Responsible Disclosure

A Case Study of CERT VU#800133, “DNS Cache Poisoning Issue”

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2008 OARC Workshop
September 24, 2008

Agenda

- Discovery
- Patch
- Disclosure
- Exploit
- Conclusions

Acknowledgements

This work would not have been possible without assistance from:

- The Security Information Exchange, https://sie.isc.org (data)
- Paul Vixie (coordination, validation)
- Duane Wessels (computing resources)
- Chad Dougherty (CERT Vulnerability Analysis)
- Nick Ianelli (CERT Malicious Code)

Discovery

(ssshhhhh….)

Timeline

Kaminsky Discovery

- February 2008 (?)

Notification to a small number of interested parties

- 2008.03.19

DNS Summit, 2008.03.31

- Detailed disclosure
- Proposed solution
- Proposed patch date 2008.08.07
- Detailed release date at Blackhat

What is this?

DNS cache poisoning is not a new concept

- Query ID (QID, aka TXID) is only a 16-bit number
- UDP spoofing

Not so much a vulnerability as a new technique:

- Additional resource records (RRs) in the spoofed responses get cached
- Avoid the timeout wait by asking random questions
- Payload is in Additional RRs rather than Answers

What’s the (interim) fix?

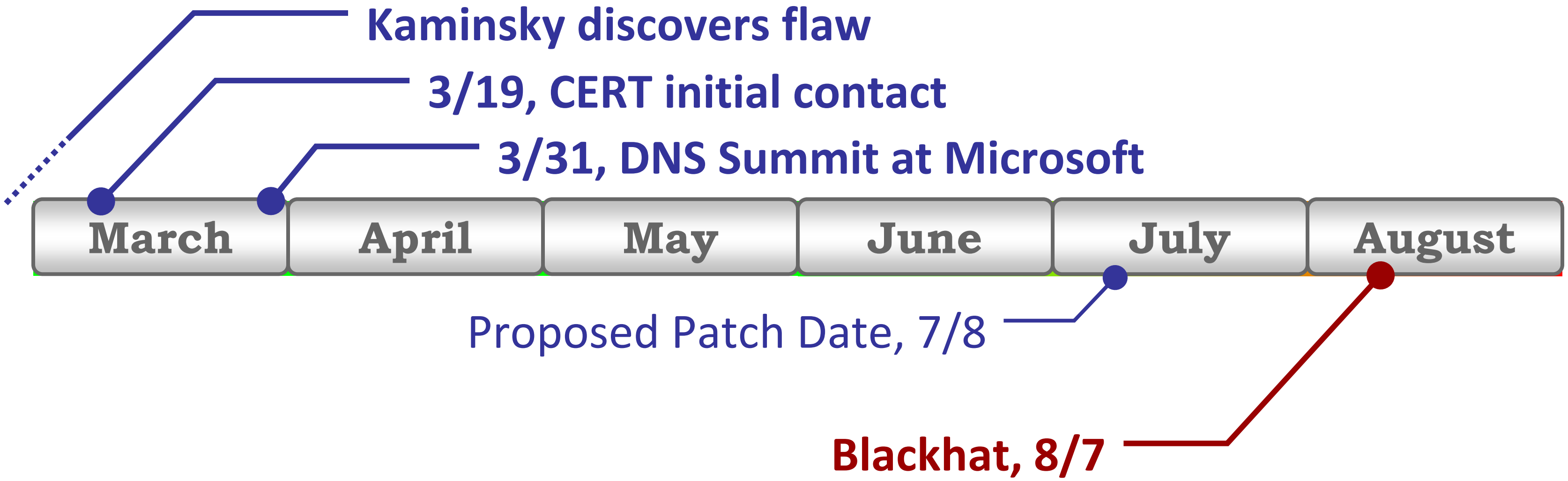
Increase entropy with a random ephemeral port

- Traditionally most name servers grab a random port at startup and hang on to it for all future queries

Before: guess TrxID: one in 65,536 (2^{16})

After: guess TrxID (2^{16}) and ephemeral port ($\sim 2^{14}$)

Timeline



Kaminsky discovers flaw

3/19, CERT initial contact

3/31, DNS Summit at Microsoft

Proposed Patch Date, 7/8

Blackhat, 8/7

Vulnerability coordination/response

After DNS summit, CERT begins notifying vendors

- First round: survey message, no details seeking independent DNS implementers
- Second round: detailed technical message and timeline

Roughly 150 vendors contacted

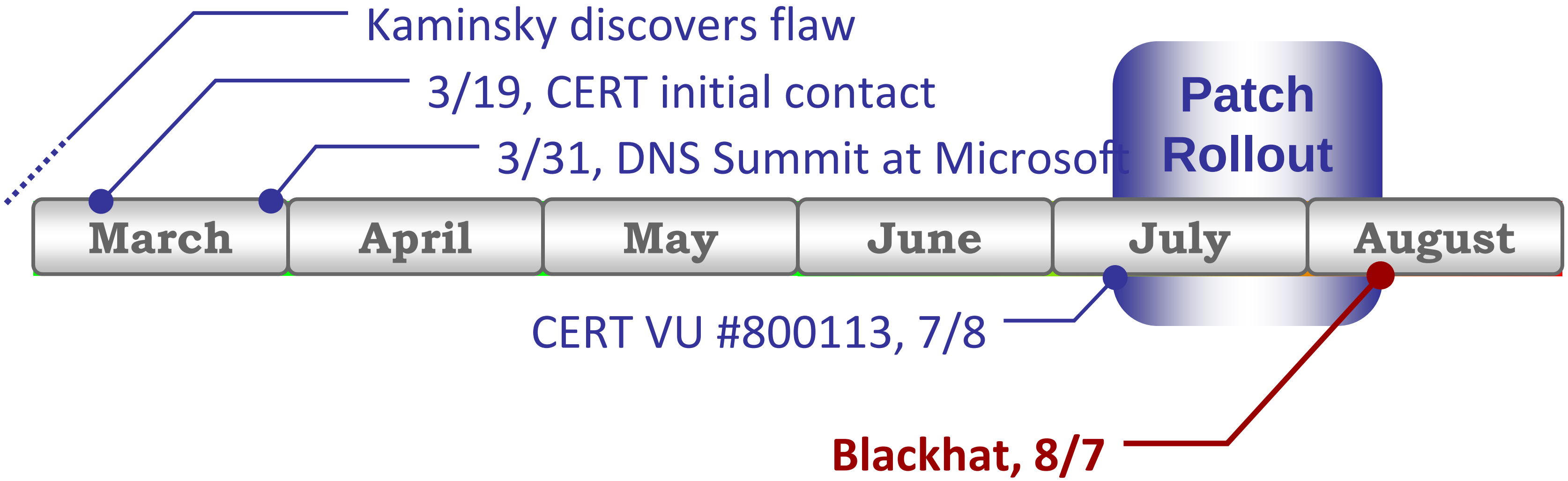
- Vendor communication is performed securely using PGP and our custom internal contact management application

2008.07.08: Announcement and patches released

Patch

…and patch, and patch, and patch…

Timeline



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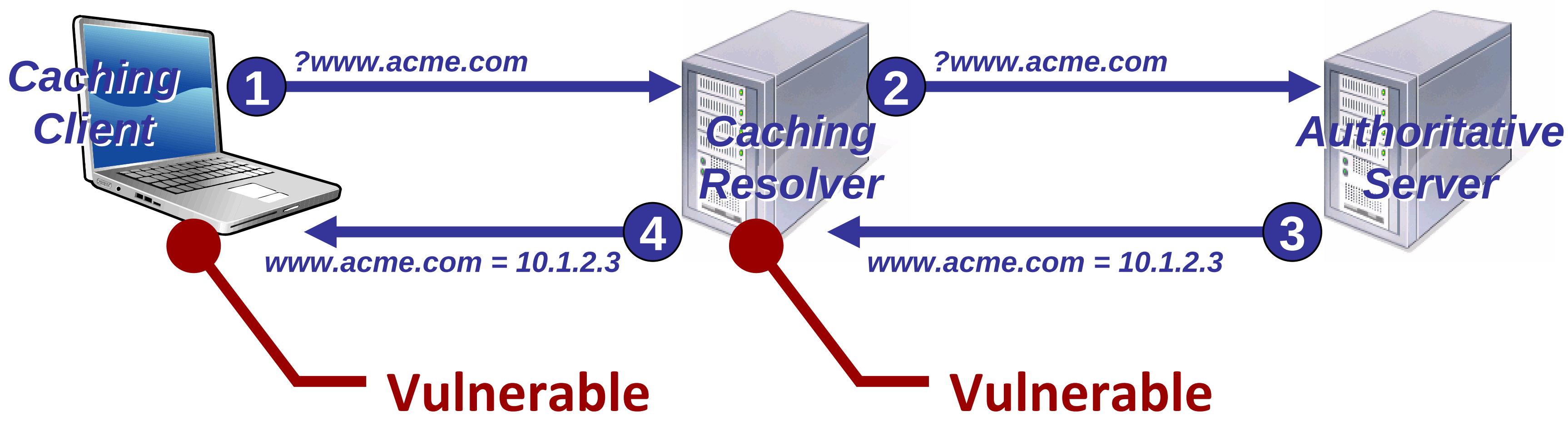
Patch Rollout

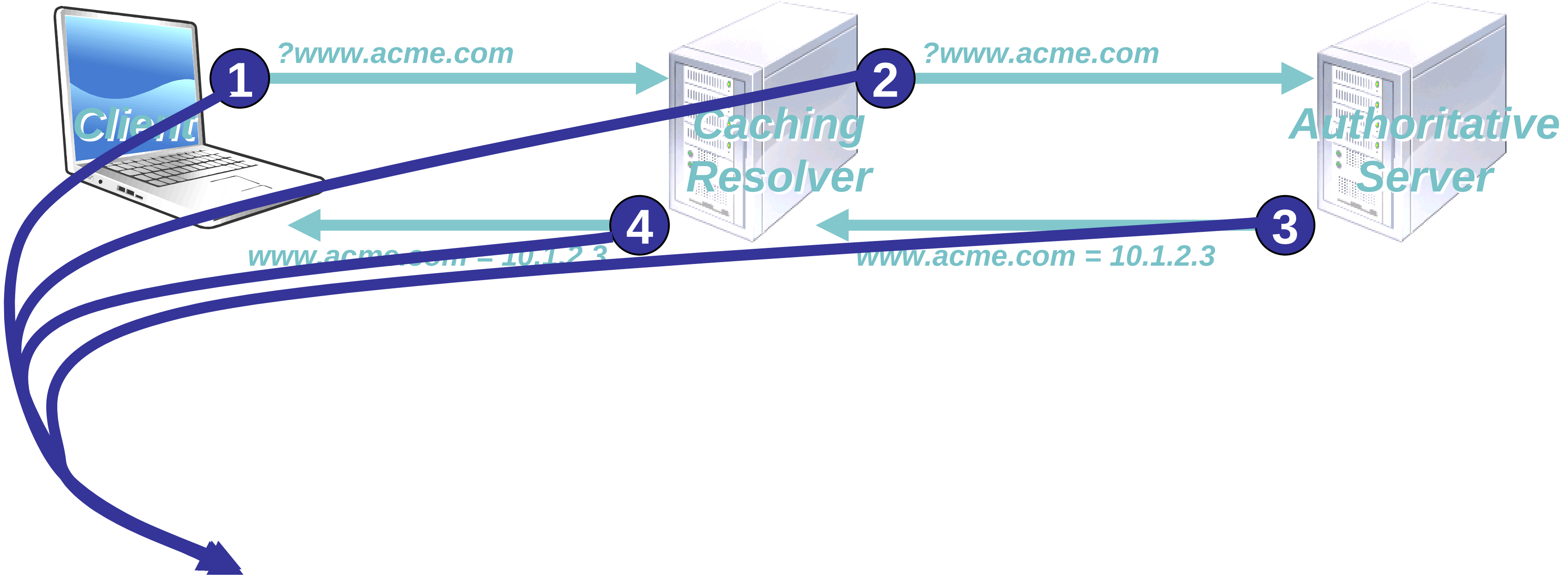
CERT VU #800113, 7/8

Blackhat, 8/7

Review: Basic DNS Architecture

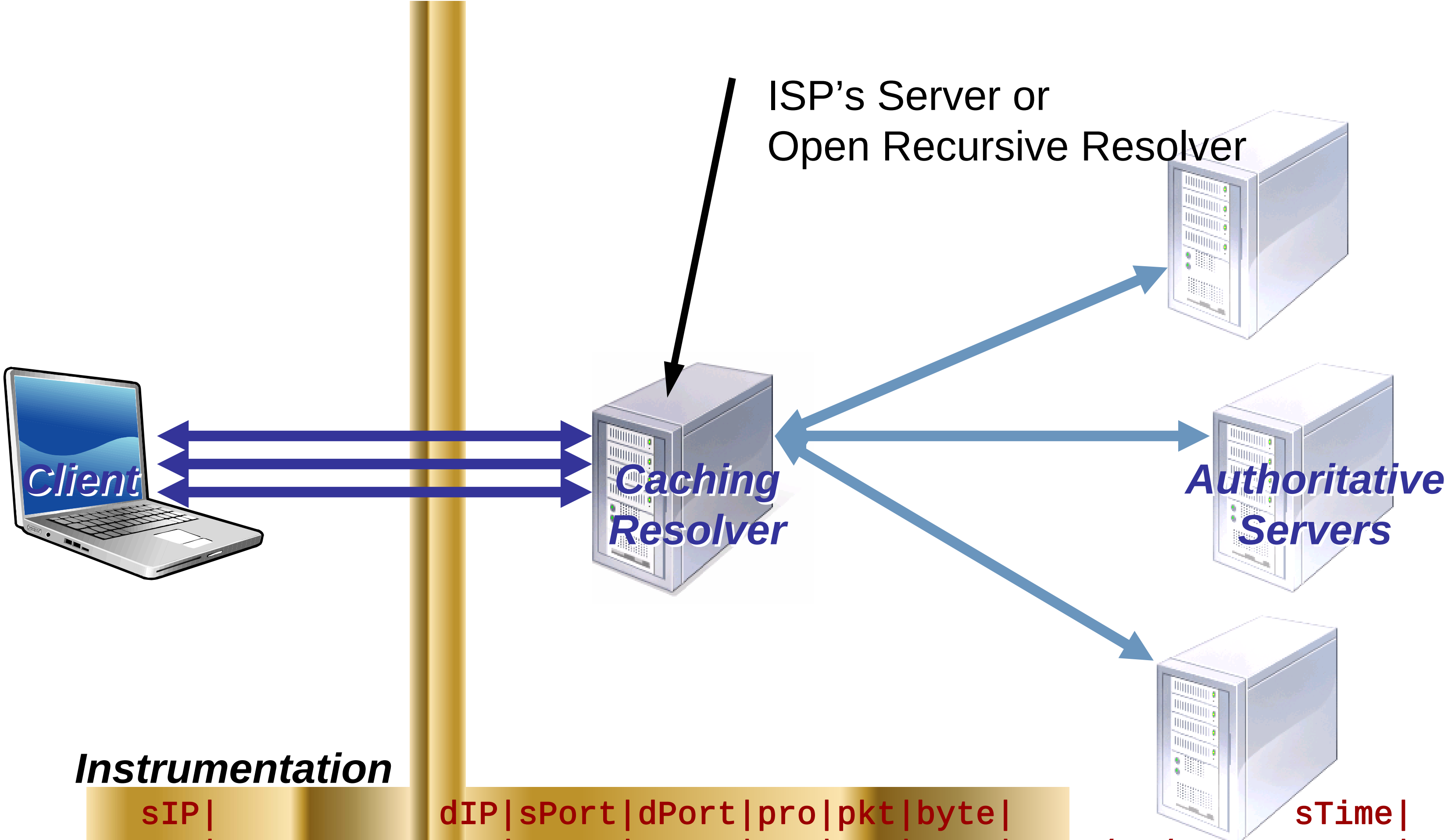


Review: Flow Collection



```
               sIP|           dIP|sPort|dPort|pro|pkt|byte|              sTime|
(1)  10.254.105.86|186.54.105.135| 1027|   53| 17|  1| 282|2008/06/11T12:00:02|
(2) 186.54.105.135|17.131.109.185|34574|   53| 17|  1| 306|2008/06/11T12:00:02|
(3) 17.131.109.185|186.54.105.135|   53|34574| 17|  1| 554|2008/06/11T12:00:03|
(4) 186.54.105.135| 10.254.105.86|   53| 1027| 17|  1| 403|2008/06/11T12:00:03|
```

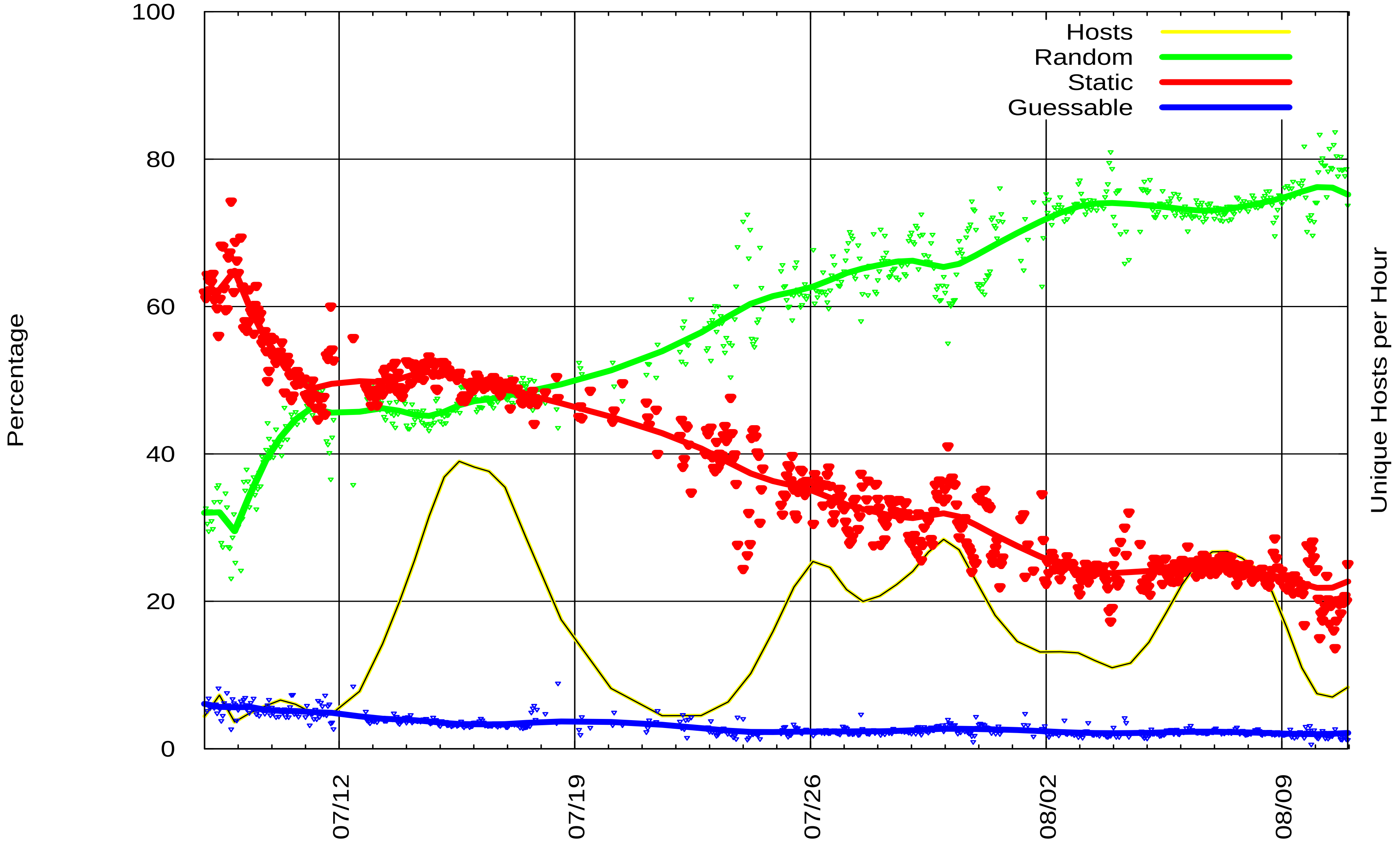
Identifying Unpatched Workstations



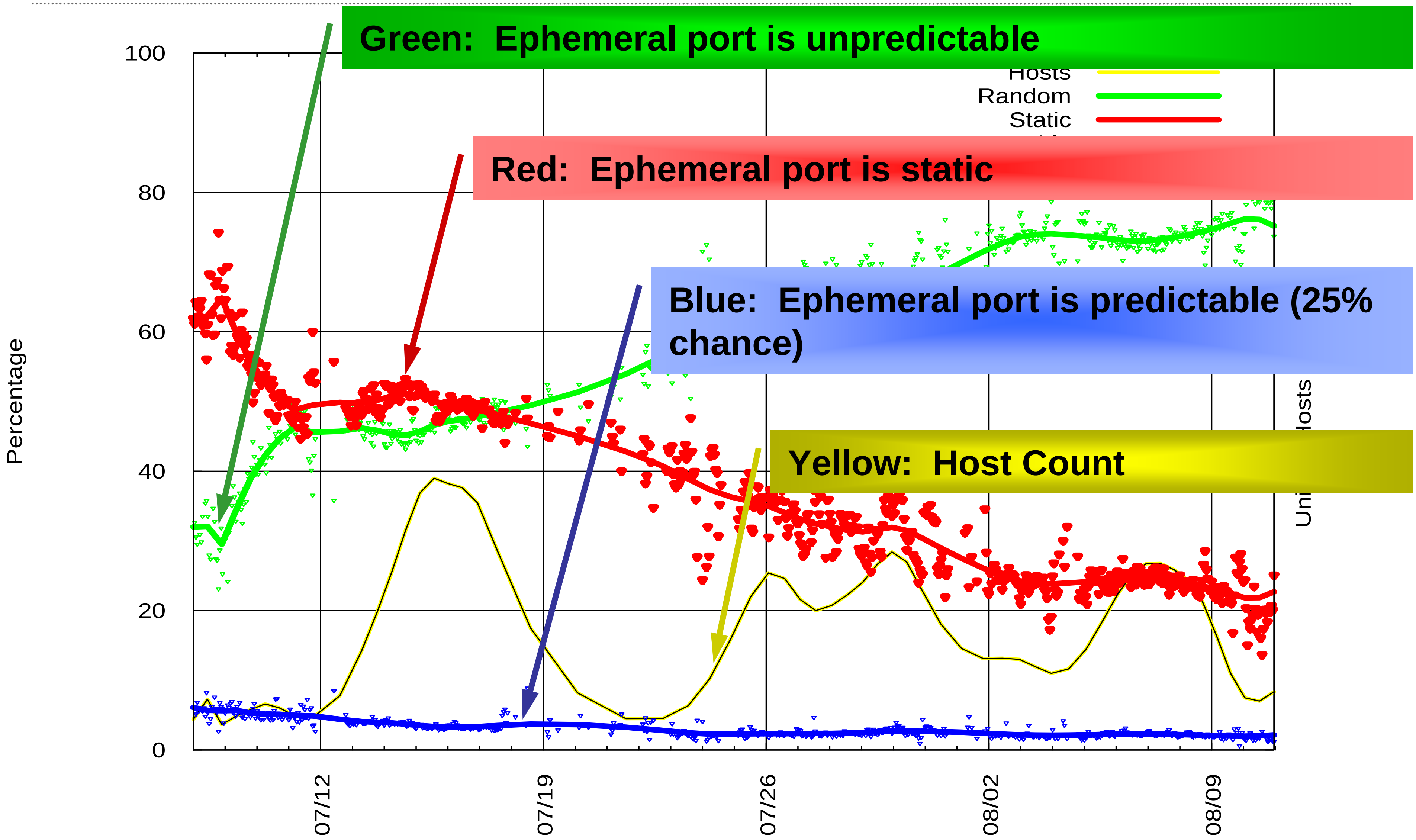
Instrumentation

```
          sIP|           dIP|sPort|dPort|pro|pkt|byte|              sTime|
10.254.105.86|186.54.105.135| 1027|   53| 17|  1| 282|2008/06/11T12:00:02|
10.254.105.86|186.54.105.135| 1031|   53| 17|  1| 282|2008/06/11T12:00:21|
10.254.105.86|186.54.105.135| 1032|   53| 17|  1| 282|2008/06/11T12:00:21|
10.254.105.86|186.54.105.135| 1058|   53| 17|  1| 282|2008/06/11T12:01:03|
```

Home User Results



Results Explained



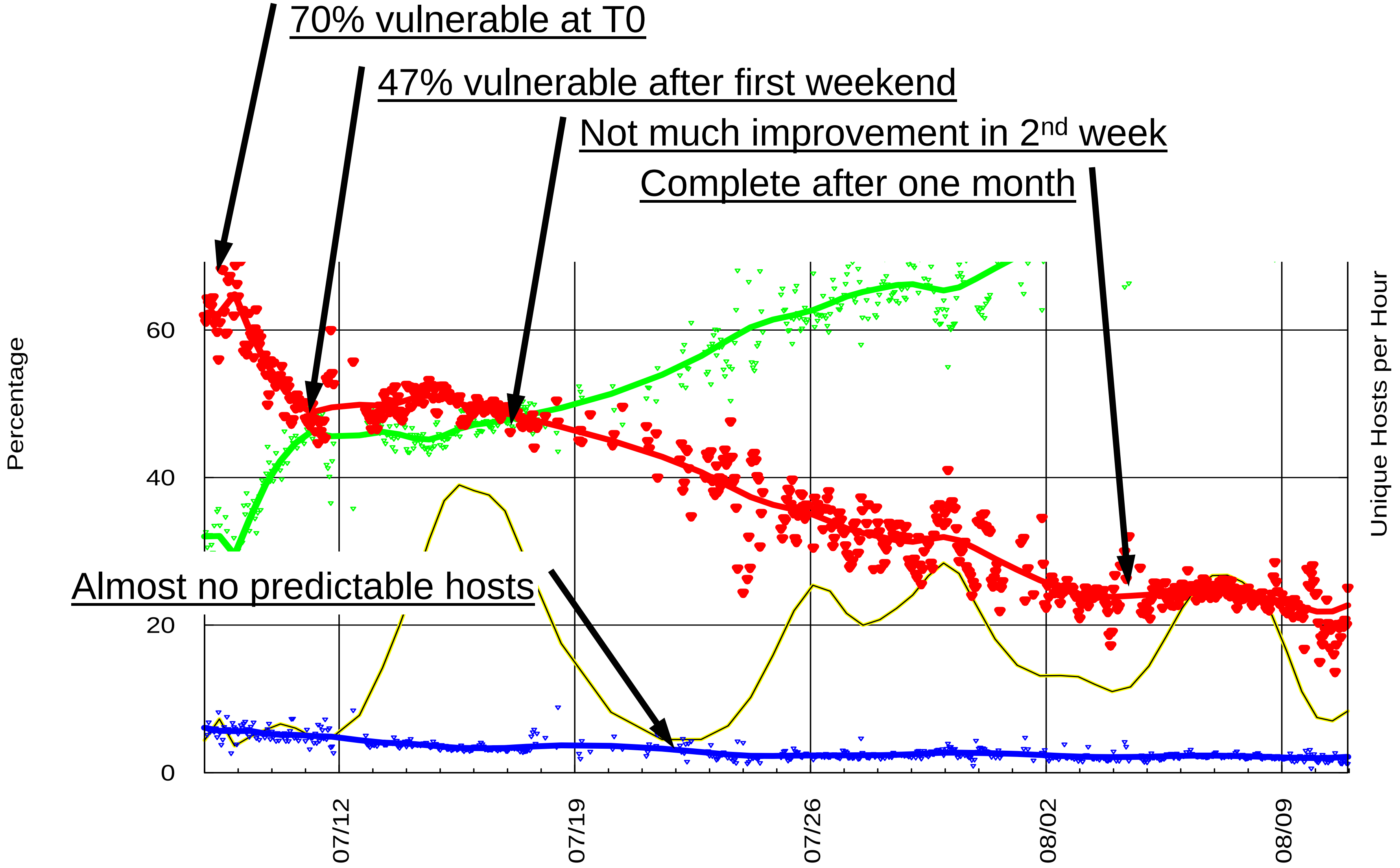
Green: Ephemeral port is unpredictable

Red: Ephemeral port is static

Blue: Ephemeral port is predictable (25% chance)

Yellow: Host Count

Home User Timeline



70% vulnerable at T0

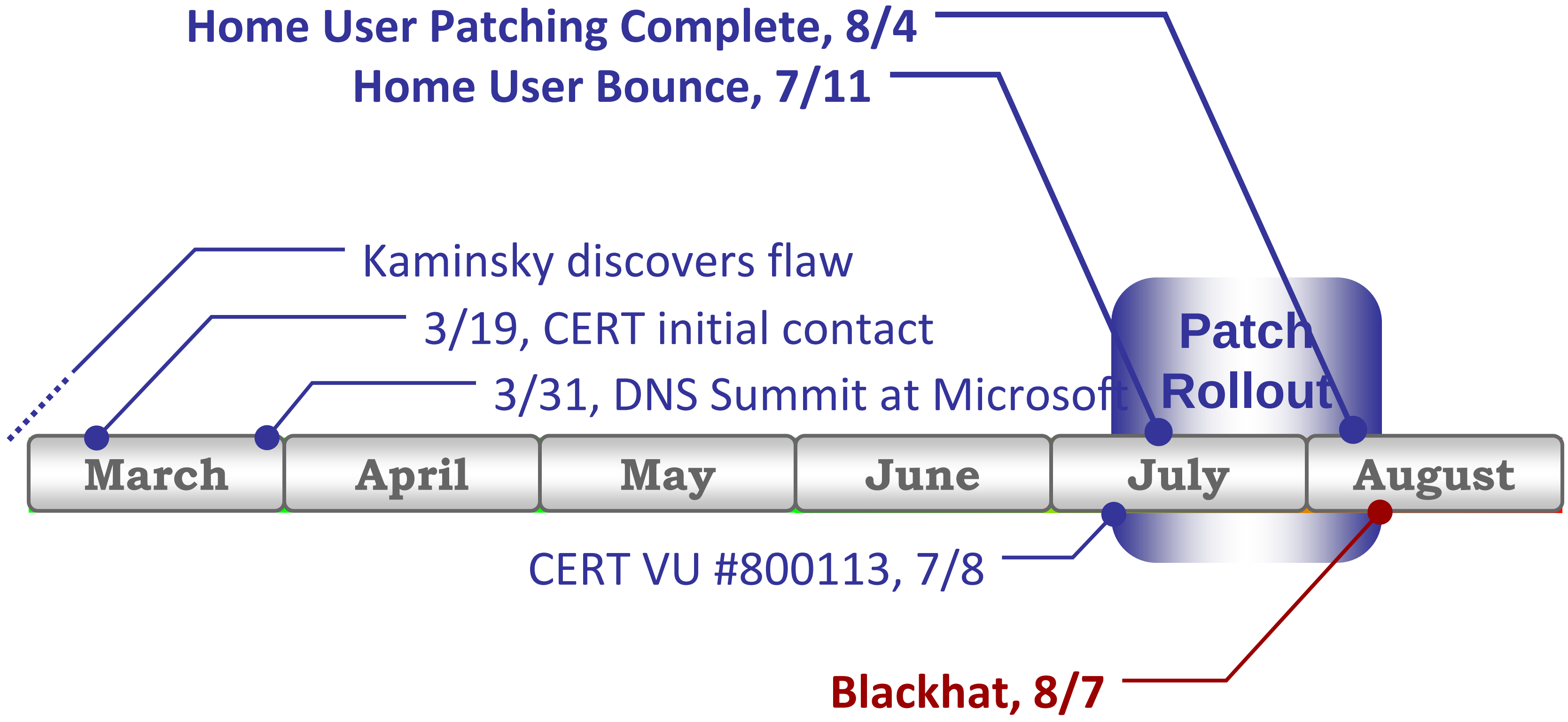
47% vulnerable after first weekend

Not much improvement in 2nd week

Complete after one month

Almost no predictable hosts

Timeline revisited



Home User Patching Complete, 8/4

Home User Bounce, 7/11

Kaminsky discovers flaw

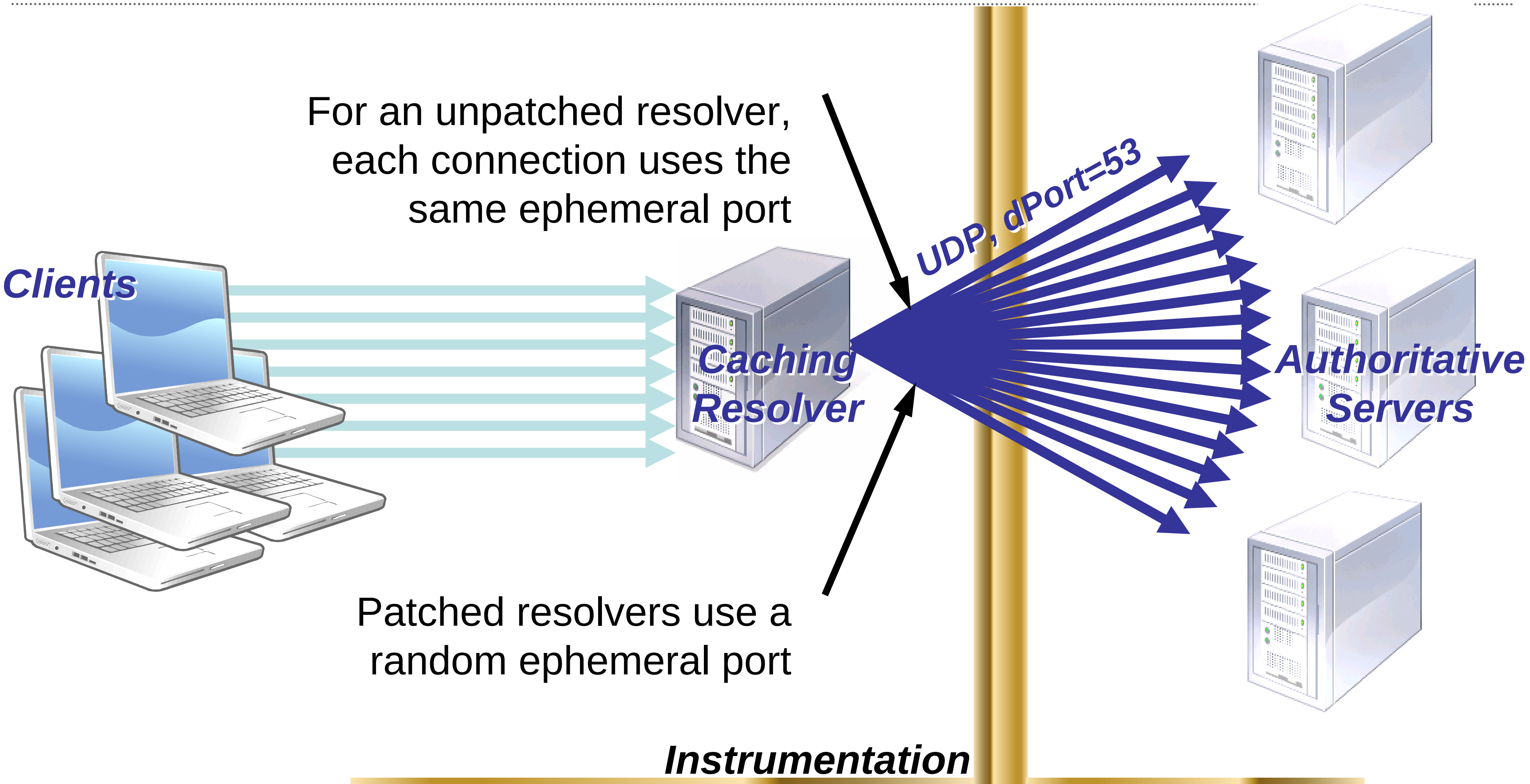
3/19, CERT initial contact

3/31, DNS Summit at Microsoft

CERT VU #800113, 7/8

Blackhat, 8/7

Identifying unpatched servers

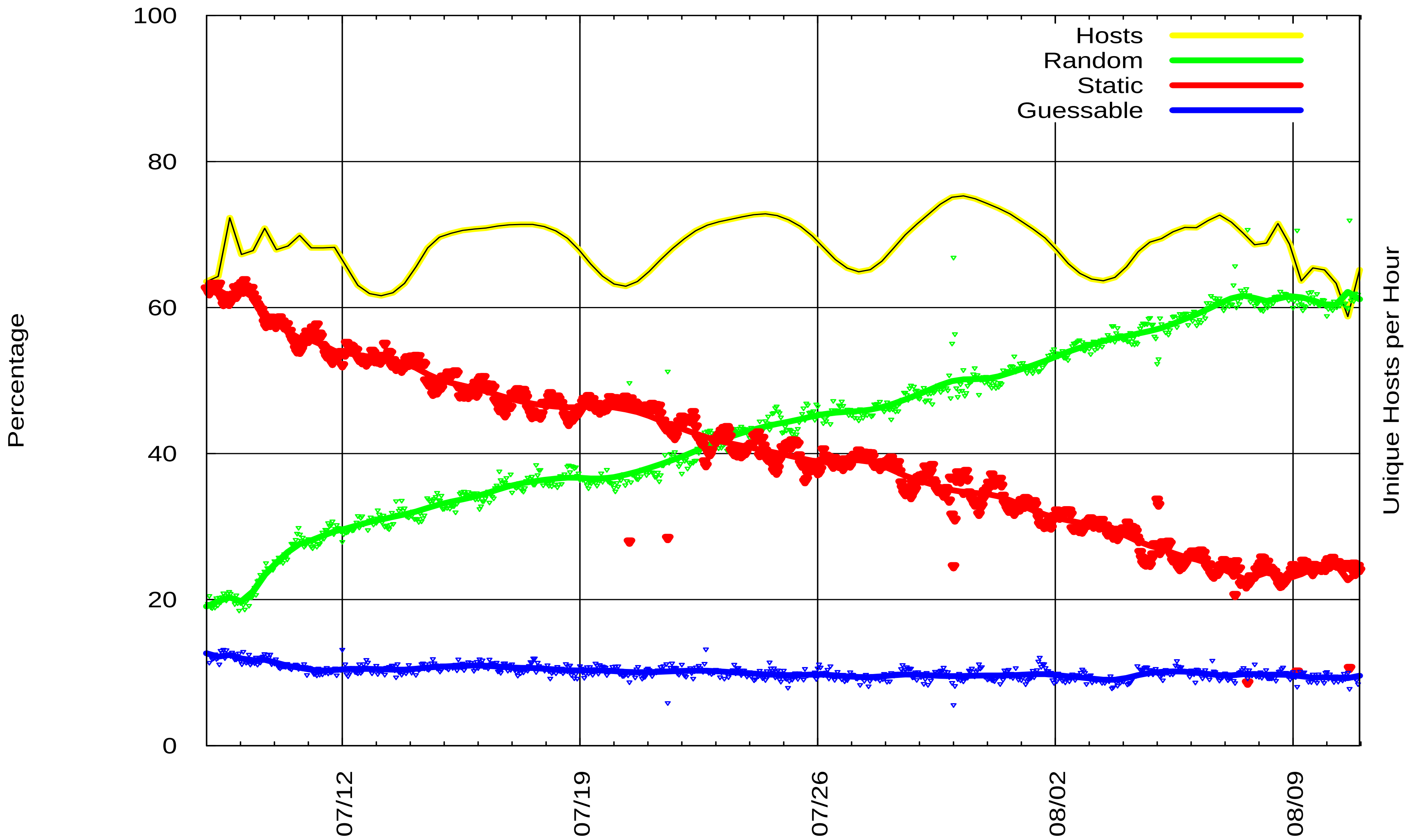


For an unpatched resolver, each connection uses the same ephemeral port

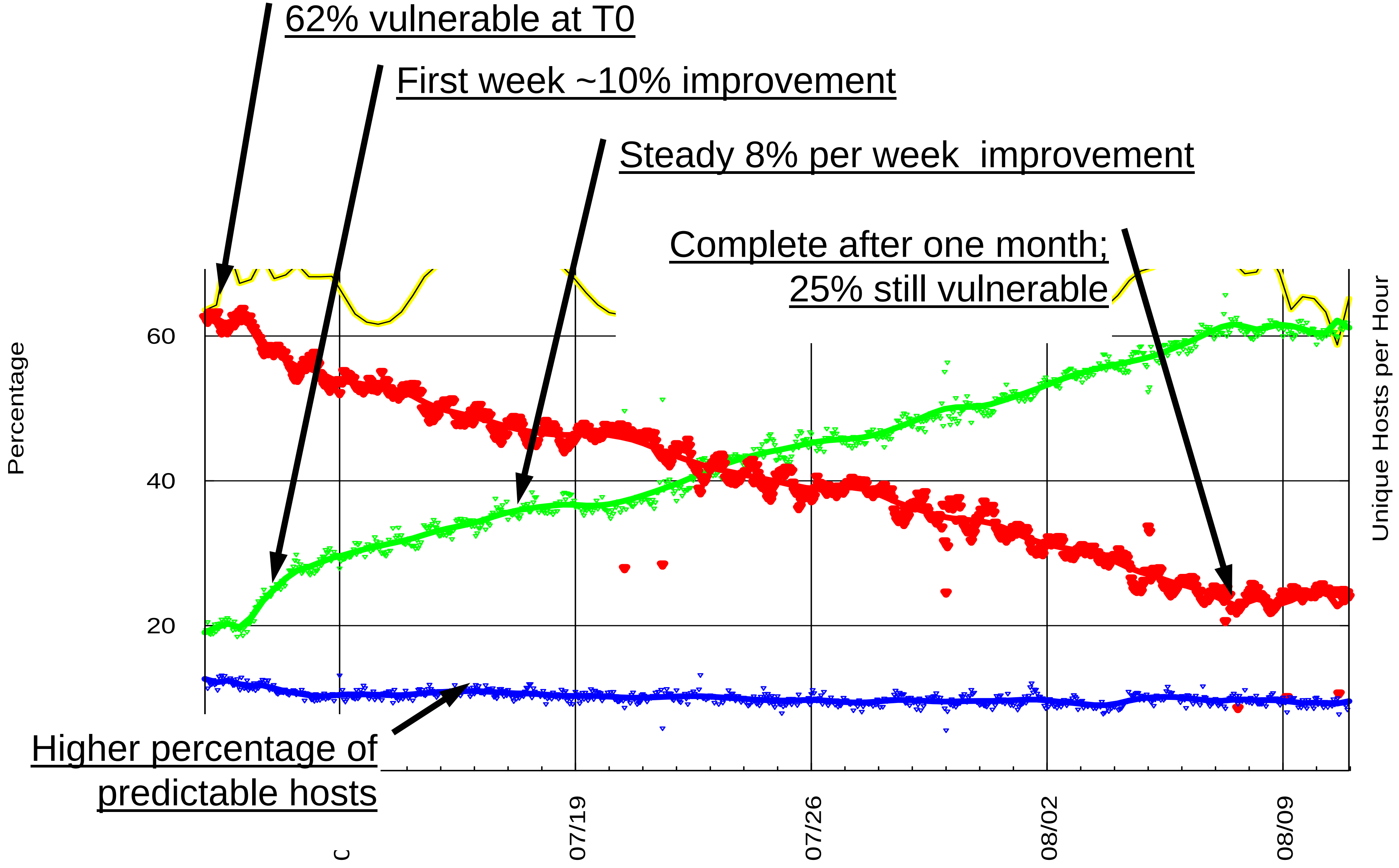
Patched resolvers use a random ephemeral port

```
           sIP|           dIP|sPort|dPort|pro|pkt|byte|               sTime|
186.54.105.135| 16.64.195.188|32556|   53| 17|  1| 282|2008/06/11T12:00:02|
186.54.105.135|   203.37.75.8|32557|   53| 17|  1| 258|2008/06/11T12:00:21|
186.54.105.135| 114.154.44.64|32558|   53| 17|  1| 322|2008/06/11T12:00:21|
186.54.105.135| 21.87.225.250|32559|   53| 17|  1| 196|2008/06/11T12:01:03|
```

Enclave Server Results



Enclave Server Results (2)



62% vulnerable at T0

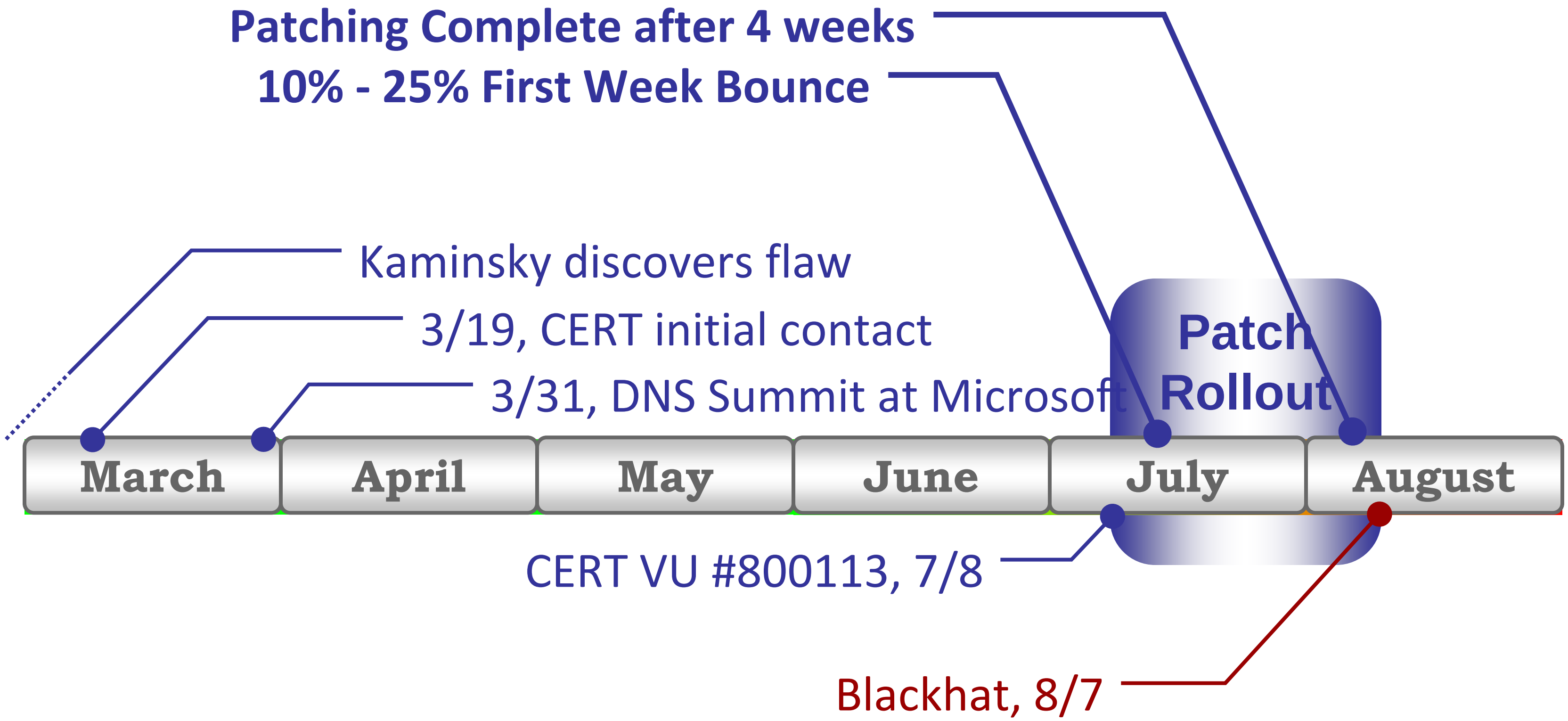
First week ~10% improvement

Steady 8% per week improvement

Complete after one month;
25% still vulnerable

Higher percentage of
predictable hosts

Timeline--including patching



Patching Complete after 4 weeks

10% - 25% First Week Bounce

Kaminsky discovers flaw

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CERT VU #800113, 7/8

Blackhat, 8/7

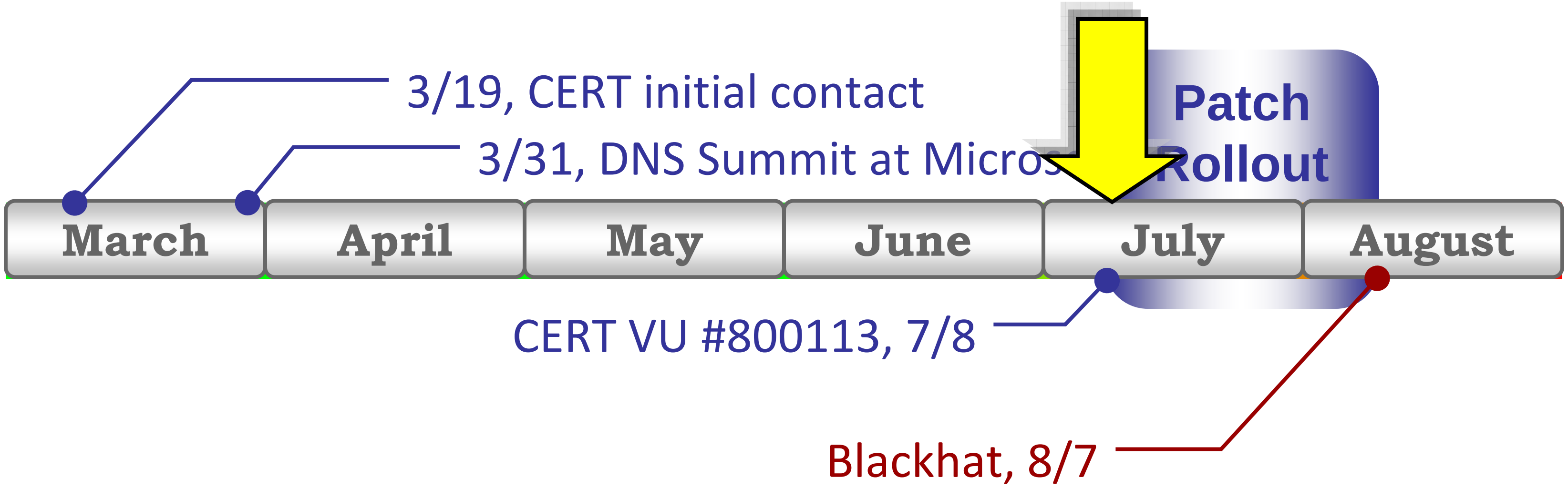
Disclosure

What was that again? Oh, of course…

Reaction to initial release

Posted in an Underground IRC channel (which was talking about marijuana):

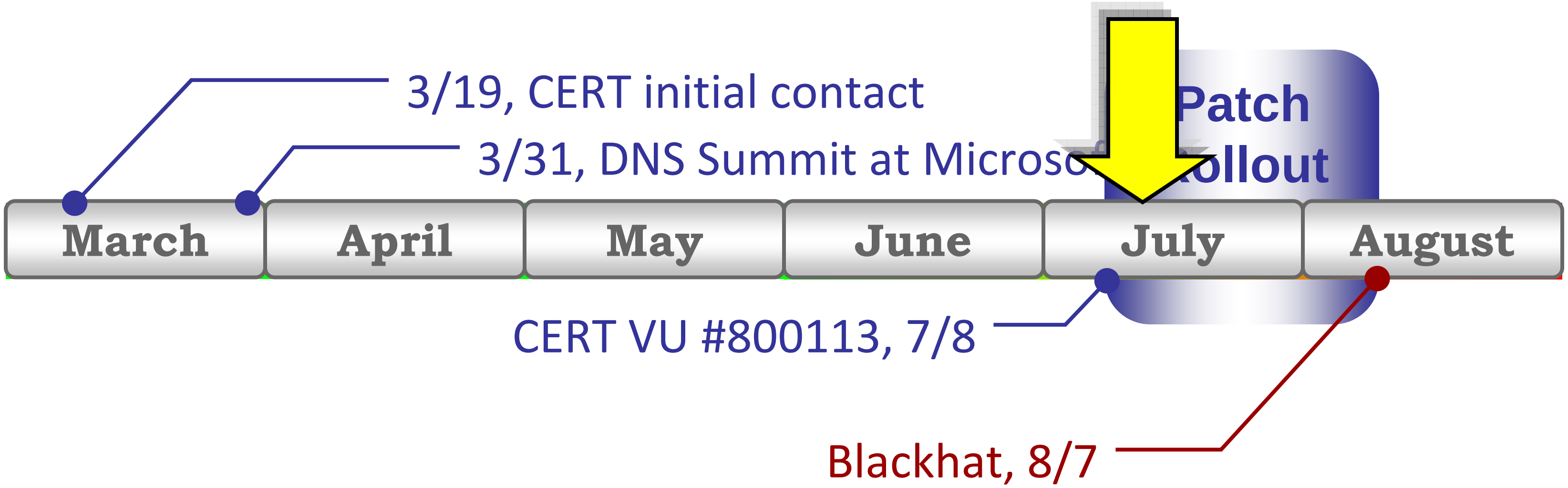
- http://securosis.com/2008/07/08/dan-kaminsky-discovers-fundamental-issue-in-dns-massive-multivendor-patch-released/
- Reaction: "haha nice"



Is your server vulnerable?

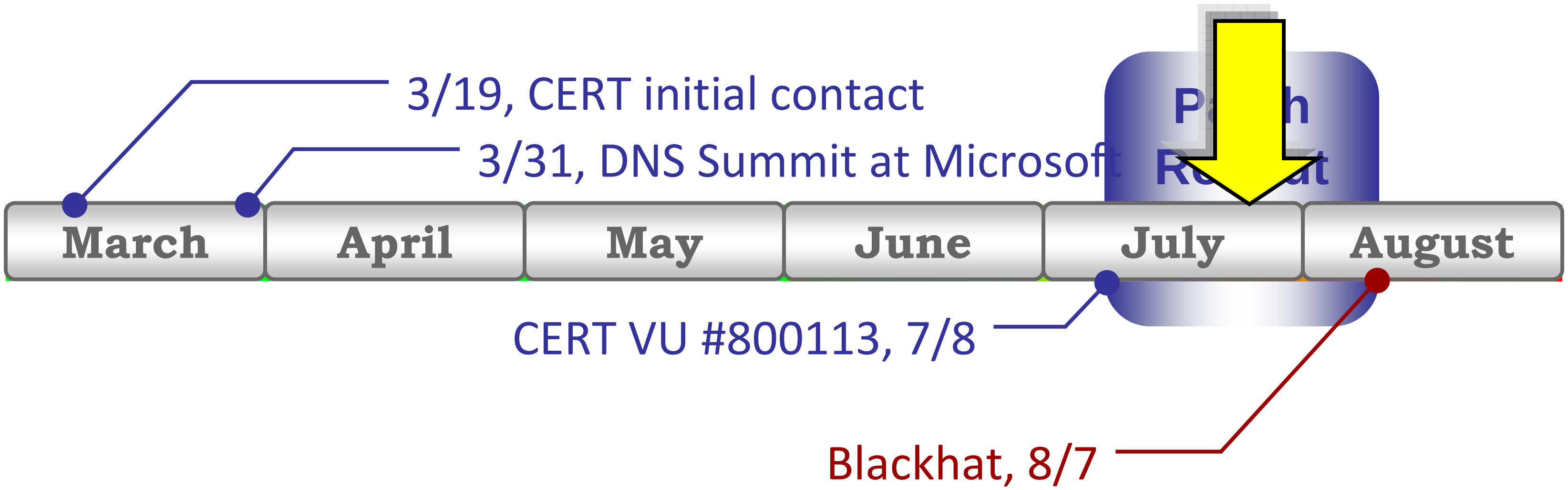
Community tools to test if your server was vulnerable:

- 2008.07.11(OARC) dig +short porttest.dns-oarc.net TXT
- 2008.07.14:
  - http://www.provos.org/index.php?/archives/42-DNS-and-Randomness.html
  - http://www.doxpara.com



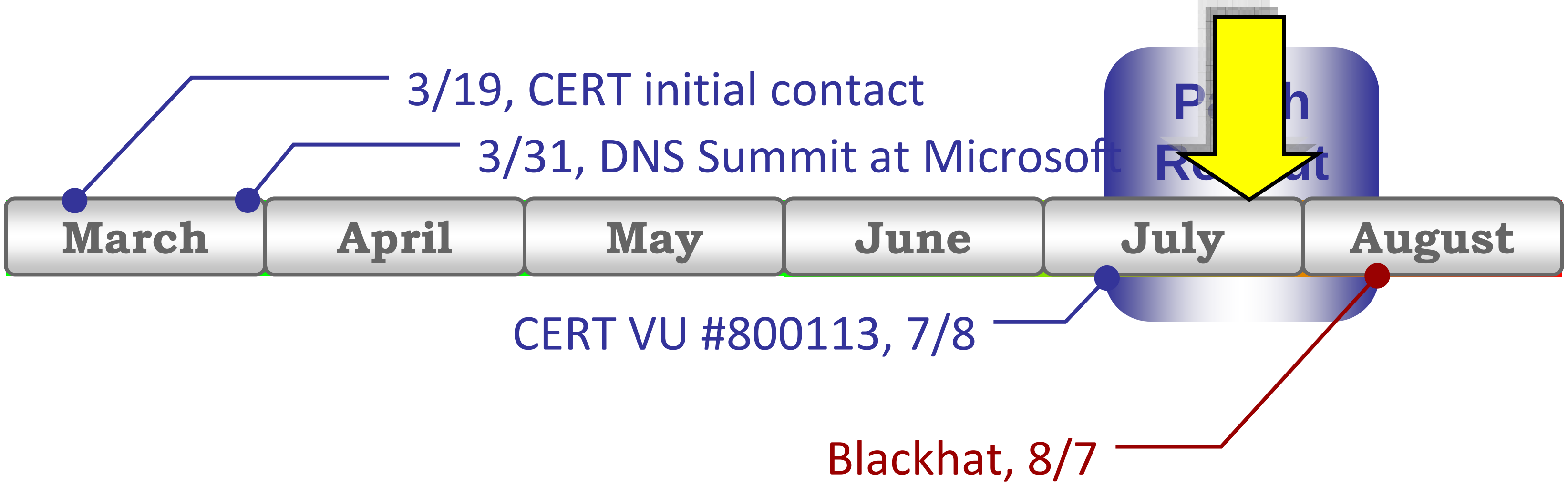
Details disclosed…no…wait…well…umm…

- **2008.07.21**: IRC bot pushes the following URL:
  - [Slashdot] Kaminsky's DNS Attack Disclosed, Then Pulled (it) - http://it.slashdot.org/article.pl?sid=08/07/21/2212227
- **2008.07.22**: The following link is posted in various underground IRC channels:
  - http://blog.invisibledenizen.org/2008/07/kaminskys-dns-issue-accidentally-leaked.html



Information in the underground (2)

- **2008.07.22**: In the middle of a discussion the following two items were posted:
  - http://blog.invisibledenizen.org/2008/07/kaminskys-dns-issue-accidentally-leaked.html
  - "It seems the cat might be out of the bag regarding Dan Kaminsky's upcoming presentation at Blackhat.“
- Link also posted in various underground IRC channels



3/19, CERT initial contact

3/31, DNS Summit at Microsoft

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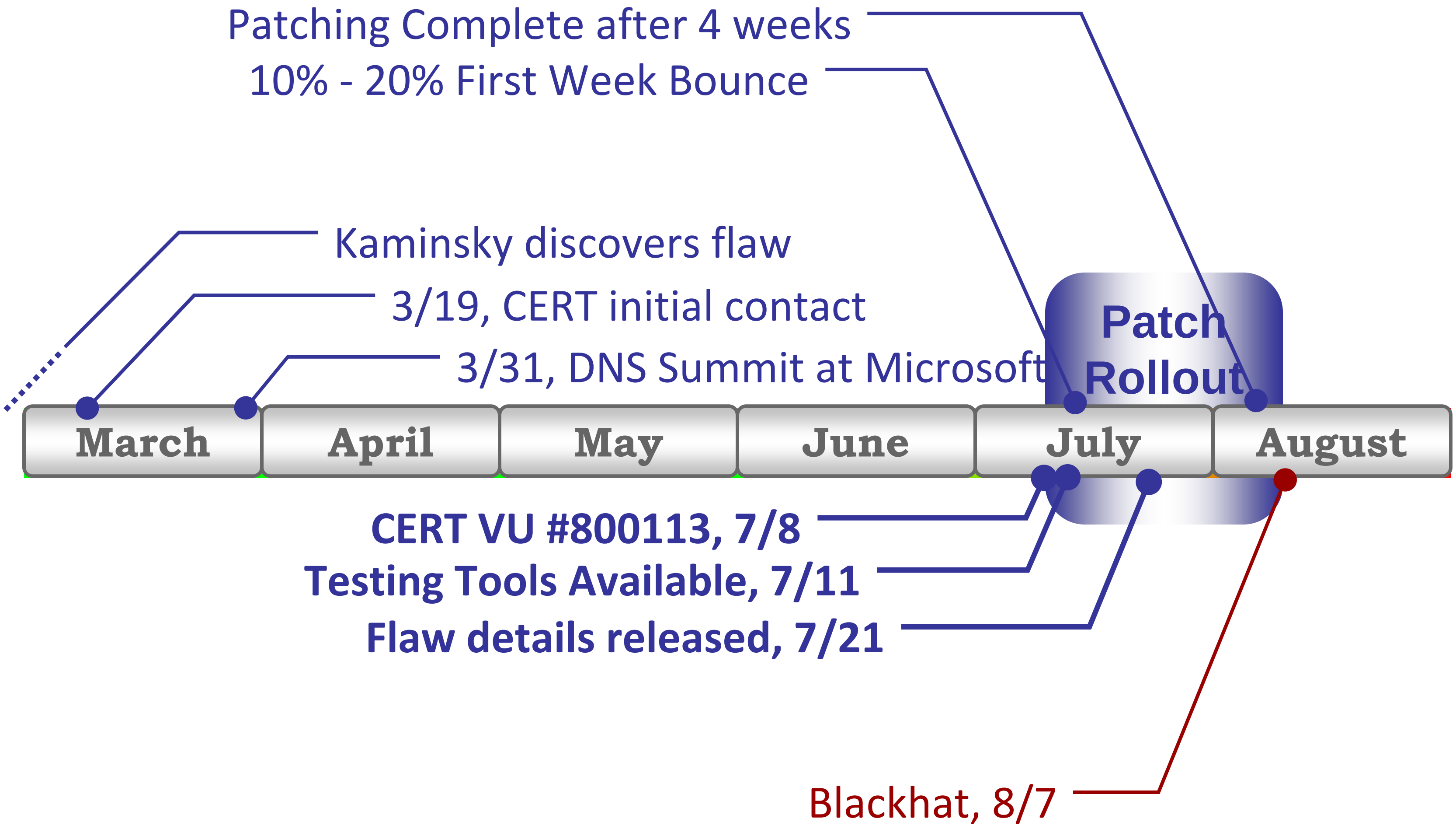
Blackhat, 8/7

Timeline--including disclosure



Patching Complete after 4 weeks

10% - 20% First Week Bounce

Kaminsky discovers flaw

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CERT VU #800113, 7/8

Testing Tools Available, 7/11

Flaw details released, 7/21

Blackhat, 8/7

Exploit

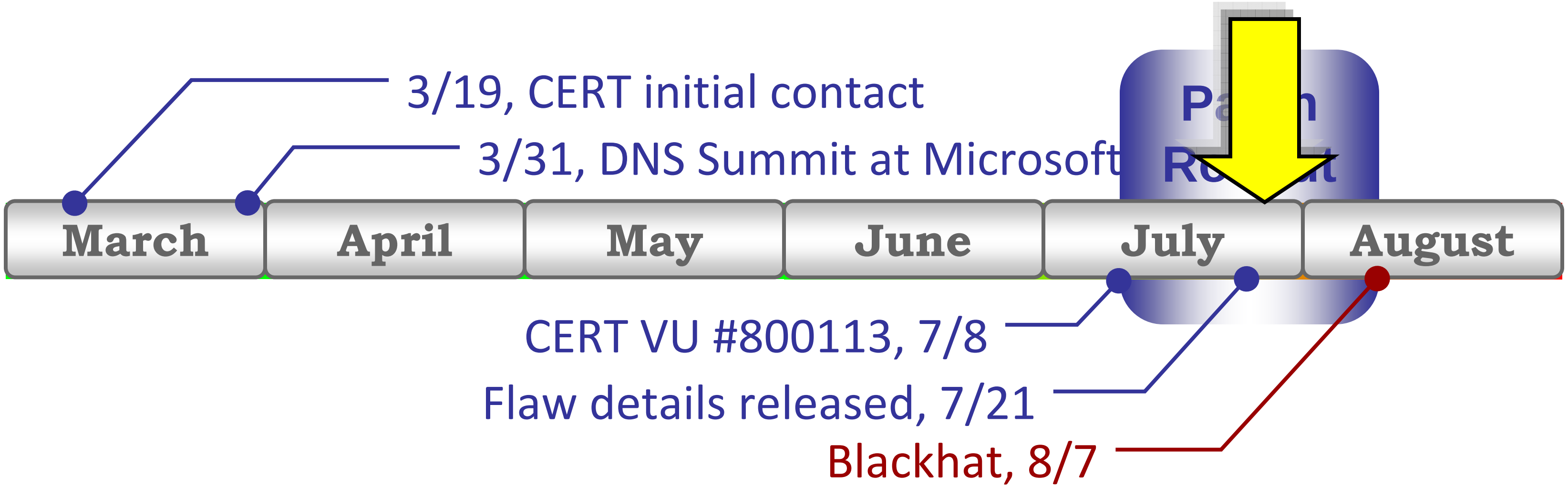
mwa ha ha ha[1]

[1] An interjection. Used to denote evilness.

Granto. “mwa ha ha ha ha.” *Urban Dictionary. 22 Feb 2004. 17 Sep 2008.*
<http://www.urbandictionary.com/define.php?term=mwa%20ha%20ha%20ha%20ha>

Publicly available exploits

- **2008.07.23**: Metasploit
  - Two days after details released
  - Part of the Metasploit framework
  - http://www.caughq.org/exploits/CAU-EX-2008-0002.txt
  - Posted on various Underground IRC channels on **2008.07.27** and **2008.08.09**


3/19, CERT initial contact
3/31, DNS Summit at Microsoft
Patch
Rollout
March
April
May
June
July
August
CERT VU #800113, 7/8
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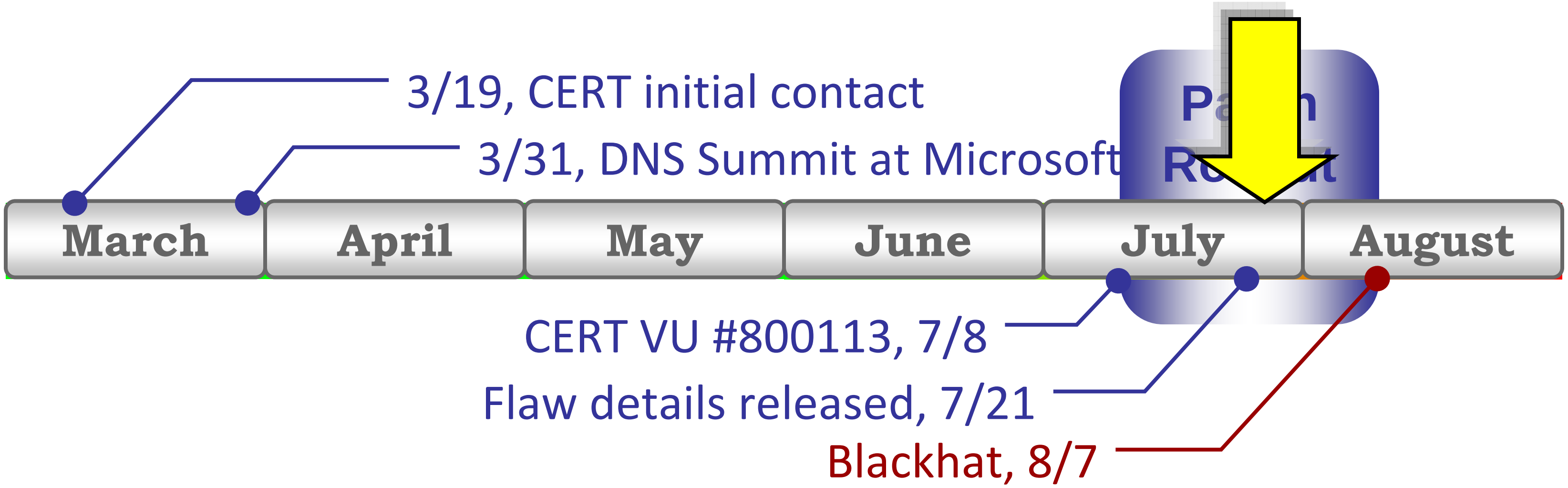
Publicly available exploits (2)

- **2008.07.24**: Metasploit v2
  - http://www.caughq.org/exploits/CAU-EX-2008-0003.txt
  - Primary difference: NS injection
  - Part of the Metasploit framework



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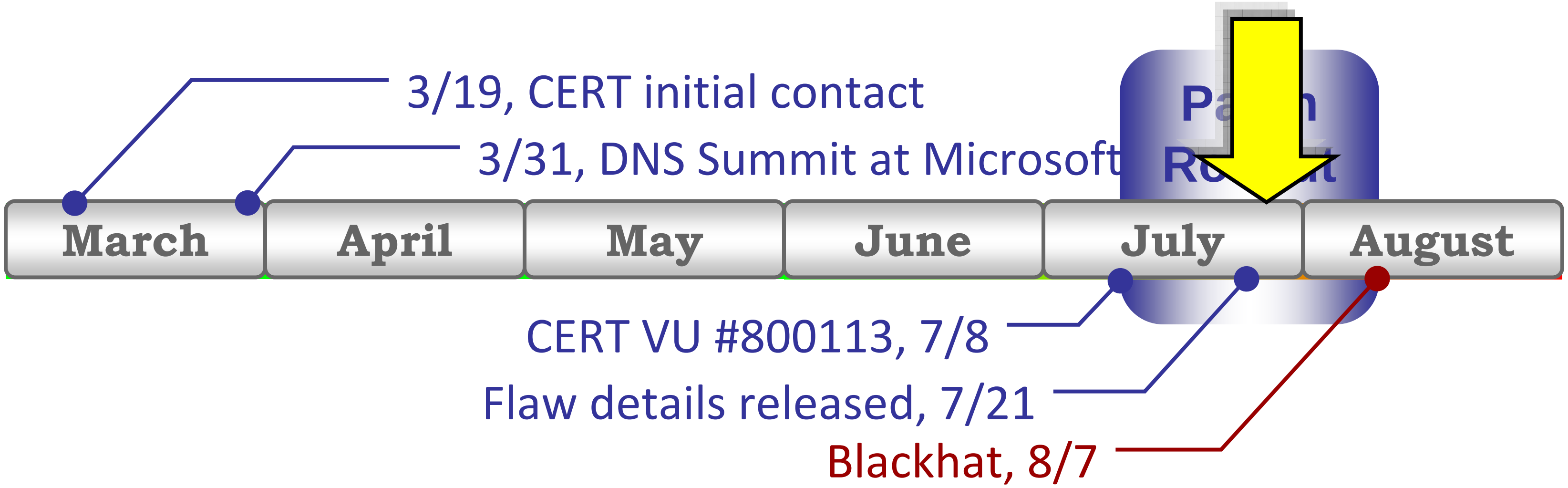
CERT VU #800113, 7/8

Flaw details released, 7/21

Blackhat, 8/7

Publicly available exploits (3)

- **2008.07.24**: milw0rm
  - http://www.milw0rm.com/exploits/6130
  - C based exploit



3/19, CERT initial contact

3/31, DNS Summit at Microsoft

CERT VU #800113, 7/8

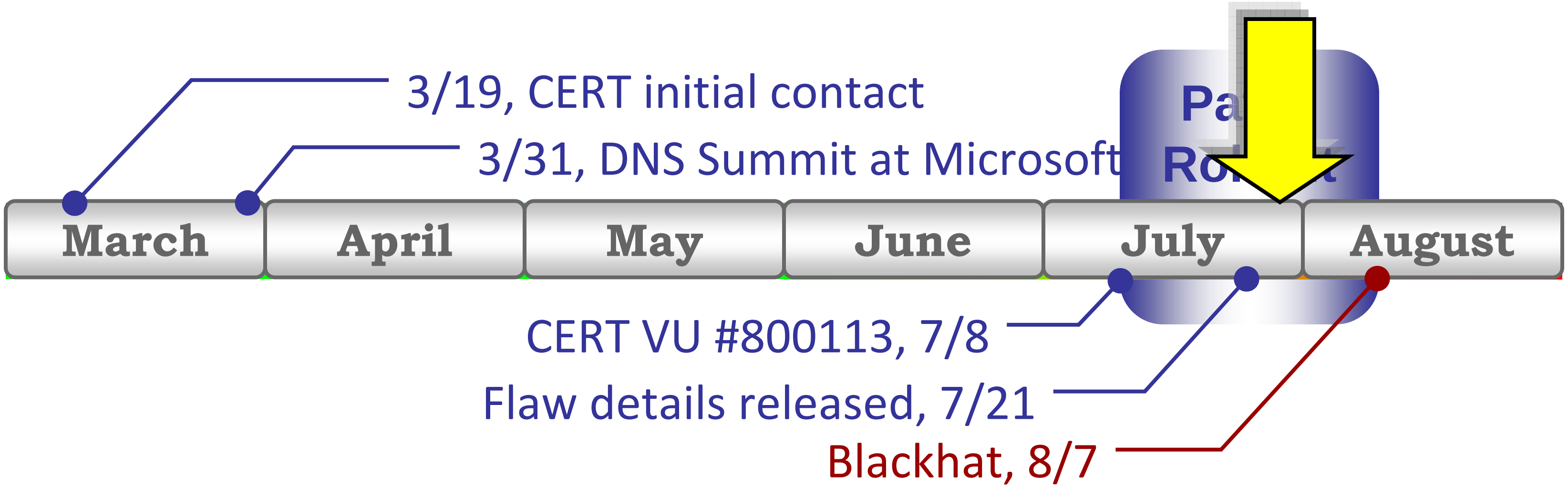
Flaw details released, 7/21

Blackhat, 8/7

Publicly available exploits (4)

- **2008.07.28:** Evilgrade
  - Evilgrade framework includes DNS cache poisoning
  - URL picked up on some underground IRC Channels:

    http://www.infobyte.com.ar/down/isr-evilgrade-Readme.txt



3/19, CERT initial contact

3/31, DNS Summit at Microsoft

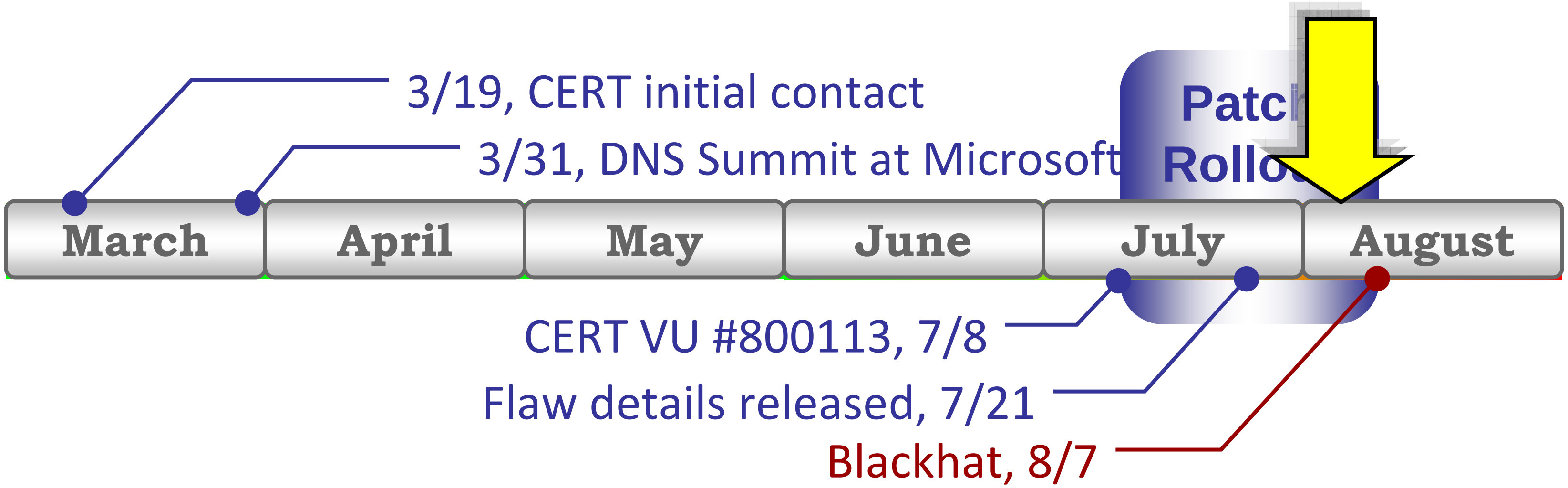
CERT VU #800113, 7/8

Flaw details released, 7/21

Blackhat, 8/7

Publicly available exploits (5)

- **2008.08.04:** adns
    - Asynchronous-capable DNS client library and utilities
    - Two weeks following detailed disclosure
    - Minor DNS utility, yet enough of a following to generate an exploit



3/19, CERT initial contact

3/31, DNS Summit at Microsoft

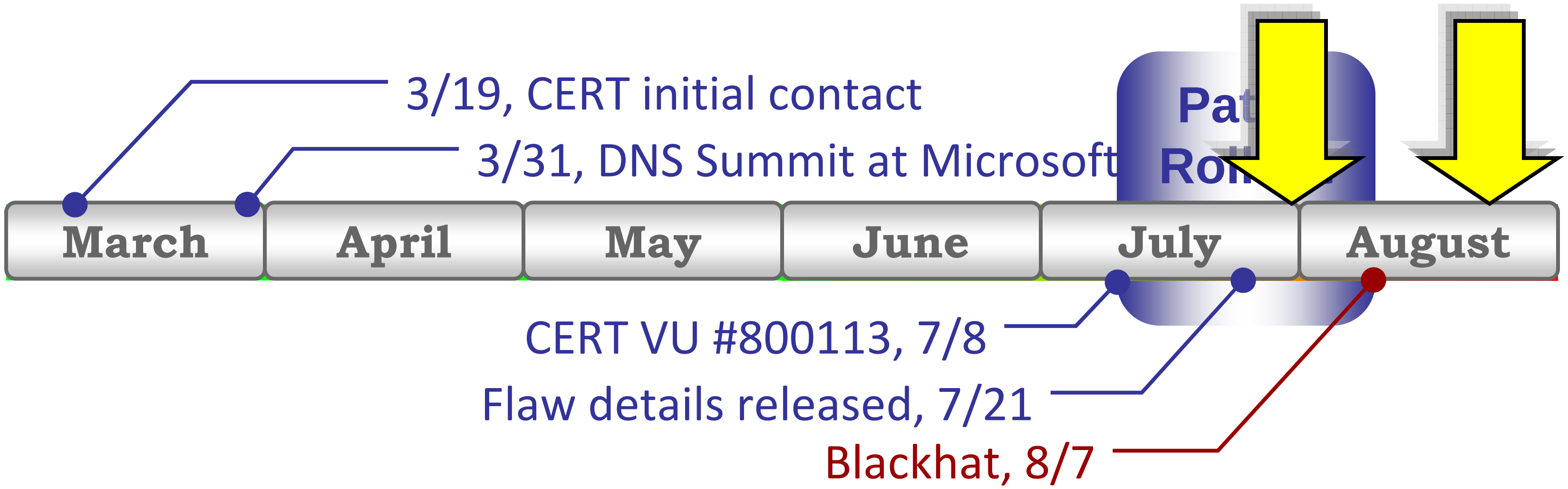
CERT VU #800113, 7/8

Flaw details released, 7/21

Blackhat, 8/7

We have attacks!

- **2008.07.30**
  - Confirmation obtained that sites are compromised via DNS Cache poisoning attacks
  - A full week after exploits were available
- **2008.08.21**
  - DNS cache flaw used to poison Chinese ISP's server



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CERT VU #800113, 7/8

Flaw details released, 7/21

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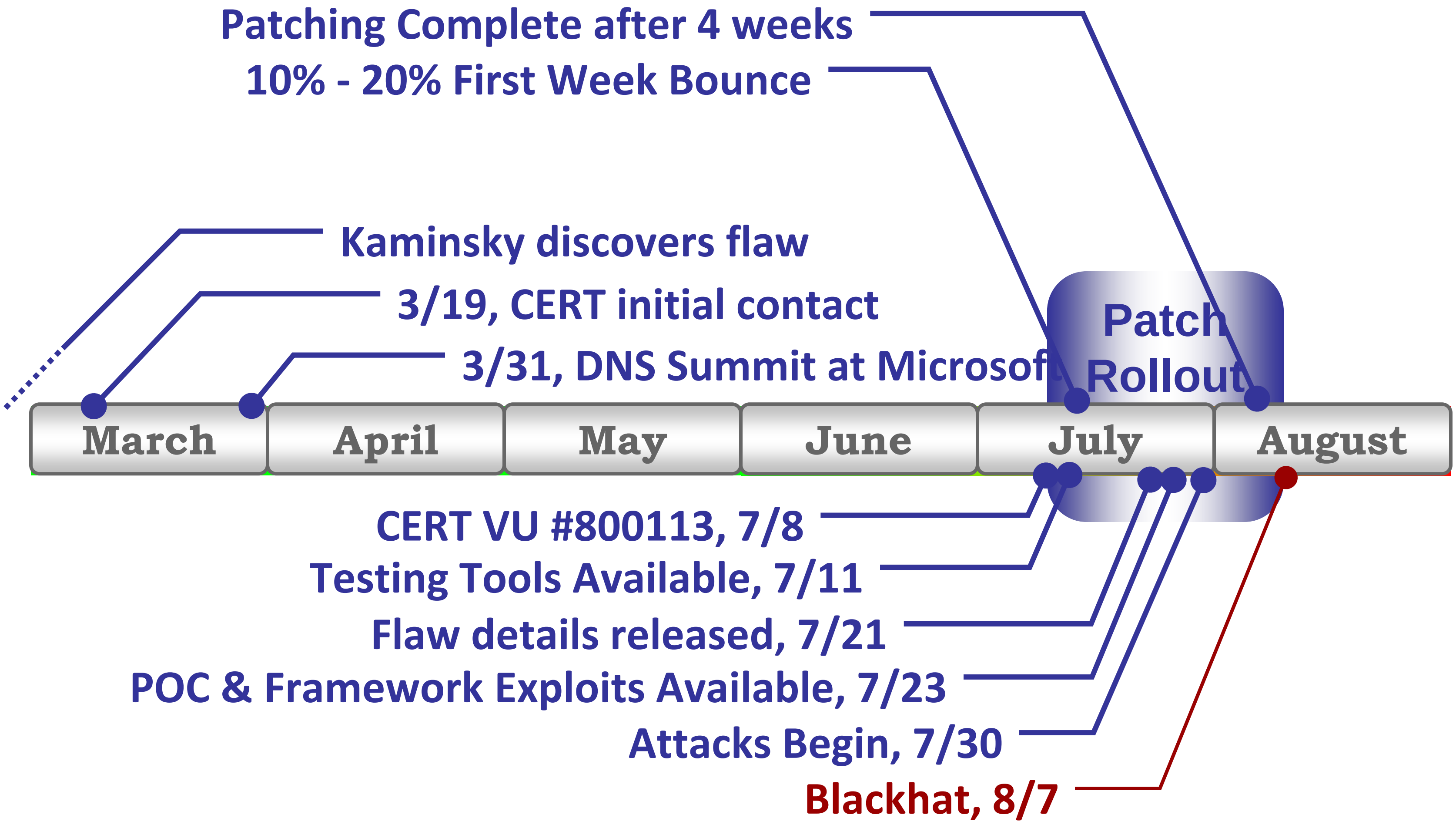
Timeline Yet Again



Patching Complete after 4 weeks

10% - 20% First Week Bounce

Kaminsky discovers flaw

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CERT VU #800113, 7/8

Testing Tools Available, 7/11

Flaw details released, 7/21

POC & Framework Exploits Available, 7/23

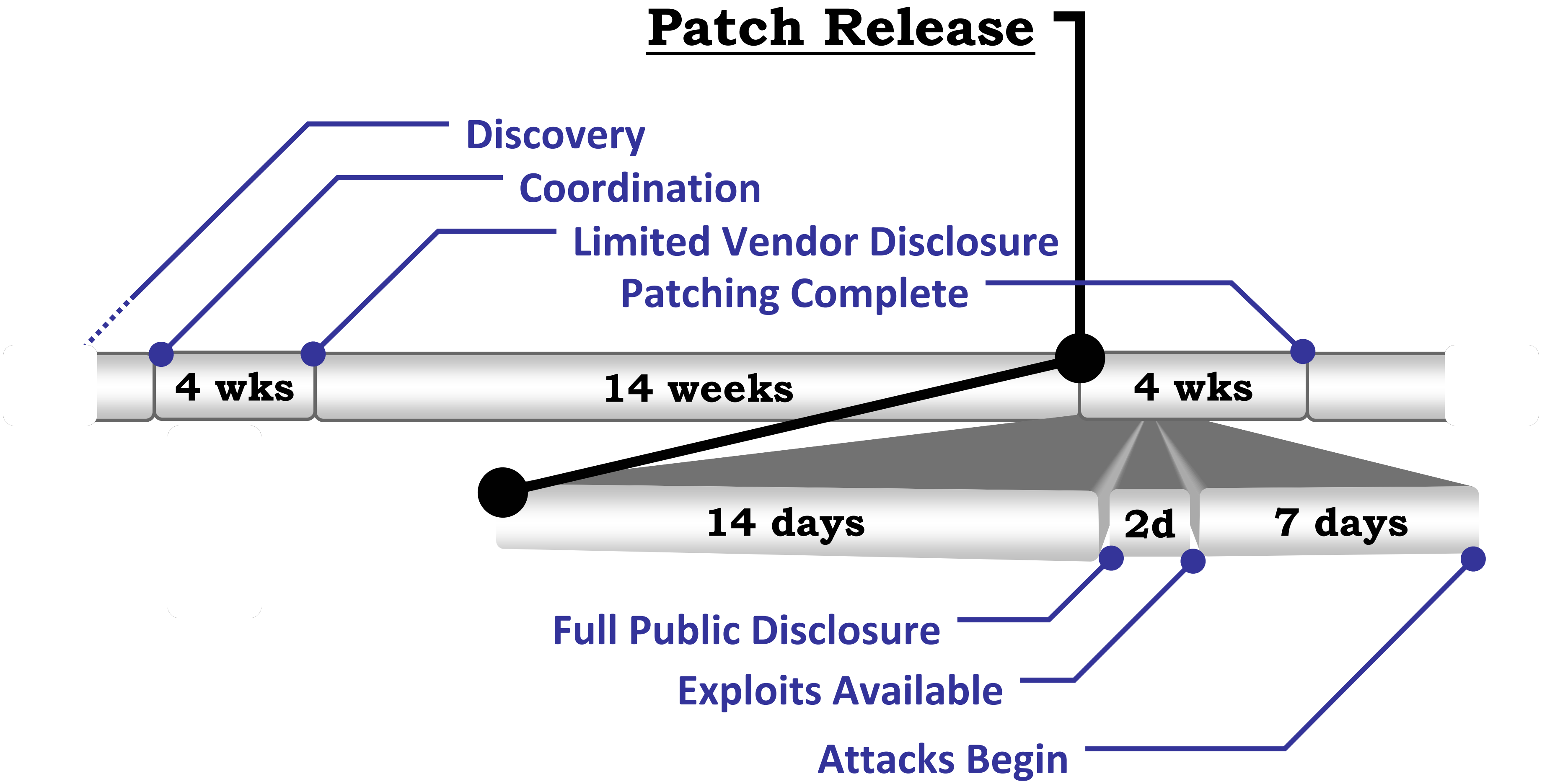
Attacks Begin, 7/30

Blackhat, 8/7

Conclusions

Gee, I think I already knew that…

Perhaps two timelines?



Specific Observations

Timeline

- Extended time between private disclosure and patch only added minimal risk
- Proposed 30-day window between patch and disclosure was sufficient
- Early disclosure caused attacks before patch rollout had been completed

Who has patched?

- 20-25% remained vulnerable
- 5-10% impacted by “gateway” issue

General Conclusions

Responsible Disclosure Worked

- Despite publicity, only 10-20% of machines patched within a week

- Within a month, most patches had been applied
- Critical milestone / warning sign for risk management is detailed disclosure
- There’s still some time between disclosure and attack.

There’s nothing really new here, just a quantitative confirmation of past qualitative observations.

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For More Information

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http://www.cert.org/

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