Welcome to the World of Standards

ETSI TC Cyber Working Group for Quantum Safe Cryptography

Chairman's report, September 2017

Mark Pecen, chairman

Agenda

1. About the working group QSC
2. Recent organisational changes
3. Summary of published work items
4. Technology roadmap introduction

Technical Committee Cyber, Working Group Quantum Safe Cryptography (QSC)

- **Founded March 2015 as Industry Specification Group (ISG) QSC**
- **Our focus is on the practical implementation of quantum safe primitives, including performance considerations, implementation capabilities, benchmarking and practical architectural considerations for specific applications**
- **Our work may feed into other ETSI groups and projects as 3GPP and other standards bodies such as International Telecommunication Union (ITU), e.g. SG-17 or ISO/IEC JTC1 SC27**
- **Our objectives DON'T include the development of cryptographic primitives or focus on QKD**
  - These are propositions best left to academia and other groups who specialise in the area

ISG QSC becomes TC Cyber QSC

- In order to produce normative ETSI specifications, such as Technical Reports (TR) or Technical Specifications (TS), it was necessary to promote the group to become a Working Group (WG) of a ETSI Technical Committee (TC)
- After 2 years of operating as an Industry Specification Group (ISG), the QSC became part of a larger Technical Committee (TC), TC Cyber Working Group for Quantum Safe Cryptography (WG-QSC) in March 2017
- Existing QSC officers were re-elected to continue serving in TC Cyber WG-QSC and maintain its working pace and environment
- TC Cyber WG-QSC chairman regularly reports to TC Cyber
- All WG approved output documents flow into TC Cyber plenary for final approval

Summary GROUP REPORT (GR) QSC-001 "Quantum-Safe Primitives Assessment"

- **Provides an overview and best practices by industry and academia for assessing cryptographic primitives that have been proposed for key establishment and authentication applications, and which may be suitable for standardization by ETSI and subsequent use by industry to develop quantum-safe solutions for real-world applications**
- **Primitive families under consideration**
  - **Lattice-based** primitives where the security depends on the difficulty of solving a short or close vector problem in a lattice
  - **Multivariate-based** primitives where the security depends on the difficulty of solving a system of multivariate polynomial equations
  - **Code-based** primitives where the security depends on the difficulty of solving a decoding problem in a linear code
  - **Hash-based** primitives where the security depends on the difficulty of finding collisions or preimages in cryptographic hash functions
  - **Isogeny-based** key primitives where the security depends on the difficulty of finding an unknown isogeny between a pair of supersingular elliptic curves

Summary GROUP REPORT (GR) QSC-003 "Case studies and deployment scenarios"

- **Examines a number of real-world uses cases for the deployment of quantum-safe cryptography (QSC)**
  - **Typical applications** where cryptographic primitives are deployed today
  - **Identifies some of the consequences** of adapting services and applications to quantum safe equivalents, along with features that may need change to accommodate quantum-safe cryptography
  - **Options for upgrading** public-key primitives for key establishment and authentication, although several alternative, non public-key options are also discussed
- **Cases include**
  - **Network security services**, including TLS, where design choices such as drop-in replacement, hybrid approaches and re-engineering are considered
  - **Potential integration issues** for deploying quantum safe equivalents into existing protocol stacks, including the handling of large key sizes
  - **Offline services**, such as e-mail, and credentials for offline services
  - **Internet of Things (IoT)** aspects, including processor, bandwidth, power consumption and size limitations and impact on cryptosystems
  - **Satellite communications**, and associated limitations
  - **Also** key distribution centres, authentication and certain exotic applications for cryptosystems

Summary GROUP REPORT (GR) QSC-004 "Quantum Safe Threat Analysis"

- **Simplified threat assessment following the guidelines of ETSI Technical Specification (TS) 102 165-1 for a number of use cases**
- **Identification of required capabilities for certain algorithms**
  - Grover's algorithm
  - Shor's algorithm
  - Further implications
- **Threat assessment for various aspects of security**
  - Symmetric key algorithms
  - Public key algorithms
  - Random number generation
  - Security protocols like TLS, IPsec, IKE, S/MIME and PKI
- **Industry-specific issues are identified**
  - Banking and e-commerce
  - Intelligent transportation systems
  - eHealth

Summary GROUP REPORT (GR) QSC-006 "Limits of Quantum Computing"

- **Analysis of quantum computing capabilities is presented within the context of solving symmetric key cryptographic problems**
- **Evolution of quantum computing is discussed**
  - Learning curves, such as Moore's law
  - Commercial quantum computers
  - "worst-case" quantum computing
  - Upper-bounds to quantum computing
- **Assumptions regarding keys and parameter sizes, symmetric keys and output lengths**
- **Some conclusions are made – although speculative, this analysis suggests that symmetric key crypto AES-256 may still be used in the year 2050 based on the assumed power of future quantum computers**

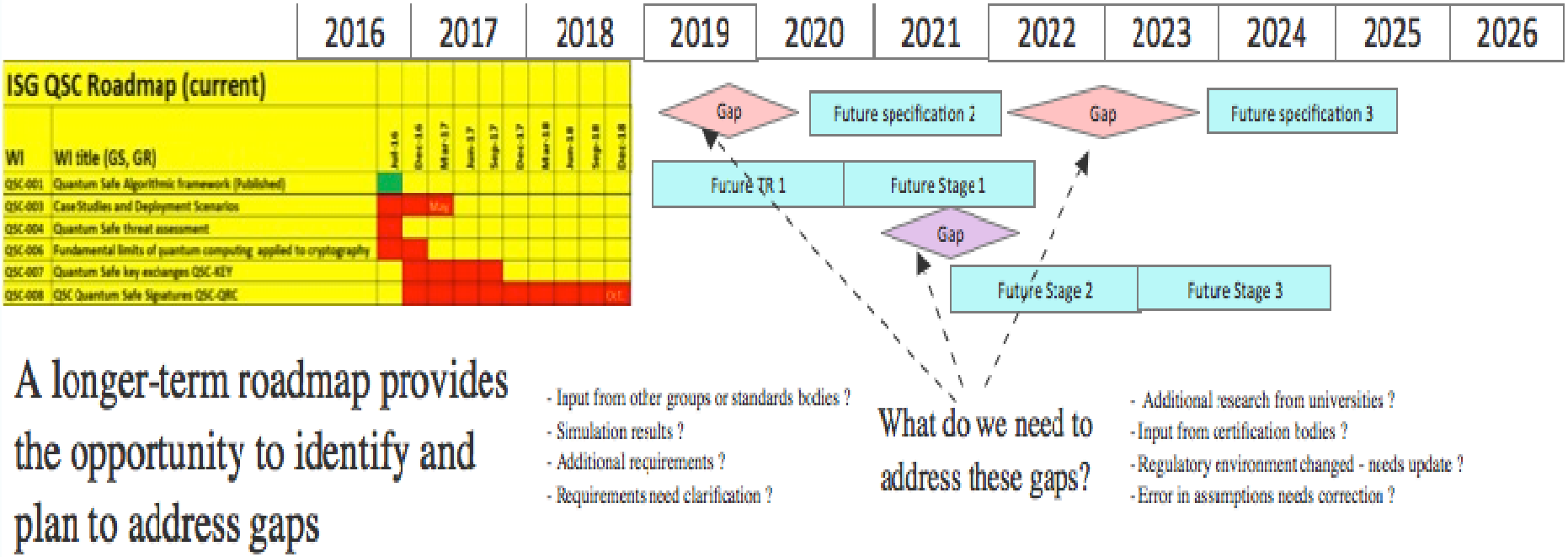
Three new work items created recently

- **Created Two New Work Items of major interest at QSC#7, September 2016**
  - QSC-007: Quantum-Safe Key Exchanges: proposed by CESG, supported by Phillips International, ISARA Corp., CESG, Thales U.K. and Queens University Belfast proposed in QSC#7, September 2016
  - QSC-008: Quantum-Safe Cryptographic Signature assessment: proposed by INRIA, supported by Phillips International, Thales U.K. limited, CESG, Queens University Belfast and Security Innovation Inc., Belfast proposed in QSC#7, September 2016

- **New Work Item created at QSC#1, March 2017 (Note the numbering scheme starts at #1 again after promoting the group to a TC)**
  - QSC-009: Quantum Safe Virtual Private Network (VPN): proposed by ISARA Corporation, supported by NCSC, Phillips, Amazon, Qunion, PIDS, Thales UK Ltd.

Extended roadmapping: 10+ years

- Gaps are difficult to identify in the longer term…
- Unless we search together



A longer-term roadmap provides the opportunity to identify and plan to address gaps

- Input from other groups or standards bodies ?
- Simulation results ?
- Additional requirements ?
- Requirements need clarification ?

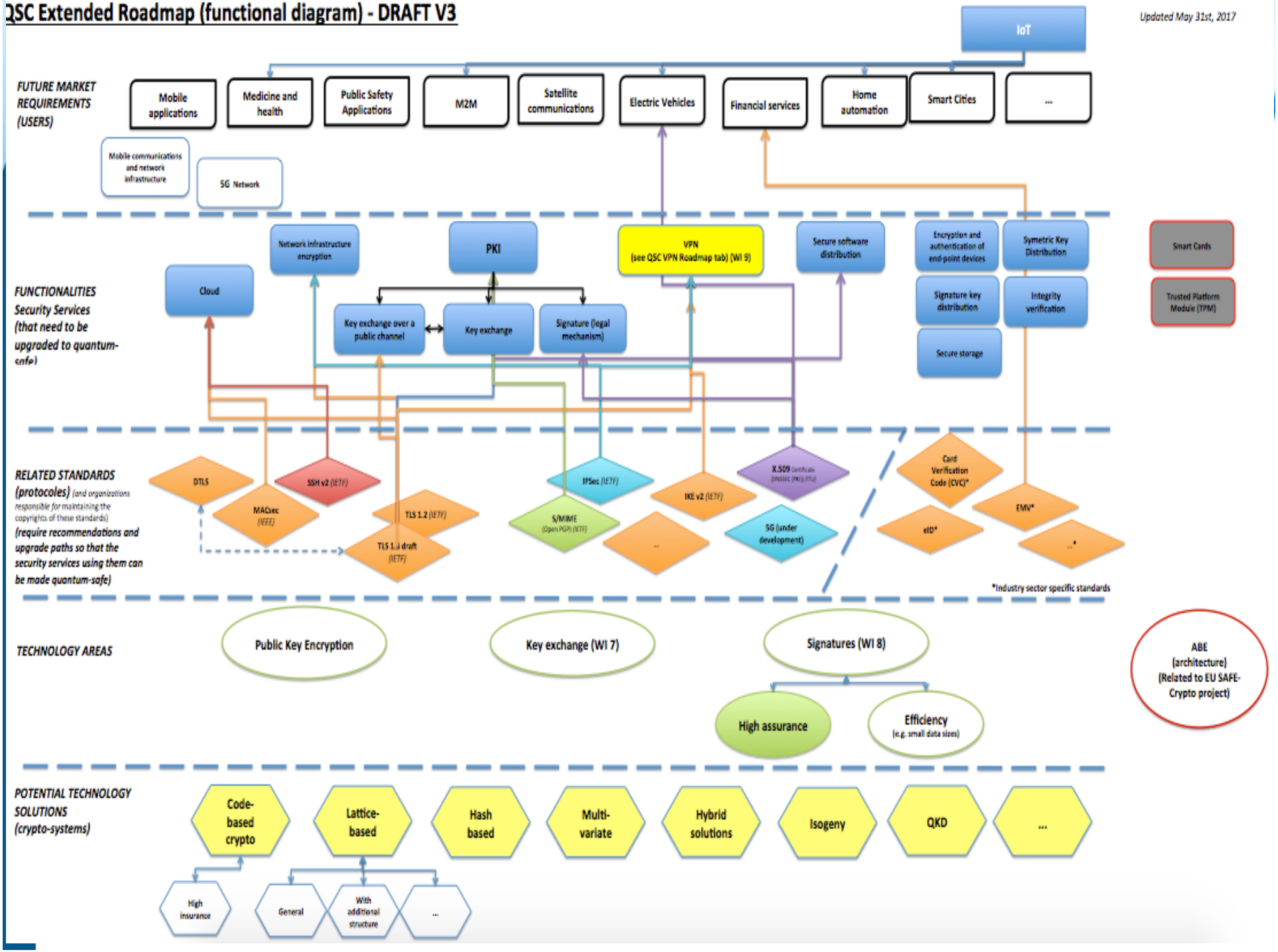
What do we need to address these gaps?

- Additional research from universities ?
- Input from certification bodies ?
- Regulatory environment changed - needs update ?
- Error in assumptions needs correction ?

We have begun roadmapping activities in QSC#9 and plan roadmapping workshops for future QSC meetings

QSC Extended Roadmap (functional diagram) - DRAFT V3

Updated May 31st, 2017



QSC Extended Roadmap (functional diagram) - DRAFT V3

Updated May 31st, 2017

FUTURE MARKET REQUIREMENTS (USERS)

IoT

Mobile applications | Medicine and health | Public Safety Applications | M2M | Satellite communications | Electric Vehicles | Financial services | Home automation | Smart Cities | ...

Mobile communications and network infrastructure

5G Network

FUNCTIONALITIES
Security Services (that need to be upgraded to quantum-safe)

Cloud | Network infrastructure encryption | PKI | VPN (WI 9) | Secure software distribution | Encryption and authentication of end-point devices | Symetric Key Distribution | Smart Cards | Signature key distribution | Integrity verification | Trusted Platform Module (TPM) | Secure storage

Key exchange over a public channel | Key exchange | Signature (legal mechanism)

RELATED STANDARDS (protocoles) *(and organizations responsible for maintaining the copyrights of these standards) (require recommendations and upgrade paths so that the security services using them can be made quantum-safe)*

DTLS | SSH v2 (IETF) | MACsec (IEEE) | TLS 1.2 (IETF) | TLS 1.3 draft (IETF) | IPSec (IETF) | S/MIME (Open PGP) (IETF) | IKE v2 (IETF) | ...

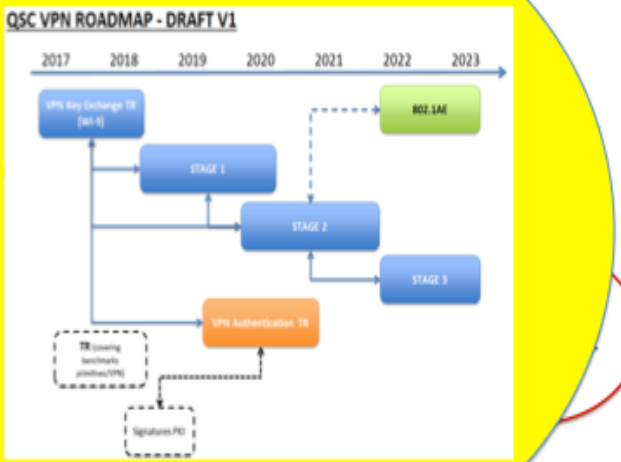
TECHNOLOGY AREAS

Public Key Encryption | Key exchange (WI 7) | High assurance

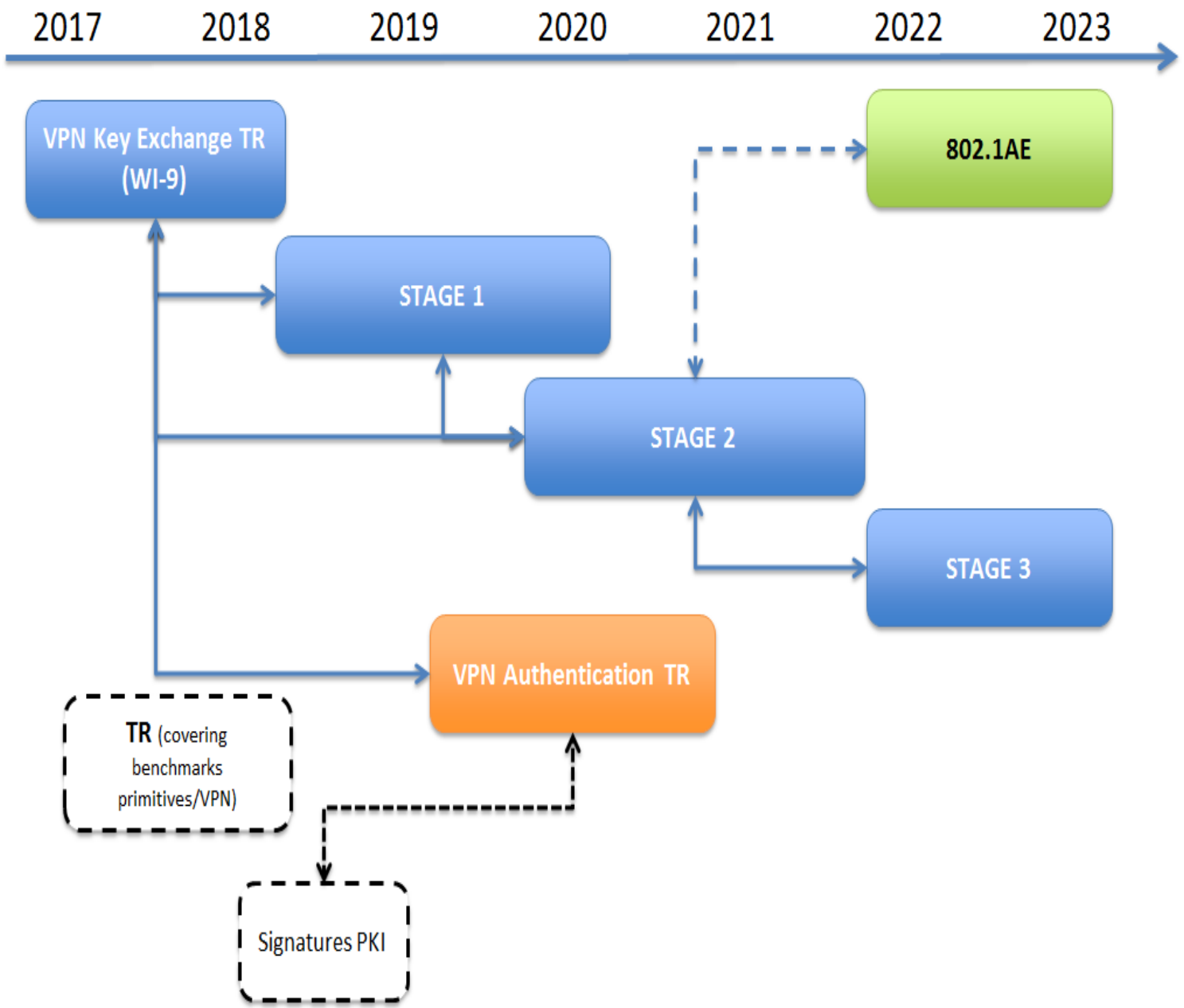
POTENTIAL TECHNOLOGY SOLUTIONS (crypto-systems)

Code-based crypto | Lattice-based | Hash based | Multi-variate | Hybrid solutions | Isogeny | QKD

High insurance | General | With additional structure | ...



QSC VPN ROADMAP - DRAFT V1



Picture of a superconducting qubit from labs of the Institute for Quantum Computing, CANADA

Contact Details:
Mark PECEN, Chairman QSC
mpecen@approachinfinity.ca