Security and Token Auth Debugging

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Goals for today:

• Learn the fundamental ‘jargon’ associated with access control in HTCSS.

• Understand the parts of the authorization handshake between client and server.

• Get a few debugging tips specific to token authentication.

• Learn the how security credentials are mapped into HTCondor identifiers and then authorized.
The Basic Vocabulary

• **Authentication**: Establishing an ‘identifier’ for a remote entity.

• **Identity Mapping**: Mapping between identifiers, such as from a Kerberos credential to a HTCondor identifier.

• **Authorization**: Determining whether an entity is permitted to perform a certain operation.

• **Encryption**: Maintaining confidentiality during a session.

• **Integrity**: Detecting modifications to a session done during transit.
Lifetime of a (Typical) Handshake

TCP Connection

Parameter Negotiation

Authentication Method #1

... Authentication Method #N

Identifier Mapping

Authorization!
Parameter Negotiation

TCP Connection

Parameter Negotiation

Authentication Method #1

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Identifier Mapping

Authorization!
Parameter Negotiation

- Parameter negotiation consists of a ClassAd sent from client to server followed by one from server to client.

- Each side states their policy on topics like:
  - Is authentication required?
  - What authentication methods should be used?
  - Should encryption / integrity checking be used?
Parameter Negotiation

- It is possible for the client and server to have incompatible policy (example: no common methods).
- In this case, the server will abruptly close the socket. The client will report the dreaded SECMAN:2007:Failed to end classad message.
Authentication

TCP Connection

Parameter Negotiation

Authentication Method #1

... Authentication Method #N

Identifier Mapping

Authorization!
Authentication Methods

- **IDTOKENS**: Client authenticates with a JSON Web Token (JWT) signed by the server.
- **SCITOKENS**: Client authenticates with a SciToken (https://scitokens.org/) JWT, signed by a trust third party.
- **SSL**: Client and server uses the venerable TLS protocol, same as HTTPS.
- **KERBEROS**: Client and server use Kerberos authentication.
- And other, less-commonly-used options:
  - NTSSPI, PASSWORD, CLAIMTOBE, ANONYMOUS, FS_REMOTE
Authentication: IDTOKENS
Authentication Protocol

• The IDTOKEN is used to establish a shared secret. The public portion is sent to the server; if the server has the right key, then it can regenerate the signature.

• Now, both sides have a shared secret (the token signature) and can use a key exchange protocol (AKEP2) to demonstrate possession to the other side.

• The client is identified by the subject in the token.

Decoded

```
eyJhbGciOiJIUzI1NiIsImtpZCI6I1BPT0wiQ.
eyJleHAiOiE2ODg5NTk5MDksIm1hdCI6MTY4ODk1OTg8OSwiaXNzIjoiaGNjLWJyaWFudGVz

Decoded

```

```

HEADER: ALGORITHM & TOKEN

{
  "alg": "HS256",
  "kid": "POOL"
}

PAYLOAD: DATA

{
  "exp": 1688959989,
  "iat": 1688959849,
  "iss": "hcc-briantest7.unl.edu",
  "jti": "d9d59db1fd3d89dd755227498aee61c",
  "scope": "condor:READ",
  "sub": "bbockelm@hcc-briantest7.unl.edu"
}
```
IDTOKENS - Authorizations

• As the IDTOKEN is generated by HTCondor, the ‘subject’ in the token is considered an HTCondor identifier
  -> No mapping step!

• Tokens can contain restrictions on allowed authorizations.
  • Can only act as a restriction on what the token can otherwise do – does not grant access beyond what’s configured.
Key Concept – Trust Domains

• If the IDTOKEN subject is “native” to HTCondor, which instance?
  • After all, my identifier (“bbockelm”) for CHTC is different than for the OSPool (“brian.bockelman.1”)

• We have added the concept of “Trust Domain” – the set of all services that are run by the same administrators.
  • We assume a named signing key in a trust domain always has the same value.

• Each server belongs to a given trust domain. It’ll ignore tokens from a different trust domain.

Trip Hazard: In 10.0.0, the default value of TRUST_DOMAIN changed! Check your tokens are still valid if you started using tokens in 9.x.
Finding the IDTOKEN

- There’s a defined directory that holds tokens for a client (typically, `~/.condor/tokens.d`). The client iterates through each token in the directory, using the first one that “matches”:
  - “Matches” means the token is in the same trust domain as the server and signed with a key the server knows.
Authentication: SciTokens
Authentication Protocol

- A TLS connection is established between client and server.
- The client verifies the server’s host certificate.
- The client sends the SciToken across the secure channel.
- The server verifies the token was signed using the issuer’s public key.

Note:
- The client authenticates the server via TLS.
- The server authenticates the client using the token.
Finding the SciToken

• The client will send the token it finds in its environment using the Bearer Token Discovery protocol.

• Short version:
  • Look at the contents of the $BEARER_TOKEN environment variable.
  • Look at the contents of the file referred to by $BEARER_TOKEN_FILE.
  • Look at the contents of $XDG_RUNTIME/bt_u$UID
  • Look at the contents of /tmp/bt_u$UID

• The first token discovered is used; no matching is performed as in IDTOKENS.
Compare and Contrast: Token Auth’n

**IDTOKENS-Specific**
- Signed by the server (or whoever holds the symmetric key).
- Only verified by the same symmetric key.
- Discovery in a well-known user directory.
- Not sent to server; used to establish a shared secret.

**Common**
- Token format is JWT; can be introspected with any common JWT tools.
- Token contains common JWT attributes: expiration, validity time, subject/identifier.

**SCITOKENS-Specific**
- Signed by third-party JWT issuer.
- Verified by anyone who can download the public key.
- Discovered via WLCG Bearer token discovery protocol.
- Sent to server over TLS (Server needs host certificate)
Authentication: SSL
Authentication Protocol

• Well … you know … TLS!
  • It is framed using HTCSS’s CEDAR protocol, not raw TCP sockets. Cannot debug this with “openssl s_client”.
  • About every 2 years we review the TLS crypto parameters to ensure they are modern (e.g., no MD5!).

• Client certificate / RFC 3820 proxy certificate is optional; the server can be configured to require one, however.

• Client certificate is discovered only using the value of AUTH_SSL_CLIENT_CERTFILE AUTH_SSL_CLIENT_KEYFILE; does not follow Globus conventions
Authentication Failures

- When authentication fails, the client tool prints out every method it tried.
- It **does not** print out the failure reason for any of the protocols.
  - Sometimes this is because the server provides no error message about the rejection.
- Enabling security debug logging (D_SECURITY:2) is necessary to debug authentication failures.
Authentication Failures

Compare output with debug disabled (left) versus enabled (right)

PATH Partnership to Advance Throughput Computing
Identity Mapping & Authorization
HTCSS has an ‘Identifier Mapfile’

• For identity-based schemes, the mapfile is an important tool to translate between authentication credentials and a HTCondor identifier.
• This mapfile has 3 columns: authentication method, authentication identifier, target HTCondor identifier.
  • By default, authentication identifier is a regexp.
• Sadly, this is known as the “CERTIFICATE_MAPFILE”.
Identifier Mapfile Example

SCITOKENS "https://demo.scitokens.org" bbockelm@test.wisc.edu
SCITOKENS "https://wlcg.cloud.cnaf.infn.it/\,27234843-fedf-42c8-bb81-a1695bbd7c28" bbockelm@test.wisc.edu
SCITOKENS /^https:\/\/\/osg\-htc\."org\/osdf,OSDF-(.*)@osg-htc.org$/ $1@osg-htc.org
SSL "/DC=ch/DC=cern/OU=Organic Units/OU=Users/CN=bbockelm/CN=659869/CN=Brian Paul Bockelman" bbockelm@test.wisc.unl.edu
INCLUDE /etc/condor/mapfile.d
Anonymous Identifiers

• If no HTCondor identifier can be established, protocols will default to an anonymous one.

• Unfortunately, we spell ‘anonymous’ as…
  • ‘unauthenticated@unmapped’ if no authentication is used.
  • ‘unauthenticated@unmapped’ if SSL is used but no client certificate is presented.
  • ‘ssl@unmapped’ if SSL is used, a client certificate is presented, but no mapping is available.
  • CONDOR_ANONYMOUS_USER@CONDOR_ANONYMOUS_USER if the ANONYMOUS method is used.
  • scitokens@unmapped if SCITOKENS is successful but no mapping is available.
Authorization

TCP Connection

Parameter Negotiation

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... Authentication Method #N

Identifier Mapping

Authorization!
Authorizations

• Once a HTCondor identifier is established, we finally determine whether the action is allowable.

• These are controlled by the ALLOW_* / DENY_* configurations.

• The ALLOW/DENY configurations are a list of identifiers of the form “$identifier/$host_restriction”. Examples:
  • *@wisc.edu/124.104.3.*
  • bbockelm@unl.edu
  • */*.wisc.edu

• DENY entries take precedence. If no matches for ALLOW, then the authorization is denied.
Authorization Failures

Finally! We have an error message.
If in doubt – condor_ping it!

```
[bbockelm@hcc-briantest7 ~]$ condor_ping -table ALL -type SCHEDD

<table>
<thead>
<tr>
<th>Instruction Authentication</th>
<th>Encryption</th>
<th>Integrity</th>
<th>Decision</th>
<th>Identity</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALLOW</td>
<td>FS</td>
<td>AES</td>
<td>AES</td>
<td>ALLOW <a href="mailto:bbockelm@hcc-briantest7.unl.edu">bbockelm@hcc-briantest7.unl.edu</a></td>
</tr>
<tr>
<td>READ</td>
<td>FAIL</td>
<td>FAIL</td>
<td>FAIL</td>
<td>FAIL FAIL (use -verbose for more info)</td>
</tr>
<tr>
<td>WRITE</td>
<td>FAIL</td>
<td>AES</td>
<td>AES</td>
<td>ALLOW <a href="mailto:bbockelm@hcc-briantest7.unl.edu">bbockelm@hcc-briantest7.unl.edu</a></td>
</tr>
<tr>
<td>NEGOTIATOR</td>
<td>FAIL</td>
<td>FAIL</td>
<td>FAIL</td>
<td>FAIL FAIL (use -verbose for more info)</td>
</tr>
<tr>
<td>ADMINISTRATOR</td>
<td>FAIL</td>
<td>FAIL</td>
<td>FAIL</td>
<td>FAIL FAIL (use -verbose for more info)</td>
</tr>
<tr>
<td>OWNER</td>
<td>FAIL</td>
<td>FAIL</td>
<td>FAIL</td>
<td>FAIL FAIL (use -verbose for more info)</td>
</tr>
<tr>
<td>CONFIG</td>
<td>FAIL</td>
<td>AES</td>
<td>AES</td>
<td>ALLOW <a href="mailto:bbockelm@hcc-briantest7.unl.edu">bbockelm@hcc-briantest7.unl.edu</a></td>
</tr>
<tr>
<td>DAEMON</td>
<td>FAIL</td>
<td>AES</td>
<td>AES</td>
<td>ALLOW <a href="mailto:bbockelm@hcc-briantest7.unl.edu">bbockelm@hcc-briantest7.unl.edu</a></td>
</tr>
<tr>
<td>ADVERTISE_MONITOR</td>
<td>FS</td>
<td>AES</td>
<td>AES</td>
<td>ALLOW <a href="mailto:bbockelm@hcc-briantest7.unl.edu">bbockelm@hcc-briantest7.unl.edu</a></td>
</tr>
<tr>
<td>ADVERTISE_SCHED</td>
<td>FAIL</td>
<td>FAIL</td>
<td>FAIL</td>
<td>FAIL FAIL (use -verbose for more info)</td>
</tr>
<tr>
<td>ADVERTISE_MASTER</td>
<td>FS</td>
<td>AES</td>
<td>AES</td>
<td>ALLOW <a href="mailto:bbockelm@hcc-briantest7.unl.edu">bbockelm@hcc-briantest7.unl.edu</a></td>
</tr>
</tbody>
</table>
```

[bbockelm@hcc-briantest7 ~]$
Final Thoughts / TODO list

• This was a fun overview to write!
• Please view this as a framework for understanding security handshake failures; impossible to enumerate all the possible reasons.
• Some observations from my side:
  • Incompatibility of settings is indecipherable from a network error.
  • The failure messages never say what part of the security handshake failed.
  • Authentication failure reasons are not in the failure messages, only the failure logs.
• Some great TODOs for the dev team!
Acknowledgements

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