testing your IPv6-firewall with ft6

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Agenda

1. idsv6, origin of ft6
2. design of ft6
3. test specification
4. live demo
5. *(optionally: writing your own tests)*

idsv6

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

Universität Potsdam

BEUTH HOCHSCHULE
FÜR TECHNIK
BERLIN
University of Applied Sciences

EANTC

STRATO

- lack of IPv6-enabled tools for
  - analyzing threat level
  - checking firewall/IDS configuration
  - checking firewall/IDS capabilities
  - checking IPv6 "readiness"

idsv6: contributions

- IPv6 Darknet

  $/48$-net $<$ 1200 packets in 9 months
- IPv6 Honeypot

  honeydv6
- IPv6 Plugin for Snort

  maintains network state, allows signatures for IPv6 header fields
- load tests

  done by eantc
- protocol tests

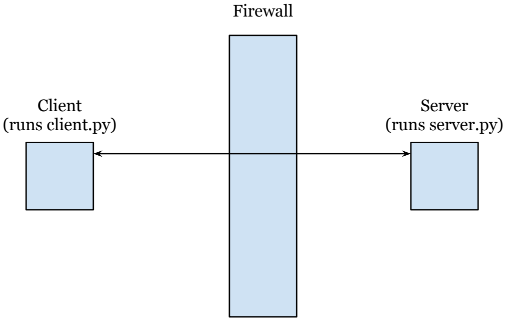
  ft6

`www.idsv6.de`

motivation

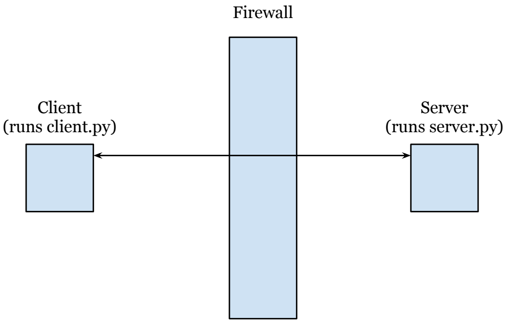
- say you are...
  - new to IPv6
  - try to improve your firewall config
  - try to compare firewalls
  - ...
- lot of `SHOULD`s, `MUST`s and `REQUIRED`s for IPv6
- across lot of different `RFC`s
- vague
- best practices
- hard to keep track
- EANTC wrote a sepcification
- ft6 implements 9 of those tests

ft6 – Architecture



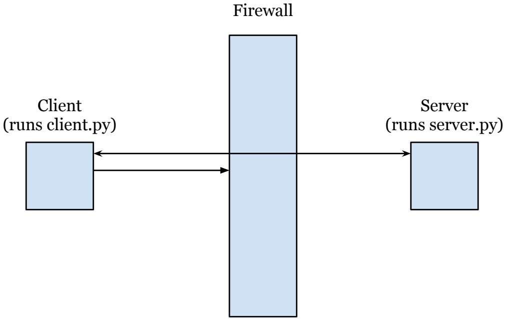
- ft6 is a client-server application
- requires machines on both sides of your firewall
- one open port
- place machines not more than one hop away from firewall

Running ft6



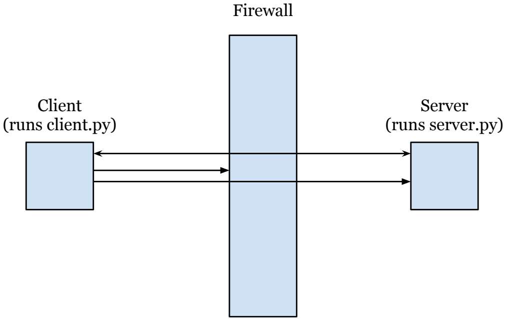
- Client and Server exhange control messages
  - Start / End / Results

Running ft6



- Client sends packets
- Server sniffs

Running ft6



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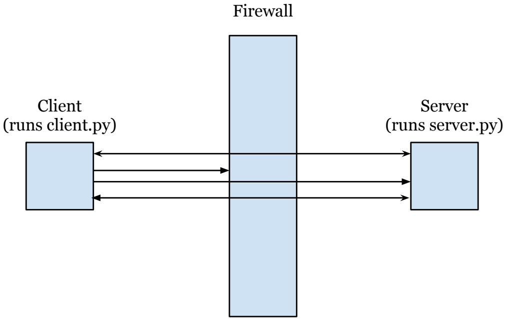
Running ft6



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

Design of ft6

- goal: easy to configure and visualize results
- open-source (Creative Commons BY-NC-SA 3.0)
- uses scapy 2.2.0, python 2.7, PyQt 4
- developed on Debian Linux 6 (2.6.32), tested with more recent grml (3.7.1)
- *should* work on Windows 7, Mac OS X
- can act as a framework for new tests

Test cases

test 1: ICMPv6 filtering

- Check if the firewall correctly forwards and discards ICMPv6 Packets.
- Depends upon `type` and `code` field.
- Categories *mandatory*, *optional* and *nonfiltered*
- RFC 4890 "Recommendations for Filtering ICMPv6 Messages in Firewalls"

test 2: Routing Header

- Check if the firewall correctly forwards and discards packets containing a Routing Header.
- Depends upon `type` and `segments-left` field.
- RFC 5095 "Deprecation of Type 0 Routing Headers in IPv6"

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)
- RFC 2460 "Internet Protocol, Version 6 (IPv6) Specification"

test 4: Overlapping Fragments

- Check if the firewall correctly detects overlapping fragments
- Forward only if no overlap
- RFC 5722 "Handling of Overlapping IPv6 Fragments"

tests 5 and 6: Tiny IPv6 Fragments Timeout

- Check if the firewall can inspect the second fragment if no Layer 4 is present within the first fragment
- 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
- drop after 60 seconds
- RFC 2460 " Internet Protocol, Version 6 (IPv6) Specification"

test 7: Excessisve HBH/DSTOPT Options

- Check if the firewall blocks packets with multiple options
- Most options should occur at most once
- Only Pad1 and PadN are allowed multiple times
- RFC 4942 "IPv6 Transition/Coexistence Security Considerations"

test 8: PadN Covert Channel

- Check if the firewall can block packets with non-zero padding
- RFC 4942 "IPv6 Transition/Coexistence Security Considerations"

test 9: Adress Scopes

- Verify that the firewall does not route traffic from an inappropriate scope.
- `ff00::/16` and `fe80::/10`
- RFC 4942 "IPv6 Transition/Coexistence Security Considerations"

Live Demo

ft6 version 2: 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

ft6 version 2: 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

ft6 version 2: pitfalls

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

ft6 version 2: 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?

ft6 version 2: "security focus"

- switch from *rfc-conformity* focus to *security* focus
- if a result is not in accordance with rfc but "more secure":
  ⇒ no longer red
- can’t make it green:
  ⇒ for example: dropping *all* RH, kills Mobile-IPv6 feature

ft6 version 2: "security focus"

results:

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

future work

- ft6 is a work in progress
- lots of improvement could be done
- better results
- more tests

Thank You! Questions?

- your thoughts: `contact@idsv6.de`
- get ft6 from: `https://redmine.cs.uni-potsdam.de/projects/ft6`
- more info on the project: `www.idsv6.de`

Writing your own test

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

1. create a class for your test
2. implement the `execute` method
3. implement the `evaluate` method
4. register your test with the application

(More detailed in ft6's documentation)

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: implement the `execute` method

```
def execute(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)
  payload = "ipv6-qab"*128

  packet = e/ip/udp/(payload + "randomword")
  sendp(packet)

  packet = e/ip/udp(payload + "someotherword")
  sendp(packet)
```

Writing your own tests

Step 3: implement the `evaluate` method

```
def evaluate(self, packets):
  results = []
  found_random = False
  found_otherword = False

   # iterate over the packets, filter those that belong to the test
   for p in packets:
      tag = str(p.lastlayer())
      if not "ipv6-qab" in tag:
          continue

      if "randomword" in tag:
          found_random = True

      if "someotherword" in tag:
          found_otherword = True
```

Writing your own tests

Step 3: implement the `evaluate` method

```
# evaluate the flags
if found_random:
      results.append("Success", "Your firewall forwarded
      a packet with a random word!")
else:
      results.append("Failure", "Your firewall dropped
      a packet with a random word!")

if found_otherword:
    results.append("Warning", "Your firewall forwarded
    a packet with some other word. That’s very weird!")
else:
    results.append("Success", "Your firewall dropped
    a packet with some other word. Well done firewall!")

return results
```

Writing your own tests

Step 4: 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)
```