Feeding TOFU to a Condor: Trust and Authorization Changes in HTCSS

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Well, what did you expect?

Slide from HTCondor Week 2020

"Forget what you know about HTCondor security. We changed it"

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We Kept Working in 2021!

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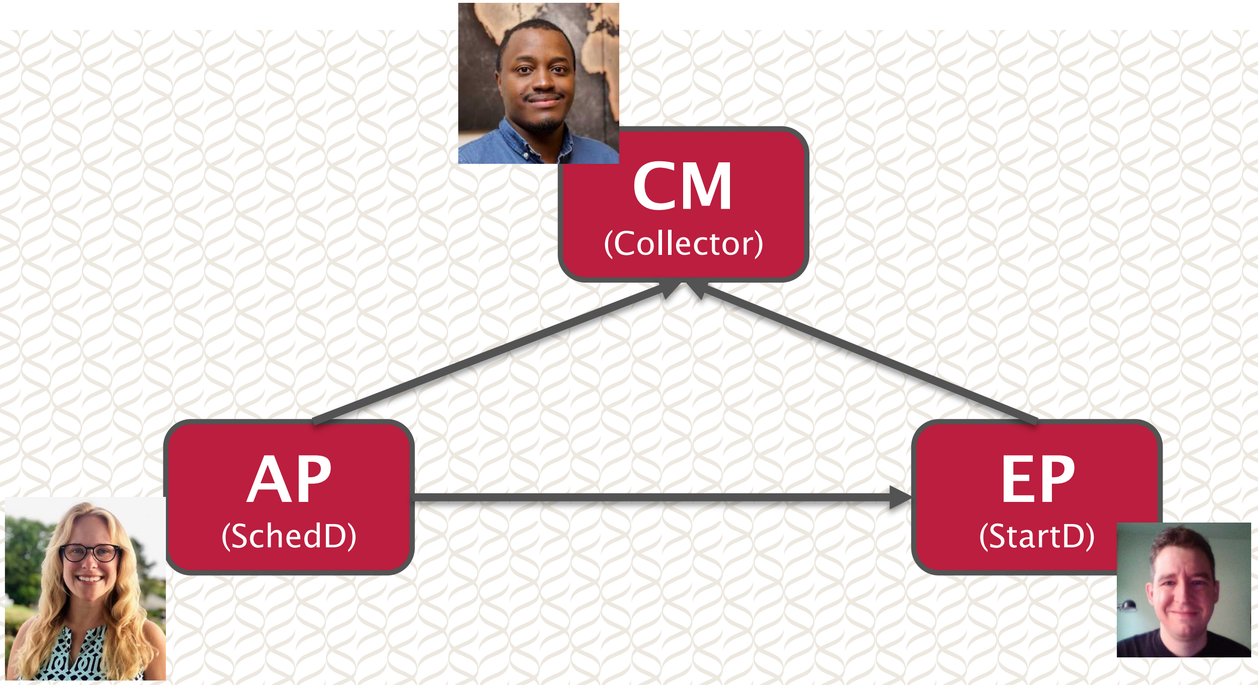
For more introductory material, see last year's HTCondor Week talk on security.

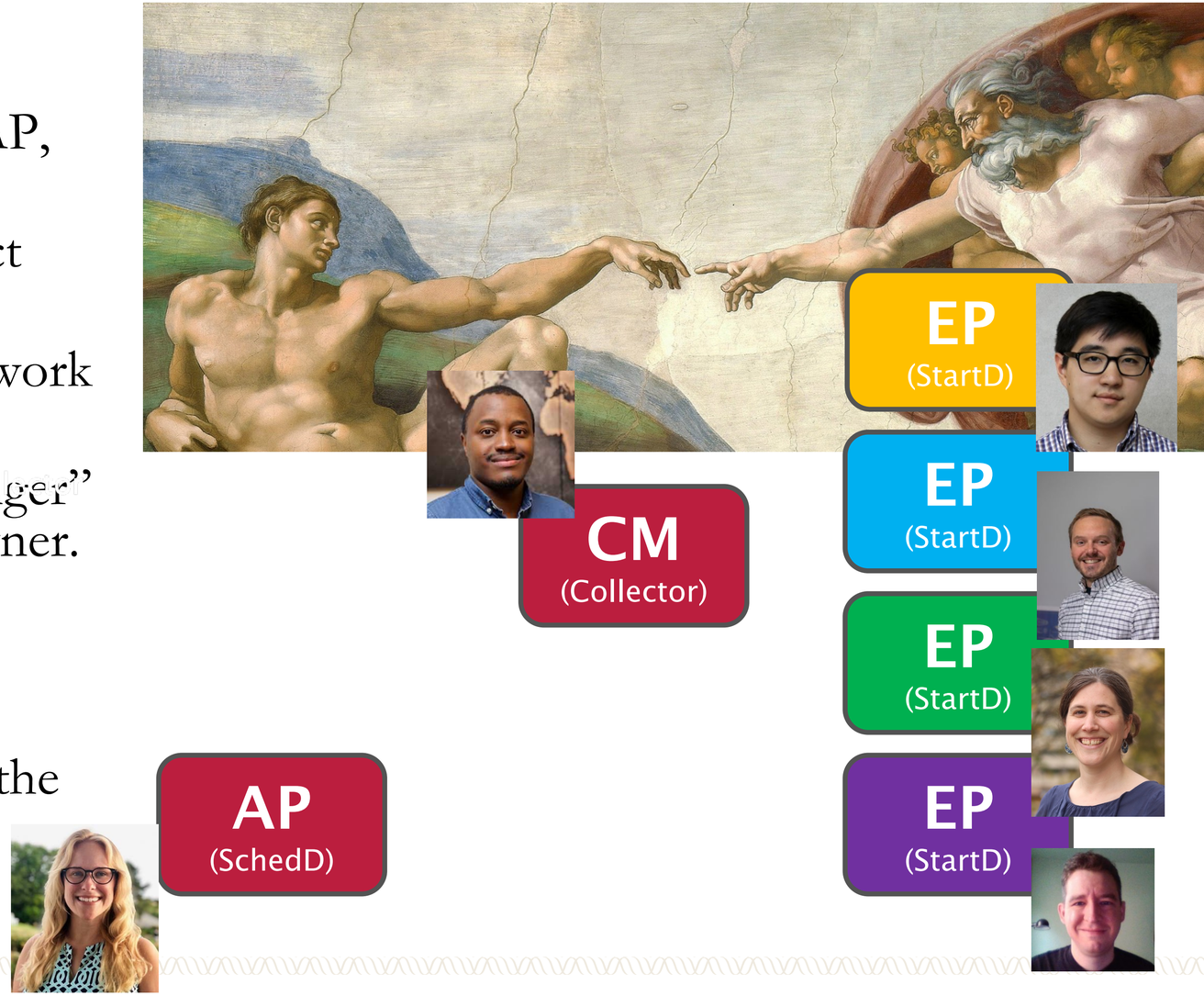
Trust Models for HTCondor



In the beginning …

Trust model has separate identities for the user, AP, EP, and CM.

- Each of these were unique entities with distinct concerns.
  - HTCondor provides a robust policy framework so each entity could
  - Strongly influenced by the "desktop scavenger" model – the EP owner was the desktop owner.
- Also required HTCondor to have a complex authentication and authorization model:
  - Each daemon had its only identity and the admin configures a set of policies on what the identity is permitted to do.

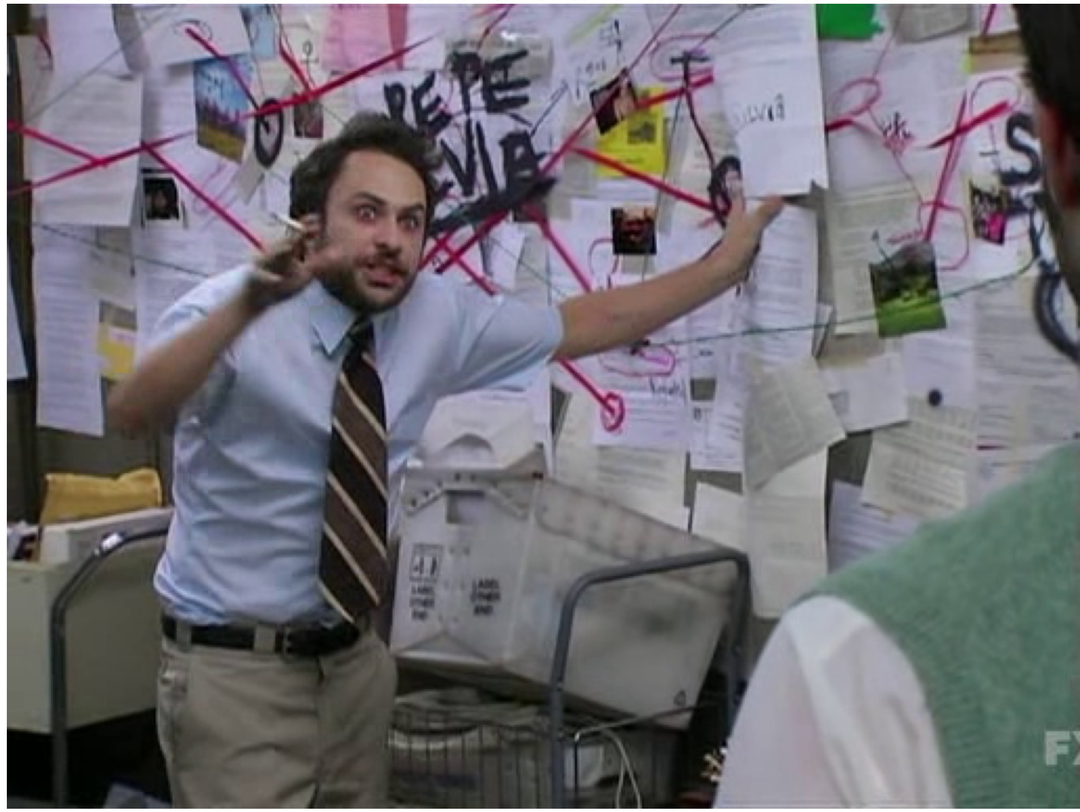


Authentication and Trust in HTCondor

Setting up trust in classic HTCondor in 7 easy steps:

- Decide on a trusted third party. Generate a root certificate representing that third party.
- Distribute the publickey to all your hosts (somehow) and configure AUTH_SSL_SERVER_CAFILE and AUTH_SSL_SERVER_CAFILE.
- Have each of the daemon owners generate a certificate request with their legal (passport) name and send the request to the trusted third party.
  - Have that person verify the identity against the user's passport then sign the request.
- Install the new cert and key onto the server.
- Configure SSL in the daemons by setting AUTH_SSL_SERVER_CERTFILE, AUTH_SSL_CLIENT_CERTFILE, AUTH_SSL_SERVER_KEYFILE, and AUTH_SSL_CLIENT_KEYFILE.
- Map the certificate subjects to a HTCondor identity in the mapfile.
- Setup the access control lists (ALLOW_READ, ALLOW_WRITE, etc) to give permissions to the correct individual.

Easy, right?



Depicted here: the lone sysadmin after spending a week in the HTCondor manual's chapter on security configuration.

A crack in the trust framework (~2009)

A first crack in the trust model occurred with the introduction of the lovably-named knob 'SEC_ENABLE_MATCH_PASSWORD_AUTHENTICATION'.

- When set, the StartD would generate a random string of characters and send it to the collector.
  - Any entity who could present this random string – **a capability** – was permitted to claim the StartD and run jobs.

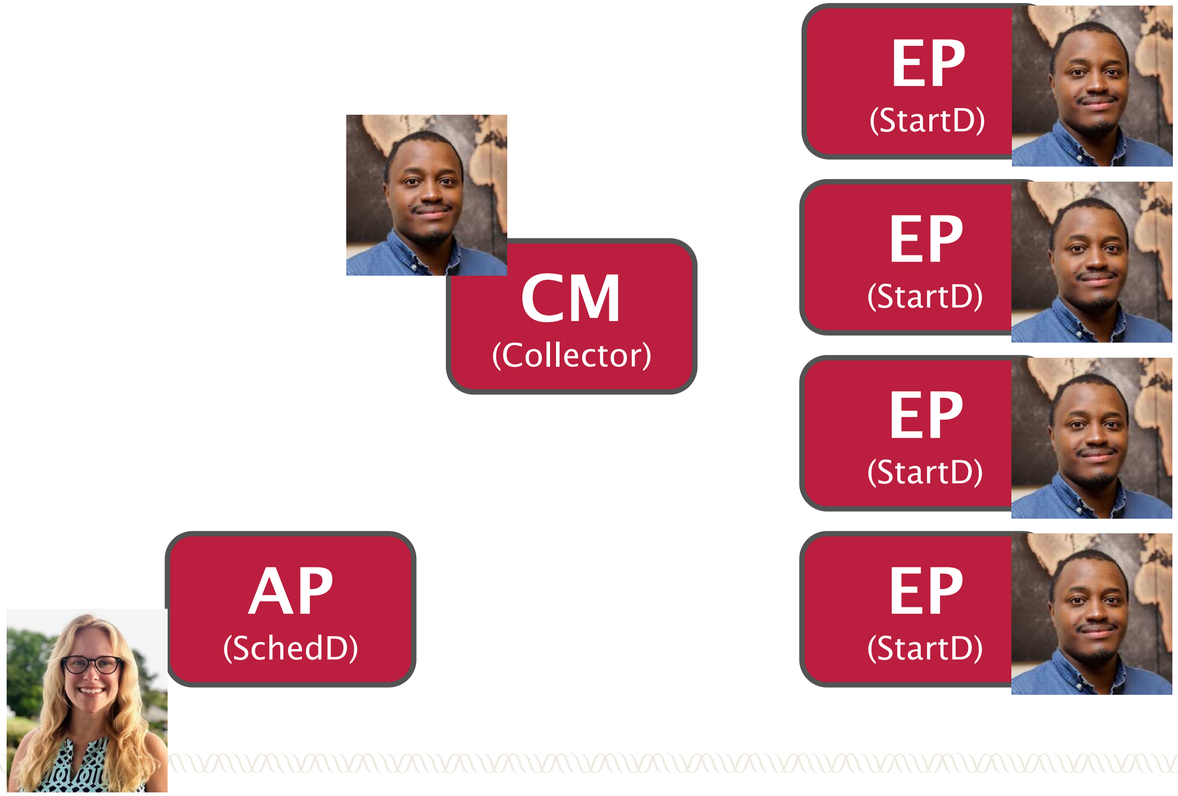
What's the change?

- The StartD does not authenticate the remote entity with jobs. It trusts (and authorizes) anyone who is trusted by the collector.
- Similarly, the SchedD does not authenticate the StartD. There is transitive trust – the SchedD trusts the StartD through the mutual collector.

What makes this work? A change in ownership…

You _can_ still use HTCondor as a desktop scavenger. However, it's far more common to see HTCondor as a batch system.

- One individual owns / operates a pool of resources. These resources are far more homogeneous – especially policy-wise.
- **If you trust the resource pool (CM), then you trust all the resources (EP).**
  - In 2019, we introduced the **TRUST_DOMAIN**: a set of resources under the control of a single administrator.



2019: IDTOKENS – a built-in authentication infrastructure

The IDTOKENS authentication method introduced in 2019 had a few new concepts:

- The trust domain provided a **namespace for identity**.
  - Signing keys are associated with a trust domain and are all-powerful.
  - Simply drop a key in place and you can create tokens.
  - No global namespaces!
- **HTCondor itself could create credentials**.
  - No need to rely on external third-party services (Kerberos, SSL, GSI).
  - **Bootstrapping**: An anonymous user can request an identity and an administrator can approve it out-of-band.
- Authorization can be limited in the credential itself.

condor — bbockelm@hcc-briantest7:~ — ssh hcc-briantest7.unl.edu — 80×8

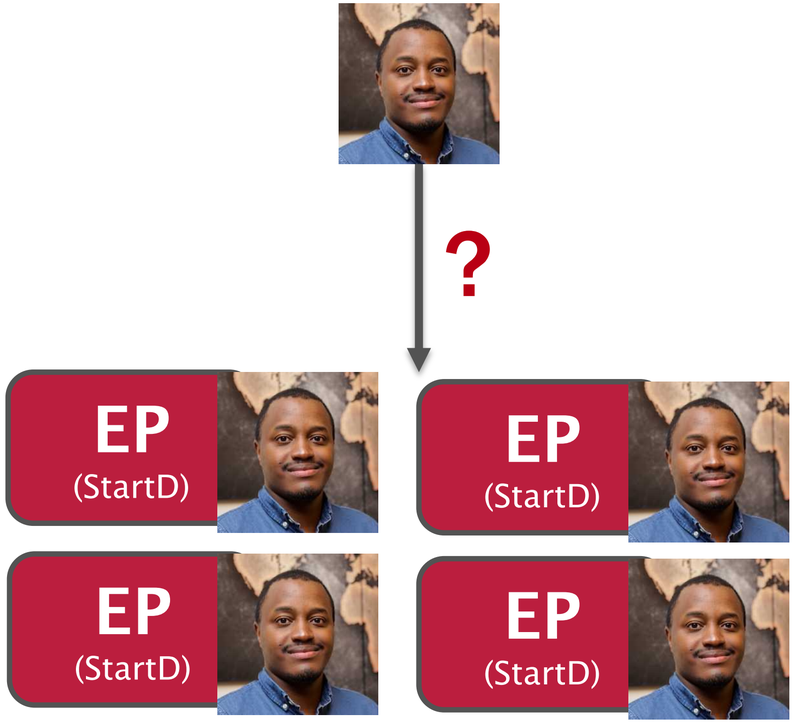
```
[bbockelm@hcc-briantest7 ~]$ condor_token_request -pool cm-1.ospool.osg-htc.org
-identity bbockelm@flock.opensciencegrid.org
Token request enqueued.  Ask an administrator to please approve request 6361875.
```

IDTOKENS - Limitations

IDTOKENS are based on a symmetric signature. **To verify a token is valid, you need the signing key**.

1. What happens when the admin wants to send a command to a remote EP?
   - The EP needs the signing key to verify the admin's IDTOKEN – but now you're distributing the 'keys to the kingdom' to every worker node!
2. The token only validates the client; the server does not have a distinct identity.
3. There is no concept of a secure, anonymous session. To use IDTOKENS, you need an IDTOKEN.
   - Bad for remote reads of a condor daemon.
   - **To bootstrap/request an IDTOKEN, you can't use the IDTOKENS authentication!**

What would happen if the only person who could validate your driver's license was the state DMV and not the grocery store clerk?



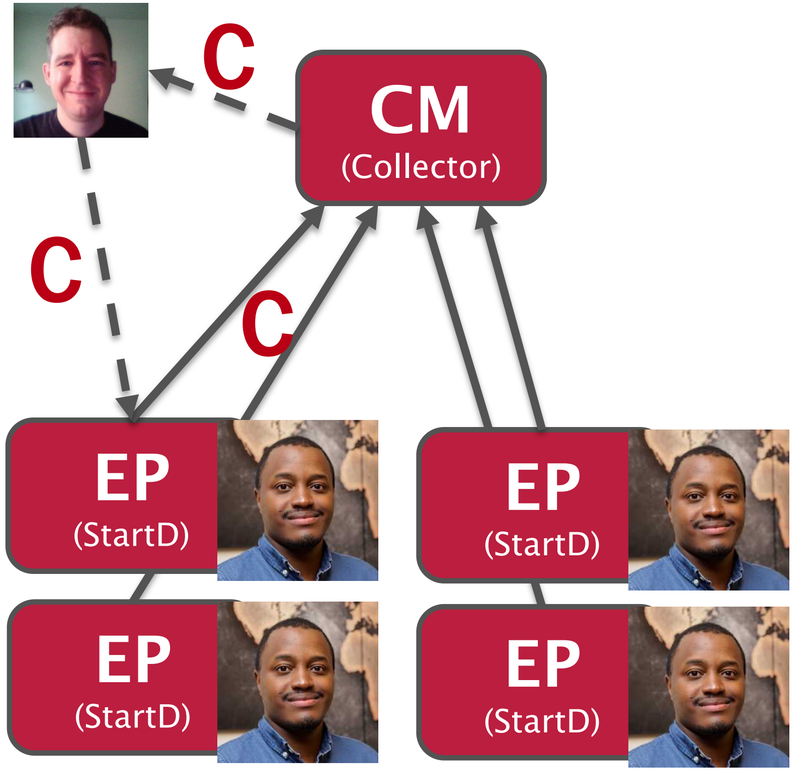
‘Fixing’ IDTOKENS, part I

One ‘fix’ is a change in the trust model. HTCondor 9.9.0 will introduce **remote administration capabilities**.

- The EP will generate a capability and send it to the CM.
- The CM will <u>only</u> send this capability to individuals it considers as being an ‘administrator’.
- The individual sends the capability to the EP to be authorized to perform admin actions (shutdown, fetch logs).

Important trust model changes:

- The EP trusts the CM completely to authorize individuals on its behalf.
- The EP never learns the identity of the administrator. No authentication, no identity mapping.



We did not ‘fix’ IDTOKENS but simply made HTCSS code reflect the most common trust model – the EP ‘belongs’ to the pool and trusts it as an admin.

Fixing IDTOKENS, part II

To 'fix' bootstrapping, we've always pointed people at SSL authentication:

- For SSL, anonymous clients are extremely common – most common way to use HTTPS!
- **Just what we need**: SSL provides an encrypted, integrity-checked channel for anonymous clients to request tokens.

What's the problem? **See Slide 4: SSL is a mess to setup!**

How do we fix things?

Change the trust model!

TOFU mode

TOFU = Trust on First Use

Most uses of SSL rely on global purveyors of trust – certificate authorities – whose business is being a trustworthy source of global identity.

- Expensive, often complex, and strongly oriented toward identifying hosts on the public internet. **Is this the only to establish trust?**

Of course not! We are all quite familiar (and likely comfortable) with SSH's 'trust on first use' model.

- The first time you use a service, you are asked if you'd like to trust it. Trusting the identity is an 'exercise left to the user'. Some users are diligent; some are not.
- This identity is saved locally; subsequent requests are compared against the 'first use' key.

Let's apply TOFU to SSL!

Server side

- On startup, if one is not present, the CM will generate a self-signed CA certificate and key.
  - This is now a CA for the trust domain.
- If a host cert is not present, generate one from the CA.
- That's it! Behaves like a normal SSL authentication.

Client side

- The client will proceed with a SSL handshake.
- On a CA verification failure, the TOFU logic will engage:
  - The user will be asked if they'd like to trust the unknown CA and be shown a fingerprint.
  - If there's no terminal (i.e., the client is a daemon), question is answered based on config file (default: don't trust).
- If yes, the authentication continues, and the key is written into a known_hosts file.

TOFU in Action

bbockelm — bbockelm@hcc-briantest7:~/projects/condor-build — ssh hcc-briantest7.unl.edu — 108×7

```
[bbockelm@hcc-briantest7 condor-build]$ condor_q -all
The remote host hcc-briantest7.unl.edu presented an untrusted CA certificate with the following fingerprint:
SHA-256: 781b:1d:1:ca:b:f7:ab:b6:e4:a3:31:80:ae:28:9d:b0:a9:ee:1b:c1:63:8b:62:29:83:1f:e7:88:29:75:6:
Subject: /O=condor/CN=hcc-briantest7.unl.edu
Would you like to trust this server for current and future communications?
Please type 'yes' or 'no':
```

bbockelm — bbockelm@hcc-briantest7:~/projects/condor-build — ssh hcc-briantest7.unl.edu — 108×8

```
[bbockelm@hcc-briantest7 condor-build]$ cat ~/.condor/known_hosts
hcc-briantest7.unl.edu SSL MIIBvjCCAWSgAwIBAgIJAJRheVnN5ZDyMAoGCCqGSM49BAMCMDIxDzANBgNVBAoMBmNvbmRvcjEfMB0GA
1UEAwwWaGNjLWJyaWFudGVzdDcudW5sLmVkdTAeFw0yMTA1MTcxOTQ3MjRaFw0zMTA1MTUxOTQ3MjNaMDIxDzANBgNVBAoMBmNvbmRvcjEfM
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W+suELxSzSdi9u20hFs/aSXpd+gwJ6Ne8jjG+y/2AIhAO6f3ff9nnYRmesFbvt1lv+LosOMbeiUdVoaKFOGIyuJ
[bbockelm@hcc-briantest7 condor-build]$
```

TOFU in Action – known_hosts file

The past certificates observed for a user are kept in ~/.condor/known_hosts; the format is 'SSH inspired'

- One line per remote host.
- Line records the triplet of "name, method, pubkey".
  - Method is important: if we authenticate via IDTOKENS originally, do not count this daemon as 'first use' for SSL!
  - Similarly, do NOT trust a host that previously authenticated fine with SSL.
- Lines prefixed with "!" are <u>not</u> trusted.
  - Want to change your mind later? Just remove the "!"

Do NOT trust this key!

bbockelm — bbockelm@hcc-briantest7:~/projects/condor-build — ssh hcc-briantest7.unl.edu — 108×8

```
[bbockelm@hcc-briantest7 condor-build]$ cat ~/.condor/known_hosts
!hcc-briantest7.unl.edu SSL MIIBvjCCAWSgAwIBAgIJAJRheVnN5ZDyMAoGCCqGSM49BAMCMDIxDzANBgNVBAoMBmNvbmRvcjEfMB0G
A1UEAwwWaGNjLWJyaWFudGVzdDcudW5sLmVkdTAeFw0yMTA1MTcxOTQ3MjRaFw0zMTA1MTUxOTQ3MjNaMDIxDzANBgNVBAoMBmNvbmRvcjEf
MB0GA1UEAwwWaGNjLWJyaWFudGVzdDcudW5sLmVkdTBZMBMGByqGSM49AgEGCCqGSM49AwEHA0IABPN7qu+qdsfP6WR++UucrZYvMhssre8j
vgWsnPBdzCYU/EqHYp+wri/aAKyDrLM5R1lWX44jSykgIpTOCLJUS/ajYzBhMB0GA1UdDgQWBBRBPe8Ga9Q7X3F198fWBSg6VT1DZDAfBgNV
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fW+suELxSzSdi9u20hFs/aSXpd+gwJ6Ne8jjG+y/2AIhAO6f3ff9nnYRmesFbvt1lv+LosOMbeiUdVoaKFOGIyuJ
[bbockelm@hcc-briantest7 condor-build]$
```

Beyond TOFU

Why is TOFU powerful?

TOFU provides us with a new trust model, one well-understood (and likely accepted) by anyone who uses SSH.

- It provides us with a **simple way** to establish an anonymous, encrypted, integrity-checked mechanism to talk to a remote HTCondor daemon.
  - Hopefully a first step in removing less-secure CLAIMTOBE and ANONYMOUS authentication from the default configuration.
  - It simplifies bootstrapping of IDTOKENS auth – perhaps we'll see it in get_htcondor soon?

Reduces the complexity of using SSL!

- SSL is a prerequisite for using SCITOKENS authorization.

Hope to see this code land in 9.10!

New Technology is Great – But more important is the TRUST MODEL

Note changes in technology and trust model go hand-in-hand:

- The original model was each daemon established a full, direct trust relationship (authentication, identity mapping, authorization). Made sense when each daemon was bespoke.
- Over the past two years, we've evolved so the CM is the central source of trust: if you establish trust with the collector, you can use the pool.
- Simplifying the trust relationship – and deploying new technology to match it – has enabled us to tackle the complexity of securing HTCSS.

What's next?

- One side-effect of TOFU mode is it establishes a public key with a trust domain.
  - I want to leverage the fact we can now verify credentials without having access to signing keys…

Stay Tuned for 2023!

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