

## Open Pluggable Edge Services (OPES) Callout Protocol (OCP) Core

### Status of This Memo

This document specifies an Internet standards track protocol for the Internet community, and requests discussion and suggestions for improvements. Please refer to the current edition of the "Internet Official Protocol Standards" (STD 1) for the standardization state and status of this protocol. Distribution of this memo is unlimited.

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### Abstract

This document specifies the core of the Open Pluggable Edge Services (OPES) Callout Protocol (OCP). OCP marshals application messages from other communication protocols: An OPES intermediary sends original application messages to a callout server; the callout server sends adapted application messages back to the processor. OCP is designed with typical adaptation tasks in mind (e.g., virus and spam management, language and format translation, message anonymization, or advertisement manipulation). As defined in this document, the OCP Core consists of application-agnostic mechanisms essential for efficient support of typical adaptations.

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## 1. Introduction

The Open Pluggable Edge Services (OPES) architecture [RFC3835] enables cooperative application services (OPES services) between a data provider, a data consumer, and zero or more OPES processors. The application services under consideration analyze and possibly transform application-level messages exchanged between the data provider and the data consumer.

The OPES processor can delegate the responsibility of service execution by communicating with callout servers. As described in [RFC3836], an OPES processor invokes and communicates with services on a callout server by using an OPES callout protocol (OCP). This document specifies the core of that protocol ("OCP Core").

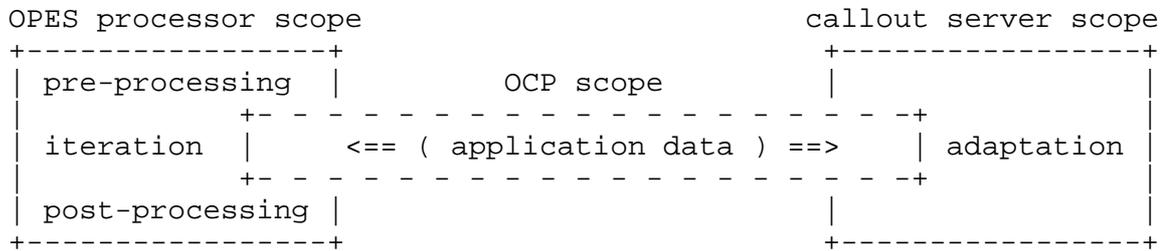
The OCP Core specification documents general application-independent protocol mechanisms. A separate series of documents describes application-specific aspects of OCP. For example, "HTTP Adaptation with OPES" [OPES-HTTP] describes, in part, how HTTP messages and HTTP meta-information can be communicated over OCP.

Section 1.2 provides a brief overview of the entire OPES document collection, including documents describing OPES use cases and security threats.

1.1. Scope

The OCP Core specification documents the behavior of OCP agents and the requirements for OCP extensions. OCP Core does not contain requirements or mechanisms specific for application protocols being adapted.

As an application proxy, the OPES processor proxies a single application protocol or converts from one application protocol to another. At the same time, OPES processor may be an OCP client, using OCP to facilitate adaptation of proxied messages at callout servers. It is therefore natural to assume that an OPES processor takes application messages being proxied, marshals them over OCP to callout servers, and then puts the adaptation results back on the wire. However, this assumption implies that OCP is applied directly to application messages that OPES processor is proxying, which may not be the case.



An OPES processor may preprocess (or postprocess) proxied application messages before (or after) they are adapted at callout servers. For example, a processor may take an HTTP response being proxied and pass it as-is, along with metadata about the corresponding HTTP connection. Another processor may take an HTTP response, extract its body, and pass that body along with the content-encoding metadata. Moreover, to perform adaptation, the OPES processor may execute several callout services, iterating over several callout servers. Such preprocessing, postprocessing, and iterations make it impossible to rely on any specific relationship between application messages being proxied and application messages being sent to a callout service. Similarly, specific adaptation actions at the callout server are outside OCP Core scope.

This specification does not define or require any specific relationship among application messages being proxied by an OPES processor and application messages being exchanged between an OPES processor and a callout server via OCP. The OPES processor usually provides some mapping among these application messages, but the processor's specific actions are beyond OCP scope. In other words, this specification is not concerned with the OPES processor role as

an application proxy or as an iterator of callout services. The scope of OCP Core is communication between a single OPES processor and a single callout server.

Furthermore, an OPES processor may choose which proxied application messages or information about them to send over OCP. All proxied messages on all proxied connections (if connections are defined for a given application protocol), everything on some connections, selected proxied messages, or nothing might be sent over OCP to callout servers. OPES processor and callout server state related to proxied protocols can be relayed over OCP as application message metadata.

## 1.2. OPES Document Map

This document belongs to a large set of OPES specifications produced by the IETF OPES Working Group. Familiarity with the overall OPES approach and typical scenarios is often essential when one tries to comprehend isolated OPES documents. This section provides an index of OPES documents to assist the reader with finding "missing" information.

- o "OPES Use Cases and Deployment Scenarios" [RFC3752] describes a set of services and applications that are considered in scope for OPES and that have been used as a motivation and guidance in designing the OPES architecture.
- o The OPES architecture and common terminology are described in "An Architecture for Open Pluggable Edge Services (OPES)" [RFC3835].
- o "Policy, Authorization, and Enforcement Requirements of OPES" [RFC3838] outlines requirements and assumptions on the policy framework, without specifying concrete authorization and enforcement methods.
- o "Security Threats and Risks for OPES" [RFC3837] provides OPES risk analysis, without recommending specific solutions.
- o "OPES Treatment of IAB Considerations" [RFC3914] addresses all architecture-level considerations expressed by the IETF Internet Architecture Board (IAB) when the OPES WG was chartered.
- o At the core of the OPES architecture are the OPES processor and the callout server, two network elements that communicate with each other via an OPES Callout Protocol (OCP). The requirements for this protocol are discussed in "Requirements for OPES Callout Protocols" [RFC3836].

- o This document specifies an application agnostic protocol core to be used for the communication between an OPES processor and a callout server.
- o "OPES Entities and End Points Communications" [RFC3897] specifies generic tracing and bypass mechanisms for OPES.
- o The OCP Core and communications documents are independent from the application protocol being adapted by OPES entities. Their generic mechanisms have to be complemented by application-specific profiles. "HTTP Adaptation with OPES" [OPES-HTTP] is such an application profile for HTTP. It specifies how application-agnostic OPES mechanisms are to be used and augmented in order to support adaptation of HTTP messages.
- o Finally, "P: Message Processing Language" [OPES-RULES] defines a language for specifying what OPES adaptations (e.g., translation) must be applied to what application messages (e.g., e-mail from bob@example.com). P language is intended for configuring application proxies (OPES processors).

### 1.3. Terminology

In this document, the keywords "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119]. When used with the normative meanings, these keywords will be all uppercase. Occurrences of these words in lowercase constitute normal prose usage, with no normative implications.

The OPES processor works with messages from application protocols and may relay information about those application messages to a callout server. OCP is also an application protocol. Thus, protocol elements such as "message", "connection", or "transaction" exist in OCP and other application protocols. In this specification, all references to elements from application protocols other than OCP are used with an explicit "application" qualifier. References without the "application" qualifier refer to OCP elements.

**OCP message:** A basic unit of communication between an OPES processor and a callout server. The message is a sequence of octets formatted according to syntax rules (section 3.1). Message semantics is defined in section 11.

**application message:** An entity defined by OPES processor and callout server negotiation. Usually, the negotiated definition would match the definition from an application protocol (e.g., [RFC2616] definition of an HTTP message).

application message data: An opaque sequence of octets representing a complete or partial application message. OCP Core does not distinguish application message structures (if there are any). Application message data may be empty.

data: Same as application message data.

original: Referring to an application message flowing from the OPES processor to a callout server.

adapted: Referring to an application message flowing from an OPES callout server to the OPES processor.

adaptation: Any kind of access by a callout server, including modification, generation, and copying. For example, translating or logging an SMTP message is adaptation of that application message.

agent: The actor for a given communication protocol. The OPES processor and callout server are OCP agents. An agent can be referred to as a sender or receiver, depending on its actions in a particular context.

immediate: Performing the specified action before reacting to new incoming messages or sending any new messages unrelated to the specified action.

OCP extension: A specification extending or adjusting this document for adaptation of an application protocol (a.k.a., application profile; e.g., [OPES-HTTP]), new OCP functionality (e.g., transport encryption and authentication), and/or new OCP Core version.

## 2. Overall Operation

The OPES processor may use the OPES callout protocol (OCP) to communicate with callout servers. Adaptation using callout services is sometimes called "bump in the wire" architecture.

### 2.1. Initialization

The OPES processor establishes transport connections with callout servers to exchange application messages with the callout server(s) by using OCP. After a transport-layer connection (usually TCP/IP) is established, communicating OCP agents exchange Connection Start (CS) messages. Next, OCP features can be negotiated between the processor and the callout server (see section 6). For example, OCP agents may negotiate transport encryption and application message definition.

When enough settings are negotiated, OCP agents may start exchanging application messages.

OCP Core provides negotiation and other mechanisms for agents to encrypt OCP connections and authenticate each other. OCP Core does not require OCP connection encryption or agent authentication. Application profiles and other OCP extensions may document and/or require these and other security mechanisms. OCP is expected to be used, in part, in closed environments where trust and privacy are established by means external to OCP. Implementations are expected to demand necessary security features via the OCP Core negotiation mechanism, depending on agent configuration and environment.

## 2.2. Original Dataflow

When the OPES processor wants to adapt an application message, it sends a Transaction Start (TS) message to initiate an OCP transaction dedicated to that application message. The processor then sends an Application Message Start (AMS) message to prepare the callout server for application data that will follow. Once the application message scope is established, application data can be sent to the callout server by using Data Use Mine (DUM) and related OCP message(s). All of these messages correspond to the original dataflow.

## 2.3. Adapted Dataflow

The callout server receives data and metadata sent by the OPES processor (original dataflow). The callout server analyses metadata and adapts data as it comes in. The server usually builds its version of metadata and responds to the OPES processor with an Application Message Start (AMS) message. Adapted application message data can be sent next, using Data Use Mine (DUM) OCP message(s). The application message is then announced to be "completed" or "closed" by using an Application Message End (AME) message. The transaction may be closed by using a Transaction End (TE) message, as well. All these messages correspond to adapted data flow.

```

+-----+
|      OPES      | == (original data flow) ==> |callout|
|  processor    | <== (adapted data flow) === |server |
+-----+

```

The OPES processor receives the adapted application message sent by the callout server. Other OPES processor actions specific to the application message received are outside scope of this specification.

## 2.4. Multiple Application Messages

OCP Core specifies a transactions interface dedicated to exchanging a single original application message and a single adapted application message. Some application protocols may require multiple adapted versions for a single original application message or even multiple original messages to be exchanged as a part of a single OCP transaction. For example, a single original e-mail message may need to be transformed into several e-mail messages, with one custom message for each recipient.

OCP extensions MAY document mechanisms for exchanging multiple original and/or multiple adapted application messages within a single OCP transaction.

## 2.5. Termination

Either OCP agent can terminate application message delivery, transaction, or connection by sending an appropriate OCP message. Usually, the callout server terminates adapted application message delivery and the transaction. Premature and abnormal terminations at arbitrary times are supported. The termination message includes a result description.

## 2.6. Message Exchange Patterns

In addition to messages carrying application data, OCP agents may also exchange messages related to their configuration, state, transport connections, application connections, etc. A callout server may remove itself from the application message processing loop. A single OPES processor can communicate with many callout servers and vice versa. Though many OCP exchange patterns do not follow a classic client-server model, it is possible to think of an OPES processor as an "OCP client" and of a callout server as an "OCP server". The OPES architecture document [RFC3835] describes configuration possibilities.

The following informal rules illustrate relationships between connections, transactions, OCP messages, and application messages:

- o An OCP agent may communicate with multiple OCP agents. This is outside the scope of this specification.
- o An OPES processor may have multiple concurrent OCP connections to a callout server. Communication over multiple OCP connections is outside the scope of this specification.

- o A connection may carry multiple concurrent transactions. A transaction is always associated with a single connection (i.e., a transaction cannot span multiple concurrent connections).
- o A connection may carry at most one message at a time, including control messages and transaction-related messages. A message is always associated with a single connection (i.e., a message cannot span multiple concurrent connections).
- o A transaction is a sequence of messages related to application of a given set of callout services to a single application message.

A sequence of transaction messages from an OPES processor to a callout server is called original flow. A sequence of transaction messages from a callout server to an OPES processor is called adapted flow. The two flows may overlap in time.

- o In OCP Core, a transaction is associated with a single original and a single adapted application message. OCP Core extensions may extend transaction scope to more application messages.
- o An application message (adapted or original) is transferred by using a sequence of OCP messages.

## 2.7. Timeouts

OCP violations, resource limits, external dependencies, and other factors may lead to states in which an OCP agent is not receiving required messages from the other OCP agent. OCP Core defines no messages to address such situations. In the absence of any extension mechanism, OCP agents must implement timeouts for OCP operations. An OCP agent MUST forcefully terminate any OCP connection, negotiation, transaction, etc. that is not making progress. This rule covers both dead- and livelock situations.

In their implementation, OCP agents MAY rely on transport-level or other external timeouts if such external timeouts are guaranteed to happen for a given OCP operation. Depending on the OCP operation, an agent may benefit from "pinging" the other side with a Progress Query (PQ) message before terminating an OCP transaction or connection. The latter is especially useful for adaptations that may take a long time at the callout server before producing any adapted data.

## 2.8. Environment

OCP communication is assumed usually to take place over TCP/IP connections on the Internet (though no default TCP port is assigned to OCP in this specification). This does not preclude OCP from being implemented on top of other transport protocols, or on other networks. High-level transport protocols such as BEEP [RFC3080] may be used. OCP Core requires a reliable and message-order-preserving transport. Any protocol with these properties can be used; the mapping of OCP message structures onto the transport data units of the protocol in question is outside the scope of this specification.

OCP Core is application agnostic. OCP messages can carry application-specific information as a payload or as application-specific message parameters.

OCP Core overhead in terms of extra traffic on the wire is about 100 - 200 octets per small application message. Pipelining, preview, data preservation, and early termination optimizations, as well as as-is encapsulation of application data, make fast exchange of application messages possible.

## 3. Messages

As defined in section 1.3, an OCP message is a basic unit of communication between an OPES processor and a callout server. A message is a sequence of octets formatted according to syntax rules (section 3.1). Message semantics is defined in section 11. Messages are transmitted on top of OCP transport.

OCP messages deal with transport, transaction management, and application data exchange between a single OPES processor and a single callout server. Some messages can be emitted only by an OPES processor; some only by a callout server; and some by both OPES processor and callout server. Some messages require responses (one could call such messages "requests"); some can only be used in response to other messages ("responses"); some may be sent without solicitation; and some may not require a response.

### 3.1. Message Format

An OCP message consists of a message name followed by optional parameters and a payload. The exact message syntax is defined by the following Augmented Backus-Naur Form (ABNF) [RFC2234]:

```

message = name [SP anonym-parameters]
         [CRLF named-parameters CRLF]
         [CRLF payload CRLF]
         ";" CRLF

anonym-parameters = value *(SP value)           ; space-separated
named-parameters  = named-value *(CRLF named-value) ; CRLF-separated
list-items        = value *(", " value)         ; comma-separated

payload = data

named-value = name ":" SP value

value       = structure / list / atom
structure   = "{" [anonym-parameters] [CRLF named-parameters CRLF] "}"
list        = "(" [ list-items ] ")"
atom        = bare-value / quoted-value

name = ALPHA *safe-OCTET
bare-value = 1*safe-OCTET
quoted-value = DQUOTE data DQUOTE
data = size ":" *OCTET           ; exactly size octets

safe-OCTET = ALPHA / DIGIT / "-" / "_"
size = dec-number                ; 0-2147483647
dec-number = 1*DIGIT             ; no leading zeros or signs

```

Several normative rules accompany the above ABNF:

- o There is no "implied linear space" (LWS) rule. LWS rules are common to MIME-based grammars but are not used here. The whitespace syntax is restricted to what is explicitly allowed by the above ABNF.
- o All protocol elements are case sensitive unless it is specified otherwise. In particular, message names and parameter names are case sensitive.
- o Sizes are interpreted as decimal values and cannot have leading zeros.
- o Sizes do not exceed 2147483647.

- o The size attribute in a quoted-value encoding specifies the exact number of octets following the column (':') separator. If size octets are not followed by a quote ('"') character, the encoding is syntactically invalid.
- o Empty quoted values are encoded as a 4-octet sequence "0:".
- o Any bare value can be encoded as a quoted value. A quoted value is interpreted after the encoding is removed. For example, number 1234 can be encoded as four octets 1234 or as eight octets "4:1234", yielding exactly the same meaning.
- o Unicode UTF-8 is the default encoding. Note that ASCII is a UTF-8 subset, and that the syntax prohibits non-ASCII characters outside of the "data" element.

Messages violating formatting rules are, by definition, invalid. See section 5 for rules governing processing of invalid messages.

### 3.2. Message Rendering

OCP message samples in this specification and its extensions may not be typeset to depict minor syntactical details of OCP message format. Specifically, SP and CRLF characters are not shown explicitly. No rendering of an OCP message can be used to infer message format. The message format definition above is the only normative source for all implementations.

On occasion, an OCP message line exceeds text width allowed by this specification format. A backslash ("\"), a "soft line break" character, is used to emphasize a protocol-violating presentation-only linebreak. Bare backslashes are prohibited by OCP syntax. Similarly, an "\r\n" string is sometimes used to emphasize the presence of a CRLF sequence, usually before OCP message payload. Normally, the visible end of line corresponds to the CRLF sequence on the wire.

The next section (section 3.3) contains specific OCP message examples, some of which illustrate the above rendering techniques.

### 3.3. Message Examples

OCP syntax provides for compact representation of short control messages and required parameters while allowing for parameter extensions. Below are examples of short control messages. The required CRLF sequence at the end of each line is not shown explicitly (see section 3.2).

```
PQ;
TS 1 2;
DWM 22;
DWP 22 16;
x-doit "5:xyzyzy";
```

The above examples contain atomic anonymous parameter values, such as number and string constants. OCP messages sometimes use more complicated parameters such as item lists or structures with named values. As both messages below illustrate, structures and lists can be nested:

```
NO ({"32:http://www.iana.org/assignments/opes/ocp/tls"});
NO ({"54:http://www.iana.org/assignments/opes/ocp/http/response"
Optional-Parts: (request-header)
}, {"54:http://www.iana.org/assignments/opes/ocp/http/response"
Optional-Parts: (request-header,request-body)
Transfer-Encodings: (chunked)
});
```

Optional parameters and extensions are possible with a named parameters approach, as illustrated by the following example. The DWM (section 11.17) message in the example has two anonymous parameters (the last one being an extension) and two named parameters (the last one being an extension).

```
DWM 1 3
Size-Request: 16384
X-Need-Info: "26:twenty six octet extension";
```

Finally, any message may have a payload part. For example, the Data Use Mine (DUM) message below carries 8865 octets of raw data.

```
DUM 1 13
Modp: 75
\r\n
8865:... 8865 octets of raw data ...;
```

### 3.4. Message Names

Most OCP messages defined in this specification have short names, formed by abbreviating or compressing a longer but human-friendlier message title. Short names without a central registration system (such as this specification or the IANA registry) are likely to cause conflicts. Informal protocol extensions should avoid short names. To emphasize what is already defined by message syntax, implementations cannot assume that all message names are very short.

## 4. Transactions

An OCP transaction is a logical sequence of OCP messages processing a single original application message. The result of the processing

may be zero or more application messages, adapted from the original. A typical transaction consists of two message flows: a flow from the OPES processor to the callout server (sending the original application message), and a flow from the callout server to the OPES processor (sending adapted application messages). The number of application messages produced by the callout server and whether the callout server actually modifies the original application message may depend on the requested callout service and other factors. The OPES processor or the callout server can terminate the transaction by sending a corresponding message to the other side.

An OCP transaction starts with a Transaction Start (TS) message sent by the OPES processor. A transaction ends with the first Transaction End (TE) message sent or received, explicit or implied. A TE message can be sent by either side. Zero or more OCP messages associated with the transaction can be exchanged in between. The figure below illustrates a possible message sequence (prefix "P" stands for the OPES processor; prefix "S" stands for the callout server). Some message details are omitted.

```
P: TS 10;
P: AMS 10 1;
  ... processor sending application data to the callout server
S: AMS 10 2;
  ... callout server sending application data to the processor
  ... processor sending application data to the callout server
P: AME 10 1 result;
S: AME 10 2 result;
P: TE 10 result;
```

## 5. Invalid Input

This specification contains many criteria for valid OCP messages and their parts, including syntax rules, semantics requirements, and relationship to agents state. In this context, "Invalid input" means messages or message parts that violate at least one of the normative rules. A message with an invalid part is, by definition, invalid. If OCP agent resources are exhausted while parsing or interpreting a message, the agent **MUST** treat the corresponding OCP message as invalid.

Unless explicitly allowed to do otherwise, an OCP agent **MUST** terminate the transaction if it receives an invalid message with transaction scope and **MUST** terminate the connection if it receives an invalid message with a connection scope. A terminating agent **MUST** use the result status code of 400 and **MAY** specify termination cause information in the result status reason parameter (see section 10.10). If an OCP agent is unable to determine the scope of an invalid message it received, the agent **MUST** treat the message as having connection scope.

OCP usually deals with optional but invasive application message manipulations for which correctness ought to be valued above robustness. For example, a failure to insert or remove certain optional web page content is usually far less disturbing than corrupting (making unusable) the host page while performing that insertion or removal. Most OPES adaptations are high level in nature, which makes it impossible to assess correctness of the adaptations automatically, especially if "robustness guesses" are involved.

## 6. Negotiation

The negotiation mechanism allows OCP agents to agree on the mutually acceptable set of features, including optional and application-specific behavior and OCP extensions. For example, transport encryption, data format, and support for a new message can be negotiated. Negotiation implies intent for a behavioral change. For a related mechanism allowing an agent to query capabilities of its counterpart without changing the counterpart's behavior, see the Ability Query (AQ) and Ability Answer (AA) message definitions.

Most negotiations require at least one round trip time delay. In rare cases when the other side's response is not required immediately, negotiation delay can be eliminated, with an inherent risk of an overly optimistic assumption about the negotiation response.

A detected violation of negotiation rules leads to OCP connection termination. This design reduces the number of negotiation scenarios resulting in a deadlock when one of the agents is not compliant.

Two core negotiation primitives are supported: negotiation offer and negotiation response. A Negotiation Offer (NO) message allows an agent to specify a set of features from which the responder has to select at most one feature that it prefers. The selection is sent by using a Negotiation Response (NR) message. If the response is positive, both sides assume that the selected feature is in effect immediately (see section 11.19 for details). If the response is negative, no behavioral changes are assumed. In either case, further offers may follow.

Negotiating OCP agents have to take into account prior negotiated (i.e., already enabled) features. OCP agents MUST NOT make and MUST reject offers that would lead to a conflict with already negotiated features. For example, an agent cannot offer an HTTP application profile for a connection that already has an SMTP application profile enabled, as there would be no way to resolve the conflict for a given transaction. Similarly, once TLSv1 connection encryption is negotiated, an agent must not offer and must reject offers for SSLv2 connection encryption (unless a negotiated feature explicitly allows for changing an encryption scheme on the fly).

Negotiation Offer (NO) messages may be sent by either agent. OCP extensions documenting negotiation MAY assign the initiator role to one of the agents, depending on the feature being negotiated. For example, negotiation of transport security feature should be initiated by OPES processors to avoid situations where both agents wait for the other to make an offer.

As either agent may make an offer, two "concurrent" offers may be made at the same time, by the two communicating agents. Unmanaged concurrent offers may lead to a negotiation deadlock. By giving OPES processor a priority, offer-handling rules (section 11.18) ensure that only one offer per OCP connection is honored at a time, and that the other concurrent offers are ignored by both agents.

### 6.1. Negotiation Phase

A Negotiation Phase is a mechanism ensuring that both agents have a chance to negotiate all features they require before proceeding further. Negotiation Phases have OCP connection scope and do not overlap. For each OCP agent, the Negotiation Phase starts with the first Negotiation Offer (NO) message received or the first Negotiation Response (NR) message sent, provided the message is not a part of an existing Phase. For each OCP agent, Negotiation Phase

ends with the first Negotiation Response (NR) message (sent or received), after which the agent expects no more negotiations. Agent expectation rules are defined later in this section.

During a Negotiation Phase, an OCP agent MUST NOT send messages other than the following "Negotiation Phase messages": Negotiation Offer (NO), Negotiation Response (NR), Ability Query (AQ), Ability Answer (AA), Progress Query (PQ), Progress Answer (PA), Progress Report (PR), and Connection End (CE).

Multiple Negotiation Phases may happen during the lifespan of a single OCP connection. An agent may attempt to start a new Negotiation Phase immediately after the old Phase is over, but it is possible that the other agent will send messages other than "Negotiation Phase messages" before receiving the new Negotiation Offer (NO). The agent that starts a Phase has to be prepared to handle those messages while its offer is reaching the recipient.

An OPES processor MUST make a negotiation offer immediately after sending a Connection Start (CS) message. If the OPES processor has nothing to negotiate, the processor MUST send a Negotiation Offer (NO) message with an empty features list. These two rules bootstrap the first Negotiation Phase. Agents are expected to negotiate at least the application profile for OCP Core. Thus, these bootstrapping requirements are unlikely to result in any extra work.

Once a Negotiation Phase starts, an agent MUST expect further negotiations if and only if the last NO sent or the last NR received contained a true "Offer-Pending" parameter value. Informally, an agent can keep the phase open by sending true "Offer-Pending" parameters with negotiation offers or responses. Moreover, if there is a possibility that the agent may need to continue the Negotiation Phase, the agent must send a true "Offer-Pending" parameter.

## 6.2. Negotiation Examples

Below is an example of the simplest negotiation possible. The OPES processor is offering nothing and is predictably receiving a rejection. Note that the NR message terminates the Negotiation Phase in this case because neither of the messages contains a true "Offer-Pending" value:

```
P: NO ();  
S: NR;
```

The next example illustrates how a callout server can force negotiation of a feature that an OPES processor has not negotiated. Note that the server sets the "Offer-Pending" parameter to true when

responding to the processor Negotiation Offer (NO) message. The processor chooses to accept the feature:

```
P: NO ();
S: NR
  Offer-Pending: true
  ;
S: NO ({ "22:ocp://feature/example/" })
  Offer-Pending: false
  ;
P: NR { "22:ocp://feature/example/" };
```

If the server seeks to stop the above negotiations after sending a true "Offer-Pending" value, its only option would be send an empty negotiation offer (see the first example above). If the server does nothing instead, the OPES processor would wait for the server and would eventually time out the connection.

The following example shows a dialog with a callout server that insists on enabling two imaginary features: strong transport encryption and volatile storage for responses. The server is designed not to exchange sensitive messages until both features are enabled. Naturally, the volatile storage feature has to be negotiated securely. The OPES processor supports one of the strong encryption mechanisms but prefers not to offer (to volunteer support for) strong encryption, perhaps for performance reasons. The server has to send a true "Offer-Pending" parameter to get a chance to offer strong encryption (which is successfully negotiated in this case). Any messages sent by either agent after the (only) successful NR response are encrypted with "strongB" encryption scheme. The OPES processor does not understand the volatile storage feature, and the last negotiation fails (over a strongly encrypted transport connection).

```
P: NO ({ "29:ocp://example/encryption/weak" })
  ;
S: NR
  Offer-Pending: true
  ;
S: NO ({ "32:ocp://example/encryption/strongA" }, \
  { "32:ocp://example/encryption/strongB" })
  Offer-Pending: true
  ;
P: NR { "32:ocp://example/encryption/strongB" }
  ;
... all traffic below is encrypted using strongB ...
```

```

S: NO ({"31:ocp://example/storage/volatile"})
  Offer-Pending: false
  ;
P: NR
  Unknowns: ({"31:ocp://example/storage/volatile"})
  ;
S: CSE { 400 "33:lack of VolStore protocol support" }
  ;

```

The following example from [OPES-HTTP] illustrates successful HTTP application profile negotiation:

```

P: NO ({"54:http://www.iana.org/assignments/opes/ocp/http/response"
  Aux-Parts: (request-header,request-body)
  })
  SG: 5;
S: NR {"54:http://www.iana.org/assignments/opes/ocp/http/response"
  Aux-Parts: (request-header)
  Pause-At-Body: 30
  Wont-Send-Body: 2147483647
  Content-Encodings: (gzip)
  }
  SG: 5;

```

## 7. 'Data Preservation' Optimization

Many adaptations do not require any data modifications (e.g., message logging or blocking). Some adaptations modify only a small portion of application message content (e.g., HTTP cookies filtering or ad insertion). Yet, in many cases, the callout service has to see complete data. By default, unmodified data would first travel from the OPES processor to the callout server and then back. The "data preservation" optimization in OCP helps eliminate the return trip if both OCP agents cooperate. Such cooperation is optional: OCP agents MAY support data preservation optimization.

To avoid sending back unmodified data, a callout service has to know that the OPES processor has a copy of the data. As data sizes can be very large and the callout service may not know in advance whether it will be able to use the processor copy, it is not possible to require the processor to keep a copy of the entire original data. Instead, it is expected that a processor may keep some portion of the data, depending on processor settings and state.

When an OPES processor commits to keeping a data chunk, it announces its decision and the chunk parameters via a Kept parameter of a Data Use Mine (DUM) message. The callout server MAY "use" the chunk by sending a Data Use Yours (DUY) message referring to the preserved

chunk. That OCP message does not have payload and, therefore, the return trip is eliminated.

As the mapping between original and adapted data is not known to the processor, the processor MUST keep the announced-as-preserved chunk until the end of the corresponding transaction, unless the callout server explicitly tells the processor that the chunk is not needed. As implied by the above requirement, the processor cannot assume that a data chunk is no longer needed just because the callout server sent a Data Use Yours (DUY) message or adapted data with, for instance, the same offset as the preserved chunk.

For simplicity, preserved data is always a contiguous chunk of original data, described by an (offset, size) pair using a "Kept" parameter of a Data Use Mine (DUM) message. An OPES processor may volunteer to increase the size of the kept data. An OPES processor may increase the offset if the callout server indicated that the kept data is no longer needed.

Both agents may benefit from data reuse. An OPES processor has to allocate storage to support this optimization, but a callout server does not. On the other hand, it is the callout server that is responsible for relieving the processor from data preservation commitments. There is no simple way to resolve this conflict of interest on a protocol level. Some OPES processors may allocate a relatively small buffer for data preservation purposes and stop preserving data when the buffer becomes full. This technique would benefit callout services that can quickly reuse or discard kept data. Another processor strategy would be to size the buffer based on historical data reuse statistics. To improve chances of beneficial cooperation, callout servers are strongly encouraged to immediately notify OPES processors of unwanted data. The callout server that made a decision not to send Data Use Yours (DUY) messages (for a specific data ranges or at all) SHOULD immediately inform the OPES processor of that decision with the corresponding Data Preservation Interest (DPI) message(s) or other mechanisms.

#### 8. 'Premature Dataflow Termination' Optimizations

Many callout services adapt small portions of large messages and would preferably not be in the loop when that adaptation is over. Some callout services may not seek data modification and would preferably not send data back to the OPES processor, even if the OPES processor is not supporting the data preservation optimization (Section 7). By OCP design, unilateral premature dataflow termination by a callout server would lead to termination of an OCP transaction with an error. Thus, the two agents must cooperate to allow for error-free premature termination.

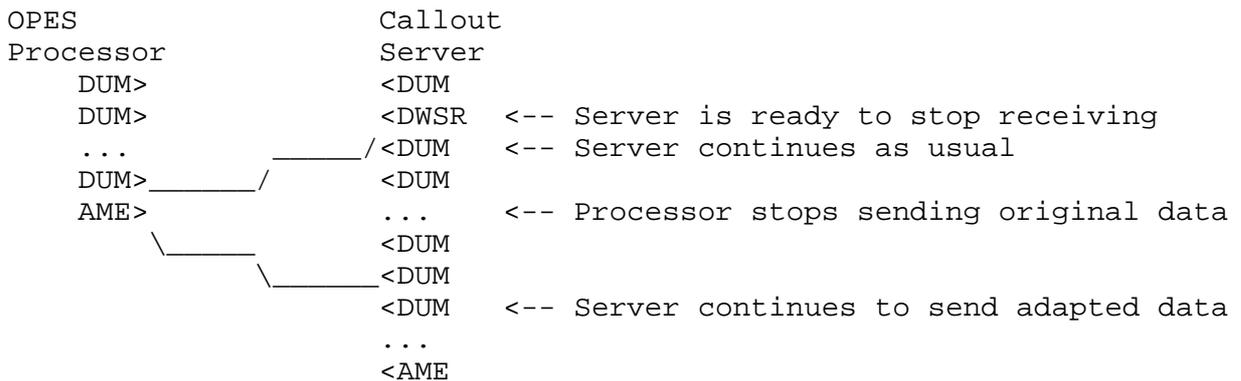
This section documents two mechanisms for premature termination of original or adapted dataflow. In combination, the mechanisms allow the callout server to get out of the processing loop altogether.

### 8.1. Original Dataflow

There are scenarios where a callout server is not interested in the remaining original dataflow. For example, a simple access blocking or "this site is temporary down" callout service has to send an adapted (generated) application down message but would preferably not receive original data from the OPES processor.

OCF Core supports premature original dataflow termination via the Want Stop Receiving Data (DWSR) message. A callout server that does not seek to receive additional original data (beyond a certain size) sends a DWSR message. The OPES processor receiving a DWSR message terminates original dataflow by sending an Application Message End (AME) message with a 206 (partial) status code.

The following figure illustrates a typical sequence of events. The downward lines connecting the two dataflows illustrate the transmission delay that allows for more OCP messages to be sent while an agent waits for the opposing agent reaction.



The mechanism described in this section has no effect on the adapted dataflow. Receiving an Application Message End (AME) message with 206 (partial) result status code from the OPES processor does not introduce any special requirements for the adapted dataflow termination. However, it is not possible to terminate adapted dataflow prematurely after the original dataflow has been prematurely terminated (see section 8.3).

## 8.2. Adapted Dataflow

There are scenarios where a callout service may want to stop sending adapted data before a complete application message has been sent. For example, a logging-only callout service has to receive all application messages but would preferably not send copies back to the OPES processor.

OCP Core supports premature adapted dataflow termination via a combination of Want Stop Sending Data (DWSS) and Stop Sending Data (DSS) messages. A callout service that seeks to stop sending data sends a DWSS message, soliciting an OPES processor permission to stop. While waiting for the permission, the server continues with its usual routine.

An OPES processor receiving a Want Stop Sending Data message responds with a Stop Sending Data (DSS) message. The processor may then pause to wait for the callout server to terminate the adapted dataflow or may continue sending original data while making a copy of it. Once the server terminates the adapted dataflow, the processor is responsible for using original data (sent or paused after sending DSS) instead of the adapted data.

The callout server receiving a DSS message terminates the adapted dataflow (see the Stop Sending Data (DSS) message definition for the exact requirements and corner cases).

The following figure illustrates a typical sequence of events, including a possible pause in original dataflow when the OPES processor is waiting for the adapted dataflow to end. The downward lines connecting the two dataflows illustrate the transmission delay that allows for more OCP messages to be sent while an agent waits for the opposing agent reaction.

```

OPES Processor          Callout Server
DUM>                   <DUM
DUM>                   <DWSS  <-- Server is ready to stop sending
...                   /<DUM  <-- Server continues as usual,
DUM>_____ /         <DUM  waiting for DSS
DSS>
\                   ...
possible \           <DUM
org-dataflow \       <DUM
pause _____ /   <AME 206 <-- Server terminates adapted dataflow
                           upon receiving the DSS message
_____ /
DUM>                   <-- Processor resumes original dataflow
DUM>                   to the server and starts using
...                   original data without adapting it
AME>

```

Premature adapted dataflow preservation is not trivial, as the OPES processor relies on the callout server to provide adapted data (modified or not) to construct the adapted application message. If the callout server seeks to quit its job, special care must be taken to ensure that the OPES processor can construct the complete application message. On a logical level, this mechanism is equivalent to switching from one callout server to another (non-modifying) callout server in the middle of an OCP transaction.

Other than a possible pause in the original dataflow, the mechanism described in this section has no effect on the original dataflow. Receiving an Application Message End (AME) message with 206 (partial) result status code from the callout server does not introduce any special requirements for the original dataflow termination.

### 8.3. Getting Out of the Loop

Some adaptation services work on application message prefixes and do not seek to be in the adaptation loop once their work is done. For example, an ad insertion service that did its job by modifying the first fragment of a web "page" would not seek to receive more original data or to perform further adaptations. The 'Getting Out of the Loop' optimization allows a callout server to get completely out of the application message processing loop.

The "Getting Out of the Loop" optimization is made possible by terminating the adapted dataflow (section 8.2) and then by terminating the original dataflow (section 8.1). The order of termination is very important.

If the original dataflow is terminated first, the OPES processor would not allow the adapted dataflow to be terminated prematurely, as the processor would not be able to reconstruct the remaining portion of the adapted application message. The processor would not know which suffix of the remaining original data has to follow the adapted parts. The mapping between original and adapted octets is known only to the callout service.

An OPES processor that received a DWSS message followed by a DWSR message MUST NOT send an AME message with a 206 (partial) status code before sending a DSS message. Informally, this rule means that a callout server that wants to get out of the loop fast should send a DWSS message immediately followed by a DWSR message; the server does not have to wait for the OPES processor's permission to terminate adapted dataflow before requesting that the OPES processor terminates original dataflow.

## 9. Protocol Element Type Declaration Mnemonic (PETDM)

A protocol element type is a named set of syntax and semantics rules. This section defines a simple, formal declaration mnemonic for protocol element types, labeled PETDM. PETDM simplicity is meant to ease type declarations in this specification. PETDM formality is meant to improve interoperability among implementations. Two protocol elements are supported by PETDM: message parameter values and messages.

All OCP Core parameter and message types are declared by using PETDM. OCP extensions SHOULD use PETDM when declaring new types.

Atom, list, structure, and message constructs are four available base types. Their syntax and semantics rules are defined in section 3.1. New types can be declared in PETDM to extend base types semantics by using the following declaration templates. The new semantics rules are meant to be attached to each declaration using prose text.

Text in angle brackets "<>" are template placeholders, to be substituted with actual type names or parameter name tokens. Square brackets "[]" surround optional elements such as structure members or message payload.

- o Declaring a new atomic type:

```
<new-type-name>: extends atom;
```

- o Declaring a new list with old-type-name items:

```
<new-type-name>: extends list of <old-type-name>;
```

Unless it is explicitly noted otherwise, empty lists are valid and have the semantics of an absent parameter value.

```

o Declaring a new structure with members:
<new-type-name>: extends structure with {
    <old-type-nameA> <old-type-nameB> [<old-type-nameC>] ...;
    <member-name1>: <old-type-name1>;
    <member-name2>: <old-type-name2>;
    [<member-name3>: <old-type-name3>];
    ...
};

```

The new structure may have anonymous members and named members. Neither group has to exist. Note that it is always possible for extensions to add more members to old structures without affecting type semantics because unrecognized members are ignored by compliant agents.

```

o Declaring a new message with parameters:
<new-type-name>: extends message with {
    <old-type-nameA> <old-type-nameB> [<old-type-nameC>] ...;
    <parameter-name1>: <old-type-name1>;
    <parameter-name2>: <old-type-name2>;
    [<parameter-name3>: <old-type-name3>];
    ...
};

```

The new type name becomes the message name. Just as when a structure is extended, the new message may have anonymous parameters and named parameters. Neither group has to exist. Note that it is always possible for extensions to add more parameters to old messages without affecting type semantics because unrecognized parameters are ignored by compliant agents.

```

o Extending a type with more semantics details:

```

```

<new-type-name>: extends <old-type-name>;

```

```

o Extending a structure- or message-base type:
<new-type-name>: extends <old-type-name> with {
    <old-type-nameA> <old-type-nameB> [<old-type-nameC>] ...;
    <member-name1>: <old-type-name1>;
    <member-name2>: <old-type-name2>;
    [<member-name3>: <old-type-name3>];
    ...
};

```

New anonymous members are appended to the anonymous members of the old type, and new named members are merged with named members of the old type.

o Extending a message-base type with payload semantics:  
`<new-type-name>: extends <old-type-name> with {`  
`...`  
`}` and payload;

Any any OCP message can have payload, but only some message types have known payload semantics. Like any parameter, payload may be required or optional.

o Extending type semantics without renaming the type:  
`<old-type-name>: extends <namespace>::<old-type-name>;`

The above template can be used by OCP Core extensions that seek to change the semantics of OCP Core types without renaming them. This technique is essential for extending OCP messages because the message name is the same as the message type name. For example, an SMTP profile for OCP might use the following declaration to extend an Application Message Start (AMS) message with Am-Id, a parameter defined in that profile:

```
AMS: extends Core::AMS with {
    Am-Id: am-id;
};
```

All extended types may be used as replacements of the types they extend. For example, a Negotiation Offer (NO) message uses a parameter of type Features. Features (section 10.12) is a list of feature (section 10.11) items. A Feature is a structure-based type. An OCP extension (e.g., an HTTP application profile) may extend the feature type and use a value of that extended type in a negotiation offer. Recipients that are aware of the extension will recognize added members in feature items and negotiate accordingly. Other recipients will ignore them.

The OCP Core namespace tag is "Core". OCP extensions that declare types MUST define their namespace tags (so that other extensions and documentation can use them in their PETDM declarations).

### 9.1. Optional Parameters

Anonymous parameters are positional: The parameter's position (i.e., the number of anonymous parameters to the left) is its "name". Thus, when a structure or message has multiple optional anonymous parameters, parameters to the right can be used only if all parameters to the left are present. The following notation

```
[name1] [name2] [name3] ... [nameN]
```

is interpreted as

```
[name1 [ name2 [ name3 ... [nameN] ... ]]]
```

When an anonymous parameter is added to a structure or message that has optional anonymous parameters, the new parameter has to be optional and can only be used if all old optional parameters are in use. Named parameters do not have these limitations, as they are not positional, but associative; they are identified by their explicit and unique names.

## 10. Message Parameter Types

This section defines parameter value types that are used for message definitions (section 11). Before using a parameter value, an OCP agent **MUST** check whether the value has the expected type (i.e., whether it complies with all rules from the type definition). A single rule violation means that the parameter is invalid. See Section 5 for rules on processing invalid input.

OCP extensions **MAY** define their own types. If they do, OCP extensions **MUST** define types with exactly one base format and **MUST** specify the type of every new protocol element they introduce.

### 10.1. uri

```
uri: extends atom;
```

Uri (universal resource identifier) is an atom formatted according to URI rules in [RFC2396].

Often, a uri parameter is used as a unique (within a given scope) identifier. Uni semantics is incomplete without the scope specification. Many uri parameters are URLs. Unless it is noted otherwise, URL identifiers do not imply the existence of a serviceable resource at the location they specify. For example, an HTTP request for an HTTP-based URI identifier may result in a 404 (Not Found) response.

### 10.2. uni

```
uni: extends atom;
```

Uni (unique numeric identifier) is an atom formatted as dec-number and with a value in the [0, 2147483647] range, inclusive.

A uni parameter is used as a unique (within a given scope) identifier. Uni semantics is incomplete without the scope specification. Some OCP messages create identifiers (i.e., bring them into scope). Some OCP messages destroy them (i.e., remove them

from scope). An OCP agent **MUST NOT** create the same uni value more than once within the same scope. When creating a new identifier of the same type and within the same scope as some old identifier, an OCP agent **MUST** use a higher numerical value for the new identifier. The first rule makes uni identifiers suitable for cross-referencing logs and other artifacts. The second rule makes efficient checks of the first rule possible.

For example, a previously used transaction identifier "xid" must not be used for a new Transaction Start (TS) message within the same OCP transaction, even if a prior Transaction End (TE) message was sent for the same transaction.

An OCP agent **MUST** terminate the state associated with uni uniqueness scope if all unique values have been used up.

### 10.3. size

size: extends atom;

Size is an atom formatted as dec-number and with a value in the [0, 2147483647] range, inclusive.

Size value is the number of octets in the associated data chunk.

OCP Core cannot handle application messages that exceed 2147483647 octets in size, that require larger sizes as a part of OCP marshaling process, or that use sizes with granularity other than 8 bits. This limitation can be addressed by OCP extensions, as hinted in section 15.1.

### 10.4. offset

offset: extends atom;

Offset is an atom formatted as dec-number and with a value in the [0, 2147483647] range, inclusive.

Offset is an octet position expressed in the number of octets relative to the first octet of the associated dataflow. The offset of the first data octet has a value of zero.

### 10.5. percent

percent: extends atom;

Percent is an atom formatted as dec-number and with a value in the [0, 100] range, inclusive.

Percent semantics is incomplete unless its value is associated with a boolean statement or assertion. The value of 0 indicates absolute impossibility. The value of 100 indicates an absolute certainty. In either case, the associated statement can be relied upon as if it were expressed in boolean rather than probabilistic terms. Values in the [1,99] inclusive range indicate corresponding levels of certainty that the associated statement is true.

#### 10.6. boolean

```
boolean: extends atom;
```

Boolean type is an atom with two valid values: true and false. A boolean parameter expresses the truthfulness of the associated statement.

#### 10.7. xid

```
xid: extends uni;
```

Xid, an OCP transaction identifier, uniquely identifies an OCP transaction within an OCP connection.

#### 10.8. sg-id

```
sg-id: extends uni;
```

Sg-id, a service group identifier, uniquely identifies a group of services on an OCP connection.

#### 10.9. modp

```
modp: extends percent;
```

Modp extends the percent type to express the sender's confidence that application data will be modified. The boolean statement associated with the percentage value is "data will be modified". Modification is defined as adaptation that changes the numerical value of at least one data octet.

#### 10.10. result

```
result: extends structure with {  
    atom [atom];  
};
```

The OCP processing result is expressed as a structure with two documented members: a required Uni status code and an optional

reason. The reason member contains informative textual information not intended for automated processing. For example:

```
{ 200 OK }
{ 200 "6:got it" }
{ 200 "27:27 octets in UTF-8 encoding" }
```

This specification defines the following status codes:

#### Result Status Codes

code	text	semantics
200	OK	Overall success. This specification does not contain any general actions for a 200 status code recipient.
206	partial	Partial success. This status code is documented for Application Message End (AME) messages only. The code indicates that the agent terminated the corresponding dataflow prematurely (i.e., more data would be needed to reconstruct a complete application message). Premature termination of one dataflow does not introduce any special requirements for the other dataflow termination. See dataflow termination optimizations (section 8) for use cases.
400	failure	An error, exception, or trouble. A recipient of a 400 (failure) result of an AME, TE, or CE message MUST destroy any state or data associated with the corresponding dataflow, transaction, or connection. For example, an adapted version of the application message data must be purged from the processor cache if the OPES processor receives an Application Message End (AME) message with result code of 400.

Specific OCP messages may require code-specific actions.

Extending result semantics is made possible by adding new "result" structure members or by negotiating additional result codes (e.g., as a part of a negotiated profile). A recipient of an unknown (in

then-current context) result code MUST act as if code 400 (failure) were received.

The recipient of a message without the actual result parameter, but with an optional formal result parameter, MUST act as if code 200 (OK) were received.

Textual information (the second anonymous parameter of the result structure) is often referred to as "reason" or "reason phrase". To assist manual troubleshooting efforts, OCP agents are encouraged to include descriptive reasons with all results indicating a failure.

In this specification, an OCP message with result status code of 400 (failure) is called "a message indicating a failure".

#### 10.11. feature

```
feature: extends structure with {  
    uri;  
};
```

The feature type extends structure to relay an OCP feature identifier and to reserve a "place" for optional feature-specific parameters (sometimes called feature attributes). Feature values are used to declare support for and to negotiate use of OCP features.

This specification does not define any features.

#### 10.12. features

```
features: extends list of feature;
```

Features is a list of feature values. Unless it is noted otherwise, the list can be empty, and features are listed in decreasing preference order.

#### 10.13. service

```
service: extends structure with {  
    uri;  
};
```

Service structure has one anonymous member, an OPES service identifier of type uri. Services may have service-dependent parameters. An OCP extension defining a service for use with OCP MUST define service identifier and service-dependent parameters, if there are any, as additional "service" structure members. For example, a service value may look like this:

```
{"41:http://www.iana.org/assignments/opes/ocp/tls" "8:blowfish"}
```

#### 10.14. services

services: extends list of service;

Services is a list of service values. Unless it is noted otherwise, the list can be empty, and the order of the values is the requested or actual service application order.

#### 10.15. Dataflow Specializations

Several parameter types, such as offset apply to both original and adapted dataflow. It is relatively easy to misidentify a type's dataflow affiliation, especially when parameters with different affiliations are mixed together in one message declaration. The following statements declare new dataflow-specific types by using their dataflow-agnostic versions (denoted by a <type> placeholder).

The following new types refer to original data only:

org-<type>: extends <type>;

The following new types refer to adapted data only:

adp-<type>: extends <type>;

The following new types refer to the sender's dataflow only:

my-<type>: extends <type>;

The following new types refer to the recipient's dataflow only:

your-<type>: extends <type>;

OCP Core uses the above type-naming scheme to implement dataflow specialization for the following types: offset, size, and sg-id. OCP extensions SHOULD use the same scheme.

### 11. Message Definitions

This section describes specific OCP messages. Each message is given a unique name and usually has a set of anonymous and/or named parameters. The order of anonymous parameters is specified in the message definitions below. No particular order for named parameters is implied by this specification. OCP extensions MUST NOT introduce order-dependent named parameters. No more than one named-parameter

with a given name can appear in the message; messages with multiple equally named parameters are semantically invalid.

A recipient **MUST** be able to parse any message in valid format (see section 3.1), subject to the limitations of the recipient's resources.

Unknown or unexpected message names, parameters, and payloads may be valid extensions. For example, an "extra" named parameter may be used for a given message, in addition to what is documented in the message definition below. A recipient **MUST** ignore any valid but unknown or unexpected name, parameter, member, or payload.

Some message parameter values use uni identifiers to refer to various OCP states (see section 10.2 and Appendix B). These identifiers are created, used, and destroyed by OCP agents via corresponding messages. Except when creating a new identifier, an OCP agent **MUST NOT** send a uni identifier that corresponds to an inactive state (i.e., that was either never created or already destroyed). Such identifiers invalidate the host OCP message (see section 5). For example, the recipient must terminate the transaction when the xid parameter in a Data Use Mine (DUM) message refers to an unknown or already terminated OCP transaction.

#### 11.1. Connection Start (CS)

CS: extends message;

A Connection Start (CS) message indicates the start of an OCP connection. An OCP agent **MUST** send this message before it sends any other message on the connection. If the first message an OCP agent receives is not Connection Start (CS), the agent **MUST** terminate the connection with a Connection End (CE) message having 400 (failure) result status code. An OCP agent **MUST** send Connection Start (CS) message exactly once. An OCP agent **MUST** ignore repeated Connection Start (CS) messages.

At any time, a callout server **MAY** refuse further processing on an OCP connection by sending a Connection End (CE) message with the status code 400 (failure). Note that the above requirement to send a CS message first still applies.

With TCP/IP as transport, raw TCP connections (local and remote peer IP addresses with port numbers) identify an OCP connection. Other transports may provide OCP connection identifiers to distinguish logical connections that share the same transport. For example, a single BEEP [RFC3080] channel may be designated as a single OCP connection.

### 11.2. Connection End (CE)

```
CE: extends message with {  
    [result];  
};
```

A Connection End (CE) Indicates the end of an OCP connection. The agent initiating closing or termination of a connection MUST send this message immediately prior to closing or termination. The recipient MUST free associated state, including transport state.

Connection termination without a Connection End (CE) message indicates that the connection was prematurely closed, possibly without the closing-side agent's prior knowledge or intent. When an OCP agent detects a prematurely closed connection, the agent MUST act as if a Connection End (CE) message indicating a failure was received.

A Connection End (CE) message implies the end of all transactions, negotiations, and service groups opened or active on the connection being ended.

### 11.3. Service Group Created (SGC)

```
SGC: extends message with {  
    my-sg-id services;  
};
```

A Service Group Created (SGC) message informs the recipient that a list of adaptation services has been associated with the given service group identifier ("my-sg-id"). Following this message, the sender can refer to the group by using the identifier. The recipient MUST maintain the association until a matching Service Group Destroyed (SGD) message is received or the corresponding OCP connection is closed.

Service groups have a connection scope. Transaction management messages do not affect existing service groups.

Maintaining service group associations requires resources (e.g., storage to keep the group identifier and a list of service IDs). Thus, there is a finite number of associations an implementation can maintain. Callout servers MUST be able to maintain at least one association for each OCP connection they accept. If a recipient of a Service Group Created (SGC) message does not create the requested association, it MUST immediately terminate the connection with a Connection End (CE) message indicating a failure.

#### 11.4. Service Group Destroyed (SGD)

```
SGD: extends message with {  
    my-sg-id;  
};
```

A Service Group Destroyed (SGD) message instructs the recipient to forget about the service group associated with the specified identifier. The recipient **MUST** destroy the identified service group association.

#### 11.5. Transaction Start (TS)

```
TS: extends message with {  
    xid my-sg-id;  
};
```

Sent by an OPES processor, a Transaction Start (TS) message indicates the start of an OCP transaction. Upon receiving this message, the callout server **MAY** refuse further transaction processing by responding with a corresponding Transaction End (TE) message. A callout server **MUST** maintain the state until it receives a message indicating the end of the transaction or until it terminates the transaction itself.

The required "my-sg-id" identifier refers to a service group created with an a Service Group Created (SGC) message. The callout server **MUST** apply the list of services associated with "my-sg-id", in the specified order.

This message introduces the transaction identifier (xid).

#### 11.6. Transaction End (TE)

```
TE: extends message with {  
    xid [result];  
};
```

A Transaction End (TE) indicates the end of the identified OCP transaction.

An OCP agent **MUST** send a Transaction End (TE) message immediately after it makes a decision to send no more messages related to the corresponding transaction. Violating this requirement may cause, for

example, unnecessary delays, rejection of new transactions, and even timeouts for agents that rely on this end-of-file condition to proceed.

This message terminates the life of the transaction identifier (xid).

#### 11.7. Application Message Start (AMS)

```
AMS: extends message with {
    xid;
    [Services: services];
};
```

An Application Message Start (AMS) message indicates the start of the original or adapted application message processing and dataflow. The recipient MAY refuse further processing by sending an Application Message End (AME) message indicating a failure.

When an AMS message is sent by the OPES processor, the callout server usually sends an AMS message back, announcing the creation of an adapted version of the original application message. This announcement may be delayed. For example, the callout server may wait for more information from the OPES processor.

When an AMS message is sent by the callout server, an optional "Services" parameter describes OPES services that the server MAY apply to the original application message. Usually, the "services" value matches what was asked by the OPES processor. The callout server SHOULD send a "Services" parameter if its value would differ from the list of services requested by the OPES processor. As the same service may be known under many names, the mismatch does not necessarily imply an error.

#### 11.8. Application Message End (AME)

```
AME: extends message with {
    xid [result];
};
```

An Application Message End (AME) message indicates the end of the original or adapted application message processing and dataflow. The recipient should expect no more data for the corresponding application message.

An Application Message End (AME) message ends any data preservation commitments and any other state associated with the corresponding application message.

An OCP agent MUST send an Application Message End (AME) message immediately after it makes a decision to stop processing of its application message. Violating this requirement may cause, for example, unnecessary delays, rejection of new transactions, and even timeouts for agents that rely on this end-of-file condition to proceed.

#### 11.9. Data Use Mine (DUM)

```
DUM: extends message with {
    xid my-offset;
    [As-is: org-offset];
    [Kept: org-offset org-size ];
    [Modp: modp];
} and payload;
```

A Data Use Mine (DUM) message carries application data. It is the only OCP Core message with a documented payload. The sender MUST NOT make any gaps in data supplied by Data Use Mine (DUM) and Data Use Yours (DUY) messages (i.e., the my-offset of the next data message must be equal to the my-offset plus the payload size of the previous data message). Messages with gaps are invalid. The sender MUST send payload and MAY use empty payload (i.e., payload with zero size). A DUM message without payload is invalid. Empty payloads are useful for communicating meta-information about the data (e.g., modification predictions or preservation commitments) without sending data.

An OPES processor MAY send a "Kept" parameter to indicate its current data preservation commitment (section 7) for original data. When an OPES processor sends a "Kept" parameter, the processor MUST keep a copy of the specified data (the preservation commitment starts or continues). The Kept offset parameter specifies the offset of the first octet of the preserved data. The Kept size parameter is the size of preserved data. Note that data preservation rules allow (i.e., do not prohibit) an OPES processor to decrease offset and to specify a data range not yet fully delivered to the callout server. OCP Core does not require any relationship between DUM payload and the "Kept" parameter.

If the "Kept" parameter value violates data preservation rules but the recipient has not sent any Data Use Yours (DUY) messages for the given OCP transaction yet, then the recipient MUST NOT use any preserved data for the given transaction (i.e., must not send any Data Use Yours (DUY) messages). If the "Kept" parameter value violates data preservation rules and the recipient has already sent Data Use Yours (DUY) messages, the DUM message is invalid, and the rules of section 5 apply. These requirements help preserve data integrity when "Kept" optimization is used by the OPES processor.

A callout server MUST send a "Modp" parameter if the server can provide a reliable value and has not already sent the same parameter value for the corresponding application message. The definition of "reliable" is entirely up to the callout server. The data modification prediction includes DUM payload. That is, if the attached payload has been modified, the modp value cannot be 0%.

A callout server SHOULD send an "As-is" parameter if the attached data is identical to a fragment at the specified offset in the original dataflow. An "As-is" parameter specifying a data fragment that has not been sent to the callout server is invalid. The recipient MUST ignore invalid "As-is" parameters. Identical means that all adapted octets have the same numeric value as the corresponding original octets. This parameter is meant to allow for partial data preservation optimizations without a preservation commitment. The preserved data still crosses the connection with the callout server twice, but the OPES processor may be able to optimize its handling of the data.

The OPES processor MUST NOT terminate its data preservation commitment (section 7) in reaction to receiving a Data Use Mine (DUM) message.

#### 11.10. Data Use Yours (DUY)

```
DUY: extends message with {
    xid org-offset org-size;
};
```

The callout server tells the OPES processor to use the "size" bytes of preserved original data, starting at the specified offset, as if that data chunk came from the callout server in a Data Use Mine (DUM) message.

The OPES processor MUST NOT terminate its data preservation commitment (section 7) in reaction to receiving a Data Use Yours (DUY) message.

#### 11.11. Data Preservation Interest (DPI)

```
DPI: extends message with {
    xid org-offset org-size;
};
```

The Data Preservation Interest (DPI) message describes an original data chunk by using the first octet offset and size as parameters. The chunk is the only area of original data that the callout server may be interested in referring to in future Data Use Yours (DUY)

messages. This data chunk is referred to as "reusable data". The rest of the original data is referred to as "disposable data". Thus, disposable data consists of octets below the specified offset and at or above the (offset + size) offset.

After sending this message, the callout server MUST NOT send Data Use Yours (DUY) messages referring to disposable data chunk(s). If an OPES processor is not preserving some reusable data, it MAY start preserving that data. If an OPES processor preserves some disposable data, it MAY stop preserving that data. If an OPES processor does not preserve some disposable data, it MAY NOT start preserving that data.

A callout server MUST NOT indicate reusable data areas that overlap with disposable data areas indicated in previous Data Preservation Interest (DPI) messages. In other words, reusable data must not grow, and disposable data must not shrink. If a callout server violates this rule, the Data Preservation Interest (DPI) message is invalid (see section 5).

The Data Preservation Interest (DPI) message cannot force the OPES processor to preserve data. In this context, the term reusable stands for callout server interest in reusing the data in the future, given the OPES processor cooperation.

For example, an offset value of zero and the size value of 2147483647 indicate that the server may want to reuse all the original data. The size value of zero indicates that the server is not going to send any more Data Use Yours (DUY) messages.

#### 11.12. Want Stop Receiving Data (DWSR)

```
DWSR: extends message with {
    xid org-size;
};
```

The Want Stop Receiving Data (DWSR) message informs OPES processor that the callout server wants to stop receiving original data any time after receiving at least an org-size amount of an application message prefix. That is, the server is asking the processor to terminate original dataflow prematurely (see section 8.1) after sending at least org-size octets.

An OPES processor receiving a Want Stop Receiving Data (DWSR) message SHOULD terminate original dataflow by sending an Application Message End (AME) message with a 206 (partial) status code.

An OPES processor MUST NOT terminate its data preservation commitment (section 7) in reaction to receiving a Want Stop Receiving Data (DWSR) message. Just like with any other message, an OPES processor may use information supplied by Want Stop Receiving Data (DWSR) to decide on future preservation commitments.

#### 11.13. Want Stop Sending Data (DWSS)

```
DWSS: extends message with {  
    xid;  
};
```

The Want Stop Sending Data (DWSS) message informs the OPES processor that the callout server wants to stop sending adapted data as soon as possible; the server is asking the processor for permission to terminate adapted dataflow prematurely (see section 8.2). The OPES processor can grant this permission by using a Stop Sending Data (DSS) message.

Once the DWSS message is sent, the callout server MUST NOT prematurely terminate adapted dataflow until the server receives a DSS message from the OPES processor. If the server violates this rule, the OPES processor MUST act as if no DWSS message were received. The latter implies that the OCP transaction is terminated by the processor, with an error.

An OPES processor receiving a DWSS message SHOULD respond with a Stop Sending Data (DSS) message, provided the processor would not violate DSS message requirements by doing so. The processor SHOULD respond immediately once DSS message requirements can be satisfied.

#### 11.14. Stop Sending Data (DSS)

```
DSS: extends message with {  
    xid;  
};
```

The Stop Sending Data (DSS) message instructs the callout server to terminate adapted dataflow prematurely by sending an Application Message End (AME) message with a 206 (partial) status code. A callout server is expected to solicit the Stop Sending Data (DSS) message by sending a Want Stop Sending Data (DWSS) message (see section 8.2).

A callout server receiving a solicited Stop Sending Data (DSS) message for a yet-unterminated adapted dataflow MUST immediately terminate dataflow by sending an Application Message End (AME) message with a 206 (partial) status code. If the callout server

already terminated adapted dataflow, the callout server MUST ignore the Stop Sending Data (DSS) message. A callout server receiving an unsolicited DSS message for a yet-unterminated adapted dataflow MUST either treat that message as invalid or as solicited (i.e., the server cannot simply ignore unsolicited DSS messages).

The OPES processor sending a Stop Sending Data (DSS) message MUST be able to reconstruct the adapted application message correctly after the callout server terminates dataflow. This requirement implies that the processor must have access to any original data sent to the callout after the Stop Sending Data (DSS) message, if there is any. Consequently, the OPES processor either has to send no data at all or has to keep a copy of it.

If a callout server receives a DSS message and, in violation of the above rules, waits for more original data before sending an Application Message End (AME) response, a deadlock may occur: The OPES processor may wait for the Application Message End (AME) message to send more original data.

#### 11.15. Want Data Paused (DWP)

```
DWP: extends message with {
    xid your-offset;
};
```

The Want Data Paused (DWP) message indicates the sender's temporary lack of interest in receiving data starting with the specified offset. This disinterest implies nothing about sender's intent to send data.

The "your-offset" parameter refers to dataflow originating at the OCP agent receiving the parameter.

If, at the time the Want Data Paused (DWP) message is received, the recipient has already sent data at the specified offset, the message recipient MUST stop sending data immediately. Otherwise, the recipient MUST stop sending data immediately after it sends the specified offset. Once the recipient stops sending more data, it MUST immediately send a Paused My Data (DPM) message and MUST NOT send more data until it receives a Want More Data (DWM) message.

As are most OCP Core mechanisms, data pausing is asynchronous. The sender of the Want Data Paused (DWP) message MUST NOT rely on the data being paused exactly at the specified offset or at all.

## 11.16. Paused My Data (DPM)

```
DPM: extends message with {
    xid;
};
```

The Paused My Data (DPM) message indicates the sender's commitment to send no more data until the sender receives a Want More Data (DWM) message.

The recipient of the Paused My Data (DPM) message MAY expect the data delivery being paused. If the recipient receives data despite this expectation, it MAY abort the corresponding transaction with a Transaction End (TE) message indicating a failure.

## 11.17. Want More Data (DWM)

```
DWM: extends message with {
    xid;
    [Size-request: your-size];
};
```

The Want More Data (DWM) message indicates the sender's need for more data.

Message parameters always refer to dataflow originating at the other OCP agent. When sent by an OPES processor, your-size is adp-size; when sent by a callout server, your-size is org-size.

The "Size-request" parameter refers to dataflow originating at the OCP agent receiving the parameter. If a "Size-request" parameter is present, its value is the suggested minimum data size. It is meant to allow the recipient to deliver data in fewer chunks. The recipient MAY ignore the "Size-request" parameter. An absent "Size-request" parameter implies "any size".

The message also cancels the Paused My Data (DPM) message effect. If the recipient was not sending any data because of its DPM message, the recipient MAY resume sending data. Note, however, that the Want More Data (DWM) message can be sent regardless of whether the dataflow in question has been paused. The "Size-request" parameter makes this message a useful stand-alone optimization.

## 11.18. Negotiation Offer (NO)

```
NO: extends message with {
    features;
    [SG: my-sg-id];
    [Offer-Pending: boolean];
};
```

A Negotiation Offer (NO) message solicits a selection of a single "best" feature out of a supplied list, using a Negotiation Response (NR) message. The sender is expected to list preferred features first when it is possible. The recipient MAY ignore sender preferences. If the list of features is empty, the negotiation is bound to fail but remains valid.

Both the OPES processor and the callout server are allowed to send Negotiation Offer (NO) messages. The rules in this section ensure that only one offer is honored if two offers are submitted concurrently. An agent MUST NOT send a Negotiation Offer (NO) message if it still expects a response to its previous offer on the same connection.

If an OPES processor receives a Negotiation Offer (NO) message while its own offer is pending, the processor MUST disregard the server offer. Otherwise, it MUST respond immediately.

If a callout server receives a Negotiation Offer (NO) message when its own offer is pending, the server MUST disregard its own offer. In either case, the server MUST respond immediately.

If an agent receives a message sequence that violates any of the above rules in this section, the agent MUST terminate the connection with a Connection End (CE) message indicating a failure.

An optional "Offer-Pending" parameter is used for Negotiation Phase maintenance (section 6.1). The option's value defaults to "false".

An optional "SG" parameter is used to narrow the scope of negotiations to the specified service group. If SG is present, the negotiated features are negotiated and enabled only for transactions that use the specified service group ID. Connection-scoped features are negotiated and enabled for all service groups. The presence of scope does not imply automatic conflict resolution common to programming languages; no conflicts are allowed. When negotiating connection-scoped features, an agent MUST check for conflicts within each existing service group. When negotiating group-scoped features, an agent MUST check for conflicts with connection-scoped features

already negotiated. For example, it must not be possible to negotiate a connection-scoped HTTP application profile if one service group already has an SMTP application profile, and vice versa.

OCP agents SHOULD NOT send offers with service groups used by pending transactions. Unless it is explicitly noted otherwise in a feature documentation, OCP agents MUST NOT apply any negotiations to pending transactions. In other words, negotiated features take effect with the new OCP transaction.

As with other protocol elements, OCP Core extensions may document additional negotiation restrictions. For example, specification of a transport security feature may prohibit the use of the SG parameter in negotiation offers, to avoid situations where encryption is enabled for only a portion of overlapping transactions on the same transport connection.

#### 11.19. Negotiation Response (NR)

```
NR: extends message with {
    [feature];
    [SG: my-sg-id];
    [Rejects: features];
    [Unknowns: features];
    [Offer-Pending: boolean];
};
```

A Negotiation Response (NR) message conveys recipient's reaction to a Negotiation Offer (NO) request. An accepted offer (a.k.a., positive response) is indicated by the presence of an anonymous "feature" parameter, containing the selected feature. If the selected feature does not match any of the offered features, the offering agent MUST consider negotiation failed and MAY terminate the connection with a Connection End (CE) message indicating a failure.

A rejected offer (negative response) is indicated by omitting the anonymous "feature" parameter.

The successfully negotiated feature becomes effective immediately. The sender of a positive response MUST consider the corresponding feature enabled immediately after the response is sent; the recipient of a positive response MUST consider the corresponding feature enabled immediately after the response is received. Note that the scope of the negotiated feature application may be limited to a specified service group. The negotiation phase state does not affect enabling of the feature.

If negotiation offer contains an SG parameter, the responder MUST include that parameter in the Negotiation Response (NR) message. The recipient of an NR message without the expected SG parameter MUST treat negotiation response as invalid.

If the negotiation offer lacks an SG parameter, the responder MUST NOT include that parameter in the Negotiation Response (NR) message. The recipient of an NR message with an unexpected SG parameter MUST treat the negotiation response as invalid.

An optional "Offer-Pending" parameter is used for Negotiation Phase maintenance (section 6.1). The option's value defaults to "false".

When accepting or rejecting an offer, the sender of the Negotiation Response (NR) message MAY supply additional details via Rejects and Unknowns parameters. The Rejects parameter can be used to list features that were known to the Negotiation Offer (NO) recipient but could not be supported given negotiated state that existed when NO message was received. The Unknowns parameter can be used to list features that were unknown to the NO recipient.

#### 11.20. Ability Query (AQ)

```
AQ: extends message with {
    feature;
};
```

An Ability Query (AQ) message solicits an immediate Ability Answer (AA) response. The recipient MUST respond immediately with an AA message. This is a read-only, non-modifying interface. The recipient MUST NOT enable or disable any features due to an AQ request.

OCP extensions documenting a feature MAY extend AQ messages to supply additional information about the feature or the query itself.

The primary intended purpose of the ability inquiry interface is debugging and troubleshooting and not automated fine-tuning of agent behavior and configuration. The latter may be better achieved by the OCP negotiation mechanism (section 6).

#### 11.21. Ability Answer (AA)

```
AA: extends message with {
    boolean;
};
```

An Ability Answer (AA) message expresses the sender's support for a feature requested via an Ability Query (AQ) message. The sender MUST set the value of the anonymous boolean parameter to the truthfulness of the following statement: "At the time of this answer generation, the sender supports the feature in question". The meaning of "support" and additional details are feature specific. OCP extensions documenting a feature MUST document the definition of "support" in the scope of the above statement and MAY extend AA messages to supply additional information about the feature or the answer itself.

#### 11.22. Progress Query (PQ)

```
PQ: extends message with {  
    [xid];  
};
```

A Progress Query (PQ) message solicits an immediate Progress Answer (PA) response. The recipient MUST immediately respond to a PQ request, even if the transaction identifier is invalid from the recipient's point of view.

#### 11.23. Progress Answer (PA)

```
PA: extends message with {  
    [xid];  
    [Org-Data: org-size];  
};
```

A PA message carries the sender's state. The "Org-Data" size is the total original data size received or sent by the agent so far for the identified application message (an agent can be either sending or receiving original data, so there is no ambiguity). When referring to received data, progress information does not imply that the data has otherwise been processed in some way.

The progress inquiry interface is useful for several purposes, including keeping idle OCP connections "alive", gauging the agent processing speed, verifying the agent's progress, and debugging OCP communications. Verifying progress, for example, may be essential to implement timeouts for callout servers that do not send any adapted data until the entire original application message is received and processed.

A recipient of a PA message MUST NOT assume that the sender is not working on any transaction or application message not identified in the PA message. A PA message does not carry information about multiple transactions or application messages.

If an agent is working on the transaction identified in the Progress Query (PQ) request, the agent MUST send the corresponding transaction ID (xid) when answering the PQ with a PA message. Otherwise, the agent MUST NOT send the transaction ID. If an agent is working on the original application message for the specified transaction, the agent MUST send the Org-Data parameter. If the agent has already sent or received the Application Message End (AME) message for the original dataflow, the agent MUST NOT send the Org-data parameter.

Informally, the PA message relays the sender's progress with the transaction and original dataflow identified by the Progress Query (PQ) message, provided the transaction identifier is still valid at the time of the answer. Absent information in the answer indicates invalid, unknown, or closed transaction and/or original dataflow from the query recipient's point of view.

#### 11.24. Progress Report (PR)

```
PR: extends message with {
    [xid];
    [Org-Data: org-size];
};
```

A Progress Report (PR) message carries the sender's state. The message semantics and associated requirements are identical to those of a Progress Answer (PA) message except that the PR message, is sent unsolicited. The sender MAY report progress at any time. The sender MAY report progress unrelated to any transaction or original application message or related to any valid (current) transaction or original dataflow.

Unsolicited progress reports are especially useful for OCP extensions dealing with "slow" callout services that introduce significant delays for the final application message recipient. The report may contain progress information that will make that final recipient more delay tolerant.

#### 12. IAB Considerations

OPES treatment of IETF Internet Architecture Board (IAB) considerations [RFC3238] are documented in [RFC3914].

#### 13. Security Considerations

This section examines security considerations for OCP. OPES threats are documented in [RFC3837]

OCF relays application messages that may contain sensitive information. Appropriate transport encryption can be negotiated to prevent information leakage or modification (see section 6), but OCF agents may support unencrypted transport by default. These configurations will expose application messages to third-party recording and modification, even if OPES proxies themselves are secure.

OCF implementation bugs may lead to security vulnerabilities in OCF agents, even if OCF traffic itself remains secure. For example, a buffer overflow in a callout server caused by a malicious OPES processor may grant that processor access to information from other (100% secure) OCF connections, including connections with other OPES processors.

Careless OCF implementations may rely on various OCF identifiers to be unique across all OCF agents. A malicious agent can inject an OCF message that matches identifiers used by other agents, in an attempt to gain access to sensitive data. OCF implementations must always check an identifier for being "local" to the corresponding connection before using that identifier.

OCF is a stateful protocol. Several OCF commands increase the amount of state that the recipient has to maintain. For example, a Service Group Created (SGC) message instructs the recipient to maintain an association between a service group identifier and a list of services.

Implementations that cannot correctly handle resource exhaustion increase security risks. The following are known OCF-related resources that may be exhausted during a compliant OCF message exchange:

OCF message structures: OCF message syntax does not limit the nesting depth of OCF message structures and does not place an upper limit on the length (number of OCTETs) of most syntax elements.

concurrent connections: OCF does not place an upper limit on the number of concurrent connections that a callout server may be instructed to create via Connection Start (CS) messages.

service groups: OCF does not place an upper limit on the number of service group associations that a callout server may be instructed to create via Service Group Created (SGC) messages.

concurrent transactions: OCF does not place an upper limit on the number of concurrent transactions that a callout server may be instructed to maintain via Transaction Start (TS) messages.

concurrent flows: OCP Core does not place an upper limit on the number of concurrent adapted flows that an OPES processor may be instructed to maintain via Application Message Start (AMS) messages.

#### 14. IANA Considerations

The IANA maintains a list of OCP features, including application profiles (section 10.11). For each feature, its uri parameter value is registered along with the extension parameters (if there are any). Registered feature syntax and semantics are documented with PETDM notation (section 9).

The IESG is responsible for assigning a designated expert to review each standards-track registration prior to IANA assignment. The OPES working group mailing list may be used to solicit commentary for both standards-track and non-standards-track features.

Standards-track OCP Core extensions SHOULD use <http://www.iana.org/assignments/opes/ocp/> prefix for feature uri parameters. It is suggested that the IANA populate resources identified by such "uri" parameters with corresponding feature registrations. It is also suggested that the IANA maintain an index of all registered OCP features at the <http://www.iana.org/assignments/opes/ocp/> URL or on a page linked from that URL.

This specification defines no OCP features for IANA registration.

#### 15. Compliance

This specification defines compliance for the following compliance subjects: OPES processors (OCP client implementations), callout servers (OCP server implementations), and OCP extensions. An OCP agent (a processor or callout server) may also be referred to as the "sender" or "recipient" of an OCP message.

A compliance subject is compliant if it satisfies all applicable "MUST" and "SHOULD" requirements. By definition, to satisfy a "MUST" requirement means to act as prescribed by the requirement; to satisfy a "SHOULD" requirement means either to act as prescribed by the requirement or to have a reason to act differently. A requirement is applicable to the subject if it instructs (addresses) the subject.

Informally, OCP compliance means that there are no known "MUST" violations, and that all "SHOULD" violations are deliberate. In other words, "SHOULD" means "MUST satisfy or MUST have a reason to violate". It is expected that compliance claims be accompanied by a

list of unsupported SHOULDs (if any), in an appropriate format, explaining why the preferred behavior was not chosen.

Only normative parts of this specification affect compliance. Normative parts are those parts explicitly marked with the word "normative", definitions, and phrases containing unquoted capitalized keywords from [RFC2119]. Consequently, examples and illustrations are not normative.

#### 15.1. Extending OCP Core

OCP extensions MUST NOT change the OCP Core message format, as defined by ABNF and accompanying normative rules in Section 3.1. This requirement is intended to allow OCP message viewers, validators, and "intermediary" software to at least isolate and decompose any OCP message, even a message with semantics unknown to them (i.e., extended).

OCP extensions are allowed to change normative OCP Core requirements for OPES processors and callout servers. However, OCP extensions SHOULD NOT make these changes and MUST require on a "MUST"-level that these changes are negotiated prior to taking effect. Informally, this specification defines compliant OCP agent behavior until changes to this specification (if any) are successfully negotiated.

For example, if an RTSP profile for OCP requires support for offsets exceeding 2147483647 octets, the profile specification can document appropriate OCP changes while requiring that RTSP adaptation agents negotiate "large offsets" support before using large offsets. This negotiation can be bundled with negotiating another feature (e.g., negotiating an RTSP profile may imply support for "large offsets").

As implied by the above rules, OCP extensions may dynamically alter the negotiation mechanism itself, but such an alternation would have to be negotiated first, using the negotiation mechanism defined by this specification. For example, successfully negotiating a feature might change the default "Offer-Pending" value from false to true.

## Appendix A. Message Summary

This appendix is not normative. The table below summarizes key OCP message properties. For each message, the table provides the following information:

name: Message name as seen on the wire.

title: Human-friendly message title.

P: Whether this specification documents message semantics as sent by an OPES processor.

S: Whether this specification documents message semantics as sent by a callout server.

tie: Related messages such as associated request, response message, or associated state message.

name	title	P	S	tie
CS	Connection Start	X	X	CE
CE	Connection End	X	X	CS
SGC	Service Group Created	X	X	SGD TS
SGD	Service Group Destroyed	X	X	SGC
TS	Transaction Start	X		TE SGC
TE	Transaction End	X	X	TS
AMS	Application Message Start	X	X	AME
AME	Application Message End	X	X	AMS DSS
DUM	Data Use Mine	X	X	DUY DWP
DUY	Data Use Yours		X	DUM DPI
DPI	Data Preservation Interest		X	DUY
DWSS	Want Stop Sending Data		X	DWSR DSS
DWSR	Want Stop Receiving Data		X	DWSS
DSS	Stop Sending Data	X		DWSS
DWP	Want Data Paused	X	X	DPM
DPM	Paused My Data	X	X	DWP DWM
DWM	Want More Data	X	X	DPM
NO	Negotiation Offer	X	X	NR SGC
NR	Negotiation Response	X	X	NO
PQ	Progress Query	X	X	PA
PA	Progress Answer	X	X	PQ PR
PR	Progress Report	X	X	PA
AQ	Ability Query	X	X	AA
AA	Ability Answer	X	X	AQ

Appendix B. State Summary

This appendix is not normative. The table below summarizes OCP states. Some states are maintained across multiple transactions and application messages. Some correspond to a single request/response dialog; the asynchronous nature of most OCP message exchanges requires OCP agents to process other messages while waiting for a response to a request and, hence, while maintaining the state of the dialog.

For each state, the table provides the following information:

state: Short state label.

birth: Messages creating this state.

death: Messages destroying this state.

ID: Associated identifier, if any.

state	birth	death	ID
connection	CS	CE	
service group	SGC	SGD	sg-id
transaction	TS	TE	xid
application message and dataflow	AMS	AME	
premature org-dataflow termination	DWSR	AME	
premature adp-dataflow termination	DWSS	DSS AME	
paused dataflow	DPM	DWM	
preservation commitment negotiation	DUM	DPI AME	
progress inquiry	NO	NR	
ability inquiry	PQ	PA	
	PQ	PA	

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