Practical Privacy-Preserving Authentication for SSH

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Stanislav Lyakhov
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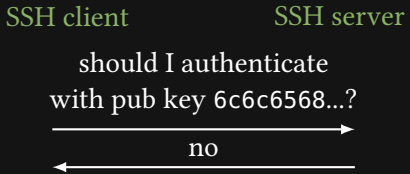
ia.cr/2022/740

2022-08-12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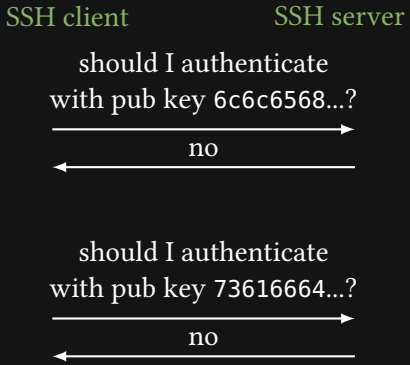
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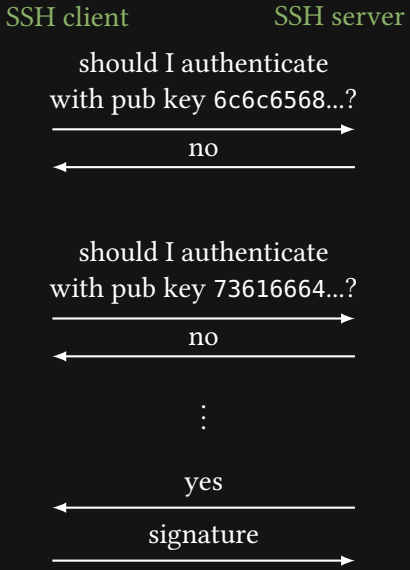
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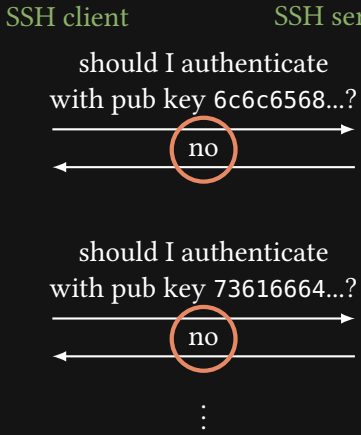

problem: server can fingerprint client:

- refuse all advertisements ⟹ learn all keys


SSH client
SSH server
problem:
shou
with p
shou
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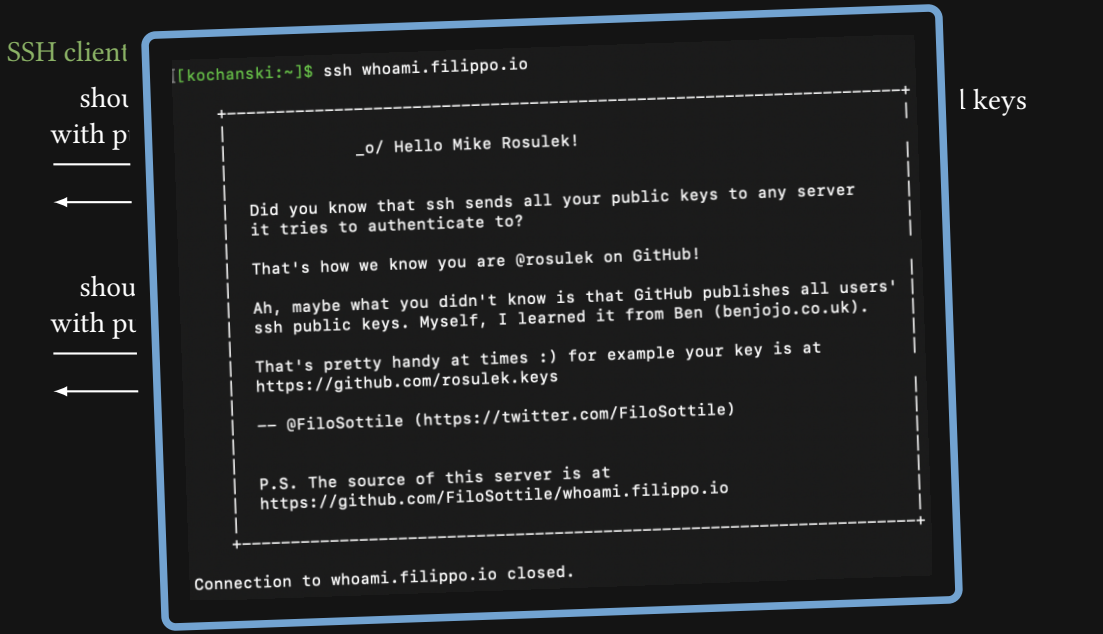
04 Aug 2015
SSH WHOAMI.FILIPPO.IO
Here's a fun PoC I built thanks to Ben's dataset.
I don't want to ruin the surprise, so just try this command. (It's harmless.)
ssh whoami.filippo.io
For the security crowd: don't worry, I don't have any OpenSSH oday and even if I did I wouldn't burn them on my blog. Also, ssh is designed to log into untrusted servers.
Filippo Valsorda https://words.filippo.io/ssh-whoami-filippo-io/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[[kochanski:~]$ ssh whoami.filippo.io
_o/ Hello Mike Rosulek!
Did you know that ssh sends all your public keys to any server
it tries to authenticate to?
That's how we know you are @rosulek on GitHub!
Ah, maybe what you didn't know is that GitHub publishes all users'
ssh public keys. Myself, I learned it from Ben (benjojo.co.uk).
That's pretty handy at times :) for example your key is at
https://github.com/rosulek.keys
-- @FiloSottile (https://twitter.com/FiloSottile)
P.S. The source of this server is at
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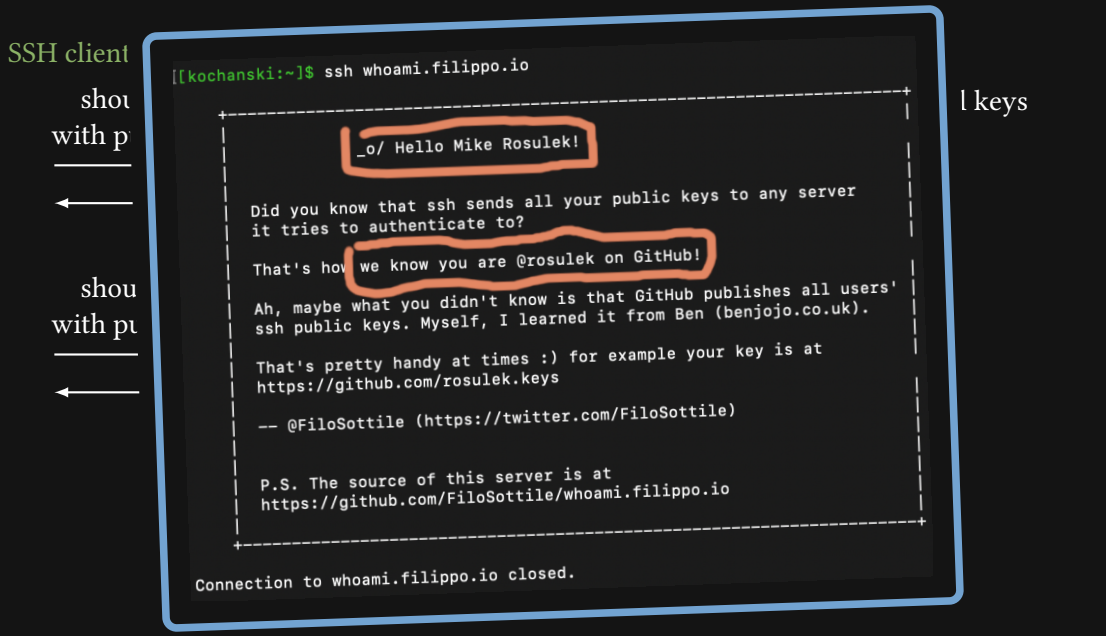
Connection to whoami.filippo.io closed.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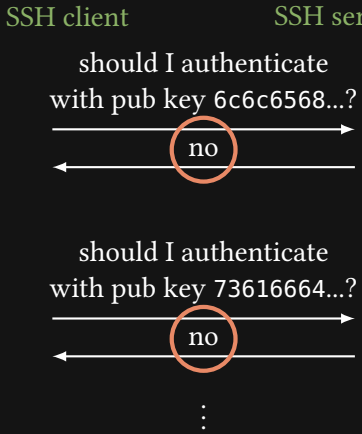

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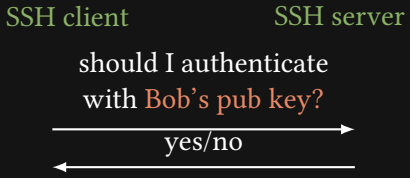

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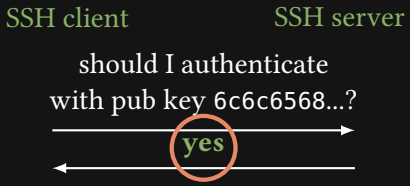

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problem: server can act as honeypot:

- accept *any* key, even ones never seen before
- fundamental to protocol

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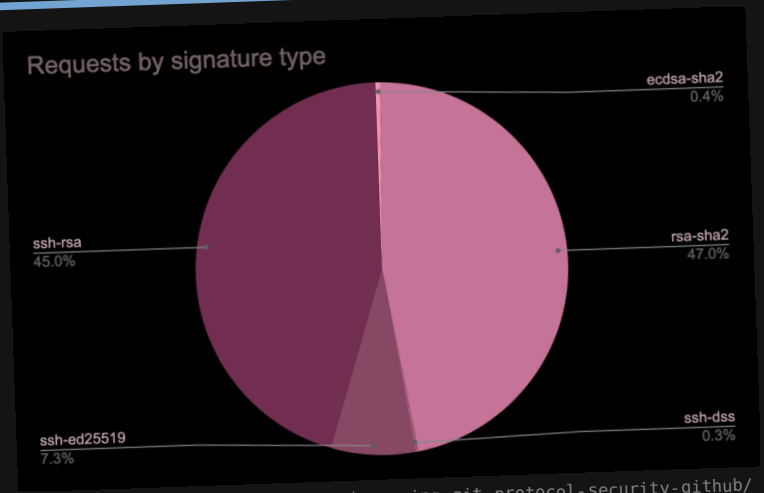
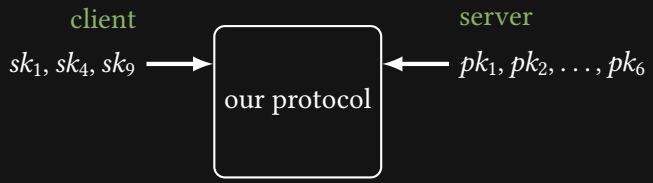


https://github.blog/2021-09-01-improving-git-protocol-security-github/

goals of this work

1. server & client should learn minimal information
2. authenticate with respect to existing SSH keys
3. minimize reliance on per-site configuration

our new authentication method: big picture



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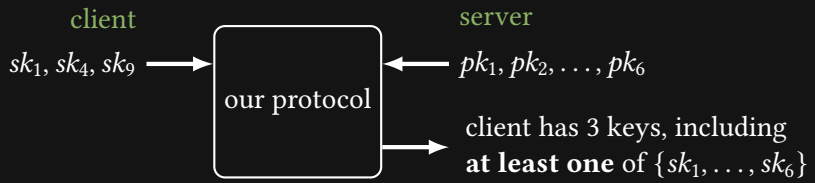

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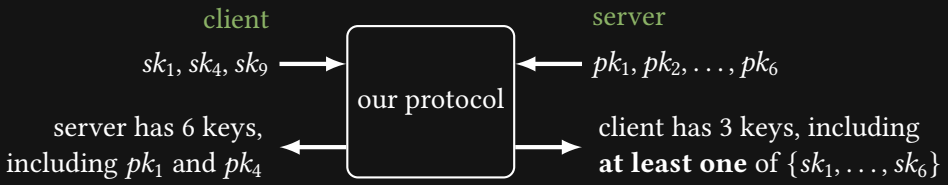

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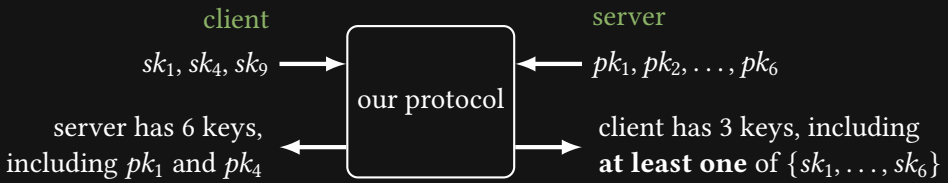

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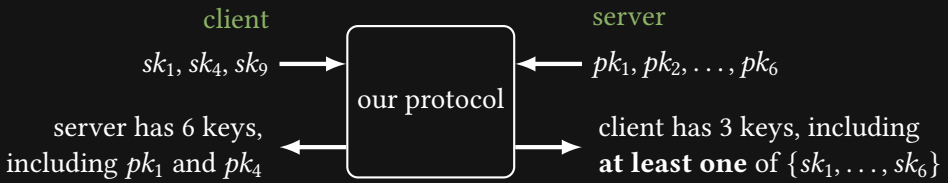

- any **mixture** of existing RSA, ECDSA, EdDSA keys, in a single authentication attempt
- does not depend on site-specific configuration; safe to use **all keys** in every authentication attempts
- client won't connect unless server **knows** and **explicitly includes** one of client's keys

technical overview

client (with $\{sk_i\}_i$):

server (with $\{pk_j\}_j$):

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server (with $\{pk_j\}_j$):

$c, \{m_j\}_j \leftarrow \mathsf{Enc}\Big(\{pk_j\}_j\Big)$

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address ciphertext to $\{pk_j\}_j$;
sk_j decrypts c to m_j;
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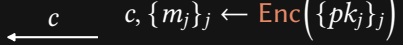

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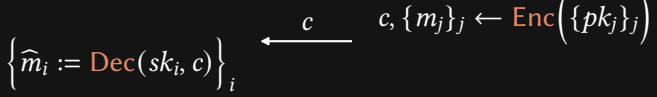

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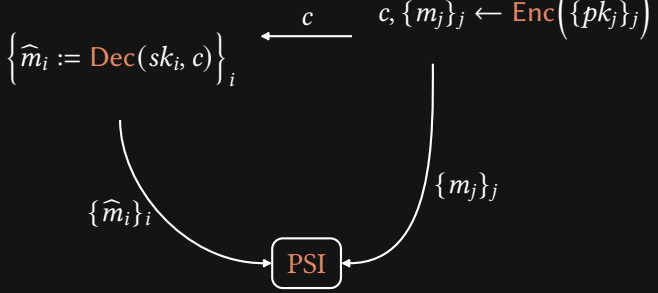

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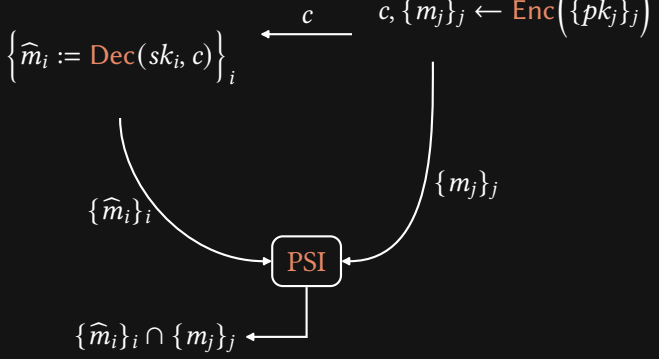

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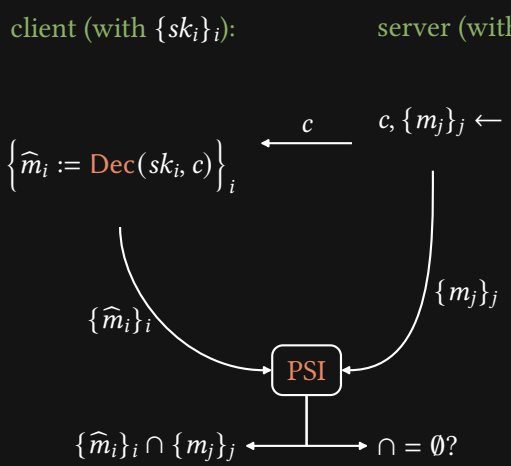

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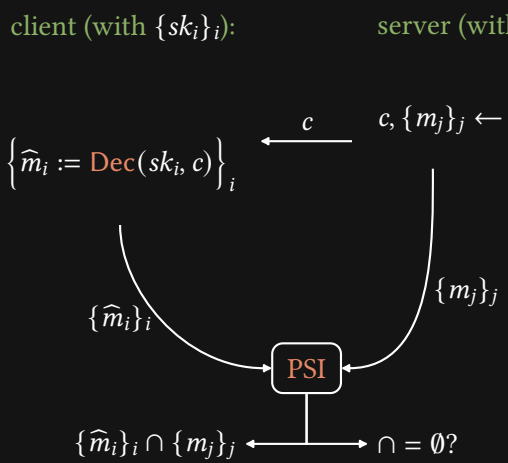

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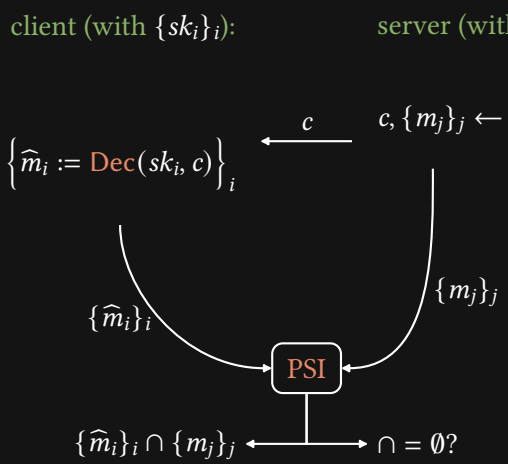

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add "proof of nonempty intersection" to [RosulekTrieu21] PSI

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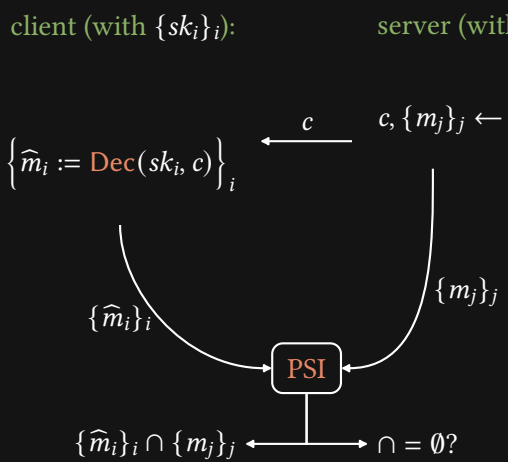

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+ full UC security analysis

concrete performance (in OpenSSH):

# of keys		RSA keys only (worst case for us)		{EC,Ed}DSA keys only (best case for us)	
client	server	time	comm	time	comm

`github.com/osu-crypto/PSIPK-ssh`

2 commodity desktop computers on LAN

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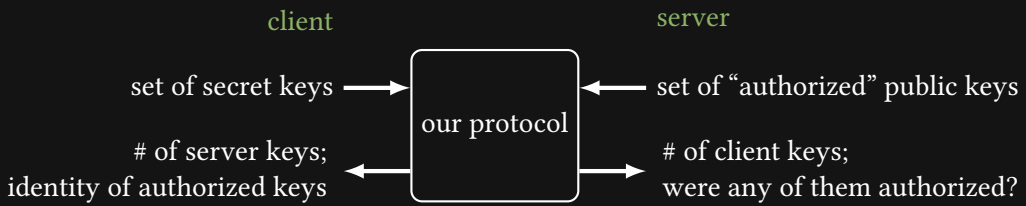

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- ✓ mixture of existing RSA & EC keys
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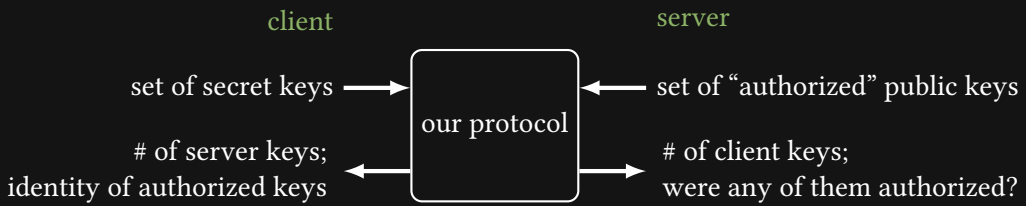

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(backup slides)

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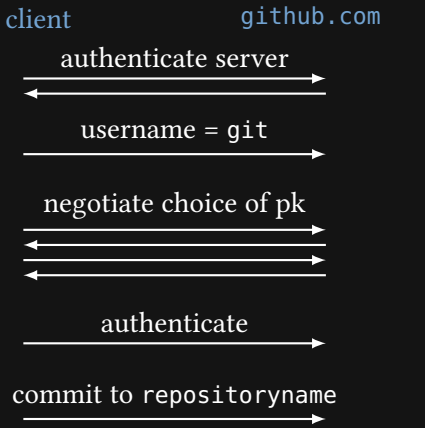

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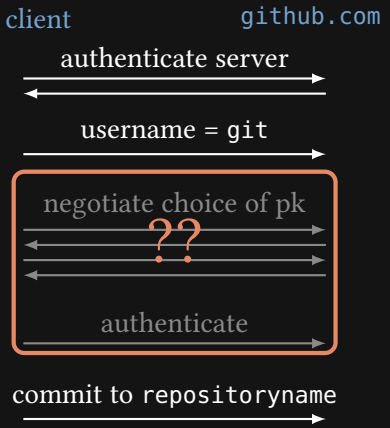

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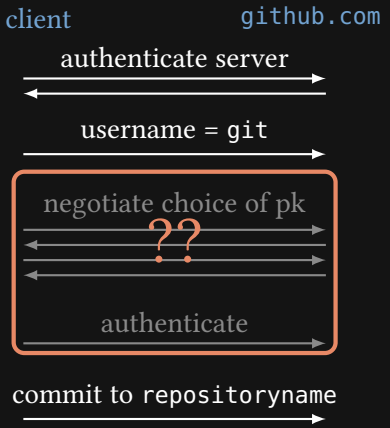

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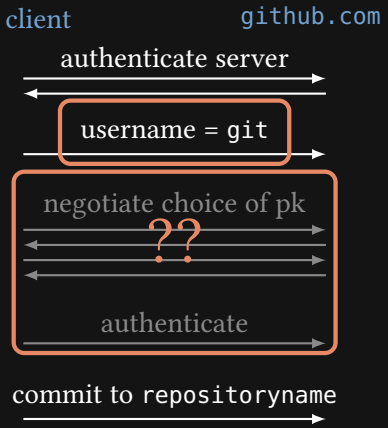

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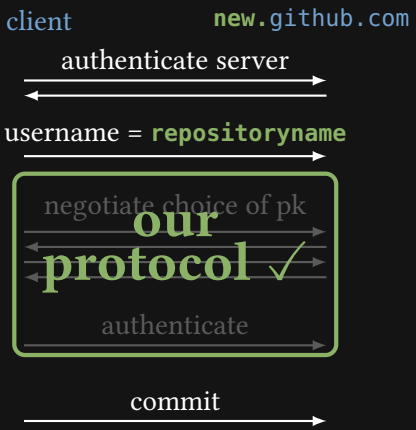

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- server does not know repository name yet!
- use repository name as `username`