Comparing the implementations of Network Coding on different OSI layers – Work in Progress

Jacobus L. van Wyk, Albertus S. J. Helberg, Leenta M.J. Grobler
This work is done in the Telkom-Grintek Centre Excellence together with the Telenet Research Group, School of Electrical, Electronic and Computer Engineering, North-West University, Potchefstroom, South Africa
(phone: +2718 299 1961; e-mail: 20026277@nwu.ac.za*).*

Abstract—Network coding is a method that can improve the throughput of a network by combining multiple messages into one message of the same length as the original messages. Network coding can be implemented in various layers of the OSI protocol stack, but the different implementations have not been compared with one another. In this paper we propose an evaluation of selected implementations of network coding in the different layers of the OSI stack. This evaluation will be based on the throughput of a wireless ad hoc network in a simulation using OPNET.

Index Terms—Multicasting, Network Coding, OSI protocol stack, Wireless ad hoc network.

I. INTRODUCTION

Wireless networks have grown significantly in terms of capability and implementation, as a result of its connection flexibility. It is this characteristic that pushes technology and research even further to find new ways to accommodate the ever increasing needs of people. Network coding is a technique used to increase the throughput in a network. There are different ways to implement it in a network.

II. BACKGROUND

A. Network coding

Network coding [3][5] is a technique used to increase the capacity of a network by combining multiple messages sent over the network into a message of the same length as the messages it consists of. It can be used as long as the intended recipients have a sufficient number of the original messages so that is can decode the network coded message by using the original messages. Linear network coding [8] uses an algorithm that combines messages so that the result is a linear combination of the original messages. Linear network coding is often preferred over non-linear versions because it is easier to understand and implement. Linear network coding can easily be implemented using a XOR to combine messages without the result being larger than the constituting messages. The original messages can be derived from a combined (XORed) message if the combined message is XORed with all but one of the original messages. Therefore if messages can be sent through multiple paths in a network, network coding can be implemented because some original messages can be distributed along other paths to be used by the final destination for decoding a network coded message. One type of network that may benefit from network coding is a MANET.

B. Wireless ad hoc networks

A wireless ad hoc network [3] is a network consisting of wireless nodes; no other infrastructure besides the wireless nodes themselves is needed. The entire network consists of the nodes and the network organises and manages itself. Depending on the routing protocol, a path is created on demand, or a routing table is used. Data is passed on from one node to another to the final destination. Various methods of data transmission can be used, including unicasting, multicasting or broadcasting.

In a wireless ad hoc network, all that is needed to create a network are the nodes themselves, and this makes these networks more flexible, reliable, and possibly cheaper as well. These characteristics cause wireless ad hoc networks to become increasingly popular.

The unstructured arrangement of ad hoc network nodes make these networks ideal for network coding because multiple paths from one node to another often exist.

A wireless interface is necessary for mobile networks, and the broadcast nature of wireless networks also contribute to making it more ideal for network coding, because adjacent nodes can overhear messages which it can later use for decoding network coded messages. When we consider implementing network coding, it is necessary to consider where in the OSI stack to do this.

C. OSI model

Communication systems are divided into a set of layers. Each layer has certain tasks to ensure communication with another system. Standard protocols are used on each layer so that systems can communicate [6].

Two popular layered models are the TCP and OSI models. The TCP model is used in the internet and has four layers, while the OSI model has seven layers. These two models layers serve the same purpose and largely coincide:

TCP	OSI
Application	Application
	Presentation
	Session
Transport	Transport
Internet	Network
Link	Data link
	Physical

We want to use our knowledge of the technology discussed in sections A, B and C in order to propose the following research:

III. PROPOSED RESEARCH

Network coding has definitive advantages, and can improve the throughput of a network. It can be implemented in various ways and in conjunction with a variety of protocols. The diverse implementations of network coding can be seen in the following articles: [1-5, 7-9, 11].

The fact that network coding can be applied in so many different ways makes it difficult to create a definite standard. Considerable research has lead to even more possibilities. No research has been done on where network coding is best or most efficiently implemented in the OSI model for wireless networks. A simulated network can be created, where network coding is implemented and tested on the various layers of the OSI protocol stack. The OSI model is chosen because it contains everything in the TCP model and has more detail. In order to do this we plan on using a specific methodology.

IV. METHODOLOGY

Several simulations will be done in OPNET to determine where network coding can be done most efficiently. OPNET will be used because it uses validated models. Network coding will be implemented at as many as possible layers in a wireless network. The changes in throughput as a result of the implementation on the various layers can be compared to each other. Standard or most used protocols will be chosen at each layer.

The purpose of this research will be to test existing protocols with network coding. Choosing a standard well known network typology and setting up each node's routing manually will be beneficial. The well known butterfly [12] or bowtie network can be chosen to use as it is easy to understand and set up.

Network coding causes complications with the routing of data. As two data units are added into one, the protocols used only provide space for one address and the data will only be routed to a single address. The data will not be delivered to both intended destinations, and thus a method will have to be implemented to ensure that the data reaches both destinations. Multicasting can be implemented on the different layers as network coding is applied in each applicable layer to resolve this problem.

V. CONCLUSION

Network coding has already been proposed in different layers in the OSI stack. (This work [3-5, 11] can be used to aid in the proposed research.) The protocols and routing methods will be selected so that each test is subject to the same conditions. The network throughput due to network coding can then be compared from the different layers.

VI. REFERENCES

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Jacobus L. Van Wyk is currently pursuing a M.Eng degree in Computer Engineering at the North-West University in the Telenet Research Group (Telkom-Grintek Centre of Excellence). He received his B.Eng degree in Computer and Electronic Engineering in 2008 from the same institution.