STATUS AND DIRECTIONS OF INTERNET MANAGEMENT

KEYNOTE PRESENTATION
AT THE *SEMINAR ON TELECOMMUNICATION MANAGEMENT*
STOCKHOLM, SWEDEN
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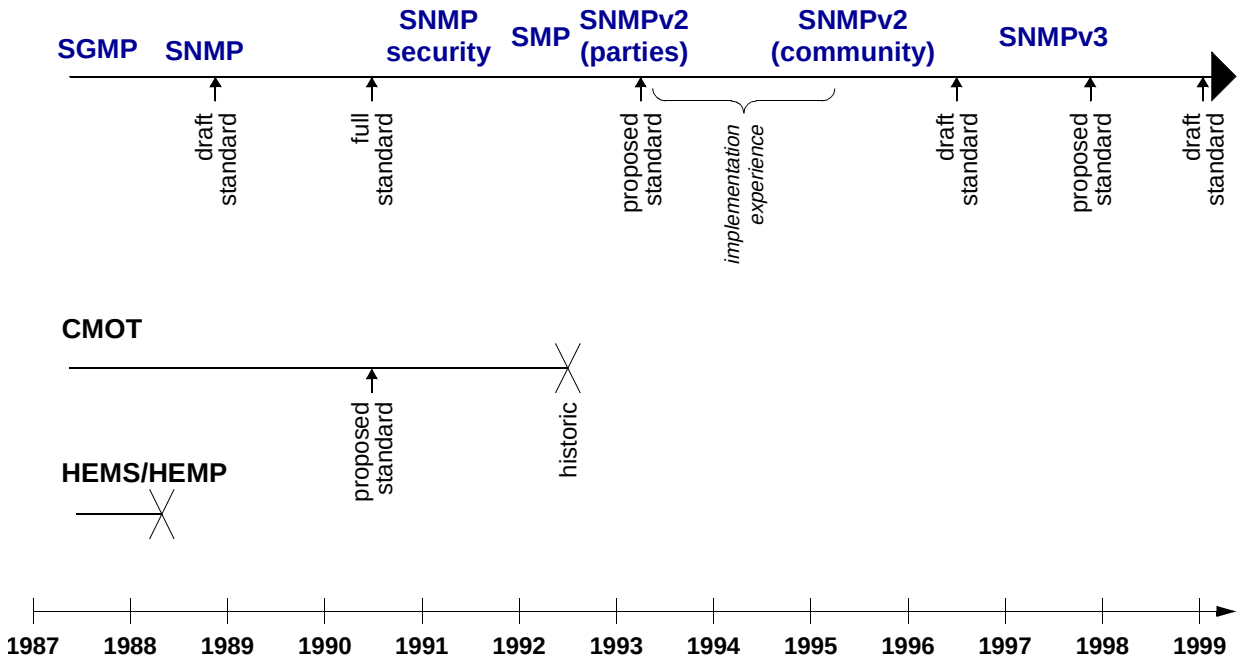
OVERVIEW

- HISTORY OF INTERNET MANAGEMENT
- SNMPv1
- SNMPv2
- SNMPv3
- DISTRIBUTED MANAGEMENT
- EXTENSIBLE AGENT TECHNOLOGY
- POLICY BASED MANAGEMENT
- IRTF NETWORK MANAGEMENT RESEARCH GROUP (NMRG)
- FURTHER INFORMATION

SNMP HISTORY



SNMPv1: GOALS

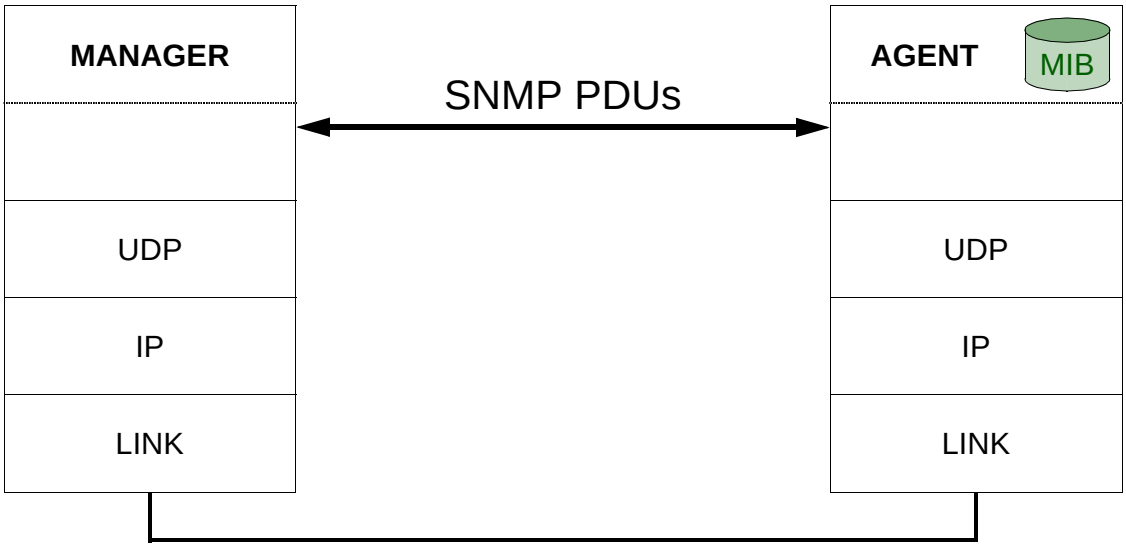
UBIQUITY
- PCs AND CRAYs

INCLUSION OF MANAGEMENT SHOULD BE INEXPENSIVE
- SMALL CODE
- LIMITED FUNCTIONALITY

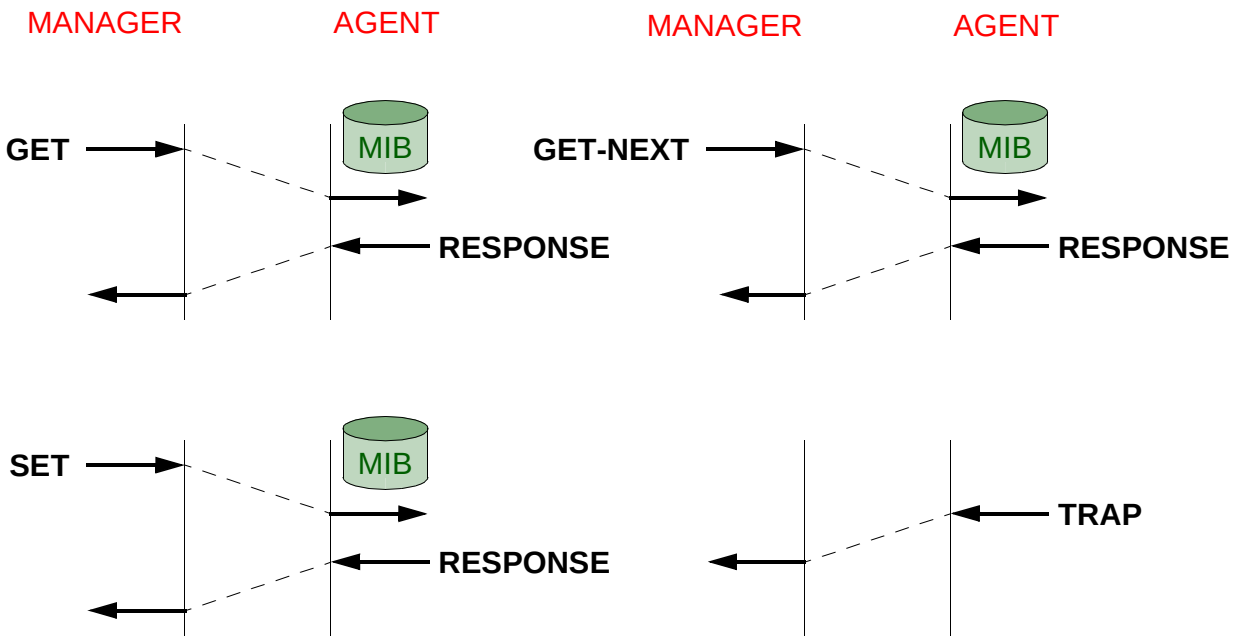
MANAGEMENT EXTENSIONS SHOULD BE POSSIBLE
- NEW MIBs

MANAGEMENT SHOULD BE ROBUST
- CONNECTIONLESS TRANSPORT

STRUCTURE



OVERVIEW OF PDUs



SNMPv1 RFCs

SMI
• STRUCTURE OF MANAGEMENT INFORMATION
• RFC 1155

MIB-II
• MANAGEMENT INFORMATION BASE
• RFC 1213
• A LARGE NUMBER OF ADDITIONAL MIBs EXIST

SNMP
• SIMPLE NETWORK MANAGEMENT PROTOCOL
• RFC 1157
• NAME IS USED IN A MORE GENERAL SENSE

SNMPv2

WORK STARTED IN 1993

IMPROVED INFORMATION MODEL (SMIv2)
• ADDITIONAL DATA TYPES
• TEXTUAL CONVENTIONS (E.G. ROW STATUS)
• NOTIFICATIONS

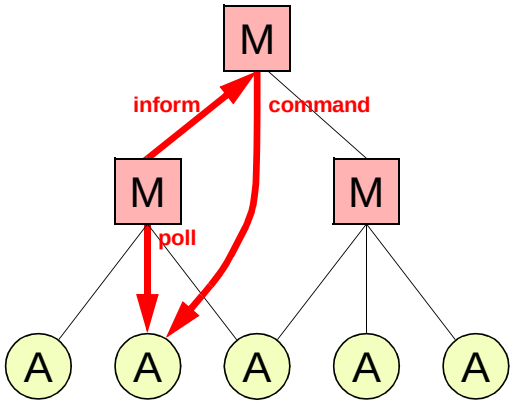
IMPROVED COMMUNICATION MODEL
• TRAPS HAVE SAME FORMAT AS OTHER PDUS
• BETTER PERFORMANCE (GET-BULK PDU)
• ADDITIONAL ERROR CODES FOR SETS

INDEPENDENCE OF UNDERLYING TRANSPORT
• MIB-II SPLIT INTO MODULES

HIERARCHIES AND SECURITY: •••

HIERARCHIES: ORIGINAL IDEA

MANAGER TO MANAGER (M2M) MIB



- STANDARD MIB APPROACH
- LIMITED FUNCTIONALITY

HIERARCHIES: STATUS

WORK HAS MOVED TO A SEPARATE DISTRIBUTED MANAGEMENT GROUP (DISMAN)

THREE APPROACHES ARE STANDARDIZED:

- MIB BASED (EXPRESSION, EVENT AND NOTIFICATION LOG MIB)
- SCRIPT BASED (SCRIPT AND SCHEDULE MIB)
- REMOTE OPERATIONS BASED (REMOPS MIB)

SECURITY: WHAT HAPPENED?

APRIL 1993:
PROPOSED STANDARD
FOUR EDITORS
SECURITY BASED ON *PARTIES*
FIRST PROTOTYPES APPEARED SOON

JUNE 1995:
PROPOSED STANDARD REJECTED BY TWO OF THE ORIGINAL EDITORS!

AUGUST 1995:
GENERAL AGREEMENT THAT PARTY BASED MODEL WAS TOO COMPLEX!
MANY NEW PROPOSALS APPEARED:
• SNMPv2C: COMMUNITY BASED
• SNMPv2U: USER BASED

1997:
NEW SNMPv3 WORKING GROUP WAS FORMED
WITH NEW EDITORS

SNMPv2 RFCs

INFORMATION MODEL:
• STANDARD
• RFC2578, RFC2579, RFC2580

COMMUNICATION MODEL
• DRAFT STANDARD
• RFC 1905, RFC1906

SECURITY MODEL - SNMPv2C:
• COMMUNITY BASED SNMP
• SAME 'SECURITY MECHANISMS' AS SNMPv1
• EXPERIMENTAL STATUS
• RFC 1901

SECURITY MODEL - SNMPv2U:
• USER BASED SECURITY (AUTHENTICATION / ENCRYPTION / ACCESS CONTROL)
• EXPERIMENTAL STATUS
• RFC 1909, RFC1910

SNMPv3

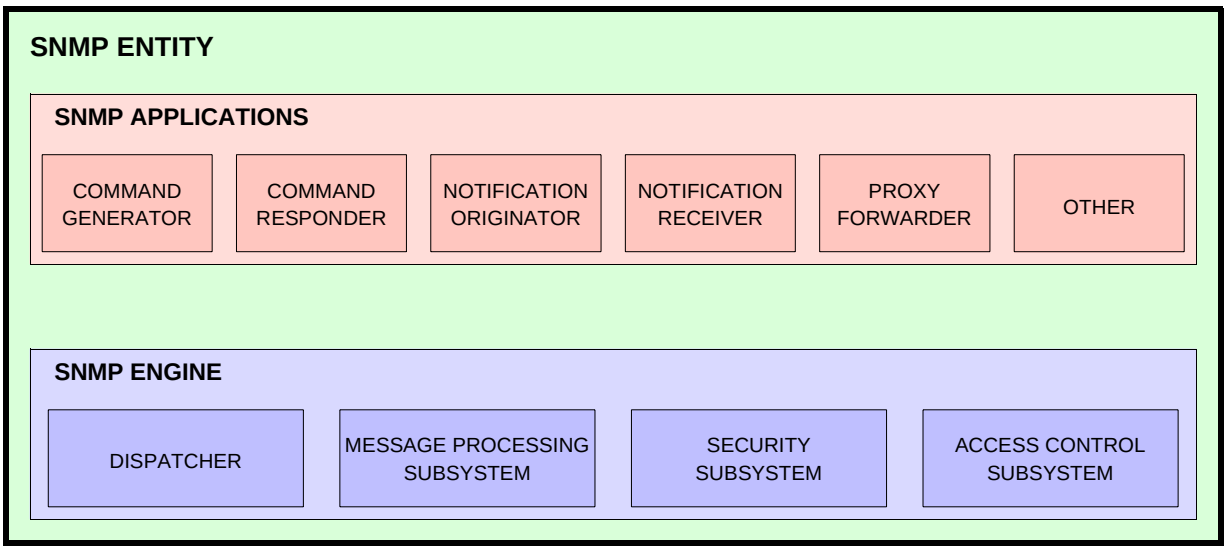
HAS A MODULAR ARCHITECTURE

ALLOWS SECURE COMMUNICATION

PROVIDES ACCESS CONTROL

HAS MANY IMPLEMENTATIONS

MODULAR ARCHITECTURE



SECURE COMMUNICATION

THREAT	ADDRESSED?	MECHANISM
MASQUERADE	YES	MD5 / SHA-1
REPLAY	YES	TIME STAMP
DISCLOSURE	YES	DES
INTEGRITY	YES	(MD5)
DENIAL OF SERVICE	NO	
TRAFFIC ANALYSIS	NO	

ACCESS CONTROL TABLES

MIB VIEW	ALLOWED OPERATIONS	ALLOWED MANAGERS	REQUIRED LEVEL OF SECURITY
Interface Table	SET	John	Authentication Encryption
Interface Table	GET / GETNEXT	John, Paul	Authentication
Systems Group	GET / GETNEXT	George	None
•••	•••	•••	•••
•••	•••	•••	•••
•••	•••	•••	•••
•••	•••	•••	•••

IMPLEMENTATIONS

ACE*COMM
AdventNet
BMC Software
Cisco
Epilogue
Gambit communications
Halcyon
IBM
ISI
IWL
MG-SOFT
MultiPort Corporation
SimpleSoft
SNMP Research

SNMP++
TU of Braunschweig
UCD
University of Quebec

DISTRIBUTED MANAGEMENT

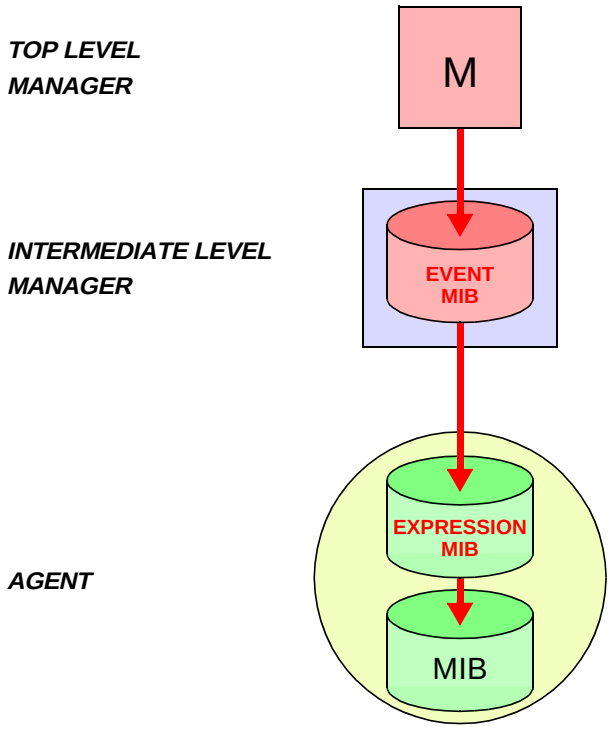
THREE APPROACHES ARE BEING DEFINED

MIB BASED
- EXPRESSION MIB
- EVENT MIB
- NOTIFICATION LOG MIB

SCRIPT BASED
- SCRIPT MIB
- SCHEDULE MIB

REMOTE OPERATIONS BASED
- REMOTE OPERATIONS MIB

EXPRESSION AND EVENT MIB



EXPRESSION AND EVENT MIB: CHARACTERISTICS

• STANDARD MIB APPROACH

• RESEMBLES THE OLD SNMPv2 M2M MIB

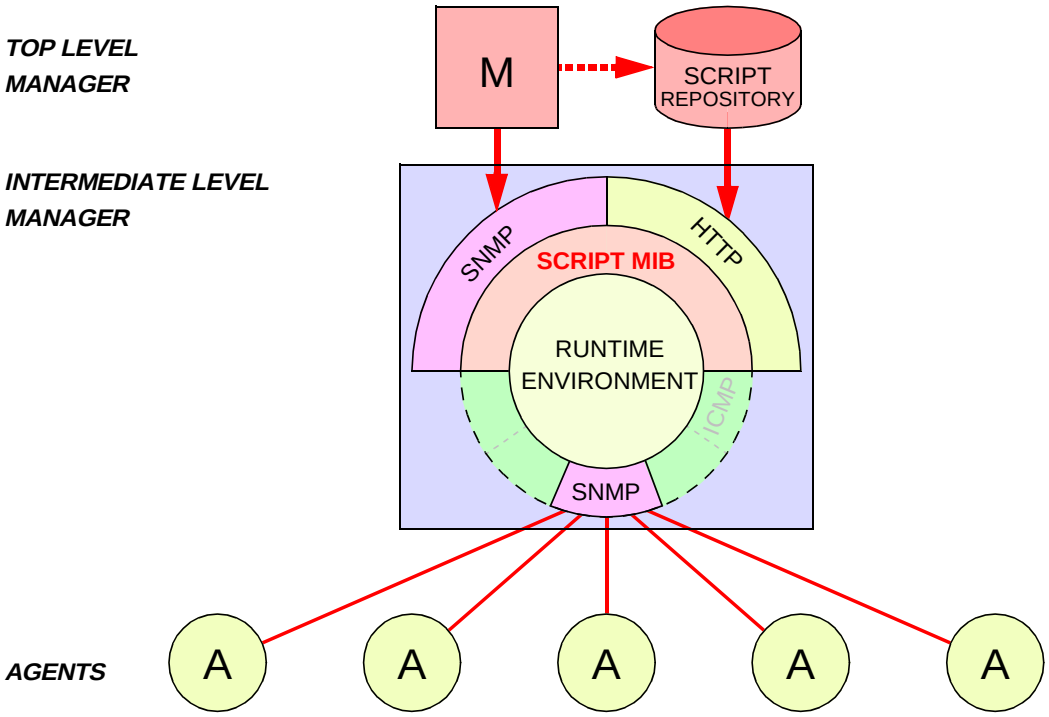
EXPRESSION MIB:

• INPUT ARE (WILDCARDED) VARIABLES OF A (LOCAL) MIB
• OPERATES ON ABSOLUTE AS WELL AS DELTA VALUES
• RICH SET OF EXPRESSIONS
• THE OUTPUT IS STORED IN THE *VALUE TABLE*
• THIS TABLE MAY SERVE AS INPUT FOR OTHER EXPRESSIONS

EVENT MIB:

• INPUT ARE VARIABLES OF A (REMOTE) MIB
• TRIGGERS ON CHANGES, OR TRESHOLD CROSSING
• GENERATES A NOTIFICATION OR SET OPERATION

SCRIPT MIB



SCRIPT MIB: CHARACTERISTICS

• FUNCTIONALITY CAN BE DEFINED AT RUN-TIME

• POWERFUL AUTONOMOUS ACTIONS

• MAY BE EASIER TO OPERATE FOR THE TOP-LEVEL MANAGER

• PROTECTION MECHANISMS NECESSARRY

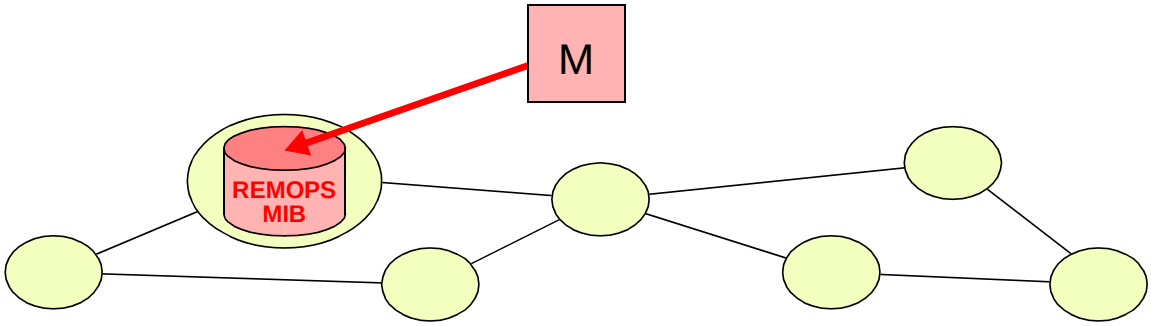
• DIFFERENT SCRIPT LANGUAGES

REMOTE OPERATIONS MIB

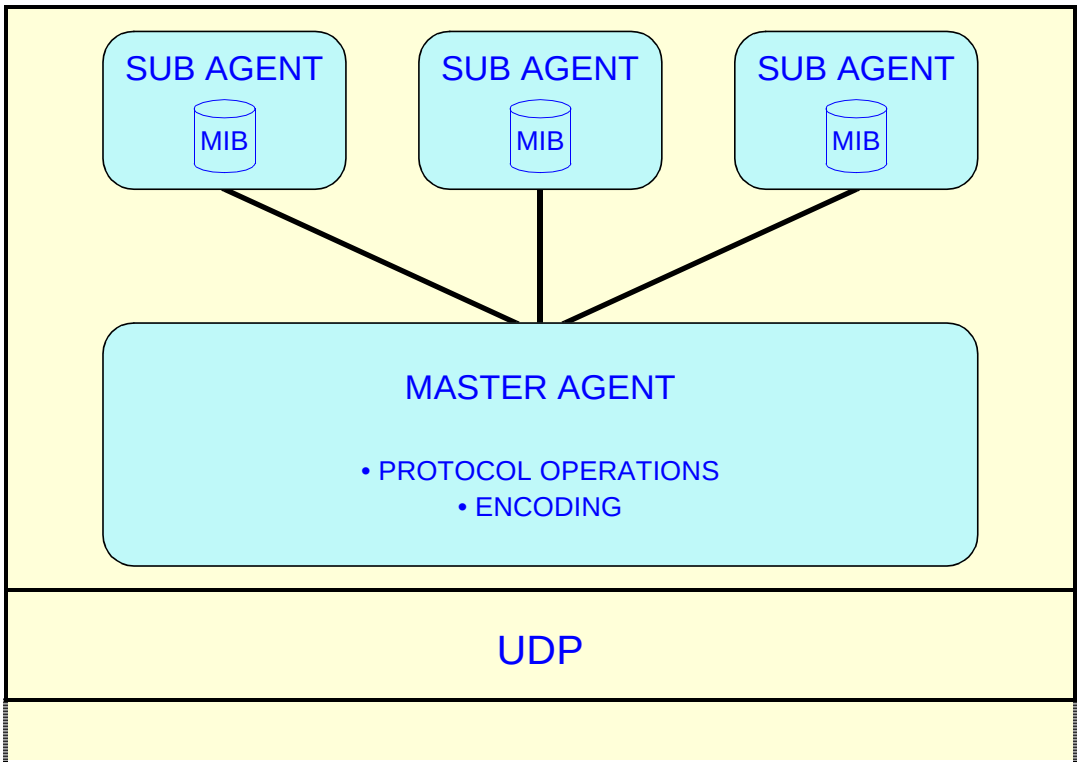
PING MIB
• TO PERFORM PING FROM A REMOTE HOST

TRACEROUTE MIB
• TO PERFORM TRACEROUTE FROM A REMOTE HOST

NAME LOOKUP MIB
• TO PERFORM NAME LOOKUP FROM A REMOTE HOST



EXTENSIBLE AGENTS



HISTORY

SMUX (RFC 1227)
SNMP MULTIPLEXING PROTOCOL

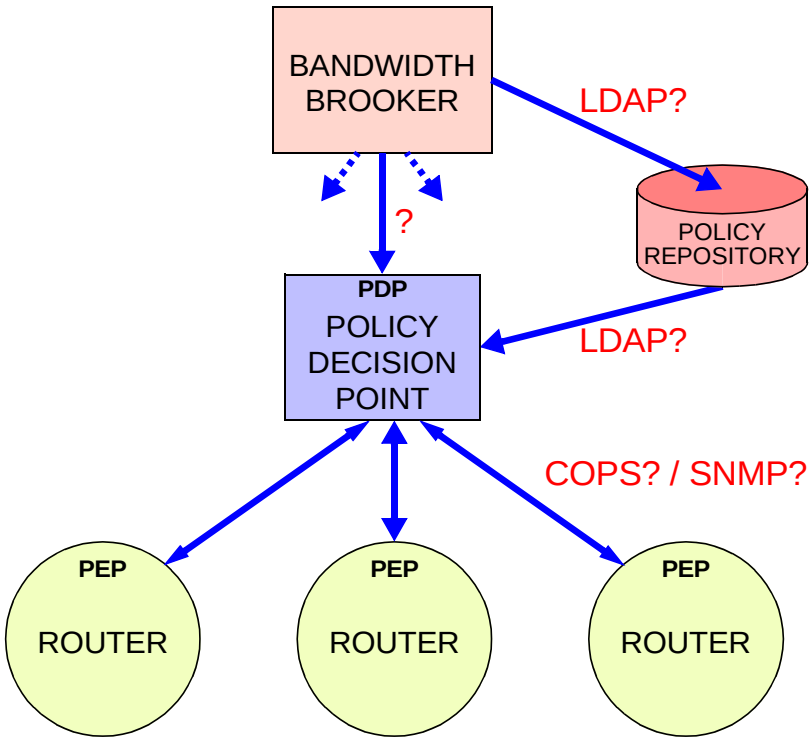
DPI (RFC 1228 & RFC 1592)
DISTRIBUTED PROTOCOL INTERFACE

RESEARCH PROTOTYPES
FOR EXAMPLE: UNIVERSITY OF TWENTE - UT-SNMPv2

COMMERCIAL PRODUCTS
FOR EXAMPLE: SNMP RESEARCH - EMANATE
(ENHANCED MANAGEMENT AGENT THROUGH EXTENSIONS)

AGENTX (RFC2257)

POLICY BASED MANAGEMENT



COPS VERSUS SNMP

COPS:

• SPECIAL CASE OF CONFIGURATION MANAGEMENT
• HIGHER LEVEL OBJECTS THAN USUAL WITH SNMP
• POLICY INFORMATION BASE (PIB)
• SINGLE OPERATION TO ADD OR DELETE TABLE ROWS
• RELIABLE COMMUNICATION BETWEEN PDP AND PEP (BECAUSE OF TCP)
• EACH PEP IS CONNECTED TO SINGLE PDP

SNMP:

• INTEGRATED APPROACH TO MANAGEMENT
• POLICIES CAN BE DEFINED WITHIN MIBs
• EACH PEP MAY BE CONNECTED TO MULTIPLE PDPs

IRTF NMRG

EFFICIENT TRANSFER OF BULK MANAGEMENT DATA

• SNMP OVER TCP
• COMPRESSION
• GET-SUBTREE OPERATOR

SMI NEXT GENERATION

• INDEPENDENT FROM OTHER EXTERNAL STANDARDS
• BASED ON AUGMENTED BNF
• MORE DATA TYPES
• EASIER TO PARSE

ACTIVE MANAGEMENT

• ALLOW MANAGEMENT FUNCTIONS WITHIN MIBs
• CAN BE INTEGRATED WITH SMIv2
• CAN BE USED OVER SNMP OR COPS
• POWERFUL NEW IDEA!

FURTHER INFO: WWW SERVERS

• IETF
http://www.ietf.org/

• The SimpleWeb
http://www.simpleweb.org/

• The Simple Times
http://www.simple-times.org/

• The Smurfland NM Web Server
http://netman.cit.buffalo.edu/

ARTICLES

The Simple Times: *Special issue on Agent Extensibility*
Issue 4-2, April 1996

The Simple Times: *Special issue on SNMPv3*
Issue 5-1, December 1997

The Simple Times: *An overview of the AgentX Protocol*
Issue 6-1, March 1998

The Simple Times: *Special issue on SNMPv3*
Issue 7-2, November 1999

William Stallings,
Security Comes to SNMP: The New SNMPv3 Proposed Internet Standards
The Protocol Journal, December 1998

William Stallings,
SNMPv3: A Security Enhancement for SNMP,
IEEE Communications Survey, Q4, 1998