“Have you got TIME?”

Chris Little
Co-Chair of OGC Temporal Domain Working Group
Tuesday, 2014-10-28

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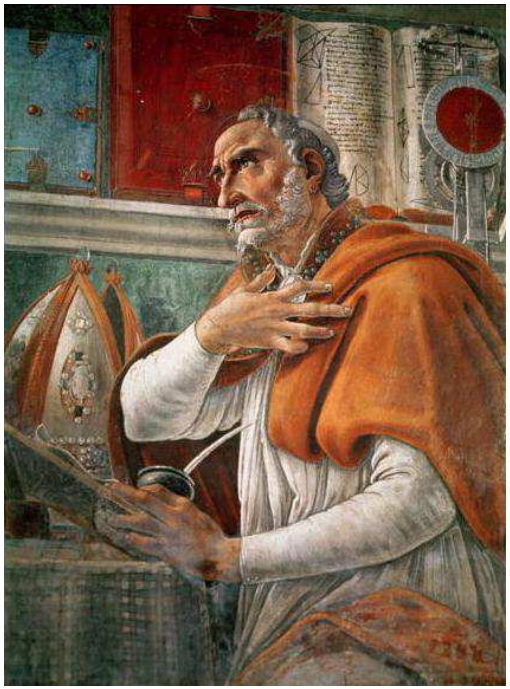
Making location count.

OGC Temporal DWG



Quid est ergo tempus?

Si nemo ex me quaerat, scio.

Si quaerenti explicare velim, nescio.

Saint Augustine, Confessions, XI, 14

What then is time?

If no one asks me, I know.

If I wish to explain to him who asks, I do not know.

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OGC Temporal Domain WG: Why?

- OGC: the standards development organization for geospatial
  - Geographers think earth is 2D, flat and does not change
  - Time is an attribute of map features, not a Coordinate Ref System
  - However, Abstract Ref Model talks of Time as a Coordinate
- 2013-01 Ad Hoc group called at OGC Tech Conf, Redlands
  - various more Ad hoc meetings
  - wiki and mailing list established
- 2013-12 formally established at OGC Tech Conf, Mumbai
  - Peter Baumann Chair, replaced by Piero Campolani
  - Chris Little Co-chair
  - Now need replacement for Piero
  - Working on tightly scoped Best Practice

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OGC Temporal Domain WG Charter extracts

- Act as a focus to discuss and help resolve time issues arising from geospatial interoperability.

- Clarify the role of **time** alongside *space*, and strive for a handling of time which is coherent and integrated with that of space.

- "… lack of awareness can give rise to badly implemented algorithms, overly complicated software, mislabeled data, and erroneous information processing."

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Temporal DWG Achievements

- It now exists and survived change of Chairs!

- Temporal CRSs now registered in OGC Naming Authority:
  - AnsiDate
  - ChronometricGeologicTime
  - JulianDate
  - TruncatedJulianDate
  - UnixTime
- Working on:
  - 360DayYear
- Proposal for WKT for Time (Well Known Text)
- Started writing Best Practice
- Interacting with W3C time group

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Coordinate reference systems:

http://www.opengis.net/def/crs/OGC/0/AnsiDate
http://www.opengis.net/def/crs/OGC/0/ChronometricGeologicTime
http://www.opengis.net/def/crs/OGC/0/JulianDate
http://www.opengis.net/def/crs/OGC/0/TruncatedJulianDate
http://www.opengis.net/def/crs/OGC/0/UnixTime

Coordinate system axes:

http://www.opengis.net/def/axis/OGC/0/days
http://www.opengis.net/def/axis/OGC/0/mya
http://www.opengis.net/def/axis/OGC/0/seconds

Datums:

http://www.opengis.net/def/datum/OGC/0/AnsiDateDatum
http://www.opengis.net/def/datum/OGC/0/JulianDateDatum
http://www.opengis.net/def/datum/OGC/0/TruncatedJulianDateDatum
http://www.opengis.net/def/datum/OGC/0/UnixTimeDatum
http://www.opengis.net/def/datum/OGC/0/YearZeroDatum

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Simple Temporal CRS form for registration

1. Clearly specified and determined datum (epoch)
   - May be absolute (E.g. specified in UTC or TAI)
   - Or relative (start of ice core, start of Tiglathpileser III's reign)
2. Well defined and named unit of duration
3. Well defined directions (+ and -)
4. Normal arithmetic
   - No missing or extra years, seconds, etc
   - There is a value of zero at the datum
   - There may be 'earliest' or 'latest' practical values
5. Sensible CRS name
6. Passes OGC-NA criteria
   - URI scheme
7. Has convincing use case to be separate from existing CRSs

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WKT for Temporal Geometry - 1

- Draft Paper: Matthias Müller & Peter Broßheit, TU Dresden
  - "Well-known Text Representation for Temporal Geometries"

- ISO 8601 has implicit precision/interval of omitted elements:
  - 2014 – the year 2014
  - 2014-04 – April 2014
  - 2014-04-01 – 1st April 2014
  - 2014-04-01T12 – full hour from one to two o'clock, 1st April 2014
  - 2014-04-01T12:00 – minute from 12:00 to 12:01, 1st April 2014
  - 2014-04-01T12:00:00 – second 12:00:00 to 12:00:01, 1st April 2014
  - 2014-04-01T12:00:00 – millisecond from 12:00:00.000 to 12:00:00.001 on 1st April 2014

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WKT for Temporal Geometry - 2

- Instant is point on time axis with precision interval
- Period is set of contiguous points on a continuous time axis

- Multi-instant is a set of instants
- Multi-period is a set of periods

- Duration has no position in time, but defined only by a length
  - Absolute: expressed in invariant units (e.g. ticks on an atomic clock)
  - Relative: expressed in variant calendar and variant time units (like year, month, or day; hour and minute) – think leap days or seconds

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WKT for Temporal Geometry - 3

Temporal Type	Text Representation
Instant	CAL(gregorian)2014-03-12T11:13:17.141
Instant	TCS(unix)1342177280
Period	ORD(geologic)Jurassic/Triassic
Period	TCS(julianDay)2456157.07553/2456158.07553
Period	2014-08-15T18:06/2014-08-15T20:20:20
MultiInstant	2014-08-15T18:06,2014-08-15T20:20:20
MultiPeriod	2014-08-15T18:06/2014-08-15T20:20:20, 2014-09-15T18:06/2014-09-15T20:20:20
RegularMultiInstant	R23/2014-08-13/PT1H
RegularMultiPeriod	CAL(Julian)R10/2014-08-13T8/P1D/PT9H

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Several Temporal “REGIMES”

0. Events, no clocks, logic only

1. Clocks, ticks, integer arithmetic only, no –ve times

2. CRSs, number line to interpolate between ticks, real arithmetic, extrapolate before zero/datum/epoch

3. Calendars, abnormal arithmetic, earth, sun and moon rotations, months, weeks

4. Astronomical times, local solar time, sidereal time, relativistic, helio-spatial, accountancy, etc

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Regime 0: Events

- Set of EVENTS ordered in time (t_a, t_b, t_c, … t_n), that may be:
  - Finite or
  - Countably infinite (like the integers)
  - *No clocks*
- Simple Logic Operators defined to determine if 2 times are:
  - The same
  - One earlier, other later (maybe an earliest and latest times?)
- 2 times define Relation(t_a,t_b), $t_a<t_b$, but NOT duration (t_b-t_a)
- Any 3 or 4 times allow logic (Allen 1983) such as:
  - tb is in (ta,tb), ta<tb<tc
  - (ta,tc) overlaps (tb,td), ta<tb<tc<td,
  - (ta,td) contains (tb,tc), ta<tb<tc<td,
- No other times exist or can be interpolated
  - May be different sets of events, possibly linked

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Regime 1: Clock & Timescale

- "Clock" defined as any regularly repeating physical event
- Countably infinite set of ordered time INSTANTS.
- Fixed precision, determined by interval between instants
- No intermediate times can be calculated between ticks
- Similar set of operations:
  - Same
  - Earlier/later
  - Operations for Instants and Intervals
- Can now calculate duration (tb-ta) as metric defined
- Could be an earliest or latest, or an epoch (datum time)
- TAI International Atomic Time is an example.
  - Cannot be used to time events to femtosecond precision
  - Cannot be used to time events prior to Epoch!

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Regime 2: CRS Coordinate Reference System

- Precision defined by countably infinite set of ‘ticks’ of clock
- Assume normal mathematical interpolation between ticks
- Epoch defined, perhaps with practical earliest/latest times
- Assume mathematical extrapolation before epoch: +/-
- Logical Operations and calculations well defined
- Other ‘UoM’ can be defined but must be totally ‘regular’
  - E.g: 1 hour = 60 mins, 1 day=24 hours, 1 year = 360 days
  - E.g: milliseconds, kiloseconds
- Examples: Unix milliseconds, Julian Days, Julian Years, etc
- Epoch may be ill-defined (start of reign of Ashburnipal III) so CRS is relative, not absolute – see Regime 0.
- Epoch should be defined in terms of TAI, UTC, etc

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Regime 3: Calendar

- Anything requiring an algorithm beyond normal arithmetic
  - E.g: Years CE and BCE (AD & BC). There is no year 0BCE or 0CE, so ‘normal arithmetic’ gives unexpected results
  - E.g. UTC Gregorian, Mayan, Jewish, Ba’hai, etc
- Should have an Epoch
- May have earliest and latest defined times, or times when algorithm invalid
- Usually approximates a CRS to astronomical events
- Algorithmic rather than observed calendar

A CRS is not a Calendar

A Calendar is not a CRS

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Regime 4+: Astronomical

- Requires observation of moon, sun or stars
- Could be several regimes:
  - Observation based calendars
  - Sidereal time
  - Local Solar time, Mean Tropical Year
  - Space weather time on Sun
  - Relativistic
  - Etc
- Plenty of realistic detailed use cases
- Accountancy? Weeks and months!
- Plenty of calendars in this regime
- Real issue is software behaviour

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Notation is not a Timescale, CRS or Calendar

ISO 8601:2004: 2014-10-28T11:00:00.0

Or is it ISO 8601:2004: 2014-10-28T10:00:00.0Z ?

Is 0000-01-01T00:00:00.0 valid?

Q1: 2013-07-01T00:00:00 minus 2013-06-30T23:59:00 = ?

59 or 60 or 61 seconds?

Q2: 2012-07-01T00:00:00Z minus 2012-06-30T23:59:00Z = ?

59 or 60 or 61 seconds?

Do not assume notation implies arithmetic, CRS or calendar!

What notation applicable for each regime?

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Temporal DWG Current Work

1. Writing and need some recommended Best Practice:
   - E.g. Regime 0
   - Do not label Geologic era with ISO8601 notation:
   - -63000000-00-00T00:00:00.0Z

   - E.g. Regime 1
   - Similarly, do not notate Atomic times with ISO8601

   - E.g. Regime 4
   - How to distinguish Gregorian UTC, local Gregorian and solar time?

   - Will probably miss 2014-12 OGC TC Tokyo deadline

2. What to do with WKT for Temporal Geometry?
   - Propose as OGC standard?

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Temporal DWG Future Work?

- Do we need to revise the OGC Abstract Reference Model?
- Do we need to revise ISO19108?
- Do we need to revise ISO 8601?
- Do we need an industry wide testing framework?
- Do we need an industry wide software certification scheme?
- How do we stop the appalling puns about time?

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Any Questions?

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