IGS INTERNATIONAL GNSS SERVICE

Collaborative Development of a Standards-Based XML System for IGS Site Log Metadata Management and Dissemination

Fran Boler, Nicholas Brown, Roger Fraser, Carey Noll, Melinda Squibb, Markus Bradke, Carine Bruyninx, Erwin Wiesensarter, and Ignacio Romero

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Collaboration of the DCWG

Authors and Affiliations

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Melinda Squibb :: Scripps Institution of Oceanography

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Ignacio Romero :: ESA/ESOC, Darmstadt

Motivation to Improve Site Log System

For 20 years the IGS has relied on the text Site Log file to document metadata

Meanwhile, the IGS Network has grown in the number of stations and the complexity (MGEX, RT)

For Data Centers the task of keeping metadata up to date, complete, and synchronized can be made more efficient

For Analysis Centers and other data users, the task of accessing metadata can be made simpler

We can achieve benefits of standards and discoverability described in N. Brown's talk

```
     MAHU Site Information Form (site log)
     International GPS Service
     See Instructions at:
       ftp://igscb.jpl.nasa.gov/pub/station/general/sitelog_instr.txt

0.   Form

     Prepared by (full name)  : Susan Jeffries
     Date Prepared            : 2014-11-18
     Report Type              : UPDATE
     If Update:
      Previous Site Log       : mahu_20141113.log
      Modified/Added Sections : (n.n,n.n,...)


1.   Site Identification of the GNSS Monument

     Site Name                : Mahukona
     Four Character ID        : MAHU
     Monument Inscription     :
     IERS DOMES Number        : (A9)
     CDP Number               : (A4)
     Monument Description     : BEDROCK-BOLTED MAST
       Height of the Monument :  (m)
       Monument Foundation    : (STEEL RODS, CONCRETE BLOCK, ROOF, etc)
       Foundation Depth       :  (m)
     Marker Description       : Top of mast
     Date Installed           : 2006-10-27T00:00Z
     Geologic Characteristic  : (BEDROCK/CLAY/CONGLOMERATE/GRAVEL/SAND/etc)
       Bedrock Type           : (IGNEOUS/METAMORPHIC/SEDIMENTARY)
       Bedrock Condition      : (FRESH/JOINTED/WEATHERED)
       Fracture Spacing       : (1-10 cm/11-50 cm/51-200 cm/over 200 cm)
       Fault zones nearby     : (YES/NO/Name of the zone)
         Distance/activity    : (multiple lines)
     Additional Information   :


2.   Site Location Information

     City or Town             : Hawaii
     State or Province        : Hawaii
     Country                  : USA
     Tectonic Plate           : Pacific
     Approximate Position (ITRF)
       X coordinate (m)       : -5466400.0582
       Y coordinate (m)       : -2445845.7747
       Z coordinate (m)       : 2187682.0476
       Latitude (N is +)      : +201130.84
       Longitude (E is +)     : -1555340.92
       Elevation (m,ellips.)  : 99.3
     Additional Information   :
```

Current System

Text Site Log

Advantages

- Trustworthy
- Complete
- Everything in one place
- Human readable

Disadvantages

- Parsing and vetting challenges
- Metadata also needed in other formats (SINEX, station.info, etc.)
- Managing files can be a chore
- No facilitation of machine-to-machine (M2M) exchange

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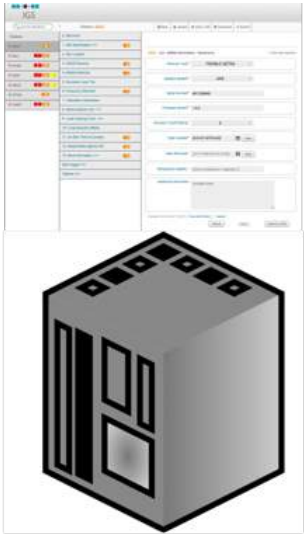

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SiteLogManager System

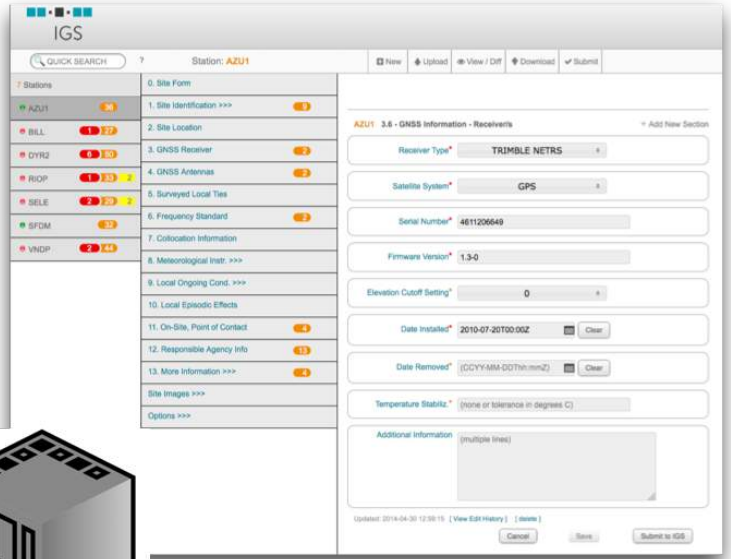
The Site Log Manager database and interface aids in timely metadata tracking and accuracy and some vetting but does not address metadata access, i.e. access is still through text Site Logs via ftp; interoperability is not facilitated

Vision for the New System

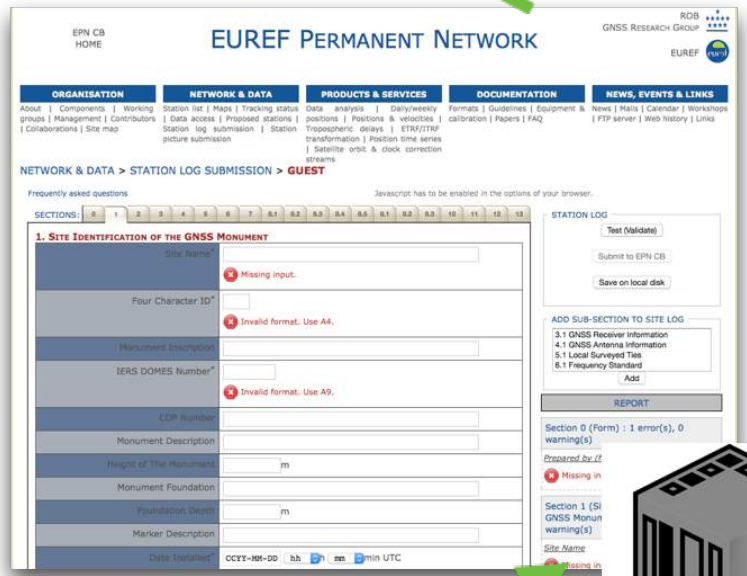
M2M Interoperability

IGS Central Bureau

European Permanent Network



Machine-to-Machine interoperability within IGS



Simplification of updates, for example EPN to IGS Central Bureau and other metadata systems. Site Log Manager system will incorporate XML-schema-based vetting of content including parsing and validation, consistency checking, and verifying completeness.

Vision for the New System

Human-to-Machine (H2M) Interoperability

Alternate formats can be provided via web query

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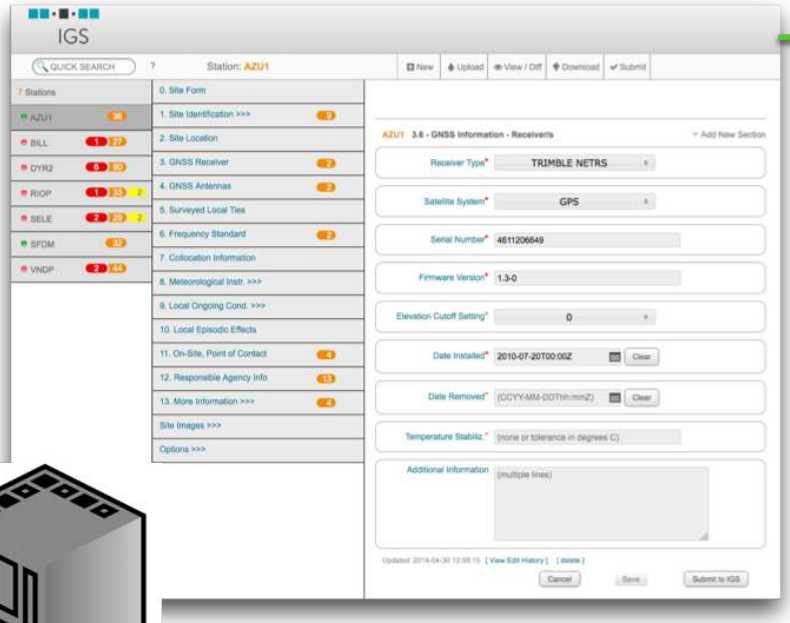
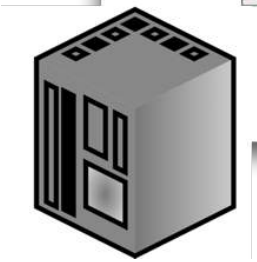
     Additional Information   :
```

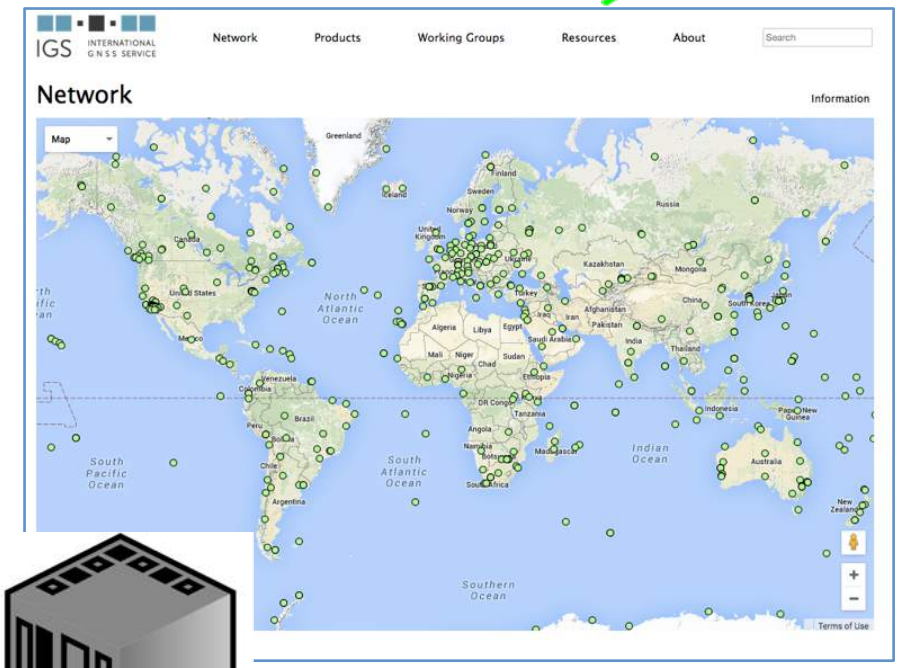



```
%=SNX 2.01 UNAVCO GSAC
*-----------------------
+SITE/ID
*CODE PT __DOMES__ T _ST
 P405  A           P Tri
-SITE/ID
*-----------------------------------------------------------------------------
+SITE/RECEIVER
*SITE PT SOLN T DATA_START__ DATA_END____ DESCRIPTION_________ S/N__ FIRMWARE___
 P405  A    1 P 06:209:76725 10:199:86385 TRIMBLE NETRS        45422 1.1-2 19 Ap
 P405  A    1 P 10:200:00000 15:346:86385 TRIMBLE NETRS        45422       1.3-0
-SITE/RECEIVER
*-----------------------------------------------------------------------------
+SITE/ANTENNA
*SITE PT SOLN T DATA_START__ DATA_END____ DESCRIPTION_________ S/N__
 P405  A    1 P 06:209:76725 10:199:86385 TRM29659.00     SCIT 02203
 P405  A    1 P 10:200:00000 15:346:86385 TRM29659.00     SCIT 02203
-SITE/ANTENNA
*-----------------------------------------------------------------------------
+SITE/ECCENTRICITY
*                                                UP_____ NORTH___ EAST____
*SITE PT SOLN T DATA_START__ DATA_END____ AXE ARP->BENCHMARK(M)_____________
 P405  A    1 P 06:209:76725 10:199:86385 UNE   0.0083   0.0000   0.0000
 P405  A    1 P 10:200:00000 15:346:86385 UNE   0.0083   0.0000   0.0000
-SITE/ECCENTRICITY
%ENDSNX
```



Vision for the New System

Improving discoverability of IGS Metadata, Data, and Products



To achieve this requires (1) adopting international standards that have been developed for the spatial data and broader Earth observation communities AND (2) linking the metadata definitions that encapsulate geodesy to these broader communities. GeodesyML, an XML OGC and ISO compliant application schema, is the mechanism to forge this link.

Why XML?

W3C » Standards » Web Design and Applications » XML Technology » XML Essentials

XML ESSENTIALS

What is XML?

The Extensible Markup Language (XML) is a simple text-based format for representing structured information: documents, data, configuration, books, transactions, invoices, and much more. It was derived from an older standard format called SGML (ISO 8879), in order to be more suitable for Web use.

What is XML Used For?

XML is one of the most widely-used formats for sharing structured information today: between programs, between people, between computers and people, both locally and across networks.

A short example:

```
<part number="1976">
  <name>Windscreen Wiper</name>
  <description>The Windscreen wiper
    automatically removes rain
    from your windscreen, if it
    should happen to splash there.
    It has a rubber <ref part="1977">blade</ref>
    which can be ordered separately
    if you need to replace it.
  </description>
</part>
```

https://www.w3.org/standards/xml/core.html

If you are already familiar with HTML, you can see that XML is very similar. However, the syntax rules of XML are strict: XML tools will not process files that contain errors, but instead will give you error messages so that you fix them. This means that almost all XML documents can be processed reliably by computer software.

Site Log XML Example

Text Site Log designed for human readability

```
3.1  Receiver Type            : ASHTECH Z-XII3
     Satellite System         : GPS
     Serial Number            : LP03105
     Firmware Version         : CB00
     Elevation Cutoff Setting :
     Date Installed           : 1999-10-28T00:00Z
     Date Removed             : 2000-04-05T00:00Z
     Temperature Stabiliz.    :
     Additional Information   : 120 second sampling rate until telemetry
                              : established
```

XML Site Log encoding - human readable, but more typically handled by software

```
<gnssReceiver>
  <equip:receiverType>ASHTECH Z-XII3</equip:receiverType>
  <equip:satelliteSystem>GPS</equip:satelliteSystem>
  <equip:serialNumber>LP03105</equip:serialNumber>
  <equip:firmwareVersion>CB00</equip:firmwareVersion>
  <equip:elevationCutoffSetting></equip:elevationCutoffSetting>
  <equip:dateInstalled>1999-10-28T00:00Z</equip:dateInstalled>
  <equip:dateRemoved>2000-04-05T00:00Z</equip:dateRemoved>
  <equip:temperatureStabilization></equip:temperatureStabilization>
  <equip:notes>120 second sampling rate until telemetry established</equip:notes>
</gnssReceiver>
```

Site Log XML Example

codebeautify.org/xmlviewer

Code Beautify

JSONFormatter.org | News | My Ip | Search | Recent Links | Sample | Save | More | Sign in | (?)

XML VIEWER

Save & Share

XML Input sample

```
1  <igsSiteLog xmlns:mi="http://sopac.ucsd.edu/ns/geodesy/doc/igsSiteLog/monumentInfo/2004" xmlns:equip
   ="http://sopac.ucsd.edu/ns/geodesy/doc/igsSiteLog/equipment/2004" xmlns:li="http://sopac.ucsd.edu/ns
   /geodesy/doc/igsSiteLog/localInterferences/2004" xmlns:contact="http://sopac.ucsd.edu/ns/geodesy/doc
   /igsSiteLog/contact/2004" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http://sopac.ucsd
   .edu/ns/geodesy/doc/igsSiteLog/2004" xsi:schemaLocation="http://sopac.ucsd.edu/ns/geodesy/doc/igsSiteLog
   /2004 http://sopac.ucsd.edu/ns/geodesy/doc/igsSiteLog/2004/igsSiteLog.xsd">
2  <formInformation>
3  <mi:preparedBy>David Maggert</mi:preparedBy>
4  <mi:datePrepared>2013-11-21</mi:datePrepared>
5  <mi:reportType>UPDATE</mi:reportType>
6  </formInformation>
7  <siteIdentification>
8  <mi:fourCharacterID>SFDM</mi:fourCharacterID>
9  <mi:siteName>Santa Felicia Dam</mi:siteName>
10 <mi:monumentInscription/>
11 <mi:iersDOMESNumber>49826M001</mi:iersDOMESNumber>
12 <mi:cdpNumber/>
13 <mi:dateInstalled>1999-10-28T00:00Z</mi:dateInstalled>
14 <mi:monumentDescription>DEEP DRILLED-BRACED</mi:monumentDescription>
15 <mi:heightOfTheMonument/>
16 <mi:monumentFoundation>DEEP-DRILLED BRACED</mi:monumentFoundation>
17 <mi:foundationDepth>10.670</mi:foundationDepth>
18 <mi:markerDescription>SCIGN Mount</mi:markerDescription>
19 <mi:geologicCharacteristic>Bedrock</mi:geologicCharacteristic>
20 <mi:bedrockType>SEDIMENTARY</mi:bedrockType>
21 <mi:bedrockCondition>WEATHERED</mi:bedrockCondition>
22 <mi:fractureSpacing/>
23 <mi:faultZonesNearby/>
24 <mi:distance-Activity/>
25 <mi:notes>
26 (multiple lines) SCIGN - Southern California Integrated GPS Network. Monument is Wyatt-type drilled
   -braced geodetic monument composed of stainless steel supports and new SCIGN antenna adaptor. Fixed
   antenna height is 0.0083 m. A secondary measurement, the adaptor/divot distance, taken from the bottom
   of the lower adaptor plate to the center of a divot drill-mark on the north-facing tripod leg, is not
   yet measured Geodetic reference point is Top of center support screw on SCIGN D3 antenna adaptor.
   Monument model is Wyatt/Agnew drilled-braced.
27 </mi:notes>
28 </siteIdentification>
29 <siteLocation>
30 <mi:city>Piru</mi:city>
31 <mi:state>California</mi:state>
32 <mi:country>United States</mi:country>
33 <mi:tectonicPlate>PACIFIC</mi:tectonicPlate>
34 <mi:approximatePositionITRF>
35 <mi:xCoordinateInMeters>-2532676.4067</mi:xCoordinateInMeters>
36 <mi:yCoordinateInMeters>-4615598.8587</mi:yCoordinateInMeters>
37 <mi:zCoordinateInMeters>3588781.3303</mi:zCoordinateInMeters>
38 <mi:latitude-North>+342735.30</mi:latitude-North>
39 <mi:longitude-East>-1184516.22</mi:longitude-East>
40 <mi:elevation-m_ellips.>291.52</mi:elevation-m_ellips.>
41 </mi:approximatePositionITRF>
42 <mi:notes>Ventura County.</mi:notes>
43 </siteLocation>
44 <gnssReceiver>
45 <equip:receiverType>ASHTECH Z-XII3</equip:receiverType>
46 <equip:satelliteSystem>GPS</equip:satelliteSystem>
47 <equip:serialNumber>LP03105</equip:serialNumber>
48 <equip:firmwareVersion>CB00</equip:firmwareVersion>
49 <equip:elevationCutoffSetting/>
50 <equip:dateInstalled>1999-10-28T00:00Z</equip:dateInstalled>
51 <equip:dateRemoved>2000-04-05T00:00Z</equip:dateRemoved>
```

Load Url

Browse

Tree View

Beautify / Format

Minify

It's gone. Undo

What was wrong with this ad?

- Repetitive
- Inappropriate
- Irrelevant

Google

XML To JSON

Export To CSV

Download

Result : XML Tree View

- igssitelog ..
  - @xmlns:mi: http://sopac.ucsd.edu/ns/geodesy/doc/igsSiteLog/monumentInfo/2004
  - @xmlns:equip: http://sopac.ucsd.edu/ns/geodesy/doc/igsSiteLog/equipment/2004
  - @xmlns:li: http://sopac.ucsd.edu/ns/geodesy/doc/igsSiteLog/localInterferences/2004
  - @xmlns:contact: http://sopac.ucsd.edu/ns/geodesy/doc/igsSiteLog/contact/2004
  - @xmlns:xsi: http://www.w3.org/2001/XMLSchema-instance
  - @xmlns: http://sopac.ucsd.edu/ns/geodesy/doc/igsSiteLog/2004
  - @xsi:schemaLocation: http://sopac.ucsd.edu/ns/geodesy/doc/igsSiteLog/2004 http://sopac.ucsd.edu/ns/geodesy/doc/igsSiteLog/2004/igsSiteLog.xsd
  - forminformation ..
    - mi:preparedby David Maggert
    - mi:dateprepared 2013-11-21
    - mi:reporttype UPDATE
  - siteidentification ..
    - mi:fourcharacterid SFDM
    - mi:sitename Santa Felicia Dam
    - mi:monumentinscription
    - mi:iersdomesnumber 49826M001
    - mi:cdpnumber
    - mi:dateinstalled 1999-10-28T00:00Z
    - mi:monumentdescription DEEP DRILLED-BRACED
    - mi:heightofthemonument
    - mi:monumentfoundation DEEP-DRILLED BRACED
    - mi:foundationdepth 10.670
    - mi:markerdescription SCIGN Mount
    - mi:geologiccharacteristic Bedrock
    - mi:bedrocktype SEDIMENTARY
    - mi:bedrockcondition WEATHERED
    - mi:fracturespacing
    - mi:faultzonesnearby
    - mi:distance-activity
    - mi:notes (multiple lines) SCIGN - Southern California Integrated GPS Network. Monument is Wyatt-type drilled-braced geodetic monument composed of stainless steel supports and new SCIGN antenna adaptor. Fixed

Similar to HTML editor/viewer software, XML viewers are available

Changes in Text Site Log Coming

Certain elements of the text site log will change to follow the XML schema and, where applicable, standards being used (ISO, OGC/GeodesyML)

Changes will be announced in the usual way, with text site log template and documentation available from the IGS Central Bureau

```
              TurboRogue: DORNE MARGOLIN T

                          -----
                     /     +     \                      <-- 0.128  L2
                    |      +      |                     <-- 0.110  L1
   +-------------------------------------------------+   <-- 0.102 TCR
   |                                                 |
   |                                                 |
   |                                                 |
   |                                                 |
 +-+-------------------------------------------------+-+ <-- 0.038
 +-------------------+-------------+-------------------+ <-- 0.035  BCR
                     |             |
                     |             |
                     +------x------+                     <-- 0.000  ARP

<--                       0.381                      -->

   ARP: Antenna Reference Point   BPA: Bottom of Preamplifier 1A
```

Example 1. Antenna diagrams will be dropped, and antenna information from online documentation will instead be referenced

Changes in Text Site Log Coming

Example 2. Support for 9-character RINEX3 filenames in XML and text site logs

```
<geo:siteLocation>
    <geo:city>Melbourne</geo:city>
    <geo:state>Victoria</geo:state>
    <geo:countryCodeISO>AUS</geo:countryCodeISO>
    <geo:tectonicPlate>Indian/Australian</geo:tectonicPlate>
    <geo:approximatePositionITRF>
        <geo:xCoordinateInMeters>-4130636.106</geo:xCoordinateInMeters>
        <geo:yCoordinateInMeters>2894953.089</geo:yCoordinateInMeters>
        <geo:zCoordinateInMeters>-3890531.051</geo:zCoordinateInMeters>
        <geo:latitude-North>-37.82941634</geo:latitude-North>
        <geo:longitude-East>144.9753351</geo:longitude-East>
        <geo:elevation-m_ellips.>40.674</geo:elevation-m_ellips.>
    </geo:approximatePositionITRF>
    <geo:notes>The GPS is located at the old Melbourne Observatory, located in the Royal Melbourne Botanical Gardens</geo:notes>
</geo:siteLocation>
```

```
2.   Site Location Information

     City or Town              : Melbourne
     State or Province         : Victoria
     Country Code              : AUS
     Tectonic Plate            : AUSTRALIAN
```

```
<geo:Monument gml:id="MONUMENT_1">
    <gml:description>Centre of base of 5/8" spigot on GPS</gml:description>
    <gml:name codeSpace="urn:ga-gov-au:monument-siteName">Melbourne Observatory</gml:name>
    <gml:name codeSpace="urn:ga-gov-au:monument-fourCharacterID">MOBS</gml:name>
    <gml:name codeSpace="urn:ga-gov-au:monument-iersDOMESNumber">50182M001</gml:name>
    <gml:name codeSpace="urn:ga-gov-au:monument-cdpNumber">Not Available</gml:name>
    <geo:type codeSpace="urn:ga-gov-au:monument-type">CORS</geo:type>
    <geo:installedDate>2002-09-15Z</geo:installedDate>
    <geo:monumentNumber>0</geo:monumentNumber>
    <geo:receiverNumber>0</geo:receiverNumber>
</geo:Monument>
```

```
1.   Site Identification of the GNSS Monument

     Site Name                 : Melbourne Observatory
     Four Character ID         : MOBS
     Monument Number           : 0
     Reciever Number           : 0
     Monument Inscription      :
```

Changes in Text Site Log Coming

Example 3. Geographic coordinates decimal degrees in XML and text site logs

```
<geo:siteLocation>
    <geo:city>Melbourne</geo:city>
    <geo:state>Victoria</geo:state>
    <geo:countryCodeISO>AUS</geo:countryCodeISO>
    <geo:tectonicPlate>Indian/Australian</geo:tectonicPlate>
    <geo:approximatePositionITRF>
        <geo:xCoordinateInMeters>-4130636.106</geo:xCoordinateInMeters>
        <geo:yCoordinateInMeters>2894953.089</geo:yCoordinateInMeters>
        <geo:zCoordinateInMeters>-3890531.051</geo:zCoordinateInMeters>
        <geo:latitude-North>-37.82941634</geo:latitude-North>
        <geo:longitude-East>144.9753351</geo:longitude-East>
        <geo:elevation-m_ellips.>40.674</geo:elevation-m_ellips.>
    </geo:approximatePositionITRF>
    <geo:notes>The GPS is located at the old Melbourne Observatory, located in the Royal Melbourne Botanical Gardens</geo:notes>
</geo:siteLocation>
```

```
2.   Site Location Information

     City or Town              : Melbourne
     State or Province         : Victoria
     Country Code              : AUS
     Tectonic Plate            : AUSTRALIAN
```

```
<geo:Monument gml:id="MONUMENT_1">
    <gml:description>Centre of base of 5/8" spigot on GPS</gml:description>
    <gml:name codeSpace="urn:ga-gov-au:monument-siteName">Melbourne Observatory</gml:name>
    <gml:name codeSpace="urn:ga-gov-au:monument-fourCharacterID">MOBS</gml:name>
    <gml:name codeSpace="urn:ga-gov-au:monument-iersDOMESNumber">50182M001</gml:name>
    <gml:name codeSpace="urn:ga-gov-au:monument-cdpNumber">Not Available</gml:name>
    <geo:type codeSpace="urn:ga-gov-au:monument-type">CORS</geo:type>
    <geo:installedDate>2002-09-15Z</geo:installedDate>
    <geo:monumentNumber>0</geo:monumentNumber>
    <geo:receiverNumber>0</geo:receiverNumber>
</geo:Monument>
```

```
1.   Site Identification of the GNSS Monument

     Site Name                 : Melbourne Observatory
     Four Character ID         : MOBS
     Monument Number           : 0
     Reciever Number           : 0
     Monument Inscription      :
```

Future Metadata Workflow

Metadata Entry

As is the case now, IGS Site Log Manager system:

- Will accept upload of text Site Log from authenticated users
- Will accept manual entry of metadata from authenticated users
- IGS Network Coordinator vets this metadata

New functionality to be built as part of this effort, IGS Site Log Manager system:

- Will accept upload of XML Site Log from authenticated users
- Will accept input of XML metadata via web services from trusted authenticated sources (no vetting by IGS Network Coordinator required)

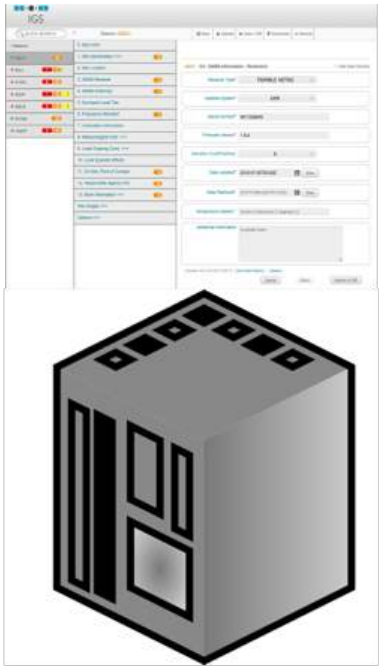
Metadata Access

As is the case now:

- Text Site Logs will be available via FTP

New functionality to be built as part of this effort, IGS Site Log Manager system:

- Will output XML via web service (full site log or selected elements)
- Will output a variety of text formats via web service
- Standalone software scripts for output of alternate formats from XML will be made available



SiteLogManager System

Summarizing the Benefits

Adopting an XML format has these benefits within IGS:

- Solves parsing challenges of Text Site Log
- Leads to efficiencies in tracking site log metadata
  - Automated updating of Site Log Manager by trusted systems
  - Validation done by machines rather than humans
- Facilitates any desired presentation format for metadata (SINEX, station.info, etc.)
- Extensible: as metadata needs evolve, schema can be extended
  - *A proposed extension is to track quality metadata like number of available daily data files in last year; average percent of daily file completeness in last (year/month/day), etc.*

Adoption of GeodesyML, a standards-based XML schema, has these additional benefits for IGS and beyond:

- Global unification of standards for encoding geodetic data and metadata
- Machine-to-machine exchange of data and metadata over the Internet with existing web services
- Greater interoperability with the geospatial and Earth observation communities
- Enhanced discovery of IGS data and metadata
- Database and GIS vendors support international standards

Application to other geodetic techniques:

- This effort can be leveraged by ILRS, IDS, IVS

Implementation

Milestones to date:

- Agreement on elements to be included in Site Log XML schema version 1.0
- Agreement on certain encoding changes for consistency
- Adoption of GeodesyML with Site Log XML schema version 1.0 as application schema

Next steps:

- Documentation of schema 1.0
- Agree on GeoServer Application Server or other exchange mechanism
- Provide list of all available software (client and server) for enabling this activity
- Agree on and implement software distribution mechanism
- Sandbox exploration
- Identify 2-3 groups to do a pilot demonstration of use cases/mechanisms
- Adoption of exchange mechanisms
- Documentation of exchange mechanisms
- Adopt a process for handling future needs
- Site Log Manager system (and others as desired) implement Application Server and supporting software

Much of this can happen in 2016

Final Thoughts

Needed from all stakeholders:
Use cases - document how would you like to interact with this metadata system

You can learn more about this effort by subscribing to the igs-dcwg mailing list

Thanks for your attention

Questions?