[MS-FSMW]:
Middleware Protocol Specification

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Revision Summary

Date	Revision History	Revision Class	Comments
11/06/2009	0.1	Major	Initial Availability
02/19/2010	1.0	Major	Updated and revised the technical content
03/31/2010	1.01	Editorial	Revised and edited the technical content
04/30/2010	1.02	Editorial	Revised and edited the technical content
06/07/2010	1.03	Editorial	Revised and edited the technical content
06/29/2010	1.04	Editorial	Changed language and formatting in the technical content.
07/23/2010	1.04	No change	No changes to the meaning, language, or formatting of the technical content.
09/27/2010	1.04	No change	No changes to the meaning, language, or formatting of the technical content.
11/15/2010	1.04	No change	No changes to the meaning, language, or formatting of the technical content.
12/17/2010	1.04	No change	No changes to the meaning, language, or formatting of the technical content.

Table of Contents

1 Introduction

This document specifies the Middleware Protocol Specification. This protocol provides a mechanism for an implementation to call methods that are located in a different address space over the network. A protocol client constructs parameters that it sends to the protocol server as part of the call message. The protocol server sends a return value to the protocol client in the response. In addition to the basic data types, applications exchange information encoded in the Cheetah data model. For more information, see [MS-FSCHT].

1.1 Glossary

The following terms are defined in [MS-GLOS]:

authentication
certificate
credential
Hypertext Transfer Protocol (HTTP)
Hypertext Transfer Protocol over Secure Sockets Layer (HTTPS)
Kerberos
NT LAN Manager (NTLM) Authentication Protocol
UTF-8

The following terms are defined in [MS-OFCGLOS]:

abstract object reference (AOR)
channel URI
Cheetah checksum
Cheetah entity
client proxy
FAST Search Interface Definition Language (FSIDL)
host name
name server
server interface

The following terms are specific to this document:

MAY, SHOULD, MUST, SHOULD NOT, MUST NOT: These terms (in all caps) are used as described in [RFC2119]. All statements of optional behavior use either MAY, SHOULD, or SHOULD NOT.

1.2 References

1.2.1 Normative References

We conduct frequent surveys of the normative references to assure their continued availability. If you have any issue with finding a normative reference, please contact dochelp@microsoft.com. We will assist you in finding the relevant information. Please check the archive site, http://msdn2.microsoft.com/en-us/library/E4BD6494-06AD-4aed-9823-445E921C9624, as an additional source.

[IEEE754] Institute of Electrical and Electronics Engineers, "Standard for Binary Floating-Point Arithmetic", IEEE 754-1985, October 1985, http://ieeexplore.ieee.org/servlet/opac?punumber=2355

[MS-DTYP] Microsoft Corporation, "Windows Data Types", January 2007.

[MS-FSCHT] Microsoft Corporation, "Cheetah Data Structure", November 2009.

[MS-KILE] Microsoft Corporation, "Kerberos Protocol Extensions", January 2007.

[MS-NLMP] Microsoft Corporation, "NT LAN Manager (NTLM) Authentication Protocol Specification", June 2007.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997, http://www.ietf.org/rfc/rfc2119.txt

[RFC2616] Fielding, R., Gettys, J., Mogul, J., et al., "Hypertext Transfer Protocol -- HTTP/1.1", RFC 2616, June 1999, http://www.ietf.org/rfc/rfc2616.txt

1.2.2 Informative References

[CORBA] Object Management Group, "Common Object Request Broker Architecture (CORBA/IIOP) Specification", http://www.omg.org/technology/documents/formal/corba_iiop.htm

[MSDN-MIDL] Microsoft Corporation, "Microsoft Interface Definition Language (MIDL)", http://msdn.microsoft.com/en-us/library/ms950375.aspx

[MS-GLOS] Microsoft Corporation, "Windows Protocols Master Glossary", March 2007.

[MS-OFCGLOS] Microsoft Corporation, "Microsoft Office Master Glossary", June 2008.

[RFC5234] Crocker, D., Ed., and Overell, P., "Augmented BNF for Syntax Specifications: ABNF", STD 68, RFC 5234, January 2008, http://www.ietf.org/rfc/rfc5234.txt

1.3 Protocol Overview (Synopsis)

This protocol specifies a mechanism for an application to call methods that are located in a different address space over the network. Input values to the method are sent as part of the call message and return values are sent in the response. In addition to the basic data types, applications exchange information encoded as Cheetah entities. The procedure for serializing Cheetah entities is described in [MS-FSCHT].

This section presents a brief overview of the following:

- The remote method call model
- Localizing and binding protocol servers
- Fundamental interfaces

1.3.1 Remote Method Call Model

This protocol specifies how to call a method when the calling application and the target method are located in different address spaces. The following figure is an example.

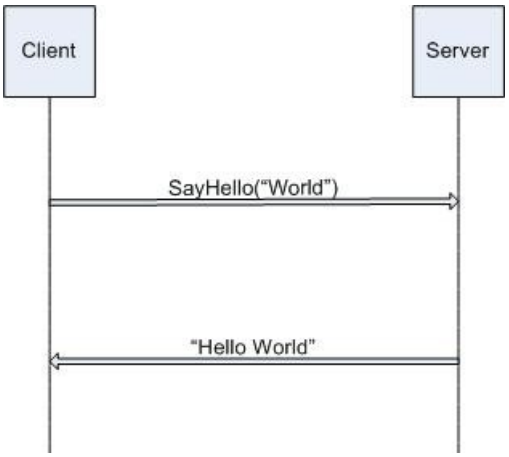


Figure 1: The Middleware protocol

This protocol specifies two roles: protocol client and protocol server. The protocol client initiates communication by calling a remote method with input values and a **client proxy**. The server object receives the request from the client proxy, processes the method as specified in the parameters in the request, and sends a return value to the client proxy, which then sends it to the protocol client.

The remote method sends user exceptions to the protocol client when errors occur during processing in the implementation-specific part of the protocol server. Generic protocol server errors such as connection errors, data validity errors, and availability errors are returned to the protocol client as system exceptions. Server objects and client proxies are represented as **abstract object references** (AOR) when associated with remote methods as parameters or return values. The following figure shows a protocol client that sends an abstract object reference to a protocol server, where the protocol server uses the abstract object reference to call back to the protocol client.

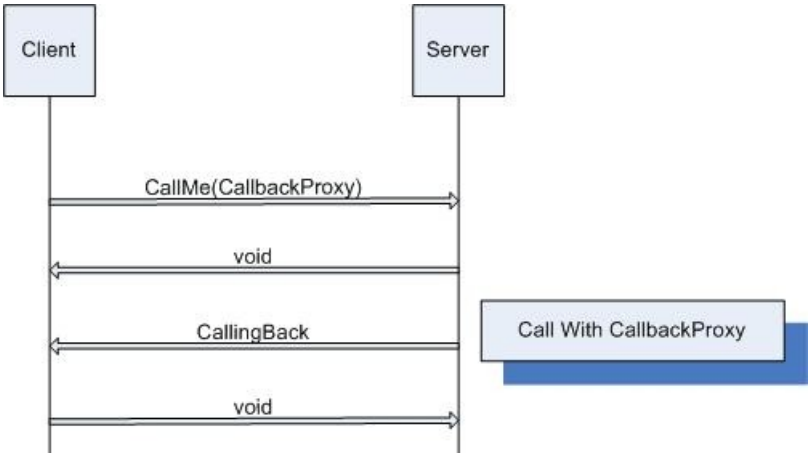


Figure 2: An abstract object reference sent by the protocol client and then used by the protocol server to call back the protocol client

1.3.2 Localizing and Binding Servers

A protocol client requires an abstract object reference to create a client proxy that communicates with a specified server object. When a server object is instantiated, a server object URI is constructed from the AOR, and includes information such as the network **host name** and port of the

server object. Likewise, client proxies create a server method URI from the AOR to call a remote method.

A **name server** associates logical names with server objects so that protocol clients and protocol servers do not explicitly manage AORs. Protocol clients contact the name server to request a server object specified by its logical name. An example is shown in the following figure, where the protocol client looks up the reference to the "Hello" server object in the name server, creates a client proxy based on the AOR and calls the **SayHello** method on the server object.

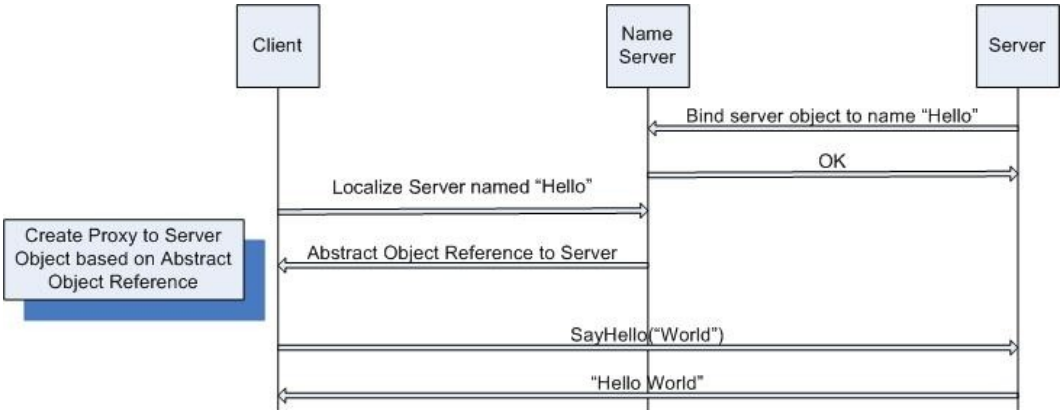


Figure 3: Binding a server object to the logical name "Hello" in the name server

By using the name server, protocol clients and protocol servers explicitly manage only the AOR that represents the name server. They use the name server to localize all other server objects. The **server interface** implemented by the name server is described in section 3.4.

1.3.3 Fundamental Interfaces

In addition to the name server, this protocol specifies two fundamental server interfaces that are implemented by applications that use this protocol. The first interface specifies controls and queries for runtime states, including whether the protocol server is running, suspended, terminating, or stopped. This interface is described in section 3.8.

The second interface queries the protocol server for runtime statistics such as the average duration of method processing, or the values of implementation-specific parameters. The interface is described in section 3.6.

1.4 Relationship to Other Protocols

This protocol specifies how to convert a remote method into an exchange of encoded messages. User applications are layered on top of this protocol and use its services for application-specific purposes.

This protocol depends on other structures and protocols to encode and transport its messages. Cheetah entities specify additional data types to encode nested and tree-structured data structures. Transmission on the wire is performed using the Hypertext Transfer Protocol (**HTTP**) or the Hypertext Transfer Protocol over the Secure Sockets Layer (**HTTPS**), and protocol client **authentication (2)** is optionally done through either the NT LAN Manager (NTLM) Authentication Protocol (**NTLM**) or **Kerberos**.

1.5 Prerequisites/Preconditions

The protocol server deploys a **certificate (1)** if the HTTPS transport is used. Typically, protocol clients and protocol servers are deployed with a name server protocol server to avoid managing abstract object references explicitly.

This protocol does not specify any means to activate a protocol server or protocol client. The protocol server is configured to listen on a **channel URI** as specified by the implementation. For more information about channel URIs, see section 3.2.1, Abstract Data Model.

Protocol clients and protocol servers need to agree on the remote method specifications and the Cheetah entity specifications.

1.6 Applicability Statement

This protocol calls remote methods in a distributed environment. It is designed for use on private networks, and is not appropriate for use on public networks. For more information, see section 5.1, Security Considerations for Implementers.

1.7 Versioning and Capability Negotiation

This document covers versioning issues in the following areas:

- **Supported Transports:** This protocol can be implemented on top of HTTP/HTTPS.
- **Protocol Versions:** There is only one version of this protocol.
- **Security and Authentication Methods:** The protocol relies on the security provided by HTTPS, NTLMv1, NTLMv2, and Kerberos. The protocol does not have any security provisions of its own.

1.8 Vendor-Extensible Fields

None.

1.9 Standards Assignments

None.

2 Messages

2.1 Transport

This protocol uses HTTP transport as specified in [RFC2616] to transmit method requests and responses. The protocol client sends a message as part of an HTTP request, and the protocol server replies with an HTTP response. Port 80 is the standard port assignment for HTTP and port 443 is the standard port assignment for HTTPS. Use of other ports is implementation-dependent.

If the application that calls this protocol requires NTLM authentication [MS-NLMP] or Kerberos authentication [MS-KILE], the application MUST provide implementation-specific **credentials** as either a user name/password or a certificate. This protocol MUST NOT process the credentials or authentication information, because processing is implementation-dependent.

The calling application MUST specify the maximum number of octets that the HTTP request and response message body can contain.

2.2 Common Data Types

This section specifies the structures of the common types that are supported by this protocol. A protocol type is identified by a case-sensitive name, and specifies the structure of data. This protocol supports the **BYTE**, **INT32** and **INT64** types specified in [MS-DTYP] in addition to single-precision IEEE floating-point. The byte-ordering of the **INT32** and **INT64** data types MUST be big-endian. The signed data types use two's complement to represent the negative numbers.

The *cht::core* Cheetah entities specified by this protocol and the corresponding Cheetah type identifiers are specified in the following table.

cht::core Cheetah entities	Cheetah type identifier
alloc	0
named_value	1
bool_value	2
scope	5
resource_report	6
float_value	8
long_value	10
string_value	11
longlong_value	12

The **Cheetah checksum** for *cht::core* entities MUST be -1479218033.

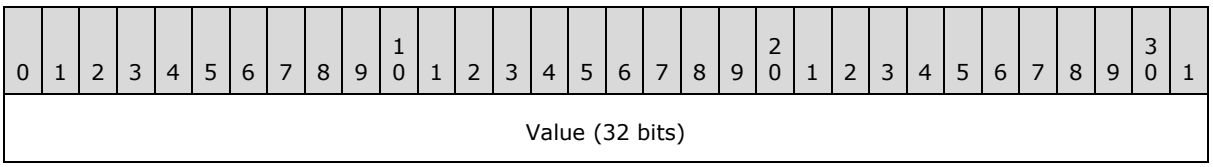
The *cht::nameservermsg* Cheetah entities specified by this protocol and the corresponding Cheetah type identifiers are specified in the following table.

cht::nameservermsg Cheetah entities	Cheetah type identifier
aor	0

cht::nameservermsg Cheetah entities	Cheetah type identifier
aor_list	1

The Cheetah checksum for *cht::nameserver* entities MUST be 277807848.

2.2.1 Float



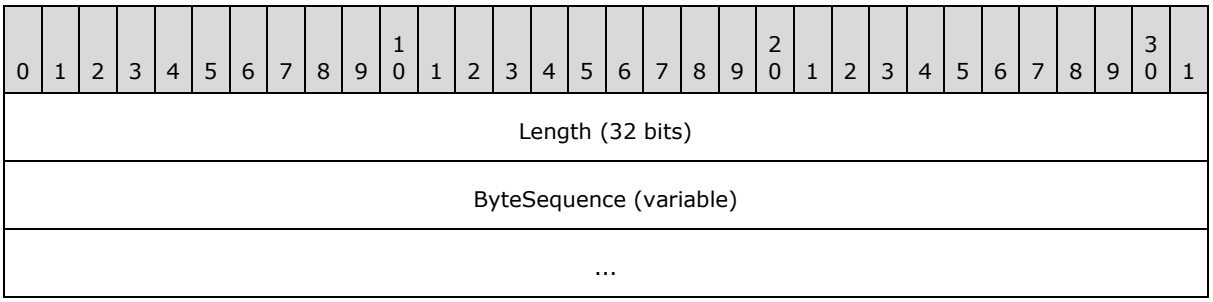
Value (32 bits): A 32-bit single-precision floating-point field, as specified in [IEEE754]. **Float** values range from negative 3.402823e38 to positive 3.402823e38.

2.2.2 Void

This represents an empty data value.

2.2.3 LengthPrefixedByteSequence

This represents a sequence of **BYTE** values.

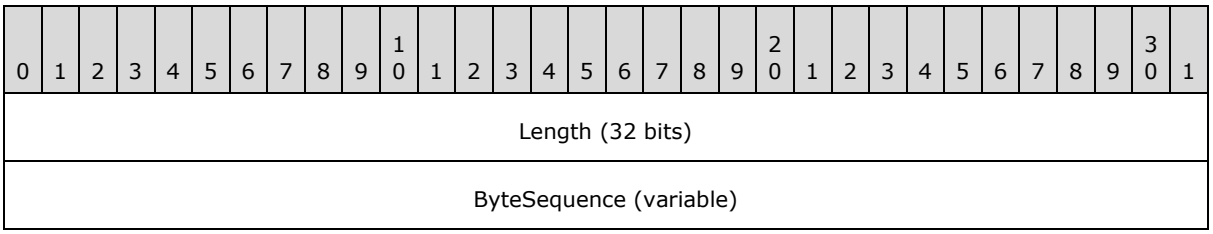


Length (32 bits): An **INT32** that represents the length of the sequence. The value MUST be 0 or a positive number.

ByteSequence (variable): A sequence of **BYTE** values. The number of **BYTE** values MUST be equal to the *Length* field.

2.2.4 String

This represents a **UTF-8** encoded string, and is prefixed by a value that specifies the number of **BYTE**s that represent the encoded string.



...

Length (32 bits): An **INT32** that represents the length of the sequence. The value MUST be 0 or a positive number.

ByteSequence (variable): A sequence of **BYTE** values. The number of **BYTE** values MUST be equal to the *Length* field.

2.2.5 LengthPrefixedInt32Sequence

This represents a sequence of **INT32** values.

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
Length (32 bits)																															
Int32Sequence (variable)																															
...																															

Length (32 bits): An **INT32** that represents the length of the sequence. The value MUST be 0 or a positive number.

Int32Sequence (variable): A sequence of **INT32** values. The number of **INT32** values is specified in the *Length* field.

2.2.6 LengthPrefixedInt64Sequence

This represents a sequence of **INT64** values.

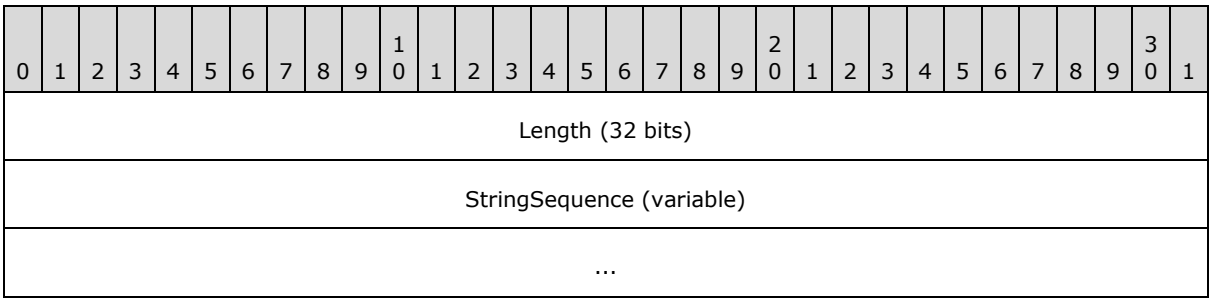
0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
Length (32 bits)																															
Int64Sequence (variable)																															
...																															

Length (32 bits): An **INT32** that represents the length of the sequence. The value MUST be 0 or a positive number.

Int64Sequence (variable): A sequence of **INT64** fields. The number of **INT64** fields is specified in the *Length* field.

2.2.7 LengthPrefixedStringSequence

This represents a sequence of *String* fields. The length MUST be of type **INT32**, and specifies the number of *String* elements in the sequence.

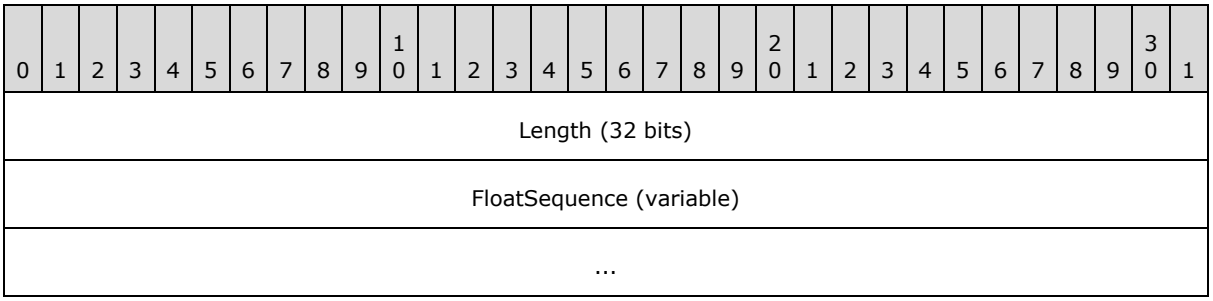


Length (32 bits): An **INT32** that represents the length of the sequence. The value MUST be 0 or a positive number.

StringSequence (variable): A sequence of *String* fields, as specified in section 2.2.4. The number of *String* fields is specified in the *Length* field.

2.2.8 LengthPrefixedFloatSequence

This represents a sequence of **Float** values.

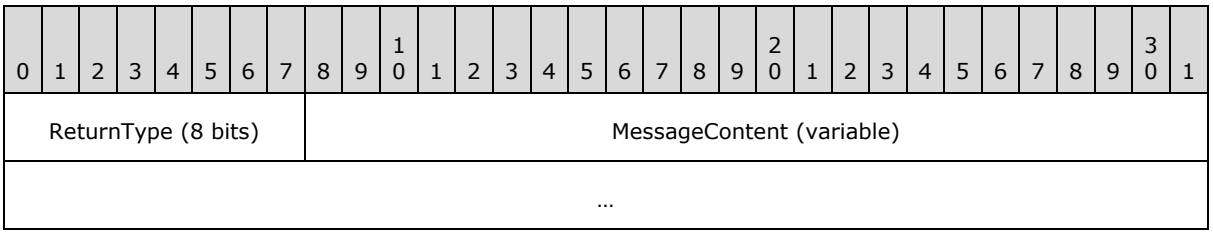


Length (32 bits): An **INT32** that represents the length of the sequence. The value MUST be 0 or a positive number.

FloatSequence (variable): A sequence of **Float** values, as specified in section 2.2.1. The number of **Float** values is specified in the *Length* field.

2.2.9 OutputValue

This represents the protocol server response resulting from a remote method invocation at the server object.

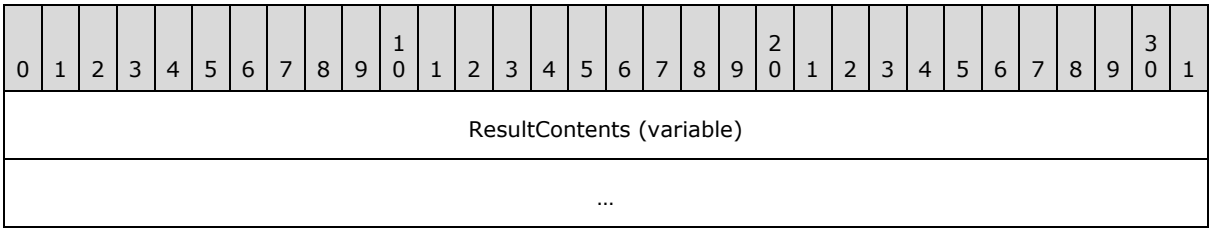


ReturnType (8 bits): A **BYTE** value that MUST contain the value 48, 49, or 50. If the value is 48, the *MessageContent* field contains a *CallResult* message. If the value is 49, the *MessageContent* field contains a *UserException*. If the value is 50, the *MessageContent* field contains a *SystemException*.

MessageContent (variable): MUST contain a *CallResult*, *UserException*, or *SystemException* record.

2.2.10 CallResult

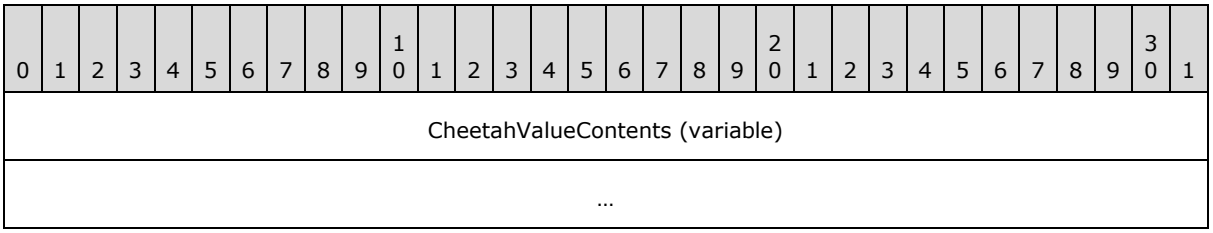
This represents the result value from invoking a remote method call.



ResultContents (variable): MUST be a field of type **Void**, **BYTE**, **INT32**, **INT64**, **Float**, **String**, **LengthPrefixedByteSequence**, **LengthPrefixedStringSequence**, **LengthPrefixedInt32Sequence**, **LengthPrefixedInt64Sequence**, **LengthPrefixedFloatSequence**, **AbstractObjectReference**, or **CheetahValue**.

2.2.11 CheetahValue

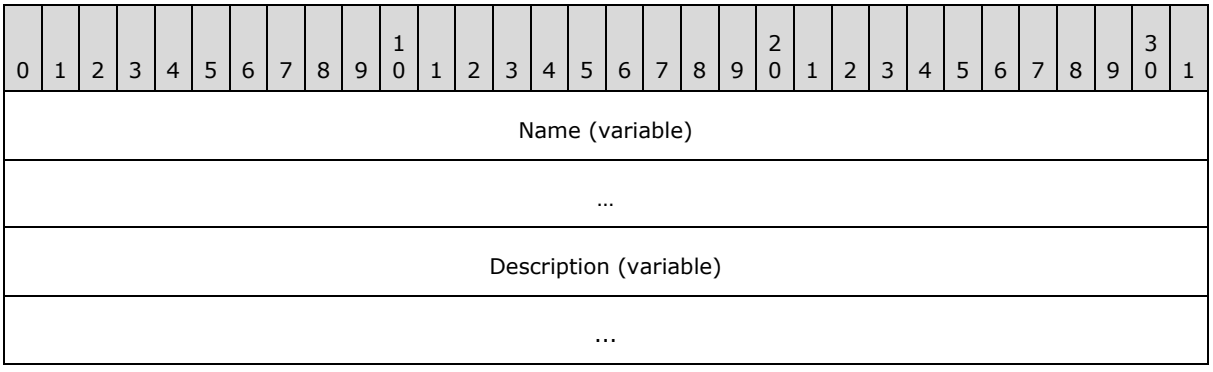
This represents the Cheetah entity in serialized form, as specified in [MS-FSCHT] section 2.



CheetahValueContents (variable): MUST be a single Cheetah entity.

2.2.12 SystemException

This represents a system exception thrown by the protocol server. The *SystemException* record is identified with a *Name* field and a *Description* field.

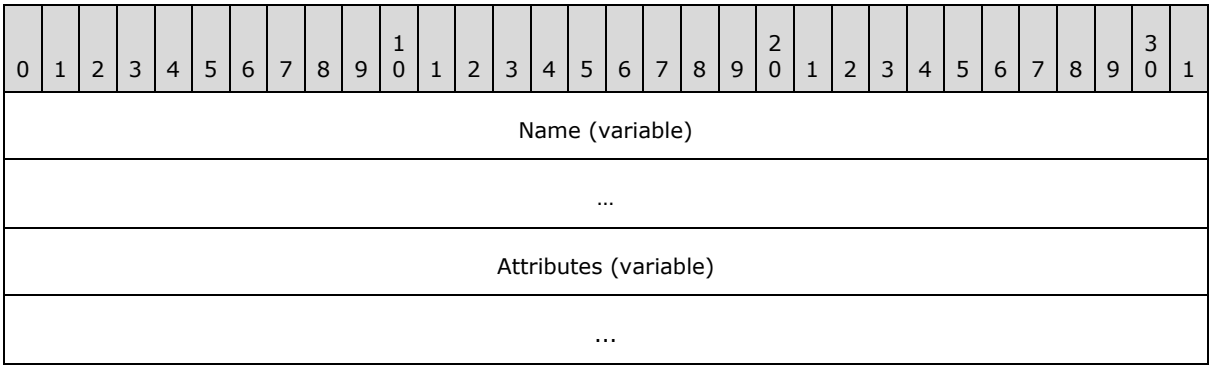


Name (variable): A *String* field that MUST contain the value "system_exception".

Description (variable): A *String* field that contains the description of the system exception.

2.2.13 UserException

This represents an exception thrown by the implementation-specific part of a remote method in a server object. The *UserException* record is identified with a *Name* field and, optionally, a set of *Attributes* fields.

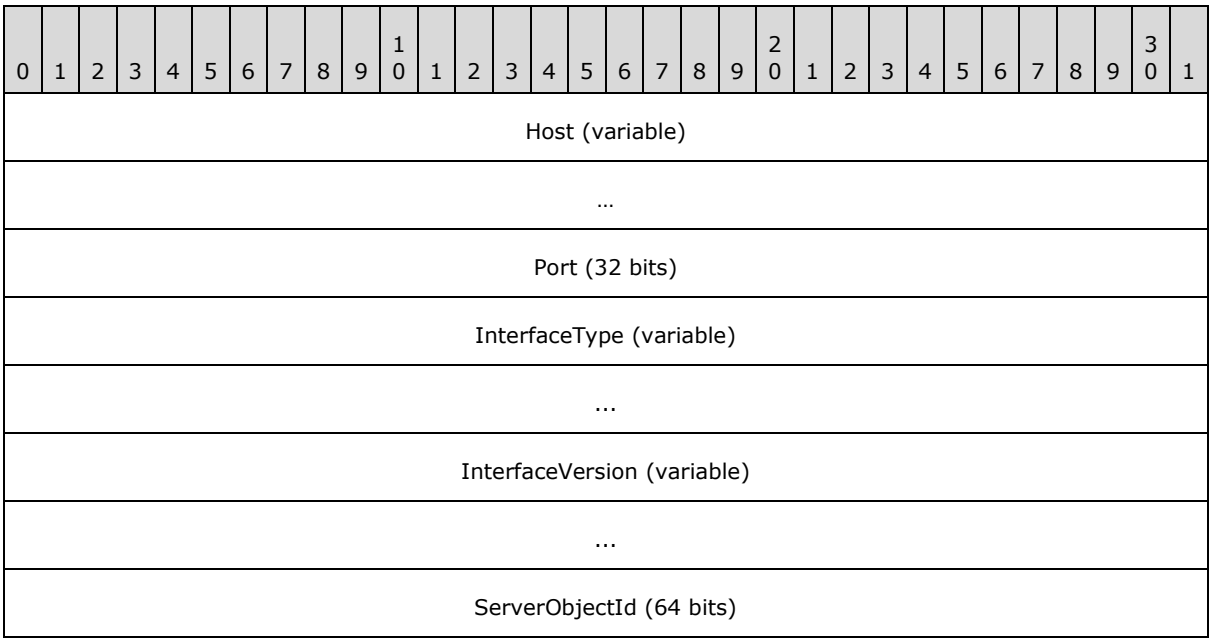


Name (variable): A *String* field that represents the name of the *UserException*.

Attributes (variable): This contains 0 or more fields of type **BYTE**, **INT32**, **INT64**, **Float**, or **String**. If no fields are represented, the *Attributes* field MUST contain the value **Void**. Values are not padded to a byte boundary when more than 1 value is represented

2.2.14 AbstractObjectReference

This represents a server object that is sent between a protocol client and a protocol server.



Host (variable): A *String* field that contains a host name.

Port (32 bits): An **INT32** field that contains a port number that MUST be in the range 0-65535.

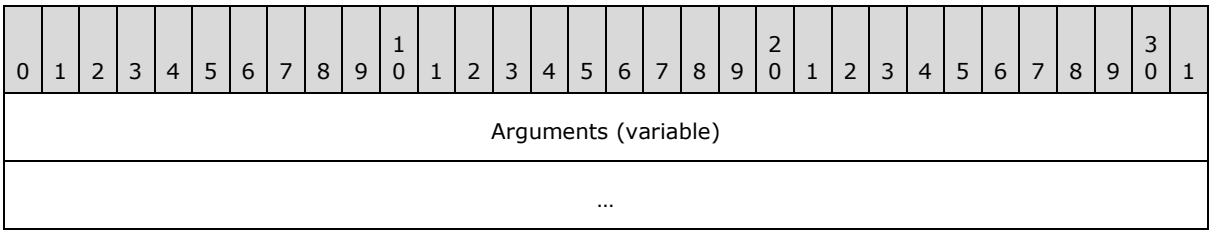
InterfaceType (variable): A *String* field that contains the name of the server interface.

InterfaceVersion (variable): A *String* field that contains the server interface version.

ServerObjectId (64 bits): An **INT64** field that contains the server object identifier.

2.2.15 CallArguments

This represents the input values specified by the protocol client. The input values are specified by one or more *Arguments* fields.



Arguments (variable): Contains 0 or more values of type **BYTE**, **INT32**, **INT64**, **Float**, **String**, **CheetahValue**, **AbstractObjectReference**, **LengthPrefixedByteSequence**, **LengthPrefixedInt32Sequence**, **LengthPrefixedInt64Sequence**, **LengthPrefixedFloatSequence**, or **LengthPrefixedStringSequence**. If no values are represented, the *Arguments* field MUST be the **Void** value. Values are not padded when more than 1 value is represented.

2.2.16 ServerObjectURI

This represents the server object URI. The server object URI is the path segments of the HTTP Request-URI that identifies a server object, and is thus a prefix of the *ServerMethodURI*. The *ServerObjectURI* is a URI path that consists of the following three path segments, delimited by the "/" character:

InterfaceType: Represents the protocol server interface.

InterfaceVersion: Represents the server interface version.

ServerObjectId: A 64-bit number in decimal digit form that represents the server object identifier.

The following string pattern using Augmented Backus-Naur Form (ABNF) syntax specified in [RFC5234] specifies the **ServerObjectURI**:

```
InterfaceType     =     1*(ALPHA / DIGIT / "_") "::" 1*(ALPHA / DIGIT / "_")
InterfaceVersion  =     1*DIGIT "." 1*DIGIT
ServerObjectId    =     1*DIGIT
ServerObjectURI   =     InterfaceType "/" InterfaceVersion "/" ServerObjectId
```

For example, in the *ServerMethodURI* string "core::fds_component/1.2/42", the *InterfaceType* field is "core::fds_component", the *InterfaceVersion* field contains "1.2", and the *ServerObjectId* field is "42".

2.2.17 ServerMethodURI

This represents a specific remote method. It MUST contain a *ServerObjectURI* that specifies which server object contains the remote method.

MethodName: Represents the name of a remote method.

ServerMethodURI: URI specified in the following string pattern, using Augmented Backus-Naur Form (ABNF) syntax specified in [RFC5234].

```
MethodName          =     1*(ALPHA / DIGIT / "_")
ServerMethodURI     =     ServerObjectURI "/" MethodName
```

For example, in the *ServerMethodURI* string "core::fds_component/1.2/42/get_resource_report", the *MethodName* is "get_resource_report" and the *ServerObjectURI* is "core::fds_component/1.2/42".

2.2.18 cht::nameservermsg::aor

This represents an abstract object reference, and is specified by the following Cheetah entity:

```
root entity aor
{
  attribute string host;
  attribute int port;
  attribute string interface_type;
  attribute string interface_version;
  attribute longint object_id;
  attribute string bound_name;
};
```

host: A **string** that represents the host name of the server object.

port: A field of type **int** that represents the port number of the server object.

interface_type: A **string** that represents the interface of the server object.

interface_version: A **string** that represents the version of the interface.

object_id: A field of type **longint** that represents the identifier of the server object.

bound_name: A **string** that represents the *name* field in the logical name associated with this abstract object reference, as specified in section 3.4.1.

The *cht::nameservermsg::aor* attributes are mapped to *AbstractObjectReference* fields except the bound_name attribute, as specified in section 2.2.14, and in the following table.

cht::nameservermsg::aor attributes	AbstractObjectReference fields
Host	Host
Port	Port
interface_type	InterfaceType

cht::nameservermsg::aor attributes	AbstractObjectReference fields
interface_version	InterfaceVersion
object_id	ServerObjectId

The Cheetah entity attributes are the same as the corresponding *AbstractObjectReference* fields.

2.2.19 cht::nameservermsg::aor_list

This represents a collection of *cht::nameservermsg::aor*, and is specified by the following Cheetah entity:

```
root entity aor_list
{
  collection aor aors;
};
```

aors: A collection of *cht::nameservermsg::aor* Cheetah entities, as specified in section 2.2.18.

2.2.20 nameservice::nameserver::not_bound_exception

This states that there is no association between a given logical name, as specified in section 3.4.1, and an AOR in the name server. The **FAST Search Interface Definition Language (FSIDL)** specification for the exception is as follows:

```
exception not_bound_exception {};
```

2.2.21 nameservice::nameserver::resolve_exception

This states that a specified Logical Name, as specified in section 3.4.1, does not exist in the name server. The FSIDL specification for the exception is as follows:

```
exception resolve_exception {};
```

2.2.22 cht::core::resource_report

This represents a resource allocation report based on the resource allocation table, resource scope table, and resource value table of the protocol server, as specified in section 3.6.1. The *cht::core::resource_report* is specified by the following Cheetah entity:

```
root entity resource_report {
  attribute longint when;
  collection alloc allocs;
  collection scope scopes;
  collection named_value values;
};
```

when: A field of type **longint** that represents the time in number of seconds since January 1, 1970.

allocs: A collection of *cht::core::alloc* Cheetah entities, as specified in section 2.2.23.

scopes: A collection of *cht::core::scope* Cheetah entities, as specified in section 2.2.24.

values: A collection of *cht::core::named_value* Cheetah entities, as specified in section 2.2.25.

2.2.23 cht::core::alloc

This represents an implementation-specific counter that counts named resources such as files or memory units in the server object. The content is based on an entry of the resource allocation table, as specified in section 3.6.1. The *cht::core::alloc* is specified by the following Cheetah entity:

```
entity alloc {
  attribute string name;
  attribute int current;
  attribute int total;
};
```

name: A field of type **string** that represents the name of the resource allocation.

current: A field of type **int** that represents the current number of resource allocations.

total: A field of type **int** that represents the total number of resource allocations.

2.2.24 cht::core::scope

This represents an implementation-specific name specified by a well-formed set of programming language statements, typically in a function or method within the server object. The content of a resource scope is based on an entry in the resource scope table, as specified in section 3.6.1. The *cht::core::scope* is specified by the following Cheetah entity:

```
entity scope {
  attribute string name;
  attribute int current;
  attribute int total;
  attribute int min_time;
  attribute int max_time;
  attribute int avg_time;
};
```

name: A **string** that represents the name of the resource scope.

current: A field of type **int** that represents the current number of calls for this resource scope.

total: A field of type **int** that represents the total number of calls for this resource scope.

min_time: A field of type **int** that represents the minimum time in milliseconds used for a call of this resource scope.

max_time: A field of type **int** that represents the maximum time in milliseconds used for a call of this resource scope.

avg_time: A field of type **int** that represents the average time in milliseconds used for a call of this resource scope.

2.2.25 cht::core::named_value

This represents a resource value, which is an implementation-specific field that is associated with a unique name within the server object. The content is based on an entry in the resource value table, as specified in section 3.6.1.

The *cht::core::named_value* Cheetah entity is subtyped by the following Cheetah entities: *cht::core::bool_value, cht::core::float_value, cht::core::string_value, cht::core::long_value*, and *cht::core::longlong_value*.

The *cht::core::named_value* is specified by the following Cheetah entity:

```
entity named_value {
  attribute string name;
};
```

name: A string that represents the name of the resource value.

2.2.26 cht::core::bool_value

This is a subtype of the *cht::core::named_value* that represents a resource value of type **BOOL** and is specified by the following Cheetah entity:

```
entity bool_value : named_value {
  attribute bool value;
};
```

value: A field of type **BOOL** that represents the value.

2.2.27 cht::core::float_value

This is a subtype of the *cht::core::named_value* that represents a resource value of type **float** and is specified by the following Cheetah entity:

```
entity float_value : named_value {
  attribute float value;
};
```

value: A field of type **float** that represents the value.

2.2.28 cht::core::string_value

This is a subtype of the *cht::core::named_value* that represents a resource value of type **string** and is specified by the following Cheetah entity:

```
entity string_value : named_value {
  attribute string value;
};
```

value: A **string** that represents the value.

2.2.29 cht::core::long_value

This is a subtype of the *cht::core::named_value* that represents a resource value of type **int** and is specified by the following Cheetah entity:

```
entity long_value : named_value {
  attribute int value;
};
```

value: A field of type **int** that represents the value.

2.2.30 cht::core::longlong_value

This is a subtype of the *cht::core::named_value* that represents a resource value of type **longint** and is specified by the following Cheetah entity:

```
entity longlong_value : named_value {
  attribute longint value;
};
```

value: A field of type **longint** that represents the value.

2.2.31 core::lifecycle::state

This specifies the four runtime states for a protocol server process: **initializing**, **running**, **suspended**, and **terminating**, as specified in section 3.8.1. The FSIDL specification for the enumeration is as follows:

```
enum state {
  initializing, running, suspended, terminating
};
```

3 Protocol Details

3.1 Common Middleware Details

3.1.1 Abstract Data Model

This section describes a conceptual model of possible data organization that an implementation maintains to participate in this protocol. The described organization is provided to facilitate the explanation of how the protocol behaves. This document does not mandate that implementations adhere to this model as long as their external behavior is consistent with that described in this document.

The middleware data model represents defined data structures and values that are implementation-specific, as well as the remote method invocation input values, return values, or any system or user exceptions resulting from the invocation. FSIDL specifies the middleware data model instead of mapping to a specific programming language. Section 3.1.4.1 contains information about FSIDL specifications, and specifies how to map the FSIDL notation into the corresponding middleware types.

Middleware type

A middleware type is identified by a case-sensitive name, and specifies the structure of data. FSIDL notation refers to the name of the type. The middleware data model supports the **BYTE**, **INT32**, and **INT64** types specified in [MS-DTYP]. In addition, the middleware data model specifies the following types:

- **Float:** Represents a 32-bit single-precision floating-point value, as specified in section 2.2.1.
- **Void:** A type that specifies no value, as specified in section 2.2.2.
- **LengthPrefixedByteSequence:** A sequence of **BYTE** values, as specified in section 2.2.3.
- **String:** A sequence of **BYTE** values that represents a **String**, as specified in section 2.2.4.
- **LengthPrefixedInt32Sequence:** A sequence of **INT32** values, as specified in section 2.2.5.
- **LengthPrefixedInt64Sequence:** A sequence of **INT64** values, as specified in section 2.2.6.
- **LengthPredixedStringSequence:** A sequence of **String** values, as specified in section 2.2.7.
- **LengthPrefixedFloatSequence:** A sequence of **Float** values, as specified in section 2.2.8.
- **CheetahValue:** A Cheetah entity, as specified in section 2.2.11.
- **AbstractObjectReference:** An abstract object reference, as specified in section 2.2.14.
- **SystemException:** A system exception, as specified in section 2.2.12.
- **UserException:** A user exception, as specified in section 2.2.13.

Middleware data value

A middleware data value is an instance of a middleware type.

Server interface

This encapsulates a set of method declarations. Multiple versions of the same protocol server interface can be instantiated in the same protocol server.

Server interface version

This represents the version of a specific server interface.

Server object

An instance of a server interface that is associated with the specified version and server object identifier.

Server object identifier

A number that is unique for each server object within the network host where the server object is instantiated.

Client proxy

This sends information to the protocol server used to call the remote methods on the server object. The client proxy uses an abstract object reference to refer to the server object.

Abstract object reference

This represents a server object that is sent between a protocol client and a protocol server. It contains sufficient information to construct a client proxy that calls remote methods on the server object. More specifically, an abstract object reference for a specified server object is identified by the following:

- **Host Name:** The host name where the server object executes.
- **Port Number:** The port number associated with the server object.
- **Server Interface:** The server interface of the server object.
- **Server Interface Version:** The server interface version of the server object.
- **Server Object Identifier:** The identifier of the server object.

The abstract object reference is represented by the *AbstractObjectReference* record specified in section 2.2.14.

Remote method

Represents a method that is called remotely and that is declared in a server interface. The specification of a remote method contains the following:

- **Name:** The name of the remote method. A remote method is uniquely identified within a protocol server interface by the remote method *Name*.
- **Arguments:** An ordered collection of *Argument*, where each *Argument* has a name and a *Middleware type*.
- **Exceptions:** A collection of user exceptions that the remote method throws. Each user exception has a name.
- **Return Type:** The type of the value returned by the remote method.

The remote method request and response consist of the following:

- **Name:** The name of the remote method.
- **Input Values:** An ordered collection of values, one for each remote method *Argument* field. Each value is a *Middleware data value*. The input values are represented by the *CallArguments* record specified in section 2.2.15.
- **Return Value:** The value that contains the result of the remote method, in an *OutputValue* record, as specified in section 2.2.9. The *OutputValue* record contains one of three possible results from a remote method:

A value with the same type as the *Return Type* field returned by the remote method. The value returned from a remote method is represented by the *CallResult* record specified in section 2.2.10.

A system exception that represents a processing error associated with a remote method. A system exception contains a human-readable message that specifies the error. If a human-readable message is not possible to infer from the underlying error, an empty message or the message "N/A" is used. A system exception is represented by the *SystemException* record specified in section 2.2.12.

A user exception that represents an implementation-specific processing error associated with a remote method. A user exception is represented by the *UserException* record specified in section 2.2.13.

3.1.2 Timers

None.

3.1.3 Initialization

None.

3.1.4 Message Processing Events and Sequencing Rules

The following specifies the format of FSIDL specifications, how to map FSIDL specifications to remote method specifications, and how data types in FSIDL specifications are mapped to the corresponding middleware types.

3.1.4.1 FSIDL Specifications

Applications use this protocol to specify server interfaces with FSIDL specifications. An implementation of this protocol does not require the use of FSIDL, whose notation specifies the interfaces between protocol clients and protocol servers .

FSIDL specifications resemble MIDL specifications, as described in [MSDN-MIDL], and provide a subset of the OMG IDL language, as described in [CORBA]. The following string pattern, using Augmented Backus-Naur Form (ABNF) syntax specified in [RFC5234], specifies the FSIDL specifications:

```
FSIDLSpecification = (Cheetah / (Cheetah FSIDL) / FSIDL) LWSP ";"
Cheetah = "module" LWSP "cht" LWSP "{" LWSP 1*CheetahModuleDecl LWSP ";" LWSP "}"
CheetahModuleDecl = "module" LWSP CheetahModule LWSP "{" LWSP CheetahTypedef LWSP
1*CheetahEntityTypeDef LWSP "}"
CheetahTypedef = "typedef" LWSP "sequence" LWSP "<" LWSP "octet" LWSP ">" LWSP "cheetah" LWSP
";"
CheetahEntityTypedef = "typedef" LWSP "cheetah" LWSP CheetahEntity LWSP ";"
CheetahModule = Name
```

```
CheetahEntity = Name
CheetahEntityName = "cht::" CheetahModule "::" CheetahEntity
FSIDL = "module" LWSP "interfaces" LWSP "{" LWSP 1*FSIDLModule LWSP "}"
FSIDLModule = "module" LWSP FSIDLModuleName LWSP "{" LWSP 1*Definition LWSP "}" LWSP ";"
FSIDLModuleName = Name
Definition = EnumDecl LWSP ";" / TypedefDecl LWSP ";" / ExceptionDecl LWSP ";" / ForwardDecl
LWSP ";" / InterfaceDecl LWSP ";"
EnumDecl = "enum" LWSP EnumName LWSP "{" LWSP EnumList LWSP "}"
EnumList = Enum 1*(LWSP "," LWSP Enum)
EnumName = Name
Enum = Name
TypedefDecl = "typedef" LWSP TypeSpecification LWSP TypeName
TypeSpecification = AtomicType / SequenceType
TypeName = Name
AtomicType = IntegerType / CharType / BooleanType / FloatType / OctetType / StringType
SequenceType = "sequence" LWSP "<" LWSP (IntegerType / CharType / OctetType / FloatType /
StringType) LWSP ">"
IntegerType =  ("long" / "long" LWSP "long")
CharType = "char"
OctetType = "octet"
FloatType = "float"
BooleanType = "bool"
StringType = "string"
ExceptionDecl = "exception" LWSP ExceptionName LWSP "{" LWSP [ExceptionAttributes] "}"
ExceptionName = Name
ExceptionAttributes = AtomicType LWSP TypeName LWSP ";"
ForwardDecl = "interface" LWSP InterfaceName
InterfaceDecl = "interface" LWSP InterfaceName LWSP [InheritsInterface] LWSP "{" LWSP
InterfaceBody LWSP "}"
InheritsInterface = ":" LWSP InterfaceName
InterfaceName = NamespaceName
NamespaceName = Name ["::" Name]
InterfaceBody = [InterfaceVersionDecl] 1*MethodDecl
InterfaceVersionDecl = "#pragma" LWSP "version" LWSP InterfaceVersion
InterfaceVersion = (1*DIGIT "." 1*DIGIT)
MethodDecl = ReturnType LWSP MethodName LWSP Arguments [LWSP RaisesDecl]
ReturnType = TypeSpecification / InterfaceName / CheetahEntityName / EnumName / "void"
MethodName = Name
RaisesDecl = "raises" LWSP "(" LWSP RaisesExceptions LWSP ")"
RaisesExceptions = NamespaceName *(LWSP "," LWSP NamespaceName)
Arguments = "(" LWSP Argument *(LWSP "," LWSP Argument) LWSP ")" / "(" LWSP "void" LWSP ")" /
"(" LWSP ")"
Argument = "in" LWSP ArgumentType LWSP ArgumentName
ArgumentName = Name
ArgumentType = TypeSpecification / InterfaceName / CheetahEntityName / EnumName
Name = ALPHA *(ALPHA / DIGIT / "_")
```

The following uses the notation "FSIDL RuleName" when referring to a rule RuleName that is specified by the previous ABNF grammar.

3.1.4.2 Mapping FSIDL MethodDecl to Remote Method Specifications

The FSIDL MethodDecl specifies the *name*, *Arguments*, *Exceptions*, and *Return Type* of the remote method. The FSIDL ReturnType statement specifies the *Return Type* of the remote method, the FSIDL MethodName statement the name of the remote method, the FSIDL Arguments specifies the *Arguments* of the remote method, and the FSIDL RaisesExceptions specifies the *Exceptions* of the remote method.

3.1.4.3 Mapping Remote Method Request

The name of the remote method is specified by the FSIDL ArgumentName. The middleware type for each *Argument* of the remote method *Arguments* is specified by the FSIDL ArgumentType. The input values of the remote method MUST be serialized as a *CallArguments* record, as specified in section 2.2.15. Each *Argument* field in the *CallArguments* record MUST contain the value that corresponds to the type specified by the FSIDL ArgumentType. The input values of the remote method MUST be serialized in same order as the FSIDL Arguments.

3.1.4.4 Mapping Remote Method Reply

This consists of a *CallResult* record which contains a value, a system exception, or a user exception. The FSIDL ReturnType specifies the *Return Type* for the remote method **Return Value**. The remote method **Return Value** MUST be serialized as a *CallResult* record, as specified in section 2.2.10. The *ResultContents* field MUST contain the serialized **Return Value**.

3.1.4.5 Mapping FSIDL AtomicType

The following table specifies the mapping between types specified by the FSIDL AtomicType and the corresponding protocol types.

For FSIDL BooleanType, the **BYTE** value 0 represents **false**, and the **BYTE** value 1 represents **true**.

For FSIDL StringType, and empty string MUST be serialized as a **String** record, as specified in section 2.2.4, with the **Length** field set to 0.

FSIDL Atomic type	Protocol Type
char	**BYTE**, as specified in [MS-DTYP].
octet	**BYTE**, as specified in [MS-DTYP].
boolean	**BYTE**, as specified in [MS-DTYP]. The **BYTE** value 0 represents **false**, and the **BYTE** value 1 represents **true**.
string	**String**, as specified in section 2.2.4.
long	**INT32**, as specified in [MS-DTYP].
long long	**INT64**, as specified in [MS-DTYP].
float	**Float**, as specified in section 2.2.1.
void	**Void**, as specified in section 2.2.2.

3.1.4.6 Mapping FSIDL SequenceType

The following table specifies the mapping between types specified by the FSIDL SequenceType and the corresponding protocol types.

FSIDL Sequence Type	Protocol Type
sequence<char>	**LengthPrefixedByteSequence**, as specified in section 2.2.3
sequence<octet>	**LengthPrefixedByteSequence**, as specified in section 2.2.3

FSIDL Sequence Type	Protocol Type
sequence<long>	**LengthPrefixedInt32Sequence**, as specified in section 2.2.5.
sequence<long long>	**LengthPrefixedInt64Sequence**, as specified in section 2.2.6.
sequence<string>	**LengthPrefixedStringSequence**, as specified in section 2.2.7.
sequence<float>	**LengthPrefixedFloatSequence**, as specified in section 2.2.8.

3.1.4.7 Mapping FSIDL EnumName

This specifies an integer whose values are associated with unique names specified by a FSIDL Enum. A value MUST be serialized as an **INT32** value that begins with the value 0, increasing by 1 in the order specified by the FSIDL EnumList.

3.1.4.8 Mapping FSIDL CheetahEntityName

The FSIDL CheetahEntityName specifies a Cheetah entity and MUST be serialized as a *CheetahValue* record, as specified in section 2.2.11.

3.1.4.9 Mapping FSIDL InterfaceName

The FSIDL InterfaceName specifies a server interface as a remote method *Argument* or *Return Type*. It is serialized as an *AbstractObjectReference* record, as specified in section 2.2.14, where the *InterfaceType* field contains the FSIDL InterfaceName, and the *InterfaceVersion* field contains the FSIDL InterfaceValue.

3.1.4.10 Mapping FSIDL ExceptionName

This specifies a user exception for a server interface. The FSIDL ExceptionName MUST be serialized into the *UserException* record as specified in section 2.2.13. The FSIDL ExceptionAttributes MUST map to the *Attribute* fields of the *UserException* record in the same order they occur in the FSIDL ExceptionDecl.

3.1.5 Timer Events

None.

3.1.6 Other Local Events

None.

3.2 Middleware Server Details

3.2.1 Abstract Data Model

This section describes a conceptual model of possible data organization that an implementation maintains to participate in this protocol. The described organization is provided to facilitate the explanation of how the protocol behaves. This document does not mandate that implementations adhere to this model as long as their external behavior is consistent with that described in this document.

Server Object Table

This table associates server object URIs with the corresponding server objects.

Channel Table

This contains an association between a channel URI and a server object table. A channel URI is an entry point from which a protocol server receives connection requests from a protocol client. A protocol server hosts one or more channel URIs. The channel URI is specified with a URI scheme, a network host name, and a port number. The channel URI scheme field MUST contain a value of either "http" or "https".

3.2.2 Timers

None.

3.2.3 Initialization

The protocol server channel table MUST be initialized and associated with a server object table by the higher layer. Higher-level protocols MUST specify the following information about the transport:

- If an authentication mechanism such as Kerberos or NTLM is required, the required credentials MUST be specified. If HTTPS is required, a certificate MUST be specified.
- The maximum size of HTTP response and requests, specified in octets.

For each channel URI, the protocol server listens at the network host name and port number specified by the channel URI, and uses the transport specified by the channel URI scheme.

The host network interface, port number, channel URI scheme, credentials, and certificate are specified with command line options on the protocol server, or they can be specified in a configuration file.

When the higher layer registers a server object, a server object URI represented by the *ServerObjectURI* in section 2.2.16 MUST be constructed. The higher layer MUST provide values for the **InterfaceType** and the **InterfaceVersion** fields. The protocol server MUST generate a server object identifier for the **ServerObjectId** field. The protocol servers generate the server object identifier by concatenating a random number, the number of registered server objects with this server interface in the protocol server, and the thread identifier for the protocol server.

After the protocol server constructs the server object URI, it performs the following:

- If the server object URI does not exist in the server object table, the protocol server adds the server object URI and server object to the server object table.
- If the server object URI is already present in the server object table, the protocol server notifies the higher layer about the error.

When the higher layer unregisters a server object using the server object URI, a protocol server MUST do the following:

- Remove the entry with the server object URI from the server object table.
- The requests that are being processed, if any, will finish processing. Because request processing does not always finish in a timely manner, completing such requests is implementation-specific.

If the server object URI is not found in the server object table, the higher layer is notified about the error.

3.2.4 Message Processing Events and Sequencing Rules

There are no sequencing rules in this protocol. This section specifies the following:

Method	Description
Remote Method Call	Specifies how to receive, process, and respond to a remote method request.
__ping	Determines whether a server object is responding.

3.2.4.1 Remote Method Invocation

A protocol server MUST perform the following actions when it receives a message from the protocol client.

- Receive the HTTP request
- Look up the server object
- De-serialize the request message content
- Validate and dispatch the call
- Serialize the response-message content
- Send the response

Receive HTTP request

A protocol server MUST determine the channel URI associated with the received message in an implementation-specific way. The protocol client request MUST be mapped to an HTTP request message. The protocol server MUST accept HTTP request messages that are sent using HTTP/1.1. If the HTTP method is not POST or if the Content-Type is not "application/octet-stream", a protocol server sends a transport fault to the protocol client. The protocol server MUST format the transport fault as follows:

- HTTP Status-Code of the response is set to 200.
- The body of the response contains an *OutputValue*, with a *ReturnType* field whose value is 50 and a *MessageContent* field of type *SystemException*.

If an HTTP request is not received before an implementation-specific time-out has elapsed, the protocol server cancels the request.

Look up the server object

The message contains an HTTP Request-URI that specifies the protocol server method to which to route the message, as specified in section 2.2.17. The server object URI is a prefix of the protocol server method URI. A protocol server looks up the server object URI in the server object table. If the server object URI is found in the **Server Object Table**, then the corresponding server object in the table is used to dispatch the call.

If the server object URI is not found, then the protocol server sends an HTTP Status-Code 404 to the protocol client.

De-serialize the request message content

The message content is de-serialized from the *CallArguments* record, as specified in section 2.2.15. The remote method name MUST be parsed from the *ServerMethodURI*, as specified in section 2.2.17.

If the message content does not conform to the expected message format or the association from the serialization stream to the middleware data model resulted in an error, then this is a malformed message. If the protocol server receives a malformed message, it constructs a *SystemException*, and sends it back to the protocol client in the *MessageContent* field of an *OutputValue*. The *Description* field MUST either convey the nature of the structural error or be a zero-length string.

Validate and dispatch the call

The protocol server locates the remote method in the server object using the name of the remote method. If the remote method is not found, the protocol server constructs a *SystemException* and sends it back to the protocol client in the *MessageContent* field of an *OutputValue*. The *Description* field MUST either convey the nature of the error or be a zero-length string.

If the remote method can be located in the server object, a protocol server MUST call the remote method with the remote method **Input Values** resulting from de-serializing the *CallArguments* record, as specified previously in the section named De-Serializing the request message content.

Serialize the response message content

The completion of a remote method yields a return value, a user exception or a system exception. A protocol server constructs an *OutputValue* record that contains either a *CallResult* record as specified in section 2.2.10 based on the return value, a *UserException* record as specified in 2.2.13 based on the user exception, or a *SystemException* based on the system exception. The values are serialized into the *MessageContent* field of the *OutputValue*, and the protocol server sends the *OutputValue* to the protocol client.

If there is any error during serialization, then a protocol server constructs a *SystemException* record, and sends it back to the protocol client. The *SystemException* is serialized into the *MessageContent* field of the *OutputValue*. The *Description* field MUST either convey the nature of the error or be a zero-length string.

A value that represents a server object or a client proxy MUST be sent as an *AbstractObjectReference* record, as specified in section 2.2.14.

The implementation MUST provide a valid abstract object reference so that the server object can construct the *AbstractObjectReference* record.

Send the response

The protocol server maps the remote method response to an HTTP response, which MUST contain the following HTTP header fields:

- The Content-Type entity header of the response contains a value of "application/octet-stream".
- The Content-Length entity header of the response contains the length of the response body, specified in decimal number of octets.
- The HTTP Status-Code of the response is set to 200.
- The HTTP Reason-Phrase of the response contains a value of "OK".

The response body of the HTTP response message MUST contain an *OutputValue* record. *SystemException* records are specified in section 2.2.12, and *OutputValue* records are specified in section 2.2.9.

3.2.4.2 __ping

The **__ping** method MUST be implemented by all server objects, and is used by protocol clients to determine whether specific server objects respond to requests. The method signature is specified by the following FSIDL:

```
void __ping(void);
```

Input values:

Void: No input values.

Return value:

Void: No return value.

Exception: No exceptions are thrown other than system exceptions.

Client proxies that call the **__ping** method assume the server object is responding if the method does not return a *SystemException* record, as specified in section 2.2.12. The protocol server that hosts a server object can be subject to a transient network failure, or process slowly because of excessive load. Hence, the outcome of a single **__ping** message is not always sufficient to establish whether a server object is responding.

3.2.5 Timer Events

None.

3.2.6 Other Local Events

None.

3.3 Middleware Client Details

3.3.1 Abstract Data Model

This section describes a conceptual model of possible data organization that an implementation maintains to participate in this protocol. The described organization is provided to facilitate the explanation of how the protocol behaves. This document does not mandate that implementations adhere to this model as long as their external behavior is consistent with that described in this document.

Client Proxy Table

The client proxy table associates a client proxy with a specific server object, transport, serialization format, and the network address of the server object. It contains an entry for each client proxy instance. Each entry contains the following items:

- **Client Proxy:** The instance of the client proxy to locate in the table.
- **Abstract Object Reference:** An abstract object reference for the server object.

3.3.2 Timers

None.

3.3.3 Initialization

When a higher-level implementation requests a client proxy, it MUST provide an abstract object reference.

The higher layer requests a *cht::nameservermsg::aor* Cheetah entity from a name server by calling the **resolve** method, and converting the resulting *cht::nameservermsg::aor* Cheetah entity to an *AbstractObjectReference* record. Otherwise, the higher layer provides the information required for an abstract object reference in a way that is implementation-specific. Some protocol servers specify the abstract object reference for a name server with command line arguments to the Middleware protocol clients and protocol servers, or in a configuration file.

If the abstract object reference is not well-formed, the client proxy MUST raise a system exception for the implementation, and include a description of the structural error.

The protocol client creates a new client proxy, and adds the client proxy and the abstract object reference to the client proxy table. The protocol client can call the **__ping** method to validate that the server object associated with the client proxy is responding, before it adds the client proxy to the client proxy table. However, calling the **__ping** method is not required.

The abstract object reference is specified in section 2.2.14, the *cht::nameservermsg::aor* Cheetah entity and the mapping table are specified in section 2.2.18, the **resolve** method is specified in section 3.4.4.1, and the **__ping** method is specified in section 3.2.4.2.

3.3.4 Message Processing Events and Sequencing Rules

3.3.4.1 Remote Method Invocation

When a higher layer calls a remote method using a client proxy that sends the name and call arguments of the remote method, the protocol client MUST serialize the request, send the request to the protocol server, read the response message, de-serialize the response message, and send the de-serialized values to the caller.

Serialize the request

A protocol client looks up the abstract object reference in the client proxy table. If the client proxy is not in the table, then the higher layer MUST be reported using an implementation-specific procedure.

The abstract object reference, represented by the *AbstractObjectReference* record, is used to create a *ServerObjectURI*, as specified in section 2.2.16. The *ServerObjectURI* MUST use the *InterfaceType*, *InterfaceVersion* and *ServerObjectId* fields from the *AbstractObjectReference* record. The protocol client uses the resulting *ServerObjectURI* and the remote method name to create a *ServerMethodURI*, as specified in section 2.2.17.

A protocol client creates a *CallArguments* record, as specified in section 2.2.15, based on the remote method input values received from the higher layer. If the type of the values contained in the remote method input values does not match the type of the remote method *Arguments*, then the higher-layer MUST be reported using an implementation-specific procedure.

Send the request to the protocol server

The protocol client MUST construct an HTTP Request-URI using the *ServerMethodURI* and the *AbstractObjectReference* constructed in the previous paragraph, where the host name and port fields of the Request-URI are the same as in the *AbstractObjectReference*.

The protocol client maps the remote method request to an HTTP request, which MUST contain the following HTTP header values:

- An implementation MUST use HTTP/1.1.
- The HTTP Method MUST be a POST.
- The Request-URI of the HTTP request message MUST be the *ServerMethodURI* of the remote method, as specified in section 2.2.17.
- The Content-Length entity header MUST contain the length of the request body in decimal number of octets.
- The Content-Type entity header MUST be "application/octet-stream".
- The body of the HTTP request MUST be a *CallArguments* record, as specified in section 2.2.15.

Read the response from the connection

If the protocol client does not receive a response within a specified amount of time after sending a request, it MUST cancel the request, raise a system exception with a description of the time-out, and send the message to the higher layer. The timeout MUST be defined by the higher layer.

If the status code of the HTTP response is one of the successful codes as specified in [RFC2616] section 10.2, the protocol client MUST de-serialize the response message. If the status code is a protocol client-error code as specified in [RFC2616] section 10.4, a protocol server-error code as specified in [RFC2616] section 10.5 or an unknown error code, the protocol client MUST stop processing the response, and instead, use an implementation-specific procedure to notify the higher layer of the error.

De-serialize the response message

The response message MUST contain an *OutputValue* record, as specified in section 2.2.9. The protocol client de-serializes the *OutputValue* record to obtain the remote method return value, system exception, or user exception. If the message content does not match the abstract data model, then the protocol client stops processing the message and notifies the higher layer about the error.

Return the de-serialized values to the caller

The protocol client MUST return the de-serialized return value to the calling application, or it MUST raise a system exception or user exception. If the type of the de-serialized values does not match the type of the remote method *Return Type*, then the higher-layer is also notified of the error.

3.3.5 Timer Events

None.

3.3.6 Other Local Events

None.

3.4 name server Server Details

3.4.1 Abstract Data Model

This section describes a conceptual model of possible data organization that an implementation maintains to participate in this protocol. The described organization is provided to facilitate the explanation of how the protocol behaves. This document does not mandate that implementations adhere to this model as long as their external behavior is consistent with that described in this document.

Before a protocol client can communicate with a protocol server, the protocol client requires the abstract object reference for the protocol server. The name server provides a mapping from a logical name to an abstract object reference. A protocol client can then locate a specific server object by querying the name server protocol server for a logical name that the protocol client and protocol server have agreed to use for this server object.

Logical Name

The *Logical Name* is a triple that uniquely represents an abstract object reference in the name server, and consists of the following three entries:

- **Name:** A symbolic name that represents the abstract object reference.
- **Server Interface:** The server interface name of the abstract object reference.
- **Server Interface Version:** The server interface version of the abstract object reference.

Name Server Abstract Object Reference Table

The name server AOR table associates logical name entries to abstract object references. The name server stores AORs so that the protocol clients can find an AOR based on the logical name of that AOR. For each unique logical name, there MUST be only one AOR.

3.4.2 Timers

None.

3.4.3 Initialization

A server object URI that represents the name server server object MUST be created and a mapping from the server object URI to the name server server object MUST be inserted in the server object table of the Middleware protocol server that hosts the name server protocol server.

The server object URI is represented concretely by the *ServerObjectURI* record specified in section 2.2.16, where the *InterfaceType* field MUST be "nameservice::nameserver", the *ServerObjectId* field MUST be "0", and the *InterfaceVersion* field MUST be "1.0".

3.4.4 Message Processing Events and Sequencing Rules

There are no sequencing rules in this protocol. This interface includes the following methods:

Method	Description
resolve	Looks up the information needed to construct an abstract object reference for a specified server object.

Method	Description
bind	Associates an abstract object reference with a logical name in the name server.
unbind	Removes the association between an abstract object reference and the associated logical name in the name server
list_any	Requests a collection of abstract object references that match all of the specified input values.
list_host	Requests a collection of abstract object references that match a specific host name.
list_name	Requests a collection of abstract object references that match a specific logical name prefix.

3.4.4.1 resolve

The **resolve** method looks up a specified server object and returns the information needed to construct an abstract object reference. The method signature is specified by the following FSIDL:

```
cht::nameservermsg::aor resolve(in string name,
                                in string interface_type,
                                in string version)
        raises (resolve_exception);
```

Input values:

name: A string that represents the Name part of the **Logical Name** in the name server that is associated with the abstract object reference.

interface_type: A string that represents the server interface of the server object.

version: A string that represents the server interface version of the server object.

Return value:

cht::nameservermsg::aor: A Cheetah entity, as specified in section 2.2.18, that represents the abstract object reference for the server object. This Cheetah entity can be converted to an *AbstractObjectReference* record.

Exceptions:

resolve_exception: No association exists between the requested server object and logical name.

The **resolve** method MUST return an abstract object reference encoded as a *cht::nameservermsg::aor* Cheetah entity. The method looks for the abstract object reference in the name server AOR table by using the input values for the logical name triple. If no abstract object reference is found, the method MUST raise a *nameservice::nameserver::resolve_exception* user exception, as specified in section 2.2.21.

If an abstract object reference is found, a *cht::nameservermsg::aor* Cheetah entity is constructed from the AOR as specified in section 2.2.18 and sent to the protocol client.

3.4.4.2 bind

The **bind** method associates an abstract object reference with a logical name in the name server. The method signature is specified by the following FSIDL:

```
void bind(in cht::nameservermsg::aor the_aor);
```

Input values:

the_aor: A Cheetah entity, as specified in section 2.2.18, that represents the abstract object reference for the server object.

Return value:

void: No value returned.

Exceptions: No exceptions are thrown other than system exceptions.

The logical name triple MUST be constructed based on the attributes in *the_aor*. An abstract object reference MUST be constructed from the *the_aor* based on the mapping table in section 2.2.18.

The name server AOR table MUST be updated to specify the mapping from the logical name to the abstract object reference.

3.4.4.3 unbind

The **unbind** method removes the association between an abstract object reference and the associated logical name in the name server. The method signature is specified by the following FSIDL:

```
void unbind(in string name,
          in string interface_type,
          in string version)
raises (not_bound_exception);
```

Input values:

name: A string that represents the *name* field of the logical name triple that is associated with the AOR in the name server.

interface_type: A **string** that represents the server interface of the server object.

version: A **string** that represents the server interface version of the server object.

Return value:

void: No value returned.

Exceptions:

not_bound_exception: The logical name is not associated with an abstract object reference.

The abstract object reference MUST be removed from the name server AOR table. The logical name MUST be used to locate and remove the abstract object reference. If no abstract object reference is found, a *not_bound_exception* user exception, as specified in section 2.2.20, must be raised.

3.4.4.4 list_any

The **list_any** method requests a collection of abstract object references that matches all of the specified input values. The method signature is specified by the following FSIDL:

```
cht::nameservermsg::aor_list list_any(in string name_prefix,
                                      in string interface_type,
                                      in string version,
                                      in string host);
```

Input values:

name_prefix: A string that represents a prefix of the *name* field in the logical name triple in the name server.

interface_type: A string that represents the server interface of the server object.

version: A string that represents the server interface version of the server object.

host: A string that represents the host name of the server object.

Return value:

cht::nameservermsg::aor_list: A collection of Cheetah entities, as specified in section 2.2.19, that represents the abstract object references for the requested server objects.

Exceptions: No exceptions are thrown other than system exceptions.

The protocol server MUST traverse the name server AOR table and return a *cht::nameservermsg::aor_list* Cheetah entity. An entry in the table MUST fulfill the following criteria to be included in the resulting return value:

- If the *name_prefix* field is not the empty string, the *name* field in the logical name triple MUST begin with the value of *name_prefix*.
- If the *interface_type* field is not the empty string, the server interface of the logical name MUST be equal to the value of interface_type.
- If the *version* field is not the empty string, the server interface *version* of the logical name MUST be equal to the value of version.
- If the *host* field is not the empty string, the host name of the abstract object reference MUST be be equal to the value of host.

If one or more of the input values are the empty strings, fields with an empty string matches all entries for that field in the name server AOR table. Thus, if all input values to **list_any** are the empty strings, all entries of the name server AOR table MUST be included in the resulting *cht::nameservermsg::aor_list* Cheetah entity.

3.4.4.5 list_host

The **list_host** method requests a collection of abstract object references matching a specific host name. The method signature is specified by the following FSIDL:

```
cht::nameservermsg::aor_list list_host(in string host,
                                       in string interface_type);
```

Input values:

host: A string that represents the host name of the server object.

interface_type: A string that represents the server interface of the server object.

Return value:

cht::nameservermsg::aor_list: A collection of Cheetah entities, as specified in section 2.2.19, that represent the abstract object references for the requested server objects.

Exceptions: No exceptions are thrown other than system exceptions.

If both the *host* and *interface_type* input values are empty strings, a *cht::nameservermsg::aor_list* Cheetah entity with an empty collection MUST be returned.

The protocol server MUST traverse the name server AOR table and return the *cht::nameservermsg::aor_list* Cheetah entity.

An entry in the name server AOR table MUST fulfill the following criteria to be included in the resulting return value:

- The host name of the abstract object reference MUST be the same as the value of the *host* field.
- If the *interface_type* field is not the empty string, the server interface of the logical name MUST be equal to the value of *interface_type*.

3.4.4.6 list_name

The **list_name** method requests a collection of abstract object references matching a specific logical name prefix. The method signature is specified by the following FSIDL:

```
cht::nameservermsg::aor_list list_name(in string name_prefix,
                                       in string interface_type);
```

Input values:

name_prefix: A string that represents a prefix of the *name* field in the logical name triple in the name server.

interface_type: A string that represents the server interface of the server object.

Return value:

cht::nameservermsg::aor_list: A collection of Cheetah entities, as specified in section 2.2.19,that represent the abstract object references for the requested server objects.

Exceptions: No exceptions are thrown other than system exceptions.

The protocol server MUST traverse the name server AOR table and return the *cht::nameservermsg::aor_list* Cheetah entity.

An entry in the table MUST fulfill the following criteria to be included in the resulting return value:

- If the *name_prefix* field is not the empty string, the *name* field in the logical name triple MUST begin with the value of *name_prefix*.
- If the *interface_type* field is not the empty string, the server interface field in the logical name triple MUST be equal to the value of *interface_type*.

If both input values for the **list_name** method are the empty string, all entries of the name server AOR table MUST be included in the resulting Cheetah entity.

3.4.5 Timer Events

None.

3.4.6 Other Local Events

None.

3.5 name server Client Details

3.5.1 Abstract Data Model

This section describes a conceptual model of possible data organization that an implementation maintains to participate in this protocol. The described organization is provided to facilitate the explanation of how the protocol behaves. This document does not mandate that implementations adhere to this model as long as their external behavior is consistent with that described in this document.

3.5.2 Timers

None.

3.5.3 Initialization

The name server protocol client is a client proxy that calls remote methods on a name server protocol server. A protocol client creates a client proxy, based on an abstract object reference to the name server object, to call remote methods on the name server protocol server as specified in section 3.3.3.

An *AbstractObjectReference* record represents the abstract object reference for the name server object, as specified in section 2.2.14. The implementation MUST specify that the *InterfaceType* field of the *AbstractObjectReference* record contains "nameservice::nameserver", the *ServerObjectId* field contains "0", and the *InterfaceVersion* contains "1.0".

3.5.4 Message Processing Events and Sequencing Rules

Before calling the **bind** remote method (section 3.4.4.2), an implementation MUST first call the **resolve** remote method (section 3.4.4.1), with the same logical name that the **bind** remote method will use.

If the **resolve** method returns a *cht::nameservermsg::aor* (section 2.2.18), the protocol server MUST create a client proxy as specified in section 3.3.3, and then call the **__ping** method (section 3.2.4.2) using the client proxy.

If the **__ping** method does not raise a system exception or a user exception, then another server object has previously registered with the same logical name, and therefore the protocol server MUST NOT call the **bind** method.

3.5.5 Timer Events

None.

3.5.6 Other Local Events

None.

3.6 core::fds_component Server Details

This interface is implemented by all protocol servers and is used by protocol clients to request status and resource usage information from the protocol servers.

3.6.1 Abstract Data Model

This section describes a conceptual model of possible data organization that an implementation maintains to participate in this protocol. The described organization is provided to facilitate the explanation of how the protocol behaves. This document does not mandate that implementations adhere to this model as long as their external behavior is consistent with that described in this document.

Debug State Table

This represents the correspondence between a debug module and a debug level:

- **Debug Module:** A name that identifies an implementation-specific part of the protocol server.
- **Debug Level:** A number that specifies an implementation-specific debug level.

The protocol server uses the debug level to decide whether to output debug messages. Some protocol servers configure debugging output through implementation-specific command line arguments that override the debug module and debug level settings.

Resource Scope Table

A **Resource Scope** is an implementation-specific scope name defined over a well-defined set of program statements, typically the program statements defining a function or method. The resource scope table is a mapping between a scope name and an entry consisting of *Current Invocations*, *Total Invocations*, *Minimum Duration*, *Average Duration,* and *Maximum Duration* fields.

- **Scope Name:** A name that uniquely identifies the resource scope.
- **Current Invocations:** The number of threads currently executing the resource scope.
- **Total Invocations:** The number of times the resource scope has been executed.
- **Minimum Duration:** The minimum amount of time spent executing the resource scope in milliseconds.
- **Average Duration:** The average amount of time spent executing the resource scope in milliseconds.
- **Maximum Duration:** The maximum amount of time the spent executing the resource scope in milliseconds.

Resource Allocation Table

A **Resource Allocation** is an implementation-specific counter used to count named resources such as files or memory units. The **Resource Allocation Table** is a mapping between an *Allocation Name* field and an entry consisting of *Current Allocations* and *Total Allocations* fields.

- **Allocation Name:** A name that uniquely identifies the resource allocation.
- **Current Allocations:** Contains the current count for the specified *Allocation Name* field.
- **Total Allocations:** Contains the total count for the specified *Allocation Name* field.

Resource Value Table

A **Resource Value** is an implementation-specific value that is associated with a unique name. More specifically, the resource value table specifies a mapping between a unique *Value Name* field and the implementation-specific resource value.

3.6.2 Timers

None.

3.6.3 Initialization

The *core::fds_component* server object MUST be initialized by a higher-level implementation that uses the protocol server. The protocol server MUST call the **bind** method, as specified in section 3.4.4.2.

The input values to the **bind** method is a *cht::nameservermsg::aor* Cheetah entity, as specified in section 2.2.18.

name: A string value supplied by the higher-level application.

object_id: A value that is implementation specific— that is, determined by the higher-level application.

host: A string that contains the host name of the server object on the protocol server. The value is implementation specific and determined by the higher-level application.

port: The port number used by the protocol server. It is implementation specific and determined by the higher level application.

interface_type: A string value that MUST be " core::fds_component ".

interface_version: A string value that MUST be "5.1".

The debug level MUST be initialized by the higher-level implementation.

3.6.4 Message Processing Events and Sequencing Rules

There are no sequencing rules in this protocol. This interface includes the following methods:

Method	Description
get_hostname	Return the host name used for the channel URI of the protocol server.
get_resource_report	Returns the content of the resource allocation table.
uptime	Return the number of seconds that elapsed after the protocol server process started.
get_version	Return a string that represents the server version for a protocol server.

Method	Description
get_model_version	Return a version string for the protocol server interface versions in the protocol server.
get_fds_version	Return a version string that identifies the product version.
get_middleware_port	Return the port number used for the channel URI of the protocol server.
set_trace_level	Sets the debug log level for an implementation-specific module in the protocol server.

3.6.4.1 get_hostname

The **get_hostname** method returns the host name for the channel URI of the protocol server. The method signature is specified by the following FSIDL:

```
string get_hostname(void);
```

Input values:

Void: No input values.

Return value:

string: A string that represents the host name for the channel URI of this server object.

Exceptions: No exceptions are thrown other than system exceptions.

Return the host name of the protocol server. The host name MUST be specified by the higher-level implementation as part of the configuration.

3.6.4.2 get_resource_report

The **get_resources_report** method retrieves the contents of the resource allocation table. The method signature is specified by the following FSIDL:

```
cht::core::resource_report get_resource_report(void);
```

Input values:

Void: No input values.

Return value:

cht::core::resource_report: A Cheetah entity, as specified in section 2.2.22, that represents a resource report from a protocol server.

Exceptions: No exceptions are thrown other than system exceptions.

Returns a *cht::core::resource_report* Cheetah entity. The *cht::core::resource_report* is a Cheetah entity that contains three collections with the type *cht::core::alloc* specified in section 2.2.23, *cht::core::scope* specified section 2.2.24 , and *cht::core::named_value* specified in section 2.2.25.

The method constructs a *cht::core::alloc* Cheetah entity for each entry in the resource allocation table, where the *name* attribute maps to the *Allocation Name* field, the *current* attribute maps to the *Current Allocations* field, and the *total* attribute maps to the *Total Allocations* field.

The method constructs a *cht::core::named_value* Cheetah entity for each entry in the resource value table, where the *name* attribute maps to the *Value Name* field, and the *value* attribute maps to the corresponding value.

The method constructs a *cht::core::scope* Cheetah entity for each entry in the resource scope table, where the *name* attribute maps to scope name, the *current* attribute maps to the *Current Invocations* field, the *total* attribute maps to the *Total Invocations* field, the *min_time* attribute maps to the *Minimum Duration* field, the *max_time* field maps to the *Maximum Duration* field, and the *avg_time* field maps to the *Average Duration* field.

The method creates a *cht::core::resource_report* Cheetah entity with the *cht::core::alloc*, *cht::core::named_value* and *cht::core::scope* collections. The *when* attribute of the *cht::core::resource_report* contains the number of seconds since January 1, 1970.

3.6.4.3 uptime

The **uptime** method returns the number of seconds elapsed after the protocol server process was started. The method signature is specified by the following FSIDL:

```
long uptime(void);
```

Input values:

Void: No input values.

Return value:

long: A **long** that represents the number of seconds elapsed after the protocol server process was started.

Exceptions: No exceptions are thrown other than system exceptions.

Return the number of seconds elapsed after the protocol server process was started.

3.6.4.4 get_version

The **get_version** method retrieves the server version for a protocol server. The method signature is specified by the following FSIDL:

```
string get_version(void);
```

Input values:

Void: No input values.

Return value:

string: A string that represents an implementation-specific version for a protocol server. An empty string or the string "N/A" is used when a meaningful value cannot be determined by the implementation.

Exceptions: No exceptions are thrown other than system exceptions.

Return an implementation-specific string that represents the version number for the protocol server that contains the server object for the *core::fds_component* server interface.

3.6.4.5 get_model_version

The **get_model_version** method retrieves the version string for the protocol server. The method signature is specified by the following FSIDL:

```
string get_model_version(void);
```

Input values:

Void: No input values.

Return value:

string: This represents an implementation-specific version for all interfaces implemented by this protocol server. An empty string or the string "N/A" is used when a meaningful value cannot be determined by the implementation.

Exceptions: No exceptions are thrown other than system exceptions.

Return an implementation-specific string that uniquely represents the server interface version for all server interfaces instantiated by the protocol server.

3.6.4.6 get_fds_version

The **get_fds_version** method retrieves a version string that identifies the product version. The method signature is specified by the following FSIDL:

```
string get_fds_version(void);
```

Input values:

Void: No input values.

Return value:

string: This represents an implementation-specific version for all protocol servers constituting the system. An empty string or the string "N/A" is used when the implementation can not determine a meaningful value.

Exceptions: No exceptions are thrown other than system exceptions.

Return an implementation-specific version string that identifies product version.

3.6.4.7 get_middleware_port

The **get_middleware_port** method retrieves the port number used for the channel URI in the protocol server. See section 3.2.3 for details. The method signature is specified by the following FSIDL:

```
long get_middleware_port(void);
```

Input values:

Void: No input values.

Return value:

long: The port number used by the channel URI of this protocol server.

Exceptions: No exceptions are thrown other than system exceptions.

Return the port number used for all abstract object references contained in the protocol server. The port number MUST be specified by the higher-level implementation as part of the configuration.

3.6.4.8 set_tracelevel

The **set_tracelevel** method sets the debug log level for an implementation-specific module in the protocol server. The method signature is specified by the following FSIDL:

```
void set_tracelevel(in string module_name, in long level);
```

Input values:

module_name: A string that represents an implementation-specific module within the protocol server.

level: A **long** that represents the debug level for the module specified by the *module_name* input value. Debug logging is disabled when this field is set to 0. The verbosity of debug logging increases with the level number.

Return value:

Void: No return value.

Exceptions: No exceptions are thrown other than system exceptions.

This method MUST set the debug state for the *Module Name* entry that matches *module_name* in the debug state table to the value represented by *level*.

3.6.5 Timer Events

None.

3.6.6 Other Local Events

None.

3.7 core::fds_component Client Details

3.7.1 Abstract Data Model

This section describes a conceptual model of possible data organization that an implementation maintains to participate in this protocol. The described organization is provided to facilitate the

explanation of how the protocol behaves. This document does not mandate that implementations adhere to this model as long as their external behavior is consistent with that described in this document.

3.7.2 Timers

None.

3.7.3 Initialization

The protocol client calls the **resolve** method, as specified in section 3.4.4.1 on a name server protocol server with the following input values:

name: Specified by the higher-level implementation.

interface_type: A string with the value "core::fds_component".

version: A string with the value "5.1".

An abstract object reference is created based on the *cht::nameservermsg::aor* Cheetah entity returned by the **resolve** method. A client proxy for the core::fds_component object is created based on the abstract object reference, as specified in section 3.3.3.

3.7.4 Message Processing Events and Sequencing Rules

None.

3.7.5 Timer Events

None.

3.7.6 Other Local Events

None.

3.8 core::lifecycle Server Details

3.8.1 Abstract Data Model

This section describes a conceptual model of possible data organization that an implementation maintains to participate in this protocol. The described organization is provided to facilitate the explanation of how the protocol behaves. This document does not mandate that implementations adhere to this model as long as their external behavior is consistent with that described in this document.

Lifecycle State

This contains the current state for the protocol server. The value MUST be one of the values specified by the *core::lifecycle::state* enumeration, as specified in section 2.2.31.

A higher-level implementation can modify the lifecycle state according to the runtime state of the process hosting the protocol server. Some protocol servers do not adjust the runtime state of the process correctly, and a malfunctioning protocol server can be prohibited from executing the code that updates the lifecycle state.

3.8.2 Timers

None.

3.8.3 Initialization

The server object for core::lifecycle MUST be initialized by a higher-level implementation using the protocol server. The protocol server calls the **bind** method, as specified in section 3.4.4.2.

The input parameter to the **bind** method is a *cht::nameservermsg::aor* Cheetah entity, as specified in section 2.2.18. The *cht::nameservermsg::aor* Cheetah entity sets the *interface_type* attribute to "core::lifecycle" and the *interface_version* attribute to "5.1".

The *Lifecycle State* field MUST be set to **initializing**, as specified by the enum in section 2.2.31.

3.8.4 Message Processing Events and Sequencing Rules

This interface includes the following methods:

Method	Description
stop	Sets the state of the protocol server to **terminating**.
resume	Sets the state of the protocol server to **running**.
suspend	Sets the state of the protocol server to **suspended**.
get_state	Return the value of the *Lifecycle State* **field**.

The **resume** method is called only after the **suspend** method has been called. No method in this interface is called after the **stop** method has been called. Protocol servers that do not adjust the runtime state of the process hosting the protocol server are not required to follow the sequencing rules.

3.8.4.1 stop

The **stop** method sets the state of the protocol server to **terminating**. The method signature is specified by the following FSIDL:

```
void stop(void);
```

Input values:

Void: No input values.

Return value:

Void: No return value.

Exceptions: No exceptions are thrown other than system exceptions.

The method sets the *Lifecycle State* field to the value represented by the **terminating** enum specified in section 2.2.31. The protocol server can call the necessary procedures to terminate the process hosting the protocol server, although this is implementation-specific. Some protocol servers ignore terminating the process hosting the protocol server.

3.8.4.2 resume

The **resume** method sets the state of the protocol server to **running**. The method signature is specified by the following FSIDL:

```
void resume(void);
```

Input values:

Void: No input values.

Return value:

Void: No return value.

Exceptions: No exceptions are thrown other than system exceptions.

This method sets the *Lifecycle State* to the value represented by the **running** constant of the enum specified in section 2.2.31. The protocol server can call the necessary procedures to resume the execution of the process hosting the protocol server, although this is implementation-specific.

3.8.4.3 suspend

The **suspend** method sets the state of the protocol server to **suspended**. The method signature is specified by the following FSIDL:

```
void suspend(void);
```

Input values:

Void: No input values.

Return value:

Void: No return value.

Exceptions: No exceptions are thrown other than system exceptions.

This method sets the *Lifecycle State* to the value represented by the **suspended** constant of the enum specified in section 2.2.31. The protocol server can call the necessary procedures to suspend the execution of the process hosting the protocol server, although suspending is implementation-specific.

3.8.4.4 get_state

The **get_state** method retrieves the state of the protocol server. The method signature is specified by the following FSIDL:

```
state get_state(void);
```

Input values:

Void: No input values.

Return value:

state: An enumerated type that represents the state of the protocol server, as specified in section 2.2.31, core::lifecycle::state.

Exceptions: No exceptions are thrown other than system exceptions.

Returns the value of the *Lifecycle State.*

3.8.5 Timer Events

None.

3.8.6 Other Local Events

None.

3.9 core::lifecycle Client Details

3.9.1 Abstract Data Model

This section describes a conceptual model of possible data organization that an implementation maintains to participate in this protocol. The described organization is provided to facilitate the explanation of how the protocol behaves. This document does not mandate that implementations adhere to this model as long as their external behavior is consistent with that described in this document.

3.9.2 Timers

None.

3.9.3 Initialization

The protocol client MUST call the **resolve** method, as specified in section 3.4.4.1, on a name server protocol server with the following input values:

name: Specified by the higher-level implementation.

interface_type: A string with the value "core::lifecycle".

version: A string with the value "5.1".

An abstract object reference MUST be created based on the *cht::nameservermsg::aor* Cheetah entity returned by the **resolve** method. A protocol server creates a client proxy for the core::lifecycle server object based on the abstract object reference, as specified in section 3.3.3.

3.9.4 Message Processing Events and Sequencing Rules

None.

3.9.5 Timer Events

None.

3.9.6 Other Local Events

None.

4 Protocol Examples

The following two samples shows the remote methods that create a client proxy based on an abstract object reference retrieved from a name server protocol server, similar to the procedure described in section 3.3.3.

4.1 Resolving an abstract object reference

This sample calls the **resolve** remote method, as described in section 3.4.4.1, on a name server protocol server that implements the nameservice::nameserver interface, as described in section 3.4. The relevant parts of the nameservice::nameserver interface are specified by the following FSIDL specification:

```
module interfaces {
  module nameservice {
    exception resolve_exception { };

    interface nameserver {
  #pragma version nameserver 1.0
      cht::nameservermsg::aor resolve(in string name,
                                      in string interface_type,
                                      in string version)
        raises (resolve_exception);
    }
  }
}
```

The **cht::nameservermsg::aor** Cheetah entity is described in section 2.2.18.

```
root entity aor
{
  attribute string host;
  attribute int port;
  attribute string interface_type;
  attribute string interface_version;
  attribute longint object_id;
  attribute string bound_name;
};
```

The protocol client calls the **resolve** method with the following parameters:

```
name = "esp/subsystems/processing/dispatcher/0"
interface_type = "core::fds_component"
version = "5.1"
```

The server object for the the nameservice::nameserver interface is located at "http://www.cohowinery.com:16099/nameservice::nameserver/1.0/0".

The HTTP headers of the request are as follows:

```
POST /nameservice::nameserver/1.0/0/resolve HTTP/1.1
Content-Type: application/octet-stream
User-Agent: Middleware client/1.0
```

```
Host: www.cohowinery.com:16099
Content-Length: 72
Connection: Keep-Alive
```

The request is an HTTP/1.1 request. The HTTP headers are set as described in section 3.2.4.1. The protocol server method URI is "/nameservice::nameserver/1.0/0/resolve", where the remote method name is "resolve" and the server object URI "/nameservice::nameserver/1.0/0".

The body of the request message is as follows:

```
00 00 00 26 65 73 70 2F ...&esp/
73 75 62 73 79 73 74 65 subsyste
6D 73 2F 70 72 6F 63 65 ms/proce
73 73 69 6E 67 2F 64 69 ssing/di
73 70 61 74 63 68 65 72 spatcher
2F 30 00 00 00 13 63 6F /0....co
72 65 3A 3A 66 64 73 5F re::fds_
63 6F 6D 70 6F 6E 65 6E componen
74 00 00 00 03 35 2E 31 t....5.1
```

The interpretation of the preceding message content is as follows:

```
CallArguments:
  name, String:
    Length: 0x00000026
    ByteSequence: subsystems/processing/dispatcher/0
  interface_type, String:
    Length: 0x00000013
    ByteSequence: core::fds_component
  version, String:
    Length: 0x00000003
    ByteSequence: 5.1
```

The HTTP headers of the response are shown as follows:

```
HTTP/1.1 200 OK
Content-Length: 115
Content-Type: application/octet-stream
Server: Microsoft-HTTPAPI/2.0
Date: Mon, 04 May 2009 10:50:56 GMT
```

The body of the response message is as follows:

```
30 10 8F 02 E8 00 00 00 0.?.è...
00 00 00 00 12 77 77 77 .....www
2E 63 6F 68 6F 77 69 6E .cohowin
65 72 79 2E 63 6F 6D 00 ery.com.
00 3E E3 00 00 00 13 63 .>ã....c
6F 72 65 3A 3A 66 64 73 ore::fds
5F 63 6F 6D 70 6F 6E 65 _compone
6E 74 00 00 00 03 35 2E nt....5.
31 11 3D 33 BE 26 17 78 1.=3¾&.x
01 00 00 00 26 65 73 70 ....&esp
2F 73 75 62 73 79 73 74 /subsyst
```

```
65 6D 73 2F 70 72 6F 63 ems/proc
65 73 73 69 6E 67 2F 64 essing/d
69 73 70 61 74 63 68 65 ispatche
72 2F 30                r/0
```

The interpretation of the preceding message content is as follows:

```
OutputValue:
  ReturnType: 0x30
  MessageContent:
    CallResult:
      CheetahValue:
        CheetahValueContents:
          Cheetah checksum: 0x108f02e8
          Entity TypeId: 0x00000000
          host, LengthPrefixString:
            Length: 0x00000012
            Bytes: www.cohowinery.com
          port, INT32: 0x00003ee3
          interface_type, LengthPrefixString:
            Length: 0x00000012
            Bytes: core::fds_component
          interface_version, LengthPrefixString:
            Length: 0x00000003
            Bytes: 5.1
          object_id, INT64: 0x113D33BE26177801
          bound_name, LengthPrefixString:
            Length: 0x00000026
            Bytes: esp/subsystems/processing/dispatcher/0
```

4.2 Calling __ping

The next sample uses the *cht::nameservermsg::aor* Cheetah entity returned by the **resolve** method in the previous sample to call the **__ping** remote method on the server object represented by the **cht::nameservermsg::aor**.

The server object represented by the *cht::nameservermsg::aor* Cheetah entity is located at "http://www.cohowinery.com:16099/core::fds_component/5.1/1242205964000000001".

The HTTP headers of the request are shown as follows:

```
POST /core::fds_component/5.1/1242205964000000001/__ping HTTP/1.1
Content-Type: application/octet-stream
User-Agent: Python WinHTTP client/1.0
Host: www.cohowinery.com:16099
Content-Length: 0
Connection: Keep-Alive
```

The request is an HTTP/1.1 request. The HTTP headers are set as described in section 3.2.4.1. The protocol server method URI is "/core::fds_component/5.1/1242205964000000001/__ping", where the remote method name is "__ping" and the server object URI is "/core::fds_component/5.1/1242205964000000001". The server object identifier part of the server object URI, "1242205964000000001", is the hex value 0x113D33BE26177801 converted to base 10. The request has no further message content, as indicated by the Content-Length value 0.

The headers of the HTTP response are as follows:

```
HTTP/1.1 200 OK
Content-Length:  1
Content-Type: application/octet-stream
Server: Microsoft-HTTPAPI/2.0
Date: Mon, 04 May 2009 10:50:56 GMT
```

The body of the response message is as follows:

```
30                      0
```

The interpretation of the preceding message content is as follows:

```
OutputValue:
  ReturnType: 0x30
    MessageContent:
      CallResult:
        Void:
```

5 Security

5.1 Security Considerations for Implementers

None.

5.2 Index of Security Parameters

Security Parameter	Section
HTTP authentication	Transport, see section 2.1.
HTTPS	Transport, see section 2.1.

6 Appendix A: Full FSIDL

For ease of implementation, the full FSIDL and complete listing of Cheetah entities used in this protocol are provided in the following sections.

6.1 FSIDL

For ease of implementation, the following full FSIDL is provided.

```
module interfaces {
  module core {
    interface fds_component;
    interface lifecycle;

    enum state {
      initializing, running, suspended, terminating
    };

    exception unsupported_guarantee_set {
      string message;
    };

    interface fds_component {
#pragma version fds_component 5.1
      string get_hostname();
      cht::core::resource_report get_resource_report();
      long uptime();
      string get_version();
      string get_model_version();
      string get_fds_version();
      long get_middleware_port();
      void set_tracelevel(in string module_name, in long level);
    };

    interface lifecycle {
#pragma version lifecycle 5.1
      void stop();
      void resume();
      void suspend();
      state get_state();
    };
  };

  module nameservice {
    exception not_bound_exception { };
    exception resolve_exception { };
    interface nameserver {
#pragma version nameserver 1.0
      cht::nameservermsg::aor resolve(in string name,
                                      in string interface_type,
                                      in string version)
        raises (resolve_exception);

      void bind(in cht::nameservermsg::aor the_aor);

      void unbind(in string name, in string interface_type, in string version)
        raises (not_bound_exception);
```

```
        cht::nameservermsg::aor_list list_name(in string name_prefix,
                                               in string interface_type);

        cht::nameservermsg::aor_list list_host(in string host,
                                               in string interface_type);

        cht::nameservermsg::aor_list list_any(in string name_prefix,
                                              in string interface_type,
                                              in string version,
                                              in string host);
      };
    };
  };
```

6.2 Cheetah Entities

```
root entity aor {
  attribute string host;
  attribute int port;
  attribute string interface_type;
  attribute string interface_version;
  attribute longint object_id;
  attribute string name;
};

root entity aor_list {
  collection aor aors;
};

entity alloc {
  attribute string name;
  attribute int current;
  attribute int total;
};

entity scope {
  attribute string name;
  attribute int current;
  attribute int total;
  attribute int min_time;
  attribute int max_time;
  attribute int avg_time;
};

entity named_value {
  attribute string name;
};

entity bool_value : named_value {
  attribute bool value;
};

entity float_value : named_value {
  attribute float value;
};
```

```
entity long_value : named_value {
  attribute int value;
};

entity string_value : named_value {
  attribute string value;
};

entity longlong_value : named_value {
  attribute longint value;
};

root entity resource_report {
  attribute longint when;
  collection alloc allocs;
  collection scope scopes;
  collection named_value values;
};
```

7 Appendix B: Product Behavior

The information in this specification is applicable to the following Microsoft products or supplemental software. References to product versions include released service packs:

- Microsoft® FAST™ Search Server 2010

Exceptions, if any, are noted below. If a service pack or Quick Fix Engineering (QFE) number appears with the product version, behavior changed in that service pack or QFE. The new behavior also applies to subsequent service packs of the product unless otherwise specified. If a product edition appears with the product version, behavior is different in that product edition.

Unless otherwise specified, any statement of optional behavior in this specification that is prescribed using the terms SHOULD or SHOULD NOT implies product behavior in accordance with the SHOULD or SHOULD NOT prescription. Unless otherwise specified, the term MAY implies that the product does not follow the prescription.

8 Change Tracking

No table of changes is available. The document is either new or has had no changes since its last release.

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