Securing Cassandra

Not as hard as it sounds

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Who am I and what do I do?

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- Co-founder and CTO of Instaclustr -> www.instaclustr.com

<sales>

- Instaclustr provides Cassandra-as-a-Service in the cloud.
- Currently in AWS, Azure and IBM Softlayer with more to come.
- We currently manage 150+ nodes for various customers, who do various things with it.

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What this talk will cover

- Why do we care about security?
- A meandering tour of Cassandra security controls
- Tips and tricks


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Why do we care about security?

Why do we care about security

- Hackers
- Compliance…
- We now have a information security officer / architect
- Some sort of misguided sense of obligation to protecting end user information?

But I run C* behind a firewall…

- Stops dumb mistakes (running dev scripts on prod)
- Stops malicious internal actors
- Multi data-centre clusters (GL with that VPN…)
- Run in the cloud?

So what do I need to care about?

Access Control

Access Control

- Authentication: org.apache.cassandra.auth.IAuthenticator
  - AllowAllAuthenticator - no auth, default
  - ISaslAuthenticator - extends Authenticator
  - PasswordAuthentication - username and password auth, standard db stuff, uses ISaslAuthenticator

Authentication - General flow

- ServerConnection maintains QueryState, three states:
  - UNINITIALIZED
  - AUTHENTICATION
  - READY
- Driver sends a STARTUP message, then CREDENTIALS/AUTH_RESPONSE.
- CredentialsMessage class calls the defined Authenticators authenticate method and then sets the state to ready.
- You are then ready to start executing queries and authenticate does not get called again for the life of the connection. The authenticated user gets stored in the ClientState.
- If your app uses short lived connections, uses a driver that does not pool them (e.g. php), this will hurt.

Authentication - PasswordAuthentication

- CredentialsMessage calls authenticate which is implemented by PasswordAuthentication:
  - Checks whether you have actually provided a username / password combo
  - Queries Cassandra with: SELECT salted_hash FROM system_auth.credentials WHERE username = ?
  - Queries using LOCAL_ONE for all users, except the user “cassandra” which occurs at QUORUM
    - default system_auth keyspace replication is set to 1… this should be set to all nodes

Access Control

- Authorisation: org.apache.cassandra.auth.IAuthorizer
  - AllowAllAuthorizer - no permissions, default
  - CassandraAuthorizer - extends IAuthorizer, must be used with PasswordAuthenticator

Authorisation - General flow

- CredentialsMessage calls state.getClientState().login(user). Which checks again if the user exists.
- ClientState provides an authorize method to get permissions for the logged in user against a specific resource.
- Alter, CreateIndex, DropIndex, Insert/Update, Select and Truncate all call hasColumnFamilyAccess (or hasKeyspaceAccess) on the client state to check if an operation is permitted.
- If it isn’t an UnauthorizedException is raised

Authentication - CassandraAuthorizer

- CassandraAuthorizer gets called to return a set of permissions by Auth.
- Auth wraps these calls in a permissions Cache, otherwise the authorizer gets called for every single operation.
- CassandraAuthorizer gets passed a user and a resource (keyspace or cf) and returns the permissions it can find for that user, resource pair.
- ALL KEYSPACES is treated as the root data resource.

CassandraAuthorizer + PasswordAuthenticator

- Run these together
- Currently the user lookups and the permissions checks are in the read/write path (even with the permissions cache).
- Be vigilant with your system_auth replication and keeping it repaired.
- Poorly configured/maintained system_auth keyspace can and will create 0% availability in your other keyspaces… irrespective of their replication factor
- Don’t use the cassandra user


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Auth changes in 2.2

- API has changed to support the concept of roles
- This includes inheritance!
- Roles are first class resources (like keyspaces and tables), so you can grant permissions on certain roles.
- AuthZ in Cassandra has finally grown up!

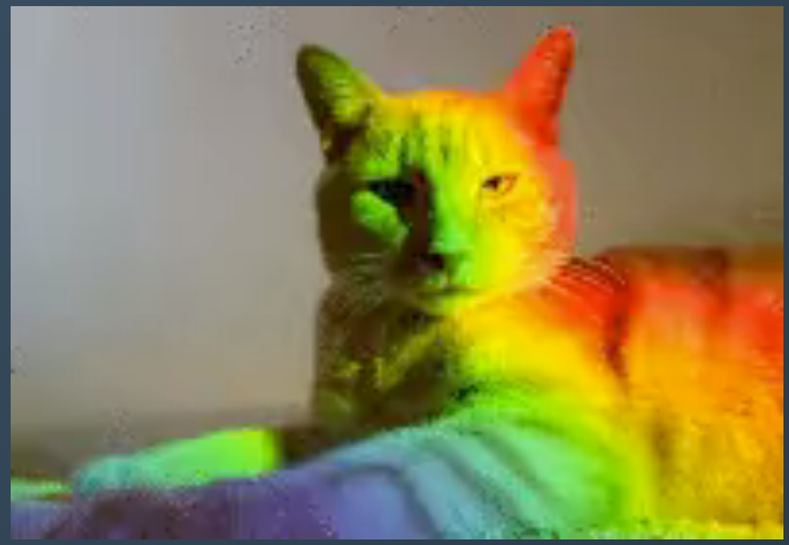
Internode Authentication

- Yes it does exist!
- Currently the only provided internode authenticator is AllowAll
- Can be extended to authenticate based on remoteAddress and port.
- No ability atm to use a shared secret or not, at best would support a whitelist

~~ENCRYPTION!!!1!~~

Confidentiality

- Internode encryption
- Client <> Node encryption
- Whole disk encryption



Internode Encryption

- Leverages SSLServerSockets from Netty (native)
- Server certificate stored in KeyStore, trust certificates stored in TrustStore
- If requires_client_auth == true, the client must provide a certificate the SSL context can build a chain of trust back to a cert in the TrustStore.
- This can either be the provided certificate itself, or the CA that signed that cert.

Configuring encryption

```
server_encryption_options:
    internode_encryption: none # all, none, dc, rack
    keystore: conf/.keystore
    keystore_password: cassandra
    truststore: conf/.truststore
    truststore_password: cassandra
```

Configuring encryption

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```

Configuring encryption

```
server_encryption_options:
    …
    protocol: TLS # TLSv1.2, SSLv3.0 etc
    algorithm: SunX509 # PKIK
    store_type: JKS # support for different
keystrokes
    cipher_suites: [TLS_RSA_WITH_AES_128_CBC_SHA,…]
    require_client_auth: true
```

Configuring encryption

- Strongly recommend you download the full strength JCE otherwise Cassandra will not start with the default cipher suites
- Distribute the CA public cert in the truststore rather than individual public certificates.
- troubleshooting certificate issues? use the openssl client

Client Encryption

- Pretty much the same as internode encryption under the hood.
- Supports require_client_auth as well
- Must be able to build a chain of trust to a valid certificate within the truststore
- Does not actually set the AuthenticatedUser based on certificate CN or anything like that

Configuring client drivers for encryption

- Your driver will want the its certificates in either PEM, DER or as a Keystore. Learn to love the openssl cli
- Cqlsh in some recent versions of Cassandra struggles with requires_client_auth.
- Just use stunnel and plaintext cqlsh

At rest encryption

- Whole disk/volume
  - dmcrypt/LUKS
- DSE Transparent Data Encryption (TDE)
  - SSTable encryption
- In app encryption

At rest encryption

- dmcrypt/LUKS - up to a few % difference in throughput, minimal cpu load if using cpus with AES-NI instruction set
- DSE SSTable encryption, we haven’t done any benchmarking but according to DS there is a slight hit on perf.
- In app -> Variable… makes slice queries really hard

At rest encryption

- dmcrypt/LUKS -> Up to 8 keys per block device, Requires key management at boot or via crypttab
- DSE TDE, now supports external KMIP servers for external key management.
- In app -> Key management -> roll your own

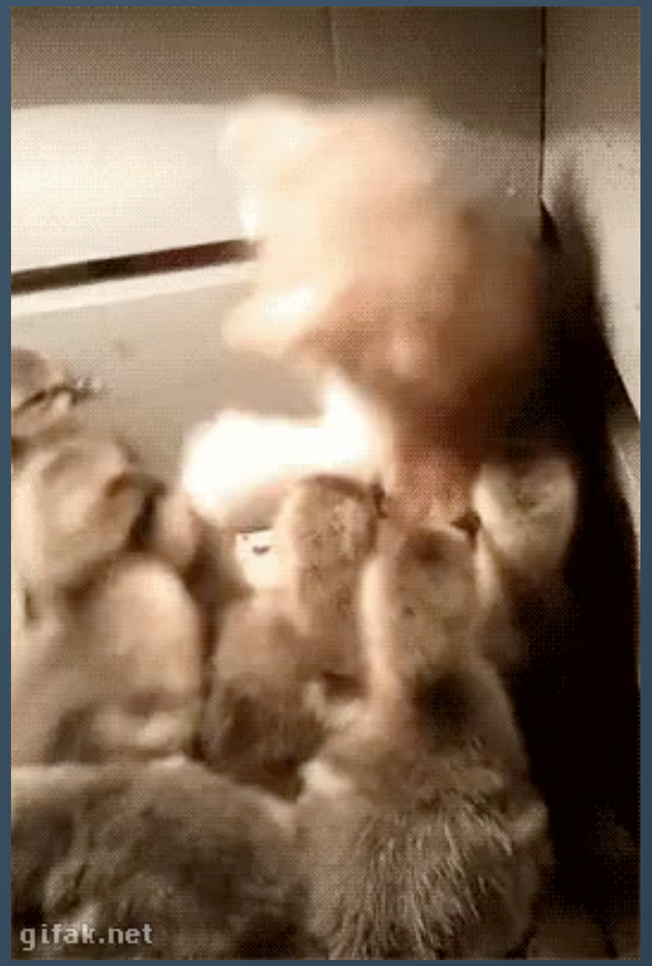
At rest encryption

- Should I do it?
  - PCI? Yup probably
  - Otherwise… the threats it protects against are fairly low risk
  - Vulnerable to cold memory attacks (litterally cool ram modules, to persist state).
  - Decryption key kept in memory
  - You need to trust your DC/Cloud provider

Availability

- This should be pretty simple right? RF = 1,000,000
- There are a few things to keep in mind that an unauthenticated attacker / unprivileged user can do to make things interesting.

Availability



- native_transport_max_threads …

Availability

- native_transport_max_threads is by default set to 128
  - unauthenticated messages will take up one of these threads
  - use client-auth as the SSL handler will drop the connection before the message is dropped into the worker pool

Availability

Availability

- System_auth keyspace replication
  - Every new session queries this keyspace
  - Every new request queries either system_auth or the permissions cache
  - Increase the credential cache time
  - Increase your system_auth rf

Availability

- Resource Scheduler
  - Default - none
  - RoundRobin
    - implements a throttle limit - number of requests in flight
    - Weight by keyspace

Go forth and conquer!

Questions?