IBM MQ for z/OS SMF Skills Workshop

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Today’s agenda

Introduction to Queue Manager Internals 45 min)	Walk through the internal functionality of a queue manager to understand the internal resource threads and storage facilities underpinning each queue manager.
Introduction to Interpreting SMF data for MQ on z/OS (1 hour)	Recognize key metrics and the associated impact in SMF 115 and 116 data to identify where tuning can occur to improve MQ’s performance.
Demonstration of SMF processing (45 minutes)	Demonstration of the process IBM uses evaluate customer environments for IBM MQ health checks. IBM will demonstrate how the data gets from z/OS to readable and interpretable spreadsheets.

My goals for today

Make it clear how IBM processes your SMF data to make recommendations for your MQ environment during our health checks

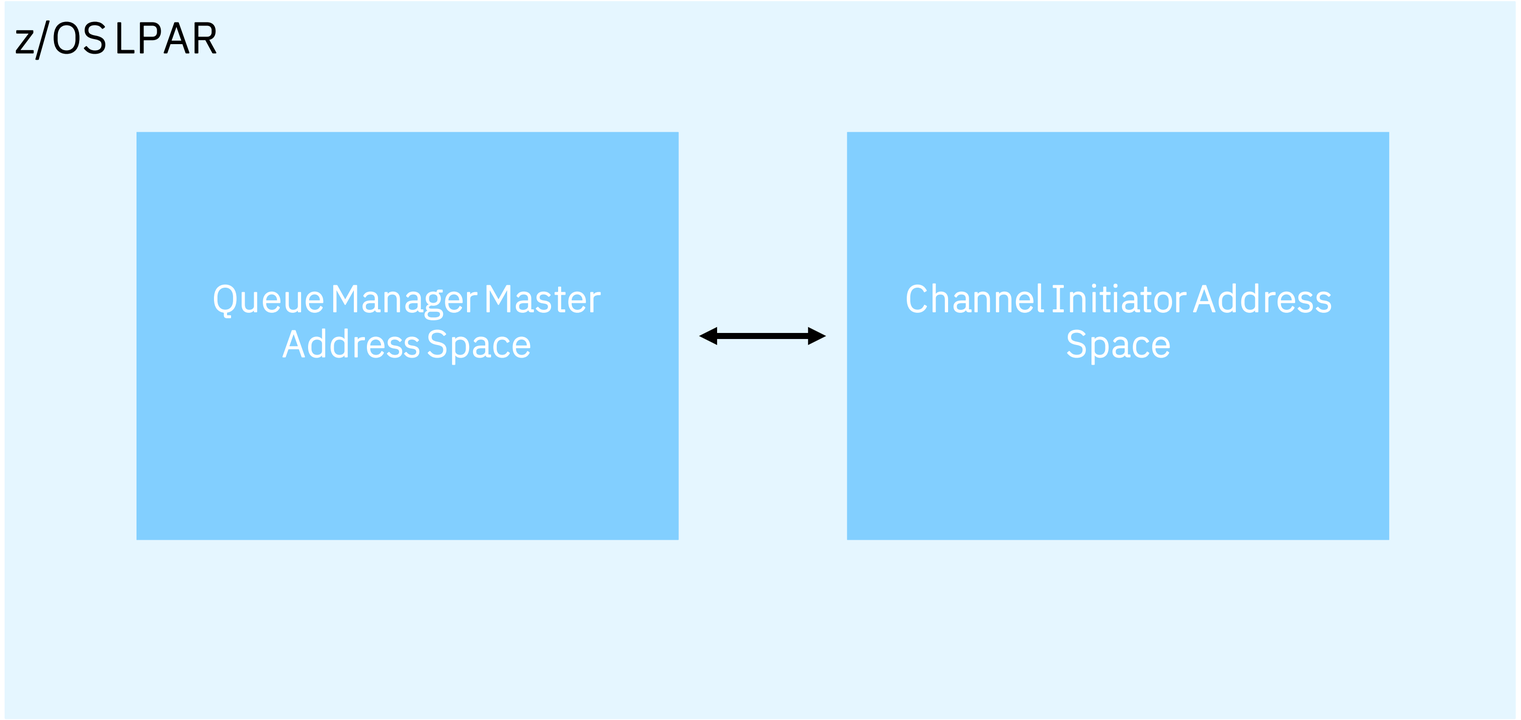
Give you a sense of the KPI’s to pay attention to when evaluating SMF data for your environment

Show you various options for how to view SMF data

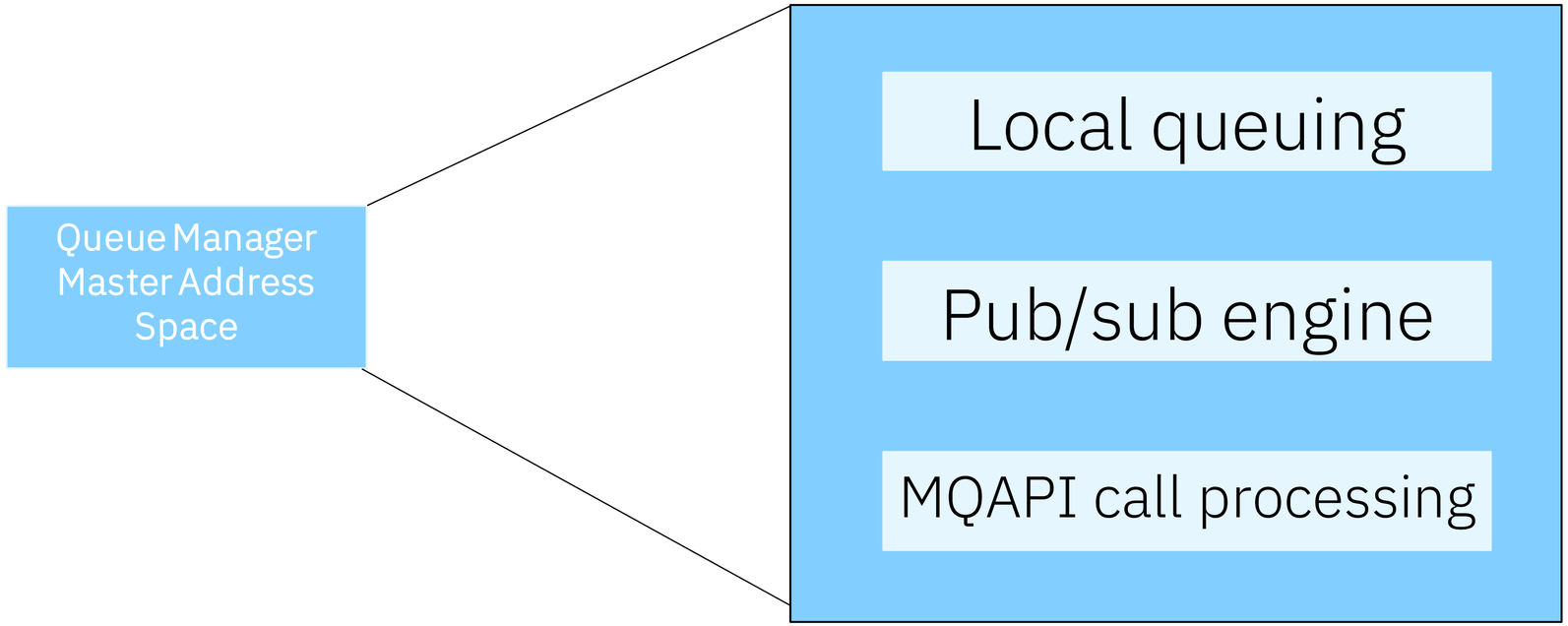
Connect the SMF data and its KPI’s back to what is actually going on inside a queue manager running on IBM MQ for z/OS

Introduction to Queue Manager Internals

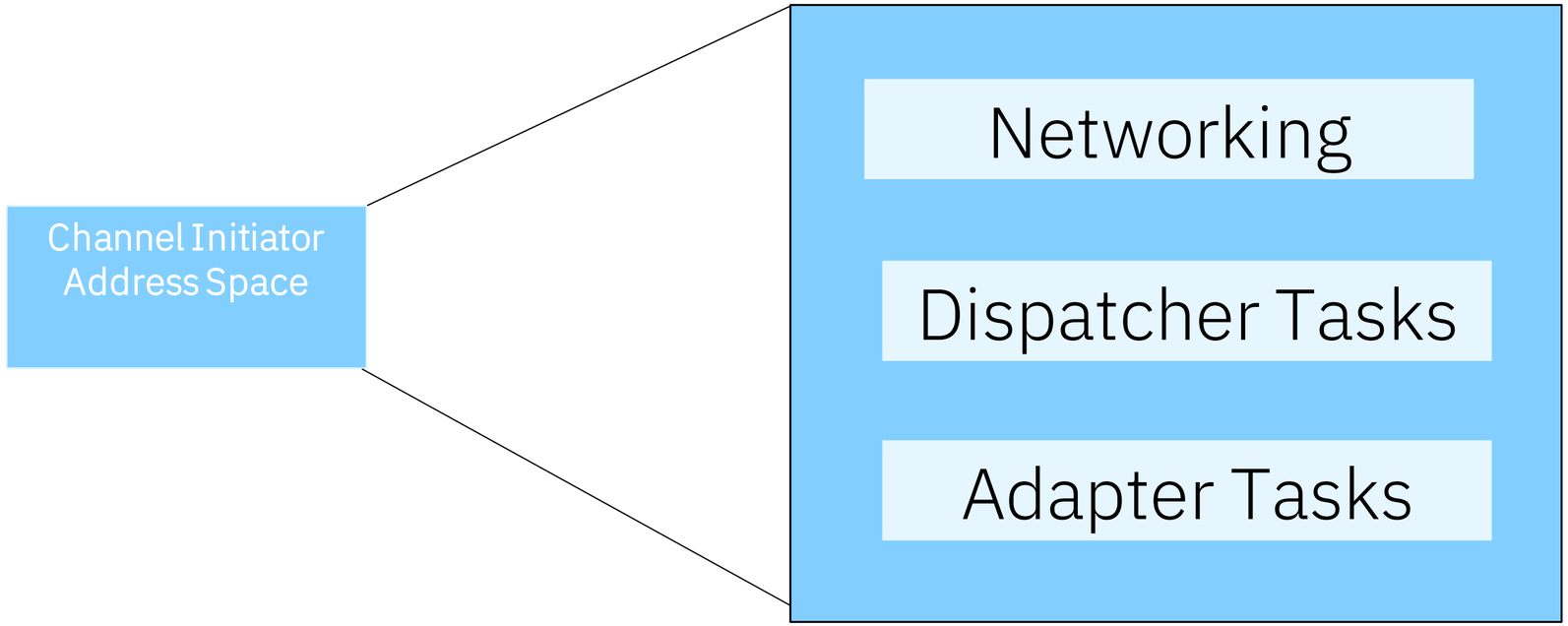
At a glance


z/OS LPAR
Queue Manager Master Address Space
Channel Initiator Address Space

Diving deeper:
Private queues



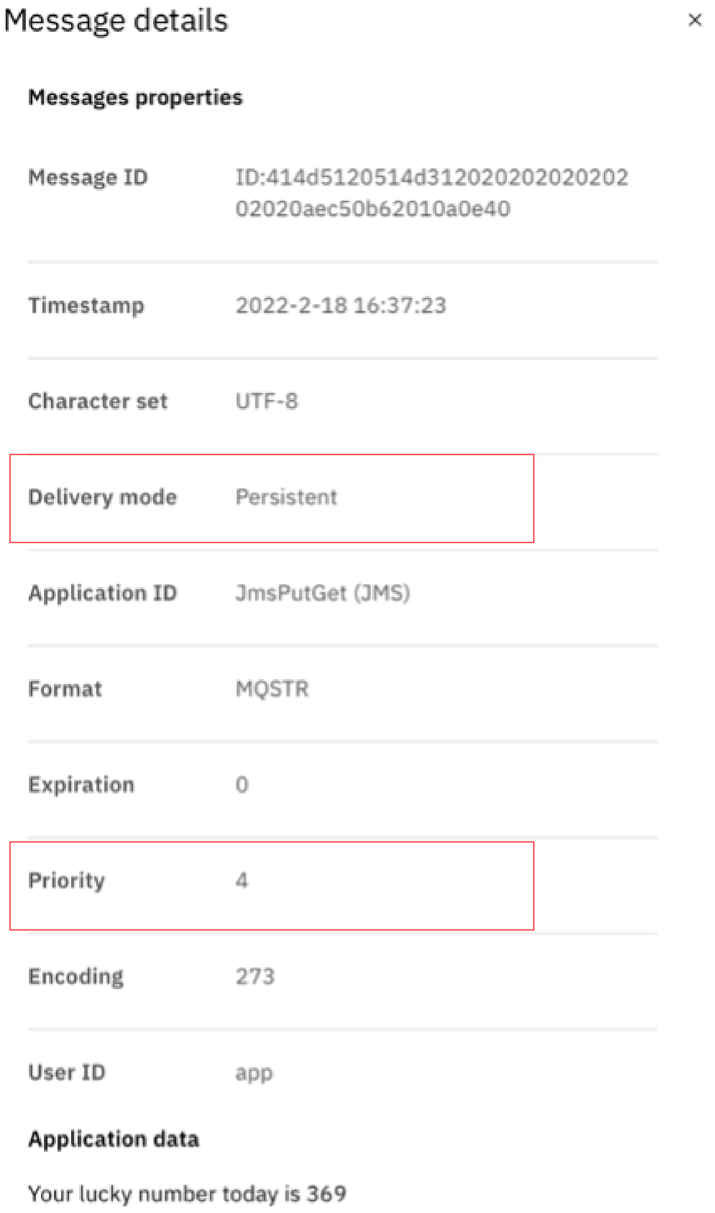
Diving deeper:
Private queues



Digging into local queuing

Message A

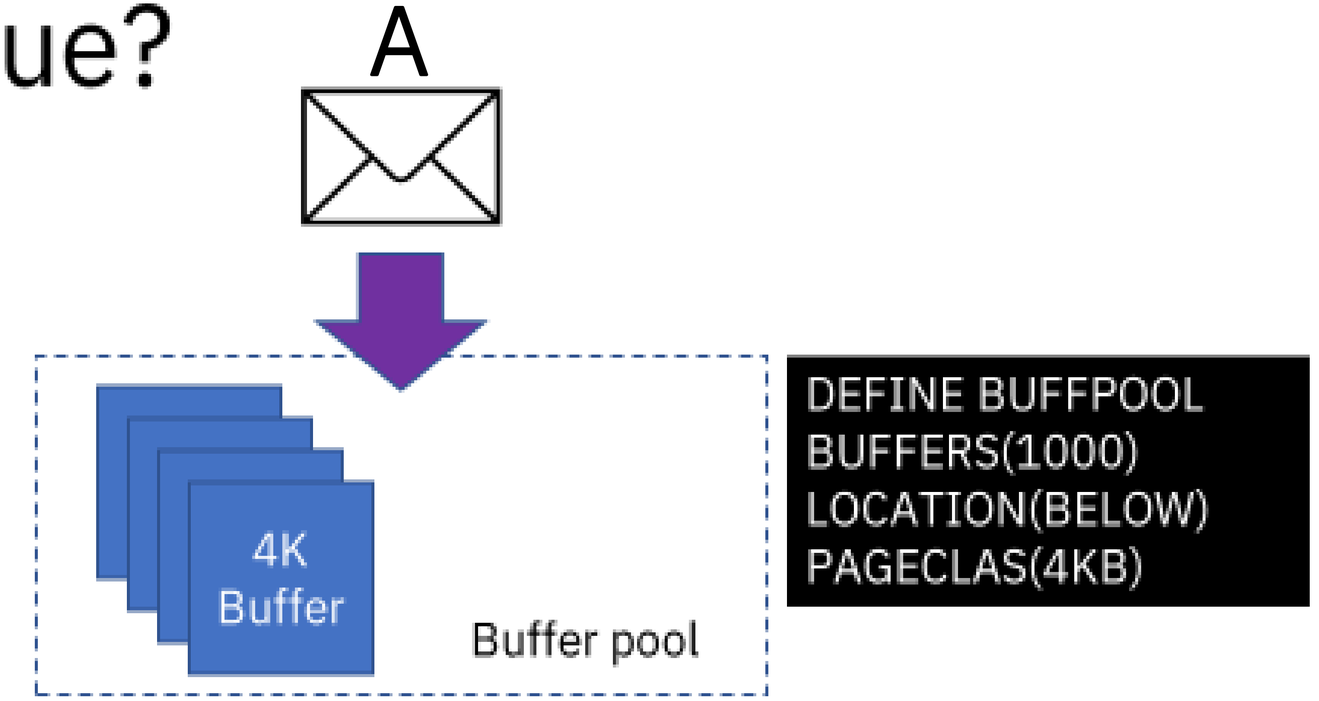
```
Sent message:

  JMSMessage class: jms_text
  JMSType:          null
  JMSDeliveryMode:  2
  JMSDeliveryDelay: 0
  JMSDeliveryTime:  1585562399950
  JMSExpiration:    0
  JMSPriority:      4
  JMSMessageID:     ID:414d5120514d312020202020202020200ac2815e024ce120
  JMSTimestamp:     1585562399950
  JMSCorrelationID: null
  JMSDestination:   queue:///DEV.QUEUE.1
  JMSReplyTo:       null
  JMSRedelivered:   false
    JMSXAppID: JmsPutGet (JMS)
    JMSXDeliveryCount: 0
    JMSXUserID: app
    JMS_IBM_PutApplType: 28
    JMS_IBM_PutDate: 20200330
    JMS_IBM_PutTime: 09595997
Your lucky number today is 926
```



How does physical storage work on a private queue?

When messages are written to buffer pools…

- When messages have been in the buffer pool for 2 log checkpoints
- When buffer pool usage exceeds the deferred write threshold
- When buffer pool usage exceeds the buffer pool threshold



How are private queues associated with physical storage?

Define these bottom-up

Queue layer

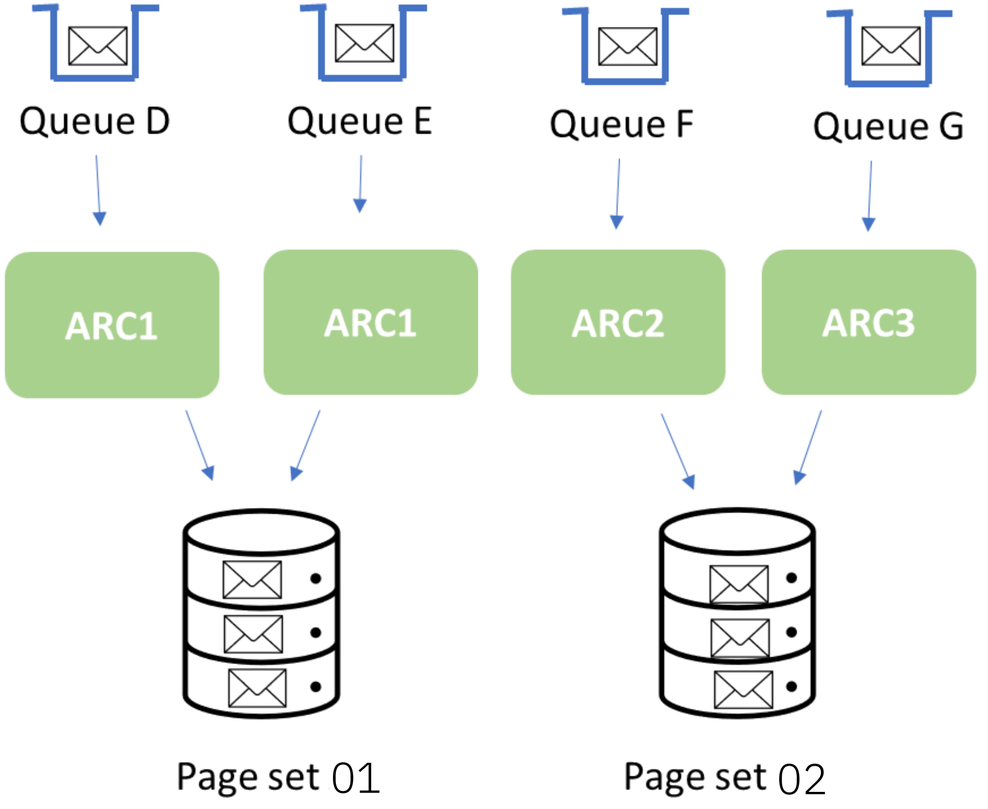
```
DEFINE QLOCAL(QUEUED)
STGCLASS(ARC1)
```

Storage class layer

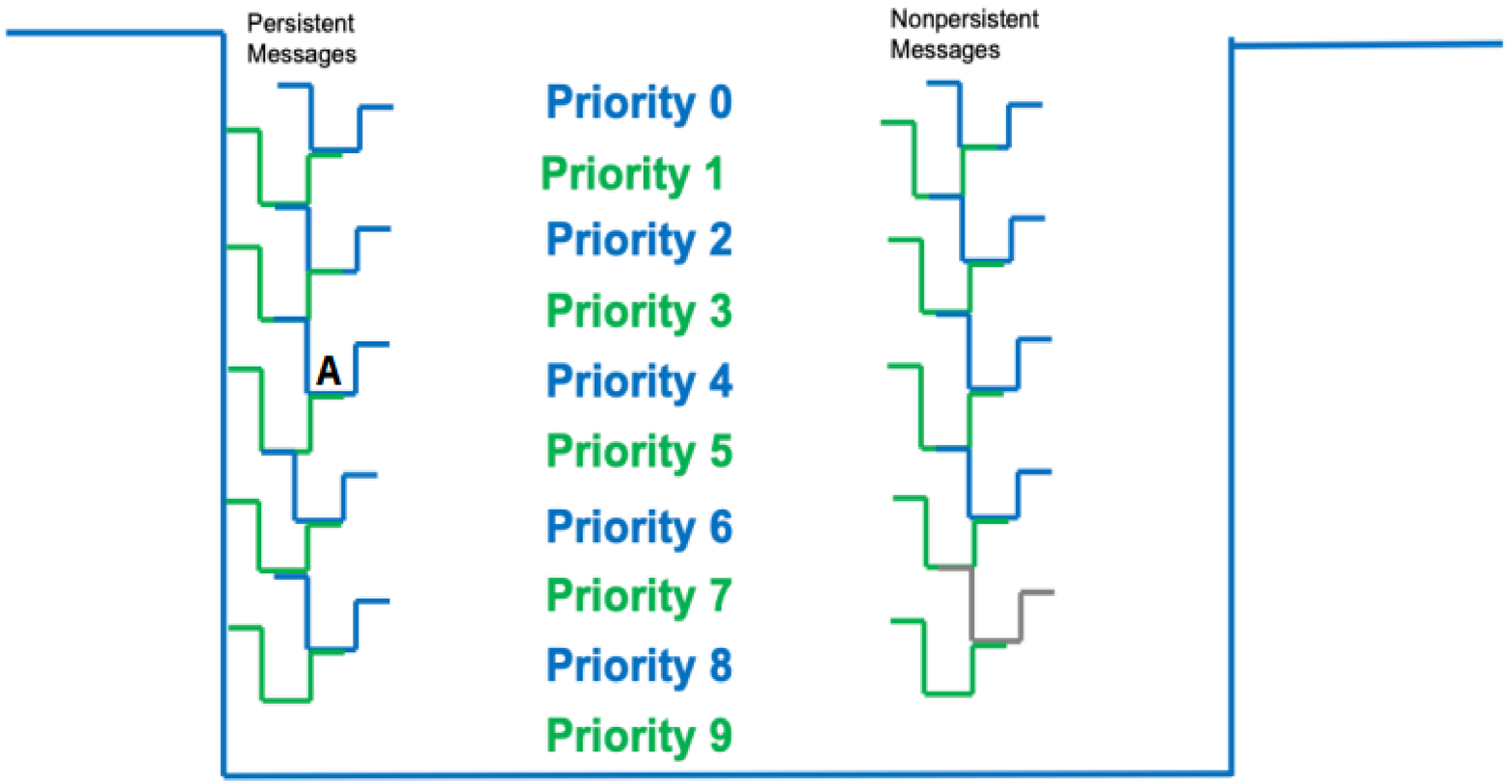
```
DEFINE STGCLASS(ARC1)
PSID(A)
```

Page set layer

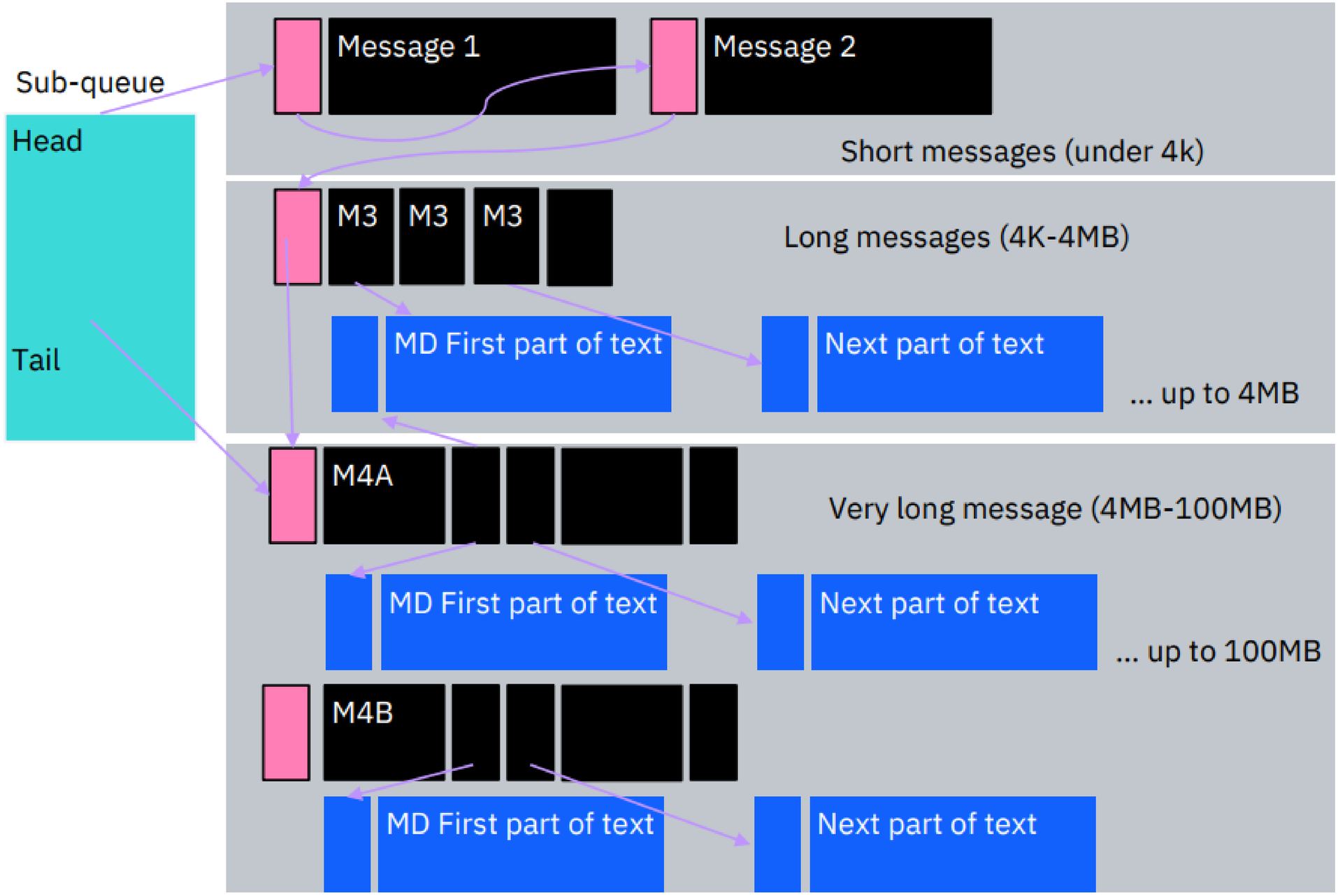
```
DEFINE PSID(01) BUFFPOOL(0)
```



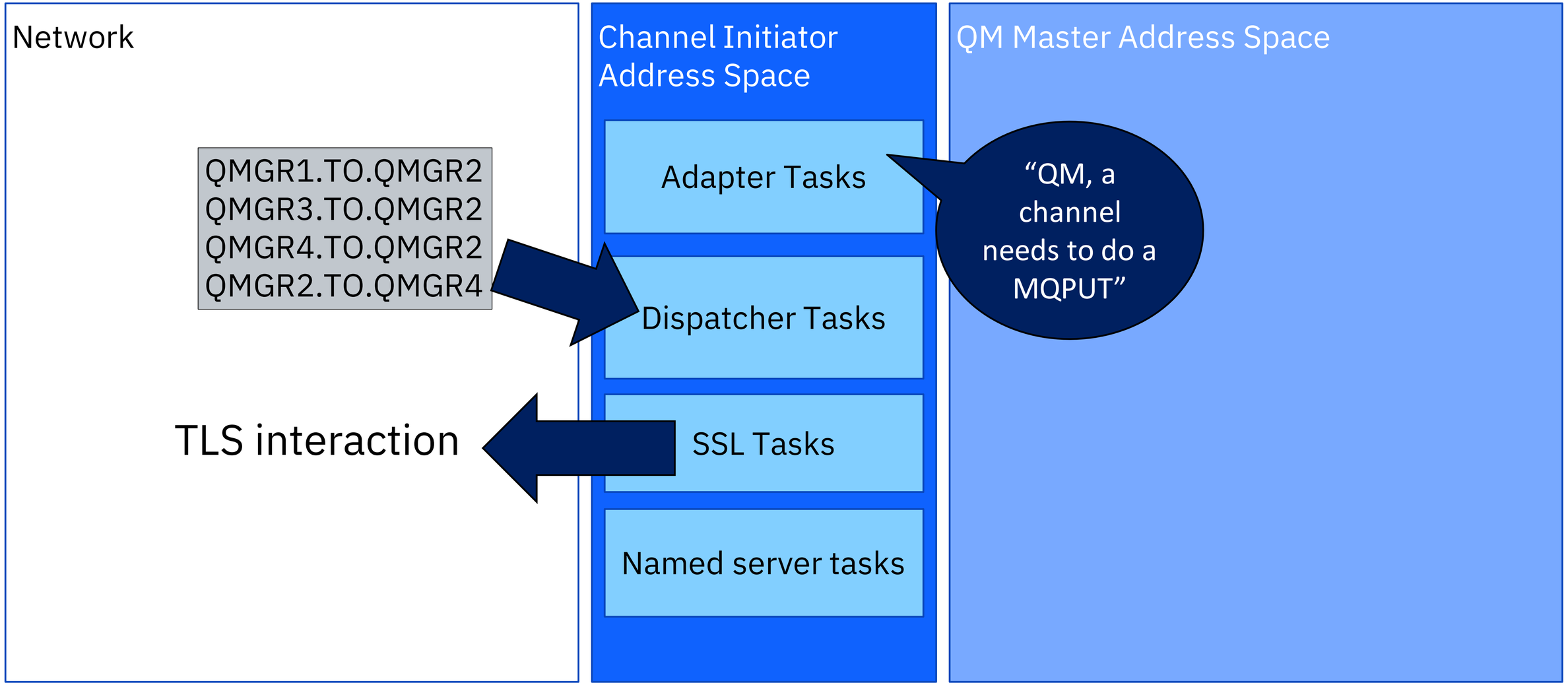
Internal Representation of a Private Queue



Sub-queue Internal View

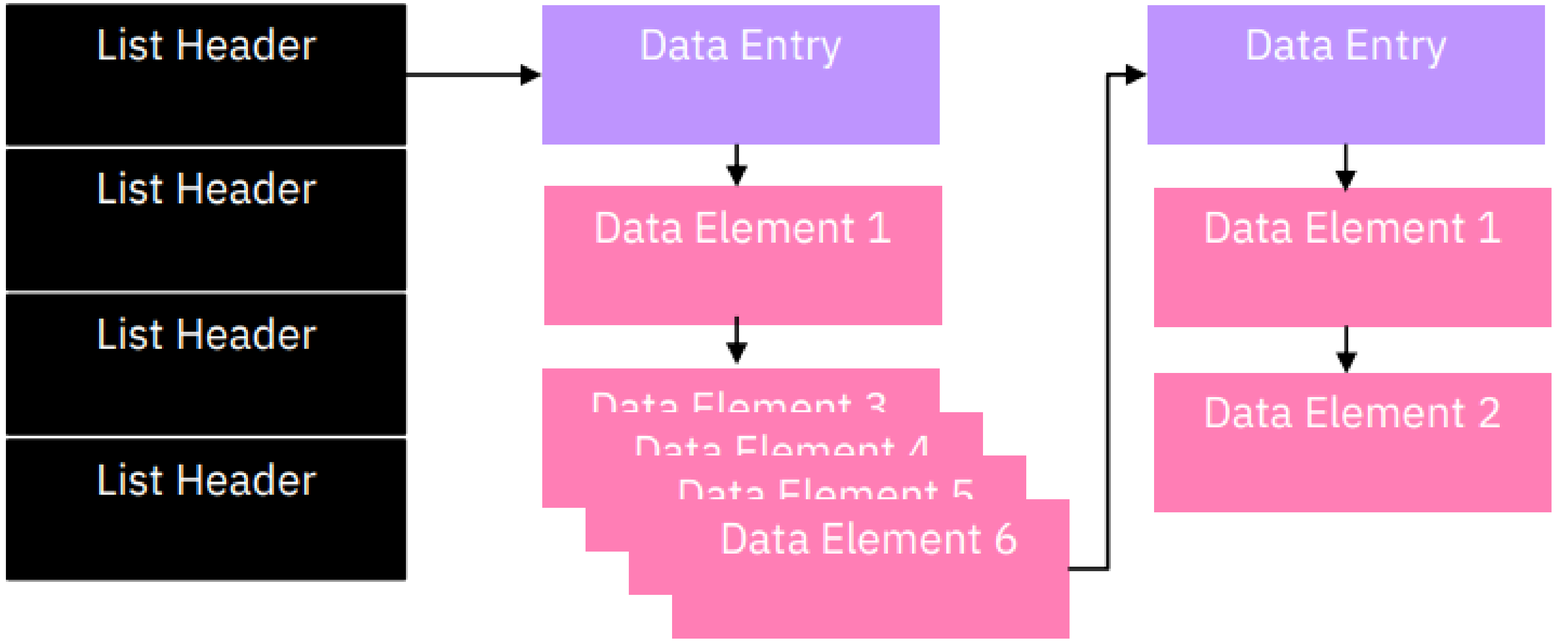


CHINIT Address Space Structure

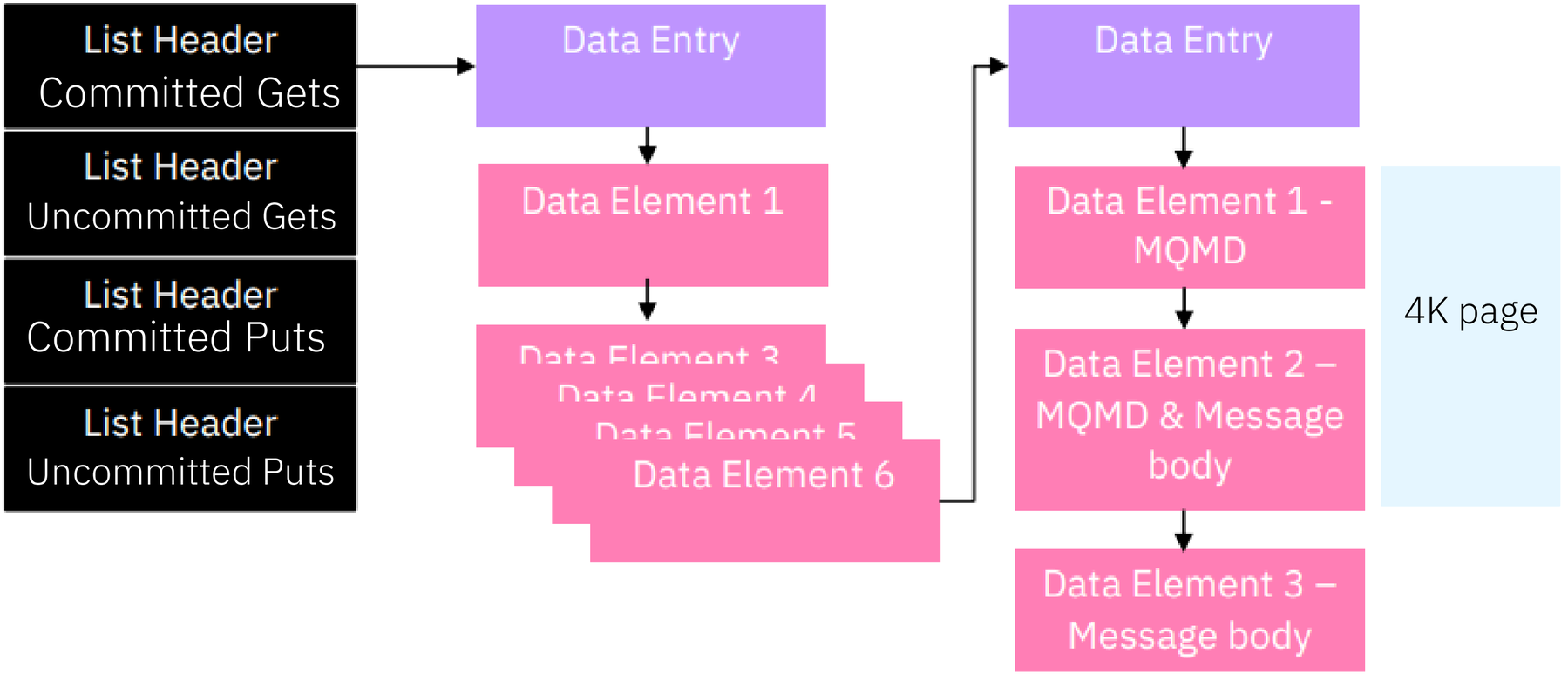


Internals of a shared queue

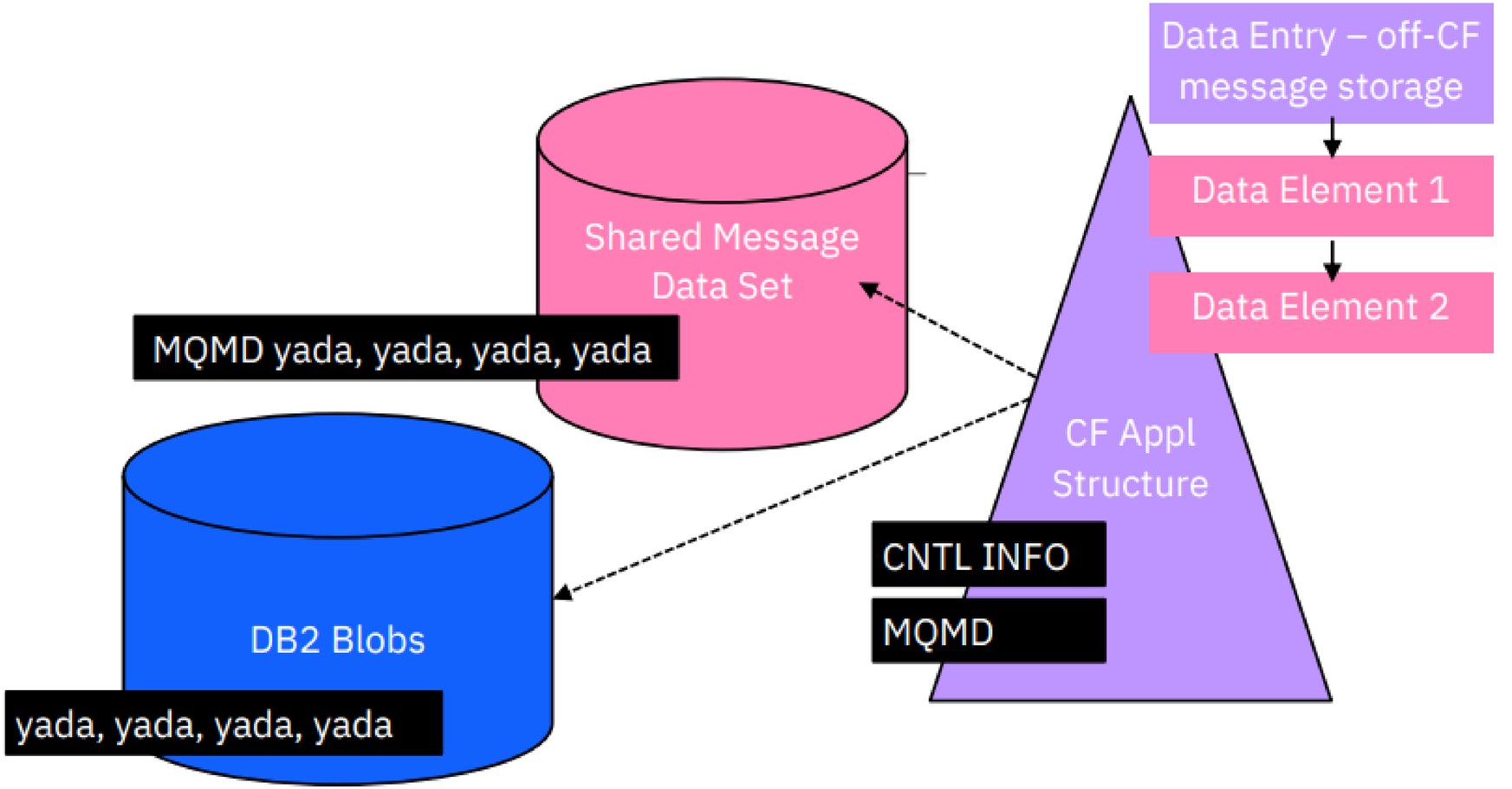
Internal Representation of a Coupling facility list structure



Internal Representation of a Shared Queue



Shared Queue Message Storage



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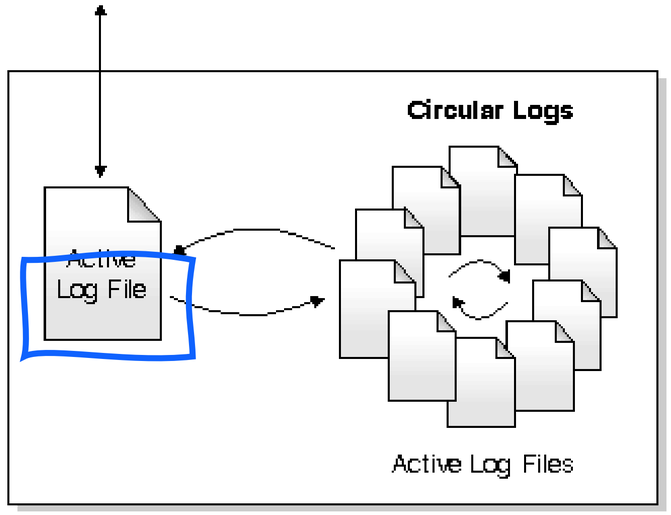
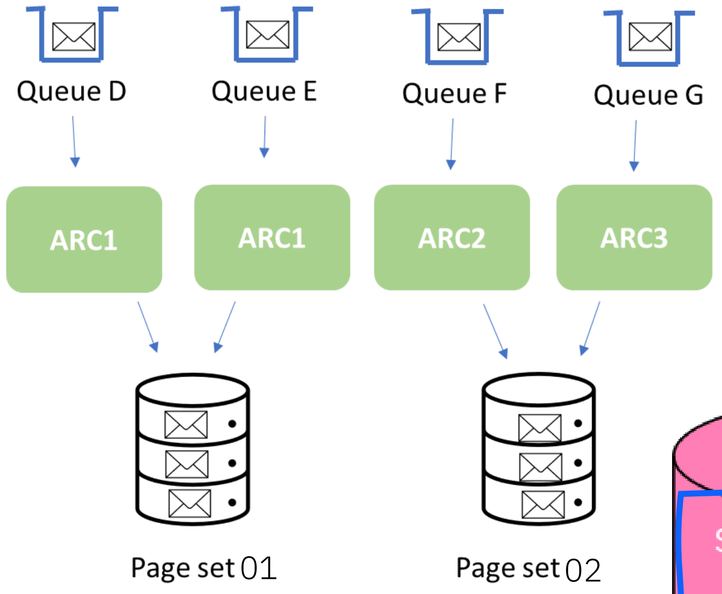
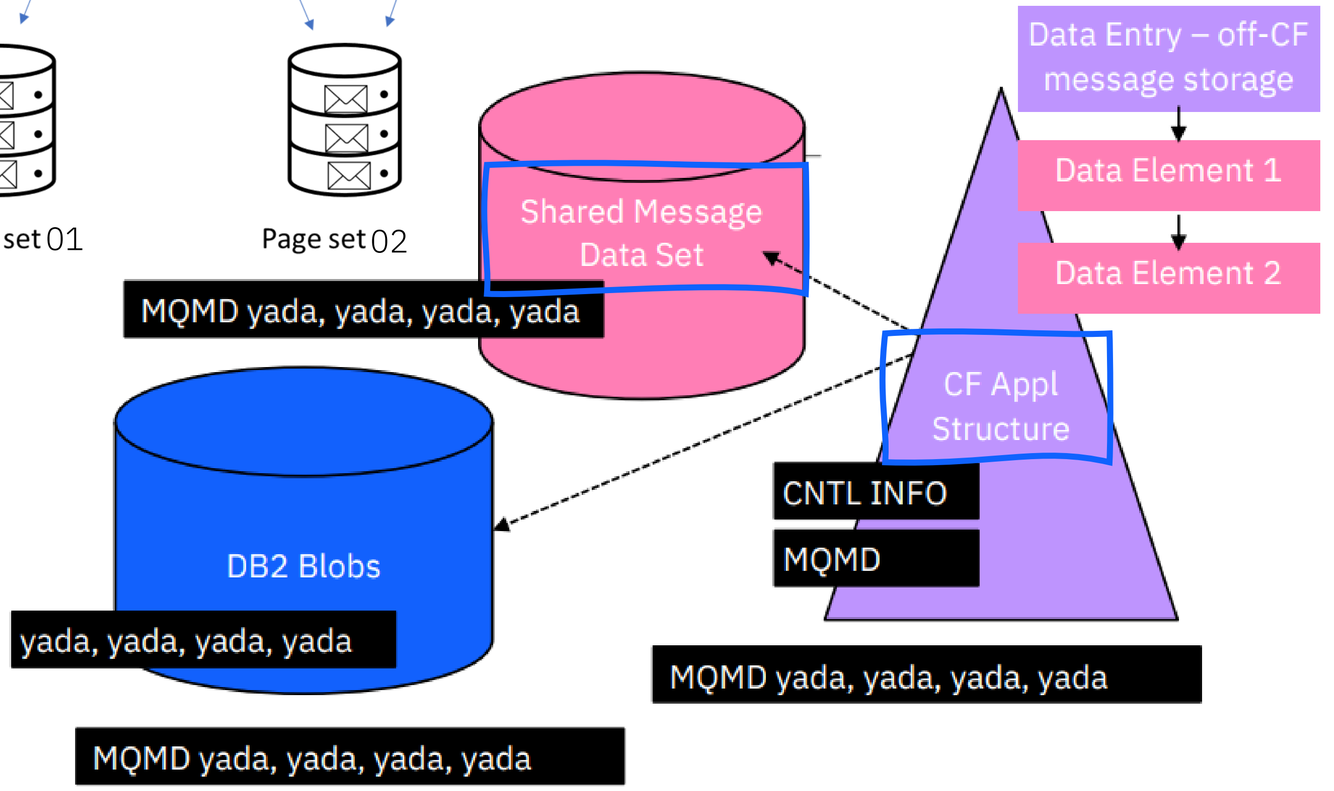
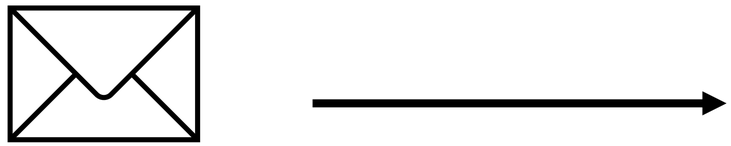






Where does logging come in?

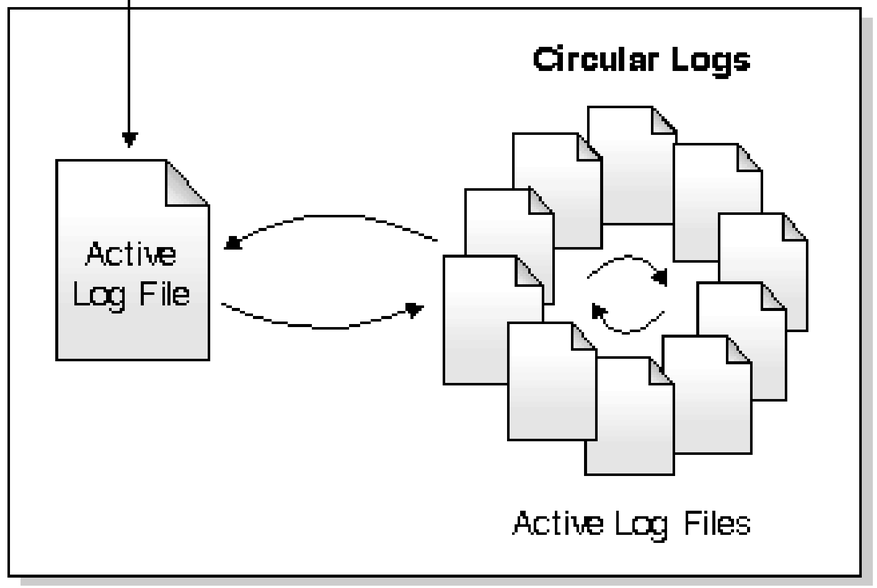
1) Persistent



2) MQ Object

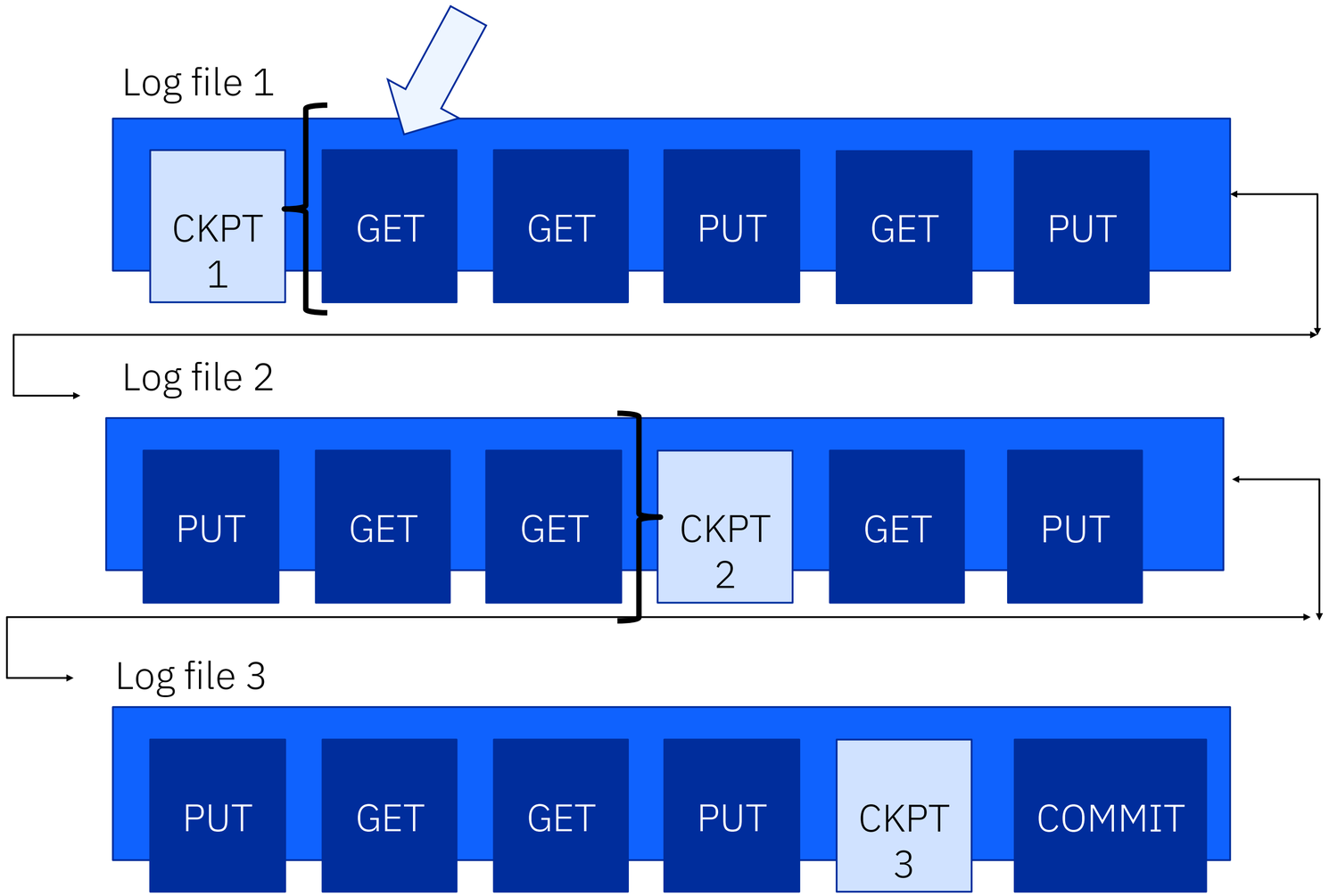
3) Queue Manager

1. Unit of recovery log records
2. Checkpoint records
3. Page set control records
4. CF structure backup records



Offloading

What does a log file look like?



Concept check

When I want to offload messages from my list structure, I should use...

(a) DB2 Blobs

(b) Shared Message Data sets

(c) Page sets

Why might a short message be classified as a 4k or less?

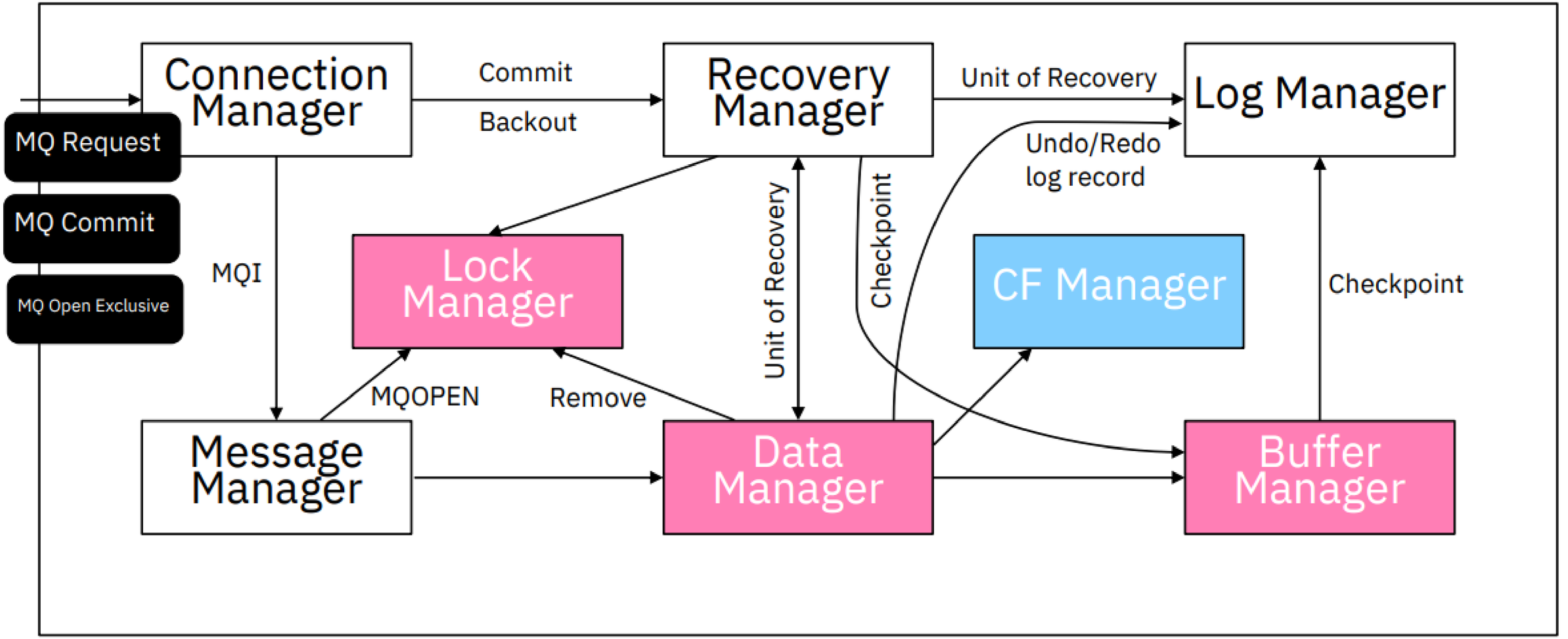
Which address space is the Pub/Sub engine associated with?

(a) QMGR master address space

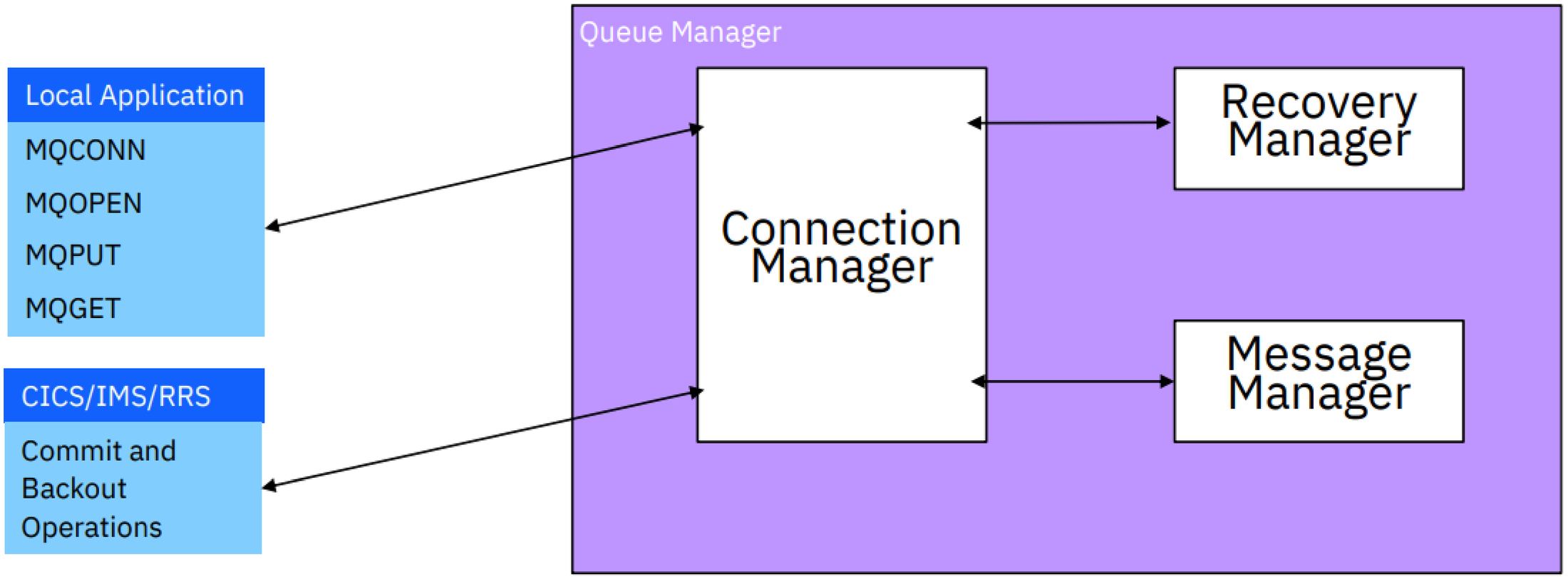
(b) CHIN address space

What is the size of an element in a list structure?

Building Blocks
Resource Managers

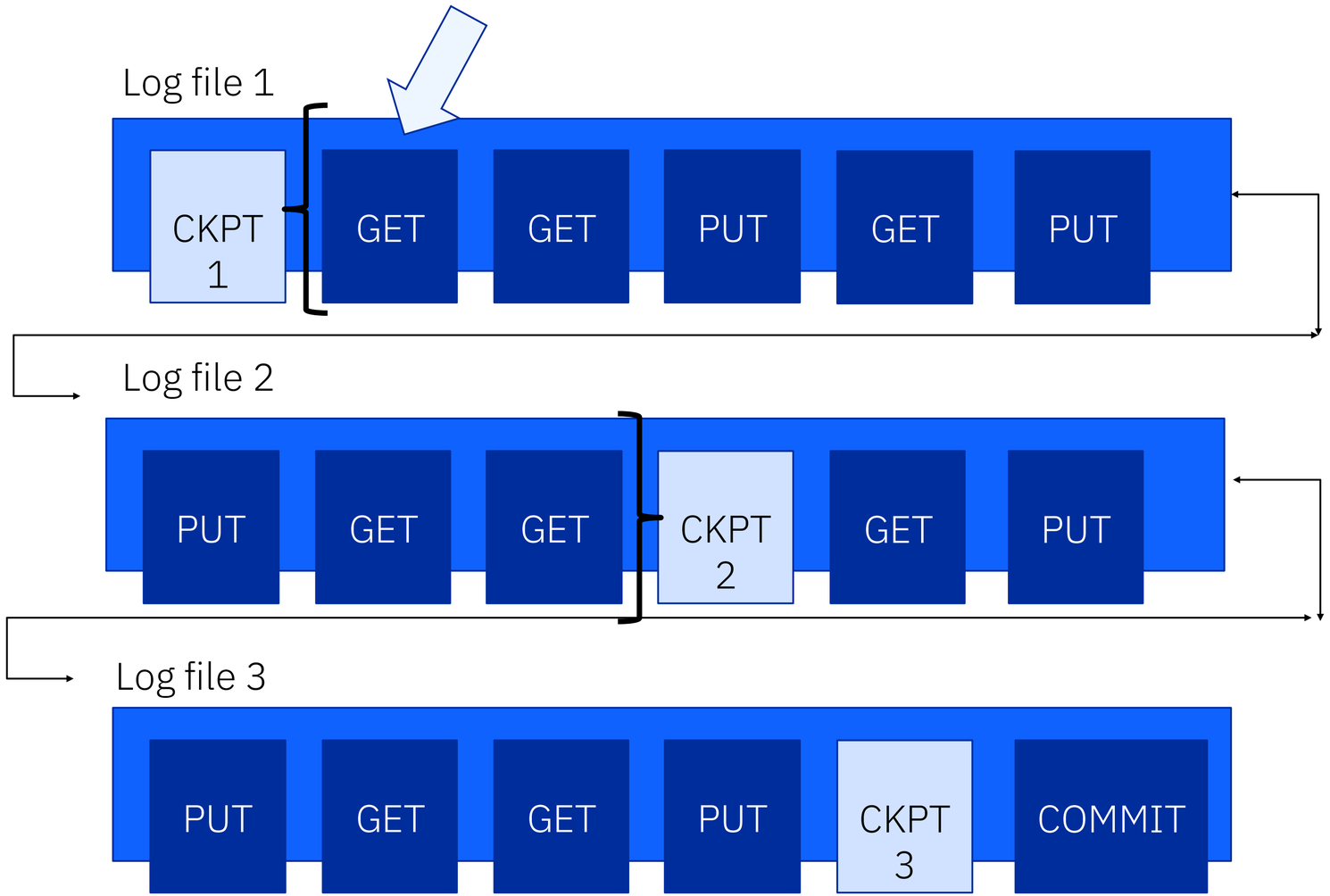


Connection Manager



Buffer Manager

Log Manager


Log file 1
CKPT 1
GET
GET
PUT
GET
PUT
Log file 2
PUT
GET
GET
CKPT 2
GET
PUT
Log file 3
PUT
GET
GET
PUT
CKPT 3
COMMIT

To recap...

Private queues use buffer pools, storage classes, and page sets to underpin queuing

Shared queues use CF list structures, shared message data sets, and BLOBs to underpin queuing

Both private and shared queues use **logging** for recovery

Understanding storage and logging sets the stage for our next presentation...

How to analyze your IBM MQ for z/OS SMF data

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IBM

There are two types of SMF records that are relevant to MQ for z/OS:

SMF 115:

Statistics data produced by an IBM MQ queue manager

SMF 116:

Accounting data produced by an IBM MQ queue manager

* You can look at this data in two ways – on z/OS and through exporting to CSV files

SMF 115

MQ Storage

SMF-QIS1.csv – Page Set Statistics

SMF-QPST.csv – Buffer Manager

SMF-QJST.csv – Log Manager

SMF-QSGM.csv - Storage

SMF-QSPH.csv - Storage

SMF-QSRS.csv - Storage

SMF-QSST.csv – Storage

SMF-QESD.csv – Shared Message Data Set

SMF-QEST.csv – Coupling Facility Statistics

SMF-Q5ST.csv – BLOB Statistics

MQ Requests

SMF-QLST.csv – Lock Manager

SMF-QMST.csv – Message Manager

SMF-QIST.csv – Data Manager Statistics

SMF-QCCT.csv – Channel Statistics

SMF-QCTADP.csv – Adapter Task Statistics

SMF-QCTDSP.csv – Dispatcher Task Statistics

SMF-QCTSSL.csv – SSL Statistics

SMF-QTST.csv – Publications Statistics

SMF 116

MQ
Tasks

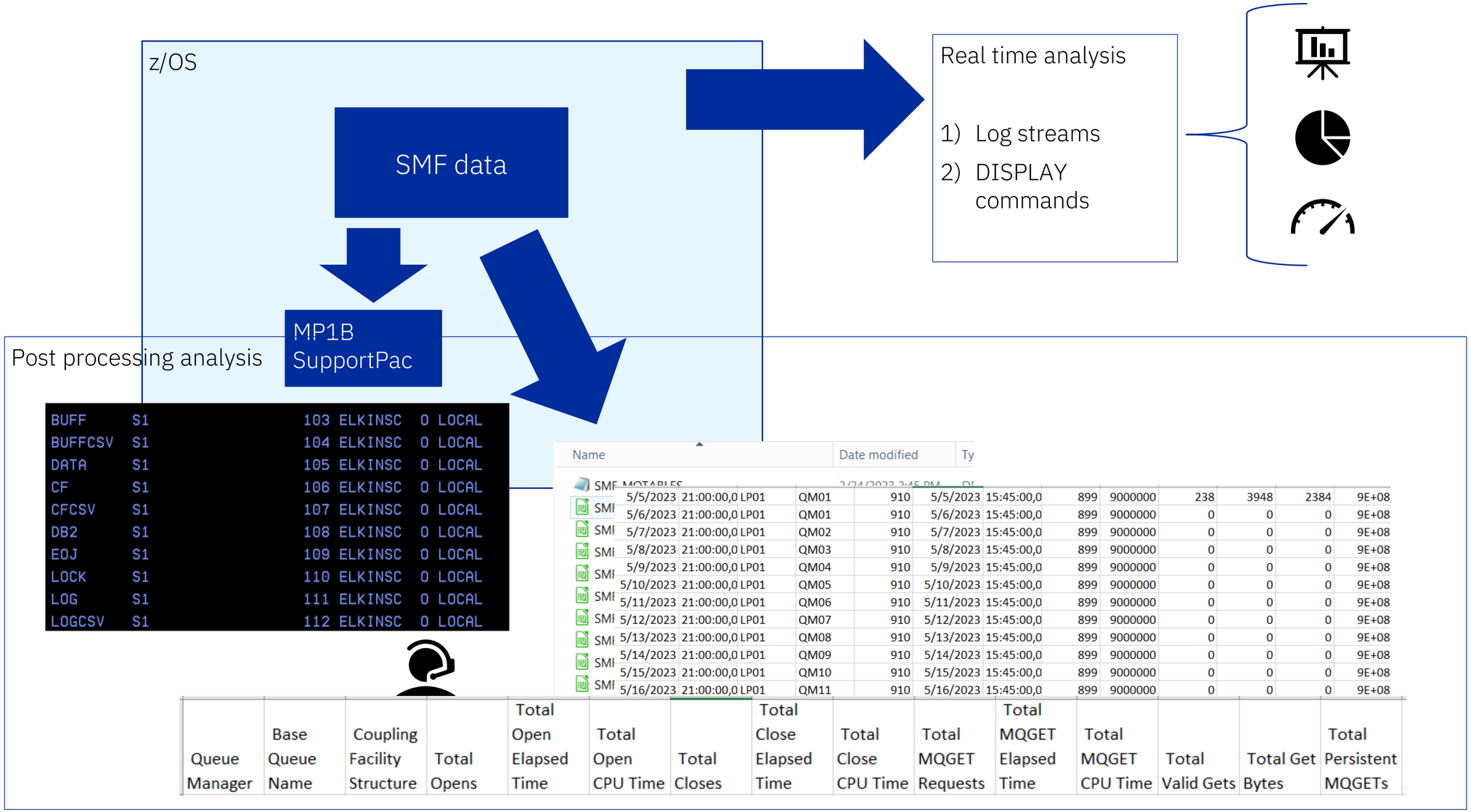
SMF-QCST.csv – Channel Accounting

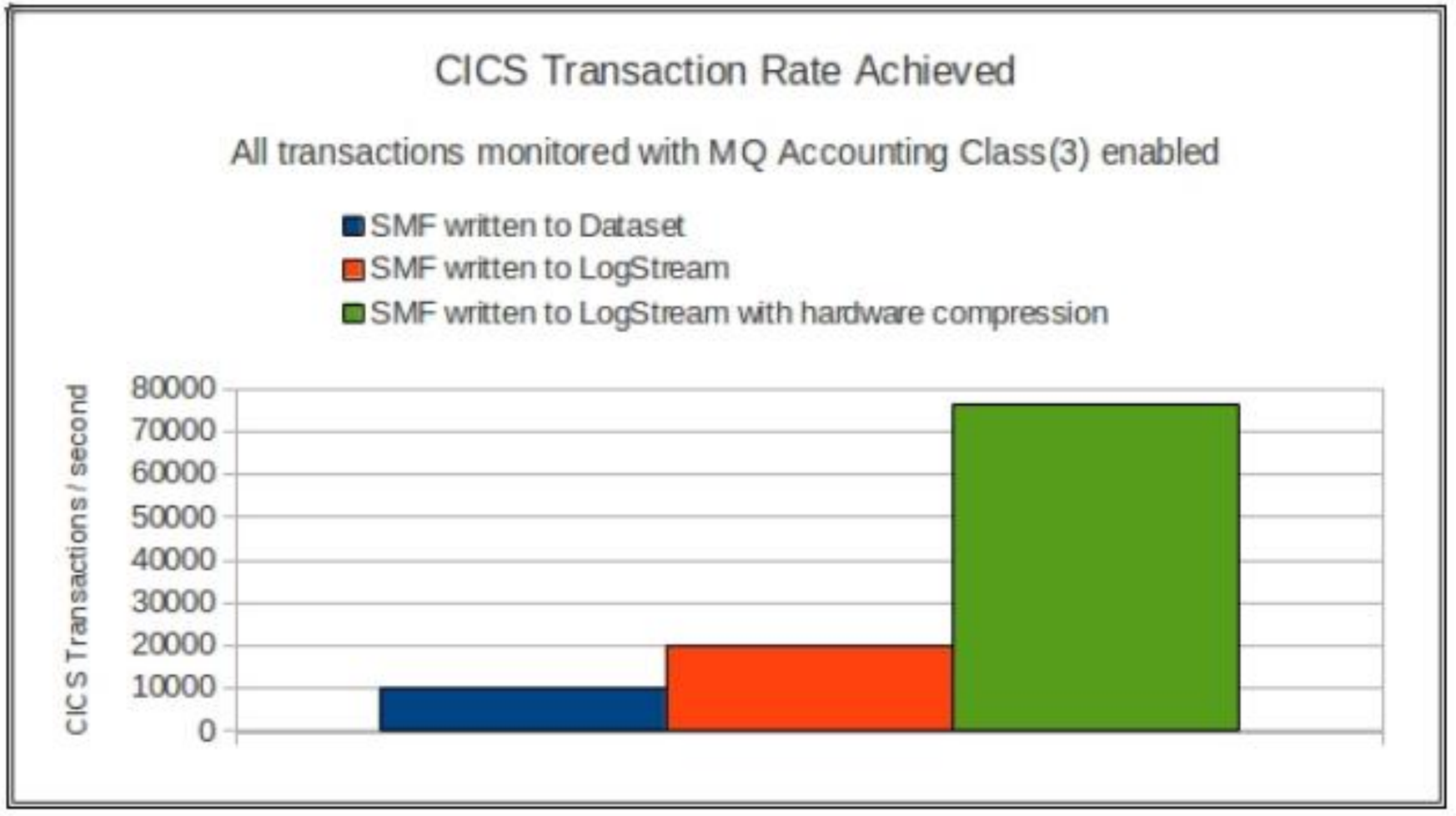
SMF-WQ.csv – Task Queue Accounting

SMF-WTAS.csv – Task Accounting

SMF-WTID.csv – Task ID Accounting

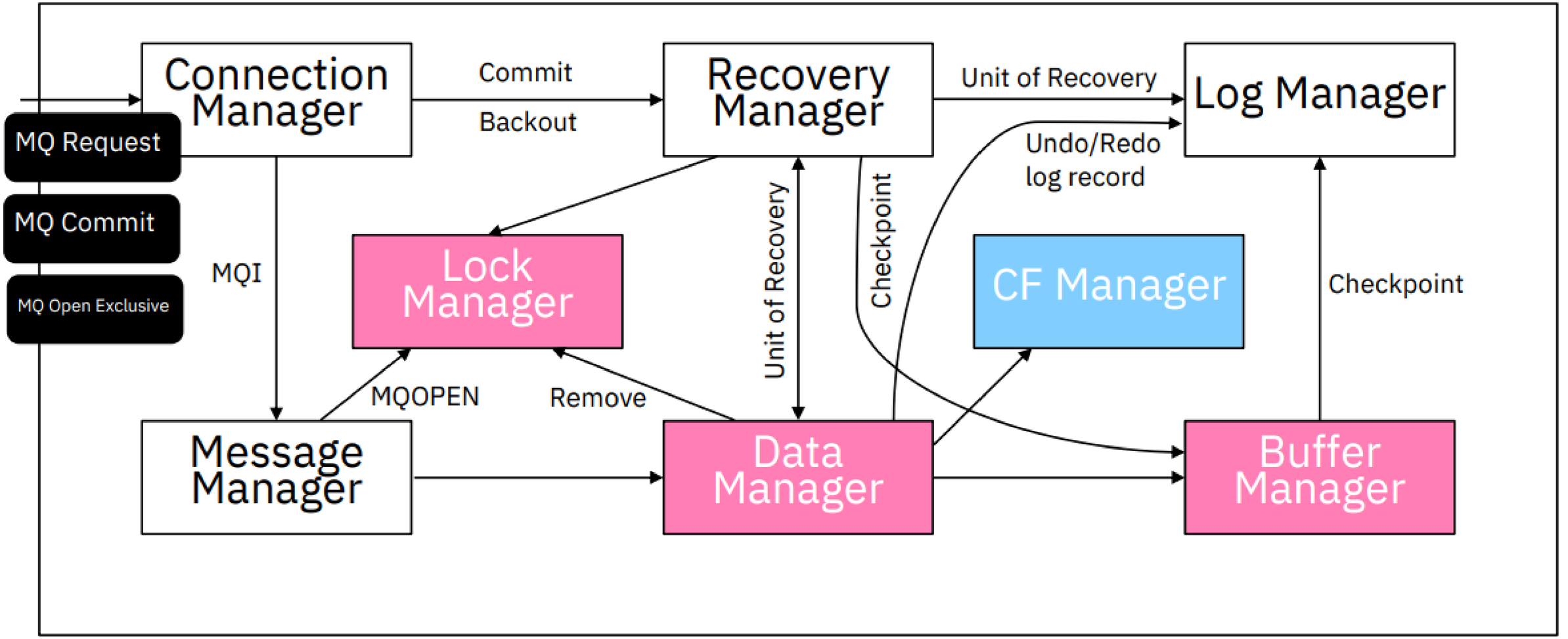
How do you look at SMF data?




CICS Transaction Rate Achieved
All transactions monitored with MQ Accounting Class(3) enabled
SMF written to Dataset
SMF written to LogStream
SMF written to LogStream with hardware compression
CICS Transactions / second
80000
70000
60000
50000
40000
30000
20000
10000
0

Interpreting SMF 115 data for private queues

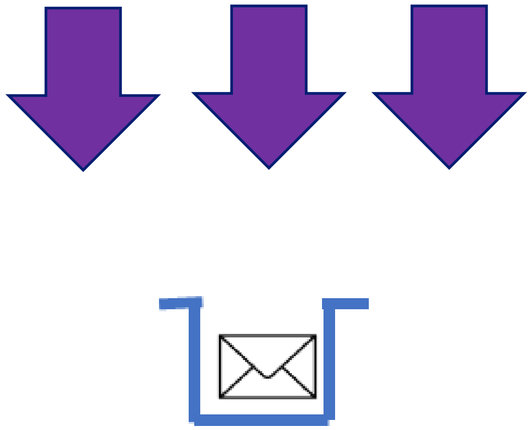
Building Blocks
Resource Managers



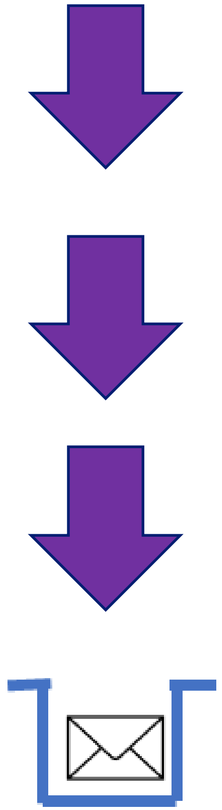
SMF-QLST.csv – Lock Manager

- GET_LOCK_REQUESTS
- GET_LOCK_HELD
- RELEASE_LOCK
- Not usually helpful in terms of performance analysis

MQOO_INPUT_SHARED



MQOO_INPUT_EXCLUSIVE



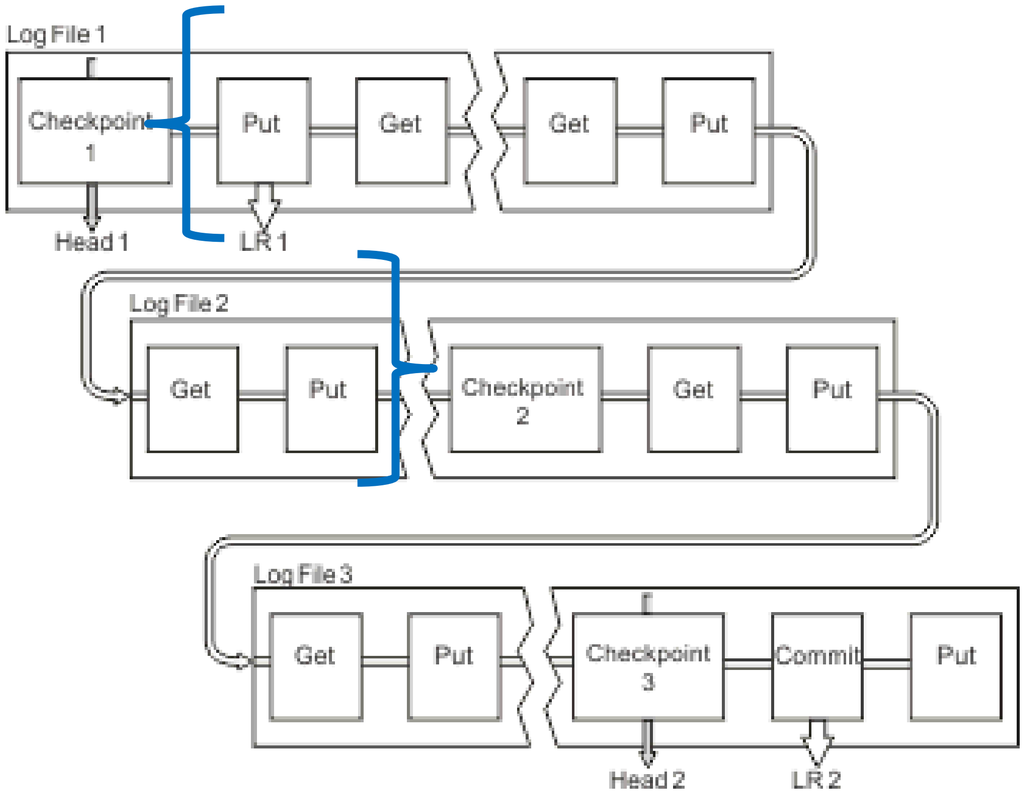
SMF-QPST.csv – Buffer Manager Statistics

Date
Time
LPAR
QMgr
MQ Version
Interval Duration
Buffer Pool
Buffer Count
Lowest Stealable
Highest Used
Highest Used Percent
Current Stealable
Getp Old Requests
Getp New Requests
DASD Read
Set Write Pages
Pages Written
DASD Write
Sync Writes
Defer Write Thold
Reached
Sync Write Thold Reached
Buffer Steals
Buffer Steals Hash Changes
Suspend No Buffers
Location
Pagefixed

SMF-QJST.csv – Log Manager Statistics

- The log is conceptually a very long buffer
- Metrics are considered in terms of time here

- Critical metrics here:
  - Log Reads
  - Log Task Busy
  - Checkpoints
  - Unavailable buffer count
  - I/O Max Duration Log Copy – how long it takes to do physical I/O



SMF-QMST.csv – Message Manager Statistics

- Records API requests
- Less useful for problem determination
- More useful for observing workload volume and peak periods
- Critical metrics here:
  - MQPUT – When an application made a put request onto the QM
  - MQPUT1 – When an application has made a request to do an open and a put together

SMF-QTST.csv – Publications Statistics

Date Time LPAR QMgr

Interval Duration

Total Publication Request Count

Total Publication API Count

Administrative Publications - Total Proxy Publications - Total

High point of Publications Publications - Low Point

Publications with no Subscriber to Topic

Longest ET for publication in microseconds

Total ET for publications in microseconds

SMF-QIST.csv – Data Manager Statistics

DATE TIME QMGR

Message Mgr MQGETs

Data Mgr MQGETs

MQGET Difference

Message Mgr MQPUTs; Message Mgr MQPUT1s; Total Message Mgr Puts

Data Mgr MQPUTs

PUT Difference

MSG_COUNT

OBJECT CREATE; OBJECT DELETE;

OBJECT PUT; OBJECT GET; OBJECT LOCATE

- Implications:
  - GET difference can indicate scrolling
  - PUT difference can indicate put to waiting getter performance enhancement
  - Object creates and deletes shows temporary dynamic queue utilization

MQ Objects

Queues

IBM MQ queue managers

Process definitions

Namelists

Authentication information objects

Communication information objects

Channels

Communications

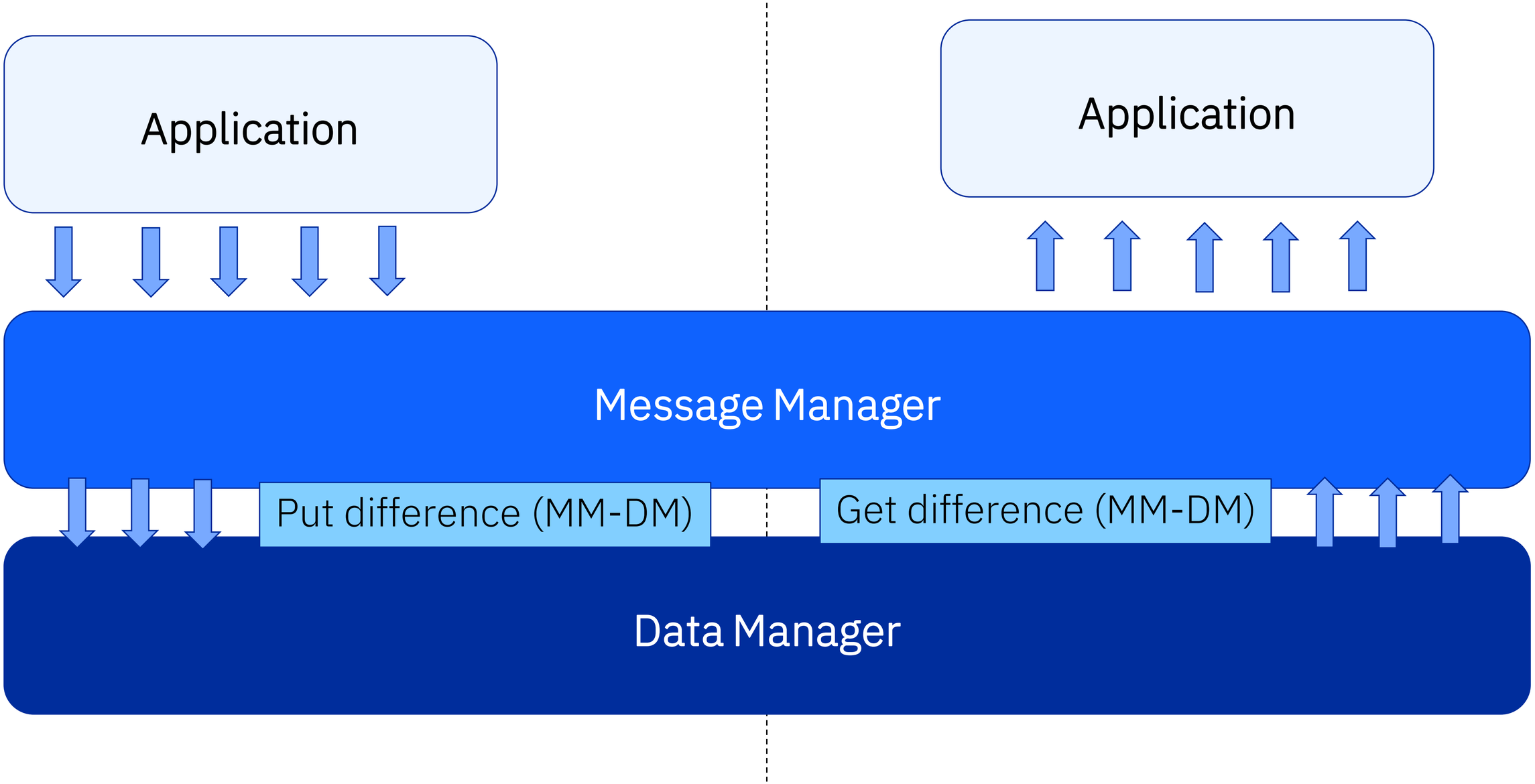
Client connection channels

Storage classes

Listeners

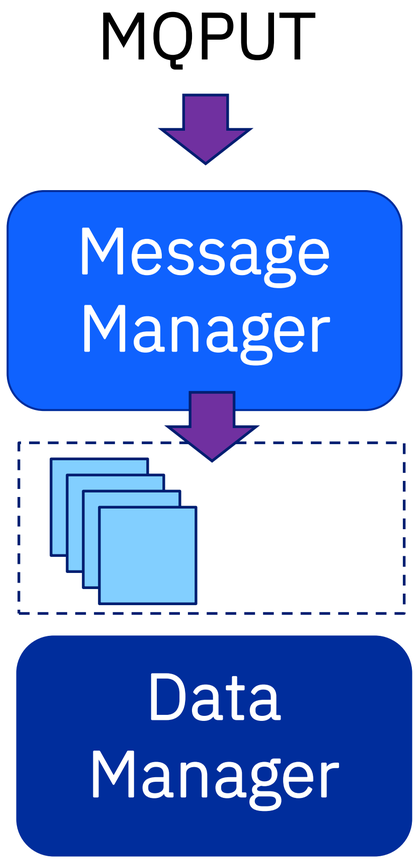
Services

Topic objects


Application
Application
Message Manager
Put difference (MM-DM)
Get difference (MM-DM)
Data Manager

Positive put difference

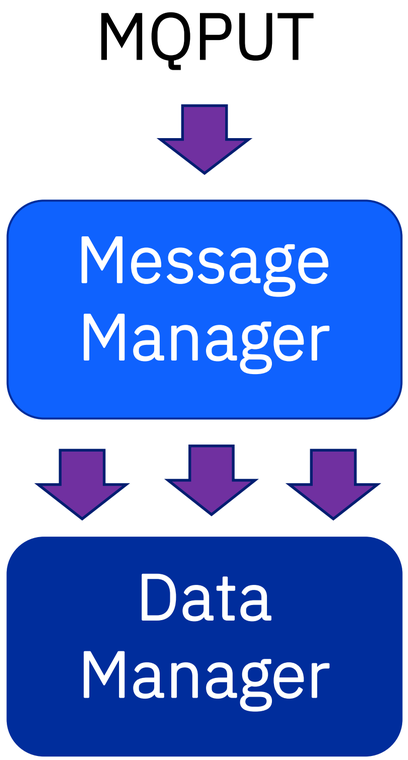
MM puts > DM puts



Put to waiting getter advantage

Negative put difference

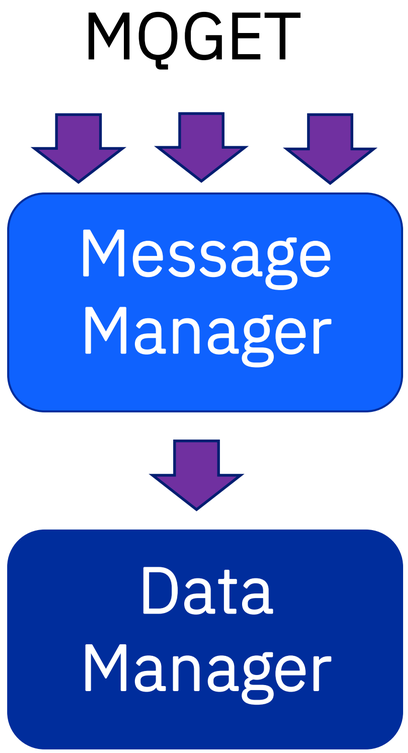
DM puts > MM puts



Publications or generated messages from triggering

Positive get difference

MM gets > DM gets

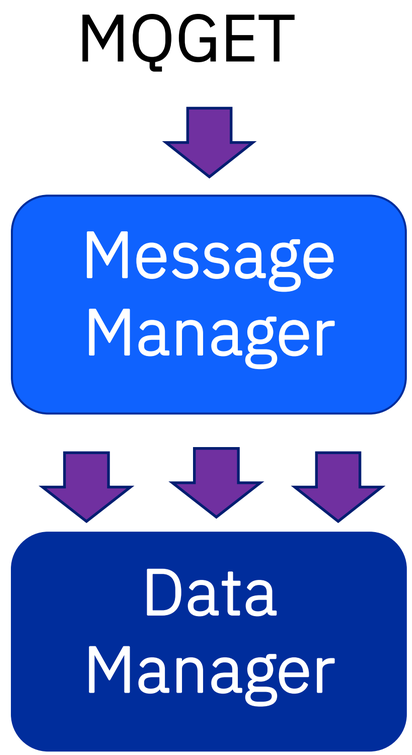


Target queue is empty

Not a problem

Negative get difference

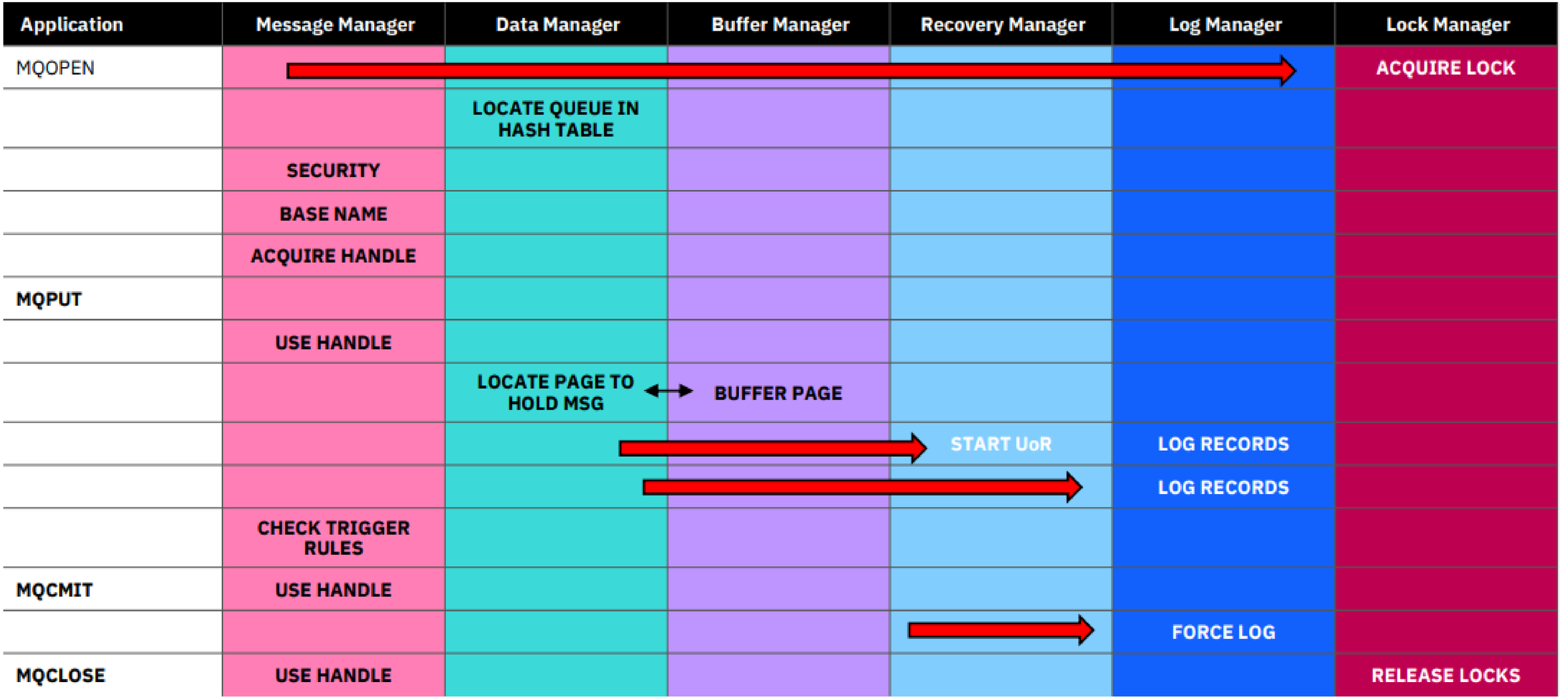
DM gets > MM gets



May indicate scrolling

Look for skipped messages

Scenario: Persistent MQPut on a Triggered Queue

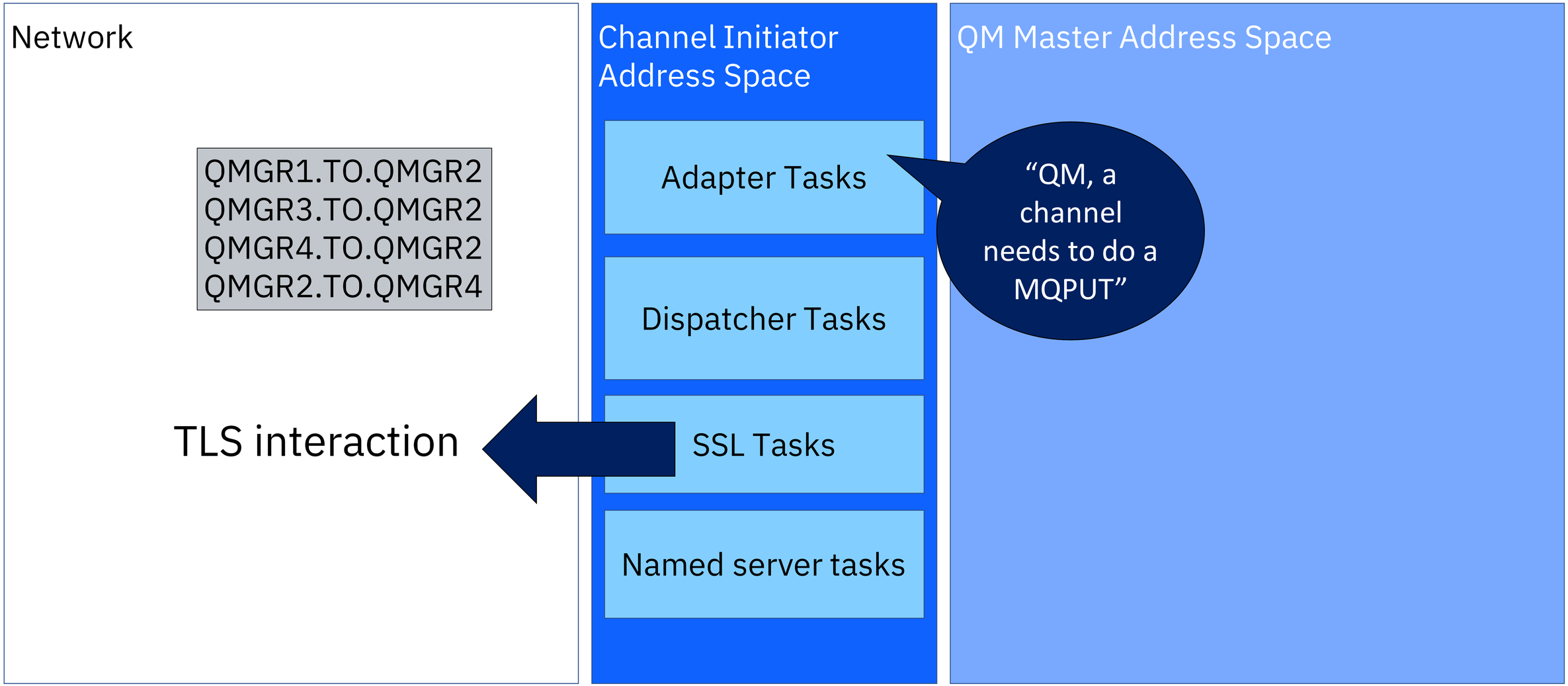


Scenario: MQGet from a Queue

Application	Message Manager	Data Manager	Buffer Manager	Recovery Manager	Log Manager	Lock Manager
MQOPEN						ACQUIRE LOCK
		LOCATE QUEUE IN HASH TABLE				
	SECURITY					
	BASE NAME					
	ACQUIRE HANDLE					
MQGET						
	USE HANDLE					
		FIND MSG (INDEX/NEXT)				
			BUFFER PAGE			
				START UR	LOG RECORDS	
					LOG RECORDS	
MQCMIT	USE HANDLE					
					FORCE LOG	
MQCLOSE	USE HANDLE					RELEASE LOCKS

Interpreting SMF 115 channel information

CHINIT Address Space Structure



SMF-QCCT.csv – Channel Statistics

CHINIT job name

QSG name if it is in a QSG

Peak number of current channels

Peak number of active channels

MAXCHL - maximum permitted current channels

ACTCHL - maximum permitted active channels

TCPCHL - maximum permitted

TCP/IP channels

LU62CHL - maximum permitted LU62 channels

Storage used by CHINIT

SMF-QCTADP.csv – Adapter Task Statistics

Date LPAR QMgr

Adapter Task Number – always unique

Total Requests for this Adapter Task

Total CPU for this Adapter Task

Total Elapsed Time for this Adapter Task – could be in a wait state

Total Wait Time for this Adapter Task

SMF-QCTDSP.csv – Dispatcher Task Statistics

Date LPAR QMgr

Dispatcher Task Number

Total Requests for this Dispatcher Task

Total CPU for this Dispatcher Task

Total Elapsed Time for this Dispatcher Task

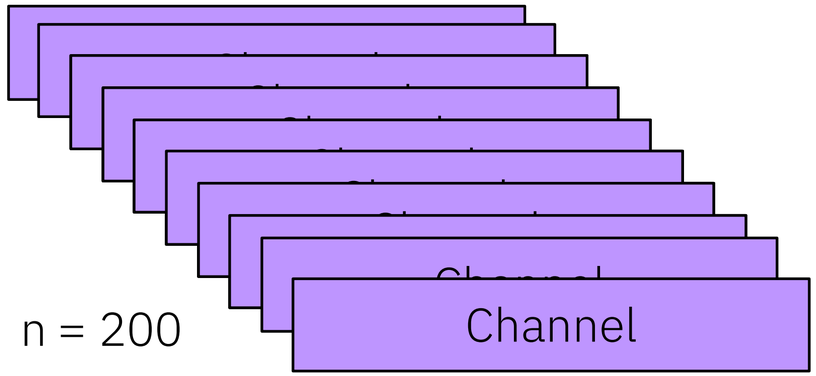
Total Wait Time for this Dispatcher Task

Maximum channels for this dispatcher task for Day

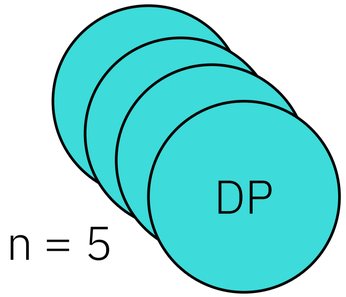
How dispatcher tasks are assigned to channels

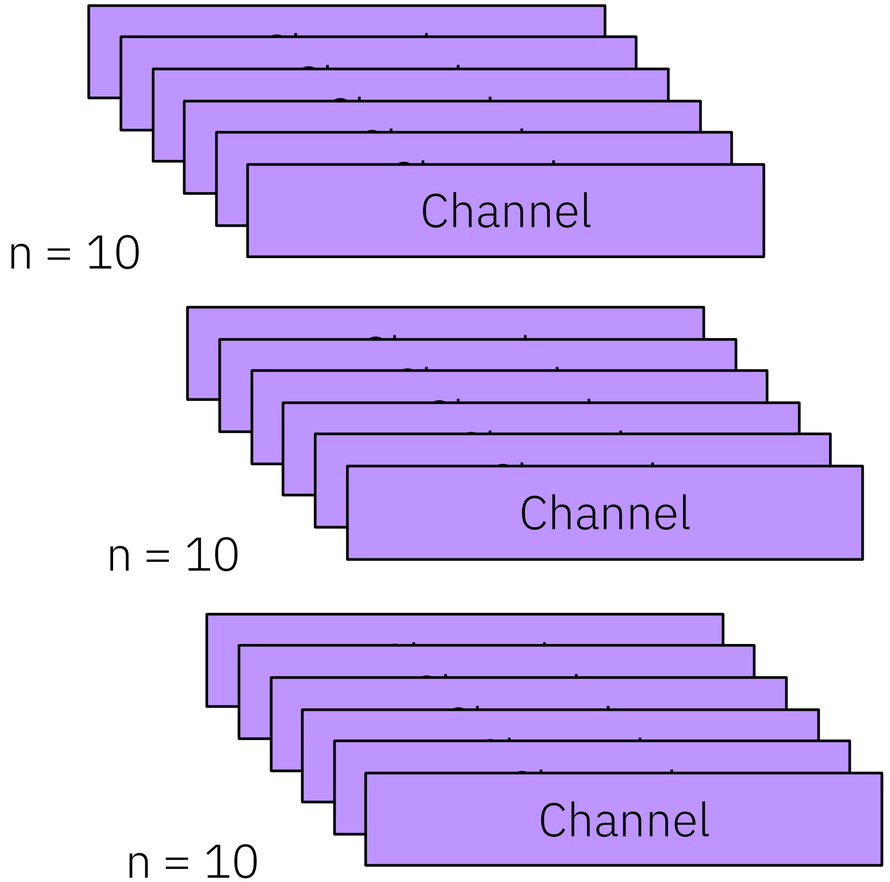
Scenario 1:
200 / 5 = 40 | 40 > 10 (from the rule of 10) | SO, 10 channels will be assigned to each dispatcher task

Active Channel Max of 200



Dispatcher Tasks allocated





How dispatcher tasks are assigned to channels

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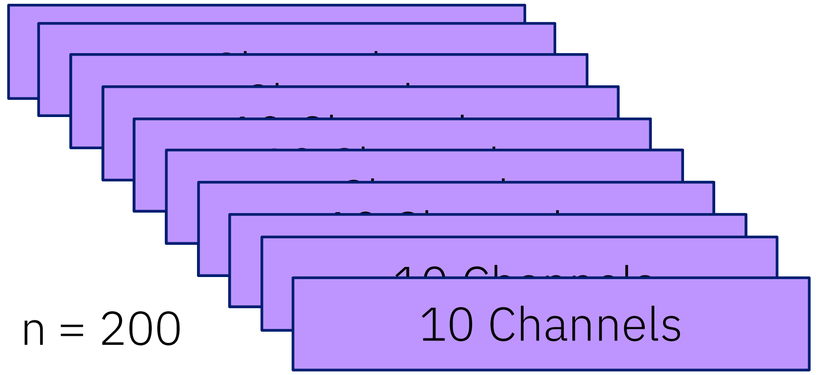
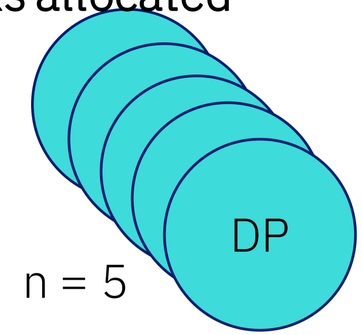


Dispatcher Tasks allocated



SMF statistics for shared queues

SMF-QEST.csv – Coupling Facility Statistics

"DATE"

, "TIME"

, "LPAR"

, "QMGR" , "MQ_VERSION"

, "INTERVAL_START_DATE"

"INTERVAL_START_TIME"

"INTERVAL_DURATION"

, "STRUCTURE_NAME"

, "STRUCTURE_NUMBER"

, "IXLLSTE_CALLS"

, "IXLLSTM_CALLS"

, "IXLLSTE_REDRIVES"

, "IXLLSTM_REDRIVES"

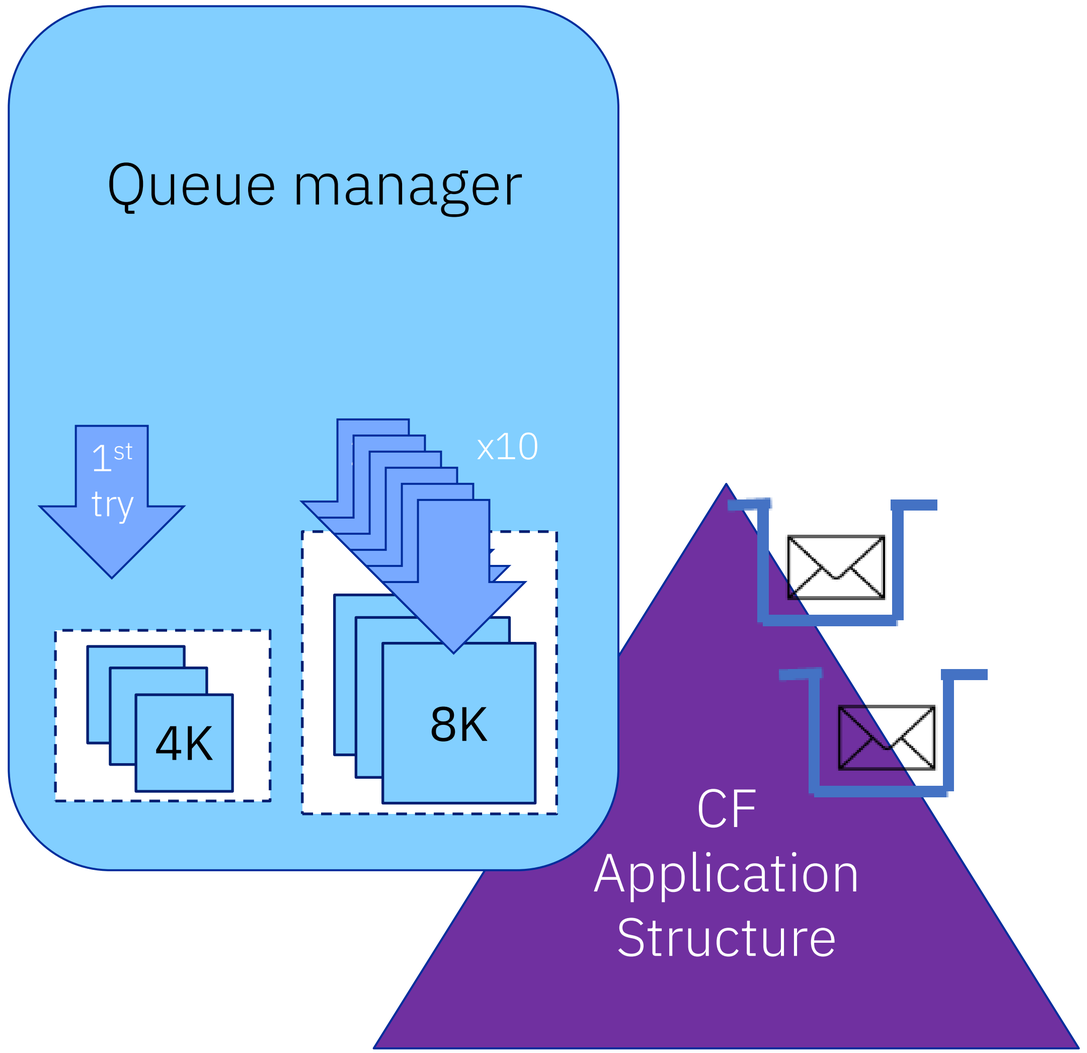
, "STRUCTURE_FULL"

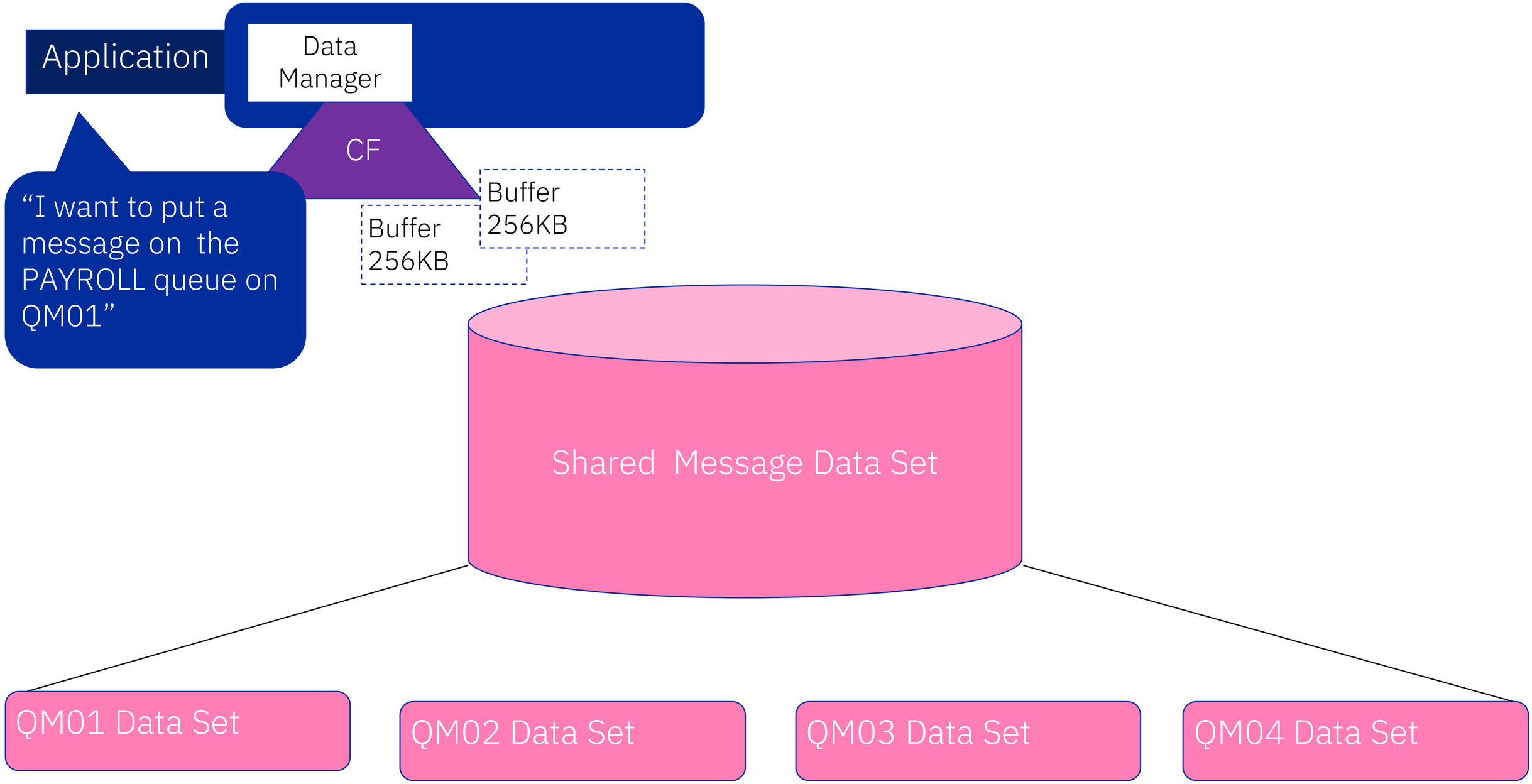
Single and multi-entry Redrives

Redrives, both single and multiple entry, are when the coupling facility detects that we need a larger buffer for returning a message.

Once queue manager gets the notification that it needs a larger buffer, it will use the buffer size necessary.

Using redrives allows for more flexibility in message sizes




Application
Data Manager
CF
Buffer 256KB
Buffer 256KB
“I want to put a message on the PAYROLL queue on QM01”
Shared Message Data Set
QM01 Data Set
QM02 Data Set
QM03 Data Set
QM04 Data Set

SMF 116 Accounting Data

SMF-QCST.csv – Channel Accounting

“QMGR”

"COLLECTION_TIME_DATE" DATE

, "COLLECTION_TIME_TIME" CHAR(19)

, "CHL_NAME"

, "DISPOSITION”

, "TYPE"

, "STATUS"

, "STAT_SETTING"

, "CONNECTION_NAME"

, "START_DATE" "

And more….

SMF-WTID.csv – Task ID Accounting

"DATE"
, "TIME"
, "LPAR"
, "QMGR"
, "MQ_VERSION"
, "WTAS_CORRELATOR"
, "APPL_TYPE"
, "CONNECTION_NAME"
, "OPERATOR_ID"
, "NID"
, "CORREL_HEX"
, "CORREL_CHAR"
, "UOW_ID"
, "ACCOUNTING_TOKEN"
, "CHANNEL_NAME"
, "CHANNEL_CONNECTION_NAME"
, "CONTEXT_TOKEN"
, "MVS_USERID"

SMF-WTAS.csv – Task Accounting

'QMgr','Correl',

'Longest_Latch',

'Max Latch Wait Microseconds',

'Max Latch Wait Type',

'Start Date’

'Start Time',

'QMgr’,

'Correl',

'Type 11 Latch Wait Time (Over 5000 mics.)',

'Type 11 Wait Count',

'Task Start Date’,

‘Task Start Time',

SMF-WQ.csv – Task Queue Accounting

Base Queue Name

Open Name

Bufferpool ID

Pageset ID

Coupling Facility Structure

Total Opens

Total Open Elapsed Time

Total Open CPU Time

Total Closes

Total Close Elapsed Time

Total Close CPU Time

Total MQGET Requests

Total MQGET Elapsed Time

Total MQGET CPU Time

Total Valid Gets

Total Get Bytes

Total Persistent MQGETs

Total Messages Skipped

Total Messages Expired

Total MQPUT Requests

Total MQPUT Elapsed Time

Total MQPUT CPU Time

Total MQPUT1 Requests

Total MQPUT1 Elapsed Time

Total MQPUT1 CPU Time

Total Valid MQPUTs

Total Bytes Put

Total Puts to Waiting Getter

Total Put1s to Waiting Getter

Total Generated Messages

Total Persistent MQPUTs

Total Persistent MQPUT1s

Max Depth on Queue

Max Time on Queue

Min Time on Queue

Total Inquiries

Total Sets

Get percent unfulfilled

Index Type

To recap...

SMF 115 data

SMF 115 for shared queues specifically

SMF 116 data

Concept check

What is a redrive?

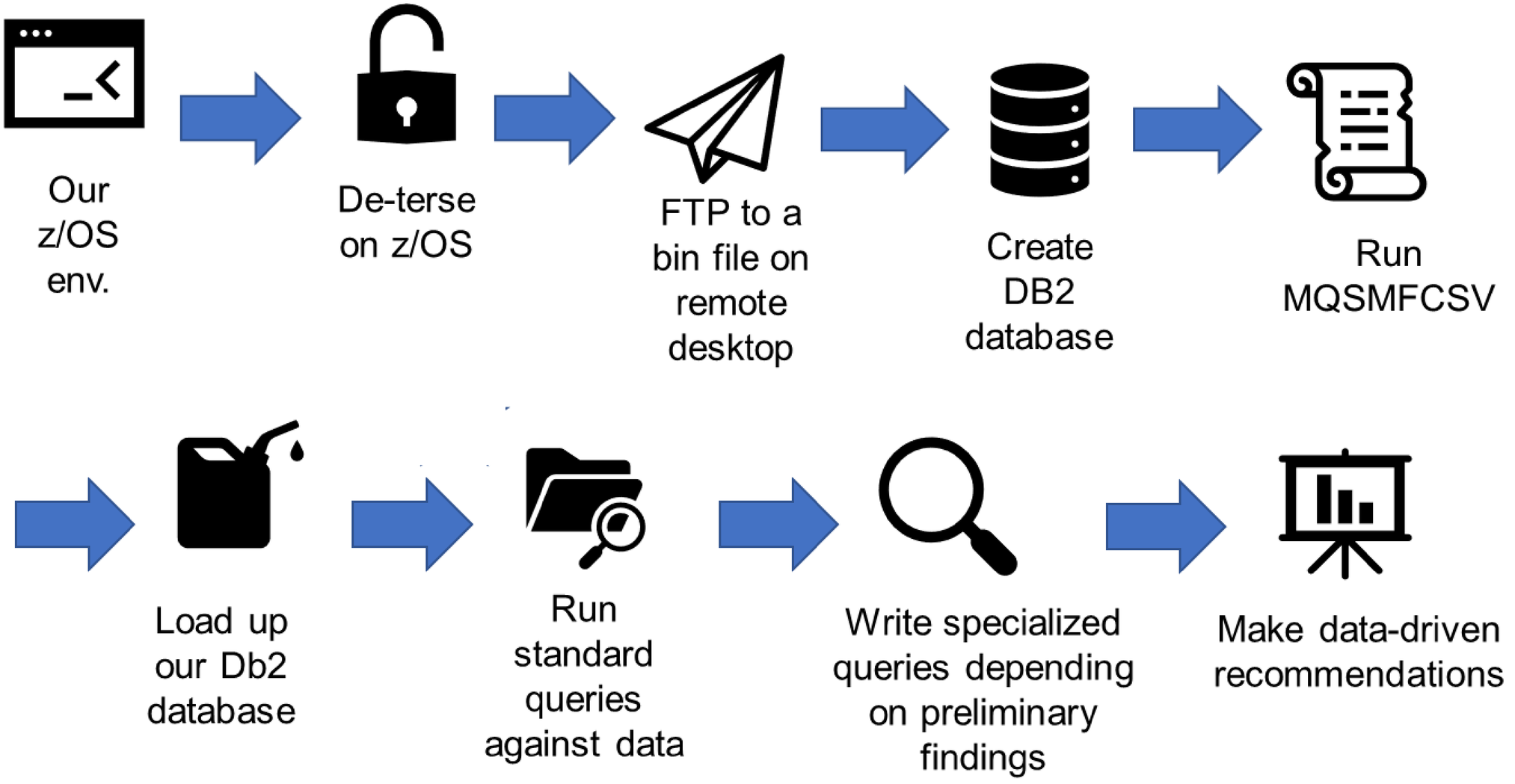
1) When you have to drive the same route twice
2) When the queue manager makes a call to the CF and the CF responds saying you need a larger buffer
3) When an adapter and dispatcher task interfere with one another

What is the difference between assignment for adapter and dispatcher tasks?

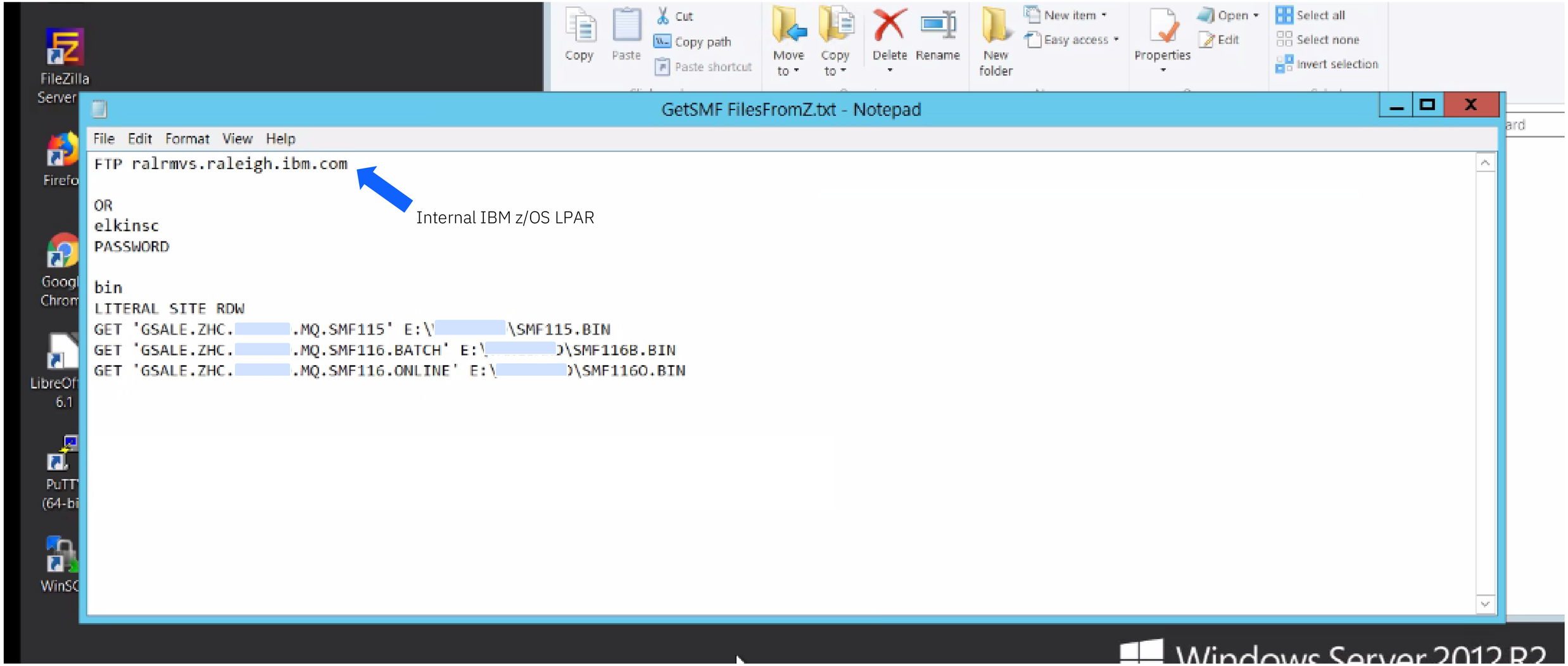
1) Dispatcher tasks are worker tasks for channel code to run on. Adapter task issue MQ API calls on behalf of channels
2) Dispatcher tasks connect the queue manager to the CHINIT address space. Adapter tasks connect the network to the CHINIT address space.
3) Adapter tasks can become more evenly distributed by reducing the MAXACTCHL.

Demonstration

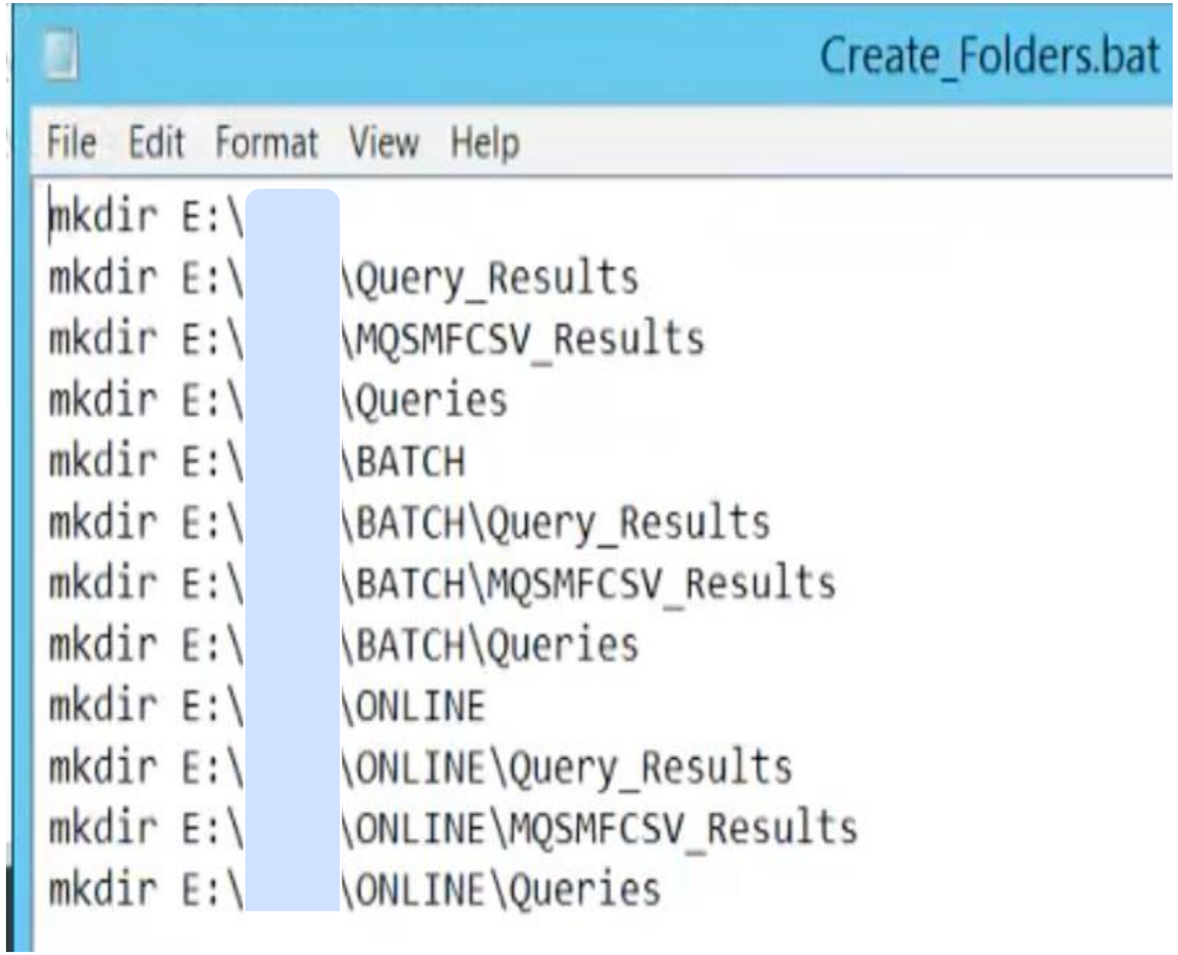
At a bird's eye



Pull data down from z/OS



Create file system



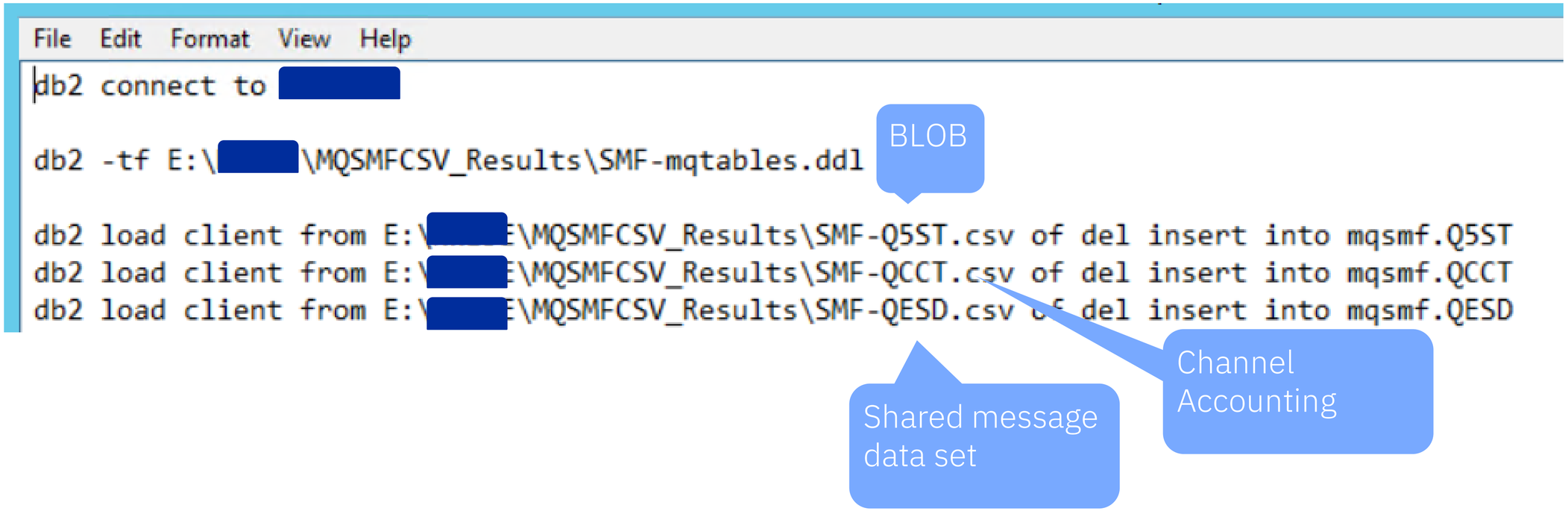
Create DB2 database(s)

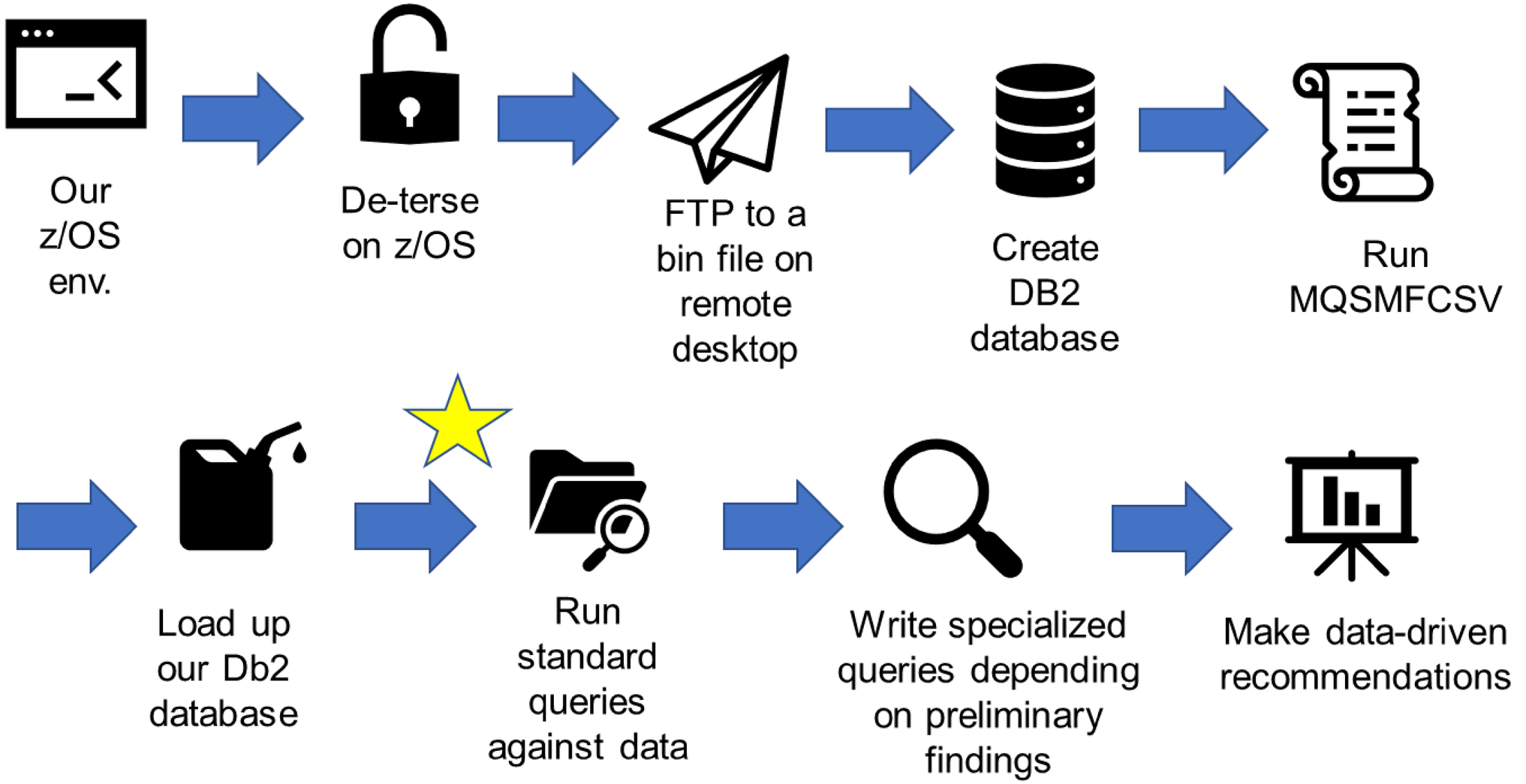
```
Db2 CREATE DATABASE XXXXXX AUTOMATIC STORAGE YES ON ‘E:\XXXXXX’
DBPATH ON ‘C:’ ;
```

Run MQSMFCSV

```
mqsmfcsv -f sql -i E:\customerdir\MQ115.bin  -o E:\customerdir\MQSMFCSV_Results
```

Load the database(s)

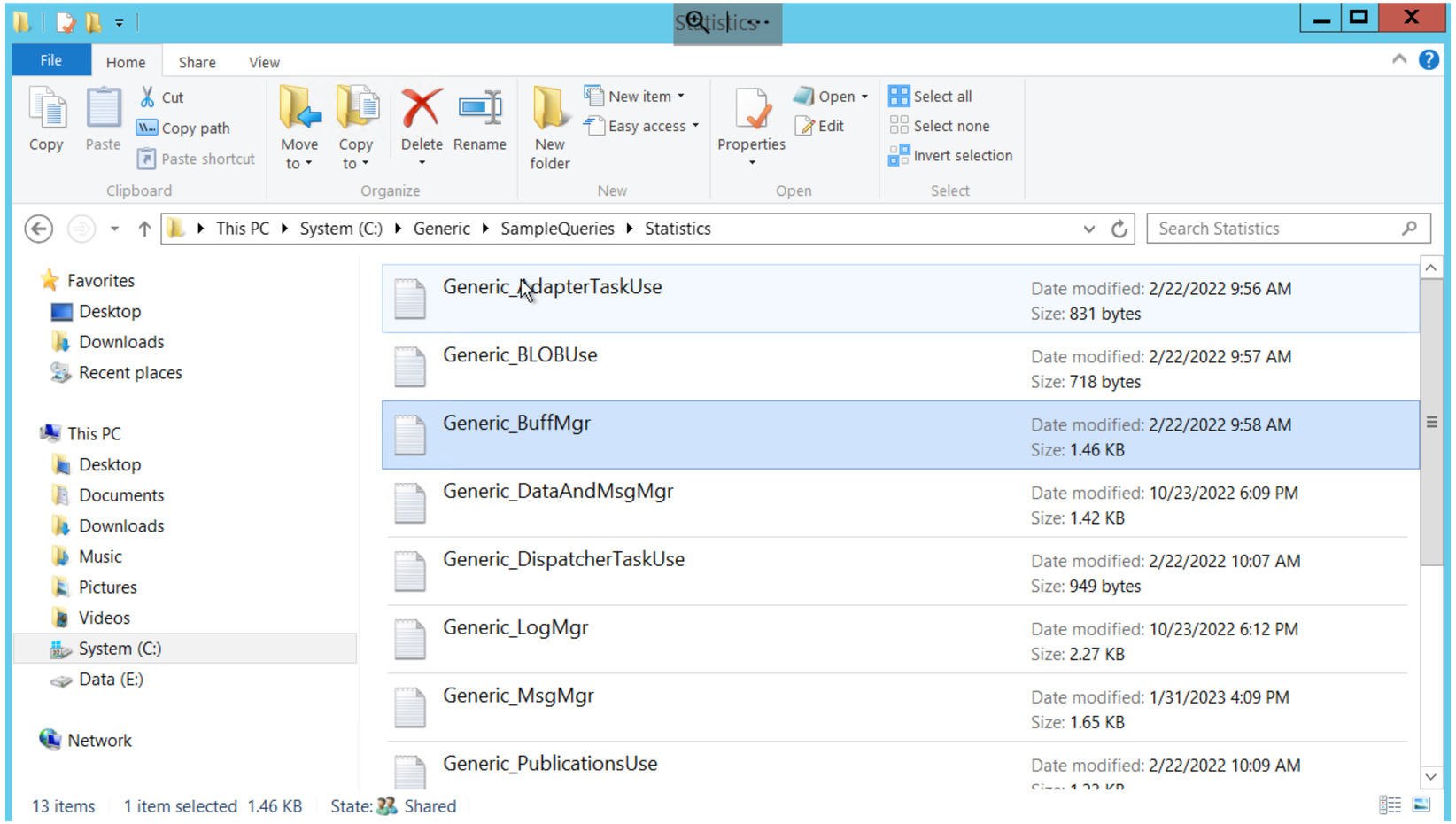



Our z/OS env.
De-terse on z/OS
FTP to a bin file on remote desktop
Create DB2 database
Run MQSMFCSV
Load up our Db2 database
Run standard queries against data
Write specialized queries depending on preliminary findings
Make data-driven recommendations

Check who is here

```
SELECT DISTINCT LPAR,
QMGR
FROM MQSMF.QMST (message manager)
 ORDER BY LPAR.
```

Customize some queries



Run the queries against the data

```
DB2 -TVF E:\      \Queries\      _AdapterTaskUse.txt
DB2 -TVF E:\      \Queries\      _BuffMgr.txt
DB2 -TVF E:\      \Queries\      _DataAndMsgMgr.txt
DB2 -TVF E:\      \Queries\      _DispatcherTaskUse.txt
DB2 -TVF E:\      \Queries\      _LogMgr.txt
DB2 -TVF E:\      \Queries\      _LongLatches.txt
DB2 -TVF E:\      \Queries\      _MsgMgr.txt
DB2 -TVF E:\      \Queries\      _OpenCloseCF.txt
DB2 -TVF E:\      \Queries\      _PublicationsUse.txt
DB2 -TVF E:\      \Queries\      _QueueSumm.txt
DB2 -TVF E:\      \Queries\      _SharedQueueSumm.txt
DB2 -TVF E:\      \Queries\      _Type11Latches.txt
DB2 -TVF E:\      \Queries\      _AdapterTaskUse.txt
DB2 -TVF E:\      \Queries\      _BuffMgr.txt
DB2 -TVF E:\      \Queries\      _DataAndMsgMgr.txt
DB2 -TVF E:\      \Queries\      _DispatcherTaskUse.txt
DB2 -TVF E:\      \Queries\      _LogMgr.txt
```

Good starting point scenarios

1. Check if buffer pools are highly utilized
2. If you see a highly utilized buffer pool, investigate which queues are most active for given buffer pool
3. Move queues to less busy buffer pool

1. Check for get difference on your data manager
2. Verify get difference is due to skipped messages
3. If get difference is negative, look at queue summary to identify which queues are busy and not indexed
4. Index queues

1. Check adapter task utilization
2. Check adapter tasks aren’t filled up due to scrolling
3. If adapter tasks are all full, allocate more adapter tasks within reason

Further reading and resources:

Understanding MQ SMF Data: MP1B MQSMF pdf

Capacity planning and tuning guide for IBM MQ on z/OS: MP16 pdf

https://github.com/ibm-wsc/mq-wildfire-mqv9zos/

MQ and SMF - How might I process the data? (ibm.com)

GitHub - ibm-messaging/mq-smf-csv: Simple formatter for MQ's SMF records to assist with import to spreadsheets and databases

Dorothy-Quincy/generic_smf (ibm.com)

Dorothy-Quincy/smf_chinit_task_interpretation (ibm.com)

Thank you!

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Dorothy.quincy@ibm.com