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Towards XML-oriented Internet Management

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IBR

Overview

- current situation in internet management
- XML technologies in internet management
- mapping MIB definitions to XML Schema definitions
- SNMP/XML gateway
- conclusion / outlook

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Current Situation in Internet Management

Status

- based on SNMP and MIB modules
- based on 10,000+ object definitions in 160+ standard MIBs,
- constitutes a formal and de-facto standard

Problems

- a "low-level" technology
- a complicated technology
- no standardized storage representation of management data

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XML — The Way Out?

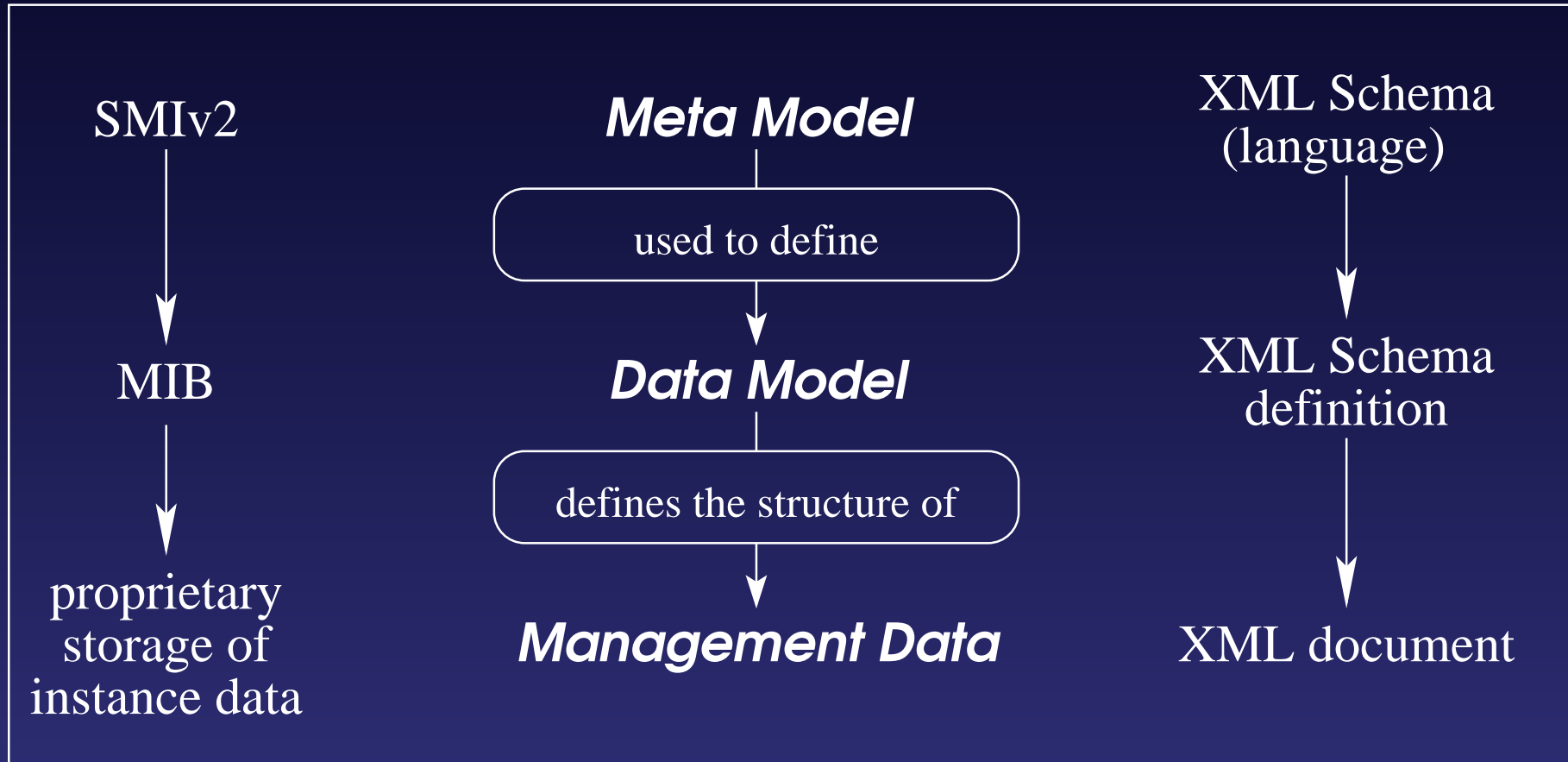| Technologies	General Use Cases	Network Management Use Cases
XML	encoding for storage and transmission of structured data	representation of management data
HTTP, HTTP/SSL, SSH	push and pull (potentially large) data chunks; addressed by URLs	transfer of management data
DOM, SAX	APIs to parse and access XML documents	applicable by management applications
XPath	addressing portions of XML documents	applicable by management applications
XSLT	programmable transformation of XML documents to various formats	generate web pages, statistics, correlated logs, etc.
XML Schema	ensuring integrity of XML documents through formal grammars	ensuring integrity of mgmt data, defining mgmt interfaces
WSDL, SOAP	definition and protocol for high-level remote operations based on XML document exchange	applicable by management applications

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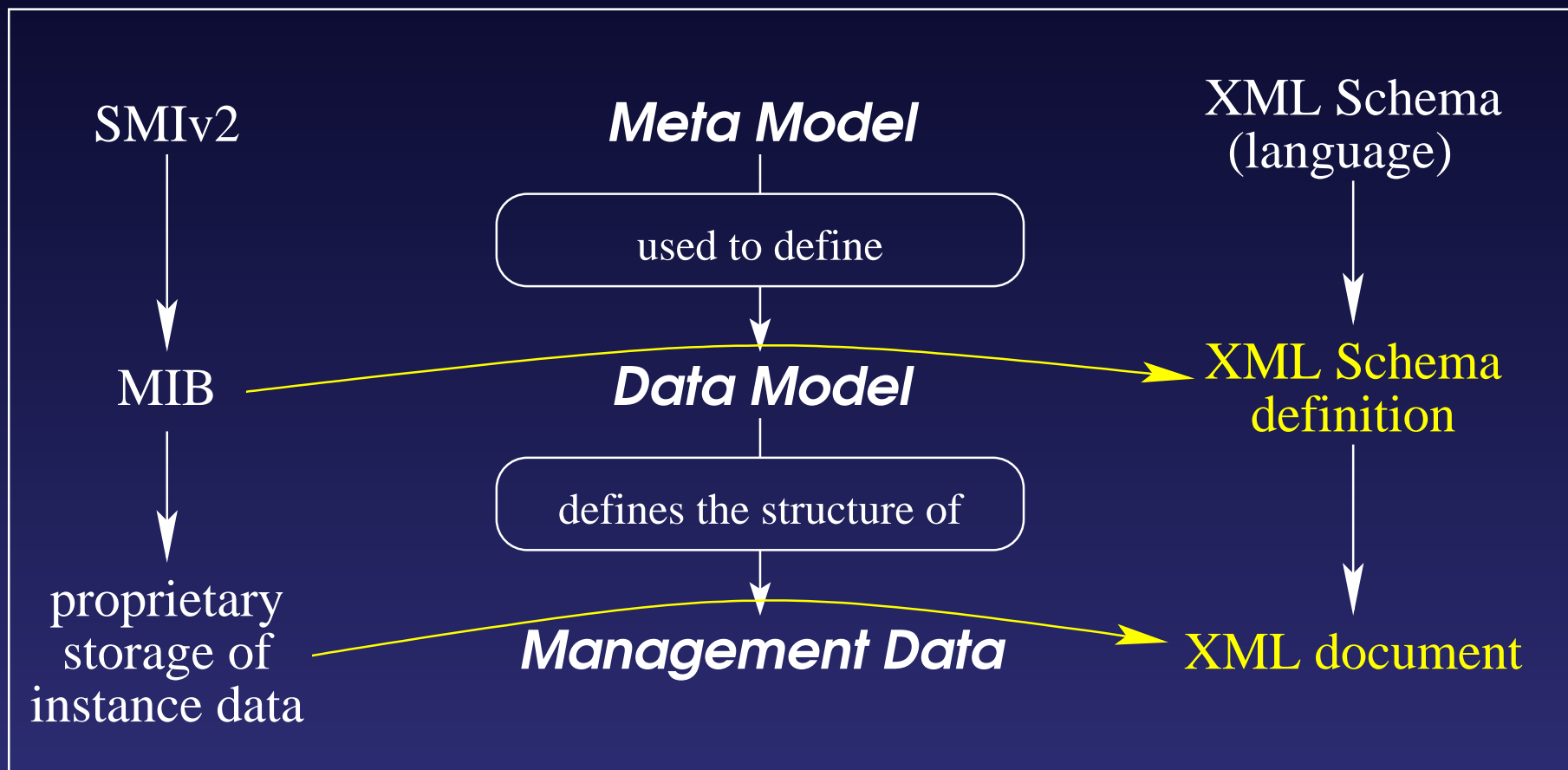| Technologies	General Use Cases	Network Management Use Cases
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Mapping MIB Definitions to XML Schema Definitions

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SMIv2

↓

MIB

↓

proprietary
storage of
instance data

Meta Model

used to define

↓

Data Model

defines the structure of

↓

Management Data

XML Schema
(language)

↓

XML Schema
definition

↓

XML document

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Mapping MIB Definitions to XML Schema Definitions

SMIv2   *Meta Model*   XML Schema
                                                         (language)

                    used to define

MIB   *Data Model*   XML Schema
                                                         definition

                    defines the structure of

proprietary
storage of   *Management Data*   XML document
instance data

General Goals of the XML Schema Mapping

- follow the "XML style" as close as possible

- make XML instance documents as convenient for reading and processing as possible

- use the power of XML Schema where possible

- saving investments on MIB definitions and implementations

- supporting automatic translations

Multiple "Contexts" per XML Document

A single document may contain data

- of multiple agents
  - @ipaddr
  - @hostname
  - @port
- of multiple per-agent communities
  - @community
- of multiple points in time
  - @time

```
<?xml version="1.0"?>
<snmp-data [...]>
  <context
      ipaddr="134.169.246.1"
      hostname="ciscobs.rz.tu-bs.de"
      port="161"
      community="public"
      time="2003-03-10T10:31:16Z">
    [...context data...]
  </context>

  <context [...]>
    [...context data...]
  </context>

  [...]
</snmp-data>
```

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No "deep" Element Nestings

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- 1st level element   `<snmp-data>`
  independent root element
  (not bound to a specific MIB, agent, or point in time)

- 2nd level elements   `<context>`

- 3rd level elements   e.g. `<system>`,`<ifEntry ifIndex="1">`

  - groups of scalar elements

  - table rows, identified through index attributes

- 4th level elements   e.g. `<sysContact>`,`<ifInOctets>`

  - scalar elements

  - columnar elements (also of table augmentations)

- deeper level elements
  only for "table-in-table" relationships

Note: The element nesting is **not** based on the OID tree.

Using XML Namespaces to Identify Modules

- Each MIB will be compiled to a separate XML Schema that defines an according namespace:

```
<xsd:schema
    targetNamespace="http://example.com/IF-MIB" [...]>
  [...]
```

- Imports from MIB modules are translated to imports of namespaces:

```
<xsd:schema [...]
    xmlns:SNMPv2-MIB="http://example.com/SNMPv2-MIB" [...]>
  [...]
  <xsd:import
    namespace="http://example.com/SNMPv2-MIB" [...]/>
  [...]
```

- Elements can be named uniquely with namespace prefixes:

```
<SNMPv2-MIB:system>
    <SNMPv2-MIB:sysContact>root@foo.com</SNMPv2-MIB:sysContact>
</SNMPv2-MIB:system>
```

Value Representations and Schema Definitions

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- numeric values

  XML: display hints applied, represented in decimal digits
  Schema: range restrictions (`<minInclusive>`, `<maxInclusive>`)
             display hints (`<fractionDigits>`)

- octet strings with display hints

  XML: represented as strings conforming to display hints,
  Schema: DISPLAY-HINTs converted to `<pattern>` reg-exp's

- octet strings without display hints

  XML: represented as sequences of hex values
  Schema: based on the `hexBinary` type

- enumeration values

  XML: represented as labels
  Schema: `<enumeration>` values

- bit set values

  XML: represented as sequences of labels
  Schema: `<list>`s of `<enumeration>` values

MIB Information in `<annotation>` Clauses

MIB information that is not primarily relevant for XML processing is stored in XML Schema `<annotation>` sub-elements:

- `<appinfo>` for potential automatic processing
  - `<maxAccess>`
  - `<oid>`
  - `<status>`
  - `<flags>` (create, implied)
  - `<displayHint>`
  - `<defaultValue>` (to be done)
- `<documentation>`
  - DESCRIPTIONs
  - REFERENCEs (to be done)

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Example — XML Document

```
<snmp-data>
  <context ipaddr="134.169.34.81" hostname="tom.example.com"
           port="161" community="public" time="2003-03-17T11:07:53Z">
    <TCP-MIB:tcp>
      <TCP-MIB:tcpRtoAlgorithm>other</TCP-MIB:tcpRtoAlgorithm>
      <TCP-MIB:tcpRtoMin>0</TCP-MIB:tcpRtoMin>
      [...]
    </TCP-MIB:tcp>
    <TCP-MIB:tcpConnEntry
        tcpConnLocalAddress="0.0.0.0" tcpConnLocalPort="9"
        tcpConnRemAddress="0.0.0.0" tcpConnRemPort="0">
      <TCP-MIB:tcpConnState>listen</TCP-MIB:tcpConnState>
    </TCP-MIB:tcpConnEntry>
    <TCP-MIB:tcpConnEntry
        tcpConnLocalAddress="134.169.34.81" tcpConnLocalPort="42077"
        tcpConnRemAddress="134.169.34.79" tcpConnRemPort="6010">
      <TCP-MIB:tcpConnState>established</TCP-MIB:tcpConnState>
    </TCP-MIB:tcpConnEntry>
  </context>
</snmp-data>
```
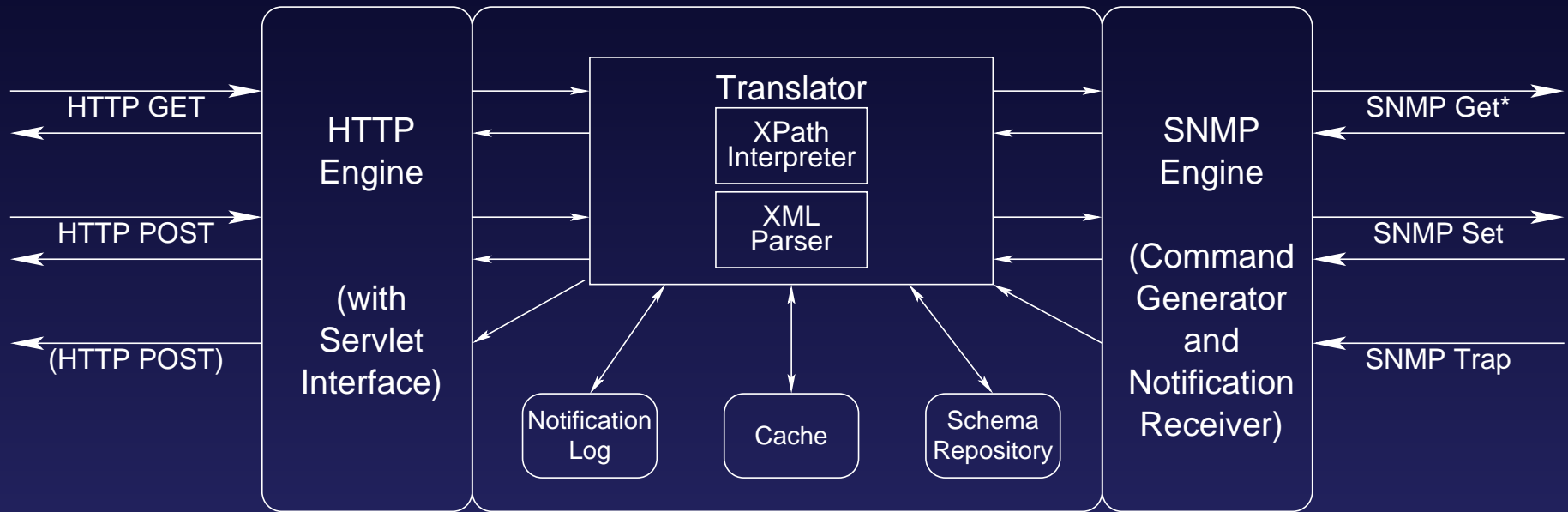
Applications

Possible Scenarios

- notification processing:
  post-processing notifications that are stored as XML documents

- agent validation:
  partly validating agent implementations of MIBs

Implementations

- mibdump:
  first prototype to fetch instance data

- SNMP/XML gateway:
  Java servlet for communicating to SNMP agents via HTTP

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SNMP/XML Gateway

HTTP GET	HTTP Engine	Translator	SNMP Engine	SNMP Get*

HTTP GET

HTTP POST

(HTTP POST)

HTTP Engine

(with Servlet Interface)

Translator

XPath Interpreter

XML Parser

Notification Log

Cache

Schema Repository

SNMP Engine

(Command Generator and Notification Receiver)

SNMP Get*

SNMP Set

SNMP Trap

Example: Retrieve the descriptions of the interfaces at talisker.ibr.cs.tu-bs.de
        that are currently in operation:

```
$ lynx -dump 'http://www.ibr.cs.tu-bs.de/snmp-xml-gw?\
  get=/snmp-data/context[@hostname="talisker.ibr.cs.tu-bs.de"]\
  /ifEntry[ifOperStatus="up"]/ifDescr'
```

Conclusions and Outlook

- SNMP has several problems WRT current management needs

- a smooth bridging from SNMP and MIBs to XML based management is essential

- SNMP MIBs and MIB data can be transformed to XML Schemas and XML in a reasonable way

- future work will have to address
  - trap handling,
  - SNMPv3,
  - instance creation/deletion (gateway)

Links

- libsmi — An open source SMI library and MIB compiler
  `http://www.ibr.cs.tu-bs.de/projects/libsmi/`

- NMRG — IRTF Network Management Research Group
  `http://www.ibr.cs.tu-bs.de/projects/nmrg/`

- SMIXML Mailinglist — Discussion of SMI to XML mappings
  `http://www.ibr.cs.tu-bs.de/mailman/listinfo/smixml`

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Thanks!
Q & A