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Non-Gregorian Recurrence Rules in iCalendar
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Abstract

This document defines how non-Gregorian recurrence rules can be specified in iCalendar data.

Status of this Memo

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1. Introduction

The iCalendar [RFC5545] data format is in widespread use to represent calendar data. iCalendar represents dates and times using the Gregorian calendar system only. It does provide a way to use non-Gregorian calendar systems via a "CALSCALE" property, however this has never been formally used. However, there is a need to support at least non-Gregorian recurrence patterns to cover anniversaries, and many local, religious, or civil holidays based on non-Gregorian dates.

There are several disadvantages to using the existing "CALSCALE" property in iCalendar for implementing non-Gregorian calendars:

1. The "CALSCALE" property exists in the top-level "VCALENDAR" objects and thus applies to all components within that object. In today's multi-cultural society, that restricts the ability to mix events from different calendar systems within the same iCalendar object. e.g., it would prevent having both the Gregorian New Year and Chinese New Year in the same iCalendar object.

2. Many countries observe daylight savings time, encoded in iCalendar using the "VTIMEZONE" component. Timezone and daylight saving time rules are always specified via Gregorian calendar based recurrence rules (e.g., "the 3rd Sunday in March"). This is problematic for non-Gregorian uses of "CALSCALE" which would by default also apply to the dates and rules used in the "VTIMEZONE" components in the corresponding iCalendar object.

This specification solves these issues by allowing the "CALSCALE" to remain set to Gregorian, but re-defining the recurrence rule property "RRULE" to accept new items including one that allows non-Gregorian calendar systems to be used. With this, all the date, time and period values in the iCalendar object would remain specified using the Gregorian calendar system, but repeating patterns in other calendar systems could be defined. It is then up to calendar user agents and servers to map between Gregorian and non-Gregorian calendar systems in order to expand out recurrence instances.

This specification does not itself define calendar systems, rather it utilizes the calendar system registry defined by the Unicode Consortium in their CLDR (Common Locale Data Repository) project [UNICODE.CLDR].

2. Conventions Used in This Document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

The notation used in this memo is the ABNF notation of [RFC5234] as used by iCalendar [RFC5545]. Any syntax elements shown below that are not explicitly defined in this specification come from iCalendar [RFC5545], iTIP [RFC5546], and CalDAV [RFC4791].

When XML element types in the namespaces "DAV:" and "urn:ietf:params:xml:ns:caldav" are referenced in this document outside of the context of an XML fragment, the string "DAV:" and "CALDAV:" will be prefixed to the element type names respectively.

When a Gregorian calendar date value is shown in text, it will use the format "YYYYMMHH", where "YYYY" is the 4-digit year, "MM" the 2-digit month, and "DD" the 2-digit day (this is the same format used in iCalendar [RFC5545]). The Chinese calendar will be used as an example of a non-Gregorian calendar for illustrative purposes. When a Chinese calendar date value is shown in text, it will use the format "{C}YYYYMM[L]DD" - i.e., the same format as Gregorian but with a "{C}" prefix, and an optional "L" character after the month element to indicate a leap month. Similarly, {E} and {H} are used in other examples as prefixes for Ethiopic (Amete Mihret) and Hebrew dates, respectively. Note that the Chinese calendar years shown in the examples are based on the Unicode (ICU) [UNICODE.ICU] library's Chinese calendar epoch. Whilst there are several different Chinese calendar epochs in common use, the choice of one over another does not impact the actual calculation of the Gregorian equivalent dates, provided conversion is always done using the same epoch.

3. Overview

In the Gregorian calendar system, each year is composed of a fixed number of months (12), with each month having a fixed number of days (between 30 and 31), except for the second month (February) which contains either 28 days, or 29 days (in a leap year). Weeks are composed of 7 days, with day names Monday, Tuesday, Wednesday, Thursday, Friday, Saturday and Sunday. Years can have either 365 or 366 days (the later in a leap year). The number of whole weeks in a year is 52.

In iCalendar, the "RECUR" value type defines various fields used to express a recurrence pattern, and those fields are given limits based

on those of the Gregorian calendar system. Since other calendar systems can have different limits and other behaviors that need to be accounted for, the maximum values for the elements in the "RECUR" value are not covered by this specification.

To generate a set of recurring instances in a non-Gregorian calendar system, the following procedure is used:

1. iCalendar data continues to use the "GREGORIAN" calendar system, so all "DATE", "DATE-TIME" and "PERIOD" values continue to use the Gregorian format and limits.

2. The "RRULE" property is extended to include an "RSCALE" element in its value that specifies the calendar system to use for the recurrence pattern. The existing elements of the "RRULE" value type are used, but modified to support different upper limits, based on the "RSCALE" value, as well as a modification to month numbers to allow a leap month to be specified. Existing requirements for the use of "RRULE" all still apply (e.g., the "RRULE" has to match the "DTSTART" value of the master instance). Other recurrence properties such as "RECURRENCE-ID", "RDATE" and "EXDATE" continue to use the Gregorian date format as "CALSCALE" is unchanged.

When generating instances, the following procedure might be used:

1. Convert the "DTSTART" property value of the master recurring component into the date and time components for the calendar system specified by the "RSCALE" element in the "RRULE" value. This provides the "seed" value for generating subsequent recurrence instances.

2. Iteratively generate instances using the "RRULE" value applied to the year, month, and day components of the date in the new calendar system.

3. For each generated instance, convert the date values back from the non-Gregorian form into Gregorian and use those values for other properties such as "RECURRENCE-ID".

Consider the following example for an event representing the Chinese New Year:

```
DTSTART;VALUE=DATE:20130210
RRULE:RSCALE=CHINESE;FREQ=YEARLY
SUMMARY:Chinese New Year
```

To generate instances, first the "DTSTART" value "20130210" is

converted into the Chinese calendar system giving "{C}46500101". Next, the year component is incremented by one to give "{C}46510101", and that is then converted back into Gregorian as "20140131". Additional instances are generated by iteratively increasing the year component in the Chinese date value and converting back to Gregorian.

4. Extended RRULE Property

This specification extends the existing "RRULE" iCalendar property value to include a new "RSCALE" element that can be used to indicate the calendar system used for generating the recurrence pattern.

When "RSCALE" is present, the other changes to "RRULE" are:

1. Elements that include numeric values (e.g., "BYYEARDAY") have numeric ranges defined by the "RSCALE" value (i.e., in some calendar systems there might be more than 366 days in a year).

2. Month numbers can include an "L" suffix to indicate that the specified month is a leap month in the corresponding calendar system.

3. A "SKIP" element is added to define how "missing" instances are handled. e.g., if a yearly recurring event starts in a leap month, the "SKIP" element determines whether instances in non-leap years are ignored ("SKIP" set to "YES"), appear in the preceding regular month ("SKIP" set to "BACKWARD" - the default when "RSCALE" is present), or appear in the following regular month ("SKIP" set to "FORWARD"). This applies for both leap days and leap months. The "SKIP" processing is done after all rule elements, other than "BYSETPOS", "COUNT" and "UNTIL", have been processed.

The syntax for the "RECUR" value is modified in the following fashion:

```
recur-rule-part /=   ("RSCALE" "=" rscale)
                   / ("SKIP" "=" skip)

rscale          = (iana-token  ; A CLDR-registered calendar system
                               ; name.
                   / x-name)   ; A non-standard, experimental
                               ; calendar system name.
                               ; Names are case-insensitive,
                               ; but uppercase values are preferred.

skip            = ("YES" / "BACKWARD" / "FORWARD")
                  ; Optional, with default value "BACKWARD",
                  ; and MUST only be present if "RSCALE" is present.

monthnum        = 1*2DIGIT  ["L"]
                  ; Existing element modified to include a leap
                  ; month indicator suffix.
```

4.1. Handling Leap Months

Leap months can occur in different calendar systems. For such calendar systems the following rules are applied for "identifying" months:

1. Numeric values 1 through N are used to identify regular, non-leap, months (where N is the number of months in a regular, non-leap, year).

2. The suffix "L" is added to the regular month number to indicate a leap month which follows the regular month. e.g., "5L" is a leap month that follows the 5th regular month in the year.

Care has to be taken when mapping the month identifiers used here with those of any underlying calendar system library being used. In particular, the Hebrew calendar system used by Unicode (ICU) [UNICODE.ICU] uses a month number scheme of 1 through 13, with month 6 being the leap month, and in non-leap years, month 6 is skipped. In iCalendar, this would map to months 1 through 12 with "5L" as the leap month.

4.2. Examples

4.2.1. Chinese New Year

Consider the following set of iCalendar properties:

```
DTSTART;VALUE=DATE:20130210
RRULE:RSCALE=CHINESE;FREQ=YEARLY
SUMMARY:Chinese New Year
```

These define a recurring event for the Chinese New Year, with the first instance the one in Gregorian year 2013.

The Chinese date corresponding to the first instance is {C}46500101. The table below shows the initial instance, and the next four, each of which is determined by adding the appropriate amount to the year component of the Chinese date. Also shown is the conversion back to the Gregorian date:

Chinese Date	Gregorian Date
{C}46500101	20130210 - DTSTART value
{C}46510101	20140131
{C}46520101	20150219
{C}46530101	20160208
{C}46540101	20170128

4.2.2. Ethiopic 13th Month

Consider the following set of iCalendar properties:

```
DTSTART;VALUE=DATE:201300906
RRULE:RSCALE=ETHIOPIC;FREQ=YEARLY;BYMONTH=13
SUMMARY:First day of 13th month
```

These define a recurring event for the first day of the 13th month, with the first instance the one in Gregorian year 2013.

The Ethiopic date corresponding to the first instance is {E}20051301. The table below shows the initial instance, and the next four, each of which is determined by adding the appropriate amount to the year component of the Ethiopic date. Also shown is the conversion back to the Gregorian date:

Ethiopic Date	Gregorian Date
{E}20051301	20130906 - DTSTART value
{E}20061301	20140906
{E}20071301	20150906
{E}20081301	20160906

{E}20091301	20170906

Note that in this example, the value of the "BYMONTH" component in the "RRULE" matches the Ethiopic month value and not the Gregorian month.

4.2.3. Hebrew anniversary starting in a leap month

Consider the following set of iCalendar properties:

```
DTSTART;VALUE=DATE:20140208
RRULE:RSCALE=HEBREW;FREQ=YEARLY;BYMONTH=5L;BYMONTHDAY=8;SKIP=FORWARD
SUMMARY:Anniversary
```

These define a recurring event for the 8th day of the Hebrew month of Adar I (the leap month identified by "5L"), with the first instance the one in Gregorian year 2014.

The Hebrew date corresponding to the first instance is {H}577405L08, which is a leap month in year 5774. The table below shows the initial instance, and the next four, each of which is determined by adding the appropriate amount to the year component of the Hebrew date, taking into account that only year 5776 is a leap year. Thus in other years the Hebrew month component is adjusted forward to month 6. Also shown is the conversion back to the Gregorian date:

Hebrew Date	Gregorian Date
{H}577405L08	20140208 - DTSTART value
{H}57750608	20150227
{H}577605L08	20160217
{H}57770608	20170306
{H}57780608	20180223

4.2.4. Gregorian leap day with SKIP

Consider the following set of iCalendar properties:

```
DTSTART;VALUE=DATE:20120229
RRULE:FREQ=YEARLY
SUMMARY:Anniversary
```

These define a recurring event for the 29th February, 2012 in the standard iCalendar calendar scale - Gregorian. The standard iCalendar behavior is that non-existent dates in a recurrence set are

ignored. Thus the properties above would only generate instances in leap years (2016, 2020, etc), which is likely not what users expect. The new "RSCALE" option defined by this specification provides the "SKIP" element which can be used to "fill in" the missing instances in an appropriate fashion. The set of iCalendar properties below do that:

```
DTSTART;VALUE=DATE:20120229
RRULE:RSCALE=GREGORIAN;FREQ=YEARLY;SKIP=FORWARD
SUMMARY:Anniversary
```

With these properties, the "missing" instances in non-leap year now appear on the 1st March in those years:

Instances (with SKIP=FORWARD)	Instances (without RSCALE)
20120229	20120229 - DTSTART value
20130301	
20140301	
20150301	
20160229	20160229
20170301	

5. Registering Calendar Systems

This specification uses the Unicode Consortium's registry of calendar systems [UNICODE.CLDR] to define valid values for the "RSCALE" element of an "RRULE". Note that the underscore character "_" is never used in CLDR-based calendar system names. New values can be added to this registry following Unicode Consortium rules. It is expected that many implementations of non-Gregorian calendars will use software libraries provided by Unicode (ICU) [UNICODE.ICU], and hence it makes sense to re-use their registry rather than creating a new one. For consistency, when used, the "RSCALE" values SHOULD be uppercased.

CLDR supports the use of "alias" values as alternative names for specific calendar systems. These alias values MUST be treated as valid "RSCALE" element values.

When using the CLDR data, calendar agents SHOULD take into account the "deprecated" value and use the alternative "preferred" calendar system. In particular, the "islamicc" calendar system is considered deprecated in favor of the "islamic-civil" calendar system.

6. Use with iTIP

iTIP [RFC5546] defines how iCalendar data can be sent between calendar user agents to schedule calendar components between calendar users. It is often not possible to know the capabilities of a calendar user agent to which an iTIP message is being sent, but iTIP defines fallback behavior in such cases.

For calendar user agents that do not support the "RSCALE" element, the following can occur when iTIP messages containing an "RSCALE" element are received:

The receiving calendar user agent can reject the entire iTIP message and return an iTIP reply with a "REQUEST-STATUS" property set to the "3.1" status code (as per Section 3.6.14 of [RFC5546]).

The receiving calendar user agent can fallback to a non-recurring behavior for the calendar component (effectively ignoring the "RRULE" property) and return an iTIP reply with a "REQUEST-STATUS" property set to the "2.3", "2.5", "2.8", or "2.10" status codes (as per Sections 3.6.3, 3.6.6, 3.6.9, or 3.6.11, respectively, of [RFC5546]).

For calendar user agents that support the "RSCALE" element but do not support the calendar system specified by the "RSCALE" element value, the following can occur:

the iTIP message SHOULD be rejected, returning a "REQUEST-STATUS" property set to the "3.1" status code (as per Section 3.6.14 of [RFC5546]).

if the iTIP message is accepted and the calendar component treated as non-recurring, an iTIP reply with a "REQUEST-STATUS" property set to the "2.8" or "2.10" status codes (as per Sections 3.6.9 or 3.6.11, respectively, of [RFC5546]) SHOULD be returned.

7. Use with CalDAV

The CalDAV [RFC4791] calendar access protocol allows clients and server to exchange iCalendar data. In addition, CalDAV clients are able to query calendar data stored on the server, including time-based queries. Since an "RSCALE" element value determines the time ranges for recurring instances in a calendar component, CalDAV servers need to support it to interoperate with clients also using the "RSCALE" element.

A CalDAV server advertises a CALDAV:supported-rscale-set WebDAV

property on calendar home or calendar collections if it supports use of "RSCALE" element as described in this specification. The server can advertise a specific set of supported calendar systems by including one or more CALDAV:supported-rscale XML elements within the CALDAV:supported-rscale-set XML element. If no CALDAV:supported-rscale XML elements are included in the WebDAV property, then clients can try any calendar system value, but need to be prepared for a failure when attempting to store the calendar data.

Clients MUST NOT attempt to store iCalendar data containing "RSCALE" elements if the CALDAV:supported-rscale-set WebDAV property is not advertised by the server.

The server SHOULD return an HTTP 403 response with a DAV:error element containing a CALDAV:supported-rscale XML element, if a client attempts to store iCalendar data with an "RSCALE" element value not supported by the server.

It is possible for a "RSCALE" value to be present in calendar data on the server being accessed by a client that does not support an "RSCALE" element or its specified value. It is expected that existing clients, unaware of "RSCALE", will fail gracefully by ignoring the calendar component, whilst still processing other calendar data on the server.

7.1. CALDAV:supported-rscale-set Property

Name: supported-rscale-set

Namespace: urn:ietf:params:xml:ns:caldav

Purpose: Enumerates the set of supported iCalendar "RSCALE" element values supported by the server.

Protected: This property MUST be protected and SHOULD NOT be returned by a PROPFIND allprop request (as defined in Section 14.2 of [RFC4918]).

Description: See above.

Definition:

```
<!ELEMENT supported-rscale-set (supported-rscale*) >
<!ELEMENT supported-rscale (#PCDATA)>
<!-- PCDATA value: string - case-insensitive but
     uppercase preferred -->
```

Example:

```
<C:supported-rscale-set
     xmlns:C="urn:ietf:params:xml:ns:caldav">
  <C:supported-rscale>GREGORIAN</C:supported-rscale>
  <C:supported-rscale>CHINESE</C:supported-rscale>
  <C:supported-rscale>ISLAMIC-CIVIL</C:supported-rscale>
  <C:supported-rscale>HEBREW</C:supported-rscale>
  <C:supported-rscale>ETHIOPIC</C:supported-rscale>
</C:supported-rscale-set>
```

8. Security Considerations

This specification does not introduce any addition security concerns beyond those described in [RFC5545], [RFC5546], and [RFC4791].

9. IANA Considerations

This specification does not define any new IANA registries or values.

10. Acknowledgments

Thanks to the following for feedback: Mark Davis, Mike Douglass, Peter Edberg, Marten Gajda, Arnaud Quillaud, Dave Thewlis, and Umaoka Yoshito. This specification came about via discussions at the Calendaring and Scheduling Consortium.

11. References

11.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC4791] Daboo, C., Desruisseaux, B., and L. Dusseault, "Calendaring Extensions to WebDAV (CalDAV)", RFC 4791, March 2007.

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[RFC5234] Crocker, D. and P. Overell, "Augmented BNF for Syntax Specifications: ABNF", STD 68, RFC 5234, January 2008.

[RFC5545] Desruisseaux, B., "Internet Calendaring and Scheduling Core Object Specification (iCalendar)", RFC 5545, September 2009.

[RFC5546] Daboo, C., "iCalendar Transport-Independent Interoperability Protocol (iTIP)", RFC 5546, December 2009.

[UNICODE.CLDR] "CLDR calendar.xml Data", Unicode Consortium CLDR, August 2013, <http://www.unicode.org/repos/cldr/tags/release-24/common/bcp47/calendar.xml>.

11.2. Informative References

[UNICODE.ICU] "International Components for Unicode", Unicode Consortium ICU, April 2014, <http://site.icu-project.org>.

Appendix A. Change History (To be removed by RFC Editor before publication)

Changes in -04:

1. Always use "L" suffix for leap months, even for Hebrew calendar.

2. Remove negative month numbers to go back to base 5545 definition.

3. Added example for Gregorian leap day with skip.

4. Clarify that RSCALE names are case insensitive, but with upper case preferred.

5. Clarify that BYSETPOS processing is done after SKIP.

6. Remove Islamic example in favor of Ethiopic example which shows a 13th month.

Changes in -03:

1. Added details about handling RSCALE in iTIP.

2. Added details about handling RSCALE in CalDAV.

3. Fixed examples to use ICU Chinese epoch and added text describing why that is not an issue for actual recurrence calculations.

Changes in -02:

1. Fixed some incorrect dates in examples.

2. Clarified use of CLDR and alias, deprecated, preferred attributes.

3. Clarified when SKIP processing occurs.

Changes in -01:

1. Removed requirement that RSCALE be the first item in an RRULE.

2. Added BYLEAPMONTH element and removed BYMONTH "L" suffix.

3. Removed Open Issues.

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