The SciTokens Authorization Model: JSON Web Tokens & OAuth

Jim Basney <jbasney@ncsa.Illinois.edu>

Brian Bockelman <bbockelm@cse.unl.edu>

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SciTokens Project

- The SciTokens project, starting July 2017, aims to:
  - Introduce a ***capabilities-based*** **authorization infrastructure** for distributed scientific computing,
  - Provide a **reference platform**, combining CILogon, HTCondor, CVMFS, and XRootD, and
  - **Implement specific use cases** to help our science stakeholders (LIGO and LSST) better achieve their scientific aims.

Identity-based Authorization

- At the core of today's grid security infrastructure is the concept of *identity* and *impersonation*.
  - A grid certificate provides you with a globally-recognized identification.
  - The grid proxy allows a third party to impersonate you, (ideally) on your behalf.
  - The remote service maps your identity to some set of locally-defined authorizations.
- We believe this approach is fundamentally wrong because it exposes too much global state: identity and policy should be kept locally!

Capability-based Authorization

- We want to change the infrastructure to focus on *capabilities*!
  - The tokens passed to the remote service describe what authorizations the bearer has.
  - For traceability purposes, there may be an identifier that allows tracing of the token bearer back to an identity.
  - Identifier != identity. It may be privacy-preserving, requiring the issuer (VO) to provide help in mapping.
- Example: “The bearer of this piece of paper is entitled to write into /castor/cern.ch/cms".

Capabilities versus Impersonation

- If GSI took over the world, an attacker could use a stolen grid proxy to make withdrawals from your bank account.
- With capabilities, a stolen token only gets you access to a specific authorization (“stageout to /store/user at Nebraska”).
- SciTokens is following the **principle of least privilege** for distributed scientific computing.

The World Uses Capabilities!

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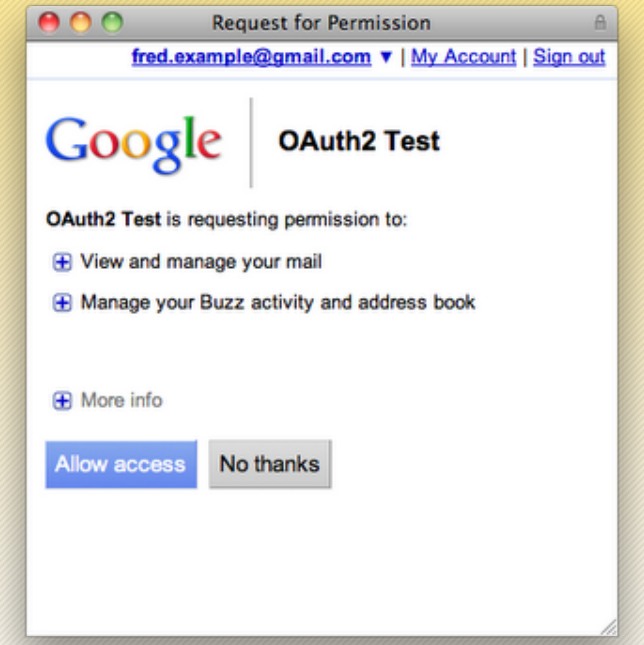
- The rest of the world uses capabilities for distributed services.
  - The authorization service creates a token that describes a certain capability or authorization.
  - Any bearer of that token may present it to a resource service and utilize the authorization.
- The primary way this is implemented is through OAuth2.
- When you click “allow access” on the right, the **client** at “OAuth2 Test” will receive a token. This token will permit it to access the listed subset of Google services for your account.
- OAuth2 is used by Microsoft, Facebook, Google, Dropbox, Box, Twitter, Amazon, GitHub, Salesforce (and more) to allow distributed access to their identity services.



Three-Legged Authorization

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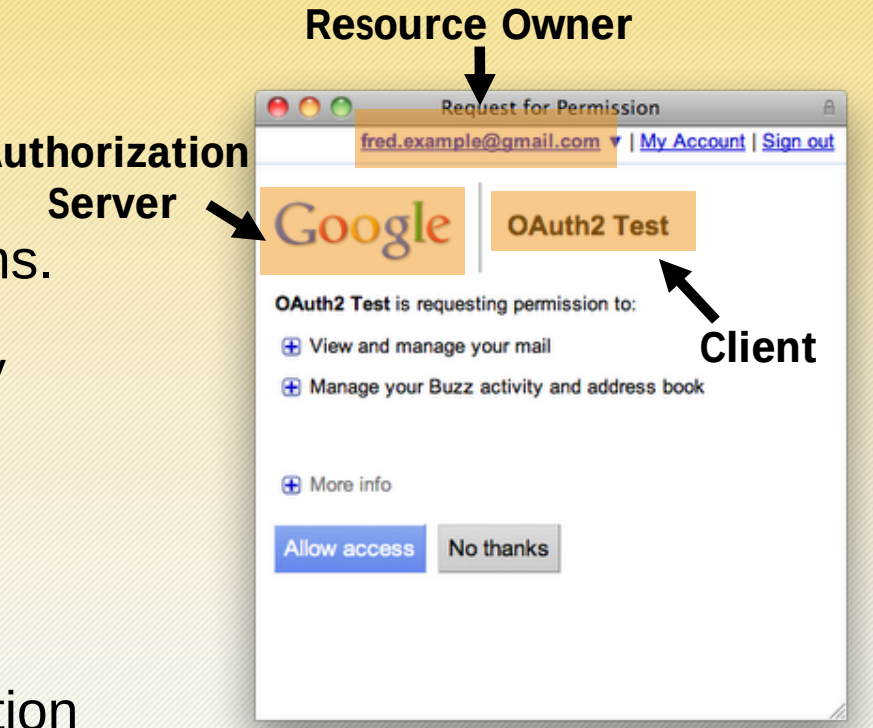
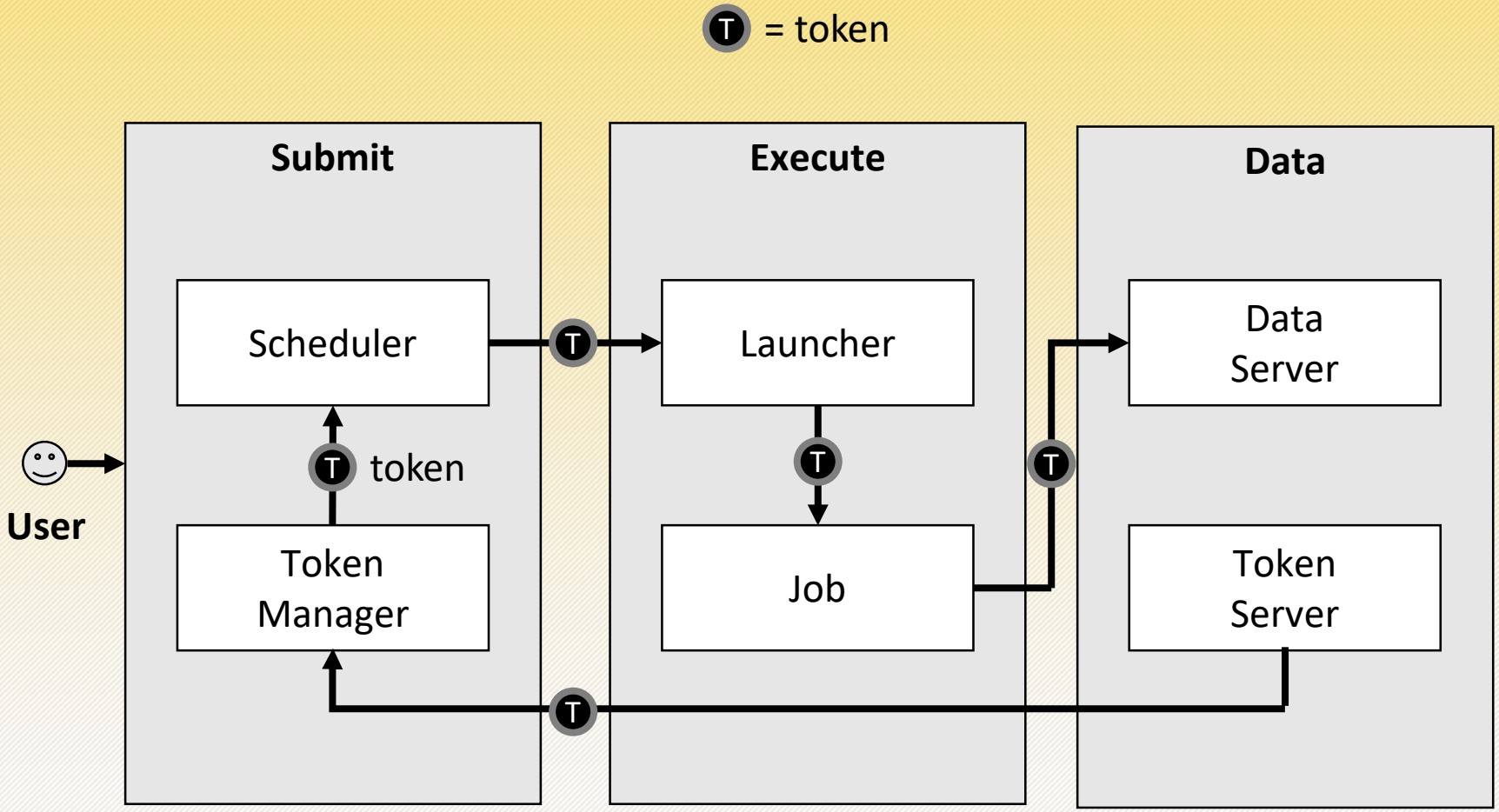
- In OAuth2, there are three abstract entities involved in the authorization workflow:
  - **Authorization server** issues capabilities (tokens).
  - The **resource owner** (end-user) approves authorizations.
  - The **client** receives tokens. Often, this is the third-party website or smartphone app.
- Once the token is issued, it can be used at the **resource server** to access some protected resource.
  - In the Google example, Google runs both the authorization and resource servers.



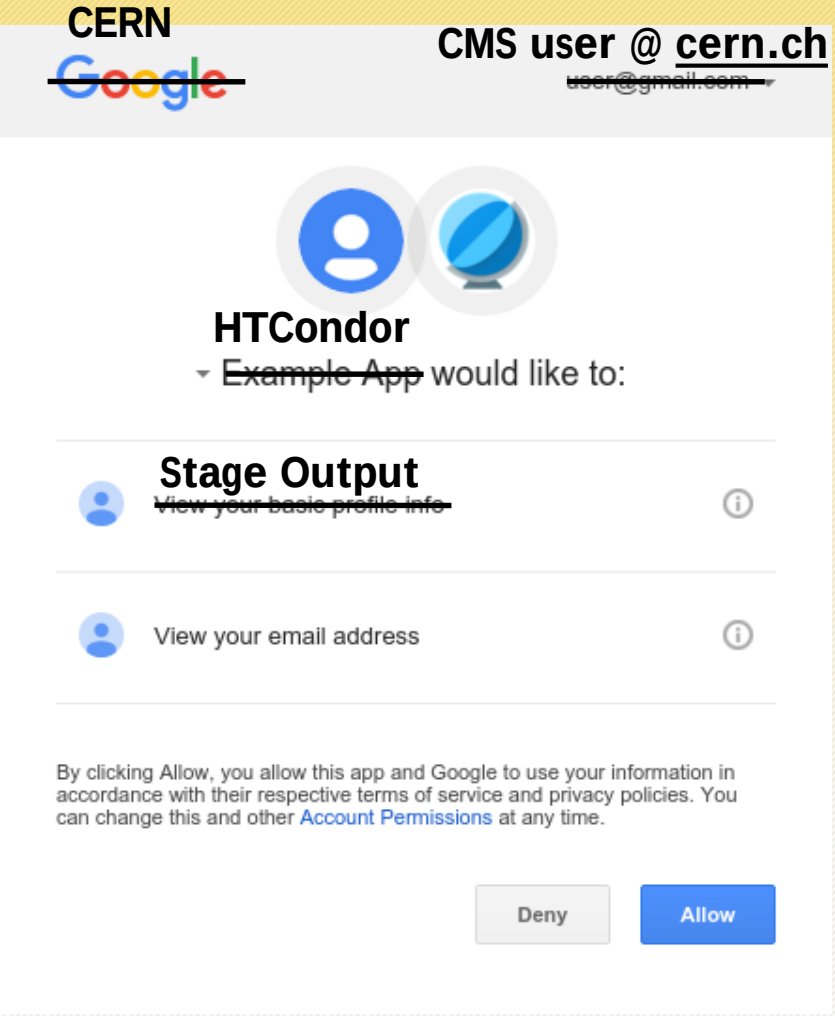
SciTokens Model

- Integrating an OAuth2 client on the HTCondor submit host
- Enhancing CILogon to support OAuth2 with VO-defined scopes
- Enhancing HTCondor to manage token refresh, attenuation, and delivery to jobs
- Enhancing data services (CVMFS, Xrootd) to allow read/writes using tokens instead of grid proxies



End-Goal

- The end-goal is this →
- The first time you use HTCondor, you navigate to a web interface and setup your desired permissions.
  - On every subsequent `condor_submit`, HTCondor will transparently create the access token for you. *User sees nothing*.
- Replace CERN, usernames, and authorization as desired.
  - **Goal**: our first use of OAuth2 will be to stageout from payload jobs to Box.



SCITOKENS

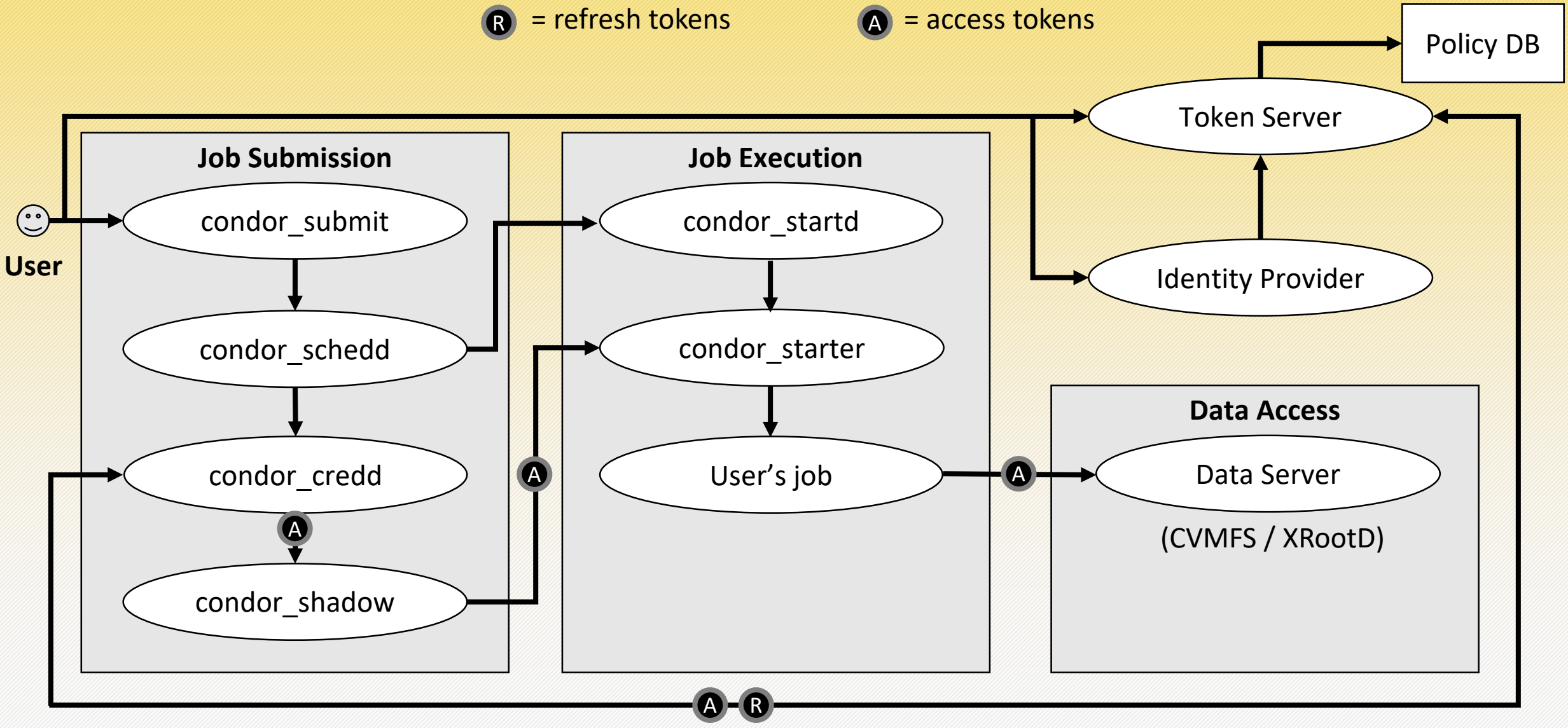
~~USER MANAGEMENT OF FILES~~

~~PASSWORD IN TERMINAL~~

~~SCITOKENS-PROXY-INIT~~

~~COPY / PASTE~~

Architecture



OAuth2 Authorization Framework

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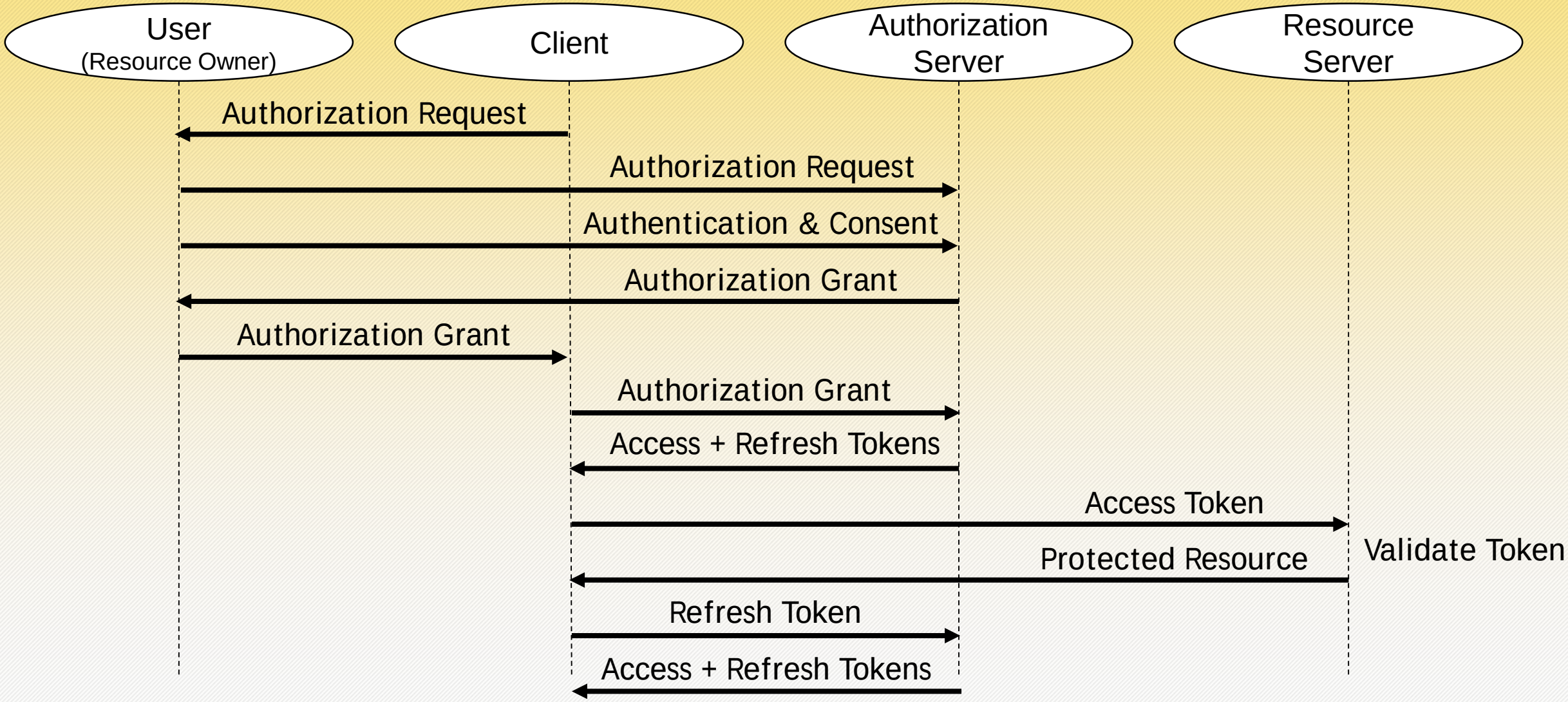


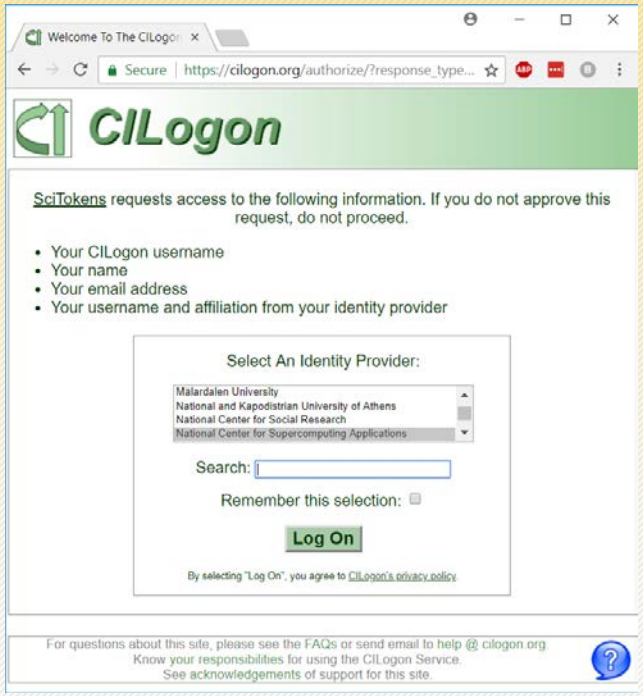
CILogon and SciTokens

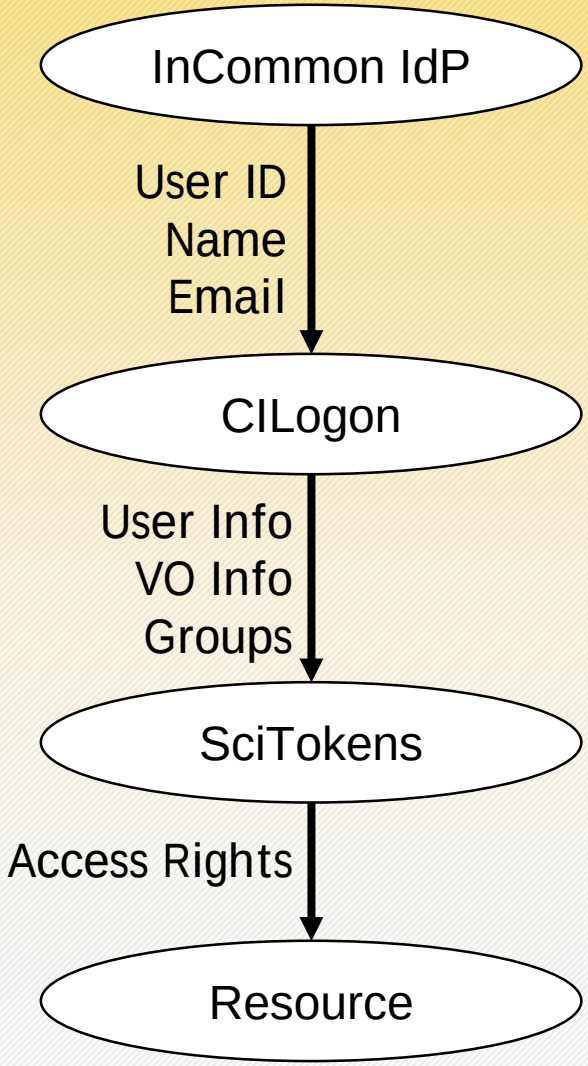
CILogon

- Federated Identity Management
- OpenID Connect
- ID Tokens

SciTokens

- Federated Authorization
- OAuth 2.0
- Access Tokens





Tokens for Distributed Science Infrastructures

- Distributed science infrastructures are distinct from a “resource server” like Google because they are not run by a single central entity.
- Hence, unlike Google, we can’t use opaque random strings for the token. We need something that allows for **distributed verification**.
  - Given a token, a storage service can determine it is valid.
  - Analogously, given a proxy chain and a set of trust roots, you can determine the GSI proxy is valid.
- Goal: Sites set aside some area for each VO; VOs manage the authorizations within these “VO home” areas.

JWT in action!

- Free tokens! Navigate to https://demo.scitokens.org to get your free tokens!
- This demo illustrates the access token format we're working on.
  - Utilizes JSON Web Tokens (JWT) as the access token format.
  - Various RFCs provide clear guidance on how to verify token integrity.
  - Adds a few domain-specific claims for receiving access to storage.
- The tokens are base64-encoded and can be used as part of a curl command to use protected resources.

Example Token, Decoded

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- The decoded token contains multiple scopes - basically filesystem authorizations.
- The audience narrows who the token is intended for.
- The issuer identifies who created the token; value used to locate the public keys needed to validate signature.
- The subject is an opaque identifier for the resource owner. In this case, it also happens to be the identity.
- The expiration is a Unix timestamp when the token expires. A typical lifetime is 10 minutes.

HEADER: ALGORITHM & TOKEN TYPE

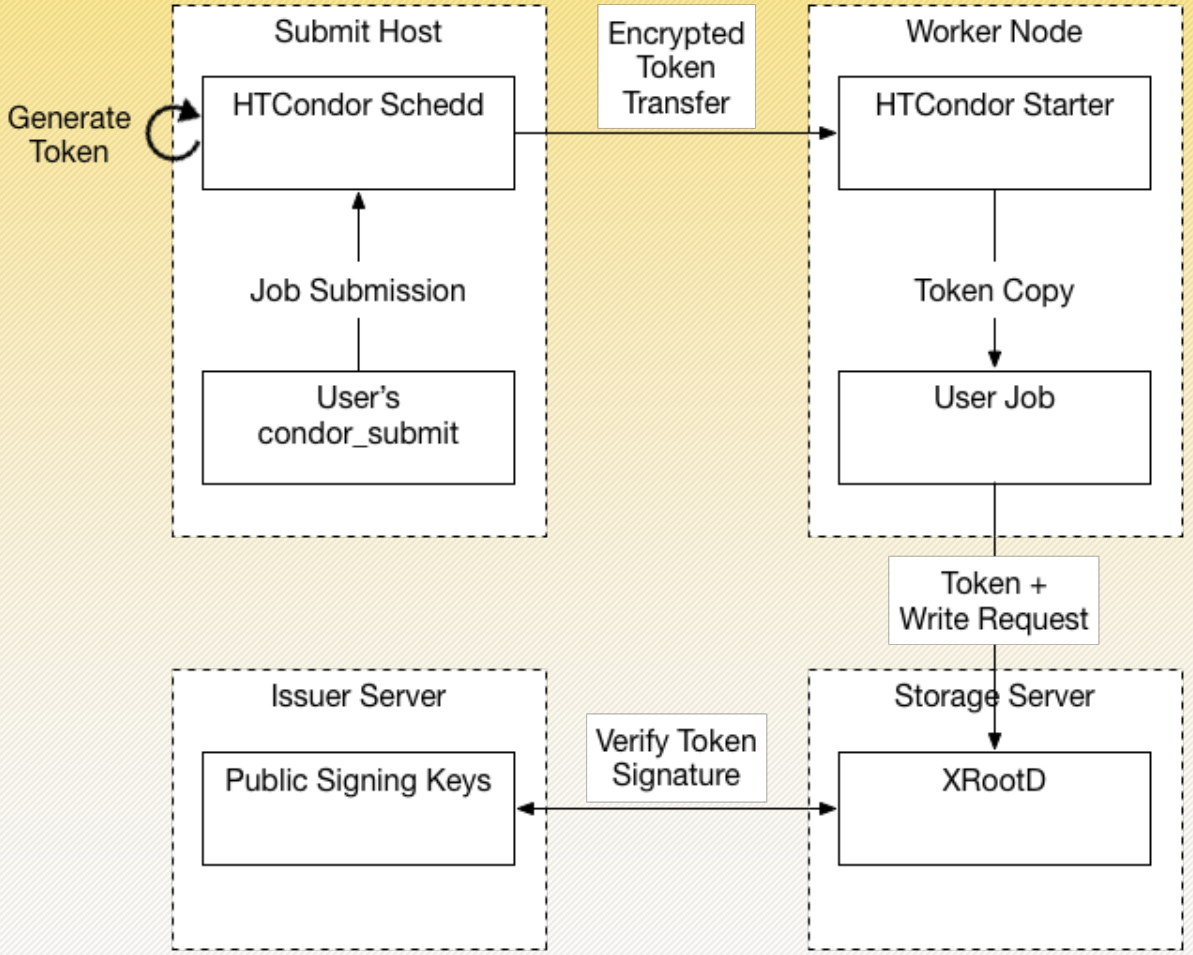

```
{
  "typ": "JWT",
  "alg": "RS256"
}
```


PAYLOAD: DATA


```
{
  "scope": "read:/protected write:/store/u25321",
  "aud": "https://demo.scitokens.org",
  "iss": "https://demo.scitokens.org",
  "sub": "bbockelm@cern.ch",
  "exp": 1526954997,
  "iat": 1526954397,
  "nbf": 1526954397,
  "jti": "78c44ce9-62bb-43e8-a7a6-f035f7ebd42b"
}
```

Early results on OSG

- We have been able to get a basic end-to-end token-based auth{z,n} workflow working for the OSG VO submit service.
- *This includes* patches to Xrootd to validate tokens presented via HTTP and to write files out with the correct Unix user permissions.
- **Cheats**:
  - instead of using OAuth2 to generate the token, we keep a signing key on the submit host.
  - only one token needed.
  - submit host and storage server owned by OSG.



Wait, I've seen this before!

- If you're from ALICE and getting a sense of déjà vu — you're right!
  - The capability-based infrastructure is precisely the authorization infrastructure used by ALICE for the **past decade**.
  - SciTokens takes this **successful model**, recasts it using modern web protocols, and utilizes OAuth2 workflows to issue the tokens.
- The use of common protocols and workflows means that we have a large number of battle-tested libraries we can leverage (spend our time doing other stuff besides writing the basics!).
- Using JWT-formatted access tokens is somewhat-commonplace among web companies.
  - We *think* SciTokens is unique in using JWT access tokens for distributed verification in a federated infrastructure.

Status & Next Steps

- So far we have:
  - Version 1.0 of Python and Java libraries
  - Simple HTCondor OAuth client implementation
  - XRootD token validation plugins
  - Token-based CVMFS access
  - X509-to-SciToken translation service
  - 3rd-party HTTPS FTS transfers authorized with SciTokens
- Next steps:
  - Use Java library for a dCache authorization plugin
  - Release plugin for CVMFS support
  - More fine-grained token management in HTCondor
  - Integration with LIGO LDAP
  - Enhancing HTCondor token support with OAuth flows

Thanks!

Visit
https://scitokens.org/
for more info.

Any questions?