Using Open Source based solutions to bootstrap!

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Abstract

Open Source based products and solutions are in many cases a cost effective alternative to proprietary solutions and could be used by anyone to build their "Digital highways" at a fraction of what proprietary alternatives would cost. This paper highlights some of the work that has been done in Sweden to demonstrate the use of such a product in production networks – the Bifrost router, and discusses the entrepreneurial opportunities available, especially in the context of the establishment of research and education networks in Africa.

1. Introduction

Good infrastructure, including communication networks, is a fundamental requirement for the development of any country. Building such infrastructure, however, requires huge capital investment. Reducing the capital expenditure on infrastructure is valuable since any savings on the purchase of hardware and software can be used to offset development costs of services and applications. In this paper we show how to take advantage of readily available systems based on Open Source software and selected off-the-shelf hardware components for communication infrastructure. We illustrate how such components can be used for large production networks,

such as dedicated networks for research and education, including campus networks connected to National,Research and Education Networks (NRENs) [25] connected to dedicated regional and global backbones., such as GÉANT, INTERNET2, RedClara, TEIN, etc..

We focus on the Bifrost router that has been extensively tested in production networks in Sweden since more than ten years [11] and currently is being tried in some African countries [4,5].

There are other initiatives in the routing area that are approaching production quality, including:

- XORP [23] that is written in C++ and has an IP multicast implementation.

- BIRD at the Faculty of Math and Physics, Charles University, Prague, Czech Republic, implements BGP and OSPF, although OSPF still only IPv4.

2. Emerging NRENs in Africa

Over the past several years there have been ongoing discussions in regard to the issue of setting up terrestrial networks interconnecting African universities, research institutions and other tertiary educational institutes on the continent. There is strong consensus amongst all stake-holders that partaking in the global information society is the way forward.

These NRENs would form such a dedicated network interconnecting the institutions in each country. The interconnected institutions would then be able to share resources and access global research and education data directly by interconnecting these dedicated networks to each other and to the already existing corresponding networks on other continents. The NREN members would also be getting Internet access more effectively and efficiently than via the current satellite based connections from each institution or even research group.

New intercontinental submarine cables and an emerging terrestrial optical fibre infrastructure are increasingly making this reality possible. This new infrastructure will create a wealth of new opportunities not only in the area of research and higher education, but in all sectors of society.

With the will demonstrated to establish research and education networks, the next question that crops up is how to best use the limited resources that can be raised to carry out these projects and at the same time serve their countries by educating students that can take advantage of the new opportunities.

In order to build the necessary infrastructure, an option to be considered is for the institutions of the

continent to educate her greatest resource – the human resource. The infrastructure together with a well educated citizenry is what will best serve the continent.

3. Work at KTH

The Royal Institute of Technology (KTH) [1] in Stockholm has over the past decade been involved in different projects both at the campus and at different locations in Africa in order to support the students to serve their home countries by taking advantage of the new opportunities.

Post graduate students at KTH's School of Information and Communications Technology have carried out various projects as part of their problem-oriented, project-driven Communication Systems Design course (CSD) [2]. Most of these projects have been carried out using Open Source based products, including the Bifrost router.

Work is underway to deploy the Bifrost router in the upcoming NRENs, MAREN in Malawi [4] and MOReNET in Mozambique [5]. These networks have been designed by KTH post graduate students in their final years basing the designs on the Bifrost router.

All these projects demonstrate clearly that Open Source solutions work and work well just like the proprietary ones except that the Open Source variant is relatively cheaper with a much lower total cost of ownership (TOC) [6]. This means that by deploying Open Source based solutions in the emerging NRENs, Africa could do more with less money. And these products and solutions could be the answer to at least some of Africa's problems. And they could easily be the missing piece in the puzzle.

Apart from the economics, there is another aspect which people tend to overlook in many cases. This is the transfer of knowledge and technology that comes with these products. As the name implies, Open Source products are open for everyone to be able to dig in and see how the devices work were designed and in some cases modify them to suit local requirements. If these products are embraced, people in Africa would benefit through this technology transfer. Students at universities and other institutions would have a chance to indulge into the devices to a level that would otherwise be impossible with proprietary systems. This is important because it ensures that the Africans will be able to participate in further development of the technology and in so doing gain knowledge without having to pay a hefty fee for doing so.

4. The Bifrost Open Source based router

The Bifrost router [3] was initially developed by a team at the Swedish University of Agricultural Sciences in Uppsala more than a decade ago. Since then, the router has been deployed in the university's own production networks and at the Karolinska Institute of Medical Sciences where in both cases, it has operated reliably over the past ten years [11, 18].

The router uses a very slim and robust version of the Linux operating system and takes advantage of other Open Source projects such as Zebra and Quagga [22]. Quagga, a fork of the Zebra software, offers production quality code for BGP/OSPF RIP, RIPNG for both IPv4 & IPv6 and supporting Unix like platforms such as Linux, NetBSD, FreeBSD and Solaris. Other projects that the Bifrost router relies on include command line utilities that are used for configuration and operation such as iproute2[26] . Bifrost also includes optimized drivers for selected off-the shelf hardware components, including network interface cards up to 10 GE with optical ports and support for digital optical monitoring. The operating system and all the utilities of the Bifrost router can be stored on a bootable flush disk such that one avoids the electromechanical devices e.g. hard disk. This dramatically improves the reliability and durability of the router.

As the Linux community constantly develops the kernel, some of these developments have direct impact on the router and are reflected in its increasingly better and enhanced performance. An example of such development is the kernel's support for multi queues which effectively enhances the router's throughput. The latest version of the router has reached speeds of 10Gbps [10]. This version has been deployed in a 10G fibre optic network, incorporating a high definition video conferencing and streaming link between KTH in Kista and the Karolinska Institute in Solna just outside the city of Stockholm [13].

More and more research is being initiated to increase the scalability of open source routing exploiting ideas developed in an IETF working group to separate the control and forwarding planes of routing elements [12]. Additionally, some European projects regarding virtualization are ongoing [14]. More research in this direction is also being proposed in the context of Future Internet Research programmes [15,16].

5. Commercializing Bifrost

OpCon, one of the KTH CSD teams, developed a business plan template that could be used by anyone who would interested in starting a business around this router in Africa to take and use the template to write a business plan for the startup [7]. The idea here was and still is that apart from helping the continent to build her infrastructure with solutions that cost a fraction of the proprietary alternatives, individuals and companies could actually earn money by starting businesses around these products and solutions. Before writing the business plan template the team did extensive research and market analysis work and

carried out case studies on four major companies dealing in Open Source products in order to understand the these companies did business around such products [8].

Among the companies the OpCon team closely looked at was Vyatta,[17] an American company that is offering Open Source based routers in North America, Canada and the far East. Corporations and educational institutions in these regions have started embracing the idea of this Open Source based products phenomena. Vyatta is interesting in this regard because they are offering a similar Open Source based product even though at the time of writing, there's no evidence showing Vyatta's entrance into the African router market.

Recently we have noted a new comer to the market, the Swedish company Really Nice Routers (RNR) [24]. This company has a range of routers based on Bifrost. Although there's no information on their web site regarding services and pricing, they seem to be focusing on an entirely different market segment.

As a proof of concept, two actual business plans discussed in section 6 were written for startups in Malawi and Mozambique where the technical (MAREN and MoRENET) teams were designing networks for the NRENs in those countries [4,5] . Any one of the two business plans could be adopted for other countries on the continent with just slight modifications.

6. New Business Model

As an extension to the work carried out by the OpCon team, one of the team members opted to carry on where the team left off and to undertake further research on the business model [9]. His work included a survey among potential customers of the routers in universities, research institutions, hospitals, banks and ISPs in various countries on the continent. Results of this survey indicate that there is awareness, openness for and willingness to use Open Source based solutions in the respondents' networks. However, in order to succeed, certain conditions have to be met by the suppliers of such solutions. See figure 1.

Among the conditions cited were guarantees for good technical support, prompt resolution of problems, proper documentation on equipment and the assurance that the supplier will be around for support. Basing on these findings, the business model that was proposed by the OpCon team has been revised in order to address the issues raised by the respondents. OpCon's model put all the responsibility of procuring components for the router, building and testing the router, marketing, offering and managing technical support on the individual start-ups without any central control or supervision. This could lead to severe problems for both the start-ups and the customers.

The new model proposed in the thesis report introduces a third entity called the "Central company" which would take care of the component procurement, building and testing processes and take care of all the customer relationship management, central fault reporting system and technical support management. This would improve aspects of customer satisfaction

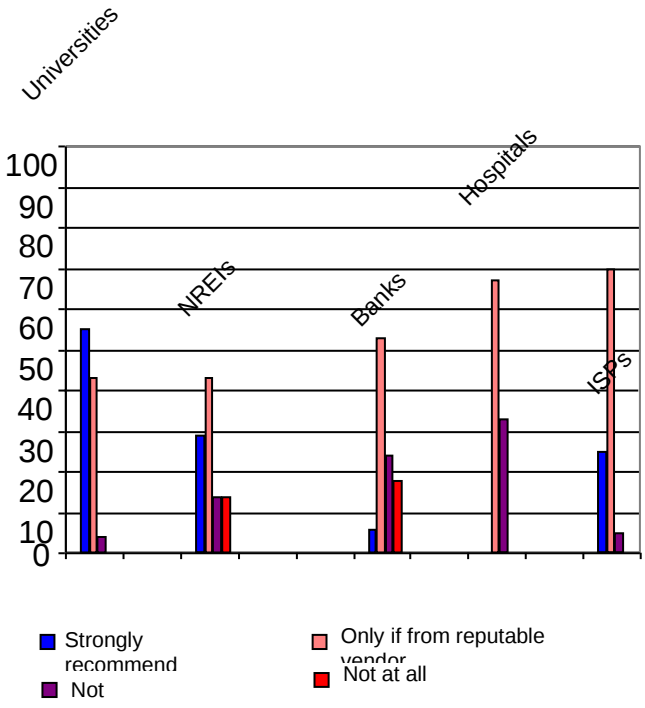

Figure 1 shows how different interviewees responded to the question of whether or not they would recommend use of Open Source based solutions in their respective networks. The interviewees were people responsible for computer networks at their respective institutions, e.g. Network managers, Network administrators, System administrators etc at the various institutions. Sourced from [9].

7. Conclusion

In this paper we have tried to show how Open Source based products and solutions could help Africa not only to develop her information sharing infrastructure so that the continent can effectively be part of the information age society but at the same time making sure that her people get the necessary skills that are lacking today.

With the Internet penetration rate on the continent expected to have an exponential trend in the next few years, individuals and companies could benefit too by creating businesses that offer services around these products such as support and training.

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