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LINUX ENCRYPTOR OF NETWORK TRAFFIC

CA5: Post-Quantum Cryptography

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Overview

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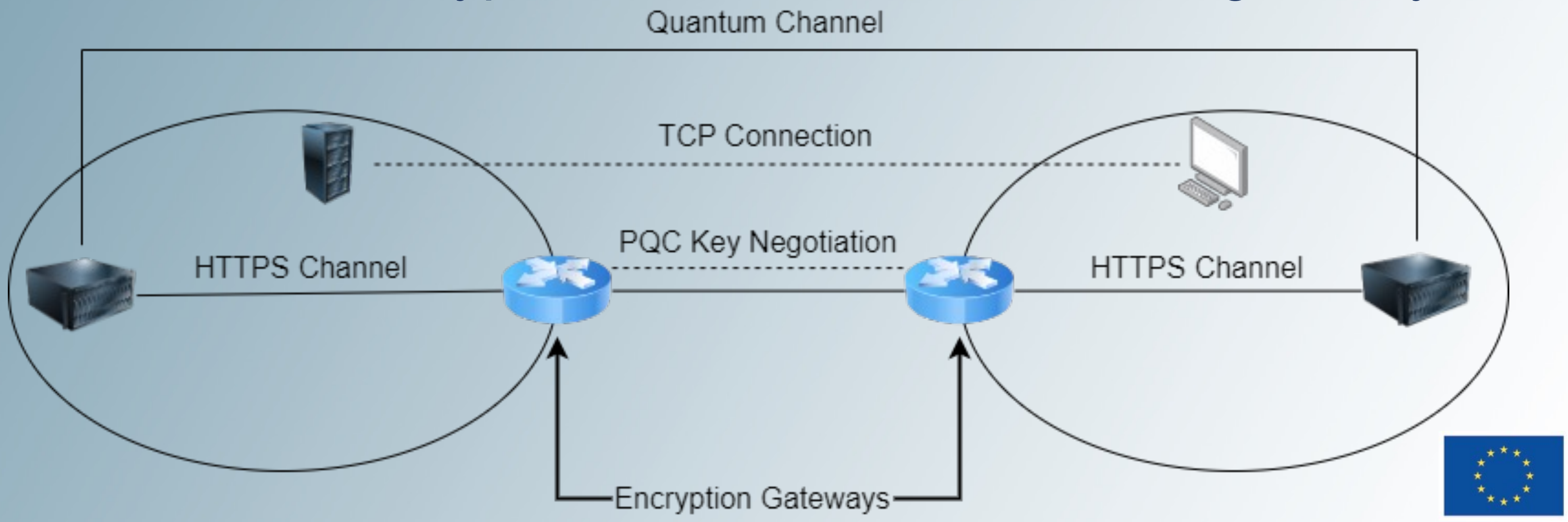
- Originally a student project at Brno University of Technology, CZ
- Goal of this subproject is to create Linux implementation of IPv4 network traffic encryptor using quantum resistant algorithms.
- Network encryptors serve as inter-network gateways.



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Gateway Properties

- Network traffic routed using virtual interfaces
- Packet-by-packet encryption in tunnel mode
- 60 bytes packet expansion – MTU decrease needed
- Encrypted traffic is wrapped in UDP and sent to port number 62 000
- Other traffic is considered to be unencrypted

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Used Algorithms

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- Hybrid key establishment – 2 parts:
  - Post-Quantum Cryptography: Crystals Kyber 512
  - Quantum Key Distribution: COW Protocol in IDQ Clavis
  - Key combination: SHA3-256

- Symmetric encryption: AES-256-GCM
  - 16 B nonce
  - 16 B authentication tag

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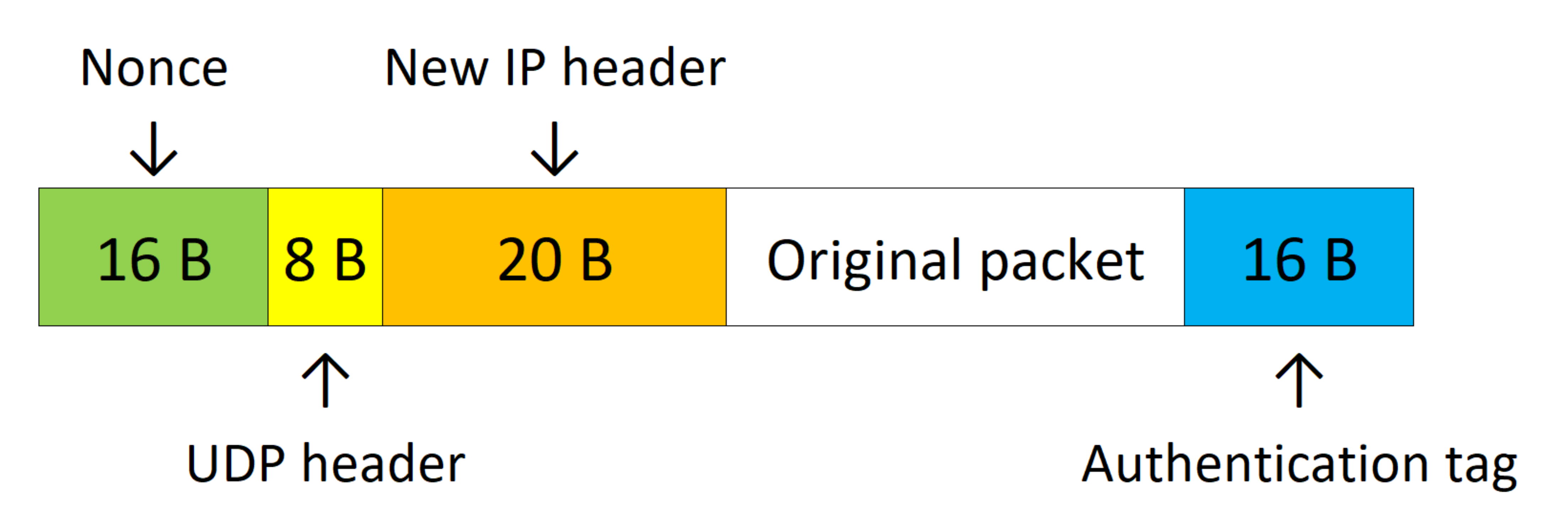
Encrypted Packet Structure



Nonce

New IP header

16 B

8 B

20 B

Original packet

16 B

UDP header

Authentication tag

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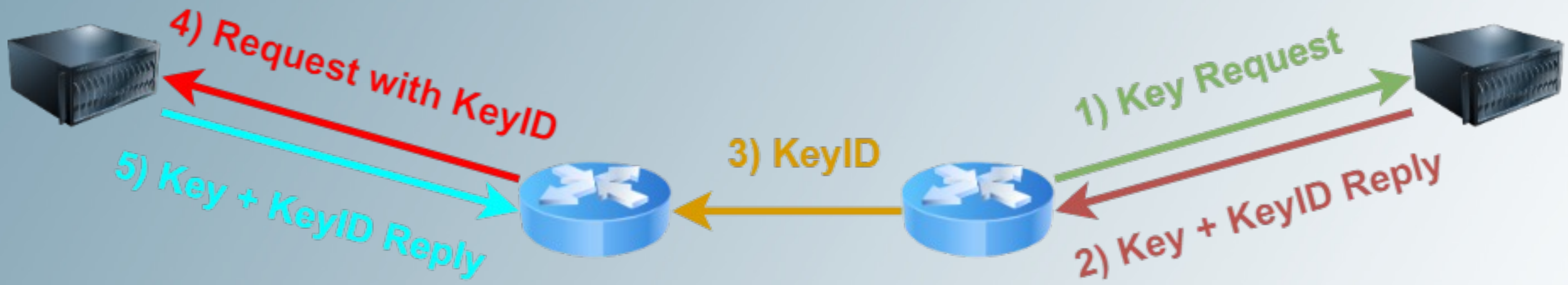
Rekeying

- Occurs every 200 000 encrypted packets
  - Hybrid key recalculated with new QKD part



- TCP port 61000 is used to transfer key ID
- Rekey causes packet loss
  - Packets transferred during steps 1-3 fail integrity check

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Performance

- Average speed of file transfer measured using wget utility

Encryption	1 MB [mbps]	500 MB [mbps]	1 GB [mbps]	5 GB [mbps]
No encryption	435,4	499,8	476	458,6
Rekeying	162,7	142,6	140,3	140,6
No rekeying	162,7	144	145,3	145,8

- CPU: Intel Core i7 1065G7 Ice Lake

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Installation and Usage

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- Requirements:
  - Debian or Debian-based Linux distribution + root privileges
- Installation:

```
git clone https://github.com/gabsssq/Linux-network-traffic-encryptor.git
cd Linux-network-traffic-encryptor
chmod +x install.sh
./install.sh [IP address of other gateway network {x.x.x.x/y}]
```

- Usage:
  - 1st Gateway – server: `./encryptor_server [QKD system IP]`
  - 2nd Gateway – client: `./encryptor_client [QKD system IP] [Server gateway IP]`

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Summary

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- Encryptor is used to create encryption gateways
- Quantum and post-quantum algorithms are used for key establishment
- AES-256-GCM is used to encrypt network traffic on virtual interfaces
- Gateways can serve as physical or virtual devices, with either physical or virtual interfaces. VPN clients are supported.

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References

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- Brno University of Technology: https://www.vut.cz/en
- Github: https://github.com/gabsssq/Linux-network-traffic-encryptor
- Crystals Kyber: https://pq-crystals.org/kyber/
- hajny@vut.cz

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