Telemetry Integration

Enterprise integration of SCADA, remote monitoring and control devices using WebSphere MQ Integrator

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Agenda

High-level overview

Publish/Subscribe

SCADA and remote telemetry

WebSphere MQ messaging

WebSphere MQ Integrator

MQIsdp protocol

Customer Projects
"Executive" Summary

End to end telemetry integration

From remote monitoring and telemetry devices *in* to Enterprise applications, and from command/control applications *out* to remote control devices

Using a lightweight publish/subscribe protocol (MQIsdp), WebSphere MQ messaging, and WebSphere MQ Integrator.
End-to-end business integration from SCADA telemetry to Enterprise Applications

Remote telemetry data collected "in the field". Event-driven publications

e.g. oil/gas pipeline monitoring/control, automated meter reading, factory automation, process control, environmental monitoring, utilities, security, transport...

End-to-End integration has $$$ value!
Publish/Subscribe

WMQI Broker

IBM Software
Publishers
- publish messages to a broker on a named 'Topic'

Subscribers
- register a Subscription with broker and receive messages on identified topics

Message Broker
- manages connections, authentication, subscriptions, ACLs, message routing, format transformation

publishers and subscribers are 'anonymous' to each other
Topic name space

Publish

▶ weather/London/temperature/current
  ➥ "15.2 C"

▶ weather/London/temperature/max
  ➥ "18.2 C 18-Jul-99 13:43"

Subscribe

▶ weather/London/temperature/current
  ➥ current temperature in London

▶ weather/+/temperature/max
  ➥ maximum temperatures from all stations
SCADA Telemetry Integration

Supervisory, Control, And Data Acquisition

Remote Monitoring

Telemetry and Control

Telemetry Integration
Telemetry Integration applications

Pipeline: oil, gas, water
  ▶ SCADA, pressure, temperature, flow rate, valve control, Automated Meter Reading (AMR), Electronic Flow Measurement (EFM), nomination systems

Energy and Utilities: electricity, gas, oil, water
  ▶ SCADA operations, automated meter reading (AMR), trading floor data Supply Chain Management (SCM)

Process control, factory automation
  ▶ chemical industry, reservoir management, manufacturing systems, stock control

trucks, cars, railways, boats, security, safety, food and drink, environmental monitoring, weather, etc.
  ...Both MONITORING and CONTROL

"anything that moves, that you want to know about!"
Remote monitoring station
Arcom Controls "Director"

"Industrial Network Gateway"

MQIIsdp client

TCP/IP serial, digital, and analogue Input/Output

protocol conversions

local polling

Report By Exception (RBE) logic

IBM Software

Arcom is an IBM Business Partner  http://www.arcomcontrols.com
SCADA industry evolution

Moving from polling to "report by exception" model

Physical events have $$$ value, particularly if you can get them onto the trading floor!

Major problems with proprietary architecture and protocols - "rat's nest" of solutions

Customer demand for end-to-end integration

Acquisitions and mergers
► inherit yet another set of proprietary solutions

"how do we integrate raw telemetry data directly into our Production Systems?"
Telemetry Integration example

A remote SCADA device publishes a message using MQIsdp, reporting that a volume of oil has been successfully transferred to a tanker for a Customer.

The WebSphere MQ Integrator broker transforms the message into a WebSphere MQ message using an SAP message format template from the Message Repository Manager (MRM).

The message is routed via WebSphere MQ to the SAP ERP system in the Enterprise to trigger the sending of a bill to the Customer.

... End to End Telemetry Integration
WebSphere MQ Integrator

- Workflow, Process Flow
- Application Services
- Tools

- Xform, Rules, Routing
- API Framework
- Templates, Utilities

- Messaging Services
- Standard Formats
- Tools

Family Traits
- Modular Set of Offerings
- WebSphere MQ
- Foundation
- Common Look and Feel
- Management/Monitoring
- Messaging Tools
WebSphere MQ Basic Features

A single, multi-platform API
- Easy to use
- Network independent
- Faster application development

Assured message delivery

Time independent processing
- Asynchronous messaging
Types of Messaging

Message/Queuing
On-line/Real-time
Topology Choices...
WebSphere MQ Integrator

Message Broker for WebSphere MQ and other protocols (MQ, MQIsdp, MQSeries everyplace, Web-Scale)

Publish/Subscribe matching engine
  ▶ topic and content matching
  ▶ Access Control Lists

Message Flow Engine for
  ▶ business logic, message transformation, message routing

Message repository
  ▶ for message transformation, XML, EDI, etc
WMQI block diagram

MQIsdp (Telemetry Integration)

MQ

MQe

input

transform/compute

output

MQe

MQIsdp (Telemetry Integration)

IBM Software
Publishers and Subscribers can be:

- remote monitoring devices
  - MQ SCADA device protocol (MQIsdp)

- hand-held Pervasive devices
  - (MQSeries everyplace)

- WebSphere MQ applications
  - Application Messaging Interface (AMI)
  - Java Messaging Service (JMS)
What is a Message Flow?
IBM Software

Message Sets Message Flows Assignments Topology Topics Subscriptions Operations

Message Flows
- Format testing
- Examples
  - Out of stock notification
  - myBookstore.com
  - Stock Trading
- Simple flows
  - BMPrimitives
  - tTerminal
  - OutTerminal
  - Check
  - Filter
  - Copy
  - Extract
  - Complete
  - NeonFormatter
  - Insert
  - DataInsert
  - DataDelete
  - DataUpdate
  - Database
  - Warehouse
  - MQInput
  - MQOutput
  - MQReply
  - NeonRules
  - ResetProperties
  - Publication
  - Throw

Message Flow Definition

Stock Trading

NYSE Trade → Normalise NYSE

AMEX Trade → Check for high value trade

DAX Trade → Normalise DAX

Store high value trades
Publish to customers
Telemetry Integration input node

Input node for WMQI message flows

- Allows remote devices to connect into the broker using the MQIsdp protocol

- Input node has a TCP/IP socket listener on a configurable port. Default is IANA-assigned port **1883**

- Can connect many clients to one input node.

- a "publish" message from an MQIsdp client starts the message flow, and the message propagates through the nodes as usual.

- Clients can be publishers and/or subscribers
Telemetry Integration message flow

MQSeries Integrator Control Center - test.xml

Message Sets  Message Flows  Assignments  Topology  Topics  Subscriptions  Operations  Log

Designer  Debugger

Message Flows
- IBMPrimitives
  - SendMailPlugIn
  - Check
  - Compute
  - Database
  - DataDelete
  - DataInsert
  - DataUpdate
  - Extract
  - Filter
  - FlowOrder
  - Input Terminal
  - Label
  - MQInput
  - MQOutput
  - MQInput
  - MQReply
  - MQReply
  - NEONMap

Message Flow Definition

SCADAInput1  Compute1  Trace1  Trace2  Publication1  SendMailPlugIn1
MQIsdp protocol

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MQ Integrator SCADA Device Protocol

Lightweight wire protocol for publish and subscribe over TCP/IP with various assurances of delivery

Optimised for
- minimal network bandwidth (2 byte fixed header)
  - this is a key competitive advantage!
- ease of implementation on embedded systems

API for pub/sub
- connect/disconnect, subscribe/unsubscribe, publish, keepalive

Device vendors implement client software on their platform which talks the MQIsdp protocol.
**MQIIsdp positioning**

An "open" protocol: although jointly developed by IBM and Arcom Controls, we hope that (one day) all device manufacturers will implement it.


Several device manufacturers currently implementing MQIIsdp on their devices, mainly in response to Customer requirements.

Arcom Controls has the first fully tested, supported (by them) implementation of the protocol, so they are likely to be involved in many of our projects.
Quality of Service

Three levels of "assurance of delivery"

QoS 0
▶ "fire and forget"
▶ at most once delivery
▶ equivalent to WebSphere MQ "non-persistent" messaging

QoS 1
▶ at least once delivery
▶ simple message acknowledgment

QoS 2
▶ exactly once delivery
▶ equivalent to WebSphere MQ "persistent" messaging
**Last Will and Testament**

- When an MQIsdp client connects to the broker, it can optionally specify a
  - Will topic, Will message
  - Keepalive interval

- If the client fails to publish anything during the keepalive time, the Last Will and Testament is invoked:

- The broker assumes the "untimely death" of the client, and closes the client connection, then publishes the specified Will message to the Will topic on the client's behalf.

- If the client disconnects cleanly, there is no LW&T.
Weather Station Project
How it works

- **Publisher**: connector
- **Subscribers**: XML over MQIsdp or JMS
- **Brokers**: TCP/IP
- **Protocols**: XML over MQIsdp, Binary over RS232

IBM Software
**Topic space**

**temperature**
- indoor/outdoor
  - current/high/low

**wind**
- average/current/high

**humidity**
- indoor/outdoor
  - current/high/low

**rain**
- rate/total

**barometer**

**windchill, dew point, prediction**

e.g. weather/Chale/humidity[indoor/current]
Weatherbox

http://weatherbox.ngi.ibm.com
Pipeline project
Customer Project - original system

4000 field devices (polling)
Customer Project - now in production

20 to 1
ramping to 600

WMQI
AIX

T1

field devices
20 to 1

Arcom
"Director"
ramping to 600

IBM Software
Message types

12,000 meters, 20:1 to 600 Arcom Directors
  ► over 20 mile line-of-sight spread-spectrum radio

Daily readings
  ► rollups of hourly readings, averages, max/min readings

Hourly readings
  ► specific gravity, mole%CO2, BTU content, base
temp/pressure, average temp/pressure, density factors

Gas Chromatograph Analysis results

Calibration data

Operational SCADA (every 3-5 mins)
  ► pressure, temperature, flowrate, energy rate, battery voltage,

Alarms (urgent) - pager alerts

Events (non urgent - logged and auditable)

...Both MONITORING and CONTROL
Automated Meter Reading project
Oil Pipeline - AMR project

- 120 pumping stations with flow computers
- previously, read manually and faxed to HQ
- faxes keyed into Oracle Forms application
- downstream applications read data from Oracle
Oil Pipeline - AMR project

- Flow computers fronted by Arcom Directors
- Transmission over VSAT satellite link
- "e-ticket" data published to WebSphere MQ Integrator broker (on NT)
- ODBC link from WMQI to Oracle database
- Downstream applications read data from Oracle as before
"Pub Pub/Sub"
Electricity meter monitoring
SCADA lights

IBM MQI${\text{sd}}p$ SCADA lights

Applet started.
SCADA mouse trap

Arcom "Field Sentry"

digital inputs

MQIsdp over PPP

SMS via SMTP

WMQI Broker on NT
SCADA mouse trap
Telemetry Integration

Integrating Monitoring and Telemetry Devices into the Enterprise with WebSphere MQ Integrator

Thanks for listening!

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