Network Security

Traffic analysis and anonymization

Radboud University Nijmegen, The Netherlands

Autumn 2014

The next weeks

- **Today (Monday, Oct. 13):** last lecture
- **Friday Oct. 17:** werkcollege
- **Monday Oct. 20:** extra werkcollege
- **Friday Oct. 24:** last homework solution + exam Q&A
- **Monday Nov. 3, 12:30–15:30:** Exam

TUN/TAP example

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tyrion # echo 1 > /proc/sys/net/ipv4/ip_forward
tyrion # ip tuntap add dev tun3 mode tun
tyrion # ip addr add dev tun3 10.0.5.1/24
tyrion # ip l set dev tun3 up

arya # echo 1 > /proc/sys/net/ipv4/ip_forward
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- Best option: TLS_ECDHE_RSA_WITH_AES256_GCM_SHA384

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- DigiNotar compromised in 2011: >300,000 Iranian Gmail users compromised

OpenSSL Heartbleed Bug

Bug in the implementation of the Heartbeat Extension (RFC 6520):

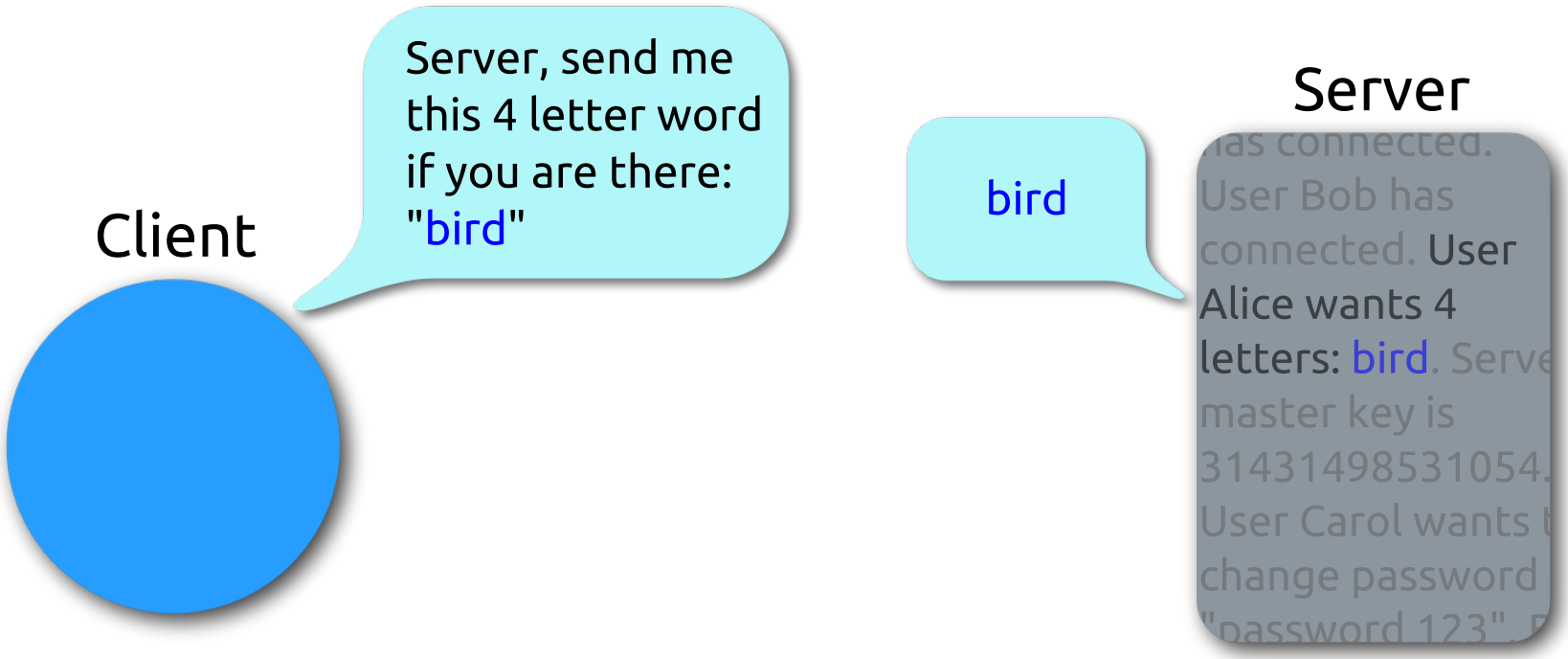
```
struct {
   HeartbeatMessageType type;
   uint16 payload_length;
   opaque payload[HeartbeatMessage.payload_length];
   opaque padding[padding_length];
 } HeartbeatMessage;

 [...]
 When a HeartbeatRequest message is received [...],
 the receiver MUST send a corresponding HeartbeatResponse
 message carrying an exact copy of the payload of the received
 HeartbeatRequest.
```

OpenSSL failed to check actual length of payload data.

OpenSSL Heartbleed Bug

Heartbeat – Normal usage



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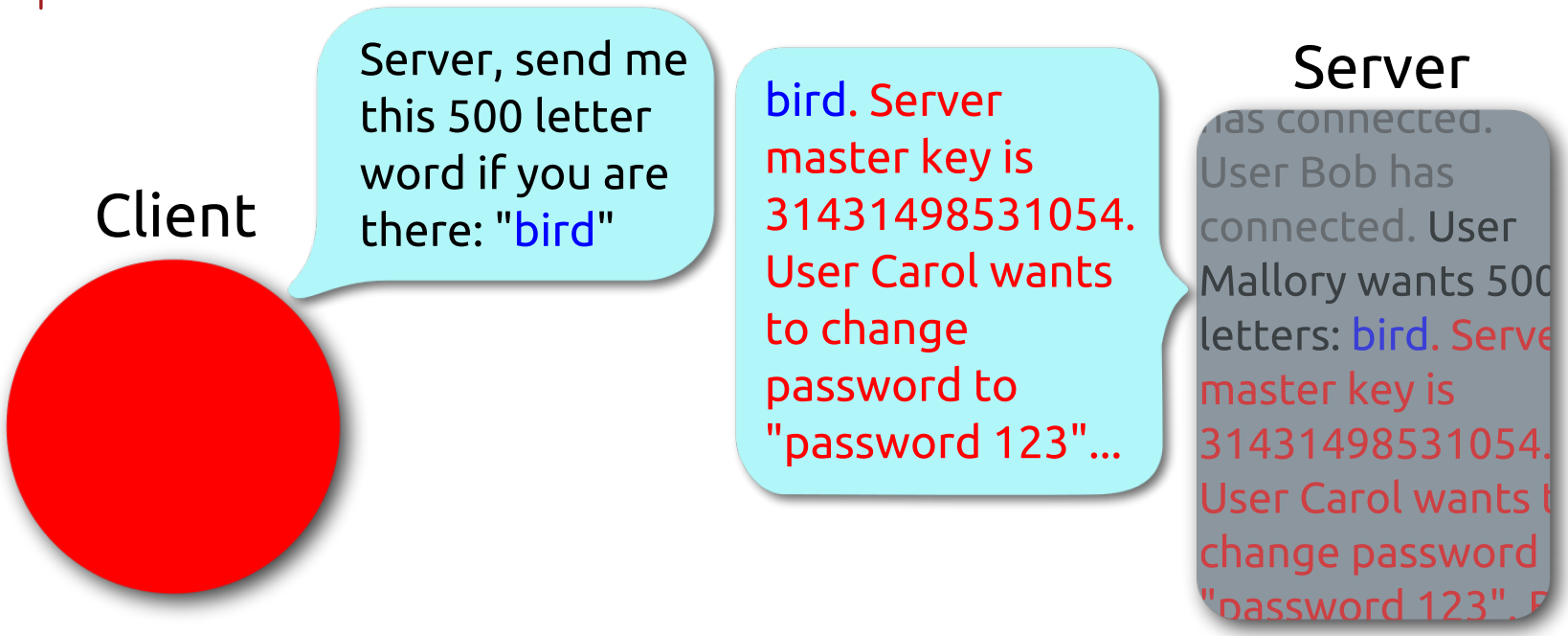

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- Most users visit websites by clicking on links (or HTTP 301/302)
- Consider a website `http://www.target.com` (note that it's HTTP!)
- Assume that this website has a link of the following form:

```
<a href="https://www.target.com/login.html">login</a>
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- User clicks on this link and uses HTTPS
- Active MitM attacker can modify this link to

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- User clicks on this link and uses HTTP!

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- Attacker can strip the HSTS header in the *first request* to the server
- Firefox and Chrome ship with a list of known HSTS sites

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From the article:

"Early last year–before the Snowden revelations–encrypted traffic accounted for 2.29 percent of all peak hour traffic in North America, according to Sandvine's report. Now, it spans 3.8 percent. But that's a small jump compared to other parts of the world. In Europe, encrypted traffic went from 1.47 percent to 6.10 percent, and in Latin America, it increased from 1.8 percent to 10.37 percent."

—Klint Finley on wired.com, May 16, 2014.

The perfect world (crypto-wise)

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- ... applied cryptographers have trouble finding a job.

What *does* an attacker see?

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Encrypting and authenticating content does not prevent any of this!

What can you do with “meta data”?

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“We kill people based on metadata.”

—Michael Hayden, former director of the NSA and the CIA

Is "metadata" all an attacker gets?

- Common assumption: an attacker sees only traffic data ("meta data")
- Example, interview with Jimmy Wales (Wikipedia founder):

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  - This is not the only thing an attacker sees; more in the homework

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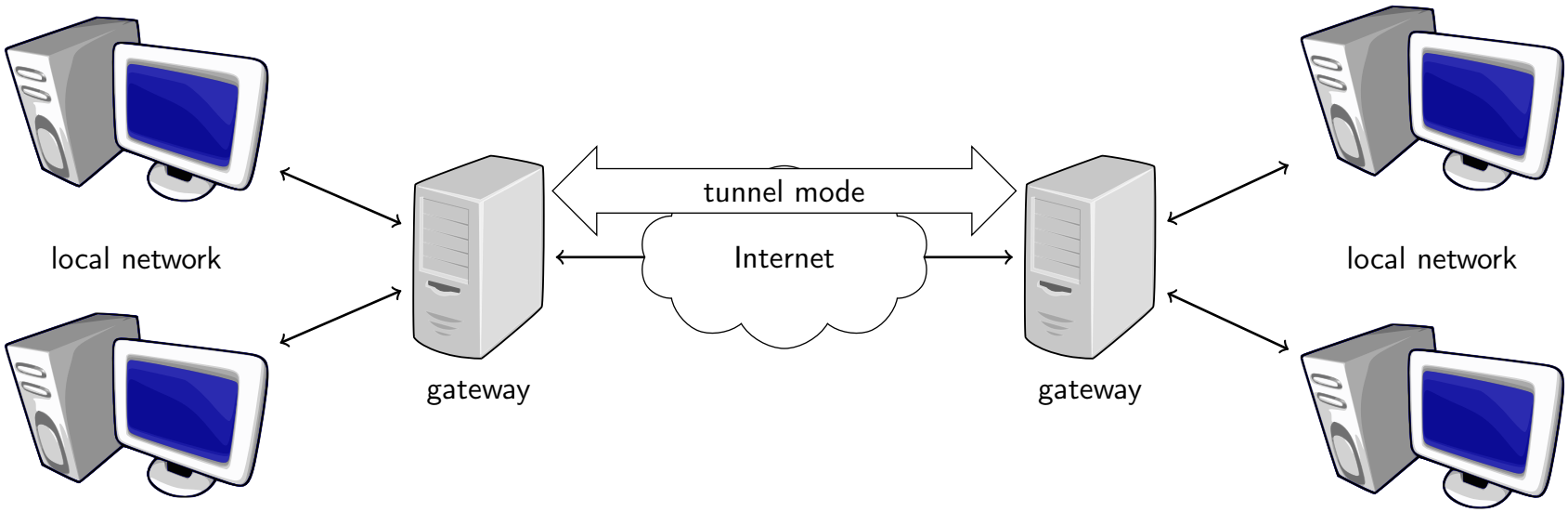

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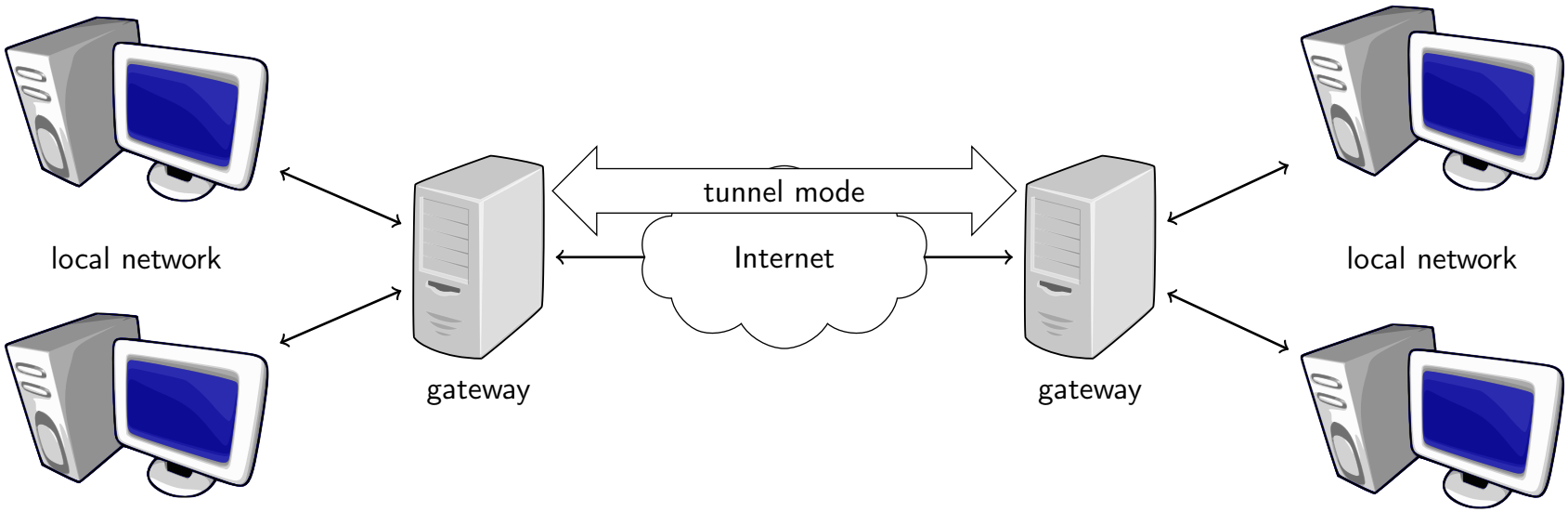

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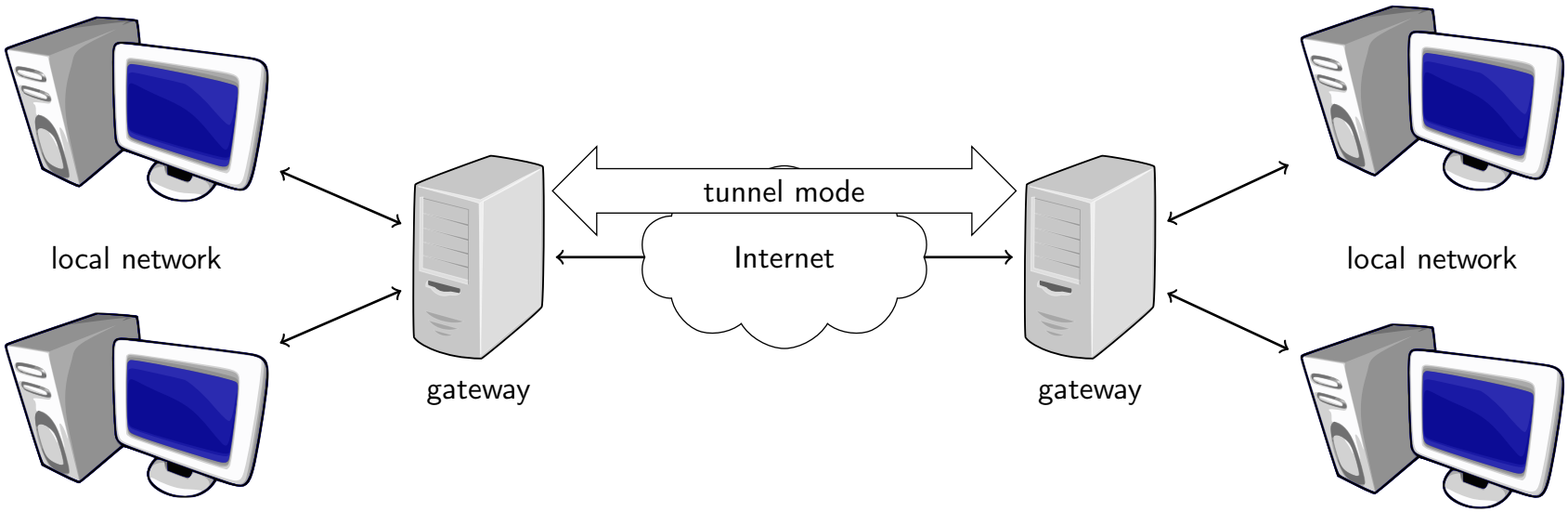

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- Problem 2: Potentially small *anonymity set*

Anonymizing proxies

- Somewhat similar idea (without crypto): use a proxy server
- Typically: application-specific proxies (e.g., HTTP proxies)
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- Can add crypto to the proxy (e.g., OpenVPN Service)
- That still does not solve problems 1 and 2

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- Receiver Bob decrypts and obtains M
- Achieves anonymity if encrypted messages are indistinguishable
- Very important: never repeat input and output!
- Has high communication latency (wait for enough messages)

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- R_1, K_X are random one-time symmetric keys
- A_X is Alice's real address

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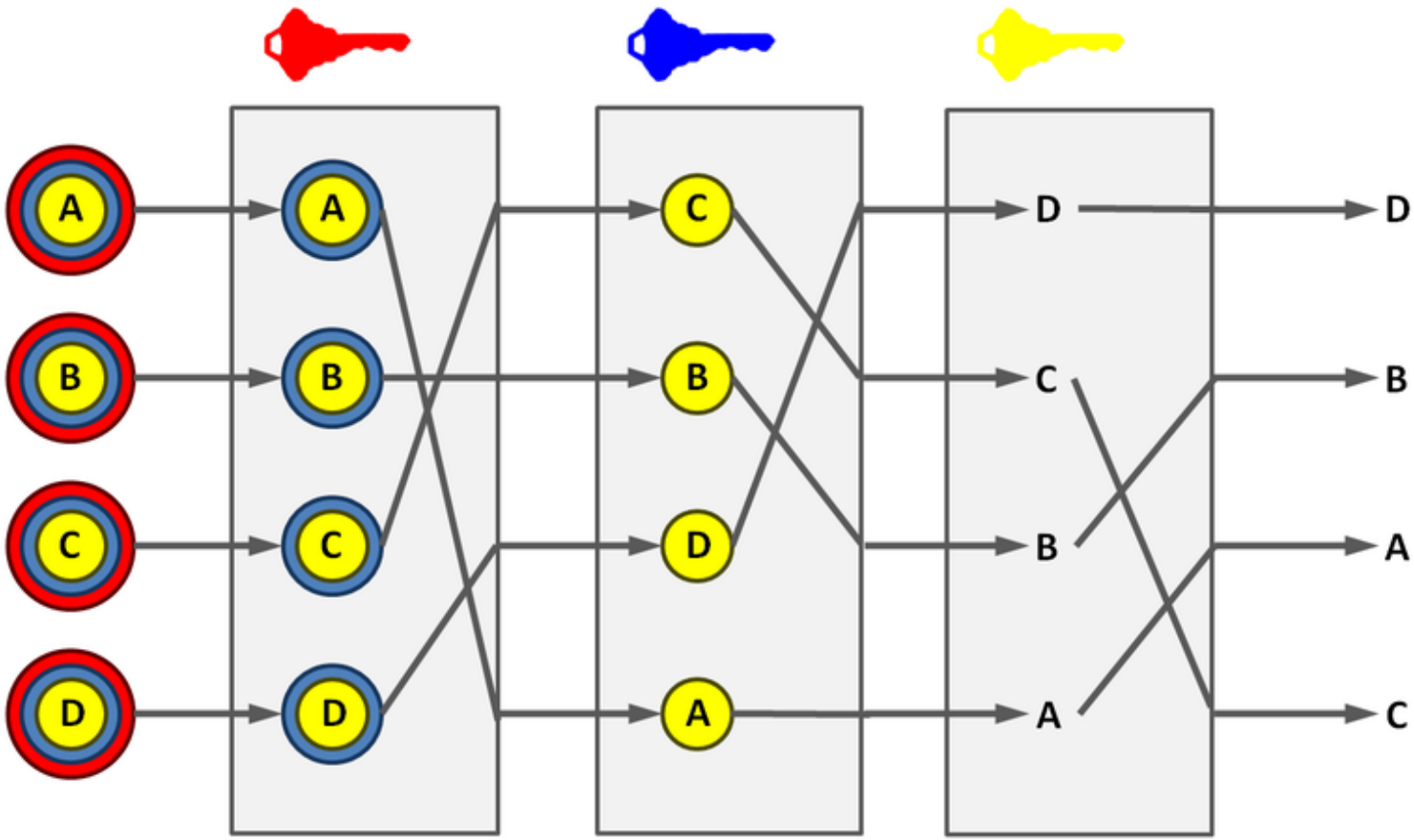
- Only Alice can decrypt, because only she knows both K_X and R_1

Cascading Mixes



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Idea of Tor (The Onion Router): Combine advantages:

- Use cascade of "proxies", called *Tor relays* or *Tor nodes*
- Use fast symmetric crypto instead of asymmetric crypto

Onion Routing and Tor

- Assume that user shares symmetric keys with three *relays*:
  - Entry relay R_1 (key K_{R_1})
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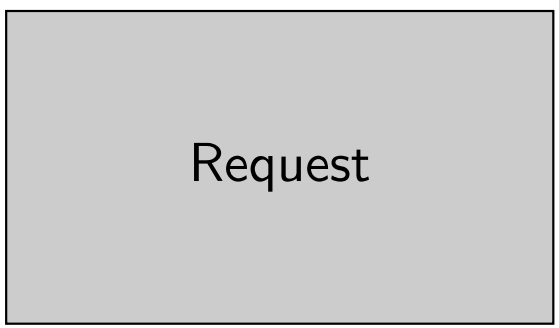

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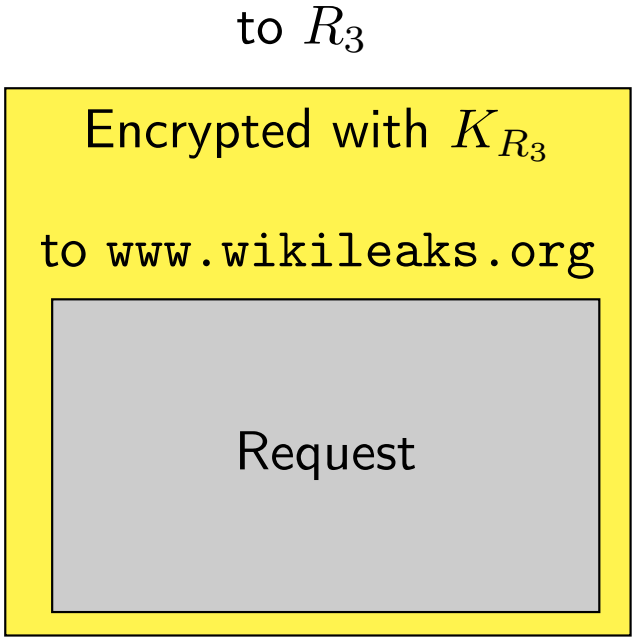

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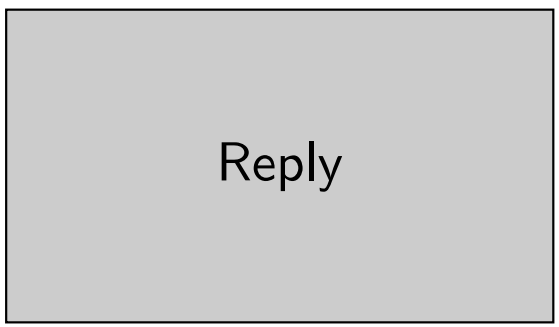

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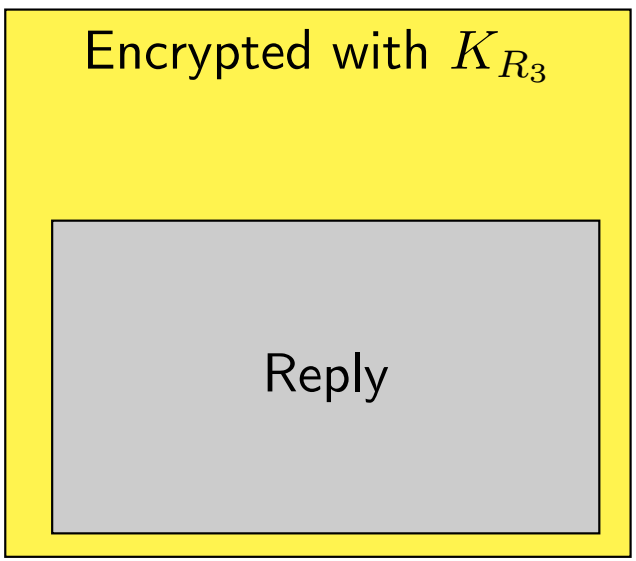

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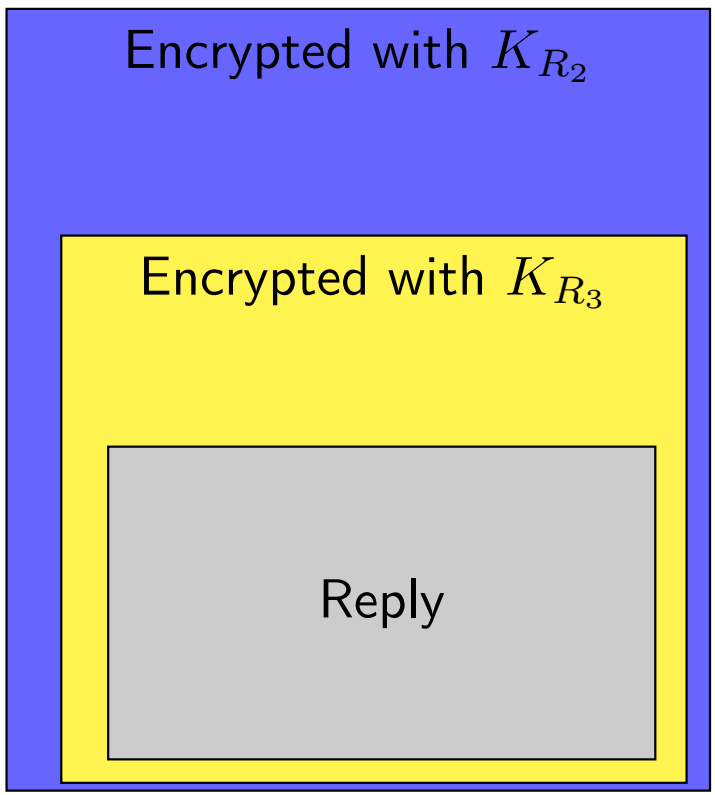

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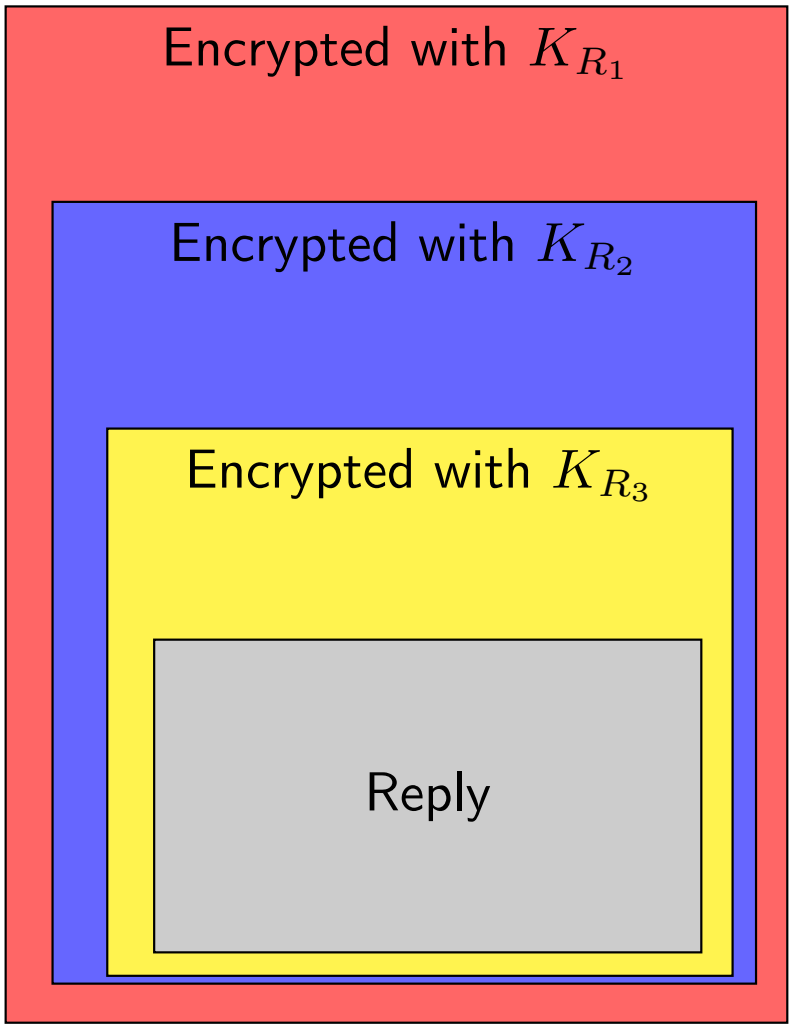

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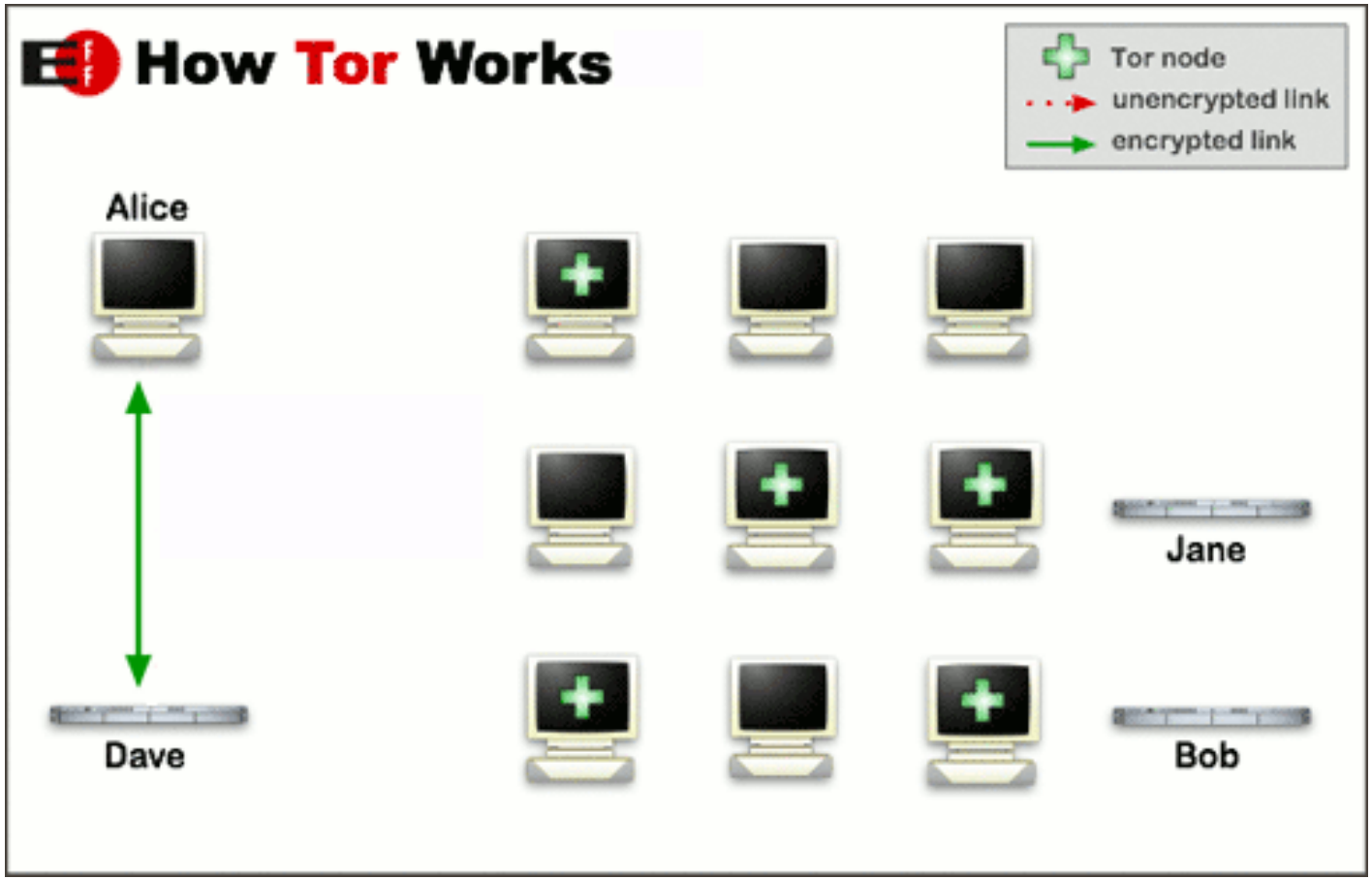

Request listing of Tor nodes from directory server (DS)

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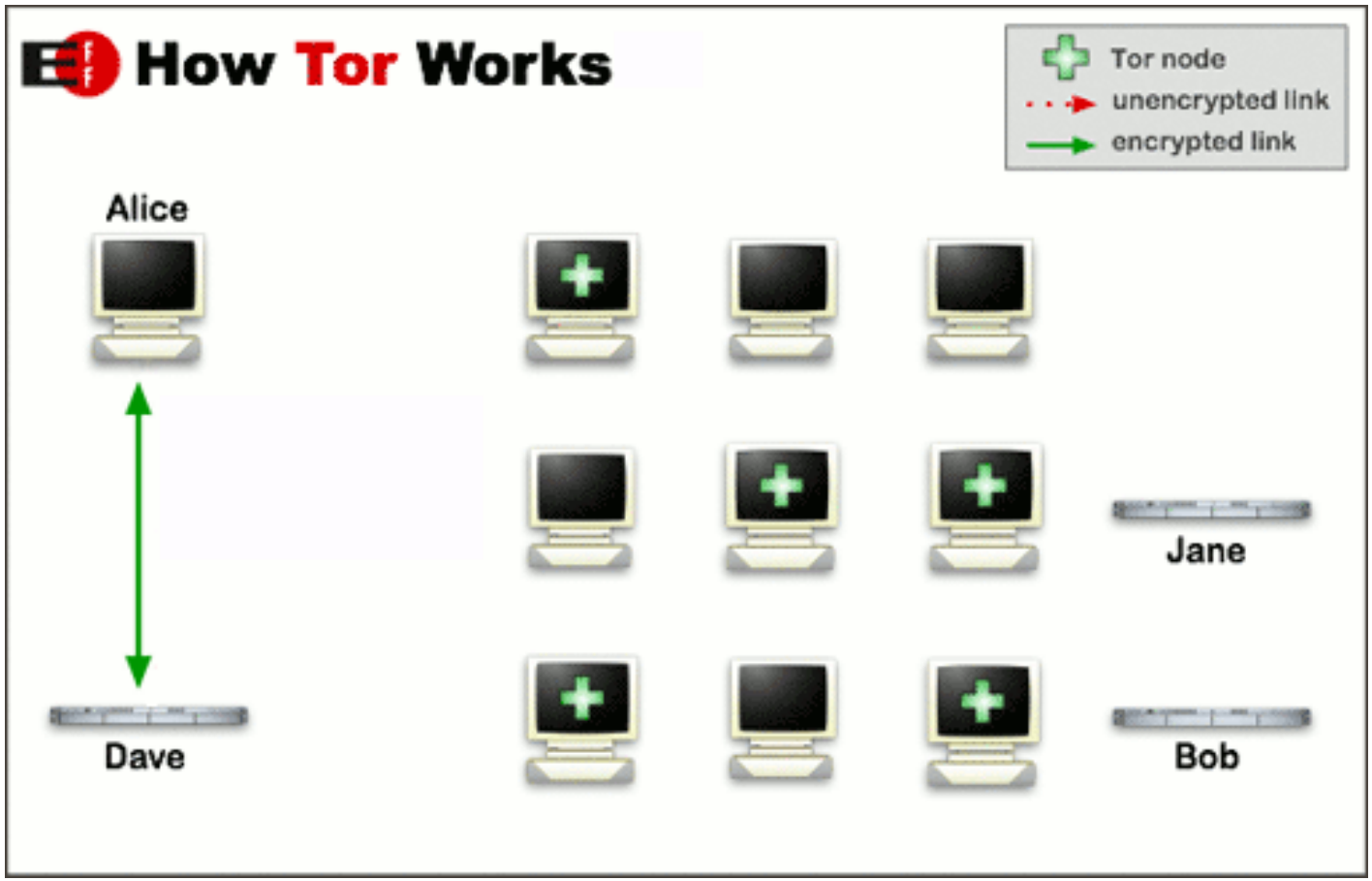

Pick entry, guard, and exit node; obtain their public keys from DS

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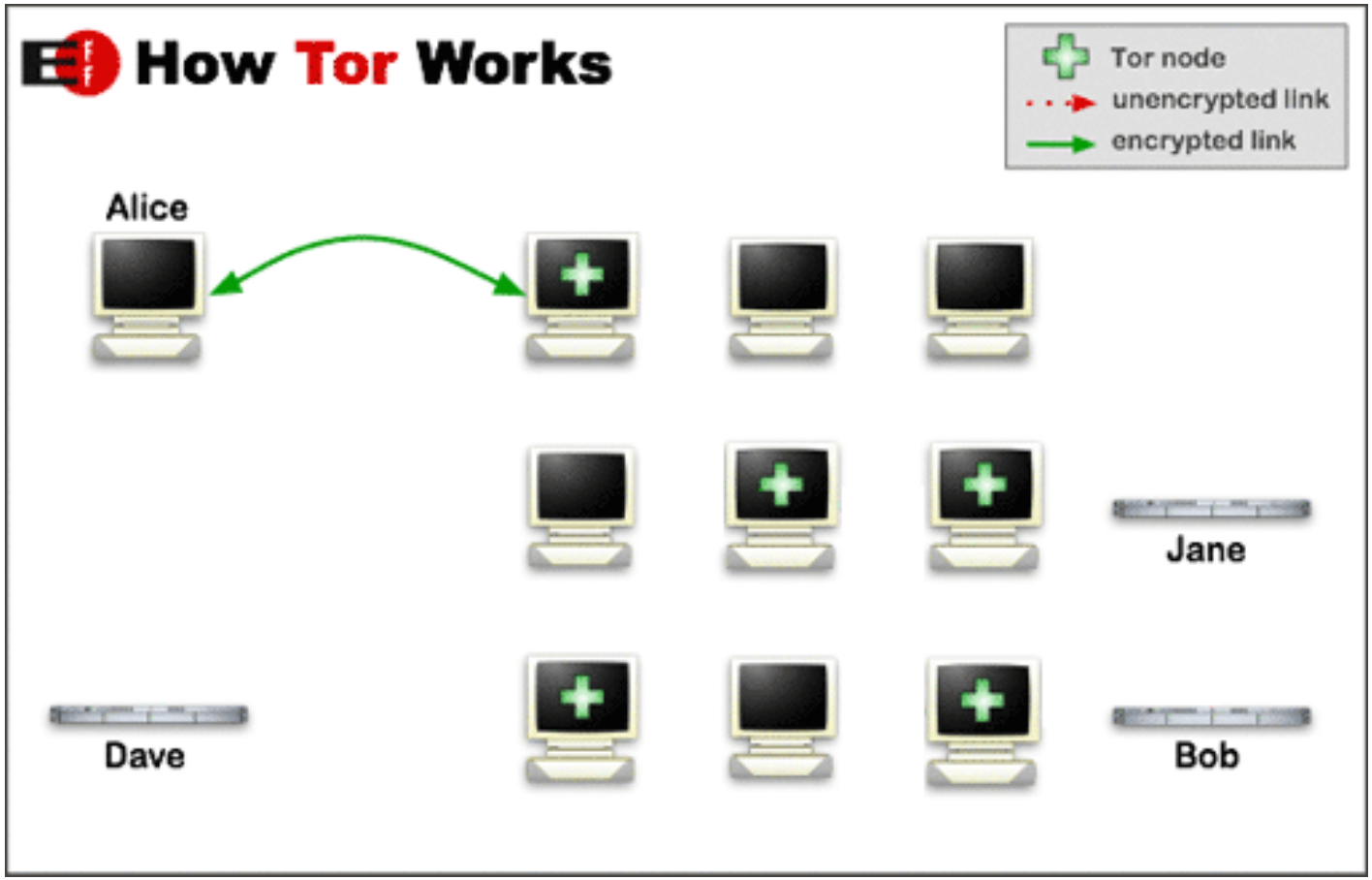

Exchange symmetric key with entry node (Diffie-Hellman)

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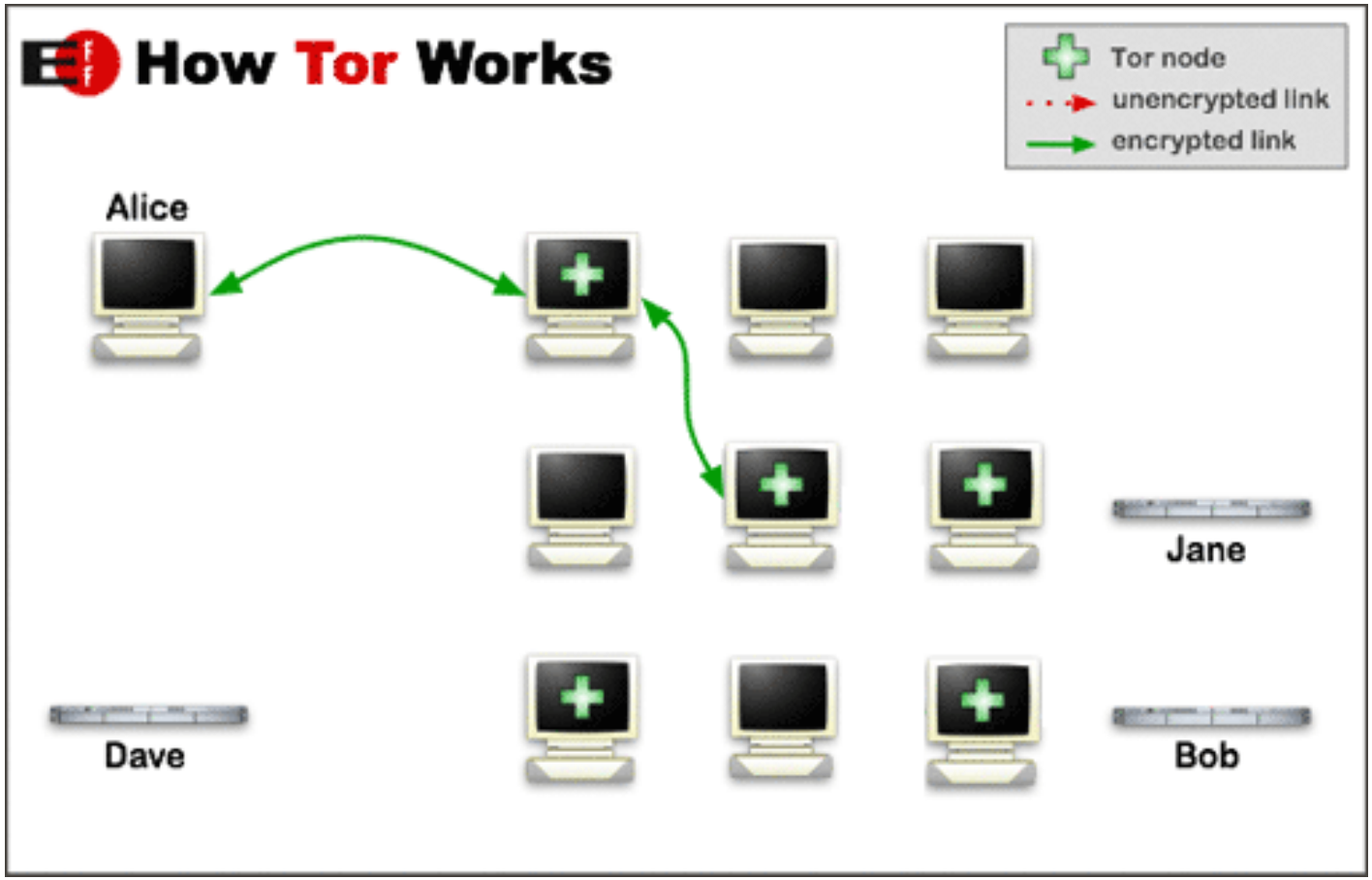

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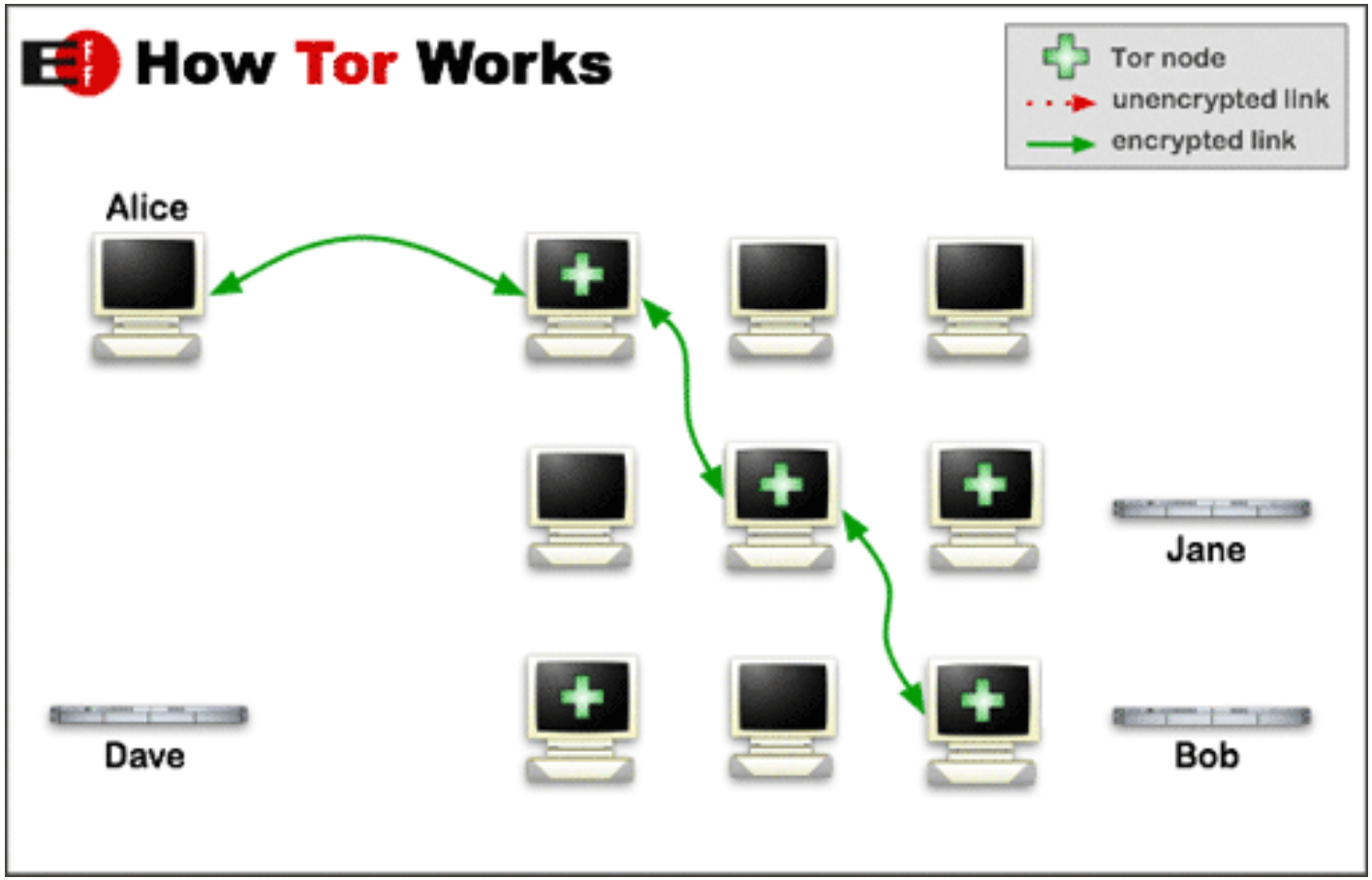

Exchange key with exit node (proxied by entry and guard node!)

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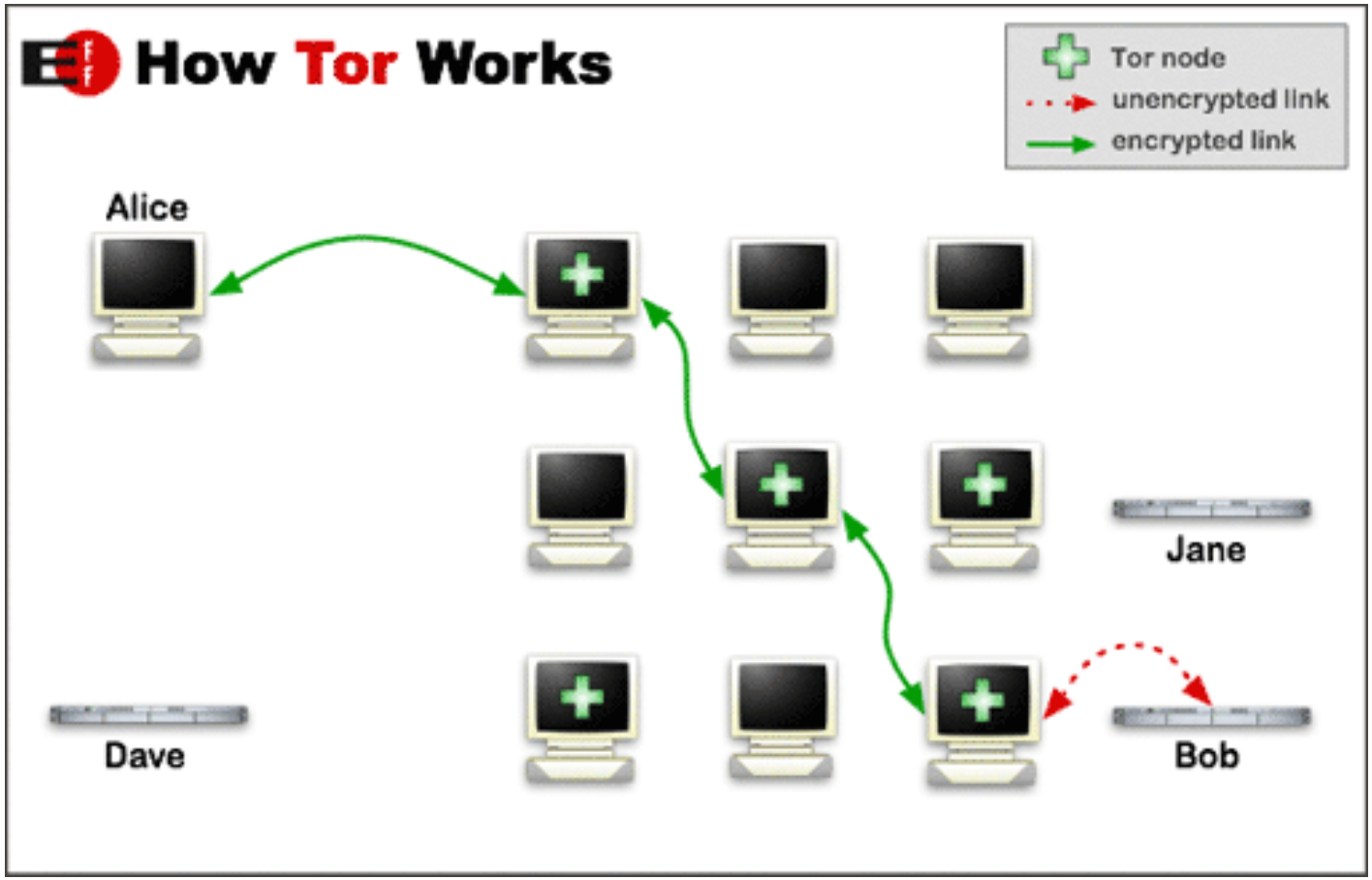

Communicate with Bob (`www.wikileaks.org`)

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- Tor offers anonymity up to the transport layer
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- Tor re-uses an existing circuit for new TCP connections for 10 minutes
- Leaking your IP address to Bittorrent may also de-anonymize your browser session (bad apple attack)!

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- Very controversial discussion ensued... see
  http://blog.fefe.de/?ts=af0134f5

“Tor stinks”

- Snowden leaked NSA slides “Tor stinks” from 2007
- Quotes from these slides:

  “We will never be able to de-anonymize all Tor users all the time.”

  *“With manual analysis we can de-anonymize a **very small fraction** of Tor users, however **no** success de-anonymizing a user in response to a TOPI request/on demand.”*

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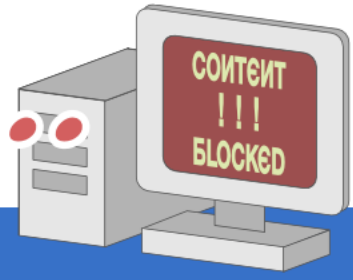
- Pluggable Transport API allows communication between ofuscator and Tor client

★ YOU ★

Can Help Protect

Freedom Of Speech

Online...



Run a

TOR RELAY

Today!

★ ★ TorProject.org ★ ★