Multi-Path Time Synchronization

draft-shpiner-multi-path-synchronization-00

Alex Shpiner  Technion – Israel Institute of Technology
Richard Tse  PMC-Sierra
Craig Schelp  PMC-Sierra
Tal Mizrahi  Marvell

IETF Meeting 85, November 2012
Background: Well-Known Time Sync Paradigms

Slave is connected to a single master using a single path, e.g. PTP.

- Client combines information from multiple servers, e.g., NTP.
- Slave connected to multiple masters. One active, others standby, e.g. ITU-T G.8265.1
Multiple paths allow Slave Diversity:
- High accuracy.
- Fault protection.
- Security.

Temporary congestion in path 0.
Path 1 still provides accurate information.

---
Multi-Path Time Synchronization in IP Networks

- This draft defines two protocols:
  - Multi-Path PTP (MPPTP).
  - Multi-Path NTP (MPNTP).

- Define an additional layer without modifying PTP or NTP.
- Interoperability with conventional PTP / NTP.
Multi-Path Time Synchronization – Logical Layers

- **Slave: Path Combining Layer**
- **Time Sync Protocol Layer**
- **Multi-Path Layer**

- Combining information from different paths.
- Standard PTP / NTP.
- Path discovery.
- Path identification.
Multi-Path Time Synchronization

- **Two-way multi-path synchronization:**
  - Both master and slave support multiple paths.

- **One-way multi-path synchronization:**
  - Only slave supports multiple paths.
  - Interoperable with conventional existing nodes.
Multi-Path Synchronization – Logical Building Blocks

- Two-way multi-path synchronization:

  \begin{itemize}
  \item Slave
  \item Master Clock
  \item Path 0
  \item Path 1
  \item Slave
  \item Multi-path layer
  \item Slave 0
  \item Slave 1
  \item Master
  \item Multi-path layer
  \item Master
  \item Path 0
  \item Path 1
  \item Standard PTP/NTP clock
  \end{itemize}
Multi-Path Synchronization – Logical Building Blocks

- **One-way multi-path synchronization:**

  - **Path 0**
  - **Path 1**
  - **Master**
  - **Slaves**

  **Combining algorithm:**
  - Slave 0
  - Slave 1
  - Multi-path layer

  **Master sees two slaves.**

  **Standard PTP/NTP clock**
Path Discovery / Configuration

- The multi-path layer discovers all possible paths between the current clock and the peer clock.

- **Multiple paths:**
  - Traffic engineered.
  - or
  - Discovered using Traceroute (e.g. Paris Traceroute: path discovery by scanning IP address / IPv6 flow label).

- Path discovery / configuration is a function of the network’s load balancing mechanisms.
Two-Way Multi-Path Time Synchronization

- Each node has multiple IP addresses.
- Different \{master IP, slave IP\} pairs are used for each path.
- Unicast messages.

Master / slave use \{master IP, slave IP\} pairs to identify path ID.
One-Way Multi-Path Time Synchronization

- Each node has multiple IP addresses.
- Different slave IP addresses are used for each path.
  - PTP: also different clock identity for each path.

Pros:
- Interoperable with multi-path unaware master.

Cons:
- May produce less diverse paths than the two-way variant.
  - Destination based load balancing: single slave \rightarrow master path.

![Diagram of Master and Slave Nodes](image-url)

Master sees 2 slaves.

Slave uses:
- 2 IP addresses.
- PTP: 2 Clock IDs.
Next Steps

- Feedback from the WG.
- Request WG adoption.
Thanks
IP: Multiple Paths over IP
Mitigating MITM Attacks using Multiple Paths

- **Slave algorithm:**
  - Bob computes TOD\(_0\), TOD\(_1\), … TOD\(_{N-1}\) (TOD = Time Of Day) Corresponding to path 0, 1, … , N-1
  - If TOD\(_j\) is significantly different than Average\(_{i \neq j}(TOD_i)\), then assume TOD\(_j\) is based on false information, and ignore path j.
  - Bob’s TOD is Average(TOD\(_i\)) of the TOD values from the paths that have not shown faulty behavior.

- A similar algorithm can detect m>1 attacked paths.

---