@raphaelrobert

Messaging Layer Security

Introduction

Raphael Robert

GI FG NETSEC July 2020

Intro

- **MLS: Messaging Layer Security**
- MLS is a new protocol for end-to-end encrypted messaging
- MLS is now an IETF working group
- Why is this important now?

- Raphael Robert: Head of Security at @wire


moz://a


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Current status

Secure Messaging

Lots of secure messaging apps.

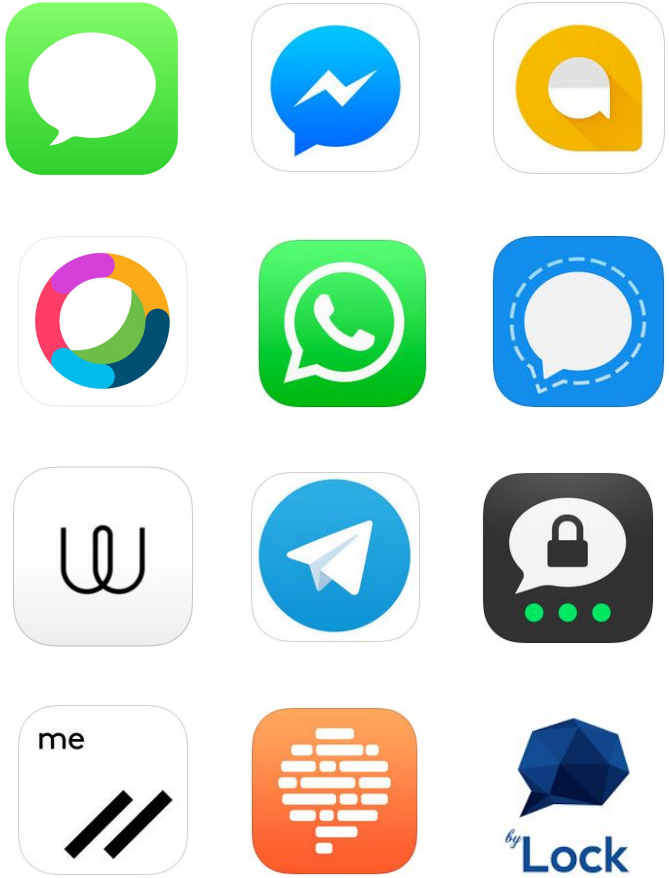
Some use similar protocols...

... some are quite different.

... but all have similar challenges.

Very different levels of analysis.

Everyone maintaining their own libraries.



History of security properties

What about groups?

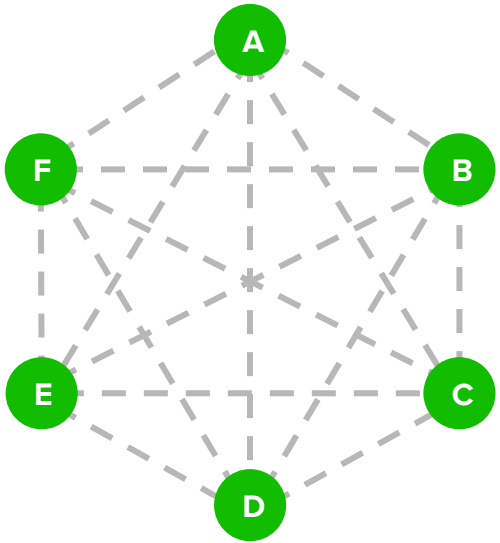
Pairwise protocols cannot “just” be extended to accommodate for groups

The pairwise channels can be superposed to simulate a group

Tradeoff between security properties and scalability

Groups with pairwise protocols

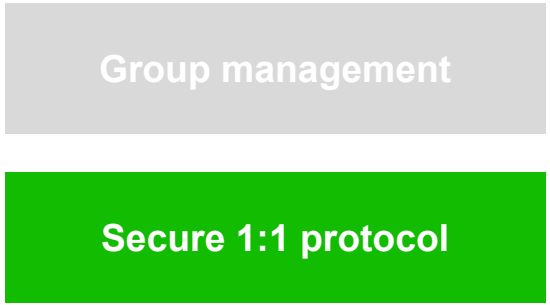
Pairwise protocols superpose 1:1 connections in a group (full mesh)



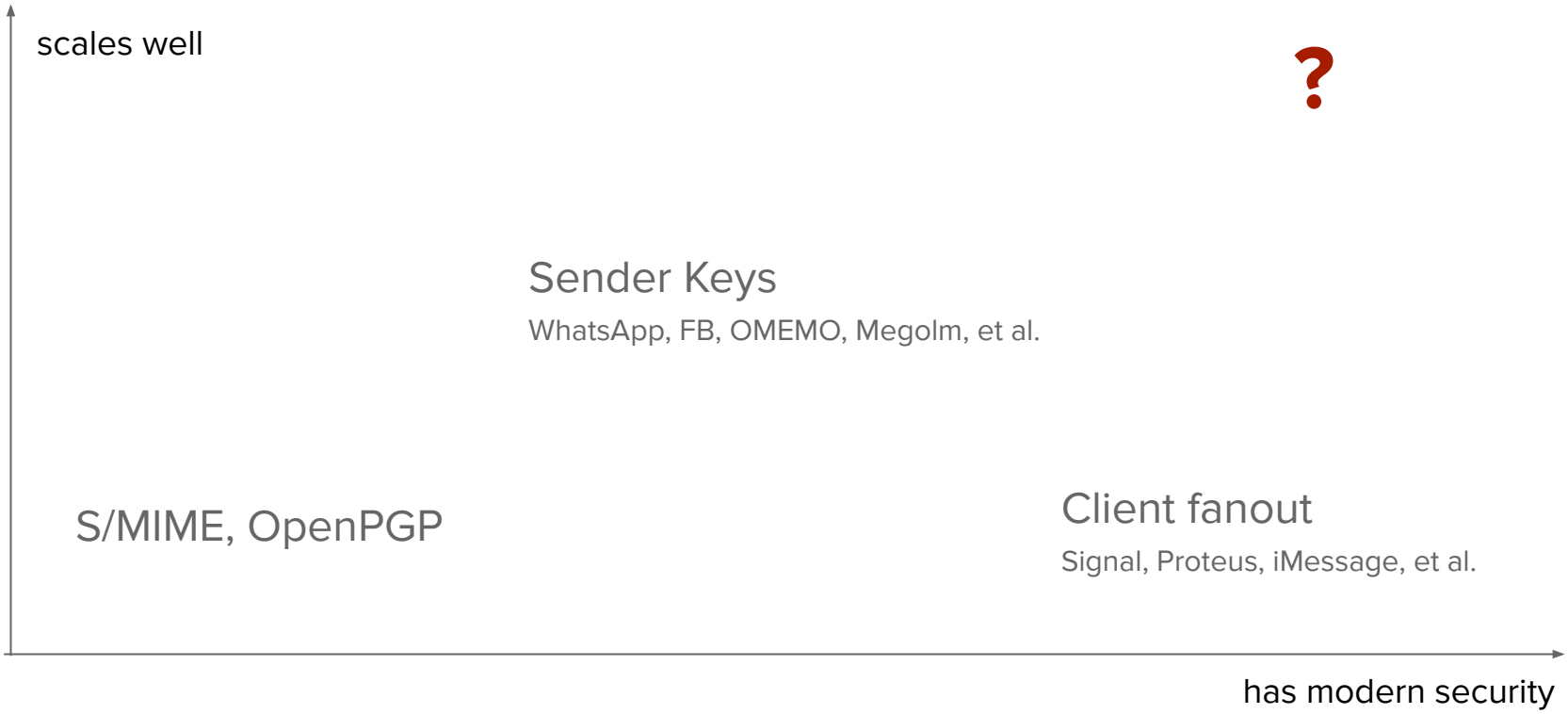
What about groups?

Creating groups on top of a pairwise protocol is hiding the complexity behind a non-standard layer.

Everybody has a different solution and everybody has different security properties.



Modern security & scaling



Objectives

What do we want?

Security Protocol with modern security properties:

What do we want?

Async - Support sessions where no two members are online at the same time

Group Messaging - Support large, dynamic groups with efficient scaling

Multi-device support - Users should be able to use more than one device

Federation - Members of groups should not be limited to only one server/service

Usable - Focus on a practical drop-in for existing applications

What do we want?

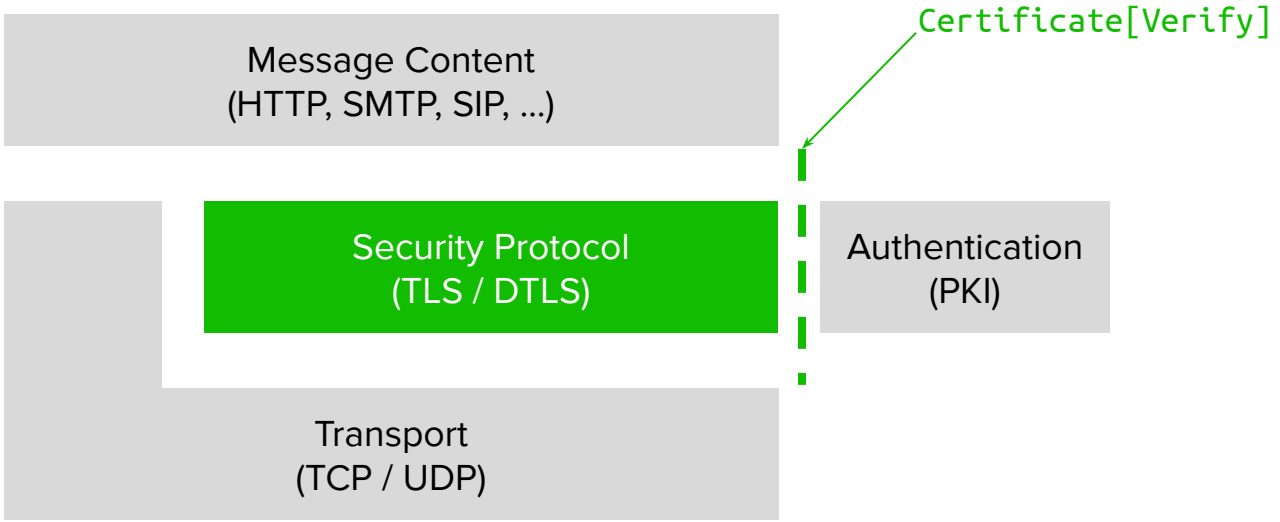
Open standard - Complete specification usable by anyone

Code reuse - Robust implementations that can be used in different contexts

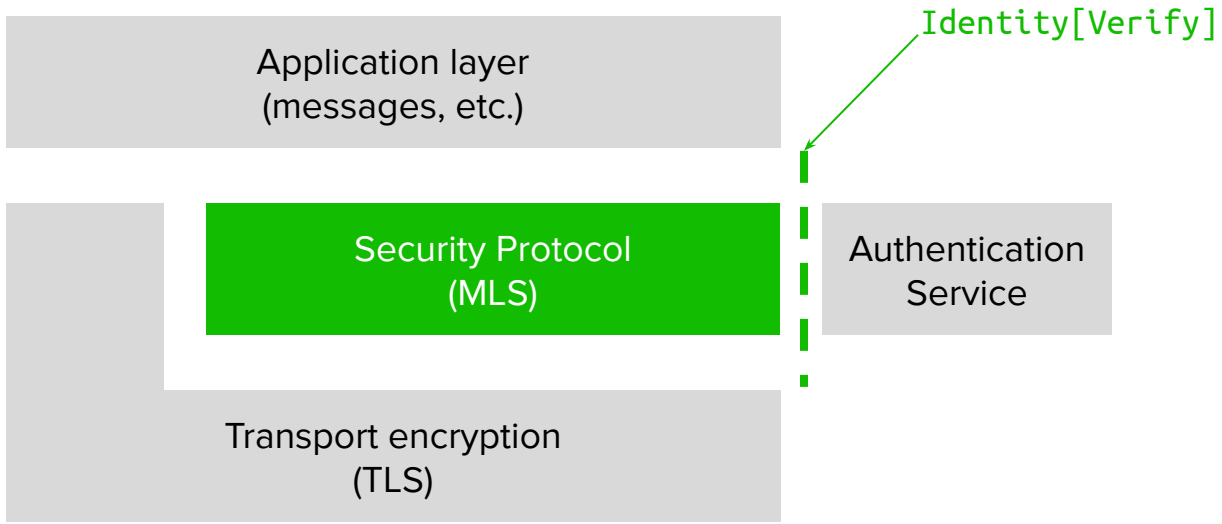
Security analysis - Involvement from the academic community

MLS

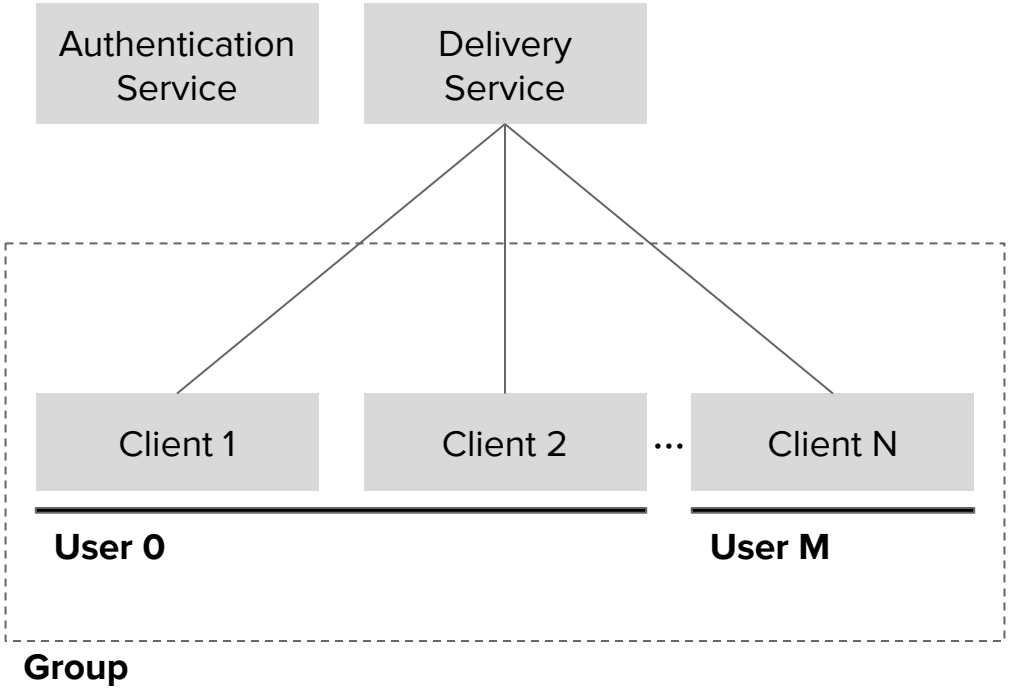
Scope of TLS


Certificate[Verify]
Message Content
(HTTP, SMTP, SIP, ...)
Security Protocol
(TLS / DTLS)
Authentication
(PKI)
Transport
(TCP / UDP)

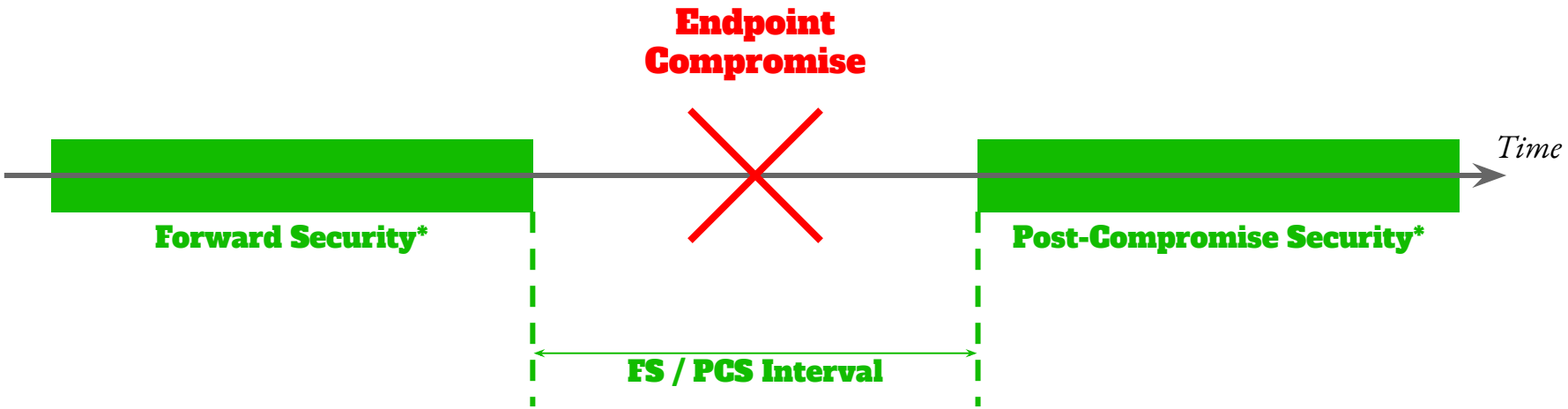
Scope of MLS


Identity[Verify]
Application layer
(messages, etc.)
Security Protocol
(MLS)
Authentication
Service
Transport encryption
(TLS)

Architecture



FS & PCS



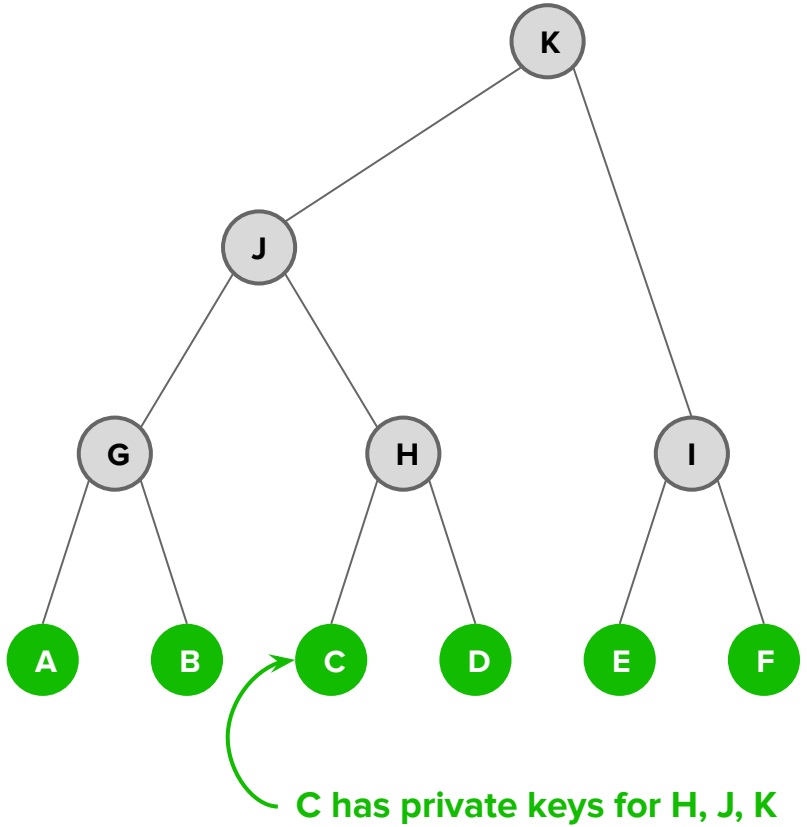
* ... with regard to a member

The core: TreeKEM

The public state of a group is composed of a left-balanced binary tree of asymmetric public keys

Each member of the group occupies a leaf and knows all secrets in its path to the root.

Secrecy invariant: The private key for an intermediate node is only known to members of the subtree.



Efficiency

Pairwise sending:

- Sending messages is in **O(N)**

Sender keys:

- Fan-out an **encryption key** to everyone and use it for messages
- Sending the **encryption key** out is still in **O(N)**, sending a **message** is in **O(1)**
- Problem: if a member leaves the group, everyone has to fan-out a new key in **O(N^2)**

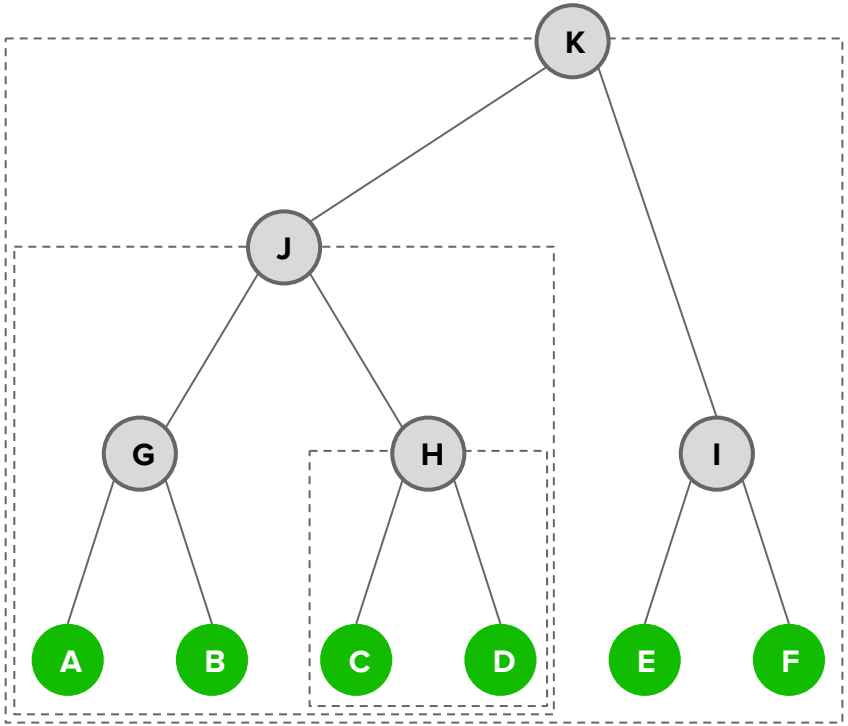
Efficiency

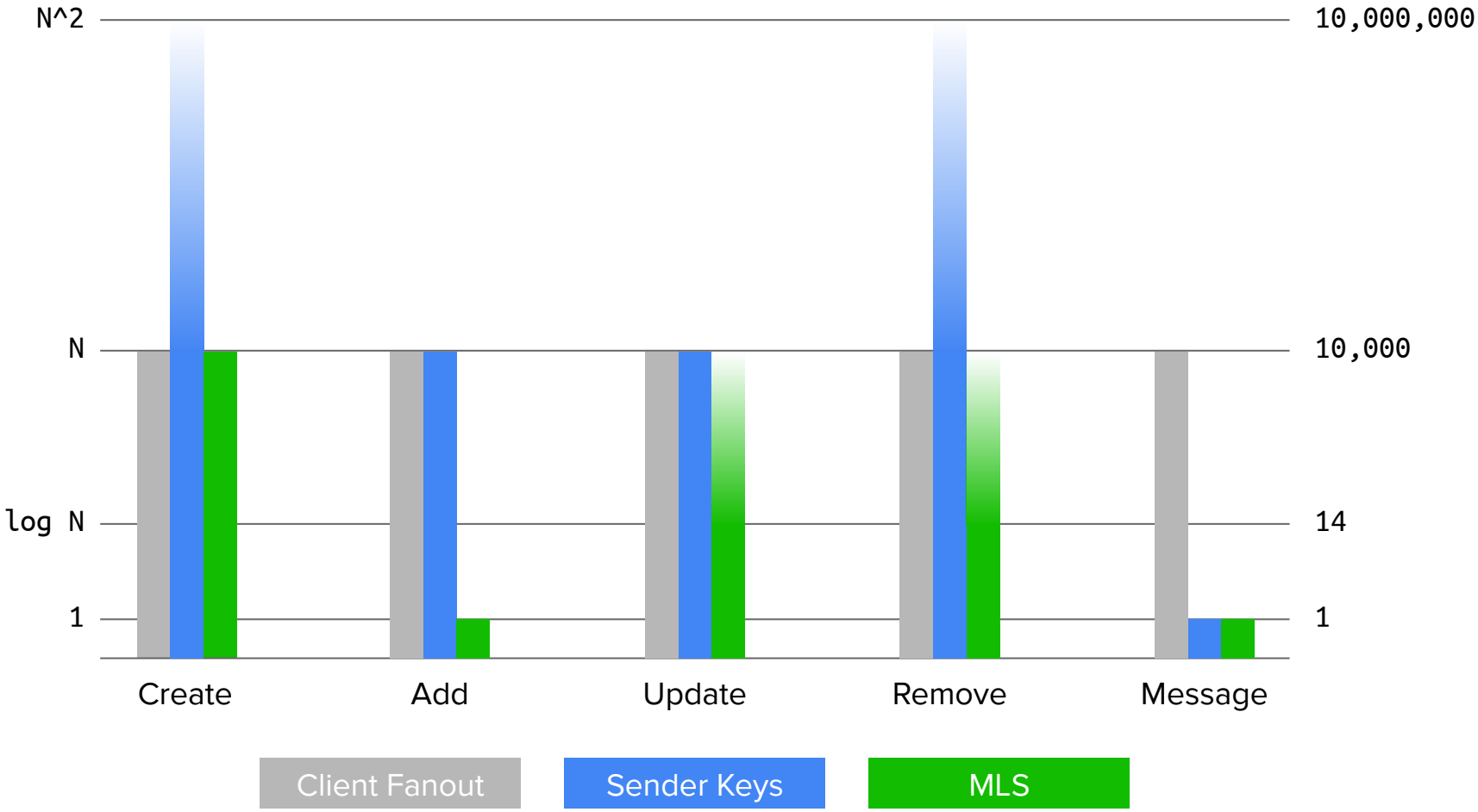
MLS allows to maintain a group secret in **O(log N)** by using left-balanced binary trees

Example: 100k members and message size of 1kb

Pairwise: 100k operations and payload of 100k * 1kb = 100mb

MLS: 17 operations and payload of 17 * 1kb = 17kb




N^2
N
log N
1
10,000,000
10,000
14
1
Create
Add
Update
Remove
Message
Client Fanout
Sender Keys
MLS

Metadata protection

Message content is secret because of end-to-end encryption

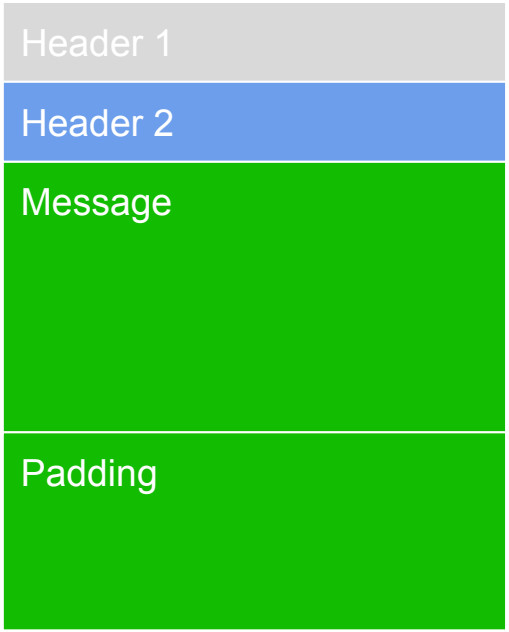
What data should we try to protect additionally?

There are two kinds of metadata:

- Observable metadata
- Persisted metadata

Metadata protection

- Servers will keep messages in queues, we just need to tell the server in which queue to save the message
- We can encrypt the sender of a message, the server doesn't need to have that information
- We can have arbitrary padding, so that clients can make messages indistinguishable from each other

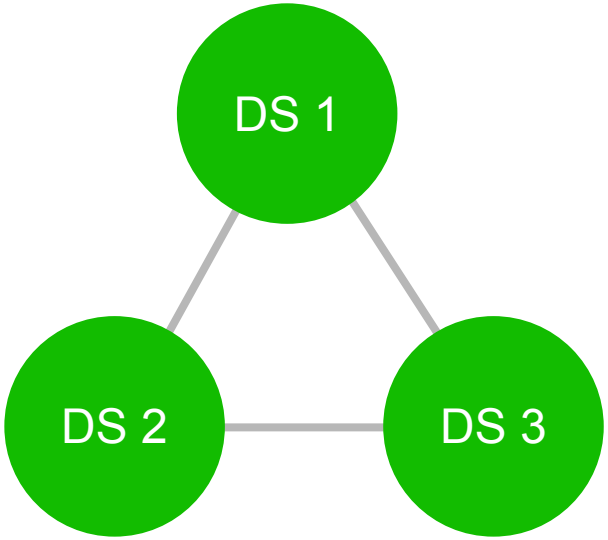


Federation

Are we limited to one **Delivery Service**?

Ordering for handshake messages is important

If we can **distribute** the ordering problem across multiple delivery services, **federation** becomes possible.



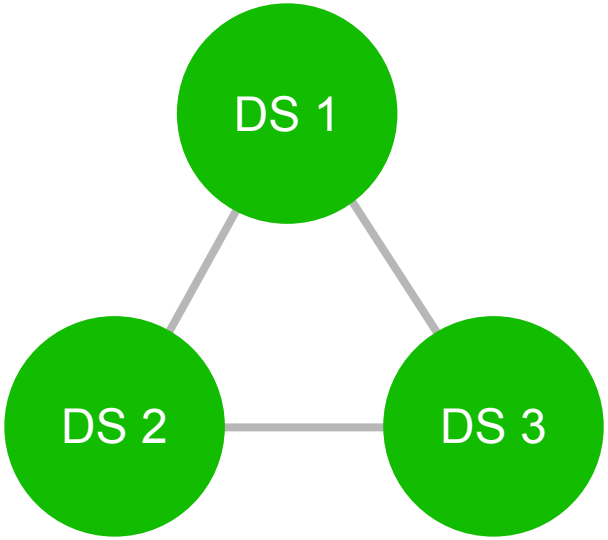
Federation

Federation without redundancy

Simple approach: designate which **Delivery Service** is responsible for the ordering

Federation with redundancy

More advanced approach: have some consensus among the **Delivery Services** on which one is responsible for ordering



Business messaging

Business communication is seeing a transformation from using email towards using messaging.

This change is driven by consumer experience.

Business messaging

The encryption challenge

Status quo: Most solutions only use transport encryption (TLS) to protect messages and files.

Scalability: End-to-end encryption is challenging at scale.

Retention: Implementing compliance requirements is not straight forward.

Business messaging

The feature challenge

Most solutions only enable users of the same organisation to talk to each other.

Email is still popular as a legacy technology, because anyone can be reached.

Federation contributed to the popularity of email.

Summary

- MLS aims to be new standard for secure messaging, especially in (large) groups
- Modern security properties
- Robust, usable open specification
- Usable solution for new and existing products

More information: messaginglayersecurity.rocks

Raphael Robert
@raphaelrobert
raphael@wire.com

Thanks