

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

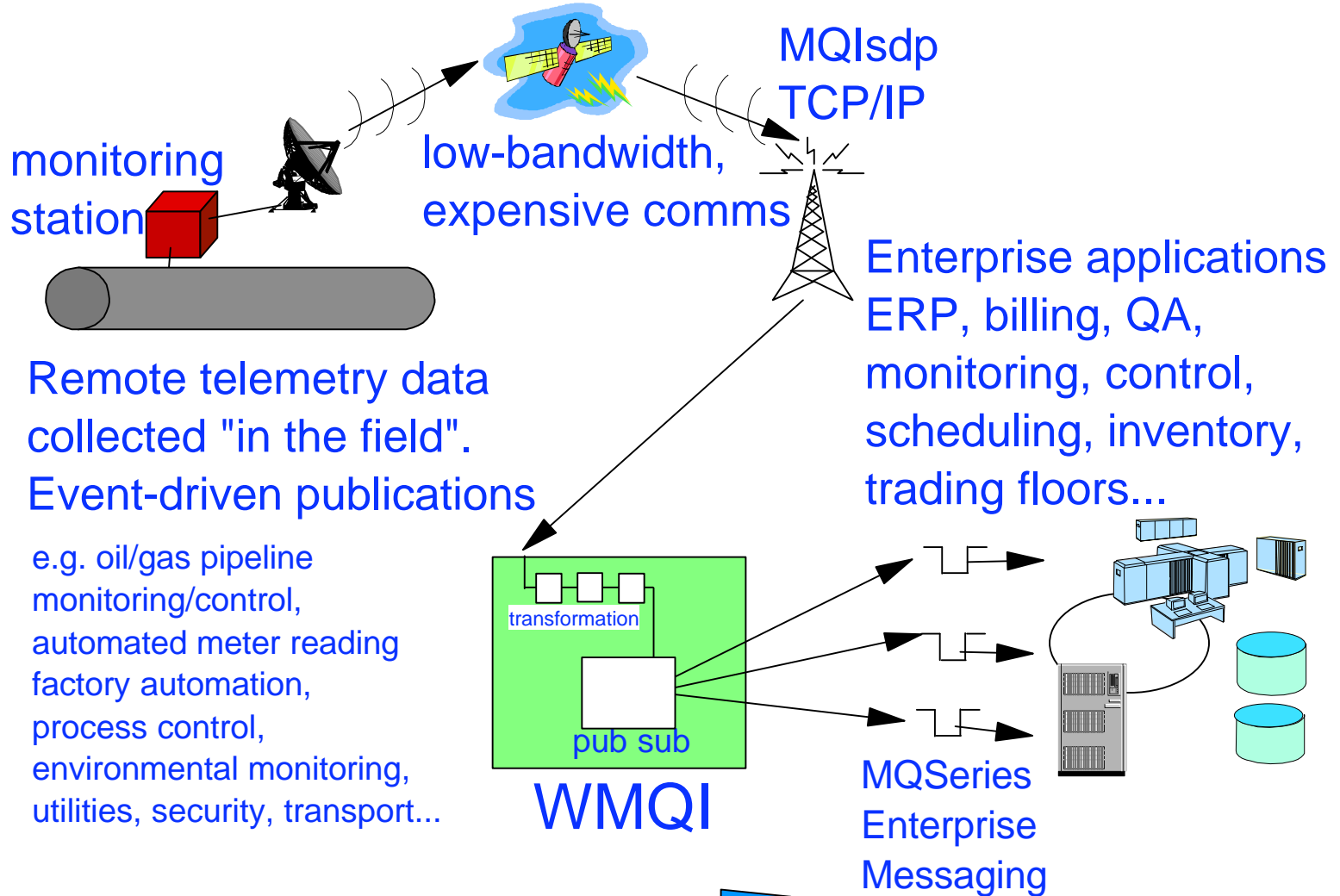
"Executive" Summary

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 (MQI sdp), WebSphere MQ messaging, and WebSphere MQ Integrator.

End-to-end business integration from SCADA telemetry to Enterprise Applications

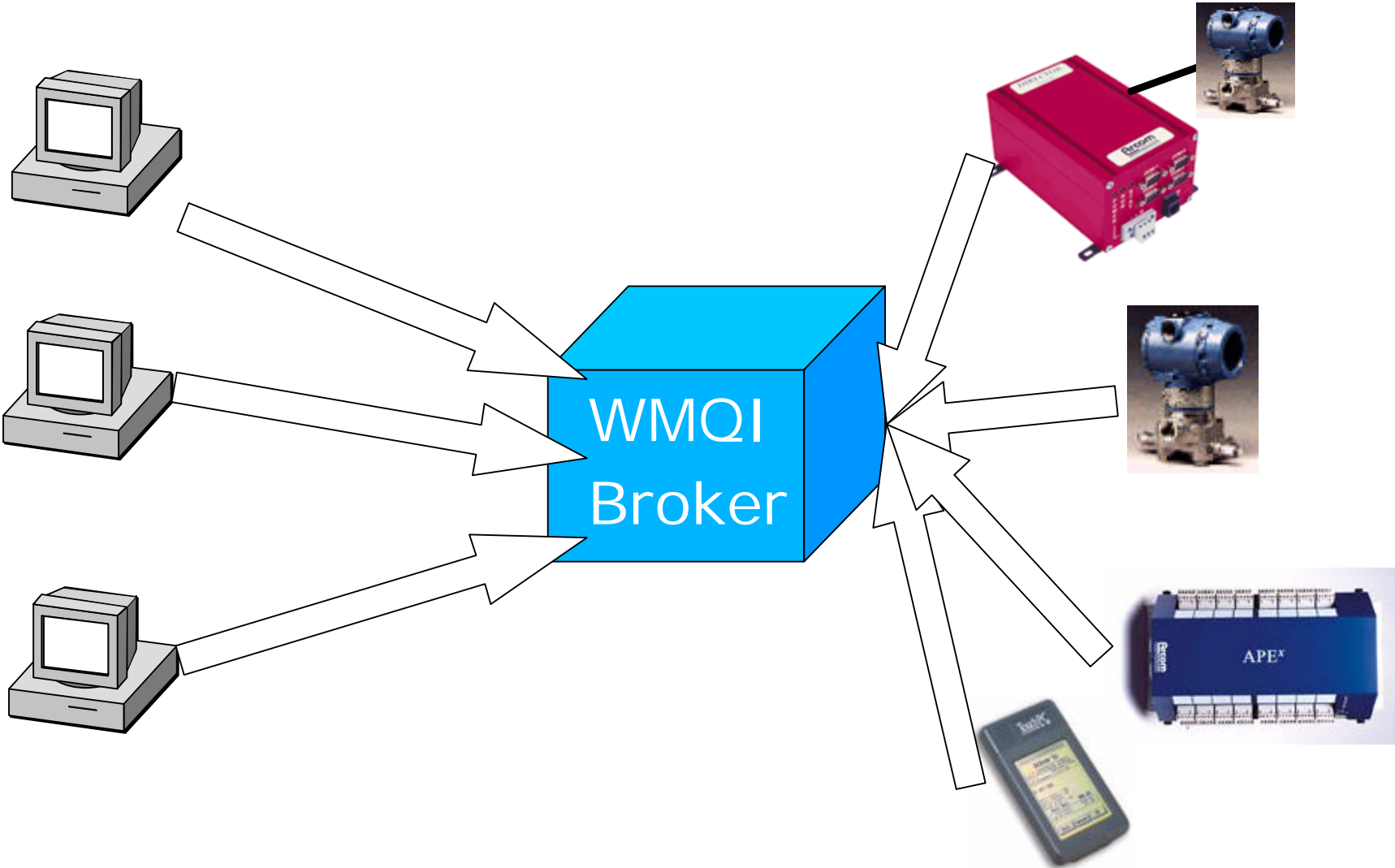


Remote telemetry data collected "in the field".
Event-driven publications
e.g. oil/gas pipeline monitoring/control, automated meter reading, factory automation, process control, environmental monitoring, utilities, security, transport...

Enterprise applications
ERP, billing, QA, monitoring, control, scheduling, inventory, trading floors...

End-to-End integration has \$\$\$ value!

Publish/Subscribe



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Publish/Subscribe

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

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"anything that moves, that you want to know about!"

Remote monitoring station



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Arcom Controls "Director"

"Industrial Network Gateway"

MQIsdp client

TCP/IP

serial, digital, and analogue Input/Output



protocol conversions

local polling

Report By Exception (RBE) logic

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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?"

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Telemetry Integration example

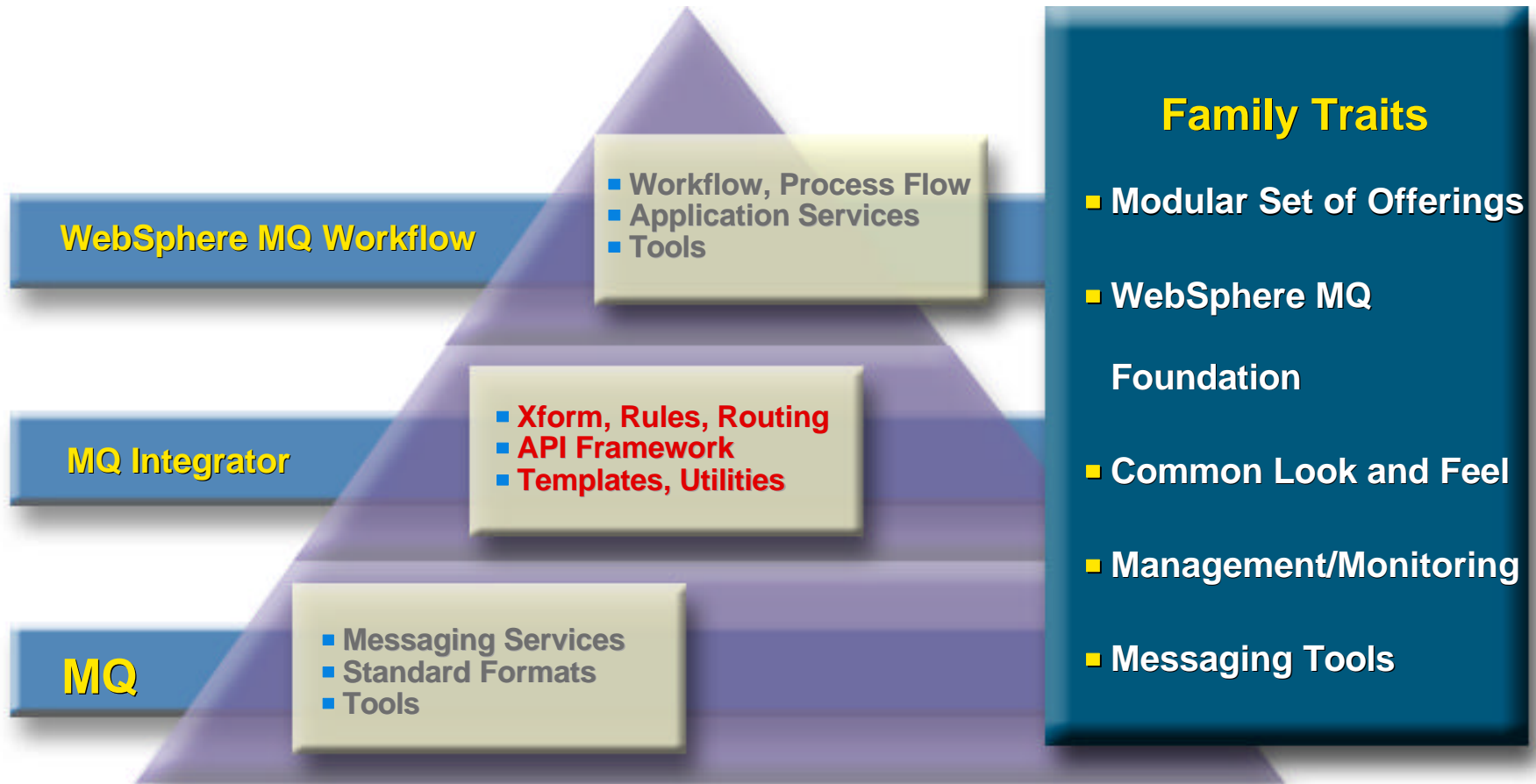
A remote SCADA device publishes a message using MQIsdp, reporting that a volume of oil has been successfully transferred to a tanker for a Customer.

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



WebSphere MQ Basic Features

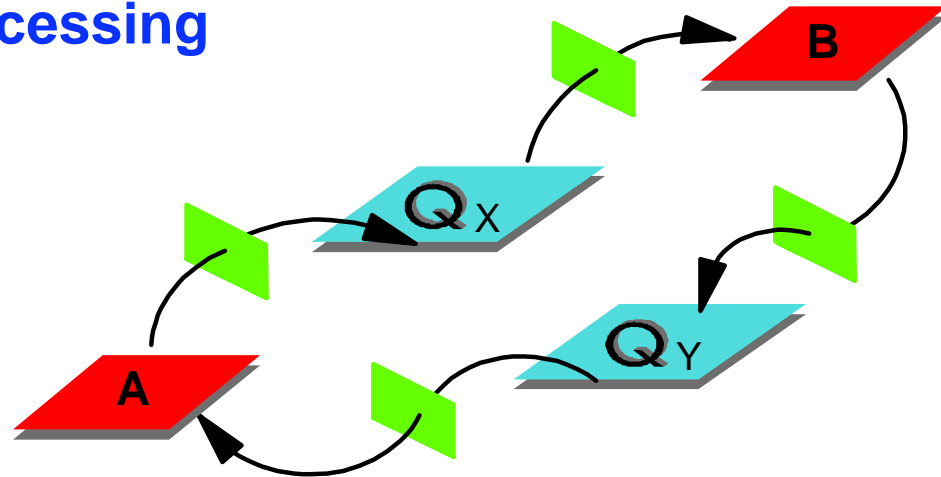
A single, multi-platform API

- Easy to use
- Network independent
- Faster application development

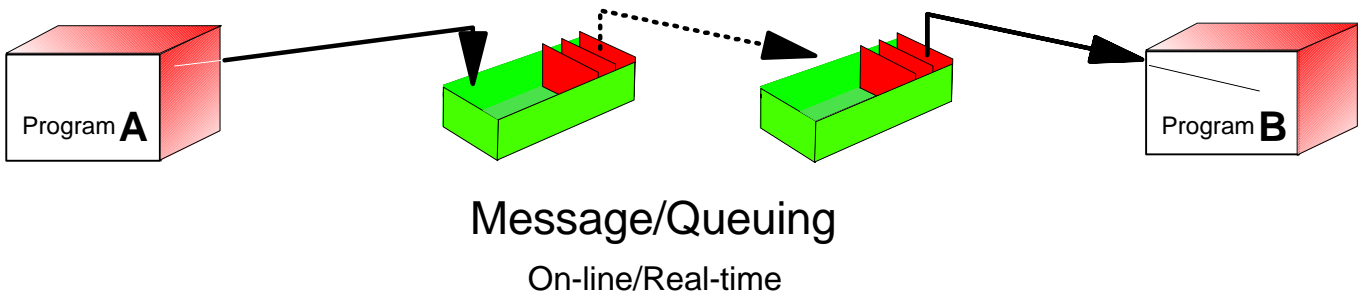
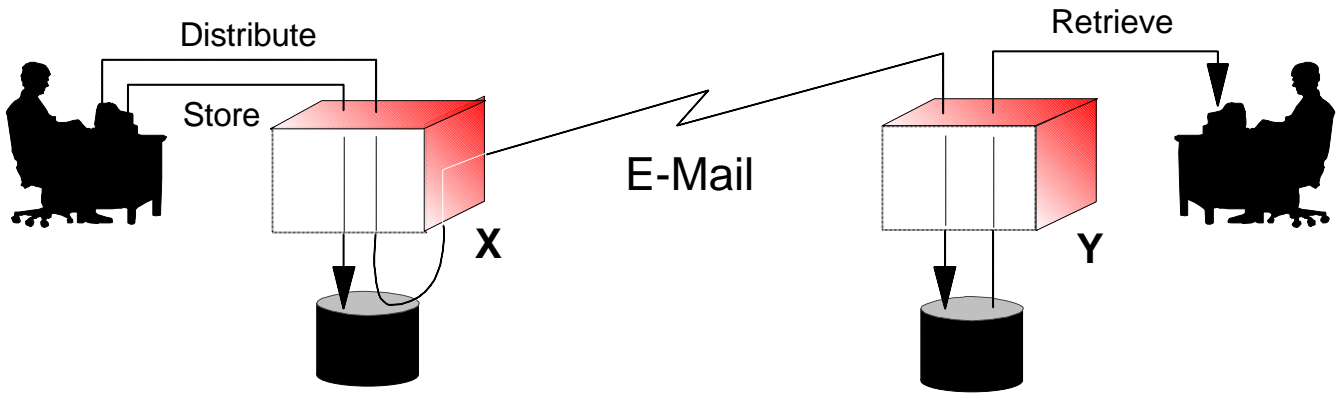
Assured message delivery

Time independent processing

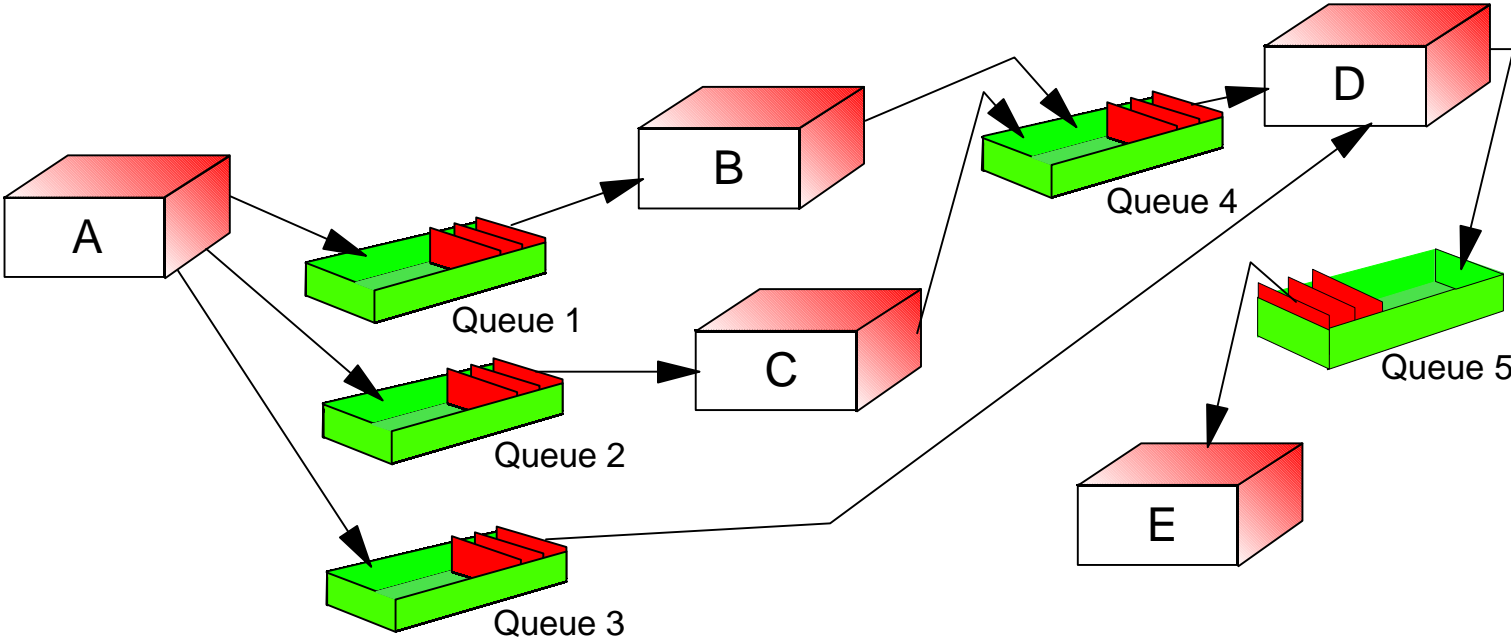
- Asynchronous messaging



Types of Messaging



Topology Choices...



WebSphere MQ Integrator

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

Publish/Subscribe matching engine

- ▶ topic and content matching
- ▶ Access Control Lists

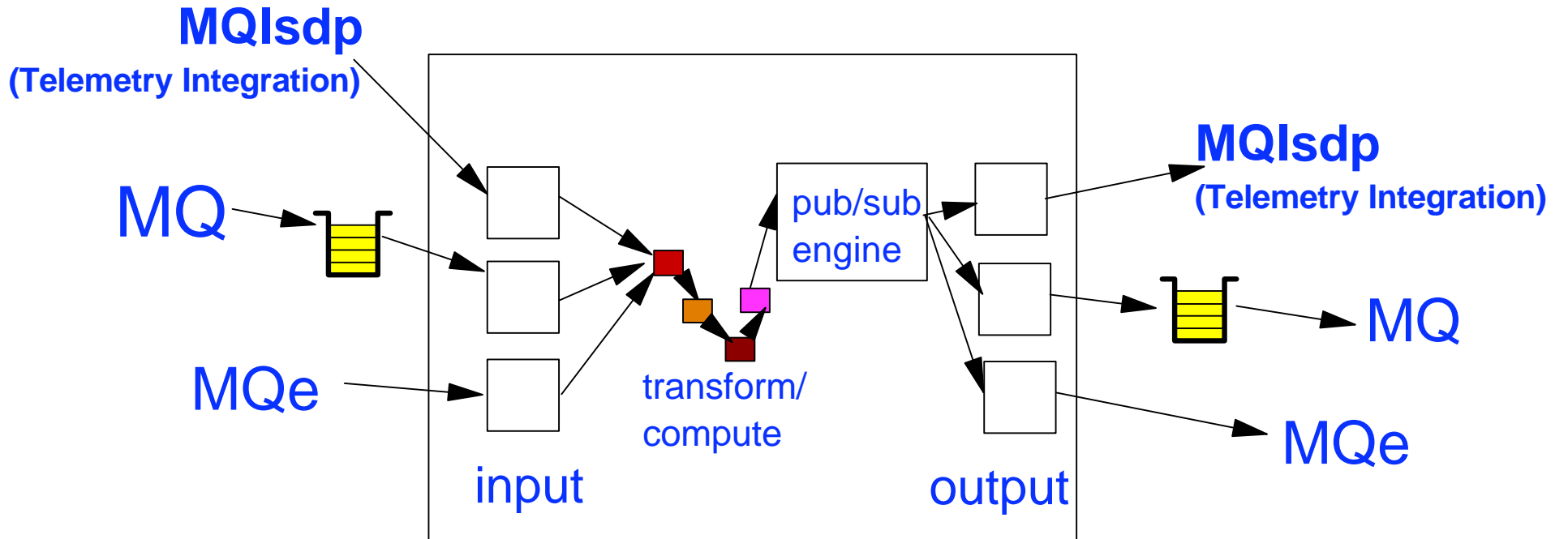
Message Flow Engine for

- ▶ business logic, message transformation, message routing

Message repository

- ▶ for message transformation, XML, EDI, etc

WMQI block diagram



Crossing The Streams

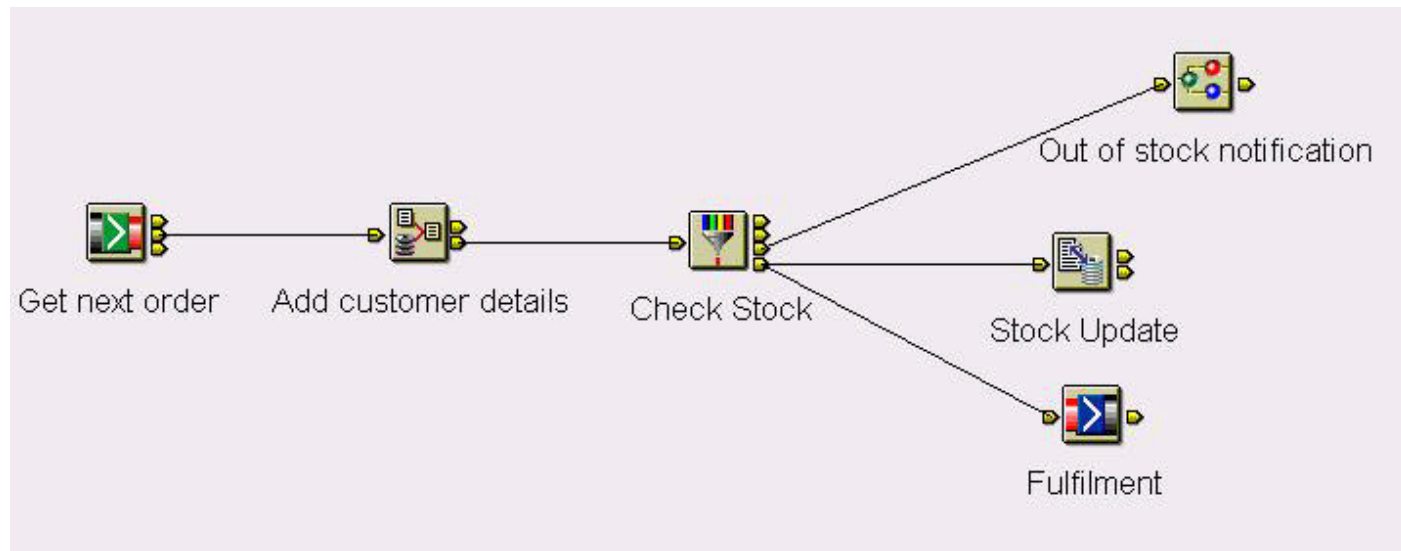
Publishers and Subscribers can be:

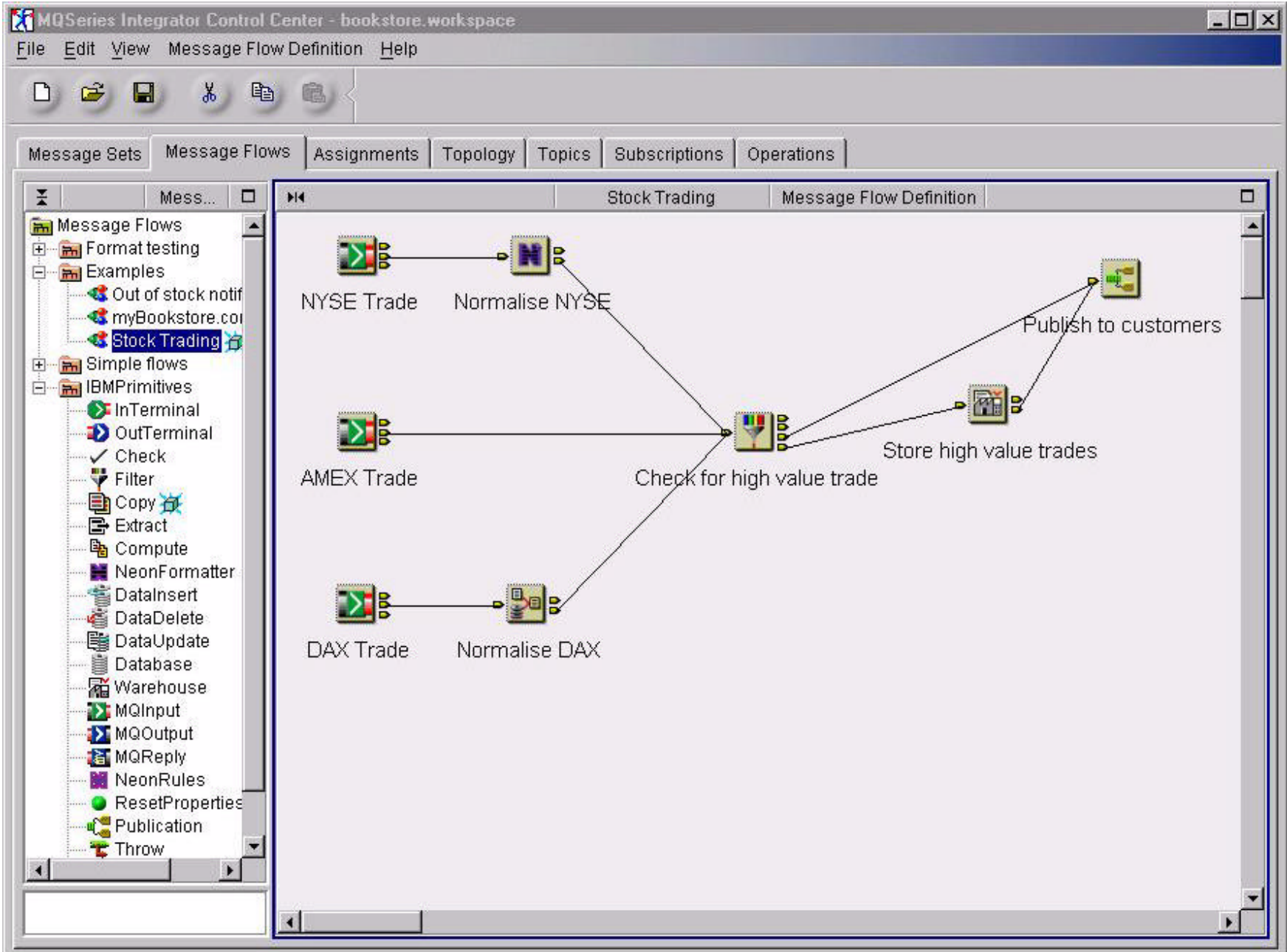
- ▶ remote monitoring devices
 - MQ SCADA device protocol (MQIsdp)

- ▶ hand-held Pervasive devices
 - (MQSeries everywhere)

- ▶ WebSphere MQ applications
 - Application Messaging Interface (AMI)
 - Java Messaging Service (JMS)

What is a Message Flow?





IBM MQSeries Integrator

File Edit View Selected Window Help

Messages Message Flows MessageFlow Assignments Pub/Sub Topology Subscriptions **Access Control** Operations

Topics-Users Users/Topics

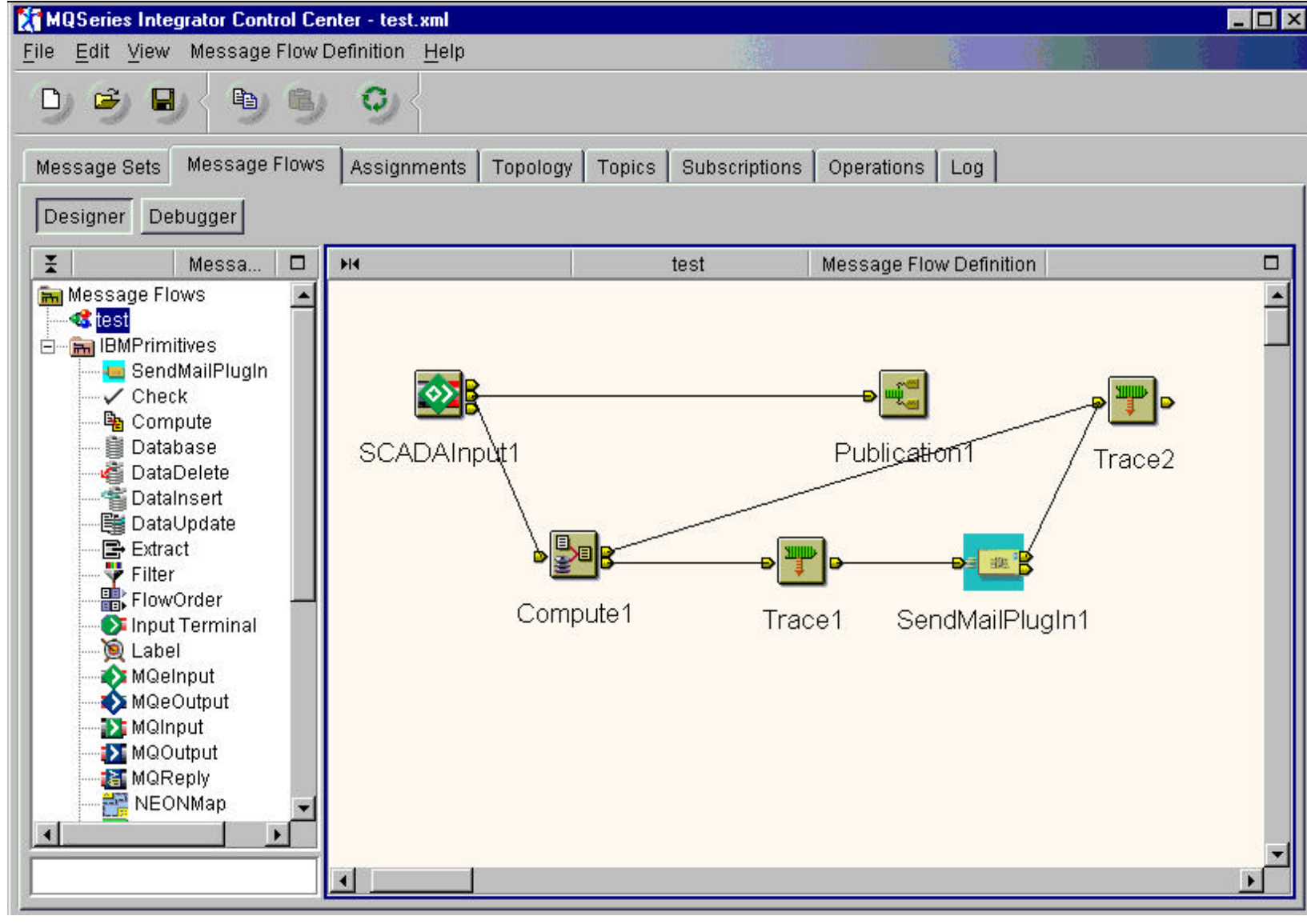
Users	Topic	Publish	Subscribe	Guaranteed
Groups	Accounts	Deny	Inherit	No
Trading floor	Transfers	Allow	Deny	Yes
Accounting	Transactions	Allow	Allow	Yes
Messaging Group	Balances	Deny	Allow	No
Finance	Cash	Allow	Allow	Yes
Analysts	Securities	Deny	Allow	No
Account Administrators	Products & Services	Allow	Deny	Yes
Directors	Bonds & Treasuries	Allow	Allow	Yes
Human Resources	Life Insurance	Deny	Allow	No
Users	Mutual Funds	Inherit	Deny	Yes
	Research	Allow	Allow	Yes
	News	Deny	Allow	No
	Industries	Allow	Deny	Yes
	Mutual Funds	Allow	Allow	Yes
	Quotes	Deny	Allow	No
	Charts	Inherit	Deny	Yes
	Performance	Allow	Allow	Yes
	Job Applications	Deny	Allow	No
	Customer Accounts	Allow	Deny	Yes
	Trading	Allow	Allow	Yes
	Limit Orders	Deny	Inherit	No
	Market Orders	Deny	Inherit	No

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



MQIsdp protocol

	Description	7	6	5	4	3	2	1	0
Topic Name									
byte 1	Length MSB (0)	0	0	0	0	0	0	0	0
byte 2	Length LSB (3)	0	0	0	0	0	0	1	1
byte 3	'a' (0x61)	0	1	1	0	0	0	0	1
byte 4	'/' (0x2F)	0	0	1	0	1	1	1	1
byte 5	'b' (0x62)	0	1	1	0	0	0	1	0
Requested QoS									
byte 6	Requested QoS (1)	x	x	x	x	x	x	0	1
Topic Name									
byte 7	Length MSB (0)	0	0	0	0	0	0	0	0
byte 8	Length LSB (3)	0	0	0	0	0	0	1	1
byte 9	'c' (0x63)	0	1	1	0	0	0	1	1
byte 10	'/' (0x2F)	0	0	1	0	1	1	1	1
byte 11	'd' (0x64)	0	1	1	0	0	1	0	0
Requested QoS									
byte 12	Requested QoS (2)	x	x	x	x	x	x	1	0

MQIsdp

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.

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MQIsdp positioning

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

Protocol specification published in the WMQI Programming Reference manual.

Several device manufacturers currently implementing MQIsdp 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

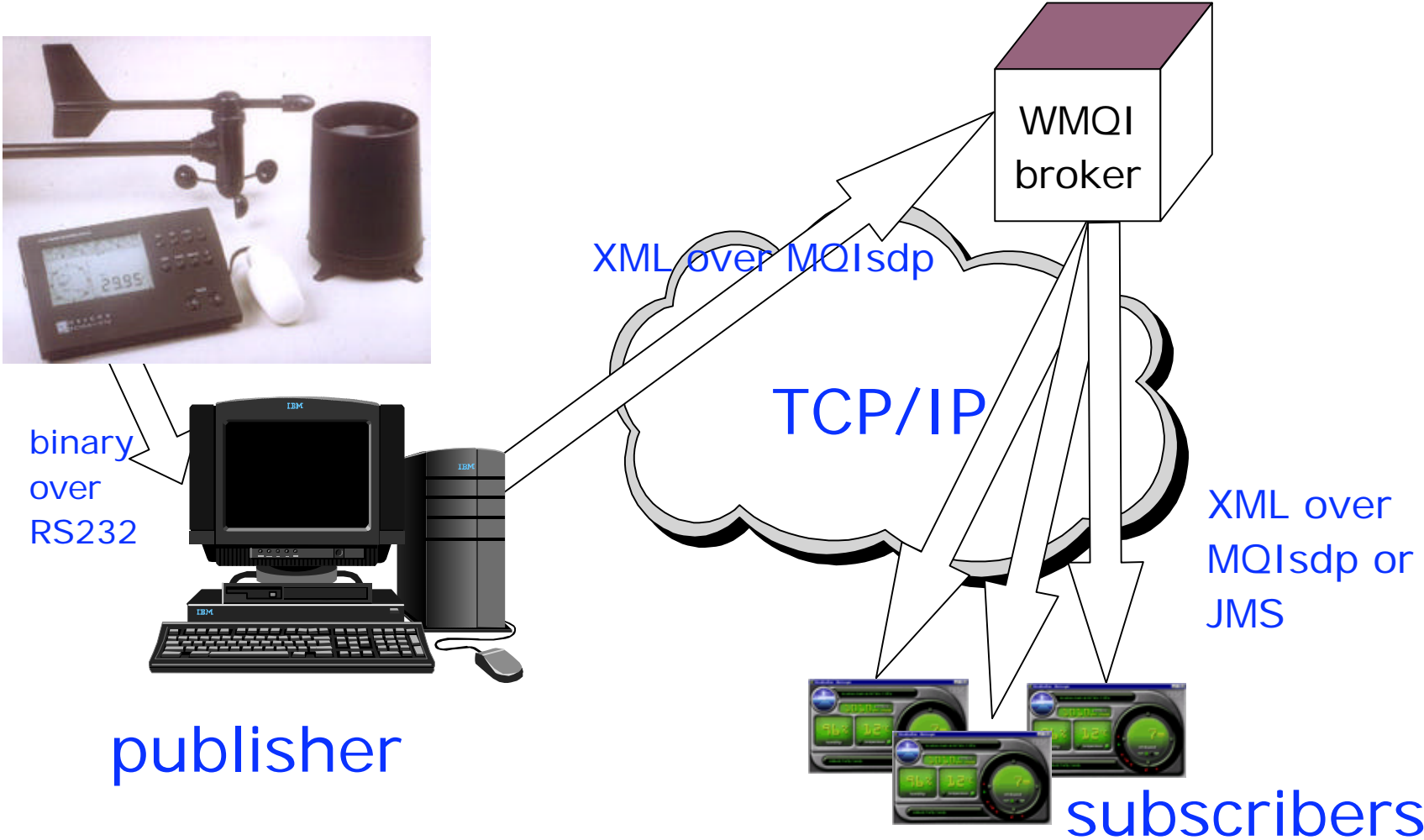
- **When an MQIsdp client connects to the broker, it can optionally specify a**
 - Will topic, Will message
 - keepalive interval
- **If the client fails to publish anything during the keepalive time, the Last Will and Testament is invoked:**
- **The broker assumes the "untimely death" of the client, 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



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How it works



Topic space

temperature

- ▶ indoor/outdoor
 - current/high/low

wind

- ▶ average/current/high

humidity

- ▶ indoor/outdoor
 - current/high/low

rain

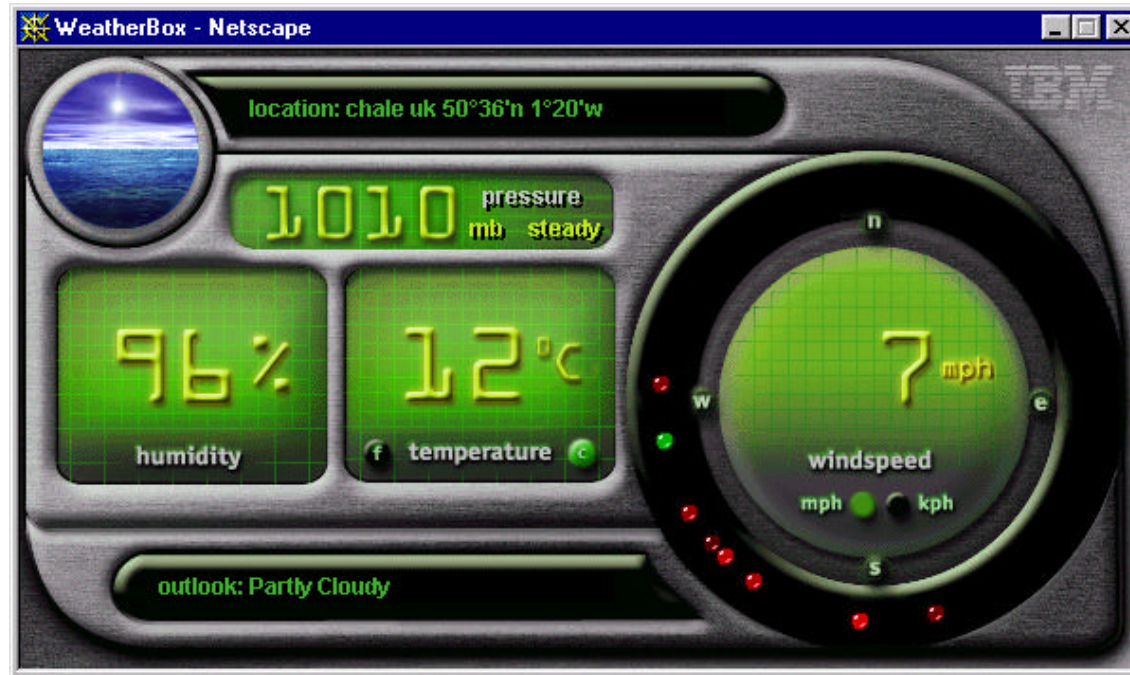
- ▶ rate/total

barometer

windchill, dew point, prediction

e.g. weather/Chale/humidity/indoor/current

Weatherbox



<http://weatherbox.ngi.ibm.com>

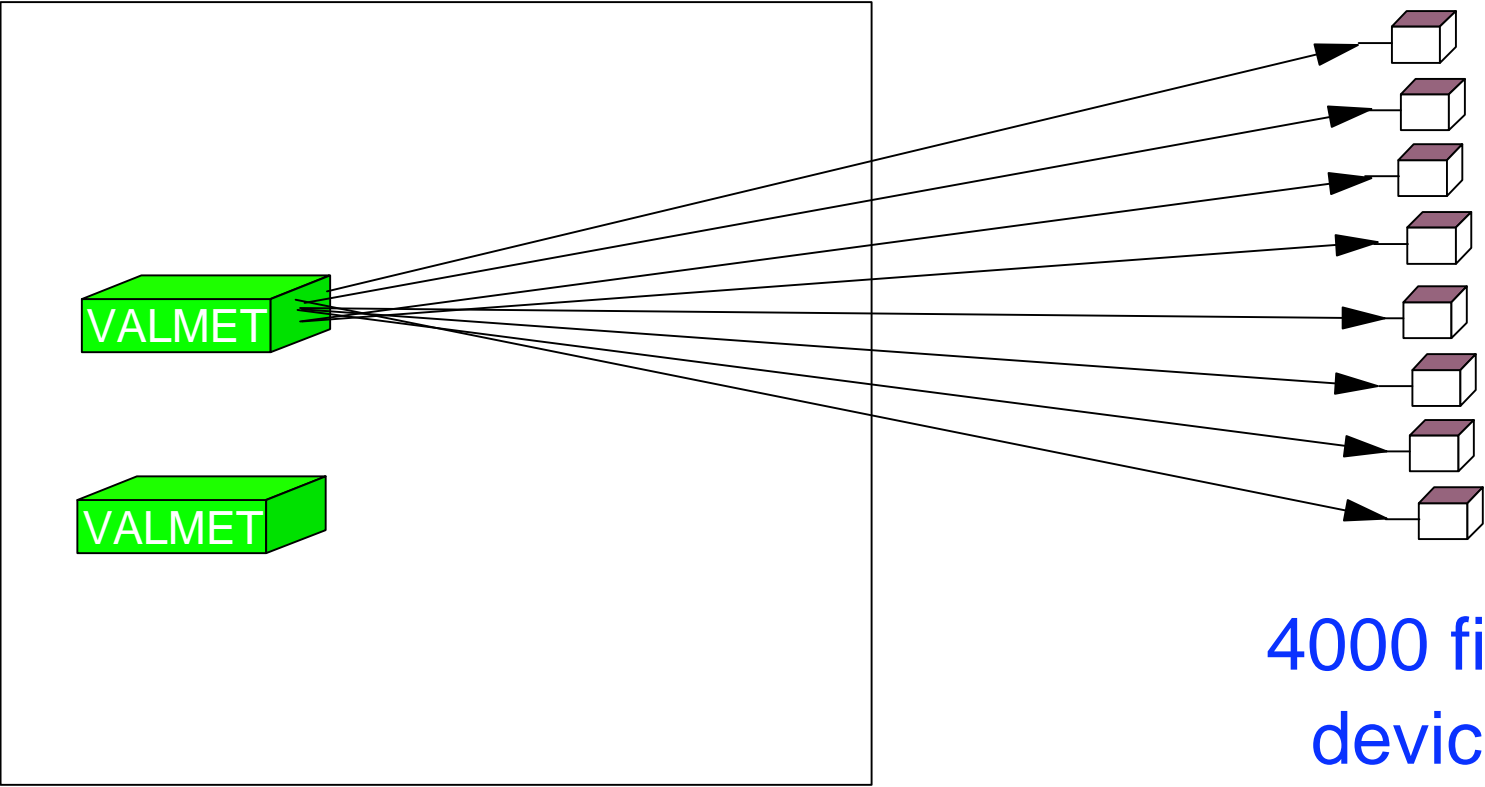
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Pipeline project



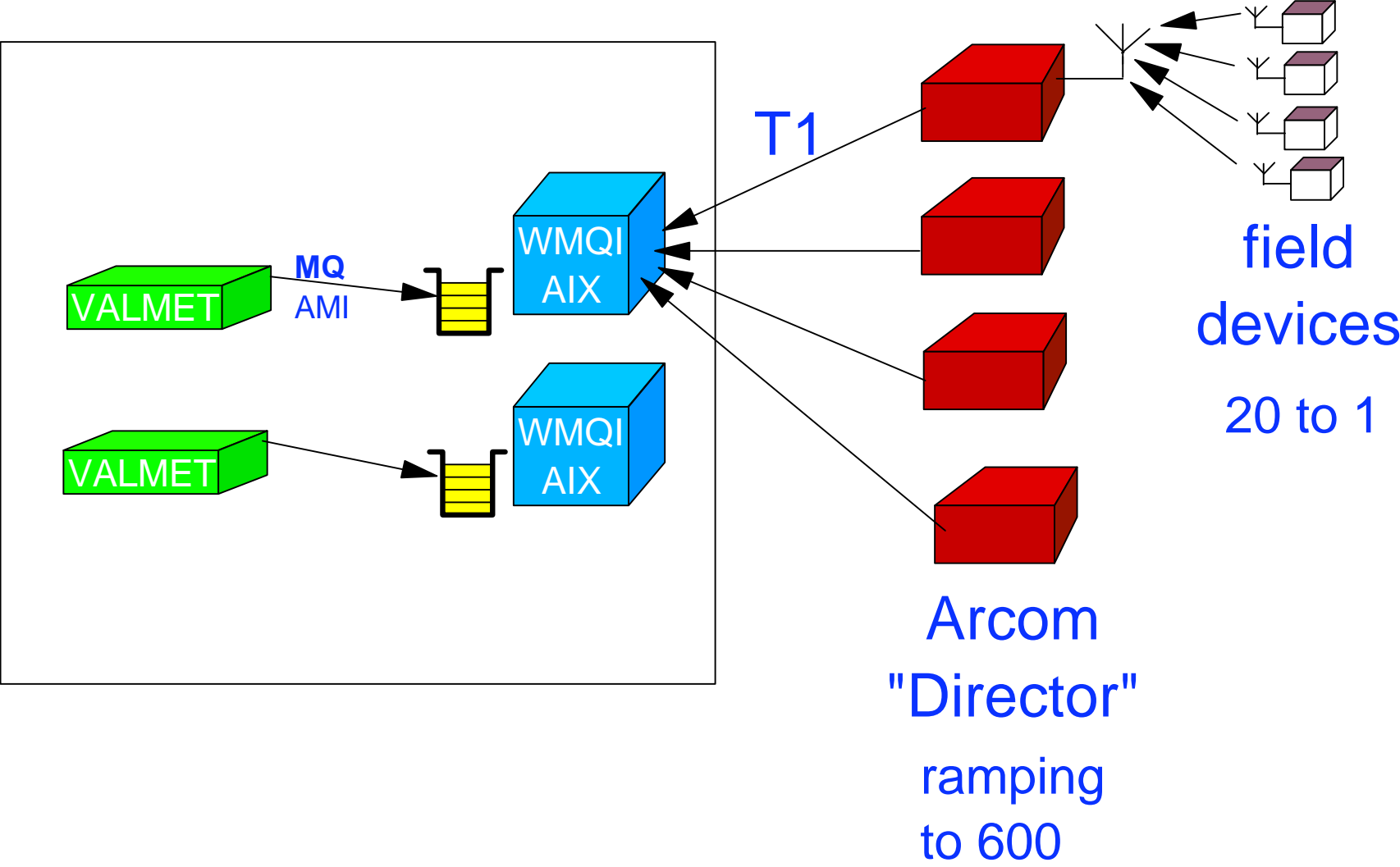
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Customer Project - original system



4000 field
devices
(polling)

Customer Project - now in production



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



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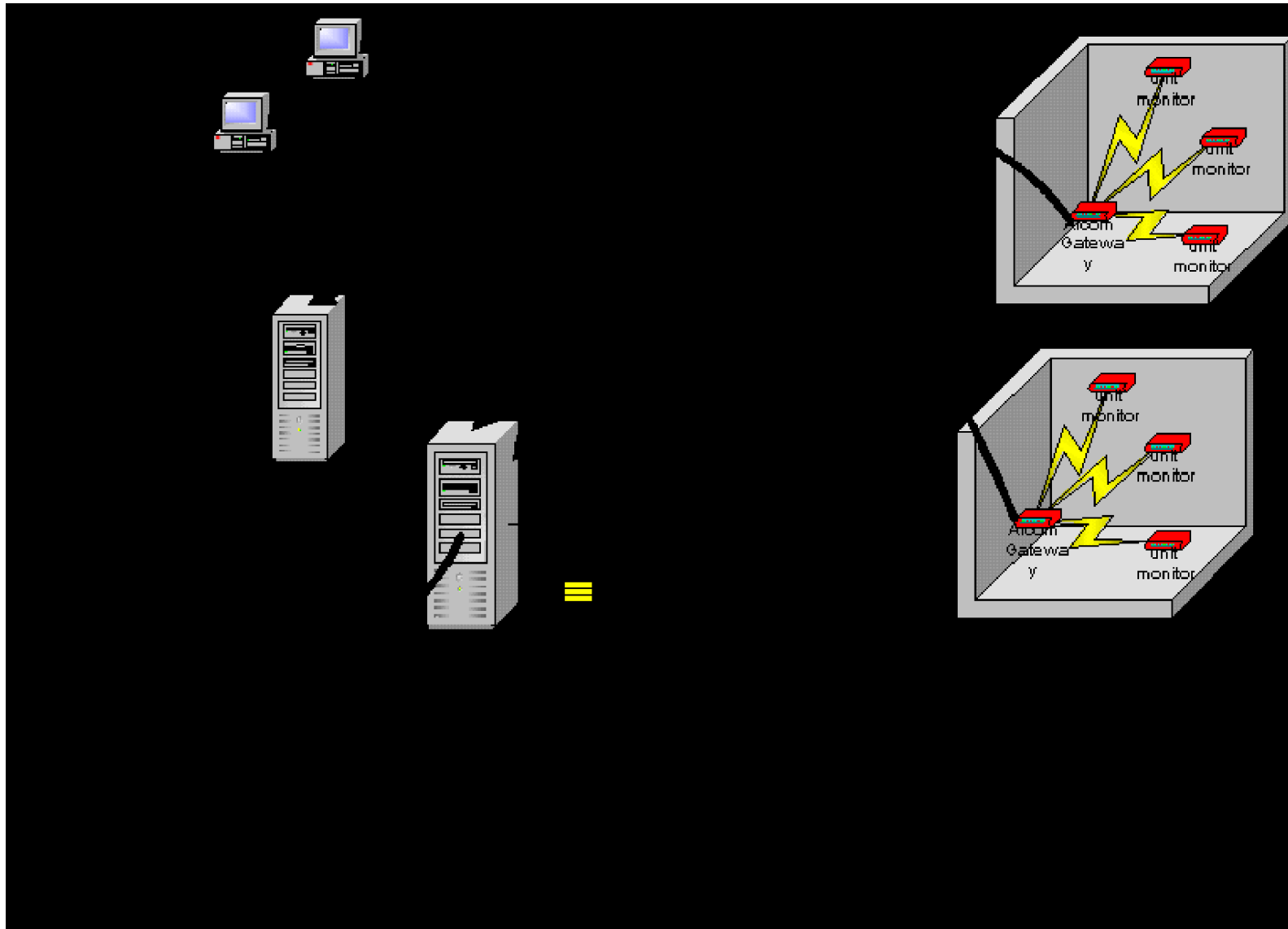
Oil Pipeline - AMR project

- **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**

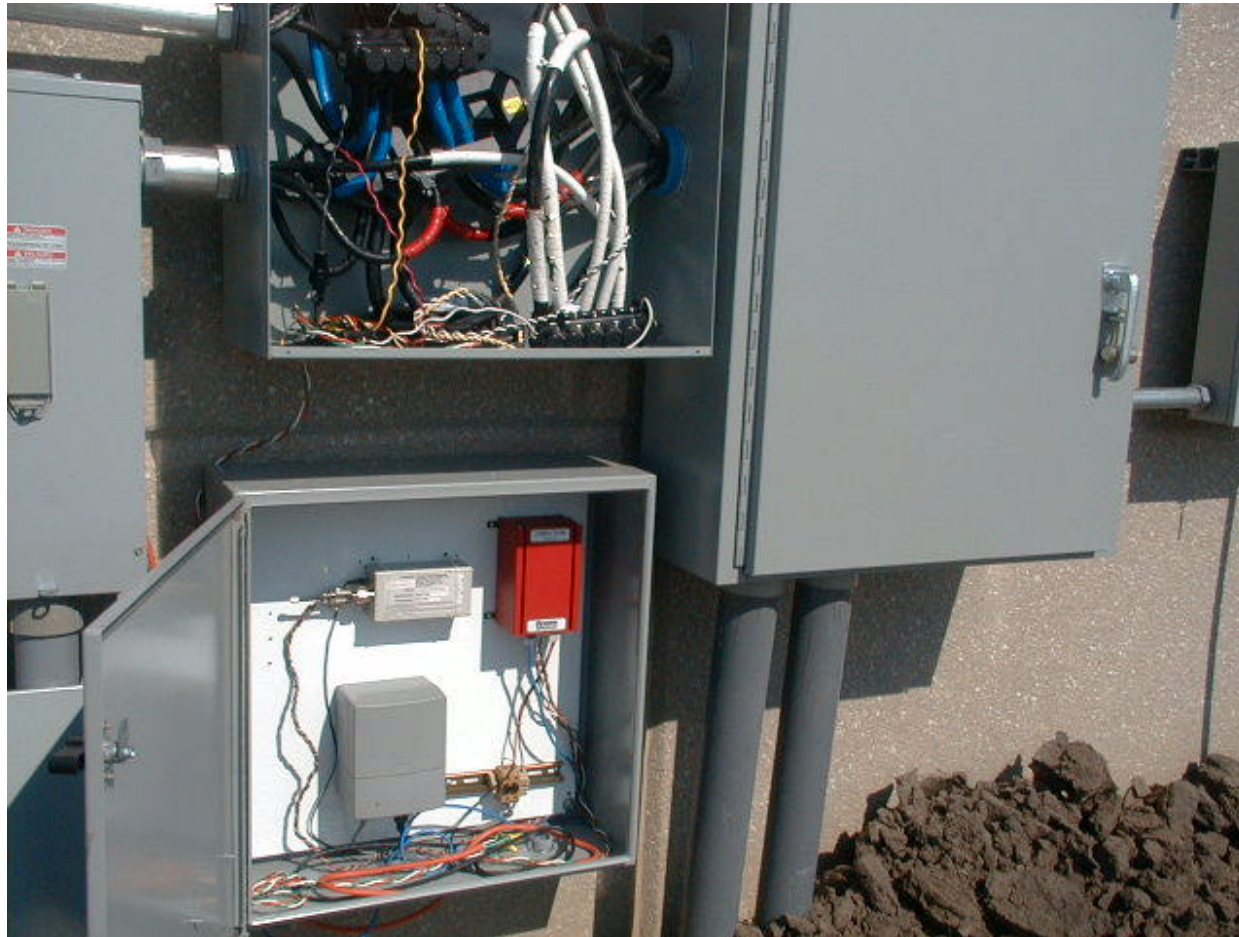
Oil Pipeline - AMR project

- **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"

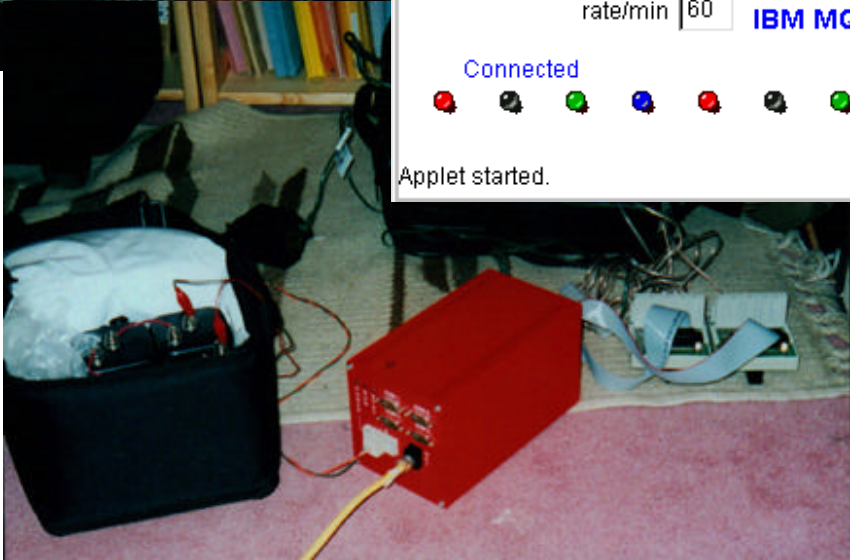


Electricity meter monitoring



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SCADA lights



Applet Viewer: SCADALights.SCADALights

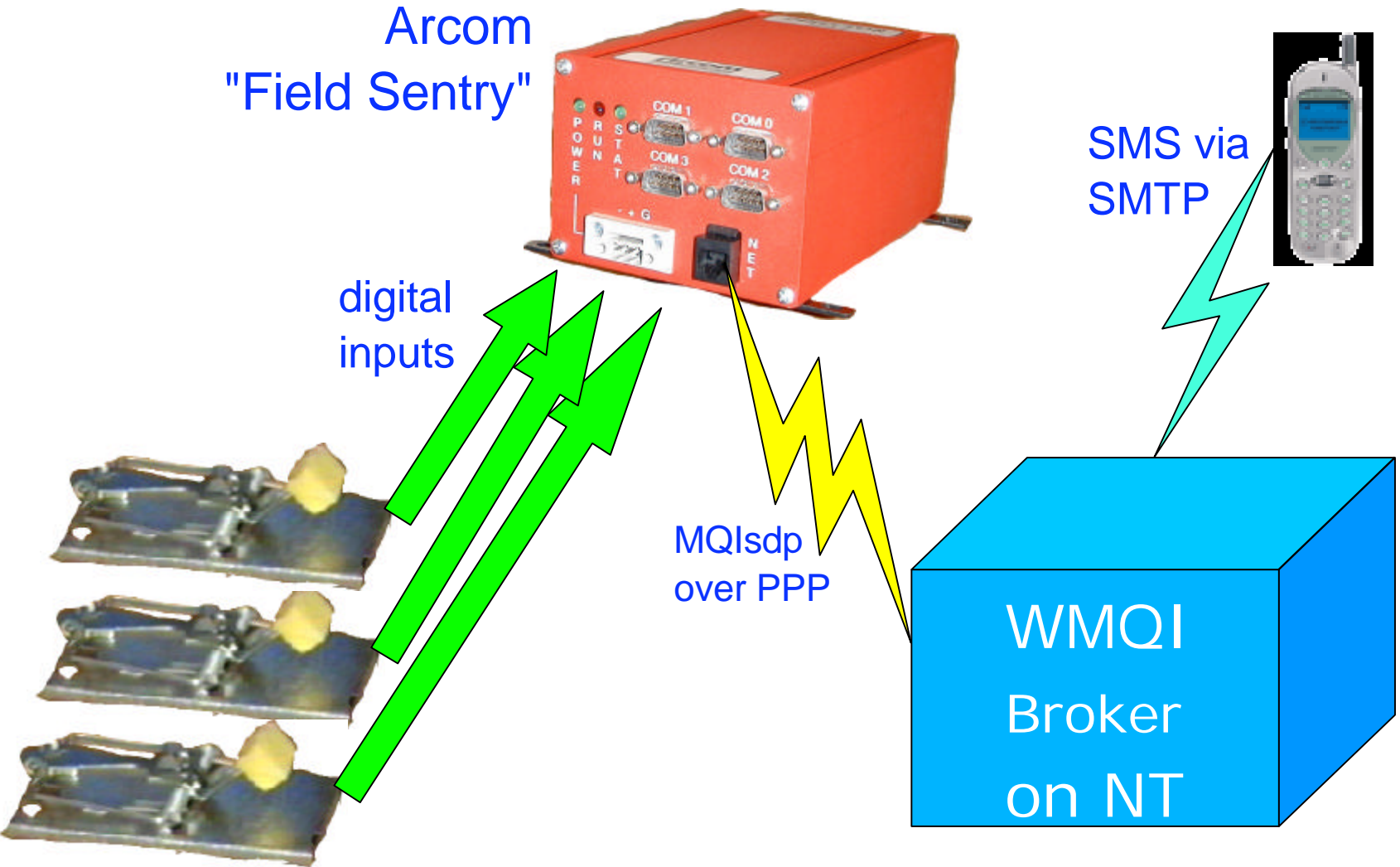
Applet

RED	YELLOW	GREEN	BLUE	
OFF	ON	OFF	OFF	
FLASH	FLASH	FLASH	FLASH	
rate/min 60	rate/min 60	rate/min 60	rate/min 60	
all ON	all FLASH	pipe	random	weather
rate/min 60		IBM MQIsdp SCADA lights		

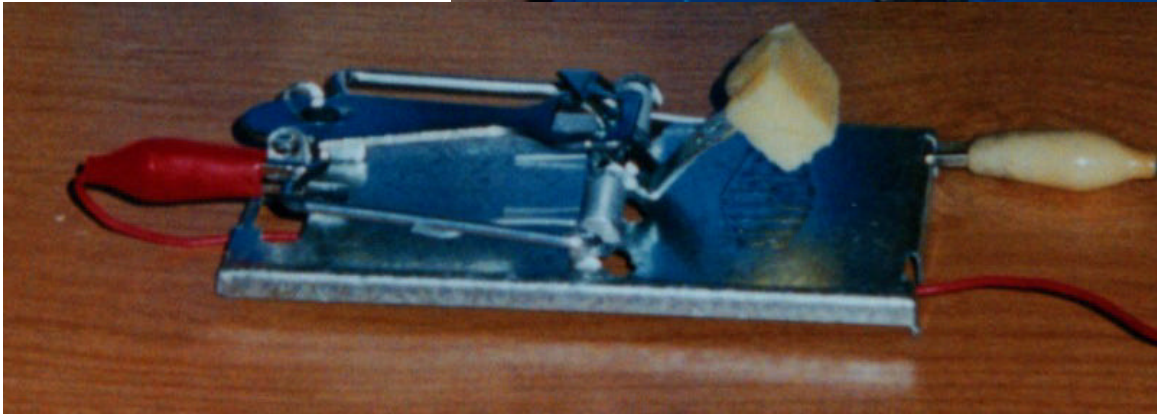
Connected

Applet started.

SCADA mouse trap



SCADA mouse trap



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Telemetry Integration

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

**Thanks for
listening !**

andysc@uk.ibm.com

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