Accountable authentication with privacy protection: The Larch system for universal login

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Challenging to determine extent of compromise

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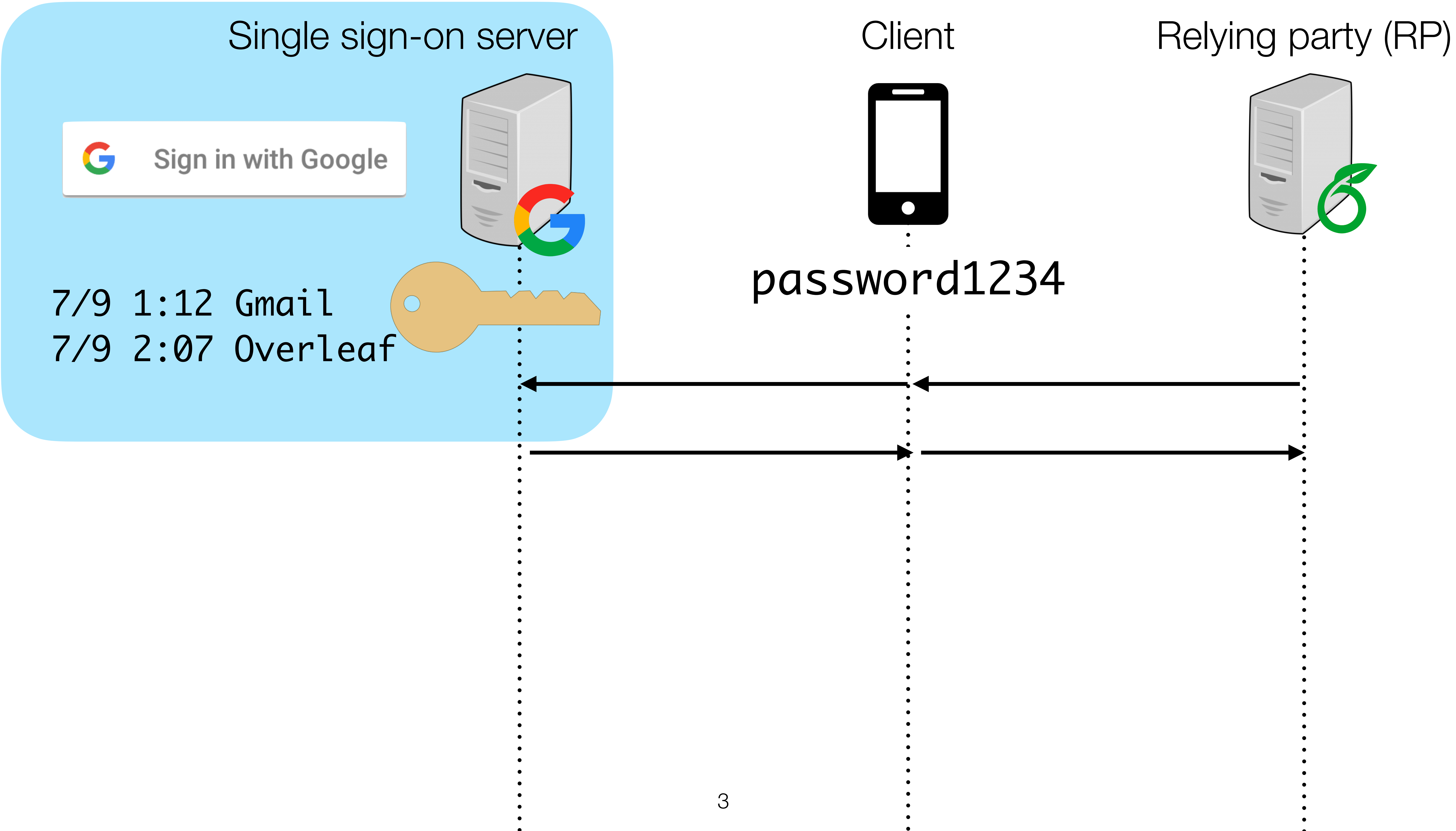
LastPass' latest data breach exposed some customer information

Okta ends Lapsus$ hack investigation, says breach lasted just 25 minutes

Data Breach Could Compromise Lawmakers' Personal Information

Single sign-on enforces credential logging



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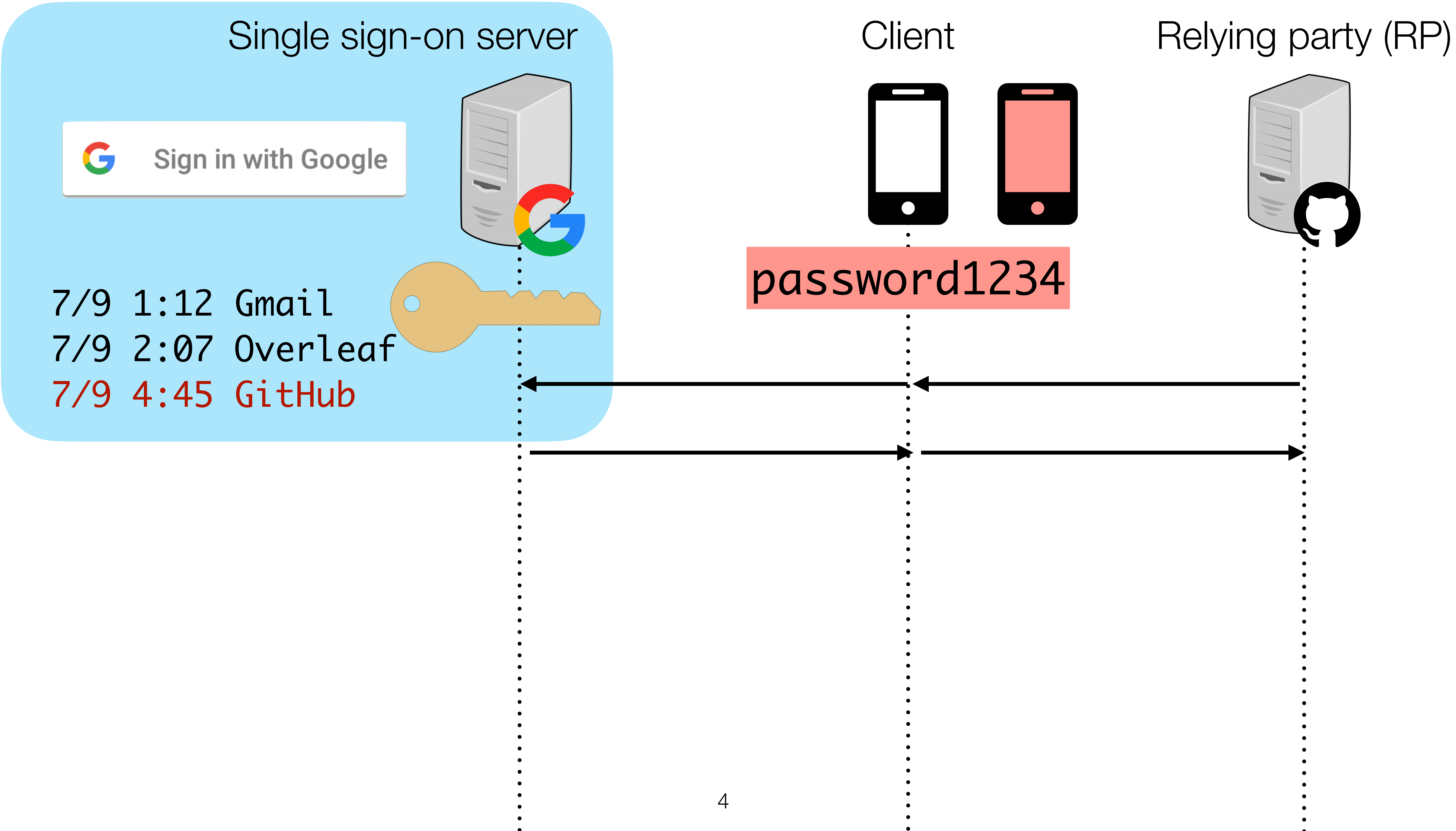

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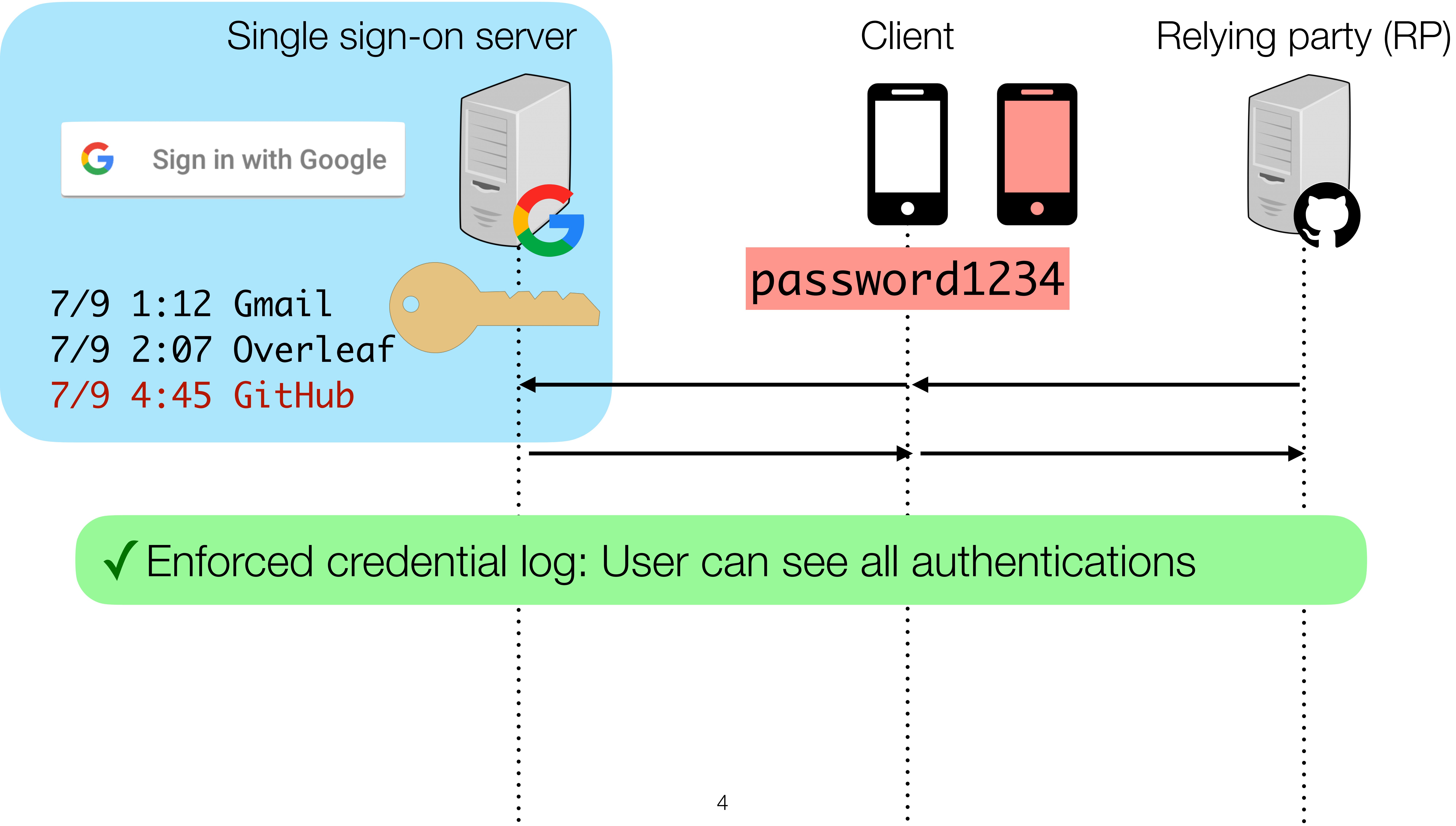
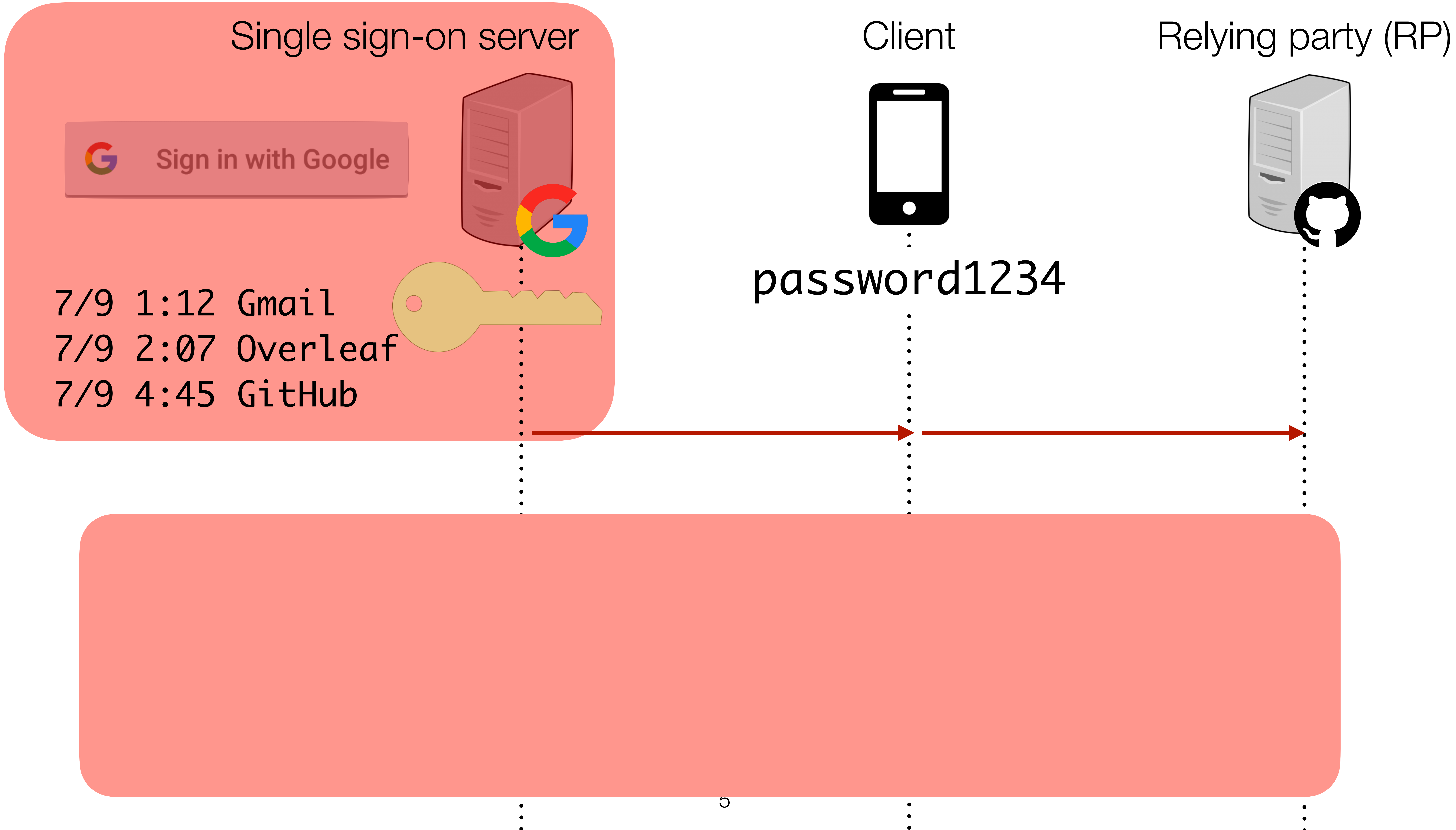


Single sign-on: single point of security failure



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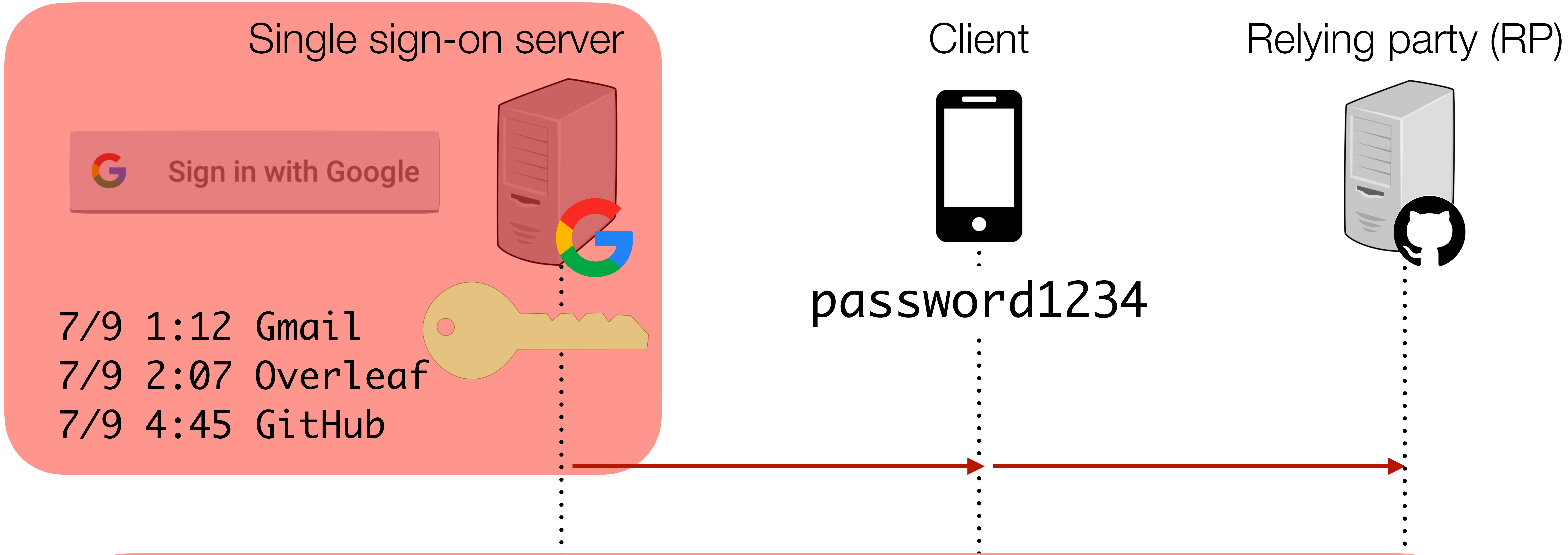

✓ Enforced credential log: User can see all authentications

✗ Security: Attacker can access user's accounts

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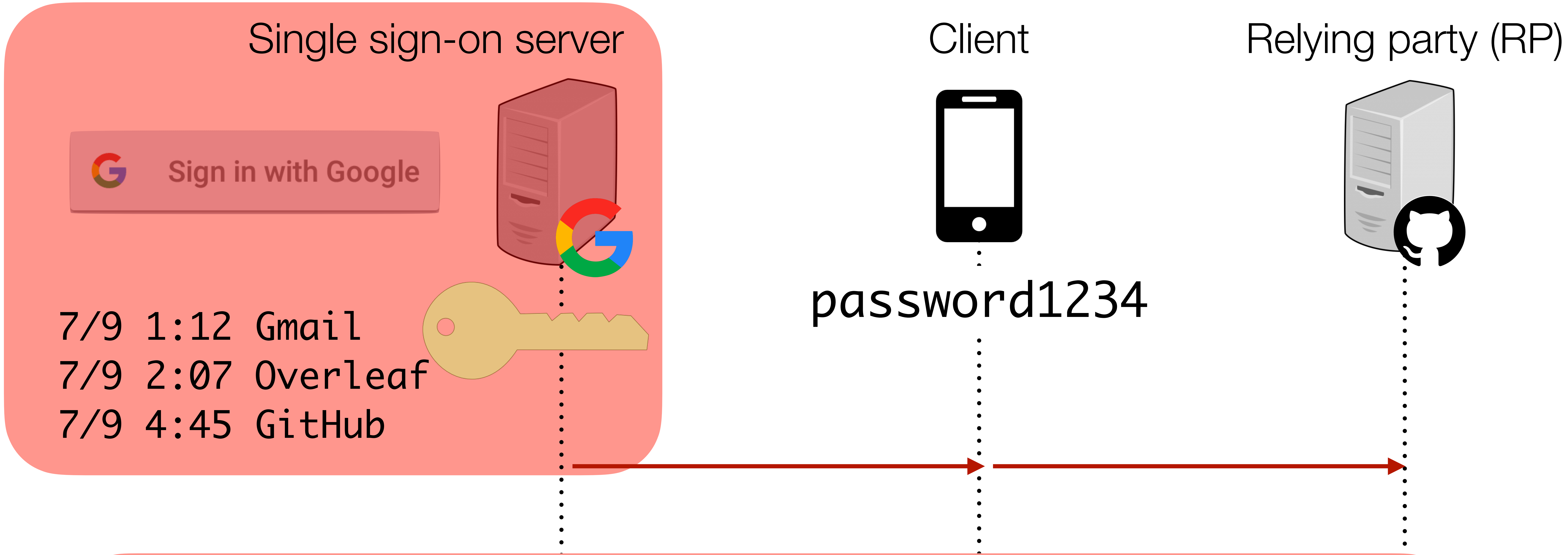

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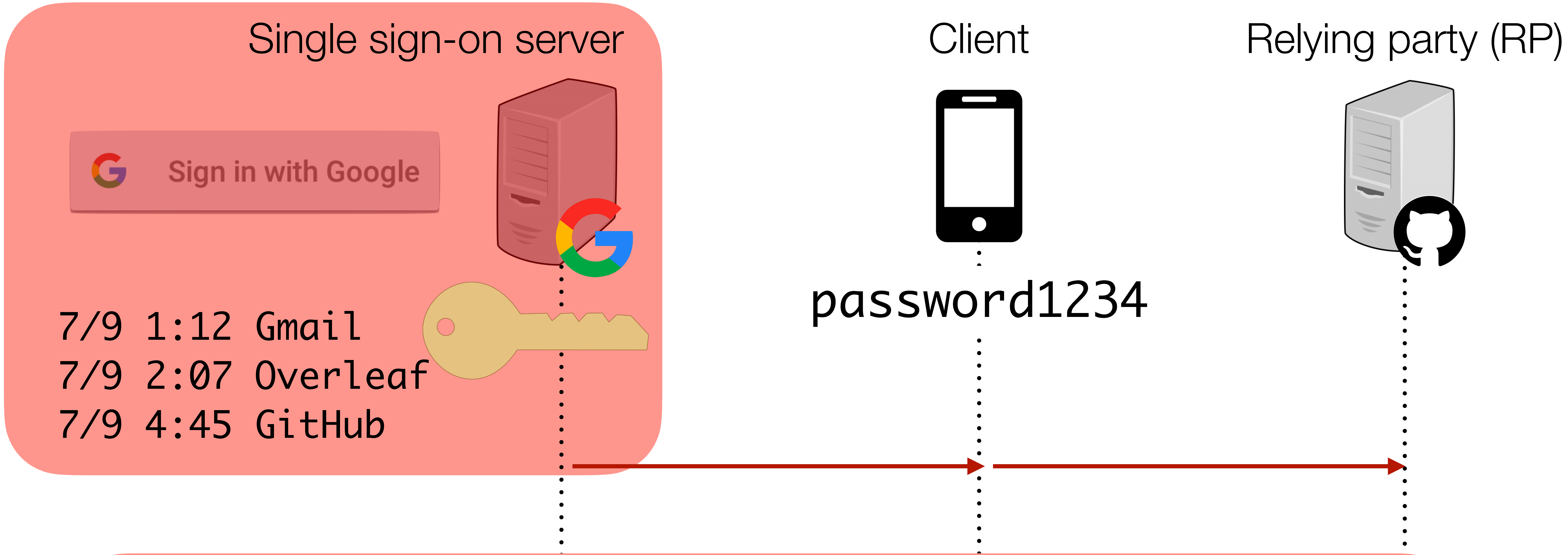
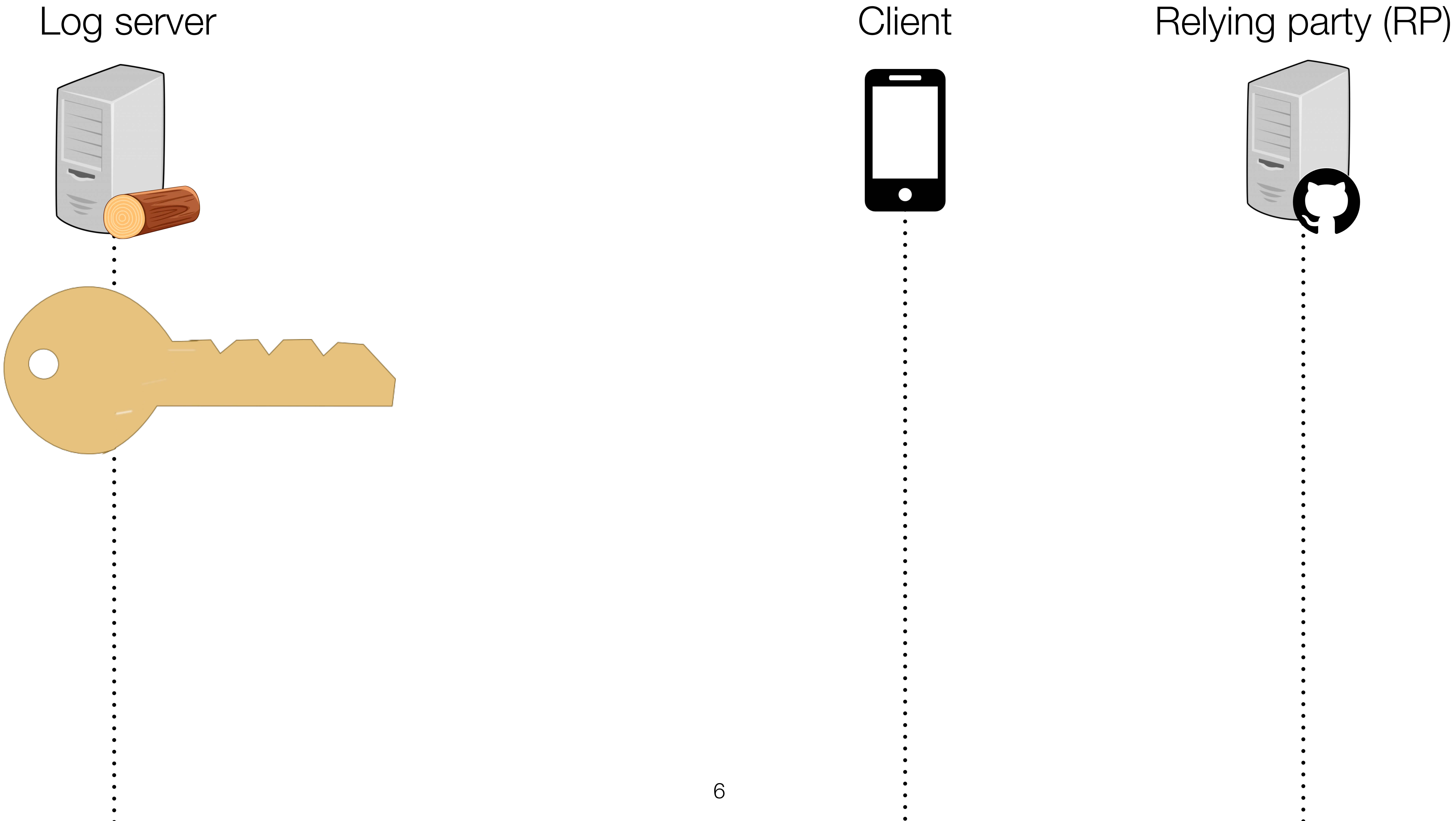


✓ Enforced credential log: User can see all authentications
✗ Security: Attacker can access user's accounts
✗ Privacy: Attacker (and legitimate server) can read credential log
✗ Universal support: Not supported by all RPs

Larch: Split secret key between client and log



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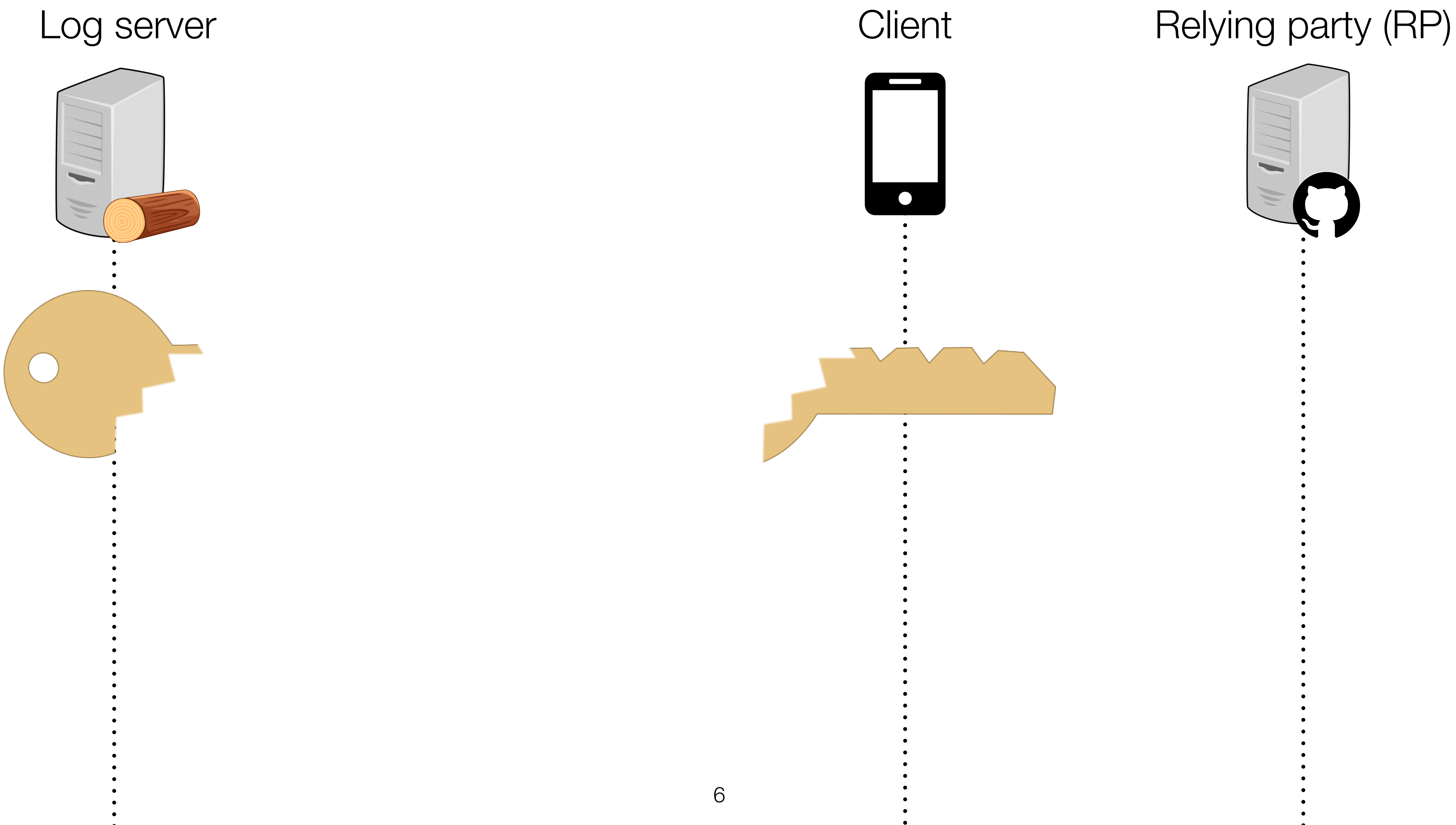

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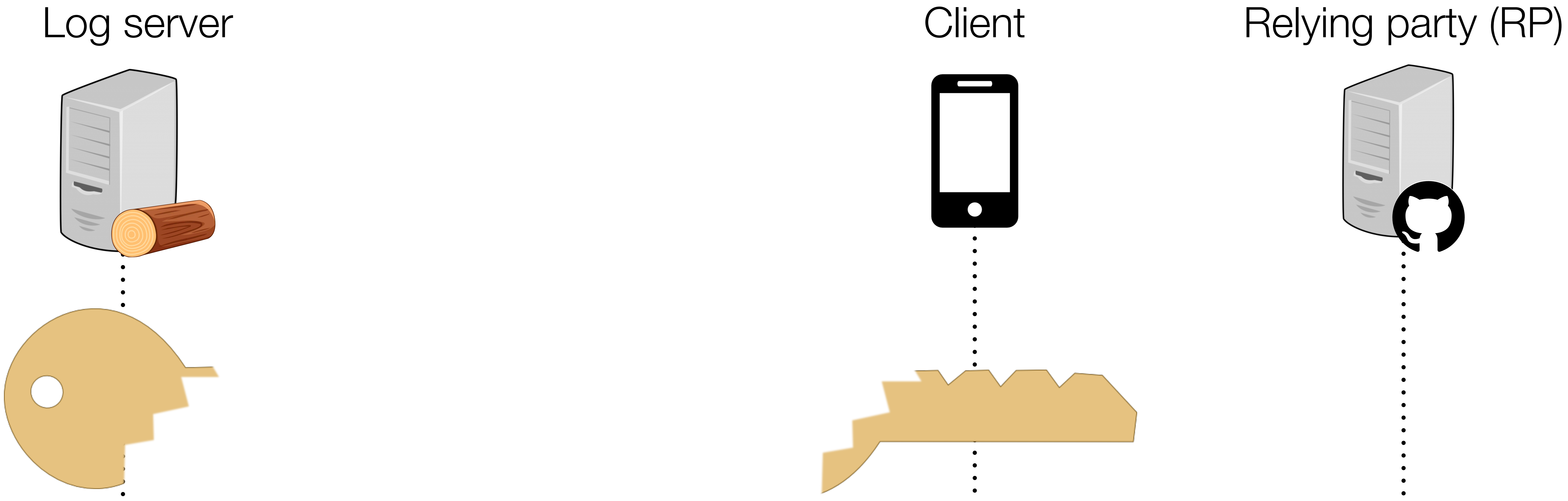
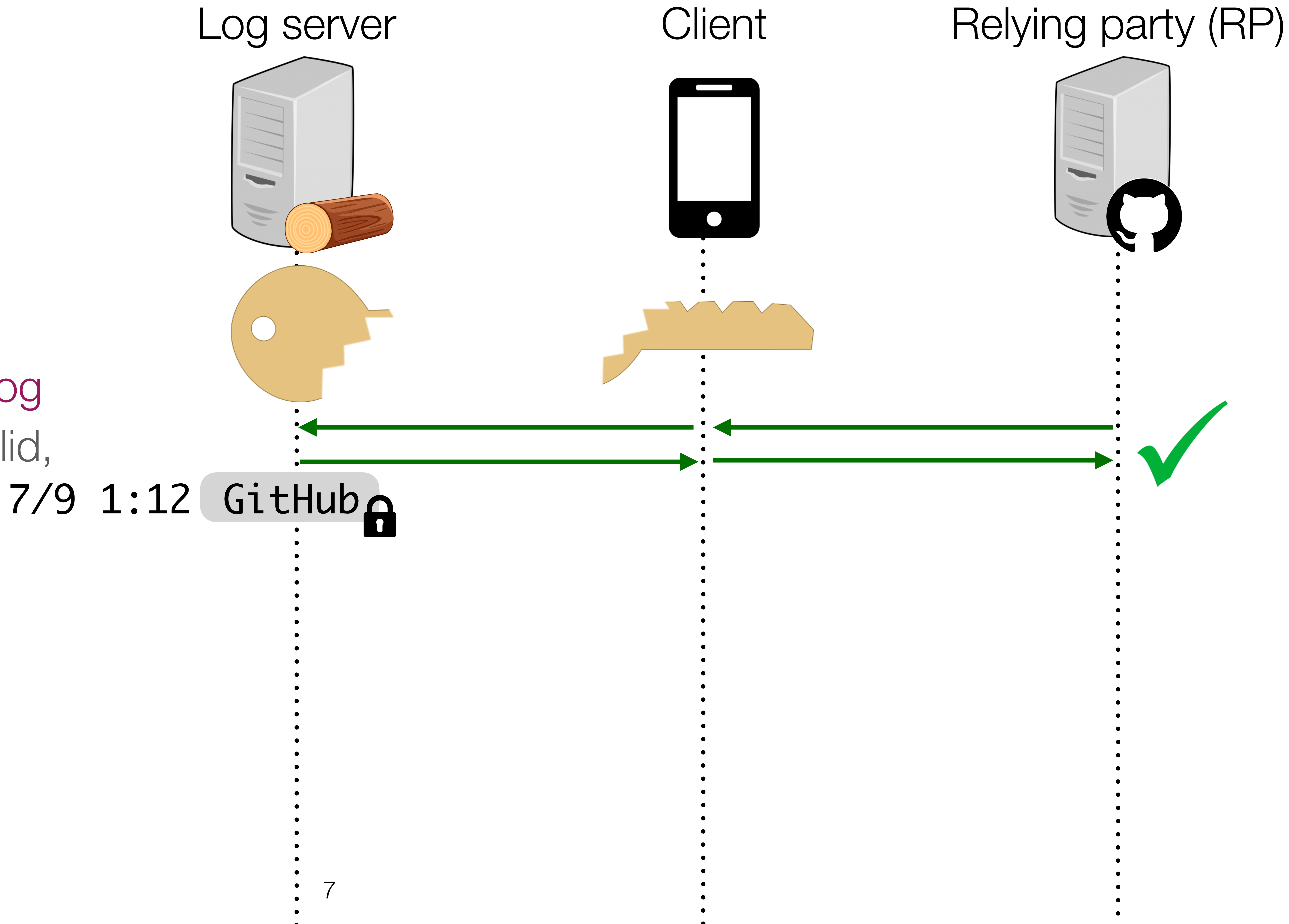


- ✓ Enforced credential log
- ✓ Security
- ✓ Privacy
- ✓ Universal support

Larch: Enforced credential log with strong security



Enforced, **encrypted** credential log

Client authentications result in valid, encrypted log records.

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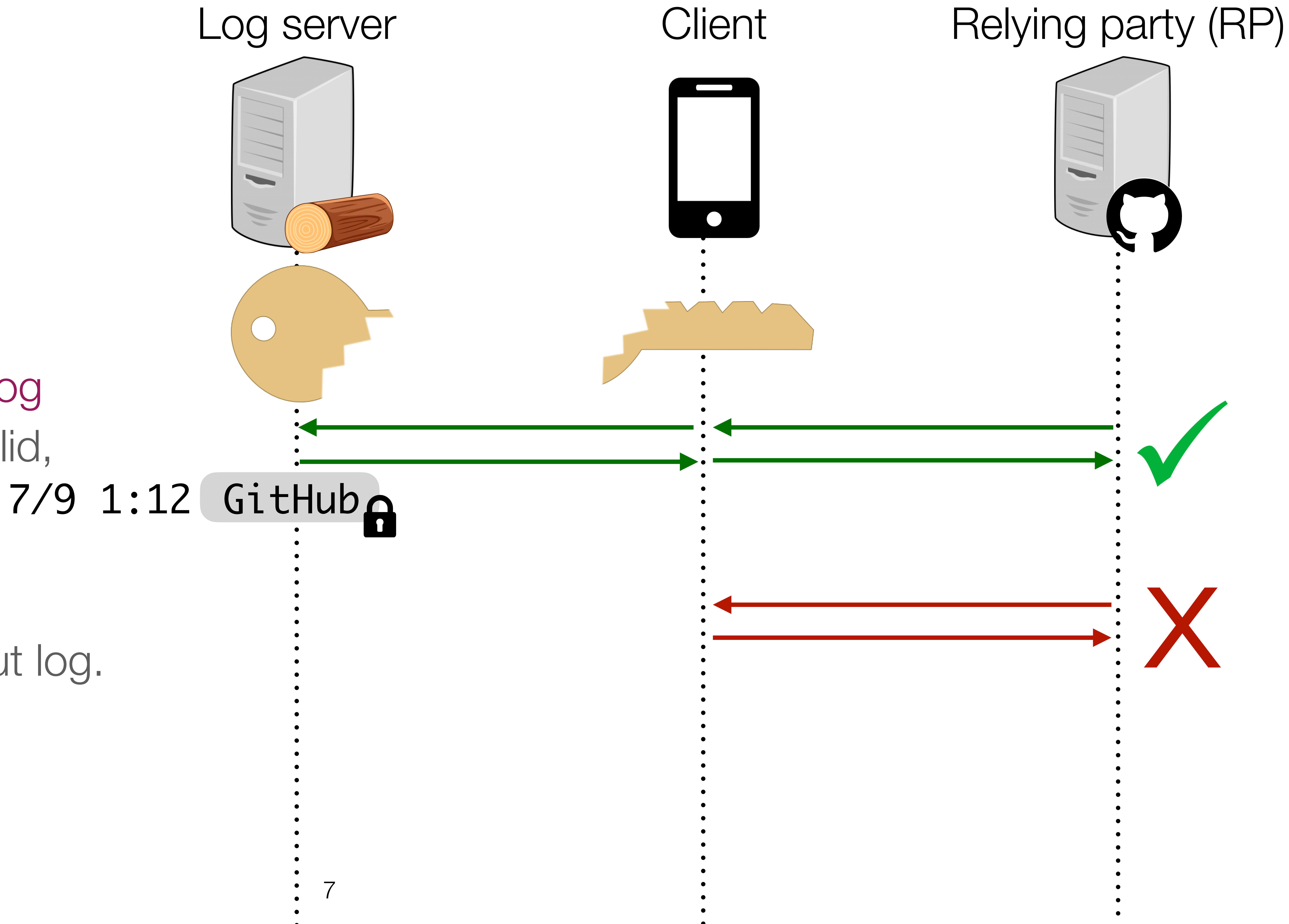

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Protect against malicious client

Client cannot authenticate without log.

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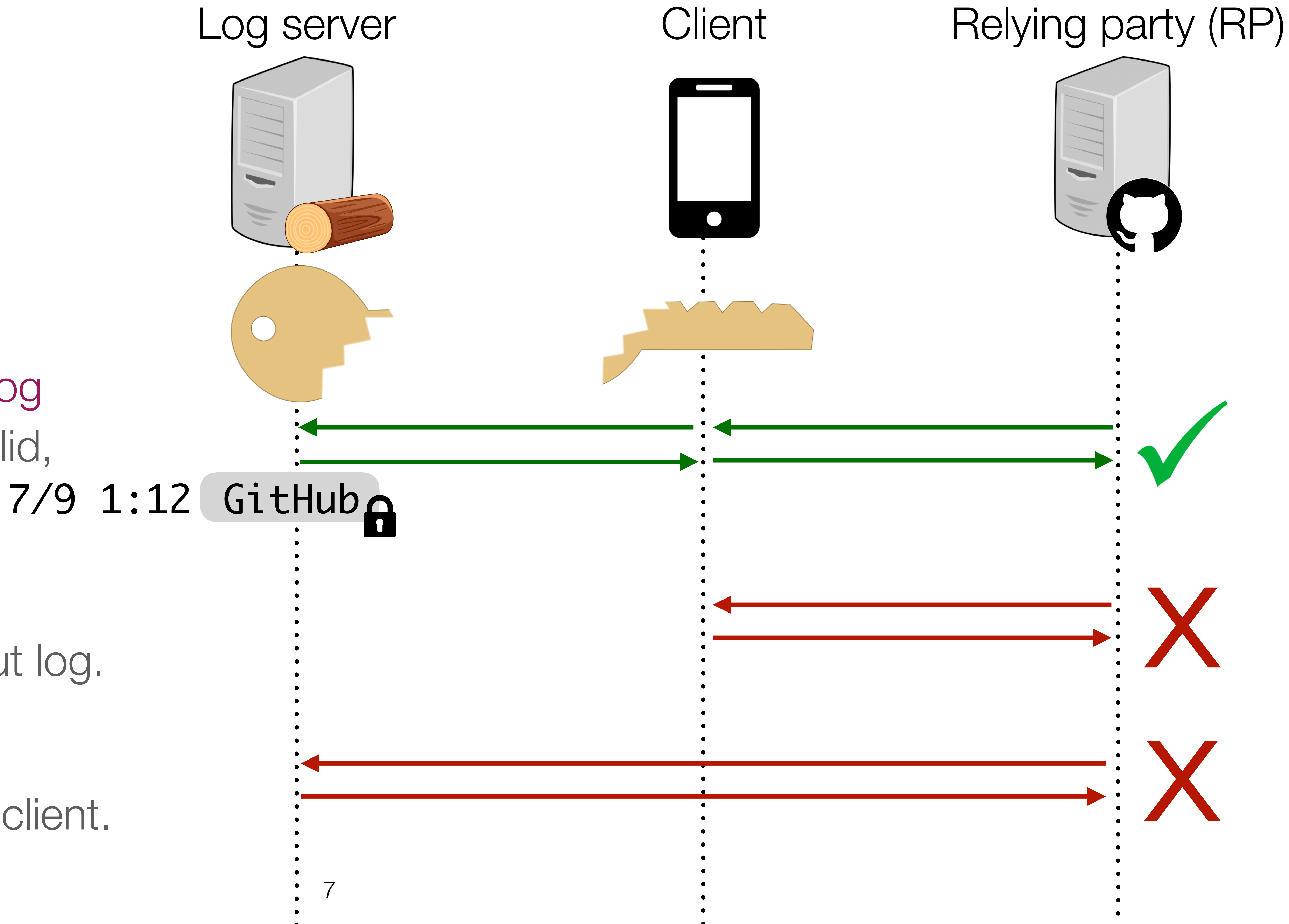

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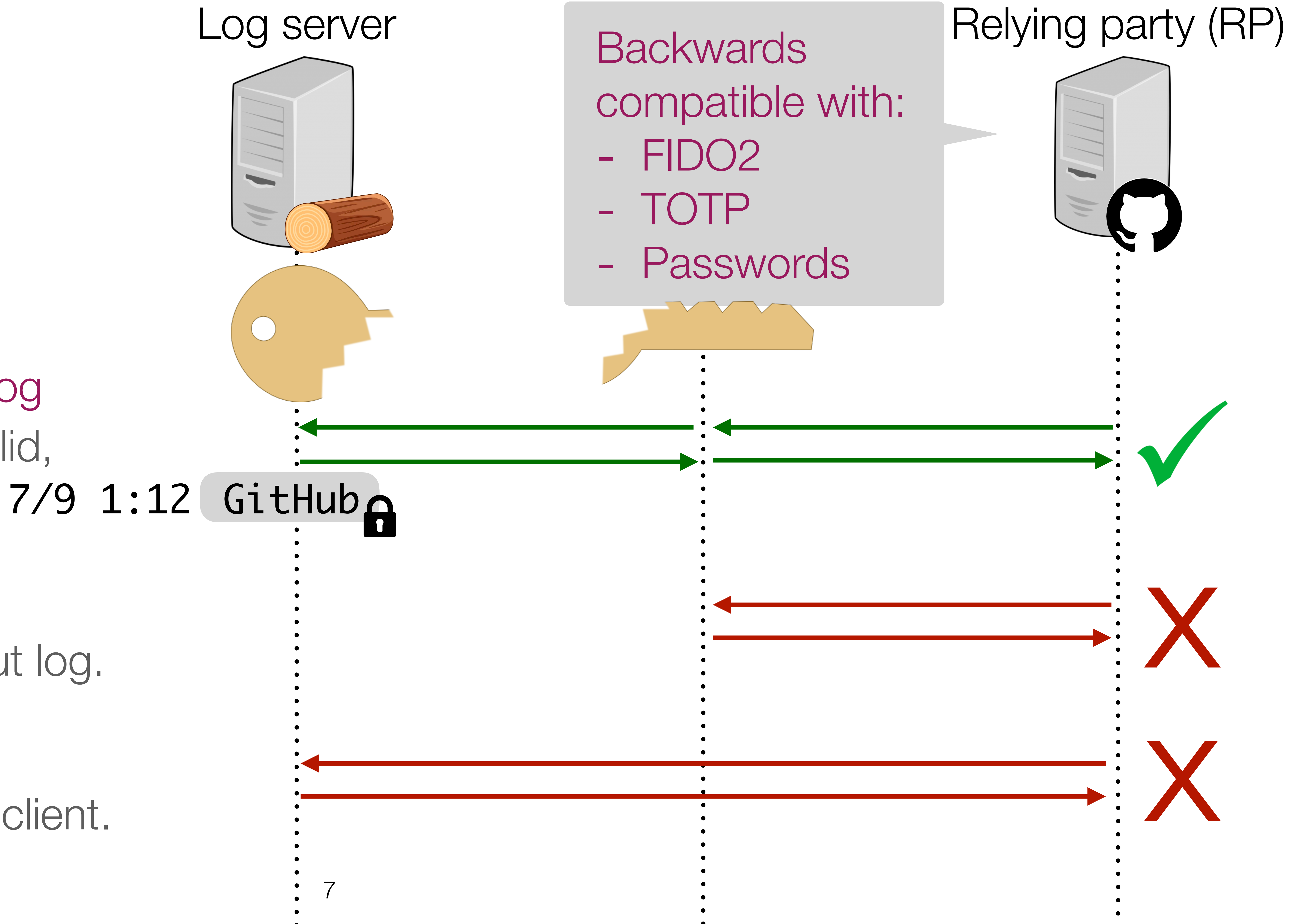

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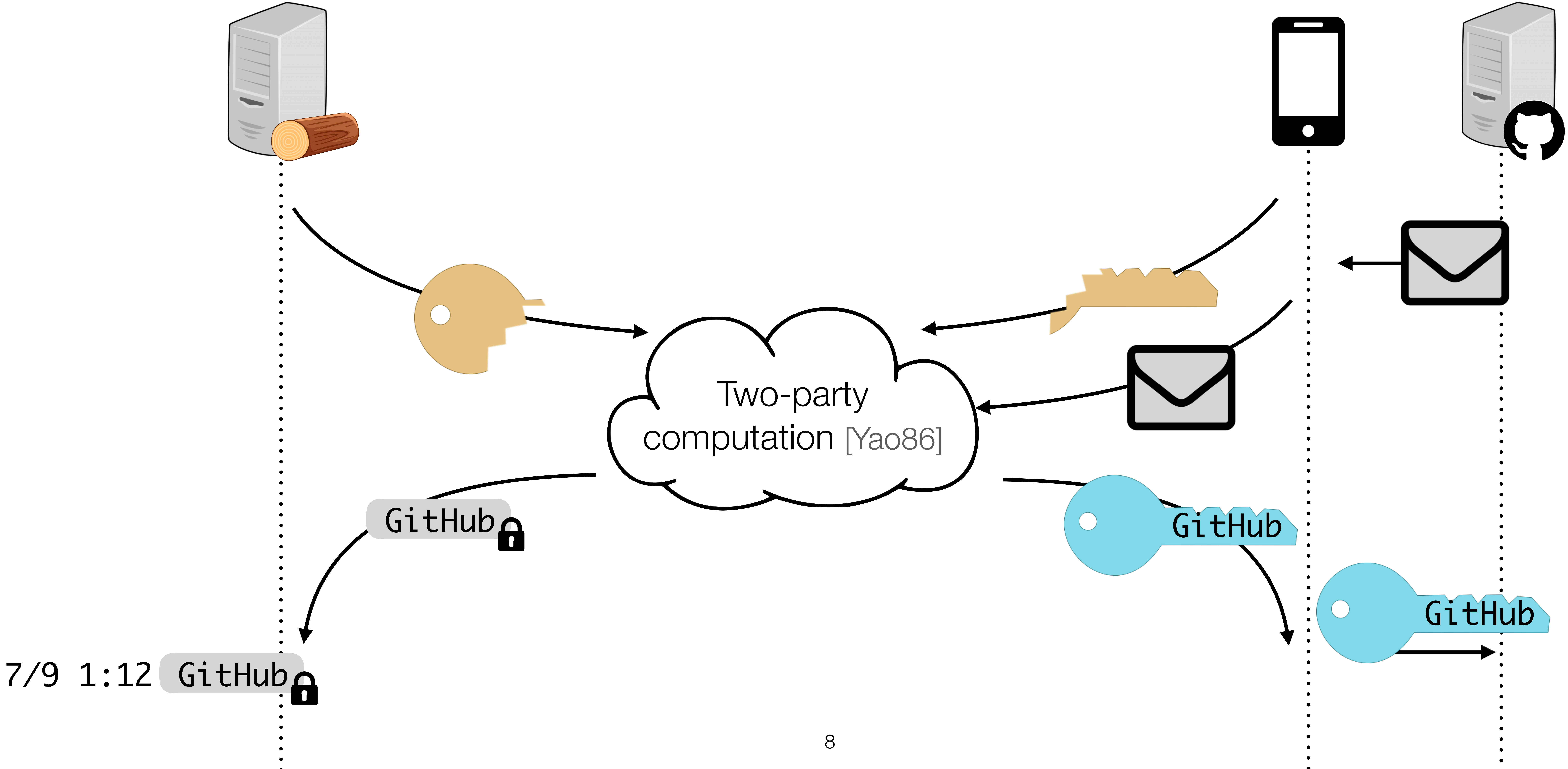
If client authenticates, log gets encrypted log record



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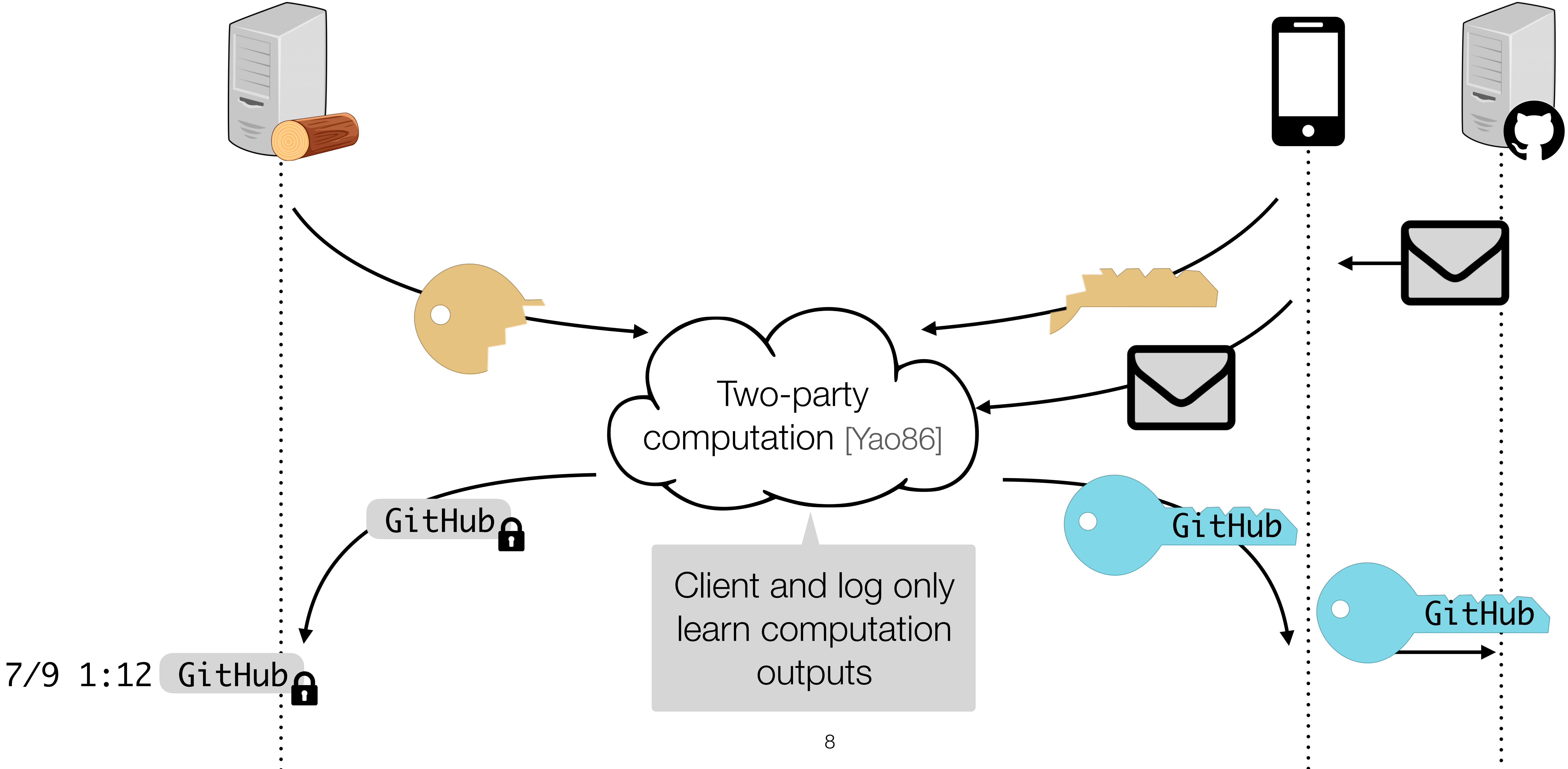
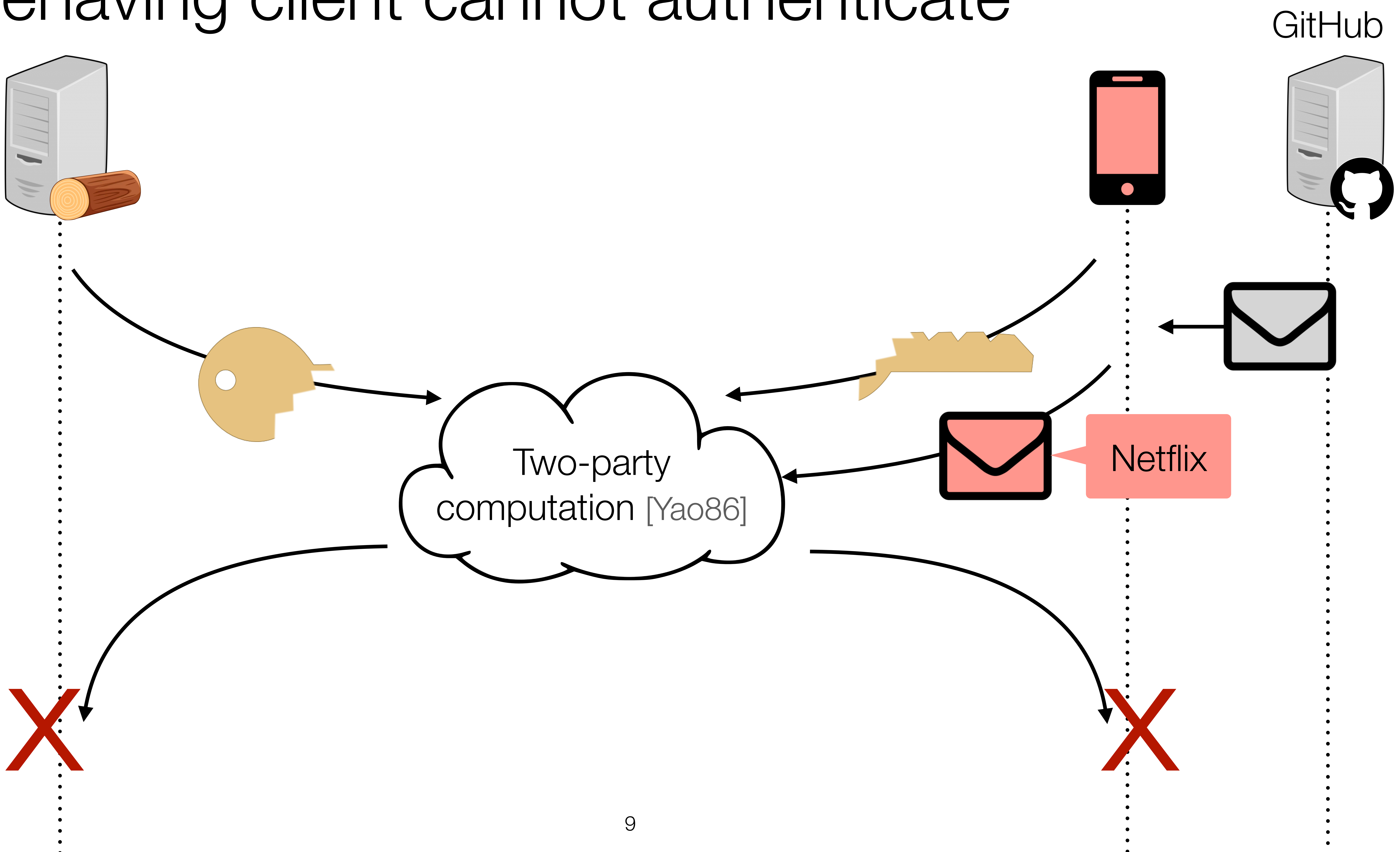
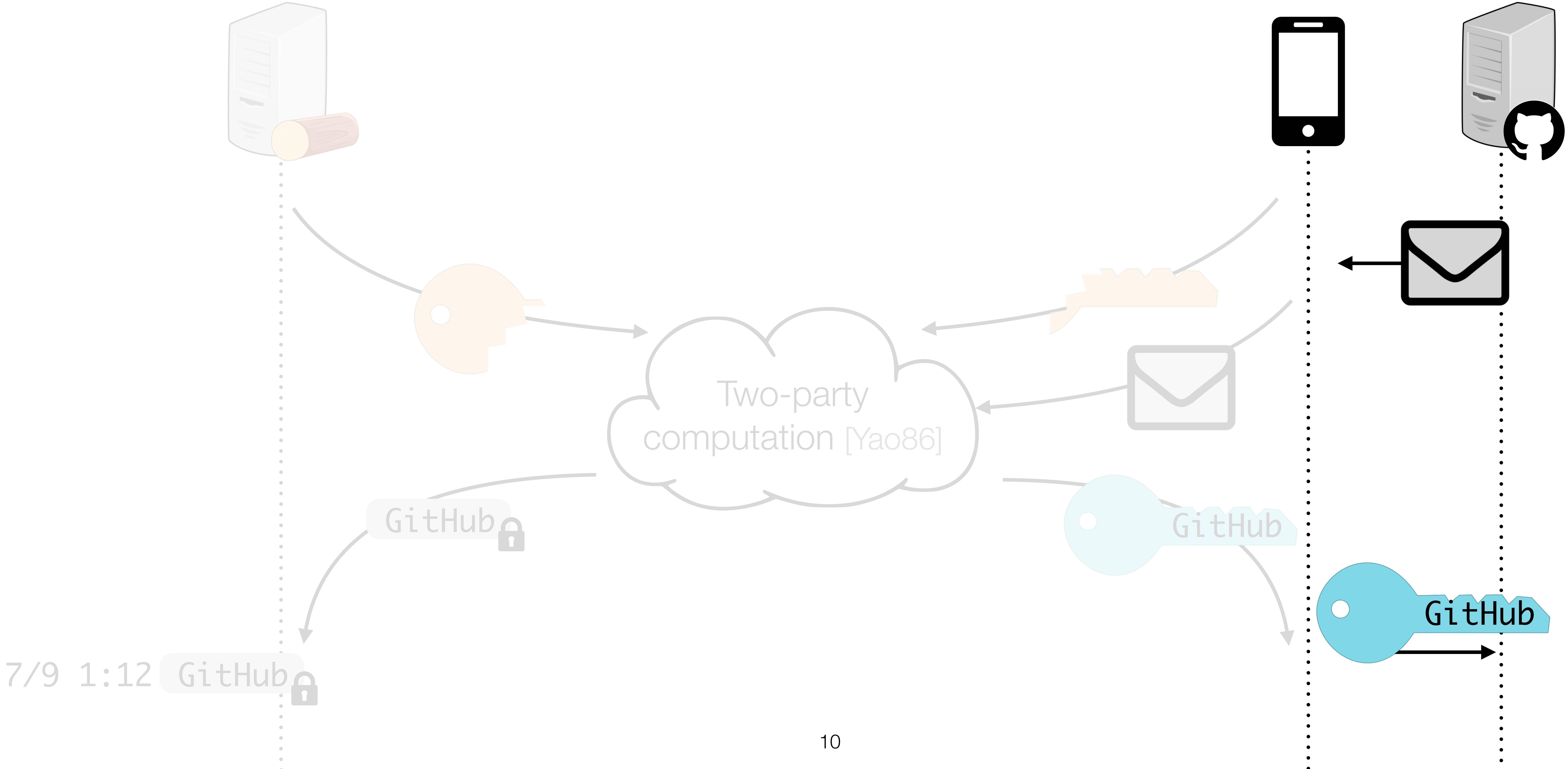


Misbehaving client cannot authenticate



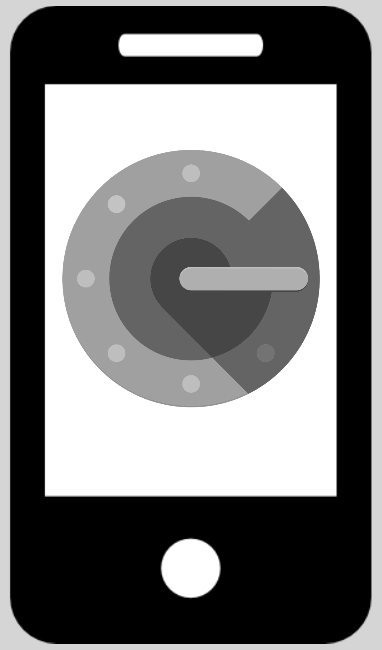
Relying party is unaware client is running larch



Larch is compatible with relying parties running:

FIDO2
(this talk)

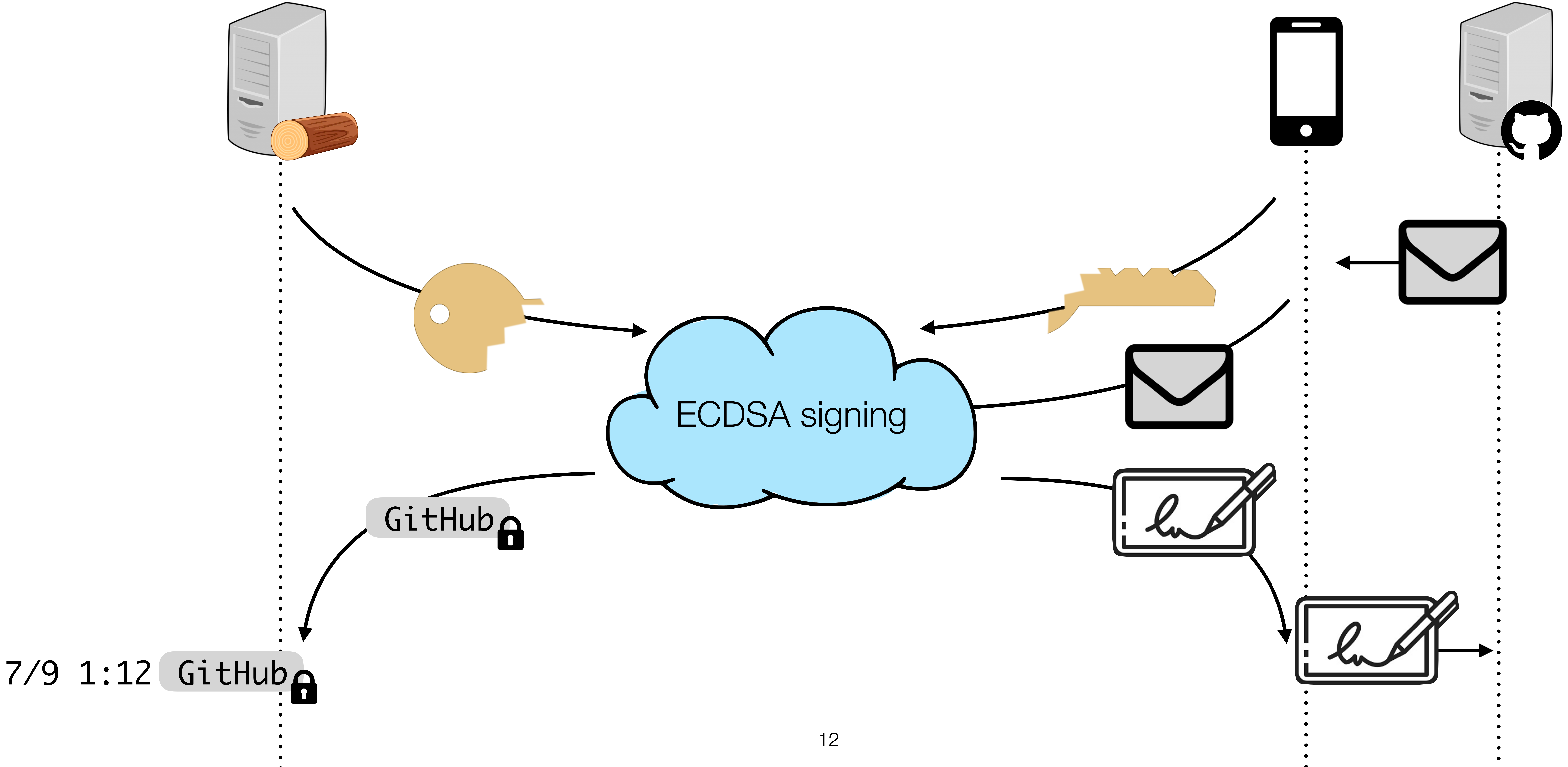
TOTP
(see paper)



Passwords
(see paper)

67bZ!9g92&

Larch for FIDO2



Larch for FIDO2

ECDSA threshold signing

- Extensive prior work with high costs [GGN16, Lindell17, DKLS18, GG18, CGG+20, DJN+20, GS21, ANO+22, …]
- Idea: take advantage of fact that client is honest at enrollment for *precomputation*

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To sign a message m with signing nonce r,
compute $f_1(r) \cdot (m + f_2(r) \cdot \mathsf{sk})$

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Precompute at enrollment

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Evaluation

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Code available at: `https://github.com/edauterman/larch`

Experiment setup:

- Log server on c5.4xlarge (8 cores, 32 GiB memory)
- Client on c5.2xlarge (4 cores, 16 GiB memory)
- 20ms RTT
- Bandwidth 100Mbps
- TOTP with 20 accounts; passwords with 128 accounts
- Do not include network latency between client and RP in measurements

Evaluation

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	FIDO2	**TOTP**	**Password**
Online auth time	150 ms	91 ms	74 ms
Total auth time	150 ms	1.32 s	74 ms
Online auth comm.	1.73 MiB	201 KiB	3.25 KiB
Total auth comm.	1.73 MiB	65 MiB	3.25 KiB
Log auths/core/s	6.18	0.73	47.62

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Special-purpose protocols

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Credential compromise will happen

✓ Enforced credential log: easy to determine extent of account compromise

✓ Security: log cannot access user's accounts

✓ Privacy: log records are encrypted

✓ Universal support: compatible with unmodified relying parties

Key idea: splitting authentication secret between client and log

Moving forward: need tools to make it easier to recover from compromise

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https://arxiv.org/pdf/2305.19241.pdf

https://github.com/edauterman/larch