Notice of the Final Oral Examination
for the Degree of Doctor of Philosophy

of

FAHAD GHONAITEM

MEng (University of Victoria, 2011)
BSc (King Abdul-Aziz University, KSA, 2007)

“Adaptive Router Bypass Techniques to
Enhance Core Network Efficiency”

Department of Electrical and Computer Engineering

Thursday, March 29, 2018
1:00 P.M.
Engineering and Computer Science Building
Room 468

Supervisory Committee:
Dr. Thomas Darcie, Department of Electrical and Computer Engineering, University of Victoria (Co-Supervisor)
Dr. Sudhakar Ganti, Department of Computer Science, UVic (Co-Supervisor)
Dr. Stephen Neville, Department of Electrical and Computer Engineering, UVic (Member)

External Examiner:
Dr. Ljiljana Trajkovic, School of Engineering Science, Simon Fraser University

Chair of Oral Examination:
Dr. Nathan Lachowsky, School of Public Health and Social Policy, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies
Abstract

Internet traffic is increasing exponentially, driven by new technologies such as Internet of Things (IoT) and rich streaming media. The traditional IP router becomes a bottleneck for further Internet expansion due to its high power consumption and inefficiency in processing the growing traffic. Router bypass has been introduced to overcome capacity limitations and the processing costs of IP routers. With router bypass, a portion of traffic is provisioned to bypass the router and is switched by the transport layer. Router bypass has shown to provide significant savings in network costs. These advantages are limited by a reduction in the statistical multiplexing associated with the subdivision of the available bandwidth typically into bypass and traditional portions thus limiting the interest in bypass techniques.

This thesis will explore multiple techniques to enhance the efficiency of router bypass. The main goals are to address the issue of the reduction in statistical multiplexing and to add a dynamic approach to the router bypass mechanism.

The recent advancements in the Optical Transport Network (OTN) play a major role in the transport network. This proposal takes full advantage of OTN in the router-bypassing context by applying recent developments such as Hitless Adjustments ODUex (HAO), which allow the provisioned channels to be adjusted without re-establishing the connections. In addition, it will allow the bypassing mechanism to be flexible enough to meet the traffic behaviour needs of the future. This thesis will study multiple approaches to enhance the router bypass mechanism including: an adaptive provisioning style using various degrees of provisioning granularities and controlling the provisioning based on traffic behaviour. In addition, this thesis will explore the impact of automation in Software-Defined Networking (SDN) on router bypass. The application-driven infrastructure in SDN is moving the network to be more adaptive, which paves the way for an enhanced implementation of router bypass.

Many challenges still face the industry to fully integrate the three layers (3, 2, and 1) to transform the current infrastructure into an adaptive application driven network. The IP router (layer 3) is provisions and restores the connection regardless of the underlying layers (layer 2 and 1) and the transport layer does the same regardless of the IP layer. Although allowing every layer to develop without being constrained by other layers offers a huge advantage, it renders the transport layer static and not fully aware of the traffic behaviour.

It is my hope that this thesis is a step forward in transforming the current network into a dynamic, efficient and responsive network. A simulation has been built to imitate the router bypassing concept and then many measurements have been recorded.