NTIA Report 93-295

Network Management: A Review of Emerging Concepts, Standards, and Products

R.D. Jennings
R.F. Linfield
M.D. Meister

U.S. DEPARTMENT OF COMMERCE
Ronald H. Brown, Secretary

Thomas J. Sugrue, Acting Assistant Secretary
for Communications and Information

April 1993

PREFACE

The Institute for Telecommunication Sciences (ITS) is performing a series of projects concerned with the roles of advanced communication satellites in Integrated Services Digital Networks (ISDN) and the use of advanced satellite system technology to enhance rapid restoration of services provided by the Public Switched Network (PSN) following a natural or "manmade" disaster. Goals of the work are (1) to promote an effective integration of advanced satellite systems with the developing terrestrial broadband networks, (2) to perform studies that examine uses of advanced communication satellite systems to reduce national vulnerability to telecommunication outages, and (3) to identify needs and recommend interface and functional standards required for integrated services, such as ISDN, in a terrestrial-satellite broadband transmission and switching environment.

The purpose of the project addressed in this report has been to present a conceptual development of the technology termed network management, to describe the many organizations that are actively involved with the development of network management standards, to examine the functional characteristics of a variety of network management products, and to discuss some of the important issues and trends that are creating new requirements for network management. Interest in network management technology and some initial support for this work have been provided by the National Communications System, Washington, DC. That support is gratefully acknowledged.

Certain commercial systems, equipment, and telecommunications services are identified in this report so as to adequately develop the concepts presented, explain the functions that comprise network management, and describe typical products that are available to perform network management functions. In no case does such identification imply any recommendation or endorsement by the National Telecommunications and Information Administration. Neither does this identification imply that any of these systems, equipment, or services are the best available for the purpose.

There also are product and service names, such as DOS, UNIX, and Centrex, used in this report that have trademark or registered trademark status. However, that status is not acknowledged in the customary manner, e.g., UNIX™ or Centrex®. There is no intention by the National Telecommunications and Information Administration or the U.S. Department of Commerce, either intended or implied, by these omissions to ignore or infringe upon the recognized trademark ownerships. Rather, the appropriate acknowledgments have been omitted because we find such practice is widespread in the technical literature, and we are unable to be consistent and thorough in determining and using the appropriate acknowledgments.

This report describes the development of network management standards, as well as the organizations involved, and the characteristics of typical commercial products for network management as these components of the technology existed and were available in 1992.

CONTENTS

CONTENTS (cont.)

FIGURES

Page

FIGURES (cont.)

Page

TABLES

Page

ACRONYMS AND ABBREVIATIONS

ACD	Automatic Call Distribution
ACSE	Association Control Service Element
ACTS	Advanced Communications Technology Satellite
ADP	Automatic Data Processing
AG	Advisory Group
AI	Artificial Intelligence
ANSC	American National Standards Committee
ANSI	American National Standards Institute
AO&M	Administration, Operations, and Maintenance
AOM&P	Administration, Operations, Maintenance, and Provisioning
AOW	Asian - Oceania Workshop
ARCAN	ARCnet Analyzer (Anasys, Inc. product)
ASE	Accredited Standards Committee
ASC T1	Accredited Standards Committee for Telecommunications
ASC X3	Accredited Standards Committee for Information Processing Systems
AT&T	American Telephone and Telegraph Company
ATM	Asynchronous Transfer Mode
B-ISDN	Broadband Integrated Services Digital Network
BER	Basic Encoding Rules
BH	Busy Hour
BOC	Bell Operating Company
CBEMA	Computer and Business Equipment Manufacturers Association
CBIS	Cincinnati Bell Information Systems
CCIR	International Radio Consultative Committee
CCITT	International Telegraph and Telephone Consultative Committee
CCS	Common Channel Signaling
CD	Committee Draft
CDR	Call Detail Recording
CEPT	European Conference of Posts and Telecommunications
CME	Conformant Management Entity
CMIP	Common Management Information Protocol
CMIS	Common Management Information Services
CMISE	Common Management Information Services Element
CMOL	CMIP Over Logic Link Control (LLC)
CMOT	CMIP Over TCP
CNOM	Committee on Network Operations and Management
CO	Central Office
COS	Corporation for Open Systems
CPE	Customers Premises Equipment

ACRONYMS AND ABBREVIATIONS (cont.)

CSMA/CD	Carrier Sense Multiple Access/Collision Detection
CSU	Channel Service Unit
CTR	Conformance Test Report
DCN	Data Communications Network
DEC	Digital Equipment Corporation
DIP	Dual In-line Package
DIS	Draft International Standard
DISA	Defense Information Systems Agency
DoC	Department of Commerce
DoD	Department of Defense
DoE	Department of Energy
DoS	Department of State
DOS	Disk Operating System
DoT	Department of Transportation
DP	Draft Proposal
DPN	Data Packet Network (prefix for Northern Telecom products)
DSU	Data or Digital Service Unit
EC	European Community
ECMA	European Computers Manufacturing Association
ECSA	Exchange Carriers Standards Association
EIA	Electronic Industries Association
EMA	Enterprise Management Architecture
EMUG	European Manufacturers User's Group
ENM	Enterprise Network Management
EPRI	Electrical Power Research Institute
ESP	Enhanced Service Provider
ETSI	European Telecommunications Standards Institute
FAX	Facsimile
FCC	Federal Communications Commission
FDDI	Fiber Digital Data Interface
FIPS	Federal Information Processing Standards
FTAM	File Transfer, Access and Management
FTS	Federal Telephone System
FTSC	Federal Telecommunications Standards Committee
GC	Global Control
GNMP	Government Network Management Protocol
GOSIP	Government Open System Interconnection Profile
GSA	General Services Administration

ACRONYMS AND ABBREVIATIONS (cont.)

HDMS	High Density Management System (Microcom, Inc. product)
HP	Hewlett-Packard Company
I/O	Input/Output
IA	Implementation Agreement
IAB	Internet Activities Board
IBM	International Business Machines
ID	Identification
IEC	International Electrotechnical Commission (or)
IEC	Inter-Exchange Carrier
IEEE	Institute of Electrical and Electronic Engineers
IESG	Internet Engineering Steering Group
IETF	Internet Engineering Task Force
IFIP	International Federation for Information Processing
IILC	Information Industry Liaison Committee
INM	International Network Management
INMS	Integrated Network Management Service (offered by MCI)
IP	Internet Protocol
IRTF	Internet Research Task Force
IS	International Standard
ISDN	Integrated Services Digital Network
ISG	(related to NYNEX)
ISO	International Organization for Standardization
ISP	International Standardized Profile
ITU	International Telecommunications Union
IWS	Integrated Work Stations
JTC 1	Joint Technical Committee 1
LAN	Local Area Network
LC	Local Control
LCN	Local Communication Network
LEC	Local-Exchange Carrier
LLC	Link Level Control
LM	Layer Modules
LPP	Lightweight Presentation Protocol
MAN	Metropolitan Area Network
MAP	Manufacturing Automation Protocol
MCI	Microwave Communications, Incorporated
MD	Mediation Device

ACRONYMS AND ABBREVIATIONS (cont.)

ME	Managed Element
MEM	Managed Element Management
MHS	Message Handling System
MIB	Management Information Base
MIS	Management-Information System
MIT	Management Information Tree
MN	Management Network
MS	Management Solution
MSI	Management Services Interface
MTS	Mobile Telecommunication System
MUX	Multiplex or Multiplexer
NAMS	Network Analysis and Management System (Digilog, Inc. product)
NCMS	Network Control and Management System (NEC America, Inc. product)
NCSL	National Computer Systems Laboratory
NE	Network Element
NICE	Network Information Control Exchange (DEC, Inc. product)
NIST	National Institute of Standards and Technology
NIU	North American ISDN Users (Forum)
NM	Network Management
NMA	Network Management Architecture
NMC	Network Management Center
NMCS	Network Management Control System (Tellabs, Inc. product)
NMF	Network Management Forum
NMS	Network Management System
NMSC	Network Management Subcommittee
NMSIG	Network Management Special Interest Group
NMVT	Network Management Vector Transport
NOS	Network Operating System
NREN	National Research and Education Network
NTIA	National Telecommunications and Information Administration
NTM	Network Traffic Management (AT&T term for Network Management)
OAM&P	Operations, Administration, Maintenance and Provisioning
OICS	Object Implementation Conformance Statements
OIW	OSI Implementors Workshop
OIM	OSI Internet Management
ONA	Open Network Architecture
OS	Operations System
OSI	Open Systems Interconnection
PABX	Private Automatic Branch Exchange
PAD	Packet Assembler/Disassembler

ACRONYMS AND ABBREVIATIONS (cont.)

PBX	Private Branch Exchange
PC	Personal Computer
PCS	Personal Communication System
PDN	Public Data Network
PICS	Protocol Implementation Conformance Statements
POP	Point of Presence
POSI	Promoting Conference for OSI (Japan)
POTS	Plain Old Telephone Service
PSTN	Public Switched Telephone Network
PTT	Postal Telephone and Telegraph
RFC	Request for Comment
ROSE	Remote Operations Service Element
SDH	Synchronous Digital Hierarchy
SEC	Secretariat
SICS	SMASE Implementation Conformance Statements
SIG	Special Interest Group
SMAE	System Management Applications Entity
SMASE	Systems Management Service Element
SMDR	Station Message Detail Recording
SMDS	Switched Multi-megabit Data Service
SMI	Structure of Management Information
SNA	Systems Network Architecture
SNMP	Simple Network Management Protocol
SONET	Synchronous Optical Network
SPAG	Standards Promotion and Applications Group
T1	Digital transmission service at 1.544 Mbps that provides 24 voice circuits using two wire-pairs (or
T1	Accredited Standards Committee for Telecommunications
T1M1	Technical Committee for Internetwork Operations, Administration, Maintenance and Provisioning
TAG	Technical Advisory Group
TC	Telecommunications
TCP/IP	Transport Control Protocol/Internet Protocol
TIA	Telecommunications Industry Association
TMN	Telecommunications Management Network
TMS	Telephone Management System
TOP	Technical Office Protocol

ACRONYMS AND ABBREVIATIONS (cont.)

UAOS	User Alliance for Open Systems
UDP	User Datagram Protocol
UNMA	Unified Network Management Architecture
UPT	Universal Personal Telecommunications
U.S.	United States
VGA	Video Graphics Adapter
VPLN	Virtual Private-Line Network
VTP	Virtual Terminal Protocol
WAN	Wide Area Network
WD	Working Draft
WG	Working Group
WS	Workstation
X3	Accredited Standards Committee Information Processing Systems