Report of the Second Ad Hoc Network Management Review Group

Status of this Memo

   This RFC reports an official Internet Activities Board (IAB) policy
   position on the treatment of Network Management in the Internet. This
   RFC presents the results and recommendations of the second Ad Hoc
   Network Management Review on June 12, 1989. The results of the first
   such meeting were reported in RFC 1052 [1]. This report was approved
   and its recommendations adopted by the IAB as assembled on July 11-
   13, 1989. Distribution of this memo is unlimited.

INTRODUCTION

   On February 29, 1988, an Ad Hoc Network Management Review Group was
   convened to consider the state of network management technology for
   the Internet and to make recommendations to the Internet Activities
   Board as to network management policy. The outcome of that meeting
   was summarized in RFC 1052 and essentially established a framework in
   which two network management protocols now known respectively as
   Simple Network Management Protocol (SNMP) and Common Management
   Information Protocol on TCP (CMOT) were selected for further work.
   Subsequently, both SNMP [6] and CMOT [5] were advanced to Draft-
   Standard/Recommended status for use in the Internet [SNMP: RFC 1098,
   CMOT: RFC 1095].

   Simultaneously, it was agreed to establish a working group to
   coordinate the definition and specification of managed objects to be
   used in common with either protocol. In addition, it was agreed to
   use the then current ISO Structure of Management Information (SMI)
   specification as a reference standard to guide the naming and
   abstraction conventions that would be followed in constructing the
   common Internet Management Information Base (MIB). The Internet
   versions of SMI and MIB were specified in RFC 1065 [2] and RFC 1066
   [3] respectively.

   In the intervening fifteen months, considerable progress has been
   made in the specification of a common Management Information Base and
   in the implementation, deployment and use of network management tools
   in the Internet.

The current public subtree of the Internet MIB contains roughly 100
variables (i.e., managed objects) agreed by the SNMP and CMOT working
groups as mandatory for Internet network management. The June 12,
1989 meeting which this document reports was convened to review the
progress to date, to determine whether actions were needed to foster
further evolution of network management tools and to recommend
specific actions in this area to the IAB.

SNMP STATUS

Immediately after the meeting reported in RFC 1052, a group was
convened to make extensions and changes to the predecessor to SNMP:
Simple Gateway Monitoring Protocol. A "connectathon" was held at
NYSERNet, an RFC published, and demonstrations of network management
tools using SNMP were offered in the Fall at Interop 88 [a conference
and show presented by Advanced Computing Environments (ACE)]. The
protocol is in use in a number of networks within the Internet as
well as in private packet networks internationally. A number of
vendor implementations are in the field (e.g., cisco Systems,
Proteon, The Wollongong Group), vendor independent reference
implementations (e.g., NYSERNet, Case and Key in Tennessee) along
with some freely available versions (e.g., MIT, CMU).

It is important to note that while the common Internet Management
Information Base has roughly 100 variables, a typical SNMP monitoring
system may support anywhere from 100 to 200 ADDITIONAL objects which
have been defined in private or experimental MIB space. Many of
these are device or protocol dependent variables.

Scaling to include larger numbers of monitored objects and subsystems
remains a challenge. It was observed that fault monitoring was
easier to scale than performance and configuration monitoring, since
the former may operate on an exception basis while the latter is more
likely to require periodic reporting.

CMOT STATUS

RFC 1095 (CMOT) was recently published and built upon experience
gained earlier with prototype implementations demonstrated at Interop
88 in the Fall of that year. The present specification for CMOT is
based on the ISO Draft International Standard version of Common
Management Information Protocol (CMIP). The CMIP is being moved to
International Standard status, though the precise timing is not
perfectly clear. It will happen late in 1989 or perhaps in the first
quarter of 1990. Some changes will be made to correct known errors
and the CMIP document itself will probably be restructured.

During this discussion, it was pointed out that there is much to

network management which is not addressed by either the CMOT or the
SNMP specifications: for example, down loading of software,
configuration management and user access control. Authentication of
the source of network management commands and responses is another
area important to providers and users of network management tools.

The National Institute for Standards and Technology (NIST) is
sponsoring the development of implementors' agreements on the
functional behavior of network management tools including, inter
alia, logging, event reporting, error reporting, structured object
management, and alarm reporting.

Although at the time of the meeting, there were no publicly available
implementations of CMOT reported, developments were reportedly
planned by a number of vendors both in the form of agents and network
management tools. The University of Wisconsin plans to demonstrate
CMOT using the ISODE software at Interop 89 [(tm) ACE] in September
1989.

MIB AND SMI STATUS

In the Fall of 1988, two RFCs were published (1065 and 1066) to
specify the Structure of Management Information (SMI) and the initial
Internet Management Information Base (MIB) respectively. There were
some challenges in crafting this set of commonly agreed variables; in
the end, roughly 100 were agreed and defined as mandatory for
Internet management.

It was recognized in this process that the definition of the layer
BELOW IP was a difficult task. IP is sufficiently simple and general
that it has been moved in encapsulated form over many media including
the MAC level of various local nets, X.25 packet level, serial line
protocols, multiplexors, tunnels and, it is rumored, tin cans and
string.

At the Transport level, specifically for TCP, it was observed that
information about the transient status of connections was potentially
inaccessible to the network management tools since the loss of a TCP
connection typically meant loss of its Transmission Control Block
(status block) just when you wanted to look back into the history of
its state. Countervailing this observation was evidence that looking
at TCBs with network management tools yielded far more insight into
the transient behavior of TCP than looking at aggregated network
statistics.

It was clear from the discussion that there is strong interest in
extending the variables accessible via network management tools.
Adding new devices, new higher level protocols and the ability to

manipulate configuration information were high on the list of
desirable extensions, although several participants felt that this
desire needed some moderation.

A vital, but unsettled research area has to do with relationships
among groups of monitored variables. A particular implementation may
have IP operating atop X.25. The problem is to be able to make
queries about the condition of monitored variables so that those for
the IP level can be correlated with those for a lower layer, for
instance. This notion of relationship is especially important as
network devices (including hosts) begin to sport multiple network
connections and multiple protocol suites operating in parallel. Just
how the dynamics of such relationships are to be specified, defined
and instantiated is the research question. What sort of SMI is
appropriate? What generic structure is needed for the management
objects?

Another difficult topic has to do with version numbers for SMI. The
issue is "which version of MIB is instantiated in this monitored
system?" As consideration of extensions to the currently agreed SMI
were contemplated during the last fifteen months, it became apparent
that the question of versions was central.

Not far behind was the question of functionality of the underlying
support protocols (SNMP and CMOT). The RFC 1052 recommendation was
to tightly link the MIB/SMI, keeping only one such definition for
both protocols. In theory, this plan would make it easier to move
from one protocol base to another. In practice, it appears to have
stifled exploration of new variable and function definitions in
operating network environments. This point needs to be underscored:
it is essential for the Internet community to have the freedom to
explore the utility of the OSI offerings while, at the same time,
having the freedom to respond to operational needs through the
definition and use of new MIB variables and SMI features.

Yet another area still needing development has to do with the
archiving of operational data collected by means of a network
management tool. The ISO Common Management Information Service
(CMIS) specifications do not treat this matter.

Finally, it was pointed out that registration of managed objects and
their definitions was still an open area although the NIST has
apparently made progress through its Network Management Special
Interest Group (NMSIG) in planning for cataloging of defined
management information objects.

APPLICATION PROGRAMMING INTERFACE (API)

   It was generally agreed that the actual network management tools
   available to operators, rather than the specifics of the protocols
   supporting the tools, would be the determining factor in the
   effectiveness of any Internet network management system. A brief
   report was offered and discussion ensued on the possibility of
   creating a common application programming interface that could be
   used independent of the specific protocol (CMOT, SNMP, CMIP or
   proprietary) used to transport queries and commands.

   It was acknowledged that the present service interfaces of both SNMP
   and CMIS have limitations (e.g., neither has any sense of time other
   than "now"; this makes it impossible to express queries for
   historical information, or to issue command requests of the form: Do
   X at device Y, beginning in 30 minutes). These limitations hinder
   both SNMP and CMOT from directly offering a comprehensive API for
   network management applications.

   Although some positive sentiment was expressed for defining a kind of
   "super SMI" metalanguage to aid in the the definition of a general
   API, it was not clear whether the current crop of supporting
   protocols had sufficient semantic commonality to be used in this way.
   The matter remains open for investigation.

NIST ACTIVITIES

   The Ad Hoc Review had the benefit of representatives from NIST who
   are active in the network management area. It was reported that the
   major focus at present is at layers 3 and 4 where objects are being
   defined in accordance with "templates" provided by ISO's SC21. IEEE
   802 is also pursuing the definition of MIB objects, though not with
   the benefit of the same templates now in use by the NIST NMSIG. The
   layers above transport are just beginning to receive attention.

   It was observed that the Internet SMI is not quite a subset of the
   ISO CMIS SMI. The Internet variable naming conventions are a little
   different and some functionality may vary. There was some
   uncertainty about the treatment of gauges in the Internet SMI and the
   corresponding OSI SMI. [L. Steinberg reported, subsequent to the
   meeting, that gauges latch and counters roll over in the OSI SMI, as
   they appear to do in the Internet SMI - VGC].

   The general sense of this portion of the discussion was that a
   considerable amount of activity is underway with the sponsorship of
   NIST and that this work is relevant to the Internet community,
   particularly as the time approaches in which coexistence of the OSI
   protocol suite with the existing Internet protocols is the norm.

CONCLUSIONS AND RECOMMENDATIONS

   The assembled attendees came to the conclusions enumerated below and
   recommends to the IAB that actions be taken which are consistent with
   these conclusions:

      1. The Internet will exist in a pluralistic protocol stack
         environment and the need to coexist will persist.

      2. Expansion of the common MIB has been impeded by an inability to
         agree on a common, extended SMI.

      3. The Internet community must not ignore the work of other groups
         in the network management area, while at the same time, coping
         with the current operational needs of the Internet (and
         internet) communities.

      4. Until we can gain operational experience with OSI network
         management tools (e.g., with CMIP on TCP or on OSI), we cannot
         specify a plan for coexistence with and transition to use of
         the OSI-based protocols in the Internet.

   Therefore:

      (a) We want to foster an environment for real CMOT/CMIP use.

      (b) We should take action as needed to extend SNMP for operational
          reasons.

      (c) We must preserve the utility of the first agreed common MIB
          (RFC 1066).

      (d) We should develop, separately, experimental and enterprise MIB
          variables and seek opportunity for placing these in the common
          MIB.

      (e) In a coexisting environment, we will need to access the same
          set of variables (e.g., in a given gateway or router) by means
          of more than one protocol (e.g., SNMP, CMIP/TCP, CMIP/CLNP,
          etc.).

   It is recommended to the IAB that the network management efforts
   using SNMP and CMOT be allowed independently to explore new variables
   and potentially non-overlapping SMI definitions for the next 12
   months so as to foster operational deployment and experience with
   these network management tools. In essence, it is recommended that
   the binding of SNMP and CMOT to a common MIB/SMI be relaxed for this
   period of exploration. Variables which are NOT supportable in common

by both protocols should be defined in the experimental or private
parts of the MIB definition space. Obviously, care should be taken
to achieve agreement within each respective working group on any
variables added to the distinct SNMP and CMOT experimental spaces.

Specifically, the CMOT working group should extend its MIB and SMI
definitions in the direction of the OSI/NIST specifications so as to
bring CMOT into closer alignment with the OSI CMIS design.

During this period of experimentation, it is strongly recommended
that the IAB seek opportunities to encourage the introduction of
Internet elements which use the OSI protocols into the Internet
environment. Such OSI-based elements offer an opportunity to obtain
operational experience with monitoring and management support by way
of the CMIP and CMOT protocols. It is anticipated that network
management systems based on the OSI Common Management Information
Service (CMIS) will be developed which use CMIP or CMOT, as
appropriate, to manage various elements in the Internet.

It is also recommended that the IAB engage in an active liaison
effort with the NIST, focusing especially on the question of
coexistence of the Internet protocols with OSI protocols. If at all
possible, joint experimental or test-bed efforts should be initiated
to identify means for supporting this coexistence.

As necessary, the Internet Engineering Task Force should be directed
to restructure its network management efforts both to support the
need for MIB/SMI exploration by the SNMP and CMOT groups and to
strengthen links between the IETF efforts and those of NIST.

Finally, it is recommended that the Ad Hoc Review Group be reconvened
at 6 month intervals to review status and to determine whether
opportunities for expanding the common MIB/SMI are available.

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       Knoxville, NYSERNet, Inc., Rensselaer Polytechnic Institute, and
       MIT Laboratory for Computer Science, April 1989.

Appendix A - Ad Hoc Net Management Review Attendance List

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   Paul Brusil   MITRE
   John Burruss   Wellfleet Communications
   Jeff Case   University of Tennessee at Knoxville
   Vint Cerf   National Research Initiatives
   Ralph Droms   Bucknell University (on sabbatical at NRI)
   Mark Fedor   NYSERNet
   Phill Gross   National Research Initiatives
   Lee LaBarre   MITRE
   Bruce Laird   Bolt Beranek and Newman
   Gary Malkin   Proteon
   Keith McCloghrie   Wollongong
   Craig Partridge   Bolt Beranek and Newman
   Marshall Rose   NYSERNet
   Greg Satz   cisco Systems
   Marty Schoffstall   NYSERNet
   Louis Steinberg   IBM
   Dan Stokesberry   NIST
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