

Timing Precision on Ark - RADclock

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► The Big Picture

- **Host has hardware counters (TSC, HPET, ACPI..)**
 - but these drift, need disciplining
 - extra hardware (GPS, atomic clock) expensive
 - convenient to access a reference clock over the network
- **Network timing is hierarchal**
 - *Stratum-1* has access to reference hardware
 - *Stratum-2* references stratum-1, etc.
- **NTP protocol**
 - transports timestamps (of its own pkts!) between server & client
- **Kernel**
 - maintains a system clock, timestamps packets
- **Userland**
 - runs a clock sync daemon, providing key parameters defining a clock
- **Timestamping**
 - needed in kernel and userland, must be fast
 - critical both for clock sync itself, and network measurement

► What RADclock Provides

■ Basic

- more accurate absolute timestamps (100's of μs rather than ms)
- much higher robustness to network delays, disruptive events

■ Basic ++

- a *difference clock* (specialist clock for `short' time differences)
 - far more accurate ($<1\mu\text{s}$, even 10's of ns)
 - extraordinarily robust (lose server for hours, no problem)
- reliable error bounds

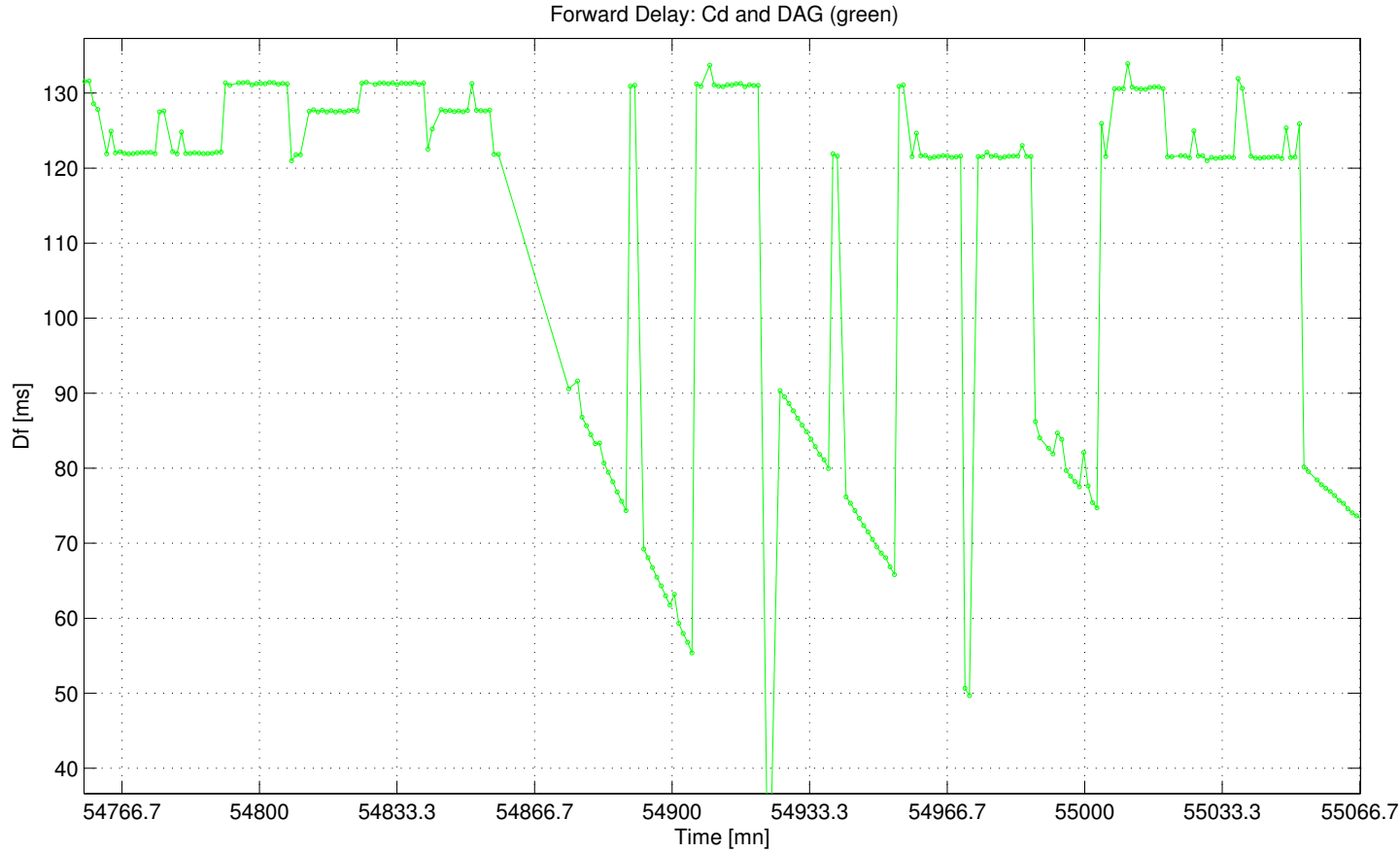
■ Advanced

- Ability to `replay' raw timing data
 - capture raw timestamps fast, convert to UTC later
 - upgradable final timestamping
- naturally compatible with virtualized operating systems

► Potential of Ark + RADclock

- **Coordinated distributed experiments (trust timing)**
 - ◉ eg: Internet coordinate systems, route disambiguation
 - ◉ think of Spanner (Google's time aware distributed database)
- **Time Server vetting (can't trust stratum 1's)**
 - ◉ to better select Ark's own stratum 1's
 - ◉ as a service provided by Ark
- **Waiting in the wings**
 - ◉ RADclock servers as well as clients
 - ◉ more support to ease advanced use

time.nist.gov



Client-Server OWD: Server shows frequent jumps in the 10-100ms range plus some regions with skew of one PPM. (meanwhile the RTT is very close to a constant.)
min(RTT) = 187 ms

► Potential of Ark + RADclock

- **Coordinated distributed experiments (if one could trust timing)**
 - eg: Internet coordinate systems, route disambiguation
 - think of Spanner (Google's time aware distributed database)
- **Time Server vetting (can't trust stratum 1's)**
 - to better select Ark's own stratum 1's
 - as a service provided by Ark
- **Down the track**
 - RADclock servers as well as clients
 - more support to ease advanced use (like replay)

▶ How Ark can Help Timing Research

■ Network Timing System (NTS) to replace NTP

- involves inter-linking strata 1 & 2, server recommendation, ..
- Ark an ideal platform to develop and test NTP
- requires some Ark monitors to be stratum-1

■ Network Timing Health Monitoring

- exploit Ark's vantage point diversity to perform wide scale vetting
- detailed one-off studies, on-going monitoring of public infrastructure

■ Synergy

- each project helps the other
- even one or two GPS-enabled Ark nodes a big benefit
- each will improve Ark's timing service further

► Support

■ FreeBSD

- patches for 8.1 (includes Zen support) + userland code
 - *ntpd* based system clock untouched
 - RADclock + *ntpd* system clock available in parallel
- more mature version (but incomplete) adopted into 10.1
 - can select RADclock as the system clock transparently, plus extras
- Expectation of full inclusion in 11

■ Linux

- *patches up to 2.6.32 available*
- Raspberry Pi support almost there

■ Looking for partners

- to help push development along
- to jointly address specific needs

► Resources

- ***SyncLab website***

- <http://www.synclab.org/radclock/>
- *Papers*
- *Patches*

- ***ACMQueue high level article***

- <http://queue.acm.org/detail.cfm?id=1773943>

- ***Google TechTalk***

- https://www.youtube.com/watch?v=o3nXgeh7v_U