26th annual **FIRST** conference

BOSTON

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JUNE 22—27, 2014

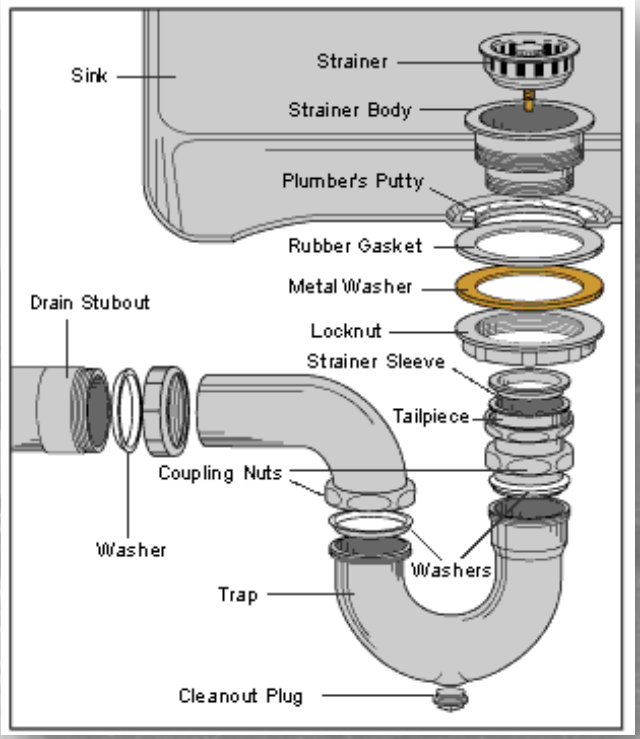
Back to the 'root' of Incident Response

Boston Park Plaza Hotel | June 22-27, 2014

The art of sinkholing

Tomasz Bukowski

CERT Polska / NASK



About

WHOIS

- Name:Tomasz Bukowski (tomasz.bukowski@cert.pl)
- Works in CERT Polska/NASK
- 5 years in IRT
- Fight malware && monitor botnets

- Linux user and sysadadmin
- Programmer
- Member of Dragon Sector CTF team ☺

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Introduction

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So, you want fight botnets ?

Botnet lifecycle:

1. write/buy malware
2. write/buy exploit pack
3. buy/hack VPS/hosting for (1) and (2)
4. buy domain for (3)
5. spred malware using exploit pack
6. $ profit $

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So, you want fight botnets ?

Life of security researcher:

1. monitor spam/social media/internets
2. see malware spreding using exploit pack
3. gather samples
4. monitoring / analysis / incubation
5. locate CnC domains
6. locate rest of infrastructure
7. << action required ! >>

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Fighting botnets ...

Malware domain takedown:

+ cut off botmaster from his flock of sheep

- devices still infected, no one get noticed

Malware domain takeover:

+ cut off botmaster from his flock of sheep
+ malware will keep talking to CnC
+ can gather and share infrmation on infections!

→ make cyberspace better place

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Sinkholing

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Sinkholing ?

Sinkholing – let me google it for you ...

Sinkholing is a technique that researchers use to redirect the identification of the malicious command-and-control (C&C) server to their own analysis server. This way, the malicious traffic that comes from each client goes straight to the research box, ready to be analyzed.

source: the internet

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Sinkholing

Scope : global

- **Take over CnC domain**
  - Point to researcher box (directly or by nameserver)
  - Doable
  - Need to provide evidence
  - Good will from domain operator (TLD)
- **Take over CnC IP :**
  - Hard to do - need persuade IP owner (ISP/Hosting)
- **Take over CnC infrastructure (server)**
  - Physicaly takeover
  - Often can be done only by law enforcements

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Sinkholing

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a lot of legislation problems

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Sinkholing

„Local” sinkholing (LAN) - redirect CnC traffic:

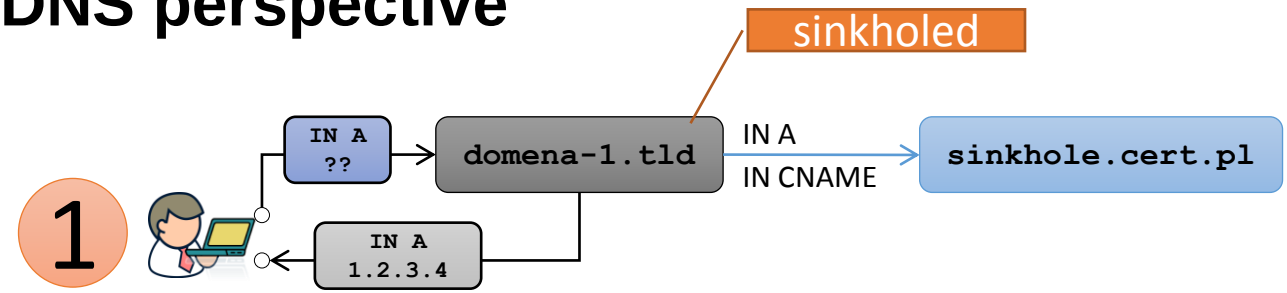
- By DNS : local DNS redirection
- By destination IP: traffic redirection

- Provide usefull information on infected workstations
  - Especially when you run multi-layered big internal company network ☺

source: the internet

Sinkholing

DNS perspective



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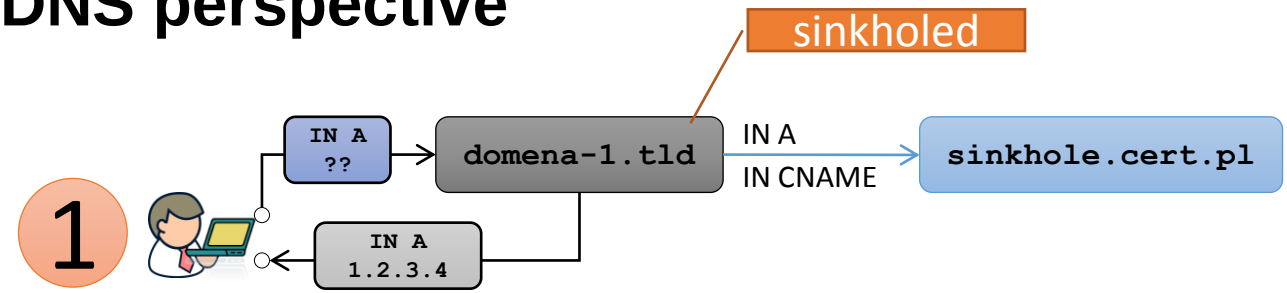
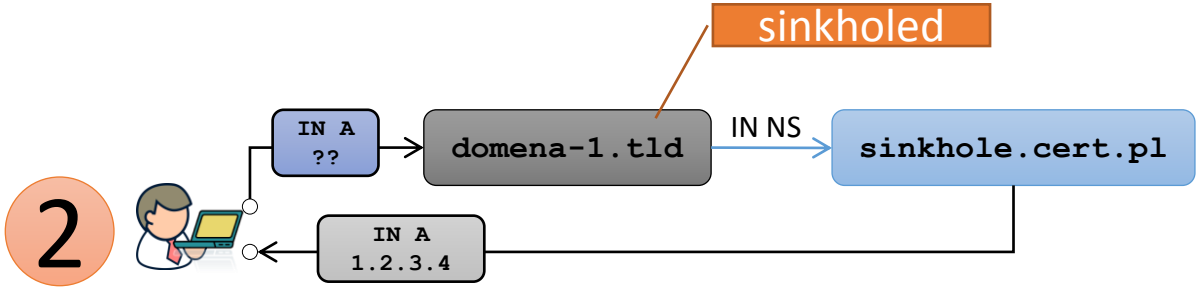
Sinkholing

DNS perspective





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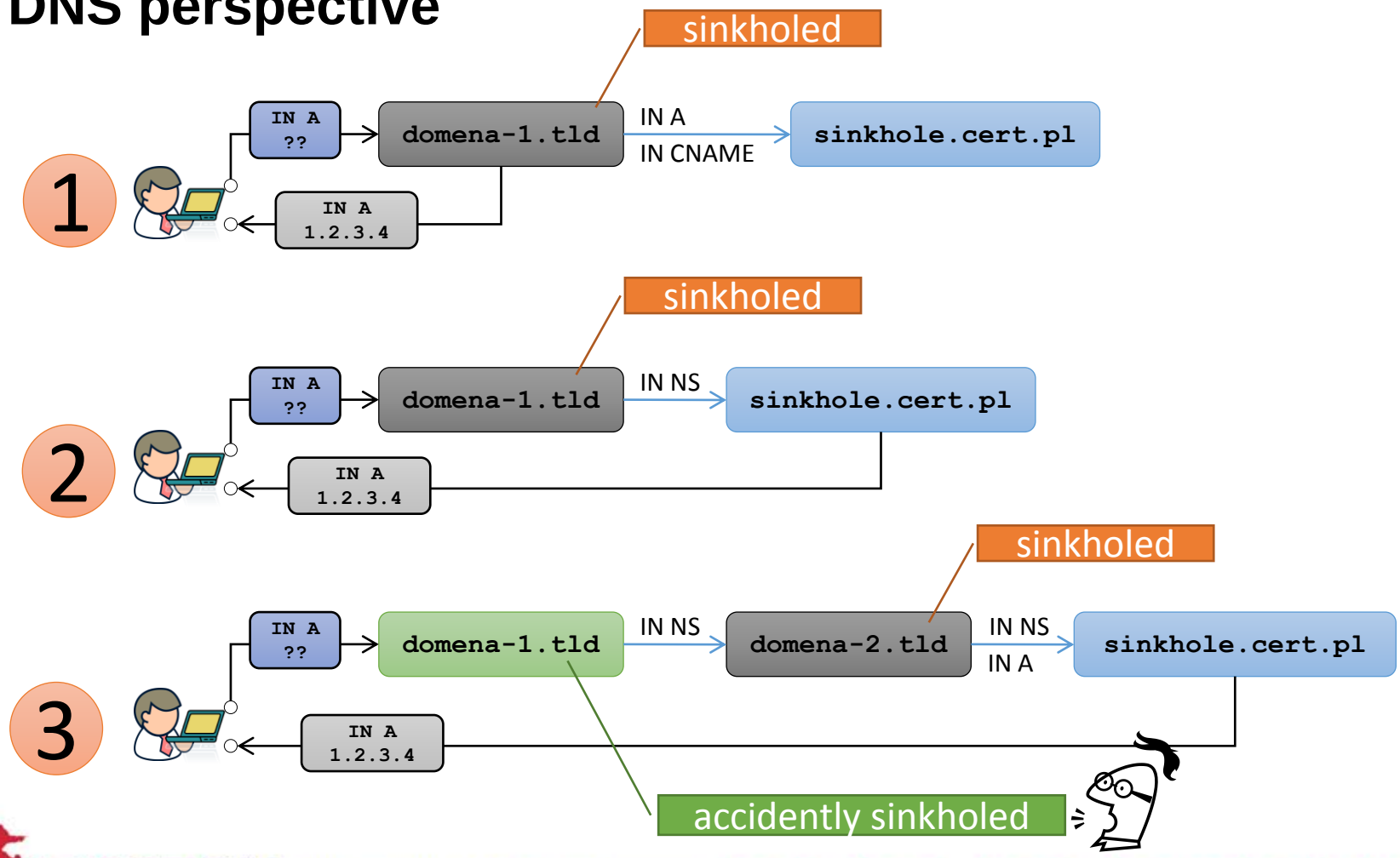
Sinkholing

DNS perspective



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Sinkholing

„the goal”

- Allow malware to connect to your box
- Keep malware connected to your sinkhole as long as possible
- Prevent malware from using alternative/bacup communication channels

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CnC

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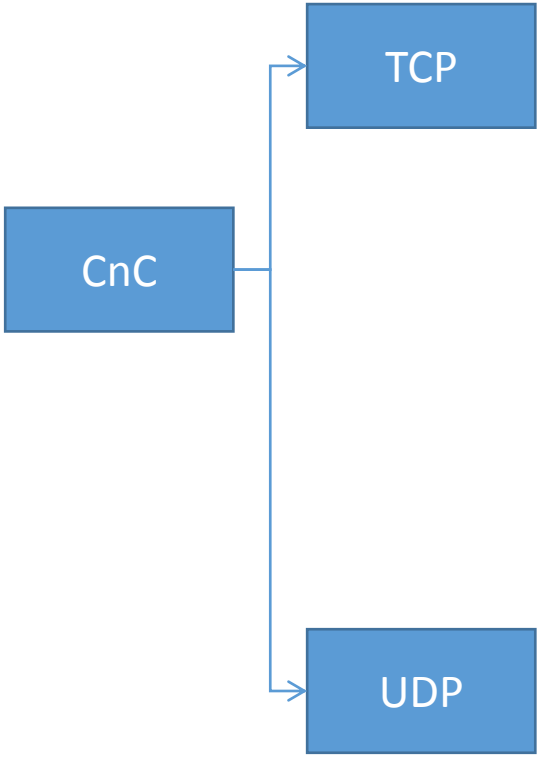
CnC Types



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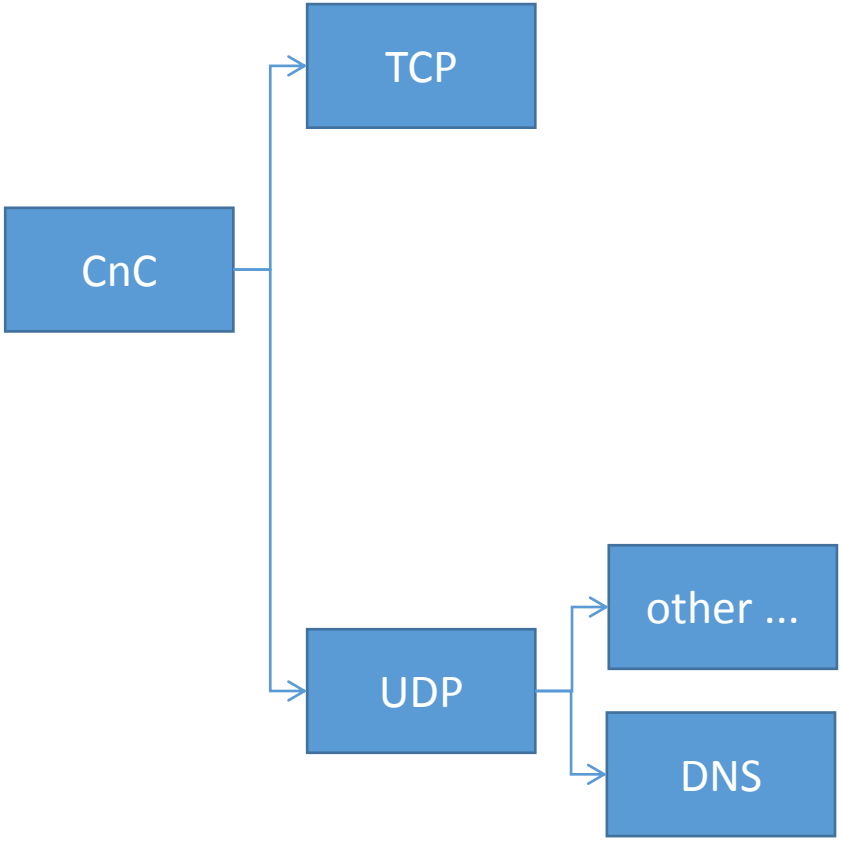
CnC Types



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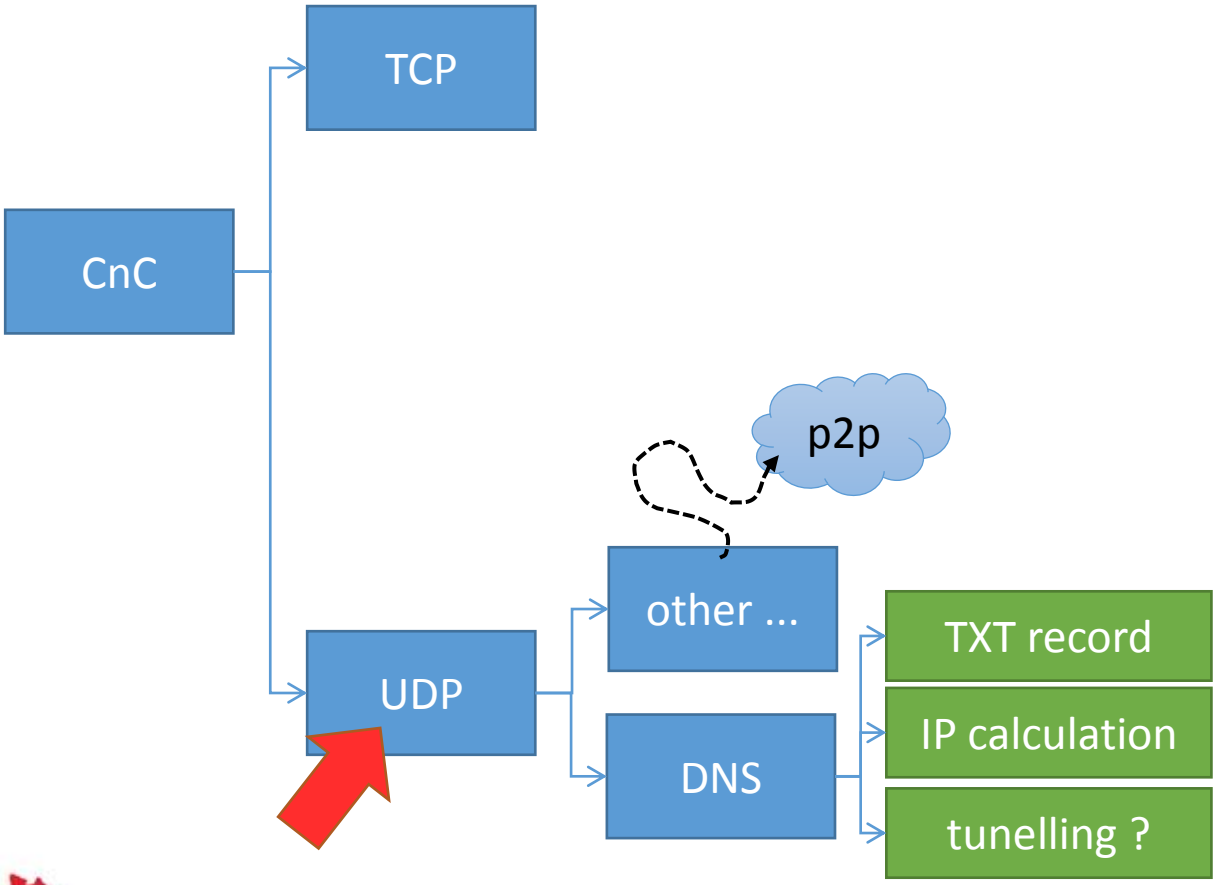
CnC Types



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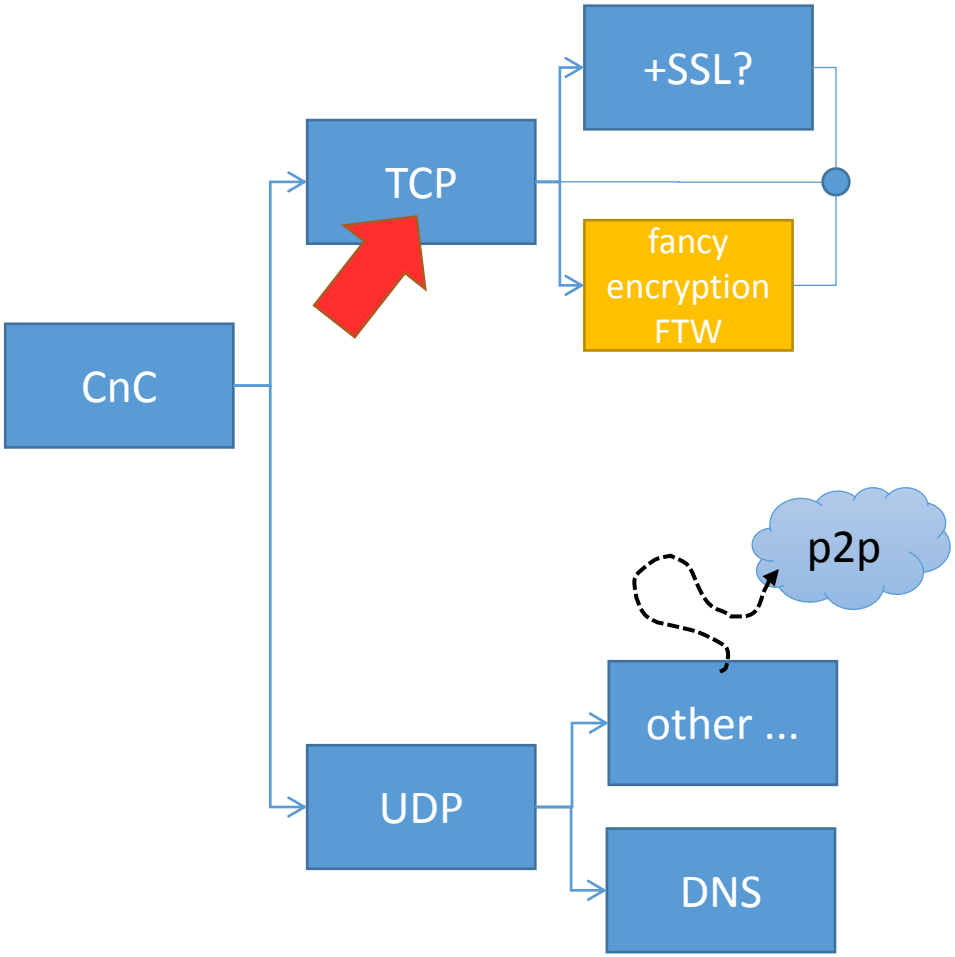
CnC Types



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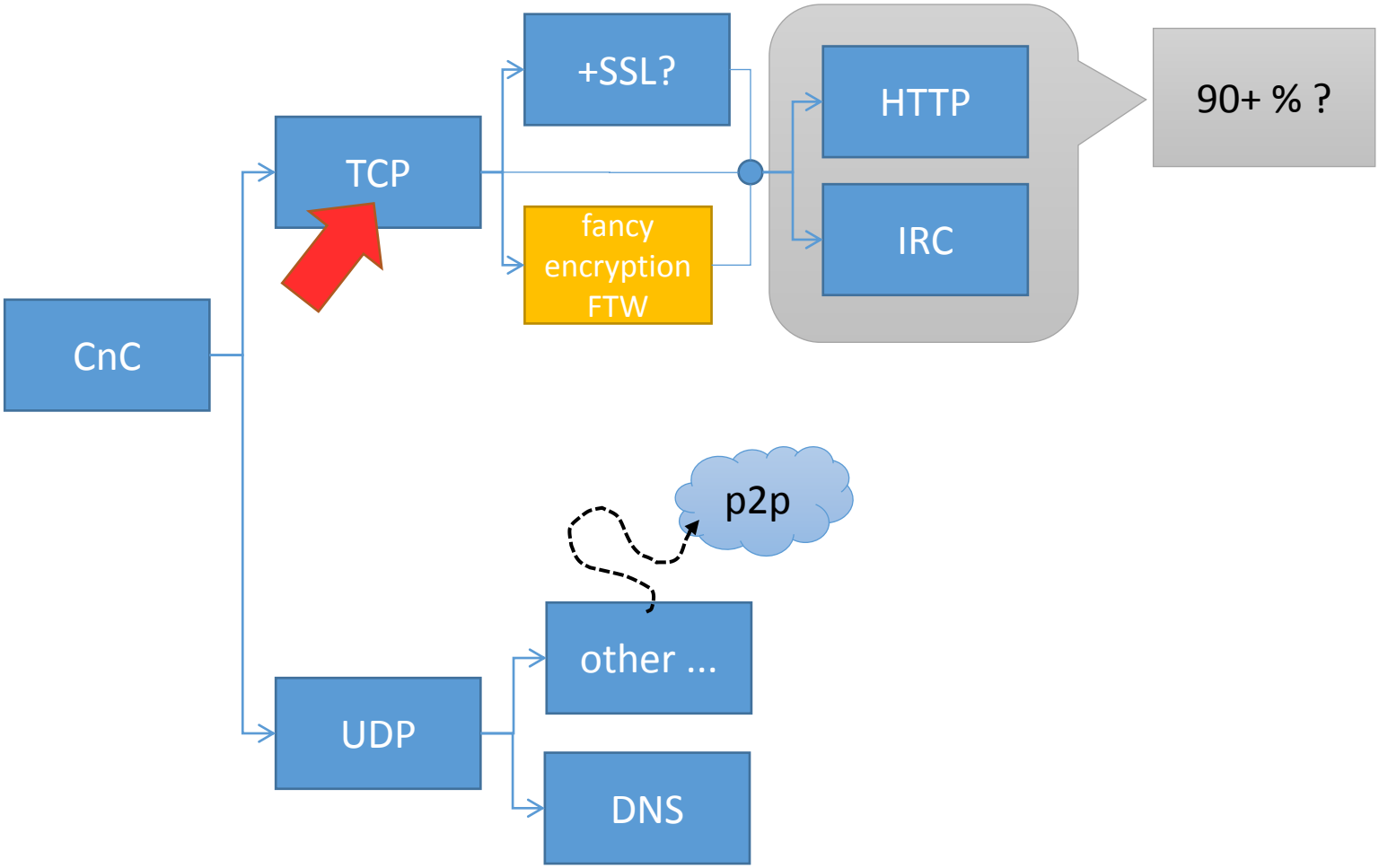
CnC Types



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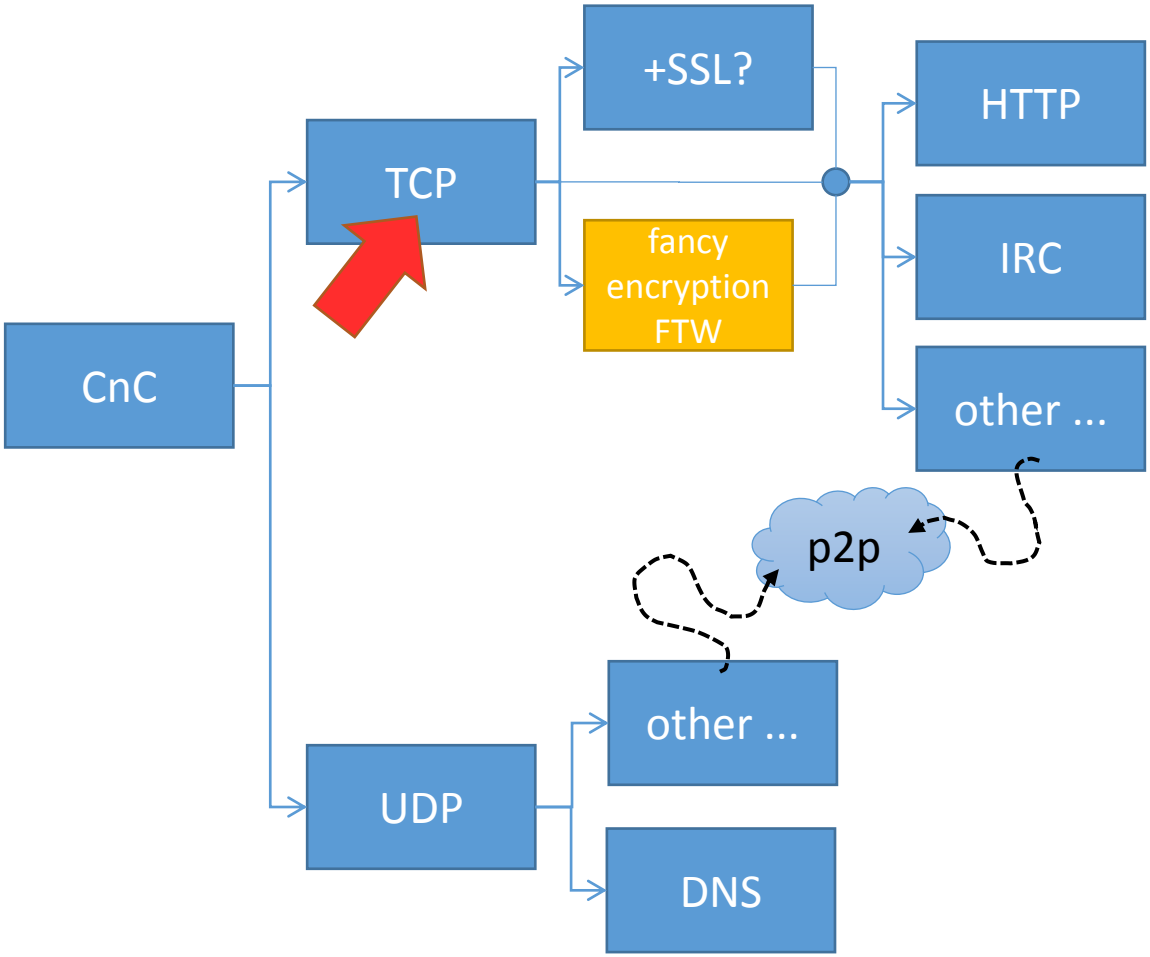
CnC Types



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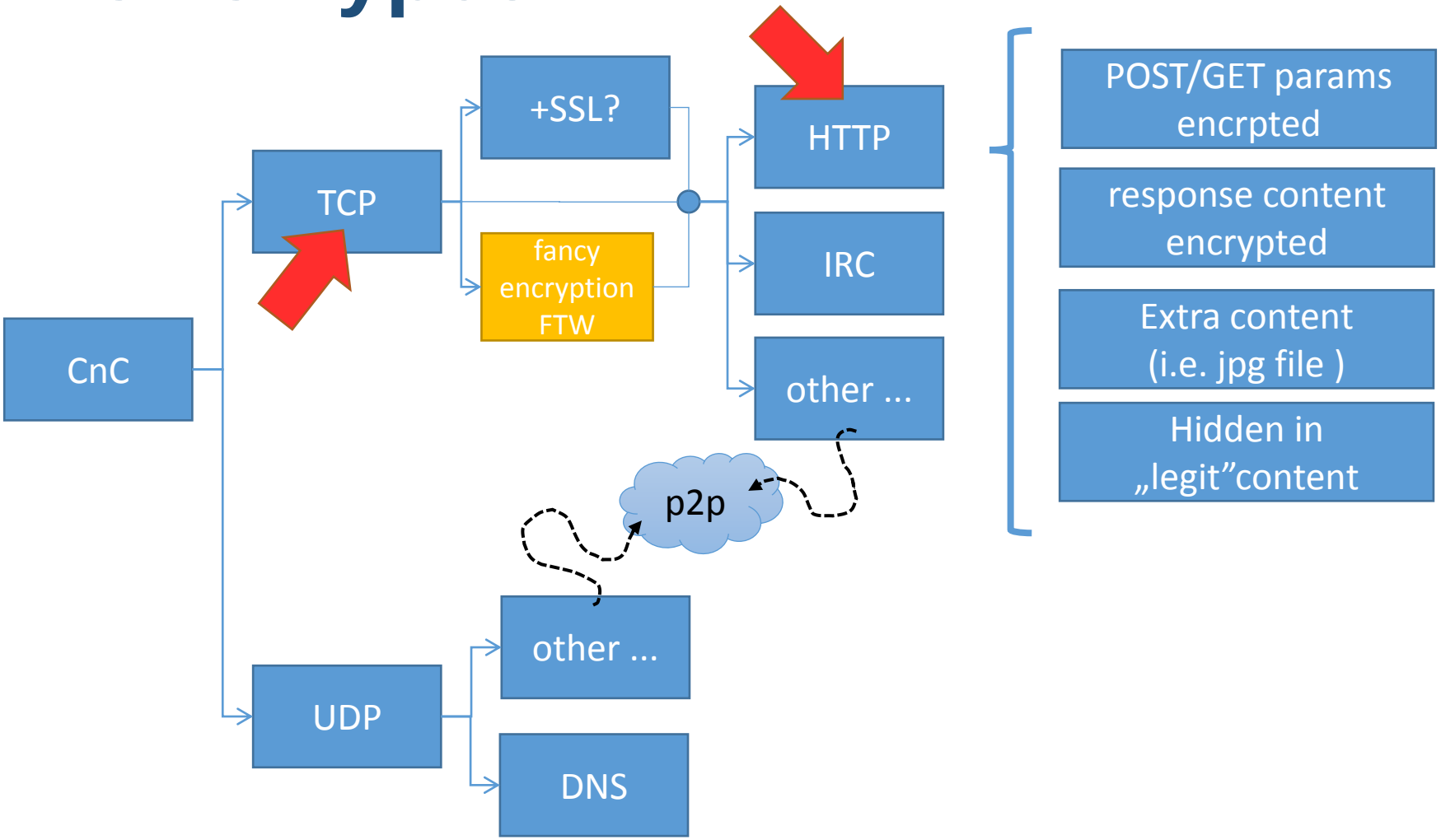

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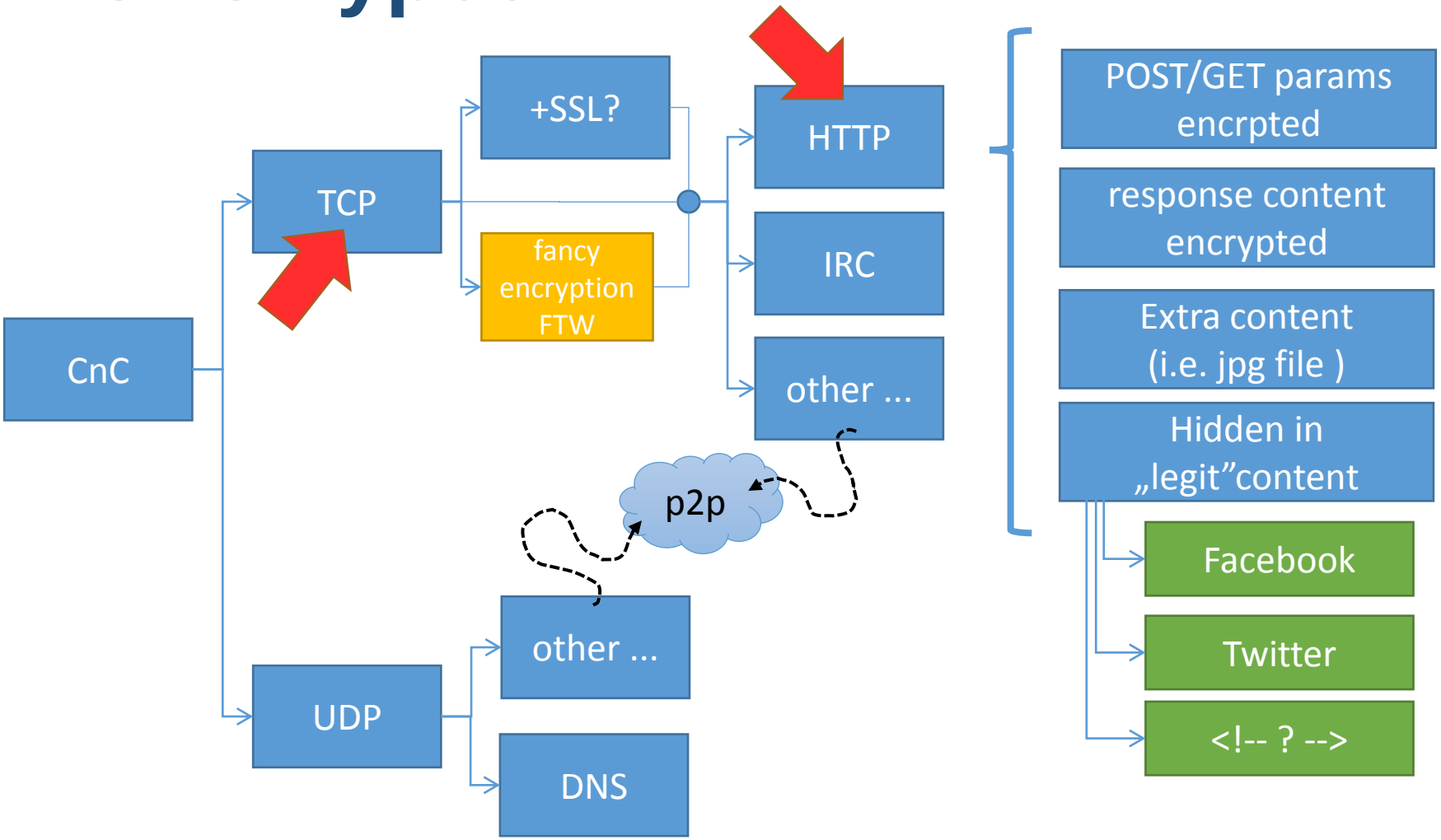
CnC Types



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CERT .PL story (1)

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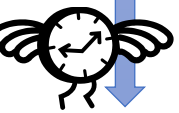
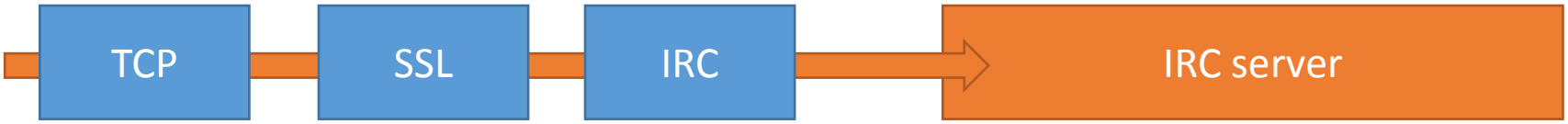
Timeline

end of 2012 – dorkbot

- Yet another malware using .pl domain as CnC
- Yet did not have TLD sinkhole procedure (in progres)
- Registrar decided to help (after abuse report)
- Am... but we do not have sinkhole !?



CnC – example: Dorkbot



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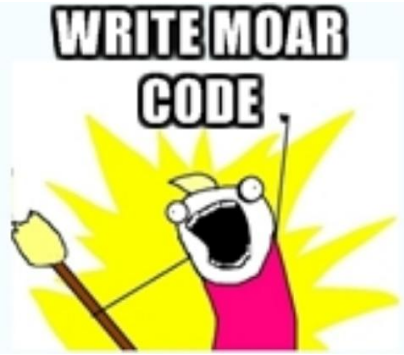
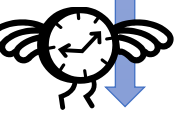
Timeline

end of 2012 – dorkbot

-> Take this old unused server and do somethink
(4 GB RAM, 2x 3.0 Ghz CPU, 160 GB HDD , decend 1U !)

-> We need TLS IRC
->Take charybdis irc server, remove 80 % functions





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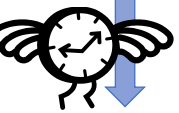
Timeline

end of 2012 – dorkbot

begin of 2013 – virut

- Realy long-living malware still sitting on .pl domains ☹

- TLD sinkhole procedure in progres
- Promising results from sinkholing dorkbot ☺
- Decistion : we need to do this !



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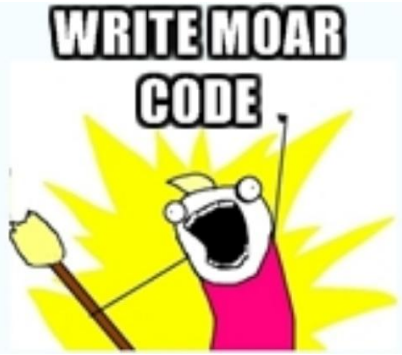
Timeline

end of 2012 – dorkbot

begin of 2013 – virut

- We already got hadrware (+)
- We need (a lot) more software



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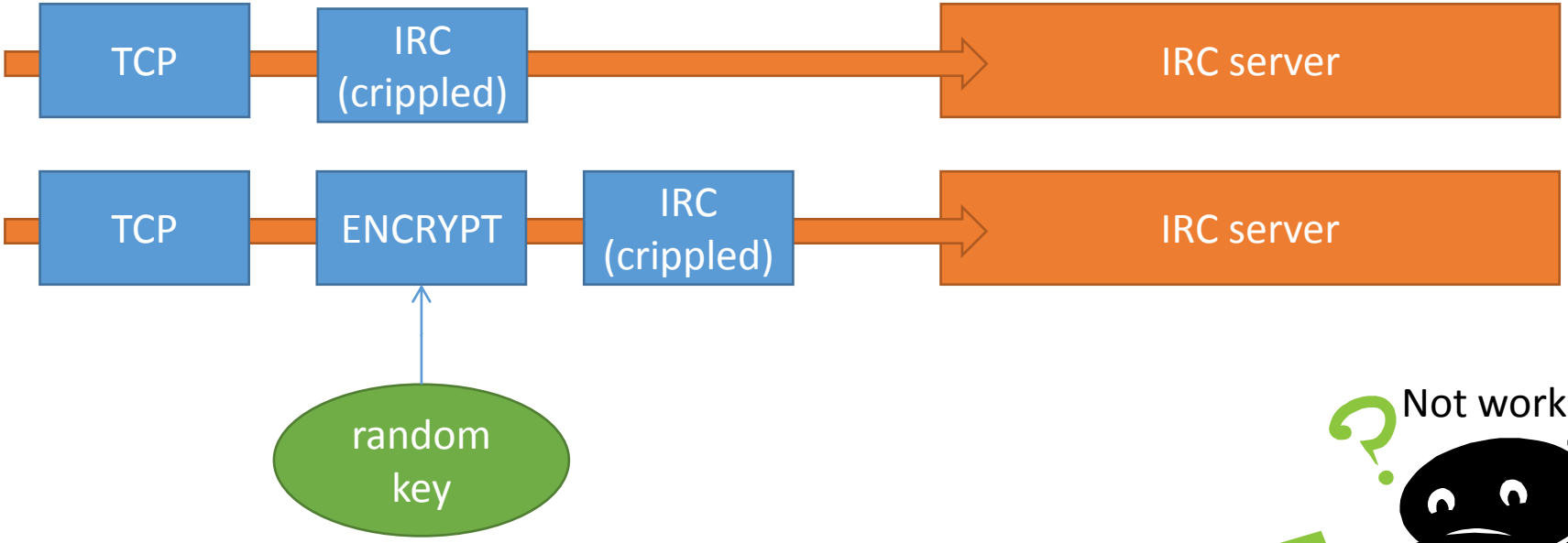
CnC – example: Virut

(expectations)



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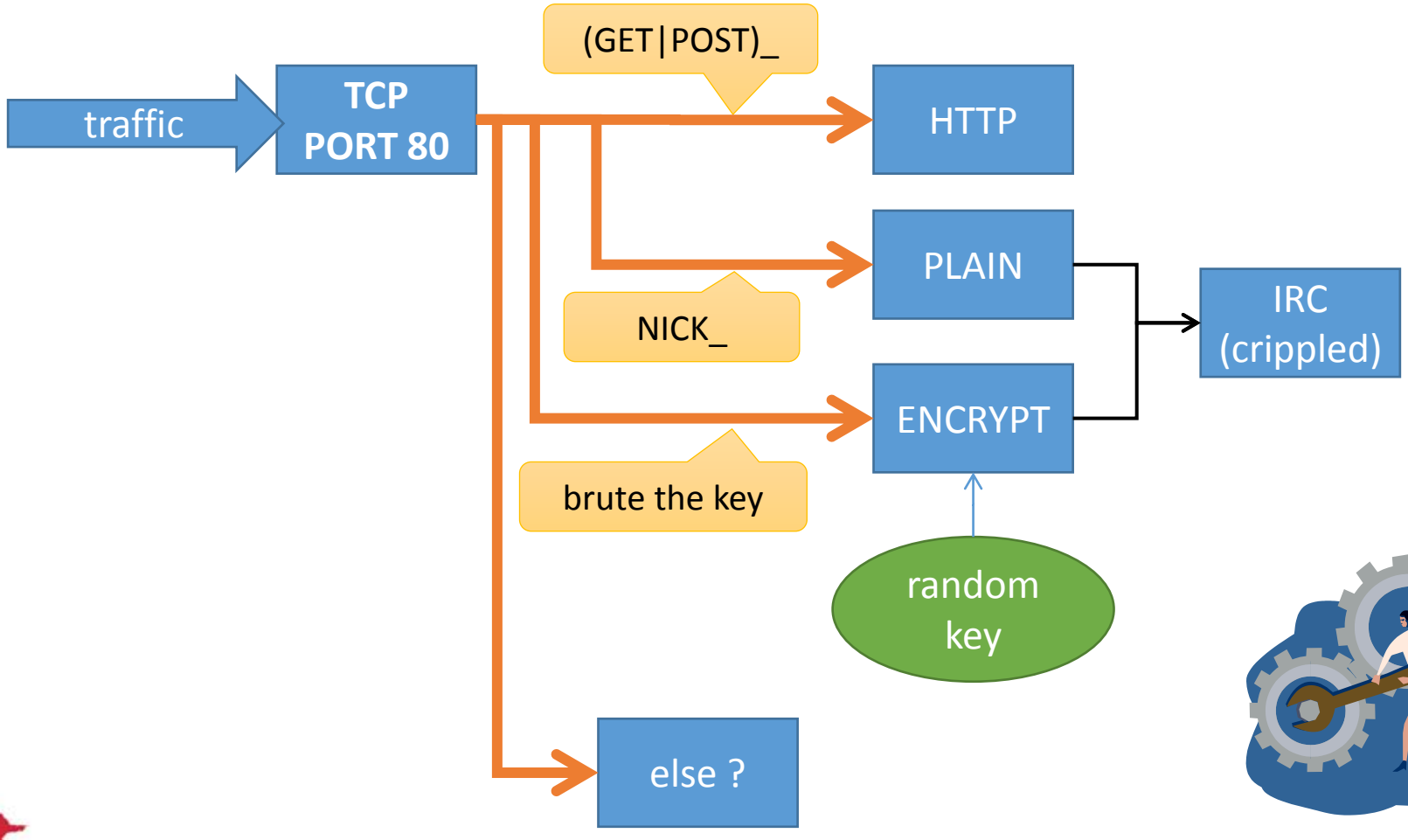
CnC – example: Virut - reality

(reality)



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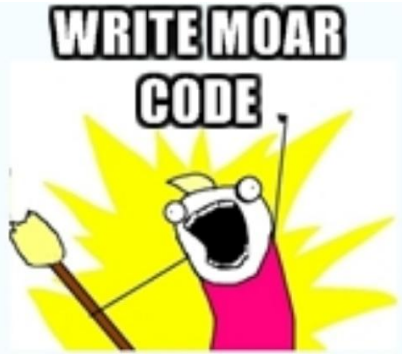
Timeline

end of 2012 – dorkbot

begin of 2013 – virut

- Write python script
  - peek first 5 bytes (decision: irc/http/crypted)
  - keep TCP connection as long as possible



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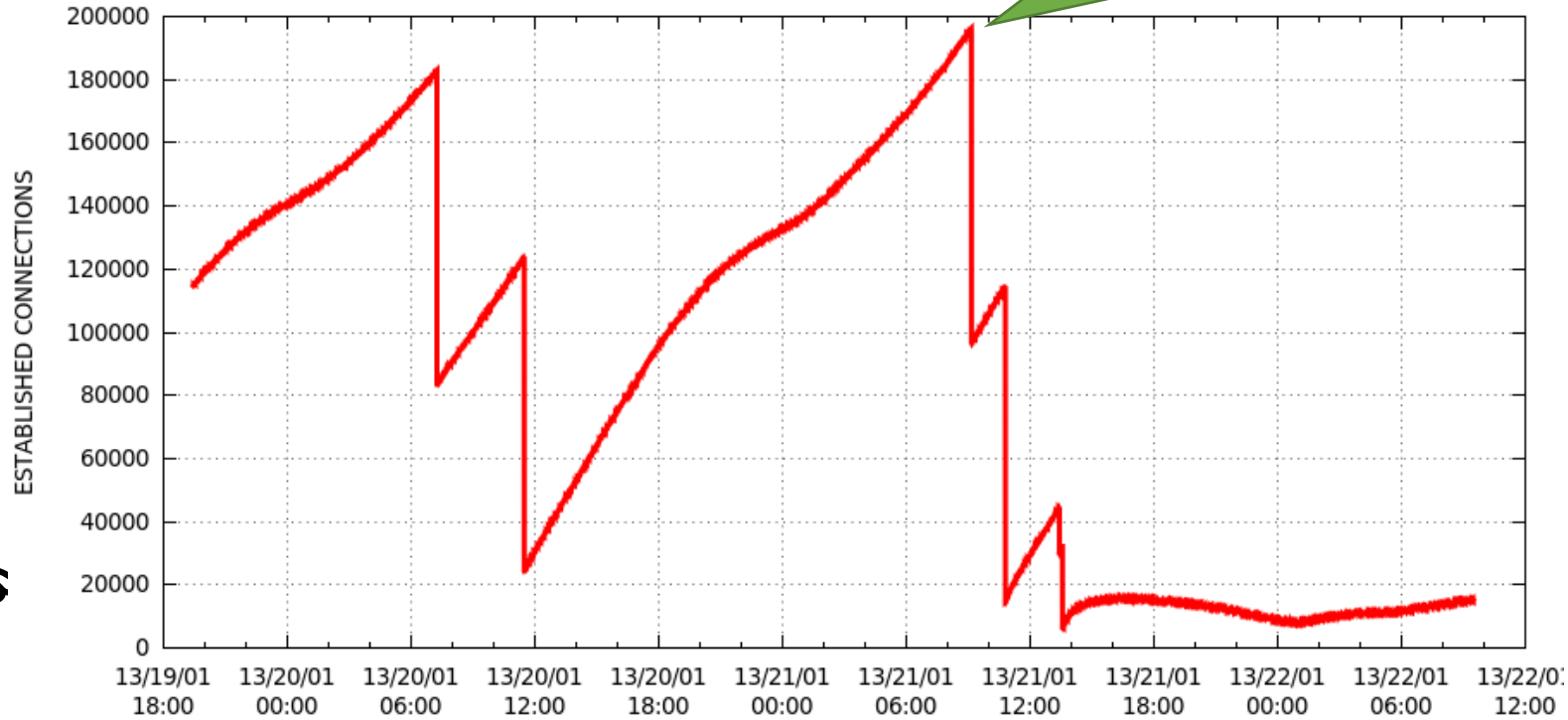
Timeline

end of 2012 – dorkbot

begin of 2013 – virut

200 K connections in „established" state !?



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Timeline

Encountered problems: TCP timeouts

- close timeout = 10s
- close-wait timeout = 60s
- established timeout = 5 days
- fin-wait timeout = 120s
- last-ack timeout = 30s
- syn-received timeout = 60s
- syn-sent timeout = 120s
- time-wait timeout = 120s

srsly ! it is just waiting for RST

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Timeline

Encountered problems: software

(you know them when you hit the limit ☹)

Somewhere in code you need to „select()" over opened file descriptors. It uses limited size bit-fields !

Hint: on Linux use poll !

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Timeline

Encountered problems: default OS limits

(you know them when you hit the limit ☹)

- max opened file descriptors (each tcp connection=new FD)
  - ➢ can be easily fixed : **`ulimit -n 999999`** ☺

- max entries in contract table
  - ➢ requires kernel param tweak, fixable ☺

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Timeline

Conclusion (1)

Establishing TCP connection and leaving it with default settins is <u>bad idea</u> !

Use SO_KEEPALIVE socet option ☺ (obvious ?)

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Timeline

Conclusion (2)

~~**SELECT()**~~

POLL()

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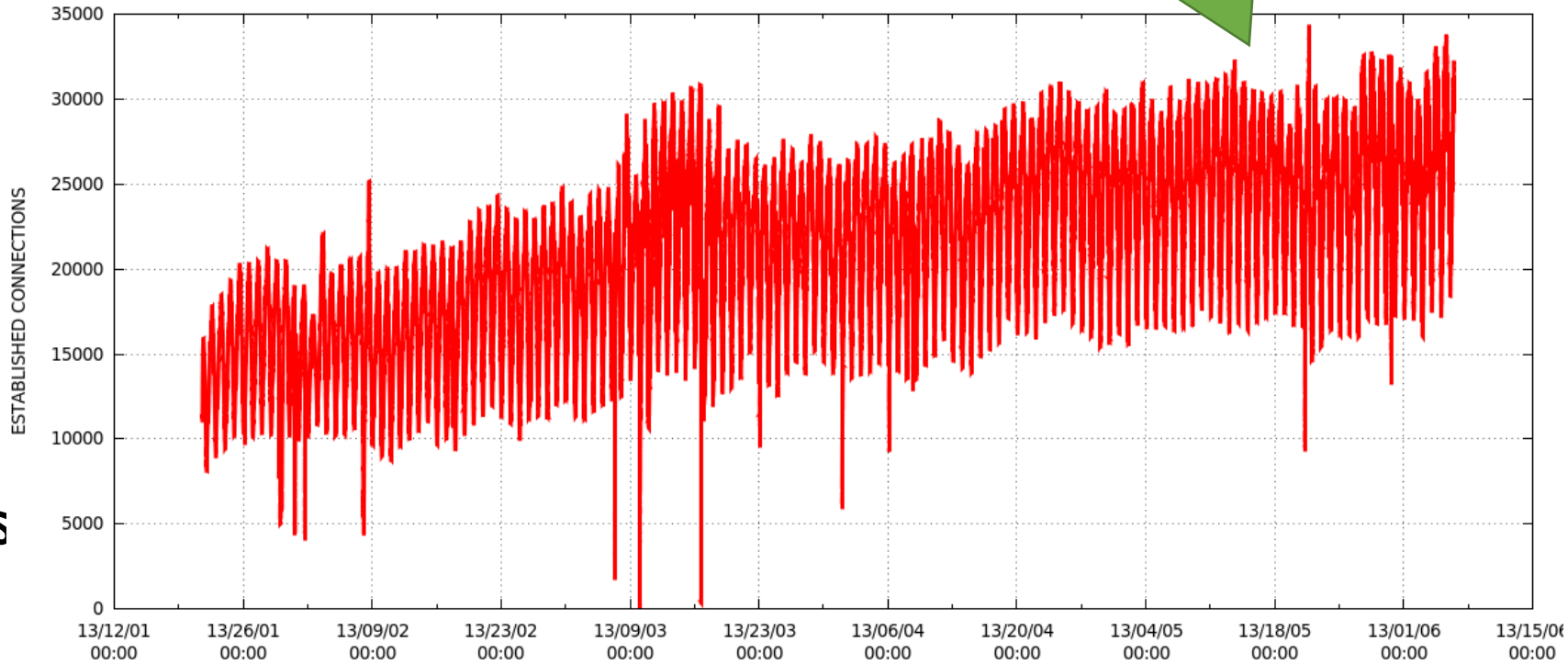
Timeline

end of 2012 – dorkbot

begin of 2013 – virut

30K simultanious connections ☺



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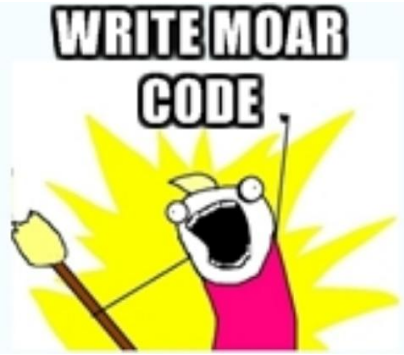
Timeline

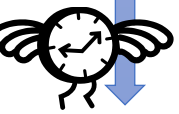
end of 2012 – dorkbot

begin of 2013 – virut

spring 2013 – few ZueS domains

- Write python script that will understand HTTP and decode incoming zeus data ...





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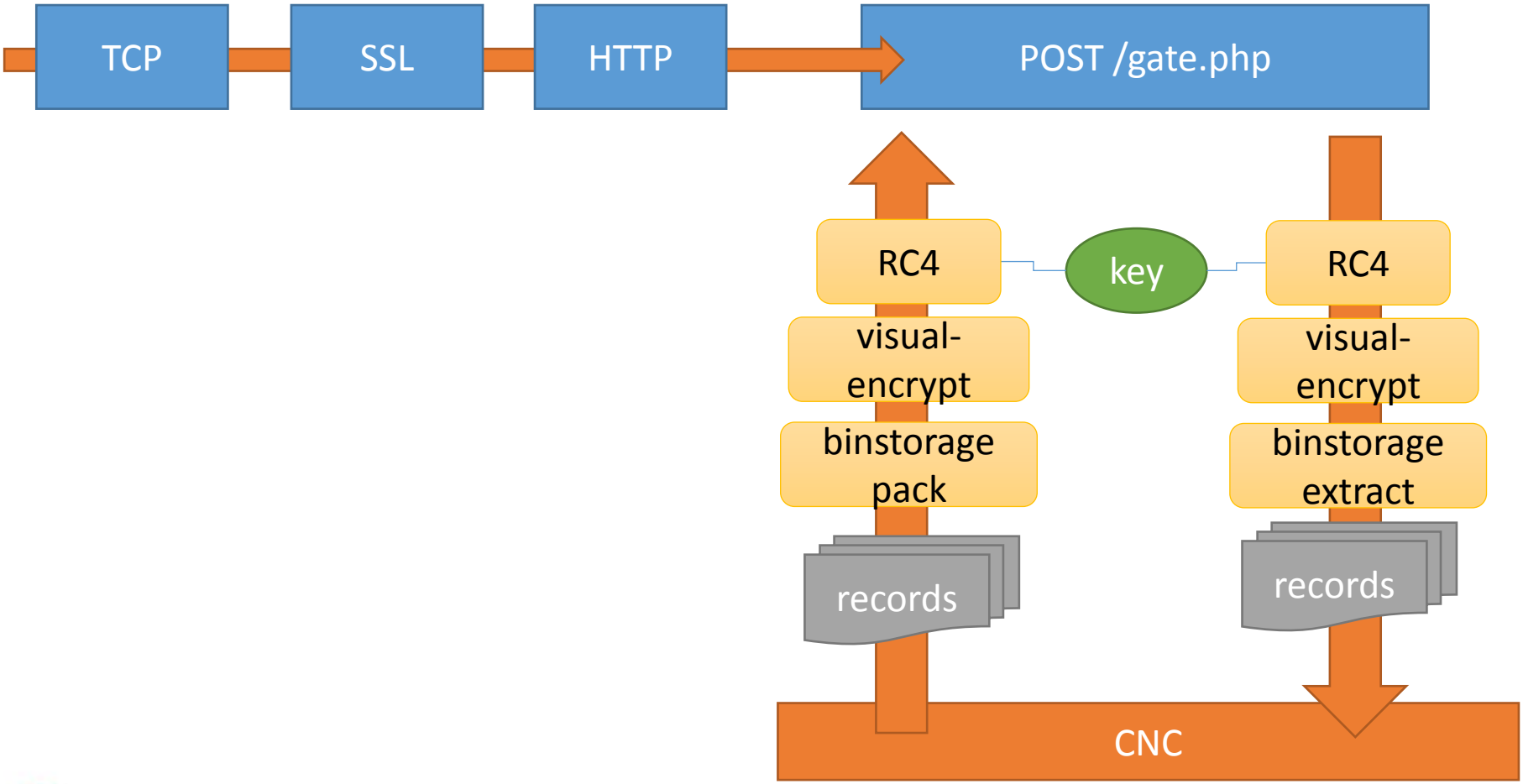
CnC – example: ZeuS



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Timeline

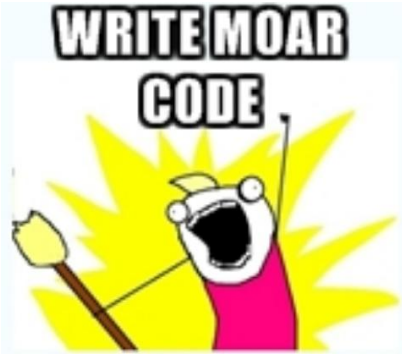
end of 2012 – dorkbot

begin of 2013 – virut

spring 2013 – few ZueS domains

summer 2013 – domainsilver takedown

- A LOT of various malware domains
- Write python scripts .... ?



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Timeline

Encountered problems:

we already got numerous different python scripts running different CnC

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Timeline

Conclusion (3)

Need decent sinkhole software ☺

(obvious ?)

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sink-soft ☺

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Requirements

- Build consistent framework for sinkholing
- Make event logging/sharing easy
- Identify common content processing functions
- Handle undret of TCP connections from
- Be as elastic as possible
- Implement any fancy encryption/encoding anywhere

Allow to sinkhole new malware with lowest possible effort

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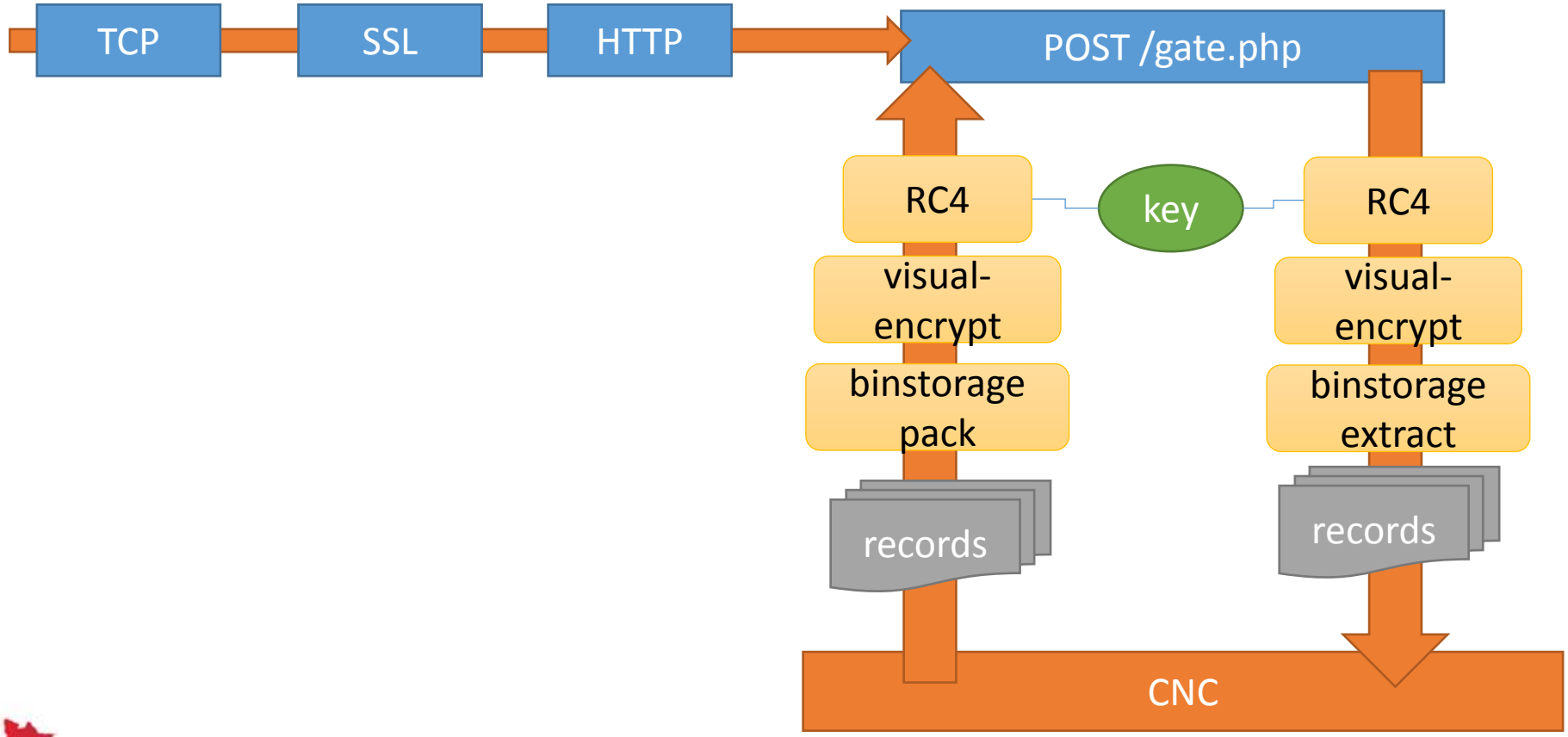
Design

Build your sinkhole out of blocks (modules) ☺



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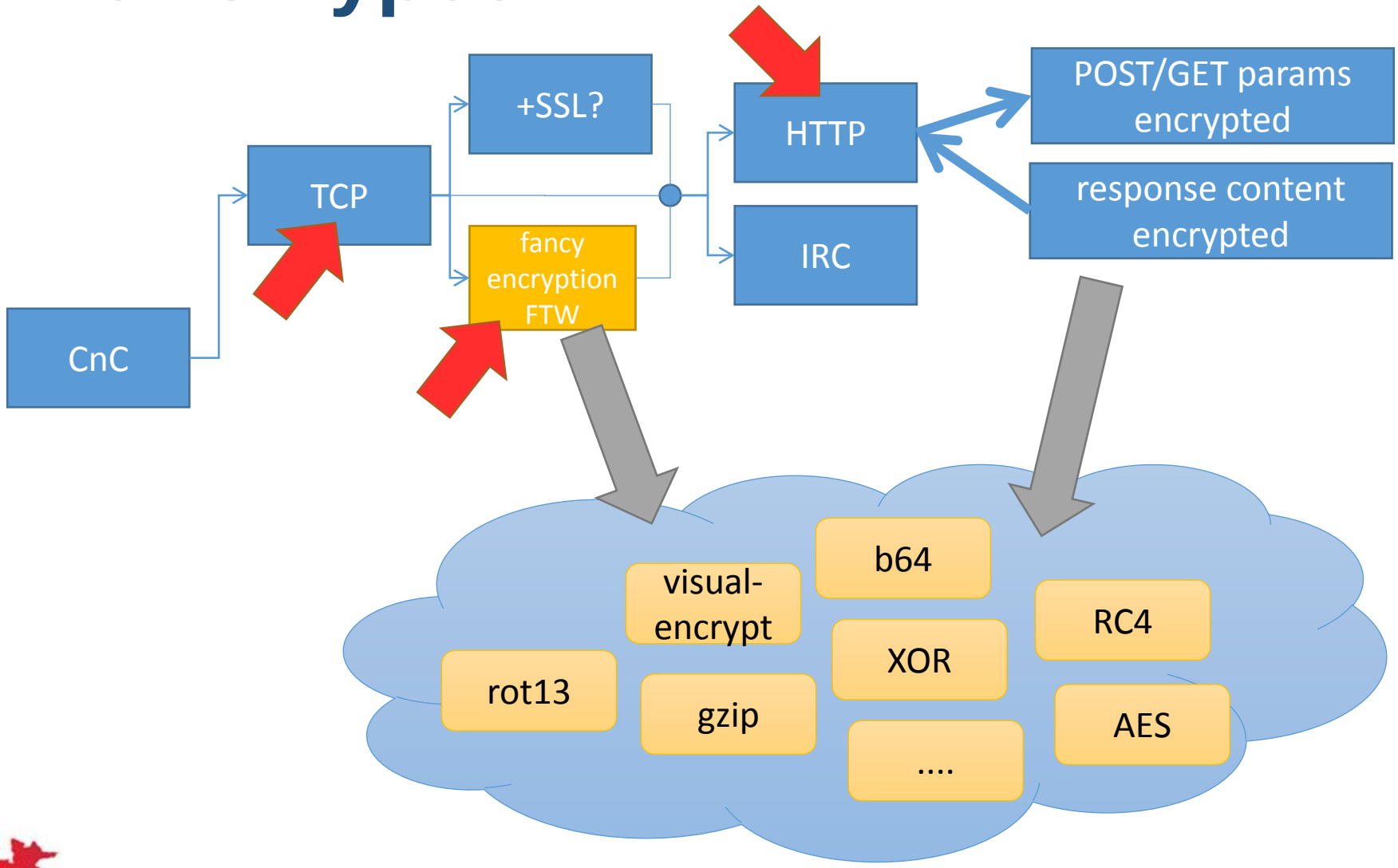
CnC Types



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Design

- Provide TCP conevtivity layer
- Use MQ – ZeroMQ (fast && simple)
- PUB-SUB messaging pattern
- Deployed as standalone package with lowest possible requirements (msgpack && zmq-python)
- Easy configuration (chose ip,port and modules chain)
- unpack & config & run

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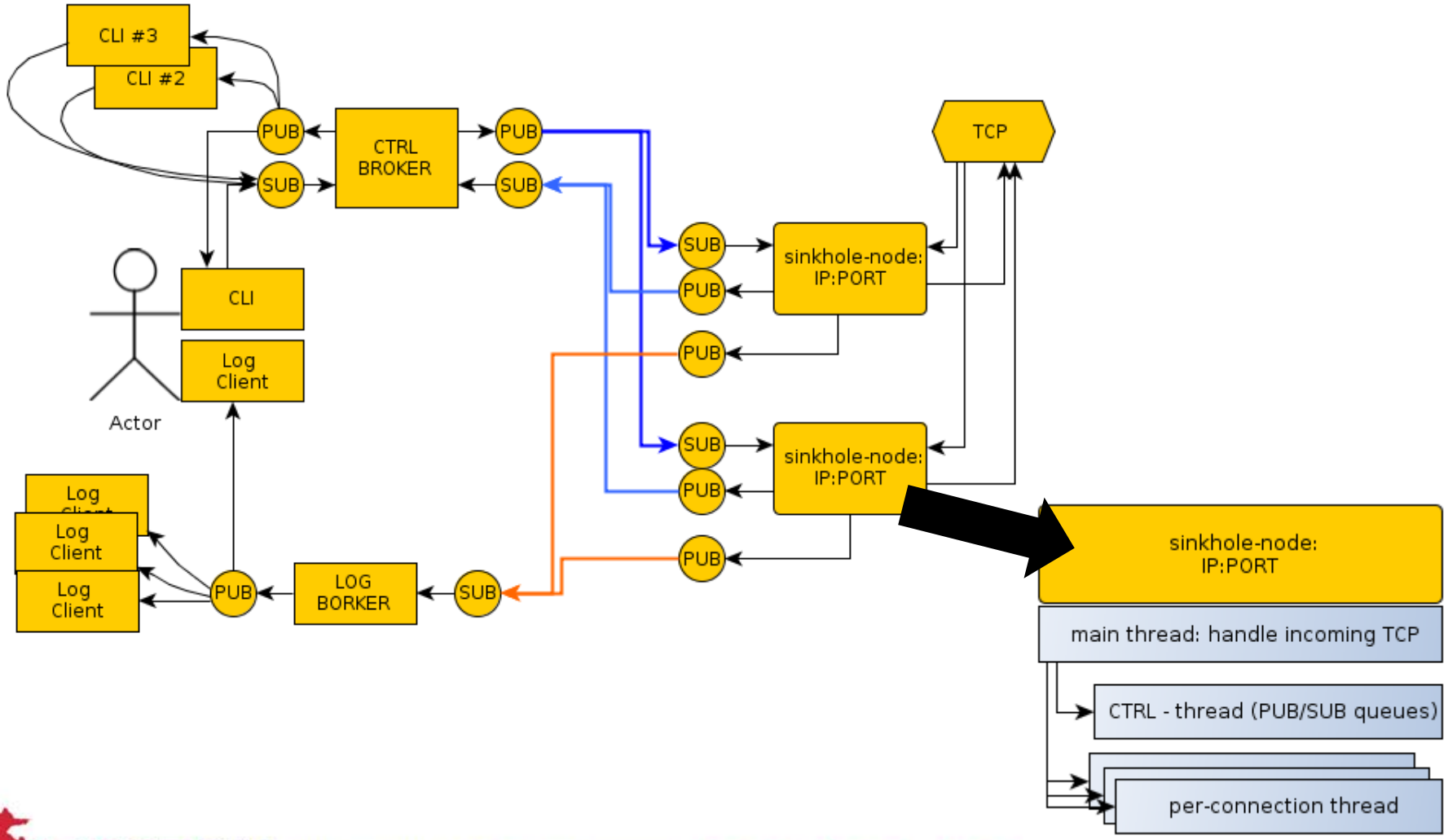
Design



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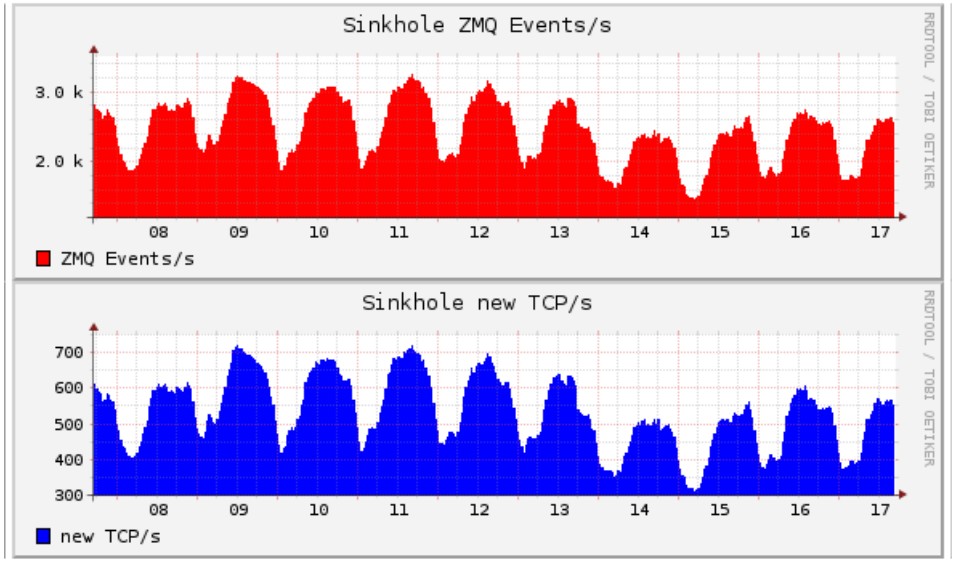
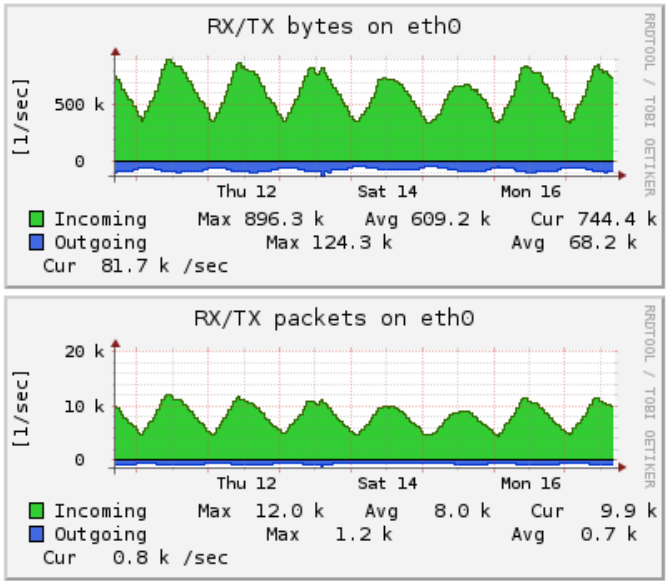
Sink-soft

Sinkholing > 200 active malware domains






```
root@sinkhole:~# w
 14:20:38 up 561 days, 19:05,  4 users,  load average: 0.00, 0.00, 0.00
```

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Sink-soft

demo :)

Fin.

Tomasz Bukowski

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