LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

MNM TEAM

Quantum Secure Key Exchange for IEEE 802.1AE (MACSec)

Antrittsvortrag zur Masterarbeit

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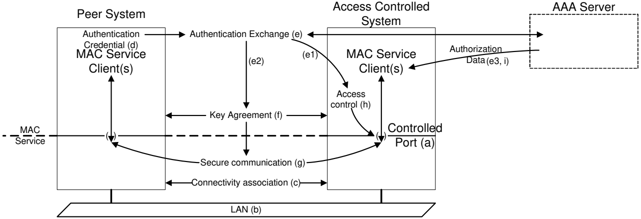
	Dr. Tobias Guggemos

September 8, 2020

IEEE 802.1X

- Mutual authentication in LANs



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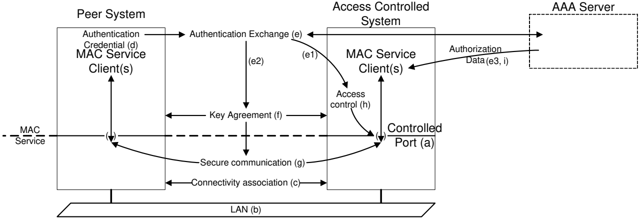
- Mutual authentication in LANs
  - Supplicant (Peer)



IEEE 802.1X

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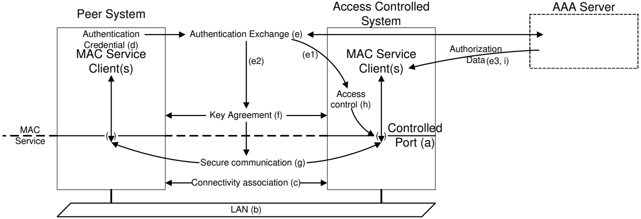

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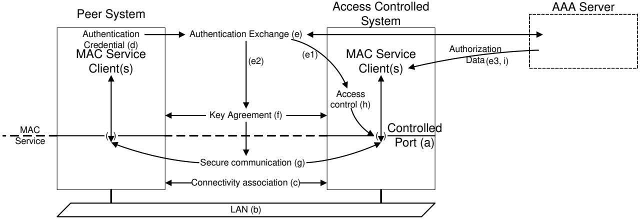

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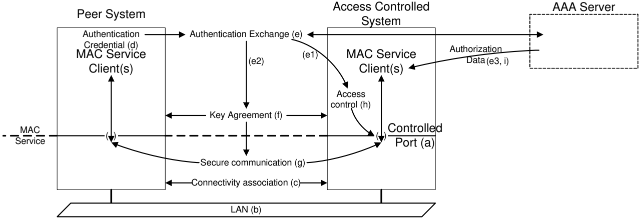

IEEE 802.1X

- Mutual authentication in LANs
  - Supplicant (Peer)
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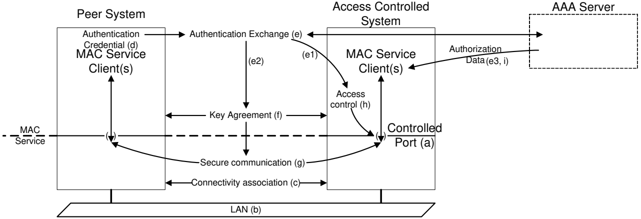
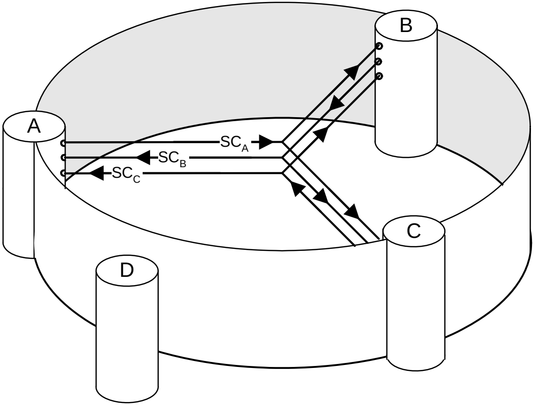
- Mutually trusted CAs (c)
- EAP framework (e,f)
  - Asymmetric key exchange



IEEE 802.1AE (MACSec)

- Ethernet frame encryption



IEEE 802.1AE (MACSec)

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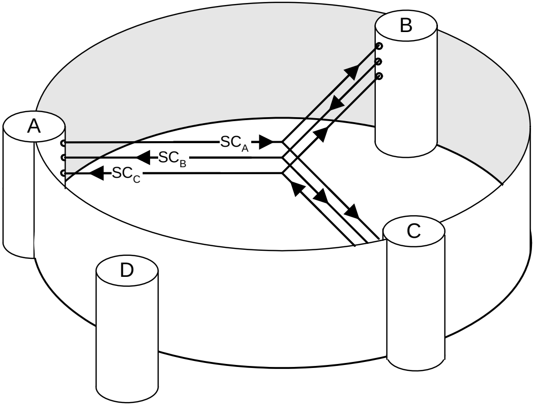
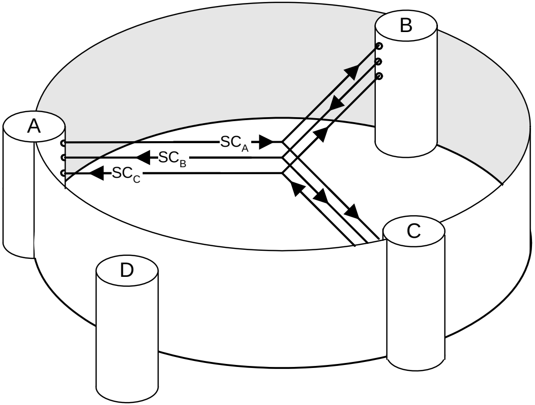


IEEE 802.1AE (MACSec)

- Ethernet frame encryption
  - Uses 802.1X CAs for authentication
  - Uses MKA for symmetric key exchange



Motivation

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  - Search problems
  - Optimizations (Adiabatic QC)

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- New algorithms:
  - Quantum teleportation

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    Breaks (EC)DH and RSA based crypto in polynomial time

Practical Quantum Computer

When to panic?

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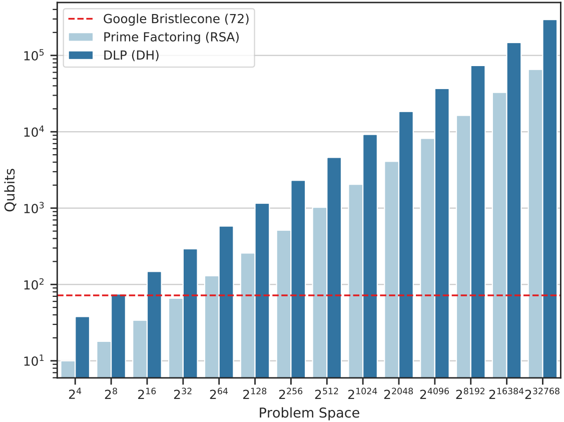
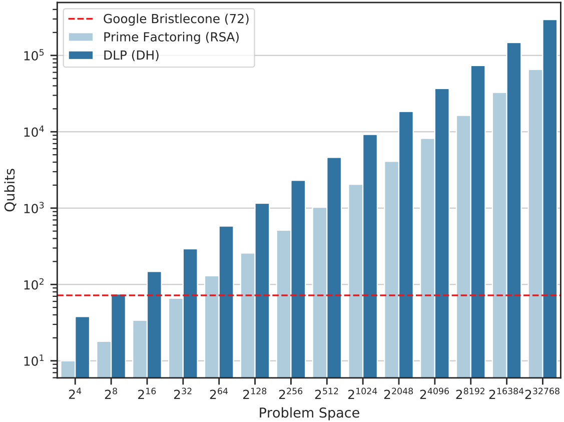
- #Qubits to break a n-bit key
    - RSA: $2n + 2$ [1]
    - DLP: $9n + 2\ln(n)$ [2]



Practical Quantum Computer

When to panic?

- #Qubits to break a n-bit key
  - RSA: $2n + 2$ [1]
  - DLP: $9n + 2\ln(n)$ [2]
- Coherency time
  - Keeping a state is tricky
  - Implementation dependent
  - Hard to predict



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  2. **Implement quantum safe algorithms**

NIST PQ Project

- Start Dec 20, 2016
- 3. Round announced Jul 22, 2020

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- Goal: Select quantum safe key exchange and signature algorithms

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- Different Foundations
    - Lattice-based
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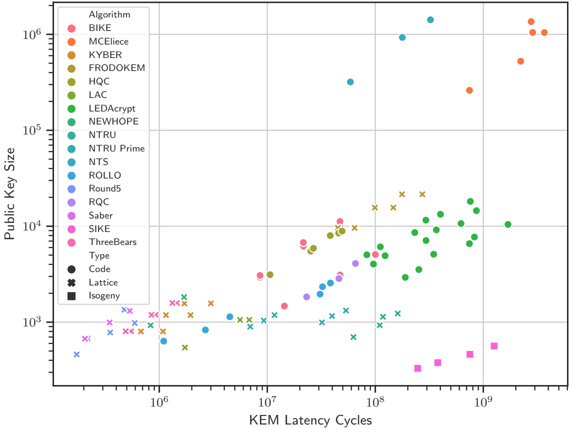
- Different Trade-offs
  - Latency
  - Key size
  - Maturity



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- Web-Server
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- IoT & WSN
  - Small traffic volume
- Long-term signatures
  - Maturity

Existing Applications

- Internet-Drafts for TLS 1.X[3][4][5][6][7]
- QuaSiModO: Quantum resistant IKEv2[8]
- “New Hope” in Google Chrome[9]

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- Industry relevance
    - Part of QuaSiModO/ADVA cooperation

Outline

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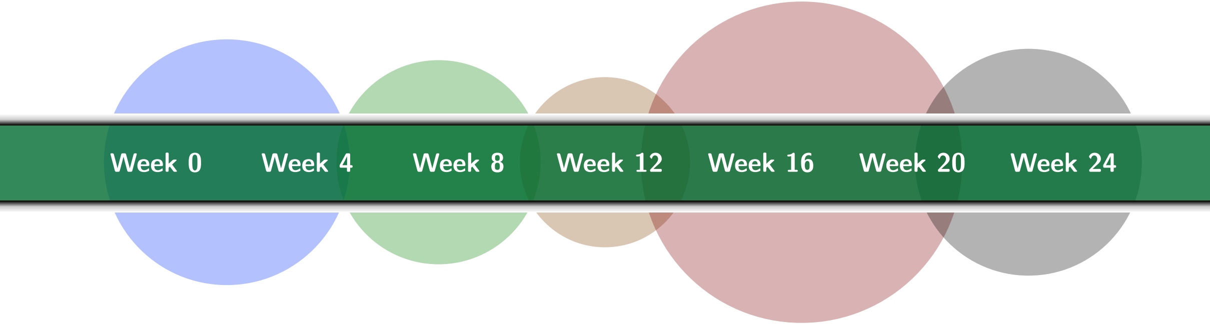
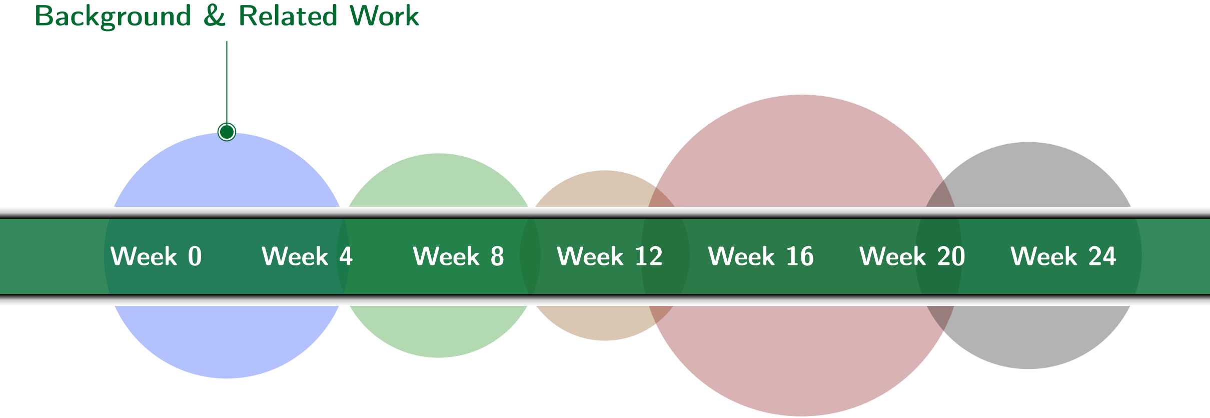
- Evaluation of IEEE 802.1(X|AE)
  - Identify vulnerable components
  - Extract requirements for quantum safe design
- Evaluation of quantum safe algorithms
- Design of a quantum safe alternative
- Implementation in a real-world test-case
- Extensive experimental evaluation

Outline

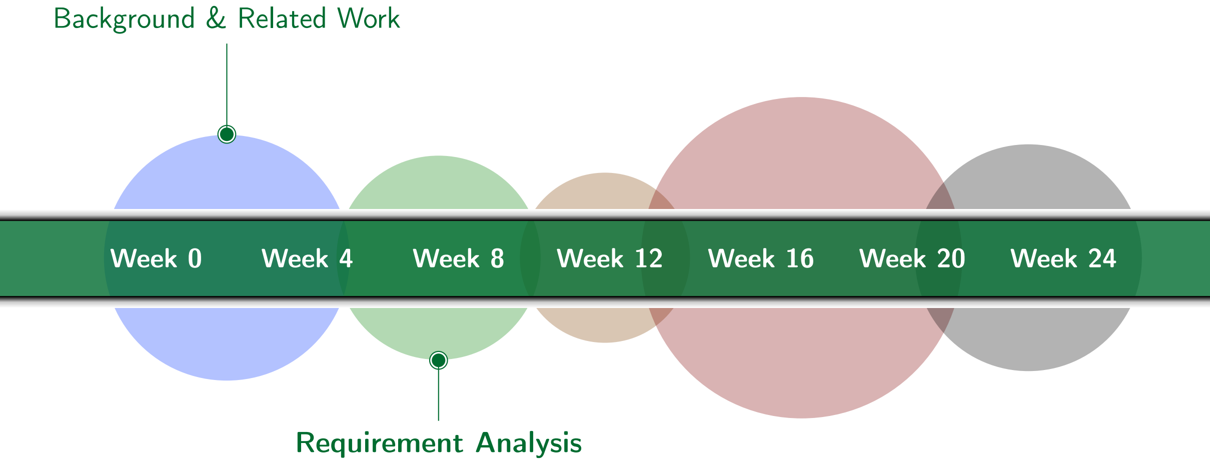


Week 0 Week 4 Week 8 Week 12 Week 16 Week 20 Week 24

Outline


Background & Related Work
Week 0
Week 4
Week 8
Week 12
Week 16
Week 20
Week 24

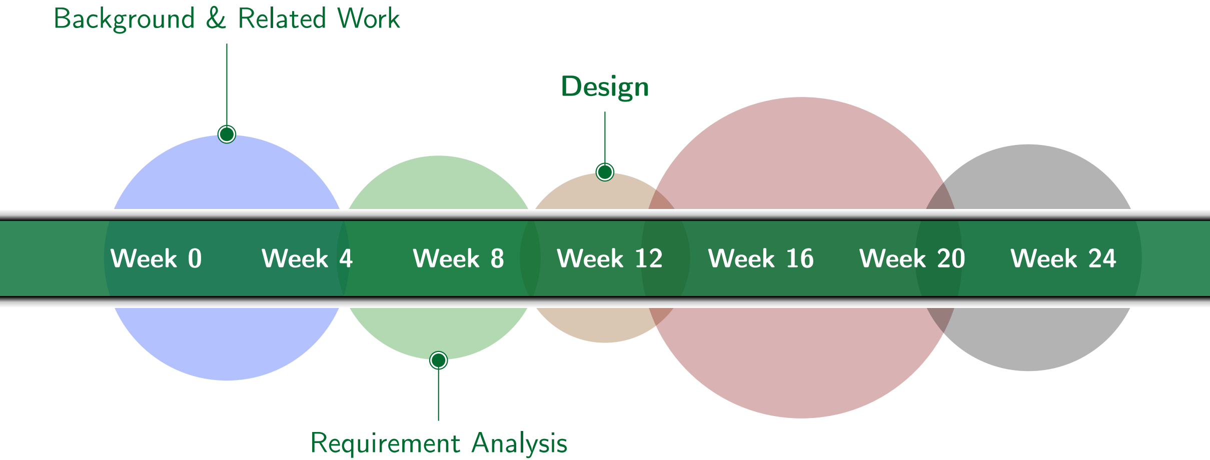
Outline



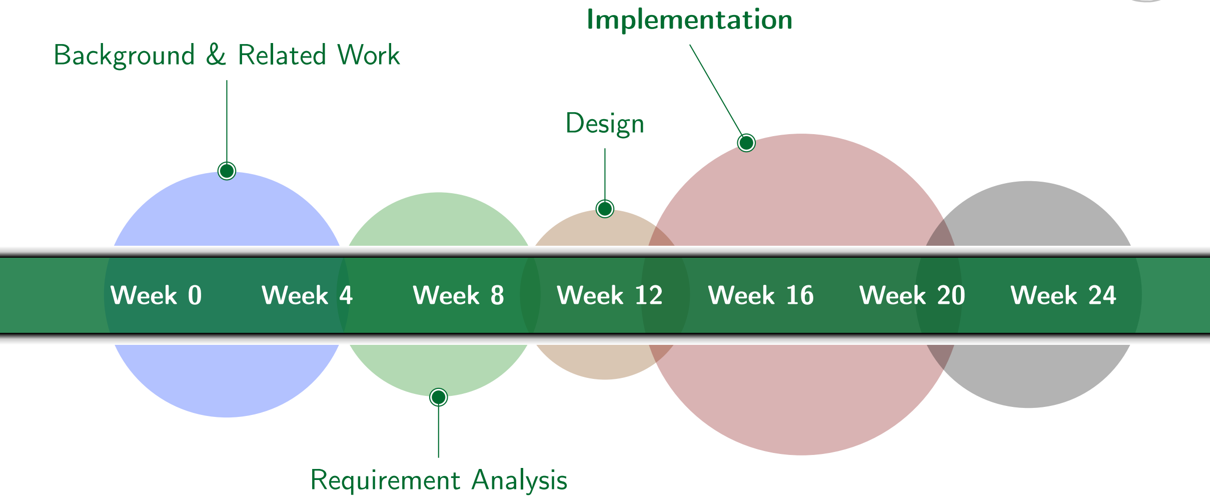
Background & Related Work

Requirement Analysis

Outline


Background & Related Work
Design
Week 0
Week 4
Week 8
Week 12
Week 16
Week 20
Week 24
Requirement Analysis

Outline


Implementation
Background & Related Work
Design
Week 0
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Week 16
Week 20
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Requirement Analysis

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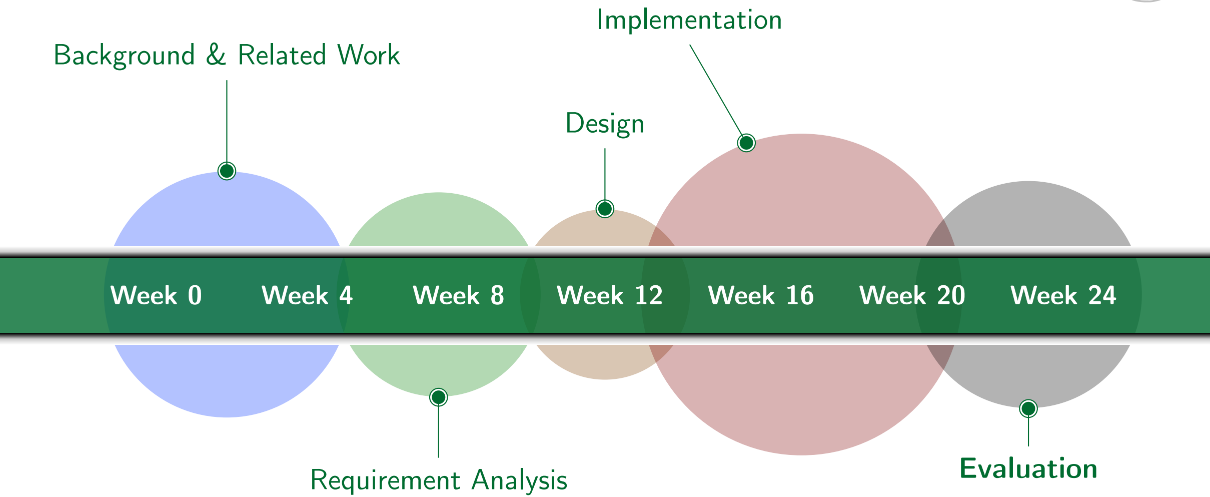
Implementation
Background & Related Work
Design
Week 0
Week 4
Week 8
Week 12
Week 16
Week 20
Week 24
Requirement Analysis
Evaluation

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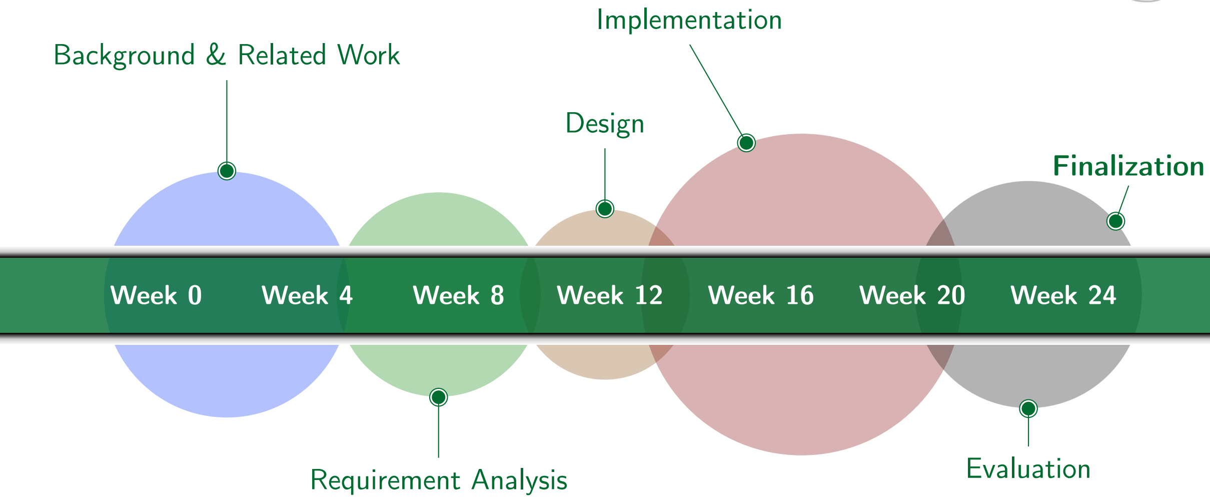
Background & Related Work
Implementation
Design
Finalization
Week 0
Week 4
Week 8
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Week 24
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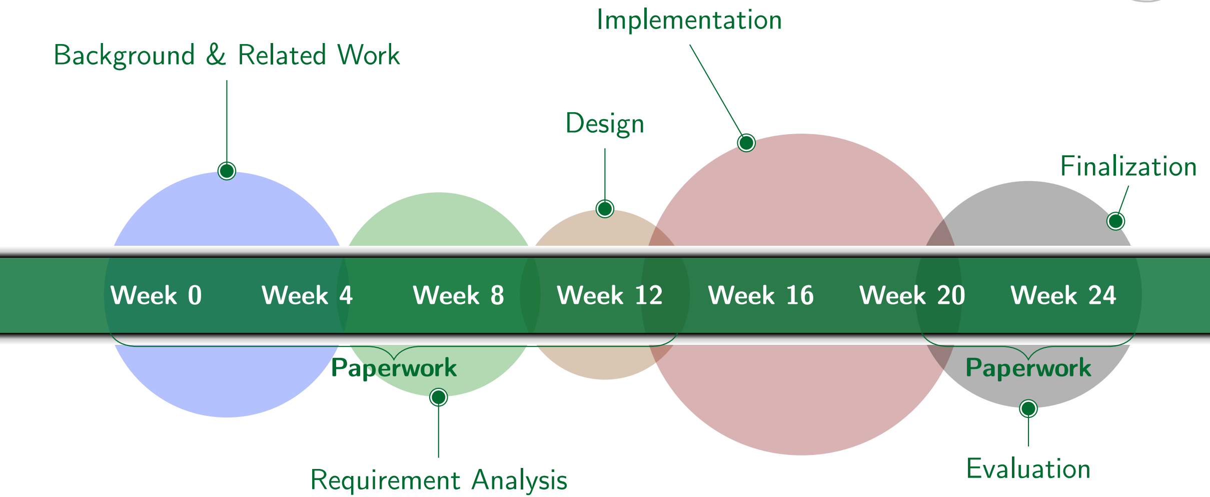
Implementation
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Week 0
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Paperwork
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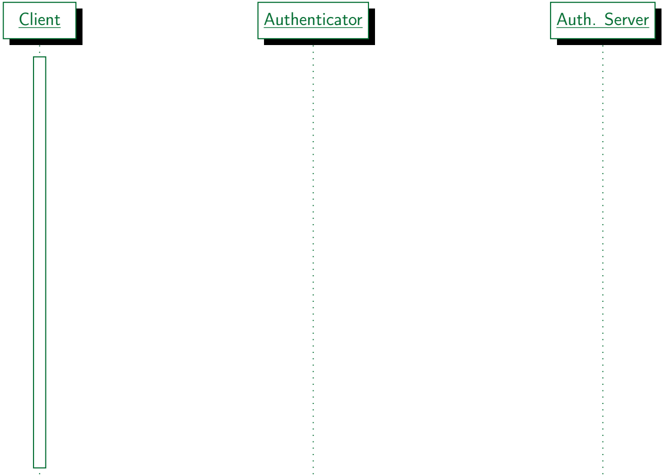
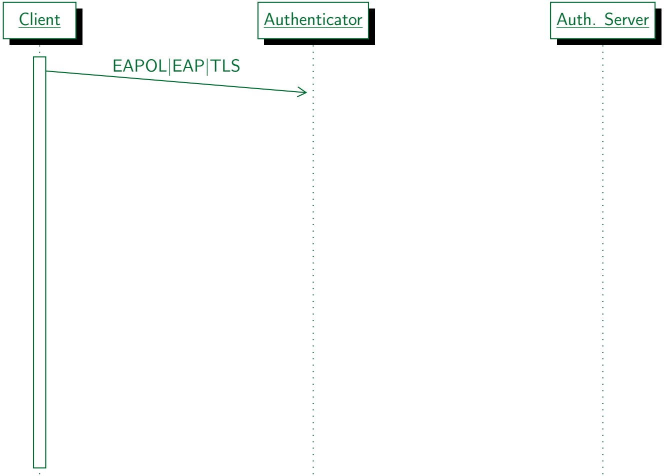


Client

Authenticator

Auth. Server

Outline



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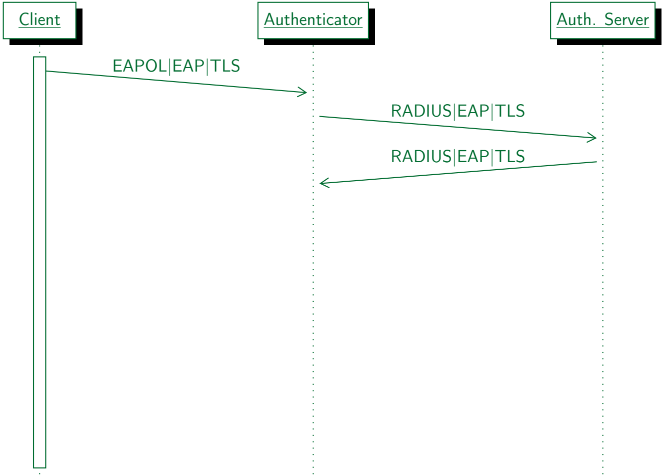
Client
Authenticator
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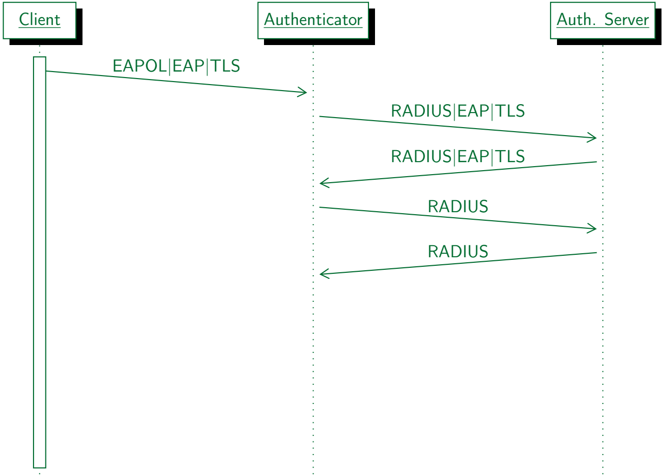
RADIUS|EAP|TLS
RADIUS|EAP|TLS

Outline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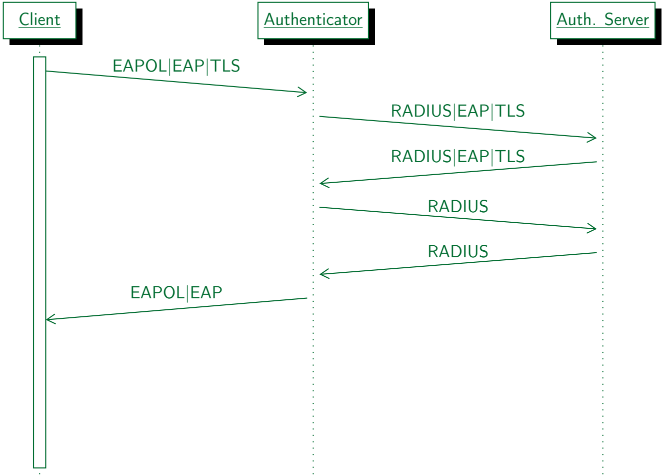
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EAPOL|EAP

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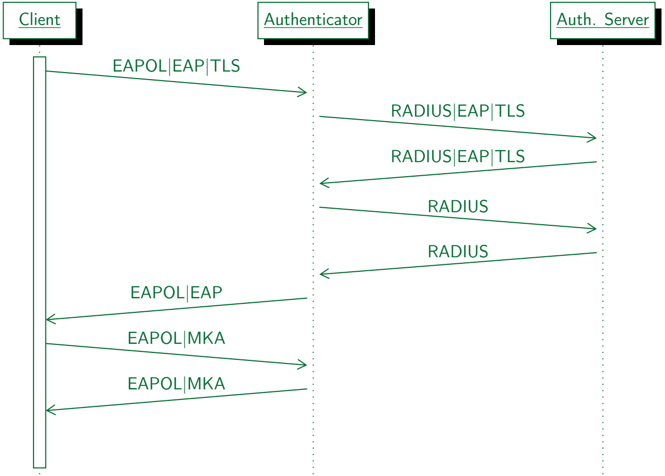
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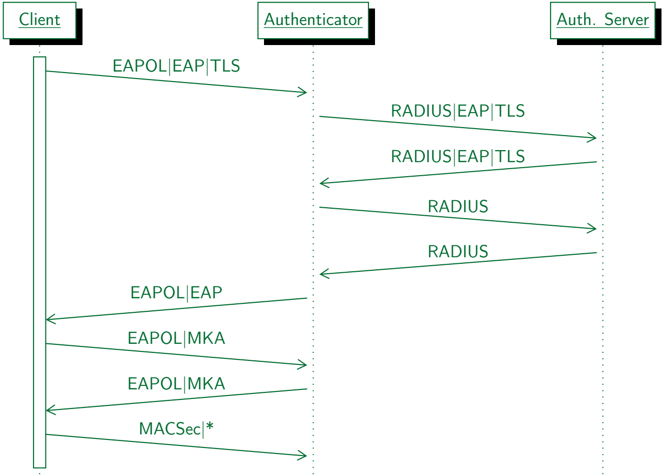
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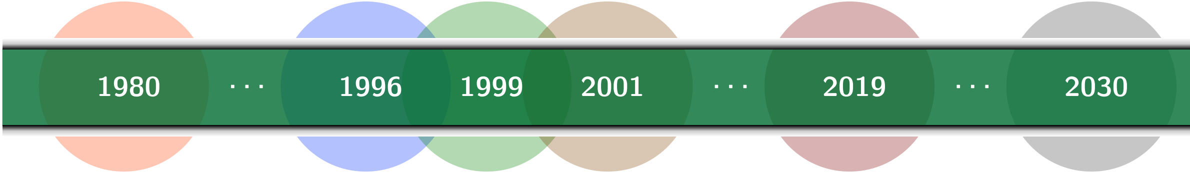
EAPOL|MKA
MACSec|*

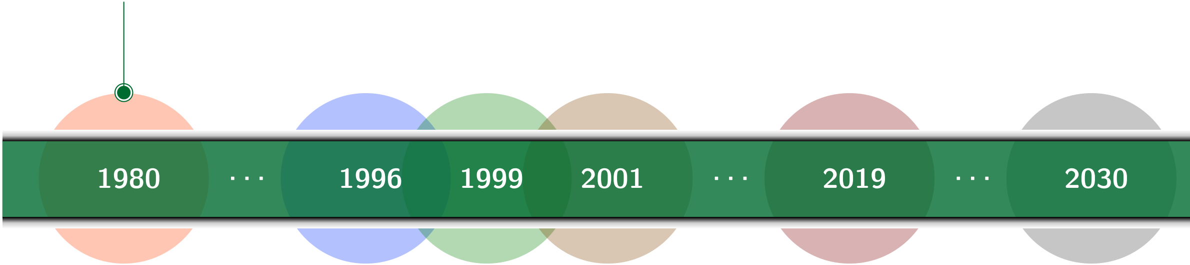
A short history of quantum computing



1980 · · · 1996 1999 2001 · · · 2019 · · · 2030

A short history of quantum computing

Benioff's Quantum TM[10]



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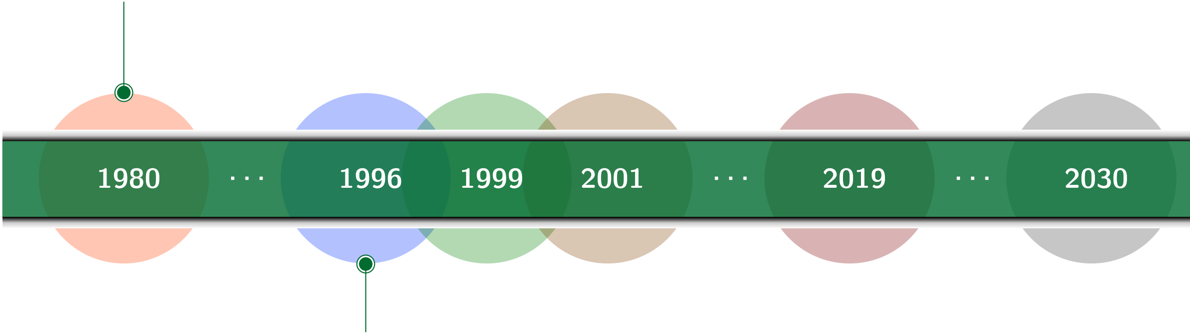

Gover's Algorithm[11]

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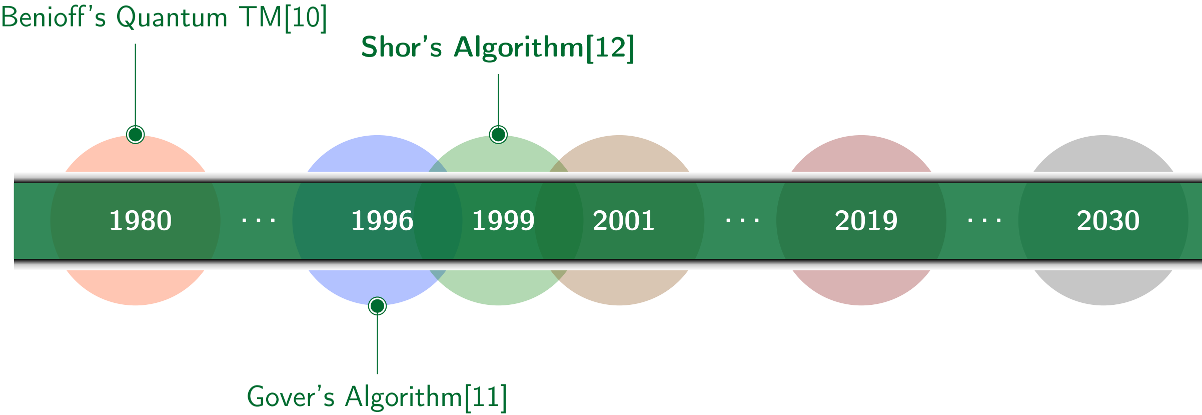

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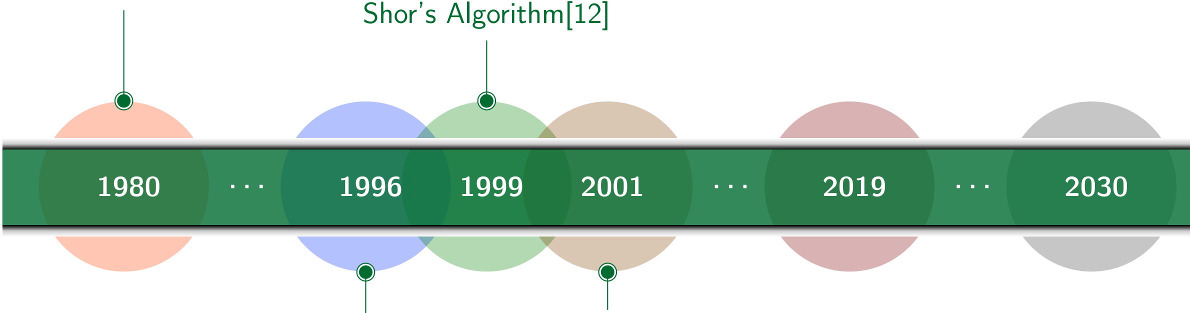

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Factorization $N = 15$**[13]**

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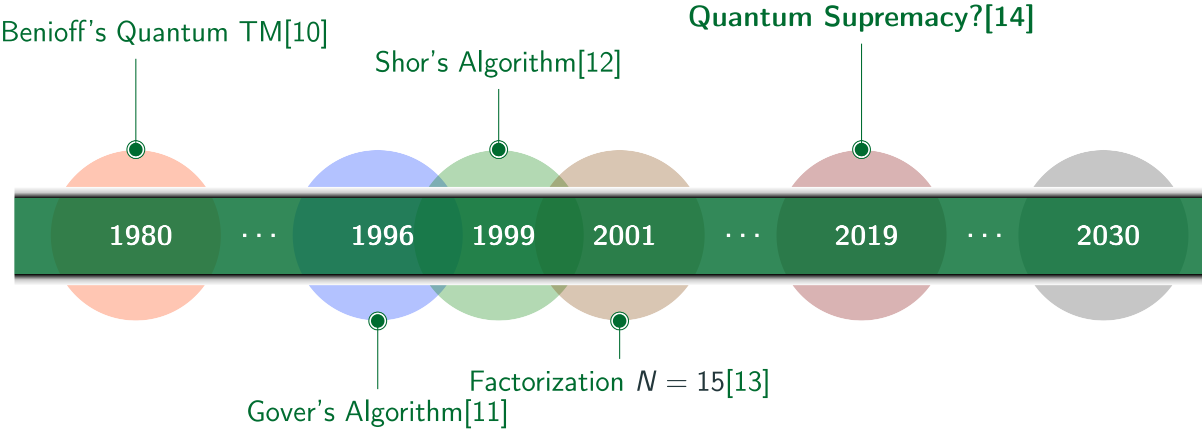

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Quantum Supremacy?[14]

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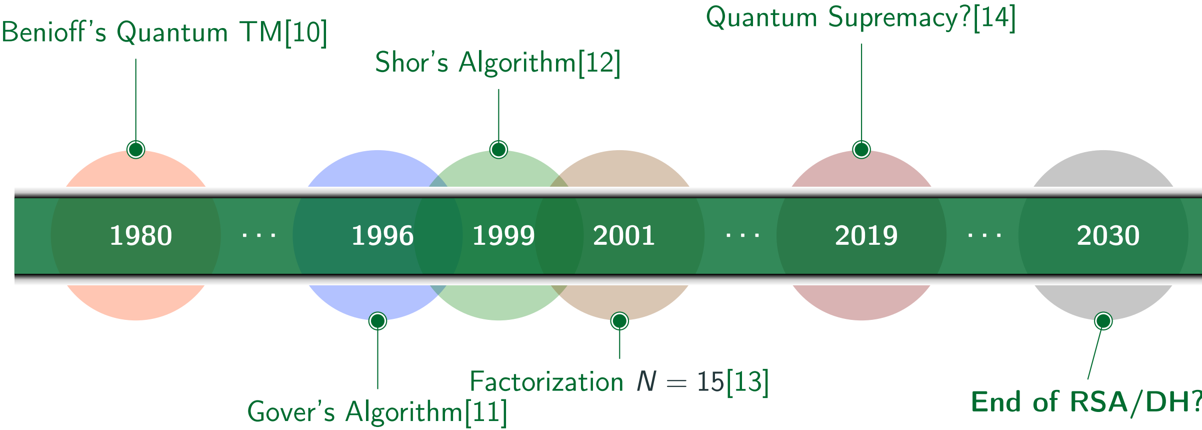

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2019 Quantum Supremacy?[14]

· · ·

2030 **End of RSA/DH?**

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