Handling of DDos attacks

By Kajetan Staszkiewicz, SysAdmin @ InnoGames

About me

- Neighbourhood network admin since 1999.
- Worked for various local ISPs in Kraków.
- Currently Директор Интернета at InnoGames GmbH.

InnoGames

1. What is a DDoS attack and how does it work?
2. Why are we attacked?
3. How do DDoS attacks affect (hard|soft)ware?
4. How do we detect DDoS attacks?
5. How do we protect against DDoS attacks?

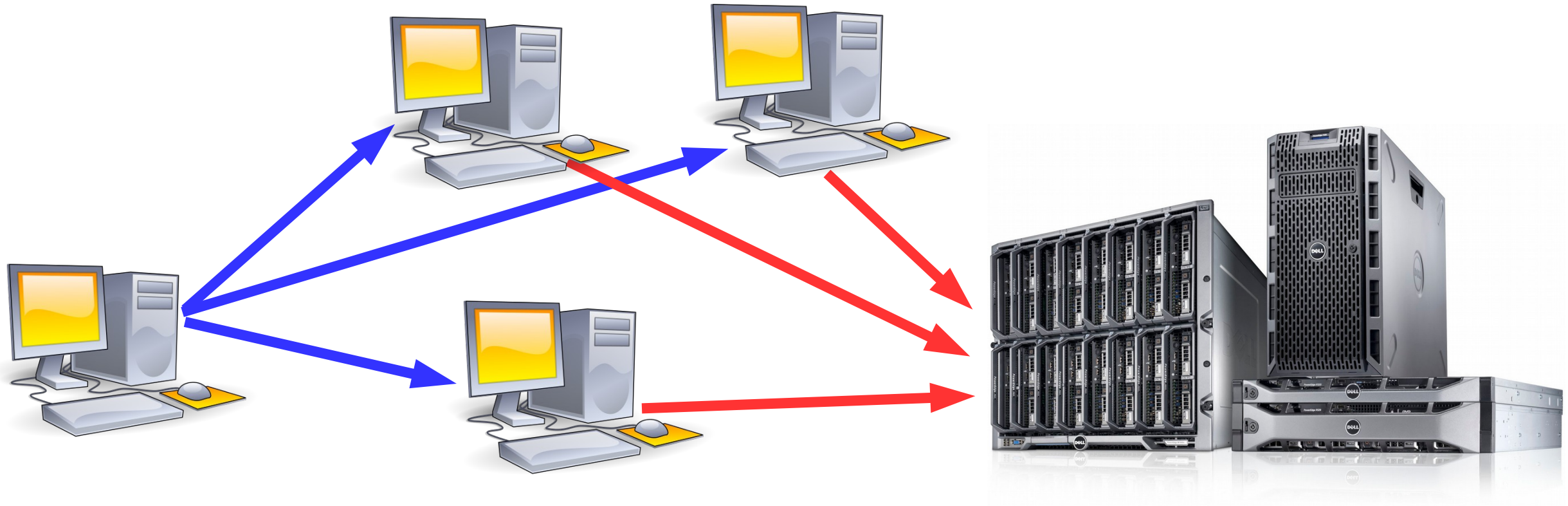
What is a DDoS attack and how does it work?

1. What is a DDoS attack and how does it work?

Direct attack:

- Attack force (pps, rps) limited by computer and Internet connection of attacker
- Source Datacenter might filter attack.

1. What is a DDoS attack and how does it work?



Distributed Denial of Service:

- Attack force (pps, rps) is multiplied.
- Attacker needs control over attacking machines.

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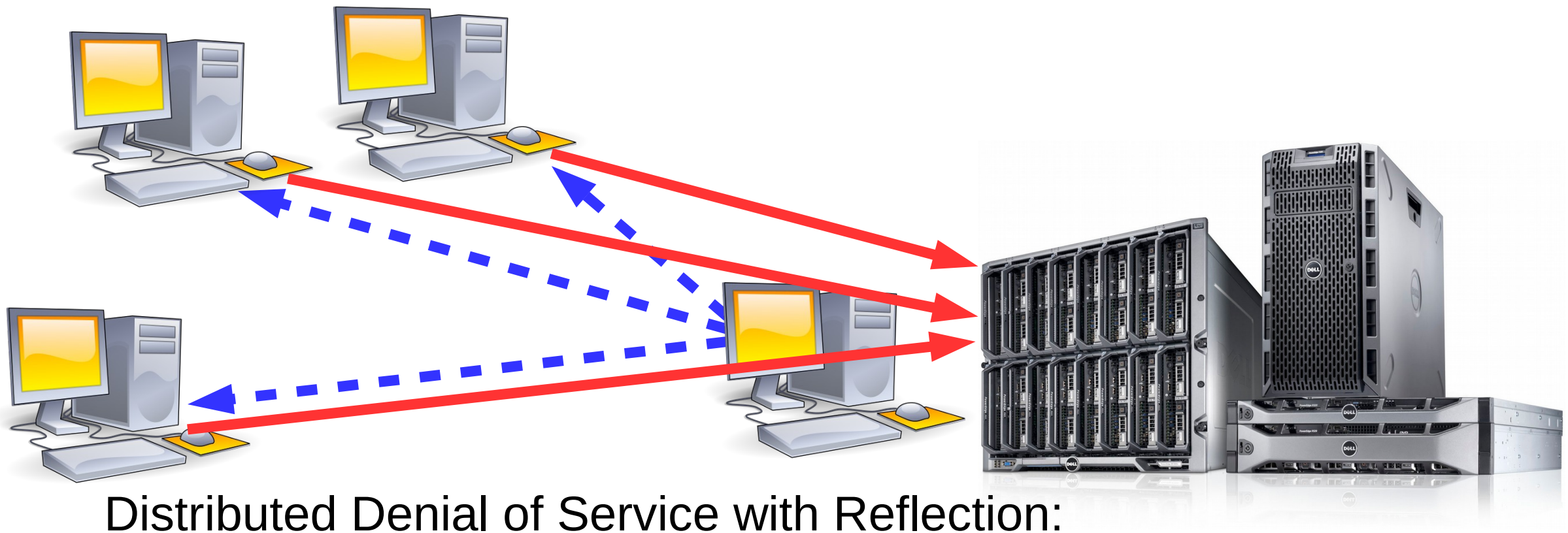

Distributed Denial of Service with Reflection:

- Attack force (pps, rps) is multiplied.
- Innocent, uninfected machines perform attack for the attacker.
- Attack sources think that we attack them – extra paperwork.

How is it possible?

- Internet providers and Datacenters don't always verify source addresses of packets from their networks.
- For reflection attack connectionless, UDP-based services (DNS, SNMP, NTP) are used:
  - DNS – up to 54×, 179× with DNSSEC
  - NTP – up to 556×
  - 300Gb/s attack can be performed.

How to attack?

- Maybe having own server with big link?
- Maybe searching in TOR/Darknet?
- Maybe asking your friends to constantly hit F5 in web browsers?

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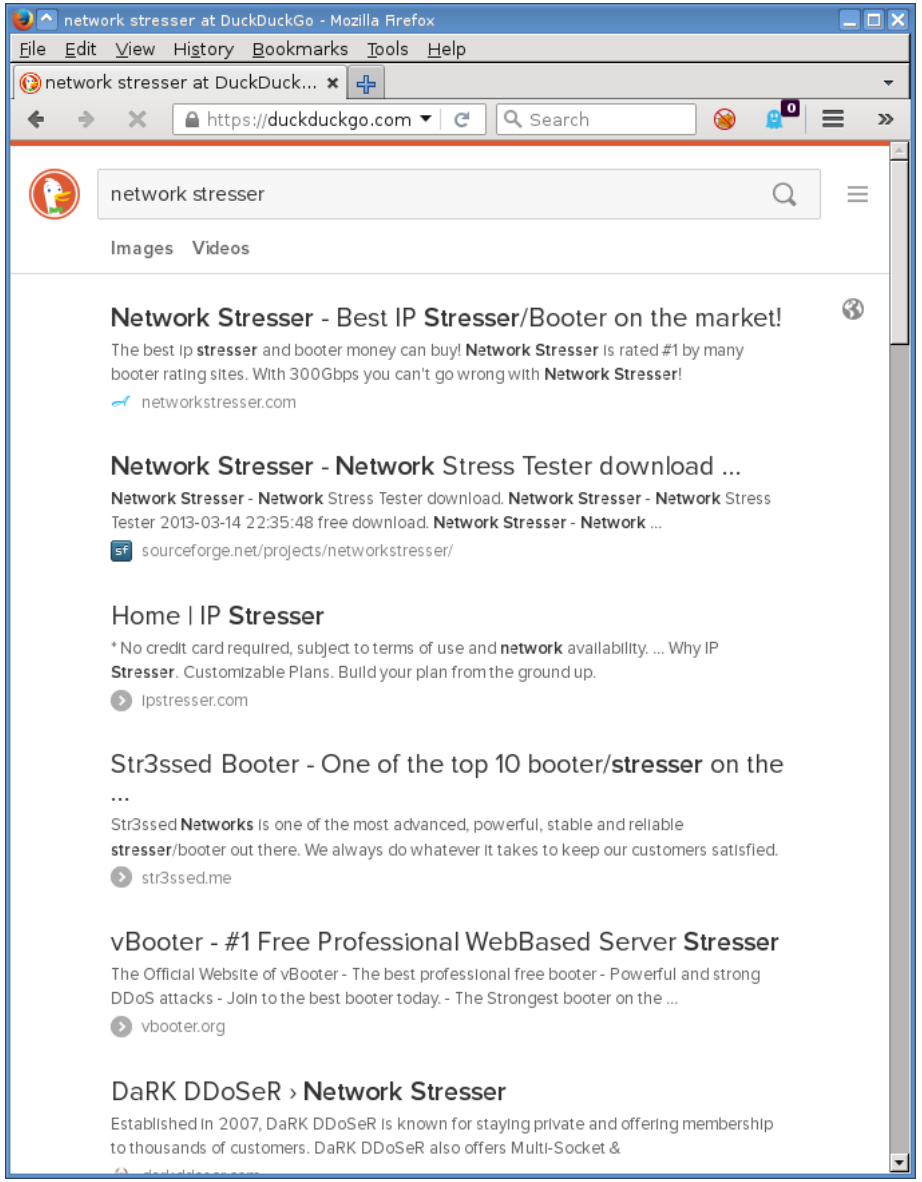

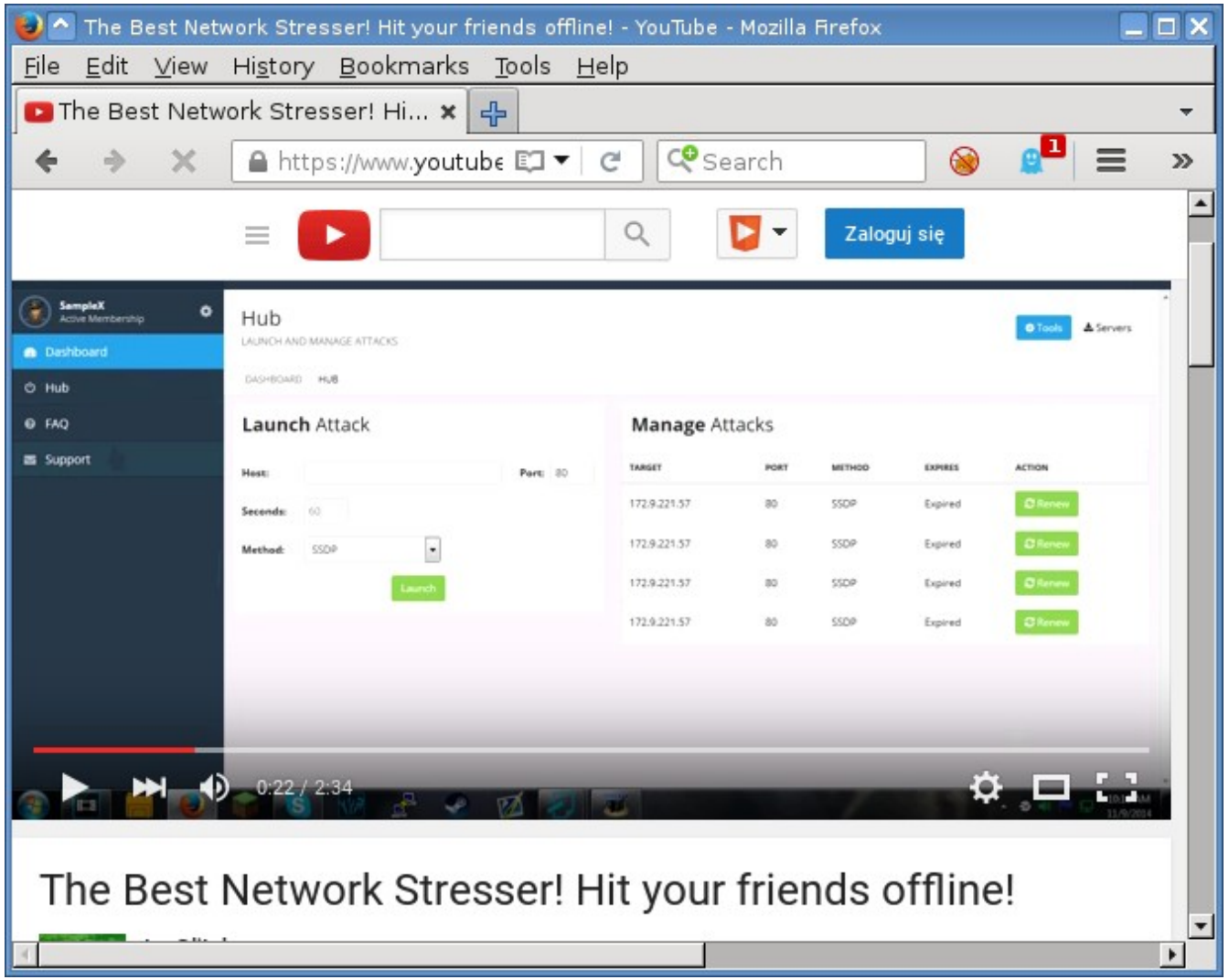

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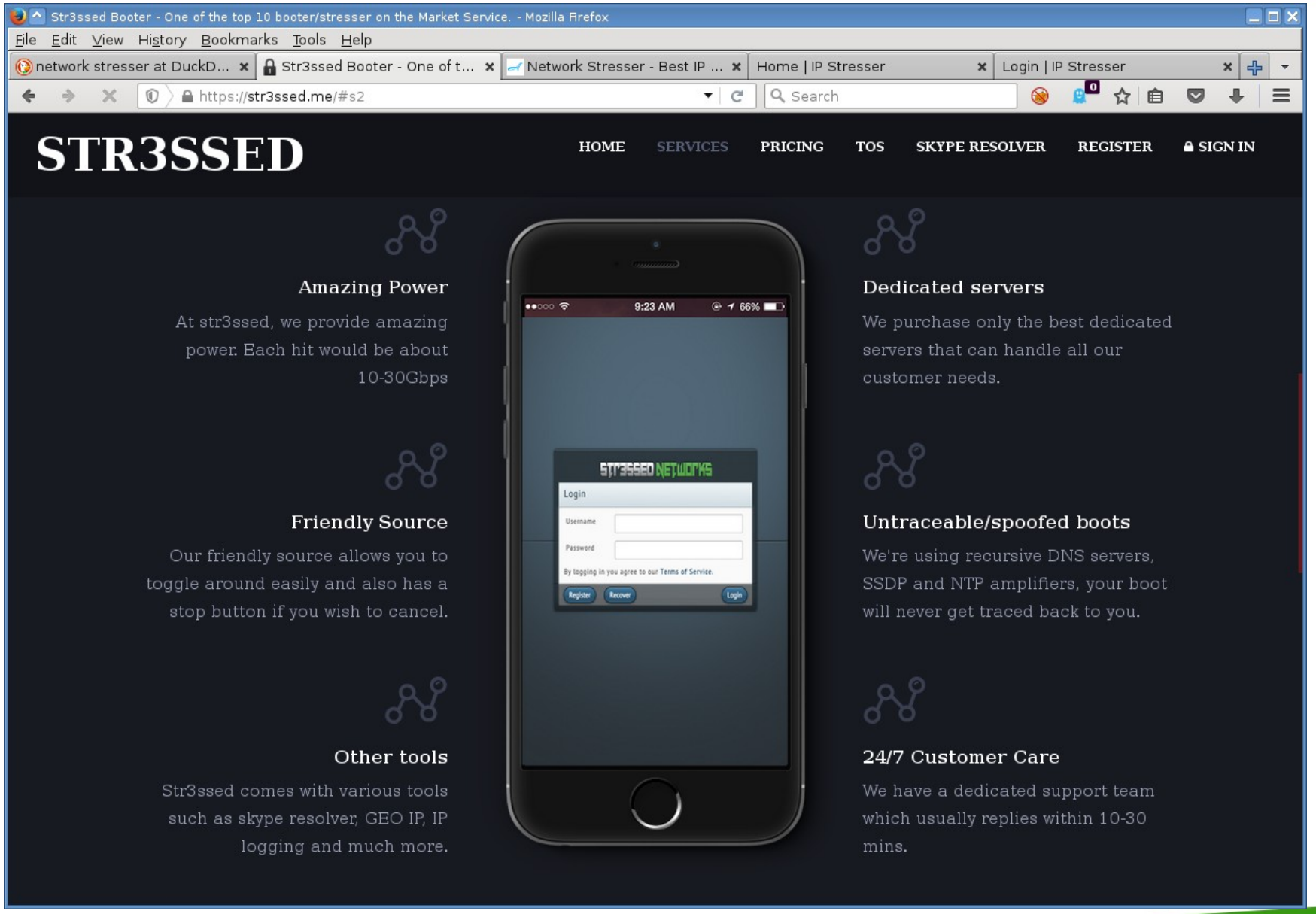

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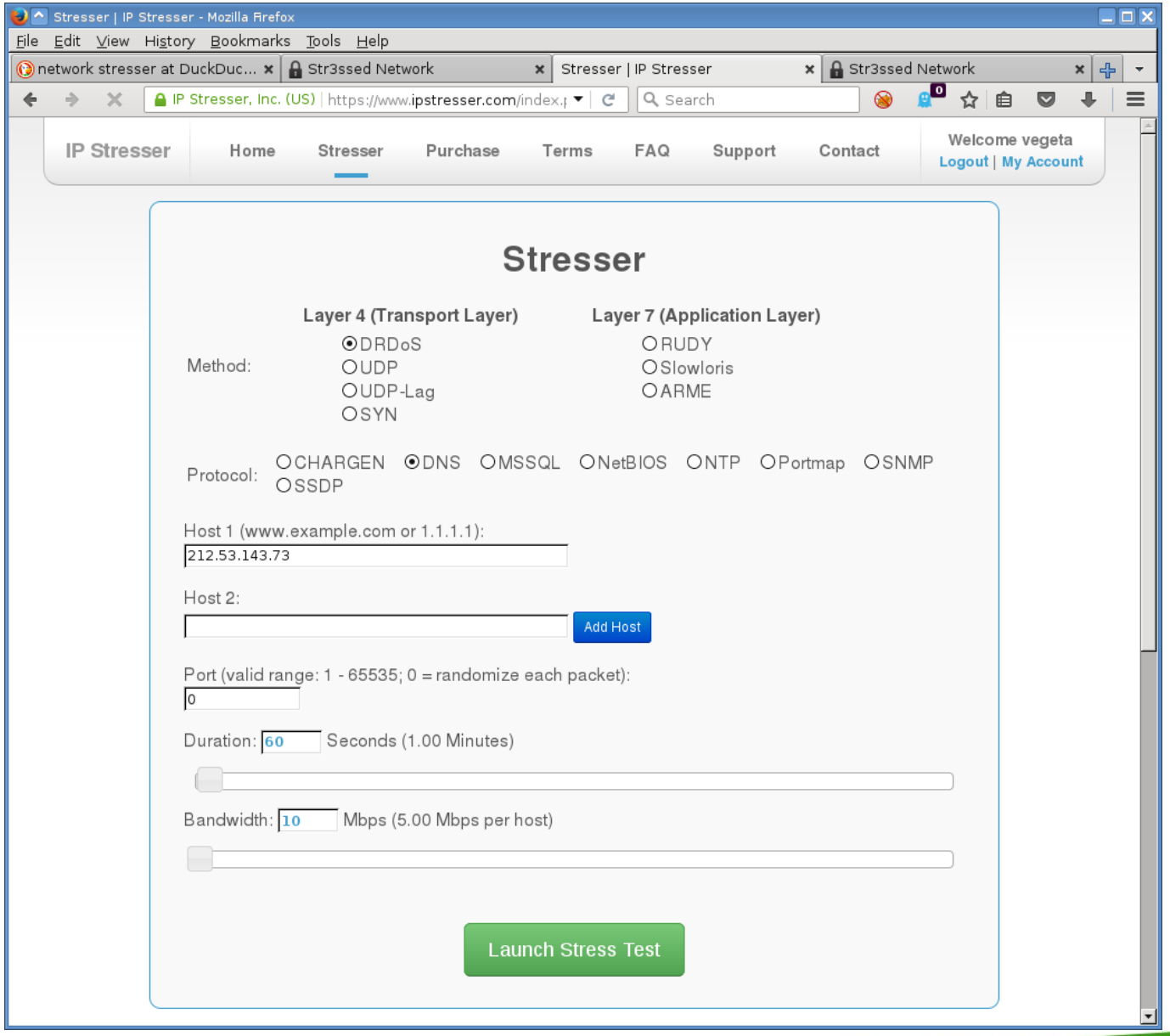

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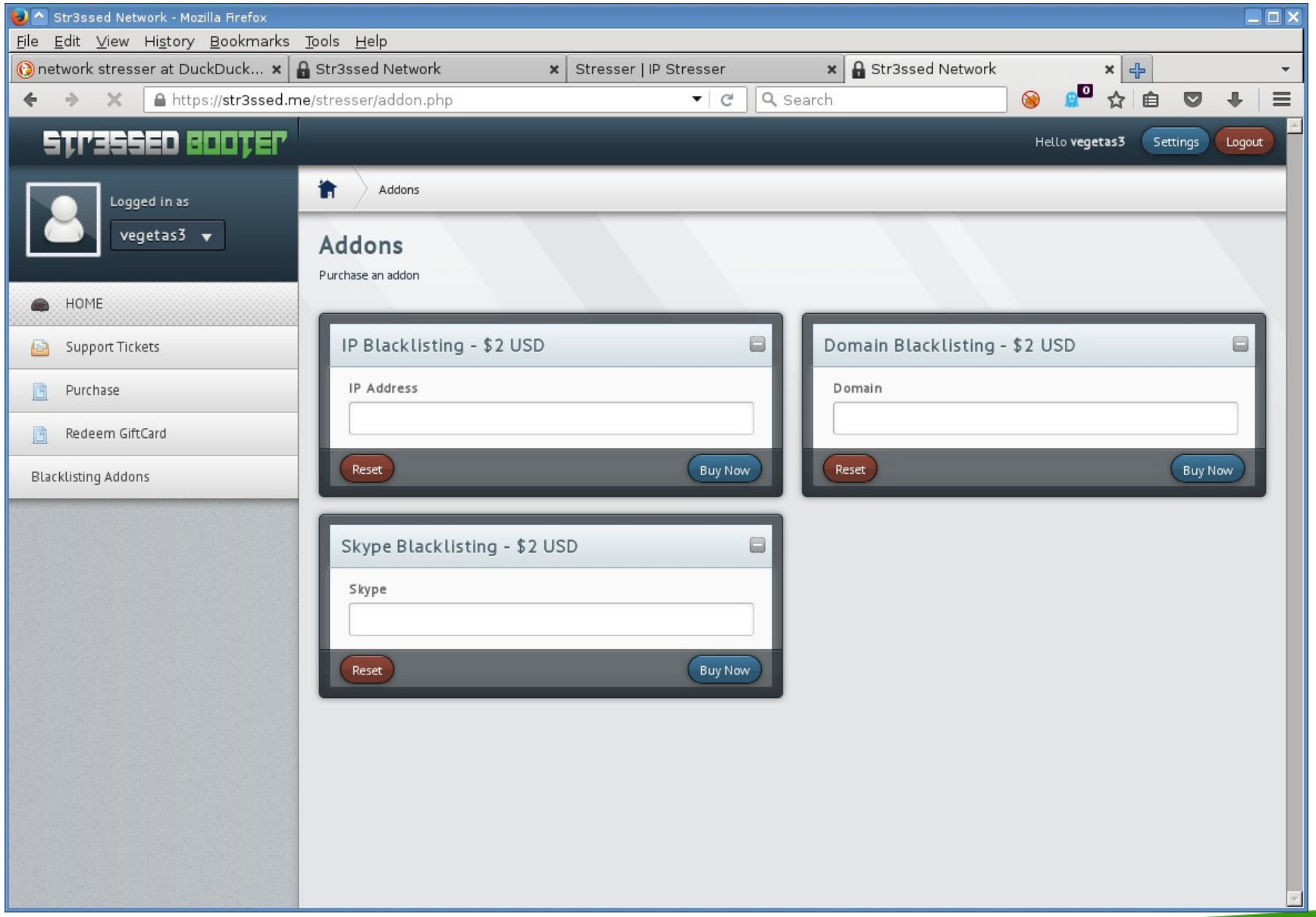


What is targeted?

- UDP-based reflection: volumetric attack saturating network links.
- TCP SYN flood: web, mail servers, loadbalancers, firewalls: resource depletion.
- ICMP floods: no idea, probably side effect.

SYN Flood

- For each SYN kernel accepts a connection
- TCP stack resource shortage.
- Legitimate clients won't be able to connect.
- Maybe something crashes and does not recover even if the attack is stopped
- Does not affect stateless routers nor switches.

UDP Flood

- Does not affect particular application directly.
- Saturates network links: ours and datacenter's.
- Can drop Datacenter from Internet if BGP sessions break.
- Can cause trouble only for some customers.

Why are we attacked?

Attacks you read about

- Days long.
- Ransom demands.
- Check blogs of Arbor, CloudFlare, Incapsula etc.

Why are we attacked?

- Attacks are short (minutes, tens of minutes).
- AFAIK nobody ever wanted money.
- Particular markets and worlds are attacked more often.

→ Advantage of blocking other players from playing?

How do DDoS attacks affect (hard|soft)ware?

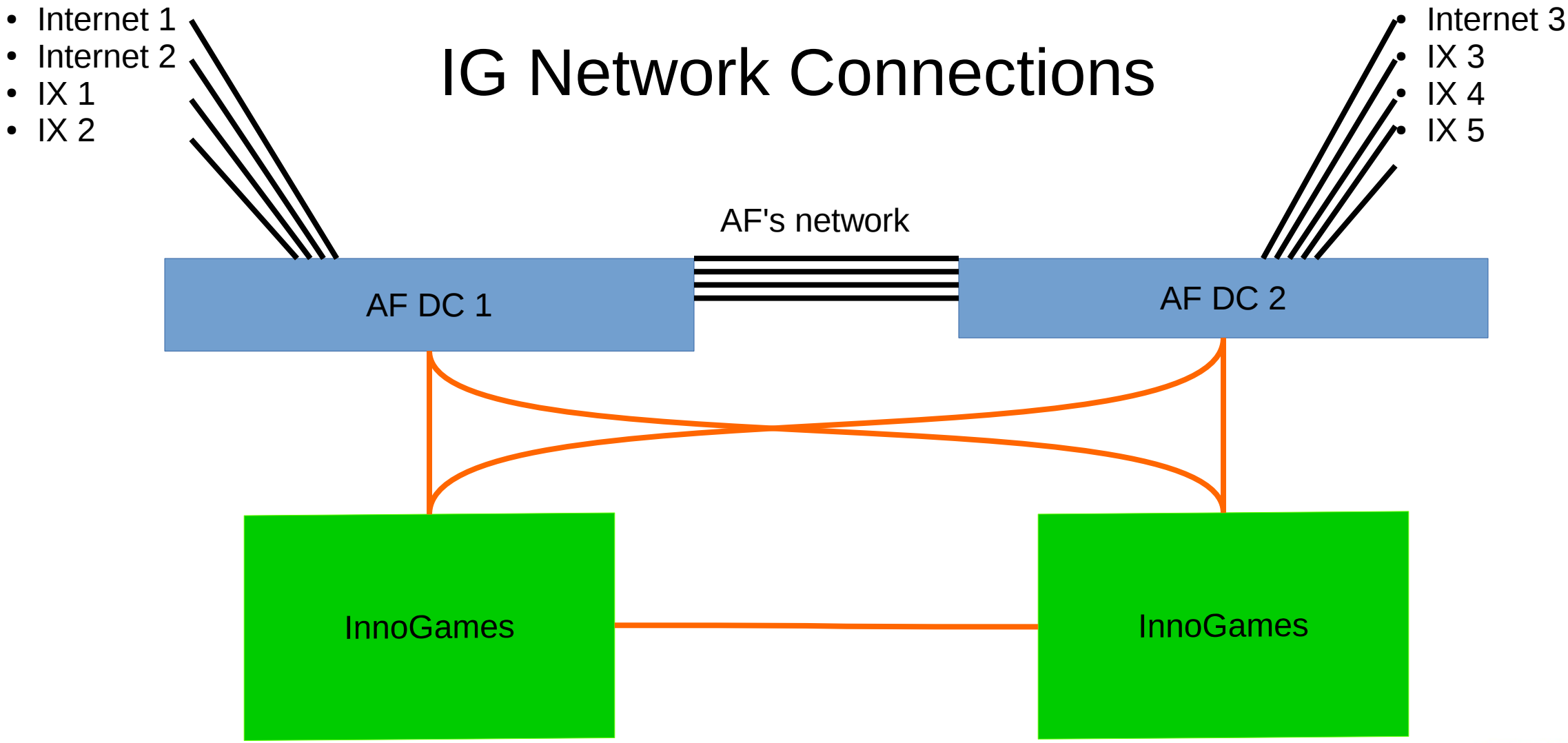
What we see at InnoGames

- SYN Floods
- UDP Floods – recently the most popular thing.
- Usually some combination of the above.

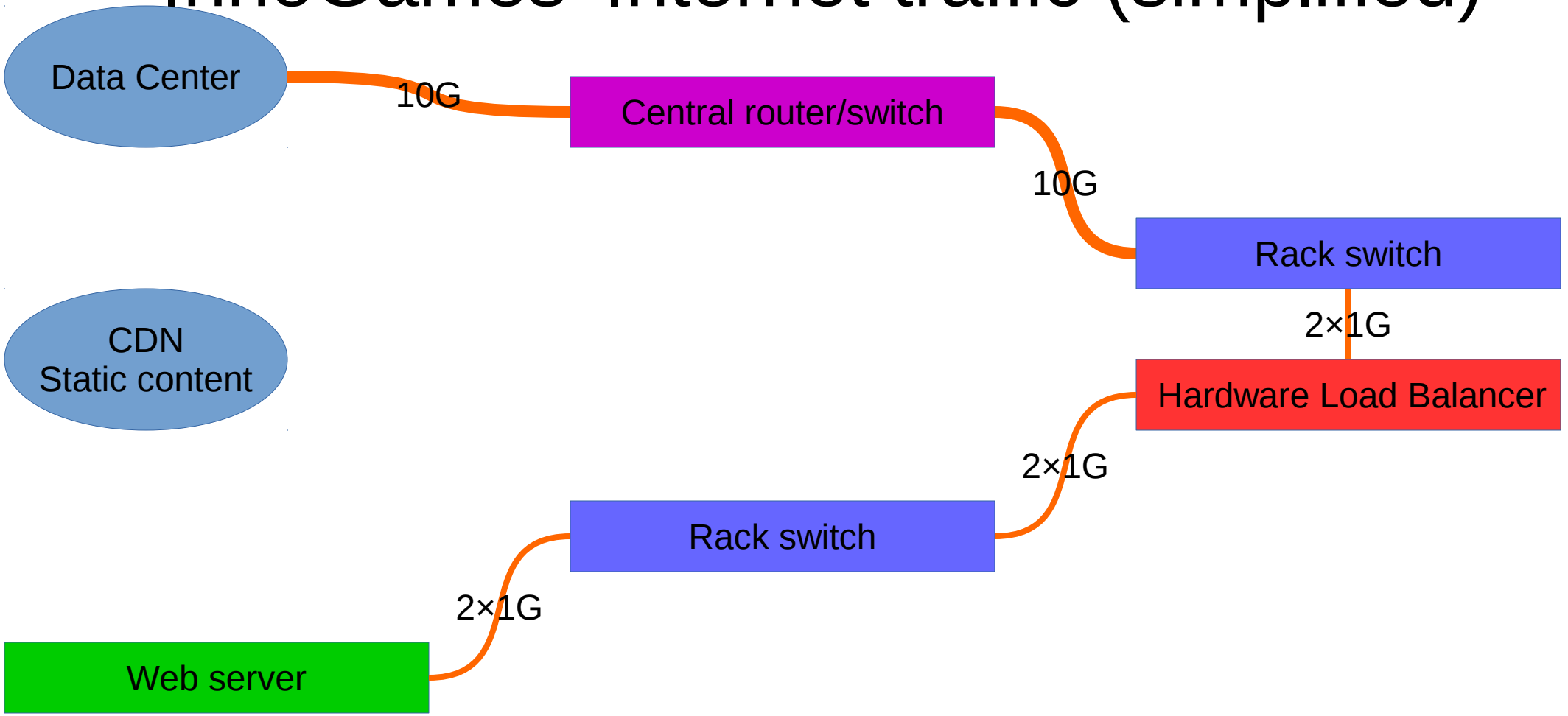
Other possibilities

- Long & Slow Layer7 attacks – not really seen but maybe they happen?

IG Network Connections



InnoGames' Internet traffic (simplified)



Effects on Datacenter

- Huge UDP Floods can drop whole Datacenter from the Internet (dead BGP).
- Or just make it unreachable from only some ISPs.
- Attacks on other customers can (will) influence us.
- You might not encounter any problems from home or office.

Effects on Network

- UDP Floods only.
- Saturation of links.
- Other projects affected when one is under attack.
- Generally the same type of trouble as in Datacenter.

Effects on LoadBalancers

- 36 HWLBs running FreeBSD and pf.
- 2 or 3 HWLBs per game.
- SYN Floods: state and source table overflow.
- UDP Floods: link (n×1G) bandwidth overflow.
- Other projects affected when one is under attack.

Effects on Servers

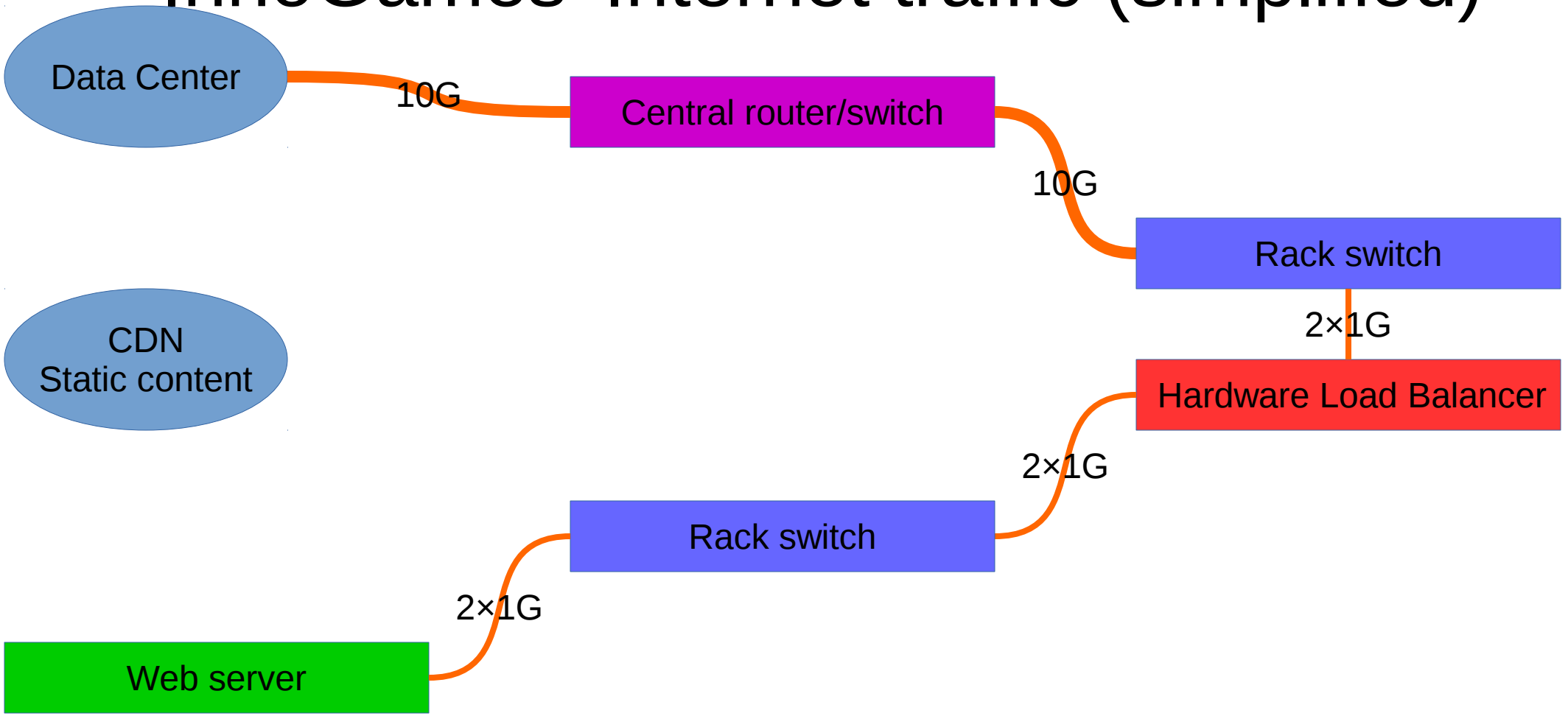
- Attacks stop on LoadBalancers and never really reach servers.

How do we detect DDoS attacks?

How is an attack seen by us?

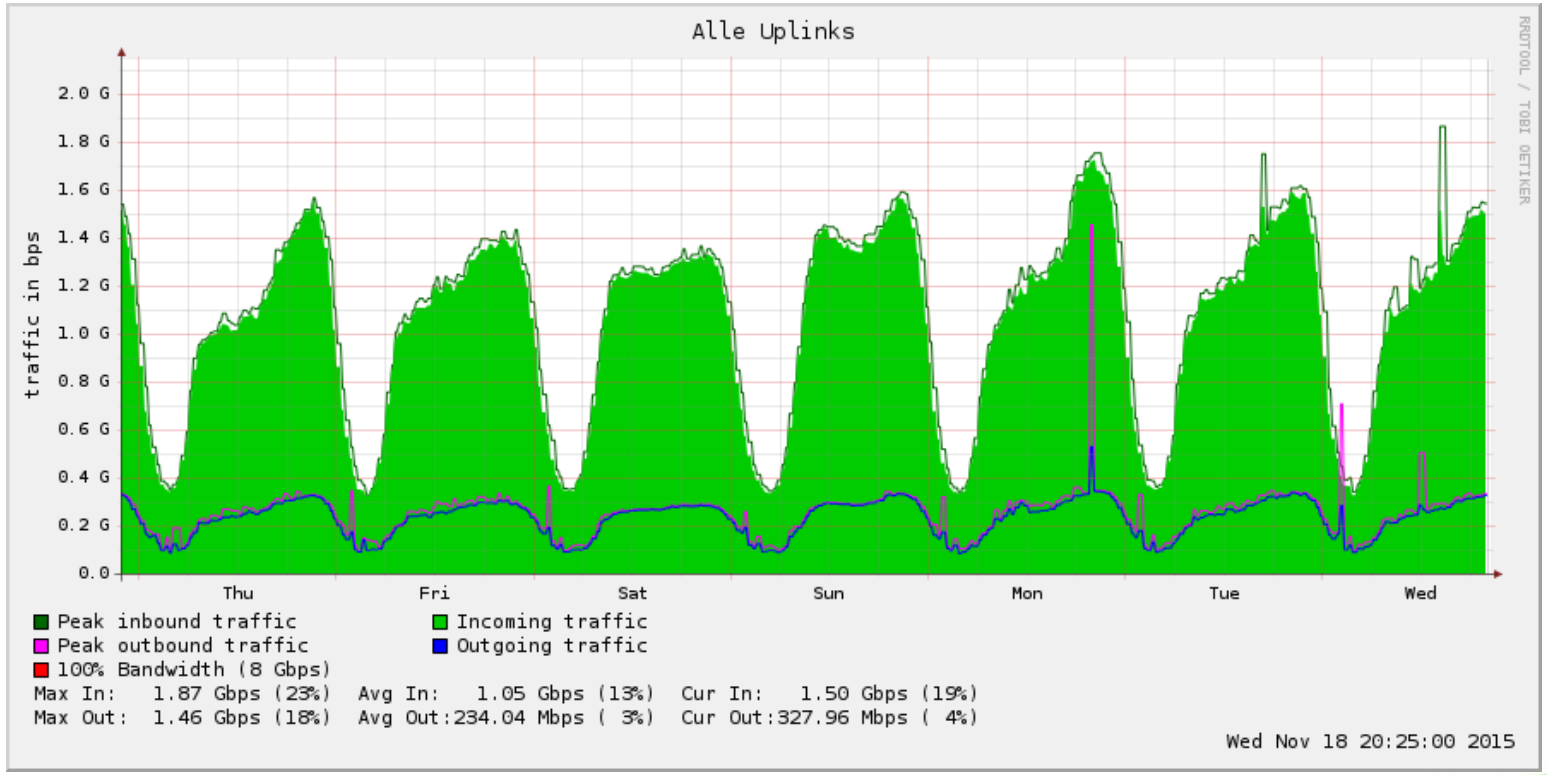
- Call at night.
- Monitoring: Servers fine but Services unreachable.
- High CPU load on LoadBalancers.
- High traffic on switches and uplinks, normally we fit within a few Gb/s total.
- Attacks on DC's other customers are harder to detect and prove.

InnoGames' Internet traffic (simplified)



Monitoring Internet uplinks

- Uplink bandwidth does not point out attack target.
- Graph averaging kills short spikes.



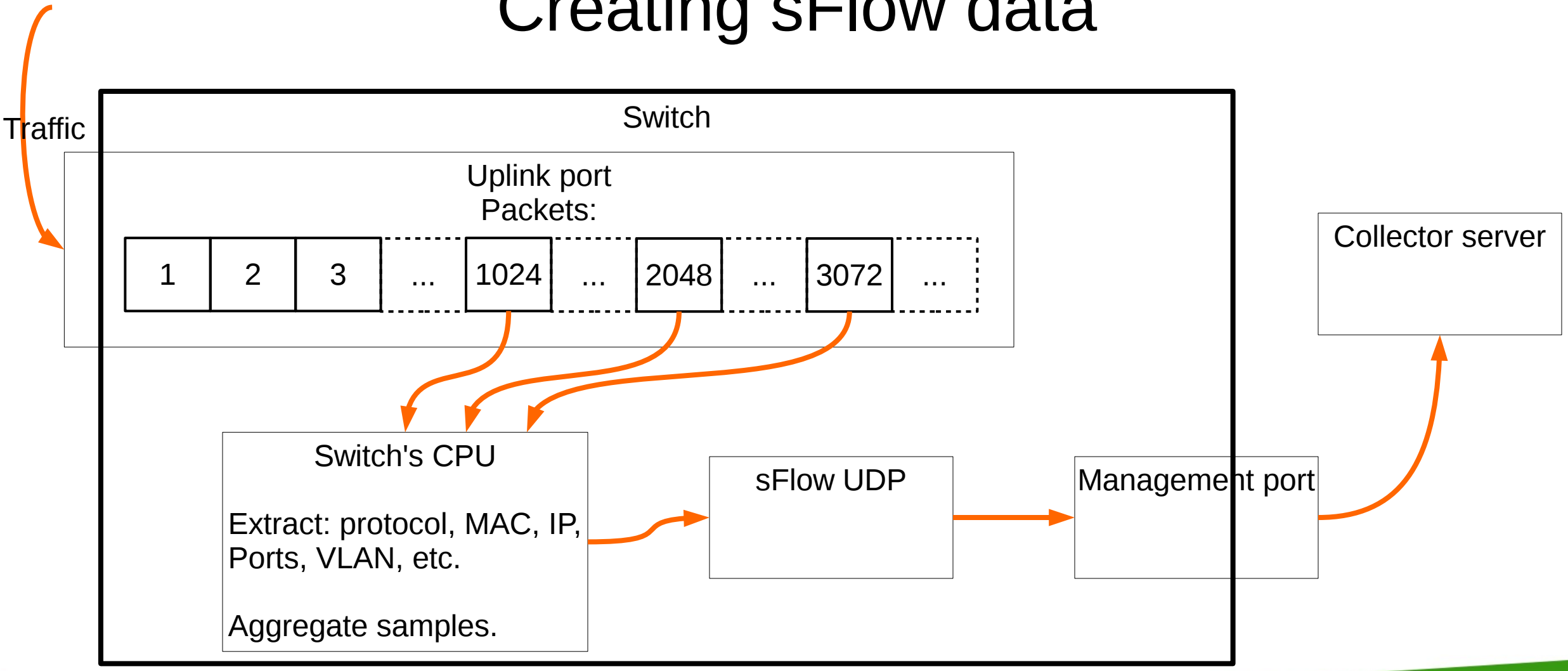
Monitoring traffic within our network

- On Servers – UDP attacks will not be passed by LoadBalancers, TCP will be limited and seen smaller than they really are.
- On LoadBalancers – monitoring will fail if they fail, detectable size limited to uplinks bandwidth.
- On links – limited to their bandwidth.

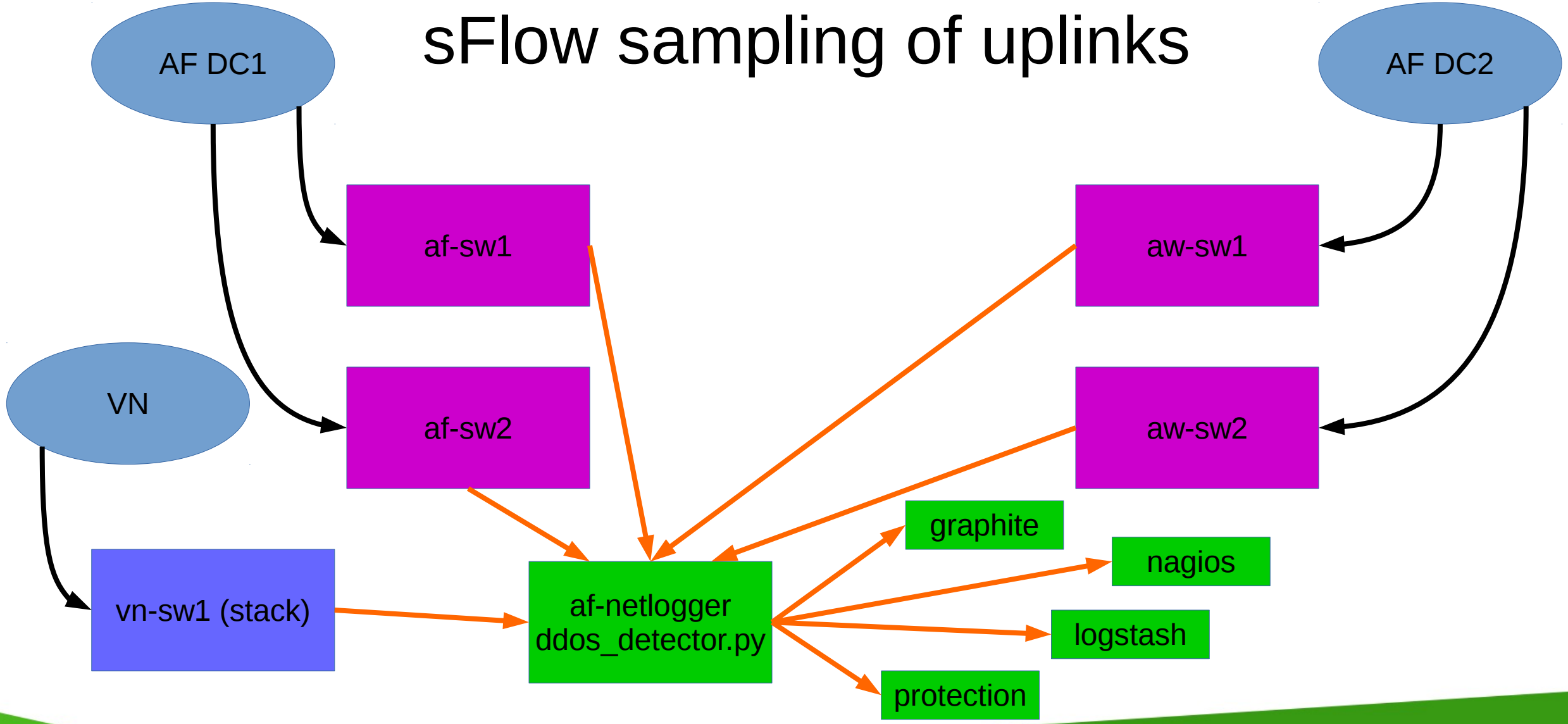
Monitoring Internet uplinks

- Impossible to log every packet.
- sFlow – sampling of traffic incoming links.
- Not accurate but approximate.
- But for EVERY target IP address in our network (currently ~6k addresses in Graphite)

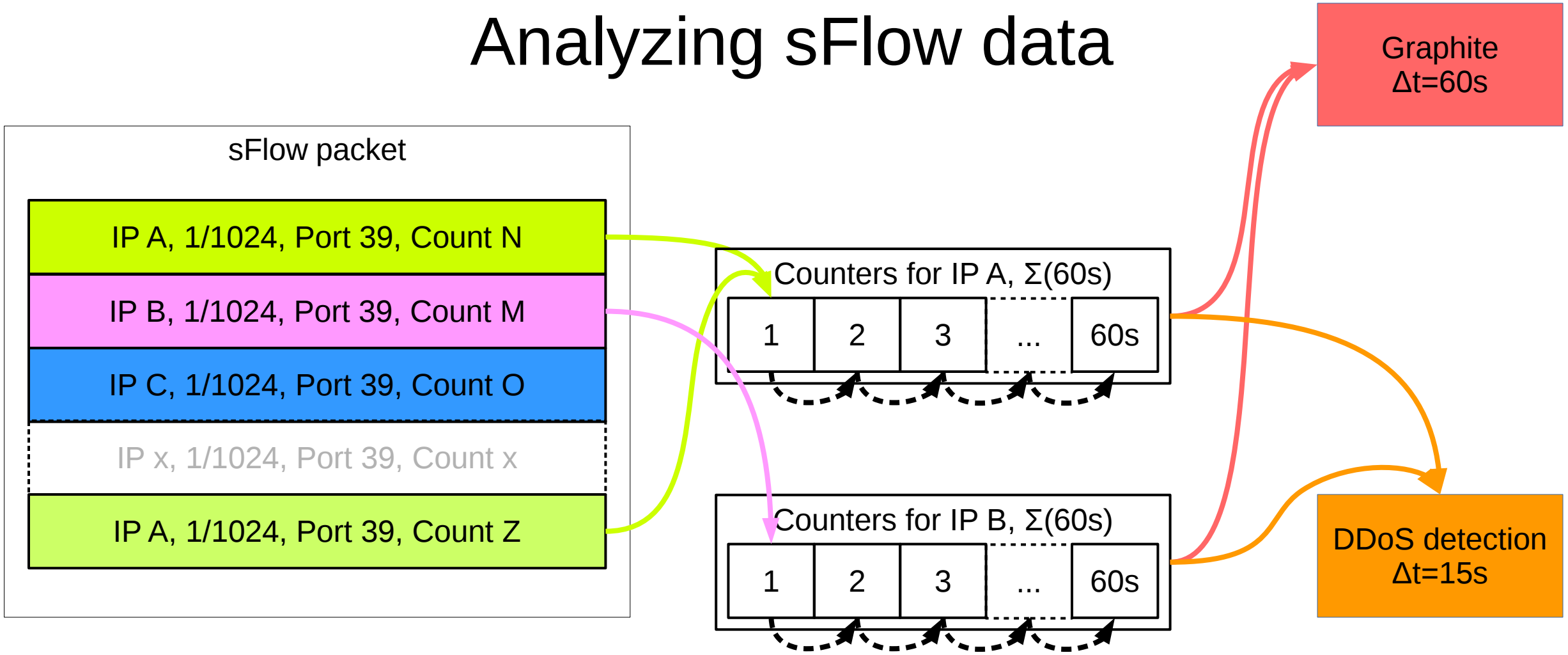
Creating sFlow data



sFlow sampling of uplinks

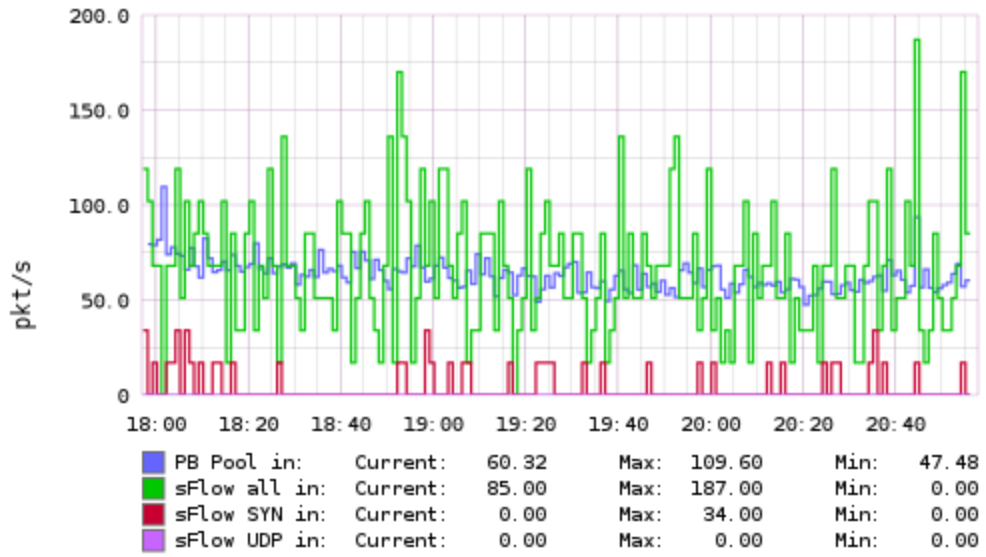


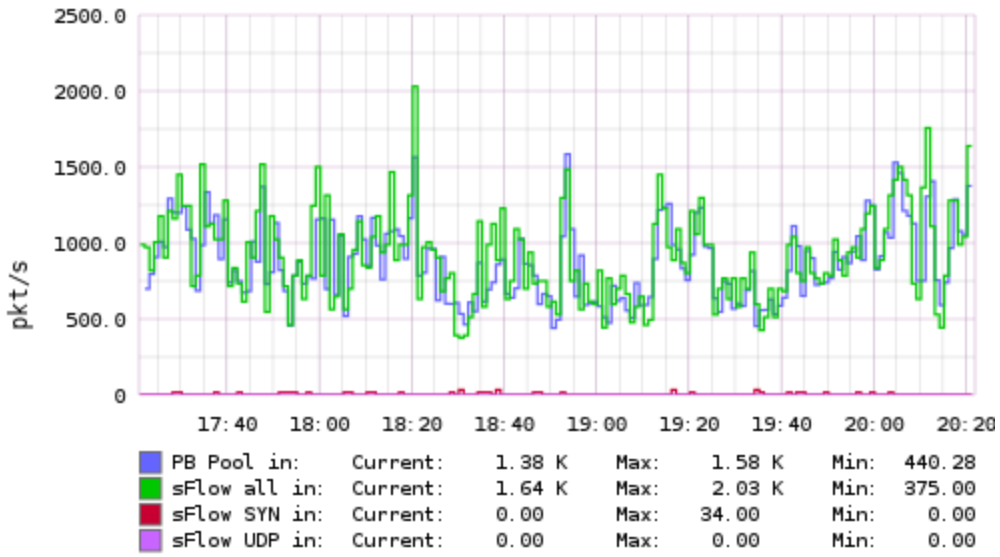
Analyzing sFlow data



sFlow results

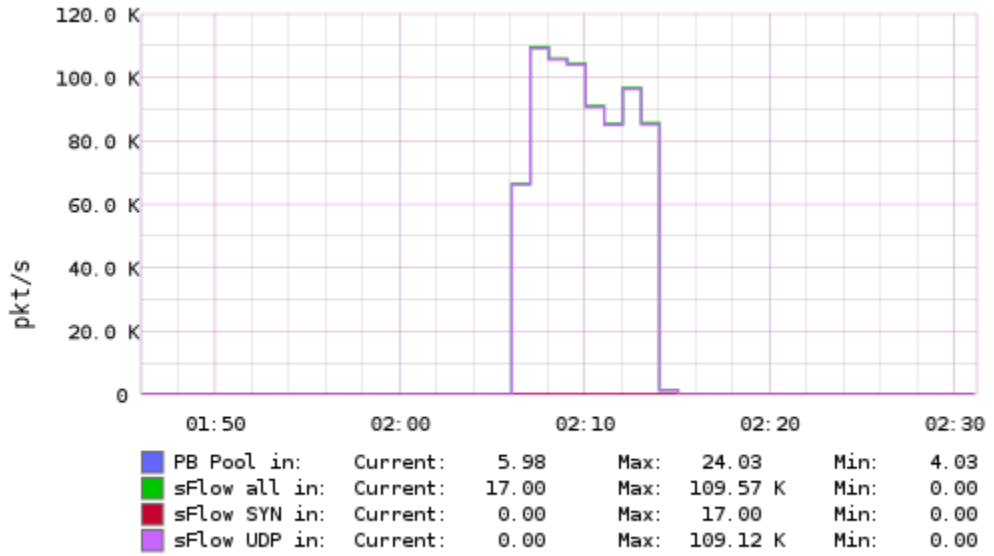
Accuracy improves with amount of traffic.





sFlow results

- UDP Flood around 100kp/s.
- sFlow from all 4 uplinks.



What is considered an attack?

- Any UDP over 85kp/s (around 1Gb/s).
- TCP with SYN flag over 25kp/s.

How do we protect against DDoS attacks?

General defense mechanisms

- SYN Proxy – do not pass traffic to target server until Firewall fully establishes connection.
- SYN Cookies – do not store state about half-established connection, wait for client to respond with SYN+ACK.
- RST Cookies – reject new connections at first, valid clients will reconnect.
- What about UDP Floods?

How to defend on LoadBalancers?

- Improving pf ruleset:
  - Early blocking non-matching traffic.
  - State lifetime, especially for internal states.
  - Limiting effects of attacks to given LB Pool by limiting states per target IP.
  - No SYN Cookie mechanism in pf at the moment.
  - SYN Proxy useless because it creates full states.

How to defend on LoadBalancers?

- Improving pf code:
  - O(n²) algorithms (PR#176763)
  - Traffic leaking from rules blocked due to too many states (PR#177810)
  - Source tracking only after state is established.
  - Performance improvements (PR#184003)
  - Many more bugs and features not related to DDoS.

How to defend in network?

- Upgrading to 10Gb/s links. Or n×10Gb/s.
- Rate limiting on central switches / routers:
  - ➔ Limiting UDP traffic on core switches (DNS uses separate subnet, NTP is not crucial).
  - ➔ Limiting any traffic to attacked IP on core switches.

Rate limiting on Extreme switches

```
# configure qosscheduler weighted-round-robin

# configure qosprofile QP1 maxbuffer 100 weight 3
# configure qosprofile QP2 maxbuffer 100 weight 2
# configure qosprofile QP3 maxbuffer 100 weight 1
# configure qosprofile QP5 maxbuffer 100 weight 3
# configure qosprofile QP8 maxbuffer 100 weight 3

# configure qosprofile QP3 minbw 0 peak_rate 50000 K ports all

# enable dot1p replacement port all

# show dot1p replacement
 QOSProfile    VPri
        QP1 -> 0
        QP2 -> 1
        QP3 -> 2
        QP5 -> 4
        QP8 -> 7
```

Rate limiting on Extreme switches

```
# create access-list network-zone ddos_detector

# edit policy ddos_udp_flood

entry ddos_detector {
 if match all {
  destination-zone ddos_detector ;
 }
 then {
  qosprofile qp3 ;
  }
}

# configure access-list ddos_udp_flood ports 47 ingress
```

Rate limiting on Extreme switches

```
# configure access-list network-zone ddos_detector add ipaddress 42.1.2.3
# configure access-list network-zone ddos_detector delete ipaddress 42.1.2.3
# refresh access-list network-zone ddos_detector
```

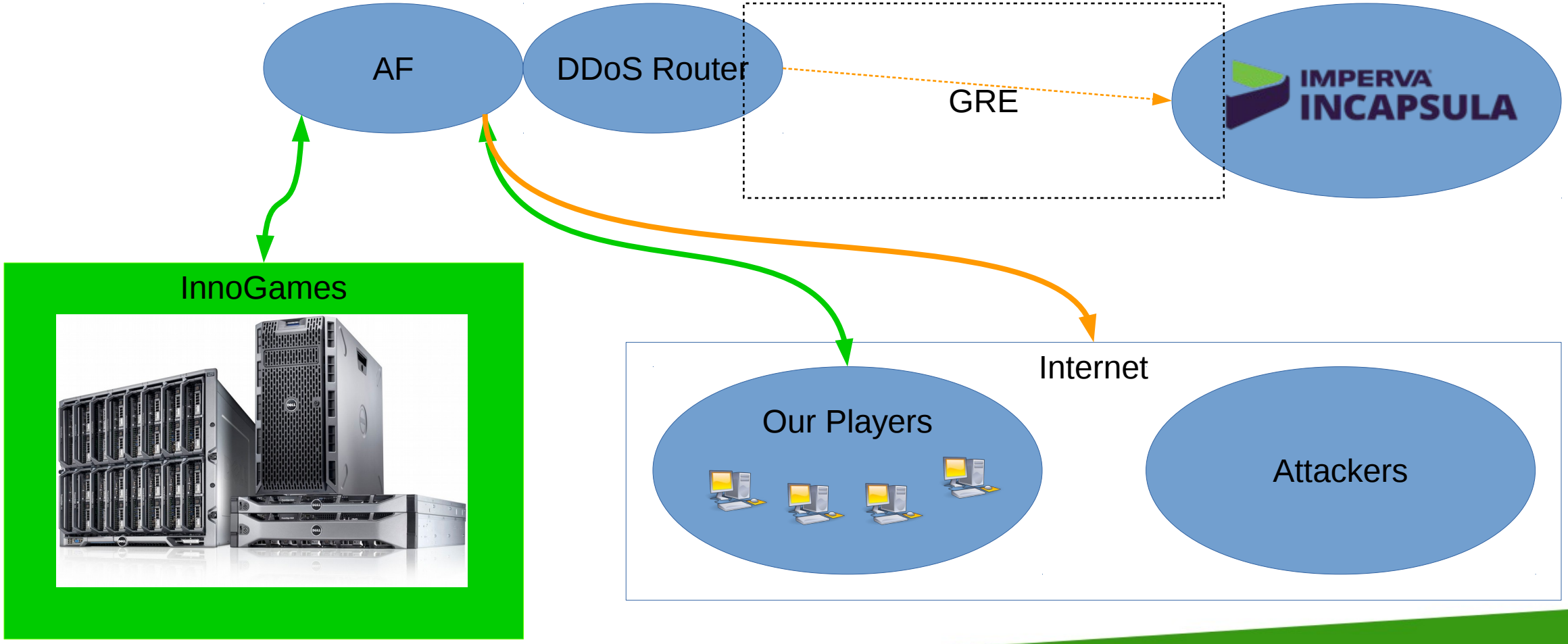
Using external protection provider

- Announces our /24 prefixes, intercepts traffic, filters it, tunnels clean traffic to us.
- Currently it is Incapsula.
- They can handle attacks bigger than sum of our or uplink capacity.
- Our network must survive only short period of attacks before we use their service.

External provider's problems

- False positives.
- Increased latency.
- Not catching an attack and tunelling >>Gb/s of dirty traffic, killing our Cisco router.
- Their own problems when they handle some other big attacks.
- Tunnels+BGP die if attack saturates Datacenter's links.

External tunneling protection



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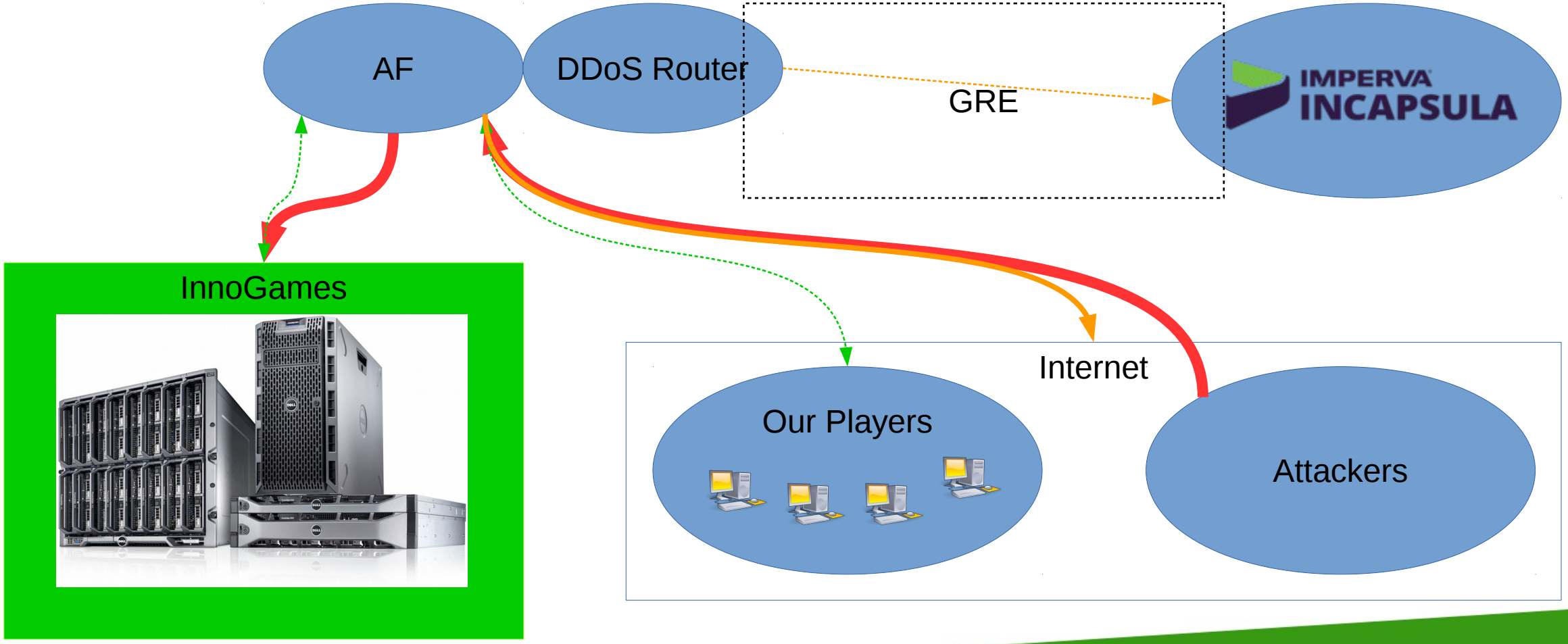

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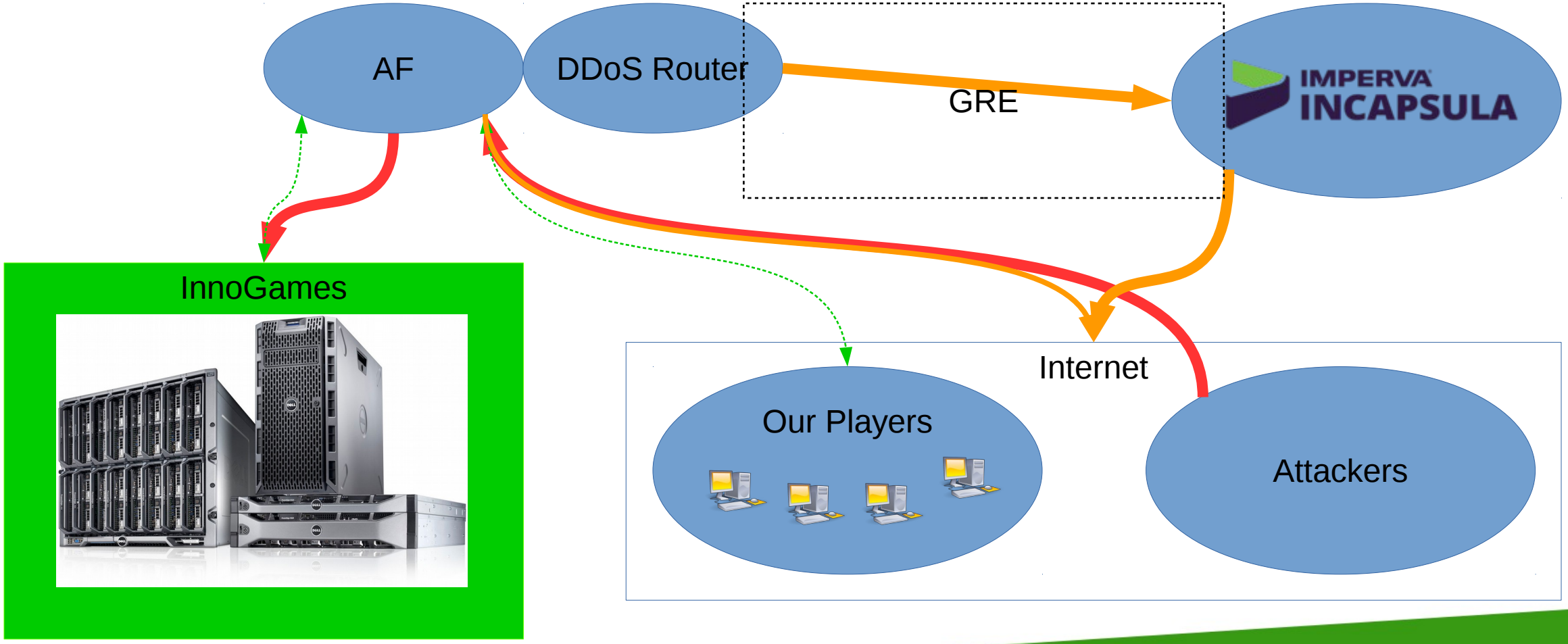

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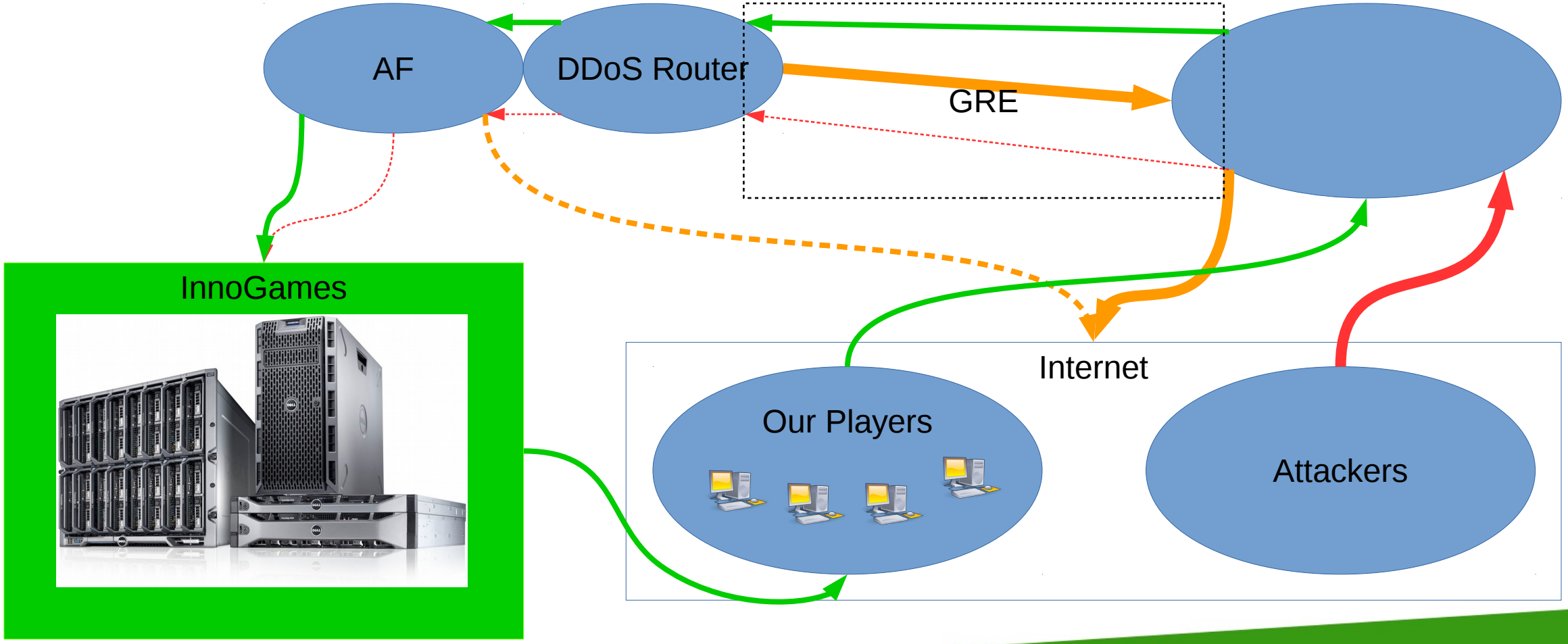

Automatic protection

- ddos_detector.py is capable of:
  - Configuring traffic shaping on central switches.
  - Enabling external protection service.

Summary

- External protection is a must.
- Fast reaction thanks to in-house detection tools.
- Software has (had) bugs.
- Dynamic network configuration.
- Network upgrades.

<applause>

Fin