

AMQ RFC 006

The AMQP/Fast Wire-Level Protocol

version 0.9a0

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Revised: 2005/05/30

Contents

1	Cover	1
1.1	State of This Document	1
1.1.1	Recent Change History	1
1.2	Copyright Notice	1
1.3	Authors	1
1.4	Abstract	1
2	Introduction	2
2.1	Purpose and Goals of AMQP/Fast	2
2.2	Intended Operating Lifespan	2
2.3	An Extensible Functionality	3
2.4	Ease of Implementation	3
2.5	Guidelines for Implementors	3
2.6	AMQP Standard Models	4
2.7	Definitions	5
2.8	Limitations	7
3	Design Proposal	8
3.1	Data Type Representation	8
3.1.1	Goals and Principles	8
3.1.2	Formal Grammar for AMQP/Fast Fields	8
3.1.3	Integers	8
3.1.4	Strings	9
3.1.5	Field Tables	9
3.2	Negotiating a Connection	9
3.2.1	Goals and Principles	9
3.2.2	Protocol and Version	10
3.2.3	Encryption and Authentication	11
3.2.4	Client and Server Limits	11
3.2.5	Identification and Capabilities	11
3.3	Multiplexing and Pipelining	12
3.3.1	Goals and Principles	12
3.3.2	Multiplexing Design	12
3.3.3	Pipelining Design	12
3.4	The Framing Design	12
3.4.1	Goals and Principles	12
3.4.2	The Transport Layer	13
3.4.3	Delimiting Frames	13
3.4.4	The Frame Header Wire Format	14
3.4.5	Method Frames	14
3.4.6	Content Frames	14
3.4.7	Out-of-Band Transport Frames	15
3.4.8	Trace Frames	15
3.4.9	Heartbeat Frames	16
3.4.10	Meta Frames	16
3.4.11	Extended Frame Header Wire Format	16
3.5	The Abstract Content Model	17
3.5.1	Formal Grammar for Content Frames	17

3.5.2	Content Header Frame Wire Format	17
3.5.3	Content Body Frame Wire Format	18
3.5.4	Structured Content	18
3.5.5	Multiplexed Channel Content	19
3.5.6	Content Classes	19
3.5.7	Content Type and Encoding	20
3.6	The Class/Method Model	20
3.6.1	Goals and Principles	20
3.6.2	Client and Server Roles	21
3.6.3	Method Frame Body Wire Format	21
3.6.4	The Synchpoint Function	22
3.6.5	The Interface Test Function	23
3.6.6	The Distributed Trace Function	23
3.7	Summary of Classes and Methods	23
3.7.1	Goals and Principles	23
3.7.2	Overall Grammar	24
3.7.3	Connection Class - Work With Socket Connections	25
3.7.4	Channel Class - Work With Channels	26
3.7.5	Access Class - Work With Access Tickets	26
3.7.6	Destination Class - Work With Dynamic Destinations	26
3.7.7	Subscription Class - Work With Subscriptions	27
3.7.8	Jms Class - Work With Jms Content	28
3.7.9	File Class - Work With File Content	29
3.7.10	Stream Class - Work With Streaming Content	30
3.7.11	Tx Class - Work With Standard Transactions	30
3.7.12	Dtx Class - Work With Distributed Transactions	30
3.7.13	Test Class - Test Functional Primitives Of The Implementation	30
3.7.14	Explanatory Notes	31
3.8	Queueing and Routing Mechanisms	31
3.8.1	Goals and Principles	31
3.8.2	Virtual Hosts	32
3.8.3	Queue Destinations	32
3.8.4	Topic Destinations	32
3.8.5	Subscriptions	33
3.8.6	Selection and Routing	33
3.8.7	Message Persistence	33
3.8.8	Message Priorities	34
3.8.9	Acknowledgements	34
3.8.10	Flow Control	34
3.8.11	Transactions	34
3.9	Error Handling	35
3.9.1	Goals and Principles	35
3.9.2	Existing Standards	35
3.9.3	The Assertion/Exception Model	36
3.9.4	Hand-shaked Closure	36
3.10	The JMS Operational Model	36
3.10.1	Goals and Principles	36
3.10.2	JMS Content Properties	36
3.11	The File Transfer Operational Model	37
3.11.1	Goals and Principles	37
3.11.2	File Content Properties	37

3.12	The Stream Operational Model	38
3.12.1	Goals and Principles	38
3.12.2	Stream Content Properties	38
3.13	Security	38
3.13.1	Goals and Principles	38
3.13.2	Buffer Overflows	38
3.13.3	Denial of Service Attacks	38
3.14	Miscellaneous Topics	39
3.14.1	Performance	39
3.14.2	Message Templating	39
3.14.3	Field Dictionaries	39
3.14.4	Message Selectors	39
3.14.5	Topic Selectors	39
3.14.6	Destination Templating	39
4	Reference Section	40
4.1	Class Quick Reference	40
4.1.1	Overall Grammar	40
4.1.2	Connection Class - Work With Socket Connections	41
4.1.3	Channel Class - Work With Channels	42
4.1.4	Access Class - Work With Access Tickets	42
4.1.5	Destination Class - Work With Dynamic Destinations	42
4.1.6	Subscription Class - Work With Subscriptions	43
4.1.7	Jms Class - Work With Jms Content	44
4.1.8	File Class - Work With File Content	45
4.1.9	Stream Class - Work With Streaming Content	46
4.1.10	Tx Class - Work With Standard Transactions	46
4.1.11	Dtx Class - Work With Distributed Transactions	46
4.1.12	Test Class - Test Functional Primitives Of The Implementation	46
4.2	The Connection Class	47
4.2.1	The Connection.Start Method	48
4.2.2	The Connection.Start Ok Method	49
4.2.3	The Connection.Secure Method	49
4.2.4	The Connection.Secure Ok Method	49
4.2.5	The Connection.Tune Method	50
4.2.6	The Connection.Tune Ok Method	51
4.2.7	The Connection.Open Method	52
4.2.8	The Connection.Open Ok Method	53
4.2.9	The Connection.Unknown Method	54
4.2.10	The Connection.Close Method	55
4.2.11	The Connection.Close Ok Method	55
4.3	The Channel Class	56
4.3.1	The Channel.Open Method	56
4.3.2	The Channel.Open Ok Method	57
4.3.3	The Channel.Flow Method	58
4.3.4	The Channel.Close Method	58
4.3.5	The Channel.Close Ok Method	59
4.4	The Access Class	59
4.4.1	The Access.Grant Method	60
4.4.2	The Access.Grant Ok Method	61
4.5	The Destination Class	61
4.5.1	The Destination.Define Method	62

4.5.2	The Destination.Define Ok Method	64
4.5.3	The Destination.Query Method	64
4.5.4	The Destination.Query Ok Method	65
4.5.5	The Destination.Purge Method	65
4.5.6	The Destination.Purge Ok Method	66
4.5.7	The Destination.Cancel Method	67
4.5.8	The Destination.Cancel Ok Method	68
4.6	The Subscription Class	68
4.6.1	The Subscription.Define Method	69
4.6.2	The Subscription.Define Ok Method	71
4.6.3	The Subscription.Query Method	72
4.6.4	The Subscription.Query Ok Method	72
4.6.5	The Subscription.Purge Method	73
4.6.6	The Subscription.Purge Ok Method	73
4.6.7	The Subscription.Cancel Method	74
4.6.8	The Subscription.Cancel Ok Method	74
4.7	The Jms Class	75
4.7.1	The Jms.Consume Method	76
4.7.2	The Jms.Consume Ok Method	78
4.7.3	The Jms.Cancel Method	78
4.7.4	The Jms.Publish Method	79
4.7.5	The Jms.Deliver Method	79
4.7.6	The Jms.Browse Method	80
4.7.7	The Jms.Browse Ok Method	81
4.7.8	The Jms.Browse Empty Method	82
4.7.9	The Jms.Ack Method	82
4.7.10	The Jms.Reject Method	83
4.8	The File Class	84
4.8.1	The File.Consume Method	85
4.8.2	The File.Consume Ok Method	87
4.8.3	The File.Cancel Method	87
4.8.4	The File.Publish Method	88
4.8.5	The File.Deliver Method	89
4.8.6	The File.Browse Method	90
4.8.7	The File.Browse Ok Method	91
4.8.8	The File.Browse Empty Method	92
4.8.9	The File.Ack Method	92
4.8.10	The File.Reject Method	93
4.9	The Stream Class	94
4.9.1	The Stream.Consume Method	94
4.9.2	The Stream.Consume Ok Method	96
4.9.3	The Stream.Cancel Method	96
4.9.4	The Stream.Publish Method	97
4.9.5	The Stream.Deliver Method	98
4.10	The Tx Class	98
4.10.1	The Tx.Commit Method	99
4.10.2	The Tx.Commit Ok Method	99
4.10.3	The Tx.Abort Method	100
4.10.4	The Tx.Abort Ok Method	100
4.11	The Dtx Class	100
4.11.1	The Dtx.Start Method	101

4.11.2	The Dtx.Start Ok Method	101
4.12	The Test Class	102
4.12.1	The Test.Integer Method	102
4.12.2	The Test.Integer Ok Method	103
4.12.3	The Test.String Method	103
4.12.4	The Test.String Ok Method	104
4.12.5	The Test.Table Method	104
4.12.6	The Test.Table Ok Method	105
4.12.7	The Test.Content Method	105
4.12.8	The Test.Content Ok Method	106

1 Cover

1.1 State of This Document

This document is a request for comments. Distribution of this document is currently limited to use by iMatix, JPMorgan, and approved partners under cover of the appropriate non-disclosure agreements.

This document is a formal standard. This document is ready for review.

1.1.1 Recent Change History

2005/05/28 - 0.9a0:

- Refactored the protocol using new framing model and protocol class/method architecture. First provisional draft specification.

1.2 Copyright Notice

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1.3 Authors

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1.4 Abstract

We propose a wire-level protocol for the AMQ open middleware architecture. The protocol - AMQP/Fast - is one of a family of AMQ protocols. AMQP/Fast is specifically aimed at managing fast multitasking connections across a reliable network. It supports standard middleware semantics and uses a binary framing model aimed at efficiency and security.

2 Introduction

2.1 Purpose and Goals of AMQP/Fast

AMQP/Fast is designed to be the high-performance member of the AMQP family of standardised general-purpose message-oriented middleware wire-level protocols.

A "wire-level protocol" can be as simple as a "this is how we define packets on the wire". AMQP/Fast is more ambitious than that. It tries to provide formal answers to a series of questions that we must answer in order to implement useful messaging between protocols.

We want to be able to:

- Construct logical "messages" out of data of any type and size, and move these message efficiently across a network of clients and servers.
- Provide queueing and routing semantics for messages so that the behaviour of the server is unambiguously defined by the protocol.
- Define explicit operational semantics for common messaging models, including JMS, file transfer, and streaming, at the protocol level.
- Define quality-of-service levels semantics so client applications can explicitly choose appropriate trade-offs between speed and reliability.
- Create a fully-asynchronous network so that messages can be queued when clients are disconnected, and forwarded when they are connected.
- Allow interoperation and bridging with other middleware systems.
- Allow implementation in any language, on any kind of hardware.
- Avoid license and patent concerns that might hinder adoption of the protocol as a standard.
- Allow the marshalling layers of protocol implementations to be easily generated using code generation technology.
- Allow the creation of an abstract network where services, and their data, can move around the network opaquely to the clients.

2.2 Intended Operating Lifespan

AMQP/Fast is designed to give a useful lifespan of 50 years or more. Our goal is that an AMQP/Fast peer will be able to operate continuously with no upgrades or incompatibility for at least this duration, without requiring "legacy support". One should be able to build a client or server into physical infrastructure.

While the protocol version may and will change, the protocol mechanics (framing, method structures, etc.) must operate unchanged for the full intended lifespan of the protocol, allowing full and perfect forwards compatibility with all future versions of the protocol.

We have applied "Moore's Law" - the theory of exponential growth of capacity of technology - to all capacity limits to identify and eliminate potential future bottlenecks, specifically for:

1. Message sizes: the largest messages (files) are today around 20GB. We expect this to grow by 50% per year, reaching the limit defined by a 64-bit size in 50 years.

2. Frame sizes: IPv4 is limited to 64KB frames, IPv6 to 4GB frames. Ethernet itself is limited to 12000 byte frames due to its CRC algorithm. We expect the maximum networking frame size to grow by 50% per year, in large leaps. We will thus reach the limit of 64-bit sized packets in 50 years.
3. Sequencing: we use method sequencing to allow matching of replies and errors with requests, so called "synchpoints". The method sequence number is 32 bits. This allows 4G methods to be exchanged between synchpoints. We do not see this as a limitation in any scenario, present or future.
4. Protocol classes and methods: the current protocol defines about ten classes and about ten or fewer methods per class. We expect that new versions of the protocol will add classes and methods at a constant rate of 1 to 5 per year. The limit of 255 classes and methods per class should be sufficient to last until 2055.
5. Channels: the limit of 4G channels allows growth of 50% per year from an estimated usage of 10 channels per connection today.
6. Timestamps: we use 64-bit time-stamp values.

2.3 An Extensible Functionality

AMQP/Fast is intended to be extensible in several directions, including new directions totally outside the scope of the protocol as it is designed today. These are the aspects of AMQP/Fast that have been deliberately designed to be extensible (in order of increasing generality and power):

1. Adding new properties to content domains.
2. Adding new arguments to methods.
3. Adding new methods to classes.
4. Adding new content domains.
5. Adding new classes.
6. Adding new frame types.
7. Adding new protocols.

All of these should be feasible while maintaining full backwards compatability with existing implementations.

2.4 Ease of Implementation

Our goal is to achieve some of the cost-benefit ratio of protocols such as SMTP and HTTP, where a simple client can be trivial to build but a full client can be very sophisticated. Keeping AMQP/Fast accessible to simple clients is possible if we hold to these design rules:

1. The use of all complex functionality (e.g. more sophisticated data types or structures) must be optional.
2. The protocol must be able to operate entirely synchronously, since an asynchronous model - though efficient and reliable - is a barrier for simple implementations.
3. The protocol must be formally defined so that significant parts of a client or server protocol interface can be mechanically generated.

2.5 Guidelines for Implementors

- We use the terms MUST, MUST NOT, SHOULD, SHOULD NOT, and MAY as defined by IETF RFC 2119. Where possible we note the security implications of the guidelines.

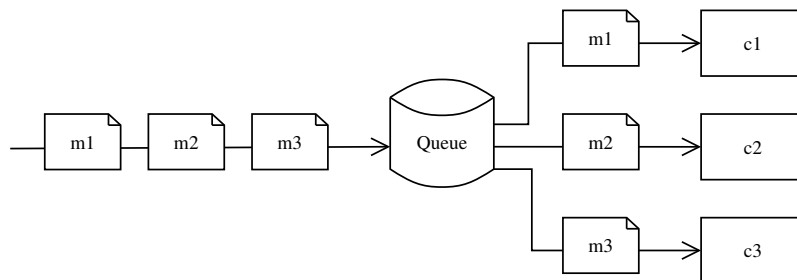
- We use the term "the server" when discussing the specific behaviour required of a conforming AMQP/Fast server.
- We use the term "the client" when discussing the specific behaviour required of a conforming AMQP/Fast client.
- We use the term "the peer" to mean "the server or the client".
- All numeric values are decimal unless otherwise indicated.
- Protocol constants are shown as uppercase names. AMQP/Fast implementations SHOULD use these names when defining and using constants in source code and documentation.
- Property names, method arguments, and frame fields are shown as lowercase names. AMQP/Fast implementations SHOULD use these names in source code and documentation.
- Protocol methods are defined using a formal language as defined in AMQ RFC xxx.

2.6 AMQP Standard Models

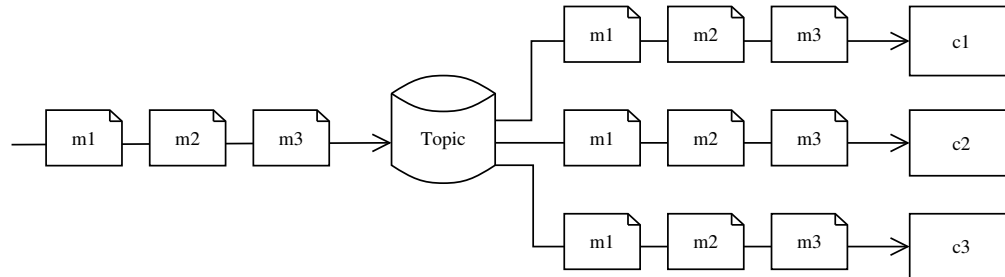
All AMQP protocols including AMQP/Fast implement a common and interoperable queueing and routing model based on these concepts:

1. Application-level messages ("content domains").
2. Persistent and non-persistent message storage ("destination").
3. A distributor mechanism ("queue").
4. A multiplier mechanism ("topic").
5. A way for clients to send messages to destinations ("publish").
6. A way for clients to request messages from destinations ("subscribe").
7. A way for clients to request individual messages from destinations ("browse").
8. A way for clients to inform the server when a message has been successfully processed ("acknowledgement").

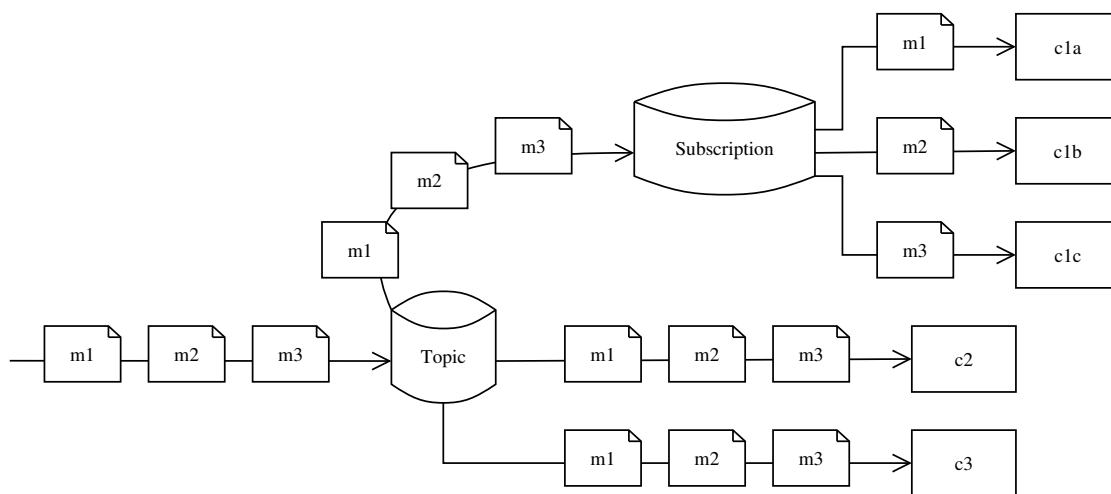
The AMQP "queue" concept acts to distribute messages ("m1", "m2", "m3") between a set of consumers ("c1", "c2", "c3"):



The AMQP "topic" concept acts to multiply messages to a set of consumers:



The AMQP "subscription" concept acts like a queue:



2.7 Definitions

Connection A network connection, e.g. a TCP/IP socket connection.

Channel A bi-directional stream of communications between two AMQP/Fast peers. Channels are multiplexed so that a single network connection can carry multiple channels.

Client The initiator of an AMQP/Fast connection or channel. AMQP/Fast is not symmetrical. Clients produce and consume messages while servers queues and route messages.

Server The party that accepts client connections and implements the standard AMQ queueing and routing functions.

Peer Either party in an AMQP/Fast connection. An AMQP/Fast connection involves exactly two peers (one is the client, one is the server).

Frame A formally-defined package of connection data. Frames are always written and read contiguously - as a single unit - on the connection.

Extended_Frame A frame capable of using more channels and carrying more data than a normal frame.

Meta_Frame A specific type of frame that has the sole purpose of indicating that the next frame will be an extended frame.

Protocol_Class A collection of methods that deal with a specific type of functionality.

Method A specific type of frame that passes instructions from one peer to the other.

Content Application data passed from client to server and from server to client. AMQP/Fast content can be structured into multiple parts.

Header A specific type of frame that describes content.

Body A specific type of frame that contains raw application data. Body frames are entirely opaque - the server does not examine or modify these in any way.

Trace_Frame A specific type of frame that carries information to a "trace handler", an abstract processing unit that may be embedded in an peer.

Message A specific type of content, the application-to-application message.

Destination A queue, topic, or subscription, able to hold and route messages of various types. A server manages access to a set of destinations.

Static_Destination Destinations that are configured by the server administrator.

Dynamic_Destination Destinations that are created and managed by clients via protocol methods. Unlike "temporary" destinations, dynamic destinations provide true disconnected asynchronous processing in which a client can create a response queue, then continue to receive queued messages even when going offline.

Subscription A queue-based destination that receives messages from one or more topic destinations based on a topic name pattern and content-based matching. Subscriptions are analogous with queues in most ways except that they are never published to or selected on directly. Subscriptions may be private or shared, persistent or temporary. Subscriptions may be defined explicitly using the Subscription class, or defined automatically, when starting a consumer on a topic destination.

Consumer A client that requests messages from a destination.

Producer A client that publishes messages to a destination.

Virtual_host A collection of destinations and associated subscriptions, consumers, etc. Virtual hosts are independent server domains that share a common authentication and encryption environment.

Realm A group of destinations covered by a single security policy and access control. Applications ask for access to realms, rather than to individual destinations.

Streaming The process by which the server will send messages to the client at a pre-arranged rate.

Staging The process by which a peer will transfer a large message to a temporary holding area before formally handing it over to the recipient. This is how AMQP/Fast implements restartable file transfers.

Synchpoint A synchronous confirmed step in what is otherwise an asynchronous exchange of methods.

Out-of-band_transport The technique by which data is exchanged outside the network connection. For example, two peers can exchange frames across a TCP/IP connection and then switch to using shared memory if they discover they are on the same system.

Zero_copy The technique of transferring data without copying it to or from intermediate buffers. Zero copy requires that the protocol allow the transfer of data as opaque blocks, which AMQP/Fast does.

Assertion A condition that must be true for processing to continue.

Exception A failed assertion, handled by closing either the channel or the connection.

2.8 Limitations

These limitations are formally part of the AMQP/Fast specifications:

- Number of channels per connection, normal frames: 255.
- Number of channels per connection, extended frames: 64K-1.
- Size of a short string: 0 to 255 octets.
- Size of a long string: 0 to 64K-1 octets.
- Size of a normal frame: 0 to 64K-1 octets.
- Size of an extended frame: 0 to 2e64-1 octets.
- Number of possible content domains: 255.
- Number of protocol classes: 255 per peer.
- Number of methods: 255 per protocol class.
- Number of methods sent between synchpoints: 4G.

3 Design Proposal

3.1 Data Type Representation

3.1.1 Goals and Principles

We use a small set of basic data types that are guaranteed to work on all platforms and be easily implemented in all languages. More sophisticated data types can be packaged using the basic AMQP/Fast data types.

3.1.2 Formal Grammar for AMQP/Fast Fields

This formal grammar defines the AMQP/Fast data types:

```

amqp-field          = BIT
                    / OCTET
                    / short-integer
                    / long-integer
                    / long-long-integer
                    / short-string
                    / long-string
                    / field-table

short-integer       = 2*OCTET
long-integer        = 4*OCTET
long-long-integer   = 8*OCTET
short-string        = OCTET *string-char
string-char         = %d1 .. %d255
long-string         = short-integer *OCTET
field-table         = long-integer *field-value-pair
field-value-pair    = field-name field-value
field-name          = short-string
field-value         = 'S' short-string
                    / 'L' long-string
                    / 'I' signed-integer
                    / 'D' decimal-value
                    / 'T' time-stamp
                    / 'F' field-table

signed-integer      = 4*OCTET
decimal-value       = decimals long-integer
decimals            = OCTET
time-stamp          = long-long-integer

```

Guidelines for implementors:

- A peer **MUST** support all the above data types.

3.1.3 Integers

AMQP/Fast defines these integer types:

- Bit values, which are accumulated into octets.
- Unsigned octet (8 bits).
- Unsigned short integers (16 bits).
- Unsigned long integers (32 bits).
- Unsigned long long integers (64 bits).

Integers and string lengths are always unsigned and held in network byte order. We make no attempt to optimise the case when two low-high systems (e.g. two Intel CPUs) talk to each other.

Guidelines for implementors:

- Implementors **MUST NOT** assume that integers encoded in a frame are aligned on memory word boundaries.

3.1.4 Strings

All strings are variable-length and represented by an integer length followed by zero or more octets of data. AMQP/Fast defines these string types:

- Short strings, stored as a 1-octet length followed by zero or more octets of data. Short strings are capable of carrying UTF-8 data, and may not contain binary zero octets. In the current version of the protocol short strings may only contain US-ASCII (ISO-8859-1) characters.
- Long strings, stored as a short integer length followed by zero or more octets of data. Long strings can contain any data.

3.1.5 Field Tables

Field tables are long strings that contain name-value pairs. Each name-value pair is a structure that provides a field name, a field type, and a field value. A field can hold a tiny text string, a short binary string, a long signed integer, a decimal, a date and/or time, or another field table.

Guidelines for implementors:

- Field names **MUST** start with a letter, '\$' or '#' and may continue with letters, '\$' or '#', digits, or underlines, to a maximum length of 128 characters.
- A peer **SHOULD** validate field names.
- Specifically and only in field tables, integer values are signed (31 bits plus sign bit).
- Decimal values are not intended to support floating point values, but rather business values such as currency rates and amounts. The 'decimals' octet is not signed.
- Time values are held in the 64-bit POSIX time_t format with an accuracy of one second.
- A peer **MUST** handle duplicate fields by using only the first instance.

As a convention when documenting values allowed in field tables we will use this syntax:

```
Name=(Type)Content
```

For example:

```
EXPIRATION-TIME=(Time)
IDENTIFIER=(String)01-ABCD-9876
MAXIMUM-SIZE=(Integer)
```

3.2 Negotiating a Connection

3.2.1 Goals and Principles

Negotiation means that one party in a discussion declares an intention or capability and the other party either acknowledges it, modifies it, or rejects it. In AMQP/Fast, we negotiate a number of specific aspects of the protocol:

1. The actual protocol and version.
2. Encryption arguments and the authentication of both parties.

3. Operational constraints.

3.2.2 Protocol and Version

An AMQP client and server agree on a protocol and version using this negotiation model:

1. The client opens a new socket connection on a well-known or configured port and sends an initiation sequence consisting of the text "AMQP" followed by a protocol ID (2 decimal digits) and a protocol version (2 decimal digits holding the high and low version numbers).
2. The server either accepts or rejects the initiation sequence. If it rejects the initiation sequence it closes the socket. Otherwise it leaves the socket open and implements the protocol accordingly.

Protocol grammar:

```

protocol-header      = 'AMQP' protocol-id protocol-version
protocol-id          = protocol-class protocol-instance
protocol-class       = OCTET
protocol-instance    = OCTET
protocol-version     = protocol-major protocol-minor
protocol-major       = OCTET
protocol-minor       = OCTET

```

For AMQP/Fast these are the correct values:

- protocol-class = 1 (this is the class of all AMQP/Fast protocols)
- protocol-instance = 1 (this is the instance of AMQP/Fast over TCP/IP)
- protocol-major = 0
- protocol-minor = 9

'A'	'M'	'Q'	'P'	1	1	0	9
-----	-----	-----	-----	---	---	---	---

octet

Guidelines for implementors:

- An AMQP server MAY accept multiple AMQP protocols including AMQP/Fast on the same socket.
- An AMQP server MAY accept non-AMQP protocols such as HTTP.
- An AMQP server MUST accept the AMQP/Fast protocol as defined by class = 1, instance = 1.
- If the server does not recognise the first 4 octets of data on the socket, or does not support the specific protocol version that the client requests, it MUST close the socket without sending any response back to the client.
- An AMQP client MAY detect the server protocol version by attempting to connect with its highest supported version and decreasing this if the server rejects the connection.
- An AMQP server MUST NOT ban or delay a client that requests an unsupported protocol version.
- An AMQP server MAY ban or delay a client that requests unknown protocol IDs.

The protocol negotiation model is compatible with existing protocols such as HTTP that initiate a connection with an constant text string, and with firewalls that sniff the start of a protocol in order to decide what rules to apply to it.

3.2.3 Encryption and Authentication

AMQP/Fast uses the SASL architecture for security. SASL encapsulates TLS, GSSAPI, Kerberos, and other encryption and authentication technologies.

Security is negotiated between server and client as follows:

1. The server sends a challenge to the client. The challenge lists the security mechanisms that the server supports.
2. The client selects a suitable security mechanism and responds to the server with relevant information for that security mechanism.
3. The server can send another challenge, and the client another response, until the SASL layer at each end has received enough information.
4. The server can now use the selected security mechanism and authenticated client identity to perform access controls on its data and services.

The "relevant information" is an opaque binary blob that is passed between the SASL layers embedded in the client and in the server.

SASL gives us the freedom to replace the security libraries with better (more secure or faster) technologies at a later date without modifying the protocol, the client, or the server implementations.

3.2.4 Client and Server Limits

The protocol allows the client and server to agree on limits to ensure operational stability. Limits allow both parties to pre-allocate key buffers, avoiding deadlocks. Every incoming frame either obeys the agreed limits, so is "safe", or exceeds them, in which case the other party is faulty and can be disconnected.

Rather than fix the limits in the protocol, we negotiate them. This lets us tune the protocol dynamically for different types of efficiency, e.g. minimal memory consumption vs. maximum performance.

Limits are negotiated to the lowest agreed value as follows:

1. The server tells the client what limits it proposes.
2. The client can respond to lower the limits for its connection.

3.2.5 Identification and Capabilities

During the negotiation of limits the peers **MUST** exchange this mandatory information about themselves:

- The specific content domains that they support (see later).

A peer **MAY** use this information to adapt its behaviour appropriately.

And the peers **MAY** exchange this optional information about themselves:

- Their public product name, for logging and tracking.
- Their version number.
- The platform they are running on.

For security reasons, all these pieces of information are optional and a highly-security conscious peer **MAY** choose to provide some or none of them. A peer **MUST NOT** use this information to adapt its behaviour.

3.3 Multiplexing and Pipelining

3.3.1 Goals and Principles

Connection multiplexing allows multiple threads of communication to share a single socket connection. This is valuable when threads are short-lived since the cost of opening and closing TCP/IP sockets can be relatively high.

Pipelining means that each peer can send frames asynchronously without waiting for the recipient to acknowledge each one. This is an important facility because it greatly improves performance.

3.3.2 Multiplexing Design

AMQP/Fast uses the concept of "channel" to carry bi-directional streams of communication between peers. AMQP/Fast provides methods to open, use, and close channels. Large messages are broken into smaller frames so that channels get fair (round-robin) use of the socket connection.

3.3.3 Pipelining Design

Our design is based on these principles:

1. Most operations succeed. We can thus optimise traffic in many cases by stating that "no response" means "successful".
2. Channels represent serial streams, where the order of methods and their acknowledgements is stable.
3. In general we want to send data as fast as possible in an asynchronous fashion. Where necessary, we can implement windowing and throttling at a higher level.

These principles provide the basis for a simple and efficient pipelining design based on "selective synchronisation". Some methods are explicitly synchronous - a specific request is always paired with a specific reply unless there is an error - and other methods are asynchronous unless the sender asks for a synchronisation response.

The recipient indicates an error by closing the channel. The close method includes the ID of the method that caused the error.

Methods on a specific channel are processed strictly in order. Thus the client can set "synchronisation points" by asking for a confirmation, and handle errors unambiguously (all methods up to but not including the failed method will have succeeded).

3.4 The Framing Design

3.4.1 Goals and Principles

Framing is the part of the protocol where we define how data is sent "to the wire". The framing design used in AMQP/Fast is designed to be compact, easy and very fast to parse, extensible, and robust.

The key parts of this design are:

- How the transport layer carries data.
- How we delimit frames on the connection.
- How we multiplex frames on the connection.
- How different types of frame carry data.
- How we handle out-of-band transport.

- How we support future protocols (e.g. IPv6).

3.4.2 The Transport Layer

We assume a reliable stream-oriented network transport layer (TCP/IP or equivalent). If an unreliable transport layer is used, we assume that the AMQP/Fast frames would be wrapped with additional traffic-control information such as windowing.

AMQP/Fast explicitly excludes any support for traffic control but does not disallow this to be implemented in an additional layer. We may at a future point provide protocol wrappers that wrap AMQP/Fast frames with traffic management to allow reliable transfer over multicast and point-to-point UDP.

3.4.3 Delimiting Frames

TCP/IP is a stream protocol, i.e. there is no in-built mechanism for delimiting frames. Existing protocols solve this in several different ways:

- Sending a single frame per connection. This is simple but adds considerable overhead to the protocol due to the opening and closing of connections.
- Adding frame delimiters to the stream. This is used in protocols such as SMTP but has the disadvantage that the stream must be parsed to find the delimiters. This makes implementations of the protocol slow.
- Counting the size of frames and sending the size in front of each frame. This is the fastest approach, and our choice.

Each frame is thus sent as a "frame header" which contains the frame size, followed by a "frame body" of the specified size (the header is not counted). Frames can carry methods and other data. To read a frame we use this logic:

1. Read and decode the frame header to get the size of the frame body.
2. If the frame body is larger than the agreed limit, close the connection with a suitable error reply code.
3. Otherwise, read the specified number of octets into a frame buffer.
4. Decode the frame buffer as needed.

To write a frame we use this logic:

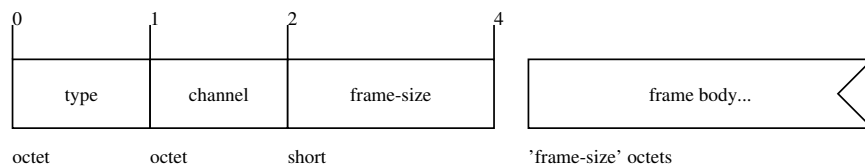
1. Marshal the frame buffer as needed.
2. Encode the length of this buffer into a frame header and write it.
3. Write the frame buffer contents, being the frame body.

Guidelines for implementors:

- A peer **MUST** write the frame body immediately after the frame header unless the body size is zero, or out-of-band transport is being used.

3.4.4 The Frame Header Wire Format

All frames start with a 4-octet header composed of a one-octet type indicator and a 3-octet size indicator:



AMQP/Fast defines several types of frame, with different type indicators:

- Type = 1, "METHOD": method frame.
- Type = 2, "HEADER": content header frame.
- Type = 3, "BODY": content body frame.
- Type = 4, "OOB METHOD": out-of-band method frame.
- Type = 5, "OOB HEADER": out-of-band band header frame.
- Type = 6, "OOB BODY": out-of-band body frame.
- Type = 7, "TRACE": trace frame.
- Type = 8, "HEARTBEAT": heartbeat frame.
- Type = 9, "META": meta frame.

The channel number is 0 for all frames which are global to the connection, and 1 .. 255 for frames that refer to specific channels (1 .. 64K-1 in extended frames).

Guidelines for implementors:

- If a peer receives a frame with a type that is not one of these defined types, it MUST treat this as a fatal protocol error and close the connection without sending any further data on it.

3.4.5 Method Frames

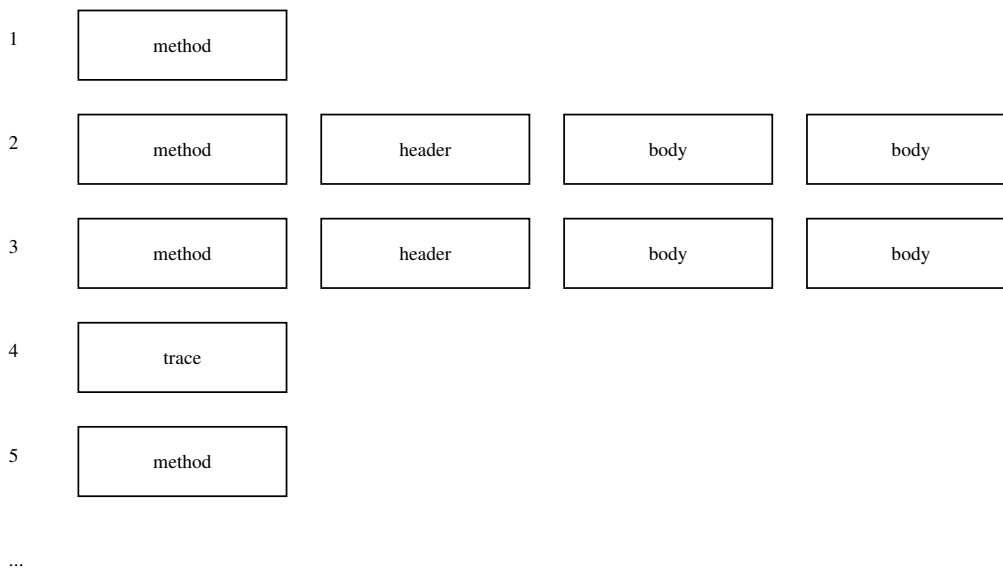
The method frame design is intended to be fast to read and write, and compact when only partly filled.

Method frames (also called "methods" in the following discussion, for brevity) are invariant. They contain no conditional or repeated fields. Methods are constructed out of a constant series of AMQP/Fast data fields (bits, integers, strings and string tables). Thus the marshalling code can be easily generated, and can be very rapid. In the OpenAMQ server and clients this code is generated directly from the protocol specifications.

3.4.6 Content Frames

Certain methods signal to the recipient that there is content arriving on the connection. Simple content consists of a header frame followed by zero or more body frames. Structured content may consist of a series of header frames followed by the appropriate body frames.

Looking at the frames as they pass on the wire, we might see something like this:



There is a specific reason for placing content body in distinct frames as compared to including the header and body in the method. We want to support "zero copy" techniques in which content is never marshalled or encoded, and can be sent via out-of-band transport such as shared memory or remote DMA.

Guidelines for implementors:

- The channel number in content frames MUST NOT be zero.
- Content frames on a specific channel form an strict list. That is, they may be mixed with frames of different types or on different channels, but two contents may not be mixed or overlapped on a single channel.

3.4.7 Out-of-Band Transport Frames

Method, content header, and content body frames can be sent using out-of-band transport. The frame header is sent on the normal connection but the frame body is sent via another mechanism. The specific out-of-band transport used, and its configuration, is defined when a channel is opened.

3.4.8 Trace Frames

Trace frames are intended for a "trace handler" embedded in the recipient. The significance and implementation of the trace handler is implementation-defined.

Guidelines for implementors:

- Both server and client MAY send trace frames at any point in the connection after protocol negotiation and before a Connection.Close method.
- If the recipient of a trace frame does not have a suitable trace handler, it MUST discard the trace frame without signalling any error or fault.
- The semantics and structure and of trace frames including the channel number are not formally defined by AMQP/Fast and implementations MUST NOT assume any interoperability with respect to trace frames unless and until formal standards are defined for these.

3.4.9 Heartbeat Frames

Although TCP/IP guarantees that data is not dropped or corrupted it can be slow to detect that a peer process has gone "offline". The heartbeat frame allows peers to detect network failure rapidly. This frame has no body.

The peers negotiate heartbeat parameters at the start of a connection.

Guidelines for implementors:

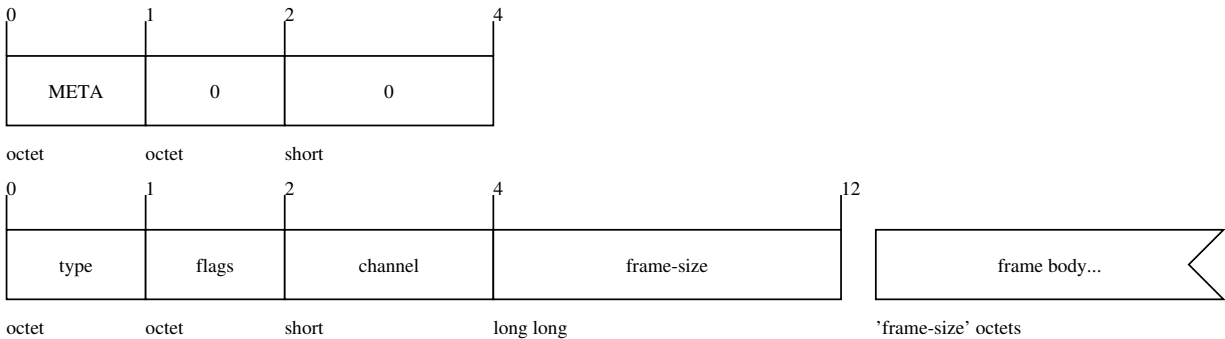
- The channel number in a heartbeat frame **MUST** be zero.
- An AMQP peer **MUST** handle a non-zero channel number as a connection exception.

3.4.10 Meta Frames

Meta frames are used to send frames of 64KB or larger (the size of a normal frame body is limited to 64KB-1 octets), and to use channel numbers above 255. Meta frames are designed to support high-capacity out-of-band transports and IPv6 (which has a 4GB frame limit, although ethernet still cannot handle frames larger than 12000 bytes).

3.4.11 Extended Frame Header Wire Format

A meta frame is followed by an "extended frame header" with a short integer channel number and a long long size:



Guidelines for implementors:

- The meta frame channel number and size **MUST** be zero.
- The sender **MUST NOT** send intervening frames between the meta frame and the extended frame.
- After a meta frame all frame types are valid except a meta frame.
- The "flags" octet is reserved for future use and **MUST** be set to zero.
- The frame body is not affected in any way by the presence or absence of a meta frame, except that the frame body **MAY** be larger than 64KB after a meta frame.

3.5 The Abstract Content Model

AMQP/Fast uses an abstract content model that has these goals and features:

- It supports tree-structured content in which each content can contain further content ("child-content"), to any level.
- It provides multiple content types to allow optimal encoding for different applications.
- It supports content bodies of any size from zero octets up to infinity.
- Content body can be read and written directly from application memory with no formatting or copying ("zero copy").
- Content headers are sent before content body so that the recipient can selectively discard content that it does not want to process.
- Content body is sent in separate frames to support the AMQP/Fast channel multiplexing model.

3.5.1 Formal Grammar for Content Frames

This is the formal grammar for the AMQP/Fast content model:

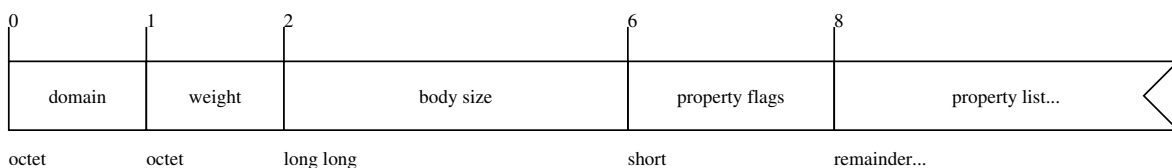
```

content      = header-frame child-content *body-frame
header-frame = HEADER channel frame-size header-payload
channel      = octet
frame-size   = short-integer
header-payload = class weight body-size
               property-flags property-list
content-class = OCTET
content-weight = OCTET
body-size      = long-long-integer
property-flags = 15*BIT %b0 / 15*BIT %b1 property-flags
property-list  = amqp-field
child-content  = weight*content
body-frame     = BODY channel frame-size body-payload
body-payload  = *OCTET

```

3.5.2 Content Header Frame Wire Format

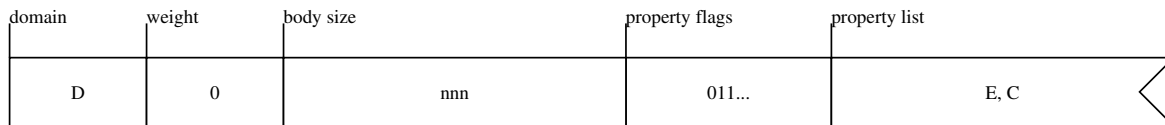
A content header frame has this format:



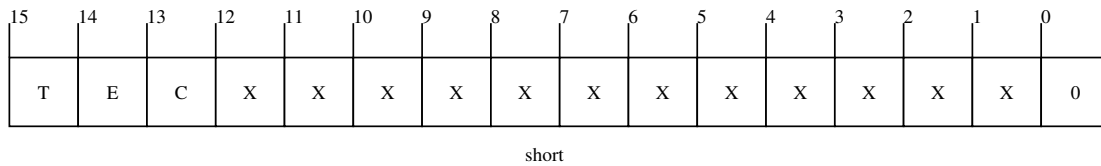
- The content class specifies the set of properties (with a predefined syntax and semantics) that the header frame may hold. The standard AMQP/Fast content classes are defined later.
- The weight field specifies whether the content is structured or not. Unstructured content has a weight of zero. Structured content has a weight of 1 to 255. This is the number of child-contents that the content contains.
- The body size is a 64-bit value that defines the total size of the body content. It may be zero, indicating that there will be no body frames.
- The property flags are a bit array that indicates the presence or absence of each property value.
- The property values are class-specific data fields. The properties are formatted as AMQP/Fast data types (integers, strings, field tables).

The set of properties for a content class can be any size. The first two properties for all content classes are the content MIME type and the content encoding. Following these, each content class has a specific set of properties defined in a strict order from most to least significant.

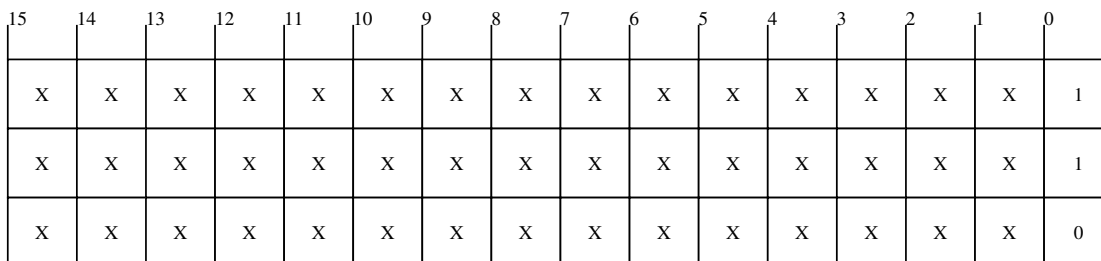
As an example, we take an imaginary content class "D" which has three properties, T, E and C. Imagine a simple content that has properties E and C but not T. The header frame will be formatted thus:



The property flags are ordered from high to low, the first property being indicated by bit 15, and so on:

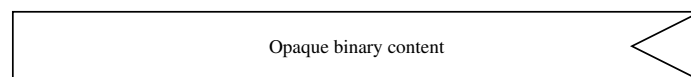


The property flags can specify more than 16 properties. If bit 0 is set, it indicates that a further property flags field follows. There can be several property flag fields in succession:



3.5.3 Content Body Frame Wire Format

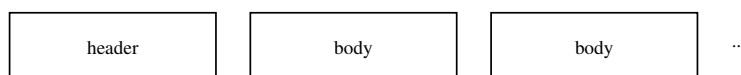
A content body frame has this format:



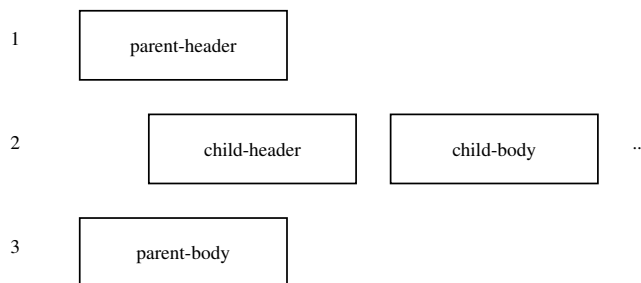
Where the size of the frame is defined in the frame header.

3.5.4 Structured Content

The "weight" field in the content header frame indicates whether the content has child-contents or not. In the simplest case (weight = zero) content consists of a header frame plus zero or more body frames:



If the content has child-contents, these are inserted between the header and body of the parent content:



This organisation means that a principle content (e.g. a very large video file) can have child content (e.g. subtitles and menus) which will be sent before the main content. If a more specific order of content is needed, it can be done by defining a top-level content that has no body, only a header.

3.5.5 Multiplexed Channel Content

Content consists of one or more frames. The recipient of content that has been sent in multiple frames can unambiguously reconstruct the content by implementing the content grammar defined above, on a per-channel basis.

Guidelines for implementors:

- Content frames **MUST** be sent on a single channel, and **MAY** be intermixed with non-content frames (method, trace, and heartbeat frames).
- Content frames **MUST NOT** be intermixed with frames of a different content.
- A peer **MUST NOT** make any assumptions about the minimum or maximum size of a body frame except that the minimum size is zero bytes and the maximum size is the smallest of either the negotiated maximum frame size or the remaining expected of content body (body-size minus amount of body data received so far).
- Empty body frames are permitted but a peer may not assign any special meaning to these: it **MUST** discard them with no side-effects of any kind.

3.5.6 Content Classes

The content class is not intended to provide data typing or encoding information. Its purpose is to allow functional clarity in the property sets and methods that we define per class of message.

Content classes turn AMQP/Fast from an abstract content-carrying protocol into a functional tool by providing data and operations that are directly and clearly mapped to the kinds of API that an application programmer needs to see.

AMQP/Fast defines these standard content classes:

- JMS: the content is a JMS-compliant message.
- File: the content is a file.
- Stream: the content is a streamed message.

Note that the ID of each content class is the same as the ID of the protocol class (JMS, File, Stream) that supports it.

Each class has a specific access model, though they all share the basic AMQP queueing and routing mechanisms including topic multipliers. These classes are defined in the next sections. This model lets us extend AMQP/Fast into new functional areas by defining new content classes and appropriate methods, without breaking interoperability.

Guidelines for implementors:

- The client MAY support any or all of the defined content classes.
- The server MUST support at least one of the defined content classes.

3.5.7 Content Type and Encoding

AMQP/Fast enforces MIME-compliance on all content classes using two standard properties that are the first defined in all content classes:

- `ContentType` (tiny string) - the MIME content type of the message body. The default value is "application/octet-stream".
- `ContentEncoding` (tiny string) - The content encoding of the message body. The default value is "binary".

Guidelines for implementors:

- The server SHOULD not modify the `ContentType` and `ContentEncoding` for content moved between producing and consuming clients.
- The server MAY set the `ContentType` and `ContentEncoding` properties for content produced by the server or by applications embedded in the server.

3.6 The Class/Method Model

3.6.1 Goals and Principles

AMQP/Fast allows two peers to connect and exchange data. There are several types of data and several ways of exchanging this data. The combinations rapidly get complex. Worse, it is not always clear which replies depend on which requests, since the exchange of data is often asynchronous, pipelined, and generally hard to follow.

Rather than attempt to formalise the exact flow of data from client to server and back, we use an metaphor taken from the software world, namely the object-oriented metaphor of "classes" and "methods".

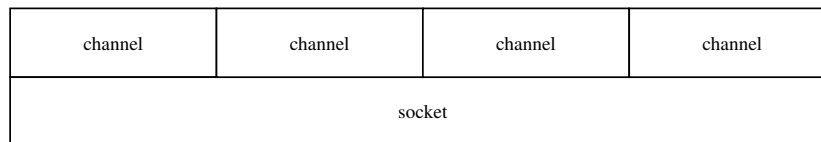
We build this as follows:

1. Each peer supports a set of classes. These classes have names and cover specific areas of functionality. A peer can support all the AMQP/Fast classes, or a subset of them. Since the operational functionality of the protocol depends on the classes, the operational functionality of a particular implementation is clear to see.
2. Each class supports a set of methods. These methods have names and provide specific functionalities. A peer can support all the AMQP/Fast methods in a particular class, or a subset of them. As with classes, this unambiguously defines the operational functionality of a peer.
3. The methods are either synchronous or asynchronous. A synchronous method replies immediately. An asynchronous method replies at some later time and may send multiple replies. A method "replies" by invoking the appropriate method in the requesting peer. A request and reply always involves two methods: one to implement the request and one to implement the reply.

4. Each method is either a client method, server method, or provided by both client and server). A particular method in a particular class always has an identical behaviour whether it is in a "client" or "server".
5. A peer can thus combine the roles of client and server in various degrees by implementing the necessary classes and methods. At any point the operational functionality of the peer can be unambiguously defined by the methods that it supports.

3.6.2 Client and Server Roles

The AMQP/Fast protocol is pseudo-symmetrical with client-initiated connections. We can visualise the protocol as governing two levels of connection - network connections (sockets) and virtual connections (channels):



Each connection (socket and channel) has a clear client role - the peer that initiated the connection, and a clear server role - the peer that accepted the connection. For both network and virtual connections the general protocol model is the same:

1. The client requests the server to open connection.
2. The server responds and the peers negotiate the connection.
3. The client and the server exchange information.
4. Either peer requests to close the connection.
5. The other peer responds and they negotiate the shut-down.

AMQP/Fast foresees two main architectures that use this model:

1. Client-server, in which the same peer acts as client in all connections. This is the "usual" architecture.
2. Peer-to-peer, in which one peer acts as client in the network connection but the peers can take either role in the virtual connection.

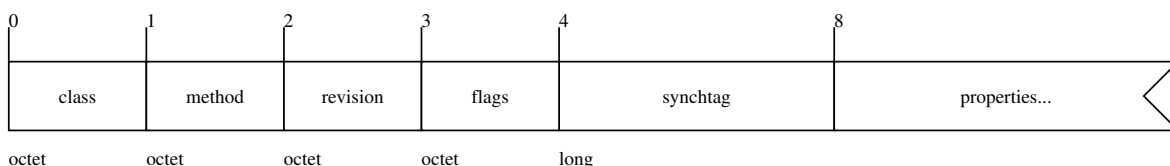
The peer-to-peer architecture requires that both peers can act as both client and server.

Guidelines for implementors:

- A peer **MUST** support at least either the client or server role.
- A peer **MAY** support both roles.

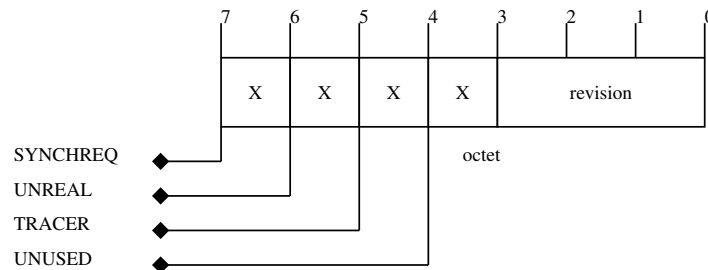
3.6.3 Method Frame Body Wire Format

A method frame body has this format:



- The class and method are protocol-constant values.
- The revision number indicates a revision of the method with new or modified properties.
- The flags provide a set of operational indicators.
- The synctag is an arbitrary value that the sender chooses to identify the method instance.
- The properties are a set of AMQP/Fast fields that specific to each method.

The flags are defined as follows:



- 7 = SYNCHREQ - if 1, requests a "synchpoint", turning an asynchronous method into a synchronous one. Has no effect on a synchronous method.
- 6 = UNREAL - if 1, requests an "interface test", in which the recipient responds with an echo of the method but does not otherwise execute the method.
- 5 = TRACER - if 1, requests a "distributed trace", in which the recipient will trace all responses to this and other clients which the method provokes.
- 4 = UNUSED - this bit is not used.
- 3-0 = revision - must be zero in this protocol.

Guidelines for implementors:

- The revision **MUST** be zero in major releases of the protocol. It is used to indicate revised methods in minor releases of the protocol. A peer **MAY** support multiple revisions of a protocol. A peer **MUST** support the specific method revisions defined in the protocol minor version number agreed during connection negotiation.
- Synctags **SHOULD BE** unique since the last synchpoint (we explain synchpoints later).
- Bits 2 to 0 of the flags octet are reserved for future use and **MUST** be zero.

3.6.4 The Synchpoint Function

A client can request a synchpoint when sending an asynchronous request method. The server responds with a Channel.Synch method when it finishes processing the request method. Synchpoints are only sent if the method completes successfully. If the method fails, the server replies with a Channel.Close or Connection.Close depending on the severity of the error.

Clients can use synchpoints to force occasional synchronisation or to force a fully-synchronous dialogue. E.g. A client can be designed to use synchpoints at every asynchronous method, which turns the entire protocol into a synchronous protocol. This may be simpler for some scenarios than a normal asynchronous exchange of methods.

Guidelines for implementors:

- The server **MUST** ignore the SYNCHREQ flag on all methods that require a synchronous reply.

- The server **MUST NOT** set the **SYNCHREQ** flag on methods sent to the client, and the client **MUST** treat any method with the **SYNCHREQ** flag as a fatal connection error.

3.6.5 The Interface Test Function

A peer can test the capability of the other peer by sending methods with the **UNREAL** flag set. When a peer receives a message with this flag set it de-marshals the frame, reconstructs it with the same fields, and sends it back to the requesting peer. We assume that a specially designed peer, a "monitor client" will perform the tests.

The purpose of **UNREAL** flag is to allow a monitor client to determine what methods a peer supports.

Guidelines for implementors:

- A peer **MUST** respect the **UNREAL** flag on all methods that it supports.
- A peer **MUST** reply to unsupported methods with the **UNREAL** flag set, with a **Connection.Unknown** method.
- A peer **MUST** treat an unsupported methods with the **UNREAL** flag cleared as a fatal error and close the connection.
- A peer **MAY** use interface testing to adapt its behaviour dynamically.
- A peer **MUST** respond to a supported method with the **UNREAL** flag set as follows: (a) decode the method and perform syntactic validation. (b) recreate the method with the same arguments and send it with the **UNREAL** flag set.

3.6.6 The Distributed Trace Function

A distributed trace is a temporary and single-threaded trace of all messages produced by a specific server method. A distributed trace will last as long as the effects of the original method. There is no functionality to end a distributed trace, nor to distinguish more than one trace at once.

Guidelines for implementors:

- A server **SHOULD** implement the **DTRACE** flag as follows: (a) process the method as normal. (b) set the **DTRACE** flag on all methods, to all clients, that are the direct or indirect consequence of the original received method.

3.7 Summary of Classes and Methods

3.7.1 Goals and Principles

We aim to provide a clear and extensible organisation of the classes and methods that a peer provides. Classes and methods are numbered but also have constant names (shown in uppercase). The names are chosen to be consistent across classes, so a similar method in different classes has the same name and may have similar arguments where appropriate. The full definition of each class and method is provided later.

We define methods as being either:

- a synchronous request ("syn request"). The sending peer **SHOULD** wait for the specific reply method, but **MAY** implement this asynchronously.
- a synchronous reply ("syn reply for XYZ").

- an asynchronous request or reply ("async"). The sending peer will usually not expect a synchronous reply but MAY set the SYNCHREQ flag to request a synchpoint.

A full explanation of classes and methods is provided in the Reference section of this document.

3.7.2 Overall Grammar

```

connection          = open-connection *use-connection close-connection
open-connection      = C:protocol-header
                      S:START C:START_OK
                      *challenge
                      S:TUNE C:TUNE_OK
                      C:OPEN S:OPEN_OK

challenge            = S:SECURE C:SECURE_OK
use-connection        = S:UNKNOWN
                      / C:UNKNOWN
                      / channel

close-connection     = C:CLOSE S:CLOSE_OK
                      / S:CLOSE C:CLOSE_OK

channel              = open-channel *use-channel close-channel
open-channel          = C:OPEN S:OPEN_OK
use-channel           = C:FLOW
                      / S:FLOW
                      / S:SYNCH
                      / access
                      / destination
                      / subscription
                      /.jms
                      / file
                      / stream
                      / tx
                      / dtx
                      / test

close-channel        = C:CLOSE S:CLOSE_OK
                      / S:CLOSE C:CLOSE_OK

access               = C:GRANT S:GRANT_OK
destination          = C:DEFINE S:DEFINE_OK
                      / C:QUERY S:QUERY_OK
                      / C:PURGE S:PURGE_OK
                      / C:CANCEL S:CANCEL_OK

subscription         = C:DEFINE S:DEFINE_OK
                      / C:QUERY S:QUERY_OK
                      / C:PURGE S:PURGE_OK
                      / C:CANCEL S:CANCEL_OK

.jms                 = C:CONSUME S:CONSUME_OK
                      / C:CANCEL
                      / C:PUBLISH content
                      / S:DELIVER content
                      / C:BROWSE ( S:BROWSE_OK content / S:BROWSE_EMPTY )
                      / C:ACK
                      / C:REJECT

file                 = C:OPEN S:OPEN_OK
                      / S:OPEN C:OPEN_OK
                      / C:STAGE
                      / S:STAGE
                      / C:CONSUME S:CONSUME_OK
                      / C:CANCEL
                      / C:PUBLISH content
                      / S:DELIVER content
                      / C:BROWSE ( S:BROWSE_OK content / S:BROWSE_EMPTY )
                      / C:ACK
                      / C:REJECT

file                 = C:CONSUME S:CONSUME_OK
                      / C:CANCEL
                      / C:PUBLISH content
                      / S:DELIVER content

tx                   = C:COMMIT S:COMMIT_OK
                      / C:ABORT S:ABORT_OK

dtx                  = C:START S:START_OK

test                 = C:INTEGER S:INTEGER_OK
                      / S:INTEGER C:INTEGER_OK
                      / C:STRING S:STRING_OK
                      / S:STRING C:STRING_OK
                      / C:TABLE S:TABLE_OK
                      / S:TABLE C:TABLE_OK

```

```

/ C:CONTENT S:CONTENT_OK
/ S:CONTENT C:CONTENT_OK

```

3.7.3 Connection Class - Work With Socket Connections

Connection.Start ID=1/1 - client, sync request, start connection negotiation.

```

version_major    octet      # negotiated protocol major version
version_minor    octet      # negotiated protocol major version
mechanisms       shortstr   # available security mechanisms

```

Connection.Start Ok ID=1/2 - server, sync reply for Start, select security mechanism.

```

mechanism        shortstr   # selected security mechanism

```

Connection.Secure ID=1/3 - client, sync request, security mechanism challenge.

```

challenge        longstr    # security challenge data

```

Connection.Secure Ok ID=1/4 - server, sync reply for Secure, security mechanism response.

```

response         longstr    # security response data

```

Connection.Tune ID=1/5 - client, sync request, propose connection tuning parameters.

```

frame_max        long       # maximum frame size
channel_max      short      # maximum number of channels
access_max       short      # maximum number of access tickets
consumer_max     short      # maximum consumers per channel
heartbeat        short      # desired heartbeat delay
txn_limit        short      # maximum transaction size
jms_support      bit        # JMS content is supported?
file_support     bit        # file content is supported?
stream_support   bit        # stream content is supported?

```

Connection.Tune Ok ID=1/6 - server, sync reply for Tune, negotiate connection tuning parameters.

```

frame_max        long       # maximum frame size
channel_max      short      # maximum number of channels
ticket_max       short      # maximum number of access tickets
heartbeat        short      # desired heartbeat delay
jms_support      bit        # JMS content is supported?
file_support     bit        # file content is supported?
stream_support   bit        # stream content is supported?
prefetch_max     long       # maximum prefetch size for connection

```

Connection.Open ID=1/7 - server, sync request, open a path to a virtual host.

```

virtual_path     shortstr   # path value virtual server path
client_id        shortstr   # client identifier

```

Connection.Open Ok ID=1/8 - client, sync reply for Open, signal that the connection is ready.

```

client_id        shortstr   # assigned client identifier

```

Connection.Unknown ID=1/9 - client, async, signal that an interface test method has failed.

```

class            octet      # failing method class
method           octet      # failing method ID
synctag         short      # failing method synctag
reply_code       short      # reply code from server reply code
reply_text       shortstr   # localised reply text localised reply text

```

Connection.Close ID=1/10 - client, sync request, request a connection close.

```

reply_code       short      # reply code from server reply code
reply_text       shortstr   # localised reply text localised reply text
class            octet      # failing method class
method           octet      # failing method ID
synctag         short      # failing method synctag

```

Connection.Close Ok ID=1/11 - client, sync reply for Close, confirm a connection close. No specific fields.

3.7.4 Channel Class - Work With Channels

Channel.Open ID=2/1 - server, sync request, open a channel for use.

prefetch_max	long	#	maximum prefetch size for channel
out_of_band	shortstr	#	out-of-band settings for channel
tx_mode	octet	#	transaction mode for channel

Channel.Open Ok ID=2/2 - client, sync reply for Open, signal that the channel is ready. No specific fields.

Channel.Flow ID=2/3 - client, async, enable/disable flow from peer.

flow_pause	bit	#	start/stop content frames
------------	-----	---	---------------------------

Channel.Close ID=2/4 - client, sync request, request a channel close.

reply_code	short	#	reply code from server reply code
reply_text	shortstr	#	localised reply text localised reply text
class	octet	#	failing method class
method	octet	#	failing method ID
synctag	short	#	failing method synctag

Channel.Close Ok ID=2/5 - client, sync reply for Close, confirm a channel close. No specific fields.

3.7.5 Access Class - Work With Access Tickets

Access.Grant ID=3/1 - server, sync request, request an access ticket.

realm	shortstr	#	path value realm to work with
exclusive	bit	#	request exclusive access
query	bit	#	request query rights
publish	bit	#	request publish rights
consume	bit	#	request consume rights
subscribe	bit	#	request subscriber rights
dynamic	bit	#	request dynamic destination rights
purge	bit	#	request purge rights

Access.Grant Ok ID=3/2 - client, sync reply for Grant, grant access to server resources.

ticket	short	#	access ticket granted by server
--------	-------	---	---------------------------------

3.7.6 Destination Class - Work With Dynamic Destinations

Destination.Define ID=4/1 - server, sync request, create or verify a dynamic destination.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name
template	shortstr	#	destination template
private	bit	#	request private destination
auto_cancel	bit	#	auto-cancel when finished

Destination.Define Ok ID=4/2 - client, sync reply for Define, confirms a destination definition.

destination	shortstr	#	destination name name of destination
message_count	long	#	number of messages in queue destination

Destination.Query ID=4/3 - server, sync request, query status of destination.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name

Destination.Query Ok ID=4/4 - client, sync reply for Query, provide status of destination.

service_type	octet	# destination service type
destination	shortstr	# destination name name of destination
message_count	long	# number of messages in queue destination
consumer_count	long	# number of consumers
subscriber_count	long	# number of subscribers

Destination.Purge ID=4/5 - server, sync request, purge a destination.

ticket	short	# access ticket granted by server
service_type	octet	# destination service type
destination	shortstr	# destination name name of destination

Destination.Purge Ok ID=4/6 - client, sync reply for Purge, confirms a destination purge.

message_count	long	# number of messages purged
---------------	------	-----------------------------

Destination.Cancel ID=4/7 - server, sync request, cancel a dynamic destination.

ticket	short	# access ticket granted by server
service_type	octet	# destination service type
destination	shortstr	# destination name
ifempty	bit	# cancel only if empty

Destination.Cancel Ok ID=4/8 - client, sync reply for Cancel, confirm cancellation of a dynamic destination.

message_count	long	# number of messages purged
---------------	------	-----------------------------

3.7.7 Subscription Class - Work With Subscriptions

Subscription.Define ID=5/1 - server, sync request, create or configure a persistent subscription.

ticket	short	# access ticket granted by server
subscription	shortstr	# subscription name
template	shortstr	# subscription template
topic_selector	shortstr	# topic name or pattern
topic_seltype	octet	# type of topic selector
message_selector	longstr	# message selector
message_seltype	octet	# type of message selector
private	bit	# request private subscription
auto_cancel	bit	# auto-cancel when finished

Subscription.Define Ok ID=5/2 - client, sync reply for Define, confirms a subscription definition.

subscription	shortstr	# subscription name
topic_selector	shortstr	# topic name or pattern
topic_seltype	octet	# type of topic selector
message_count	long	# number of messages in subscription

Subscription.Query ID=5/3 - server, sync request, query status of subscription.

ticket	short	# access ticket granted by server
subscription	shortstr	# subscription name subscription name

Subscription.Query Ok ID=5/4 - client, sync reply for Query, provide status of subscription.

subscription	shortstr	# subscription name
message_count	long	# number of messages in subscription
consumer_count	long	# number of consumers

Subscription.Purge ID=5/5 - server, sync request, purge a subscription.

ticket	short	# access ticket granted by server
subscription	shortstr	# subscription name

Subscription.Purge Ok ID=5/6 - client, sync reply for Purge, confirms a subscription purge.

message_count	long	# number of messages purged
---------------	------	-----------------------------

Subscription.Cancel ID=5/7 - server, sync request, cancel a subscription.

ticket	short	# access ticket granted by server
subscription	shortstr	# subscription name
ifempty	bit	# cancel only if empty

Subscription.Cancel Ok ID=5/8 - client, sync reply for Cancel, confirm cancellation of a subscription.

message_count	long	# number of messages purged
---------------	------	-----------------------------

3.7.8 Jms Class - Work With Jms Content

Jms.Consume ID=6/1 - server, sync request, start a destination consumer.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name
subscription	shortstr	#	subscription name
prefetch_size	short	#	prefetch window in octets
prefetch_count	short	#	prefetch window in messages
no_local	bit	#	do not receive own messages
auto_ack	bit	#	no acknowledgement needed
exclusive	bit	#	request exclusive access
message_selector	longstr	#	message selector
message_seltype	octet	#	type of message selector
auto_cancel	long	#	cancel consumer after N messages

Jms.Consume Ok ID=6/2 - client, sync reply for Consume, confirm a new consumer.

consumer_tag	short	#	server-assigned consumer tag
--------------	-------	---	------------------------------

Jms.Cancel ID=6/3 - server, async, end a destination consumer.

consumer_tag	short	#	server-assigned consumer tag
--------------	-------	---	------------------------------

Jms.Publish ID=6/4 - server, async, carries content, publish a message to a destination.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name
immediate	bit	#	assert immediate delivery

Jms.Deliver ID=6/5 - client, async, carries content, notify the client of a consumer message.

delivery_tag	longlong	#	server-assigned delivery tag
redelivered	bit	#	signal a redelivered message
destination	shortstr	#	destination name

Jms.Browse ID=6/6 - server, sync request, direct access to a destination.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name
subscription	shortstr	#	subscription name
no_local	bit	#	do not receive own messages
auto_ack	bit	#	no acknowledgement needed

Jms.Browse Ok ID=6/7 - client, sync reply for Browse, carries content, provide client with a browsed message.

delivery_tag	longlong	#	server-assigned delivery tag
redelivered	bit	#	signal a redelivered message
destination	shortstr	#	destination name
message_count	long	#	number of messages pending

Jms.Browse Empty ID=6/8 - client, sync reply for Browse, indicate no messages available. No specific fields.

Jms.Ack ID=6/9 - server, async, acknowledge one or more messages.

delivery_tag	longlong	#	server-assigned delivery tag
multiple	bit	#	acknowledge multiple messages

Jms.Reject ID=6/10 - server, async, reject an incoming message.

delivery_tag	longlong	#	server-assigned delivery tag
requeue	bit	#	requeue the message

3.7.9 File Class - Work With File Content

File.Consume ID=7/1 - server, sync request, start a destination consumer.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name
subscription	shortstr	#	subscription name
prefetch_size	short	#	prefetch window in octets
prefetch_count	short	#	prefetch window in messages
no_local	bit	#	do not receive own messages
auto_ack	bit	#	no acknowledgement needed
exclusive	bit	#	request exclusive access
message_selector	longstr	#	message selector
message_seltype	octet	#	type of message selector
auto_cancel	long	#	cancel consumer after N messages

File.Consume Ok ID=7/2 - client, sync reply for Consume, confirm a new consumer.

consumer_tag	short	#	server-assigned consumer tag
--------------	-------	---	------------------------------

File.Cancel ID=7/3 - server, async, end a destination consumer.

consumer_tag	short	#	server-assigned consumer tag
--------------	-------	---	------------------------------

File.Publish ID=7/4 - server, async, carries content, publish a message to a destination.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name
immediate	bit	#	assert immediate delivery

File.Deliver ID=7/5 - client, async, carries content, notify the client of a consumer message.

delivery_tag	longlong	#	server-assigned delivery tag
redelivered	bit	#	signal a redelivered message
destination	shortstr	#	destination name

File.Browse ID=7/6 - server, sync request, direct access to a destination.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name
subscription	shortstr	#	subscription name
no_local	bit	#	do not receive own messages
auto_ack	bit	#	no acknowledgement needed

File.Browse Ok ID=7/7 - client, sync reply for Browse, carries content, provide client with a browsed message.

delivery_tag	longlong	#	server-assigned delivery tag
redelivered	bit	#	signal a redelivered message
destination	shortstr	#	destination name
message_count	long	#	number of messages pending

File.Browse Empty ID=7/8 - client, sync reply for Browse, indicate no messages available. No specific fields.

File.Ack ID=7/9 - server, async, acknowledge one or more messages.

delivery_tag	longlong	#	server-assigned delivery tag
multiple	bit	#	acknowledge multiple messages

File.Reject ID=7/10 - server, async, reject an incoming message.

delivery_tag	longlong	#	server-assigned delivery tag
requeue	bit	#	requeue the message

3.7.10 Stream Class - Work With Streaming Content

Stream.Consume ID=8/1 - server, sync request, start a destination consumer.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name
subscription	shortstr	#	subscription name
prefetch_size	short	#	prefetch window in octets
prefetch_count	short	#	prefetch window in messages
consume_rate	long	#	transfer rate in octets/second
no_local	bit	#	do not receive own messages
exclusive	bit	#	request exclusive access

Stream.Consume Ok ID=8/2 - client, sync reply for Consume, confirm a new consumer.

consumer_tag	short	#	server-assigned consumer tag
--------------	-------	---	------------------------------

Stream.Cancel ID=8/3 - server, async, end a destination consumer.

consumer_tag	short	#	server-assigned consumer tag
--------------	-------	---	------------------------------

Stream.Publish ID=8/4 - server, async, carries content, publish a message to a destination.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name
immediate	bit	#	assert immediate delivery

Stream.Deliver ID=8/5 - client, async, carries content, notify the client of a consumer message.

destination	shortstr	#	destination name
immediate	bit	#	assert immediate delivery

3.7.11 Tx Class - Work With Standard Transactions

Tx.Commit ID=9/1 - server, sync request, commit the current transaction. No specific fields.

Tx.Commit Ok ID=9/2 - client, sync reply for Commit, confirm a successful commit. No specific fields.

Tx.Abort ID=9/3 - server, sync request, abandon the current transaction. No specific fields.

Tx.Abort Ok ID=9/4 - client, sync reply for Abort, confirm a successful abort. No specific fields.

3.7.12 Dtx Class - Work With Distributed Transactions

Dtx.Start ID=10/1 - server, sync request, start a new distributed transaction.

dtx_identifier	shortstr	#	distributed transaction identifier
----------------	----------	---	------------------------------------

Dtx.Start Ok ID=10/2 - client, sync reply for Start, confirm the start of a new distributed transaction. No specific fields.

3.7.13 Test Class - Test Functional Primitives Of The Implementation

Test.Integer ID=11/1 - client, sync request, test integer handling.

integer_1	octet	#	octet test value
integer_2	short	#	short test value
integer_3	long	#	long test value
integer_4	longlong	#	long-long test value
operation	octet	#	operation to test

Test.Integer Ok ID=11/2 - client, sync reply for Integer, report integer test result.

```
result          longlong      # result value
```

Test.String ID=11/3 - client, sync request, test string handling.

```
string_1        shortstr      # short string test value
string_2        longstr       # long string test value
operation        octet         # operation to test
```

Test.String Ok ID=11/4 - client, sync reply for String, report string test result.

```
result          longstr       # result value
```

Test.Table ID=11/5 - client, sync request, test field table handling.

```
table           table         # field table of test values
integer_op      octet         # operation to test on integers
string_op       octet         # operation to test on strings
```

Test.Table Ok ID=11/6 - client, sync reply for Table, report table test result.

```
integer_result  longlong      # integer result value
string_result   longstr       # string result value
```

Test.Content ID=11/7 - client, sync request, carries content, test content handling. No specific fields.

Test.Content Ok ID=11/8 - client, sync reply for Content, carries content, report content test result.

```
content_checksum long         # content hash
```

3.7.14 Explanatory Notes

Methods are numbered locally per class and there is no attempt to keep a consistent numbering for similar methods in different classes, nor to distinguish client or server methods through special numbering schemes. Method numbering has no significance beyond uniquely identifying the method.

The grammars use this notation:

- 'S:' indicates data or a method sent from the server to the client.
- 'C:' indicates data or a method sent from the client to the server.
- +term or +(…) expression means '1 or more instances'.
- *term or *(…) expression means 'zero or more instances'.
- Methods are indicated by uppercase names, e.g. OPEN.

3.8 Queueing and Routing Mechanisms

3.8.1 Goals and Principles

The AMQP queueing and routing mechanisms define how content is moved between an AMQP server and its clients. Our goal is to define a single coherent queueing and routing model that can support a range of different highly-functional content classes.

Our design is based on these elements:

- Virtual hosts: an independent collection of destinations.
- Queue destinations: a queue distributes messages between consumers.
- Topic destinations: a topic multiplies messages across subscriptions.

- Subscriptions: a subscription distributes messages between consumers.
- Selection and routing mechanisms: allowing consumers and subscriptions to be specific about which messages they receive.
- Message persistence: defining the level of assurance that a message will be successfully delivered despite crashes and failures.
- Message priorities: allowing messages to be delivered out-of-sequence according to their importance.
- Destination browsing: allowing a client to read messages in a simple synchronous manner.
- Acknowledgements: allowing a client to tell the server when it has successfully processed a message.
- Window-based flow control: allowing a client to control how many messages it receives
- Transactions: allowing a client to group multiple messages and acknowledgements into a single unit of work.

In general all these mechanisms apply to all content classes. Certain content classes may elect to use a simpler model for performance reasons. This is specifically the case for streamed content, which does not support persistence, browsing, acknowledgements, or transactions.

3.8.2 Virtual Hosts

AMQP/Fast has explicit support for virtual hosts. The client chooses a virtual host as the last stage in negotiating the connection. A virtual host has its own set of destinations and access controls.

3.8.3 Queue Destinations

A queue is a named object that acts as an asynchronous buffer for messages. Queues may be held in memory, on disk, or some combination. Each virtual host provides a namespace for queues. Queues hold messages and distribute them between one or more clients (consumers). A message published to a queue is never sent to more than one client unless it is being resent after a failure or rejection.

Note that mixed content on a queue is generally sent asynchronously using the appropriate Deliver methods, to those clients that have asked for it. The Browse method allows clients to selectively receive single JMS or File messages but not Stream messages.

Guidelines for implementors:

- Queues are not tied to specific content classes.
- A server **MUST** allow any content class to be sent to any queue, in any mix, depending on the access rights of the producing client.

3.8.4 Topic Destinations

Topics are named objects that act as multipliers. Topics do not hold messages: rather they copy messages to subscriptions. Each virtual host provides a namespace for topics. A message published to a topic is duplicated to each subscription that has asked for it (using one of the selection mechanisms explained below).

Guidelines for implementors:

- Topics are not tied to specific content classes.
- A server **MUST** allow any content class to be sent to any topic, in any mix, depending on the access rights of the producing client.
- A server **MAY** hold topic messages for which there are no subscribers.

- The server MAY apply subscriptions retroactively to such queued messages. It MAY age such messages and expire them after a certain period. However clients MUST NOT rely on this behaviour.

3.8.5 Subscriptions

Subscriptions are named or unnamed objects that resemble queues and may be implemented using the same internal mechanisms in the server. Each virtual host provides a namespace for subscriptions. Subscriptions may be held in memory, on disk, or some combination. Subscriptions can have a single consumer (the normal case) but also multiple consumers, in which case their messages are distributed between them in the same way as messages published to a queue.

Guidelines for implementors:

- Subscriptions are not tied to specific content classes.
- A server MUST allow any content class to be sent to any subscription, depending on the access rights of the producing client.

3.8.6 Selection and Routing

AMQP/Fast provides these mechanisms for a client to select messages, and for a server to route them:

1. By destination name.
2. By destination pattern, for topics only.
3. By message properties, for queues and topics. This mechanism is called a "selector".
4. By implementation-dependent functionality embedded in the server.

The syntax for destination patterns and selectors is defined later.

3.8.7 Message Persistence

A persistent message is held securely on disk and guaranteed to be delivered even if there is a serious network failure, server crash, overflow etc.

Messages may be persistent or not, depending on several criteria:

1. In the JMS content class, messages are individually marked as persistent or non-persistent.
2. In the File content class, messages are always persistent.
3. In the Stream content class, messages are never persistent.

Guidelines for implementors:

- The server MUST do a best-effort to hold persistent messages on a fully-reliable storage medium.
- The server MUST NOT discard persistent messages in case of overflow but SHOULD use the Channel.Flow method to slow or stop a producer when necessary.
- The server MAY overflow non-persistent JMS or Stream messages to persistent storage, or MAY discard non-persistent JMS or Stream messages on a priority basis if the queue exceeds some configured maximum size.

3.8.8 Message Priorities

A high priority message is sent ahead of lower priority messages waiting in the same queue or subscription. When messages must be discarded in order to maintain a specific service quality level the server will first discard low-priority messages.

Guidelines for implementors:

- A server **MUST** implement at least 2 priority levels for non-persistent messages. A server **MAY** implement up to 10 priority levels.
- A server **MAY** implement all persistent messages as a single priority.

3.8.9 Acknowledgements

When the client finishes processing a message it tells the server via an acknowledgement. AMQP/Fast defines different acknowledgement models for different levels of performance and reliability:

- Acknowledgement by the application after it has processed a message.
- Acknowledgement by the client layer when it has received a message and before it passes it to the application.
- Acknowledgement by the server when it has sent a message to the client.

The first two models use the same protocol mechanics. The difference is when the client API sends the acknowledgement. The last model uses a specific protocol option, in the CONSUME method for those classes that support acknowledgement.

3.8.10 Flow Control

AMQP/Fast flow control is based on these concepts:

1. Allowing the client to specify a prefetch - how many messages it will receive without acknowledgement. We call this "window-based flow control".
2. Allowing one peer to halt and restart a flow of messages coming from the other peer, using the Channel.Flow method, which we call "channel flow control".

Since Publish methods are not acknowledged, there is no window-based flow control for publishing and the recommended way to pause a publisher is to use channel flow control.

Guidelines for implementors:

- A server **MUST** support window-based flow control for clients.
- A server **MAY** use channel flow control to pause publishers when queues or subscriptions overflow.
- A client **MUST** respect channel flow control when publishing messages to the server.
- A server **MAY** disconnect and/or ban clients that do not respect channel flow control methods.

3.8.11 Transactions

AMQP/Fast supports three kinds of transactions, each kind progressively slower, more complex, and more reliable:

1. Automatic transactions, in which every method is wrapped in a transaction. Automatic transactions provide no way to create units of work. Every message and acknowledgement is processed as a stand-alone transaction.

2. AMQP/Fast transactions, which cover units of work on a per-channel basis. Transactions cover messages published, and messages received and acknowledged. There is no "start transaction" method: a transaction starts when the channel is opened and after every commit or rollback. If the channel is closed without a commit, all pending work is rolled-back. Nested transactions are not allowed.
3. XA 2-phase transactions, using the XA class. This is still under construction.

The transaction type is chosen on a per-channel basis.

3.9 Error Handling

3.9.1 Goals and Principles

Error handling is a critical aspect of any protocol. First, we need a clear statement of what situations can provoke an error. Secondly, we need a clear way of reporting errors. Lastly we need unambiguous error handling that leaves both peers in a clear state.

The AMQP/Fast error handling model is based on an answer to each of these questions:

1. Use an exception-based model to define protocol correctness.
2. Use existing standards for error reporting.
3. Use a hand-shaked close to handle errors.

3.9.2 Existing Standards

The standard for error handling (defined semi-independently in several IETF RFCs) is the 3-digit reply code. This format has evolved into a fine-grained tool for communicating success or failure. It is also well-structured for expansion as a protocol gets more mature.

The current AMQP reply codes are standard to all protocols in the AMQP family and are defined in AMQ RFC 011.

The reply code is constructed as follows:

- The first digit - the completion indicator - reports whether the request succeeded or not.
- The second digit - the category indicator - provides more information on failures.
- The third digit - the instance indicator - distinguishes different situations with the same completion/category.

The completion indicator has one of these values:

```
1 = ready to be performed, pending some confirmation.
2 = successful.
3 = ready to be performed, pending more information.
4 = failed, but may succeed later.
5 = failed, requires intervention.
```

The category indicator has one of these values:

```
0 = error in syntax.
1 = the reply provides general information.
2 = problem with session or connection.
3 = problem with security.
4 = application-specific.
```

The instance indicator is 0 to 9 as needed to distinguish different situations.

3.9.3 The Assertion/Exception Model

AMQP/Fast uses an assertion/exception model that has these goals:

- identify and document all protocol preconditions ("assertions").
- define the exception level caused by any assertion failure.
- define a formal procedure for handling such exceptions.

AMQP/Fast defines two exception levels:

1. Channel exceptions. These close a single virtual connection. A channel exception is raised when a peer cannot complete some request because of transient or configuration errors.
2. Connection exceptions. These close the socket connection. A connection exception is raised when a peer detects a syntax error, badly-formed frame, or other indicator that the other peer is not conformant with AMQP/Fast.

We document the assertions formally in the definition of each class and method.

3.9.4 Hand-shaked Closure

Closing a connection for any reason - normal or exceptional - must be done carefully. Abrupt closure is not always detected rapidly, and in the case of errors, it means that error responses can be lost. The correct design is to hand-shake all closure so that we close only after we are sure the other party is aware of the situation.

A peer can close a channel or connection at any time for internal reasons, or as a reaction to an error. It sends a Close method to the other party. The receiving peer must respond to a Close with a Close-Ok method. The closing peer reads methods back until it gets a Close-Ok, at which point it closes the connection and frees resources.

3.10 The JMS Operational Model

3.10.1 Goals and Principles

JMS is a standard API for messaging middleware brokers. The AMQP/Fast JMS implementation is compatible with providers that conform to the SUN JMS specifications (within the bounds of JMS standardisation, which does not guarantee interoperability). JMS messages can be published and consumed using a set of methods that map cleanly to the JMS API, including:

- Publishing a message to a destination.
- Creating a consumer for a destination.
- Browsing a destination for messages.

3.10.2 JMS Content Properties

These are the properties defined for JMS content:

- ContentType (tiny string)
- ContentEncoding (tiny string)
- DeliveryMode (octet)
- Priority (octet)

- CorrelationID (tiny string)
- ReplyTo (tiny string)
- Destination (tiny string)
- Expiration (tiny string)
- MessageID (tiny string)
- Timestamp (tiny string)
- Type (tiny string)
- UserID (tiny string)
- AppID (tiny string)
- Headers (field table)

3.11 The File Transfer Operational Model

3.11.1 Goals and Principles

The file transfer operational model is designed for enterprise-wide file transfer based on the AMQP/Fast queueing and routing models. For instance, routing files via the publish and subscribe functionality of topics and subscriptions.

File content is specifically different from JMS content in that:

- Files are always persistent.
- File transfer is restartable: if a file has been partially transferred when a connection is broken, the sender can resend just the remainder.

File transfers always happen in two steps:

1. The sender "stages" the file into a temporary area provided by the recipient.
2. The sender notifies the recipient of the file, using Publish (a client to a server), or Deliver (a server to a client).

A File message is persistent and optimised for restartable transfers across possibly unreliable network connections.

3.11.2 File Content Properties

These are the properties defined for File content:

- ContentType (tiny string)
- ContentEncoding (tiny string)
- Priority (octet)
- ReplyTo (tiny string)
- Destination (tiny string)
- MessageID (tiny string)
- FileName (tiny string)
- Timestamp (tiny string)
- Headers (field table)

3.12 The Stream Operational Model

3.12.1 Goals and Principles

Streaming is intended for multimedia applications: video, music, etc. A stream consists of an unterminated series of messages, each message containing a fragment of streamed data.

The AMQP/Fast streaming model separates the compression technology (codec) from the streaming technology. The streaming model is compatible with any codec that allows data to be fragmented.

Streamed messages use the full AMQP/Fast queueing and routing mechanisms with some simplifications:

1. Streamed content is non-persistent though the server MAY hold it on disk if needed.
2. Streamed data sent to a queue cannot be shared between multiple consumers (each would receive partial streams).
3. Streamed data sent to a subscription via a topic cannot be shared between multiple consumers (each would receive partial streams).

A stream producer can use topics to distribute streams to multiple consumers at once. Topics can be used - e.g. - to provide different qualities of the same stream.

A stream consumer can specify the rate at which data is wanted.

3.12.2 Stream Content Properties

These are the properties defined for Stream content:

- ContentType (tiny string)
- ContentEncoding (tiny string)
- Priority (octet)
- Destination (tiny string)
- Timestamp (tiny string)
- Headers (field table)

3.13 Security

3.13.1 Goals and Principles

We guard against buffer-overflow exploits by using length-specified buffers in all places. All externally-provided data can be verified against maximum allowed lengths whenever any data is read.

Invalid data can be handled unambiguously, by closing the channel or the connection.

3.13.2 Buffer Overflows

All data is length-specified so that applications can allocate memory in advance and avoid deadlocks. Length-specified strings protect against buffer-overflow attacks.

3.13.3 Denial of Service Attacks

AMQP/Fast handles errors by returning a reply code and then closing the channel or connection. This avoids ambiguous states after errors.

It should be assumed that exceptional conditions during connection negotiation stage are due to an hostile attempt to gain access to the server. The general response to any exceptional condition in the connection negotiation is to pause that connection (presumably a thread) for a period of several seconds and then to close the network connection. This includes syntax errors, over-sized data, or failed attempts to authenticate. The server implementation should log all such exceptions and flag or block clients provoking multiple failures.

3.14 Miscellaneous Topics

3.14.1 Performance

To be completed.

3.14.2 Message Templating

To be completed.

3.14.3 Field Dictionaries

To be completed.

3.14.4 Message Selectors

To be completed.

3.14.5 Topic Selectors

To be completed.

3.14.6 Destination Templating

To be completed.

4 Reference Section

4.1 Class Quick Reference

4.1.1 Overall Grammar

```

connection      = open-connection *use-connection close-connection
open-connection = C:protocol-header
                  S:START C:START_OK
                  *challenge
                  S:TUNE C:TUNE_OK
                  C:OPEN S:OPEN_OK
challenge        = S:SECURE C:SECURE_OK
use-connection   = S:UNKNOWN
                  / C:UNKNOWN
                  / channel
close-connection = C:CLOSE S:CLOSE_OK
                  / S:CLOSE C:CLOSE_OK
channel          = open-channel *use-channel close-channel
open-channel     = C:OPEN S:OPEN_OK
use-channel      = C:FLOW
                  / S:FLOW
                  / S:SYNCH
                  / access
                  / destination
                  / subscription
                  / jms
                  / file
                  / stream
                  / tx
                  / dtx
                  / test
close-channel    = C:CLOSE S:CLOSE_OK
                  / S:CLOSE C:CLOSE_OK
access           = C:GRANT S:GRANT_OK
destination      = C:DEFINE S:DEFINE_OK
                  / C:QUERY S:QUERY_OK
                  / C:PURGE S:PURGE_OK
                  / C:CANCEL S:CANCEL_OK
subscription     = C:DEFINE S:DEFINE_OK
                  / C:QUERY S:QUERY_OK
                  / C:PURGE S:PURGE_OK
                  / C:CANCEL S:CANCEL_OK
jms              = C:CONSUME S:CONSUME_OK
                  / C:CANCEL
                  / C:PUBLISH content
                  / S:DELIVER content
                  / C:BROWSE ( S:BROWSE_OK content / S:BROWSE_EMPTY )
                  / C:ACK
                  / C:REJECT
file             = C:OPEN S:OPEN_OK
                  / S:OPEN C:OPEN_OK
                  / C:STAGE
                  / S:STAGE
                  / C:CONSUME S:CONSUME_OK
                  / C:CANCEL
                  / C:PUBLISH content
                  / S:DELIVER content
                  / C:BROWSE ( S:BROWSE_OK content / S:BROWSE_EMPTY )
                  / C:ACK
                  / C:REJECT
file             = C:CONSUME S:CONSUME_OK
                  / C:CANCEL
                  / C:PUBLISH content
                  / S:DELIVER content
tx               = C:COMMIT S:COMMIT_OK
                  / C:ABORT S:ABORT_OK
dtx              = C:START S:START_OK
test             = C:INTEGER S:INTEGER_OK
                  / S:INTEGER C:INTEGER_OK
                  / C:STRING S:STRING_OK
                  / S:STRING C:STRING_OK

```

```

/ C:TABLE S:TABLE_OK
/ S:TABLE C:TABLE_OK
/ C:CONTENT S:CONTENT_OK
/ S:CONTENT C:CONTENT_OK

```

4.1.2 Connection Class - Work With Socket Connections

Connection.Start ID=1/1 - client, sync request, start connection negotiation.

version_major	octet	#	negotiated protocol major version
version_minor	octet	#	negotiated protocol major version
mechanisms	shortstr	#	available security mechanisms

Connection.Start Ok ID=1/2 - server, sync reply for Start, select security mechanism.

mechanism	shortstr	#	selected security mechanism
-----------	----------	---	-----------------------------

Connection.Secure ID=1/3 - client, sync request, security mechanism challenge.

challenge	longstr	#	security challenge data
-----------	---------	---	-------------------------

Connection.Secure Ok ID=1/4 - server, sync reply for Secure, security mechanism response.

response	longstr	#	security response data
----------	---------	---	------------------------

Connection.Tune ID=1/5 - client, sync request, propose connection tuning parameters.

frame_max	long	#	maximum frame size
channel_max	short	#	maximum number of channels
access_max	short	#	maximum number of access tickets
consumer_max	short	#	maximum consumers per channel
heartbeat	short	#	desired heartbeat delay
txn_limit	short	#	maximum transaction size
jms_support	bit	#	JMS content is supported?
file_support	bit	#	file content is supported?
stream_support	bit	#	stream content is supported?

Connection.Tune Ok ID=1/6 - server, sync reply for Tune, negotiate connection tuning parameters.

frame_max	long	#	maximum frame size
channel_max	short	#	maximum number of channels
ticket_max	short	#	maximum number of access tickets
heartbeat	short	#	desired heartbeat delay
jms_support	bit	#	JMS content is supported?
file_support	bit	#	file content is supported?
stream_support	bit	#	stream content is supported?
prefetch_max	long	#	maximum prefetch size for connection

Connection.Open ID=1/7 - server, sync request, open a path to a virtual host.

virtual_path	shortstr	#	path value virtual server path
client_id	shortstr	#	client identifier

Connection.Open Ok ID=1/8 - client, sync reply for Open, signal that the connection is ready.

client_id	shortstr	#	assigned client identifier
-----------	----------	---	----------------------------

Connection.Unknown ID=1/9 - client, async, signal that an interface test method has failed.

class	octet	#	failing method class
method	octet	#	failing method ID
synctag	short	#	failing method synctag
reply_code	short	#	reply code from server reply code
reply_text	shortstr	#	localised reply text localised reply text

Connection.Close ID=1/10 - client, sync request, request a connection close.

reply_code	short	#	reply code from server reply code
reply_text	shortstr	#	localised reply text localised reply text
class	octet	#	failing method class
method	octet	#	failing method ID
synctag	short	#	failing method synctag

Connection.Close Ok ID=1/11 - client, sync reply for Close, confirm a connection close. No specific fields.

4.1.3 Channel Class - Work With Channels

Channel.Open ID=2/1 - server, sync request, open a channel for use.

prefetch_max	long	#	maximum prefetch size for channel
out_of_band	shortstr	#	out-of-band settings for channel
tx_mode	octet	#	transaction mode for channel

Channel.Open Ok ID=2/2 - client, sync reply for Open, signal that the channel is ready. No specific fields.

Channel.Flow ID=2/3 - client, async, enable/disable flow from peer.

flow_pause	bit	#	start/stop content frames
------------	-----	---	---------------------------

Channel.Close ID=2/4 - client, sync request, request a channel close.

reply_code	short	#	reply code from server reply code
reply_text	shortstr	#	localised reply text localised reply text
class	octet	#	failing method class
method	octet	#	failing method ID
synctag	short	#	failing method synctag

Channel.Close Ok ID=2/5 - client, sync reply for Close, confirm a channel close. No specific fields.

4.1.4 Access Class - Work With Access Tickets

Access.Grant ID=3/1 - server, sync request, request an access ticket.

realm	shortstr	#	path value realm to work with
exclusive	bit	#	request exclusive access
query	bit	#	request query rights
publish	bit	#	request publish rights
consume	bit	#	request consume rights
subscribe	bit	#	request subscriber rights
dynamic	bit	#	request dynamic destination rights
purge	bit	#	request purge rights

Access.Grant Ok ID=3/2 - client, sync reply for Grant, grant access to server resources.

ticket	short	#	access ticket granted by server
--------	-------	---	---------------------------------

4.1.5 Destination Class - Work With Dynamic Destinations

Destination.Define ID=4/1 - server, sync request, create or verify a dynamic destination.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name
template	shortstr	#	destination template
private	bit	#	request private destination
auto_cancel	bit	#	auto-cancel when finished

Destination.Define Ok ID=4/2 - client, sync reply for Define, confirms a destination definition.

destination	shortstr	#	destination name name of destination
message_count	long	#	number of messages in queue destination

Destination.Query ID=4/3 - server, sync request, query status of destination.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name

Destination.Query Ok ID=4/4 - client, sync reply for Query, provide status of destination.

service_type	octet	# destination service type
destination	shortstr	# destination name name of destination
message_count	long	# number of messages in queue destination
consumer_count	long	# number of consumers
subscriber_count	long	# number of subscribers

Destination.Purge ID=4/5 - server, sync request, purge a destination.

ticket	short	# access ticket granted by server
service_type	octet	# destination service type
destination	shortstr	# destination name name of destination

Destination.Purge Ok ID=4/6 - client, sync reply for Purge, confirms a destination purge.

message_count	long	# number of messages purged
---------------	------	-----------------------------

Destination.Cancel ID=4/7 - server, sync request, cancel a dynamic destination.

ticket	short	# access ticket granted by server
service_type	octet	# destination service type
destination	shortstr	# destination name
ifempty	bit	# cancel only if empty

Destination.Cancel Ok ID=4/8 - client, sync reply for Cancel, confirm cancellation of a dynamic destination.

message_count	long	# number of messages purged
---------------	------	-----------------------------

4.1.6 Subscription Class - Work With Subscriptions

Subscription.Define ID=5/1 - server, sync request, create or configure a persistent subscription.

ticket	short	# access ticket granted by server
subscription	shortstr	# subscription name
template	shortstr	# subscription template
topic_selector	shortstr	# topic name or pattern
topic_seltype	octet	# type of topic selector
message_selector	longstr	# message selector
message_seltype	octet	# type of message selector
private	bit	# request private subscription
auto_cancel	bit	# auto-cancel when finished

Subscription.Define Ok ID=5/2 - client, sync reply for Define, confirms a subscription definition.

subscription	shortstr	# subscription name
topic_selector	shortstr	# topic name or pattern
topic_seltype	octet	# type of topic selector
message_count	long	# number of messages in subscription

Subscription.Query ID=5/3 - server, sync request, query status of subscription.

ticket	short	# access ticket granted by server
subscription	shortstr	# subscription name subscription name

Subscription.Query Ok ID=5/4 - client, sync reply for Query, provide status of subscription.

subscription	shortstr	# subscription name
message_count	long	# number of messages in subscription
consumer_count	long	# number of consumers

Subscription.Purge ID=5/5 - server, sync request, purge a subscription.

ticket	short	# access ticket granted by server
subscription	shortstr	# subscription name

Subscription.Purge Ok ID=5/6 - client, sync reply for Purge, confirms a subscription purge.

message_count	long	# number of messages purged
---------------	------	-----------------------------

Subscription.Cancel ID=5/7 - server, sync request, cancel a subscription.

ticket	short	# access ticket granted by server
subscription	shortstr	# subscription name
ifempty	bit	# cancel only if empty

Subscription.Cancel Ok ID=5/8 - client, sync reply for Cancel, confirm cancellation of a subscription.

message_count	long	# number of messages purged
---------------	------	-----------------------------

4.1.7 Jms Class - Work With Jms Content

Jms.Consume ID=6/1 - server, sync request, start a destination consumer.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name
subscription	shortstr	#	subscription name
prefetch_size	short	#	prefetch window in octets
prefetch_count	short	#	prefetch window in messages
no_local	bit	#	do not receive own messages
auto_ack	bit	#	no acknowledgement needed
exclusive	bit	#	request exclusive access
message_selector	longstr	#	message selector
message_seltype	octet	#	type of message selector
auto_cancel	long	#	cancel consumer after N messages

Jms.Consume Ok ID=6/2 - client, sync reply for Consume, confirm a new consumer.

consumer_tag	short	#	server-assigned consumer tag
--------------	-------	---	------------------------------

Jms.Cancel ID=6/3 - server, async, end a destination consumer.

consumer_tag	short	#	server-assigned consumer tag
--------------	-------	---	------------------------------

Jms.Publish ID=6/4 - server, async, carries content, publish a message to a destination.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name
immediate	bit	#	assert immediate delivery

Jms.Deliver ID=6/5 - client, async, carries content, notify the client of a consumer message.

delivery_tag	longlong	#	server-assigned delivery tag
redelivered	bit	#	signal a redelivered message
destination	shortstr	#	destination name

Jms.Browse ID=6/6 - server, sync request, direct access to a destination.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name
subscription	shortstr	#	subscription name
no_local	bit	#	do not receive own messages
auto_ack	bit	#	no acknowledgement needed

Jms.Browse Ok ID=6/7 - client, sync reply for Browse, carries content, provide client with a browsed message.

delivery_tag	longlong	#	server-assigned delivery tag
redelivered	bit	#	signal a redelivered message
destination	shortstr	#	destination name
message_count	long	#	number of messages pending

Jms.Browse Empty ID=6/8 - client, sync reply for Browse, indicate no messages available. No specific fields.

Jms.Ack ID=6/9 - server, async, acknowledge one or more messages.

delivery_tag	longlong	#	server-assigned delivery tag
multiple	bit	#	acknowledge multiple messages

Jms.Reject ID=6/10 - server, async, reject an incoming message.

delivery_tag	longlong	#	server-assigned delivery tag
requeue	bit	#	requeue the message

4.1.8 File Class - Work With File Content

File.Consume ID=7/1 - server, sync request, start a destination consumer.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name
subscription	shortstr	#	subscription name
prefetch_size	short	#	prefetch window in octets
prefetch_count	short	#	prefetch window in messages
no_local	bit	#	do not receive own messages
auto_ack	bit	#	no acknowledgement needed
exclusive	bit	#	request exclusive access
message_selector	longstr	#	message selector
message_seltype	octet	#	type of message selector
auto_cancel	long	#	cancel consumer after N messages

File.Consume Ok ID=7/2 - client, sync reply for Consume, confirm a new consumer.

consumer_tag	short	#	server-assigned consumer tag
--------------	-------	---	------------------------------

File.Cancel ID=7/3 - server, async, end a destination consumer.

consumer_tag	short	#	server-assigned consumer tag
--------------	-------	---	------------------------------

File.Publish ID=7/4 - server, async, carries content, publish a message to a destination.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name
immediate	bit	#	assert immediate delivery

File.Deliver ID=7/5 - client, async, carries content, notify the client of a consumer message.

delivery_tag	longlong	#	server-assigned delivery tag
redelivered	bit	#	signal a redelivered message
destination	shortstr	#	destination name

File.Browse ID=7/6 - server, sync request, direct access to a destination.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name
subscription	shortstr	#	subscription name
no_local	bit	#	do not receive own messages
auto_ack	bit	#	no acknowledgement needed

File.Browse Ok ID=7/7 - client, sync reply for Browse, carries content, provide client with a browsed message.

delivery_tag	longlong	#	server-assigned delivery tag
redelivered	bit	#	signal a redelivered message
destination	shortstr	#	destination name
message_count	long	#	number of messages pending

File.Browse Empty ID=7/8 - client, sync reply for Browse, indicate no messages available. No specific fields.

File.Ack ID=7/9 - server, async, acknowledge one or more messages.

delivery_tag	longlong	#	server-assigned delivery tag
multiple	bit	#	acknowledge multiple messages

File.Reject ID=7/10 - server, async, reject an incoming message.

delivery_tag	longlong	#	server-assigned delivery tag
requeue	bit	#	requeue the message

4.1.9 Stream Class - Work With Streaming Content

Stream.Consume ID=8/1 - server, sync request, start a destination consumer.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name
subscription	shortstr	#	subscription name
prefetch_size	short	#	prefetch window in octets
prefetch_count	short	#	prefetch window in messages
consume_rate	long	#	transfer rate in octets/second
no_local	bit	#	do not receive own messages
exclusive	bit	#	request exclusive access

Stream.Consume Ok ID=8/2 - client, sync reply for Consume, confirm a new consumer.

consumer_tag	short	#	server-assigned consumer tag
--------------	-------	---	------------------------------

Stream.Cancel ID=8/3 - server, async, end a destination consumer.

consumer_tag	short	#	server-assigned consumer tag
--------------	-------	---	------------------------------

Stream.Publish ID=8/4 - server, async, carries content, publish a message to a destination.

ticket	short	#	access ticket granted by server
service_type	octet	#	destination service type
destination	shortstr	#	destination name
immediate	bit	#	assert immediate delivery

Stream.Deliver ID=8/5 - client, async, carries content, notify the client of a consumer message.

destination	shortstr	#	destination name
immediate	bit	#	assert immediate delivery

4.1.10 Tx Class - Work With Standard Transactions

Tx.Commit ID=9/1 - server, sync request, commit the current transaction. No specific fields.

Tx.Commit Ok ID=9/2 - client, sync reply for Commit, confirm a successful commit. No specific fields.

Tx.Abort ID=9/3 - server, sync request, abandon the current transaction. No specific fields.

Tx.Abort Ok ID=9/4 - client, sync reply for Abort, confirm a successful abort. No specific fields.

4.1.11 Dtx Class - Work With Distributed Transactions

Dtx.Start ID=10/1 - server, sync request, start a new distributed transaction.

dtx_identifier	shortstr	#	distributed transaction identifier
----------------	----------	---	------------------------------------

Dtx.Start Ok ID=10/2 - client, sync reply for Start, confirm the start of a new distributed transaction. No specific fields.

4.1.12 Test Class - Test Functional Primitives Of The Implementation

Test.Integer ID=11/1 - client, sync request, test integer handling.

integer_1	octet	#	octet test value
integer_2	short	#	short test value
integer_3	long	#	long test value
integer_4	longlong	#	long-long test value
operation	octet	#	operation to test

Test.Integer Ok ID=11/2 - client, sync reply for Integer, report integer test result.

```
result          longlong    #  result value
```

Test.String ID=11/3 - client, sync request, test string handling.

```
string_1        shortstr    #  short string test value
string_2        longstr     #  long string test value
operation        octet       #  operation to test
```

Test.String Ok ID=11/4 - client, sync reply for String, report string test result.

```
result          longstr     #  result value
```

Test.Table ID=11/5 - client, sync request, test field table handling.

```
table           table       #  field table of test values
integer_op       octet       #  operation to test on integers
string_op        octet       #  operation to test on strings
```

Test.Table Ok ID=11/6 - client, sync reply for Table, report table test result.

```
integer_result   longlong    #  integer result value
string_result    longstr     #  string result value
```

Test.Content ID=11/7 - client, sync request, carries content, test content handling. No specific fields.

Test.Content Ok ID=11/8 - client, sync reply for Content, carries content, report content test result.

```
content_checksum long        #  content hash
```

4.2 The Connection Class

The connection class provides methods for a client to establish a network connection to a server, and for both peers to operate the connection thereafter. The ID of the Connection class is 1.

This is the formal grammar for the class:

```
connection      = open-connection *use-connection close-connection
open-connection = C:protocol-header
                  S:START C:START_OK
                  *challenge
                  S:TUNE C:TUNE_OK
                  C:OPEN S:OPEN_OK
challenge        = S:SECURE C:SECURE_OK
use-connection   = S:UNKNOWN
                  / C:UNKNOWN
                  / channel
close-connection = C:CLOSE S:CLOSE_OK
                  / S:CLOSE C:CLOSE_OK
```

This class contains the following server methods:

- Connection.Start Ok - select security mechanism (ID = 2) (sync reply for Start)
- Connection.Secure Ok - security mechanism response (ID = 4) (sync reply for Secure)
- Connection.Tune Ok - negotiate connection tuning parameters (ID = 6) (sync reply for Tune)
- Connection.Open - open a path to a virtual host (ID = 7) (sync request)
- Connection.Unknown - signal that an interface test method has failed (ID = 9) (async)
- Connection.Close - request a connection close (ID = 10) (sync request)
- Connection.Close Ok - confirm a connection close (ID = 11) (sync reply for Close)

This class contains the following client methods:

- Connection.Start - start connection negotiation (ID = 1) (sync request)

- Connection.Secure - security mechanism challenge (ID = 3) (sync request)
- Connection.Tune - propose connection tuning parameters (ID = 5) (sync request)
- Connection.Open Ok - signal that the connection is ready (ID = 8) (sync reply for Open)
- Connection.Unknown - signal that an interface test method has failed (ID = 9) (async)
- Connection.Close - request a connection close (ID = 10) (sync request)
- Connection.Close Ok - confirm a connection close (ID = 11) (sync reply for Close)

Guidelines for implementors:

- The server MUST implement this class. Each method may have specific guidelines.
- The client MUST implement this class. Each method may have specific guidelines.
- Any assertion failures in the Connection methods MUST BE treated as connection exceptions - i.e. the peer that detects the error MUST respond with Connection.Close.

4.2.1 The Connection.Start Method

This method starts the connection negotiation process by telling the client the protocol version that the server proposes, along with a list of security mechanisms which the client can use for authentication.

The Connection.Start method has the following specific fields:

- version_major (octet) - The protocol major version that the server agrees to use, which cannot be higher than the client's major version.
- version_minor (octet) - The protocol minor version that the server agrees to use, which cannot be higher than the client's minor version.
- mechanisms (shortstr) - A list of the security mechanisms that the server supports, delimited by spaces. Currently AMQP/Fast supports these mechanisms: PLAIN.

This is the Connection.Start pseudo-structure:

```
define Connection.Start {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
    version_major   octet      # negotiated protocol major version
    version_minor   octet      # negotiated protocol minor version
    mechanisms      shortstr   # available security mechanisms
}
```

Guidelines for implementors:

- If the client cannot handle the protocol version suggested by the server it MUST close the socket connection.
- The server MUST provide a protocol version that is lower than or equal to that requested by the client in the protocol header. If the server cannot support the specified protocol it MUST NOT send this method, but MUST close the socket connection.
- The client MUST implement this method.
- This method is a synchronous request that expects one of: Connection.Start Ok unless there is an exception.
- The "version_major" field MUST be equal to 0.
- The "version_minor" field MUST be equal to 9.
- The "mechanisms" field MUST not be empty.

4.2.2 The Connection.Start Ok Method

This method selects a SASL security mechanism. AMQP/Fast uses SASL (RFC2222) to negotiate authentication and encryption.

The Connection.Start Ok method has the following specific fields:

- mechanism (shortstr) - A single security mechanisms selected by the client; one of those specified by the server. The client **SHOULD** authenticate using the highest-level security profile it can handle from the list provided by the server.

This is the Connection.Start Ok pseudo-structure:

```
define Connection.Start Ok {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
    mechanism       shortstr   # selected security mechanism
}
```

Guidelines for implementors:

- The server **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.
- The "mechanism" field **MUST** not be empty.
- The client **SHOULD** authenticate using the highest-level security profile it can handle from the list provided by the server.

4.2.3 The Connection.Secure Method

The SASL protocol works by exchanging challenges and responses until both peers have received sufficient information to authenticate each other. This method challenges the client to provide more information.

The Connection.Secure method has the following specific fields:

- challenge (longstr) - Challenge information, a block of opaque binary data passed to the security mechanism.

This is the Connection.Secure pseudo-structure:

```
define Connection.Secure {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
    challenge       longstr    # security challenge data
}
```

Guidelines for implementors:

- The client **MUST** implement this method.
- This method is a synchronous request that expects one of: Connection.Secure Ok unless there is an exception.
- The "challenge" field **MUST** not be empty.

4.2.4 The Connection.Secure Ok Method

This method attempts to authenticate, passing a block of SASL data for the security mechanism at the server side.

The Connection.Secure Ok method has the following specific fields:

- response (longstr) - A block of opaque data passed to the security mechanism. The contents of this data are defined by the SASL security mechanism.

This is the Connection.Secure Ok pseudo-structure:

```
define Connection.Secure Ok {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag   long       # synctag
    response        longstr     # security response data
}
```

Guidelines for implementors:

- The server **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.
- The "response" field **MUST** not be empty.

4.2.5 The Connection.Tune Method

This method proposes a set of connection configuration values to the client. The client can accept and/or adjust these.

The Connection.Tune method has the following specific fields:

- frame_max (long) - The largest frame size or fragment size that the server is prepared to accept, in octets. The frame-max must be large enough for any method frame. The frame-max may exceed 64K if the peer is willing to read and write meta frames.
- channel_max (short) - The maximum total number of channels that the server allows per connection. Zero means that the server does not impose a fixed limit, but the number of allowed channels may be limited by available server resources.
- access_max (short) - The maximum total number of access tickets that the server allows per connection. Zero means that the server does not impose a fixed limit, but the number of allowed access tickets may be limited by available server resources.
- consumer_max (short) - The maximum number of consumers that the server allows per channel. Zero means that the server does not impose a fixed limit, but the number of possible consumers may be limited by available server resources.
- heartbeat (short) - The delay, in seconds, of the connection heartbeat that the server wants. Zero means the server does not want a heartbeat.
- txn_limit (short) - The highest number of messages that the server will accept per transaction. Zero means the server does not impose a fixed limit, but the size of transactions may be limited by available server resources.
- jms_support (bit) - Indicates whether the server supports the JMS content domain or not. If the jms-support field is 1, the client **MAY** use the JMS class methods. If this field is zero, the client **MUST NOT** use the JMS class methods.
- file_support (bit) - Indicates whether the server supports the file content domain or not. If the file-support field is 1, the client **MAY** use the File methods. If this field is zero, the client **MUST NOT** use the File methods.

- `stream_support` (bit) - Indicates whether the server supports the stream content domain or not. If the `stream-support` field is 1, the client MAY use the Stream methods. If this field is zero, the client MUST NOT use the Stream methods.

This is the `Connection.Tune` pseudo-structure:

```
define Connection.Tune {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synctag  long     # synctag
    frame_max       long     # maximum frame size
    channel_max     short    # maximum number of channels
    access_max      short    # maximum number of access tickets
    consumer_max    short    # maximum consumers per channel
    heartbeat       short    # desired heartbeat delay
    txn_limit       short    # maximum transaction size
    jms_support     bit      # JMS content is supported?
    file_support    bit      # file content is supported?
    stream_support  bit      # stream content is supported?
}
```

Guidelines for implementors:

- The client MUST implement this method.
- This method is a synchronous request that expects one of: `Connection.Tune Ok` unless there is an exception.
- The "frame_max" field MUST be greater than or equal to 1024.
- If the `jms-support` field is 1, the client MAY use the JMS class methods. If this field is zero, the client MUST NOT use the JMS class methods.
- If the `file-support` field is 1, the client MAY use the File methods. If this field is zero, the client MUST NOT use the File methods.
- If the `stream-support` field is 1, the client MAY use the Stream methods. If this field is zero, the client MUST NOT use the Stream methods.

4.2.6 The Connection.Tune Ok Method

This method sends the client's connection tuning parameters to the server. Certain fields are negotiated, others provide capability information.

The `Connection.Tune Ok` method has the following specific fields:

- `frame_max` (long) - The largest frame size or fragment size that the server is prepared to accept, in octets. The frame-max must be large enough for any method frame. The frame-max may exceed 64K if the peer is willing to read and write meta frames. Must not be higher than the value specified by the server.
- `channel_max` (short) - The maximum total number of channels that the client will use per connection. May not be higher than the value specified by the server. The server MAY ignore the channel-max value or MAY use it for tuning its resource allocation.
- `ticket_max` (short) - The maximum total number of access tickets that the client will use per connection. May not be higher than the value specified by the server. The server MAY ignore the ticket-max value or MAY use it for tuning its resource allocation.
- `heartbeat` (short) - The delay, in seconds, of the connection heartbeat that the client wants. Zero means the client does not want a heartbeat.
- `jms_support` (bit) - Indicates whether the client supports the JMS content domain.
- `file_support` (bit) - Indicates whether the client supports the file content domain.

- `stream_support` (bit) - Indicates whether the client supports the stream content domain.
- `prefetch_max` (long) - This value governs the total amount of prefetch data that the client is willing to accept per connection. Prefetching is the technique of sending messages to a client in advance, which reduces the latency of message processing. Normally each consumer specifies its own prefetch window. The `prefetch_max` field specifies a global limit at the connection level. If it is zero, the server does not impose any connection-level limit. The server **MUST NOT** send a client more data in advance than this value allows. If sending a specific message in advance would exhaust the connection prefetch window, it **MUST NOT** send the message. Setting this field to a very low non-zero value - e.g. 1 - effectively disables all prefetching.

This is the `Connection.Tune Ok` pseudo-structure:

```
define Connection.Tune Ok {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synctag  long     # synctag
    frame_max       long     # maximum frame size
    channel_max     short    # maximum number of channels
    ticket_max      short    # maximum number of access tickets
    heartbeat       short    # desired heartbeat delay
    jms_support     bit      # JMS content is supported?
    file_support    bit      # file content is supported?
    stream_support  bit      # stream content is supported?
    prefetch_max    long     # maximum prefetch size for connection
}
```

Guidelines for implementors:

- The server **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.
- The `"frame_max"` field **MUST** be greater than or equal to 1024.
- The `"frame_max"` field **MUST** be less than or equal to the value of 'frame max' in the last received `Connection.Tune` method.
- The `"channel_max"` field **MUST** be greater than 0.
- The `"channel_max"` field **MUST** be less than or equal to the value of 'channel max' in the last received `Connection.Tune` method.
- The server **MAY** ignore the channel-max value or **MAY** use it for tuning its resource allocation.
- The `"ticket_max"` field **MUST** be greater than 0.
- The `"ticket_max"` field **MUST** be less than or equal to the value of 'access max' in the last received `Connection.Tune` method.
- The server **MAY** ignore the ticket-max value or **MAY** use it for tuning its resource allocation.
- The server **MUST NOT** send a client more data in advance than this value allows. If sending a specific message in advance would exhaust the connection prefetch window, it **MUST NOT** send the message. Setting this field to a very low non-zero value - e.g. 1 - effectively disables all prefetching.

4.2.7 The `Connection.Open` Method

This method opens a path to a virtual host on the server. The virtual host is a collection of destinations, and acts to separate multiple application domains on the server.

The Connection.Open method has the following specific fields:

- `virtual_path` (shortstr) - Must start with a slash "/" and continue with path names separated by slashes. A path name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [.-_+!=:]. The virtual access path of the virtual host to work with. The virtual path must be known to the server, either as a configured value or as a built-in value.
- `client_id` (shortstr) - The client identifier, used to identify persistent resources belonging to the client. This is a string that uniquely defines the client. The client MUST supply an ID that it used previously if it wants to continue using previously-allocated resources. If the client-id is empty, the server MUST allocate a new ID that uniquely and persistently identifies the client to the server instance. The server MUST restrict a specific client identifier to being active in at most one connection at a time. The server SHOULD detect when a client disconnects and release all temporary resources owned by that client.

This is the Connection.Open pseudo-structure:

```
define Connection.Open {
    method_class      octet      # class ID
    method_id         octet      # method ID
    method_flags      octet      # method flags
    method_synchtag   long       # synchtag
    virtual_path       shortstr   # path value virtual server path
    client_id         shortstr   # client identifier
}
```

Guidelines for implementors:

- The server MUST support the default virtual host, "/".
- The server SHOULD verify that the client has permission to access the specified virtual host, using the authenticated client identity.
- The client MUST open a path to a virtual host before doing any work on the connection.
- The server MUST implement this method.
- This method is a synchronous request that expects one of: Connection.Open Ok unless there is an exception.
- The client MUST supply an ID that it used previously if it wants to continue using previously-allocated resources.
- If the client-id is empty, the server MUST allocate a new ID that uniquely and persistently identifies the client to the server instance.
- The server MUST restrict a specific client identifier to being active in at most one connection at a time.
- The server SHOULD detect when a client disconnects and release all temporary resources owned by that client.

4.2.8 The Connection.Open Ok Method

This method signals to the client that the connection is ready for use.

The Connection.Open Ok method has the following specific fields:

- `client_id` (shortstr) - Confirms or provides the client id. If the client provided an id when sending Connection.Open, this field confirms the ID. If the client did not provide an ID, the server generates one and provides it in this field.

This is the Connection.Open Ok pseudo-structure:

```
define Connection.Open Ok {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags     octet      # method flags
    method_synchtag  long       # synchtag
    client_id        shortstr   # assigned client identifier
}
```

Guidelines for implementors:

- The client **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.
- The "client_id" field **MUST** not be empty.

4.2.9 The Connection.Unknown Method

This method signals that an interface test method has failed. This may happen after a method is sent with the UNREAL flag set.

The Connection.Unknown method has the following specific fields:

- class (octet) - The class id of the interface test method that failed.
- method (octet) - The method id of the interface test method that failed.
- synchtag (short) - The synchtag the interface test method that failed.
- reply_code (short) - The reply code. The AMQ reply codes are defined in AMQ RFC 011.
- reply_text (shortstr) - The localised reply text. This text can be logged as an aid to resolving issues.

This is the Connection.Unknown pseudo-structure:

```
define Connection.Unknown {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags     octet      # method flags
    method_synchtag  long       # synchtag
    class           octet      # failing method class
    method          octet      # failing method ID
    synchtag         short      # failing method synchtag
    reply_code       short      # reply code from server reply code
    reply_text       shortstr   # localised reply text localised reply text
}
```

Guidelines for implementors:

- A peer that uses the UNREAL flag **MUST** implement this method.
- The client **SHOULD** implement this method.
- The server **SHOULD** implement this method.
- This method is asynchronous. The recipient **MUST** handle it at any point as defined by the class grammar. The sender **MUST** not expect any specific reply unless the SYNCHREQ flag is set (which will solicit a Channel.Synch reply).
- The "class" field **MUST NOT** be equal to 0.
- The "method" field **MUST NOT** be equal to 0.

4.2.10 The Connection.Close Method

This method indicates that the sender wants to close the connection. This may be due to internal conditions (e.g. a forced shut-down) or due to an error handling a specific method, i.e. an exception. When a close is due to an exception, the sender provides the class, method id, and synchtag of the method which caused the exception.

The Connection.Close method has the following specific fields:

- reply_code (short) - The reply code. The AMQ reply codes are defined in AMQ RFC 011.
- reply_text (shortstr) - The localised reply text. This text can be logged as an aid to resolving issues.
- class (octet) - When the close is provoked by a method exception, this is the class of the method.
- method (octet) - When the close is provoked by a method exception, this is the ID of the method.
- synchtag (short) - When the close is provoked by a method exception, this is the synchtag of the method.

This is the Connection.Close pseudo-structure:

```
define Connection.Close {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synchtag long     # synchtag
    reply_code      short    # reply code from server
    reply_text      shortstr # localised reply text
    class           octet    # failing method class
    method          octet    # failing method ID
    synchtag        short    # failing method synchtag
}
```

Guidelines for implementors:

- After sending this method any received method except Connection.Close_ok MUST be discarded.
- The peer sending this method MAY use a counter or timeout to detect failure of the other peer to respond correctly with Connection.Close_ok.
- The client MUST implement this method.
- The server MUST implement this method.
- This method is a synchronous request that expects one of: Connection.Close Ok unless there is an exception.

4.2.11 The Connection.Close Ok Method

This method confirms a Connection.Close method and tells the recipient that it is safe to release resources for the connection and close the socket. This method has no fields apart from the standard method header.

This is the Connection.Close Ok pseudo-structure:

```
define Connection.Close Ok {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synchtag long     # synchtag
}
```

Guidelines for implementors:

- A peer that detects a socket closure without having received a Connection.Close_ok handshake method SHOULD log the error.

- The client **MUST** implement this method.
- The server **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.

4.3 The Channel Class

The channel class provides methods for a client to establish a virtual connection - a channel - to a server and for both peers to operate the virtual connection thereafter. The ID of the Channel class is 2.

This is the formal grammar for the class:

```
channel          = open-channel *use-channel close-channel
open-channel     = C:OPEN S:OPEN_OK
use-channel      = C:FLOW
                  / S:FLOW
                  / S:SYNCH
                  / access
                  / destination
                  / subscription
                  / jms
                  / file
                  / stream
                  / tx
                  / dtx
                  / test
close-channel    = C:CLOSE S:CLOSE_OK
                  / S:CLOSE C:CLOSE_OK
```

This class contains the following server methods:

- Channel.Open - open a channel for use (ID = 1) (sync request)
- Channel.Flow - enable/disable flow from peer (ID = 3) (async)
- Channel.Close - request a channel close (ID = 4) (sync request)
- Channel.Close Ok - confirm a channel close (ID = 5) (sync reply for Close)

This class contains the following client methods:

- Channel.Open Ok - signal that the channel is ready (ID = 2) (sync reply for Open)
- Channel.Flow - enable/disable flow from peer (ID = 3) (async)
- Channel.Close - request a channel close (ID = 4) (sync request)
- Channel.Close Ok - confirm a channel close (ID = 5) (sync reply for Close)

Guidelines for implementors:

- The server **MUST** implement this class. Each method may have specific guidelines.
- The client **MUST** implement this class. Each method may have specific guidelines.
- Any assertion failures in the Channel methods **MUST BE** treated as channel exceptions - i.e. the peer that detects the error **MUST** respond with Channel.Close.

4.3.1 The Channel.Open Method

Client asks server to open a new channel.

The Channel.Open method has the following specific fields:

- `prefetch_max` (long) - This value governs the total amount of prefetch data that the client is willing to accept per channel. Prefetching is the technique of sending messages to a client in advance, which reduces the latency of message processing. Normally each consumer specifies its own prefetch window. The prefetch-max field specifies an overall limit at the channel level. If it is zero, the server does not impose any channel-level limit. The server **MUST NOT** send a client more data in advance than this value allows. If sending a specific message in advance would exhaust the channel prefetch window, it **MUST NOT** send the message. Setting this field to a very low non-zero value - e.g. 1 - effectively disables all prefetching on the channel.
- `out_of_band` (shortstr) - Configures out-of-band transfers on this channel. The syntax and meaning of this field will be formally defined at a later date.
- `tx_mode` (octet) - Configures the transaction mode for the channel. AMQP/Fast supports three transactional models: automatic, standard, and distributed (e.g. XA).

This is the Channel.Open pseudo-structure:

```
define Channel.Open {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
    prefetch_max    long       # maximum prefetch size for channel
    out_of_band     shortstr   # out-of-band settings for channel
    tx_mode         octet      # transaction mode for channel
}
```

Guidelines for implementors:

- This method is not allowed when the channel is already open.
- The server **MUST** implement this method.
- This method is a synchronous request that expects one of: Channel.Open Ok unless there is an exception.
- The server **MUST NOT** send a client more data in advance than this value allows. If sending a specific message in advance would exhaust the channel prefetch window, it **MUST NOT** send the message. Setting this field to a very low non-zero value - e.g. 1 - effectively disables all prefetching on the channel.
- The "out_of_band" field **MUST** be empty.
- The "tx_mode" field **MUST** be one of: 1=automatic (value.), 2=standard (value.), 3=distributed (value.).

4.3.2 The Channel.Open Ok Method

This method signals to the client that the channel is ready for use. This method has no fields apart from the standard method header.

This is the Channel.Open Ok pseudo-structure:

```
define Channel.Open Ok {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
}
```

Guidelines for implementors:

- The client **MUST** implement this method.

- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.

4.3.3 The Channel.Flow Method

This method asks the peer to pause or restart the flow of content data. This is a simple flow-control mechanism that a peer can use to avoid overflowing its queues or otherwise finding itself receiving more messages than it can process. Note that this method is not intended for window control.

The Channel.Flow method has the following specific fields:

- flow_pause (bit) - If 1, the peer stops sending content frames. If 0, the peer restarts sending content frames.

This is the Channel.Flow pseudo-structure:

```
define Channel.Flow {
  method_class    octet      # class ID
  method_id       octet      # method ID
  method_flags    octet      # method flags
  method_synctag  long       # synctag
  flow_pause      bit        # start/stop content frames
}
```

Guidelines for implementors:

- When sending content data in multiple frames, a peer **SHOULD** monitor the channel for incoming methods and respond to a Channel.Flow as rapidly as possible.
- A peer **MAY** use the Channel.Flow method to throttle incoming content data for internal reasons, for example, when proxying data over a slower connection.
- The peer that requests a Channel.Flow method **MAY** disconnect and/or ban a peer that does not respect the request.
- The server **MUST** implement this method.
- The client **MUST** implement this method.
- This method is asynchronous. The recipient **MUST** handle it at any point as defined by the class grammar. The sender **MUST** not expect any specific reply unless the SYNCHREQ flag is set (which will solicit a Channel.Synch reply).

4.3.4 The Channel.Close Method

This method indicates that the sender wants to close the channel. This may be due to internal conditions (e.g. a forced shut-down) or due to an error handling a specific method, i.e. an exception. When a close is due to an exception, the sender provides the class, method id, and synctag of the method which caused the exception.

The Channel.Close method has the following specific fields:

- reply_code (short) - The reply code. The AMQ reply codes are defined in AMQ RFC 011.
- reply_text (shortstr) - The localised reply text. This text can be logged as an aid to resolving issues.
- class (octet) - When the close is provoked by a method exception, this is the class of the method.
- method (octet) - When the close is provoked by a method exception, this is the ID of the method.
- synctag (short) - When the close is provoked by a method exception, this is the synctag of the method.

This is the Channel.Close pseudo-structure:

```
define Channel.Close {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
    reply_code      short      # reply code from server reply code
    reply_text      shortstr   # localised reply text localised reply text
    class           octet      # failing method class
    method          octet      # failing method ID
    synctag         short      # failing method synctag
}
```

Guidelines for implementors:

- After sending this method any received method except Channel.Close.ok MUST be discarded.
- The peer sending this method MAY use a counter or timeout to detect failure of the other peer to respond correctly with Channel.Close.ok..
- The client MUST implement this method.
- The server MUST implement this method.
- This method is a synchronous request that expects one of: Channel.Close Ok unless there is an exception.

4.3.5 The Channel.Close Ok Method

This method confirms a Channel.Close method and tells the recipient that it is safe to release resources for the channel and close the socket. This method has no fields apart from the standard method header.

This is the Channel.Close Ok pseudo-structure:

```
define Channel.Close Ok {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
}
```

Guidelines for implementors:

- A peer that detects a socket closure without having received a Channel.Close.ok handshake method SHOULD log the error.
- The client MUST implement this method.
- The server MUST implement this method.
- This method is a synchronous response. The sender MUST NOT expect a specific method in return, except as defined by the class grammar.

4.4 The Access Class

AMQP/Fast controls access to server resources using access tickets. A client must explicitly request access tickets before doing work. An access ticket grants a client the right to use a specific set of resources - called a "realm" - in specific ways. The ID of the Access class is 3.

This is the formal grammar for the class:

```
access          = C:GRANT S:GRANT_OK
```

This class contains the following server methods:

- Access.Grant - request an access ticket (ID = 1) (sync request)

This class contains the following client methods:

- Access.Grant Ok - grant access to server resources (ID = 2) (sync reply for Grant)

Guidelines for implementors:

- The server MUST implement this class. Each method may have specific guidelines.
- The client MUST implement this class. Each method may have specific guidelines.
- Any assertion failures in the Access methods MUST BE treated as connection exceptions - i.e. the peer that detects the error MUST respond with Connection.Close.

4.4.1 The Access.Grant Method

This method requests an access ticket for an access realm. The server responds by granting the access ticket. If the client does not have access rights to the requested realm this causes a connection exception. Access tickets may be shared across channels within a connection and expire with the connection.

The Access.Grant method has the following specific fields:

- realm (shortstr) - Must start with a slash "/" and continue with path names separated by slashes. A path name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [.-+!=:].
- exclusive (bit) - Request exclusive access to the realm. If the server cannot grant this - because there are other active tickets for the realm - it raises a channel exception. The server MUST grant clients exclusive access to a realm if they ask for it.
- query (bit) - Request query rights to the specified access realm. Query rights allow a client to get information about destinations in the domain but not make any changes to them.
- publish (bit) - Request publisher rights to the specified access realm. A publisher can send messages to all destinations in the realm.
- consume (bit) - Request consumer rights to the specified access realm. A consumer can receive and process messages from all destinations in the realm.
- subscribe (bit) - Request subscriber rights to the specified access realm. A subscriber can receive messages from all topics in the realm.
- dynamic (bit) - Request the right to define and cancel dynamic destinations in the specified access realm.
- purge (bit) - Request the right to purge destinations and subscriptions in the specified access realm.

This is the Access.Grant pseudo-structure:

```
define Access.Grant {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
    realm           shortstr   # path value realm to work with
    exclusive       bit        # request exclusive access
    query           bit        # request query rights
    publish         bit        # request publish rights
    consume         bit        # request consume rights
    subscribe       bit        # request subscriber rights
    dynamic         bit        # request dynamic destination rights
    purge          bit        # request purge rights
}
```

Guidelines for implementors:

- The realm name MUST start with either `"/data"` (for application resources) or `"/admin"` (for server administration resources).
- The server MUST implement the `/data` realm and MAY implement the `/admin` realm. The mapping of destinations to realms is not defined in the protocol - this is a server-side configuration issue.
- The server MUST implement this method.
- This method is a synchronous request that expects one of: `Access.Grant Ok` unless there is an exception.
- The server MUST grant clients exclusive access to a realm if they ask for it.

4.4.2 The Access.Grant Ok Method

This method provides the client with an access ticket. The access ticket is valid within the current channel and for the lifespan of the channel.

The `Access.Grant Ok` method has the following specific fields:

- ticket (short) - An access ticket granted by the server for a certain set of access rights within a specific realm. Access tickets may be shared across channels within a connection and expire with the connection.

This is the `Access.Grant Ok` pseudo-structure:

```
define Access.Grant Ok {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
    ticket          short      # access ticket granted by server
}
```

Guidelines for implementors:

- The client MUST NOT use access tickets except within the same channel as originally granted.
- The server MUST isolate access tickets per channel and treat an attempt by a client to mix these as a connection exception.
- The client MUST implement this method.
- This method is a synchronous response. The sender MUST NOT expect a specific method in return, except as defined by the class grammar.

4.5 The Destination Class

Destinations are queues or topics, capable of storing and routing all content classes, that are created at runtime rather than as server configured objects. A dynamic destination is normally persistent - i.e. it continues to exist and accept messages even when the creating client has disconnected, or the server has restarted. This class lets clients create and manage dynamic destinations. The ID of the Destination class is 4.

This is the formal grammar for the class:

```
destination = C:DEFINE S:DEFINE_OK
            / C:QUERY S:QUERY_OK
            / C:PURGE S:PURGE_OK
            / C:CANCEL S:CANCEL_OK
```

This class contains the following server methods:

- `Destination.Define` - create or verify a dynamic destination (ID = 1) (sync request)

- Destination.Query - query status of destination (ID = 3) (sync request)
- Destination.Purge - purge a destination (ID = 5) (sync request)
- Destination.Cancel - cancel a dynamic destination (ID = 7) (sync request)

This class contains the following client methods:

- Destination.Define Ok - confirms a destination definition (ID = 2) (sync reply for Define)
- Destination.Query Ok - provide status of destination (ID = 4) (sync reply for Query)
- Destination.Purge Ok - confirms a destination purge (ID = 6) (sync reply for Purge)
- Destination.Cancel Ok - confirm cancellation of a dynamic destination (ID = 8) (sync reply for Cancel)

Guidelines for implementors:

- The server SHOULD implement this class. Each method may have specific guidelines.
- The client MAY implement this class. Each method may have specific guidelines.
- Any assertion failures in the Destination methods MUST BE treated as channel exceptions - i.e. the peer that detects the error MUST respond with Channel.Close.

4.5.1 The Destination.Define Method

This method creates or reconfigures a dynamic destination. Various fields in this method let the client control the persistence of the destination. For example, one can implement a JMS-style temporary destination by setting both the private and auto-cancel fields. A client can work with an existing dynamic destination without using this method.

The Destination.Define method has the following specific fields:

- ticket (short) - An access ticket granted by the server for a certain set of access rights within a specific realm. Access tickets may be shared across channels within a connection and expire with the connection. When a client defines a new dynamic destination, this belongs to the access realm of the ticket used. All further work done with that destination - including publishing and consuming messages - must be done with an access ticket for the same realm. The client MUST provide a valid access ticket giving "dynamic" access rights. If the destination already exists, the ticket must also be for the destination's access realm.
- service_type (octet) - Destinations are either queues or topics - this field specifies the type of the destination. The "fuzzy" type searches first for a queue, then for a topic with the specified destination name. The client MUST NOT use the fuzzy type when defining a new destination.
- destination (shortstr) - A destination name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:]. Destination names starting with _ are reserved for server use. Specifies the name of the destination. For publishers and consumers, dynamic destinations do not have any visible naming difference from configured destinations. A peer MUST NOT use naming conventions to distinguish dynamic destinations from configured destinations. The destination name MAY be empty, in which case the server MUST create a new unique name automatically and return this to the client in the Define.ok method.
- template (shortstr) - Specifies the name of a destination template, which is a server configured object that provides configuration options for dynamic destinations. Templates are not standardised; these are names defined on an implementation basis. If the template is empty the server SHOULD use a suitable default. The server MUST ignore the template field if the destination already exists.

- **private (bit)** - If set, the destination is private and owned by the current client. This will fail if the destination already exists and is owned by another client. Private destinations cannot be consumed from by clients except the owner. The server **MUST** support both private and shared dynamic destinations. The server **MUST** use the client identifier supplied at connection open time to identify the owner of a private destination. The client identifier is persistent even if the client disconnects and reconnects. The server **MUST** ignore the private field if the destination already exists.
- **auto_cancel (bit)** - If set, the destination is cancelled when all clients have finished using it. The server **MUST** implement the auto-cancel function in this manner: it counts the number of queue consumers or topic subscribers (depending on the destination service type), and when the last consumer or subscription is cancelled, it **MUST** delete the destination and dead-letter any messages it holds. The server **MUST** ignore the auto-cancel field in this method if the destination already exists. A client cannot modify the auto-cancel after the destination has been defined by another client.

This is the Destination.Define pseudo-structure:

```
define Destination.Define {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
    ticket          short      # access ticket granted by server
    service_type    octet      # destination service type
    destination     shortstr   # destination name
    template        shortstr   # destination template
    private         bit        # request private destination
    auto_cancel     bit        # auto-cancel when finished
}
```

Guidelines for implementors:

- The server **MUST** implement this method.
- This method is a synchronous request that expects one of: Destination.Define Ok unless there is an exception.
- The client **MUST** provide a valid access ticket giving "dynamic" access rights. If the destination already exists, the ticket must also be for the destination's access realm.
- The client **MUST NOT** use the fuzzy type when defining a new destination.
- A peer **MUST NOT** use naming conventions to distinguish dynamic destinations from configured destinations.
- The destination name **MAY** be empty, in which case the server **MUST** create a new unique name automatically and return this to the client in the Define.ok method.
- If the template is empty the server **SHOULD** use a suitable default.
- The server **MUST** ignore the template field if the destination already exists.
- The server **MUST** support both private and shared dynamic destinations.
- The server **MUST** use the client identifier supplied at connection open time to identify the owner of a private destination. The client identifier is persistent even if the client disconnects and reconnects.
- The server **MUST** ignore the private field if the destination already exists.
- The server **MUST** implement the auto-cancel function in this manner: it counts the number of queue consumers or topic subscribers (depending on the destination service type), and when the last consumer or subscription is cancelled, it **MUST** delete the destination and dead-letter any messages it holds.
- The server **MUST** ignore the auto-cancel field in this method if the destination already exists. A client cannot modify the auto-cancel after the destination has been defined by another client.

4.5.2 The Destination.Define Ok Method

This method confirms a Define method and confirms the name of the destination, essential for automatically-named destinations.

The Destination.Define Ok method has the following specific fields:

- **destination** (shortstr) - A destination name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:]. Destination names starting with `_` are reserved for server use. Confirms the name of the destination. If the server generated a destination name, this field contains that name.
- **message_count** (long) - For queue destinations, provides the number of messages in the queue. For topics this is always zero.

This is the Destination.Define Ok pseudo-structure:

```
define Destination.Define Ok {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synchtag long       # synchtag
    destination     shortstr   # destination name name of destination
    message_count   long       # number of messages in queue destination
}
```

Guidelines for implementors:

- The client **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.
- The "destination" field **MUST** not be empty.

4.5.3 The Destination.Query Method

This method queries the status of a destination. This can be a dynamic destination or a configured destination, and it can be a queue or a topic as defined by the service-type field.

The Destination.Query method has the following specific fields:

- **ticket** (short) - An access ticket granted by the server for a certain set of access rights within a specific realm. Access tickets may be shared across channels within a connection and expire with the connection. The client **MUST** provide a valid access ticket giving "query" access rights to the destination's access realm.
- **service_type** (octet) - Destinations are either queues or topics - this field specifies the type of the destination. The "fuzzy" type searches first for a queue, then for a topic with the specified destination name.
- **destination** (shortstr) - A destination name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:]. Destination names starting with `_` are reserved for server use. Specifies the name of the destination, which must exist.

This is the Destination.Query pseudo-structure:

```
define Destination.Query {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synchtag long       # synchtag
    ticket          short      # access ticket granted by server
    service_type    octet      # destination service type
    destination     shortstr   # destination name
}
```

Guidelines for implementors:

- The server **MUST** implement this method.
- This method is a synchronous request that expects one of: Destination.Query Ok unless there is an exception.
- The client **MUST** provide a valid access ticket giving "query" access rights to the destination's access realm.
- The "destination" field **MUST** not be empty.

4.5.4 The Destination.Query Ok Method

This method returns the status of the destination.

The Destination.Query Ok method has the following specific fields:

- `service_type` (octet) - Destinations are either queues or topics - this field specifies the type of the destination. The "fuzzy" type searches first for a queue, then for a topic with the specified destination name.
- `destination` (shortstr) - A destination name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:]. Destination names starting with _ are reserved for server use. Confirms the name of the destination.
- `message_count` (long) - For queue destinations, provides the number of messages in the queue. For topics this is always zero.
- `consumer_count` (long) - Provides the number of consumers for the queue or topic. For topics the number may be inaccurate if topic selectors are used to steer multiple topics into a single subscriber.
- `subscriber_count` (long) - For topic destinations, provides the number of subscribers that are using the topic. The number may be inaccurate if topic selectors are used to steer multiple topics into a single subscriber.

This is the Destination.Query Ok pseudo-structure:

```
define Destination.Query Ok {
    method_class      octet      # class ID
    method_id         octet      # method ID
    method_flags      octet      # method flags
    method_synchtag   long       # synchtag
    service_type      octet      # destination service type
    destination       shortstr   # destination name name of destination
    message_count     long       # number of messages in queue destination
    consumer_count    long       # number of consumers
    subscriber_count  long       # number of subscribers
}
```

Guidelines for implementors:

- The client **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.
- The "destination" field **MUST** not be empty.

4.5.5 The Destination.Purge Method

This method removes all messages from a queue destination or all messages from the subscriptions for a topic. It does not cancel consumers or subscriptions. Purged messages are deleted without any formal "undo" mechanism.

The Destination.Purge method has the following specific fields:

- ticket (short) - An access ticket granted by the server for a certain set of access rights within a specific realm. Access tickets may be shared across channels within a connection and expire with the connection. The access ticket must be for the access realm that holds the destination. The client MUST provide a valid access ticket giving "purge" access rights to the destination's access realm.
- service_type (octet) - Destinations are either queues or topics - this field specifies the type of the destination. The "fuzzy" type searches first for a queue, then for a topic with the specified destination name.
- destination (shortstr) - A destination name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:]. Destination names starting with _ are reserved for server use. The name of the destination to purge. This can be a configured destination or a dynamic destination.

This is the Destination.Purge pseudo-structure:

```
define Destination.Purge {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag   long       # synctag
    ticket           short      # access ticket granted by server
    service_type     octet      # destination service type
    destination      shortstr   # destination name name of destination
}
```

Guidelines for implementors:

- On transacted channels the server MUST not purge messages that have already been sent to a client but not yet acknowledged.
- When purging a topic, the server SHOULD purge subscriptions that are unambiguously made on this topic. The server MAY ignore subscriptions that use topic wildcarding to subscribe to more than one topic.
- The server MAY implement a purge queue or log that allows system administrators to recover accidentally-purged messages. The server SHOULD NOT keep purged messages in the same storage spaces as the live messages since the volumes of purged messages may get very large.
- The server MUST implement this method.
- This method is a synchronous request that expects one of: Destination.Purge Ok unless there is an exception.
- The client MUST provide a valid access ticket giving "purge" access rights to the destination's access realm.
- The "destination" field MUST not be empty.

4.5.6 The Destination.Purge Ok Method

This method confirms the purge of a destination.

The Destination.Purge Ok method has the following specific fields:

- message_count (long) - Provides the number of messages purged.

This is the Destination.Purge Ok pseudo-structure:

```
define Destination.Purge Ok {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synchtag long       # synchtag
    message_count   long       # number of messages purged
}
```

Guidelines for implementors:

- The client **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.

4.5.7 The Destination.Cancel Method

This method cancels (deletes) a dynamic destination. When a queue is cancelled, any pending messages are sent to a dead-letter queue if this is defined in the server configuration, and all consumers on the queue are cancelled. When a topic is cancelled, all subscriptions on that topic are also cancelled.

The Destination.Cancel method has the following specific fields:

- ticket (short) - An access ticket granted by the server for a certain set of access rights within a specific realm. Access tickets may be shared across channels within a connection and expire with the connection. The client **MUST** provide a valid access ticket giving "purge" access rights to the destination's access realm.
- service_type (octet) - Destinations are either queues or topics - this field specifies the type of the destination. The "fuzzy" type searches first for a queue, then for a topic with the specified destination name.
- destination (shortstr) - A destination name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:~]. Destination names starting with _ are reserved for server use. Specifies the name of the destination. This destination must exist. Attempting to cancel a non-existing destination causes a connection exception.
- ifempty (bit) - If set, the server will only cancel the destination if it has no messages (for a queue) or no subscriptions (for a topic). If the destination is not empty the server raises a channel exception.

This is the Destination.Cancel pseudo-structure:

```
define Destination.Cancel {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synchtag long       # synchtag
    ticket          short      # access ticket granted by server
    service_type    octet      # destination service type
    destination     shortstr   # destination name
    ifempty         bit        # cancel only if empty
}
```

Guidelines for implementors:

- The client **MUST** use an access ticket that the server granted with "dynamic" access rights to the destination's access realm.
- The server **SHOULD** use a dead-letter queue or topic to hold messages that were pending on a cancelled queue, and **MAY** provide facilities for a system administrator to move these messages back to an active queue.
- The server **MUST** implement this method.

- This method is a synchronous request that expects one of: Destination.Cancel Ok unless there is an exception.
- The client **MUST** provide a valid access ticket giving "purge" access rights to the destination's access realm.
- The "destination" field **MUST** not be empty.

4.5.8 The Destination.Cancel Ok Method

This method confirms the cancellation of a destination.

The Destination.Cancel Ok method has the following specific fields:

- message_count (long) - Provides the number of messages purged.

This is the Destination.Cancel Ok pseudo-structure:

```
define Destination.Cancel Ok {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synctag   long     # synctag
    message_count    long     # number of messages purged
}
```

Guidelines for implementors:

- The client **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.

4.6 The Subscription Class

Subscriptions are requests to receive messages from one or more topics. Subscriptions can be temporary or persistent, and private or shared. In the AMQ queuing and routing model, subscriptions are orthogonal with queues and provide very similar functionality except that a client can not send messages directly to a subscription, only via a topic. Subscriptions are capable of storing all content domains. This class provides methods for clients to create, manage, and share subscriptions. The ID of the Subscription class is 5.

This is the formal grammar for the class:

```
subscription      = C:DEFINE S:DEFINE_OK
                   / C:QUERY  S:QUERY_OK
                   / C:PURGE   S:PURGE_OK
                   / C:CANCEL  S:CANCEL_OK
```

This class contains the following server methods:

- Subscription.Define - create or configure a persistent subscription (ID = 1) (sync request)
- Subscription.Query - query status of subscription (ID = 3) (sync request)
- Subscription.Purge - purge a subscription (ID = 5) (sync request)
- Subscription.Cancel - cancel a subscription (ID = 7) (sync request)

This class contains the following client methods:

- Subscription.Define Ok - confirms a subscription definition (ID = 2) (sync reply for Define)
- Subscription.Query Ok - provide status of subscription (ID = 4) (sync reply for Query)
- Subscription.Purge Ok - confirms a subscription purge (ID = 6) (sync reply for Purge)

- Subscription.Cancel Ok - confirm cancellation of a subscription (ID = 8) (sync reply for Cancel)

Guidelines for implementors:

- AMQP assumes strongly that queues and subscriptions share the same mechanisms for holding persistent and non-persistent messages, for handling acknowledgements, for transactions, for browsing, and so on. An AMQP server SHOULD implement subscriptions using the same internal mechanisms as queues.
- The server MUST implement this class. Each method may have specific guidelines.
- The client MAY implement this class. Each method may have specific guidelines.
- Any assertion failures in the Subscription methods MUST BE treated as channel exceptions - i.e. the peer that detects the error MUST respond with Channel.Close.

4.6.1 The Subscription.Define Method

This method creates or reconfigures a subscription. A subscription is normally persistent - i.e. it continues to exist and accept messages even when the creating client has disconnected, or the server has restarted. Various fields in this method let the client control the persistence of the subscription. A client can work with an existing subscription without using this method.

The Subscription.Define method has the following specific fields:

- ticket (short) - An access ticket granted by the server for a certain set of access rights within a specific realm. Access tickets may be shared across channels within a connection and expire with the connection. When a client defines a new subscription, this belongs to the access realm of the ticket used. Any further use of the subscription requires an access ticket for that realm. The client MUST provide a valid access ticket giving "subscribe" access rights. If the subscription already exists, the ticket must also be for the correct access realm.
- subscription (shortstr) - A subscription name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:~]. Subscription names starting with _ are reserved for server use. Specifies the name of the subscription to define. The subscription name MAY be empty, in which case the server MUST create a new unique name automatically and return this to the client in the Subscription.Define_ok method.
- template (shortstr) - Specifies the name of a subscription template, which is a server configured object that provides configuration options. Templates are not standardised; these are names defined on an implementation basis. If the template is empty the server SHOULD use a suitable default. The server MUST ignore the template field if the subscription already exists.
- topic_selector (shortstr) - Specifies the topics that will be routed to this subscription. This field is either a complete existing topic name or a topic pattern using the syntax and wildcards defined by the topic_seldtype field. This field is only used when defining a new subscription. The server MUST ignore the topic-selector field if the subscription already exists.
- topic_seldtype (octet) - Specifies the syntax for the topic selector. The simple syntax uses a hierarchical naming scheme for topics where each level is delimited by a dot. The wild cards * and # replace one and zero or more hierarchical levels respectively. The tpath syntax is the same as the simple syntax but the topic hierarchy is delimited by slash ("/") characters. The regexp syntax uses Perl 5-compatible regular expressions and allows any topic naming scheme. The server MUST support the simple syntax and MAY support the tpath and regexp syntaxes.

- `message_selector` (longstr) - Specifies which precise messages will be routed to this queue or subscription. AMQP/Fast provides several alternative syntaxes for message selectors, as specified by the `message_seldtype` field. This field is only used when defining a new subscription. The server MUST ignore the `message-selector` field if the subscription already exists.
- `message_seldtype` (octet) - Specifies the syntax for the message selector. The server MUST support the simple syntax and SHOULD support the JMS syntax.
- `private` (bit) - If set, the subscription is private and owned by the current client. This will fail if the subscription already exists and is owned by another client. Private subscriptions cannot be consumed from by clients except the owner. The server MUST support both private and shared subscriptions. The server MUST use the client identifier supplied at connection open time to identify the owner of a private subscription. The client identifier is persistent even if the client disconnects and reconnects. The server MUST ignore the `private` field if the destination already exists.
- `auto_cancel` (bit) - If set, the subscription is cancelled when all clients have finished using it. The server MUST implement the auto-cancel function in this manner: it counts the number of consumers using the subscription, and when the last consumer for the subscription is cancelled, it MUST delete the subscription and any messages it holds. The server MUST ignore the `auto-cancel` field if the destination already exists.

This is the Subscription.Define pseudo-structure:

```
define Subscription.Define {
    method_class      octet      # class ID
    method_id         octet      # method ID
    method_flags      octet      # method flags
    method_synctag    long       # synctag
    ticket            short      # access ticket granted by server
    subscription       shortstr   # subscription name
    template          shortstr   # subscription template
    topic_selector    shortstr   # topic name or pattern
    topic_seldtype     octet      # type of topic selector
    message_selector   longstr    # message selector
    message_seldtype   octet      # type of message selector
    private           bit        # request private subscription
    auto_cancel       bit        # auto-cancel when finished
}
```

Guidelines for implementors:

- The server MUST implement this method.
- This method is a synchronous request that expects one of: `Subscription.Define Ok` unless there is an exception.
- The client MUST provide a valid access ticket giving "subscribe" access rights. If the subscription already exists, the ticket must also be for the correct access realm.
- The subscription name MAY be empty, in which case the server MUST create a new unique name automatically and return this to the client in the `Subscription.Define.ok` method.
- If the template is empty the server SHOULD use a suitable default.
- The server MUST ignore the template field if the subscription already exists.
- The "topic_selector" field MUST not be empty.
- The server MUST ignore the topic-selector field if the subscription already exists.
- The server MUST support the simple syntax and MAY support the tpath and regexp syntaxes.
- The "message_selector" field MUST not be empty.
- The server MUST ignore the message-selector field if the subscription already exists.
- The server MUST support the simple syntax and SHOULD support the JMS syntax.

- The server **MUST** support both private and shared subscriptions.
- The server **MUST** use the client identifier supplied at connection open time to identify the owner of a private subscription. The client identifier is persistent even if the client disconnects and reconnects.
- The server **MUST** ignore the private field if the destination already exists.
- The server **MUST** implement the auto-cancel function in this manner: it counts the number of consumers using the subscription, and when the last consumer for the subscription is cancelled, it **MUST** delete the subscription and any messages it holds.
- The server **MUST** ignore the auto-cancel field if the destination already exists.

4.6.2 The Subscription.Define Ok Method

This method confirms a Subscription.Define method and provides the client with the name of the subscription in case of automatically named subscriptions. The server also reports the topic selector and number of messages for existing subscriptions.

The Subscription.Define Ok method has the following specific fields:

- `subscription` (shortstr) - A subscription name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:]. Subscription names starting with `_` are reserved for server use. Confirms the name of the subscription. If the server generated a subscription name, this field contains that name.
- `topic_selector` (shortstr) - Specifies the topics that will be routed to this subscription. This field is either a complete existing topic name or a topic pattern using the syntax and wildcards defined by the `topic_seltype` field.
- `topic_seltype` (octet) - Specifies the syntax for the topic selector. The simple syntax uses a hierarchical naming scheme for topics where each level is delimited by a dot. The wild cards `*` and `#` replace one and zero or more hierarchical levels respectively. The tpath syntax is the same as the simple syntax but the topic hierarchy is delimited by slash (`"/"`) characters. The regexp syntax uses Perl 5-compatible regular expressions and allows any topic naming scheme.
- `message_count` (long) - For existing subscriptions, provides the number of messages waiting to be consumed. For new subscriptions this is zero.

This is the Subscription.Define Ok pseudo-structure:

```
define Subscription.Define Ok {
    method_class      octet      # class ID
    method_id         octet      # method ID
    method_flags      octet      # method flags
    method_synctag     long       # synctag
    subscription       shortstr   # subscription name
    topic_selector     shortstr   # topic name or pattern
    topic_seltype      octet      # type of topic selector
    message_count      long       # number of messages in subscription
}
```

Guidelines for implementors:

- The client **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.
- The "subscription" field **MUST** not be empty.

4.6.3 The Subscription.Query Method

This method queries the status of a subscription.

The Subscription.Query method has the following specific fields:

- ticket (short) - An access ticket granted by the server for a certain set of access rights within a specific realm. Access tickets may be shared across channels within a connection and expire with the connection. The client **MUST** provide a valid access ticket giving "query" access rights for the subscription's access realm..
- subscription (shortstr) - A subscription name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-_/+!=:~]. Subscription names starting with _ are reserved for server use. Specifies the name of the subscription to query. The subscription must exist.

This is the Subscription.Query pseudo-structure:

```
define Subscription.Query {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
    ticket          short      # access ticket granted by server
    subscription    shortstr   # subscription name subscription name
}
```

Guidelines for implementors:

- The server **MUST** implement this method.
- This method is a synchronous request that expects one of: Subscription.Query Ok unless there is an exception.
- The client **MUST** provide a valid access ticket giving "query" access rights for the subscription's access realm..
- The "subscription" field **MUST** not be empty.

4.6.4 The Subscription.Query Ok Method

This method returns the status of the subscription.

The Subscription.Query Ok method has the following specific fields:

- subscription (shortstr) - A subscription name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-_/+!=:~]. Subscription names starting with _ are reserved for server use. Confirms the name of the subscription.
- message_count (long) - Provides the number of pending messages in the subscription.
- consumer_count (long) - Provides the number of consumers for the subscription..

This is the Subscription.Query Ok pseudo-structure:

```
define Subscription.Query Ok {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
    subscription    shortstr   # subscription name
    message_count   long       # number of messages in subscription
    consumer_count  long       # number of consumers
}
```

Guidelines for implementors:

- The client **MUST** implement this method.

- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.
- The "subscription" field **MUST** not be empty.

4.6.5 The Subscription.Purge Method

This method removes all messages from a subscription. It does not cancel any consumers on the subscription.

The Subscription.Purge method has the following specific fields:

- ticket (short) - An access ticket granted by the server for a certain set of access rights within a specific realm. Access tickets may be shared across channels within a connection and expire with the connection. The access ticket must be for the access realm that holds the subscription. The client **MUST** provide a valid access ticket giving "purge" access rights for the subscription's access realm.
- subscription (shortstr) - A subscription name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:]. Subscription names starting with _ are reserved for server use. The name of the subscription to purge.

This is the Subscription.Purge pseudo-structure:

```
define Subscription.Purge {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synctag  long     # synctag
    ticket          short    # access ticket granted by server
    subscription    shortstr # subscription name
}
```

Guidelines for implementors:

- On transacted channels the server **MUST** not purge messages that have already been sent to a client but not yet acknowledged.
- The server **MUST** implement this method.
- This method is a synchronous request that expects one of: Subscription.Purge Ok unless there is an exception.
- The client **MUST** provide a valid access ticket giving "purge" access rights for the subscription's access realm.
- The "subscription" field **MUST** not be empty.

4.6.6 The Subscription.Purge Ok Method

This method confirms the purge of a subscription.

The Subscription.Purge Ok method has the following specific fields:

- message_count (long) - Provides the number of messages purged.

This is the Subscription.Purge Ok pseudo-structure:

```
define Subscription.Purge Ok {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synctag  long     # synctag
    message_count   long     # number of messages purged
}
```

Guidelines for implementors:

- The client **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.

4.6.7 The Subscription.Cancel Method

This method cancels a subscription. Note that cancellation implies a purge: any pending messages in the subscription are discarded. All consumers for the subscription are also cancelled.

The Subscription.Cancel method has the following specific fields:

- ticket (short) - An access ticket granted by the server for a certain set of access rights within a specific realm. Access tickets may be shared across channels within a connection and expire with the connection. The client **MUST** provide a valid access ticket giving "purge" access rights to the subscription's access realm.
- subscription (shortstr) - A subscription name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [.-/+!=:]. Subscription names starting with _ are reserved for server use. Specifies the name of the subscription. This subscription must exist. Attempting to cancel a non-existing subscription causes a connection exception.
- ifempty (bit) - If set, the server will only cancel the subscription if it has no messages (for a queue). If the subscription is not empty the server raises a channel exception.

This is the Subscription.Cancel pseudo-structure:

```
define Subscription.Cancel {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synctag  long     # synctag
    ticket          short    # access ticket granted by server
    subscription    shortstr # subscription name
    ifempty         bit      # cancel only if empty
}
```

Guidelines for implementors:

- The client **MUST** use an access ticket that the server granted with "dynamic" access rights.
- The server **MUST** implement this method.
- This method is a synchronous request that expects one of: Subscription.Cancel Ok unless there is an exception.
- The client **MUST** provide a valid access ticket giving "purge" access rights to the subscription's access realm.

4.6.8 The Subscription.Cancel Ok Method

This method confirms the cancellation of a subscription.

The Subscription.Cancel Ok method has the following specific fields:

- message_count (long) - Provides the number of messages purged.

This is the Subscription.Cancel Ok pseudo-structure:

```
define Subscription.Cancel Ok {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synchtag long     # synchtag
    message_count   long     # number of messages purged
}
```

Guidelines for implementors:

- The client **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.

4.7 The Jms Class

The JMS class provides methods that support the standard JMS API. JMS messages have a specific set of properties that are required for interoperability with JMS providers and consumers. JMS messages and acknowledgements are subject to channel transactions. The ID of the Jms class is 6.

This is the formal grammar for the class:

```
jms
    = C:CONSUME S:CONSUME_OK
    / C:CANCEL
    / C:PUBLISH content
    / S:DELIVER content
    / C:BROWSE ( S:BROWSE_OK content / S:BROWSE_EMPTY )
    / C:ACK
    / C:REJECT
```

This class contains the following server methods:

- Jms.Consume - start a destination consumer (ID = 1) (sync request)
- Jms.Cancel - end a destination consumer (ID = 3) (async)
- Jms.Publish - publish a message to a destination (ID = 4) (async, carries content)
- Jms.Browse - direct access to a destination (ID = 6) (sync request)
- Jms.Ack - acknowledge one or more messages (ID = 9) (async)
- Jms.Reject - reject an incoming message (ID = 10) (async)

This class contains the following client methods:

- Jms.Consume Ok - confirm a new consumer (ID = 2) (sync reply for Consume)
- Jms.Deliver - notify the client of a consumer message (ID = 5) (async, carries content)
- Jms.Browse Ok - provide client with a browsed message (ID = 7) (sync reply for Browse, carries content)
- Jms.Browse Empty - indicate no messages available (ID = 8) (sync reply for Browse)

Guidelines for implementors:

- The server **MUST** implement this class. Each method may have specific guidelines.
- The client **MAY** implement this class. Each method may have specific guidelines.
- Any assertion failures in the Jms methods **MUST BE** treated as channel exceptions - i.e. the peer that detects the error **MUST** respond with Channel.Close.

4.7.1 The Jms.Consume Method

This method asks the server to start a "consumer", which is a temporary request for messages from a specific queue or topic subscription. Consumers last as long as the channel they were created on, or until they are cancelled.

The Jms.Consume method has the following specific fields:

- ticket (short) - An access ticket granted by the server for a certain set of access rights within a specific realm. Access tickets may be shared across channels within a connection and expire with the connection. The client **MUST** provide a valid access ticket giving "consume" access rights to the access realm for the destination or subscription.
- service_type (octet) - Destinations are either queues or topics - this field specifies the type of the destination. The "fuzzy" type searches first for a queue, then for a topic with the specified destination name.
- destination (shortstr) - A destination name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [.-/+!=:]. Destination names starting with _ are reserved for server use. Specifies the name of the queue or topic to consume from. For queue consumers, the destination field **MUST** be provided. For topic consumers, the destination field **MAY** be provided but **MUST** be empty if a subscription is specified. Note that the explicit use of a subscription already defines the topic destination to use.
- subscription (shortstr) - A subscription name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [.-/+!=:]. Subscription names starting with _ are reserved for server use. Specifies the name of the subscription, for topic consumers. The subscription field **MUST** be empty for queue consumers and **MAY** be empty for topic consumers, in which case the server **MUST** create an unnamed, private, and temporary subscription automatically. This automatic subscription is cancelled when the client cancels the consumer or closes the channel. The client **MUST** define the subscription before starting a consumer on it.
- prefetch_size (short) - The client can request that messages be sent in advance so that when the client finishes processing a message, the following message is already held locally, rather than needing to be sent down the channel. Prefetching gives a performance improvement. This field specifies the prefetch window size in octets. May be set to zero, meaning "no specific limit". Note that other prefetch limits may still apply.
- prefetch_count (short) - Specifies a prefetch window in terms of whole messages. This is compatible with some JMS API implementations. This field may be used in combination with the prefetch-size field; a message will only be sent in advance if both prefetch windows (and those at the channel and connection level) allow it. The server **MAY** send less data in advance than allowed by the client's specified prefetch windows but it **MUST NOT** send more.
- no_local (bit) - If this field is set the server will not send messages to the client that published them.
- auto_ack (bit) - If this field is set the server does not expect acknowledgments for messages. That is, when a message is delivered to the client the server automatically and silently acknowledges it on behalf of the client. This functionality increases performance but at the cost of reliability. Messages can get lost if a client dies before it can deliver them to the application.
- exclusive (bit) - Request exclusive consumer access. If the server cannot grant this - because there are other consumers active - it raises a channel exception. The server **MUST** grant clients exclusive access to a destination or subscription if they ask for it.
- message_selector (longstr) - Specifies which precise messages will be routed to this queue or subscription. AMQP/Fast provides several alternative syntaxes for message selectors, as specified by the message-selector-type field. This field is only used when consuming from queues. The server **MUST** ignore the message-selector field when a client consumes from a subscription.

- `message_seldtype` (octet) - Specifies the syntax for the message selector. The server **MUST** support the simple syntax and **SHOULD** support the JMS syntax.
- `auto_cancel` (long) - This field causes the consumer to self-cancel after a specific number of messages have been delivered and acknowledged. If zero, the consumer expires when the client sends the `Jms.Cancel` method, or closes the channel.

This is the `Jms.Consume` pseudo-structure:

```
define Jms.Consume {
    method_class      octet      # class ID
    method_id         octet      # method ID
    method_flags      octet      # method flags
    method_synctag    long       # synctag
    ticket            short      # access ticket granted by server
    service_type      octet      # destination service type
    destination       shortstr   # destination name
    subscription      shortstr   # subscription name
    prefetch_size     short      # prefetch window in octets
    prefetch_count    short      # prefetch window in messages
    no_local          bit        # do not receive own messages
    auto_ack          bit        # no acknowledgement needed
    exclusive         bit        # request exclusive access
    message_selector  longstr    # message selector
    message_seldtype  octet      # type of message selector
    auto_cancel       long       # cancel consumer after N messages
}
```

Guidelines for implementors:

- The server **MAY** restrict the number of consumers per channel to an arbitrary value, which **MUST** be at least 8, and **MUST** be specified in the `Connection.Tune` method.
- The client **MUST** be able to work with the server-defined limits with respect to the maximum number of consumers per channel.
- The server **MUST** implement this method.
- This method is a synchronous request that expects one of: `Jms.Consume Ok` unless there is an exception.
- The client **MUST** provide a valid access ticket giving "consume" access rights to the access realm for the destination or subscription.
- For queue consumers, the destination field **MUST** be provided. For topic consumers, the destination field **MAY** be provided but **MUST** be empty if a subscription is specified. Note that the explicit use of a subscription already defines the topic destination to use.
- The subscription field **MUST** be empty for queue consumers and **MAY** be empty for topic consumers, in which case the server **MUST** create an unnamed, private, and temporary subscription automatically. This automatic subscription is cancelled when the client cancels the consumer or closes the channel.
- The client **MUST** define the subscription before starting a consumer on it.
- The server **MAY** send less data in advance than allowed by the client's specified prefetch windows but it **MUST NOT** send more.
- The server **MUST** grant clients exclusive access to a destination or subscription if they ask for it.
- The "message_selector" field **MUST** not be empty.
- The server **MUST** ignore the message-selector field when a client consumes from a subscription.
- The server **MUST** support the simple syntax and **SHOULD** support the JMS syntax.

4.7.2 The Jms.Consume Ok Method

This method provides the client with a consumer tag which it may use in methods that work with the consumer.

The Jms.Consume Ok method has the following specific fields:

- **consumer_tag** (short) - The server-assigned and channel-specific consumer tag. This field is an arbitrary ID number for the consumer. The consumer tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the consumer was created.

This is the Jms.Consume Ok pseudo-structure:

```
define Jms.Consume Ok {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
    consumer_tag    short      # server-assigned consumer tag
}
```

Guidelines for implementors:

- The client **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.
- This field is an arbitrary ID number for the consumer. The consumer tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the consumer was created.

4.7.3 The Jms.Cancel Method

This method cancels a consumer. This does not affect already delivered messages, but it does mean the server will not send any more messages for that consumer.

The Jms.Cancel method has the following specific fields:

- **consumer_tag** (short) - The server-assigned and channel-specific consumer tag. This field is an arbitrary ID number for the consumer. The consumer tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the consumer was created.

This is the Jms.Cancel pseudo-structure:

```
define Jms.Cancel {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
    consumer_tag    short      # server-assigned consumer tag
}
```

Guidelines for implementors:

- The server **MUST** implement this method.
- This method is asynchronous. The recipient **MUST** handle it at any point as defined by the class grammar. The sender **MUST** not expect any specific reply unless the **SYNCHREQ** flag is set (which will solicit a **Channel.Synch** reply).
- This field is an arbitrary ID number for the consumer. The consumer tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the consumer was created.

4.7.4 The Jms.Publish Method

This method publishes a message to a specific destination. The message will be saved to the destination and distributed to any consumers when the transaction is committed.

The Jms.Publish method has the following specific fields:

- ticket (short) - An access ticket granted by the server for a certain set of access rights within a specific realm. Access tickets may be shared across channels within a connection and expire with the connection. The client **MUST** provide a valid access ticket giving "publish" access rights to the access realm for the destination or subscription.
- service_type (octet) - Destinations are either queues or topics - this field specifies the type of the destination. The "fuzzy" type searches first for a queue, then for a topic with the specified destination name.
- destination (shortstr) - A destination name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:]. Destination names starting with _ are reserved for server use. Specifies the name of the destination to publish to. If the destination does not exist the server will raise a channel exception.
- immediate (bit) - Asserts that the destination has one or more consumers (for queues) or one or more subscriptions (for topics), and causes a channel exception if this is not the case. Note that a consumer can query the state of a destination before publishing to it.

This is the Jms.Publish pseudo-structure:

```
define Jms.Publish {
  method_class      octet      # class ID
  method_id         octet      # method ID
  method_flags      octet      # method flags
  method_synchtag    long       # synchtag
  ticket            short       # access ticket granted by server
  service_type      octet      # destination service type
  destination        shortstr   # destination name
  immediate          bit        # assert immediate delivery
}
```

Guidelines for implementors:

- The server **MUST** implement this method.
- This method is asynchronous. The recipient **MUST** handle it at any point as defined by the class grammar. The sender **MUST** not expect any specific reply unless the SYNCHREQ flag is set (which will solicit a Channel.Synch reply).
- The client **MUST** provide a valid access ticket giving "publish" access rights to the access realm for the destination or subscription.
- The "destination" field **MUST** not be empty.

4.7.5 The Jms.Deliver Method

This method delivers a message to the client, via a consumer. In the asynchronous message delivery model, the client starts a consumer using the Consume method, then the server responds with Deliver methods as and when messages arrive for that consumer.

The Jms.Deliver method has the following specific fields:

- delivery_tag (longlong) - The server-assigned and channel-specific delivery tag This field is an sequential ID number for the delivery. The delivery tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the message was delivered.

- redelivered (bit) - This indicates that the message has been previously delivered to this or another client. The client **MUST NOT** rely on this field but **MUST** take it as a hint that the message may already have been processed. A fully robust client must be able to track duplicate received messages on non transacted, and locally-transacted channels. The server **SHOULD** try to signal redelivered messages when it can. When redelivering a message that was not successfully acknowledged, the server **SHOULD** deliver it to the original client if possible.
- destination (shortstr) - A destination name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:]. Destination names starting with . are reserved for server use. Specifies the name of the destination that the message came from. Note that a single channel can start many consumers on different destinations, and a single subscription can collect messages from several topics.

This is the Jms.Deliver pseudo-structure:

```
define Jms.Deliver {
  method_class      octet      # class ID
  method_id         octet      # method ID
  method_flags      octet      # method flags
  method_synchtag   long       # synchtag
  delivery_tag      longlong   # server-assigned delivery tag
  redelivered       bit        # signal a redelivered message
  destination       shortstr   # destination name
}
```

Guidelines for implementors:

- The server **SHOULD** track the number of times a message has been delivered to clients and when a message is redelivered a certain number of times - e.g. 5 times - without being acknowledged, the server **SHOULD** consider the message to be unprocessable (possibly causing client applications to abort), and move the message to a dead letter queue.
- The client **MUST** implement this method.
- This method is asynchronous. The recipient **MUST** handle it at any point as defined by the class grammar. The sender **MUST** not expect any specific reply unless the SYNCHREQ flag is set (which will solicit a Channel.Synch reply).
- This field is an sequential ID number for the delivery. The delivery tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the message was delivered.
- The client **MUST NOT** rely on this field but **MUST** take it as a hint that the message may already have been processed. A fully robust client must be able to track duplicate received messages on non transacted, and locally-transacted channels. The server **SHOULD** try to signal redelivered messages when it can. When redelivering a message that was not successfully acknowledged, the server **SHOULD** deliver it to the original client if possible.
- The "destination" field **MUST** not be empty.

4.7.6 The Jms.Browse Method

This method provides a direct access to the messages in a queue or subscription using a synchronous dialogue that is designed for specific types of application where functionality is more important than performance.

The Jms.Browse method has the following specific fields:

- ticket (short) - An access ticket granted by the server for a certain set of access rights within a specific realm. Access tickets may be shared across channels within a connection and expire with the connection. The client **MUST** provide a valid access ticket giving "consume" access rights to the access realm for the destination or subscription.

- `service_type` (octet) - Destinations are either queues or topics - this field specifies the type of the destination. The "fuzzy" type searches first for a queue, then for a topic with the specified destination name.
- `destination` (shortstr) - A destination name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:]. Destination names starting with `_` are reserved for server use. Specifies the name of the destination to browse from. This field is used when the service type is "queue".
- `subscription` (shortstr) - A subscription name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:]. Subscription names starting with `_` are reserved for server use. Specifies the name of the subscription to browse from. This field is used when the service type is "topic". It is not possible to browse an automatic subscription.
- `no_local` (bit) - If this field is set the server will not send messages to the client that published them.
- `auto_ack` (bit) - If this field is set the server does not expect acknowledgments for messages. That is, when a message is delivered to the client the server automatically and silently acknowledges it on behalf of the client. This functionality increases performance but at the cost of reliability. Messages can get lost if a client dies before it can deliver them to the application.

This is the `Jms.Browse` pseudo-structure:

```
define Jms.Browse {
    method_class      octet      # class ID
    method_id         octet      # method ID
    method_flags      octet      # method flags
    method_synchtag   long       # synchtag
    ticket            short      # access ticket granted by server
    service_type      octet      # destination service type
    destination       shortstr   # destination name
    subscription      shortstr   # subscription name
    no_local          bit        # do not receive own messages
    auto_ack          bit        # no acknowledgement needed
}
```

Guidelines for implementors:

- The server **MUST** implement this method.
- This method is a synchronous request that expects one of: `Jms.Browse Ok` `Jms.Browse Empty` unless there is an exception.
- The client **MUST** provide a valid access ticket giving "consume" access rights to the access realm for the destination or subscription.

4.7.7 The `Jms.Browse Ok` Method

This method delivers a message to the client following a browse method. A browsed message will need to be acknowledged, unless the `auto-ack` option was set to one.

The `Jms.Browse Ok` method has the following specific fields:

- `delivery_tag` (longlong) - The server-assigned and channel-specific delivery tag This field is an sequential ID number for the delivery. The delivery tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the message was delivered.
- `redelivered` (bit) - This indicates that the message has been previously delivered to this or another client. The client **MUST NOT** rely on this field but **MUST** take it as a hint that the message may already have been processed. A fully robust client must be able to track duplicate received messages on non transacted, and locally-transacted channels. The server **SHOULD** try to signal redelivered messages when it can. When redelivering a message that was not successfully acknowledged, the server **SHOULD** deliver it to the original client if possible.

- **destination (shortstr)** - A destination name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [.-/+!=:]. Destination names starting with `_` are reserved for server use. In the case of browsing a subscription, this holds the original topic to which the message was sent.
- **message_count (long)** - This field reports the number of messages pending on the queue or subscription, excluding the message being delivered. Note that this figure is indicative, not reliable, and can change arbitrarily as messages are added to the queue/subscription and removed by other clients.

This is the `Jms.Browse Ok` pseudo-structure:

```
define Jms.Browse Ok {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag   long       # synctag
    delivery_tag     longlong   # server-assigned delivery tag
    redelivered      bit        # signal a redelivered message
    destination      shortstr   # destination name
    message_count    long       # number of messages pending
}
```

Guidelines for implementors:

- The client **MAY** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.
- This field is an sequential ID number for the delivery. The delivery tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the message was delivered.
- The client **MUST NOT** rely on this field but **MUST** take it as a hint that the message may already have been processed. A fully robust client must be able to track duplicate received messages on non transacted, and locally-transacted channels. The server **SHOULD** try to signal redelivered messages when it can. When redelivering a message that was not successfully acknowledged, the server **SHOULD** deliver it to the original client if possible.
- The "destination" field **MUST** not be empty.

4.7.8 The Jms.Browse Empty Method

This method tells the client that the queue or subscription has no messages available for the client. This method has no fields apart from the standard method header.

This is the `Jms.Browse Empty` pseudo-structure:

```
define Jms.Browse Empty {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag   long       # synctag
}
```

Guidelines for implementors:

- The client **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.

4.7.9 The Jms.Ack Method

This method acknowledges one or more messages delivered via the Deliver or Browse-Ok methods. The client can ask to confirm a single message or a set of messages up to and including a specific message.

The Jms.Ack method has the following specific fields:

- **delivery_tag** (longlong) - The server-assigned and channel-specific delivery tag. This field is an sequential ID number for the delivery. The delivery tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the message was delivered.
- **multiple** (bit) - If set to 1, the delivery tag is treated as "up to and including", so that the client can acknowledge multiple messages with a single method. If set to zero, the delivery tag refers to a single message. If the multiple field is 1, and the delivery tag is zero, tells the server to acknowledge all outstanding messages. The server **MUST** validate that a non-zero delivery-tag refers to an delivered message, and raise a channel exception if this is not the case.

This is the Jms.Ack pseudo-structure:

```
define Jms.Ack {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synchtag long     # synchtag
    delivery_tag    longlong  # server-assigned delivery tag
    multiple        bit      # acknowledge multiple messages
}
```

Guidelines for implementors:

- The server **MUST** implement this method.
- This method is asynchronous. The recipient **MUST** handle it at any point as defined by the class grammar. The sender **MUST** not expect any specific reply unless the SYNCHREQ flag is set (which will solicit a Channel.Synch reply).
- This field is an sequential ID number for the delivery. The delivery tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the message was delivered.
- The server **MUST** validate that a non-zero delivery-tag refers to an delivered message, and raise a channel exception if this is not the case.

4.7.10 The Jms.Reject Method

This method allows a client to reject a message. It can be used to cancel large incoming messages, or return unprocessable messages to their original queue or subscription.

The Jms.Reject method has the following specific fields:

- **delivery_tag** (longlong) - The server-assigned and channel-specific delivery tag. This field is an sequential ID number for the delivery. The delivery tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the message was delivered.
- **requeue** (bit) - If this field is zero, the message will be discarded. If this bit is 1, the message will be requeued. The server **MUST NOT** deliver the message to the same client within the context of the current channel. The recommended strategy is to attempt to deliver the message to an alternative consumer, and if that is not possible, to move the message to a dead-letter queue. The server **MAY** use more sophisticated tracking to hold the message on the queue and redeliver it to the same client at a later stage.

This is the Jms.Reject pseudo-structure:

```
define Jms.Reject {
    method_class      octet      # class ID
    method_id         octet      # method ID
    method_flags       octet      # method flags
    method_synchtag    long       # synchtag
    delivery_tag       longlong   # server-assigned delivery tag
    requeue            bit        # requeue the message
}
```

Guidelines for implementors:

- The server **SHOULD** be capable of accepting and process the Reject method while sending message content with a Deliver or Browse-Ok method. I.e. the server should read and process incoming methods while sending output frames.
- The server **SHOULD** interpret this method as meaning that the client is unable to process the message at this time.
- A client **MUST NOT** use this method as a means of selecting message to process. A rejected message **MAY** be discarded or dead-lettered.
- The server **MUST** implement this method.
- This method is asynchronous. The recipient **MUST** handle it at any point as defined by the class grammar. The sender **MUST** not expect any specific reply unless the SYNCHREQ flag is set (which will solicit a Channel.Synch reply).
- This field is an sequential ID number for the delivery. The delivery tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the message was delivered.
- The server **MUST NOT** deliver the message to the same client within the context of the current channel. The recommended strategy is to attempt to deliver the message to an alternative consumer, and if that is not possible, to move the message to a dead-letter queue. The server **MAY** use more sophisticated tracking to hold the message on the queue and redeliver it to the same client at a later stage.

4.8 The File Class

The file class provides methods that support reliable file transfer. File messages have a specific set of properties that are required for interoperability with file transfer applications. File messages and acknowledgements are subject to channel transactions. The ID of the File class is 7.

This is the formal grammar for the class:

```
file
    = C:OPEN S:OPEN_OK
    / S:OPEN C:OPEN_OK
    / C:STAGE
    / S:STAGE
    / C:CONSUME S:CONSUME_OK
    / C:CANCEL
    / C:PUBLISH content
    / S:DELIVER content
    / C:BROWSE ( S:BROWSE_OK content / S:BROWSE_EMPTY )
    / C:ACK
    / C:REJECT
```

This class contains the following server methods:

- File.Consume - start a destination consumer (ID = 1) (sync request)
- File.Cancel - end a destination consumer (ID = 3) (async)
- File.Publish - publish a message to a destination (ID = 4) (async, carries content)

- File.Browse - direct access to a destination (ID = 6) (sync request)
- File.Ack - acknowledge one or more messages (ID = 9) (async)
- File.Reject - reject an incoming message (ID = 10) (async)

This class contains the following client methods:

- File.Consume Ok - confirm a new consumer (ID = 2) (sync reply for Consume)
- File.Deliver - notify the client of a consumer message (ID = 5) (async, carries content)
- File.Browse Ok - provide client with a browsed message (ID = 7) (sync reply for Browse, carries content)
- File.Browse Empty - indicate no messages available (ID = 8) (sync reply for Browse)

Guidelines for implementors:

- The server SHOULD implement this class. Each method may have specific guidelines.
- The client MAY implement this class. Each method may have specific guidelines.
- Any assertion failures in the File methods MUST BE treated as channel exceptions - i.e. the peer that detects the error MUST respond with Channel.Close.

4.8.1 The File.Consume Method

This method asks the server to start a "consumer", which is a temporary request for messages from a specific queue or topic subscription. Consumers last as long as the channel they were created on, or until they are cancelled.

The File.Consume method has the following specific fields:

- ticket (short) - An access ticket granted by the server for a certain set of access rights within a specific realm. Access tickets may be shared across channels within a connection and expire with the connection. The client MUST provide a valid access ticket giving "consume" access rights to the access realm for the destination or subscription.
- service.type (octet) - Destinations are either queues or topics - this field specifies the type of the destination. The "fuzzy" type searches first for a queue, then for a topic with the specified destination name.
- destination (shortstr) - A destination name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:]. Destination names starting with _ are reserved for server use. Specifies the name of the queue or topic to consume from. For queue consumers, the destination field MUST be provided. For topic consumers, the destination field MAY be provided but MUST be empty if a subscription is specified. Note that the explicit use of a subscription already defines the topic destination to use.
- subscription (shortstr) - A subscription name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:]. Subscription names starting with _ are reserved for server use. Specifies the name of the subscription, for topic consumers. The subscription field MUST be empty for queue consumers and MAY be empty for topic consumers, in which case the server MUST create an unnamed, private, and temporary subscription automatically. This automatic subscription is cancelled when the client cancels the consumer or closes the channel. The client MUST define the subscription before starting a consumer on it.

- `prefetch_size` (short) - The client can request that messages be sent in advance so that when the client finishes processing a message, the following message is already held locally, rather than needing to be sent down the channel. Prefetching gives a performance improvement. This field specifies the prefetch window size in octets. May be set to zero, meaning "no specific limit". Note that other prefetch limits may still apply.
- `prefetch_count` (short) - Specifies a prefetch window in terms of whole messages. This is compatible with some file API implementations. This field may be used in combination with the `prefetch_size` field; a message will only be sent in advance if both prefetch windows (and those at the channel and connection level) allow it. The server MAY send less data in advance than allowed by the client's specified prefetch windows but it MUST NOT send more.
- `no_local` (bit) - If this field is set the server will not send messages to the client that published them.
- `auto_ack` (bit) - If this field is set the server does not expect acknowledgments for messages. That is, when a message is delivered to the client the server automatically and silently acknowledges it on behalf of the client. This functionality increases performance but at the cost of reliability. Messages can get lost if a client dies before it can deliver them to the application.
- `exclusive` (bit) - Request exclusive consumer access. If the server cannot grant this - because there are other consumers active - it raises a channel exception. The server MUST grant clients exclusive access to a destination or subscription if they ask for it.
- `message_selector` (longstr) - Specifies which precise messages will be routed to this queue or subscription. AMQP/Fast provides several alternative syntaxes for message selectors, as specified by the `message_seldtype` field. This field is only used when consuming from queues. The server MUST ignore the `message_selector` field when a client consumes from a subscription.
- `message_seldtype` (octet) - Specifies the syntax for the message selector. The server MUST support the simple syntax and SHOULD support the file syntax.
- `auto_cancel` (long) - This field causes the consumer to self-cancel after a specific number of messages have been delivered and acknowledged. If zero, the consumer expires when the client sends the `Jms.Cancel` method, or closes the channel.

This is the `File.Consume` pseudo-structure:

```
define File.Consume {
    method_class      octet      # class ID
    method_id         octet      # method ID
    method_flags      octet      # method flags
    method_synctag    long       # synctag
    ticket            short      # access ticket granted by server
    service_type      octet      # destination service type
    destination       shortstr   # destination name
    subscription      shortstr   # subscription name
    prefetch_size     short      # prefetch window in octets
    prefetch_count    short      # prefetch window in messages
    no_local          bit        # do not receive own messages
    auto_ack          bit        # no acknowledgement needed
    exclusive         bit        # request exclusive access
    message_selector  longstr    # message selector
    message_seldtype  octet      # type of message selector
    auto_cancel       long       # cancel consumer after N messages
}
```

Guidelines for implementors:

- The server MAY restrict the number of consumers per channel to an arbitrary value, which MUST be at least 8, and MUST be specified in the `Connection.Tune` method.
- The client MUST be able to work with the server-defined limits with respect to the maximum number of consumers per channel.
- The server MUST implement this method.

- This method is a synchronous request that expects one of: File.Consume Ok unless there is an exception.
- The client **MUST** provide a valid access ticket giving "consume" access rights to the access realm for the destination or subscription.
- For queue consumers, the destination field **MUST** be provided. For topic consumers, the destination field **MAY** be provided but **MUST** be empty if a subscription is specified. Note that the explicit use of a subscription already defines the topic destination to use.
- The subscription field **MUST** be empty for queue consumers and **MAY** be empty for topic consumers, in which case the server **MUST** create an unnamed, private, and temporary subscription automatically. This automatic subscription is cancelled when the client cancels the consumer or closes the channel.
- The client **MUST** define the subscription before starting a consumer on it.
- The server **MAY** send less data in advance than allowed by the client's specified prefetch windows but it **MUST NOT** send more.
- The server **MUST** grant clients exclusive access to a destination or subscription if they ask for it.
- The "message_selector" field **MUST** not be empty.
- The server **MUST** ignore the message-selector field when a client consumes from a subscription.
- The server **MUST** support the simple syntax and **SHOULD** support the file syntax.

4.8.2 The File.Consume Ok Method

This method provides the client with a consumer tag which it may use in methods that work with the consumer.

The File.Consume Ok method has the following specific fields:

- consumer_tag (short) - The server-assigned and channel-specific consumer tag This field is an arbitrary ID number for the consumer. The consumer tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the consumer was created.

This is the File.Consume Ok pseudo-structure:

```
define File.Consume Ok {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long        # synctag
    consumer_tag    short      # server-assigned consumer tag
}
```

Guidelines for implementors:

- The client **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.
- This field is an arbitrary ID number for the consumer. The consumer tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the consumer was created.

4.8.3 The File.Cancel Method

This method cancels a consumer. This does not affect already delivered messages, but it does mean the server will not send any more messages for that consumer.

The File.Cancel method has the following specific fields:

- **consumer_tag** (short) - The server-assigned and channel-specific consumer tag. This field is an arbitrary ID number for the consumer. The consumer tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the consumer was created.

This is the File.Cancel pseudo-structure:

```
define File.Cancel {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
    consumer_tag    short      # server-assigned consumer tag
}
```

Guidelines for implementors:

- The server **MUST** implement this method.
- This method is asynchronous. The recipient **MUST** handle it at any point as defined by the class grammar. The sender **MUST NOT** expect any specific reply unless the **SYNCHREQ** flag is set (which will solicit a **Channel.Synch** reply).
- This field is an arbitrary ID number for the consumer. The consumer tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the consumer was created.

4.8.4 The File.Publish Method

This method publishes a message to a specific destination. The message will be saved to the destination and distributed to any consumers when the transaction is committed.

The File.Publish method has the following specific fields:

- **ticket** (short) - An access ticket granted by the server for a certain set of access rights within a specific realm. Access tickets may be shared across channels within a connection and expire with the connection. The client **MUST** provide a valid access ticket giving "publish" access rights to the access realm for the destination or subscription.
- **service_type** (octet) - Destinations are either queues or topics - this field specifies the type of the destination. The "fuzzy" type searches first for a queue, then for a topic with the specified destination name.
- **destination** (shortstr) - A destination name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [.-/+!=:]. Destination names starting with **_** are reserved for server use. Specifies the name of the destination to publish to. If the destination does not exist the server will raise a channel exception.
- **immediate** (bit) - Asserts that the destination has one or more consumers (for queues) or one or more subscriptions (for topics), and causes a channel exception if this is not the case. Note that a consumer can query the state of a destination before publishing to it.

This is the File.Publish pseudo-structure:

```
define File.Publish {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
    ticket          short      # access ticket granted by server
    service_type    octet      # destination service type
    destination     shortstr   # destination name
    immediate       bit        # assert immediate delivery
}
```

Guidelines for implementors:

- The server **MUST** implement this method.
- This method is asynchronous. The recipient **MUST** handle it at any point as defined by the class grammar. The sender **MUST** not expect any specific reply unless the **SYNCHREQ** flag is set (which will solicit a **Channel.Synch** reply).
- The client **MUST** provide a valid access ticket giving "publish" access rights to the access realm for the destination or subscription.
- The "destination" field **MUST** not be empty.

4.8.5 The File.Deliver Method

This method delivers a message to the client, via a consumer. In the asynchronous message delivery model, the client starts a consumer using the **Consume** method, then the server responds with **Deliver** methods as and when messages arrive for that consumer.

The **File.Deliver** method has the following specific fields:

- **delivery_tag** (longlong) - The server-assigned and channel-specific delivery tag. This field is an sequential ID number for the delivery. The delivery tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the message was delivered.
- **redelivered** (bit) - This indicates that the message has been previously delivered to this or another client. The client **MUST NOT** rely on this field but **MUST** take it as a hint that the message may already have been processed. A fully robust client must be able to track duplicate received messages on non transacted, and locally-transacted channels. The server **SHOULD** try to signal redelivered messages when it can. When redelivering a message that was not successfully acknowledged, the server **SHOULD** deliver it to the original client if possible.
- **destination** (shortstr) - A destination name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:]. Destination names starting with **_** are reserved for server use. Specifies the name of the destination that the message came from. Note that a single channel can start many consumers on different destinations, and a single subscription can collect messages from several topics.

This is the **File.Deliver** pseudo-structure:

```
define File.Deliver {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags     octet      # method flags
    method_synctag   long       # synctag
    delivery_tag     longlong    # server-assigned delivery tag
    redelivered      bit        # signal a redelivered message
    destination      shortstr   # destination name
}
```

Guidelines for implementors:

- The server **SHOULD** track the number of times a message has been delivered to clients and when a message is redelivered a certain number of times - e.g. 5 times - without being acknowledged, the server **SHOULD** consider the message to be unprocessable (possibly causing client applications to abort), and move the message to a dead letter queue.
- The client **MUST** implement this method.
- This method is asynchronous. The recipient **MUST** handle it at any point as defined by the class grammar. The sender **MUST** not expect any specific reply unless the **SYNCHREQ** flag is set (which will solicit a **Channel.Synch** reply).

- This field is an sequential ID number for the delivery. The delivery tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the message was delivered.
- The client **MUST NOT** rely on this field but **MUST** take it as a hint that the message may already have been processed. A fully robust client must be able to track duplicate received messages on non transacted, and locally-transacted channels. The server **SHOULD** try to signal redelivered messages when it can. When redelivering a message that was not successfully acknowledged, the server **SHOULD** deliver it to the original client if possible.
- The "destination" field **MUST** not be empty.

4.8.6 The File.Browse Method

This method provides a direct access to the messages in a queue or subscription using a synchronous dialogue that is designed for specific types of application where functionality is more important than performance.

The File.Browse method has the following specific fields:

- ticket (short) - An access ticket granted by the server for a certain set of access rights within a specific realm. Access tickets may be shared across channels within a connection and expire with the connection. The client **MUST** provide a valid access ticket giving "consume" access rights to the access realm for the destination or subscription.
- service_type (octet) - Destinations are either queues or topics - this field specifies the type of the destination. The "fuzzy" type searches first for a queue, then for a topic with the specified destination name.
- destination (shortstr) - A destination name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:]. Destination names starting with _ are reserved for server use. Specifies the name of the destination to browse from. This field is used when the service type is "queue".
- subscription (shortstr) - A subscription name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:]. Subscription names starting with _ are reserved for server use. Specifies the name of the subscription to browse from. This field is used when the service type is "topic". It is not possible to browse an automatic subscription.
- no_local (bit) - If this field is set the server will not send messages to the client that published them.
- auto_ack (bit) - If this field is set the server does not expect acknowledgments for messages. That is, when a message is delivered to the client the server automatically and silently acknowledges it on behalf of the client. This functionality increases performance but at the cost of reliability. Messages can get lost if a client dies before it can deliver them to the application.

This is the File.Browse pseudo-structure:

```
define File.Browse {
    method_class      octet      # class ID
    method_id         octet      # method ID
    method_flags      octet      # method flags
    method_synctag    long       # synctag
    ticket            short      # access ticket granted by server
    service_type       octet      # destination service type
    destination       shortstr   # destination name
    subscription       shortstr   # subscription name
    no_local           bit        # do not receive own messages
    auto_ack          bit        # no acknowledgement needed
}
```

Guidelines for implementors:

- The server **MUST** implement this method.

- This method is a synchronous request that expects one of: File.Browse Ok File.Browse Empty unless there is an exception.
- The client **MUST** provide a valid access ticket giving "consume" access rights to the access realm for the destination or subscription.

4.8.7 The File.Browse Ok Method

This method delivers a message to the client following a browse method. A browsed message will need to be acknowledged, unless the auto-ack option was set to one.

The File.Browse Ok method has the following specific fields:

- **delivery_tag** (longlong) - The server-assigned and channel-specific delivery tag This field is an sequential ID number for the delivery. The delivery tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the message was delivered.
- **redelivered** (bit) - This indicates that the message has been previously delivered to this or another client. The client **MUST NOT** rely on this field but **MUST** take it as a hint that the message may already have been processed. A fully robust client must be able to track duplicate received messages on non transacted, and locally-transacted channels. The server **SHOULD** try to signal redelivered messages when it can. When redelivering a message that was not successfully acknowledged, the server **SHOULD** deliver it to the original client if possible.
- **destination** (shortstr) - A destination name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:]. Destination names starting with _ are reserved for server use. In the case of browsing a subscription, this holds the original topic to which the message was sent.
- **message_count** (long) - This field reports the number of messages pending on the queue or subscription, excluding the message being delivered. Note that this figure is indicative, not reliable, and can change arbitrarily as messages are added to the queue/subscription and removed by other clients.

This is the File.Browse Ok pseudo-structure:

```
define File.Browse Ok {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
    delivery_tag    longlong   # server-assigned delivery tag
    redelivered     bit        # signal a redelivered message
    destination     shortstr   # destination name
    message_count   long       # number of messages pending
}
```

Guidelines for implementors:

- The client **MAY** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.
- This field is an sequential ID number for the delivery. The delivery tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the message was delivered.
- The client **MUST NOT** rely on this field but **MUST** take it as a hint that the message may already have been processed. A fully robust client must be able to track duplicate received messages on non transacted, and locally-transacted channels. The server **SHOULD** try to signal redelivered messages when it can. When redelivering a message that was not successfully acknowledged, the server **SHOULD** deliver it to the original client if possible.
- The "destination" field **MUST** not be empty.

4.8.8 The File.Browse Empty Method

This method tells the client that the queue or subscription has no messages available for the client. This method has no fields apart from the standard method header.

This is the File.Browse Empty pseudo-structure:

```
define File.Browse Empty {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
}
```

Guidelines for implementors:

- The client **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.

4.8.9 The File.Ack Method

This method acknowledges one or more messages delivered via the Deliver or Browse-Ok methods. The client can ask to confirm a single message or a set of messages up to and including a specific message.

The File.Ack method has the following specific fields:

- `delivery_tag` (longlong) - The server-assigned and channel-specific delivery tag. This field is an sequential ID number for the delivery. The delivery tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the message was delivered.
- `multiple` (bit) - If set to 1, the delivery tag is treated as "up to and including", so that the client can acknowledge multiple messages with a single method. If set to zero, the delivery tag refers to a single message. If the multiple field is 1, and the delivery tag is zero, tells the server to acknowledge all outstanding messages. The server **MUST** validate that a non-zero delivery-tag refers to an delivered message, and raise a channel exception if this is not the case.

This is the File.Ack pseudo-structure:

```
define File.Ack {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
    delivery_tag    longlong   # server-assigned delivery tag
    multiple        bit        # acknowledge multiple messages
}
```

Guidelines for implementors:

- The server **MUST** implement this method.
- This method is asynchronous. The recipient **MUST** handle it at any point as defined by the class grammar. The sender **MUST** not expect any specific reply unless the `SYNCHREQ` flag is set (which will solicit a `Channel.Synch` reply).
- This field is an sequential ID number for the delivery. The delivery tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the message was delivered.
- The server **MUST** validate that a non-zero delivery-tag refers to an delivered message, and raise a channel exception if this is not the case.

4.8.10 The File.Reject Method

This method allows a client to reject a message. It can be used to cancel large incoming messages, or return unprocessable messages to their original queue or subscription.

The File.Reject method has the following specific fields:

- **delivery_tag** (longlong) - The server-assigned and channel-specific delivery tag. This field is an sequential ID number for the delivery. The delivery tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the message was delivered.
- **requeue** (bit) - If this field is zero, the message will be discarded. If this bit is 1, the message will be requeued. The server **MUST NOT** deliver the message to the same client within the context of the current channel. The recommended strategy is to attempt to deliver the message to an alternative consumer, and if that is not possible, to move the message to a dead-letter queue. The server **MAY** use more sophisticated tracking to hold the message on the queue and redeliver it to the same client at a later stage.

This is the File.Reject pseudo-structure:

```
define File.Reject {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synchtag long     # synchtag
    delivery_tag    longlong  # server-assigned delivery tag
    requeue         bit      # requeue the message
}
```

Guidelines for implementors:

- The server **SHOULD** be capable of accepting and process the Reject method while sending message content with a Deliver or Browse-Ok method. I.e. the server should read and process incoming methods while sending output frames.
- The server **SHOULD** interpret this method as meaning that the client is unable to process the message at this time.
- A client **MUST NOT** use this method as a means of selecting message to process. A rejected message **MAY** be discarded or dead-lettered.
- The server **MUST** implement this method.
- This method is asynchronous. The recipient **MUST** handle it at any point as defined by the class grammar. The sender **MUST** not expect any specific reply unless the SYNCHREQ flag is set (which will solicit a Channel.Synch reply).
- This field is an sequential ID number for the delivery. The delivery tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the message was delivered.
- The server **MUST NOT** deliver the message to the same client within the context of the current channel. The recommended strategy is to attempt to deliver the message to an alternative consumer, and if that is not possible, to move the message to a dead-letter queue. The server **MAY** use more sophisticated tracking to hold the message on the queue and redeliver it to the same client at a later stage.

4.9 The Stream Class

The stream class provides methods that support multimedia streaming. The stream class uses the following semantics: one message is one packet of data; delivery is unacknowledged and unreliable; the consumer can specify quality of service parameters that the server can try to adhere to; lower-priority messages may be discarded in favour of high priority messages. The ID of the Stream class is 8.

This is the formal grammar for the class:

```
file          = C:CONSUME S:CONSUME_OK
               / C:CANCEL
               / C:PUBLISH content
               / S:DELIVER content
```

This class contains the following server methods:

- Stream.Consume - start a destination consumer (ID = 1) (sync request)
- Stream.Cancel - end a destination consumer (ID = 3) (async)
- Stream.Publish - publish a message to a destination (ID = 4) (async, carries content)

This class contains the following client methods:

- Stream.Consume Ok - confirm a new consumer (ID = 2) (sync reply for Consume)
- Stream.Deliver - notify the client of a consumer message (ID = 5) (async, carries content)

Guidelines for implementors:

- The server SHOULD implement this class. Each method may have specific guidelines.
- The client MAY implement this class. Each method may have specific guidelines.
- Any assertion failures in the Stream methods MUST BE treated as channel exceptions - i.e. the peer that detects the error MUST respond with Channel.Close.

4.9.1 The Stream.Consume Method

This method asks the server to start a "consumer", which is a temporary request for messages from a specific queue or topic subscription. Consumers last as long as the channel they were created on, or until they are cancelled.

The Stream.Consume method has the following specific fields:

- ticket (short) - An access ticket granted by the server for a certain set of access rights within a specific realm. Access tickets may be shared across channels within a connection and expire with the connection. The client MUST provide a valid access ticket giving "consume" access rights to the access realm for the destination or subscription.
- service_type (octet) - Destinations are either queues or topics - this field specifies the type of the destination. The "fuzzy" type searches first for a queue, then for a topic with the specified destination name.
- destination (shortstr) - A destination name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [.-/+!=:]. Destination names starting with _ are reserved for server use. Specifies the name of the queue or topic to consume from. For queue consumers, the destination field MUST be provided. For topic consumers, the destination field MAY be provided but MUST be empty if a subscription is specified. Note that the explicit use of a subscription already defines the topic destination to use.

- **subscription** (shortstr) - A subscription name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [-./+!=:]. Subscription names starting with `_` are reserved for server use. Specifies the name of the subscription, for topic consumers. The subscription field **MUST** be empty for queue consumers and **MAY** be empty for topic consumers, in which case the server **MUST** create an unnamed, private, and temporary subscription automatically. This automatic subscription is cancelled when the client cancels the consumer or closes the channel. The client **MUST** define the subscription before starting a consumer on it.
- **prefetch_size** (short) - The client can request that messages be sent in advance so that when the client finishes processing a message, the following message is already held locally, rather than needing to be sent down the channel. Prefetching gives a performance improvement. This field specifies the prefetch window size in octets. May be set to zero, meaning "no specific limit". Note that other prefetch limits may still apply.
- **prefetch_count** (short) - Specifies a prefetch window in terms of whole messages. This field may be used in combination with the prefetch-size field; a message will only be sent in advance if both prefetch windows (and those at the channel and connection level) allow it.
- **consume_rate** (long) - Specifies a desired transfer rate in octets per second. This is usually determined by the application that uses the streaming data. A value of zero means "no limit", i.e. as rapidly as possible. The server **MAY** ignore the prefetch values and consume rates, depending on the type of stream and the ability of the server to queue and/or reply it. The server **MAY** drop low-priority messages in favour of high-priority messages.
- **no_local** (bit) - If this field is set the server will not send messages to the client that published them.
- **exclusive** (bit) - Request exclusive consumer access. If the server cannot grant this - because there are other consumers active - it raises a channel exception. The server **MUST** grant clients exclusive access to a destination or subscription if they ask for it.

This is the Stream.Consume pseudo-structure:

```
define Stream.Consume {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synctag  long     # synctag
    ticket          short    # access ticket granted by server
    service_type    octet    # destination service type
    destination     shortstr # destination name
    subscription    shortstr # subscription name
    prefetch_size   short    # prefetch window in octets
    prefetch_count  short    # prefetch window in messages
    consume_rate    long     # transfer rate in octets/second
    no_local        bit      # do not receive own messages
    exclusive       bit      # request exclusive access
}
```

Guidelines for implementors:

- The server **MAY** restrict the number of consumers per channel to an arbitrary value, which **MUST** be at least 8, and **MUST** be specified in the Connection.Tune method.
- The client **MUST** be able to work with the server-defined limits with respect to the maximum number of consumers per channel.
- The server **MUST** not allow more than one Stream consumer per subscription.
- Streaming applications **SHOULD** use different channels to select different streaming resolutions. AMQP/Fast does not assume the server is capable of filtering and/or transforming streams except on the basis of individual message priorities.
- The server **MUST** implement this method.

- This method is a synchronous request that expects one of: Stream.Consume Ok unless there is an exception.
- The client **MUST** provide a valid access ticket giving "consume" access rights to the access realm for the destination or subscription.
- For queue consumers, the destination field **MUST** be provided. For topic consumers, the destination field **MAY** be provided but **MUST** be empty if a subscription is specified. Note that the explicit use of a subscription already defines the topic destination to use.
- The subscription field **MUST** be empty for queue consumers and **MAY** be empty for topic consumers, in which case the server **MUST** create an unnamed, private, and temporary subscription automatically. This automatic subscription is cancelled when the client cancels the consumer or closes the channel.
- The client **MUST** define the subscription before starting a consumer on it.
- The server **MAY** ignore the prefetch values and consume rates, depending on the type of stream and the ability of the server to queue and/or reply it. The server **MAY** drop low-priority messages in favour of high-priority messages.
- The server **MUST** grant clients exclusive access to a destination or subscription if they ask for it.

4.9.2 The Stream.Consume Ok Method

This method provides the client with a consumer tag which it may use in methods that work with the consumer.

The Stream.Consume Ok method has the following specific fields:

- `consumer_tag` (short) - The server-assigned and channel-specific consumer tag. This field is an arbitrary ID number for the consumer. The consumer tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the consumer was created.

This is the Stream.Consume Ok pseudo-structure:

```
define Stream.Consume Ok {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
    consumer_tag    short      # server-assigned consumer tag
}
```

Guidelines for implementors:

- The client **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.
- This field is an arbitrary ID number for the consumer. The consumer tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the consumer was created.

4.9.3 The Stream.Cancel Method

This method cancels a consumer. This does not affect already delivered messages, but it does mean the server will not send any more messages for that consumer.

The Stream.Cancel method has the following specific fields:

- **consumer_tag** (short) - The server-assigned and channel-specific consumer tag. This field is an arbitrary ID number for the consumer. The consumer tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the consumer was created.

This is the Stream.Cancel pseudo-structure:

```
define Stream.Cancel {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
    consumer_tag    short      # server-assigned consumer tag
}
```

Guidelines for implementors:

- The server **MUST** implement this method.
- This method is asynchronous. The recipient **MUST** handle it at any point as defined by the class grammar. The sender **MUST NOT** expect any specific reply unless the **SYNCHREQ** flag is set (which will solicit a **Channel.Synch** reply).
- This field is an arbitrary ID number for the consumer. The consumer tag is specific to a single channel and the client **MUST NOT** use this tag in any channel except the channel where the consumer was created.

4.9.4 The Stream.Publish Method

This method publishes a message to a specific destination. The message will be saved to the destination and distributed to any consumers when the transaction is committed.

The Stream.Publish method has the following specific fields:

- **ticket** (short) - An access ticket granted by the server for a certain set of access rights within a specific realm. Access tickets may be shared across channels within a connection and expire with the connection. The client **MUST** provide a valid access ticket giving "publish" access rights to the access realm for the destination or subscription.
- **service_type** (octet) - Destinations are either queues or topics - this field specifies the type of the destination. The "fuzzy" type searches first for a queue, then for a topic with the specified destination name.
- **destination** (shortstr) - A destination name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [.-/+!=:]. Destination names starting with **_** are reserved for server use. Specifies the name of the destination to publish to. If the destination does not exist the server will raise a channel exception.
- **immediate** (bit) - Asserts that the destination has one or more consumers (for queues) or one or more subscriptions (for topics), and causes a channel exception if this is not the case. Note that a consumer can query the state of a destination before publishing to it.

This is the Stream.Publish pseudo-structure:

```
define Stream.Publish {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag  long       # synctag
    ticket          short      # access ticket granted by server
    service_type    octet      # destination service type
    destination     shortstr   # destination name
    immediate       bit        # assert immediate delivery
}
```

Guidelines for implementors:

- The server **MUST** implement this method.
- This method is asynchronous. The recipient **MUST** handle it at any point as defined by the class grammar. The sender **MUST** not expect any specific reply unless the SYNCHREQ flag is set (which will solicit a Channel.Synch reply).
- The client **MUST** provide a valid access ticket giving "publish" access rights to the access realm for the destination or subscription.
- The "destination" field **MUST** not be empty.

4.9.5 The Stream.Deliver Method

This method delivers a message to the client, via a consumer. In the asynchronous message delivery model, the client starts a consumer using the Consume method, then the server responds with Deliver methods as and when messages arrive for that consumer.

The Stream.Deliver method has the following specific fields:

- destination (shortstr) - A destination name consists of any combination of at least one of [A-Za-z0-9] plus zero or more of [.-/+!=:]. Destination names starting with _ are reserved for server use. Specifies the name of the destination that the message came from. Note that a single channel can start many consumers on different destinations, and a single subscription can collect messages from several topics.
- immediate (bit) - Asserts that the destination has one or more consumers (for queues) or one or more subscriptions (for topics), and causes a channel exception if this is not the case. Note that a consumer can query the state of a destination before publishing to it.

This is the Stream.Deliver pseudo-structure:

```
define Stream.Deliver {
    method_class    octet      # class ID
    method_id       octet      # method ID
    method_flags    octet      # method flags
    method_synctag   long       # synctag
    destination     shortstr   # destination name
    immediate       bit        # assert immediate delivery
}
```

Guidelines for implementors:

- The server **SHOULD** track the number of times a message has been delivered to clients and when a message is redelivered a certain number of times - e.g. 5 times - without being acknowledged, the server **SHOULD** consider the message to be unprocessable (possibly causing client applications to abort), and move the message to a dead letter queue.
- The client **MUST** implement this method.
- This method is asynchronous. The recipient **MUST** handle it at any point as defined by the class grammar. The sender **MUST** not expect any specific reply unless the SYNCHREQ flag is set (which will solicit a Channel.Synch reply).
- The "destination" field **MUST** not be empty.

4.10 The Tx Class

Standard transactions provide so-called "1.5 phase commit". We can ensure that work is never lost, but there is a chance of confirmations being lost, so that messages may be resent. Applications that use standard transactions must be able to detect and ignore duplicate messages. The ID of the Tx class is 9.

This is the formal grammar for the class:

```
tx          = C:COMMIT S:COMMIT_OK
           / C:ABORT S:ABORT_OK
```

This class contains the following server methods:

- Tx.Commit - commit the current transaction (ID = 1) (sync request)
- Tx.Abort - abandon the current transaction (ID = 3) (sync request)

This class contains the following client methods:

- Tx.Commit Ok - confirm a successful commit (ID = 2) (sync reply for Commit)
- Tx.Abort Ok - confirm a successful abort (ID = 4) (sync reply for Abort)

Guidelines for implementors:

- An client using standard transactions **SHOULD** be able to track all messages received within a reasonable period, and thus detect and reject duplicates of the same message. It **SHOULD NOT** pass these to the application layer.
- The server **SHOULD** implement this class. Each method may have specific guidelines.
- The client **MAY** implement this class. Each method may have specific guidelines.
- Any assertion failures in the Tx methods **MUST BE** treated as channel exceptions - i.e. the peer that detects the error **MUST** respond with Channel.Close.

4.10.1 The Tx.Commit Method

This method commits all messages published and acknowledged in the current transaction. A new transaction starts immediately after a commit. This method has no fields apart from the standard method header.

This is the Tx.Commit pseudo-structure:

```
define Tx.Commit {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synctag  long     # synctag
}
```

Guidelines for implementors:

- The server **MUST** implement this method.
- This method is a synchronous request that expects one of: Tx.Commit Ok unless there is an exception.

4.10.2 The Tx.Commit Ok Method

This method confirms to the client that the commit succeeded. Note that if a commit fails, the server raises a channel exception. This method has no fields apart from the standard method header.

This is the Tx.Commit Ok pseudo-structure:

```
define Tx.Commit Ok {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synctag  long     # synctag
}
```

Guidelines for implementors:

- The client **MUST** implement this method.

- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.

4.10.3 The Tx.Abort Method

This method abandons all messages published and acknowledged in the current transaction. A new transaction starts immediately after a rollback. This method has no fields apart from the standard method header.

This is the Tx.Abort pseudo-structure:

```
define Tx.Abort {
    method_class      octet      # class ID
    method_id         octet      # method ID
    method_flags      octet      # method flags
    method_synctag    long       # synctag
}
```

Guidelines for implementors:

- The server **MUST** implement this method.
- This method is a synchronous request that expects one of: Tx.Abort Ok unless there is an exception.

4.10.4 The Tx.Abort Ok Method

This method confirms to the client that the abort succeeded. Note that if an abort fails, the server raises a channel exception. This method has no fields apart from the standard method header.

This is the Tx.Abort Ok pseudo-structure:

```
define Tx.Abort Ok {
    method_class      octet      # class ID
    method_id         octet      # method ID
    method_flags      octet      # method flags
    method_synctag    long       # synctag
}
```

Guidelines for implementors:

- The client **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.

4.11 The Dtx Class

Distributed transactions provide so-called "2-phase commit". This is slower and more complex than standard transactions but provides more assurance that messages will be delivered exactly once. The AMQP/Fast distributed transaction model supports the X-Open XA architecture and other distributed transaction implementations. The Dtx class assumes that the server has a private communications channel (not AMQP/Fast) to a distributed transaction coordinator. The ID of the Dtx class is 10.

This is the formal grammar for the class:

```
dtx = C:START S:START_OK
```

This class contains the following server methods:

- Dtx.Start - start a new distributed transaction (ID = 1) (sync request)

This class contains the following client methods:

- Dtx.Start Ok - confirm the start of a new distributed transaction (ID = 2) (sync reply for Start)

Guidelines for implementors:

- The server MAY implement this class. Each method may have specific guidelines.
- The client MAY implement this class. Each method may have specific guidelines.
- Any assertion failures in the Dtx methods MUST BE treated as channel exceptions - i.e. the peer that detects the error MUST respond with Channel.Close.

4.11.1 The Dtx.Start Method

This method starts a new distributed transaction. This must be the first method on a new channel that uses the distributed transaction mode, before any methods that publish or consume messages.

The Dtx.Start method has the following specific fields:

- dtx.identifier (shortstr) - The distributed transaction key. This identifies the transaction so that the AMQP/Fast server can coordinate with the distributed transaction coordinator.

This is the Dtx.Start pseudo-structure:

```
define Dtx.Start {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synctag  long     # synctag
    dtx_identifier  shortstr  # distributed transaction identifier
}
```

Guidelines for implementors:

- The server MAY implement this method.
- This method is a synchronous request that expects one of: Dtx.Start Ok unless there is an exception.
- The "dtx.identifier" field MUST not be empty.

4.11.2 The Dtx.Start Ok Method

This method confirms to the client that the transaction started. Note that if a start fails, the server raises a channel exception. This method has no fields apart from the standard method header.

This is the Dtx.Start Ok pseudo-structure:

```
define Dtx.Start Ok {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synctag  long     # synctag
}
```

Guidelines for implementors:

- The client MUST implement this method.
- This method is a synchronous response. The sender MUST NOT expect a specific method in return, except as defined by the class grammar.

4.12 The Test Class

The test class provides methods for a peer to test the basic operational correctness of another peer. The test methods are intended to ensure that all peers respect at least the basic elements of the protocol, such as frame and content organisation and field types. We assume that a specially-designed peer, a "monitor client" would perform such tests. The ID of the Test class is 11.

This is the formal grammar for the class:

```
test          = C:INTEGER S:INTEGER_OK
               / S:INTEGER C:INTEGER_OK
               / C:STRING S:STRING_OK
               / S:STRING C:STRING_OK
               / C:TABLE S:TABLE_OK
               / S:TABLE C:TABLE_OK
               / C:CONTENT S:CONTENT_OK
               / S:CONTENT C:CONTENT_OK
```

This class contains the following server methods:

- Test.Integer - test integer handling (ID = 1) (sync request)
- Test.Integer Ok - report integer test result (ID = 2) (sync reply for Integer)
- Test.String - test string handling (ID = 3) (sync request)
- Test.String Ok - report string test result (ID = 4) (sync reply for String)
- Test.Table - test field table handling (ID = 5) (sync request)
- Test.Table Ok - report table test result (ID = 6) (sync reply for Table)
- Test.Content - test content handling (ID = 7) (sync request, carries content)
- Test.Content Ok - report content test result (ID = 8) (sync reply for Content, carries content)

This class contains the following client methods:

- Test.Integer - test integer handling (ID = 1) (sync request)
- Test.Integer Ok - report integer test result (ID = 2) (sync reply for Integer)
- Test.String - test string handling (ID = 3) (sync request)
- Test.String Ok - report string test result (ID = 4) (sync reply for String)
- Test.Table - test field table handling (ID = 5) (sync request)
- Test.Table Ok - report table test result (ID = 6) (sync reply for Table)
- Test.Content - test content handling (ID = 7) (sync request, carries content)
- Test.Content Ok - report content test result (ID = 8) (sync reply for Content, carries content)

Guidelines for implementors:

- The server **MUST** implement this class. Each method may have specific guidelines.
- The client **SHOULD** implement this class. Each method may have specific guidelines.
- Any assertion failures in the Test methods **MUST BE** treated as channel exceptions - i.e. the peer that detects the error **MUST** respond with Channel.Close.

4.12.1 The Test.Integer Method

This method tests the peer's capability to correctly marshal integer data.

The Test.Integer method has the following specific fields:

- integer_1 (octet) - An octet integer test value.
- integer_2 (short) - A short integer test value.
- integer_3 (long) - A long integer test value.
- integer_4 (longlong) - A long long integer test value.
- operation (octet) - The client must execute this operation on the provided integer test fields and return the result.

This is the Test.Integer pseudo-structure:

```
define Test.Integer {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synctag  long     # synctag
    integer_1       octet    # octet test value
    integer_2       short    # short test value
    integer_3       long     # long test value
    integer_4       longlong # long-long test value
    operation       octet    # operation to test
}
```

Guidelines for implementors:

- The client MUST implement this method.
- The server MUST implement this method.
- This method is a synchronous request that expects one of: Test.Integer Ok unless there is an exception.
- The "operation" field MUST be one of: 1=add (value.), 2=min (value.), 3=max (value.).

4.12.2 The Test.Integer Ok Method

This method reports the result of an Integer method.

The Test.Integer Ok method has the following specific fields:

- result (longlong) - The result of the tested operation.

This is the Test.Integer Ok pseudo-structure:

```
define Test.Integer Ok {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synctag  long     # synctag
    result          longlong # result value
}
```

Guidelines for implementors:

- The client MUST implement this method.
- The server MUST implement this method.
- This method is a synchronous response. The sender MUST NOT expect a specific method in return, except as defined by the class grammar.

4.12.3 The Test.String Method

This method tests the peer's capability to correctly marshal string data.

The Test.String method has the following specific fields:

- string_1 (shortstr) - An short string test value.
- string_2 (longstr) - A long string test value.
- operation (octet) - The client must execute this operation on the provided string test fields and return the result.

This is the Test.String pseudo-structure:

```
define Test.String {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synctag  long     # synctag
    string_1        shortstr # short string test value
    string_2        longstr  # long string test value
    operation       octet    # operation to test
}
```

Guidelines for implementors:

- The client MUST implement this method.
- The server MUST implement this method.
- This method is a synchronous request that expects one of: Test.String Ok unless there is an exception.
- The "operation" field MUST be one of: 1=add (value.), 2=min (value.), 3=max (value.).

4.12.4 The Test.String Ok Method

This method reports the result of a String method.

The Test.String Ok method has the following specific fields:

- result (longstr) - The result of the tested operation.

This is the Test.String Ok pseudo-structure:

```
define Test.String Ok {
    method_class    octet    # class ID
    method_id       octet    # method ID
    method_flags    octet    # method flags
    method_synctag  long     # synctag
    result          longstr  # result value
}
```

Guidelines for implementors:

- The client MUST implement this method.
- The server MUST implement this method.
- This method is a synchronous response. The sender MUST NOT expect a specific method in return, except as defined by the class grammar.

4.12.5 The Test.Table Method

This method tests the peer's capability to correctly marshal field table data.

The Test.Table method has the following specific fields:

- table (table) - A field table of test values.
- integer_op (octet) - The client must execute this operation on the provided field table integer values and return the result.

- `string_op` (octet) - The client must execute this operation on the provided field table string values and return the result.

This is the `Test.Table` pseudo-structure:

```
define Test.Table {
    method_class      octet      # class ID
    method_id         octet      # method ID
    method_flags      octet      # method flags
    method_synctag    long       # synctag
    table             table      # field table of test values
    integer_op        octet      # operation to test on integers
    string_op         octet      # operation to test on strings
}
```

Guidelines for implementors:

- The client **MUST** implement this method.
- The server **MUST** implement this method.
- This method is a synchronous request that expects one of: `Test.Table Ok` unless there is an exception.
- The `"integer_op"` field **MUST** be one of: 1=add (value.), 2=min (value.), 3=max (value.).
- The `"string_op"` field **MUST** be one of: 1=add (value.), 2=min (value.), 3=max (value.).

4.12.6 The Test.Table Ok Method

This method reports the result of a Table method.

The `Test.Table Ok` method has the following specific fields:

- `integer_result` (longlong) - The result of the tested integer operation.
- `string_result` (longstr) - The result of the tested string operation.

This is the `Test.Table Ok` pseudo-structure:

```
define Test.Table Ok {
    method_class      octet      # class ID
    method_id         octet      # method ID
    method_flags      octet      # method flags
    method_synctag    long       # synctag
    integer_result     longlong   # integer result value
    string_result      longstr    # string result value
}
```

Guidelines for implementors:

- The client **MUST** implement this method.
- The server **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.

4.12.7 The Test.Content Method

This method tests the peer's capability to correctly marshal content. This method has no fields apart from the standard method header.

This is the `Test.Content` pseudo-structure:

```
define Test.Content {
    method_class      octet      # class ID
    method_id         octet      # method ID
    method_flags      octet      # method flags
    method_synctag    long       # synctag
}
```

Guidelines for implementors:

- The client **MUST** implement this method.
- The server **MUST** implement this method.
- This method is a synchronous request that expects one of: `Test.Content Ok` unless there is an exception.

4.12.8 The `Test.Content Ok` Method

This method reports the result of a `Content` method. It contains the content checksum and echoes the original content as provided.

The `Test.Content Ok` method has the following specific fields:

- `content_checksum` (long) - The 32-bit checksum of the content, calculated by adding the content into a 32-bit accumulator.

This is the `Test.Content Ok` pseudo-structure:

```
define Test.Content Ok {  
    method_class    octet      # class ID  
    method_id       octet      # method ID  
    method_flags    octet      # method flags  
    method_synctag   long       # synctag  
    content_checksum long       # content hash  
}
```

Guidelines for implementors:

- The client **MUST** implement this method.
- The server **MUST** implement this method.
- This method is a synchronous response. The sender **MUST NOT** expect a specific method in return, except as defined by the class grammar.