A Network Management Software Based on Secure Shell (SSH) Channels and Java Universal Network Graph (JUNG)

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Abstract

This project presents a Network Management Software (NMS) implementation based on Secure Shell (SSH) channels and Java Universal Network Graph (JUNG). Using secure SSH channels, the NMS extracts the topology of any computer network using Open Shortest Path (OSPF) as the routing protocol. NMS consists of two subsystems: the Topology Visualization Module, and the Control Module. The first one provides a visual interface that permits dynamic interaction between the network manager and devices. The latter implements control and optimization algorithms for automatic control of the network. An example application of the Control Module is routing optimization, where the routing of traffic is dynamically adjusted to avoid congested areas or hot spots. NMS is able to handle real-time updates in the network, such as link and node failures.
Introduction

Computer networks consists of network devices and communications links. Network devices include specialized computers such as routers, which are the core of the Internet, and end users such as Laptops and mobile phones used by humans. Today, the Internet has grown into a production communication system that reaches all populated countries of the world and its use has grown exponentially [1]. A high-level overview of the Internet is shown in Figure 1 [2], where end users may be connected to the Internet by 3G providers, cable and DSL modems, and other services.

The advent and utility of networking has created dramatic economic shifts. To provide Information Technology (IT) services, any current middle and large-size enterprise must manage an important number of routers for proper operation. As a result, an entire industry, network management, has emerged to develop technologies, services, and products to facilitate the management and administration of networks.

Figure 1. Overview of the Internet architecture [2].
In order to address the continuous challenges of managing middle and large-size computer networks, this project presents a Network Management Software (NMS) implementation based on Secure Shell (SSH) [3] channels and Java Universal Network Graph (JUNG) [4]. The project focuses on the management of routers using the secure SSH protocol which implements cryptographic algorithms to provide for authentication and confidentiality. Using secure SSH channels, the NMS extracts the topology of any computer networks that use Open Shortest Path (OSPF) [5] as the routing protocol. OSPF is the most widely used routing protocol. It enables administrators to set cost weights dynamically, which adds flexibility for dynamic routing optimization [8] and traffic engineering [9].

NMS consists of two subsystems: the Topology Visualization Module, and the Control Module (Figure 2). The first one provides a visual interface that permits dynamic interaction between the network manager and devices. The latter implements control and optimization algorithms for automatic control of the network. An example application of the Control Module is routing optimization, where the routing of traffic is dynamically adjusted to avoid congested areas or hot spots. NMS is able to handle real-time updates in the network, such as link and node failures.

With NMS, routers can be manually or automatically operated according to the needs of the network manager. NMS also makes user access and troubleshooting more convenient, and will provide a feedback control system for traffic engineering [6] and network security.

Methods

Given a single IP node and SSH passwords, NMS probes the entire network for all existing layer 3 devices. The Topology Visualization Module (Figure 2) generates a visual
representation of the network (Figure 3). By clicking on a given router, an SSH channel between NMS and the router is open for management purposes.

Figure 2. Network Management Software System.

Our future work includes the Control Module (Figure 2), which will permit managers to automate security policies and traffic engineering. The latter refers to the ability of routers to route traffic optimally using optimization algorithms such as Linear Programming or Dijkstra.

Java SE is the programming environment used to build this software. Java Universal Network Graph (JUNG) and Visual Library are used for drawing the network. The test-bed used for developing and testing the NMS is composed of Cisco routers, family model 2900, used in the industry (Figure 4). Cisco routers 2900 implement SSH channels, OSPF, and several other protocols. The routers used at Northern New Mexico College (NNMC) have 2 serial synchronous interfaces and 2 Fast Ethernet interfaces. All software development is performed using the test-bed (i.e., real equipment) rather than simulation software.
Figure 3. Topology Visualization output of a real network.

Further Discussion

The NMS presented is built for network topologies using OSPF. In OSPF there are three type of networks: stub, point-to-point, and transit. A stub network is also known as Local Area Network (LAN). This is a network composed of end users that utilize a router to communicate with other LANs. A point-to-point network is a network in which two routers are serially connected. A transit network is a network in which two or more routers are connected through a LAN.

Conclusion

The first prototype of NMS has already been created and tested. The Topology Visualization Module is able to accurately build the topology of a real network. The module also permits the network manager to visually interact with any device. Current efforts include further testing of the Topology Visualization Module, integration of a Syslog [7] server for real-time updates, and the implementation of the Control Module.
References


