L24: Secure channels

Nickolai Zeldovich
6.033 Spring 2012

Subject evaluation

- Help us improve 6.033 for future years

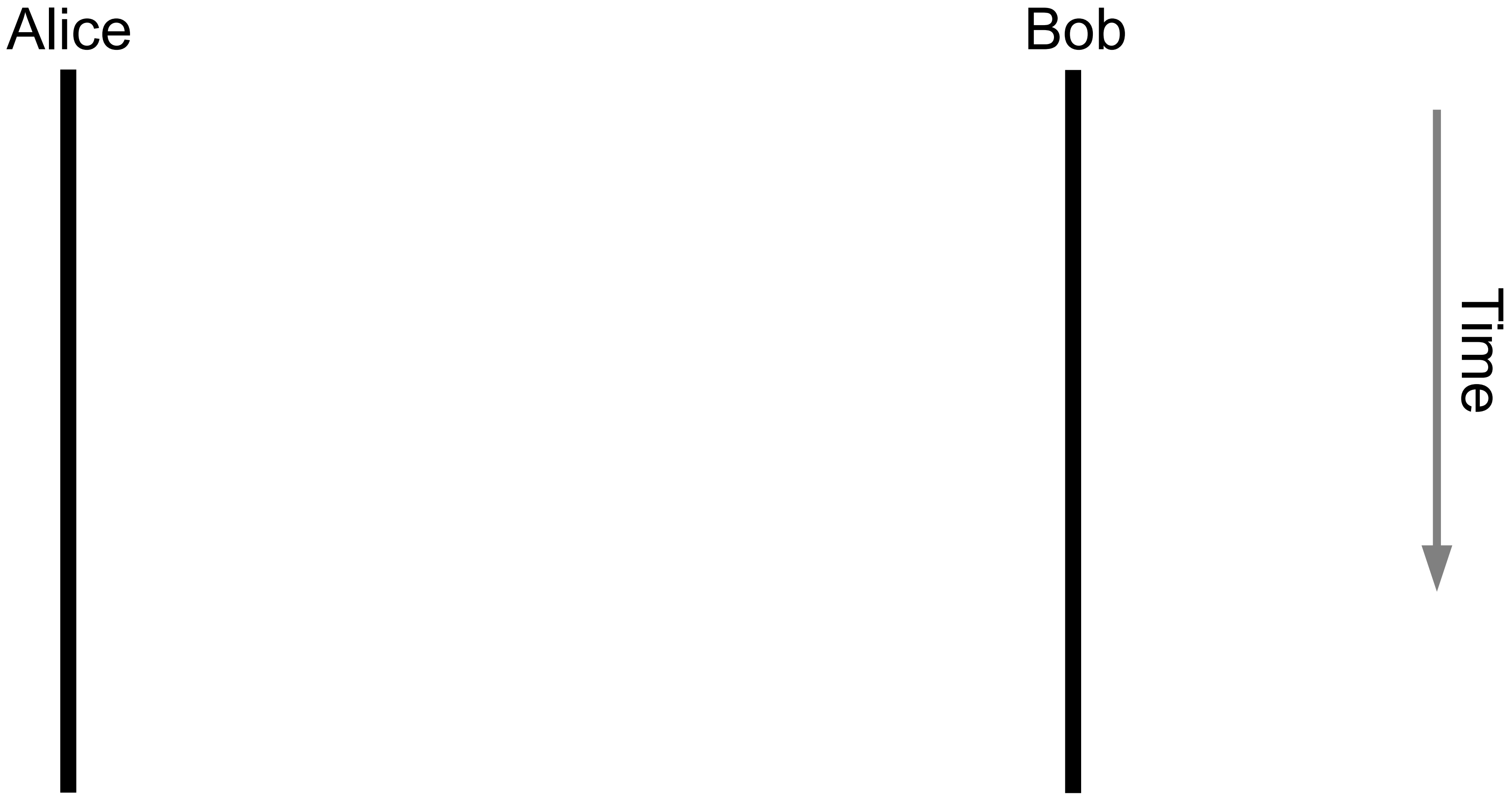
- http://web.mit.edu/subjectevaluation

- Please fill out before the beginning of finals week
- We read every one of your comments

Network insecurity

```
# tcpdump -A -s 2272 -i mon0
11:53:41.281771 2462 MHz 11g -26dB signal antenna 15 [bit 14]
  CF +QoS IP 128.31.33.180.41899 > 74.125.226.180.80: Flags
  [P.], seq 490544447:490545563, ack 2165662404, win 501,
  options [nop,nop,TS val 701636 ecr 3105280684], length 1116
...
GET /search?hl=en&source=hp&q=mit+150&... HTTP/1.1
Host: www.google.com
Connection: keep-alive
Referer: http://www.google.com/
User-Agent: Mozilla/5.0 (X11; CrOS i686 0.0.0) ...
Cookie: NID=45=0N-XmK6HCc6gnbx-DAQCk2-IBwUK8JV-79rK3iFzK08pL...
...
```

Diffie-Hellman key exchange



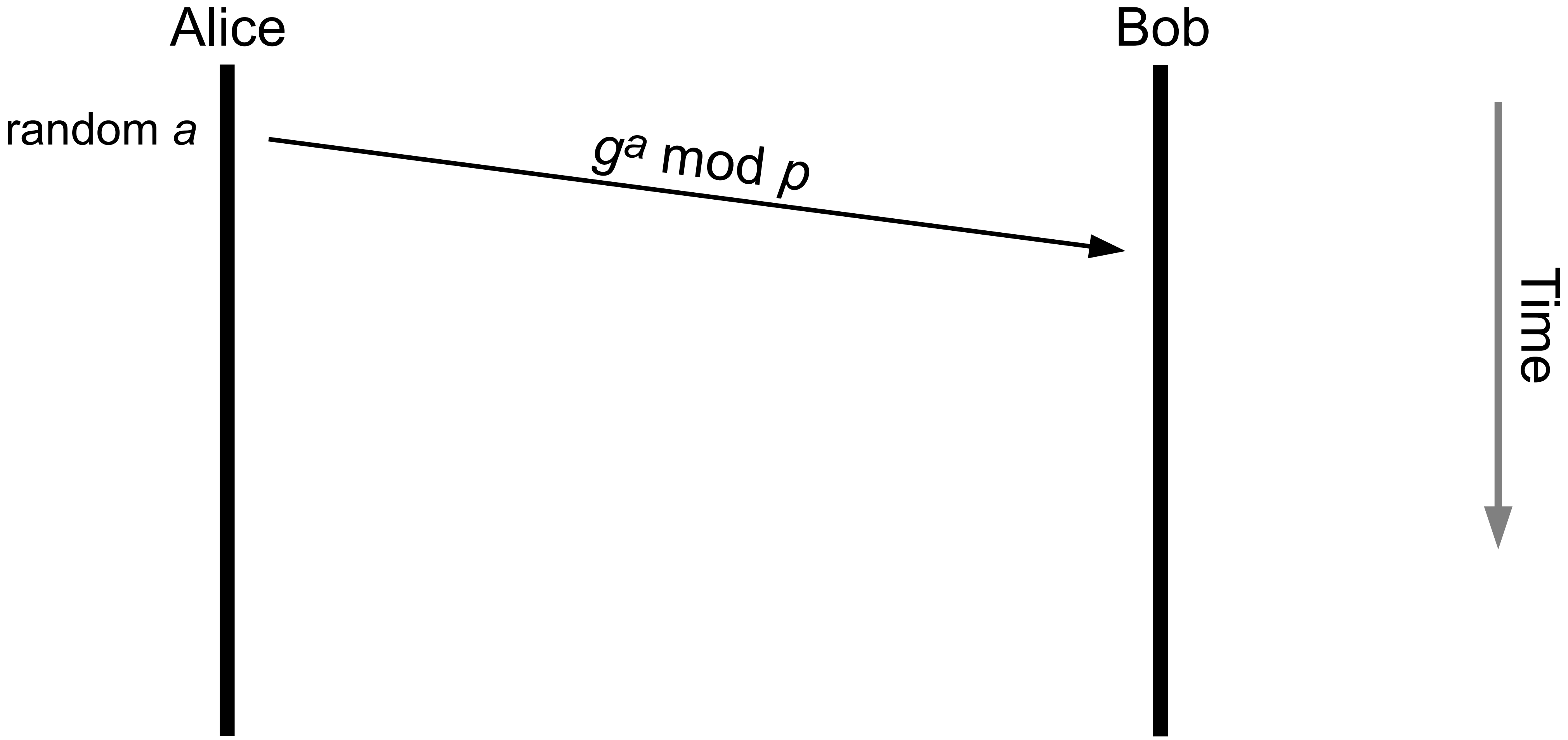
Alice

Bob

Time

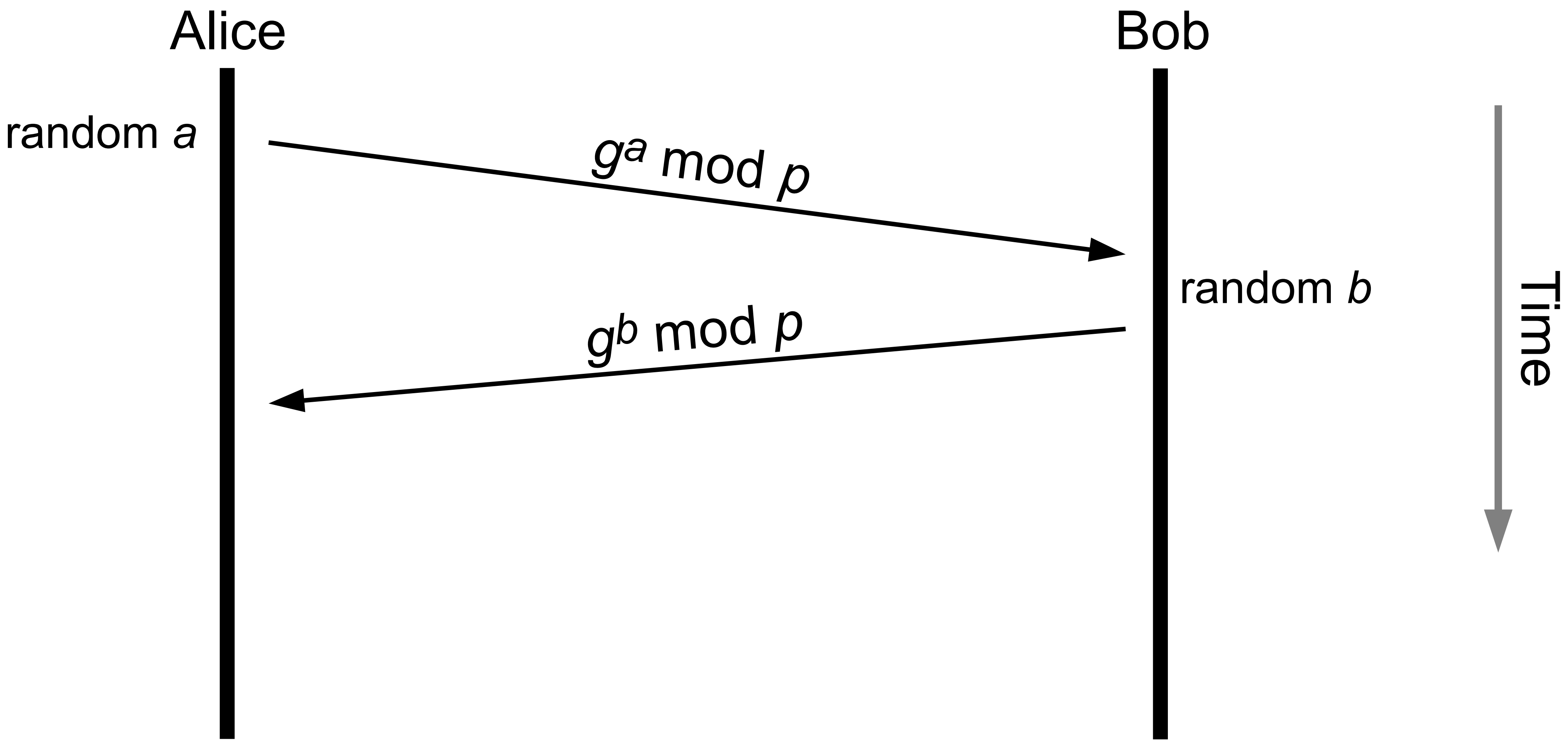
Common parameters: prime *p*, generator *g*

Diffie-Hellman key exchange



Common parameters: prime p, generator g

Diffie-Hellman key exchange



Alice

Bob

random a

$g^a \bmod p$

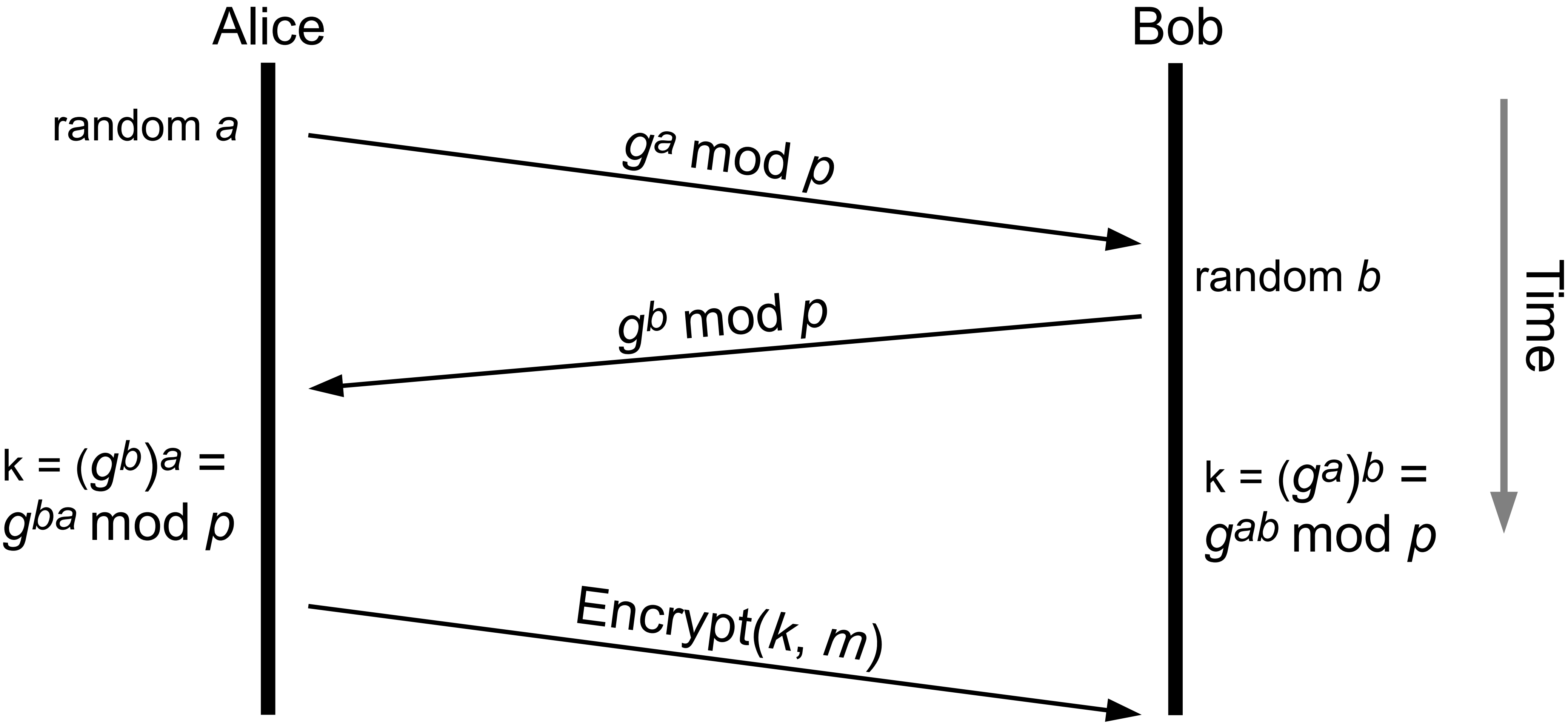
random b

$g^b \bmod p$

Time

Common parameters: prime p, generator g

Diffie-Hellman key exchange



Alice

Bob

random a

g^a mod p

random b

g^b mod p

k = $(g^b)^a$ = g^{ba} mod p

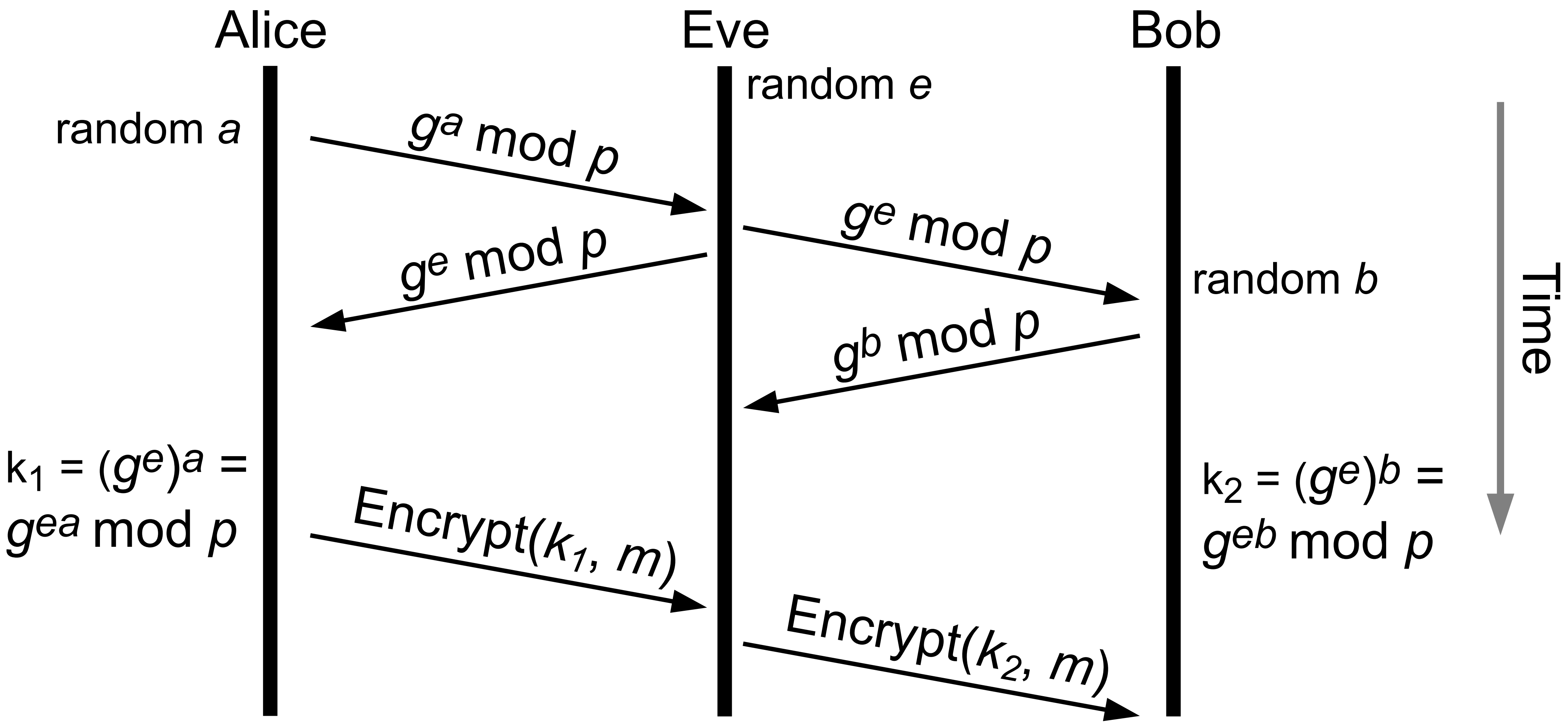
k = $(g^a)^b$ = g^{ab} mod p

Encrypt(k, m)

Time

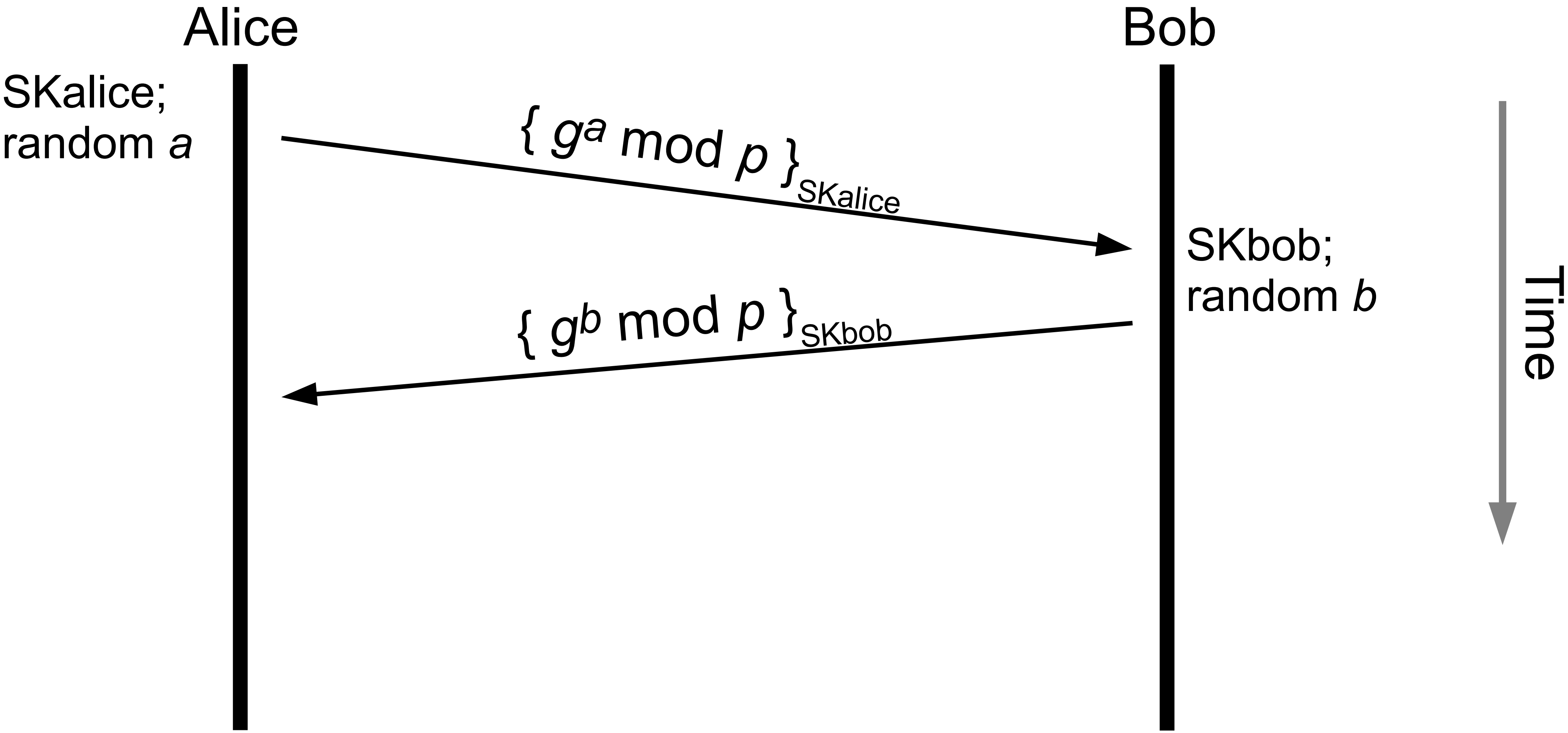
Common parameters: prime p, generator g

Man-in-the-middle (MITM) attack



Common parameters: prime p, generator g

Diffie-Hellman with signatures



Alice

Bob

SKalice;
random *a*

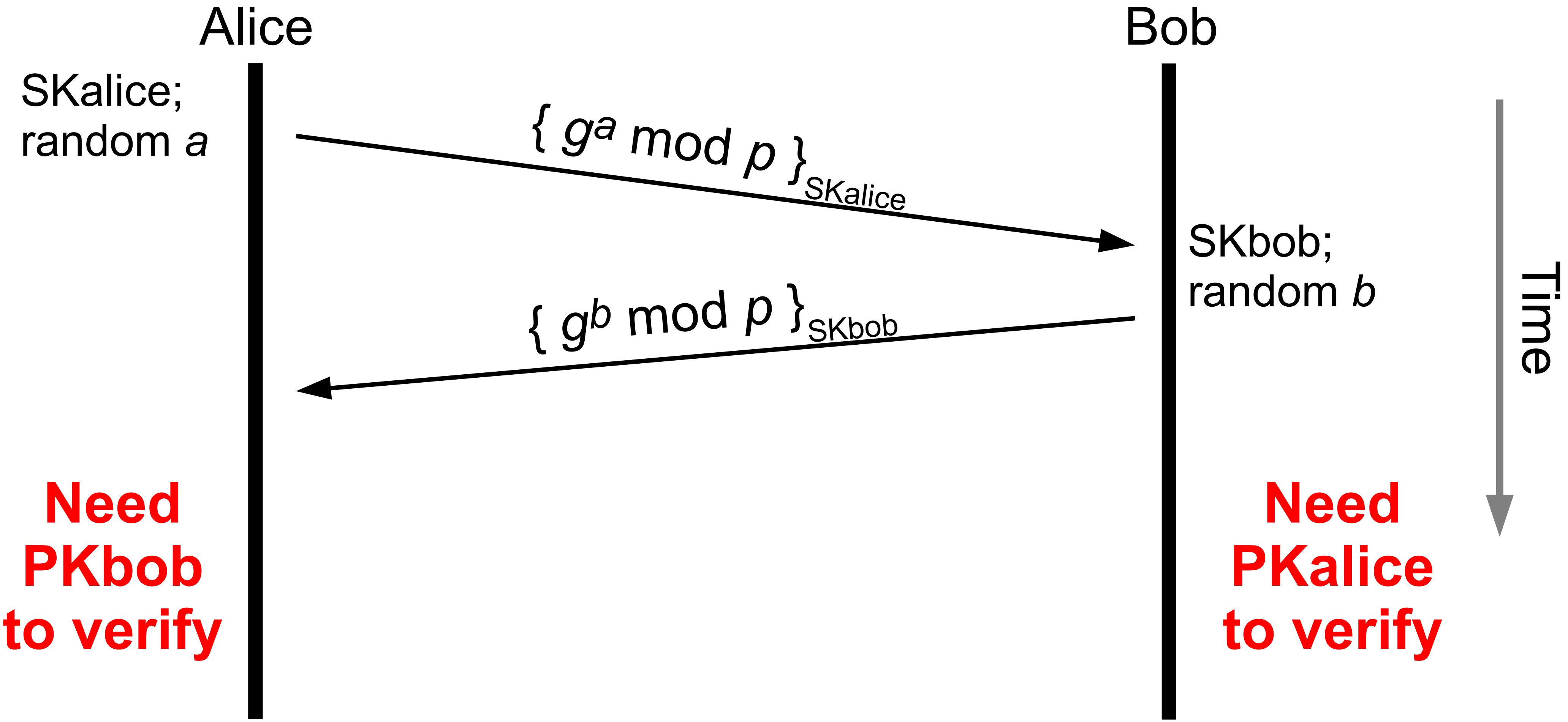
$\{\, g^{a} \bmod p \,\}_{SKalice}$

SKbob;
random *b*

$\{\, g^{b} \bmod p \,\}_{SKbob}$

Time

Diffie-Hellman with signatures



Alice

Bob

SKalice;
random a

$\{ g^a \bmod p \}_{\text{SKalice}}$

SKbob;
random b

$\{ g^b \bmod p \}_{\text{SKbob}}$

Time

Need PKbob to verify

Need PKalice to verify

Certificate authority mistakes

- 2001: Verisign cert for Microsoft Corp.
- 2011: Comodo certs for *mail.google.com*, etc
- 2011: DigiNotar cert for *.google.com

Summary

- Network adversary: secure channel abstraction
- Primitives: Encrypt/Decrypt, MAC, Sign/Verify
- Key exchange requires knowing public keys
- Certificates