TOR : THE SECOND GENERATION ONION ROUTER

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What is Onion Routing?

- Creates a random route from source to destination
- Each router is only aware of it's adjacent hops
- The route through the “onion field” is determined by the client
- Data is encrypted, including next and previous hop info (header)

What is Tor?

- Second Generation Onion Routing Network
- Provides a client / proxy for interfacing with

Onion Routers

- Speaks SOCKS to the local operating system
- Speaks TLS to the Onions Routers

Design Goals and Assumptions-1

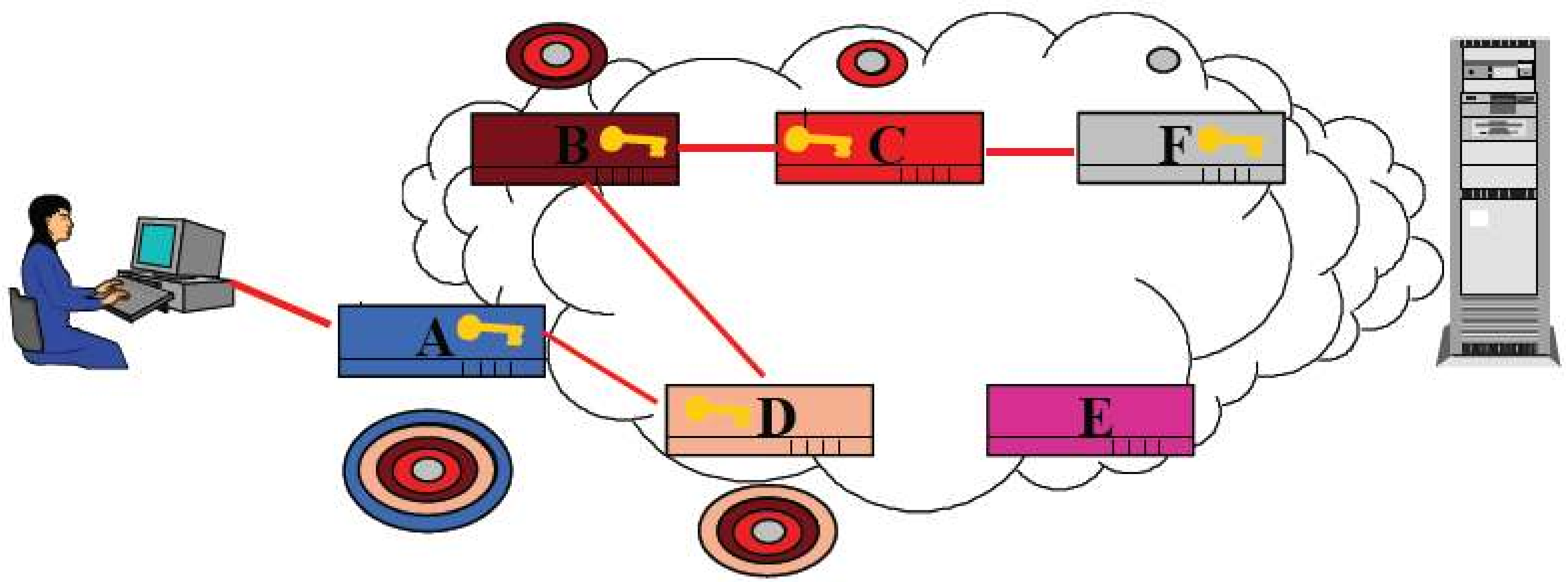
- **Goals**
  - **Deployability** – conformant for real word use
  - **Usability** – more usable , more users , more anonymity , no platform change needed
  - **Flexiblity**– is a base for future desing
  - **Simple desing**

*****Main goal is to frustrate attackers from linking communicating partners.

Design Goals and Assumptions-2

- **Non Goals**
  - **Not peer-to-peer**
    - Thousends of short lived servers, many controlled by adversary
  - **Not secure against end-to-end attack**
    - Connection between OP and entry node is the weak point

The TOR Design 1



The Tor Desing(cells and used keys)

2	1	509 bytes
CircID	CMD	DATA

2	1	2	6	2	1	498
CircID	Relay	StreamID	Digest	Len	CMD	DATA

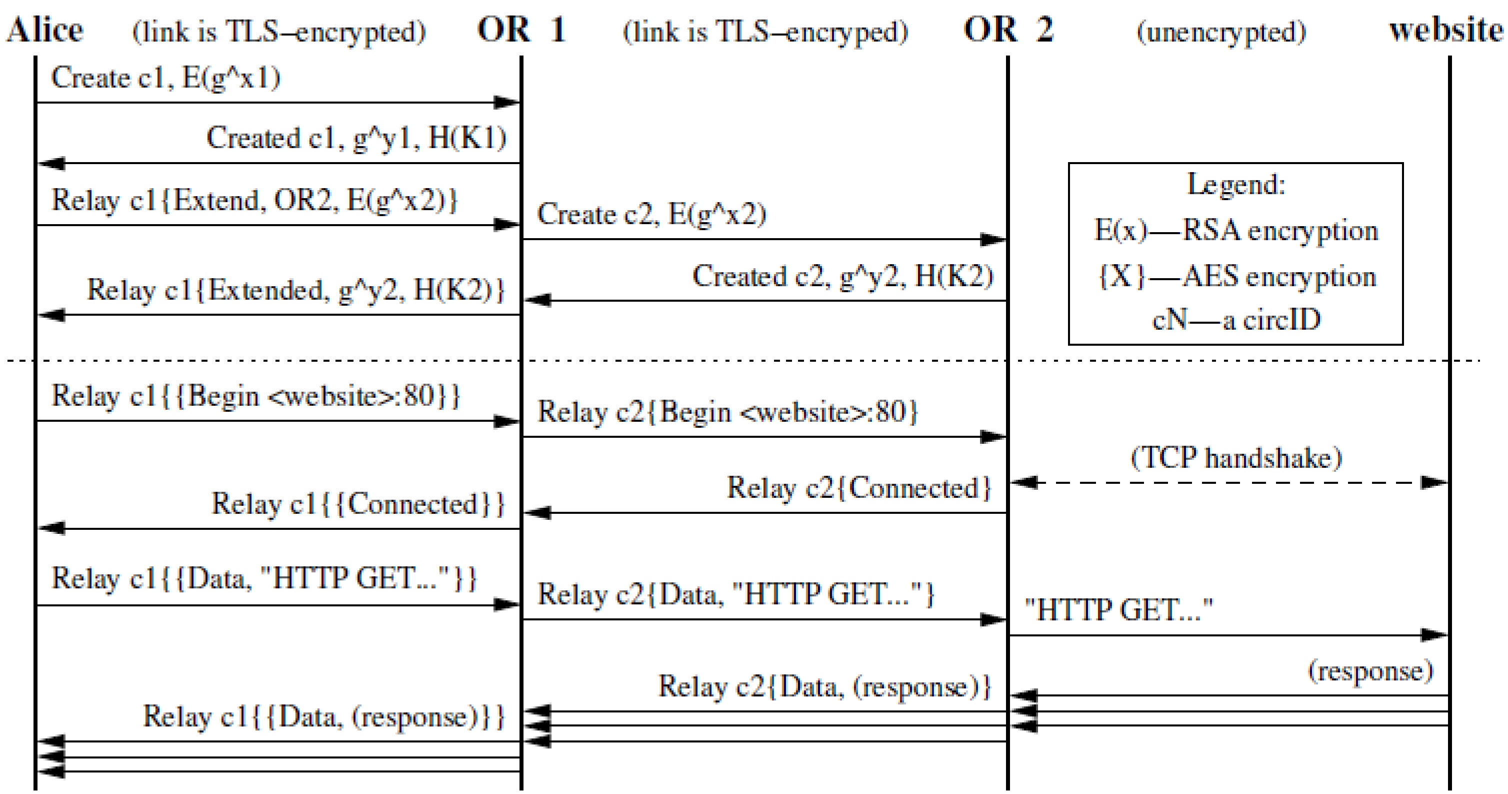
- **Cells**
  - 512 byte cells
  - Command types:control ,relay
    - control cell types:padding ,create-created , destroy
    - Relay cell types:**relay begin,relay connected**, **relay extend ,relay extended**, **relay data**,relay end ,relay truncate , relay
  - 1-**create cell** to construct circuit

    2- **relay cell**
  - Sign digest + (header-payload) encyrpted with shared Diffie Hellman key

Onion routers (OR)

- Maintains TLS connection with each node
  - long - term identity key
    - Router discription , directoryies.
  - Short – term
    - Onion key (the private key for Public key cryptography) in TLS .
    - Shared secret key with other ORs(Diffie Hellman handshake) shared by TLS .

The Tor Desing(constructing a circuit)



Tor Features

- Congestion Control
- Directory Servers
- Integrity Checking
- Configurable Exit Policies
- Perfect forward Secrecy
- Location-Hidden services, "Rendezvous

Points"

Congestion Control

- Enough user choose the same OR1-OR2 connection for their circuits.
  - **Methods:**

    1- circuit level throttling

    *OR keeps two window:

    packaging window , delivery window

    *if **packaging window = 0** then **wait relay sendme cell**

    2-stream level throttling

    packaging window , delivery window

    *if pending bytes > 10 send relay sendme cell , not after every enough data.

Directory Servers

- In Original Onion Routing each router floods its state to network periodically.
  - Because of delays Directory Servers are not syncron at a time.This helps attacker
- TOR uses trusthworthy routes as directory servers.
  - DS signs the directory , OR sends signed statement and download the directory periodically.
  - OR who has invalid key are not in directory
- Variety of attacks remain
  - Attacker can control DS.
  - Gives only nodes he controls ,
  - Differences between DS.

Directory Servers Assumptions

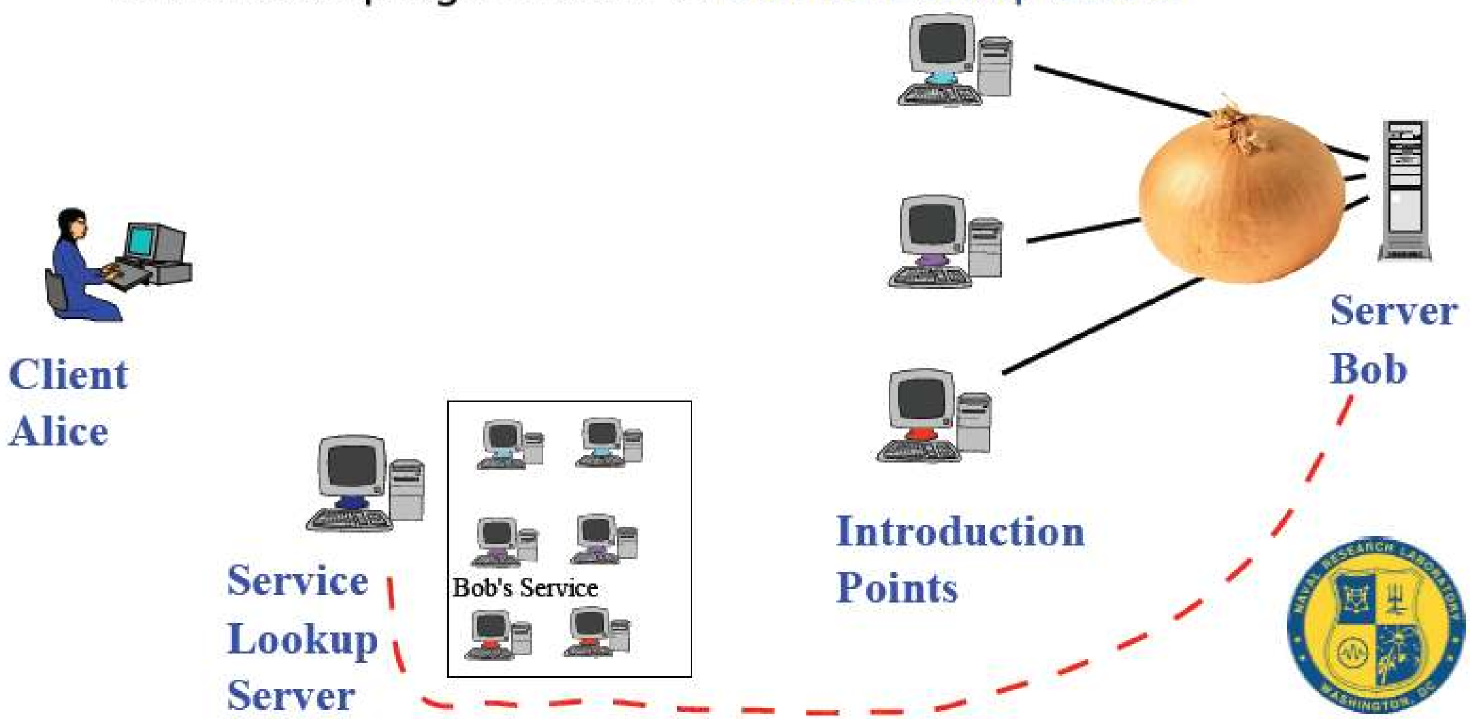
- All participants aggree on the set of Directory Servers
- Needs a threshold consensus of the current state of the network.
- When a consensus directory cannot be reached then **human administration** is needed.

Integrity Checking on streams

- Any integrity checking in Original Onion Routing
- TOR uses TLS , public key - private key cryptography together and attacker cant modify data.
- Integrity is checked at the edges.Only exit node can control the digest.

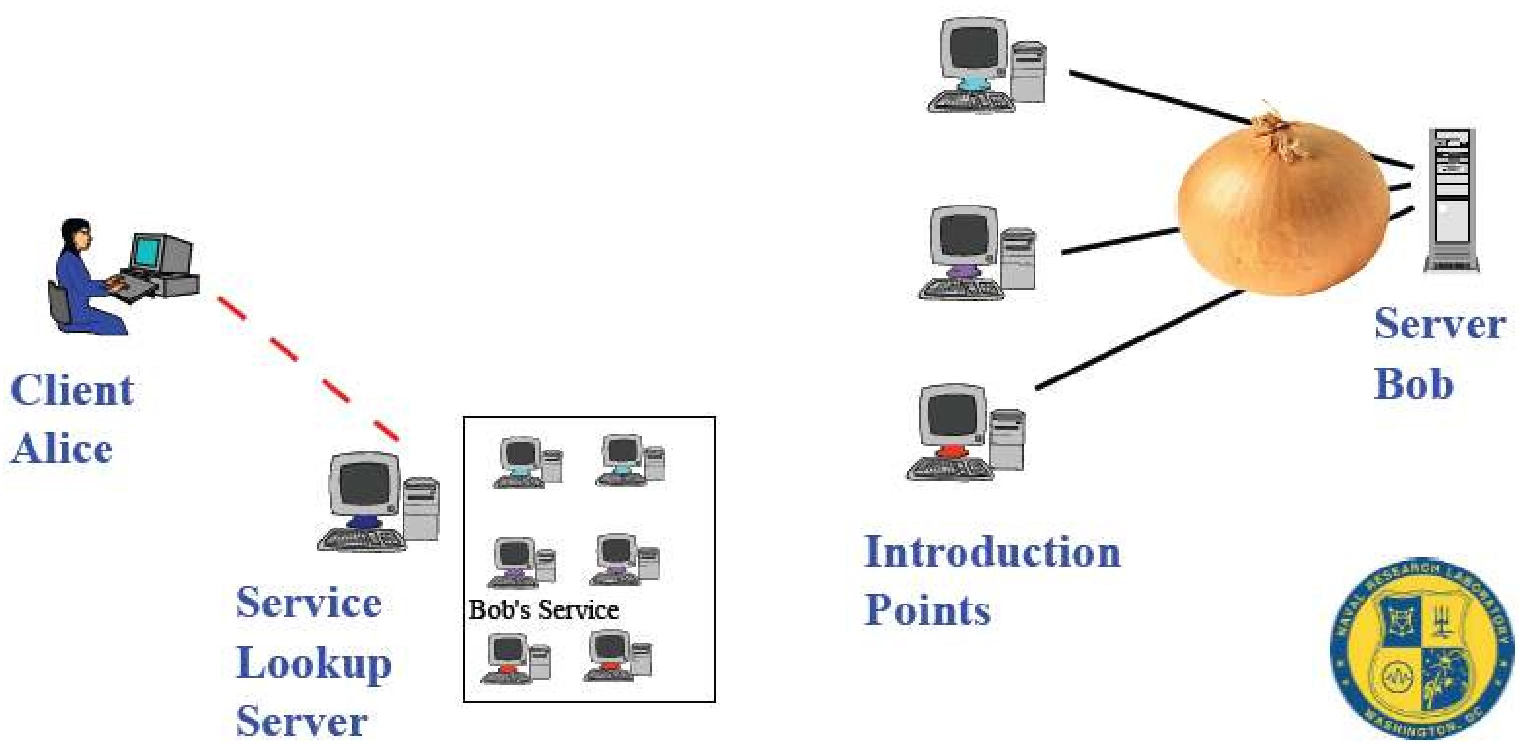
Location-Hidden services,"Rendezvous Points"

1. Server Bob creates onion routes to Introduction Points (IP)
2. Bob gets Service Descriptor incl. Intro Pt. addresses to Alice
   - In this example gives them to Service Lookup Server



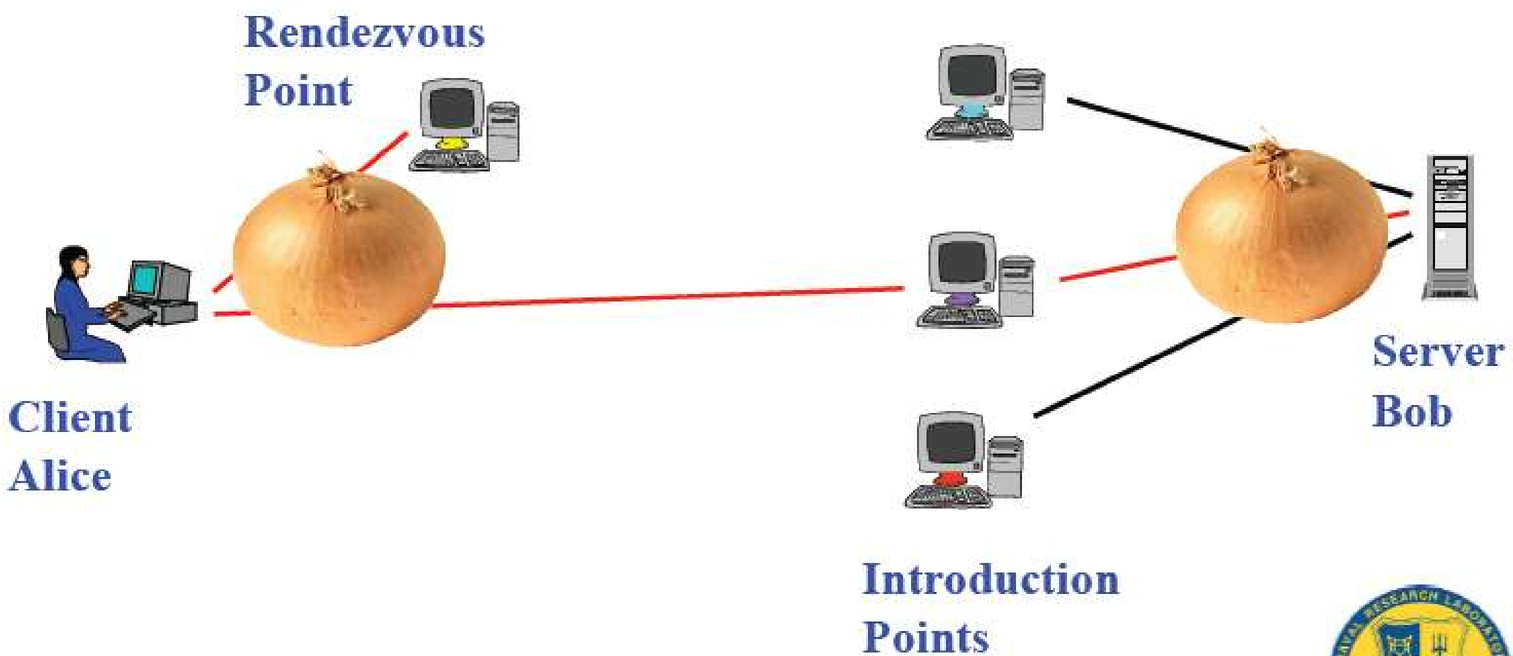
Location-Hidden services,"Rendezvous Points"

2'. Alice obtains Service Descriptor (including Intro Pt. address) at Lookup Server



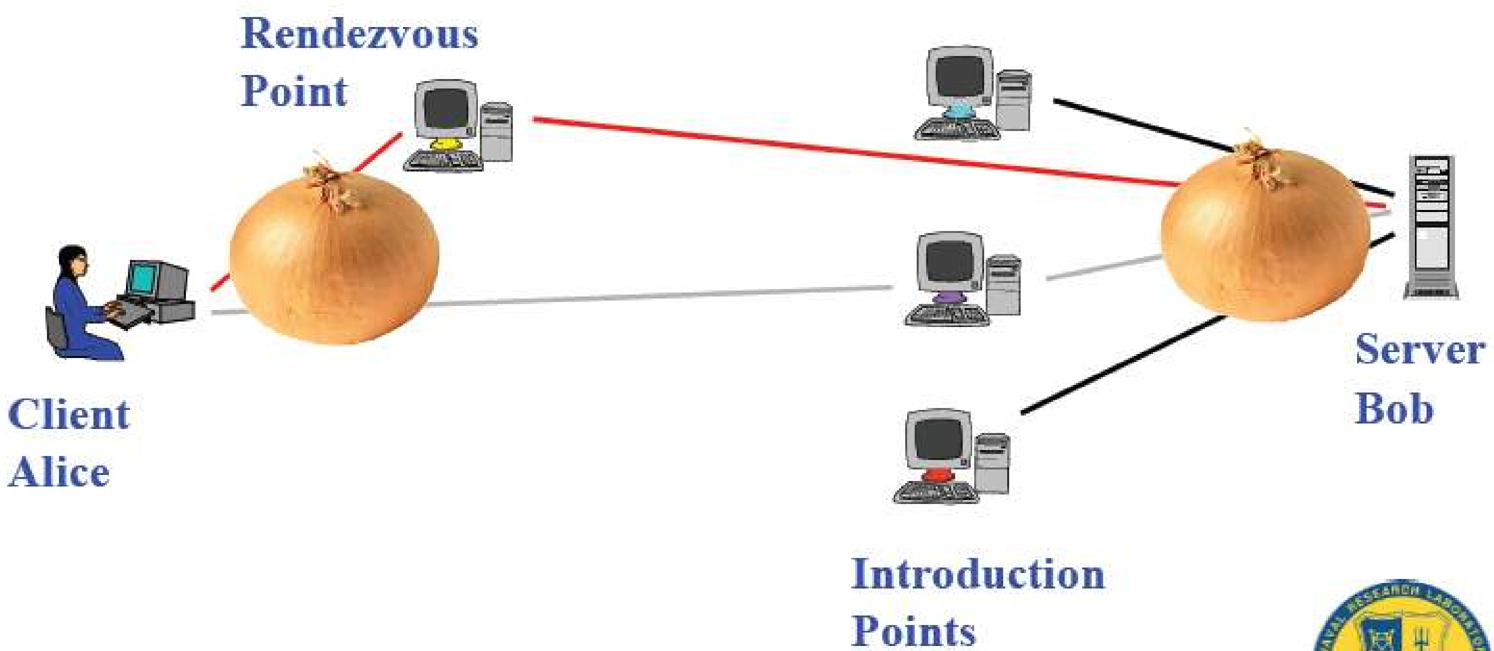
Location-Hidden services,"Rendezvous Points"

3. Client Alice creates onion route to Rendezvous Point (RP)
4. Alice sends RP addr. and any authorization through IP to Bob



Location-Hidden services,“Rendezvous Points”

5. If Bob chooses to talk to Alice, connects to Rendezvous Point
6. Rendezvous point mates the circuits from Alice and Bob



Attacks on TOR

- Traffic analysis attacks
- Compromise keys (perfect secrecy)
- Run on onion proxy
- Replace contents of unouthenticated protocols
  - Don’t use HTTP
- Run a hostile OR
  - Make itself trustworhty to a Directory Server
- Destroy directory servers
- Make many interaction nodes as a Rendezvous Point
  - Defence:Filtering in Introduction Points
- Disrupt an introduction point
  - New introduction point will be published and Introduction points published only for trusthworthy clients.
- Compromise an introduction point
  - Flood interaction requests to bob
  - Bob recognise a flood and close the related circuit.

Open questions

- What would be period of refreshing the circuits.
- What would be the hop count in a circuit.
- Is random path length is neccesary.
- Hydra topology could be used.
  - Many inputs and few exit nodes.

Future Directions

- Bandwith
  - ORs have good bandwith and latency,
  - ORs can advertise their bandwith and selecting nodes could be done according to this info.
- Incentives(teşvik)
  - Reward users with better anonymity,more nodes means more anonymity.
- Better directory distribution
  - Entire network state downloaded every 15 minutes.**Only updates** could be downloaded.
- Caching at exit nodes
  - exit nodes should run a caching proxy – forward secrecy is weakened
- Wider-scale deployment
  - Having more users , evaluation of design principles will be more realistic(robustness – latency tradeoff , abuse preventation)