The Future of Bearer Tokens

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OSG Token Transition Workshop
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Authentication & Authorization Standards

- **X.509: Certificates**
  - Grid Security Infrastructure (GSI)
  - Virtual Organization Membership Service (VOMS)

- **SAML: Security Assertion Markup Language**
  - Using XML
  - Single Sign-on for Higher Education: eduGAIN / InCommon / Shibboleth

- **JWT: JSON Web Tokens**
  - Using JavaScript Object Notation (JSON)
  - Pronounced "jot"
  - Digitally signed, self-describing **bearer tokens**

- **OAuth: Authorization Framework**
  - Optionally using JWTs
  - Tokens for limited access to resources

- **OIDC: OpenID Connect**
  - An identity layer on top of OAuth
  - Using JWTs
## Credentials for Authentication / Authorization

<table>
<thead>
<tr>
<th>Credential Issuer</th>
<th>X.509</th>
<th>SAML</th>
<th>OIDC</th>
<th>OAuth / JWT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certificate Authority</td>
<td>Identity Provider</td>
<td>OpenID Provider</td>
<td>Authorization Server</td>
<td></td>
</tr>
<tr>
<td>Credential Verifier</td>
<td>Relying Party</td>
<td>Service Provider</td>
<td>Relying Party</td>
<td>Resource Server</td>
</tr>
<tr>
<td>Credential</td>
<td>Certificate</td>
<td>Assertion</td>
<td>ID Token</td>
<td>Access Token</td>
</tr>
<tr>
<td>Language</td>
<td>ASN.1</td>
<td>XML</td>
<td>JSON</td>
<td>JSON</td>
</tr>
<tr>
<td>Credential Contents</td>
<td>Distinguished Names / Fully Qualified Attribute Names</td>
<td>Attributes</td>
<td>Claims</td>
<td>Claims</td>
</tr>
<tr>
<td>User Identifier</td>
<td>Subject DN</td>
<td>NameID / eduPersonPrincipalName</td>
<td>Subject Identifier (sub) Claim</td>
<td>Subject (sub) Claim</td>
</tr>
<tr>
<td>Managing Trust</td>
<td>CA Certificate Bundle</td>
<td>SAML Metadata</td>
<td>OpenID Provider Metadata</td>
<td>Authorization Server Metadata</td>
</tr>
</tbody>
</table>

**Language**
- ASN.1
- XML
- JSON

**Credential Contents**
- Distinguished Names / Fully Qualified Attribute Names
- Attributes
- Claims

**User Identifier**
- Subject DN
- NameID / eduPersonPrincipalName
- Subject Identifier (sub) Claim

**Managing Trust**
- CA Certificate Bundle
- SAML Metadata
- OpenID Provider Metadata
- Authorization Server Metadata
### Authorization / Access Control

<table>
<thead>
<tr>
<th>Authorization Type</th>
<th>Description</th>
<th>X.509</th>
<th>SAML</th>
<th>OIDC</th>
<th>OAuth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Identity-based</strong></td>
<td>User identifiers and access control lists</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td><strong>Attribute-based</strong></td>
<td>Access policies based on user attributes</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td><strong>Role-based</strong></td>
<td>Access controls based on group memberships and roles</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td><strong>Capability-based</strong></td>
<td>Tokens allow actions on resources</td>
<td></td>
<td></td>
<td></td>
<td>YES</td>
</tr>
</tbody>
</table>
Least Privilege Authorization

- Good security practice: grant only those privileges that are required
  - for only as long as they are required

- Identity-based authorization
  - Limit the privileges granted to an identity

- Attribute-based authorization
  - Use attributes to determine appropriate privileges at this time

- Role-based authorization
  - Assign privileges to roles, and activate roles only when needed

- Capability-based authorization
  - Issue tokens granting only those privileges that are required, for the required lifetime
OAuth and Least Privilege

- OAuth Access Token "scope" identifies specific actions that are authorized on resources in the token "aud" (audience)
- OAuth obtains consent from the resource owner prior to token issuance
- OAuth clients **should** request only those "scope" values that are required
Capabilities-based authorization for distributed scientific computing
Using the OAuth and JWT standards for distributed authorization
Implementing the Principle of Least Privilege
Visit https://scitokens.org/ for specifications, publications
Visit https://github.com/scitokens for open source implementations
Implementing Standards

- RFC 6749: OAuth 2.0 Authorization Framework
  - token request, consent, refresh
- RFC 7519: JSON Web Token (JWT)
  - self-describing tokens, distributed validation
- RFC 8414: OAuth 2.0 Authorization Server Metadata
  - token signing keys, policies, endpoint URLs
- RFC 8693: OAuth 2.0 Token Exchange
  - token delegation, drop privileges (reduce "scope")
- draft-ietf-oauth-access-token-jwt: JWT Profile for OAuth 2.0 Access Tokens
  - authorization claims using JWT "scope" and "aud"
Implementing WLCG Common JWT Profiles

- Defines profiles for Group Based Authorization (wlcg.groups) and Capability Based Authorization (scope)
- Use cases:
  a. Identity Token with Groups
  b. Access Token with Groups
  c. Access Token with Authorization Scopes
- SciTokens supports and helped define use case (c)

https://doi.org/10.5281/zenodo.3460257
https://github.com/WLCG-AuthZ-WG
Related Work: GA4GH Passports

- Global Alliance for Genomics & Health (GA4GH)
- Using JWT access tokens with OIDC / OAuth
- Visa types:
  - AffiliationAndRole (e.g., faculty@illinois.edu)
  - AcceptedTermsAndPolicies (e.g., data use terms)
  - ResearcherStatus (e.g., Registered Access Bona Fide Researcher)
  - ControlledAccessGrants (e.g., access to data set #710)
  - LinkedIdentities (e.g., jbasney@xsede.org linked to jbasney@illinois.edu)
- Used in ELIXIR (https://elixir-europe.org/)

https://doi.org/10.1038/s41431-018-0219-y
https://www.ga4gh.org/ga4gh-passports/
Collaboration and Interoperability

● Oct 18 2021 Workshop on Token-Based Authentication and Authorization
  ○ https://sciauth.org/workshop/2021/
  ○ Participation by CERN, CILogon, Fermilab, INFN, LIGO, OSG, PRP, Tapis, WLCG
  ○ Cyberinfrastructure transitioning from X.509 user (proxy) certificates to OAuth/JWT

● Ongoing:
  ○ Follow-on workshops
  ○ JWT Profile harmonization
  ○ Hackathons & Interop Testing
Transitioning to Tokens

- With the deprecation of GSI and proxy certificates, we have an opportunity to improve our authorization model
  - We don't want to simply reimplement GSI using JWTs
- Improve security using least privilege capabilities
- Improve usability and interoperability
  - Building on common JWT/OAuth technology
  - Coordinating across projects (LIGO, OSG, WLCG, etc.)
- Maintain the reliability of our infrastructure

- Our new **SciAuth** project is focused on helping with this transition

https://sciauth.org/
Workforce Development - SciAuth Student Fellows

● Now accepting applications!
● Seeking students who:
  ○ are interested in tokens!
  ○ are currently enrolled at an accredited U.S. higher education institution. Both graduate and undergraduate students are eligible.
  ○ will reside in the United States during the 12 week fellowship period (schedule to be determined by fellow and mentor).
● Travel is not required. All fellows program activities are conducted online.
● Fellows each receive a $1,000 stipend ($333.33 per month for 3 months) to support their research.
● For more info: https://sciauth.org/fellows
Thanks!

Contact: jbasney@ncsa.illinois.edu

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

Join the #scitokens channel in the OSG Slack workspace.

SciAuth Project Team:
Brian Bockelman, Derek Weitzel, Jeff Gaynor, Jim Basney

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