



BEA Tuxedo

Using the BEA Tuxedo /Q Component

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Using the BEA Tuxedo /Q Component

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1 BEA Tuxedo /Q Overview

- General Description
- Queuing System Components and Tasks
- Administrator Tasks
- Programmer Tasks

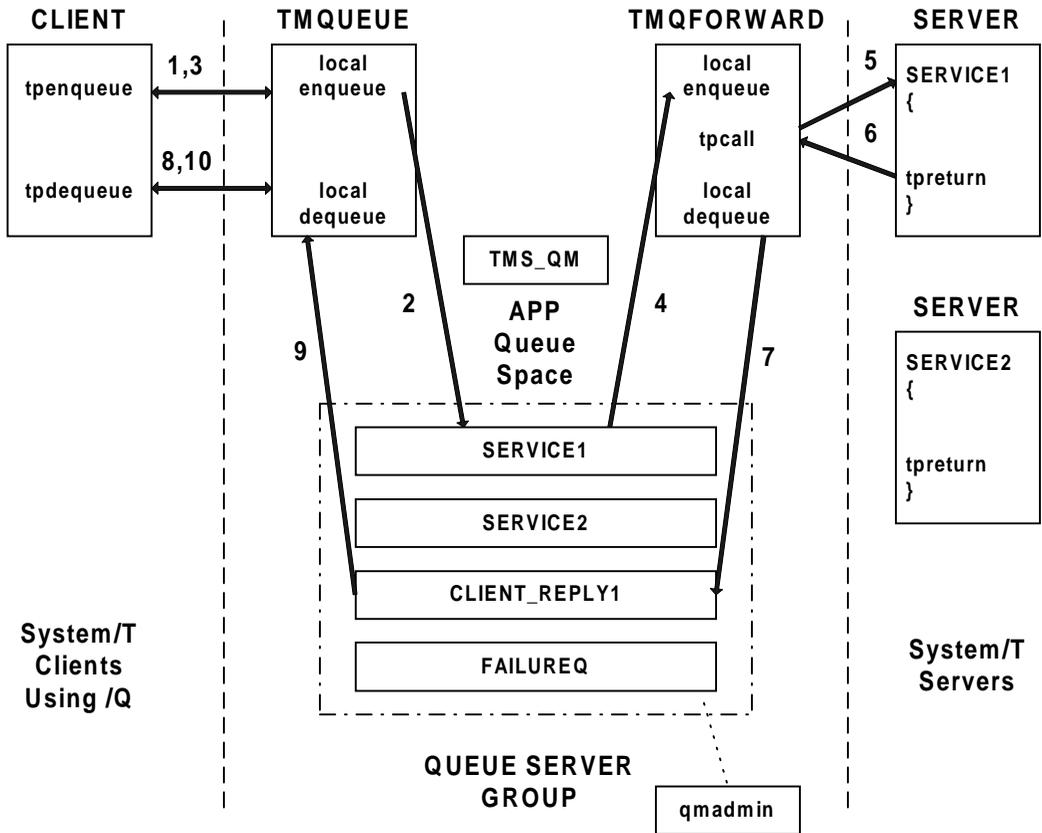
General Description

The BEA Tuxedo /Q component allows messages to be queued to persistent storage (disk) or to non-persistent storage (memory) for later processing or retrieval. The BEA Tuxedo Application-to-Transaction Monitor Interface (ATMI) provides functions that allow messages to be added to or read from queues. Reply messages and error messages can be queued for later return to client programs. An administrative command interpreter is provided for creating, listing, and modifying the queues. Servers are provided to accept requests to enqueue and dequeue messages, to forward messages from the queue for processing, and to manage the transactions that involve the queues.

Queuing System Components and Tasks

The following figure shows the components of the queued message facility.

Figure 1-1 Queued Service Invocation



The figure illustrates how each component of the queuing system operates for queued service invocation. In this discussion, we use the figure to explain how administrators and programmers work with the BEA Tuxedo /Q component to define it and use it to

queue a message for processing and get back a reply. The queuing service may also be used for simple peer-to-peer communication by using a subset of the components shown in the figure.

A queue space is a resource. Access to the resource is provided by an X/OPEN XA-compliant resource manager interface. This interface is necessary so that enqueueing and dequeueing can be done as part of a 2-phase committed transaction in coordination with other XA-compliant resource managers.

Administrator Tasks

The BEA Tuxedo administrator is responsible for defining servers and creating queue spaces and queues like those shown between the vertical dashed lines in the figure “Queued Service Invocation” on page 1-2.

The administrator must define at least one queue server group with `TMS_QM` as the transaction manager server for the group.

Two additional system-provided servers need to be defined in the configuration file. These servers perform the following functions:

- The message queue server, `TMQUEUE(5)`, is used to enqueue and dequeue messages. This provides a surrogate server for doing message operations for clients and servers, whether or not they are local to the queue.
- The message forwarding server, `TMQFORWARD(5)`, is used to dequeue and forward messages to application servers. The BEA Tuxedo system provides a `main()` for servers that handles server initialization and termination, allocates buffers to receive and dispatch incoming requests to service routines, and routes replies to the correct destination. All of this processing is transparent to the application. Existing servers do not dequeue their own messages or enqueue replies. One goal of BEA Tuxedo /Q is to be able to use existing servers to service queued messages, without change. The `TMQFORWARD` server dequeues a message from one or more queues in the queue space, forwards the message to a server with a service that is named the same as the queue, waits for the reply, and queues the success reply or failure reply on the associated reply or failure queues, respectively, as specified by the originator of the message (if the originator specified a reply or failure queue).

An administrator also must create a queue space using the queue administration program, `qmadmin(1)`, or the `APPQ_MIB(5)` Management Information Base (MIB). The queue space contains a collection of queues. In the figure “Queued Service Invocation” on page 1-2, for example, four queues are present within the APP queue space. There is a one-to-one mapping of queue space to queue server group since each queue space is a resource manager instance and only a single RM can exist in a group.

The notion of queue space allows for reducing the administrative overhead associated with a queue by sharing the overhead among a collection of queues in the following ways:

- The queues in a queue space share persistent and non-persistent storage areas for messages.
- A single message queue server, `TMQUEUE` in the figure “Queued Service Invocation” on page 1-2, can be used to enqueue and dequeue messages for multiple queues within a single queue space.
- A single message forwarding server, `TMQFORWARD` in the figure “Queued Service Invocation” on page 1-2, can be used to dequeue and forward messages to services from multiple queues within a single queue space.
- Two instances of the transaction manager server, `TMS_QM` in the figure “Queued Service Invocation” on page 1-2, can be used to complete transactions for multiple queues within a single queue space. One instance of the transaction manager server is reserved for non-blocking transactions so that they will be processed as quickly as possible and not be held up by blocking transactions. Blocking transactions are handled by the second instance of the transaction manager server.
- The administrator can define a single server group in the application configuration for the queue space by specifying the group in `UBBCONFIG` or by using `tmconfig(1)` (see `tmconfig`, `wtmconfig(1)`) to add the group dynamically.
- Finally, when the administrator moves messages between queues within a queue space the overhead is less than if the messages were in different stable storage areas, because a one-phase commit can be done.

Part of the task of defining a queue is specifying the order for messages on the queue. Queue ordering can be determined by message availability time, expiration time, priority, `FIFO`, `LIFO`, or a combination of these criteria.

The administrator specifies one or more of these sort criteria for the queue, listing the most significant criteria first. The `FIFO` and `LIFO` values must be the least significant sort criteria. Messages are put on the queue according to the specified sort criteria and dequeued from the top of the queue. The administrator can configure as many message queuing servers as are needed to keep up with the requests generated by clients for the stable queues.

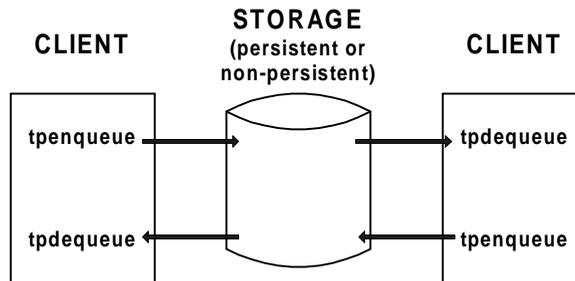
Data-dependent routing can be used to route between multiple server groups with servers offering the same service.

For housekeeping purposes, the administrator can set up a command to be executed when a threshold is reached for a queue that does not routinely get drained. This can be based on the bytes, blocks, or percentage of the queue space used by the queue or the number of messages on the queue. The command might boot a `TMQFORWARD` server to drain the queue or send mail to the administrator for manual handling.

The BEA Tuxedo system uses the Queuing Services component of the BEA Engine for some operations. (The BEA Engine provides services to BEA Systems products such as BEA Tuxedo and BEA WebLogic Enterprise.) For example, administrative operations for shared memory are provided by the Queuing Services component. Some functions are not currently applicable to BEA Tuxedo applications; this is noted in descriptions of these functions.

You can also use the queued message facility for peer-to-peer communication between clients, such that a client communicates with other clients without using any forwarding server. The peer-to-peer communication model is shown in the following figure.

Figure 1-2 Peer-to-Peer Communication



Programmer Tasks

In steps 1 through 3 of the figure “Queued Service Invocation” on page 1-2, a client enqueues a message to the `SERVICE1` queue in the APP queue space using `tpenqueue(3c)`. Optionally, the name of a reply queue and a failure queue can be included in the call to `tpenqueue()`. In the example they are the queues `CLIENT_REPLY1` and `FAILURE_Q`. The client can specify a *correlation identifier* value to accompany the message. This value is persistent across queues so that any reply or failure message associated with the queued message can be identified when it is read from the reply or failure queue.

The client can use the default queue ordering (for example, a time after which the message should be made available for dequeuing), or can specify an override of the default queue ordering (asking, for example, that this message be put at the top of the queue or ahead of another message on the queue). `tpenqueue()` sends the message to the `TMQUEUE` server, the message is queued, and an acknowledgment (step 3) is sent to the client; the acknowledgment is not seen directly by the client but can be assumed when the client gets a successful return. (A failure return includes information about the nature of the failure.)

A message identifier assigned by the queue manager is returned to the application. The identifier can be used to dequeue a specific message. It can also be used in another `tpenqueue()` to identify a message already on the queue that the subsequent message should be enqueued ahead of.

Before an enqueued message is made available for dequeuing, the transaction in which the message is enqueued must be committed successfully.

When using BEA Tuxedo /Q for queued service invocation, and the message reaches the top of the queue, the `TMQFORWARD` server dequeues the message and forwards it, via `tpcall(3c)`, to a service with the same name as the queue name. In the figure “Queued Service Invocation” on page 1-2, the queue and the service are named `SERVICE1` and steps 4, 5, and 6 in the figure show this. The client identifier and the application authentication key are set to the client that caused the message to be enqueued; they accompany the dequeued message as it is sent to the service.

When the service returns a reply, `TMQFORWARD` enqueues the reply (with an optional user-return code) to the reply queue (step 7 in the figure “Queued Service Invocation” on page 1-2).

Sometime later (steps 8, 9 and 10 in the figure “Queued Service Invocation” on page 1-2), the client uses `tpdequeue(3c)` to read from the reply queue `CLIENT_REPLY1` in order to get the reply message.

You can dequeue messages without removing them from the queue by using the `TPQPEEK` flag with `tpdequeue()`. Messages that have expired or have been deleted by an administrator are immediately removed from the queue.

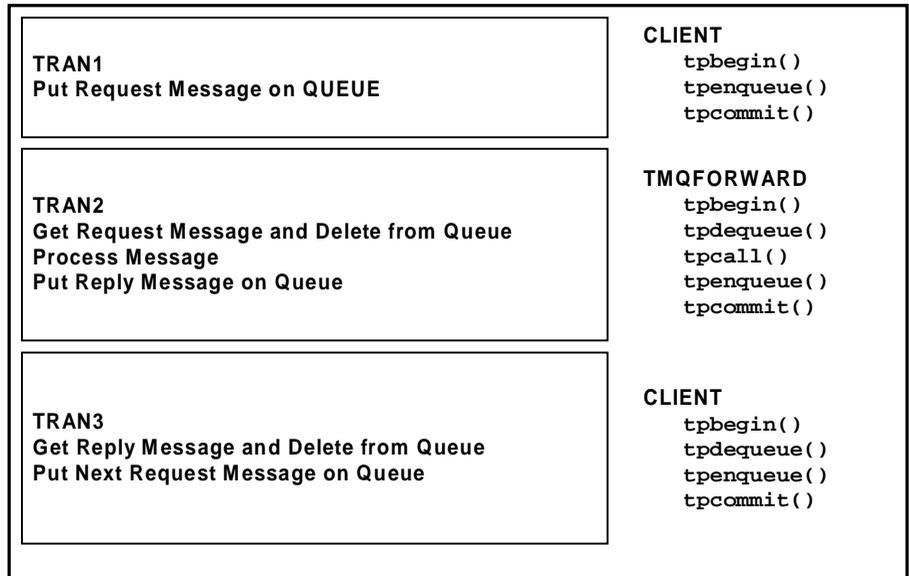
Transaction Management

With regard to transaction management, one goal is to ensure reliability by enqueueing and dequeuing messages within global transactions. However, a conflicting goal is to reduce the execution overhead by minimizing the number of transactions that are involved.

An option is provided for the caller to enqueue a message outside any transaction in which the caller is involved (decoupling the queuing from the caller's transaction). However, a timeout in this situation leaves it unknown as to whether or not the message is enqueued.

A better approach is to enqueue the message within the caller's transaction, as is shown in the following figure.

Figure 1-3 Transaction Demarcation



In the figure, the client starts a transaction, queues the message and commits the transaction. The message is dequeued within a second transaction started by `TMQFORWARD`; the service is called with `tpcall(3c)`, is executed and the reply is enqueued within the same transaction. A third transaction, started by the client, is used to dequeue the reply (and possibly enqueue another request message). In ongoing processing the third and first transactions can meld into one since enqueueing the next request can be done in the same transaction as dequeuing the response from the previous request.

Note: The system allows you to dequeue a response from one message and enqueue the next request within the same transaction, but does not allow you to enqueue a request and dequeue the response within the same transaction. The transaction in which the request is enqueued must be successfully committed before the message is available for dequeuing.

Handling Reply Messages

A reply queue can be either specified or not by the application when calling `tpenqueue()`. The effect is as follows:

- If a reply queue is not specified for a queued message, then no further work is required beyond processing the message.
- If a message is dequeued that does specify a reply queue, then the originator of the message expects a reply to be enqueued upon successful completion of the execution of the request.
 - In the case where the application explicitly dequeues the message using `tpdequeue()`, it is the responsibility of the application to call `tpenqueue()` to enqueue the reply. Normally, this would be done in the same transaction in which the request message is dequeued and executed so the entire operation is handled atomically (that is, the reply is enqueued only if the transaction succeeds).
 - In the case where the message is automatically processed by a service (dequeued and passed to the application via a `tpcall()`) by `TMQFORWARD`, `TMQFORWARD` enqueues a reply if the application service returns successfully (that is, the service routine called `tpreturn(3c)` with `TPSUCCESS` and `tpcall()` did not return 1). If `tpcall()` receives data, then the typed buffer used is enqueued to the reply queue. If no data is received in `tpcall()`, then a message with no data (that is, a `NULL` message) is enqueued; the fact that a message is enqueued (even if `NULL`) is sufficient to signify that the operation has been completed.

Error Handling

Handling of errors requires both an understanding of the nature of the errors the application may encounter and careful planning and coordination between the BEA Tuxedo administrator and the application program developers. The way BEA Tuxedo /Q works, if a message is dequeued within a transaction and the transaction is rolled back, then (if the retry parameter is greater than 0) the message ends up back on the queue where it can be dequeued and executed again.

For a transient problem, it may be desirable to delay for a short period before retrying to dequeue and execute the message, allowing the transient problem to clear. For example, if there is a lot of activity against the application database, there may be occasions when all you need is a little time to allow locks in a database to be released by another transaction. Normally, a limit on the number of retries is also useful to ensure that some application flaw doesn't cause significant waste of resources. When a queue is configured by the administrator, both a retry count and a delay period (in seconds) can be specified. A retry count of 0 implies that no retries are done. After the retry count is reached, the message is moved to an error queue that can be configured by the administrator for the queue space.

There are cases where the problem is not transient. For example, the queued message may request operations on an account that does not exist. In this case, it is desirable not to waste any resources by trying again. If the application programmer or administrator determines that failures for a particular operation are never transient, then it is simply a matter of setting the retry count to zero. It is more likely the case that for the same service some problems will be transient and some problems will be permanent; the administrator and application developers need to have more than a single approach to handle errors.

Other variations come about because the application may either dequeue messages directly or use the `TMQFORWARD` server and because an error may cause a transaction to be rolled back and the message requeued while logic dictates that the transaction should be committed. These variations and ways to deal with them are discussed in “BEA Tuxedo /Q Administration” on page 2-1, “BEA Tuxedo /Q C Language Programming” on page 3-1, and “BEA Tuxedo /Q COBOL Language Programming” on page 4-1.

Summary

To summarize, BEA Tuxedo /Q provides the following features to BEA Tuxedo application programmers and administrators:

- An application programming interface that lets you enqueue a request for subsequent processing. The system guarantees to execute the request successfully exactly once (by default, failure causes the message to be put back on the queue). An application programming interface is also provided to dequeue messages either from the top of a queue or by message identifier or correlation identifier.

- The application program and/or the administrator can control the ordering of messages on the queue. Control is via the sort criteria, which may be based on message availability time, expiration time, priority, LIFO, FIFO, or a combination of these criteria. The application can override the ordering to place the message at the queue top or ahead of a specific message that is already queued.
- A BEA Tuxedo server is provided to enqueue and dequeue messages on behalf of, possibly remote, clients and servers. The administrator decides how many copies of the server should be configured.
- A BEA Tuxedo server is provided to dequeue queued messages and forward them to services for execution. This server allows for existing servers to handle queued requests without modification. Each forwarding server can be configured to handle one or more queues. Transactions are used to guarantee exactly-once processing. The administrator controls how many forwarding servers are configured.
- The administrator can control messages stored on the queues for processing. This includes the number of times requests are retried on failure and how much time elapses between retries, reordering messages on queues, managing queue capacity and so on.

There are many application paradigms in which queued messages can be used. This feature can be used to queue requests when a machine, server, or resource is unavailable or unreliable (for example, in the case of a wide-area or wireless networks). This feature can also be used for work flow provisioning where each step generates a queued request to do the next step in the process. Yet another use is for batch processing of potentially long running transactions, such that the initiator does not have to wait for completion but is assured that the message will eventually be processed. This facility may also be used to provide a data pipe between two otherwise unrelated applications in a peer-to-peer relationship.

2 BEA Tuxedo /Q Administration

- Introduction
- Configuration
- Creating Queue Spaces and Queues
- Handling Encrypted Message Buffers
- Maintenance of the BEA Tuxedo /Q Feature
- Windows NT Standard I/O

Introduction

The BEA Tuxedo /Q administrator has three primary areas of responsibility, which are:

- Configuration of resources
- Creation of the queue space and queues
- Monitoring and maintenance of the facility

Close cooperation with the application developers and programmers is a must; the configuration and the queue attributes must reflect the requirements of the application.

Available Sample Program Called `qsample`

A brief example of the use of the queued message facility is distributed with the software and is described in “A Sample Application” on page A-1.

Configuration

Three servers are provided with the BEA Tuxedo /Q component. One is the TMS server, `TMS_QM`, that is the transaction manager server for the BEA Tuxedo /Q resource manager. That is, it manages global transactions for the queued message facility. It must be defined in the `GROUPS` section of the configuration file.

The other two, `TMQUEUE(5)` and `TMQFORWARD(5)`, provide services to users. They must be defined in the `SERVERS` section of the configuration file.

The application can also create its own queue servers, if the functionality of `TMQFORWARD` does not fully meet the needs of the application. For example, the administrator might want to have a special server to dequeue messages moved to the error queue.

The application can also choose peer-to-peer communication. In this case, the application communicates with other applications, or a client communicates with other clients, by not using any forwarding server.

Specifying the QM Server Group

There must be a server group defined for each queue space the application will use. In addition to the standard requirements of a group name tag and a value for `GRPNO` (see `UBBCONFIG(5)` for details). The `TMSNAME` and `OPENINFO` parameters need to be set. Here are examples:

```
TMSNAME=TMS_QM
```

and

```
OPENINFO="TUXEDO/QM:<device_name>:<queue_space_name>"
```

TMS_QM is the name for the transaction manager server for BEA Tuxedo /Q. In the OPENINFO parameter, TUXEDO/QM is the literal name for the resource manager as it appears in \$TUXDIR/udataobj/RM. The values for `<device_name>` and `<queue_space_name>` are instance-specific and must be set to the pathname for the universal device list and the name associated with the queue space, respectively. These values are specified by the BEA Tuxedo administrator using `qmadmin(1)`.

Note: The chronological order of these specifications is not critical. The configuration file can be created either before or after the queue space is defined. The important thing is that the configuration must be defined and queue space and queues created before the facility can be used.

There can be only one queue space per GROUPS section entry. The CLOSEINFO parameter is not used.

The following example is taken from the reference page for TMQUEUE(5).

```
*GROUPS
TMQUEUEGRP1 GRPNO=1 TMSNAME=TMS_QM
    OPENINFO="TUXEDO/QM:/dev/device1:myqueuespace"
TMQUEUEGRP2 GRPNO=2 TMSNAME=TMS_QM
    OPENINFO="TUXEDO/QM:/dev/device2:myqueuespace"
```

Specifying the Message Queue Server

The TMQUEUE(5) reference page gives a full description of the SERVERS section of the configuration file, but there are some points worth additional emphasis here.

Operation Timeout

TMQUEUE recognizes a `-t timeout` option when specified after the double dash (`--`) in the CLOPT parameter. This timeout value affects only operations begun within the server if it finds that a transaction is not in effect, in other words, either the client called `tpenqueue(3c)` or `tpdequeue(3c)` without first calling `tpbegin(3c)` or it began a transaction and called `tpenqueue()` or `tpdequeue()` with the TPNOTRAN flag set to exclude the queue request from the client's transaction. The default for `timeout` is 30 seconds. If a `tpdequeue` request is received with the `flags` set to TPQWAIT, a TPETIME error will be returned if the wait exceeds `-t timeout` seconds.

Note: `ctl` is a structure of type `TPQCTL` used by `tpenqueue(3c)` and `tpdequeue(3c)` to pass parameters between the calling process and the system. `TPQWAIT` is a flag setting available in `tpdequeue` to indicate that the process wishes to wait for a reply message. The structure is explained in detail in “TPQCTL Structure” on page 3-6 and “TPQUEDEF-REC Structure” on page 4-6. The COBOL equivalent is the `TPQUEDEF-REC` record.

Queue Space Names, Queue Names, and Service Names

There is potential confusion among queue space names, queue names, and service names. The first place you are apt to encounter the confusion is in the specification of the message queue server: `TMQUEUE`. When specifying this server in the configuration file you can use the `-s` flag of the `CLOPT` parameter to name the queue space served by a given instance of the server, which is the same as saying it is a service advertised by the function: `TMQUEUE`. In an application that uses only one queue space, it is not necessary to specify the `CLOPT -s` option; it will default to `-s TMQUEUE:TMQUEUE`. If the application requires more than a single queue space, the names of the queue spaces are included as arguments to the `-s` option in the `SERVERS` section entry for the queued message server.

An alternative way of making this specification is to rebuild the message queue server, using `buildserver(1)`, and name the queue spaces with the similar sounding `-s` option. This has the result of fixing, or *hardcoding*, the service names in the server executable.

The following two specifications are equivalent:

```
*SERVERS
TMQUEUE SRVGRP="TMQUEUEGRP1" SRVID=1000 RESTART=Y GRACE=0 \
    CLOPT="-s myqueuespace:TMQUEUE"
and
buildserver -o TMQUEUE -s myqueuespace:TMQUEUE -r TUXEDO/QM \
    -f ${TUXDIR}/lib/TMQUEUE.o
followed by
..
..
..
TMQUEUE SRVGRP="TMQUEUEGRP1" SRVID=1000 RESTART=Y GRACE=0 \
    CLOPT="-A"
```

Data-dependent Routing

The preceding discussion described the specification of services (that is, queue space names) in the message queue server. This capability can be used to bring about data-dependent routing of queued messages such that the message is queued for processing by a service within a specific group depending on a value in a field of the message buffer. To do this the same queue space name is specified in two different groups and a routing specification is made part of the configuration file to govern the group where the message is queued. Here is an example taken from the `TMQUEUE(5)` reference page (the queue space name has been changed).

```
*GROUPS
TMQUEUEGRP1 GRPNO=1 TMSNAME=TMS_QM
    OPENINFO="TUXEDO/QM:/dev/device1:myqueuespace"
TMQUEUEGRP2 GRPNO=2 TMSNAME=TMS_QM
    OPENINFO="TUXEDO/QM:/dev/device2:myqueuespace"
*SERVERS
TMQUEUE SRVGRP="TMQUEUEGRP1" SRVID=1000 RESTART=Y GRACE=0 \
    CLOPT="-s ACCOUNTING:TMQUEUE"
TMQUEUE SRVGRP="TMQUEUEGRP2" SRVID=1000 RESTART=Y GRACE=0 \
    CLOPT="-s ACCOUNTING:TMQUEUE"
*SERVICES
ACCOUNTING ROUTING="MYROUTING"
*ROUTING
MYROUTING FIELD=ACCOUNT BUFTYPE="FML" \
    RANGES="MIN-60000:TMQUEUEGRP1,60001-MAX:TMQUEUEGRP2"
```

Customized Buffer Types

`TMQUEUE` supports all of the standard BEA Tuxedo buffer types. If your application needs to add other types, it can be done by copying `$TUXDIR/tuxedo/tuxlib/types/tmsypesw.c`, adding an entry for your special buffer types, making sure to leave the final line null, and using the revised file as input to a `buildserver(1)` command. An example of the `buildserver` command is shown on the `TMQUEUE(5)` reference page.

You can also use the `-s` option of the `buildserver` command to associate additional service names with `TMQUEUE` as an alternative to specifying them in the server `CLOPT` parameter (see above).

Buffer Subtypes

You can assign a subtype to a buffer using the `tpalloc(3c)` subtype parameter and later extract the subtype using the `tpypes(3c)` function. This gives you the ability to assign a type to data without having to create an entirely new user-defined BEA Tuxedo buffer type. This is especially useful for buffers containing character arrays (`CARRAY`) or strings (`STRING`).

Specifying the Message Forwarding Server

The third system-supplied server included with the BEA Tuxedo /Q component is `TMQFORWARD(5)`. This is the server that takes messages from specified queues, passes them along to BEA Tuxedo servers via `tpcall(3c)`, and handles associated reply messages. The full description of how the server is defined in the configuration file can be found on the `TMQFORWARD(5)` reference page, but the topics that follow bring out some points that are worth additional emphasis.

`TMQFORWARD` is referred to as a server and each instance used by an application must be defined in the `SERVERS` section of the configuration file, but it has characteristics that set it apart from ordinary servers. For example:

- It is incorrect to specify services for `TMQFORWARD`.
- A client process cannot post a message for `TMQFORWARD` as you would expect in a normal request/response relationship.
- `TMQFORWARD` should not be defined as a member of an `MSSQ` set.
- `TMQFORWARD` should never have a reply queue.

An instance of `TMQFORWARD` is tied to a queue space through the server group with which it is associated, specifically through the third field in the `OPENINFO` statement for the group. In the topics that follow we will examine other key parameters, especially `CLOPT` parameters that come after the double dash.

Queue Names and Service Names: the `-q` option

A required parameter is `-q queue_name, queue_name. . .` This parameter specifies the queue(s) to be checked by this instance of the server. `queue_name` is a NULL-terminated string of up to 15 characters; it is the same as the name of the

application service that will process the message once it has been taken off the queue by `TMQFORWARD`. It is also the name that a programmer specifies as the second argument of `tpenqueue(3c)` or `tpdequeue(3c)` when preparing to call the message queue server, `TMQUEUE`.

Controlling Transaction Timeout: the `-t` option

`TMQFORWARD` does its work within a transaction that it begins and ends. The `-t trantime` option is available to specify the length of time in seconds before the transaction is timed out. The transaction is begun when `TMQFORWARD` finds a message on the queue it is checking; it is committed after a reply has been enqueued either to the reply queue or the failure queue, so the transaction encompasses calling the service that processes the message and receiving a reply. The default is 60 seconds.

Controlling Idle Time: the `-i` option

Once `TMQFORWARD` is booted it periodically checks the queue to which it is assigned. If it finds the queue empty, it pauses for `-i idletime` seconds before checking again. If a value is not specified, the default is 30 seconds; a value of 0 says to keep checking the queue constantly, which can be wasteful of CPU resources if the queue is frequently empty.

Controlling Server Exit: the `-e` option

If the `-e` option is specified, the server will shut itself down gracefully (and will create a userlog message) when it finds the queue empty. This behavior may be used to your advantage in connection with the threshold command that you can specify for a queue. There is a more complete discussion about the `-e` option and the threshold command in “Creating Queue Spaces and Queues” on page 2-8.

Delete Message after Service Failure: the `-d` option

When a service request fails after being called by `TMQFORWARD`, the transaction is rolled back, and the message is put back on the queue for a later retry (up to a limit of retries specified for the queue). The `-d` option adds the following refinement: if the failed service returns a non-NULL reply, the reply (and its associated `tpurcode`) are put on a failure queue (if one is associated with the message and the queue exists) and the

original request message is deleted. Also with the `-d` option, if the original request message is to be deleted at the same time as the retry limit configured for the queue is reached, the original request message is put into the error queue.

The rationale behind this option is that rather than blindly retrying, the originating client can be coded to examine the failure message and determine whether further attempts are reasonable. It provides a way of handling a failure that is due to some inherently reasonable condition (for example, a record is *not found* because the account does not exist).

Customized Buffer Types

Customized application buffer types can be added to the type switch and incorporated into `TMQFORWARD` with the `buildserver(1)` command. It should be noted, however, that when you customize `TMQFORWARD` it is an error to specify service names with a `-s` option.

Dynamic Configuration

We have described configuration parameters in terms of `UBBCONFIG` parameters. However, it should be noted that the specifications in the `GROUPS` and `SERVERS` sections can also be added to the `TUXCONFIG` file of a running application by using `tmconfig(1)` (see `tmconfig`, `wtmconfig(1)`). Of course, the group and the servers will have to be booted once they have been defined.

Creating Queue Spaces and Queues

This topic covers three of the `qadmin(1)` commands that are used to establish the resources of the BEA Tuxedo /Q component. The `APPQ_MIB` Management Information Base provides an alternative method of administering BEA Tuxedo /Q programmatically. See the `APPQ_MIB(5)` reference page for more information on the MIB.

Working with `qadmin` Commands

Most of the key commands of `qadmin` have positional parameters. If the positional parameters (those not specified with a dash (-) preceding the option) are not specified on the command line when the command is invoked, `qadmin` prompts you for the required information.

Creating an Entry in the Universal Device List: `crdl`

The universal device list (UDL) is a VTOC file under the control of the BEA Tuxedo system. It maps the physical storage space on a machine where the BEA Tuxedo system is run. An entry in the UDL points to the disk space where the queues and messages of a queue space are stored; the BEA Tuxedo system manages the input and output for that space. If the queued message facility is installed as part of a new BEA Tuxedo installation, the UDL is created by `tmloadcf(1)` when the configuration file is first loaded.

Before you create a queue space, you must create an entry for it in the UDL. Here is an example of the commands:

```
# First invoke the /Q administrative interface, qadmin
# The QMCONFIG variable points to an existing device where the UDL
# either resides or will reside.
QMCONFIG=/dev/rawfs qadmin
# Next create the device list entry
crdl /dev/rawfs 50 500
# The above command sets aside 500 physical pages beginning at block
# 50
# If the UDL has no previous entries, offset (block number) 0 must
# be used
```

If you are going to add an entry to an existing BEA Tuxedo UDL, the value for the `QMCONFIG` variable must be the same pathname specified in `TUXCONFIG`. Once you have invoked `qadmin`, it is recommend that you run a `lidl` command to see where space is available before creating your new entry.

Creating a Queue Space: `qspacecreate`

A queue space makes use of IPC resources; when you define a queue space you are allocating a shared memory segment and a semaphore. As noted above, the easiest way to use the command is to let it prompt you. (You can also use the `T_APPQSPACE` class of the `APPQ_MIB(5)` to create a queue space.) The sequence looks like this.

```
> qspacecreate
Queue space name: myqueuespace
IPC Key for queue space: 230458
Size of queue space in disk pages: 200
Number of queues in queue space: 3
Number of concurrent transactions in queue space: 3
Number of concurrent processes in queue space: 3
Number of messages in queue space: 12
Error queue name: errq
Initialize extents (y, n [default=n]):
Blocking factor [default=16]: 16
```

The program insists that you provide values for all prompts except the final three. As you can see, there are defaults for the last two; while you will almost certainly want to name an error queue, you are not required to. If you provide a name here, you must create the error queue with the `qcreate` command. If you choose not to name an error queue, bear in mind that messages that normally would be moved to the error queue (for example, when a retry limit is reached), are permanently lost.

The program does not prompt you to specify the size of the area to reserve in shared memory for storing non-persistent messages for all queues in the queue space. When you require non-persistent (memory-based) messages, you must specify the size of the memory area on the `qspacecreate` command line with the `-n` option.

The value for the IPC key should be picked so as not to conflict with your other requirements for IPC resources. It should be a value greater than 32,768 and less than 262,143.

The size of the queue space, the number of queues, and the number of messages that can be queued at one time all depend on the needs of your application. Of course, you cannot specify a size greater than the number of pages specified in your UDL entry. In connection with these parameters, you also need to look ahead to the queue capacity parameters for an individual queue within the queue space. Those parameters allow you to (a) set a limit on the number of messages that can be put on a queue, and (b) name a command to be executed when the number of enqueued messages on the queue

reaches the threshold. If you specify a low number of concurrent messages for the queue space, you may create a situation where your threshold on a queue will never be reached.

To calculate the number of concurrent transactions, count each of the following as one transaction:

- Each `TMS_QM` server in the group that uses this queue space
- Each `TMQUEUE` or `TMQFORWARD` server in the group that uses this queue space
- `qadmin`

If your client programs begin transactions before they call `topenqueue`, increase the count by the number of clients that might access the queue space concurrently. The worst case is that all clients access the queue space at the same time.

For the number of concurrent processes count one for each `TMS_QM`, `TMQUEUE` or `TMQFORWARD` server in the group that uses this queue space and one for a fudge factor.

You can choose to initialize the queue space as you use the `qspacecreate` command, or you can let it be done by the `qopen` command when you first open the queue space.

Creating a Queue: `qcreate`

Each queue that you intend to use must be created with the `qadmin qcreate` command. You first have to open the queue space with the `qopen` command. If you do not provide a queue space name, `qopen` will prompt for it. (You can also use the `T_APPQ` class of the `APPQ_MIB(5)` to create a queue.)

The prompt sequence for `qcreate` looks like this.

```
> qcreate
Queue name: servicel
Queue order (priority, time, fifo, lifo): fifo
Out-of-ordering enqueueing (top, msgid, [default=none]): none
Retries [default=0]: 2
Retry delay in seconds [default=0]: 30
High limit for queue capacity warning (b for bytes used, B for
blocks used,
% for percent used, m for messages [default=100%]): 80%
Reset (low) limit for queue capacity warning [default=0%]: 0%
Queue capacity command:
```

```
No default queue capacity command
Queue 'servicel' created
```

You can skip all of these prompts (except the prompt for the queue name); if you do not provide a name for the queue, the program displays a warning message and prompts again. For the other parameters, the program provides a default and displays a message that specifies the default.

The program does not prompt you for a default delivery policy and memory threshold options. The default delivery policy option allows you to specify whether messages with no specified delivery mode are delivered to persistent (disk-based) or non-persistent (memory-based) storage. The memory threshold option allows you to specify values used to trigger command execution when a non-persistent memory threshold is reached. To use these options, you must specify them on the `qcreate` command line with `-d` and `-n`, respectively.

Specifying Queue Order

Messages are put into the queue based on the order specified by this parameter and dequeued from the top of the queue unless selection criteria are applied to the dequeuing operation. If `priority`, `expiration`, and/or `time` are chosen as queue order criteria, then messages are inserted into the queue according to values in the `TPQCTL` structure. A combination of sort criteria may be specified with the most significant criteria specified first. Separate multiple criteria with commas (`,`). If `fifo` or `lifo` (which are mutually exclusive) are specified, they must be the last value specified. The sequence in which parameters are specified determines the sort criteria for the queue. In other words, a specification of `priority, fifo` would say that the queue should be arranged by message priority and that within messages of equal priority they should be dequeued on a first in, first out basis.

Enabling Out-of-order Enqueuing

If the administrator enables out-of-order enqueues; that is, if `top` and/or `msgid` are specified at the prompt, programmers can specify (via values in the `TPQCTL` structure of a `topenqueue` call) that a message is to be put at the top of the queue or ahead of the message identified by `msgid`. Give this option some thought; once the choice is made you have to destroy and recreate the queue to change it.

Specifying Retry Parameters

Normal behavior for a queued message facility is to put a message back on the queue if the transaction that dequeues it is rolled back. It will be dequeued again when it reaches the top of the queue. You can specify the number of retries that should be attempted and also a time delay between retries. Note that when a dequeued message is put back on the queue for retry, queue order specifications are, in effect, suspended for *Retry delay* seconds. During this time, the message is unavailable for any dequeuing operation.

The default for the number of retries is 0, which means that no retries are attempted. When the retry limit is reached, the system moves the message to the error queue for the queue space, assuming an error queue has been named and created. If the error queue does not exist the message is discarded.

The delay time is expressed in seconds. When message queues are lightly populated so that a message restored to the queue reaches the top almost immediately, you can save CPU cycles by building in a delay factor. Your general policy on retries should be based on the experience of your particular application. If you have a fair amount of contention for the service associated with a given queue, you may get a lot of transient problems. One way to deal with them is to specify a large number of retries. (The number is strictly subjective, as is the time between retries.) If the nature of your application is such that any rolled back transaction signals a failure that is never going to go away, you might want to specify 0 retries and move the message immediately to the error queue. (This is very much like what happens when you specify the `-d` option for `TMQFORWARD`; the only difference is that a non-zero length failure message must be received for `TMQFORWARD` automatically to drop the message from the queue.)

Using Queue Capacity Limits

There are three parameters of the `qcreate` command that can be used to partially automate the management of a queue. The parameters set a high and low threshold figure (it can be expressed as bytes, blocks, messages or percent of queue capacity) and allow you to specify a command that is executed when the high threshold is reached. (Actually, the command is executed once when the high threshold is reached, but not again until the low threshold is reached first prior to the high threshold.)

Here are two examples of ways the parameters can be used.

```
High limit for queue capacity warning (b for bytes used, B for  
blocks used, % for percent used, m for messages [default=100%]): 80%
```

```
Reset (low) limit for queue capacity warning [default=0%]: 10%
Queue capacity command: /usr/app/bin/mailme myqueuespace servicel
```

This sequence sets the upper threshold at 80% of disk-based queue capacity and specifies a command to be executed when the queue is 80% full. The command is a script you have created that sends you a mail message when the threshold is reached. (`myqueuespace` and `servicel` are hypothetical arguments to your command.) Presumably, once you have been informed that the queue is filling up you can take action to ease the situation. You do not get the warning message again unless the queue load drops to 10% of capacity or below, and then rises again to 80%. You can also set thresholds and specify commands for the management of non-persistent (memory-based) queue capacity using the `-n` option of the `qcreate` command.

Note: If you are working on an NT machine, see “Windows NT Standard I/O” on page 2-19 for additional information about configuring commands within a `qmadmin()` session.

The second example is somewhat more automated and takes advantage of the `-e` option of the `TMQFORWARD` server.

```
High limit for queue capacity warning (b for bytes used, B for
blocks used, % for percent used, m for messages [default=100%]): 90%
Reset (low) limit for queue capacity warning [default=0%]: 0%
Queue capacity command: tmboot -i 1002
```

This sequence assumes that you have configured a reserve `TMQFORWARD` server for the queue in question with `SRVID=1002` and have included the `-e` option in its `CLOPT` parameter. (It also assumes that the server is not booted or, if booted, has shut itself down as a result of finding the queue empty.) When the queue reaches 90% capacity the `tmboot` command is executed to boot the reserve server. The `-e` option causes the server to shut itself down when the queue is empty. You have set the low threshold to 0% so as not to kick off unnecessary `tmboot` commands for a server that is already booted.

The default values for the three options are 100%, 0%, and no command.

Reply and Failure Queues

The discussion above about creating a queue and providing parameters for its operation was written from the viewpoint of creating a queue for messages to be processed by a service of the same name. A queue may also be used for other purposes as well, such as peer-to-peer communication. The parameters for creating a queue are the same regardless of its use. The `TPQCTL` structure used when a message is enqueued

to a service queue includes fields to specify a reply queue and a failure queue. `TMQFORWARD` detects the success or failure of the `tpacall(3c)` it makes to the requested service and, if these queues have been created by the administrator, enqueues the reply accordingly. If no reply or failure queue exists, the success or failure response message from the service is dropped leaving the originating client with no information about the outcome of the queued request. Even if there is no reply message from the service, if a reply queue exists, a zero-length message is enqueued there by `TMQFORWARD` to inform the originating client of the outcome.

When creating a reply or a failure queue, bear in mind that in most cases messages are dequeued from these queues by a client process looking for information about an earlier enqueued request. Since the most common way of dequeuing such messages is by the `msgid` (message identifier) or `corrid` (correlation identifier) associated with the message—as opposed to taking a message off the top of the queue—the queue ordering criteria are less significant. In this case, `fifo` is probably sufficient. The `retries` and `retry delay` parameters have no significance for reply queues; just take the defaults. The `queue capacity` thresholds and commands are likely to be useful on reply queues, and the recommended usage is to alert the administrator so that he or she can intervene.

Error Queues

An error queue is a system queue. One of the `qspacecreate` prompts asks for the name of the error queue for the queue space. When you have actually created an error queue of the name specified, the system uses it as a place to move messages from the service queue that have reached their retry limit. The management of the error queue is up to the administrator who can either handle the messages manually through commands of `qadmin` or can set up an automated way of handling them through the `APPQ_MIB MIB`. The `queue capacity` parameters can be used, but all of the other `qcreate` parameters, with the exception of `qname`, are not useful for the error queue.

Note: We recommend against using the same queue as both an error queue and a service failure queue; doing so makes it more difficult to cleanly manage the application and could lead to clients trying to access the administrator's area.

Handling Encrypted Message Buffers

In general, `TMQUEUE` and `TMQFORWARD` handle *encrypted* message buffers without decrypting them. However, there are situations where the /Q component needs to decrypt enqueued message buffers, as described in “Compatibility/Interaction with /Q” on page 1-62.

As mentioned in the “Compatibility/Interaction with /Q” discussion, a non-transactional `tpdequeue()` operation has the side effect of destroying an encrypted queued message if the invoking process does not hold a valid decryption key. Thus, application programmers need to open a decryption key for a process before the process calls `tpdequeue()` to retrieve an encrypted message; otherwise, the message will be lost.

For information on opening a decryption key, see “Initializing Decryption Keys Through the Plug-ins” on page 2-50 and “Writing Code to Receive Encrypted Messages” on page 3-44 in *Using BEA Tuxedo Security*.

Maintenance of the BEA Tuxedo /Q Feature

This topic covers some things the queue administrator may have to do from time to time to keep a queue space operating efficiently.

Adding Extents to a Queue Space

If you find you need more disk storage for a queue space, you can add it with the `qaddext` command of `qadmin(1)`. (You can also use the `TA_MAXPAGES` attribute of the `T_APPQSPACE` class of `APPQ_MIB(5)` to add extents.) The `qadmin` command takes the queue space name and a number of pages as arguments. The pages come from extents defined in the UDL for the device in your `QMCONFIG` variable. The queue space must be inactive; you can use the exclamation point to execute a command outside of `qadmin` to shut down the associated server group. For example:

```
> !tmshutdown -g TMQUEUEGRP1
```

followed by

```
> qclose  
> qaddext myqueue 100
```

The queue space must be closed; `qadmin` closes it for you if you try to add extents to it while it is open. All non-persistent messages currently in the queue space are lost when the `qaddext` command is issued and completes successfully.

Backing Up or Moving Queue Space

A convenient command to use to back up a queue space is the UNIX command `dd`. Shut down the associated server group first. The command lines would look like this:

```
tmshutdown -g TMQUEUEGRP1  
dd if=<qspace_device_file> of=<output_device_filename>
```

For other options, see `dd(1)` in a UNIX system reference manual.

This same command can be used to migrate the queue space to a machine of the same architecture, although you may need to start the command sequence with a `qadmin chdl` command to provide a new device name if the present name does not exist on the target machine.

Similar archival techniques are available on server platforms that do not have the `dd` command. First, shut down the group containing the queue space you want to back up or migrate. Then, use an archival tool to save the queue space device to a file or other medium that may then be used as a back up or used to move the queue space to another server.

Moving the Queue Space to a Different Type of Machine

If you need to move a queue space to a machine with a different architecture (primarily byte order), the procedure is more complex. Create and run an application program to dequeue all messages from all queues in the queue space and write them out in machine-independent format. Then enqueue the messages in the new queue space.

TMQFORWARD and Non-Global Transactions

Messages dequeued and forwarded using `TMQFORWARD` are executed within a global transaction because the operation crosses group boundaries. If the messages are executed by servers that are not associated with an RM or that do not run within a global transaction, they should have a server group with `TMSNAME=TMS` (for the NULL XA interface).

TMQFORWARD and Commit Control

The global transaction begun by `TMQFORWARD` when it dequeues a message for execution is terminated by a `tpcommit()`. The administrator can set the `CMTRET` parameter in the configuration file to control whether the transaction commits when it is logged or when it is complete. (See the discussion of `CMTRET` in the `RESOURCES` section of the `UBBCONFIG(5)` reference page.)

Handling Transaction Timeout

Handling transaction timeout requires cooperation between the queue administrator and the programmer developing client programs that dequeue messages. When `tpdequeue(3c)` is called with the `flags` argument set to include `TPQWAIT`, the `TMQQUEUE` server will wait for a message to arrive on a queue before returning to the caller. The number of seconds before it times out is based on the following:

- The `timeout` specified in the `tpbegin` call (if the transaction is started in the client)
- The `-t timeout` flag of the `TMQQUEUE` server (if the client has not started the transaction)

If a message is not immediately available when using `TPQWAIT`, `TMQQUEUE` requires an action resource so that `TMQQUEUE` may service other requests. You may want to increase the number of actions the queue space may handle concurrently. Use the `-A actions` option to the `qspacecreate` or `qspacechange` commands. This option specifies the number of additional actions that can be handled concurrently. When a waiting operation is encountered and additional actions are available, the blocking operation is set aside until it can be satisfied. If no actions are available, the call to `tpdequeue` fails.

TMQFORWARD and Retries for an Unavailable Service

When a `TMQFORWARD` server attempts to forward messages to a service that is not available, the situation can develop where the retry limit for the queue may be reached. The message is then moved to the error queue (if one exists). To avoid this situation the administrator should either shut the `TMQFORWARD` server down or set the retry count higher.

When a message is moved to the error queue it is no longer associated with the original queue. If errors are going to be handled by the administrator moving the message back to the service queue when the service is known to be available, then the queue name may be stored as part of the `corrid` in the `TPQCTL` structure so the queue name is associated with the message.

Windows NT Standard I/O

In order to carry out a command that you have configured within a `qadmin()` session, such as the `qchange ... Queue capacity` command described in “Using Queue Capacity Limits” on page 2-13, the `NT CreateProcess()` function spawns a child process as a `DETACHED PROCESS`. This type of process does *not* have an associated console for standard input/output. Therefore, for instance, if you use standard DOS syntax to set the `qchange ... Queue capacity` command to run a built-in DOS command (such as `dir` or `date`) and then pipe or redirect the standard output to a file, the file will be empty when the command completes.

As an example of resolving this problem, suppose that for the `qchange ... Queue capacity` command you want to capture `date` information in a file using command `date /t > x.out`. To accomplish this task interactively, you would proceed as follows:

```
qadmin
> qopen yourQspace
> qchange yourQname
> go through all the setups... the threshold queue capacity warning,
  and so on
> "Queue capacity command: " cmd /c date /t > x.out
```

To accomplish this task from a command file, say *yourFile.cmd*, you would add the command `date /t > x.out` to *yourFile.cmd* and then proceed as follows:

```
qadmin
> qopen yourQspace
> qchange yourQname
> go through all the setups... the threshold queue capacity warning,
  and so on
> "Queue capacity command: " yourFile.cmd
```

3 BEA Tuxedo /Q C Language Programming

- Introduction
- Prerequisite Knowledge
- Where Requests Can Originate
- Emphasis on the Default Case
- Enqueuing Messages
- Dequeuing Messages
- Sequential Processing of Messages

Introduction

This topic deals with the use of the ATMI C language functions for enqueuing and dequeuing messages: `tpenqueue(3c)` and `tpdequeue(3c)`, plus some ancillary functions.

Prerequisite Knowledge

The BEA Tuxedo programmer coding client or server programs for the queued message facility should be familiar with the C language binding to the BEA Tuxedo ATMI. General guidance on BEA Tuxedo programming is available in *Programming a BEA Tuxedo Application Using C*. Detailed pages on all the ATMI functions are in the *BEA Tuxedo C Function Reference*.

Where Requests Can Originate

The calls used to place a message on a BEA Tuxedo /Q queue can originate from any client or server process associated with the application. The list includes:

- Clients or servers on the same machine as the queue space or on another machine on the network.
- Conversational programs, although you cannot have a conversational connection with a queue (or with the `TMQUEUE (5)` server).
- Workstation clients via a surrogate process on the server side; the administrative interface is also entirely on the server side.

Emphasis on the Default Case

The coverage of BEA Tuxedo /Q programming in this topic primarily reflects the left-hand portion of the figure “Queued Service Invocation” on page 1-2. In the figure, a client (or a process acting in the role of a client) queues a message by calling `tpenqueue (3c)` and specifying a queue space made available through a `TMQUEUE (5)` server. The client later retrieves a reply via a `tpdequeue (3c)` call to `TMQUEUE`.

The figure “Queued Service Invocation” on page 1-2 shows the queued message being dequeued by the server `TMQFORWARD(5)` and sent to an application server for processing (via `tpcall(3c)`). When a reply to the `tpcall()` is received, `TMQFORWARD` enqueues the reply message. Because a major goal of `TMQFORWARD` is to provide an interface between the queue space and existing application services, it does not require further application coding. For that reason, this topic concentrates on the client-to-queue space side.

A brief example of the use of the queued message facility is distributed with the software and is described in “A Sample Application” on page A-1.

Enqueuing Messages

The syntax for `tpenqueue()` is as follows.

```
#include <atmi.h>
int tpenqueue(char *qspace, char *qname, TPQCTL *ctl,
              char *data, long len, long flags)
```

When a `tpenqueue()` call is issued, it tells the system to store a message on the queue identified in `qname` in the space identified in `qspace`. The message is in the buffer pointed to by `data` and has a length of `len`. By the use of bit settings in `flags`, the system is informed how the call to `tpenqueue()` is to be handled. Further information about the handling of the enqueued message and replies is provided in the `TPQCTL` structure pointed to by `ctl`.

tpenqueue(3c) Arguments

There are some important arguments to control the operation of `tpenqueue(3c)`. Let’s look at some of them.

tpenqueue(): the `qspace` Argument

`qspace` identifies a queue space previously created by the administrator. When a server is defined in the `SERVERS` section of the configuration file, the service names it offers are aliases for the actual queue space name (which is specified as part of the

OPENINFO parameter in the GROUPS section). For example, when your application uses the server TMQUEUE, the value pointed at by the *qspace* argument is the name of a service advertised by TMQUEUE. If no service aliases are defined, the default service is the same as the server name, TMQUEUE. In this case the configuration file might include:

```
TMQUEUE
    SRVGRP = QUE1  SRVID = 1
    GRACE = 0  RESTART = Y  CONV = N
    CLOPT = "-A"
```

```
or
    CLOPT = "-s TMQUEUE"
```

The entry for server group QUE1 has an OPENINFO parameter that specifies the resource manager, the pathname of the device and the queue space name. The *qspace* argument in a client program then looks like this:

```
if (tpenqueue("TMQUEUE", "STRING", (TPQCTL *)&qctl,
             (char *)reqstr, 0,0) == -1) {
    Error checking
}
```

The example shown on the TMQUEUE(5) reference page shows how alias service names can be included when the server is built and specified in the configuration file. The sample program in “A Sample Application” on page A-1, also specifies an alias service name.

tpenqueue(): the qname Argument

Within a queue space, when queues are being used to invoke services, message queues are named according to the application services available to process requests. *qname* is a pointer to such an application service. Otherwise, *qname* is simply the name of the location where the message is to be stored until it is dequeued by an application (either the same application that enqueued it or another one).

tpenqueue(): the data and len Arguments

data points to a buffer that contains the message to be processed. The buffer must be one that was allocated with a call to `tpalloc(3c)`. *len* gives the length of the message. Some BEA Tuxedo buffer types (such as FML) do not require that the length of the message be specified; in such cases, the *len* argument is ignored. *data* can be NULL; when it is, *len* is ignored and the message is enqueued with no data portion.

tpenqueue(): the flags Arguments

flags values are used to tell the BEA Tuxedo system how the `tpenqueue()` call is handled; the following are valid flags:

TPNOTRAN

If the caller is in transaction mode and this flag is set, the message is not queued within the caller's transaction. A caller in transaction mode that sets this flag is still subject to the transaction timeout (and no other) when queuing the message. If message queuing fails, the caller's transaction is not affected.

TPNOBLOCK

The message is not enqueued if a blocking condition exists. If this flag is set and a blocking condition exists such as the internal buffers into which the message is transferred are full, the call fails and `tperrno(5)` is set to `TPEBLOCK`. If this flag is set and a blocking condition exists because the target queue is opened *exclusively* by another application, the call fails, `tperrno()` is set to `TPEDIAGNOSTIC`, and the diagnostic field of the `TPQCTL` structure is set to `QMESHARE`. In the latter case, the other application, which is based on a BEA product other than the BEA Tuxedo system, opened the queue for exclusive read and/or write using the Queuing Services API (QSAPI).

When `TPNOBLOCK` is not set and a blocking condition exists, the caller blocks until the condition subsides or a timeout occurs (either transaction or blocking timeout). If a timeout occurs, the call fails and `tperrno()` is set to `TPETIME`.

TPNOTIME

Setting this flag signifies that the caller is willing to block indefinitely and wants to be immune to blocking timeouts. Transaction timeouts may still occur.

TPSIGRSTRT

Setting this flag indicates that any underlying system calls that are interrupted by a signal should be reissued. When this flag is not set and a signal interrupts a system call, the call fails and sets `tperrno(5)` to `TPGOTSIG`.

TPQCTL Structure

The third argument to `tpenqueue()` is a pointer to a structure of type `TPQCTL`. The `TPQCTL` structure has members that are used by the application and by the BEA Tuxedo system to pass parameters in both directions between application programs and the queued message facility. The client that calls `tpenqueue()` sets flags to mark fields the application wants the system to fill in. The structure is also used by `tpdequeue()`; some of the fields do not come into play until the application calls that function. The complete structure is shown in the following listing.

Listing 3-1 The `tpqctl_t` Structure

```
#define TMQNAMELEN 15
#define TMMSGIDLEN 32
#define TMCORRIDLEN 32

struct tpqctl_t {
    long flags;           /* control parameters to queue primitives */
    long deq_time;       /* indicates which of the values are set */
    long priority;       /* absolute/relative time for dequeuing */
    long diagnostic;     /* enqueue priority */
    long diagnostic;     /* indicates reason for failure */
    char msgid[TMMSGIDLEN]; /* ID of message before which to queue */
    char corrid[TMCORRIDLEN]; /* correlation ID used to identify message */
    char replyqueue[TMQNAMELEN+1]; /* queue name for reply message */
    char failurequeue[TMQNAMELEN+1]; /* queue name for failure message */
    CLIENTID cltid;      /* client identifier for originating client */
    long urcode;         /* application user-return code */
    long appkey;         /* application authentication client key */
    long delivery_qos;   /* delivery quality of service */
    long reply_qos;     /* reply message quality of service */
    long exp_time;       /* expiration time */
};
typedef struct tpqctl_t TPQCTL;
```

The following is a list of valid bits for the `flags` parameter controlling input information for `tpenqueue()`.

TPNOFLAGS

No flags or values are set. No information is taken from the control structure. Leaving fields of the structure not set is equivalent to a setting of `TPNOFLAGS`.

TPQTOP

Setting this flag indicates that the queue ordering be overridden and the message placed at the top of the queue. This request may not be granted depending on whether or not the queue was configured to allow overriding the queue ordering to put a message at the top of the queue. TPQTOP and TPQBEFOREMSGID are mutually exclusive flags

TPQBEFOREMSGID

Setting this flag indicates that the queue ordering be overridden and the message placed in the queue before the message identified by *ctl->msgid*. This request may not be granted depending on whether or not the queue was configured to allow overriding the queue ordering. TPQTOP and TPQBEFOREMSGID are mutually exclusive flags. Note that the entire 32 bytes of the message identifier value are significant, so the value identified by *ctl->msgid* must be completely initialized (for example, padded with null characters).

TPQTIME_ABS

If this flag is set, the message is made available after the time specified by *ctl->deq_time*. The *deq_time* is an absolute time value as generated by `time(2)` or `mkttime(3C)`, if they are available to your application, or `gp_mktime(3c)`, provided with the BEA Tuxedo system. The value set in *ctl->deq_time* is the number of seconds since 00:00:00 Universal Coordinated Time—UTC, January 1, 1970. The absolute time is set based on the clock on the machine where the queue manager process resides. TPQTIME_ABS and TPQTIME_REL are mutually exclusive flags.

TPQTIME_REL

If this flag is set, the message is made available after a time relative to the completion of the enqueueing operation. *ctl->deq_time* specifies the number of seconds to delay after the enqueueing completes before the submitted message should be available. TPQTIME_ABS and TPQTIME_REL are mutually exclusive flags.

TPQPRIORITY

If this flag is set, the priority at which the request should be enqueued is stored in *ctl->priority*. The priority must be in the range 1 to 100, inclusive. The higher the number, the higher the priority, that is, a message with a higher number is dequeued before a message with a lower number from queues ordered by priority. For queues not ordered by priority, the value is informational.

If this flag is not set, the priority for the message is 50 by default.

TPQCORRID

If this flag is set, the correlation identifier value specified in `ctl->corrid` is available when a request is dequeued with `tpdequeue(3c)`. This identifier accompanies any reply or failure message that is queued so an application can correlate a reply with a particular request. Note that the entire 32 bytes of the correlation identifier value are significant, so the value specified in `ctl->corrid` must be completely initialized (for example, padded with null characters).

TPQREPLYQ

If this flag is set, a reply queue named in `ctl->replyqueue` is associated with the queued message. Any reply to the message is queued to the named queue within the same queue space as the request message. This string must be NULL-terminated (maximum 15 characters in length). If a reply is generated for the service and a reply queue is not specified or the reply queue does not exist, the reply is dropped.

TPQFAILUREQ

If this flag is set, a failure queue named in the `ctl->failurequeue` is associated with the queued message. If (1) the enqueued message is processed by `TMQFORWARD()`, (2) `TMQFORWARD` was started with the `-d` option, and (3) the service fails and returns a non-null reply, a failure message consisting of the reply and its associated `tpurcode` is enqueued to the named queue within the same queue space as the original request message. This string must be NULL-terminated (maximum 15 characters in length).

TPQDELIVERYQOS, TPQREPLYQOS

If the `TPQDELIVERYQOS` flag is set, the flags specified by `ctl->delivery_qos` control the quality of service for delivery of the message. In this case, one of three mutually exclusive flags—`TPQQOSDEFAULTPERSIST`, `TPQQOSPERSISTENT`, or `TPQQOSNONPERSISTENT`—must be set in `ctl->delivery_qos`. If `TPQDELIVERYQOS` is not set, the default delivery policy of the target queue dictates the delivery quality of service for the message.

If the `TPQREPLYQOS` flag is set, the flags specified by `ctl->reply_qos` control the quality of service for any reply to the message. In this case, one of three mutually exclusive flags—`TPQQOSDEFAULTPERSIST`, `TPQQOSPERSISTENT`, or `TPQQOSNONPERSISTENT`—must be set in `ctl->reply_qos`. The `TPQREPLYQOS` flag is used when a reply is returned from messages processed by `TMQFORWARD`. Applications not using

TMQFORWARD to invoke services may use the TPQREPLYQOS flag as a hint for their own reply mechanism.

If TPQREPLYQOS is not set, the default delivery policy of the `ctl->replyqueue` queue dictates the delivery quality of service for any reply. Note that the default delivery policy is determined when the reply to a message is enqueued. That is, if the default delivery policy of the reply queue is modified between the time that the original message is enqueued and the reply to the message is enqueued, the policy used is the one in effect when the reply is finally enqueued.

The following is the list of valid flags for `ctl->delivery_qos` and `ctl->reply_qos`:

TPQQOSDEFAULTPERSIST

This flag specifies that the message is to be delivered using the default delivery policy specified on the target queue.

TPQQOSPERSISTENT

This flag specifies that the message is to be delivered in a persistent manner using the disk-based delivery method. When specified, this flag overrides the default delivery policy specified on the target queue.

TPQQOSNONPERSISTENT

This flag specifies that the message is to be delivered in a non-persistent manner using the memory-based delivery method. Specifically, the message is queued in memory until it is dequeued. When specified, this flag overrides the default delivery policy specified on the target queue. If the caller is transactional, non-persistent messages are enqueued within the caller's transaction, however, non-persistent messages are lost if the system is shut down, crashes, or the IPC shared memory for the queue space is removed.

TPQEXPTIME_ABS

If this flag is set, the message has an absolute expiration time, which is the absolute time when the message will be removed from the queue. The absolute expiration time is determined by the clock on the machine where the queue manager process resides.

The absolute expiration time is indicated by the value stored in `ctl->exp_time`. The value of `ctl->exp_time` must be set to an absolute

time value generated by `time(2)`, `mktime(3C)`, or `gp_mktime(3c)` (the number of seconds since 00:00:00 Universal Coordinated Time—UTC, January 1, 1970).

If an absolute time is specified that is earlier than the time of the enqueue operation, the operation succeeds, but the message is not counted for the purpose of calculating thresholds. If the expiration time is before the message availability time, the message is not available for dequeuing unless either the availability or expiration time is changed so that the availability time is before the expiration time. In addition, these messages are removed from the queue at expiration time even if they were never available for dequeuing. If a message expires while it is within a transaction, the expiration does not cause the transaction to fail. Messages that expire while being enqueued or dequeued within a transaction are removed from the queue when the transaction ends. There is no notification that the message has expired.

`TPQEXPTIME_ABS`, `TPQEXPTIME_REL`, and `TPQEXPTIME_NONE` are mutually exclusive flags. If none of these flags is set, the default expiration time associated with the target queue is applied to the message.

`TPQEXPTIME_REL`

If this flag is set, the message has a relative expiration time, which is the number of seconds *after* the message arrives at the queue that the message is removed from the queue. The relative expiration time is indicated by the value stored in `ctl->exp_time`.

If the expiration time is before the message availability time, the message is not available for dequeuing unless either the availability or expiration time is changed so that the availability time is before the expiration time. In addition, these messages are removed from the queue at expiration time even if they were never available for dequeuing. The expiration of a message during a transaction, does not cause the transaction to fail. Messages that expire while being enqueued or dequeued within a transaction are removed from the queue when the transaction ends. There is no acknowledgment that the message has expired.

`TPQEXPTIME_ABS`, `TPQEXPTIME_REL`, and `TPQEXPTIME_NONE` are mutually exclusive flags. If none of these flags is set, the default expiration time associated with the target queue is applied to the message.

`TPQEXPTIME_NONE`

Setting this flag indicates that the message should not expire, even if the default policy of the queue includes an expiration time.

TPQEXPTIME_ABS, TPQEXPTIME_REL, and TPQEXPTIME_NONE are mutually exclusive flags. If none of these flags is set, the default expiration time associated with the target queue is applied to the message.

Additionally, the *urcode* field of TPQCTL can be set with a user-return code. This value will be returned to the application that calls `tpdequeue(3c)` to dequeue the message.

On output from `tpenqueue()`, the following fields may be set in the TPQCTL structure:

```
long flags;           /* indicates which of the values are set */
char msgid[32];      /* ID of enqueued message */
long diagnostic;     /* indicates reason for failure */
```

The following is a valid bit for the *flags* parameter controlling output information from `tpenqueue()`. If this flag is turned on when `tpenqueue()` is called, the /Q server `TMQUEUE(5)` populates the associated element in the structure with a message identifier. If this flag is turned off when `tpenqueue()` is called, `TMQUEUE()` does *not* populate the associated element in the structure with a message identifier.

TPQMSGID

If this flag is set and the call to `tpenqueue()` is successful, the message identifier is stored in `ctl->msgid`. The entire 32 bytes of the message identifier value are significant, so the value stored in `ctl->msgid` is completely initialized (for example, padded with null characters). The actual padding character used for initialization varies between releases of the BEA Tuxedo /Q component.

The remaining members of the control structure are not used on input to `tpenqueue()`.

If the call to `tpenqueue()` fails and `tperrno(5)` is set to `TPEDIAGNOSTIC`, a value indicating the reason for failure is returned in `ctl->diagnostic`. The possible values are:

[QMEINVAL]

An invalid flag value was specified.

[QMEBADRMID]

An invalid resource manager identifier was specified.

[QMENOTOPEN]

The resource manager is not currently open.

[QMETRAN]

The call was made in transaction mode or was made with the `TPNOTRAN` flag set and an error occurred trying to start a transaction in which to enqueue the message. This diagnostic is not returned by queue managers from BEA Tuxedo Release 7.1 or later.

[QMEBADMSGID]

An invalid message identifier was specified.

[QMESYSTEM]

A system error occurred. The exact nature of the error is written to a log file.

[QMEOS]

An operating system error occurred.

[QMEABORTED]

The operation was aborted. If the aborted operation was being executed within a global transaction, the global transaction is marked rollback-only. Otherwise, the queue manager aborts the operation.

[QMEPROTO]

An enqueue was done when the transaction state was not active.

[QMEBADQUEUE]

An invalid or deleted queue name was specified.

[QMENOSPACE]

Due to an insufficient resource, such as no space on the queue, the message with its required quality of service (persistent or non-persistent storage) was not enqueued. `QMENOSPACE` is returned when any of the following configured resources is exceeded: (1) the amount of disk (persistent) space allotted to the queue space, (2) the amount of memory (non-persistent) space allotted to the queue space, (3) the maximum number of simultaneously active transactions allowed for the queue space, (4) the maximum number of messages that the queue space can contain at any one time, (5) the maximum number of concurrent actions that the Queuing Services component can handle, or (6) the maximum number of authenticated users that may concurrently use the Queuing Services component.

[QMERELASE]

An attempt was made to enqueue a message to a queue manager that is from a version of the BEA Tuxedo system that does not support a newer feature.

[QMESHAARE]

When enqueuing a message from a specified queue, the specified queue is opened *exclusively* by another application. The other application is one based on a BEA product other than the BEA Tuxedo system that opened the queue for exclusive read and/or write using the Queuing Services API (QSAPI).

Overriding the Queue Order

If the administrator, in creating a queue, allows `tpenqueue()` calls to override the order of messages on the queue, you have two mutually exclusive ways to use that capability. You can specify that the message is to be placed at the top of the queue by setting `flags` to include `TPQTOP` or you can specify that it be placed ahead of a specific message by setting `flags` to include `TPQBEFOREMSGID` and setting `ctl->msgid` to the ID of the message you wish to precede. This assumes that you saved the message-ID from a previous call in order to be able to use it here. Your administrator must tell you what the queue supports; it can be created to allow either or both of these overrides, or to allow neither.

Overriding the Queue Priority

You can set a value in `ctl->priority` to specify the priority of the message. The value must be in the range 1 to 100; the higher the number the higher the priority. If `priority` was not one of the queue ordering parameters, setting a priority here has no effect on the dequeuing order, however the priority value is retained so that the value can be inspected when the message is dequeued.

Setting a Message Availability Time

You can specify in `deq_time` either an absolute time or a time relative to the completion of the enqueueing operation for the message to be made available. You set `flags` to include either `TPQTIME_ABS` or `TPQTIME_REL` to indicate how the value should be treated. A queue may be created with `time` as a queue ordering criterion, in which case the messages are ordered by the message availability time.

BEA Tuxedo /Q provides a function, `gp_mktime(3c)`, that is used to convert a date and time provided in a `tm` structure to the number of seconds since January 1, 1970. The `time(2)` and `mktime(3C)` functions may also be used instead of `gp_mktime(3c)`.

The value is returned in `time_t`, a typedef'd long. To set an absolute time for the message to be dequeued (we are using 12:00 noon, December 9, 2001), do the following.

1. Place the values for the date you want to use in the `tm` structure.

```
#include <stdio.h>
#include <time.h>
static char *const wday[] = {
    "Sunday", "Monday", "Tuesday", "Wednesday",
    "Thursday", "Friday", "Saturday", "-unknown-"
};
struct tm time_str;
/*...*/
time_str.tm_year = 2001 - 1900;
time_str.tm_mon = 12 - 1;
time_str.tm_mday = 9;
time_str.tm_hour = 12;
time_str.tm_min = 0;
time_str.tm_sec = 1;
time_str.tm_isdst = -1;
```

2. Call `gp_mktime` to produce a value for `deq_time` and set the `flags` to indicate that an absolute time is being provided.

```
#include <atmi.h>
TPQCTL qctl;
if ((qctl->deq_time = (long)gp_mktime(&time_str)) == -1) {
    /* check for errors */
}
qctl->flags = TPQTIME_ABS
```

3. Call `tpenqueue()`.

```
if (tpenqueue(qspace, qname, qctl, *data, *len, *flags) == -1) {
    /* check for errors */
}
```

If you want to specify a relative time for dequeuing, for example, *nnn* seconds after the completion of the enqueueing operation, place the number of seconds in `deq_time` and set `flags` to include `TPQTIME_REL`.

tpenqueue() and Transactions

If a caller of `tpenqueue()` is in transaction mode and `TPNOTRAN` is not set, then the enqueueing is done within the caller's transaction. The caller knows for certain from the success or failure of `tpenqueue()` whether the message was enqueued or not. If the call succeeds, the message is guaranteed to be on the queue. If the call fails, the transaction is rolled back, including the part where the message was placed on the queue.

If a caller of `tpenqueue()` is not in transaction mode or if `TPNOTRAN` is set, the message is enqueued outside of the caller's transaction. If the call to `tpenqueue()` returns success, the message is guaranteed to be on the queue. If the call to `tpenqueue()` fails with a communication error or with a timeout, the caller is left in doubt about whether the failure occurred before or after the message was enqueued.

Note that specifying `TPNOTRAN` while the caller is not in transaction mode has no meaning.

Dequeueing Messages

The syntax for `tpdequeue()` is as follows.

```
#include <atmi.h>
int tpdequeue(char *qspace, char *qname, TPQCTL *ctl, \
              char **data, long *len, long flags)
```

When this call is issued it tells the system to dequeue a message from the `qname` queue in the queue space named `qspace`. The message is placed in a buffer (originally allocated by `tpalloc(3c)`) at the address pointed to by `*data`. `len` points to the length of the data. If `len` is 0 on return from `tpdequeue()`, the message had no data portion. By the use of bit settings in `flags` the system is informed how the call to `tpdequeue()` is to be handled. The `TPQCTL` structure pointed to by `ctl` carries further information about how the call should be handled.

tpdequeue(3c) Arguments

There are some important arguments to control the operation of `tpdequeue(3c)`. Let's look at some of them.

tpdequeue(): the *qspace* Argument

qspace identifies a queue space previously created by the administrator. When the `TMQUEUE` server is defined in the `SERVERS` section of the configuration file, the service names it offers are aliases for the actual queue space name (which is specified as part of the `OPENINFO` parameter in the `GROUPS` section). For example, when your application uses the server `TMQUEUE`, the value pointed at by the *qspace* argument is the name of a service advertised by `TMQUEUE`. If no service aliases are defined, the default service is the same as the server name, `TMQUEUE`. In this case the configuration file may include:

```
TMQUEUE
    SRVGRP = QUE1  SRVID = 1
    GRACE = 0  RESTART = Y  CONV = N
    CLOPT = "-A"
or
    CLOPT = "-s TMQUEUE"
```

The entry for server group `QUE1` has an `OPENINFO` parameter that specifies the resource manager, the pathname of the device and the queue space name. The *qspace* argument in a client program then looks like this:

```
if (tpdequeue("TMQUEUE", "REPLYQ", (TPQCTL *)&qctl,
             (char **)&reqstr, &len, TPNOTIME) == -1) {
    Error checking
}
```

The example shown on the `TMQUEUE(5)` reference page shows how alias service names can be included when the server is built and specified in the configuration file. The sample program in “A Sample Application” on page A-1, also specifies an alias service/queue space name.

tpdequeue(): the qname Argument

Queue names in a queue space must be agreed upon by the applications that will access the queue space. This is especially important for reply queues. If *qname* refers to a reply queue, the administrator creates it (and often an error queue) in the same manner that he or she creates any other queue. *qname* is a pointer to the name of the queue from which to retrieve the message or reply.

tpdequeue(): the data and len Arguments

These arguments have slightly different meanings than their counterparts in `tpenqueue()`. **data* points to the address of a buffer where the system is to place the message being dequeued. When `tpdequeue()` is called, it is an error for its value to be `NULL`.

When `tpdequeue()` returns, *len* points to a long that carries information about the length of the data retrieved. If it is 0, it means that the reply had no data portion. This can be a legitimate and successful reply in some applications; receiving even a 0 length reply can be used to show successful processing of the enqueued request. If you wish to know whether the buffer has changed from before the call to `tpdequeue()`, save the length prior to the call to `tpdequeue()` and compare it to *len* after the call completes.

tpdequeue(): the flags Arguments

flags values are used to tell the BEA Tuxedo system how the `tpdequeue()` call is handled; the following are valid flags:

TPNOTRAN

If the caller is in transaction mode and this flag is set, the message is not dequeued within the caller's transaction. A caller in transaction mode that sets this flag is still subject to the transaction timeout (and no other) when dequeuing the message. If message dequeuing fails, the caller's transaction is not affected.

TPNOBLOCK

The message is not dequeued if a blocking condition exists. If this flag is set and a blocking condition exists such as the internal buffers into which the message is transferred are full, the call fails and `tperrno(5)` is set to `TPEBLOCK`. If this flag is set and a blocking condition exists because the target queue is opened *exclusively* by another application, the call fails, `tperrno()` is set to `TPEDIAGNOSTIC`, and the diagnostic field of the `TPQCTL` structure is

set to `QMESHARE`. In the latter case, the other application, which is based on a BEA product other than the BEA Tuxedo system, opened the queue for exclusive read and/or write using the Queuing Services API (QSAPI).

When `TPNOBLOCK` is not set and a blocking condition exists, the caller blocks until the condition subsides or a timeout occurs (either transaction or blocking timeout). This blocking condition does not include blocking on the queue itself if the `TPQWAIT` option in *flags* (of the `TPQCTL` structure) is specified.

`TPNOTIME`

Setting this flag signifies that the caller is willing to block indefinitely and wants to be immune to blocking timeouts. Transaction timeouts may still occur.

`TPNOCHANGE`

When this flag is set, the type of the buffer pointed to by **data* is not allowed to change. By default, if a buffer is received that differs in type from the buffer pointed to by **data*, then **data*'s buffer type changes to the received buffer's type so long as the receiver recognizes the incoming buffer type. That is, the type and subtype of the received buffer must match the type and subtype of the buffer pointed to by **data*.

`TPSIGRSTRT`

Setting this flag indicates that any underlying system calls that are interrupted by a signal should be reissued. When this flag is not set and a signal interrupts a system call, the call fails and sets `tperrno(5)` to `TPGOTSIG`.

TPQCTL Structure

The third argument to `tpdequeue()` is a pointer to a structure of type `TPQCTL`. The `TPQCTL` structure has members that are used by the application and by the BEA Tuxedo system to pass parameters in both directions between application programs and the queued message facility. The client that calls `tpdequeue()` sets flags to mark fields for which the system should supply values. As described earlier, the structure is also used by `tpenqueue()`; some of the members apply only to that function. The entire structure is shown in “The `tpqctl_t` Structure” on page 3-6.

As input to `tpdequeue()`, the following fields may be set in the `TPQCTL` structure:

```
long flags;          /* indicates which of the values are set */
char msgid[32];     /* id of message to dequeue */
char corrid[32];    /* correlation identifier of message to dequeue */
```

The following are valid flags on input to `tpdequeue()`.

TPNOFLAGS

No flags are set. No information is taken from the control structure.

TPQGETBYMSGID

Setting this flag requests that the message with the message identifier specified by `ctl->msgid` be dequeued. The message identifier is determined through a prior call to `tpenqueue()`. Note that the message identifier changes if the message is moved from one queue to another. Note also that the entire 32 bytes of the message identifier value are significant, so the value specified by `ctl->msgid` must be completely initialized (for example, padded with null characters).

TPQGETBYCORRID

Setting this flag requests that the message with the correlation identifier specified by `ctl->corrid` be dequeued. The correlation identifier is specified by the application when enqueueing the message with `tpenqueue()`. Note that the entire 32 bytes of the correlation identifier value are significant, so the value specified by `ctl->corrid` must be completely initialized (for example, padded with null characters).

TPQWAIT

Setting this flag indicates that an error should not be returned if the queue is empty. Instead, the process should wait until a message is available. If `TPQWAIT` is set in conjunction with `TPQGETBYMSGID` or `TPQGETBYCORRID`, it indicates that an error should not be returned if no message with the specified message identifier or correlation identifier is present in the queue. Instead, the process should wait until a message meeting the criteria is available. The process is still subject to the caller's transaction timeout, or, when not in transaction mode, the process is still subject to the timeout specified for the `TMQUEUE` process by the `-t` option.

If a message matching the desired criteria is not immediately available and the configured action resources are exhausted, `tpdequeue()` returns `-1`, `tperrno()` is set to `TPEDIAGNOSTIC`, and the diagnostic field of the `TPQCTL` structure is set to `QMESYSTEM`.

Note that each `tpdequeue()` request specifying the `TPQWAIT` control parameter requires that a queue manager (`TMQUEUE`) action object be available if a message satisfying the condition is not immediately available. If an action object is not available, the `tpdequeue()` request fails. The number of available queue manager actions are specified when a queue space is created or modified. When a waiting dequeue request completes, the associated action object associated is made available for another request.

TPQPEEK

If this flag is set, the specified message is read but is not removed from the queue. The `TPNOTRAN` flag must also be set.

When a thread is non-destructively dequeuing a message using `TPQPEEK`, the message may not be seen by other non-blocking dequeuers for the brief time the system is processing the non-destructive dequeue request. This includes dequeuers using specific selection criteria (such as message identifier and correlation identifier) that are looking for the message currently being non-destructively dequeued.

The following is a list of valid bits for the `flags` parameter controlling output information from `tpdequeue()`. For any of these bits, if the flag bit is turned on when `tpdequeue()` is called, the associated field in the structure (see “The `tpqctl_t` Structure” on page 3-6) is populated with the value provided when the message was queued, and the bit remains set. If a value is not available (that is, no value was provided when the message was queued) or the bit is not set when `tpdequeue()` is called, `tpdequeue()` completes with the flag turned off.

TPQPRIORITY

If this flag is set, the call to `tpdequeue()` is successful, and the message was queued with an explicit priority, then the priority is stored in `ctl->priority`. The priority is in the range 1 to 100, inclusive, and the higher the number, the higher the priority (that is, a message with a higher number is dequeued before a message with a lower number). For queues not ordered by priority, the value is informational.

If no priority was explicitly specified when the message was queued and the call to `tpdequeue()` is successful, the priority for the message is 50.

TPQMSGID

If this flag is set and the call to `tpdequeue()` is successful, the message identifier is stored in `ctl->msgid`. The entire 32 bytes of the message identifier value are significant.

TPQCORRID

If this flag is set, the call to `tpdequeue()` is successful, and the message was queued with a correlation identifier, then the correlation identifier is stored in `ctl->corrid`. The entire 32 bytes of the correlation identifier value are significant. Any BEA Tuxedo /Q provided reply to a message has the correlation identifier of the original request message.

TPQDELIVERYQOS

If this flag is set, the call to `tpdequeue()` is successful, and the message was queued with a delivery quality of service, then the flag—`TPQQOSDEFAULTPERSIST`, `TPQQOSPERSISTENT`, or `TPQQOSNONPERSISTENT`—is stored in `ctl->delivery_qos`. If no delivery quality of service was explicitly specified when the message was queued, the default delivery policy of the target queue dictates the delivery quality of service for the message.

TPQREPLYQOS

If this flag is set, the call to `tpdequeue()` is successful, and the message was queued with a reply quality of service, then the flag—`TPQQOSDEFAULTPERSIST`, `TPQQOSPERSISTENT`, or `TPQQOSNONPERSISTENT`—is stored in `ctl->reply_qos`. If no reply quality of service was explicitly specified when the message was queued, the default delivery policy of the `ctl->replyqueue` queue dictates the delivery quality of service for any reply.

Note that the default delivery policy is determined when the reply to a message is enqueued. That is, if the default delivery policy of the reply queue is modified between the time that the original message is enqueued and the reply to the message is enqueued, the policy used is the one in effect when the reply is finally enqueued.

TPQREPLYQ

If this flag is set, the call to `tpdequeue()` is successful, and the message was queued with a reply queue, then the name of the reply queue is stored in `ctl->replyqueue`. Any reply to the message should go to the named reply queue within the same queue space as the request message.

TPQFAILUREQ

If this flag is set, the call to `tpdequeue()` is successful, and the message was queued with a failure queue, then the name of the failure queue is stored in `ctl->failurequeue`. Any failure message should go to the named failure queue within the same queue space as the request message.

The following remaining bits for the *flags* parameter are cleared (set to zero) when `tpdequeue()` is called: `TPQTOP`, `TPQBEFOREMSGID`, `TPQTIME_ABS`, `TPQTIME_REL`, `TPQEXPTIME_ABS`, `TPQEXPTIME_REL`, and `TPQEXPTIME_NONE`. These bits are valid bits for the *flags* parameter controlling input information for `tpenqueue()`.

If the call to `tpdequeue()` failed and `tperrno(5)` is set to `TPEDIAGNOSTIC`, a value indicating the reason for failure is returned in `ctl->diagnostic`. The valid codes for `ctl->diagnostic` include those for `tpenqueue()` described in “TPQCTL Structure” on page 3-6 (except for `QMENOSPACE` and `QMERELLEASE`) and the following additional codes.

[`QMENOMSG`]

No message was available for dequeuing. Note that it is possible that the message exists on the queue and another application process has read the message from the queue. In this case, the message may be put back on the queue if that other process rolls back the transaction.

[`QMEINUSE`]

When dequeuing a message by message identifier or correlation identifier, the specified message is in use by another transaction. Otherwise, all messages currently on the queue are in use by other transactions. This diagnostic is not returned by queue managers from BEA Tuxedo Release 7.1 or later.

Using TPQWAIT

When `tpdequeue()` is called with *flags* (of the `TPQCTL` structure) set to include `TPQWAIT`, if a message is not immediately available, the `TMQUEUE` server waits for the arrival, on the queue, of a message that matches the `tpdequeue()` request before `tpdequeue()` returns control to the caller. The `TMQUEUE` process sets the waiting request aside and processes requests from other processes while waiting to satisfy the first request. If `TPQGETBYMSGID` and/or `TPQGETBYCORRID` are also specified, the server waits until a message with the indicated message identifier and/or correlation identifier becomes available on the queue. If neither of these flags is set, the server waits until any message is put onto the queue. The amount of time it waits is controlled by the caller’s transaction timeout, if the call is in transaction mode, or by the `-t` option in the `CLOPT` parameter of the `TMQUEUE` server, if the call is not in transaction mode.

The `TMQUEUE` server can handle a number of waiting `tpdequeue()` requests at the same time, as long as action resources are available to handle the request. If there are not enough action resources configured for the queue space, `tpdequeue()` fails. If this happens on your system, increase the number of action resources for the queue space.

Error Handling When Using `TMQFORWARD` Services

In considering how best to handle errors when dequeuing it is helpful to differentiate between two types of errors:

- Errors encountered by `TMQFORWARD(5)` as it attempts to dequeue a message to forward to the requested service
- Errors that occur in the service that processes the request

By default, if a message is dequeued within a transaction and the transaction is rolled back, then (if the `retry` parameter is greater than 0) the message ends up back on the queue and can be dequeued and executed again. It may be desirable to delay for a short period before retrying to dequeue and execute the message, allowing the transient problem to clear (for example, allowing for locks in a database to be released by another transaction). Normally, a limit on the number of retries is also useful to ensure that an application flaw doesn't cause significant waste of resources. When a queue is configured by the administrator, both a retry count and a delay period (in seconds) can be specified. A retry count of 0 implies that no retries are done. After the retry count is reached, the message is moved to an error queue that is configured by the administrator for the queue space. If the error queue is not configured, then messages that have reached the retry count are simply deleted. Messages on the error queue must be handled by the administrator who must work out a way of notifying the originator that meets the requirements of the application. The message handling method chosen should be mostly transparent to the originating program that put the message on the queue. There is a virtual guarantee that once a message is successfully enqueued it will be processed according to the parameters of `tpenqueue()` and the attributes of the queue. Notification that a message has been moved to the error queue should be a rare occurrence in a system that has properly tuned its queue parameters.

A failure queue (normally, different from the queue space error queue) may be associated with each queued message. This queue is specified on the enqueueing call as the place to put any failure messages. The failure message for a particular request can be identified by an application-generated correlation identifier that is associated with the message when it is enqueued.

The default behavior of retrying until success (or a predefined limit) is quite appropriate when the failure is caused by a transient problem that is later resolved, allowing the message to be handled appropriately.

There are cases where the problem is not transient. For example, the queued message may request operating on an account that does not exist (and the application is such that it won't come into existence within a reasonable time period if at all). In this case, it is desirable not to waste any resources by trying again. If the application programmer or administrator determines that failures for a particular operation are never transient, then it is simply a matter of setting the retry count to zero, although this will require a mechanism to constantly clear the queue space error queue of these messages (for example, a background client that reads the queue periodically). More likely, it is the case that some problems will be transient (for example, database lock contention) and some problems will be permanent (for example, the account doesn't exist) for the same service.

In the case that the message is processed (dequeued and passed to the application via a `tpcall()`) by `TMQFORWARD`, there is no mechanism in the information returned by `tpcall()` to indicate whether a `TPESVCFAIL` error is caused by a transient or permanent problem.

As in the case where the application is handling the dequeuing, a simple solution is to return success for the service, that is, `tpreturn` with `TPSUCCESS`, even though the operation failed. This allows the transaction to be committed and the message removed from the queue. If reply messages are being used, the information in the buffer returned from the service can indicate that the operation failed and the message will be enqueued on the reply queue. The `rcode` argument of `tpreturn` can also be used to return application specific information.

In the case where the service fails and the transaction must be rolled back, it is not clear whether or not `TMQFORWARD` should execute a second transaction to remove the message from the queue without further processing. By default, `TMQFORWARD` will not delete a message for a service that fails. `TMQFORWARD`'s transaction is rolled back and the message is restored to the queue. A command line option may be specified for `TMQFORWARD` that indicates that a message should be deleted from the queue if the service fails and a reply message is sent back with length greater than 0. The message is deleted in a second transaction. The queue must be configured with a delay time and retry count for this to work. If the message is associated with a failure queue, the reply data will be enqueued to the failure queue in the same transaction as the one in which the message is deleted from the queue.

Procedure for Dequeueing Replies from Services Invoked Through TMQFORWARD

If your application expects to receive replies to queued messages, here is a procedure you may want to follow.

1. As a preliminary step, the queue space must include a reply queue and a failure queue. The application must also agree on the content of the correlation identifier. The service should be coded to return `TPSUCCESS` on a logical failure and return an explanatory code in the `rcode` argument of `tpreturn`.
2. When you call `tpenqueue()` to put the message on the queue, set `flags` to turn on the bits for the following flags.

```
TPQCORRID      TPQREPLYQ
TPQFAILUREQ   TPQMSGID
```

Fill in the values for `corrid`, `replyqueue` and `failurequeue` before issuing the call. On return from the call, save `corrid`.

3. When you call `tpdequeue()` to check for a reply, specify the reply queue in the `qname` argument and set `flags` to turn on the bits for the following flags:

```
TPQCORRID      TPQREPLYQ
TPQFAILUREQ   TPQMSGID
TPQGETCORRID
```

Use the saved correlation identifier to populate `corrid` before issuing the call. If the call to `tpdequeue()` fails and sets `tperrno(5)` to `TPEDIAGNOSTIC`, then further information is available in `diagnostic`. If you receive the error code `QMENOMSG`, it means that no message was available for dequeueing.

4. Set up another call to `tpdequeue()`. This time have `qname` point to the name of the failure queue and set `flags` to turn on the bits for the following flags:

```
TPQCORRID      TPQREPLYQ
TPQFAILUREQ   TPQMSGID
TPQGETBYCORRID
```

Populate `corrid` with the correlation identifier. When the call returns, check `len` to see if data has been received and check `urcode` to see if the service has returned a user return code.

Sequential Processing of Messages

Sequential processing of messages can be achieved by having one service enqueue a message for the next service in the chain before its transaction is committed. The originating process can track the progress of the sequence with a series of `tpdequeue()` calls to the `reply_queue`, if each member uses the same correlation-ID and returns a 0 length reply.

Alternatively, word of the successful completion of the entire sequence can be returned to the originator by using unsolicited notification. To make sure that the last transaction in the sequence ended with a `tpcommit`, a job step can be added that calls `tpnotify` using the client identifier that is carried in the `TPQCTL` structure returned from `tpdequeue()` or in the `TPSVCINFO` structure passed to the service. The originating client must have called `tpsetunsol` to name the unsolicited message handler being used.

Using Queues for Peer-to-Peer Communication

In all of the foregoing discussion of enqueueing and dequeueing messages there has been an implicit assumption that queues were being used as an alternative form of request/response processing. A message does not have to be a service request. The queued message facility can transfer data from one process to another as effectively as a service request. This style of communication between applications or clients is called peer-to-peer communication.

If it suits your application to use BEA Tuxedo /Q for this purpose, have the administrator create a separate queue and code your own receiving program for dequeueing *messages* from that queue.

4 BEA Tuxedo /Q COBOL Language Programming

- Introduction
- Prerequisite Knowledge
- Where Requests Can Originate
- Emphasis on the Default Case
- Enqueuing Messages
- Dequeuing Messages
- Sequential Processing of Messages

Introduction

This topic provides information about using the ATMI COBOL language functions for enqueuing and dequeuing messages: `TPENQUEUE (3cbl)` and `TPDEQUEUE (3cbl)`, plus some ancillary functions.

Prerequisite Knowledge

The BEA Tuxedo programmer coding client or server programs for the queued message facility should be familiar with the COBOL language binding to the BEA Tuxedo ATMI. General guidance on BEA Tuxedo programming is available in *Programming a BEA Tuxedo Application Using COBOL*. Detailed pages on all the ATMI functions are in the *BEA Tuxedo COBOL Function Reference*.

Where Requests Can Originate

The calls used to place a message on a BEA Tuxedo /Q queue can originate from any client or server process associated with the application. The list includes:

- Clients or servers on the same machine as the queue space or on another machine on the network
- Conversational programs, although you cannot have a conversational connection with a queue (or with the `TMQUEUE (5)` server)
- Workstation clients via a surrogate process on the native side; the administrative interface is also entirely on the native side

Emphasis on the Default Case

The discussion of BEA Tuxedo /Q programming in this topic primarily reflects the client-side portion of the figure “Queued Service Invocation” on page 1-2. The figure shows how a client (or a process acting in the role of a client) queues a message by calling `TPENQUEUE (3cb1)` and specifying a queue space made available through a `TMQUEUE (5)` server. The client later retrieves a reply via a `TPDEQUEUE (3cb1)` call to `TMQUEUE`.

The figure shows the queued message being dequeued by the server `TMQFORWARD(5)` and sent to an application server for processing (via `TPCALL(3cb1)`). When a reply to `TPCALL` is received, `TMQFORWARD` enqueues the reply message. Because `TMQFORWARD` provides an interface between the queue space and existing application services, further application coding is not required. For that reason, this topic concentrates on the client-to-queue space side.

Some examples of customization are given after the discussion of the basic model.

Enqueuing Messages

The syntax for `TPENQUEUE()` is as follows.

```
01 TPQUEDEF-REC.
   COPY TPQUEDEF.
01 TPTYPE-REC.
   COPY TPTYPE.
01 DATA-REC.
   COPY User Data.
01 TPSTATUS-REC.
   COPY TPSTATUS.
CALL "TPENQUEUE" USING TPQUEDEF-REC TPTYPE-REC DATA-REC TPSTATUS-REC.
```

When a `TPENQUEUE()` call is issued it tells the system to store a message on the queue identified in `QNAME` in `TPQUEDEF-REC` in the space identified in `QSPACE-NAME` in `TPQUEDEF-REC`. The message is in `DATA-REC`, and `LEN` in `TPTYPE-REC` has the length of the message. By the use of settings in `TPQUEDEF-REC`, the system is informed how the call to `TPENQUEUE()` is to be handled. Further information about the handling of the enqueued message and replies is provided in the `TPQUEDEF-REC` structure.

TPENQUEUE() Arguments

There are some important arguments to control the operation of `TPENQUEUE(3cb1)`. Lets look at some of them.

TPENQUEUE(): the QSPACE-NAME in TPQUEDEF-REC Argument

QSPACE-NAME identifies a queue space previously created by the administrator. When a server is defined in the SERVERS section of the configuration file, the service names it offers are aliases for the actual queue space name (which is specified as part of the OPENINFO parameter in the GROUPS section). For example, when your application uses the server TMQUEUE, the value pointed at by QSPACE-NAME is the name of a service advertised by TMQUEUE. If no service aliases are defined, the name of the default service is the same as the server name, TMQUEUE. In this case the configuration file might include the following.

```
TMQUEUE
    SRVGRP = QUE1  SRVID = 1
    GRACE = 0  RESTART = Y  CONV = N
    CLOPT = "-A"

or

    CLOPT = "-s TMQUEUE"
```

The entry for server group QUE1 has an OPENINFO parameter that specifies the resource manager, the pathname of the device and the queue space name. The QSPACE-NAME argument in a client program then looks like this.

```
01  TPQUEDEF-REC.
    COPY TPQUEDEF.
01  TPTYPE-REC.
    COPY TPTYPE.
01  TPSTATUS-REC.
    COPY TPSTATUS.
01  USER-DATA-REC  PIC X(100).
*
*
*
MOVE LOW-VALUES TO TPQUEDEF-REC.
MOVE "TMQUEUE" TO QSPACE-NAME IN TPQUEDEF-REC.
MOVE "STRING" TO QNAME IN TPQUEDEF-REC.
SET TPTRAN IN TPQUEDEF-REC TO TRUE.
SET TPBLOCK IN TPQUEDEF-REC TO TRUE.
SET TPTIME IN TPQUEDEF-REC TO TRUE.
SET TPSIGRSTRT IN TPQUEDEF-REC TO TRUE.
MOVE LOW-VALUES TO TPTYPE-REC.
MOVE "STRING" TO REC-TYPE IN TPTYPE-REC.
MOVE LENGTH OF USER-DATA-REC TO LEN IN TPTYPE-REC.
CALL "TPENQUEUE" USING
    TPQUEDEF-REC
    TPTYPE-REC
    USER-DATA-REC
    TPSTATUS-REC.
```

The example shown on the `TMQUEUE(5)` reference page shows how alias service names can be included when the server is built and specified in the configuration file. The sample program in “A Sample Application” on page A-1, also specifies an alias service name.

TPENQUEUE(): the QNAME in TPQUEDEF-REC Argument

When message queues are being used within a queue space to invoke services, they are named according to application services that process the requests. `QNAME` contains such a value; an exception in which `QNAME` is not an application service is described in “Procedure for Dequeuing Replies from Services Invoked Through `TMQFORWARD`” on page 4-29.

TPENQUEUE(): the DATA-REC and LEN in TPTYPE-REC Arguments

`DATA-REC` contains the message to be processed. `LEN` in `TPTYPE-REC` gives the length of the message. Some BEA Tuxedo record types (`VIEW`, for example) do not require `LEN` to be specified; in such cases, the argument is ignored. If `RECTYPE` in `TPTYPE-REC` is `SPACES`, `DATA-REC` and `LEN` are ignored and the message is enqueued with no data portion.

TPENQUEUE(): the Settings in TPQUEDEF-REC

Settings in `TPQUEDEF-REC` are used to tell the BEA Tuxedo system how the `TPENQUEUE()` call is handled; the following are valid settings:

`TPNOTRAN`

If the caller is in transaction mode and this setting is used, the message is not enqueued within the caller’s transaction. A caller in transaction mode that sets this to true is still subject to the transaction timeout (and no other). If message enqueueing fails that was invoked with this setting, the caller’s transaction is not affected. Either `TPNOTRAN` or `TPTRAN` must be set.

`TPTRAN`

If the caller is in transaction mode, this setting specifies that the enqueueing of the message is to be done within the same transaction. Either `TPNOTRAN` or `TPTRAN` must be set.

TPNOBLOCK

The message is not enqueued if a blocking condition exists. If TPNOBLOCK is set and a blocking condition exists such as the internal buffers into which the message is transferred are full, the call fails and `tperrno(5)` is set to TPBLOCK. If TPNOBLOCK is set and a blocking condition exists because the target queue is opened *exclusively* by another application, the call fails, `tperrno()` is set to TPDIAGNOSTIC, and the diagnostic field of the TPQCTL structure is set to QMESHARE. In the latter case, the other application, which is based on a BEA product other than the BEA Tuxedo system, opened the queue for exclusive read and/or write using the Queuing Services API (QSAPI). Either TPNOBLOCK or TPBLOCK must be set.

TPBLOCK

When TPBLOCK is set and a blocking condition exists, the caller blocks until the condition subsides or a timeout occurs (either transaction or blocking timeout). Either TPNOBLOCK or TPBLOCK must be set.

TPNOTIME

This setting asks that the call be immune to blocking timeouts; transaction timeouts may still occur. Either TPNOTIME or TPTIME must be set.

TPTIME

This setting asks that the call will receive blocking timeouts. Either TPNOTIME or TPTIME must be set.

TPSIGRSTRT

This setting says that any underlying system calls that are interrupted by a signal should be reissued. Either TPSIGRSTRT or TPNOSIGRSTRT must be set.

TPNOSIGRSTRT

This setting says that any underlying system calls that are interrupted by a signal should not be reissued. The call fails and sets TP-STATUS to TPEGOTSIG. Either TPSIGRSTRT or TPNOSIGRSTRT must be set.

TPQUEDEF-REC Structure

The *TPQUEDEF-REC* structure has members that are used by the application and by the BEA Tuxedo system to pass parameters in both directions between application programs and the queued message facility. It is defined in the COBOL *COPY* file. The client that calls *TPQUEDEF-REC* uses settings to mark members the application wants

the system to fill in. The structure is also used by `TPDEQUEUE()`; some of the members do not come into play until the application calls that function. The complete structure is shown in the following listing.

Listing 4-1 The TPQUEDEF-REC Structure

```

05 TPBLOCK-FLAG          PIC S9(9) COMP-5.
    88 TPBLOCK           VALUE 0.
    88 TPNOBLOCK        VALUE 1.
05 TPTRAN-FLAG          PIC S9(9) COMP-5.
    88 TPTRAN           VALUE 0.
    88 TPNOTRAN        VALUE 1.
05 TPTIME-FLAG          PIC S9(9) COMP-5.
    88 TPTIME           VALUE 0.
    88 TPNOTIME        VALUE 1.
05 TPSIGRSTRT-FLAG      PIC S9(9) COMP-5.
    88 TPNOSIGRSTRT    VALUE 0.
    88 TPSIGRSTRT      VALUE 1.
05 TPNOCHANGE-FLAG      PIC S9(9) COMP-5.
    88 TPCHANGE        VALUE 0.
    88 TPNOCHANGE      VALUE 1.
05 TPQUE-ORDER-FLAG     PIC S9(9) COMP-5.
    88 TPQDEFAULT      VALUE 0.
    88 TPQTOP          VALUE 1.
    88 TPQBEFOREMSGID  VALUE 2.
05 TPQUE-TIME-FLAG      PIC S9(9) COMP-5.
    88 TPQNOTIME       VALUE 0.
    88 TPQTIME-ABS     VALUE 1.
    88 TPQTIME-REL     VALUE 2.
05 TPQUE-PRIORITY-FLAG  PIC S9(9) COMP-5.
    88 TPQNOPRIORITY   VALUE 0.
    88 TPQPRIORITY     VALUE 1.
05 TPQUE-CORRID-FLAG    PIC S9(9) COMP-5.
    88 TPQNOCORRID     VALUE 0.
    88 TPQCORRID       VALUE 1.
05 TPQUE-REPLYQ-FLAG    PIC S9(9) COMP-5.
    88 TPQNOREPLYQ     VALUE 0.
    88 TPQREPLYQ       VALUE 1.
05 TPQUE-FAILQ-FLAG     PIC S9(9) COMP-5.
    88 TPQNOFAILUREQ   VALUE 0.
    88 TPQFAILUREQ     VALUE 1.
05 TPQUE-MSGID-FLAG     PIC S9(9) COMP-5.
    88 TPQNOMSGID      VALUE 0.
    88 TPQMSGID        VALUE 1.
05 TPQUE-GETBY-FLAG     PIC S9(9) COMP-5.
    88 TPQGETNEXT      VALUE 0.

```

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```
      88 TPQGETBYMSGIDOLD      VALUE 1.
      88 TPQGETBYCORRIDOLD    VALUE 2.
      88 TPQGETBYMSGID        VALUE 3.
      88 TPQGETBYCORRID      VALUE 4.
05 TPQUE-WAIT-FLAG          PIC S9(9) COMP-5.
      88 TPQNOWAIT            VALUE 0.
      88 TPQWAIT              VALUE 1.
05 TPQUE-DELIVERY-FLAG    PIC S9(9) COMP-5.
      88 TPQNODELIVERYQOS    VALUE 0.
      88 TPQDELIVERYQOS      VALUE 1.
05 TPQUEQOS-DELIVERY-FLAG PIC S9(9) COMP-5.
      88 TPQQOSDELIVERYDEFAULTPERSIST VALUE 0.
      88 TPQQOSDELIVERYPERSISTENT   VALUE 1.
      88 TPQQOSDELIVERYNONPERSISTENT VALUE 2.
05 TPQUE-REPLY-FLAG      PIC S9(9) COMP-5.
      88 TPQNOREPLYQOS        VALUE 0.
      88 TPQREPLYQOS          VALUE 1.
05 TPQUEQOS-REPLY-FLAG   PIC S9(9) COMP-5.
      88 TPQQOSREPLYDEFAULTPERSIST  VALUE 0.
      88 TPQQOSREPLYPERSISTENT      VALUE 1.
      88 TPQQOSREPLYNONPERSISTENT   VALUE 2.
05 TPQUE-EXPTIME-FLAG    PIC S9(9) COMP-5.
      88 TPQNOEXPTIME         VALUE 0.
      88 TPQEXPTIME-ABS        VALUE 1.
      88 TPQEXPTIME-REL        VALUE 2.
      88 TPQEXPTIME-NONE       VALUE 3.
05 TPQUE-PEEK-FLAG       PIC S9(9) COMP-5.
      88 TPQNOPEEK            VALUE 0.
      88 TPQPEEK              VALUE 1.
05 DIAGNOSTIC            PIC S9(9) COMP-5.
      88 QMEINVAL              VALUE -1.
      88 QMEBADRMID            VALUE -2.
      88 QMENOTOPEN            VALUE -3.
      88 QMETRAN                VALUE -4.
      88 QMEBADMSGID           VALUE -5.
      88 QMESYSTEM              VALUE -6.
      88 QMEOS                  VALUE -7.
      88 QMEABORTED            VALUE -8.
      88 QMEPROTO              VALUE -9.
      88 QMEBADQUEUE           VALUE -10.
      88 QMENOMSG              VALUE -11.
      88 QMEINUSE              VALUE -12.
      88 QMENOSPACE            VALUE -13.
      88 QMERELASE             VALUE -14.
      88 QMEINVHANDLE          VALUE -15.
      88 QMESHARE              VALUE -16.
05 DEQ-TIME              PIC 9(9) COMP-5.
05 EXP-TIME              PIC 9(9) COMP-5.
05 PRIORITY              PIC S9(9) COMP-5.
```

```

05 MSGID                PIC X(32) .
05 CORRID               PIC X(32) .
05 QNAME                PIC X(15) .
05 QSPACE-NAME         PIC X(15) .
05 REPLYQUEUE          PIC X(15) .
05 FAILUREQUEUE        PIC X(15) .
05 CLIENTID OCCURS 4 TIMES PIC S9(9) COMP-5.
05 APPL-RETURN-CODE    PIC S9(9) COMP-5.
05 APPKEY               PIC S9(9) COMP-5.

```

The following is a list of valid settings for the parameters controlling input information for `TPENQUEUEE`.

TPQTOP

Setting this value indicates that the queue ordering be overridden and the message placed at the top of the queue. This request may not be granted depending on whether or not the queue was configured to allow overriding the queue ordering. Set `TPQDEFAULT` to use default queue ordering. `TPQTOP`, `TPQBEFOREMSGID`, or `TPQDEFAULT` must be set.

TPQBEFOREMSGID

Setting this value indicates that the queue ordering be overridden and the message placed in the queue before the message identified by `MSGID`. This request may not be granted depending on whether or not the queue was configured to allow overriding the queue ordering. Set `TPQDEFAULT` to use default queue ordering. `TPQTOP`, `TPQBEFOREMSGID`, or `TPQDEFAULT` must be set.

Note that the entire 32 bytes of the message identifier value are significant, so the value identified by `MSGID` must be completely initialized (for example, padded with spaces).

TPQTIME-ABS

If this value is set, the message is made available after the time specified by `DEQ-TIME`. `DEQ-TIME` is an absolute time value as generated by `time(2)` or `mktime(3C)` (the number of seconds since 00:00:00 Universal Coordinated Time—UTC, January 1, 1970). Set `TPQNOTIME` if neither an absolute or relative time value is set. `TPQTIME-ABS`, `TPQTIME-REL`, or `TPQNOTIME` must be set. The absolute time is determined by the clock on the machine where the queue manager process resides.

TPQTIME-REL

If this value is set, the message is made available after a time relative to the completion of the enqueueing operation. `DEQ-TIME` specifies the number of seconds to delay after the enqueueing completes before the submitted message should be available. Set `TPQNOTIME` if neither an absolute or relative time value is set. `TPQTIME-ABS`, `TPQTIME-REL`, or `TPQNOTIME` must be set.

TPQPRIORITY

If this value is set, the priority at which the message should be enqueued is stored in `PRIORITY`. The priority must be in the range 1 to 100, inclusive. The higher the number, the higher the priority (that is, a message with a higher number is dequeued before a message with a lower number). For queues not ordered by priority, this value is informational. If `TPQNOPRIORITY` is set, the priority for the message is 50 by default.

TPQCORRID

If this value is set, the correlation identifier value specified in `CORRID` is available when a message is dequeued with `TPDEQUEUE ()`. This identifier accompanies any reply or failure message that is queued so that an application can correlate a reply with a particular request. Set `TPQNOCORRID` if a correlation identifier is not available.

Note that the entire 32 bytes of the correlation identifier value are significant, so the value specified in `CORRID` must be completely initialized (for example, padded with spaces).

TPQREPLYQ

If this value is set, a reply queue named in `REPLYQUEUE` is associated with the queued message. Any reply to the message is queued to the named queue within the same queue space as the request message. Set `TPQNOREPLYQ` if a reply queue name is not available.

TPQFAILUREQ

If this value is set, a failure queue named in `FAILUREQUEUE` is associated with the queued message. If (1) the enqueued message is processed by `TMQFORWARD ()`, (2) `TMQFORWARD` was started with the `-d` option, and (3) the service fails and returns a non-null reply, a failure message consisting of the reply and its associated `tpurcode` is enqueued to the named queue within the same queue space as the original request message. Set `TPQNOFAILUREQ` if a failure queue name is not available.

TPQDELIVERYQOS

TPQREPLYQOS

If TPQDELIVERYQOS is set, the flags specified by TPQUEQOS-DELIVERY-FLAG control the quality of service for message delivery. One of the following mutually exclusive flags must be set: TPQQOSDELIVERYDEFAULTPERSIST, TPQQOSDELIVERYPERSISTENT, or TPQQOSDELIVERYNONPERSISTENT. If TPQDELIVERYQOS is not set, TPQNODELIVERYQOS must be set. When TPQNODELIVERYQOS is set, the default delivery policy of the target queue dictates the delivery quality of service for the message.

If TPQREPLYQOS is set, the flags specified by TPQUEQOS-REPLY-FLAG control the quality of service for reply message delivery for any reply. One of the following mutually exclusive flags must be set:

TPQQOSREPLYDEFAULTPERSIST, TPQQOSREPLYPERSISTENT, or TPQQOSREPLYNONPERSISTENT. The TPQREPLYQOS flag is used when a reply is returned from messages processed by TMQFORWARD. Applications not using TMQFORWARD to invoke services may use the TPQREPLYQOS flag as a hint for their own reply mechanism.

If TPQREPLYQOS is not set, TPQNOREPLYQOS must be set. When TPQNOREPLYQOS is set, the default delivery policy of the REPLYQUEUE queue dictates the delivery quality of service for any reply. Note that the default delivery policy is determined when the reply to a message is enqueued. That is, if the default delivery policy of the reply queue is modified between the time that the original message is enqueued and the reply to the message is enqueued, the policy used is the one in effect when the reply is finally enqueued.

The valid TPQUEQOS-DELIVERY-FLAG and TPQUEQOS-REPLY-FLAG flags are:

TPQQOSDELIVERYDEFAULTPERSIST

TPQQOSREPLYDEFAULTPERSIST

These flags specify that the message is to be delivered using the default delivery policy specified on the target or reply queue.

TPQQOSDELIVERYPERSISTENT

TPQQOSREPLYPERSISTENT

These flags specify that the message is to be delivered in a persistent manner using the disk-based delivery method. When specified, these flags override the default delivery policy specified on the target or reply queue.

TPQQOSDELIVERYNONPERSISTENT

TPQQOSREPLYNONPERSISTENT

These flags specify that the message is to be delivered in a non-persistent manner using the memory-based delivery method; the message is queued in memory until it is dequeued. When specified, these flags override the default delivery policy specified on the target or reply queue.

If the caller is transactional, non-persistent messages are enqueued within the caller's transaction, however, non-persistent messages are lost if the system is shut down or crashes or the IPC shared memory for the queue space is removed.

TPQEXPTIME-ABS

If this value is set, the message has an absolute expiration time, which is the absolute time when the message will be removed from the queue. The absolute expiration time is determined by the clock on the machine where the queue manager process resides.

The absolute expiration time is specified by the value stored in `EXP-TIME`. `EXP-TIME` must be set to an absolute time generated by `time(2)` or `mkttime(3C)` (the number of seconds since 00:00:00 Universal Coordinated Time—UTC, January 1, 1970).

If an absolute time is specified that is earlier than the time of the enqueue operation, the operation succeeds, but the message is not counted for the purpose of calculating thresholds. If the expiration time is before the message availability time, the message is not available for dequeuing unless either the availability or expiration time is changed so that the availability time is before the expiration time. In addition, these messages are removed from the queue at expiration time even if they were never available for dequeuing. If a message expires during a transaction, the expiration does not cause the transaction to fail. Messages that expire while being enqueued or dequeued within a transaction are removed from the queue when the transaction ends. There is no acknowledgment that the message has expired.

One of the following must be set: `TPQEXPTIME-ABS`, `TPQEXPTIME-REL`, `TPQEXPTIME-NONE`, or `TPQNOEXPTIME`.

TPQEXPTIME-REL

If this value is set, the message has a relative expiration time, which is the number of seconds *after* the message arrives at the queue that the message is

removed from the queue. The relative expiration time is specified by the value stored in `EXP-TIME`.

If the expiration time is before the message availability time, the message is not available for dequeuing unless either the availability or expiration time is changed so that the availability time is before the expiration time. In addition, these messages are removed from the queue at expiration time even if they were never available for dequeuing. The expiration of a message during a transaction does cause the transaction to fail. Messages that expire while being enqueued or dequeued within a transaction are removed from the queue when the transaction ends. There is no acknowledgment that the message has expired.

One of the following must be set: `TPQEXPTIME-ABS`, `TPQEXPTIME-REL`, `TPQEXPTIME-NONE`, or `TPQNOEXPTIME`.

`TPQEXPTIME-NONE`

Setting this value indicates that the message should not expire. This flag overrides any default expiration policy associated with the target queue. You can remove a message by dequeuing it or by deleting it via an administrative interface. One of the following must be set: `TPQEXPTIME-ABS`, `TPQEXPTIME-REL`, `TPQEXPTIME-NONE`, or `TPQNOEXPTIME`.

`TPQNOEXPTIME`

Setting this value specifies that the default expiration time associated with the target queue applies to the message. One of the following must be set: `TPQEXPTIME-ABS`, `TPQEXPTIME-REL`, `TPQEXPTIME-NONE`, or `TPQNOEXPTIME`.

Additionally, the `APPL-RETURN-CODE` member of `TPQUEDEF-REC` can be set with a user-return code. This value is returned to the application that calls `TPDEQUEUE()` to dequeue the message.

As output from `TPENQUEUE()`, the following may be set in the `TPQUEDEF-REC` structure.

```
05 DIAGNOSTIC          PIC S9(9) COMP-5.
05 MSGID               PIC X(32).
```

The following is a valid setting in `TPQUEDEF-REC` controlling output information from `TPENQUEUE()`. If this setting is true when `TPENQUEUE()` is called, the BEA Tuxedo /Q server `TMQUEUE(5)` populates the associated element in the record with a message identifier. If this setting is not true when `TPENQUEUE()` is called, `TMQUEUE()` does *not* populate the associated element in the record with a message identifier.

TPQMSGID

If this value is set and the call to `TPENQUEUE ()` is successful, the message identifier is stored in `MSGID`. The entire 32 bytes of the message identifier value are significant, so the value stored in `MSGID` is completely initialized (for example, padded with null characters). The actual padding character used for initialization varies between releases of the BEA Tuxedo /Q component. If `TPQNOMSGID` is set, the message identifier is not available.

The remaining members of the control structure are not used on input to `TPENQUEUE ()`.

If the call to `TPENQUEUE ()` fails and `TP-STATUS` is set to `TPEDIAGNOSTIC`, a value indicating the reason for failure is returned in `DIAGNOSTIC`. The following are the possible values.

[QMEINVAL]

An invalid setting value was specified.

[QMEBADRMID]

An invalid resource manager identifier was specified.

[QMENOTOPEN]

The resource manager is not currently open.

[QMETRAN]

The call was not in transaction mode or was made with the `TPNOTRAN` setting and an error occurred trying to start a transaction in which to enqueue the message. This diagnostic is not returned by a queue manager from BEA Tuxedo Release 7.1 or later.

[QMEBADMSGID]

An invalid message identifier was specified.

[QMESYSTEM]

A system error has occurred. The exact nature of the error is written to a log file.

[QMEOS]

An operating system error has occurred.

[QMEABORTED]

The operation was aborted. If the aborted operation was being executed within a global transaction, the global transaction is marked rollback-only. Otherwise, the queue manager aborts the operation.

[QMEPROTO]

An enqueue was done when the transaction state was not active.

[QMEBADQUEUE]

An invalid or deleted queue name was specified.

[QMENOSPACE]

Due to an insufficient resource, such as no space on the queue, the message with its required quality of service (persistent or non-persistent storage) was not enqueued. QMENOSPACE is returned when any of the following configured resources is exceeded: (1) the amount of disk (persistent) space allotted to the queue space, (2) the amount of memory (non-persistent) space allotted to the queue space, (3) the maximum number of simultaneously active transactions allowed for the queue space, (4) the maximum number of messages that the queue space can contain at any one time, (5) the maximum number of concurrent actions that the Queuing Services component can handle, or (6) the maximum number of authenticated users that may concurrently use the Queuing Services component.

[QMERERELEASE]

An attempt was made to enqueue a message to a queue manager that is from a version of the BEA Tuxedo system that does not support a newer feature.

[QMESHARE]

When enqueueing a message from a specified queue, the specified queue is opened *exclusively* by another application. The other application is one based on a BEA product other than the BEA Tuxedo system that opened the queue for exclusive read and/or write using the Queuing Services API (QSAPI).

Overriding the Queue Order

If the administrator, in creating a queue, allows TPENQUEUE () calls to override the order of messages on the queue, you have two mutually exclusive ways to use the override capability. You can specify that the message is to be placed at the top of the queue by setting TPQTOP or you can specify that it be placed ahead of a specific message by setting TPQBEFOREMSGID and setting MSGID to the ID of the message you wish to precede. This assumes that you saved the message-ID from a previous call in order to be able to use it here. Your administrator must tell you what the queue supports; it can be created to allow either or both of these overrides, or to allow neither.

Overriding the Queue Priority

You can set a value in `PRIORITY` to specify the priority for the message. The value must be in the range 1 to 100; the higher the number, the higher the priority, unlike values specified with the UNIX `nice` command. If `PRIORITY` was not one of the queue ordering parameters, setting a priority here has no effect on the dequeuing order. The priority value is retained however, so that it can be inspected when the message is dequeued.

Setting a Message Availability Time

You can specify in `DEQ-TIME` either an absolute time or a time relative to the completion of the enqueueing operation at which the message is made available. You set either `TPQTIME-ABS` or `TPQTIME-REL` to indicate how the value should be treated. A queue may be created with `time` as a queue-ordering criterion, in which case messages are ordered by the message availability time.

The following example shows how to enqueue a message with a relative time. The sample message will become available sixty seconds in the future.

```
01  TPQUEDEF-REC .
    COPY TPQUEDEF .
01  TPATYPE-REC .
    COPY TPAATYPE .
01  TPSTATUS-REC .
    COPY TPSTATUS .
01  USER-DATA-REC  PIC X(100) .
*
*
*
MOVE LOW-VALUES TO TPQUEDEF-REC .
MOVE "QSPACE1" TO QSPACE-NAME IN TPQUEDEF-REC .
MOVE "Q1" TO QNAME IN TPQUEDEF-REC .
SET TPTRAN IN TPQUEDEF-REC TO TRUE .
SET TPBLOCK IN TPQUEDEF-REC TO TRUE .
SET TPTIME IN TPQUEDEF-REC TO TRUE .
SET TPASIGRSTRRT IN TPQUEDEF-REC TO TRUE .
SET TPQDEFAULT IN TPQUEDEF-REC TO TRUE .
SET TPQTIME-REL IN TPQUEDEF-REC TO TRUE .
MOVE 60 TO DEQ-TIME IN TPQUEDEF-REC .
SET TPQNOPRIORITY IN TPQUEDEF-REC TO TRUE .
SET TPQNOCORRID IN TPQUEDEF-REC TO TRUE .
SET TPQNOREPLYQ IN TPQUEDEF-REC TO TRUE .
```

```

SET TPQNOFAILUREQ IN TPQUEDEF-REC TO TRUE.
SET TPQMSGID IN TPQUEDEF-REC TO TRUE.
MOVE LOW-VALUES TO TPTYPE-REC.
MOVE "STRING" TO REC-TYPE IN TPTYPE-REC.
MOVE LENGTH OF USER-DATA-REC TO LEN IN TPTYPE-REC.
CALL "TPENQUEUE" USING
    TPQUEDEF-REC
    TPTYPE-REC
    USER-DATA-REC
    TPSTATUS-REC.

```

TPENQUEUE() and Transactions

If the caller of `TPENQUEUE()` is in transaction mode and `TPTRAN` is set, then the enqueueing is done within the caller's transaction. The caller knows for certain from the success or failure of `TPENQUEUE()` whether the message was enqueued or not. If the call succeeds, the message is guaranteed to be on the queue. If the call fails, the transaction is rolled back, including the part where the message was placed on the queue.

If the caller of `TPENQUEUE()` is not in transaction mode or if `TPNOTRAN` is set, the message is enqueued outside of the caller's transaction. If the call to `TPENQUEUE()` returns success, the message is guaranteed to be on the queue. If the call to `TPENQUEUE()` fails with a communication error or with a timeout, the caller is left in doubt about whether the failure occurred before or after the message was enqueued.

Note that specifying `TPNOTRAN` while the caller is not in transaction mode has no meaning.

Dequeueing Messages

The syntax for `TPDEQUEUE()` is as follows.

```

01 TPQUEDEF-REC.
   COPY TPQUEDEF.
01 TPTYPE-REC.
   COPY TPTYPE.
01 DATA-REC.

```

```
COPY User Data.  
01 TPSTATUS-REC.  
COPY TPSTATUS.  
CALL "TPDEQUEUE" USING TPQUEDEF-REC TPTYPE-REC DATA-REC TPSTATUS-REC.
```

When this call is issued it tells the system to dequeue a message from the QNAME in TPQUEDEF-REC queue, in the queue space named QSPACE-NAME in TPQUEDEF-REC. The message is placed in DATA-REC. LEN in TPTYPE-REC is set to the length of the data. If LEN is 0 on return from TPDEQUEUE (), the message had no data portion. By the use of settings in TPQUEDEF-REC the system is informed how the call to TPDEQUEUE () is to be handled.

TPDEQUEUE() Arguments

There are some important arguments to control the operation of TPDEQUEUE(3cb1). Let's look at some of them.

TPDEQUEUE(): the QSPACE-NAME in TPQUEDEF-REC Argument

QSPACE-NAME identifies a queue space previously created by the administrator. When the TMQUEUE server is defined in the SERVERS section of the configuration file, the service names it offers are aliases for the actual queue space name (which is specified as part of the OPENINFO parameter in the GROUPS section). For example, when your application uses the server TMQUEUE, the value pointed at by QSPACE-NAME is the name of a service advertised by TMQUEUE. If no service aliases are defined, the name of the default service is the same as that of the server, TMQUEUE. In this case the configuration file may include the following.

```
TMQUEUE  
    SRVGRP = QUE1  SRVID = 1  
    GRACE = 0  RESTART = Y  CONV = N  
    CLOPT = "-A"  
  
or  
    CLOPT = "-s TMQUEUE"
```

The entry for server group QUE1 has an OPENINFO parameter that specifies the resource manager, the path name of the device, and the queue space name. The QSPACE-NAME argument in a client program then looks like the following:

```

01 TPQUEDEF-REC .
   COPY TPQUEDEF .
01 TPTYPE-REC .
   COPY TPTYPE .
01 TPSTATUS-REC .
   COPY TPSTATUS .
01 USER-DATA-REC  PIC X(100) .
*
*
*
MOVE LOW-VALUES TO TPQUEDEF-REC .
MOVE "TMQUEUE" TO QSPACE-NAME IN TPQUEDEF-REC .
MOVE "REPLYQ" TO QNAME IN TPQUEDEF-REC .
SET TPTRAN IN TPQUEDEF-REC TO TRUE .
SET TPBLOCK IN TPQUEDEF-REC TO TRUE .
SET TPTIME IN TPQUEDEF-REC TO TRUE .
SET TPSIGRSTRT IN TPQUEDEF-REC TO TRUE .
MOVE LOW-VALUES TO TPTYPE-REC .
MOVE "STRING" TO REC-TYPE IN TPTYPE-REC .
MOVE LENGTH OF USER-DATA-REC TO LEN IN TPTYPE-REC .
CALL "TPDEQUEUE" USING
      TPQUEDEF-REC
      TPTYPE-REC
      USER-DATA-REC
      TPSTATUS-REC .

```

The example shown on the `TMQUEUE(5)` reference page shows how alias service names can be included when the server is built and specified in the configuration file. The sample program in “A Sample Application” on page A-1, also specifies an alias service name.

TPDEQUEUE(): the QNAME in TPQUEDEF-REC Argument

Queue names in a queue space must be agreed upon by the applications that will access the queue space. This requirement is especially important for reply queues. If `QNAME` refers to a reply queue, the administrator creates it (and often an error queue) in the same manner that he or she creates any other queue. `QNAME` contains the name of the queue from which to retrieve a message or reply.

TPDEQUEUE(): the DATA-REC and LEN in TPTYPE-REC Arguments

These arguments have a different flavor than they do on `TPENQUEUE()`. `DATA-REC` is where the system is to place the message being dequeued.

It is an error for `LEN` to be 0 on input. When `TPDEQUEUE()` returns, `LEN` contains the length of the data retrieved. If it is 0, it means that the reply had no data portion. This can be a legitimate and successful reply in some applications; receiving even a 0 length reply can be used to show successful processing of the enqueued request. If you wish to know whether the record has changed from before the call to `TPDEQUEUE()`, save the length prior to the call to `TPDEQUEUE()` and compare it to `LEN` after the call completes. If the reply is larger than `LEN`, then `DATA-REC` will contain only as many bytes as will fit. The remainder are discarded and `TPDEQUEUE()` fails with `TPTRUNCATE`.

TPDEQUEUE(): the Settings in TPQUEDEF-REC

Settings in `TPQUEDEF-REC` are used to tell the BEA Tuxedo system how the `TPDEQUEUE()` call is handled; the following are valid settings:

TPNOTRAN

If the caller is in transaction mode, this setting specifies that the message is to be dequeued outside of the caller's transaction. Either `TPNOTRAN` or `TPTRAN` must be set.

TPTRAN

If the caller is in transaction mode, this setting specifies that the message is to be dequeued within the same transaction. Either `TPNOTRAN` or `TPTRAN` must be set.

TPNOBLOCK

The message is not dequeued if a blocking condition exists. If `TPNOBLOCK` is set and a blocking condition exists such as the internal buffers into which the message is transferred are full, the call fails and `tperrno(5)` is set to `TPEBLOCK`. If `TPNOBLOCK` is set and a blocking condition exists because the target queue is opened *exclusively* by another application, the call fails, `tperrno()` is set to `TPEDIAGNOSTIC`, and the diagnostic field of the `TPQCTL` structure is set to `QMESHAPE`. In the latter case, the other application, which is based on a BEA product other than the BEA Tuxedo system, opened the queue for exclusive read and/or write using the Queuing Services API (QSAPI). Either `TPNOBLOCK` or `TPBLOCK` must be set.

TPBLOCK

When `TPBLOCK` is set and a blocking condition exists, the caller blocks until the condition subsides or a timeout occurs (either transaction or blocking timeout). This blocking condition does not include blocking on the queue itself if the `TPQWAIT` setting is specified. Either `TPNOBLOCK` or `TPBLOCK` must be set.

TPNOTIME

Setting this value asks that the call be immune to blocking timeouts; transaction timeouts may still occur. Either `TPNOTIME` or `TPTIME` must be set.

TPTIME

Setting this value asks that the call receive blocking timeouts. Either `TPNOTIME` or `TPTIME` must be set.

TPNOCHANGE

If this value is set, the record type of `DATA-REC` is not allowed to change. That is, the type and sub-type of the received record must match the type and subtype of the record `DATA-REC`. Either `TPNOCHANGE` or `TPCHANGE` must be set.

TPCHANGE

By default, if a record is received that differs in type from the record `DATA-REC`, `DATA-REC`'s record type changes to the received record's type so long as the receiver recognizes the incoming record type. That is, the type and sub-type of the received record must match the type and sub-type of the record `DATA-REC`. Either `TPNOCHANGE` or `TPCHANGE` must be set.

TPSIGRSTRT

Setting this value says that any underlying system calls that are interrupted by a signal should be reissued. Either `TPSIGRSTRT` or `TPNOSIGRSTRT` must be set.

TPNOSIGRSTRT

If this value is set and a signal is received, the call fails and sets `TP-STATUS` to `TPEGOTSIG`. Either `TPSIGRSTRT` or `TPNOSIGRSTRT` must be set.

TPQUEDEF-REC Structure

The first argument to `TPDEQUEUE()` is the structure `TPQUEDEF-REC`. The `TPQUEDEF-REC` structure has members that are used by the application and by the BEA Tuxedo system to pass parameters in both directions between application programs and the queued message facility. The client that calls `TPDEQUEUE()` uses settings to mark members the application wants the system to fill in. As described earlier, the structure is also used by `TPENQUEUE()`; some of the members only apply to that function. The entire structure is shown in “The TPQUEDEF-REC Structure” on page 4-7.

As input to `TPDEQUEUE()`, the following elements may be set in the `TPQUEDEF` structure.

```
05 MSGID                PIC X(32).
05 CORRID               PIC X(32).
```

The following is a list of valid settings in `TPQUEDEF-REC` that control input for `TPDEQUEUE()`.

TPQGETNEXT

Setting this value requests that the next message on the queue be dequeued, using the default queue order. One of the following must be set: `TPQGETNEXT`, `TPQGETBYMSGID`, or `TPQGETBYCORRID`.

TPQGETBYMSGID

Setting this value requests that the message identified by `MSGID` be dequeued. The message identifier is returned by a prior call to `TPENQUEUE()`. Note that the message identifier is not valid if the message has moved from one queue to another. Note also that the entire 32 bytes of the message identifier value are significant, so the value identified by `MSGID` must be completely initialized (for example, padded with spaces).

One of the following must be set: `TPQGETNEXT`, `TPQGETBYMSGID`, or `TPQGETBYCORRID`.

TPQGETBYCORRID

Setting this value requests that the message identified by `CORRID` be dequeued. The correlation identifier is specified by the application when enqueueing the message with `TPENQUEUE()`. Note that the entire 32 bytes of the correlation identifier value are significant, so the value identified by `CORRID` must be completely initialized (for example, padded with spaces).

One of the following must be set: `TPQGETNEXT`, `TPQGETBYMSGID`, or `TPQGETBYCORRID`.

`TPQWAIT`

Setting this value indicates that an error should not be returned if the queue is empty. Instead, the process should wait until a message is available. Set `TPQNOWAIT` to not wait until a message is available. If `TPQWAIT` is set in conjunction with `TPQGETBYMSGID` or `TPQGETBYCORRID`, it indicates that an error should not be returned if no message with the specified message identifier or correlation identifier is present in the queue. Instead, the process should wait until a message meeting the criteria is available. The process is still subject to the caller's transaction timeout, or, when not in transaction mode, the process is still subject to the timeout specified on the `TMQUEUE` process by the `-t` option.

If a message matching the desired criteria is not immediately available and the configured action resources are exhausted, `TPDEQUEUE` fails, `TP-STATUS` is set to `TPEDIAGNOSTIC`, and `DIAGNOSTIC` is set to `QMESYSTEM`.

Note that each `TPDEQUEUE ()` request specifying the `TPQWAIT` control parameter requires that a queue manager (`TMQUEUE`) action object be available if a message satisfying the condition is not immediately available. If one is not available, the `TPDEQUEUE ()` request fails. The number of available queue manager actions are specified when a queue space is created or modified. When a waiting dequeue request completes, the associated action object associated is made available for another request.

`TPQPEEK`

If `TPQPEEK` is set, the specified message is read but not removed from the queue. The `TPNOTRAN` flag must be set. It is not possible to read messages enqueued or dequeued within a transaction before the transaction completes.

When a thread is non-destructively dequeuing a message using `TPQPEEK`, the message may not be seen by other non-blocking dequeuers for the brief time the system is processing the non-destructive dequeue request. This includes dequeuers using specific selection criteria (such as message identifier and correlation identifier) that are looking for the message currently being non-destructively dequeued.

On output from `TPDEQUEUE()`, the following elements may be set in `TPQUEDEF-REC`:

```
05 PRIORITY          PIC S9(9) COMP-5.
05 MSGID             PIC X(32).
05 CORRID           PIC X(32).
05 TPQUEQOS-DELIVERY-FLAG PIC S9(9) COMP-5.
05 TPQUEQOS-REPLY-FLAG  PIC S9(9) COMP-5.
05 REPLYQUEUE       PIC X(15).
05 FAILUREQUEUE     PIC X(15).
05 DIAGNOSTIC       PIC S9(9) COMP-5.
05 CLIENTID OCCURS 4 TIMES PIC S9(9) COMP-5
05 APPL-RETURN-CODE  PIC S9(9) COMP-5.
05 APPKEY           PIC S9(9) COMP-5.
```

The following is a list of valid settings in `TPQUEDEF-REC` controlling output information from `TPDEQUEUE()`. For any of these settings, if the setting is true when `TPDEQUEUE()` is called, the associated element in the record is populated with the value provided when the message was queued, and the setting remains true. If the value is not available (that is, no value was provided when the message was queued) or the setting is not true when `TPDEQUEUE()` is called, `TPDEQUEUE()` completes with the setting not true.

TPQPRIORITY

If this value is set, the call to `TPDEQUEUE()` is successful, and the message was queued with an explicit priority, then the priority is stored in `PRIORITY`. The priority is in the range 1 to 100, inclusive, and the higher the number, the higher the priority (that is, a message with a higher number is dequeued before a message with a lower number). If `TPQNOPRIORITY` is set, the priority is not available.

Note that if no priority was explicitly specified when the message was queued, the priority for the message is 50.

TPQMSGID

If this value is set and the call to `TPDEQUEUE()` is successful, the message identifier is stored in `MSGID`. The entire 32 bytes of the message identifier value are significant. If `TPQNOMSGID` is set, the message identifier is not available.

TPQCORRID

If this value is set, the call to `TPDEQUEUE()` is successful, and the message was queued with a correlation identifier, then the correlation identifier is stored in `CORRID`. The entire 32 bytes of the correlation identifier value are significant. Any BEA Tuxedo /Q provided reply to a message has the

correlation identifier of the original message. If `TPQNOCCORRID` is set, the correlation identifier is not available.

`TPQDELIVERYQOS`

If this value is set, the call to `TPDEQUEUE()` is successful, and the message was queued with a delivery quality of service, then the flag—`TPQQOSDELIVERYDEFAULTPERSIST`, `TPQQOSDELIVERYPERSISTENT`, or `TPQQOSDELIVERYNONPERSISTENT`—specified by `TPQUEQOS-DELIVERY-FLAG` indicates the delivery quality of service. If `TPQNODELIVERYQOS` is set, the delivery quality of service is not available.

Note that if no delivery quality of service was explicitly specified when the message was queued, the default delivery policy of the target queue dictates the delivery quality of service for the message.

`TPQREPLYQOS`

If this value is set, the call to `TPDEQUEUE()` is successful, and the message was queued with a reply quality of service, then the flag—`TPQQOSREPLYDEFAULTPERSIST`, `TPQQOSREPLYPERSISTENT`, or `TPQQOSREPLYNONPERSISTENT`—specified by `TPQUEQOS-REPLY-FLAG` indicates the reply quality of service. If `TPQNOREPLYQOS` is set, the reply quality of service is not available.

Note that if no reply quality of service was explicitly specified when the message was queued, the default delivery policy of the `REPLYQUEUE` queue dictates the delivery quality of service for any reply. The default delivery policy is determined when the reply to a message is enqueued. That is, if the default delivery policy of the reply queue is modified between the time that the original message is enqueued and the reply to the message is enqueued, the policy used is the one in effect when the reply is finally enqueued.

`TPQREPLYQ`

If this value is set, the call to `TPDEQUEUE()` is successful, and the message was queued with a reply queue, then the name of the reply queue is stored in `REPLYQUEUE`. Any reply to the message should go to the named reply queue within the same queue space as the request message. If `TPQNOREPLYQ` is set, the reply queue is not available.

`TPQFAILUREQ`

If this value is set, the call to `TPDEQUEUE()` is successful, and the message was queued with a failure queue, then the name of the failure queue is stored in `FAILUREQUEUE`. Any failure message should go to the named failure queue

within the same queue space as the request message. If `TPQNOFAILUREQ` is set, the failure queue is not available.

The remaining settings in `TPQUEDEF-REC` are set to the following values when `TPDEQUEUE()` is called: `TPQNOTOP`, `TPQNOBEFOREMSGID`, `TPQNOTIME_ABS`, `TPQNOTIME_REL`, `TPQNOEXPTIME_ABS`, `TPQNOEXPTIME_REL`, and `TPQNOEXPTIME_NONE`.

If the call to `TPDEQUEUE()` fails and `TP-STATUS` is set to `TPEDIAGNOSTIC`, a value indicating the reason for failure is returned in `DIAGNOSTIC`. The valid settings for `DIAGNOSTIC` include those for `TPENQUEUE()` described in “`TPQUEDEF-REC Structure`” on page 4-6 (except for `QMENOSPACE` and `QMERERELEASE`) and the following additional codes.

[`QMENOMSG`]

No message was available for dequeuing. Note that it is possible that the message exists on the queue and another application process has read the message from the queue. In this case, the message may be put back on the queue if that other process rolls back the transaction.

[`QMEINUSE`]

When dequeuing a message by message identifier or correlation identifier, the specified message is in use by another transaction. Other wise all messages currently on the queue are in use by other transactions. This diagnostic is not returned by a queue manager from BEA Tuxedo Release 7.1 or later.

Using TPQWAIT

When `TPDEQUEUE()` is called with flags set to include `TPQWAIT`, if a message is not immediately available, the `TMQUEUE` server waits for the arrival, on the queue, of a message that matches the `TPDEQUEUE()` request before `TPDEQUEUE()` returns control to the caller. The `TMQUEUE` process sets the waiting request aside and processes requests from other processes while waiting to satisfy the first request. If `TPQGETBYMSGID` and/or `TPQGETBYCORRID` are also specified, the server waits until a message with the indicated message identifier and/or correlation identifier becomes available on the queue. If neither of these flags is set, the server waits until any message is put onto the queue. The amount of time it waits is controlled by the caller’s transaction timeout, if the call is in transaction mode, or by the `-t` option in the `CLOPT` parameter of the `TMQUEUE` server, if the call is not in transaction mode.

The `TMQUEUE` server can handle a number of waiting `TPDEQUEUE ()` requests at the same time, as long as action resources are available to handle the request. If there are not enough action resources configured for the queue space, `TPDEQUEUE ()` fails. If this happens on your system, increase the number of action resources for the queue space.

Error Handling When Using `TMQFORWARD` Services

In considering how best to handle errors when dequeuing it is helpful to differentiate between two types of errors:

- Errors encountered by `TMQFORWARD (5)` as it attempts to dequeue a message to forward to the requested service
- Errors that occur in the service that processes the request

By default, if a message is dequeued within a transaction and the transaction is rolled back, then the message ends up back on the queue and can be dequeued and executed again. It may be desirable to delay for a short period before retrying to dequeue and execute the message, allowing the transient problem to clear (for example, allowing for locks in a database to be released by another transaction). Normally, a limit on the number of retries is also useful to ensure that an application flaw doesn't cause significant waste of resources. When a queue is configured by the administrator, both a retry count and a delay period (in seconds) can be specified. A retry count of 0 implies that no retries are done. After the retry count is reached, the message is moved to an error queue that is configured by the administrator for the queue space. If the error queue is not configured, then messages that have reached the retry count are simply deleted. Messages on the error queue must be handled by the administrator who must work out a way of notifying the originator that meets the requirements of the application. The message handling method chosen should be mostly transparent to the originating program that put the message on the queue. There is a virtual guarantee that once a message is successfully enqueued it will be processed according to the parameters of `TPENQUEUE ()` and the attributes of the queue. Notification that a message has been moved to the error queue should be a rare occurrence in a system that has properly tuned its queue parameters.

A failure queue (normally, different from the queue space error queue) may be associated with each queued message. This queue is specified on the enqueueing call as the place to put any failure messages. The failure message for a particular request can be identified by an application-generated correlation identifier that is associated with the message when it is enqueued.

The default behavior of retrying until success (or a predefined limit) is quite appropriate when the failure is caused by a transient problem that is later resolved, allowing the message to be handled appropriately.

There are cases where the problem is not transient. For example, the queued message may request operating on an account that does not exist (and the application is such that it won't come into existence within a reasonable time period if at all). In this case, it is desirable not to waste any resources by trying again. If the application programmer or administrator determines that failures for a particular operation are never transient, then it is simply a matter of setting the retry count to zero, although this will require a mechanism to constantly clear the queue space error queue of these messages (for example, a background client that reads the queue periodically). More likely, it is the case that some problems will be transient (for example, database lock contention) and some problems will be permanent (for example, the account doesn't exist) for the same service.

In the case that the message is processed (dequeued and passed to the application via a `TPCALL`) by `TMQFORWARD`, there is no mechanism in the information returned by `TPCALL` to indicate whether a `TPESVCFAIL` error is caused by a transient or permanent problem.

As in the case where the application is handling the dequeuing, a simple solution is to return success for the service, that is, `TPRETURN` with `TPSUCCESS`, even though the operation failed. This allows the transaction to be committed and the message removed from the queue. If reply messages are being used, the information in the buffer returned from the service can indicate that the operation failed and the message will be enqueued on the reply queue. The `APPL-CODE` in the `TPSVCRET-REC` argument of `TPRETURN` can also be used to return application specific information.

In the case where the service fails and the transaction must be rolled back, it is not clear whether or not `TMQFORWARD` should execute a second transaction to remove the message from the queue without further processing. By default, `TMQFORWARD` will not delete a message for a service that fails. `TMQFORWARD`'s transaction is rolled back and the message is restored to the queue. A command line option may be specified for `TMQFORWARD` that indicates that a message should be deleted from the queue if the service fails and a reply message is sent back with length greater than 0. The message is deleted in a second transaction. The queue must be configured with a delay time and retry count for this to work. If the message is associated with a failure queue, the reply data is enqueued to the failure queue in the same transaction as the one in which the message is deleted from the queue.

Procedure for Dequeuing Replies from Services Invoked Through TMQFORWARD

If your application expects to receive replies to queued messages, here is a procedure you may want to follow.

1. As a preliminary step, the queue space must include a reply queue and a failure queue. The application must also agree on the content of the correlation identifier. The service should be coded to return `TPSUCCESS` on a logical failure and return an explanatory code in the `APPL-CODE` in the `TPSVCRET-REC` argument of `TPRETURN`.

2. When you call `TPENQUEUE()` to put the message on the queue, set the following:

```
TPQCORRID      TPQREPLYQ
TPQFAILUREQ    TPQMSGID
```

(Fill in the values for `CORRID`, `REPLYQUEUE` and `FAILUREQUEUE` before issuing the call. On return from the call, save `CORRID`.)

3. When you call `TPDEQUEUE()` to check for a reply, specify the reply queue in `QNAME` and set the following:

```
TPQCORRID      TPQREPLYQ
TPQFAILUREQ    TPQMSGID
TPQGETBYCORRID
```

(Use the saved correlation identifier to populate `CORRID` before issuing the call. If the call to `TPDEQUEUE()` fails and sets `TP-STATUS` to `TPDIAGNOSTIC`, then further information is available in the `DIAGNOSTIC` settings. If you receive the error code `QMENOMSG`, it means that no message was available for dequeuing.)

4. Set up another call to `TPDEQUEUE()`. This time have `QNAME` point to the name of the failure queue and set the following:

```
TPQCORRID      TPQREPLYQ
TPQFAILUREQ    TPQMSGID
TPQGETBYCORRID
```

Populate `TPQCORRID` with the correlation identifier. When the call returns, check `LEN` to see if data has been received and check `APPL-RETURN-CODE` to see if the service has returned a user return code.

Sequential Processing of Messages

Sequential processing of messages can be achieved by having one service enqueue a message for the next service in the chain before its transaction is committed. The originating process can track the progress of the sequence with a series of `TPDEQUEUE()` calls to the `reply_queue`, if each member uses the same correlation-ID and returns a 0 length reply.

Alternatively, word of the successful completion of the entire sequence can be returned to the originator by using unsolicited notification. To make sure that the last transaction in the sequence ended with a `TPCOMMIT`, a job step can be added that calls `TPNOTIFY` using the client identifier that is carried in the `TPQUEDEF-REC` structure. The originating client must have called `TPSETUNSOL` to name the unsolicited message handler being used.

Using Queues for Peer-to-Peer Communication

In all of the foregoing discussion of enqueueing and dequeuing messages there has been an implicit assumption that queues were being used as an alternative form of request/response processing. A message does not have to be a service request. The queued message facility can transfer data from one process to another as effectively as a service request. This style of communication between applications or clients is called peer-to-peer communication.

If it suits your application to use BEA Tuxedo /Q for this purpose, have the administrator create a separate queue and code your own receiving program for dequeuing *messages* from that queue.

A A Sample Application

- Overview
- Prerequisites
- What Is qsample
- Building qsample
- Suggestions for Further Exploration

Overview

The sample application in this topic contains a description of a one-client, one-server application using BEA Tuxedo /Q called `qsample`. An interactive form of this software is distributed with the BEA Tuxedo software.

Prerequisites

Before you can run the sample application, the BEA Tuxedo software must be installed and built so that the files and commands referred to in this topic are available. If you are personally responsible for installing the BEA Tuxedo software, consult the *Installing the BEA Tuxedo System* for information about how to install the BEA Tuxedo system.

If the installation has already been done by someone else, you need to know the pathname of the root directory of the installed software. You also need to have read and execute permissions on the directories and files in the BEA Tuxedo directory structure so you can copy `qsample` files and execute BEA Tuxedo commands.

What Is `qsample`

`qsample` is a very basic BEA Tuxedo application that uses BEA Tuxedo /Q. It has one application client and server, and uses two system servers. `TMQUEUE(5)` and `TMQFORWARD(5)`. The client calls `TMQUEUE` to enqueue a message in a queue space created for `qsample`. The message is dequeued by `TMQFORWARD` and passed to the application server. The server converts a string from lower case to upper case and returns to `TMQFORWARD`. `TMQFORWARD` enqueues the reply message. The client meanwhile has called `TMQUEUE` to dequeue the reply. When the reply is received, the client displays it on the user's screen.

Building `qsample`

The following procedure provides instructions on building and running the `qsample` application.

1. Make a directory for `qsample` and `cd` to it:

```
mkdir qsampdir
cd qsampdir
```

This is suggested so you will be able to see clearly the `qsample` files you have at the start and the additional files you create along the way. Use the standard shell (`/bin/sh`) or the Korn shell; not the C shell (`/bin/csh`).

2. Copy the `qsample` files.

```
cp $TUXDIR/apps/qsample/* .
```

You will be editing some of the files and making them executable, so it is best to begin with a copy of the files rather than the originals delivered with the software.

3. List the files.

```
$ ls
README
client.c
crlog
crque
makefile
rmipc
runsample
server.c
setenv
ubb.sample
$
```

The files that make up the application are:

README	A file that describes the application and how to configure and run it
setenv	A script that sets environment variables
crlog	A script that creates a TLOG file
crque	A script that defines the queue space and queues for the application
makefile	A makefile that creates the executables for the application
client.c	The source code for the client program
server.c	The source code for the server program
ubb.sample	The ASCII form of the configuration file for the application

`runsample`

A script that calls all the necessary commands to build and run the sample application

`rmipc`

A script that removes the IPC resources for the queue space

4. Edit the `setenv` file.

Open the `setenv` file and modify the `TUXDIR` value to the absolute path of the root directory of the BEA Tuxedo system installation. Remove the angle bracket characters (< and >) when editing this value.

5. Run `runsample`.

The `runsample` script contains several commands; each command is preceded by a comment line that describes the purpose of the command.

```
#set the environment
. ./setenv
chmod +w ubb.sample
uname="`uname -n`"
ed ubb.sample<<!
g;<uname -n>;s; ;${uname};
g;<full path of Tuxedo software>;s; ;${TUXDIR};
g;<full path of APPDIR>;s; ;${APPDIR};
w
q
!
#build the client and server
make client server
#create the tuxconfig file
tmloadcf -y ubb.sample
#create the TLOG
./crlog
#create the QUE
./crque
#boot the application
tmboot -y
#run the client
client
#shutdown the application
tmshutdown -y
#remove the client and server
make clean
#remove the QUE ipc resources
./rmipc
```

```
#remove all files created
rm tuxconfig QUE stdout stderr TLOG ULOG*
```

When you run this script you will see a series of messages on your screen that are generated by the various commands. Included among them are the following lines.

```
before: this is a q example
after:  THIS IS A Q EXAMPLE
```

The `before:` line is a copy of the string that `client` enqueues for processing by server. The `after:` line is what server sends back. These two lines prove that the program worked successfully.

Suggestions for Further Exploration

While it might prove interesting to build and run the sample application using `runserver`, you will probably find it more instructive to examine the individual pieces of the application. In this topic, we suggest some things that we recommend you look at and try; you will undoubtedly be able to think of others as you explore the application more closely.

setenv: Set the Environment

The script `setenv` is an example of a file often used in BEA Tuxedo development. Three of the variables that are set (`TUXDIR`, `APPDIR`, and `PATH`) are needed whenever you are working with the BEA Tuxedo system. Notice that if you are running on a SUN machine, there is another `bin` you must have at the beginning of your `PATH` variable. `LD_LIBRARY_PATH`, `SHLIB_PATH`, or `LIBPATH` are important if you are building the system with shared libraries. The correct variable to use depends on your operating system. `TUXCONFIG` must be set before you can boot the system. `QADMIN` can be set in a variable or provided on the `qadmin(1)` command line.

Points to consider: should you plan to have such a file where you will be doing your BEA Tuxedo /Q work? Should you have a command in your `.profile` so that you set your environment as you log in?

makefile: Make Your Application

Notice that the `makefile` uses `buildserver(1)` and `buildclient(1)` to build the server and client, respectively. You can, of course, execute these commands individually or use the capability of `make` to keep the application current.

While we are on the subject of the `makefile`, this might be a good time to look through the `.c` files for the client and server programs. Of particular interest in connection with BEA Tuxedo /Q are the `topenqueue` and `tpdequeue` calls. Notice particularly the values for the `qspace` and the `qname` arguments. When we look at the configuration file, we will see where those values come from.

ubb.sample: The ASCII Configuration File

The three most pertinent entries in the configuration file are the `CLOPT` parameters for the `TMQUEUE` and `TMQFORWARD` servers and the `OPENINFO` parameter in the `*GROUPS` entry. We will extract those items to call them to your attention here:

```
# First the CLOPT parameter from TMQUEUE:
    CLOPT = "-s QSPACENAME:TMQUEUE -- "
# Then the CLOPT parameter from TMQFORWARD:
    CLOPT="-- -i 2 -q STRING"
# Finally, the OPENINFO parameter from the QUE1 group:
    OPENINFO = "TUXEDO/QM:<APPDIR pathname>/QUE:QSPACE"
```

The `CLOPT` parameter from `TMQUEUE` specifies a service alias of `QSPACENAME`. Look back again at `client.c` and check the `qspace` argument of `topenqueue` and `tpdequeue`. The `CLOPT` parameter for `TMQFORWARD` specifies a service `STRING` by means of the `-q` option. This is also the name given to the queue where messages are enqueued for that service and is specified as the `qname` argument of `topenqueue` in `client.c`.

The `tmloadcf(1)` command is used to compile the ASCII configuration file into a `TUXCONFIG` file.

crlog: Create the Transaction Log

The script in `crlog` invokes `tmadmin(1)` to create a device list entry for the `TLOG` and then create the log for the site specified in our configuration. Because all messages for the queued message facility are enqueued and dequeued within transactions, you must have a log in which to keep track of transactions managed by the `TMS_QM` server.

crque: Create the Queue Space and Queues

The script in `crque` invokes `qmadmin(1)` to create the queue space and queues for the sample application. Notice that the queue space is named `QSPACE` (that is also the name specified as the last argument of the `OPENINFO` parameter in the configuration file). Queues named `STRING` and `RPLYQ` are created. In the `qspacecreate` portion of the script an error queue is named, but the script does not include any `qcreate` command to create that queue. That is a modification you might want to make later.

Boot, Run, and Shut Down the Application

After making the application programs, loading `TUXCONFIG`, and creating the queue space and queues, the next step is to boot the application and run it. The command to boot is

```
tmboot -y
```

The `-y` option keeps `tmboot` from prompting for an okay before booting.

The sample application is run simply by entering the command:

```
client
```

The `tmshutdown` command is used to bring the application down.

Clean Up

The `runsample` script includes three commands that restore the environment to the state it was in before the script was run. The `make clean` command uses `make` to remove the object and executable files for the client and server.

The `rmipc` command is included because the IPC resources for the queue space are not automatically removed by `tmshutdown` (which does remove the BEA Tuxedo IPC resources used by the application). If you look at `rmipc` you will find that it invokes `qmadm` and uses its version of the `ipcrm` command, naming `QSPACE` to identify resources to be removed.

The final command in the script is the `rm` command, which removes a number of files that are generated by the application. There is no harm in leaving these files; in fact, as you work more with the sample application you will probably want to keep `tuxconfig`, `QUE`, and `TLOG` to save having to recreate them.