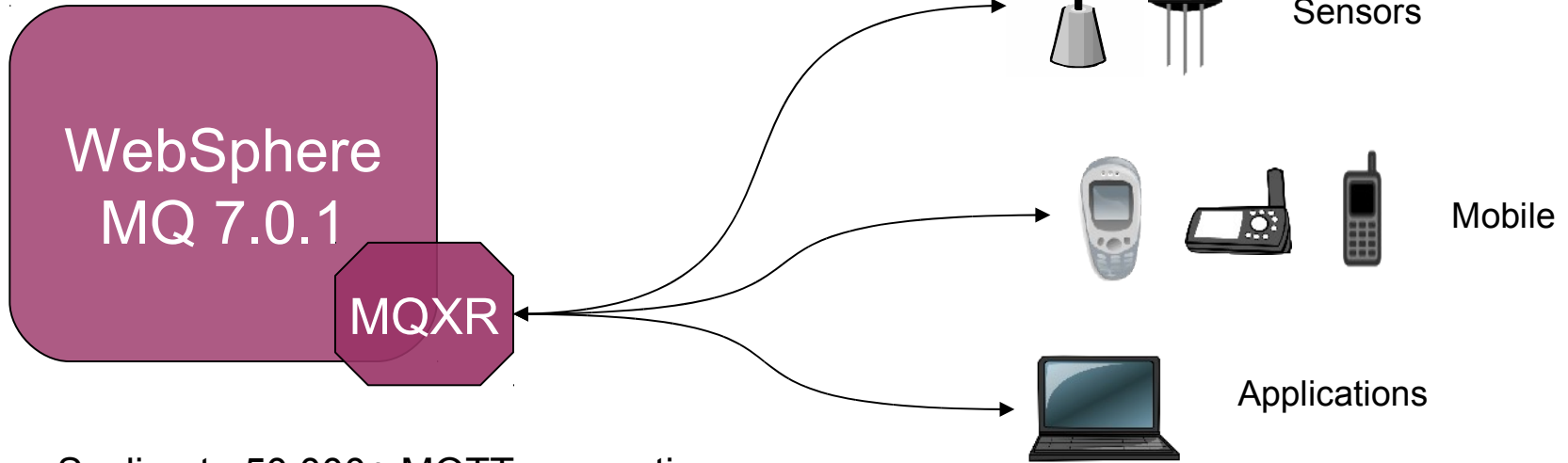
Retained publication

[?] [OK] [Cancel]

Last updated: 10:47:12

Topology example: “simple” clients

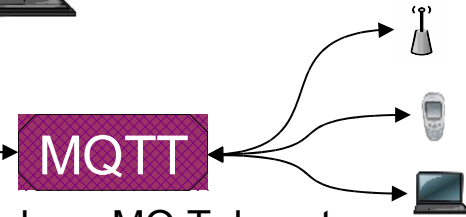
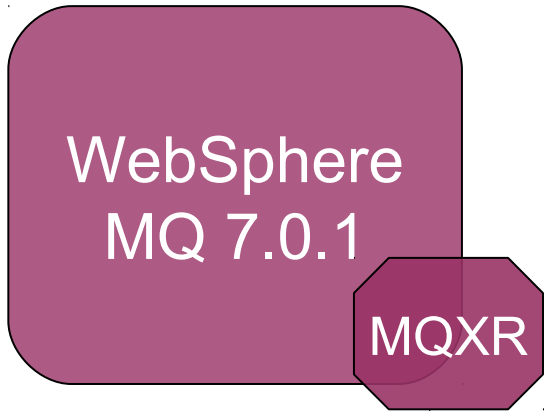
WebSphere MQ Telemetry



Scaling to 50,000+ MQTT connections to a single queue manager*

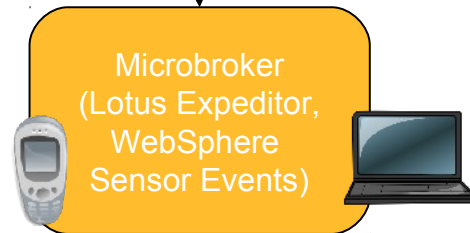
Topology example: “advanced” clients

WebSphere MQ Telemetry



WebSphere MQ Telemetry Daemon for Devices

Rich clients requiring buffering, remote management capabilities, or advanced data handling



WebSphere software

Lotus software

Security options

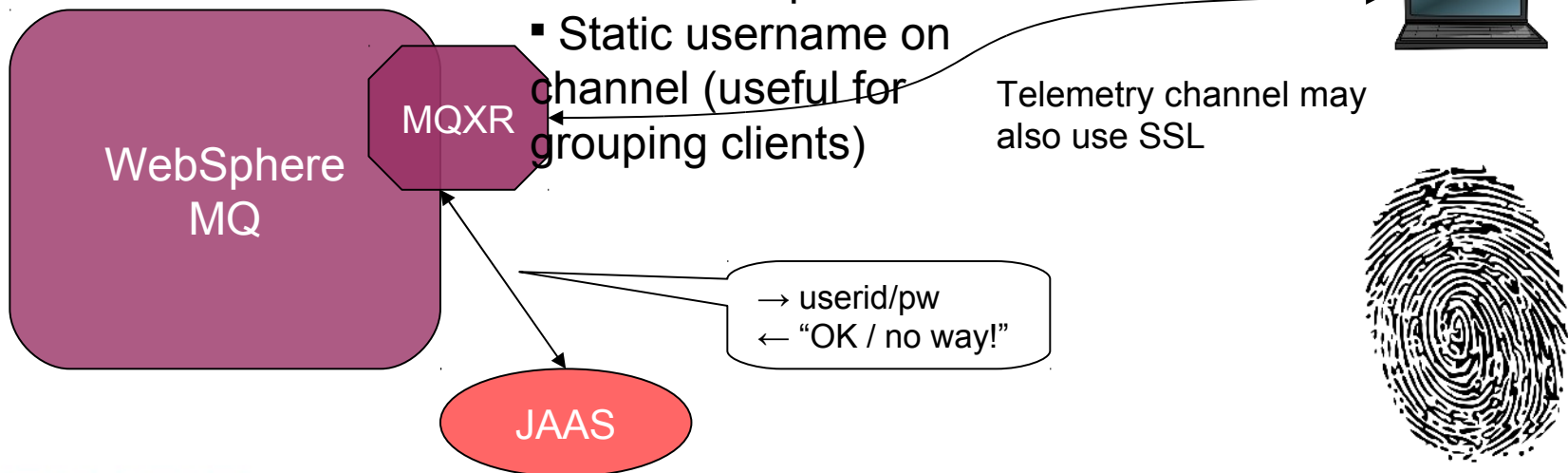
Securing mobile / remote clients can be vital!

WMQ Telemetry supports two key technologies:

- SSL – encryption and authentication
- JAAS – authorization

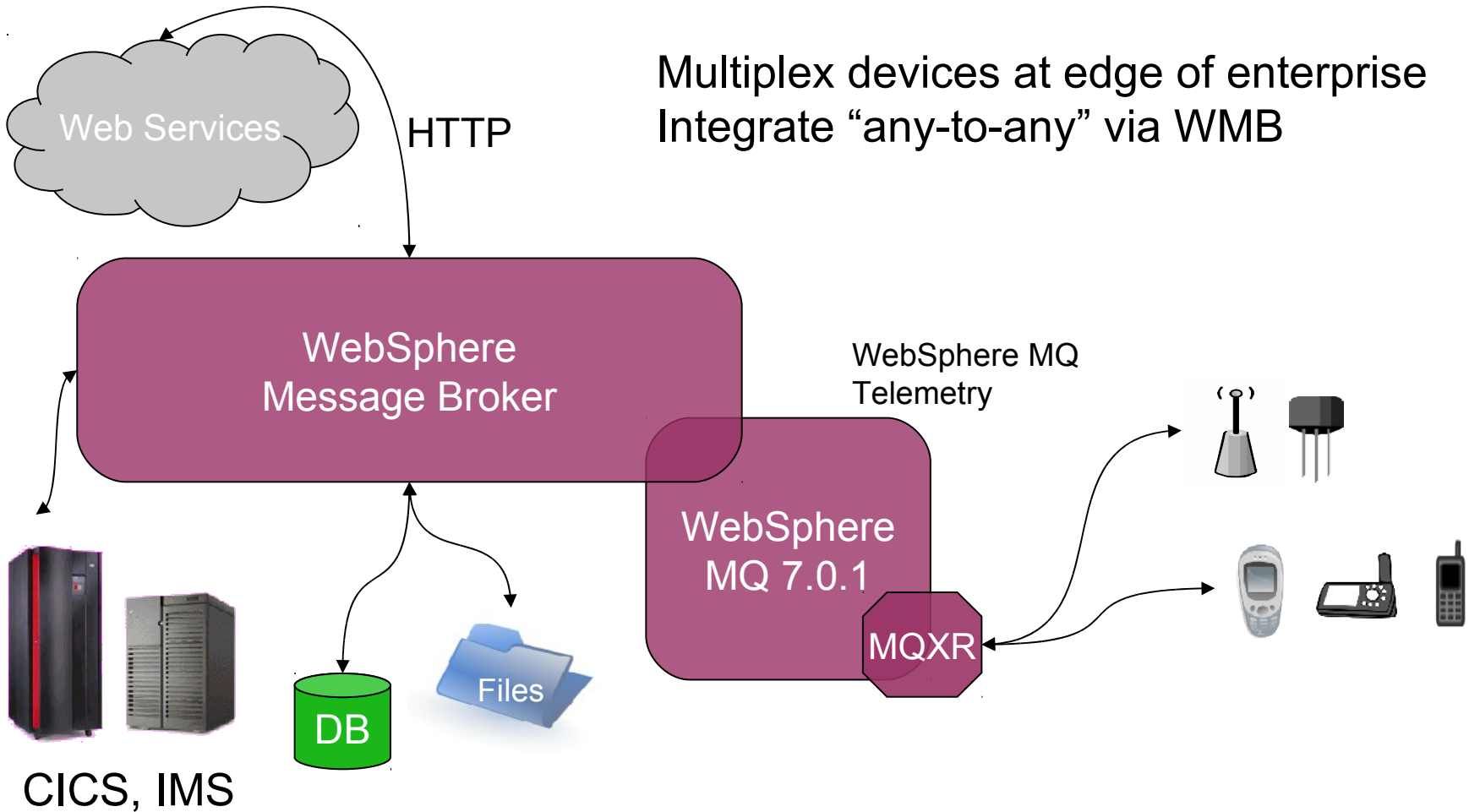
Configurable:

- Use clientId
- Use userid/pw on API
- Static username on channel (useful for grouping clients)



Topology example: enterprise gateway

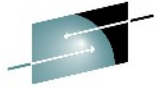
Multiplex devices at edge of enterprise
Integrate “any-to-any” via WMB



Migration from WMB SCADA nodes

High-level steps:

- Upgrade to WMQ v7
- Upgrade to WMB v7
- Install WMQ Telemetry feature
- Ensure MQTT v3 protocol used by client apps
- Modify message flows to use JMSInput or MQInput nodes in place of SCADA nodes



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Case studies



SHARE in Boston

Transforming Railway Operations

National railway infrastructure company created solution for real-time rail monitoring



Client Pains

Difficulty integrating and sharing information

Lack of real-time data

Home-grown solution expensive to build and maintain

Improved reliability and timeliness of train services

Able to allocate railway resources more efficiently

Instant access to real-time data across organization

Smarter Healthcare

Medical organization created a remote pace-maker monitoring solution to provide better patient care



Client Pains

- Physicians needed better monitoring of cardiac patients
- Improve efficiency of checkups
- Meet healthcare data capture standards

Enables *higher level of patient care and peace of mind*

Improves *administrative efficiency and maintenance*

Helps *conform to standards and ease integration of data*

Improving Energy Usage

Utility company developing an Intelligent Utility Network offering for optimizing load on electricity grids



Business Partner

Needs robust middleware technology to connect to remote smart meters

Needs to be able to rapidly scale solution nation

Able to offer daily energy savings of 15-20%

Enables utilities to reduce peaks and avoid punitive charges

Helps save electricity through better peak load management

Water Management Scorecard +

| Sectors | Target % | Actual % | Status |
|--------------------------------------|----------|----------|--------|
| Water Quality Management | | | |
| North | 97 | 98 | ▲ |
| South | 95 | 96 | ▲ |
| Central | 95 | 94 | ▲ |
| East | 97 | 97 | ▲ |
| West | 95 | 95 | ▲ |
| Water Distribution Management | | | |
| North | 97 | 97 | ▲ |
| South | 97 | 97 | ▲ |
| Central | 95 | 97 | ▲ |
| East | 97 | 98 | ▲ |
| West | 95 | 96 | ▲ |
| Water Waste Management | | | |
| North | 97 | 97 | ▲ |
| South | 97 | 97 | ▲ |
| Central | 97 | 95 | ▲ |
| East | 97 | 98 | ▲ |
| West | 95 | 97 | ▲ |
| Water Treatment Management | | | |
| North | 97 | 97 | ▲ |
| South | 97 | 97 | ▲ |
| Central | 95 | 95 | ▲ |
| East | 97 | 97 | ▲ |
| West | 95 | 95 | ▲ |

Report: Location:

Period:

Water Event Management +

| Type | ID | Source | Description | Time/Date | Status |
|----------------|---------|-------------|---|-------------|--------|
| Water Overflow | ABC234E | Water Waste | Predicted precipitation 24HRS - ETA 11:00 09/12 Ongoing maintenance/potential sewerage overflow. | 11:00 08/12 | ● |
| Water Quality | QCD234A | Water | PH Level below LCL | 10:53 08/12 | ● |

Report:

Date:

Collaboration Space *

Water + Transport Region Experts

- Water + Transport Agency (2/4)**
 - Bus Transport Agency (1/1)**
 - Michael Kehoe
 - Metro Transport Agency (0/1)**
 - E. Michael Huestis
 - Water Distribution Agency (1/2)**
 - michael_cosgrove@ie.ibm.com - Michael Cosgrove
 - Thomas J. Freund

John Meagan
Senior Waste Water Manager

Thomas Freund
Senior Water Manager

Michael Cosgrove
Senior Waste Water Engineer

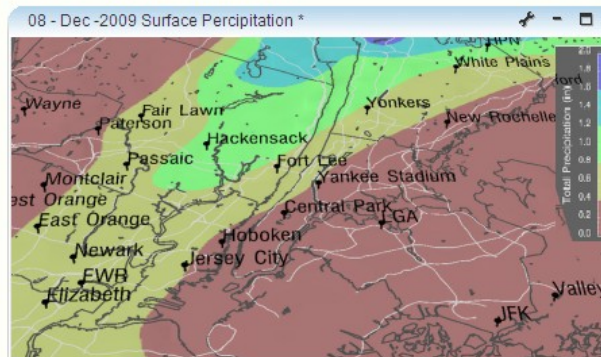
Feeds | Day-At-A-Glance | Activities | Primary Contacts

Flood Prediction *

| Attribute | Alert | Min | Max | Actual |
|--------------------|-------|-----|-----|----------|
| Wind Speed | ●●●●● | 0 | 60 | 35 knots |
| Wind Direction | ●●●●● | 90 | 270 | 80 deg |
| Temperature | ●●●●● | -10 | 50 | 21 m |
| Cloud Cover (High) | ●●●●● | 0 | 100 | 99 % |
| Cloud Cover (Low) | ●●●●● | 0 | 100 | 82 % |
| Rainfall | ●●●●● | 0 | 10 | 5 mm |

Fri 05 Jun 2009 12:00

EcoRhythms



Alarm Management

| Serviceability | Site | Status | Actual | Actual % |
|----------------|------|--------|--------|----------|
| PH | | ●●●●● | 3 | 30 |
| Pipe Breackage | | ●●●●● | 0 | 0 |
| Sewer Overflow | | ●●●●● | 0 | 0 |
| Turbidity | | ●●●●● | 6 | 60 |
| Pumping Rate | | ●●●●● | 4 | 40 |

<<MORE>>

File:

Waste Management +

Tabular Detail
System Map
Layers
Central Region v

Pipe
 Pump
 Sewers
 Hold Tanks
 Weirs
 Weather

New York

Water Waste Event Management +

| Source | Destination | Ack | Description | Time/Date | Focal Point |
|------------------|--------------------|-----|---|-------------|-------------|
| Water Waste | Water Waste | ✓ | Maintenance deployed. Open Status. | 11:45 08/12 | |
| Water Management | City Central | ✓ | Overflow alert. Potential Sewage overflow | 11:41 08/12 | |
| Water Management | Water Distribution | ✓ | Overflow alert. Potential Sewage overflow | 11:40 08/12 | |

| Type | Sew | ID |
|----------------|-----|---------|
| Water Overflow | 2 | ABC234E |

[Update](#) [Back](#)

Collaboration Space *

Water + Transport Region Experts

- John Meegan**
Senior Waste Water Manager
- Thomas Freund**
Senior Water Manager
- Michael Cosgrove**
Senior Waste Water Engineer

Water + Transport Agency (2/4)

- Bus Transport Agency (1/1)
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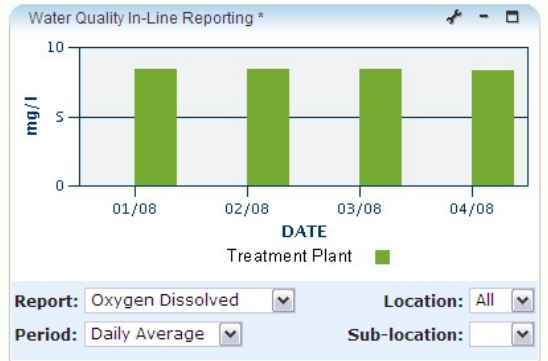
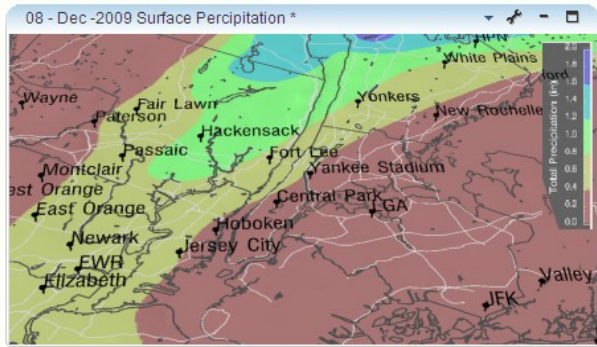
Feeds | Day-At-A-Glance | Activities | Primary Contacts

Bulletin Board

Potential CSO reported to Transport Departme...

wpsadmin - All

[Manage](#) [Add](#)



Some areas that MQTT has been used...

HVAC Control **Chemical** **Trickle**
POS **Stock Checks** **Detection** **Feed**

Field Force Automation **Asset Management**
• Sales Force Automation **And Monitoring**
• Field Service Engineers **RFID**
• Service Delivery

Fire Sensors **Pipeline Monitoring** **Parking**
 and Control **Tickets**

Flood Defence **Kiosks**
Warning **Vehicle Telematics**
• Cars / Military – Diagnostics and Prognostics
• Pay As You Drive Insurance

Home Automation

Thank you!

Contact: Andy Piper andy.piper@uk.ibm.com
<http://twitter.com/andypiper> | <http://andypiper.co.uk>

Please fill out your EVALUATION FORMS
This was Session 7056



SHARE in Boston