Document parsers "research" as passive income

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Who is this guy

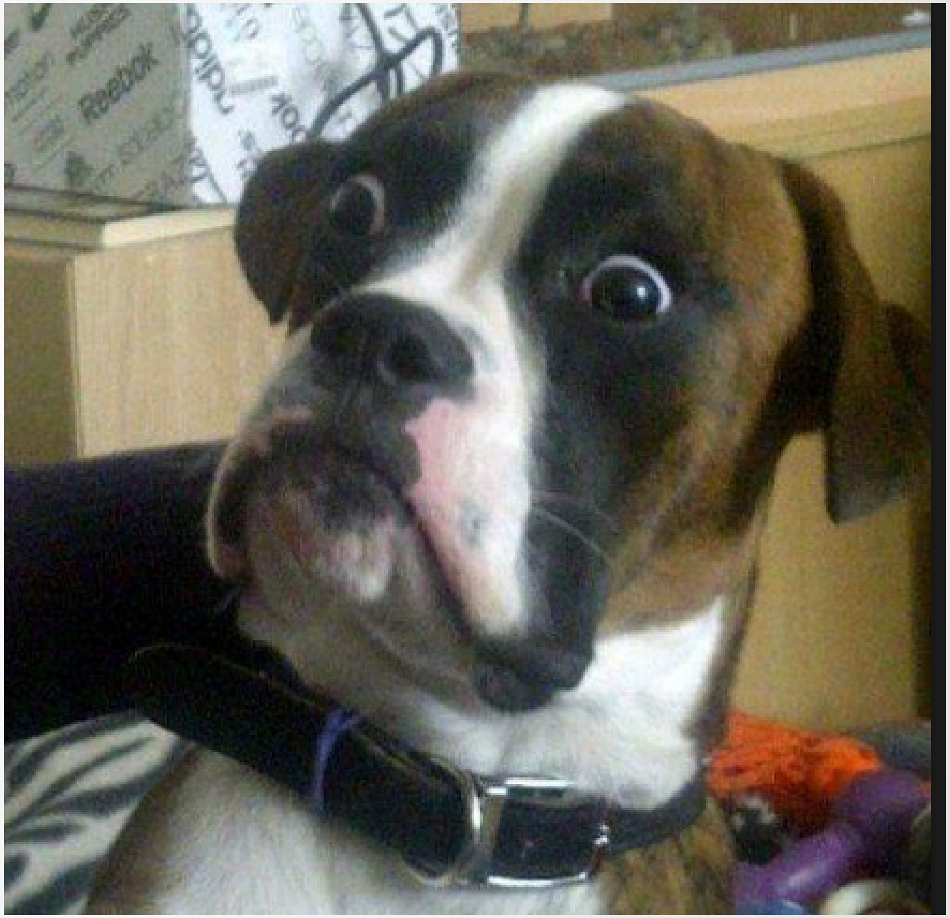
- Jaanus Kääp
- Working at Clarified Security
  - Vulnerability testing, research, trainings, cyber excercises
- Lazy

Why this topic

- Got #11 in MSRC top-100
  - Suprised but happy

Why this topic

- Got #11 in MSRC top-100
  - Suprised but happy
- Then found out who is #12
  - JAMES FORSHAW
- **WTF?**

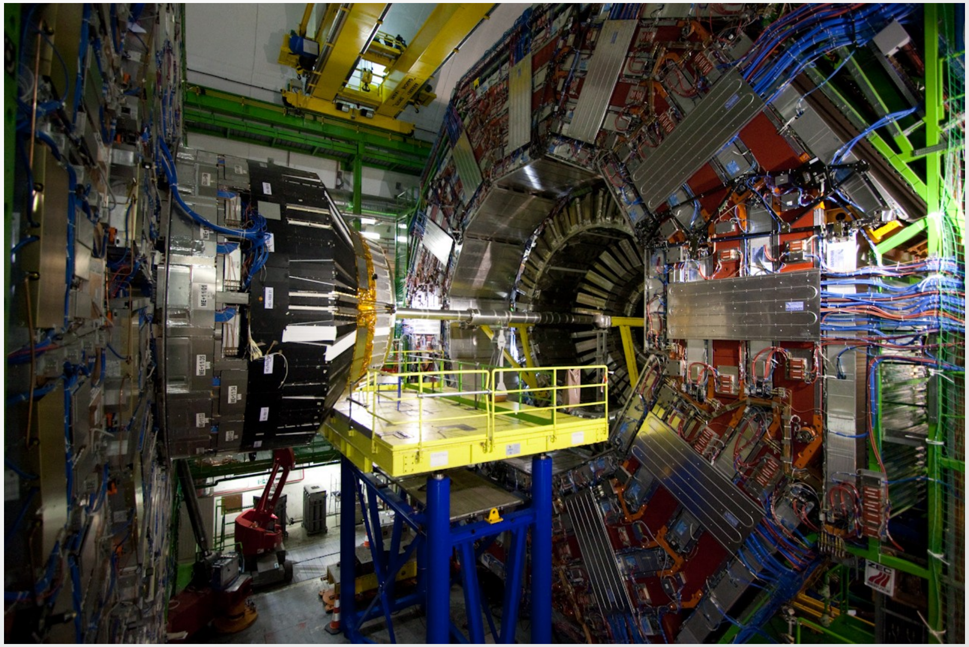


Why WTF?

- Reported things found by one fuzzing script*
- Fuzzing with same logic for 3 YEARS!
  - Dumb bit flipping fuzzing, nothing cool!
- My „passive income” through ZDI
- Still placed #11

„Research” vs Research

vs



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- My „passive income” through ZDI
- Placed #11
- **Pissed me off so here we are**

Topic itself

- Fuzzing
- My corpus distillation method
- Tools I developed
- Using with other stuff

Fuzzing

- Simple bit flipping
- 2-6 PC (Zotacs mostly)
  - Electricity cost nothing in Estonia
- Nothing special
- Except fuzzing set

Fuzzing set

- As much functionality as possible
- Lazy == no protocol implementation
- Very common filetype
- Multiple parsers

Corpus distillation

- What you need
  - Huge number of initial files
  - Application that can read them
  - Time and/or computing power
- What you do
  - Code coverage with every input
  - Analyse the coverage of all the files
  - Minimize the set

Code coverage

- Open source – simple (special flags)
- Closed source
  - Trace the code (dead slow)
  - Some tools/libs: Pin, DynamoRIO
  - Intel® PT*
  - Write coverage tool yourself

Code coverage

- Basic blocks breakpoints
- First idea:
  - Breakpoint to every basic block
- First implementation
  - Set breakpoints
  - Write down each bp-event
  - Continue execution

How to get basic blocks

- IDA pro + IDApython
- Each basic block
  - RVA from base address

First process

- Prep
  - IDA analysis
  - Basic blocks file generation
- Execution
  - Insert breakpoint
  - Catch 0xCC exceptions
  - If in the basic block list
    - Record location
    - Replace 0xCC with original value
    - EIP = EIP – 1

First run

- Foxit software
  - 611 927 breakpoint
  - Conf: 8 sec wait
  - 180 seconds for setup
  - 30 seconds for execution
  - TOTAL: ~210s/execution == 411 runs per day

- **TOO SLOW**

How to speed up?

- Most time was spent on setting breakpoints
- What is breakpoint
  - 0xCC
- Why not set them in executable?

How to get basicblocks

- IDA pro + IDApython
- Each basic block
  - RVA from base address
  - RVA/Offset in the file
  - Original value

New process

- Prep
  - IDA analysis
  - Basic blocks file generation
  - Modification of the exe/dll files
- Execution
  - Catch 0xCC exceptions
  - If in the basic block list
    - Record location
    - Replace 0xCC with original value
    - EIP = EIP – 1

Second run

- Foxit software
  - 611 927 breakpoint
  - Conf: 8 sec wait
  - 30 seconds for execution
  - TOTAL: ~30s/execution

- **MUCH BETTER**

Additional optimization

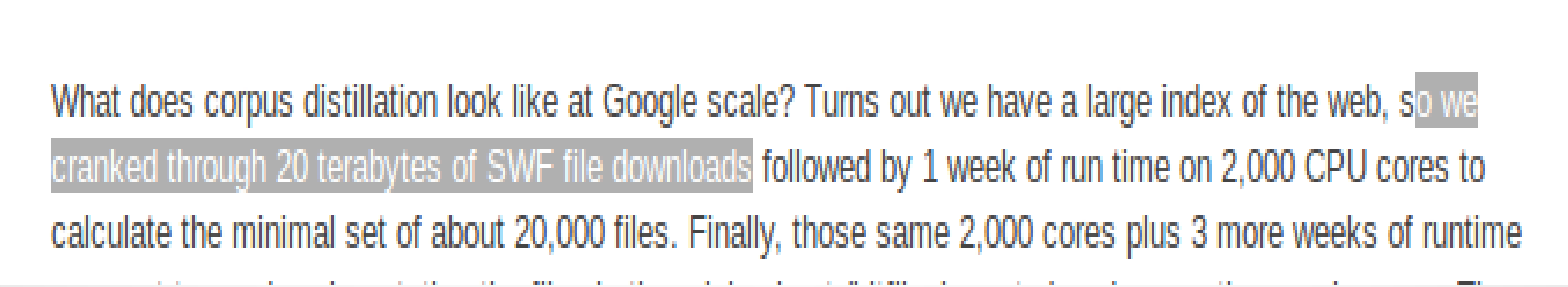
- Reducing basic blocks count
  - Analyse some(100-1000) files
  - Take some(1-25) files with most coverage
  - Add them to final set
  - Remove basicblocks covered by them

Third run

- Foxit software (simple example)
  - <600 000 breakpoint
  - Conf: 8 sec wait
  - 12 seconds for execution
  - TOTAL: ~12s/execution
- **50% overhead only for close source software**

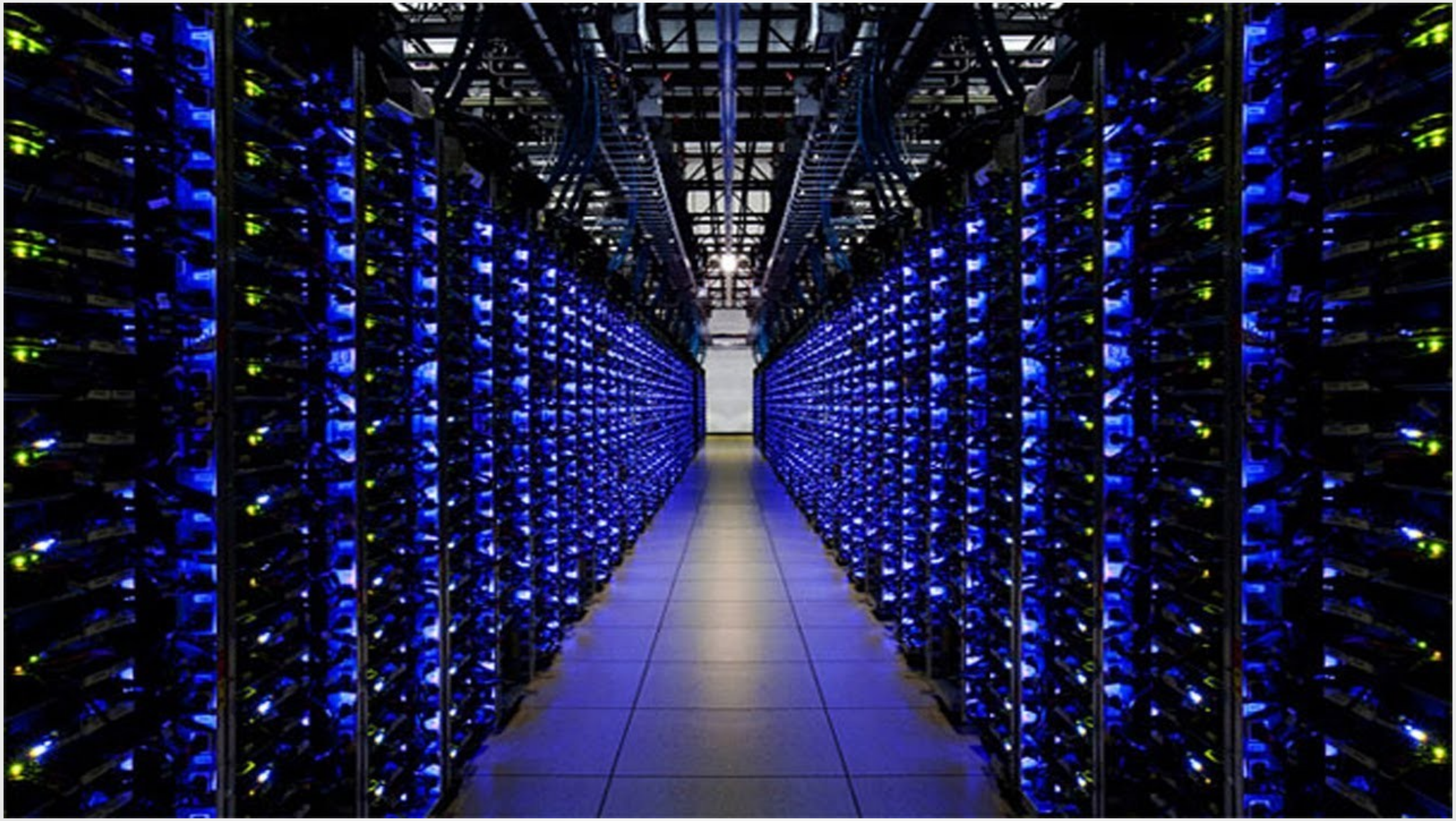
DEMO

How large initial set you need?

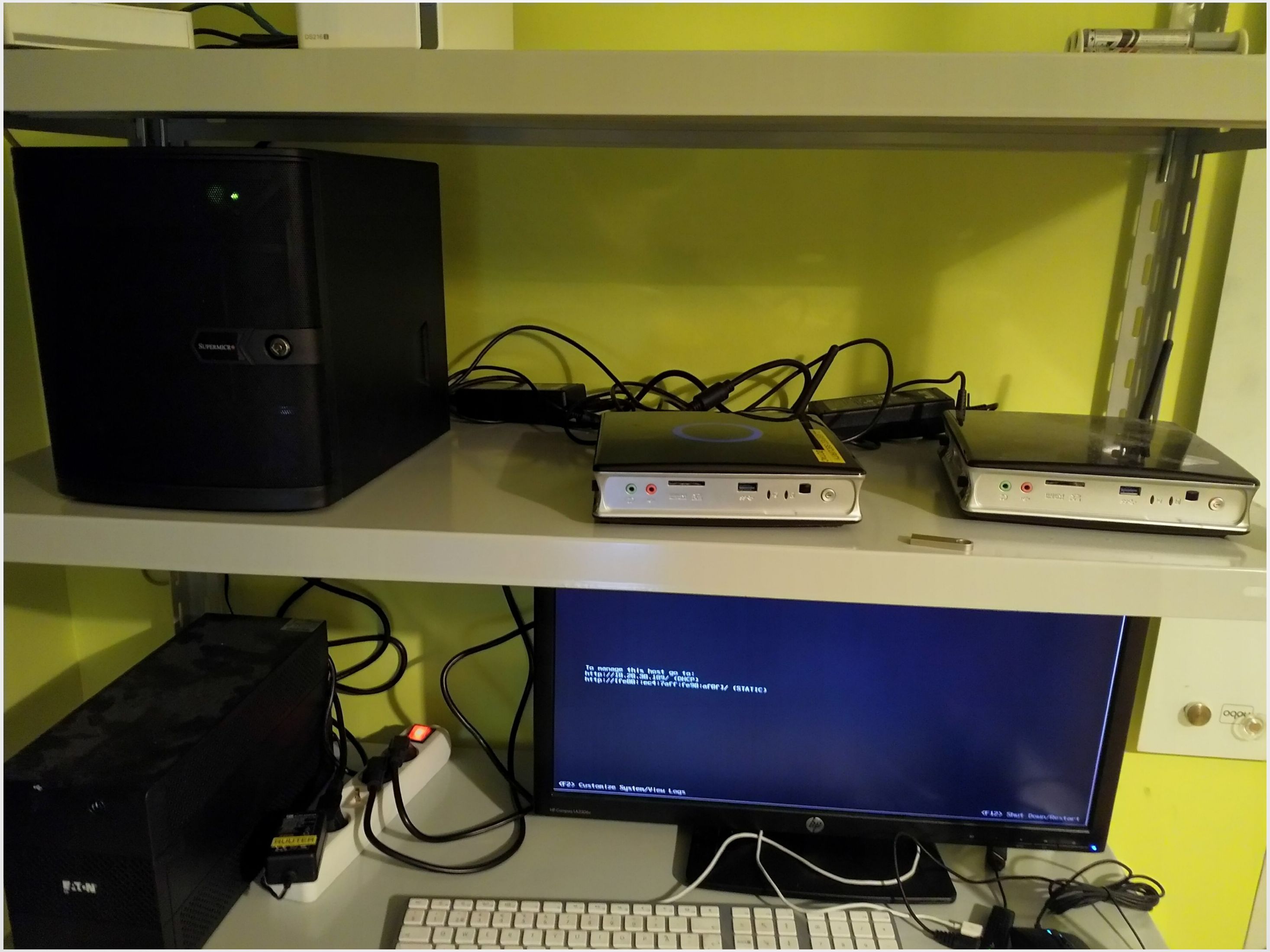


What does corpus distillation look like at Google scale? Turns out we have a large index of the web, so we cranked through 20 terabytes of SWF file downloads followed by 1 week of run time on 2,000 CPU cores to calculate the minimal set of about 20,000 files. Finally, those same 2,000 cores plus 3 more weeks of runtime

Google server room



My server room

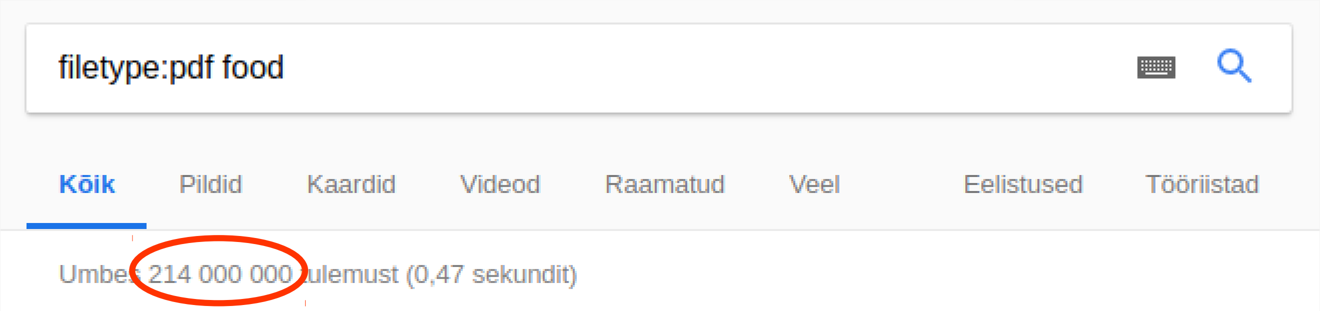

SUPERMICRO
To manage this host go to:
http://10.20.30.109/ (DHCP)
http://[fe80::ec4:7aff:fe98:af0f]/ (STATIC)
<F2> Customize System/View Logs
<F12> Shut Down/Restart
EATON

Final sets

Software	Initial set	Final set
PDF	~1 500 000	2216
DOC	~1 500 000	1309
XLS	~1 500 000	1951
PPT	~1 500 000	1379
SWF	~1 500 000	1495*

How to get these files?

- Google „filetype:pdf“



filetype:pdf food

Umbes 214 000 000 tulemust (0,47 sekundit)

How to get these files?

Additional problems

- Not real pdf files
- DDOS protection

Solution

- Searches
  - filetype:pdf aa
  - filetype:pdf ab
  - filetype:pdf ac
- Not real pdf files
  - Magic value - %PDF
- DDOS protection
  - It's all about timing
    - **45** seconds wait

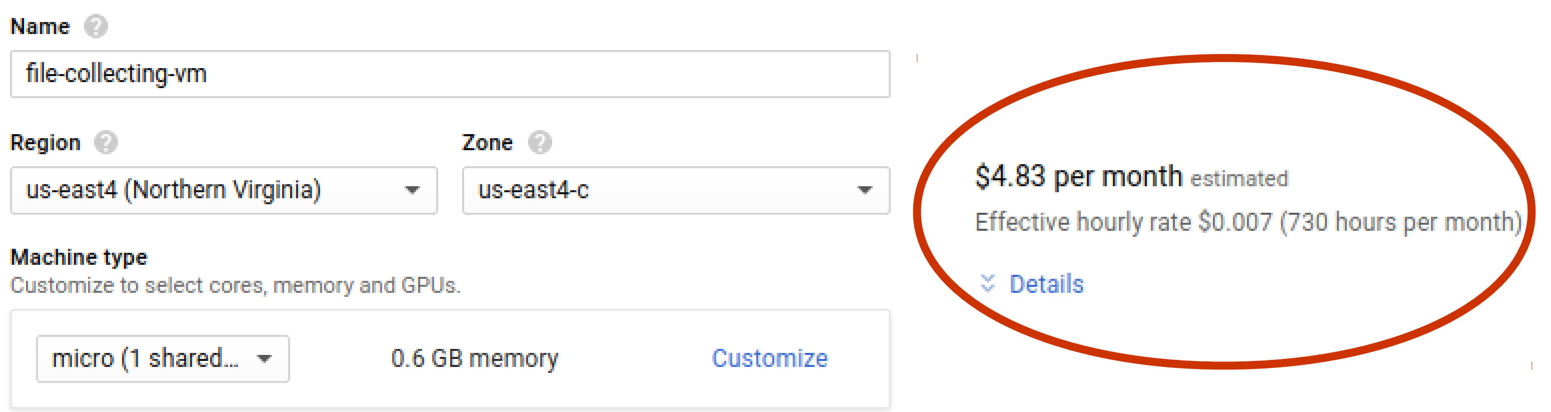
Additional tricks

- Collecting files from multiple IPs
- Anyone here from Google?
  - Please close your eyes and ears for 1-2 minute
  - Possible violation of Terms of Service
    - Hopefully not :)

Additional tricks

Additional tricks

- Every VM gets it’s own public IP
- Even the smallest and cheapest one



Name

file-collecting-vm

Region

us-east4 (Northern Virginia)

Zone

us-east4-c

Machine type

Customize to select cores, memory and GPUs.

micro (1 shared...

0.6 GB memory

Customize

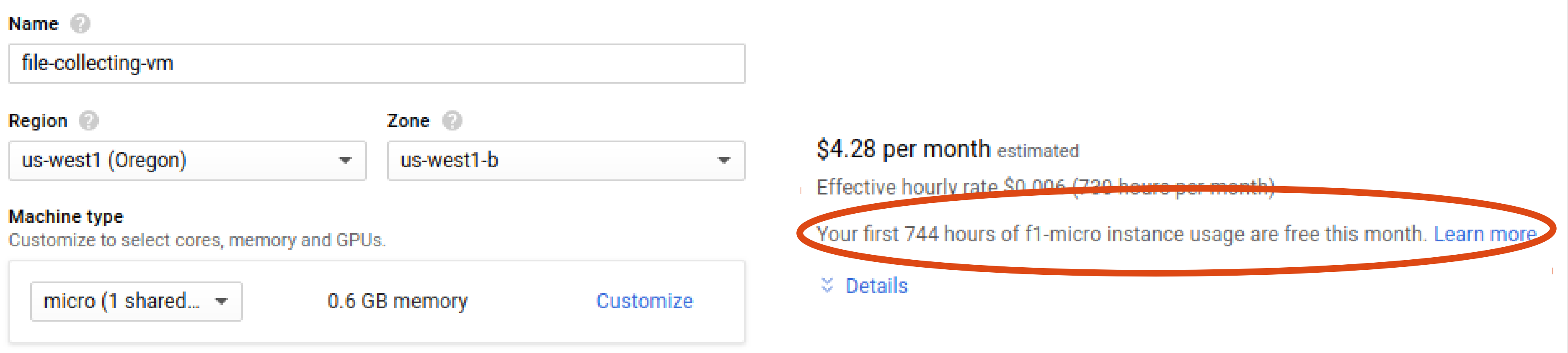
$4.83 per month estimated

Effective hourly rate $0.007 (730 hours per month)

Details

Additional tricks

- IT gets just a bit better



Name: file-collecting-vm

Region: us-west1 (Oregon)

Zone: us-west1-b

Machine type
Customize to select cores, memory and GPUs.

micro (1 shared... | 0.6 GB memory | Customize

$4.28 per month estimated

Effective hourly rate $0.006 (730 hours per month)

Your first 744 hours of f1-micro instance usage are free this month. Learn more

Details

Results & CVE-s

Vendor	CVE count
Microsoft	27
Adobe	45
Apple*	2

- Bit over 2 per month + some coming
- Actually more findings - lot from Foxit
  - Vendor not giving CVE-s == no CVE (pure laziness)

How bad against others

- Did use doc fileset to fuzz smaller office software
  - Libreoffice (64bit)
    - 32 bit + full page heap == crash......
  - WPS office
  - Polaris office
- 5days * 24hours * 16 VMs
- Microsoft & Adobe seem lot better after that

Unique crashes (reverified)

Software	ITERATIONS	NOT NULL	NULL
Libreoffice	~64K(~800/day)	6	2
WPS	~256K(~3200/day)	24	7
Polaris	~120K(~1500/day)	60	47

Unique crashes (reverified)

Software	DEP	OOBR	OVERFLOW	UAF	UNINITED	???	NULL
Libreoffice		2		2		2	2
WPS	1	14	2	1		6	7
Polaris		32	1	5	6	16	47

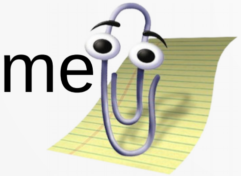
My toolset „Rehepapp”

- Analyzer tool & IDA scripts for BB list
- Tracer software
- Server for gathering data & analysis
- Scripts for file collection & coverage
- Supporting software for data modification

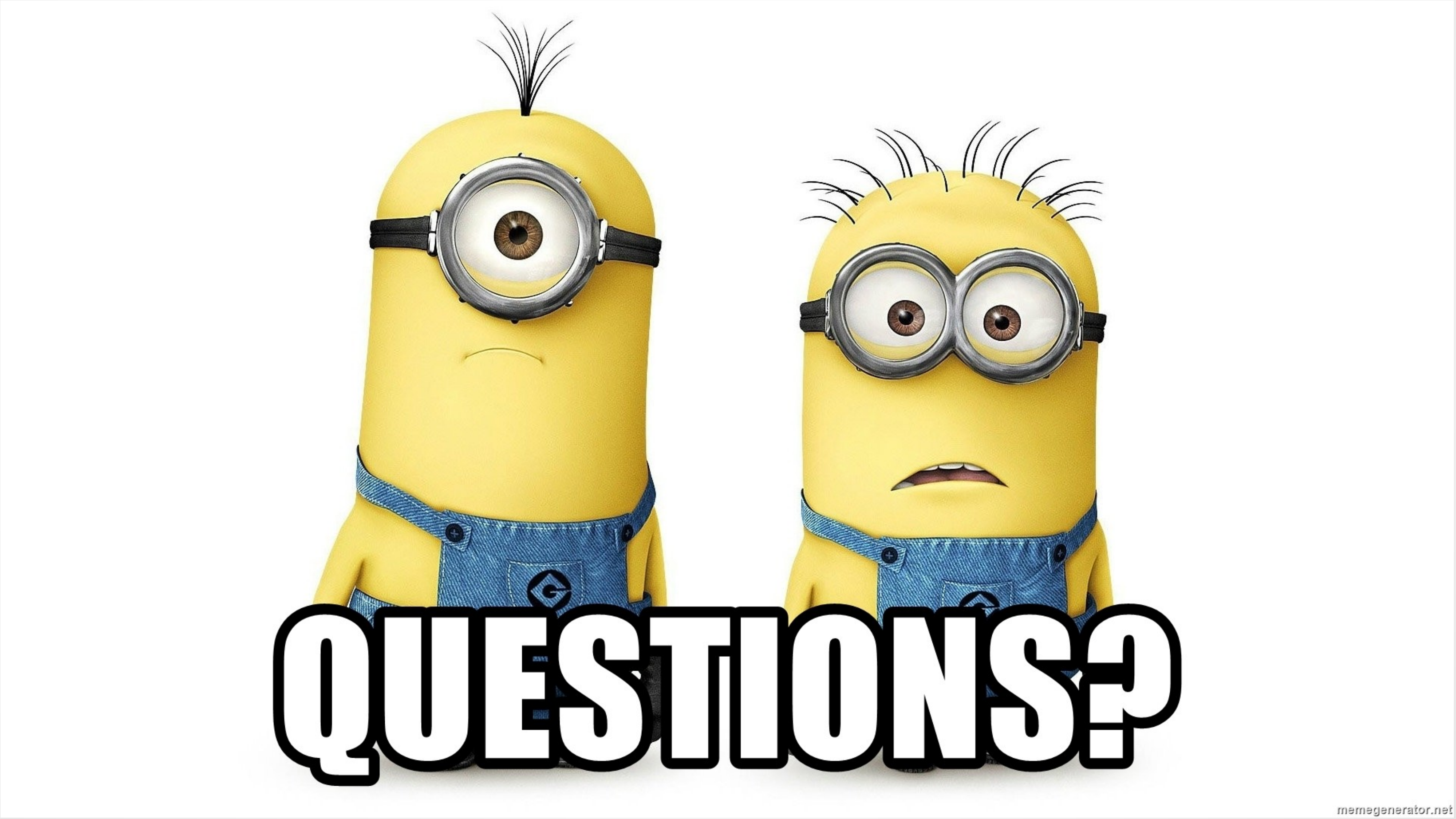
Along with others

- Input set for AFL
  - Already good coverage
  - WinAFL for closed stuff
- Help for RE by coverage info into IDA
  - Scripts will be included in future
- Possible future work
  - Replace most with Intel PT via WindowsIntelPT

Tools & sets

- Tool address
  - https://github.com/FoxHex0ne/Rehepapp
- For POC participants only: doc fileset
  - http://www.segfault.ee/POC_DOC.zip
  - Or ask from me 

Q & A



Thank you

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