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RESEARCH ARTICLE

A Proposed YANG Validator

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Abstract— Internet Engineering Task Force (IETF) has standardized the NETCONF configuration management protocol and the data modelling language compatible to NETCONF protocol called YANG. NETCONF provides consistency check and error recovery. YANG models can read XML based data. This paper explains how to build a YANG validator and how it helps NETCONF in network configuration.

Key Terms: - NETCONF; YANG; SNMP; MIB; RelaxNG

I. INTRODUCTION

IETF has standardized the NETCONF configuration management protocol and NETCONF oriented data modelling language YANG. NETCONF and YANG are simple, understandable, and robust than current systems for network configuration. The NETCONF protocol has the responsibility of consistency checks and large class of error-prone recovery. The YANG model has two major implications for network management systems. First, if the device uses a strict XML-based data model then the network management system can reuse that very same model. Secondly, the YANG models is for managing common networking tasks, such as assigning IP addresses to interfaces or changing DNS servers. This paper explains how YANG provides a more concise and readable notation of XML data models. There is symmetric mapping between YANG and the corresponding XML notation, allowing XML-based tools to validate, transform or filter the data model information.

II. ROUTING PROBLEMS IN TRADITIONAL NETWORKS

NETCONF provides configurations methods to install, delete and update of network devices. This paper explains network configuration using the NETCONF [4][5] protocol and NETCONF data modelling language YANG[5][6]. The YANG language allows data modellers to define the syntax and semantics of device configurations, and supports translations to many XML schema languages. Network configuration management is the process of organising and maintaining information about all the components of a computer network. Configuration management is not just about a technology to collect device information but also about the processes needed for network support and operations. Configuration management include hardware and software inventory, management device configuration details, detecting the changes in the configuration. The management of the configuration of a large number of networked devices remains a highly important practical problem. Device configurations and the mechanisms to retrieve and modify them are largely vendor-specific, and the most widely used configuration interfaces today are proprietary command line interfaces (CLIs), making it costly to achieve a high level of efficiency and reliability through automation. In 2003 the Internet Engineering Task Force (IETF) started an effort to develop and standardize a network configuration management protocol, which led to the publication of the Network Configuration (NETCONF) protocol at the end of 2006. The NETCONF protocol supports several features required for configuration management that were lacking in other network management protocols such as Simple Network Management Protocol (SNMP)[1][2].

NETCONF operates on so-called datastores and represents the configuration of a device as a structured document, serialized using the Extended Markup Language (XML)[3]. The protocol distinguishes different configuration modes such as running, startup, and candidate configurations. In addition, it provides primitives to assist with the coordination of concurrent configuration change requests and support distributed configuration change transactions over several devices. Finally, NETCONF provides filtering mechanisms, validation capabilities, and event notification support. The work in the IETF initially focused on the protocol design and its specification. It was, however, clear that a common data modelling language is needed in addition to the protocol to express the structure and semantics of configuration information in a vendor-neutral format. A proposal for a NETCONF data modelling language called YANG was developed in 2007 and is being standardized in the IETF since 2008.NETCONF gives access to the devices in the network, defining databases changing methods, retrieving data for operations, and invoking specific operations. YANG provides the data and operations carried through NETCONF[4][5]. Using both technologies, interoperability and commonality to devices, can be improved. This paper describes how NETCONF and YANG help to build network management applications that meet the needs of network operators.

III. YANG – THE DATA MODELLING LANGUAGE

Since NETCONF uses XML to encode network management data, it may seem obvious to use one of the existing XML schema languages to formally specify the format of these XML documents. While some parts of the industry favor the XML Schema Definition Language (XSD), there is significant uptake of RelaxNG in recent years. But putting aside the differences between XSD and RelaxNG, it is clear that additional NETCONF-specific information needs to be specified that goes well beyond the capabilities of these XML schema languages. Both XSD and RelaxNG only address part of the problem to be solved. During the development of the NETCONF protocol specifications, which are formally defined using XSD, it has been observed that XSD notation is difficult to read and verify by humans. Other schema notations such as RelaxNG (and especially its compact notation) seem to be easier to read and write. Still, both schema languages tend to be relatively far away from an implementer's view of a configuration datastore and tend to become cumbersome to use when all the necessary NETCONF-specific extensions are added. Furthermore, the validation capabilities of standard tools have limited value; what is most urgently needed is the validation of configuration datastores and not so much the validation of individual protocol messages that contain the serialization of a configuration datastore. Given the nature of the edit-config operation, individual messages might not satisfy all data model constraints but can still lead to a valid configuration datastore at commit time.

The YANG data modelling language therefore takes a different approach. YANG aims to be a highly readable and compact domain-specific language for defining NETCONF data models. YANG comes with a twin called YIN, which is an XML representation of YANG [5][6] so that standard XML tools can be used to process YANG data model definitions. A lossless two way conversion between YANG and YIN is defined. In addition, one-way conversions to XSD and RelaxNG are available so that corresponding tools can be used. All YANG definitions are contained in modules. A module is identified by its name and has its own XML namespace. A module can be further subdivided into sub modules to simplify the maintenance of complex modules. The sub module structure, however, is not visible outside of the module; all sub modules share the same XML namespace, and all definitions of all sub modules are accessible by importing the module. YANG features a small set of built-in data types and provides a library of commonly used derived data types. The data type derivation mechanisms of YANG are compatible with XSD to achieve simple translations between YANG and XSD or RelaxNG. Following schema shows the acme-dns-resolver YANG module modelling a Domain Name System (DNS) resolver. The module imports definitions from the module ietf-inet-types and defines, among other things, the derived enumerated type server-status.

IV. PROPOSED SOLUTION

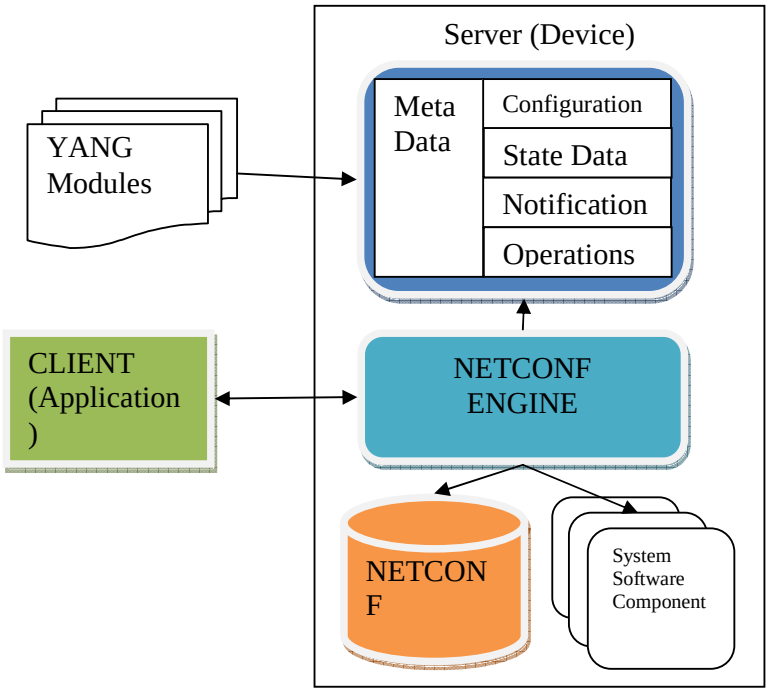

Figure 1: YANG Based Client-Server Architecture

The proposed systems explain YANG validation. This paper explains a new methodology Configuration management using YANG modules and different operations present in the NETCONF protocol. This paper also discussed the Data model corresponding to the YANG Schema and conversion of standard YANG modules to corresponding JAVA classes in the Netconf Client Library.

V. IMPLEMENTATION

A sample model (Universal YANG Data Validation module) of the proposed solution is implemented using JAVA and a custom YANG schema. A third party tool PYANG, a reference library for converting the YANG files to Document Schema Definition Language (DSDL) model , is used for converting the YANG Schema configuration files to RelaxNG model. The validation module validates the YANG XML data against the RelaxNG converted schema. The validation tool displays the results to the user in command Line Interface (CLI).

PYANG is a YANG schema validator written in python and used to validate YANG modules . Currently the PYANG tool is available for LINUX OS only. For universal YANG data validation tool, the configuration reference schema should be in any of the hybrid DSDL format. The PYANG tool is used for converting the YANG schema to RelaxNG Hybrid DSDL format.

Figure 2: YANG to DSDL conversion

A. Validation Tool

The YANG Data (in XML format) validation tool has a config directory. User can Store N number of YANG configuration files in the config directory for validation. The user should input the YANG data and corresponding version name to the CLI of the validation tool. The validation tool picks the correct DSDL schema from the config directory and converts the schema to corresponding JAVA classes. The YANG XML data is parsed and compared to the rules for each of the component using a generic DSDL validator module. If all the components matches the rules, then the tool returns with success otherwise the tool display the detailed error information in the CLI.

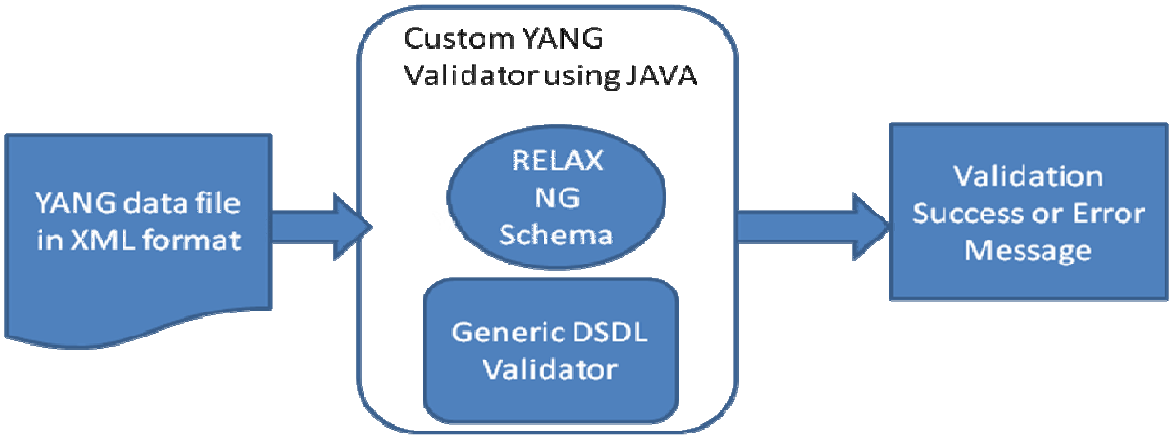

Figure 3: YANG XML Data Validation

B. Output

- Output for valid Data.

```
<terminated> YangValidator [Java Application] C:\Program Files\Java\jre6\bin\javaw.exe (Aug 21, 2012 8:01:53 AM)
Starting YANG data validation ...
Validation is Success. data\version1_data.xml is a Valid YANG data File
```

Figure 4: Validation Tool Output for Valid Data

- Output for invalid data

Changing the value of enabled field to a string other than Boolean true or false **<ein:enabled>test</ein:enabled>** results the below output

```
<terminated> YangValidator [Java Application] C:\Program Files\Java\jre6\bin\javaw.exe (Aug 21, 2012 8:00:36 AM)
Starting YANG data validation ...
Invalid YANG data file : Validation failed.
character content of element "ein:enabled" invalid; must be equal to "false" or "true"
```

Figure 5: Validation Tool Output for Invalid Data

The implementation details of the server side YANG Data Validation module of the proposed solution and the sample outputs generated. The proposed solution is able to deal with multiple versions of the configuration Datastore. The sample validation program is written in java so the module shall be portable to multiple platforms and is portable to mobile devices also.

VI. CONCLUSIONS

NETCONF and YANG provide a strong base technology for simpler, more effective, and more robust configuration management. NETCONF moves the responsibility of consistency checks and error recovery to the managed devices. This enables the protocol to robustly support transactional capabilities and proper rollback management, functionality that is extremely hard to implement correctly using traditional technology.

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