Volume : 3 | Issue : 6 | June 2014 • ISSN No 2277 - 8179

Research Paper

Engineering

KEYWORDS : Software defined networks, OpenFLow, SDN controller, virtualisation.

A Review on Software Defined Networks

T.R. Gopalakrishnan Nair	Saudi ARAMCO Endowed Chair – Technology, PMU, KSA Advanced Networking Research Group VP, Research, Research and Industry Incubation Center (RIIC), Dayananda Sagar Institutions, Bangalore 560078, India.
Kavita Sooda	Advanced Networking Research Group (RIIC), DSI and Assoc. Professor, Dept. of CSE Dept Of computer science and engineering Nitte Meenakshi Institute of Technology, B'lore, India
Sharada U Shenoy	Assistant Professor, Dept. of CSE Dept of Computer Science & Engineering NMAM Institute of Technology, Nitte, India
Raksha S R	Dept of Computer Science & Engineering NMAM Institute of Technology, Nitte, India

ABSTRACT

Today's resource-intensive application causes network traffic to grow extensively putting high demand on the existing network. Meeting current market requirements is virtually impossible with traditional network architectures. Existing network architectures were not designed to meet the requirements of users. As a result, there is a need for solution to make the network application aware by intelligently monitoring and routing the network traffic.SDN makes it possible to manage the entire network through intelligent orchestration and provisioning systems. SDN is an approach to programmable network that separates and abstracts some of the control pane functions from the network devices and places them in a centralized controller. SDN is a step in the evolution towards programmable and active networking. Software defined networks provides necessary components to make the network programmable, dynamic and application aware.SDN is often referred to as a "radical new idea of networking". The future of networking will rely more and more on software, which will accelerate the pace of innovation in computing and storage domains. Here in this paper, we discuss what SDN could provide to transform today's static network into flexible, programmable platforms with the intelligence to allocate resources dynamically.

I. Introduction

Networks have become part of the critical infrastructure of our businesses, homes and schools. This success has been both a blessing and a curse for networking researchers. The networking industries have been struck in the 'mainframe era' with integrated software and hardware system that are built upon proprietary architectures and are the same as they were years ago. Traditional network architectures are ill-switched to meet the requirements of today's enterprises, carriers and end-users. These network architectures create fragility which takes excessively long provisioning time and results in the high operational costs unnecessarily. The shift towards Software-Defined Networking represents the most transformative architectural trend in these years, delivering unmatched network agility, choice in networking hardware and optimized network operations. Software-defined Networking (SDN) is a new approach to designing, building and managing networks. The basic concept of SDN is that it separates the network's control (brains) and forwarding (muscle) planes to make it easier to optimize each. The key to SDN is an innovative approach to control how data flows through a network. In a traditional network, data flow is controlled by switches and routers. Each switch and router contains the following basic elements: [1] Data plane: The data plane physically carries data packets from one port to another port by following the rules that are programmed into the device hardware. The data forwarding plane operates at the speed same as that of the network (wire speed). [2] Control plane: The control plane contains the logic that the device uses to program the data plane, so packets are forwarded correctly throughout the network. [3]Management plane: The management plane lets an administrator log in to the device and configures it for basic activities. Most devices can be configured locally or through a network management tool.

II. OPENFLOW and sdn

Software Defined Networking is an emerging concept that proposes to disaggregate the traditional networking in order to improve manageability of networks and also the network flexibility.SDN is implemented through a protocol known as OpenFlow that lets administrators select the path through which data will flow through a network. The OpenFlow specification is controlled and published by the non-profit Open Network Foundation (ONF), which is led by a board of directors from seven companies that own and operate some of the largest networks in the world (Deutsche Telekom, Facebook, Google, Microsoft, Verizon, Yahoo and NTT), whose mission includes the promotion of SDN technology. The ONF will license the trademark "OpenFlow Switching" to companies that adopt this standard. The first iteration of the protocol originated out of a research project at Stanford University in 2008. OpenFlow is an over-the-wire protocol like IP and TCP with explicit specifications and behaviour. It is just one of several burgeoning approaches to Software Defined Network. In a router or a switch, both the control plane and the data plane reside on the device. OpenFlow enables part of control plane operations to run on external servers called controllers. The standard control plane of the device remains in a particular location or place and performs routing and switching in a traditional way. OpenFlow is an open interface for remotely controlling the forwarding tables in a network router, switches and access points. For example, the OpenFlow enables wireless networks with smooth handoff's, scalable data centre networks, host mobility, more energy efficient networks.

The OpenFlow is often referred as key enabler for software defined networks and currently is the only standardized software defined network protocol that allows the direct manipulation of the forwarding plane of the network devices. OpenFlow based SDN architecture enables the network to respond to real time changes at user session and application levels, since the OpenFlow allows the network to be programmed on a per flow basis, current IP based routing does not provide this level of control. OpenFlow based SDN architecture can integrate seamlessly with an existing infrastructure and also provides simple migration path for those segments of the networks that are in need of the Software Defined Networking functionality the most.

Software Defined Networking (SDN) is a new network paradigm that separates each network service from its point of attachment to the network, creating a far more dynamic, flexible, automated and manageable architecture Software defined networking makes it possible to manage the entire network through intelligent orchestration and provisioning systems. The

Volume : 3 | Issue : 6 | June 2014 • ISSN No 2277 - 8179

goal of Software Defined Networking is to allow the network administrators and the network engineers to respond quickly to the rapidly changing business environments. The basis of SDN is virtualization, which in its most simplistic form allows software to run separately from the underlying hardware.

In broad terms, SDN is a form of networking which has control over how data traffic is forwarded from a source to its destination, separated from the switching hardware. SDN can use an existing physical network infrastructure or a virtual overlay network to provide end station connectivity. SDN aims to create a more dynamic and flexible network architecture capable of evolving quickly with changing business, end-user and market needs. Some of the key benefits outlined by the Open Networking Foundation (ONF) include :

- Ability to manage and control networking elements from a centralized point.
- Improved automation and management through the use of common application programming interfaces (APIs) which help hide networking details from provisioning systems and applications.
- Ability to deliver new networking services without configuring individual devices or depending on vendors to create new functionality.
- Programmability of the network infrastructure by the entire system (e.g., users, enterprises, independent software vendors, etc.) allowing innovation from industry participants beyond the equipment vendor.
- Ability to apply a wide variety of policies at the session, user, device and application levels which help applications quickly adapt to the state of the network and user needs.

A. Need for New Network Architecture:

Wide spread use of server utilization of is one of the leading key factor. To match the flexibility of server virtualization, the network manager needs to be able to dynamically add, drop and change network resources. This is difficult with conventional network switches in the control logic for each switch is located with a switching logic. Another effect of this server virtualization is that the flow of traffic differs substantially from traditional client server model. These server-to-server flows change in location and intensity over time, demanding a flexible approach to managing network resources.

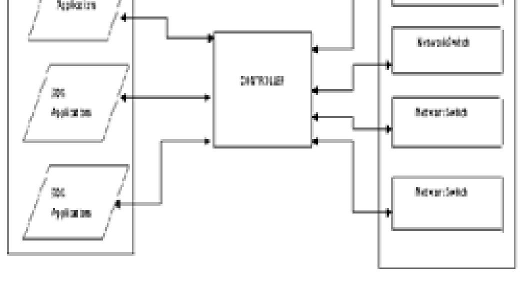
Another factor leading to switch to SDN is that the network managers must be able to respond to rapidly changing resources, security requirements and quality of services(Qos). Existing networks are able to respond to changing requirements for the management of traffic flows, providing differentiated Qos levels and security levels for individual flows but it is very much time consuming if the network is large and involves network devices from multiple vendors. SDN and OpenFlow provides an open architecture in which control functions are separated from the network device and placed in accessible control servers which enables the underlying infrastructure to be abstracted for application and networking services, enabling the network to be treated as a logical entity.SDN enables a network admin to shape traffic and deploy services to address changing business needs, without having to look or touch each individual routes or switch in the forwarding plane. Existing network architectures were not designed to meet the requirements of today's users, enterprises, and carriers; rather network designers are constrained by the limitations of current networks. To meet business and technical needs over the last few decades, the industry has evolved networking protocols to deliver higher performance and reliability, broader connectivity, and more stringent security. This has resulted in one of the primary limitations of today's networks: complexity. For example, to add or move any device, IT must touch multiple switches, routers, firewalls, Web authentication portals, etc. and update ACLs, VLANs, quality of services (QoS), and other protocol-based mechanisms using device-level management tools. The complexity of today's networks makes it very difficult for IT to apply a consistent set of access, security, QoS, and other policies to increasingly mobile users, which leaves the enterprise vulnerable to security breaches, non-compliance with regulations, and other negative consequences.

The key computing trends driving the need for a new network paradigm also includes: changing traffic patterns: Within the data center, traffic patterns have changed significantly. In contrast to client-server applications where the bulk of the communication occurs between one client and one server, today's applications access different databases and servers, creating a flurry of machine-to-machine traffic before returning data to the end user device in a traffic pattern. At the same time, users are changing network traffic patterns as they push for access to corporate content and applications from any type of device (including their own), connecting from anywhere, at any time, resulting in additional traffic across the wide area network. The "consumerization of IT": Users are increasingly employing mobile personal devices such as Smartphone's, tablets, and notebooks to access the corporate network. IT is under pressure to accommodate these personal devices in a fine-grained manner while protecting corporate data and intellectual property and meeting compliance mandates. The rise of cloud services: Enterprises have embraced both public and private cloud services, resulting in unprecedented growth of these services. Enterprise business units now want the ability to access applications, infrastructure, and other IT resources on demand. To add to the complexity, IT's planning for cloud services must be done in an environment of increased security, compliance, and auditing requirements, along with business reorganizations, consolidations, and mergers that can change assumptions overnight. Providing self-service provisioning, whether in a private or public cloud, requires elastic scaling of computing, storage, and network resources, ideally from a common viewpoint and with a common suite of tools."Big data" means more bandwidth: Handling today's "big data" or mega datasets requires massive parallel processing on thousands of servers, all of which need direct connections to each other. The rise of mega datasets is fuelling a constant demand for additional network capacity in the data center.

This mismatch between market requirements and network capabilities has brought the industry to a tipping point. In response, the industry has created the Software-Defined Networking (SDN) architecture.

III. Sdn architecture
Basic SDN architecture:
SDN architecture consists of three layers. At the top is the application layer, which includes applications that deliver services, such as switch/network virtualization, firewalls, and flow balancers. These are abstracted from the bottom layer, which is the underlying physical network layer. In between lies the SDN controller, the most critical element of SDN. The controller removes the control plane from the network hardware and runs it as software, but must integrate with all the physical and virtual devices in the network. In this way, the controller facilitates automated network management and makes it easier to integrate and administer business standards.

Fig 1: Basic SDN architecture



SDN Applications are programs that explicitly, directly, and programmatically communicate their network requirements and desired network behaviour to the SDN Controller via NBIs. They may also consume an abstracted view of the network for their internal decision making purposes. The SDN Controller is a logically centralized entity, which is in charge of (i) translating the requirements from the SDN Application layer down to the SDN Data paths and (ii) providing the SDN Applications with an abstract view of the network. The SDN Data path is a logical network device, which exposes visibility and uncontended control over its advertised forwarding and data processing capabilities. The logical representation may encompass all or a subset of the physical substrate resources. An SDN Data path comprises a CDPI agent and a set of one or more traffic forwarding engines and zero or more traffic processing functions. These engines and functions may include simple forwarding between the data path's external interfaces or internal traffic processing or termination functions. One or more SDN Data paths may be contained in a single (physical) network element—an integrated physical combination of communications resources, managed as a unit. An SDN Data path may also be defined across multiple physical network elements.

Figure 2 illustrates the logical structure of an SDN. A central controller performs all complex functions, including routing, naming, policy declaration, and security checks. This plane constitutes the *SDN Control Plane,* and consists of one or more SDN servers. The *SDN Controller* defines the data flows that occur in the *SDN Data Plane.* Each flow through the network must first get permission from the controller, which verifies that the communication is permissible by the network policy. If the controller allows a flow, it computes a route for the flow to take, and adds an entry for that flow in each of the switches along the path. With all complex functions subsumed by the controller, switches simply manage flow tables, whose entries can be populated only by the controller. Communication between the controller and the switches uses a standardized protocol and API. Most commonly this interface is the OpenFlow specification, discussed subsequently.

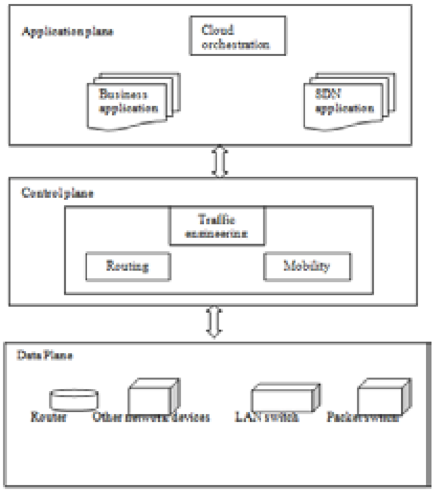


Fig 2: Logical view of SDN architecture.

The SDN architecture is remarkably flexible; it can operate with different types of switches and at different protocol layers. SDN controllers and switches can be implemented for Ethernet switches (Layer 2), Internet routers (Layer 3), transport (Layer 4) switching, or application layer switching and routing. SDN relies on the common functions found on networking devices, which essentially involve forwarding packets based on some form of flow definition. The switch in the SDN architecture performs certain functions such as; it encapsulates and forwards the first packet of the flow to an SDN controller, enabling the controller to decide whether the flow should be added to the switch flow table, it forwards incoming packets to the appropriate port based on the flow table, where the flow table includes priority information indicated by the controller. The switch can also drop packets on a particular flow as indicated by the controller, temporarily or permanently. Packet dropping is used for cubing Denial-of-service (DOS) attack or traffic, security purpose or traffic management etc.

IV. Conclusions

After more than 20 years of static, closed and proprietary systems, it's time for the networking industry to evolve and catch up with modern technology trends. It's time for the networking industry to adopt open, flexible and dynamic network architecture. The potential for SDN to ease management of virtualized networks, enable cloud computing, reduce costs and increase business agility has led networking vendors to embrace SDN and OpenFlow. Improving architectural simplicity, automation, and resilience in the underlying physical network will, in fact, improve the performance and operational feasibility of SDNs. The SDN revolution today is extremely turbulent. Presently, its development is focused heavily on the large data center and virtualization space. It may very well evolve into a useful tool for the enterprise and service provider space in the future, but there's a lot of work that needs doing by everyone involved before that can happen. The future of networking will rely more and more on software, which will accelerate the pace of innovation for networks as it has in the computing and storage domains. SDN promises to transform today's static networks into flexible. With its many advantages, SDN is on the way to becoming the new norm for networks.

REFERENCE

References | [1] www.OpenFlow.org/ | [2] "OpenFlow: Enabling innovation in campus networks", N.McKeown,T.Anderson,L.Peterson,J. Turneron,H.Balakris, ACM Computer Communication Review, Vol 38, issue2, April 2008. | [3] http://www.OpenFlowSwitch.org. | Mark Handley Orion Hodson Eddie Kohler. "XORP: | An Open Platform for Network Research," ACM | SIGCOMM Hot Topics in Networking, 2002. | [4] www.OpenFlownetworking.org/ | [5] Open Networking Research Center (ONRC). http://onrc.net. | Dimitra.E.Simeon idou, RezaNejabati, and Mayur Channegowda.Software defined optical networks technology and infrastructure: Enabling software-defined optical network operations. In Optical Fiber Communication Conference/National Fiber Optic Engineers Conference 2013. |