radware
availability | performance | security

Turbot

“Catch me if you can”

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Ziv Gadot
Security Operation Center (SOC)

Smart Network. Smart Business.

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Agenda

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- Introduction
  - What are the existing problems of Botnets communication
  - A new domain for Botnets communication: web services
- Turbot Protocol
- Turbot Demo
- Turbot Analysis
- Summary
- Q&A

Introduction

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In order to understand where Botnets communication is going to we need to understand their existing problems first.

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- Conficker
  - Conficker A,B,C : HTTP
    - Domain names are PRNG
  - Conficker D,E : P2P
- Trends
  - Why did it use HTTP first?
    - HTTP blends into common traffic
  - Why was it forced back to P2P?
    - Had a single-point-of-failure in its HTTP protocol

Blend into Common Traffic

- Advantages
  - Minimizes potential network fingerprint
  - Passes corporate policy
    - HTTP is never blocked, whereas IRC and P2P are
  - Firewall/NAT issues
- Ultimately
  - HTTP/HTML
  - Client initiates requests
  - Legitimate sites

No Single Point of Failure

- Single Point of Failure (SPOF)
  - The ability to block communication by attacking a single set of resources
    - Resource takedown
      - IP, DNS or Site takedown
    - Blacklisting
      - Blocking the known resource
  - Technologies against SPOF
    - P2P (decentralized)
    - Conficker PRNG domain name – failed

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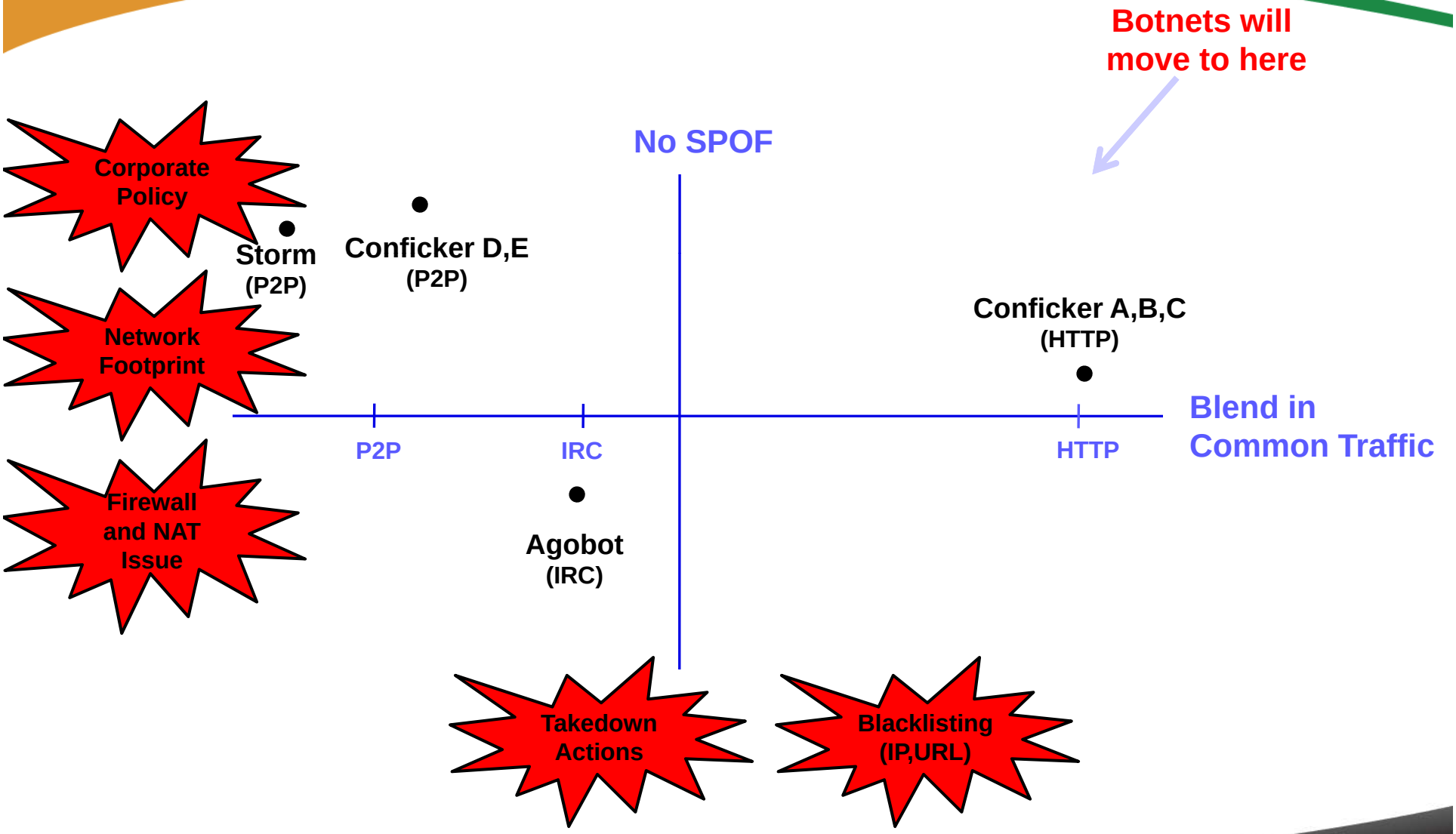

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Problem		Technology		
		IRC	P2P	HTTP
Blend in common traffic	Corporate-policy blocking	X	X	OK
	Network footprint detection	OK	X	OK
	Firewall and NAT issues	OK	X	OK
SPOF	Takedown Actions	X	OK	X
	Blacklisting (IP,URL)	OK	OK	X

- We assume a real fight against Botnets !
  - Full deployment of mitigation equipment.
  - Binaries are fully analyzed (protocol is fully known).
  - Security vendors (***security agent***) are resourceful and determined.

Turbot Protocol

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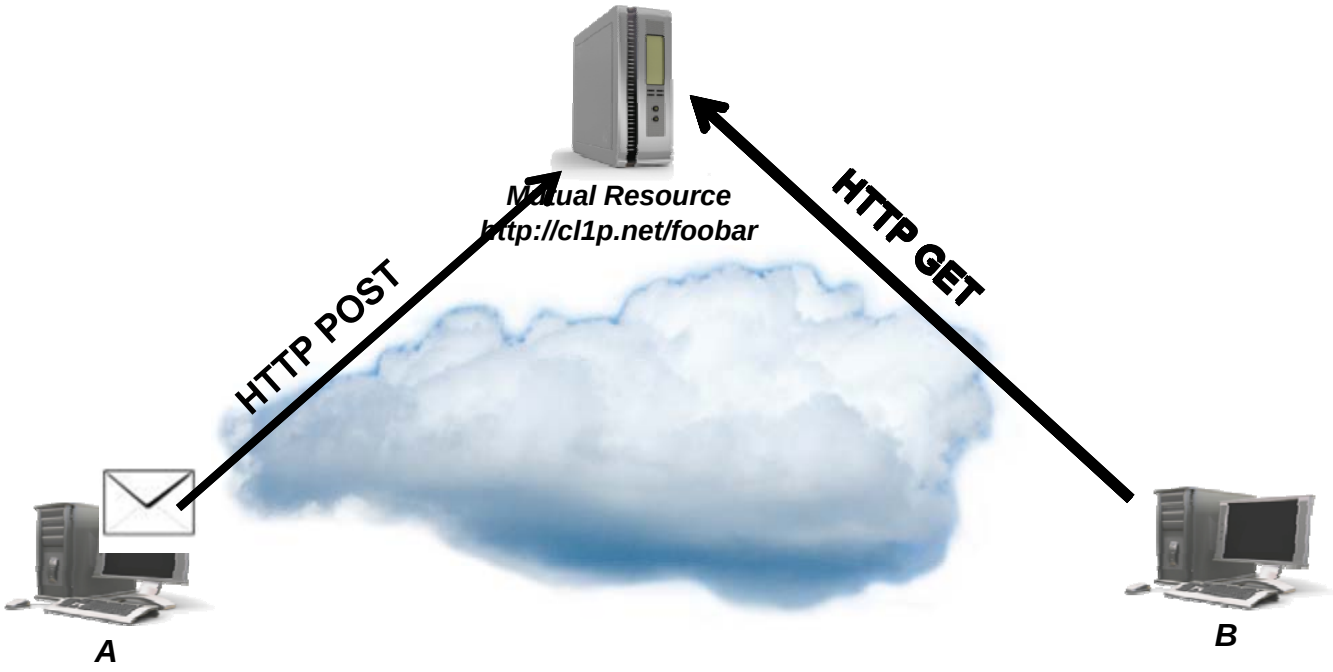
- Passing a message using web services is very easy (and obvious)
  - Open any writable mutual resource and send message in the form of new entries:
    - E-mail
    - Blog
    - Online documents
    - Wiki site
- Botnet (in particular the bots) cannot use many of them
  - No CAPTCHA or login please
    - Internet clipboards
    - Disposable email address
    - UGC (User Generated Content)

- Once A and B agree on a mutual resource they can
  - Monitor the resource for a new messages
  - Send new messages to that resource



Internet Clipboard

- Functionality
  - Copies any data to a specific URL to later paste in a different host
  - Also supports files and pictures
- Examples
  - www.cl1p.net
  - www.padfly.com
  - www.pastebin.com
- Accessibility
  - No CAPTCHA no login, since service needs to be quick

Disposable E-mail Addressing (DEA)

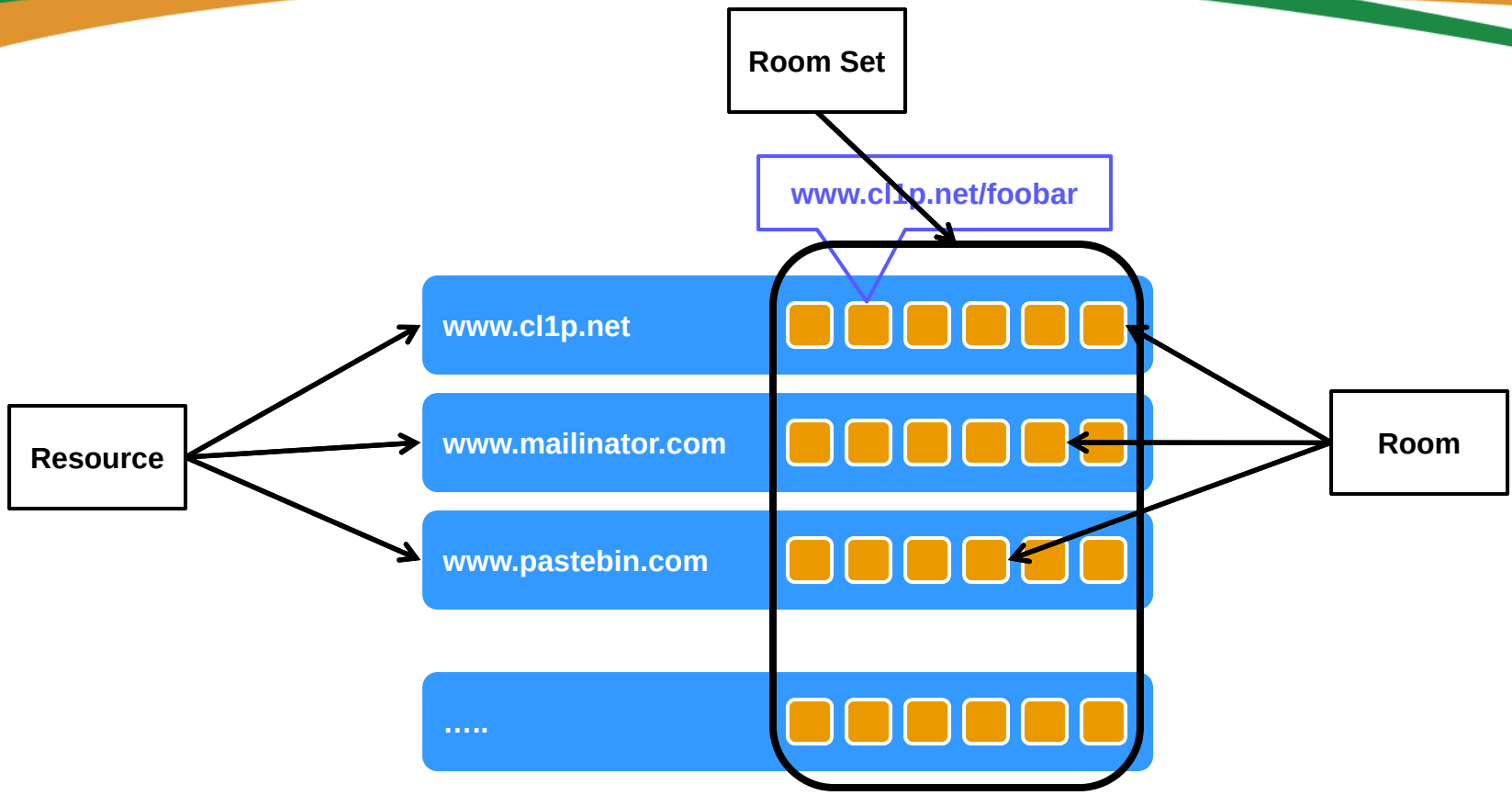
- Functionality
  - A disposable e-mail address used to avoid spamming
  - The user can choose any e-mail address within given domains, provide it, and later fetch e-mail messages
- Examples
  - www.mailinator.com
  - www.guerrillamail.com
  - www.spamex.com
- Accessibility
  - CAPTCHA, if at all, only when deleting a message
  - Sending the e-mail message can also be done by Web services (mostly offering to send large attachments easily)

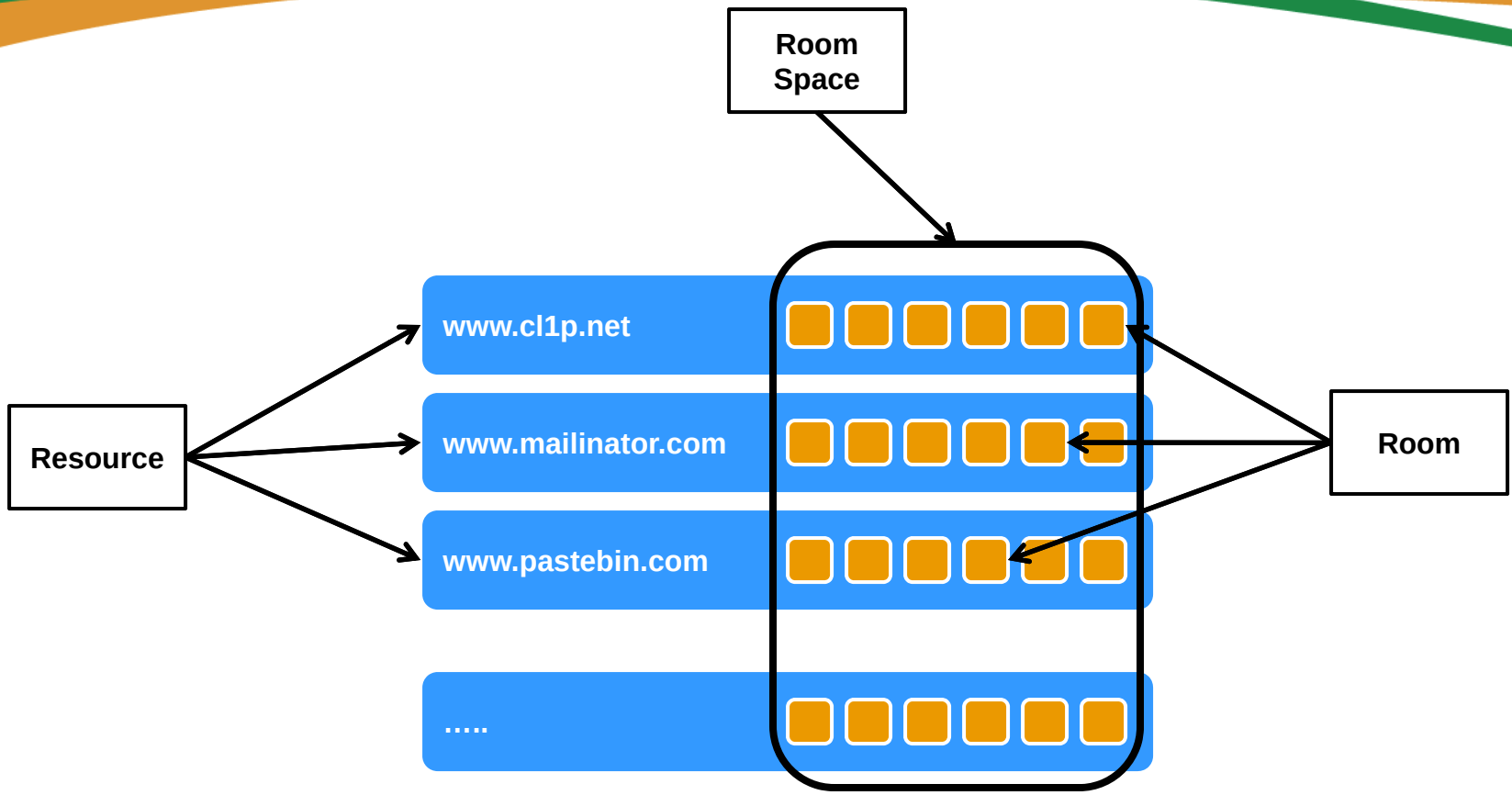
User Generated Content

- Functionality
  - User comments mostly in news sites and blogs
- Examples
  - www.moconews.net
  - www.sofiaecho.com
- Accessibility
  - Many services are protected with CAPTCHA, login or active moderation; however, a significant number are not protected.
  - It is expected that the comment be relevant to its location
    - The message can be encoded in the User **S**ite field (if supported), or it can be encoded in a link within the message.

URL Shortening

- Functionality
  - Takes a long URL and generates a short one to replace it. Purposes:
    - To prevent broken links in e-mail
    - To send links in Twitter
- Examples
  - www.tinyurl.com
  - www.dwarfurl.com
  - www.snipurl.com
- Alternative usability
  - Compression service—a long message encoded as a URL is compressed to very short URL.


Room Set
www.cl1p.net/foobar
www.cl1p.net
www.mailinator.com
www.pastebin.com
.....
Resource
Room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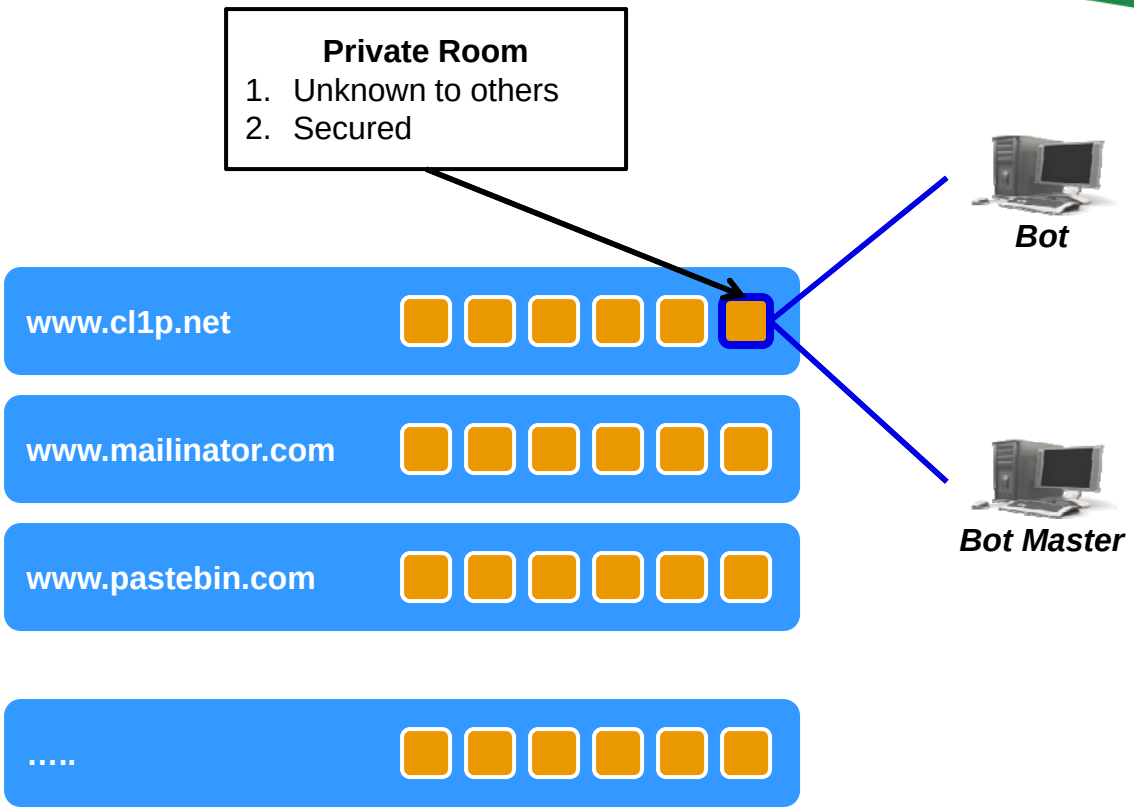
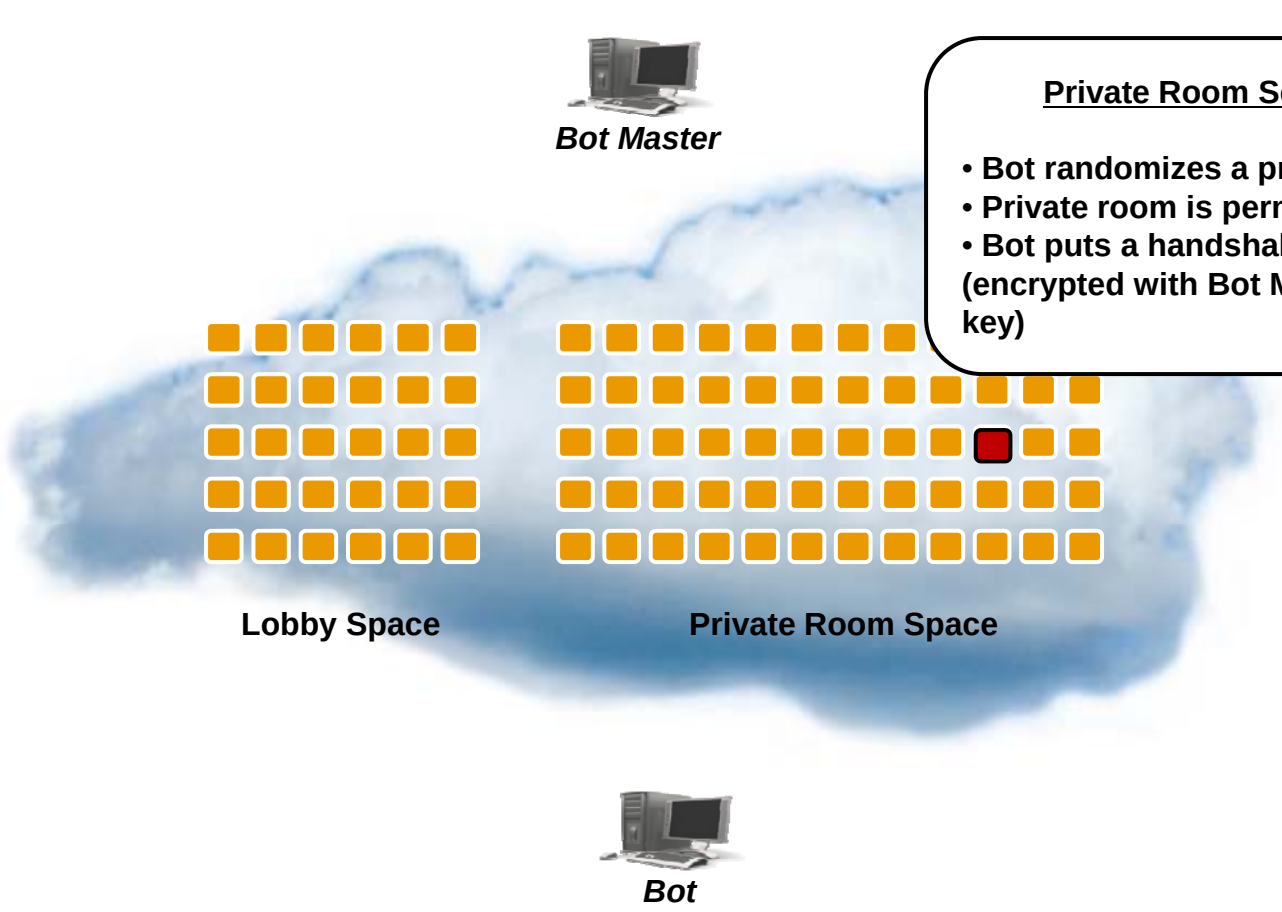

Private Room
1. Unknown to others
2. Secured
www.cl1p.net
www.mailinator.com
www.pastebin.com
.....
Bot
Bot Master

Private Room Space and Lobby Space

- Private Room space
  - Is a room space
  - Very large
  - The more resources the better
  - Private rooms are chosen from this space
- Lobby space
  - Is a room space
  - Medium size
  - The more resources the better
  - Use as common place to negotiate private rooms



1

Private Room Selection

- **Bot randomizes a private room**
- **Private room is permanent**
- **Bot puts a handshake message (encrypted with Bot Master public key)**

Invitation publish

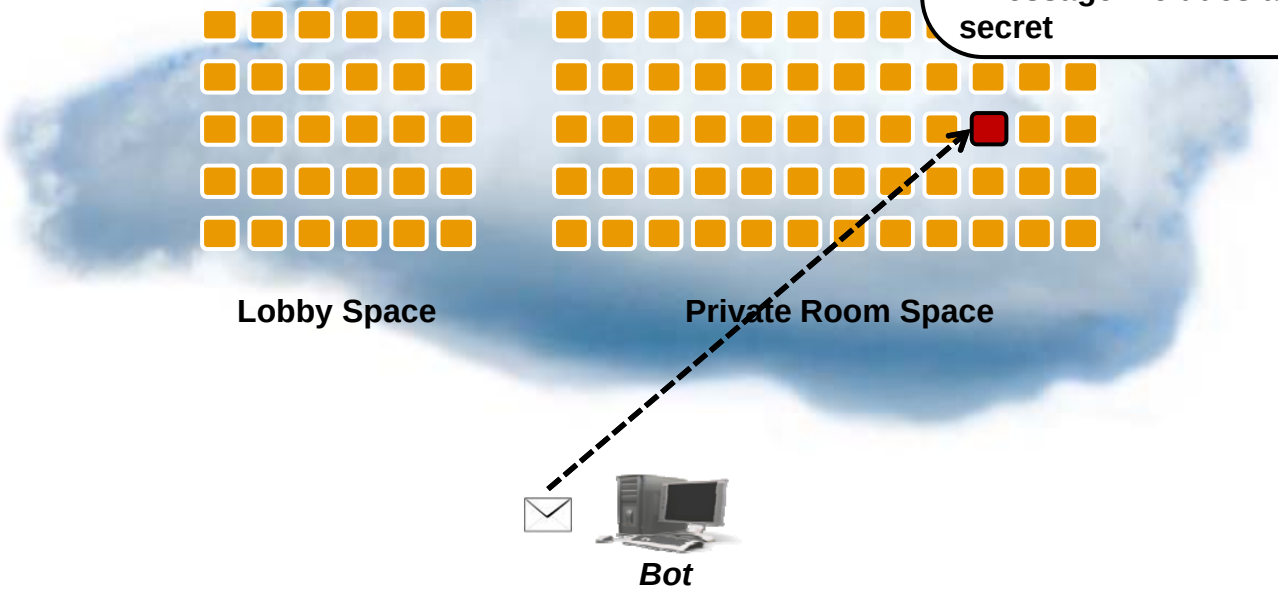
2

- Bot prepares an invitation
  - Includes private room ID
  - Encrypted with Bot Master private key
- Bot publish invitation in the lobby
  - Periodically the Bot ranodomize a room in the lobby
  - Publish the invitation in that room

Private Room Selection

1

- Bot randomizes a private room
- Private room is permanent
- Bot puts a handshake BOT HELLO message (encrypted with Bot Master public key)
- Message includes a common secret



2

Invitation publish

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  - Invitation includes private room ID
  - Encrypted with Bot Master private key
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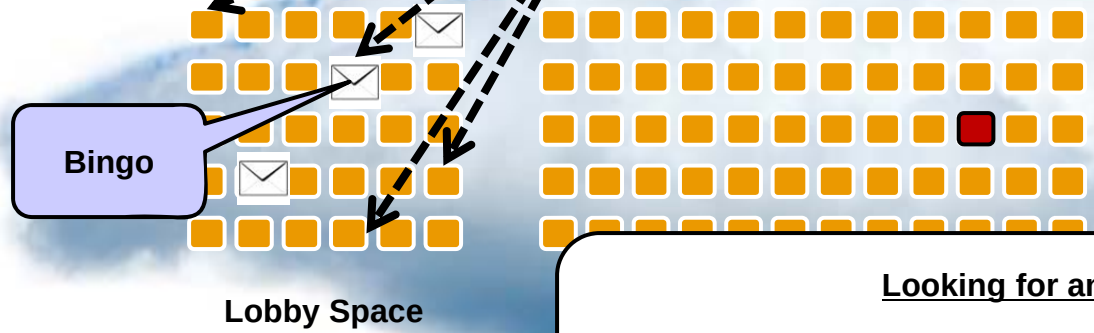
Bot Master



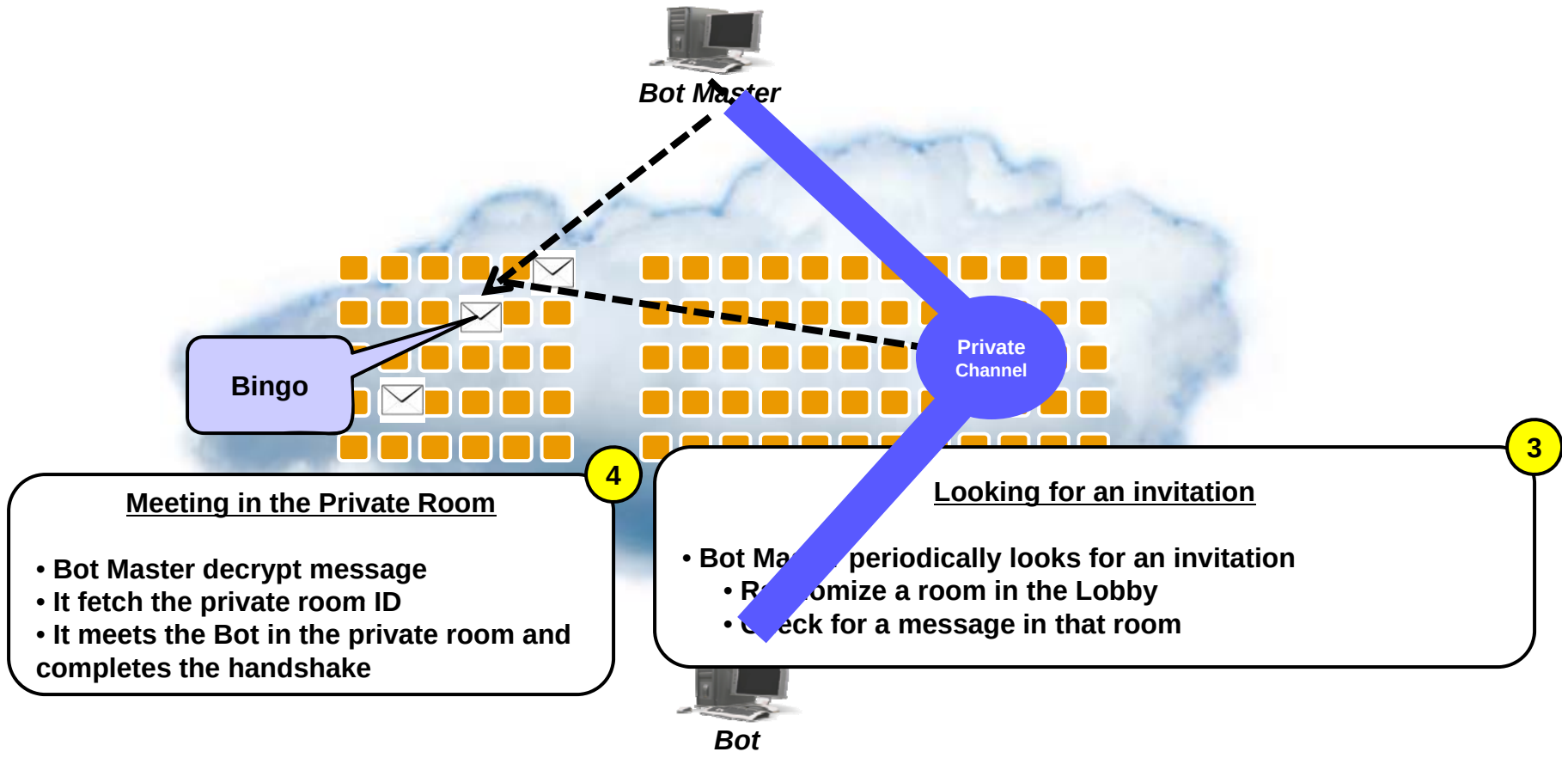
Lobby Space

3

Looking for an invitation

- Bot Master periodically looks for an invitation
  - Randomize a room in the Lobby
  - Check for a message in that room

Bot



Meeting in the Private Room

- Bot Master decrypt message
- It fetch the private room ID
- It meets the Bot in the private room and completes the handshake

4

Looking for an invitation

- Bot Ma periodically looks for an invitation
  - R omize a room in the Lobby
  - C eck for a message in that room

3

Turbot Demo

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Turbot Analysis

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Problem		Technology			
		IRC	P2P	HTTP	**Turbot**
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	Network footprint detection	OK	X	OK	
	Firewall and NAT issues	OK	X	OK	
SPOF	Takedown Actions	X	OK	X	
	Blacklisting (IP,URL)	OK	OK	X	

Technology vs. Problems

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	Blacklisting (IP,URL)	OK	OK	X	
	Efficiency				
	Interrupting communication				

- Assuming:
  - Each Bot posts 1 invitation per hour
  - Bot-Master scans for 1 room per minute
  - Botnet size is 10,000
  - Lobby size is 100,000
- Then
  - Each bot posts 720 message per month, 7,200,000 posts
  - The Bot-master will add new Bot every minunte, ~10,000 per week.
- Calculation/Simulation
  - Will be presented in the future

Corporate-Policy Traversal

- HTTP is always open
- Turbot does not use HTTPS
- Turbot does not use problematic sites (for example, anonymizers)
- No corporate-policy issues are expected

Network Footprint

- The usage of HTTP and HTML makes each message a very common one.
- Even so, it is possible that the Turbot HTTP implementation will have unique footprints.
  - Example: send “Turbot 1.0” in the “User-Agent” header
- Solution:
  - Turbot should use common libraries such as IE and FF

Firewall and NAT Issues

- Turbot doesn’t open a port
- Turbot always initiate the connection
- HTTP is the most supported and reliable protocol
- No firewall or NAT issues are expected

- There is no single site that can be taken down
  - Both Lobby-space and Private-room-space are as large as desired
  - The access to the Lobby is randomized.

Blacklisting

- Turbot spans over many resources.
- If at all, whole domains of legitimate services will have to be blocked in order block the botnet.
- The percent of organizations that can do so is very small.

- Security agents can delete message in the Lobby
- The Security agents is competing with
  - Botnet size – usually more powerful than legitimate network
  - Birthday paradox – 1 successful message is enough!
- Future
  - Exact figures
  - Simulation

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Problem		Technology			
		IRC	P2P	HTTP	**Turbot**
Blend in common traffic	Corporate-policy blocking	X	X	V	V
	Network footprint detection	V	X	V	V
	Firewall and NAT issues	X	X	V	V
SPOF	Takedown Actions	X	V	X	V
	Blacklisting (IP,URL)	V	V	X	V
	Efficiency				V
	Interrupting communication				V

- Message time
  - Messages are fetched by recipient by pulling from a common resource.
  - Time depends on the pulling frequency and is not instant.
  - Workarounds
    - Each message will contain a “next message time”

- Adding CAPTCHA or Login to Web services

Summary

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Questions & answers

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Appendix

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Appendix Content

- Additional Features
  - Indirect Access
  - Handle Bogus Bots
- Additional Analysis
  - Private Channels

Indirect Access

- Problem
  - Slaves accessing the Web leave their identity
- Solution
  - Indirect access using online site translation services
    - Examples: Google Translate, Yahoo Bubblefish, Windows Live Translator

Handle Bogus Bots

- The attack
  - Security vendors can create numerous virtual bots to slow down communication.
- Solution
  - Require each bot to perform an action that will distinguish the majority of the real zombies from the bogus ones.
    - Computational work in the form of solving a cryptologic puzzle.
    - Legal complication – ask the bot to take some verifiable illegal action which will complicate it. Security vendors cannot allow this.

- Turbot is unique in having private channels
- Pros
  - The main reason: part of the no SPOF requirement.
  - Better control of the Botnet especially when selling/renting.
- Cons
  - Bot-master has to invest labor in the C&C
    - Broadcast over Unicast can be simulated