# Public-key sudo

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# Motivation

```
$ ssh medusa
$ sudo ls
Password:
```

# Overview

- Sudo
- SSH
  - Authentication protocols
- SudoPK implementation
- Analysis

# Sudo

- Execute a command as another user.

```
$ sudo ls
```

- By default, prompts for password
- On OpenBSD, also supports:
    - S/Key, Kerberos, Radius, etc.

# SSH

- Secure remote shell

```
$ ssh bob@medusa
```

- By default, prompts for password.
- On OpenBSD, also supports:
    - S/Key, Kerberos, Radius, public keys, etc.

# SSH protocols

- Three layers
  - Transport [SSH-TRANS]
  - User authentication [SSH-USERAUTH]
  - Connection [SSH-CONNECT]

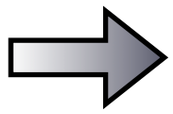
# Transport protocol

- Server host authentication
- Key exchange (Diffie-Hellman)
- Provides a confidential channel
  - Encryption
  - Integrity

# User authentication

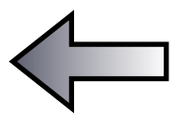
- Identifies the client to the server
- Required protocols:
  - **`"password"`**
  - **`"publickey"`**

# Password authentication



```
byte      SSH_MSG_USERAUTH_REQUEST
string    user name
string    service name
string    "password"
boolean   FALSE
string    plaintext password
```

# Password authentication



**byte SSH_MSG_USERAUTH_SUCCESS**

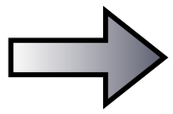
# Password authentication

- *Easy! But...*
- Susceptible to brute force
- What if the server is compromised?

# Public-key authentication

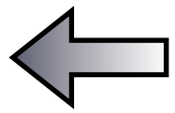
- Key distribution:
  - Generate <{id_rsa}$_S$, id_rsa.pub>
  - id_rsa → client:~/.ssh/id_rsa
  - id_rsa.pub → server:~/.ssh/authorized_keys

# Public-key authentication



```
byte      SSH_MSG_USERAUTH_REQUEST
string    user name
string    service name
string    "publickey"
boolean   FALSE
string    public key algorithm name
string    public key blob (certs)
```

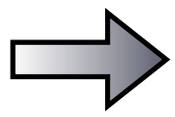
# Public-key authentication



```
byte      SSH_MSG_USERAUTH_PK_OK
string    public key algorithm name from the request
string    public key blob from the request
```

# Public-key authentication

S →



```
byte      SSH_MSG_USERAUTH_REQUEST
string    user name
string    service name
string    "publickey"
boolean   TRUE
string    public key algorithm name
string    public key
string    signature
```

# Public-key authentication

- More difficult to set up. (Not default!)
- Requires S on every connection
- No password or private key sent to remote host

# Public-key + ssh-agent

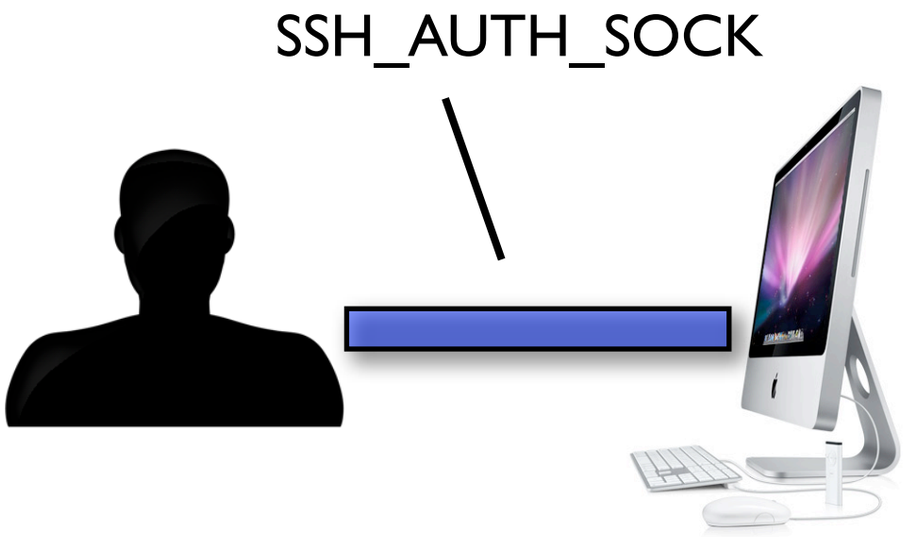
- ssh-agent manages your private keys
- Prompt for password only once

# Public-key + ssh-agent

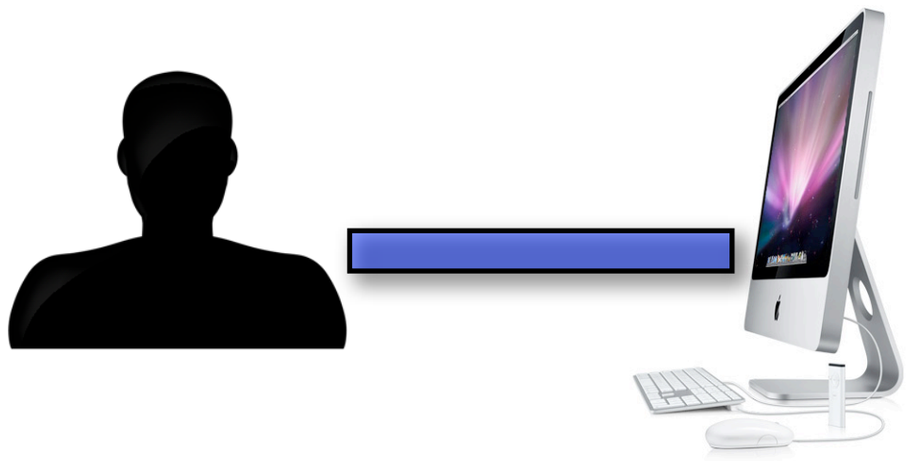
↑

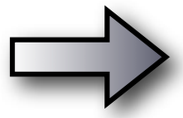
S

# Public-key + ssh-agent



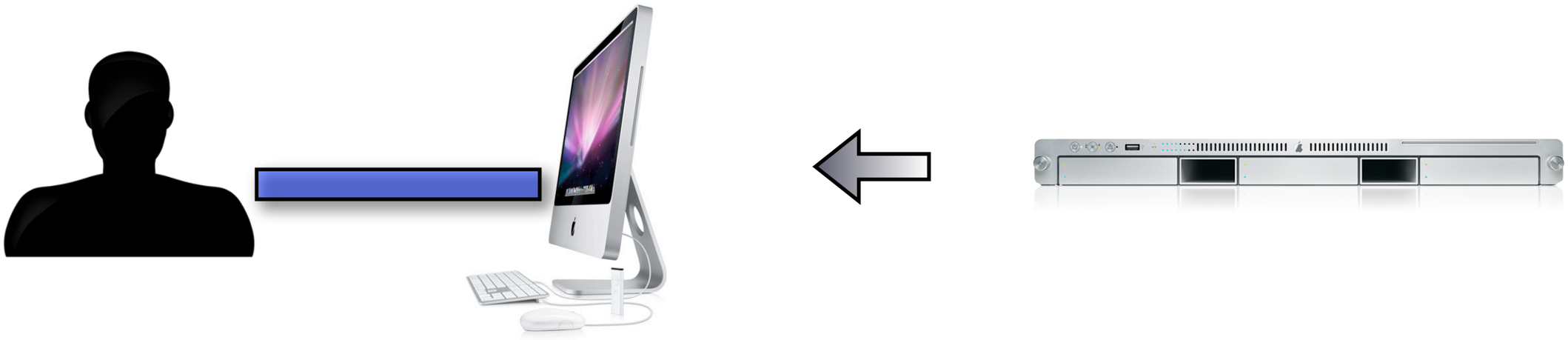
# Public-key + ssh-agent





```
byte      SSH_MSG_USERAUTH_REQUEST
string    "publickey"
...
```

# Public-key + ssh-agent



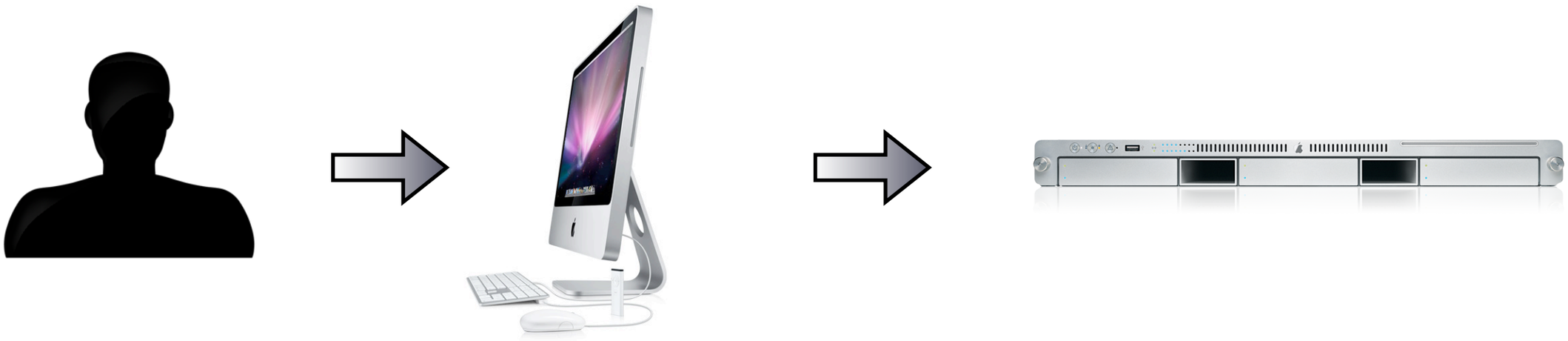
```
byte      SSH_MSG_USERAUTH_PK_OK
...
```

# Public-key + ssh-agent

**byte SSH_MSG_USERAUTH_PK_OK**

**...**

# Public-key + ssh-agent



```
byte      SSH_MSG_USERAUTH_REQUEST
string    signature
```

# Public-key + ssh-agent

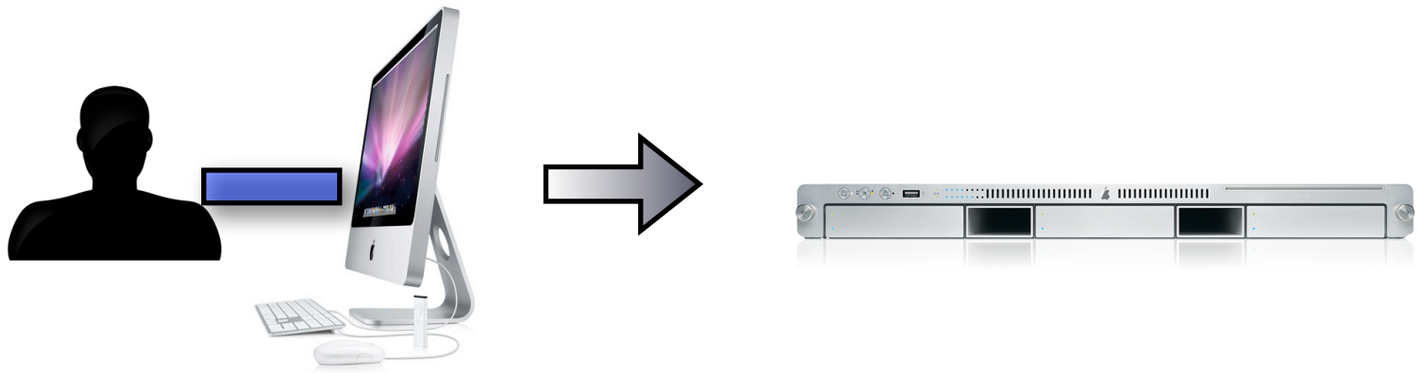
- What about subsequent outbound connections?

# ssh-agent forwarding

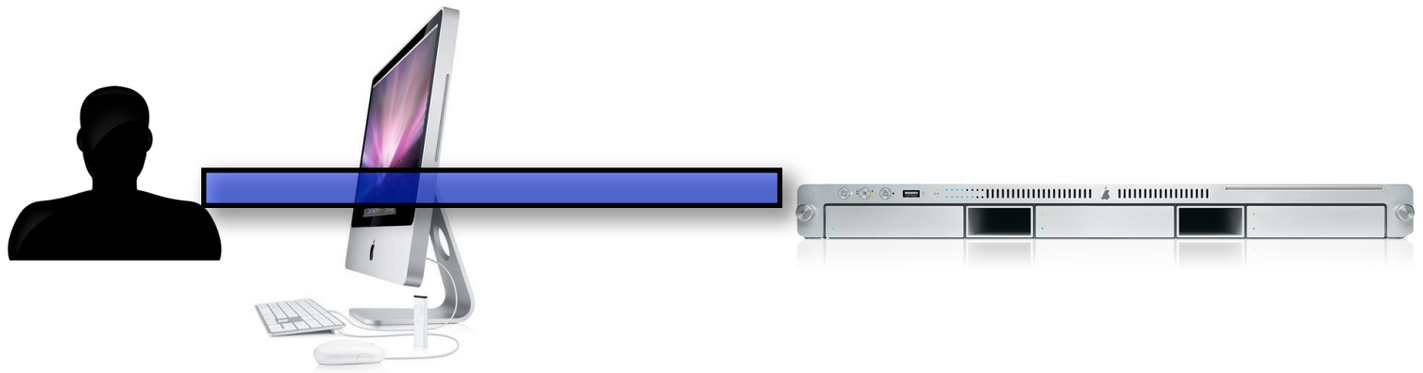
- Create chain to forward authentication requests back to originating agent

- **`SSH_AUTH_SOCK`**

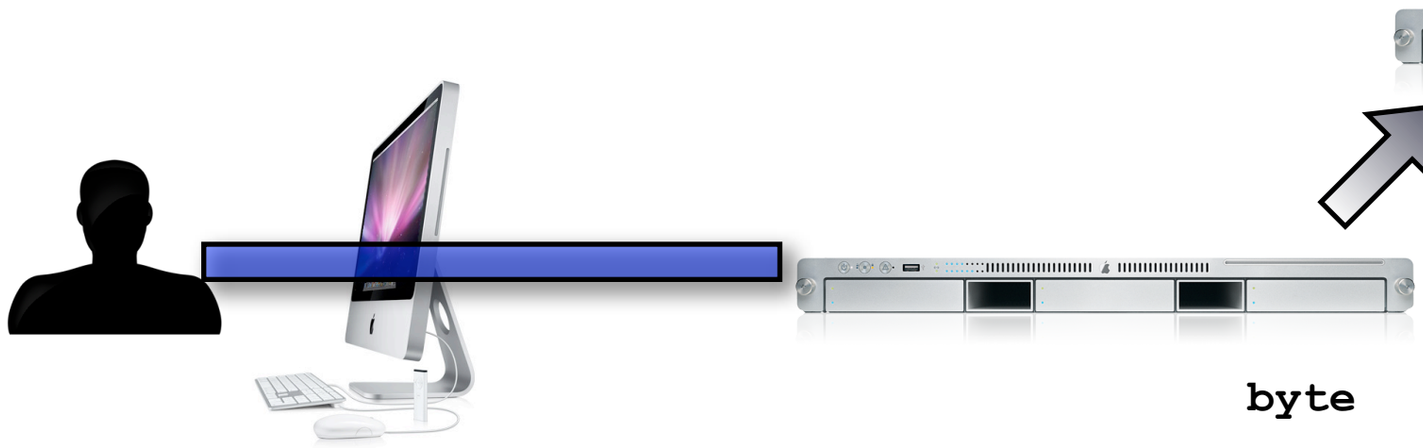
# ssh-agent forwarding



# ssh-agent forwarding

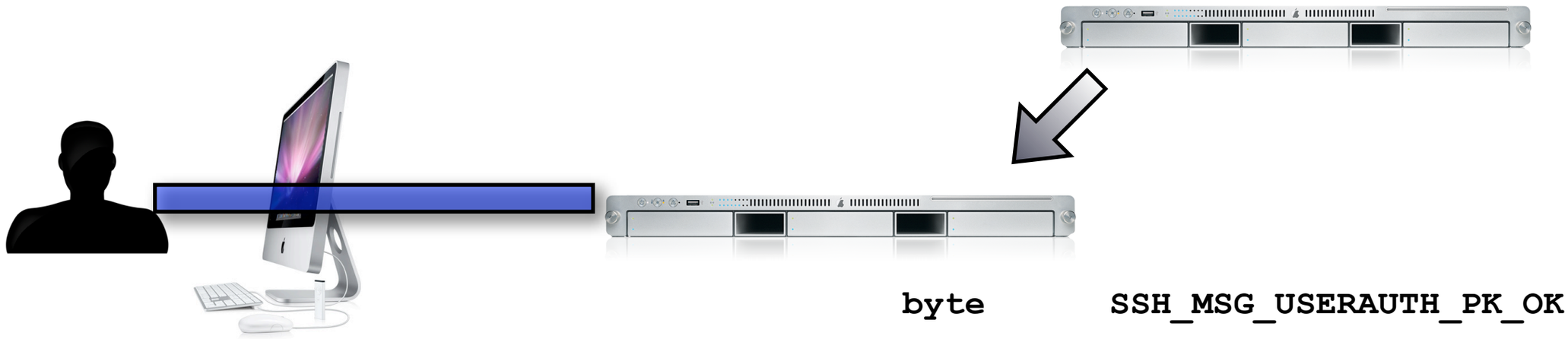


# ssh-agent forwarding



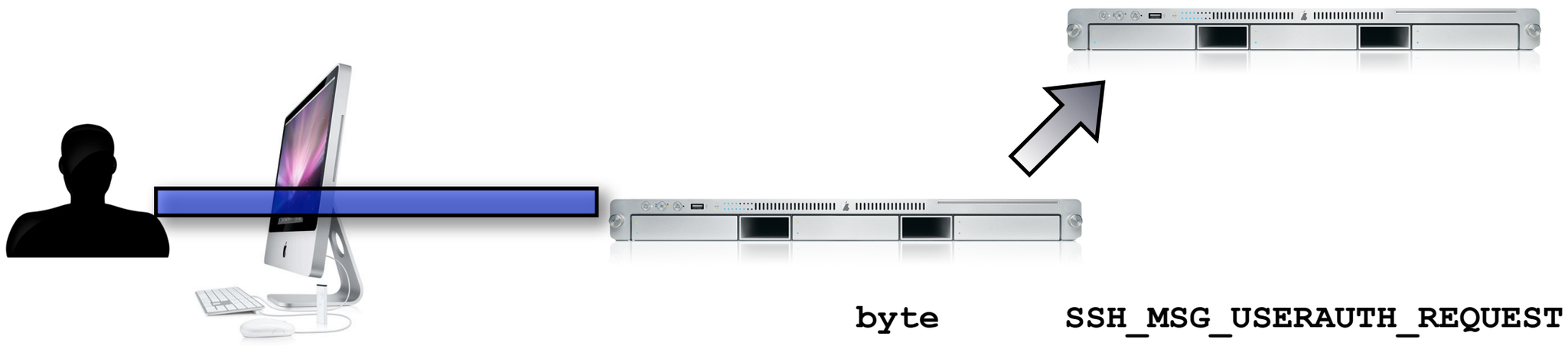
```
byte        SSH_MSG_USERAUTH_REQUEST
string      "publickey"
...
```

# ssh-agent forwarding



```
byte      SSH_MSG_USERAUTH_PK_OK
...
```

# ssh-agent forwarding



```
byte      SSH_MSG_USERAUTH_REQUEST
string    signature
```

# ssh-agent forwarding

- Added convenience.
- Private key and password never appear on the wire or at the remote host.
- But - agent hijacking!

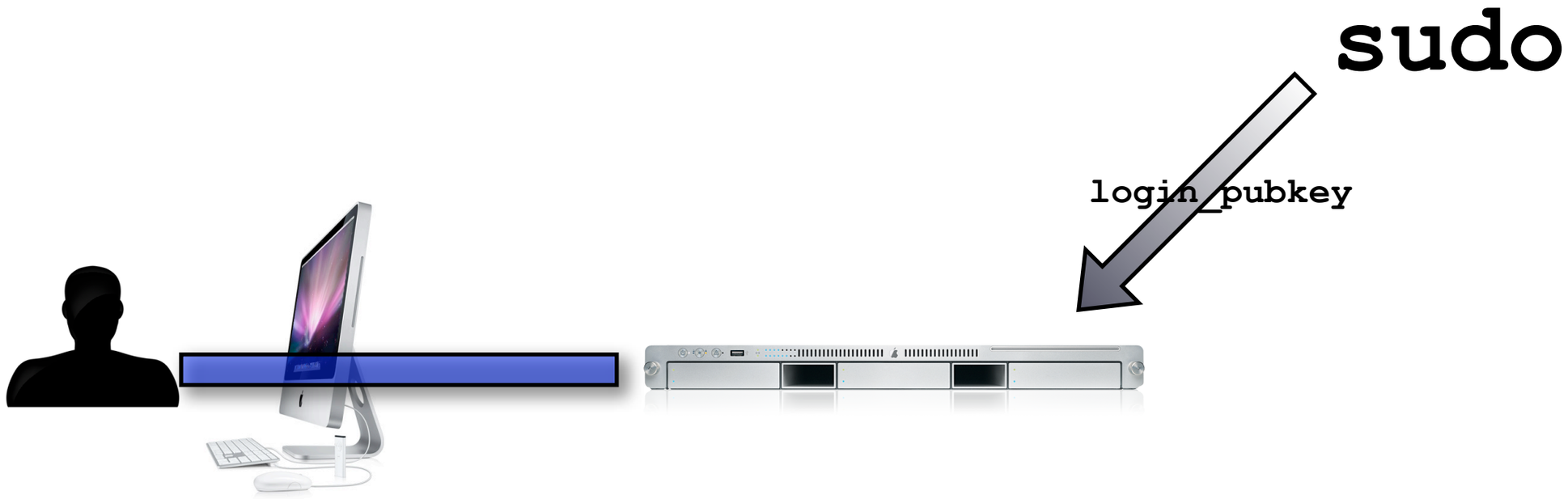
# SSH public key authentication

- Goal
  - Build a generic interface to SSH-USERAUTH
- Insight
  - Use the agent-forwarding tunnel to avoid re-implementing SSH components

# SudoPK core: `login_pubkey`

- BSD authentication module
  - Presents a **`bsdauth`** API to the SSH_AUTH_SOCK
- Easily portable to PAM

# login_pubkey



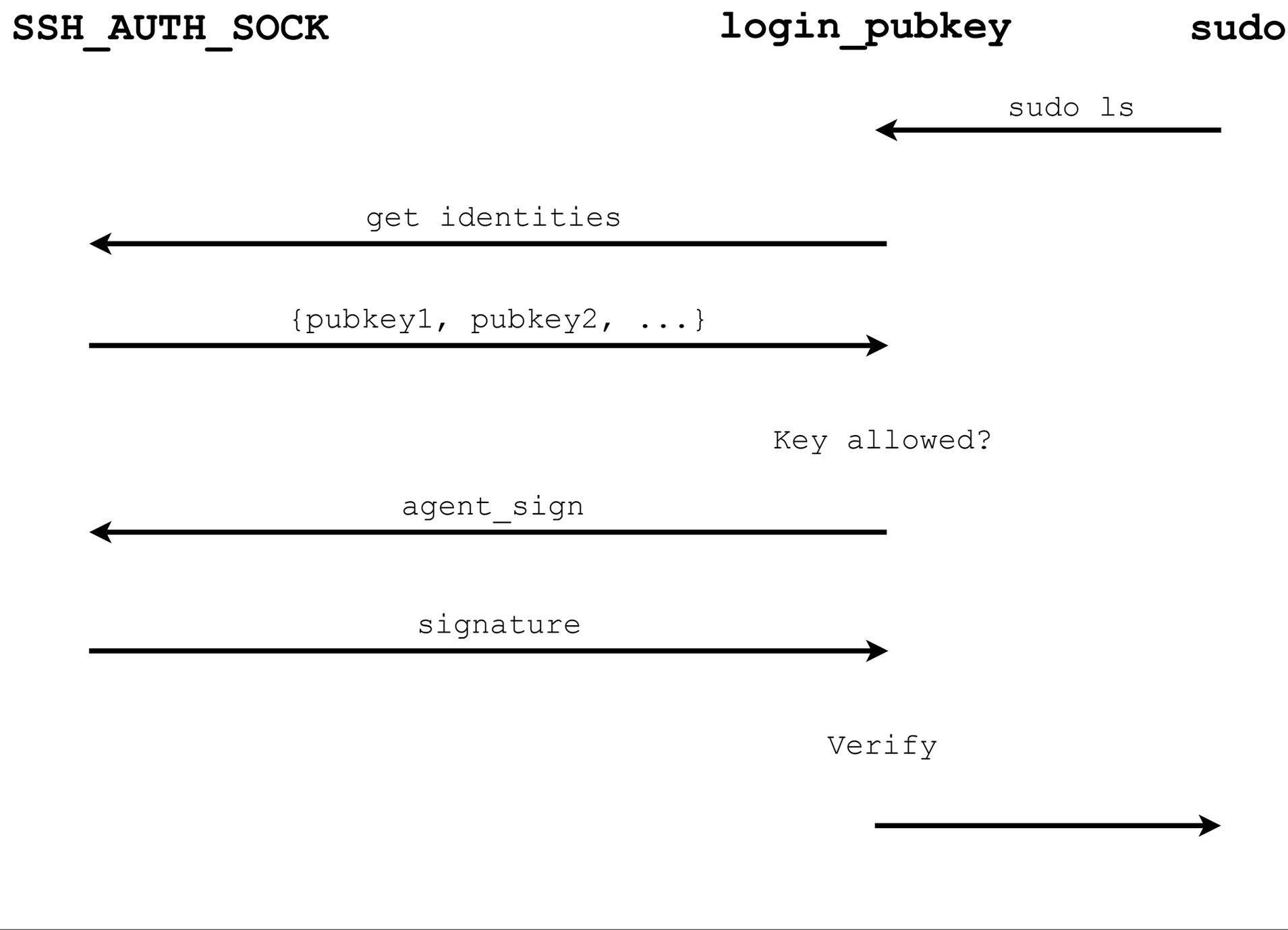
# Authentication process

```
ac = ssh_get_authentication_connection();

for (...) {
   client_key = ssh_get_next_identity(ac, &comment, version);
   if (!user_key_allowed(pw, client_key)) {
        // REJECT
}

ssh_agent_sign(ac, client_key, &signature, &slen, buf, BUFLEN);
if (key_verify(client_key, signature, slen, buf, BUFLEN)) {
     // SUCCESS
} else {
     // FAIL
}
```

# login_pubkey protocol



# login_pubkey

```
$ ssh medusa

$ sudo -a pubkey ls

...
```

# Brief security analysis

- `login_pubkey` provides ease-of-use layer on top of existing agent forwarding

- No worse than plain agent forwarding

# Agent hijacking

- **`SSH_AUTH_SOCK`** is a tunnel for signing requests

- Protect by making socket hard to find
  - Randomly chosen name, restricted file permissions

- Root can still get it

# Local confirmation

- `ssh-add -c .ssh/id_rsa`
  - Agent requests password on *every* signature

# Local confirmation

- Present message contents to user before signing.
- SSHD should verify *and confirm contents*. RFC does not enforce this!
- SudoPK package includes ssh-add and ssh-agent patches

# Conclusion

- Thanks!
- Code:

  http://www.cs.columbia.edu/~mb/code/sudopk