

What time is it? Managing Time in the Internet

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Motivation

- Internet time synchronization is performed on UTC
- People-facing applications: UTC → *current local time*
- Notoriously difficult to deal with time zones correctly
 - Account for Daylight Saving Time (DST) rules, which are changed often
 - Samoa skipped a day in December 2011



The Problem with Time & Timezones - Computerphile
Computerphile • 1.9M views • 5 years ago

Background

- Time zones originated to standardize *current local time* – coordination of railway and telegraph networks (late 19th century)
- Arrival of World War I led to creation of DST in 1918
- Knowledge/handling of time zone is necessary for modern day applications – meetings on calendars
- Time Zone Database (TZDB), is a critical asset in handling time zones
- TZDB was created by Arthur David Olson in the early 1980s

Background

- TZDB consists of *zone definitions* and *rules* for every time zone – both historical & current

```
# Zone  NAME                GMTOFF  RULES  FORMAT  [UNTIL]
Zone   America/New_York -4:56:02  -      LMT     1883 Nov 18 12:03:58
      ...
      -5:00      NYC     E%sT   1967
      -5:00      US      E%sT
```

```
# Rule  NAME  FROM  TO  TYPE  IN  ON  AT  SAVE  LETTER/S
      ...
Rule    US    2007  max  -    Mar  Sun >=8  2:00  1:00  D
Rule    US    2007  max  -    Nov  Sun >=1  2:00  0     S
```

- Organized as text files, reference implementation - C API functions and utilities

Background

- Placed in public domain in 2009 by Olson; not “owned” by anyone
- TZDB is hosted by IANA and update process defined by RFC 6557
- Maintained by volunteers and primary maintainer for the past 26 years
- Currently, primary maintainer is Paul Eggert of UCLA
- Most recent version of TZDB has 348 time zone records
- Consumed by almost all major hardware, OS vendors and programming libraries – GNU Linux, Android, iOS, pytz (Python), Joda-Time (Java) etc.

TZDB update process

- Time zones – managed/updated by local government authorities
- TZDB community discuss changes – TZ mailing list
- New TZDB release created by maintainer and published
- Onus on consumers to update their versions – OS updates
- Delay in updating TZDB version can cause disruptions
 - Case study : Turkey Elections, 2015

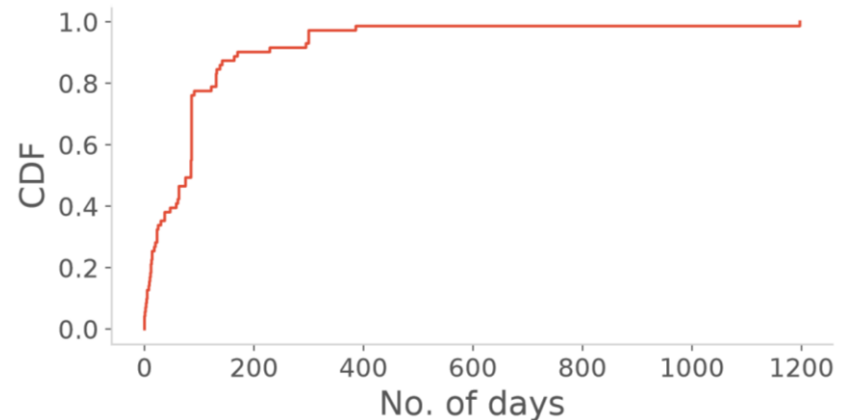
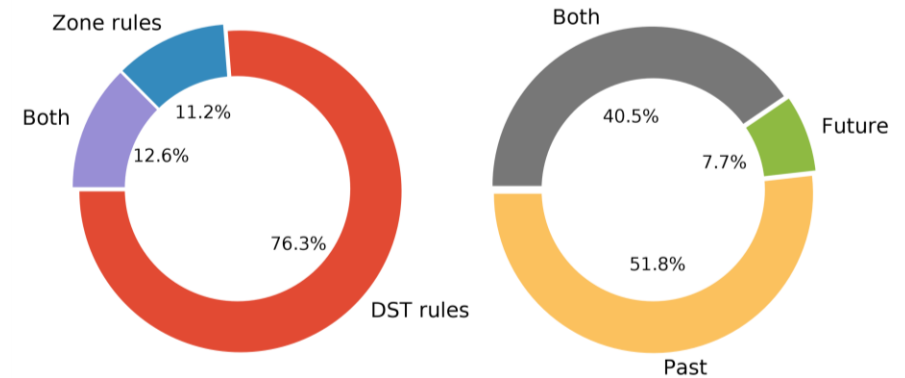
Given the practical and extremely wide-spread use of TZDB it is important to understand its evolution.

Data used for analysis

- TZ database source files from 240 releases, 26 years (1993–2019)
- Entire TZ mailing list archives, 33 years (Nov 1986–May 2019)
- We built a Python parser tool to,
 - Process zone/DST rules
 - Detect updates – effective changes between consecutive releases
 - Identify corrections – updates to previous updates
- 2,283 updates to zone and DST rules identified – with 427 correction updates

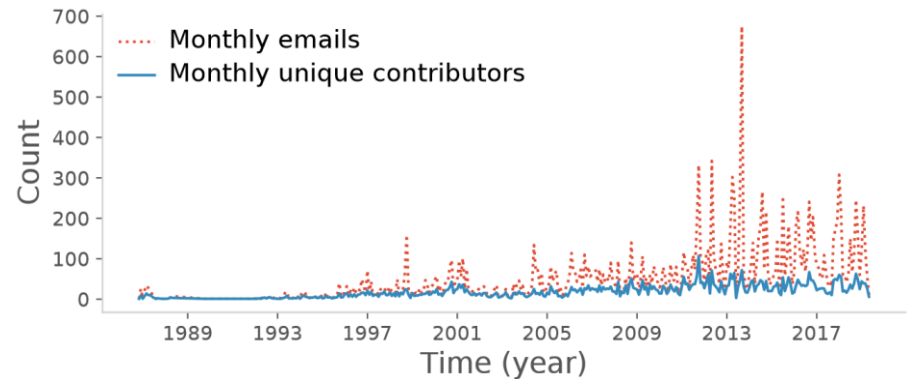
Maintenance perspective

- DST - huge influence on managing current local time on connected devices
- Majority of updates affect timestamps in the past
- ~80% of updates made within 100 days from date of effect – 20% within 15 days or less



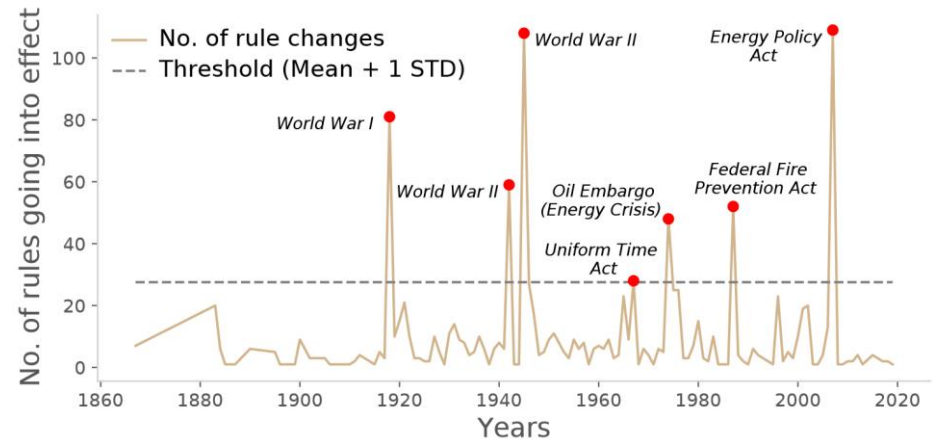
Community perspective

- 1,891 unique contributors sent 19,367 emails over 33 years
- Increasing trend seen after 2012 adoption by IANA
- Trends correlated with increasing usage of TZDB particularly due to adoption of mobile/smart devices
- Relatively large no. contributors is a potential concern



Geo-Political perspective

- Reasons for DST rules changes are often administrative
- To evaluate this hypothesis, we analyzed rule change frequency
- We generate histogram of rule changes for each time zone
- We group time zones by country and look at history
- TZDB provides unique perspective on historical events



Problems related to TZDB updates

- Highlight importance and impact of TZDB updates
- Correction updates – 19% of updates are corrections
 - Incomplete information released by authorities
- Errors – highlight problems in informal update process
 - Identified and later fixed by contributors
- Software bugs – Broke OpenJDK, Qt etc.
- Delayed updates – Issues with Android/ iOS users in Israel, Turkey

Recommendation objectives

- Intention – not to impugn individuals who have contributed time & energy
- We hope to expand perspective and start discussions
- We do not provide any implementations – use standard tools
- Intentionally high level – details to be fleshed out within the TZDB community

Our recommendations

- Codification of update process
 - Introduce formalization – release cycles, documentation, ticketing system and tests
- Secure the update process against,
 - Impersonation of a TZDB contributor or authority or Coordinator
 - A motivated attacker or e.g., a government entity may use current processes to facilitate malicious/unwanted updates to TZDB
- Audit TZDB updates – by independent third party, well documented

Summary

- We examine the evolution of the TZDB - a critical asset for reporting current local time
- We consider TZDB maintenance and update processes and elucidate anomalies and potential vulnerabilities
- We propose updates to the current system to enhance security and integrity

S. Mani, P. Barford, R. Durairajan, and J. Sommers. "What time is it? Managing Time in the Internet", To appear in the proceedings of The ACM, IRTF & ISOC Applied Networking Research Workshop, 2019

Thank you for your Time!
Questions?

Thanks to the TZDB community for their efforts in maintaining this critical database.

All the data and code from our study is available at: https://github.com/satkum/tzdb_analysis