The SciTokens Authorization Model: JSON Web Tokens & OAuth

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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!
• 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 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

- 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

User

Submit

Scheduler

Token Manager

Execute

Launcher

Job

Data

Data Server

Token Server
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.
USER MANAGEMENT OF FILES

SCITOKENS-PROXY-INIT

PASSWORD IN TERMINAL

COPY/PASTE
OAuth2 Authorization Framework

User (Resource Owner) → Authorization Request → Authorization Grant → Access + Refresh Tokens → Refresh Token → Access + Refresh Tokens

Client → Authorization Request → Authentication & Consent → Authorization Grant → Access + Refresh Tokens

Authorization Server → Authorization Request → Authorization Grant → Access + Refresh Tokens → Validate Token

Resource Server → Access Token → Protected Resource
CILOGON and SciTokens

CILOGON
- Federated Identity Management
- OpenID Connect
- ID Tokens

SciTokens
- Federated Authorization
- OAuth 2.0
- Access Tokens
• 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

- 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.
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?