

Network resource optimization

[Technology](#), [Computer](#)



Introduction

This paper investigates the ground for the network resource optimization work needed to be done in the framework of Publish/Subscribe (PUBSUB) network [psirp]. This work forms part of the project which will be undertaken in Summer Term (2010-2011) in fulfilment of the Masters Degree (University of Essex). As the project title says “ Lightpaths in Publish/Subscribe Internet Model”, the work is more focussed on developing the strategies for optimum utilization of the optical network to reflect data flows and the decisions made at routing layer of the information centric network (ICN). As the project uses two different networking notions i. e. pubsub ICN model and optical networking concept, this paper researches the background for these fields and tries to argument how they are viable candidates for the future internet. It also explains where the proposed work will fit in big picture.

Since 1970's (ARPANET) [isoc], internet has undergone immense transformations. Internet traffic is growing not just in statistical figures but also in different types of applications it is supporting today e. g. triple/quadruple play services (voice, video, data). It is being accessed today in different forms i. e. fixed landline connections to WiFi hotspots. Key market players like Cisco predict that data hungry applications like video will remain at the heart of internet usage and will contribute to the majority of the internet revenues [cisco]. Though service providers see these strong earning opportunities, challenges are posed for them to keep customers happy while making optimum use of network resources to serve more customers.

Progress in DWDM and EDFA technologies has spurred the desire of having

all optical networks [alca][cam]. Number of networking bodies today are working on building efficient total optical solutions, which are gradually making to the market to leverage the very high transport capacity offered by them (in Terabits/s) [rat].

Though service providers get away with the capacity constrain with the use of optical transport networks (OTN), they are facing problems managing t the IP layer causing possible performance bottlenecks. Blumenthal et al [blue] has thrown light on some of these problems like host centric design i. e. more focus on host to host connectivity than information being delivered. This imposes lot of overhead (maintaining states) on the multicasting services such as news, IPTV, BBC iPlayer [marco2]. It needs more control information which consumes the data bandwidth. The design, by default favours the sender, giving him/her extra power to disseminate the content to desired hosts; this accounts to unnecessary traffic along with the possibility of untrustworthy content being received. Security and mobility were added as top up components [msc]. Attempts are being made to overcome these problems like moving to IP version 6, New Internet Routing Architecture (NIRA), Translating Relaying Internet Architecture integrating Active Directories (TRIAD), Routing on Flat Labels (ROFL) [msc] etc. But all these solutions are still based on underlying IP mattress. Networking experts across the world (Van Jacobson, David Clark, Dirk Trossen) [tow][arg][blue] are hinting for the green field efforts for redesigning the internet by keeping information at the centre of the design and envision this as the internet of the future.

This project focuses on deriving the optimum traffic handling strategies for the optical layer in context of the content centric network (CCN). The work will include building simulations for various network scenarios such as different topologies and data characteristics and verification of those with the test-bed. This paper, chronologically, explains the driving factors and motivation behind this work and also looks at its economical and commercial benefits. Proposal section describes the structure, scope and methodology of the project. Work plan breaks down the project into tasks and shows with the help of Gantt chart how are those placed in time. Finally paper concludes by summarising the outcomes of planning and background study.

Contextual Review

The contextual review illustrates the technical benefits of this project and also covers the other work done/being done in this area. It also mentions economical impact this will have and tries to foresee the market this work may help.

Technical Review

The body of this project is placed on two legs pubsub networking model and optical networking. The project greatly benefits from the earlier work done in these areas. As the work related to ICN is still in research phase, it makes sense to have a look at the technical driving factors after it and to re-view the optical network in context of that. One by one, it tries to elucidate the driving factors behind these fields, their advantages and gain of combining them.

Motivation behind Optical Networking

Due to advancements in DWDM and EDFA, more light wavelengths can be injected into the fibre tremendously increasing the fibre capacity in ranges of terabits [rat]. Research in optical network elements is making them reach longer distances without amplifiers i. e. reducing the network elements and points offailurein the network.

Having multiple wavelengths in the fibre facilitates on demand light path creation (using OADM) allowing effective on the fly bandwidth management [rat][marco1]. However changing the network dynamically is risky task and needs better control. The O-E-O switches allow the demarcation of control and data plane yielding greater speed and flexibility in data forwarding plane which is controlled by but decoupled from the routing layer [marco1]. This concept is similar to that of MPLS but as the current network owners are not ready to shred the already deployed equipments to reap their investments, hence Generic MPLS plays important role where the forwarding tables can be shared by multiple forwarding fabrics. Efforts have been made (Eiji Oki et al) [oki] to engineer the IP and optical networks using GMPLS. Their work is more close to the work this paper tries to present but in framework of CCN. Eiji also talks about concept of traffic grooming which is very much relevant.

Work done by Marco et al [marco1][marco2] experiment an optical switching based on various IP properties e. g. in [marco1]the IP packets heading to identical destinations are clubbed and switched together. In previous work, switching is applied to prolonged, huge IP flows. In Paper [marco2] Optical Flow Switching is explored which switches the flows of the IP traffic by

dynamically setting up the links. It is similar to the work this paper proposes where switching decisions will be made by the content and its properties.

Flow switched optical network creates dynamic pass-through circuits at the intermediate nodes such that the data is forwarded from source to destination at the optical layer without any need to go to electrical layer. Further identical flows can be groomed together [marco2]. This feature encourages lot of equipment vendors and market players because of the economic benefit it offers. It takes load off the routing layer i. e. no need to make per hop decisions as in case of today's IP networks; forwarding can be performed in hardware and hence faster than routing. This allows network operators to carry more customer traffic with the same infrastructural setup.

Motivation behind PUBSUB model

The work this paper presents is targeted for ICN. Number of network research bodies and market players together (PERSUIT, PSIRP, CCNx) [psirp] [ccnx][needed] are already working on ICN designs and lot of work is being done in related areas. It does address the problems faced by IP networks and also add some new features of its own as described below.

Information centric approach – The nature of the applications is becoming more demanding not just in size and format of the content (like Video and VoIP) but also in timely delivery. But for service providers managing overload of control information and accessing the domain named services is becoming challenge with IP paradigm. Dirk in his paper [arg] points out that keeping information at the centre of the design truly makes sense. It will be easy if

the information is uniquely named and distributed reducing the middleware load and making it easy to access [arg].

Receiver focussed design – Receivers have power to choose the type of information they want to receive by subscribing only to that information. This benefits both end users and network providers; it inherently reduces the spam and possibility of attacks at the user end and results in sensible use of the network infrastructure for providers [msc].

Security and Mobility – Security and mobility will be embedded into the architecture unlike the add-ons in IP suite. With expected growth in mobile markets with 4G and entry of devices like smart phones, embedded mobility solution is a great asset for mobile players for efficient handling of their networks [ill][cisco].

Multicasting and Active Caching – In CCN, the edge network nodes actively monitor the content being accessed and caches the same if it is being accessed too frequently. This helps in reducing the redundant traffic through the core allowing fair utilization of the network [msc]. Multicasting is achieved through the innovative concept of zFilter [ill] which is performed at the forwarding layer. This makes it faster with most of the decisions made off the routing layer, which is attractive feature simplifying the task of network configuration.

Other work in progress – Apart from PSIRP, project like CCNx and 4WARD [ccnx][4ward] also put forward the notion of CCN for future internet. CCNx tries to get the desired content by naming it in levelled manner and 4WARD

tries to find the efficient ways to route the data over heterogeneous networks [ill].

There are some strong advantages of combining optical networks with pubsub model e. g. both of them believe in local decision making than configuring end to end paths. Dynamic optical layer can share the pressure at the routing layer for efficient content delivery resulting in fair use of the infrastructure [marco1].

Economical and Commercial Review

Apart from the research bodies and universities, people from the key market players like BT and Ericsson, Xerox [ill][lipsin][ccnx] are also actively involved in the pubsub work, unlike the earlier internet designed by the government bodies [isoc]. This has two advantages; it allows addressing the practical problems faced by these companies right at the design level rather than added as patches later on. When it comes to actual deployment of the researched work, it will have ready acceptance from these industry players and their partners which is a big plus from commercial point of view.

The work directly affects to the companies in content distribution network like Akamai, Limelight Networks [cdn]. Inherent smart multicast and caching abilities open new opportunities to them allowing cost-effective data distribution.

Further Dirk in his paper [driver] comments that metadata databases in the CCN can be used for pricing the specific services in fair manner. This does not need any burden on data bandwidth such as deep inspection or bid

packets to differentiate between the streams. Thus CCN may change the way the end user is charged.

Last point worth mentioning is CCN routers consume less electrical energy as compared to the current IP based content distribution strategies like P2P or content distribution networks [green]. Concepts like caching reduce the transit traffic helping in less energy consumption. Also less O-E-O conversions contribute to save the energy consumption at intermediate nodes.

Proposal

This project falls under PURSUIT [pursuit] which is continuation of the PSIRP project. This project will contribute to the forwarding plane related work of the PUBSUB networks, implemented using O-E-O routers. As PUBSUB uses optical networks in the ground, it is about optical traffic engineering i. e. creating on demand light paths in the network in order to make efficient use of resources. It can be explained with the figurexyz below.

NEED DIAGRAM HERE

X, Y, Z are OEO routers, inner circle shows the optical layer and outer circle depicts the electrical layer of the network. There is traffic flowing from XaY on wavelength λ_1 and also some traffic from XaZ on the same wavelength. After some time due to congestion at node Y, the traffic at Z experiences performance issues.

At this stage decision should be made to cut another wavelength λ_2 from XaZ, which is configured as pass-through at node Y so that it does not go to electrical layer and the performance at node Z is restored.

Another important decision needs to be taken is when to shut down this light path i. e. if the traffic at node Y has minimised to earlier levels, so that optical layer has minimum number of wavelength to deal with.

The decision of cutting a new wavelength will be made based on two things,

Size of the content which is going to flow – In CCN, we can know beforehand the amount of data which will flow through the nodes by looking at its metadata. If the data consumes the substantial amount of wavelength capacity then it makes sense to cut a new wavelength.

Quality metrics at the intermediate nodes – Some quality metrics at the intermediate node such as delay might make a decision to cut another wavelength when it goes beyond some threshold.

So the project fully focuses on creating/destroying new wavelengths depending on the quality metrics at the electrical layer or based on the content.

Scope of this project is limited to building simulations and then verification of them using test-bed. The simulations will be performed using proprietary simulator to study the various networking scenarios e. g. for different delay thresholds and topologies. This will yield statistical graphs for number of wavelengths in the network and delay characteristics which can be studied

further for optimization. Next step is verification of these results with the help of 3-node test-bed setup as shown in figurexyz. Though the work is limited to 3- node setup, it will serve as a prototype for the further research.

The work done can be gauged on two things,

The statistical results (graphs) generated from the simulations. Expectation is that, it will generate number of curves for delay vs number of wavelengths which will show some sweet spot where both of them are at the optimum level.

Results of the test-bed which will verify the rules of thumbs generated with simulation.

Project Plan

The project work can be broken down in the following tasks and subtasks.

Background Study – This includes numbers of things like,

Understanding concept of PUBSUB and Optical Networking

Literature Review

Project Proposal

Study of a simulator – It is necessary getting acquainted with simulator before the project approaches simulation stage. Hence initial time of the project is assigned for it.

Generating Representative Traffic Model (RTM) – This step involves defining the data models for PUBSUSB network which will be part of metadata. This will help in identifying huge data flows by reading the metadata content.

Identifying Simulation Scenarios – This will decide what type of simulation scenarios to include e. g. networks with different topologies and data stream with different quality metrics and actually running these scenarios to collect the statistics. This can be further broken down in three cases.

Modelling network with huge traffic flows

Modelling network with different delays at intermediate nodes

Modelling network with different delays and different topologies

Modelling network with different types of traffic (if time permits)

Network Optimization – It is concerned with generating rules of thumb for particular traffic or topologies from statistics collected from the simulations.

Test-bed Verification – The rules of thumbs generated from optimization process will be verified for proof of principle using the 3-node test-bed setup.

Report writing and presentation – Last one month of the project is dedicated for report writing and for preparing the presentation.

Conclusion

References

Internet Society (ISOC) All About The Internet. (Undated). History of the Internet. [Online]. Viewed on : 2 March 2011. Available: <http://www.isoc.org/internet/history/cerf.shtml> (isoc)

<https://assignbuster.com/network-resource-optimization-research-paper-samples/>

Cisco Systems. (2010, June). Cisco Visual Networking Index: Forecast and Methodology, 2009-2014. [Online]. Viewed on: 2 March 2011. Available: http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-481360.html (cisco)

Content Centric Networking (CCNx) Source. (Undated). Welcome | Project CCNx. [Online]. Viewed on: 2 March 2011. Available: <http://www.ccnx.org/> (ccnx)

Content Centric Networking (CCNx) Source. (Undated). Welcome | Project CCNx. [Online]. Viewed on: 2 March 2011. Available: <http://www.ccnx.org/> (ccnx)

(Undated). The FP7 4WARD Project. Viewed on: 2 March 2011. Available: <http://www.4ward-project.eu/> (4ward)

<http://www.psirp.org/> (psirp)

<http://www.fp7-pursuit.eu/PursuitWeb/> (pursuit)

<http://gigaom.com/2007/08/06/cdn-price-wars/> (cdn)

Alcatel Optical Networks Tutorial (alca)

Arun Somani, Cambridge (cam)

The Rationale of Optical Networking (rat)

Illustrating a Publish-Subscribe Internet Architecture (ill)

Rethinking the Design of the Internet: The End-to-End Arguments vs. the Brave New World (blue)

<https://assignbuster.com/network-resource-optimization-research-paper-samples/>

AcademicDissemination and Exploitation of a Clean-slate Internetworking Architecture: The Publish-Subscribe Internet Routing Paradigm (msc)

Towards a new generation of information-oriented internetworking architectures (tow)

Greening the Internet with Content-Centric Networking (green)

Arguments for an Information-Centric Internetworking Architecture (arg)

Not Paying the Truck Driver: Differentiated Pricing for the Future Internet (driver)

LIPSIN: Line Speed Publish/Subscribe Inter-Networking (lipsin)

Optical IP Switching for dynamic traffic engineering in next-generation optical networks (marco1)

Optical IP Switching: A Flow-Based Approach to Distributed Cross-Layer Provisioning (marco2)

Dynamic Multilayer Routing Schemes in GMPLS-Based IP+Optical Networks (oki)