High Availability
with

IBM MQSeries Workflow

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Table of Content

Part I : High end solutions with IBM MQSeries Workflow

This document provides the necessary information for setting up a more complex environment for IBM MQSeries Workflow, hereafter referred to as MQ Workflow.

1. About this document

Information about an MQ Workflow installation in a complex environment including a summary of descriptions for the configuration elements are described in *Part II : Installation of complex MQ Workflow environment*

Detailed information on how to set up MQ Workflow in an High Availability environment are provided in *Part* III : High Availability with IBM MQSeries Workflow.

The appendix includes a section about transactional support of MQ Series and several sample console output of MQ Workflow.

2. Introduction

It is assumed that you have experience with MQ Workflow and its prerequisite products. Note that none of the mentioned default installations meets the requirements described in this document.

Before you start implementing any of the described high end solutions it is mandatory to read and understand the information in *Part II : Installation of complex MQ Workflow environment.*

For a list of the DB2 and MQSeries documentation, refer to the DB2 information center and to the MQSeries information center. The MQ Workflow documentation is available on the MQ Workflow documentation CD. For updates refer to the MQ Workflow homepage at http://www-4.ibm.com/software/ts/mqseries/workflow. on the MQ Workflow services page. For the related High Availability documentation refer to *Part III : High Availability with IBM MQSeries Workflow.*

The following describes the software requirements for the setup of the solutions described in this document.

- **Workflow** 3.3 MQSeries Workflow incl. CSD1

The required prerequisite software for MQ Workflow is DB2 and MQSeries. The minimum required version for these products are:

- **DB2** 7.2 Universal Database Enterprise Edition
- **MQSeries** 5.2 MQSeries Server incl. CSD 1

For establishing the high availability solution

- **On AIX:** **HACMP** 4.4 High Availability Cluster Multi-Processing
  Note: The version 4.3 can also be used but is not recommended.

- **On Solaris:** **SunCluster** 2.2 Sun Cluster Software
  DiskSuite 4.2 Solstice DiskSuite Tool

Part II : Installation of complex MQ Workflow environments

3. Introduction

This document is intended to be used in addition to the *Installation Guide for MQSeries Workflow*. The purpose is to introduce and describe the configuration of MQ Workflow in an high availability environment. The focus is on the server portion of MQ Workflow. In general, you can extend this information to other MQ Workflow installation types.

3.1. The MQ Workflow work sheet

The MQ Workflow work sheet helps you to record the various values that must be specified during establishing and configuring the MQ Workflow environment. In the column 'Default' you find the default value for each required parameter. In the column 'Configured' you can write down your specified configuration values. For reference purposes, the values that are mandatory for MQ Workflow are already inserted in the work sheet. The column 'Sample' gives you examples for those values that can be modified according to your own needs. The sample information that is provided in the appendix is based on these sample values. Note that special requirements, as 'enhanced security' or 'high availability' are not considered in this sample. You find a separate work sheet that is intended to be used, if you have special requirements.

The completed MQ Workflow work sheet should be used as reference for creating the MQ Workflow configuration. The predefined values in the column 'Configured' must be used.

Description	MQ Workflow configuration element values		
	Default	**Configured**	**Sample**
DB2 Instance name	db2inst1		**db2ex1**
DB2 Instance home directory	/home/db2inst1 ②		**/home/db2ex1** ②
MQSeries user ID	mqm	mqm	**mqm**
MQSeries working directory	/var/mqm		**/var/mqm**
MQ Workflow administrator	fmc		**fmcex1**
MQ Workflow configuration administrator	fmc		**fmcex1**
API and client execution user ID	fmc		**fmcex1**
Import and Export user ID	fmc		
MQ Workflow configuration root directory	/var/fmc		**/fmcex/config**
MQ Workflow configuration identifier	FMC		**FMCEX**
MQ Workflow configuration profile	fmcrc	fmcrc	**fmcrc**
MQ Workflow system group	FMCGRP		**EXGRP**
MQ Workflow system	FMCSYS		**EXSYS**
Database administrator	fmc		**fmcex1**
Database name	FMCDB		**FMCEXDB**
Database location	①		**/fmcex/dbs**
Database container location	①		**/fmcex/dbs/cont**
Database log location	①		**/fmcex/dbslog**
Database space management	s		**s**
MQ resources administrator	fmc		**fmcex1**
MQ Workflow MQ principal	fmc		**fmcex1**
Queue manager name	FMCQM		**FMCEXQM**
Queue manager location	/var/mqm/qmgrs		**/var/mqm/qmgrs**
Queue prefix	FMC		**FMCEX**
Channel definition table file	/var/fmc/chltabs/MQWFCHL.TAB		**/fmcex/config/chltabs/MQWFCHL.TAB**
TCP/IP address	<hostname>		**workflow**
TCP/IP port number	5010		**5055**
Queue manager log type	c		**c**
Queue manager log file location	-		**/var/mqm/log**
The Cluster name	FMCGRP		**EXCLU**
The repository type	f		**f**
The primary queue manager name	-		**-**
The primary TCP/IP address	-		**-**
The primary TCP/IP port number	-		**-**
The primary MQ principal	-		**-**

Reference ①: Using the default setting, all database parameters are stored in the same subdirectory. It is recommended that a different subdirectory is used for the database log files. The default location is: /var/fmc/rt_db/<db2inst1>/<databasename> , where the DB2 instance and the database name are derived from the values already specified.

②: For Sun Solaris the default DB2 Instance home directory is located in /export/home/db2inst1 (the sample is /export/home/db2ex1).

Part III : High Availability with IBM MQSeries Workflow

4. IBM MQSeries Workflow and HACMP

Before you start implementing an IBM MQSeries Workflow solution in an HACMP cluster, you should read the information in this section and follow the instructions.

4.1. Where to find information about planning, installing and customizing HACMP

To become familiar with HACMP, you can either attend a HACMP course, or read the HACMP documentation. In the following you find a list of documentation about HACMP for AIX, Version 4.4

Release Notes in **/usr/lpp/cluster/doc/release_notes**
describe hardware and software requirements

```
HACMP for AIX, Version 4.4: Concepts and Facilities,
      Order Number SC23-4276-02
HACMP for AIX, Version 4.4: Planning Guide,
      Order Number SC23-4277-02
HACMP for AIX, Version 4.4: Installation Guide,
      Order Number SC23-4278-02
HACMP for AIX, Version 4.4: Administration Guide,
      Order Number SC23-4279-02
HACMP for AIX, Version 4.4: Troubleshooting Guide,
      Order Number SC23-4280-02
HACMP for AIX, Version 4.4: Programming Locking Applications,
      Order Number SC23-4281-02
HACMP for AIX, Version 4.4: Programming Client Applications,
      Order Number SC23-4282-02
HACMP for AIX, Version 4.4: Master Index and Glossary,
      Order Number SC23-4285-02
HACMP for AIX, Version 4.4: Enhanced Scalability Installation
      and Administration Guide, Vol 1, Order Number SC23-4284-02
HACMP for AIX, Version 4.4: Enhanced Scalability Installation
      and Administration Guide, Vol 2, Order Number SC23-4306-01

IBM International Program License Agreement
      Order Number S29H-1286
```

Information about HACMP also is provided in redbooks. For information about redbooks, visit the IBM redbooks – Home Page (http://www.redbooks.ibm.com).

4.2. Understanding the overall concept

This document gives instructions on how to install and configure MQ Workflow in an HACMP cluster. Before you start setting up an MQ Workflow environment in an HACMP cluster, you should be familiar with the installation and configuration of MQ Workflow including its prerequisites DB/2 and MQSeries.

This document describes two different setups of MQ Workflow in an HACMP cluster.

- In the first setup, all server elements are installed on the same node (two-tier setup).
- In the second setup, the server elements are distributed. The database is installed on one node and the MQ Workflow system and its corresponding queue manager is installed on a different node (three-tier setup). In a multi system setup you have one database node and multiple MQ Workflow system nodes.

In an HACMP environment, a node runs an application server. If an HACMP application server node fails, another HACMP node automatically takes over the responsibility of the failing application server node. Each application server can contain one of the following MQ Workflow elements:

- A complete MQ Workflow setup (2-tier setup), which consists of a database server, a queue manager and an MQ Workflow system.
- A database server only.
- An MQ Workflow system combined with a queue manager.

Note: Each MQ Workflow system group contains exactly one database server and one or more MQ Workflow systems. Each MQ Workflow system belongs to exactly one MQ Workflow system group.

Note: In an HACMP cluster all defined resource elements must have unique names. This is also true for all elements building an MQ Workflow system, including the system group itself.

4.3. Steps for setting up a MQ Workflow – HACMP solution

It is important to do the installation and configuration steps incrementally. Each part must be verified, before you go on with the next installation or configuration part. Make sure that the hardware and the network work correctly, before you implement HACMP on the system. HACMP must be working before MQ Workflow is installed. Testing and verifying each step of the system setup helps you to pinpoint problems and handle errors.

The following sections describe how to set up an MQ Workflow – HACMP solution. The required steps are numbered continuously throughout the different sections. Perform the steps in the following sequence.

4.3.1. Hardware and software setup:

1. Set up the hardware used to run the cluster and install AIX. For a detailed description of the hardware requirements, refer to the corresponding documentation. Make sure you have at least two network connections on each node. In HACMP, a node identifies an MQ Workflow server. Establish a serial network between the two nodes. You can either use an RS232 Serial Line, or a Target Mode SCSI or SSA. If you connect external SSA of SCSI disks to the system, make sure that each node can attach the disks. Use the basic AIX utilities to verify your hardware setup.
   Note: Make sure that the problems reported by AIX are solved at this stage of the installation, because any unsolved problem can result in an unstable HACMP cluster, which also has an impact on the MQ Workflow system.
2. Before you start installing the HACMP software, it is important to follow the instructions given in the *HACMP Installation Guide (Chapter 7. Additional AIX Administrative Tasks).* Having

completed the installation of HACMP, it is highly recommended that you verify the cluster software as described in the *HACMP Installation Guide (Chapter 10. Verifying Cluster Software).*

4.3.2. Defining the cluster topology

3. Set up the network parameters as described in the *HACMP Planning Guide (Chapter 3. Planning TCP/IP Networks*). Configure the serial network as described in the *HACMP Planning Guide (Chapter 4. Planning Serial Networks*).
   Note: For MQ Workflow the hardware address swapping facility that works in tandem with IP address takeover is required. The hardware address swapping binds an IP address and a hardware address (sometimes referred as 'MAC address'). This eliminates the need to flush the ARP cache of clients after an IP address takeover.
   Note: Use **smitty chinet** to configure the network interfaces. Make sure that the services adapters on all nodes are in the same network. All standby adapters must be in the same subnet too, but it must be different from the one of the service adapters. Make sure that the files /etc/hosts and .rhosts on all involved nodes are correct. To ensure that the name resolution interprets the local /etc/hosts first, create the file /etc/netsvc.conf containing the line:
   ```
   Hosts=local,bind
   ```
   Perform a rlogin test across all network interfaces. This will ensure that you have set up your file .rhosts correctly.
4. Synchronize the cluster topology by using the SMIT-HACMP dialogs.
5. Verify the synchronization of the cluster by using the SMIT-HACMP dialogs.
6. Perform a first test to ensure that potential clients can access the server machines after an HACMP takeover and a reintegration of the node. A simple 'ping' test is sufficient at this time.
7. Save the current cluster configuration. You can do this by using the cluster snapshot utility, which saves the cluster configuration in a file. For more information about this utility, refer to the *HACMP Administration Guide (Chapter 11. Saving and Restoring Cluster Configurations)*.

4.3.3. Configuring the cluster resources

8. It is helpful to draw a sketch showing the key elements of your cluster, before you start configuring the cluster resources. The instructions given in the next sections are based on the following scenario. You have two complete independent MQ Workflow setups mapped to the HACMP cluster where one node is responsible to take over the resources of all the other nodes. This implies that only one node in the cluster should fail at the same time. Explicitly you can leave out one of the MQ Workflow setups to simplify things.

To describe all necessary information in the cluster, it is a helpful to fill out the MQ Workflow work sheet. The values provided in the following sample work sheet are described later.

Description	MQ Workflow configuration element values		
	Default	**Workflow A 2-tier setup**	**Workflow C 3-tier setup**
DB2 Instance name	db2inst1	**db2inst1**	**reminst2**
DB2 Instance home directory	/home/db2inst1	**/nda_home/db2inst1**	**/ndb_home/db2inst2**
MQSeries user ID	mqm	**mqm**	**mqm**
MQSeries working directory	/var/mqm	**/nda_mqm**	**/ndc_mqm**
MQ Workflow administrator	fmc	**fmcinst1**	**fmcinst3**
MQ Workflow configuration administrator	fmc	**fmcinst1**	**fmcinst3**
API and client execution user ID	fmc	**fmcinst1**	**fmcinst3**
Import and Export user ID	fmc	**fmcinst1**	**fmcinst3**
MQ Workflow configuration root directory	/var/fmc	**/nda_fmcroot**	**/ndc_fmcroot**
MQ Workflow configuration identifier	FMC	**FMCA**	**FMCC**
MQ Workflow configuration profile	fmcrc	**fmcrc**	**fmcrc**
MQ Workflow system group	FMCGRP	**FMCGRPA**	**FMCGRPC**
MQ Workflow system	FMCSYS	**FMCSYSA**	**FMCSYSC**
Database administrator	fmc	**fmcinst1**	**fmcinst3**
Database name	FMCDB	**FMCDBA**	**FMCDBB**
Database location	①	**/nda_fmcdbs**	**/ndb_fmcdbs**
Database container location	①	**/nda_fmcdbs**	**/ndb_fmcdbs**
Database log location	①	**/nda_fmcdbslo**	**/ndb_fmcdbslo**
Database space management	s	s	**s**
MQ resources administrator	fmc	**fmcinst1**	**fmcinst3**
MQ Workflow MQ principal	fmc	**fmcinst1**	**fmcinst3**
Queue manager name	FMCQM	**FMCQMA**	**FMCQMC**
Queue manager location	/var/mqm/qmgrs	**/nda_mqm/qmgrs**	**/ndc_mqm/qmgrs**
Queue prefix	FMC	**FMCA**	**FMCC**
Channel definition table file	/var/fmc/chltabs/MQWFCHL.TAB	**/nda_fmcroot/chltabs/FMCA.TAB**	**/ndc_fmcroot/chltabs/FMCC.TAB**
TCP/IP address ②	<hostname>	**9.164.160.211** ②	**9.164.160.213** ②
TCP/IP port number	5010	**5011**	**5031**
Queue manager log type	c	**c**	**c**
Queue manager log file location	-	**/nda_mqmlog**	**/ndc_mqmlog**
The Cluster name	FMCGRP	**FMCCLUA**	**FMCCLUC**
The repository type	f	**f**	**f**
The primary Queue manager name	-	-	-
The primary TCP/IP address	-	-	-
The primary TCP/IP port number	-	-	-
The primary MQ principal	-	-	-

Reference ①: Using the default setting, all database parameters are stored in the same subdirectory. It is recommended that a different subdirectory is used for the database log files.
The default location is: /var/fmc/rt_db/<db2inst1>/<databasename>, where the DB2 instance and the database name are derived from the values already specified..

②: In an HACMP environment, the TCP/IP address must be specified. In order to avoid problems, such as a wrong name resolution, it is highly recommended that you use the TCP/IP address instead of the hostname.

In the following tables you find additional information, which is not provided by the MQ Workflow work sheet for HACMP.

2-tier MQ Workflow setup		
	Resource Group A	
Description	MQ Workflow A	
Resource group	ResGroupA	
Primary node	Node A	
Secondary node (hot standby)	Node D	
Volume groups	Nodea_vg	
Logical volumes and file systems	--- see below ---	
Application servers	mqwfa	

3-tier MQ Workflow setup		
	Resource Group B	**Resource Group C**
Description	MQ Workflow B	MQ Workflow C
Resource groups	ResGroupB	ResGroupC
Primary node	Node B	Node C
Secondary node	Node D	Node D
Volume groups	nodeb_vg	nodec_vg
Logical volumes and file systems	--- see below ---	--- see below ---
Application servers	mqwfb	mqwfc

9. The node relationship should be cascading. The concurrent mode is not supported by MQ Workflow and the rotating mode is not recommended. In this document, it is assumed that you establish a cascading HACMP setup. Therefore, you do not find information about a rotating setup.
10. Plan the setup of the shared disk devices as described in the *HACMP Planning Guide (Chapter 5. Planning Shared Disk Devices*). For MQ Workflow, you need a shared volume group containing the MQ Workflow related logical volumes and file systems. Each volume group name must be unique within the cluster. The following tables show different sample setups of the related file systems needed by MQ Workflow. Plan to add all shared file systems for a resource group in one volume group. Note that some user home directories are placed on shared disks. All file systems must be created on previously defined logical volumes. The names for these logical volumes must be unique in the cluster. During the configuration of the volume groups, quorum checking is set to NO. The following tables show the necessary file system information for a simple 2-tier setup (in the first table) and a basic 3-tier setup (in the second and third table).

MQ Workflow A (2-tier setup)			
Logical volume	**File system and mount point**	**Purpose**	**Default file system and mount point**
lvnda_dbs	/nda_fmcdbs /nda_fmcdbs	MQ Workflow database	/var /var/fmc/rt_db
lvnda_dbslog	/nda_fmcdbslo /nda_fmcdbslo	MQ Workflow database log	/var /var/fmc/rt_db
lvnda_root	/nda_fmcroot /nda_fmcroot	MQ Workflow configuration root directory	/var /var/fmc
lvnda_home	/nda_home /nda_home/fmcinst1	MQ Workflow configuration administrator home directory	/home /home/fmc
lvnda_home	/nda_home /nda_home/db2inst1	DB2 instance home directory	/home /home/db2inst1
lvnda_mqm	/nda_mqm /nda_mqm/qmgrs	Queue manager	/var/mqm /var/mqm/qmgrs
lvnda_mqmlog	/nda_mqmlog /nda_mqmlog	Queue manager logs	/var/mqm /var/mqm/log
lvnda_trace	/nda_fmctrace /nda_fmctrace	MQ Workflow traces	 Current directory
lvnda_custom	/nda_custom /nda_custom	Customer tools	

Note: As a minimum, you have two machines within a 3-tier setup, one for the database and one for the MQ Workflow system. For a multiple system setup, you can replicate the third table containing the MQ Workflow system setup.

MQ Workflow B (3-tier setup – database)			
Logical volume	**File system and mount point**	**Purpose**	**Default file system and mount point**
lvndb_dbs	/ndb_fmcdbs /ndb_fmcdbs	MQ Workflow database	/var /var/fmc/rt_db
lvndb_dbslog	/ndb_fmcdbslo /ndb_fmcdbslo	MQ Workflow database log	/var /var/fmc/rt_db
lvndb_home	/ndb_home /ndb_home/db2inst2	DB2 instance home directory	/home /home/db2inst1
lvndb_custom	/ndb_custom /ndb_custom	Customer tools	

MQ Workflow C (3-tier setup – MQ Workflow system)			
Logical volume	**File system and Mount point**	**Purpose**	**Default file system and mount point**
lvndc_root	/ndc_fmcroot /ndc_fmcroot	MQ Workflow configuration root directory	/var /var/fmc
lvndc_home	/ndc_home /ndc_home/fmcinst3	MQ Workflow configuration administrator home directory	/home /home/fmc
lvndc_home	/ndc_home /ndc_home/db2inst3	DB2 instance home directory	/home /home/db2inst1
lvndc_mqm	/ndc_mqm /ndc_mqm/qmgrs	Queue manager	/var/mqm /var/mqm/qmgrs
lvndc_mqmlog	/ndc_mqmlog /ndc_mqmlog	Queue manager logs	/var/mqm /var/mqm/log
lvndc_trace	/ndc_fmctrace /ndc_fmctrace	MQ Workflow traces	 Current directory
lvndc_custom	/ndc_custom /ndc_custom	Customer tools	

11. Ensure that the home directories on the shared disks have the necessary access rights and directory ownerships. In the following you find examples for the necessary commands. You must adapt the values according to your setup. These commands must also be performed on the node that is responsible for a takeover.

    Run the following commands on node A:

Example for MQ Workflow A (2-tier setup)
`chown bin:bin /nda_home` `chmod 755 /nda_home`

    Run the following commands on node B:

Example for MQ Workflow B (3-tier setup – database)
`chown bin:bin /ndb_home` `chmod 755 /ndb_home`

    Run the following commands on node C:

Example for MQ Workflow C (3-tier setup – MQ Workflow system)
`chown bin:bin /ndc_home` `chmod 755 /ndc_home`

    Note: Make sure that the mount points on the nodes have the appropriate access rights.

12. Create the users and groups that are necessary for the MQ Workflow setup. The users and groups must have identical IDs on both the primary and the secondary node. The home directory for the DB2 instance owner and the MQ Workflow configuration administrator must be located on a shared disk. You can use different names for the home directories, or the subdirectories, but make sure that the home directories are located on a shared disk.

Groups ①	**MQ Workflow A**	**MQ Workflow B**	**MQ Workflow C**
DB2 administrator group	db2iadm1	db2iadm2	db2iadm3
MQSeries group	mqm	mqm	mqm
MQ Workflow group	fmcgrp	fmcgrp	fmcgrp

Users ②	**MQ Workflow A (2-tier setup)**			
	Name	Group assignments		Home directory
		Primary	Secondary	
DB2 instance user	db2inst1	db2iadm1		/nda_home/db2inst1
MQSeries user	mqm	mqm		/home/mqm
MQ Workflow configuration administrator	fmcinst1	fmcgrp	mqm, db2iadm1	/nda_home/fmcinst1
Notes: Additional groups can be set according to your own needs.				

Users ③	**MQ Workflow B (3-tier setup – database)**			
	Name	Group assignments		Home directory
		Primary	Secondary	
DB2 instance user	db2inst2	db2iadm2		/ndb_home/db2inst2
Notes: Additional groups can be set according to your own needs.				

Users ④	MQ Workflow C (3-tier setup – MQ Workflow system)			
	Name	Group assignments		Home directory
		Primary	Secondary	
DB2 instance user	db2inst3	db2iadm3		/ndc_home/db2inst3
MQSeries user	mqm	mqm		/home/mqm
MQ Workflow configuration administrator	fmcinst3	fmcgrp	mqm, db2iadm3	/ndc_home/db2inst3
Notes: Additional groups can be set according to your own needs.				

Notes: On each node, set the passwords for all user IDs that exist on the node. Otherwise you might run into problems.

① It is recommended that all groups are created on all nodes, even if they are not used.
② It is not necessary to create all users on all nodes, but for transparency it is recommended.
③ On the node containing only the database no MQ Workflow or MQSeries elements are required.
④ On nodes without a database, a DB2 instance is required to get access to the remote database.

13. Certain steps must be performed to ensure that the necessary access rights and directory ownerships are provided. In the following you find examples for the necessary commands. You must adapt the values according to your setup. These commands must also be performed on the node that is responsible for a takeover.

    Run the following commands on node A:

Example for MQ Workflow A (2-tier setup)

```
chown fmcinst1:fmcgrp /nda_fmc*
chmod 770 /nda_fmc*
chown fmcinst1:db2iadm1 /nda_fmcdbs*
chmod 770 /nda_fmcdbs*
chown -R mqm:mqm /nda_mqm*
chmod –R 770 /nda_mqm*
```

    Run the following commands on node B:

Example for MQ Workflow B (3-tier setup – database)

```
chown db2inst2:db2iadm2 /ndb_fmc*
chmod 770 /ndb_fmc*
```

    Run the following commands on node C:

Example for MQ Workflow C (3-tier setup – MQ Workflow system)

```
chown fmcinst3:fmcgrp /ndc_fmc*
chmod 770 /ndc_fmc*
chown -R mqm:mqm /ndc_mqm*
chmod –R 770 /ndc_mqm*
```

    Note: Make sure that the mount points on the nodes have the appropriate access rights.

14. Synchronize the cluster resources by using the SMIT-HACMP dialogs.
15. Verify the synchronization of the cluster by using the SMIT-HACMP dialogs.
16. Test, if the cluster nodes are working properly by performing a takeover and a rejoin of a node.

17. Save the current cluster configuration. You can do this by using the cluster snapshot utility, which saves the cluster configuration in a file. For more information on this utility, refer to the *HACMP Administration Guide*.
18. After you have successfully tested the resource groups, keep the cluster active. If a special constellation of the cluster software is required to perform the described steps successfully, you find adequate instructions in this document.

4.3.4. Installing DB2, MQSeries and MQ Workflow

19. Now install the prerequisite software DB2, MQSeries and MQ Workflow on all related nodes. Make sure that all nodes within a resource group have the same software installed. Different software is required for the different node types. Before you install the software, consider the following:

    - A dedicated database node requires only DB2 EE
    - On a "2-tier setup" node all products must be installed.
    - On a dedicated MQ Workflow system it is sufficient to install the CAE portion of DB2
    - In an HACMP environment, it is recommended that the DB2 EE is installed on the MQ Workflow system nodes.

    For details about the installation, refer to the corresponding installation guides and read the latest updates of the readme files for the products to be installed.

    Note: Only use installp to install the licensed software products. Installp can be invoked via smit dialogs. Make sure that you have entered the correct DB2 license key on all nodes. Any mentioned configuration steps are performed later.

4.3.5. Configuring DB2

This section describes how to configure DB2 for MQ Workflow. You find additional information in the *IBM DB2 Universal Database for Unix Quick Beginnings (Chapter21: Other Methods to Install DB2 for AIX).* According to the chosen MQ Workflow setup, not all steps must be performed on all nodes. The following table summarizes the steps to be performed on a primary node in a HACMP resource group. The node planned to be responsible for a takeover must be equally configured as its correspondent primary node.

Overview of the necessary DB2 configuration steps for MQ Workflow				
			MQ Workflow 3-tier setup	
Step	**Short description**	**MQ Workflow 2-tier setup**	**Database**	**MQ Workflow system**
20	Create DB2 links	Recommended	Recommended	Recommended
21	Add service entries	Optional	Mandatory	No
22	Create DB2 instance	Mandatory	Mandatory	Mandatory
23	Update DB2 master catalog on the hot-standby system	No	No	No
24	Configure DB2 instance	Mandatory	Mandatory	No
25	Add DB2 registry value	Optional	Mandatory	No
26	Catalog remote tcpip node	No	No	Mandatory
27	Create start and stop scripts	Mandatory	Mandatory	Mandatory
28	Synchronize cluster resources	Mandatory	Mandatory	Mandatory
29	Retest the cluster	Mandatory	Mandatory	Mandatory
30	Keep the cluster alive	Mandatory	Mandatory	Mandatory

20. Create the links for the DB2 files. If you do this, you need not specify the full path to the product libraries and include files. For more information refer to *IBM DB2 Universal Database for Unix Quick Beginnings (Chapter21: Other Methods to Install DB2 for AIX – Step 5).*

Command to be performed on all nodes:
`/usr/lpp/db2_07_01/cfg/db2ln`

21. Create the entries for the DB2 service names in /etc/services. Make sure that all involved nodes are using the unique ports of the correspondent service names. In an HACMP environment, you can add all entries on all nodes. This can help to avoid communication problems.

    Run the following commands on node A:

Example for MQ Workflow A (2-tier setup)
`chservices -a -v db2cdb2inst1 -p tcp –n 50010` `chservices -a -v db2idb2inst1 -p tcp –n 50011`

    Run the following commands on node B:

Example for MQ Workflow B (3-tier setup – database)
`chservices -a -v db2cdb2inst2 -p tcp –n 50020` `chservices -a -v db2idb2inst2 -p tcp –n 50021`

    No action is required on node C.

    Run the following commands on node S:

Example for the hot standby system

`chservices -a -v db2cdb2inst1 -p tcp –n 50010`
`chservices -a -v db2idb2inst1 -p tcp –n 50011`
`chservices -a -v db2cdb2inst2 -p tcp –n 50020`
`chservices -a -v db2idb2inst2 -p tcp –n 50021`

22. Create the DB2 instances as described in the *IBM DB2 Universal Database for Unix Quick Beginnings (Chapter21: Other Methods to Install DB2 for AIX – Step 3).*

    Run the following commands on node A:

Example for MQ Workflow A (2-tier setup)
`/usr/lpp/db2_07_01/instance/db2icrt -u db2inst1 db2inst1`

    Run the following commands on node B:

Example for MQ Workflow B (3-tier setup – database)
`/usr/lpp/db2_07_01/instance/db2icrt -u db2inst2 db2inst2`

    Run the following commands on node C:

Example for MQ Workflow C (3-tier setup – MQ Workflow system)
`/usr/lpp/db2_07_01/instance/db2icrt -u db2inst3 db2inst3`

23. The DB2 instance master catalog information is stored in /var/db2/v71/profiles.reg . The content of this file is managed by DB2 whenever you create or drop a DB2 instance with the correspondent DB2 commands.

    Since on the hot-standby system these DB2 commands are not executed the entries in the DB2 instance master catalog are not present. For some specific tasks like remote administration these entries are required. For normal operation as required by MQSeries Workflow this information is not required.

    For providing this information on the hot-standby system a simple way is to create the information with an editor in /var/db2/v71/profiles.reg. If you chose this way include all DB2 instances from all involved nodes in this file.

    Alternately you can use NFS methods for the directory /var/db2/v71.

24. After you have created the instances successfully, certain configuration steps must be performed for each instance.
    - Update the database manager configuration to use the correct service name. On an MQ Workflow system this update is not necessary. On a CAE installation it is not possible.
    - Assign the communication protocol to be used by the instance.
    - Do not configure the instance to start automatically after a system restart. The start of the instance must be handled by HACMP.

    Run the following commands on node A:

Example for MQ Workflow A (2-tier setup)
`su – db2inst1 -c 'db2 update dbm cfg using svcename db2cdb2inst1'` `su – db2inst1 -c 'db2set -i db2inst1 db2comm=tcpip'`

    Run the following commands on node B:

Example for MQ Workflow B (3-tier setup – database)
`su – db2inst2 -c 'db2 update dbm cfg using svcename db2cdb2inst2'` `su – db2inst2 -c 'db2set -i db2inst2 db2comm=tcpip'`

    No action is required on node C.

25. The environment variable DB2_RR_TO_RS must be set to YES for MQ Workflow. For a 2-tier-setup it is set automatically during configuration. For a 3-tier-setup either add a correspondent DB2 registry entry (recommended) or alternately add a correspondent export statement in *<db2home>/sqllib/db2profile.*

    No action is required on node A.

    Run the following commands on node B:

Example for MQ Workflow B (3-tier setup – database)
`su – db2inst2 -c 'db2set -i db2inst2 DB2_RR_TO_RS=YES'`

    No action is required on node C.

26. In an MQ Workflow 3-tier setup the MQ Workflow system must have access to the DB2 instance that hosts the MQ Workflow database. Therefore you need to catalog a TCP/IP node. To be able to do this, first start the remote DB2 instance.

Example for MQ Workflow B (3-tier setup – database)
`su – db2inst2 -c 'db2start'`

The following commands must be performed on node C under control of the DB2 instance user (db2inst3). All lines starting with a # are comments and should help to understand the commands.

Example for MQ Workflow C (3-tier setup – MQ Workflow system)

`# All bold values are derived from the samples chosen above`
`# Start the DB2 instance`
`db2start`
`# Catalog the remote instance. This is mandatory for the MQ Workflow`
`# system. Different types of this command are possible. Details can be`
`# found in the DB2 documentation.`
`# <IP-address> must be replaced by your IP-address of node B`
`db2 catalog tcpip node` **`reminst2`** `remote <IP-address> server` **`50020`** `  \`
`  remote_instance` **`db2inst2`**
`# To test the communication use the attach command`
`db2 attach to` **`reminst2`** `user` **`db2inst2`** `using <password>`
`# To reset the attachment use the detach command`
`db2 detach`

27. You can now create a script that starts and stops the DB2 instance and integrate it in the HACMP resources. To do this, define an application server and configure the resource group. Details about this can be found in the *HACMP Installation Guide (Chapter 12: Configuring Cluster Resources)*.

    Note: The only command in the script is either db2start or db2stop. You can add return code handling, too.
28. Stop the cluster software and synchronize the cluster resources again by using the SMIT-HACMP dialogs.
29. Test again that the cluster nodes are working properly by taking over and rejoining a node. Verify that the DB2 instances are started correctly and can be accessed from outside the cluster.
30. After you have successfully tested the resource groups including starting and stopping the DB2 instances, keep the cluster active. It is essential for the following steps that the DB2 instances are active.

4.3.6. Configuring MQSeries

This section describes the necessary configuration steps for MQSeries. The queue managers used by MQWorkflow are created by the MQWorkflow utilities.

31. Create a default queue manager on each node. This includes any hot standby nodes. This queue manager is not a member of any resource group and need not be active at any time. Note that any queue manager that is a member of a resource group cannot be used as a default queue manager.

Command to be performed on all nodes having queue managers:
`su – mqm –c 'crtmqm –q FMCDEFQM'`

Notes: You can choose your own name for the default queue manager (the sample queue manager name is *FMCDEFQM*). It is not necessary to create a queue manager on a dedicated database node.

4.3.7. Configuring MQ Workflow

This section describes the configuration steps for MQ Workflow. On a dedicated database node no MQ Workflow configuration is required. As opposed to the DB2 configuration, MQ Workflow requires a special configuration handling for those nodes that are responsible for a takeover. In the following, you find all configuration steps that are necessary for setting up an MQ Workflow system. It is assumed that one dedicated hot standby node is present in the cluster, hereafter referred to as *node S*. Node S is responsible for taking over all nodes. If more hot standby nodes are available, you can reuse the instructions for node S for the other hot standby nodes. The MQ Workflow configuration consists of two stages. During the first stage (see steps 31 – 33), a node is enabled to handle an MQ Workflow configuration. These configuration steps must be performed once. During the second stage, all steps that are necessary to configure an MQ Workflow configuration must be performed. These steps must be repeated for every new MQ Workflow configuration, with different values.

4.3.7.1. Configuring the MQ Workflow environment

32. Configure the MQ Workflow configuration administrator user. Make sure that the DB2 environment is activated for this user. You can do this by adding a statement in the `.profile` file.

    On node A, add the following statement to /nda_home/fmcinst1/.profile

    Example for MQ Workflow A (2-tier setup)

    ```
    . /nda_home/db2inst1/sqllib/db2profile
    ```

    On node C, add the following statement to /ndc_home/fmcinst3/.profile

    Example for MQ Workflow C (3-tier setup – MQ Workflow system)

    ```
    . /ndc_home/db2inst3/sqllib/db2profile
    ```

    Note: If you want to use an additional MQ Workflow configuration administrator, repeat this step before configuring an MQ Workflow configuration.

33. Set the MQ Workflow environment and the configuration root directory on all nodes involved. If a node is intended to hold more than one MQ Workflow configuration with different MQ Workflow configuration administrator user ID, use the first one as MQ Workflow configuration owner. If the hot standby node is intended to be responsible for additional MQ Workflow configurations those MQ Workflow environment must be used. Otherwise create an MQ Workflow environment as shown in the example. Ensure that the names for the MQ Workflow configuration root directory are unique on all nodes.

    Run the following commands on node A:

    Example for MQ Workflow A (2-tier setup)

    ```
    fmczinsx –o env –c /nda_fmcroot –U fmcinst1
    ```

    Run the following commands on node C:

    Example for MQ Workflow C (3-tier setup – MQ Workflow system)

    ```
    fmczinsx –o env –c /ndc_fmcroot –U fmcinst3
    ```

Run the following commands on node S:

Example for the hot standby system
`fmczinsx –o env –c /var/fmc –U fmcinst1`

34. Now define the MQ Workflow Runtime database type.

    Run the following commands on node A:

Example for MQ Workflow A (2-tier setup)
`fmczinsx –o db2`

    Run the following commands on node C:

Example for MQ Workflow C (3-tier setup – MQ Workflow system)
`fmczinsx –o db2`

    Run the following commands on node S:

Example for the hot standby system
`fmczinsx –o db2`

35. Now define the necessary MQ Workflow infrastructure.

    Run the following commands on node A:

Example for MQ Workflow A (2-tier setup)
`fmczinsx –o inf`

    Run the following commands on node C:

Example for MQ Workflow C (3-tier setup – MQ Workflow system)
`fmczinsx –o inf`

    Run the following commands on node S:

Example for the hot standby system
`fmczinsx –o inf`

36. Now define the MQ Workflow connection type.

    Run the following commands on node A:

Example for MQ Workflow A (2-tier setup)
`fmczinsx –o mqserver`

    Run the following commands on node C:

Example for MQ Workflow C (3-tier setup – MQ Workflow system)
`fmczinsx –o mqserver`

    Run the following commands on node S:

Example for the hot standby system
`fmczinsx –o mqserver`

37. If the hot standby node is intended to be responsible for additional MQ Workflow configurations the profile containing a default configuration identifier will be created during creating the first MQ Workflow configuration. Only if no dedicated MQ Workflow configuration is established on the hot standby node, you have to create this profile manually. Do this by copying the profile from, for example, node A as shown in the following example.

Example for the hot standby system
`rcp nodea:/nda_fmcroot/fmcrc /var/fmc/fmcrc`

4.3.7.2. Configuring an MQ Workflow Configuration

38. To ensure that the MQ Workflow configurations fit into the HACMP environment, you must define unique names for the MQ Workflow databases and the queue managers that are used for the different MQ Workflow systems. The following table shows all values needed for an MQ Workflow configuration. The values are provided in the same order as required when running the utility *fmczutil*. This utility prompts you to enter all necessary values and must be performed in two phases. The first is the **definition phase** and must be performed while logged on as root user. The second is the **creation phase** and can be performed either by the MQ Workflow configuration administrator or the root user. At the end of the definition phase the utility *fmczutil* asks if the database and the queue manager should be created now. If the root user starts the creation phase, which is recommended in an HACMP environment, the environment variable MQSPREFIX must be specified before the utility *fmczutil* is started. During the second phase, the MQ Workflow database and the queue manager are created. The parameters in the following table are derived from the assumptions and definitions made above.

MQ Workflow configuration elements for fmczutil			
	Workflow A	**Workflow C**	**Default**
Configuration identifier	FMCA	FMCC	FMC
Configuration administrator	fmcinst1	fmcinst3	fmc
Select Category Menu:	s	s	①
Configure runtime database	n	n	②
Local vs. remote database	l	r	②
DB2 instance	db2inst1	db2inst3	Db2inst1
Remote DB2 instance	-	reminst2	-
DB2 database	FMCDBA	FMCDBB	FMCDB
DB2 user ID of database admin	fmcinst1	fmcinst3	Fmc
DB2 database layout file	③	③	③
DB2 database location	/nda_fmcdbs	/ndb_fmcdbs	④
DB2 container location	/nda_fmcdbs/cont	/ndb_fmcdbs/cont	④
DB2 log files location	/nda_fmcdbslo	/ndb_fmcdbslo	④
Select space management	s	s	⑤
DB2 user ID to access database	fmcinst1	fmcinst3	Fmc
System group name	FMCGRPA	FMCGRPB	FMCGRP
System name	FMCSYSA	FMCSYSC	FMCSYS
Queue manager name	FMCQMA	FMCQMC	FMCQM
Queue prefix	FMCA	FMCC	FMC
Select log type	c	c	⑥
Log files location	/nda_mqmlog	/ndc_mqmlog	⑦
Channel definition table file	/nda_fmcroot/chltabs/FMCA.TAB	/ndc_fmcroot/chltabs/FMCC.TAB	⑧
TCP/IP address	9.164.160.211	9.164.160.213	<hostname>
TCP/IP port number	5011	5031	5010
Principal name	fmcinst1	fmcinst3	Fmc
Cluster name	FMCCLUA	FMCCLUC	FMCGRP
Select repository type	f	f	⑨
Transaction coordinator userid	fmcinst1	fmcinst3	Fmc
Queue manager starter	t	t	⑩

Notes:

①	On the Select Category Menu you can choose which MQ Workflow components you want to configure for the current configuration.
②	Specify **n** to Create a new Runtime database. The option **u** (Use an existing Runtime database) must be specified for additional MQ Workflow systems in a multiple system setup. The use of a remote database requires the database to be catalogued first. In addition to the local DB2 instance you will be asked for the remote DB2 instance where the remote database is catalogued.
③	The database layout file can be used to specify dedicated database container locations. The default is /var/fmc/cfgs/FMC/fmcdblay.ini and can be different according to your definitions.
④	The built-in default is /var/fmc/rt_db/db2inst1/FMCDB . According to your definitions, the default changes, for example, for Workflow Sec /fmcsec/config/rt_db/db2sec1/FMCDBS
⑤	One of the DB2 space management methods must be specified.
⑥	You have to select one of the available log types for the queue manager.
⑦	No default is shown for the location of the queue manager log files. The built-in default is /var/mqm/log .
⑧	The built-in default is /var/fmc/chltabs/MQWFCHL.TAB
⑨	Specify **f** to make the queue manager the first within the MQ cluster. ⑩
⑩	In a default setup the configuration administrator is the starter of the queue manager and the transaction coordinator. In a secure setup, you might want to use a dedicated transaction coordination user ID. In this case, a different user ID in the group mqm must start the queue manager.

39. Based on the definitions made in the previous steps, run the MQ Workflow configuration utility and follow the instructions. Note that you have to define the environment variable MQSPREFIX before you start the utility. This forces MQSeries to create the queue manager in the specified directory. After the queue manager has been created, this environment variable is no longer needed.

    Note: During the second phase of running *fmcztuil* , you are prompted to enter a DB2 password. Here you have to enter the valid password that you have specified for the DB2 user ID to access the Runtime database during the first phase.

    Run the following commands on node A:

Example for MQ Workflow A (2-tier setup)
`export MQSPREFIX=/nda_mqm` `fmczutil`

    Run the following commands on node C:

Example for MQ Workflow C (3-tier setup – MQ Workflow system)
`export MQSPREFIX=/ndc_mqm` `fmczutil`

40. After the Workflow configuration has been created successfully, make sure that the newly created configuration can be started on the node that is responsible for a takeover. Therefore, some entries must be added to the hot standby system.

    These entries include dedicated information for the queue manager in /var/mqm/mqs.ini, additional services entries in /etc/services and /etc/inetd.conf, and a symbolic link for the MQ Workflow configuration becoming necessary because the MQ Workflow configuration root directory is different on each node. The MQ Workflow systems need to know where to find the configurations of the other nodes. To point to the corresponding MQ Workflow configurations, symbolic links are established.

    To establish this information, run the utility *fmchadef* on node S which performs the necessary steps.

    To adapt the Workflow configuration FMCA from node A on node S

Example for the hot standby system
`fmchadef –n nodea –y FMCA`

    To adapt the Workflow configuration FMCC from node C on node S

Example for the hot standby system
`fmchadef –n nodec –y FMCC`

41. Now adapt the start and stop scripts to your own needs and perform a test before you integrate them into the resource groups. These scripts start and stop the MQ Workflow system, including the queue manager and the DB2 instance necessary for MQ Workflow.

    It is recommended that you create a dedicated subdirectory for all related HACMP Workflow scripts, for example, . /var/fmcha/bin. This subdirectory with its content should be equal on all participating nodes and can not be on a shared disk. If you decide to use a different subdirectory,

adapt this information in the scripts *fmcstart* and *fmcstop*. The script *fmcadmin* performing the main work must not be adapted.

Example for starting the Workflow configuration FMCA on node A
`/var/fmcha/bin/fmcstart –y FMCA`

Example for starting the Workflow configuration FMCC on node C
`/var/fmcha/bin/fmcstart –y FMCC`

On the database server referenced as node B in this document the following scripts must be used. They are responsible for starting and stopping the DB2 instance and, in addition, they control that the remotely connected MQ Workflow servers are started and stopped correctly.

It is recommended that you use the subdirectory /var/fmcha/bin also for this scripts. If you decide to use a different subdirectory, adapt this information in the scripts *fmcdbsta* and *fmcdbsto*. The script *fmcdbadm* performing the main work is independent from the subdirectory.

In the script *fmcdbadm*, the information about the remote MQ Workflow systems must be adapted to your local needs. You only need to adapt the hostname and the configuration ID of each remote MQ Workflow system. The details are documented in the script itself.

Example for starting the DB2 instance db2inst2 on node B
`/var/fmcha/bin/fmcdbsta –d db2inst2`

42. Stop the cluster software before integrating the script into the resource groups, and synchronize the cluster resources again by using the SMIT-HACMP dialogs.
43. Now retest that the cluster nodes are working correctly. This includes a takeover and a rejoin of a node, which potentially can fail. Verify that the MQ Workflow systems are started correctly and can be accessed by the MQ Workflow configuration admin utility.
44. After you have tested the resource groups successfully, including starting and stopping the MQ Workflow systems, keep the cluster active.

4.3.8. Attach clients to the MQ Workflow system

45. Make the channel table accessible for all MQ Workflow clients.
46. Start the MQ Workflow Runtime Client interface and log on to the MQ Workflow system.

5. IBM MQSeries Workflow and Sun Cluster

Before you start implementing an IBM MQSeries Workflow solution in a Sun Cluster, you should read the information in this section and follow the instructions.

5.1. Where to find information about planning, installing and customizing Sun Cluster

To become familiar with Sun Cluster, you can either attend a Sun Cluster course, or read the Sun Cluster documentation. In the following you find a list of documentation about Sun Cluster Version 2.2

Product Family	Title	Part Number
Sun Cluster	Sun Cluster 2.2 System Administration Guide	806-5343
	Sun Cluster 2.2 API Developer's Guide	806-5344
	Sun Cluster 2.2 Error Messages Manual	805-4242
	Sun Cluster 2.2 Release Notes	806-5345
Hardware	Sun Cluster 2.2 Hardware Site Preparation, Planning and Installation Guide	806-5346
	Sun Cluster 2.2 Hardware Service Manual	806-5347
Solstice	DiskSuite Solstice DiskSuite 4.2 Installation/Product Notes	805-5960
	Solstice DiskSuite 4.2 User's Guide	805-5961
	Solstice DiskSuite 4.2 Reference	805-5962

5.2. Understanding the overall concept

This document gives you instructions on how to install and configure MQ Workflow in a Sun Cluster. Before you start setting up an MQ Workflow environment in a Sun Cluster, you should be familiar with the installation and configuration of MQ Workflow, including its prerequisites DB/2 and MQSeries.

This document describes two different setups of MQ Workflow in a Sun Cluster:

- In the first setup, all server elements are installed on the same node (two-tier setup).
- In the second setup, the server elements are distributed. The database is installed on one node, and the MQ Workflow system and its corresponding queue manager is installed on a different node (three-tier setup). In a multi system setup, you have one database node and multiple MQ Workflow system nodes.

In a Sun Cluster environment, a node runs a data service. If a Sun Cluster node fails, another Sun Cluster node automatically takes over the responsibility of the failing node.
Each Sun Cluster data service can contain one of the following MQ Workflow elements:

- A complete MQ Workflow setup (2-tier setup), which consists of a database server, a queue manager and an MQ Workflow system.
- A database server only.
- An MQ Workflow system combined with a queue manager.

Note: Each MQ Workflow system group contains exactly one database server and one or more MQ Workflow systems. Each MQ Workflow system belongs to exactly one MQ Workflow system group.

Note: In a Sun Cluster all defined resource elements must have unique names. This is also true for all elements building an MQ Workflow system, including the system group itself.

5.3. Steps for setting up a MQ Workflow – Sun Cluster solution

It is important to do the installation and configuration steps incrementally. Each part must be verified, before you go on with the next installation or configuration part. Make sure that the hardware and the network work correctly, before you implement Sun Cluster on the system. Sun Cluster must be working correctly before MQ Workflow is installed. Testing and verifying each step of the system setup helps you to pinpoint problems and handle errors.

The following sections describe how to set up an MQ Workflow – Sun Cluster solution. The required steps are numbered continuously throughout the different sections. Perform the steps in the following sequence.

5.3.1. Hardware and software setup:

1. Set up the hardware used to run the cluster and install Solaris. For a detailed description of the hardware requirements, refer to the corresponding documentation.
   Make sure you have at least:

   - One administration workstation
   - One Terminal Concentrator
   - Two hosts (up to four)
   - One or more public network interfaces per system
   - A redundant private network interface
   - One source of shared, mirrored disk storage

2. Set up the Terminal Concentrator. The TC is a hardware interface, consisting of several components that provide the only access path to the cluster host systems when these systems are halted or before any operating system is installed.
3. Set up the Administration Workstation as described in the Sun Cluster documentation and install the Sun Cluster Client software.
4. Install the volume manager software Solstice DiskSuite and the Sun Cluster Server software.

5.3.2. Defining the cluster topology

5. Set up the new cluster with its nodes.
6. Define network interfaces (NAFO groups).
7. When you have completed the Sun Cluster installation and configuration, verify that the basic cluster configuration information is present by using the scconf command.
   Note: Run the scconf command on each of the configured cluster host systems to verify that their configuration database files agree.
8. Perform a first test to ensure that potential clients can access the server machines after a Sun Cluster takeover and a reconfiguration of the node. A ‘ping’ test is sufficient at this time.

5.3.3. Configuring the cluster resources

9. It is helpful to draw a sketch showing the key elements of your cluster, before you start configuring the cluster resources. The instructions given in the next sections are based on the following scenario. You have two complete independent MQ Workflow setups mapped to the Sun Cluster where one node is responsible to take over the resources of all the other nodes. This implies that only one node in the cluster should fail at the same time. Explicitly you can leave out one of the MQ Workflow setups to simplify things.

   To describe all necessary information in the cluster, it is helpful to fill out the MQ Workflow work sheet. The values provided in the following sample work sheet are described later.

Description	MQ Workflow configuration element values		
	Default	**Workflow A 2-tier setup**	**Workflow C 3-tier setup**
DB2 Instance name	db2inst1	**db2inst1**	**reminst2**
DB2 Instance home directory	/export/home/db2inst1	**/nda_home/db2inst1**	**/ndb_home/db2inst2**
MQSeries user ID	mqm	**mqm**	**mqm**
MQSeries working directory	/var/mqm	**/nda_mqm**	**/ndc_mqm**
MQ Workflow administrator	fmc	**fmcinst1**	**fmcinst3**
MQ Workflow configuration administrator	fmc	**fmcinst1**	**fmcinst3**
API and client execution user ID	fmc	**fmcinst1**	**fmcinst3**
Import and Export user ID	fmc	**fmcinst1**	**fmcinst3**
MQ Workflow configuration root directory	/var/fmc	**/nda_fmcroot**	**/ndc_fmcroot**
MQ Workflow configuration identifier	FMC	**FMCA**	**FMCC**
MQ Workflow configuration profile	fmcrc	**fmcrc**	**fmcrc**
MQ Workflow system group	FMCGRP	**FMCGRPA**	**FMCGRPC**
MQ Workflow system	FMCSYS	**FMCSYSA**	**FMCSYSC**
Database administrator	fmc	**fmcinst1**	**fmcinst3**
Database name	FMCDB	**FMCDBA**	**FMCDBB**
Database location	①	**/nda_fmcdbs**	**/ndb_fmcdbs**
Database container location	①	**/nda_fmcdbs**	**/ndb_fmcdbs**
Database log location	①	**/nda_fmcdbslo**	**/ndb_fmcdbslo**
Database space management	s	**s**	**s**
MQ resources administrator	fmc	**fmcinst1**	**fmcinst3**
MQ Workflow MQ principal	fmc	**fmcinst1**	**fmcinst3**
Queue manager name	FMCQM	**FMCQMA**	**FMCQMC**
Queue manager location	/var/mqm/qmgrs	**/nda_mqm/qmgrs**	**/ndc_mqm/qmgrs**
Queue prefix	FMC	**FMCA**	**FMCC**
Channel definition table file	/var/fmc/chltabs/MQWFCHL.TAB	**/nda_fmcroot/chltabs/FMCA.TAB**	**/ndc_fmcroot/chltabs/FMCC.TAB**
TCP/IP address ②	<hostname>	**9.164.160.211** ②	**9.164.160.213** ②
TCP/IP port number	5010	**5011**	**5031**
Queue manager log type	c	**c**	**c**
Queue manager log file location	-	**/nda_mqmlog**	**/ndc_mqmlog**
The Cluster name	FMCGRP	**FMCCLUA**	**FMCCLUC**
The repository type	f	**f**	**f**
The primary Queue manager name	-	-	-
The primary TCP/IP address	-	-	-
The primary TCP/IP port number	-	-	-
The primary MQ principal	-	-	-

Reference ①: Using the default setting, all database parameters are stored in the same subdirectory. It is recommended that a different subdirectory is used for the database log files.
The default location is: /var/fmc/rt_db/<db2inst1>/<databasename>, where the DB2 instance and the database name are derived from the values already specified.

②: In a Sun Cluster environment, the TCP/IP address must be specified. In order to avoid problems, such as a wrong name resolution, it is highly recommended that you use the TCP/IP address instead of the hostname.

In the following tables you find additional information, which is not provided by the MQ Workflow work sheet for Sun Cluster.

2-tier MQ Workflow setup		
	Logical Host A	
Description	MQ Workflow A	
Logical host	LogHostA	
Primary node	Node A	
Secondary node (hot standby)	Node D	
Disk sets	Nodea_set	
File systems	--- see below ---	
Data service	mqwfa	

3-tier MQ Workflow setup		
	Logical Host B	**Logical Host C**
Description	MQ Workflow B	MQ Workflow C
Logical host	LogHostB	LogHostC
Primary node	Node B	Node C
Secondary node (hot standby)	Node D	Node D
Disk sets	Nodeb_set	Nodec_set
File systems	--- see below ---	--- see below ---
Data service	mqwfb	mqwfc

10. In this document, it is assumed that you establish an N+1 Sun Cluster setup. Therefore, you do not find information about any other topology.
11. Plan the setup of the shared disk devices as described in the Sun Cluster documentation. For MQ Workflow, you need a shared disk set containing the MQ Workflow related file systems. Each disk set name must be unique within the cluster. The following tables show different sample setups of the related file systems needed by MQ Workflow. Plan to add all shared file systems for a logical host in one disk set. Note that some user home directories are placed on shared disks. The following tables show the necessary file system information for a simple 2-tier setup (in the first table) and a basic 3-tier setup (in the second and third table).
12. Use the Solstice DiskSuite tool to create the disk sets.
13. To run a highly available data service, a client system must be able to communicate with the data service over the network. This is done by using a logical hostname that is converted to an IP address.
    A logical host in the Sun Cluster HA environment is a collection of network definitions and disk storage. A logical host, consisting of one or more IP addresses, assigned network adapters, and disk storage, is configured as the unit of failover. One or more data services are configured to run in a logical host, so that when the logical host moves, the data service follows it.
    Use the scconf -L command to create the logical host.
    Use the scconf -F command to create the administrative file system.

MQ Workflow A (2-tier setup)			
Disk set	**File system and mount point**	**Purpose**	**Default file system and mount point**
Nodea_set	/nda_fmcdbs /nda_fmcdbs	MQ Workflow database	/var /var/fmc/rt_db
Nodea_set	/nda_fmcdbslo /nda_fmcdbslo	MQ Workflow database log	/var /var/fmc/rt_db
Nodea_set	/nda_fmcroot /nda_fmcroot	MQ Workflow configuration root directory	/var /var/fmc
Nodea_set	/nda_home /nda_home/fmcinst1	MQ Workflow configuration administrator home directory	/export/home /export/home/fmc
Nodea_set	/nda_home /nda_home/db2inst1	DB2 instance home directory	/export/home /export/home/db2inst1
Nodea_set	/nda_mqm /nda_mqm/qmgrs	Queue manager	/var/mqm /var/mqm/qmgrs
Nodea_set	/nda_mqmlog /nda_mqmlog	Queue manager logs	/var/mqm /var/mqm/log
Nodea_set	/nda_fmctrace /nda_fmctrace	MQ Workflow traces	 Current directory
Nodea_set	/nda_custom /nda_custom	Customer tools	

Note: As a minimum, you have two machines within a 3-tier setup, one for the database and one for the MQ Workflow system. For a multiple system setup, you can replicate the third table containing the MQ Workflow system setup.

MQ Workflow B (3-tier setup – database)			
Disk set	**File system and mount point**	**Purpose**	**Default file system and mount point**
Nodeb_set	/ndb_fmcdbs /ndb_fmcdbs	MQ Workflow database	/var /var/fmc/rt_db
Nodeb_set	/ndb_fmcdbslo /ndb_fmcdbslo	MQ Workflow database log	/var /var/fmc/rt_db
Nodeb_set	/ndb_home /ndb_home/db2inst2	DB2 instance home directory	/export/home /export/home/db2inst1
Nodeb_set	/ndb_custom /ndb_custom	Customer tools	

MQ Workflow C (3-tier setup – MQ Workflow system)			
Disk set	**File system and Mount point**	**Purpose**	**Default file system and mount point**
Nodec_set	/ndc_fmcroot /ndc_fmcroot	MQ Workflow configuration root directory	/var /var/fmc
Nodec_set	/ndc_home /ndc_home/fmcinst3	MQ Workflow configuration administrator home directory	/export/home /export/home/fmc
Nodec_set	/ndc_home /ndc_home/db2inst3	DB2 instance home directory	/export/home /export/home/db2inst1
Nodec_set	/ndc_mqm /ndc_mqm/qmgrs	Queue manager	/var/mqm /var/mqm/qmgrs
Nodec_set	/ndc_mqmlog /ndc_mqmlog	Queue manager logs	/var/mqm /var/mqm/log
Nodec_set	/ndc_fmctrace /ndc_fmctrace	MQ Workflow traces	 Current directory
Nodec_set	/ndc_custom /ndc_custom	Customer tools	

14. Ensure that the home directories on the shared disks have the necessary access rights and directory ownerships. In the following you find examples for the necessary commands. You must adapt the values according to your setup. These commands must also be performed on the node that is responsible for a takeover.

    Run the following commands on node A:

Example for MQ Workflow A (2-tier setup)
`chown root:root /nda_home` `chmod 755 /nda_home`

    Run the following commands on node B:

Example for MQ Workflow B (3-tier setup – database)
`chown root:root /ndb_home` `chmod 755 /ndb_home`

    Run the following commands on node C:

Example for MQ Workflow C (3-tier setup – MQ Workflow system)
`chown root:root /ndc_home` `chmod 755 /ndc_home`

    Note: Make sure that the mount points on the nodes have the appropriate access rights.

15. Create the users and groups that are necessary for the MQ Workflow setup. The users and groups must have identical IDs on both the primary and the secondary node. The home directory for the DB2 instance owner and the MQ Workflow configuration administrator must be located on a shared disk. You can use different names for the home directories, or the subdirectories, but make sure that the home directories are located on a shared disk.

Groups ①	**MQ Workflow A**	**MQ Workflow B**	**MQ Workflow C**
DB2 administrator group	db2iadm1	db2iadm2	db2iadm3
MQSeries group	mqm	mqm	mqm
MQ Workflow group	fmcgrp	fmcgrp	fmcgrp

Users ②	**MQ Workflow A (2-tier setup)**			
	Name	Group assignments		Home directory
		Primary	Secondary	
DB2 instance user	db2inst1	db2iadm1		/nda_home/db2inst1
MQSeries user	mqm	mqm		/export/home/mqm
MQ Workflow configuration administrator	fmcinst1	fmcgrp	mqm, db2iadm1	/nda_home/fmcinst1
Notes: Additional groups can be set according to your own needs.				

Users ③	**MQ Workflow B (3-tier setup – database)**			
	Name	Group assignments		Home directory
		Primary	Secondary	
DB2 instance user	db2inst2	db2iadm2		/ndb_home/db2inst2
Notes: Additional groups can be set according to your own needs.				

Users ④	MQ Workflow C (3-tier setup – MQ Workflow system)			
	Name	Group assignments		Home directory
		Primary	Secondary	
DB2 instance user	db2inst3	db2iadm3		/ndc_home/db2inst3
MQSeries user	mqm	mqm		/export/home/mqm
MQ Workflow configuration administrator	fmcinst3	fmcgrp	mqm, db2iadm3	/ndc_home/db2inst3
Notes: Additional groups can be set according to your own needs.				

Notes: On each node, set the passwords for all user IDs that exist on the node. Otherwise you might run into problems.

① It is recommended that all groups are created on all nodes, even if they are not used.

② It is not necessary to create all users on all nodes, but for transparency it is recommended.

③ On the node containing only the database no MQ Workflow or MQSeries elements are required.

④ On nodes without a database, a DB2 instance is required to get access to the remote database.

16. Certain steps must be performed to ensure that the necessary access rights and directory ownerships are provided. In the following you find examples for the necessary commands. You must adapt the values according to your setup. These commands must also be performed on the node that is responsible for a takeover.

    Run the following commands on node A:

Example for MQ Workflow A (2-tier setup)

```
chown fmcinst1:fmcgrp /nda_fmc*
chmod 775 /nda_fmc*
chown fmcinst1:db2iadm1 /nda_fmcdbs*
chmod 775 /nda_fmcdbs*
chown -R mqm:mqm /nda_mqm*
chmod –R 775 /nda_mqm*
```

    Run the following commands on node B:

Example for MQ Workflow B (3-tier setup – database)

```
chown db2inst2:db2iadm2 /ndb_fmc*
chmod 775 /ndb_fmc*
```

    Run the following commands on node C:

Example for MQ Workflow C (3-tier setup – MQ Workflow system)

```
chown fmcinst3:fmcgrp /ndc_fmc*
chmod 775 /ndc_fmc*
chown -R mqm:mqm /ndc_mqm*
chmod –R 775 /ndc_mqm*
```

    Note: Make sure that the mount points on the nodes have the appropriate access rights.

17. When you have completed the logical host and file system definition, you should verify that the basic cluster configuration information is present by using the scconf command.
    Note: You should run the scconf command on each of the configured cluster host systems to verify that their configuration database files agree.
18. Test, if the cluster nodes are working properly by performing a takeover and a rejoin of a node.

5.3.4. Installing DB2, MQSeries and MQ Workflow

19. Before installing MQ Workflow and prerequisite products you have to adapt the Solaris kernel configuration parameters on all cluster nodes. Recommended values are:

```
set msgsys:msginfo_msgmax = 65535
set msgsys:msginfo_msgmnb = 65535
set msgsys:msginfo_msgmap = 1026
set msgsys:msginfo_msgmni = 256
set msgsys:msginfo_msgssz = 16
set msgsys:msginfo_msgtql = 1024
set msgsys:msginfo_msgseg = 32767

set shmsys:shminfo_shmmax = 483183820
set shmsys:shminfo_shmseg = 1024
set shmsys:shminfo_shmmni = 1024
set shmsys:shminfo_shmmin = 1

set semsys:seminfo_semaem = 16384
set semsys:seminfo_semvmx = 32767
set semsys:seminfo_semmni = 1024
set semsys:seminfo_semmap = 1026
set semsys:seminfo_semmns = 16384
set semsys:seminfo_semmsl = 100
set semsys:seminfo_semopm = 100
set semsys:seminfo_semmnu = 2048
set semsys:seminfo_semume = 256
```

20. Reboot all nodes and restart the cluster.
21. Now install the prerequisite software DB2, MQSeries and MQ Workflow including fixpacks on all related nodes. Different software is required for the different node types. Before you install the software, consider the following:

    - A dedicated database node requires only DB2 EE
    - On a "2-tier setup" node all products must be installed.
    - On a dedicated MQ Workflow system it is sufficient to install the CAE portion of DB2
    - On the hot standby node all products must be installed.
    - In a Sun Cluster environment, it is recommended that the DB2 EE is installed on the MQ Workflow system nodes.

    For details about the installation, refer to the corresponding installation guides and read the latest updates of the readme files for the products to be installed.

    Note: Only use pkgadd to install the licensed software products. Make sure that you have entered the correct DB2 license key on all nodes. Any mentioned configuration steps are performed later.

5.3.5. Configuring DB2

This section describes how to configure DB2 for MQ Workflow. You find additional information in the *IBM DB2 Universal Database for Unix Quick Beginnings (Chapter 6: Installing DB2 for Solaris).* According to the chosen MQ Workflow setup, not all steps must be performed on all nodes. The following table summarizes the steps to be performed on the primary node of a Sun Cluster logical host. The node planned to be responsible for a takeover must be equally configured as its correspondent primary node.

Overview of the necessary DB2 configuration steps for MQ Workflow				
			MQ Workflow 3-tier setup	
Step	Short description	MQ Workflow 2-tier setup	Database	MQ Workflow system
22	Create DB2 links	Mandatory	Mandatory	Mandatory
23	Add service entries	Optional	Mandatory	No
24	Create DB2 instance	Mandatory	Mandatory	Mandatory
25	Update DB2 master catalog on the hot-standby system	No	No	No
26	Configure DB2 instance	Mandatory	Mandatory	No
27	Add DB2 registry value	Optional	Mandatory	No
28	Catalog remote tcpip node	No	No	Mandatory
29	Create start and stop scripts	Mandatory	Mandatory	Mandatory
30	Retest the cluster	Mandatory	Mandatory	Mandatory
31	Keep the cluster alive	Mandatory	Mandatory	Mandatory

22. Create the links for the DB2 files. If you do this, you need not specify the full path to the product libraries and include files.

Command to be performed on all nodes:
`ln –s  /opt/IBMdb2/V7.1/lib/libdb2.so  /usr/lib` `ln –s  /opt/IBMdb2/V7.1/lib/libdb2.so.1  /usr/lib`

23. Create the entries for the DB2 service names in /etc/services. Make sure that all involved nodes are using the unique ports of the correspondent service names. In a Sun Cluster environment, you can add all entries on all nodes. This can help to avoid communication problems.

    Add the following to /etc/services on node A:

Example for MQ Workflow A (2-tier setup)
`db2cdb2inst1   50010/tcp` `db2idb2inst1   50011/tcp`

    Add the following to /etc/services on node B:

Example for MQ Workflow B (3-tier setup – database)
`db2cdb2inst2   50020/tcp` `db2idb2inst2   50021/tcp`

    No action is required on node C.

    Add the following to /etc/services on node S:

Example for the hot standby system

`db2cdb2inst1   50010/tcp`
`db2idb2inst1   50011/tcp`
`db2cdb2inst2   50020/tcp`
`db2idb2inst2   50021/tcp`

24. Create the DB2 instances as described in the *IBM DB2 Universal Database for Unix Quick Beginnings (Chapter 6: Installing DB2 for Solaris).*

Run the following commands on node A:

Example for MQ Workflow A (2-tier setup)
`/opt/IBMdb2/V7.1/instance/db2icrt -u db2inst1 db2inst1`

Run the following commands on node B:

Example for MQ Workflow B (3-tier setup – database)
`/opt/IBMdb2/V7.1/instance/db2icrt -u db2inst2 db2inst2`

Run the following commands on node C:

Example for MQ Workflow C (3-tier setup – MQ Workflow system)
`/opt/IBMdb2/V7.1/instance/db2icrt -u db2inst3 db2inst3`

25. The DB2 instance master catalog information is stored in /var/db2/v71/profiles.reg . The content of this file is managed by DB2 whenever you create or drop a DB2 instance with the correspondent DB2 commands.

    Since on the hot-standby system these DB2 commands are not executed the entries in the DB2 instance master catalog are not present. For some specific tasks like remote administration these entries are required. For normal operation as required by MQSeries Workflow this information is not required.

    For providing this information on the hot-standby system a simple way is to create the information with an editor in /var/db2/v71/profiles.reg. If you chose this way include all DB2 instances from all involved nodes in this file.

    Alternately you can use NFS methods for the directory /var/db2/v71.

26. After you have created the instances successfully, certain configuration steps must be performed for each instance.

    - Update the database manager configuration to use the correct service name. On a MQ Workflow system this update is not necessary. On a CAE installation it is not possible.
    - Assign the communication protocol to be used by the instance.
    - Do not configure the instance to start automatically after a system restart. The start of the instance must be handled by Sun Cluster.

    Run the following commands on node A:

Example for MQ Workflow A (2-tier setup)
`su – db2inst1 -c 'db2 update dbm cfg using svcename db2cdb2inst1'` `su – db2inst1 -c 'db2set -i db2inst1 db2comm=tcpip'`

    Run the following commands on node B:

Example for MQ Workflow B (3-tier setup – database)
`su – db2inst2 -c 'db2 update dbm cfg using svcename db2cdb2inst2'` `su – db2inst2 -c 'db2set -i db2inst2 db2comm=tcpip'`

    No action is required on node C.

27. The environment variable DB2_RR_TO_RS must be set to YES for MQ Workflow. For a 2-tier-setup it is set automatically during MQ Workflow configuration. For a 3-tier-setup either add a correspondent DB2 registry entry (recommended) or alternately add a correspondent export statement in *<db2home>/sqllib/db2profile*.

    No action is required on node A.

    Run the following commands on node B:

Example for MQ Workflow B (3-tier setup – database)
`su – db2inst2 -c 'db2set -i db2inst2 DB2_RR_TO_RS=YES'`

    No action is required on node C.

28. In a MQ Workflow 3-tier setup the MQ Workflow system must have access to the DB2 instance that hosts the MQ Workflow database. Therefore you need to catalog a TCP/IP node. To be able to do this, first start the remote DB2 instance.

Example for MQ Workflow B (3-tier setup – database)
`su – db2inst2 -c 'db2start'`

    The following commands must be performed on node C under control of the DB2 instance user (db2inst3). All lines starting with a # are comments and should help to understand the commands.

Example for MQ Workflow C (3-tier setup – MQ Workflow system)

`# All bold values are derived from the samples chosen above`
`# Start the DB2 instance`
`db2start`
`# Catalog the remote instance. This is mandatory for the MQ Workflow`
`# system. Different types of this command are possible. Details can be`
`# found in the DB2 documentation.`
`# <IP-address> must be replaced by your IP-address of node B`
`db2 catalog tcpip node` **`reminst2`** `remote <IP-address> server` **`50020`** `  \`
`  remote_instance` **`db2inst2`**
`# To test the communication use the attach command`
`db2 attach to` **`reminst2`** `user` **`db2inst2`** `using <password>`
`# To reset the attachment use the detach command`
`db2 detach`

29. You can now create scripts for starting / stopping the DB2 instance and integrate them as Sun Cluster data services.

    Note: The only command in the script is either db2start or db2stop. You can add return code handling, too.

30. Test again that the cluster nodes are working properly by taking over and rejoining a node. Verify that the DB2 instances are started correctly and can be accessed from outside the cluster.
31. After you have successfully tested the data services including starting and stopping the DB2 instances, remove these data services and keep the cluster active. It is essential for the following steps that the DB2 instances are active.

5.3.6. Configuring MQSeries

This section describes the necessary configuration steps for MQSeries. The queue managers used by MQ Workflow are created by the MQ Workflow utilities.

32. Create a default queue manager on each node. This includes any hot standby nodes. This queue manager is not a member of any data service and need not be active at any time. Note that any queue manager that is a member of a data service cannot be used as a default queue manager.

Command to be performed on all nodes having queue managers:
`su – mqm –c 'crtmqm –q FMCDEFQM'`

Notes: You can choose your own name for the default queue manager (the sample queue manager name is *FMCDEFQM*). It is not necessary to create a queue manager on a dedicated database node.

5.3.7. Configuring MQ Workflow

This section describes the configuration steps for MQ Workflow. On a dedicated database node no MQ Workflow configuration is required. As opposed to the DB2 configuration, MQ Workflow requires a special configuration handling for those nodes that are responsible for a takeover. In the following, you find all configuration steps that are necessary for setting up a MQ Workflow system. It is assumed that one dedicated hot standby node is present in the cluster, hereafter referred to as *node S*. Node S is responsible for taking over all nodes. If more hot standby nodes are available, you can reuse the instructions for node S for the other hot standby nodes. The MQ Workflow configuration consists of two stages. During the first stage (see steps 33 – 38), a node is enabled to handle a MQ Workflow configuration. These configuration steps must be performed once. During the second stage, all steps that are necessary to configure a MQ Workflow configuration must be performed. These steps must be repeated for every new MQ Workflow configuration, with different values.

5.3.7.1. Configuring the MQ Workflow environment

33. Configure the MQ Workflow configuration administrator user. Make sure that the DB2 environment is activated for this user. You can do this by adding a statement in the `.profile` file.

    On node A, add the following statements to /nda_home/fmcinst1/.profile

Example for MQ Workflow A (2-tier setup)
`export LANG=en_US` `. /nda_home/db2inst1/sqllib/db2profile`

    On node C, add the following statements to /ndc_home/fmcinst3/.profile

Example for MQ Workflow C (3-tier setup – MQ Workflow system)
`export LANG=en_US` `. /ndc_home/db2inst3/sqllib/db2profile`

Note: If you want to use an additional MQ Workflow configuration administrator, repeat these steps before configuring a MQ Workflow configuration.

34. Set the MQ Workflow environment and the configuration root directory on all nodes involved. If a node is intended to hold more than one MQ Workflow configuration with different MQ Workflow configuration administrator user ID, use the first one as MQ Workflow configuration owner. If the

hot standby node is intended to be responsible for additional MQ Workflow configurations those MQ Workflow environment must be used. Otherwise create a MQ Workflow environment as shown in the example. Ensure that the names for the MQ Workflow configuration root directory are unique on all nodes.

Run the following command on node A:

Example for MQ Workflow A (2-tier setup)
`fmczinsx –o env –c /nda_fmcroot –U fmcinst1`

Run the following command on node C:

Example for MQ Workflow C (3-tier setup – MQ Workflow system)
`fmczinsx –o env –c /ndc_fmcroot –U fmcinst3`

Run the following command on node S:

Example for the hot standby system
`fmczinsx –o env –c /var/fmc –U fmcinst1`

35. Now define the MQ Workflow Runtime database type.

    Run the following command on node A:

Example for MQ Workflow A (2-tier setup)
`fmczinsx –o db2`

    Run the following command on node C:

Example for MQ Workflow C (3-tier setup – MQ Workflow system)
`fmczinsx –o db2`

    Run the following command on node S:

Example for the hot standby system
`fmczinsx –o db2`

36. Now define the necessary MQ Workflow infrastructure.

    Run the following command on node A:

Example for MQ Workflow A (2-tier setup)
`fmczinsx –o inf`

    Run the following command on node C:

Example for MQ Workflow C (3-tier setup – MQ Workflow system)
`fmczinsx –o inf`

    Run the following commands on node S:

Example for the hot standby system
`fmczinsx –o inf`

37. Now define the MQ Workflow connection type.

    Run the following command on node A:

Example for MQ Workflow A (2-tier setup)
`fmczinsx –o mqserver`

    Run the following command on node C:

Example for MQ Workflow C (3-tier setup – MQ Workflow system)
`fmczinsx –o mqserver`

    Run the following command on node S:

Example for the hot standby system
`fmczinsx –o mqserver`

38. If the hot standby node is intended to be responsible for additional MQ Workflow configurations the profile containing a default configuration identifier will be created during creating the first MQ Workflow configuration. Only if no dedicated MQ Workflow configuration is established on the hot standby node, you have to create this profile manually. Do this by copying the profile from e.g node A as shown in the following example.

Example for the hot standby system
`rcp nodea:/nda_fmcroot/fmcrc /var/fmc/fmcrc`

5.3.7.2. Configuring a MQ Workflow Configuration

39. To ensure that the MQ Workflow configurations fit into the Sun Cluster environment, you must define unique names for the MQ Workflow databases and the queue managers that are used for the different MQ Workflow systems. The following table shows all values needed for a MQ Workflow configuration. The values are provided in the same order as required when running the utility *fmczutil*. This utility prompts you to enter all necessary values and must be performed in two phases. The first is the **definition phase** and must be performed while logged on as root user. The second is the **creation phase** and can be performed either by the MQ Workflow configuration administrator or the root user. At the end of the definition phase the utility *fmczutil* asks if the database and the queue manager should be created now. If the root user starts the creation phase, which is recommended in a Sun Cluster environment, please notice that the environment variable MQSPREFIX must be specified before the utility *fmczutil* is started. During the second phase, the MQ Workflow database and the queue manager are created. The parameters in the table are derived from the assumptions and definitions made above.

MQ Workflow configuration elements for fmczutil			
	Workflow A	**Workflow C**	**Default**
Configuration identifier	FMCA	FMCC	FMC
Configuration administrator	fmcinst1	fmcinst3	fmc
Select Category Menu:	s	s	①
Configure runtime database	n	n	②
Local vs. remote database	l	r	②
DB2 instance	db2inst1	db2inst3	db2inst1
Remote DB2 instance	-	reminst2	-
DB2 database	FMCDBA	FMCDBB	FMCDB
DB2 user ID of database admin	fmcinst1	fmcinst3	fmc
DB2 database layout file	③	③	③
DB2 database location	/nda_fmcdbs	/ndb_fmcdbs	④
DB2 container location	/nda_fmcdbs/cont	/ndb_fmcdbs/cont	④
DB2 log files location	/nda_fmcdbslo	/ndb_fmcdbslo	④
Select space management	s	s	⑤
DB2 user ID to access database	fmcinst1	fmcinst3	fmc
System group name	FMCGRPA	FMCGRPC	FMCGRP
System name	FMCSYSA	FMCSYSC	FMCSYS
Queue manager name	FMCQMA	FMCQMC	FMCQM
Queue prefix	FMCA	FMCC	FMC
Select log type	c	c	⑥
Log files location	/nda_mqmlog	/ndc_mqmlog	⑦
Channel definition table file	/nda_fmcroot/chltabs/FMCA.TAB	/ndc_fmcroot/chltabs/FMCC.TAB	⑧
TCP/IP address	9.164.160.211	9.164.160.213	<hostname>
TCP/IP port number	5011	5031	5010
Principal name	fmcinst1	fmcinst3	fmc
Cluster name	FMCCLUA	FMCCLUC	FMCGRP
Select repository type	f	f	⑨
Transaction coordinator userid	fmcinst1	fmcinst3	fmc
Queue manager starter	t	t	⑩

Notes:

①	On the Select Category Menu you can choose which MQ Workflow components you want to configure for the current configuration.
②	Specify **n** to Create a new Runtime database. The option **u** (Use an existing Runtime database) must be specified for additional MQ Workflow systems in a multiple system setup. Use of a remote database requires the database to be cataloged first. In addition to the remote DB2 instance you will be asked for the local DB2 instance where the remote database is cataloged.
③	The database layout file can be used to specify dedicated database container locations. The default is /var/fmc/cfgs/FMC/fmcdblay.ini and can be different according to your definitions.
④	The built-in default is /var/fmc/rt_db/db2inst1/FMCDB . According to your definitions, the default changes, for example for Workflow Sec /fmcsec/config/rt_db/db2sec1/FMCDBS
⑤	One of the DB2 space management methods must be specified.
⑥	You have to select one of the available log types for the queue manager.
⑦	No default is shown for the location of the queue manager log files. The built-in default is /var/mqm/log .
⑧	The built-in default is /var/fmc/chltabs/MQWFCHL.TAB
⑨	Specify **f** to make the queue manager the first within the MQ cluster. ⑩
⑩	In a default setup the configuration administrator is the starter of the queue manager and the transaction coordinator. In a secure setup you might wish to use a dedicated transaction coordination user ID. In this case another user ID in the group mqm must start the queue manager.

40. Based on the definitions made in the previous steps, run the MQ Workflow configuration utility and follow the instructions. Note, that you have to define the environment variable MQSPREFIX before you start the utility. This forces MQSeries to create the queue manager in the specified directory. After the queue manager has been created, this environment variable is no longer needed.

    Note: During the second phase of running *fmcztuil* , you are prompted to enter a DB2 password. Here you have to enter the valid password that you have specified for the DB2 user ID to access the Runtime database during the first phase.

    Run the following commands on node A:

Example for MQ Workflow A (2-tier setup)
`export MQSPREFIX=/nda_mqm` `fmczutil`

    Run the following commands on node C:

Example for MQ Workflow C (3-tier setup – MQ Workflow system)
`export MQSPREFIX=/ndc_mqm` `fmczutil`

41. After the Workflow configuration has been created successfully, make sure that the newly created configuration can be started on the node that is responsible for a takeover. Therefore, some entries must be added to the hot standby system.

    These entries include dedicated information for the queue manager in /var/mqm/mqs.ini, additional services entries in /etc/services and /etc/inetd.conf and a symbolic link for the Workflow configuration becoming necessary because the MQ Workflow configuration root directory is different on each node. The MQ Workflow systems need to know where to find the configurations of the other nodes. To point to the corresponding MQ Workflow configurations, symbolic links are established.

    You can do this by running the utility *fmchadef* on node S which performs the necessary steps.

    To adapt the Workflow configuration FMCA from node A on node S

Example for the hot standby system
`fmchadef –n nodea –y FMCA`

    To adapt the Workflow configuration FMCC from node C on node S

Example for the hot standby system
`fmchadef –n nodec –y FMCC`

42. Now adapt the start and stop scripts to your own needs and perform a test before you integrate them as data services. These scripts start and stop the MQ Workflow system, including the queue manager and the DB2 instance necessary for MQ Workflow.

    We recommend to create a dedicated subdirectory for all related Workflow data service scripts in the administrative file system (/Nodea_set/workflow or /Nodec_set/workflow). This subdirectory with its content should be equal on all participating nodes.

Example scripts for starting / stopping the Workflow configuration FMCA on node A
#!/usr/bin/ksh /Nodea_set/workflow/fmcadmin –o start –y FMCA –d –q exit
#!/usr/bin/ksh /Nodea_set/workflow/fmcadmin –o stop –y FMCA –d –q –f exit

Example scripts for starting / stopping the Workflow configuration FMCC on node C
#!/usr/bin/ksh /Nodec_set/workflow/fmcadmin –o start –y FMCC –d –q exit
#!/usr/bin/ksh /Nodec_set/workflow/fmcadmin –o stop –y FMCC –d –q –f exit

On the database server referenced as node B in this document the following scripts must be used. They are responsible for starting and stopping the DB2 instance and in addition they control that the remote connected Workflow server are proper started and stopped.
We recommend to use the subdirectory /Nodeb_set/workflow in the administrative file system.

In the script *fmcdbadm* the information about the remote Workflow systems must be adapted to your local needs. The only thing you need to adapt is the logical hostname and the configuration Id of each remote Workflow system. The details are documented in the script itself.

Example scripts for starting / stopping the DB2 instance db2inst2 on node B
#!/usr/bin/ksh /Nodeb_set/workflow/fmcdbadm –o start –d db2inst2 exit
#!/usr/bin/ksh /Nodeb_set/workflow/fmcdbadm –o stop –d db2inst2 exit

43. Before you can integrate these scripts as data services you have to create wrapper scripts as shown in the above examples because start or stop scripts with command line options cannot be registered within a data service.
Assuming you have named these scripts

- /Nodea_set/workflow/start_wf_a
- /Nodea_set/workflow/stop_wf_a
- /Nodeb_set/workflow/start_db_b
- /Nodeb_set/workflow/stop_db_b
- /Nodec_set/workflow/start_wf_c
- /Nodec_set/workflow/stop_wf_c

Example for registering and activating data service on node A
hareg –r mqwfa –v 3.3 –m START_NET=start_wf_a \ –t START_NET=90 –m STOP_NET=stop_wf_a –t STOP_NET=90 \ –b /Nodea_set/workflow –h LogHostA hareg –y mqwfa

Example for registering and activating data service on node B

```
hareg –r mqwfb –v 3.3 –m START_NET=start_db_b                    \
   –t START_NET=90 –m STOP_NET=stop_db_b –t STOP_NET=90           \
   –b /Nodeb_set/workflow –h LogHostB
hareg –y mqwfb
```

Example for registering and activating data service on node C

```
hareg –r mqwfc –v 3.3 –m START_NET=start_wf_c                    \
   –t START_NET=90 –m STOP_NET=stop_wf_c –t STOP_NET=90           \
   –b /Nodec_set/workflow –h LogHostC
hareg –y mqwfc
```

44. Now retest that the cluster nodes are working properly. This includes a takeover and a rejoin of a node, which potentially may fail. Verify that the MQ Workflow systems are started correctly and can be accessed by the MQ Workflow configuration admin utility.
45. After you have tested the data services successfully, including starting and stopping the MQ Workflow systems, keep the cluster active.

5.3.8. Attach clients to the MQ Workflow system

46. Make the channel table accessible for all MQ Workflow clients.
47. Start the MQ Workflow Runtime Client interface and log on to the MQ Workflow system.

    Note: After a Sun Cluster reconfiguration a broadcast is sent to the public network because the logical host runs now on a machine with a different MAC address. It can take some minutes until the MQ Workflow Runtime Client can reconnect because the client machine has to refresh its arp cache. It depends on the router timeout setting how long this refresh takes (default is 10 minutes).

Appendix

6. Scripts used in a High Availability Environment

All scripts described below can be invoked with the option –h to see a help. This might be useful to see which options are available. In general only the correspondent Workflow configuration identifier must be specified. All other information normally will be retrieved automatically.

All these scripts should be installed in a separate directory (e.g. /var/fmcha/bin) and in an high availability environment it is recommended to use a local disk. If another directory should be used, the information about the new directory must be customized in all scripts.

6.1.1. fmcstart

To start a Workflow system some prerequisite programs must be started in sequence before. The first program to be started is the DB2 instance containing the Workflow database. The second program is the queue manager for the Workflow system. The third program is the trigger monitor and optional the fourth is the command server. When all are up and running the administration server for the Workflow system can be started. The servers of the Workflow system are started automatically through the administration server based on the current definitions in the Workflow database.

Typically all of these programs are started by the Workflow configuration administrator. The default user Id is fmc but another userid can be defined as Workflow configuration administrator. To be able to start all these programs it is the default, that the user Id is member of the administrative groups for DB2 (the default is db2iadm1) and MQSeries (mqm). Other setups where the programs are started by different persons is in general possible and mentioned as the enhanced security concept. In an high availability environment the complete system will be started automatically without any user interaction under control of the root user.

This script can be used to start a Workflow system. All programs are started under control of the correspondent user ID since the ownership of the various programs and processes should not be root.

In addition this script can also be used by the Workflow configuration administrator which might be an option outside an high availability environment or for test purposes.

6.1.2. fmcstop

In opposite to the start script this script stops a Workflow system.

In addition this script can also be used by the Workflow configuration administrator which might be an option outside an high availability environment or for test purposes.

6.1.3. fmcadmin

The main work for starting or stopping a Workflow system is done by this script. It is called by fmcstart and fmcstop to do the correspondent work.

In addition this script can also be used by the Workflow configuration administrator which might be an option outside an high availability environment or for test purposes.

6.1.4. fmcdbsta

In a 3-tier environment the dependencies between programs, which must be started in sequence, are more complex since the programs are on different machines. In an high availability environment these dependencies have to be managed automatically.

A supported 3-tier setup is to use a dedicated database machine. In this case the remote Workflow system must be started remotely after the local DB2 instance is up and running.

This script can be used to start a remote Workflow system. It must be invoked on the node where the DB2 instance resides. The remote Workflow system will be started via the remote shell technique and by using the fmcadmin shell on the remote node.

In this case on the remote node a DB2 instance must be available where the local DB2 instance is catalogued. Since in an high availability environment it is possible that both DB2 instances may be active on the same node, it is mandatory to have unique names service names in the cluster.

6.1.5. fmcdbsto

In opposite to the start script this script stops a remote Workflow system.

6.1.6. fmcdbadm

The main work for starting or stopping a remote Workflow system is done by this script. It is called by fmcdbsta and fmcdbsto to do the correspondent work. In addition it can be used directly.

Through customization the mandatory information about the remote Workflow must be adapted to this script. Also this script can handle more than one remote Workflow system if they are in the same system group (connecting to the same database).

6.1.7. fmchadef

During configuring a Workflow system several customization data will be created. Based on this a queue manager will be created and customized. The customization is necessary for a proper working Workflow system. In a 2-tier environment a database will be created and initialized for Workflow. In a 3-tier environment the remote database will be catalogued and information about the current new created Workflow system will be added into the database.

Besides this several system entries are necessary to ensure that the Workflow system can work. When creating a queue manager or database, the MQSeries and DB2 functions will ensure that they are correct created. In addition some entries must be added manually if special functions should be used. Normally this entries are added automatically via the configuration utility (fmczutil). This entries are:

- A port to be used by the queue manager
- A stanza in /etc/inetd.conf which is necessary to starting a listener for a queue manager automatically.

On a hot-standby system no queue manager or database are created. Therefore the correspondent system entries are not created. Also those added by the Workflow configuration utility (fmczutil) are not available on the hot-standby system. The queue manager and the database must be on a shared disk also the Workflow configuration data are typically located on a shared disk. The system entries must be on local disks since they are located in places being necessary for booting a machine.

To ensure that a Workflow system can be taken over all these data must be available and consistent. The queue manager, the database and the Workflow configuration data are on shared disks handled by High Availability software whereas the system entries located on local disks must be duplicated to the hot-standby system. To avoid manually typing errors, use this script to create the necessary system entries for a Workflow system on the hot-standby system. In addition this script checks whether the requested resources are free (e.g. the port in /etc/services).

In a High Availability cluster it is possible to manage more than one Workflow system which may result in the situation that two Workflow systems must be handled on the hot-standby system in parallel. Assuming this, the Workflow configuration data is located on different filesystems. The data on this filesystem is organized in several subdirectories. The default location is /var/fmc which can be changed according to your local naming convention. In terms of Workflow it is called configuration root directory. Since Workflow works with only one configuration root directory the data located in the other configuration root directory must be made available via links.

In detail this script creates the following entries on the hot-standby system:

- A link for the Workflow configuration in the local configuration root directory
- A port to be used by the queue manager of the Workflow configuration
- A stanza in /etc/inetd.conf which is necessary to starting a listener for a queue manager automatically.
- A stanza for the queue manager in /var/mqm/mqs.ini.

7. Multiple Queue Managers on Cluster Nodes

In a cluster environment it may happen, that queue managers originated on different nodes may be started on the same node (e.g. the hot-standby system). In this case the queue managers are located on different filesystems belonging to different volume groups (on AIX) respective disk sets (on SUN) which results in severe problems. To avoid these problems the minimum is to use the script halinkmqm out of a MQSeries support pack:

- For AIX activate MQSeries support pack “MA63”
- For Sun Solaris activate MQSeries support pack “MA69”

After installing the support pack mount the correspondent filesystems containing the queue manager on each node and execute the script as follows. The filesystems must be mounted in sequence on all involved nodes each after another before the script is executed.

Example for MQ Workflow A (2-tier setup)
`su – mqm –c 'halinkmqm FMCQMA FMCQMA /nda_mqm'`

Example for MQ Workflow C (3-tier setup – MQ Workflow system)
`su – mqm –c 'halinkmqm FMCQMC FMCQMC /ndc_mqm'`

Example for the hot standby system
`su – mqm –c 'halinkmqm FMCQMA FMCQMA /nda_mqm'` `su – mqm –c 'halinkmqm FMCQMC FMCQMC /ndc_mqm'`

8. Transactional support

MQ Workflow groups a set of updates into a *unit of work*. These updates usually are logically related and must all be successful for data integrity to be preserved. If one update succeeds while another fails, data integrity is lost.

A unit of work **commits** when it completes successfully. At this point, all updates made within that unit of work are made permanent or irreversible. If the unit of work fails, then all updates are *backed out*. *Syncpoint coordination* is the process by which units of work are either committed or backed out with integrity.

- A *local* unit of work is one in which the only resources updated are those of the MQSeries queue manager. Here syncpoint coordination is provided by the queue manager using a single-phase commit process.
- A *global* unit of work is one in which resources belonging to other resource managers, such as XA-compliant databases (in our case DB2), are also updated. Here, a two-phase commit procedure must be used and the unit of work can be coordinated by the queue manager.

For more information about transactional support of MQSeries, refer to the *MQSeries System Administration Guide Chapter 14. Transactional support.*

MQ Workflow uses MQSeries to act as a transaction manager and to coordinate updates made by external resource managers within MQSeries units of work. The external DB2 resource manager complies with the X/Open XA interface.

MQSeries on UNIX systems support coordination of transactions by external syncpoint managers which utilize the X/Open XA interface. This support is available only on server configurations. The interface is not available to client applications.

In an XA configuration MQSeries on UNIX systems fulfill the role of an XA Resource Manager. An XA syncpoint coordinator can manage a set of XA Resource Managers, and synchronize the commit or backout of transactions in both Resource Managers. This is how it works for a statically-registered resource manager:

1. An application notifies the syncpoint coordinator that it wishes to start a transaction.
2. The syncpoint coordinator issues a call to any resource managers that it knows of, to notify them of the current transaction.
3. The application issues a call (for example MQGET in syncpoint) to the resource manager that is associated with the current transaction.
4. The application requests that the syncpoint coordinator either commit or roll back the transaction.
5. The syncpoint coordinator issues a call to each resource manager using two-phase commit protocols to complete the transaction as requested.

XA requires each Resource Manager to provide a structure called an *XA Switch*. This structure declares the capabilities of the Resource Manager, and the functions that are to be called by the syncpoint coordinator.

8.1. XA Switch file for MQ Workflow

The necessary XA Switch file for MQ Workflow is provided by MQ Workflow. During configuring a queue manager that is responsible for MQ Workflow, the necessary XA ResourceManager stanza for DB2 is created. A sample stanza for MQ Workflow based on the values in the sample work sheet looks like

On AIX:

```
XAResourceManager:
   Name=db2ex1 FMCEXDB
   SwitchFile=/usr/lpp/fmc/db2swit/db2swit
   XAOpenString=FMCEXDB, db2ex1, password
```

On Solaris:

```
XAResourceManager:
   Name=db2ex1 FMCEXDB
   SwitchFile=/opt/fmc/db2swit/db2swit
   XAOpenString=FMCEXDB, db2ex1, password
```

The XA open string for DB2 must have the following format:

```
database_alias<,username,password>
```

where:

- database_alias is the name of the database, unless you have explicitly cataloged an alias name after the database has been created. In this case specify the alias instead.
  The following two parameters are optional. They provide alternative authentication information to the database if it was set up with authentication=server. This is required, if the database is not located on the same machine as the queue manager.
- *username* specifies a user ID defined to DB2.
- *password* is the password for the specified user ID.

Note: DB2 does not require an XA close string.

In an high availability environment the username and the password must be specified, even if the database is on the same machine as the queue manager. After a take over the database and the queue manager are working on a different system. The DB2 server authentication method cannot handle this because two different machines with possibly different DB2 instances are working on the remaining machine. In this case the HA software 'simulates' the second machine.

8.2. XA Open String considerations for MQ Workflow

If you have to consider security aspects for the password in the stanza, you have the following options:

1. In an environment where both DB2 and MQSeries are located on the same machine, and HA software is not available, remove the *username* and the *password* from the stanza.
2. You can set up the DB2 client authentication on the database server. This forces the authentication to be performed on the client that hosts the queue manager. You can also remove the *username* and the *password* from the stanza.
3. Establish a dedicated user on the database server and lock the account. This user does not have to be part of any group, nor have privileges on your system. It is only mandatory to give the user the DB2 connect privileges to the MQ Workflow database. If you specify this user including the password in the stanza, the transaction coordination works correctly.

9. Sample MQ Workflow configuration console output

In this section, you find the configuration console output that is created during performing the configuration steps. All data is related to the sample values provided in the MQ Workflow work sheet in *chapter 3.1 The MQ Workflow work* sheet. Assuming you choose different values, the output will be different.

9.1. Sample MQ Workflow environment configuration

To configure the MQ Workflow environment, you must be logged on as the root user. The following boxes show the sample output of the necessary steps, which are defining the general MQ Workflow environment and the MQ Workflow infrastructure. Details about these steps can be found in the *Installation Guide for MQSeries Workflow (Chapter: After Installing oMQ Workflow on UNIX).*

```
# fmczinsx -o env -c /fmcex/config -U fmcex1
FMC003 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
FMC004 +++ Started at ......: Mon Sep 24 12:33:01 DFT 2001
FMC005 +++ by user .........: root
FMC007 +++ invocation args .: /usr/bin/fmczinsx -o env -c /fmcex/config -U fmcex1
FMC009 +++ current version .: 3.3.0
FMC003 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
FMC00233 Check the MQSeries Workflow user/group = fmcex1/fmcgrp
FMC00231 Retrieve the MQSeries Workflow components and create installation profile
FMC00121 Creating the Workflow installation profile /usr/lpp/fmc/fmcrc
FMC00229 Operating system language: en_US
FMC00230 Installation language: enu
FMC00171 +++ Function completed successfully +++
FMC00172 +++ Log information is located in: /tmp/fmczinsx.log.tmp.107906
```

```
# fmczinsx -o inf
FMC003 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
FMC004 +++ Started at ......: Mon Sep 24 12:33:07 DFT 2001
FMC005 +++ by user .........: root
FMC007 +++ invocation args .: /usr/bin/fmczinsx -o inf
FMC009 +++ current version .: 3.3.0
FMC003 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
FMC00100 Values from installation profile /usr/lpp/fmc/fmcrc successfully read.
FMC00233 Check the MQSeries Workflow user/group = fmcex1/fmcgrp
FMC00233 Check the MQSeries Workflow user/group = fmcex1/fmcgrp
FMC00216 The directory /fmcex/config successfully created.
FMC00216 The directory /fmcex/config/cfgs successfully created.
FMC00216 The directory /fmcex/config/chltabs successfully created.
FMC00216 The directory /fmcex/config/ipc successfully created.
FMC00216 The directory /fmcex/config/log successfully created.
FMC00216 The directory /fmcex/config/qmgrs successfully created.
FMC00216 The directory /fmcex/config/rt_db successfully created.
FMC00171 +++ Function completed successfully +++
FMC00172 +++ Log information is located in: /fmcex/config/fmczinsx.log
```

```
# fmczinsx -o db2
FMC003 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
FMC004 +++ Started at ......: Mon Sep 24 12:33:12 DFT 2001
FMC005 +++ by user .........: root
FMC007 +++ invocation args .: /usr/bin/fmczinsx -o db2
FMC009 +++ current version .: 3.3.0
FMC003 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
FMC00100 Values from installation profile /usr/lpp/fmc/fmcrc successfully read.
FMC00150 System wide Workflow setup changed to support database DB2
FMC00155 Checking availability of required shared libraries for database DB2
FMC00156 Found shared library /usr/lib/libdb2.a
FMC00171 +++ Function completed successfully +++
FMC00172 +++ Log information is located in: /fmcex/config/fmczinsx.log
```

```
# fmczinsx -o mqs
FMC003 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
FMC004 +++ Started at ......: Mon Sep 24 12:33:16 DFT 2001
FMC005 +++ by user .........: root
FMC007 +++ invocation args .: /usr/bin/fmczinsx -o mqs
FMC009 +++ current version .: 3.3.0
FMC003 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
FMC00100 Values from installation profile /usr/lpp/fmc/fmcrc successfully read.
FMC00150 System wide Workflow setup changed to support MQServer interface
FMC00171 +++ Function completed successfully +++
FMC00172 +++ Log information is located in: /fmcex/config/fmczinsx.log
```

9.2. Sample configuration of a MQ Workflow configuration

You have to perform three steps to configure an MQ Workflow configuration. In the first step, you define the MQ Workflow configuration. To perform this step, you must be logged on as the root user. In the second step, an MQ Workflow database is created, and in the third step the MQ Workflow queue manager is created. Perform the second and the third step can be done directly after the first step by the root user or later. In this case you must be logged on as the MQ Workflow configuration administrator. The following boxes show the sample output of these steps, being all performed by the root user.

fmczutil console output - part 1 of 4

```
# fmczutil

   FMC33201I Configuration Commands Menu:
     l ... List
     c ... Create
     x ... Exit Configuration Commands Menu
c
     Configuration identifier : [FMC] FMCEX
     Configuration administrator : [fmcex1]

   FMC33210I Select Category Menu:
     s ... ( ) Server
     i ... ( ) Runtime Database Utilities
     c ... ( ) Client with queue manager
     j ... ( ) Java Agent
     w ... ( ) Web Client
     a ... all
     n ... none
     x ... Exit Select Category Menu
s
```

fmczutil console output - part 2 of 4

```
FMC33210I Select Category Menu:
     s ... (X) Server
     i ... (X) Runtime Database Utilities
     c ... (U) Client with queue manager
     j ... ( ) Java Agent
     w ... ( ) Web Client
     a ... all
     n ... none
     x ... Exit Select Category Menu
x
-  Configuration of Runtime database ...

     u ... ( ) Use an existing Runtime database
     n ... (X) Create a new Runtime database

     l ... (X) Local database
     r ... ( ) Remote database

     DB2 instance             : [db2inst1] db2ex1
     DB2 database             : [FMCDB] fmcexdb
     DB2 user ID of database administrator       : [fmcex1]
     DB2 database layout file : [/fmcex/config/cfgs/FMCEX/fmcdblay.ini]
     DB2 database location    : [/fmcex/config/rt_db/db2ex1/FMCEXDB] /fmcex/dbs
     DB2 container location   : [/fmcex/dbs] /fmcex/dbs/cont
     DB2 log files location   : [/fmcex/dbs] /fmcex/dbslog

   FMC33526I Select space management ...:
     s ... (X) Managed by system
     d ... ( ) Managed by database
     r ... ( ) Managed by database (using raw device)

-  FMC33749I Selected Space management : Managed by system

     DB2 user ID to access Runtime database      : [fmcex1]

     System group name        : [FMCGRP] exgrp
     System name              : [FMCSYS] exsys
     Queue manager name       : [FMCQM] fmcexqm
     Queue prefix             : [FMC] fmcex


-  Configuration of queue manager ...

   FMC33513I Select log type ...:
     c ... (X) Circular log
     l ... ( ) Linear log (prerequisite for backup)

-  FMC33749I Selected Log type : Circular log

     Queue manager log files location     : []

     Channel definition table file         : [/fmcex/config/chltabs/MQWFCHL.TAB]

     TCP/IP address           : [workflow]
     TCP/IP port number       : [14000] 5050

     Principal name           : [fmcex1]

     Cluster name             : [EXGRP] exclu

   FMC33537I Select repository type ...:
     f ... (X) 'FMCEXQM' is the first queue manager in cluster 'EXCLU'
     a ... ( ) 'FMCEXQM' is an additional queue manager in cluster 'EXCLU'

-  FMC33749I Selected Repository type : 'FMCEXQM' is the first queue manager in
cluster 'EXCLU'
```

fmczutil console output - part 3 of 4

```
   FMC33632I Transaction coordination will be used between MQSeries and DB2.
   FMC33633I The queue manager 'FMCEXQM' will connect to the database 'FMCEXDB'.

     DB2 user ID of transaction coordinator      : [fmcex1]

   FMC33506I Which user ID will regularly start the queue manager 'FMCEXQM'? :
     t ... ( ) the transaction coordinator user ID 'fmcex1'
     o ... (X) another user ID within the group 'mqm'

-  Configuration of client ...

     c ... Create configuration profile for 'FMCEX' now
     s ... Save input to file
     r ... Review/change input
     x ... Exit (input for configuration 'FMCEX' will be lost)
c
-  FMC33680I The profile for the configuration 'FMCEX' was updated successfully.

-  FMC33682I The general configuration profile was updated successfully.

-  Do you want to create the Runtime database 'FMCEXDB' now?
     y ... Yes
     n ... No
y
     Enter password for user ID 'fmcex1'   : []
     Confirm password for user ID 'fmcex1' : []
FMC33136I Generating database layout.
FMC33153W The managed by value for tablespaces belonging to group INDEX is not
customizable.
FMC33110I The database manager is already active.
FMC33115I Creating the database - FMCEXDB
FMC33116I Please wait... This may take a while.
FMC33117I Database FMCEXDB has been created.
FMC33120I Updating the database configuration.
FMC33132I Creating tablespaces.
FMC33133I Creating tables.
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbact.bnd (1/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbadm.bnd (2/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbadt.bnd (3/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbad2.bnd (4/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbatr.bnd (5/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbblk.bnd (6/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbccn.bnd (7/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbctr.bnd (8/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbdcn.bnd (9/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbepi.bnd (10/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdblst.bnd (11/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbmat.bnd (12/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbmod.bnd (13/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbopr.bnd (14/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbprc.bnd (15/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbqmg.bnd (16/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbses.bnd (17/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbsgo.bnd (18/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbstf.bnd (19/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbsvs.bnd (20/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbtop.bnd (21/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbtpl.bnd (22/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbwcs.bnd (23/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbwit.bnd (24/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbwiv.bnd (25/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcpqe01.bnd (26/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcpqe02.bnd (27/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcpqe03.bnd (28/39)
```

fmczutil console output - part 4 of 4

```
FMC33126I Binding /usr/lpp/fmc/bnd/fmcpqe04.bnd (29/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcpqe05.bnd (30/39)
FMC33143W Warning during bind occurred. See file
/fmcex/config/cfgs/FMCEX/log/fmcpqe05.msg.db2ex1 for details.
FMC33126I Binding /usr/lpp/fmc/bnd/fmcpqe06.bnd (31/39)
FMC33143W Warning during bind occurred. See file
/fmcex/config/cfgs/FMCEX/log/fmcpqe06.msg.db2ex1 for details.
FMC33126I Binding /usr/lpp/fmc/bnd/fmcpqe07.bnd (32/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcpqe08.bnd (33/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcpqe09.bnd (34/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcddsql.bnd (35/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbcln.bnd (36/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbntf.bnd (37/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbqry.bnd (38/39)
FMC33126I Binding /usr/lpp/fmc/bnd/fmcdbwcs.bnd (39/39)
FMC33130I Initializing the database.
FMC33003I fmczbstr -gEXGRP -sEXSYS -xFMCEX -dFMCEXDB -ufmcex1
FMC24500I fmczbstr is starting.
FMC24560I fmczbstr finished and found 0 errors 0 warnings. RC = 0
FMC33131I Loading reference FDL.
FMC20500I Start parsing /fmcex/config/cfgs/FMCEX/fdl/fmczref.fdl.
FMC25100I CREATE LEVEL '0' finished.
FMC25100I CREATE LEVEL '1' finished.
FMC25100I CREATE LEVEL '2' finished.
FMC25100I CREATE LEVEL '3' finished.
FMC25100I CREATE LEVEL '4' finished.
FMC25100I CREATE LEVEL '5' finished.
FMC25100I CREATE LEVEL '6' finished.
FMC25100I CREATE LEVEL '7' finished.
FMC25100I CREATE LEVEL '8' finished.
FMC25100I CREATE LEVEL '9' finished.
FMC25100I CREATE STRUCTURE 'Default Data Structure' finished.
FMC25100I REPLACE DOMAIN 'DOMAIN' finished.
FMC25100I REPLACE GROUP 'EXGRP' finished.
FMC25100I REPLACE SYSTEM 'EXSYS' finished.
FMC25100I REPLACE PERSON 'ADMIN' finished.
FMC25100I REPLACE ROLE 'System administrator' finished.
FMC25100I CREATE SERVER 'CLEANSVR.EXSYS.EXGRP' finished.
FMC25100I CREATE SERVER 'EXECSVR.EXSYS.EXGRP' finished.
FMC25100I CREATE SERVER 'SCHEDSVR.EXSYS.EXGRP' finished.
FMC25100I CREATE SERVER 'PESERVER.EXSYS.EXGRP' finished.
FMC25100I CREATE QUEUE_MANAGER 'FMCEXQM' finished.
FMC20510I Finished parsing /fmcex/config/cfgs/FMCEX/fdl/fmczref.fdl.
-  FMC33911I The new Runtime database FMCEXDB was created successfully.

-  Do you want to create the queue manager 'FMCEXQM' now?
     y ... Yes
     n ... No
y
MQSeries queue manager created.
Creating or replacing default objects for FMCEXQM.
Default objects statistics : 29 created. 0 replaced. 0 failed.
Completing setup.
Setup completed.
MQSeries queue manager 'FMCEXQM' started.
MQSeries queue manager ending.
MQSeries queue manager ended.
-  FMC33736I The queue manager FMCEXQM has been updated successfully.
   FMC33201I Configuration Commands Menu:
     l ... List
     s ... Select
     c ... Create
     x ... Exit Configuration Commands Menu
x
```

9.3. Sample verification of the MQ Workflow configuration

To verify the MQ Workflow configuration it is mandatory to start the server and recommended to check if the administration utility can connect to the server.

Server verification - console output

```
$ strmqm FMCEXQM
MQSeries queue manager 'FMCEXQM' started.
$ runmqtrm -m FMCEXQM -q FMCTRIGGER &
[1]    75142
$ 0783845, 5765-B73 (C) Copyright IBM Corp. 1994, 2000  ALL RIGHTS RESERVED.
MQSeries trigger monitor started.

_____________________________________________________
Waiting for a trigger message

$ fmcamain -y FMCEX &
[2]    40772
$ FMC10110I Administration server for system EXSYS started.

/fmcex/config/cfgs/FMCEX/bin/fmczemst 'TMC    2
     FMCEX.EXGRP.EXSYS.PROC.EXE
          /fmcex/config/cfgs/FMCEX/bin/fmczemst
               &
                    -i:ExeSvr -y:FMCEX
                         FMCEXQM                                    ' &
End of application trigger.

_____________________________________________________
Waiting for a trigger message

/fmcex/config/cfgs/FMCEX/bin/fmczemst 'TMC    2
     FMCEX.EXGRP.EXSYS.PROC.EXE
          /fmcex/config/cfgs/FMCEX/bin/fmczemst
               &
                    -i:ExeSvr -y:FMCEX
                         FMCEXQM                                    ' &
End of application trigger.

_____________________________________________________
Waiting for a trigger message
FMC10200I Execution server for system EXSYS started.
FMC10200I Execution server for system EXSYS started.
FMC10200I Execution server for system EXSYS started.

$ fmcautil -uadmin -ppassword -yFMCEX
-  FMC16006I Administration Utility started.
     System group name   : [EXGRP] EXGRP
     System name         : [EXSYS] EXSYS
     Userid              : [ADMIN] ADMIN
     Password            : [********] ********
-  FMC16301I UserID 'ADMIN' connected to system 'EXSYS'.
=  FMC16110I Receive thread for userID 'ADMIN' at system 'EXSYS' started.
   FMC15010I Main Menu:
     s ... System Commands Menu
     m ... Select Server Menu
     e ... Errorlog Commands Menu
     l ... Systemlog Commands Menu
     u ... User Commands Menu
     x ... Exit Main Menu
x
-  FMC16008I Waiting for receive thread(s) to complete. Please wait ...
=  FMC16120I Receive thread for userID 'ADMIN' at system 'EXSYS' ended.
$
```