"Interconnection between SDN Adhoc Controllers"

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Abstract:
Recent and famous method to computer the architecture of network monitoring and controlling the whole network providing several qualities is the object of Software Defined Networking (SDN) is programmatically and centrally. Nevertheless, deployment of SDN in broad scale networks of various operators and service offers is constrained because of lack of standardized connection between the controllers of SDN and use of routing algorithms of conventional networks. In addition, different networks that use adhoc technologies need special management in the combination between software Defined networks (SDN) and heterogeneous Networks. An examination of SDN basics, present resolution and ways to scale their performance for various networks are presented in this dissertation, and we shape problems of SDN field interconnection for eastwest communication with relying on the examination. We suggest, to find a solution for this problem, a new architecture for correlation of controllers in different fields of SDN for development of SDN to allow controllers of SDN and applications in multi-cluster or field networks to coordinate in a higher quality.

1. Introduction
Due to improved means of approaching and increased popularity of multimedia and P2P, growing is preserved by internet traffic, whereas modern and original applications need even further resources and network criterions with high efficiency. Nowadays, Ethernet and Multiprotocol Label Switching (MPLS) resolutions are the base for various networks, some being upgraded with Shortest Path Bridging (SPB) and Generalized MPLS (GMPLS). Routing between these bearers Autonomous Systems (AS) is applied by Internet global routing table and Border Gateway Protocol (BGP). There is very little research about the high qualities of correlation of different controllers in diverse fields of SDN although research in the domain of Software Defined Networking (SDN) is in the core of attraction and developing the controller performance and is just getting into the spotlight. To simplify using of SDN and modern creative applications in various networks and permit rising of SDN deployment among networks are the motivation for this paper, and a new way for interconnection of different control planes (CP) is presented in this paper. The interconnection system can be used in different areas SDN and permit coordination and communication of control plane (CP) to get a better supplying of services across multiple areas. So, we suggest, to achieve this, a new interface for controllers of SDN to link areas with the use of a new vendor neutral communication protocol.

2. The State of the Art
In this part, we examine SDN and its possible advantages and restrictions. Moreover, we explore problems of scaling the control plane of SDN to use in various networks and their linkage to make use of it in SDN-Adhoc networks.

2.1 Software Defined Networking
To boost computer networks flexibility, manageability and expansion, and the secondary aim which is to reduce equipment costs are the overall motivation behind SDN, and to accomplish this, usefulness of quick progress is taken, and cycle of comparatively inexpensive software applications in contradiction to costly particularized networking hardware is employed. Software Defined Networking (SDN) is considered a new pattern in computer network architecture, and the goal of it is to monitor and control all nodes of network with programs. This permits finding the key to several problems that occur in conventional methods to network and enable new characteristics, too. Furthermore, SDN (Gray & Nadeau, 2013) is considered a new method which seeks monitoring the whole network in programmatic way from a logically centralized node. Implantations of networking equipment can be sectioned in a theoretical way to switch of traffic data between interfaces (Data Forwarding plane and Control plane). Rules formed by processor directing operating system, address translation, routing algorithms, and other higher functions. Both control plane (CP) and data forwarding plane (DP) are performed in each node of conventional network, often with
the use of specialized hardware. This permits each tool to act completely autonomous and make all high level resolutions, such as packet routing autonomously in Figure 1, the basic foundation of SDN architecture that is described, and is a detachment of control plane and data forwarding planes that are connected via standard interface (ONF, 2012). The use of centralized perspective of the entire network provides a high-level resolution of traffic controlling to be performed just once, outcomes then distributed to be applied by all nodes in data forwarding plane. There is a potentiality to centralize resolutions and arrangement of all network gadgets through implementing of detached control plane by software for common purpose computer from forwarding plane on network equipment. Moreover, the centralized control plane that is performed in software accomplished on general purpose processors can achieve several benefits in network and particularly speeding up creativity, new network characteristics progress and deployment. While there are many methods to SDN, OpenFlow is the major enabler of SDN and actual standard communication protocol.

2.1.1 OpenFlow
OpenFlow (Balakrishnan et Al., 2008 ) is a non-profit association with assignment of commercializing and promoting SDN that is based on OpenFlow. Furthermore, the OpenFlow switch standard (OF, 2012) must be performed by the devices of control plane (CP) and forwarding plane because it determines communication interface between the two sides. It is considered a free standard that was initially progressed at universities and at the present time, it is directed by Open Network Foundation (ONF). Moreover, Controller of OpenFlow produces and makes resolutions with high level switching in shaping of control plane into routing rules, consisting of procedures and matches. These rules are entries for Flow Tables applied by OpenFlow switch in routing plane to manage incoming packets.
When OpenFlow enabled switch obtains a packet, it is managed in OpenFlow pipeline consisting of one Flow Table or more, and each one includes records with rules and procedures that are implemented on the packet that is existed in the flow. If rule is set up to send anonymous packets to Controller, and it is not possible to discover correspondence for the packet in any Flow Table, it is sent to the controller. After that, the packet is processed by controller by either dropping the packet or creating a new flow through producing a new entry in Flow Tables.

2.1.2 Alternative and Related Technologies
SDN is a large-scale system in a continues change, and several new views in SDN implementation are still under development and progress despite of the fact that OpenFlow is the most common method at present times. Moreover, some technologies can be viewed as part of SDN enablers beside other projects which can hugely take advantage from
deployment with SDN. The objective of some commercial solutions, such as Cisco ONE and Nuage Virtualized Services Platform is to offer kind of programmability for gadgets from these sellers, to different open solutions including Interface to the Routing System (I2RS) (Atlas et al., 2013), ForCES (Salim et al., 2010), NETCONF (Bjorklund et al., 2011) and PCEP (Le Roux & Vasseur, 2009). The view towards PCEP particularly with MPLS and its numerous additions is a progressive movement towards SDN with no problems or interruption of the internet, and keeps current interoperability, an essential factor for various operators. ForCES NETCONF and PCEP are older technologies repurpose for use in SDN while I2RS is a new and aspiring way that aims at offering typical unified interface to routing system to achieve monitoring and direction. In this regard, OpenFlow is revolutionary while PCE can be viewed as an evolutionary track towards SDN using already deployed equipment of conventional network. Network Function Virtualization (NFV) is an initiative action driven by carrier in order to virtualize functions of network and move them from devices designed on purpose to common servers. Both SDN and NFV include homogeneous features and can take advantage of each other. They are autonomous and do not need to deploy the other in network.

2.2 Scaling SDN Control Plane

For a long period of time, Scale has been an effective and progressive theme frequently in the discourse about SDN. The problem of scaling the control plane (CP) of SDN in several networks, i.e. the Internet, and challenges in the connection of SDN controller is examined in this part. Criticizing the pattern of SDN says that changing the implementation model of the control plane from anything other than complete allocation will cause challenges and difficulties in scalability. In addition, there is a general interest which investigates the scalability of using conventional SDN, i.e. OpenFlow, to monitor physical switches and transformations because of the limits of the forwarding table. Theoretically, any approach of SDN is able to gain the identical scaling attributes like conventional networking. For instance, it is difficult to discover a cause why controllers cannot manage conventional routing protocols among them. Nevertheless, scaling attributes of a system that is built using an SDN approach that really takes advantage of the architecture, and scaling properties of an SDN system different from the conventional networks is more appealing attempt. There are different methods to scaling SDNs that exist at the present in various phases of progress and deployment, and these are categorized into two groups. The first one scales up the implantation of single SDN controller with raised optimization and comparing of implementation, such as Maestro (Cai, 2012) and NOX MT (Casado, 2012). Moreover, There are mixed resolutions that use actual distributed controllers in groups with various examples of single reasonable controller Onix(Poutievski et al., 2010), xBar (Shenker et al., 2013), ElastiCon (Kompella et al., 2013), HyperFlow (Tootoonchian & Ganjali, 2010), yet they are prepared for the using of just single field.

Figure 2: Illustration of our design
The second one scales out through diffusion of various interrelated controllers that connect for working together. Furthermore, there is the side of whether all of the interrelated SDN controllers are in the same scope or a number of them are in distinct ones. To clarify meaning of some terms used in this paper, we provide illustration of design in Figure 2. Implementation of controllers gets more essential to developers at the time of rising number of controllers of OpenFlow are deployed and developed. Nevertheless, a single actual controller, although it has a high performance, is inadequate to monitor a large network. High accessibility and maintaining low answer times are among the serious causes behind the need of network to various controllers. EWBridge suggests a design for communication system with high performance between diverse Network Operating Systems and division large operator network field into sub networks. East-West Bridge (EWBridge) (Wang et Al., 2013) is an approach to interconnect controllers SDN, and this approach is being developed. One of the first to cope with connecting fields of SDN with the use of an automated system is SDN interconnect (SDNi). SDNi draft (Lopez et Al., 2013) suggested an open protocol SDNi for the interface between fields of SDN to exchange data between the domain SDN Controllers.

3. Problem Statement

Work has hardly done to find out an architecture which divide an SDN-Adhoc network into clusters and interconnect main controllers of diverse sub network clusters and benefit from SDN despite there are schemes to scale or diffuse the controller functions of SDN to achieve a high level of containing a distinct network with clusters of active nodes. Nevertheless, conventional network protocols such as BGP are applied by controllers in SDN islands to reciprocate only directing information among domains. This is a constraining element for advantages and resilience that can be presented by fully networks based on SDN. Although distant access and physical change of controllers in partners network is potential to certain degree, this way is not possible for the adhoc nodes and is also contrary to SDN basic of network monitoring automation. The theory of this dissertation is to offer architecture to divide SDN-Adhoc network into clusters and give the ability to interconnect controllers in different clusters of SDN-Adhoc network to communicate and reciprocate information. This will lead to achieve better provisioning services with greater resilience over network. These fractional goals arise from the theory to determine a communication interface in SDN controller for the linkage protocol. To demonstrate the implementation of the designed protocol and ways through comparing it with unchanged network and substitute present ways and finally to form new universal east-west communication protocol for linkage of diverse clusters SDN-Adhoc network.

4. Suggested Architecture

Communication protocol for controllers, interfaces applied and the functions of SDN in addition to formal model of communication protocol are defined in this section. Our designed architecture for interconnecting two SDN domains is depicted in Figure 3. Design of Architecture for interrelatation of controllers of SDN is also described here. New linkage architecture is needed in order to accomplish some objectives that are determined in problem statement. SDN-Adhoc clusters \([S_1; S_2; \ldots; S_r]\), each one consists of body of forwarders\([F_1; F_2; \ldots; F_j]\), belonging to cluster \(S_i\) and one controller \([C_i\) belonging to cluster \(S_j\)]. Single SDN-Adhoc cluster is managed and considered identical with Autonomous System in BGP. Clusters as \(S_a\) and \(S_b\) are interconnected just with conventional directing protocols, e.g. BGP to offer IP connectivity in data forwarding plane. SDN-Adhoc cluster is considered a segment of SDN-Adhoc network which is run by one reasonable SDN controller \(C_i\), despite it can be performed as body consists of several actual controllers. For interconnection of Clusters \(S_a\) and \(S_b\) in control plane to benefit from SDN applications through these clusters, we suggest substituting conventional routing protocols with our Suggested Architecture. In this suggested architecture, Manager \(M_i\) controls all configuration and interconnections of Interface \(I_i\) to control the message interchange among controllers. Interconnection of clusters \(S_a\) and \(S_b\) is directed via Manager Application \(M_i\) of controller \(C_i\) for each domain \(S_i\). Manager Applications \(M_a\) and \(M_b\) control operation of data forwarding plane connection between edge forwarders \(F_{ai}\) and \(F_{bj}\) linking domains \(S_a\) and \(S_b\). Connection of control planes itself is done between Interfaces \(I_a\) and \(I_b\) that are constituents of \(M_a\) and \(M_b\) in clusters \(S_a\) and \(S_b\) alternately. Manager and Interface are the main functions of The Architecture. The
Manager is in charge of explaining network topology routers of data plane their connection run by a SDN controller, into a virtual router. Virtual router is responsible to set up connections with other controllers and present sessions direction, and it also provides interface for domain administrator to run parallel connection setup, session administration and advertised domain SDN and/or NFV abilities.

Networks in the controller field and accessible networks, with different track metrics for all of them are presented by virtual router. Ways to enhance connection to diverse controllers has been already determined by OpenFlow switch specification, but controller coordination keeps unstandardized. Manager requires applying suitable API for Northbound communication with a specified controller in order for the Architecture to be applicable in diverse conditions with different controllers of SDN-Adhoc, and each controller applies somehow different base of data to keep information about traffic data and its cluster topology, but most offers general Northbound interface to approach this data. Interface is in charge of controlling the connection between Managers of various controllers of SDN-Adhoc clusters whereas Manager collects network topology data and displays a management point to handle the interconnection session. This connection can be categorized into, intra-domain which means among controllers in the same management cluster, sometimes handling the same cluster with the coordination to present power with higher process and/or repeating controller.

**Figure 3: Designed Architecture**

### 4.1 Protocol

The Protocol offers not only scalability characteristics for controllers in one management cluster, but also different levels of network topology abstraction and handle for parallel controllers in disconnected SDN-Adhoc clusters. It also offers not only scalability characteristics for controllers in one management cluster, but also different levels of network topology abstraction and handle for parallel controllers in disconnected SDN-Adhoc clusters, and allows intra-domain and inter-domain path setup and sharing information among controllers about their abilities. Manager Functions of various SDN-Adhoc controllers are linked and communicate with the use of protocol over TLS or plain TCP session. The protocol itself is slightly motivated by current protocols like BGP and is consisted of three sub-layers:

- **Sharing of abilities Information:** it is accountable for sharing information about cluster abilities and networks obtainable inside and through the cluster with path metrics.
- **Session Management:** it is applied for parallel connection setup and session handling. Connection structuring in the administrative cluster have to be automated to reduce administration overhead, but need physical setup for inter-domain for security and goals.
• Path Setup: it is employed in end-to-end flow path setup in all the clusters along the traffic route between nodes depending on path metrics requirements of the first cluster controller.

Little to no manual management is in need to interconnect session to be started and network information shared between controllers, for controllers handle fractions of the same network and there are no limitations on exchanged information. Interconnection of SDN-Adhoc controllers in one controlling cluster is considered a comparatively direct operation. Due to additional technical complexities caused by typically risky connection, special management and safety plans; it is harder to interlink controllers in various clusters in Figure 4. Making interconnection session and path setup between two parallel SDN-Adhoc controllers Protocol is explained by message flow.

![SDN-Adhoc controllers Protocol](image)

**Figure 4: SDN-Adhoc controllers Protocol**

4.2 Verification

Practical tests using prototype implementation of our suggested Architecture in virtual environment used for testing by Mininet emulator.

5. conclusion

Notion of centrally handled and programmable SDN became very interesting due to network management complication and rising. However, scaling SDN control plane for sizable, different networks has been an active and often progressive topic. Criticizing SDN paradigm discusses that to turn the control plane implementation model from anything other than complete distribution of conventional networks will cause scalability difficulties and challenges. However, existing SDN architecture is constrained in taking most of advantages it provides in broad scale interlinked networks by lack of standardized communication among controllers. To find a solution for this problem, we suggest Architecture to develop SDN-Adhoc clusters for interconnection and coordination between controllers in different clusters. Architecture contains Manager and Interface functions, together with extensible Protocol for standardizes communication between various diverse SDN-Adhoc controllers.
References


