Internet Management Standards

What is needed in the future?

Presentation at the University of Surrey, Guildford, 31 May 2000

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Outline

1. $\boxed{\text{Todays Network Management Technology Fragmentation}}$

2. Future of Internet Management Standards:
   - Scenario 1: Forget About Network Management Technologies (in the IETF)
   - Scenario 2: Established Focussed Technologies for Specific Problem Domains
   - Scenario 3: Select and Evolve a Technology to Avoid Competing Technologies
   - Scenario 4: Create a Framework which Integrates at the Conceptual Model Layer

3. Research Projects:
   - Efficient Bulk Transfer of MIB Data
   - Secure Management by Delegation
   - SMIng – Next Generation SMI Data Definition Language
   - Reverse Engineering SMI MIBs
   - Towards Command-Oriented Management

4. Summary and Discussion

Network Management Technology Fragmentation

CIM / WBEM

GDMO / CMIP

XML / HTTP

DEN / LDAP

Active Networks ?

SMI / SNMP

IDL / IIOP

SPPI / COPS

Mobile Agents ?

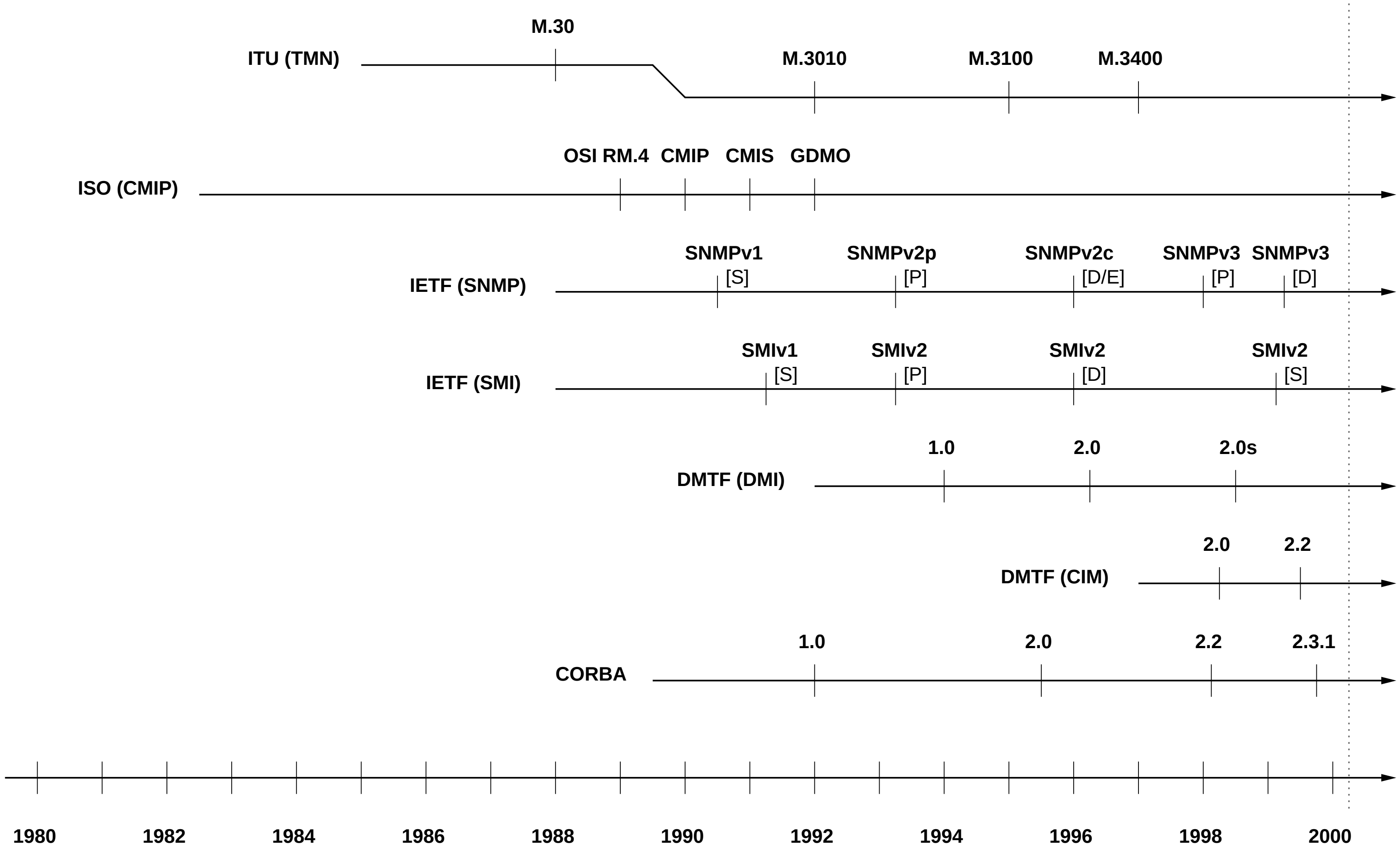
TL1

CLI / TELNET

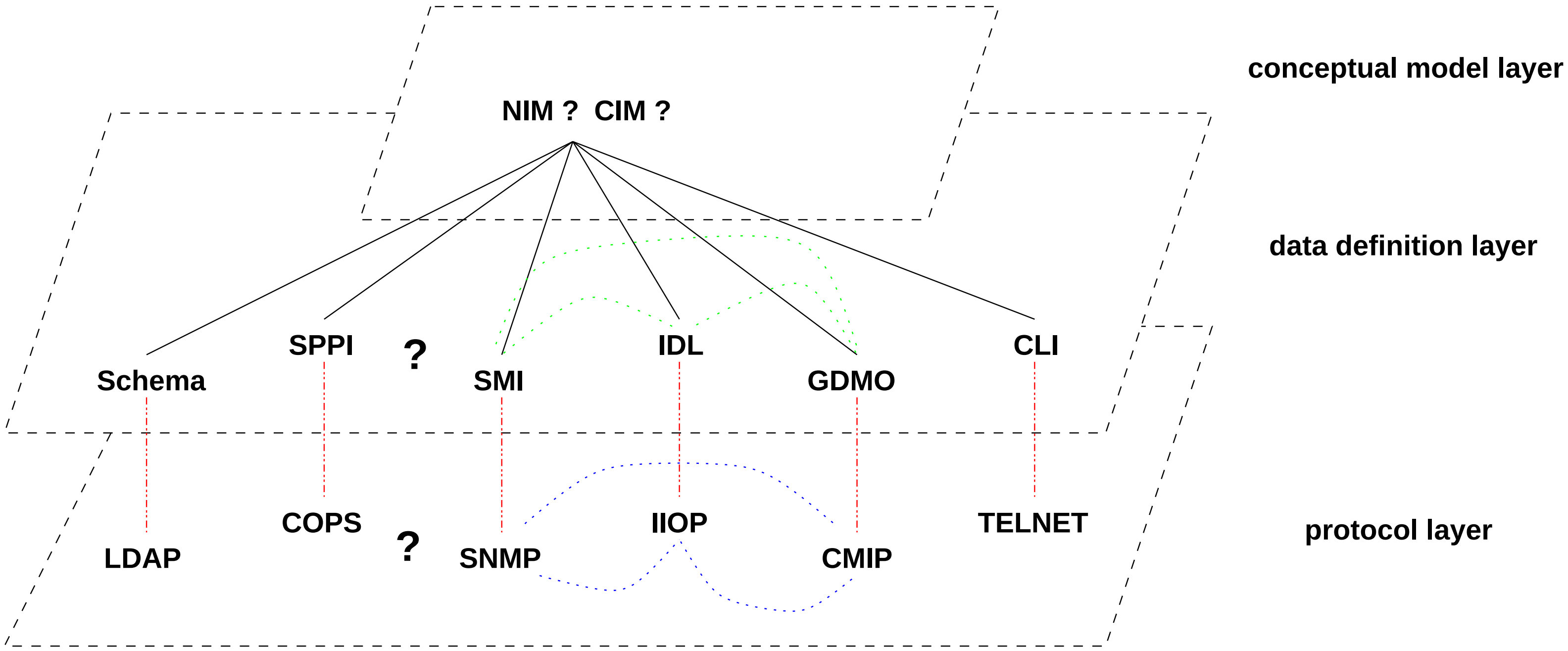
- High costs for network device and management software vendors since they must support multiple technologies.

- Network operators have serious problems to deliver flexible and reliable services in such a fragmented management environment efficiently.

Historic Perspective



The Three-Layer Model



- Translations within an abstraction layer:
  - JIDM Specification and Interaction Translations (Open Group C802)
- Mappings between abstraction layers:
  - CIM Policy Model to LDAP Schema Mapping (IETF Policy WG)

⇒ Experience says that algorithmic mappings and translations are non-trivial problems.

Some Thoughts on IETF Standardization

- The success of a standard must be measured in terms of wide-spread deployment.

- Standardizing MIBs in order to establish an open market between device vendors and management software vendors does not work very well in many cases:
  1. Standardization takes too long.
  2. Consensus often on the lowest common denominator.
  3. Operationally important information often contained in proprietary MIB definitions.
  4. Implementation and resource costs hinder fast and wide-spread deployment.

- Things to keep in mind while developing standards:
  1. KISS: Complex standards which require people with special skills will not survive.
  2. Timeliness: Standards need to address real problems in a timely manner.
  3. Concentration processes have given a few “big players” strong influence on the success of standards.

⇒ The sheer number of standardization efforts and proposals distract those who do the actual work from doing the actual work.

Driving Forces

- Internet QoS/CoS leads to much more complex and dynamic device configurations.
- There is no widely deployed vendor neutral configuration management solution.
- There is a need for much more rapid service creation and deployment.
- Overall Internet availability and robustness becomes a key factor for network operators.
- Network complexity requires to move from a device-oriented viewpoint to a network-oriented viewpoint.
- Network-wide policies with automatic translations into device configurations are proposed as a way to move from a device "assembler" programming model to "higher-level" network programming model.
- The IETF WGs have the protocol expertise and hence the IETF WGs are a natural home for the definition of management interfaces.

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Scenario 1: Forget About Network Management Technologies

The IETF does not have the middleware technology which is needed to build scalable, distributed management systems and it should therefore cooperate with other standards bodies that have appropriate technologies and focus on data definitions for those technologies.

+ Concentrate resources and expertise on the definition of management interfaces for IETF protocols rather then the development of management technologies.

- There are big investments in IETF management technologies and associated specifications which make it very unlikely that a volunteer driven organization like the IETF throws them away.

- Dependencies between standardization bodies are likely to become problematic when the goals shift into different directions.

Scenario 2: Standards for Specific Problem Domains

Instead of trying to define generic management standards, the IETF should stimulate focused work on specific problem domains and encourage the development of solutions that are optimized for these problem domains.

+ This approach helps to achieve timely results that are not overloaded with complexity.

+ Necessary protocol updates or replacements are localized to problem domains.

+ Successful examples are routing protocols that automate routing table updates or dynamic host configuration protocols.

- High risks to reinvent the wheel (e.g. security solutions) several times slightly different.

- Difficulties to separate the problem domains cleanly – there will always be cases of overlap.

Scenario 3: Evolve a Technology to Overcome Fragmentation

The IETF should select and evolve a single management technology quickly in order to address the network operators and vendors needs in a timely manner and to reduce the necessity for competing standards (at least within the IETF).

+ Concentration of resources and expertise increases the chances to establish a well-accepted and widely deployed standard.

+ Overall cost reduction through a common technology.

+ Starting from a well-understood technology reduces the risks of getting locked in serious design problems.

- Must overcome barriers in some brains who are not willing to support a certain technology (unless it is their favorite choice).

- Timeliness is especially important for such an approach to succeed.

Scenario 4: Integration at the Conceptual Model Layer

The IETF accepts the fragmentation in the network management world as a given fact and stimulates work to define an integrated conceptual network model based on modern technologies which is used to derive non-conflicting data models for the various management technologies.

+ A successful integrated conceptual network model will make it much easier to develop interoperable management solutions that support multiple technologies.

+ Usage of modern technologies for the specification of the conceptual network model makes it easier to get non-networking experts involved.

- Creation of an integrated conceptual network model takes much time and the break-even point where the invested time pays back may not be reached for many years.

- A failure of the attempt to define a widely accepted integrated conceptual network model is likely to increase the original problem.

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Efficient Bulk Transfer of MIB Data

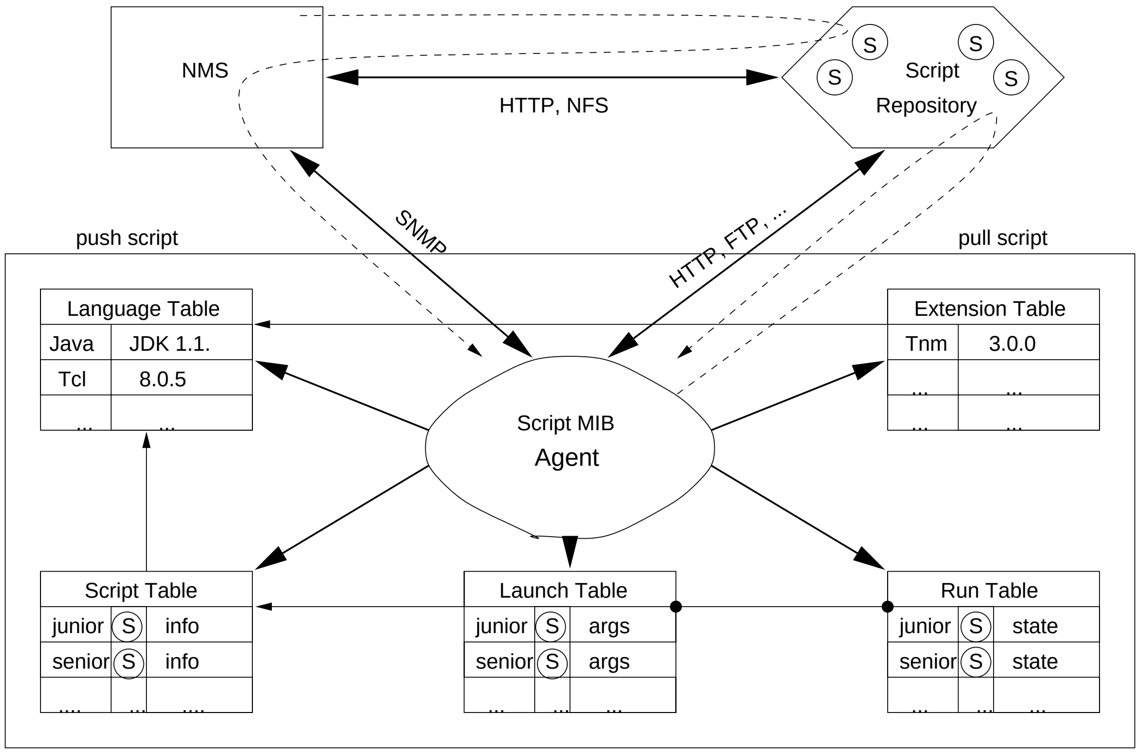
- Approach #1: SNMP extensions for bulk MIB data transfers
  - Use TCP as a transport protocol since it is optimized for bulk data transfers.
  - Compression of SNMP messages to improve bandwidth efficiency (e.g. gzip).
  - OID delta compression algorithm which does not “burn” the CPU.
  - Introduction of a new `GetSubtree` protocol operation.

- Approach #2: SNMP in conjunction with FTP
  - Definition of a MIB for storing MIB data in local files.
  - Use FTP to transfers the data files, controlled via a MIB.

- Approach #3: Alternate protocols and data representations
  - Definition of a MIME type for carrying MIB data.
  - Transfer of MIME encapsulated MIB data via HTTP or SMTP.

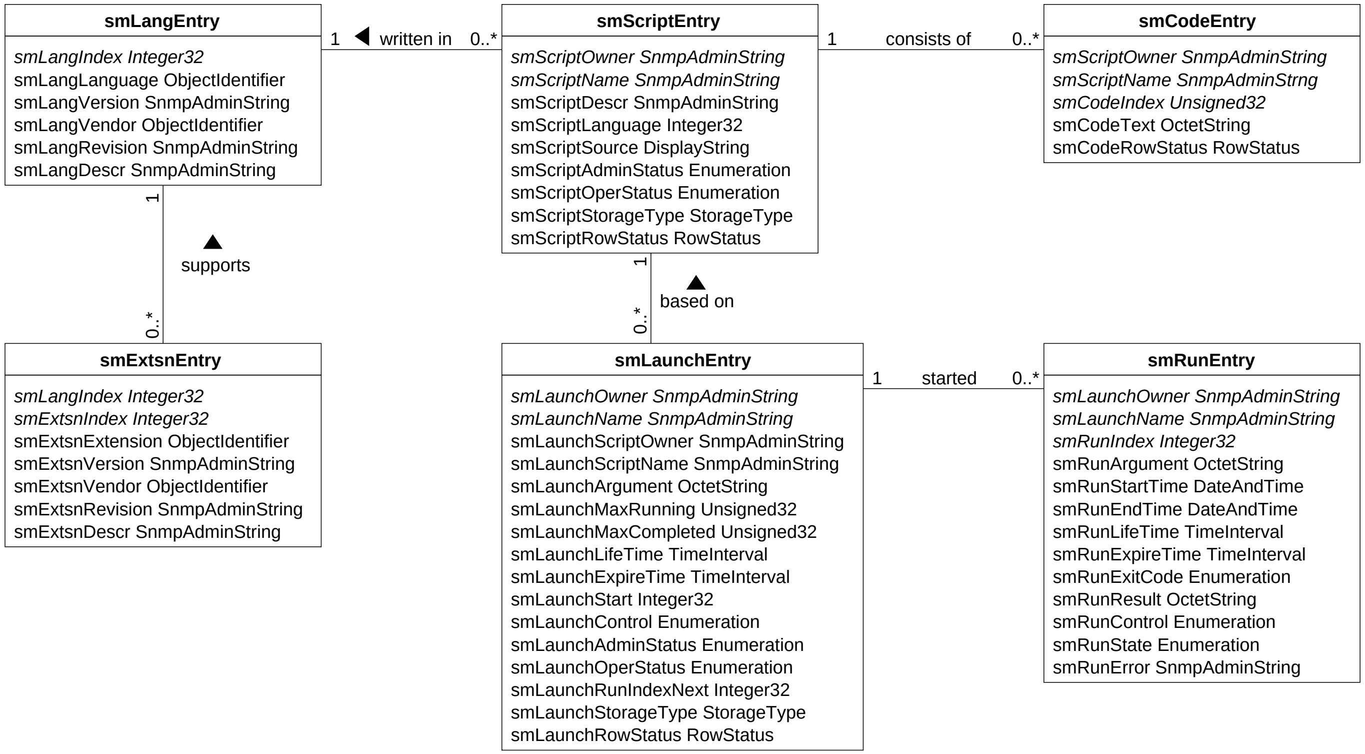
⇒ The Network Management Research Group (NMRG) is working on approach #1.

Secure Management by Delegation



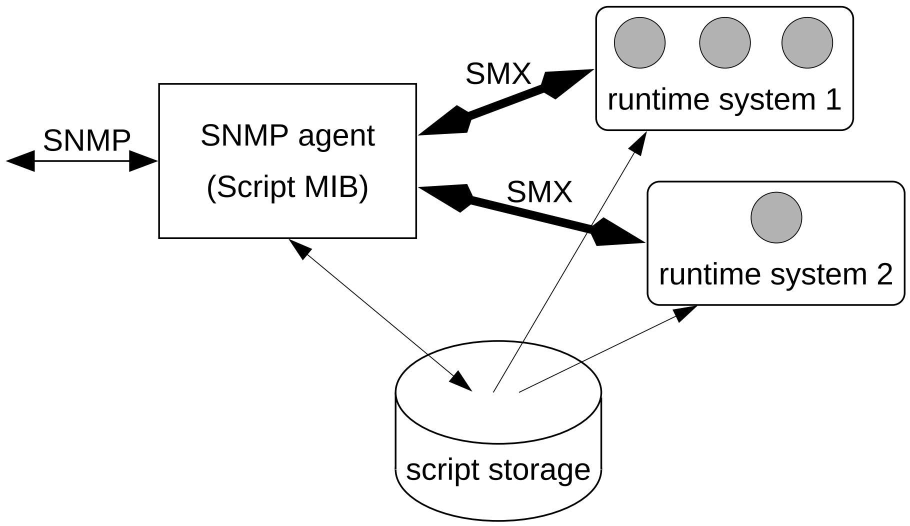
- Dynamic delegation of management functions to remote systems.
- Tight integration into the SNMPv3 view-based access control mechanism.
- Supports "sandboxes" for different users of the script MIB agent.

Structure of the Script MIB (RFC 2592)



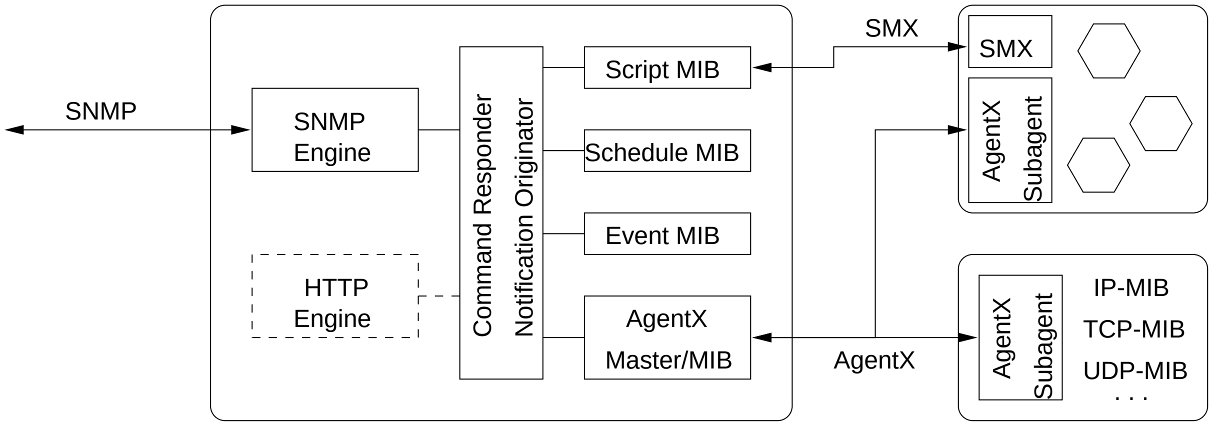
- The `smCodeTable` is optional and not required for conformance.
- The `smLangTable` and `smExtsnTable` are read-only.
- Rudimentary resource controls (smLaunchMaxRunning, smScriptLifeTime).

Script MIB Extensibility Protocol (RFC 2593)



- Separates language specific runtime systems from the runtime system independent Script MIB implementation.
- Supports multiple languages and runtime systems with different security profiles.
- SMX is a simple ASCII protocol running over a local TCP connection.
- Connection establishment procedure verifies a security cookie.
- Uses the local file system to pass executable code to runtime systems.

Secure, Extensible and Programmable SNMP Agents



- SNMPv3 provides message security and authorization services.
- AgentX provides the services for dynamic agent extensions.
- Distributed management MIBs realize the control infrastructure.

⇒ No documented "manager extensibility" protocol yet for allowing "MIBlets" to access other SNMP capable devices via the existing SNMP engine.

⇒ Jasmin prototype implementation being worked on at the Technical University of Braunschweig and NEC C&C Research in Berlin.

SMIng – Next Generation SMI Data Definition Language

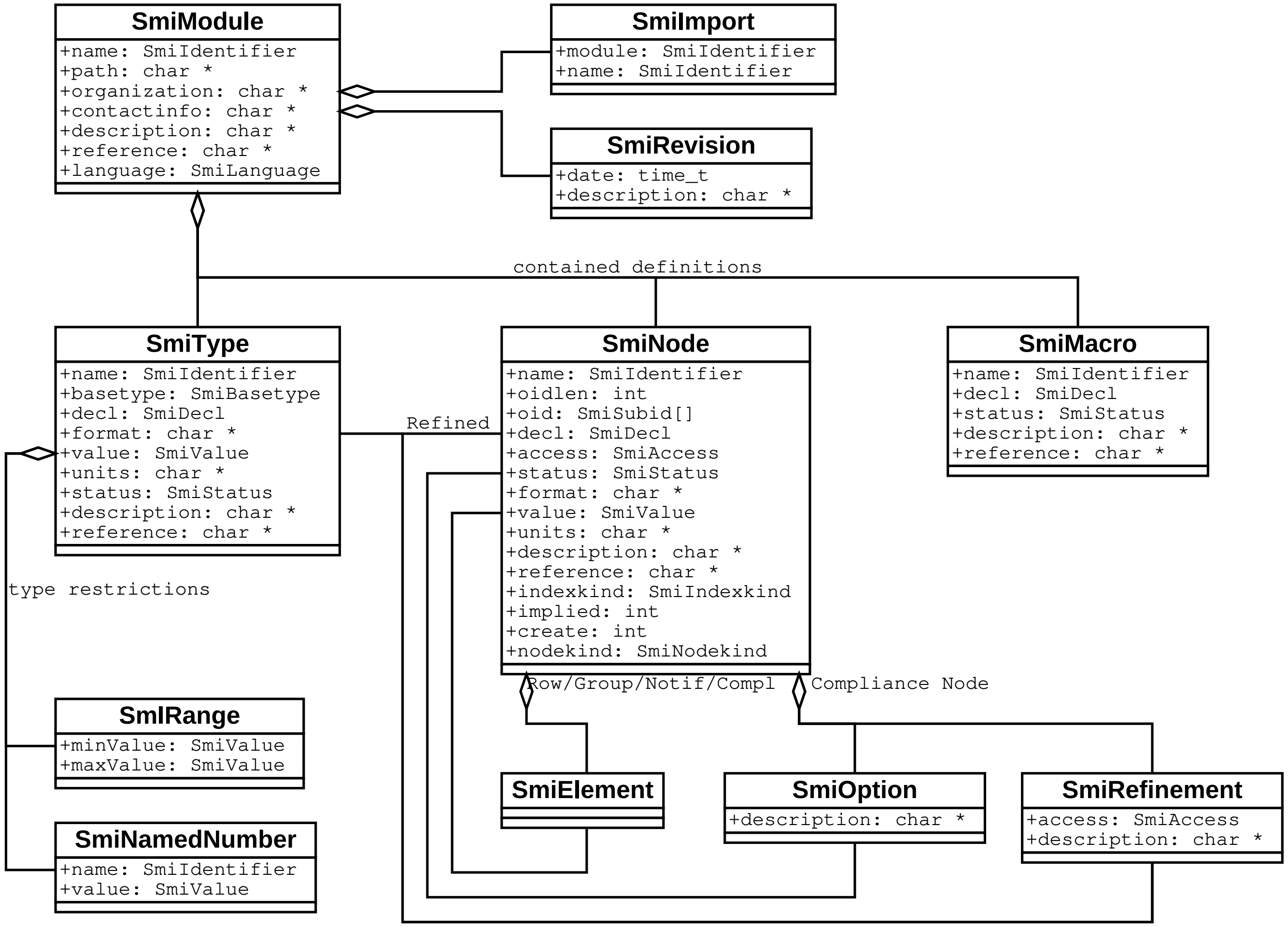
- Design Goals:
  - SMIng should be independent from any other “external” standards.
  - SMIng specification written in the augmented BNF (ABNF).
  - SMIng statements follow a small set of core syntax rules. (no ASN.1!)
  - SMIng simplifies the implementation of parsers.
  - SMIng keeps related definitions close together to enhance (human) readability.
  - SMIng has a complete set of base data types (64 bit and floating point numbers).
  - SMIng supports future extensions through the extension and unknown statements.

- Implementation of a “C” library to access MIB definitions (`libsmi`):
  - Several back-end parsers for SMIv1, SMIv2 and SMIng.
  - Applications using `libsmi`: `smidump`, `smilint`, `tcpdump`, `scotty`, `gxsnmp`, ...
  - SMIng is compatible with JIDM specification translation rules.

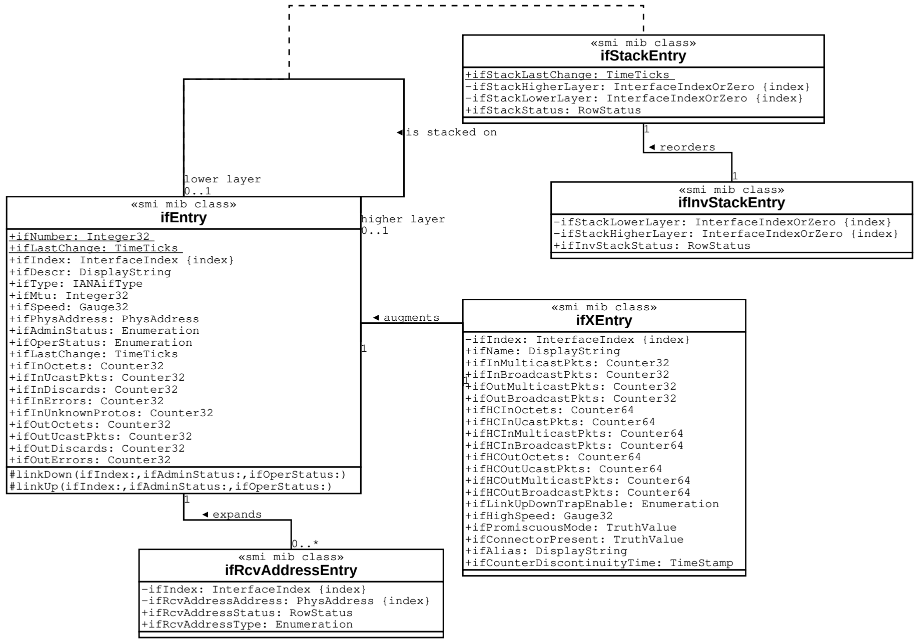
⇒ Research project at the Technical University of Braunschweig.

⇒ Further development of the SMIng specification within the NMRG.

Internal `libsmi` Data Representation



Reverse Engineering SMI MIBs



- MIBs are a low-level representation of some underlying conceptual model.
- The conceptual model is usually not well documented and hidden in many details.
- Understanding MIBs is much easier if you first understand the conceptual model.

⇒ Invent a heuristic algorithm which reverse engineers the conceptual model from the low-level MIB definition.

Outline of the Reverse Engineering Algorithm

1. Create a graph with nodes for each table and each scalar.
2. Add edges for table augmentations.
3. Add edges for table expansions (inferred from the indexing structure).
4. Add edges for sparse table expansions (inferred from the indexing structure).
5. Add edges for table reorderings (inferred from the indexing structure).
6. Reorder edges based on typical naming conventions.
7. Add edges by interpreting type information of index objects.
8. Assign scalars to tables based on typical naming conventions.
9. Group remaining scalars on the position in the OID registration tree.
10. Add edges for table columns that point to other tables based on typical naming and typing conventions.
11. Assign notifications to nodes based on the notification variables.
12. Convert the graph into a an UML exchange format by printing nodes as UML classes and edges as UML associations.

$\Rightarrow$ Ongoing research project at the Technical University of Braunschweig.

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Summary

- It is technically feasible to evolve the existing Internet Management Framework into a technology which addresses the needs of todays and tomorrows Internet.

- It is questionable whether IETF WGs are willing to move into that direction quickly enough.

- It is questionable whether the market and the big players will support such an evolution.

- There are reasonable chances to attract new markets (which are right now selecting their core management technologies).

$\Rightarrow$ Only the future will give us clear answers.

$\Rightarrow$ If I knew the answer, I would not be standing here. :-)

Thanks for Listening!

Any Questions ?

References and URLs

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  - J. Saperia, J. Schönwälder: Policy-Based Enhancements to the SNMP Framework, Technical Report 00-02, Computer Science, TU Braunschweig, May 2000

- URLs:
  - Jasmin Prototype: `http://www.ibr.cs.tu-bs.de/projects/jasmin/`
  - libsmi Library: `http://www.ibr.cs.tu-bs.de/projects/libsmi/`
  - Internet Research Task Force (IRTF): `http://www.irtf.org/`
  - Network Management Research Group (NMRG): `http://www.ibr.cs.tu-bs.de/projects/nmrg/`