testing your IPv6-firewall with ft6

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Agenda

1. ids, origin of ft6
2. design of ft6
3. test specification
4. live demo
5. (optionally: writing your own tests)
"IPv6 Intrusion Detection System" Project (2011 - 2013)
- funded by "Bundesministerium für Bildung und Forschung"

- 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 SHOULDs, MUSTs and REQUIREDs for IPv6
- across lot of different RFCs
- vague
- best practices
- hard to keep track
- EANTC wrote a specification
- 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 exchange control messages
  - Start / End / Results
Running ft6

- Client sends packets
- Server sniffs
Running ft6

- Client sends packets
- Server sniffs
Running ft6

- Server sends back list of packets it received
- 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
- 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: Excessive 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.
- $\text{ff00::/16}$ and $\text{fe80::/10}$
- 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-ifs*
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)
Step 2: implement the `execute` method

```python
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)
```
Step 3: implement the `evaluate` method

```python
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
```

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Writing your own tests

Step 3: implement the evaluate method

```python
# 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

```python
# 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)
sself.registerTest(tRandomWord)
```