A Brief History of Time (Synchronisation)

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Synchronisation

Master Clocks

- Pulse on the hour jumpsyncs
- GrandMaster per city
- Master per site
- SubMaster per building





The ultimate timing reference
One pulse, on the second
Most gear offers negative delays
Cable delay compensation

IRIG B

Inter-Range Instrumentation Group
i.e. rockets, missiles
IkHz signal
Time, Day of year

IOMhz / 5Mhz

- Lab frequency references
- Usually sine wave, sometimes square
- IOMhz current standard, 5Mhz old

"Time Code"

- SMTPE Audio time code
- VITC Video time code
- Used in audio, video, film production
- Accurate to sub-frame
- Bi-Phase & Tach for speed

Word Clock

- Digital audio synchronisation
- AES "Black Burst"
 - Standard AES signal, just all-zeros

NTP Network Time Protocol

- vl RFC958 September 1985
- Capable of <100ns lock within a LAN
- Ims long-term over internet
- Many high-quality public servers

Strata

An aside...

NTP Strata

- Stratum 0 Master clock
- Stratum I Directly connected to master
- Stratum 2 Slaved to a Stratum I
- Stratum 3 Slaved to a Stratum 2

• Stratum 16 – Slaved to a Stratum 15

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Telco Strata

Stratum	OR	Accuracy
	PRC	10-11
2	SC	I 0 ⁻⁹
3	SC	I 0 ⁻⁸
	SEC	5 * 10-6

PTP Precision Time Protocol

- "Replacement" for NTP
- vl (2002) multicast LAN only
- v2 (2008) routable, only slightly better then NTP, incompatible with v1
- No serious deployment outside labs



Managing Time Systems

Why have accurate time?

- Users complain if >10 min
- Kerberos refuses if > 5 min
- Users actually complain if > 0min
 - "Why did this e-mail take so long"
 - "Why am I getting e-mail from the future"
- Log analysis sucks if out

• "Out" can mean <30ms for big logs

Time Standards

- GMT Greenwich Mean Time
- UTC Civil standard
 - UT0 Astronomical Time
 - UTI Mean Solar Time
 - UTIR Smoothed out tides
 - UT2 Smoothed out seasons
 - UT2R Smoothed out tides & seasons
- TAI Atomic time, UTC with no leap seconds

Time Zones

Time Zone Databases

"tz Database" – The canonical Database
Used by just about everybody
Except Microsoft
Keep updated
DST changes *multiple* times per year

Daylight Savings

Usually I hour "forward" in summer
Lord Howe Island uses 30m
20m and 2h have been used

Silly Time Zones

- AU Adelaide UTC+9:30
- AU Eucla UTC+8:45
- SI Singapore UTC+7:20 (Historic, pre 1941)
- IR Dublin UTC-0:25 (Historic, pre Oct 1916)
- LR Liberia UTC-0:44 (Historic, pre 1972)
- LR Liberia UTC-0:43:08 (Historic, pre 1919)

Large Scale Distributed Timing

Local Masters

- Two or three *physical* hosts with good clocks
- Synced off:
 - Nearby Stratum I/2 NTP (3-5 no more)

Locked

- GPS
- Caesium / Rubidium & GPS/NTP
- Consider NTP appliances

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Datum TymServe

Distribution

- If > 1000 clients then distribution may be needed
- Or with older NTP appliances, > 50
- Physical hosts
- Sync with 3-5 masters no more



- Sync to masters or distribution as appropriate
- 3-5 masters no more

NTP"Local"

- Most default NTP configs set up a local clock
- Disable on everything that's not a master

Virtual Machines

Virtual guests are never timing masters
Lucky to get <5s skew over 24h

Managing Time Applications

Time Zones

- Use the OS' zone database
 Store everything as UTC + offset
- Store everything as local + zone

Daylight Savings

- For embedded developers only
 - Everyone else use tz DB
- 0-2h offset, by minute or 15m
- Direction
- Day starts, day stops
 - As date & day of week of month
- Hour starts, hour stops

• Remember start day > stop day in south

Leap Seconds

Not every minute has 60 seconds
Some have 61
Unless you're doing a lab experiment

IGNORE

Questions?

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