THALES
Building a future we can all trust

Planning for Global Specifications: Agility

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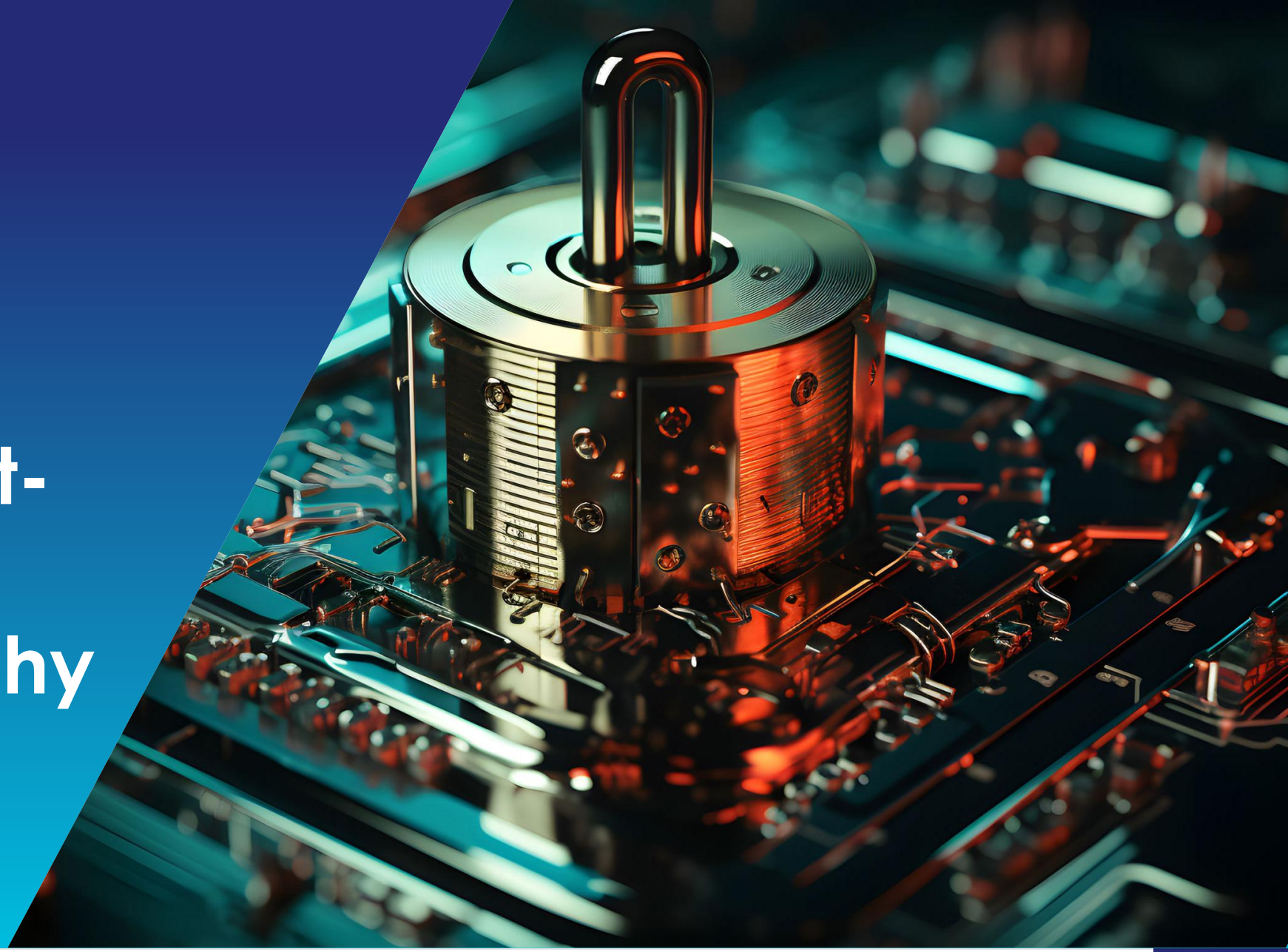
GlobalPlatform CVF
Munich | October 21, 2026

A Growing Consensus Around Post-Quantum Cryptography



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When will it be a problem?

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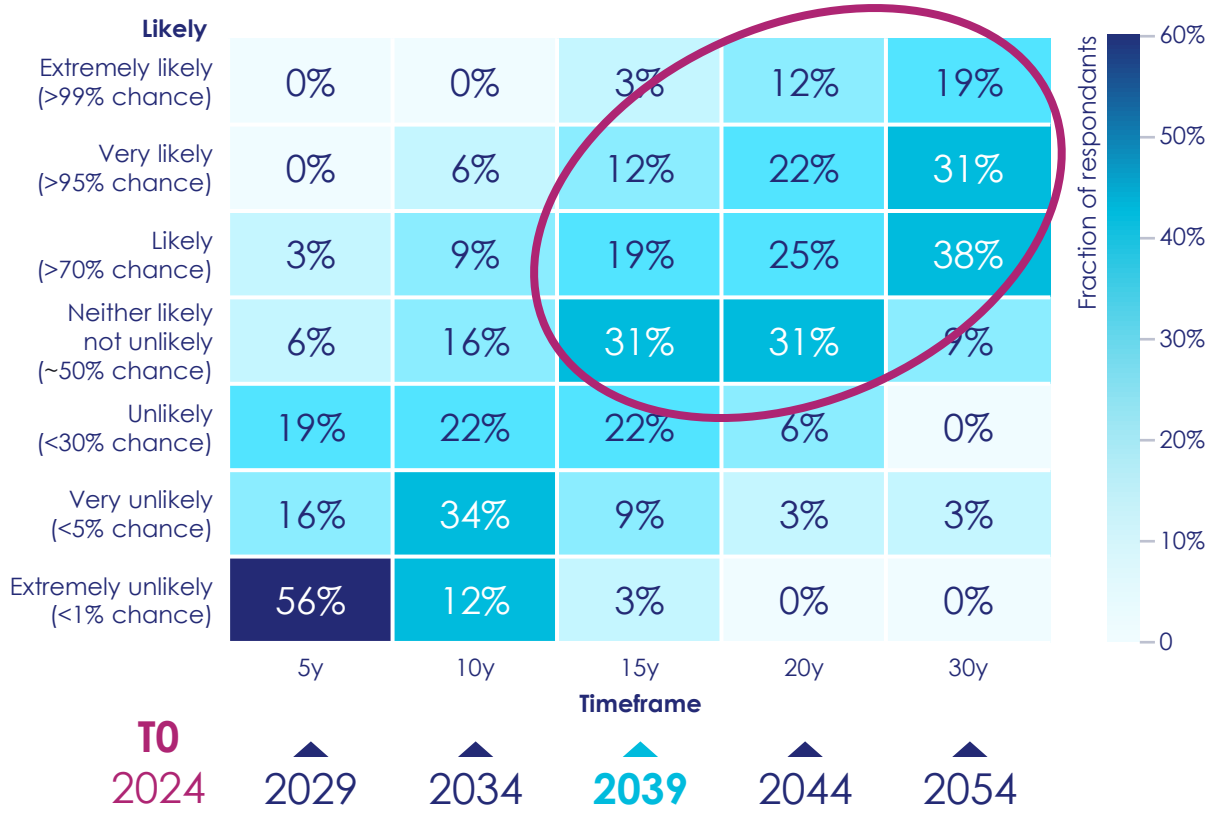
Likelihood of RSA-2048 break in 24 hours by a Quantum Computer

2024 Experts' views

The experts indicated their estimate for the likelihood of a quantum computer that is cryptographically relevant – in the specific sense of being able to break RSA-2048 quickly – for various time frames, from a short term of 5 years all the way to 30 years

Fraction of experts who indicated a certain likelihood in each indicated timeframe



Source: ***Michele Mosca, Marco Piani, Quantum Threat Time Line Report 2024.*** *https://globalriskinstitute.org/publication/2024-quantum-threat-timeline-report/*

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The most urgent: protect against HNDL

HARVEST NOW AND DECRYPT LATER (HNDL)

> Data is collected NOW for later decryption, when quantum computers are available.

HNDL is already a threat to sensitive data that must remain confidential for many years.

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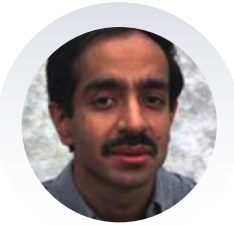
How a quantum computer impacts cryptography

Cryptographic algorithm targeted	Type	Purpose	Impact from large scale QC
RSA	**Public key**	**Signatures, Key establishment**	**NO LONGER SECURE**
Digital Signature Algorithm		Signatures, Key exchange	
ECDSA (Elliptic Curve DSA)			
AES	**Symmetric key**	**Encryption**	**e.g. longer keys needed**
SHA-2, SHA-3	----------	Hash functions	**e.g. larger output needed**

Peter **SHOR**



Lov **GROVER**

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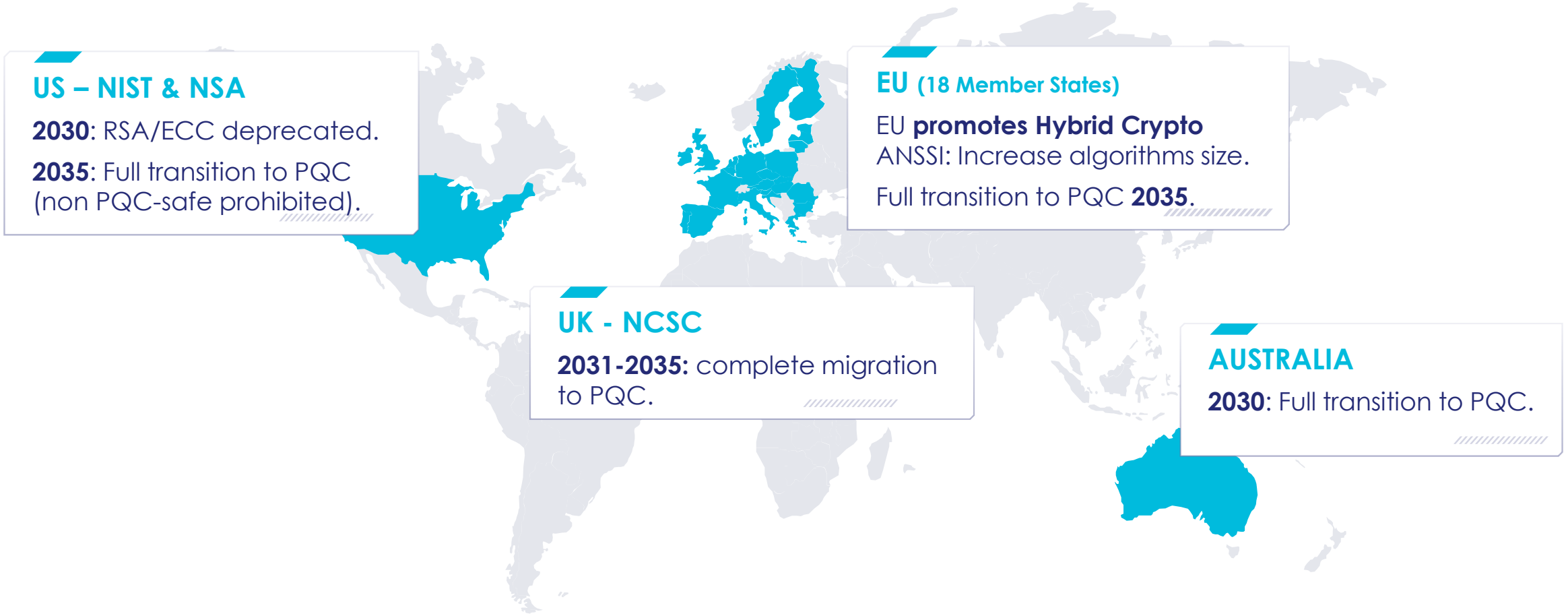
Transition recommended by national regulations



US – NIST & NSA

2030: RSA/ECC deprecated.

2035: Full transition to PQC (non PQC-safe prohibited).

EU (18 Member States)

EU **promotes Hybrid Crypto**
ANSSI: Increase algorithms size.

Full transition to PQC **2035**.

UK - NCSC

2031-2035: complete migration to PQC.

AUSTRALIA

2030: Full transition to PQC.

PQC-READY BY 2030 >> PQC-FULL BY 2035

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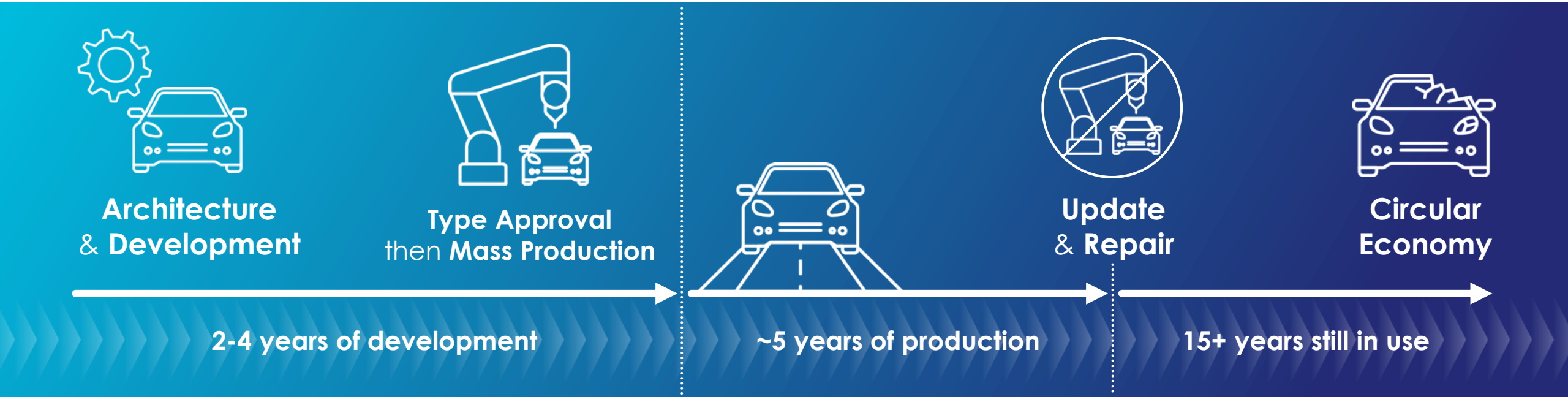
The long development and lifespan of vehicles



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Two Quantum Threats to Automotive Public-Key Cryptography

PUBLIC-KEY CRYPTOGRAPHY IS USED IN:

Vehicle PKI, cloud connectivity, OTA updates, Plug & Charge, V2X communications and secure boot.

HARVEST NOW, DECRYPT LATER

CONFIDENTIALITY

- Capture encrypted traffic today
- Decrypt sensitive data in the future

TRUST NOW, FORGE LATER

INTEGRITY & AUTHENTICITY

- Forge identities and messages
- Insert malicious firmware
- Bypass authentication mechanisms
- Compromise trust across vehicle fleets

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Thales's recommendation: a step-by-step approach

AUDIT AND PROTECT YOUR DATA

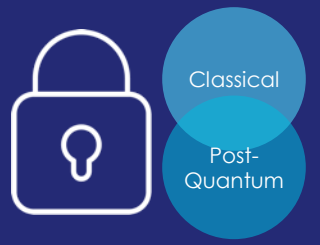
Assess risks and activity

Safeguard sensitive information

HNDL risk?

- **Adapt protocols and key management**
- **Adapt standards** when relevant

ANTICIPATE IN YOUR SOFTWARE & HARDWARE



Hybrid cryptography

Crypto Agility

- **Hybrid cryptography:** Combination of classical cryptographic algorithms with post-quantum algorithms in a single protocol or operation.
- **Crypto agility:** Ability of a system to support cryptographic evolution.

HNDL: Harvest Now Decrypt Later

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GlobalPlatform Crypto Sub-Task Force

01 MONITOR
Regional developments and recommendations from agencies worldwide

02 ALIGN
Timelines, security levels, algorithms and hybrid constructions

03 GUIDE
Cryptographic Algorithm Recommendations
GP_TEN_053

CRYPTOGRAPHIC TRANSITION PATH

DEPRECATED	LEGACY USE	RECOMMENDED	HYBRID PQC	PQC ERA
Do not use	Until 2030	At least		At least
• DES / 3DES • SHA-1, SHA-224 • RSA-1024 • ECC < 224 bits • TLS v1.0 & TLS v1.1	• RSA-2048	• AES-128 / SHA-256 • RSA-3072 • ECDSA-256 • TLS 1.2 / TLS 1.3	• Classical + PQC algorithms	• AES-128 • SHA-256 • ML-KEM* • ML-DSA* • LMS / XMSS * NIST Category 3 or 5

Plan the transition from legacy cryptography to hybrid, then standalone PQC, while preserving interoperability.

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GlobalPlatform Secure Element Committee

01 PROTECT
Critical management operations

- Application and content loading
- Key provisioning
- Management commands
- Software and configuration updates

02 EVOLVE
Cryptographic mechanisms

- Certificates and signatures
- Authentication and key establishment
- Secure channel protocols
- Hybrid and standalone PQC modes

03 SPECIFY
GlobalPlatform response

- Amd K SCP04: crypto-agile symmetric secure channel
- Amd O SCP12: PQC-capable asymmetric secure channel
- Amd P: PQC certificates and signatures
- Amd A: Confidential Card Content Management

Crypto agility must be designed into protocols, not added after deployment.

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PQC Migration Requires an Ecosystem-Wide Effort

01	**ALGORITHMS** **NIST · ETSI · ISO**	PQC algorithms, security levels, hybrid schemes and migration guidance
02	**SECURE ELEMENT PROTOCOLS & APIs** **GlobalPlatform · Java Card Forum**	Secure channels, certificates, signatures, APIs and on-card mechanisms
03	**CONNECTIVITY & DIGITAL IDENTITY** **GSMA · ETSI · 3GPP · IETF**	eSIM, telecom, authentication and connected services
04	**AUTOMOTIVE INTEGRATION** **Automotive ecosystem ·OEMs ·suppliers**	Vehicle architectures, long-lifecycle products and deployment use cases

Crypto agility only works if specifications evolve consistently and remain interoperable across the ecosystem.

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The PQC toolbox is becoming clearer

Hash-based
- Merkle signatures
- Sphincs

Multivariate
- Multivariate quadratic

Lattice-based
- NTRU
- Learning with errors
- Ring-LWE

Isogenies
- Supersingular elliptic curve isogenies

NIST PUBLISHED FIPS STANDARDS (August 2024)

- **Key Exchange Mechanism (KEM)**
  - **FIPS 203**: Module-Lattice-Based Key-Encapsulation Mechanism Standard (**ML-KEM**)
  - **HQC** selection (March 2025) as a backup for ML-KEM (standard expected in 2027)
- **Signature**
  - **FIPS 204**: Module-Lattice-Based Digital Signature Standard (**ML-DSA**)
  - **FIPS 205**: Stateless Hash-Based Digital Signature Standard (**SLH-DSA**)
  - To come by end 2026 **FIPS 206 FN-DSA** (Falcon)
  - More to come, (possibly non-lattice-based) selection is ongoing

Special Publication NIST SP 800-208 (October 2020) LMS/XMSS

- **Stateful Hash-Based Signature Schemes**
  - Specific constraints of implementation
  - Niche use cases such as **Firmware or Software signatures**

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ML-KEM-768: Engineering Impact for Key Establishment

SECURITY ROBUSTNESS
NIST Category 3

eSE BENCHMARK CONTEXT
FULL-SW | ARM Cortex-M3 | 24 KB RAM

COMPARISON BASELINE
ECDH-256 = 1

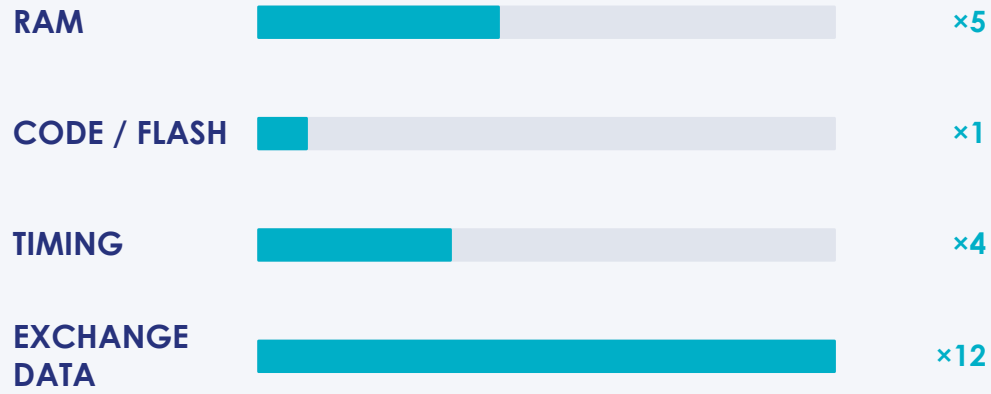
FUNCTION
KEM / shared-secret establishment

OBJECT SIZES

PUBLIC KEY	1,184 B
CIPHERTEXT	1,088 B
PRIVATE KEY	2,400 B

Main pressure: exchanged data, APDU/message sizing and temporary buffers.

INDICATIVE RATIOS VS ECDH-256



Ratios are benchmark-specific and depend on implementation, optimization and countermeasures.

ML-KEM is already viable on current Secure Element technology.

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ML-DSA-65: Engineering Impact for Digital Signatures

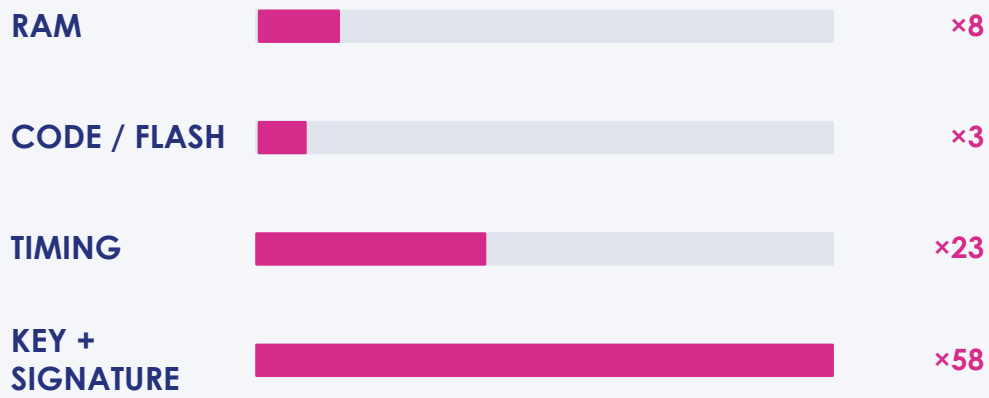
SECURITY ROBUSTNESS	eSE BENCHMARK CONTEXT	COMPARISON BASELINE	FUNCTION
NIST Category 3	FULL-SW | ARM Cortex-M3 | 24 KB RAM	ECDSA-256 = 1	Signature generation / verification

OBJECT SIZES

PUBLIC KEY	1,952 B
SIGNATURE	3,309 B
PRIVATE KEY	4,032 B

Main pressure: certificates, signed objects, NVM/Flash and verification flows.

INDICATIVE RATIOS VS ECDSA-256 SIGN / VERIF



Verification is significantly faster (~ x3 to x4 compared to ECDSA)

Ratios are benchmark-specific and depend on implementation, optimization and countermeasures.

ML-DSA is feasible on Secure Element technology, but signature generation remains demanding.

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Secure Elements Enable Crypto Agility Across the Vehicle Lifecycle

SECURE KEY LIFECYCLE

- Secure key provisioning
- Manufacturing to operation
- Field renewal and replacement

SECURE CONTROL

- Protected execution of critical security services
- Controlled use of keys and cryptography
- Isolation of security functions

PROVIDE CRYPTO AGILITY

- Support for algorithm migration
- Secure OS and applet updates
- Long-term PQC readiness

Secure Elements turn specification agility into deployable automotive solutions.

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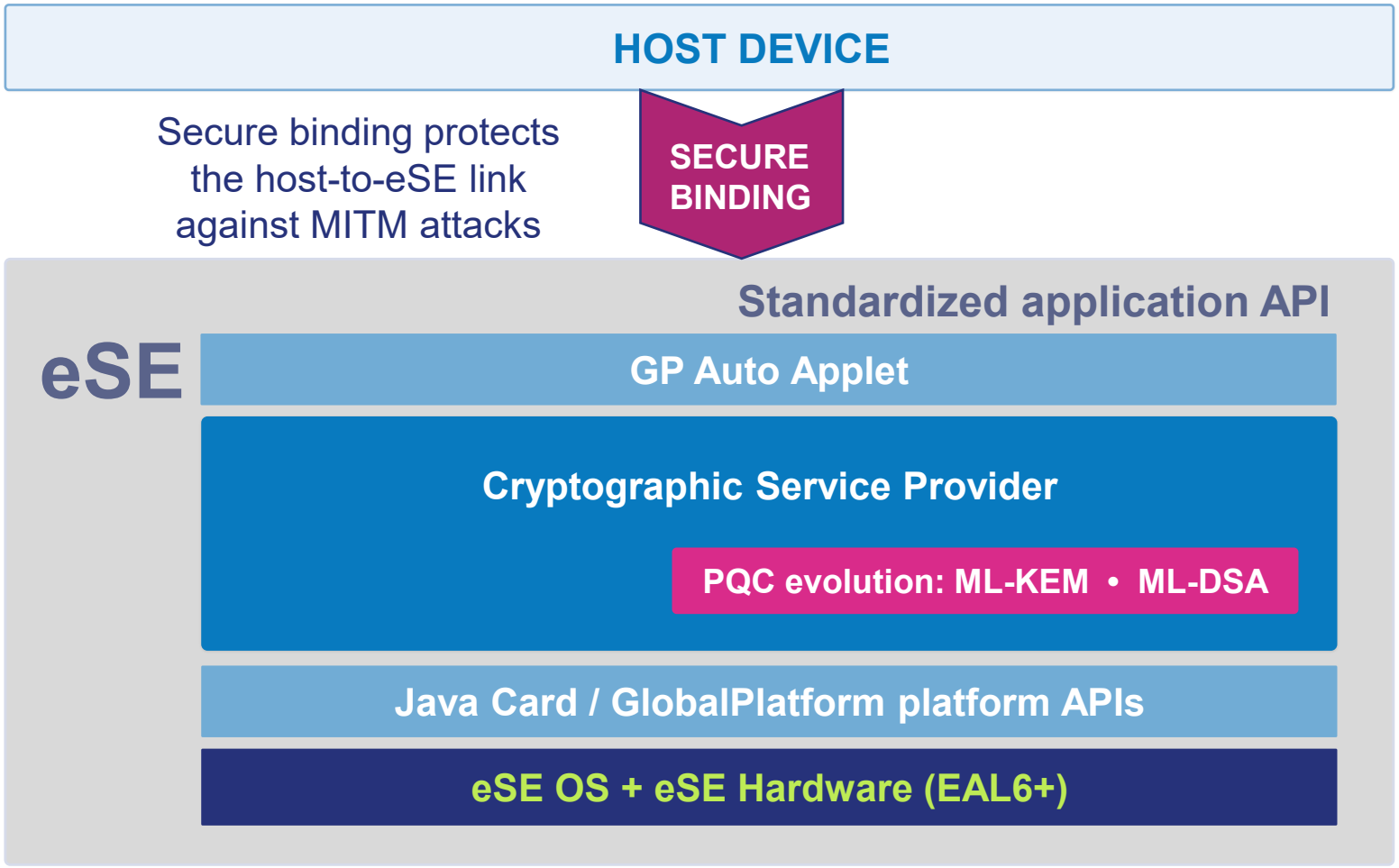
Secure Element Architecture for Crypto Agility



STABLE APPLICATIONS, EVOLVING CRYPTOGRAPHY

- GP Auto Applet provides a standardized API
- GP Auto Applet relies on CSP interfaces
- CSP evolves to support ML-KEM and ML-DSA
- CSP avoids platform-specific certification of the GP Auto Applet

Architecture supporting cryptographic evolution

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Key Takeaways

ENABLE CRYPTO AGILITY

> **AUDIT:**
Assess cryptographic dependencies across systems, protocols and lifecycles.

> **PRIORITIZE:**
- Protect long-lived data exposed to Harvest Now, Decrypt Later
- Protect critical trust mechanisms (secure boot, firmware updates)

> **PLAN THE TRANSITION:**
Define a phased migration path toward PQC

> **ANTICIPATE:**
Plan for additional memory, processing time, communication overhead and implementation resources

> **ENABLE CRYPTO AGILITY:**
Prepare deployed systems for cryptographic evolution
Consider embedded SE as a complement to HSMs and TrustZone

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