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Implementation of Remote Configuration Using SDN Approach

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

فَدَلَّ عَلَى لَدَامِ نَوَاحِي الْفَنَاءِ وَالْعَدْوِ الْجَدِيدِ جَاءَ

صَدَقَ اللَّهُ الْعَظِيمَ

DEDICATION

We dedicate this thesis to our parents who have always been nearest and so close to us whenever we needed. It is their unconditional loves that motivate us to set higher targets.

We also dedicate this thesis to our sisters and brothers who are always nearest to us and have provided us with strong love shield that always surrounds us and never let any sadness enter inside.

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Thank God for the wisdom and perseverance that he has been bestowed upon us during this research project, and indeed, throughout our life, we can do everything through him who gives us strength.

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ABSTRACT

Recently new networking design approach called Software-Defined Networking (SDN) is emerging fast. This approach is based on the separation of data and control planes, which affords a network operator certain advantages in term of centralized programmatic control. This centralized approach of management and control maintains a global view of the network rather than manage tens of thousands of lines of configuration scattered among thousands of network devices.

The purpose of this research is to take advantages of SDNs and implement remote configuration of virtual local area network (VLAN) from a single controlling point. The case study that has been adopted is to balance the loads between multiple VLANs when one of these VLANs is faced by load more than it can handle. The reason for choosing this case study is that SDN gives computer system more flexibility in changing the network configuration automatically. This flexibility can be used to increase the performance by bringing down the level of load balancing to layer-2 instead of layer-3.

المستخلص

مؤخراً، تطور بسرعة مفهوم جديد في تصميم الشبكات يدعى الشبكات المعرفة برمجياً. يعتمد هذا المفهوم على الفصل بين وحدتي البيانات والتحكم ، والذي يتيح لمشغل الشبكة مزايا محددة من حيث التحكم البرمجي المركزي. هذا النهج المركزي من حيث الإدارة والتحكم يوفر نظرة شاملة للشبكة بدلاً من إدارة عشرات الآلاف من خطوط التكوين المنتشرة بين الآلاف من أجهزة الشبكة.

الغرض من هذا البحث هو الاستفادة من مزايا الشبكات المعرفة برمجياً وتنفيذ تكوين عن بعد للشبكة المحلية الافتراضية من نقطة تحكم واحدة. دراسة الحالة التي تم اعتمادها هي موازنة الاحمال بين عدة شبكات محلية افتراضية عندما تواجه إحداها حمولة أكثر من ما يمكن ان تتعامل معه. سبب إختيار دراسة الحالة هذه هو ان الشبكات المعرفة برمجياً تعطي أنظمة الحاسوب مرونة أكثر في تغيير تكوين الشبكة تلقائياً. هذه المرونة يمكن استخدامها لزيادة الأداء عبر تقليل مستوى موازنة الاحمال ليصبح في الطبقة-2 بدلاً عن الطبقة-3.

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Abbreviations

API	Application Programming Language
CLI	Command Line Interface
CN	Cognitive Network
GNS3	Graphical Network Simulator
GUI	Graphical User Interface
I/O	Input / Output
IOS	Internetwork Operating System
IP	Internet Protocol
ISP	Internet Service Provider
LAN	Local Area Network
OODA	Observe, Orient, Decide and Act
OS	Operating System
PC	Personal Computer
QOS	Quality of Service
SDN	Software Defined Network
SME	Small and Medium Enterprise
SNMP	Simple Network Management Protocol
SVG	Scalable Vector Graphics
TCP	Transmission Control Protocol

UDP	User Datagram Protocol
VLAN	Virtual Local Area Network

Chapter One

Introduction

1. Introduction

1.1. Preface

Despite their widespread adoption, traditional networks are complex and very hard to manage. It is both difficult to configure the network according to predefined policies, and to reconfigure it to respond to faults, load and changes. To make matters even more difficult, current networks are also vertically integrated, which means that the control and data planes are bundled together [1].

Software-Defined Networking (SDN) is an emerging paradigm that promises to change this state of affairs, by breaking the vertical integration, separating the network's control logic from the underlying routers and switches, promoting (logical) centralization of network control, and introducing the ability to program the network. SDN makes it easier to create and introduce new abstractions in networking, simplifying network management and facilitating network evolution [2].

The motivation of this research is to take advantages of the new centralized networking approach of SDNs and implement remote configuration of virtual local area network (VLAN) from a single controlling point. The purpose of this project is to analyze the possibilities that SDN provides to develop a more efficient resources allocation along the network when more than one possible route between source and destination exists. The case study that has been adopted to test the feasibility of this approach is load balancing between different VLANs.

1.2. Problem Statement

Data traffic in networks has been escalating exponentially since the beginning of networking at the same time that user demands for new kind of services increased. Those factors led to a complex networks that cannot satisfy the needs of service providers, application developers and end users, and resulted in making the user requirements exceed the capabilities of the microprocessors. All these factors caused the appearance of load balancing concept [3].

So far load balancing is applied at network layer level, but as a consequence of that, network performance is degraded and additional traffic is generated to achieve the load balancing.

1.3. Proposed Solution

The concept of SDN gives computer system more flexibility in changing the network configuration automatically. This flexibility can be used to increase the network performance by bringing down the level of load balancing to layer-2. Therefore SDN change the load balancing concept from network procedure to processor procedure.

In this thesis an implementation of remote configuration using SDN approach is achieved, which is based on balancing the load of VLANs by sending the configuration file that balance the load of different VLANs from the SDN controller to the switch that contains these VLANs.

1.4. Objectives

- To simulate VLAN to be the SDN Data plane.
- To assure the connectivity between the control plane and the data plane.
- To simulate SDN Control functionality by pushing configuration files to the network nodes.
- To develop SDN Controller using Computer Programming Language.

1.5. Methodology

In order to achieve the objectives of this research, deductive approach and evolutionary prototyping are adopted [4].

This thesis focuses on the implementation of SDN approach on VLANs to automatically change its configuration and to achieve a high level of performance and reliability by changing the Topology of the network with less manual work by sending desired configurations via SDN Controller to reconfigure fail routers or configuring new routers in less time, just by configuring one interface with the appropriate access configuration, and send the rest of the configurations as one packet file.

After building VLANs on a network simulator, three phases of development has been followed to reach the expected result, start by testing whether the VLANs can be accessed from a remote control point or not, then a complete configuration file has been sent and executed, and finally SDN controller has been constructed using a programming language to make the process of file sending done automatically.

By taking load balancing as a case study, two cases have been discussed. The first case which is the normal or the default case is based on sharing the

network traffic between two routers in half; this case assumes that the traffic that comes from all the network elements is equal. The second case assumes that some network elements generate traffic more than the rest and thus one of the two routers will handle 60% of the network elements and the second one will handle the rest.

1.6. Research Outlines

In the next chapter, Chapter Two serves as the literature review of the SDN and CN systems. It highlights the timeline of the SDN development with a survey of its infrastructure, and its relationship with CN. Chapter Three addresses the different network load balancing techniques and strategies and analyze the possibilities that SDN provides to develop a more efficient resources allocation along the network when more than one possible route between source and destination exists. The aim of Chapter Four is to discuss the implementation procedure that has been followed. Finally the conclusion and the future works are drawn in Chapter Five; the appendix constitutes the visual basic code.