Application Servers
G22.3033-011

Session 13 – Sub-Topic 1 Presentation
Sample Messaging Service - WebSphere MQ

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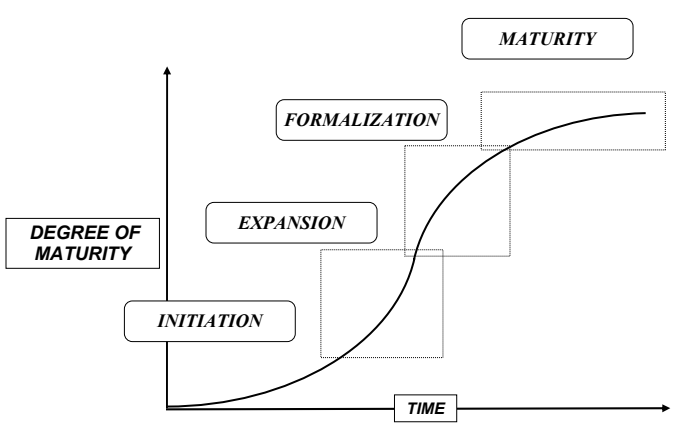
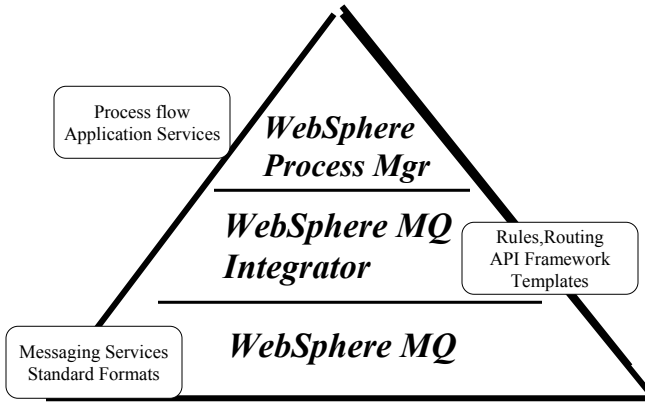
WebSphere MQ

4000 MQ Customers Growing at 20% Annually



Pretty set in their ways and tools

IBM's MQ Family now re-branded under WebSphere unbrella



Content of presentation

- Objectives of presentation:
  - What is MQ
  - Sample MQ Interface to IMS

Messaging Fundamentals

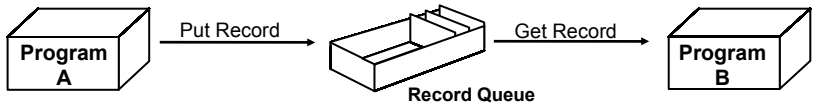
WebSphere MQ enables application programs to communicate with each other using ***messages*** and ***queues***. This form of communication is referred to as ***commercial messaging***.

There are two methods for applications to communicate:

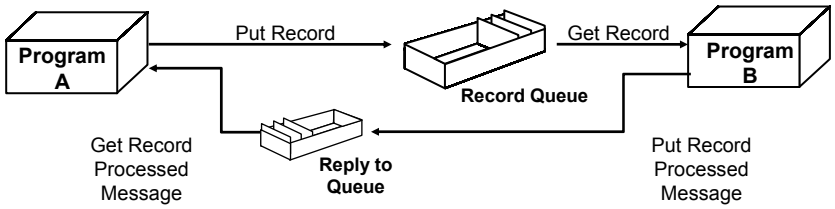
Fire and Forget
Request/Response

Application Communications

Fire and Forget



Request/Response



What is a message?

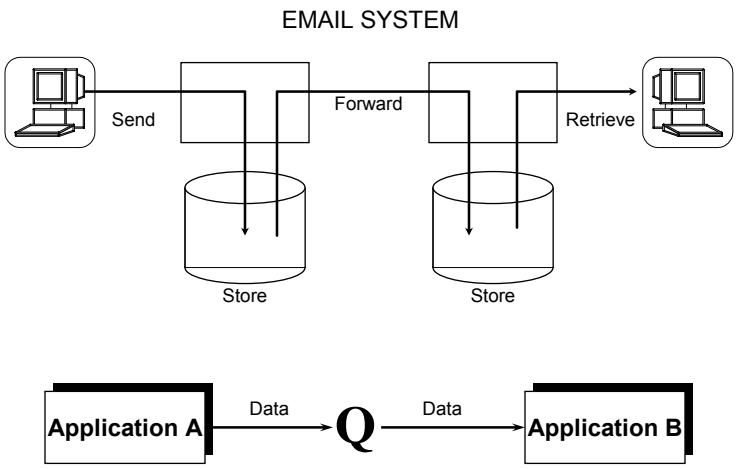
Message = Header(s) + Application Data

Header	…	Application Data

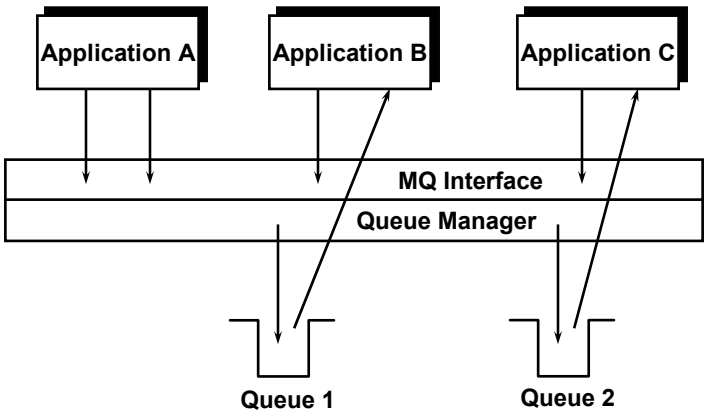
A ***message consists*** of a ***header*** and the attached application ***data***.
Headers typically contain elements like:
- Unique Message Id
- Routing information
- Message format

The following are examples of the ***data*** part of a message:
- A record from an indexed or flat file
- A row from a DB2 table
- Individual columns from DB2 tables
- Multiple rows or records

Messaging



MQ Messaging



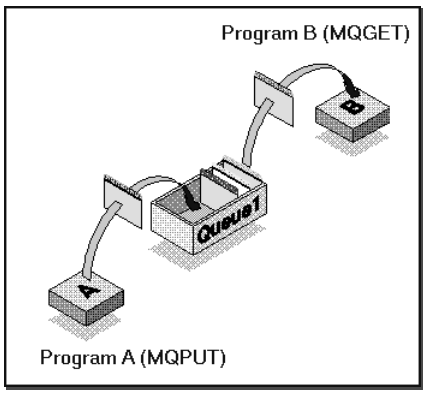
Enterprise-Wide Problems

- Communications required at application level
- Active connections required
- Different throughput rates
- Application Programming Interfaces not consistent between protocols and vendors
- Difficult to recover after failures

What is a Queue?

A queue is simply a place to put data.

This figure shows how messaging works in the simple case where the program putting the message and program getting the message are both on the same computer and connected to the same ***queue manager***.



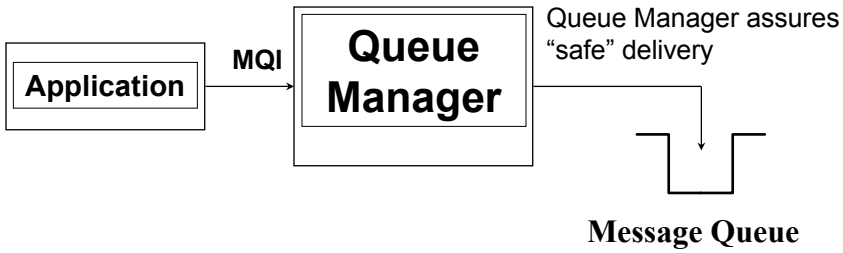
MQ Queues

A queue is an MQ object that deals with storage or movement of messages. It has attributes that determine what processing occurs when an application accesses it through the MQI calls.

Queue Definition Types

- Application
  - Local
  - Remote
  - Alias
  - Dynamic
    - Permanent
    - Temporary
  - Model
- System
  - Transmission
  - Event Queues
    - Performance
    - Channel
    - System
  - Dead letter
  - Initiation
  - Command server
  - Broker Management
  - Cluster Management

Local Queues

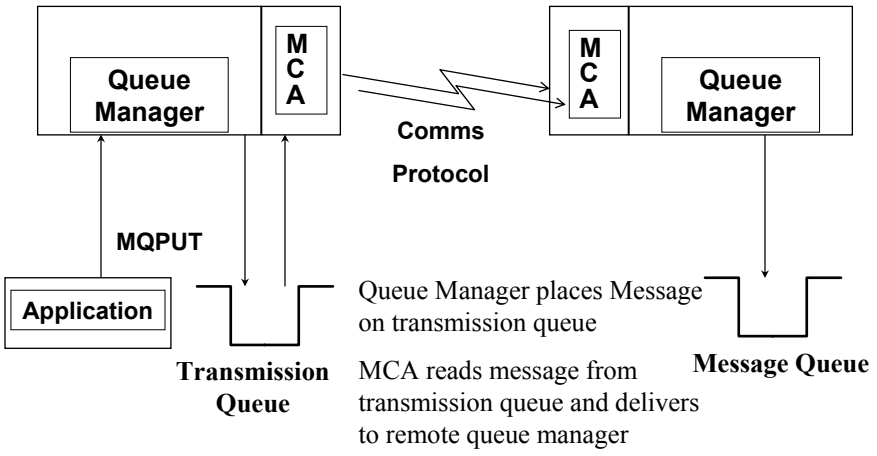


- Example of local Message Queue receiving data
- Destination is "local" or residing on same node

Transmission Queue

- A transmission queue has to be defined for each channel
- A local queue associated with a sender channel
- Usually has the same name as the destination queue manager
- Local queue manager places all messages for remote queues on a transmission queue

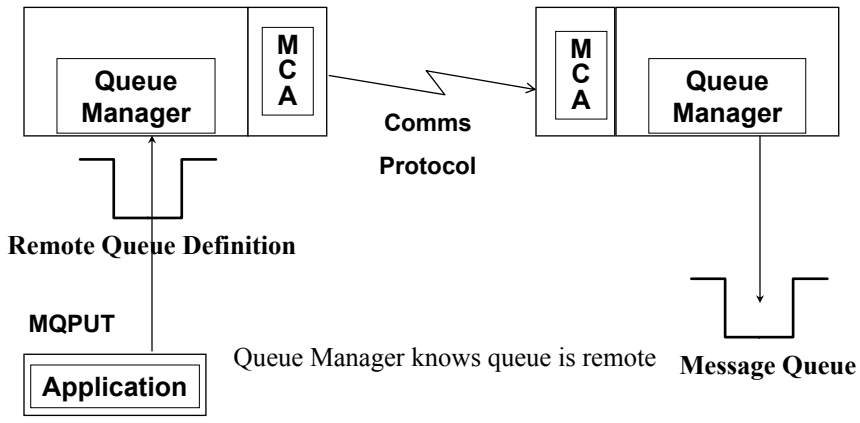
Transmission Queue



Remote Queue

- Is a local definition of a queue residing on another queue manager
- Definition specifies:
  - Remote Queue Name
  - Remote Queue Manager Name
  - (optionally) Transmission Queue Name
- Transmission Queue name binds Remote Queue to a Channel

Remote Queue



Alias Queues

- Another name to use in reference to a queue
- Can refer to Local or Remote Queue

Initiation Queue

- Used in conjunction with triggers
  - A local queue where the queue manager places trigger messages
  - A trigger monitor application reads trigger events from the initiation queue
  - The trigger monitor application starts the appropriate application to process the message
  - At least one initiation queue must be defined to the queue manager if triggers are active

Command Queue

- Command queue accepts messages to support remote administration
  - Text messages
  - Programmable Command Format (PCF)
- Command server supports program administration
  - Consistent message format across several platforms
  - Messages can be sent to remote administration queue

Event Queues

- Used to receive event messages
- The event messages indicate an instrumentation event has occurred
- Three system administration event queues
  - SYSTEM.ADMIN.QMGR.EVENTS
  - SYSTEM.ADMIN.PERFM.EVENTS
  - SYSTEM.ADMIN.CHANNEL.EVENTS

Model Queue

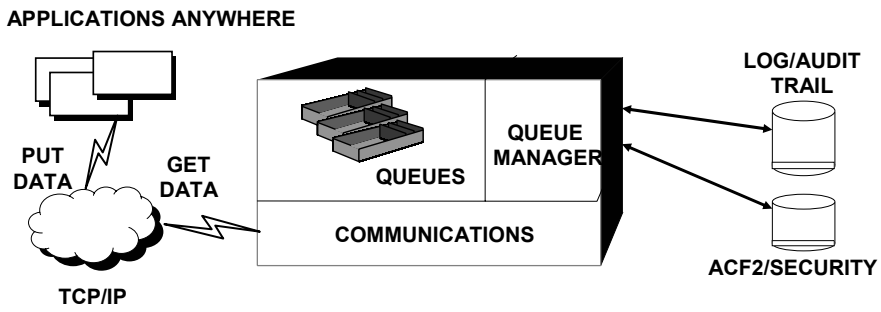
- Exists to specify default attributes for dynamic queue creation
- Name of model queue used to create queue, attributes of model queue are used but temporary name is generated

Dead Letter Queue

- Queue specified for undeliverable messages
- Optional facility within MQ
  - Queue Manager will stop Channel Agent if message undeliverable

What is Queue Manager?

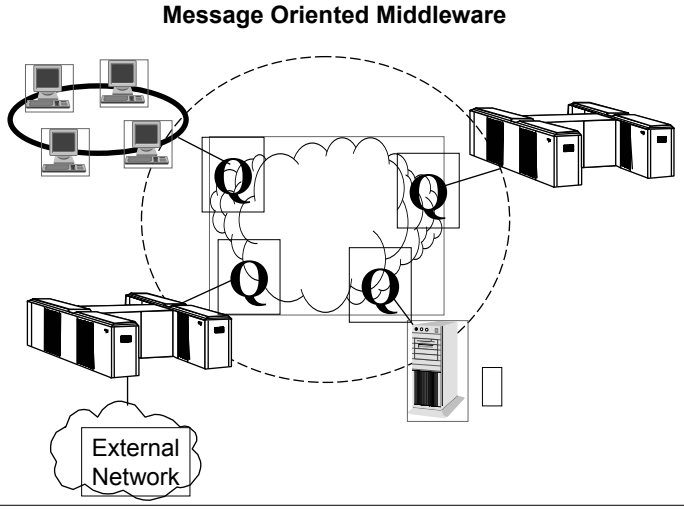
A ***queue manager*** is the ***subsystem*** software which controls access to the individual queues assigned to it. The queue manager ***logs*** all activity with each individual queue thus creating an ***audit trail***. Multiple queue managers can coexist with each other. The limiting factor is the availability of system resources.



Queue Manager

A queue manager is the MQ component that provides the messaging and queuing services to application programs through Message Queue Interface (MQI) program calls.

Queuing Technology



MQ Benefits

- Take away the communications nightmares
- Component-built applications approach
- Allow control of load balancing
- Allow protocol independence
- Provide consistent programming interface across platforms
- More platforms than any other products

MQ System Perspective

- Time independent (asynchronous) processing
- Connectionless communications
- Assured message delivery
- Once and once only delivery
- Syncpoint control

MQ Application Development Perspective

- Single, multi-platform Application Programming Interface (API)
  - Procedural (COBOL, PL/1, RPG, etc.)
  - Object Oriented (C++, Java, ActiveX, etc.)
- Faster application development
- Portable code

MQ Objects

- Queue managers
- Queues
- Channels
- Processes
- Namelists

Namelists

A Namelist is an MQ object that contains a list of other MQ objects.

Processes

A process is an MQ object that defines an application to the MQ Queue Manager.

Process Characteristics

- Process definition used to identify applications to be started by a trigger monitor
- The process definition includes application ID and type, plus some application specific data

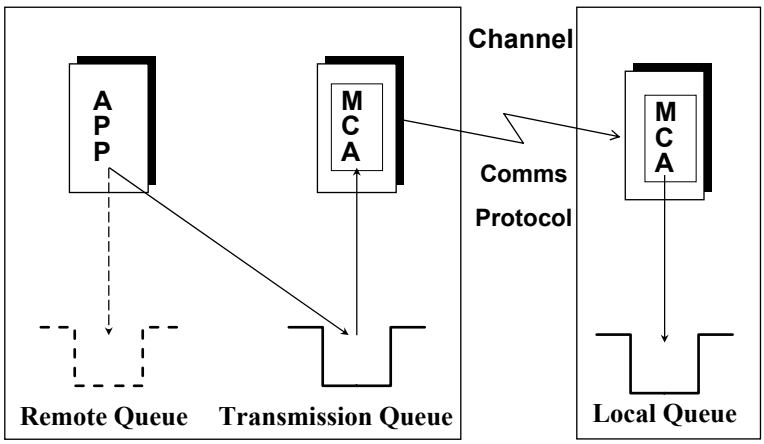
MQ Channels

A channel is a communication link providing a path on the same or different platforms. The message channel is used for the transmission of messages from one queue manager to another, and shields the application programs from the complexities of the underlying networking protocols.

Channels

- Definitions that connect 2 queue managers
- Uni-directional
- A pair of MCA programs communicating with each other
- Transmission queue ties remote queue to channel
- Can control message delivery priority through use of multiple channels

Channels



Types of Channels

- Message Channels:
  - Sender - Receiver
  - Server - Requestor
  - Sender - Requestor
  - Server - Receiver
- Client Channels:
  - Server Connection Channel
- Cluster Channels:
  - Cluster Sender Channel
  - Cluster Receiver Channel

Supported Platforms

WebSphere MQ supports the following platforms:

- **OS/390 MVS**
- **OS/390 Linux**
- **AIX**
- **HP-UX**
- **Solaris:Intel & SPARC**
- **OS/400**
- **Windows NT, 2000, XP**
- **Windows: 3.1, 95, 98**
- **OS/2**
- **Open VMS**
- **Tandem NSK**
- **VSE**
- **Digital UNIX**
- **Compaq Tru64 UNIX**

MQ Platforms

Servers:

DYNIX/Ptx *
Compaq Tru64 UNIX
Compaq (Digital) VMS
Compaq (Tandem) NSK
Hewlett Packard HP-UX
Hitachi
AIX
VSE/ESA & MVS/ESA & OS/390
OS/2 Warp
AS/400 (IMPI & RISC)
Linux (Intel)
Windows NT/2000
NCR (AT&T GIS) UNIX
Siemens Nixdorf SINIX and DC/OSx
SCO OpenServer *
Stratus Continuum/400
NUMA-Q (Sequent)
SCO UnixWare *
SGI *
Solaris
Unisys (ClearPath OS 2200)

Clients:

Apple MacOS *	**Linux (Intel & OS/390)**
Compaq Tru64 UNIX	**Windows 3.1/95/98**
EMC DG/UX *	**Windows 2000/NT**
Compaq VMS	**NCR (AT&T GIS) UNIX**
Hewlett Packard HP-UX	**Pyramid DC/OSx**
Hewlett Packard HP 3000	**Siemens Nixdorf SINIX**
MPE/ix *	**Siemens Nixdorf DC/OSx**
Hitachi	**SCO OpenServer ***
IBM AIX	**NUMA-Q (Sequent)**
IBM MVS/ESA	**SCO UnixWare ***
IBM OS/2 Warp	**SGI ***
IBM TPF	**Stratus VOS (Stratus)**
IBM VM/ESA	**Stratus Continuum/400**
IBM 4690 OS **	**Sun Solaris (Sparc/Intel)**
Java	**Unisys A (MSS)**

Leaf Node Servers (limited functionality):

Windows 3.1/95/98
IBM TPF

** Available from Willow Technology* *** Available from Commerce Quest*

Security

Version 5 Release 3 offers added security using Secure Sockets Layer (SSL), the Internet standard for secure communication.

Application Programming Interfaces (API)

WebSphere MQ Programming APIs

Application Messaging Interface (AMI)

High level of abstraction, moves message handling logic into the middleware
- **Policy name "How"**
- **Service name "Where"**

Available for C, C++, COBOL, Java

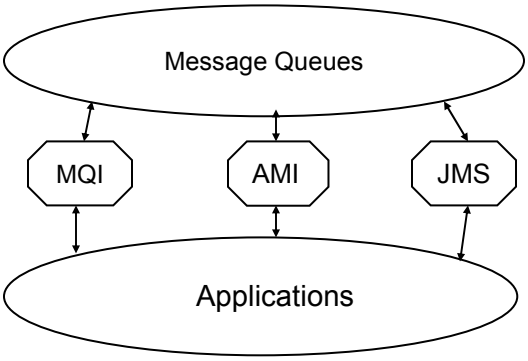
Java Message Service (JMS)

Emerging Java standard underpinned by WebSphere MQ
Abstracts MQ details
Interface for J2EE/WebSphere

Message Queue Interface (MQI)

Native calls to provided functions are available in the following languages: 390 Assembler, C, C++, COBOL, COM, LotusScript, Java, PL/1, VisualBasic

WebSphere MQ Programming APIs



MQI, AMI, JMS all interoperate

Message Queue Interface (Procedural)

- 13 verbs
- 7 are used most commonly
- 6 have specialized use
- Important to understand use of call parameters

(Also Object Oriented access to MQ)

Common MQI Calls

- MQCONN — Connect to Queue Manager
- MQOPEN — Open a queue
- MQPUT — Put message to queue
- MQPUT1 — Put one message on a queue
- MQGET — Get message from queue
- MQCLOSE — Close a queue
- MQDISC — Disconnect from Queue Manager

Specialized MQI Calls

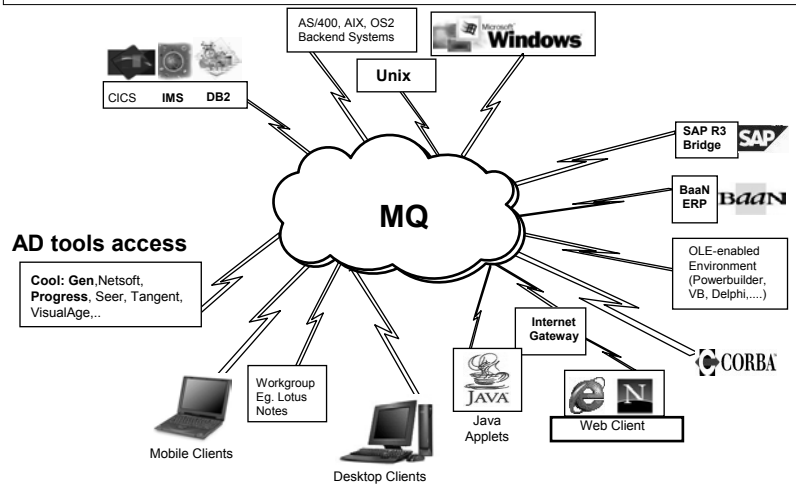
- MQBEGIN — Signals start of Unit of Work
- MQCMIT — Commits Unit of Work
- MQBACK — Rollback Unit of Work
- MQINQ — Inquire on MQ object
- MQSET — Set queue attributes
- MQCONNX — Connect with special options

Bridges/Adapters/Connectors

MQ Adapters

- From IBM
  - CICS Bridges, IMS Bridge, SAP Bridge, Notes Bridge, ...
- From 75 other vendors
- More than 150 adapters
  - databases, ERP, CRM, MOM, message brokers, packaged
  - applications, transaction managers

MQ Adapters



Electronic Data Interchange Processing

This is an example of a possible EDI processing methodology using WebSphere MQ components.

The components used are:

WebSphere MQ

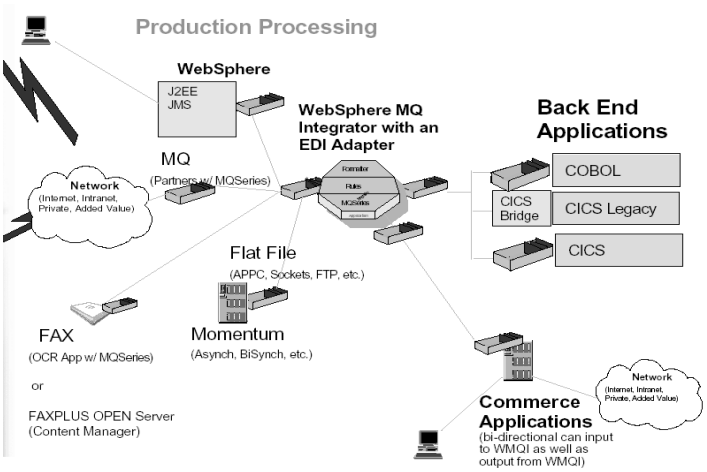
WebSphere – Web transaction monitor

WebSphere MQ Integrator

EDI Adapter – Builds EDI transformations and load into WMQI

OCR application to handle Fax and move content to WebSphere MQ

Electronic Data Interchange Processing

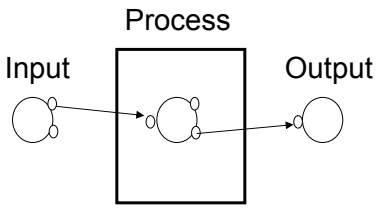


Message Brokers

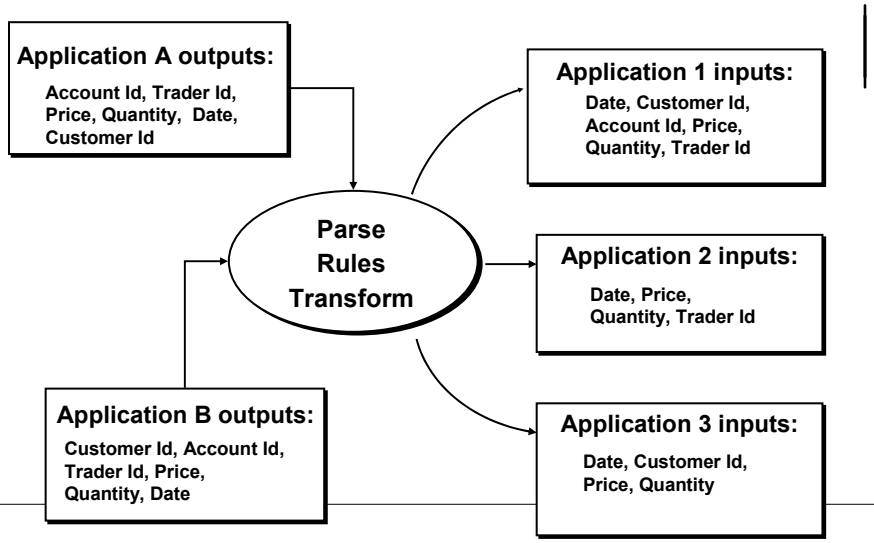
The Message Flow

A Message Flow is:

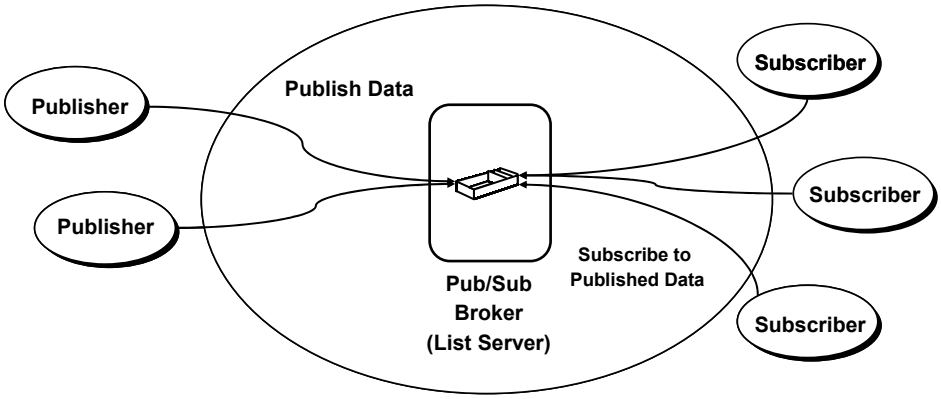
- A sequence of operations *on a message*
- Dependant upon message content



Message Brokering Example



Publish/Subscribe



WebSphere MQ
Message/Queuing

Customer Benefits of MQ

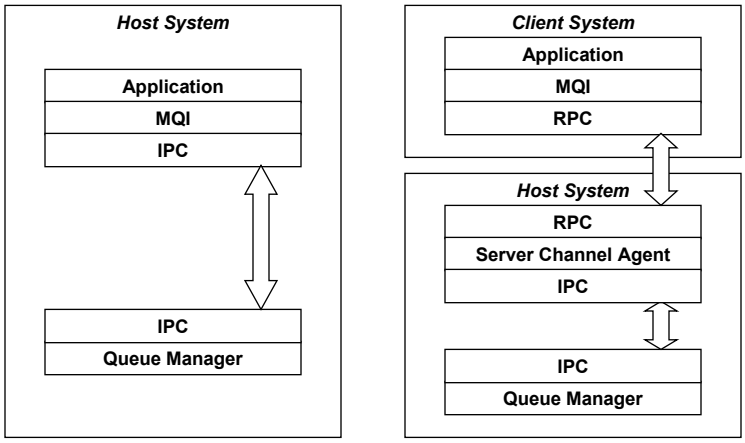
- Wide selection of available platforms
- Network is transparent to the application programmer
- Applications can be changed quickly and easily in response to changing business needs
- Applications run in an asynchronous manner - parallelism
- Assured delivery of information - anywhere in the network
- Transactional messaging support for coordinated updating of multiple data sources
- Trusted, dependable for mission critical applications

MQ Clients

MQ Clients

- An MQ Client is a component that can be installed on a separate machine from the Base product and Server
- MQ applications can run on client
- Client uses a server queue manager via a network protocol (SNA, TCP/IP, NetBIOS, DECNet, SPX)

MQ Clients



Why Clients

- Supported on:
  - PCs (MS-DOS, Windows 3.11/95/98/2000)
  - MacOS (Willow Technology)
  - Unix Workstations
- Reduces client hardware requirements
- Client license typically cheaper than server license

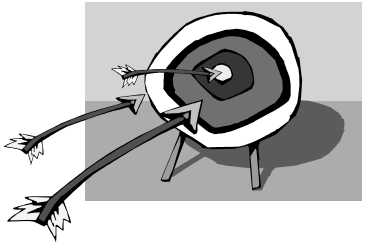
MQ Client Weakness

- Requires Real-time connection to Server
- What about Travelling Users?
- User maintains connection to MQ until MQDISC call is issued

Securing a WMQ infrastructure

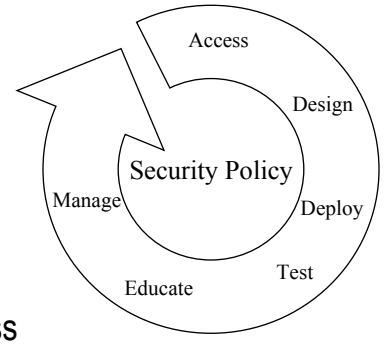
Session Layout and Aim

- Define the scenario
- MQ specific security
  - Issues
  - Vulnerabilities
  - Threats
- Using cryptography to secure an MQ infrastructure

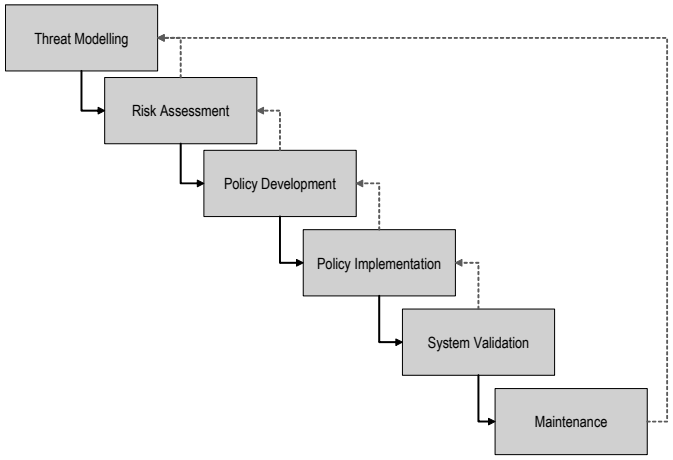


What Is Information Security?

- Information security is a process, not a product !
- Information security can be defined as the process of balancing risk to the business with the cost of implementation, management, and reward.

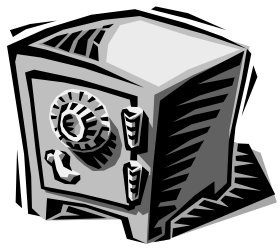


The Linear Security Process.



Why Do We Need Security in WebSphere MQ?

- Systems based on WebSphere MQ form the core of many businesses
- The data flowing is often of a high risk value
- The enterprise WebSphere MQ environment crosses many boundaries
- Many vulnerabilities in WebSphere MQ exist



MQ Vulnerabilities

- **Access control policies**
  - **QM, Channels, Queues**
- **Network level security**
- **Application level security**
- **Clusters !**
  - **A QM joining a cluster inherits all the privileges from the repository**
- **Clients !**
  - **C/S connection is OPEN !**
  - **Use of MCAUSER may be difficult**
  - **Strong Authentication may be required**

Cryptographic services

Modern Cryptographic services can help us most of the above issues.

CAVEAT:

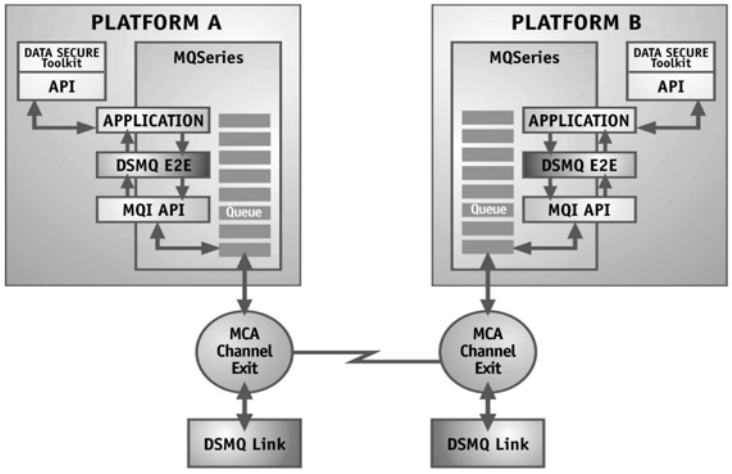
The System Context bears functional consequences

Cryptographic services

- **Privacy (Encryption)**
- **Integrity (no tampering)**
- **Authentication**
- **Non Repudiation**
- **Mutual Authentication (PEA)**

Again: The System Context bears functional consequences

Cryptographic services



E2E vs P2P Security

Functional issues

Service/Context	P2P	E2E
PEA	Appropriate; can be implemented. Since PEA is a protocol, P2P is the correct context for this functionality. The entity that is authenticated is the channel (node).	Cannot be implemented. Since the users and applications leave the communications to MQ, PEA does not make sense at this level.
Confidentiality	Appropriate and can be implemented. Messages in the queue are not encrypted.	Appropriate and can be implemented. Messages in the queues are encrypted.
Integrity	Appropriate and can be implemented. You are assured that messages are not counterfeited on the channel.	Appropriate and can be implemented. You are assured that messages are not counterfeited on queues or channels.
Authentication	Appropriate and can be implemented. The authentic origin of the message is the original point of transmission (the sender channel or node)	Appropriate and can be implemented. The authentic origin of the message is the originating user or application process.
Non-repudiation	Not appropriate, but can be implemented. Non-repudiation is meaningful at the application level.	Appropriate and can be implemented. The originating user or application process cannot deny having sent the message.

E2E vs P2P Security

Management issues

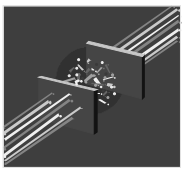
Service/Context	P2P	E2E
Participants in the communication	Channels or nodes	Users or application processes
Key managers	Site administrators, therefore suitably skilled persons.	Users: if you wish to guarantee non-repudiation the managers must be the users themselves, usually not highly skilled. Application processes: application specialists
Number of participants	Equal or proportional to the number of nodes.	Significantly greater than the number of nodes.
Implementation costs	Low to very low. Deployment of a channel solution can be quantified as a few hours for each node involved.	Low to medium if a tranparent solution is applicable. If code changes are required than the cost would range from high to very high. In some cases it would be impossible (the source may not be available)
Management costs	Same as for E2E (except for key management, which is greater in the E2E context on account of the greater number and lower skill level of participants).	Same as for P2P, (except for key management, which is greater in the E2E context on account of the greater number and lower skill level of participants).

Implementing MQ Security

- **Any modern and secure crypto implementation must be standard PKI based**
- **Any modern crypto implementation must use the relevant standards (PKCS, S/MIME, X.509) to ensure robustness and interoperability be standard PKI based**
- **The most relevant may be:**
  - **X.509 for certificates**
  - **PKCS#7 for digital signatures (and ciphers)**
  - **PKCS#11 for tokens (key management)**

Implementing P2P Security

- **Functionally equivalent to SSL**
- **Use the security exit for Principals Authentication (PEA)**
- **Use msg or S/R receive exit for Encryption, No tampering, Authentication**
- **Shut down the channel if PEA or Authentication fails; you may be under attack !**
- **LOG and Audit**



Security

Implementing E2E Security

- **Use the API crossing exits whenever possible (WMQ 5.3)**
- **Use a robust, standard based crypto toolkit**
- **Refer to PKCS based, PKI compliant toolkits**
- **By using standards you leave yourself independent from vendors (!)**
- **Perform PKCS#7 - S/MIME operation when putting**
- **Perform symmetrical operation when getting**
- **Using API crossing exits allows for application transparent implementations, although it is somewhat a “lower level” security**
- **Use a commercially available product for transparent operation. Implement your own solution with Standard Toolkits**

Example: How MQ works with IMS applications

MQ and IMS interfaces

- **MQ offers two(2) interfaces to IMS Applications:**
  - The IMS Adapter
  - The MQ-IMSBridge

MQ and IMS - The IMS Adapter

- The IMS adapter is the interface between IMS application programs and an MQ subsystem.
- It makes it possible for IMS application programs to use the MQ API (MQI).
- The adapter supports a two-phase commit protocol for changes made to resources owned by MQ with IMS acting as the syncpoint coordinator.

MQ and IMS - The IMS Adapter Benefits

- The IMS adapter provides access to MQ resources for programs running in:
  - Task (TCB) mode
  - Problem state
  - Non-cross-memory mode
  - Non-access register mode
- The adapter provides a connection thread from an application task control block (TCB) to MQ.

MQ and IMS - The IMS Bridge

- Component of MQ for OS/390 that allows

  direct access from MQ applications to applications on your IMS system
  - **Enables implicit MQI support**
- An IMS *Open Transaction Manager Access* (OTMA) client.

The MQ-IMSBridge: Benefits

- You can re-engineer legacy applications that were controlled by 3270-connected terminals to be controlled by MQ messages
- You do not have to rewrite, recompile, or re-link your IMS programs.

How do MQ applications use the IMSBridge to access IMS applications?

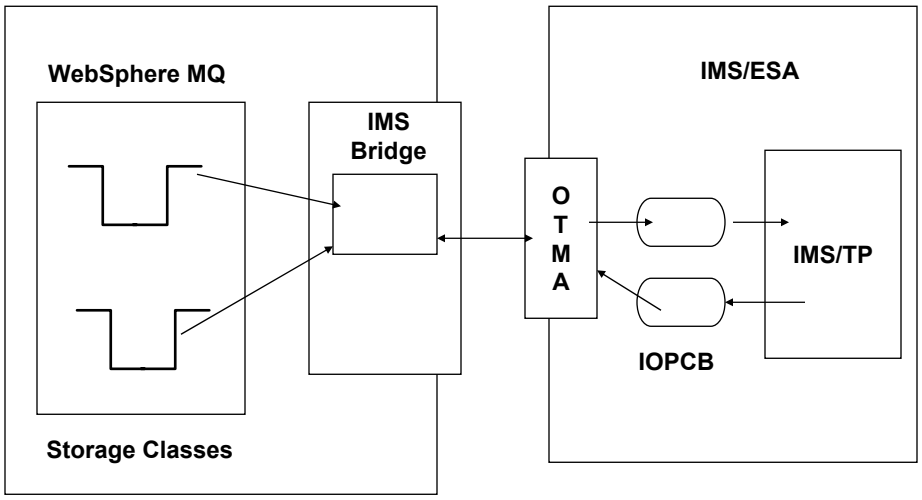
- In bridge applications there are no MQ calls within the IMS application.
- The IMS application gets its input using a GET UNIQUE (GU) to the IOPCB
- Sends its output using an ISRT to the IOPCB. MQ applications using the IMS header

  (the MQIIH structure) in the message data to ensure that the applications can execute as they did when driven by nonprogrammable terminals.

How do MQ applications use the IMSBridge to access IMS applications?

- MQ applications puts the message to a “special” MQ queue
- The messages contain IMS transaction data
- The storage class of the MQ queue determines whether the queue is an *OTMA queue(contains the XCF Group Name and IMS Target System name)*
- Once the message is written to the bridge queue, an IMS transaction can be started

The MQ-IMSBridge Flow



What is OTMA?

- IMS OTMA (Open Transaction Manager Access)
- The IMS OTMA facility is a transaction-based connectionless client/server protocol
- Runs on IMS Version 5.1 or later. It functions as an interface for host-based communications servers accessing IMS TM applications through the OS/390 *Cross Systems Coupling Facility* (XCF).
- How do you connect a client to a server so that the client can support a large network (or a large number of sessions), while maintaining high performance?

What is OTMA?

- MQ as a client can be used to support a large IMS network supporting several sessions simultaneously
- OTMA is implemented in an OS/390 sysplex environment.
- The domain of OTMA is restricted to the domain of MVS Cross-coupling facility(XCF).
- XCF is the transport layer of OTMA

Benefits of OTMA?

- Full-duplex processing provides an environment in which transactions and output messages are sent and processed in parallel.
- You can implement IMS device support outside IMS.
- You can also implement device support for your IMS subsystem that is different from what IMS provides, or enable device support that IMS does not provide.

Benefits of OTMA?

- Solves IMS problem:
  How do you connect a client to a server so that the client can support a large network (or a large number of sessions), while maintaining high performance?
- Supports several clients by enabling them as gateway to IMS applications (MQ for OS/390, OEM, TCP/IP,DCE/RPC, and other IBM applications)

MQ as client of OTMA

- MQ as a client can connect to IMS in a high performance manner to
  - support a large IMS network
- OTMA is implemented in an OS/390 sysplex environment.
- The domain of OTMA is restricted to the domain of XCF.

IMS Message Flow in an OTMA Environment