Construction of Time Zones Composed of Time Zone Regions

1. A time zone is defined by its name. A time zone specifies a GMT offset, either a daylight savings time rule or a fixed saved time offset, and a the datetime when it becomes effective. A time zone can change over time, resulting in different time zone versions with the same name.
2. A time zone can be considered to be composed of *periods.* A *period* is a continuous period of time where the applicable daylight savings time rule (DSTR) version and GMT offset remain the same.
3. A DSTR is identified by its name. A DSTR specifies an amount of time saved (e.g., additional offset from GMT), a specification defining the datetime during the year when it becomes effective, and a period of applicability, delineated by a *from year* and a *to year*. A DSTR can change over time, resulting in different rule versions with the same name.
4. A DSTR version becomes effective at a point in the *from year* specified by a month and either a day of the month or a weekday specification (e.g., the 2nd Sunday of the month). When a weekday specification is used, the rule becomes effective at different times during different years.
5. At most, one DSTR may be applicable during a given period. However, multiple versions of the DSTR may be, and often are, applicable during the period. Of the applicable DSTR versions, at most one may be effective at any point in time. A DSTR remains effective until another DSTR becomes effective (or, in the edge case, where the time zone version changes to one with no or a different DSTR during the effective period of the original DSTR). As such, a DSTR may remain effective into the year beyond its *to year*, though, by definition, not beyond the end of the period.
6. In the most common case of a time zone period, two versions of a DSTR, one representing standard time, and one representing daylight savings time are applicable. The effective DSTR version alternates between the two versions. As long as the GMT offset remains the same, and the applicable instances remain the same, the time zone remains within a single period.
7. If we consider a calendar year, except in the edge case, where a DSTR becomes effective at midnight on January 1st, the year begins with the last effective DSTR from the previous year. Thus, period boundaries will seldom fall on year boundaries.
8. A new time zone period begins when either of the following occurs:
   1. A new version of the time zone, with either a different GMT offset or which changes from DSTR specified to fixed saved time or vice versa, becomes effective. A change from one DSTR to another does not cause an end to the period on the effective date of the new time zone version.
   2. A version of a *different DSTR*, from the applicable DSTR for the period becomes effective. The new DSTR will become *applicable* when the new time zone version becomes effective, which, in general, is before it becomes *effective*.
   3. A new version of the time zone, with the same DSTR, but a different set of applicable DSTR versions becomes effective, and the first version of the new set of DSTR versions becomes effective. This is the case, even when the DSTR version that becomes effective is a member of the set of DSTR versions associated with the original time zone version. In this case, the new version of the time zone becomes effective because of a rule version losing applicability due to the passage of time, or a rule version gaining applicability due to the changing of time. At the start of each year within the total range of applicability of the rule we need to compute the set of applicable rules and compare it to the set at the start of the previous year. When there is a change, we then need to determine when the first rule becomes effective in that year. That is when the period changes and the new time zone version becomes effective.
9. We need to find the until time for a time zone version on a wall time frame of reference. The are 3 cases to consider, and sub cases within those cases:
   1. Until frame of reference is wall – no translation necessary
   2. Until frame of reference is standard – convert DSTR to standard frame of reference
      1. No DSTR specified – wall time = standard time. Create a s-w UTCOffset with zero duration and apply
      2. DSTR AT time is standard frame of reference. No translation necessary to

determine applicable DSTR. Create a s-w UTCOffset from the DSTR and apply

* + 1. DSTR AT time is universal frame of reference. Create a u-s UTCOffset from GMTOffset and apply to AT time to determine applicable DSTR. Create a s-w UTCOffset from the DSTR and apply. \*\*\*\* This can be problematic if we have an edge condition where we can’t determine the GMTOffset if we don’t know which time zone version is applicable. If we assume the current GMTOffset is applicable and the rule falls within the time zone version, we can use that rule. If it does not fall within the time zone version under that assumption, the rule should not be used.
    2. DSTR AT time is wall frame of reference. Create a w-s UTCOffset from the DSTR and apply to AT time to determine applicable DSTR. Create a s-w UTCOffset from the DSTR and apply
  1. Until frame of reference is universal
     1. No DSTR specified – Create a u-w UTCOffset from the GMTOffset and apply.
     2. DSTR AT time is universal frame of reference. No translation necessary to determine applicable DSTR.
     3. DSTR AT time is standard frame of reference. Translate AT time to universal using GMTOffset. See b. iii.
     4. DSTR AT time is wall. Translate AT time to universal using DSTR offset and GMTOffset. See b.iii.

1. Selected cases. These cases assumes periods are created working backwards from the until datetime of the current version to the until datetime of the previous version
   1. Case 1
      1. Time zone has a specified rule
      2. There is no applicable rule set in the until year, uuuu
      3. A new period begins on 1/1 of the year after the last year before uuuu that has an applicable rule set or on the last until datetime
   2. Case 2
      1. Time zone has a specified rule
      2. A new rule set becomes applicable in year, nnnn == the until year, uuuu
      3. If the earliest effective date of a rule in the rule set in year nnnn, < UntilDatetime, a new period begins on that effective date or the last until datetime
      4. If the earliest effective date of a rule in the rules set in year nnnn >= UntilDatetime, no new period is created
   3. Case 3
      1. Time zone has a specified rule
      2. A new rule set becomes applicable in year, nnnn < the until year, uuuu
      3. A new period begins on the datetime the first rule in the set becomes effective or the last until datetime
2. Overall period creation algorithm
   1. Iterate through time zone versions in chronological order
   2. In each time zone version
      1. Establish the Until datetime in wall frame of reference
      2. Work backwards through the time zone, finding applicable rule sets. The previous datetime if the first effective date of the applicable rule setp