IoT, IPv6 and the new ISP challenges for Internet security

European MUM – 2017

Milan / Italy

Wardner Maia

Introduction

Wardner Maia

Electronic and Telecommunications Engineer;
Internet Service Provider since 1995;
Training Business since 2002;
Certified Mikrotik Trainer since 2007;
MD Brasil IT & Telecom CTO;
Member of the board of directors of LACNIC.

MD Brasil

ISP (radio and optical), ~ 6.000 customers
Distributor and training center

Previous Participations on European MUMs

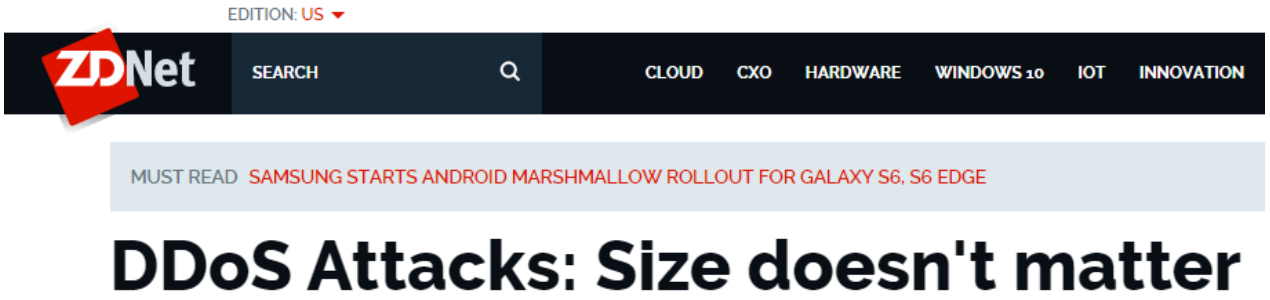
1) Wireless Security (2008 – Krakow/PL)
2) Wireless Security for OLPC project (2009 – Prague/CZ)
3) Layer 2 Security (2010 – Wroclaw/PL)
4) Routing Security (2011 – Budapest/HU)
5) IPv6 Security (2012 - Warsaw/PL)
6) BGP Filtering (2013 – Zagreb/CR)
7) MPLS VPNs Security (2014 – Venice/IT)
8) Network Simulation (2015 – Prague/CZ)
9) DDoS – detection and mitigation (2016 – Ljubljana/SL)

Today: IoT, IPv6 and new ISP challenges for Internet Security

http://mikrotikbrasil.com.br/artigos

One year ago...
February, 2016

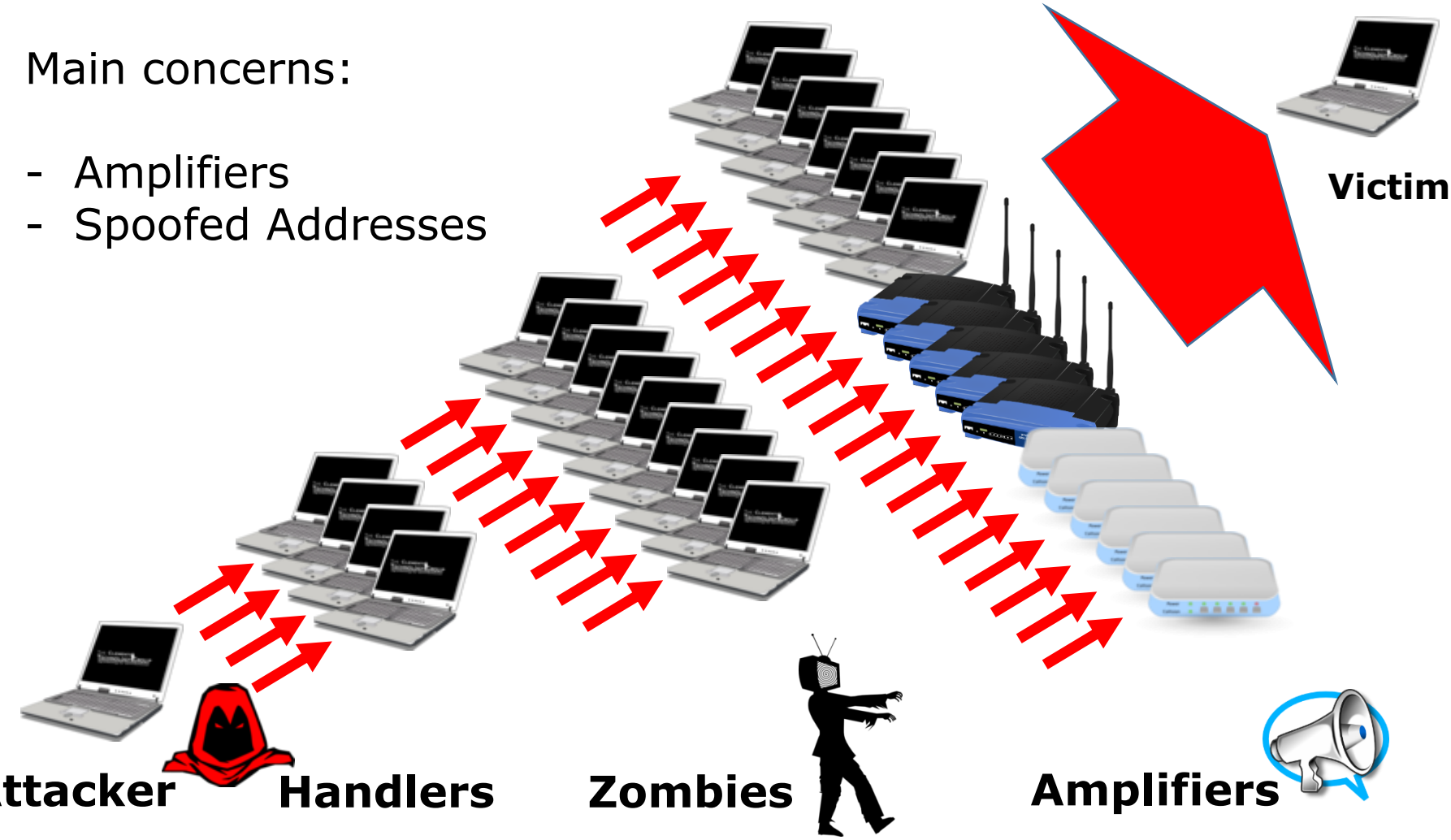
DDoS attacks



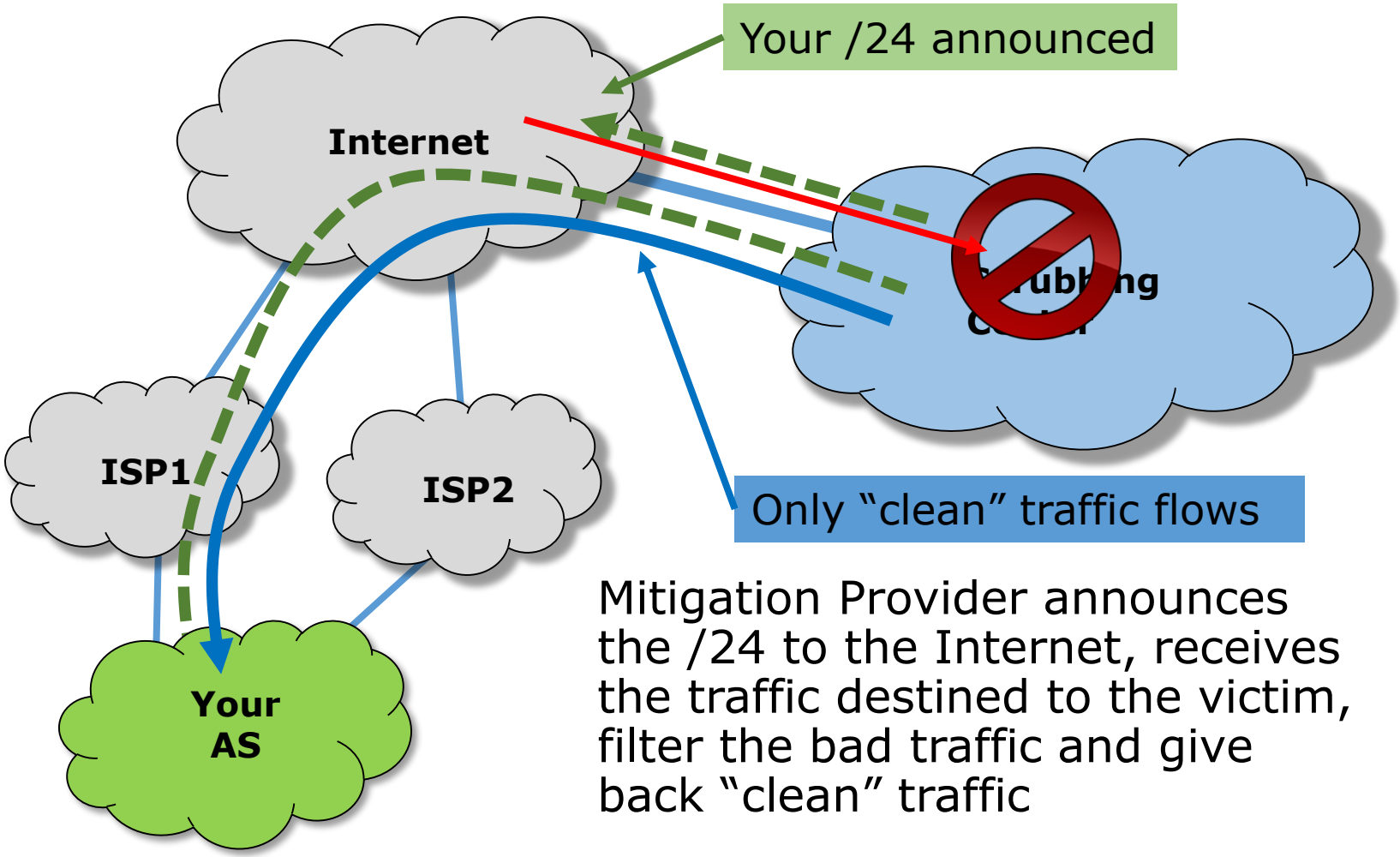
Anatomy of a DRDoS attack

Main concerns:

- Amplifiers
- Spoofed Addresses



Mitigation On the Cloud



Mitigation Provider announces the /24 to the Internet, receives the traffic destined to the victim, filter the bad traffic and give back “clean” traffic

Mitigation Schema

Mikrotik Traffic Flow

ExaBGP

+

Detection and mitigation schema based on Open Source tools (Fastnetmon, ExaBGP, InfluxDB and Grafana) interacting with RouterOS

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2016, what a year!

May, 2016

WISPs CPE attacked

WISP's CPEs attacked

More than 200 thousand people without Internet access! (only in our region)

WISP's CPE attacked


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MENU G1 RIO PRETO E ARAÇATUBA

15/05/2016 17h05 - Atualizado em 15/05/2016 17h05

Ataque hacker deixa milhares de pessoas sem internet na região

Mais de 200 mil pessoas estão sem acesso a internet via rádio há três dias. Transmissão só deve ser normalizada em uma semana.

A Smart "WORM"

- An EXPLOIT, exploited a flaw in the http/https service;
- Once one equipment was infected it starts to scan the neighborhood to find other targets;
- That is the reason that people called it a "worm" ou "Virus"

WISP's CPE attacked


globo.com | g1 | globoesporte | gshow | famosos & etc | vídeos

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A Smart "WORM"

- There are many variants of the "Virus". With the most common WISPs had their Equipment reset and password changed to "m[redacted]r"

- WISPs loose the access to the equipment an have to go to the towers and remote location to fix the problem.

- Some Customers stayed without service for more than a week!!!

WISP's CPEs attacked

ZDNet

VIDEOS SMART CITY WINDOWS 10 CLOUD INNOVATION SECURITY ENTERPRISE IOT MORE

MUST READ THIS MAC MALWARE WANTS TO STEAL PASSWORDS AND IPHONE BACKUPS

[redacted] Networks devices targeted by firmware worm

The problem has been made worse due to vendors and users failing to update their firmware.

By Charlie Osborne for Zero Day | May 20, 2016 -- 08:49 GMT (01:49 PDT) | Topic: Security

SecurityIntelligence

Analysis and Insight for Information Security Professionals

NEWS 34 TOPICS INDUSTRIES

NEWS May 23, 2016 @ 2:00 PM

[redacted] Routers Attacked by Worm

By Larry Loeb

Ubiquiti Netw
alert this week
update their a
was in respon
company's ro
performed by

The alert note
payloads are

PCWorld

FROM IDG

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Privacy Encryption Antivirus

Home / Security

NEWS

Worm infects unpatched [redacted] wireless devices

The vulnerability has been known for almost a year, but many users haven't applied the patches

May 2016

WISP's CPE attacked

The flaw was previously known by the Manufacturer, thanks a **Bug Bounty Program**.

The manufacturer did **release an update** with a correction but **didn't emphasize the importance of doing that update**.

On the other hand, the affected WISPs didn't do the firmware update and weren't using other **good practices** for security, disabling unnecessary services, changing ports, restricting access from a known IP, etc.

WISP's CPE attacked

I have to highlight the work of Alexandre Correa (Onda Internet)

https://www.linkedin.com/in/ajcorrea/

who did a great job helping ISPs with problems making some scripts to find vulnerable equipment and automatically correcting them.

The scripts are available at Github: https://github.com/ajcorrea/cleanmf

July, 2016

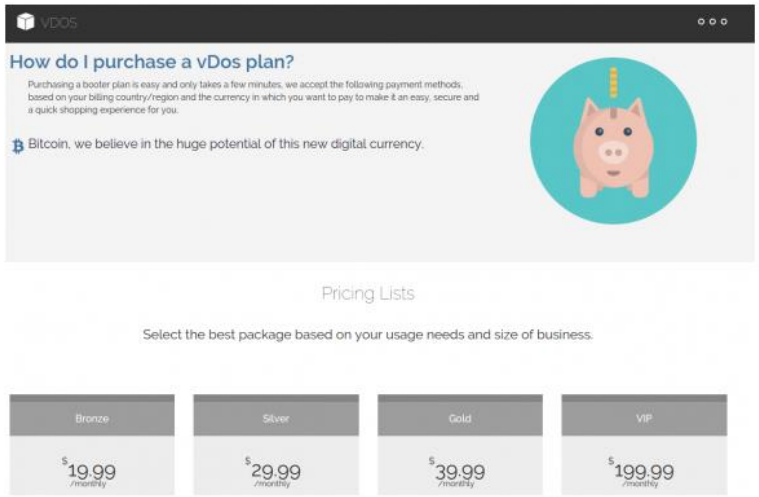
DDoS Hackers Exposed

Hackers Exposed!

pastebin.com/Rg1xT68V

July, 2016

08 SEP 16 **Israeli Online Attack Service 'vDOS' Earned $600,000 in Two Years**



The vDos home page.

Brian Krebs, an investigative reporter known for his works about profit-seeking hacker organizations, revealed the vDOS web site.

Soon after Krebs report, two men were arrested and the Web site was taken offline.

September, 2016

Hackers Fightback!

Hackers Fightback!

September, 2016

BUSINESS INSIDER ENTERPRISE

Akamai kicked journalist Brian Krebs' site off its servers after he was hit by a 'record' cyberattack

FORTUNE | Google Rescues a Security Blogger Under Attack from Hackers

MEDIA AND TECHNOLOGY

Google Rescues a Security Blogger Under Attack from Hackers

Brian's blog received a DDoS of 620 Gbps and the hosting company kicked the site off!

Google shield program "rescued" the Security Blogger

2016
September, October

OVH massive attack

September 2016

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150,000 IoT Devices Abused for Massive DDoS Attacks on OVH

~ 1 Tbps attack

ars TECHNICA

BIZ & IT | TECH | SCIENCE | POLICY | CARS | GAMING & CULTURE

RISK ASSESSMENT —

Record-breaking DDoS reportedly delivered by >145k hacked cameras

Once unthinkable, 1 terabit attacks may soon be the new normal.

Dyn massive attack

October 2016

CIO DIVE Home Library Viewpoints

BRIEF

14K web domains dropped Dyn following massive DDoS attack

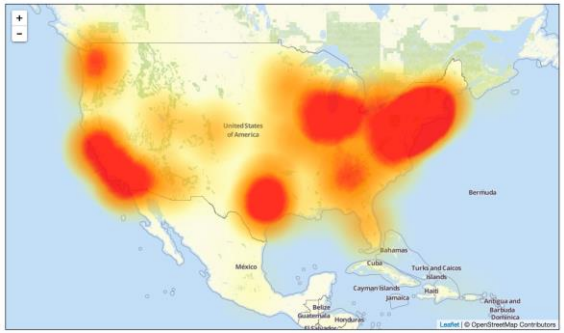
COMPUTERWORLD FROM IDG

Home > Security

NEWS

DNS provider Dyn hit by DDoS attack that takes out major sites

Twitter, GitHub, Etsy, Spotify, The New York Times and the Boston Globe were knocked offline



ZDNet VIDEOS SMART CITY WINDOWS 10 CLOUD INNOVATION SECURITY ENTERPRISE IOT MORE NEWSLETTERS

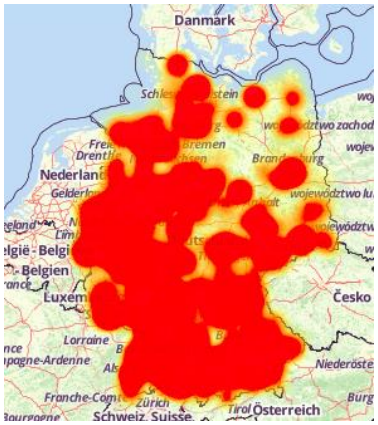
MUST READ FROM MALWARE TO CYBER-SPIES, THE 15 BIGGEST THREATS ONLINE, RANKED

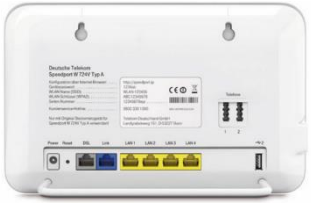
Dyn DDoS part 2: The hackers strike back

2016, November

Routers, again...

Deutsche Telekom Routers Attacked





November 2016

Deutsche Telekom Routers Attacked

Deutsche Telekom

- The attack explored the older TR-064 protocol, through port 7547.
- Port 7547 is the same used by TR-069
- The attacker managed to inject code in the routers making them download malicious software;
- The routers can be turned on robots for DDoS attacks.

2016

Lessons Learned

Lessons Learned

2016

A new way to do DDoS massive attacks

- No amplifiers were used
- No spoofed address
- Mainly Application attacks
- Small bandwidth per device but tons of devices at the same time.
- Big use of the “things” of the Internet of things!

IoT Attacks

ZDNet VIDEOS SMART CITY WINDO

Internet of Things

Welcome to the world of connected everything

ars TECHNICA BIZ & IT TECH SCIENCE POLICY CARS GAMING & CULTURE FORUMS

TECHNOLOGY LAB —

How one rent-a-botnet army of cameras, DVRs caused Internet chaos

Attacks that took down Dyn appear to have been "rented" from multiple botnets.

SEAN GALLAGHER - 10/25/2016, 6:45 PM

EDITION: US

ZDNet VIDEOS SMART CITY WINDOWS 10 CLOUD INNOVATION SECURITY ENTERPRISE IOT MORE NEWSLETTERS

MUST READ MICROSOFT ISSUES CRITICAL SECURITY PATCHES, BUT LEAVES ZERO-DAY FLAWS AT RISK

Surveillance cameras sold on Amazon infected with malware

A security researcher has discovered malicious code embedded within cameras offered for sale on the e-commerce platform.

By Charlie Osborne for Zero Day | April 11, 2016 -- 09:53 GMT (02:53 PDT) | Topic: Security

Mirai Botnet

December 2016

“**Mirai**,” a malware strain that enslaves poorly secured Internet of Things (IoT) devices like wireless routers and security cameras into a botnet for use in large cyberattacks.

https://krebsonsecurity.com

To end 2016 with a flourish…

Mirai Source Code Released!


[FREE] World's Largest Net:Mirai Botnet, Client, Echo Loader, CNC source code release

Yesterday, 12:50 PM (This post was last modified: Yesterday 04:29 PM by Anna-senpai.)

Anna-senpai

L33t Member

L33T

Preface

Greetz everybody,

When I first go in DDoS industry, I wasn't planning on staying in it long. I made my money, there's lots of eyes looking at IOT now, so it
However, I know every skid and their mama, it's their wet dream to have something besides qbot.

So today, I have an amazing release for you. With Mirai, I usually pull max 380k bots from telnet alone. However, after the Kreb DDoS,
shutting down and cleaning up their act. Today, max pull is about 300k bots, and dropping.

So, I am your senpai, and I will treat you real nice, my hf-chan.

"When I first go in DDoS industry, I wasn't planning on staying in it long. I made my money, ***there's lots of eyes looking at IoT now****, so it's time to GTFO.*

So today, I have an amazing release for you…"

Anna-senpai

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TI&TELECOM

How Powerful are the “Things” of the Internet of Things?

How Many Things are there in the IoT?

Gartner

WHY GARTNER ANALYSTS RESEARCH EVENTS CONSULTING ABOUT

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STAMFORD, Conn., November 10, 2015

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Gartner Says 6.4 Billion Connected "Things" Will Be in Use in 2016, Up 30 Percent From 2015

Table 1: Internet of Things Units Installed Base by Category (Millions of Units)

Category	2014	2015	2016	2020
Consumer	2,277	3,023	4,024	13,509
Business: Cross-Industry	632	815	1,092	4,408
Business: Vertical-Specific	898	1,065	[illegible]	[illegible]
Grand Total	**3,807**	**4,902**	**6,392**	**20,797**

Source: Gartner (November 2015)

IEEE SPECTRUM

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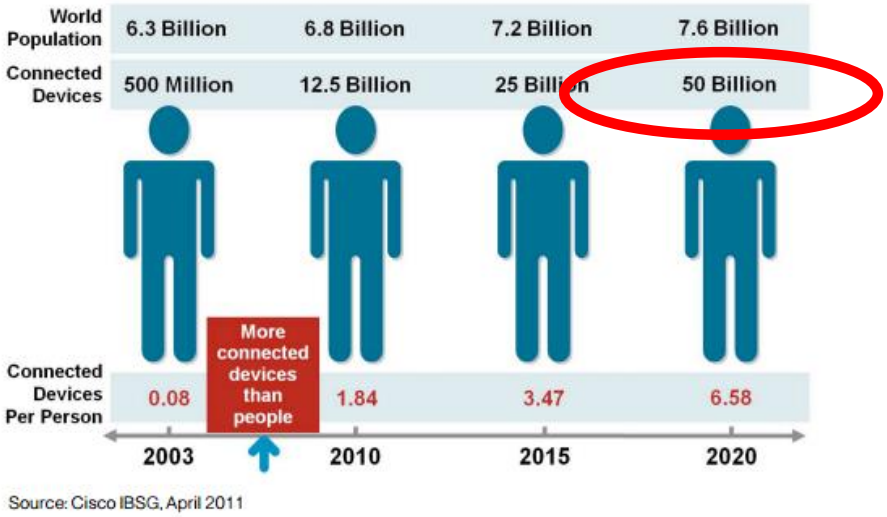
Popular Internet of Things Forecast of 50 Billion Devices by 2020 Is Outdated



Source: Cisco IBSG, April 2011

Anything else to Highlight in 2016?

2016
IPv6 20 years old!

Internet Society

Who We Are | What We Do | Events | Publications | The

Previous IETF Fellows

Home » Blog » Tech Matters » Celebrating New Year 2016 with 10% IPv6!

Celebrating New Year 2016 with 10% IPv6!

04 January 2016 Tech Matters

ars TECHNICA BIZ & IT TECH SCIENCE POLICY CARS GAMING & CULTURE

MINISTRY OF INNOVATION —

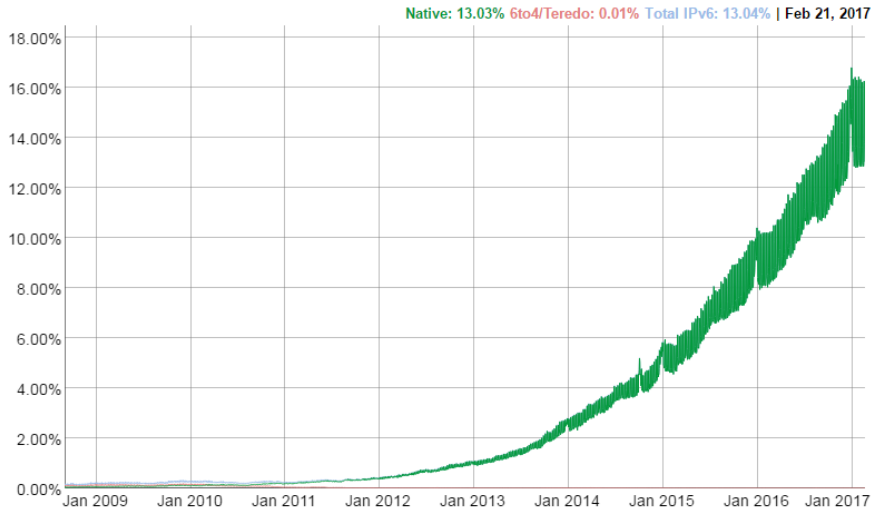
IPv6 celebrates its 20th birthday by reaching 10 percent deployment

All I want for my birthday is a new IP header.

ILJITSCH VAN BEIJNUM - 1/3/2016, 3:00 PM

IPv6 Adoption

We are continuously measuring the availability of IPv6 connectivity among Google users. The graph shows the percentage of users that access Google over IPv6.



2016
IAB Statement

https://www.iab.org/2016/11/07/iab-statement-on-ipv6/

…

"The IAB expects that the IETF **will stop requiring IPv4 compatibility in new or extended protocols**. Future IETF protocol work will then optimize for and depend on IPv6."

…

New Internet Scenario

IoT + IPv6 − NAT

As an ISP, should I care?

ISP's Responsibility

IoT and IoT security is sure an ISP's responsibility!

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TI&TELECOM

Since this retrospective has been made…

Presentation Goals

Presentation Goals

1) Good practices to secure the "things" of the IoT that are **under our control** (ISP);

2) Good practices to provide a **minimum of security** for our customers' "things";

3) How to manage security implementation in large scale in a **pro-active an automated way**.

Security

*The complete working solution in a small ISP using **open-source and free tools** will be showed.*

Agenda

Introduction, motivation, relevant facts ✓

Reminder of good practices to secure RouterOS equipment at Outside Plant and at Customer Premises;

IPv6 protocol - issues, configurations and some recommended practices;

Customer Security – How to provide a minimum of security keeping neutrality and privacy;

Large scale security management – A real case implementation.

21’

Agenda

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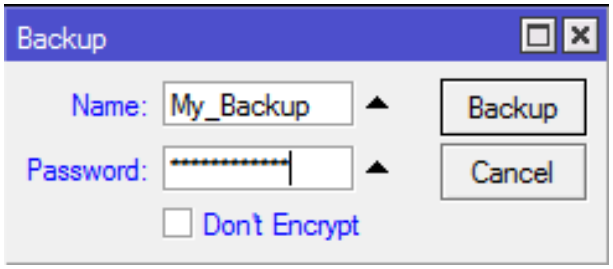
Large scale security management – A real case implementation.

16’

Physical Security

Physical Security

Equipment Outside Plant or in Customer Premises



- Disable unused Interfaces;

- Take care about local Backups. Do not leave them inside the boxes;

- Don’t use local database for users. Use Radius instead;

- If you Technicians convinced you that it is absolutely necessary a local login, consider to create one but restrict it to ssh, and the use a RSA key;

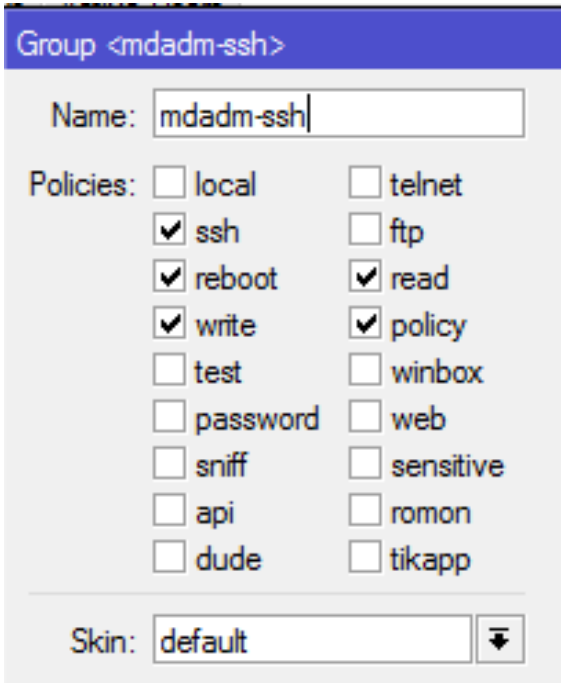
Creating and uploading a RSA key

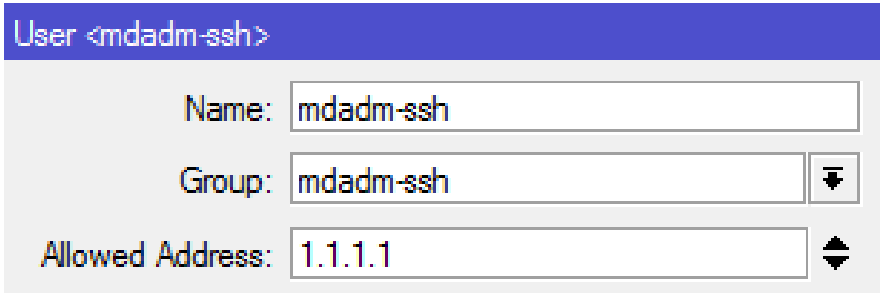
```
maia@xps:~$ ssh-keygen -t rsa
Generating public/private rsa key pair.
Enter file in which to save the key (/home/maia/.ssh/id_rsa): mdadm-ssh
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in mdadm-ssh.
Your public key has been saved in mdadm-ssh.pub.
The key fingerprint is:
SHA256:6A4QANxds2fmF/BsWp5v0C2vUc+qZUT24MKm2x0eleE maia@xps
The key's randomart image is:
+---[RSA 2048]----+
|= . . .o .       |
| o . .  o +      |
|  .     . + *  +. |
|   .   .= =.++ooo|
|  .    . So =+ooEo|
|   . .    .ooo+o.|
|    . .   .  +=.o|
|     o     o.=o+ |
|      .    . oo+ |
+----[SHA256]-----+
maia@xps:~$
```

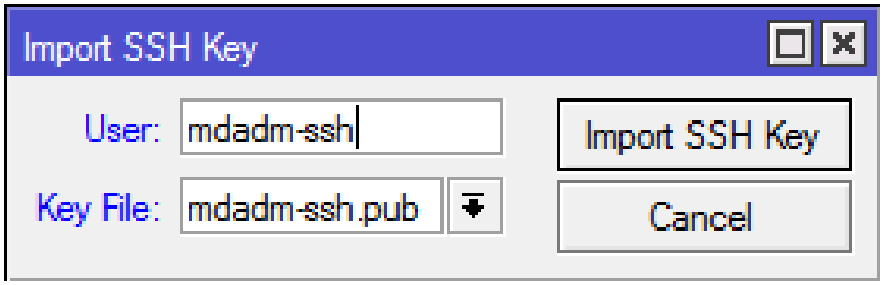
```
maia@xps:~$ ftp 192.168.1.1
Connected to 192.168.1.1.
220 AP-Maia FTP server (MikroTik 6.38.5) ready
Name (192.168.1.1:maia): admin
331 Password required for admin
Password:
230 User admin logged in
Remote system type is UNIX.
ftp> put mdadm-ssh.pub
local: mdadm-ssh.pub remote: mdadm-ssh.pub
200 PORT command successful
150 Opening ASCII mode data connection for '/mdadm-ssh.pub'
226 ASCII transfer complete
391 bytes sent in 0.03 secs (14.3910 kB/s)
ftp>
```

Physical Security

Creating a user with restricted rights







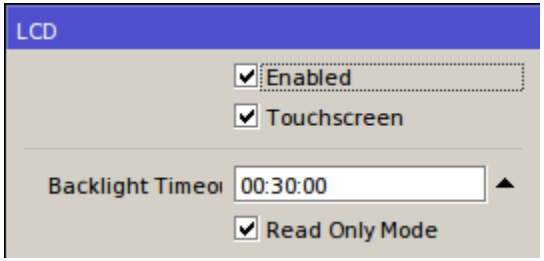

```
maia@xps:~$ ssh -l mdadm-ssh -p 6922 -i /home/maia/mdadm-ssh 192.168.1.1
mdadm-ssh@192.168.1.1's password:
```

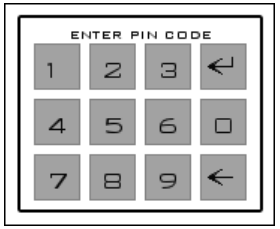
- Consider a script to “visit” your outside boxes and change regularly (e.g weekly) the local access credentials.

Physical Security

LCD

If you really need the LCD on, make sure LCD is on read-only mode. otherwise, the PIN code (default = 1234) will be asked and someone who has it can add an IP address, reboot or even reset the router.





Physical Security

Protected Bootloader

Allows the protection of RouterOS configuration and files from a physical attacker by disabling ether boot.

Can be enabled and disabled only from within RouterOS after login;

When this setting is enabled - reset button, reset pin-hole is and console access is disabled;

Special package for this is provided.

https://wiki.mikrotik.com/wiki/Manual:RouterBOARD_settings#Protected_bootloader

Layer 2 Security

Layer 2 Security

There are a lot of issues in Layer 2 that have to be considered depending on the specific topology and features used;

- Mac Flooding
- MNDP / CDP
- DHCP Starvation
- Vlan hopping attack
- Spanning tree attacks
- ARP poisoning attacks
- Deauth attack

Layer 2 Security

RouterOS has several features that can be used to mitigate Layer 2 issues, like:

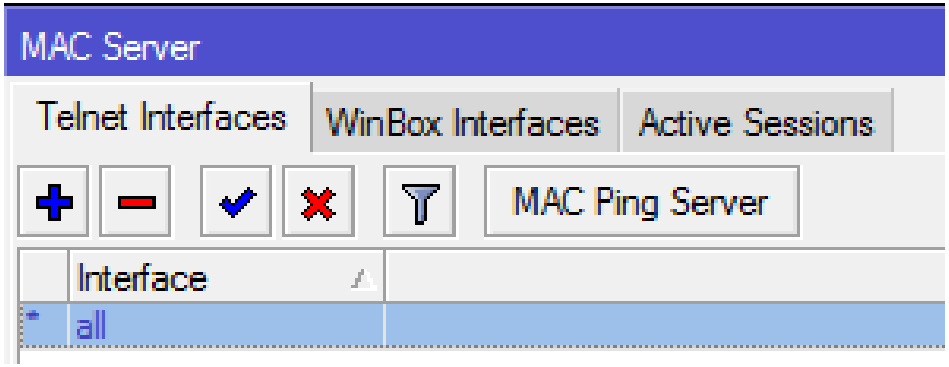
- Bridge Filtering
- Layer 2 Isolation
- Management Protection (Wireless)

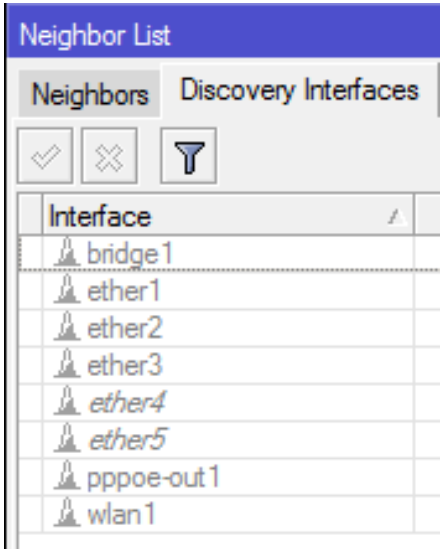
Use and overuse RouterOS features!

Reference – MUM 2010 Wroklaw / Poland:
Layer 2 Security – Attacks and Countermeasures using MikroTik RouterOS

Layer 2 Security

MAC-Server
Disable MAC-Server for Telnet and Winbox whenever possible. If "necessary" enable only on specific interfaces

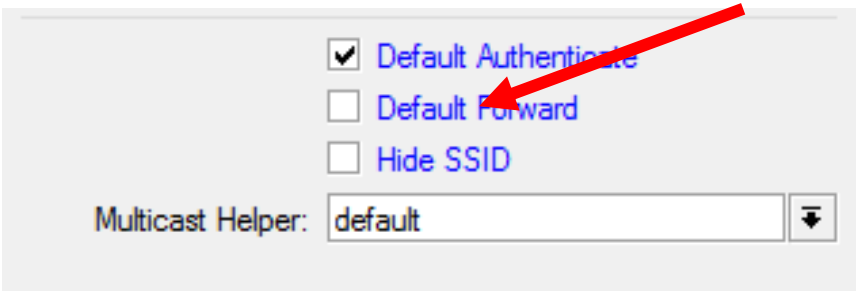




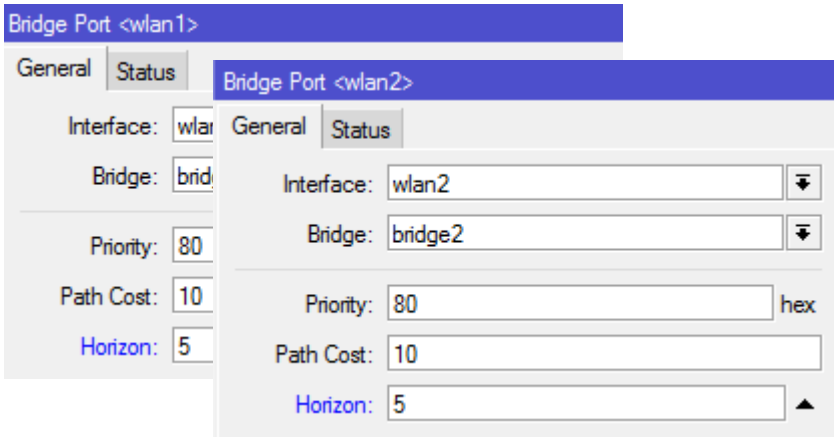
MNDP
Disable Discovery Interfaces whenever possible to avoid MNDP attacks.

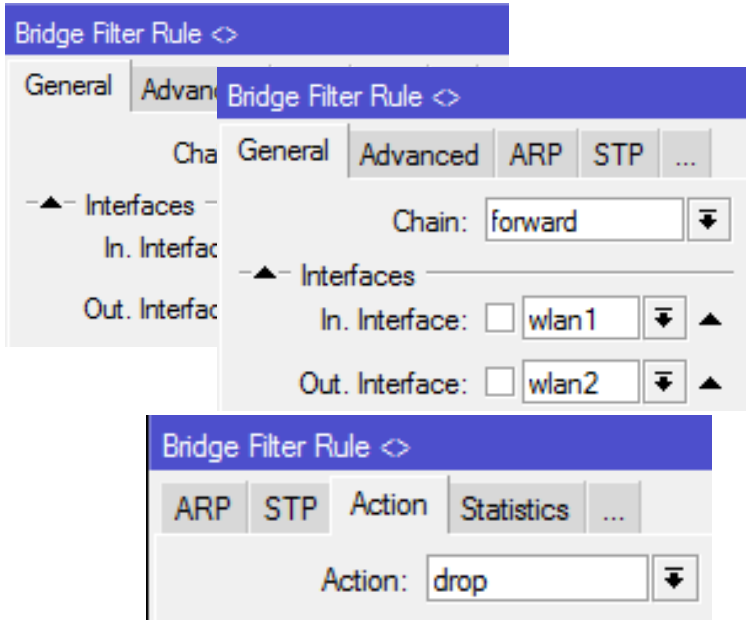
Layer 2 Security (Wireless)

Interface Wireless



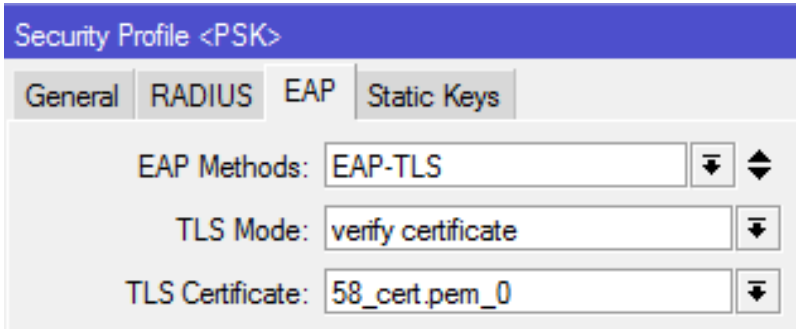
In case you have more than one Wireless interface,
use also Horizon, or Bridge Filters



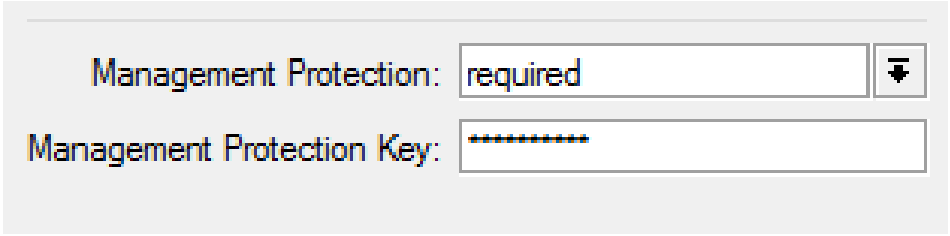


Layer 2 Security (Wireless)

Interface Wireless



Use strong encryption methods, preferably using Certificates



Protect against **Deauth Attack** and MAC spoofing, specially in Point to Point links

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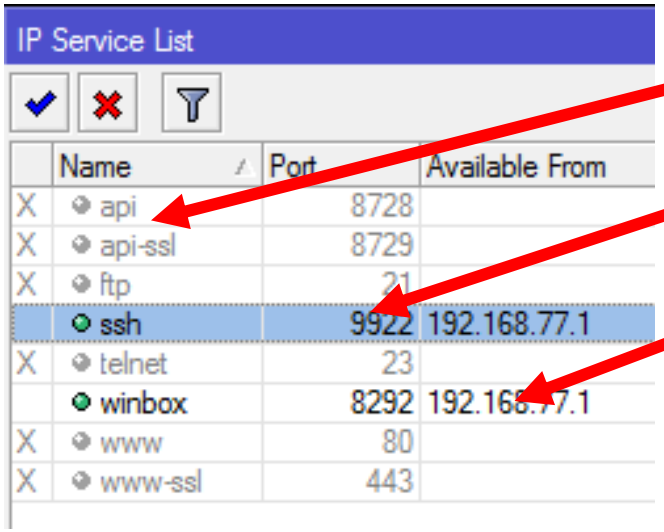
Services Security

Services Security

IP Services



Disable unnecessary services;

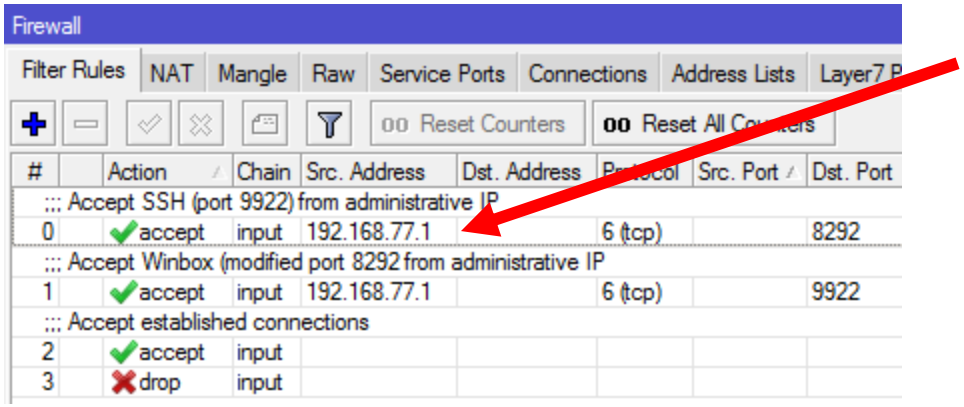
Change default ports;

Restrict access from a particular IP

Can sounds a little bit paranoid, but besides the above, **for running services** it's important to block also in /ip firewall (see next slide)

Services Security

IP Firewall



On Input channel restrict the access to services only for administrative IPs; **

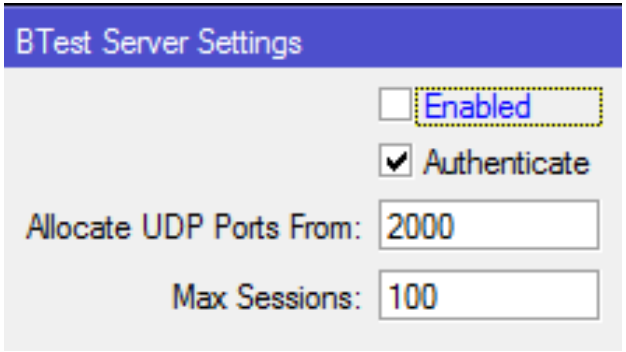
** Although it seems redundant, the reason to block services/ports also in /ip firewall was pointed by **Tom Smyth** (wirelessconnect.eu):

*"As far as I am aware and from tests I carried out about 7 or 8 years ago the allowed from IP addresses in IP services menu uses TCP wrappers and actually allows TCP connections from any address **(regardless of what IPs you specified)** the decision to allow or deny a user login is taken after the connection is made so there could be a window for the exploit to be uploaded."*

Services Security

Bandwidth Test Server

There is no reason to leave Bandwidth test server enabled by default. Enable it only when and where you want to test something



Enable Strong Crypto

Since v.30 Mikrotik has changed ssh module, introducing stronger encryption algorithms and methods.

```
[mdadm-ssh@AP-Maia] > ip ssh set strong-crypto=yes
[mdadm-ssh@AP-Maia] >
```

Strong crypto is disabled by default and should be considered whenever the impacts on hardware resources would not be a problem.

Services Security

Services disabled by default that should be kept disabled:

/ip upnp
/ip smb
/ip socks
…

If you are not sure which services are running in your box, try to find them with nmap:

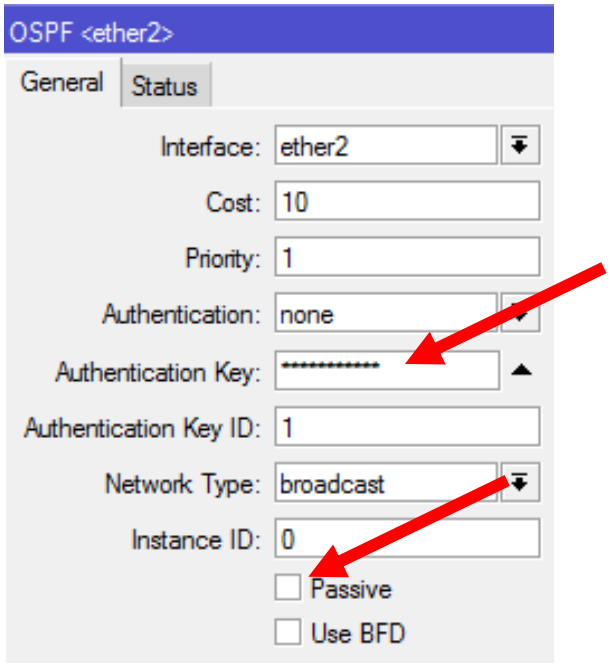
```
maia@xps:~$ sudo nmap -A -T4 192.168.88.1
[sudo] password for maia:

Starting Nmap 7.01 ( https://nmap.org ) at 2017-03-29 15:22 CEST
```

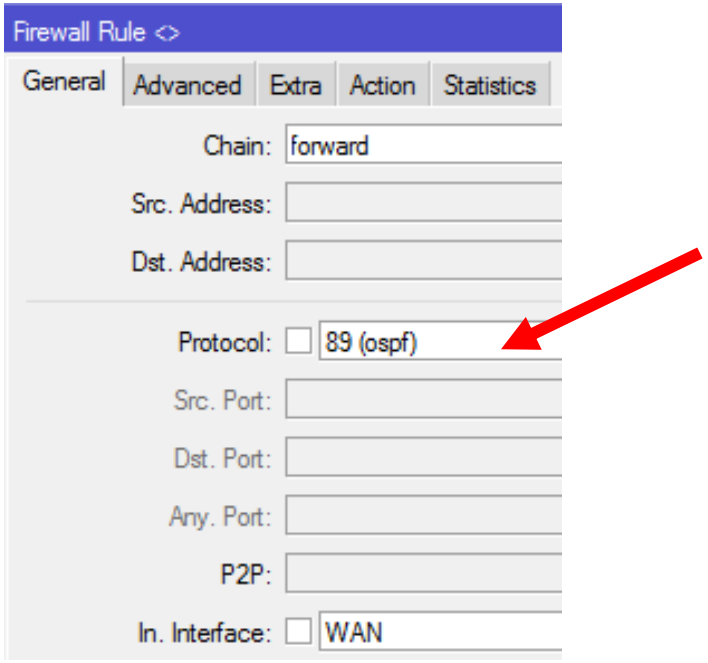
Routing Security

Routing Security

OSPF and OSPFv3

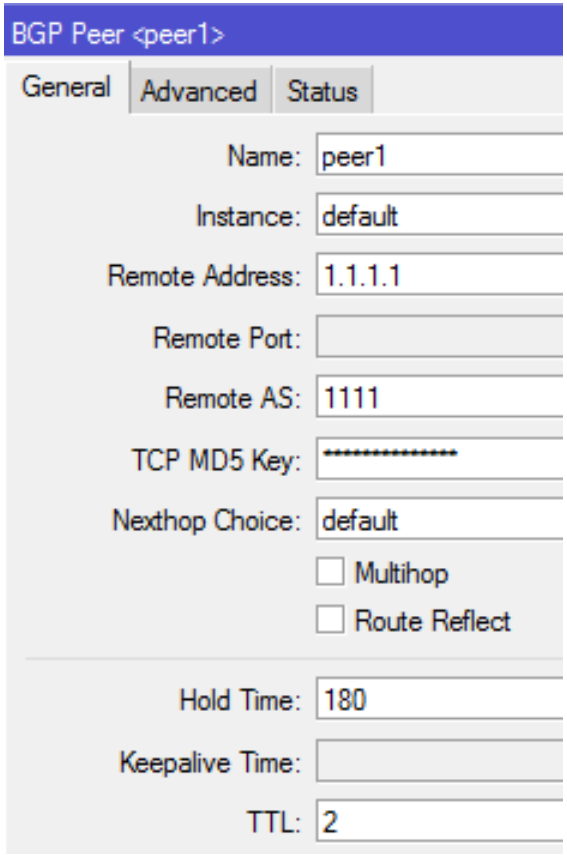
- Use encryption;
- Set interfaces to passive mode on links where clients are connected in;
- Drop protocol 89 on appropriate Interfaces.





[Routing Security – Hungary MUM 2011]

Routing Security

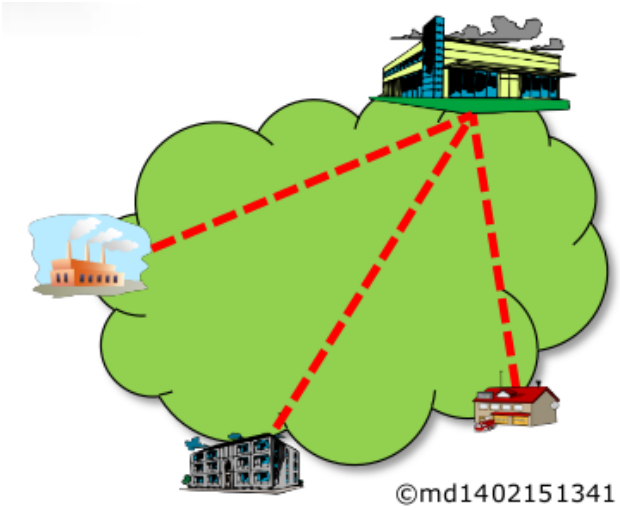


BGP

- Use MD5 encryption;
- Use TTL "hack";
- Filter BOGONs prefixes;
- Filter unwanted prefixes, like own prefix;
- Filter too large AS-Path;
- etc…

Routing Security – Hungary MUM 2011
BGP Filtering – Croatia MUM 2013

Routing Security

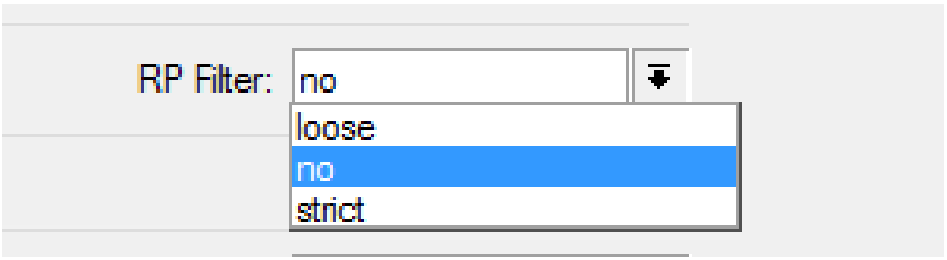


MPLS VPNs

- Use only static routing between CE -> PE;
- Do not give your customer access to CE routers;
- Protect network against spoofing using uRPF;
- Consider using IPSec between PEs

MPLS VPN Security – Italy MUM 2014

uRPF Filter



To avoid spoofing from your customers it is **very important** to enable URPF;

- **strict mode:** the packet must be received on the interface that the router would use to forward the return packet

- **loose mode:** for a received packet, router has to have some route to deliver the return packet.

Agenda

Introduction, motivation, relevant facts;

Reminder (check list) of good practices to secure RouterOS equipment at Outside Plant and at Customer Premises;

IPv6 protocol - issues, configurations and some recommended practices;

Customer Security – How to provide a minimum of security keeping neutrality and privacy;

Large scale security management – A real case implementation.

30’

Misconceptions about IPv6 Security

Misconceptions about IPv6 security

1) **IPv6 is more secure than IPv4 because it uses IPSec**

IPSec

IPSec was originally developed for IPv6 an backported to IPv4. It was a ***mandatory feature***.

RFC 6434 (https://tools.ietf.org/html/rfc6434), changed from mandatory to optional

SHOULD != MUST

Misconceptions about IPv6 security

2) Scanning is impossible in IPv6

The smallest recommend network (/64) has the current Internet IPv4 space squared. This makes traditional (sequential) scan methods pointless.

However, selective techniques based on the way addresses are formed and configured can make a successful scanning.

Besides that, multicast addresses can be used to gather information inside the network, identifying routers, routers, OSPF, routers, etc.

Scanning

Misconceptions about IPv6 security

Some articles about scanning, by Fernando Gont

Vast IPv6 address space actually enables IPv6 attacks
http://searchsecurity.techtarget.com/tip/Analysis-Vast-IPv6-address-space-actually-enables-IPv6-attacks

How to use DNS reverse mapping to scan IPv6 addresses
http://searchsecurity.techtarget.com/tip/How-to-use-DNS-reverse-mapping-to-scan-IPv6-addresses

DNS reverse address mapping: Exploiting the scanning technique
http://searchsecurity.techtarget.com/tip/DNS-reverse-address-mapping-Exploiting-the-scanning-technique

Misconceptions about IPv6 security

Multicast addresses in IPv6

Address	Description
FF02::1	Find Nodes on a subnet
FF02::2	Return Local Subnet Routers
FF02::5	OSPF Routers
FF02::6	Designed OSPF Routers (DR's)
FF02::9	RIP Routers
FF02::D	PIM Routers
FF02::1:2	DHCP Agents

Scanning

Misconceptions about IPv6 security

ff02::1 (All Hosts)

```
maia@maia-laptop:~$ sudo ping6 -I wlan0 ff02::1
PING ff02::1(ff02::1) from fe80::223:14ff:fe21:d4a8 wlan0: 56 data bytes
64 bytes from fe80::223:14ff:fe21:d4a8: icmp_seq=1 ttl=64 time=0.097 ms
64 bytes from fe80::a00:27ff:fe20:1052: icmp_seq=1 ttl=64 time=0.328 ms (DUP!)
64 bytes from fe80::a00:27ff:fe20:1052: icmp_seq=1 ttl=64 time=0.392 ms (DUP!)
64 bytes from fe80::20c:42ff:fe61:b3c3: icmp_seq=1 ttl=64 time=0.917 ms (DUP!)
64 bytes from fe80::20c:42ff:fe0c:a003: icmp_seq=1 ttl=64 time=1.20 ms (DUP!)
64 bytes from fe80::20c:42ff:fe3a:8e24: icmp_seq=1 ttl=64 time=1.63 ms (DUP!)
64 bytes from fe80::223:14ff:fe21:d4a8: icmp_seq=2 ttl=64 time=0.107 ms
64 bytes from fe80::a00:27ff:fe20:1052: icmp_seq=2 ttl=64 time=0.299 ms (DUP!)
64 bytes from fe80::a00:27ff:fe20:1052: icmp_seq=2 ttl=64 time=0.375 ms (DUP!)
```

ff02::2 (All Routers)

```
maia@maia-laptop:~$ sudo ping6 -I wlan0 ff02::2
PING ff02::2(ff02::2) from fe80::223:14ff:fe21:d4a8 wlan0: 56 data bytes
64 bytes from fe80::20c:42ff:fe61:b3c3: icmp_seq=1 ttl=64 time=8.77 ms
64 bytes from fe80::20c:42ff:fe61:b3c3: icmp_seq=2 ttl=64 time=0.804 ms
64 bytes from fe80::20c:42ff:fe61:b3c3: icmp_seq=3 ttl=64 time=0.904 ms
64 bytes from fe80::20c:42ff:fe61:b3c3: icmp_seq=4 ttl=64 time=0.832 ms
```

ff02::5 (All OSPF Routers)

```
maia@maia-laptop:~$ sudo ping6 -I wlan0 ff02::5
PING ff02::5(ff02::5) from fe80::223:14ff:fe21:d4a8 wlan0: 56 data bytes
64 bytes from fe80::20c:42ff:fe61:b3c3: icmp_seq=1 ttl=64 time=0.826 ms
64 bytes from fe80::20c:42ff:fe0c:a003: icmp_seq=1 ttl=64 time=1.26 ms (DUP!)
64 bytes from fe80::20c:42ff:fe61:b3c3: icmp_seq=2 ttl=64 time=0.870 ms
64 bytes from fe80::20c:42ff:fe0c:a003: icmp_seq=2 ttl=64 time=1.17 ms (DUP!)
64 bytes from fe80::20c:42ff:fe61:b3c3: icmp_seq=3 ttl=64 time=0.804 ms
64 bytes from fe80::20c:42ff:fe0c:a003: icmp_seq=3 ttl=64 time=1.15 ms (DUP!)
```

Scanning

ff02::1:2 (All DHCP Servers)

```
maia@maia-laptop:~$ sudo ping6 -I wlan0 ff02::1:2
PING ff02::1:2(ff02::1:2) from fe80::223:14ff:fe21:d4a8 wlan0: 56 data bytes
64 bytes from fe80::20c:42ff:fe61:b3c3: icmp_seq=1 ttl=64 time=9.80 ms
64 bytes from fe80::20c:42ff:fe3a:8e24: icmp_seq=1 ttl=64 time=10.3 ms (DUP!)
64 bytes from fe80::20c:42ff:fe61:b3c3: icmp_seq=2 ttl=64 time=0.916 ms
64 bytes from fe80::20c:42ff:fe3a:8e24: icmp_seq=2 ttl=64 time=1.25 ms (DUP!)
64 bytes from fe80::20c:42ff:fe61:b3c3: icmp_seq=3 ttl=64 time=0.820 ms
64 bytes from fe80::20c:42ff:fe3a:8e24: icmp_seq=3 ttl=64 time=2.56 ms (DUP!)
```

http://mum.mikrotik.com/presentations/PL12/maia.pdf
https://www.youtube.com/watch?v=zZ6s1nVe-O0

Misconceptions about IPv6 security

4) Because my network doesn't have IPv6, I don't have to care about IPv6 security

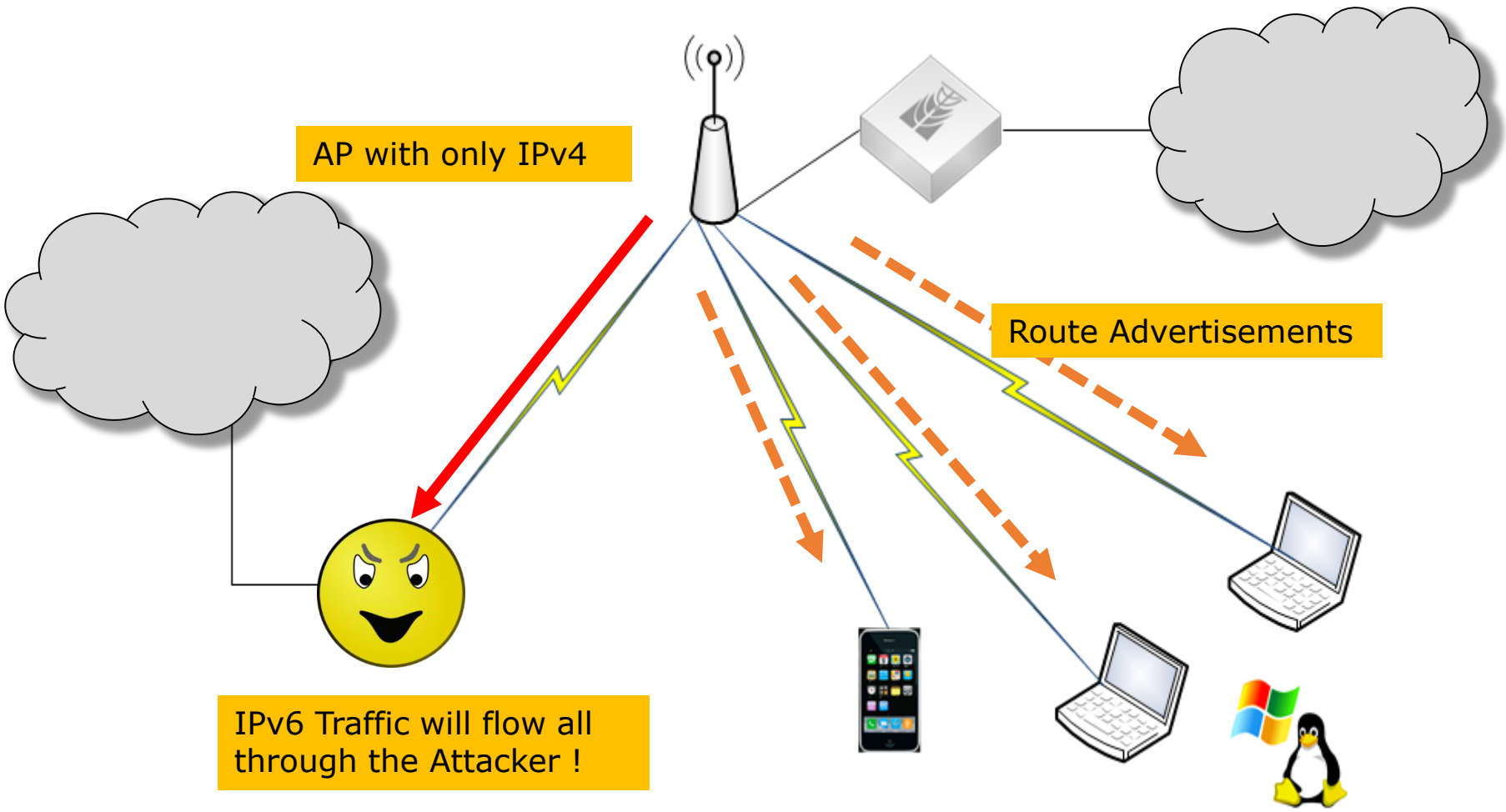
Even if your network doesn't support IPv6, you should care about IPv6 security, because of:

- Automatic transition techniques (Teredo, 6to4)
- Possible attacks on public hotspots

I don't care about IPv6 security

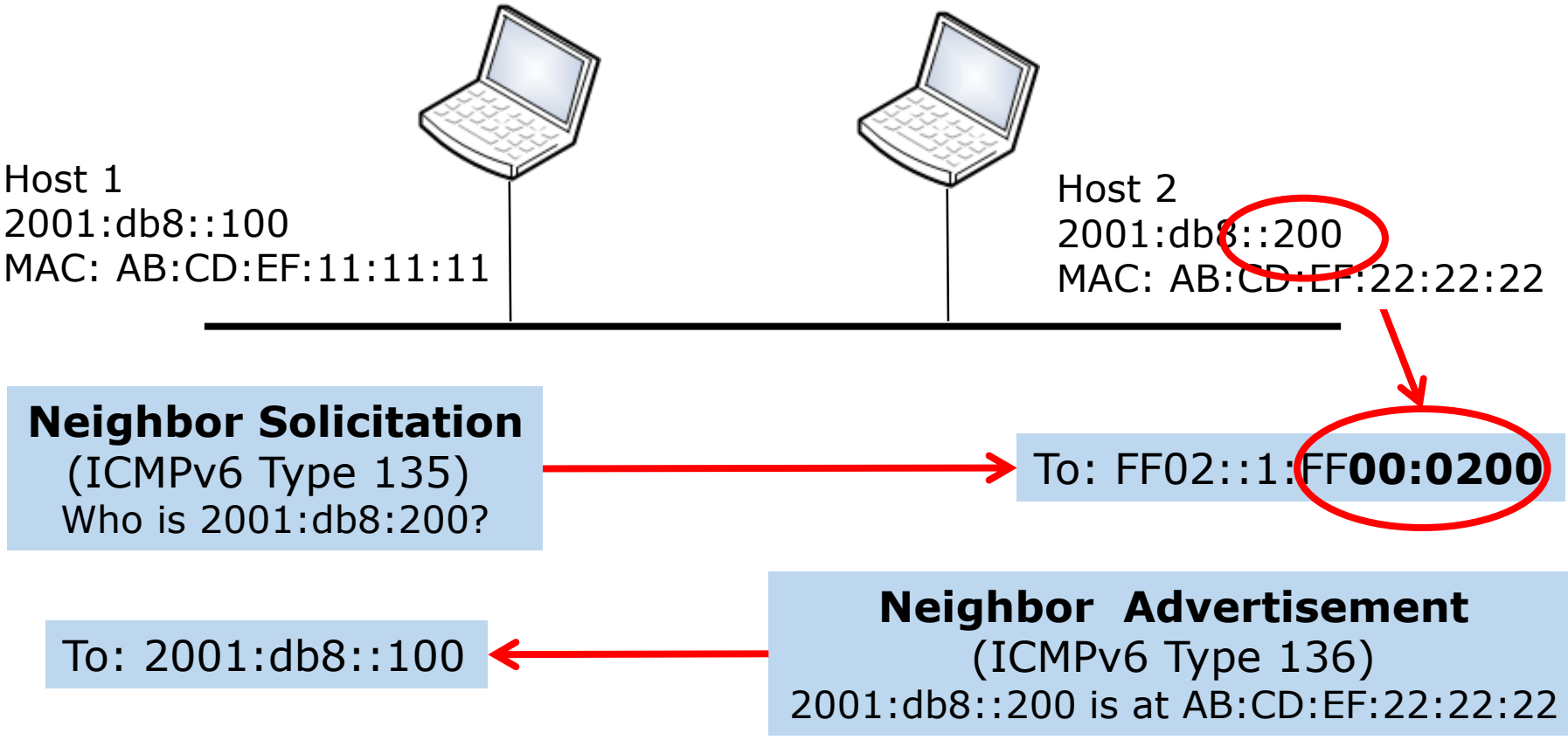
Please, see:
http://mum.mikrotik.com/presentations/PL12/maia.pdf
https://www.youtube.com/watch?v=zZ6s1nVe-O0

Abusing a Hotspot IPv4 only

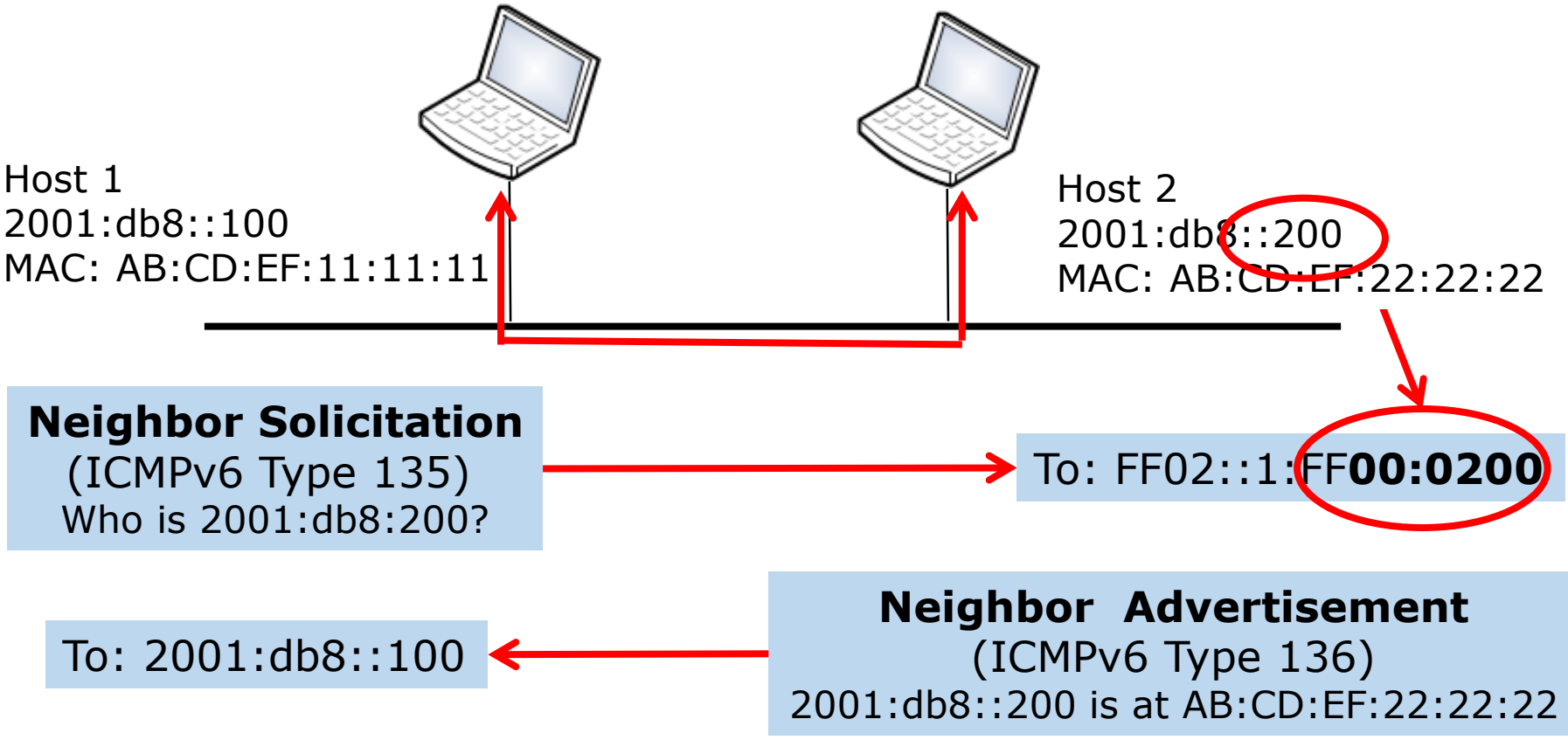


Some IPv6 security issues

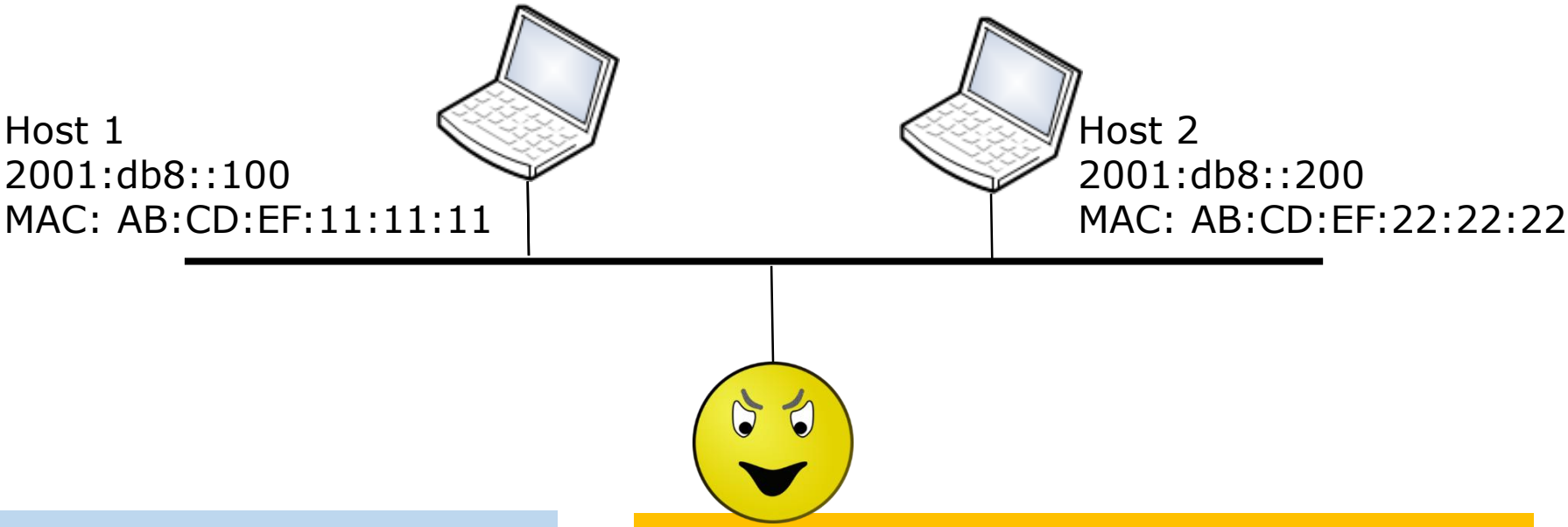
Neighbor discovery on IPv6



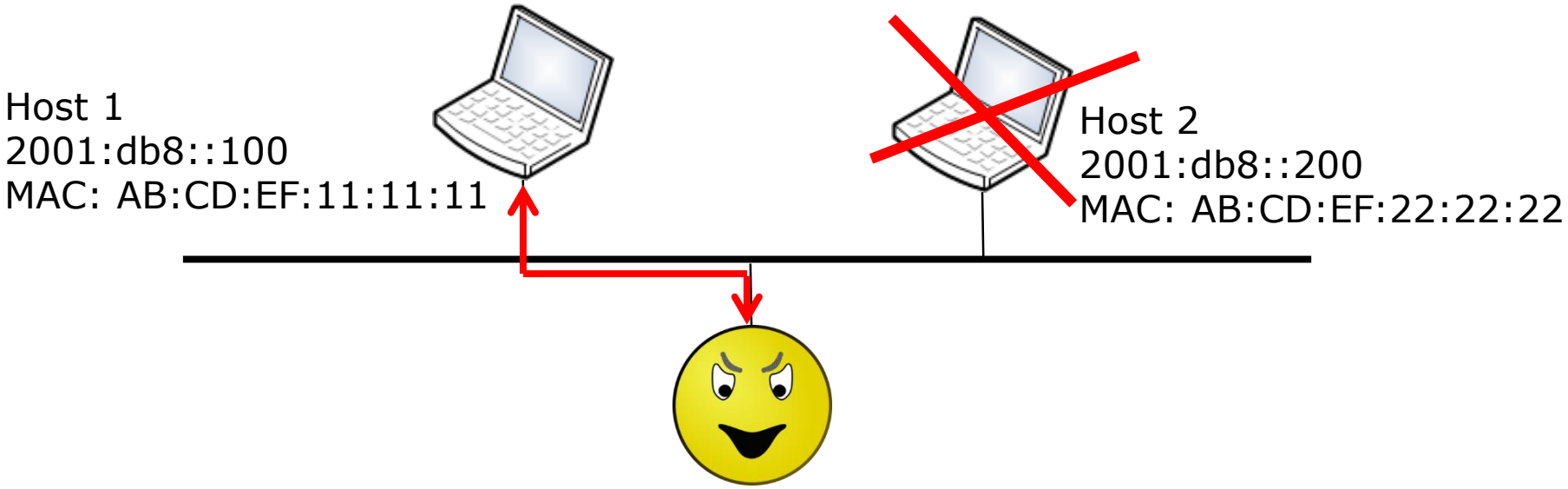
Neighbor discovery on IPv6



Exploring Neighbor Discovery

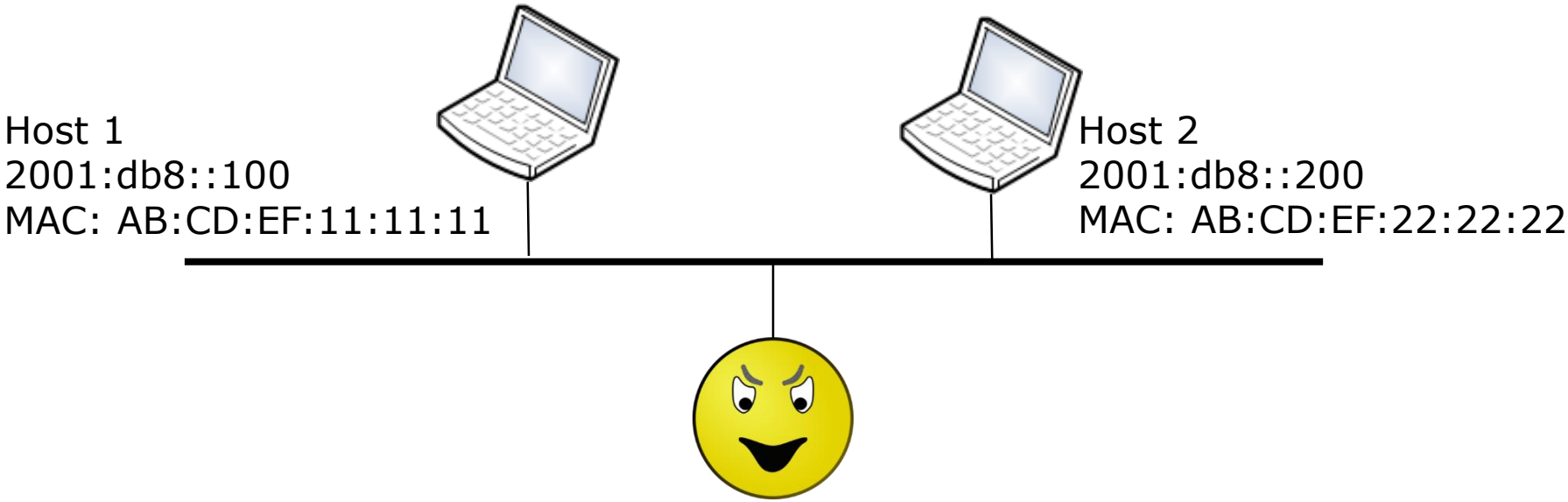


Exploring Neighbor Discovery



Host 1 thinks 2001:db8::200 is the attacker and send traffic layer 2 to it

Man-In-The-Middle



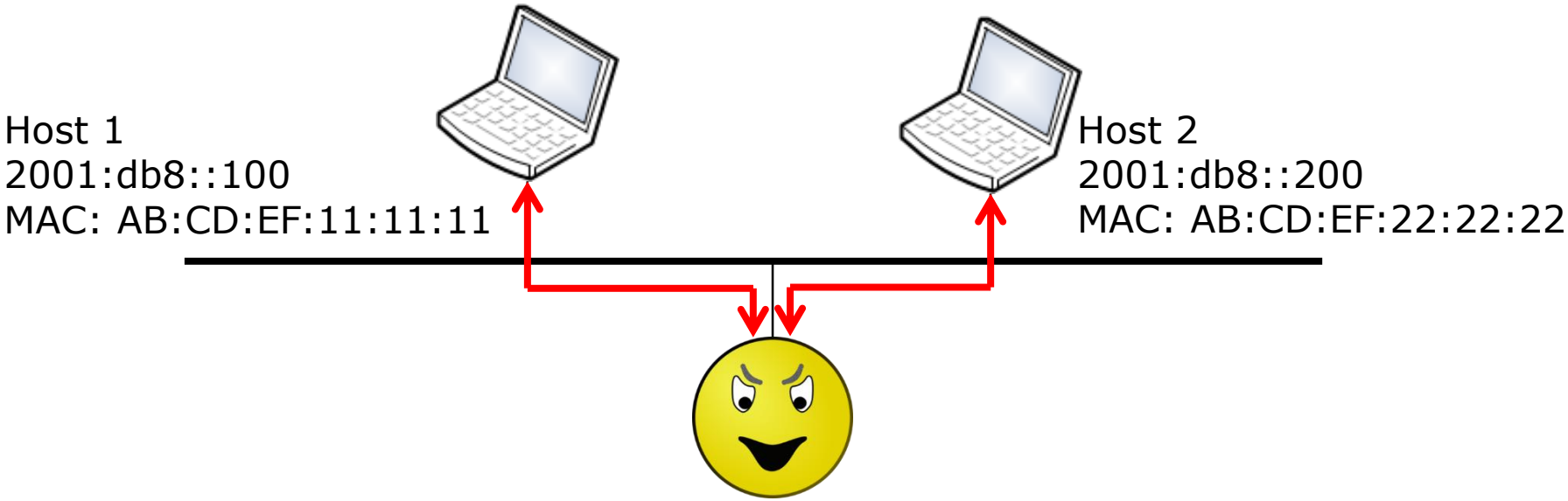
Fake Neighbor Advertisement
(ICMPv6 Type 136)
2001:db8::200 is at BA:DB:AD:66:66:66:66

To: 2001:db8::100

Fake Neighbor Advertisement
(ICMPv6 Type 136)
2001:db8::100 is at BA:DB:AD:66:66:66:66

To: 2001:db8::200

Man-In-The-Middle



Fake Neighbor Advertisement
(ICMPv6 Type 136)
2001:db8::200 is at BA:DB:AD:66:66:66:66

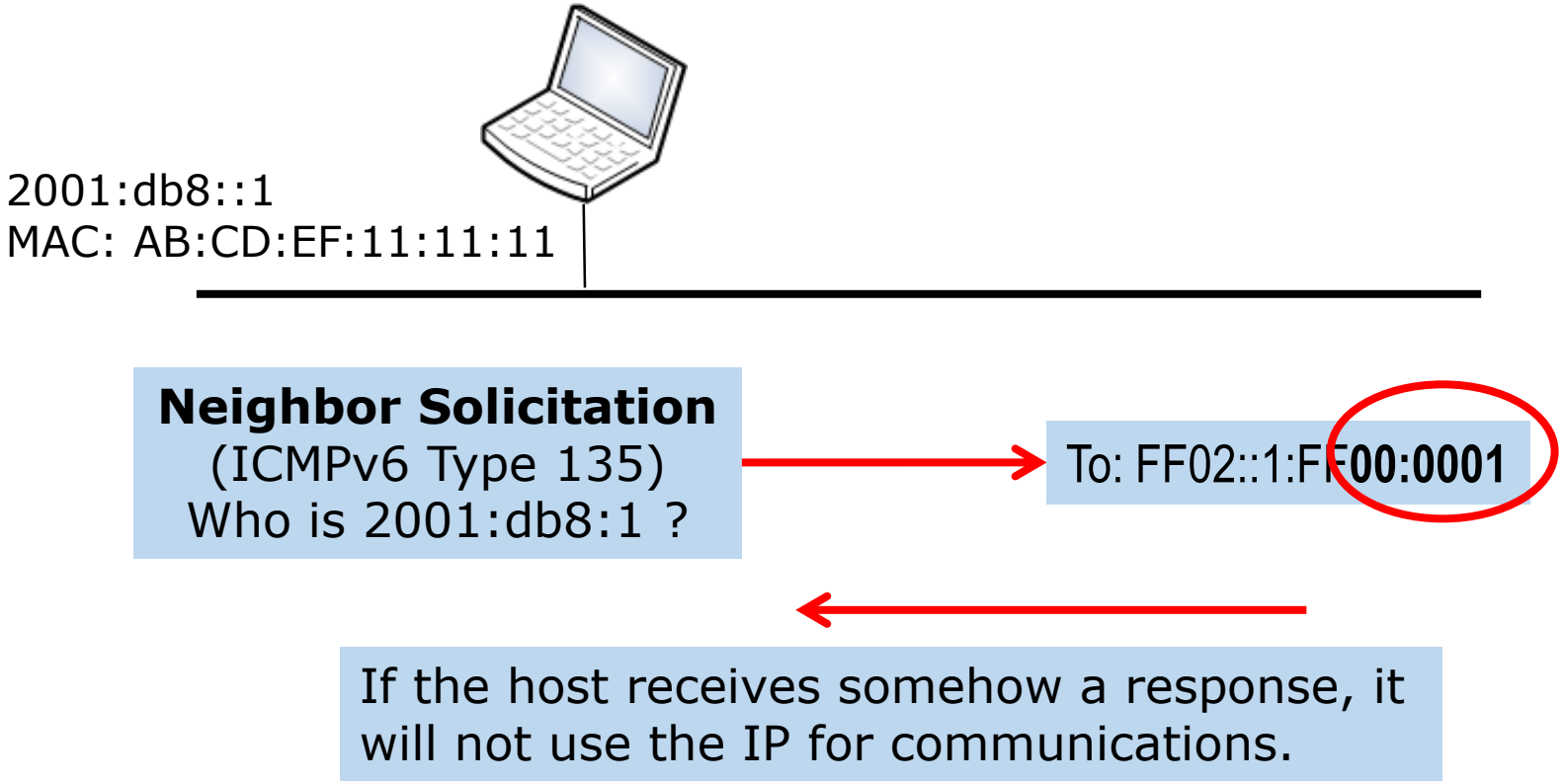
To: 2001:db8::100

Fake Neighbor Advertisement
(ICMPv6 Type 136)
2001:db8::100 is at BA:DB:AD:66:66:66:66

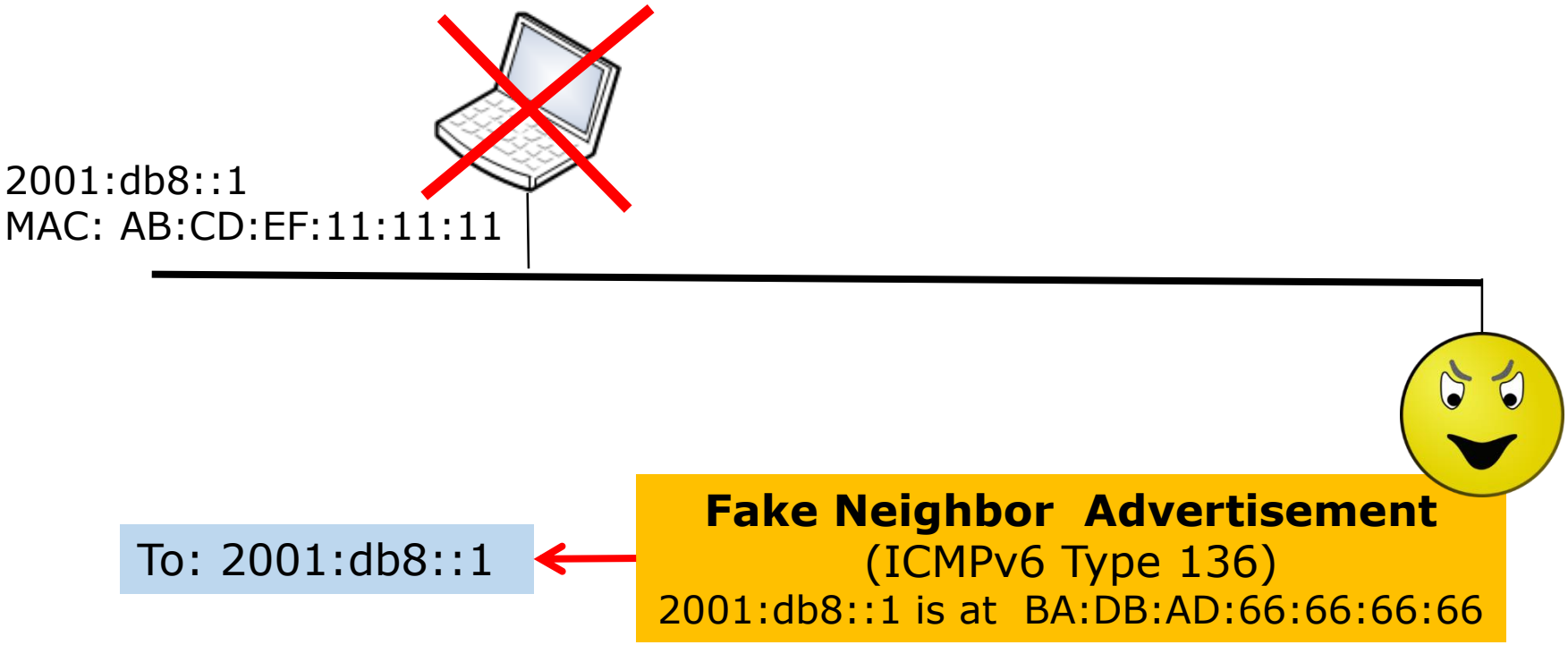
To: 2001:db8::200

DAD – Duplicate Address Detection

After a boot or an IP change, DAD must be executed before using any IPv6 address (including link local address).



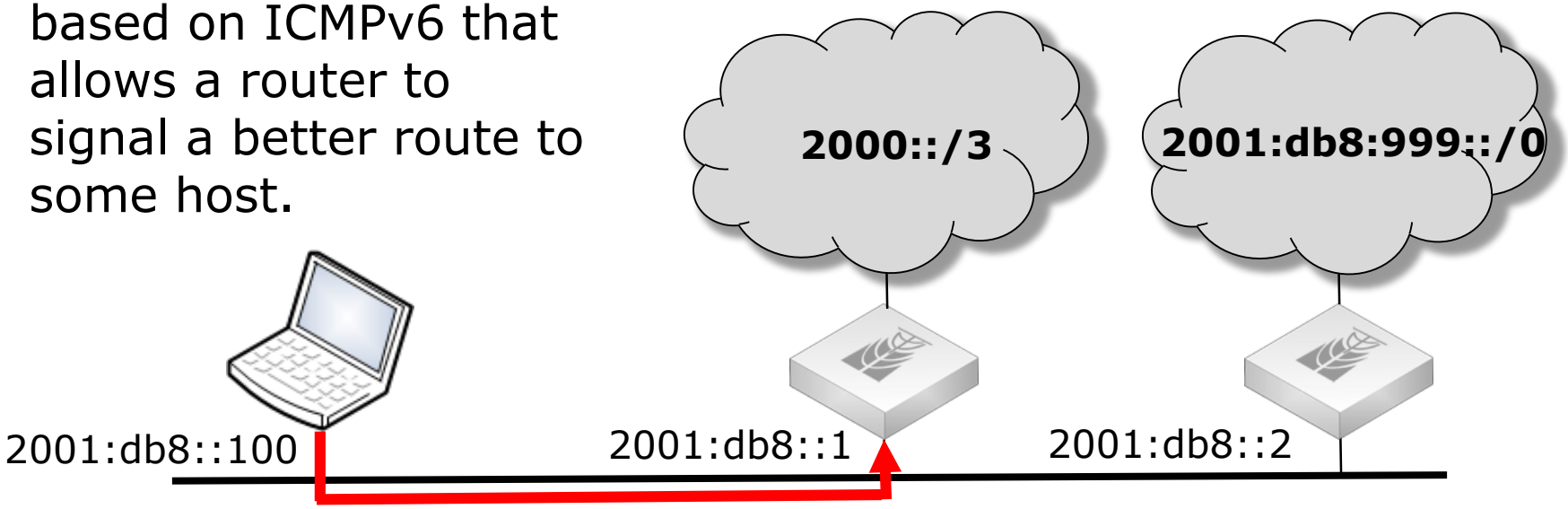
Exploring DAD



DAD exploitation can be used to cause a DoS to a specific device, the whole network or to impersonate some device.

ICMPv6 Redirects

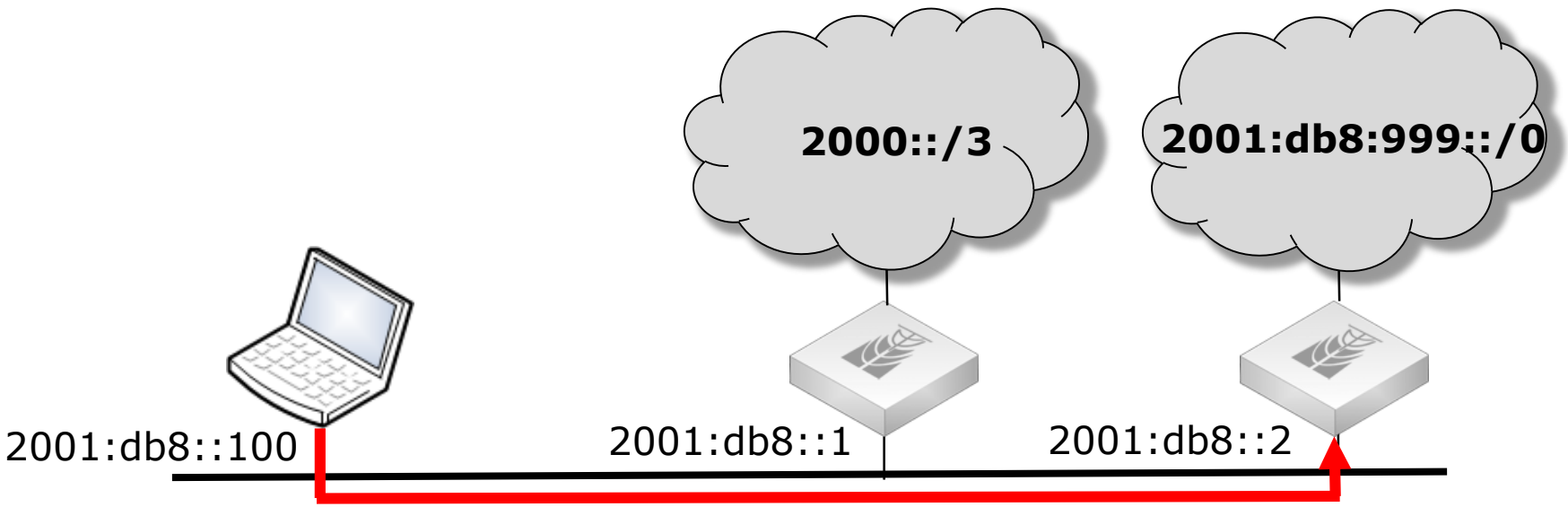
Redirection is a feature based on ICMPv6 that allows a router to signal a better route to some host.



Packet to 2001:db8::999::X → To default gateway (2001:db8::1)

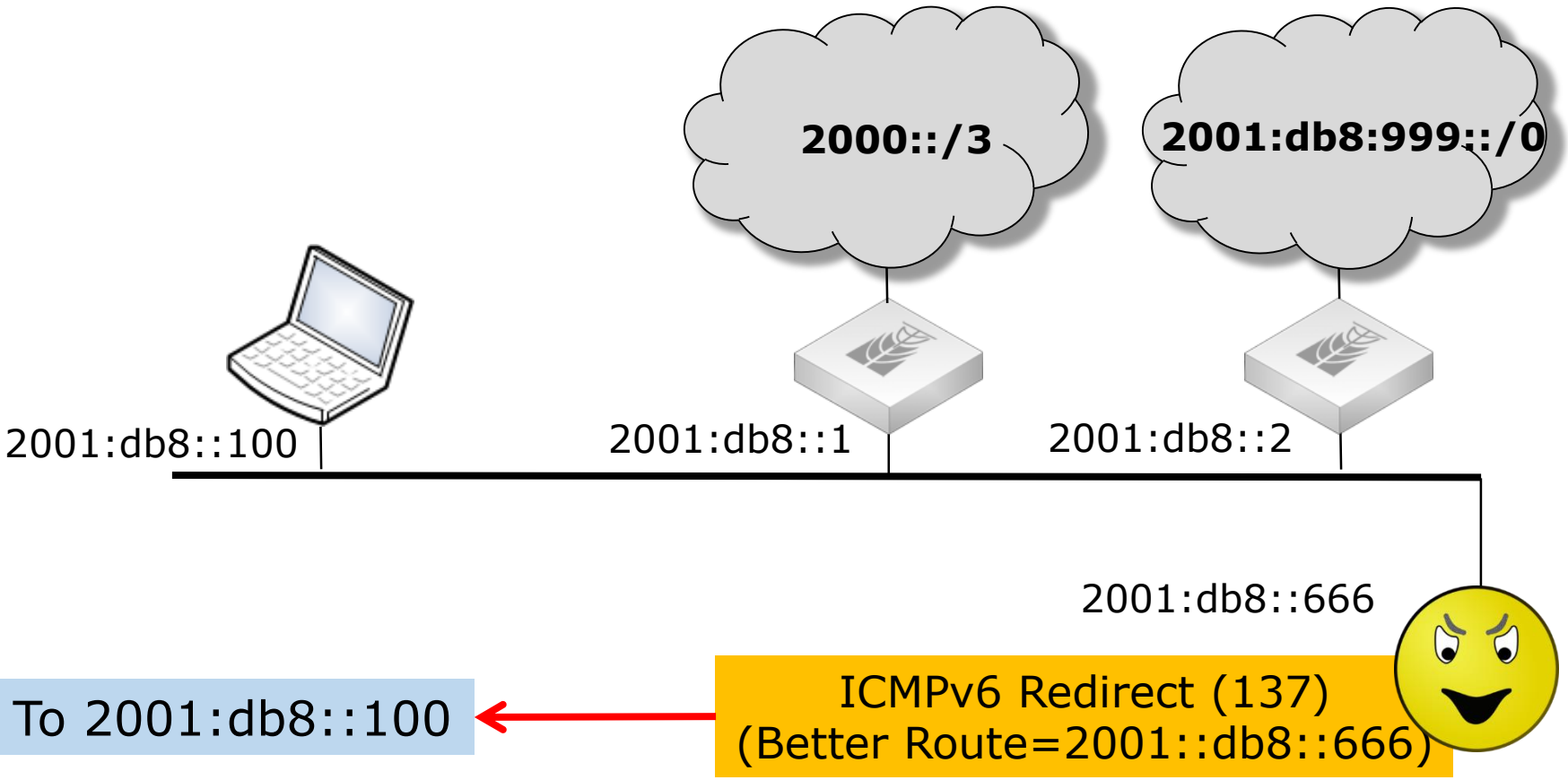
ICMPv6 Redirect (137)
(Better Route=2001::db8::2) → To 2001:db8::100

ICMPv6 Redirects

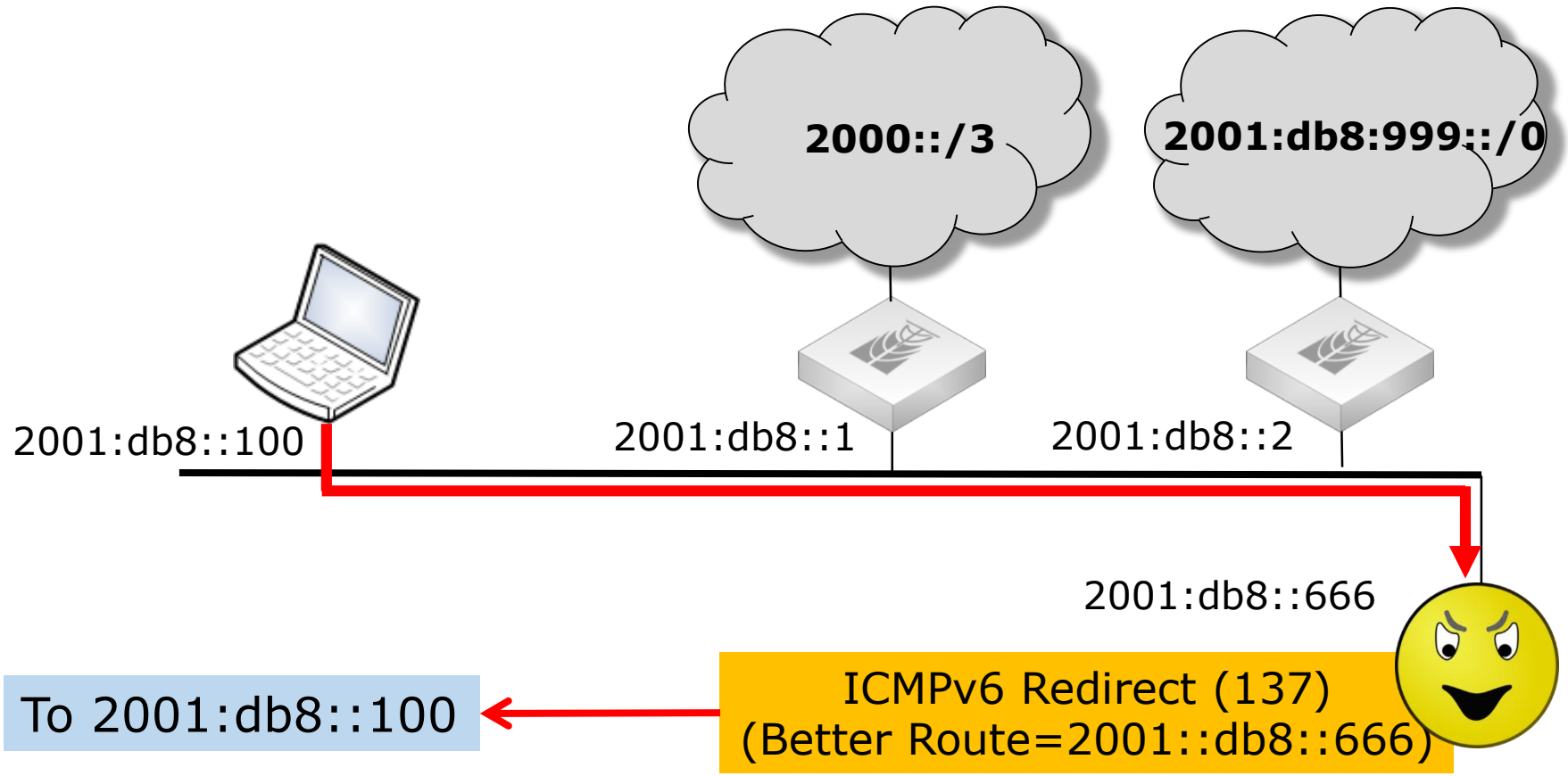


Further communication to 2001:db8:999::/0 will be sent through 2001:db8::2

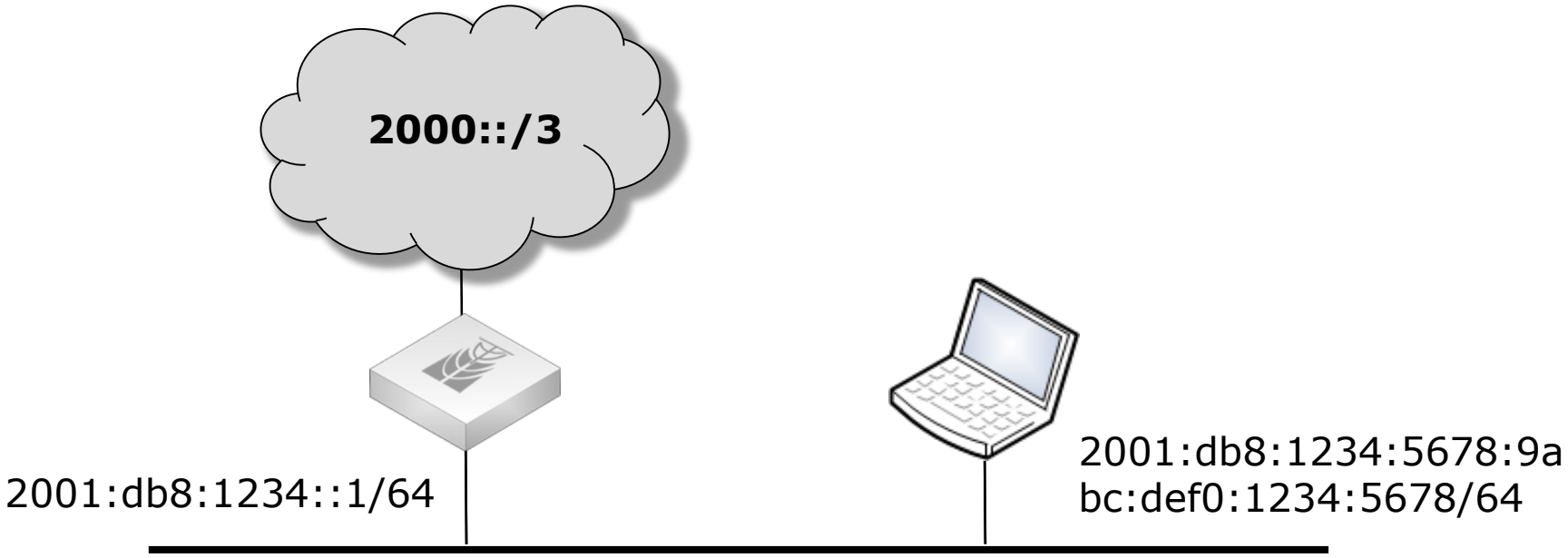
Exploring ICMPv6 Redirects



Exploring ICMPv6 Redirects



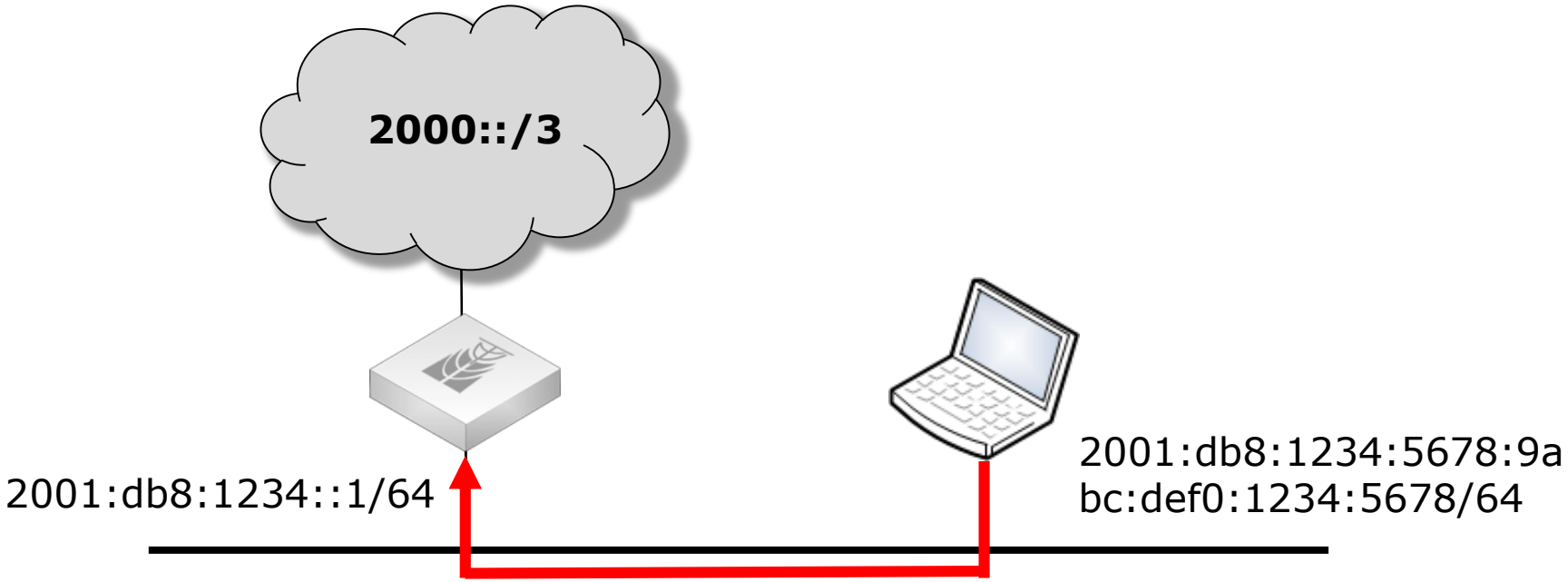
Router Advertisement



Router Advertisement
(ICMPv6 Type 134)
Source: Link-local address
Contents: Options, prefixes, lifetime, auto configuration flag

→ To: FF02::1 (All nodes on link)

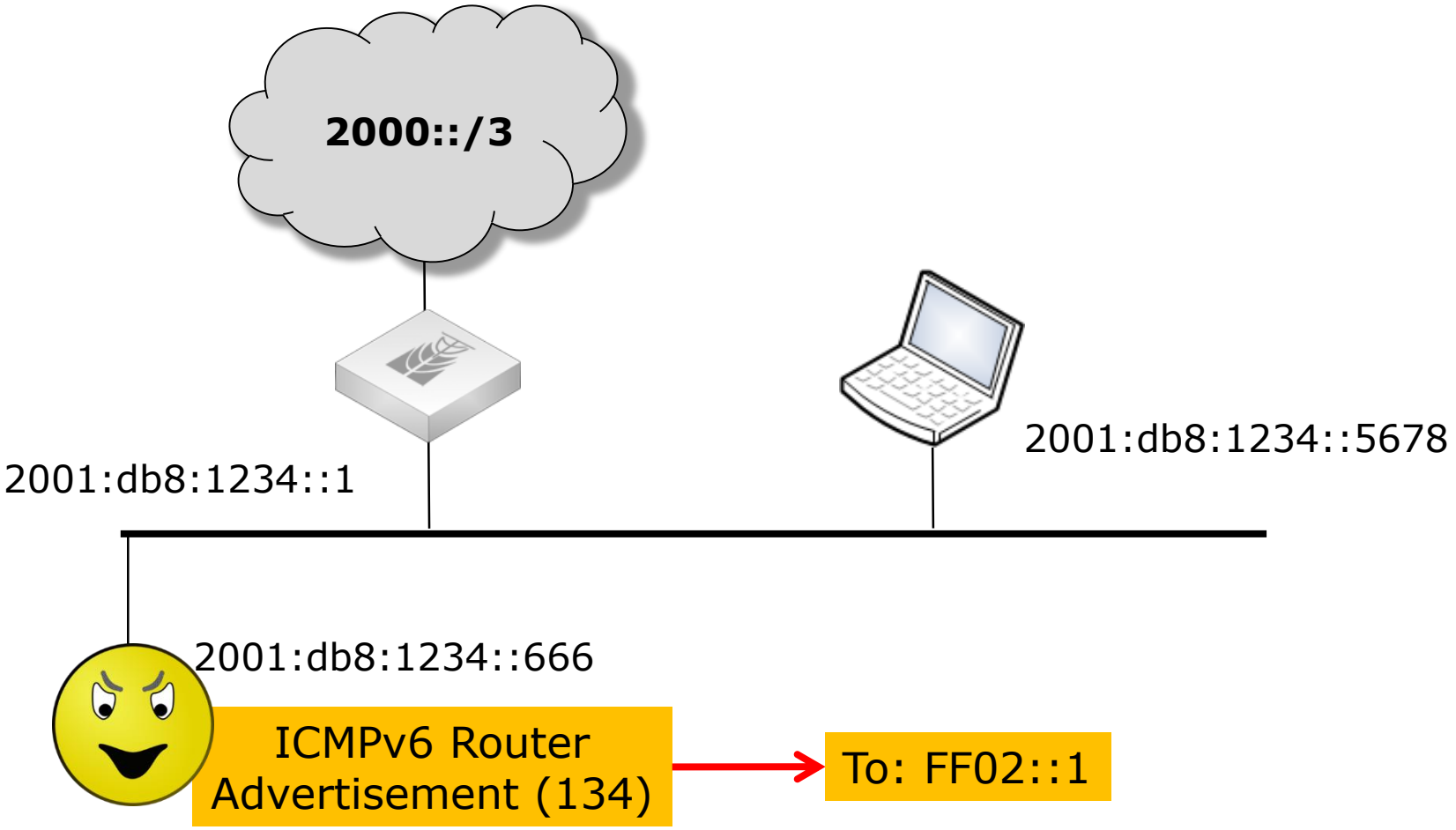
Router Advertisement



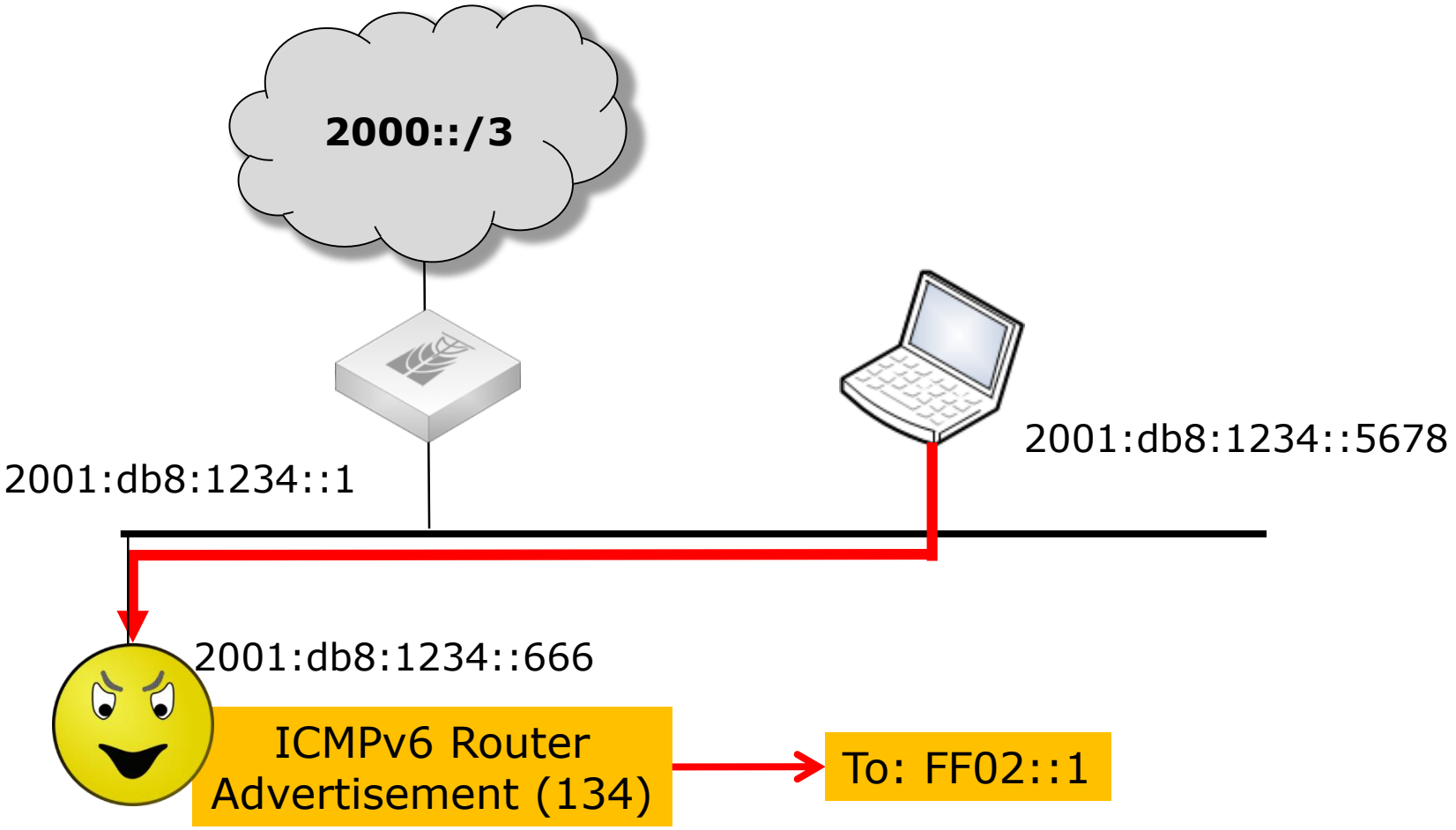
Router Advertisement
(ICMPv6 Type 134)
Source: Link-local address
Contents: Options, prefixes, lifetime, auto configuration flag

→ To: FF02::1 (All nodes on link)

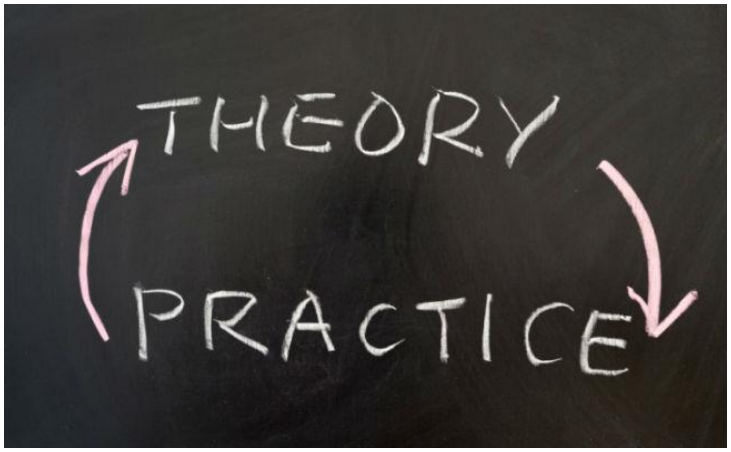
Exploring Router Advertisement



Exploring Router Advertisement



md brasil
TI&TELECOM



Do those stuff sound too theoretical?

Does this stuff sound too theoretical?

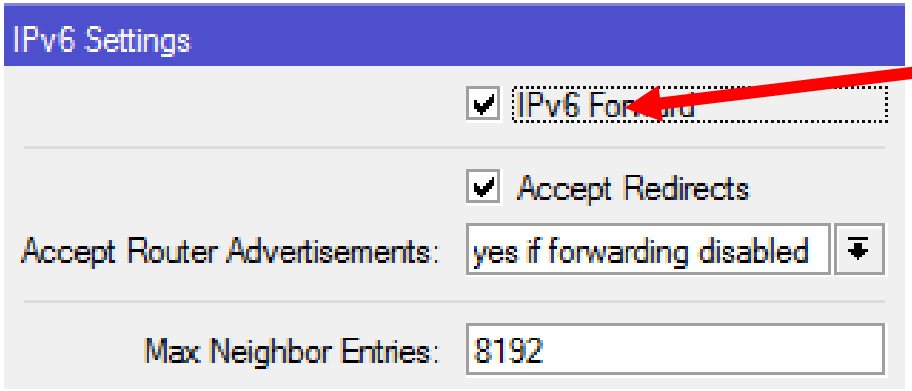
```
maia@xps:~$ sudo apt-get install thc-ipv6
```

```
maia@xps:~$ atk6-
atk6-address6              atk6-fake_mld26          atk6-implementation6
atk6-alive6                atk6-fake_mld6           atk6-implementation6d
atk6-covert_send6          atk6-fake_mldrouter6     atk6-inject_alive6
atk6-covert_send6d         atk6-fake_pim6           atk6-inverse_lookup6
atk6-denial6               atk6-fake_router26       atk6-kill_router6
atk6-detect-new-ip6        atk6-fake_router6        atk6-ndpexhaust26
atk6-detect_sniffer6       atk6-fake_solicitate6    atk6-ndpexhaust6
atk6-dnsdict6              atk6-firewall6           atk6-node_query6
atk6-dnsrevenum6           atk6-flood_advertise6    atk6-parasite6
atk6-dnssecwalk            atk6-flood_dhcpc6        atk6-passive_discovery6
atk6-dos_mld               atk6-flood_mld26         atk6-randicmp6
atk6-dos-new-ip6           atk6-flood_mld6          atk6-redir6
atk6-dump_dhcp6            atk6-flood_mldrouter6    atk6-redirsniff6
atk6-dump_router6          atk6-flood_redir6        atk6-rsmurf6
atk6-exploit6              atk6-flood_router26      atk6-sendpees6
atk6-extract_hosts6        atk6-flood_router6       atk6-sendpeesmp6
atk6-extract_networks6     atk6-flood_rs6           atk6-smurf6
atk6-fake_advertise6       atk6-flood_solicitate6   atk6-thcping6
atk6-fake_dhcps6           atk6-four2six            atk6-thcsyn6
atk6-fake_dns6d            atk6-fragmentation6      atk6-toobig6
atk6-fake_dnsupdate6       atk6-fuzz_dhcps6         atk6-trace6
atk6-fake_mipv6            atk6-fuzz_ip6
maia@xps:~$
```

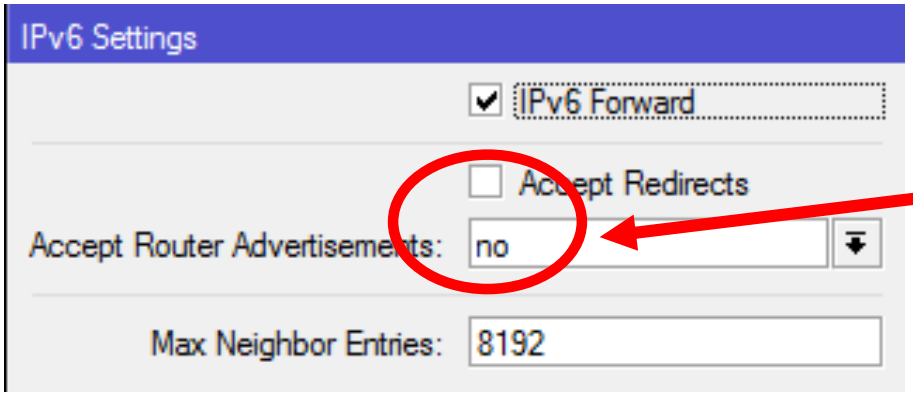
IPv6 Settings

Securing IPv6 Equipment

IPv6 Settings (default)



Disable IPv6 Forward on equipment that do not need to route packets from interfaces based on IPv6



Do not accept redirects avoiding potential man-in-the-middle attack;

Do not accept router advertisements.

Using Link Local Addresses

RFC 7404

RFC 7404 “Using only Link-Local addresses inside an IPv6 Network” is a document intended for informational purposes that discusses de advantages and disadvantages of this technique;

For this approach to work properly, for all routers, a global routable IPv6 address must be configured in a loopback interface;

Using only LLAs on infrastructure links ***reduces the attack surface*** of a router.

https://tools.ietf.org/html/rfc7404

Firewalling

Firewalling
Basic Sanity

Packets to be droped:

- Packets with a multicast source address
- Packets with a multicast destination address over or equal to the router multicast scope
- Packets non-Internet Routable : bogon address, unspecified address, loopback address, documentation address, ULA…

Firewalling
Basic Sanity

Illegal_Addresses

IPv6 Firewall

Filter Rules | Mangle | Raw | Connections | Address Lists

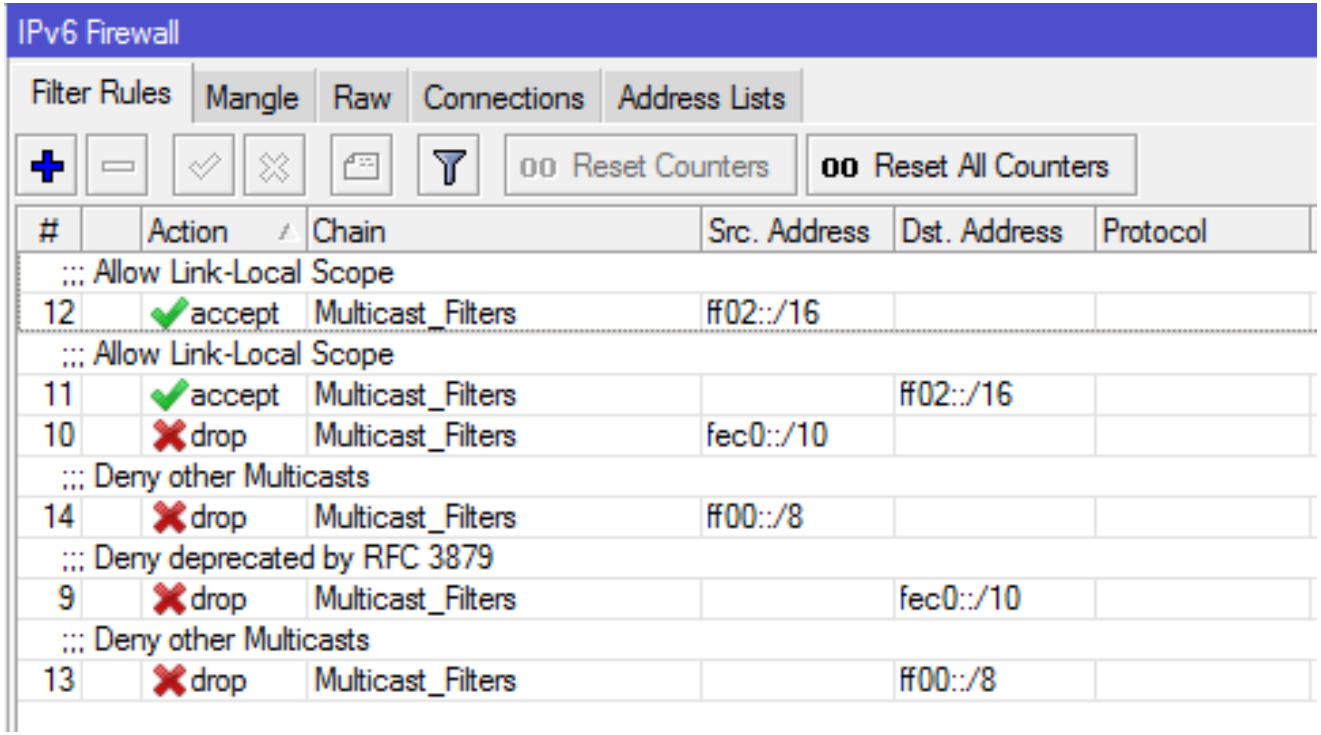
00 Reset Counters | 00 Rese

#	Action	Chain	Src. Address
;;; Loopback Address			
36	drop	Illegal Addresses	::1
;;; IPv4 Compatible addresses			
37	drop	Illegal Addresses	::/96
;;; Other Compatible Addresses			
38	drop	Illegal Addresses	::224.0.0.0/100
39	drop	Illegal Addresses	::127.0.0.0/104
40	drop	Illegal Addresses	::/104
41	drop	Illegal Addresses	::255.0.0.0/104
;;; False 6to4 packets			
42	drop	Illegal Addresses	2002:e000::20
43	drop	Illegal Addresses	2002:7f00::/24
44	drop	Illegal Addresses	2002::/24
45	drop	Illegal Addresses	2002:ff00::/24
46	drop	Illegal Addresses	2002:a00::/24
47	drop	Illegal Addresses	2002:ac10::/28
48	drop	Illegal Addresses	2002:c0a8::/32

;;; Link Local Addresses			
49	drop	Illegal Addresses	fe80::/10
;;; Site Local Addresses (dprecated)			
50	drop	Illegal Addresses	fec0::/10
;;; Unique-local packets			
51	drop	Illegal Addresses	fc00::/7
;;; Multicast Packets (as a source address)			
52	drop	Illegal Addresses	ff00::/8
;;; Documentation Adresses			
53	drop	Illegal Addresses	2001:db8::/32
;;; 6bone Addresses (deprecated)			
54	drop	Illegal Addresses	3ffe::/16

Firewalling
Basic Sanity

Multicast Filtering



#	Action	Chain	Src. Address	Dst. Address	Protocol
;;; Allow Link-Local Scope					
12	accept	Multicast_Filters	ff02::/16		
;;; Allow Link-Local Scope					
11	accept	Multicast_Filters		ff02::/16	
10	drop	Multicast_Filters	fec0::/10		
;;; Deny other Multicasts					
14	drop	Multicast_Filters	ff00::/8		
;;; Deny deprecated by RFC 3879					
9	drop	Multicast_Filters		fec0::/10	
;;; Deny other Multicasts					
13	drop	Multicast_Filters		ff00::/8	

Firewalling
ICMPv6 Filtering

RFC 4890
Recommendations for Filtering ICMPv6 Messages in Firewalls
https://www.ietf.org/rfc/rfc4890.txt

Basically, RFC 4890 allows unexpected inbound :

- echo request
- some ICMPv6 error messages
- some mobile IPv6 messages
- authenticated headers

Firewalling
ICMPv6 Filtering

Custom channel ICMPv6_Control

IPv6 Firewall

Filter Rules | Mangle | Raw | Connections | Address Lists

00 Reset Counters | 00 Reset All Counters

#		Action	Chain	Protocol	ICMP Options/ICMP Type	ICMP Options/ICMP Code	E
;;; Accept Destination Unreacheable (type 1)							
24		accept	ICMPv6_Control	58 (icmpv6)	1 (destination unreachable)		
;;; Accept Packet too big (type 2)							
25		accept	ICMPv6_Control	58 (icmpv6)	2 (packet too big)		
;;; Accept Time exceeded (type 3, code 0)							
26		accept	ICMPv6_Control	58 (icmpv6)	3 (limit exceeded)	0	
;;; Accept Parameter problem (type 4, code 1)							
27		accept	ICMPv6_Control	58 (icmpv6)	4 (bad header)	1	
;;; Accept Parameter problem (type 4)							
28		accept	ICMPv6_Control	58 (icmpv6)	4 (bad header)	2	
;;; Accept Parameter problem (type 4, code 2)							
29		accept	ICMPv6_Control	58 (icmpv6)	4 (bad header)		
;;; Accept limited Echo Requests (type 128) - 5/sec, burst 10							
30		accept	ICMPv6_Control	58 (icmpv6)	128 (echo request)		
;;; Accept limited Echo Replies (type 129) - 5/sec, burst 10							
31		accept	ICMPv6_Control	58 (icmpv6)	129 (echo reply)		

Agenda

Introduction, motivation, relevant facts;

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IPv6 protocol - issues, configurations and some recommended practices;

Customer Security – How to provide a minimum of security keeping neutrality and privacy;

Large scale security management – A real case implementation.

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Security in a World without NAT

NAT was invented to extend IPv4 life and not for Security;

However, NAT gives as a "bonus" a stateful Firewall hiding internal topology from the Internet!

> [T]he Internet of Things is going to drive a large population of connected devices, but most of those devices should never connect outside of their own local network.
>
> **Paul Vixie**
> CEO, Farsight Security

Security in a World without NAT

Thinking as a final Customer

If I don't want my devices external connected:

- In the IPv4+NAT World, I do nothing!;

- In the IPv6 World, I have to take care with SLAAC and configure them with a ULA or place Firewall rules;

If I want my devices connected:

- In the IPv4+NAT World, I have to do the appropriate dst-nat rule;

- In the IPv6 World, I do nothing!

> **[T]he Internet of Things is going to drive a large population of connected devices, but most of those devices should never connect outside of their own local network.**
>
> **Paul Vixie**
> CEO, Farsight Security

What does the customer expect from her/his ISP?

What does the customer expect from her/his ISP?

nominum

BACK TO NEWS & EVENTS

Consumers Want Simple Online Protection

YouGov UK

PRESS RELEASE

Consumers Want Simple Online Protection

Survey shows consumers want simpler online protection from Internet Service Providers. Growth of connected devices in the home leaves consumers feeling more vulnerable.

READ MORE

http://nominum.com/press_item/survey-shows-consumers-want-simpler-online-protection-from-internet-service-providers/

What does the customer expect from her/his ISP?

1,106 consumers polled in the United States.

- **63%** would like it if their current ISP provided one simple solution to increase security across all their connected devices.

- **51%** agreed they would ***switch to another provider*** if they offered a higher level of online protection, without additional monthly charges.

- **22%** have never changed their home gateway password at all !!!

Security in a World without NAT

What is allowed to an ISP?

- Drop lower ports (0 – 1023)?
- Drop connections initiated from external World?
- Do nothing?

What about net neutrality, privacy, etc.?

What does your country's regulation say?

Securing IPv6 CPEs

RFC 4864
Local Network Protection for IPv6
https://tools.ietf.org/html/rfc4864

RFC 6092
Recommended Simple Security Capabilities in Customer Premises Equipment (CPE) for Providing Residential IPv6 Internet Service.
https://tools.ietf.org/html/rfc6092

draft-ietf-v6ops-balanced-ipv6-security
Balanced Security for IPv6 Residential CPE
https://www.ietf.org/archive/id/draft-ietf-v6ops-balanced-ipv6-security-01.txt (expired & archived)

Securing IPv6 CPEs

RFC 6092
Simple security in IPv6 Gateway CPE

RFC 6092 provides best practices recommendations (50 in total)

- Recommends implementation of stateful firewall which only allow incoming traffic **if initiated from inside the network**;

- However, RFC imposes a "transparent" mode of operation, **that users can turn on**. In this mode the CPE forwards all unsolicited flows regardless of forwarding direction;

- ***IPsec traffic is always permitted***, inbound and outbound;

MD Brasil Implementation CPE Security

/ipv6 firewall – Forward channel

IPv6 Firewall

Filter Rules | Mangle | Raw | Connections | Address Lists

00 Reset Counters | 00 Rese

#		Action	Chain	Protocol	IC
;;; Transparent mode					
15	X	accept	forward		
;;; Accept connections originated inside the network					
16		accept	forward		
;;; Accept established connections					
17		accept	forward		
;;; Accept related connections					
18		accept	forward		
;;; Accept IPSec-esp					
19		accept	forward	50 (ipsec-esp)	
;;; Accept IPSec-ah					
20		accept	forward	51 (ipsec-ah)	
;;; Accept TCP connections to port 500					
21		accept	forward	6 (tcp)	
;;; Accept TCP connections from port 500					
22		accept	forward	6 (tcp)	

22		accept	forward	6 (tcp)
;;; Jump to ICMPv6 Control				
23		jump	forward	58 (icmpv6)
;;; Jump to Bogons and Illegal Addresses blocking				
51		jump	forward	
;;; Jump to Illegal Multicast Adresses				
52		jump	forward	
;;; Drop all the rest				
82		drop	forward	

MD Brasil Implementation
CPE Security

(Work in progress)

- Existing users are being communicated about the new security features and could opt to stay as they are (no default security).

- Silence means security policies will be implemented.

- New users will strongly advised to opt for the security policies.

- **Anytime, users can turn off** the features enabling the transparent mode at customers' portal.

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After security measures implemented and tested...

Time to Relax?

Bad things happen all the time...

- Some damaged equipment is replaced “on a rush” to reestablish the service and technicians forget to do all appropriate configuration;

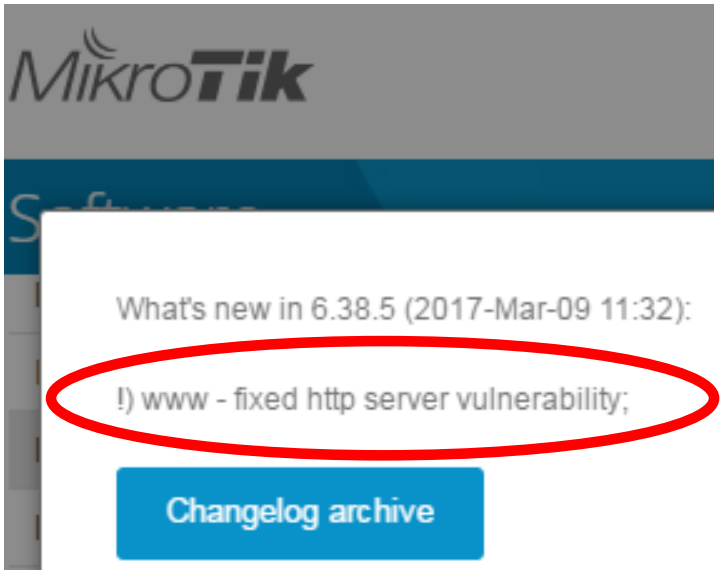
- Someone in the staff change something for testing purposes and forget to roll back;

- A more skilled customer turns transparent mode on but is running some kind of malware;

- The manufacturer releases an important security update.

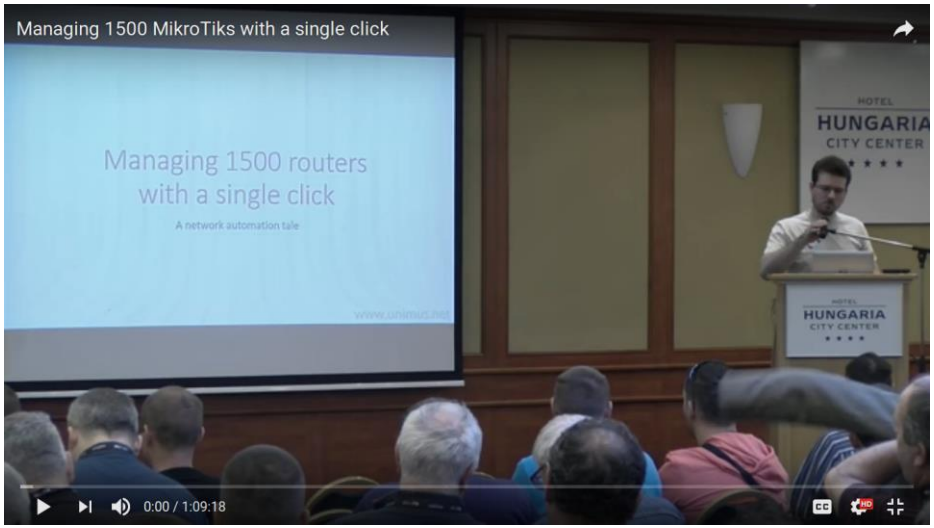
...

Time to Relax?



Thank you Mikrotik Guys for the quick fix!

Large Scale Management



Managing 1500 Mikrotik with a single click

Thanks to Tomas Kimak for the great presentation at 2016 Hungary MUM:

https://mum.mikrotik.com/2016/HU/agenda/EN#

Tools for monitoring/controlling

+

RANCID

ZABBIX

Telegram

Tools for monitoring/controlling

iTop is a free software for managing hardware, software and associated services enabling to centralize data about devices, software, users, locations, etc. It allows to streamline the Helpdesk, manage quality of services and govern the IT environment (ITSM).

Together with the other tools it will be used security related incidents management in a formal way.

Open source tool with no license nor limitations

https://www.combodo.com/itop-193

Tools for monitoring/controlling

Zabbix is a software designed for real-time monitoring that can be used for several monitoring applications

Security regular checks like open ports or services, firmware versions and even physical access can be easily performed by Zabbix and timely notifications sent to exclude breaches or minimize losses from illegal actions.

Zabbix is Open Source and comes at no cost.

http://www.zabbix.com/

Tools for monitoring/controlling/ messaging

RANCID (Really Awesome New Cisco Config Differ) is a free tool that monitors a router's (or more generally a device's) configuration, including software and hardware (cards, serial numbers, etc) and uses CVS (Concurrent Version System), Subversion or Git to maintain history of changes.

http://www.shrubbery.net/rancid/

Tools for monitoring/controlling/ messaging

Telegram is a cloud-based mobile (IOS and Android) and desktop messaging app (Windows, MacOS and Linux).

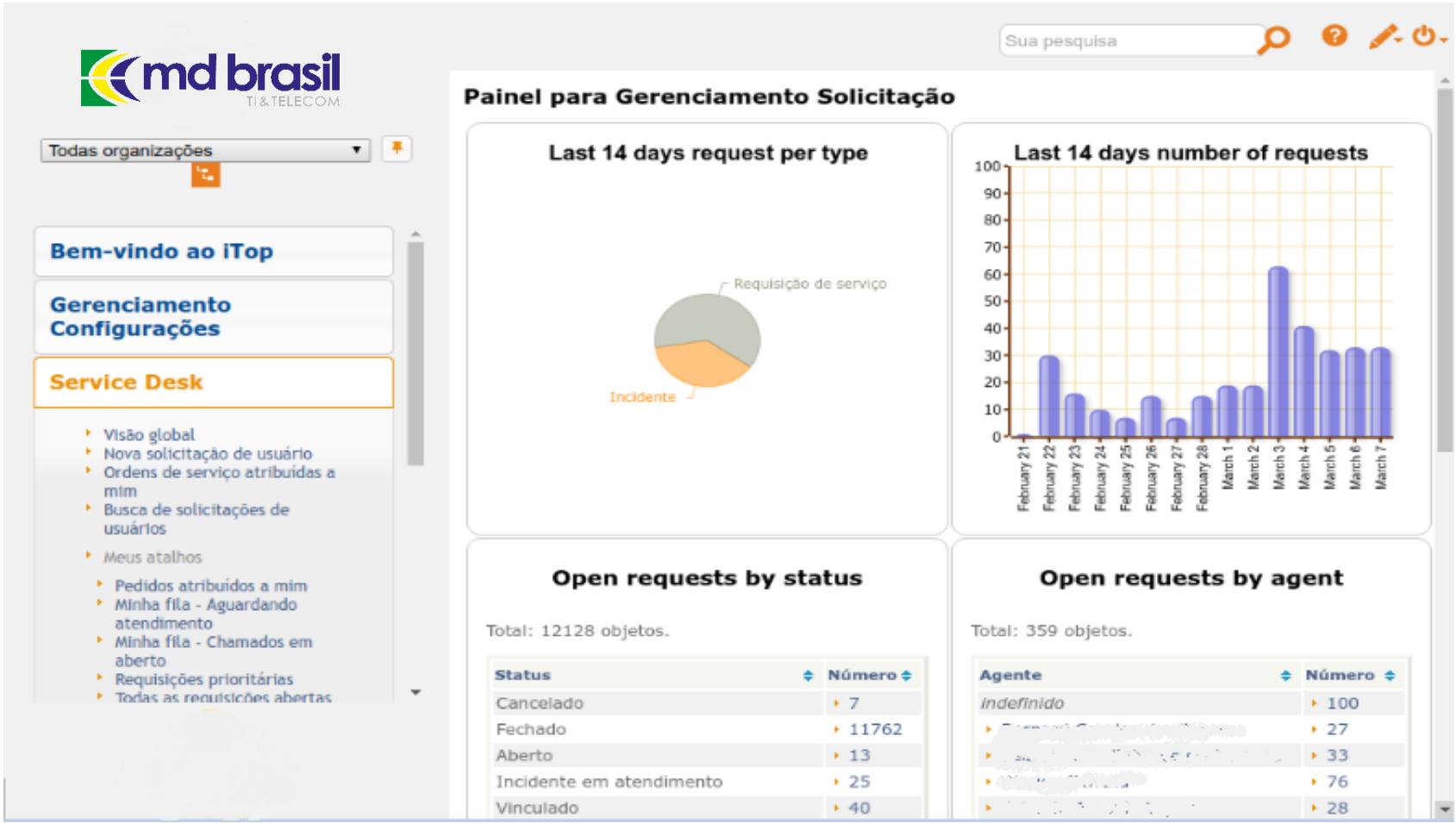
Telegram has an open API and a Bot API, allowing to interact with other systems. https://telegram.org/

Integration with Telegram uses BatBot API
batbot.sh is a bash script that can reply messages and execute commands:

https://github.com/theMiddleBlue/BaTbot

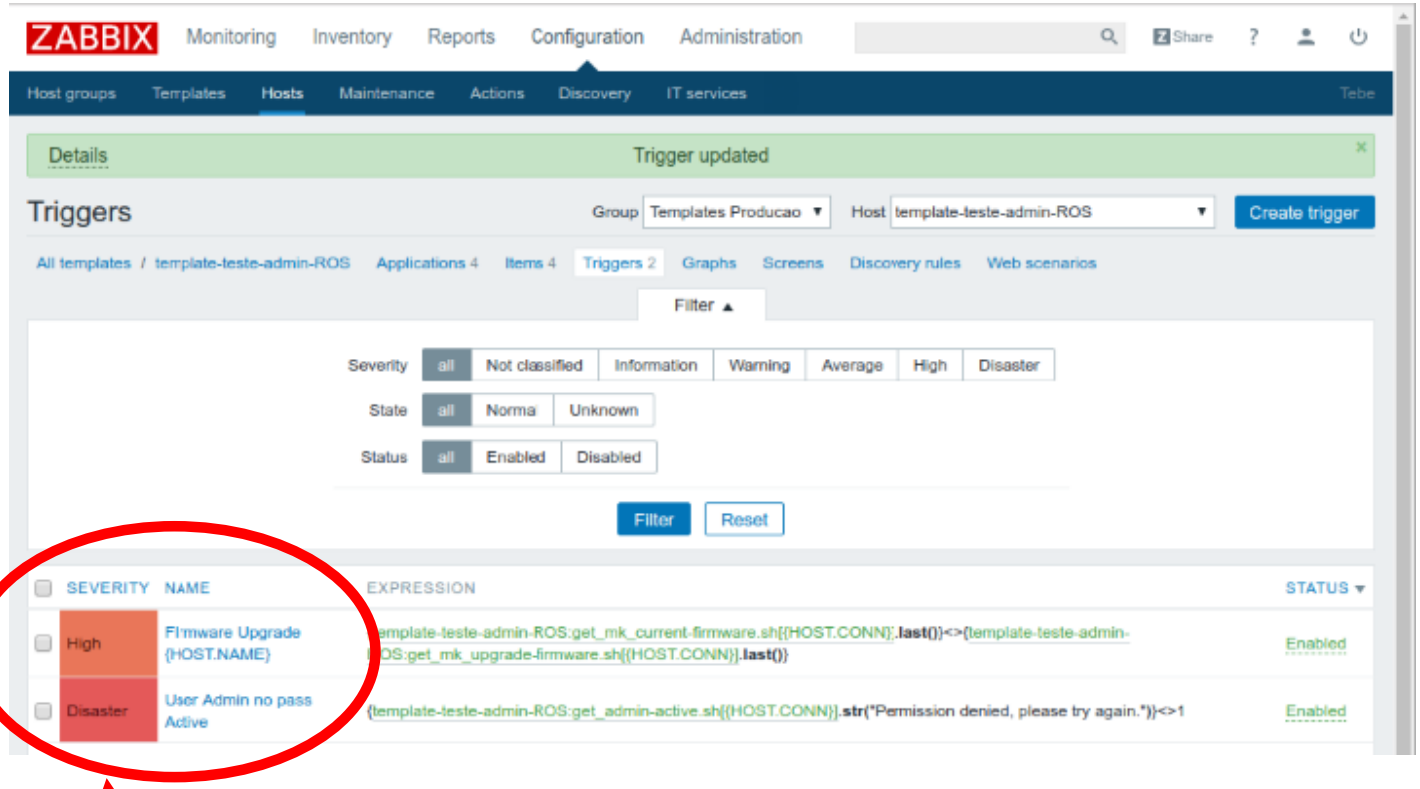
Framework in action

Itop Dashboard



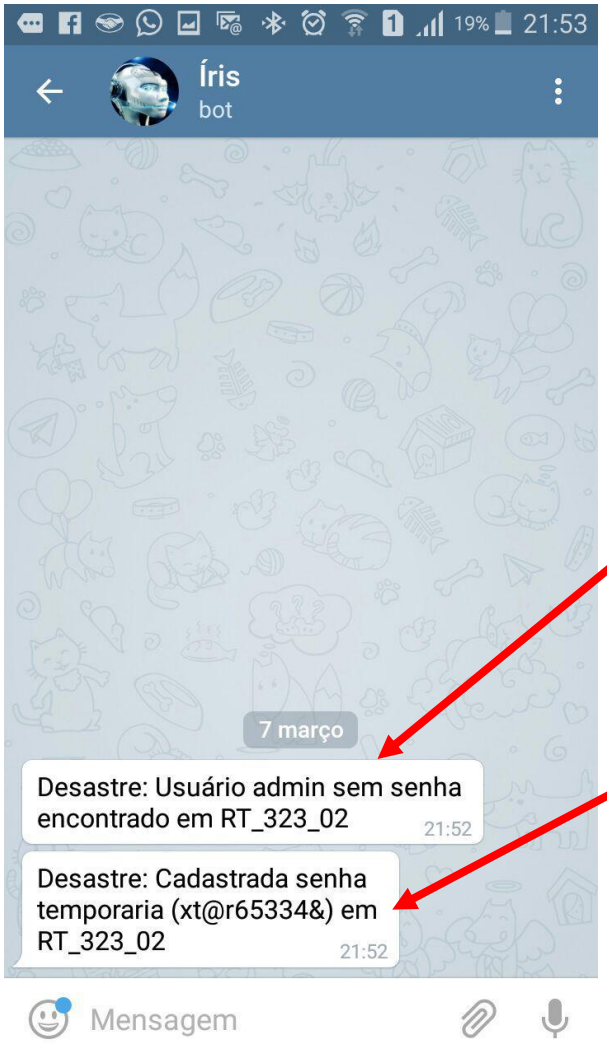
Framework in action

Zabbix configuration



For instance, we selected 2 events – Firmware upgrade (Severity High) and Router with user=admin, no password (Severity Disaster)

Framework in action

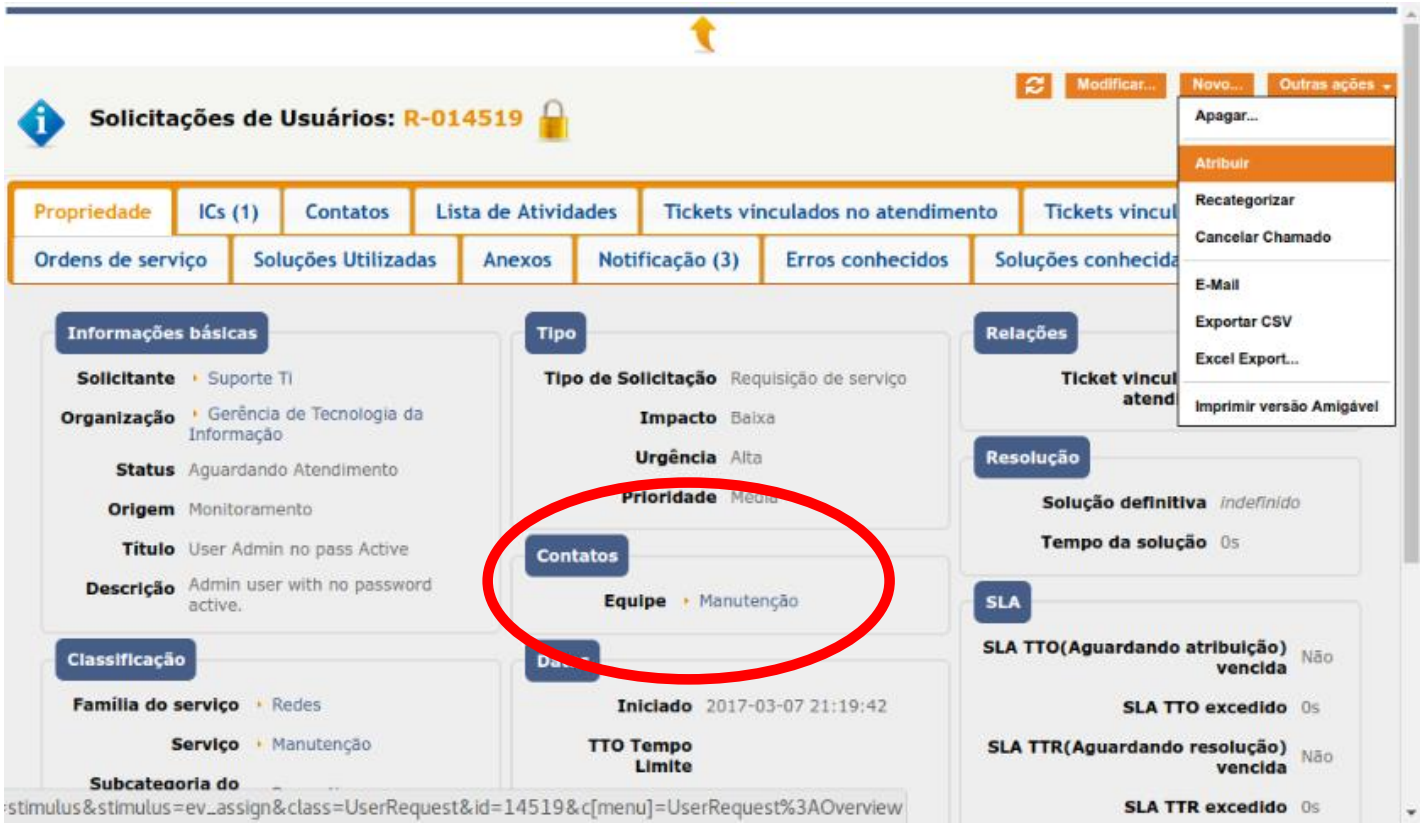


Telegram

A notification is made via Telegram to the group of responsible technicians.

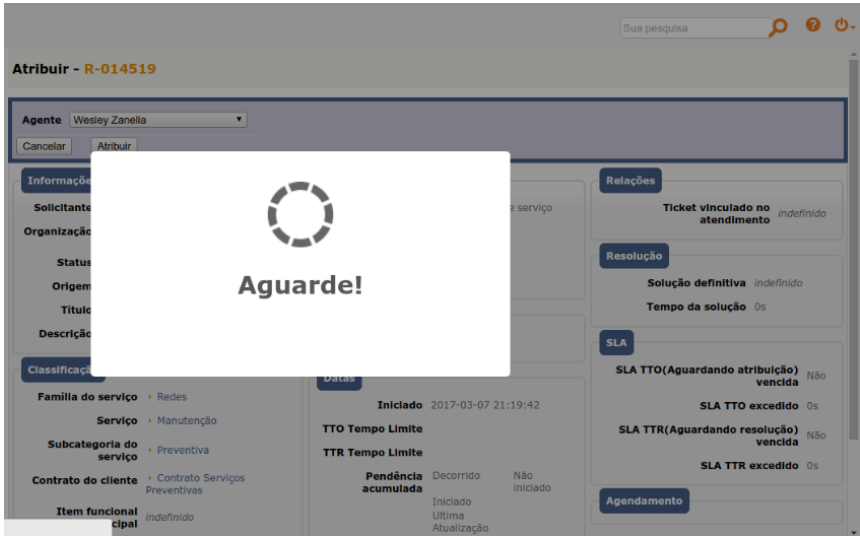
And Zabbix automatically configure a temporary random password!

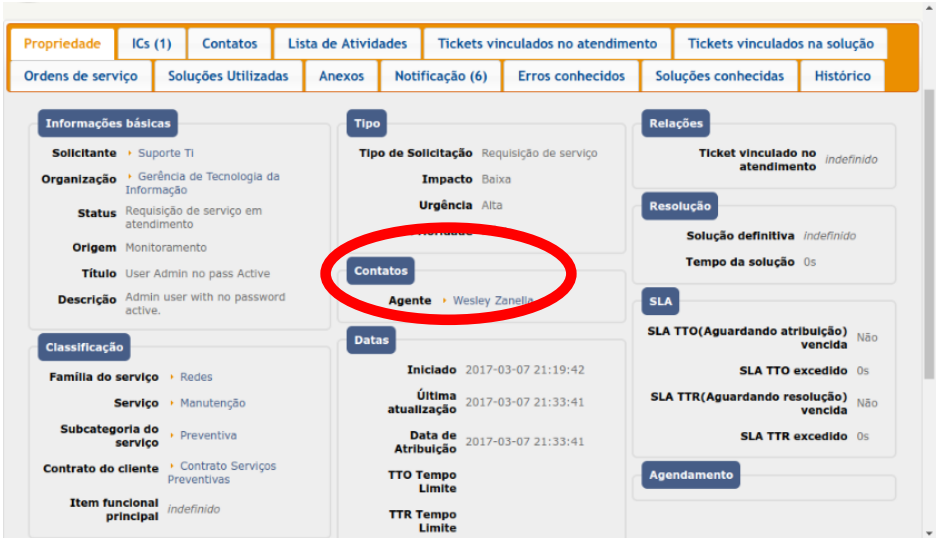
Framework in action



iTOP registers the event notifying back office. One service ticket is generated.

Framework in action





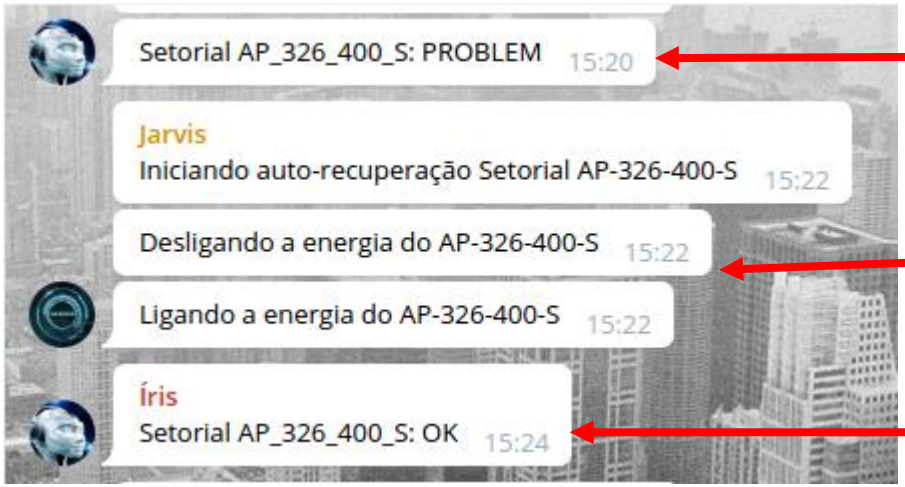
Back office forward to the appropriate technician who receives e-mail and telegram notification to fix the problem

Framework in action

The responsible technician fix the problem and inform iTOP closing the ticket

Framework in action

Many actions can be done automatically, like rebooting an irresponsive equipment.

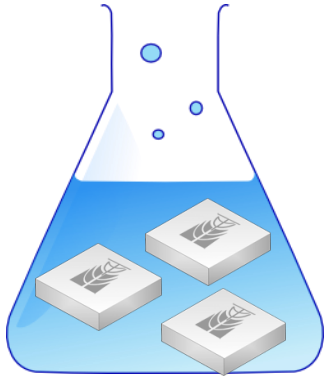


An access point is presenting problems;

Automatic reboot via RB 750UP;

Access point is now alive.

md brasil
TI&TELECOM



Online Demo

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60’

References

Securing Networks with Mikrotik RouterOS – Tom Smyth
https://mum.mikrotik.com//presentations/HR13/legend.pdf

IPV6 Security by Scott Hogg, Eric Vyncke
http://www.ciscopress.com/store/ipv6-security-9781587055942

RFC 4890
Recommendations for Filtering ICMPv6 Messages in Firewalls
https://www.ietf.org/rfc/rfc4890.txt

RFC 4864 - Local Network Protection for IPv6
https://tools.ietf.org/html/rfc4864

RFC 6092 - Recommended Simple Security Capabilities in CPE for Providing Residential IPv6 Internet Service.
https://tools.ietf.org/html/rfc6092

Extra Slides

Firewall Rules

Input Channel (1/2)

/ipv6 firewall
add action=accept chain=input comment="Accept Established and Related Connections" connection-state=established,related

add action=accept chain=input comment="Accept Connections from IPv6 administrative addresses" src-address-list="Administrative IPv6 Adressess"

add action=accept chain=input comment="Accept DHCPv6 (UDP ports 547->546)" dst-port=546 protocol=udp src-port=547

Firewall Rules

Input Channel (2/2)

/ipv6 firewall

add action=accept chain=input comment="Accept DHCPv6 (TCP ports 547->546)" dst-port=546 protocol=tcp src-port=547

add action=jump chain=input comment="Jump to ICMPv6 Control" connection-state="" jump-target=ICMPv6_Control

add action=drop chain=input comment="Drop all the rest"

Firewall Rules

Output Channel (1/2)

/ipv6 firewall

add action=accept chain=output comment="Accept Established and Related Connections" connection-state=established,related

add action=accept chain=output comment="Accept Connections from IPv6 administrative addresses" src-address-list="Administrative IPv6 Adressess“

add action=accept chain=output comment="Accept DHCPv6 (UDP ports 546->547)" dst-port=547 protocol=udp src-port=546

Firewall Rules

Output Channel (1/2)

/ipv6 firewall

add action=accept chain=output comment="Accept DHCPv6 (TCP ports 546->547)" dst-port=547 protocol=tcp src-port=546

add action=jump chain=output comment="Jump to ICMPv6 Control" connection-state="" jump-target=ICMPv6_Control

add action=drop chain=output comment="Drop all the rest"

Firewall Rules

Forward Channel (1/3)

/ipv6 firewall filter

add action=accept chain=forward comment="Transparent mode" disabled=yes

add action=accept chain=forward comment="Accept connections originated inside the network" connection-state=new out-interface=pppoe-out1

add action=accept chain=forward comment="Accept established connections" connection-state=established,related

Firewall Rules

Forward Channel (2/3)

/ipv6 firewall filter

add action=accept chain=forward comment="Accept IPSec-esp" connection-state=related protocol=ipsec-esp

add action=accept chain=forward comment="Accept IPSec-ah" connection-state=related protocol=ipsec-ah

add action=accept chain=forward comment="Accept TCP connections to port 500" dst-port=500 protocol=tcp

add action=accept chain=forward comment="Accept TCP connections from port 500" protocol=tcp src-port=500

Firewall Rules

Forward Channel (3/3)

/ipv6 firewall filter

add action=jump chain=forward comment="Jump to Bogons and Illegal Addresses blocking" jump-target="Illegal Addresses"

add action=jump chain=forward comment="Jump to Illegal Multicast Adresses" jump-target="Illegal Addresses"

add action=jump chain=forward comment="Jump to ICMPv6 Control" jump-target=ICMPv6_Control protocol=icmpv6

add action=drop chain=forward comment="Drop all the rest"

Firewall Rules

ICMPv6 Control (1/5)

/ipv6 firewall filter

add action=accept chain=ICMPv6_Control comment="Accept Destination Unreacheable (type 1)" icmp-options=1:0-255 protocol=icmpv6

add action=accept chain=ICMPv6_Control comment="Accept Packet too big (type 2)" icmp-options=2:0-255 protocol=icmpv6

add action=accept chain=ICMPv6_Control comment="Accept Time exceeded (type 3, code 0)" icmp-options=3:0 protocol=icmpv6

Firewall Rules

ICMPv6 Control (2/5)

/ipv6 firewall filter

add action=accept chain=ICMPv6_Control comment=Accept Parameter problem (type 4, code 1)" icmp-options=4:1 protocol= icmpv6

add action=accept chain=ICMPv6_Control comment="Accept Parameter problem (type 4)" icmp-options=4:2 protocol=icmpv6

add action=accept chain=ICMPv6_Control comment="Accept Parameter problem (type 4, code 2)" icmp-options=4:0-255 protocol=icmpv6

Firewall Rules

ICMPv6 Control (3/5)

/ipv6 firewall filter

add action=accept chain=ICMPv6_Control comment="Accept limited Echo Requests (type 128) - 5/sec, burst 10" icmp-options=128:0-255 protocol=icmpv6

add action=accept chain=ICMPv6_Control comment="Accept limited Echo Replies (type 129) - 5/sec, burst 10" icmp-options=129:0-255 limit=5,10:packet protocol=icmpv6

add action=accept chain=ICMPv6_Control comment="Accept 143, code 0, hop limit 255" hop-limit=equal:255 icmp-options=143:0 protocol=icmpv6

Firewall Rules

ICMPv6 Control (4/5)

/ipv6 firewall filter

add action=accept chain=ICMPv6_Control comment="Accept 133, code 0, hop limit 255" hop-limit=equal:255 icmp-options=133:0 protocol=icmpv6

add action=accept chain=ICMPv6_Control comment="Accept 134, code 0, hop limit 255" hop-limit=equal:255 icmp-options=134:0 protocol=icmpv6

add action=accept chain=ICMPv6_Control comment="Accept 135, code 0, hop limit 255" hop-limit=equal:255 icmp-options=135:0 protocol=icmpv6

Firewall Rules

ICMPv6 Control (5/5)

/ipv6 firewall filter

add action=accept chain=ICMPv6_Control comment="Accept 136, code 0, hop limit 255" hop-limit=equal:255 icmp-options=136:0 protocol=icmpv6

add action=drop chain=ICMPv6_Control protocol=icmpv6

Firewall Rules

Illegal Addresses (1/6)

/ipv6 firewall filter

add action=drop chain="Illegal Addresses" comment="Loopback Address" src-address=::1/128

add action=drop chain="Illegal Addresses" comment="IPv4 Compatible addresses" src-address=::/96

add action=drop chain="Illegal Addresses" comment="Other Compatible Addresses" src-address=::224.0.0.0/100

add action=drop chain="Illegal Addresses" src-address=::127.0.0.0/104

Firewall Rules

Illegal Addresses (2/6)

/ipv6 firewall filter

add action=drop chain="Illegal Addresses" src-address=::/104

add action=drop chain="Illegal Addresses" src-address=::255.0.0.0/104

add action=drop chain="Illegal Addresses" comment="False 6to4 packets" src-address=2002:e000::20/128

add action=drop chain="Illegal Addresses" src-address=2002:7f00::/24

Firewall Rules

Illegal Addresses (3/6)

/ipv6 firewall filter

add action=drop chain="Illegal Addresses" src-address=2002::/24

add action=drop chain="Illegal Addresses" src-address=2002:ff00::/24

add action=drop chain="Illegal Addresses" src-address=2002:a00::/24

add action=drop chain="Illegal Addresses" src-address=2002:ac10::/28

Firewall Rules

Illegal Addresses (4/6)

/ipv6 firewall filter

add action=drop chain="Illegal Addresses" src-address=2002:c0a8::/32

add action=drop chain="Illegal Addresses" comment="Link Local Addresses" src-address=fe80::/10

add action=drop chain="Illegal Addresses" comment="Site Local Addresses (deprecated)" src-address=fec0::/10

add action=drop chain="Illegal Addresses" comment="Unique-local packets" src-address=fc00::/7

Firewall Rules

Illegal Addresses (5/6)

/ipv6 firewall filter

add action=drop chain="Illegal Addresses" comment="Multicast Packets (as a source address)" src-address=ff00::/8

add action=drop chain="Illegal Addresses“ comment="Documentation Adresses" src-address=2001:db8::/32

add action=drop chain="Illegal Addresses" comment="6bone Addresses (deprecated)" src-address=3ffe::/16

add action=drop chain=Multicast_Filters comment="Deny deprecated by RFC 3879" dst-address=fec0::/10

Firewall Rules

Illegal Addresses (6/6)

/ipv6 firewall filter

add action=drop chain=Multicast_Filters src-address=fec0::/10

add action=accept chain=Multicast_Filters comment="Allow Link-Local Scope" dst-address=ff02::/16

add action=accept chain=Multicast_Filters comment="Allow Link-Local Scope" src-address=ff02::/16

add action=drop chain=Multicast_Filters comment="Deny other Multicasts" dst-address=ff00::/8

add action=drop chain=Multicast_Filters comment="Deny other Multicasts" src-address=ff00::/8

10 years of Official Training

Questions, comments, suggestion and critics

maia@mdbrasil.com.br

Grazie!