



SNMPv2

The Evolution of SNMP

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The Limitations of SNMPv1

- For the management of large networks, *polling* may represent a performance problem;
- SNMP is not suitable for the transfer of large amounts of information;
- The trap messages are not confirmed (there is no guarantee that a critical message will be delivered! Or that it comes from whoever it says it is ...);
- Authentication based on community strings is trivial (it is recommended then use SNMP to monitor only and not to control!);
- The triggering of an event results only from the change of a value, and not, for example, from the combination of factors or execution of procedures;
- ...

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The Limitations of SNMPv1

- ...
- The MIB model is limited (not intended for manipulations or complex queries of values and data types);
- Communication is always between the Manager and the Agent (there is no communication Manager to Manager);
- SNMP messages are carried only in UDP.

And the fact is that Industry had assumed that SNMP would be only the interim solution until OSI network management based on CMIS / CMIP matured!...



Improvements

The major improvements or innovations included in SNMPv2 were:

- Extension of the OID tree
- Data Types
- Macros
- Textual conventions
- Protocol operations that facilitate the transfer of large amounts of data
- Error Codes
- Multi-protocol transport support



SMIv2

RFC 2578 (STD 58) – “*Structure of Management Information Version 2 (SMIv2)*”

- The SMI object tree is extended with the addition of the **snmpV2** branch to the **internet** subtree
- The OID for the new branch is {1.3.6.1.6} or **iso.org.dod.internet.snmpV2**
- Below this there are: *Transport domains* (**snmpDomains**), *Transport proxies* (**snmpProxys**) and *Module identities* (**snmpModules**)

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SMIv2 RFC 2578 (STD0058)

```
SNMPv2-SMI DEFINITIONS ::= BEGIN

-- the path to the root

org          OBJECT IDENTIFIER ::= { iso 3 } -- "iso" = 1
dod          OBJECT IDENTIFIER ::= { org 6 }
internet     OBJECT IDENTIFIER ::= { dod 1 }

directory    OBJECT IDENTIFIER ::= { internet 1 }

mgmt         OBJECT IDENTIFIER ::= { internet 2 }
mib-2        OBJECT IDENTIFIER ::= { mgmt 1 }
transmission OBJECT IDENTIFIER ::= { mib-2 10 }

experimental OBJECT IDENTIFIER ::= { internet 3 }

private      OBJECT IDENTIFIER ::= { internet 4 }
enterprises  OBJECT IDENTIFIER ::= { private 1 }

security     OBJECT IDENTIFIER ::= { internet 5 }

snmpV2       OBJECT IDENTIFIER ::= { internet 6 }

-- transport domains
snmpDomains  OBJECT IDENTIFIER ::= { snmpV2 1 }

-- transport proxies
snmpProxys   OBJECT IDENTIFIER ::= { snmpV2 2 }

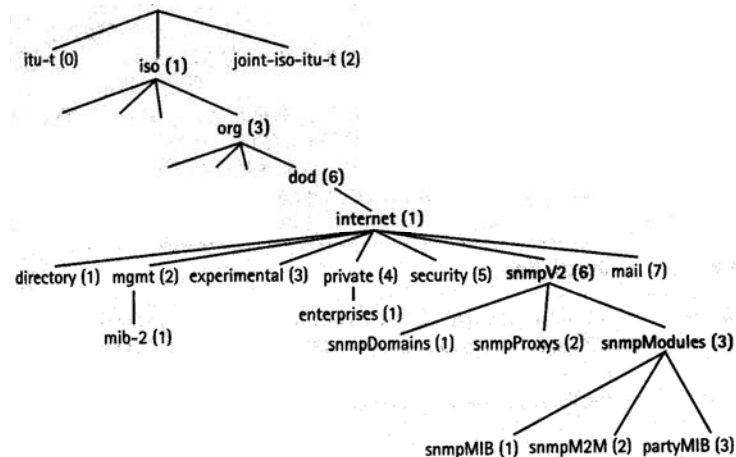
-- module identities
snmpModules  OBJECT IDENTIFIER ::= { snmpV2 3 }
```

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OIDs SNMPv2 Tree



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New Data Types

Data Types	Description
Integer32	Same as an INTEGER , values between -2^{31} and $2^{31} - 1$ inclusive.
Counter32	Same as Counter ; is a non-negative integer that is successively incremented until the maximum value $2^{32} - 1$, then restarts from 0.
Counter64	Same as Counter32 , but the maximum value is $2^{64} - 1$. It is used on objects that quickly reach the maximum with a Counter32 .
Gauge32	Same as Gauge , is a non-negative integer that increases or decreases but never exceeds the maximum of $2^{32} - 1$.
Unsigned32	Decimal values between 0 and $2^{32} - 1$ inclusive.
BITS	Named bits enumeration.

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Macro OBJECT-TYPE

```
<name> OBJECT-TYPE
  SYNTAX <datatype>
  UnitsParts <Optional>
  MAX-ACCESS Access
  STATUS Status
  DESCRIPTION Text
  AUGMENTS { <name of table> }
  ::= { <Unique OID that defines the object> }
```

UnitsParts	Textual description of the units used to represent the object (e.g. "seconds", "packets", etc.)
MAX-ACCESS	Can be in ascending order: not-accessible, accessible-for-notify, read-only, read-write, read-create
STATUS	::= "current" "deprecated" "obsolete"
AUGMENTS	Allows to extend a table by adding one or more columns



New Macros

- NOTIFICATION-TYPE
- MODULE-COMPLIANCE
- OBJECT-GROUP
- AGENT-CAPABILITIES



Textual Conventions (TC)

RFC 2579 (STD0058) – “*Textual Conventions for SMIPv2*”

- They define new data types with similar syntax (formal) but more precise semantics (meaning);
- The great advantage is to allow more intelligible for humans reading a module of a MIB.

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TC

DisplayString ::= TEXTUAL-CONVENTION

DISPLAY-HINT "255a"

STATUS current

DESCRIPTION

"Represents textual information taken from the NVT ASCII character set, as defined in pages 4, 10-11 of RFC 854.

To summarize RFC 854, the NVT ASCII repertoire specifies:

- the use of character codes 0-127 (decimal)
- the graphics characters (32-126) are interpreted as US ASCII
- NUL, LF, CR, BEL, BS, HT, VT and FF have the special meanings specified in RFC 854
- the other 25 codes have no standard interpretation
- the sequence 'CR LF' means newline
- the sequence 'CR NUL' means carriage-return
- an 'LF' not preceded by a 'CR' means moving to the same column on the next line.
- the sequence 'CR x' for any x other than LF or NUL is illegal. (Note that this also means that a string may end with either 'CR LF' or 'CR NUL', but not with CR.)

Any object defined using this syntax may not exceed 255 characters in length."

SYNTAX OCTET STRING (SIZE (0..255))

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TC

[...]

```
PhysAddress ::= TEXTUAL-CONVENTION
  DISPLAY-HINT "1x:"
  STATUS      current
  DESCRIPTION
    "Represents media- or physical-level addresses."
  SYNTAX      OCTET STRING

MacAddress ::= TEXTUAL-CONVENTION
  DISPLAY-HINT "1x:"
  STATUS      current
  DESCRIPTION
    "Represents an 802 MAC address represented in the
    `canonical' order defined by IEEE 802.1a, i.e., as if it
    were transmitted least significant bit first, even though
    802.5 (in contrast to other 802.x protocols) requires MAC
    addresses to be transmitted most significant bit first."
  SYNTAX      OCTET STRING (SIZE (6))
```

[...]

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TC (cont.)

Convention	Description
DisplayString	Text information of the NVT ASCII character set
PhysAddress	Physical address represented as an OCTET STRING
MacAddress	Six octets
TruthValue	Boolean value, true or false.
TestAndIncr	Used to prevent two NMS from modifying the same object at the same time
AutonomousType	An OID used to define an additional subtree
InstancePointer	Obsolete in RFC1903
VariablePointer	Pointer to an instance of an object
RowPointer	Pointer to a row of a table
RowStatus	Used to create or delete rows from a table
TimeStamp	Value of the sysUpTime object in an instance
TimeInterval	Time interval in hundredths of a second
DateAndTime	OCTET STRING with the day and time
StorageType	Memory type used in the agent
TDomain	Type of transport service
TAddress	Transport Service Address, 1 - 255 octets

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SNMPv2 Protocol Operations

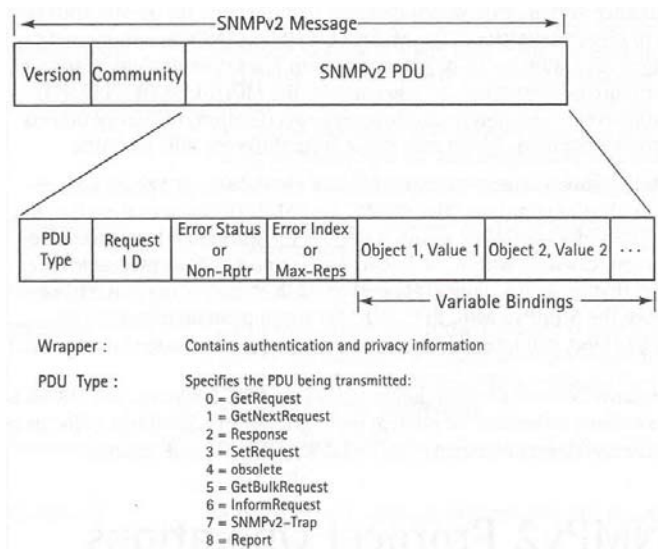
- *get*
- *get-next*
- *get-bulk* (SNMPv2)
- *set*
- *get-response* (SNMPv2 simplifies the name to *response*)
- *trap*
- *notification* (SNMPv2, PDU equal to *set* and *get*)
- *inform* (SNMPv2, manager-to-manager)
- *report* (SNMPv2, planned but never implemented)

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SNMPv2 PDU



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PDU - Source and destination

PDU SNMPv2	Generated on Agent	Received on Agent	Generated on Manager	Received on Manager
GetRequest		X	X	
GetNextRequest		X	X	
Response	X		X	X
SetRequest		X	X	
GetBulkRequest		X	X	
InformRequest			X	X
SNMPv2-Trap	X			X

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SNMPv2 PDU (cont.)

PDU Type	Request ID	Error Status or Non-Rptr	Error Index or Max-Reps	Object 1, Value 1	Object 2, Value 2	...
Variable Bindings						

Request ID :

Used to correlate the Request and Response

Error Status :

Exception Condition for the request. Values are:

- 0 = noError
- 1 = tooBig
- 2 = noSuchName
- 3 = badValue
- 4 = readOnly
- 5 = genErr
- 6 = noAccess
- 7 = wrongType
- 8 = wrongLength
- 9 = wrongEncoding
- 10 = wrongValue
- 11 = noCreation
- 12 = inconsistentValue
- 13 = resourceUnavailable
- 14 = commitFailed
- 15 = undoFailed
- 16 = authorizationError
- 17 = notWritable
- 18 = inconsistentName

SNMPv1

SNMPv2

Error Index :

Pointer to the Variable Binding that caused the error

Non-Rptr :

Non-Repeaters, how many of the requested variables will not be processed repeatedly, e.g. single instances of variables. Used in GetBulkRequests only.

Max-Reps :

Maximum-Repetitions, the maximum number of repeated executions to retrieve specific variables. Used in GetBulkRequests only.

Variable Bindings :

Pairing of object name and value

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Error Messages

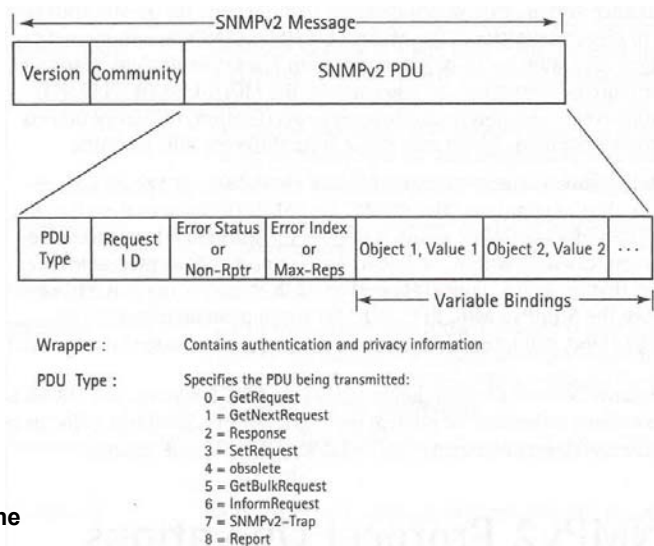
0 = noError	
1 = tooBig	
2 = noSuchName	
3 = badValue	
4 = readOnly	← Usually not used, noSuchName is equivalent
5 = genErr	← Generic answer
6 = noAccess	
7 = wrongType	
8 = wrongLength	
9 = wrongEncoding	
10 = wrongValue	
11 = noCreation	
12 = inconsistentValue	
13 = resourceUnavailable	
14 = commitFailed	← Generic response to set operations
15 = undoFailed	
16 = authorizationError	← Not used in SNMPv2, according to RFC1901
17 = notWritable	
18 = inconsistentName	

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Error Index



e.g.
errorStatus=noSuchName
errorIndex=2

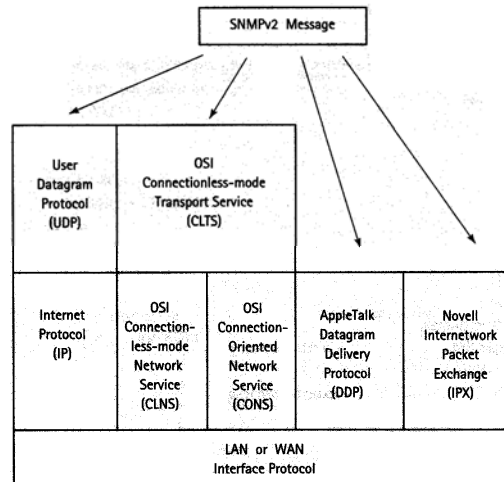
You can only know that there was a **noSuchName** error for the varbind at position 2
In that case you can't know whether any other value is valid....

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Transport

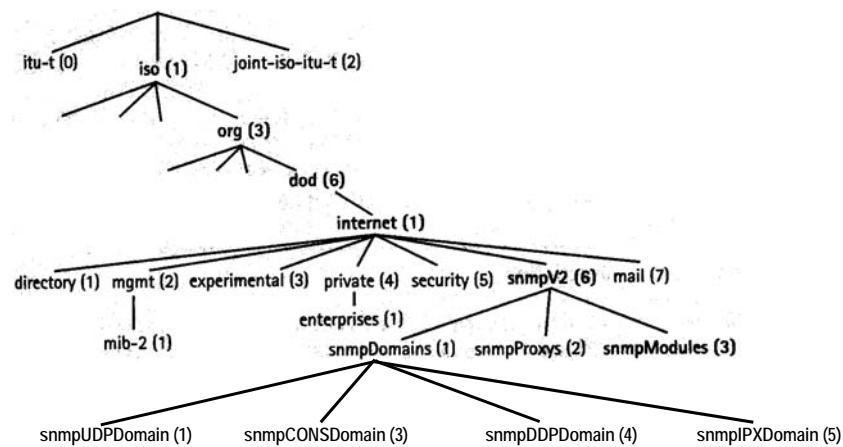


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snmpDomains



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Transport

- SNMPv2 over UDP
- SNMPv2 over OSI
- SNMPv2 over AppleTalk Datagram Delivery Protocol (DDP)
- SNMPv2 over Novell Internetwork Packet Exchange (IPX)



Transport Mappings

```
SNMPv2-TM DEFINITIONS ::= BEGIN

IMPORTS
    MODULE-IDENTITY, OBJECT-IDENTITY,
    snmpModules, snmpDomains, snmpProxys
        FROM SNMPv2-SMI
    TEXTUAL-CONVENTION
        FROM SNMPv2-TC;

snmpv2tm MODULE-IDENTITY
    LAST-UPDATED "200210160000Z"
    ORGANIZATION "IETF SNMPv3 Working Group"
    DESCRIPTION
        "The MIB module for SNMP transport mappings.

        Copyright (C) The Internet Society (2002). This
        version of this MIB module is part of RFC 3417;
        see the RFC itself for full legal notices.
        "
    REVISION      "200210160000Z"
    DESCRIPTION   "Clarifications, published as RFC 3417."
    REVISION      "199601010000Z"
    DESCRIPTION   "Clarifications, published as RFC 1906."
    REVISION      "199304010000Z"
    DESCRIPTION   "The initial version, published as RFC 1449."
    DESCRIPTION   "The initial version, published as RFC 1449."
    ::= { snmpModules 19 }
```



SNMPv2 over UDP

```
-- SNMP over UDP over IPv4

snmpUDPDomain OBJECT-IDENTITY
    STATUS      current
    DESCRIPTION
        "The SNMP over UDP over IPv4 transport domain.
         The corresponding transport address is of type
         SnmpUDPAddress."
    ::= { snmpDomains 1 }

SnmpUDPAddress ::= TEXTUAL-CONVENTION
    DISPLAY-HINT "1d.1d.1d.1d/2d"
    STATUS      current
    DESCRIPTION
        "Represents a UDP over IPv4 address:

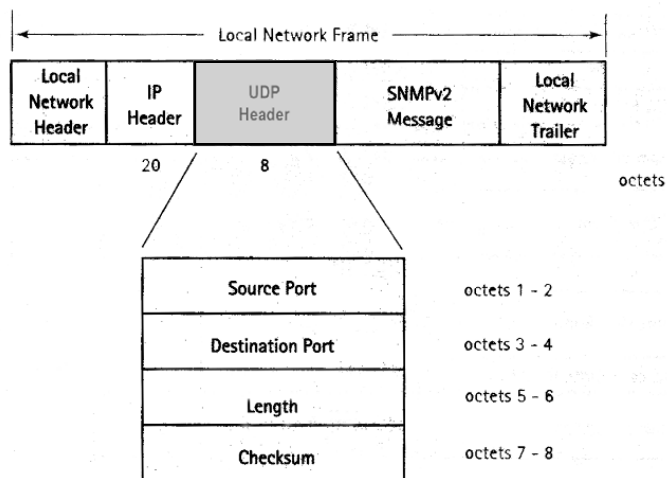
        octets  contents      encoding
        1-4     IP-address    network-byte order
        5-6     UDP-port      network-byte order
        "
    SYNTAX      OCTET STRING (SIZE (6))
```

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SNMPv2 over UDP



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SNMPv2 over OSI

```
-- SNMP over OSI

snmpCLNSDomain OBJECT-IDENTITY
    STATUS      current
    DESCRIPTION
        "The SNMP over CLNS transport domain.
        The corresponding transport address is of type
        SnmpOSIAddress."
    ::= { snmpDomains 2 }

snmpCONSDomain OBJECT-IDENTITY
    STATUS      current
    DESCRIPTION
        "The SNMP over CONS transport domain.
        The corresponding transport address is of type
        SnmpOSIAddress."
    ::= { snmpDomains 3 }

SnmpOSIAddress ::= TEXTUAL-CONVENTION
    DISPLAY-HINT  "*lx:/lx:"
    STATUS      current
    DESCRIPTION
        "Represents an OSI transport-address:

        octets      contents      encoding
         1          length of NSAP  'n' as an unsigned-integer
                                   (either 0 or from 3 to 20)
        2..(n+1)    NSAP          concrete binary representation
        (n+2)..m    TSEL          string of (up to 64) octets
        "

    SYNTAX      OCTET STRING (SIZE (1 | 4..85))
```

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SNMPv2 over AppleTalk

```
-- SNMP over DDP

snmpDDPDomain OBJECT-IDENTITY
    STATUS      current
    DESCRIPTION
        "The SNMP over DDP transport domain. The corresponding
        transport address is of type SnmpNBPAAddress."
    ::= { snmpDomains 4 }

SnmpNBPAAddress ::= TEXTUAL-CONVENTION
    STATUS      current
    DESCRIPTION
        "Represents an NBP name:

        octets      contents      encoding
         1          length of object 'n' as an unsigned integer
        2..(n+1)    object          string of (up to 32) octets
        n+2         length of type  'p' as an unsigned integer
        (n+3)..(n+2+p) type         string of (up to 32) octets
        n+3+p       length of zone  'q' as an unsigned integer
        (n+4+p)..(n+3+p+q) zone     string of (up to 32) octets

        For comparison purposes, strings are
        case-insensitive. All strings may contain any octet
        other than 255 (hex ff)."
```

SYNTAX OCTET STRING (SIZE (3..99))

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SNMPv2 over IPX

```
-- SNMP over IPX

snmpIPXDomain OBJECT-IDENTITY
  STATUS      current
  DESCRIPTION
    "The SNMP over IPX transport domain. The corresponding
    transport address is of type SnmpIPXAddress."
  ::= { snmpDomains 5 }

SnmpIPXAddress ::= TEXTUAL-CONVENTION
  DISPLAY-HINT "4x.1x:1x:1x:1x:1x:1x.2d"
  STATUS      current
  DESCRIPTION
    "Represents an IPX address:

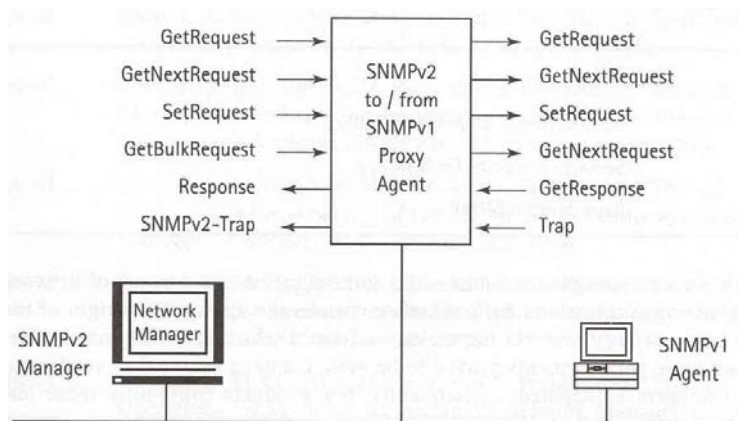
        octets  contents          encoding
        1-4     network-number    network-byte order
        5-10    physical-address  network-byte order
        11-12   socket-number     network-byte order
    "
  SYNTAX      OCTET STRING (SIZE (12))
```

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SNMPv1/SNMPv2 Proxy



RFC2576 – Coexistence between Version 1 and Version 2
The Manager is bilingual or a proxy is used

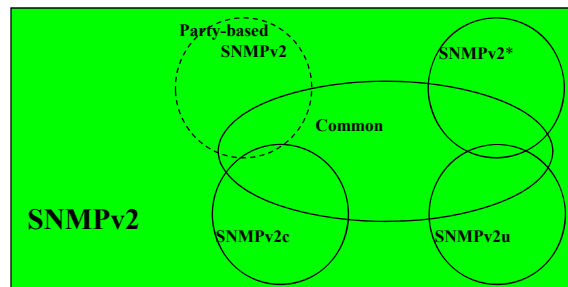
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Security

- There have been several attempts to solve the problem of security of the *community strings*, hence the various versions...



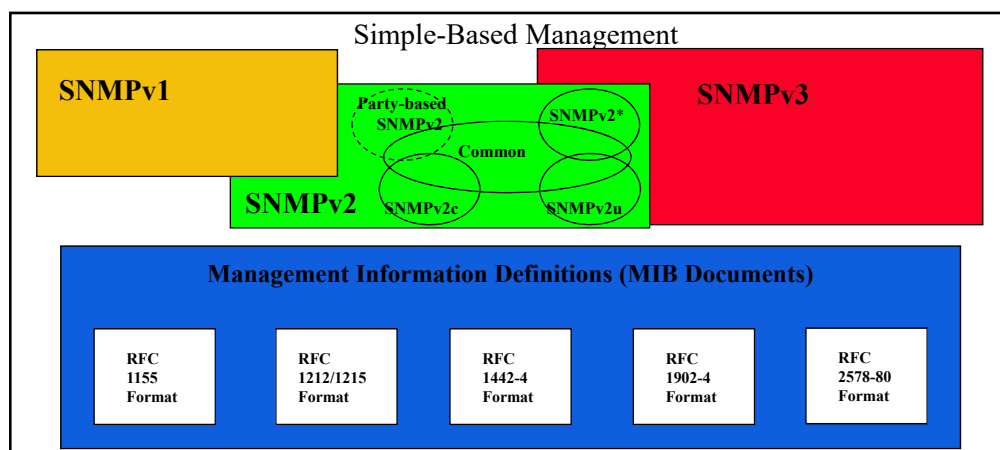
... without consensus! Only a new version of SNMP can solve the problem!

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Protocol Versions



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Evolution of the Protocol

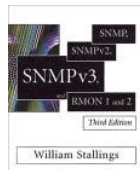
Generation	Protocol Operations	Transport Mappings	Security & Administration
1 st	RFC 1157 (1988-1993)		Community-based
2 nd	RFC 1905 (1993-)	RFC 1906 (1993-)	Party-based RFC 1445-47 (1993-1995)
3 rd	SNMP EOS (new work)		User-based RFC 2570-76 (1998-)

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Bibliography



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Addison-Wesley Publishing Company, 3rd Ed.
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