



RIPE NCC
RIPE NETWORK COORDINATION CENTRE

Time, NTP, & Leap Seconds

Outline



- Overview of time
- Recent leap second + the NTP pool
- Measurements, solutions



Time

Time is tricky



- It's really hard to get time right

Celestial Bodies



- Astronomical time
- Atomic time



Standards Bodies



- International Telecommunications Union (ITU)
 - International Atomic Time (TAI)
 - Solar time (UT1)
 - Coordinated Universal Time (UTC)

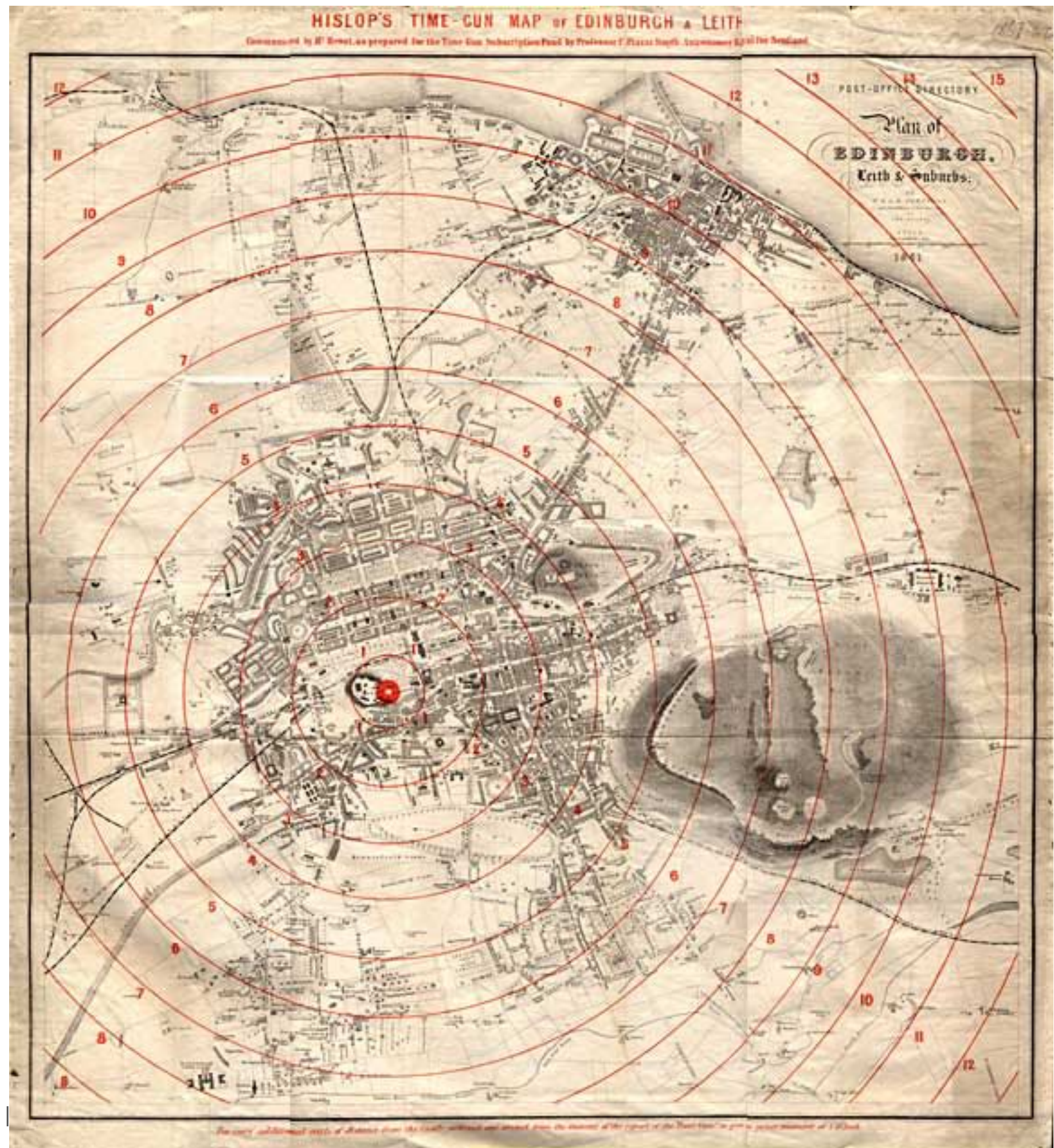


(Celestial | Standards) Bodies



- This is all okay so far
- We have other pain points with *calendars*
 - summer/standard time
 - leap years
- But these don't mess with UTC

Seconds Matter:



Leap Seconds



- Leap seconds are announced by IERS
 - the International Earth Rotation and Reference Systems Service
 - <https://hpiers.obspm.fr/iers/bul/bulc/bulletinc.dat>

**NO leap second will be introduced at the end of June 2017.
The difference between Coordinated Universal Time UTC and the
International Atomic Time TAI is :**

**from 2017 January 1, 0h UTC, until further notice:
UTC-TAI = -37 s**

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Standards



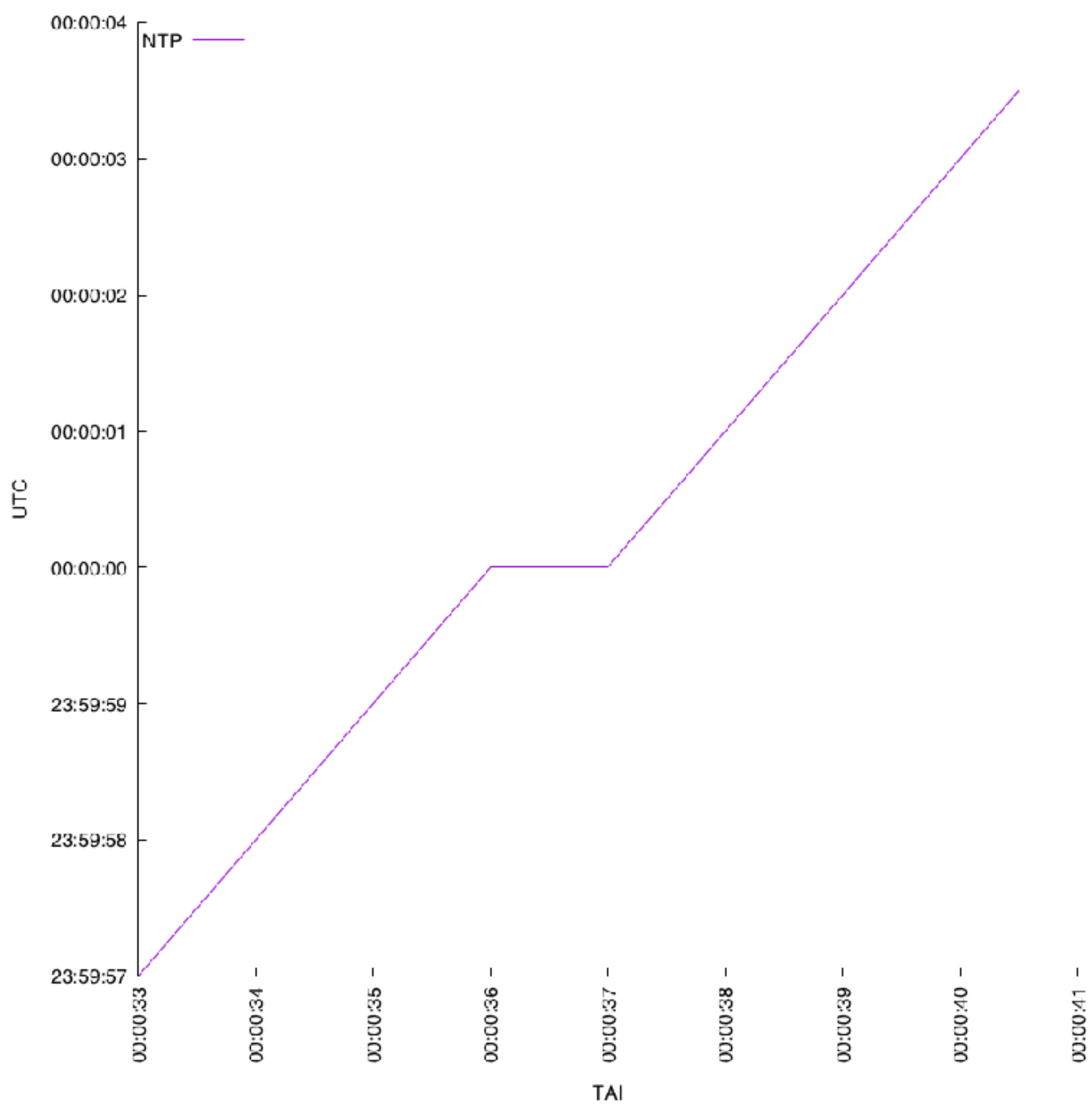
- NTP
- POSIX



What NTP Does



- Assume NTP servers are aware of the approaching leap second
- NTP *effectively* halts its clock for 1 second



What NTP Does

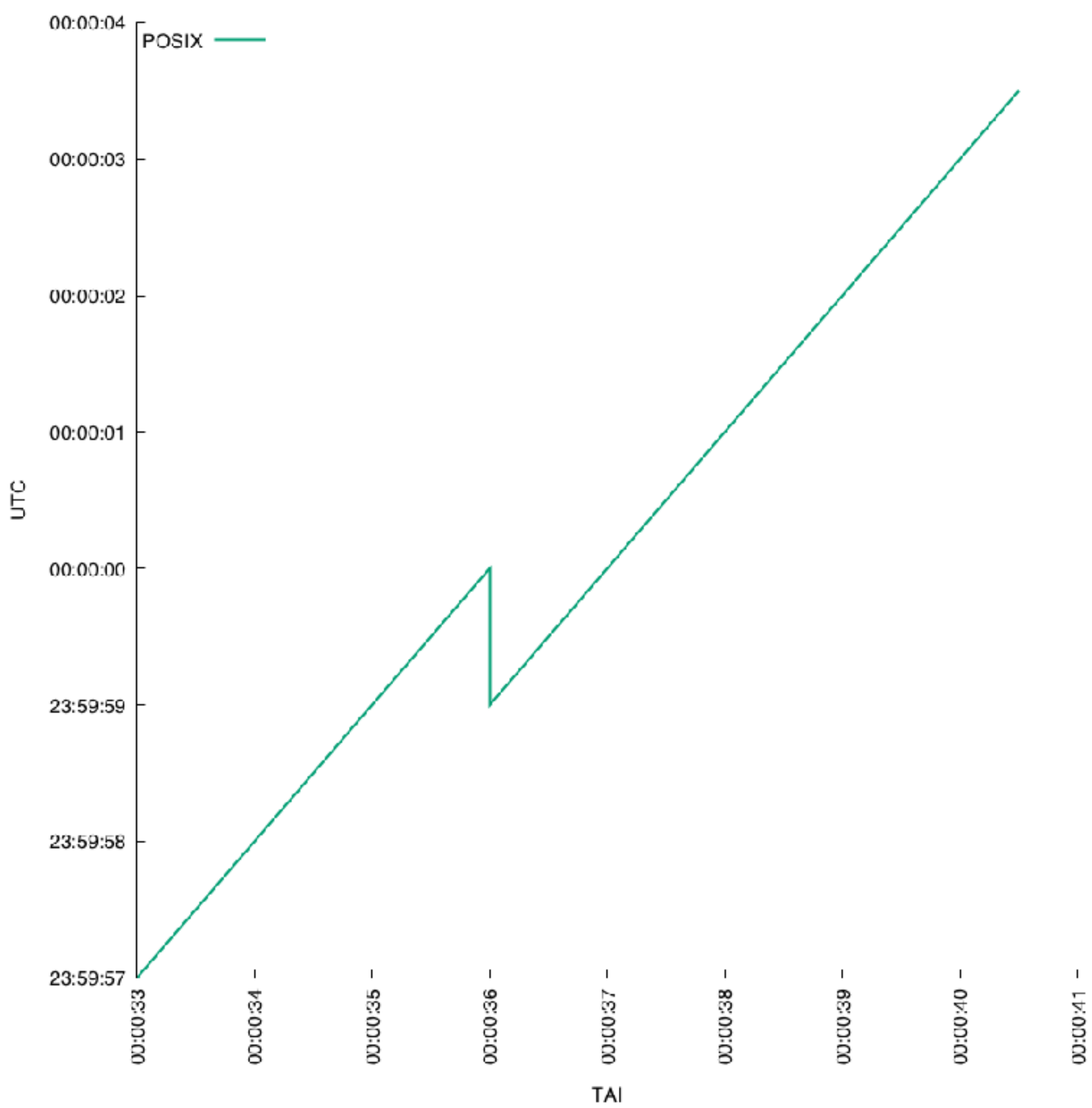


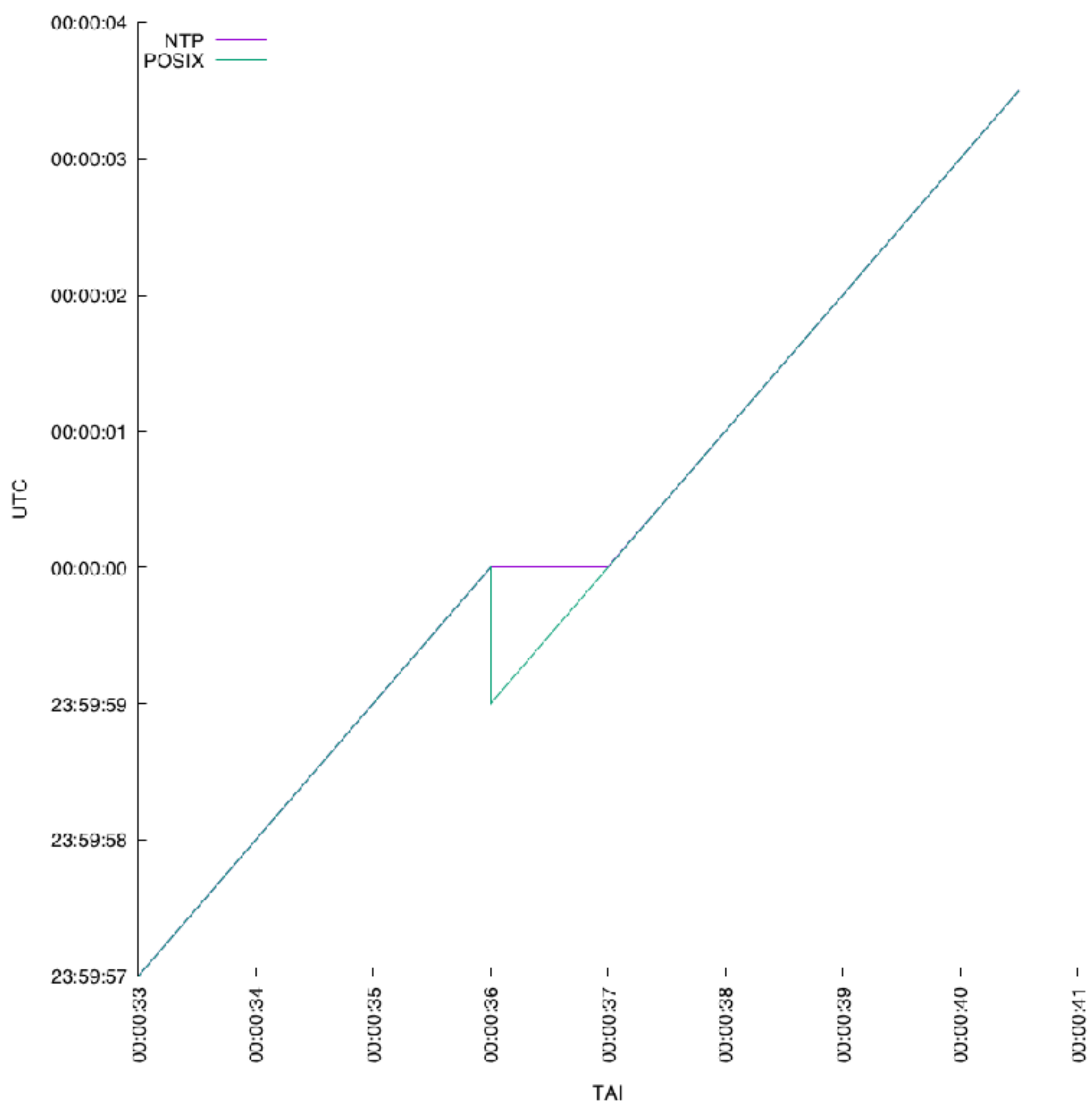
- *But also:*
 - Responses from an NTP server carry a Leap Indicator (LI) flag
 - Intended to inform other NTP servers and hosts
 - ntpd can inform the local host that the leap second is near

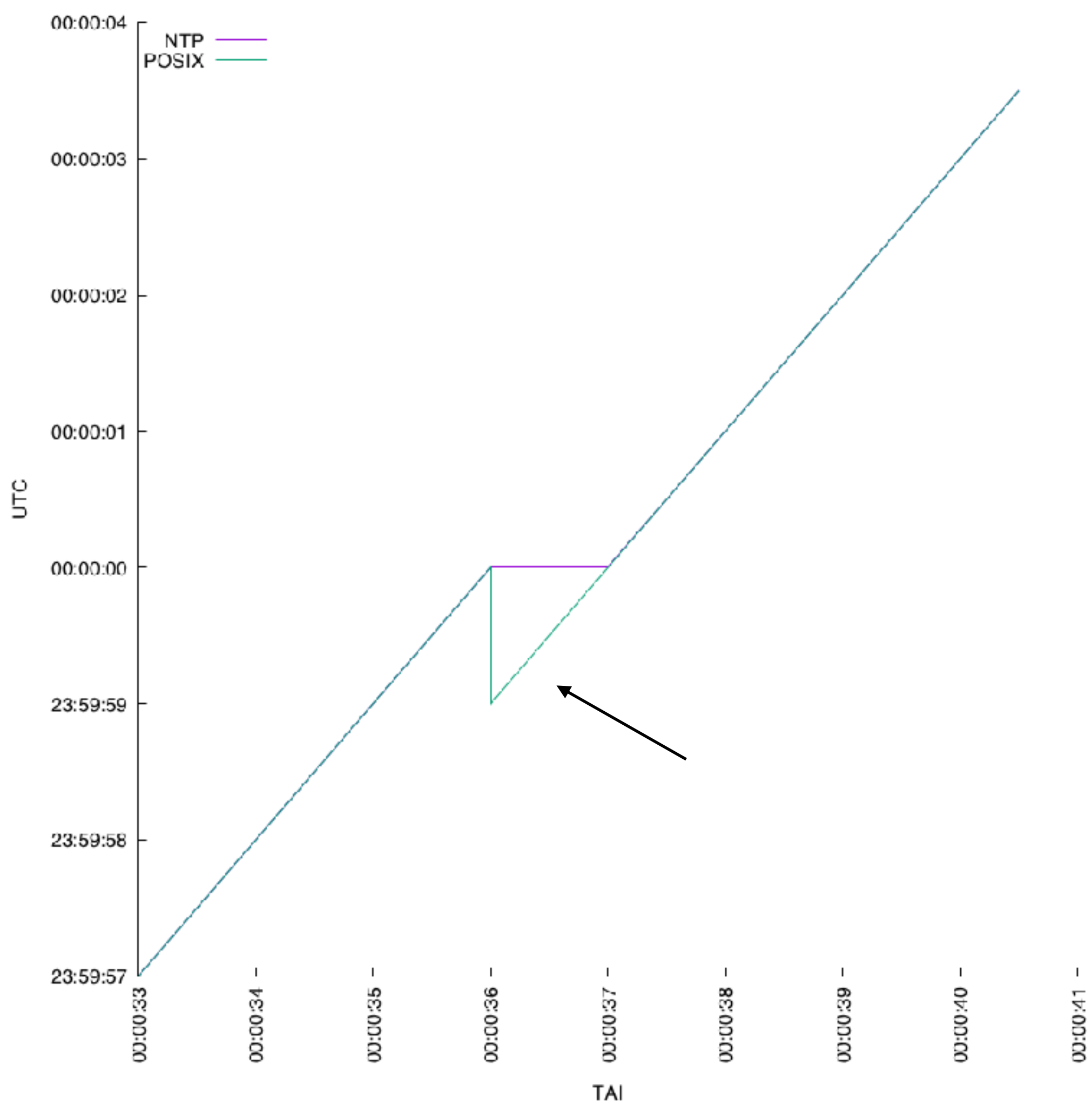
What POSIX Does

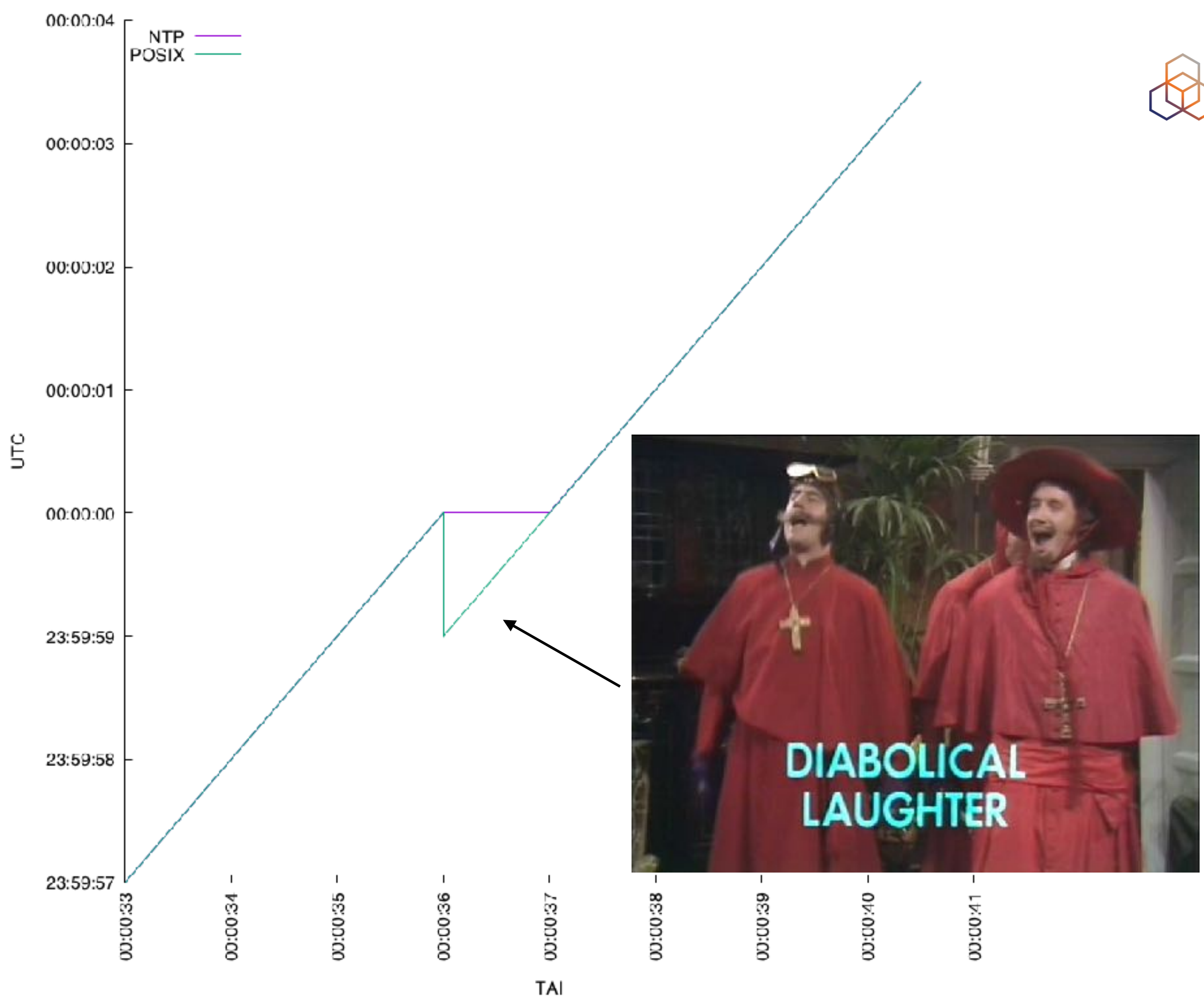


- POSIX steps the clock
 - analogous to UTC, time is discontinuous
 - all days are 86400 seconds long









Things go wrong



- developers/ops/researchers* often assume that time is linear
 - * (humans in general)

Things go wrong



Things go wrong



- Infamous:
 - https://bugzilla.redhat.com/show_bug.cgi?id=479765
- 2017:
 - <https://blog.cloudflare.com/how-and-why-the-leap-second-affected-cloudflare-dns/>
 - <http://www.cisco.com/c/en/us/about/supplier-sustainability/leap-second.html>



Measurements

RIPE Atlas & NTP Measurements



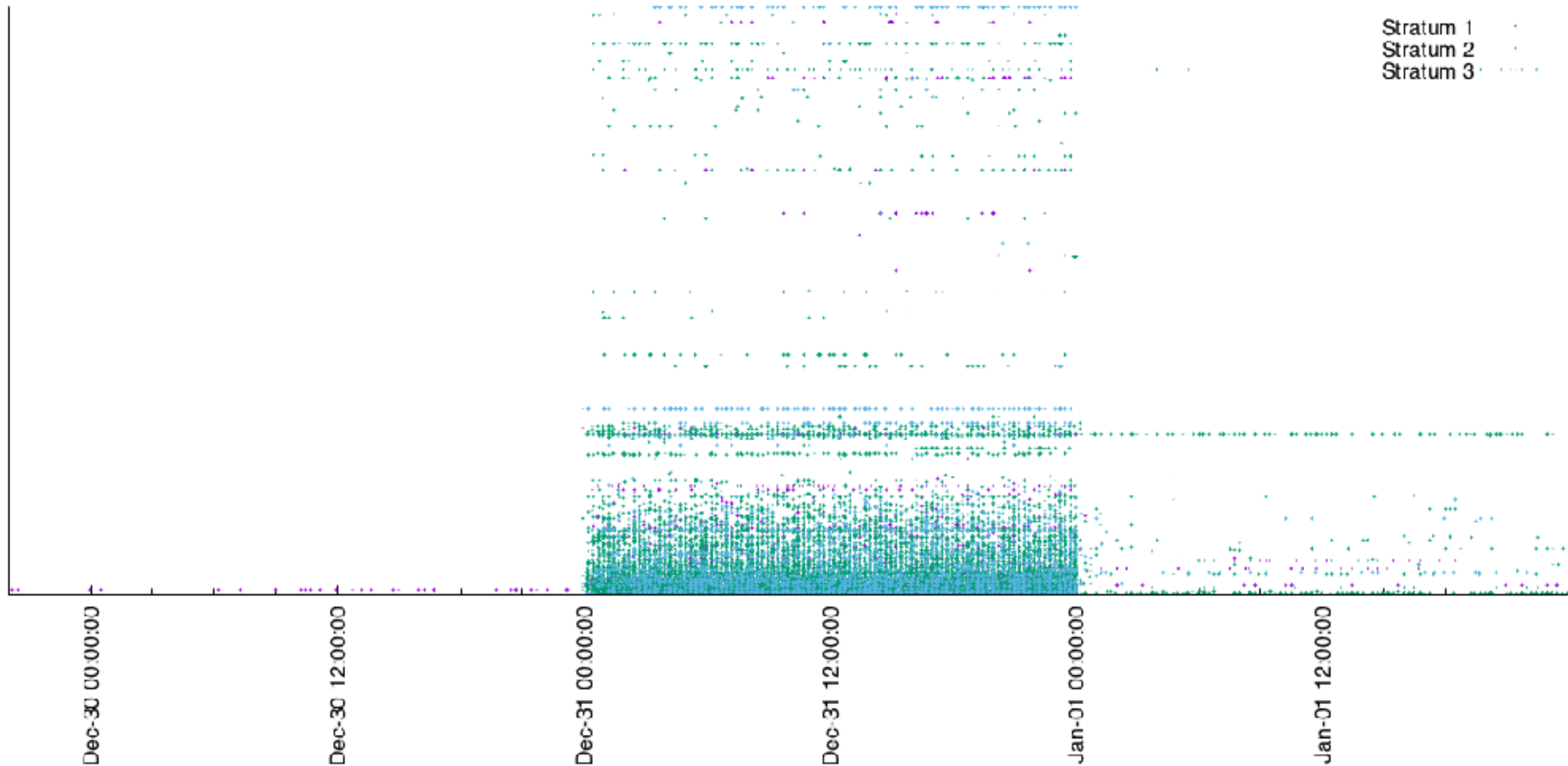
- This gets tricky for all the reasons you expect
 - clocks drift
 - people block NTP
 - analysis:
 - https://labs.ripe.net/Members/philip_homburg/ntp-measurements-with-ripe-atlas
- *But* the RIPE Atlas anchors are pretty stable and can talk NTP

Long-running Measurements

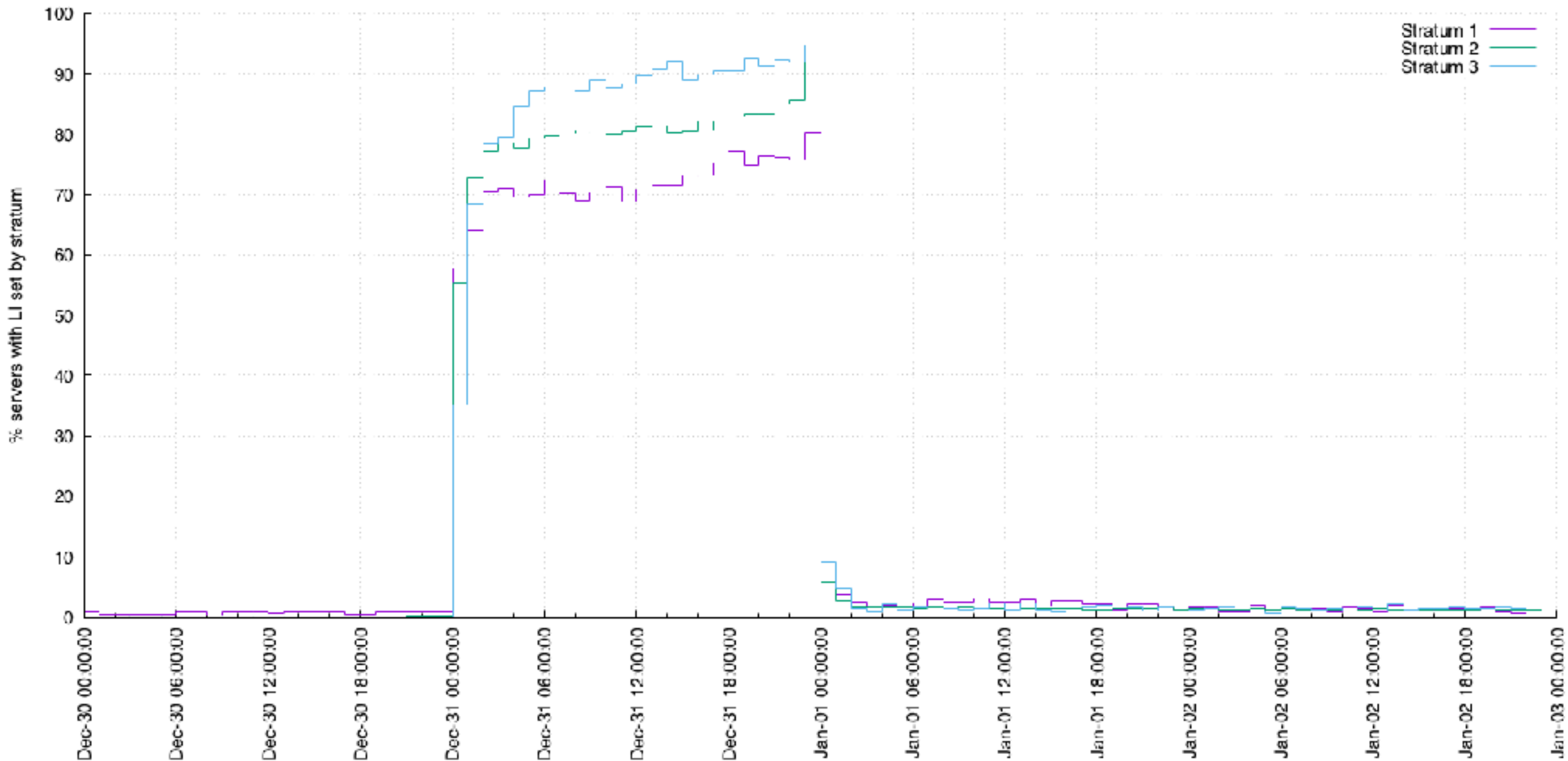


- NTP Pool measurements:
 - IPv6: <https://atlas.ripe.net/measurements/2048609/>
 - IPv4: <https://atlas.ripe.net/measurements/2048605/>

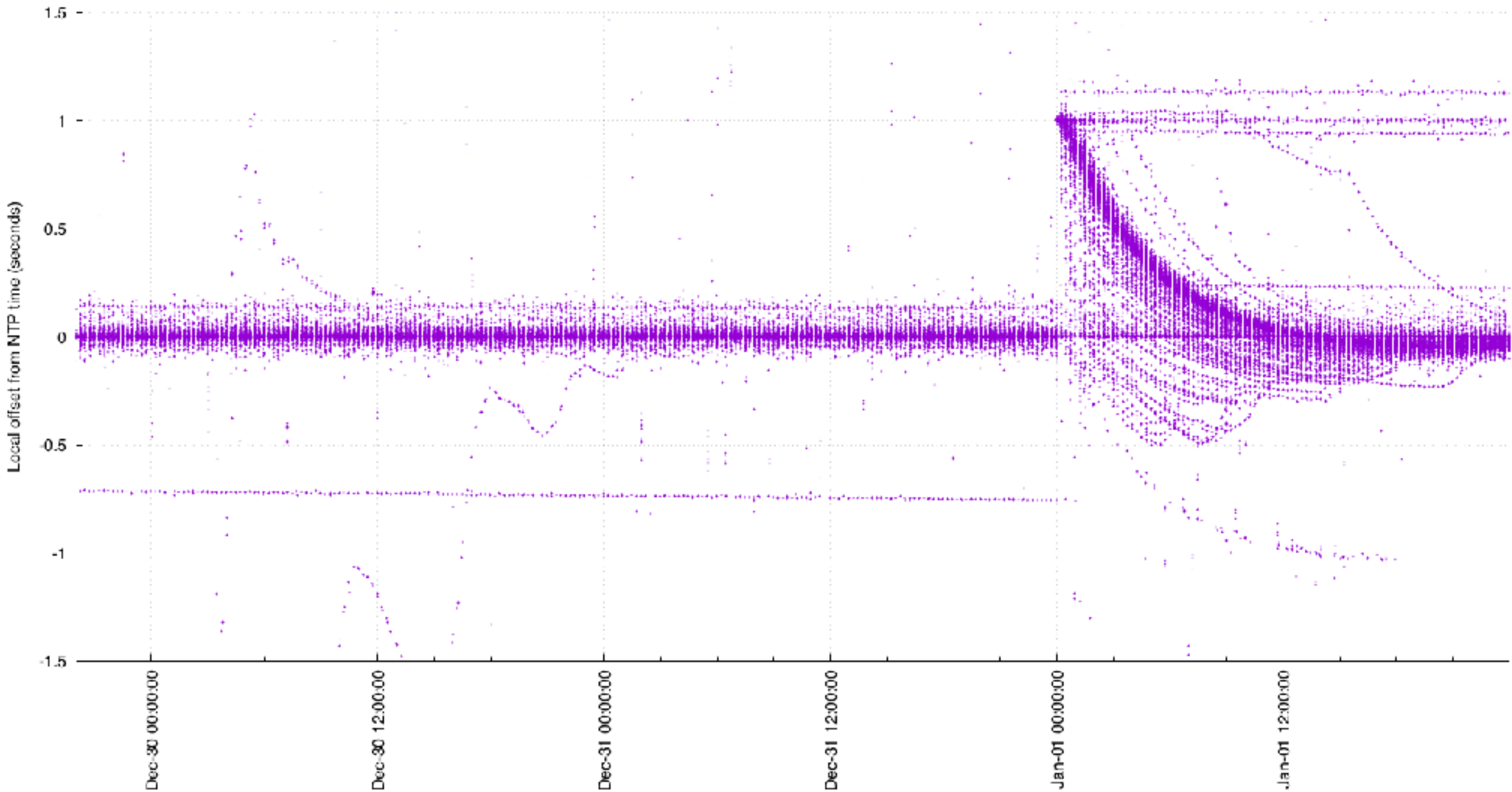
NTP Pool Leap Indicators



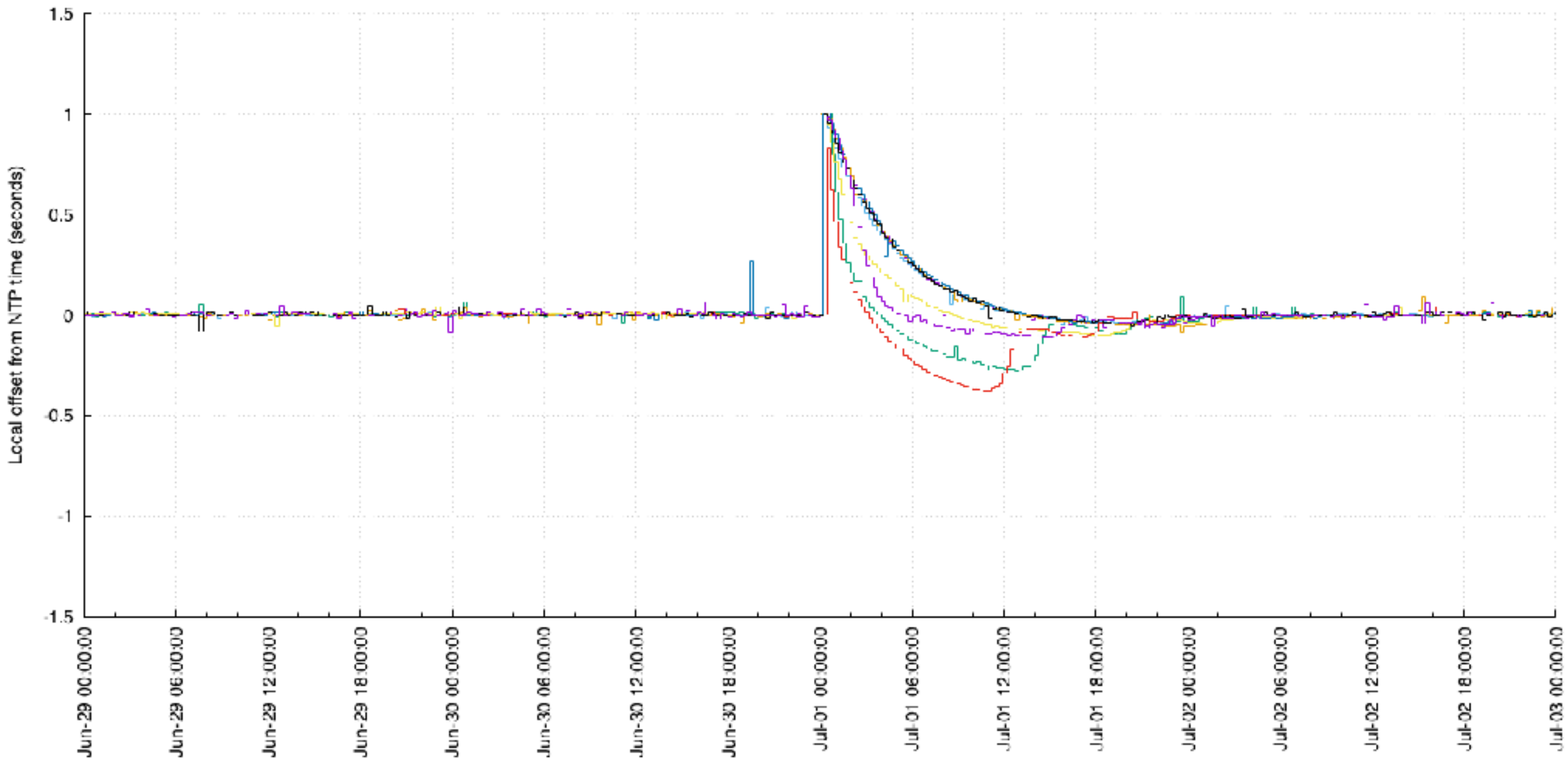
NTP Pool Leap Indicators



Leap-second Offsets



`ntpd -x -g` response





Solutions

Get rid of leap seconds?



- UTC is here for a while:
 - https://www.itu.int/net/pressoffice/press_releases/2015/53.aspx
 - *“New reference time scale to be considered by World Radiocommunication Conference in 2023”*

Ignore the leap second?



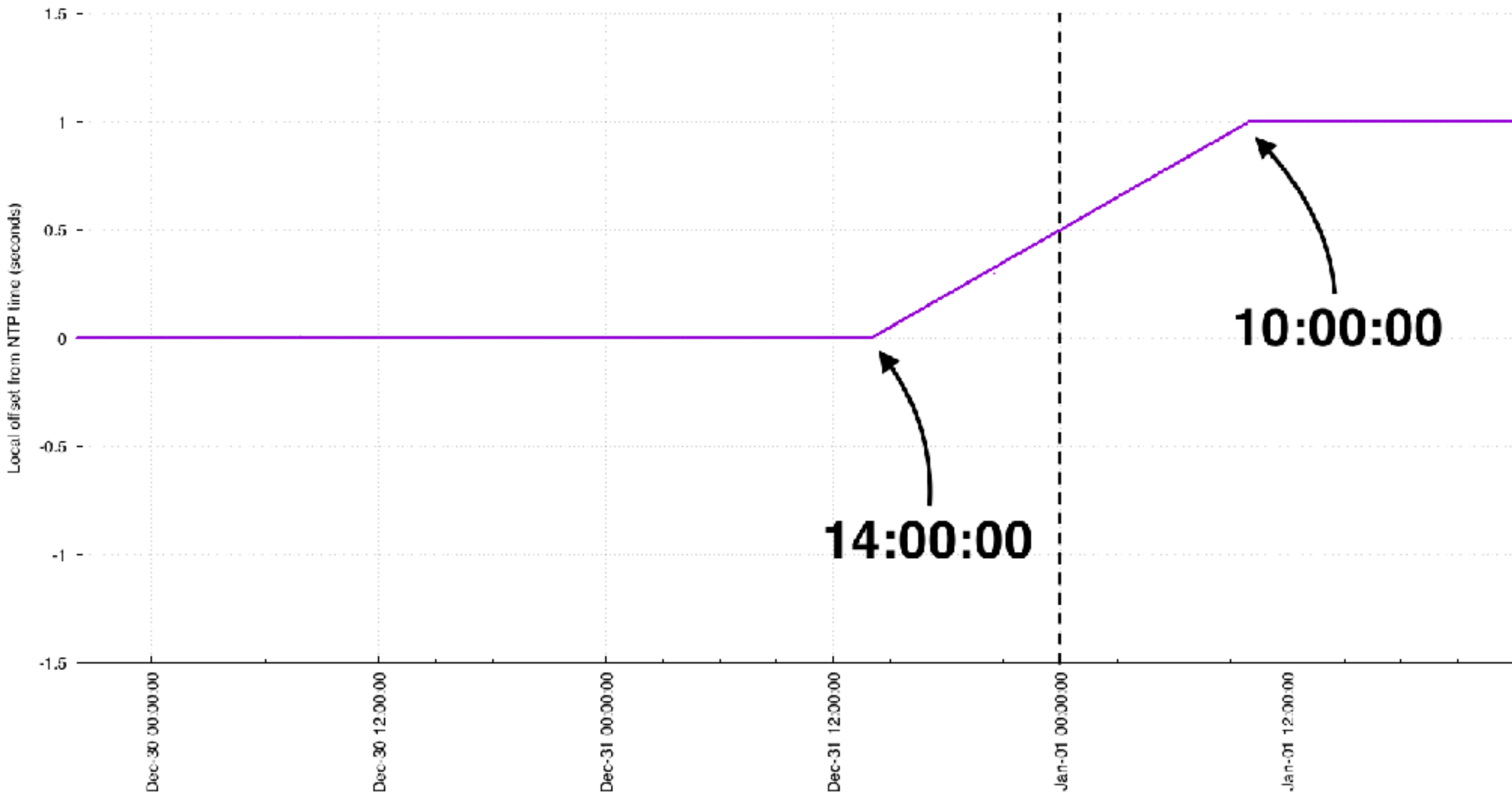
- `ntpd -x -g`
- `openntpd`
 - deliberately ignores the leap indicator

Leap-smear



- Growing consensus?
- Stretch/shrink seconds around the leap second insertion
- **Important:** during the leap-smear, *not* UTC
 - but in most cases, this is probably an acceptable trade-off

time[1-3]?.google.com smear





Conclusions

Conclusions?



- Time is really tricky
 - What are your hosts/devices/time servers configured to do?
- If you don't strictly need UTC?
 - openntpd, ntpd -x -g
 - leap smear
 - each attempts to maintain continuous time, at the cost of a longer adjustment period



Questions

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