Token Taxonomy

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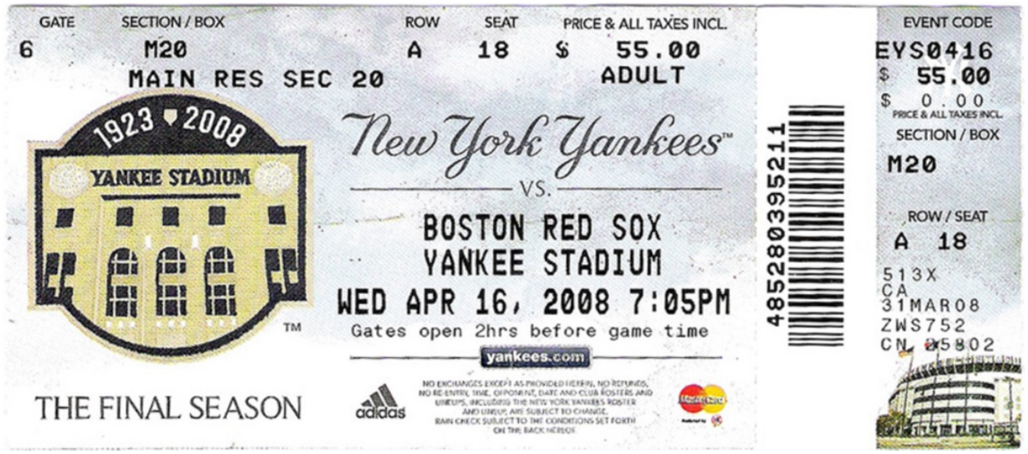
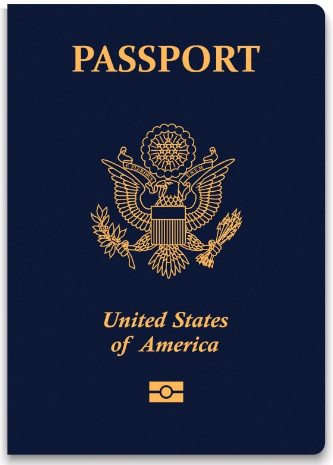
European HTCondor Workshop 2023

Tokens: A Primer

Authorization and Credentials

- A credential is a document detailing an issued identity or an authorization.
    - Think: passport, driver's license, diploma.
- In computing, we typically use credentials as part of the **authorization** to utilize a resource.
- Two common approaches to auth'z:
    - Authentication and identity mapping: credential establishes *who you are* and then mapped to a local identity with enumerated authorizations.
    - Capabilities: credential is an assertion of *what you can do*.





Capabilities are the right way to go on distributed systems!

Bearer Tokens and JWT

- Capability-based credentials are often implemented as *bearer tokens*.
  - To establish authorization, one must establish "proof of possession" to the remote side.
  - For X.509 credentials, this is done by signing a statement with the private key bound to the credential.
  - For tokens, we prove possession by sending the token itself to the remote side.
    - *What are the tradeoffs here?*
- Whoever bears the token is assumed to have the authorization – hence the name!

eyJraWQiOiJyc2ExIiwiYWxnIjoiUlMyNTYifQ.eyJ3bGNnLnZlciI6IjEuMCIsInN1YiI6IjI3MjM0ODQzLWZlZGY
tNDJjOC1iYjgxLWExNjk1YmJkN2MyOCIsImF1ZCI6Imh0dHBzOlwvXC93bGNnLmNlcm4uY2hcL2p3dFwvdjFcL2Fue
SIsIm5iZiI6MTYxODc3Njg4NCwic2NvcGUiOiJvcGVuaWQgb2ZmbGluZV9hY2Nlc3Mgc3RvcmFnZS5yZWFkOlwvIHN
0b3JhZ2UubW9kaWZ5OlwvIHdsY2ciLCJpc3MiOiJodHRwczpcL1wvd2xjZy5jbG91ZC5jbmFmLmluZm4uaXRcLyIsI
mV4cCI6MTYxODc4MDQ4NCwiaWF0IjoxNjE4Nzc2ODg0LCJqdGkiOiJjM2MwYWFkYi0wMDIzLTQwMzEtYmVhZS0wYTJ
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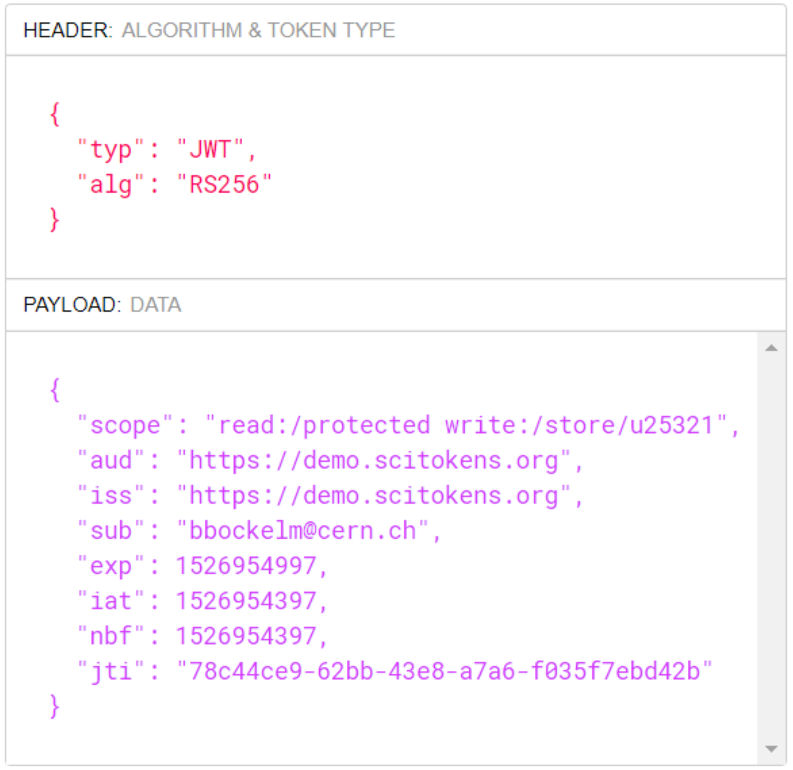


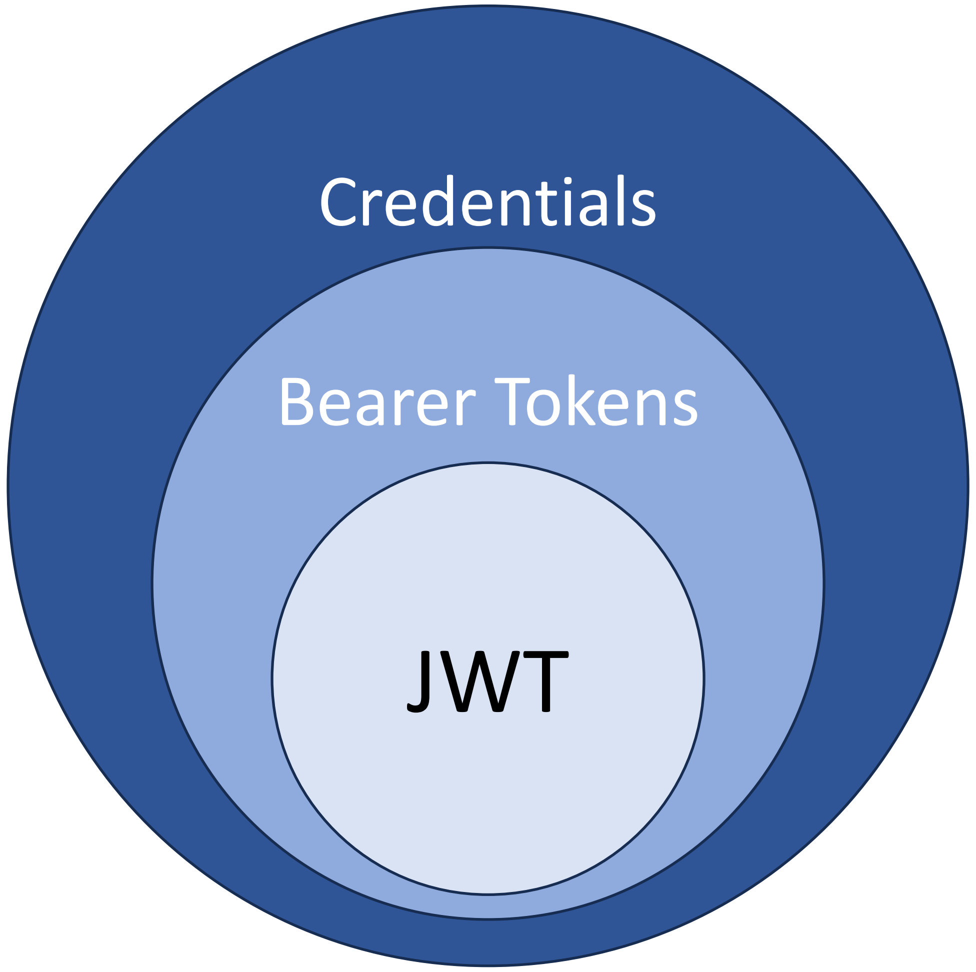
HEADER: ALGORITHM & TOKEN TYPE

```
{
  "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"
}
```

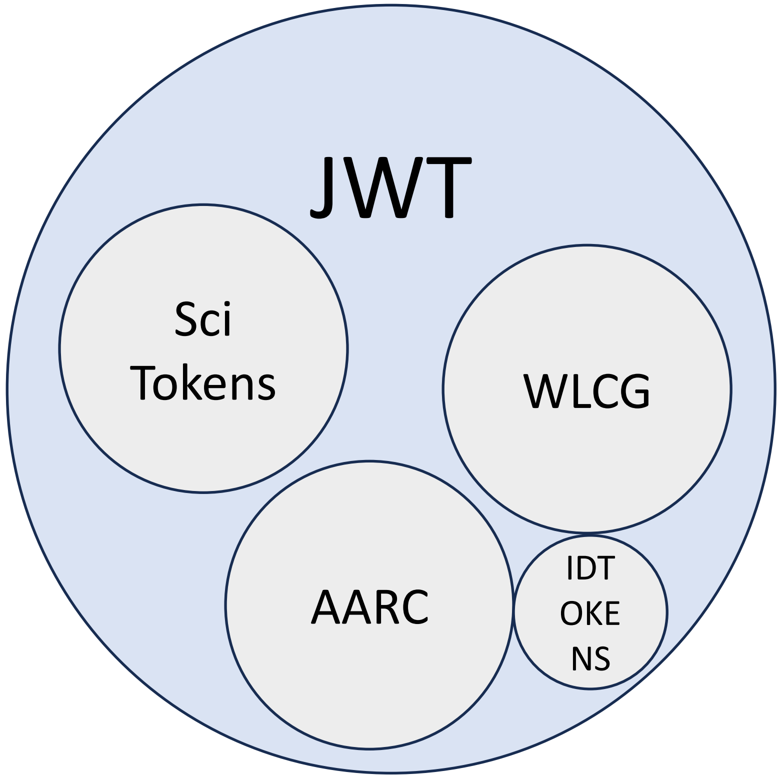
Bearer Tokens and JWT



- An opaque bearer token is a random sequence of bytes.
    - Quite secure but typically difficult to coordinate in a distributed system with many independent actors.
- A JSON Web Token (JWT) is a bearer token using a specific JSON-based format:
    - Often signed by a public key.
    - Allows arbitrary key-value pairs to be asserted.
    - Sequence of RFCs defining the semantics of certain keys (subject, expiration time, issuer, unique identifier).

Building Authorization Schemes with JWTs

- Think of a JWT as a format and a toolbox for building an authorization system.
- To build an authorization system, there needs to be common agreement on how to interpret the contents of the JWT and common semantics.
- We must therefore build a **<u>profile</u>** describing how the system work.
  - Analogy: X.509 vs GSI
  - Analogy: Grammar vs Language



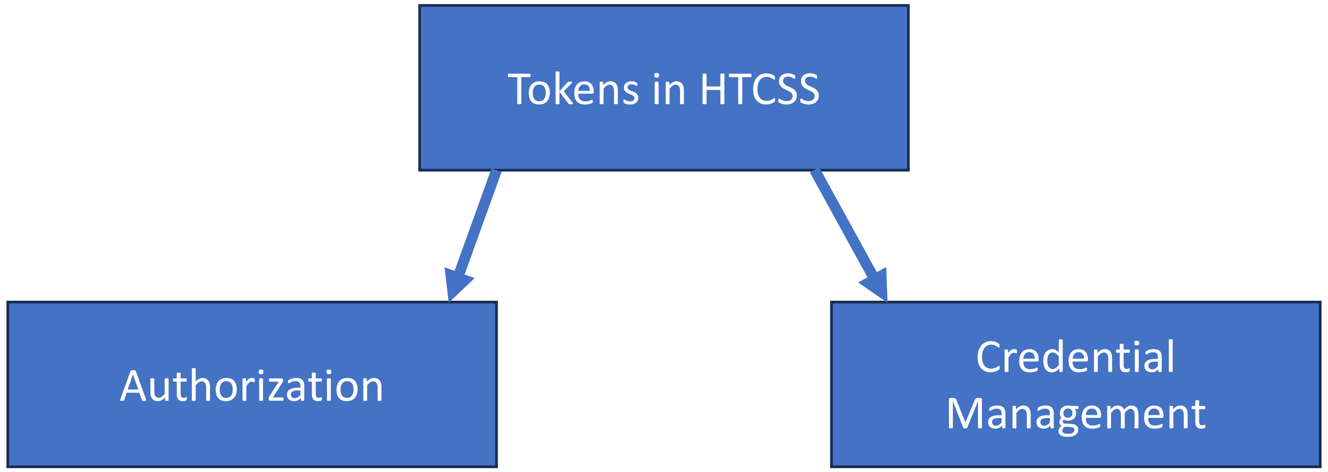
Note: An authorization profile is both a superset and subset of JWTs. It restricts what's considered a valid token plus adds rules for interpretation.

HTCSS and Tokens

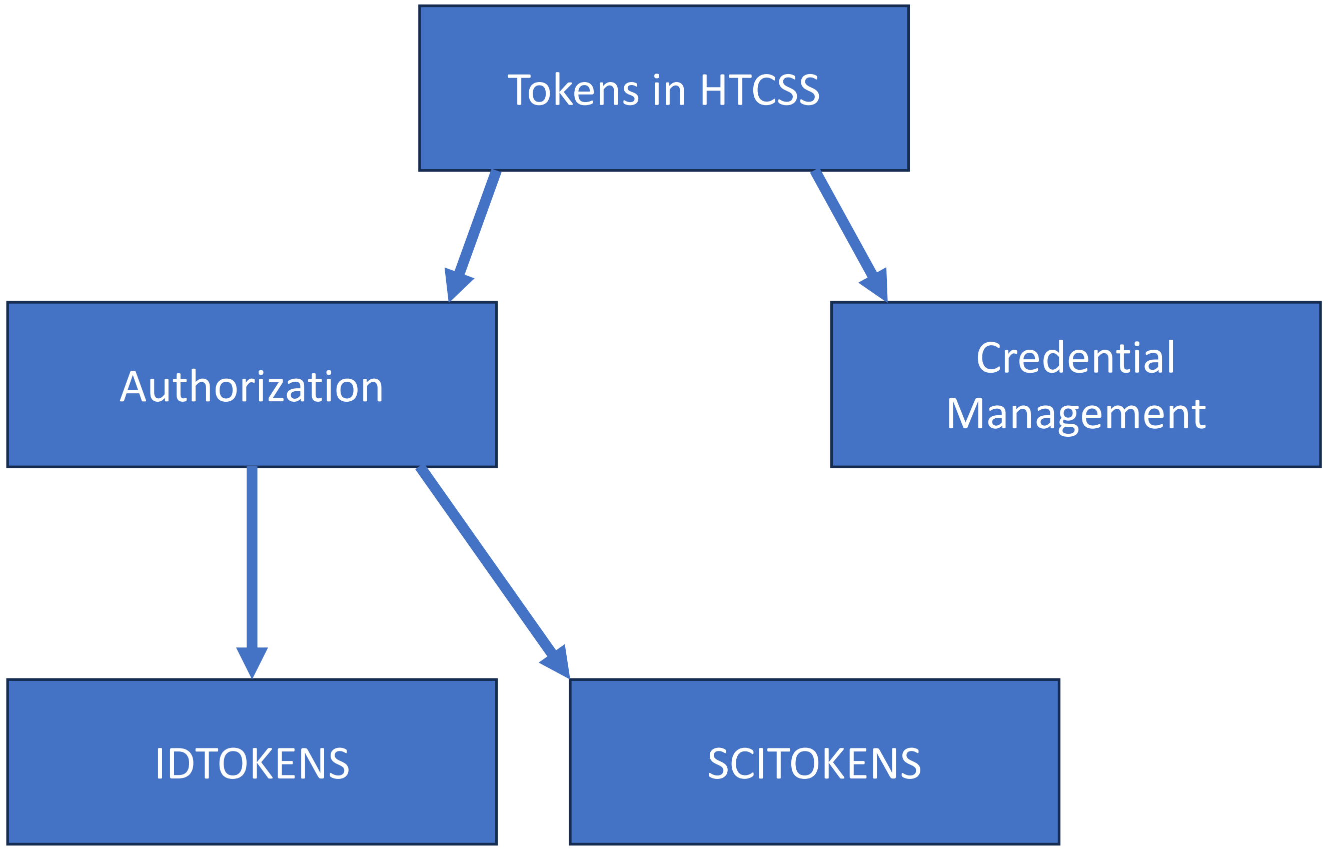
Authorization vs Management

HTCSS uses tokens in two contexts:

- **Authorization**: Providing access to a HTCSS component / daemon.
- **Credential Management**: Managing credentials on behalf of a user, typically meant for using credentials within jobs.



Tokens and Authorization



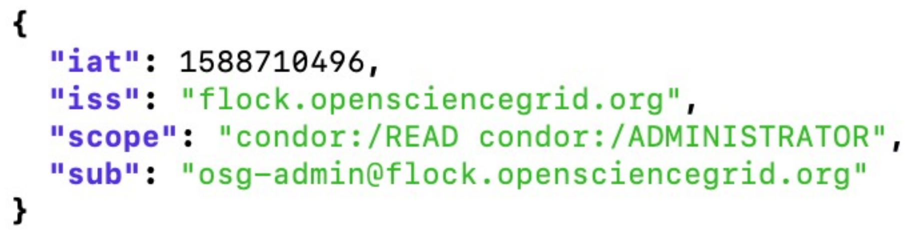
HTCSS supports two different profiles for token-based authorization:

- **IDTOKENS**: HTCSS's "native" token format for establishing identity.
- **SCITOKENS**: Authorization based on signed JWTs from an independent issuer.

Parts of an IDTOKEN

An IDTOKEN is a token signed with a symmetric key held by the remote daemon. It has the following parts:

- **Identifier**: This is the "HTCondor identity"
- **Issuer**: The trust domain – where the token is expected to be honored.
- **Signing key name**: The name of the key used to sign the token. The server must have this key to accept the token!
- **Restrictions on use**:
  - "Not before" and "expiration" times.
  - A list of authorizations for the token (**intersected** with the authorizations the HTCondor identity already has!).



```
{
  "iat": 1588710496,
  "iss": "flock.opensciencegrid.org",
  "scope": "condor:/READ condor:/ADMINISTRATOR",
  "sub": "osg-admin@flock.opensciencegrid.org"
}
```

Discussion Topics:

- Why symmetric signatures?
- What's important about the "trust domain"?

IDTOKEN Authentication

- The IDTOKEN authentication protocol is based on a shared secret verification protocol (AKEP2).

1. Client sends the *public* part of the token to the server and a client nonce.
2. Server uses its symmetric key to compute the token signature.
   - Now both sides can derive a shared secret based on the token signature!
3. Server responds with a server nonce and the hash of the token + client nonce + shared secret.
4. Client verifies the server response and sends its hash of the token + server nonce + shared secret.

To succeed: Client needs the signed token, server needs the signing key.

Note: at no point are secrets sent over the network! Public contents of the token are sent in the clear.

SCITOKENS

- Like IDTOKENS, SCITOKENS builds on JWT.
  - Uses libSciTokens from the scitokens-cpp project. Any token conforming to a supported profile can be used (misnomer: *not* limited to SciTokens. WLCG tokens are great!).
- Signatures are *public key* based. Daemon does *not* need the private key to verify the token's validity.
  - Good when the daemon is independent from the signing entity.
  - Daemon looks up the signing key based on the issuer URL.
- Otherwise, many similar concepts – subjects, issuers, restrictions.
  - Since it's not a "native" credential, the subject/groups are mapped to a local HTCondor identifier.

SCITOKENS Authentication

- Since the daemon doesn't have the signing key, we *don't* have a shared secret.
- Instead, we bootstrap the secure channel by establishing a TLS connection from client to server.
  - **NOTE**: Implies the server has a host certificate, shares common CAs with client.
- Once established, the client sends the entire token to the server.
  - Server can then verify the token then authorize the client.
  - **Food for thought**: what's the impact of a malicious server?

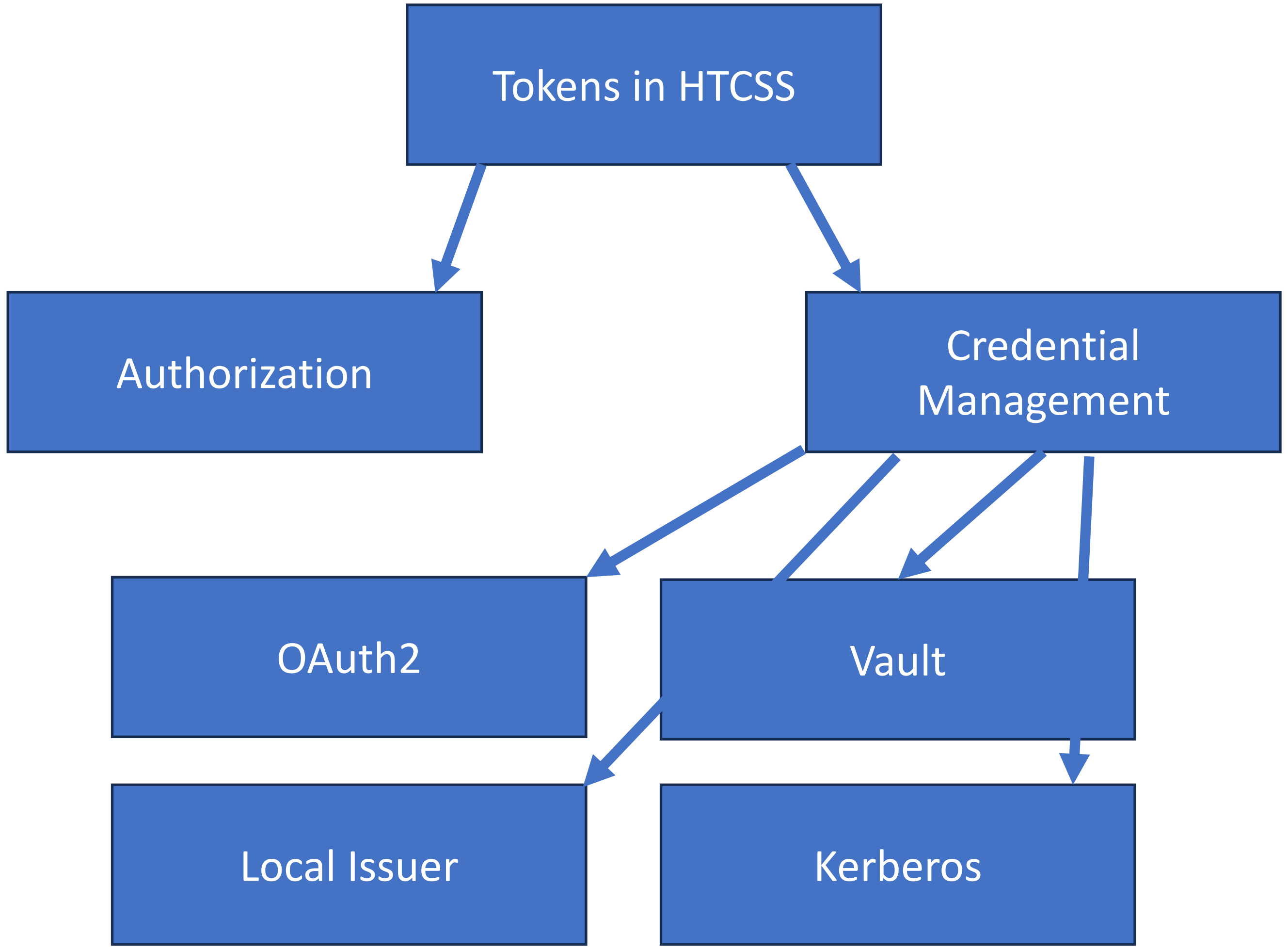
Token Arcana

We try to have a complete ecosystem around tokens. Examples:

- `condor_token_request`: Securely request any arbitrary token.
  - *Approval* of such a request is left to the admin. Great for bootstrapping authentication when you have a way to communicate with the user out-of-band. No copy/pasting tokens in your email!
- `condor_token_fetch`: Returns a fresh IDTOKEN equivalent to the current security session.
- `condor_scitoken_exchange`: Returns a fresh IDTOKEN equivalent to the mapped input SciToken.
  - Note: SCITOKENS auth requires a TLS cert for the remote daemon. IDTOKENS does not!

Credential Management

Credential Management



An HTCSS AP can manage a user's credential wallet.

- Each user has their own wallet.
- The types of available credentials are configured by the administrator.
- A job specifies the credentials it needs!
- HTCondor ensures the token is available & up-to-date on the EP.

Credentials – the User View

Each job specifies a list of credential services required to execute:

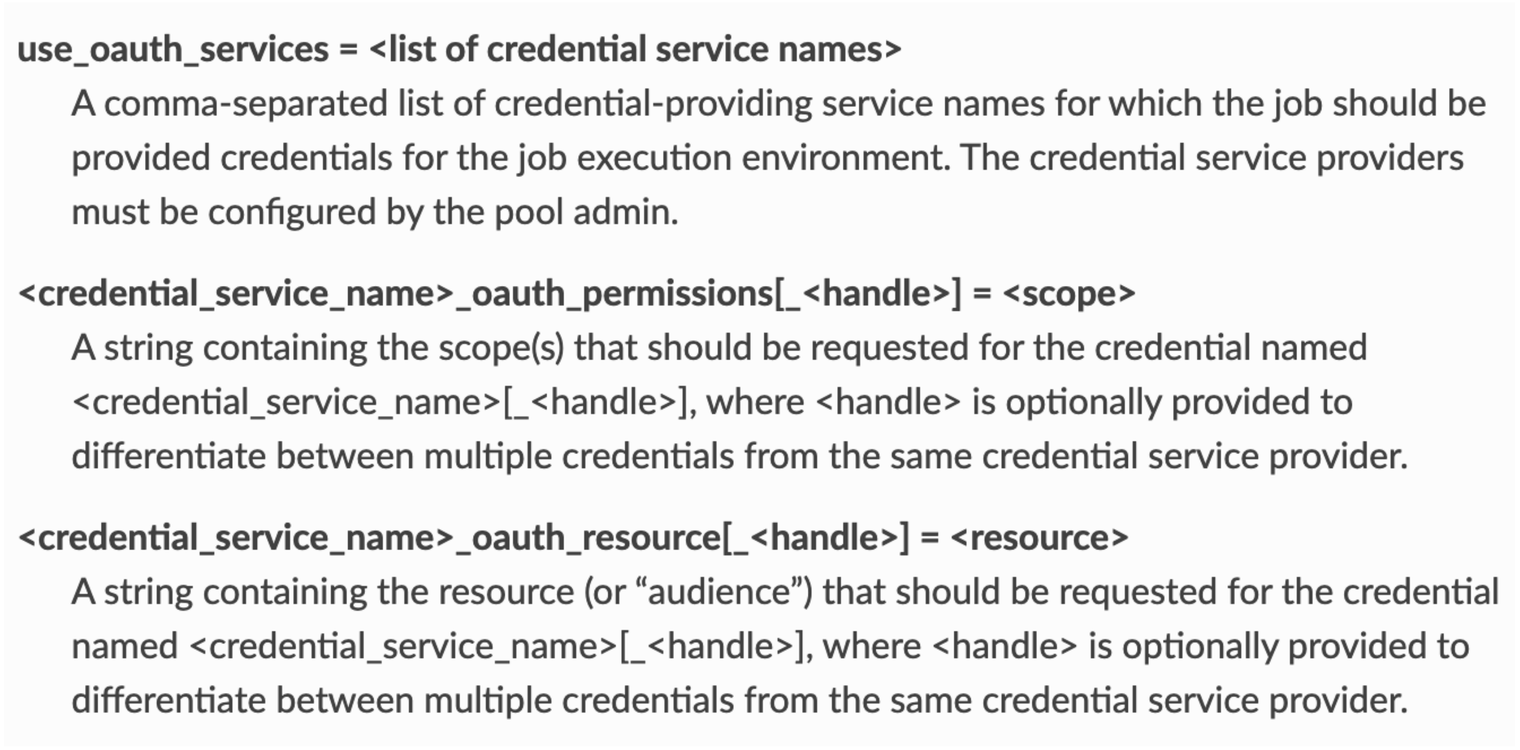
- The credential services list is managed by the AP administrator.
- Some services can generate multiple credentials; these additional credentials are referred to by “handles”.
    - This allows the user to specify more fine-grained authorizations than the default.

condor_submit interprets this list, potentially asking the user for additional information to generate the credential.

- Depending on the credential service implementation, this information may come via the CLI (Kerberos) or a link to complete the generation in a browser (OAuth2).

WARNING: We're bad at naming things

- We call the condor_submit configurations for credential management "oauth" :(
    - In fact, only one of four commonly used plugins use oauth!



use_oauth_services = <list of credential service names>

A comma-separated list of credential-providing service names for which the job should be provided credentials for the job execution environment. The credential service providers must be configured by the pool admin.

<credential_service_name>_oauth_permissions[_<handle>] = <scope>

A string containing the scope(s) that should be requested for the credential named <credential_service_name>[_<handle>], where <handle> is optionally provided to differentiate between multiple credentials from the same credential service provider.

<credential_service_name>_oauth_resource[_<handle>] = <resource>

A string containing the resource (or "audience") that should be requested for the credential named <credential_service_name>[_<handle>], where <handle> is optionally provided to differentiate between multiple credentials from the same credential service provider.

Work-in-progress:

Significant cleanup of terminology and abstractions are desired for HTCSS 23.x! For example:

- You can't ask the AP the list of services.
- You can't enumerate the available handles or their definitions.
- You can't fetch your own credentials
- You can't BYOC: Bring Your Own Credential.
- The "API" to interact is largely condor_submit

Credentials - the Admin View

Credentials in the wallet are <u>opaque</u>. The AP doesn't assume a specific type or format!

- Hence, each credential type must be serviced by a daemon implementing a "credmon" interface.
    - Several daemons are shipped with HTCSS … but you're encouraged to write your own if needed!
    - There are two credmon interfaces – Oauth and Kerberos. Each AP can only have one of each.
- The CredD daemon provides the API for credential management.
    - Must be running for users to utilize the wallet!

We’re bad at naming things, Redux

- Want to store a credential?

  Use condor_store_cred

- Want to delete a credential?

  Use condor_store_cred

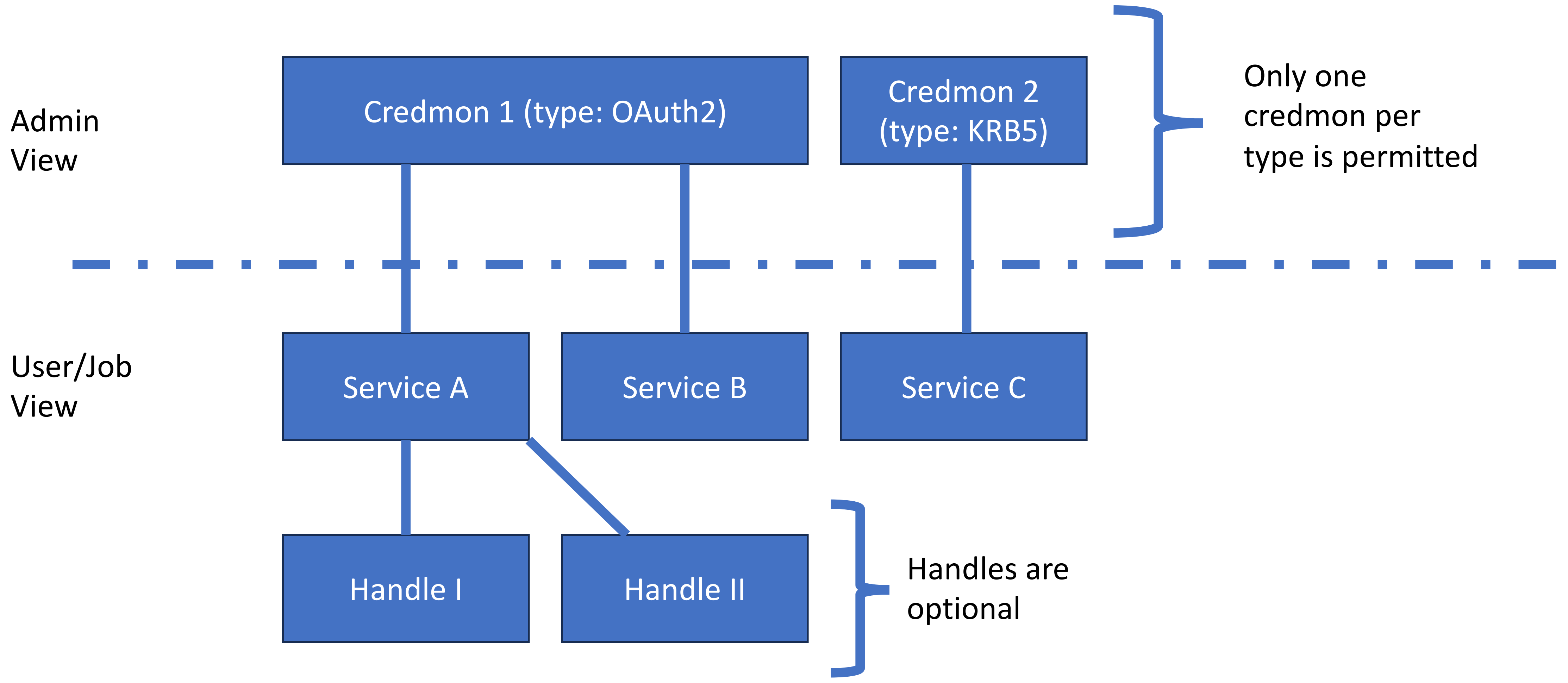
- Want to query a credential?

  Use condor_store_cred

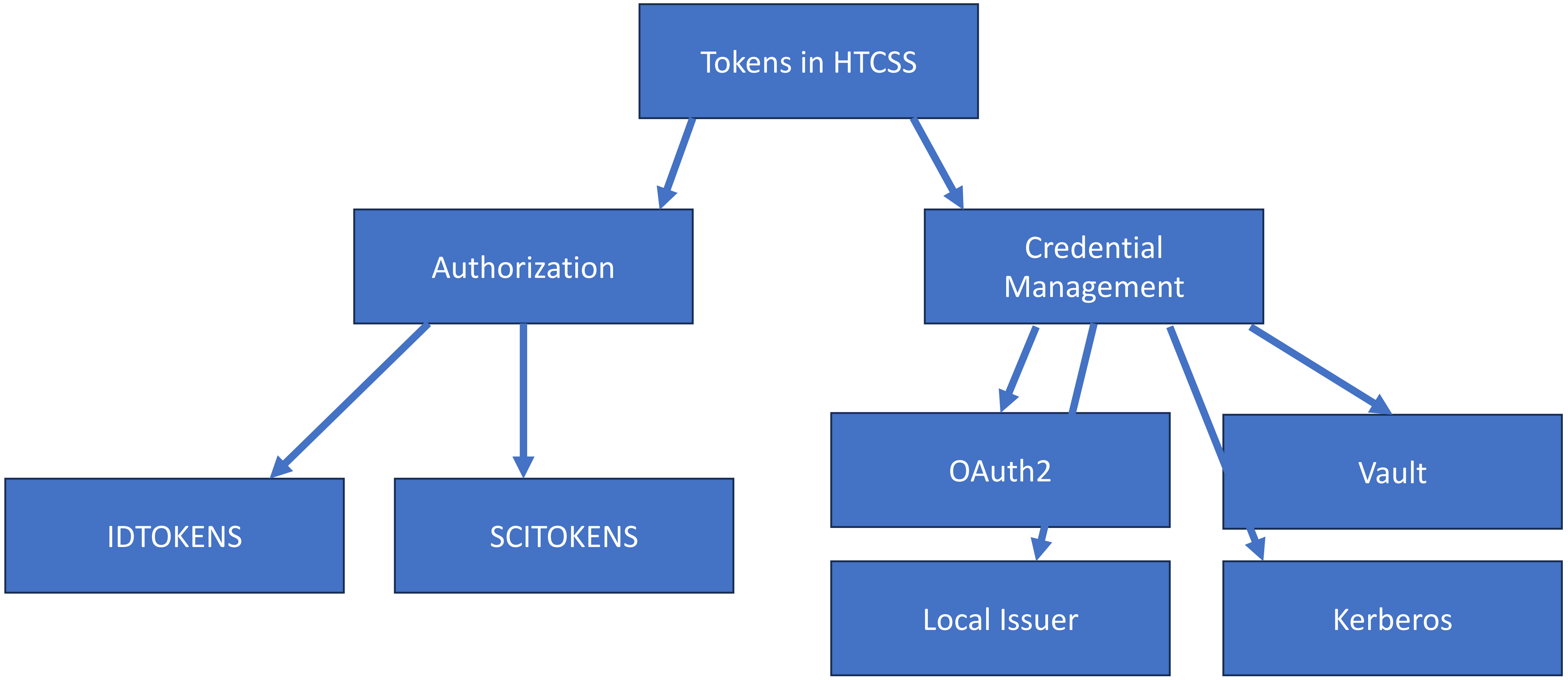
- Want to list your credentials?

  Too bad!

Credential Management Data Model



Our Complete Taxonomy



Questions?

This project is supported by the National Science Foundation under Cooperative Agreements OAC-2030508 and OAC-2114989. Any opinions, findings, conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.