# Let Live and Let Die: Handling the State of Hash-based Signatures

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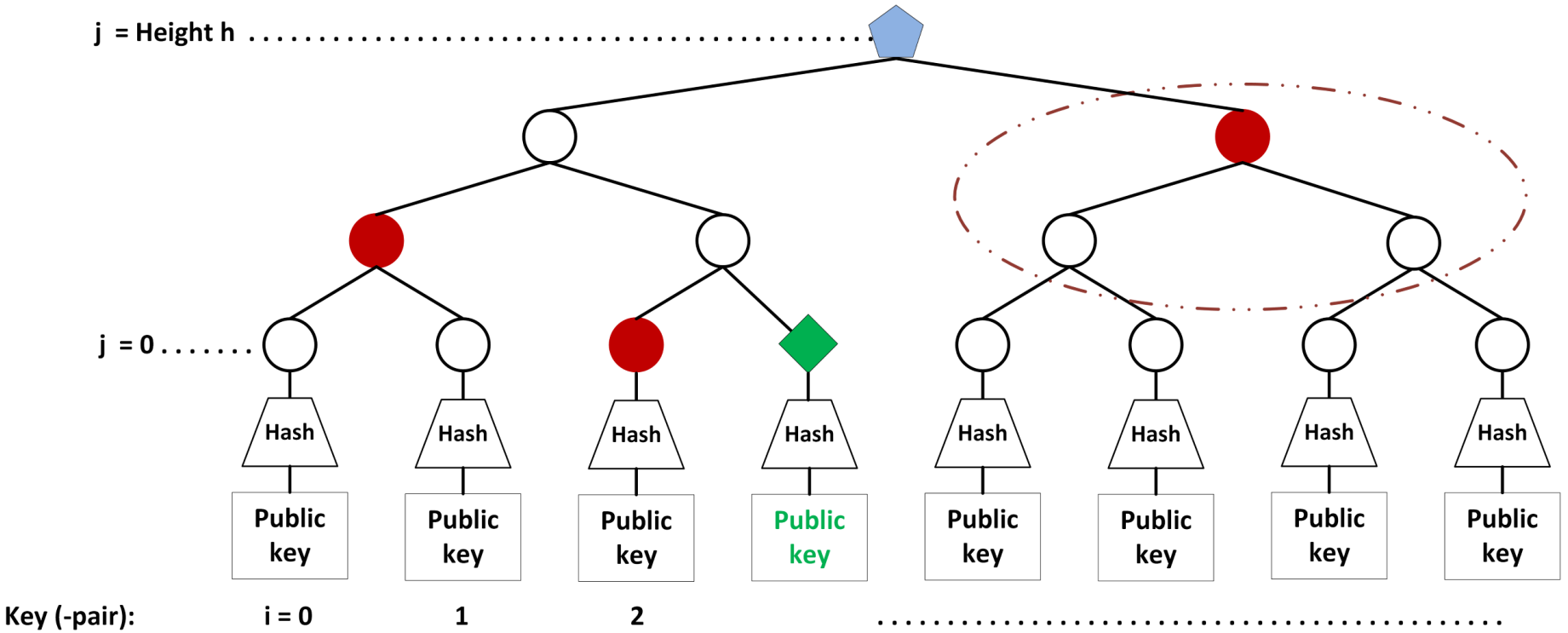
# Presentation

- Introduction
- Statefulness
- Handling the state
- Protocol Integration and other considerations

# Introduction: Merkle / XMSS tree



# Statefulness

What's so bad about the state?

- Security leaks possible
- Software does not consider keys being stateful
- Missing infrastructure

# Statefulness

Why bother coping with the state?

- Hash-based signatures well understood and post-quantum
- Current stateful methods faster than stateless ones
- Currently smaller signatures
- Forward secure constructions

# Considerations

What we want:

Secure usage of secret key

What we need:

Practicability

# The secret key

Considerations for the key:

- Any copies may reveal secrets
- Interrupts may threaten consistency
- Key is critical resource

# Handling the state

How to cope with the state

- Index handling
- Error / consistency checking
- Storing

# Index handling

Single state

Several two state solutions

Delegation of subtrees

# Errors and Consistency

Does the index fit the actual state?

Is the state consistent itself?

# Storing the secret key

Who's able to access the storage?

Has the key actually been written to storage?

$\Rightarrow$ Doesn't fit current libraries that well

# Runtimes

Lots of use cases without tight restrictions:

- Update signing
- Email signing

But even with stricter timing:

- 200 ms maximum for SSH signature procedure

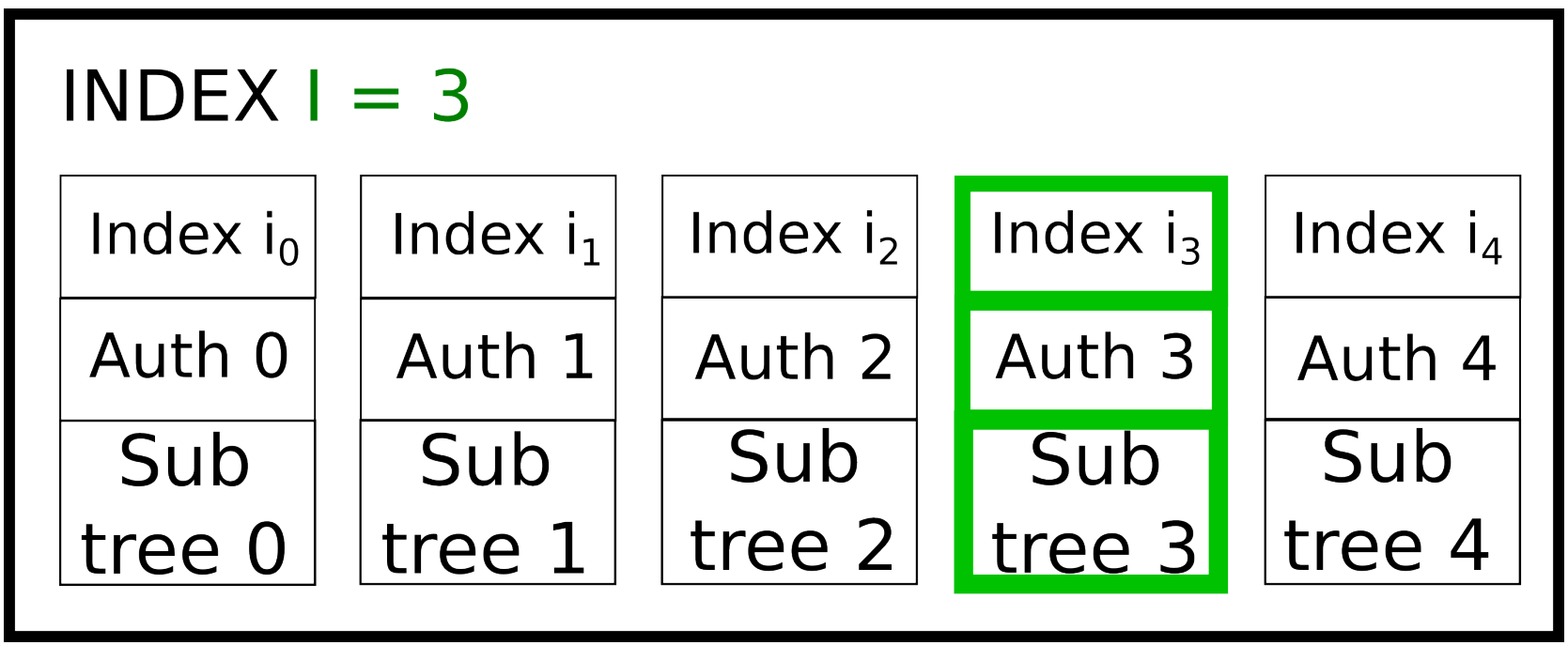
# Key Management

Key provider concept

$\Rightarrow$ external management of key

Offers API to receive and write SK, PK, authentication path information

Delegation of subsets of SK



# Protocol integration

Keys still fit most communication protocols

Need a PQ key exchange

Need PQ signatures (hash-based) for that

# Standardization

As seen in Andreas Hülsing's talk before

Internet-Draft available
draft-huelsing-cfrg-hash-sig-xmss-00

# Statelessness

SPHINCS

See Daniel J. Bernstein's talk and SPHINCS paper
http://sphincs.cr.yp.to/

# Conclusion

State can be managed a feasible way

But:
*Trade-off*: security <> performance

TBD: Exact comparison of those trade-offs

# Thank you!

Questions?

www.pqsignatures.org