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Increasing Throughput in IP Networks with ESP-Based Forwarding: ESPBasedForwarding

Abstract

This document proposes an experimental way of reaching infinite bandwidth in IP networks by the use of ESP-based forwarding.

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1. Introduction

Mechanisms for efficient packet forwarding has evolved over the past years. The demand for bandwidth is always increasing. Instead of optimizing forwarding performance and link capacity in an incremental fashion, we propose a brand new concept in packet forwarding that will provide unsurpassed end user performance regardless of link capacity, distance, and number of hops.

1.1. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

2. Background

During the past years, there have been a lot of improvements made in the domain of packet forwarding. Both software and hardware optimizations combined with increased link capacities have cut down round-trip times. Despite these improvements, many users find themselves frustrated since their demand for bandwidth has increased faster than the supply.

The current incremental approach to lower latency and increase capacity will soon reach the end of the road. The reason for this has been known for some time and is stated in RFC 1925 [RFC1925] clause 2:

"(2) No matter how hard you push and no matter what the priority, you can't increase the speed of light."

Our research has finally been able to circumvent this boundary by the development of zero-latency network paths.

Inspired by RFC 1072 [RFC1072], where a network containing a long, fat pipe is called LFN (pronounced "elephan(t)"), we will refer to an internet path with zero-latency as "infinitely fat", and a network containing this path as "IFN" (pronounced "infan(t)").

Before the invention of this new forwarding principle, several experimental methods were tried. We have chosen to share our failed attempts in order help others avoid the same mistakes that we encountered. The following two methods have been dismissed:

- Black Fiber
- Schrodinger's cat experiment

2.1. Experiments with Black Fiber

Attempting to push the speed-of-light limitation by means of using black fiber looked promising at first. Shortly after initiating the experiment, lack of light was detected in the black fiber. This was interpreted as proof of successful data transmission faster than the speed of light. After popping the champagne, the following problems were detected:

1. No data reached the receiver.
2. The fiber was not connected at the transmitting side.

This clearly spoiled the mood of the party.

2.2. Schrodinger's Cat Experiment

The Schrodinger's netcat experiment was based on an attempt to implement the method described by E. Schrodinger [Schrodinger35]. The original procedure includes locking up cats in boxes with radioactive materials and poisonous gas. Data communication capabilities were added to the experiment, by using netcat. The research team was dumbfounded by the notion that the cat experiment seemed to work and not work at the same time. This was also confirmed by a friend of Wigner's [Wigner].

A detailed analysis of the experiment indicated that the probability vectors collapsed whenever traffic was sent to the box. The conclusion was that this approach would only work without traffic, thus eliminating all practical applications.

3. ESP-Based Forwarding

Experiments with ESP-based (Extra Sensory Perception) forwarding has proved to successfully remove the limitation in RFC 1925 [RFC1925].

The foundation for the ESP-based forwarding scheme is to reduce latency by means of precognitive datagram detection and generation. By applying this technology, latency will not only reach zero, but might even become negative.

Experiments performed by Benjamin Libet [Libet85] regarding the readiness potential (Bereitschaftspotential) concludes that the end user latency from impulse to the conscious mind is approximately 350 - 400 ms. In order to reach the highest possible data transport without confusing the end user, it is important to take this latency into consideration.

3.1. Principle of Operation

Traffic between the end user and the server reaches the ESP-enabled router. Inside the ESP-based router, the data stream is first analyzed by the DPAUI (Deep Packet And User Inspection). The DPAUI sends a signal to the PPG (Deep Packet And User Inspection), which generates uplink IP datagrams supported by the IID (Infinite Improbability Drive). The generated IP datagram is sent to the CFE (Clairvoyant Forwarding Engine) that forwards the datagram. Finally, the "real" uplink, the end user datagram is received and forwarded to the ND (Null Device).

3.2. Architectural Components

The current ESP-based forwarding architecture includes the following components:

- DPAUI
- PPG
- IID
- CFE
- PPS
- ND

3.2.1. DPAUI

The DPAUI (Deep Packet And User Inspection) monitors the data streams for all individual users. The DPAUI is implemented by means of implementing a learning agent that analyzes each individual user. The output from the DPAUI is a signal that indicates that an IP datagram will be sent by the end user within a couple of seconds.

3.2.2. PPG

The purpose of the PPG (Precognitive Packet Generator) is to generate the IP datagram that the end user will trigger to be sent. In order to craft such a datagram, the PPG will perform a lookup based on the offset and length parameters generated by the IID. The PPG will generate the future packet by means of the function:

```
struct mbuf * CopyDatagramFromPi(
                insane long offset,
                unsigned int len);
```

The CopyDatagramFromPi() function will return a pointer to an mbuf containing the IP datagram. The offset value and len matches a corresponding offset and length in the decimal set for pi that contains the bit pattern for the future datagram. This method of operation will reduce the complex matter of precognitive packet generation to a simple lookup.

Concerns have been raised that the full decimal set of pi requires an infinite amount of memory. This might have a negative effect on the manufacturing cost of the router. These concerns were successfully managed by using a perfectly circular buffer. This reduced the previous stated memory requirements at least by half.

3.2.3. IID

The purpose of the IID (Infinite Improbability Drive) is to assist the PPG and PPS with improbable probabilities (and the other way around). The IID was originally invented by Douglas Adams [Adams79]. The original implementation was based on hooking up the logic circuits of a Bambleweeny 57 sub-meson Brain to an atomic vector plotter suspended in a strong Brownian motion producer (i.e., a nice hot cup of tea).

The research team struggled with the implementation of the strong Brownian motion producer. As a matter of fact, the majority of the research budget was wasted before it was fully conceived that a warm cup of tea and router equipment rarely mix.

Aided by the gastronomical department (working on Bistromathic Drive), the research team managed to attach a brownie on top of a radio controlled hovercraft full of eels. This not only caused a lot of noise and disarray, but also a sufficient amount of Brownian motion. The research team is still working on an entirely software-based solution. Hopefully, the eel-filled hovercraft will soon be replaced with a different type of python script.

3.2.4. CFE

After the IP datagram has been produced by the PPG, the CFE (Clairvoyant Forwarding Engine) will attempt to find the right route. Since the route might not exist yet, direct access to a routing table might result in routing errors.

The implementation of the CFE is very straightforward: any off-the-shelf routing stack with a routing table and a routing daemon can be used. A standard Ouija board is simply put on top of the routing table. For each datagram, the CFE initiates an Ouija board session that will establish a connection with the routing deamons. The CFE will seek guidance for the future of the IP datagram and then send it along for a low cost, to meet a tall, dark server rack.

3.2.5. PPS

The PPS (Pre-Preemptive Scheduler) is synchronized by means of an NTP connection to the IID based NTP server. This ensures that the ESP process will execute ten seconds ahead of local time (layman’s term: "into the future"). This value should ensure operation even with very long Round Trip Times and should also include the readiness potential of the end user.

The pre-preemptive scheduler not only provides a separate user space, but a separate dimension for the code to execute in. The dimension alignment is based on string theory and has been implemented in the language C, simply by including the library string.h and then using strcpy to copy the PPS function pointer into an eleven-dimensional array.

3.2.6. ND

After a little time, less than the ’end user to server’ Round-trip time (RTT), the real end user datagram will reach the ingress side of the ESP-based router, since the datagram has already been sent, routed and returned. The datagram is directly routed to the ND (Null Device) and the ingress packet counter is decremented.

Experimentation showed that the ND is a perfect source of entropy and is able to store all digits of pi. The research team had great hopes of reducing the memory footprint for the PPG even further, but ran into problems with read access times.

The ND is readily available in most operating systems.

4. End User Considerations

End user considerations and differentiated traffic classes:

1. In order to facilitate a pleasant end user gaming experience, packets destined for the spinal cord (i.e., force feedback information, etc.) must be delayed by 350 ms in order to synchronize with the traffic that is routed by the end user to the cerebrum and cortex.

2. RFC 1216 [RFC1216], Section 3.3 states that "bad news travels fast". This means that additional delay must be introduced when the end user is browsing on news sites. Negative latency might make the end user suspect that the news is even worse than indicated by the news sites.

3. Machine-to-Machine (M2M) communication might experience reduced performance due to difficulties for the DPAUI to work correctly. When the concept starts working for M2M communication, this can be used as an indication that a technological singularity might be near.

5. TCP Slow-Start Considerations

The lack of RTT of IFNs might cause some problems with TCP slow-start. More precisely, it will most likely not be slow at all. This might be handled by implementing a congestion avoidance mechanism, but will need further study.

6. Market Considerations

Unfortunately, we foresee that this product will never be ready for the market. This is especially true for the Pre-preemptive Scheduler, which by nature, will always be slightly ahead of its time.

7. Security Considerations

- Introducing an end user RTT delay of zero might cause crashes in badly implemented TCP/IP stacks. This is because division by zero might occur when calculating bandwidth-delay product.

- ESP forwarding of traffic generated by psychics might lead to problems with recursiveness.

- Lawful Intercept of the Deep User and Intention Inspection might violate personal integrity.

- Terrorist organizations might exploit the "bad news travels fast" loophole in RFC 1216 [RFC1216].

8. References

8.1. Normative References

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