PQC @ ETSI

Matthew Campagna

2023-03-03

Outline

A brief history of the TC CYBER WG QSC

Basic information about the working group today

Completed Technical Recommendations and Specifications

Concatenate & Cascade Hybrid Key Exchanges

Current Work Items

How to participate in ETSI TC CYBER WG QSC

AWS's perspective on PQ migration

ETSI

European Telecommunication Standards Institute

- Regionalized standards body focused on ITS
  - 29 Technical Committees, 17 Industry Specification Groups, 2 Open Source Groups
- Special role in Europe to produce Harmonized European Standards (CEN, CENELC, ETSI)
- Partners in 3GPP and oneM2M
- Funded through membership and EC, Europe Free Trade Association (EFTA)
- Director-General: Luis Jorge Romero

ETSI TC CYBER WG QSC

2013 1st ETSI-IQC Quantum Safe Cryptography Workshop

2015 ETSI published the Quantum Safe Cryptography and Security Paper

2015 ETSI Industry Specification Group (ISG) on QSC

2017 QSC becomes a working group of TC CYBER

Meetings are coordinated with CYBER, meet 4 times a year in Sophia-Antipolis

ETSI TC CYBER WG QSC

Chair: Matthew Campagna (Amazon)

Vice chairs:

Philip Lafrance (ISARA)

Dan Grundy (NCSC)

Secretary: Anthony Barnett (Thales)

Technical Officer: Sonia Compans (ETSI)

Healthy participation: 30 – 40 registered participants from corporate/government/academia

Finished TR/TS

CYBER; Quantum-Safe Key Exchanges, ETSI TR 103 507 V1.1.1 (2017-10)

Quantum-Safe Public Key Encryption and Key Encapsulation, ETSI TR 103 832 V1.1.2 (2021-09)

CYBER; Quantum-Safe Signatures, ETSI TR 103 616 V1.1.1 (2021-09)

CYBER; Quantum-Safe Virtual Private Networks, ETSI TR 103 617 V1.1.1 (2018-09)

CYBER; Quantum-Safe Identity-Based Encryption, ETSI TR 103 618 V1.1.1 (2019-12)

CYBER; Migration strategies for Quantum Safe schemes, ETSI TR 103 619 V1.1.1 (2020-07)

State Management for stateful authentication mechanisms, ETSI TR 103 692 V1.1.1 (2021-11)

CYBER; Quantum-safe Hybrid Key Exchanges, ETSI TS 103 744 V1.1.1 (2020-12)

Concatenate hybrid key exchange

Alice

Bob

(d, P) = Generate( )
(sk, R) = Generate ( )

Form M_A = (P, R, …)

Concatenate hybrid key exchange

Alice

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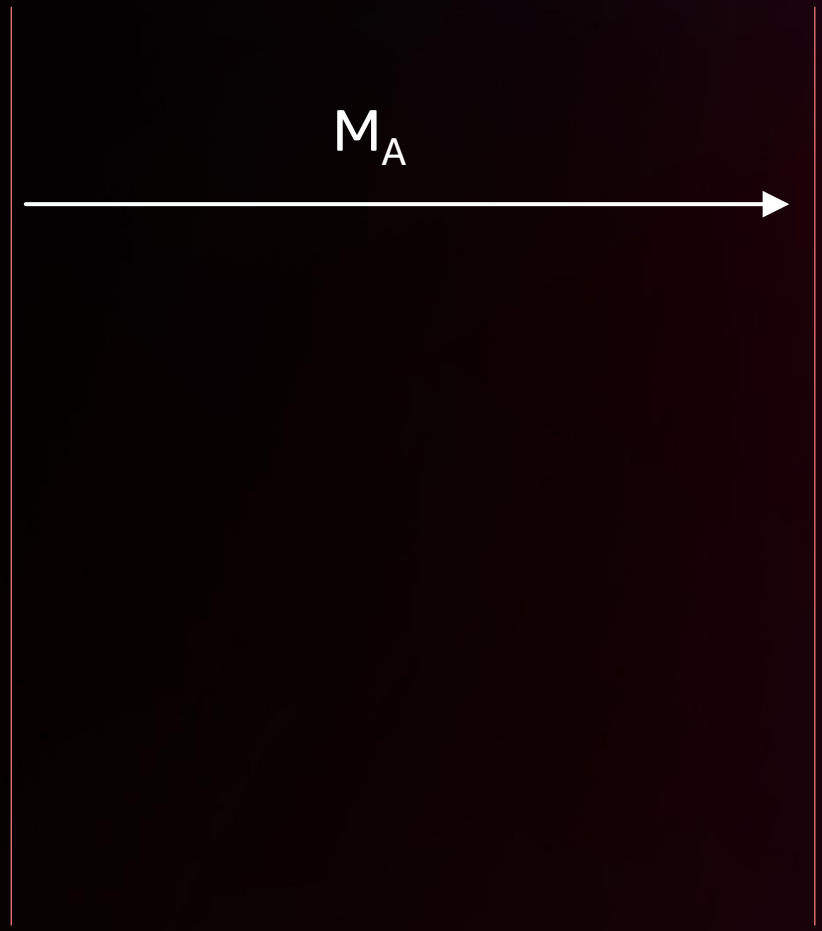
(sk, R) = Generate ( )

Form M_A = (P, R, …)



Bob

(k, Q) = Generate( )
ss, CT = Encaps(R)

Form M_B = (Q, CT, …)

Concatenate hybrid key exchange

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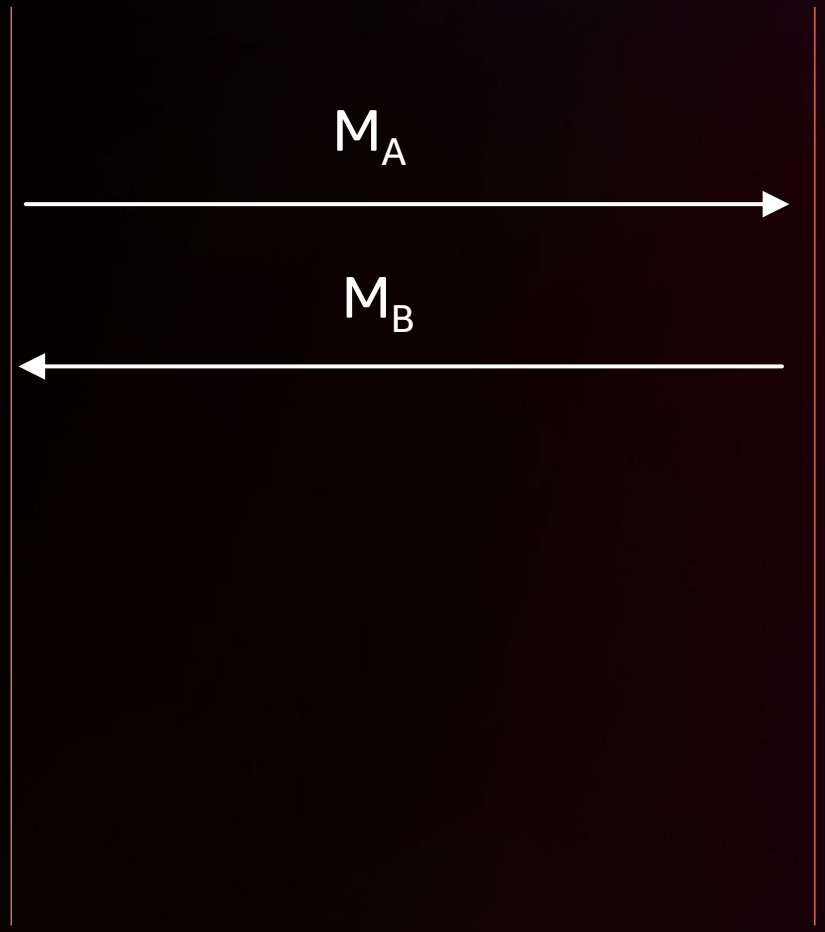

Bob

(k, Q) = Generate( )
ss, CT = Encaps(R)

Form M_B = (Q, CT, …)

ss = Decaps(sk, CT)

secret = dQ || ss

key = KDF(secret, M_A || M_B)

secret = kP || ss

key = KDF(secret, M_A || M_B)

Concatenate hybrid key exchange

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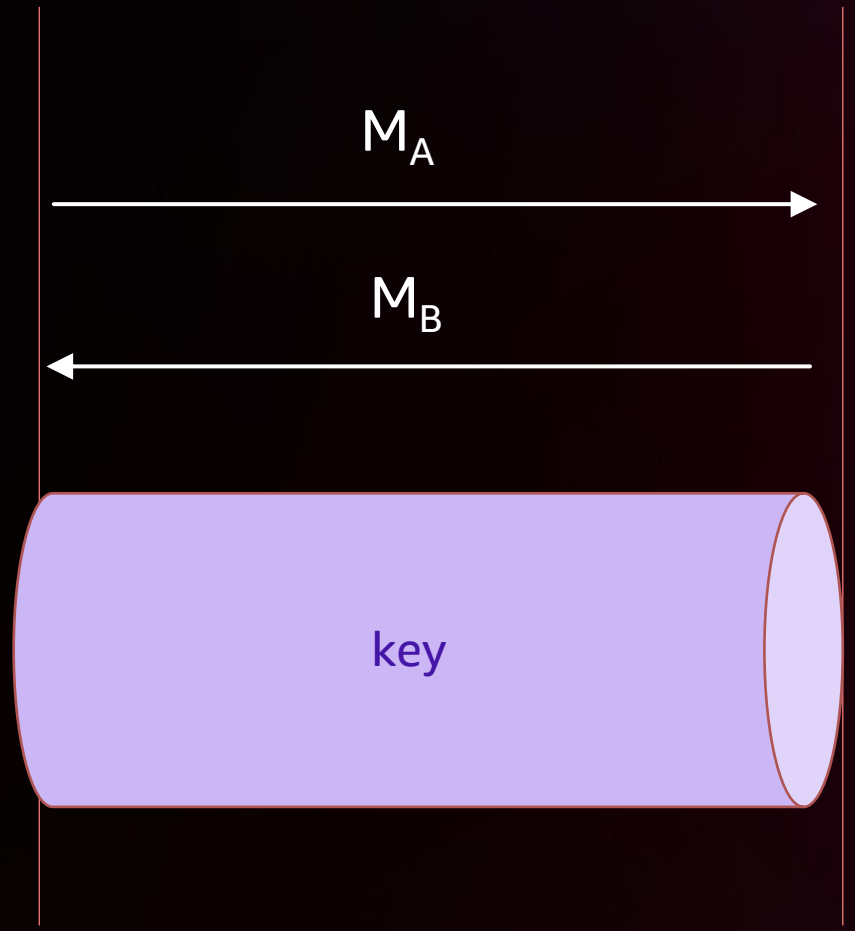

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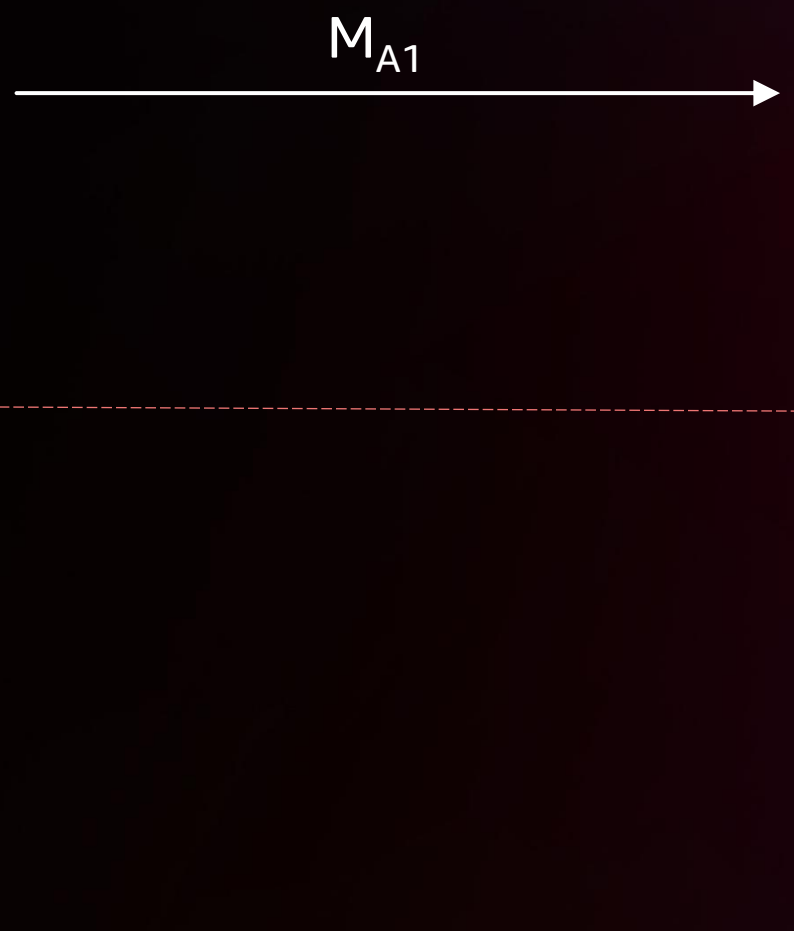
Cascade hybrid key exchange

Alice

Bob

(d, P) = Generate( )
Form M_{A1} = (P, …)



Cascade hybrid key exchange

Alice

(d, P) = Generate( )
Form M_{A1} = (P, …)

Bob

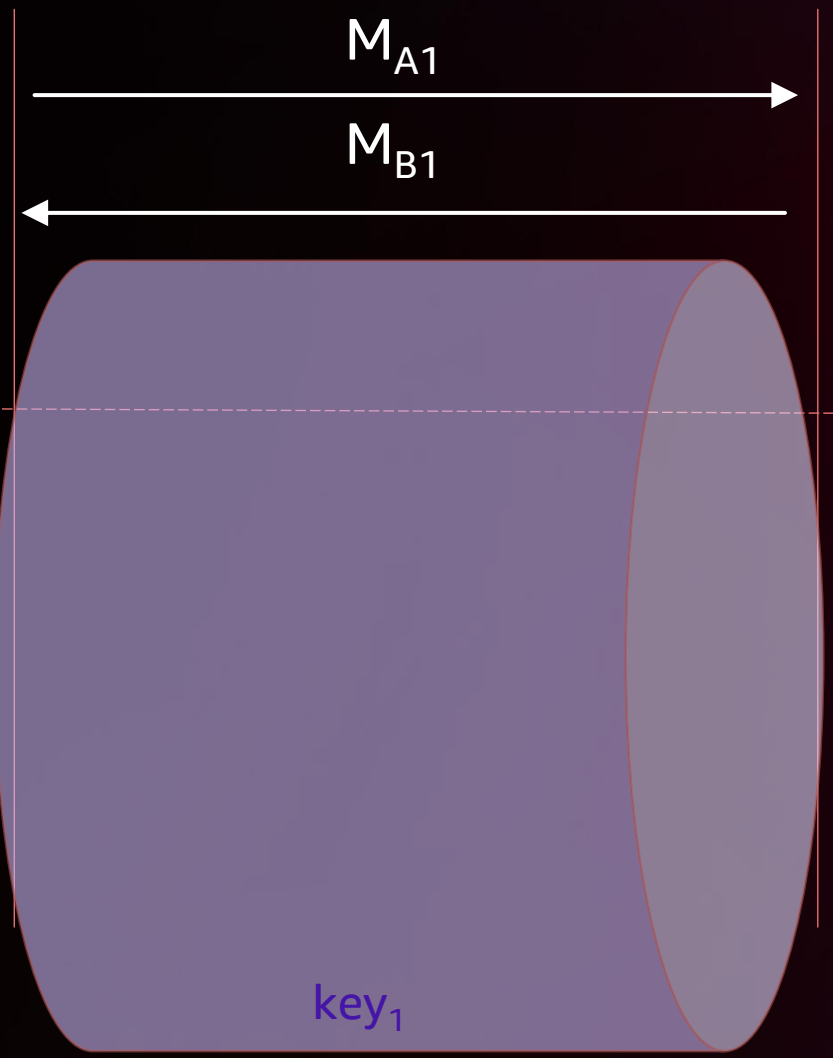
(k, Q) = Generate( )
Form M_{B1} = (Q, …)

Cascade hybrid key exchange

Alice

(d, P) = Generate( )
Form M_{A1} = (P, …)

secret = PRF(cs, dQ, M_{A1}, M_{B1})
cs || key_1 = KDF(secret, …)



Bob

(k, Q) = Generate( )
Form M_{B1} = (Q, …)

secret = PRF(cs, kP, M_{A1}, M_{B1})
cs || key_1 = KDF(secret, …)

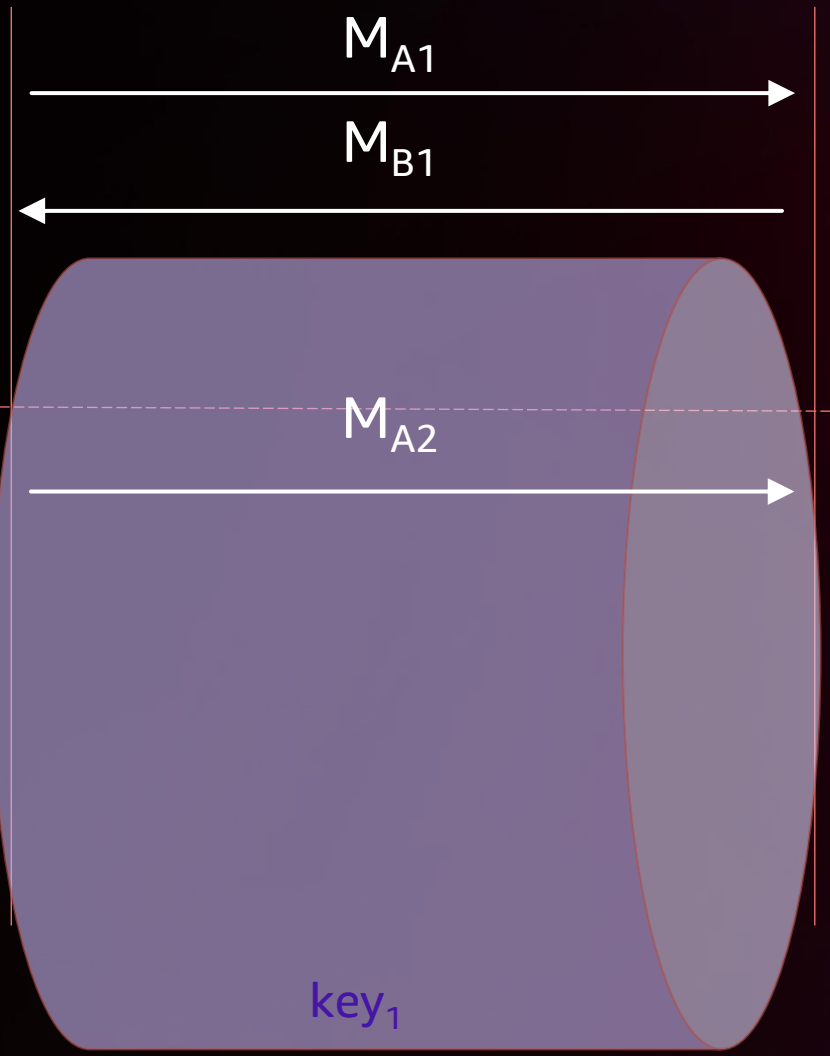
Cascade hybrid key exchange

Alice

(d, P) = Generate( )
Form M_{A1} = (P, …)

secret = PRF(cs, dQ, M_{A1}, M_{B1})
cs || key_1 = KDF(secret, …)

(sk, R) = Generate( )
Form M_{A2} = (R, …)



Bob

(k, Q) = Generate( )
Form M_{B1} = (Q, …)

secret = PRF(cs, kP, M_{A1}, M_{B1})
cs || key_1 = KDF(secret, …)

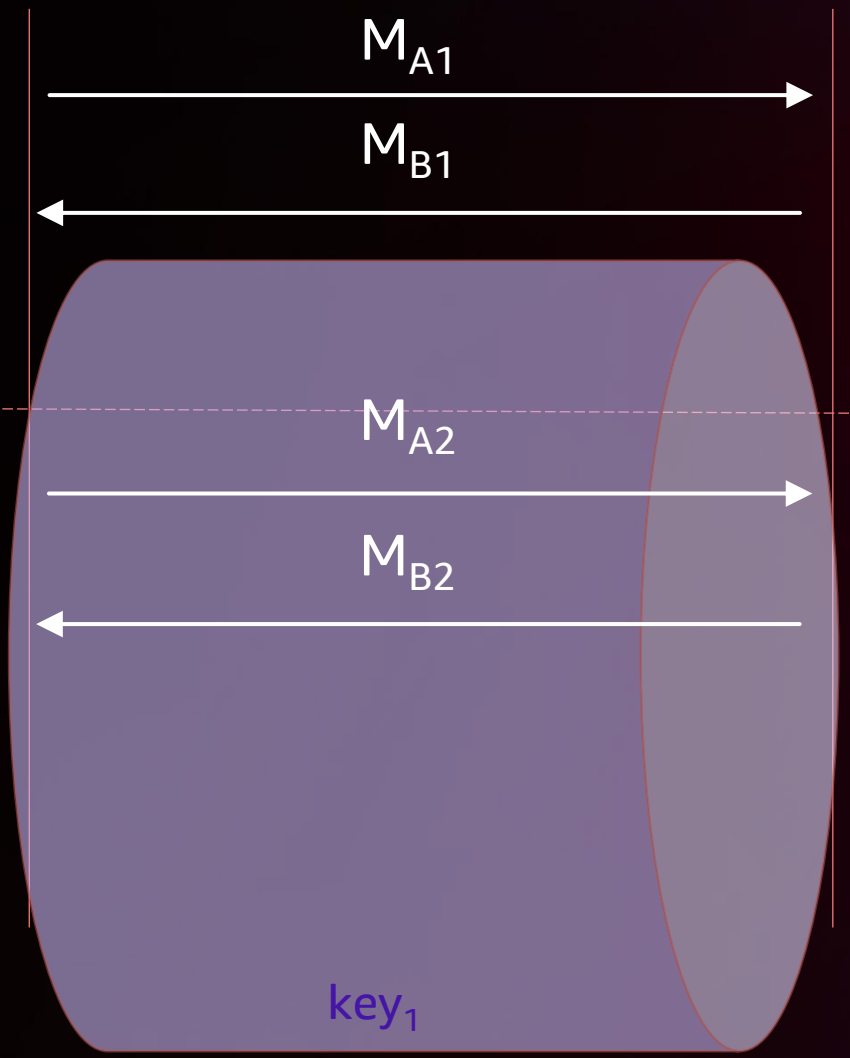
Cascade hybrid key exchange

Alice

(d, P) = Generate( )
Form M_{A1} = (P, …)

secret = PRF(cs, dQ, M_{A1}, M_{B1})
cs || key_1 = KDF(secret, …)

(sk, R) = Generate( )
Form M_{A2} = (R, …)



Bob

(k, Q) = Generate( )
Form M_{B1} = (Q, …)

secret = PRF(cs, kP, M_{A1}, M_{B1})
cs || key_1 = KDF(secret, …)

(ss, CT) = Encaps(R)
Form M_{B1} = (Q, …)

Cascade hybrid key exchange

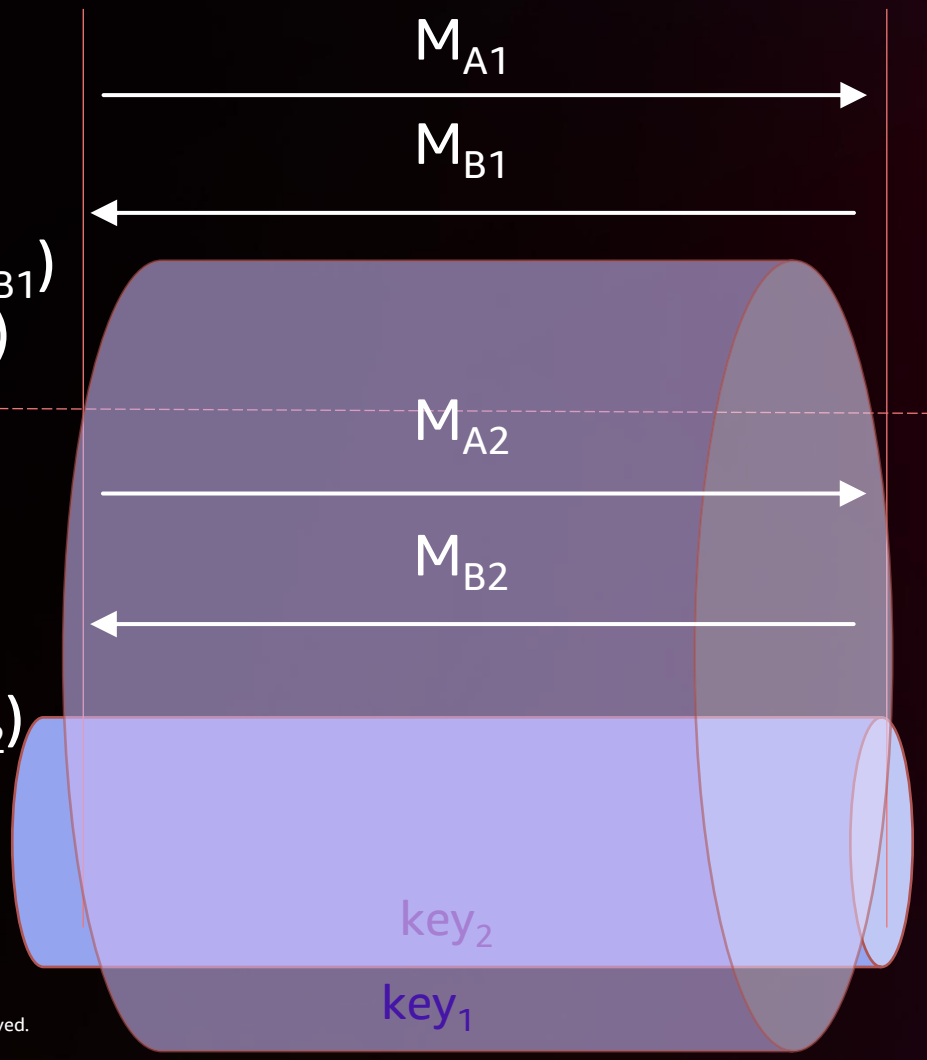
Alice

(d, P) = Generate( )
Form M_{A1} = (P, …)

secret = PRF(cs, dQ, M_{A1}, M_{B1})
cs || key_1 = KDF(secret, …)

(sk, R) = Generate( )
Form M_{A2} = (R, …)

ss = Decaps(sk, CT)
secret = PRF(cs, ss, M_{A2}, M_{B2})
cs || key_2 = KDF(secret, …)



Bob

(k, Q) = Generate( )
Form M_{B1} = (Q, …)

secret = PRF(cs, kP, M_{A1}, M_{B1})
cs || key_1 = KDF(secret, …)

(ss, CT) = Encaps(R)
Form M_{B2} = (Q, …)

secret = PRF(cs, ss, M_{A2}, M_{B2})
cs || key_2 = KDF(secret, …)

Current Work Items

CYBER; Migration to QSC for ITS, DTR/CYBER-QSC-0018 (TR)

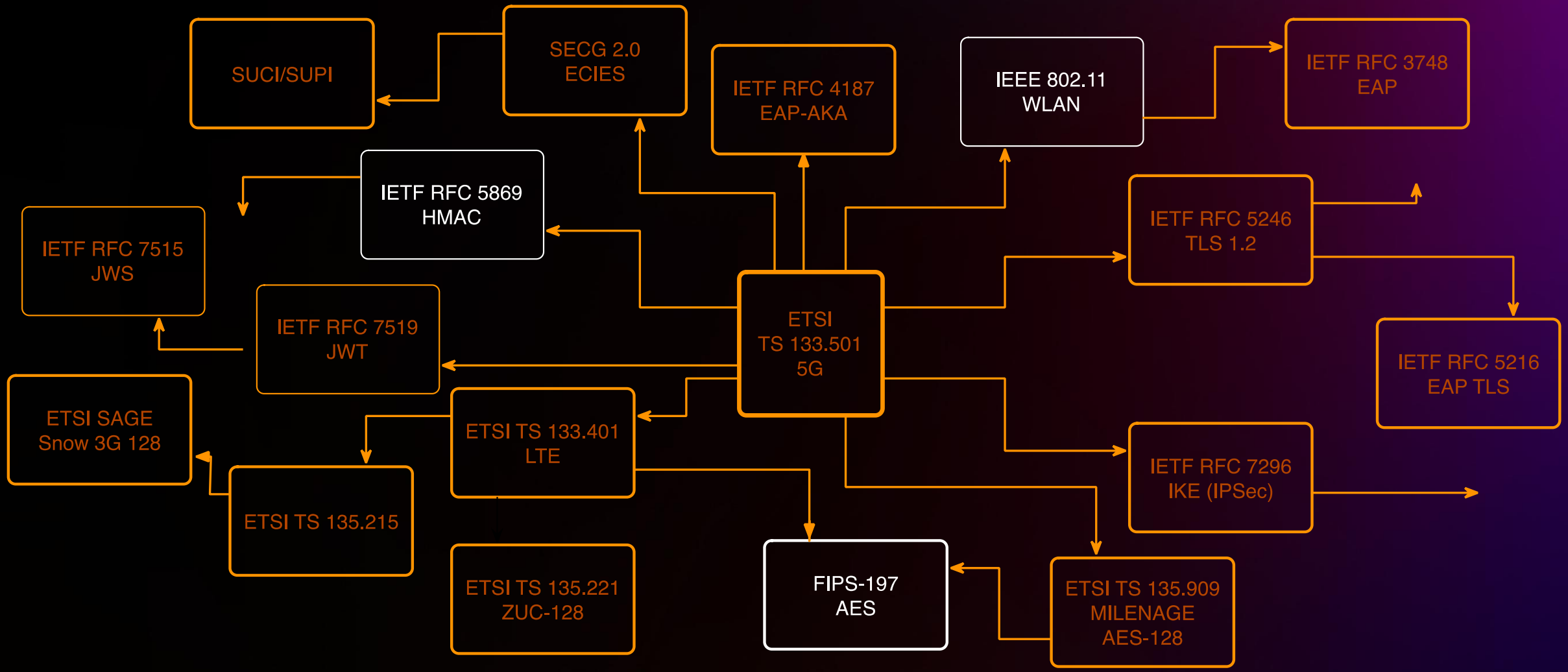
CYBER; Deployment Considerations for Hybrid Schemes, DTR/CYBER-QSC-0021(TR)

CYBER; Quantum-Safe Hybrid Key Exchanges, RTS/CYBER-QSC-0019 (TS 103 744)

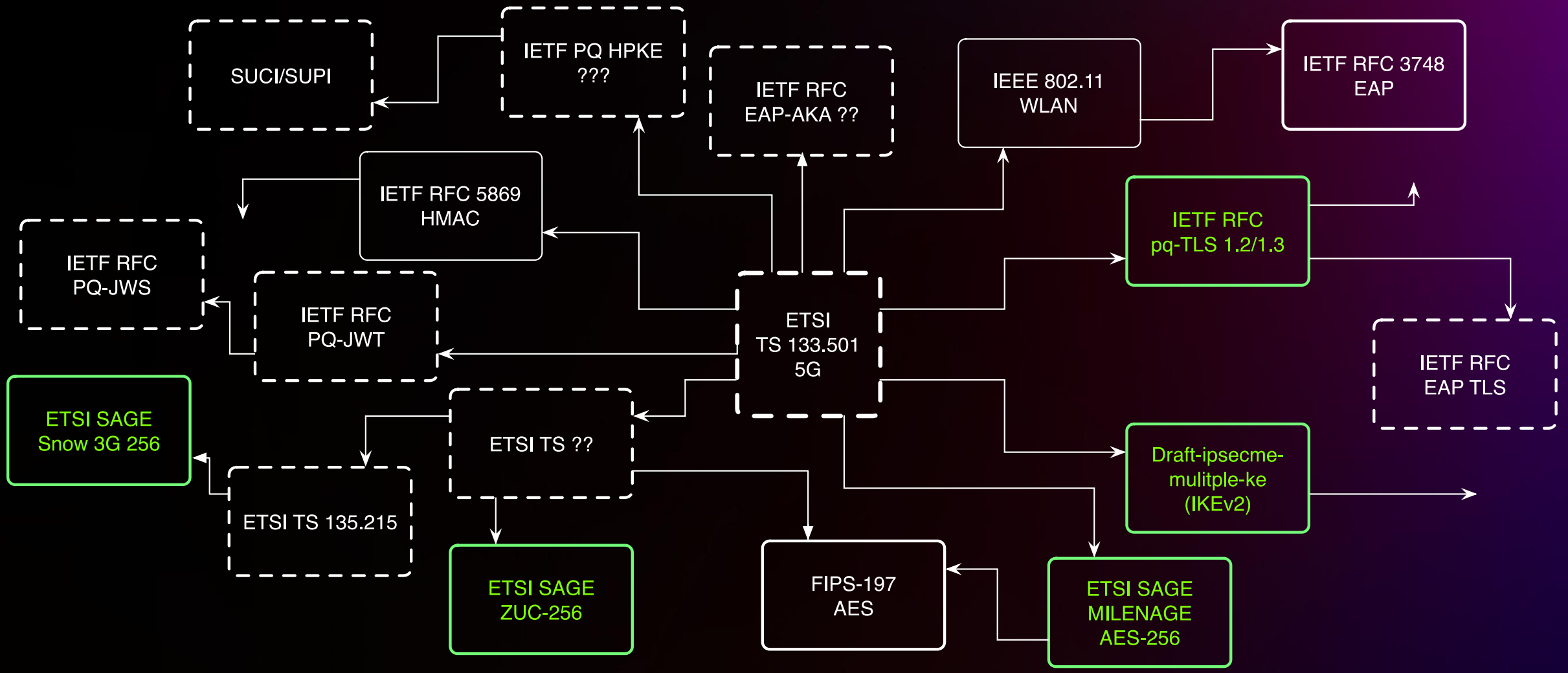
Impact of Quantum Computing on Cryptographic Security Proofs, DTR/CYBER-QSC-0020(TR)

CYBER; Impact of Quantum Computing on Symmetric Cryptography, DTR/CYBER-QSC-0022(TR)

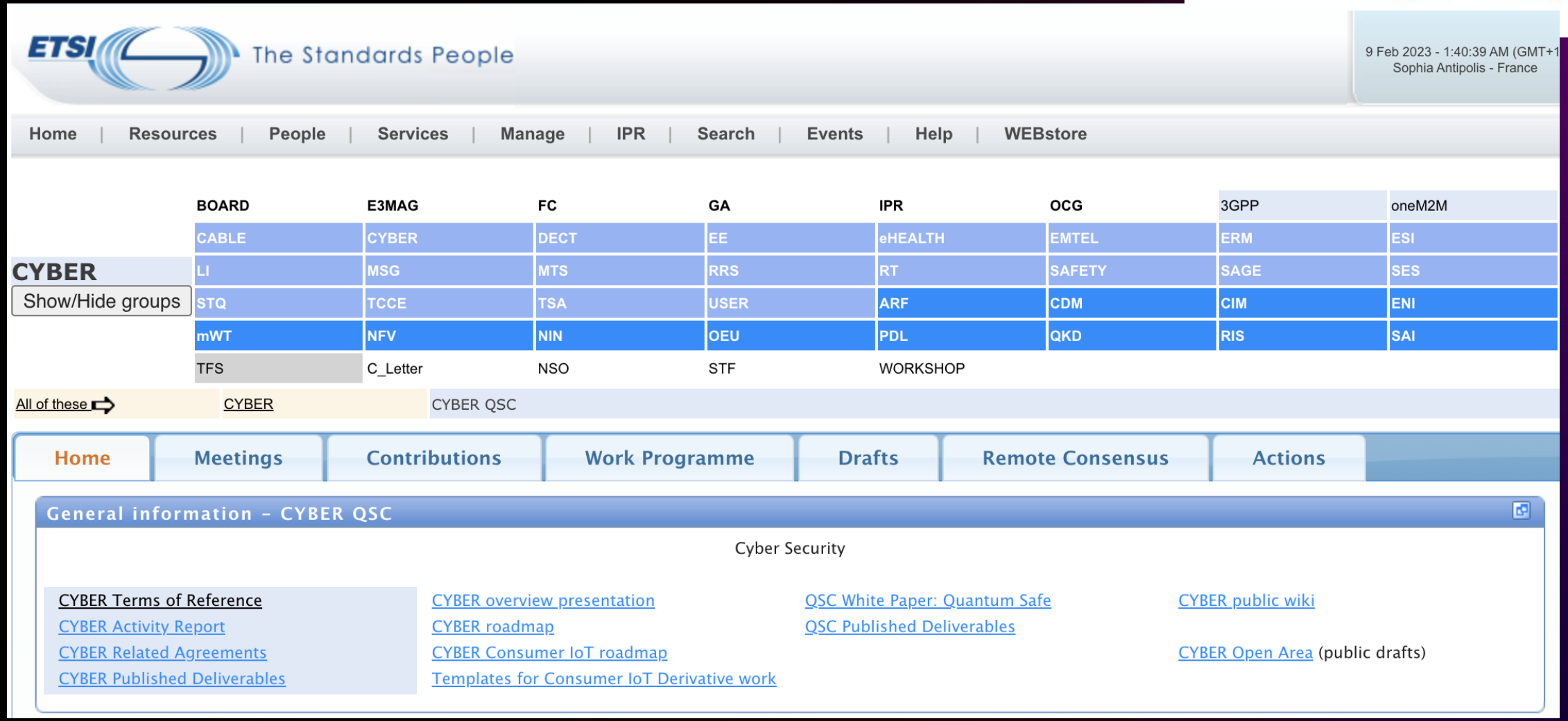
5G Standards map



5G PQ Standards Map



How to participate



How to participate

23 May – CYBER QSC#30 (Sophia Antipolis, FR)

19 September – CYBER QSC#31 (Sophia Antipolis, FR)

5 December – CYBER QSC#32 (Sophia Antipolis, FR)

AWS Cryptography


CloudHSM


Key Management Service


Secrets Manager


Certificate Manager


Signer


AWS Encryption SDK and LibCrypto Libraries

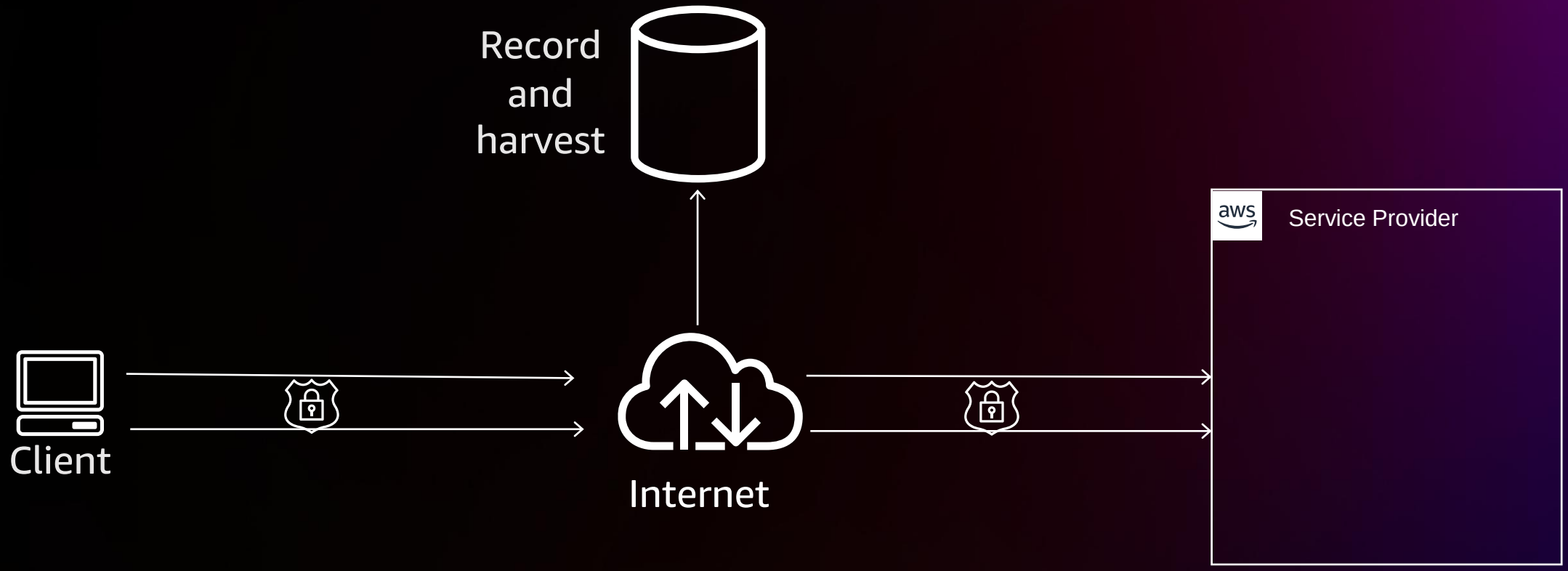

AWS OpenSource TLS and QUIC protocols

AWS Crypto Bar Raisers

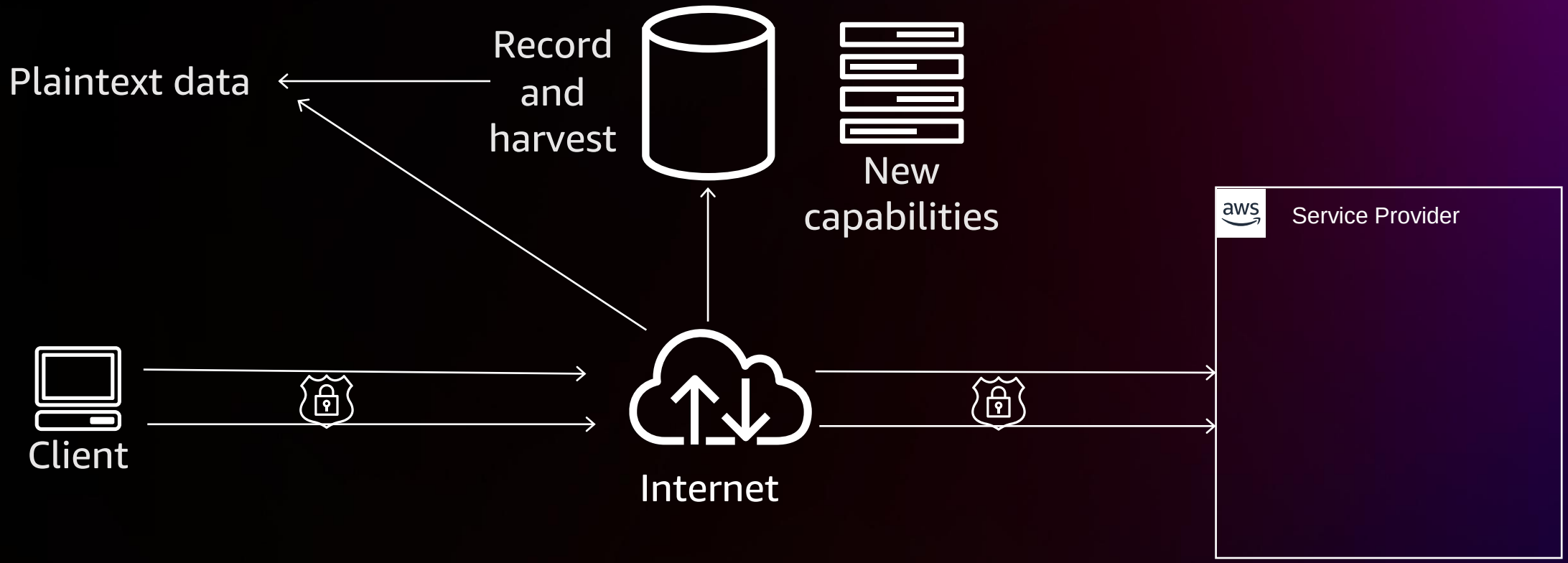
Post-quantum cryptography

Cryptographic computing

Long-term confidentiality



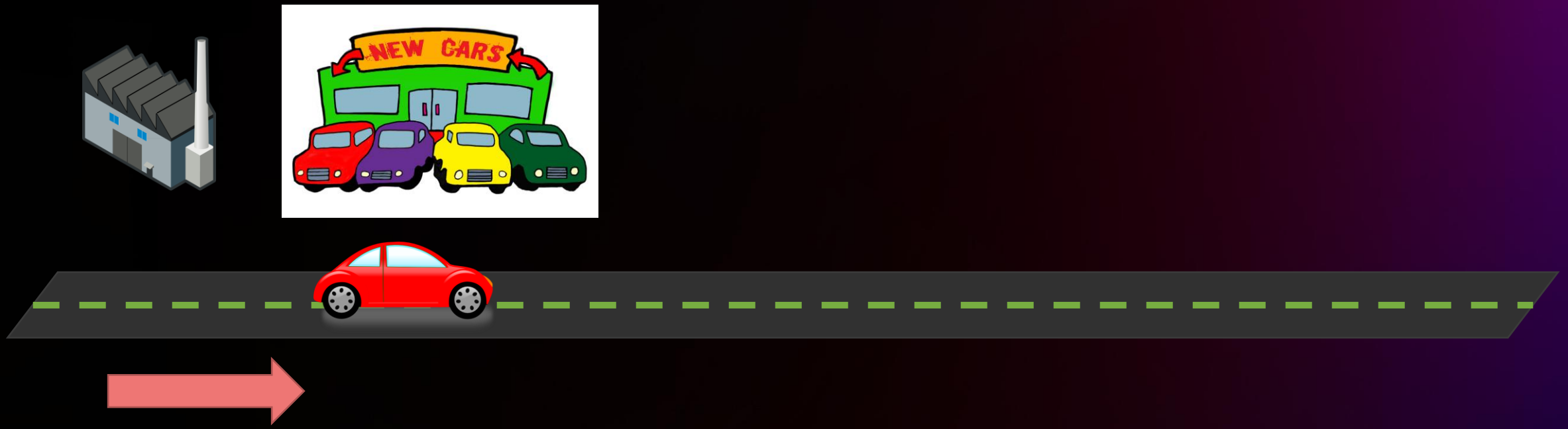
Long-term confidentiality



Long-term roots of trust

http://clipart-library.com/clipart/cars-clipart-2.htm

Long-term roots of trust



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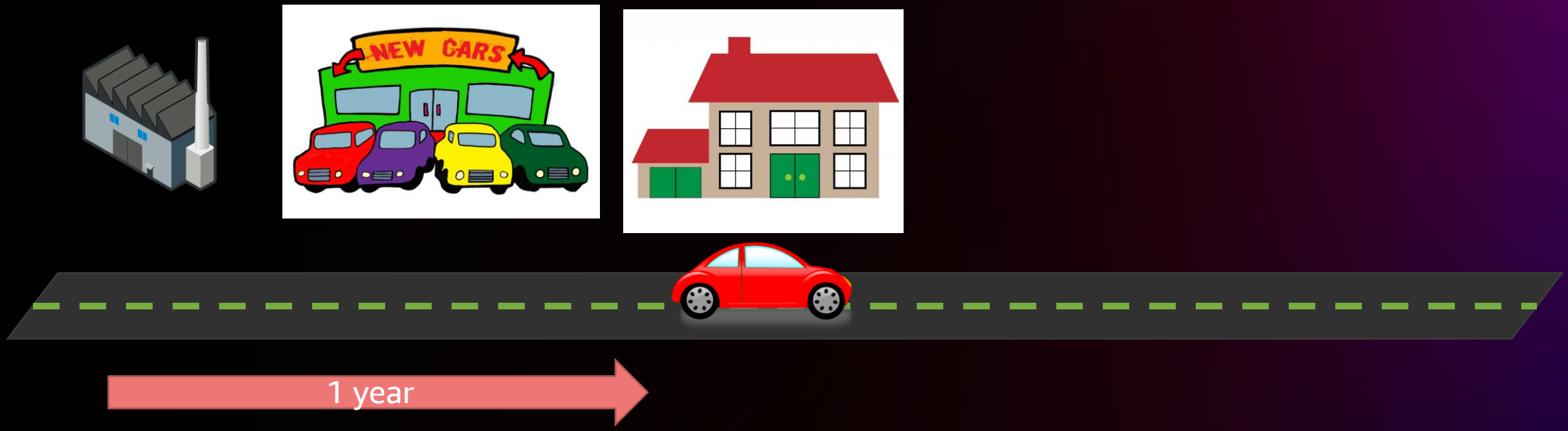
Long-term roots of trust



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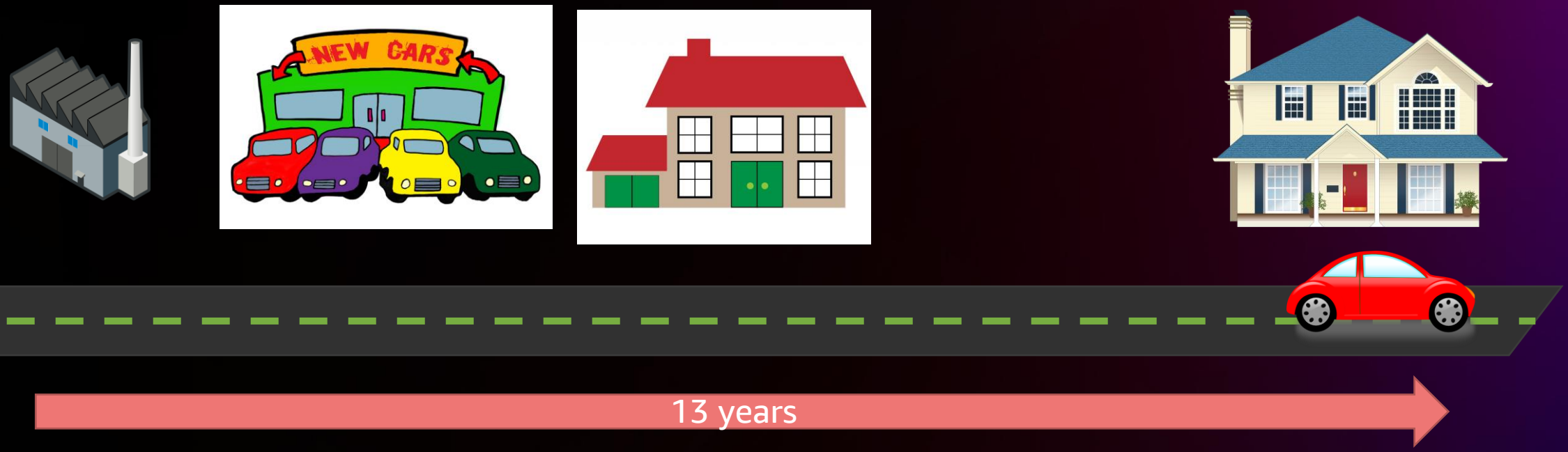

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Recent US Government News

2022-05-04 National Security Memorandum on mitigating risks dues to QC

- 90 days, Establish Migration to Post-Quantum Cryptography Project at NIST.
- 180 days, Establish Requirements for inventorying all currently deployed cryptographic systems (with NIST, CISA and NSA)

2022-09 CNSA 2.0 - Commercial National Security Algorithm Suite 2.0

- 2033 - Forecast transition to quantum-resistant cryptography
- 2025 – Suggested transition to QR firmware and software signing

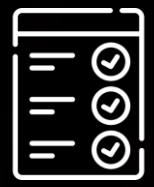
2022-11-18 OMB Memo Migrating to Post-Quantum Cryptography

- 2023-05-04 date for Agencies to provide initial inventory for high impact or High Value Assets systems

H.R.7535 - Quantum Computing Cybersecurity Preparedness Act

- 180 days - Director of OMB (with CISA) issue guidance on inventory and migration to PQC.
- 1 year – Agencies shall provide OMB with inventory and develop a plan for migration.

How is AWS Preparing?



CORE STANDARDS

NIST

- PQC Standards

ETSI – Quantum Safe Cryptography

- PQ Hybrid Standards
- PQ Migration

PROTOCOLS

IETF

- PQ-TLS 1.2 and 1.3
- PQ SSH
- PQ Signatures in X.509
- PQ KEMs in X.509
- PQ QUIC

LIBRARIES

s2n-TLS

- PQ Hybrid TLS 1.3 in s2n
- Available in AWS KMS, ACM, Secrets Manager

AWS-LC

- PQ key exchange and Signature schemes

AWS Java SDK w/ CRT

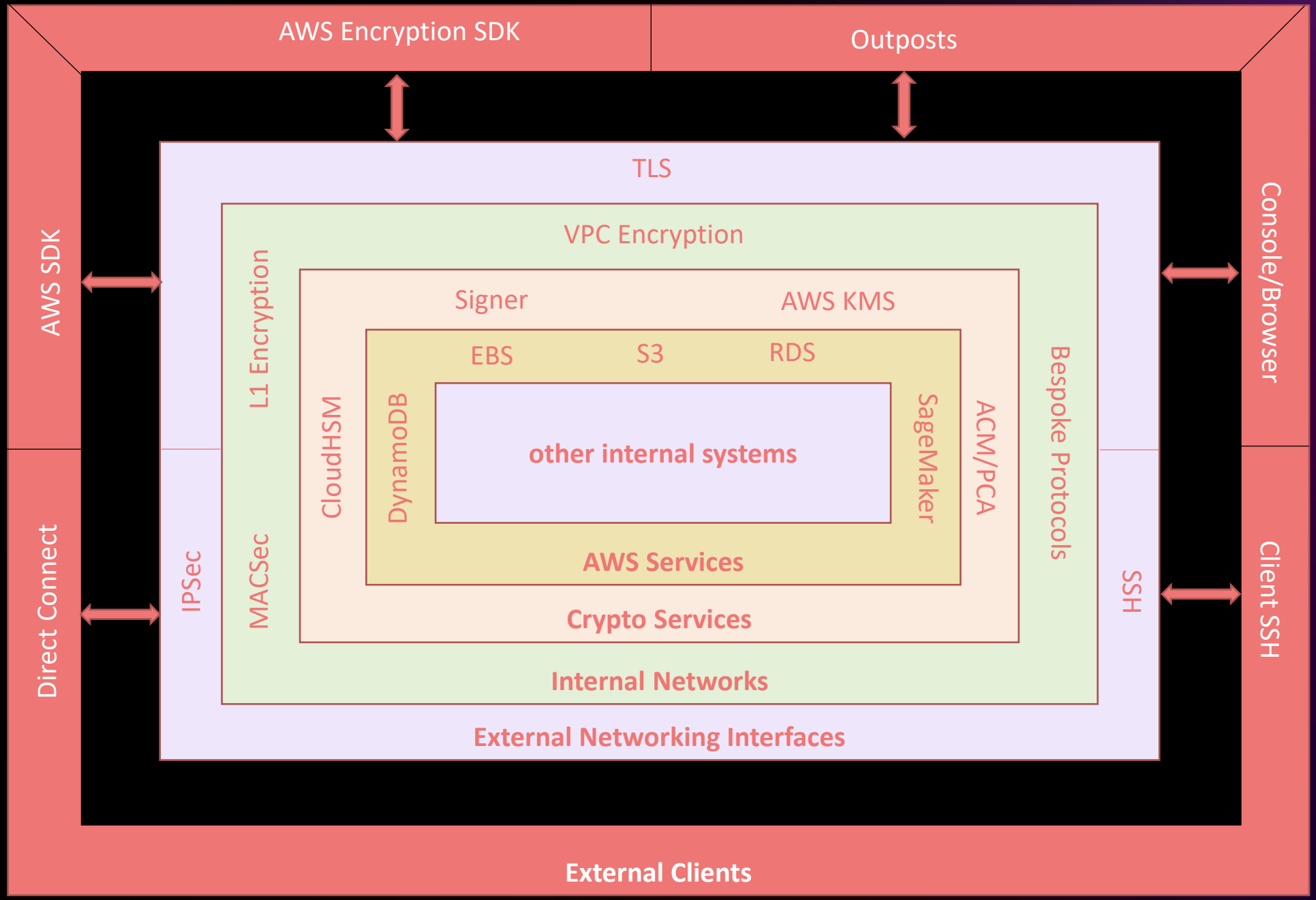
COLLABORATIONS

NCCoE

- Industry PQ-migration experiments

University of Waterloo

- Open Quantum Safe libOQS



Migration (as fast as possible)

Phase 0 (+2 years): Inventory of existing systems, identification & development of new standards, testing, migration plans.

Phase 1 (0 – 5 years): Deployment of PQ-KEMs for long-term confidentiality

(opportunistic with agile systems now, and less agile systems after standardization)

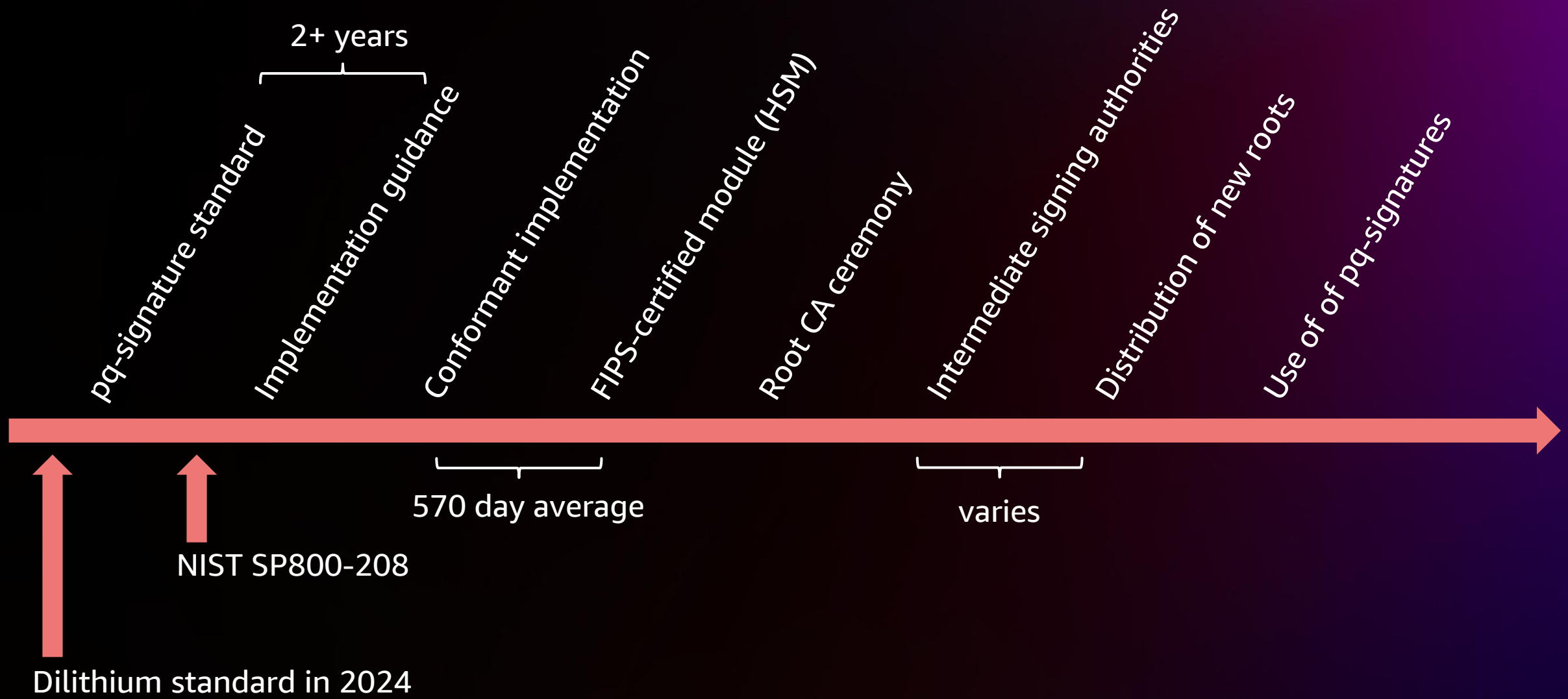
Phase 2: (2 – 5 years): Deployment of new PQ long-lived roots of trust

(smaller, specialized or closed systems moving to use)

Phase 3: (T – 5 years): Wide-scale use of PQ signatures

NOTE: This slide does not represent AWS's pq migration timeline – rather it states an opinion that this is the fastest an entity could prudently move to pqc.

Timeline for stateful-HBS signing authority



Question

Background:

- NIST has published NIST SP800-208 on Stateful Hash-Based Signatures (sHBS), a quantum resistant scheme.
- NSA has updated CNSA 2.0 to recommend that government systems begin transitioning to this by 2025 for firmware and software authentication.

Question:

How urgent are your needs for sHBS?

References

https://aws.amazon.com/security/post-quantum-cryptography/

https://www.whitehouse.gov/briefing-room/statements-releases/2022/05/04/national-security-memorandum-on-promoting-united-states-leadership-in-quantum-computing-while-mitigating-risks-to-vulnerable-cryptographic-systems/

https://media.defense.gov/2022/Sep/07/2003071834/-1/-1/0/CSA_CNSA_2.0_ALGORITHMS_.PDF

https://www.whitehouse.gov/wp-content/uploads/2022/11/M-23-02-M-Memo-on-Migrating-to-Post-Quantum-Cryptography.pdf

https://www.congress.gov/bill/117th-congress/house-bill/7535/text

Thank you!