Generic vs. Specific Simple Network Management Tools

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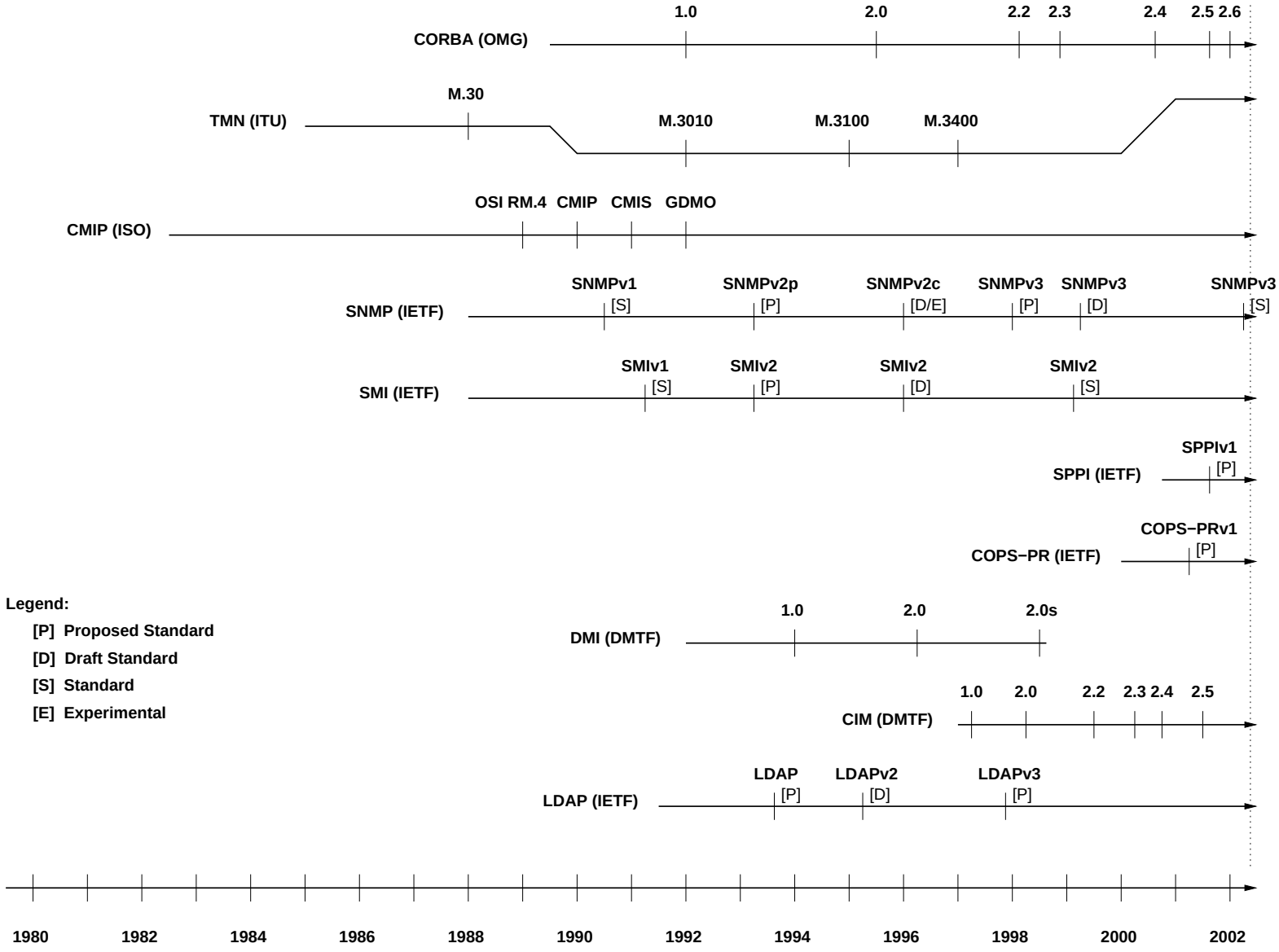
Network Management Standards



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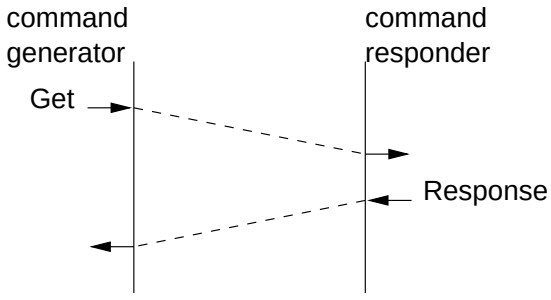
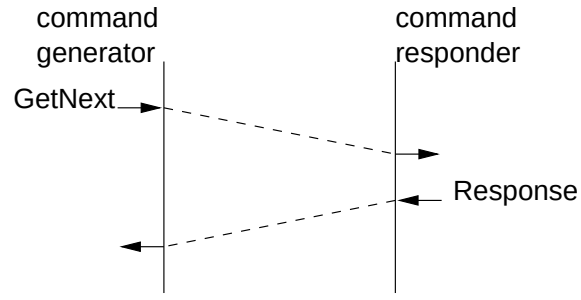
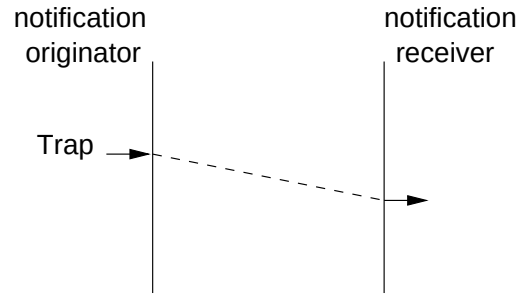
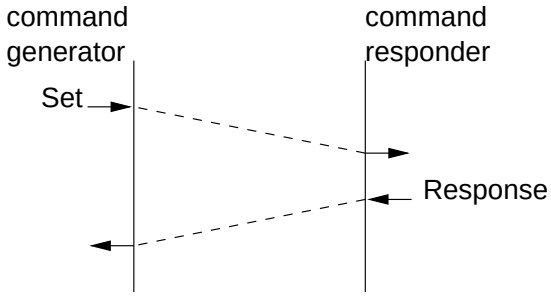
- Each variable is uniquely named by an OID value (a sequence of numbers defining a path in a global registration tree).
- SNMP operates on a (lexicographically) ordered list of variables (varbind list). Each element consists of an OID identifying a variable and its value.

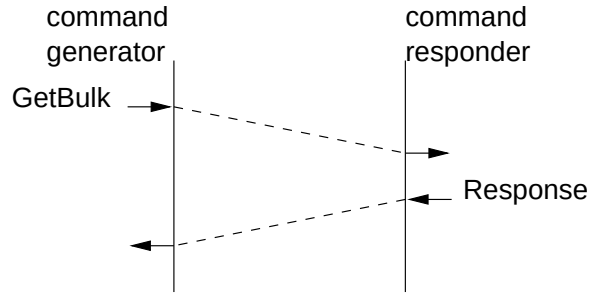
SNMP v2c/v3 Protocol Operations

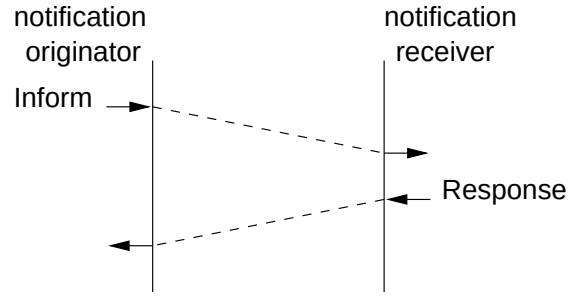












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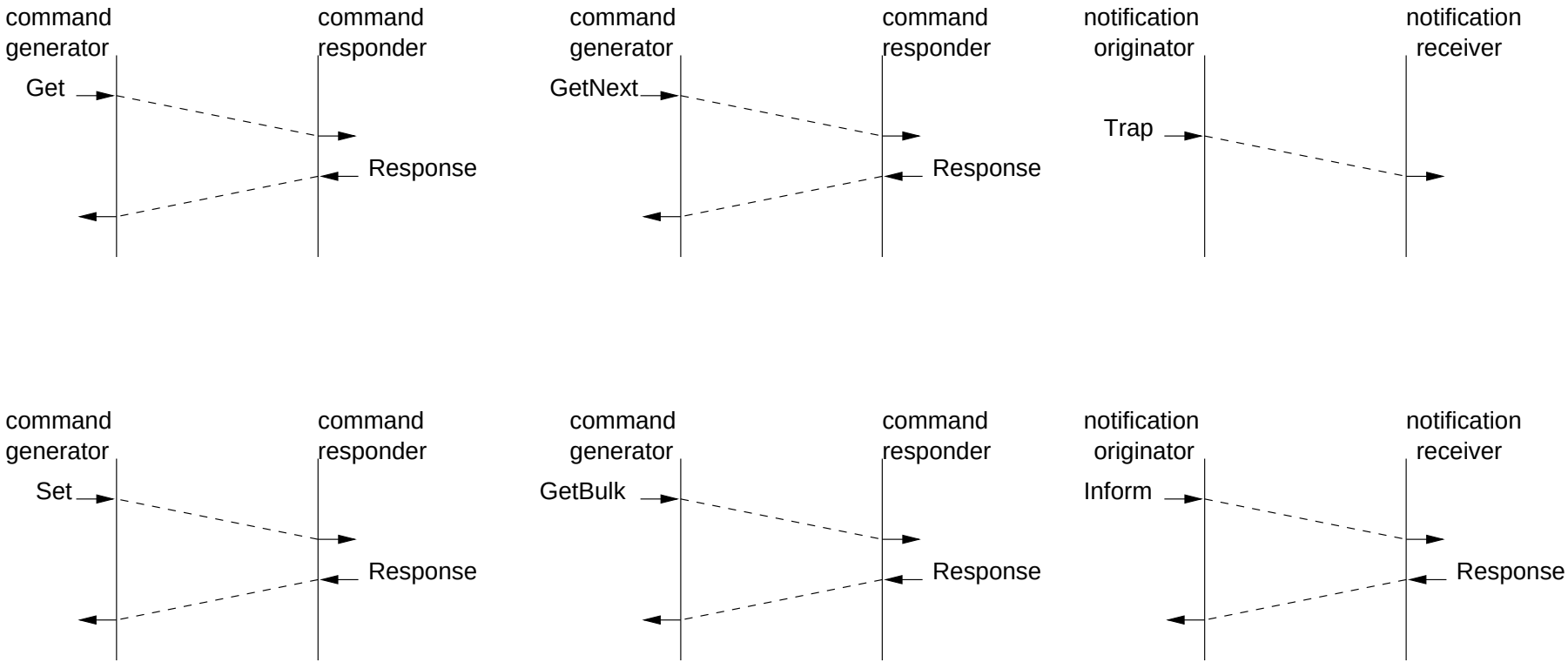
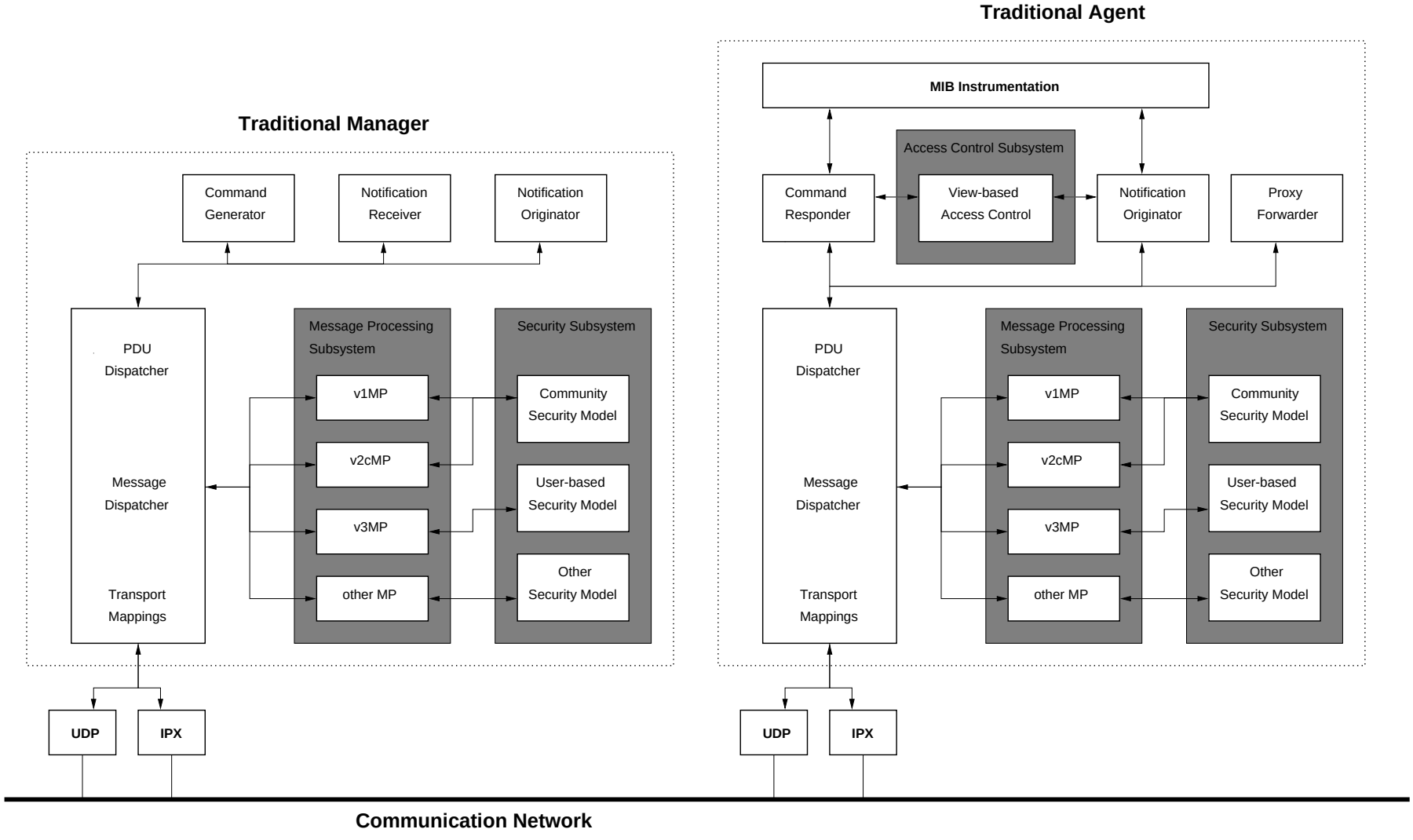


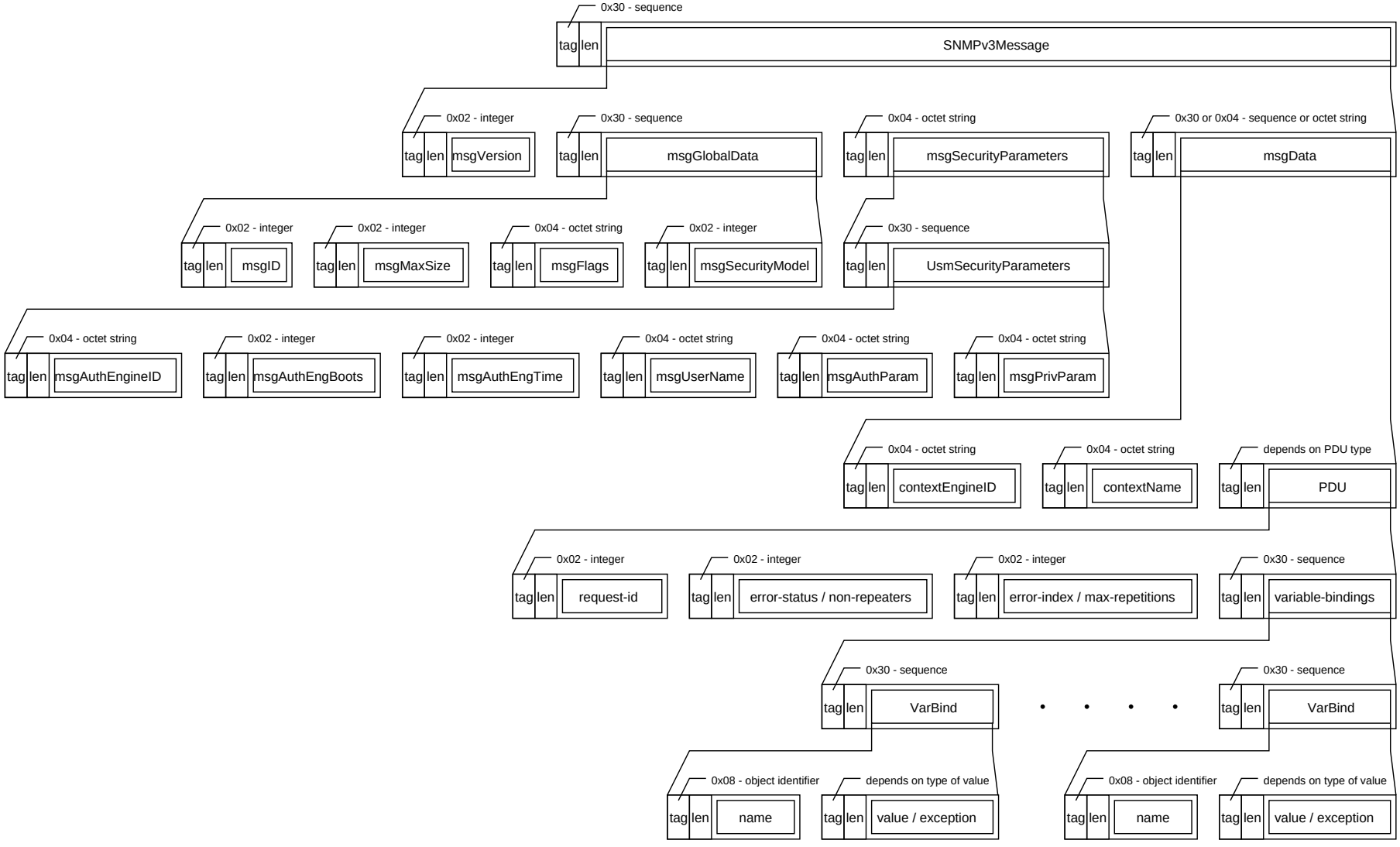
Due to the simplicity of the operations, people call SNMP

- *the peek/poke/trap protocol of the Internet* or
- *the turing machine for network management*.

SNMP Architecture



SNMPv3 Message Encoding



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- You need good tools/libraries to invoke the rather simplistic SNMP operations.
- Once you can invoke SNMP operations, you need to write meaningful management procedures to overcome the peek/poke/trap abstraction level.
- Since humans can’t remember OIDs, you need tools/libraries which help to avoid dealing with OIDs.

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- Tcl extensions (`Tnm`)
- ...

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- SNMP Command Line Interface (`scli`)

Tnm extension for Tcl

- Tnm provides a generic SNMP API for Tcl
- Written entirely in C for good performance
- Tightly integrated into the Tcl event mechanism
- Scripts can talk to many devices simultaneously
- Traffic shaping for smoothing bulky message streams
- Several (generic) applications exist on top of Tnm (`tkined`, `sgmospy`, `sbrowser`, ...)
- Used by several companies to drive test suites
- Available since 1994, relative few changes since 1999

Retrieving Interface Status with Tnm

```
package require Tnm 3.0

proc walkproc {s stat vbl} {
    if {$stat == "noError"} {
        set i [Tnm::mib unpack [Tnm::snmp oid $vbl 0]]
        set o [Tnm::snmp value $vbl 0]
        set a [Tnm::snmp value $vbl 1]
        puts "[$s cget -address]\t$i\t$o\t$a"
    }
}

puts "ADDRESS\t\tIFACE\tOPER\tADMIN"
foreach host $argv {
    set s [Tnm::snmp generator -address $host]
    $s walk {ifOperStatus ifAdminStatus} { walkproc %S %E "%V" }
}
Tnm::snmp wait
exit
```

Cracking SNMP Community Strings

```
package require Tnm 3.0

proc checkproc {s stat vbl} {
    if {$stat == "noError"} {
        puts "[$s cget -address]\t[$s cget -community]\t$vbl"
    }
}

proc check {hosts community} {
    foreach h $hosts {
        set s [Tnm::snmp generator -address $h -community $community \
                    -version SNMPv2c -window 100 -delay 5 -timeout 2]
        $s get sysDescr.0 { checkproc %S %E "%V"; %S destroy }
    }
}

while {! [eof stdin]} { check $argv [gets stdin] }
Tnm::snmp wait
exit
```

Limitations of the Tnm Approach

- Not everyone is interested in writing Tnm scripts
- Not everyone is interested to understand the sometimes subtle semantics of MIB variables
- Administrators/operators prefer specific tools rather than generic tools
- Low-level APIs cause scripts to be fragile
- Scripts tend to be site specific and not portable
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$\Rightarrow$ Create specific rather than generic tools

$\Rightarrow$ Build infrastructure to do this efficiently

SNMP Command Line Interface

- Command line interface with runs locally
- Uses standard SNMP interactions and MIBs
- Interworks with devices produced by different vendors
- Commands are structured in a hierarchy
- Related commands are logically grouped into modes
- Select objects using names and regular expressions
- Support simple short-term monitoring activities
- Command editing/history and command aliases
- Default output format is optimized for human readability
- XML output format optimized for machine readability

show entity containment

local

```
Agent Boot Time:  2001-09-24 17:21:51 +02:00
Interfaces:       12
Bridge Type:      source route transparent (SRT)
(ciscobs.rz) scli > show entity containment
ENTITY CLASS     CONTAINMENT
     1 chassis     7206VXR chassis, Hw Serial#: 21275454, Hw Revision: D
     2 module      |- NPE 300 Card, Hw Serial#: 21275454, Hw Revision: D
     3 container   |- Chassis Slot
     4 module      |  `- I/O FastEthernet (TX-ISL)
     5 port        |     `- DEC21140A
     6 container   |- Chassis Slot
     7 module      |  `- 2 Port Fast Ethernet/ISL 100BaseTX Port Adapter
     8 port        |     |- AmdFE
     9 port        |     `- AmdFE
    10 container   |- Chassis Slot
    11 module      |  `- POS Port Adapter (SM)
    12 port        |     `- Packet over Sonet
    13 container   |- Chassis Slot
    14 container   |- Chassis Slot
    15 module      |  `- ATM Lite Port Adaptor (SM)
    16 port        |     `- TI1570 ATM
    17 container   |- Chassis Slot
    18 container   `- Chassis Slot
(ciscobs.rz) scli >
```

monitor interface stats

local

```
Agent:    ciscobs.rz:161 up 9 days 23:34:35                              15:56:26
Descr:    Cisco Internetwork Operating System Software   IOS (tm) 7200 Software
IPv4:     6435 pps in 6408 pps out 6399 pps fwd    0 pps rasm    0 pps frag
UDP:         8 pps in    6 pps out
TCP:         0 sps in    0 sps out    0 con est    0 con aopn    0 con popn
Command:  monitor interface stats
```

INTERFACE	STATUS	I-BPS	O-BPS	I-PPS	O-PPS	I-ERR	O-ERR	DESCRIPTION
1	UUCN	1m	2m	3270	3152	0	0	FastEthernet0/0
2	UUCN	0	23	0	0	0	0	FastEthernet1/0
3	UUCN	10k	10k	50	50	0	0	FastEthernet1/1
4	UUCN	2m	1m	3197	3254	0	0	POS2/0
5	UDCN	0	0	0	0	0	0	ATM4/0
6	UD--	----	----	----	----	----	----	ATM4/0-atm layer
7	UD--	----	----	----	----	----	----	ATM4/0.0-atm subif
8	UDNN	0	----	0	----	----	----	ATM4/0-aal5 layer
9	UDNN	0	----	0	----	----	----	ATM4/0.0-aal5 layer
10	UUNN	0	2105	0	18	0	0	Null0
11	UUNN	0	0	0	0	0	0	Loopback0
12	UUNN	0	0	0	0	0	0	Tunnel34

scli interface mode

```
set interface status <regexp> <status>
set interface alias <regexp> <string>
set interface notifications <regexp> <value>
set interface promiscuous <regexp> <bool>

show interface info [<regexp>]
show interface details [<regexp>]
show interface stack [<regexp>]
show interface stats [<regexp>]

monitor interface stats [<regexp>]

dump interface
```

scli nortel mode

```
create nortel bridge vlan <vlanid> <name>
delete nortel bridge vlan <regexp>

set nortel bridge vlan ports <regexp> <ports>
set nortel bridge vlan default <string> <ports>

show nortel bridge vlan info [<regexp>]
show nortel bridge vlan details [<regexp>]
show nortel bridge vlan ports

dump nortel bridge vlan
```

Configuring VLANs using `scli` and `m4`

```
delete nortel bridge vlan "^(134|ibr-)"     # regexps are cool :-)

create nortel bridge vlan 544 ibr-core
create nortel bridge vlan 545 ibr-cip
create nortel bridge vlan 546 ibr-test
create nortel bridge vlan 547 ibr-wlan
```

```
define(UP,‘25,185’)                 # uplink ports
define(WLAN,‘2,56’)                 # wireless vlan
define(CORE,‘1,3-24,33-55,65-88’) # core vlan

include(vlan-all.scli)              # create the vlans

set nortel bridge vlan ports ibr-core UP,CORE
set nortel bridge vlan default ibr-core CORE
set nortel bridge vlan ports ibr-wlan UP,WLAN
set nortel bridge vlan default ibr-wlan UP,WLAN
```

Software Design Goals

Extensibility:

- Make it easy for programmers to add new features

Robustness:

- Ensure that errors are detected and handled gracefully

Efficiency:

- Short startup times for efficient usage in shell scripts

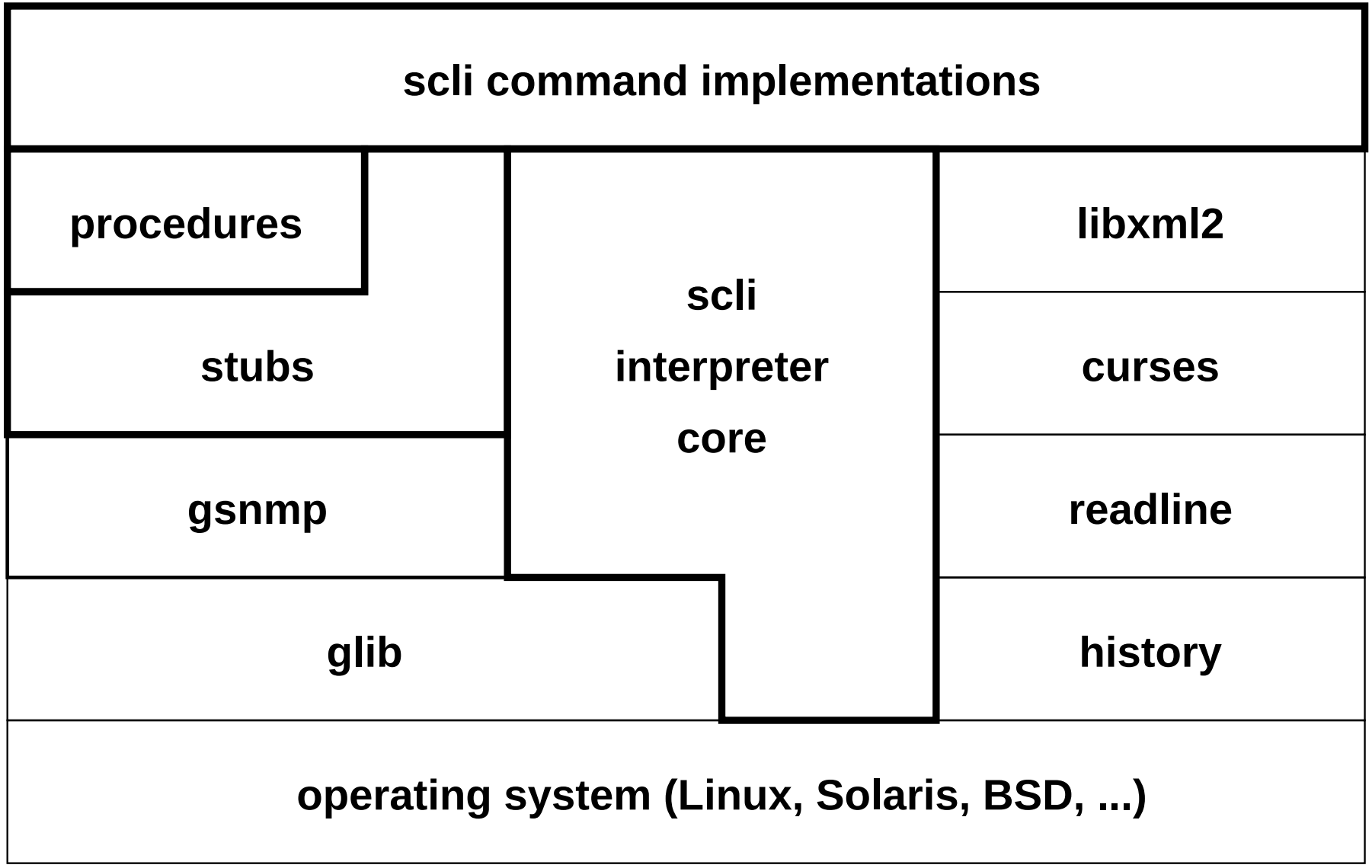
Portability:

- Tools should run on all major Unix platforms

Maintainability:

- Manual must be consistent with the implementation

Software Architecture



Stub Code Generator

- Stub functions for retrieving and/or modifying
  - complete conceptual tables
  - rows of conceptual tables
  - groups of scalars
- Stubs hide all low-level SNMP details such as
  - OID naming / (un-)packing of instance identifiers
  - automatic type and range checking
- Generated data structures force programmers to validate data members (pointers) before using them
- Implemented as part of the `libsmi` package

Printer-MIB::prtConsoleLightEntry

```
typedef struct {
    gint32   hrDeviceIndex;
    gint32   prtConsoleLightIndex;
    gint32   *prtConsoleOnTime;
    gint32   *prtConsoleOffTime;
    gint32   *prtConsoleColor;
    guchar   *prtConsoleDescription;
    gsize    _prtConsoleDescriptionLength;
} printer_mib_prtConsoleLightEntry_t;

extern void
printer_mib_get_prtConsoleLightTable(GSnmpSession *s,
    printer_mib_prtConsoleLightEntry_t ***prtConsoleLightEntry,
    gint mask);

extern void
printer_mib_free_prtConsoleLightTable(
    printer_mib_prtConsoleLightEntry_t **prtConsoleLightEntry);

/* ... more stub prototypes deleted ... */
```

Command Implementation

```
static int
show_printer_console_lights(scli_interp_t *interp, int argc, char **argv)
{
    printer_mib_prtConsoleLightEntry_t **lightTable;
    int i, width = 12;

    if (argc > 1) return SCLI_SYNTAX;

    printer_mib_get_prtConsoleLightTable(interp->peer, &lightTable, 0);
    if (interp->peer->error_status) return SCLI_SNMP;

    if (lightTable) {
        for (i = 0; lightTable[i]; i++) {
            if (lightTable[i]->_prtConsoleDescriptionLength > width)
                width = lightTable[i]->_prtConsoleDescriptionLength;
        }
        g_string_sprintfa(interp->header, "PRINTER LIGHT %-*s STATUS COLOR",
                                          width, "DESCRIPTION");
        for (i = 0; lightTable[i]; i++) {
            fmt_printer_console_light(interp->result, lightTable[i], width);
        }
    }

    if (lightTable) printer_mib_free_prtConsoleLightTable(lightTable);
    return SCLI_OK;
}
```

Formatting Function

```
static void
fmt_printer_console_light(GString *s, printer_mib_prtConsoleLightEntry_t *lightEntry, int width)
{
    const char *state = "off", *e;

    g_string_sprintfa(s, "%6d  ", lightEntry->hrDeviceIndex);
    g_string_sprintfa(s, "%4d  ", lightEntry->prtConsoleLightIndex);

    if (lightEntry->prtConsoleDescription) {
        g_string_sprintfa(s, "%-*.*s ", width,
                    (int) lightEntry->_prtConsoleDescriptionLength,
                          lightEntry->prtConsoleDescription);
    } else {
        g_string_sprintfa(s, "%*s", width, "");
    }

    if (*lightEntry->prtConsoleOnTime && !*lightEntry->prtConsoleOffTime) {
        state = "on";
    } else if (!*lightEntry->prtConsoleOnTime && *lightEntry->prtConsoleOffTime) {
        state = "off";
    } else if (*lightEntry->prtConsoleOnTime && *lightEntry->prtConsoleOffTime) {
        state = "blink";
    }
    g_string_sprintfa(s, " %-*s ", 5, state);

    e = fmt_enum(printer_mib_enums_prtConsoleColor, lightEntry->prtConsoleColor);
    g_string_sprintfa(s, "%s\n", e ? e : "");
}
```

Command Registration

```
void scli_init_printer_mode(scli_interp_t * interp)
{
    static scli_cmd_t cmds[] = {
        { "show printer console lights", NULL,
          "The ‘show printer console lights’ command shows the current\n"
          "status of the lights attached to the printer. The command\n"
          "generates a table with the following columns:\n"
          "\n"
          "  PRINTER     logical printer number\n"
          "  LIGHT       number identifying the light/led\n"
          "  DESCRIPTION description of the light/led\n"
          "  STATUS      current status (on, off, blink)\n"
          "  COLOR       current color of the light",
          SCLI_CMD_FLAG_NEED_PEER,
          NULL, NULL, show_printer_console_lights },

        { NULL, NULL, NULL, 0, NULL, NULL, NULL }
    };

    static scli_mode_t printer_mode = {
        "printer",
        "The scli printer mode is based on the Printer-MIB as\n"
        "published in RFC 1759.",
        cmds
    };

    scli_register_mode(interp, &printer_mode);
}
```

Try it yourself!

Software:

- http://wwwsnmp.cs.utwente.nl/≈schoenw/scotty/
- http://www.ibr.cs.tu-bs.de/projects/scli/
- http://www.ibr.cs.tu-bs.de/projects/libsmi/

Papers:

- Tcl Extensions for Network Management Applications, 3rd Usenix Tcl/Tk Workshop, Toronto, 1995
- Specific Simple Network Management Tools, LISA 2001, San Diego, 2001
- Married with Tcl, 1st European Tcl/Tk User Meeting, June 2000