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# TLS 1.3 and RIOT-OS

AMSTERDAM - 13/09/2018

# We’re going to talk about:

1. What is SSL
2. What’s new in TLS 1.3
3. RIOT-OS wolfSSL pkg design and implementation

# What is SSL

And why it is important for the IoT

# What is SSL?

- Enables **security** in network communications, defined as:

| | |
|---|---|
| **Confidentiality** | + Prevent eavesdropping |
| **Authentication** | + Prevent impersonation |
| **Integrity** | + Prevent modification |

# What is SSL?

- Provides **end-to-end** security
  - Using the same standard protocols and ciphers as the remote endpoint
  - Enabling built-in security for the most popular communication protocols (https, ssh), even IoT specific (mqtts)
  - Not relying on security features from third party technology, like data link for the first leg of the communication path

# Security in IoT

- It's no longer a myth
  - Most connected embedded systems require secure communication
- Easy interaction with the existing IT infrastructure and cloud servers
  - Same families of **protocols**…

# Security in IoT

…different **technologies**, so different implementation **approach**:

- Resources required by the SSL implementation (RAM, flash, …)
- Computational power/time to execute encryption operations
- Integration with communication libraries (TCP/IP or other communication stacks)

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- **Designed for embedded systems**
  - Small footprint, limited amount of resource required
  - Built-in hardware acceleration and assembly optimization
  - Modular to allow scalability to the single algorithm/feature
- **Portable and easy to integrate**
  - Callback-based API for bare metal and OS integration
  - Built-in support for many OS/environment/platforms
- **Mature codebase**
- **Professional support**
- **Fast release cycle**
- **GPL**

# What is new in TLS 1.3

The new standard protocol for secure communication





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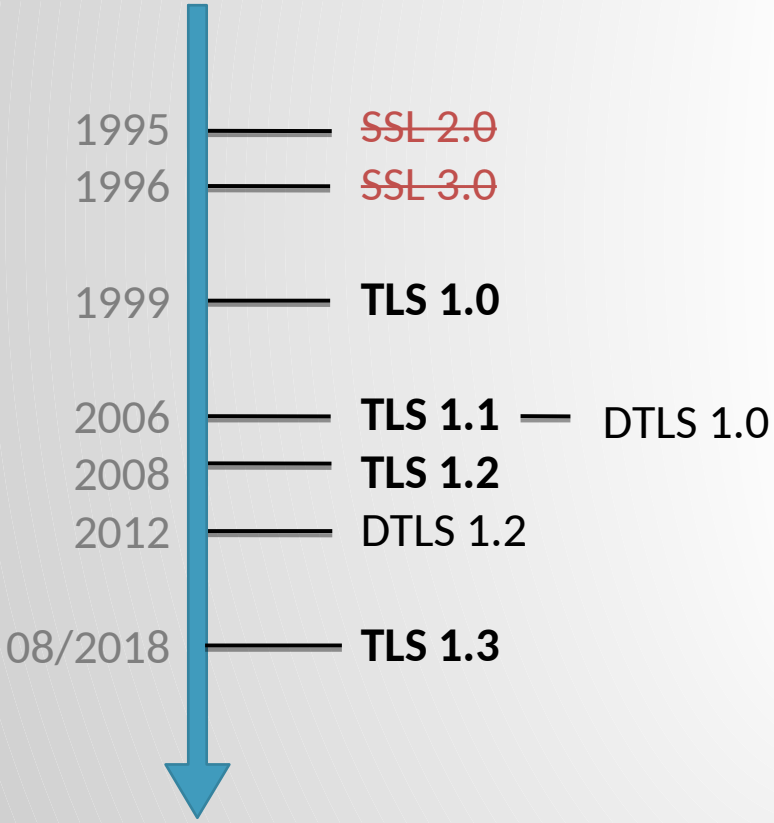
# Protocols

- Timeline of the protocols standard




**Notes:**

- SSL 2.0/3.0 are insecure
- SSL = “Secure Sockets Layer”
- TLS = “Transport Layer Security”
- DTLS = “Datagram TLS”

# TLS 1.3: **major improvements**

- Faster handshake (1-RTT/0-RTT)
- Full session encryption
- New cipher suites
- Deprecated vulnerable ciphers and algorithms
- Removed obsolete/insecure features

# TLS 1.3: improved handshake

TLS Handshake now requires only one RTT instead of two

Client can start sending data immediately after the first reply from the server

**Less RTT == faster handshake, less traffic, less power used**





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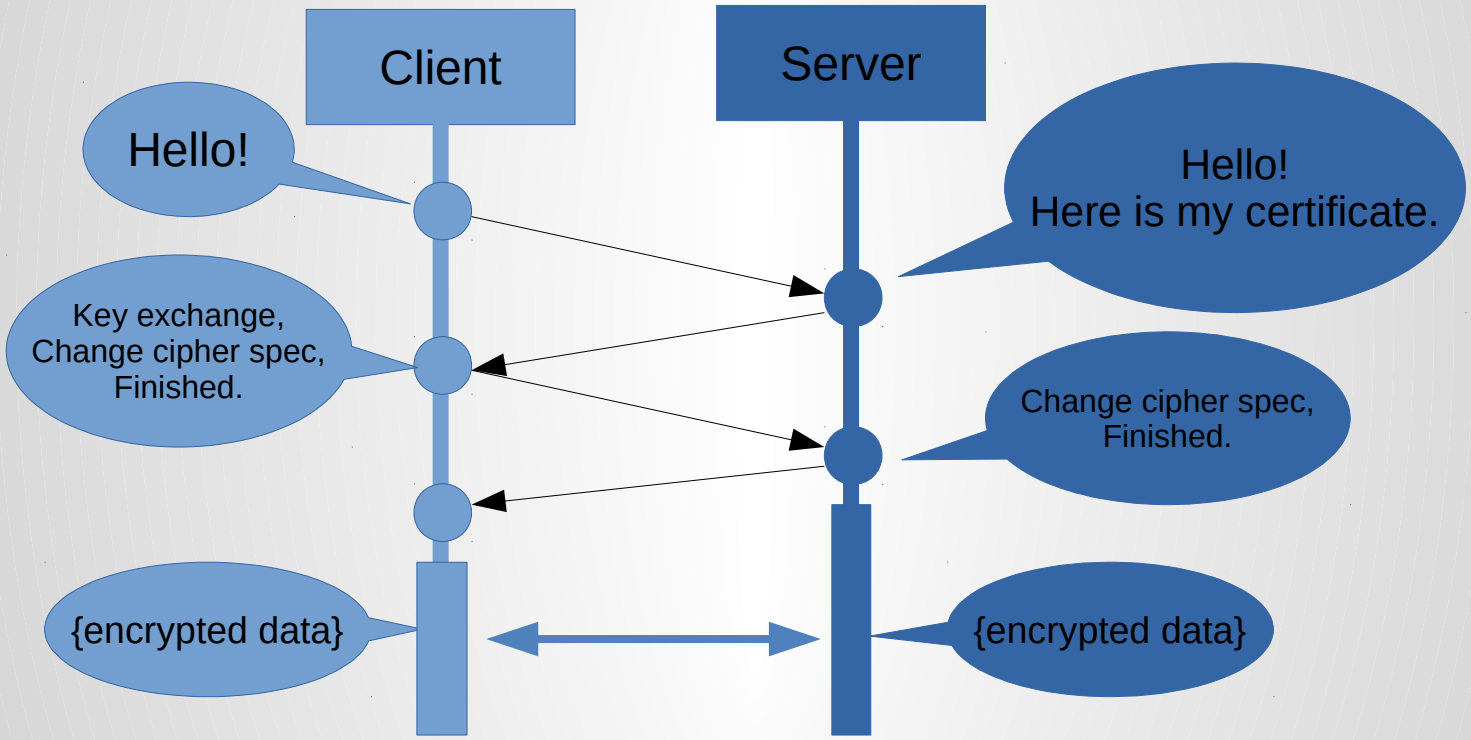
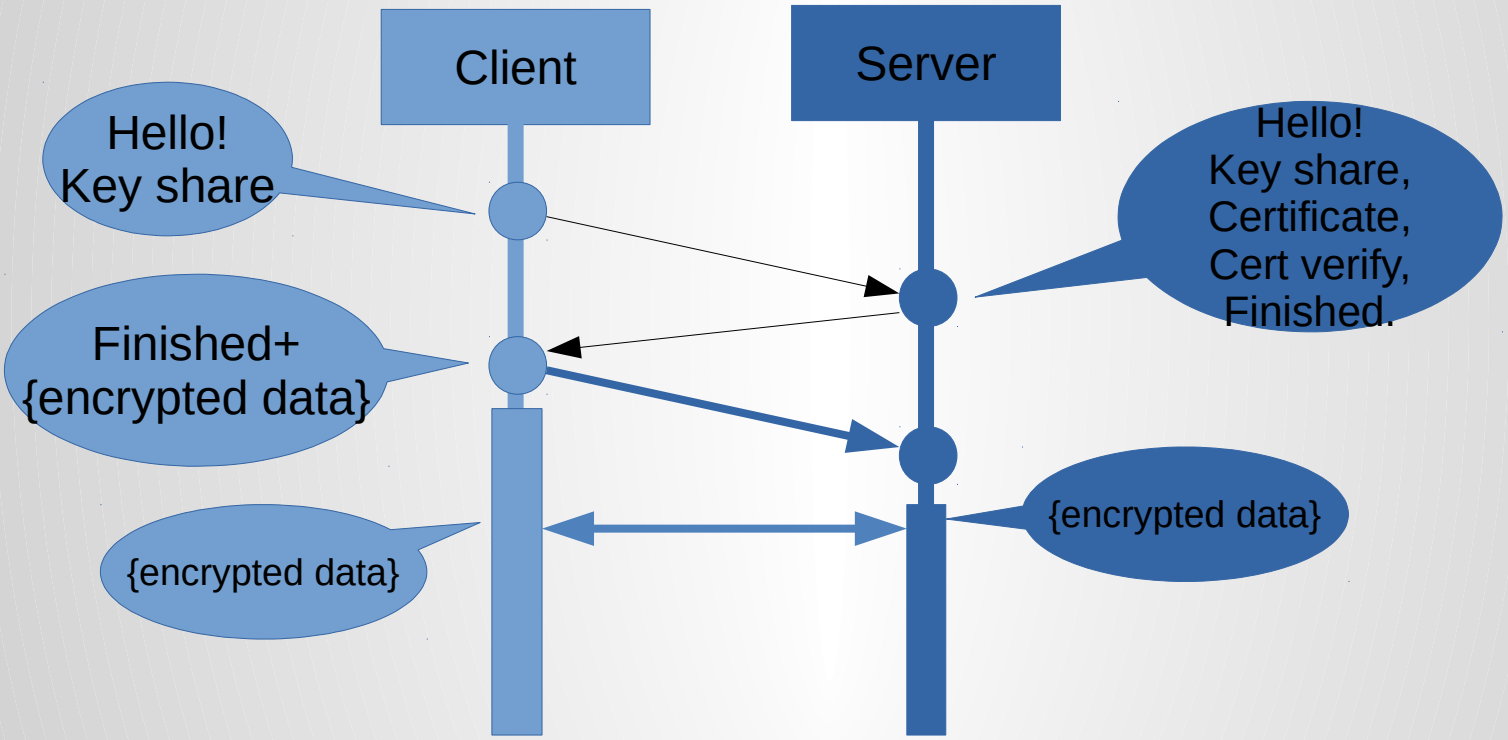
# Classic TLS v1.1/v1.2 handshake



# TLS 1.3 handshake



# Encryption algorithms

- TLS uses a variety of encryption algorithms to secure data

# Ciphers

- Does the configuration support the needed cipher suites?

| Public Key | Block / Stream | Hash |
| --- | --- | --- |
| RSA, DSS, DH, NTRU … | DES, 3DES, AES, ARC4, RABBIT, HC-128 … | MD2, MD4, MD5, SHA-128, SHA-256, RIPEMD … |

Ex: TLS_RSA_WITH_AES_128_CBC_SHA

# TLS 1.3: **new cipher suites**

- A common **CIPHER SUITE** is negotiated during the initial handshake:

SSL_RSA_WITH_DES_CBC_SHA
SSL_DHE_RSA_WITH_DES_CBC_SHA
TLS_RSA_WITH_AES_128_CBC_SHA
TLS_DHE_DSS_WITH_AES_128_CBC_SHA
TLS_DHE_RSA_WITH_AES_256_CBC_SHA
TLS13-AES128-GCM-SHA256
TLS13-AES256-GCM-SHA384
TLS13-CHACHA20-POLY1305-SHA256
TLS13-AES128-CCM-SHA256
TLS13-AES128-CCM-8-SHA256



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# TLS 1.3: abandoned algorithms

- The following algorithms are obsolete and should not be used:
  - RC4
  - SHA1
  - MD5
  - SHA224

# TLS 1.3: removed features

- The following features are obsolete and are no longer part of TLS:
  - Compression
  - Renegotiation
  - All non-AEAD ciphers
  - Non-PFS Key exchange (static RSA and static DH)
  - Custom DHE groups
  - Change Cipher Spec
  - Fallback to old SSL standard during negotiation

# TLS 1.3: Added algorithms

- The following algorithms are now part of TLS:
  - ChaCha20 symmetric key stream cipher
  - Poly1305 message authentication code
  - Ed25519 and Ed448 digital signature algorithms
  - curve25519 and x448 key-exchange protocols

# TLS 1.3: Session resumption

- Older TLS version allowed the client to resume a previously interrupted session
  - Server must look up the session id from its cache
  - Multiple servers should share the same cache
- TLS 1.3 uses session tickets
  - The ticket contains the server state for the session
  - The ticket is stored by the client and used for resumption, but it can only be decrypted and used by the server to resume the session
  - **Stateless servers == less resources**

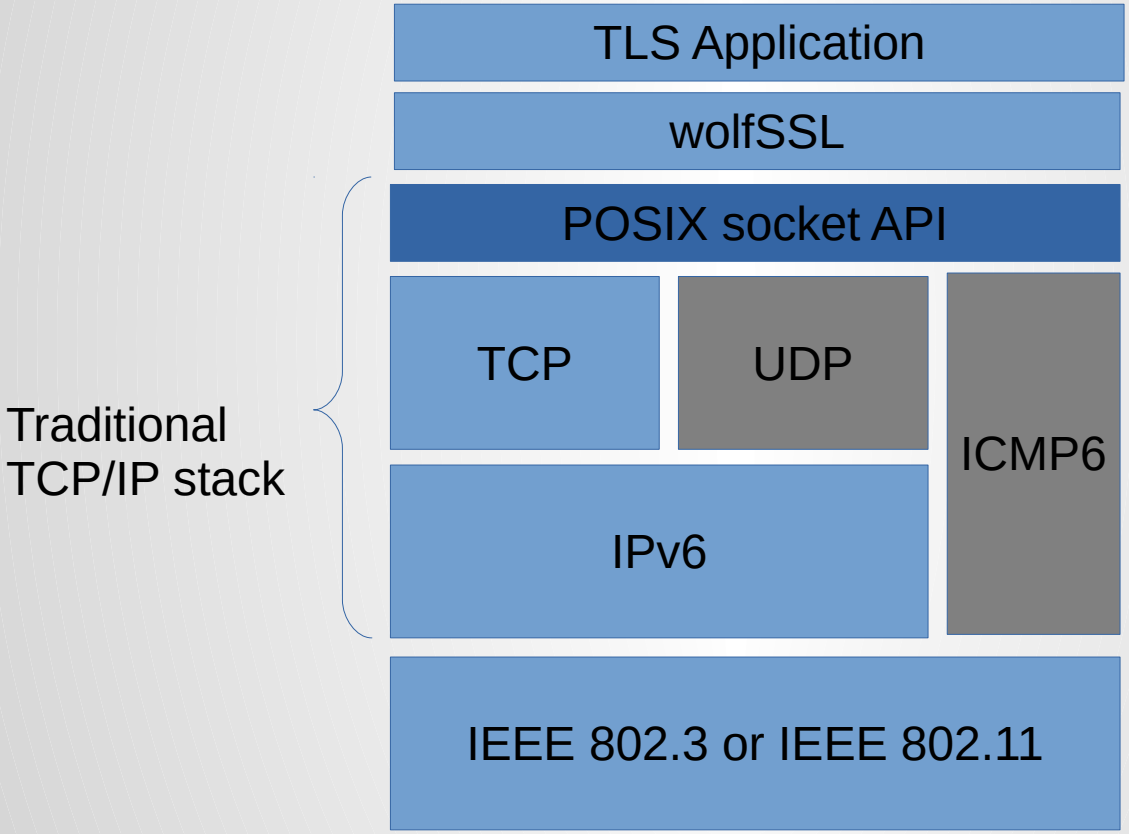
# The Riot-OS wolfSSL pkg

Design and implementation

# First approach: alpha version

- PR #6197: wolfSSL alpha examples
  - Self-contained application to show possible integration
- PR #7348: wolfSSL first pkg with TLS examples
  - Integration via Berkeley socket interface
  - Requires **traditional TCP/IP stack** (e.g. LwIP)
  - TLS client/server (TCP) examples provided

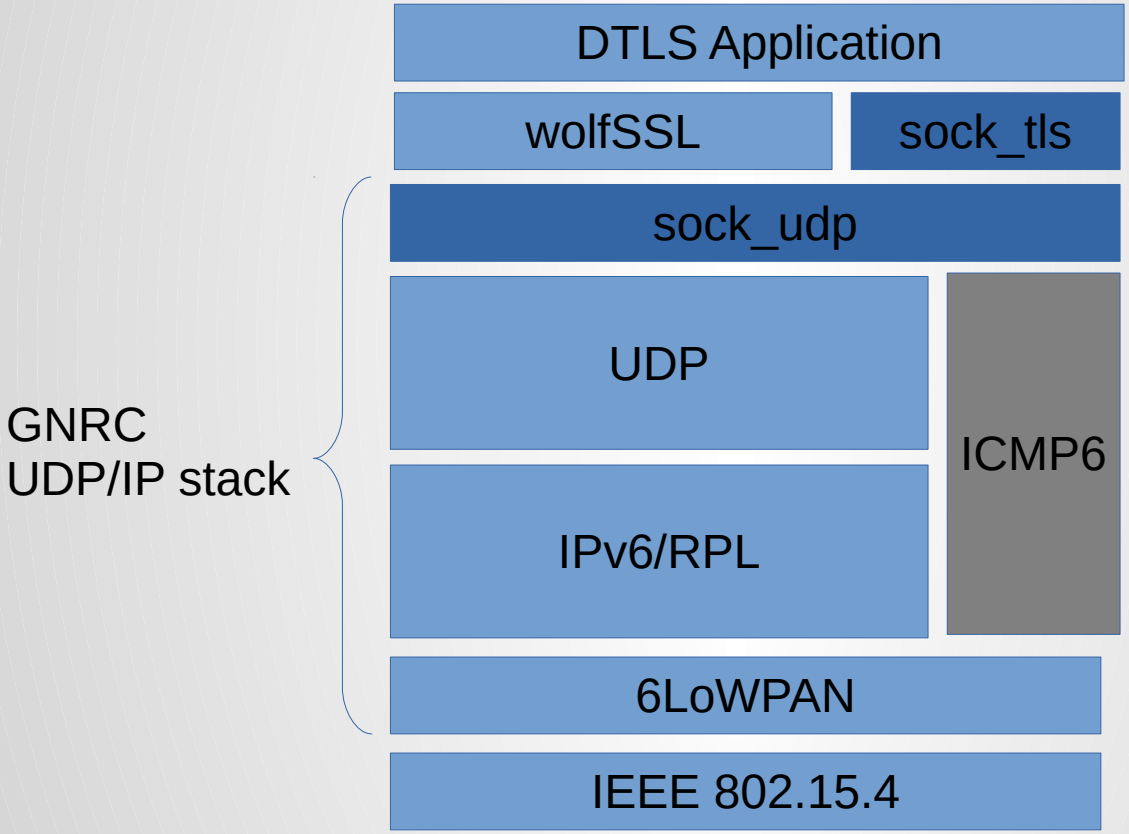
# First approach: alpha version



# Second version: GNRC support and DTLS demo

- PR #9894: wolfSSL pkg with **sock_udp** API integration
  - Built-in callbacks in wolfSSL
  - DTLS 1.2 client/server demo (tested on native)
  - Requires **gnrc_sock_udp**
  - Application API: **sock_tls_t** provided by the module **sock_tls**

# Second version: GNRC support and DTLS demo



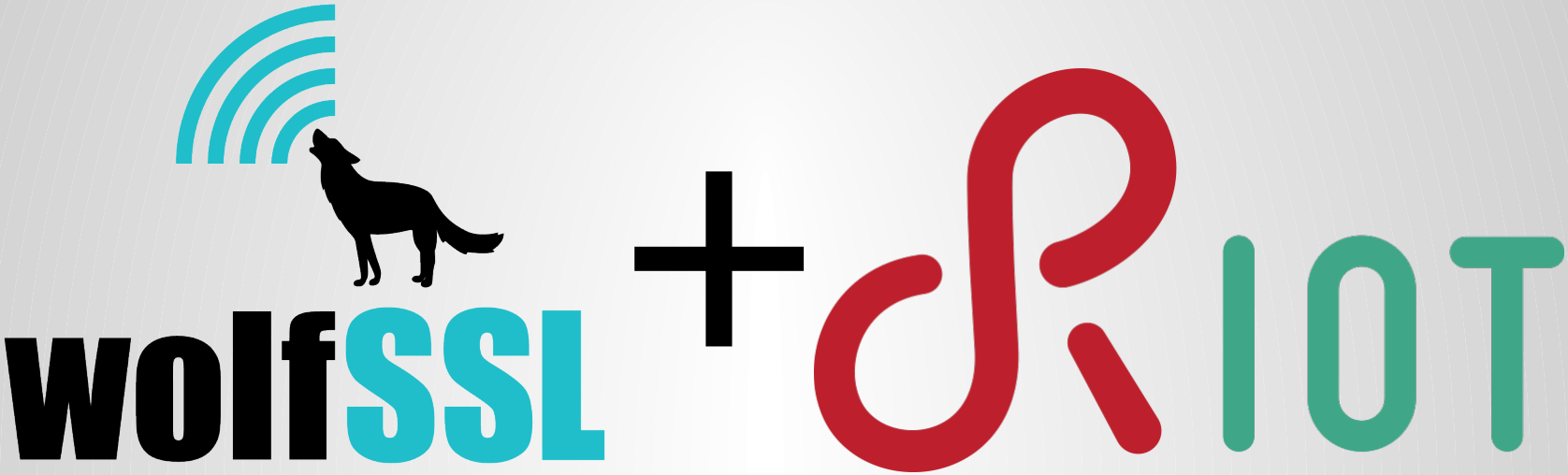
# Second version: implementation details

- **sock_tls**
  - Front-end to create TLS/DTLS sessions on top of sock_udp
  - Type: **`sock_tls_t`**
    - Groups together wolfSSL context, session, udp sock and endpoint address for DTLS session
    - Used as context by wolfSSL callbacks
- System integration:
  - Uses **`random_uint32()`** as random source

# Next steps

- Status of native TCP support?
  - TLS over **gnrc_tcp** ?
  - Plans for a generic **sock_tcp** ?
  - HTTPS/wolfMQTTS demos
  - wolfSSH

- **Feedback is appreciated. Let's work together on the best solution!**




# Thanks!

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