Post-Quantum-Kryptographie

Hashbasierte Signaturverfahren - Drawbacks of MSS

Fabio Campos

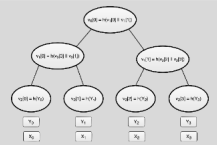
7. November 2018

RheinMain University of Applied Sciences

drawbacks

Given security level n, tree height h and message length m

public key generation time



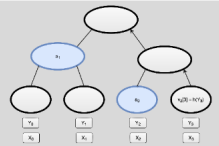
signature size

$$\sigma_i = (i, \sigma_{OTS}, Y_i, (a_0,...,a_{H-1}))$$

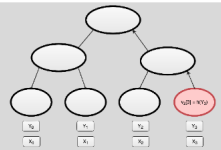
private key size

$$2bm * 2^H$$

authentication path generation time & space

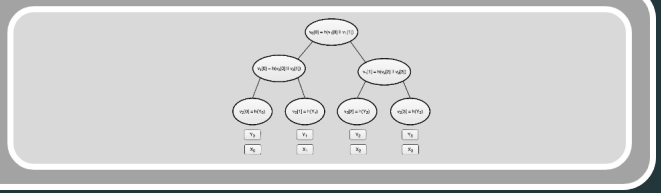


stateful

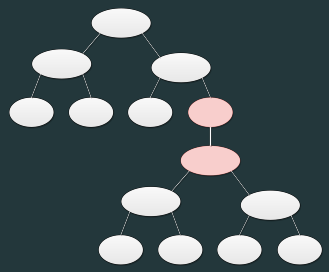


Given security level b, tree height H

public key generation time



- MSS
  - generate single trees of size of 2^H
  - cost $\sim 2^H$
- CMSS[a],XMSS[b]
  - generate t layers of trees of height H/t
  - generate t trees of size $2^{H/t}$
  - cost $\sim t * 2^{H/t}$
    (i.e. $H = 40$, $t = 2$, $2 * 2^{20} = 2^{21}$)

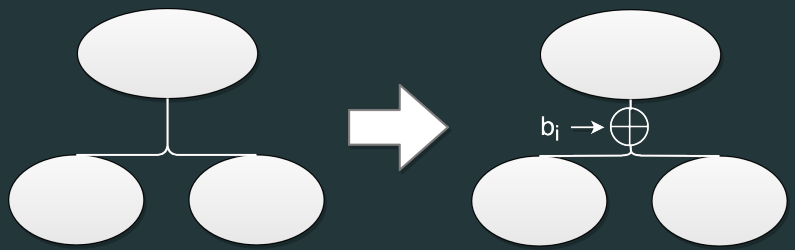


[a](BGD+06)
[b](BDH11)

Given security level b, tree height H and message length m

signature size	$\sigma_i = (i, \sigma_{OTS}, Y_i, (a_0,...,a_{H-1}))$

- using Winternitz[1] OTS $\rightarrow Y_i = f(\sigma_{OTS})$
- modifying tree construction[2] $\rightarrow$ allowing use of 2nd preimage resistant hash function



[1](Mer89)
[2](BDH11)

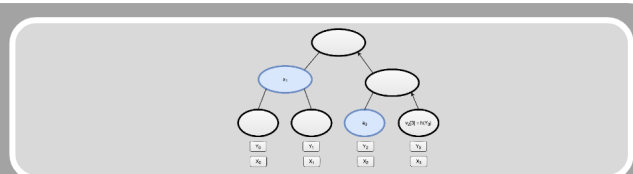
Given security level b, tree height H and message length m

- using seed-based secret key[3]: $2bm * 2^H \rightarrow b * 2^H$
- secret key size independent of message length

[3](BDH11)

Given security level b, tree height H and message length m

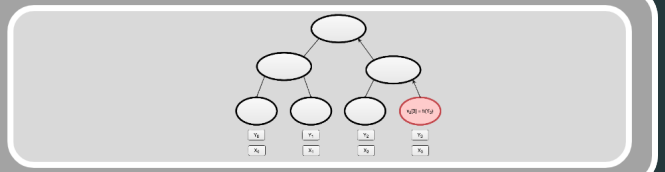
authentication path generation time & space



- MSS requires time and space of 2^H (naive)
- Treehash[4] algorithm requires only $b(H-1)$ space
- BDS[5] algorithm (time - memory trade off by parameter k):
  - time : $(H-k)/2$ (per signature)
  - memory: $(5,5H-5k-2^k)$

[4](BDS08)
[5](BDS08)

stateful

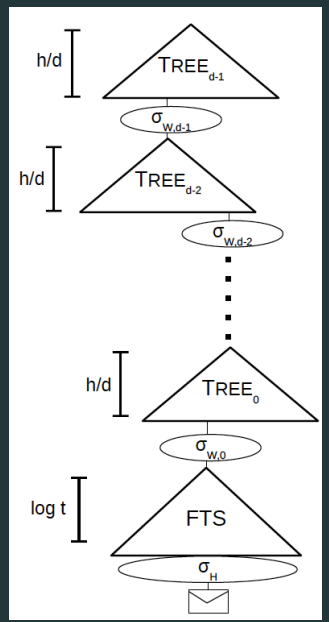


storing index $i \rightarrow$ problems:

- Load-balancing
- Multi-threading ...

Goldreich's[a] and SPHINCS[b] approach:

- use a huge/"hyper-tree"
- pick index i randomly
- messages signed with few-time signature scheme



[a] (Gol04)
[b] (BHH+15)

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2/2

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9