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# Multi-Path Time Synchronization

**draft-shpiner-multi-path-synchronization-01**

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Alex Shpiner

Technion – Israel Institute of Technology

Richard Tse

PMC-Sierra

Craig Schelp

PMC-Sierra

Tal Mizrahi

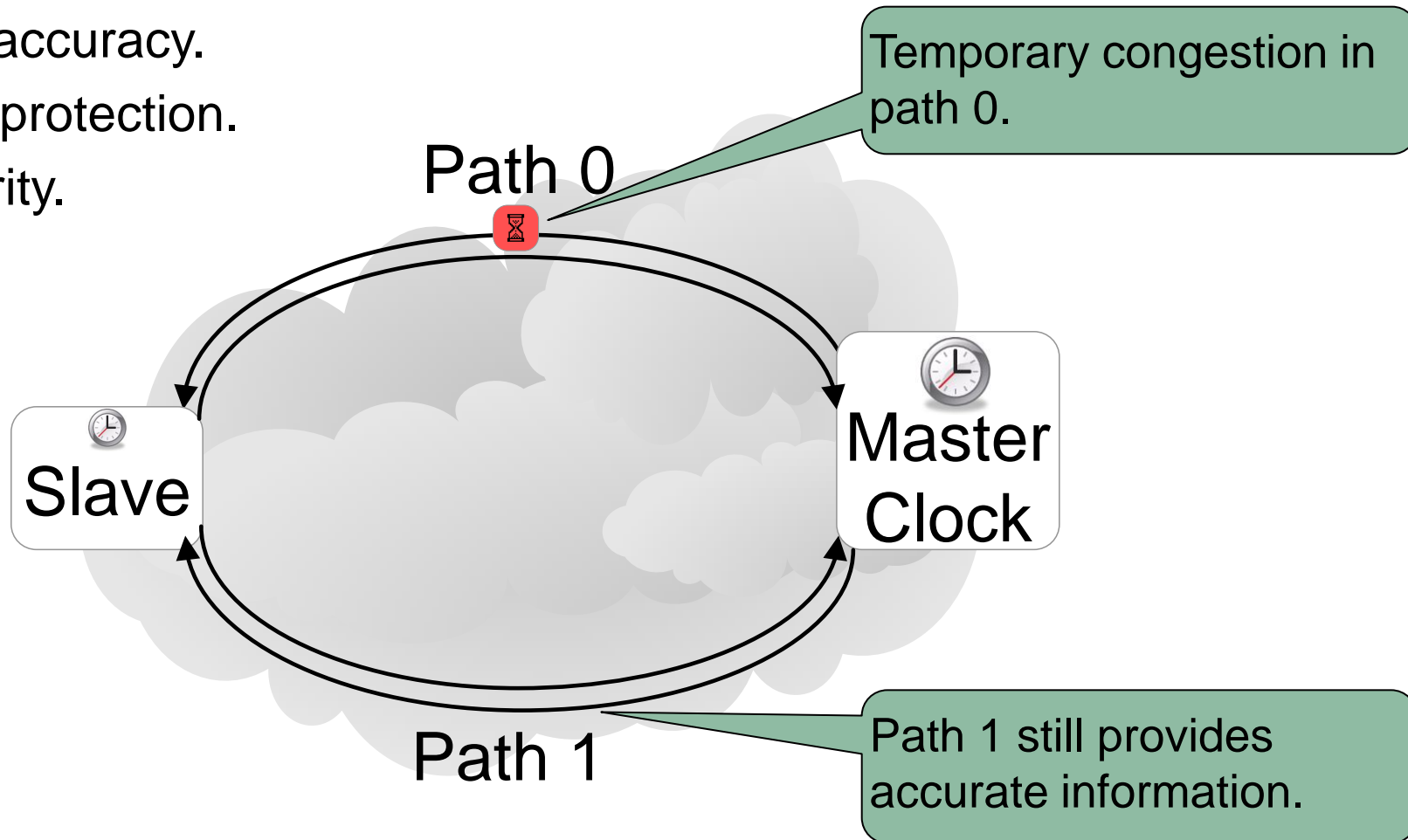
Marvell

IETF Meeting 86, March 2013

# Background: Using Multiple Paths

## ▶ Multiple paths allow Slave Diversity<sup>1</sup>:

- High accuracy.
- Fault protection.
- Security.

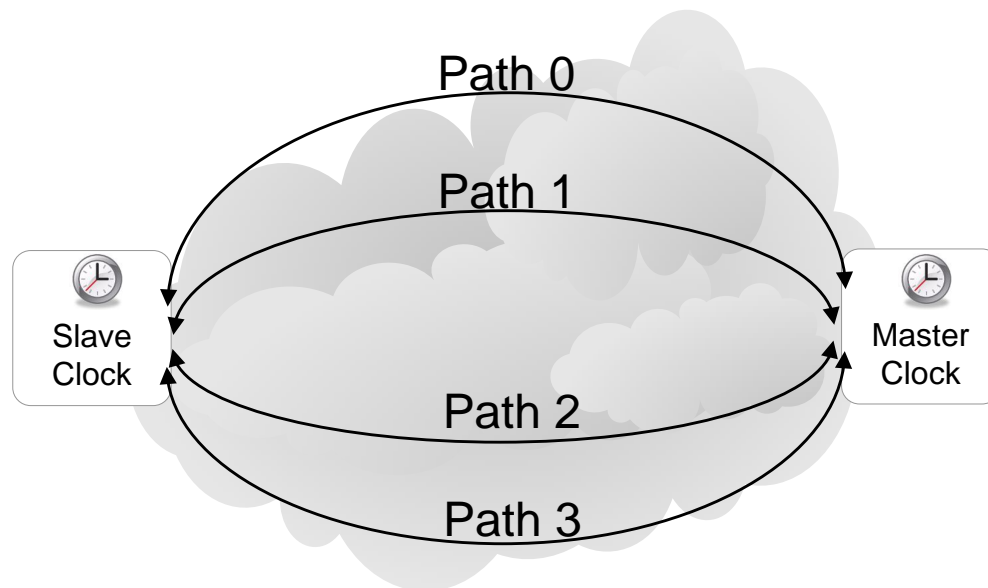


<sup>1</sup> T. Mizrahi “Slave Diversity: Using Multiple Paths to Improve the Accuracy of Clock Synchronization Protocols”, ISPCS 2012.

# Multi-Path Time Synchronization in IP Networks

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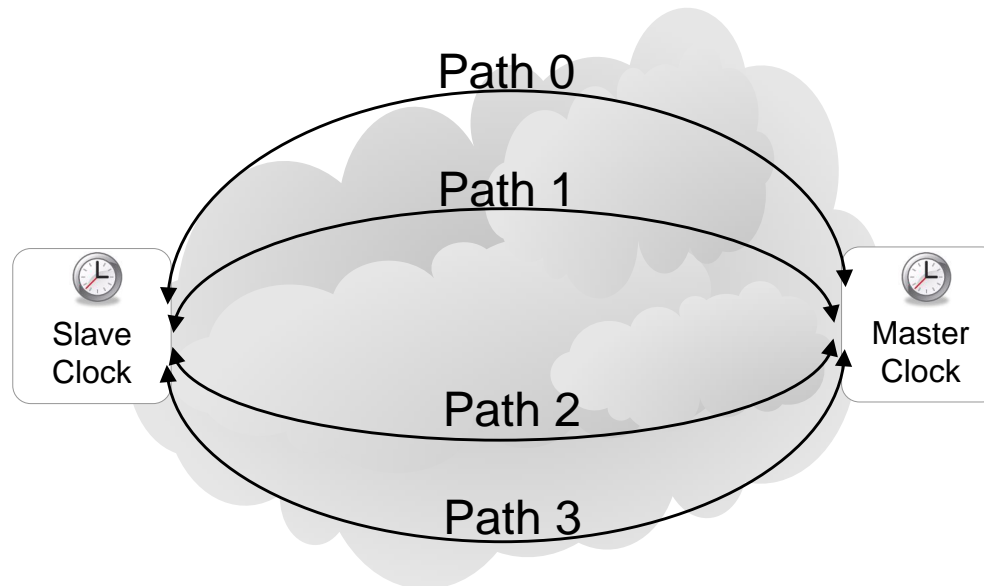
- ▶ **This draft defines two protocols:**
  - Multi-Path PTP (MPPTP).
  - Multi-Path NTP (MPNTP).
- ▶ **Define an additional layer without modifying PTP or NTP.**
- ▶ **Interoperability with conventional PTP / NTP.**



# Multi-Path Time Synchronization

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- ▶ **Dual-ended multi-path synchronization:**
  - Both master and slave support multiple paths.
- ▶ **Single-ended multi-path synchronization:**
  - Only slave supports multiple paths.
  - Interoperable with conventional existing nodes.



# Main Changes in Current Draft

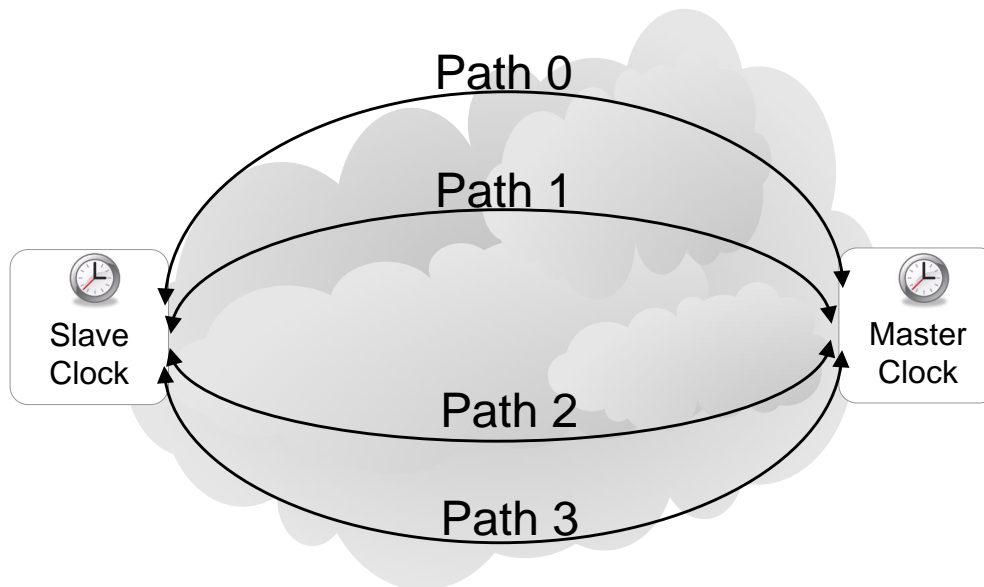
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- ▶ Changed the terms **one-way / two-way time synchronization** to **single-ended / dual-ended time synchronization**.
- ▶ **Added description about how unicast negotiation is used.**
  - Event messages must be unicast to allow transmission over multiple paths.
- ▶ **Added flexibility WRT the slave's choice of the number of paths to be used.**

# Next Steps

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- ▶ **Feedback from the WG.**
- ▶ **Request WG adoption.**



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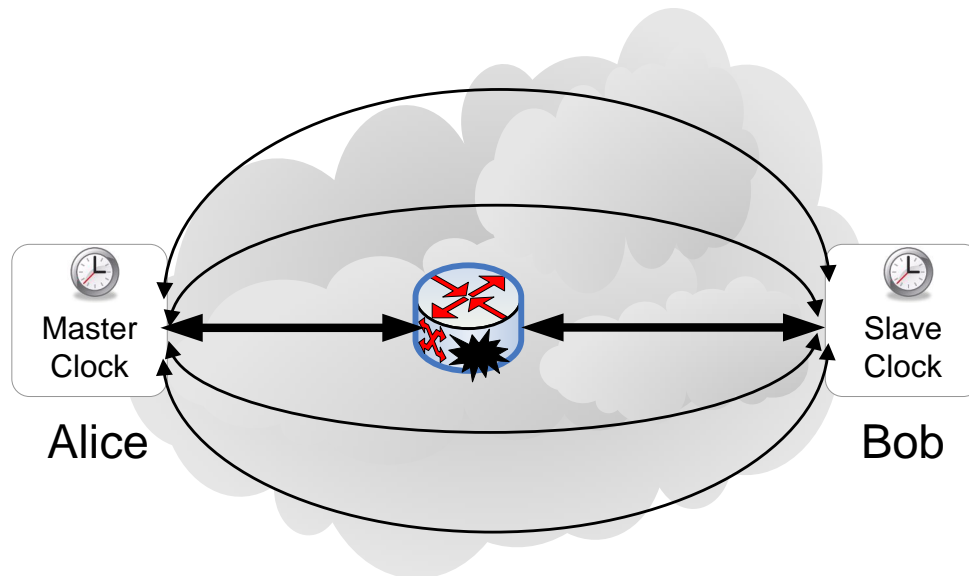
Thanks

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# Mitigating MITM Attacks using Multiple Paths<sup>1</sup>

## ▶ Slave algorithm:

- Bob computes  $TOD_0, TOD_1, \dots, TOD_{N-1}$  (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.



<sup>1</sup> T. Mizrahi, "A Game Theoretic Analysis of Delay Attacks against Time Synchronization Protocols", ISPCS, 2012.