TLS 1.3 CIP Security Impacts

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Introduction

- CIP Security is built on TLS and DTLS for authentication and data confidentiality/data authenticity
- When the CIP Security specification was released in November 2015, the most current version of TLS was TLS 1.2
- In May 2018 TLS 1.3 was approved by the IETF
- We will explore some of the changes here and the impacts to CIP Security

TLS 1.3: What's New?

- A few main changes with TLS 1.3
  - Improved privacy with perfect forward secrecy
  - Separation of authentication and key management within a handshake
  - Optimization of the handshake for improved performance
- Note that TLS 1.3 builds on TLS 1.2
  - This is not a complete re-write of TLS, but rather an evolution

Handshake Changes

- TLS 1.3 makes several changes to the handshake mechanism
- Authentication and key establishment have been decoupled
  - Previously in TLS 1.2 this was linked; a party was authenticated by virtue of successful key establishment
  - For TLS 1.3, the decoupling means that any combination of algorithms for these two functions can be used

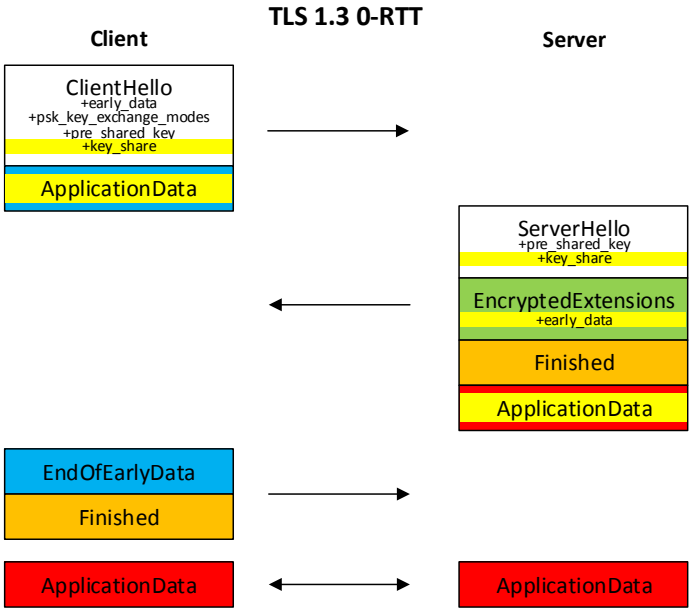
Handshake Changes – Session Renegotiation

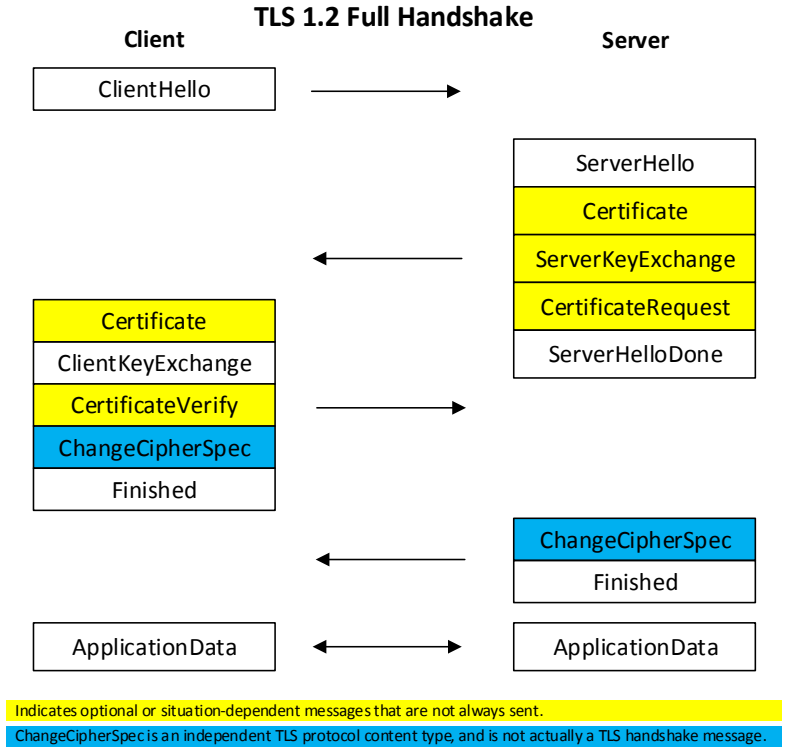
- Session renegotiation is no longer supported in TLS 1.3
  - This is something that the CIP Security specification talked about specifically
  - It was an optional feature to support sequence count rollover cases
- KeyUpdate message is supported
  - This can be used to refresh session keys, but without full renegotiation
  - This can and should be used by CIP Security if/when adopting TLS 1.3

Handshake Changes – 0-RTT

- Zero Round Trip Time (0-RTT) handshakes are potentially the biggest and most impactful change in TLS 1.3
  - When a client and server first establish a TLS connection, they can optionally share a key (referred to as a Pre-Shared Key, or PSK)
  - The next time this client and server connect, the PSK can be used to transmit application data immediately (this is referred to as “Early Data”)
  - In this way application data is sent immediately, without any handshaking

0-RTT vs Full Handshake (TLS 1.2)





0-RTT Risks

- Although 0-RTT significantly increases the performance of the TLS handshake, it is not without risk
  - Early Data is protected just with the PSK
  - Vulnerable to a replay attack
  - RFC strongly suggests that any early data sent be idempotent, meaning it does not affect the state of the client or server
    - Example would be a read request
  - For HTTP, much of the data sent at the beginning of a connection is idempotent
  - The same cannot be said of CIP
    - It could be a read attribute, or it could be a set attribute or a service which changes state

0-RTT Risks

- Note that 0-RTT is optional, both client and server must agree to using this
- Since this is optional, the user should be able to configure whether or not to leverage 0-RTT
  - User should understand the risk and benefit of this
  - For some CIP connections it might make sense, like listen-only I/O
  - Others the risk is likely too great
- Note that CIP Security with TLS 1.2 already supports PSKs through an attribute
  - This could be extended to support 0-RTT

Cipher Suites

- List of supported cipher suites cut down significantly
- All of these primitives for cryptography are no longer supported:
  - SHA-1 Hash Function
  - RC4 Steam Cipher
  - DES
  - 3DES
  - AES-CBC
  - MD5 Algorithm
  - Various Diffie-Hellman groups
  - EXPORT-strength ciphers
  - RSA Key Transport
- Supported Cipher suites are:

Encryption Cipher	HMAC for key derivation	Notes
AES-128 GCM	SHA-256	Mandatory
AES-256 GCM	SHA-384	Optional
CHACHA20 Poly1305	SHA-256	Optional
AES-128 CCM	SHA-256	Optional
AES-128-8	SHA-256	Optional

Cipher Suites – No Null Encryption

- One area of concern for CIP Security is that all of the TLS 1.3 cipher suites include confidentiality
  - For CIP Security and TLS 1.2, Authentication-only (also termed NULL Encryption) cipher suites were important
  - This allows for data authenticity without data confidentiality
  - Useful for:
    - Performance improvements of when confidentiality is not needed (e.g. CIP Motion)
    - Inspection and debugging to ensure system is operating properly
- IETF had a general philosophy to simplify TLS with TLS 1.3, hence removal of these cipher suites which are not often used within Internet communications

Bringing Authentication-only Cipher Suites to TLS 1.3

- There is an effort to include Authentication-only cipher suites within TLS 1.3
  - https://tools.ietf.org/html/draft-camwinget-tls-ts13-macciphersuites-00
  - Authored by Nancy Cam-Winget and Jack Visoky
- This draft RFC has been brought to the TLS 1.3 Working Group
  - Discussion took place within the mailing list
  - Received many comments, currently updating the draft based on the IETF discussion

TLS Extensions

- There are several extensions defined for TLS 1.3
- A few potentially useful ones for CIP Security are listed below
- Support could be added to control these extensions explicitly through CIP Security objects

Extension	Applicability to CIP Security
Supported Versions	Helpful to know what version of TLS an endpoint is supporting/using
Cookie	Can be used to prevent some DoS attacks, configuring this could be supported through a CIP attribute
Signature Algorithms	Closely related to the Allowed Cipher Suites attribute; this attribute could be extended to allow/disallow certain signature algorithms

TLS 1.3 Extensions (continued)

- A few more potentially interesting extensions

Extension	Applicability to CIP Security
Negotiated Groups	Also similar to the existing Allowed Cipher Suites Attribute, this could be enhanced to support various negotiated groups
Server Name Indicator	Could be useful to support some CIP name here which could link the TLS security with the application layer naming/addressing
Certificate Authorities	Optimize handshake, potentially support multiple identities on the target

Conclusions

- TLS 1.3 brings many benefits, although there is some risk with the lack of Authentication-only/NULL Encryption support
- Recommended to enhance CIP Security to support TLS 1.3
  - Within 3 years if NULL encryption is included in TLS 1.3
  - Within 6 years if not
- TLS 1.2 will need to continue to be supported for several years
  - User should be able to configure whether TLS 1.3 or TLS 1.2 or both are used within an endpoint
- There are several attribute changes suggested here to support TLS 1.3 new features (such as 0-RTT), it is suggested these be implemented within the CIP Specification for optimal support

THANK YOU