Testing IPv6 Firewalls with ft6

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IPv6 Security Summit @ TROOPERS14

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Outline

The beginnings

- "IPv6 Intrusion Detection System" Project (2011 - 2013)
- at University of Potsdam
- funded by "Bundesministerium für Bildung und Forschung"

The beginnings – motivation & goal

IPv6 adoption continues to rise. However, lack of IPv6-enabled tools for:

- analyzing threat level
- checking firewall/IDS configuration
- checking firewall/IDS capabilities
- checking IPv6 “readiness”

The beginnings: contributions

IPv6 Darknet

- not advertised
- check who's scanning
- /48 network
- less than 1200 packets in 9 months

The beginnings: contributions

IPv6 Honeypot

- check what attackers are doing
- `honeydv6`
- emulates a whole virtual network and services

The beginnings: contributions

IPv6 IDS

- Snort-Plugin: check Martin Schütte's talk tomorrow!

The beginnings: contributions

Performance Benchmarks

- how well does IPv6-enabled hardware perform?
- what impact do “additional” features of IPv6 have?

The beginnings: information

- project is over now
- check results and publications at:

`www.idsv6.de`

Outline

Design of ft6 – motivation

Why should I?

- you are responsible for the network
- you have to / want to migrate to IPv6
- can you switch now?
- not really a good methodology for
  - telling if your device supports IPv6
  - comparing firewalls
  - finding problems in your configuration

Design of ft6 – motivation

checking for “Supports IPv6”-stickers is not an option!

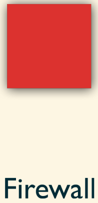
Design of ft6 – motivation

- you **must** check for yourself
- why is this hard?
- lot of `SHOULDs`, `MUSTs` and `REQUIREDs` for IPv6
- across lot of different `RFCs`
- vague
- best practices
- still evolving, hard to keep track

Design of ft6 – motivation

- ft6 should help
- goal: easy to configure and visualize results
- easily reproducable, comparable
- usually tedious, error prone work
- provide starting point for firewall evaluation
- also consider testing for performance, attacks on local network
- can act as a framework for new tests

Design of ft6 – Architecture

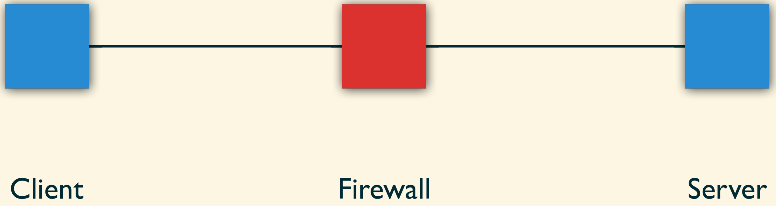


- ft6 is a client-server application

Design of ft6 – Architecture

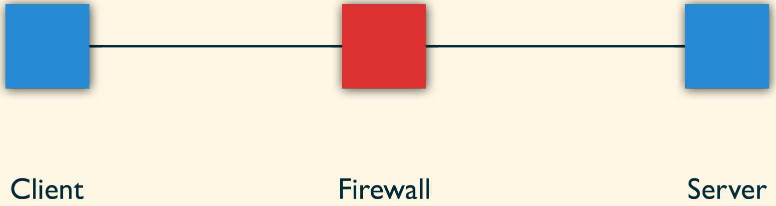
- ft6 is a client-server application
- requires machines on both sides of your firewall

Design of ft6 – Architecture



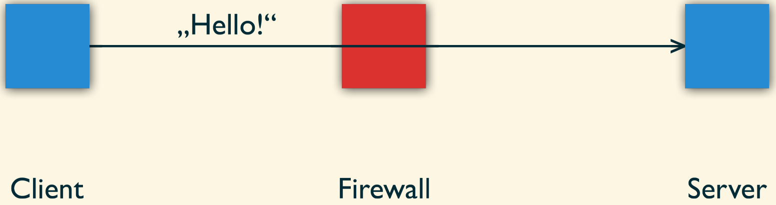
- ft6 is a client-server application
- requires machines on both sides of your firewall
- place machines not more than one hop away from firewall

Design of ft6 – Architecture



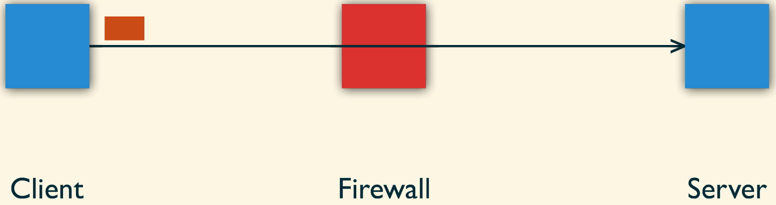
- ft6 is a client-server application
- requires machines on both sides of your firewall
- place machines not more than one hop away from firewall
- one open port

Design of ft6 – Running ft6



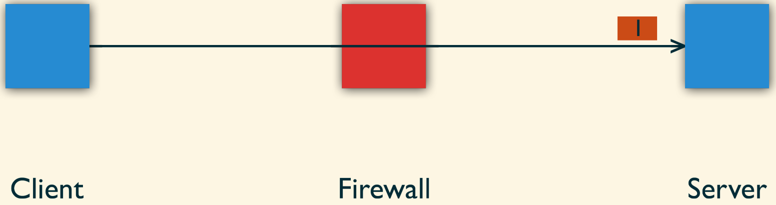
- Client and Server perform a handshake
- Server begins to sniffs

Design of ft6 – Running ft6



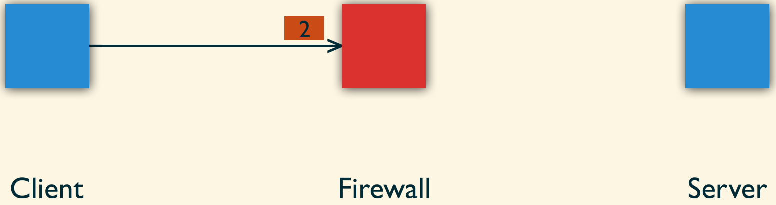
- Client and Server perform a handshake
- Server begins to sniffs
- Client starts sending packets

Design of ft6 – Running ft6



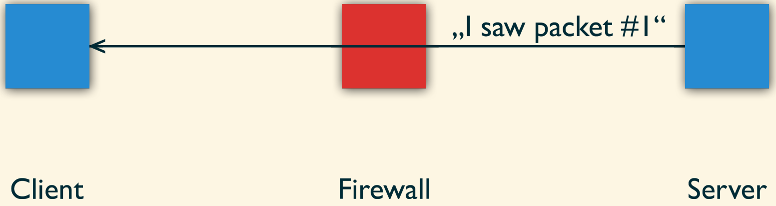
- Client and Server perform a handshake
- Server begins to sniffs
- Client starts sending packets
- Some packts pass the firewall

Design of ft6 – Running ft6



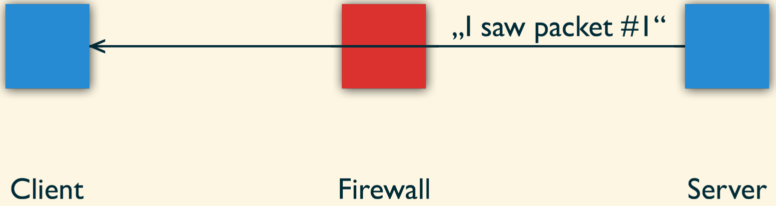
- Client and Server perform a handshake
- Server begins to sniffs
- Client starts sending packets
- Some packts pass the firewall
- Others are dropped

Design of ft6 – Running ft6



- Server sends back list of packets it recieved

Design of ft6 – Running ft6



- Server sends back list of packets it recieved
- Client figures out what went missing and displays result

Design of ft6 – Design of ft6

- open-source (Creative Commons BY-NC-SA 3.0)
- uses scapy 2.2.0, python 2.7, PyQt 4
- developed on (2.6.32), tested with more recent (3.7.1)
- *should* work on Windows 7, Mac OS X

Outline

1. The beginnings
2. Design of ft6
3. Tests done by ft6
4. Live Demo
5. Testing ip6tables
6. Pitfalls
7. (optionally: writing your own tests)

Tests done by ft6

- written by EANTC
- http://www.idsv6.de/Downloads/EANTC-IPv6-IDS-FW-Abstract-Test-Suite_v1.0-public.pdf
- ft6 does 9 of those

Tests done by ft6 – Test 1: ICMPv6 filtering

- Check if the firewall correctly forwards and discards ICMPv6 Packets.
- informational, diagnostic messages
- Identified by `type` and `code` field.

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type      |     Code      |          Checksum             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+                         Message Body                          +
|                                                               |
```

- RFC 4890 “Recommendations for Filtering ICMPv6 Messages in Firewalls”

Tests done by ft6 – Test 1: ICMPv6 filtering

- belong to one of 3 groups: *mandatory*, *optional* and *nonfiltered*
  1. *mandatory*: Always **reject** them.
     local Messages (*Neighbor Solicitation*, *Neighbor Advertisement*).
     `100, 101, 127, 130 - 143, 148, 149, 151 - 153, 200, 201, 255`.
  2. *optional*: **Reject** unless needed.
     unassigned types and codes
     `3 (Code 1), 4 (Code 0), 4-99, 102 - 126, 144 - 147, 150, 154 - 199, 202 - 254`.
  3. *nonfiltered*: Always **forward** them.
     neccessary for correct operation (*echo request*, *echo reply*, *packet too big*).
     `1, 2, 3 (Code 0), 4 (Code 1), 4 (Code 2), 128, 129`.

Tests done by ft6 – Test 2: Routing Header

- Check if the firewall correctly forwards and discards packets containing a Routing Header.
- Used to specify a list of nodes a packet has to visit
- RFC 5095 “Deprecation of Type 0 Routing Headers in IPv6”
- loops $\rightarrow$ denial of service
- applies to Routing Header type 0 only

Tests done by ft6 – Test 2: Routing Header

- Depends upon `type` and `segments-left` field.

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Next Header  |  Hdr Ext Len  |  Routing Type | Segments Left |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
.                       type-specific data                      .
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Tests done by ft6 – Test 2: Routing Header

RH-type	segs. left	action
0	$\neq 0$	drop
2	$\neq 1$	drop
others	$\neq 0$	drop

Tests done by ft6 – Test 3: Chained Extension Headers

- Check if the firewall correctly forwards and discards packets containing a number of different Extension Headers.
- DSTOPT header at most twice (before a RH, before Layer 4)
- HBH Options only after base IPv6 header
- others: at most once (should)
- avoid ambiguity, prevent denial of service
- RFC 2460 “Internet Protocol, Version 6 (IPv6) Specification”

Tests done by ft6 – Test 3: Chained Extension Headers

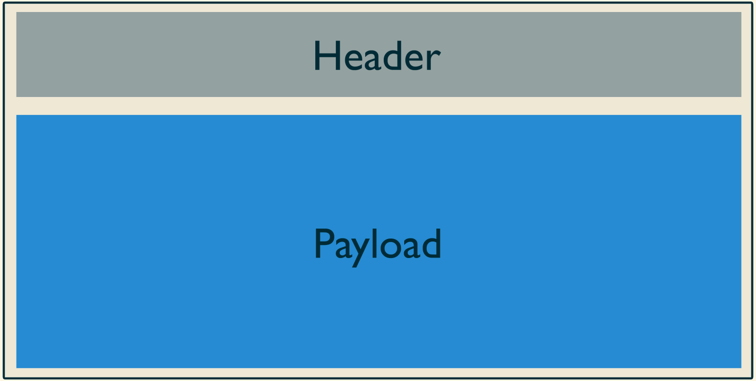
1. A single DSTOPT. Should be forwarded.
2. Two DSTOPTs in a row. Should be dropped.
3. DSTOPT, Routing Header, DSTOPT. Forward.
4. A single HBH. Forward.
5. Two HBHs in a row. Drop.
6. A DSTOPT, followed by one HBH. Drop.
7. HBH, DSTOPT, Routing Header, HBH. Drop.

Tests done by ft6 – Test 4: Overlapping Fragments

- Check if the firewall correctly detects overlapping fragments
- Forward only if no overlap
- RFC 5722 “Handling of Overlapping IPv6 Fragments”
- IPv6 fragments at source & reassembles at destination
- fragments controlled by `fragment-offset`

Tests done by ft6 – fragmentation

- source want's to send a packet that is too big



Tests done by ft6 – fragmentation

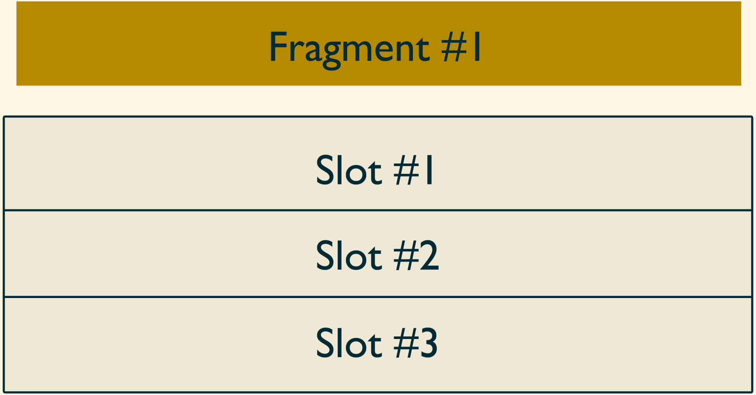
- payload is split into chunks
- each sent as separate *fragment*

Tests done by ft6 – reassembly

- destination receives fragment one, allocates buffer

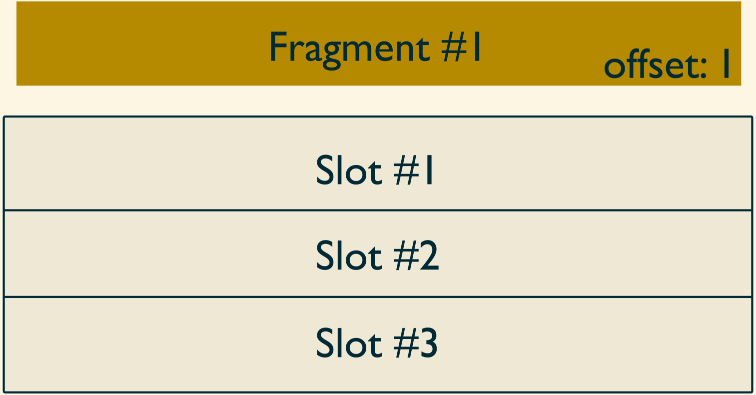
Tests done by ft6 – reassembly

- *virtually* splits buffer into slots



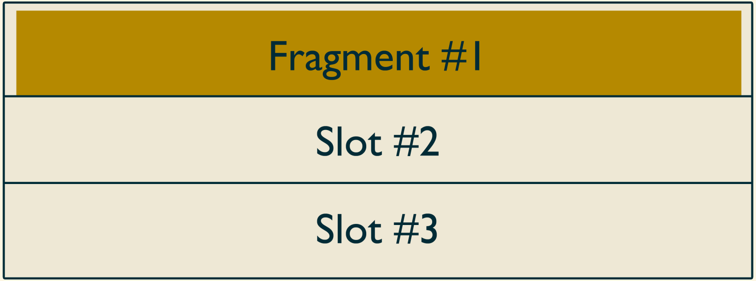
Tests done by ft6 – reassembly

- "target-slot" is determined by `fragment-offset`



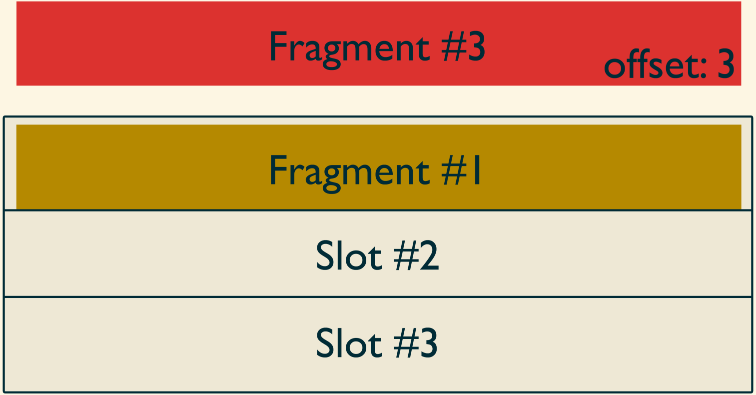
Tests done by ft6 – reassembly

- data is copied accordingly



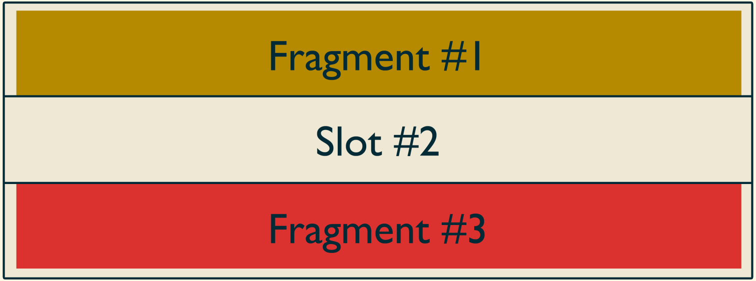
Tests done by ft6 – reassembly

- same procedure for second fragment



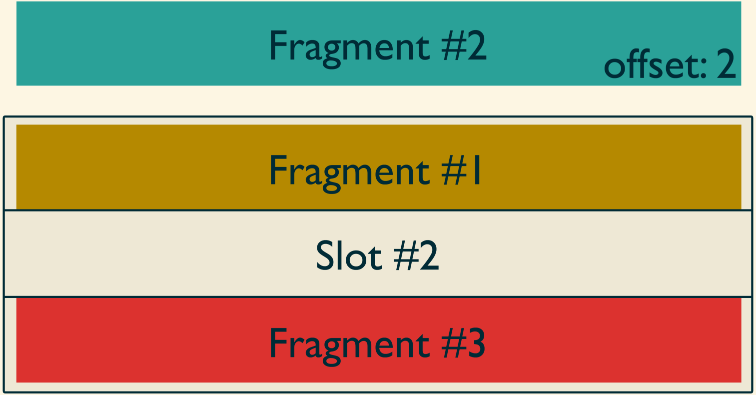
Tests done by ft6 – reassembly

- same procedure for second fragment



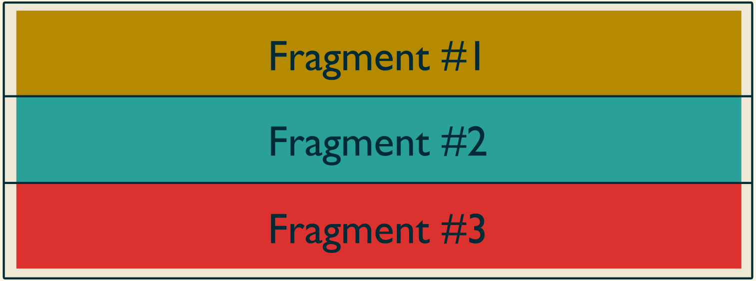
Tests done by ft6 – reassembly

- same procedure for third fragment



Tests done by ft6 – reassembly

- same procedure for third fragment



Tests done by ft6 – reassembly

- all fragments have arrived

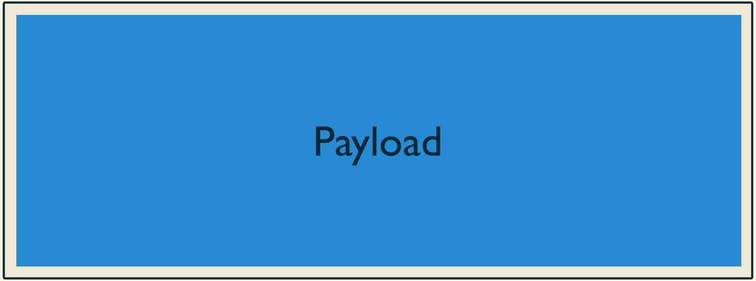
Fragment #1

Fragment #2

Fragment #3

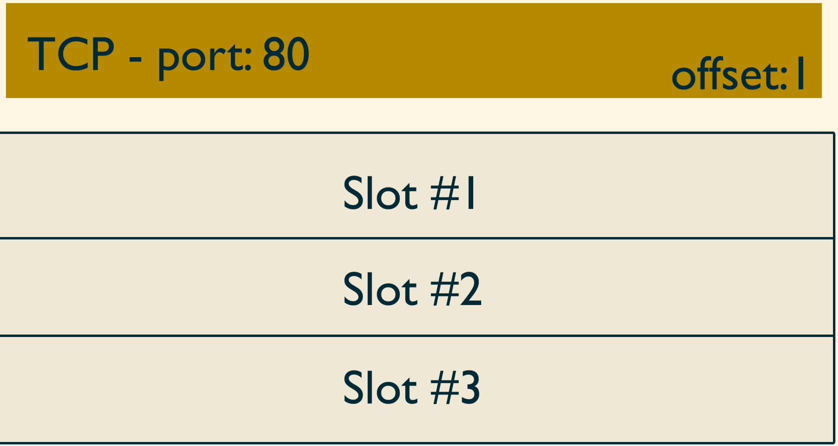
Tests done by ft6 – reassembly

- reassembly complete



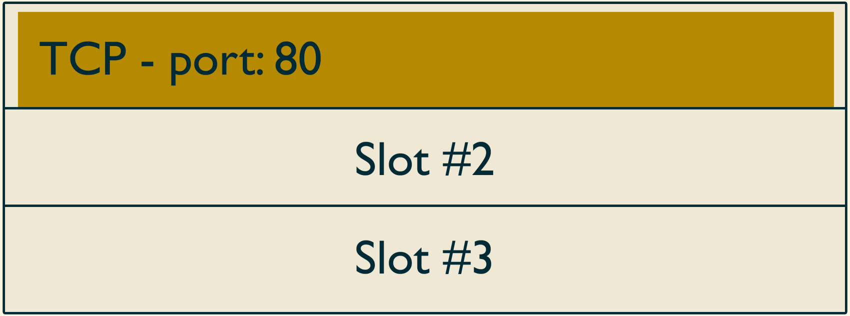
Tests done by ft6 – attack

- first fragment arrives. It carries a TCP-Header



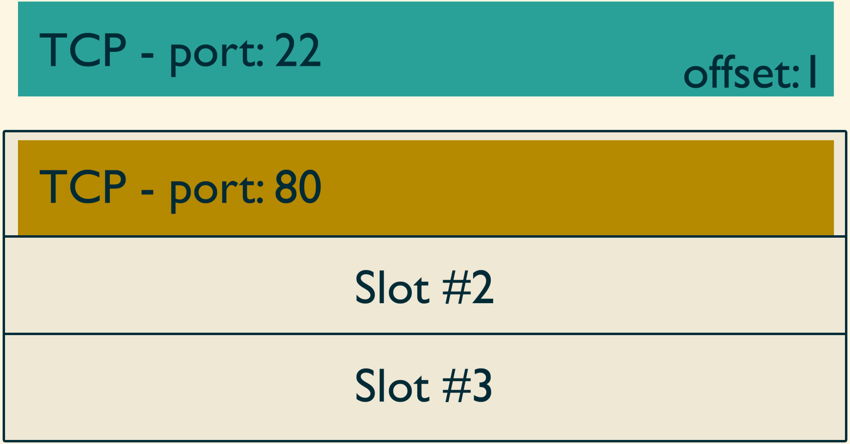
Tests done by ft6 – attack

- data is copied into buffer



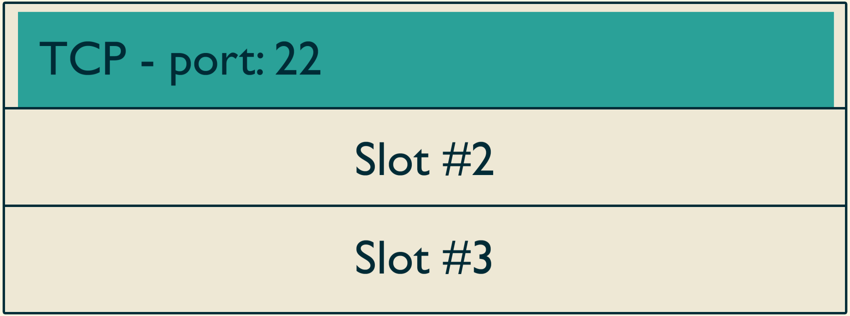
Tests done by ft6 – attack

- second fragment has “wrong” offset



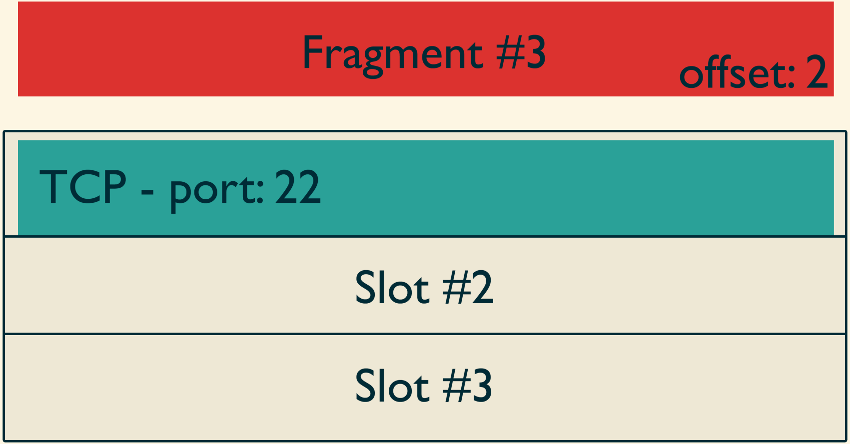
Tests done by ft6 – attack

- still, data get's copied



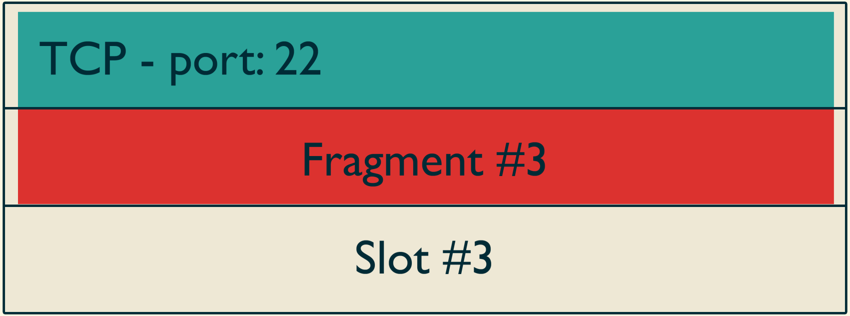
Tests done by ft6 – attack

- last fragment arrives



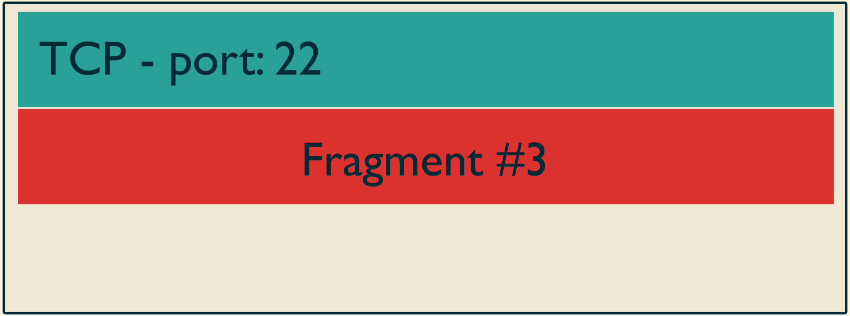
Tests done by ft6 – attack

- data get's copied



Tests done by ft6 – attack

- reassembly complete, firewall bypassed



Tests done by ft6 – Test 4: Overlapping Fragments

1. Fragments w/o overlap. Should be forwarded.
2. Overlapping fragments that overwrite the TCP-port. Drop
3. Overlapping fragments that overwrite the payload. Drop

Tests done by ft6 – Tests 5 & 6: Tiny IPv6 Fragments

- Check if the firewall inspects the second fragment if no Layer 4 is present in the first fragment
- Firewall should wait for next fragment before deciding
- `http://tools.ietf.org/id/draft-gont-6man-oversized-header-chain-02.txt`
- Check if the firewall respects the timeout as specified in the rfc
- prevent resource starvation
- allow for "some" lag
- drop after 60 seconds
- RFC 2460 "Internet Protocol, Version 6 (IPv6) Specification"

Tests done by ft6 – Tests 5 & 6: Tiny IPv6 Fragments

1. Tiny-Fragment with allowed port in second fragment. Forward.
2. Tiny-Fragment with denied port in second fragment. Drop.
3. Send first fragment, wait 59 seconds, send last fragment. Forward.
4. Send first fragment, wait 61 seconds, send last fragment. Drop.

Tests done by ft6 – Test 7: Excessive HBH/DSTOPT Options

- Check if the firewall blocks packets with multiple options
- IPv6 supports different option types per header

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+- - - - - - - - -
|  Option Type  |  Opt Data Len |  Option Data
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+- - - - - - - - -
```

- can be daisy-chained
- Most option types should occur at most once
- Only Pad1 and PadN are allowed multiple times
- prevent ambiguity, prevent denial of service
- RFC 4942 "IPv6 Transition/Coexistence Security Considerations"

Tests done by ft6 – Test 7: Excessive HBH/DSTOPT Options

Each variant has duplicate options. Each should be dropped.

1. Jumbo Payload, PadN, Jumbo Payload.
2. Router Alert, Pad1, Router Alert
3. Quick Start, Tunnel Encapsulation Limit, PadN, Quick Start
4. RPL Option, PadN, RPL Option

Tests done by ft6 – Test 8: PadN Covert Channel

- Check if the firewall can block packets with non-zero padding
- Used to align options
- (usually) don't carry a payload
- RFC 4942 "IPv6 Transition/Coexistence Security Considerations"

Tests done by ft6 – Test 8: PadN Covert Channel

1. Padding with payload all zeroes in a `HBH`. Forward.
2. Padding with other payload in a `HBH`. Drop.
3. Padding with payload all zeroes in a `DSTOPT`. Forward.
4. Padding with other payload in a `DSTOPT`. Drop.

Tests done by ft6 – Test 9: Address Scopes

- Verify that the firewall does not route traffic from an inappropriate scope.
  1. `ff00::/16` (multicast)
  2. `fe80::/10` (link local)
- RFC 4942 “IPv6 Transition/Coexistence Security Considerations”
- 256 packets with source addresses from group 1. Drop.
- 16 packets with source addresses from group 2. Drop.

Outline

Live Demo

Live Demo

Outline

Testing ip6tables – setup

- Linux grml 3.7.1-grml-amd64 Debian 3.7.9+grml.1 x86_64
- ip6tables 1.4.18
- ft6 2013-07-28
- Python 2.7.3
- Scapy 2.2.0

Testing ip6tables – procedure

- use a “default” configuration
- perform test
- if test fails:
  - try to improve config
  - perform test again

Testing ip6tables – default configuration

```
ip6tables -A FORWARD -p tcp --dport 80 -j ACCEPT
ip6tables -A FORWARD -p udp --dport 80 -j ACCEPT
ip6tables -A FORWARD -m state --state ESTABLISHED,RELATED -j ACCEPT
ip6tables -P FORWARD DROP
```

Testing ip6tables – Results

test	basic config	improved rules
ICMPv6 Filtering	✗	✓
Routing Header	✗	✓
Header Chain	✗	✗
Overlapping Fragments	✓	✓
Tiny IPv6 Fragments	✗	✗
Excessive HBH Options	✗	✓
PadN Covert Channel	✗	✗
Address Scope	✓	✓

Testing ip6tables – Test 1: ICMPv6 Filtering

Check how the firewall handles ICMPv6-messages according to the three groups *mandatory*, *optional*, *nonfiltered*.

default config

- ✓ mandatory: all dropped
- ✓ optional: all dropped
- ✗ nonfiltered: all dropped

Testing ip6tables – Test 1: ICMPv6 Filtering

Cause:

policy is DROP

improved configuration:

```
ip6tables -A FORWARD -p icmpv6 --icmpv6-type destination-unreachable \
     -j ACCEPT

ip6tables -A FORWARD -p icmpv6 --icmpv6-type packet-too-big \
     -j ACCEPT

ip6tables -A FORWARD -p icmpv6 --icmpv6-type ttl-zero-during-transit \
     -j ACCEPT
```

Testing ip6tables – Test 1: ICMPv6 Filtering

improved configuration (cont.):

```
ip6tables -A FORWARD -p icmpv6 --icmpv6-type unknown-header-type \
     -j ACCEPT

ip6tables -A FORWARD -p icmpv6 --icmpv6-type unknown-option \
     -j ACCEPT

ip6tables -A FORWARD -p icmpv6 --icmpv6-type echo-request \
     -m limit --limit 900/min -j ACCEPT

ip6tables -A FORWARD -p icmpv6 --icmpv6-type echo-reply \
     -m limit --limit 900/min -j ACCEPT
```

Testing ip6tables – Test 1: ICMPv6 Filtering

improved config

- ✓ mandatory: all dropped
- ✓ optional: all dropped
- ✓ nonfiltered: all forwarded

Testing ip6tables – Test 1: ICMPv6 Filtering

other firewalls

- most allow filtering by type and code
- some drop packets even if they are allowed (see **pitfalls**).

Testing ip6tables – Test 2: Routing Header

Check how the firewall handles Routing Headers. Depends on *RH type* and *segments left*.

default config

- ✓ type $=$ 0, segments-left $=$ 0: forwarded
- ✗ type $=$ 0, segments-left $\neq$ 0: forwarded
- ✗ type $=$ 2, segments-left $\neq$ 1: forwarded
- ✓ type $=$ 2, segments-left $=$ 1: forwarded
- ✓ type $=$ 200, segments-left $=$ 0: forwarded
- ✗ type $=$ 200, segments-left $\neq$ 0: forwarded

Testing ip6tables – Test 2: Routing Header

Cause:

- Packets are directed at allowed port 80
- ip6tables does not check the Routing Header

Solution:

Use the ip6tables-module `rt`. But **not** like this:

```
ip6tables -A FORWARD -m rt --rt-type 0 -j ACCEPT
```

This will accept all packets containing a routing header w/o checking for the port. Better: handle RH in separate chain.

Testing ip6tables – Test 2: Routing Header

improved configuration:

```
ip6tables -N routinghdr
ip6tables -A routinghdr -m rt --rt-type 0 ! --rt-segsleft 0 -j DROP
ip6tables -A routinghdr -m rt --rt-type 2 ! --rt-segsleft 1 -j DROP
ip6tables -A routinghdr -m rt --rt-type 0 --rt-segsleft 0 -j RETURN
ip6tables -A routinghdr -m rt --rt-type 2 --rt-segsleft 1 -j RETURN
ip6tables -A routinghdr -m rt ! --rt-segsleft 0 --j DROP

ip6tables -A FORWARD -m ipv6header --header ipv6-route --soft \
     -j routinghdr
```

Testing ip6tables – Test 2: Routing Header

improved configuration

- ✓ type $= 0$, segments-left $= 0$: forwarded
- ✓ type $= 0$, segments-left $\neq 0$: dropped
- ✓ type $= 2$, segments-left $\neq 1$: dropped
- ✓ type $= 2$, segments-left $= 1$: forwarded
- ✓ type $= 200$, segments-left $= 0$: forwarded
- ✓ type $= 200$, segments-left $\neq 0$: dropped

Testing ip6tables – Test 2: Routing Header

other firewalls

- some can only drop *all* or *no* RH
- some can only inspect *type*, not *segments-left*

Testing ip6tables – Test 3: Extension Header Chain

Check how the firewall handles packets containing header chains.

default config

- ✓ DSTOPT: forwarded
- ✗ HBH: dropped
- ✗ DSTOPT-HBH: forwarded
- ✗ DSTOPT-DSTOPT: forwarded
- ✓ HBH-HBH: dropped
- ✓ DSTOPT-RH-DSTOPT: forwarded
- ✓ HBH-DSTOPT-RH-HBH: dropped

Testing ip6tables – Test 3: Extension Header Chain

Cause:

- Packets are directed at allowed port 80
- ip6tables does not check the DSTOPT or HBH

Solution:

Use ip6tables-module `ipv6header` or `ipv6headerorder`. Check headers in separate chain. Problems:

- Not stateful enough – need to enumerate *all possible combinations*
- Rule for forwarding single HBH didn't work.
- Dropping duplicate DSTOPT-DSTOPT also drops single DSTOPT.

Testing ip6tables – Test 3: Extension Header Chain

other firewalls

- similar problems
- only a Cisco ASA w/ additional *IPS*-module could detect duplicates.
- performance benchmark showed importance:
- throughput down to approx. 65 when sending extension headers

Testing ip6tables – Test 4: Overlapping Fragments

Check how the firewall handles packets containing fragments.

default config

- ✓ no overlap: forwarded
- ✓ overlap overwriting the port: dropped
- ✓ overlap overwriting the payload: dropped

Testing ip6tables – Test 4: Overlapping Fragments

other firewalls

- some do not allow fragments at all
- some do not recognize overlap

Testing ip6tables – Tests 5 & 6: Tiny Fragments

Check how the firewall handles “Tiny Fragments” (upper layer header not present in first fragment). Check if timeout of 60s is handled correclty

default config

- ✗ port 80 in second fragment (allowed): dropped
- ✓ port 22 in second fragment (forbidden): dropped
- ✗ last fragment arriving after 59 seconds: dropped
- ✓ last fragment arriving after 61 seconds: dropped

Testing ip6tables – Tests 5 & 6: Tiny Fragments

Problem:

- ip6tables appears to drop all tiny fragments
- checking for timeout is not useful.
- no solution was found, no improved config.

other firewalls

- similar results

Testing ip6tables – Test 7: Excessive HBH/DSTOPT Options

Check how the firewall handles extension headers containing duplicate options.

default config

- ✓ HBH with Jumbo-PadN-Jumbo: dropped
- ✗ DSTOPT with Jumbo-PadN-Jumbo: forwarded
- ✗ HBH with RouterAlert-Pad1-RouterAlert: forwarded
- ✗ DSTOPT with RouterAlert-Pad1-RouterAlert: forwarded
- ✗ HBH with QuickStart-TunnelEncapLimit-PadN-QuickStart: forwarded
- ✗ DSTOPT with QuickStart-TunnelEncapLimit-PadN-QuickStart: forwarded
- ✓ HBH with RPL-PadN-RPL: dropped
- ✗ DSTOPT with RPL-PadN-RPL: forwarded

Testing ip6tables – Test 7: Excessive HBH/DSTOPT Options

Cause:

not really sure...

Solution:

- Use ip6tables-modules `hbh` and `dst` to check for payload of these headers.
- enumerate *all possible combinations*
- example config for dropping second combination:
- `ip6tables -A FORWARD -m dst --dst-opts 194,1,194 -j DROP`

Testing ip6tables – Test 7: Excessive HBH/DSTOPT Options

improved config

- ✓ HBH with Jumbo-PadN-Jumbo: dropped
- ✓ DSTOPT with Jumbo-PadN-Jumbo: dropped
- ✓ HBH with RouterAlert-Pad1-RouterAlert: dropped
- ✓ DSTOPT with RouterAlert-Pad1-RouterAlert: dropped
- ✓ HBH with QuickStart-TunnelEncapLimit-PadN-QuickStart: dropped
- ✓ DSTOPT with QuickStart-TunnelEncapLimit-PadN-QuickStart: dropped
- ✓ HBH with RPL-PadN-RPL: dropped
- ✓ DSTOPT with RPL-PadN-RPL: dropped

Testing ip6tables – Test 7: Excessive HBH/DSTOPT Options

other firewalls

- most were unable to inspect contents of options
- some were only able to inspect the first option

Testing ip6tables – Test 8: PadN Covert Channel

Check how the firewall handles packets containing a PadN-option. It's payload should be all zeroes.

default config

- ✗ HBH with PadN-payload $= 0$: dropped
- ✓ HBH with PadN-payload $\neq 0$: dropped
- ✓ DSTOPT with PadN-payload $= 0$: forwarded
- ✗ DSTOPT with PadN-payload $\neq 0$: forwarded

Testing ip6tables – Test 8: PadN Covert Channel

Cause:

- ip6tables doesn't seem to check payload at all
- no solution found, no improved config.

other firewalls

- same result

Testing ip6tables – Test 9: Address Scopes

Check how the firewall handles packets originating from an inappropriate scope.

default config

- ✓ multicast: all dropped
- ✓ link-local: all dropped

other firewalls

- same result

Testing ip6tables – conclusion

test	improved rules
ICMPv6 Filtering	✓
Routing Header	✓
Header Chain	✗
Overlapping Fragments	✓
Tiny IPv6 Fragments	✗
Excessive HBH Options	✓[1]
PadN Covert Channel	✗
Address Scope	✓

[1] not very elegant

Outline

Pitfalls

- ideal world scenario: tests performed automatically
- mismatch between rfc's intent, your setup, firewall capabilities
- ft6's results may be misleading in some cases

Pitfalls

Example:

- ICMPv6 non-filtered messages include `Packet Too Big`, `Time Exceeded` and `Parameter Problem`
- in our tests: were dropped by some firewalls, marked red in ft6
- responses to some previous malformed packet
- ft6 doesn't send the previous packet
- firewall more capable than assumed

Pitfalls

- how would you fix that?
- you can't (reliably)
- too many edge-cases, to many differences across vendors
- problem remains: what's the result of that ICMP test?

Pitfalls

another example: Routing Header

- decision to drop or forward depends upon value of `segments-left` field.
- some firewalls were unable to inspect the field.
- all or nothing
- firewall less capable than assumed
- yet: dropping valid RH is arguably better than forwarding invalid RH
- how do we reflect that in ft6?

Pitfalls

- don't focus too hard on *rfc-conformity*
- if a result is not in accordance with rfc but "more secure":
  $\Rightarrow$ no longer red
- can't make it green:
  $\Rightarrow$ for example: dropping *all* RH, kills Mobile-IPv6 feature

Pitfalls

results:

- more yellow, longer explanations
- more interpretation required
- shows problems of IPv6. Too many *what-if*s

Outline

Writing your own test

Example: build own test, to see if packets containing the string "randomword"can traverse the firewall. Requires three steps:

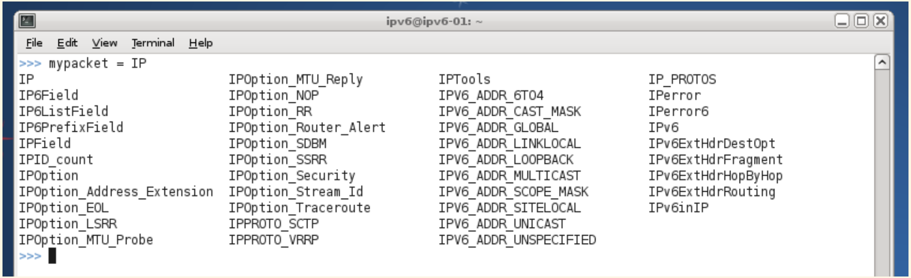
1. create a class for your test
2. craft packets in the `prepare` method
3. register your test with the application

(More detailed in ft6's documentation)

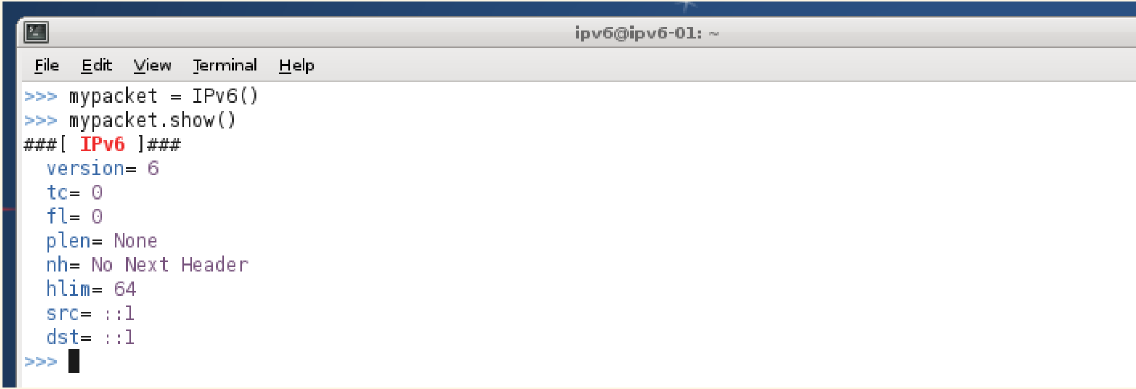
Writing your own tests – packet handling with scapy

- handling network packets is usually messy
  - binary protocols
  - accessing individual flags invovles bitshifting or bitmasking
- sending and receiving is error-prone, too
- scapy does all that for you and is human readable.
- great TAB-completion

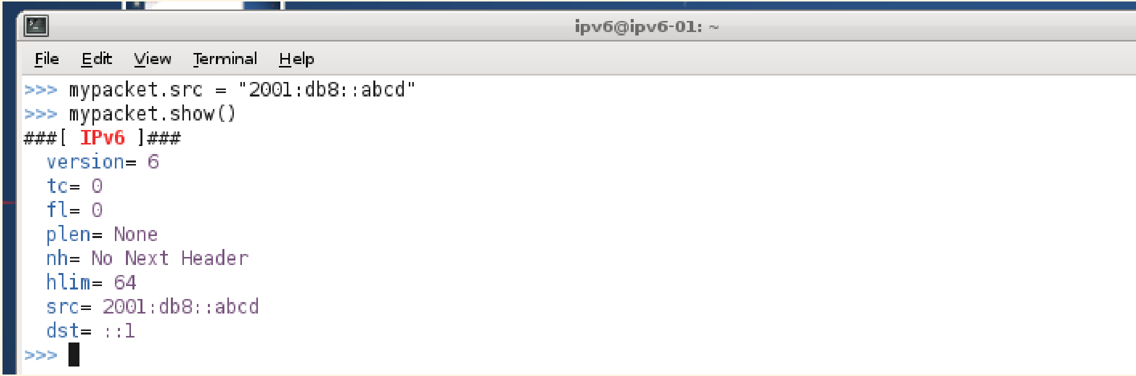
Writing your own tests – packet handling with scapy



Writing your own tests – packet handling with scapy



Writing your own tests – packet handling with scapy



Writing your own tests – packet handling with scapy

ipv6@ipv6-01: ~

File Edit View Terminal Help

```
>>> tcp=TCP(dport=80)
>>> payload = "GET index.html HTTP/1.1"
>>> result = mypacket/tcp/payload
>>> 
```

Writing your own tests – packet handling with scapy

ipv6@ipv6-01: ~

File Edit View Terminal Help

```
>>> result.show2()
###[ IPv6 ]###
  version= 6L
  tc= 0L
  fl= 0L
  plen= 43
  nh= TCP
  hlim= 64
  src= 2001:db8::abcd
  dst= ::1
###[ TCP ]###
     sport= ftp_data
     dport= www
     seq= 0
     ack= 0
     dataofs= 5L
     reserved= 0L
     flags= S
     window= 8192
     chksum= 0xd79d
     urgptr= 0
     options= []
###[ Raw ]###
        load= 'GET index.html HTTP/1.1'
>>> 
```

Writing your own tests

Step 1: Create a class for your test

```
class TestRandomWord(Test):
  def __init__(self, id, name, description, test_settings, app):
    super(TestRandomWord, self).__init__(id, name, description,
      test_settings, app)
```

(copy-paste, change the name)

Writing your own tests

Step 2: Craft packets in the prepare-method

```
def prepare(self):
  e  = Ether(dst=self.test_settings.router_mac)
  ip = IPv6(dst=self.test_settings.dst, src=self.test_settings.src)
  udp= UDP(dport=self.test_settings.open_port, sport=12345)

  p = Ft6Packet(e/ip/udp/Raw("randomword"))
  p.setValid()
  p.setDescription("A valid packet containing a random word")
  p.ifDropped("This violates rfc #23")
  self.addPacket(p)
```

Writing your own tests

Step 2: Craft packets in the prepare-method

```
p = Ft6Packet(e/ip/udp/Raw("otherword"))
p.setInvalid()
p.setDescription("An invalid packet containing some other word")
p.ifForwarded("This violates rfc #42")
self.addPacket(p)
```

Writing your own tests

- That's it!
- ft6 will send each packet that has been added like this
- and add results according to the packet's state

Writing your own tests

Step 3: register your test

```
# create test classes, store them in the dictionary
# so they can later be called by their id
tICMP = TestICMP(1, "ICMPv6 Filtering", "The ICMP Test",
    self.test_settings, app)
self.registerTest(tICMP)

...

tRandomWord = TestRandomWord(42, "My Random Word Test",
  "Tests for Random Words", self.test_settings, app)
self.registerTest(tRandomWord)
```

Wrap up

- a lot of things to take care of
- don't trust the vendors
- also do performance, link-local tests
- ft6 is a work in progress
- lots of improvement could be done
- better results
- more tests

Thank You! Questions?

- get ft6 from: `https://github.com/olivereggert/ft6`
- more info on the project: `www.idsv6.de`