

Space-Time Coordinate Metadata for Applications

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STC Vision

- To provide a metadata model that will support (not preclude) full interoperability (at some future date) between all of our communities
- It has the hooks to support collaborations:
 - Galactic astronomy
 - Extragalactic
 - Solar
 - Planetary
 - Simulations ... and more
- But that does not mean everybody has to support everything at all times

What Is Needed?

- Full integrity:
 - **Completeness**
 - Be explicit in all assumptions; don't assume anything is "obvious"
 - There are painful examples involving Doppler definitions
 - Observatory location
 - **Consistency**
 - Do not mix apples and oranges
- A serialization that retains the full model is preferred

Spatial Coordinate Systems

- There is a reasonable starter subset:
 - ICRS
 - GALACTIC
- But just one or the other won't do:
 - Very common constraints (like: $|b| > 20$) do not translate easily

Spatial Coordinate Systems

- Advice:
 - Services should preferably keep positions in both systems
 - If that is not feasible, support the one most likely used by the majority of their users and inform others: Sorry, not supported
- Advantage: it enables seamless transition to increased interoperability
- Don't forget the other axes!

What Is Covered?

- Time
- Space
 - position and velocity
 - 1, 2, 3-D; spherical, Cartesian, and more
- Spectral coordinate
- Redshift / Doppler velocity
- Pixel space
- Any other coordinate (e.g., flux)

What Is Provided?

- Coordinate system
 - Frames
 - Reference positions
 - Transformations
- Coordinates:
 - Value
 - Error
 - Resolution
 - Size
 - Pixel size
- Volume in coordinate space
 - Intervals
 - Regions

Selective Use

- VOEvent: **WhereWhen**
- **stc:ObsDataLocation**
 - **ObservatoryLocation**
 - One specific coordinate system
 - Possibly using a library of observatories
 - **ObservationLocation**
 - Limited set of stored coordinate systems
 - most clients will only deal with a subset
 - Services know what to fill into templates, clients know what to look for in parsing

STC Software Support

- At CfA:
 - Java class library for STC metadata components
 - Create Java instance from STC-compliant xml
 - Create STC-compliant xml from Java instance
 - Xlink resolver
 - Validate STC document (fragment)
 - STC-X ↔ STC-S converter
 - STC ↔ FITS WCS converter

STC Software Support

- JHU:
 - Region services
- AST:
 - Coordinate transformations

STC-X → STC-S

```
<CatalogEntryLocation xsi:schemaLocation="http://www.ivoa.net/xml/STC/stc-v1.30.xsd stc-v1.30.xsd"
xmlns="http://www.ivoa.net/xml/STC/stc-v1.30.xsd" xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <AstroCoordSystem id="ID_2">
    <TimeFrame id="ID_23">
      <TimeScale>TT</TimeScale>
      <GEOCENTER/>
    </TimeFrame>
    <SpaceFrame id="ID_93">
      <ICRS/>
      <GEOCENTER/>
      <SPHERICAL coord_naxes="2"/>
    </SpaceFrame>
    <SpectralFrame id="ID_101">
      <BARYCENTER>
        <PlanetaryEphem>JPL-DE405</PlanetaryEphem>
      </BARYCENTER>
    </SpectralFrame>
    <RedshiftFrame value_type="VELOCITY" id="ID_102">
      <DopplerDefinition>OPTICAL</DopplerDefinition>
      <BARYCENTER>
        <PlanetaryEphem>JPL-DE405</PlanetaryEphem>
      </BARYCENTER>
    </RedshiftFrame>
  </AstroCoordSystem>
```

STC-X → STC-S

```
<AstroCoords id="ID_103" coord_system_id="ID_2">  
  <Time unit="s">  
    <Name>Time</Name>  
    <TimeInstant>  
      <MJDTime>50814.0</MJDTime>  
    </TimeInstant>  
    <Error>1.2</Error>  
    <Resolution>0.8</Resolution>  
    <Size>1024.0</Size>  
    <PixSize>1024.0</PixSize>  
  </Time>  
  <Position2D unit="deg">  
    <Name>Position</Name>  
    <Name1>RA</Name1>  
    <Name2>Dec</Name2>  
    <Value2>  
      <C1>179.0</C1>  
      <C2>-11.5</C2>  
    </Value2>  
    <Error2Radius pos_unit="arcsec">3.2</Error2Radius>  
</AstroCoords>
```

STC-X → STC-S

```
<AstroCoordArea id="ID_172" coord_system_id="ID_2">
  <TimeInterval>
    <StartTime>
      <ISOTime>1996-01-01T00:00:00</ISOTime>
    </StartTime>
    <StopTime>
      <ISOTime>1996-01-01T00:30:00</ISOTime>
    </StopTime>
  </TimeInterval>
  <Circle>
    <Center>
      <C1>179</C1>
      <C2>-11.5</C2>
    </Center>
    <Radius>0.5</Radius>
  </Circle>
  <RedshiftInterval vel_time_unit="s" unit="km">
    <LoLimit>200</LoLimit>
    <HiLimit>2300</HiLimit>
  </RedshiftInterval>
</AstroCoordArea>
</CatalogEntryLocation>
```

STC-X → STC-S

- TimeInterval TT GEOCENTER
1996-01-01T00:00:00 1996-01-01T00:30:00
Time 50814.0 Error 1.2
Resolution 0.8 PixSize 1024.0
- Circle ICRS GEOCENTER 179.0 -11.5 0.5
Position 179.0 -11.5 Error 0.000889
Resolution 0.001778 Size 0.000333 0.000278
PixSize 0.000083 0.000083
- Spectral BARYCENTER 1420.4 unit MHz
Resolution 10.0
- RedshiftInterval BARYCENTER VELOCITY OPTICAL
200.0 2300.0 Redshift 300.0
Resolution 0.7 PixSize 0.3

Coordinate Transformations

- Java libraries:
 - Pat Wallace's Java version of SLALIB
 - Pat Dowler's Java wrap of WCSLIB
 - Ray Plante's unsupported Java WCS lib
 - Tom McGlynn's SkyNode(?) Java lib