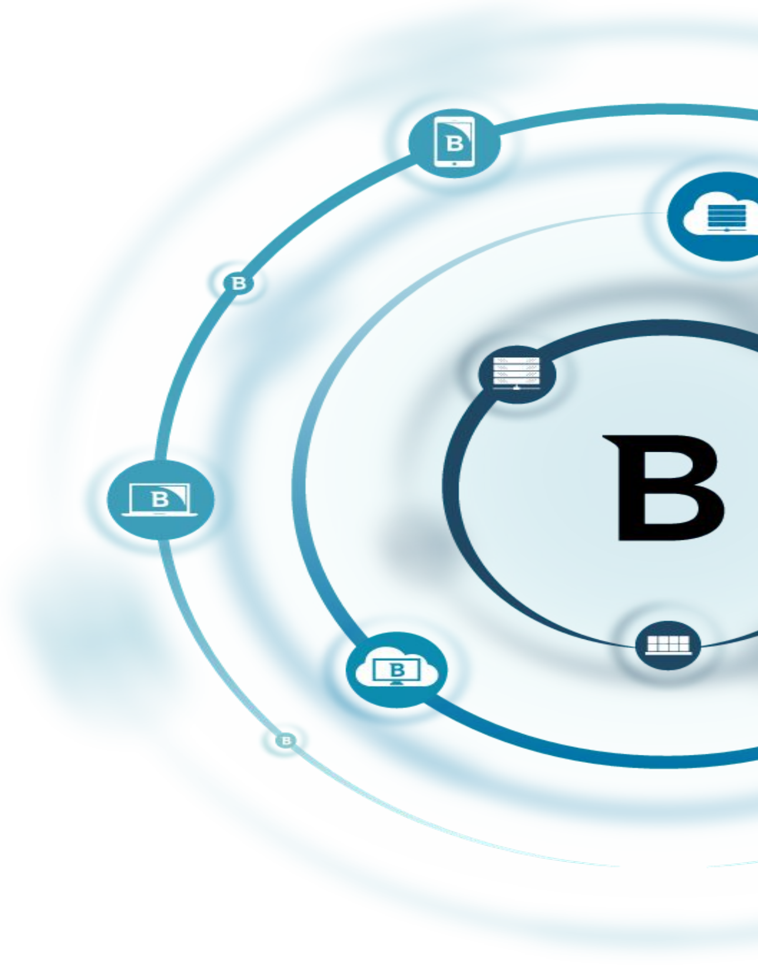
Bitdefender

Hide’n’Seek

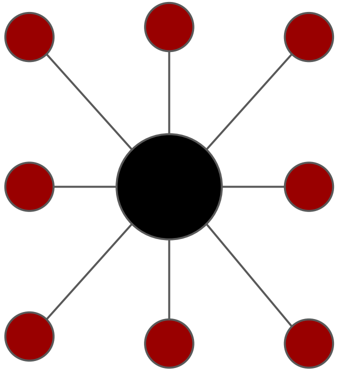
An Adaptive Peer-to-Peer Botnet

Adrian Șendroiu
Vladimir Diaconescu



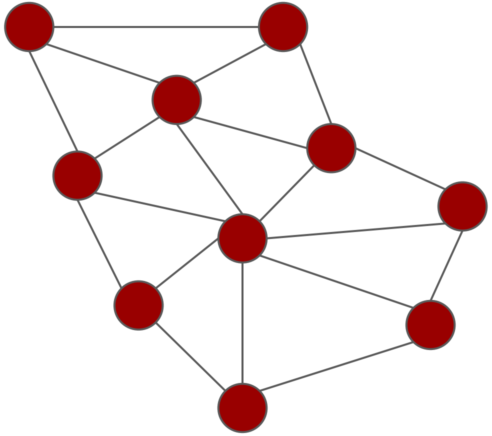
Context

- IoT Botnets increasing in impact and diversity
- Tried and tested models (Mirai)
  - Central C2 Server
  - (Different) Infecting machine
  - (Different) Reporting machine
- Dictionary and CVE extensions
- Main objective: DDoS



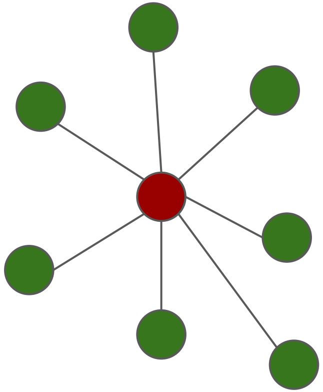
Analysis - Overview

- A new idea: Peer-to-Peer botnet
  - Also seen in Hajime
- Custom protocol
- Modular
- Authenticated
- Different goals



Functionality

- Two main components
  - Scanner



Functionality

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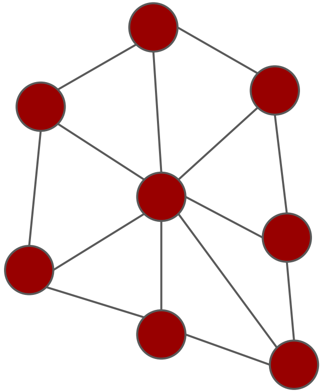
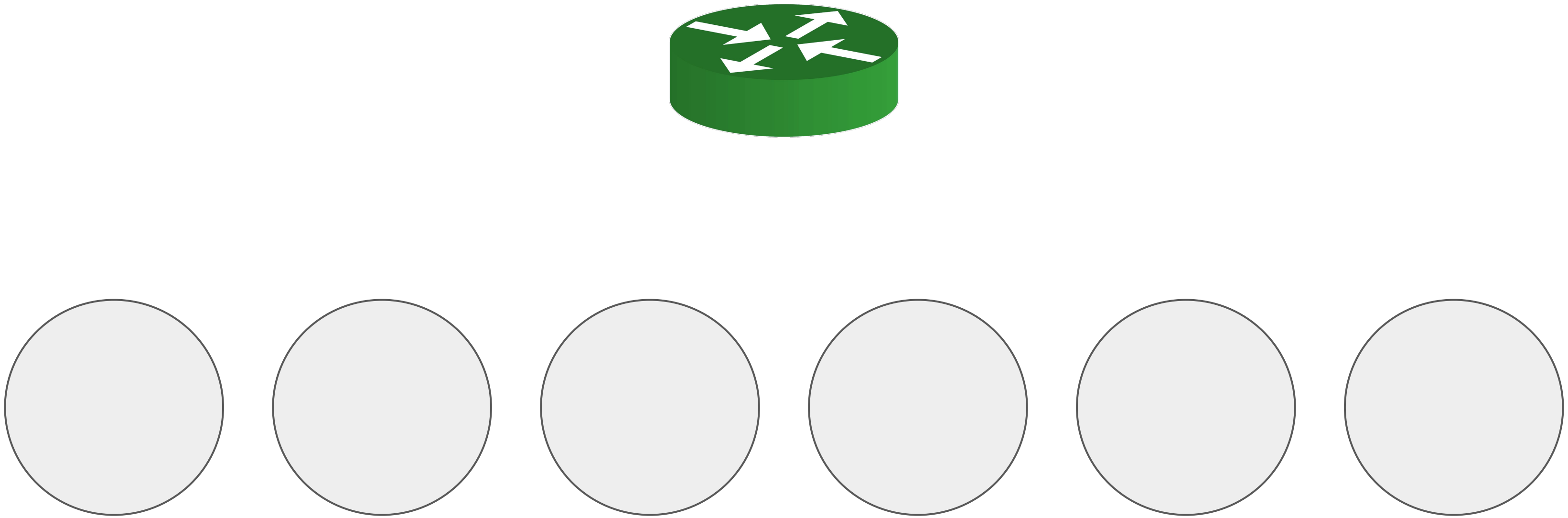
  - Scanner
  - P2P protocol



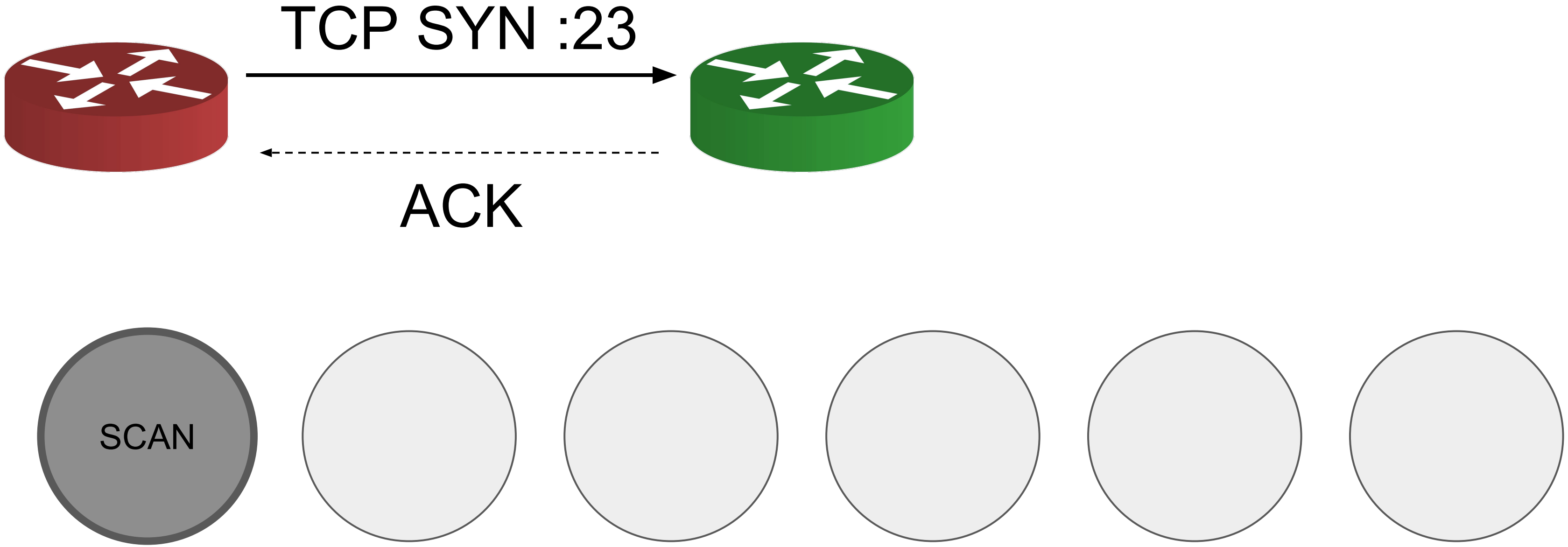
Scanning for victims

- Pick a random IP and a port
  - 23, 2323 (telnet) - try default credentials
  - 80, 8080 (http) - try known IoT exploits
  - 5555 - ADB
  - Others (2480, 5984)

Analysis - Infection process



Analysis - Infection process: Scan

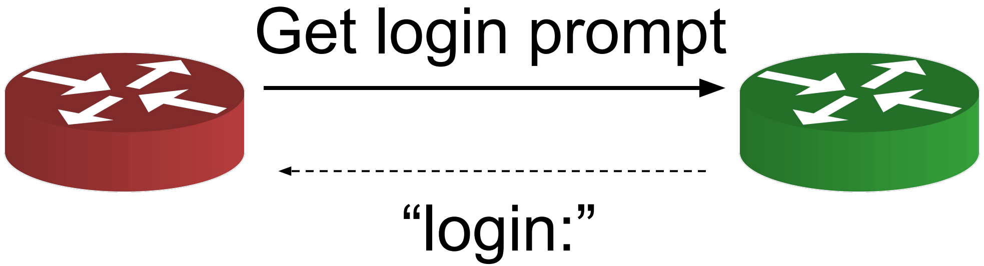


TCP SYN :23

ACK

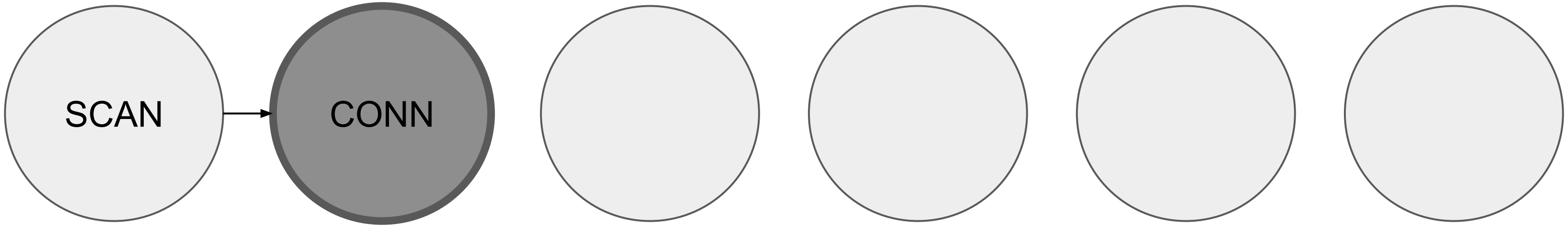
SCAN

Analysis - Infection process: Connect



Get login prompt

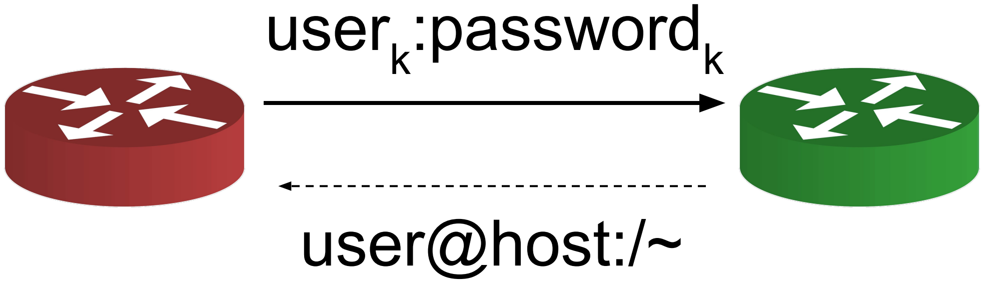
“login:”

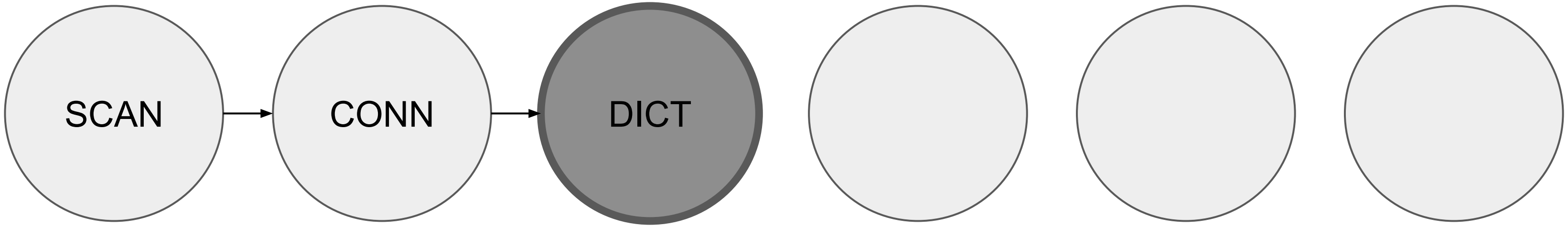


SCAN

CONN

Analysis - Infection process: Dictionary





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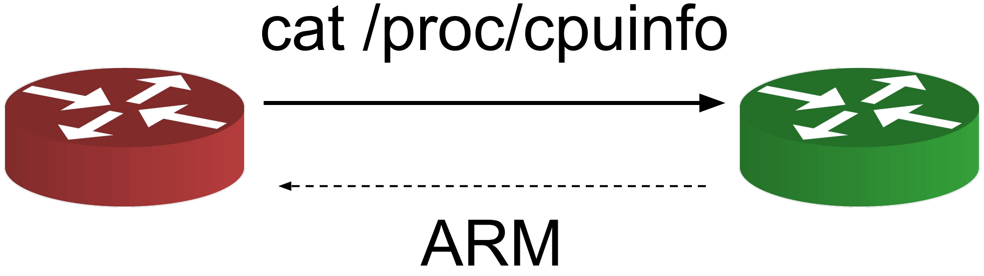
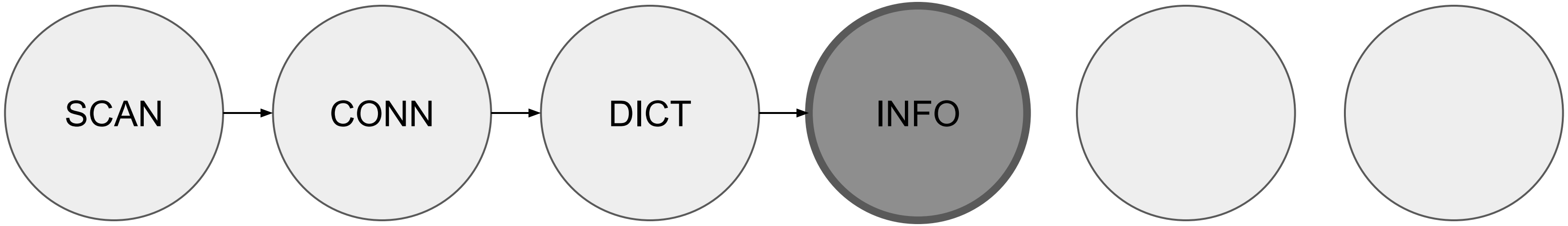
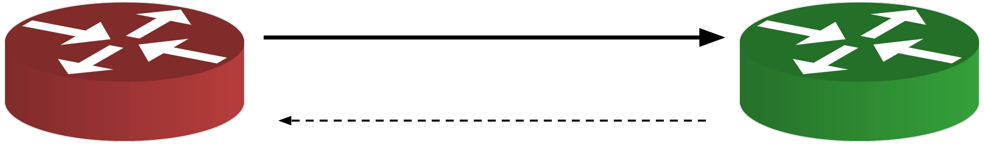
Analysis - Infection process: Sysinfo



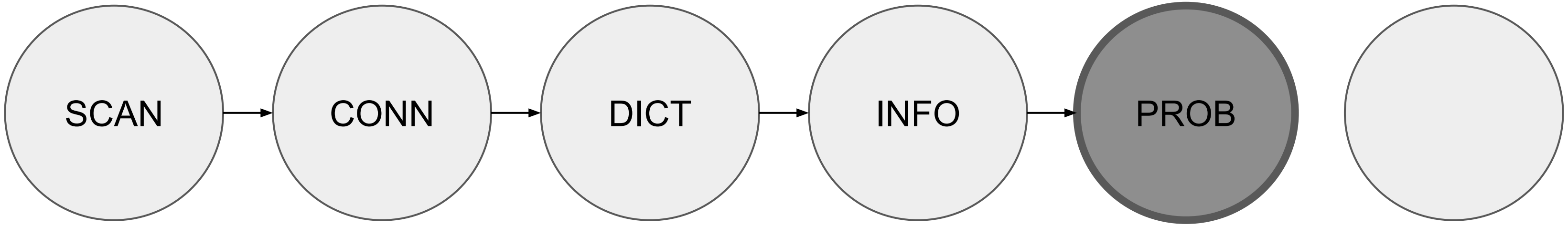


Analysis - Infection process: Probing

wget
curl
base64



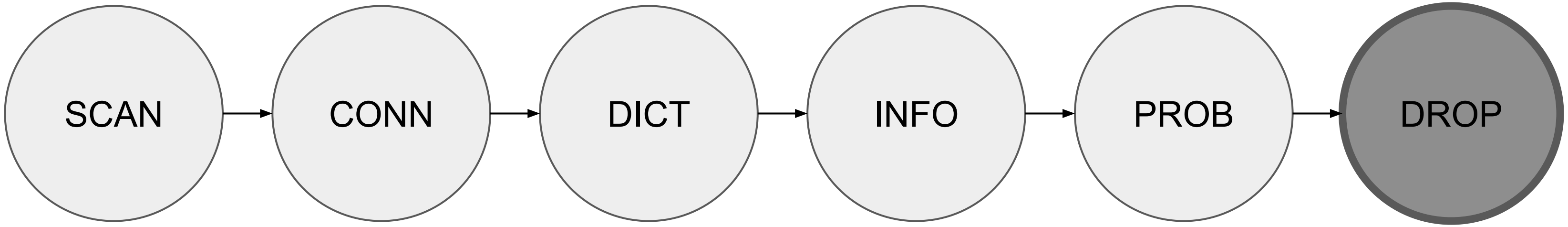
wget: not found
curl: not found



SCAN → CONN → DICT → INFO → PROB →

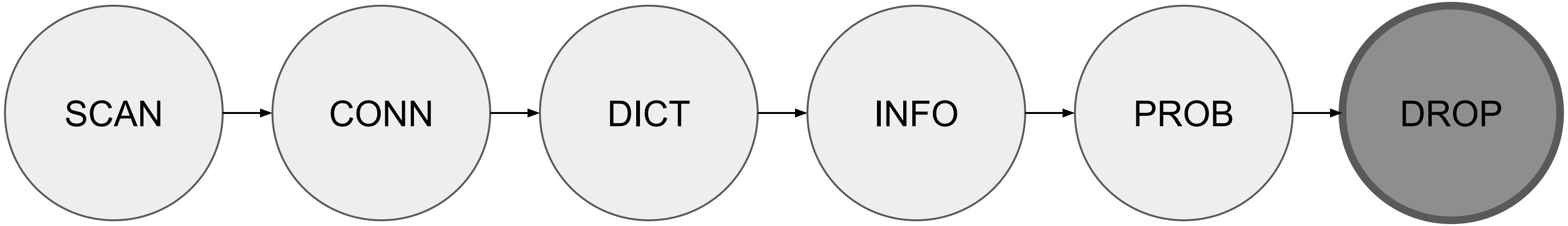
Analysis - Infection process: Dropping

- “echo -e ‘\x7fELF…’ > abc”
- chmod +x abc



Analysis - Infection process: Dropping

- ./abc a1.2.3.4:5678 k23 l4444 e5.4.3.2:80



Analysis - Infection process: Dropping

- ./abc a1.2.3.4:5678 k23 l4444 e5.4.3.2:80
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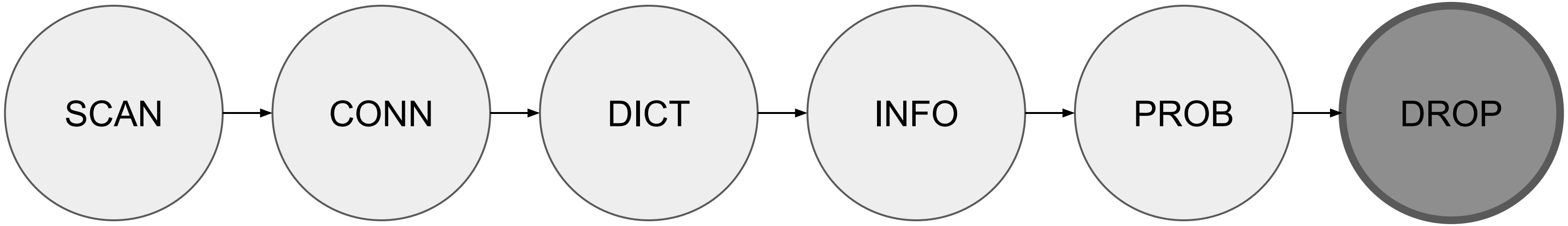

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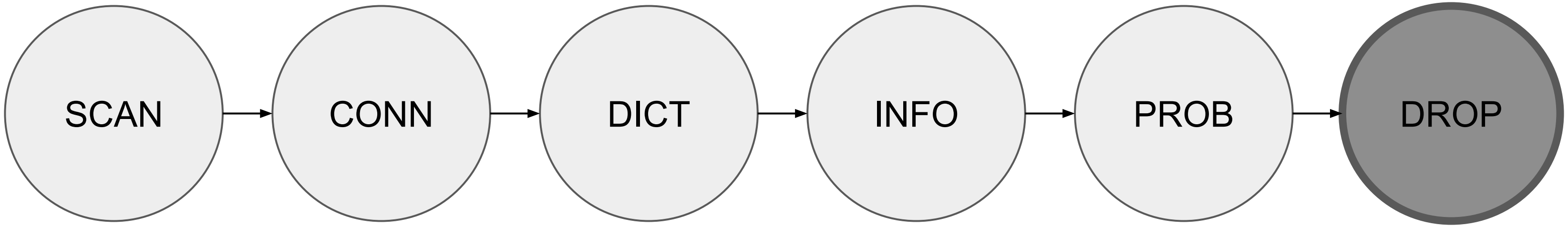
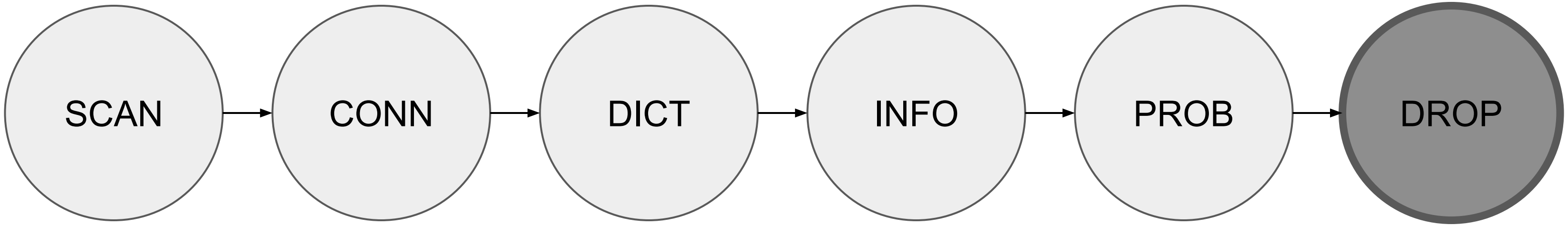
Analysis - Infection process: Dropping

- ./abc a1.2.3.4:5678 k23 l4444 e5.4.3.2:80
  - Initial starting peers
  - Kill port



Analysis - Infection process: Dropping

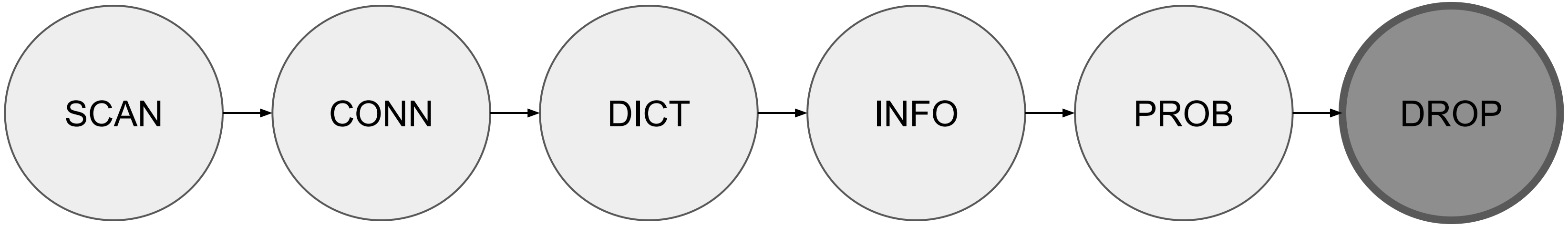
- ./abc a1.2.3.4:5678 k23 l4444 e5.4.3.2:80
  - Initial starting peers
  - Kill port
  - P2P listening port (UDP)



Bitdefender

Analysis - Infection process: Dropping

- ./abc a1.2.3.4:5678 k23 l4444 e5.4.3.2:80
  - Initial starting peers
  - Kill port
  - P2P listening port (UDP)
  - Additional scan targets



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P2P protocol

- Custom UDP protocol
  - Data structures
  - Messages

Data structures - Peer table

IP	port
1.2.3.4	20123
5.6.7.8	30456
4.3.2.1	40789

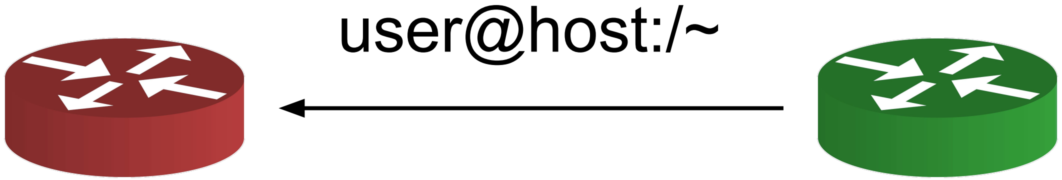
Data structures - Caches

payload id	->	hash
0x15	->	1af3...
0x13	->	3f14...

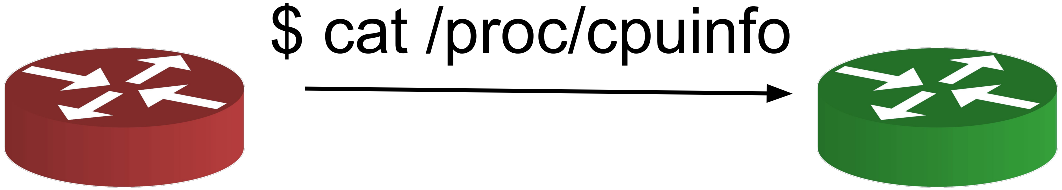
config cache

hash	->	data
3f14…	->	\x7fELF...
1af3...	->	\x7fELF…

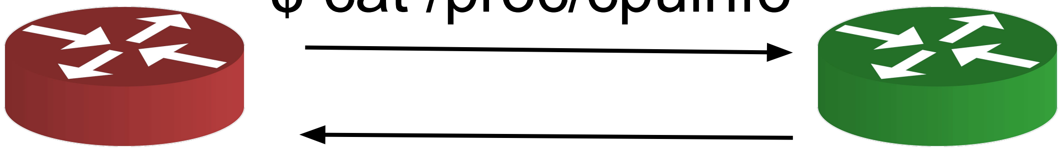
data cache



user@host:/~



```
$ cat /proc/cpuinfo
```



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```
...
model name      : ARMv7 Processor rev 1
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```
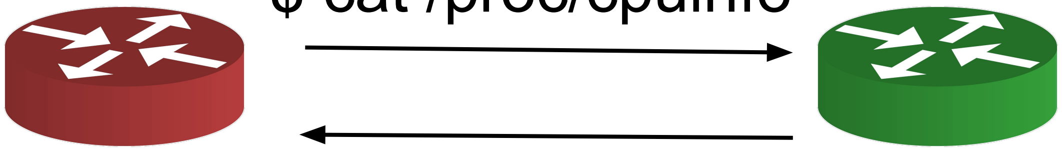

- What to download?



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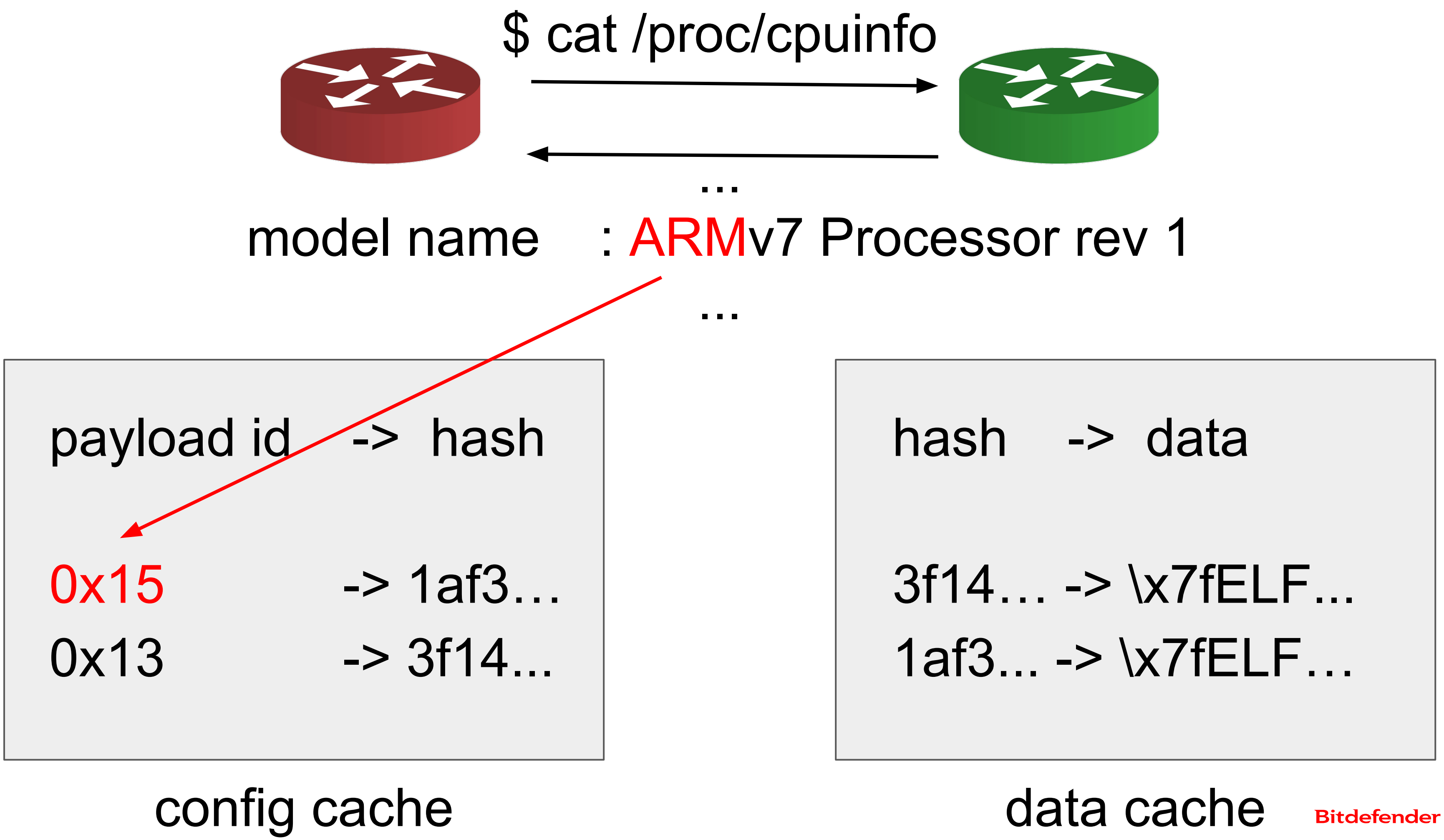

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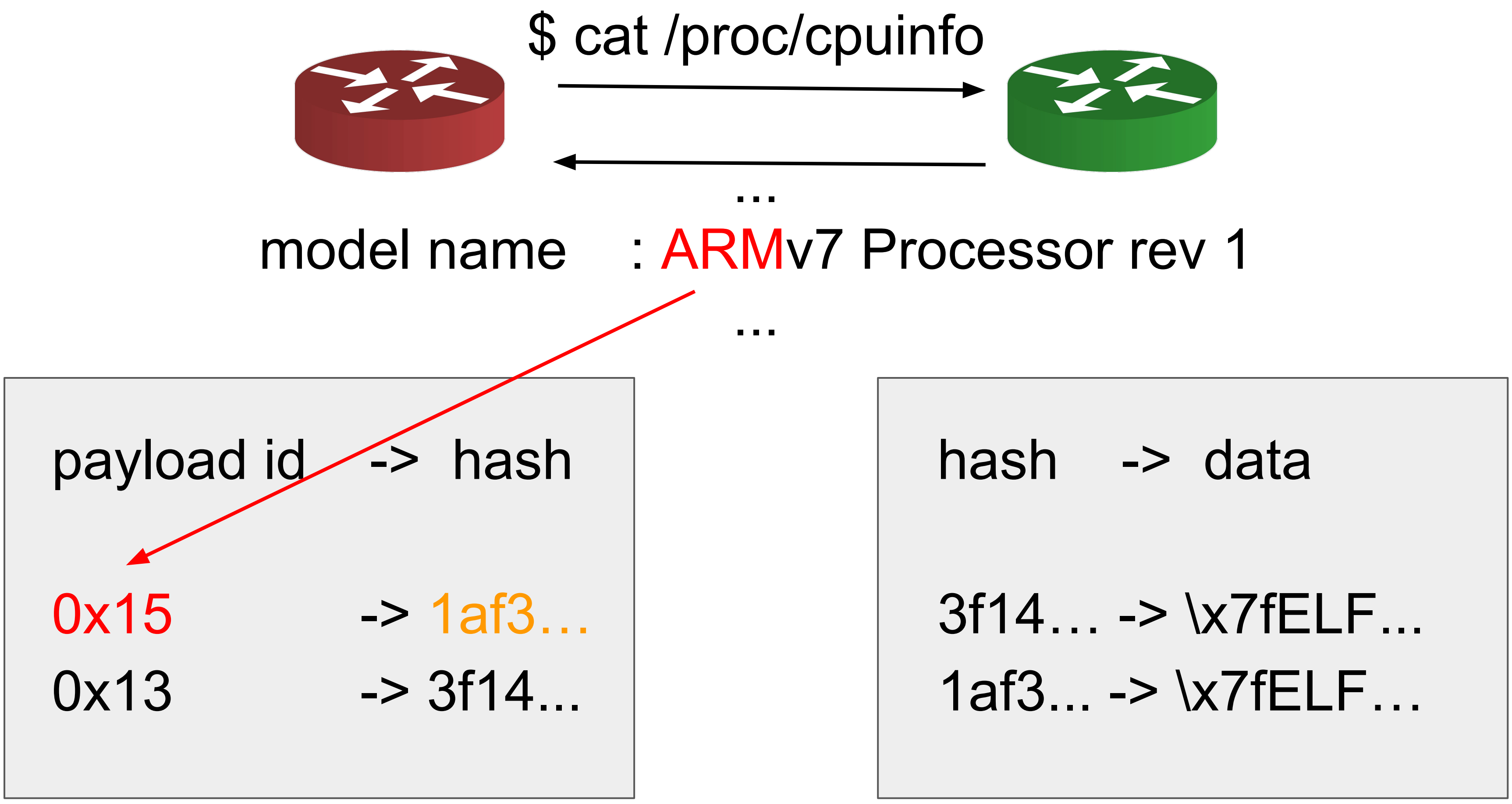

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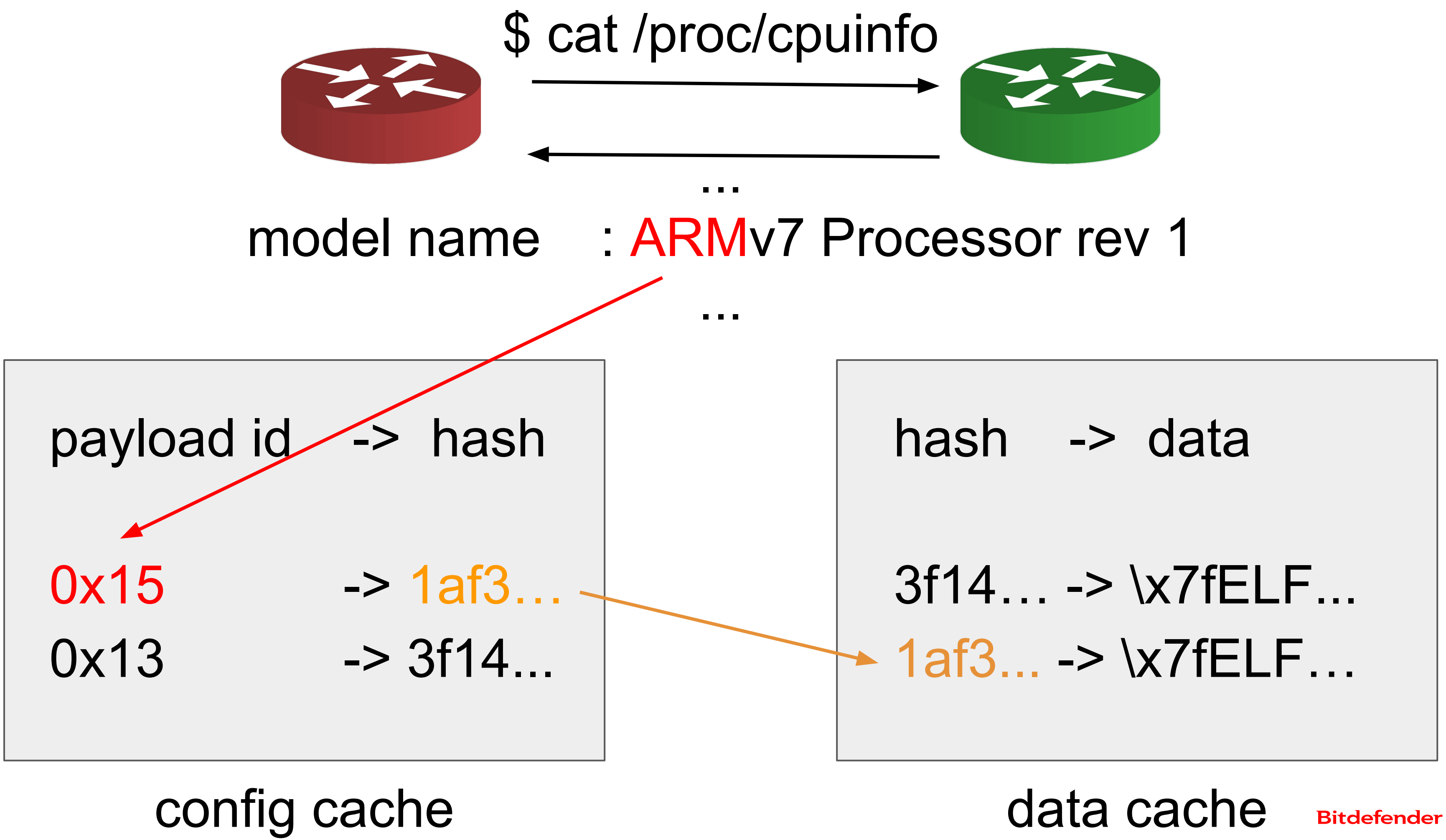

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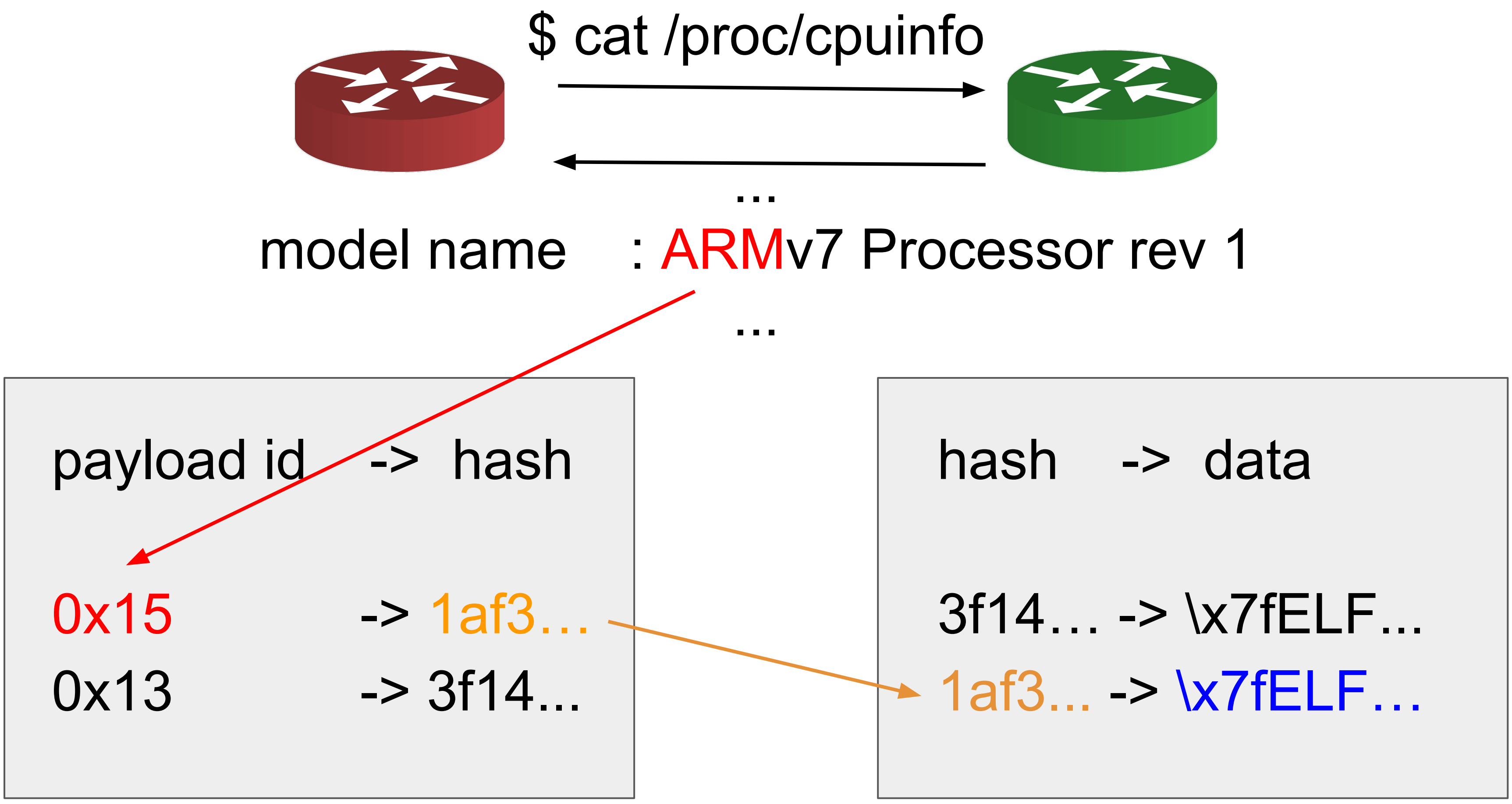

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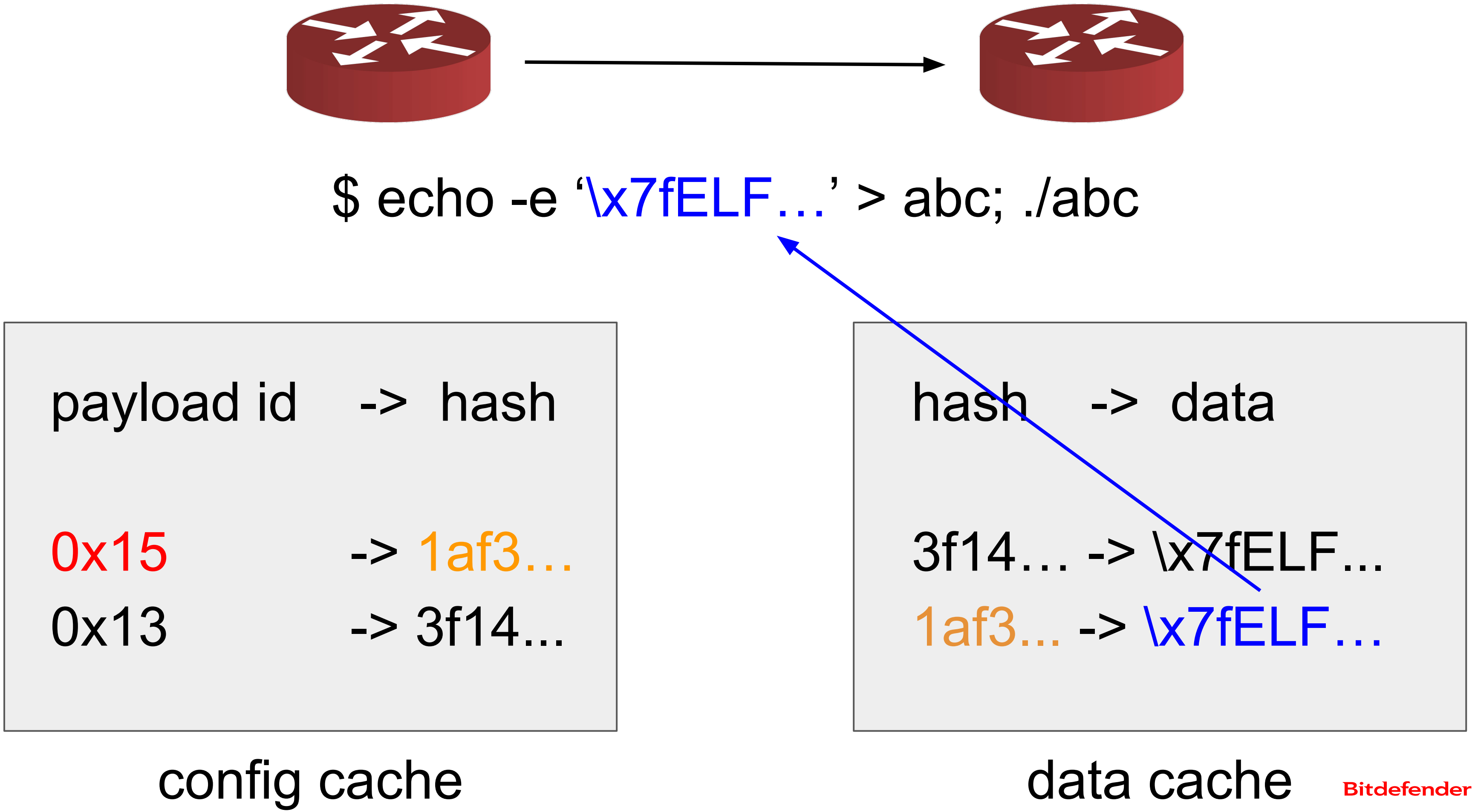

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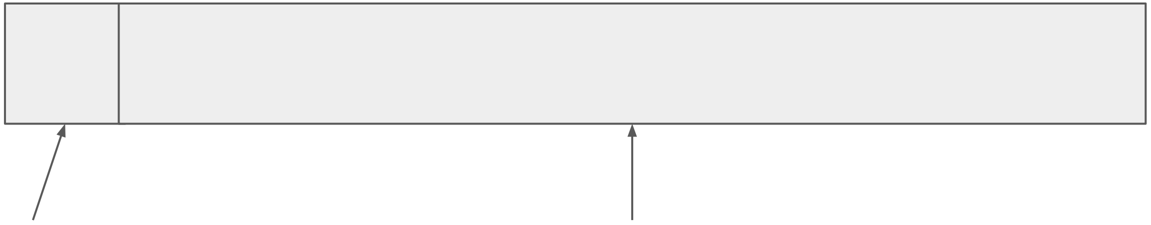
data cache

P2P protocol messages

- Config cache update
- Peer management
- Target reporting



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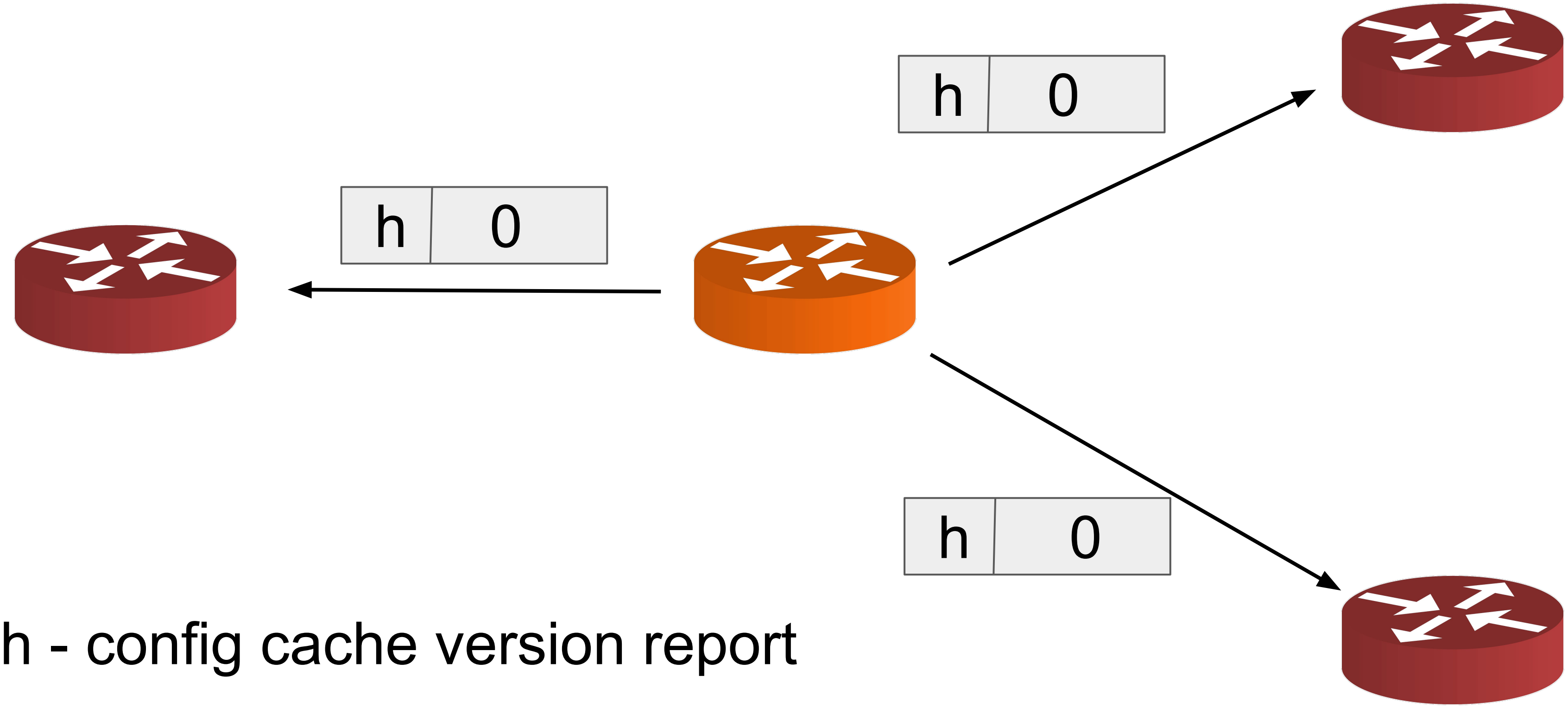

h - config cache version report

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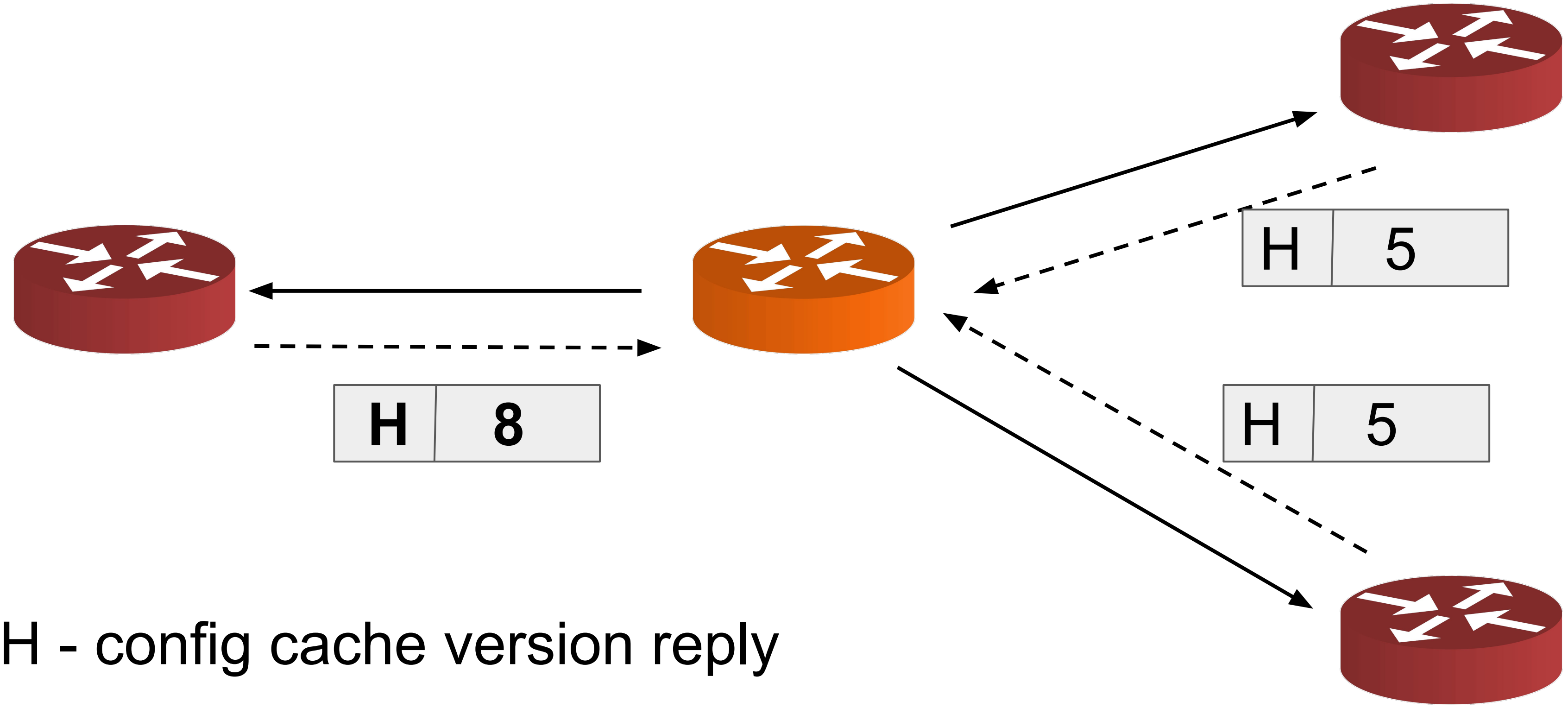
Config cache update



H - config cache version reply

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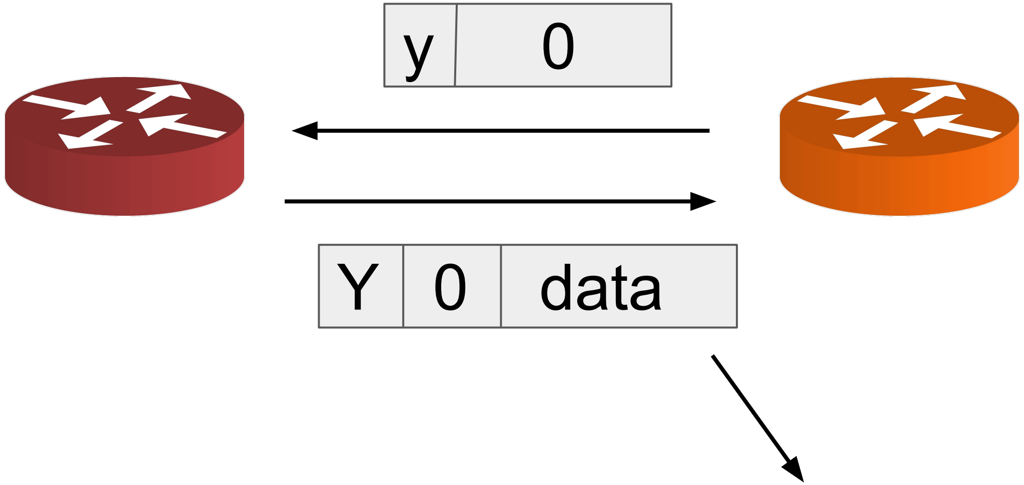
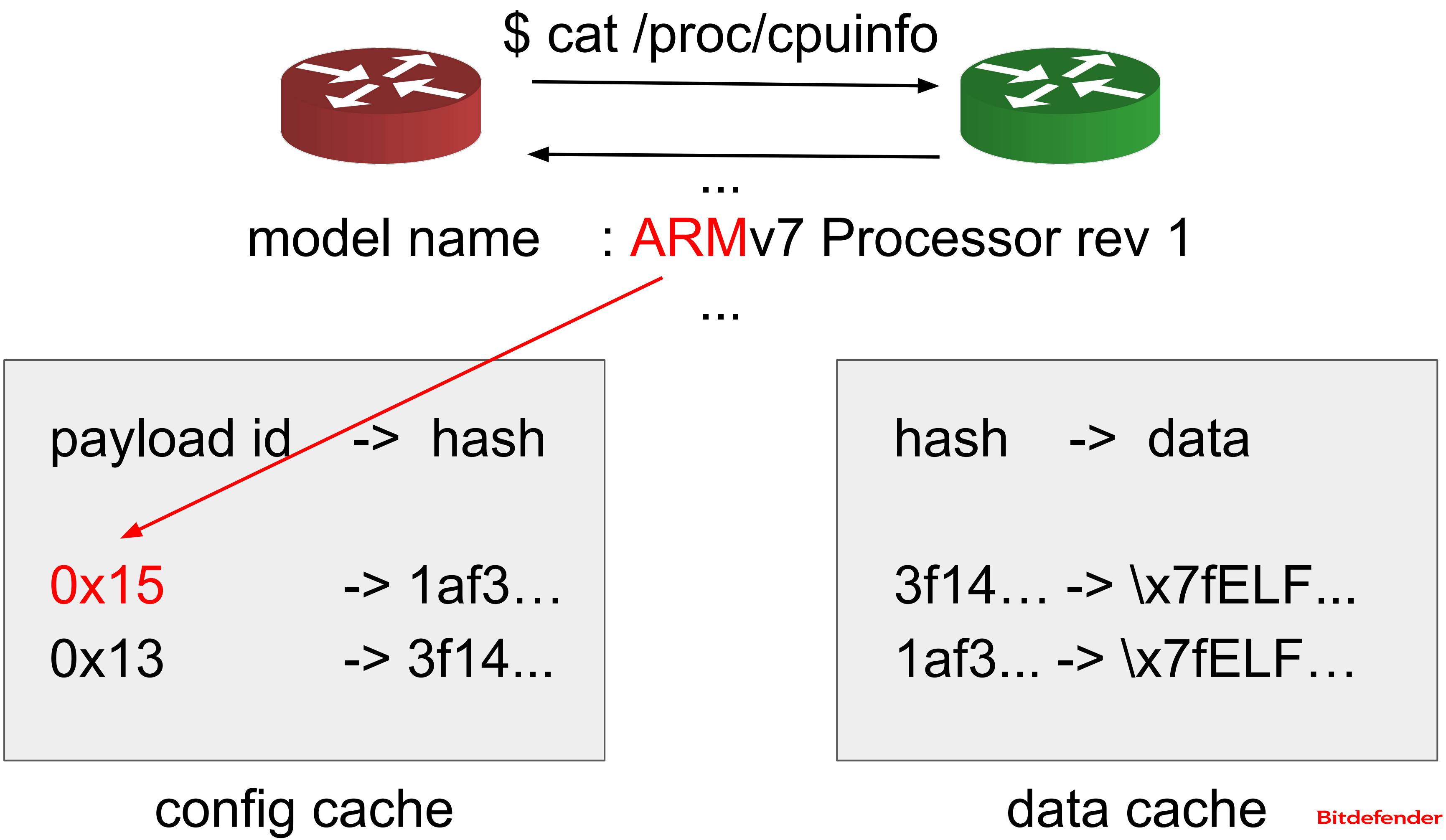
Config cache update



check signature

y - chunk request
Y - chunk reply



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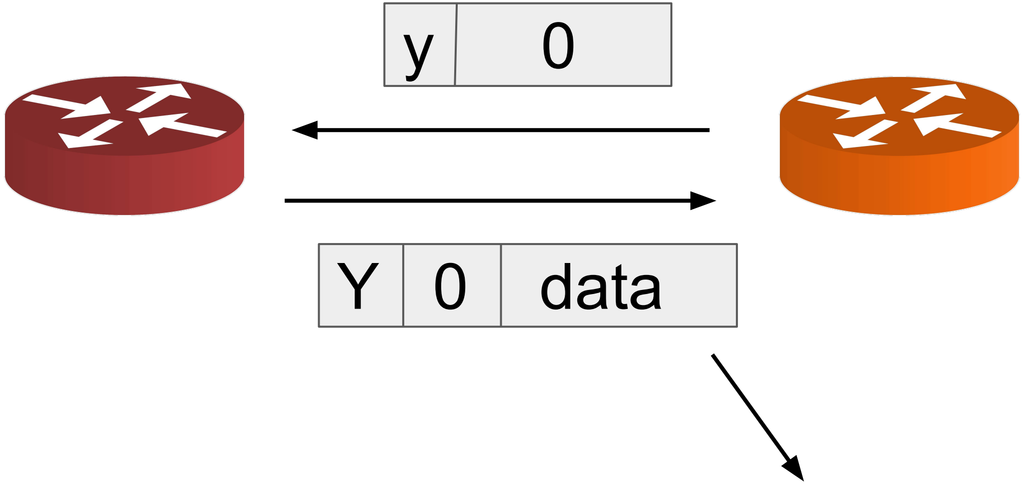

check signature

y - chunk request
Y - chunk reply

Bitdefender

Data cache update

hash -> data

3f14… -> \x7fELF...

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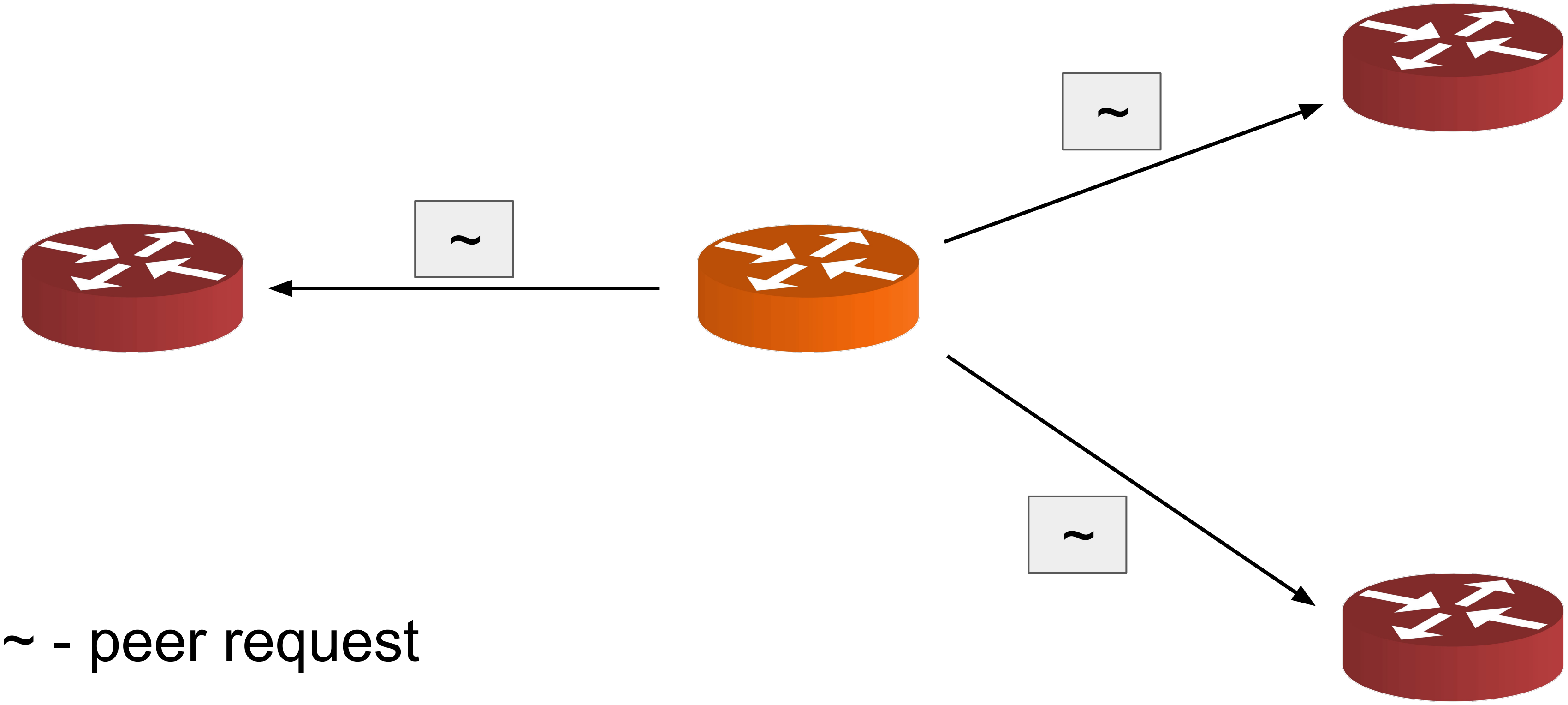
Peer update



~ - peer request

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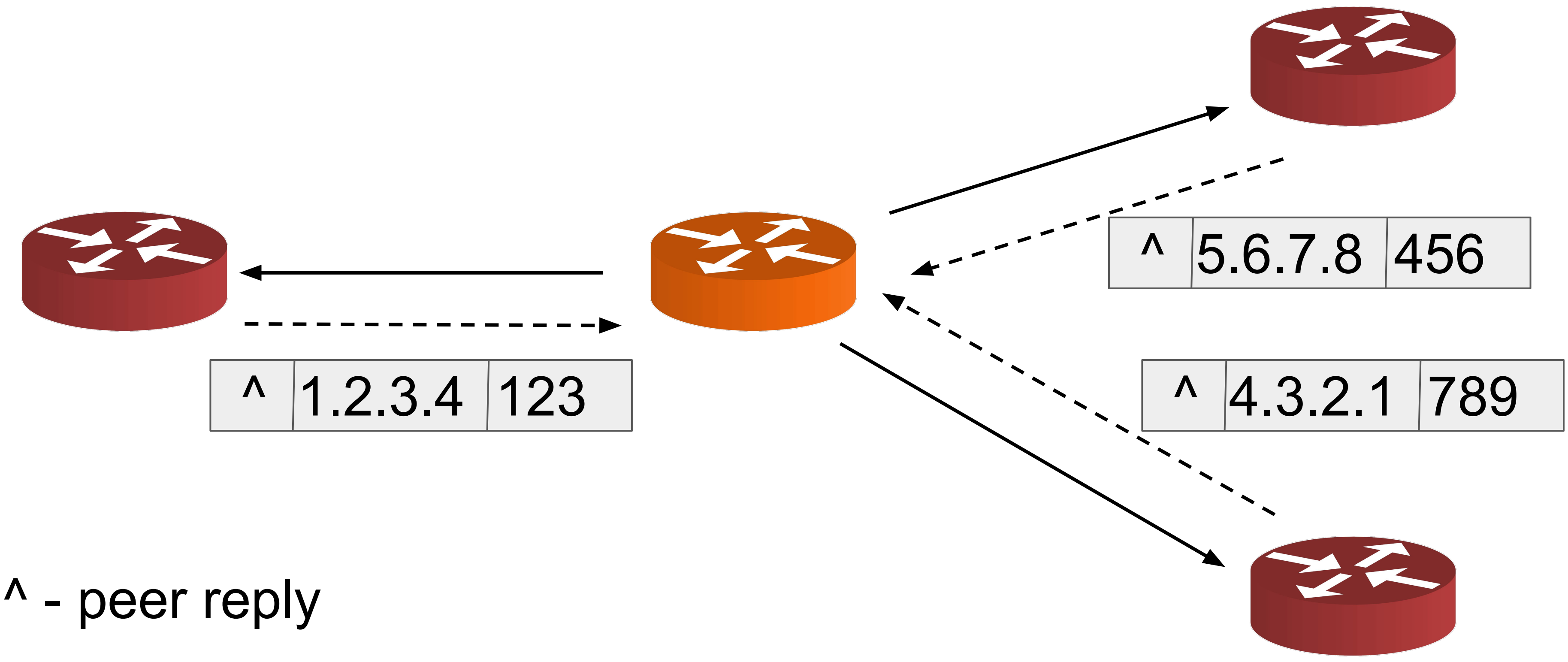
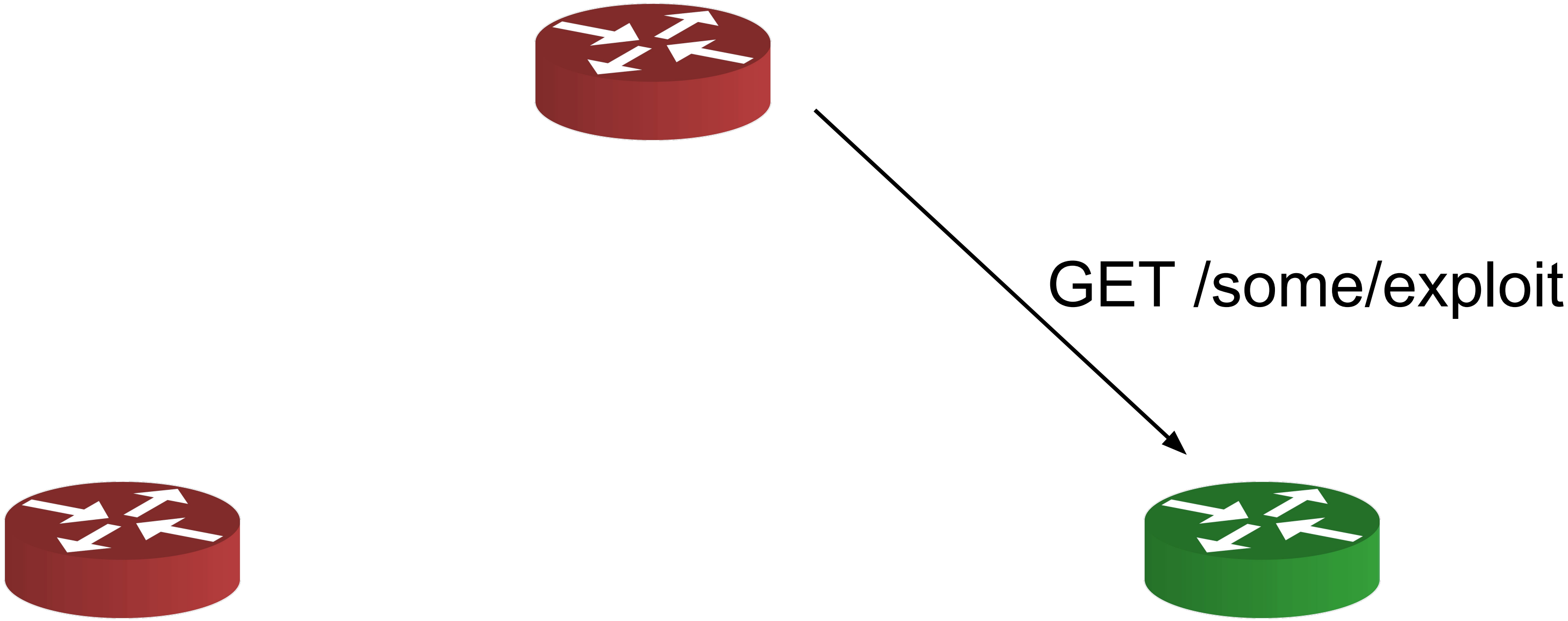
Peer update



^ - peer reply

Target device reporting



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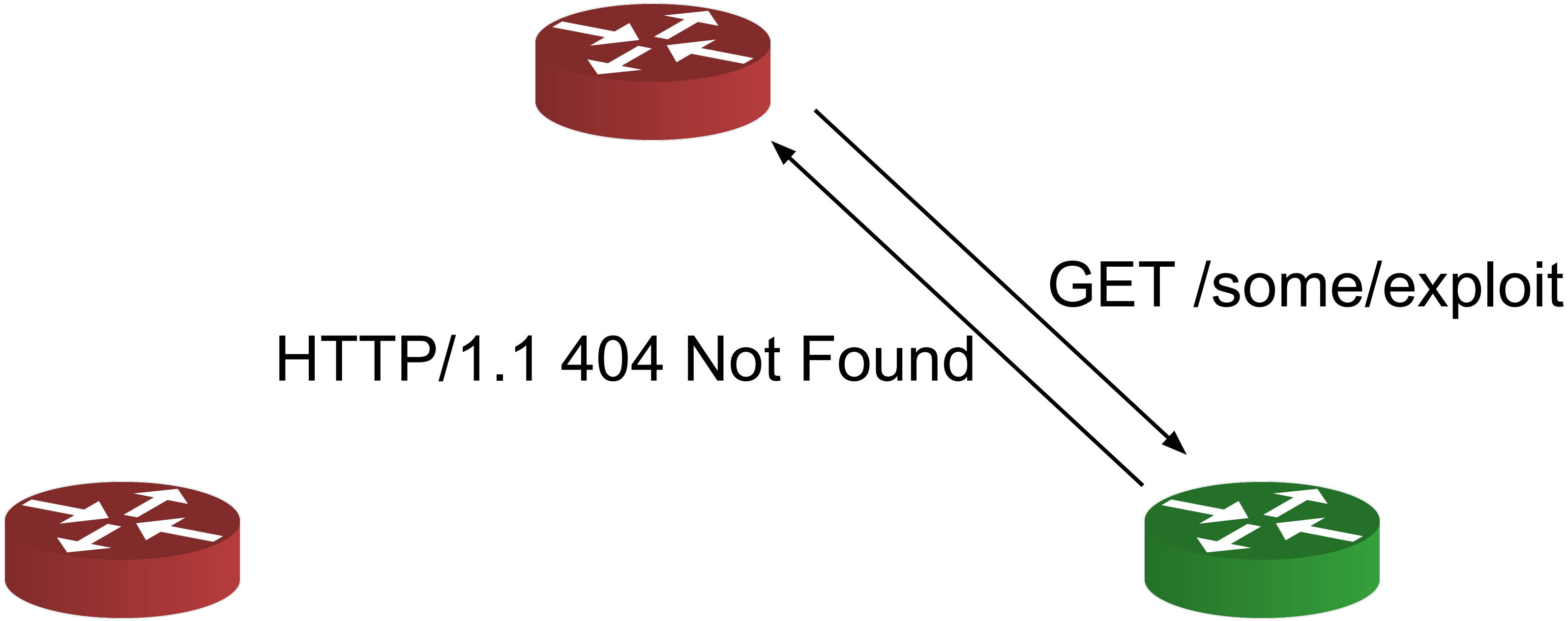
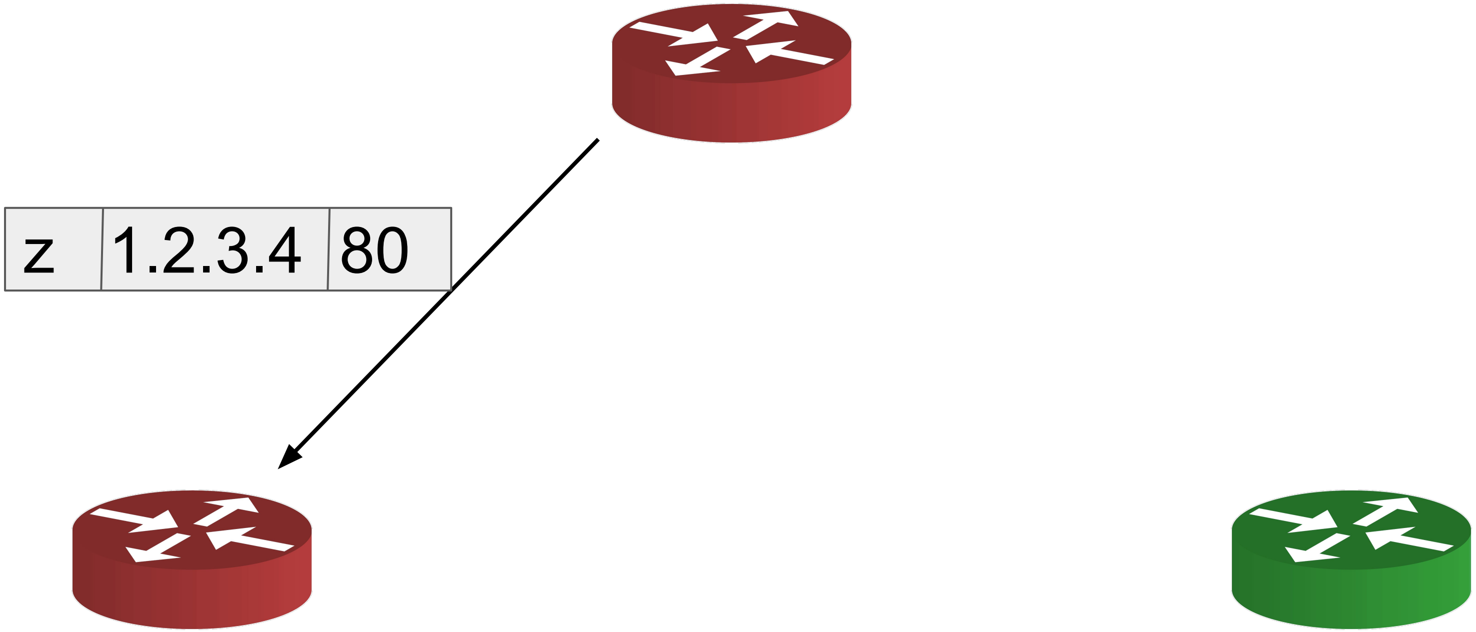


GET /some/exploit

HTTP/1.1 404 Not Found

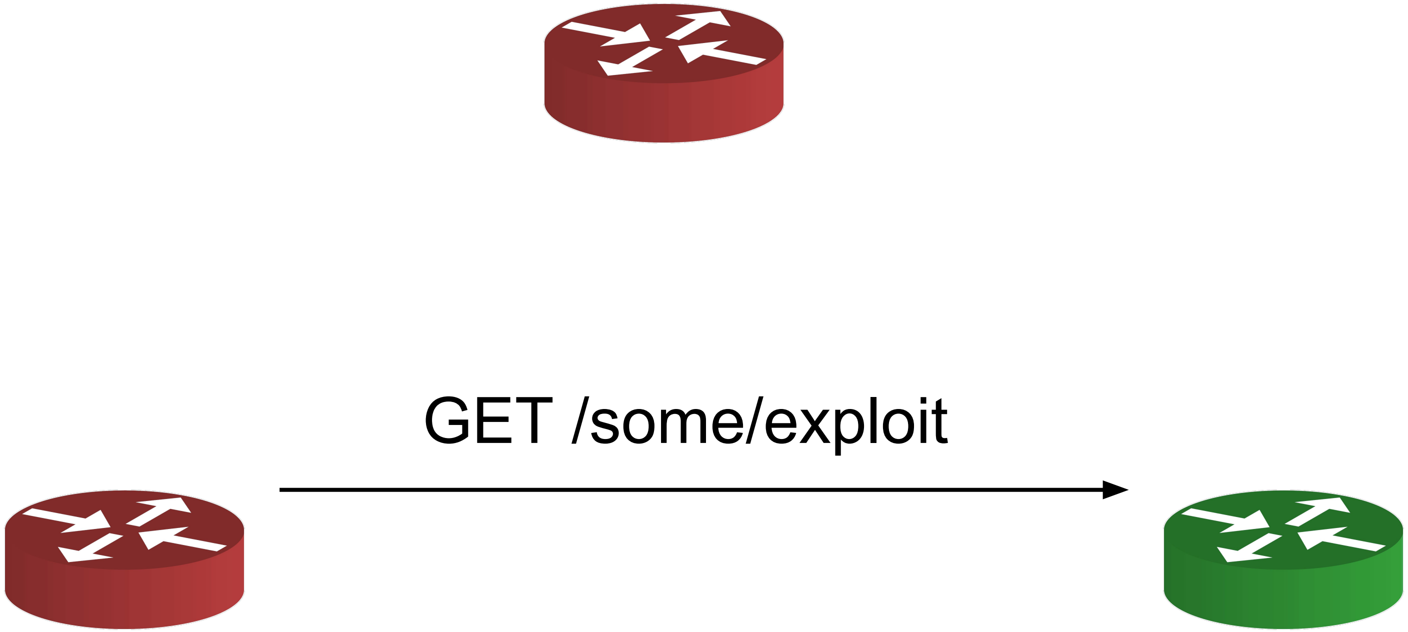
Bitdefender

Target device reporting



z	1.2.3.4	80

Target device reporting



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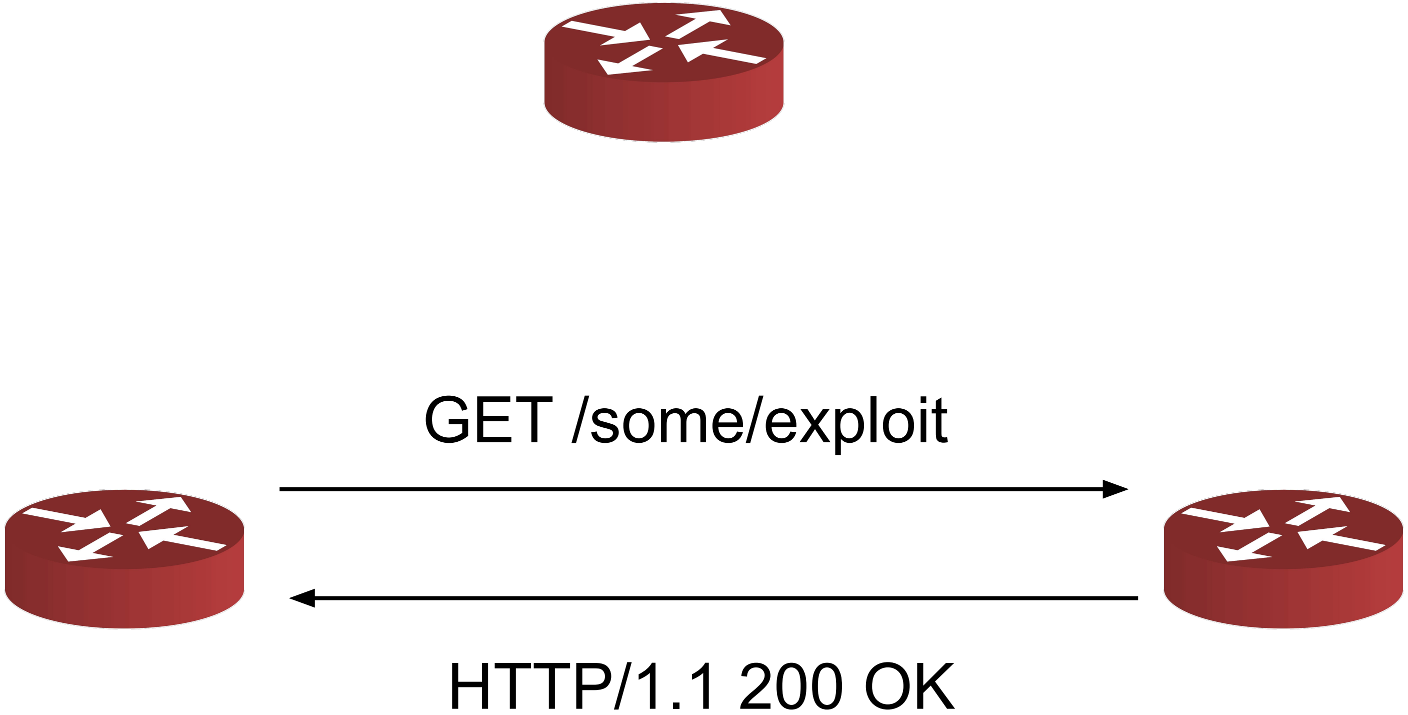

GET /some/exploit

HTTP/1.1 200 OK

Hide’n’Seek - Summary

- Infects many kinds of IoT systems
- Decentralized P2P architecture
- Network controlled by the author

Updates

Updates

- ~30 samples
  - Code refactoring
  - New functionality

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- Persistency (copy itself to /etc/init.d/S99abcd)

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  - New functionality
- Persistency (copy itself to /etc/init.d/S99abcd)
- Dropping other binaries
  - cpuminer

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- HTTP-based exploits for more IoT vendors

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- RCE via OrientDB and CouchDB

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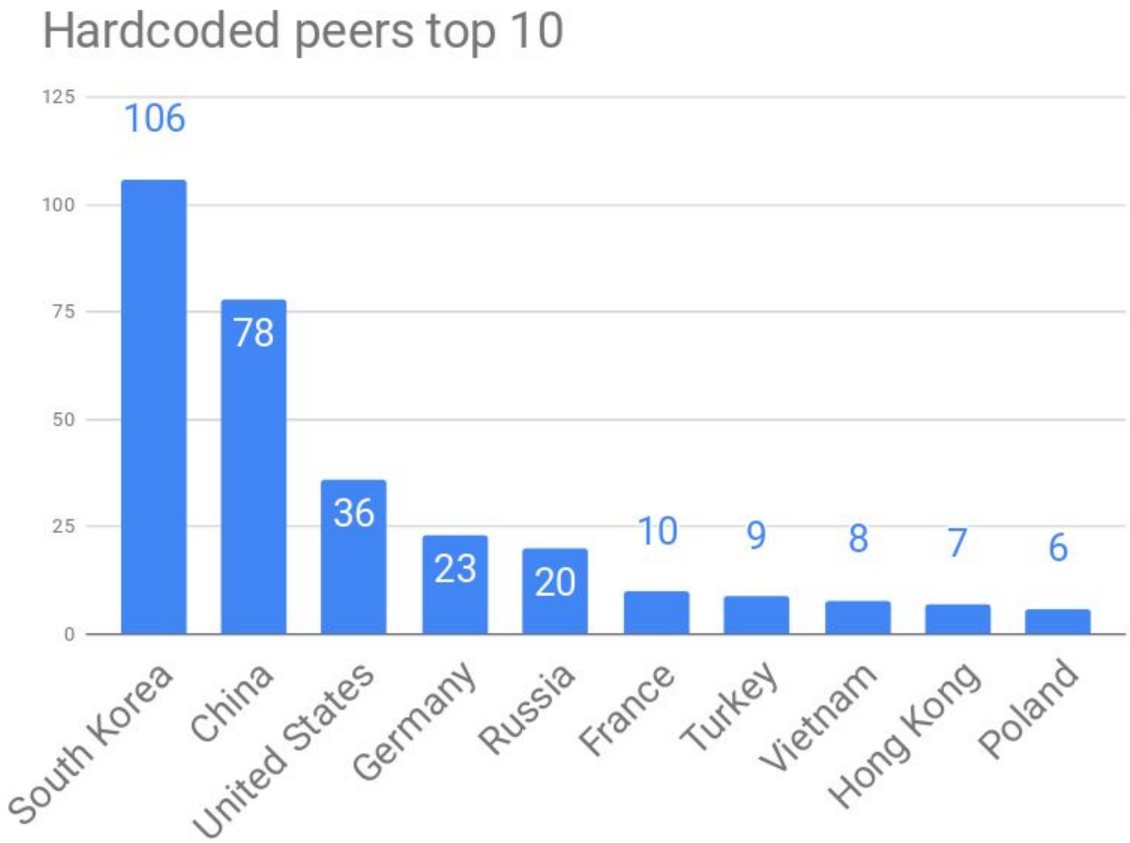
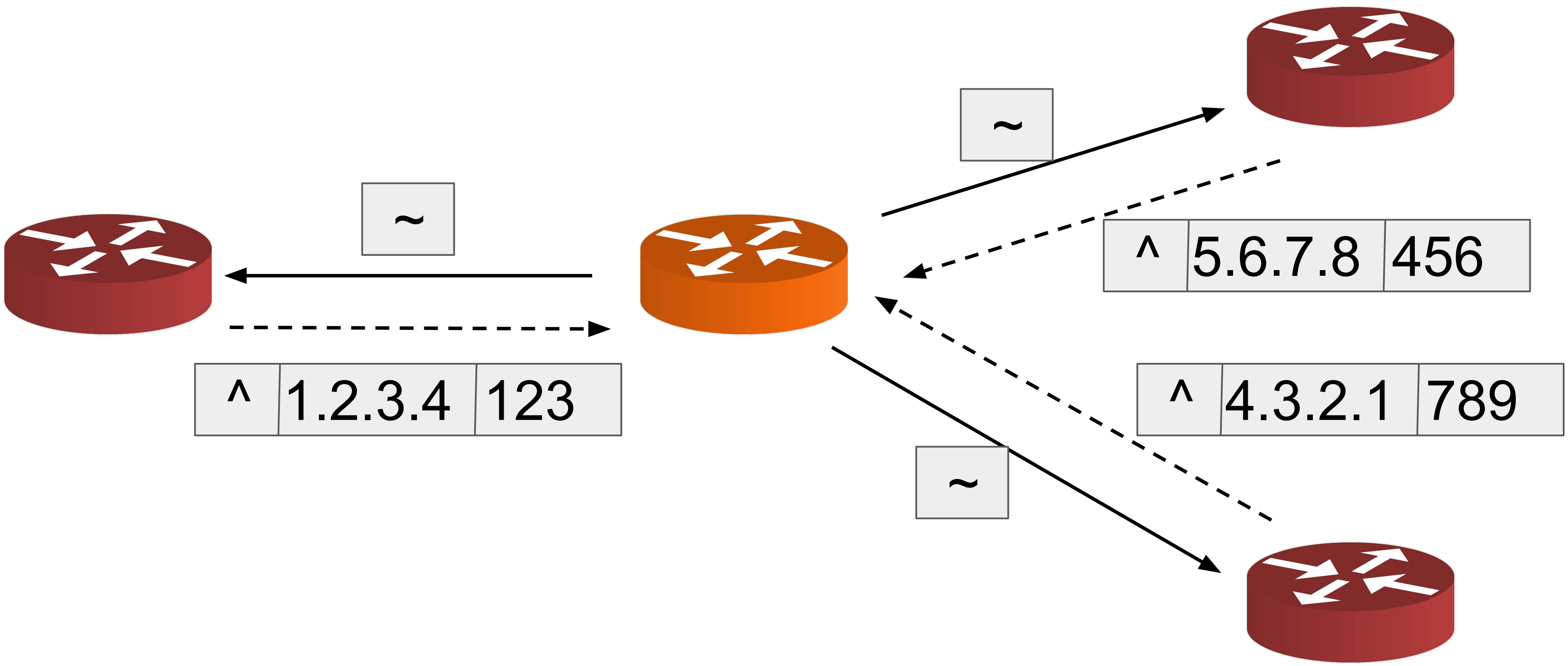
- RCE via OrientDB and CouchDB
- Hijacking devices via ADB

Monitoring



Hardcoded peers top 10
125
100
75
50
25
0
106
78
36
23
20
10
9
8
7
6
South Korea
China
United States
Germany
Russia
France
Turkey
Vietnam
Hong Kong
Poland

Monitoring



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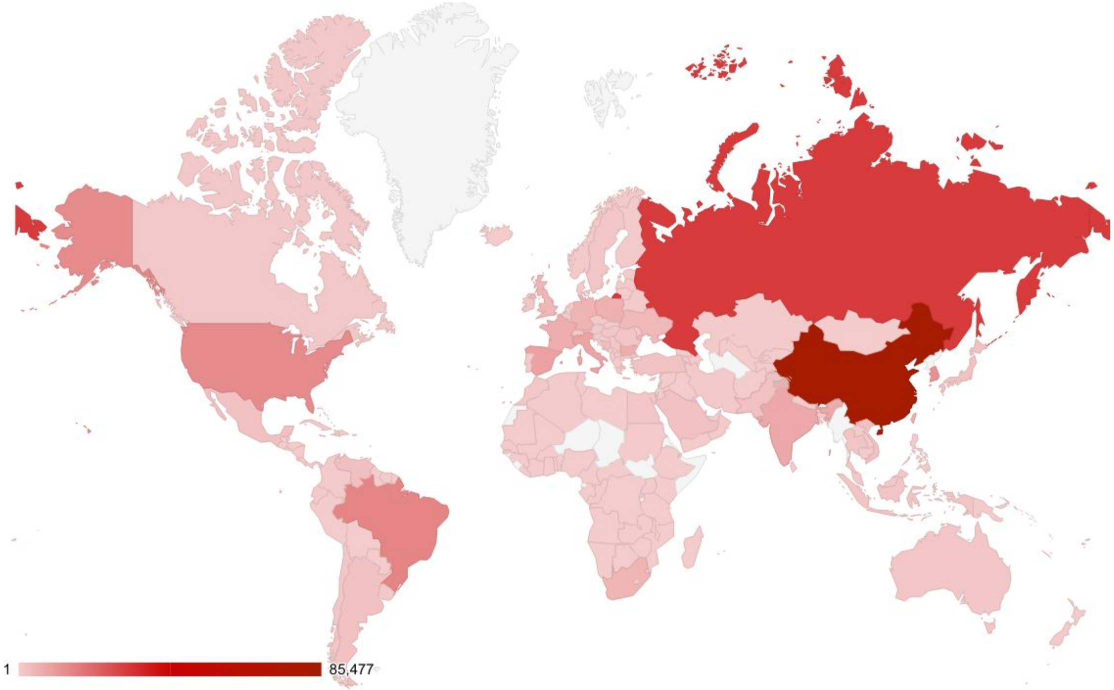
Monitoring

- ~300,000 peers



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Conclusions

- A new trend in the IoT landscape
  - Qbot, Mirai

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Conclusions

- A new trend in the IoT landscape
  - Qbot, Mirai
  - Hajime, Satori, Reaper, VPNFilter, HNS
- More threats to come

Q&A