rBridge: User Reputation Based Tor Bridge Distribution with Privacy Preservation

Qiyan Wang
Nikita Borisov

University of Illinois at Urbana-Champaign

Zi Lin
Nicholas J Hopper

University of Minnesota

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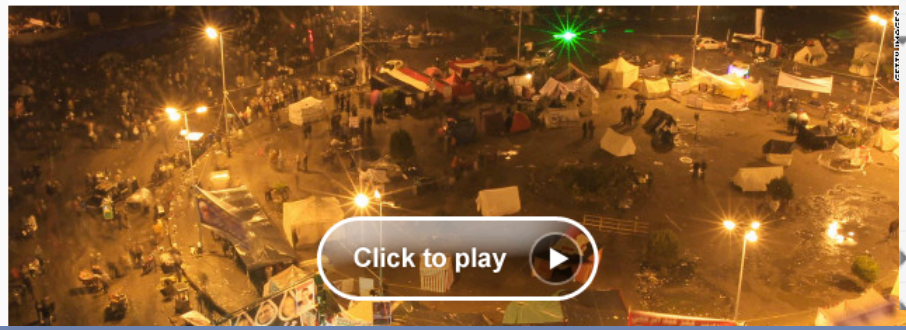

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Falun Gong

From Wikipedia, the free encyclopedia
(Redirected from Falungong)

Falun Gong or **Falun Dafa** (literally means "*Law Wheel Practice*") is a spiritual discipline first introduced in China in 1992 through public lectures by its founder, Li Hongzhi.[1] It combines the practice of meditation and slow-

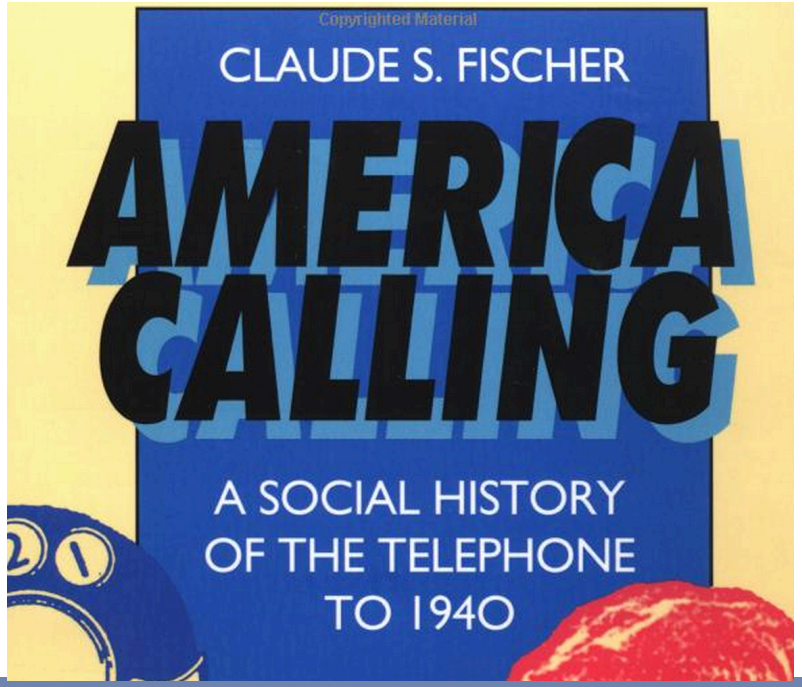
Falun Gong

The Falun Dafa emblem

of entering an upcoming bicycle race but do not really know how to start or how to get yourself

Utopian Dreams

"[It] is a force for democracy, because it permits citizens to communicate, to collaborate, and even to conspire uncontrolled by a central authority."



it with the desire to supply, in some degree, a

Internet censorship

- 7 out of top 10 non-Chinese sites[1] are blocked by the "Great Firewall of China".
- The Chinese government employs an Internet policy force of over 30,000 people[2] .

Top 10 non-Chinese sites	Blocked by GFW?
Google	**Partially**
Facebook	**Yes**
YouTube	**Yes**
Yahoo!	**Partially**
Wikipedia	**Yes**
Windows Live	No
Twitter	**Yes**
Amazon	No
Blogspot	**Yes**
LinkedIn	No

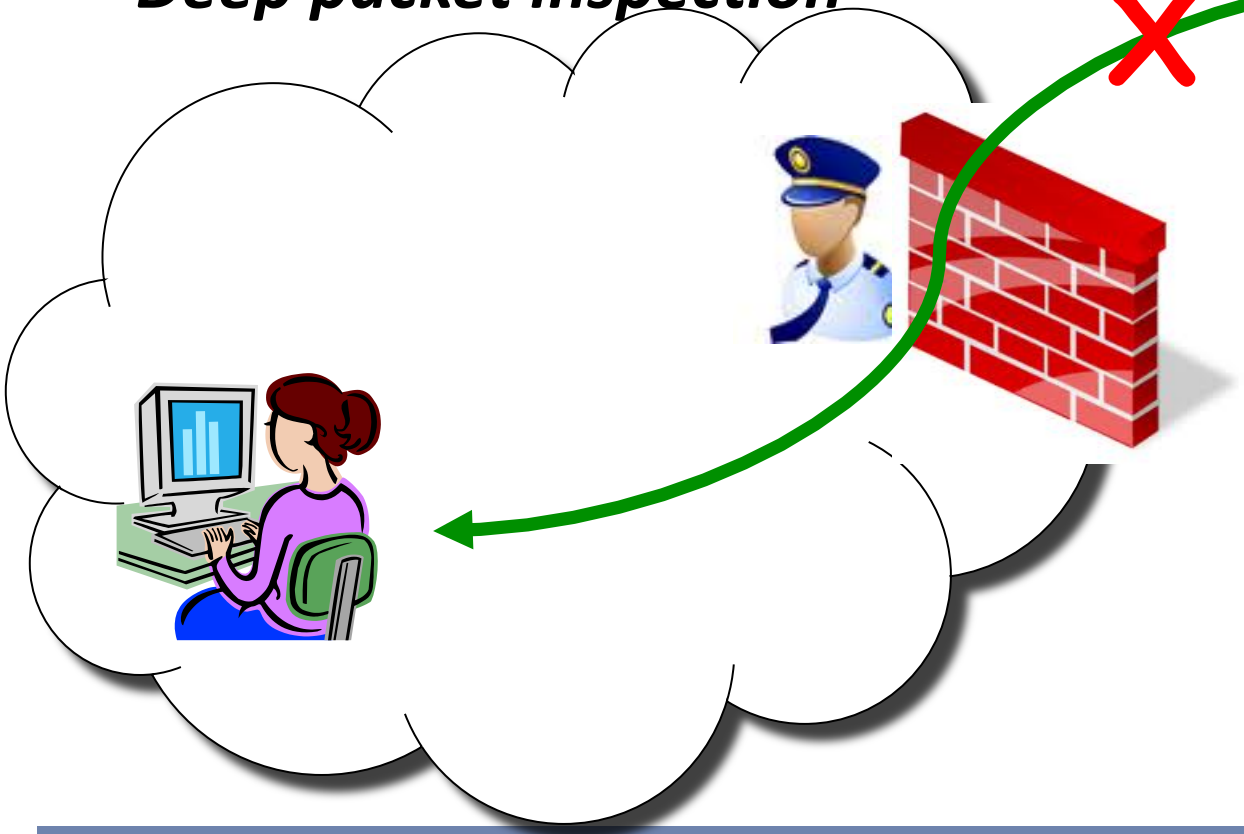
[1] Test report (Apr.3.2012-May.3.2012) from https://en.greatfire.org
[2] http://www.ibtimes.com/articles/113590/20110217/

Censorship techniques

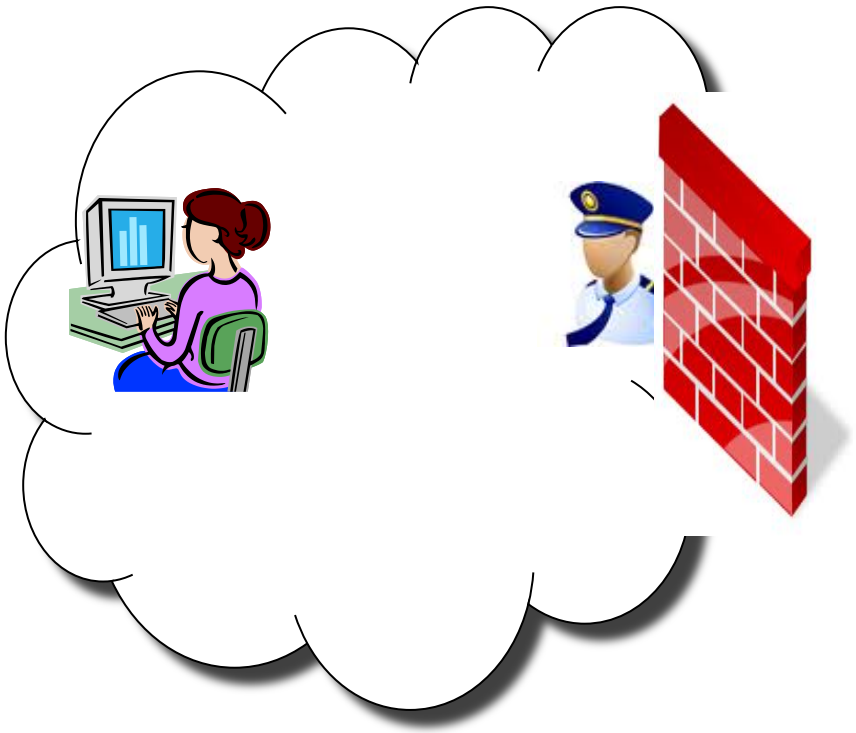
IP blocking

DNS hijiacking

Deep packet inspection

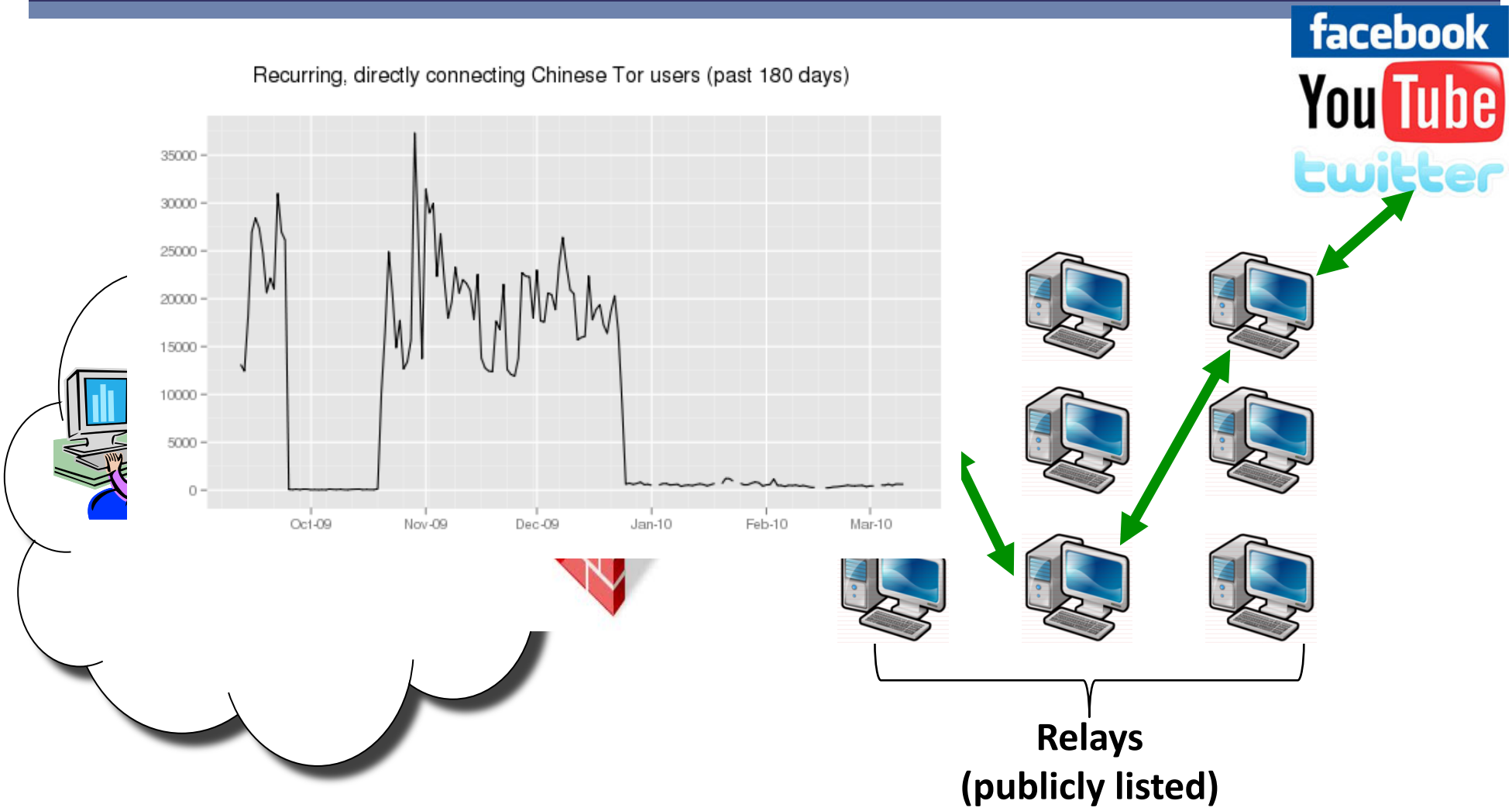


Censorship circumvention using Tor

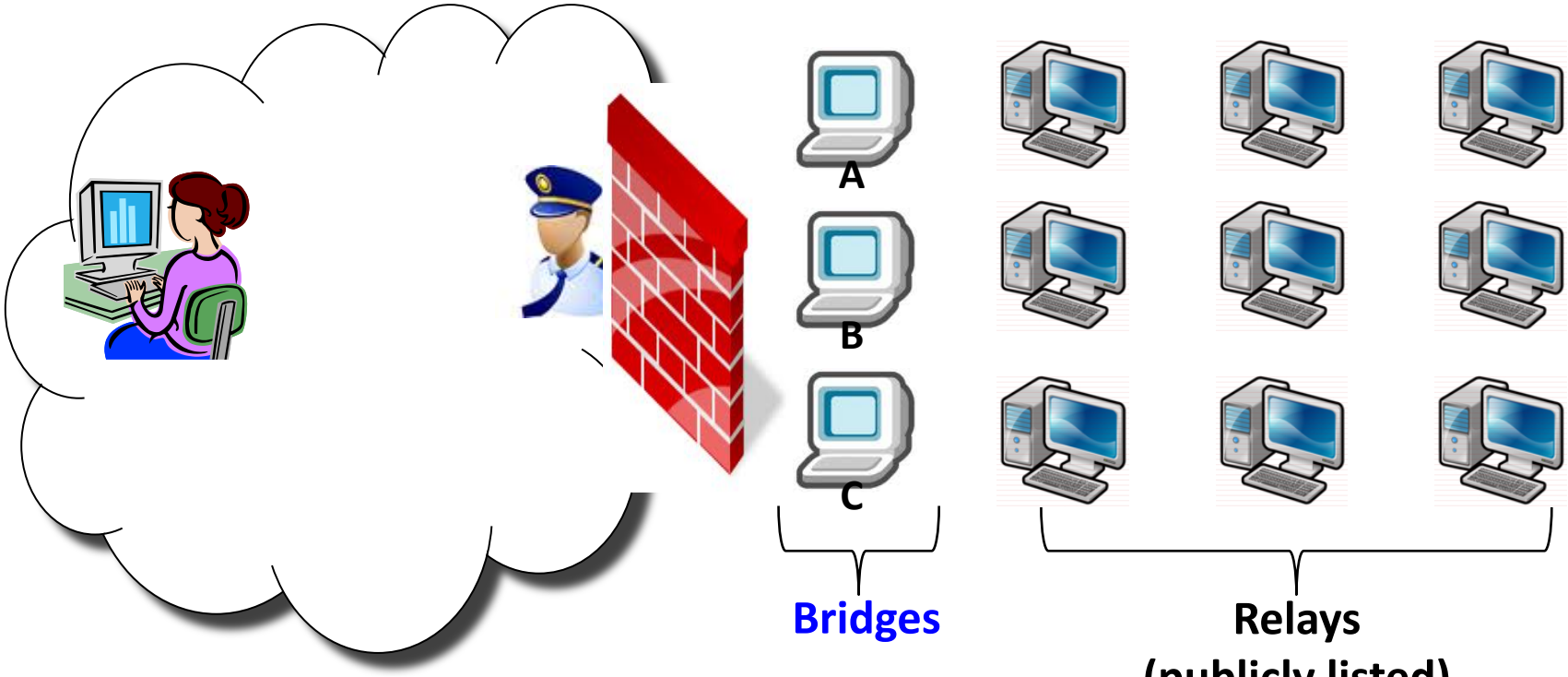


Relays
(publicly listed)

Censorship circumvention using Tor



Censorship circumvention using Tor bridges



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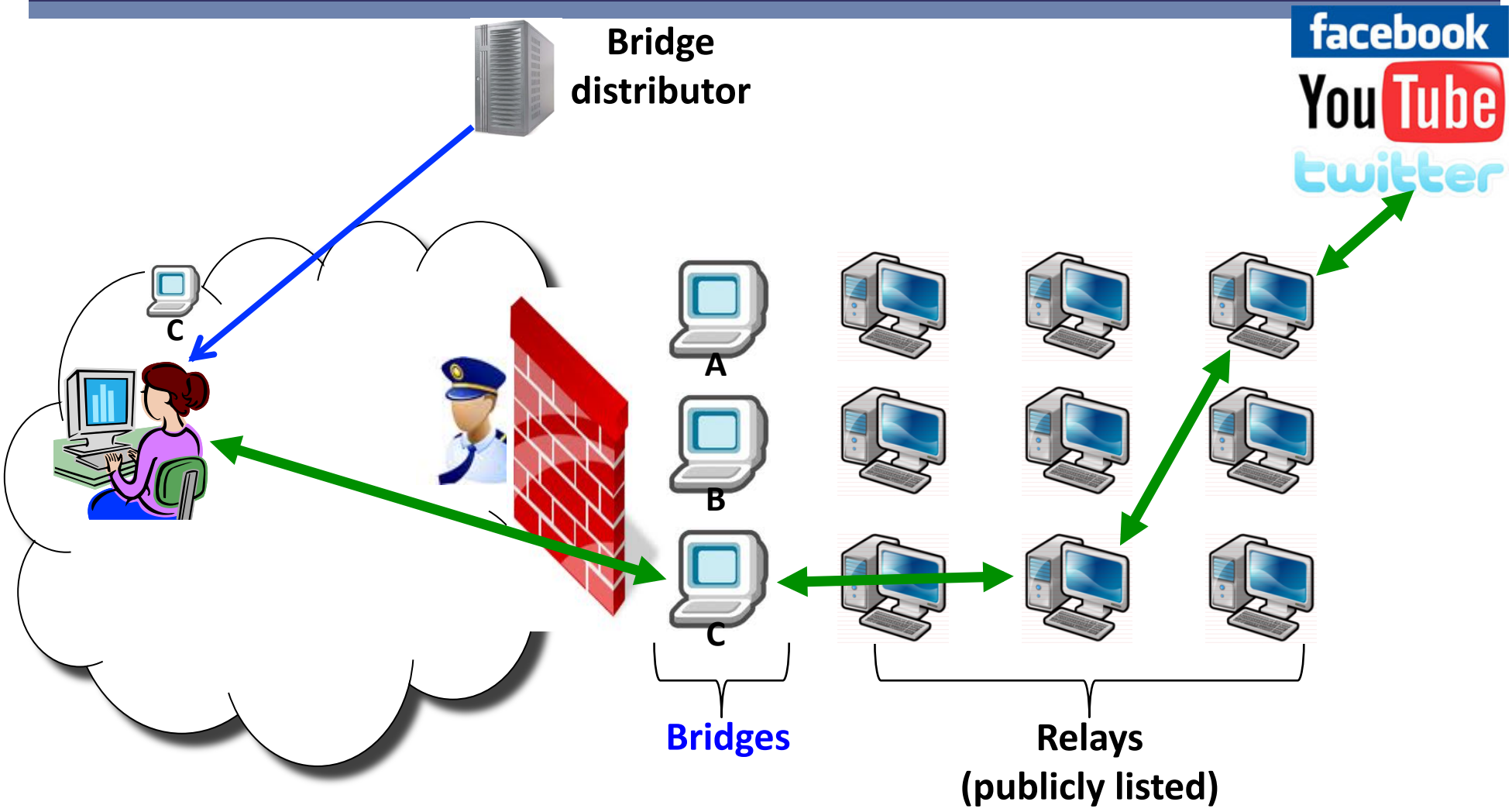
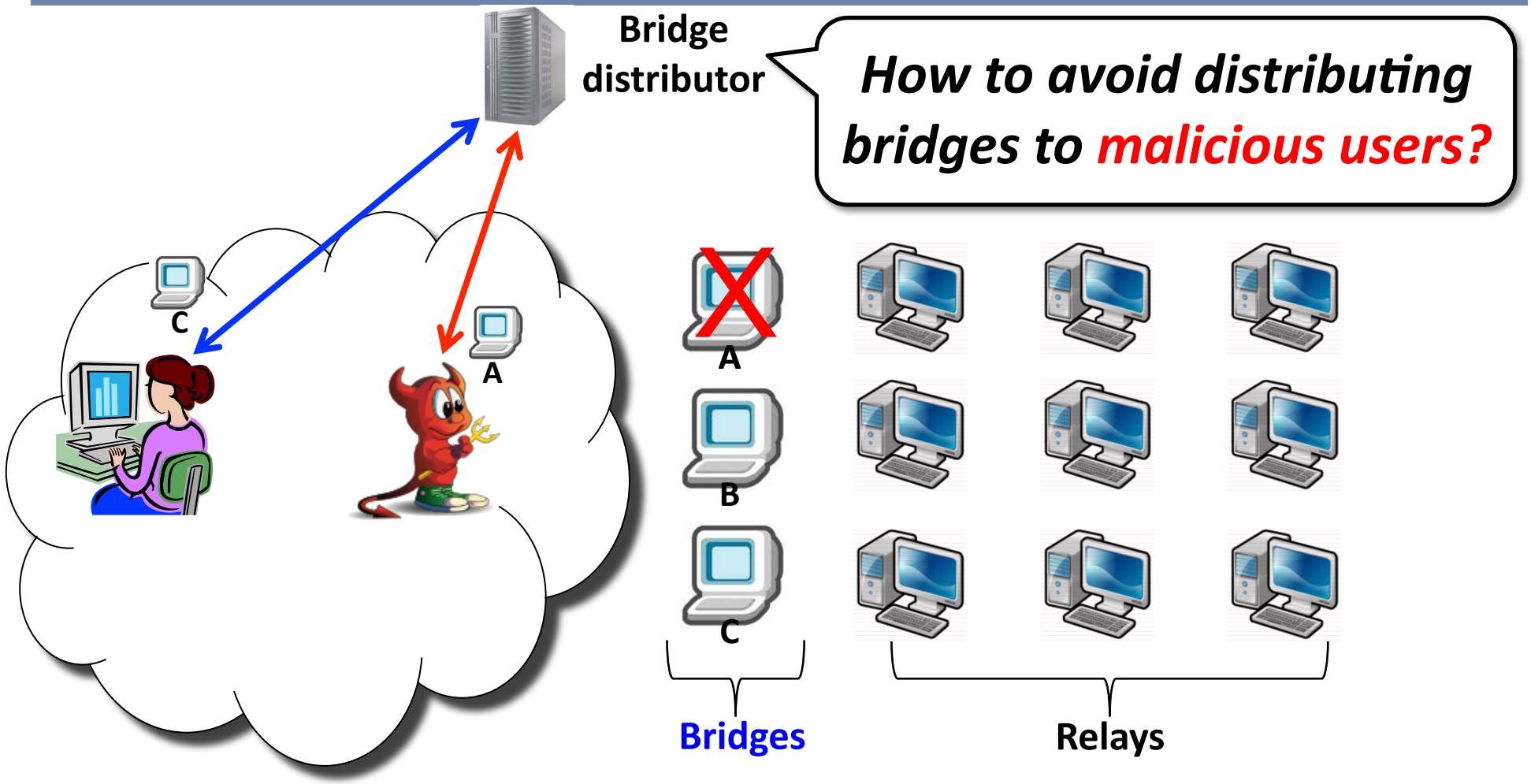


Tor via bridges

Censorship circumvention using Tor bridges



Rate limiting

One bridge per IP address / Gmail address

Bridge distributor

A

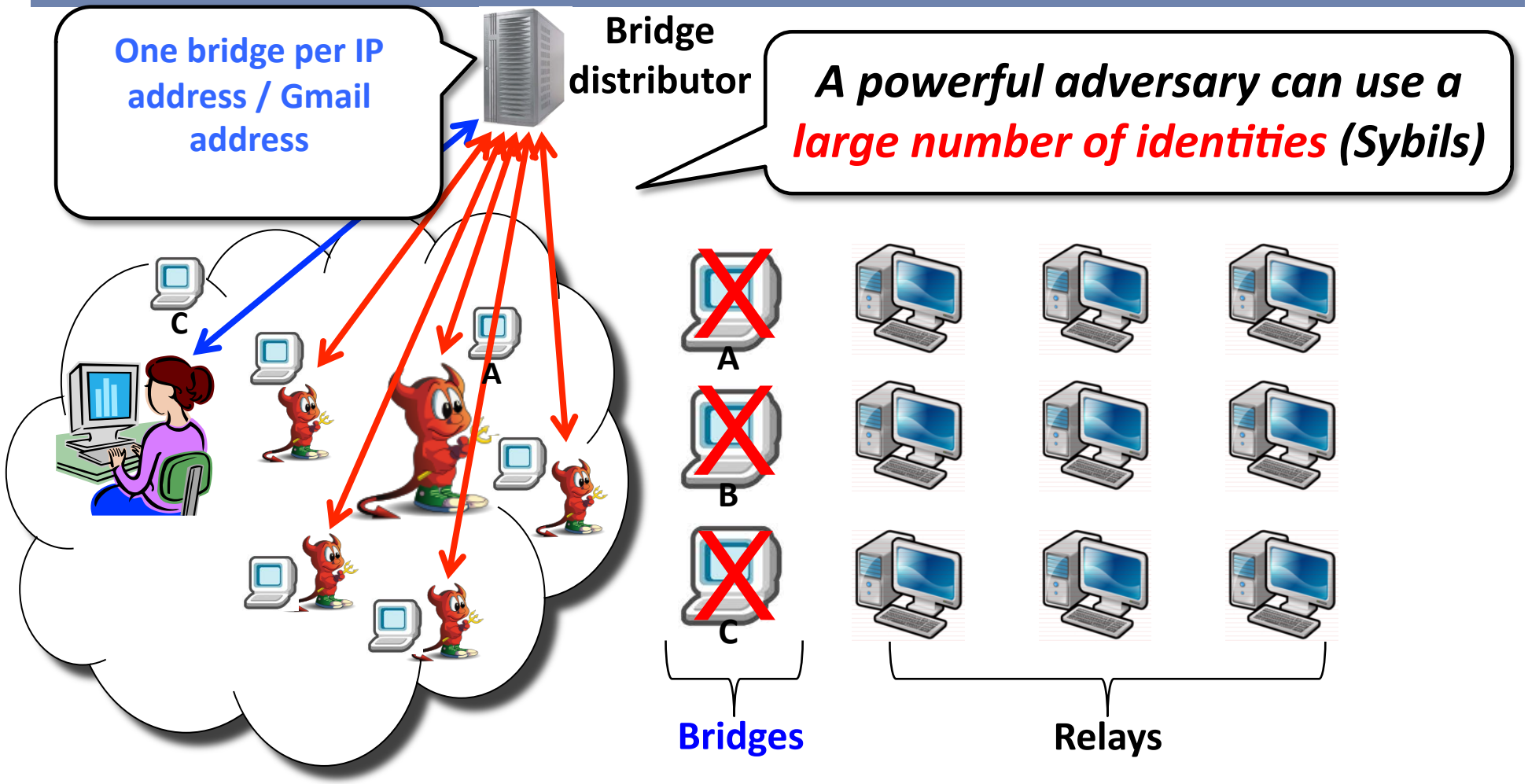
B

C

Bridges

Relays

Rate limiting

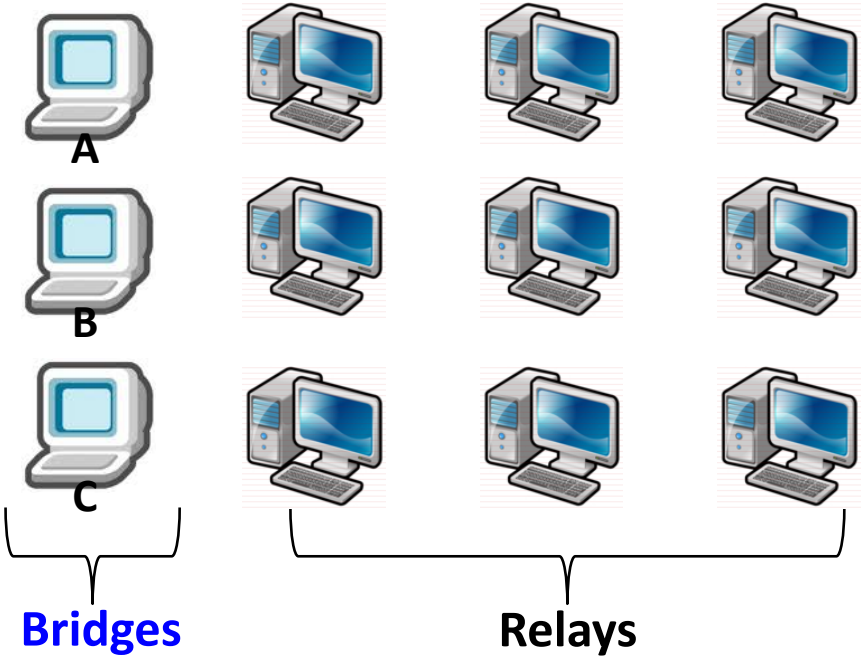


The Chinese government were able to enumerate all bridges in under a month in 2010.

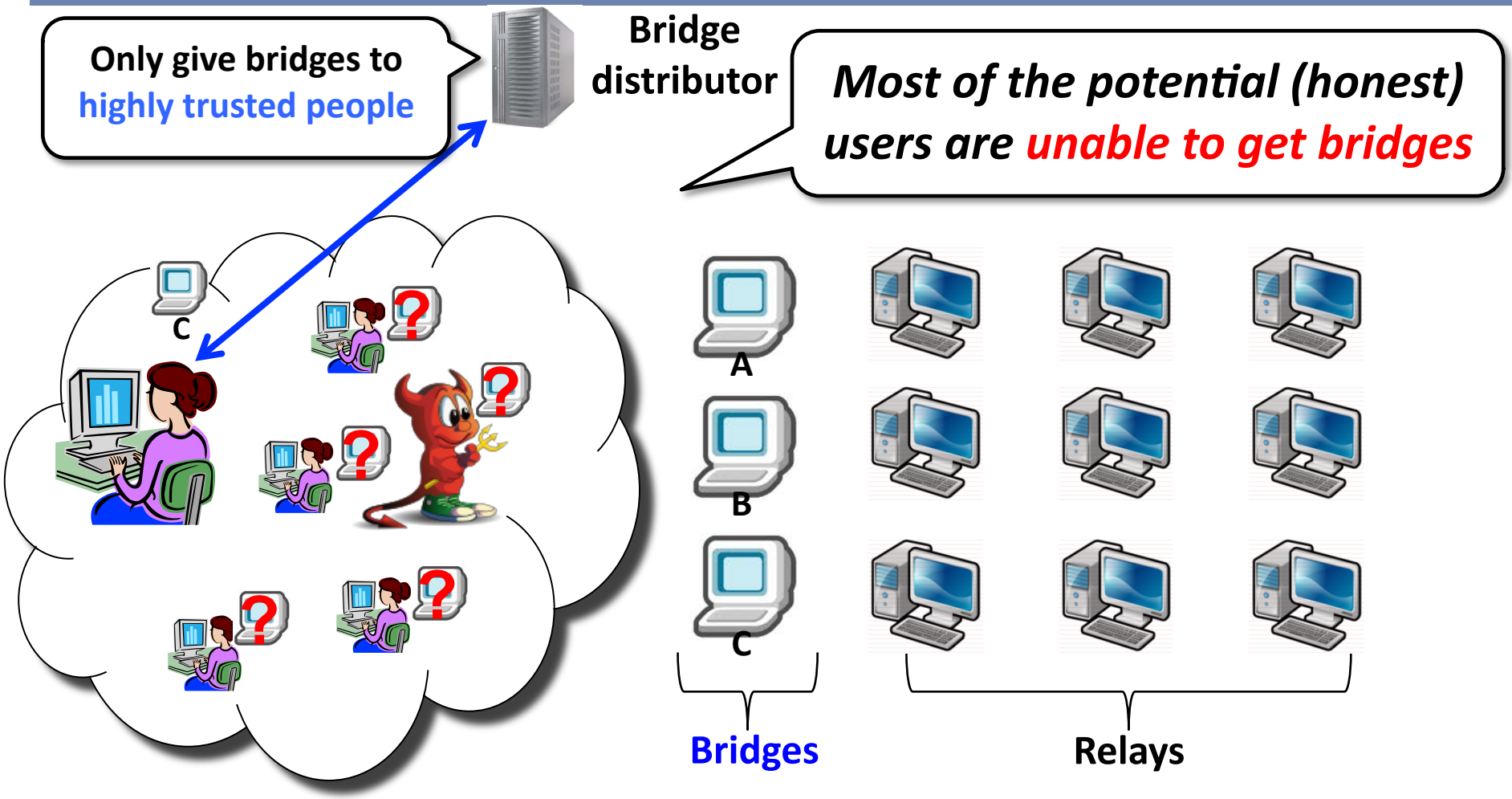
Limited access

Only give bridges to highly trusted people

Bridge distributor



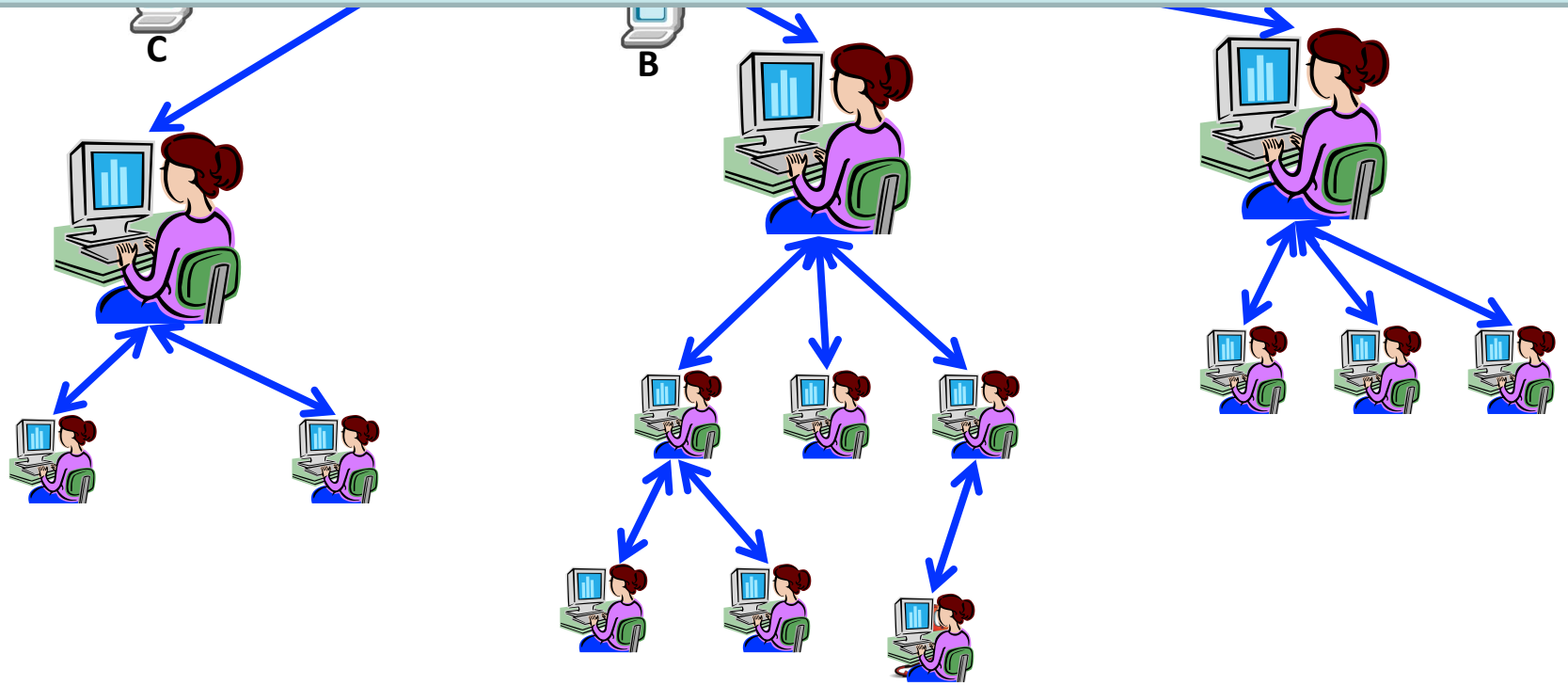
Limited Access



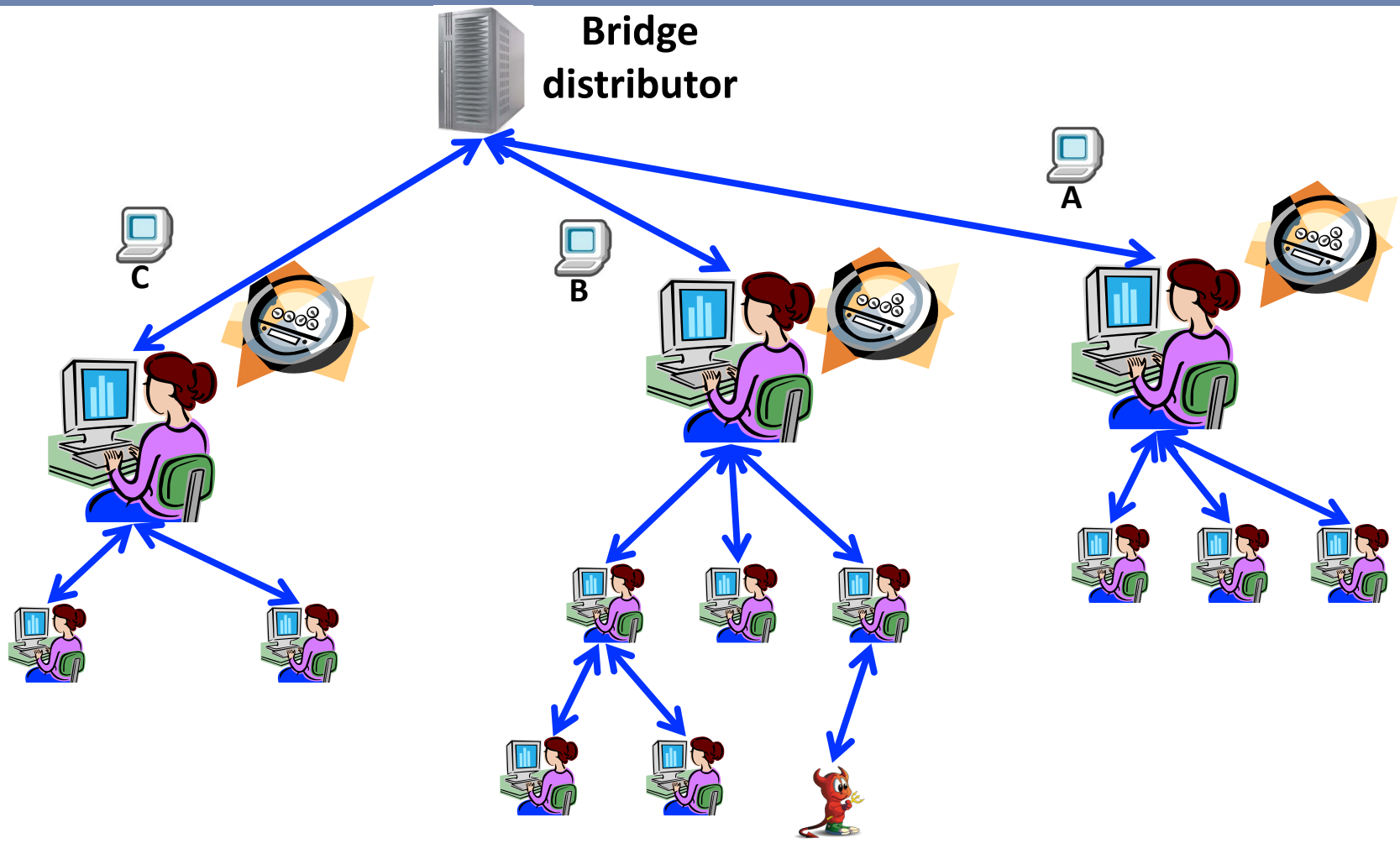
Social Distribution

Bridge distributor

Conflict between robustness and openness!



Proximax [McCoy et al., FC'11]



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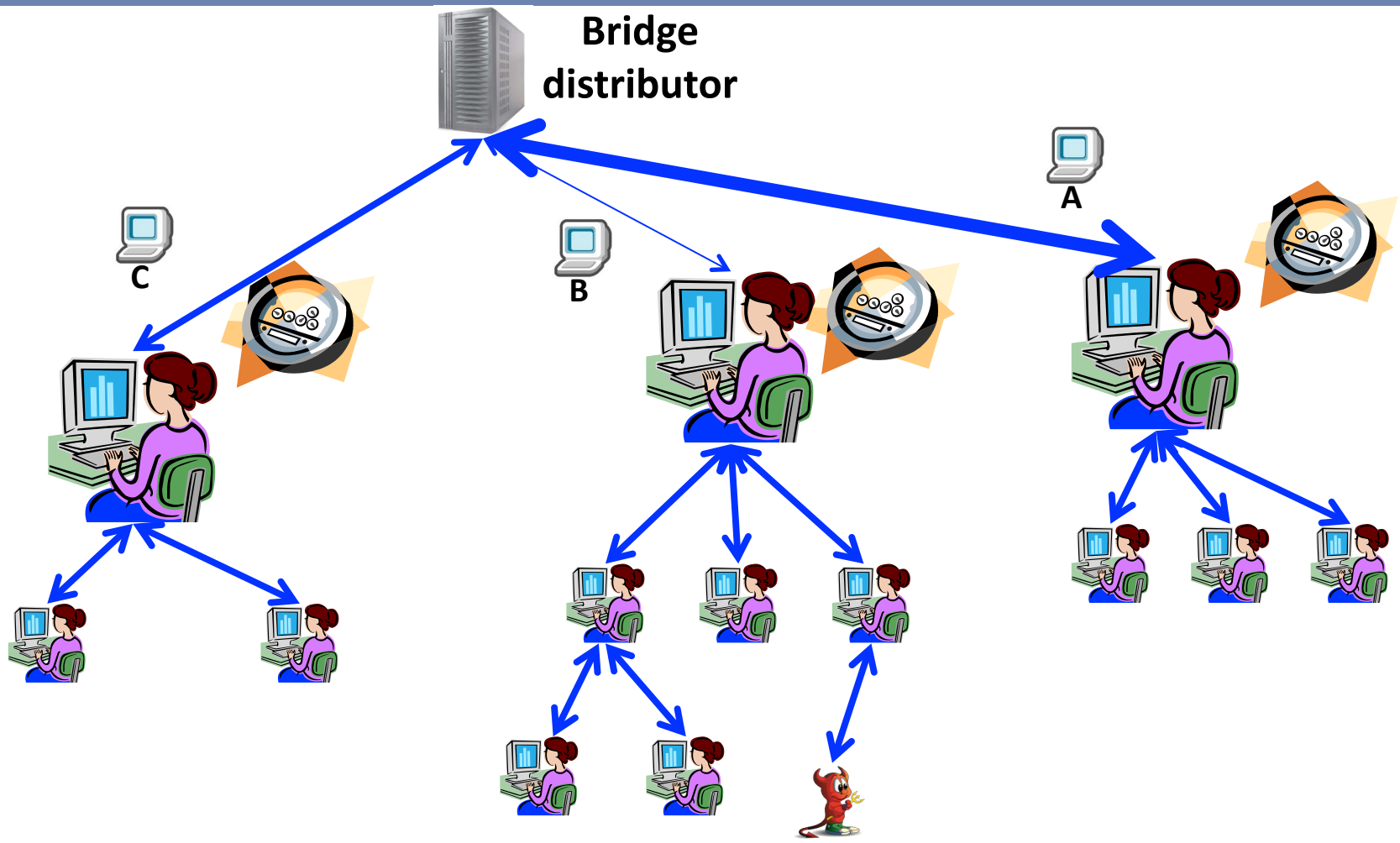
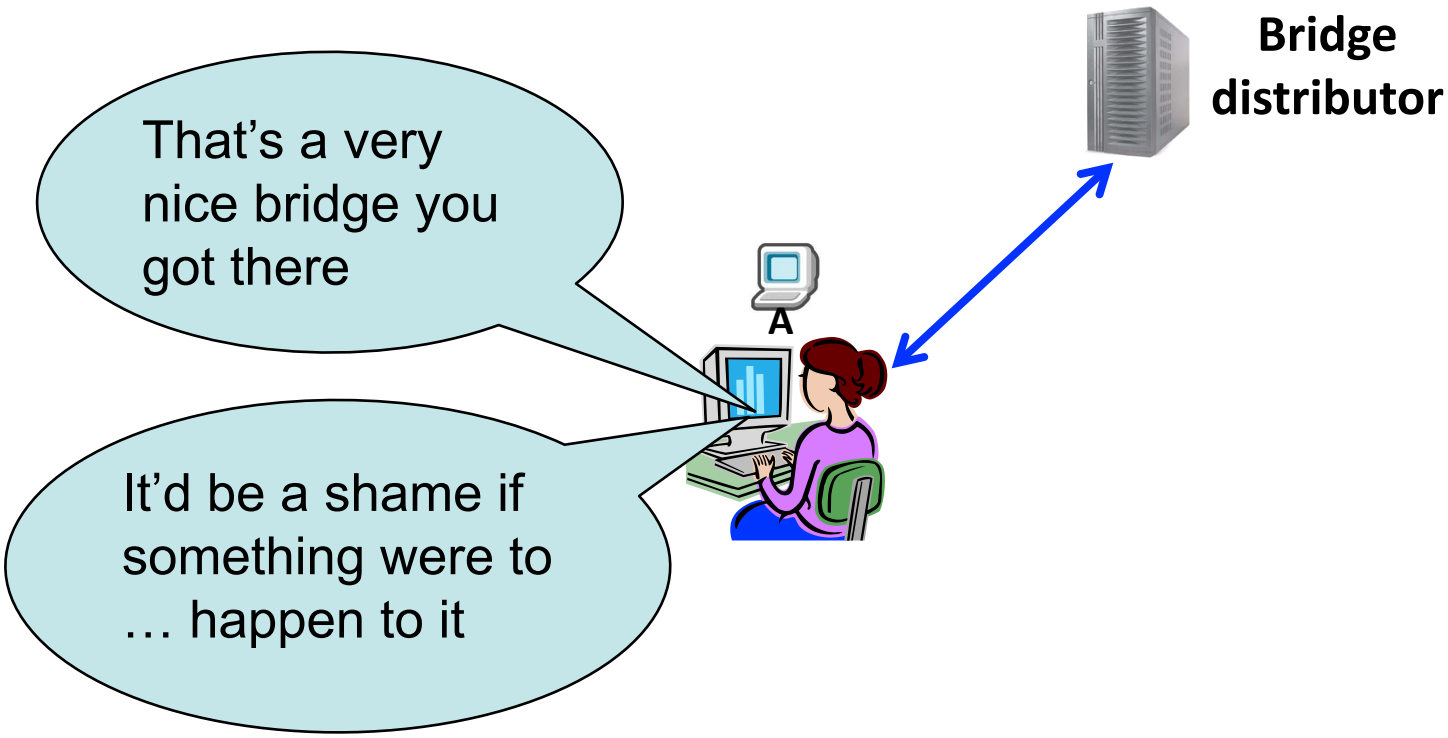


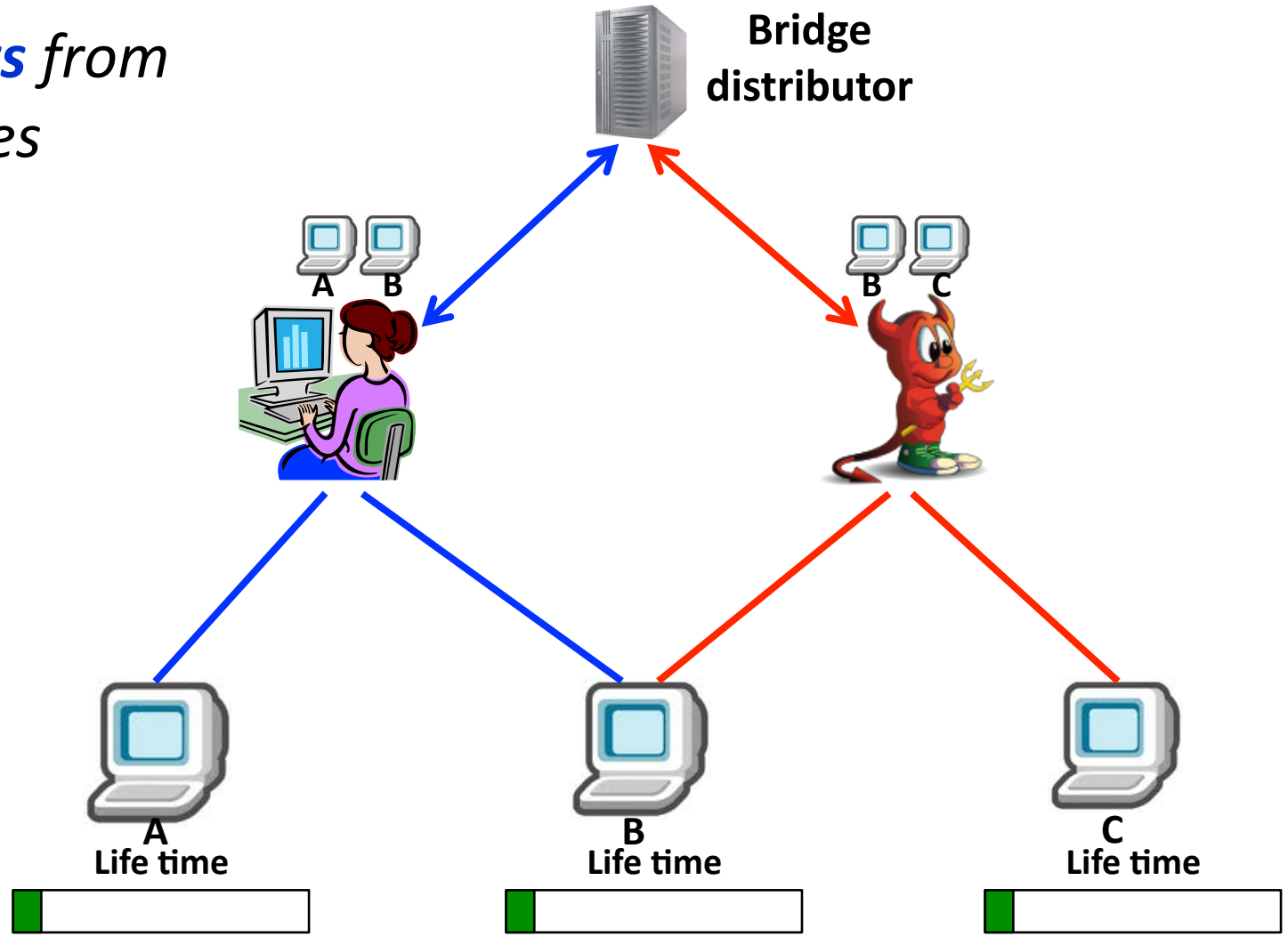
Our basic idea: Incentives



Pay users to keep bridges unblocked!

rBridge: user reputation

Earn credits *from alive bridges*



pyramid and a planet. Every step explained in detail including exactly

rBridge: user reputation

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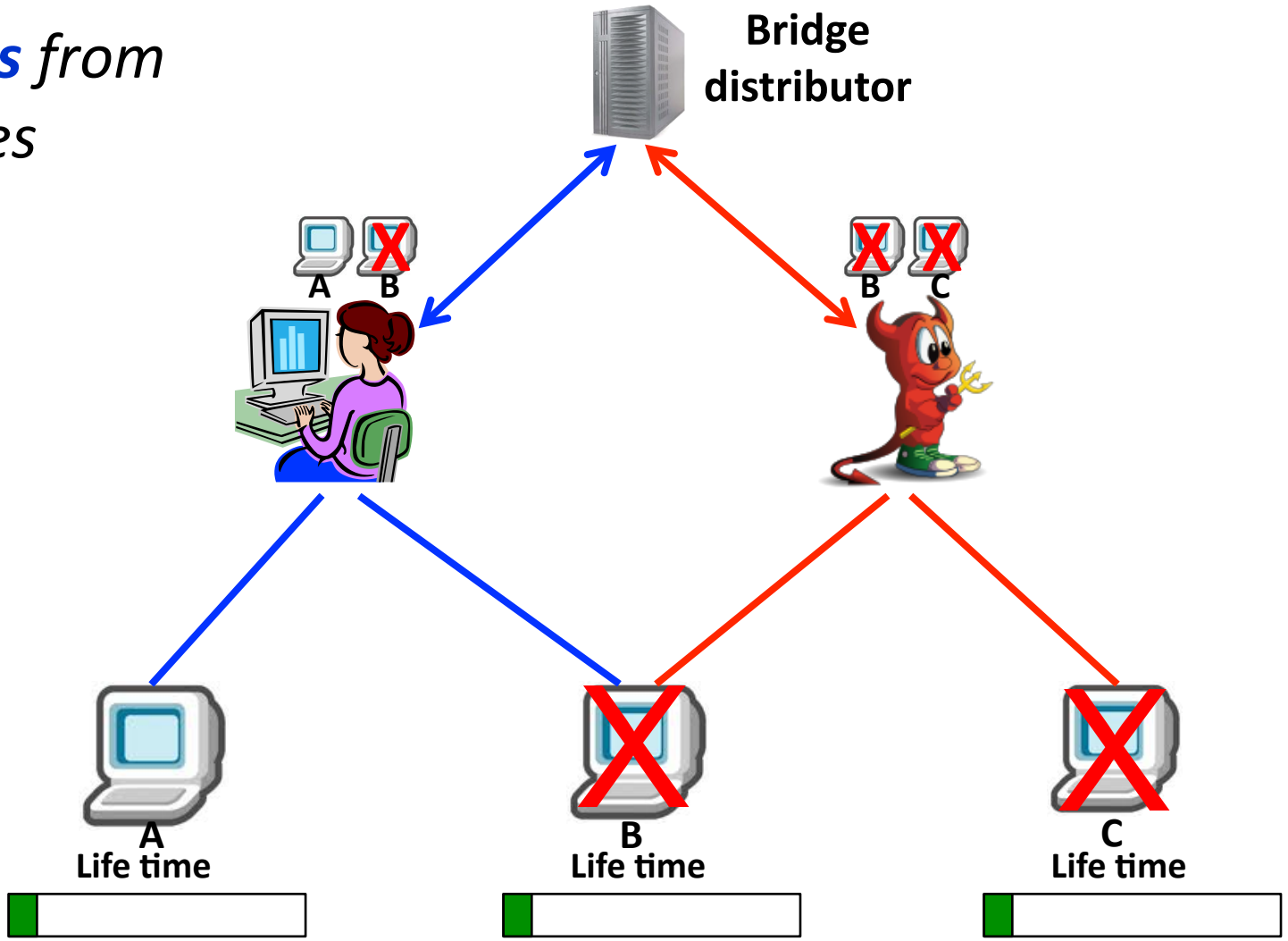

These are big promises! Why should

rBridge: user reputation

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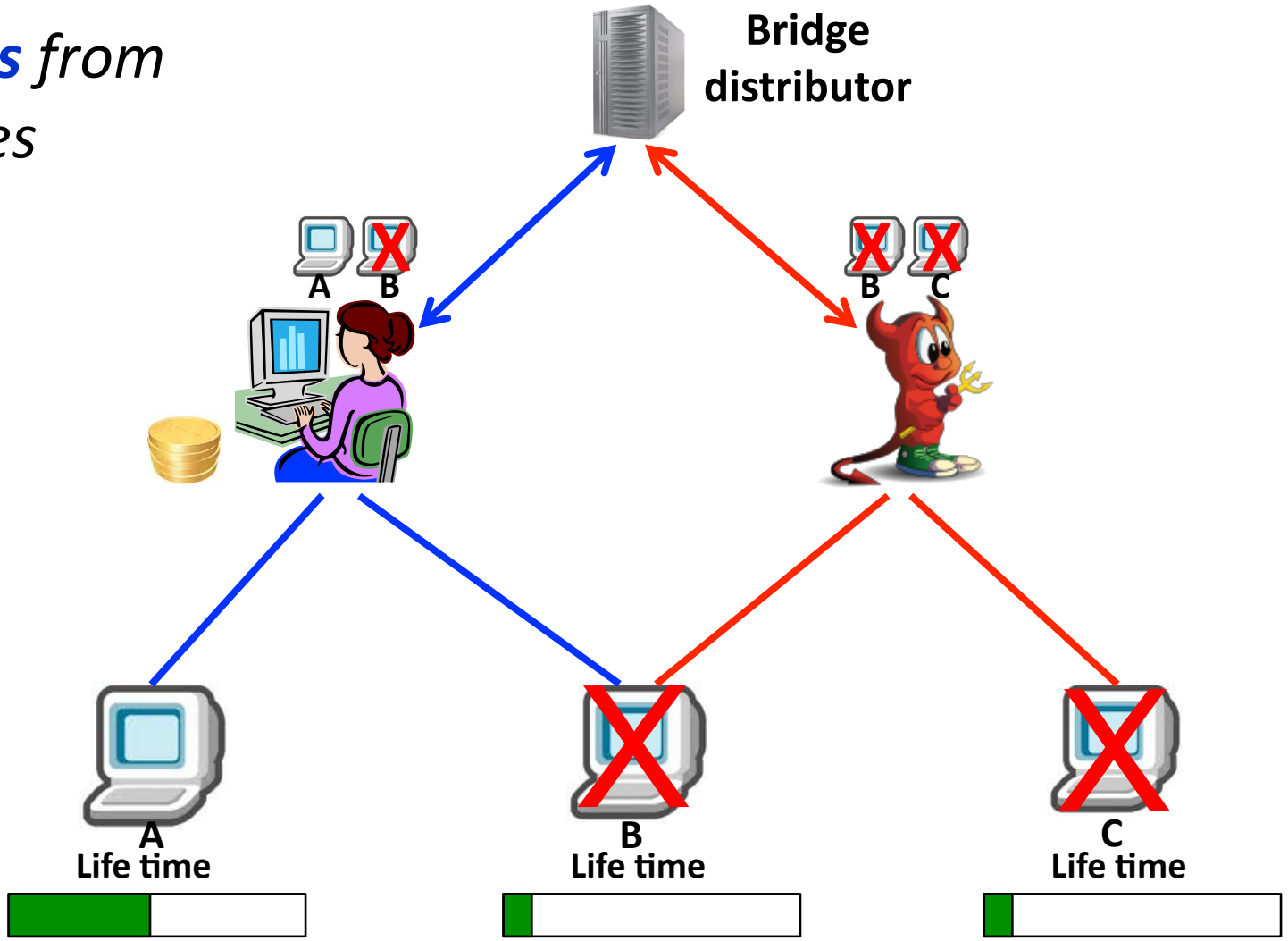

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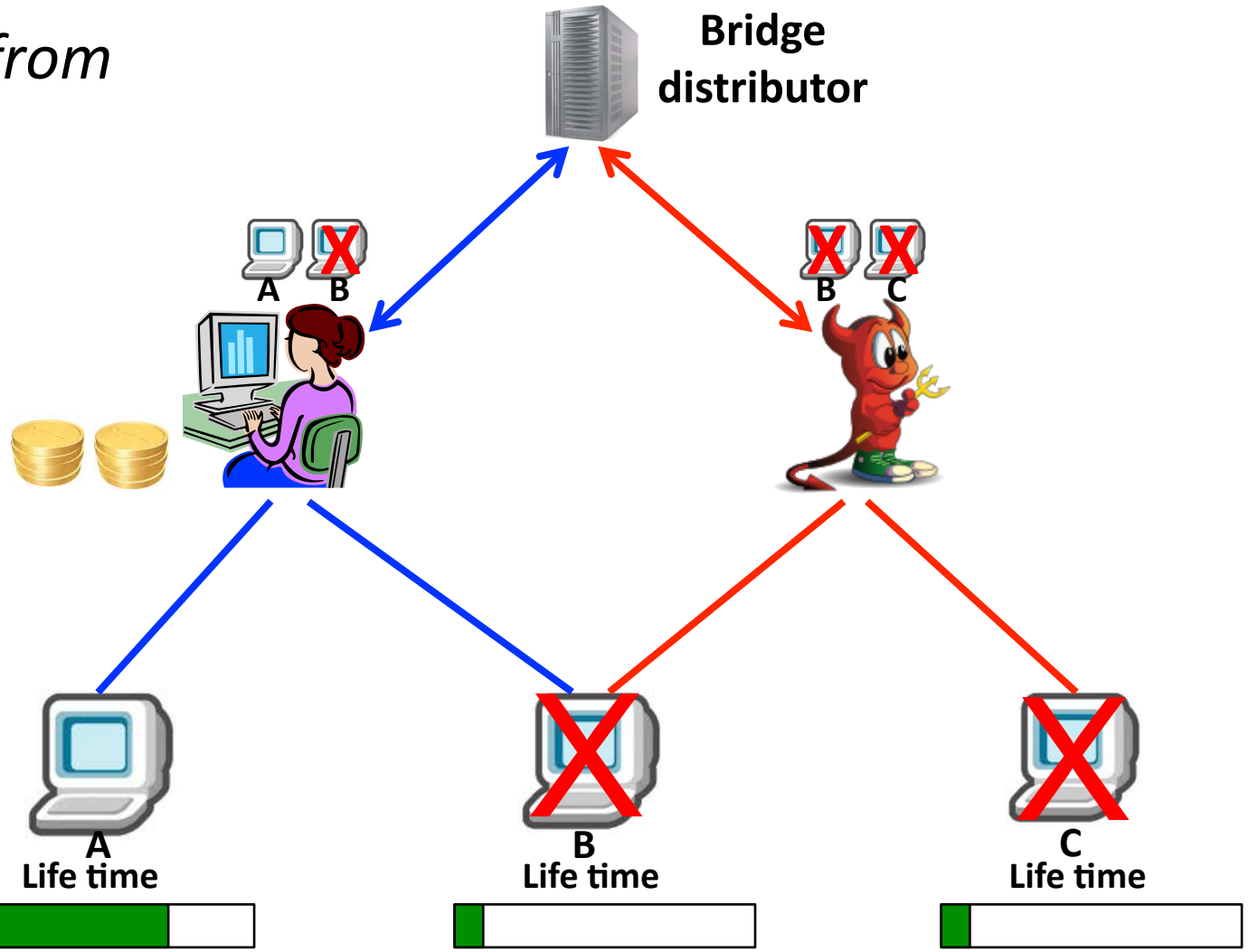

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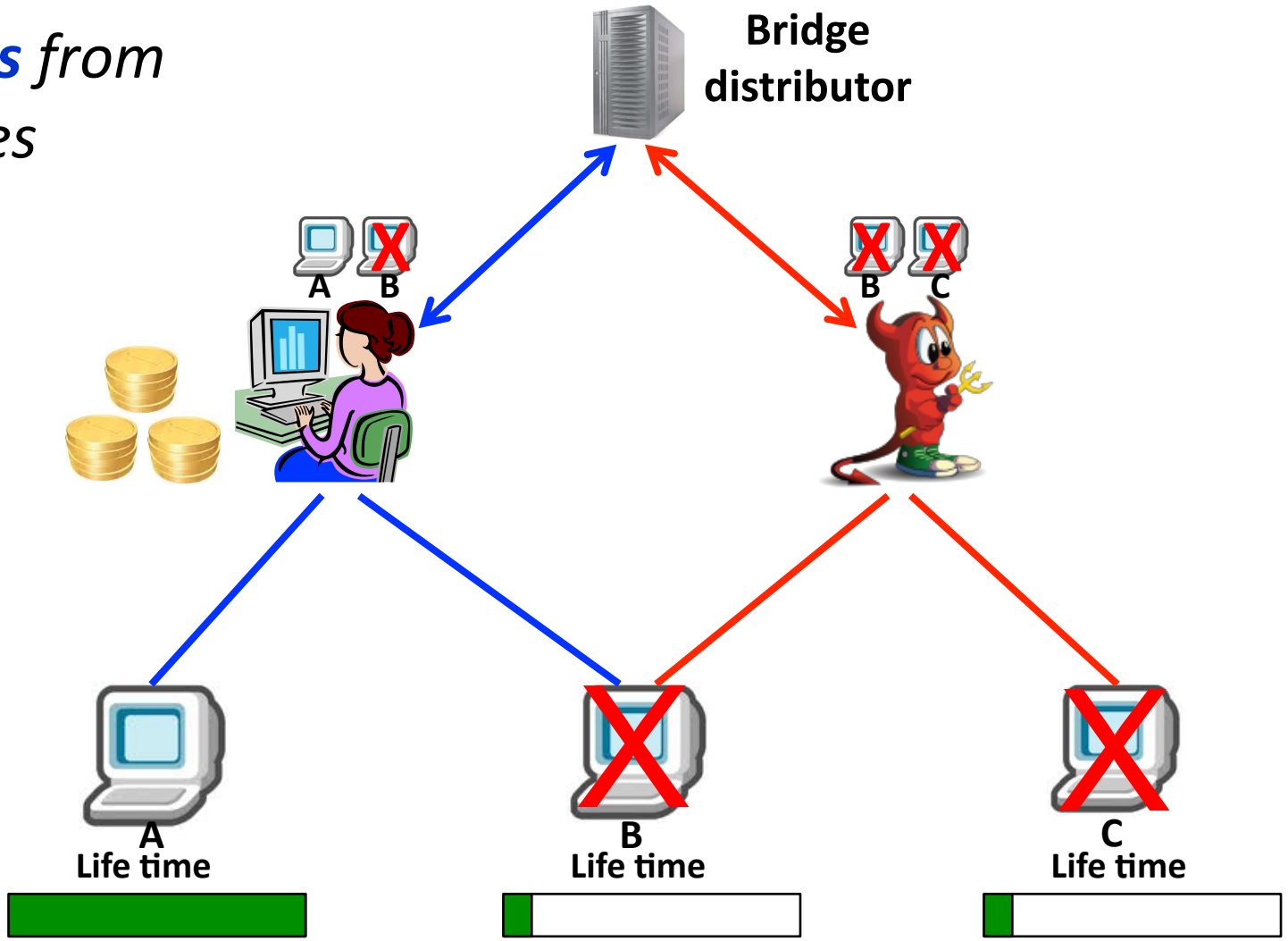
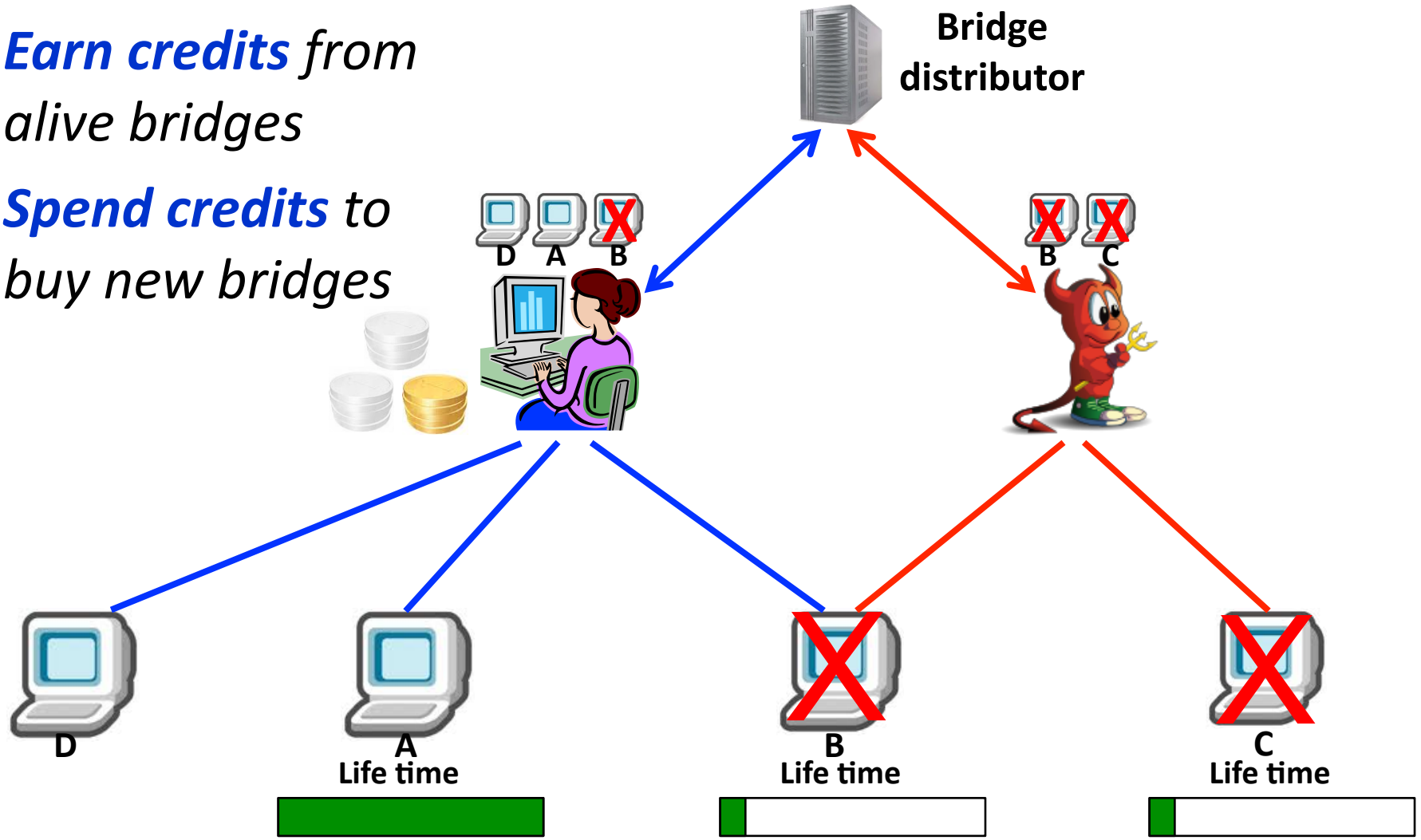


rBridge: user reputation

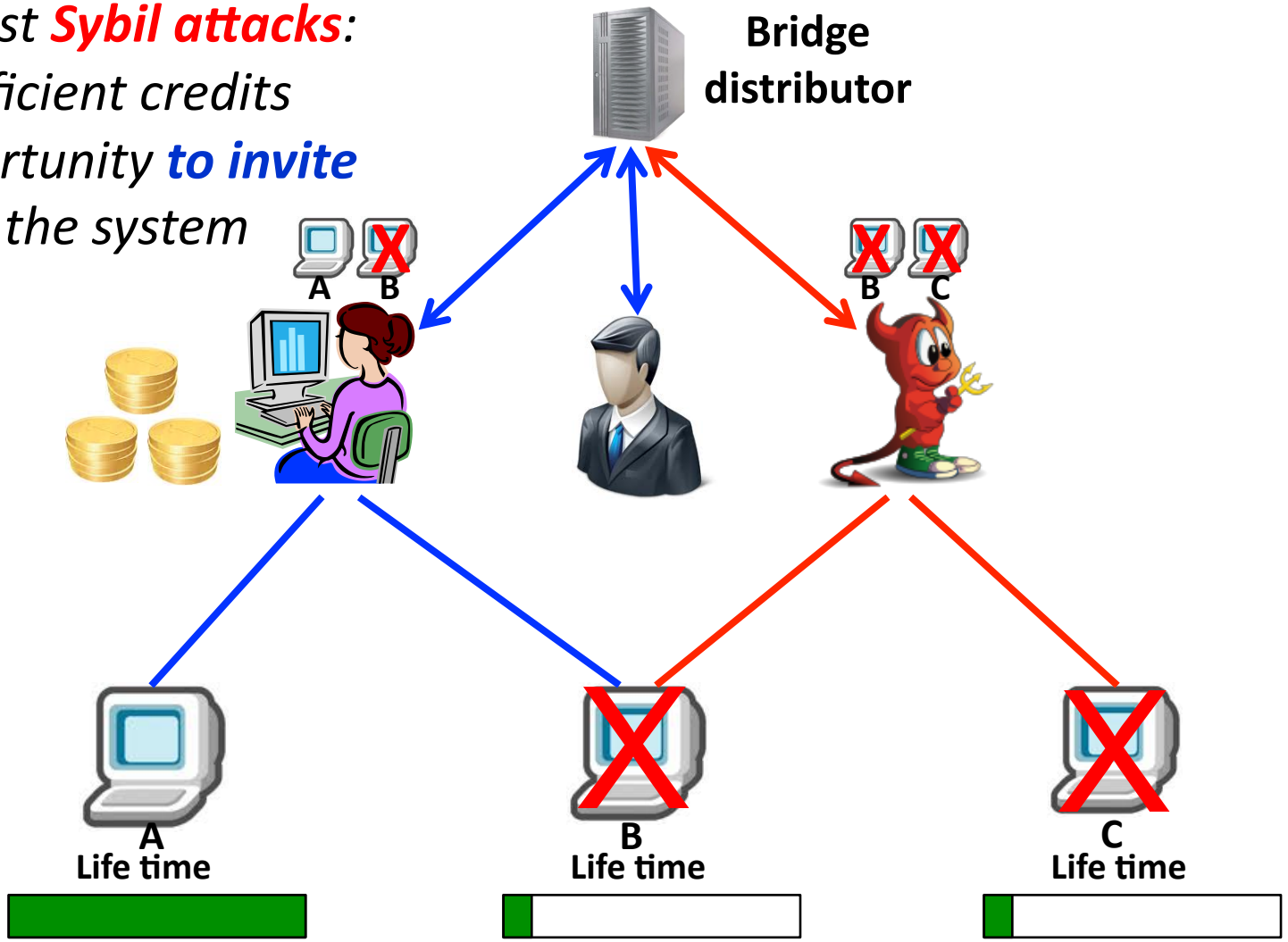
Earn credits *from alive bridges*

Spend credits *to buy new bridges*

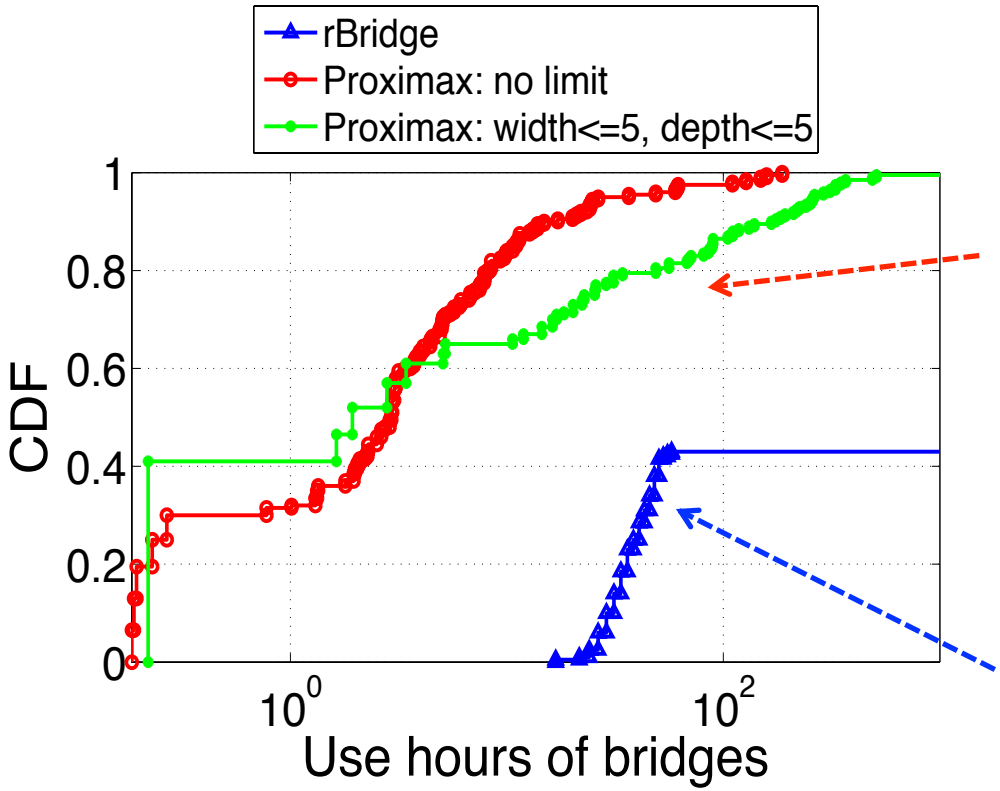


rBridge: user reputation

*Defense against **Sybil attacks**: users with sufficient credits have the opportunity **to invite friends** to join the system*



Comparison with Proximax (the state-of-the art scheme)



Proximax: less than **5% bridges** can serve more than **20 user-hours** before being blocked.

rBridge: over **80% bridges** can serve at least **60 user-hours** before being blocked, and about **60% bridges** are **never blocked**.

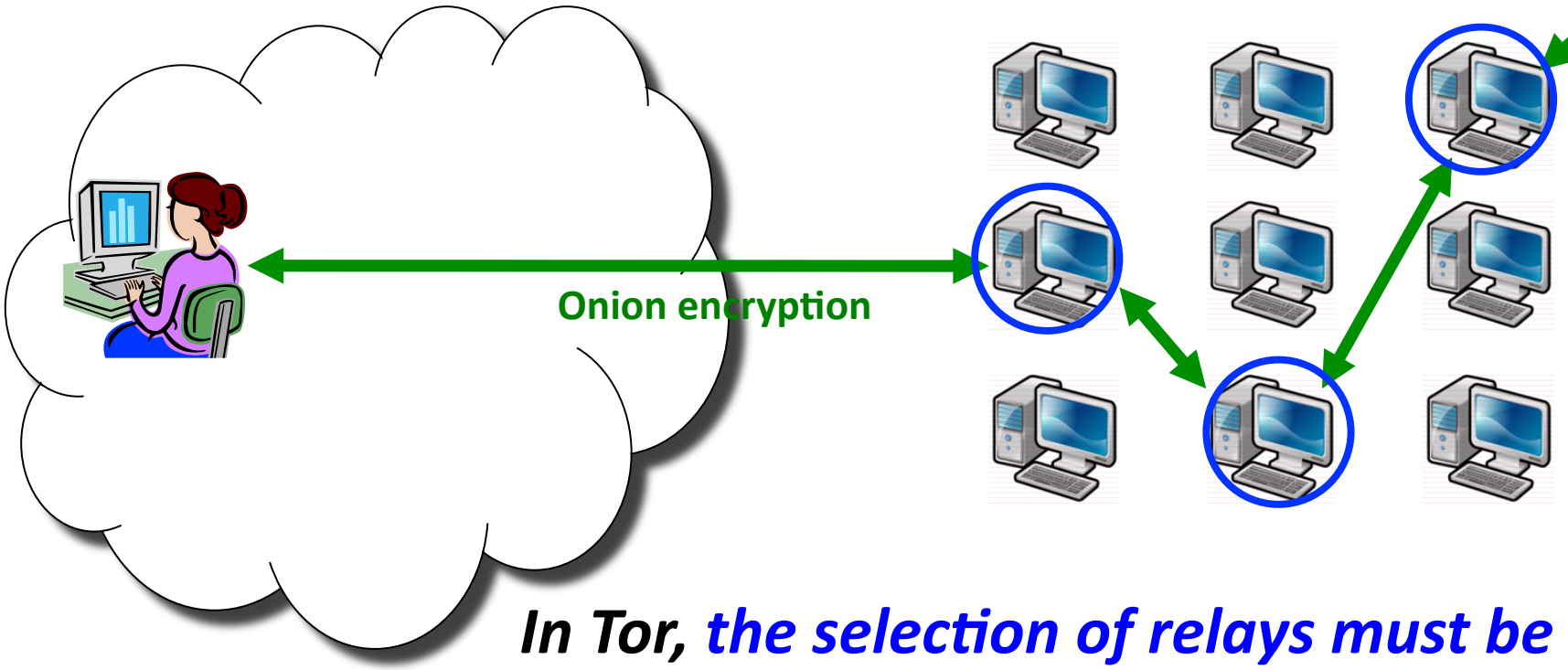
Privacy preservation

Directory authority

facebook

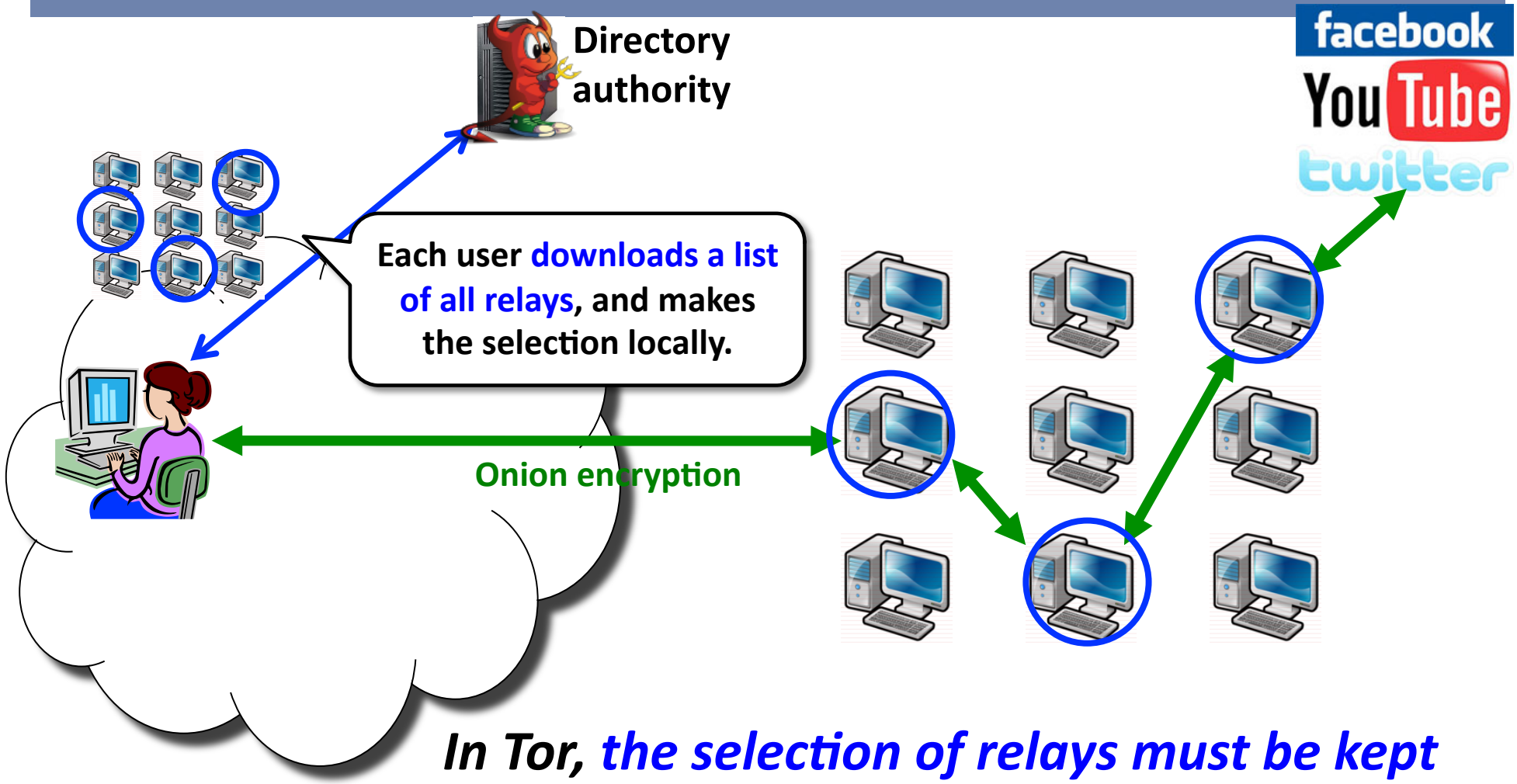
YouTube

twitter



In Tor, the selection of relays must be kept secret, even from the directory authority!

Privacy preservation



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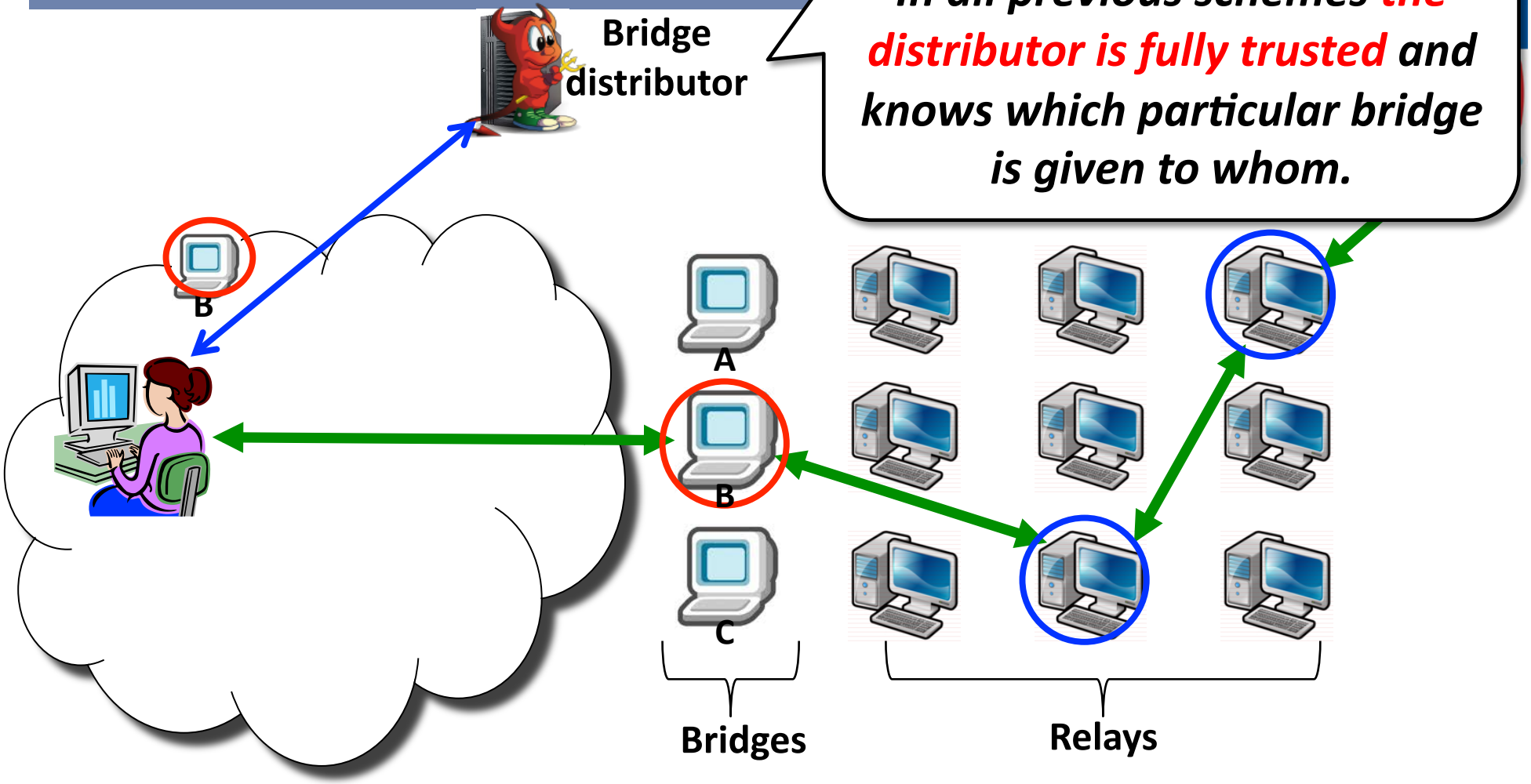
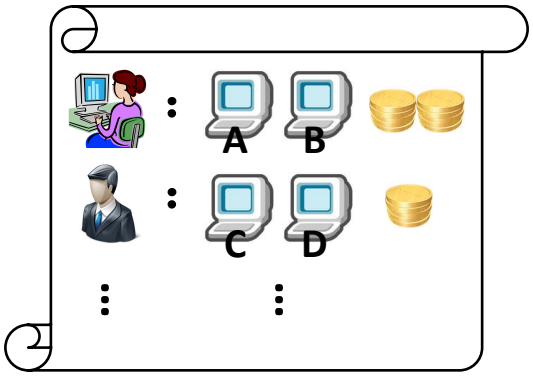


rBridge: privacy preservation

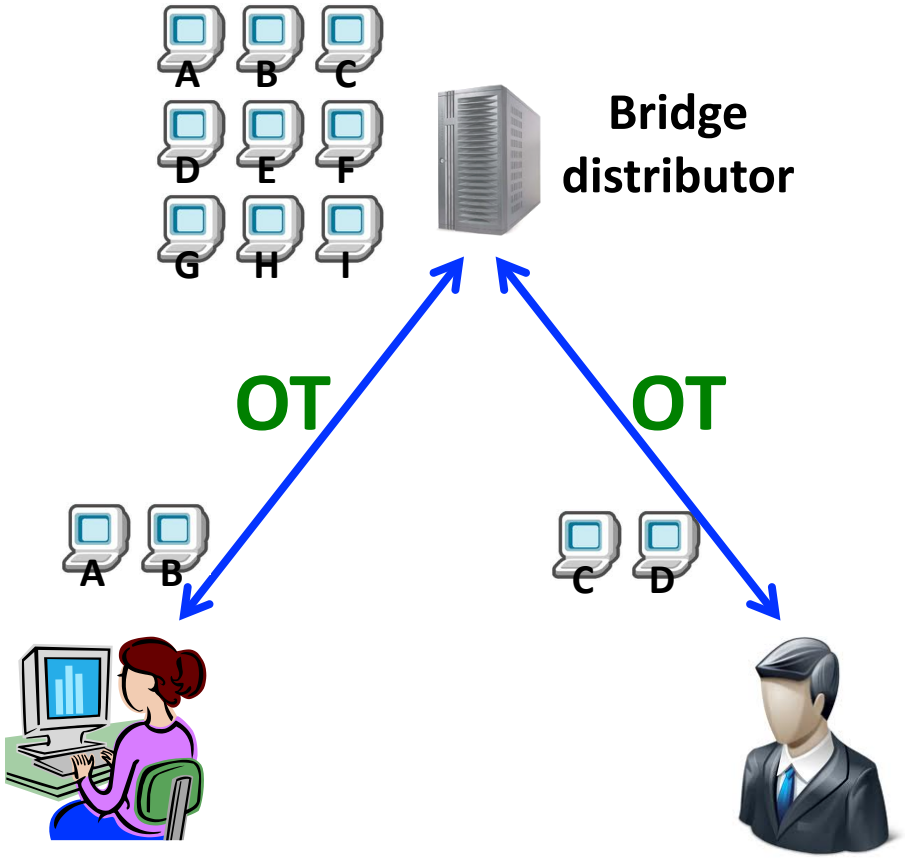
The basic rBridge scheme (without privacy preservation):



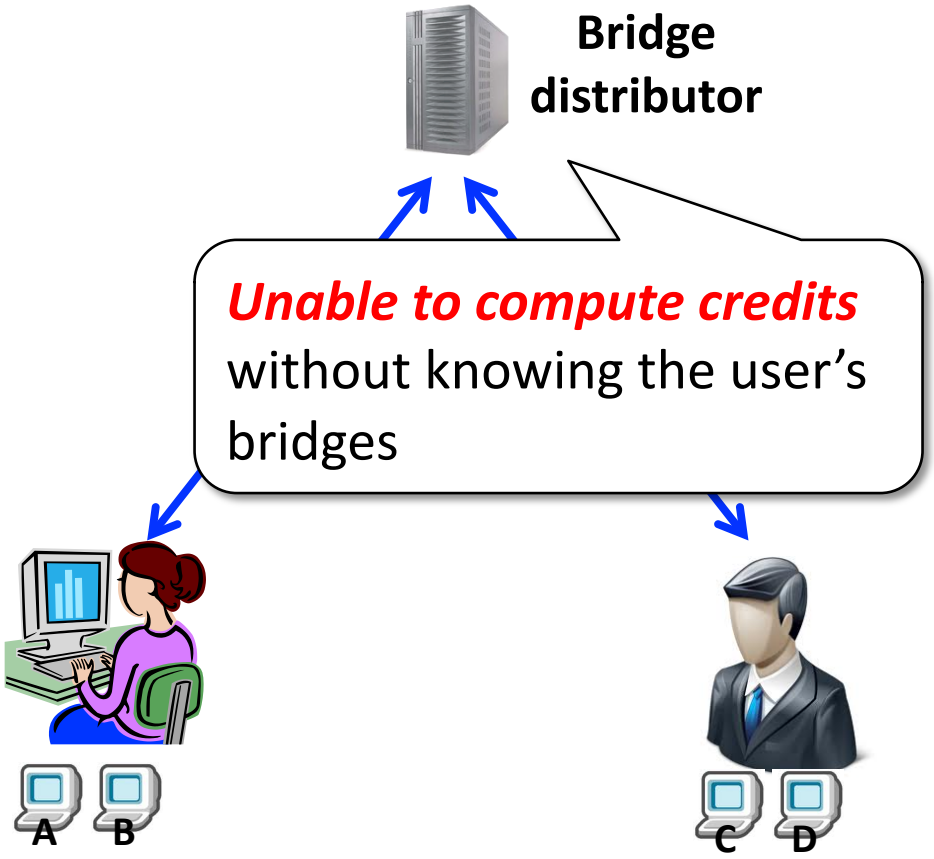
Bridge distributor

rBridge: privacy preservation

Use ***Oblivious Transfer (OT)*** to give out bridges, while ***hiding which bridges are received by the user***.

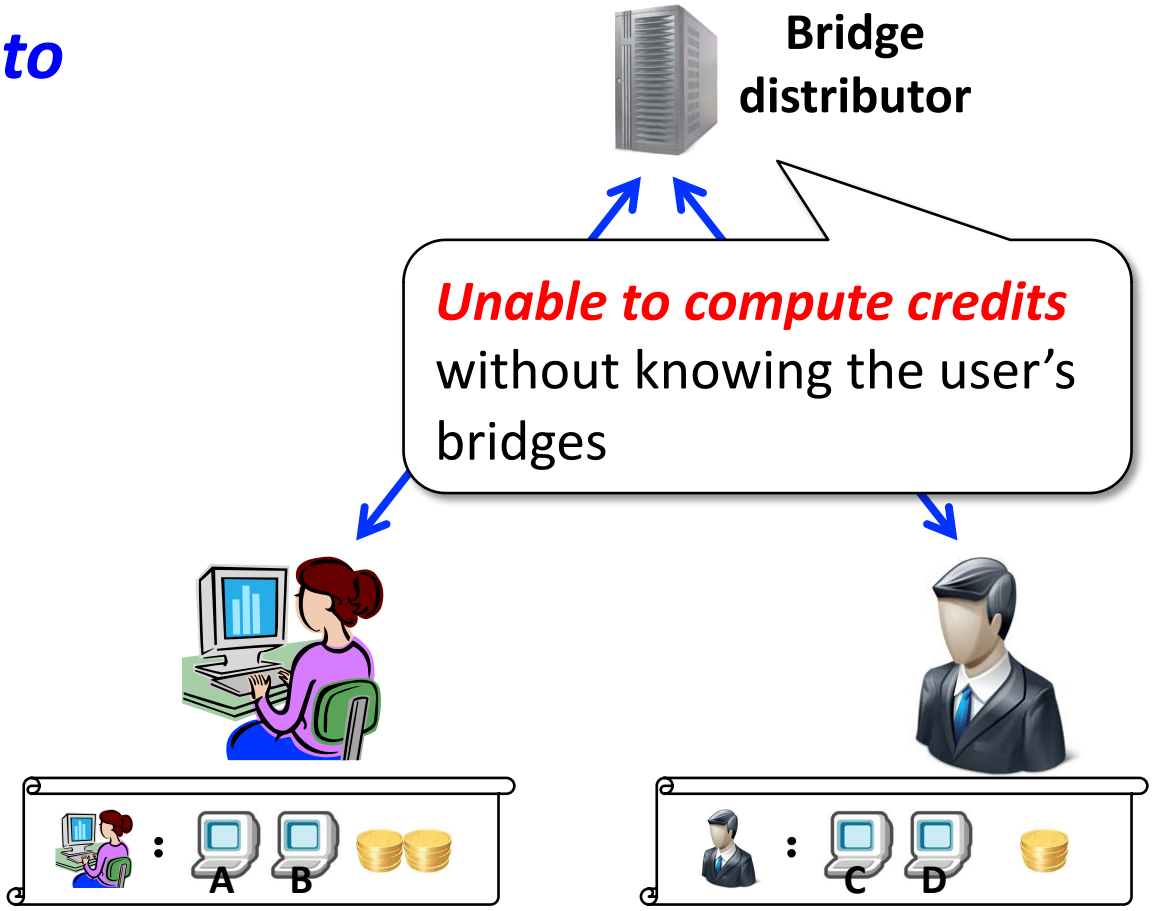


rBridge: privacy preservation



rBridge: privacy preservation

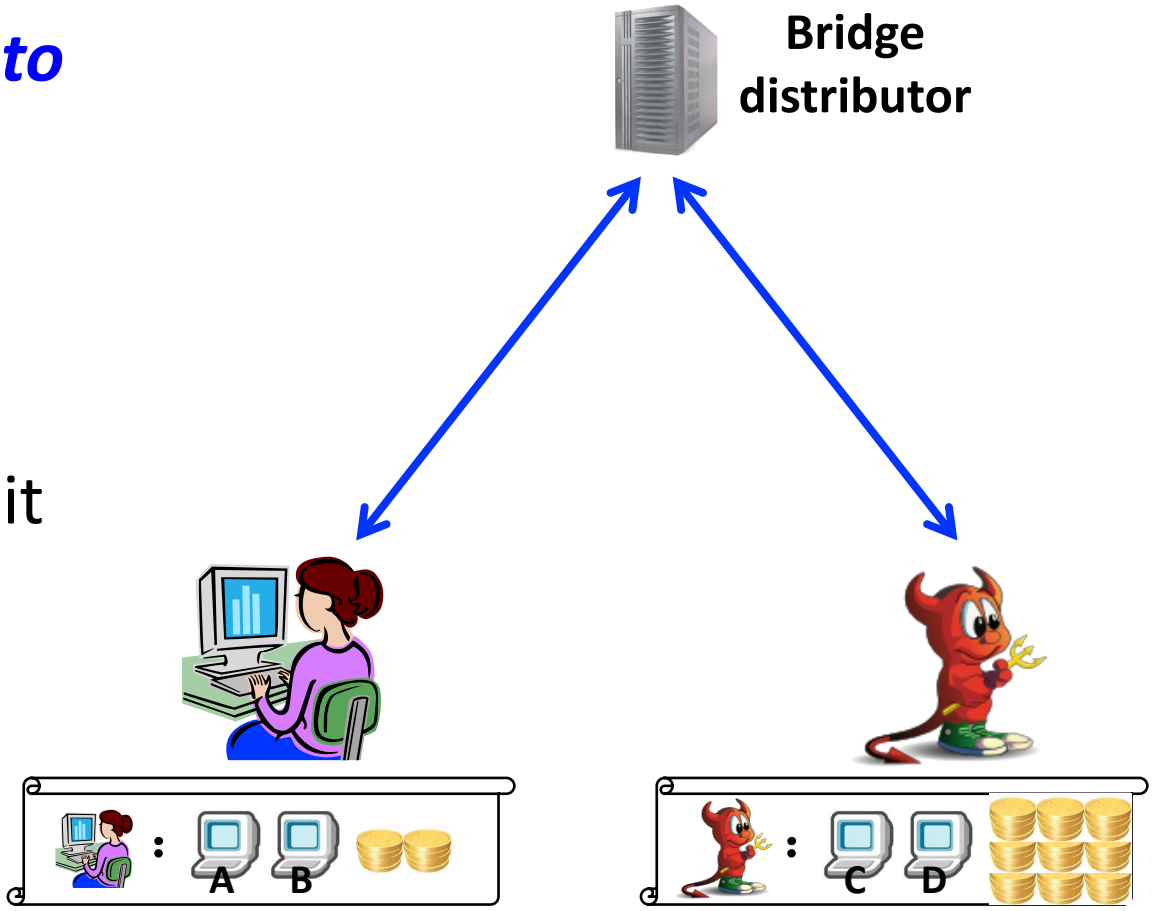
Delegate the task of computing reputation to users themselves.



rBridge: privacy preservation

Delegate the task of computing reputation to users themselves.

We need to prevent ***user misbehavior***, e.g., manipulating credit balance.



rBridge: privacy preservation

Anonymous Credential

: **Pseudonym X**

: **Credit balance Φ**

: ID of assigned **bridge B_i**,
time T_i when B_i was given to X,
#credits Φ_i earned from B_i

rBridge: privacy preservation

Anonymous Credential

: **Pseudonym X**

: **Credit balance Φ**

: ID of assigned **bridge B_i**, **time T_i** when B_i was given to X, **#credits Φ_i** earned from B_i

Use ***blind signature*** to sign each part of the credential to ***prevent manipulation***.

rBridge: privacy preservation

Anonymous Credential

: **Pseudonym X**

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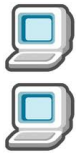
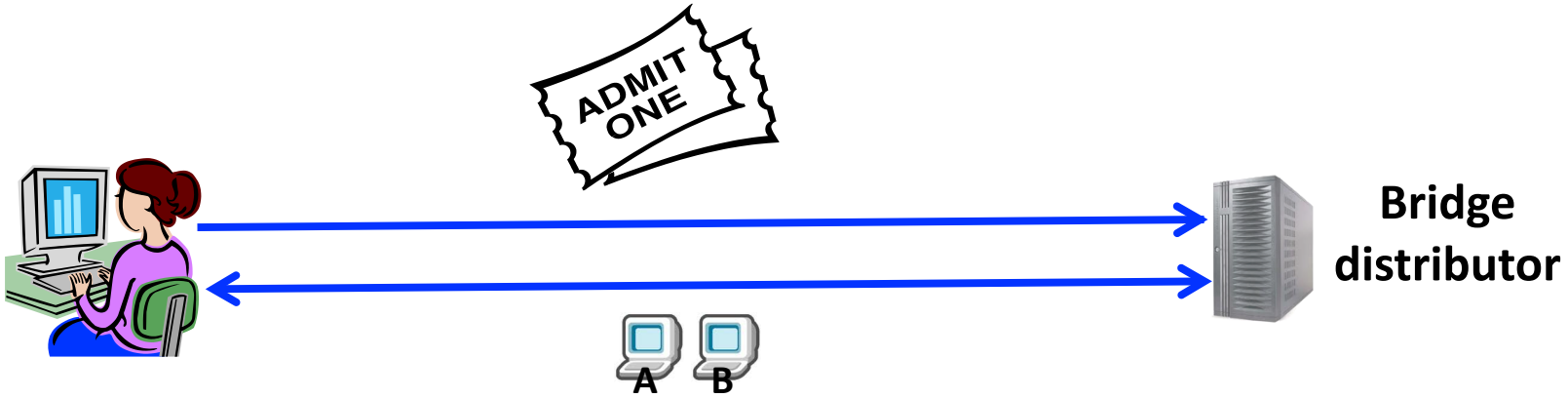


: ID of assigned **bridge B**
time T_i when B_i was gi
#credits Φ_i earned fro

Use ***blind signature*** to sign each part of the credential to ***prevent manipulation***.

Use ***zero-knowledge proofs*** to prove the information on the credential is correct while ***hiding all the information from the bridge distributor***.

1. Registration



OT

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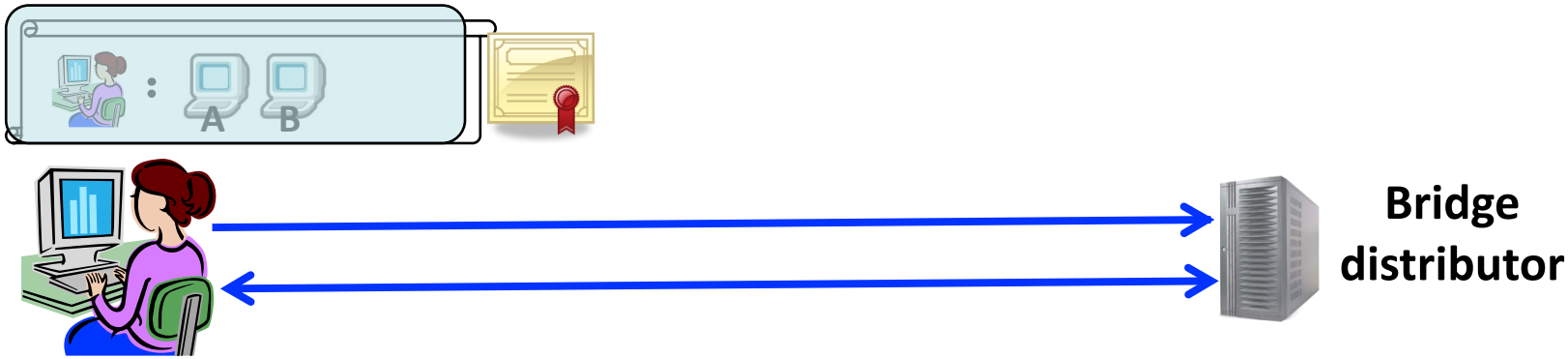

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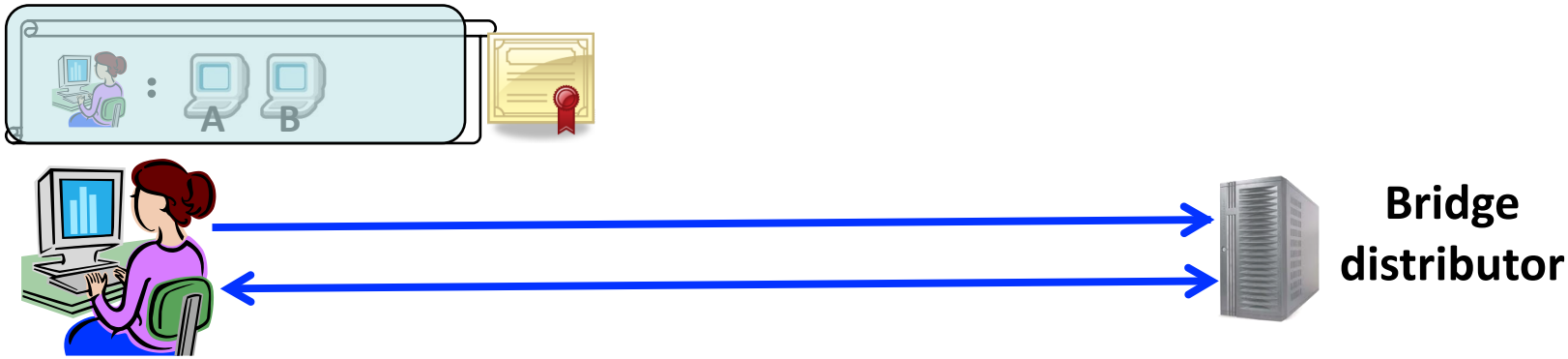

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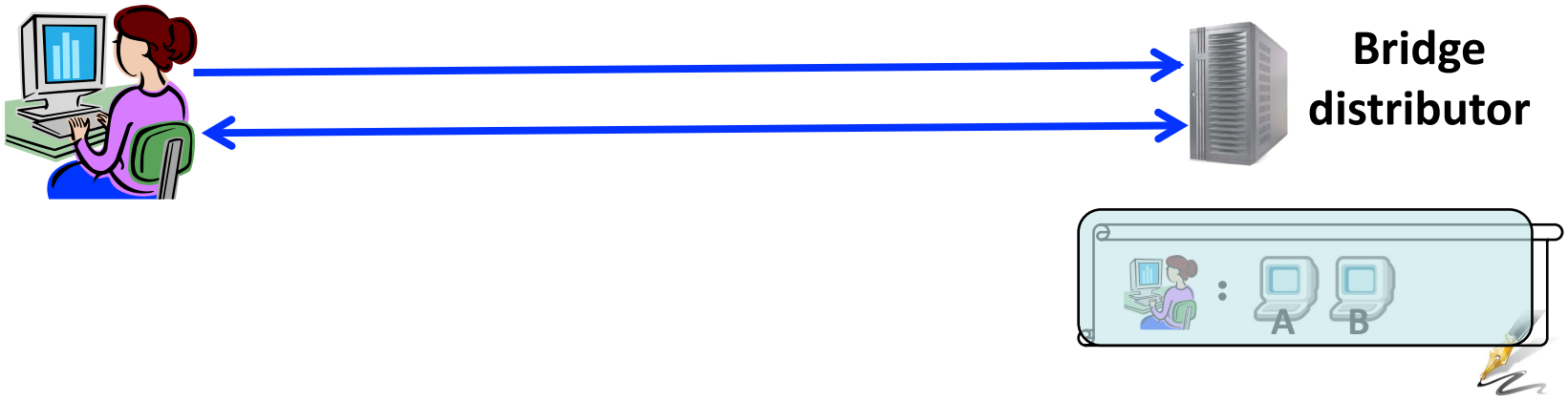
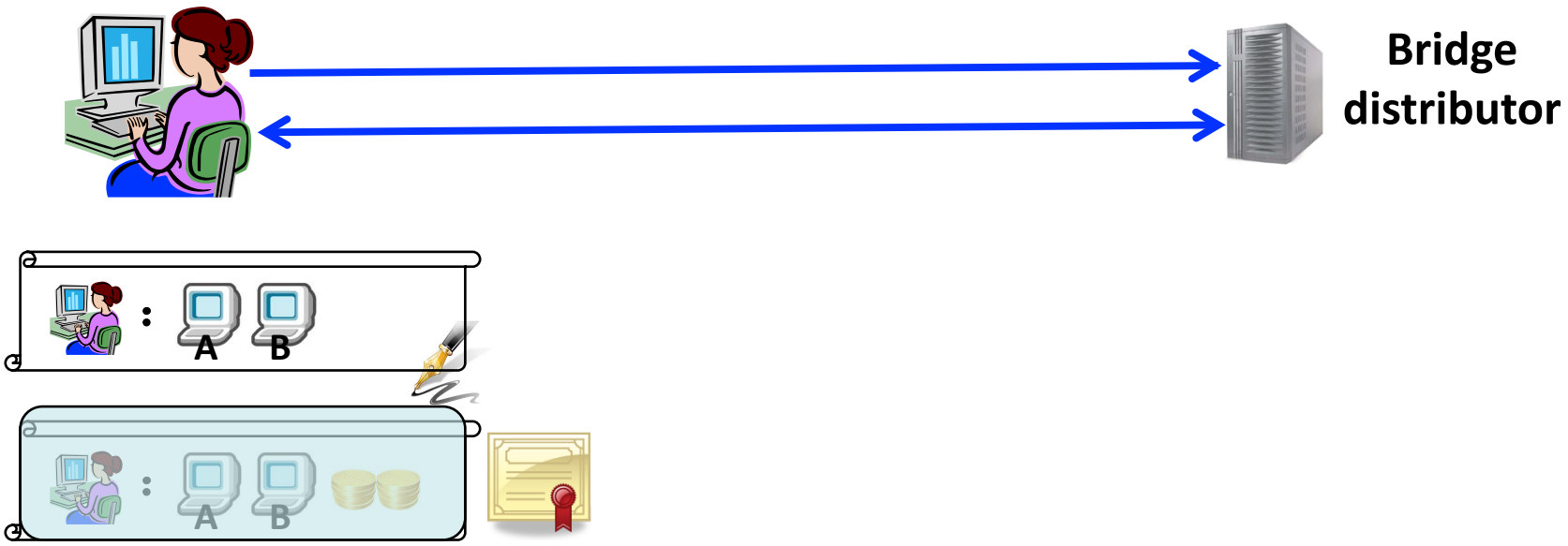


2. Update Credit Balance



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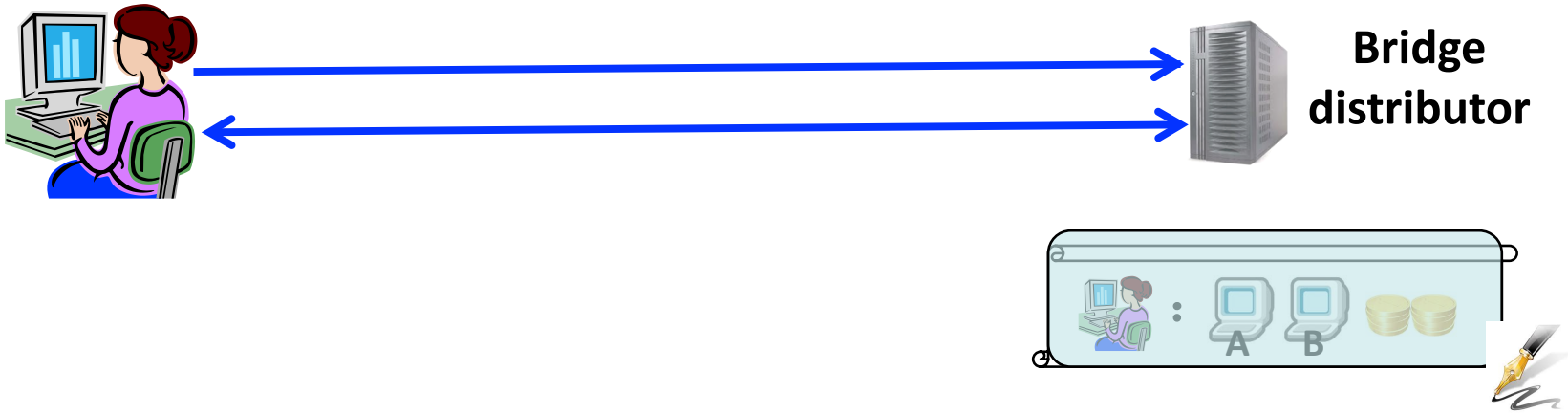
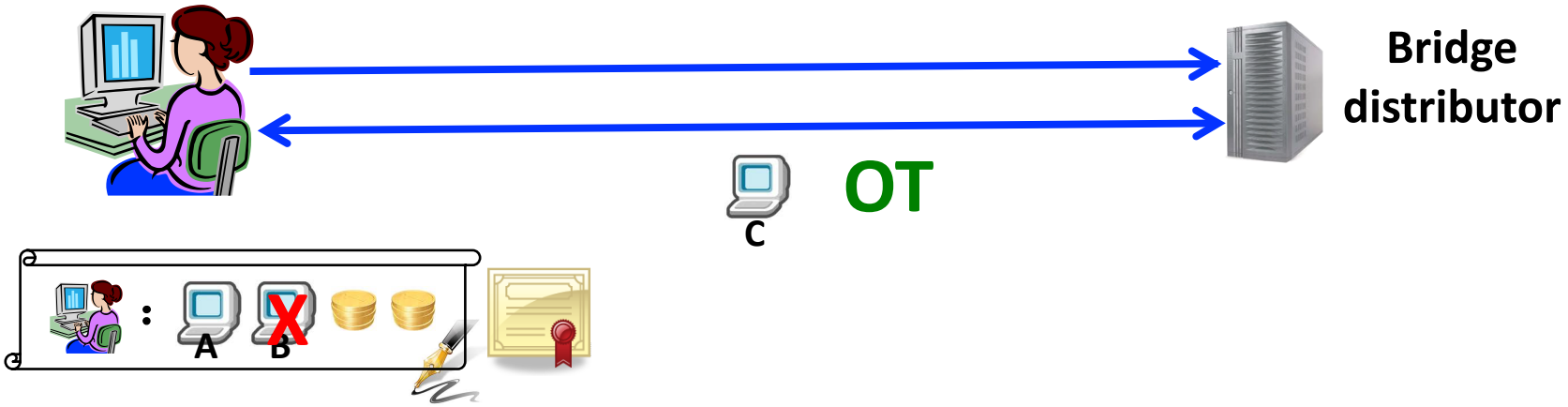


3. Bridge Exchange



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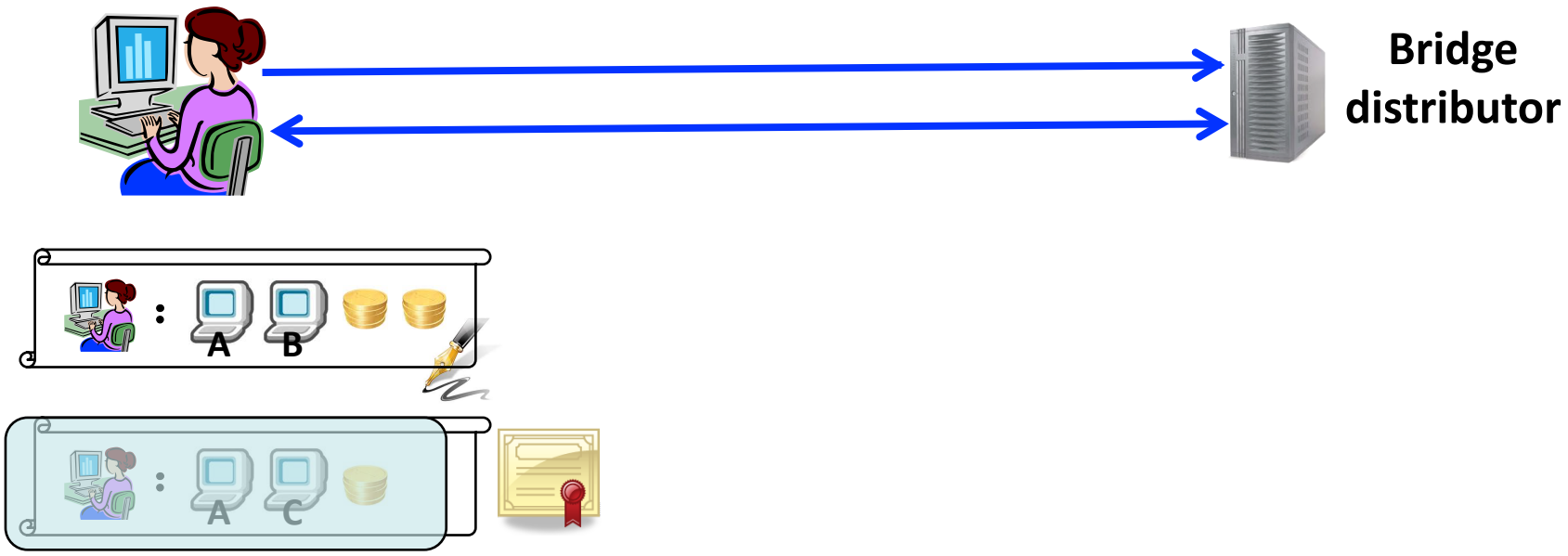

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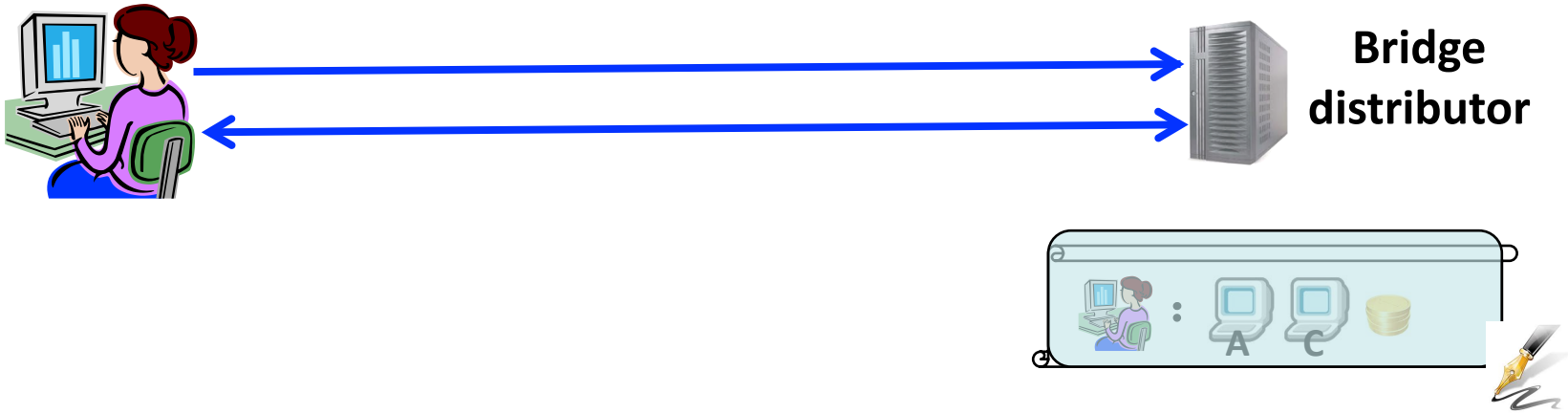

Performance evaluation

Table 1: Performance (averaged over 100 runs)

Operation	Comp. (s) U	Comp. (s) D	Comm. (KB)
Registration	5.15	17.44	388.1
Updating credit balance	0.51	0.47	34.7
Getting a new bridge	5.35	17.62	340.1
Inviting new users	0.27	0.16	2.0

These operations are ***infrequent***!

Performance evaluation

Table 1: Performance (averaged over 100 runs)

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These operations are ***infrequent***!

In the current Tor network, each client needs to download 120 KB network-status file every 3 hours

Summary

- Leverage ***user reputation*** to bridge the gap between robustness and openness in Tor bridge distribution.
  - High-reputation users can ***buy*** bridges and ***invite*** new friends
  - Much higher ***robustness*** than previous work
- Design the first ***privacy-preserving*** bridge distribution scheme
  - Use Oblivious Transfer, Commitment, Zero-knowledge Proof, and Blind Signature as building blocks.

Thank you!

Question?