PILA: Pervasive Internet-Wide Low-Latency Authentication

Cyrill Krähenbühl Markus Legner Silvan Bitterli
Adrian Perrig
Department of Computer Science
ETH Zurich, Switzerland

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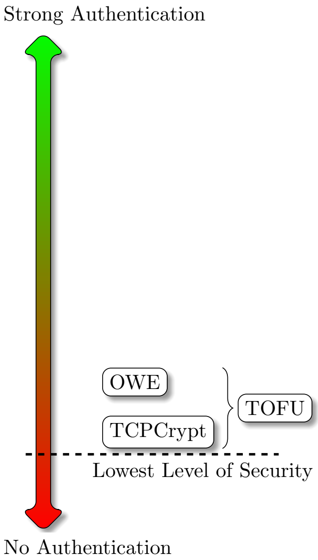
Motivation

- Trust on first use (TOFU):
  - every on-path entity can attack



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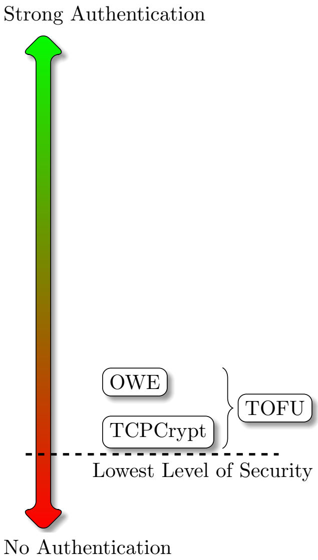

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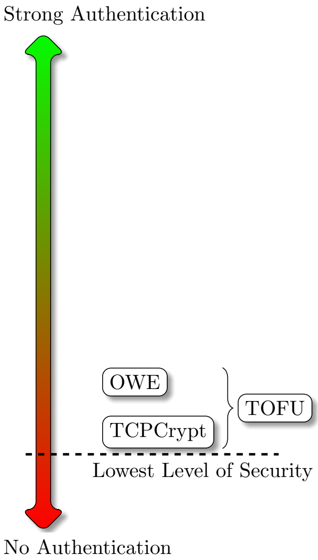

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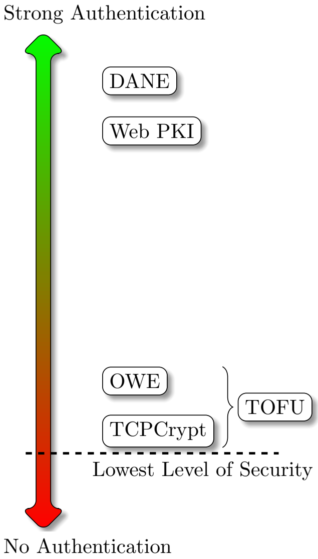

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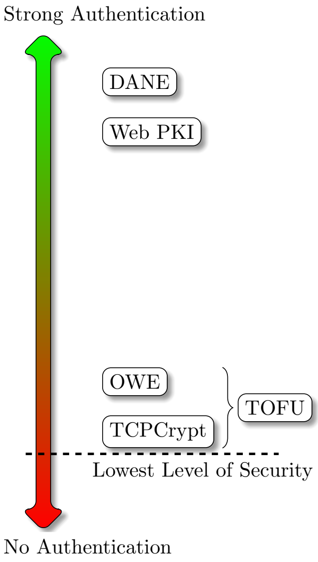

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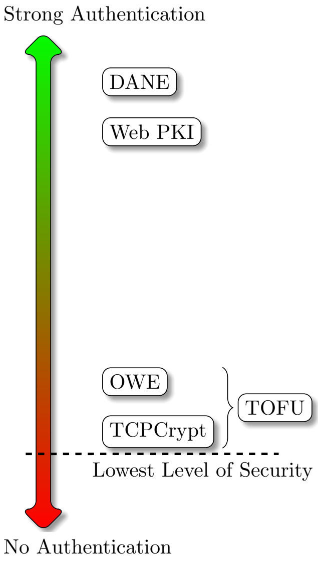

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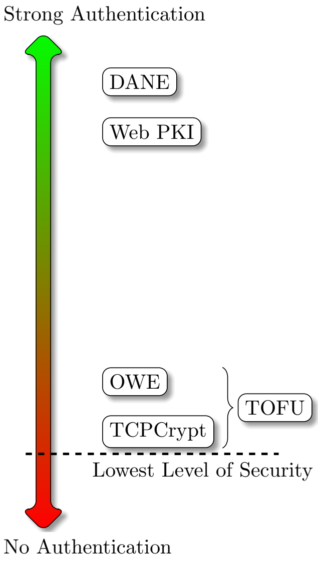

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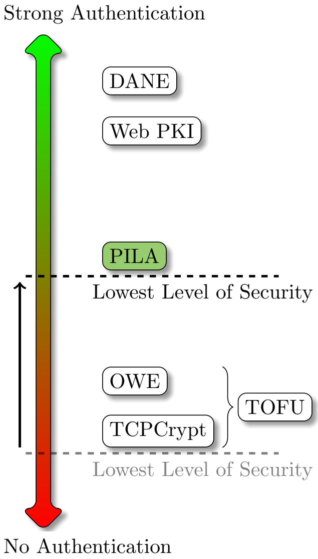
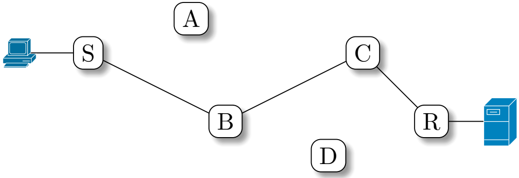
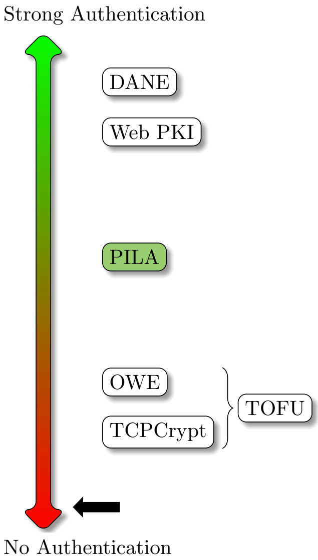
- Can we fill the gap between TOFU and strong authentication?
  - PILA **improves** the base layer for encryption on the Internet



Trust Amplification

- No Authentication





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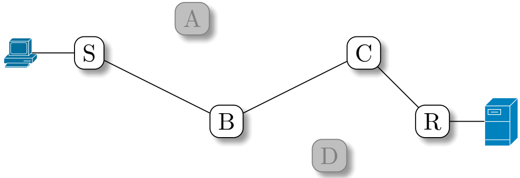

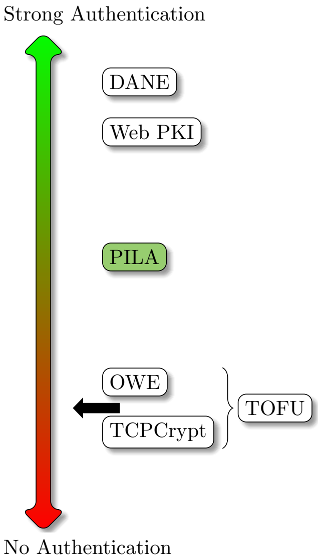

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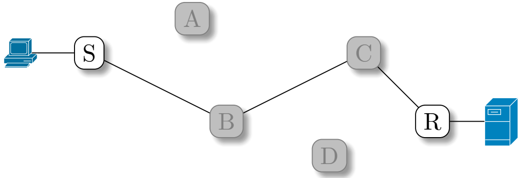

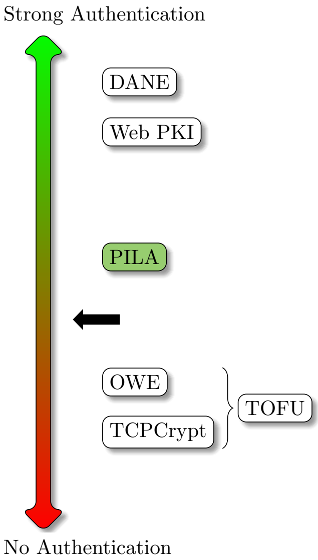

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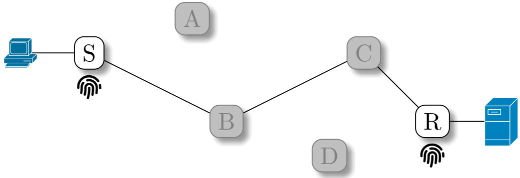
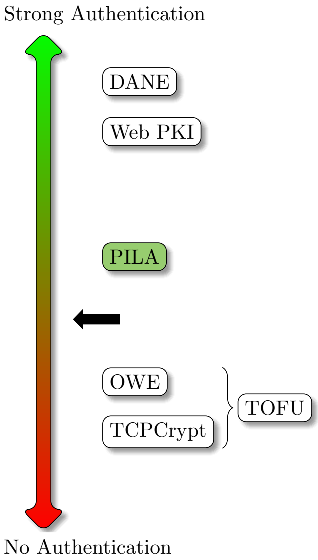
  - Accountability





Trust Amplification

- No Authentication
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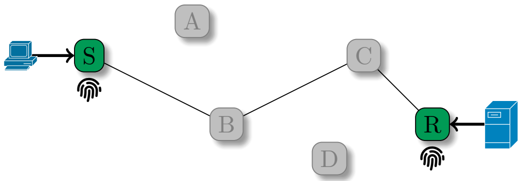
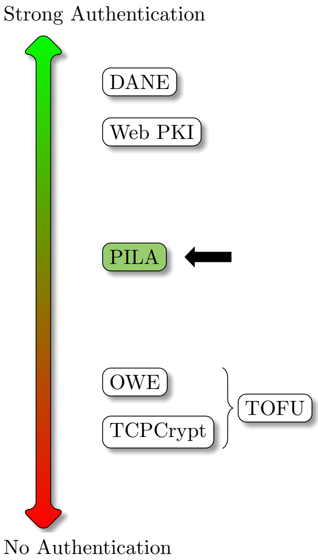
    - Crude Authentication
    - Accountability
    - Leverage





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Authentication should ...

- be widely applicable

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Pervasive Internet-Wide Low-Latency Authentication

PILA ...

- uses IP-address–based authentication
- has a minimal latency overhead
- automatically generates and fetches certificates
- increases security of TOFU key establishment (only used if strong authentication protocols are not available)

Authentication should ...

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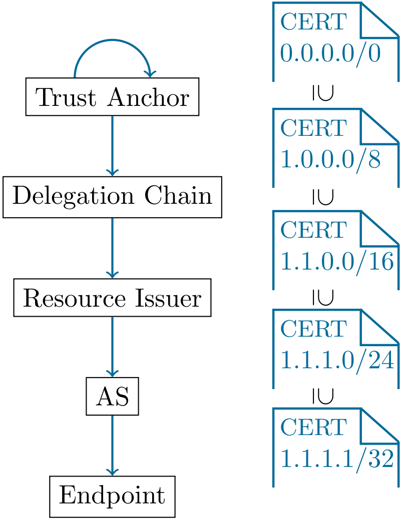
RPKI as Trust Root

- IANA/RIRs as trust anchor



RPKI as Trust Root

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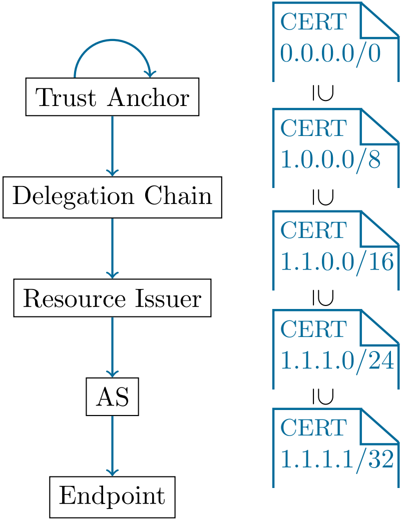

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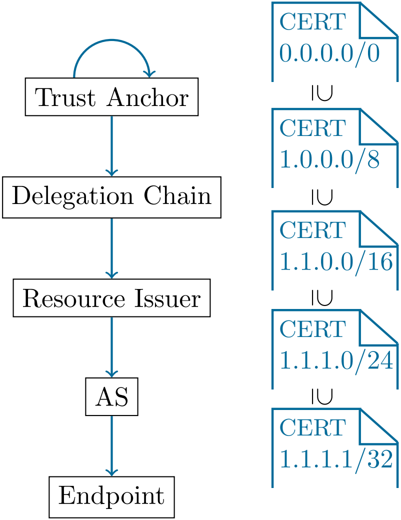

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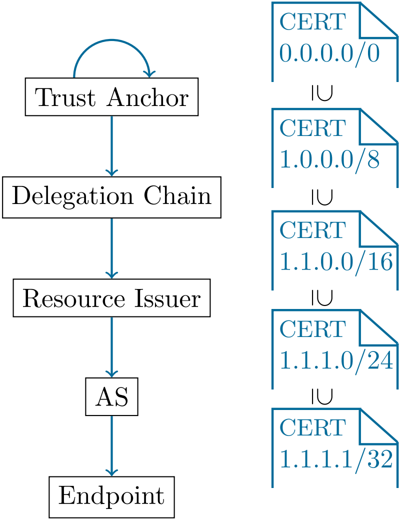

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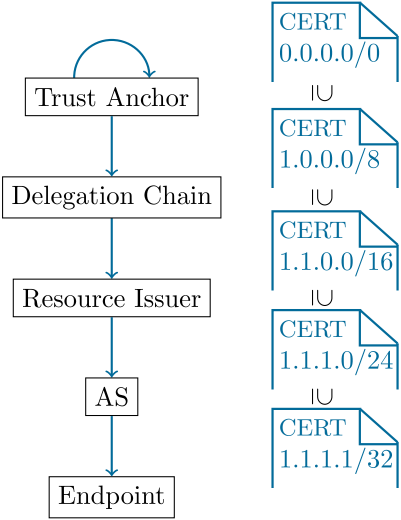
- AS issues short-lived certificates for an IP address to endpoints
- AS misbehavior (i.e., equivocation) is detectable and cryptographically provable
- ASes are curious but cautious
- Flexible PKI choice (e.g., control-plane PKI in SCION)

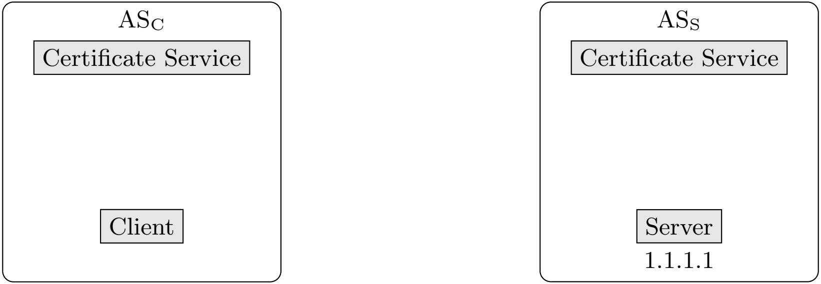


Use Cases

- Remote Login (SSH)
- Secure Session-Establishment (TLS)
- Query-Response (DNS)

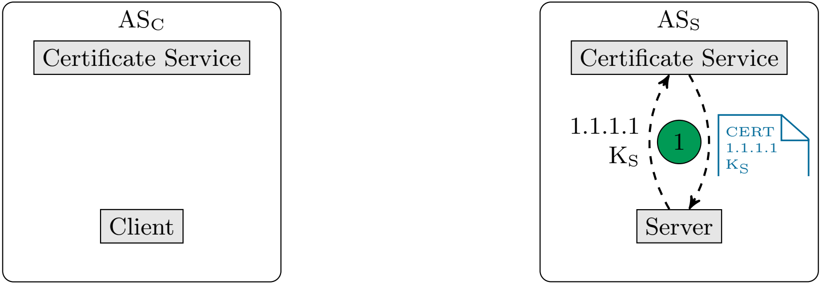
SSH PILA

Server at **1.1.1.1** wants to authenticate itself to the client



SSH PILA

Server periodically fetches short-lived certificate from its local certificate service



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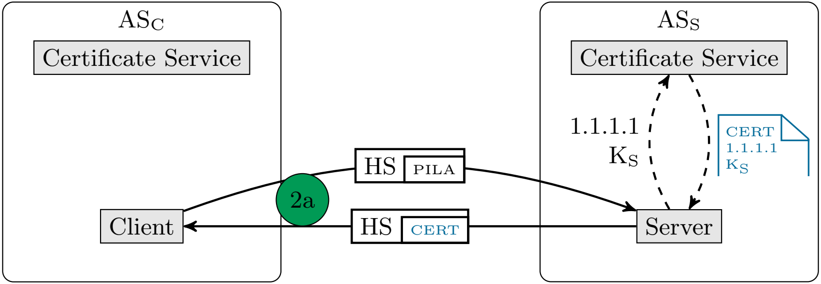
In parallel:

- SSH_{PILA} Handshake (reply contains the certificate)



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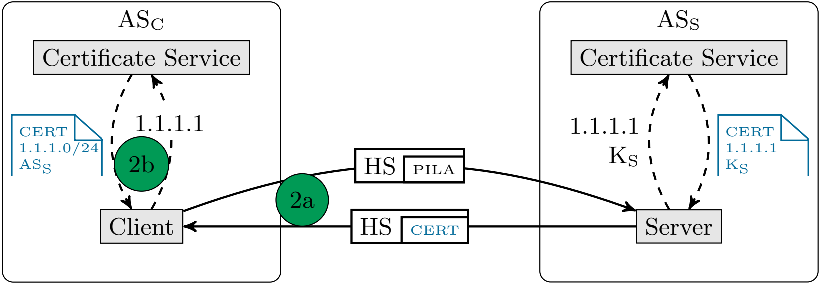
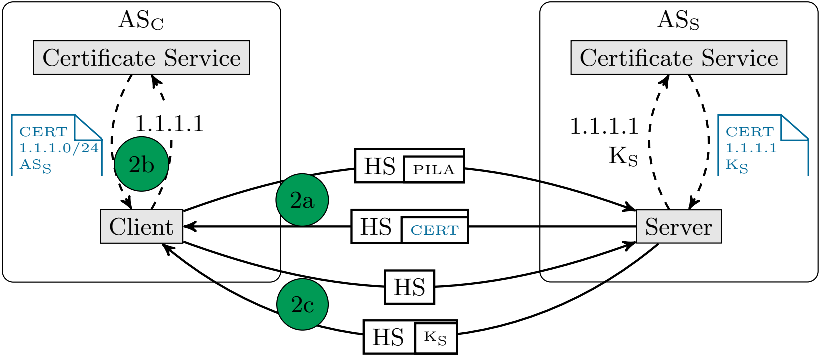


SSH PILA

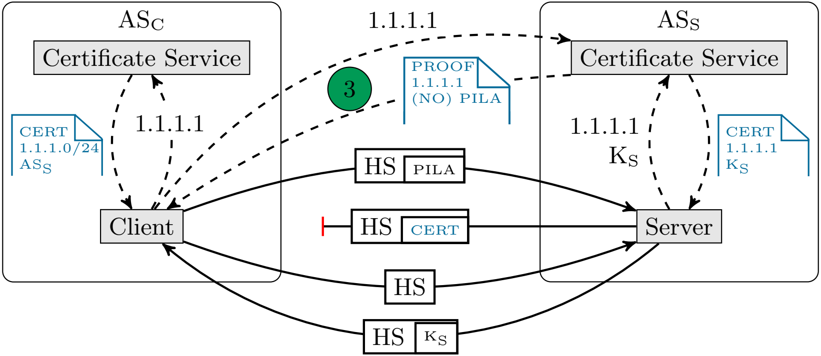
In parallel:

- SSH_{PILA} Handshake (reply contains the certificate)
- Client fetches AS certificate for 1.1.1.1
- Regular SSH Handshake (reply contains the public key)



SSH PILA

If the SSH_{PILA} handshake fails, the client requests a proof that the server does not support PILA



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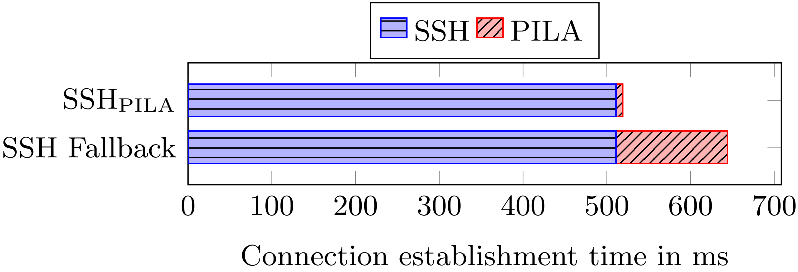
Latency Overhead



SSH PILA

Processing Delay

Average processing times of SSH_{PILA} operations in ms at the client, server, and certificate service:

	Client	Server	Certificate Service
Handshake Overhead	0.8	0.1	-
`GetEPCert`	-	1.0	17.0
`GetASCert`	4.3	-	8.3
`GetProof`	0.6	-	5.1

Conclusion

- Increase security through trust amplification
- PILA offers a new minimum level for fully automatic low latency key establishment
- Implementation and evaluation of PILA in combination with SSH, TLS, and DNS

Thank you!

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Network Security Group
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cyrill.kraehenbuehl@inf.ethz.ch