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Updates for IPPM's Framework: Timestamping and Use Cases
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Abstract

Quality and accuracy of measurements depend on the selection of appropriate locations and timers for timestamp acquisition. This memo updates the IP Performance Metrics (IPPM) Framework [RFC 2330](#) with new considerations on timers, timestamps and time-related definitions with particular focus on wireless networks and virtualized hosts.

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](#)].

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IPPM Time

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[1.](#) Introduction

The IETF IP Performance Metrics (IPPM) working group first created a framework for metric development in [[RFC2330](#)]. This framework has stood the test of time and enabled development of many fundamental metrics. It has been updated in the area of metric composition [[RFC5835](#)], and in several areas related to active stream measurement of modern networks with reactive properties [[RFC7312](#)].

Time is fundamental to measurements. The IPPM framework [[RFC2330](#)] includes a comprehensive terminology, definition and discussion of time- and clock-related concepts. But network technology has evolved since 1998. First, host computing performance and software complexity have increased while network delays have decreased. These advances enable development of new concepts like host virtualization in cloud computing, and network function virtualization. One side-

effect of these technologies is that packets spend more and more time in software, their propagation through the stack being biased by a series of uncertainty factors like buffers, queues and operating system scheduling. Measurements can acquire timestamps in various locations within the host's software stack, causing potentially

significant variances in timestamp values [[MCDC](#)]. This is a consequence of just one alternative that the IPPM framework [[RFC2330](#)] defines for these timestamps: host time. This memo seeks to update this aspect of the IPPM framework by discussing alternatives and proposing generic solutions that can be referenced by metric definitions.

Second, the IPPM framework was approved one year before the release of the first IEEE 802.11 series standard. This was a time when the data communication landscape was dominated by wired communication technologies and wireless data communications were in their infancy. This fact originated IPPM definitions like host time or wire time. Today, after more than one decade and half, wireless IEEE 802.11 networks and cellular packet-switched data technologies like High-Speed Packet Access (HSPA) and Long Term Evolution (LTE) are responsible for an essential part of the worldwide Internet access traffic. This raises the question, how the IPPM framework concept of wire time can be mapped to wireless networks.

This memo revisits and updates time-related IPPM framework [[RFC2330](#)] definitions like host time and wire time in the light of technological advances.

[2.](#) Scope

The purpose of this memo is to update the IPPM metrics framework [[RFC2330](#)] with respect to timestamps and virtualization. Concepts like "host time" or "wire time" must be revisited to be applicable for wireless networks and virtualized environments.

The scope is to update key sections of [[RFC2330](#)] ...

Potential Topics (Draft outline for discussion):

- Fundamentals

1. Host Time (further develop the definition as mentioned but not defined in [RFC2330](#). Explain variants, propose examples and guidance). Dedicated subsection and challenge: virtualization.

2. Wire Time (rename "Wire Time" to "Medium Time" or "Media Time" to account for wireless networks; revisit the definition of "Media Arrival Time" and "Media Exit Time" in the light of encryption, complex network coding, interleaving etc. Define how to measure media time in wireless networks) Dedicated subsection and challenge: virtualization

3. Define new terms wrt timestamps that help to differentiate between software delays within a host. Ideally it should give guidance and define terms that allow to differentiate between delays (uncertainties) that a) are caused by host load, timer resolution, system scheduling, etc. and b) the ones that originate when packets wait in drivers because of network access policies or network congestion. A "network (or IP) timestamp" can be useful in (virtualized) environments it might make sense to define the term "network timestamp" as "tcpdump timestamp of the host instance that is located closest to the hardware". Hypervisor tcpdump timestamps should be preferred over VM timestamps.

4. (optional) Protocol design considerations: (Security vs. flexibility): adding timestamps into headers/payload protocol fields at driver level (tcpdump equivalent) is difficult/impossible if link is protected using SSL/TLS/IPsec. Meaningful: insert timestamp in application space.

5. (probably not in IPPM) NTP is understood to operate sub-optimally for time-transfer to virtual machines (VM) as guest-clients in some hosts. What mechanisms can be employed to improve time accuracy and stability when VMs intend to perform time measurement?

3. Definition and Use of Wire Time

[RFC2330] defines the following terms related to wire time (defined in terms of an Internet host H observing an Internet link L at a particular location):

- o For a given packet P, the 'wire arrival time' of P at H on L is the first time T at which any bit of P has appeared at H's observational position on L
- o For a given packet P, the 'wire exit time' of P at H on L is the first time T at which all the bits of P have appeared at H's observational position on L.

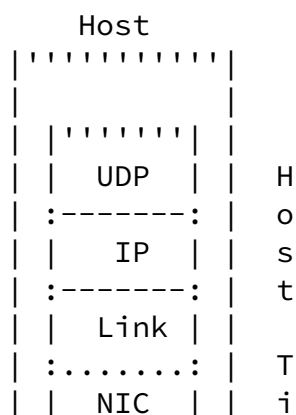
However, wireless LAN and cellular networks are essential components of today's Internet. This memo proposes to replace the term "wire time" by the equivalent term "media time" and provides additional guidance for wireless network measurements.

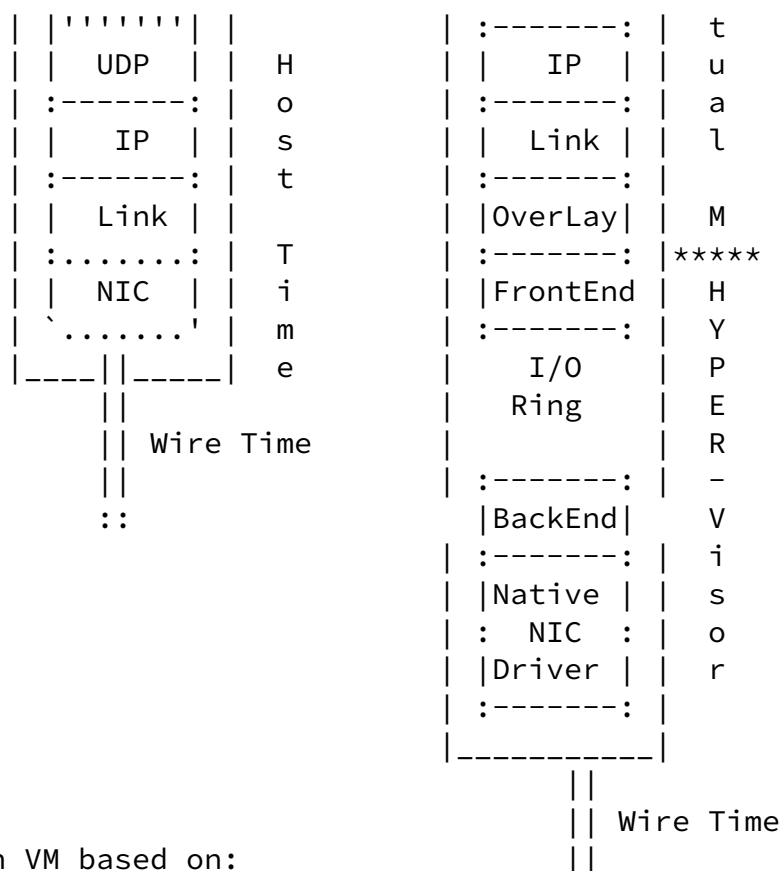
This definition of media time raises one additional challenge: how can "media arrival time" and "media exit time" be defined for wireless networks. Aligning with existing physical-layer standards of other standardization organizations like the 3GPP, this memo recommends the antenna connector of the Host(?) to be used for measuring media time in wireless networks.

[3.1.](#) Virtualization

Virtualization adds additional level of uncertainty for timestamps: VM application, VM tcpdump, Hypervisor tcpdump. What about wire time for virtual network interfaces? Should it be bound to the related physical interface or to the hypervisor/virtual interface?

There was some flexibility in the original mention of Host Time. Virtualization adds more layers where host timestamps could be applied or derived, and the specification requires its own framework:





Xen VM based on:

<http://www.cc.gatech.edu/~lingliu/papers/2012/YiRen-CollaborateCom2012.pdf>

5. Encryption

6. Security Considerations

The security considerations that apply to any active measurement of live paths are relevant here as well. See [RFC4656] and [RFC5357].

When considering privacy of those involved in measurement or those whose traffic is measured, the sensitive information available to potential observers is greatly reduced when using active techniques which are within this scope of work. Passive observations of user traffic for measurement purposes raise many privacy issues. We refer the reader to the privacy considerations described in the Large Scale Measurement of Broadband Performance (LMAP) Framework [RFC7594], which covers active and passive techniques.

7. IANA Considerations

This memo makes no requests of IANA.

8. Acknowledgements

The authors thank ...

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