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Internet by Ethernet

From: Comnet/Aalto University

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Introduction

Power density and power consumption by Routers is already a problem. The higher up in the protocol stack switching takes place the more power is consumed. While optical switching lacks maturity or the necessary flexibility to efficiently serve Internet –like traffic, the most power efficient solution is to simplify the Network architecture and push all electronic switching to L2. This implies that routing, TE, network virtualization, network hiding and mobility management need to be supported on L2. At the same time, the current Internet is bogged down by unwanted traffic. We see this as a consequence of a missing Trust Architecture. It must be possible to deploy L2 based Internet smoothly. Each step must have the right incentives in place.

There are two significant hindrance factors to deployment of solutions involving battery powered devices. One is that there is no uniform and agreed way of making these devices reachable on the Internet using an interrupt driven architecture. The recommended solution is UNSAF that uses polling leading to fast depletion of the battery. Moreover, UNSAF requires application specific code in hosts. Other, tailor made, application level solutions are also being proposed. The second issue is that once reachable, such a device becomes vulnerable to attacks and unwanted traffic. The well known protection tools that work on PC's do not scale to battery powered devices. A firewall on a battery powered device will only deplete the battery faster leading to DOS. These problems apply equally well to mobile devices.

IPv6 is the official protocol that is supposed to follow IPv4. We believe that this is wrong. Instead of solving scalability problems, IPv6 is likely to make them worse. The idea of a flat address space is unsuitable for battery powered devices and most future networked devices are going to be battery powered. Long addresses and large packet header overhead are not suitable for small devices. We want to hide from the world most devices we may own in the future although we want to access them from our own controller devices through the network. Instead of IPv6, we should base global communication on *globally unique names, locally significant addresses and locally significant identities*. We propose Customer Edge Switching and the Trust-to-Trust protocol to do this. The T2T protocol lets the receiving network decide based on policy and state weather to admit an incoming packet or drop it. Customer Edge switching integrates packet access control into the global Internet architecture. CES makes battery powered devices reachable without polling, i.e. the access is interrupt-driven. CES is still a reactive solution similar to Firewalls. We propose to address the problem of unwanted traffic *proactively* by a new global trust architecture that pushes the cost of communication from the receivers to the senders.

Synchronous transport links run with constant capacity. When used in for transporting bursty data traffic, all bits carried use energy but most of them are meaningless. Energy efficient Ethernet (EEE) standards are being created by the IEEE. The first of them 802.3az, applicable to copper links, is available. One cost driver is broadband wireless and mobile networking. For example LTE access network will consume up to 40 times more power than a GSM access network. It is expected that the sleep mode in EEE will save hundreds of millions of Euros worldwide when deployed. Another energy cost driver is higher capacity that is needed for the Future Internet links: with a given technology energy consumption tends to grow relative to the second power of link speed. With terabit links just a few years in the future, energy consumption with the current technology base and network architecture is becoming intolerable.

The current protocol stack is IP or IP/MPLS over PPP or Ethernet over SDH/PDH. When the underlying transport changes to Ethernet, the PHD/SDH layer is removed saving energy and OPEX as well as CAPEX. Ethernet frames have addresses. When Ethernet is enhanced for wide area, another equipment layer, namely IP Routers can be eliminated. At the same time, we note that MPLS has scalability limitations: in large networks the cost of fault management grows faster than linearly and scaling to inter-carrier networks is limited.

Before Ethernet can become ubiquitous from access and corporate networks to mobile and fixed access and core networks, be that local, metropolitan or wide area, research and development are needed for example in co-existence of clock distribution and EEE, Traffic Engineering in EEE networks, wide area addressing, support of mobility on Ethernet layer, intra domain and inter carrier routing on Ethernet layer, Identity/locator split, smooth deployment scenarios etc. We have been pursuing many of these directions for the past 3 to 4 years.

Recommendations for Advancement of Technology

We propose to enhance Ethernet technology with the target of making it the ubiquitous packet transport technology supporting intra domain and inter-carrier networking, energy efficiency, low OPEX, mission critical networking, fast convergence, tight interoperation with optics, network virtualization, traffic engineering, inter-carrier services and mobility.

In order to achieve the goal, we need an EEE solution for optical and wireless links, a native Ethernet based virtualization and TE solution that is independent of IP that also will provide managed inter-carrier virtual networks making network capacity a commodity that is available on-demand at a minute's notice globally. The mobility solution needs to be applicable to mobile broadband access networks leading to simplification of the protocol stack and lower OPEX and CAPEX.

We further propose a new interrupt driven access architecture that scales to mobile and battery powered devices. IP hosts do not need to be changed and the solution interoperates nicely with legacy IP destinations and clients. To complement the architecture, we propose a global trust system for making sending unwanted traffic unprofitable.

Future Orientation

The proposed development will give a new breath of life to increasing the capacity of the data networks and to the deployment of mobile broadband allowing the implementation of the Instant Wireless Internet available anytime, anywhere. Trusted access will allow deploying new types of services to mobile devices and mobile computers. A global system of trust will make it possible to win the war against the shady economy of unwanted traffic.

What can Comnet/Aalto University contribute now?

In the 100GET project, we have developed and implemented a routed Ethernet technology based on TRILL but one that does not use broadcasting for ARP nor for MAC learning, and supports mobility without changes in the end hosts. The solution can for example be applied to wireless access eliminating a lot of irrelevant traffic that a WLAN card on a PC sees and for scaling Ethernet to a wider area network than is possible with the legacy techniques. The implementation has also a major positive impact on privacy. In the FP7 ETNA project, together with our partners we have developed a native Ethernet based carrier grade transport solution that supports both intra- and inter-carrier connectivity services allowing the virtualization of the network and selling network capacity worldwide as a commodity. Capacity can be made available on a minute's notice worldwide. We are developing ways to leverage and enhance these technologies for different use scenarios.

The development of Ethernet as a ubiquitous transport technology links nicely with our work on Trust-to-Trust for the access and the Internet as a whole. Our trust driven access solution, i.e. Customer Edge Switching, smoothly accommodates Ethernet transport but does not presume it facilitating smooth migration to new technology.

We have built the competence to advance this technology till it can be taken over by the vendors.

Experimentation Facilities

We work closely with FUNET, the Finnish NREN on other fronts and are willing to participate in large scale experiments with the Future Internet technologies.

More information on the site: www.re2ee.org.