# "eSCADA"

IBM

# Integrating Monitoring and Telemetry Devices into the Enterprise with MQSI v2.0.2

Andy Stanford-Clark

MQSeries Development
IBM Hursley

andysc@uk.ibm.com

*IBM Software*

## *Agenda*

**High-level overview**

**Publish/Subscribe**

**SCADA and remote monitoring**
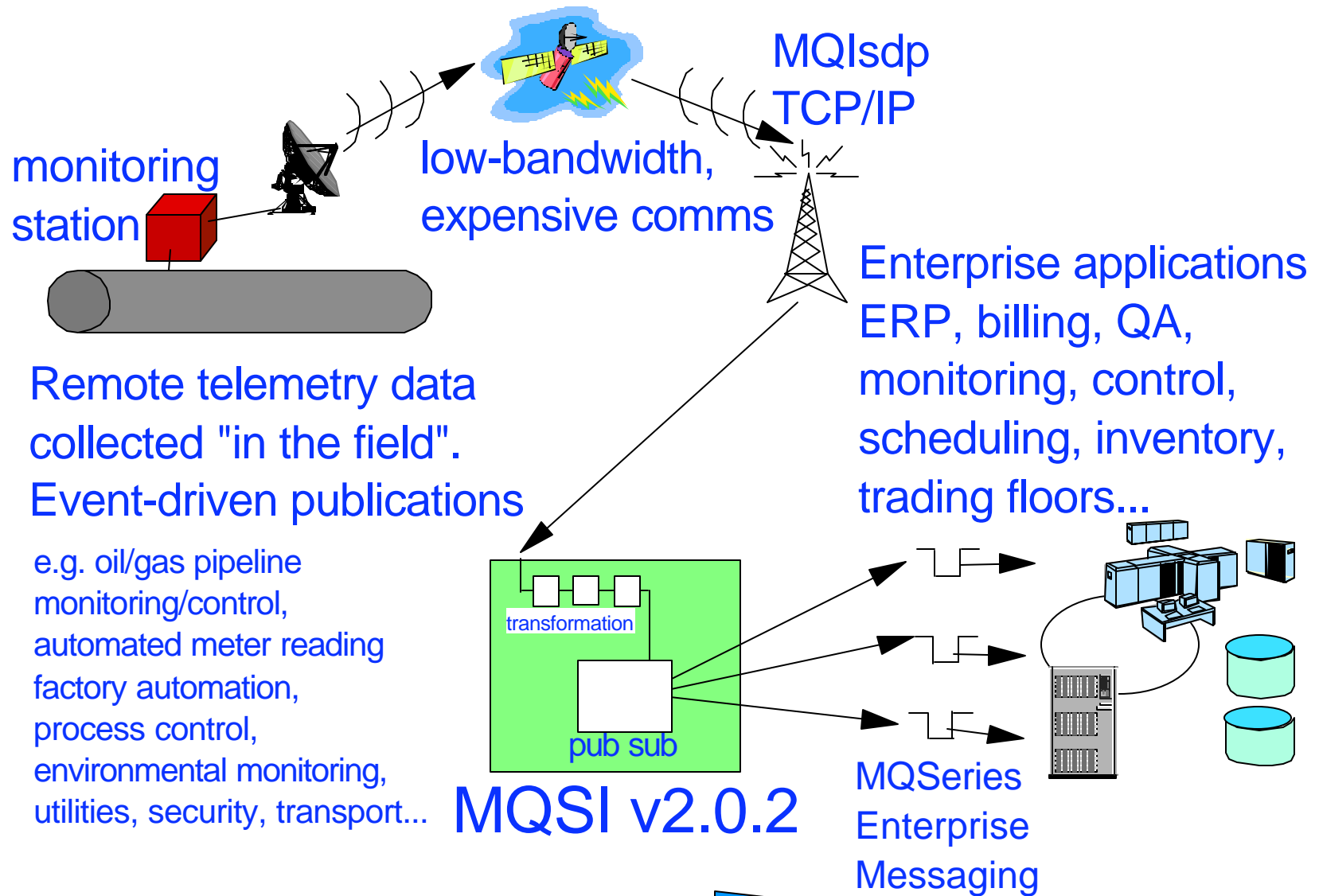
**MQSI v2.0.2**

**MQIsdp protocol**

**Customer Projects**

# End to end business integration

**From remote monitoring and telemetry devices _in_ to Enterprise applications, and from command/control applications _out_ to remote control devices**
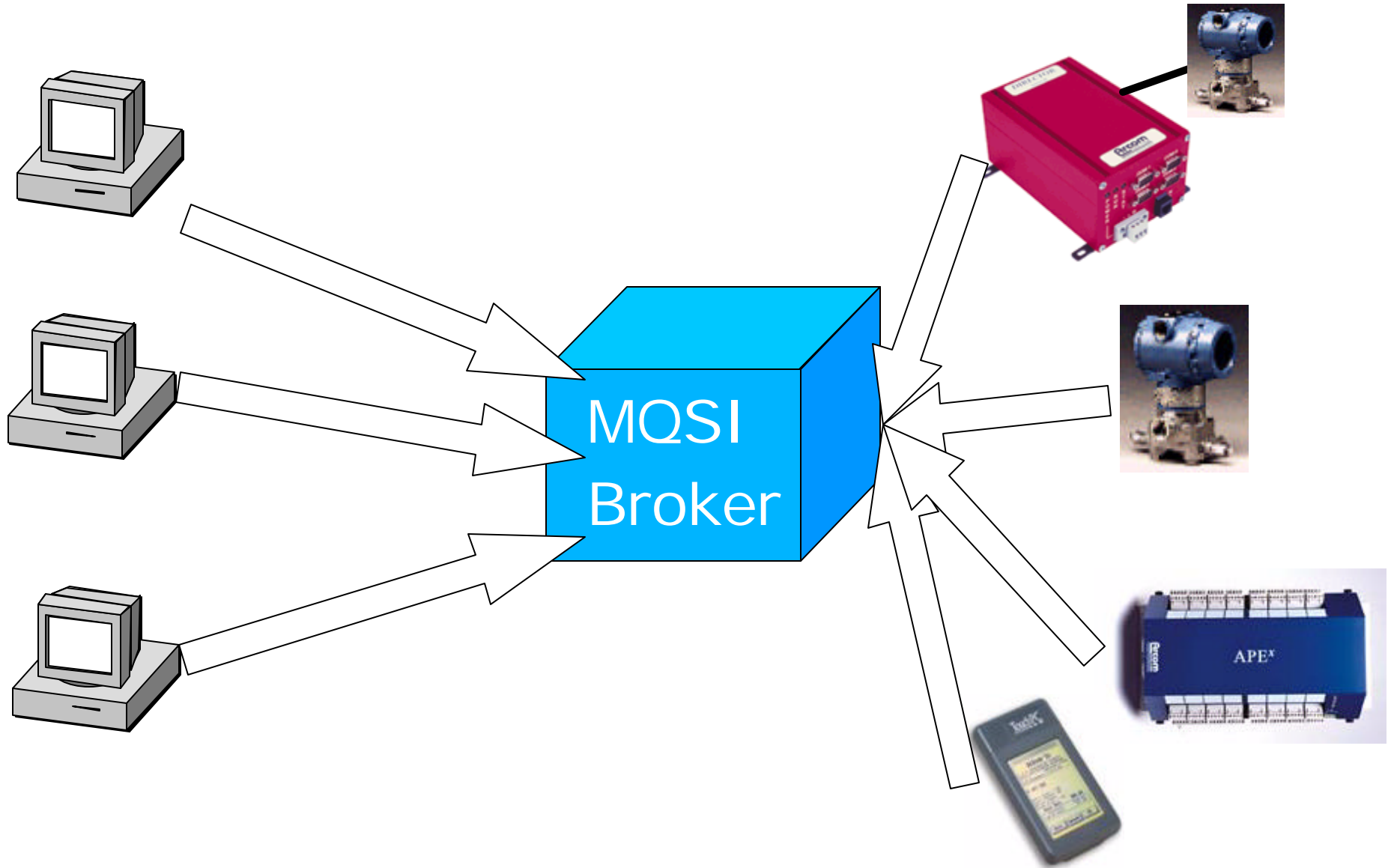
**Using a new lightweight pub/sub protocol (MQIsdp), MQSeries messaging, and MQ Series Integrator V2.0.2**

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

MQIsdp
TCP/IP

**monitoring station**

**low-bandwidth, expensive comms**

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

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...

transformation

pub sub

MQSI v2.0.2

MQSeries Enterprise Messaging

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

# Publish/Subscribe



**MQSI Broker**

# *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

# *Crossing The Streams*

**Publishers and Subscribers can be:**

► remote monitoring devices (MQIsdp)

► hand-held Pervasive devices (MQe)

► MQSeries applications (AMI, JMS)

*Typically* **find remote devices use MQIsdp, and Enterprise applications use MQSeries with AMI or JMS. Exploit Enterprise MQ infrastructure!**

Supervisory, Control,
And Data Acquisition

Remote Monitoring

Telemetry and Control

## *SCADA applications*

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

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

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

**trucks, cars, railways, boats, security, environmental monitoring, weather, etc, etc.**

...Both MONITORING *and* CONTROL

*IBM Software*

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

# Remote monitoring station

# 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

*IBM Software*

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

## SCADA *industry evolution*

**Moving from polling to publish/subscribe 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 feed raw telemetry data *directly* into our Production Systems?"**
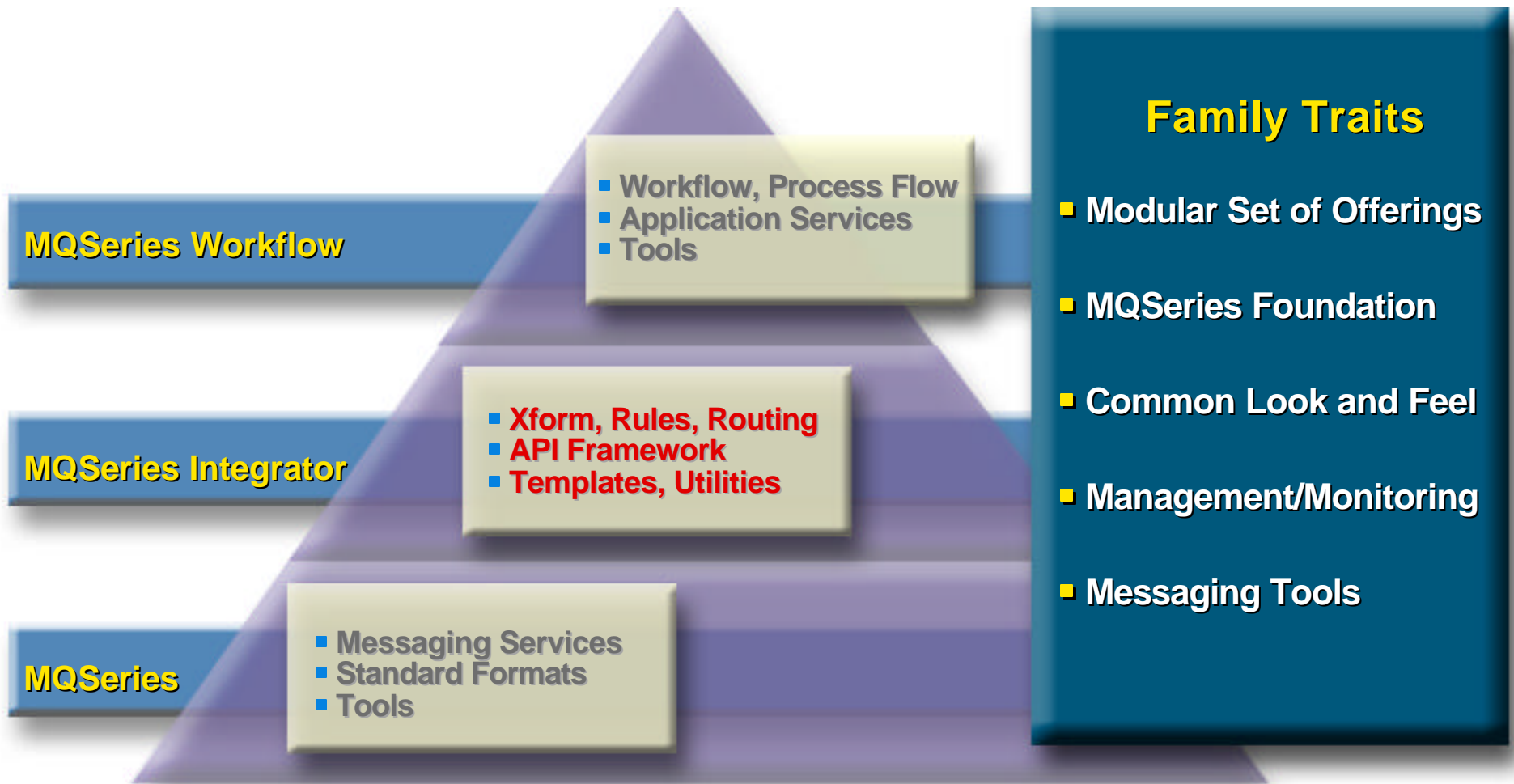
*IBM Software*

## *Integration example*

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

The MQSI broker transforms the message into an MQSeries message using an SAP format message template from the Message Repository (MRM).

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

... End to End Business Integration

# *MQSeries Integrator v2.0.2*

## Family Traits

- **Modular Set of Offerings**
- **MQSeries Foundation**
- **Common Look and Feel**
- **Management/Monitoring**
- **Messaging Tools**

**MQSeries Workflow**

- Workflow, Process Flow
- Application Services
- Tools

**MQSeries Integrator**

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

**MQSeries**

- Messaging Services
- Standard Formats
- Tools

*IBM Software*

# *SCADA input node*

## A new input node for MQSI message flows

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

- ► 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 (there is an implicit MQIsdp output node hidden in the publication node, which routes back to the input node)

*IBM Software*

# SCADA message flow
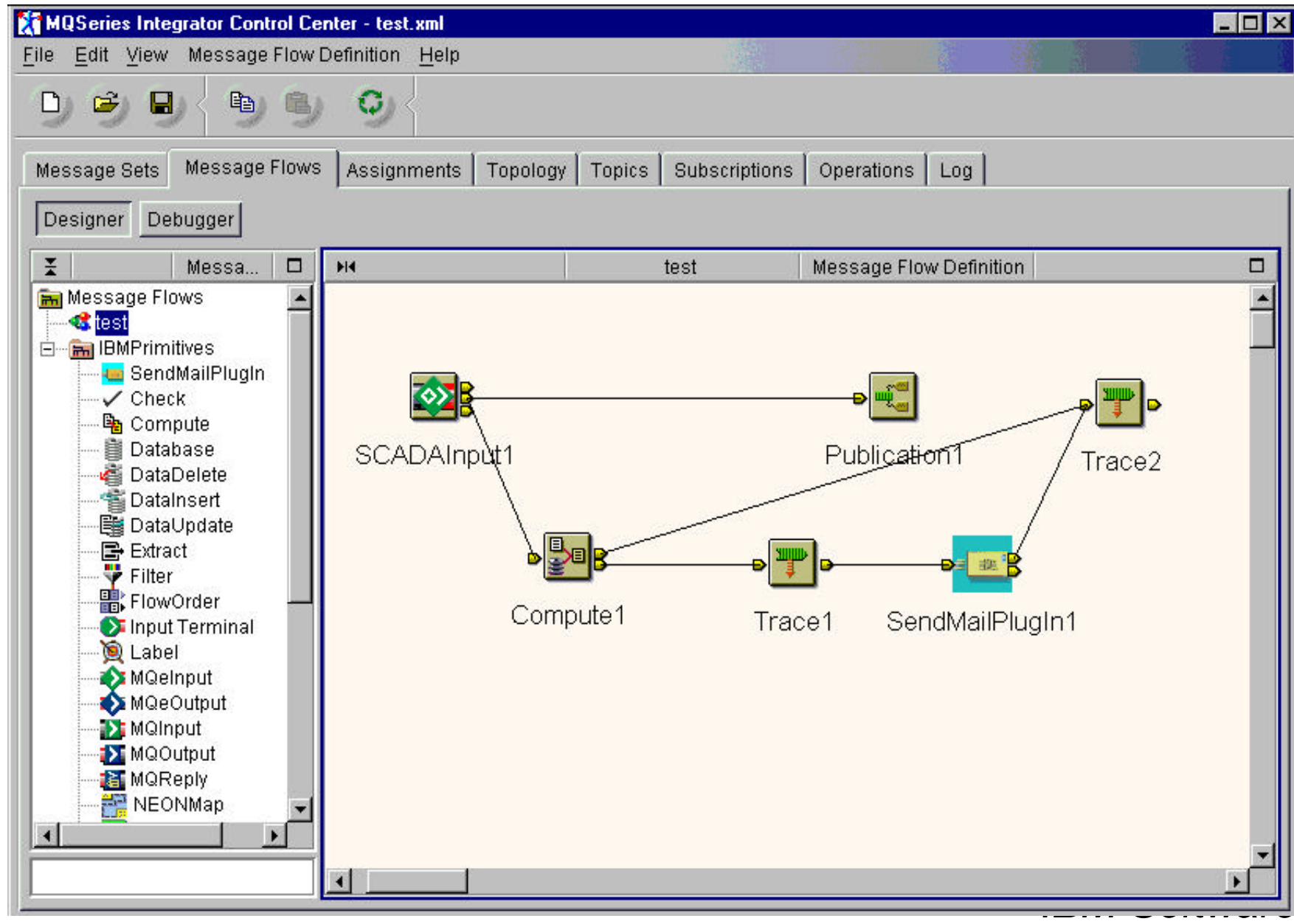
# MQIsdp protocol

| | 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 |

*IBM Software*

## *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 differentiator over our competition!
- ease of implementation on embedded systems

**API for pub/sub**
- connect/disconnect, subscribe/unsubscribe, publish, ping/pong

**Implementations in Java, C, C++,Perl, embedded C**

*IBM Software*

## 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 as an appendix to the MQSI 2.0.2 user manual.

Talking to a number of other device manufacturers about implementations, 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 with many of our early projects.

# *Quality of Service*

## Three levels of "assurance of delivery"

### QoS 0
- ► "fire and forget"
- ► at most once delivery
- ► equivalent to MQSeries "non-persistent" messaging

### QoS 1
- ► at least once delivery

### QoS 2
- ► exactly once delivery
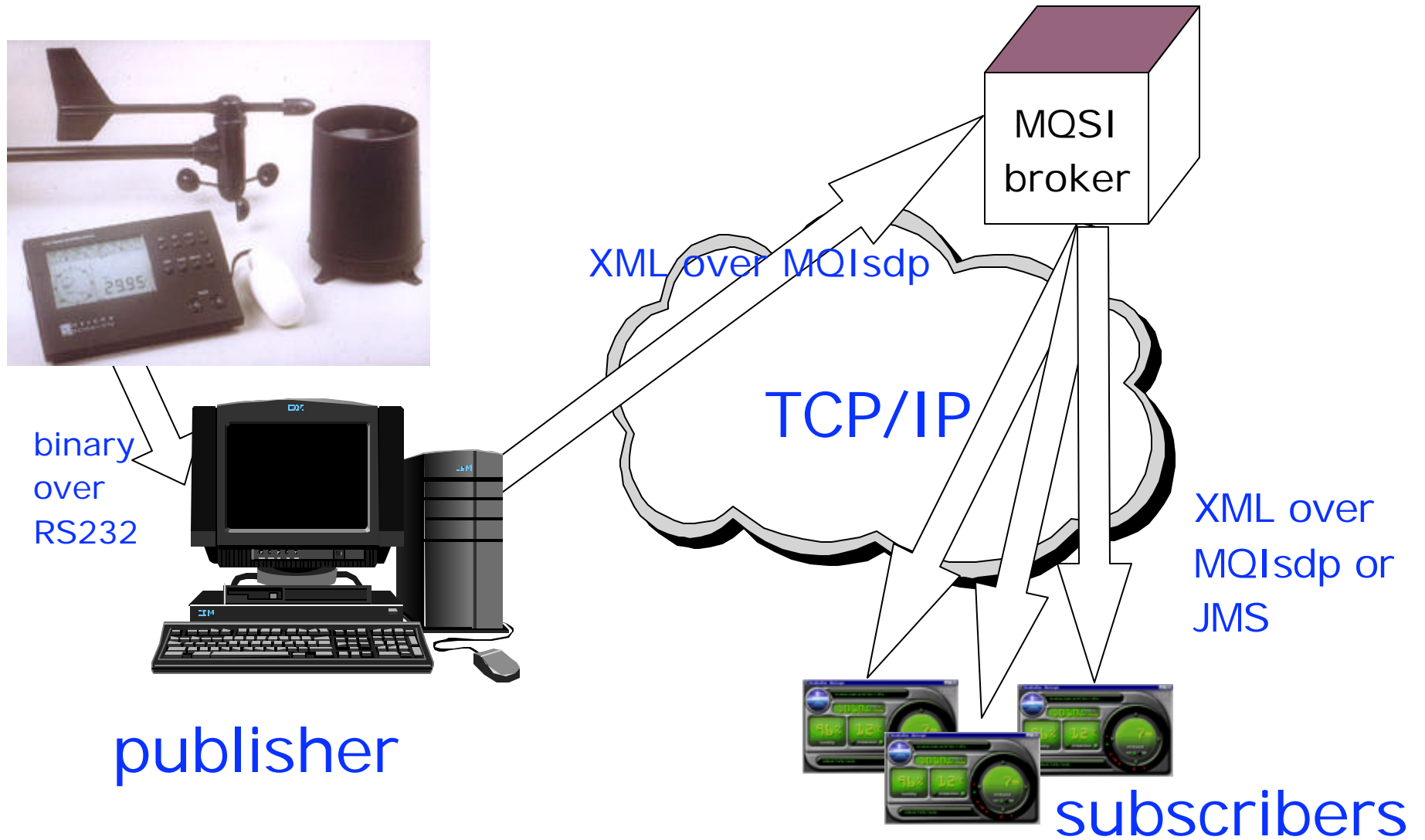- ► equivalent to MQSeries "persistent" messaging

## _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:**

- **Assuming the "untimely death" of the client, the broker closes the client connection, and 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*



binary over RS232

publisher

XML over MQIsdp

MQSI broker

TCP/IP

XML over MQIsdp or JMS

subscribers

*IBM Software*

## _Topic space_

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

**wind**
- ▶ average/current/high

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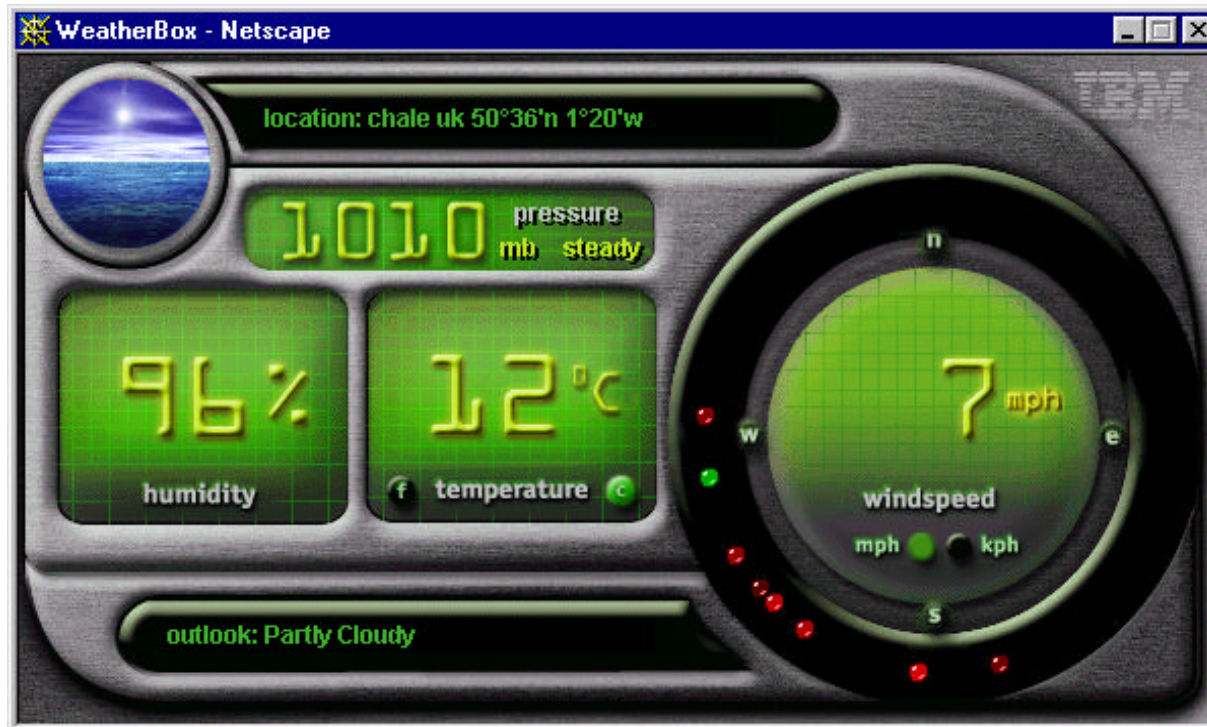- ▶ indoor/outdoor
  - ▬ current/high/low

**rain**
- ▶ rate/total

**barometer**

**windchill, dew point, prediction**
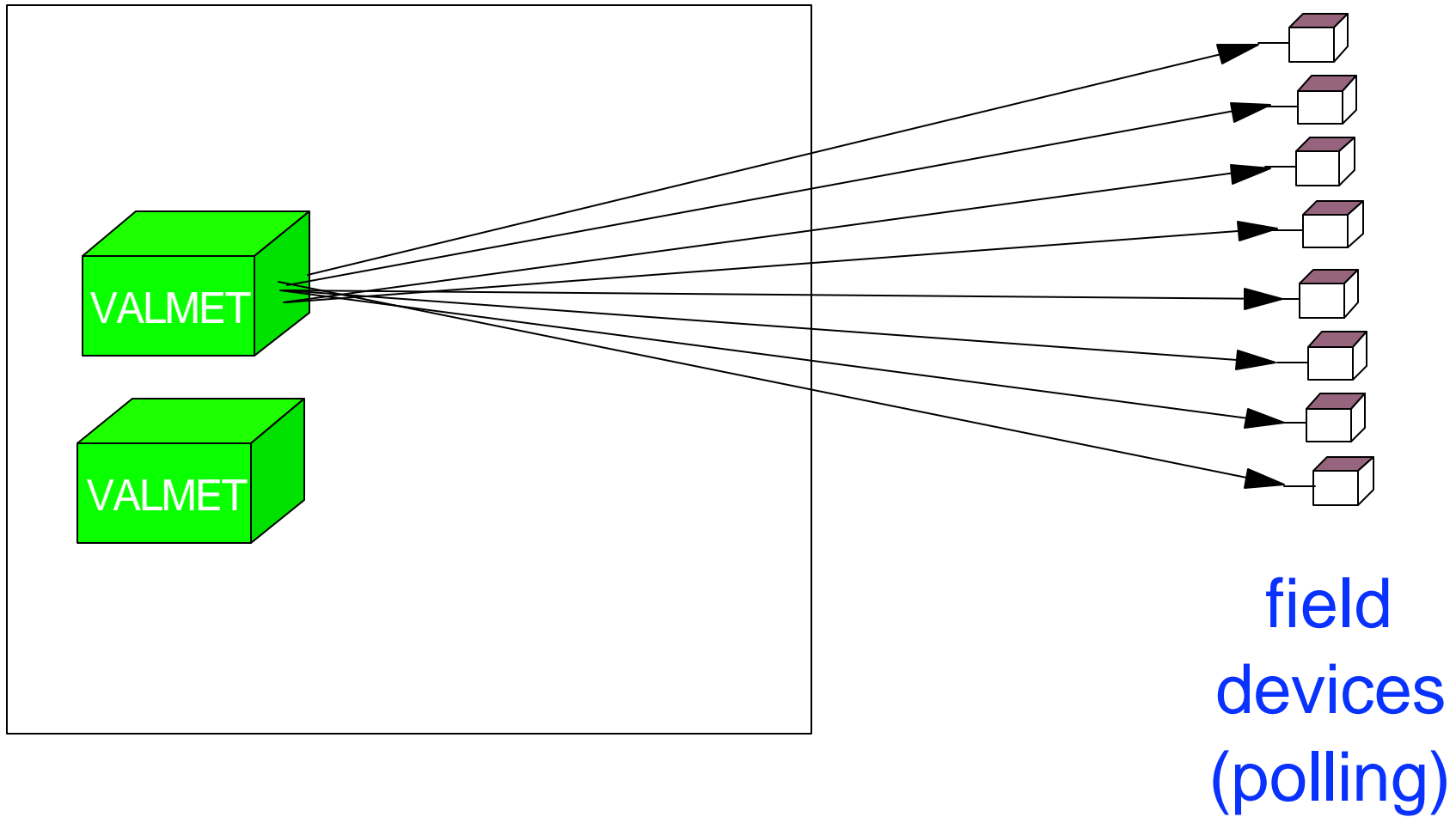
e.g. weather/Chale/humidity/indoor/current

# *Weatherbox*



## http://weatherbox.ngi.ibm.com
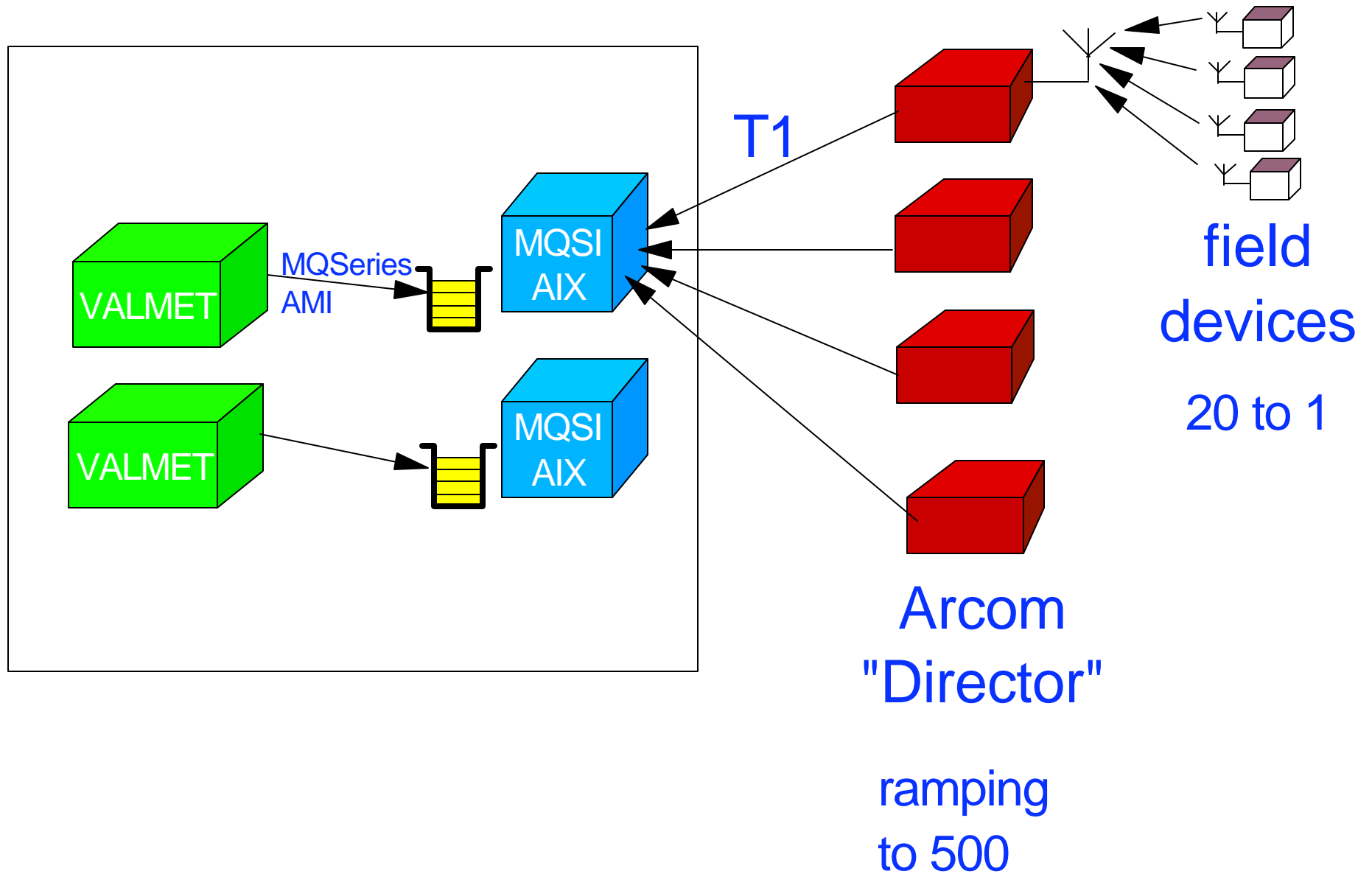
# *Pipeline project*

# Customer Project - original system



VALMET

VALMET

field devices (polling)

# Customer Project - now in production



VALMET

MQSeries AMI

MQSI AIX

VALMET

MQSI AIX

T1

field devices

20 to 1

Arcom "Director"

ramping to 500

*IBM Software*

# _Message types_

## 10,000 meters, 20:1 to 500 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%$CO_2$, 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

_IBM Software_

# Automated Meter Reading project

# Oil Pipeline - AMR project

- **120 pumping stations with flow computers**

- **currently 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 MQSI broker (on NT)**

- **MQSeries pub/sub delivered to MQ/Oracle "adapter" application (subscriber)**

- **downstream applications read data from Oracle as before**

# *SCADA lights*
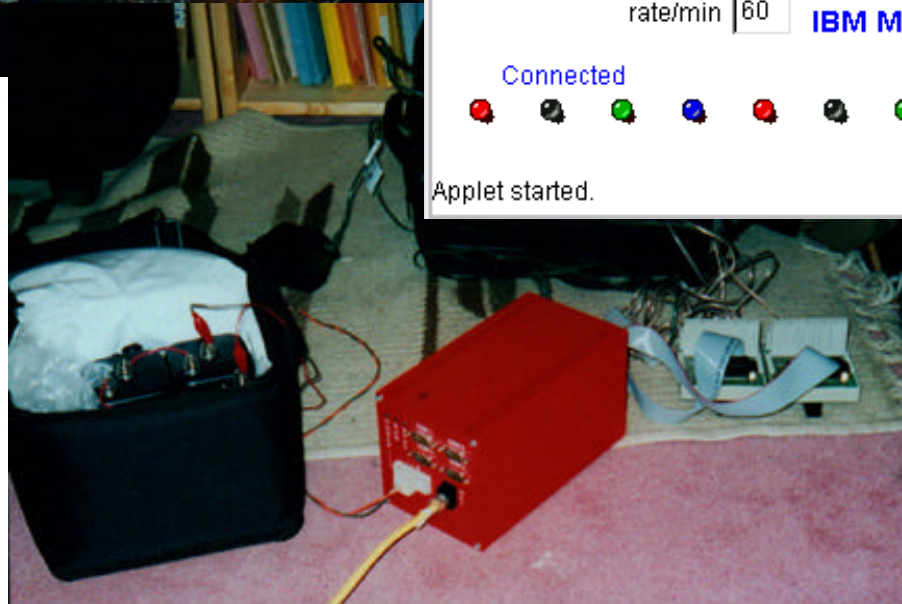
**Integrating Monitoring and Telemetry
Devices into the Enterprise
with MQSI V2.0.2**

*Thanks for*

*listening !*

andysc@uk.ibm.com