Reduction of Key Sizes on Rainbow-like Multivariate Signature Schemes

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Context

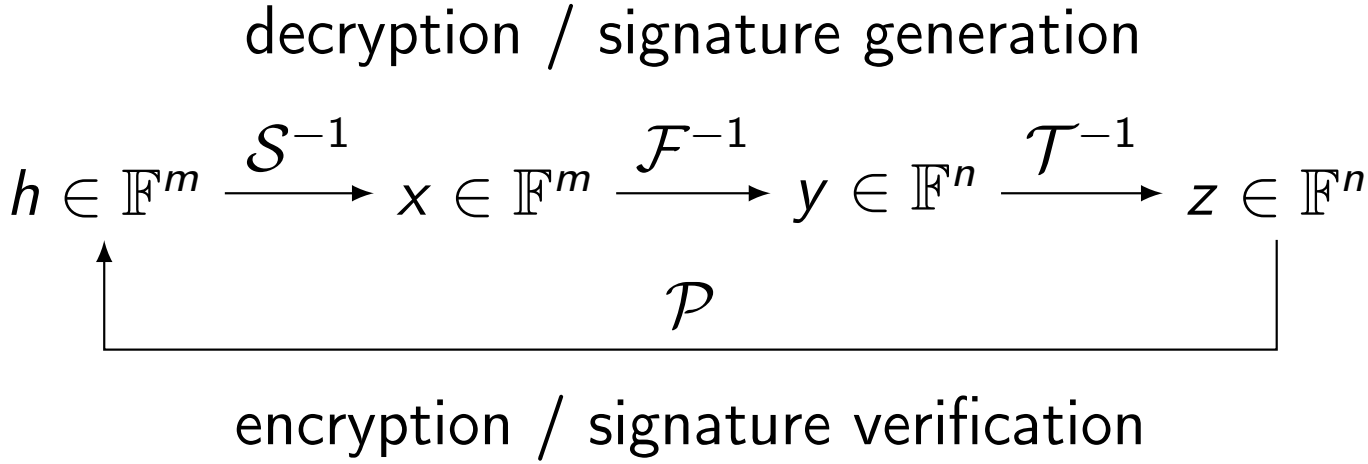
- Guarantee protection and privacy of messages sent digitally
- Security of digital signature schemes is based on problems from number theory
- There exist quantum algorithms [Sho97] that solve these problems efficiently
- Post-quantum cryptography aims to create cryptosystems based on problems immune to quantum speedups

Motivation

- Imminent threat from quantum computers
- Several active branches of post-quantum cryptography
  - Focus on cryptosystems that are based on the difficulty of solving systems of equations
- Standardization calls by institutions such as NIST and IRTF
- Development of quantum computers by corporations, such as Google and Intel

Multivariate cryptography

- Cryptography based on systems of multivariate quadratic equations over finite fields

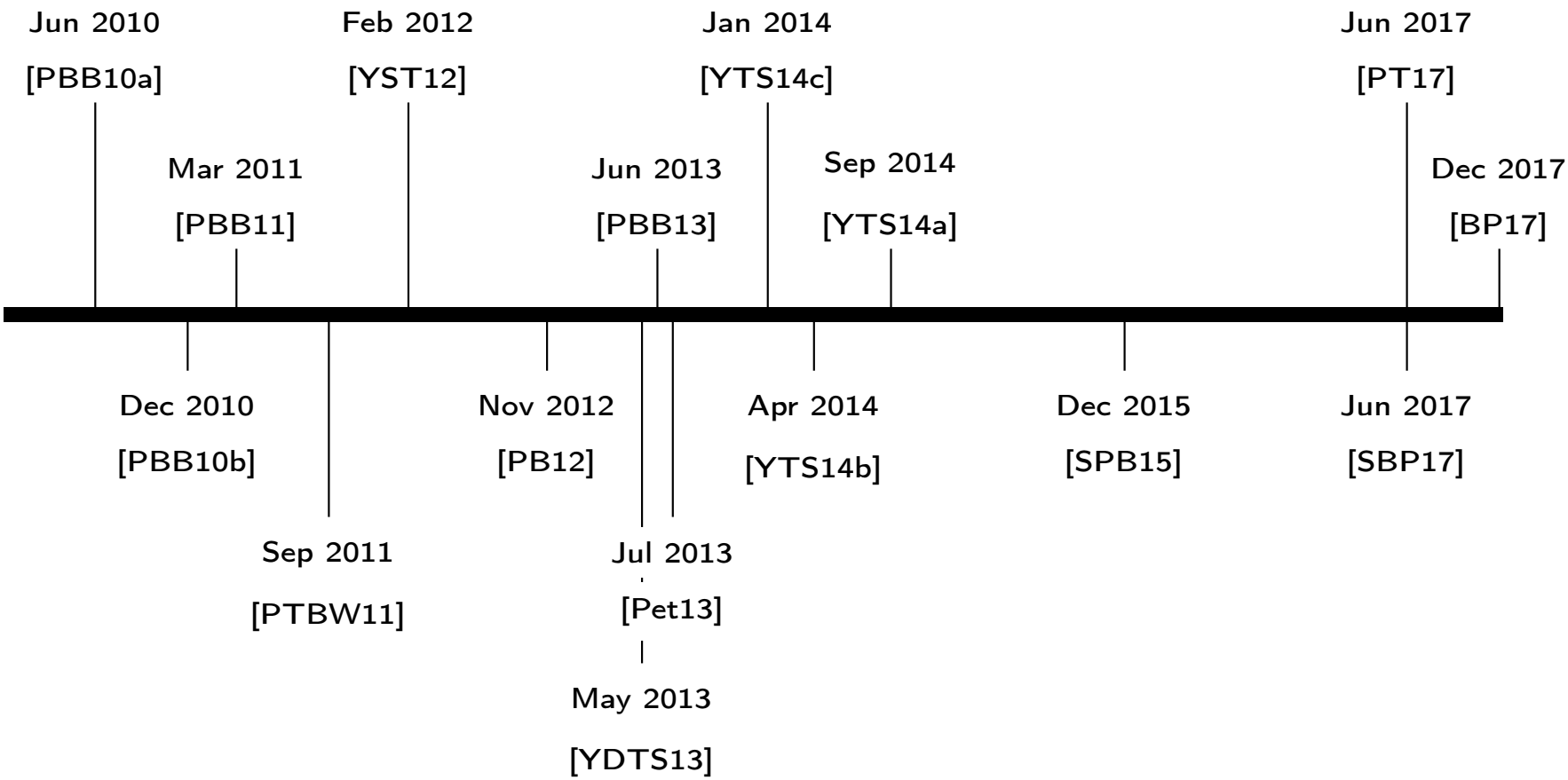


- Fast operations, small signature sizes, large keys

Underlying issue

- Focus on the Rainbow signature scheme, due to Ding and Schmidt [DS05], submitted to NIST for standardization
- Easy description, good balance between signature and key sizes
- Keys in the order of 10 KB, while classical schemes feature sub-1 KB
- Introduction of structures in the keys may lower security

Related works



Hypothesis

- Works have reduced either private or public keys, separately
- Do there exist any restrictions in doing both at the same time?
- Is it possible to generate a structured public key from a similarly composed private key?
- Introduction of matrix symmetries as possible arrangements may lower security

Objectives

- Establishment of fit matrix structures to be introduced
- Measurement of security achieved by keys created with those matrices
- Development of a method in which private and public keys are structurally related
- Description of a new signature scheme with carefully chosen parameters for devices with distinct requirements

Methodology

- Review schemes that reduce key sizes, cryptanalysis of these, and study matrix-like symmetric structures
- Create an algorithm to generate a compact private-public key pair
- Apply currently known cryptanalytic methods to test security of signatures created by these keys
- Compare performance and security with related works
- Publish and present results through papers, dissertation etc.

Expected results

- Identify the relationship between matrix types and their effect on security
- Deep analysis on how to maintain structure when generating a key pair
- Present a Rainbow-like signature scheme that features reduction of private and public key sizes
- International collaboration and scientific contributions

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