Using the Qpid Messaging API

Cross-Platform AMQP Messaging

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Chapter 1. Using the Qpid Messaging API

The Qpid Messaging API is quite simple, consisting of only a handful of core classes.

- A *message* consists of a standard set of fields (e.g. `subject`, `reply-to`), an application-defined set of properties, and message content (the main body of the message).
- A *connection* represents a network connection to a remote endpoint.
- A *session* provides a sequentially ordered context for sending and receiving *messages*. A session is obtained from a connection.
- A *sender* sends messages to a target using the `sender.send` method. A sender is obtained from a session for a given target address.
- A *receiver* receives messages from a source using the `receiver.fetch` method. A receiver is obtained from a session for a given source address.

The following sections show how to use these classes in a simple messaging program.

1.1. A Simple Messaging Program in C++

The following C++ program shows how to create a connection, create a session, send messages using a sender, and receive messages using a receiver.

Example 1.1. "Hello world!" in C++

```
#include <qpid/messaging/Connection.h>
#include <qpid/messaging/Message.h>
#include <qpid/messaging/Receiver.h>
#include <qpid/messaging/Sender.h>
#include <qpid/messaging/Session.h>

#include <iostream>

using namespace qpid::messaging;

int main(int argc, char** argv) {
std::string broker = argc > 1 ? argv[1] : "localhost:5672";
std::string address = argc > 2 ? argv[2] : "amq.topic";
std::string connectionOptions = argc > 3 ? argv[3] : "";

Connection connection(broker, connectionOptions);
try {
       connection.open();  1
       Session session = connection.createSession(); 2

       Receiver receiver = session.createReceiver(address); 3
       Sender sender = session.createSender(address); 4
```

```
        sender.send(Message("Hello world!"));

        Message message = receiver.fetch(Duration::SECOND * 1); 5
        std::cout << message.getContent() << std::endl;
        session.acknowledge(); 6

        connection.close(); 7
        return 0;
} catch(const std::exception& error) {
        std::cerr << error.what() << std::endl;
        connection.close();
        return 1;
}
}
```

1. Establishes the connection with the messaging broker.
2. Creates a session object on which messages will be sent and received.
3. Creates a receiver that receives messages from the given address.
4. Creates a sender that sends to the given address.
5. Receives the next message. The duration is optional, if omitted, will wait indefinitely for the next message.
6. Acknowledges receipt of all fetched messages on the session. This informs the broker that the messages were transferred and processed by the client successfully.
7. Closes the connection, all sessions managed by the connection, and all senders and receivers managed by each session.

1.2. A Simple Messaging Program in Python

The following Python program shows how to create a connection, create a session, send messages using a sender, and receive messages using a receiver.

Example 1.2. "Hello world!" in Python

```
import sys
from qpid.messaging import *

broker =  "localhost:5672" if len(sys.argv)<2 else sys.argv[1]
address = "amq.topic" if len(sys.argv)<3 else sys.argv[2]

connection = Connection(broker)

try:
connection.open()  1
session = connection.session()   2

sender = session.sender(address)  3
receiver = session.receiver(address)  4

sender.send(Message("Hello world!"));

message = receiver.fetch(timeout=1)  5
```

```
print message.content
session.acknowledge() 6

except MessagingError,m:
print m
finally:
connection.close()  7
```

1 Establishes the connection with the messaging broker.
2 Creates a session object on which messages will be sent and received.
4 Creates a receiver that receives messages from the given address.
3 Creates a sender that sends to the given address.
5 Receives the next message. The duration is optional, if omitted, will wait indefinitely for the next message.
6 Acknowledges receipt of all fetched messages on the session. This informs the broker that the messages were transfered and processed by the client successfully.
7 Closes the connection, all sessions managed by the connection, and all senders and receivers managed by each session.

1.3. A Simple Messaging Program in .NET C#

The following .NET C# [1] program shows how to create a connection, create a session, send messages using a sender, and receive messages using a receiver.

Example 1.3. "Hello world!" in .NET C#

```
using System;
using Org.Apache.Qpid.Messaging;  1

namespace Org.Apache.Qpid.Messaging {
class Program {
static void Main(string[] args) {
String broker = args.Length > 0 ? args[0] : "localhost:5672";
String address = args.Length > 1 ? args[1] : "amq.topic";

Connection connection = null;
try {
connection = new Connection(broker);
connection.Open();   2
Session session = connection.CreateSession();   3

Receiver receiver = session.CreateReceiver(address);   4
Sender sender = session.CreateSender(address);   5

sender.Send(new Message("Hello world!"));

Message message = new Message();
message = receiver.Fetch(DurationConstants.SECOND * 1);   6
Console.WriteLine("{0}", message.GetContent());
```

[1] The .NET binding for the Qpid C++ Messaging API applies to all .NET Framework managed code languages. C# was chosen for illustration purposes only.

```
session.Acknowledge();   7

connection.Close();   8
} catch (Exception e) {
Console.WriteLine("Exception {0}.", e);
if (null != connection)
connection.Close();
}
}
}
}
```

1. Permits use of Org.Apache.Qpid.Messaging types and methods without explicit namespace qualification. Any .NET project must have a project reference to the assembly file `Org.Apache.Qpid.Messaging.dll` in order to obtain the definitions of the .NET Binding for Qpid Messaging namespace.
2. Establishes the connection with the messaging broker.
3. Creates a session object on which messages will be sent and received.
4. Creates a receiver that receives messages from the given address.
5. Creates a sender that sends to the given address.
6. Receives the next message. The duration is optional, if omitted, will wait indefinitely for the next message.
7. Acknowledges receipt of all fetched messages on the session. This informs the broker that the messages were transfered and processed by the client successfully.
8. Closes the connection, all sessions managed by the connection, and all senders and receivers managed by each session.

1.4. Addresses

An *address* is the name of a message target or message source. [2] The methods that create senders and receivers require an address. The details of sending to a particular target or receiving from a particular source are then handled by the sender or receiver. A different target or source can be used simply by using a different address.

An address resolves to a *node*. The Qpid Messaging API recognises two kinds of nodes, *queues* and *topics* [3]. A queue stores each message until it has been received and acknowledged, and only one receiver can receive a given message [4]. A topic immediately delivers a message to all eligible receivers; if there are no eligible receivers, it discards the message. In the AMQP 0-10 implementation of the API, [5] queues map to AMQP queues, and topics map to AMQP exchanges. [6]

In the rest of this tutorial, we present many examples using two programs that take an address as a command line parameter. **spout** sends messages to the target address, **drain** receives messages from the source

[2] In the programs we have just seen, we used `amq.topic` as the default address if none is passed in. This is the name of a standard exchange that always exists on an AMQP 0-10 messaging broker.

[3] The terms *queue* and *topic* here were chosen to align with their meaning in JMS. These two addressing 'patterns', queue and topic, are sometimes refered as point-to-point and publish-subscribe. AMQP 0-10 has an exchange type called a *topic exchange*. When the term *topic* occurs alone, it refers to a Messaging API topic, not the topic exchange.

[4] There are exceptions to this rule; for instance, a receiver can use `browse` mode, which leaves messages on the queue for other receivers to read.

[5] The AMQP 0-10 implementation is the only one that currently exists.

[6] In AMQP 0-10, messages are sent to exchanges, and read from queues. The Messaging API also allows a sender to send messages to a queue; internally, Qpid implements this by sending the message to the default exchange, with the name of the queue as the routing key. The Messaging API also allows a receiver to receive messages from a topic; internally, Qpid implements this by setting up a private subscription queue for the receiver and binding the subscription queue to the exchange that corresponds to the topic.

address. The source code is available in C++, Python, and .NET C# and can be found in the examples directory for each language. These programs can use any address string as a source or a destination, and have many command line options to configure behavior—use the **-h** option for documentation on these options. [7] The examples in this tutorial also use the **qpid-config** utility to configure AMQP 0-10 queues and exchanges on a Qpid broker.

Example 1.4. Queues

Create a queue with **qpid-config**, send a message using **spout**, and read it using **drain**:

```
$ qpid-config add queue hello-world
$ ./spout hello-world
$ ./drain hello-world

Message(properties={spout-id:c877e622-d57b-4df2-bf3e-6014c68da0ea:0}, content='
```

The queue stored the message sent by **spout** and delivered it to **drain** when requested.

Once the message has been delivered and and acknowledged by **drain**, it is no longer available on the queue. If we run **drain** one more time, no messages will be retrieved.

```
$ ./drain hello-world
$
```

Example 1.5. Topics

This example is similar to the previous example, but it uses a topic instead of a queue.

First, use **qpid-config** to remove the queue and create an exchange with the same name:

```
$ qpid-config del queue hello-world
$ qpid-config add exchange topic hello-world
```

Now run **drain** and **spout** the same way we did in the previous example:

```
$ ./spout hello-world
$ ./drain hello-world
$
```

Topics deliver messages immediately to any interested receiver, and do not store messages. Because there were no receivers at the time **spout** sent the message, it was simply discarded. When we ran **drain**, there were no messages to receive.

Now let's run **drain** first, using the `-t` option to specify a timeout in seconds. While **drain** is waiting for messages, run **spout** in another window.

[7] Currently, the C++, Python, and .NET C# implementations of **drain** and **spout** have slightly different options. This tutorial uses the C++ implementation. The options will be reconciled in the near future.

First Window:

```
$ ./drain -t 30 hello-word
```

Second Window:

```
$ ./spout hello-word
```

Once **spout** has sent a message, return to the first window to see the output from **drain**:

```
Message(properties={spout-id:7da2d27d-93e6-4803-8a61-536d87b8d93f:0}, content='
```

You can run **drain** in several separate windows; each creates a subscription for the exchange, and each receives all messages sent to the exchange.

1.4.1. Address Strings

So far, our examples have used address strings that contain only the name of a node. An *address string* can also contain a *subject* and *options*.

The syntax for an address string is:

```
address_string ::=  <address> [ / <subject> ] [ ; <options> ]
options ::=  { <key> : <value>, ... }
```

Addresses, subjects, and keys are strings. Values can be numbers, strings (with optional single or double quotes), maps, or lists. A complete BNF for address strings appears in Section 1.4.4, “Address String Grammar”.

So far, the address strings in this tutorial have only used simple names. The following sections show how to use subjects and options.

1.4.2. Subjects

Every message has a property called *subject*, which is analogous to the subject on an email message. If no subject is specified, the message's subject is null. For convenience, address strings also allow a subject. If a sender's address contains a subject, it is used as the default subject for the messages it sends. If a receiver's address contains a subject, it is used to select only messages that match the subject—the matching algorithm depends on the message source.

In AMQP 0-10, each exchange type has its own matching algorithm. This is discussed in Section 1.16, “The AMQP 0-10 mapping”.

Note

Currently, a receiver bound to a queue ignores subjects, receiving messages from the queue without filtering. Support for subject filtering on queues will be implemented soon.

Example 1.6. Using subjects

In this example we show how subjects affect message flow.

First, let's use **qpid-config** to create a topic exchange.

```
$ qpid-config add exchange topic news-service
```

Now we use drain to receive messages from `news-service` that match the subject `sports`.

First Window:

```
$ ./drain -t 30 news-service/sports
```

In a second window, let's send messages to `news-service` using two different subjects:

Second Window:

```
$ ./spout news-service/sports
$ ./spout news-service/news
```

Now look at the first window, the message with the subject `sports` has been received, but not the message with the subject `news`:

```
Message(properties={qpid.subject:sports, spout-id:9441674e-a157-4780-a78e-f7c
```

If you run **drain** in multiple windows using the same subject, all instances of **drain** receive the messages for that subject.

The AMQP exchange type we are using here, `amq.topic`, can also do more sophisticated matching. A sender's subject can contain multiple words separated by a "." delimiter. For instance, in a news application, the sender might use subjects like `usa.news`, `usa.weather`, `europe.news`, or `europe.weather`. The receiver's subject can include wildcard characters— "#" matches one or more words in the message's subject, "*" matches a single word. For instance, if the subject in the source address is `*.news`, it matches messages with the subject `europe.news` or `usa.news`; if it is `europe.#`, it matches messages with subjects like `europe.news` or `europe.pseudo.news`.

Example 1.7. Subjects with multi-word keys

This example uses drain and spout to demonstrate the use of subjects with two-word keys.

Let's use **drain** with the subject `*.news` to listen for messages in which the second word of the key is `news`.

First Window:

```
$ ./drain -t 30 news-service/*.news
```

Now let's send messages using several different two-word keys:

Second Window:

```
$ ./spout news-service/usa.news
$ ./spout news-service/usa.sports
$ ./spout news-service/europe.sports
$ ./spout news-service/europe.news
```

In the first window, the messages with `news` in the second word of the key have been received:

```
Message(properties={qpid.subject:usa.news, spout-id:73fc8058-5af6-407c-9166-b
Message(properties={qpid.subject:europe.news, spout-id:f72815aa-7be4-4944-99f
```

Next, let's use **drain** with the subject `#.news` to match any sequence of words that ends with `news`.

First Window:

```
$ ./drain -t 30 news-service/#.news
```

In the second window, let's send messages using a variety of different multi-word keys:

Second Window:

```
$ ./spout news-service/news
$ ./spout news-service/sports
$ ./spout news-service/usa.news
$ ./spout news-service/usa.sports
$ ./spout news-service/usa.faux.news
$ ./spout news-service/usa.faux.sports
```

In the first window, messages with `news` in the last word of the key have been received:

```
Message(properties={qpid.subject:news, spout-id:cbd42b0f-c87b-4088-8206-26d76
Message(properties={qpid.subject:usa.news, spout-id:234a78d7-daeb-4826-90e1-1
Message(properties={qpid.subject:usa.faux.news, spout-id:6029430a-cfcb-4700-8
```

1.4.3. Address String Options

The options in an address string can contain additional information for the senders or receivers created for it, including:

- Policies for assertions about the node to which an address refers.

For instance, in the address string `my-queue; {assert: always, node:{ type: queue }}`, the node named `my-queue` must be a queue; if not, the address does not resolve to a node, and an exception is raised.

- Policies for automatically creating or deleting the node to which an address refers.

  For instance, in the address string `xoxox ; {create: always}`, the queue `xoxox` is created, if it does not exist, before the address is resolved.

- Extension points that can be used for sender/receiver configuration.

  For instance, if the address for a receiver is `my-queue; {mode: browse}`, the receiver works in `browse` mode, leaving messages on the queue so other receivers can receive them.

- Extension points providing more direct control over the underlying protocol.

  For instance, the `x-bindings` property allows greater control over the AMQP 0-10 binding process when an address is resolved.

Let's use some examples to show how these different kinds of address string options affect the behavior of senders and receives.

1.4.3.1. assert

In this section, we use the `assert` option to ensure that the address resolves to a node of the required type.

Example 1.8. Assertions on Nodes

Let's use **qpid-config** to create a queue and a topic.

```
$ qpid-config add queue my-queue
$ qpid-config add exchange topic my-topic
```

We can now use the address specified to drain to assert that it is of a particular type:

```
$ ./drain 'my-queue; {assert: always, node:{ type: queue }}'
$ ./drain 'my-queue; {assert: always, node:{ type: topic }}'
2010-04-20 17:30:46 warning Exception received from broker: not-found: not-
Exchange my-queue does not exist
```

The first attempt passed without error as my-queue is indeed a queue. The second attempt however failed; my-queue is not a topic.

We can do the same thing for my-topic:

```
$ ./drain 'my-topic; {assert: always, node:{ type: topic }}'
$ ./drain 'my-topic; {assert: always, node:{ type: queue }}'
2010-04-20 17:31:01 warning Exception received from broker: not-found: not-
Queue my-topic does not exist
```

Now let's use the `create` option to create the queue `xoxox` if it does not already exist:

1.4.3.2. create

In previous examples, we created the queue before listening for messages on it. Using `create: always`, the queue is automatically created if it does not exist.

Example 1.9. Creating a Queue Automatically

First Window:

```
$ ./drain -t 30 "xoxox ; {create: always}"
```

Now we can send messages to this queue:

Second Window:

```
$ ./spout "xoxox ; {create: always}"
```

Returning to the first window, we see that **drain** has received this message:

```
Message(properties={spout-id:1a1a3842-1a8b-4f88-8940-b4096e615a7d:0}, content='')
```

The details of the node thus created can be controlled by further options within the node. See Table 1.2, “Node Properties” for details.

1.4.3.3. browse

Some options specify message transfer semantics; for instance, they may state whether messages should be consumed or read in browsing mode, or specify reliability characteristics. The following example uses the `browse` option to receive messages without removing them from a queue.

Example 1.10. Browsing a Queue

Let's use the browse mode to receive messages without removing them from the queue. First we send three messages to the queue:

```
$ ./spout my-queue --content one
$ ./spout my-queue --content two
$ ./spout my-queue --content three
```

Now we use drain to get those messages, using the browse option:

```
$ ./drain 'my-queue; {mode: browse}'
Message(properties={spout-id:fbb93f30-0e82-4b6d-8c1d-be60eb132530:0}, conte
Message(properties={spout-id:ab9e7c31-19b0-4455-8976-34abe83edc5f:0}, conte
Message(properties={spout-id:ea75d64d-ea37-47f9-96a9-d38e01c97925:0}, conte
```

We can confirm the messages are still on the queue by repeating the drain:

```
$ ./drain 'my-queue; {mode: browse}'
```

```
Message(properties={spout-id:fbb93f30-0e82-4b6d-8c1d-be60eb132530:0}, conte
Message(properties={spout-id:ab9e7c31-19b0-4455-8976-34abe83edc5f:0}, conte
Message(properties={spout-id:ea75d64d-ea37-47f9-96a9-d38e01c97925:0}, conte
```

1.4.3.4. x-bindings

Greater control over the AMQP 0-10 binding process can be achieved by including an `x-bindings` option in an address string. For instance, the XML Exchange is an AMQP 0-10 custom exchange provided by the Apache Qpid C++ broker. It allows messages to be filtered using XQuery; queries can address either message properties or XML content in the body of the message. The xquery is specified in the arguments field of the AMQP 0-10 command. When using the messaging API an xquery can be specified in and address that resolves to an XML exchange by using the x-bindings property.

An instance of the XML Exchange must be added before it can be used:

```
$ qpid-config add exchange xml xml
```

When using the XML Exchange, a receiver provides an XQuery as an x-binding argument. If the query contains a context item (a path starting with "."), then it is applied to the content of the message, which must be well-formed XML. For instance, `./weather` is a valid XQuery, which matches any message in which the root element is named `weather`. Here is an address string that contains this query:

```
xml; {
link: {
x-bindings: [{exchange:xml, key:weather, arguments:{xquery:"./weather"} }]
}
}
```

When using longer queries with **drain**, it is often useful to place the query in a file, and use **cat** in the command line. We do this in the following example.

Example 1.11. Using the XML Exchange

This example uses an x-binding that contains queries, which filter based on the content of XML messages. Here is an XQuery that we will use in this example:

```
let $w := ./weather
return $w/station = 'Raleigh-Durham International Airport (KRDU)'
and $w/temperature_f > 50
and $w/temperature_f - $w/dewpoint > 5
and $w/wind_speed_mph > 7
and $w/wind_speed_mph < 20
```

We can specify this query in an x-binding to listen to messages that meet the criteria specified by the query:

First Window:

```
$ ./drain -f "xml; {link:{x-bindings:[{key:'weather',
arguments:{xquery:\"$(cat rdu.xquery )\"}}]}}"
```

In another window, let's create an XML message that meets the criteria in the query, and place it in the file `rdu.xml`:

```
<weather>
<station>Raleigh-Durham International Airport (KRDU)</station>
<wind_speed_mph>16</wind_speed_mph>
<temperature_f>70</temperature_f>
<dewpoint>35</dewpoint>
</weather>
```

Now let's use **spout** to send this message to the XML exchange:

Second Window:

```
spout --content "$(cat rdu.xml)" xml/weather
```

Returning to the first window, we see that the message has been received:

```
$ ./drain -f "xml; {link:{x-bindings:[{exchange:'xml', key:'weather', arguments:{x
      Message(properties={qpid.subject:weather, spout-id:31c431de-593f-4bec-a3dd-
      content='<weather>
      <station>Raleigh-Durham International Airport (KRDU)</station>
      <wind_speed_mph>16</wind_speed_mph>
      <temperature_f>40</temperature_f>
      <dewpoint>35</dewpoint>
      </weather>')
```

1.4.3.5. Address String Options - Reference

Table 1.1. Address String Options

option	value	semantics
assert	one of: always, never, sender or receiver	Asserts that the properties specified in the node option match whatever the address resolves to. If they do not, resolution fails and an exception is raised.
create	one of: always, never, sender or receiver	Creates the node to which an address refers if it does not exist. No error is raised if the node does exist. The details of the node may be specified in the node option.
delete	one of: always, never, sender or receiver	Delete the node when the sender or receiver is closed.

option	value	semantics
node	A nested map containing the entries shown in Table 1.2, “Node Properties”.	Specifies properties of the node to which the address refers. These are used in conjunction with the assert or create options.
link	A nested map containing the entries shown in Table 1.3, “Link Properties”.	Used to control the establishment of a conceptual link from the client application to or from the target/ source address.
mode	one of: browse, consume	This option is only of relevance for source addresses that resolve to a queue. If browse is specified the messages delivered to the receiver are left on the queue rather than being removed. If consume is specified the normal behaviour applies; messages are removed from the queue once the client acknowledges their receipt.

Table 1.2. Node Properties

property	value	semantics
type	topic, queue	Indicates the type of the node.
durable	True, False	Indicates whether the node survives a loss of volatile storage e.g. if the broker is restarted.
x-declare	A nested map whose values correspond to the valid fields on an AMQP 0-10 queue-declare or exchange-declare command.	These values are used to fine tune the creation or assertion process. Note however that they are protocol specific.

x-bindings	A nested list in which each binding is represented by a map. The entries of the map for a binding contain the fields that describe an AMQP 0-10 binding. Here is the format for x-bindings:
	`[`
	`{`
	`exchange: <exchange>,`
	`queue: <queue>,`
	`key: <key>,`
	`arguments: {`
	`<key_1>: <value_1>,`
	`...,`
	`<key_n>: <value_n> }`
	`},`
	`...`
	`]`
		In conjunction with the create option, each of these bindings is established as the address is resolved. In conjunction with the assert option, the existence of each of these bindings is verified during resolution. Again, these are protocol specific.

Table 1.3. Link Properties

option	value	semantics
reliability	one of: unreliable, at-least-once, at-most-once, exactly-once	Reliability indicates the level of reliability that the sender or receiver. `unreliable` and `at-most-once` are currently treated as synonyms, and allow messages to be lost if a broker crashes or the connection to a broker is lost. `at-least-once` guarantees that a message is not lost, but duplicates may be received. `exactly-once` guarantees that a message is not lost, and is delivered precisely once. Currently only `unreliable` and `at-least-once` are supported. [a]
durable	True, False	Indicates whether the link survives a loss of volatile storage e.g. if the broker is restarted.
x-declare	A nested map whose values correspond to the valid fields of an AMQP 0-10 queue-declare command.	These values can be used to customise the subscription queue in the case of receiving from an exchange. Note however that they are protocol specific.
x-subscribe	A nested map whose values correspond to the valid fields of an AMQP 0-10 message-subscribe command.	These values can be used to customise the subscription.
x-bindings	A nested list each of whose entries is a map that may contain fields (queue, exchange, key and arguments) describing an AMQP 0-10 binding.	These bindings are established during resolution independent of the create option. They are considered logically part of the linking process rather than of node creation.

[a] If at-most-once is requested, unreliable will be used and for durable messages on durable queues there is the possibility that messages will be redelivered; if exactly-once is requested, at-least-once will be used and the application needs to be able to deal with duplicates.

1.4.4. Address String Grammar

This section provides a formal grammar for address strings.

Tokens. The following regular expressions define the tokens used to parse address strings:

```
LBRACE: \\{
RBRACE: \\}
LBRACK: \\[
RBRACK: \\]
COLON:  :
SEMI:   ;
SLASH:  /
COMMA:  ,
```

```
NUMBER: [+-]?[0-9]*\\.?[0-9]+
ID:     [a-zA-Z_](?:[a-zA-Z0-9_-]*[a-zA-Z0-9_])?
STRING: "(?:[^\\\\"]|\\\\.)*"|\'(?:[^\\\\']|\\\\.)*\'
ESC:    \\\\[^ux]|\\\\x[0-9a-fA-F][0-9a-fA-F]|\\\\u[0-9a-fA-F][0-9a-fA-F][0-9a-fA
SYM:    [.#*%@$^!+-]
WSPACE: [ \\n\\r\\t]+
```

Grammar. The formal grammar for addresses is given below:

```
address := name [ SLASH subject ] [ ";" options ]
name := ( part | quoted )+
subject := ( part | quoted | SLASH )*
quoted := STRING / ESC
part := LBRACE / RBRACE / COLON / COMMA / NUMBER / ID / SYM
options := map
map := "{" ( keyval ( "," keyval )* )? "}"
keyval "= ID ":" value
value := NUMBER / STRING / ID / map / list
list := "[" ( value ( "," value )* )? "]"
```

Address String Options. The address string options map supports the following parameters:

```
<name> [ / <subject> ] ; {
create: always | sender | receiver | never,
delete: always | sender | receiver | never,
assert: always | sender | receiver | never,
mode: browse | consume,
node: {
type: queue | topic,
durable: True | False,
x-declare: { ... <declare-overrides> ... },
x-bindings: [<binding_1>, ... <binding_n>]
},
link: {
name: <link-name>,
durable: True | False,
reliability: unreliable | at-most-once | at-least-once | exactly-once,
x-declare: { ... <declare-overrides> ... },
x-bindings: [<binding_1>, ... <binding_n>],
x-subscribe: { ... <subscribe-overrides> ... }
}
}
```

Create, Delete, and Assert Policies

The create, delete, and assert policies specify who should perfom the associated action:

- *always*: the action is performed by any messaging client
- *sender*: the action is only performed by a sender

- *receiver*: the action is only performed by a receiver
- *never*: the action is never performed (this is the default)

Node-Type

The node-type is one of:

- *topic*: in the AMQP 0-10 mapping, a topic node defaults to the topic exchange, x-declare may be used to specify other exchange types
- *queue*: this is the default node-type

1.5. Sender Capacity and Replay

The send method of a sender has an optional second parameter that controls whether the send call is synchronous or not. A synchronous send call will block until the broker has confirmed receipt of the message. An asynchronous send call will return before the broker confirms receipt of the message, allowing for example further send calls to be made without waiting for a roundtrip to the broker for each message. This is desirable where increased throughput is important.

The sender maintains a list of sent messages whose receipt has yet to be confirmed by the broker. The maximum number of such messages that it will hold is defined by the capacity of the sender, which can be set by the application. If an application tries to send with a sender whose capacity is already fully used up, the send call will block waiting for capacity regardless of the value of the sync flag.

The sender can be queried for the available space (i.e. the unused capacity), and for the current count of unsettled messages (i.e. those held in the replay list pending confirmation by the server). When the unsettled count is zero, all messages on that sender have been successfully sent.

If the connection fails and is transparently reconnected (see Section 1.10.2, “Connection Options” for details on how to control this feature), the unsettled messages for each sender over that connection will be re-transmitted. This provides a transparent level of reliability. This feature can be controlled through the link's reliability as defined in the address (see Table 1.3, “Link Properties”). At present only at-least-once guarantees are offered.

1.6. Receiver Capacity (Prefetch)

By default, a receiver requests the next message from the server in response to each fetch call, resulting in messages being sent to the receiver one at a time. As in the case of sending, it is often desirable to avoid this roundtrip for each message. This can be achieved by allowing the receiver to *prefetch* messages in anticipation of fetch calls being made. The receiver needs to be able to store these prefetched messages, the number it can hold is controlled by the receivers capacity.

1.7. Acknowledging Received Messages

Applications that receive messages should acknowledge their receipt by calling the session's acknowledge method. As in the case of sending messages, acknowledged transfer of messages to receivers provides at-least-once reliability, which means that the loss of the connection or a client crash does not result in lost messages; durable messages are not lost even if the broker is restarted. Some cases may not require this however and the reliability can be controlled through a link property in the address options (see Table 1.3, “Link Properties”).

The acknowledge call acknowledges all messages received on the session (i.e. all message that have been returned from a fetch call on a receiver created on that session).

The acknowledge call also support an optional parameter controlling whether the call is synchronous or not. A synchronous acknowledge will block until the server has confirmed that it has received the acknowledgement. In the asynchronous case, when the call returns there is not yet any guarantee that the server has received and processed the acknowledgement. The session may be queried for the number of unsettled acknowledgements; when that count is zero all acknowledgements made for received messages have been successful.

1.8. Receiving Messages from Multiple Sources

A receiver can only read from one source, but many programs need to be able to read messages from many sources. In the Qpid Messaging API, a program can ask a session for the “next receiver”; that is, the receiver that is responsible for the next available message. The following examples show how this is done in C++, Python, and .NET C#.

Note that to use this pattern you must enable prefetching for each receiver of interest so that the broker will send messages before a fetch call is made. See Section 1.6, “Receiver Capacity (Prefetch)” for more on this.

Example 1.12. Receiving Messages from Multiple Sources

C++:

```
Receiver receiver1 = session.createReceiver(address1);
receiver1.setCapacity(10);
Receiver receiver2 = session.createReceiver(address2);
receiver2.setCapacity(10);

Message message =  session.nextReceiver().fetch();
std::cout << message.getContent() << std::endl;
session.acknowledge(); // acknowledge message receipt
```

Python:

```
receiver1 = session.receiver(address1)
receiver1.capacity = 10
receiver2 = session.receiver(address)
receiver2.capacity = 10
message = session.next_receiver().fetch()
print message.content
session.acknowledge()
```

.NET C#:

```
Receiver receiver1 = session.CreateReceiver(address1);
receiver1.Capacity = 10;
Receiver receiver2 = session.CreateReceiver(address2);
receiver2.Capacity = 10;

Message message = new Message();
message =  session.NextReceiver().Fetch();
Console.WriteLine("{0}", message.GetContent());
```

```
session.Acknowledge();
```

1.9. Transactions

Sometimes it is useful to be able to group messages transfers - sent and/or received - on a session into atomic grouping. This can be done be creating the session as transactional. On a transactional session sent messages only become available at the target address on commit. Likewise any received and acknowledged messages are only discarded at their source on commit [8] .

Example 1.13. Transactions

C++:

```
Connection connection(broker);
Session session =  connection.createTransactionalSession();
...
if (smellsOk())
session.commit();
else
session.rollback();
```

.NET C#:

```
Connection connection = new Connection(broker);
Session session =  connection.CreateTransactionalSession();
...
if (smellsOk())
session.Commit();
else
session.Rollback();
```

1.10. Connections

Messaging connections are created by specifying a broker or a list of brokers, and an optional set of connection options. The constructor prototypes for Connections are:

```
Connection connection();
Connection connection(const string url);
Connection connection(const string url, const string& options);
Connection connection(const string url, const Variant::Map& options);
```

Messaging connection URLs specify only the network host address(es). Connection options are specified separately as an options string or map. This is different from JMS Connection URLs that combine the network address and connection properties in a single string.

[8]Note that this currently is only true for messages received using a reliable mode e.g. at-least-once. Messages sent by a broker to a receiver in unreliable receiver will be discarded immediately regardless of transctionality.

1.10.1. Connection URLs

Connection URLs describe the broker or set of brokers to which the connection is to attach. The format of the Connection URL is defined by AMQP 0.10 Domain:connection.amqp-host-url.

```
amqp_url = "amqp:" prot_addr_list
prot_addr_list = [prot_addr ","]* prot_addr
prot_addr = tcp_prot_addr | tls_prot_addr

tcp_prot_addr = tcp_id tcp_addr
tcp_id = "tcp:" | ""
tcp_addr = [host [":" port] ]
host = <as per http://www.ietf.org/rfc/rfc3986.txt>
port = number
```

Examples of Messaging Connection URLs

```
localhost
localhost:5672
localhost:9999
192.168.1.2:5672
mybroker.example.com:5672
amqp:tcp:localhost:5672
tcp:locahost:5672,localhost:5800
```

1.10.2. Connection Options

Aspects of the connections behaviour can be controlled through specifying connection options. For example, connections can be configured to automatically reconnect if the connection to a broker is lost.

Example 1.14. Specifying Connection Options in C++, Python, and .NET

In C++, these options can be set using `Connection::setOption()` or by passing in a set of options to the constructor. The options can be passed in as a map or in string form:

or

```
Connection connection("localhost:5672");
connection.setOption("reconnect", true);
try {
connection.open();
!!! SNIP !!!
```

In Python, these options can be set as attributes of the connection or using named arguments in the `Connection` constructor:

```
connection = Connection("localhost:5672", reconnect=True)
try:
connection.open()
```

```
!!! SNIP !!!
```

or

```
connection = Connection("localhost:5672")
connection.reconnect = True
try:
connection.open()
!!! SNIP !!!
```

In .NET, these options can be set using `Connection.SetOption()` or by passing in a set of options to the constructor. The options can be passed in as a map or in string form:

```
Connection connection= new Connection("localhost:5672", "{reconnect: true}");
try {
connection.Open();
!!! SNIP !!!
```

or

```
Connection connection = new Connection("localhost:5672");
connection.SetOption("reconnect", true);
try {
connection.Open();
!!! SNIP !!!
```

See the reference documentation for details in each language.

The following table lists the supported connection options.

Table 1.4. Connection Options

option name	value type	semantics
`username`	string	The username to use when authenticating to the broker.
`password`	string	The password to use when authenticating to the broker.
`sasl_mechanisms`	string	The specific SASL mechanisms to use with the python client when authenticating to the broker. The value is a space separated list.
`reconnect`	boolean	Transparently reconnect if the connection is lost.
`reconnect_timeout`	integer	Total number of seconds to continue reconnection attempts before giving up and raising an exception.

option name	value type	semantics
`reconnect_limit`	integer	Maximum number of reconnection attempts before giving up and raising an exception.
`reconnect_interval_min`	integer representing time in seconds	Minimum number of seconds between reconnection attempts. The first reconnection attempt is made immediately; if that fails, the first reconnection delay is set to the value of `reconnect_interval_min`; if that attempt fails, the reconnect interval increases exponentially until a reconnection attempt succeeds or `reconnect_interval_max` is reached.
`reconnect_interval_max`	integer representing time in seconds	Maximum reconnect interval.
`reconnect_interval`	integer representing time in seconds	Sets both `reconnection_interval_min` and `reconnection_interval_max` to the same value.
`heartbeat`	integer representing time in seconds	Requests that heartbeats be sent every N seconds. If two successive heartbeats are missed the connection is considered to be lost.
`transport`	string	Sets the underlying transport protocol used. The default option is 'tcp'. To enable ssl, set to 'ssl'. The C++ client additionally supports 'rdma'.
`tcp-nodelay`	boolean	Set tcp no-delay, i.e. disable Nagle algorithm. [C++ only]
`protocol`	string	Sets the application protocol used. The default option is 'amqp0-10'. To enable AMQP 1.0, set to 'amqp1.0'.

1.11. Maps and Lists in Message Content

Many messaging applications need to exchange data across languages and platforms, using the native datatypes of each programming language.

The Qpid Messaging API supports `map` and `list` in message content. [9] [10] Specific language support for `map` and `list` objects are shown in the following table.

Table 1.5. Map and List Representation in Supported Languages

Language	map	list
Python	`dict`	`list`

[9] Unlike JMS, there is not a specific message type for map messages.
[10] Note that the Qpid JMS client supports MapMessages whose values can be nested maps or lists. This is not standard JMS behaviour.

Language	map	list
C++	`Variant::Map`	`Variant::List`
Java	`MapMessage`	
.NET	`Dictionary<string, object>`	`Collection<object>`

In all languages, messages are encoded using AMQP's portable datatypes.

Tip

Because of the differences in type systems among languages, the simplest way to provide portable messages is to rely on maps, lists, strings, 64 bit signed integers, and doubles for messages that need to be exchanged across languages and platforms.

1.11.1. Qpid Maps and Lists in Python

In Python, Qpid supports the `dict` and `list` types directly in message content. The following code shows how to send these structures in a message:

Example 1.15. Sending Qpid Maps and Lists in Python

```
from qpid.messaging import *
# !!! SNIP !!!

content = {'Id' : 987654321, 'name' : 'Widget', 'percent' : 0.99}
content['colours'] = ['red', 'green', 'white']
content['dimensions'] = {'length' : 10.2, 'width' : 5.1,'depth' : 2.0};
content['parts'] = [ [1,2,5], [8,2,5] ]
content['specs'] = {'colors' : content['colours'],
'dimensions' : content['dimensions'],
'parts' : content['parts'] }
message = Message(content=content)
sender.send(message)
```

The following table shows the datatypes that can be sent in a Python map message, and the corresponding datatypes that will be received by clients in Java or C++.

Table 1.6. Python Datatypes in Maps

Python Datatype	→ C++	→ Java
bool	bool	boolean
int	int64	long
long	int64	long
float	double	double
unicode	string	java.lang.String
uuid	qpid::types::Uuid	java.util.UUID
dict	Variant::Map	java.util.Map
list	Variant::List	java.util.List

1.11.2. Qpid Maps and Lists in C++

In C++, Qpid defines the the `Variant::Map` and `Variant::List` types, which can be encoded into message content. The following code shows how to send these structures in a message:

Example 1.16. Sending Qpid Maps and Lists in C++

```
using namespace qpid::types;

// !!! SNIP !!!

Message message;
Variant::Map content;
content["id"] = 987654321;
content["name"] = "Widget";
content["percent"] = 0.99;
Variant::List colours;
colours.push_back(Variant("red"));
colours.push_back(Variant("green"));
colours.push_back(Variant("white"));
content["colours"] = colours;

Variant::Map dimensions;
dimensions["length"] = 10.2;
dimensions["width"] = 5.1;
dimensions["depth"] = 2.0;
content["dimensions"]= dimensions;

Variant::List part1;
part1.push_back(Variant(1));
part1.push_back(Variant(2));
part1.push_back(Variant(5));

Variant::List part2;
part2.push_back(Variant(8));
part2.push_back(Variant(2));
part2.push_back(Variant(5));

Variant::List parts;
parts.push_back(part1);
parts.push_back(part2);
content["parts"]= parts;

Variant::Map specs;
specs["colours"] = colours;
specs["dimensions"] = dimensions;
specs["parts"] = parts;
content["specs"] = specs;

encode(content, message);
sender.send(message, true);
```

The following table shows the datatypes that can be sent in a C++ map message, and the corresponding datatypes that will be received by clients in Java and Python.

Table 1.7. C++ Datatypes in Maps

C++ Datatype	→ Python	→ Java
bool	bool	boolean
uint16	int | long	short
uint32	int | long	int
uint64	int | long	long
int16	int | long	short
int32	int | long	int
int64	int | long	long
float	float	float
double	float	double
string	unicode	java.lang.String
qpid::types::Uuid	uuid	java.util.UUID
Variant::Map	dict	java.util.Map
Variant::List	list	java.util.List

1.11.3. Qpid Maps and Lists in .NET

The .NET binding for the Qpid Messaging API binds .NET managed data types to C++ `Variant` data types. The following code shows how to send Map and List structures in a message:

Example 1.17. Sending Qpid Maps and Lists in .NET C#

```
using System;
using Org.Apache.Qpid.Messaging;

// !!! SNIP !!!

Dictionary<string, object> content = new Dictionary<string, object>();
Dictionary<string, object> subMap = new Dictionary<string, object>();
Collection<object> colors = new Collection<object>();

// add simple types
content["id"] = 987654321;
content["name"] = "Widget";
content["percent"] = 0.99;

// add nested amqp/map
subMap["name"] = "Smith";
subMap["number"] = 354;
content["nestedMap"] = subMap;

// add an amqp/list
colors.Add("red");
```

```
colors.Add("green");
colors.Add("white");
content["colorsList"] = colors;

// add one of each supported amqp data type
bool mybool = true;
content["mybool"] = mybool;

byte mybyte = 4;
content["mybyte"] = mybyte;

UInt16 myUInt16 = 5;
content["myUInt16"] = myUInt16;

UInt32 myUInt32 = 6;
content["myUInt32"] = myUInt32;

UInt64 myUInt64 = 7;
content["myUInt64"] = myUInt64;

char mychar = 'h';
content["mychar"] = mychar;

Int16 myInt16 = 9;
content["myInt16"] = myInt16;

Int32 myInt32 = 10;
content["myInt32"] = myInt32;

Int64 myInt64 = 11;
content["myInt64"] = myInt64;

Single mySingle = (Single)12.12;
content["mySingle"] = mySingle;

Double myDouble = 13.13;
content["myDouble"] = myDouble;

Guid myGuid = new Guid("000102030405060708090a0b0c0d0e0f");
content["myGuid"] = myGuid;

Message message = new Message(content);
Send(message, true);
```

The following table shows the mapping between datatypes in .NET and C++.

Table 1.8. Datatype Mapping between C++ and .NET binding

C++ Datatype	→ .NET binding
void	nullptr
bool	bool
uint8	byte

C++ Datatype	→ .NET binding
uint16	UInt16
uint32	UInt32
uint64	UInt64
uint8	char
int16	Int16
int32	Int32
int64	Int64
float	Single
double	Double
string	string [a]
qpid::types::Uuid	Guid
Variant::Map	Dictionary<string, object> [a]
Variant::List	Collection<object> [a]

[a]Strings are currently interpreted only with UTF-8 encoding.

1.12. The Request / Response Pattern

Request / Response applications use the reply-to property, described in Table 1.9, “Mapping to AMQP 0-10 Message Properties”, to allow a server to respond to the client that sent a message. A server sets up a service queue, with a name known to clients. A client creates a private queue for the server's response, creates a message for a request, sets the request's reply-to property to the address of the client's response queue, and sends the request to the service queue. The server sends the response to the address specified in the request's reply-to property.

Example 1.18. Request / Response Applications in C++

This example shows the C++ code for a client and server that use the request / response pattern.

The server creates a service queue and waits for a message to arrive. If it receives a message, it sends a message back to the sender.

```
Receiver receiver = session.createReceiver("service_queue; {create: always}");

 Message request = receiver.fetch();
 const Address&amp;amp; address = request.getReplyTo(); // Get "reply-to" from request
 if (address) {
 Sender sender = session.createSender(address); // ... send response to "reply-to"
 Message response("pong!");
 sender.send(response);
 session.acknowledge();
 }
```

The client creates a sender for the service queue, and also creates a response queue that is deleted when the client closes the receiver for the response queue. In the C++ client, if the address starts with the character #, it is given a unique name.

```
Sender sender = session.createSender("service_queue");

Address responseQueue("#response-queue; {create:always, delete:always}");
Receiver receiver = session.createReceiver(responseQueue);

Message request;
request.setReplyTo(responseQueue);
request.setContent("ping");
sender.send(request);
Message response = receiver.fetch();
std::cout << request.getContent() << " -> " << response.getContent() << std::endl
```

The client sends the string `ping` to the server. The server sends the response `pong` back to the same client, using the `replyTo` property.

1.13. Performance Tips

- Consider prefetching messages for receivers (see Section 1.6, “Receiver Capacity (Prefetch)”). This helps eliminate roundtrips and increases throughput. Prefetch is disabled by default, and enabling it is the most effective means of improving throughput of received messages.
- Send messages asynchronously. Again, this helps eliminate roundtrips and increases throughput. The C ++ and .NET clients send asynchronously by default, however the python client defaults to synchronous sends.
- Acknowledge messages in batches (see Section 1.7, “Acknowledging Received Messages”). Rather than acknowledging each message individually, consider issuing acknowledgements after n messages and/ or after a particular duration has elapsed.
- Tune the sender capacity (see Section 1.5, “Sender Capacity and Replay”). If the capacity is too low the sender may block waiting for the broker to confirm receipt of messages, before it can free up more capacity.
- If you are setting a reply-to address on messages being sent by the c++ client, make sure the address type is set to either queue or topic as appropriate. This avoids the client having to determine which type of node is being refered to, which is required when hanling reply-to in AMQP 0-10.
- For latency sensitive applications, setting tcp-nodelay on qpidd and on client connections can help reduce the latency.

1.14. Cluster Failover

The messaging broker can be run in clustering mode, which provides high reliability through replicating state between brokers in the cluster. If one broker in a cluster fails, clients can choose another broker in the cluster and continue their work. Each broker in the cluster also advertises the addresses of all known brokers [11] . A client can use this information to dynamically keep the list of reconnection urls up to date.

In C++, the `FailoverUpdates` class provides this functionality:

Example 1.19. Tracking cluster membership

In C++:

[11] This is done via the amq.failover exchange in AMQP 0-10

```
#include <qpid/messaging/FailoverUpdates.h>
...
Connection connection("localhost:5672");
connection.setOption("reconnect", true);
try {
connection.open();
std::auto_ptr<FailoverUpdates> updates(new FailoverUpdates(connection));
```

In python:

```
import qpid.messaging.util
...
connection = Connection("localhost:5672")
connection.reconnect = True
try:
connection.open()
auto_fetch_reconnect_urls(connection)
```

In .NET C#:

```
using Org.Apache.Qpid.Messaging;
...
connection = new Connection("localhost:5672");
connection.SetOption("reconnect", true);
try {
connection.Open();
FailoverUpdates failover = new FailoverUpdates(connection);
```

1.15. Logging

To simplify debugging, Qpid provides a logging facility that prints out messaging events.

1.15.1. Logging in C++

The Qpidd broker and C++ clients can both use environment variables to enable logging. Linux and Windows systems use the same named environment variables and values.

Use QPID_LOG_ENABLE to set the level of logging you are interested in (trace, debug, info, notice, warning, error, or critical):

```
export QPID_LOG_ENABLE="warning+"
```

The Qpidd broker and C++ clients use QPID_LOG_OUTPUT to determine where logging output should be sent. This is either a file name or the special values stderr, stdout, or syslog:

```
export QPID_LOG_TO_FILE="/tmp/myclient.out"
```

From a Windows command prompt, use the following command format to set the environment variables:

```
set QPID_LOG_ENABLE=warning+
set QPID_LOG_TO_FILE=D:\tmp\myclient.out
```

1.15.2. Logging in Python

The Python client library supports logging using the standard Python logging module. The easiest way to do logging is to use the **basicConfig()**, which reports all warnings and errors:

```
from logging import basicConfig
 basicConfig()
```

Qpidd also provides a convenience method that makes it easy to specify the level of logging desired. For instance, the following code enables logging at the **DEBUG** level:

```
from qpid.log import enable, DEBUG
 enable("qpid.messaging.io", DEBUG)
```

For more information on Python logging, see http://docs.python.org/lib/node425.html. For more information on Qpid logging, use **$ pydoc qpid.log**.

1.16. The AMQP 0-10 mapping

This section describes the AMQP 0-10 mapping for the Qpid Messaging API.

The interaction with the broker triggered by creating a sender or receiver depends on what the specified address resolves to. Where the node type is not specified in the address, the client queries the broker to determine whether it refers to a queue or an exchange.

When sending to a queue, the queue's name is set as the routing key and the message is transfered to the default (or nameless) exchange. When sending to an exchange, the message is transfered to that exchange and the routing key is set to the message subject if one is specified. A default subject may be specified in the target address. The subject may also be set on each message individually to override the default if required. In each case any specified subject is also added as a qpid.subject entry in the application-headers field of the message-properties.

When receiving from a queue, any subject in the source address is currently ignored. The client sends a message-subscribe request for the queue in question. The accept-mode is determined by the reliability option in the link properties; for unreliable links the accept-mode is none, for reliable links it is explicit. The default for a queue is reliable. The acquire-mode is determined by the value of the mode option. If the mode is set to browse the acquire mode is not-acquired, otherwise it is set to pre-acquired. The exclusive and arguments fields in the message-subscribe command can be controlled using the x-subscribe map.

When receiving from an exchange, the client creates a subscription queue and binds that to the exchange. The subscription queue's arguments can be specified using the x-declare map within the link properties. The reliability option determines most of the other parameters. If the reliability is set to unreliable then

an auto-deleted, exclusive queue is used meaning that if the client or connection fails messages may be lost. For exactly-once the queue is not set to be auto-deleted. The durability of the subscription queue is determined by the durable option in the link properties. The binding process depends on the type of the exchange the source address resolves to.

- For a topic exchange, if no subject is specified and no x-bindings are defined for the link, the subscription queue is bound using a wildcard matching any routing key (thus satisfying the expectation that any message sent to that address will be received from it). If a subject is specified in the source address however, it is used for the binding key (this means that the subject in the source address may be a binding pattern including wildcards).
- For a fanout exchange the binding key is irrelevant to matching. A receiver created from a source address that resolves to a fanout exchange receives all messages sent to that exchange regardless of any subject the source address may contain. An x-bindings element in the link properties should be used if there is any need to set the arguments to the bind.
- For a direct exchange, the subject is used as the binding key. If no subject is specified an empty string is used as the binding key.
- For a headers exchange, if no subject is specified the binding arguments simply contain an x-match entry and no other entries, causing all messages to match. If a subject is specified then the binding arguments contain an x-match entry set to all and an entry for qpid.subject whose value is the subject in the source address (this means the subject in the source address must match the message subject exactly). For more control the x-bindings element in the link properties must be used.
- For the XML exchange,[12] if a subject is specified it is used as the binding key and an XQuery is defined that matches any message with that value for qpid.subject. Again this means that only messages whose subject exactly match that specified in the source address are received. If no subject is specified then the empty string is used as the binding key with an xquery that will match any message (this means that only messages with an empty string as the routing key will be received). For more control the x-bindings element in the link properties must be used. A source address that resolves to the XML exchange must contain either a subject or an x-bindings element in the link properties as there is no way at present to receive any message regardless of routing key.

If an x-bindings list is present in the link options a binding is created for each element within that list. Each element is a nested map that may contain values named queue, exchange, key or arguments. If the queue value is absent the queue name the address resolves to is implied. If the exchange value is absent the exchange name the address resolves to is implied.

The following table shows how Qpid Messaging API message properties are mapped to AMQP 0-10 message properties and delivery properties. In this table `msg` refers to the Message class defined in the Qpid Messaging API, `mp` refers to an AMQP 0-10 `message-properties` struct, and `dp` refers to an AMQP 0-10 `delivery-properties` struct.

Table 1.9. Mapping to AMQP 0-10 Message Properties

Python API	**C++ API** [a]	**AMQP 0-10 Property**[b]
msg.id	msg.{get,set}MessageId()	mp.message_id
msg.subject	msg.{get,set}Subject()	mp.application_headers["qpid.subject"]
msg.user_id	msg.{get,set}UserId()	mp.user_id
msg.reply_to	msg.{get,set}ReplyTo()	mp.reply_to[c]
msg.correlation_id	msg.{get,set}CorrelationId()	mp.correlation_id

[12] Note that the XML exchange is not a standard AMQP exchange type. It is a Qpid extension and is currently only supported by the C++ broker.

Python API	C++ API [a]	AMQP 0-10 Property[b]
msg.durable	msg.{get,set}Durable()	dp.delivery_mode == delivery_mode.persistent[d]
msg.priority	msg.{get,set}Priority()	dp.priority
msg.ttl	msg.{get,set}Ttl()	dp.ttl
msg.redelivered	msg.{get,set}Redelivered()	dp.redelivered
msg.properties	msg.getProperties()/ msg.setProperty()	mp.application_headers
msg.content_type	msg.{get,set}ContentType()	mp.content_type

[a] The .NET Binding for C++ Messaging provides all the message and delivery properties described in the C++ API. See Table 2.13, ".NET Binding for the C++ Messaging API Class: Message" .

[b] In these entries, `mp` refers to an AMQP message property, and `dp` refers to an AMQP delivery property.

[c] The reply_to is converted from the protocol representation into an address.

[d] Note that msg.durable is a boolean, not an enum.

1.16.1. 0-10 Message Property Keys

The QPID Messaging API also recognises special message property keys and automatically provides a mapping to their corresponding AMQP 0-10 definitions.

- When sending a message, if the properties contain an entry for `x-amqp-0-10.app-id`, its value will be used to set the `message-properties.app-id` property in the outgoing message. Likewise, if an incoming message has `message-properties.app-id` set, its value can be accessed via the `x-amqp-0-10.app-id` message property key.
- When sending a message, if the properties contain an entry for `x-amqp-0-10.content-encoding`, its value will be used to set the `message-properties.content-encoding` property in the outgoing message. Likewise, if an incoming message has `message-properties.content-encoding` set, its value can be accessed via the `x-amqp-0-10.content-encoding` message property key.
- The routing key (`delivery-properties.routing-key`) in an incoming messages can be accessed via the `x-amqp-0-10.routing-key` message property.
- If the timestamp delivery property is set in an incoming message (`delivery-properties.timestamp`), the timestamp value will be made available via the `x-amqp-0-10.timestamp` message property. [13]

Example 1.20. Accessing the AMQP 0-10 Message Timestamp in Python

The following code fragment checks for and extracts the message timestamp from a received message.

```
try:
msg = receiver.fetch(timeout=1)
if "x-amqp-0-10.timestamp" in msg.properties:
print("Timestamp=%s" % str(msg.properties["x-amqp-0-10.timestamp"]))
except Empty:
pass
```

[13] This special property is currently not supported by the Qpid JMS client.

Example 1.21. Accessing the AMQP 0-10 Message Timestamp in C++

The same example, except in C++.

```
messaging::Message msg;
if (receiver.fetch(msg, messaging::Duration::SECOND*1)) {
if (msg.getProperties().find("x-amqp-0-10.timestamp") != msg.getProperties().
std::cout << "Timestamp=" << msg.getProperties()["x-amqp-0-10.timestamp"].asS
}
}
```

1.17. Using Message Groups

This section describes how messaging applications can use the Message Group feature provided by the Broker.

> **Note**
> The content of this section assumes the reader is familiar with the Message Group feature as described in the AMQP Messaging Broker user's guide. Please read the message grouping section in the Broker user's guide before using the examples given in this section.

1.17.1. Creating Message Group Queues

The following examples show how to create a message group queue that enforces ordered group consumption across multiple consumers.

Example 1.22. Message Group Queue Creation - Python

```
sender = connection.session().sender("msg-group-q;" +
                                     " {create:always, delete:receiver," +
                                     " node: {x-declare: {arguments:" +
                                     " {'qpid.group_header_key':'THE-GROUP'," +
                                     " 'qpid.shared_msg_group':1}}}}")
```

Example 1.23. Message Group Queue Creation - C++

```
std::string addr("msg-group-q; "
                 " {create:always, delete:receiver,"
                 " node: {x-declare: {arguments:"
                 " {qpid.group_header_key:'THE-GROUP',"
                 " qpid.shared_msg_group:1}}}}");
Sender sender = session.createSender(addr);
```

Example 1.24. Message Group Queue Creation - Java

```
Session s = c.createSession(false, Session.CLIENT_ACKNOWLEDGE);
```

```
String addr = "msg-group-q; {create:always, delete:receiver," +
                            " node: {x-declare: {arguments:" +
                            " {'qpid.group_header_key':'THE-GROUP'," +
                            " 'qpid.shared_msg_group':1}}}}";
Destination d = (Destination) new AMQAnyDestination(addr);
MessageProducer sender = s.createProducer(d);
```

The example code uses the x-declare map to specify the message group configuration that should be used for the queue. See the AMQP Messaging Broker user's guide for a detailed description of these arguments. Note that the qpid.group_header_key's value MUST be a string type if using the C++ broker.

1.17.2. Sending Grouped Messages

When sending grouped messages, the client must add a message property containing the group identifier to the outgoing message. If using the C++ broker, the group identifier must be a string type. The key used for the property must exactly match the value passed in the 'qpid.group_header_key' configuration argument.

Example 1.25. Sending Grouped Messages - Python

```
group = "A"
m = Message(content="some data", properties={"THE-GROUP": group})
sender.send(m)

group = "B"
m = Message(content="some other group's data", properties={"THE-GROUP": group})
sender.send(m)

group = "A"
m = Message(content="more data for group 'A'", properties={"THE-GROUP": group})
sender.send(m)
```

Example 1.26. Sending Grouped Messages - C++

```
const std::string groupKey("THE-GROUP");
{
    Message msg("some data");
    msg.getProperties()[groupKey] = std::string("A");
    sender.send(msg);
}
{
    Message msg("some other group's data");
    msg.getProperties()[groupKey] = std::string("B");
    sender.send(msg);
}
{
    Message msg("more data for group 'A'");
    msg.getProperties()[groupKey] = std::string("A");
    sender.send(msg);
}
```

Example 1.27. Sending Grouped Messages - Java

```
String groupKey = "THE-GROUP";

TextMessage tmsg1 = s.createTextMessage("some data");
tmsg1.setStringProperty(groupKey, "A");
sender.send(tmsg1);

TextMessage tmsg2 = s.createTextMessage("some other group's data");
tmsg2.setStringProperty(groupKey, "B");
sender.send(tmsg2);

TextMessage tmsg3 = s.createTextMessage("more data for group 'A'");
tmsg3.setStringProperty(groupKey, "A");
sender.send(tmsg3);
```

The examples above send two groups worth of messages to the queue created in the previous example. Two messages belong to group "A", and one belongs to group "B". Note that it is not necessary to complete sending one group's messages before starting another. Also note that there is no need to indicate to the broker when a new group is created or an existing group retired - the broker tracks group state automatically.

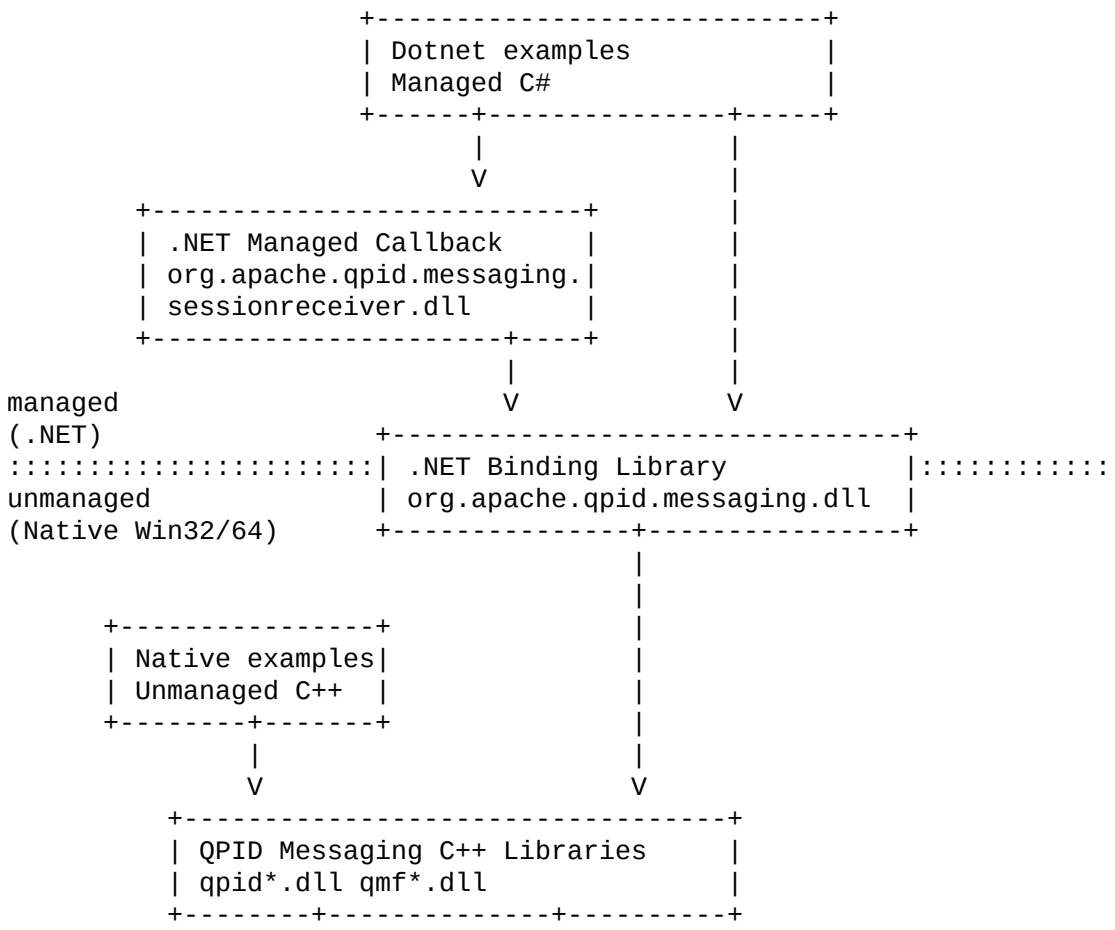
1.17.3. Receiving Grouped Messages

Since the broker enforces group policy when delivering messages, no special actions are necessary for receiving grouped messages from the broker. However, applications must adhere to the rules for message group consumption as described in the AMQP Messaging Broker user's guide.

Chapter 2. The .NET Binding for the C++ Messaging Client

The .NET Binding for the C++ Qpid Messaging Client is a library that gives any .NET program access to Qpid C++ Messaging objects and methods.

2.1. .NET Binding for the C++ Messaging Client Component Architecture



This diagram illustrates the code and library components of the binding and the hierarchical relationships between them.

Table 2.1. .NET Binding for the C++ Messaging Client Component Architecture

Component Name	Component Function
QPID Messaging C++ Libraries	The QPID Messaging C++ core run time system

Component Name	Component Function
Unmanaged C++ Example Source Programs	Ordinary C++ programs that illustrate using qpid/cpp Messaging directly in a native Windows environment.
.NET Messaging Binding Library	The .NET Messaging Binding library provides interoprability between managed .NET programs and the unmanaged, native Qpid Messaging C++ core run time system. .NET programs create a Reference to this library thereby exposing all of the native C++ Messaging functionality to programs written in any .NET language.
.NET Messaging Managed Callback Library	An extension of the .NET Messaging Binding Library that provides message callbacks in a managed .NET environment.
Managed C# .NET Example Source Programs	Various C# example programs that illustrate using .NET Binding for C++ Messaging in the .NET environment.

2.2. .NET Binding for the C++ Messaging Client Examples

This chapter describes the various sample programs that are available to illustrate common Qpid Messaging usage.

Table 2.2. Example : Client - Server

Example Name	Example Description
csharp.example.server	Creates a Receiver and listens for messages. Upon message reception the message content is converted to upper case and forwarded to the received message's ReplyTo address.
csharp.example.client	Sends a series of messages to the Server and prints the original message content and the received message content.

Table 2.3. Example : Map Sender – Map Receiver

Example Name	Example Description
csharp.map.receiver	Creates a Receiver and listens for a map message. Upon message reception the message is decoded and displayed on the console.
csharp.map.sender	Creates a map message and sends it to map.receiver. The map message contains values for every supported .NET Messaging Binding data type.

Table 2.4. Example : Spout - Drain

Example Name	Example Description
csharp.example.spout	Spout is a more complex example of code that generates a series of messages and sends them to peer program Drain. Flexible command line arguments allow the user to specify a variety of message and program options.
csharp.example.drain	Drain is a more complex example of code that receives a series of messages and displays their contents on the console.

Table 2.5. Example : Map Callback Sender – Map Callback Receiver

Example Name	Example Description
csharp.map.callback.receiver	Creates a Receiver and listens for a map message. Upon message reception the message is decoded and displayed on the console. This example illustrates the use of the C# managed code callback mechanism provided by .NET Messaging Binding Managed Callback Library.
csharp.map.callback.sender	Creates a map message and sends it to map_receiver. The map message contains values for every supported .NET Messaging Binding data type.

Table 2.6. Example - Declare Queues

Example Name	Example Description
csharp.example.declare_queues	A program to illustrate creating objects on a broker. This program creates a queue used by spout and drain.

Table 2.7. Example: Direct Sender - Direct Receiver

Example Name	Example Description
csharp.direct.receiver	Creates a Receiver and listens for a messages. Upon message reception the message is decoded and displayed on the console.
csharp.direct.sender	Creates a series of messages and sends them to csharp.direct.receiver.

Table 2.8. Example: Hello World

Example Name	Example Description
csharp.example.helloworld	A program to send a message and to receive the same message.

2.3. .NET Binding Class Mapping to Underlying C++ Messaging API

This chapter describes the specific mappings between classes in the .NET Binding and the underlying C ++ Messaging API.

2.3.1. .NET Binding for the C++ Messaging API Class: Address

Table 2.9. .NET Binding for the C++ Messaging API Class: Address

.NET Binding Class: Address	
Language	**Syntax**
C++	class Address
.NET	public ref class Address
Constructor	
C++	Address();
.NET	public Address();
Constructor	
C++	Address(const std::string& address);
.NET	public Address(string address);
Constructor	
C++	Address(const std::string& name, const std::string& subject, const qpid::types::Variant::Map& options, const std::string& type = "");
.NET	public Address(string name, string subject, Dictionary<string, object> options);
.NET	public Address(string name, string subject, Dictionary<string, object> options, string type);
Copy constructor	
C++	Address(const Address& address);
.NET	public Address(Address address);
Destructor	
C++	~Address();
.NET	~Address();
Finalizer	
C++	n/a
.NET	!Address();
Copy assignment operator	
C++	Address& operator=(const Address&);
.NET	public Address op_Assign(Address rhs);
Property: Name	
C++	const std::string& getName() const;

.NET Binding Class: Address	
Language	**Syntax**
C++	void setName(const std::string&);
.NET	public string Name { get; set; }
Property: Subject	
C++	const std::string& getSubject() const;
C++	void setSubject(const std::string&);
.NET	public string Subject { get; set; }
Property: Options	
C++	const qpid::types::Variant::Map& getOptions() const;
C++	qpid::types::Variant::Map& getOptions();
C++	void setOptions(const qpid::types::Variant::Map&);
.NET	public Dictionary<string, object> Options { get; set; }
Property: Type	
C++	std::string getType() const;
C++	void setType(const std::string&);
.NET	public string Type { get; set; }
Miscellaneous	
C++	std::string str() const;
.NET	public string ToStr();
Miscellaneous	
C++	operator bool() const;
.NET	n/a
Miscellaneous	
C++	bool operator !() const;
.NET	n/a

2.3.2. .NET Binding for the C++ Messaging API Class: Connection

Table 2.10. .NET Binding for the C++ Messaging API Class: Connection

.NET Binding Class: Connection	
Language	**Syntax**
C++	class Connection : public qpid::messaging::Handle<ConnectionImpl>
.NET	public ref class Connection
Constructor	
C++	Connection(ConnectionImpl* impl);
.NET	n/a
Constructor	

.NET Binding Class: Connection	
Language	**Syntax**
C++	Connection();
.NET	n/a
Constructor	
C++	Connection(const std::string& url, const qpid::types::Variant::Map& options = qpid::types::Variant::Map());
.NET	public Connection(string url);
.NET	public Connection(string url, Dictionary<string, object> options);
Constructor	
C++	Connection(const std::string& url, const std::string& options);
.NET	public Connection(string url, string options);
Copy Constructor	
C++	Connection(const Connection&);
.NET	public Connection(Connection connection);
Destructor	
C++	~Connection();
.NET	~Connection();
Finalizer	
C++	n/a
.NET	!Connection();
Copy assignment operator	
C++	Connection& operator=(const Connection&);
.NET	public Connection op_Assign(Connection rhs);
Method: SetOption	
C++	void setOption(const std::string& name, const qpid::types::Variant& value);
.NET	public void SetOption(string name, object value);
Method: open	
C++	void open();
.NET	public void Open();
Property: isOpen	
C++	bool isOpen();
.NET	public bool IsOpen { get; }
Method: close	
C++	void close();
.NET	public void Close();
Method: createTransactionalSession	
C++	Session createTransactionalSession(const std::string& name = std::string());
.NET	public Session CreateTransactionalSession();

.NET Binding Class: Connection	
Language	**Syntax**
.NET	public Session CreateTransactionalSession(string name);
Method: createSession	
C++	Session createSession(const std::string& name = std::string());
.NET	public Session CreateSession();
.NET	public Session CreateSession(string name);
Method: getSession	
C++	Session getSession(const std::string& name) const;
.NET	public Session GetSession(string name);
Property: AuthenticatedUsername	
C++	std::string getAuthenticatedUsername();
.NET	public string GetAuthenticatedUsername();

2.3.3. .NET Binding for the C++ Messaging API Class: Duration

Table 2.11. .NET Binding for the C++ Messaging API Class: Duration

.NET Binding Class: Duration	
Language	**Syntax**
C++	class Duration
.NET	public ref class Duration
Constructor	
C++	explicit Duration(uint64_t milliseconds);
.NET	public Duration(ulong mS);
Copy constructor	
C++	n/a
.NET	public Duration(Duration rhs);
Destructor	
C++	default
.NET	default
Finalizer	
C++	n/a
.NET	default
Property: Milliseconds	
C++	uint64_t getMilliseconds() const;
.NET	public ulong Milliseconds { get; }
Operator: *	
C++	Duration operator*(const Duration& duration, uint64_t multiplier);

.NET Binding Class: Duration	
Language	**Syntax**
.NET	public static Duration operator *(Duration dur, ulong multiplier);
.NET	public static Duration Multiply(Duration dur, ulong multiplier);
C++	Duration operator*(uint64_t multiplier, const Duration& duration);
.NET	public static Duration operator *(ulong multiplier, Duration dur);
.NET	public static Duration Multiply(ulong multiplier, Duration dur);
Constants	
C++	static const Duration FOREVER;
C++	static const Duration IMMEDIATE;
C++	static const Duration SECOND;
C++	static const Duration MINUTE;
.NET	public sealed class DurationConstants
.NET	public static Duration FORVER;
.NET	public static Duration IMMEDIATE;
.NET	public static Duration MINUTE;
.NET	public static Duration SECOND;

2.3.4. .NET Binding for the C++ Messaging API Class: FailoverUpdates

Table 2.12. .NET Binding for the C++ Messaging API Class: FailoverUpdates

.NET Binding Class: FailoverUpdates	
Language	**Syntax**
C++	class FailoverUpdates
.NET	public ref class FailoverUpdates
Constructor	
C++	FailoverUpdates(Connection& connection);
.NET	public FailoverUpdates(Connection connection);
Destructor	
C++	~FailoverUpdates();
.NET	~FailoverUpdates();
Finalizer	
C++	n/a
.NET	!FailoverUpdates();

2.3.5. .NET Binding for the C++ Messaging API Class: Message

Table 2.13. .NET Binding for the C++ Messaging API Class: Message

.NET Binding Class: Message	
Language	**Syntax**
C++	class Message
.NET	public ref class Message
Constructor	
C++	Message(const std::string& bytes = std::string());
.NET	Message();
.NET	Message(System::String ^ theStr);
.NET	Message(System::Object ^ theValue);
.NET	Message(array<System::Byte> ^ bytes);
Constructor	
C++	Message(const char*, size_t);
.NET	public Message(byte[] bytes, int offset, int size);
	Copy constructor
C++	Message(const Message&);
.NET	public Message(Message message);
	Copy assignment operator
C++	Message& operator=(const Message&);
.NET	public Message op_Assign(Message rhs);
Destructor	
C++	~Message();
.NET	~Message();
Finalizer	
C++	n/a
.NET	!Message()
Property: ReplyTo	
C++	void setReplyTo(const Address&);
C++	const Address& getReplyTo() const;
.NET	public Address ReplyTo { get; set; }
Property: Subject	
C++	void setSubject(const std::string&);
C++	const std::string& getSubject() const;
.NET	public string Subject { get; set; }
Property: ContentType	
C++	void setContentType(const std::string&);

.NET Binding Class: Message	
Language	**Syntax**
C++	const std::string& getContentType() const;
.NET	public string ContentType { get; set; }
Property: MessageId	
C++	void setMessageId(const std::string&);
C++	const std::string& getMessageId() const;
.NET	public string MessageId { get; set; }
Property: UserId	
C++	void setUserId(const std::string&);
C++	const std::string& getUserId() const;
.NET	public string UserId { get; set; }
Property: CorrelationId	
C++	void setCorrelationId(const std::string&);
C++	const std::string& getCorrelationId() const;
.NET	public string CorrelationId { get; set; }
Property: Priority	
C++	void setPriority(uint8_t);
C++	uint8_t getPriority() const;
.NET	public byte Priority { get; set; }
Property: Ttl	
C++	void setTtl(Duration ttl);
C++	Duration getTtl() const;
.NET	public Duration Ttl { get; set; }
Property: Durable	
C++	void setDurable(bool durable);
C++	bool getDurable() const;
.NET	public bool Durable { get; set; }
Property: Redelivered	
C++	bool getRedelivered() const;
C++	void setRedelivered(bool);
.NET	public bool Redelivered { get; set; }
Method: SetProperty	
C++	void setProperty(const std::string&, const qpid::types::Variant&);
.NET	public void SetProperty(string name, object value);
Property: Properties	
C++	const qpid::types::Variant::Map& getProperties() const;
C++	qpid::types::Variant::Map& getProperties();
.NET	public Dictionary<string, object> Properties { get; set; }

.NET Binding Class: Message	
Language	**Syntax**
Method: SetContent	
C++	void setContent(const std::string&);
C++	void setContent(const char* chars, size_t count);
.NET	public void SetContent(byte[] bytes);
.NET	public void SetContent(string content);
.NET	public void SetContent(byte[] bytes, int offset, int size);
Method: GetContent	
C++	std::string getContent() const;
.NET	public string GetContent();
.NET	public void GetContent(byte[] arr);
.NET	public void GetContent(Collection<object> __p1);
.NET	public void GetContent(Dictionary<string, object> dict);
Method: GetContentPtr	
C++	const char* getContentPtr() const;
.NET	n/a
Property: ContentSize	
C++	size_t getContentSize() const;
.NET	public ulong ContentSize { get; }
Struct: EncodingException	
C++	struct EncodingException : qpid::types::Exception
.NET	n/a
Method: decode	
C++	void decode(const Message& message, qpid::types::Variant::Map& map, const std::string& encoding = std::string());
C++	void decode(const Message& message, qpid::types::Variant::List& list, const std::string& encoding = std::string());
.NET	n/a
Method: encode	
C++	void encode(const qpid::types::Variant::Map& map, Message& message, const std::string& encoding = std::string());
C++	void encode(const qpid::types::Variant::List& list, Message& message, const std::string& encoding = std::string());
.NET	n/a
Method: AsString	
C++	n/a
.NET	public string AsString(object obj);
.NET	public string ListAsString(Collection<object> list);
.NET	public string MapAsString(Dictionary<string, object> dict);

2.3.6. .NET Binding for the C++ Messaging API Class: Receiver

Table 2.14. .NET Binding for the C++ Messaging API Class: Receiver

.NET Binding Class: Receiver	
Language	**Syntax**
C++	class Receiver
.NET	public ref class Receiver
Constructor	
.NET	Constructed object is returned by Session.CreateReceiver
Copy constructor	
C++	Receiver(const Receiver&);
.NET	public Receiver(Receiver receiver);
Destructor	
C++	~Receiver();
.NET	~Receiver();
Finalizer	
C++	n/a
.NET	!Receiver()
Copy assignment operator	
C++	Receiver& operator=(const Receiver&);
.NET	public Receiver op_Assign(Receiver rhs);
Method: Get	
C++	bool get(Message& message, Duration timeout=Duration::FOREVER);
.NET	public bool Get(Message mmsgp);
.NET	public bool Get(Message mmsgp, Duration durationp);
Method: Get	
C++	Message get(Duration timeout=Duration::FOREVER);
.NET	public Message Get();
.NET	public Message Get(Duration durationp);
Method: Fetch	
C++	bool fetch(Message& message, Duration timeout=Duration::FOREVER);
.NET	public bool Fetch(Message mmsgp);
.NET	public bool Fetch(Message mmsgp, Duration duration);
Method: Fetch	
C++	Message fetch(Duration timeout=Duration::FOREVER);
.NET	public Message Fetch();
.NET	public Message Fetch(Duration durationp);
Property: Capacity	

.NET Binding Class: Receiver	
Language	**Syntax**
C++	void setCapacity(uint32_t);
C++	uint32_t getCapacity();
.NET	public uint Capacity { get; set; }
Property: Available	
C++	uint32_t getAvailable();
.NET	public uint Available { get; }
Property: Unsettled	
C++	uint32_t getUnsettled();
.NET	public uint Unsettled { get; }
Method: Close	
C++	void close();
.NET	public void Close();
Property: IsClosed	
C++	bool isClosed() const;
.NET	public bool IsClosed { get; }
Property: Name	
C++	const std::string& getName() const;
.NET	public string Name { get; }
Property: Session	
C++	Session getSession() const;
.NET	public Session Session { get; }

2.3.7. .NET Binding for the C++ Messaging API Class: Sender

Table 2.15. .NET Binding for the C++ Messaging API Class: Sender

.NET Binding Class: Sender	
Language	**Syntax**
C++	class Sender
.NET	public ref class Sender
Constructor	
.NET	Constructed object is returned by Session.CreateSender
Copy constructor	
C++	Sender(const Sender&);
.NET	public Sender(Sender sender);
Destructor	
C++	~Sender();

.NET Binding Class: Sender	
Language	**Syntax**
.NET	~Sender();
Finalizer	
C++	n/a
.NET	!Sender()
Copy assignment operator	
C++	Sender& operator=(const Sender&);
.NET	public Sender op_Assign(Sender rhs);
Method: Send	
C++	void send(const Message& message, bool sync=false);
.NET	public void Send(Message mmsgp);
.NET	public void Send(Message mmsgp, bool sync);
Method: Close	
C++	void close();
.NET	public void Close();
Property: Capacity	
C++	void setCapacity(uint32_t);
C++	uint32_t getCapacity();
.NET	public uint Capacity { get; set; }
Property: Available	
C++	uint32_t getAvailable();
.NET	public uint Available { get; }
Property: Unsettled	
C++	uint32_t getUnsettled();
.NET	public uint Unsettled { get; }
Property: Name	
C++	const std::string& getName() const;
.NET	public string Name { get; }
Property: Session	
C++	Session getSession() const;
.NET	public Session Session { get; }

2.3.8. .NET Binding for the C++ Messaging API Class: Session

Table 2.16. .NET Binding for the C++ Messaging API Class: Session

.NET Binding Class: Session	
Language	**Syntax**
C++	class Session
.NET	public ref class Session
Constructor	
.NET	Constructed object is returned by Connection.CreateSession
Copy constructor	
C++	Session(const Session&);
.NET	public Session(Session session);
Destructor	
C++	~Session();
.NET	~Session();
Finalizer	
C++	n/a
.NET	!Session()
Copy assignment operator	
C++	Session& operator=(const Session&);
.NET	public Session op_Assign(Session rhs);
Method: Close	
C++	void close();
.NET	public void Close();
Method: Commit	
C++	void commit();
.NET	public void Commit();
Method: Rollback	
C++	void rollback();
.NET	public void Rollback();
Method: Acknowledge	
C++	void acknowledge(bool sync=false);
C++	void acknowledge(Message&, bool sync=false);
.NET	public void Acknowledge();
.NET	public void Acknowledge(bool sync);
.NET	public void Acknowledge(Message __p1);
.NET	public void Acknowledge(Message __p1, bool __p2);
Method: Reject	

.NET Binding Class: Session	
Language	**Syntax**
C++	void reject(Message&);
.NET	public void Reject(Message __p1);
Method: Release	
C++	void release(Message&);
.NET	public void Release(Message __p1);
Method: Sync	
C++	void sync(bool block=true);
.NET	public void Sync();
.NET	public void Sync(bool block);
Property: Receivable	
C++	uint32_t getReceivable();
.NET	public uint Receivable { get; }
Property: UnsettledAcks	
C++	uint32_t getUnsettledAcks();
.NET	public uint UnsetledAcks { get; }
Method: NextReceiver	
C++	bool nextReceiver(Receiver&, Duration timeout=Duration::FOREVER);
.NET	public bool NextReceiver(Receiver rcvr);
.NET	public bool NextReceiver(Receiver rcvr, Duration timeout);
Method: NextReceiver	
C++	Receiver nextReceiver(Duration timeout=Duration::FOREVER);
.NET	public Receiver NextReceiver();
.NET	public Receiver NextReceiver(Duration timeout);
Method: CreateSender	
C++	Sender createSender(const Address& address);
.NET	public Sender CreateSender(Address address);
Method: CreateSender	
C++	Sender createSender(const std::string& address);
.NET	public Sender CreateSender(string address);
Method: CreateReceiver	
C++	Receiver createReceiver(const Address& address);
.NET	public Receiver CreateReceiver(Address address);
Method: CreateReceiver	
C++	Receiver createReceiver(const std::string& address);
.NET	public Receiver CreateReceiver(string address);
Method: GetSender	
C++	Sender getSender(const std::string& name) const;

.NET Binding Class: Session	
Language	**Syntax**
.NET	public Sender GetSender(string name);
Method: GetReceiver	
C++	Receiver getReceiver(const std::string& name) const;
.NET	public Receiver GetReceiver(string name);
Property: Connection	
C++	Connection getConnection() const;
.NET	public Connection Connection { get; }
Property: HasError	
C++	bool hasError();
.NET	public bool HasError { get; }
Method: CheckError	
C++	void checkError();
.NET	public void CheckError();

2.3.9. .NET Binding Class: SessionReceiver

The SessionReceiver class provides a convenient callback mechanism for Messages received by all Receivers on a given Session.

```
using Org.Apache.Qpid.Messaging;
using System;

namespace Org.Apache.Qpid.Messaging.SessionReceiver
{
    public interface ISessionReceiver
    {
        void SessionReceiver(Receiver receiver, Message message);
    }

    public class CallbackServer
    {
        public CallbackServer(Session session, ISessionReceiver callback);

        public void Close();
    }
}
```

To use this class a client program includes references to both Org.Apache.Qpid.Messaging and Org.Apache.Qpid.Messaging.SessionReceiver. The calling program creates a function that implements the ISessionReceiver interface. This function will be called whenever message is received by the session. The callback process is started by creating a CallbackServer and will continue to run until the client program calls the CallbackServer.Close function.

A complete operating example of using the SessionReceiver callback is contained in cpp/bindings/qpid/dotnet/examples/csharp.map.callback.receiver.