



IVOA Provenance DM in TAP :

Issues and solutions

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Why Provenance in TAP ?

- Provenance information can be attached to data in various ways :
 - Embedded in the data « header » itself
 - Linked to the data record via DataLink or URL
 - Retrievable via ProvSAP via data id.
- In addition to that , Provenance metadata in a TAP service will allow to discover « data » by constraining Provenance features.
 - It's a « reverse » mechanism.



« The » issue = complexity (see « FAIR high level data for Cherenkov astronomy »)

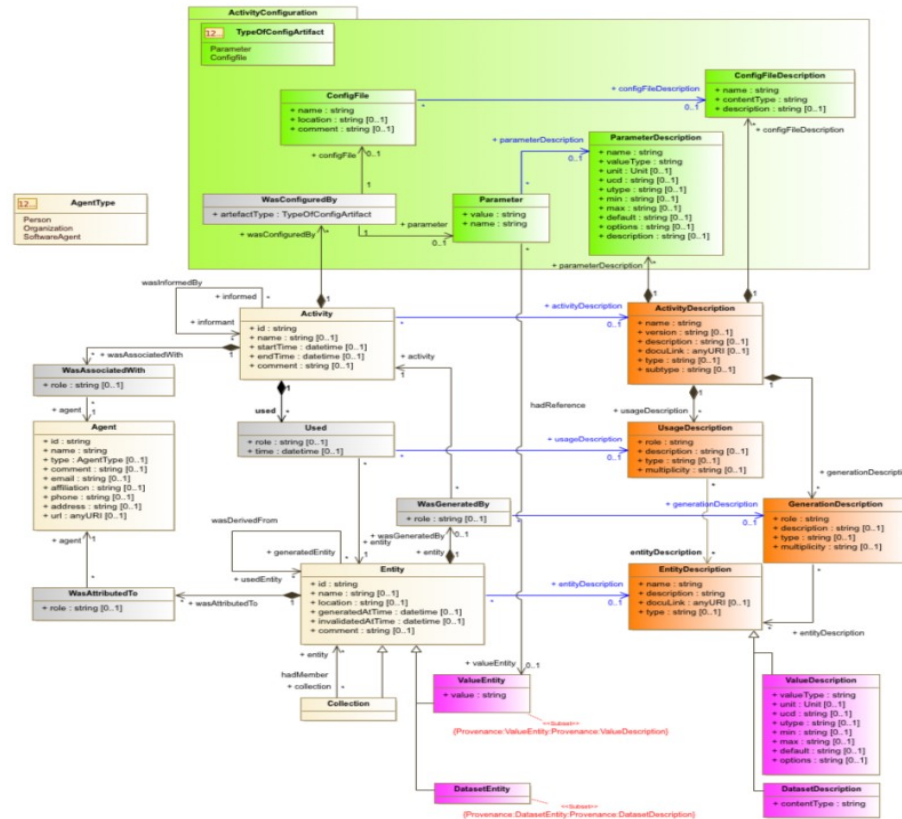


Figure 8: Full class diagram of the IVOA Provenance Data Model.



« The » issue = complexity

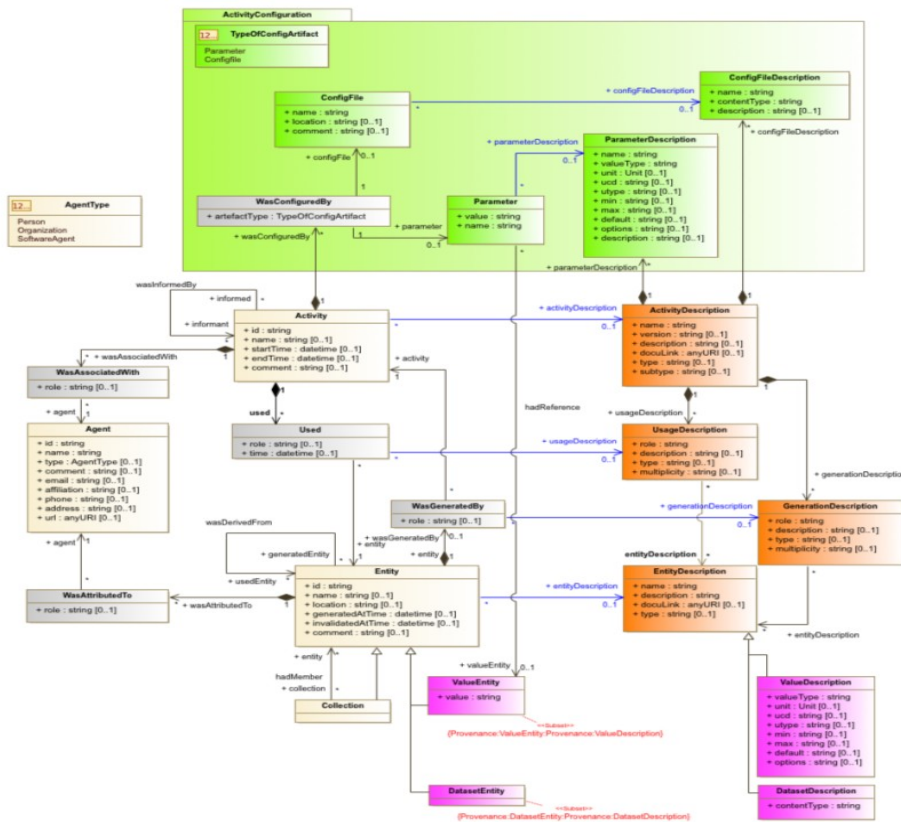


Figure 8: Full class diagram of the IVOA Provenance Data Model.

1 table per class ?
----> ProvTAP



ProvTAP status

- There is an internal draft on the IVOA DAL page
- TAP schema mapping classes as tables
- ProvHiPS (provenance of HiPS and HiPS tiles) is an implementation prototype
- From now examples and demos from ProvHiPS



IVOA Provenance Table Access Protocol (ProvTAP)

Version 1.0

IVOA Working Draft 2018-03-22

Working group

DM

This version

<http://www.ivoa.net/documents/ProvTAP/20180322>

Latest version

<http://www.ivoa.net/documents/ProvTAP>

Previous versions

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Editor(s)

François Bonnarel

Abstract

This document describes the ProvTAP protocol for accessing provenance information according to the IVOA ProvenanceDM standard. It defines how the elements of ProvDM are described in the TAP schema tables and provides guidelines for implementing with TAP 1.1.

ProvTAP TAP_SCHEMA: Entity table

Name	ucd	utype	datatype	status
e_id	meta.id	voprov:Entity.id	char	M
e_name	meta.title	voprov:Entity.name	char	O
e_type	meta.code.class	voprov:Entity.type	char	O
e_rights	meta.code.class	voprov:Entity.rights	char	O
e_location	meta.ref.url	voprov:Entity.location	char	O
e_generated	time.start	voprov:Entity.generatedAtTime	char	O
e_invalidated	time.stop	voprov:Entity.invalidatedAtTime	char	O
e_comment	meta.description	voprov:Entity.comment	char	O
e_classtype	meta.code.class	voprov:Entity.classtype	char OPTION	M
e_value	stat.value	voprov:Entity.value	char	O
→ e_description	meta.id	voprov:Entity.description_id	reference	O

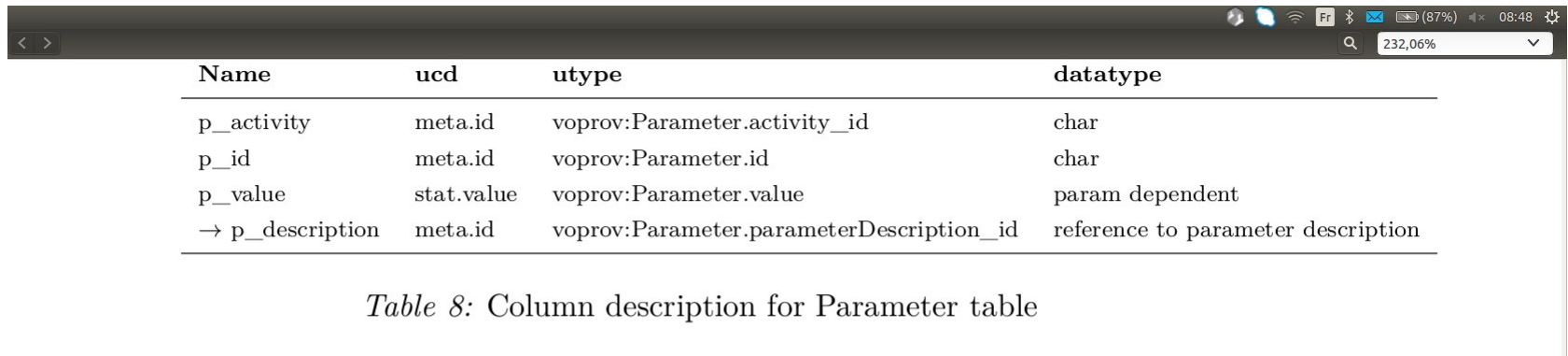
Table 2: Column description for Entity table. The e_classtype column may have the following two values : "dataset" and "value"



ProvTAP TAP_SCHEMA: parameterDescription table

Name	ucd	utype	datatype
pd_activitydescription	meta.id	voprov:ParameterDescription.activityDescription_id	char
pd_id	meta.id	voprov:ParameterDescription.id	char
pd_name	meta.title	voprov:ParameterDescription.name	param dependent
pd_description	meta.description	voprov:ParameterDescription.description	char
pd_datatype	meta	voprov:ParameterDescription.datatype	char
pd_unit	meta.unit	voprov:ParameterDescription.unit	char
pd_ucd	meta.ucd	voprov:ParameterDescription.ucd	char
pd_utype	meta	voprov:ParameterDescription.utype	char
pd_min	stat.min	voprov:ParameterDescription.min	param dependent
pd_max	stat.max	voprov:ParameterDescription.max	param dependent
pd_options	meta	voprov:ParameterDescription.options	param dependent

ProvTAP TAP_SCHEMA: parameter table



The image shows a screenshot of a database viewer window. The window title bar includes system icons for network, battery (87%), and time (08:48). A search bar in the top right corner contains the text '232,06%'. The main content area displays a table with four columns: Name, ucd, utype, and datatype. The table lists the following rows:

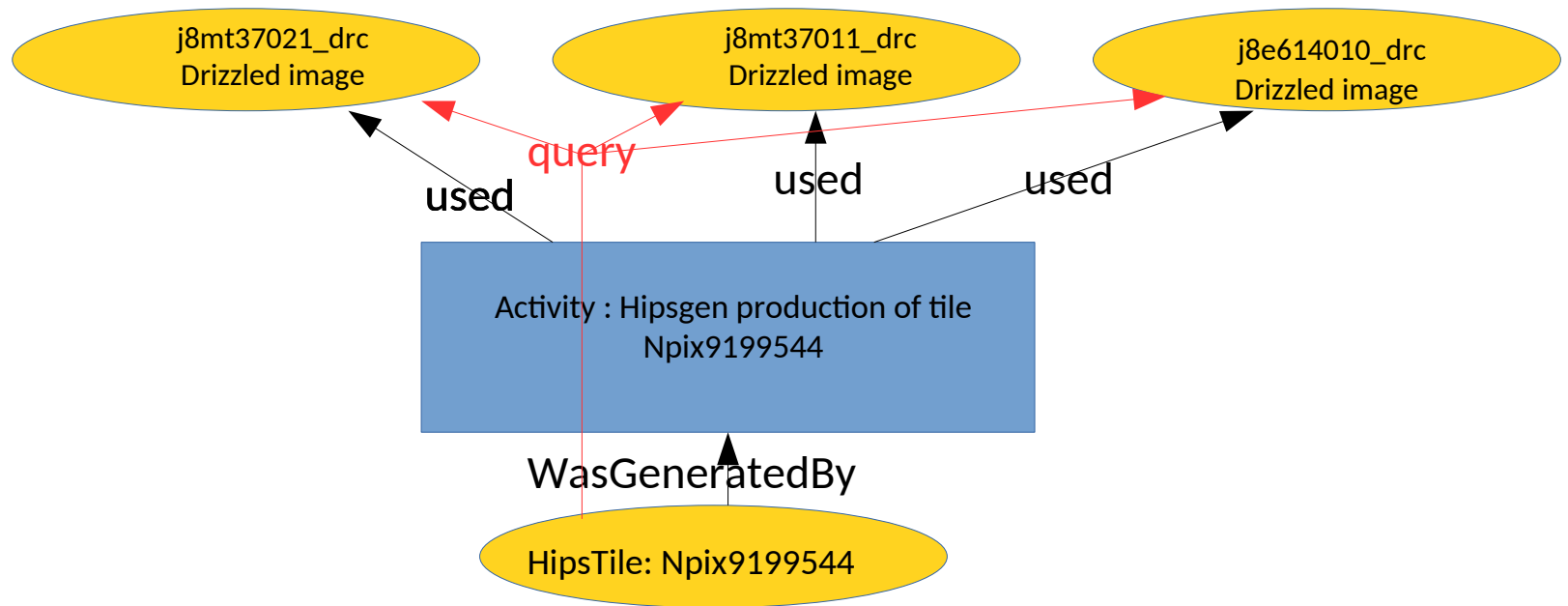
Name	ucd	utype	datatype
p_activity	meta.id	voprov:Parameter.activity_id	char
p_id	meta.id	voprov:Parameter.id	char
p_value	stat.value	voprov:Parameter.value	param dependent
→ p_description	meta.id	voprov:Parameter.parameterDescription_id	reference to parameter description

Table 8: Column description for Parameter table



ProvHiPS ADQL query examples :

Finding out drizzled images « progenitors » of a specific HiPS tile.



ProvHiPS ADQL query examples :

Finding out drizzled images « progenitors » of a specific HiPS tile.

```
select e.e_name, e.e_comment, a_name, a_starttime, a_comment, ee.e_name  
       ee.e_comment from entity e  
join wasgeneratedby on e.e_id = wgb_entity  
join activity on wgb_activity = a_id  
join used on a_id = u_activity  
join entity ee on ee.e_id = u_entity  
where e.e_name like '%Npix9199544'
```



ProvHiPS ADQL query examples :

Finding out drizzled images « progenitors » of a specific HiPS tile.

Window TAP Registry Edit Interop Help

TOPCAT(48): Table Browser

Table Browser for 48: TAP_54_entity,wasgeneratedby,activity,used,entit...

	e_name	e_comment	a_name	a_starttime	a_comment	e_name	e_comment
1	HST_V_Order10_Npix9199544	Npix9199544 tile of HST-V HiPS of size 12.25 a...	HST_V_Order10_Npix9199544 Generation	2019-01-09T02:34Z	hipsGEN version 10.101 generation of Npix91...	j8e614010_drc	Drizzled HST image from ACS centered on 53.0...
2	HST_V_Order10_Npix9199544	Npix9199544 tile of HST-V HiPS of size 12.25 a...	HST_V_Order10_Npix9199544 Generation	2019-01-09T02:34Z	hipsGEN version 10.101 generation of Npix91...	j8mt37011_drc	Drizzled HST image from ACS centered on 53.0...
3	HST_V_Order10_Npix9199544	Npix9199544 tile of HST-V HiPS of size 12.25 a...	HST_V_Order10_Npix9199544 Generation	2019-01-09T02:34Z	hipsGEN version 10.101 generation of Npix91...	j8mt37021_drc	Drizzled HST image from ACS centered on 52.9...
4	HST_V_Order10_Npix9199544	Npix9199544 tile of HST-V HiPS of size 12.25 a...	HST_V_Order10_Npix9199544 Generation	2019-01-09T02:34Z	hipsGEN version 10.101 generation of Npix91...	j8mt37031_drc	Drizzled HST image from ACS centered on 52.9...
5	HST_V_Order10_Npix9199544	Npix9199544 tile of HST-V HiPS of size 12.25 a...	HST_V_Order10_Npix9199544 Generation	2019-01-09T02:34Z	hipsGEN version 10.101 generation of Npix91...	j8mt38011_drc	Drizzled HST image from ACS centered on 53.0...
6	HST_V_Order10_Npix9199544	Npix9199544 tile of HST-V HiPS of size 12.25 a...	HST_V_Order10_Npix9199544 Generation	2019-01-09T02:34Z	hipsGEN version 10.101 generation of Npix91...	j8mt38021_drc	Drizzled HST image from ACS centered on 53.0...
7	HST_V_Order10_Npix9199544	Npix9199544 tile of HST-V HiPS of size 12.25 a...	HST_V_Order10_Npix9199544 Generation	2019-01-09T02:34Z	hipsGEN version 10.101 generation of Npix91...	j8mt38031_drc	Drizzled HST image from ACS centered on 52.9...
8	HST_V_Order10_Npix9199544	Npix9199544 tile of HST-V HiPS of size 12.25 a...	HST_V_Order10_Npix9199544 Generation	2019-01-09T02:34Z	hipsGEN version 10.101 generation of Npix91...	j8mt39011_drc	Drizzled HST image from ACS centered on 53.0...
9	HST_V_Order10_Npix9199544	Npix9199544 tile of HST-V HiPS of size 12.25 a...	HST_V_Order10_Npix9199544 Generation	2019-01-09T02:34Z	hipsGEN version 10.101 generation of Npix91...	j8mt39021_drc	Drizzled HST image from ACS centered on 53.0...
10	HST_V_Order10_Npix9199544	Npix9199544 tile of HST-V HiPS of size 12.25 a...	HST_V_Order10_Npix9199544 Generation	2019-01-09T02:34Z	hipsGEN version 10.101 generation of Npix91...	j8mt39031_drc	Drizzled HST image from ACS centered on 53.0...
11	HST_V_Order10_Npix9199544	Npix9199544 tile of HST-V HiPS of size 12.25 a...	HST_V_Order10_Npix9199544 Generation	2019-01-09T02:34Z	hipsGEN version 10.101 generation of Npix91...	jbwj1020_drc	Drizzled HST image from ACS centered on 53.0...
12	HST_V_Order10_Npix9199544	Npix9199544 tile of HST-V HiPS of size 12.25 a...	HST_V_Order10_Npix9199544 Generation	2019-01-09T02:34Z	hipsGEN version 10.101 generation of Npix91...	jc602020_drc	Drizzled HST image from ACS centered on 53.0...
13	HST_V_Order10_Npix9199544	Npix9199544 tile of HST-V HiPS of size 12.25 a...	HST_V_Order10_Npix9199544 Generation	2019-01-09T02:34Z	hipsGEN version 10.101 generation of Npix91...	jc602020_drc	Drizzled HST image from ACS centered on 53.0...
14	HST_V_Order10_Npix9199544	Npix9199544 tile of HST-V HiPS of size 12.25 a...	HST_V_Order10_Npix9199544 Generation	2019-01-09T02:34Z	hipsGEN version 10.101 generation of Npix91...	jc602030_drc	Drizzled HST image from ACS centered on 53.0...
15	HST_V_Order10_Npix9199544	Npix9199544 tile of HST-V HiPS of size 12.25 a...	HST_V_Order10_Npix9199544 Generation	2019-01-09T02:34Z	hipsGEN version 10.101 generation of Npix91...	jc604010_drc	Drizzled HST image from ACS centered on 53.0...
16	HST_V_Order10_Npix9199544	Npix9199544 tile of HST-V HiPS of size 12.25 a...	HST_V_Order10_Npix9199544 Generation	2019-01-09T02:34Z	hipsGEN version 10.101 generation of Npix91...	jc604020_drc	Drizzled HST image from ACS centered on 53.0...
17	HST_V_Order10_Npix9199544	Npix9199544 tile of HST-V HiPS of size 12.25 a...	HST_V_Order10_Npix9199544 Generation	2019-01-09T02:34Z	hipsGEN version 10.101 generation of Npix91...	jc609010_drc	Drizzled HST image from ACS centered on 52.9...
18	HST_V_Order10_Npix9199544	Npix9199544 tile of HST-V HiPS of size 12.25 a...	HST_V_Order10_Npix9199544 Generation	2019-01-09T02:34Z	hipsGEN version 10.101 generation of Npix91...	jc609020_drc	Drizzled HST image from ACS centered on 52.9...
19	HST_V_Order10_Npix9199544	Npix9199544 tile of HST-V HiPS of size 12.25 a...	HST_V_Order10_Npix9199544 Generation	2019-01-09T02:34Z	hipsGEN version 10.101 generation of Npix91...	jc611010_drc	Drizzled HST image from ACS centered on 52.9...

Total: 36 Visible: 36 Selected: 0

used
valuedescription
wasassociatedwith
unattributed

Service Capabilities

Query Language: ADQL-2.0 Max Rows: 1000000 (default) Uploads: unavailable

ADQL Text

Mode: Synchronous

```

select e.e_name, e.e_comment, a_name, a_starttime, a_comment, ee.e_name, ee.e_comment from entity e
join wasgeneratedby on e.e_id = wgb_entity
join activity on wgb_activity = a_id
join used on a_id = u_activity
join entity ee on ee.e_id = u_entity
where e.e_name like '%Npix9199544'
    
```



Issues

- Table is denormalized : a lot of redundant information
- Loop issue : several occurrences of the same triplet (name,utype,ucd) in the same table for different « objects »
- Let's try minimum or last step provenance by creating a standardized view



Solutions

-1 Single step = single table (= join)

- The join is a permanent view described in the TAP schema
- Columns :
 - entity_name, entity_location, entity_comment, ...
 - generating_activity_name, generating_activity_starttime,
 - agent_role, agent_name,
 - used_entity_list
- → Redundancy may be avoided if we group all used entities ids in a single cell
- → possible Recursivity



Solutions

Single step = single table (= join)

- View (in postgres)

create view last_step_provenance as select

e.e_id AS entity_id, e.e_name AS entity_name, e.e_location AS entity_location, e.e_generated AS entity_generated,
e.e_invalidated AS entity_invalidated, e.e_comment AS entity_comment,

activity.a_name AS generating_activity_name, activity.a_starttime AS generating_activity_starttime,
activity.a_endtime AS generating_activity_endtime, activity.a_comment AS generating_activity_comment,

wasattributedto.wat_role AS agent_role, agent.ag_name AS agent_name, agent.ag_type AS agent_type,
agent.ag_affiliation AS agent_affiliation, agent.ag_email AS agent_email, agent.ag_address AS agent_address,
agent.ag_phone AS agent_phone, agent.ag_comment AS agent_comment,

string_agg(used.u_entity::text, '::text) AS used_entities_list
FROM entity e

JOIN wasgeneratedby ON e.e_id::text = wasgeneratedby.wgb_entity::text

JOIN activity ON wasgeneratedby.wgb_activity::text = activity.a_id::text

join used on u_activity = a_id

join entity as ee on ee.e_id = u_entity

join wasattributedto on wat_entity = e.e_id

join agent on ag_id = wat_agent ;



Solutions

Single step = view query execution

saada.u-strasbg.fr/taphandle/#

http://vo-proto.cds.unistra.fr:8080/tap

voproto.cds.unistra.fr:8080/tap-provenance>entity-849

Show 10 entries

Showing 1 to 7 of 7 entries

entity_name	entity_location	entity_generated	entity_invalidated	entity_comment	generating_activity_name	generating_activity_starttime	generating_activity_endtime	generating_activity_comment	agent_role	agent_name	agent_type	agent_affiliation	agent_email	agent_address	agent_phone	agent_comment	used_entities_list
j00x37020_drc		2018-12-05T02:19Z	null	Context image of Drizzl ...	j00x37020_drc_DrizzleGe ...	2018-12-05T02:19Z	2018-12-05T03:19Z	Production of image j00 ...	creator	STScI	Organization	AURA	stsci@stsci.edu	Martin Drive Baltimore	01 25436789	Space Telescope Science ...	file_225341.flow_225340...
j02p99020_drc		2018-12-05T02:19Z	null	Context image of Drizzl ...	j02p99020_drc_DrizzleGe ...	2018-12-05T02:19Z	2018-12-05T03:19Z	Production of image j02 ...	creator	STScI	Organization	AURA	stsci@stsci.edu	Martin Drive Baltimore	01 25436789	Space Telescope Science ...	flow_227732.flow_227732 ...
j0a536010_drc		2018-12-05T02:19Z	null	Context image of Drizzl ...	j0a536010_drc_DrizzleGe ...	2018-12-05T02:19Z	2018-12-05T03:19Z	Production of image j0a ...	creator	STScI	Organization	AURA	stsci@stsci.edu	Martin Drive Baltimore	01 25436789	Space Telescope Science ...	flow_230234.flow_230217 ...
j0yq07020_drc		2018-12-05T02:19Z	null	Context image of Drizzl ...	j0yq07020_drc_DrizzleGe ...	2018-12-05T02:19Z	2018-12-05T03:19Z	Production of image j0y ...	creator	STScI	Organization	AURA	stsci@stsci.edu	Martin Drive Baltimore	01 25436789	Space Telescope Science ...	flow_232670.flow_232668 ...
j0yp02020_drc		2018-12-05T02:19Z	null	Context image of Drizzl ...	j0yp02020_drc_DrizzleGe ...	2018-12-05T02:19Z	2018-12-05T03:19Z	Production of image j0y ...	creator	STScI	Organization	AURA	stsci@stsci.edu	Martin Drive Baltimore	01 25436789	Space Telescope Science ...	flow_233104.flow_233106 ...
j0zq03020_drc		2018-12-05T02:19Z	null	Context image of Drizzl ...	j0zq03020_drc_DrizzleGe ...	2018-12-05T02:19Z	2018-12-05T03:19Z	Production of image j0z ...	creator	STScI	Organization	AURA	stsci@stsci.edu	Martin Drive Baltimore	01 25436789	Space Telescope Science ...	file_237143.flow_237140 ...
j09z22010_drc		2018-12-05T02:19Z	null	Context image of Drizzl ...	j09z22010_drc_DrizzleGe ...	2018-12-05T02:19Z	2018-12-05T03:19Z	Production of image j09 ...	creator	STScI	Organization	AURA	stsci@stsci.edu	Martin Drive Baltimore	01 25436789	Space Telescope Science ...	flow_237526.flow_237530 ...

SUBMIT

Select What

Where

Position

Plain Text Query

Job Control

Result Limit

100

```
select * from minimum_provenance ;
```

Widgets do not reflect the query anymore after you modified it directly



Success and limitations

- Clear column names for distinct objects
- No more redundancy
- But :
 - Complex recursivity to manage
 - No direct retrieval for chains of provenance



Going Further

- TAP annotation of the simple table query
(see Mireille's talk)
- Renormalized response (multitable)
- Instance query
(see DaveMorris/Laurent Michel talk)
→ no simulation here



Renormalized solution

```
-<VOTABLE version="1.3" xsi:schemaLocation="http://www.ivoa.net/xml/VOTable/v1.3 http://www.ivoa.net/xml/VOTable/v1.3">
-<RESOURCE type="results">
-<TABLE ID="e" name="entity" utype="voprov:Entity">
<FIELD ID="eid" arraysize="*" datatype="char" name="e_id" ucd="meta.id" utype="voprov:Entity.id"/>
<FIELD arraysize="*" datatype="char" name="e_name" ucd="meta.title" utype="voprov:Entity.name"/>
<FIELD arraysize="*" datatype="char" name="e_comment" ucd="meta.description" utype="voprov:Entity.comment"/>
-<DATA>
-<TABLEDATA>
-<TR>
<TD>e_1</TD>
<TD>HST_V_Order10_Npix9199544</TD>
-<TD>
Npix9199544 tile of HSTV HiPS of size 12.25 and including position 53.0124731662895 and -27.8250294208907
</TD>
</TR>
-<TR>
<TD>e_1000</TD>
<TD>jcn604010_drc</TD>
-<TD>
Drizzled HST image from ACS centered on 53.02167776837-27.8496587892353 in spectral band WAVE MIN to WAVEMAX around target ANY
</TD>
</TR>
-<TR>
<TD>e_1001</TD>
<TD>jcn602030_drc</TD>
-<TD>
Drizzled HST image from ACS centered on 53.0216928281361-27.8496708083596 in spectral band WAVE MIN to WAVEMAX around target ANY
</TD>
</TR>
-<TR>
<TD>e_1002</TD>
<TD>jcn602020_drc</TD>
-<TD>
Drizzled HST image from ACS centered on 53.0216868548142-27.8496543123239 in spectral band WAVE MIN to WAVEMAX around target ANY
</TD>
</TR>
-<TR>
<TD>e_1003</TD>
<TD>jcn602010_drc</TD>
-<TD>
Drizzled HST image from ACS centered on 53.0216840785274-27.8496558628425 in spectral band WAVE MIN to WAVEMAX around target ANY
</TD>
</TR>
-<TR>
<TD>e_1004</TD>
<TD>jbwjq1020_drc</TD>
-<TD>
Drizzled HST image from ACS centered on 53.0237936758097-27.7961925580348 in spectral band WAVE MIN to WAVEMAX around target Q+A.ACS.CTR.2
</TD>
</TR>
-<TR>
<TD>e_1005</TD>
<TD>j8mt39031_drc</TD>
-<TD>
Drizzled HST image from ACS centered on 53.004998675959-27.8234268251943 in spectral band WAVE MIN to WAVEMAX around target ANY
</TD>
</TR>
</TABLEDATA>
</DATA>
</TABLE>
-<TABLE ID="a" name="activity" utype="voprov:Activity">
<FIELD ID="aid" arraysize="*" datatype="char" name="a_id" ucd="meta.id" utype="voprov:Activity.id"/>
<FIELD arraysize="*" datatype="char" name="a_name" ucd="meta.title" utype="voprov:Activity.name"/>
<FIELD arraysize="*" datatype="char" name="a_starttime" ucd="time.start" utype="voprov:Activity.starttime"/>
<FIELD arraysize="*" datatype="char" name="a_comment" ucd="meta.description" utype="voprov:Activity.comment"/>
-</TABLE>
```



HiPS Tile entity
And used drizzled
HST images entities



Renormalized solution

```
</TABLE>
-<TABLE ID="a" name="activity" utype="voprov:Activity">
  <FIELD ID="aid" arraysize="*" datatype="char" name="a_id" ucd="meta.id" utype="voprov:Activity.id"/>
  <FIELD arraysize="*" datatype="char" name="a_name" ucd="meta.title" utype="voprov:Activity.name"/>
  <FIELD arraysize="*" datatype="char" name="a_starttime" ucd="time.start" utype="voprov:Activity.startTime"/>
  <FIELD arraysize="*" datatype="char" name="a_comment" ucd="meta.description" utype="voprov:Activity.comment"/>
-<DATA>
-<TABLEDATA>
-<TR>
  <TD>a_1</TD>
  <TD>HST_V_Order10_Npix9199544_Generation</TD>
  <TD>2019-01-09T02:34Z</TD>
-<TD>
  hipsGEN version 10.101 generation of Npix9199544tile of HSTV HIPS
  </TD>
</TR>
</TABLEDATA>
</DATA>
</TABLE>
-<TABLE name="used" utype="voprov:Used">
-<GROUP name="foreignKey" ref="e">
  <FIELDref ref="ue"/>
  <FIELDref ref="eid"/>
</GROUP>
-<GROUP name="foreignKey" ref="a">
  <FIELDref ref="ua"/>
  <FIELDref ref="aid"/>
</GROUP>
<FIELD ID="ue" arraysize="*" datatype="char" name="u_entity" ucd="meta.id" utype="voprov:Used.entity"/>
<FIELD ID="ua" arraysize="*" datatype="char" name="u_activity" ucd="meta.id" utype="voprov:Used.activity"/>
-<DATA>
-<TABLEDATA>
-<TR>
  <TD>e_1000</TD>
  <TD>a_1</TD>
</TR>
-<TR>
  <TD>e_1001</TD>
  <TD>a_1</TD>
</TR>
-<TR>
  <TD>e_1002</TD>
  <TD>a_1</TD>
</TR>
-<TR>
  <TD>e_1003</TD>
  <TD>a_1</TD>
</TR>
-<TR>
  <TD>e_1004</TD>
  <TD>a_1</TD>
</TR>
-<TR>
  <TD>e_1005</TD>
  <TD>a_1</TD>
</TR>
</TABLEDATA>
</DATA>
</TABLE>
-<TABLE name="wasgeneratedby" utype="voprov:WasGeneratedBy">
-<GROUP name="foreignKey" ref="e">
  <FIELDref ref="wgbe"/>
  <FIELDref ref="eid"/>
</GROUP>
-<GROUP name="foreignKey" ref="a">
  <FIELDref ref="wgba"/>
  <FIELDref ref="aid"/>
</GROUP>
<FIELD ID="wgbe" arraysize="*" datatype="char" name="wgb_entity" ucd="meta.id" utype="voprov:WasGeneratedBy.entity"/>
<FIELD ID="wgba" arraysize="*" datatype="char" name="wgb_activity" ucd="meta.id" utype="voprov:WasGeneratedBy.activity"/>
-<DATA>
-<TABLEDATA>
-<TR>
  <TD>e_1</TD>
  <TD>a_1</TD>
  <TD/>
</TR>
</TABLEDATA>
</DATA>
</TABLE>
</RESOURCE>
```

Activity producing the tile (hipsgen)

VOTable Foreign Keys mechanism
Applied to « used »

Used table contains relationships
between activities and used entities

VOTable Foreign Keys mechanism
Applied to « wasgeneratedby »

Wasgeneratedby table contains
relationships between activities
and generated entities

Renormalisation

- How to generate queries doing that ?
 - « User Defined Function » for reformatting ?
- Need to have clients making full usage of multitable and foreign key mechanisms



ProvTAP annotation

```
-<VOTABLE version="1.3" xsi:schemaLocation="http://www.ivoa.net/xml/VOTable/v1.3 http://www.ivoa.net/xml/VOTable/v1.3">
-<VODML>
-<MODEL_INSTANCE name="ProvDM" syntax="ModelInstanceInVot" uri="https://github.com/ivoa-std/MANGO/blob/master/vo-dml/mango.vo-dml.xml">
-<TABLE_MAPPING tableref="result_S1635375430691">
-<COLLECTION dmrole="root">
-<TABLE_ROW_TEMPLATE>
-<INSTANCE dmrole="root" dmtype="provdm:Entity">
<ATTRIBUTE dmrole="provdm:Entity.name" dmtype="ivoa:string" ref="e_name"/>
<ATTRIBUTE dmrole="provdm:Entity.comment" dmtype="ivoa:string" ref="e_comment"/>
-<INSTANCE dmrole="provdm:Wasgeneratedby" dmtype="provdm:Wasgeneratedby">
-<INSTANCE dmrole="provdm:Activity" dmtype="provdm:Activity">
<ATTRIBUTE dmrole="provdm:Activity.name" dmtype="ivoa:string" ref="a_name"/>
<ATTRIBUTE dmrole="provdm:Activity.startTime" dmtype="ivoa:string" ref="a_starttime"/>
<ATTRIBUTE dmrole="provdm:Activity.comment" dmtype="ivoa:string" ref="a_comment"/>
-<COLLECTION>
-<INSTANCE dmrole="provdm:Used" dmtype="provdm:Used">
-<INSTANCE dmrole="provdm:Entity" dmtype="provdm:Entity">
<ATTRIBUTE dmrole="provdm:Entity.name" dmtype="ivoa:string" ref="ee_name"/>
<ATTRIBUTE dmrole="provdm:Entity.comment" dmtype="ivoa:string" ref="ee_comment"/>
</INSTANCE>
</INSTANCE>
</COLLECTION>
</INSTANCE>
</INSTANCE>
</TABLE_ROW_TEMPLATE>
</COLLECTION>
</TABLE_MAPPING>
</MODEL_INSTANCE>
</VODML>
-<RESOURCE type="results">
<INFO name="QUERY STATUS" value="OK"/>
<INFO name="PROVIDER" value="CDS"/>
<INFO name="QUERY" value="select e.e_name, e.e_comment, a_name, a_starttime, a_comment, ee.e_name, ee.e_comment from provenance.entity e join wasgeneratedby on e.e_id = wgb_entity join activity on wgb_activity = a_id join used on a_id = u_activity join entity ee on ee.e_id = u_entity where e.e_name like '%Npix9199544'"/>
-<TABLE name="result_S1635375430691">
<FIELD ID="e_name" arraysize="*" datatype="char" name="e_name" ucd="meta.title" utype="voprov:Entity.name"/>
<FIELD ID="e_comment" arraysize="*" datatype="char" name="e_comment" ucd="meta.description" utype="voprov:Entity.comment"/>
<FIELD ID="a_name" arraysize="*" datatype="char" name="a_name" ucd="meta.title" utype="voprov:Activity.name"/>
<FIELD ID="a_starttime" arraysize="*" datatype="char" name="a_starttime" ucd="time.start" utype="voprov:Activity.startTime"/>
<FIELD ID="a_comment" arraysize="*" datatype="char" name="a_comment" ucd="meta.description" utype="voprov:Activity.comment"/>
<FIELD ID="ee_name" arraysize="*" datatype="char" name="e_name" ucd="meta.title" utype="voprov:Entity.name"/>
<FIELD ID="ee_comment" arraysize="*" datatype="char" name="e_comment" ucd="meta.description" utype="voprov:Entity.comment"/>
-<DATA>
```

Mapping allows to reproduce
the tree/loop structure of
the instances of the model



ProvTAP annotation

- Nice solution if we have a TAP annoter able to generate annotation
- Need some client
 - Generic ?
 - ProvDM aware ?



Related Posters

- → see X4-010 poster on all this
(Object Oriented Data Model strategy in the context of IVOA
Table Access Protocol services)
- And also X3-010 (annotation)

