Is Java Card ready for hash-based signatures?

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[2] Radboud University, Nijmegen, The Netherlands

2018-09-04
IWSEC 2018

Not really, no.

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Reviewer 1: *"an ill-fated attempt"*

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- This talk: hash-based signatures
  - Pre-image resistance: $\mathcal{H}(x) = y \not\Rightarrow x$
  - *The* conservative choice
  - RFC 8391: XMSS and XMSS^{MT}

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- Authentication step:
  - Publish $\boxed{s_{YES}}$ or $\boxed{s_{NO}}$ to authenticate 'YES' or 'NO'
- Anyone can check and compare to hashes
- Can never re-use!

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- ‘Classic example’ of hash-based signatures

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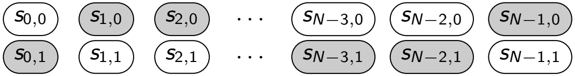

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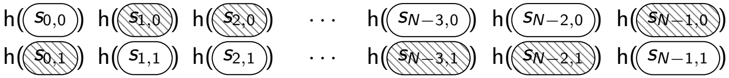

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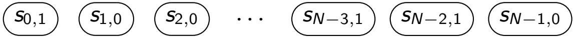

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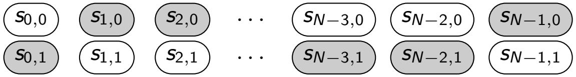
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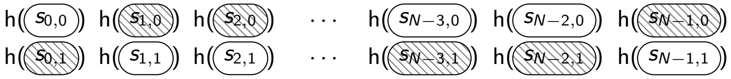
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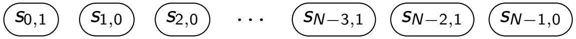
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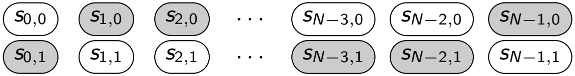
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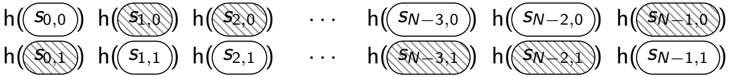
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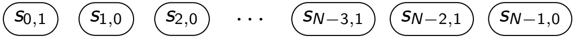
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- Can still only do this **once**!

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- Idea: sign groups of $\log(w)$ bits (let $w = 2^n$)
- Trade time for signature and key size

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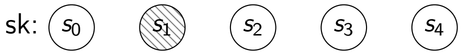

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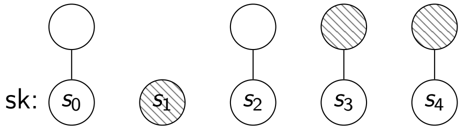

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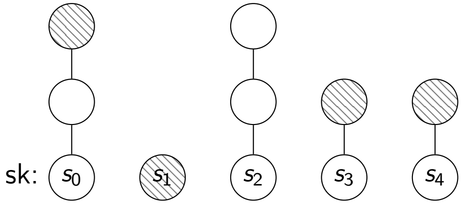

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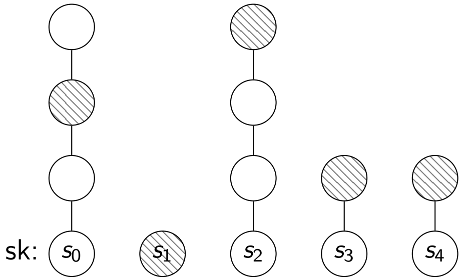

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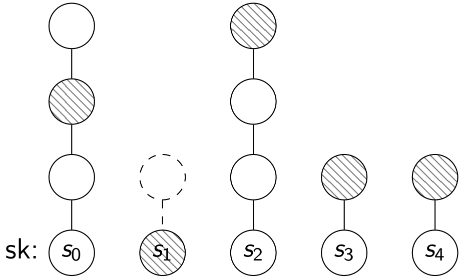

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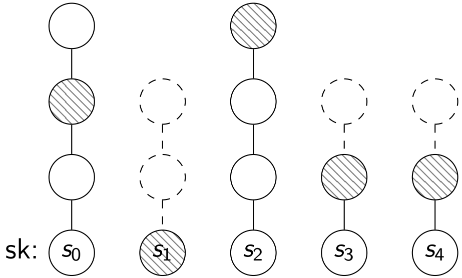

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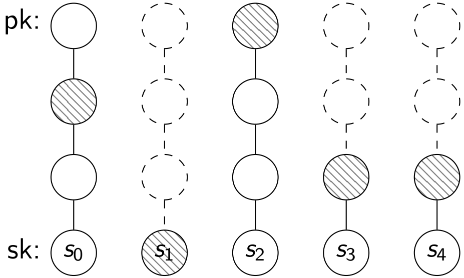

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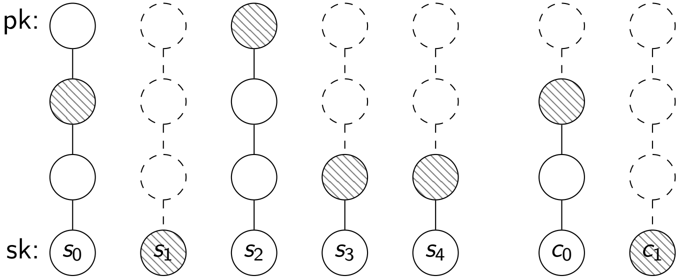

- Checksum: $\Sigma_{i=1}^{\ell_1}(w - 1 - m_i)$, convert to base w

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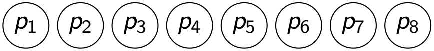

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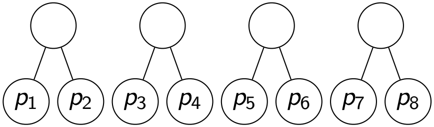

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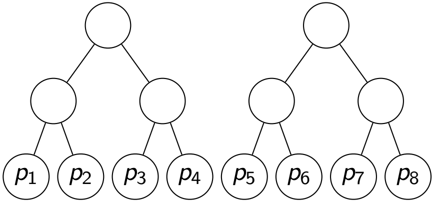

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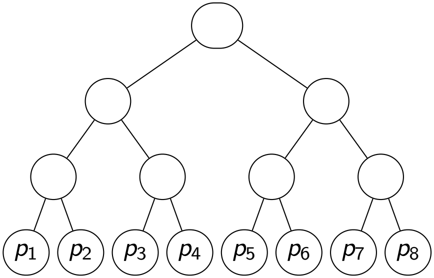

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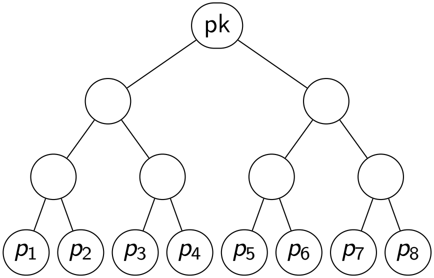

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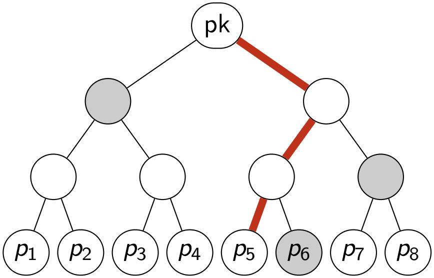

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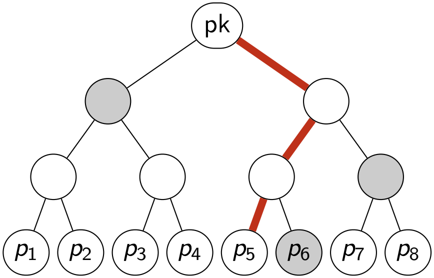

- Verification
  1. Implicitly verify OTS signature (reconstruct OTS public key)
  2. Reconstruct root node (using authentication path)

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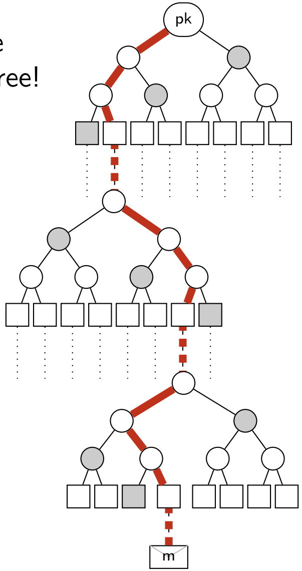

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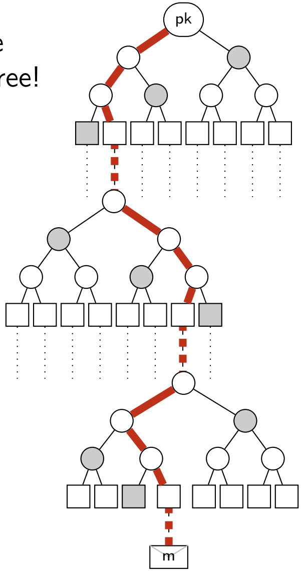

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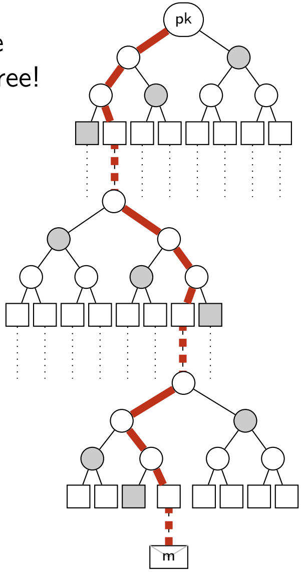

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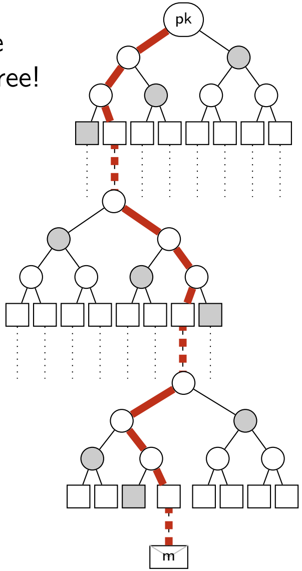
- In practice:
  - Prevent multi-target attacks
  - 64 byte public keys, 2-20 KiB sig.
  - Standardized as RFC 8391



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  - Context: already-deployed Java Cards, to authenticate VPN

Implementation

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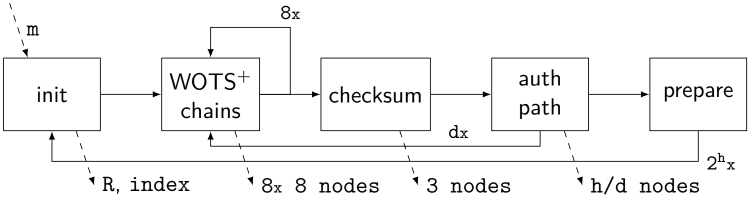

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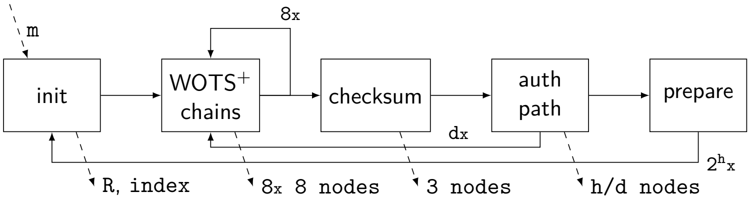

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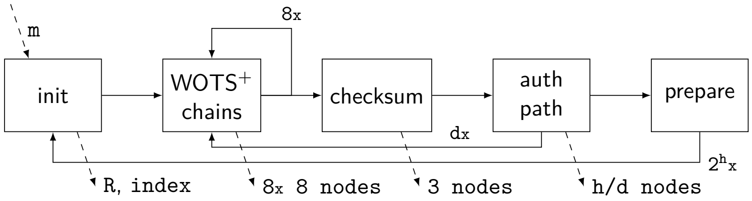

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- Java stack is the bottleneck!

- $h = 20, d = 5$, 13 KiB signatures; 50 sec. signing!

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- Code is available (public domain): `https://joostrijneveld.nl/papers/javacard-xmss`