Port Scanning and WebSockets

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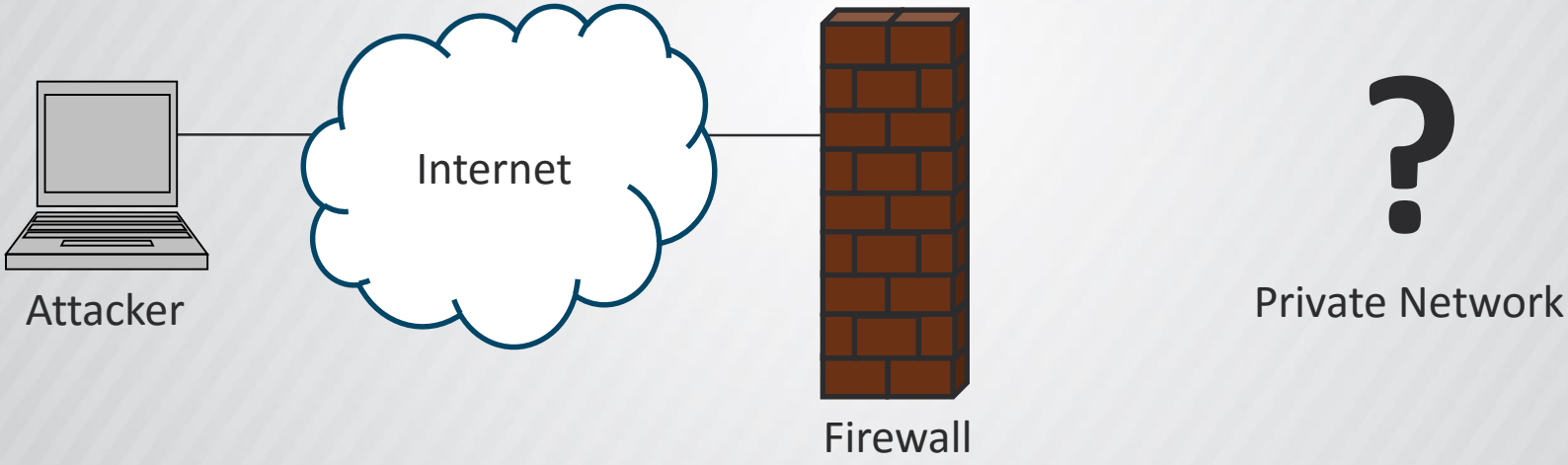
Overview

- Background
- Existing mitigations
- Current weaknesses
- Proposed mitigation

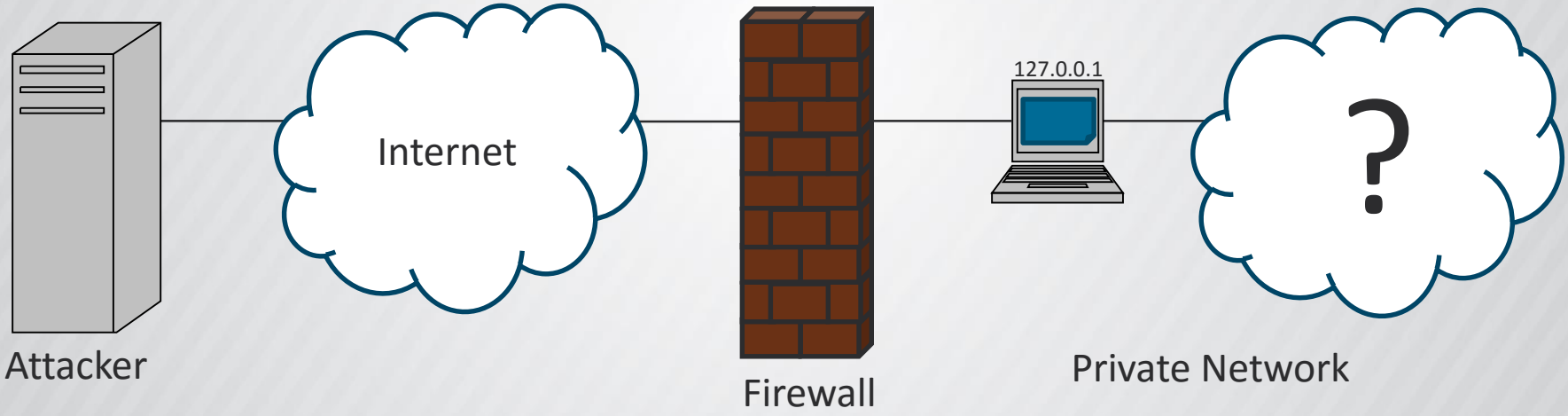
Background

Base Assumption



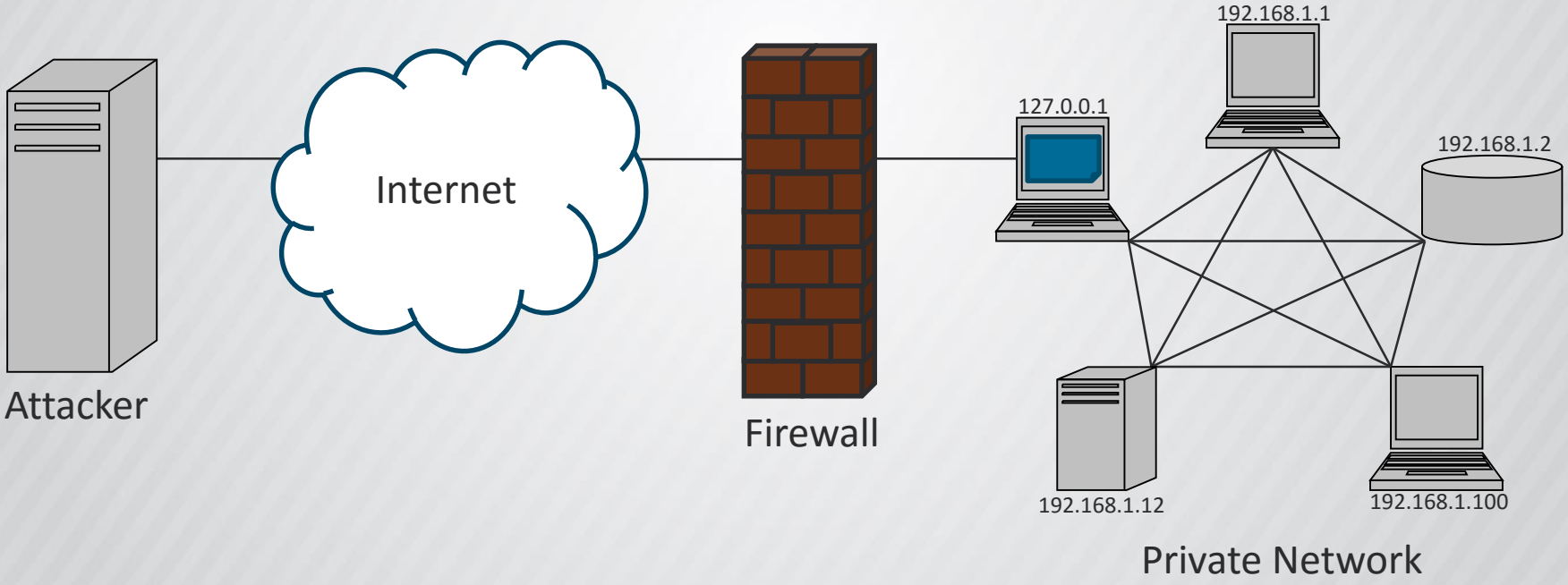
Background

Reasonable Assumption



Background

Reality



Generally How this Works

1. JavaScript can *make requests* to private IP addresses

2. JavaScript can *time responses* of those requests

3. An attacker can *infer from timing differences*
   - Short times indicate a responding port
   - Longer times indicate no response

A More Detailed Look

Proof of Concept Code (JavaScript)

```
var ports = [80, 443, 445, 554, 3306, 3690, 1234];
for (var i = 0; i < ports.length; i++) {
    var s = new WebSocket("ws://192.168.1.1:" + ports[i]);
    s.start = performance.now();
    s.port = ports[i];
    s.onerror = function() { console.log("Port " + this.port + ": " + (performance.now() - this.start) + " ms"); };
    s.onopen = function() { console.log("Port " + this.port + ": " + (performance.now() - this.start) + " ms"); };
}
```

Timing Results

Port 80: 632 ms
Port 443: 3043 ms
Port 445: 345 ms
Port 554: 4254 ms
Port 3306: 3697 ms
Port 3690: 4113 ms
Port 1234: 529 ms

Browser Mitigations

Blocking: protects some well-known ports

Including: TCPMUX, Echo, Wake-on LAN, Systat, Daytime Protocol, Netstat, Chargen, FTP, SSH, Telnet, SMTP, TIME, WINS, WHOIS, DNS, Finger, Exchange, POP3, ONC RPC, Ident, Simple File Transfer, NNTP, NTP, MS RPC, NetBIOS, IMAP4, BGP, LDAP, Kerberos, rexec, rlogin, syslog, LPD/LPR, NFS

Throttling: reduces speed of port scanning

Mitigation Limitations

Blocking

- Browser inconsistency
- ~60 ports blocked
- Hard to be confident about additional blocking

Throttling

- Clustered address allocation
- Determined attackers
- WebSockets technique

WebSockets/WebWorkers

Throttle: *per process* limit on open connections

WebWorkers: child *processes*

WebSockets: arbitrary connections; *accessible from WebWorkers*

WebSocket **x** WebWorker **=** Faster Mapping

Proposed Mitigation

Focus on the WebSocket protocol

Problem: timing differences in handshake error

Solution: report errors at fixed latency

Proposal Disadvantages

Does creating fixed latency *increase latency*?

Yes, but *only on error*

Enhanced security is worth the performance hit for an application already experiencing errors.

Mitigation Results

Proof of Concept Code (JavaScript)

```
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}
```

Current Mitigation Results

Port 80: 632
Port 443: 3043
Port 445: 345
Port 554: 4254
Port 3306: 3697
Port 3690: 4113
Port 1234: 529

Proposed Mitigation Results

Port 80: 6043
Port 443: 6021
Port 445: 6125
Port 554: 6104
Port 3306: 6028
Port 3690: 6110
Port 1234: 6031

What's Next?

Internet-Draft:
draft-gallagher-hybiWebSocketEnhancement-00

Browser adoption of updates

Consider this issue in *future discussions of other protocols* accessible from JavaScript

Questions

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