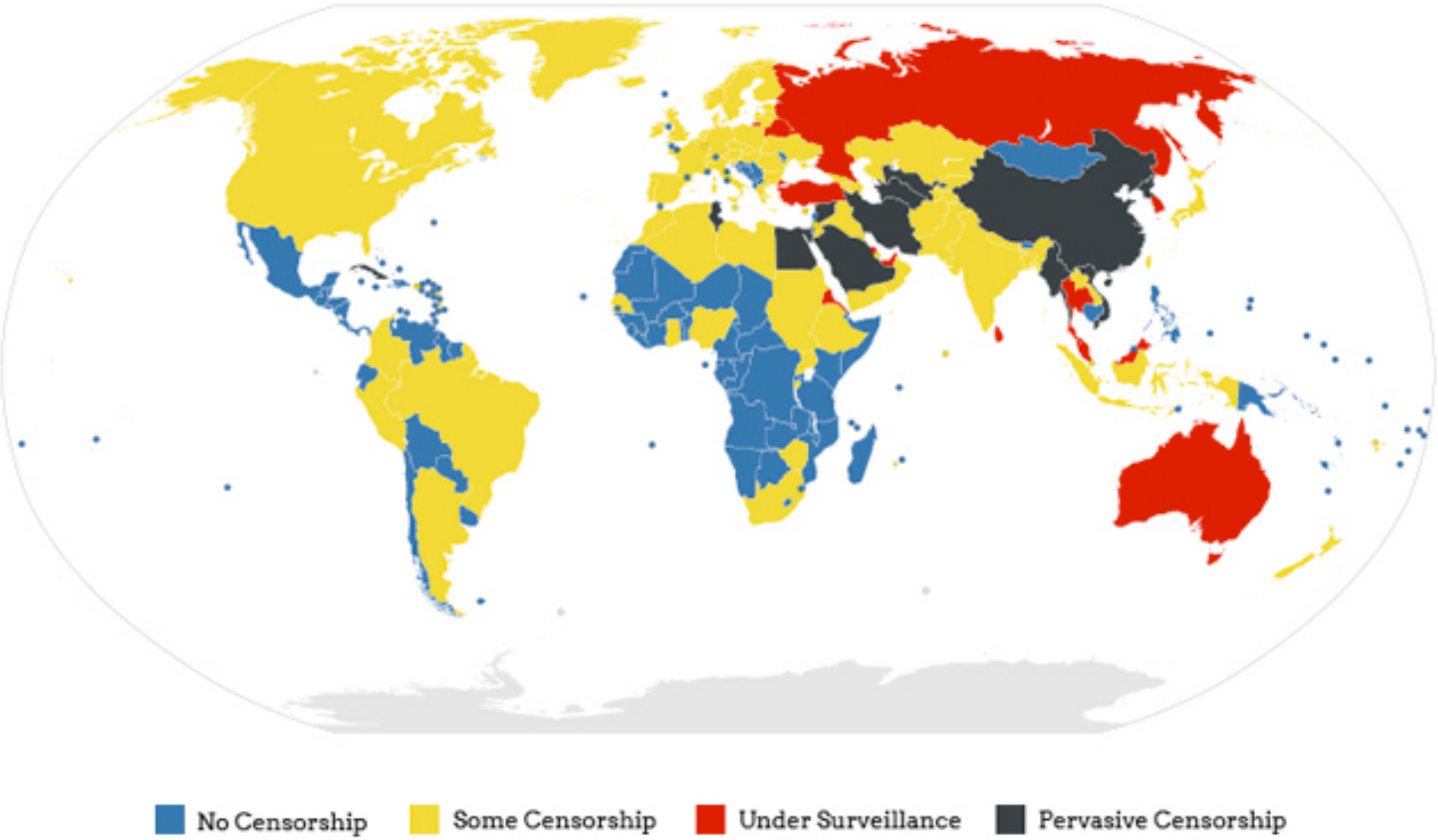
ON DECOY ROUTING

AND BUILDING A PRACTICAL INFRASTRUCTURE

STRUCTURE

- Motivation
- Decoy Routing
- Software-Defined Networking
- Do Decoy *Switches* Help?

MOTIVATION



Data Source: Reporters Without Borders

- Governments and ISPs censor data.
    - What data?
        - Blogs, Political Parties, Individuals, NGOs …
    - Why?
        - National Security, Values, Stability

- Standard Approach: Onion Routing
- Build route of relays
  - Nested encryption
  - Only entry node sees source location
  - Only exit node sees destination

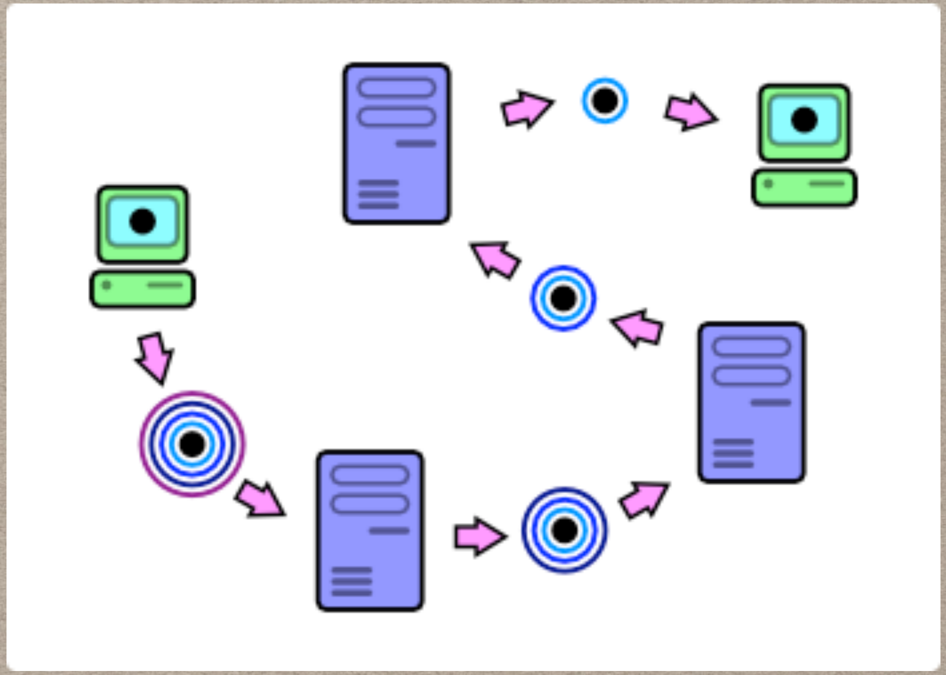


Image by William Hua, McMaster University

- Caveats :
  - Use SOCKS 4a proxy (Else DNS server sees)
  - Use HTTPS anyway
  - Must find entry relays to use Tor

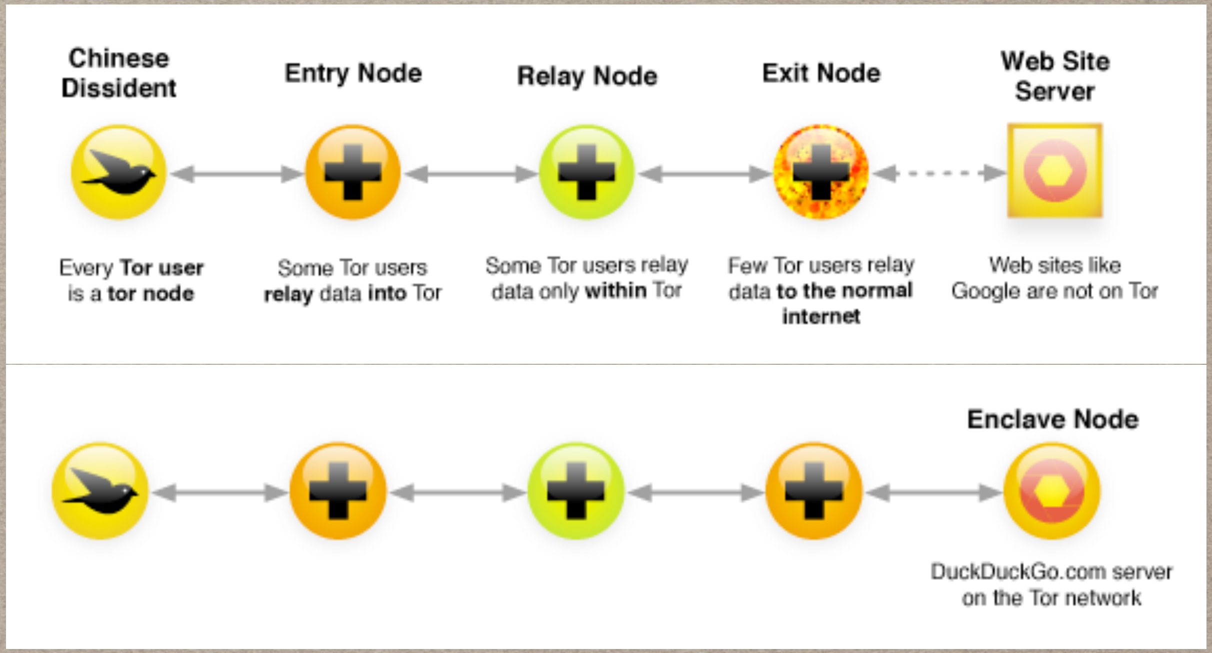

Chinese Dissident
Entry Node
Relay Node
Exit Node
Web Site Server
Every Tor user is a tor node
Some Tor users relay data into Tor
Some Tor users relay data only within Tor
Few Tor users relay data to the normal internet
Web sites like Google are not on Tor
Enclave Node
DuckDuckGo.com server on the Tor network

Image by indolering.com

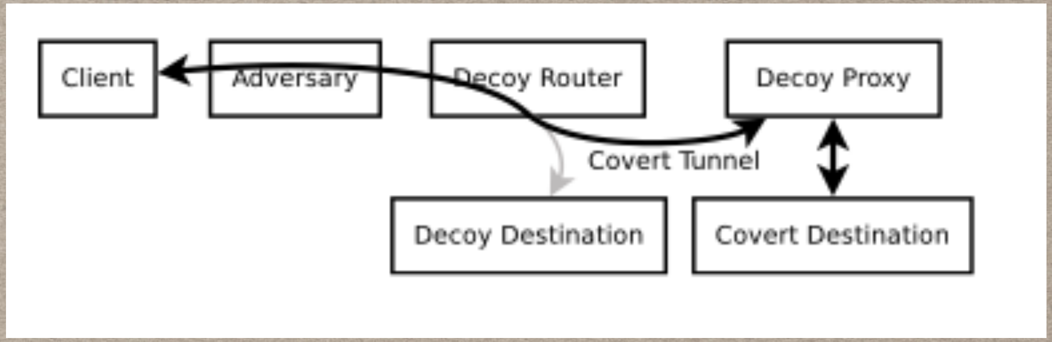
- Entry relay list publicly available from directory
  - Adversary sees, blocks
- Make some secret entry relays *not* in directory
  - Tor bridges
- … still need to be discoverable
  - Adversary sees, blocks

- Winter/Lindskog (2012) :
  - China etc. use deep pattern inspection to detect “handshake”
  - Make Tor traffic look like something else
    - Skype etc.
    - Obfsproxy …

- This is an arms race
- Pluggable transports are not immune to detection
  - obfs, obfs2 deprecated …
  - now: obfs3, scramblesuit, fte, obfs4
- Can we find another solution?

DECOY ROUTING

- *Hosts* are easily filtered by IP address.
- *Routers*, not so.
  - Packets have no router addresses
  - IP network cannot control upstream path
  - Use well-placed router. Block Traceroute.



Decoy Routing, Karlin et al, FOCI 2011

- Basic idea: IP addresses are nonsense
    - Just used to get a flow through decoy router
- Covert signal to router to hijack
    - Port knocking, Payload lengths …
- TCP session hijacked, sent to decoy proxy
    - TCP options (window scale, SACK) passed encrypted (TLS client 28-byte random field)

- Notable implementations
  - Decoy Routing
  - Telex
  - Cirripede
  - TapDance

- … Problems with Practicality!
    - Cirripede : uses a registration server
        - all traffic sent by decoy router to server
        - could not be implemented
    - TapDance : let the message through
        - do without inline blocking. It’s too hard.

- What do we need?
    - Smart, controllable router … complex operations
    - Able to handle large-volume traffic at line speed
    - For example, TapDance implemented on 16-core server attached to mirror port on HP switch

SOFTWARE-DEFINED NETWORK

- Basic idea:
  - general purpose forwarding devices
  - data plane simple, configured remotely
  - controller - switch separation

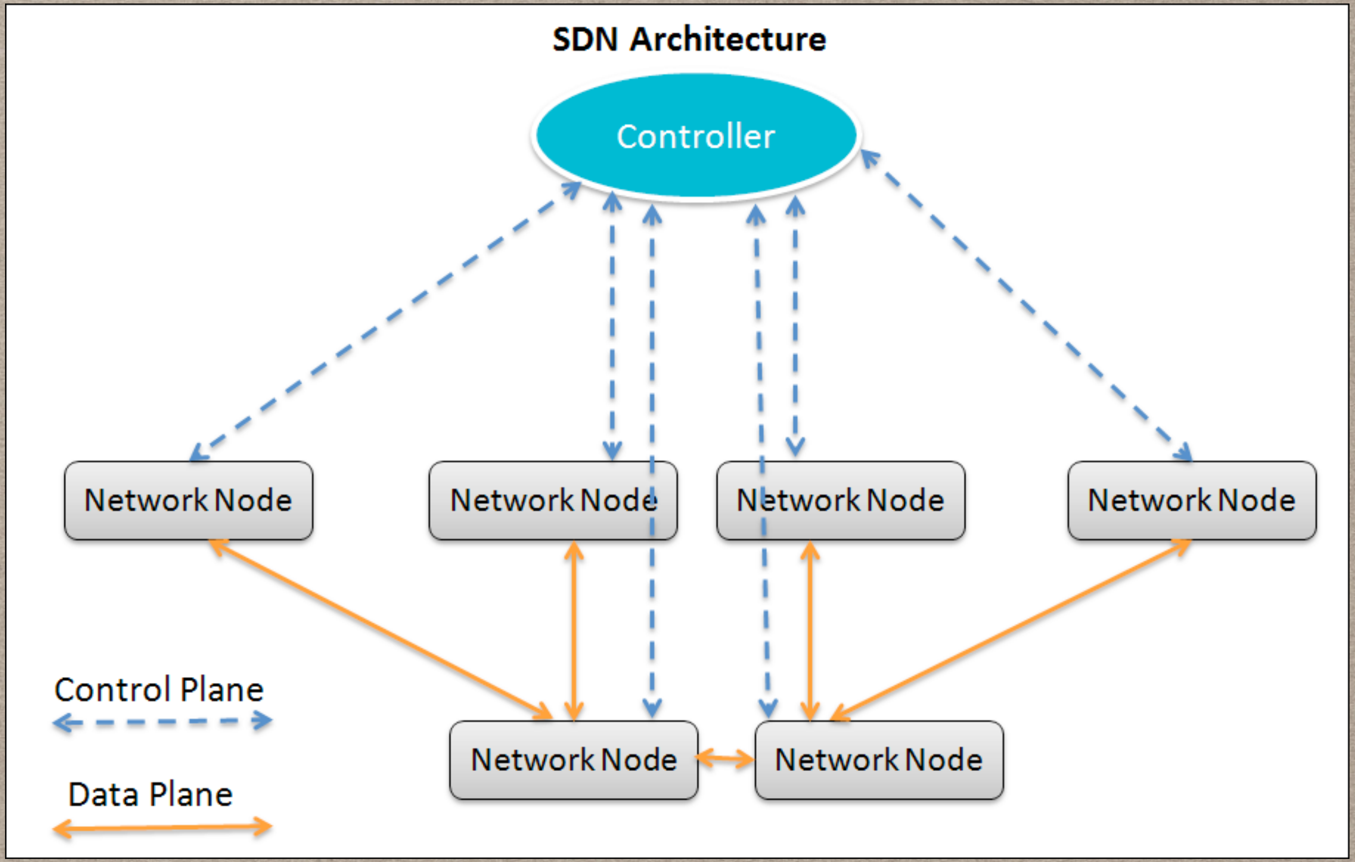


Image from aryaka.com

- Simple control plane - data plane interface
  - Standard : OpenFlow
- Switch :
  - Flow tables
  - Channel to controller
- Multiple flow tables, visited in order
  - Multiple actions can be applied to a packet
  - Push/pop labels, redirect at will
  - No encrypt/decrypt

- Controller makes decisions …
  - unknown flow? Send packet to controller
    - Cirripede
- Who IS controller?
  - Assuming ISP as adversary … isn’t controller under adversary control?

- Can we perhaps build decoy routers using SDN infrastructure?
  - Once out of the censoring domain, *we* can be the ISP!
- … do we *need* to be given controller access?

- Switch connections can be established with multiple controllers.
    - Default : OFPCR_ROLE_EQUAL
    - Hand-offs handled by … controllers
    - Switch dumb
        - reports all
        - no arbitration

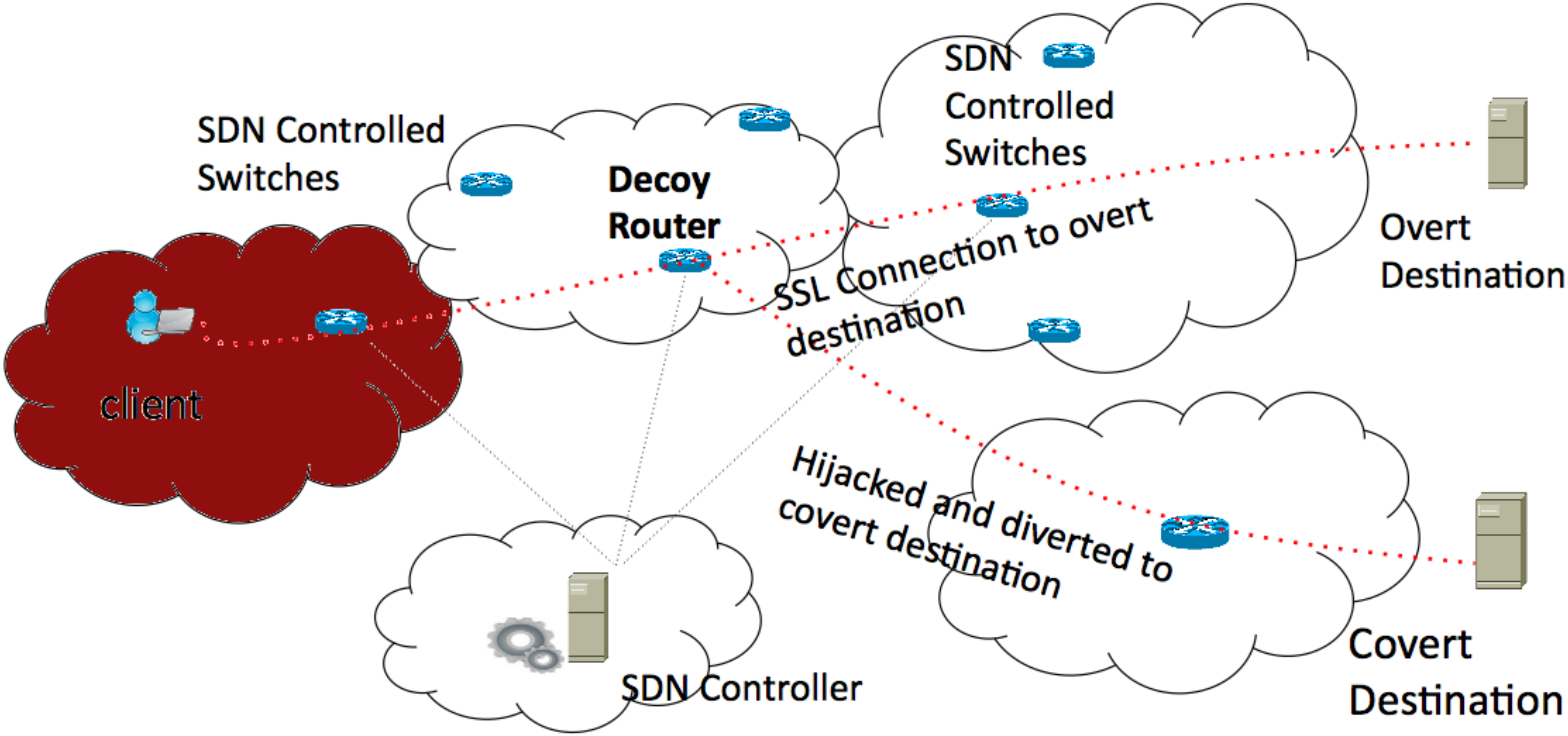
- Security not great - seems to be getting worse
    - OpenFlow 1.0 : TLS
    - OpenFlow 1.4 : TCP
(or TLS … but most take the easy road)
- Pwn switch : dpctl
- Pwn controller :
REST APIs,
poor passwords

DO DECOY *SWITCHES* HELP?

- Simple operations …
    - Switch just does traffic redirection
        - inline blocking etc. easy now

- Heck, if we really want, we can do complex stuff
    - Controller can detect handshakes using DPI etc.

Decoy Routing Architecture Involving SDN Controlled Switches (Acting as Decoy Routers)



- What are the major wins?
  - Speed, for one. L3 (NAT-like) rather than L5 proxy function.
  - Choice. We now have multiple decoy routers.
  - General SDN wins : administration
    - Load balancing, Failover, Error detection

- Blue-sky : use controller to get a directory service?
  - Right now - simply redirect client request (covert “give me choices” message) to directory server, to get overt destinations
- Hiding tracks
  - Two SDNs … X decoys the messages between Y’s controller and switches, and vice versa

- How far have we got?
  - Not very - simulating NAT vs proxy performance on Mininet …
  - Next step : evaluate on real iron (ExoGENI)
  - Long term : cascade routers, detect misbehavior, see resilience to DoS

Ideas, Questions, Todos, …

-Thanks!