A framework towards adaptable and delegated end-to-end transport-layer security for Internet-integrated Wireless Sensor Networks

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Outline

1) Motivation and goals
2) Proposed framework
3) Proposed system architecture
4) Delegated ECC public-key authentication
5) Experimental evaluation
6) Conclusions

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1) **Motivation and goals**
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Motivation and goals

We may currently observe that:

- Sensing applications on the IoT will require appropriate security mechanisms, including to protect end-to-end communications.
- Security should be quantifiable and adaptable.

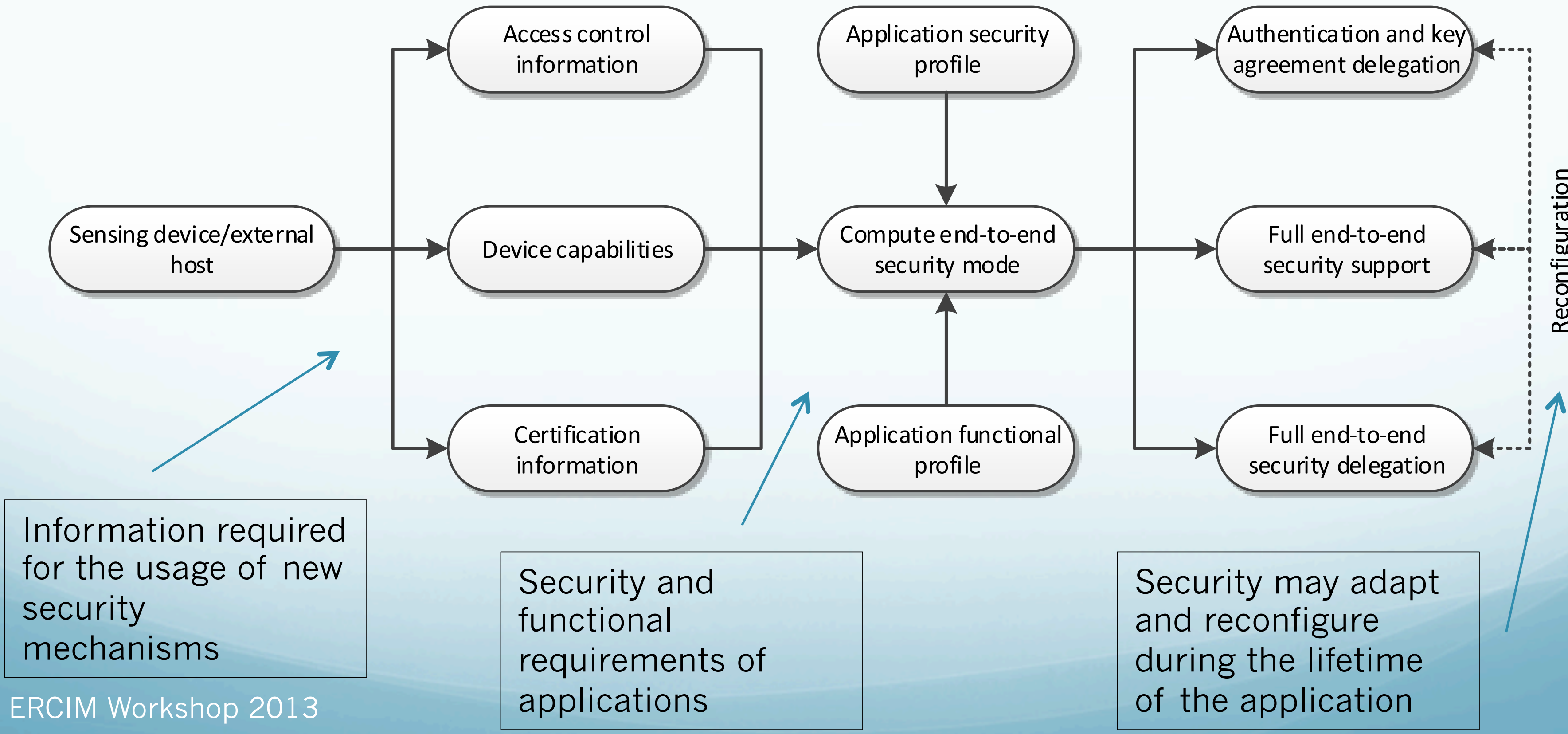
Main goals:

- Propose a framework supporting adaptable end-to-end security in the context of Internet-interconnected WSN.
- Address end-to-end transport-layer security with delegated ECC public-key authentication.
- Evaluate experimentally the proposed mechanisms in the context of the proposed framework.

Outline

Proposed framework

- A framework for the usage of secure end-to-end transport-layer communications with Internet-integrated sensing applications:



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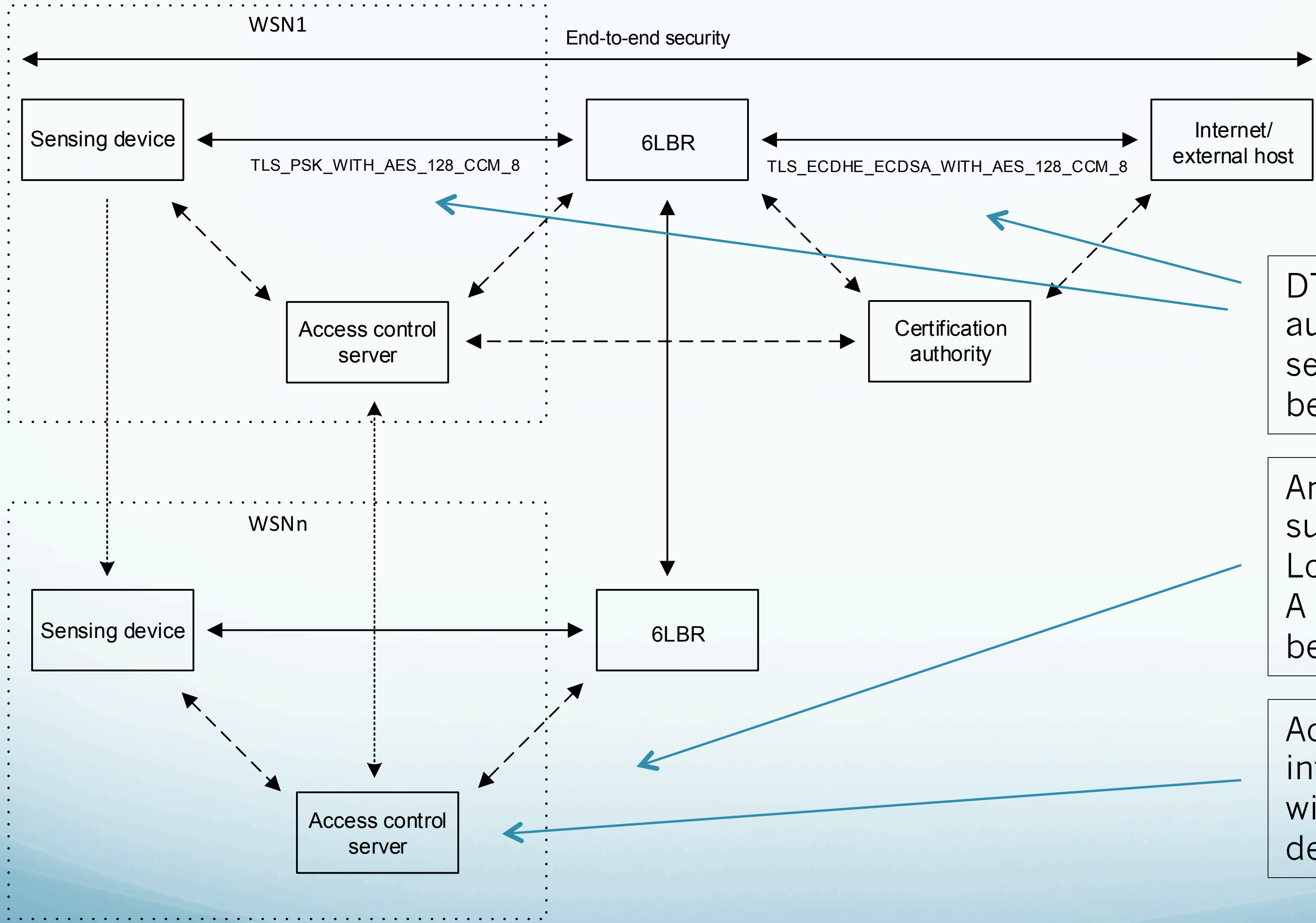
Proposed system architecture

Main goals:

- Support of end-to-end transport-layer security in three usage modes: full DTLS security, DTLS with delegated handshake, DTLS with fully delegated handshake.
- Support of future security mechanisms in the context of Internet-integrated WSN.
- Full compatibility with application-layer CoAP and 6LoWPAN security

Proposed system architecture



DTLS delegated authentication, other security suites may be supported

An application may support multiple LoWPAN domains
A device may move between domains

Access control information related with LoWPAN devices

Outline

Delegated ECC public-key authentication

Regarding CoAP security:

- CoAP supports three security modes :
  - *PreSharedKey* (TLS_PSK_WITH_AES_128_CCM_8)
  - *RawPublicKey* and *Certificates* (TLS_ECDHE_ECDSA_WITH_AES_128_CCM_8)
- Encryption may use AES (CCM,CBC)
- AES/CCM is available in sensing platforms such as the TelosB implementing IEEE 802.15.4

Delegated ECC public-key authentication

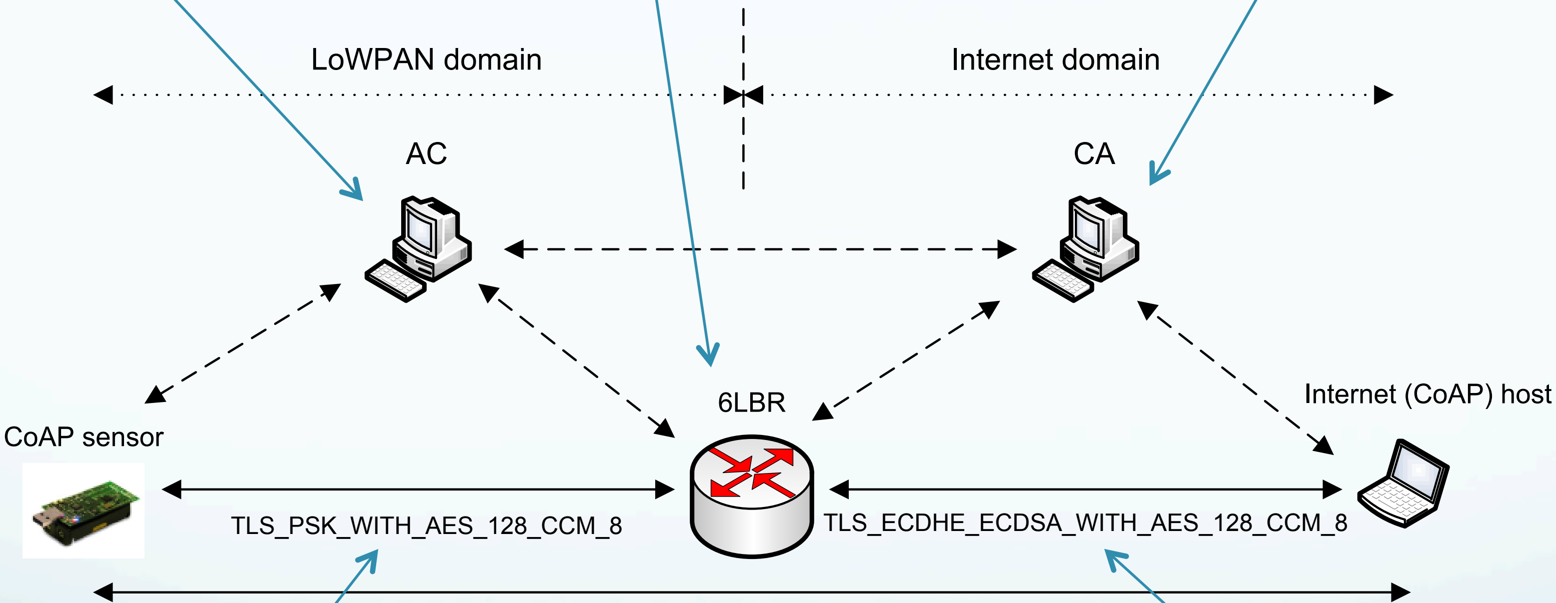
- A secure DTLS session requires the two parties to agree on:
  - The cipher suite
  - The encryption keys
- The DTLS handshake transports the information required for both parties to obtain encryption keys:
  - A shared master key is obtained from a pair of client and server random values plus a pre-shared master secret key (PMSK)
  - Final encryption keys are obtained from the shared master secret.
- PMSK generation depends on the cipher employed:
  - With public-key suites the client generates the PMSK and sends it to the server
  - Pre-shared keys suites don't support this, but we may **modify** TLS_PSK_WITH_AES_128_CCM_8 as long as we maintain appropriate security on the LoWPAN

Delegated ECC public-key authentication

Trust and security between 6LBR and 6LoWPAN devices

Intercepts and forwards packets at the transport-layer

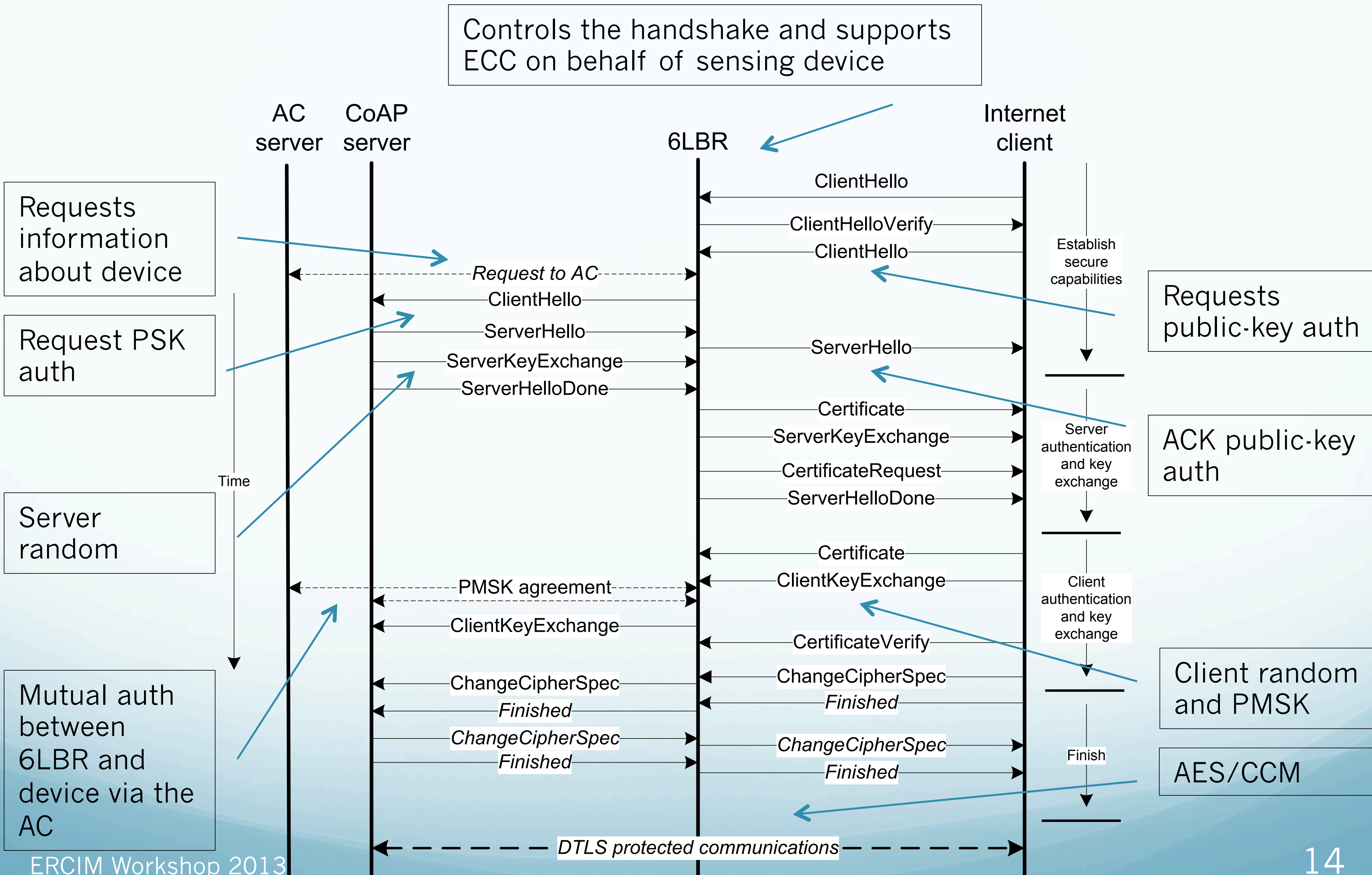
Public-key certification of communicating entities



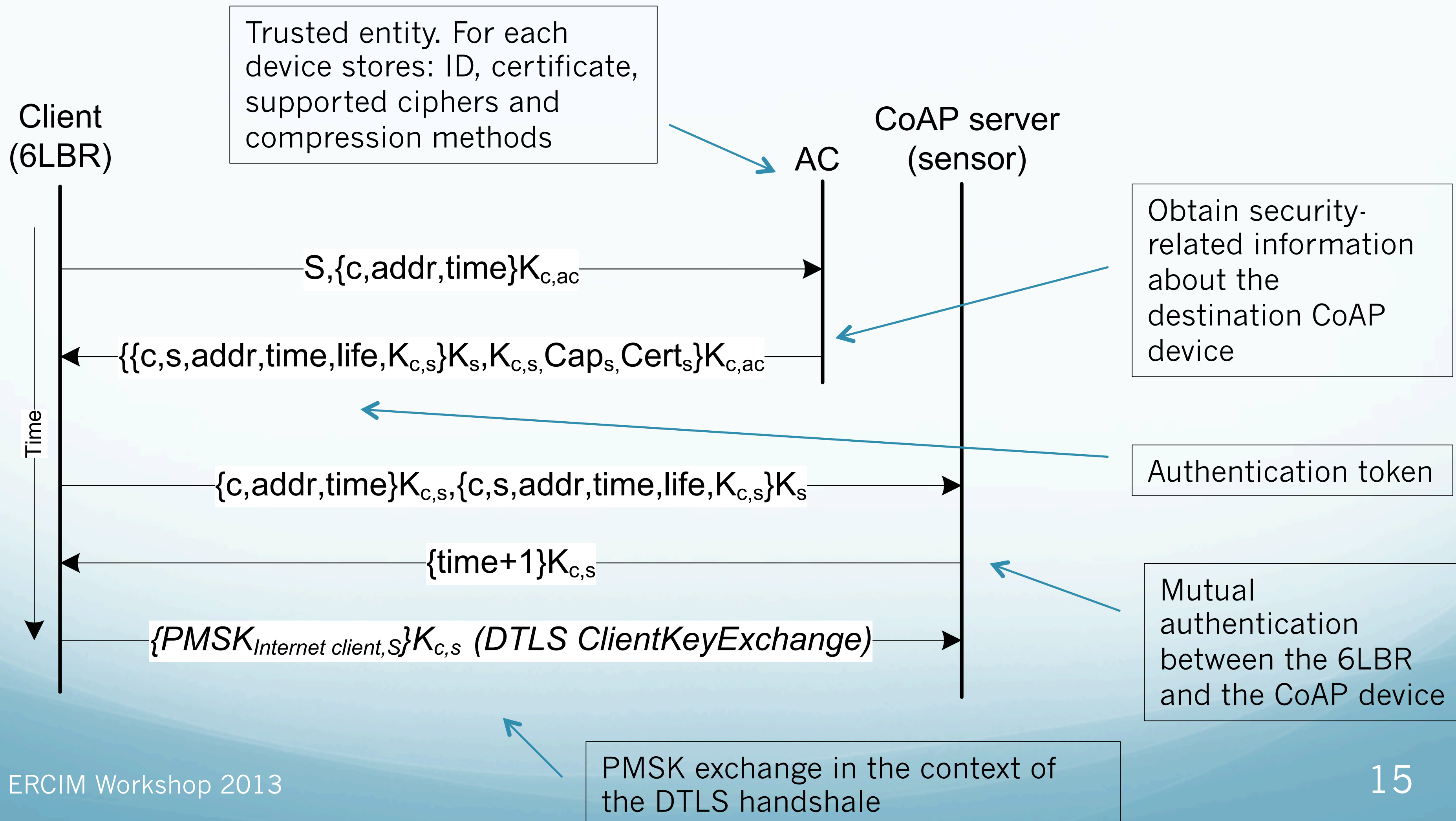
PreSharedKey CoAP security mode (modified)

Certificates CoAP security mode

Mediated DTLS handshake



6LBR and CoAP server mutual authentication



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Experimental evaluation

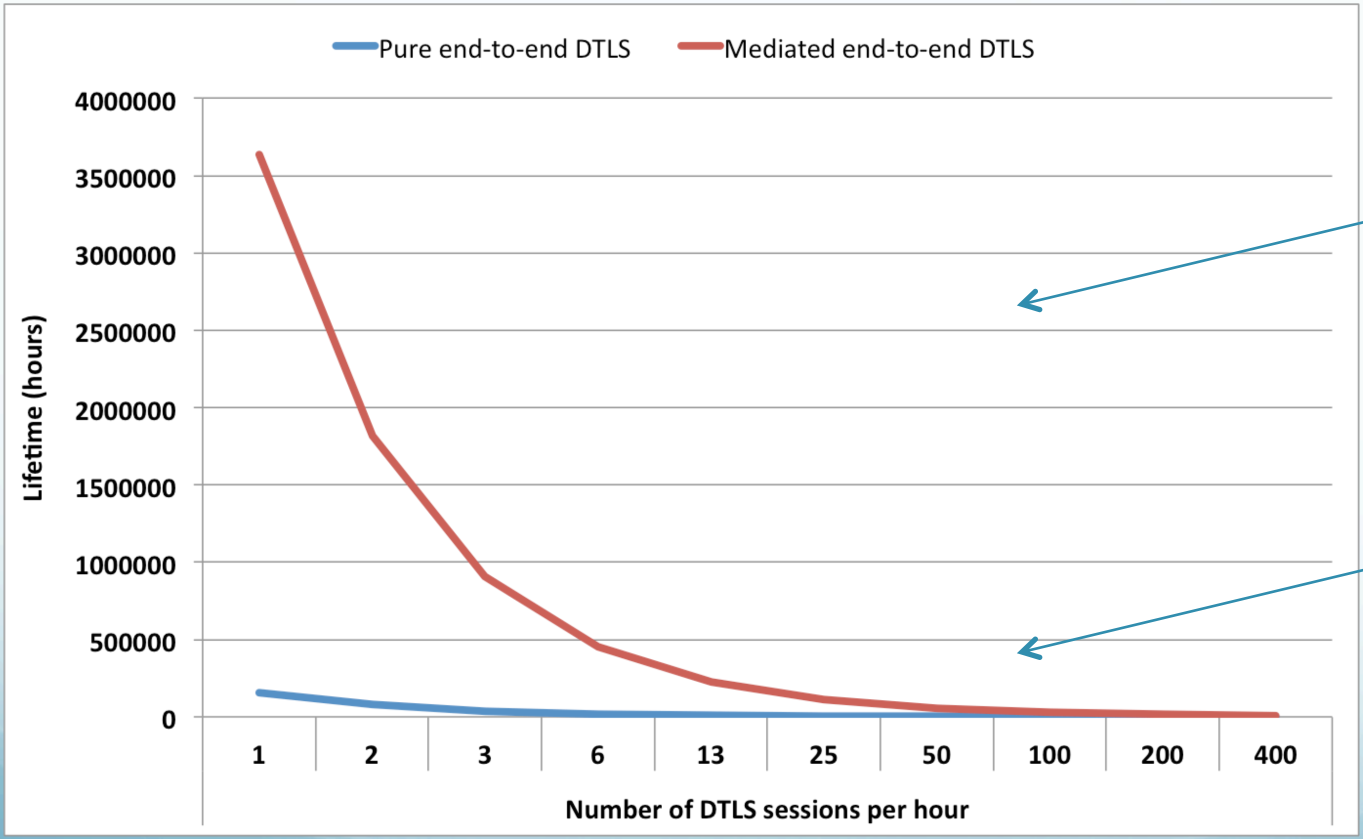
- Experimental evaluation setup using Linux and TelosB devices
- TelosB: 16-bit MSP430, 48KB ROM, 10KB RAM, IEEE 802.15.4
- Support of TinyOS, BLIP, CoAP, DTLS (ECDSA, ECDHE), SHA-256 and LoWPAN authentication
- Standalone AES/CCM hardware encryption
- LibCoAP with DTLS support

Experimental evaluation

- Two application profiles:
  - Moderate number of DTLS sessions/hour (1 to 400) and of CoAP requests per DTLS session (2).
  - Higher number of DTLS sessions/hour (14 to 7200) and of CoAP requests per DTLS session (10).
- Evaluate end-to-end security in two usage modes:
  - Support of full end-to-end DTLS security.
  - Delegated DTLS authentication using the proposed mediated handshake.

Experimental evaluation

- Impact on the lifetime of sensing applications (moderate usage profile):

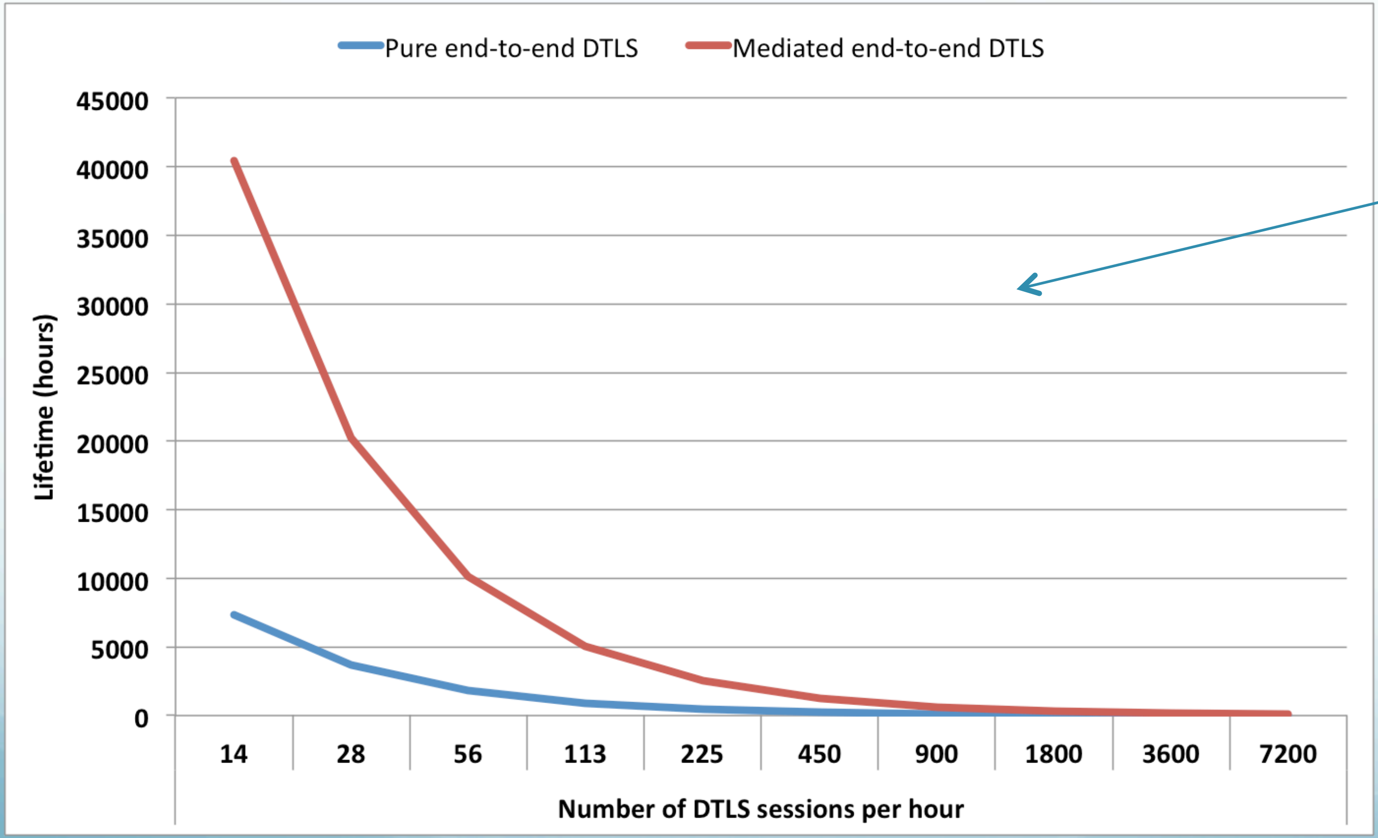


Clear advantage of delegated DTLS authentication, particularly for a lower number of DTLS sessions per hour

Advantage is less expressive for higher values, due to the higher impact of AES/CCM encryption in comparison with the DTLS handshake

Experimental evaluation

- Impact on the lifetime of sensing applications (higher usage profile):



Similar conclusions regarding the advantages of delegated DTLS authentication

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Conclusions

- Efficient support of end-to-end security using delegated mutual authentication.
- Compatibility with standardized CoAP security.
- Other security mechanisms based on a security gateway may be adopted in the future (application-layer message analysis and filtering, 6LoWPAN security).
- Future work:
  - Transparent end-to-end security for mobile devices.
  - Mechanisms to configure security according to application profiles and characteristics of devices.
  - Adoption of other security suites on the LoWPAN domain.