

Network Design Assistant System Based on Network Description Language

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Abstract—In recent years, various network devices have been provided by many vendors. Therefore, administrators must have knowledge of those network devices and network technologies when to design, configure and monitor their networks. To reduce administrative cost, we proposed Network Description Language (NDL) for network lifecycle (design, configuration and monitoring) managements. The administrator only needs to write network specification in NDL. Configuration files for individual network devices will be automatically generated from the specification. However, it is not easy to write the specification in NDL. This paper describes Network Design Assistant System based on NDL. It assists to create specifications from user requirements.

Keywords—Network Description Language, Network Design, Network Management, XML

I. INTRODUCTION

In recent years, various network devices and network technologies have been developed. Therefore, administrators must have knowledge of those network devices and network technologies when to design, configure and monitor their networks. Usually, specific knowledge is required to configure each device even if a common function is used. In addition, there is no guarantee of integrity of design and management. It depends on human resources.

To reduce administrative cost, we proposed Network Description Language (NDL)[1] for network lifecycle (design, configuration and monitoring) management (Figure 1). The administrator only needs to write network specification in NDL. Configuration files for individual network devices will be automatically generated from the specification. NDL is an XML (Extensible Markup Language) [2] style description language. It has four kind of elements, i.e. network nodes, agents, links, and flows, described with three models, i.e. specification model, device model and snapshot.

A traditional method of the network management is shown in Figure 2. The unified design and management framework cannot be undertaken without an experienced person. Designing specification for each individual device needs understanding of the network and the knowledge of individual device. In addition, network management and configurations need to be designed for updates, though updates are not so often.

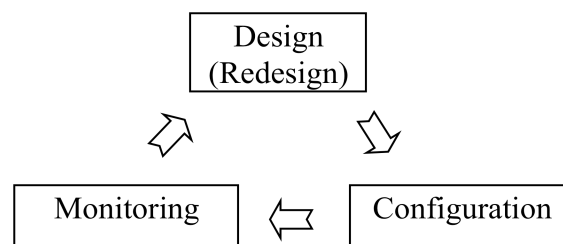


Figure 1. Network lifecycle.

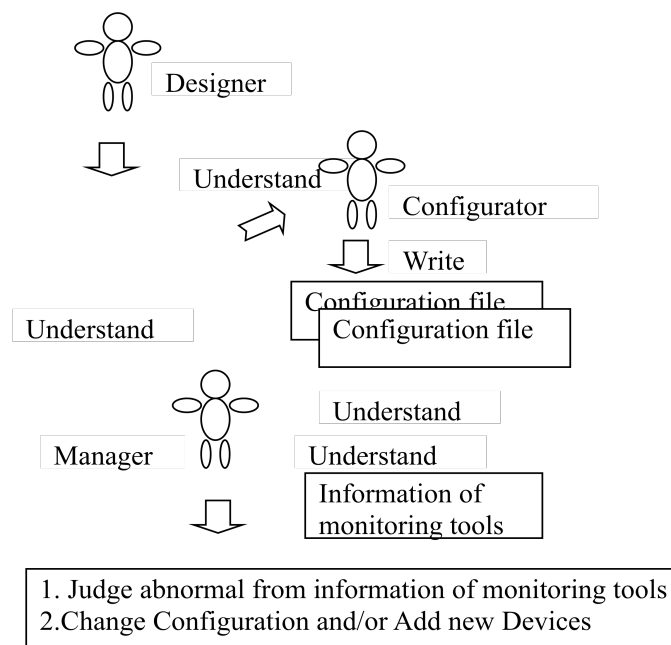


Figure 2. Traditional flow of network lifecycle management.

It is not clear what kind of configuration files are easy to be understood in grasping the roots of various monitoring data from operation.

In contrast, Figure 3 shows the proposed flow of network lifecycle management described as follows,

(1) Create network specification model. (network design)

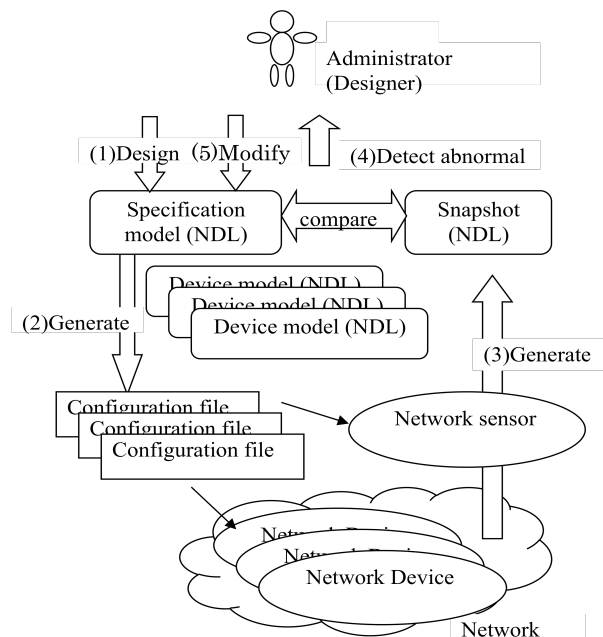


Figure 3. Proposed flow of network lifecycle management.

- (2)Generate configuration files automatically from the specification model and apply it to individual devices by using XSL (Extensible Stylesheet Language). (Configuration)
- (3)Generate snapshot representing the current state of network obtained by network sensors. (Monitoring)
- (4)Detect unknown devices and/or flows by comparing the specification model and the snapshot. Treat them if these are illegal devices and/or flows.
- (5)Modify the specification (i.e. add new devices and/or flows) if there are undefined legal devices and/or flows. (Redesign)

By using NDL, administrative costs can be reduced. However, it is difficult to write a specification in NDL. This paper describes Network Design Assistant System based on NDL. It assists to create a specification according to user requirements

II. NETWORK DESCRIPTION LANGUAGE

A. Overview

NDL is an XML (Extensible Markup Language) style description language. It has four kinds of elements, i.e. network nodes, agents, links, and flows, described with three models, i.e. specification model, device model and snapshot.

B. Description Elements

A network can be represented with nodes, agents, links and flows as the four basic elements. Each element is described as follows,

```
<?xml version="1.0" encoding="utf-8"?>
<ndl version="1.0">
  <node id=2>
    <type>PC</type>
    <link_to> <node_id>1</node_id></link_to>
    <interfaces>
      <interface>
        <type>ether</type>
        <ipv4>192.168.1.2</ipv4>
      </interface>
    </interfaces>
    <agent>
      <type>web client</type>
      <port>*</port>
      <flow_to>
        <protocol>6</protocol>
        <dst-ipv4>192.168.1.1</dst-ipv4>
        <dst-port>80</dst-port>
      </flow_to>
    </agent>
  </node>
</ndl>
```

Figure 4. NDL example of web client node with an agent.

- 1) Node is a network device, e.g. router, layer 2 switch, PC or etc.
- 2) Agent is a software or service, e.g. web server or client.
- 3) Link is a physical connection between the two nodes, e.g. optical fiber, Ethernet cable or etc.
- 4) Flow is defined by communication between two agents.

C. Description Model

The Network Description Language describe three models, 1) Specification model, 2) Device model and 3) Snapshot. We describe these models as follow,

1) Specification model

Specification model defines individual devices (vendor and model No) and configuration parameters. This model is described by network administrator at the end of the design process by using Network Design Assistant System (see Section III). The nature of the communication is described to configure the network equipment and services. This model consists of nodes and agents. There are individual device's name and individual software's name.

2) Device model

Device model describes the individual specification of network Device.

3) Snapshot

Snapshot is the current state of the network automatically gathered by the network sensor. In this paper, we used network management software (such as OpenNMS [3], nagios [4]) to produce a snapshot of an active network.

D. Description Method

NDL describes the model of the equipment by using XML (Extensible Markup Language) [2] and XSL (Extensible Stylesheet Language). Model description is designed to define the model by stating actual rules of the equipment. Until now, XML and XSL-designed model is described with the model and equipment. And XSLT (XSL Transformations) configuration can be generated to confirm the basic testing. Preparation of network sensors for monitoring the network is almost finished to generate a functional specification, with providing design models and verification tools, and preparing snapshots.

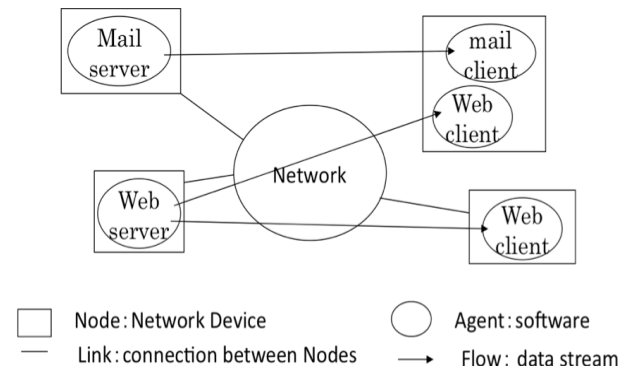


Figure 5. An example of requirements model.

E. Expected Application

Companies would monitor whether its internal information face leakage, transportation to illegal or unauthorized communication devices or not.

It is possible to verify that the specification is not illegal and to automatically detect unauthorized communication devices by studying the network specification (design model) and the current state of the network (snapshot) created by network sensors. High level of security and network management at the same time meant to be used for network design and management is expected to reduce costs.

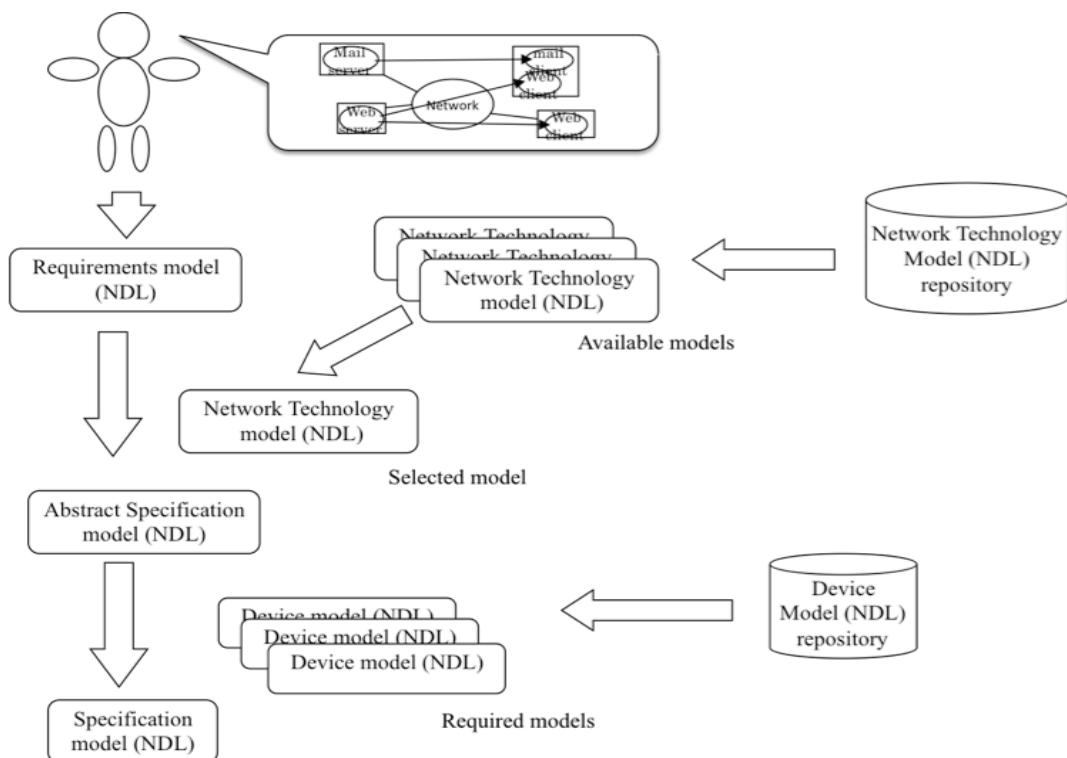


Figure 6. Proposed Network Design Assistant System.

III.NETWORK DESIGN ASSISTANT SYSTEM BASED ON NETWORK DESCRIPTION LANGUAGE

Network design process has three steps. First, administrator understands user requirements. Second, administrator translates user requirements to specification. Finally, administrator selects individual devices. To create a specification model, administrator must have a lot of knowledge of network technologies and individual device features. It is a difficult task, and quality of its design depends on the ability of administrator.

We propose Network Design Assistant System based on Network Description Language and three models for design process which are different from another Network Description Languages [5,6]. Figure 6 shows overview of our system. We explain in detail as follows.

- 1) Requirements model: This model defines how to use the network, not defines network technologies and individual devices. This model is network requirement, which is described by network administrator in the design process. The nature of the communication is described to configure the network equipment and services. This model consists of nodes and abstract representation of the agents. It is not individual software's name (for example, Apache and Firefox) but a web server or a web client.
- 2) Network technology model: This model defines what kind of technology is used. For example, some model consists of traditional router and HUB, another model consists of layer 2 switch with VLAN, and so on. And this model includes translation program from requirement model to abstract specification model. These translation programs can be realized by adopt recent research results of systematic network design for example [7].
- 3) Abstract specification model: This model defines network topology and abstract devices. Abstract device is defined with a type of network device (i.e. router, layer 2 switch, firewall, and so on), not individual device.
- 4) Device model: This model defines individual device's features and translation program from specification model to device native configuration.
- 5) Specification model: This model defines individual devices (vendor and model No) and configuration parameters.

IV.CONCLUSIONS

In this paper, we proposed Network Design Assistant System based on Network Description Language. By using this system, administrator creates specification model easily. We can realize network lifecycle management by using that specification model. We defined requirements model, network technology model, abstract specification model, device model and specification model.

To evaluate our Network Design Assistant System, we will implement GUI tools. And, we will create a requirement

model and some types of network technology model. Then, we will create different abstract specification models by using different network technology model for the same requirement model.

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