The Software Bug All Stars

… and what we can learn from them

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esentri

9/9

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1000 " stopped - arctan ✓ { 1.2700 9.037 847 025
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13" sec (032) MP - MC ~~1.982647000~~ ~~2.130476415 (-3)~~ 4.615925059(-2)

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(moth) in relay.

First actual case of bug being found.

~~1[illegible]~~ 1630 Arctangent started.

1700 closed down.

Schadenfreude

"The experience of pleasure, joy, or self-satisfaction that comes from learning of or witnessing the troubles, failures, pain, or humiliation of another."

(Wikipedia)

$ 1,5 Trillion

Costs due to
"Operational Software Failures"
in 2020 in the US

(Consortium for Information & Software Quality Report)

The Stars

Mars Climate Orbiter

(1999)

Mars Climate Orbiter

What happened?

Contact lost with space probe after orbital insertion at Mars

Mars Climate Orbiter

What happened?

$ 327 Millionen

spacecraft lost

Mars Climate Orbiter

What happened?

Planned orbit: 150 km

Actual orbit: 57 km

Mars Climate Orbiter

Causes

Different teams working on different subsystems

(Lockheed Martin & NASA JPL)

Mars Climate Orbiter

Causes

Lockheed Martin used imperial units

(Pounds of Force)

NASA used SI units

(Newton)

Mars Climate Orbiter

Causes

The ground team actually realized something was wrong

… but management chose to ignore them

Mars Climate Orbiter

Lessons to learn

What can we take away?

"this surely can't happen to us... or can it?"

Mars Climate Orbiter

Lessons to learn

```
public int getTotalAmount();
```

Mars Climate Orbiter

Lessons to learn

```
/**
 * @returns
 *   the total amount the customer should be billed
 *   (in EUR)
 */
public int getTotalAmount();
```

Mars Climate Orbiter

Lessons to learn

```
/**
 * @returns
 *   the total amount the customer should be billed
 */
public int getTotalAmountInEUR();
```

Mars Climate Orbiter

Lessons to learn

```
/**
 * @returns
 *   the total amount the customer should be billed
 */
public MonetaryValue getTotalAmount ();
```

Mars Climate Orbiter

Lessons to learn

Solid API Design

(e.g. types and value objects)

Therac-25

(1980s)

What happened?

Three people died from an overdose during radiation therapy

What happened?

The manufacturer told the doctors that the Therac-25 could not overdose a patient

… after the accident happened

Causes

Race condition
when entering data

Therac-25

Causes

One (1) developer

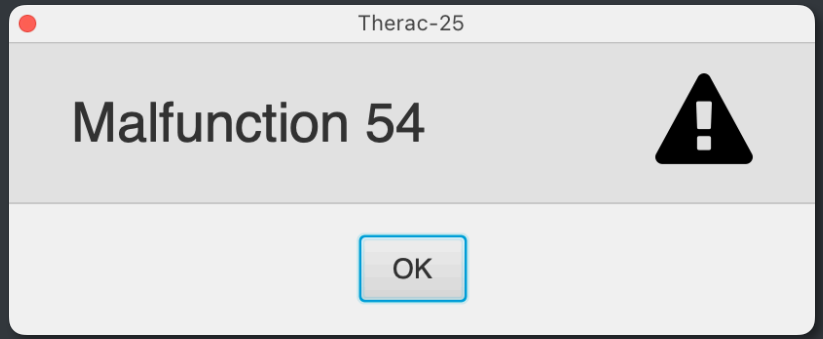
… who was also responsible for QA

Causes

Error messages like "Malfunction 54" that operators didn't know how to interpret

Therac-25

Causes



Lessons to learn

What can we take away?

"this surely can't happen to us... or can it?"

Lessons to learn

Be humble and don't dismiss the fact that it might be you!

Therac-25

Lessons to learn

Every developer is biased towards his/her results

"This can never happen!"

Lessons to learn

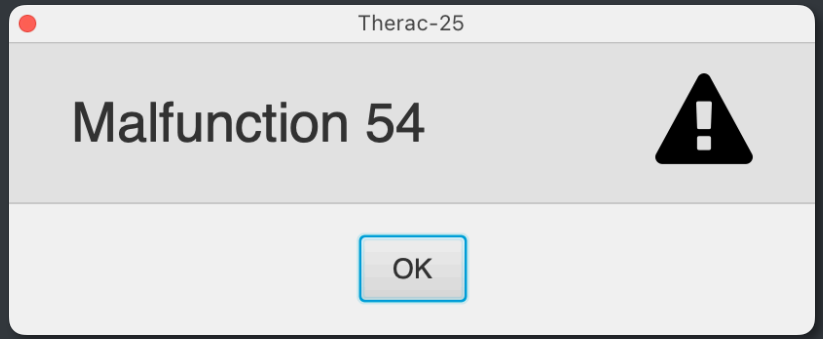
Build technical and organizational safeguards

Lessons to learn

Don't show error messages but provide details and options

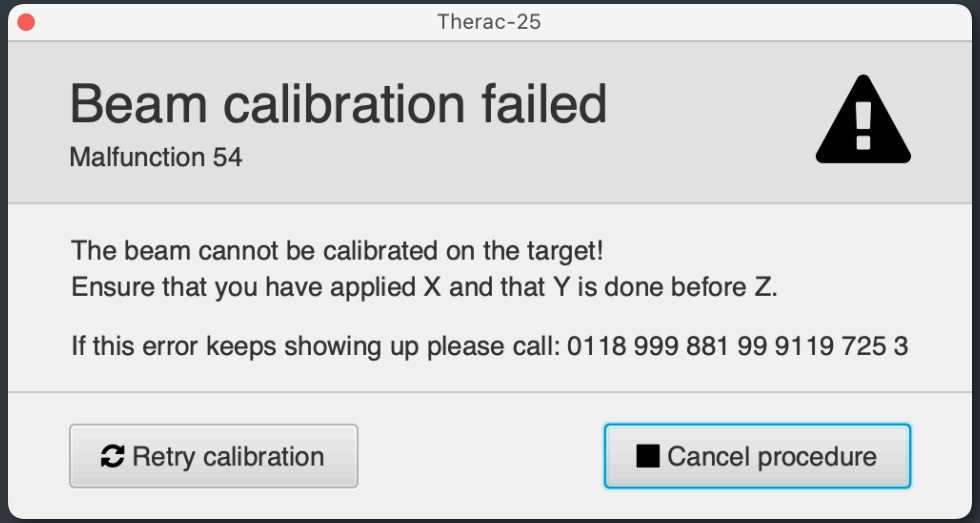
Therac-25

Lessons to learn



Therac-25

Lessons to learn



Microsoft Zune

(31.12.2008)

Microsoft Zune

What happened?

Nothing

Literally. The device didn't respond anymore.

Microsoft Zune

Causes

Edge case in date handling

(31.12.2008)

Microsoft Zune

Causes

```
while (days > 365)
{
    if (IsLeapYear(year))
    {
        if (days > 366)
        {
            days -= 366;
            year += 1;
        }
    }
    else
    {
        days -= 365;
        year += 1;
    }
}
```

Microsoft Zune

Causes

```
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31.12.2008

days = 366

Microsoft Zune

Causes

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}
```

31.12.2008

days = 366

… but iOS wasn't really that much better

(01.01.2012)

What happened?

The iOS alarm clock didn't work

(01.01.2012)

Causes

Week based year

iOS

Causes

2012 Januar	Mo	Di	Mi	Do	Fr	Sa	So
52 2011	26	27	28	29	30	31	1
1 2012	2	3	4	5	6	7	8
2 2012	9	10	11	12	13	14	15
3 2012	16	17	18	19	20	21	22
4 2012	23	24	25	26	27	28	29
5 2012	30	31	1	2	3	4	5

iOS

Causes

2012 Januar	Mo	Di	Mi	Do	Fr	Sa	So
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5 2012	30	31	1	2	3	4	5

iOS

Causes

Patrick McCarron
@McCarron
Folgen
Antwort an @charlesarthur
@charlesarthur If you use a date format string of YYYY (vs yyyy) you get 2012 until 1/7 when it becomes 2013. Easy mistake to make, I have.
Original (Englisch) übersetzen
23:28 - 2. Jan. 2013

Lockheed Martin
F-22 Raptor

(2007)

Lockheed Martin F-22 Raptor

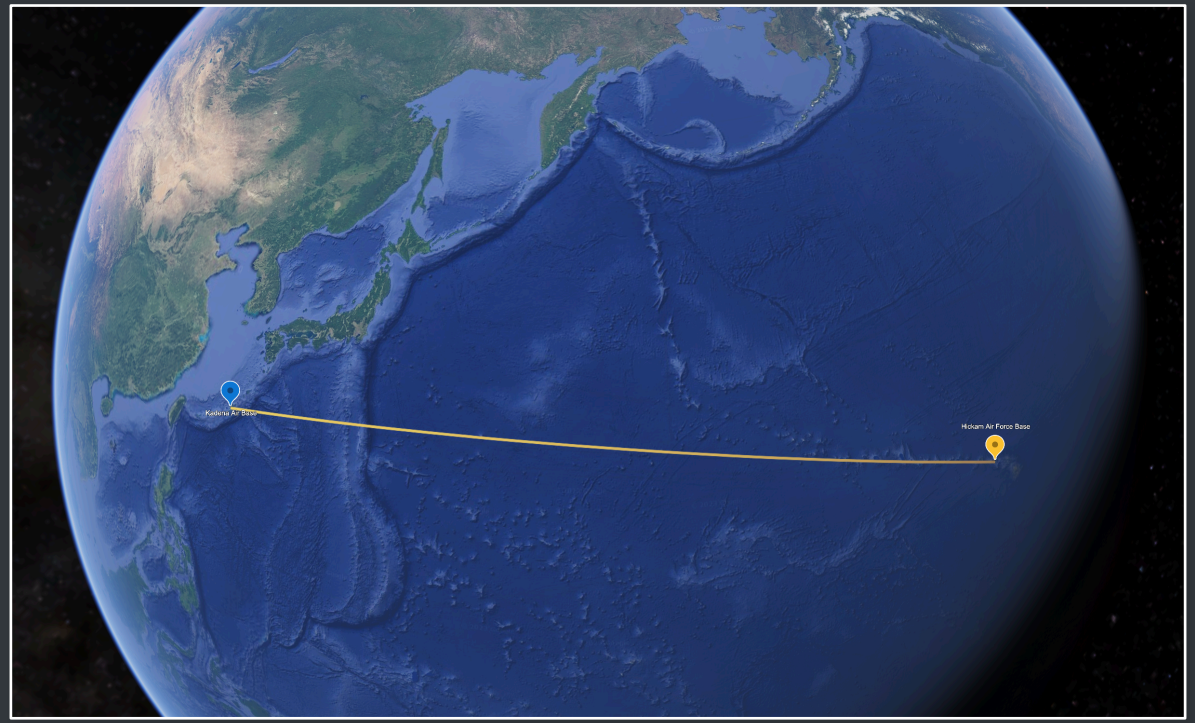
What happened?

Crash of the onboard computer in the middle of the pacific ocean

(Navigation, communikation, …)

Lockheed Martin F-22 Raptor

Causes



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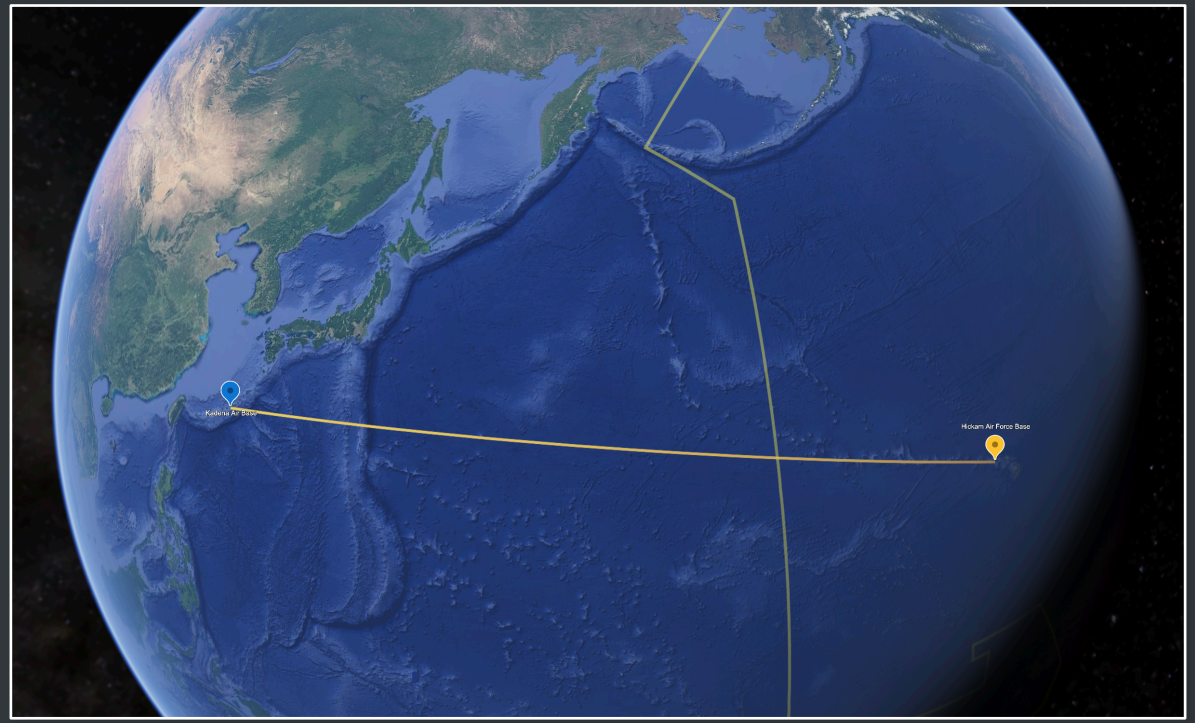

Microsoft Zune, iOS, Lockheed Martin F-22 Raptor

Lessons to learn

What can we take away?

"this surely can't happen to us... or can it?"

Microsoft Zune, iOS, Lockheed Martin F-22 Raptor

Lessons to learn

Date and time handling
is (still) complicated
and has a lot of edge cases

Microsoft Zune, iOS, Lockheed Martin F-22 Raptor

Lessons to learn

Use (and understand) proven tools, frameworks and libraries

Boeing 787 Dreamliner

(2020 - ???)

Boeing 787 Dreamliner

What ~~happened~~ is still happening?

Aircraft must be rebooted every 51 days

Boeing 787 Dreamliner

Ursachen

Historical data accumulates in memory and might lead to "display of misleading data"

Lessons to learn

Clean up after yourself!

Wrapup

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Costs

"The Cost of Poor Software Quality in the US: A 2020 Report"
https://www.it-cisq.org/the-cost-of-poor-software-quality-in-the-us-a-2020-report/

Mars Climate Orbiter

Mars Climate Orbiter
https://en.wikipedia.org/wiki/Mars_Climate_Orbiter

How NASA Lost a Spacecraft Due to a Metric Math Mistake
https://www.simscale.com/blog/2017/12/nasa-mars-climate-orbiter-metric/

Metric vs Imperial Units: How NASA lost a 327 Million Dollar Mission to Mars
https://everydayastronaut.com/mars-climate-orbiter/

Therac-25

Therac-25
https://en.wikipedia.org/wiki/Therac-25

Fatal dose: Radiation Deaths linked to AECL Computer Errors
http://www.ccnr.org/fatal_dose.html

Microsoft Zune

The Zune Bug
http://bit-player.org/2009/the-zune-bug

iOS alarm clock

Apple confirms New Year's alarm bug
https://appleinsider.com/articles/11/01/02/apple_admits_new_years_alarm_bug

Lockheed Martin F-22 Raptor

Lockeed 's F-22 Raptor Gets Zapped by International Date Line
https://web.archive.org/web/20070316132413/http://www.dailytech.com/article.aspx?newsid=6225

F-22 Squadron shot down by international date line
https://www.defenseindustrydaily.com/f22-squadron-shot-down-by-the-international-date-line-03087/

Boeing 787 Dreamliner

Boeing 787s must be turned off and on every 51 days to prevent 'misleading data' being shown to pilots
https://www.theregister.com/2020/04/02/boeing_787_power_cycle_51_days_stale_data/

Integrated Modular Avionics – Electrical Power – Repetitive Cycling
https://ad.easa.europa.eu/ad/US-2020-06-14