Metrics are money

Aurélien “beorn” Rougemont

Well. before that.

whoami(1)

---

40 years old nerd

Been pushing buttons on a C64 since i was 9

opensource software user since 1996 (slackware 3.1)

Hacked kernel code for the first time in 1999 (ISDN modem)

Wrote a few patches for linux/opensolaris/FreeBSD kernels over the past 19 years

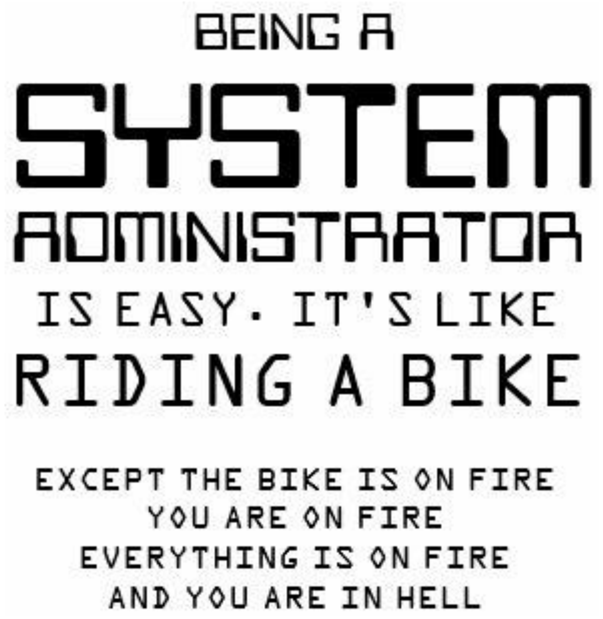
Contributed a few patches for various observability projects

On-call for the last 19 years

Woken up for stupid things for 19 years…

Been happily working for synthesio.com for 2.5 years

job(1)



BEING A
SYSTEM
ADMINISTRATOR
IS EASY. IT'S LIKE
RIDING A BIKE

EXCEPT THE BIKE IS ON FIRE
YOU ARE ON FIRE
EVERYTHING IS ON FIRE
AND YOU ARE IN HELL

CHECK YOUR
EGO
AMIGO

talk(1)

<Friend> "wow congratulations on making it to the KR conferences"

<Me> "Thanks !"

<Friend> "i was looking at the KR speakers list. I saw the usual legends. And you. Good luck with that. Sincerely"

motd(5)

This is not meant to be a public shaming session

Names and bugs were voluntarily removed

Explaining these bugs/patches to most of you would be… incongruous

You probably wrote or validated the bug… and the fix

Operations

alarm(2)

---

500 HTTP error

non zero shell return code

Segfault

Kernel panic

OOM

CRC errors

Network problems

No data

No graph

[...]

Hi mister Malloc. Could you please gimme 400MB of RAM?
You got it.
MALLOC
BANG
Why do you keep doing this?
It amuses me to see them die.
OOM KILLER
MALLOC
Daniel Stori {turnoff.us}

sleep(1)

HTTP 200 error

Failed shell script returning 0

Segfault hidden by a process supervisor

Silent data corruption

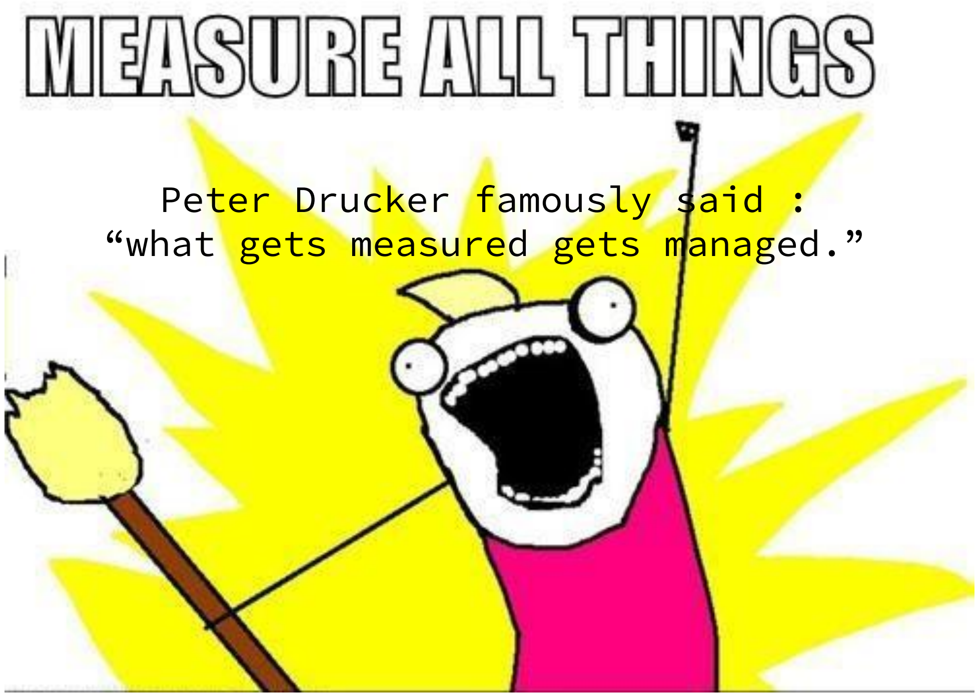
Unknown states

Pattern change

No timeout on probe

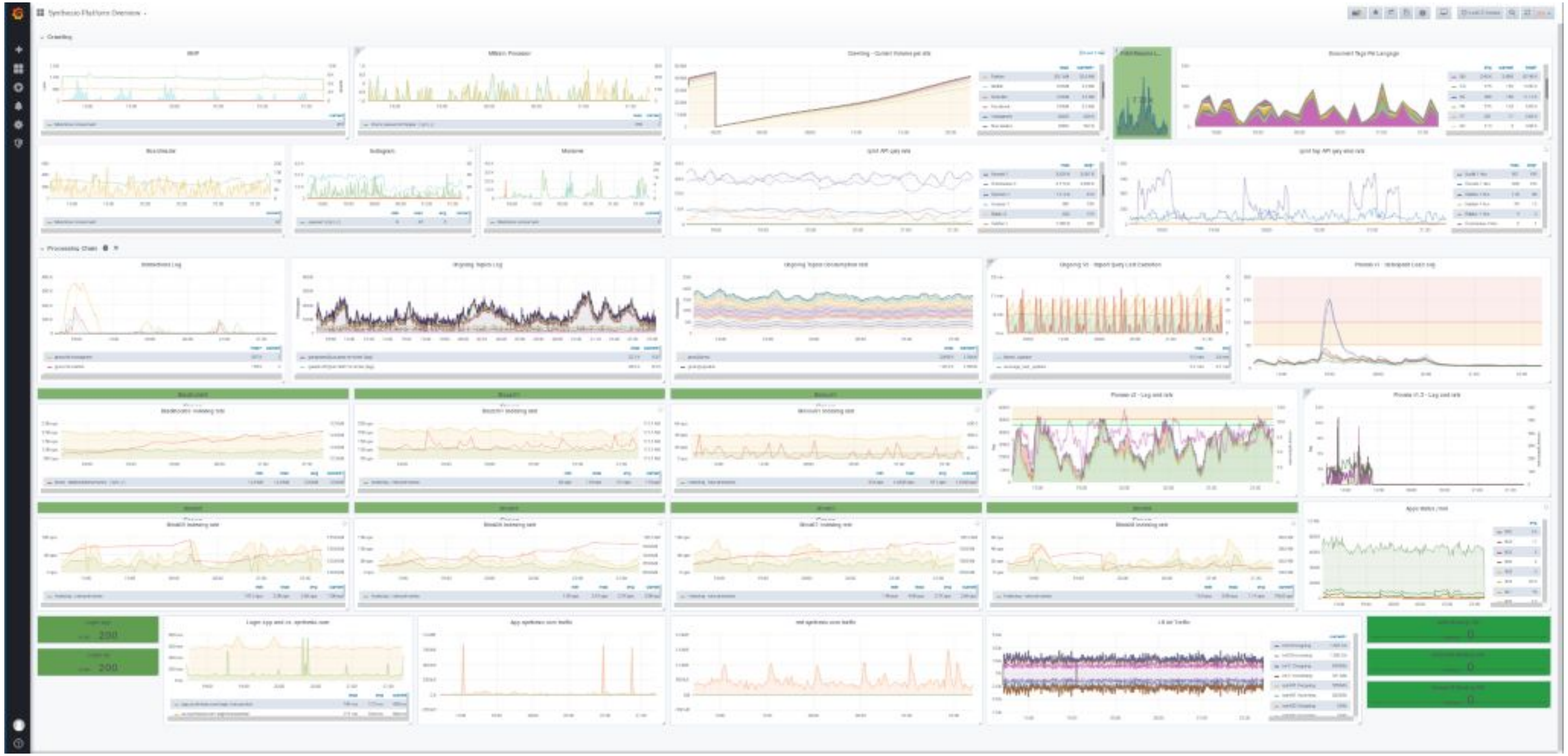
[...]

stat(1)

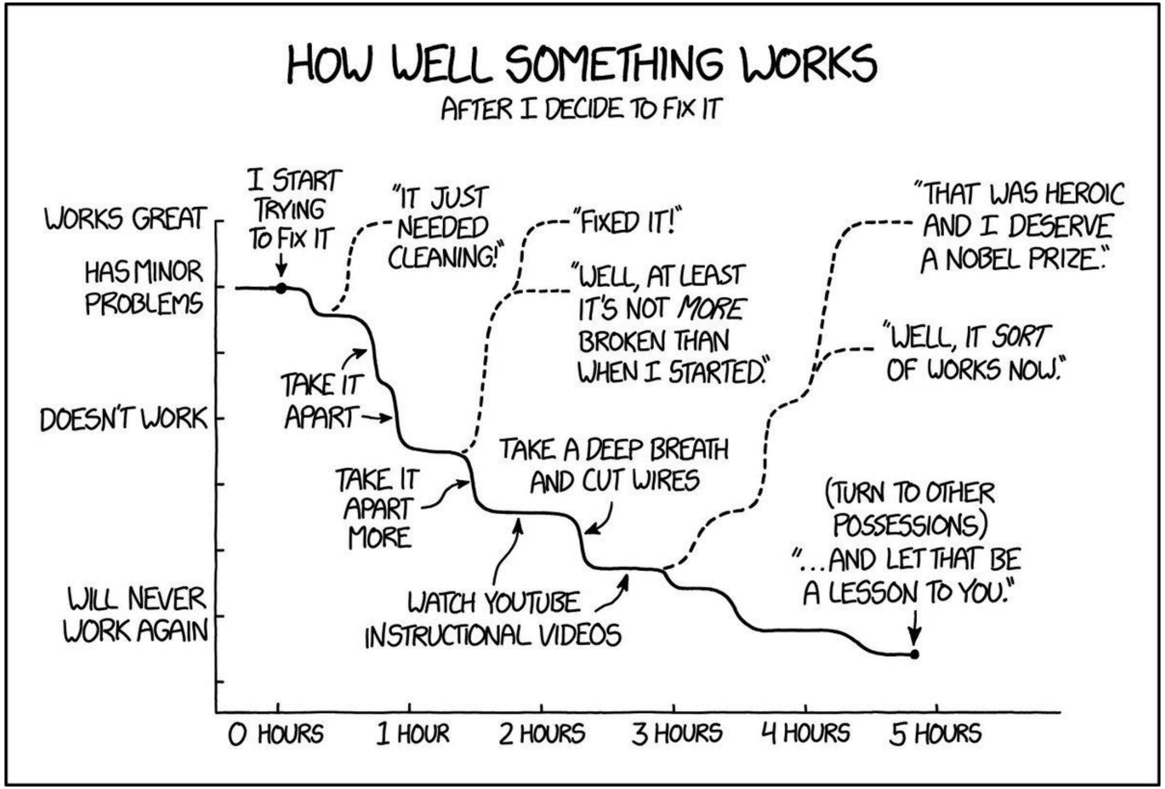


Peter Drucker famously said :
“what gets measured gets managed.”

dash(1)



keepalived(8)


HOW WELL SOMETHING WORKS
AFTER I DECIDE TO FIX IT
WORKS GREAT
HAS MINOR PROBLEMS
DOESN'T WORK
WILL NEVER WORK AGAIN
I START TRYING TO FIX IT
"IT JUST NEEDED CLEANING!"
TAKE IT APART
"FIXED IT!"
"WELL, AT LEAST IT'S NOT MORE BROKEN THAN WHEN I STARTED."
TAKE IT APART MORE
TAKE A DEEP BREATH AND CUT WIRES
WATCH YOUTUBE INSTRUCTIONAL VIDEOS
"THAT WAS HEROIC AND I DESERVE A NOBEL PRIZE."
"WELL, IT SORT OF WORKS NOW."
(TURN TO OTHER POSSESSIONS) "...AND LET THAT BE A LESSON TO YOU."
0 HOURS
1 HOUR
2 HOURS
3 HOURS
4 HOURS
5 HOURS

Just a sense of scale

prometheus(1) con 2018

Fastly

```
114 prometheus servers
28.4M timeseries
2.2M samples/s
```

Cloudflare

```
267 prometheus servers
```

Uber

```
400-600M datapoints/s pre-aggregation
20M stored datapoints per second
6.6B unique metric IDs
9k grafana dash
30B datapoints
```

free(1)

So ops guys brains working memory are saturated, among other things, by metrics

What if… Even the most basic metrics weren’t what you thought they’d be ?

What if… The same metric did not mean the same from a server to another ?

What if… We were all wrong most part of the time ?

Cognitive Overload
I think he was bombarded with a little too much information!
FRAN

Now real life stories

Server usage…

top(1)

I have played a game with other mid to senior ops guys : 2 out of 10 were almost correct.

“Load averages are an industry-critical metric – my company spends millions auto-scaling cloud instances based on them and other metrics – but on Linux there's some mystery around them.” Brendan Gregg (2017)

After all it only took around 12 screens to Brendan Gregg to explain linux load average history.

Oh and good news, linux computes load differently than other kernel/OS

Network packets…

irssi(1) /query foo

<foo> is hired, replaces a dying home-made linux-based switch with a very common one

<foo> adds metrics to this brand new switch and figures out something is wrong

Switch and server are absolutely **not giving the same results : at least 50% drop on all network tx/rx** metrics during the usual benchmarks

<foo> examines the dashboard configuration : there’s also a ***max()*** function but that was just an aggravating factor not the root cause

<foo> beorn you know collectd-fu right ?

vim(1) ~/collectd core/plugin code

```
Collectd code was pretty straight forward

Collectd reads data from /proc/net/dev

No voodoo magic here
```

history(3)

The server and the linux-based-old-switch were running the exact same old linux kernel version

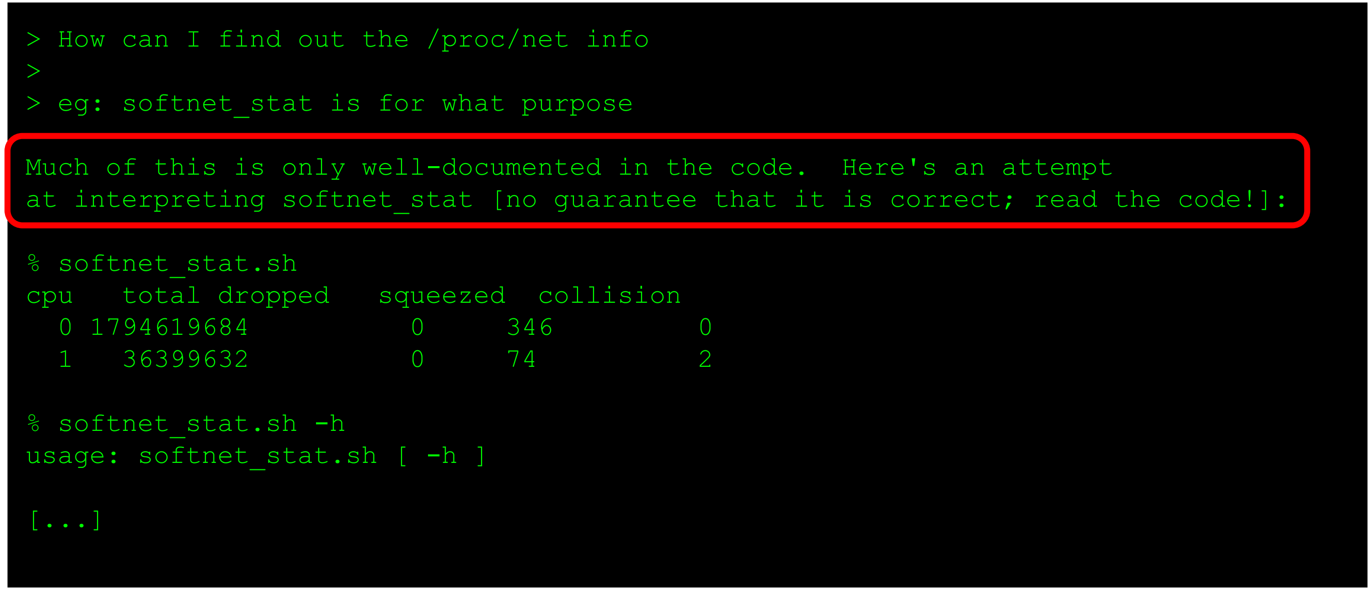
And could not be simply upgraded because of proprietary drivers of specific components

proc(5) /proc/net/dev

When this story happens there was almost no documentation for /proc/net/dev

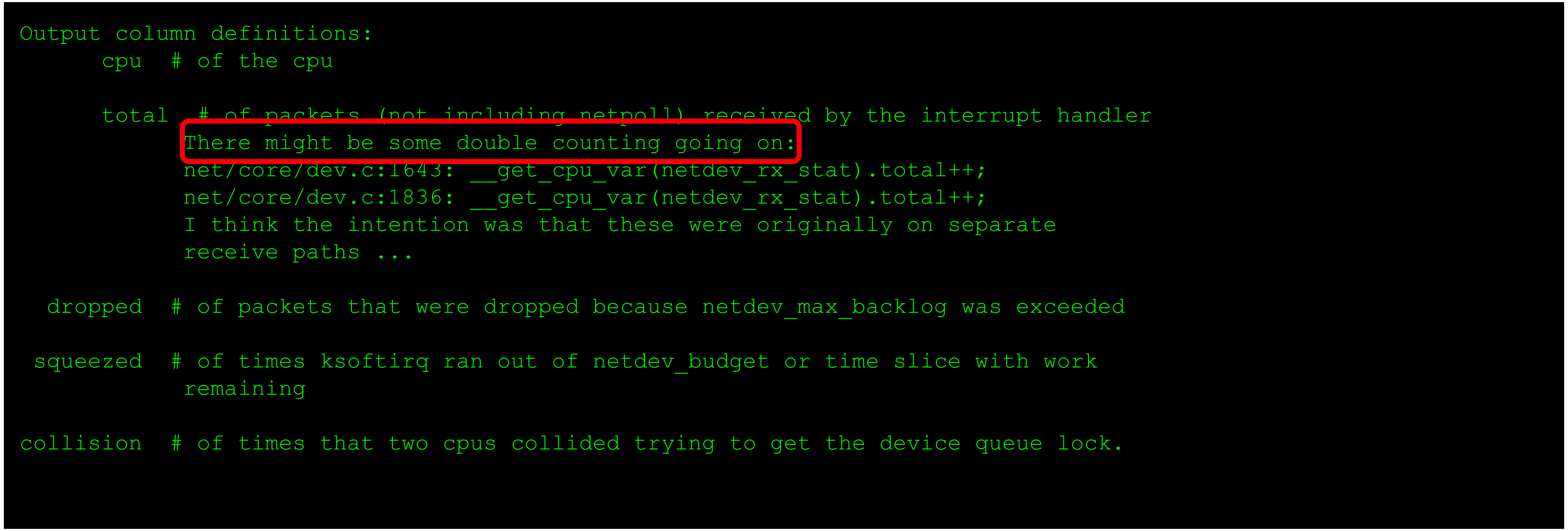
Gladly there was this old email that gave some useful hints.

mail(1)



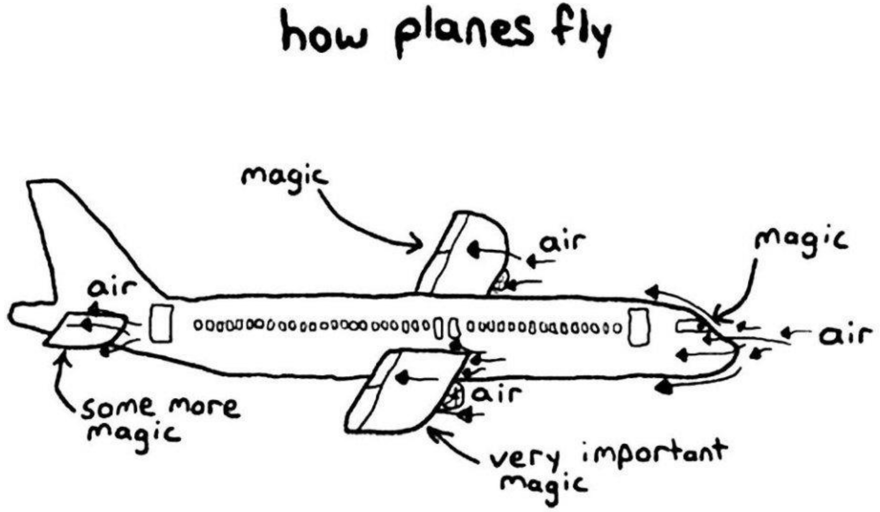
```
> How can I find out the /proc/net info
>
> eg: softnet_stat is for what purpose

Much of this is only well-documented in the code.  Here's an attempt
at interpreting softnet_stat [no guarantee that it is correct; read the code!]:

% softnet_stat.sh
cpu    total dropped   squeezed  collision
  0 1794619684          0      346          0
  1   36399632          0      74           2

% softnet_stat.sh -h
usage: softnet_stat.sh [ -h ]

[...]
```

mutt(1)



```
Output column definitions:
      cpu  # of the cpu

      total  # of packets (not including netpoll) received by the interrupt handler
            There might be some double counting going on:
            net/core/dev.c:1643: __get_cpu_var(netdev_rx_stat).total++;
            net/core/dev.c:1836: __get_cpu_var(netdev_rx_stat).total++;
            I think the intention was that these were originally on separate
            receive paths ...

  dropped  # of packets that were dropped because netdev_max_backlog was exceeded

 squeezed  # of times ksoftirq ran out of netdev_budget or time slice with work
            remaining

collision  # of times that two cpus collided trying to get the device queue lock.
```

man(1) kernel/drivers



git-log(1)

```
# git log --pretty=oneline --abbrev-commit |grep igb| grep stats
55c05dd0295d igbvf: Use net_device_stats from struct net_device
e66c083aab32 igb: fix stats for i210 rx_fifo_errors
3dbdf96928dc igb: Fix stats output on i210/i211 parts.
0a915b95d67f igb: Add stats output for OS2BMC feature on i350 devices
12dcd86b75d5 igb: fix stats handling
43915c7c9a99 igb: only read phy specific stats if in internal phy mode
128e45eb61b9 igb: Rework how netdev->stats is handled
645a3abd73c2 igb: Remove invalid stats counters
3f9c01648146 igb: only process global stats in igb_update_stats
04a5fcaaf0e1 igb: move alloc failed and csum err stats into per rx-ring stat
231835e4163c igb: Fix erroneous display of stats by ethtool -S
8d24e93309d6 igb: Use the instance of net_device_stats from net_device.
cc9073bbc901 igb: remove unused temp variable from stats clearing path
3ea73afafb8c igb: Record host memory receive overflow in net_stats
04fe63583d46 igb: update stats before doing reset in igb_down
e21ed3538f19 igb: update ethtool stats to support multiqueue
```

git-commit(1)

```
    /*
     * ENOBUFS = no kernel mem, SOCK_NOSPACE = no sndbuf space. Reporting
     * ENOBUFS might not be good (it's not tunable per se), but otherwise
     * we don't have a good statistic (IpOutDiscards but it can be too many
     * things). We could add another new stat but at least for now that
     * seems like overkill.
     */
```

ethtool(8)

Over the years the Linux networking stack had hoarded:

- Tens of (cool) features (GRO, GSO, RPS, RFS, …)
- Tens of drivers
- Tons of code-paths
- Multiple thousand sysctl entries
- A lot of bugs

Manufacturer’s tech document was 1200 pages long, and is probably bigger today

Documentation was not what it is today

sha512sum(1)

To sum it up

- notice the problem
- Fix the graph configuration (bad aggr)
- start reading the userland stats collecting (collectd here)
- realize and make sure the bug was not there
- read your kernel/driver code
- realize the bug is really in the code path that /proc/net/dev hits
- read the 1200 pages tech specs from the manufacturer
- find a few related patches
- rebuild the kernel/driver only 4 times (we were lucky)
- And just reboot production servers for weeks

All that just to read valid tx.rx packets counters !

bc(1)

```
<foo> Last year based on these metrics they doubled network
capacity for more than 2.8M euros
```

Resellers and Manufacturers…

netstat(1)

We had many servers of a validated type with 10Gbps ixgbe nics

According to capacity planning we order a 240 servers batch

Linux TCP/IP network statistics are bad : tcp retransmits, latencies, …

The new switch metrics were green

Linux did not have signal related statistics for fiber NICs

Another brand/model of SFP+ worked just fine

mutt(1) reseller

<**reseller**> *everything is fine*

<**me**> *if only we’ve had those SFP+ DOM registers in kernel/ethtool…*

<**CTO**> *you have 10 full days to prove them wrong*

<**me**> *Erm it’s the network stack we’re talking about and i’m no real kernel dev*

<**CTO**> *That’s why you have 10 full days to prove them wrong*

links(1)

Read everything i could find about optical signal, SFP+ and DOM statistics

Found a microrouter project named bifrost doing just this with a 2.6 kernel (2012)

Their Patches were never pushed upstream

We needed it to run on 3.4 kernels for features and hardware compatibility

Emailed the guys about a 3.4 patch: no luck

Let’s port this to 3.4

vim(1) patchset.diff

The network API had major changes between 2.6 and 3.4 on this particular part.

Ended up rewriting the patchset (kernel + ethtool) entirely in 5 days

Patch worked in production for a 3-4 years without a glitch

```
# ethtool -D eth0

Int-Calbr: Avr RX-Power: Alarm & Warn: TX_DISABLE: TX_FAULT: RX_LOS:
RATE_SELECT MON: RATE_SELECT: Wavelength: 850 nm
Alarms, warnings in beginning of line, Ie. AH = Alarm High, WL == Warn
Low etc
      Temp:  45.7 C                 Thresh: Lo: -45.0/-40.0  Hi: 115.0/125.0 C
      Vcc:  3.32 V            Thresh: Lo:   2.7/2.9    Hi:   3.7/3.9   V
      Tx-Bias:   6.6 mA       Thresh: Lo:   1.0/2.0    Hi:  12.0/15.0  mA
      TX-pwr:  -2.9 dBm ( 0.52 mW)  Thresh: Lo: -10.0/-8.3   Hi:   0.8/2.0   dBm
      RX-pwr:  -1.9 dBm ( 0.64 mW)  Thresh: Lo: -16.0/-14.2  Hi:   1.8/3.0   dBm
```

git-format-patch(1)

Proud and happy i wrote an email to someone *“doing things in the kernel”*

> *<kernelguy> “$#!$#!$$@%$#%#!$%#%@$”*
>
> *<me> “So what should i fix ?”*
>
> *<End Of Discussion>*

hledger(1)

After adding the ethtool output and the patchset into the reseller’s case he agreed to change the incompatible SFP+ after only 5 days of hard work

480 brand new SFP+ arrived. We changed the faulty SFP+ for weeks.

And that was it

Roughly **200K euros** were saved with these metrics

Disks…

iozone(1)

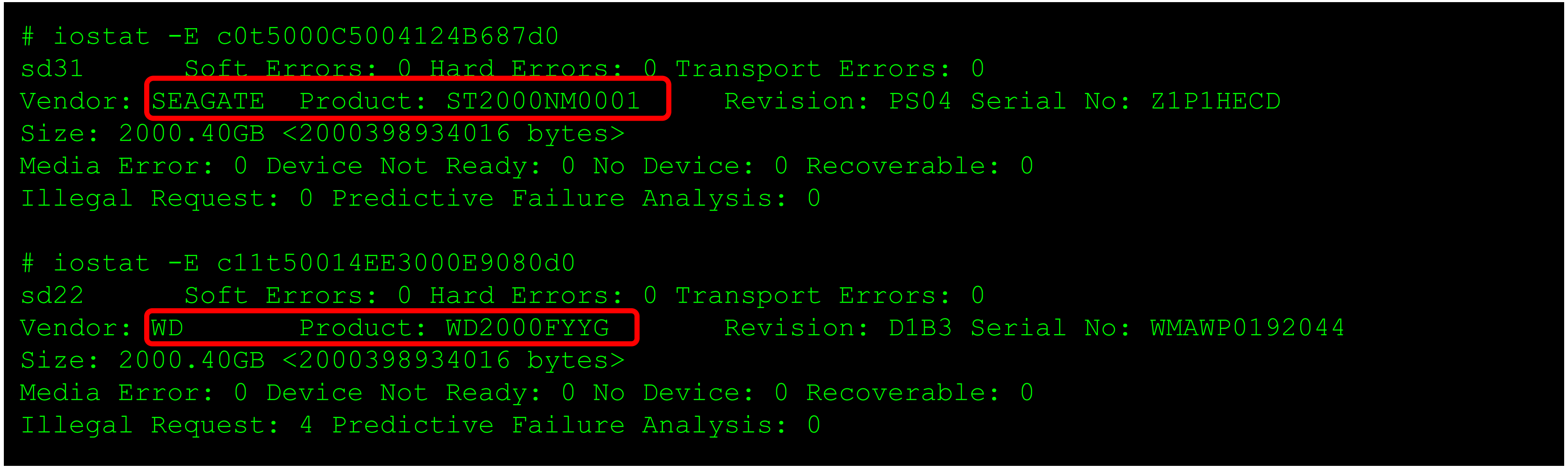
In a hosting company we built ZFS based SAN/NAS

<coworker> last batch of servers have serious storage performances issues under load

<SRE> alright let’s dig

sha256sum(1)

Disk had the same labels, same tech specs, but not exactly the same physical look



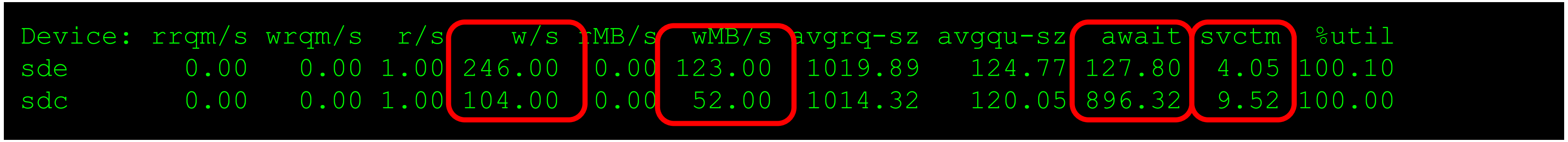
```
# iostat -E c0t5000C5004124B687d0
sd31      Soft Errors: 0 Hard Errors: 0 Transport Errors: 0
Vendor: SEAGATE  Product: ST2000NM0001     Revision: PS04 Serial No: Z1P1HECD
Size: 2000.40GB <2000398934016 bytes>
Media Error: 0 Device Not Ready: 0 No Device: 0 Recoverable: 0
Illegal Request: 0 Predictive Failure Analysis: 0

# iostat -E c11t50014EE3000E9080d0
sd22      Soft Errors: 0 Hard Errors: 0 Transport Errors: 0
Vendor: WD       Product: WD2000FYYG       Revision: D1B3 Serial No: WMAWP0192044
Size: 2000.40GB <2000398934016 bytes>
Media Error: 0 Device Not Ready: 0 No Device: 0 Recoverable: 0
Illegal Request: 4 Predictive Failure Analysis: 0
```

alpine(1)

```
<me> Sir it is not the same disk brand/model

<reseller> we do not guarantee anything else that tech specs

<me> [...] Please do something !
```

orion(1)

After extensive profiling we are able to reproduce the problematic workload



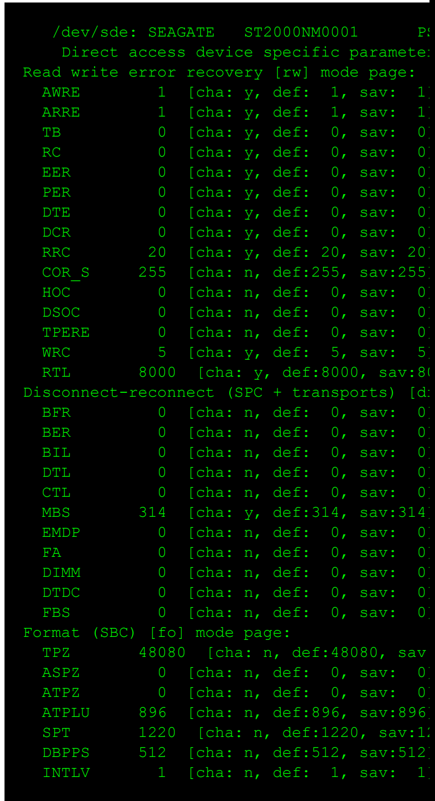
```
Device: rrqm/s wrqm/s   r/s     w/s rMB/s   wMB/s avgrq-sz avgqu-sz   await svctm  %util
sde       0.00   0.00 1.00 246.00  0.00  123.00  1019.89   124.77  127.80  4.05 100.10
sdc       0.00   0.00 1.00 104.00  0.00   52.00  1014.32   120.05  896.32  9.52 100.00
```

Which happens to be a very important workload for ZFS

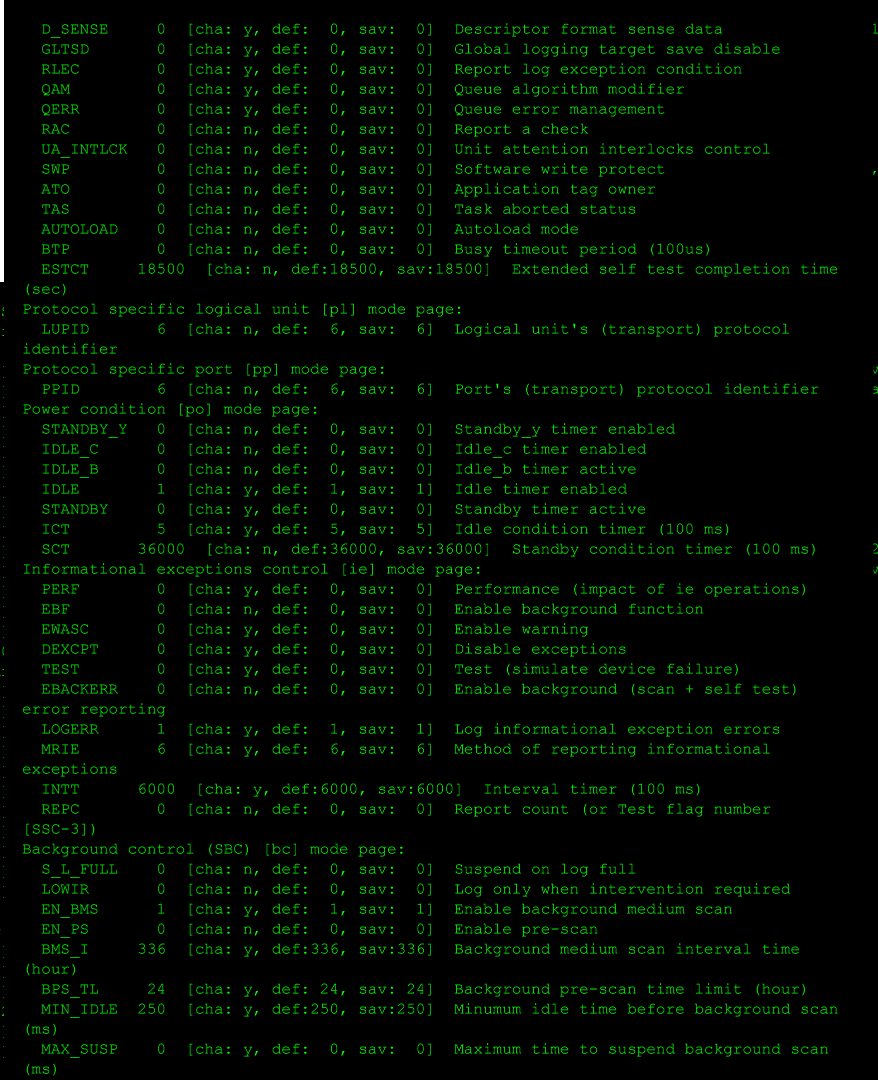
sup(1)

```
<manufacturer> Our test suite shows that the disks you have sent are fine

<me> except they are not. see the iostat output


[nothing for 1 week]
```

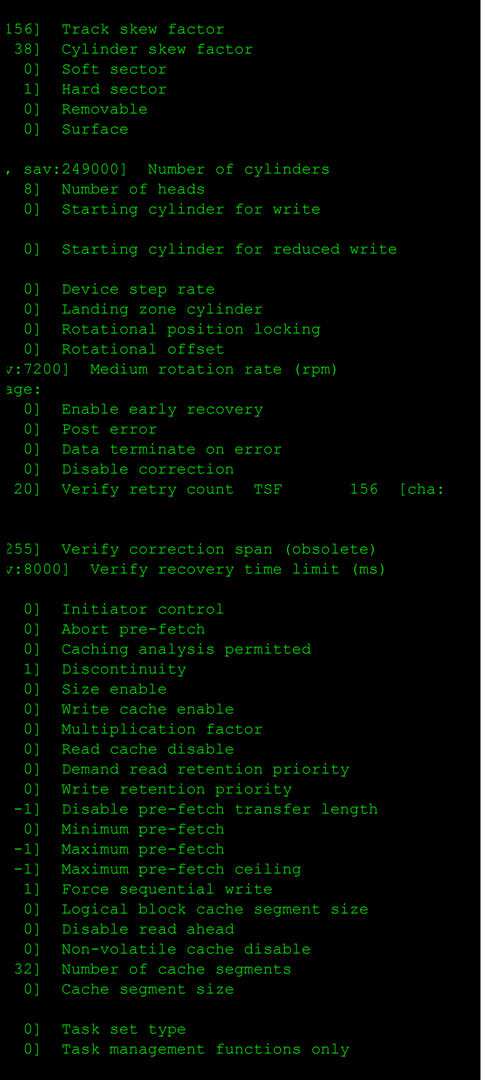
smartctl(1)



```
   /dev/sde: SEAGATE   ST2000NM0001      P
    Direct access device specific paramete
Read write error recovery [rw] mode page:
  AWRE        1  [cha: y, def:  1, sav:  1
  ARRE        1  [cha: y, def:  1, sav:  1
  TB          0  [cha: y, def:  0, sav:  0
  RC          0  [cha: y, def:  0, sav:  0
  EER         0  [cha: y, def:  0, sav:  0
  PER         0  [cha: y, def:  0, sav:  0
  DTE         0  [cha: y, def:  0, sav:  0
  DCR         0  [cha: y, def:  0, sav:  0
  RRC        20  [cha: y, def: 20, sav: 20
  COR_S     255  [cha: n, def:255, sav:255
  HOC         0  [cha: n, def:  0, sav:  0
  DSOC        0  [cha: n, def:  0, sav:  0
  TPERE       0  [cha: n, def:  0, sav:  0
  WRC         5  [cha: y, def:  5, sav:  5
  RTL       8000  [cha: y, def:8000, sav:8
Disconnect-reconnect (SPC + transports) [d
  BFR         0  [cha: n, def:  0, sav:  0
  BER         0  [cha: n, def:  0, sav:  0
  BIL         0  [cha: n, def:  0, sav:  0
  DTL         0  [cha: n, def:  0, sav:  0
  CTL         0  [cha: n, def:  0, sav:  0
  MBS       314  [cha: y, def:314, sav:314
  EMDP        0  [cha: n, def:  0, sav:  0
  FA          0  [cha: n, def:  0, sav:  0
  DIMM        0  [cha: n, def:  0, sav:  0
  DTDC        0  [cha: n, def:  0, sav:  0
  FBS         0  [cha: n, def:  0, sav:  0
Format (SBC) [fo] mode page:
  TPZ       48080  [cha: n, def:48080, sav
  ASPZ        0  [cha: n, def:  0, sav:  0
  ATPZ        0  [cha: n, def:  0, sav:  0
  ATPLU     896  [cha: n, def:896, sav:896
  SPT       1220  [cha: n, def:1220, sav:1
  DBPPS     512  [cha: n, def:512, sav:512
  INTLV       1  [cha: n, def:  1, sav:  1
```



```
  D_SENSE     0  [cha: y, def:  0, sav:  0]  Descriptor format sense data
  GLTSD       0  [cha: y, def:  0, sav:  0]  Global logging target save disable
  RLEC        0  [cha: y, def:  0, sav:  0]  Report log exception condition
  QAM         0  [cha: y, def:  0, sav:  0]  Queue algorithm modifier
  QERR        0  [cha: y, def:  0, sav:  0]  Queue error management
  RAC         0  [cha: n, def:  0, sav:  0]  Report a check
  UA_INTLCK   0  [cha: n, def:  0, sav:  0]  Unit attention interlocks control
  SWP         0  [cha: n, def:  0, sav:  0]  Software write protect
  ATO         0  [cha: n, def:  0, sav:  0]  Application tag owner
  TAS         0  [cha: n, def:  0, sav:  0]  Task aborted status
  AUTOLOAD    0  [cha: n, def:  0, sav:  0]  Autoload mode
  BTP         0  [cha: n, def:  0, sav:  0]  Busy timeout period (100us)
  ESTCT     18500  [cha: n, def:18500, sav:18500]  Extended self test completion time
(sec)
Protocol specific logical unit [pl] mode page:
  LUPID       6  [cha: n, def:  6, sav:  6]  Logical unit's (transport) protocol
identifier
Protocol specific port [pp] mode page:
  PPID        6  [cha: n, def:  6, sav:  6]  Port's (transport) protocol identifier
Power condition [po] mode page:
  STANDBY_Y   0  [cha: n, def:  0, sav:  0]  Standby_y timer enabled
  IDLE_C      0  [cha: n, def:  0, sav:  0]  Idle_c timer enabled
  IDLE_B      0  [cha: n, def:  0, sav:  0]  Idle_b timer active
  IDLE        1  [cha: y, def:  1, sav:  1]  Idle timer enabled
  STANDBY     0  [cha: y, def:  0, sav:  0]  Standby timer active
  ICT         5  [cha: y, def:  5, sav:  5]  Idle condition timer (100 ms)
  SCT       36000  [cha: n, def:36000, sav:36000]  Standby condition timer (100 ms)
Informational exceptions control [ie] mode page:
  PERF        0  [cha: y, def:  0, sav:  0]  Performance (impact of ie operations)
  EBF         0  [cha: n, def:  0, sav:  0]  Enable background function
  EWASC       0  [cha: y, def:  0, sav:  0]  Enable warning
  DEXCPT      0  [cha: y, def:  0, sav:  0]  Disable exceptions
  TEST        0  [cha: y, def:  0, sav:  0]  Test (simulate device failure)
  EBACKERR    0  [cha: n, def:  0, sav:  0]  Enable background (scan + self test)
error reporting
  LOGERR      1  [cha: y, def:  1, sav:  1]  Log informational exception errors
  MRIE        6  [cha: y, def:  6, sav:  6]  Method of reporting informational
exceptions
  INTT      6000  [cha: y, def:6000, sav:6000]  Interval timer (100 ms)
  REPC        0  [cha: n, def:  0, sav:  0]  Report count (or Test flag number
[SSC-3])
Background control (SBC) [bc] mode page:
  S_L_FULL    0  [cha: n, def:  0, sav:  0]  Suspend on log full
  LOWIR       0  [cha: n, def:  0, sav:  0]  Log only when intervention required
  EN_BMS      1  [cha: y, def:  1, sav:  1]  Enable background medium scan
  EN_PS       0  [cha: n, def:  0, sav:  0]  Enable pre-scan
  BMS_I     336  [cha: y, def:336, sav:336]  Background medium scan interval time
(hour)
  BPS_TL     24  [cha: y, def: 24, sav: 24]  Background pre-scan time limit (hour)
  MIN_IDLE  250  [cha: y, def:250, sav:250]  Minumum idle time before background scan
(ms)
  MAX_SUSP    0  [cha: y, def:  0, sav:  0]  Maximum time to suspend background scan
(ms)
```



```
156]  Track skew factor
 38]  Cylinder skew factor
  0]  Soft sector
  1]  Hard sector
  0]  Removable
  0]  Surface

, sav:249000]  Number of cylinders
  8]  Number of heads
  0]  Starting cylinder for write

  0]  Starting cylinder for reduced write

  0]  Device step rate
  0]  Landing zone cylinder
  0]  Rotational position locking
  0]  Rotational offset
v:7200]  Medium rotation rate (rpm)
age:
  0]  Enable early recovery
  0]  Post error
  0]  Data terminate on error
  0]  Disable correction
 20]  Verify retry count  TSF      156  [cha:


255]  Verify correction span (obsolete)
v:8000]  Verify recovery time limit (ms)

  0]  Initiator control
  0]  Abort pre-fetch
  0]  Caching analysis permitted
  1]  Discontinuity
  0]  Size enable
  0]  Write cache enable
  0]  Multiplication factor
  0]  Read cache disable
  0]  Demand read retention priority
  0]  Write retention priority
 -1]  Disable pre-fetch transfer length
  0]  Minimum pre-fetch
 -1]  Maximum pre-fetch
 -1]  Maximum pre-fetch ceiling
  1]  Force sequential write
  0]  Logical block cache segment size
  0]  Disable read ahead
  0]  Non-volatile cache disable
 32]  Number of cache segments
  0]  Cache segment size

  0]  Task set type
  0]  Task management functions only
```

:(){ :|:& };:

At the same time they provided us a “fix” firmware

Performances were even better than with the good disk.

Binary diff showed a 1 bit change.

Yes a boolean.

Their firmware was silently enabling write cache (without battery)

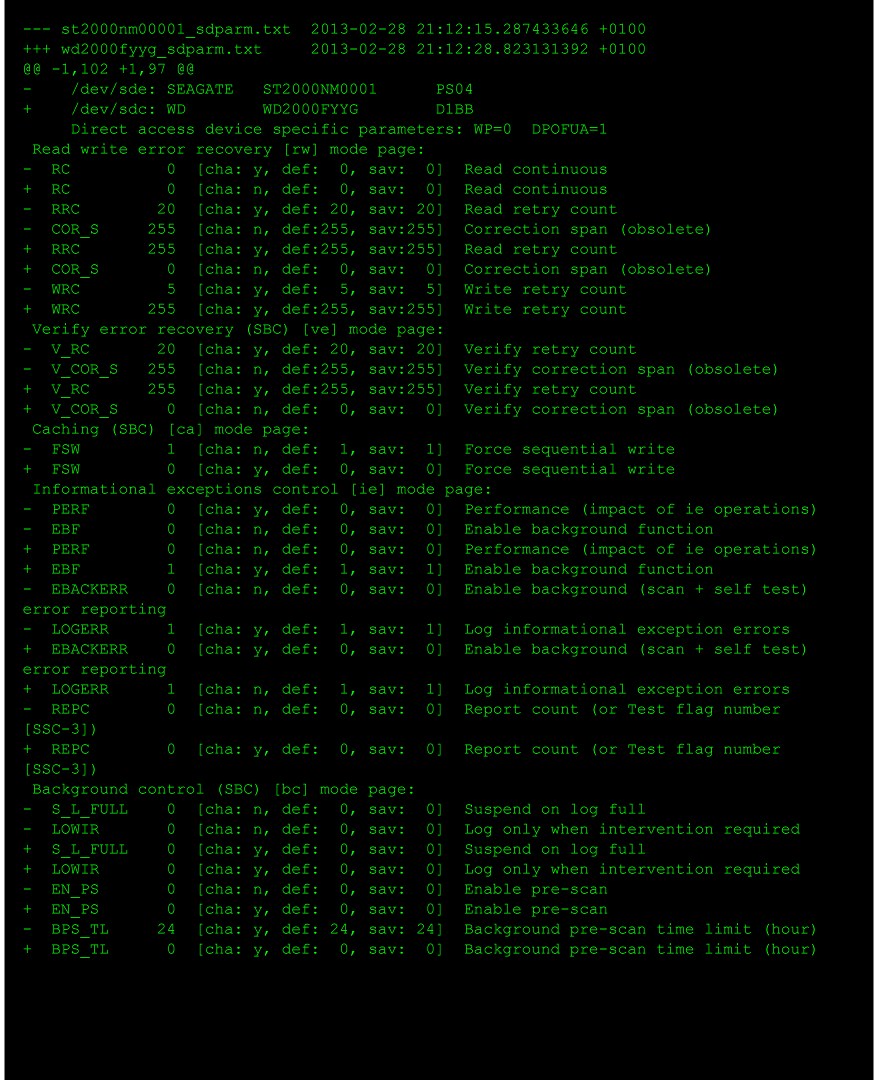
Which is to say the least dangerous

dc(1)

We proved the disks did not have the same behavior/specs using this diff

The reseller changed all the 250 disks **150K euros**

We spent the next months changing and resilvering arrays already in production



```
--- st2000nm00001_sdparm.txt  2013-02-28 21:12:15.287433646 +0100
+++ wd2000fyyg_sdparm.txt     2013-02-28 21:12:28.823131392 +0100
@@ -1,102 +1,97 @@
-    /dev/sde: SEAGATE   ST2000NM0001      PS04
+    /dev/sdc: WD        WD2000FYYG        D1BB
     Direct access device specific parameters: WP=0  DPOFUA=1
 Read write error recovery [rw] mode page:
-  RC          0  [cha: y, def:  0, sav:  0]  Read continuous
+  RC          0  [cha: n, def:  0, sav:  0]  Read continuous
-  RRC        20  [cha: y, def: 20, sav: 20]  Read retry count
-  COR_S     255  [cha: n, def:255, sav:255]  Correction span (obsolete)
+  RRC       255  [cha: y, def:255, sav:255]  Read retry count
+  COR_S       0  [cha: n, def:  0, sav:  0]  Correction span (obsolete)
-  WRC         5  [cha: y, def:  5, sav:  5]  Write retry count
+  WRC       255  [cha: y, def:255, sav:255]  Write retry count
 Verify error recovery (SBC) [ve] mode page:
-  V_RC       20  [cha: y, def: 20, sav: 20]  Verify retry count
-  V_COR_S   255  [cha: n, def:255, sav:255]  Verify correction span (obsolete)
+  V_RC      255  [cha: y, def:255, sav:255]  Verify retry count
+  V_COR_S     0  [cha: n, def:  0, sav:  0]  Verify correction span (obsolete)
 Caching (SBC) [ca] mode page:
-  FSW         1  [cha: n, def:  1, sav:  1]  Force sequential write
+  FSW         0  [cha: y, def:  0, sav:  0]  Force sequential write
 Informational exceptions control [ie] mode page:
-  PERF        0  [cha: y, def:  0, sav:  0]  Performance (impact of ie operations)
-  EBF         0  [cha: n, def:  0, sav:  0]  Enable background function
+  PERF        0  [cha: n, def:  0, sav:  0]  Performance (impact of ie operations)
+  EBF         1  [cha: y, def:  1, sav:  1]  Enable background function
-  EBACKERR    0  [cha: n, def:  0, sav:  0]  Enable background (scan + self test)
error reporting
-  LOGERR      1  [cha: y, def:  1, sav:  1]  Log informational exception errors
+  EBACKERR    0  [cha: y, def:  0, sav:  0]  Enable background (scan + self test)
error reporting
+  LOGERR      1  [cha: n, def:  1, sav:  1]  Log informational exception errors
-  REPC        0  [cha: n, def:  0, sav:  0]  Report count (or Test flag number
[SSC-3])
+  REPC        0  [cha: y, def:  0, sav:  0]  Report count (or Test flag number
[SSC-3])
 Background control (SBC) [bc] mode page:
-  S_L_FULL    0  [cha: n, def:  0, sav:  0]  Suspend on log full
-  LOWIR       0  [cha: n, def:  0, sav:  0]  Log only when intervention required
+  S_L_FULL    0  [cha: y, def:  0, sav:  0]  Suspend on log full
+  LOWIR       0  [cha: y, def:  0, sav:  0]  Log only when intervention required
-  EN_PS       0  [cha: n, def:  0, sav:  0]  Enable pre-scan
+  EN_PS       0  [cha: y, def:  0, sav:  0]  Enable pre-scan
-  BPS_TL     24  [cha: y, def: 24, sav: 24]  Background pre-scan time limit (hour)
+  BPS_TL      0  [cha: y, def:  0, sav:  0]  Background pre-scan time limit (hour)
```

TLDR;

sha256sum(1)

Metrics are everywhere in operations at an unprecedented scale and still growing fast

The vast majority of I.T. professionals do not understand fully what they are currently graphing

Graphs are meant to trigger a deeper questioning when the behavior changes

To make a costly decision based on metrics without taking the time to ensure what is exactly this metric is pure folly

Acquiring this knowledge is necessary and time consuming and requires humility

task(1) add project:young_me [...]

Kernel code ain’t no saint writing

Macros make things easy if you are not a C guru

Read git history per sub-system it helps a lot

Ask upstream if they are interested in what you plan to write

Propose a (probably stupid) way of doing the change before doing code

Then code and get things upstreamed

"That's all Folks!"