Enabling Client-Side Crash-Resistance to Overcome Diversification and Information Hiding

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Crash-Resistance

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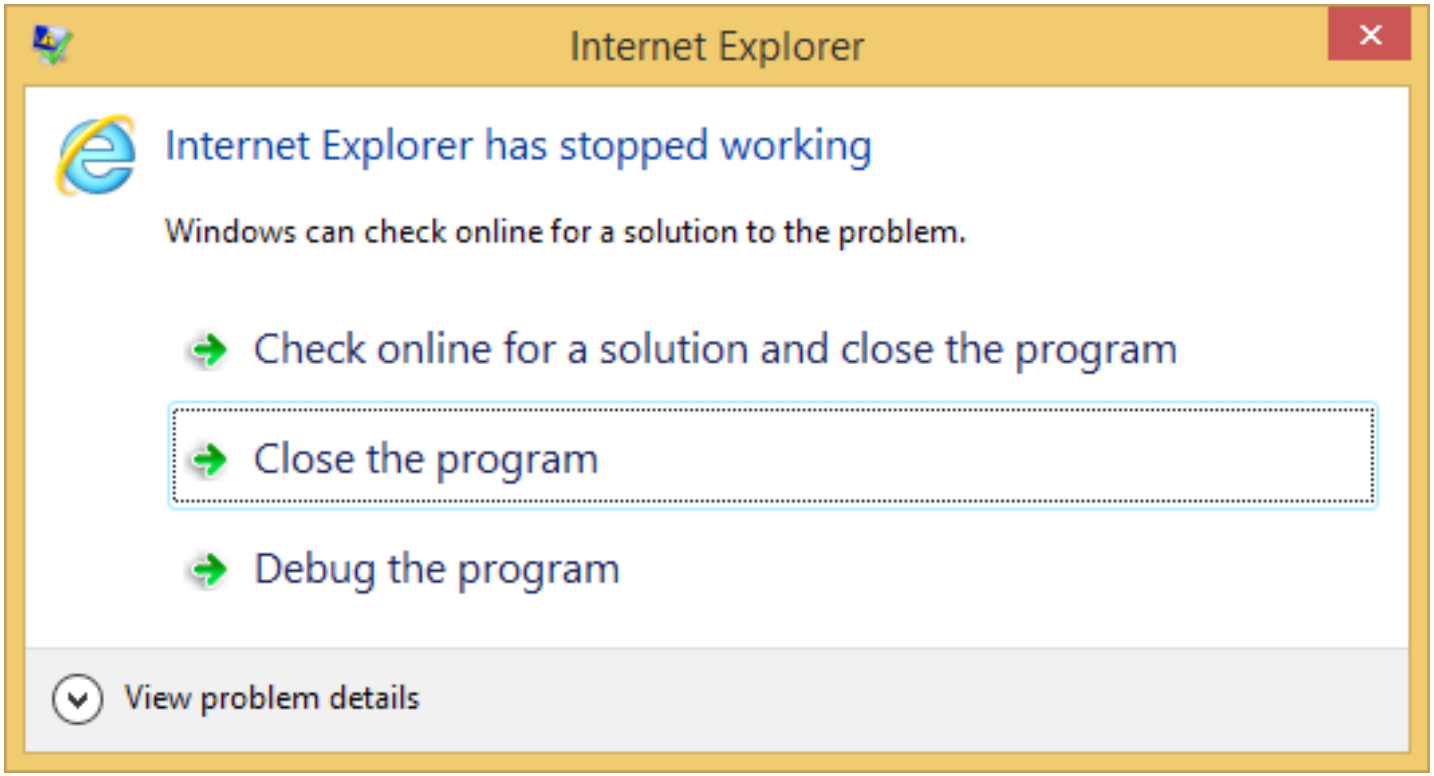
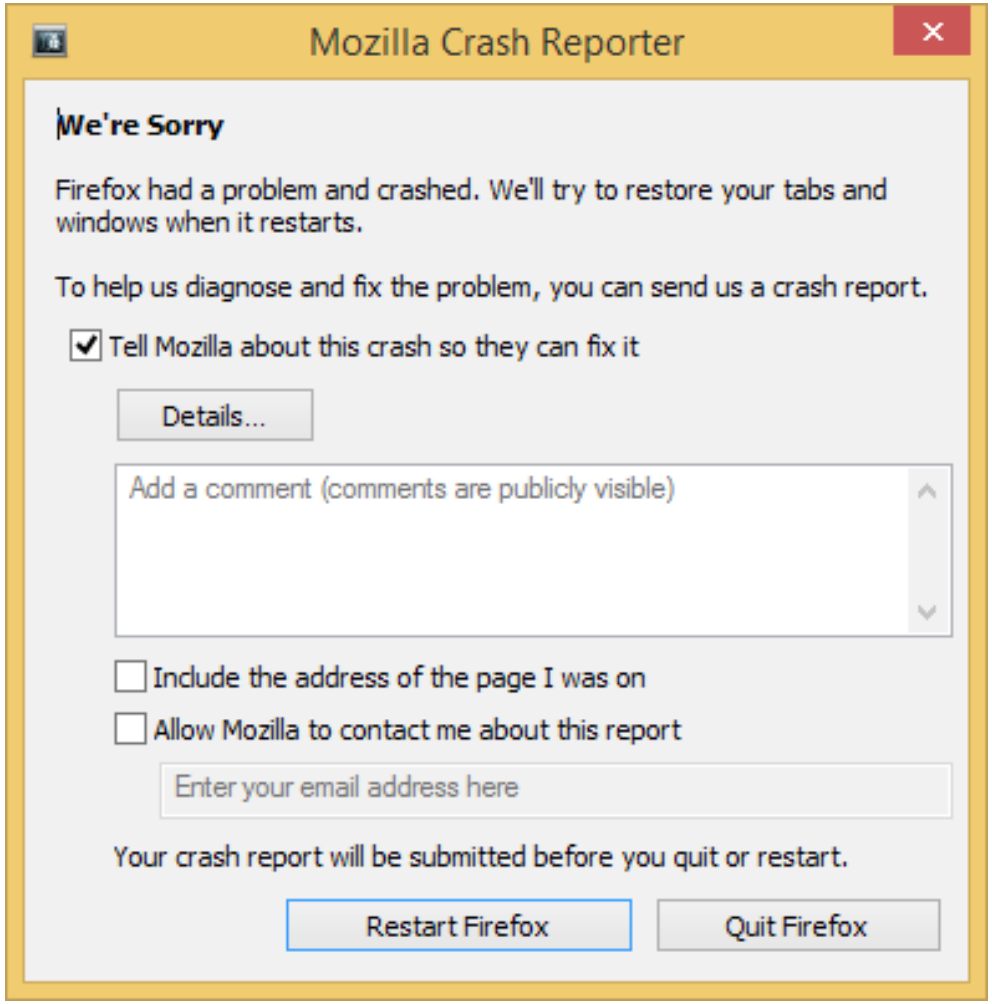
Program should terminate abnormally


Internet Explorer
Internet Explorer has stopped working
Windows can check online for a solution to the problem.
Check online for a solution and close the program
Close the program
Debug the program
View problem details


Mozilla Crash Reporter
We're Sorry
Firefox had a problem and crashed. We'll try to restore your tabs and windows when it restarts.
To help us diagnose and fix the problem, you can send us a crash report.
Tell Mozilla about this crash so they can fix it
Details...
Add a comment (comments are publicly visible)
Include the address of the page I was on
Allow Mozilla to contact me about this report
Enter your email address here
Your crash report will be submitted before you quit or restart.
Restart Firefox
Quit Firefox

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Instead:
Program runs endlessly

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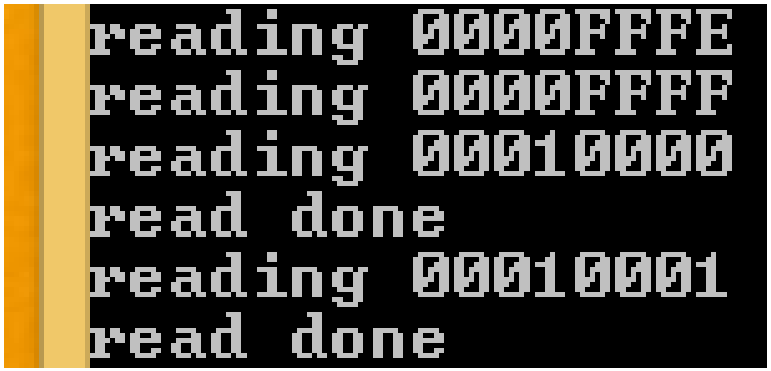

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Behind the Scenes

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DispatchMessage:
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→ *Access violation*

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continue execution

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Program continues running despite producing faults

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```
reading 0000FFFE
reading 0000FFFF
reading 00010000
read done
reading 00010001
read done
```

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⟶ Client-Side Crash-Resistance is usable as an *attack primitive*

Attacks with Client-Side Crash-Resistance

Memory Oracles with JavaScript

- Vulnerability needed to read/write address space

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⟶ If *address* is readable, *content* is returned into JavaScript variable

⟶ On a fault, reset *address* and try reading again

Memory Oracle in Internet Explorer (32-bit)

- *setInterval()* in web worker is crash-resistant
- *callback* function set with *setInterval()* queries memory
- ≈ 63 probes/s

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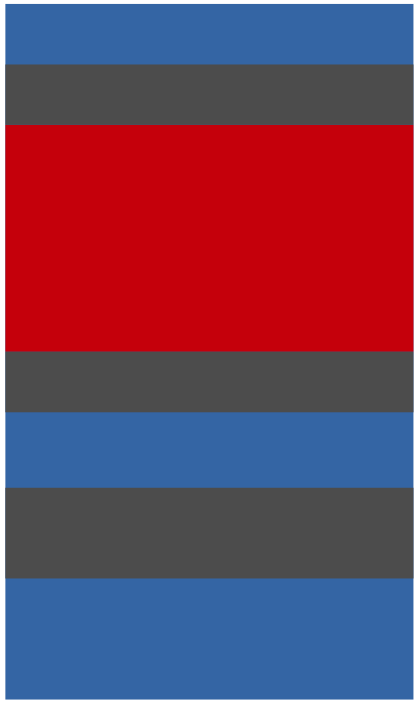
Memory Oracle in Mozilla Firefox (64-bit)

- *asm.js* uses exception handling for certain memory accesses
- Modification of *metadata* allows crash-resistant memory queries
- ≈ 700 probes/s (Windows)
- ≈ 18,000 probes/s (Linux)

Unveiling reference-less hidden memory regions

- memory region is randomized by *ASLR*
- *no references* exist to memory region

First program run



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: *readable memory*

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  - Pointer protection metadata: < 1s (Linux 64-bit)

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Overcome hidden code and code re-randomization

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To mount a control flow hijacking attack, perform *whole function code reuse*

Crash-Resistant Oriented Programming (CROP)

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(4) Read *return data* of system call and proceed to step (1)

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  - CVE 2015-6161 [4] (MS15-124 / MS15-125)
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- Defenses that prevent *memory corruption vulnerabilities*, can prevent current crash-resistance primitives

Q & A

References

[1] Shacham et al. **On the effectiveness of address-space randomization**. *CCS 2004*

[2] Bittau et al. **Hacking blind**. *Security & Privacy 2014*

[3] Evans et al. **Missing the Point(er)**. *Security & Privacy 2015*

[4] https://www.cve.mitre.org/cgi-bin/cvename.cgi?name=CVE-2015-6161

[5] https://bugzilla.mozilla.org/show_bug.cgi?id=1135903