Network Working Group   Y. Nomura
Request for Comments: 4435   Fujitsu Labs.
Category: Informational   R. Walsh
                                                         J-P. Luoma
                                                              Nokia
                                                          H. Asaeda
                                                   Keio University
                                                  H. Schulzrinne
                                               Columbia University
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         A Framework for the Usage of Internet Media Guides (IMGs)

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Abstract

   This document defines a framework for the delivery of Internet Media
   Guides (IMGs). An IMG is a structured collection of multimedia
   session descriptions expressed using the Session Description Protocol
   (SDP), SDPng, or some similar session description format. This
   document describes a generalized model for IMG delivery mechanisms,
   the use of existing protocols, and the need for additional work to
   create an IMG delivery infrastructure.

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1. Introduction

   Internet Media Guides (IMGs) provide and deliver structured
   collections of multimedia descriptions expressed using SDP [2], SDPng
   [3], or other description formats. They are used to describe sets of
   multimedia services (e.g., television program schedules, content
   delivery schedules) and refer to other networked resources including
   web pages. IMGs provide an envelope for metadata formats and session
   descriptions defined elsewhere with the aim of facilitating
   structuring, versioning, referencing, distributing, and maintaining
   (caching, updating) such information.

   IMG metadata may be delivered to a potentially large audience, which
   uses it to join a subset of the sessions described and which may need
   to be notified of changes to the IMG metadata. Hence, a framework
   for distributing IMG metadata in various different ways is needed to
   accommodate the needs of different audiences: For traditional
   broadcast-style scenarios, multicast-based (push) distribution of IMG
   metadata needs to be supported. Where no multicast is available,
   unicast-based push is required.

   This document defines a common framework model for IMG delivery
   mechanisms and their deployment in network entities. There are three
   fundamental components in the IMG framework model: data types,
   operation sets, and entities. These components specify a set of
   framework guidelines for efficient delivery and description of IMG
   metadata. The data types give generalized means to deliver and
   manage the consistency of application-specific IMG metadata. IMG
   operations cover broadcast, multicast distribution, event
   notification upon change, unicast-based push, and interactive
   retrievals similar to web pages.

   Since we envision that any Internet host can be a sender and receiver
   of IMG metadata, a host involved in IMG operations performs one or
   more of the roles defined as the entities in the IMG framework model.
   The requirements for IMG delivery mechanisms and descriptions can be
   found in the IMG requirements document [4].

   This document outlines the use of existing protocols to create an IMG
   delivery infrastructure. It aims to organize existing protocols into
   a common model and show their capabilities and limitations from the
   viewpoint of IMG delivery functions.

2. Terminology

   The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
   "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this
   document are to be interpreted as described in RFC 2119 [1].

2.1. New Terms

     Internet Media Guide (IMG): IMG is a generic term to describe the
        formation, delivery, and use of IMG metadata. The definition of
        the IMG is intentionally left imprecise [4].

     IMG Element: The smallest atomic element of metadata that can be
        transmitted separately by IMG operations and referenced
        individually from other IMG elements [4].

     IMG Metadata: A set of metadata consisting of one or more IMG
        elements. IMG metadata describes the features of multimedia
        content used to enable selection of and access to media sessions
        containing content. For example, metadata may consist of a media
        object's URI, title, airtime, bandwidth needed, file size, text
        summary, genre, and access restrictions [4].

     IMG Description: A collection of IMG metadata with a data type
        indicating a self-contained set or a subset of IMG metadata, or a
        reference to IMG metadata.

     IMG Delivery: The process of exchanging IMG metadata both in terms of
        large-scale and atomic data transfers [4].

     IMG Sender: An IMG sender is a logical entity that sends IMG metadata
        to one or more IMG receivers [4].

     IMG Receiver: An IMG receiver is a logical entity that receives IMG
        metadata from an IMG sender [4].

     IMG Transceiver: An IMG transceiver combines an IMG receiver and
        sender. It may modify received IMG metadata or merge IMG metadata
        received from a several different IMG senders [4].

     IMG Operation: An atomic operation of an IMG transport protocol, used
        between IMG sender(s) and IMG receiver(s) for the delivery of IMG
        metadata and for the control of IMG sender(s)/receiver(s) [4].

     IMG Transport Protocol: A protocol that transports IMG metadata from
        an IMG sender to IMG receiver(s) [4].

     IMG Transport Session: An association between an IMG sender and one
        or more IMG receivers within the scope of an IMG transport
        protocol. An IMG transport session involves a time-bound series
        of IMG transport protocol interactions that provide delivery of
        IMG metadata from the IMG sender to the IMG receiver(s) [4].

IMG Transfer: A transfer of IMG metadata from an IMG sender to IMG
   receiver(s).

3. IMG Common Framework Model

   Two common elements are found in all existing IMG candidate cases:
   the need to describe the services and the need to deliver the
   descriptions. In some cases, the descriptions provide multicast
   addresses and thus are part of the transport configuration. In other
   cases, descriptions are specific to the media application and may be
   meant for either human or machine consumption. Thus, the
   technologies can be roughly divided into three areas:

      o Application-specific Metadata: data describing the content of
        services and media which are both specific to certain
        applications and generally human readable.

      o Delivery Descriptions: the descriptions (metadata) that are
        essential to enable (e.g., multicast) delivery. These include
        framing (headers) for application-specific metadata, the
        metadata element identification and structure, and fundamental
        session data.

      o Delivery Protocols: the methods and protocols to exchange
        descriptions between the senders and the receivers. An IMG
        transport protocol consists of two functions: carrying IMG
        metadata from an IMG sender to an IMG receiver and controlling
        an IMG transport protocol. These functions are not always
        exclusive; therefore, some messages may combine control messages
        and metadata carriage functions to reduce the amount of the
        messaging.

3.1. IMG Data Types

   A data model is needed to precisely define the terminology and
   relationships between sets, supersets, and subsets of metadata. A
   precise data model is essential for the implementation of IMGs,
   although it is not within the scope of this framework and requires a
   separate specification. However, there are three IMG data types in
   general: Complete IMG Descriptions, Delta IMG Descriptions, and IMG
   Pointers.

3.1.1. Complete IMG Description

   A Complete IMG Description provides a self-contained set of metadata
   for one media object or service, i.e., it does not need additional
   information from any other IMG element. This is not to be confused
   with "complete IMG metadata", which, although vaguely defined here,

represents the complete IMG metadata database of an IMG sender (or
related group of IMG senders -- potentially the complete Internet IMG
knowledge). An IMG sender will generally deliver only subsets of
metadata from its complete database in a particular IMG transport
session.

3.1.2. Delta IMG Description

A Delta IMG Description provides only part of a Complete IMG
Description, defining the difference from a previous version of the
Complete IMG Description. Delta IMG Descriptions may be used to
reduce network resource usage, for instance, when data consistency is
essential and small and frequent changes occur to IMG elements.
Thus, this description does not represent a complete set of metadata
until it is combined with other metadata that may already exist or
arrive in the future.

3.1.3. IMG Pointer

An IMG Pointer identifies or locates metadata. This may be used to
separately obtain metadata (Complete or Delta IMG Descriptions) or
perform another IMG management function such as data expiry (and
erasure). The IMG Pointer may be used to reference IMG metadata
elements within the IMG transport session and across IMG transport
sessions. This pointer type does not include IMG metadata per se
(although it may also appear as a data field in Complete or Delta IMG
Descriptions).

3.2. IMG Entities

There are several fundamental IMG entities that indicate the
capability to perform certain roles. An Internet host involved in
IMG operations may adopt one or more of these roles, which are
defined in more detail in Section 3.3.

IMG Announcer: sends IMG ANNOUNCE

IMG Listener: receives IMG ANNOUNCE

IMG Querier: sends IMG QUERY and receives IMG RESOLVE

IMG Resolver: receives IMG QUERY then sends IMG RESOLVE

IMG Subscriber: sends IMG SUBSCRIBE then receives IMG NOTIFY

IMG Notifier: receives IMG SUBSCRIBE then sends IMG NOTIFY

Figure 1 shows the relationship between IMG entities and the IMG
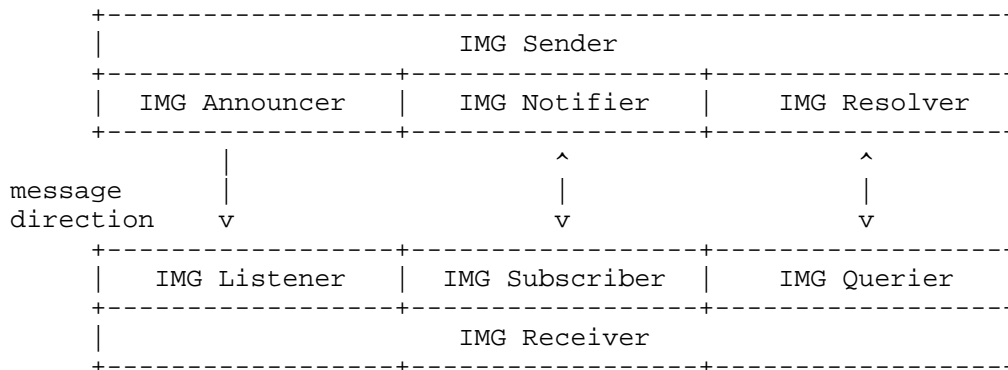sender and receiver.

```
+-----------------------------------------------------------+
|                       IMG Sender                          |
+------------------+------------------+------------------+
|  IMG Announcer   |  IMG Notifier    |  IMG Resolver    |
+------------------+------------------+------------------+
         |                 ^                  ^
message  |                 |                  |
direction     v                 v                  v
+------------------+------------------+------------------+
|  IMG Listener    |  IMG Subscriber  |  IMG Querier     |
+------------------+------------------+------------------+
|                      IMG Receiver                     |
+------------------+------------------+------------------+
```

   Figure 1: Relationship between IMG Entities, Senders, and Receivers

3.3. Operation Set for IMG Delivery

A finite set of operations both meets the IMG requirements [4] and
fits the roles of existing protocols. These are crystallized in the
next few sections.

3.3.1. IMG ANNOUNCE

When an IMG receiver participates in unidirectional communications
(e.g., over satellite, terrestrial radio, and wired multicast
networks), an IMG receiver may not need to send any IMG message to an
IMG sender prior to IMG metadata delivery. In this case, an IMG
sender can initiate unsolicited distribution for IMG metadata and an
IMG sender is the only entity that can maintain the distribution
(this includes scenarios with multiple and cooperative IMG senders).
This operation is useful when there are large numbers of IMG
receivers or the IMG receivers do not have a guaranteed uplink
connection to the IMG sender. The IMG sender may also include
authentication data in the ANNOUNCE operation so that IMG receivers
may check the authenticity of the metadata. This operation can carry
any of the IMG data types.

There is no restriction to prevent IMG ANNOUNCE from being used in an
asynchronous solicited manner, where a separate operation (possibly
out of band) enables IMG receivers to subscribe/register to the IMG
ANNOUNCE operation.

3.3.2. IMG QUERY

   If an IMG receiver needs to obtain IMG metadata, an IMG receiver can
   use an IMG QUERY operation and initiate a receiver-driven IMG
   transport session. The IMG receiver expects a synchronous response
   to the subsequent request from the IMG sender. This operation can be
   used where a bidirectional transport network is available between the
   IMG sender and receiver. Some IMG receivers may want to obtain IMG
   metadata when network connectivity is available or just to avoid
   caching unsolicited IMG metadata. The IMG receiver must indicate the
   extent and data type of metadata wanted in some message in the
   operation. The extent indicates the number and grouping of metadata
   descriptions. In some cases, it may be feasible to request an IMG
   sender's complete metadata collection.

3.3.3. IMG RESOLVE

   An IMG sender synchronously responds, and sends IMG metadata, to an
   IMG QUERY that has been sent by an IMG receiver. This operation can
   be used where a bidirectional transport network is available between
   the IMG sender and receiver. If the IMG QUERY specifies a subset of
   IMG metadata (extent and data type) that is available to the IMG
   sender, the IMG sender can resolve the query; otherwise, it should
   indicate that it is not able to resolve the query. The IMG sender
   may authenticate the IMG receiver during the QUERY operation to
   determine if the IMG receiver is authorized to receive that metadata.
   The sender may also include authentication data in the RESOLVE
   operation so that IMG receivers may check the authenticity of the
   metadata. This operation may carry any of the IMG data types.

3.3.4. IMG SUBSCRIBE

   If an IMG receiver wants to be notified when the IMG metadata it
   holds becomes stale, the IMG receiver can use the IMG SUBSCRIBE
   operation in advance in order to solicit IMG NOTIFY messages from an
   IMG sender.

   This operation may provide the IMG sender with specific details of
   which metadata or notification services it is interested in the case
   where the IMG sender offers more than the simplest "all data"
   service. This operation implicitly provides the functionality of
   unsubscribing to inform an IMG sender that an IMG receiver wishes to
   stop getting certain (or all) notifications. It should be noted that
   unsubscription may be provided implicitly by the expiry (timeout) of
   a subscription before it is renewed.

Since the IMG receiver does not know when metadata will be updated
and the notify message will arrive, this operation does not
synchronize with the notify messages. The IMG receiver may wait for
notify messages for a long time. The IMG sender may authenticate the
IMG receiver to check whether an IMG SUBSCRIBE operation is from an
authorized IMG receiver.

3.3.5. IMG NOTIFY

An IMG NOTIFY is used asynchronously in response to an earlier IMG
SUBSCRIBE. An IMG NOTIFY operation indicates that updated IMG
metadata is available or part of the existing IMG metadata is stale.
An IMG NOTIFY may be delivered more than once during the time an IMG
SUBSCRIBE is active. This operation may carry any of the IMG data
types. The IMG sender may also include authentication data in the
IMG NOTIFY operation so that IMG receivers may check the authenticity
of the messages.

3.3.6. Binding between IMG Operations and Data Types

There is a need to provide a binding between the various IMG
operations and IMG data types to allow management of each discrete
set of IMG metadata transferred using an IMG operation. This binding
must be independent of any particular metadata syntax used to
represent a set of IMG metadata, as well as be compatible with any
IMG transport protocol. The binding must uniquely identify the set
of IMG metadata delivered within an IMG transfer, regardless of the
metadata syntax used. The uniqueness may only be needed within the
domains the metadata is used, but this must enable globally unique
identification to support Internet usage. Care should be taken that
scope- and domain-specific identifiers do not leak outside the scope;
using globally unique identifiers such as URLs avoids these problems.

The binding must provide versioning to the transferred IMG metadata
so that changes can be easily handled and stale data identified, and
give temporal validity of the transferred IMG metadata. It must
invalidate the IMG metadata by indicating an expiry time, and may
optionally provide a time (presumably in the future) from when the
IMG metadata becomes valid. The temporal validity of a metadata
object may need to be updated later. Furthermore, the binding must
be independent of any specific metadata syntax used for the IMG
metadata, in the sense that no useful syntax should be excluded.

3.4. Overview of Protocol Operations

   Figure 2 gives an overview of the relationship between transport
   cases, IMG operations, and IMG data types. It is not a protocol
   stack. Generalized multicast point-to-multipoint (P-to-M) and
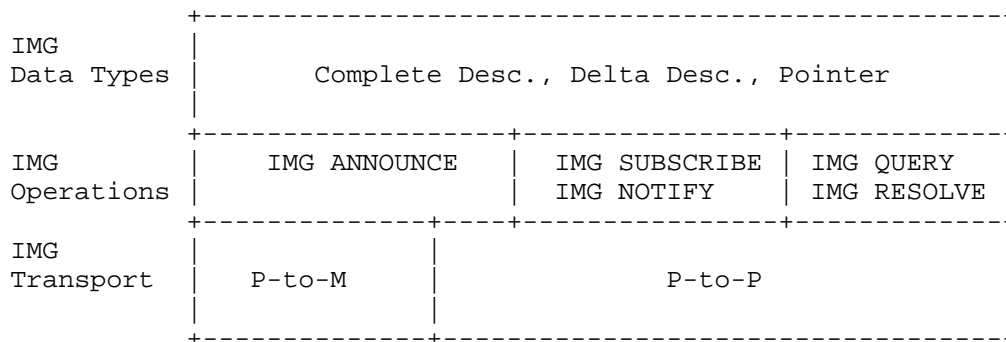   unicast point-to-point (P-to-P) transports are shown.

```
              +----------------------------------------------------+
   IMG        |                                                    |
   Data Types |       Complete Desc., Delta Desc., Pointer         |
              |                                                    |
              +------------------+---------------+-----------------+
   IMG        |   IMG ANNOUNCE   | IMG SUBSCRIBE | IMG QUERY       |
   Operations |                  | IMG NOTIFY    | IMG RESOLVE     |
              +-------------+----+---------------+-----------------+
   IMG        |             |                                     |
   Transport  |   P-to-M    |               P-to-P                |
              |             |                                     |
              +-------------+-------------------------------------+
```

        Figure 2: IMG Transport, IMG Operations, and IMG Data Types

4. Deployment Scenarios for IMG Entities

   This section provides some basic deployment scenarios for IMG
   entities that illustrate common threads from protocols to use cases.
   For the purposes of clarity, this document presents the simple
   dataflow from an IMG sender to an IMG receiver, as shown in Figure 3.

```
        +-------------+                 +---------------+
        | IMG Sender  |                 | IMG Receiver  |
        |             |---------------->|               |
        +-------------+                 +---------------+
```

        Figure 3: A Simple IMG Sender to IMG Receiver Relationship

4.1. Intermediary Cases

   Some IMG metadata may be distributed to a large number of IMG
   receivers, for example, when public metadata is distributed to all
   IMG receivers of a certain group. This kind of IMG metadata may be
   distributed from one IMG sender to multiple IMG receivers (Figure 4)
   or may be relayed across a set of IMG transceivers that receive the
   IMG metadata, possibly filter or modify its content, and then forward
   it.

```
   +----------+                                    +----------+
   |  IMG     |                                    |  IMG     |
   |  Sender  |----                        ---->|  Receiver |
   +----------+    \                      /       +----------+
                    \                    /
         .           \   +-----------+  /           .
         .            -->|IMG        |-----          .
         .            -->|Transceiver|    \          .
                      /   +-----------+     \
   +----------+      /                       \     +----------+
   |  IMG     |     /                   ---->|  IMG     |
   |  Sender  |----                           |  Receiver |
   +----------+                               +----------+
```
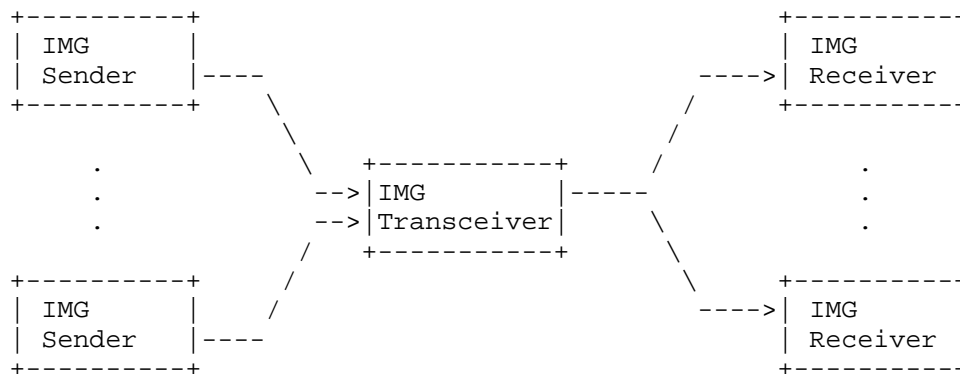
                Figure 4: A Relay Network with an IMG Transceiver

IMG senders and receivers are logical functions, and it is possible
for some or all hosts in a system to perform both roles, as, for
instance, in many-to-many communications or where a transceiver is
used to combine or aggregate IMG metadata for some IMG receivers. An
IMG receiver may be allowed to receive IMG metadata from any number
of IMG senders.

IMG metadata is used to find, obtain, manage, and play media content.
IMG metadata may be modified during IMG transfer. For example, a
server may use IMGs to retrieve media content via unicast and then
make it available at scheduled times via multicast, thus requiring a
change of the corresponding metadata. IMG transceivers may add or
delete information or aggregate IMG metadata from different IMG
senders. For example, a rating service may add its own content
ratings or recommendations to existing metadata. An implication of
changing (or aggregating) IMG metadata from one or more IMG senders
is that the original authenticity is lost. Thus, it may be
beneficial to sign fragments so that the intermediary can replace a
fragment without changing the authenticity of the remainder. For
example, smaller fragments may be appropriate for more volatile
parts, and larger ones may be appropriate for stable parts.

4.2. One-to-Many Unidirectional Multicast

   The one-to-many unidirectional multicast case implies many IMG
   receivers and one or more IMG senders implementing IMG announcer and
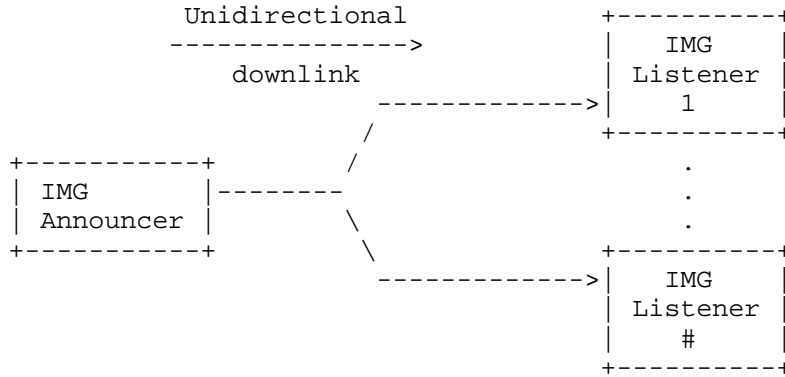   IMG listener operations as shown in Figure 5.

```
                Unidirectional           +----------+
              --------------->           |   IMG    |
                  downlink               | Listener |
                            ------------>|    1     |
                           /             +----------+
     +----------+         /                   .
     |   IMG    |--------                      .
     | Announcer |        \                    .
     +----------+          \              +----------+
                            ------------>|   IMG    |
                                         | Listener |
                                         |    #     |
                                         +----------+
```

          Figure 5: IMG Unidirectional Multicast Distribution Example

   Note, as defined in the IMG requirement REL-4 [4], an IMG transport
   protocol MUST support reliable message exchange. This includes the
   one-to-many unidirectional multicast case; however, the mechanism to
   provide this is beyond the scope of this document.

4.3. One-to-One Bidirectional Unicast

   In the one-to-one bidirectional unicast case, both query/resolve
   (Figure 6) and subscribe/notify (Figure 7) message exchange
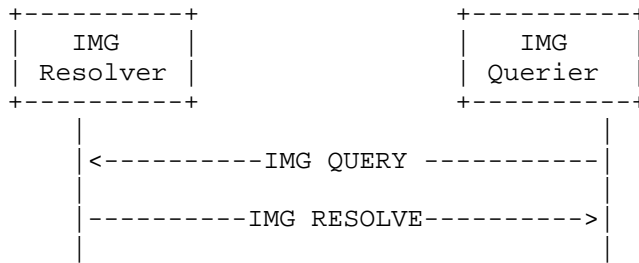   operations are feasible.

```
        +----------+              +----------+
        |   IMG    |              |   IMG    |
        | Resolver |              | Querier  |
        +----------+              +----------+
             |                         |
             |<----------IMG QUERY -----------|
             |                         |
             |----------IMG RESOLVE---------->|
             |                         |
```

            Figure 6: Query/Resolve Sequence Example

```
        +----------+                       +------------+
        |   IMG    |                       |    IMG     |
        | Notifier |                       | Subscriber |
        +----------+                       +------------+
             |                                   |
             |<---------IMG SUBSCRIBE---------|
             :                                   :
                        (time passes)
             :                                   :
             |----------IMG NOTIFY---------->|
             :                                   :
                        (time passes)
             :                                   :
             |----------IMG NOTIFY---------->|
             |                                   |
```
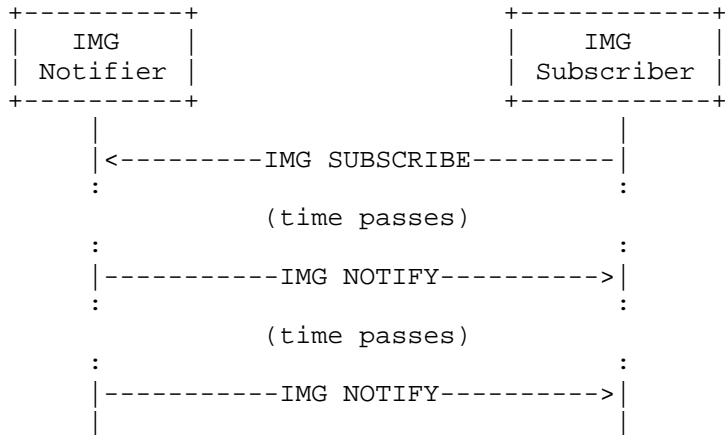
              Figure 7: Subscribe/Notify Sequence Example

4.4. Combined Operations with Common Metadata

   As shown in Figure 8, a common data model for multiple protocol
   operations allows a diverse range of IMG senders and receivers to
   provide consistent and interoperable sets of IMG metadata.

```
    IMG Metadata              IMG Senders              IMG Receivers


                                                 +--------------+
                          +-----------+   ---->| IMG Listener |
                          |   IMG     |  /      +--------------+
                         /| Announcer |-----
 +-------------+        / +-----------+      \   +--------------+
 |    IMG      |-+     /                      ---->| IMG Listener |
 | description | |-+  /                          | - - - - - - -|
 | metadata  1 | | | /   +-----------+      /--->| IMG Querier  |
 +-------------+ | | -----|   IMG     |<----/      +--------------+
   +-------------+ | \    | Resolver  |
     +-------------+  \   +-----------+<----\   +--------------+
       +-------------+  \                      \--->| IMG Querier  |
                         \  +-----------+          | - - - - - - -|
                          \| IMG       |<-------->| IMG          |
                           | Notifier  |          | Subscriber   |
                           +-----------+          +--------------+
```
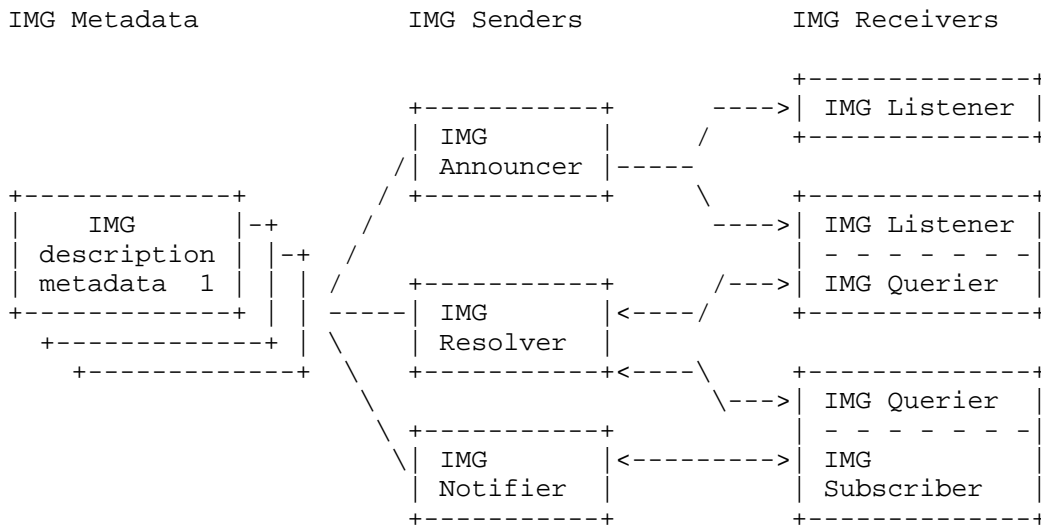
             Figure 8: Combined System with Common Metadata

5. Applicability of Existing Protocols to the Proposed Framework Model

5.1. Existing Standards Fitting the IMG Framework Model

   SDP: The SDP format [2] could be used to describe session-level
   parameters (e.g., scheduling, addressing, and the use of media
   codecs) to be included in Complete IMG Descriptions. Although there
   are extension points in SDP allowing the format to be extended, there
   are limitations in the flexibility of this extension mechanism.
   However, SDP syntax cannot provide IMG Descriptions and IMG Pointers
   without significant overhead. It is expected that the information
   conveyed by SDP is just a small subset of IMG metadata; thus, the use
   of SDP for other than session parameters may not be reasonable.

   SDPng [3]: Similar to SDP, this format could also be used for
   representing session-level parameters of IMG metadata. Compared to
   SDP, the XML-based format of SDPng should be much more flexible and
   allow extensions and integration with other description formats.

   MPEG-7: Descriptions based on the MPEG-7 standard [5] could provide
   application-specific metadata describing the properties of multimedia
   content beyond parameters carried in SDP or SDPng descriptions.
   MPEG-7 provides a machine-readable format of representing content
   categories and attributes, helping end-users or receiving software in
   choosing content for reception. MPEG-7 is based on XML, so it is
   well suited to be combined with other XML-based formats such as
   SDPng.

   TV-Anytime: The TV-Anytime Forum [6] provides descriptions based on
   XML schema for TV-specific program guides. TV-Anytime uses the
   MPEG-7 User description profile to a limited extent, only for user
   preferences and usage history, and also a TV-Anytime-specific data
   model for other schema. These are optimized to describe broadcast
   schedules, on-demand program guides and program events.

   HTTP: The HTTP protocol [7] can be used as a bidirectional unicast
   IMG transport protocol. Being a request-reply-oriented protocol,
   HTTP is well suited for implementing synchronous operations such as
   QUERY, RESOLVE, and even SUBSCRIBE. However, HTTP does not provide
   asynchronous operations such as ANNOUNCE and NOTIFY and to implement
   asynchronous operations using HTTP, IMG receivers should poll the IMG
   sender periodically. Thus, by itself, HTTP is not sufficient to
   fulfill all of the IMG requirements [4] in a unicast deployment.

   Session Announcement Protocol (SAP): The announcement mechanism
   provided by SAP [8] provides unidirectional delivery of session
   discovery information. Although SDP is the default payload format of
   SAP, the use of a MIME type identifier for the payload allows

arbitrary payload formats to be used in SAP messages. Thus, SAP
could be used to implement the multicast and unicast IMG ANNOUNCE and
IMG NOTIFY operations.

However, SAP lacks scalable and efficient reliability, extensibility
for payload size, and congestion control, and only one description is
allowed per SAP message due to lack of payload segmentation.

In principle, SAP could be extended to get around its limitations.
However, the amount of changes needed in SAP to address all of the
above limitations would effectively result in a new protocol. Due to
these limitations, the use of SAP as an IMG transport protocol is not
recommended.

SIP: The SIP-specific event mechanism described in RFC 3265 [9]
provides a way to implement IMG SUBSCRIBE and IMG NOTIFY operations
via a bidirectional unicast connection. However, there are
scalability problems with this approach, as RFC 3265 currently does
not consider multicast.

Real Time Streaming Protocol (RTSP): The RTSP protocol [10] defines a
retrieval-and-update notification mechanism, named DESCRIBE and
ANNOUNCE, for the description of a presentation or media object in
order to initialize a streaming session. These methods are a subset
of the entire streaming control operations in RTSP; thus, these could
not be available for individual mechanisms. However, the DESCRIBE
method in RTSP could be used to instantiate IMG QUERY, IMG RESOLVE,
and IMG SUBSCRIBE, and the RTSP ANNOUNCE could be used to instantiate
an IMG NOTIFY for a streaming session controlled by RTSP.

5.2. IMG Mechanism Needs Which Are Not Met by Existing Standards

Several needs result from the IMG requirements, framework model, and
existing relevant mechanisms as already shown in this document. Four
specific groupings of work are readily apparent: (a) specification of
an adequate multicast- and unidirectional-capable announcement
protocol; (b) specification of the use of existing unicast protocols
to enable unicast subscribe and announcement/notification
functionality; (c) specification of the metadata envelope that is
common to, and independent of, the application metadata syntax(es)
used; and (d) agreement on basic metadata models to enable
interoperability testing of the above. The following sections
describe each of these.

5.2.1. A Multicast Transport Protocol

   SAP is currently the only open standard protocol suited to the
   unidirectional/multicast delivery of IMG metadata. As discussed, it
   fails to meet the IMG requirements in many ways and, since it is not
   designed to be extensible, we recognize that a new multicast
   transport protocol for announcements needs to be specified to meet
   IMG needs. This protocol will be essential to IMG delivery for
   unidirectional and multicast deployments.

   The Asynchronous Layered Coding (ALC) [11] protocol from the IETF
   Reliable Multicast Transport (RMT) working group is very interesting
   as it fulfills many of the requirements, is extensible, and has the
   ability to 'plug-in' both FEC (Forward Error Correction, for
   reliability) and CC (Congestion Control) functional blocks. It is
   specifically designed for unidirectional multicast object transport.
   ALC is not fully specified, although the RMT working group had a
   fully specified protocol using ALC called FLUTE (File Delivery over
   Unidirectional Transport) [12]. FLUTE seems to be the only fully
   specified transport and open specification on which a new IMG
   announcement protocol could be designed. Thus, we recommend that ALC
   and FLUTE be the starting points for this protocol's design.

   Developing a new protocol from scratch, or attempting to improve SAP,
   is also feasible, although it would involve repeating many of the
   design processes and decisions already made by the IETF for ALC. In
   particular, any announcement protocol must feature sufficient
   scalability, flexibility, and reliability to meet IMG needs. Also,
   the IMG ANNOUNCE operation must be supported and IMG NOTIFY
   capability could be investigated for both hybrid unicast-multicast
   and unidirectional unicast systems.

5.2.2. Usage of Unicast Transport Protocols

   A thorough description of the use of existing unicast protocols is
   essential for the use of IMGs in a unicast point-to-point
   environment. Such a specification has not been published, although
   several usable unicast transport protocols and specifications can be
   harnessed for this (SIP [13], SIP events [9], HTTP [7], etc.). In
   particular, both IMG SUBSCRIBE-NOTIFY and IMG QUERY-RESOLVE operation
   pairs must be enabled. We anticipate that the IMG QUERY-RESOLVE
   operation can be achieved using HTTP, although other transport
   protocol options may be beneficial to consider too.

5.2.3. IMG Envelope

   An IMG envelope provides the binding between IMG operations and data
   types. Such a binding can be realized by defining a common minimal
   set of information needed to manage IMG metadata transfers, and by
   including this information with any set of IMG metadata delivered to
   IMG receivers.

   Four options for IMG metadata transfer envelope delivery are
   feasible:

      1. Embedding in a transport protocol header. This can be done
          with either header extensions of existing protocols, or newly
          defined header fields of a new (or new version of a) transport
          protocol. However, multiple methods for the variety of
          transport protocols would hinder interoperability and
          transport protocol independence.

      2. A separate envelope object, which points to the IMG metadata
          'object', delivered in-band with the metadata transport
          protocol session. This might complicate delivery as the
          envelope and 'service' metadata objects would have to be
          bound, e.g., by pairing some kind of transport object numbers
          (analogous to port number pairs sometimes used for RTP and
          RTCP [14]). This would also enable schemes that deliver
          envelope and metadata 'objects' by different media, also using
          more than a single transport protocol.

      3. A metadata wrapper that points to and/or embeds the service
          metadata into its 'super-syntax'. For example, XML would
          enable embedding generic text objects.

      4. Embedding in the metadata itself. However, this requires a
          new field in many metadata syntaxes and would not be feasible
          if a useful syntax were not capable of extensibility in this
          way. It also introduces a larger 'implementation
          interpretation' variety, which would hinder interoperability.
          Thus, this option is not recommended.

   It is likely that more than one of these options will fulfill the
   needs of IMGs, so the selection, and possibly optimization, is left
   for subsequent specification and feedback from implementation
   experience. Such a specification is essential for IMG delivery.

   When there are superset/subset relations between IMG Descriptions, it
   is assumed that the IMG Descriptions of the subset inherit the
   parameters of the superset. Thus, an IMG metadata transfer envelope
   carrying the IMG Descriptions of a superset may implicitly define

parameters of IMG Descriptions belonging to its subset. The
relations between IMG Descriptions may span from one envelope to
another according to a data model definition.

5.2.4. Metadata Data Model

A structured data model would allow reuse and extension of the set of
metadata and may enable use of multiple syntaxes (SDP, MPEG-7, etc.)
as part of the same body of IMG metadata.

For the successful deployment of IMGs in various environments,
further work may be needed to define metadata and data models for
application-specific requirements. Existing (and future) work on
these would need to be mapped to the IMG data types and use of the
IMG transfer envelope concept as described above.

This document is a framework for the delivery of IMG metadata and
thus further discussion on the definition data models for IMGs is
beyond its scope.

6. Security Considerations

The IMG framework is developed from the IMG requirements document
[4], and so the selection of specific protocols and mechanism for use
with the IMG framework must also take into account the security
considerations of the IMG requirements document. This framework
document does not mandate the use of specific protocols. However, an
IMG specification would inherit the security considerations of
specific protocols used.

Protocol instantiations that are used to provide IMG operations will
have very different security considerations depending on their scope
and purpose. However, there are several general issues that are
valuable to consider and, in some cases, provide technical solutions
for. These are described below.

Individual and group privacy: Customized IMG metadata may reveal
information about the habits and preferences of a user and may thus
deserve confidentiality protection, even if the original information
were public. Protecting this metadata against snooping requires the
same actions and measures as for other point-to-point and multicast
Internet communications. Naturally, the risk of snooping depends on
the amount of individual or group personalization the IMG metadata
contains.

IMG authenticity: In some cases, the IMG receiver needs to be assured
of the sender or origin of IMG metadata or its modification history.
This can prevent denial-of-service or hijacking attempts that give an

IMG receiver incorrect information in or about the metadata, thus
preventing successful access of the media or directing the IMG
receiver to the incorrect media possibly with tasteless material.

IMG receiver authorization: Some or all of any IMG sender's metadata
may be private or valuable enough to allow access to only certain IMG
receivers and thus make it worth authenticating users. Encrypting
the data is also a reasonable step, especially where group
communications methods results in unavoidable snooping opportunities
for unauthorized nodes.

Unidirectional specifics: A difficulty that is faced by
unidirectional delivery operations is that many protocols providing
application-level security are based on bidirectional communications.
The application of these security protocols in case of strictly
unidirectional links is not considered in the present document.

Malicious code: Currently, IMGs are not envisaged to deliver
executable code at any stage. However, as some IMG transport
protocols may be capable of delivering arbitrary files, it is
RECOMMENDED that the IMG operations do not have write access to the
system or any other critical areas.

7. Normative References

   [1] Bradner, S., "Key words for use in RFCs to Indicate Requirement
        Levels", BCP 14, RFC 2119, March 1997.

8. Informative References

   [2] Handley, M. and V. Jacobson, "SDP: Session Description
        Protocol", RFC 2327, April 1998.

   [3] Kutscher, D., Ott, J., and C. Bormann, "Session description and
        capability negotiation", Work in Progress, October 2003.

   [4] Nomura, Y., Walsh, R., Luoma, J-P., Ott, J., and H. Schulzrinne,
        "Requirements for Internet Media Guides", Work in Progress,
        December 2005.

   [5] "Multimedia content description interface -- Part 1: Systems",
        ISO/IEC 15938-1, July 2002.

   [6] TV-Anytime Forum, "Broadcast and On-line Services: Search,
        select, and rightful use of content on personal storage systems
        ("TV-Anytime Phase 1"); Part 2: System description," ETSI-TS 102
        822-2: System Description, V1.1.1, October 2003.

   [7] Fielding, R., Gettys, J., Mogul, J., Frystyk, H., Masinter, L.,
        Leach, P., and T. Berners-Lee, "Hypertext Transfer Protocol --
        HTTP/1.1", RFC 2616, June 1999.

   [8] Handley, M., Perkins, C., and E. Whelan, "Session Announcement
        Protocol", RFC 2974, October 2000.

   [9] Roach, A., "Session Initiation Protocol (SIP)-Specific Event
        Notification", RFC 3265, June 2002.

   [10] Schulzrinne, H., Rao, A., and R. Lanphier, "Real Time Streaming
        Protocol (RTSP)", RFC 2326, April 1998.

   [11] Luby, M., Gemmell, J., Vicisano, L., Rizzo, L., and J.
        Crowcroft, "Asynchronous Layered Coding (ALC) Protocol
        Instantiation", RFC 3450, December 2002.

   [12] Paila, T., Luby, M., Lehtonen, R., Roca, V., and R. Walsh,
        "FLUTE - File Delivery over Unidirectional Transport", RFC 3926,
        October 2004.

   [13] Rosenberg, J., Schulzrinne, H., Camarillo, G., Johnston, A.,
        Peterson, J., Sparks, R., Handley, M., and E. Schooler, "SIP:
        Session Initiation Protocol", RFC 3261, June 2002.

   [14] Schulzrinne, H., Casner, S., Frederick, R., and V. Jacobson,
        "RTP: A Transport Protocol for Real-Time Applications", STD 64,
        RFC 3550, July 2003.

9. Acknowledgements

Authors' Addresses

   Yuji Nomura
   Fujitsu Laboratories Ltd.
   4-1-1 Kamikodanaka, Nakahara-ku, Kawasaki 211-8588
   Japan

   EMail: nom@flab.fujitsu.co.jp

   Rod Walsh
   Nokia Research Center
   P.O. Box 100, FIN-33721 Tampere
   Finland

   EMail: rod.walsh@nokia.com

   Juha-Pekka Luoma
   Nokia Research Center
   P.O. Box 100, FIN-33721 Tampere
   Finland

   EMail: juha-pekka.luoma@nokia.com

   Hitoshi Asaeda
   Keio University
   Graduate School of Media and Governance
   5322 Endo, Fujisawa, 252-8520 Kanagawa,
   Japan

   EMail: asaeda@wide.ad.jp

   Henning Schulzrinne
   Dept. of Computer Science
   Columbia University
   1214 Amsterdam Avenue
   New York, NY 10027
   USA

   EMail: schulzrinne@cs.columbia.edu