                The Common Management Information Services
                      and Protocols for the Internet
                            (CMOT and CMIP)

Status of this Memo

    This memo defines a network management architecture that uses the
    International Organization for Standardization's (ISO) Common
    Management Information Services/Common Management Information
    Protocol (CMIS/CMIP) in the Internet. This RFC specifies an IAB
    standards track protocol for the Internet community, and requests
    discussion and suggestions for improvements. Please refer to the
    current edition of the "IAB Official Protocol Standards" for the
    standardization state and status of this protocol.

    Distribution of this memo is unlimited.

Table of Contents

1. Overview

   This memo is a revision of RFC 1095 - "The Common Management
   Information Services and Protocol over TCP/IP" [27]. It defines a
   network management architecture that uses the International
   Organization for Standardization's (ISO) Common Management
   Information Services/Common Management Information Protocol
   (CMIS/CMIP) in the Internet. This architecture provides a means by
   which control and monitoring information can be exchanged between a
   manager and a remote network element. In particular, this memo
   defines the means for implementing the International Standard (IS)
   version of CMIS/CMIP on top of both IP-based and OSI-based Internet
   transport protocols for the purpose of carrying management
   information defined in the Internet-standard management information
   base. Together with the relevant ISO standards and the companion
   RFCs that describe the initial structure of management information
   and management information base, these documents provide the basis
   for a comprehensive architecture and system for managing both IP-
   based and OSI-based internets, and in particular the Internet.

   In creating this revision of RFC 1095, the following technical and
   editorial changes were made:

      1) The tutorial section on OSI Management included in RFC 1095
         has been removed from this document. After some revisions,
         the tutorial material may be published as another RFC.

      2) The sections in RFC 1095 which discussed the semantics of how
         to interpret requests in the context of Internet MIBs has been
         removed from this protocol document. This topic is now
         discussed in the OIM-MIB-II draft document. This protocol
         should be useable with MIB-I or MIB-II. But, it will also be
         able to exploit the new features of the OIM-MIB-II.

      3) This document is based on the final International Standards
         for CMIS/CMIP (ISO 9595/9596) rather than the Draft
         International Standards.

      4) Many of the original agreements defined in RFC 1095 have been
         accepted and included in the OIW NMSIG implementers agreements.
         Rather than duplicating these agreements, they have been removed
         from this memo. This document should be read in conjunction
         with ISO 9595/9596 (CMIS/CMIP) and the OIW Stable Agreements
         document.

      5) The Association Negotiation describe in RFC 1095 has been
         changed to align with current international and national
         agreements. But, it has retained backwards compatibility with

      the assignment of an Application Context Name which is identical
      to the Application Context Name specified in RFC 1095.

2. Introduction

   This memo is the output of the OSI Internet Management Working Group
   of the Internet Engineering Task Force (IETF). As directed by the
   Internet Activites Board (IAB) in RFC 1052, it addresses the need for
   a long-term network management system based on ISO CMIS/CMIP. This
   memo contains a set of protocol agreements for implementing a network
   management system based on these ISO Management standards. Now that
   CMIS/CMIP has been voted an International Standard (IS), it has
   become a stable basis for product development. This profile
   specifies how to apply CMIP to management of both IP-based and OSI-
   based Internet networks. Network management using ISO CMIP to manage
   IP-based networks will be refered to as "CMIP Over TCP/IP" (CMOT).
   Network management using ISO CMIP to manage OSI-based networks will
   be refered to as "CMIP". This memo specifies the protocol agreements
   necessary to implement CMIP and accompanying ISO protocols over OSI,
   TCP and UDP transport protocols.

   This memo must be read in conjunction with ISO and Internet documents
   defining specific protocol standards. Documents defining the
   following ISO standards are required for the implementor: Abstract
   Syntax Notation One (ASN.1) [5, 6], Association Control (ACSE) [7,
   8], Remote Operations (ROSE) [9, 10], Common Management Information
   Services (CMIS) [11] and Common Management Information Protocol
   (CMIP) [12] with their addenda [32-35]. The specification of a
   lightweight presentation layer protocol is required for use with the
   CMOT section of this profile (see RFC 1085 [13]). The SMI (see RFC
   1065 [2]), the MIB-I (see RFC 1066 [3]), the MIB-II (see RFC 1156
   [28]), and the OIM-MIB-II (see [29]) are used with this management
   system.

   This memo is divided into sections for each of the protocols for
   which implementors' agreements are needed: CMISE, ACSE, ROSE, and,
   for CMOT, the lightweight presentation protocol. The protocol
   profile defined in this memo draws on the technical work of the OSI
   Network Management Forum [14] and the Network Management Special
   Interest Group (NMSIG) of the National Institute of Standards and
   Technology (NIST) (formerly the National Bureau of Standards) [30].
   Wherever possible, an attempt has been made to either directly
   reference or remain consistent with the protocol agreements reached
   by these groups.

3. Protocol Overview

    This part of the document is a specification of the protocols of the
    OIM architecture. Contained herein are the agreements required to
    implement interoperable network management systems using these
    protocols. The protocol suite defined by these implementors'
    agreements will facilitate communication between equipment of
    different vendors, suppliers, and networks. This will allow the
    emergence of powerful multivendor network management based on ISO
    models and protocols.

    The choice of a set of protocol standards together with further
    agreements needed to implement those standards is commonly referred
    to as a "profile." The selection policy for this profile is to use
    existing standards from the international standards community (ISO
    and CCITT) and the Internet community. Existing ISO standards and
    draft standards in the area of OSI network management form the basis
    of this profile. Other ISO application layer standards (ROSE and
    ACSE) are used to support the ISO management protocol (CMIP). To
    ensure interoperability, certain choices and restrictions are made
    here concerning various options and parameters provided by these
    standards.   Internet standards are used to provide the underlying
    network transport. These agreements provide a precise statement of
    the implementation choices made for implementing ISO network
    management standards in IP-based and OSI-based internets.

    In addition to the OIM working group, there are at least two other
    bodies actively engaged in defining profiles for interoperable OSI
    network management: the OSI Implementors Workshop (OIW) and the OSI
    Network Management Forum. Both of these groups are similar to the
    OIM working group in that they are each defining profiles for using
    ISO standards for network management. Both differ in that they are
    specifying the use only of underlying ISO protocols, while the OIM
    working group is concerned with using OSI management in both OSI and
    TCP/IP networks. In the interest of greater future compatibility,
    the OIM working group has attempted to make this profile conform as
    closely as possible to the ongoing work of these two bodies.

    This section will describe the CMOT Protocol Suite, the CMIP Protocol
    Suite and Conformance Requirements common to both CMOT and CMIP.
    Later sections will specify the implementers agreements for specific
    layer protocols that comprise the CMOT and CMIP Protocol Suites.

3.1. The CMOT Protocol Suite

   The following seven protocols compose the CMOT protocol suite: ISO
   ACSE, ISO DIS ROSE, ISO CMIP, the lightweight presentation protocol
   (LPP), UDP, TCP, and IP. The relation of these protocols to each
   other is briefly summarized in Figure 2.

```
         +----------------------------------------------+
                  Management Application Processes
         +----------------------------------------------+


                 +--------------------+
                          CMISE
                      ISO 9595/9596
                 +--------------------+


         +------------------+       +--------------------+
                  ACSE                       ROSE
              ISO IS 8649/8650         ISO DIS 9072-1/2
         +------------------+       +--------------------+


         +----------------------------------------------+
              Lightweight Presentation Protocol (LPP)
                          RFC 1085
         +----------------------------------------------+


         +------------------+       +--------------------+
                  TCP                        UDP
               RFC 793                    RFC 768
         +------------------+       +--------------------+


         +----------------------------------------------+
                            IP
                         RFC 791
         +----------------------------------------------+
```
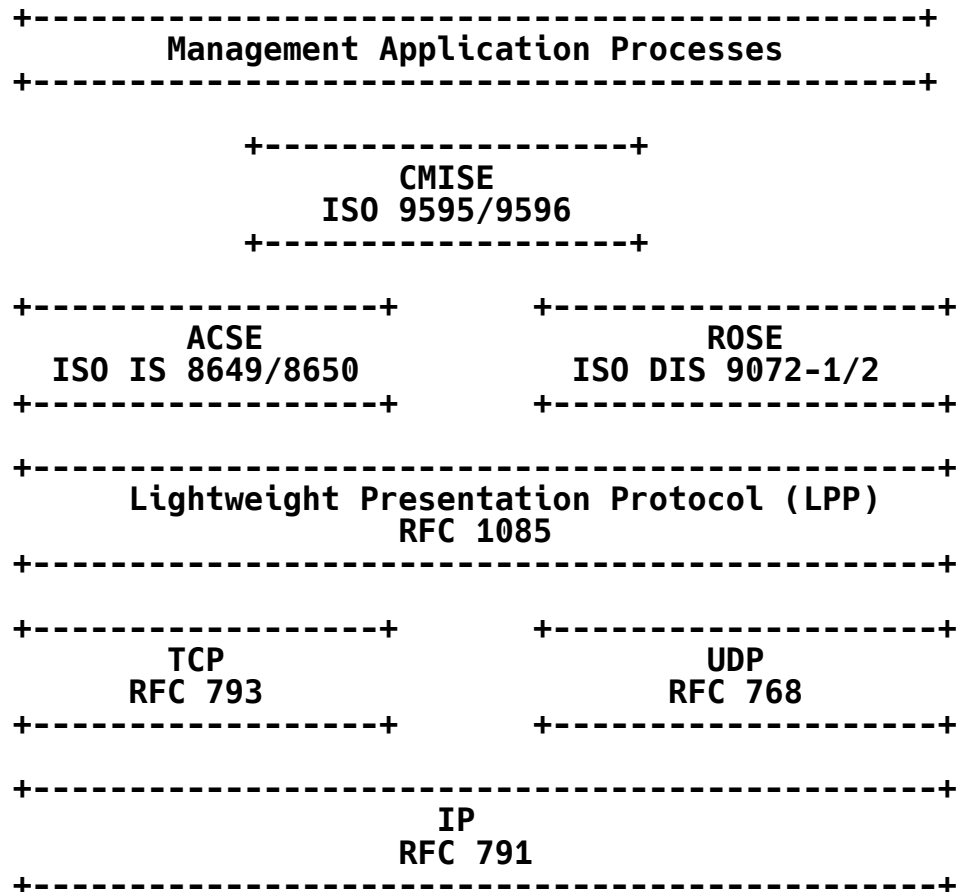
              Figure 2. The CMOT Protocol Suite

3.2. The CMIP Protocol Suite

The following six protocols compose the CMIP protocol suite: ISO
ACSE, ISO DIS ROSE, ISO CMIP, ISO Presentation, ISO Session and ISO
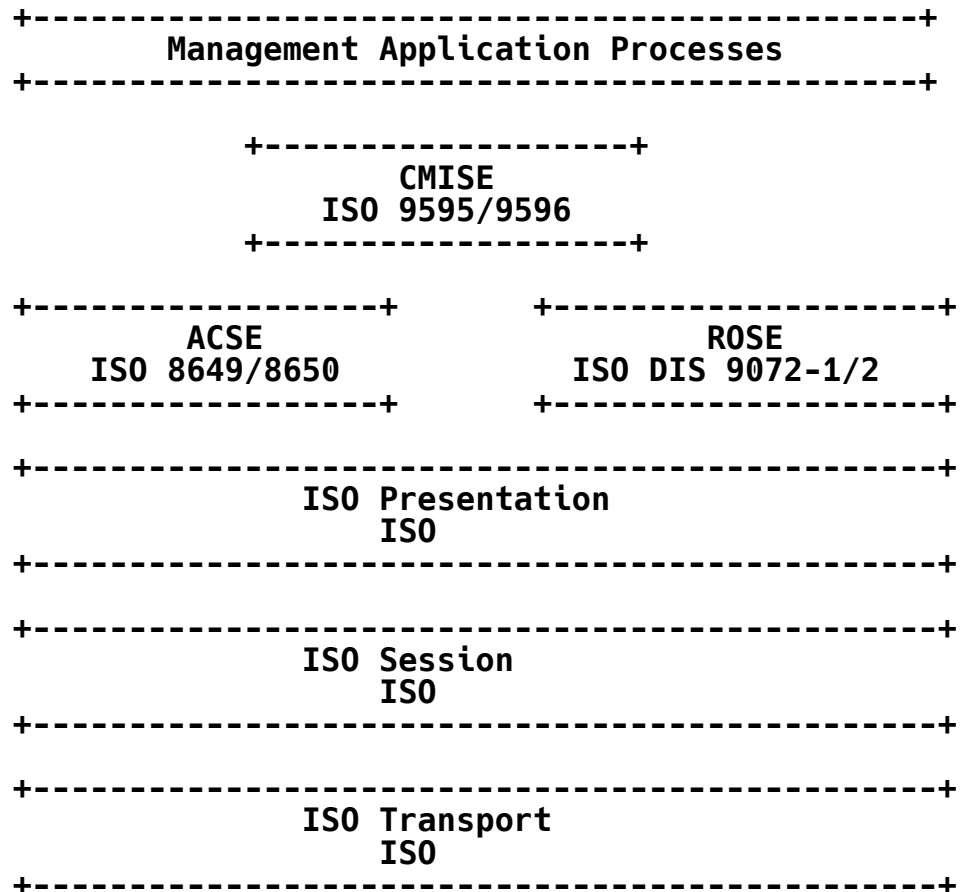Transport. The relation of these protocols to each other is briefly
summarized in Figure 3.

```
            +-----------------------------------------------+
                     Management Application Processes
            +-----------------------------------------------+

                     +-------------------+
                               CMISE
                            ISO 9595/9596
                     +-------------------+

            +------------------+       +--------------------+
                     ACSE                        ROSE
                 ISO 8649/8650             ISO DIS 9072-1/2
            +------------------+       +--------------------+

            +-----------------------------------------------+
                           ISO Presentation
                                  ISO
            +-----------------------------------------------+

            +-----------------------------------------------+
                             ISO Session
                                  ISO
            +-----------------------------------------------+

            +-----------------------------------------------+
                            ISO Transport
                                  ISO
            +-----------------------------------------------+
```

              Figure 3. The CMIP Protocol Suite

3.3. Conformance Requirements

A CMOT-conformant system must implement the following protocols:
ACSE, ROSE, CMIP, LPP, and IP. A CMOT-conformant system must support
the use of the LPP over either UDP or TCP. The use of the LPP over
both UDP and TCP on the same system may be supported.

A CMIP-conformant system must implement the following protocols:
ACSE, ROSE, CMIP, ISO Presentation, ISO Session and ISO Transport.

4. Common Management Information Service Element

   The Common Management Information Service Element (CMISE) is
   specified in two ISO documents. The service definition for the
   Common Management Information Service (CMIS) is given in ISO 9595
   [11]. The protocol specification for the Common Management
   Information Protocol (CMIP) is found in ISO 9596 [12]. In addition,
   the addenda for add/remove support in M-SET [32, 34] must be
   supported for both CMOT and CMIP. The addenda for M-CANCEL-GET [33,
   35] may be supported by an implementation, but it's use is negotiated
   as part of association negotiation.

4.1. Association Policies

   The following ACSE services are required by CMISE: A-ASSOCIATE, A-
   RELEASE, A-ABORT, and A-P-ABORT. The rest of the CMIP protocol uses
   the RO-INVOKE, RO-RESULT, RO-ERROR, and RO-REJECT services of ROSE.

   There are four types of association that may be negotiated between
   managing and managed systems. These types are:

       Event   M-EVENT-REPORTs may be sent by the
                           managed system; no other CMIP PDUs
                           are allowed

       Event/Monitor   same as Event type except that, in
                           addition, the managing system may
                           also issue M-GET requests and
                           receive M-GET responses over the
                           association

       Monitor/Control   managing system may issue M-GET,
                           M-SET, M-CREATE, M-DELETE and
                           M-ACTION requests over the
                           association; no event reporting is
                           allowed

       Full Mgr/Agent   all functions must be supported

   A conformant system must support at least one of these Association
   types. Note that a system may play both managing and managed system
   roles, but not on the same association.

   The negotiation process uses the A-ASSOCIATE and A-RELEASE services.
   Application Context Name is used to determine the requestor's "role"
   in an association (as managing or managed system) and to determine
   the type of the association.

The following values for Application Context Name are registered for
for CMOT and CMIP:

    {iso(1) identified-organization(3) dod(6)
        internet(1) mgmt(2) mib(1) oim(9) acn(1)
        cmot1095(1)}
        (for backwards compatible negotiation with RFC 1095 CMOT
        implementations)

    {iso(1) identified-organization(3) dod(6)
        internet(1) mgmt(2) mib(1) oim(9) acn(1)
        manager-event-association(2)}

    {iso(1) identified-organization(3) dod(6)
        internet(1) mgmt(2) mib(1) oim(9) acn(1)
        manager-event-monitor-association(3)}

    {iso(1) identified-organization(3) dod(6)
        internet(1) mgmt(2) mib(1) oim(9) acn(1)
        manager-monitor-control-association(4)}

    {iso(1) identified-organization(3) dod(6)
        internet(1) mgmt(2) mib(1) oim(9) acn(1)
        manager-full-association(5)}

    {iso(1) identified-organization(3) dod(6)
        internet(1) mgmt(2) mib(1) oim(9) acn(1)
        agent-event-association(6)}

The following negotiation rules are to be used:

1. A managed system may only request an Event
    association and, in fact, must create an Event
    association if it has an event to report and no
    suitable association already exists.

2. Managing systems may request any association type.

3. An association is created by the requesting system
    issuing an A-ASSOCIATE request with the
    requestor's AE-TITLE and the desired application
    context. The responding system then returns
    either 1) an A-ASSOCIATE response with the
    requestor's AE-TITLE and the application context
    which it wishes to accept or 2) an A-ASSOCIATE
    response rejecting the association.

   4.   Managed systems may negotiate "downward" from
        Full to Monitor/Control, Event/Monitor or Event by
        returning the new application context in the
        A-ASSOCIATE response to the managing system during
        the association creation process. In the same
        fashion, managed systems may negotiate from
        Event/Monitor to Event.

   5.   When a managing system receives an application
        context in an A-ASSOCIATE response that differs
        from the context sent in an A-ASSOCIATE request it
        may either proceed with the new context or refuse
        the new context by issuing an A-RELEASE request.

A-RELEASE is used when the requestor does not agree with the new
context. A-ABORT is used for invalid negotiation. If A-ABORT were
to be used to terminate an association, there exists the potential
for loss of information, such as pending events or confirmations.
A-ABORT must be used, however, when a protocol violation occurs or
where an association is not yet established.

4.2. CMIS Services

4.2.1 General Agreements on Users of CMIS

The general agreements on users of CMIS shall be as specified in the
OIW Stable Agreements [30] section 18.6.2.

The following additional agreements are specified.

   o A system need only implement the services and service
     primitives required for the association types (section 4.1)
     that it supports.

   o Current/Event times shall be fields shall use 1 millisecond
     granularity. If the system generating the PDU does not have
     the current time, yet does have the time since last boot, then
     GeneralizedTime can be used to encode this information. The
     time since last boot will be added to the base time "0001
     Jan 1 00:00:00.00" using the Gregorian calendar algorithm.
     (In the Gregorian calendar, all years have 365 days except
     those divisible by 4 and not by 400, which have 366.) The use
     of the year 1 as the base year will prevent any confusion
     with current time.

     If no meaningful time is available, then the year 0 shall be
     used in GeneralizedTime to indicate this fact.

4.2.2 Specific Agreements on Users of CMIS

   The specific agreements on users of CMIS shall be as specified in the
   OIW Stable Agreements [30] section 18.6.3.

   The following additional agreements are specified:

      o Event time shall be mandatory for all events.

      o Both the "managed Object Class" and "managed Object
         Instance" parameters must be present in the following CMIS
         Service Response/Confirmation primitives: the
         M-EVENT-REPORT Confirmed, the M-GET, the M-SET, the
         M-ACTION, the M-CREATE, and the M-DELETE.

4.3. CMIP Agreements

   The CMIS and CMIP implementers agreements documented in the OIW
   Stable Implementers Agreements [30] plus those mandated by the CMIP
   standard will be used for both CMOT and CMIP. In addition to these
   implementers agreements, the following specific agreements must be
   observed:

      o An implementation is required to support all filter items
        except subsetOf, supersetOf, nonNullSetIntersection, and
        substrings.

      o The "managedObjectInstance" field must be present in the
        ProcessingFailure Error PDU. The "managedObjectClass"
        field must be present in the NoSuchArgument Error PDU.

   [Temporary Note: The CMIS/P implementers agreements have reach a
   fairly stable status in the OIW working agreements document. It is
   expected that the CMIS/P agreements (18.6.2 and 18.6.3) will be
   recommended to be moved into the stable agreements document during
   either the June 1990 meetings. Reference [30] points to the presumed
   June 1990 updated version of the stable agreements document.]

5. Services Required by CMIP

   The services required by CMIP shall be as specified in the OIW Stable
   Implementors Agreements [30] section 18.6.5.

   The following additional agreements are specified:

      o ASCE Requirements: Application contexts shall be as defined
        in section 4.1 of these agreements. The values and defaults

of parameters to the ACSE parameters given to the presentation
service are specified in RFC 1085 [13] for CMOT and in the NIST
Stable Implementers Agreements [30] for CMIP.

o Presentation Requirements: CMOT implementations shall be
  supported by the Lightweight Presentation Protocol (LPP)
  [13]. The LPP may use either TCP or UDP. When UDP is used,
  an implementation need not accept LPP PDUs whose length
  exceeds 484 octets.

o Session Requirements: CMOT implementations will not
  require the session protocol.

6. Acknowledgements

This RFC is the result of the work of many people. The following
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        Marshall Rose, PSI
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8. Security Considerations

   Security issues are not discussed in this memo.

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