

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

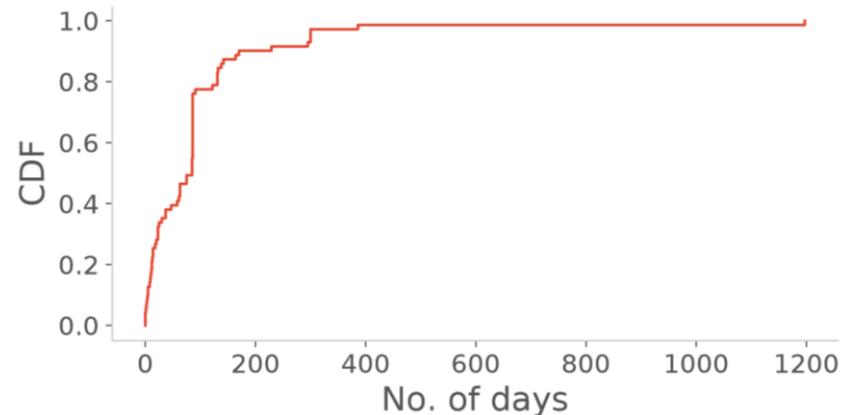
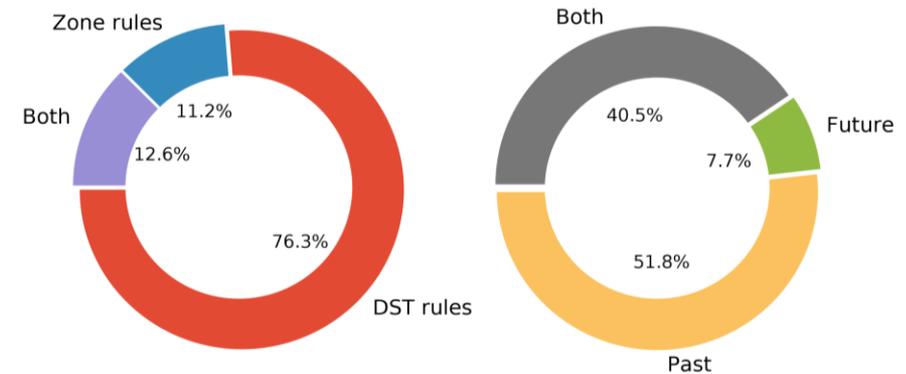
Given the practical and extremely wide-spread use of TZDB it is important to understand its evolution.

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

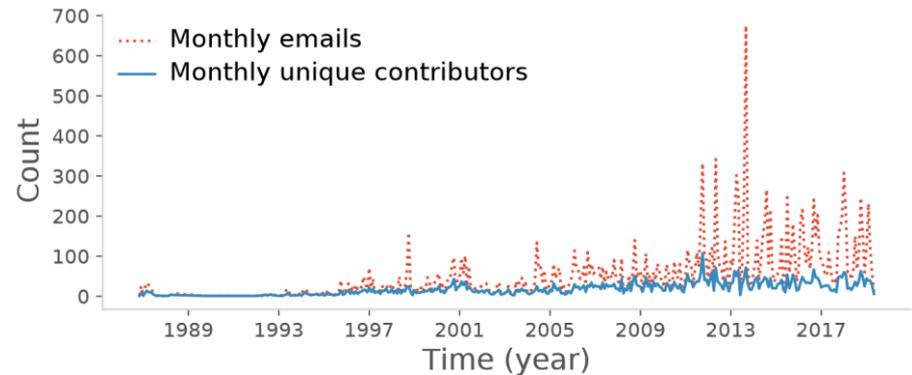
Maintenance perspective

- 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



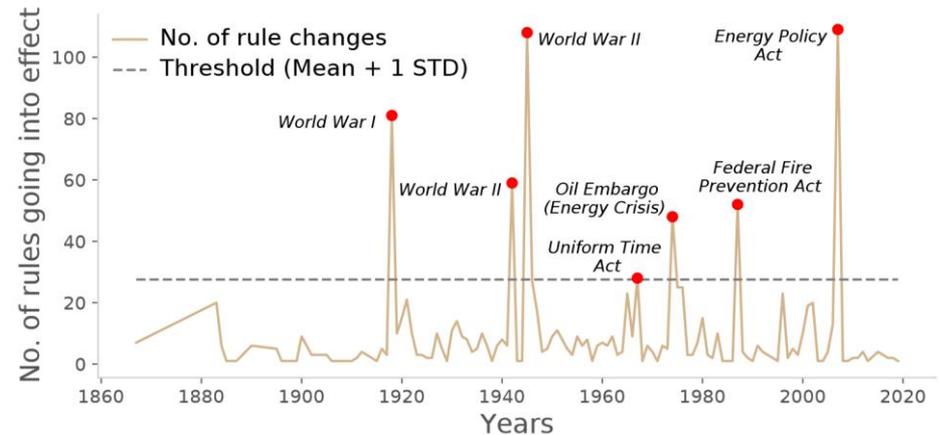
Community perspective

- 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

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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