

A SIMPLE INTRODUCTION TO TOR

The Onion Router

Fabrizio d'Amore

Privacy on Public Networks

- Internet is designed as a public network
 - Wi-Fi access points, network routers see all traffic that passes through them
- Routing information is public
 - IP packet headers identify source and destination
 - Even a passive observer can easily figure out who is talking to whom
- Encryption does not hide identities
 - Encryption hides payload, but not routing information
 - Even IP-level encryption (tunnel-mode IPsec/ESP) reveals IP addresses of IPsec gateways

Anonymity

- Anonymity = the person is not identifiable within a set of subjects
 - You cannot be anonymous by yourself!
 - Big difference between anonymity and confidentiality
 - Hide your activities among others' similar activities
- Unlinkability of action and identity
 - For example, sender and his email are no more related after adversary's observations than they were before
- Unobservability (hard to achieve)
 - Adversary can't even tell whether someone is using a particular system and/or protocol

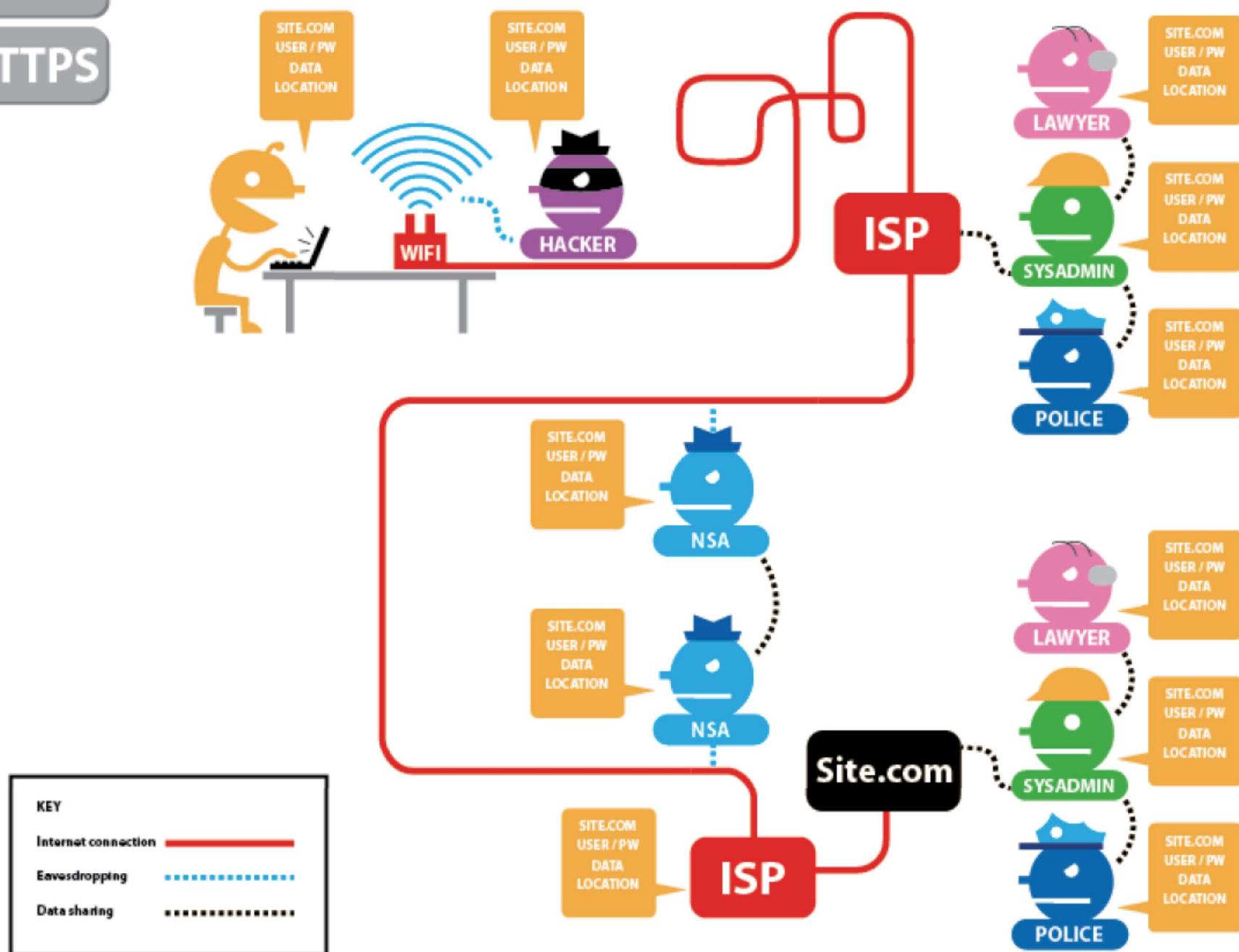
Attacks on Anonymity

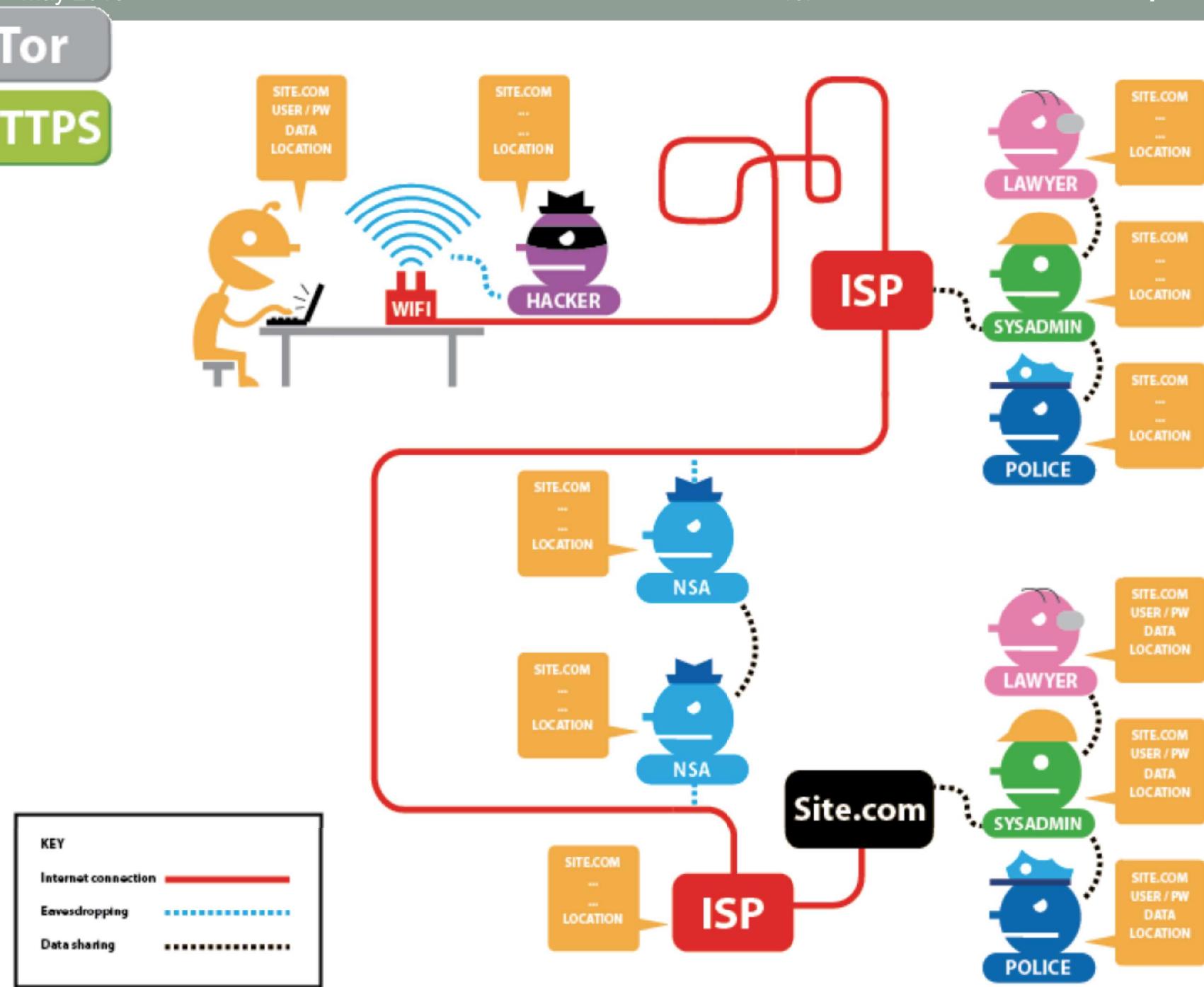
- Passive traffic analysis
 - Infer from network traffic who is talking to whom
- Active traffic analysis
 - Inject packets or put a timing signature on packet flow
- Compromise of network nodes
 - Attacker may compromise some routers
 - It is not obvious which nodes have been compromised
 - Attacker may be passively logging traffic
 - Better not to trust any individual router
 - Can assume that some fraction of routers is good, but don't know which

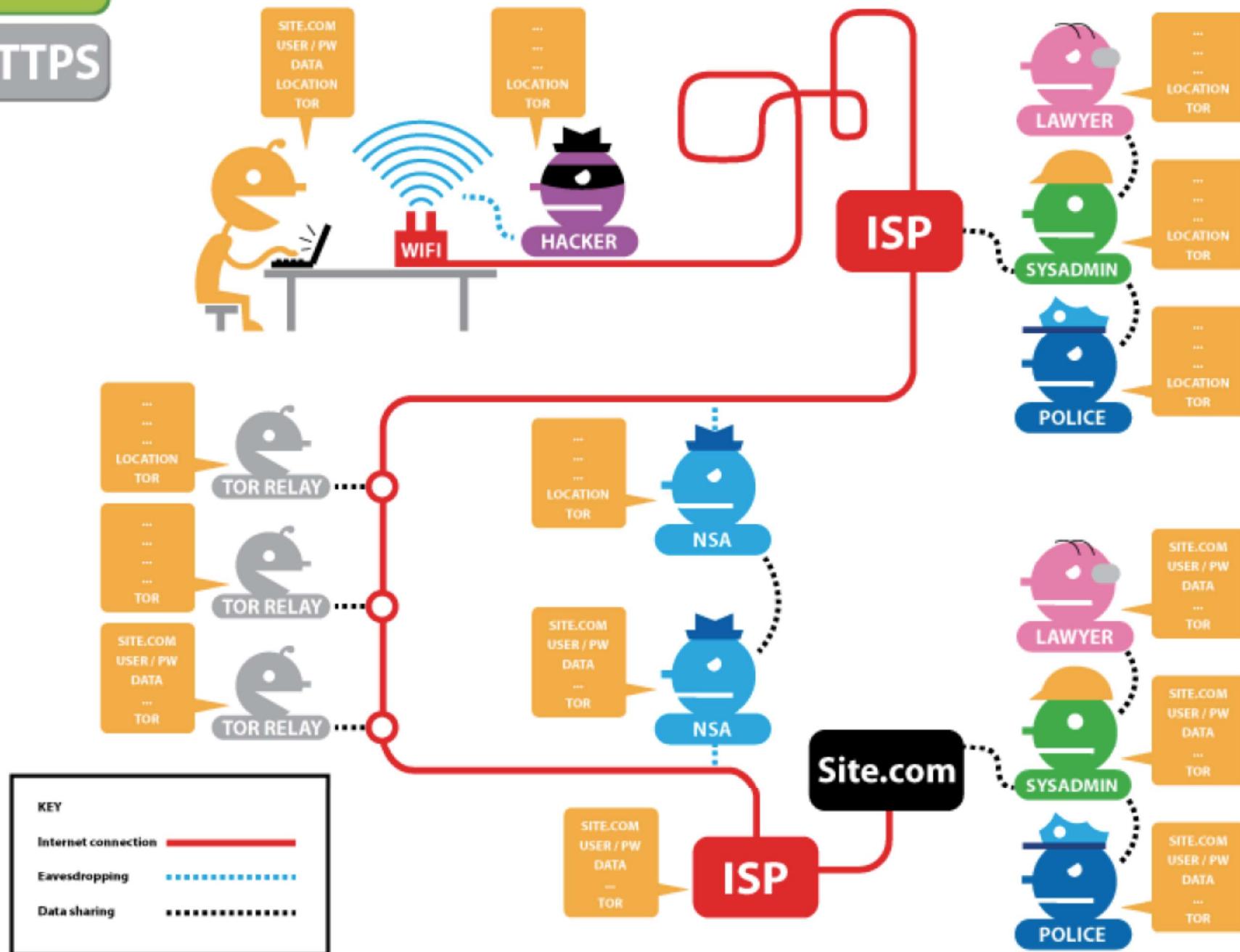
Tor

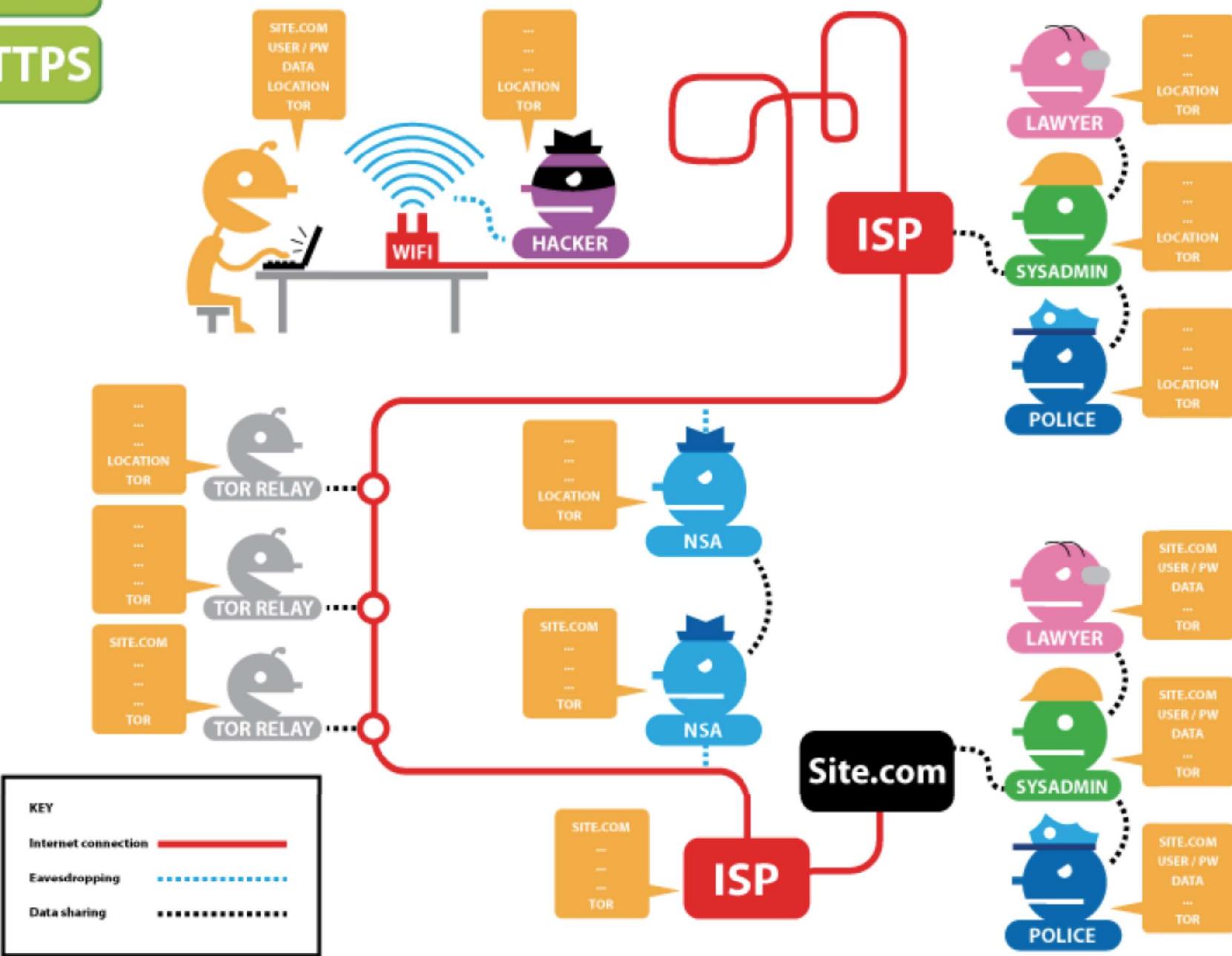
- Deployed onion routing network
 - <http://torproject.org>
 - Specifically designed for low-latency anonymous Internet communications
- Running since October 2003
 - Thousands of relay nodes, 100K-500K? of users
- Easy-to-use client proxy, integrated Web browser
- Tor is a distributed anonymous communication service using an overlay network that allows people and groups to improve their privacy and security on the Internet.
- Individuals use Tor to keep websites from tracking them, or to connect to those internet services blocked by their local Internet providers.
- Tor's hidden services let users publish web sites and other services without needing to reveal the location of the site.



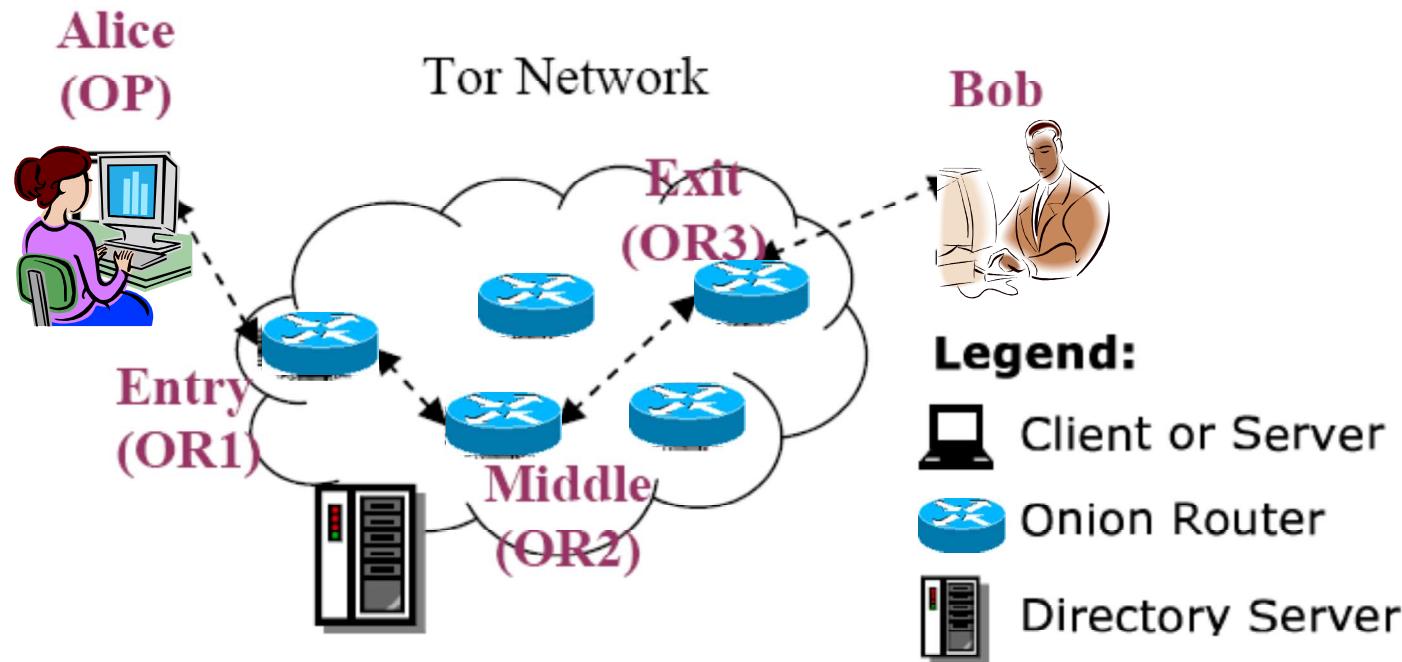
Tor**HTTPS**



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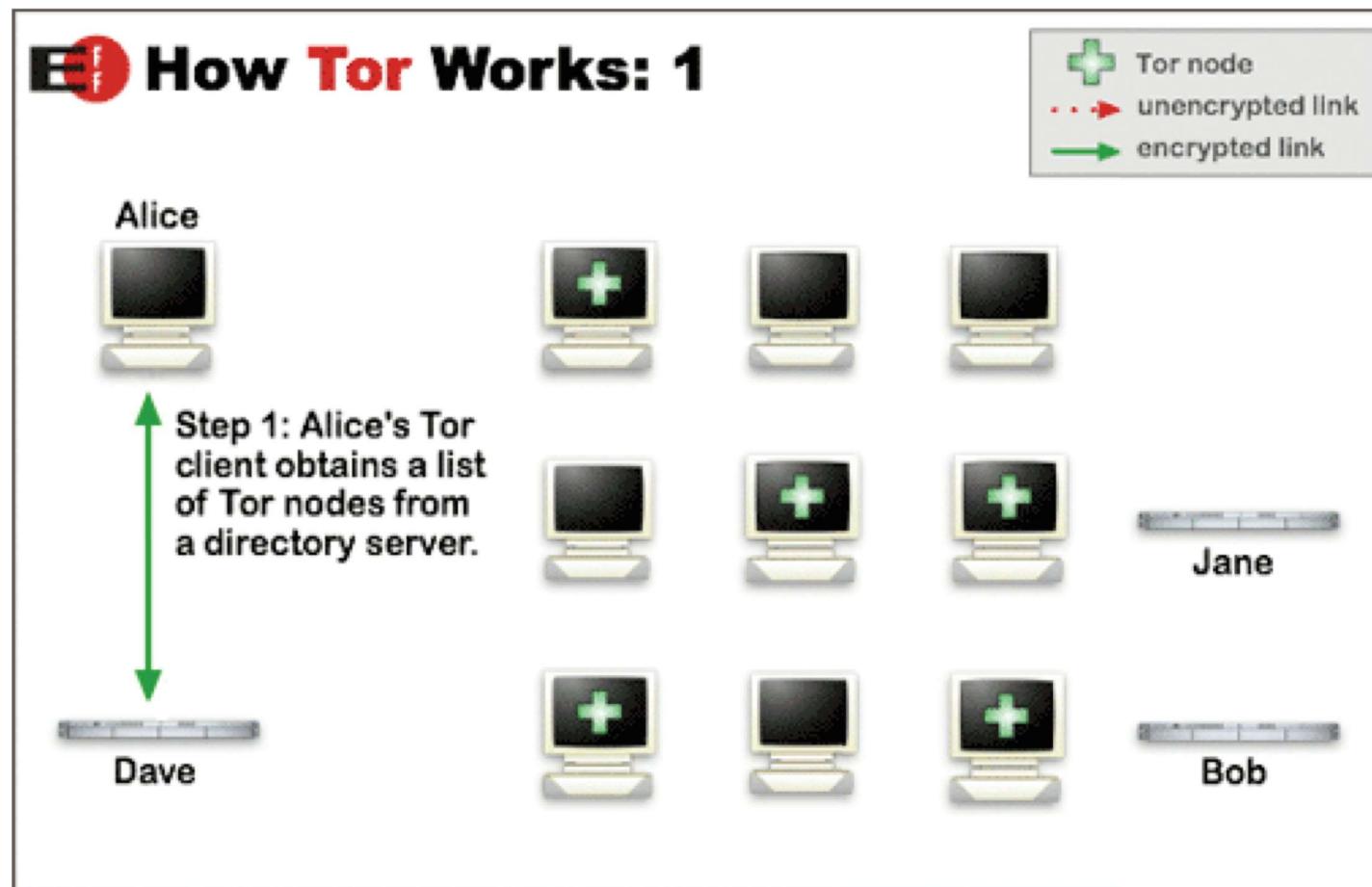
Tor**HTTPS**

Components of Tor

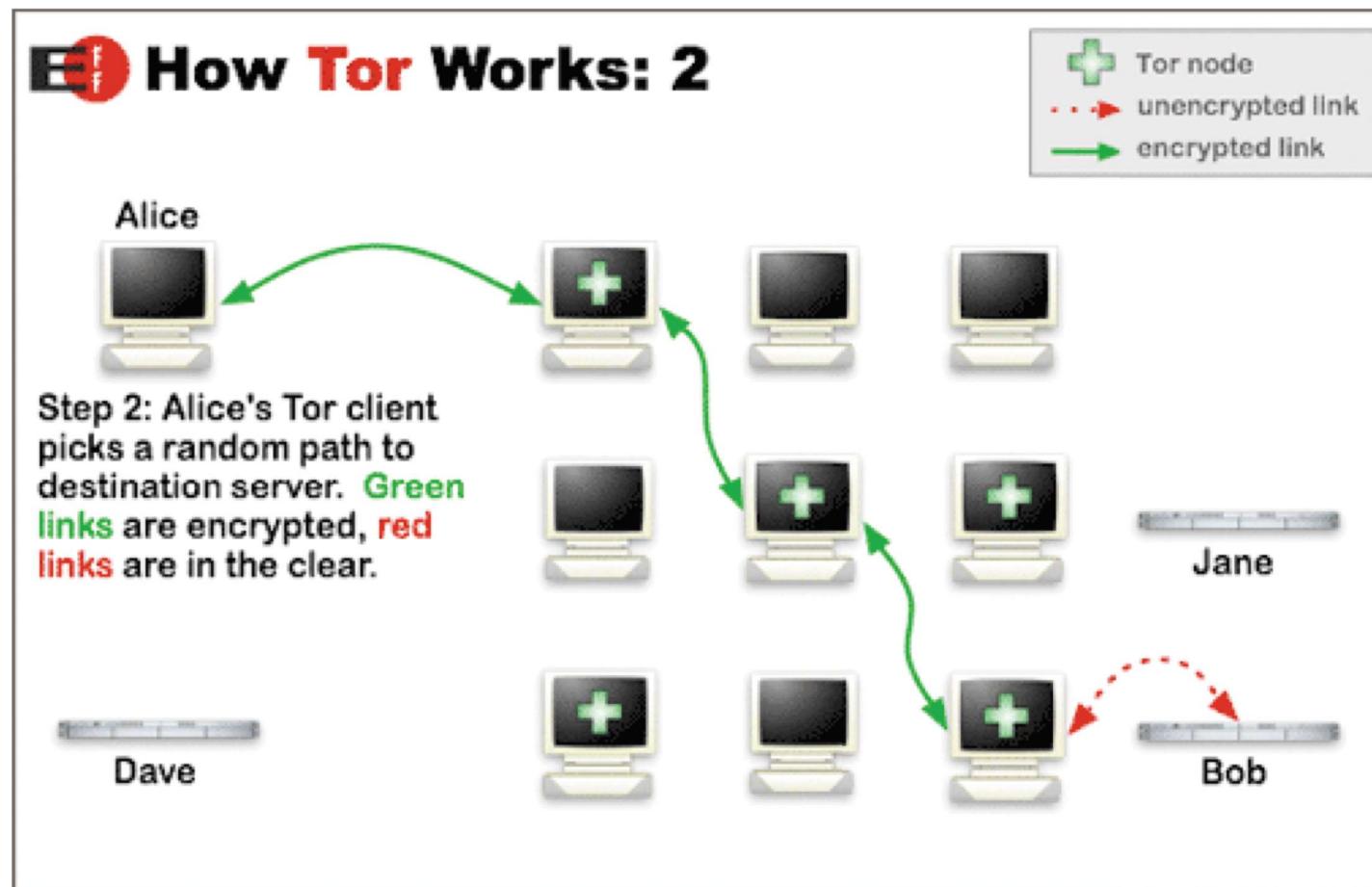


- **Client:** the user of the Tor network
- **Server:** the target TCP applications such as web servers
- **Tor (onion) router:** the special proxy relays the application data
- **Directory server:** servers holding Tor router information

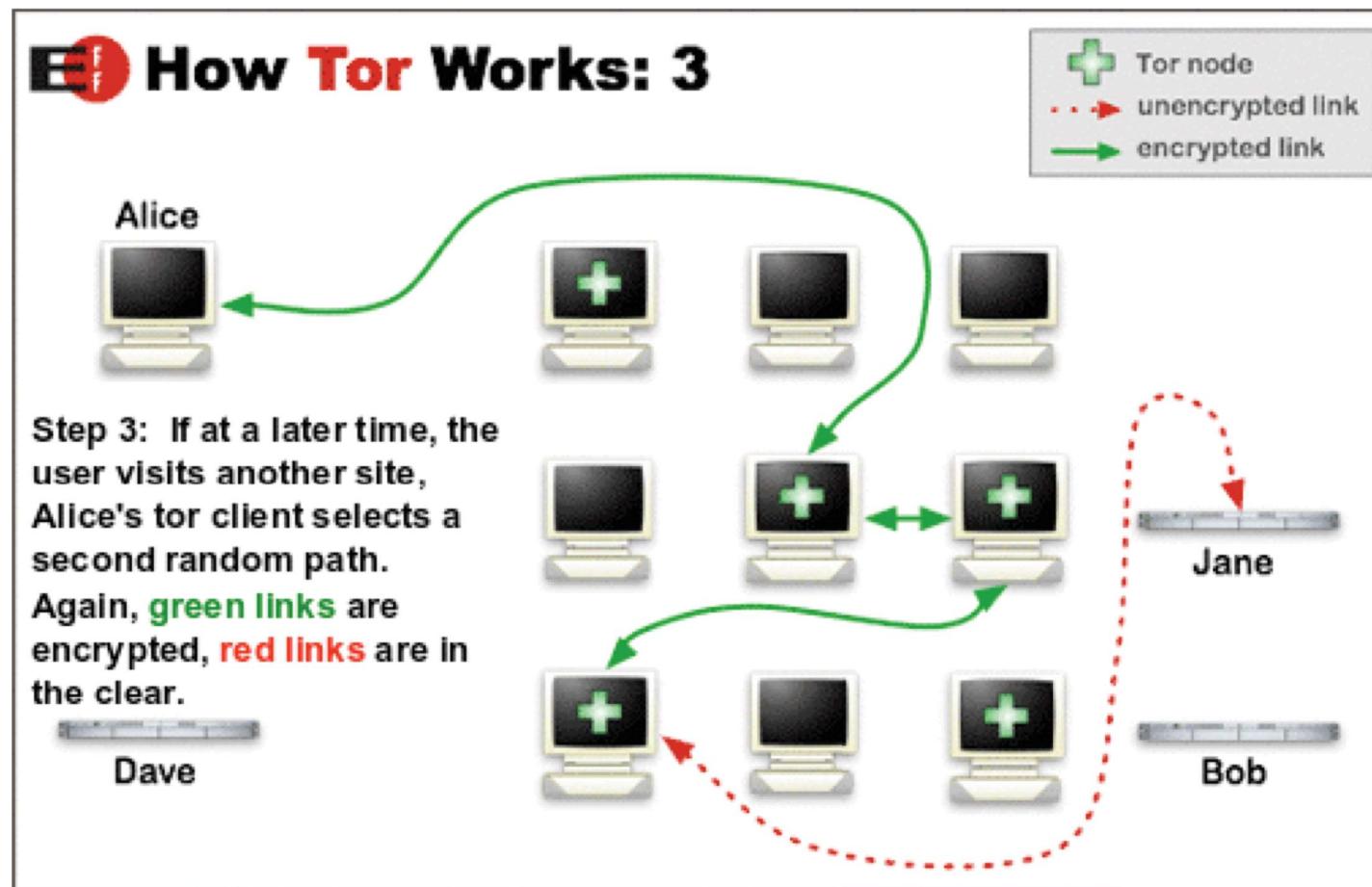
Tor operations 1



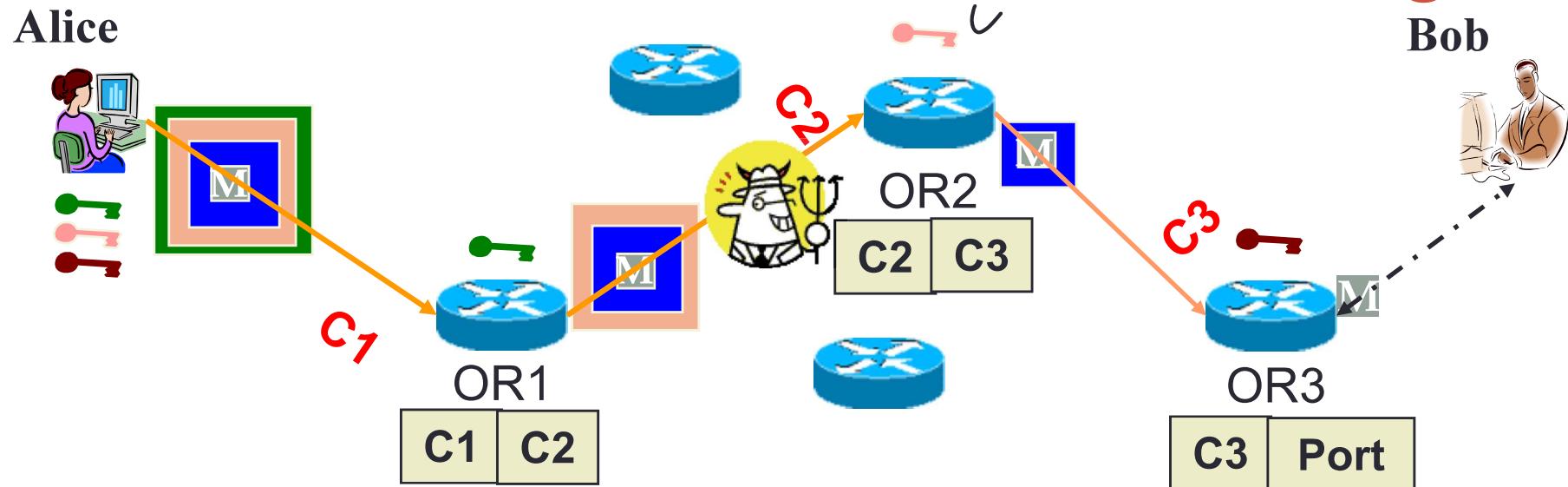
Tor operations 2



Tor operations 3

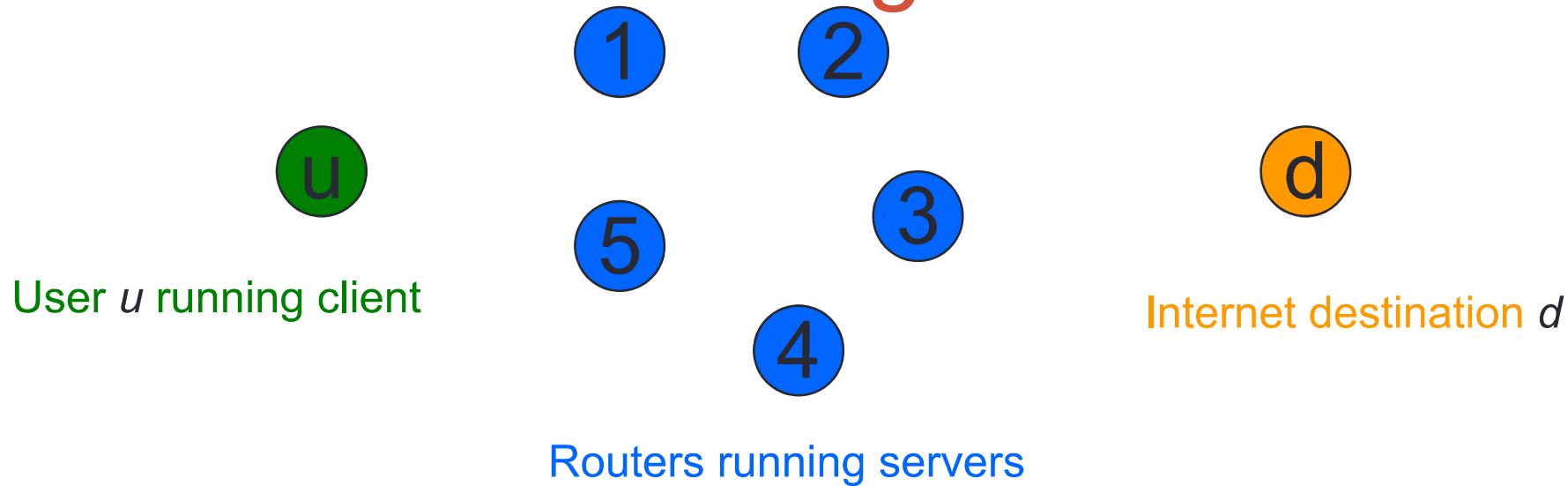


How Tor Works? --- Onion Routing

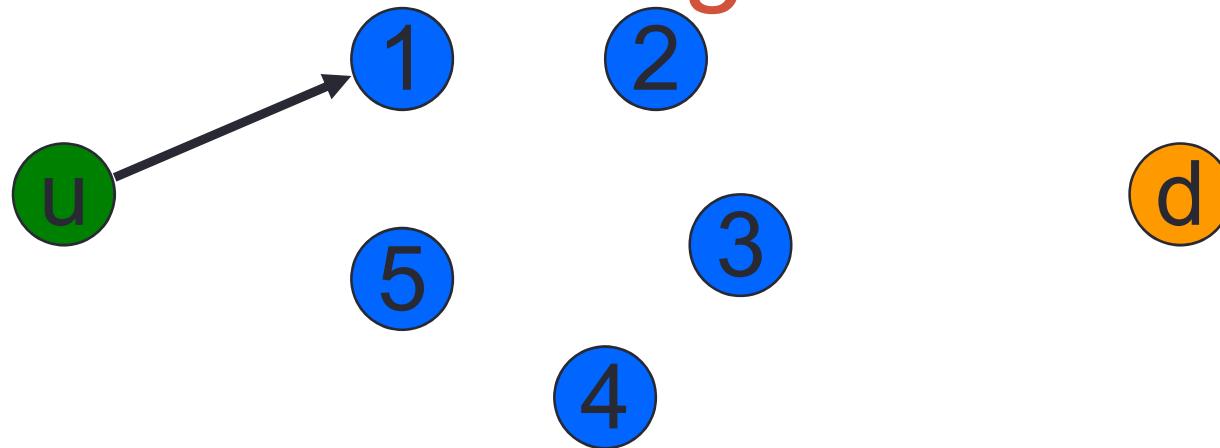


- A circuit is built incrementally one hop by one hop
- Onion-like encryption
 - Alice negotiates an AES key with each router
 - Messages are divided into equal sized cells
 - Each router knows only its predecessor and successor
 - Only the Exit router (OR3) can see the message, however it does not know where the message is from

How Onion Routing Works

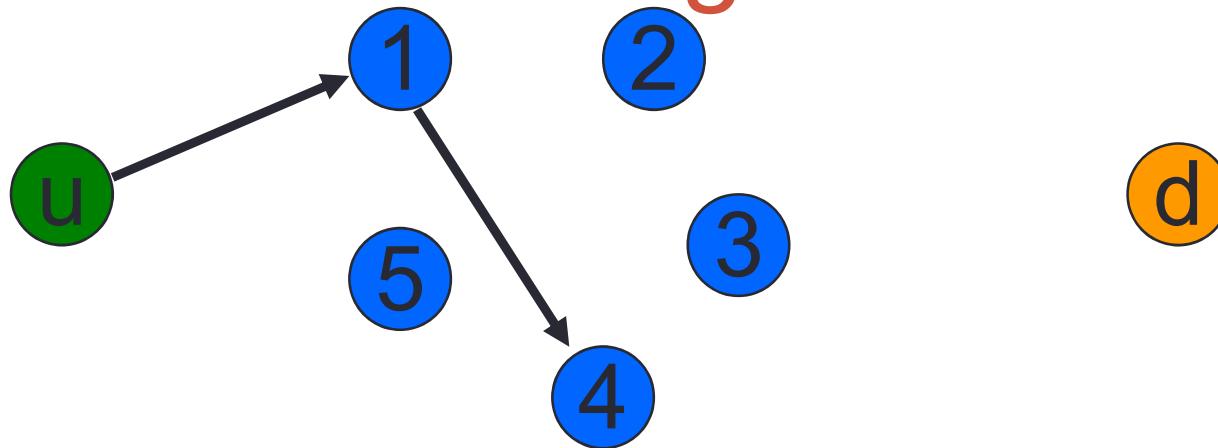


How Onion Routing Works



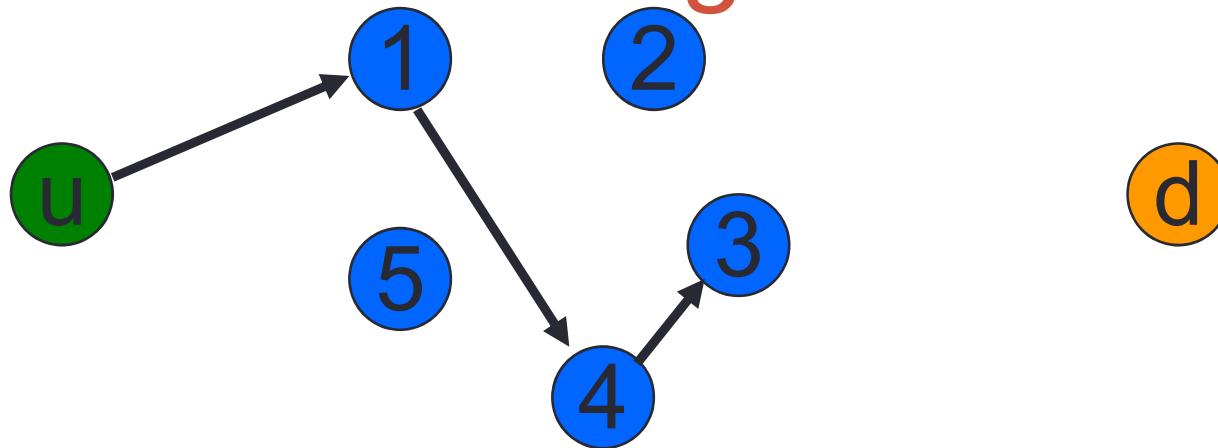
1. u creates l -hop circuit through routers

How Onion Routing Works



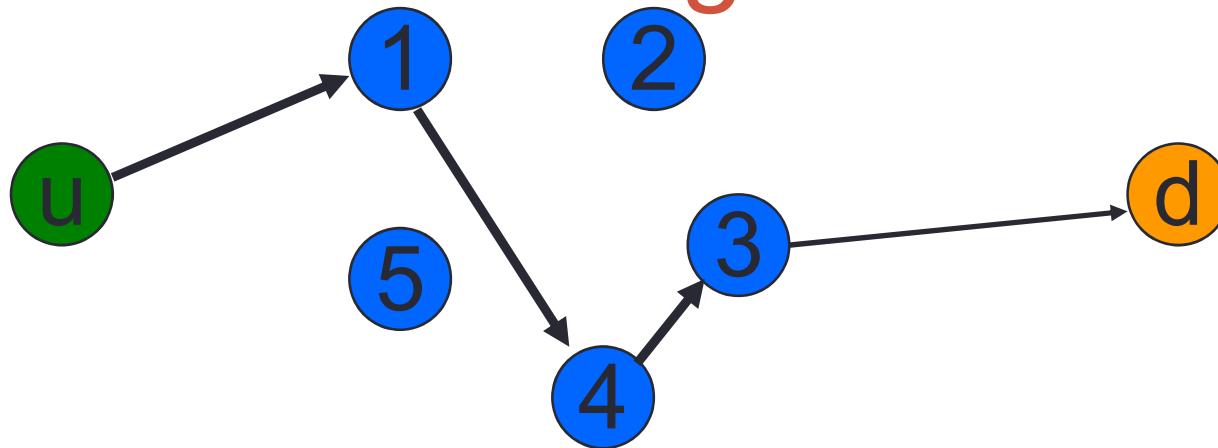
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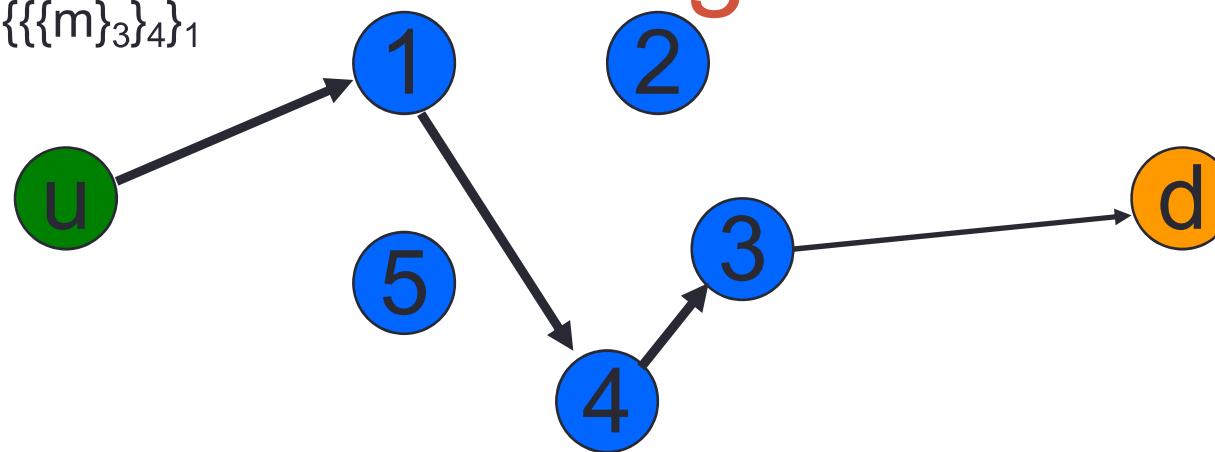
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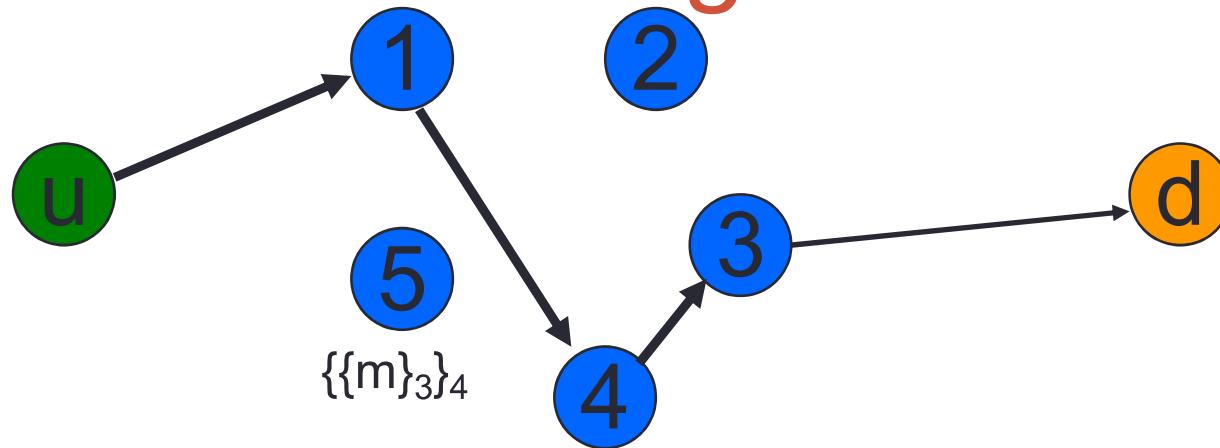
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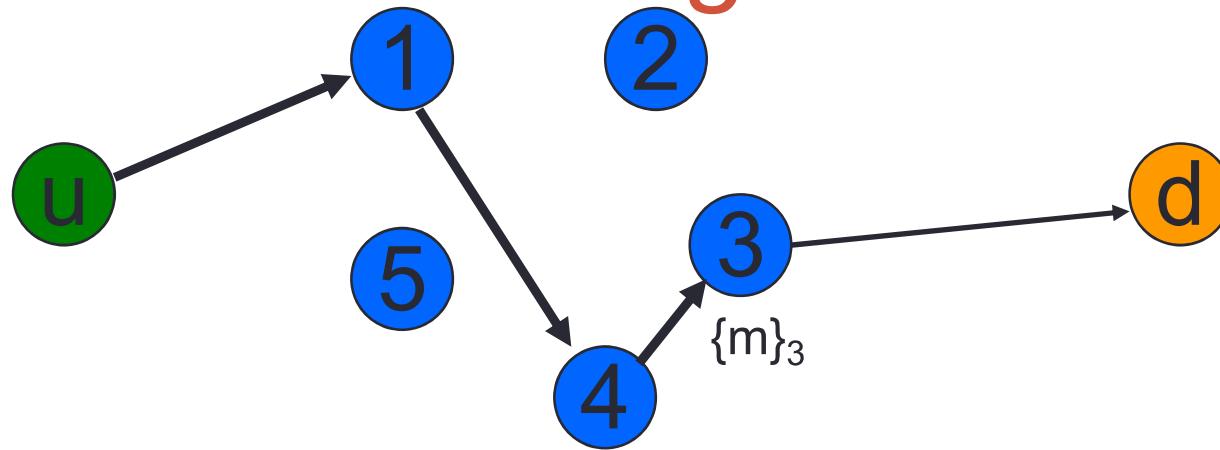
1. u creates l -hop circuit through routers
2. u opens a stream in the circuit to d
3. Data are exchanged

How Onion Routing Works



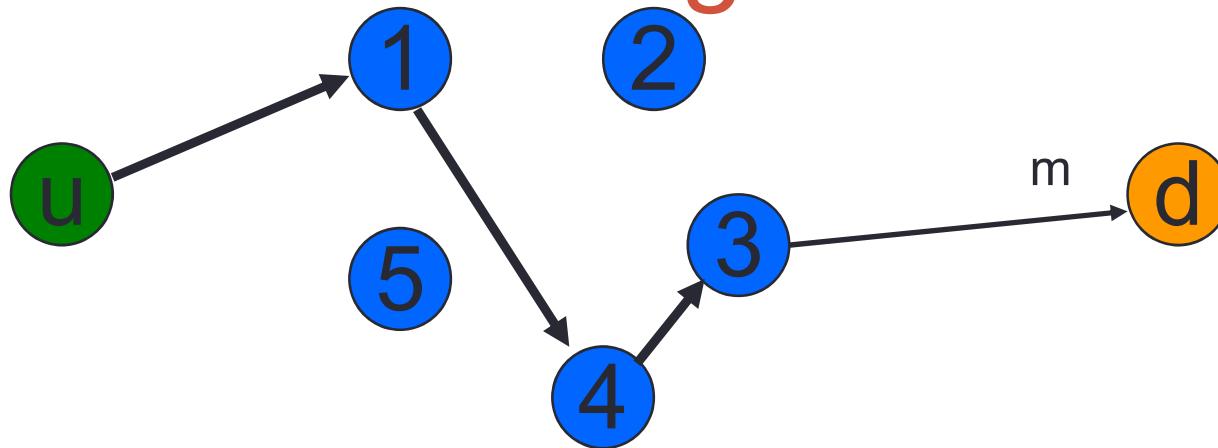
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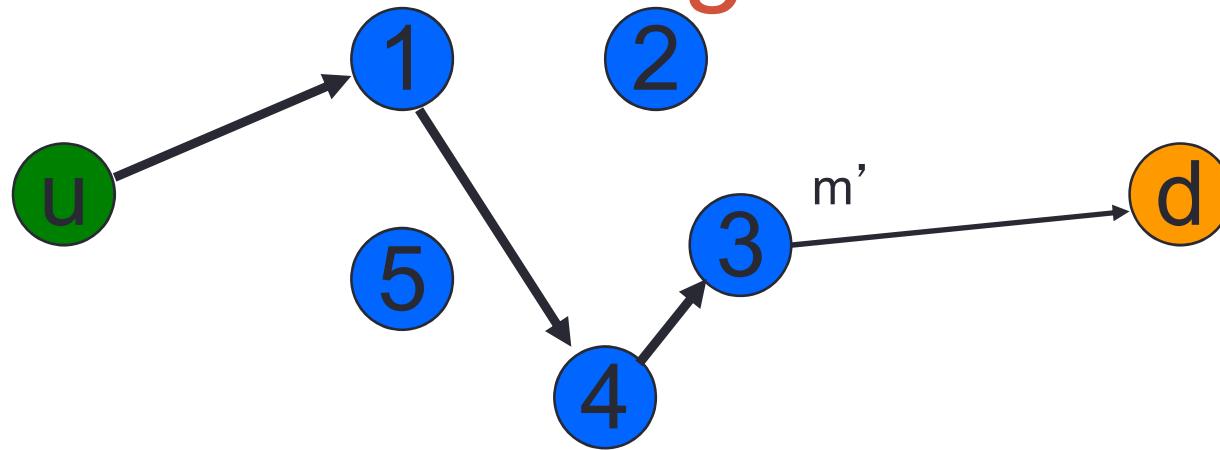
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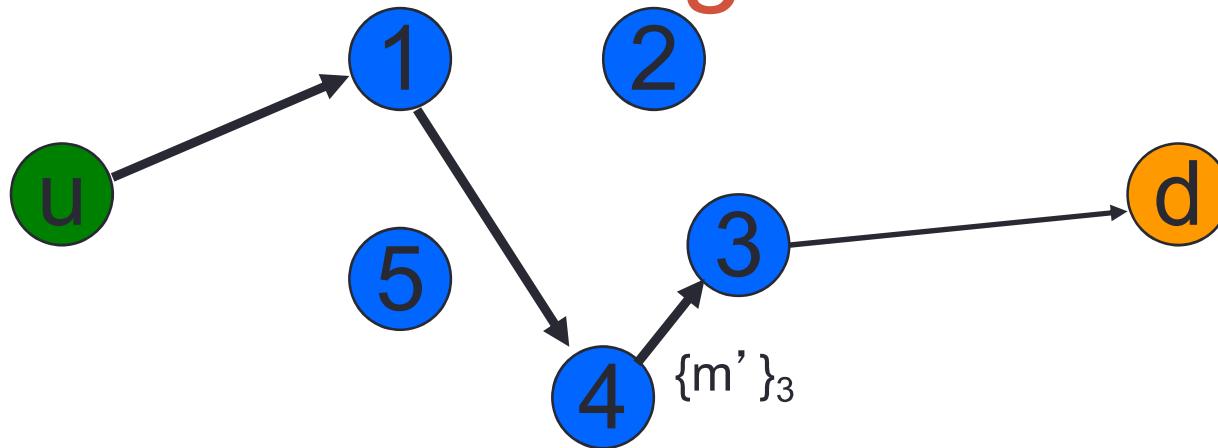
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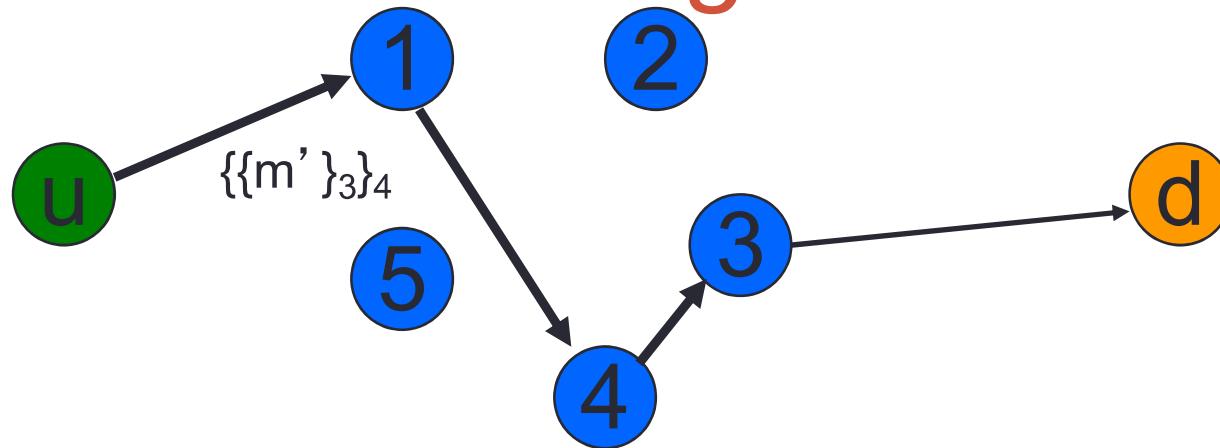
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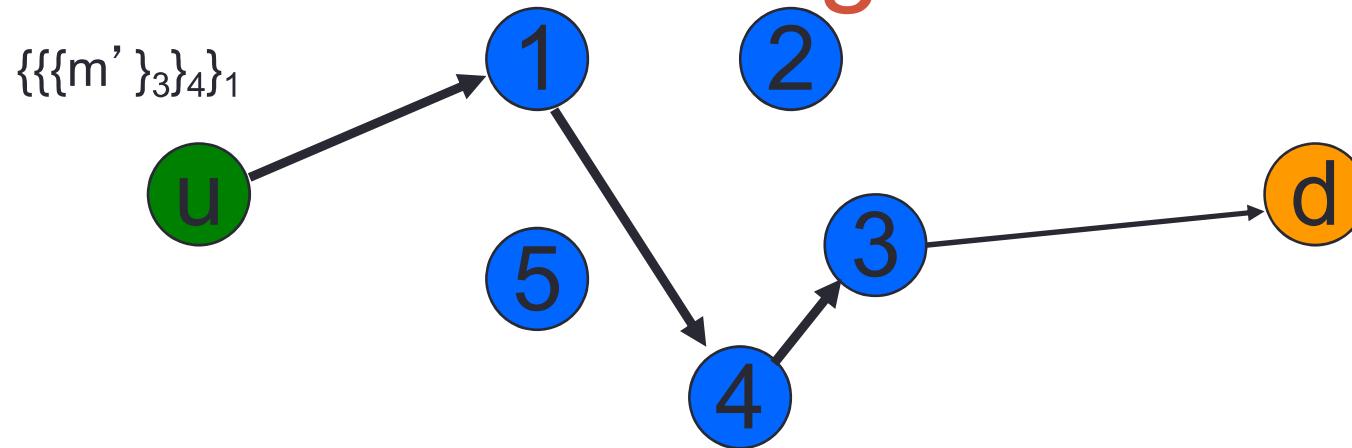
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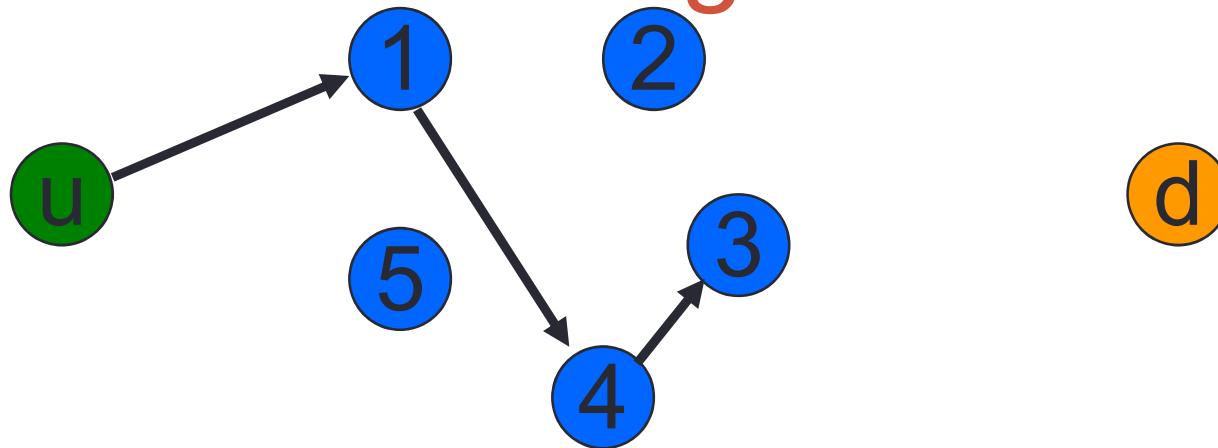
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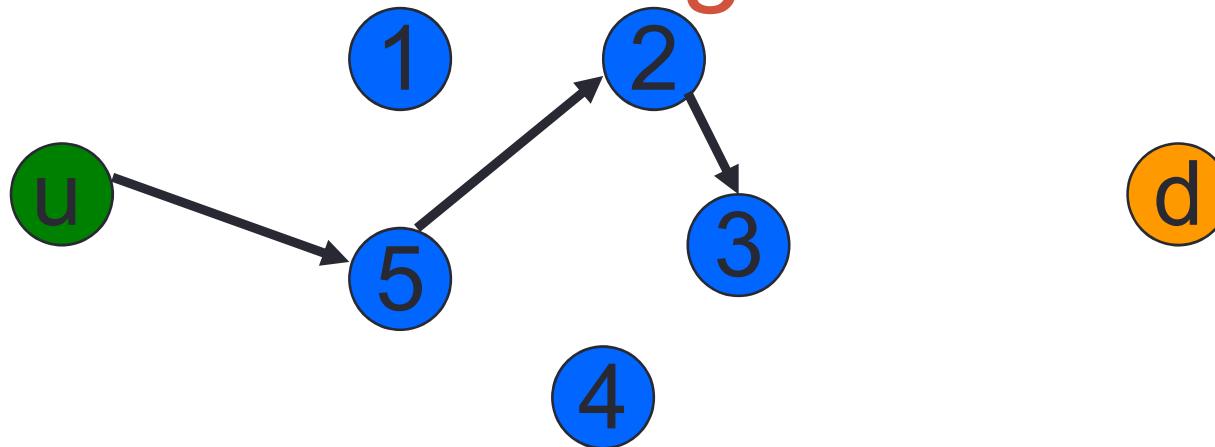
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How Onion Routing Works



1. u creates l -hop circuit through routers
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3. Data are exchanged.
4. Stream is closed.

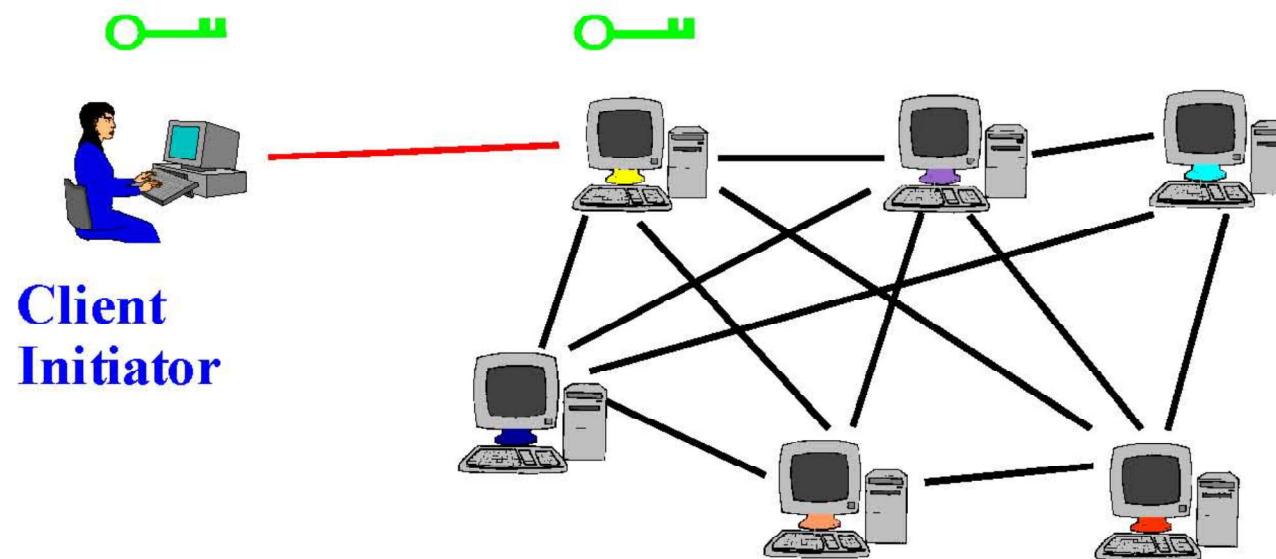
How Onion Routing Works



1. u creates l -hop circuit through routers
2. u opens a stream in the circuit to d
3. Data are exchanged.
4. Stream is closed.
5. Circuit is changed every few minutes.

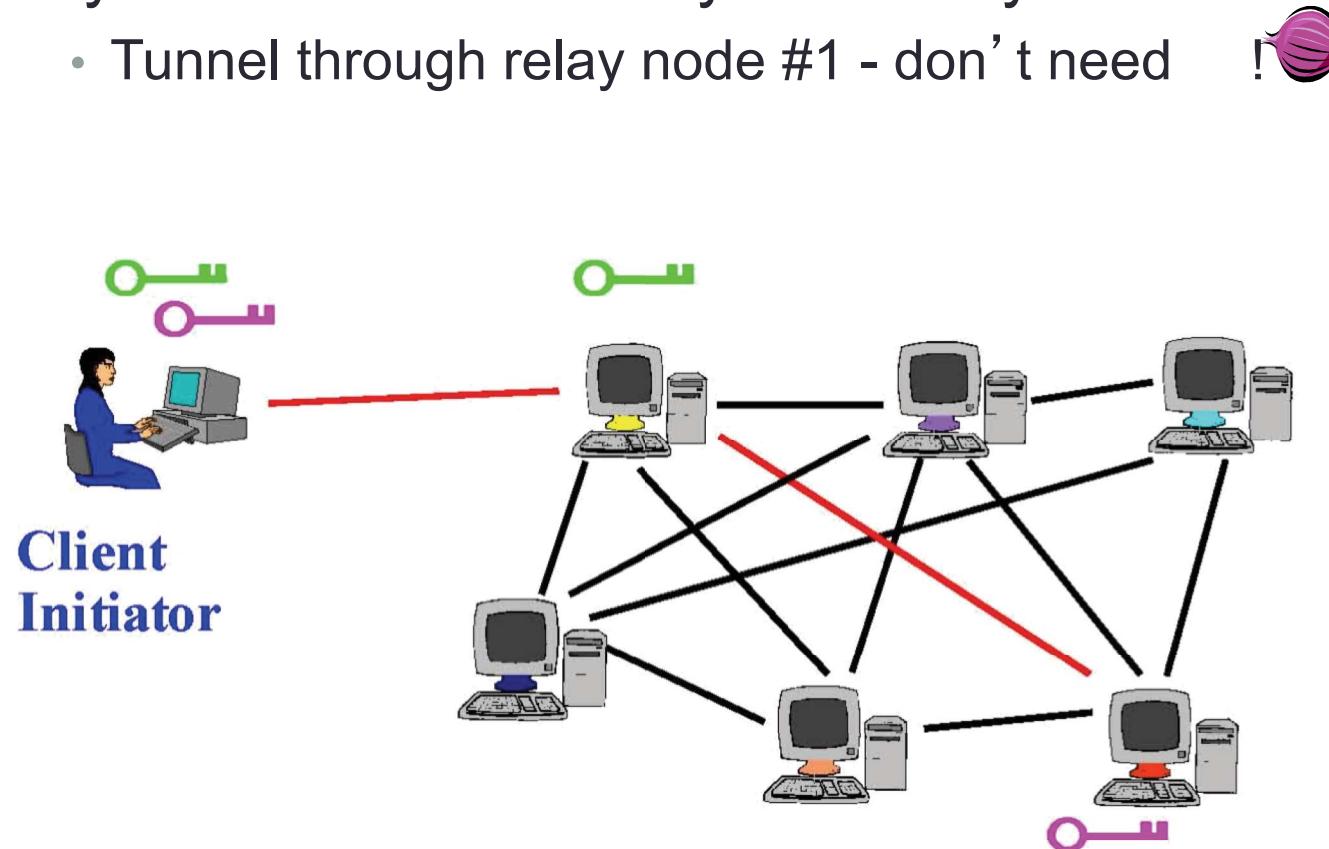
Tor Circuit Setup (1)

- Client proxy establish a symmetric session key and circuit with relay node #1



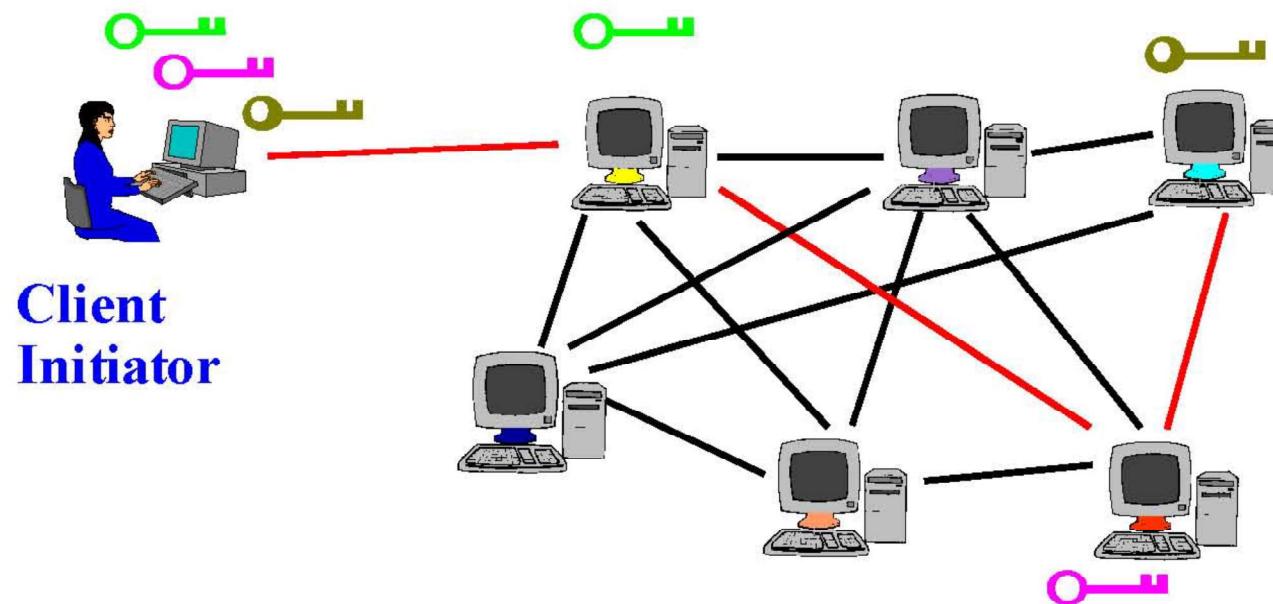
Tor Circuit Setup (2)

- Client proxy extends the circuit by establishing a symmetric session key with relay node #2
 - Tunnel through relay node #1 - don't need !



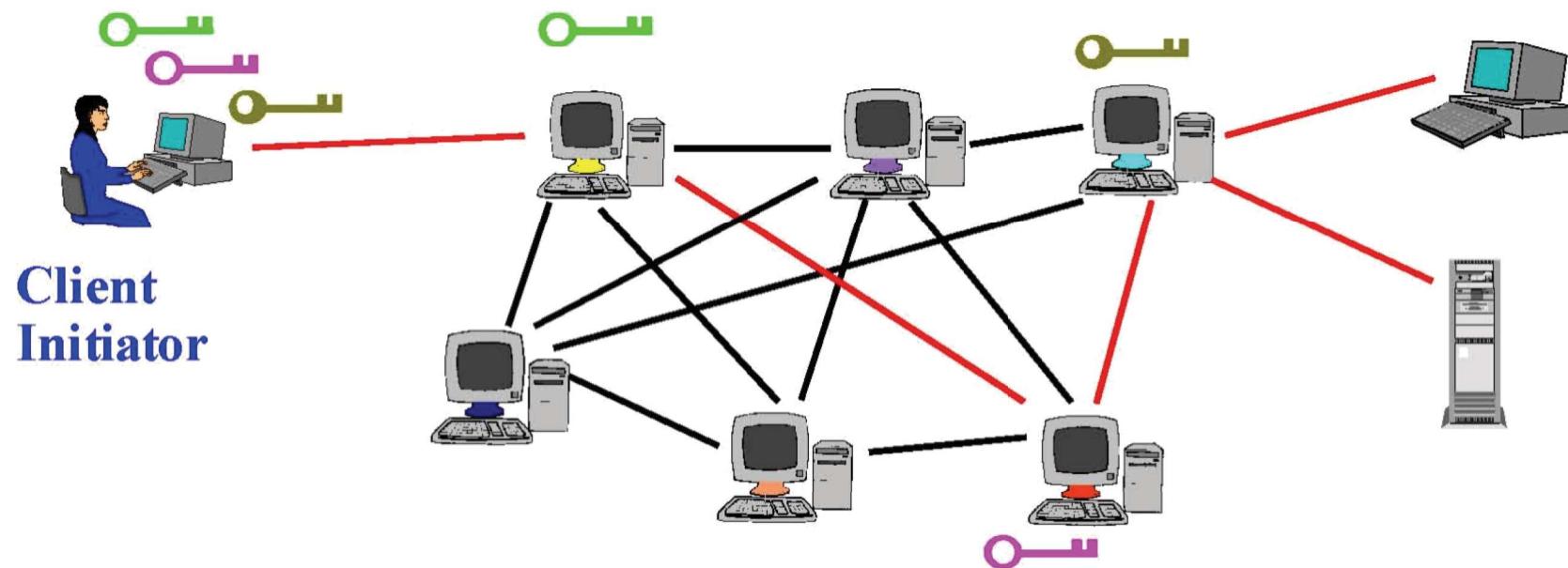
Tor Circuit Setup (3)

- Client proxy extends the circuit by establishing a symmetric session key with relay node #3
 - Tunnel through relay nodes #1 and #2



Using a Tor Circuit

- Client applications connect and communicate over the established Tor circuit
 - Datagrams decrypted and re-encrypted at each link



Additional functionality

- Integrity checking
 - Only done at the edges of a stream
 - SHA-1 digest of data sent and received
 - First 4 bytes of digest are sent with each message for verification
- OR-to-OR congestion might happen if too many users choose the same OR-to-OR connection.
- Circuit Level throttling
 - 2 windows keep track of relay data to be transmitted to other ORs (packaging window) and data transmitted out of the network (delivery window)
 - Windows are decremented after forwarding packets and increments on a relay sendme message towards OP with streamID zero.
 - When a window reaches 0, no messages are forwarded

Design

- Overlay network on the user level
- Onion Routers (OR) route traffic
- Onion Proxy (OP) fetches directories and creates virtual circuits on the network on behalf of users.
- Uses TCP with TLS
- All data is sent in fixed size (bytes) cells

Using Tor

- Many applications can share one circuit
 - Multiple TCP streams over one anonymous connection
- Tor router doesn't need root privileges
 - Encourages people to set up their own routers
 - More participants = better anonymity for everyone
- Directory servers
 - Maintain lists of active relay nodes, their locations, current public keys, etc.
 - Control how new nodes join the network
 - “Sybil attack”: attacker creates a large number of relays
 - Directory servers' keys ship with Tor code

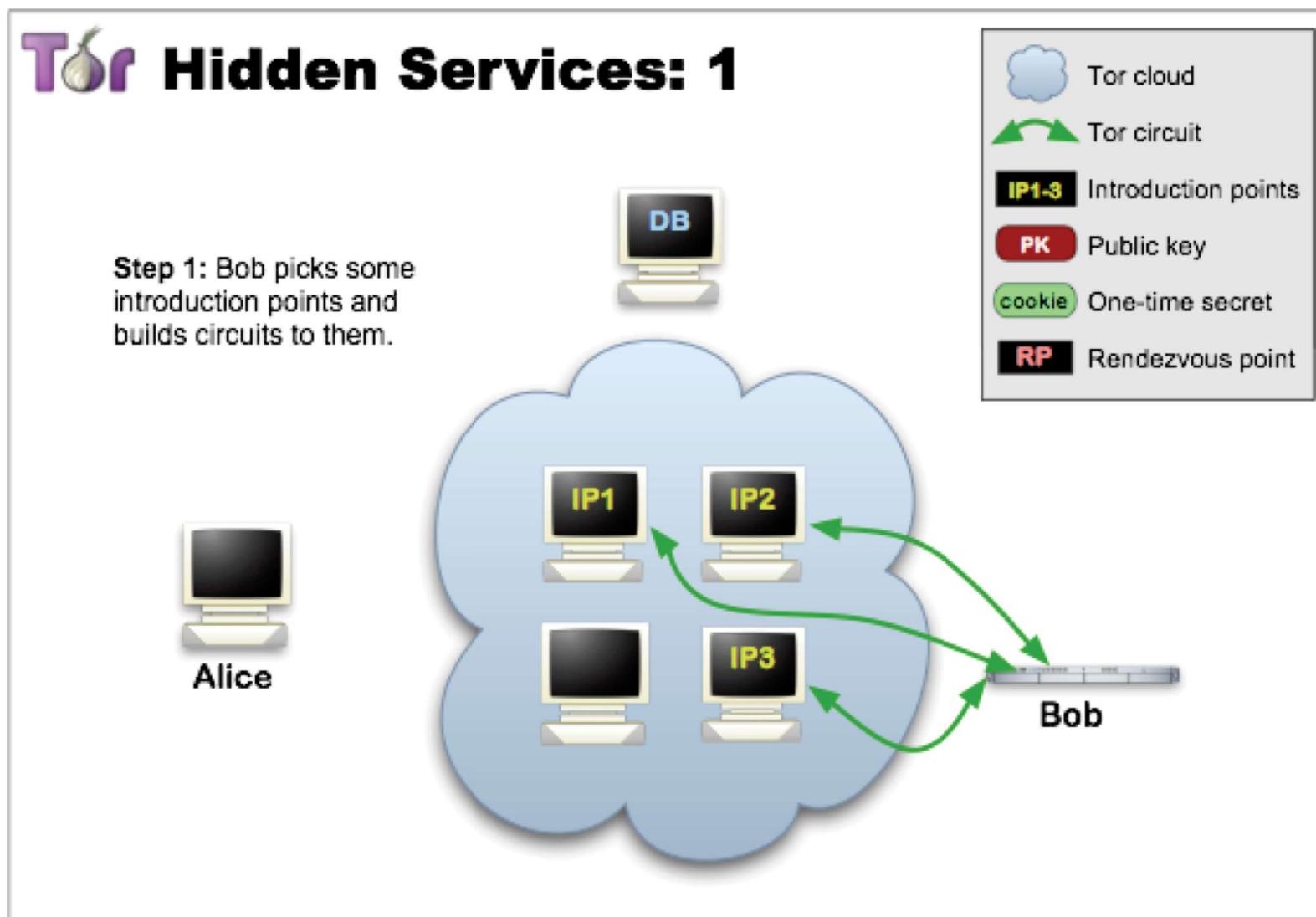
Hidden Services

- Goal: deploy a server on the Internet that anyone can connect to without knowing where it is or who runs it
- Accessible from anywhere
- Resistant to censorship, denial of service, physical attack
 - Network address of the server is hidden, thus can't find the physical server

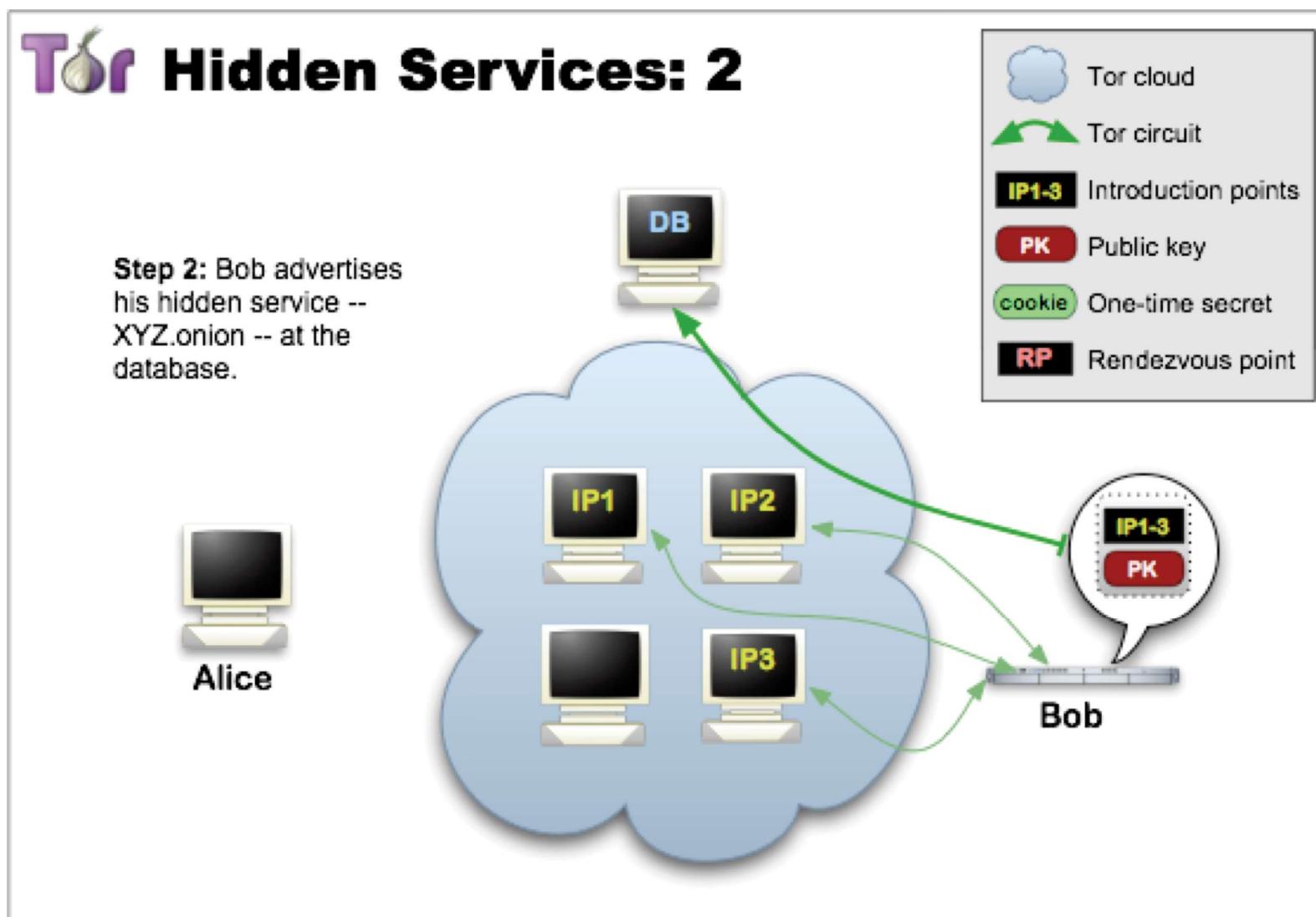
Hidden Service and Rendezvous Points

- Location-hidden services allow Bob to offer a TCP service without revealing his IP address.
- Tor accommodates receiver anonymity by allowing location hidden services
- Design goals for location hidden services
 - Access Control: filtering incoming requests (against flooding)
 - Robustness: maintain a long-term pseudonymous identity (ability to migrate service across Ors)
 - Smear-resistance: social attacker should not be able to “frame” a rendezvous router by offering an illegal location-hidden service and making observers believe the router created that service
 - Application transparency: same unmodified application
- Location hidden service leverage rendezvous points

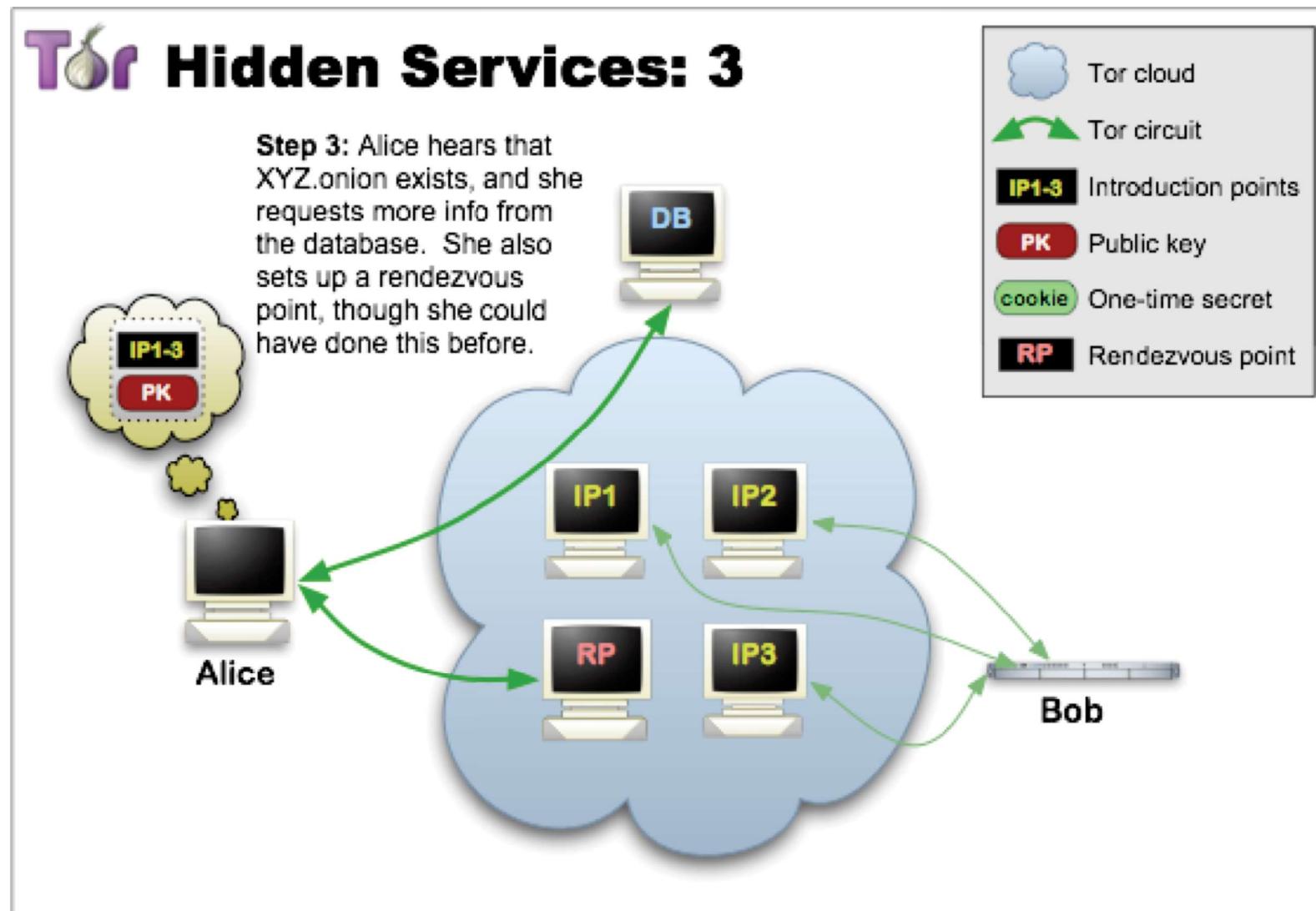
Setting up a hidden service 1



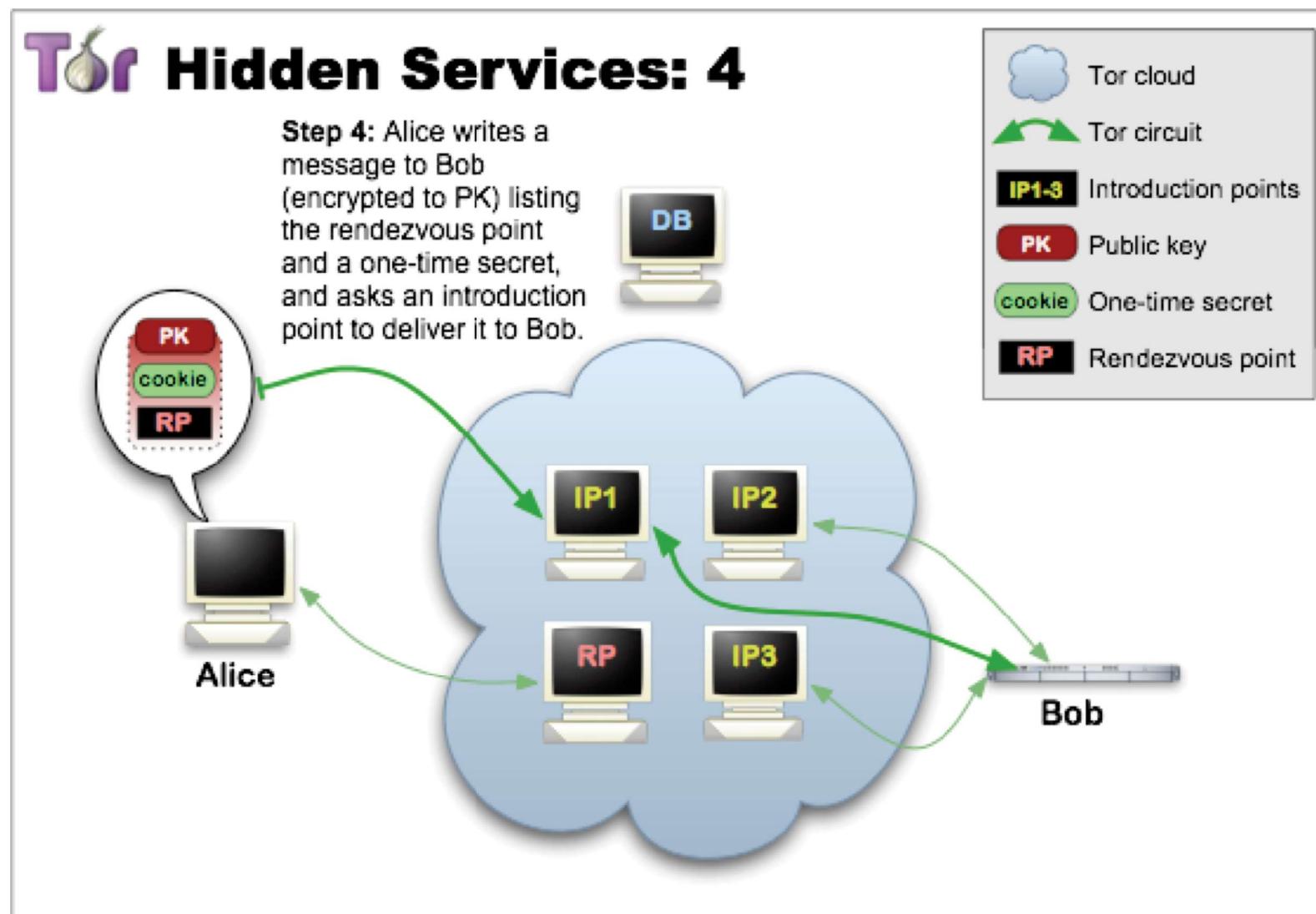
Setting up a hidden service 2



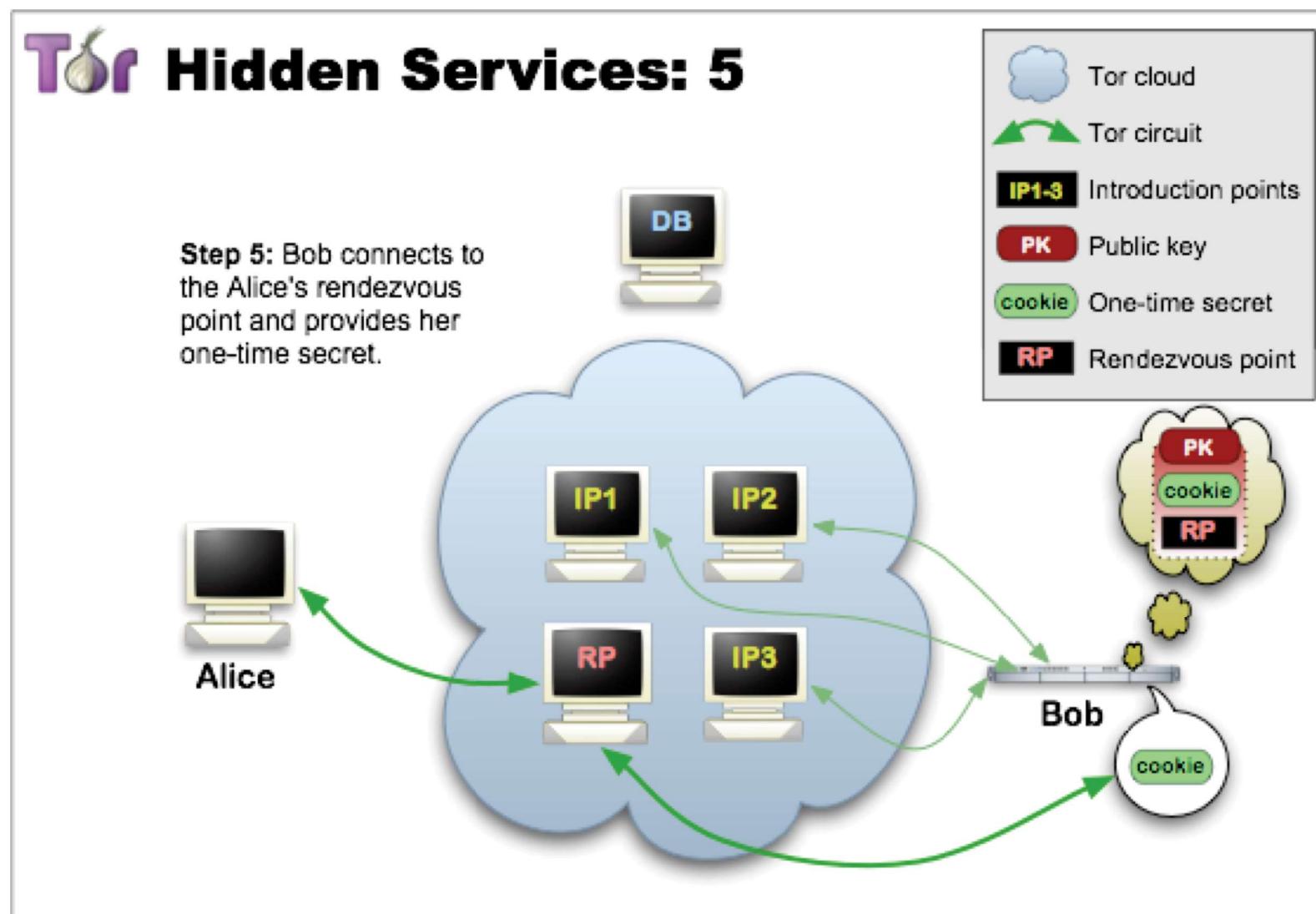
Setting up a hidden service 3



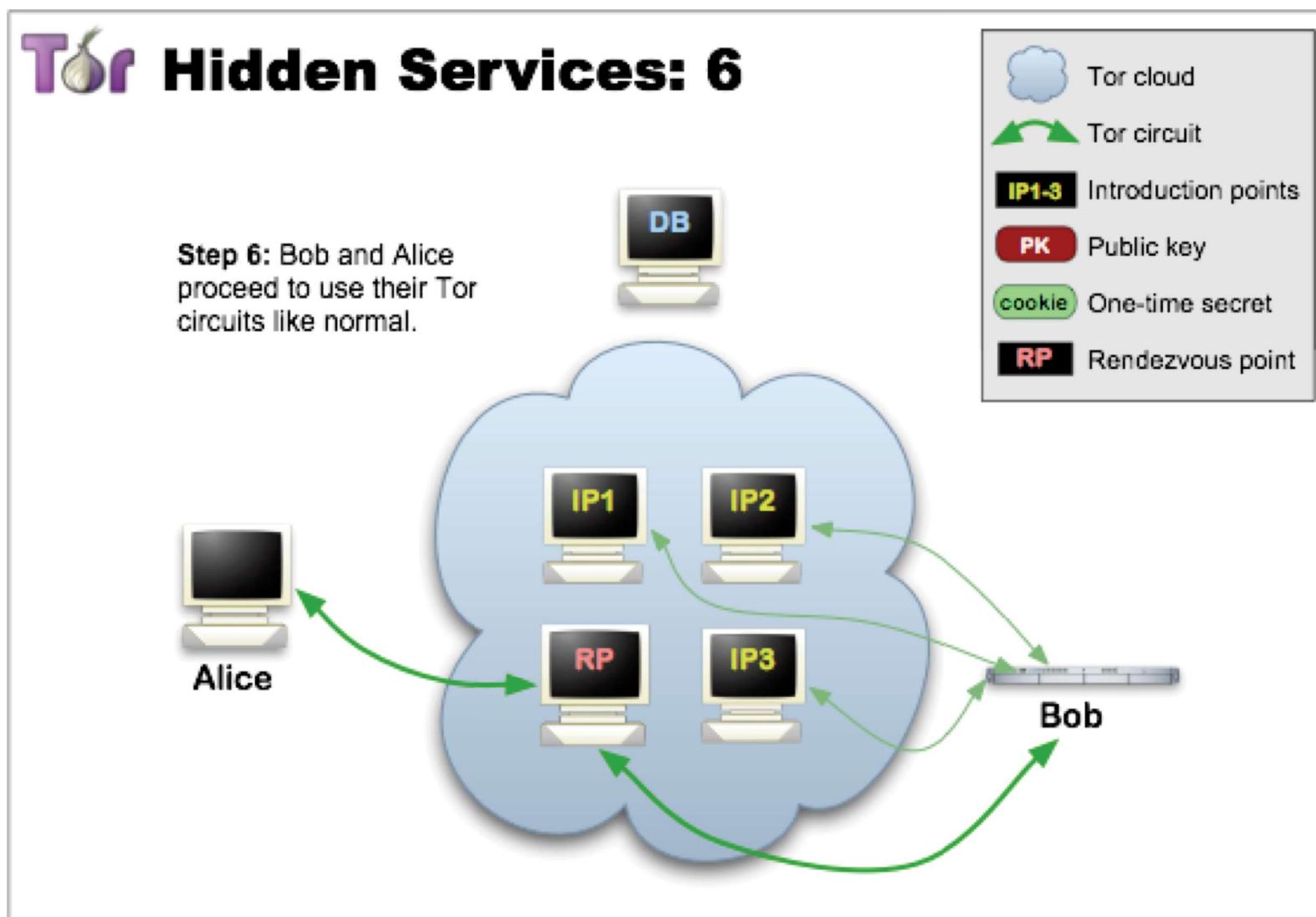
Setting up a hidden service 4



Setting up a hidden service 5



Setting up a hidden service 6



operations

- Bob generates a long-term public key pair to identify his service
- Bob chooses some introduction points, and advertises them on the lookup service, also providing his public key
- Bob builds a circuit to each of his introduction points, and tells them to wait for requests.
- Alice learns about Bob's service out of band, retrieves the details of Bob's service from the lookup service
- Alice chooses an OR as the rendezvous point (RP) for her connection to Bob's service. She builds a circuit to the RP, and gives it a randomly chosen "rendezvous cookie" to recognize Bob.
- Alice opens an anonymous stream to one of Bob's introduction points, and gives it a message (encrypted with Bob's public key) telling it about herself, her RP and rendezvous cookie, and the start of a DH handshake. The introduction point sends the message to Bob.
- If Bob wants to talk to Alice, he builds a circuit to Alice's RP and sends the rendezvous cookie, the second half of the DH handshake, and a hash of the session key they now share.
- The RP connects the two circuits. Note that RP can't recognize Alice, Bob, or data they transmit.
- Alice sends a *relay begin* cell along the circuit. It arrives at Bob's OP, which connects to Bob's webserver.
- An anonymous stream has been established, and Alice and Bob communicate as normal.

hidden services examples

**FREEDOM
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FOUNDATION**

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Support investigation based on the CIA Torture Report

Projects We Support

INVESTIGATING CIA TORTURE

While the Senate released the executive summary of the CIA torture report, there are still over 6,000 pages of the main report that remain classified. Many names, dates, and places remain redacted. [This project](#) seeks to fill in many of the holes still left in the story.

ENCRYPTION TOOLS FOR JOURNALISTS

Crowd-funding for open-source encryption tools that can better protect the communications of journalists and sources: [Open WhisperSystems](#), [Tails](#), [Tor Project](#) and the [LEAP Encryption Access Project](#). Donate to support these vital tools [here](#).

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Email or Phone Password

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Sign Up

It's free and always will be.

First name Last name

Email or mobile number

Re-enter email or mobile number

New password

Birthday

Month Day Year Why do I need to provide my birthday?

Female Male

By clicking Sign Up, you agree to our Terms and that you have read our Data Policy, including our Cookie Use.

Sign Up

Create a Page for a celebrity, band or business.

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Facebook © 2015
English (US)

how Google treats Tor

The screenshot shows the "Create your Google Account" page from a Tor browser. The interface is identical to the standard Google account creation form. It includes fields for Name (First and Last), Choose your username (@gmail.com), Create a password, Confirm your password, Birthday (Month, Day, Year), Gender (I am...), Mobile phone (with a dropdown for country code +40 and a field for phone number), Your current email address, and a CAPTCHA section. Below the form, there's a "Prove you're not a robot" checkbox with the option to skip verification. The page also features promotional text and icons for various Google services.

The screenshot shows the "Crea il tuo account Google" (Create your Google account) page from a standard browser. The layout is similar to the Tor version but includes some localized text. It features sections for Nome (Name and Surname), Scegli il tuo nome utente (Choose your username), Crea una password (Create a password), Conferma la password (Confirm password), Data di nascita (Birth date), Sesso (Gender), Cellulare (Mobile), and Il tuo indirizzo email attuale (Your current email address). A "Dimostra di non essere un robot" (Prove you're not a robot) section with a CAPTCHA is also present. The page highlights the convenience of having one account for all Google services and shows images of a laptop and a smartphone displaying maps.

crypto market

Crypto Market

cryptomktgxnd2zd.onion/cm.php

marketplace private messages (1) orders my wallet \$0.00000000 offers settings forums notifications (1)

Crypto Market

Search Search Both Ships From None Selected Search

Shadow (+257) (verified) was reviewed on 1.5g Cannabis mix (0.063036 BTC)
5/5 - good delivery time mixed, yeah, not perfect but a decent smoke. delivered next day so all good here

Osquare (+15) was reviewed on Carding CC and Paypal to BTC... 8 METHODS APRIL 2015 (0.062453 BTC)
5/5 - Awesome guy Looking forward to doing business again soon

TomJerry (+1004) (verified) was reviewed on 0.5 grams quality Heroin #3 (0.112415 BTC)
5/5 No feedback.

Osquare (+15) was reviewed on Carding CC and Paypal to BTC... 8 METHODS APRIL 2015 (0.062453 BTC)
5/5 - A must have for carding I really liked this guide and the vendor even gave me a free one !! 10/5

lafloche (+244) (verified) was reviewed on 0.5 gr iso MXE (better Ketamine) ↗ GO OUTSIDE YOUR BODY ↗ (0.151397 BTC)
5/5 - Thumbs up Came quickly to aus very potent stuff

Back 1 2 3 4 5 6 7 8 9 ... 115 116 More

 **FE 1 gram cocaine | Purity ± 70 %**
\$65 USD / 0.270630 BTC
Vendor: TomJerry (+1004) (verified)
Category: Cocaine
Ships From: the Netherlands Ships To: Worldwide

 **FE 0.5 grams Cocaine | Purity 70 %**
\$36 USD / 0.149887 BTC
Vendor: TomJerry (+1004) (verified)
Category: Cocaine
Ships From: the Netherlands Ships To: Worldwide

 **FE 0.5 grams quality Heroin #3**
\$27 USD / 0.112415 BTC
Vendor: TomJerry (+1004) (verified)
Category: Heroin
Ships From: the Netherlands Ships To: Worldwide

Cannabis
Weed (567)
Hash (85)
Edibles (5)
Concentrates (32)
Seeds (2)
Others (206)

Psychedelic
Psychedelic (17)
2C (12)
DMT (12)
LSD (41)
NB (36)
Mushrooms (27)

Ecstasy
Ecstasy (34)
MDMA (97)
Methyline (7)

more insight

- <https://svn.torproject.org/svn/projects/design-paper/tor-design.pdf>
- <http://freehaven.net/anonbib/>
- <https://www.torproject.org/docs/hidden-services.html.en>
- <https://gitweb.torproject.org/torspec.git/tree/tor-spec.txt>