Time is Money! Use WebSphere MQ Shared Queues to Reduce Outages

Lyn Elkins
elkinsc@us.ibm.com

Abstract

- Not being able to access your messages can cost your business money. Come and hear how WebSphere MQ for z/OS exploits the unique features available to z/OS - sysplex and coupling facility - to provide you with the highest level of availability for your messages.

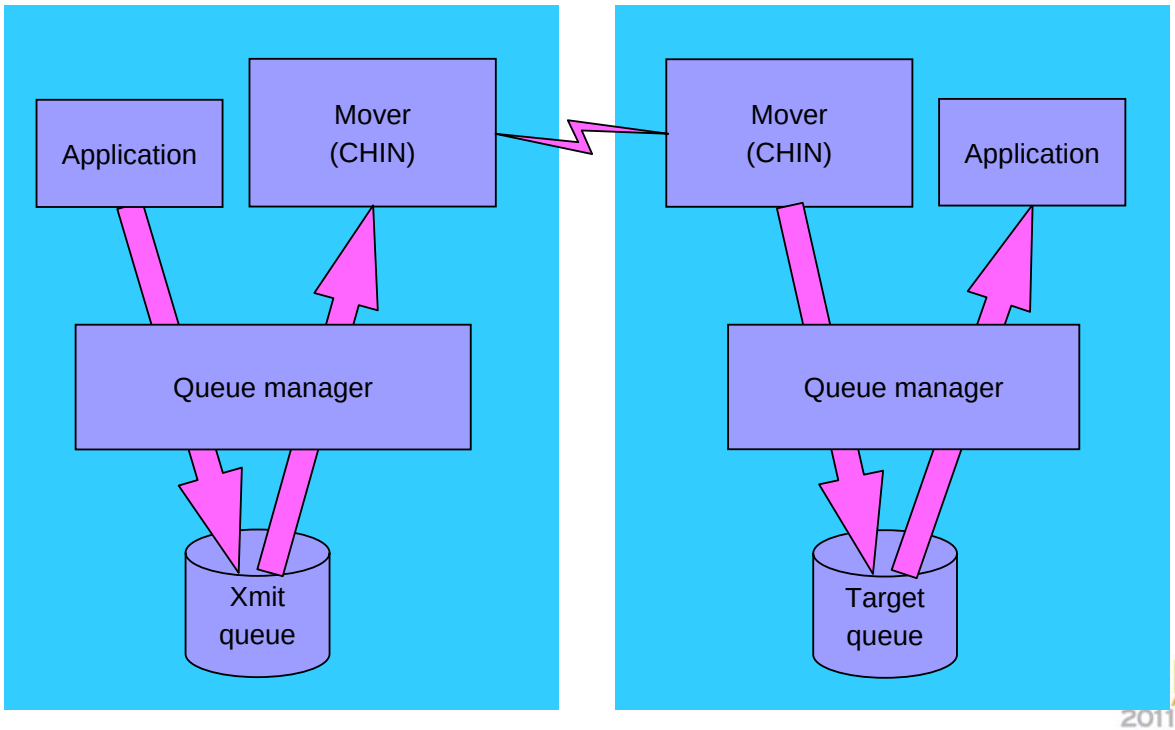
Agenda

- What shared queues are
  - Shared queues
  - Queue-sharing groups
  - Coupling Facility (CF) structures
  - Persistence and transaction integrity
- Configuring channels with shared queues
  - Inbound channel configurations
  - Outbound channel configurations
- Exploiting shared queues
  - Availability benefits of queue sharing
  - Scalability

Shared Queues?

- Function:
  - Multiple Queue Managers can access the same shared queue messages
  - Multiple Queue Managers can access the same shared queue objects
- Benefits
  - Availability for new messages
  - Availability for old messages
  - Pull workload balancing
  - Scalable capacity
  - Low cost messaging within a Sysplex

Mover



Mover

N

O

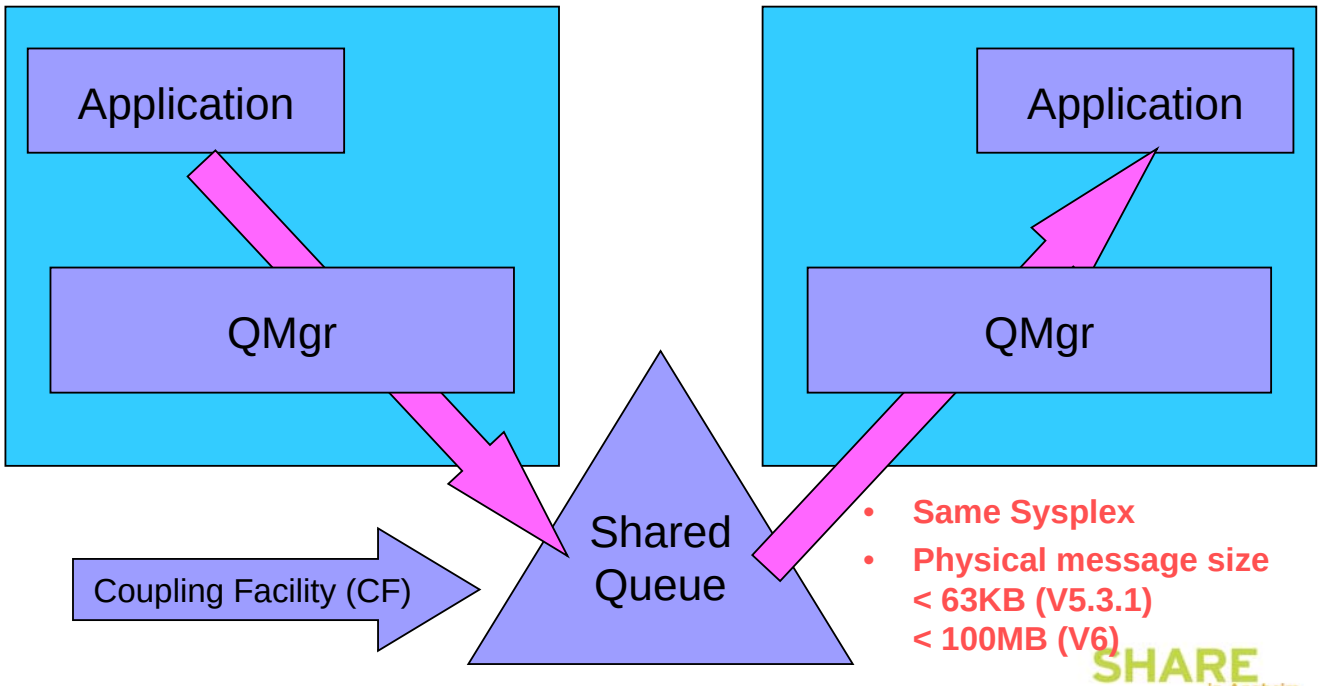
T

E

S

- Chart shows an application put to a remote target queue -- that is, the target queue is local to another queue manager. This put uses the mover as follows:
  - Application puts to remote target queue
  - Queue manager puts message on local transmit queue
  - Local mover gets message and sends to remote mover
  - Remote mover puts message to target queue
  - Remote application can now get the message.
- The remote application can put a message to the reply-to queue using the same method.
- Note that only applications connected to the target queue manager can get the message.

Shared Queues



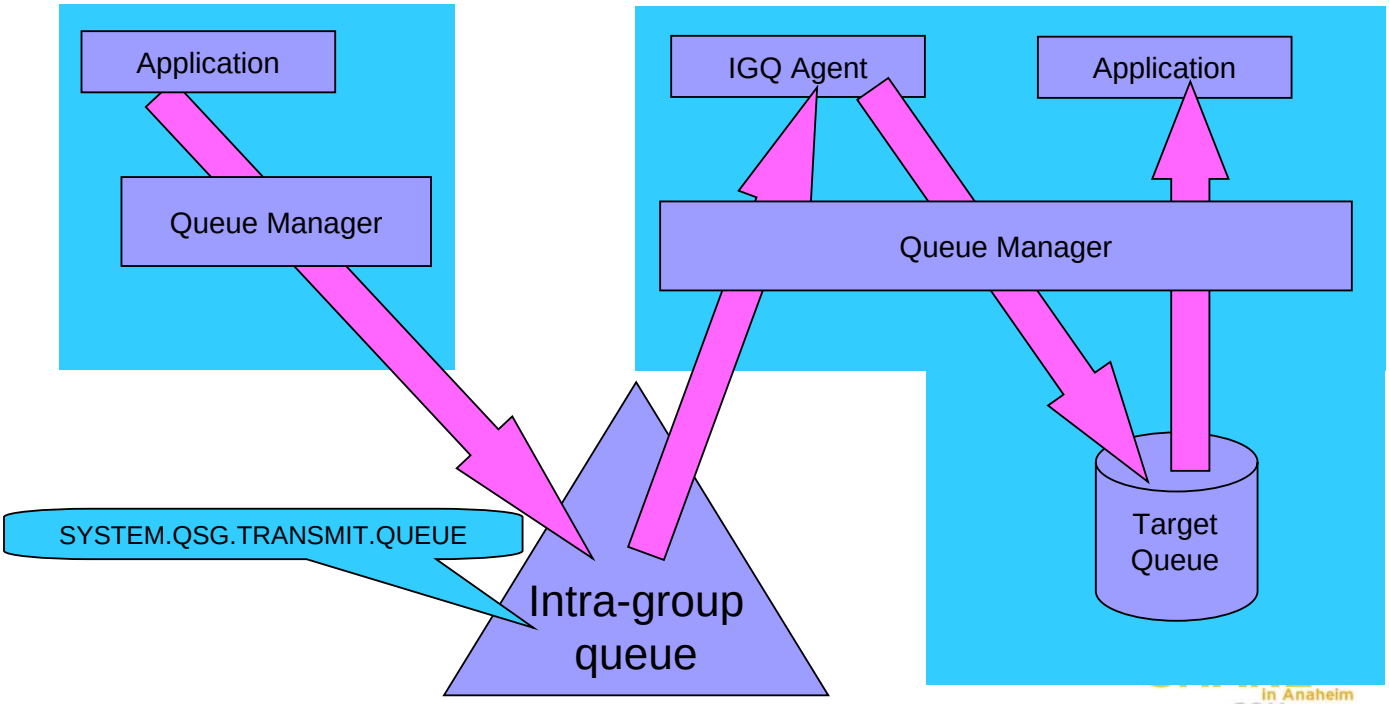
- **Same Sysplex**
- **Physical message size**
  < 63KB (V5.3.1)
  < 100MB (V6)

Shared Queues

N O T E S

- Chart shows an application put to a shared target queue -- that is, the target queue is local to more than one queue manager. This put does not use the mover:
  - Application puts to shared target queue
  - Remote application can now get the message.
- The remote application can put a message to the reply-to queue using the same method.
- Note that applications connected to any queue manager with access to the shared queue can get the message. To access the same shared queues, queue managers must be:
  - In the same z/OS Sysplex
  - In the same queue-sharing group (QSG) -- we will explain QSGs later.
- There are restrictions on shared queues, for example:
  - Maximum message length is 63KB if on MQ version less than V6
  - CF capacity is limited (compared to DASD).

Intra-Group Queue

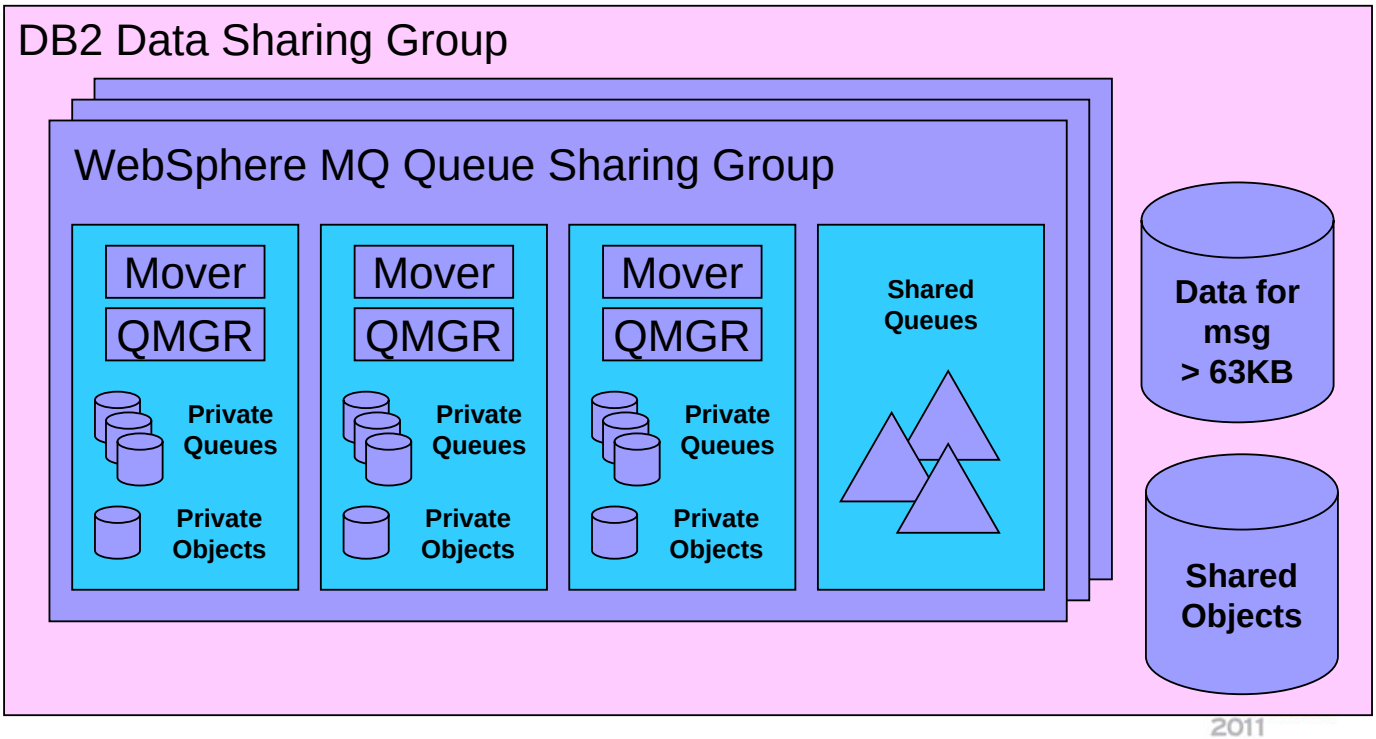


Intra-Group Queue

N O T E S

- Chart shows an application put to a remote target queue -- but the target queue is local to another queue manager in the same queue-sharing group. This put uses the intra-group queuing (IGQ):
  - Application puts to remote target queue
  - Queue manager puts message on shared IGQ queue
  - Remote IGQ agent gets message from IGQ queue
  - Remote IGQ agent puts message to target queue
  - Remote application can now get the message
- The IGQ method is similar to the mover method but more efficient -- that is, it uses much less processor power.
- There is one IGQ queue for each queue-sharing group. It has the reserved name SYSTEM.QSG.TRANSMIT.QUEUE.
- The IGQ queue (and the IGQ method) has the same restrictions as any shared queue.
- If IGQ cannot be used (large message, no IGQ queue defined, or whatever) then the put will be handled by the mover (assuming there is a suitable channel).

Queue Sharing Groups (QSGs)



Queue-Sharing Groups (QSGs)

N O T E S

- Chart shows how queue managers are organized into queue-sharing groups (QSGs) and the relationship to DB2 data-sharing groups.
- A queue-sharing group can contain one or more queue managers:
  - Each queue manager has its own private (not shared) queues and object definitions.
  - All queue managers in a QSG share the same set of shared queues and shared object definitions
  - A queue manager cannot belong to more than one QSG.
- Shared object definitions for a QSG are maintained for WebSphere MQ by DB2. Shared access to these definitions is by DB2 data sharing:
  - You must have DB2
  - You can have more than one data-sharing group, but all members of one QSG must be members of the same data-sharing group
  - Shared object definitions are cached in the queue managers.
  - A DB2 outage does not bring down the QSG (but you cannot add or change shared objects if DB2 is down).
- You do not have to define any queue-sharing groups if you do not run a Sysplex (or if you just don't want to).
- If using shared messages > 63KB then a small portion for the message is stored in the CF, and the rest is stored in DB2.

Creating a queue-sharing group

Use the CSQ5PQSG utility to create a QSG:

1 Add the QSG into the DB2 tables:

```
//stepname EXEC PGM=CSQ5PQSG,
//    PARM='ADD QSG,qsg-name,dsg-name,DB2-ssid'
```

2 Add the queue managers into the DB2 tables as members of the QSG:

```
//stepname EXEC PGM=CSQ5PQSG,
//    PARM='ADD QMGR,qmgr-name,qsg-name,dsg-name,DB2-ssid'
```

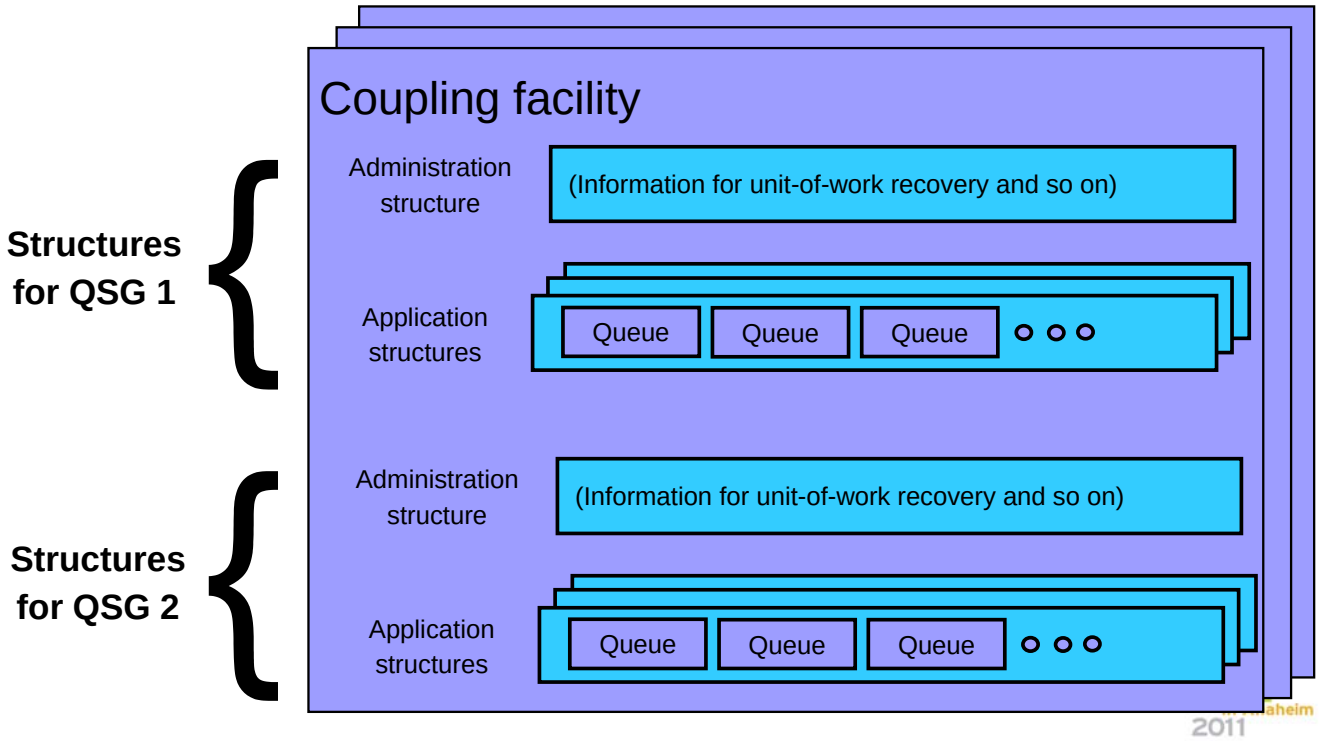
qsg-name	Name for the queue-sharing group
qmgr-name	Name of the queue manager
dsg-name	Name of the DB2 data-sharing group
DB2-ssid	DB2 subsystem ID

Creating a queue-sharing group

NOTES

- Chart shows JCL fragments for defining a QSG and adding a queue manager into a QSG (for more complete information, see *System Administration Guide*).
- You can also use CSQ5PQSG to remove a queue manager from a QSG. To do this, you must ensure that the queue manager does not have any recovery to do -- either:
  - The queue manager was stopped normally, or:
  - The queue manager has never been started.
- You can also use CSQ5PQSG to delete a QSG which has no queue managers in it -- that is:
  - You removed all the queue managers, or:
  - You never added any queue managers in the first place.
- To start a queue manager as a member of a QSG, you provide the QSG information in CSQZPARM.
- We advise you do **not** update the WebSphere MQ DB2 tables directly -- use the utilities we provide.

CF Structures for shared-queues



CF Structures for shared-queues

N O T E S

- Chart shows organization of WebSphere MQ data in coupling facility (CF) structures (actually *list* structures).
- For clarity the chart shows:
  - All structures in one CF -- actually they can be spread arbitrarily over many CFs
  - Only WebSphere MQ structures -- actually other subsystems and applications can have structures in the same CF as Websphere MQ.
- Each queue-sharing group needs:
  - One administration structure -- this is used for information that WebSphere MQ itself needs, for example to manage unit-of-work recovery
  - One or more (up to a maximum of 63) application structures -- these are used to hold the shared queues.
- Each application structure can hold up to 512 shared queues.

Creating CF structures and shared queues

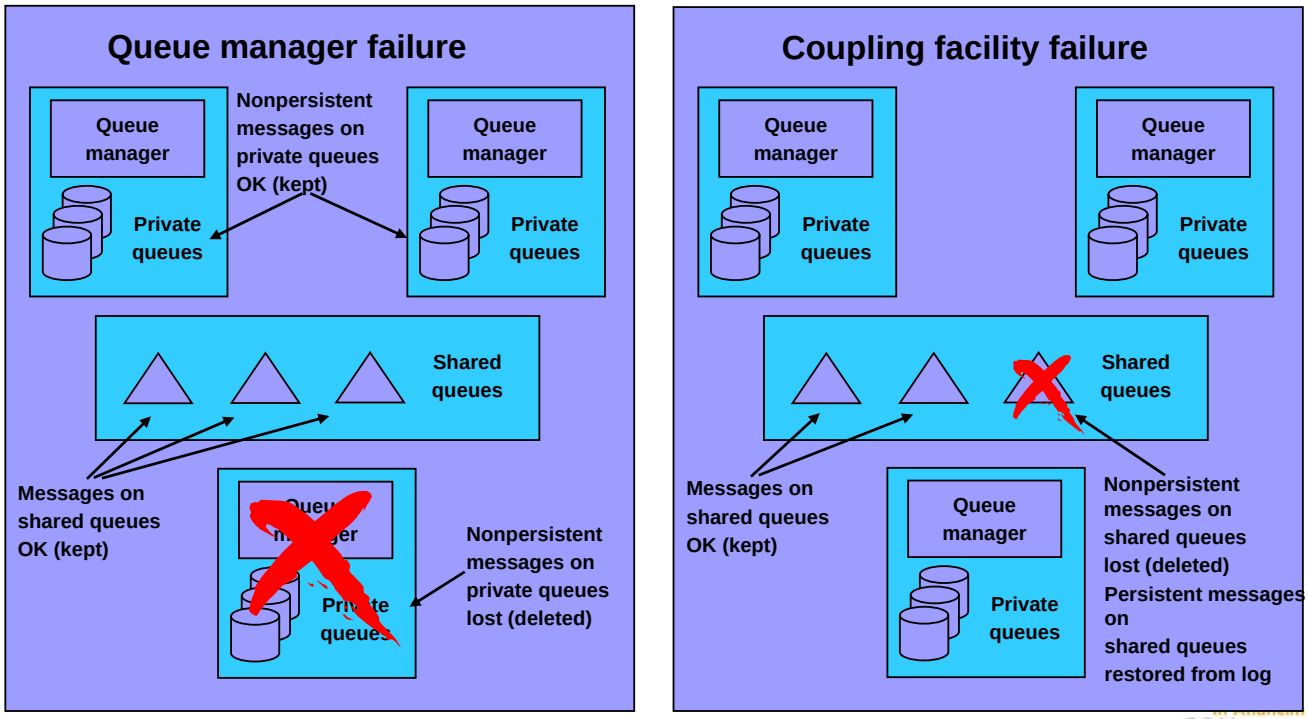
- **Define a structure to z/OS (not to WebSphere MQ) by updating the CFRM policy (see System Setup Guide):**
  - **Structure is known to WebSphere MQ by its 12-character str-name**
  - **Structure is known to z/OS by the 16-character name formed by:**
    - **qsg-name || str-name (Application structures)**
    - **qsg-name || CSQ_ADMIN (Administration structure)**
- **Define a shared queue using the DEFINE QLOCAL command on any queue manager in the QSG:**
  - **DEFINE QLOCAL(queue-name) QSGDISP(SHARED) CFSTRUCT(str-name)**
- **z/OS creates the structure when required (first use)**
- **WebSphere MQ creates the queue when required (first use)**

Creating CF structures and shared queues

N O T E S

- Chart shows the processes for creating CF list structures for use by WebSphere MQ QSGs and for creating shared queues in these structures.
- The z/OS CFRM policy for the Sysplex specifies how z/OS should allocate resources for each structure:
  - What type of CF (for example, CF must have battery back-up)
  - How big to make the structure.
- z/OS does not actually allocate any resource for the structure until first use -- in our case, the first time a queue manager connects to the structure:
  - At startup for the administration structure
  - At first queue open for application structures.
- As with private queues, defining the queue to WebSphere MQ does not create the queue. The queue is created when it is first used.
- It is best to allocate queues so that (as far as possible) all the queues accessed by any one unit-of-work are in the same structure.

Failure and persistence



Failure and persistence

N

O

T

E

S

- Chart shows implications of failures in a queue-sharing group.
- Left side of chart shows queue manager failure. If one or more queue managers in a queue-sharing group fail, or are stopped normally:
  - Non-persistent messages on queues private to the failing queue manager or managers are lost -- in fact they are deleted when a queue manager restarts
  - Messages on shared queues are not lost, they are kept -- even if *all* queue managers in the queue-sharing group fail.
- Right side of chart shows coupling facility structure failure (for simplicity the chart shows an entire CF failing). If one or more CF structures fail:
  - Messages on queues in other CF structures are not lost
  - Non-persistent messages on queues in failing CF structures are lost
  - Persistent messages on queues in failing CF structures must be restored from backup and log information on the logs
  - Restoring queue manager accesses logs of all queue managers in the QSG.
- If the administration structure fails, all the queue managers in the QSG fail.

Admin Structure Recovery

- **Prior to V7.0.1 each queue manager would rebuild its own admin structure entries**
  - **Particularly an issue in a disaster recovery (DR) situation**
    - **Need to start all queue managers to rebuild admin structure**
    - **Once recovered, application structures could be recovered**
- **At V7.0.1 active queue managers notice if other queue managers don't have entries and initiate a rebuild on their behalf**

Admin Structure Recovery

N O T E S

- If the Admin Structure was lost for some reason (DR situation, loss of power to the CF etc), then prior to V7.0.1 each queue manager had to rebuild its own Admin Structure entries. As the admin structure needs to be complete for application structure recovery to take place, it was necessary in a DR situation to start up all the queue managers in a QSG before application structure recovery could be performed.
- In V7.0.1 an enhancement has been made to admin structure recovery so that a single queue manager is able to recover the admin structure entries for all the other queue managers in the QSG. If a V7.0.1 (or higher) queue manager notices that the admin structure entries are missing for another queue manager then it will attempt to recover them on behalf of the other queue manager. It can only do this if the other queue manager is not running at the time. In a DR situation this means that it is only necessary to start a single queue manager at V7.0.1 (or higher) before being able to recover the application structures.
- A V7.0.1 queue manager can recover the entries on behalf of any version of queue manager - you don't need to have all queue managers in the QSG running at V7.0.1 before this functionality will take place.

Safeguarding against CF failure

- **Administration structure updates are logged so that this structure can be restored.**
- **Coupling Facilities are very rugged (zSeries processor technology).**
- **CF can have its own separate power supply.**
- **CF can have nonvolatile memory (battery power backup).**
- **Lost application structures can be restored from backups and logs**
  - **Can use BACKUP CFSTRUCT(*) at V7.0.1**

Safeguarding against CF failure

N

O

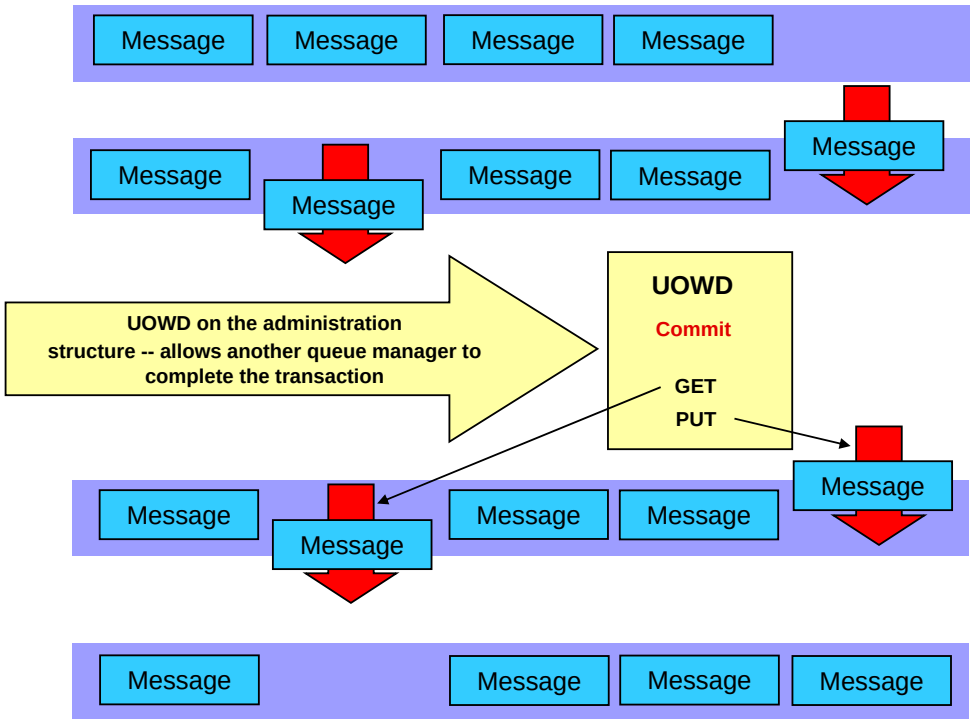
T

E

S

- Losing a Coupling Facility has a severe impact on a queue sharing group. In this respect a CF is a critical resource, similar to the log for private queues and private objects.
- Chart summarizes safeguards against CF failures.
- CFs are inherently very rugged -- especially with separate power supplies and battery backup.
- WebSphere MQ does not provide its own CF structure duplexing because this facility will be provided by System-Managed Structure Duplexing as a part of z/OS.
- Transaction state information recorded on the administration structure is logged so that a failed administration structure can be restored.
- Application structures can be backed up and persistent messages written to application structures are logged so that persistent messages in a failed application structure can be restored.

Transaction integrity



Original state of shared queue

Transaction in flight

Queue manager writes the UOWD to the administration structure

Queue manager commits the transaction

Transaction complete -- UOWD deleted

Transaction integrity

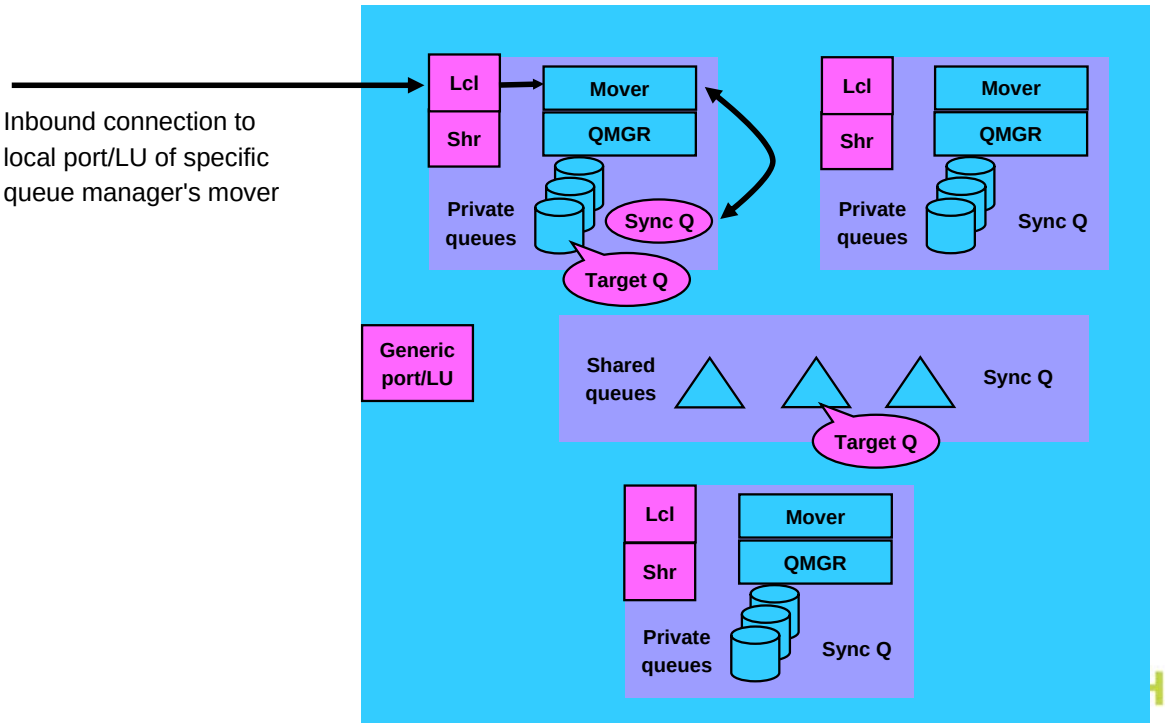
N O T E S

- Chart shows how WebSphere MQ maintains transaction integrity for shared queues.
- For clarity the chart shows a transaction acting on one shared queue. WebSphere MQ also maintains the integrity of transactions that act on multiple shared queues or that act on both shared and private queues.
- Chart shows the following states for a shared queue on an application structure (in a CF):
  1. Original state -- transaction has not started:
     - Queue has four messages on it (all committed).
  2. Transaction in flight:
     - Transaction has done one get -- message is marked in-flight-get
     - Transaction has done one put -- message is marked in-flight-put
     - Messages marked in-flight are "invisible" to other transactions
     - If queue manager fails, any other queue manager can back-out.
  3. Transaction in commit:
     - Queue manager has written unit of work descriptor (UOWD)
     - If queue manager fails, any other queue manager can complete.
  4. Transaction complete:
     - In-flight-put message unmarked -- becomes "visible"
     - Queue manager deletes the UOWD.

Agenda

- What shared queues are
  - Shared queues
  - Queue-sharing groups
  - Coupling Facility (CF) structures
  - Persistence and transaction integrity
- Configuring channels with shared queues
  - Inbound channel configurations
  - Outbound channel configurations
- Exploiting shared queues
  - Availability benefits of queue sharing
  - Scalability

Inbound channel configuration 1

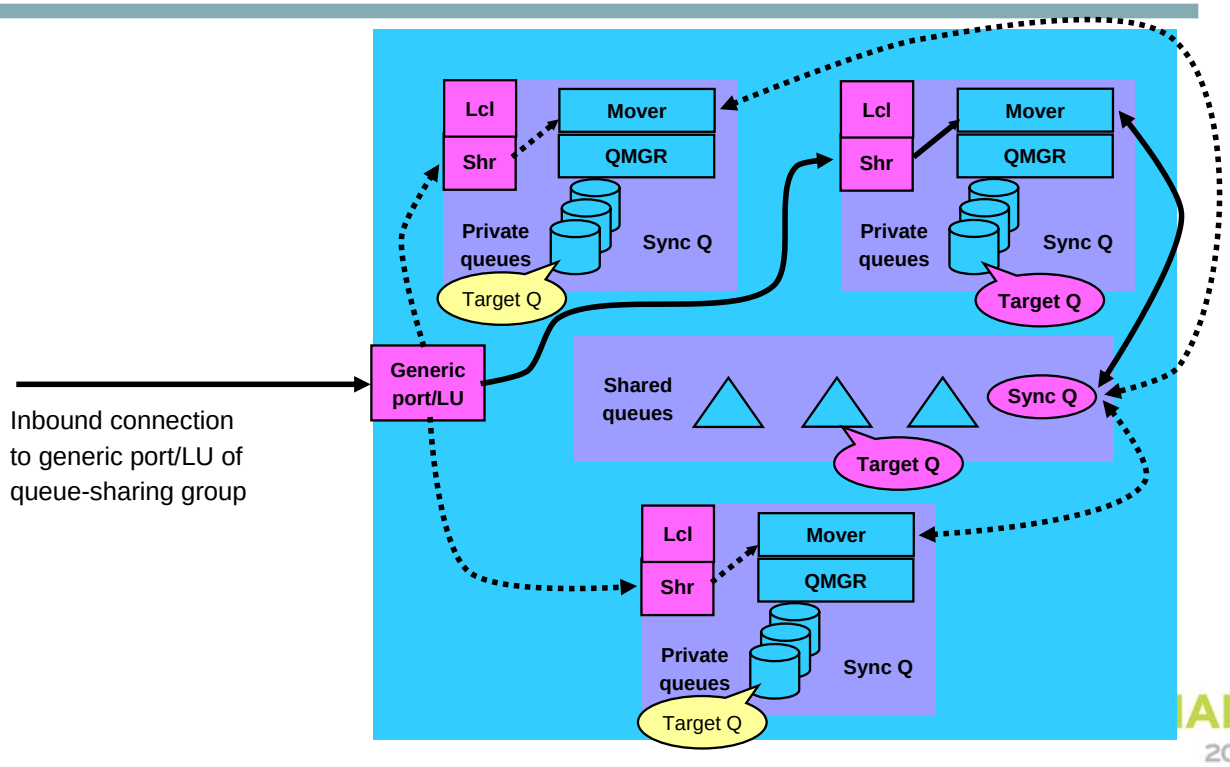


Inbound channel configuration 1

N O T E S

- This chart is the first of three which show different ways to configure inbound channels.
- This configuration uses the local port (TCP/IP) or logical unit (LU6.2) to connect to a specified mover (queue manager). It works almost exactly the way existing channel configurations work, including using the local sync queue for the channel -- but:
- Because the queue manager is part of a queue-sharing group, the channel can put messages directly onto a shared queue. That is, the target *application* can be on any of the queue managers in the QSG.
- The chart shows other ports/LUs not used by this configuration.

Inbound channel configuration 2

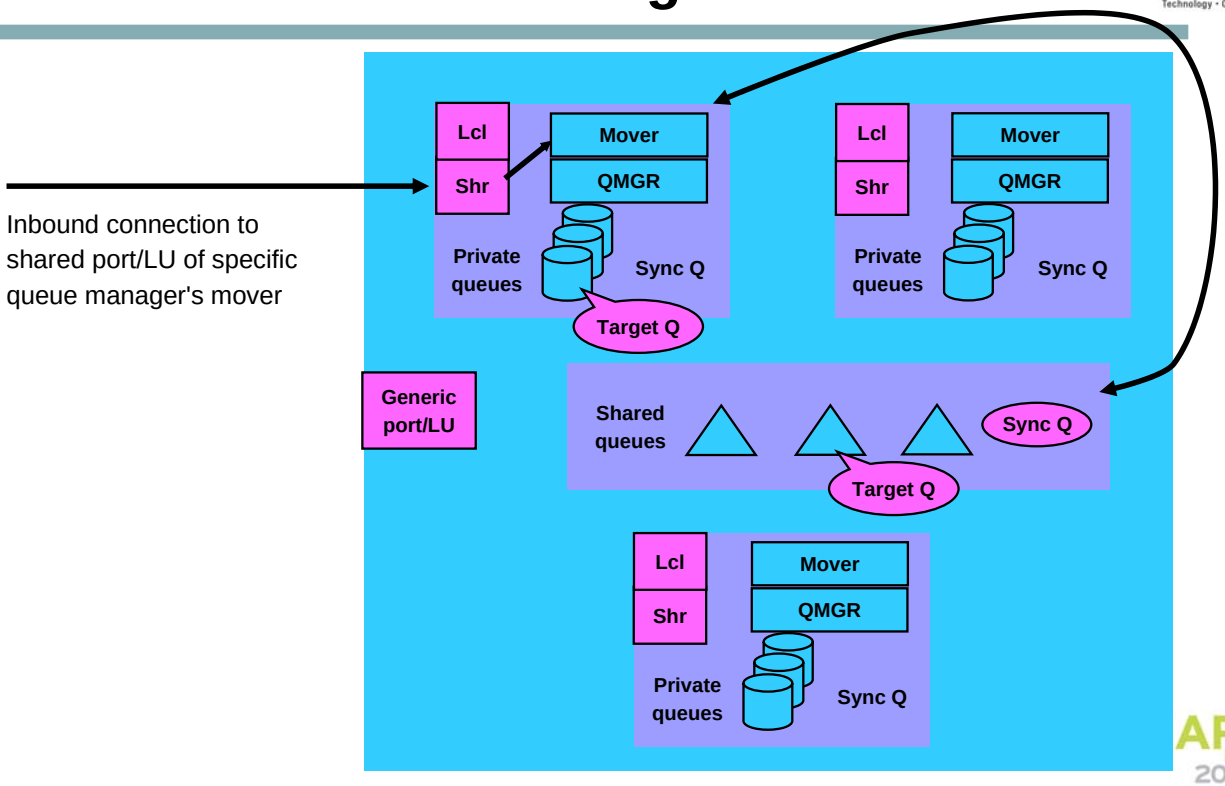


Inbound channel configuration 2

N O T E S

- This configuration uses VTAM generic resources (LU6.2) or dynamic DNS (TCP/IP) to connect to *any* mover in the queue-sharing group.
- The chart shows that the connection has "selected" the mover shown at top right, but a subsequent connection could select another mover in the QSG.
- Notice that the mover uses the shared sync queue for this channel (because access was through the shared LU or port). The shared sync queue is: SYSTEM.QSG.CHANNEL.SYNCQ.
- If the channel loses its connection (for example, because this queue manager fails), it can connect to a different mover. But this different mover can resynchronize the channel using the shared sync queue.
- You can configure VTAM generic resources or dynamic DNS to use the z/OS workload manager (WLM) to select the "least busy" mover -- providing load balancing.
- If the target queue for a put is not shared then the same private queue must be defined on each of the queue managers in the QSG.

Inbound channel configuration 3

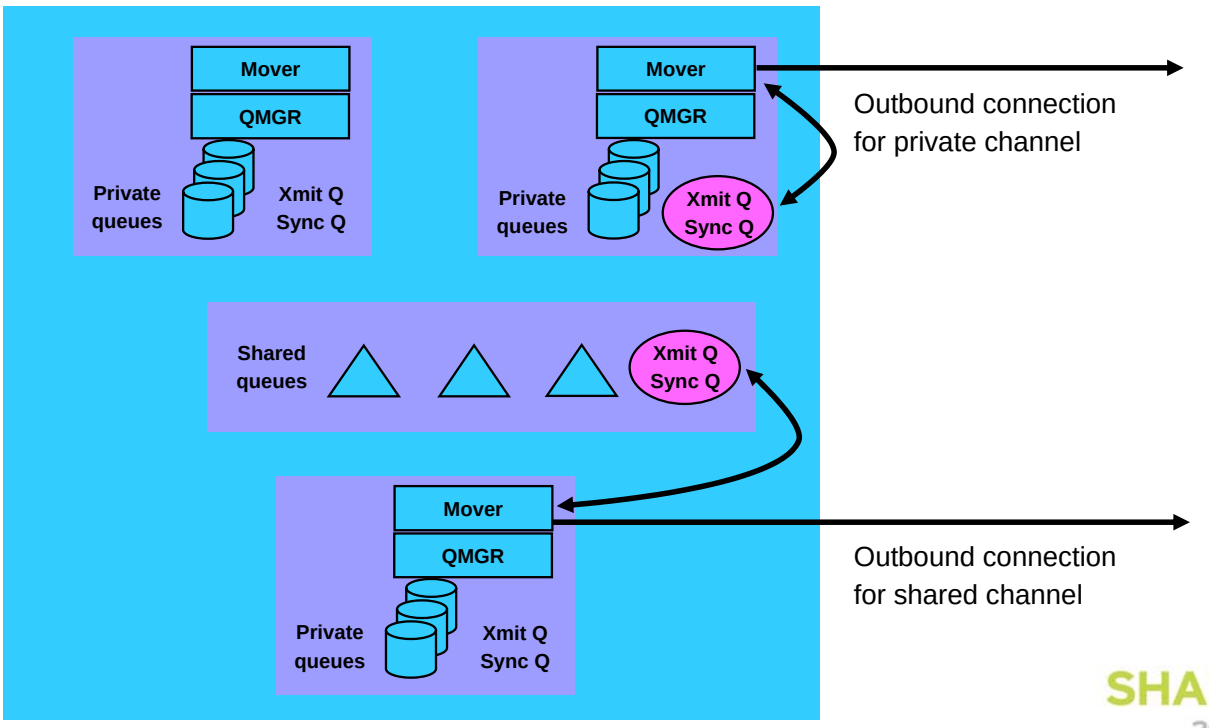


Inbound channel configuration 3

N O T E S

- This chart shows that you can connect directly to the shared port of a specified mover -- that is, you do not have to use VTAM generic resources or dynamic DNS.
- This allows you to use an "external" router to select which mover to connect to.
- By connecting to the shared port the connection uses the shared sync queue. This allows correct resynchronization if the channel fails and reconnects to the shared port of a different mover.
- A disadvantage of an external router is that it does not use the workload manager to identify the "best" (least busy) mover.

Outbound channel configurations



Outbound channel configurations

N O T E S

- This chart shows the two possible configurations for outbound channels.
- At the top is a *private* (or *local*) outbound channel. It works exactly the way existing channel configurations work:
  - Private transmission queue local to the mover
  - Private synchronization queue local to the mover.
- Below is a *shared* outbound channel:
  - Shared transmission queue -- any application in the QSG can use it
  - Shared synchronization queue.
- A shared outbound channel can start on any mover -- WebSphere MQ selects the "best" (least busy) mover.
- If a shared outbound channel fails (communication, mover, or queue manager failure), the channel can restart automatically on another mover. This is called *peer channel recovery*.
- Shared queue restrictions apply to shared transmission queues, for example:
  - Maximum message length is 63KB if version is < V6
  - CF capacity is limited (compared to DASD).

Client Channels

- **Client channels are stateless, so don't use synchronization queues**
  - **Only benefit of using a shared channel is the shared status**
  - **Can cause performance issues if using shared channel**
    - **Needs to update DB2 status for each connect/disconnect**
- **Can configure a generic port to point at INDISP(QMGR) listener on each queue manager**
  - **Can still benefit from failover and balancing of client connections without using a shared channel, and can still use QSG name on the MQCONN**
- **Will not work for Extended Transactional Client (including WAS 2-Phase Commit over client conn) until at V7.0.1**

Client Channels

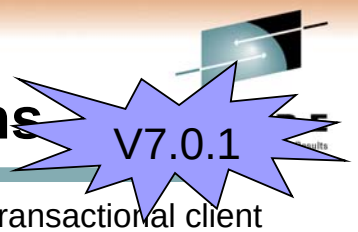
N O T E S

- As client channels are stateless, they don't use a synchronization queue. The only benefit of using a shared channel for client channels is the shared status information. However, the use of a shared server-connection channel has drawbacks as it means each connection/disconnect will cause the queue manager to update the shared channel status, which is held in DB2. This could lead to performance issues if there are lots of clients connecting.
- It is still possible to use a generic port to provide workload distribution and failover in the QSG, but rather than targeting an INDISP(SHARED) listener on each queue manager, the INDISP(QMGR) listener should targeted.
- When using client channels into a QSG it is not possible to use the Extended Transactional Client (or client connections from WAS) if you are using 2-phase commit, unless you are connecting into a V7.0.1 queue manager.

2-Phase Commit Client Connections

- **When setting up the connection, specify the QSG name rather than QMGR name**
  - **In MQConnectionFactory if using JMS under WAS, you must ensure that you are only using shared resources**
  - **This causes units of work with a GROUP unit of recovery (UR) disposition to be created, rather than QMGR**
  - **A GROUP UR can be inquired and resolved via any member of the QSG**
    - **If there is a failure, the transaction manager will reconnect to the QSG and request a list of in-doubt transactions. GROUP URs will be reported back no matter what QMGR they were started on**

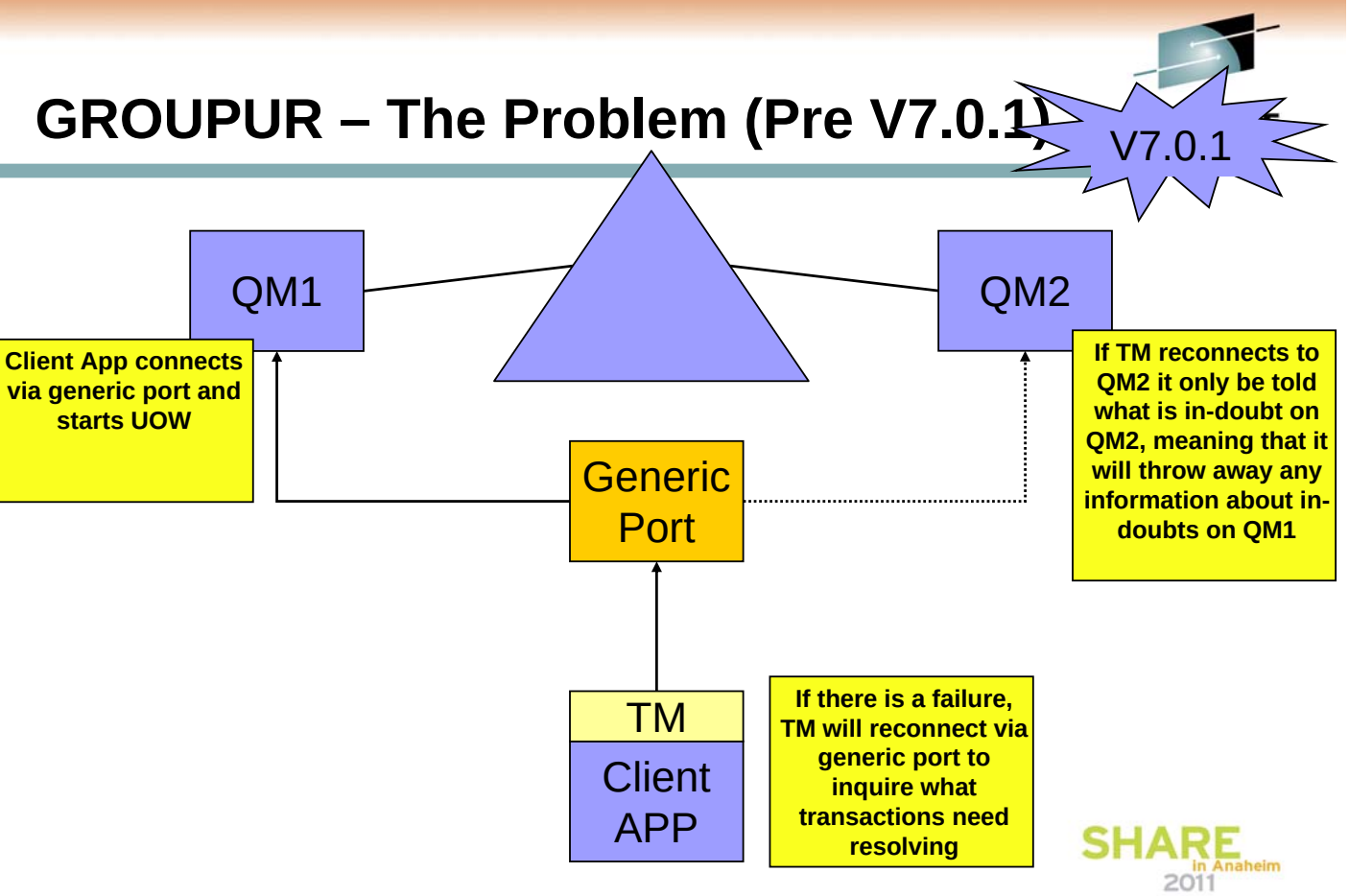
2-Phase Commit Client Connections



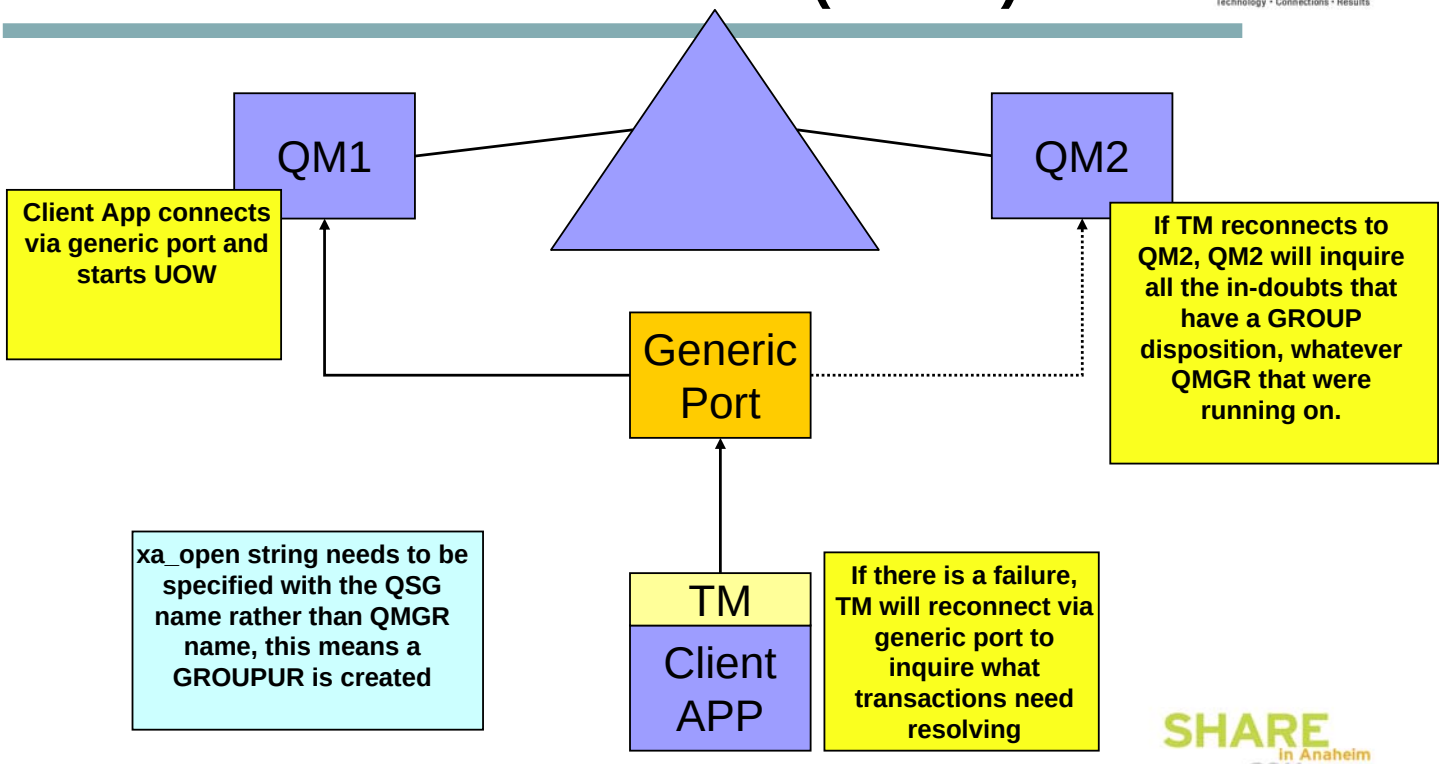
N O T E S

- When using the Extended Transactional Client, or the JMS transactional client (under WAS), it is possible to use 2-phase commit applications in a QSG. When specifying the connection options to the Transaction Manager (TM) it is necessary to provide the QSG name rather than the QMGR name, and also configure the client channel to be routed to a suitable (V7.0.1 or higher qmgr) in the QSG. When using this configuration, any Unit of Recovery (UR) that is created will have a GROUP disposition. This means that it can be inquired and resolved on any qmgr in the QSG.
- If a connection fails for some reason, and the TM reconnects to the QSG, it can inquire and resolve the transactions no matter which qmgr it is now connected to, and where the transactions were originally started.

GROUPUR – The Problem (Pre V7.0.1)



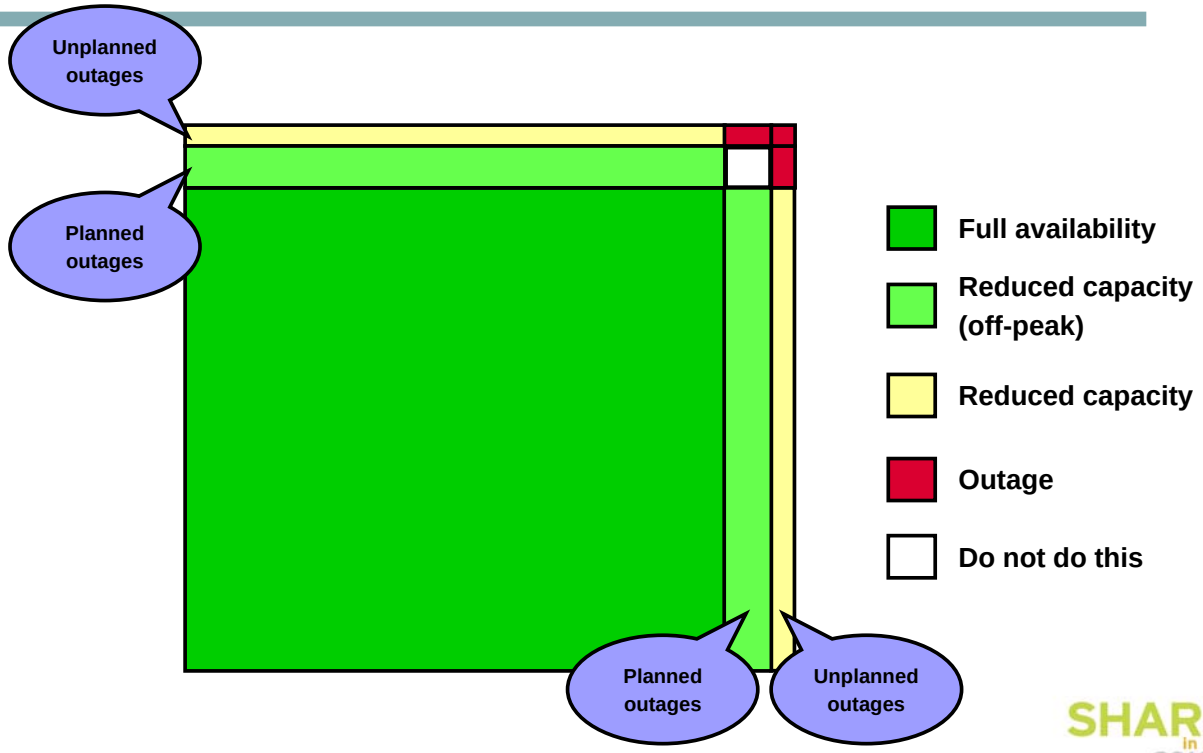
GROUPUR – The Solution (V7.0.1)



Agenda

- What shared queues are
  - Shared queues
  - Queue-sharing groups
  - Coupling Facility (CF) structures
  - Persistence and transaction integrity
- Configuring channels with shared queues
  - Inbound channel configurations
  - Outbound channel configurations
- Exploiting shared queues
  - Availability benefits of queue sharing
  - Scalability

Availability – two servers

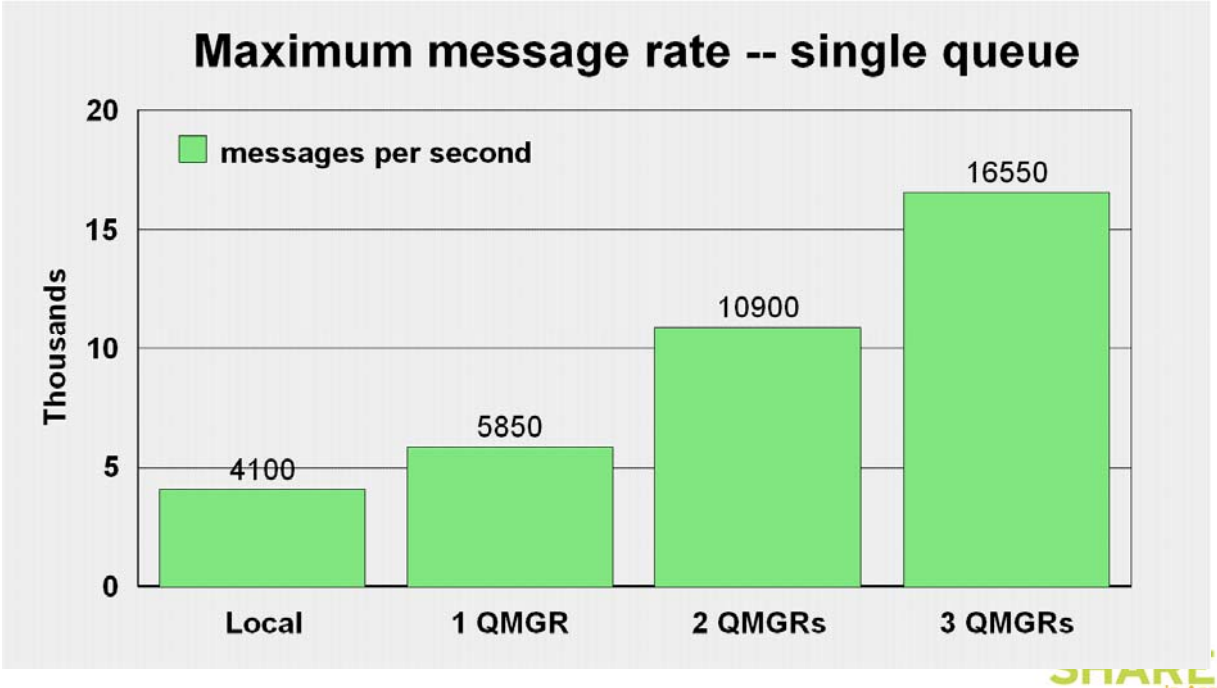


Availability – two servers

N O T E S

- This chart shows the availability impact of adding a second server.
- The chart assumes that the two servers use shared queues -- in-flight transactions on a failing server are backed-out and can be processed by the other server (the client does not see the outage).
- For many installations, unplanned outages are much less frequent than planned outages. WebSphere MQ Shared Queue Support allows one queue manager to take a planned outage without interrupting other queue managers in the QSG. This includes (for example) outages for software upgrades such as new versions and releases of the queue manager.
- Chart is only applicable for "normal" unplanned outages (such as caused by software errors or operator errors). It is not applicable for disasters (such as meteorite impacts).
- Adding more servers gives even better availability -- in particular the failure of one server has less relative impact on the overall capacity.

Shared queue scaling – non persistent



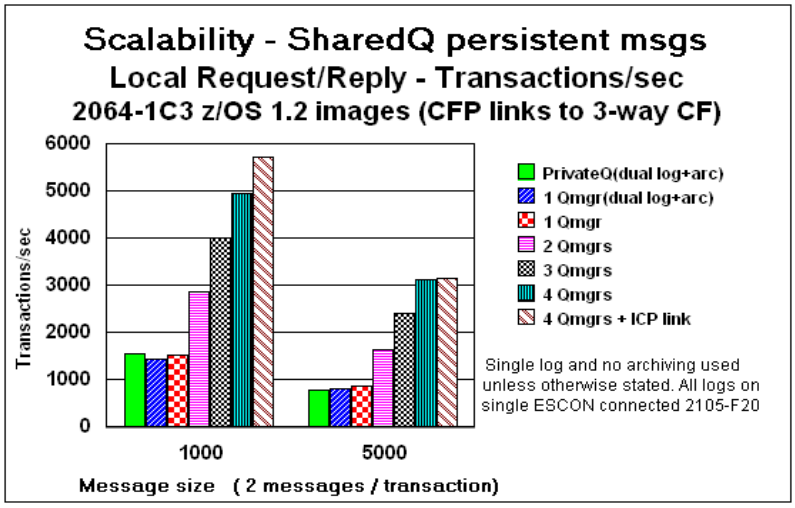
Shared queue scaling – non persistent

N O T E S

- Chart shows measured results on lab setup -- actual numbers of messages processed will vary depending on the equipment and configuration used.
- Lab setup does not include business logic.
- All messages are nonpersistent.
- In all cases one queue manager per z/OS image.
- Notice that:
  - Even for single queue manager case shared queue outperforms local queue (for this test case).
  - Scaling is near-linear for additional queue mangers.

Shared queue scaling – persistent

- **11,000+ persistent messages/sec using 4 qmgrs**
- **log DASD still likely to be first limit on throughput**



Shared queue scaling – persistent

N O T E S

- Chart shows measured results on lab setup -- actual numbers of messages processed will vary depending on the equipment and configuration used.
- Lab setup does not include business logic.
- All messages are persistent.
- In all cases one queue manager per z/OS image.
- DASD configuration enforced single logs and no archiving.

CF Link types / z/OS XCF heuristics

N O T E S

- Throughput and CPU cost depend on load
- CFP slowest, most expensive - up to 27 Km
- CBP 'ClusterBus' - 10 metres
- ICP only to CF LPAR'd within same box
- CBP performs more like ICP than CFP? (did on 9672 anyway)
- CF calls can be synchronous or async according to z/OS heuristics
- Async likely to mean order of 130+ microsec wait
- Sync means z/OS CPU is busy while call data sent, CF processes, return data received
  - typically 50+ microsecs
- Technology trends - CPU speed increasing faster than link speed

Shared queue benefits

- **No mover between servers in the QSG.**
- **Pull load-balancing for servers.**
- **Availability from multiple servers.**
- **Workload-balancing for movers.**
- **Availability from shared channels.**
- **Simplified configuration management from shared object definitions and command scoping.**
- **Flexible capacity management.**

Shared queue benefits

N

O

T

E

S

- This chart summarizes benefits from using shared queues . Mostly these are things we have discussed in this presentation.
- Using shared queues for communication within the Sysplex is faster and simpler than using the mover.
- Multiple servers get better performance from sharing the same request queue (pull load balancing) than from separate queues.
- Multiple servers provide better availability than single servers.
- Shared channels provide better availability than private channels (peer channel recovery and so on).
- Configuration management is simplified by sharing the same object definitions across many queue managers and by commands which act on more than one queue manager (command scoping, see *MQSC Command Reference*).
- Capacity can be increased (or decreased) nondisruptively by adding or upgrading processors, disks, or whatever.

More Information

- **WebSphere MQ for z/OS Concepts and Planning Guide**
- **SupportPacs MP16, MP1E**
  - **www.ibm.com/software/integration/support/supportpacs/**
- **RedPaper 3636 – WebSphere MQ Queue Sharing Group in a Parallel Sysplex environment**
  - **www.redbooks.ibm.com/redpieces/pdfs/redp3636.pdf**