Welcome to the Attestation Devroom!

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[2]Linaro, Lausanne, Switzerland

February 2, 2025

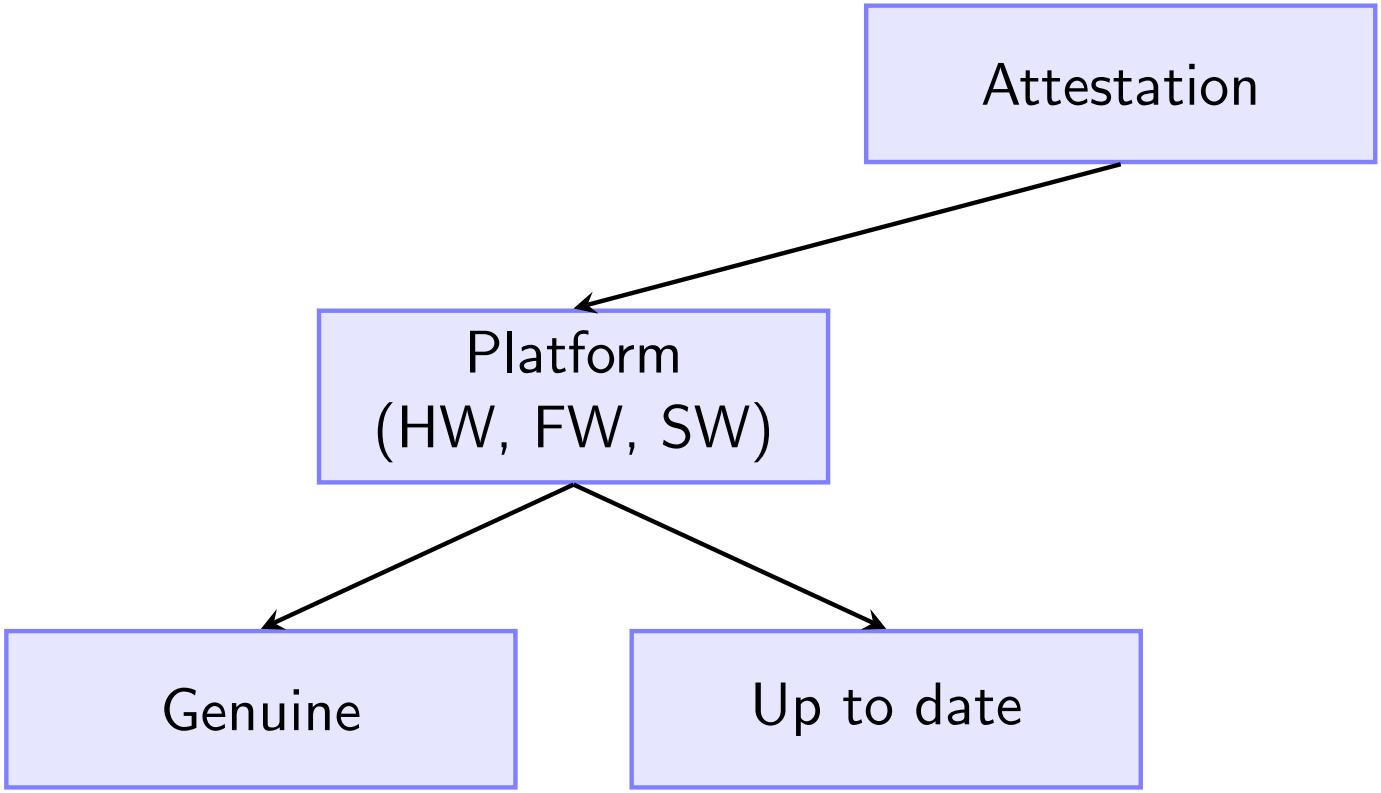
Usama would like to thank his sponsor!

Outline

Disclaimer

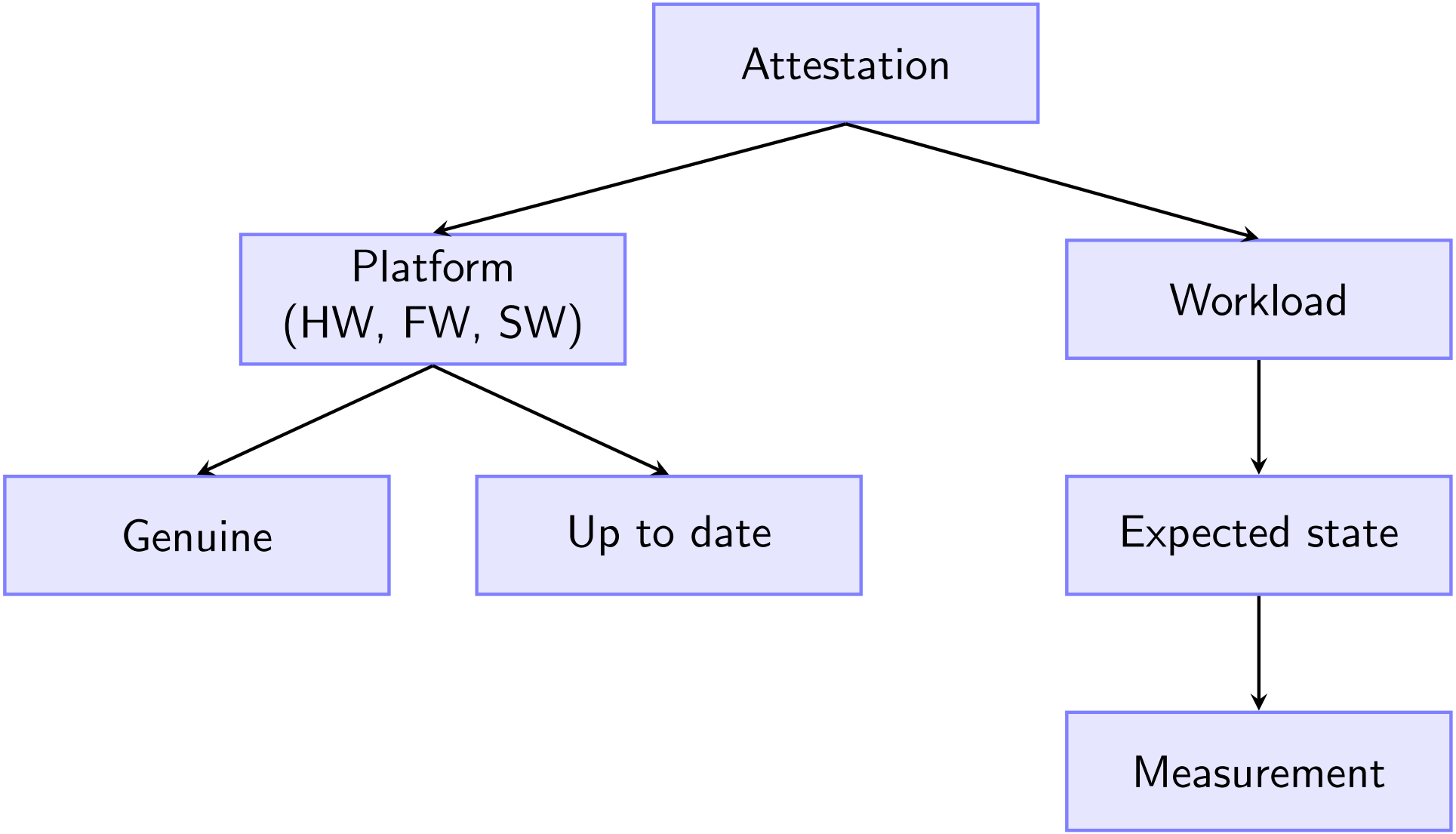
Many ambiguous and even contradicting definitions exist!

(Architecturally-defined) Attestation[1]



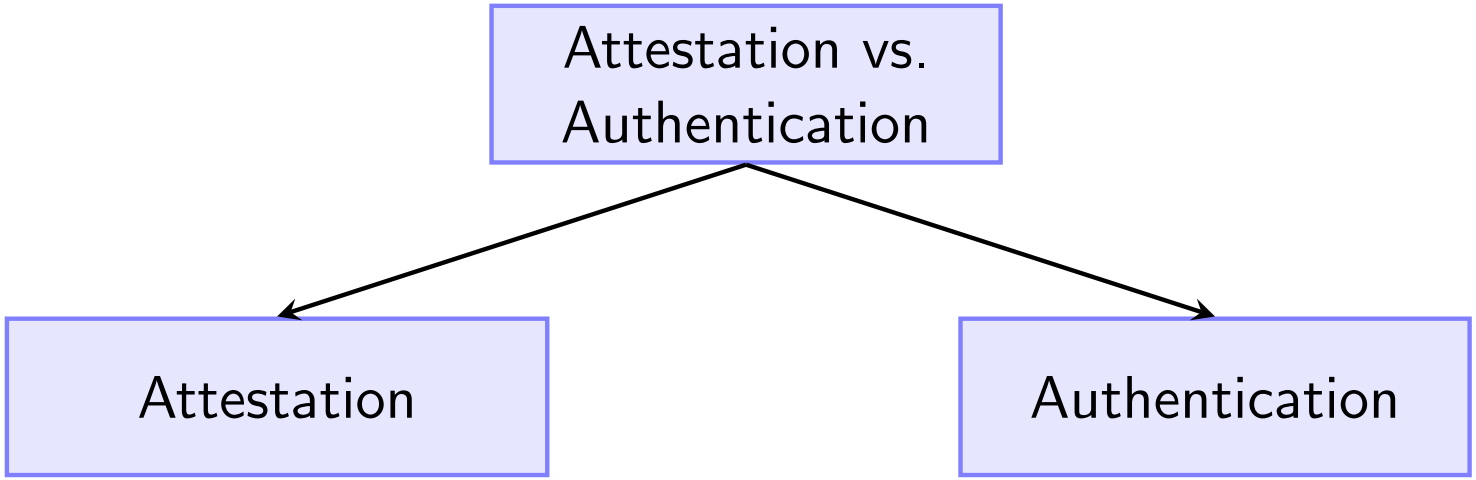
[1] Sardar, Fossati, Frost, and Xiong, "Formal Specification and Verification of Architecturally-defined Attestation Mechanisms in Arm CCA and Intel TDX", 2024.

(Architecturally-defined) Attestation[1]



[1] Sardar, Fossati, Frost, and Xiong, "Formal Specification and Verification of Architecturally-defined Attestation Mechanisms in Arm CCA and Intel TDX", 2024.

Attestation vs. Authentication



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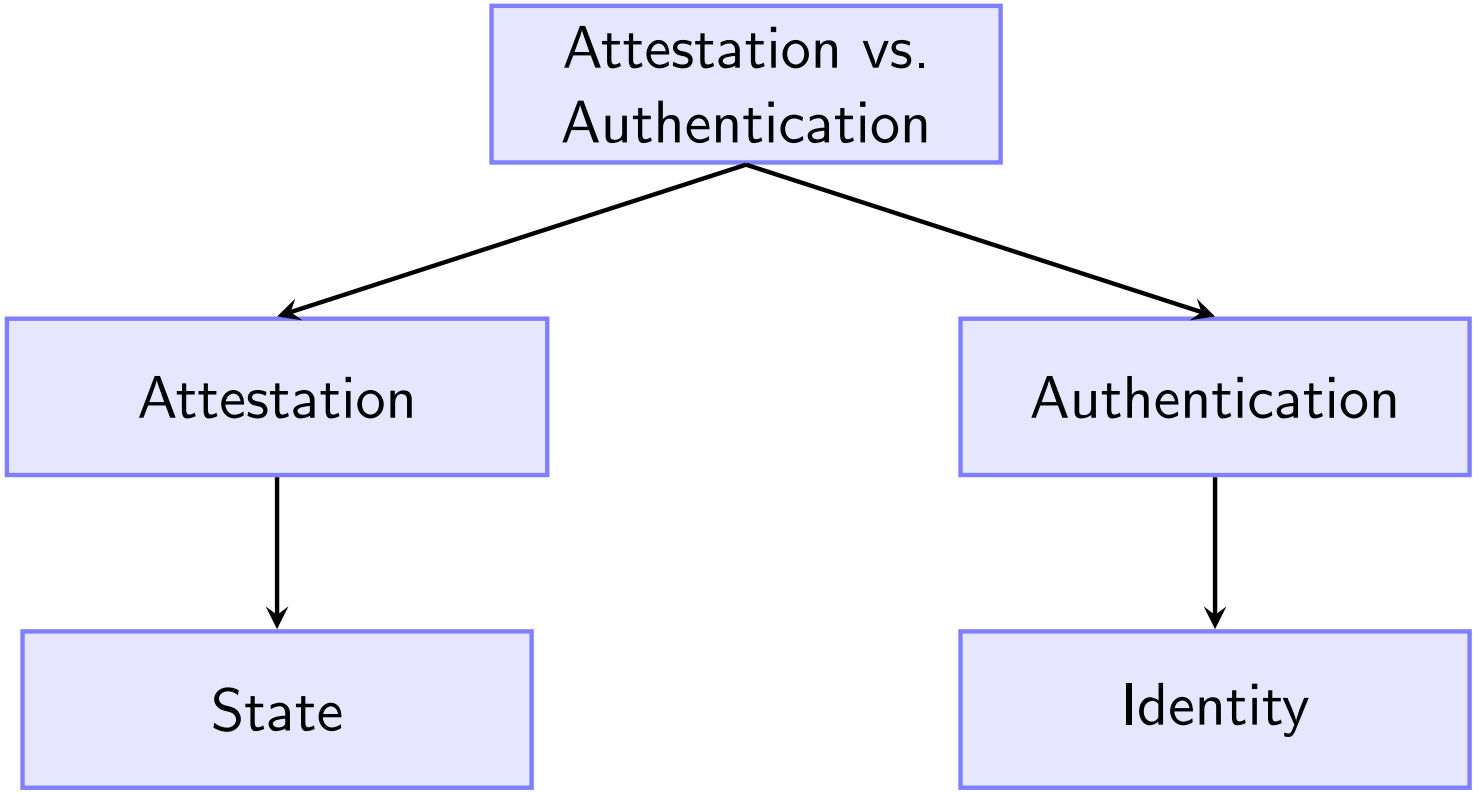

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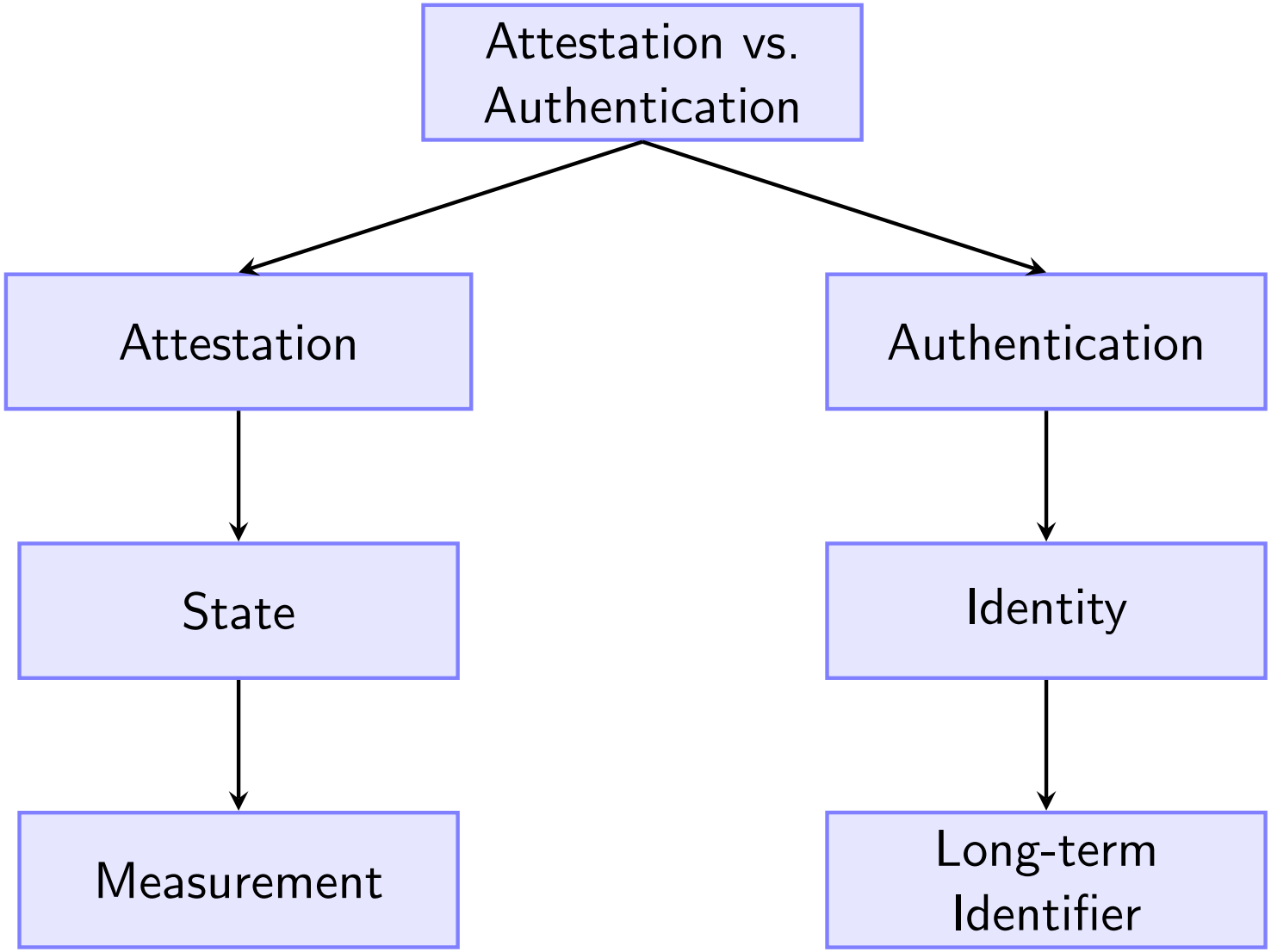
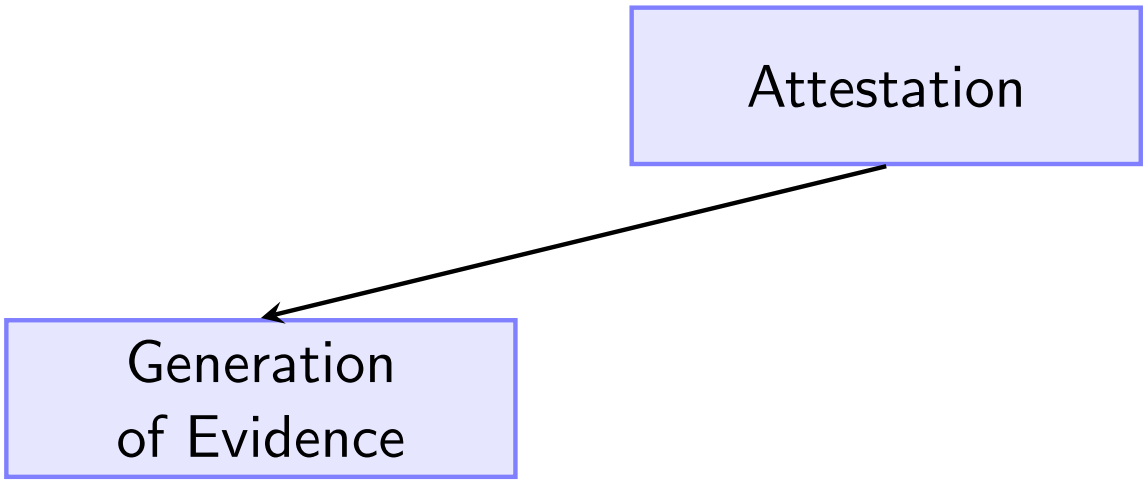
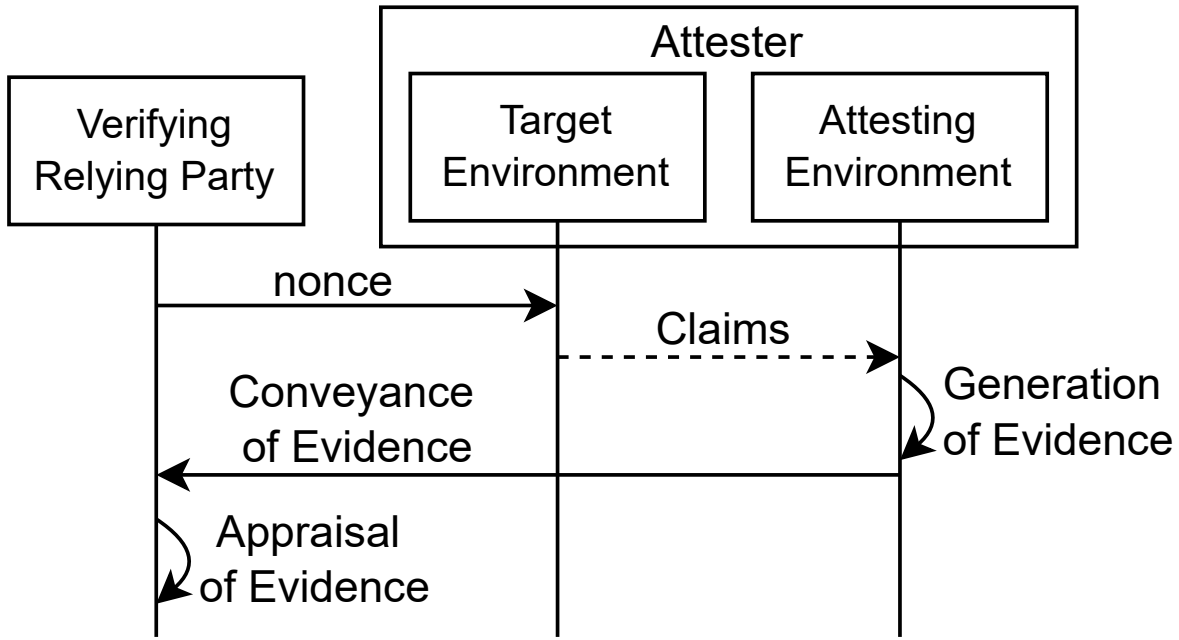


Protocol Perspective (Simplified)





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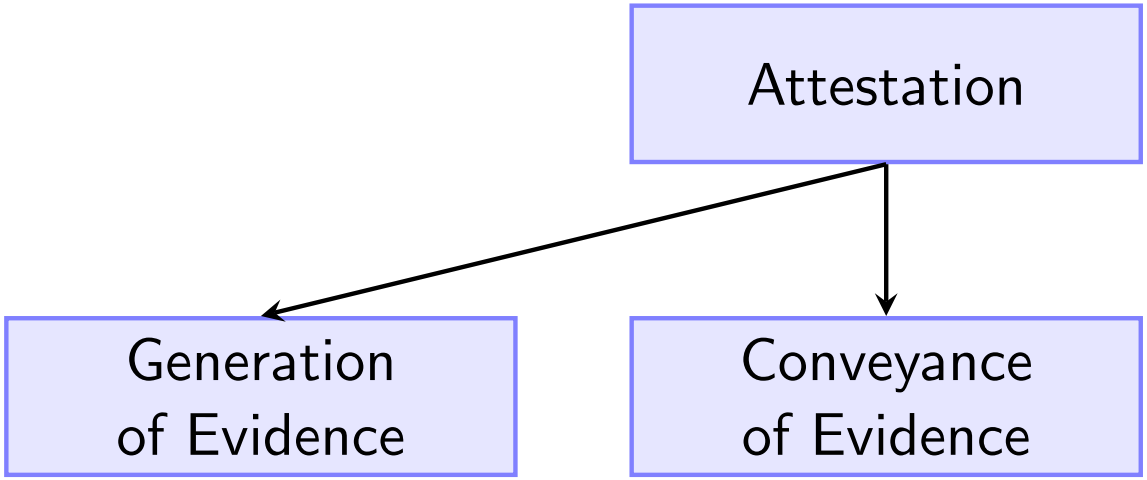

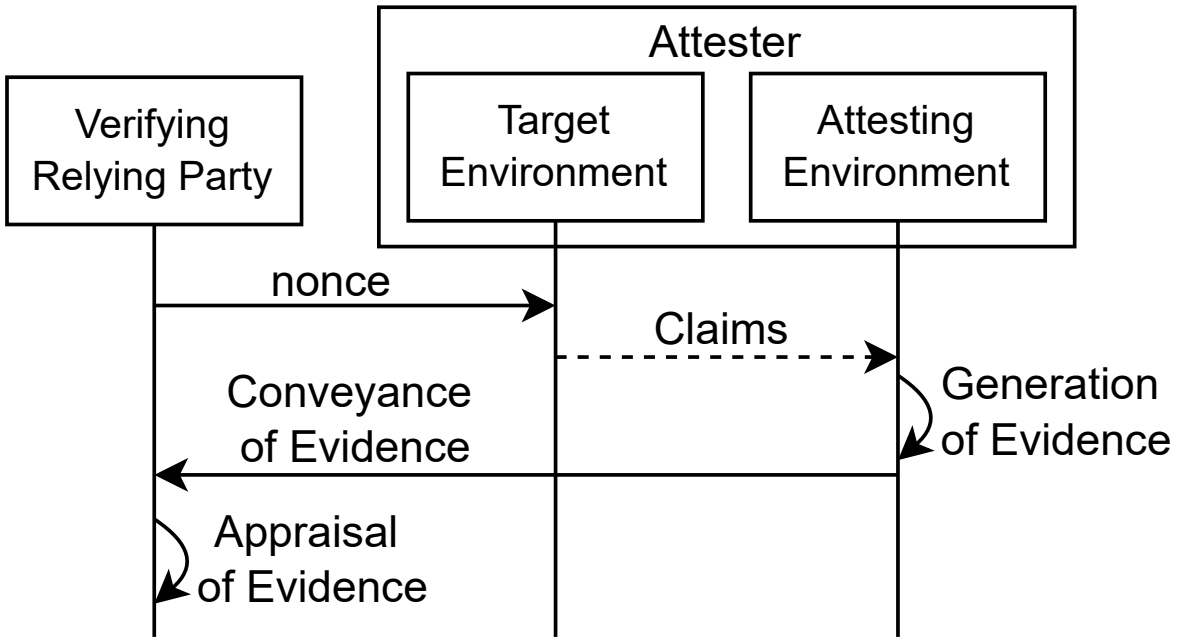

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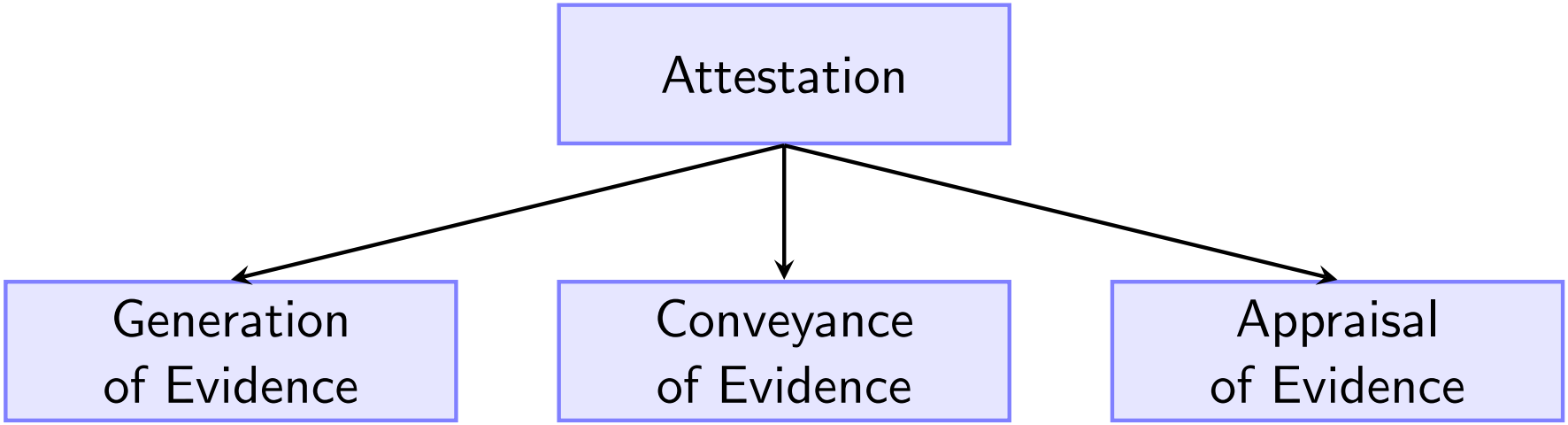
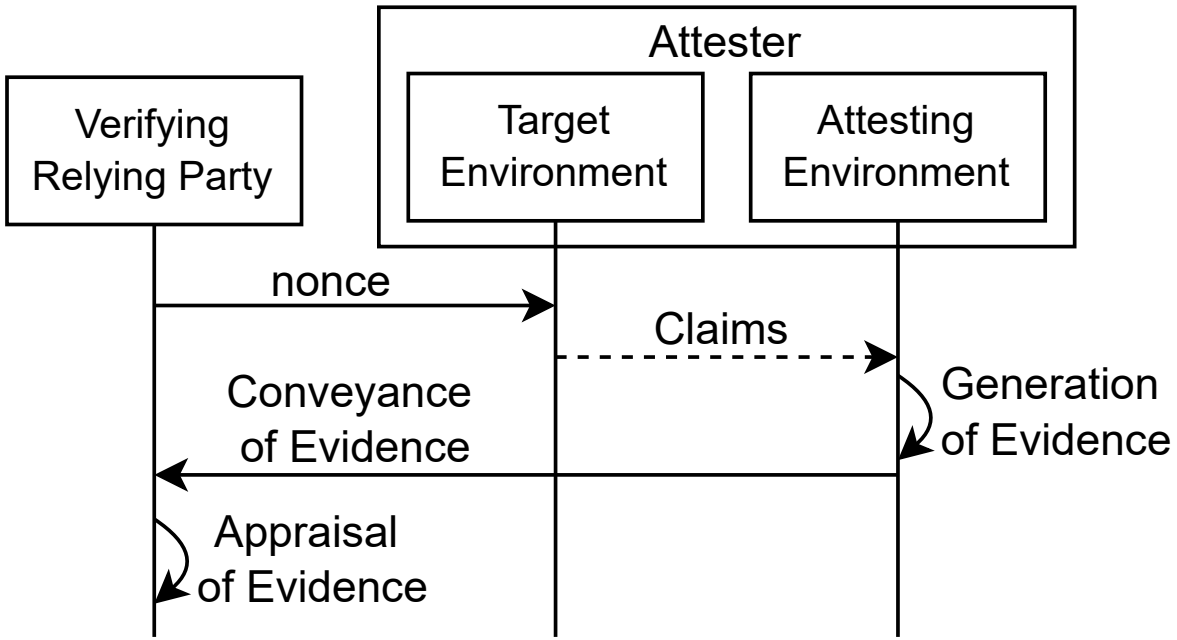
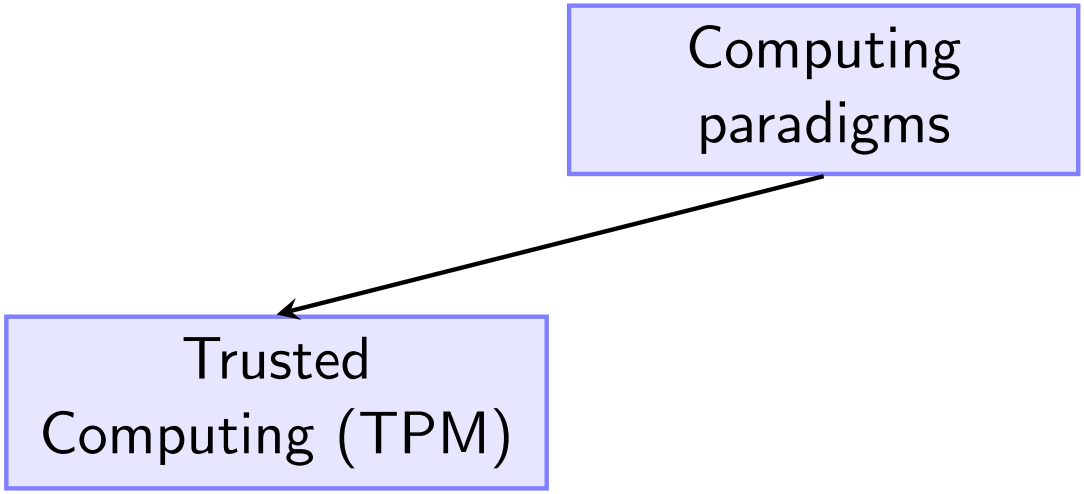




Computing Paradigms using Attestation



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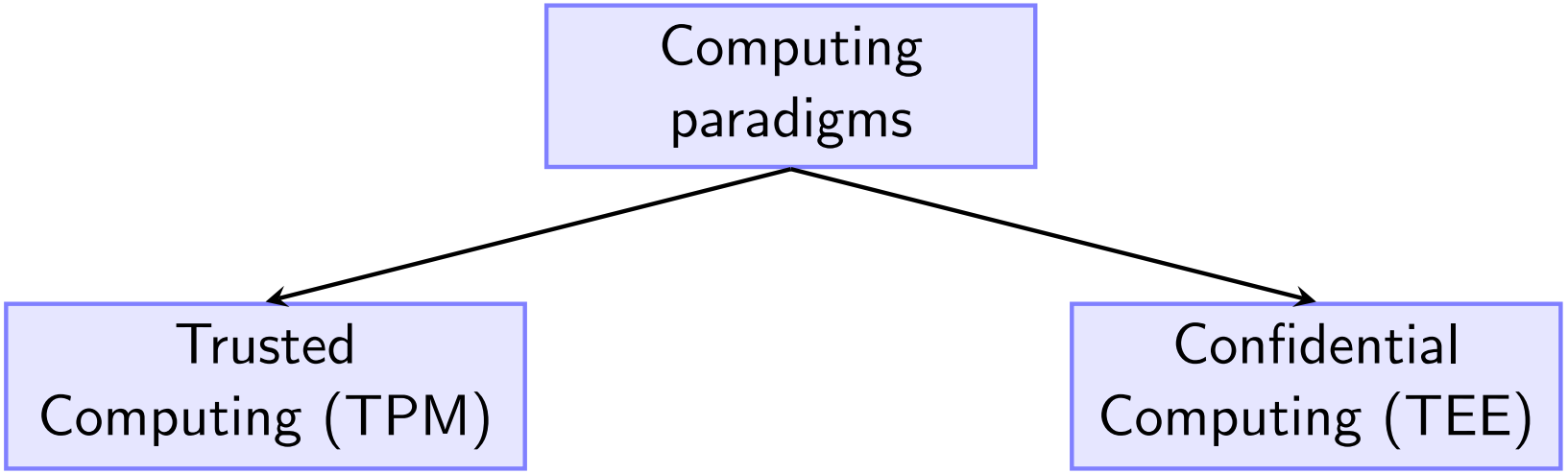

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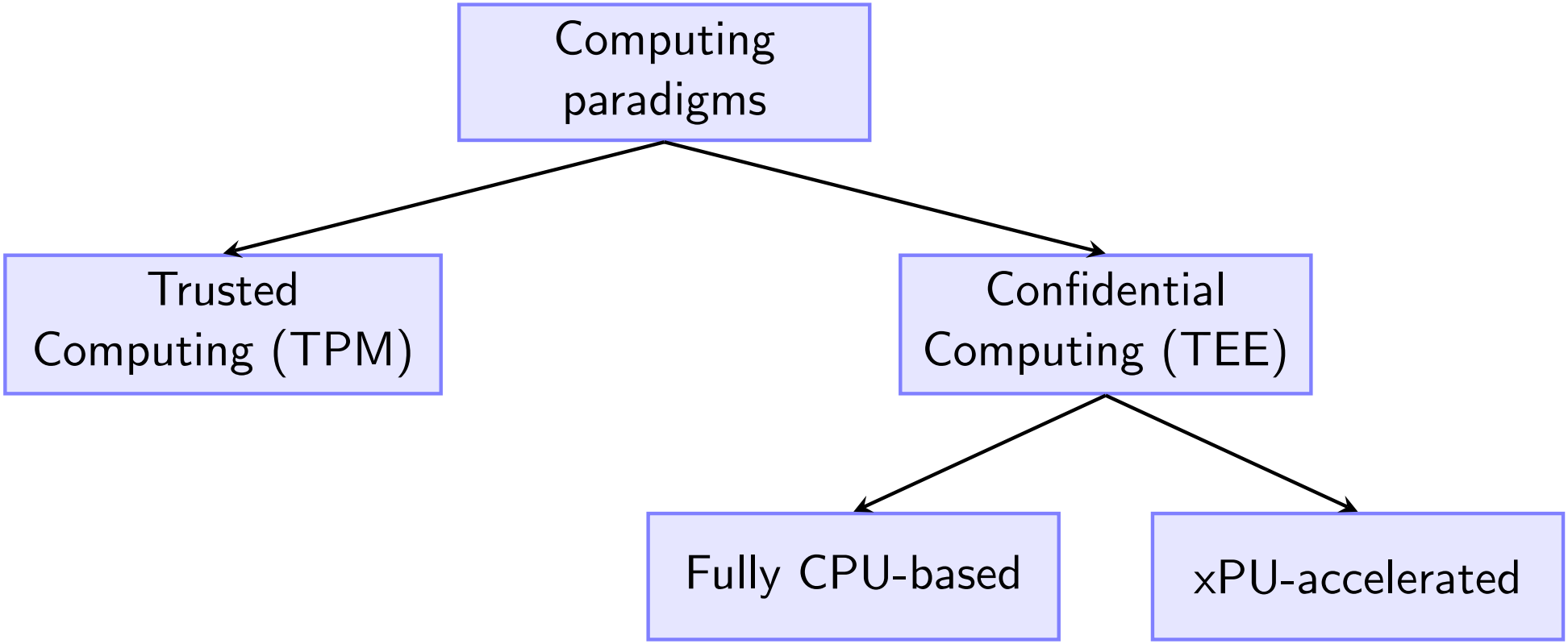

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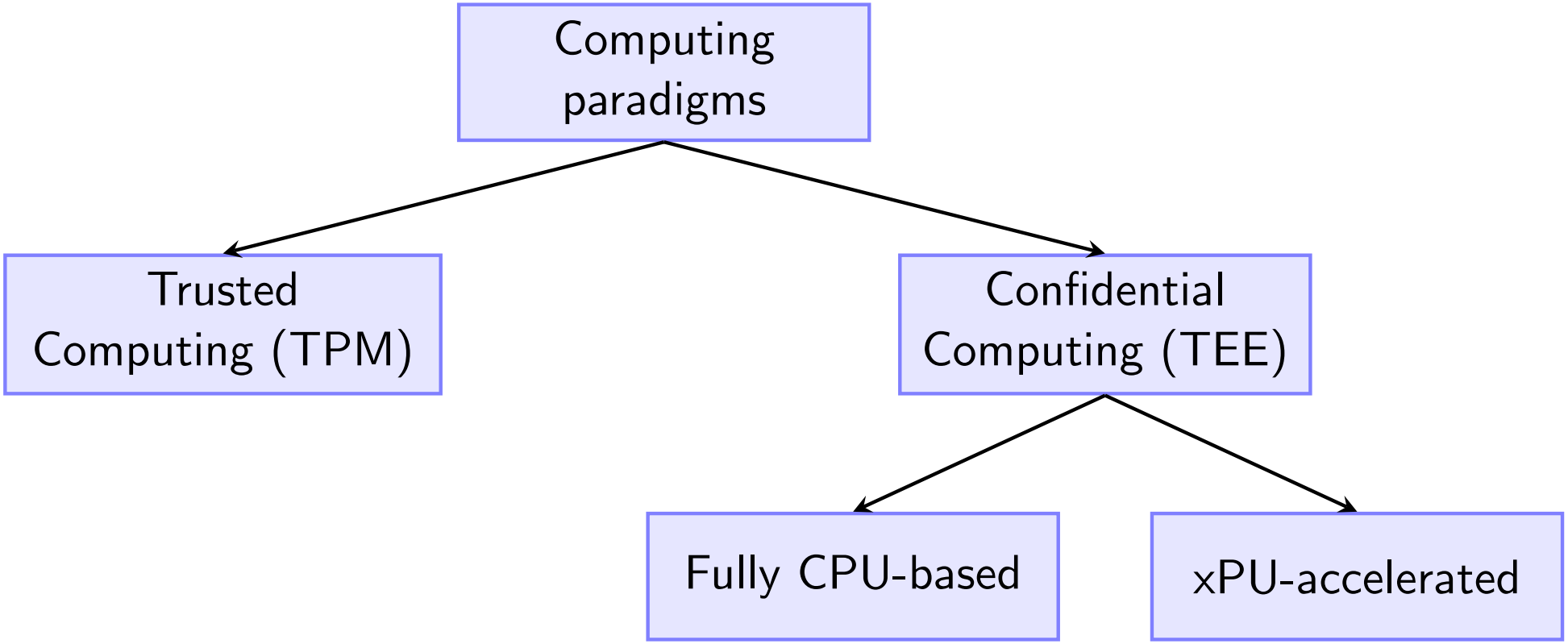
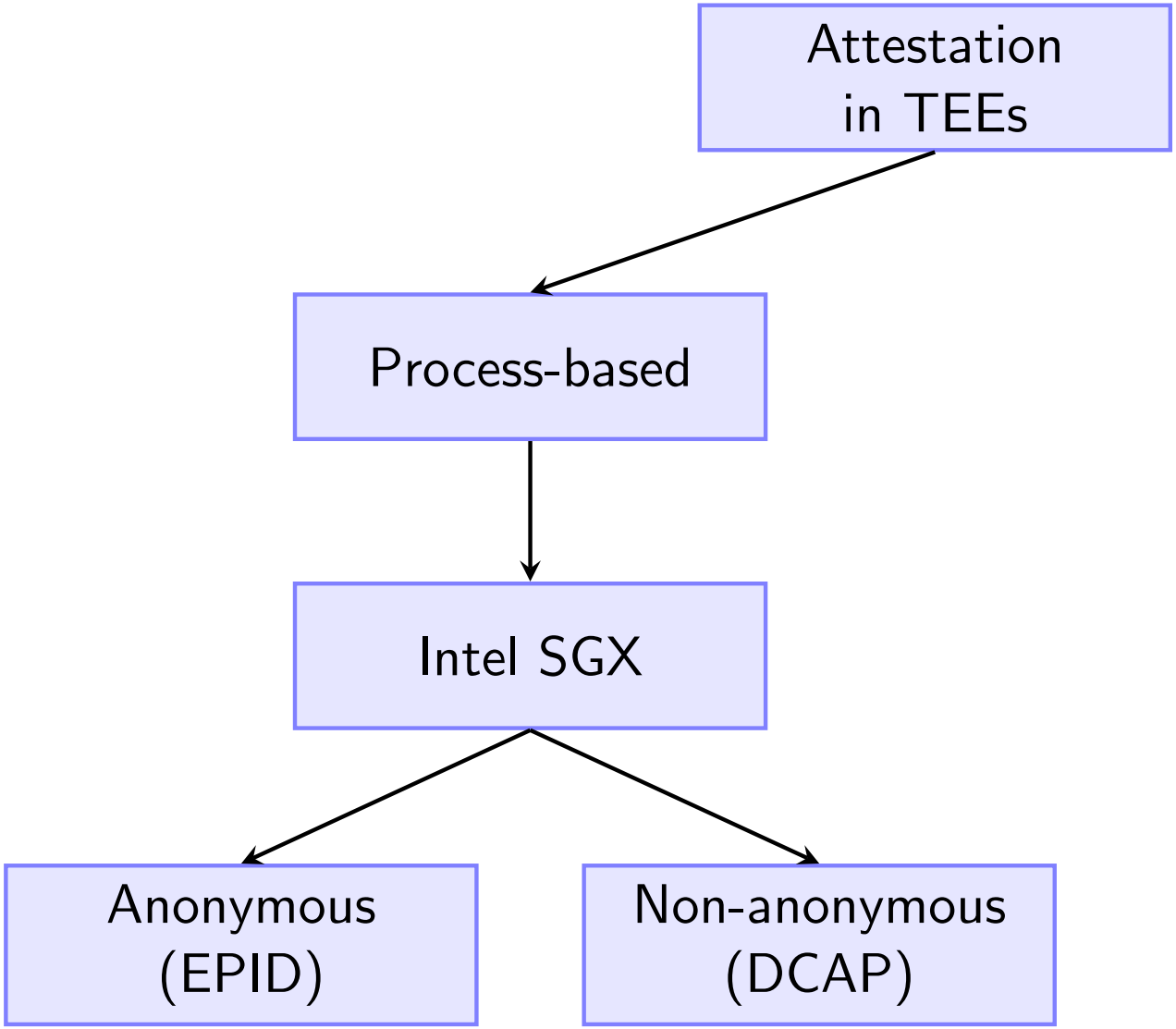
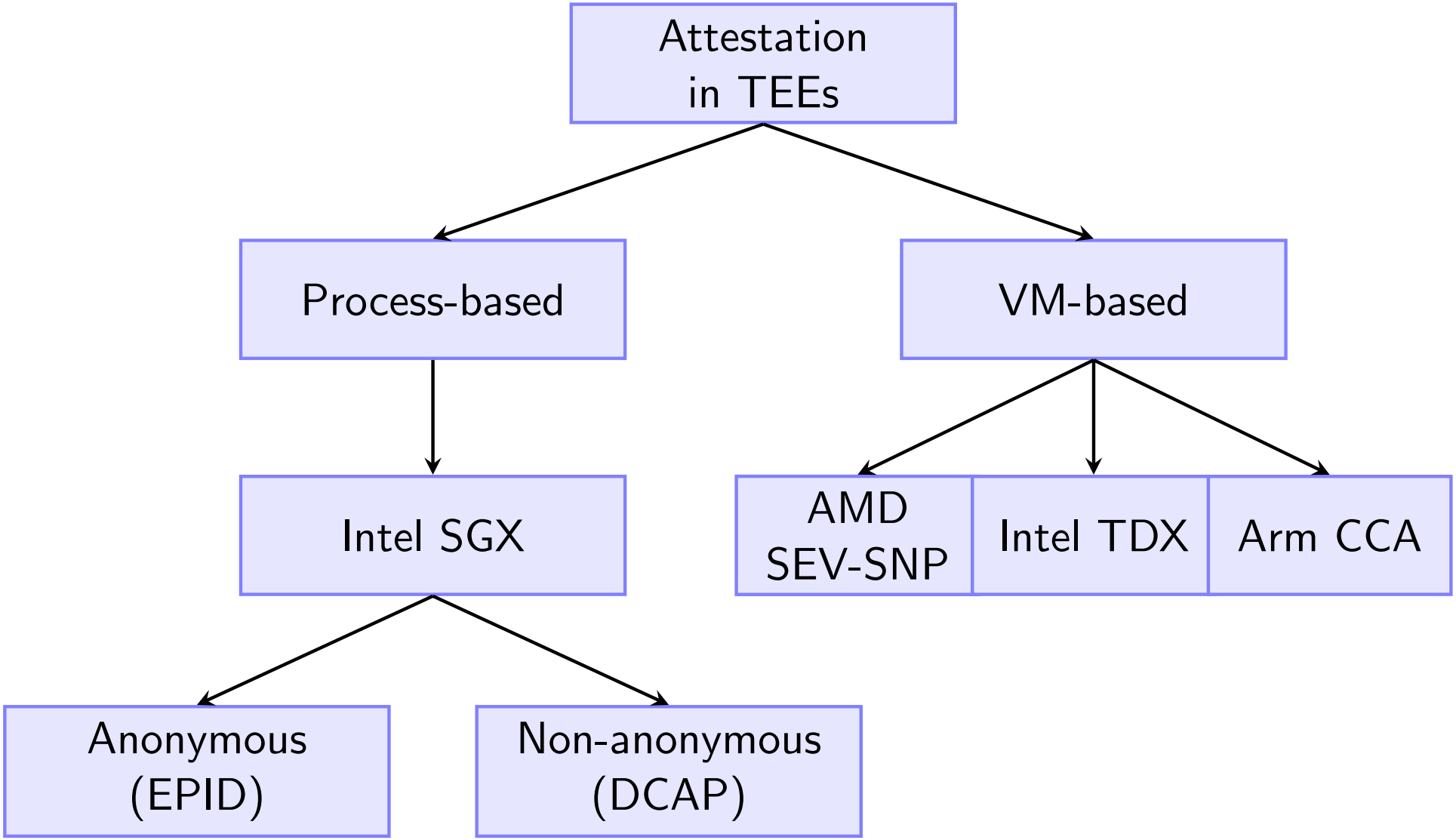


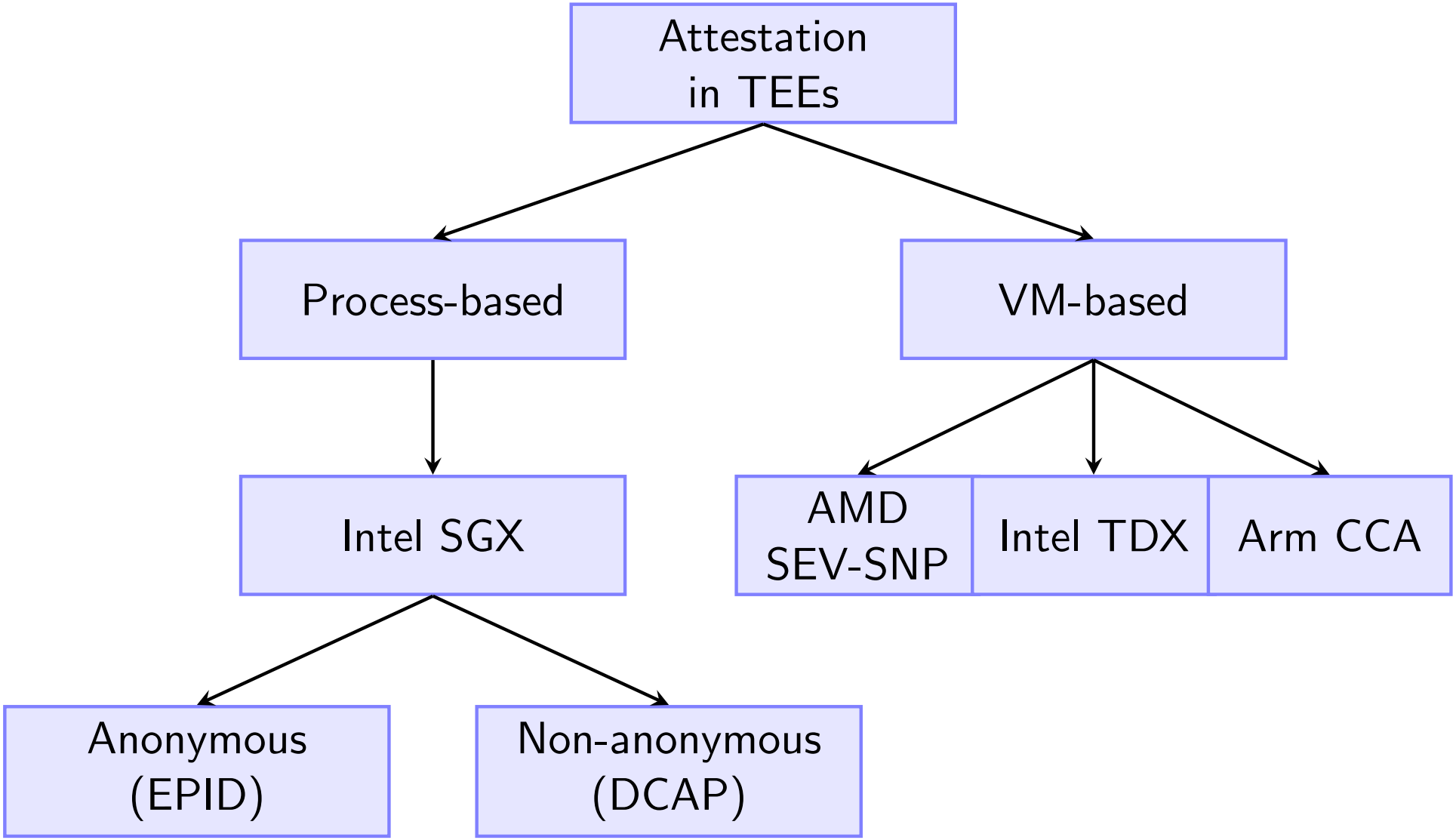
Attestation in Fully-CPU based CC



Attestation in Fully-CPU based CC

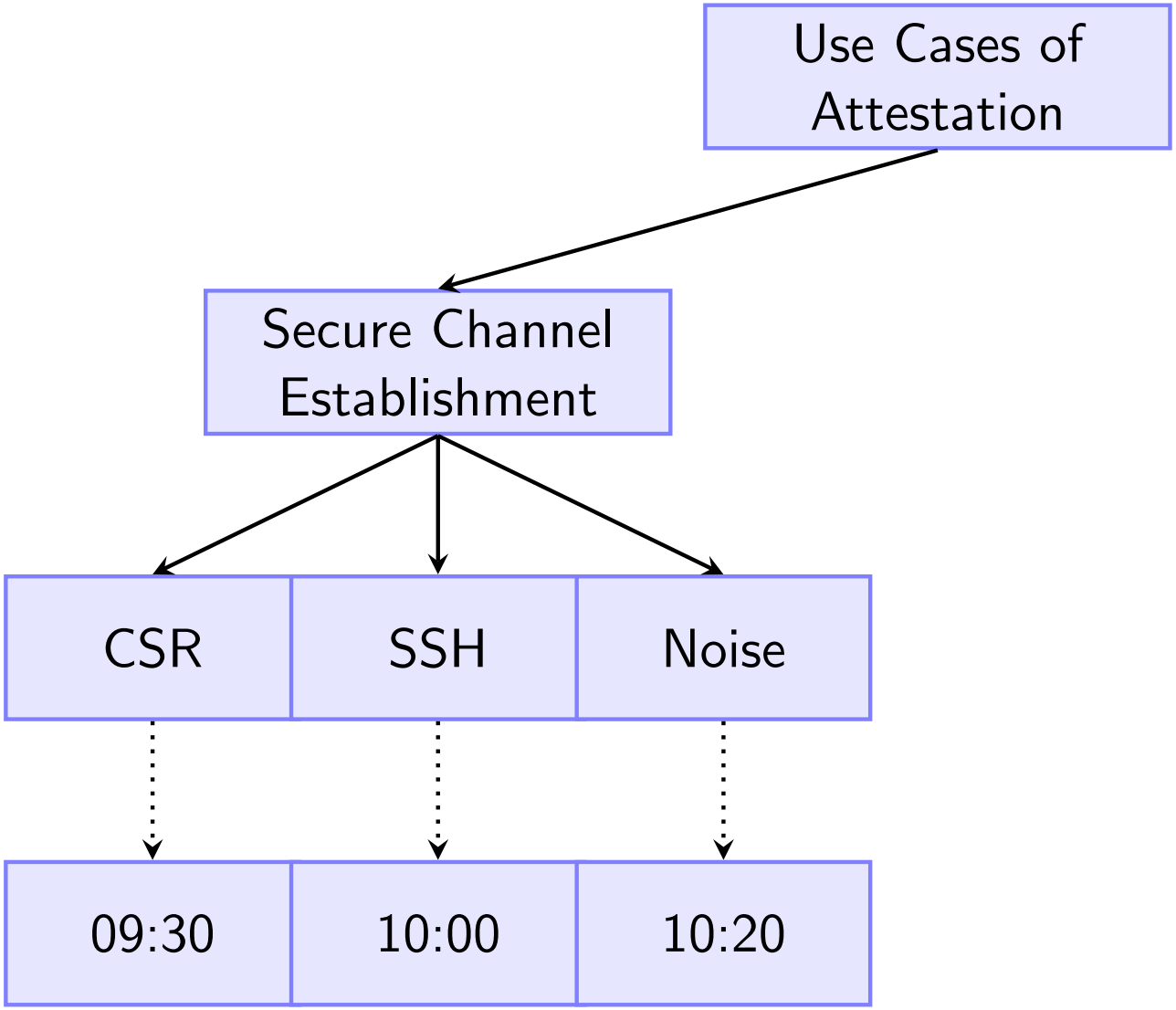


Attestation in Fully-CPU based CC

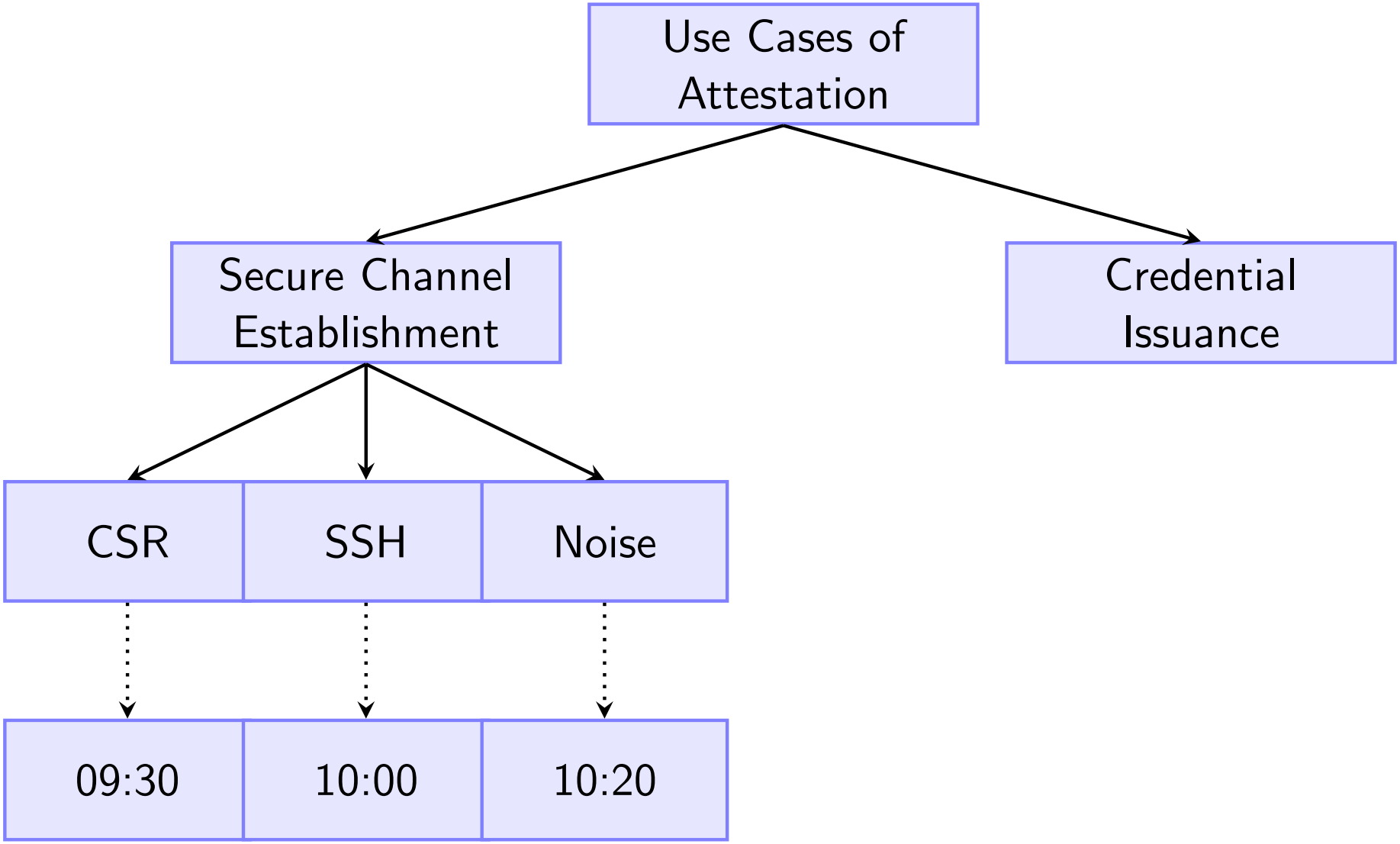


Planned EPID End Of Life (EOL): 2 April, 2025 (source)

Use Cases of Attestation



Use Cases of Attestation



Outline

Example: Attested TLS

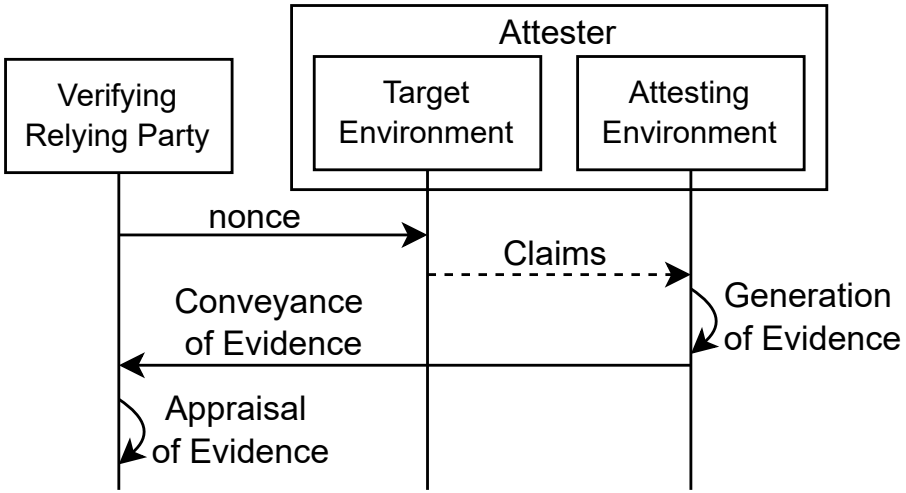


Figure: Remote Attestation

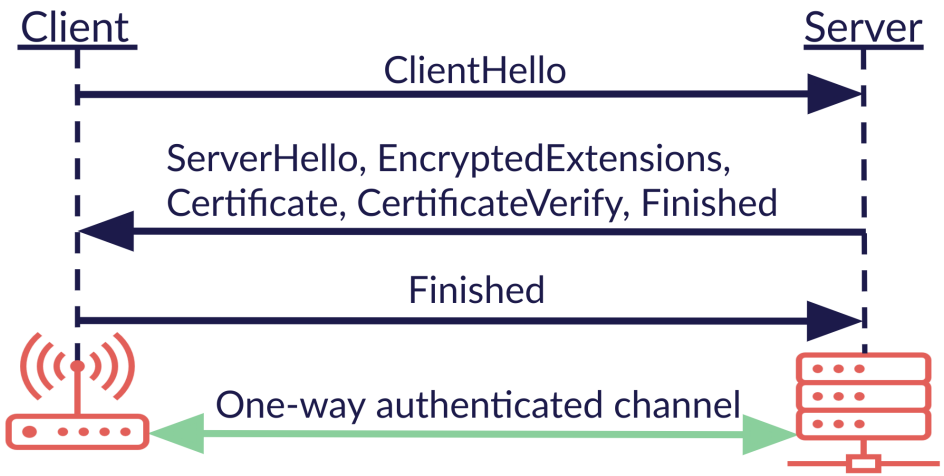
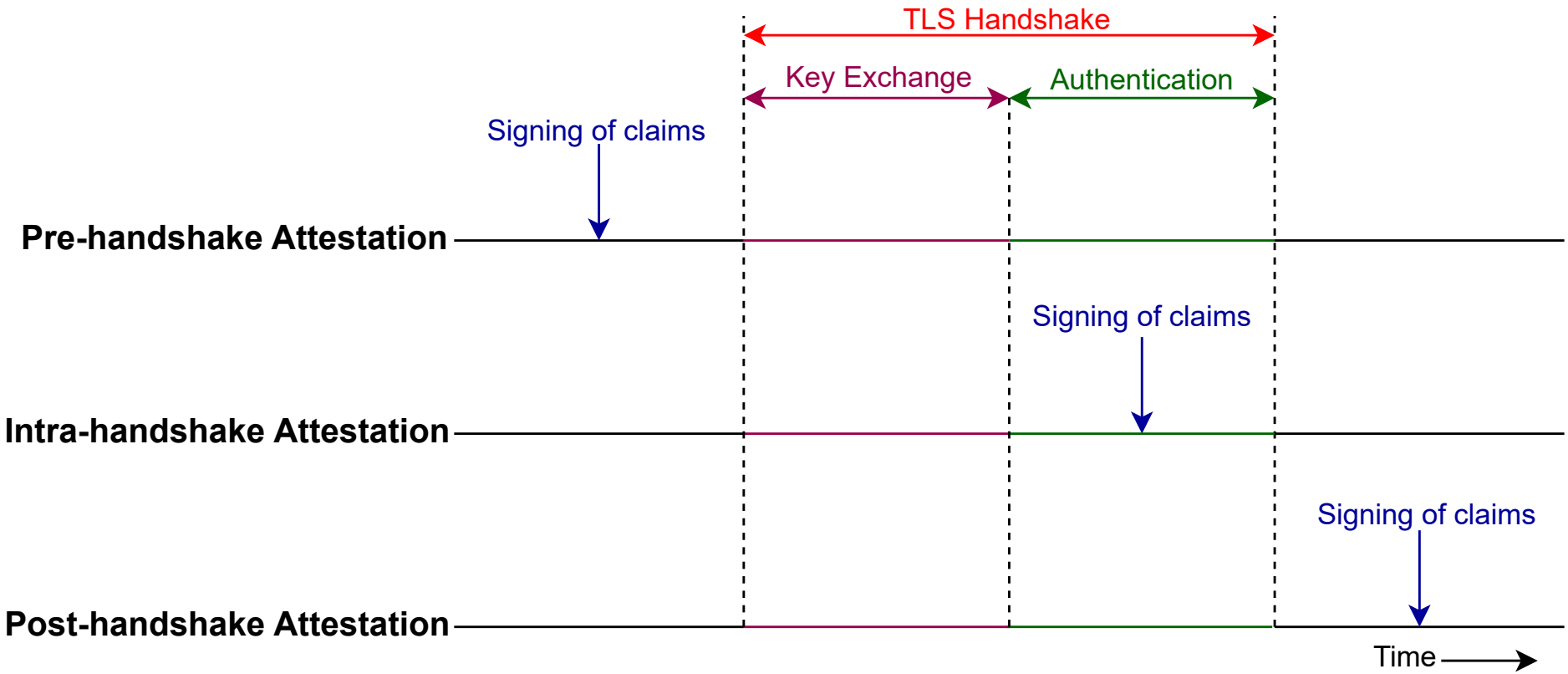


Figure: TLS 1.3

Pre-/Intra-/Post-HS Attestation



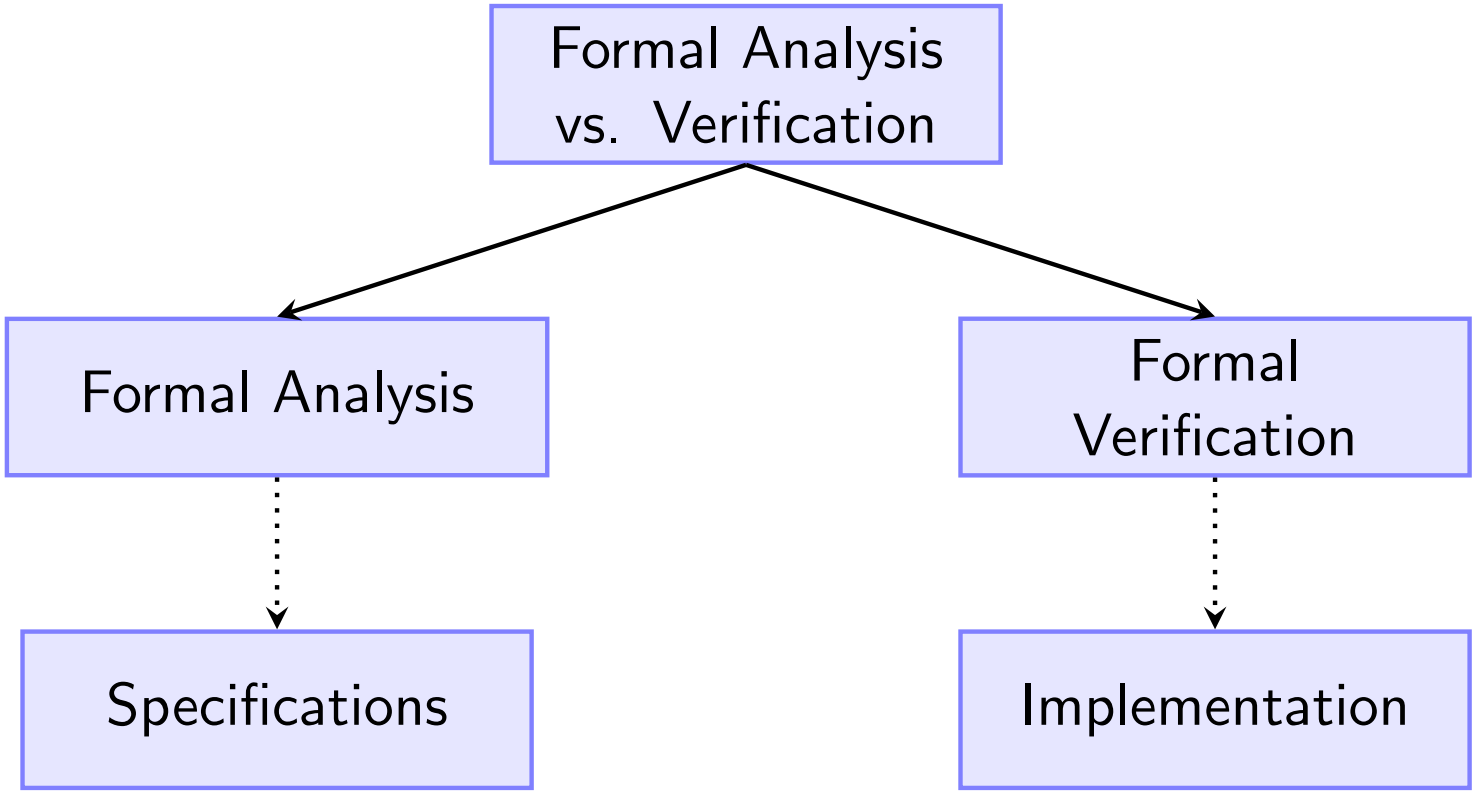
Talks Today: Attested Secure Channels

	Pre-/Intra-/Post-HS	TEE
Attested CSR	Pre-HS	Intel SGX
Attested SSH	Post-HS	Intel TDX
Attested Noise	Pre-HS?	Any

Core Idea

Open source and
precise specifications!

Formal Analysis vs. Verification



Levels of Assurance for Attested TLS Protocols

	RA-TLS[2] (Pre-HS)	TLS attest[3] (Intra-HS)	SCONE[4] (Post-HS)
(a) Open-source implementation	✓[5]	✓[6]	×
(b) Informal specifications available	×	✓[7]	×
(c) Formal specifications	✓[8]	×	×
(d) Formal analysis of specifications	✓[9]	×	×
(e) Formal verification of implementation	×	×	×

[2] Knauth, Steiner, Chakrabarti, Lei, Xing, and Vij, *Integrating Remote Attestation with Transport Layer Security*, 2018.

[3] Tschofenig, Sheffer, Howard, Mihalcea, Deshpande, Niemi, and Fossati, *Using Attestation in Transport Layer Security (TLS) and Datagram Transport Layer Security (DTLS)*, 2024.

[4] Arnautov et al., "SCONE: Secure Linux Containers with Intel SGX", 2016.

[5] *Gramine*, 2024.

[6] *Hardware-Backed Attestation in TLS*, 2024.

[7] Tschofenig, Sheffer, Howard, Mihalcea, Deshpande, Niemi, and Fossati, *Using Attestation in Transport Layer Security (TLS) and Datagram Transport Layer Security (DTLS)*, 2024.

[8] Sardar, Niemi, Tschofenig, and Fossati, "Towards Validation of TLS 1.3 Formal Model and Vulnerabilities in Intel's RA-TLS Protocol", 2024.

[9] Sardar, Niemi, Tschofenig, and Fossati, "Towards Validation of TLS 1.3 Formal Model and Vulnerabilities in Intel's RA-TLS Protocol", 2024.

Outline

Verifiers and friends

- Verification is a central concept in Attestation
- The act of appraising (making sense of) Evidence.
- Driven by a Policy provided by the *"Verifier Owner"*
- Informed by supply chain inputs: Reference Values (Attester's desired state) and Endorsements (Attester's actual state)
- Produces a (signed) appraisal statement called Attestation Result
- The AR is used by a Relying Party in a trust decision regarding the Attester
- The RATS architecture provides a dedicated role: Verifier
- Verifier can be a separate TTP, or co-located with RP

Verifiers and friends (cont.)

There are talks that directly or indirectly involve the most relevant OSS verifier [and Verifying RPs] projects:

- CoCo/Trustee AS (Magnus)
- Veraison (Jag and Suzaki-san)
- Oak (Katsiarina and Ivan)
- Keylime (Jean, but also Thore and Anderson at Friday's attestation workshop!)

Verifiers and friends (cont.)

- Lots of good stuff!
- Different use cases, different goals
- Cross-pollination is happening
- FOSDEM, CCC, IETF, Linaro Connect, is bringing us together

(More) Talks

Reference value providers

Jean-Philippe's "Virtual Machine attestation on Arm CCA"

(Highly dynamic) Attesters

Magnus's "Measurement and Attestation Schemes for Container Sandboxes"

Conveyance protocols

Jean's Secure Push Attestation with Extensible REST APIs

RATS end-to-end integrations

Jag's "Remote Attestation in the cloud"

Suzaki-san's "Remote Attestation on Arm TrustZone OP-TEE with Veraison Verifier"

Outline

Honorable Mentions (some presented in Friday workshop[10])

- Content Authenticity & its Provenance (Yogesh Deshpande)
- APIs for Endorsement Flows (Paul Howard)
- Expanding Keylime: Attestation for TEEs (Anderson Toshiyuki Sasaki)
- Remote Attestation for Confidential MPC and Collaborative AI (Drasko Draskovic, Danko Miladinovic)
- Attestation in Production (Jonathan McDowell)
- Trustless Attestation Verification with Zero-Knowledge Proofs (Dayeol Lee)
- TPM based Remote Attestation: Pitfalls and Lessons Learned (Thore Sommer)
- Secure Cloud-Native IoT (Anastassios Nanos)
- Lightweight Intra-handshake Attestation over EDHOC (Yuxuan)
- Attestation Servers and Protocols (Klaus Heinrich Kiwi, Yash Mankad)
- Privacy-Preserving Attestation (Oana Barbu)
- Attested TLS for Confidential Computing (Muhammad Usama Sardar)

[10] `https://github.com/muhammad-usama-sardar/attestation-workshop-fosdem25`

ACK

- Hannes Tschofenig (University of Applied Sciences Bonn-Rhein-Sieg and Siemens)
- Simon Frost (Arm)
- Ned Smith (Intel)
- Arto Niemi (Huawei)
- Tuomas Aura (Aalto University)
- Ionut Mihalcea (Arm)
- Carsten Weinhold (Barkhausen Institut)
- Michael Roitzsch (Barkhausen Institut)
- Yogesh Deshpande (Arm)
- Yaron Sheffer (Intuit)
- Cedric Fournet (Microsoft)
- Thore Sommer (Kiel University)
- Nikolaus Thümmel (Scontain)
- Giridhar Mandyam (Mediatek)
- Jonathan Hoyland (Cloudflare)
- Laurence Lundblade (Security Theory LLC)
- Gilang Mentari Hamidy (KU Leuven)
- Jo Van Bulck (KU Leuven)
- Dionna Amalie Glaze (Google)
- Kathleen Moriarty (Transforming Information Security LLC)

Special thanks for help in devroom organization!

- Ionut Mihalcea (Arm)
- Jo Van Bulck (KU Leuven)
- Fritz Alder (NVIDIA)

Key References

Arnautov, Sergei et al. "SCONE: Secure Linux Containers with Intel SGX". In: *USENIX Symposium on Operating Systems Design and Implementation*. 2016, pp. 689–703. URL: https://www.usenix.org/conference/osdi16/technical-sessions/presentation/arnautov.

Gramine. 2024. URL: https://github.com/gramineproject/gramine/tree/master/CI-Examples/ra-tls-mbedtls (visited on 10/10/2024).

Hardware-Backed Attestation in TLS. 2024. URL: https://github.com/CCC-Attestation/attested-tls-poc (visited on 11/30/2024).

Knauth, T., M. Steiner, S. Chakrabarti, L. Lei, C. Xing, and M. Vij. *Integrating Remote Attestation with Transport Layer Security*. Tech. rep. Intel Labs, 2018. URL: https://arxiv.org/abs/1801.05863.

Sardar, Muhammad Usama, Thomas Fossati, Simon Frost, and Shale Xiong. "Formal Specification and Verification of Architecturally-defined Attestation Mechanisms in Arm CCA and Intel TDX". In: *IEEE Access* 12 (2024), pp. 361–381. DOI: 10.1109/ACCESS.2023.3346501.

Sardar, Muhammad Usama, Arto Niemi, Hannes Tschofenig, and Thomas Fossati. "Towards Validation of TLS 1.3 Formal Model and Vulnerabilities in Intel's RA-TLS Protocol". In: *IEEE Access* 12 (2024), pp. 173670–173685. DOI: 10.1109/ACCESS.2024.3497184.

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Exciting Talks!

Event	Speakers	Start	End
Sunday			
Welcome to attestation devroom!	Thomas Fossati, Muhammad Usama Sardar	09:00	09:25
Binding Intel SGX Root-of-Trust to PKI to Establish High-Performant Trusted Channel Between Enclaves	Gilang Mentari Hamidy	09:30	09:55
Integrating Intel TDX remote attestation into SSH	Fabian Wesemann	10:00	10:15
Attested Noise Protocol for Low-TCB Trusted Execution Environments	Ivan Petrov, Katsiaryna Naliuka	10:20	10:45
Secure Push Attestation with Extensible REST APIs	Jean Snyman	10:50	11:20
Measurement and Attestation Schemes for Container Sandboxes	Magnus Kulke	11:25	11:50
Virtual Machine attestation on Arm CCA	Jean-Philippe Brucker	11:55	12:10
Remote Attestation in the cloud	Jagannathan Raman	12:15	12:35
Remote Attestation on Arm TrustZone OP-TEE with VERAISON Verifier --- current status and future plan ---	Kuniyasu Suzaki	12:40	13:00