# TAP 1.1 Authentication in TOPCAT/STILTS

Mark Taylor (Bristol)
*with input from* Markus Demleitner (ARI)

IVOA Interop
College Park MD, USA

November 2018

$Id: tapauth.tex,v 1.14 2018/11/05 14:53:56 mbt Exp $

# Outline

- TAP 1.1 authentication refresher
- Prototype implementation in TOPCAT + STILTS
  - Client behaviour
  - Implementation details
    - ▷ Overview
    - ▷ By security method
- Complaints about TAP 1.1 auth specification

# Authentication Options in TAP 1.1 PR

## PR-1.1-TAP-20180830

- Section 2: Declared resource requirements

| resource type | resource name | required |
|---|---|---|
| TAP-sync | /sync | must |
| TAP-async | /async | must |
| TAP-sync | service specific | may (alternate authentication method) |
| TAP-async | service specific | may (alternate authentication method) |
| VOSI-availability | service specific | must (should be anonymous) |
| VOSI-availability | service specific | may (alternate authentication method) |
| VOSI-capabilities | /capabilities | must (must be anonymous) |
| VOSI-tables | /tables | should |
| VOSI-tables | service specific | may (alternate authentication method) |
| DALI-examples | /examples | should |
| DALI-examples | service specific | may (alternate authentication method) |

- Capabilities document may declare multiple `interface` elements with different `securityMethod/@standardID` attributes

# Authentication Options in TAP 1.1 PR

## PR-1.1-TAP-2018030

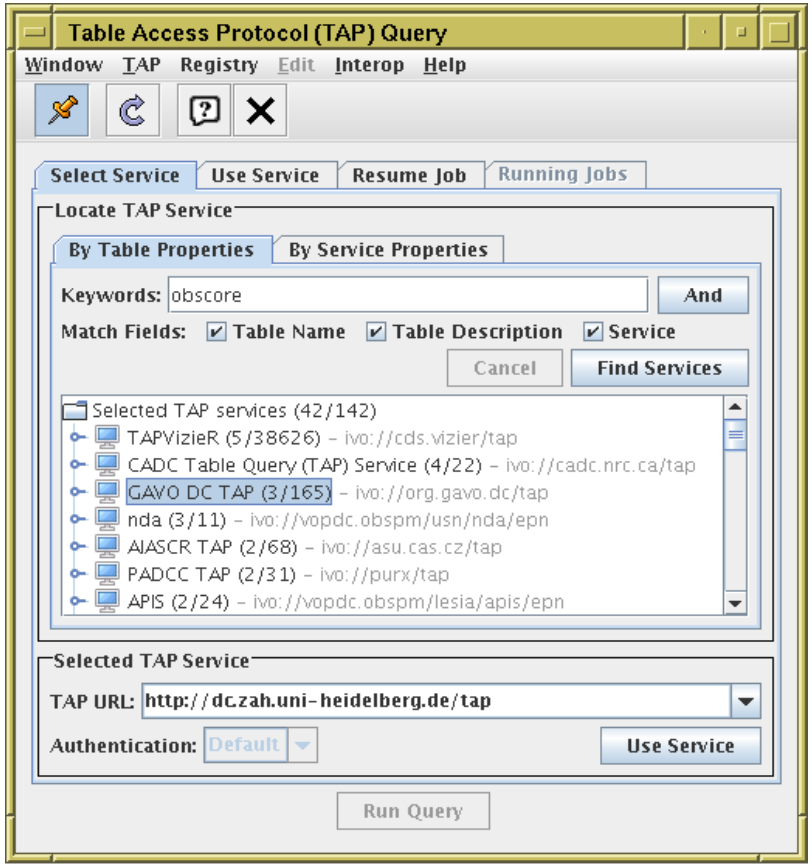
- Section 2.4: Example capabilities document:

```
<vosi:capabilities ...>

  <!-- TAP sync/async -->
  <capability standardID="ivo://ivoa.net/std/TAP">
    <interface xsi:type="urx:Sync" role="std" version="1.1">
      <accessURL use="base">http://example.net/myTAP/sync</accessURL>
      <!-- no declared securityMethod -->
    </interface>
    <interface xsi:type="urx:Sync" role="std" version="1.1">
      <accessURL use="base">https://example.net/myTAP/auth-sync</accessURL>
      <securityMethod standardID="ivo://ivoa.net/sso#BasicAA"/>
    </interface>

    <interface xsi:type="urx:Async" role="std" version="1.1">
      <accessURL use="base">http://example.net/myTAP/async</accessURL>
      <!-- no declared securityMethod -->
    </interface>
    <interface xsi:type="urx:Async" role="std" version="1.1">
      <accessURL use="base">https://example.net/myTAP/auth-async</accessURL>
      <securityMethod standardID="ivo://ivoa.net/sso#BasicAA"/>
    </interface>
  </capability>

  <!-- VOSI tables -->
  <capability standardID="ivo://ivoa.net/std/VOSI#tables-1.1">
    <interface xsi:type="vs:ParamHTTP" role="std" version="1.1">
      <accessURL use="base">http://example.net/myTAP/tables</accessURL>
      <!-- no declared securityMethod -->
    </interface>
    <interface xsi:type="vs:ParamHTTP" role="std" version="1.1">
      <accessURL use="base">https://example.net/myTAP/auth-tables</accessURL>
      <securityMethod standardID="ivo://ivoa.net/sso#BasicAA"/>
    </interface>
  </capability>
  ...
</vosi:capabilities>
```

# TOPCAT UI

## TOPCAT TAP client supports authenticated use

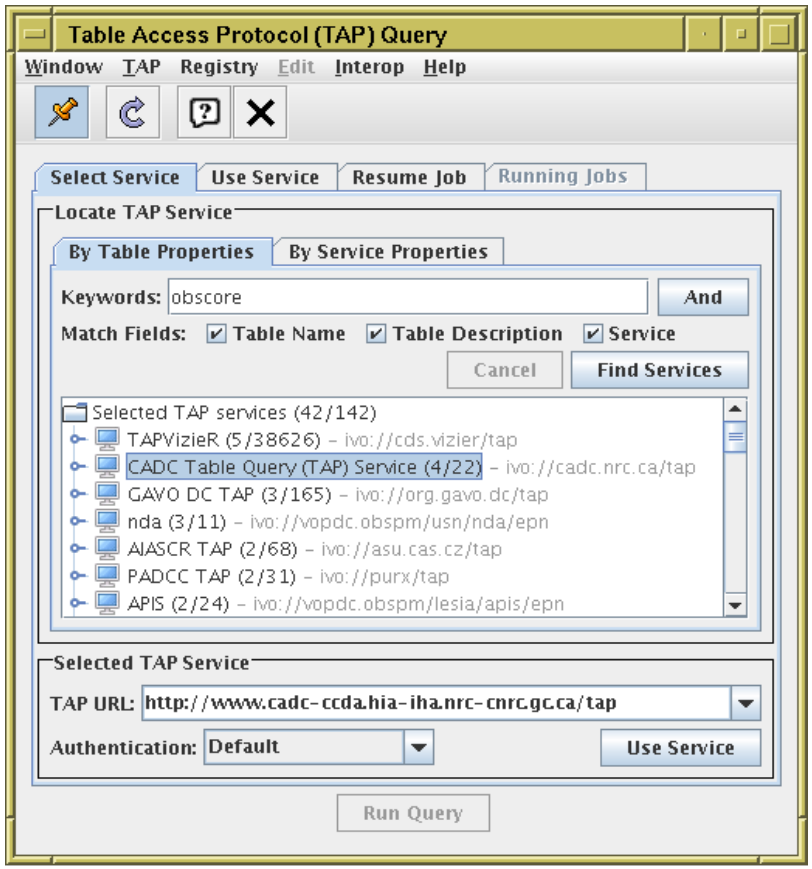
- New **Authentication** selector below TAP URL selector
- Populated asynchronously when TAP URL is selected (or entered by hand)
- Select a non-default value if you like
- SecurityMethod-specific endpoint bundle is selected accordingly



# TOPCAT UI

## TOPCAT TAP client supports authenticated use

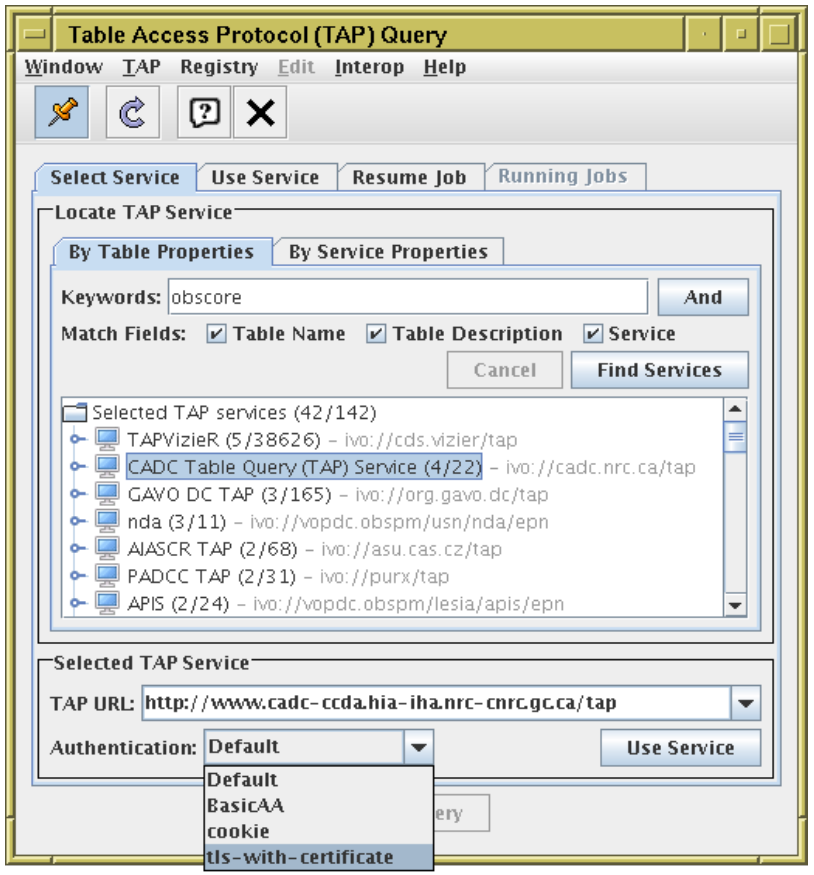
- New **Authentication** selector below TAP URL selector
- Populated asynchronously when TAP URL is selected (or entered by hand)
- Select a non-default value if you like
- SecurityMethod-specific endpoint bundle is selected accordingly



# TOPCAT UI

## TOPCAT TAP client supports authenticated use

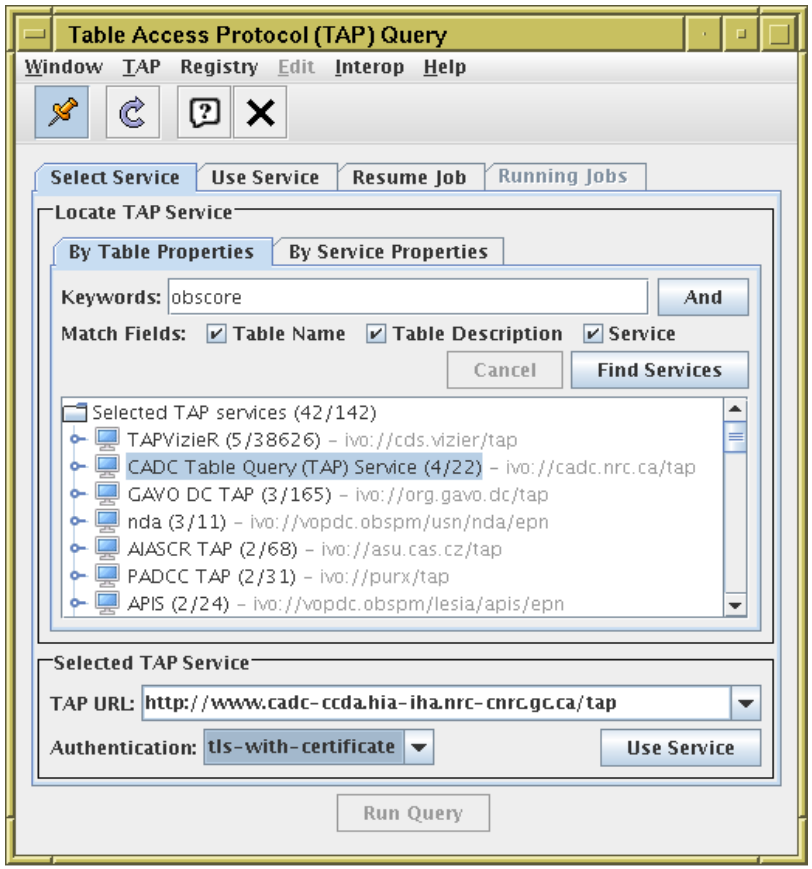
- New **Authentication** selector below TAP URL selector
- Populated asynchronously when TAP URL is selected (or entered by hand)
- Select a non-default value if you like
- SecurityMethod-specific endpoint bundle is selected accordingly



# TOPCAT UI

## TOPCAT TAP client supports authenticated use

- New **Authentication** selector below TAP URL selector
- Populated asynchronously when TAP URL is selected (or entered by hand)
- Select a non-default value if you like
- SecurityMethod-specific endpoint bundle is selected accordingly



# STILTS UI

## STILTS TAP clients support authenticated use

- New parameter `interface` for TAP client commands
- Affected commands: `tapquery`, `tapskymatch`, `taplint`
- Options:

  `interface=tap1.0`
  use standard TAP 1.0 endpoints and TAP 1.0 protocol *(default)*

  `interface=tap1.1`
  use standard TAP 1.0 endpoints and TAP 1.1 protocol

  `interface=unauth`
  read `/capabilities` document and find endpoints with no declared `securityMethod`

  `interface=auth:xxx`
  read `/capabilities` document and find endpoints with securityMethod/@standardID (approximately) matching "`xxx`"

- Examples:
  - `taplint interface=unauth tapurl=...`
  - `tapquery interface=auth:tls-with-security tapurl=...`

# Implementation

## TOPCAT/STILTS TAP clients need a *bundle* of service endpoints

- To interact with the service, they need (several of) the endpoints `sync`, `async`, `tables`, `capabilities`, `examples`

## What are these authenticated TAP client implementations doing?

- Read `/capabilities` document from service
- Sort declared capability/interface entries into per-securityMethod endpoint bundles
- Offer the available bundles to the user (choice of `securityMethod/@standardID`)
- Arrange that subsequent service interactions use the correct bundle-specific endpoints
- Nothing else!
  - ▷ Actual authentication is done outside of application code (see later slides)
  - ▷ They do not attempt to work out which bundle(s) can be used in the current context — the user has to look at the names and work it out.

# Security Method Specifics

## Application code just attempts to use given endpoints

- It doesn't know if they are authenticated or not, or which auth method is used
- Actual authentication is done at the JRE level (`HttpURLConnection` does the hard work)

## Several authentication methods are defined by SSO 2.0:

- No authentication required:
  - ▷ Easy.
- HTTP Basic Authentication, TLS-with-Client-Certificate:
  - ▷ Tested and working using JRE-level mechanisms (see next slides)
- TLS-with-Password:
  - ▷ I think it *should* work just like HTTP Basic Auth
- Cookies:
  - ▷ Only appropriate for browser clients??
- SAML, OAuth, OpenID:
  - ▷ I have no idea what these are.

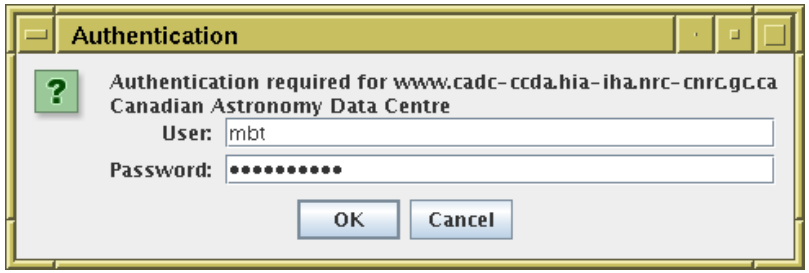
## This seems to do the job so far ... do I need to work any harder?

# HTTP Basic Authentication

`securityMethod/@standardID="ivo://ivoa.net/sso#BasicAA"`:

- Client initially attempts unauthenticated access
- This results in an HTTP 401 response
- When it sees a 401, the `java.net.HttpURLConnection` calls `java.net.Authenticator` static methods to get username/password
  - ▷ I *think* it keeps track of these by hostname
- Clients can install default `Authenticator` instances into the JVM
  - ▷ STILTS uses an instance that picks up username/password from system properties (`star.basicauth.user`, `star.basicauth.password`)
  - ▷ TOPCAT tries those system properties, but if they are not supplied, it uses a GUI prompt instead
- I *think* the same should work without code modification for `securityMethod/@standardID="ivo://ivoa.net/sso#tls-with-password"`

```
stilts -Dstar.basicauth.user=mbt
       -Dstar.basicauth.password=xxxxx
       tapquery tapurl=http://www.cadc-ccda.hia-iha.nrc-cnrc.gc.ca/tap/
                interface='auth:BasicAA'
                adql='SELECT TOP 3 * FROM caom2.siav1'
```



# TLS With Certificate

`securityMethod/@standardID="ivo://ivoa.net/sso#tls-with-certificate"`:

- HTTPS client must present a (suitable) client certificate when opening connection
- It can be configured to do so by installing a (suitable) `javax.net.ssl.SSLSocketFactory`:
  - *Either:* per connection: `connection.setSSLSocketFactory()`
  - *Or:* system-wide: `HttpsURLConnection.setDefaultSSLSocketFactory()`
- STILTS/TOPCAT lets you install a system-wide one
  - Set system property `star.cert.pem` to name of file containing (e.g.) the PEM-format proxy certificate downloaded from CANFAR authenticated web page
  - Can only have one certificate installed per JVM (TOPCAT session)
  - ... which is OK for now, since only one service (CADC) is using this auth method
- Most of the code supplied by CADC *(thanks Brian!)*
- Future improvements under investigation:
  - TOPCAT GUI prompt for certificate file rather than requiring system properties
  - Multiple certificates for different services
- Hard to say whether this will work well for other future services (similar cert format?)

```
stilts -Dstar.cert.pem=/home/mbt/certs/cadcproxy.pem
       tapquery tapurl=http://www.cadc-ccda.hia-iha.nrc-cnrc.gc.ca/tap/
                interface='auth:tls-with-certificate'
                adql='select top 3 collection, dataRelease from caom2.siav1'
                sync=true
```

# Other Security Methods

Cookies, SAML, OAuth, OpenID:

- No attempt to deal with these so far
- Possibly some JRE-level configuration will work for these too?
- Does anyone plan to use these for desktop applications?

# Availability

Working versions available:

- URLs:

  ftp://andromeda.star.bris.ac.uk/pub/star/topcat/pre/topcat-full_tap11.jar

  ftp://andromeda.star.bris.ac.uk/pub/star/stilts/pre/stilts_tap11.jar

- These are prototype versions, subject to change
  - ▷ Maybe some improvements for supplying credentials
  - ▷ Maybe changes following discussions here or IVOA feedback

# Future Work

## Better user interaction

- Better options for user to supply authentication tokens at runtime
- Smarter user interaction based on selected authentication method
- Possibility for per-service TLS certificate configuration
  (but is it worth it if only CADC is using tls-with-certificate?)
- Guess what authentication option the user will want based on available credentials?
  (but I can't see how to do this)

## Other protocols

- Authenticated Cone, SIA, SSA? (do services exist? how are they registered?)

## More testing

- Try out non-CADC authenticated TAP services (are there any?)

## Share code

- Collaborate on authentication library to share between VO Java applications?
- Already working with CADC

## Release

- Incorporate functionality in public release — when stable

# TAP 1.1 Capabilities

## PR-TAP-1.1-20181024 Section 2.4 "VOSI-capabilities":

- TAP 1.1 PR describes how to find TAP endpoints for a TAP service
- The implementation on previous slides follows this description
- ... so it can be done ...
- ... but I don't really like it.
- Quite a bit of discussion on this topic already:
  - My presentation Shanghai 2017 (some items cleared up since then: bundle assembly rules, unique capabilities file)
  - RFC page
  - DAL mailing list "TAP 1.1 authentication" thread in August and September
- Summary:
  - Some details have been cleaned up, but disagreements remain
  - Pat Dowler (TAP author) supports current approach
  - Mark Taylor, Markus Demleitner, Paul Harrison have concerns
- Details on following slides

# TAP 1.1 Capabilities: Bundles

## Why I don't much like TAP 1.1 authenticated service specification

- TAP service interaction uses several endpoints:

  `sync`, `async`, `tables`, `capabilities`, `examples`

- Clients like TOPCAT/STILTS need to work with a *bundle* of these, not just pick one
- TAP 1.0: service defined by base URL
  - Bundle specification: base URL + well-known subpaths

    `http://dc.g-vo.org/tap/sync`
    `http://dc.g-vo.org/tap/async`
    `...`
- TAP 1.1: service defined by `capabilities` document
  - Capabilities doc provides an unstructured list of (endpoint, securityMethodID) pairs
  - Bundle specification: capabilities doc + securityMethodID + bundle-assembly rules
  - There is no base URL
- TAP 1.1 is hard work for bundle-oriented clients:
  - Can't specify a bundle by just giving a URL e.g. on the command line or in an email *(except by fallback to TAP 1.0 rules)*
  - Fairly difficult to list available bundles to offer to users *(but not impossible — I implemented it)*
  - Very difficult to deal with services that may be mirrored as well as authenticated *(I gave up)*

# TAP 1.1 Capabilities: Example and discussion

PR-TAP-1.1-20181024 Section 2.4 "VOSI-capabilities":

- Explains use of capabilities file to specify endpoints
- Includes text explaining how to interpret it as bundles
  - Text supplied by me —
    as simple as I could make it for e.g. TOPCAT requirements, but still a bit involved
- Relies on (draft) UWSRegExt Note, so provisional and non-normative
  - PR-TAP-1.1-20181024 therefore does not tell clients how to use authenticated services
    (just guesses how it might work in future)
  - If UWSRegExt doesn't work out as per its current draft,
    this section will be unhelpful/misleading

# TAP 1.1 Capabilities: Suggestions

## Bundles: return to Base-URL-based system

- Markus suggests new DALI subtype of `vr:interface` (see registry mailing list 17 Oct):

```
<capability standardID="ivo://ivoa.net/std/TAP">
  <interface xsi:type="vs:DALIInterface">
    <accessURL>http://dc.g-vo.org/tap"</accessURL>
    <endpoint>sync</endpoint>
    <endpoint>async</endpoint>
    <endpoint>capabilities</endpoint>
    <endpoint>tables</endpoint>
    <endpoint>examples</endpoint>
  </interface>
</capability>
```

- I think this would reduce the complexity of Sec 2.4 and remove the need for UWSRegExt
- Looks reasonable to me? But I'm not a registry expert

## Capabilities discussion: extract to TAPRegExt

- Capabilities section is not really core to TAP 1.1, and is anyway subject to change and non-normative
- TAPRegExt 1.1 is currently in WD
- Punt capabilities details to TAPRegExt?
- ... blame Markus for this suggestion too