iClickers!

How many CS classes are you planning on taking in the fall?

A. 1
B. 2
C. 3
D. 4
E. none :(

CS61A Lecture 27

Therac Case Study/Programming Practices

Hamilton Nguyen

Administrivia

- Review Session TONIGHT – 306 Soda, 6:30-9:30pm

- Homework 13 (last HW!) due TONIGHT – 11:59pm

- Wed/Thurs (8/12) Sections converted to office hours/general review

- Final THURSDAY 8/12, 155 Dwinelle, 7-10pm

Part I: Therac Case Study

Therac-25

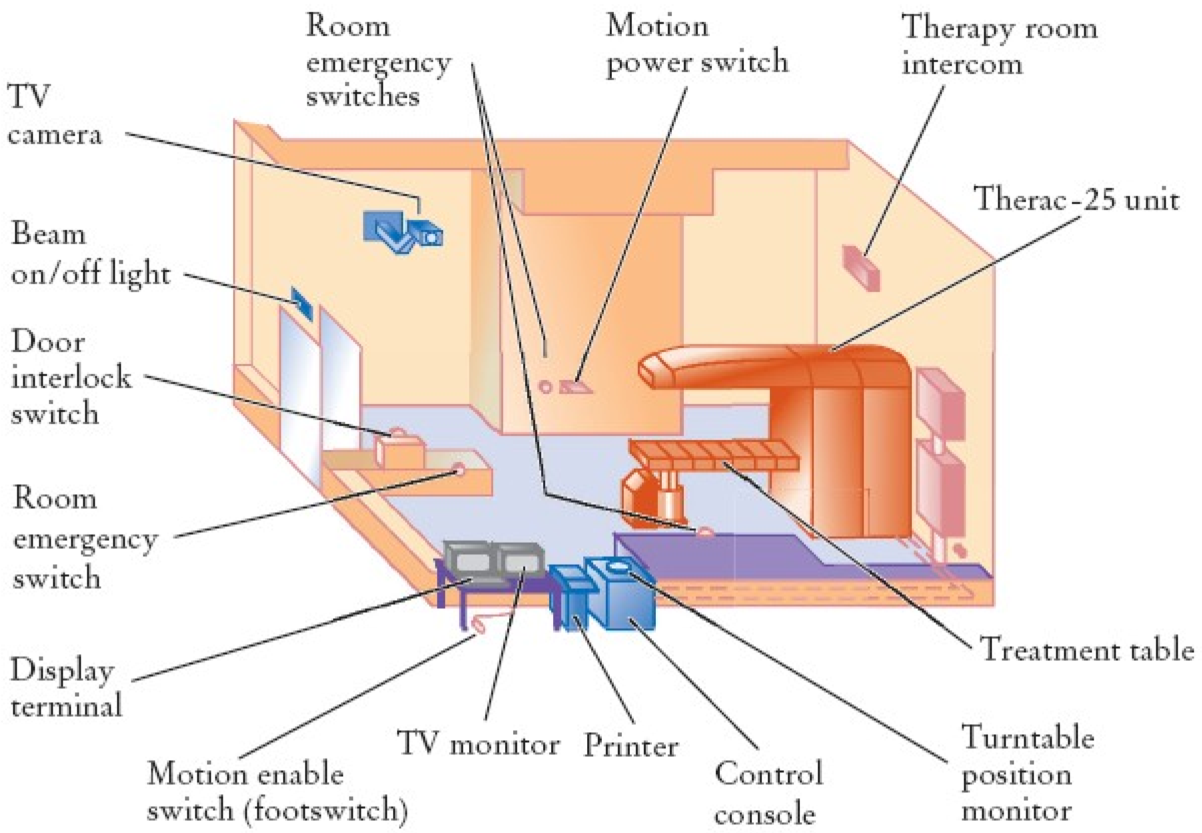


Figure 9 Typical Therac-25 Facility

What happened?

- 6 accidents – serious burns

- 4 deaths

- Otherwise effective – saved hundreds of lives

Lesson to be learned

- Social responsibility in engineering

- First real incident of fatal software failure

- What is good software engineering?

Lesson in Ethics?

- Not that simple...

- **There were no bad guys**

- **Honestly believed** there were no issues

- But something was clearly wrong...
  ...so why couldn't they see it?

“Software Rot”

- Other engineering fields: clear sense of degradation and decay

- Software doesn't become brittle or fractured... does it?

- Phenomenon of software degrading after time

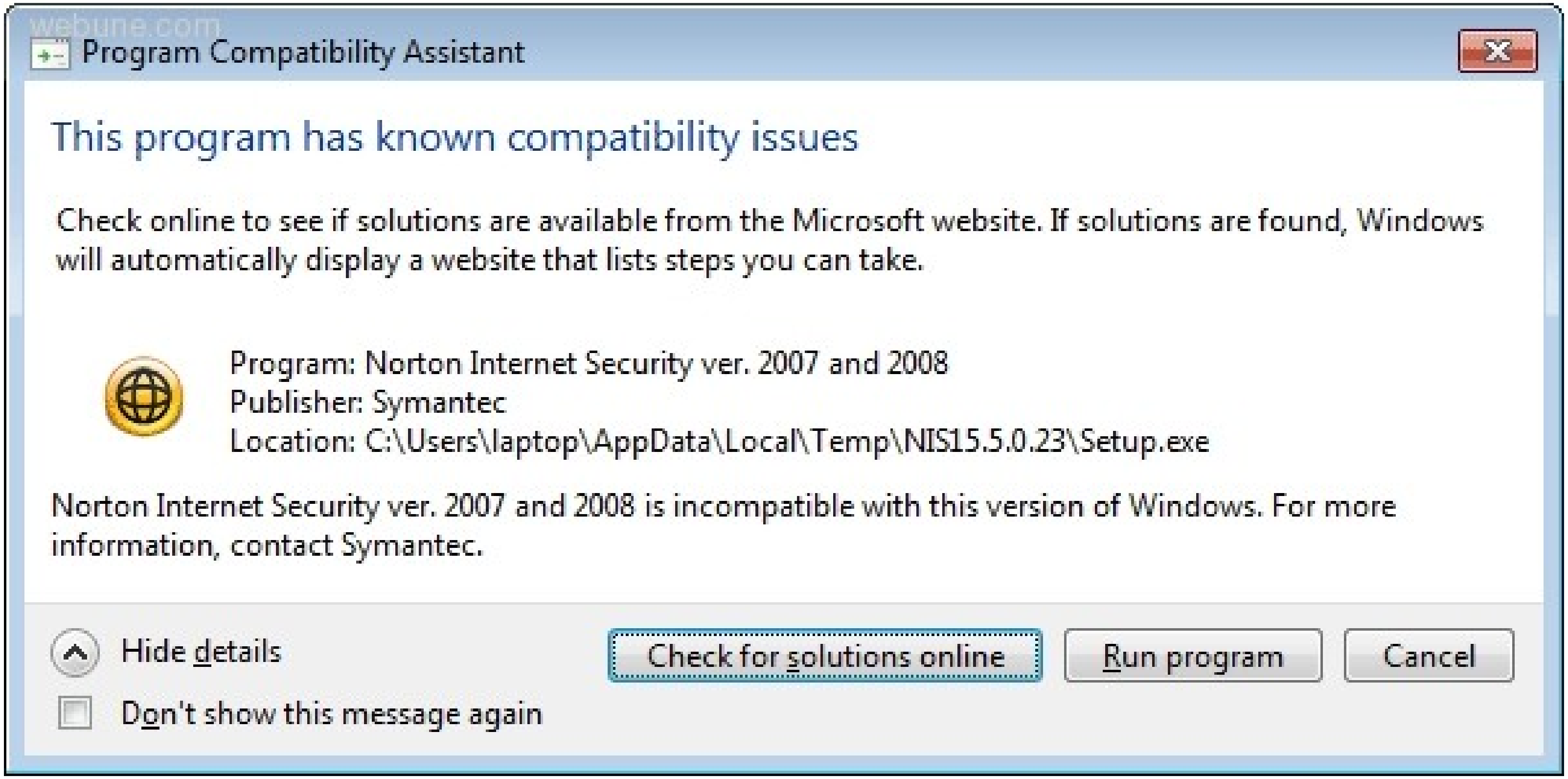
A bigger picture

- **All software is part of a bigger system**

- Software degrades because:

  - Other piece of software changes
  - Hardware changes

Ex: Compatibility Issues



This program has known compatibility issues

Check online to see if solutions are available from the Microsoft website. If solutions are found, Windows will automatically display a website that lists steps you can take.

Program: Norton Internet Security ver. 2007 and 2008
Publisher: Symantec
Location: C:\Users\laptop\AppData\Local\Temp\NIS15.5.0.23\Setup.exe

Norton Internet Security ver. 2007 and 2008 is incompatible with this version of Windows. For more information, contact Symantec.

A bigger issue

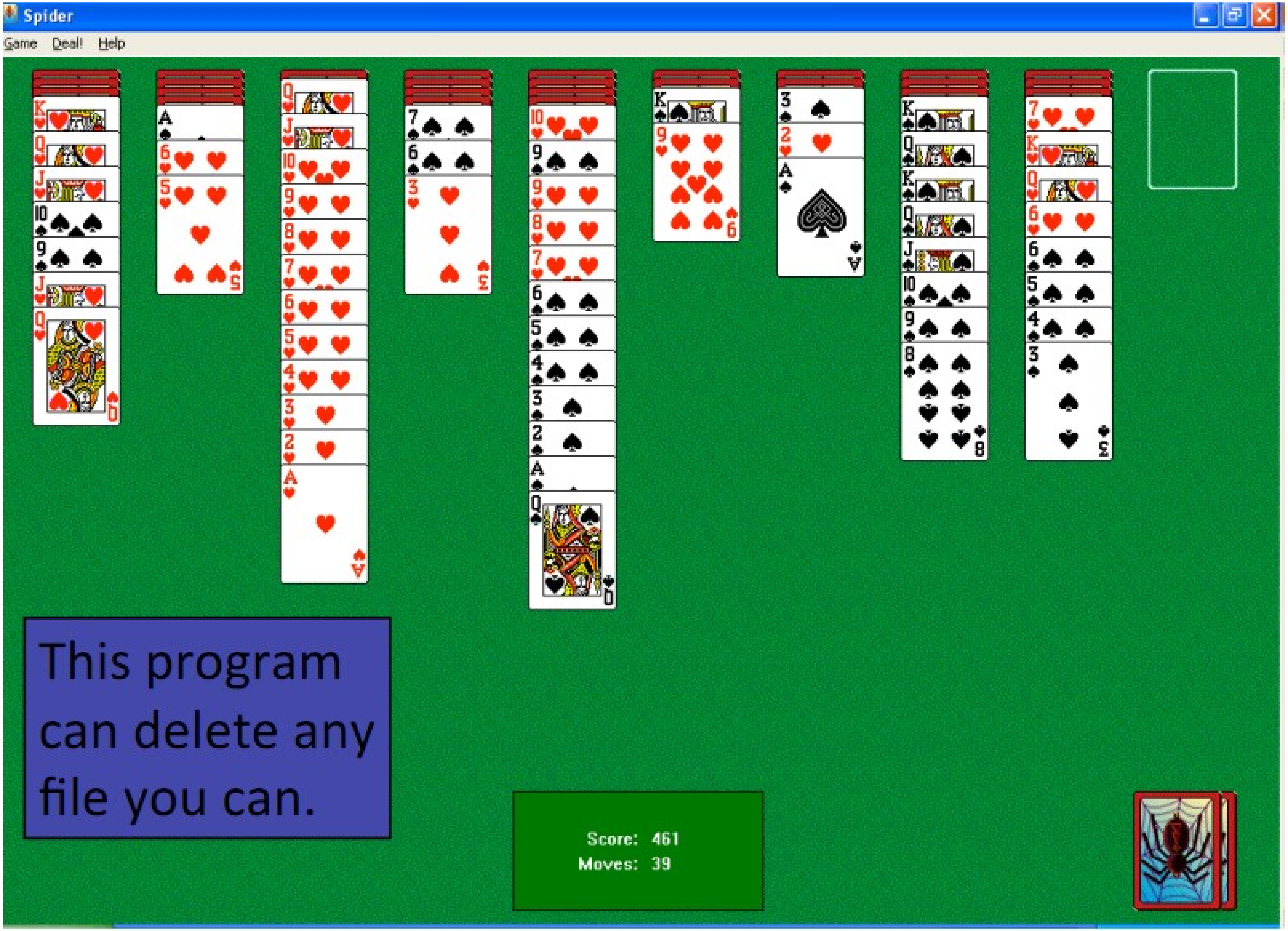
- The makers of the Therac did not fully understand the **complexity** of their software

- Characterized by intricate web of dependencies and relations

- Other engineering disciplines – complexity of their creations are more apparent

A “simple” program

- One of my favorites...
  - Spider Solitaire



Score: 461
Moves: 39

This program can delete any file you can.

source: CS161 Sp11

Complexity and You

- Hyper-technological modern society

- Limitless reach of software complexity

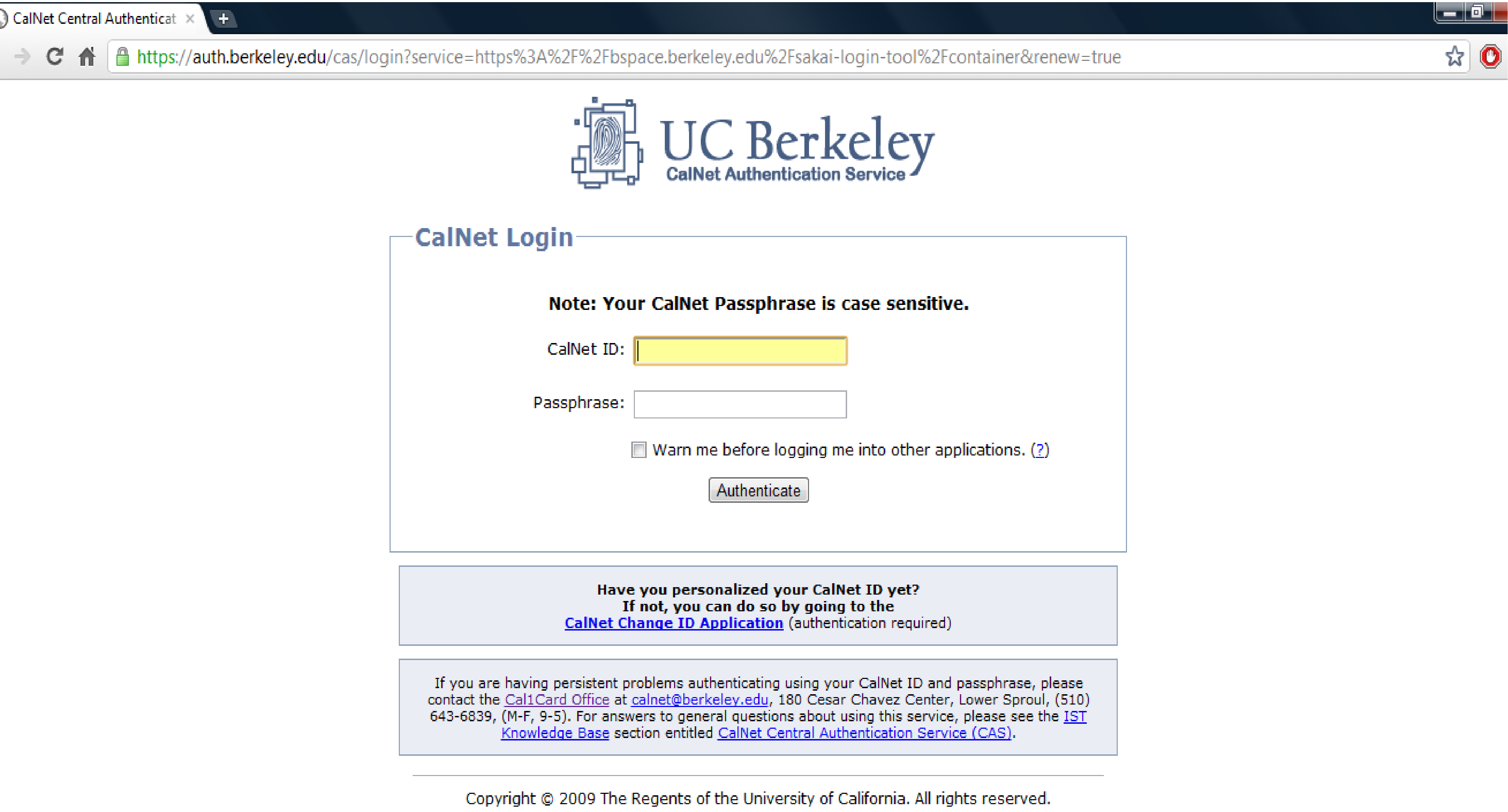
- Is every piece of software lethal?

Problems with Therac-25

- No atomic test-and-set
- No more hardware interlocks
- Abundant user interface issues

UI Problems

- Cursor position and form entry



CalNet Central Authenticat
https://auth.berkeley.edu/cas/login?service=https%3A%2F%2Fbspace.berkeley.edu%2Fsakai-login-tool%2Fcontainer&renew=true
UC Berkeley
CalNet Authentication Service

CalNet Login

Note: Your CalNet Passphrase is case sensitive.

CalNet ID:

Passphrase:

□ Warn me before logging me into other applications. (?)

Authenticate

Have you personalized your CalNet ID yet?
If not, you can do so by going to the
CalNet Change ID Application (authentication required)

If you are having persistent problems authenticating using your CalNet ID and passphrase, please contact the Cal1Card Office at calnet@berkeley.edu, 180 Cesar Chavez Center, Lower Sproul, (510) 643-6839, (M-F, 9-5). For answers to general questions about using this service, please see the IST Knowledge Base section entitled CalNet Central Authentication Service (CAS).

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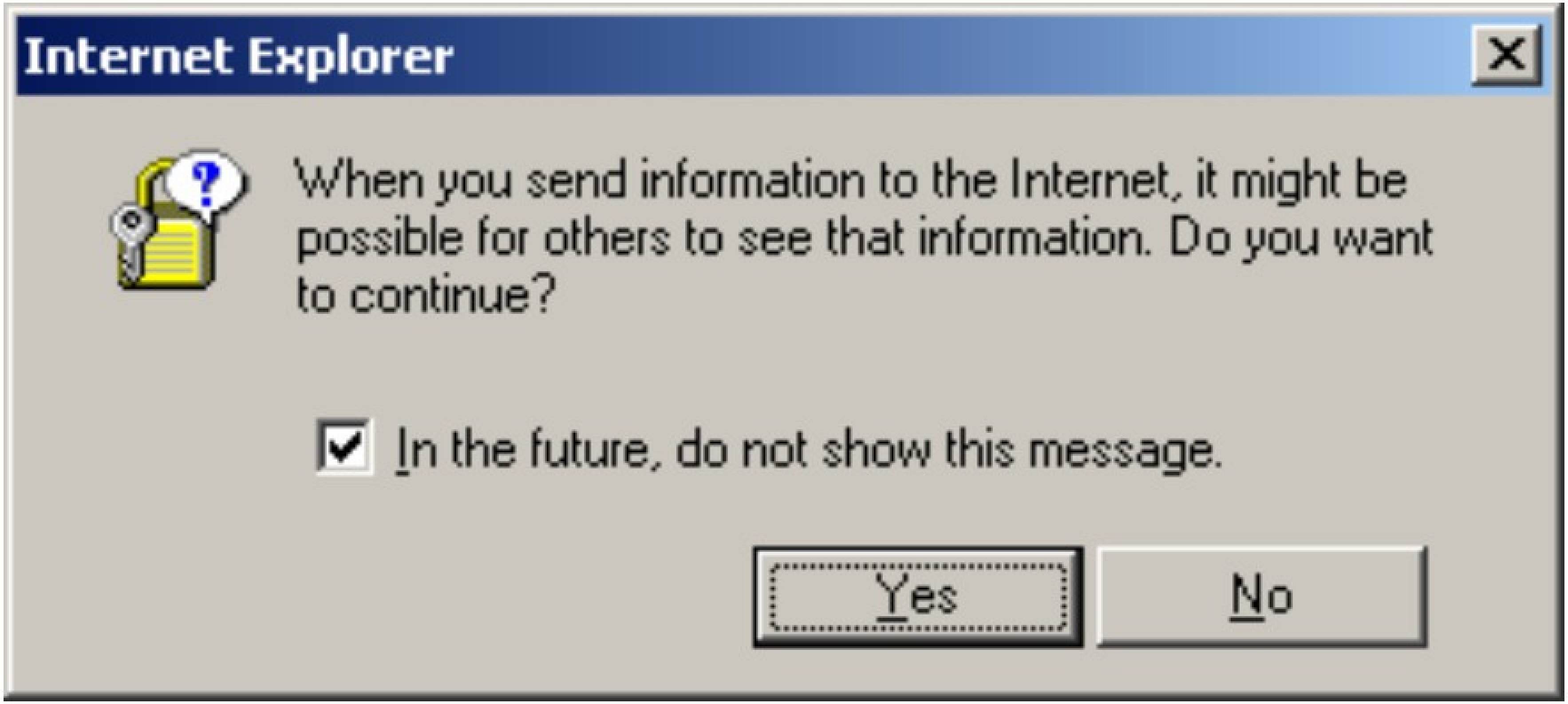
UI Problems

- Cursor position and form entry
- Default values

UI Problems

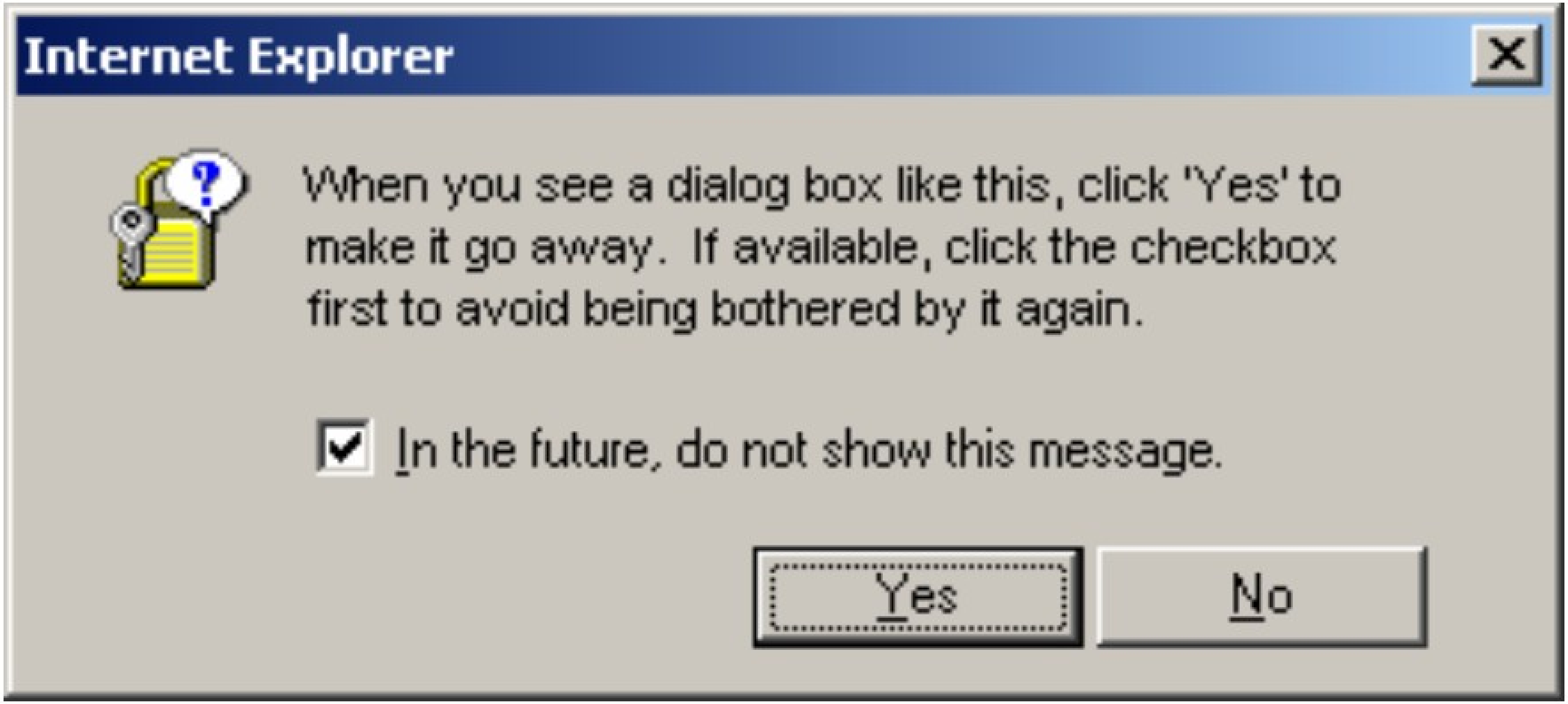
- Cursor position and form entry
- Default values
- Too many error messages



Internet Explorer

When you send information to the Internet, it might be possible for others to see that information. Do you want to continue?

☑ In the future, do not show this message.



Internet Explorer

When you see a dialog box like this, click 'Yes' to make it go away. If available, click the checkbox first to avoid being bothered by it again.

☑ In the future, do not show this message.

source: CS161 Sp11

How would you solve these?

- Cursor position and form entry

- Default values

- Too many error messages

Problems with Therac-25

- No atomic test-and-set
- No more hardware interlocks
- Abundant user interface issues
- Bad documentation
- Organization Response

How do we solve these problems?

- One idea:
  - Responsible programming
- Big idea:
  - Redundancy

```
(define (mc-eval exp env)
  (cond ((self-evaluating?...
        ((variable?...
        .
        .
        .
        (else
          (error “Unknown exp”...
```

How do we solve these problems?

- Redundancy
- Know your user
- Fail-Soft (or Fail-Safe)
- Audit Trail
- Correctness from the start

Correctness from the start

- Edsger Dijkstra: “On the Cruelty of Teaching Mathematics”

- CS students shouldn't use computers

- Rigorously prove correctness of program

Verification Techniques

- Correctness proofs
- Compilation (pre-execution) analysis

Debugging Techniques

- Black box debugging

- Glass box debugging

- Don't break what works

- And the golden rule of debugging...

> “Debug by subtraction,
> not by addition”

Prof. Brian Harvey

Can you think of examples?

- Redundancy
- Know your user
- Fail-Soft (or Fail-Safe)
- Audit Trail
- Correctness from the start

Break

iClickers!

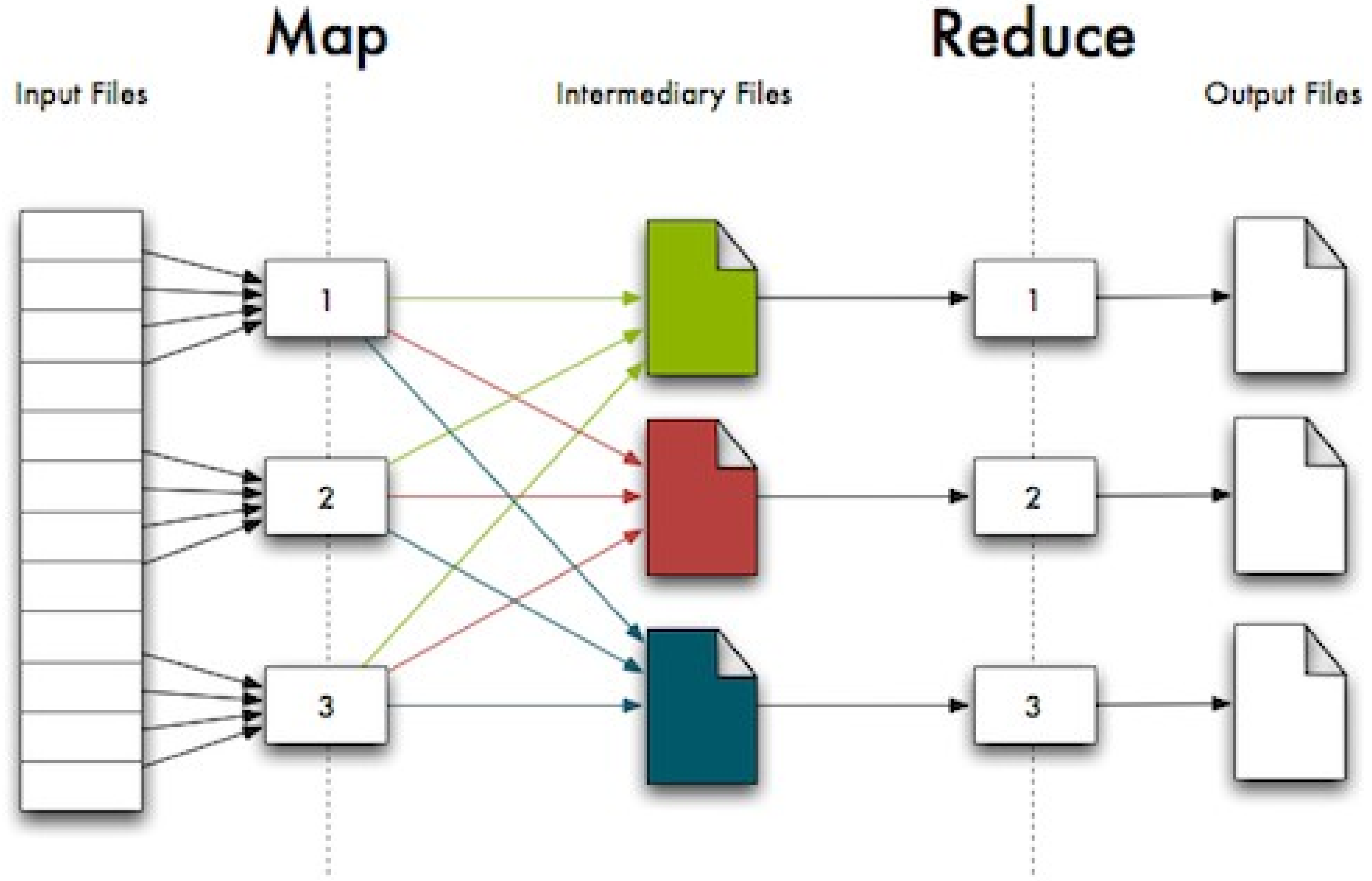
Which project was your favorite?

A. 1 – Twenty-one
B. 2 – Painter language
C. 3 – Adventure game
D. 4 – Logo interpreter
E. All of them! :)

Big Ideas

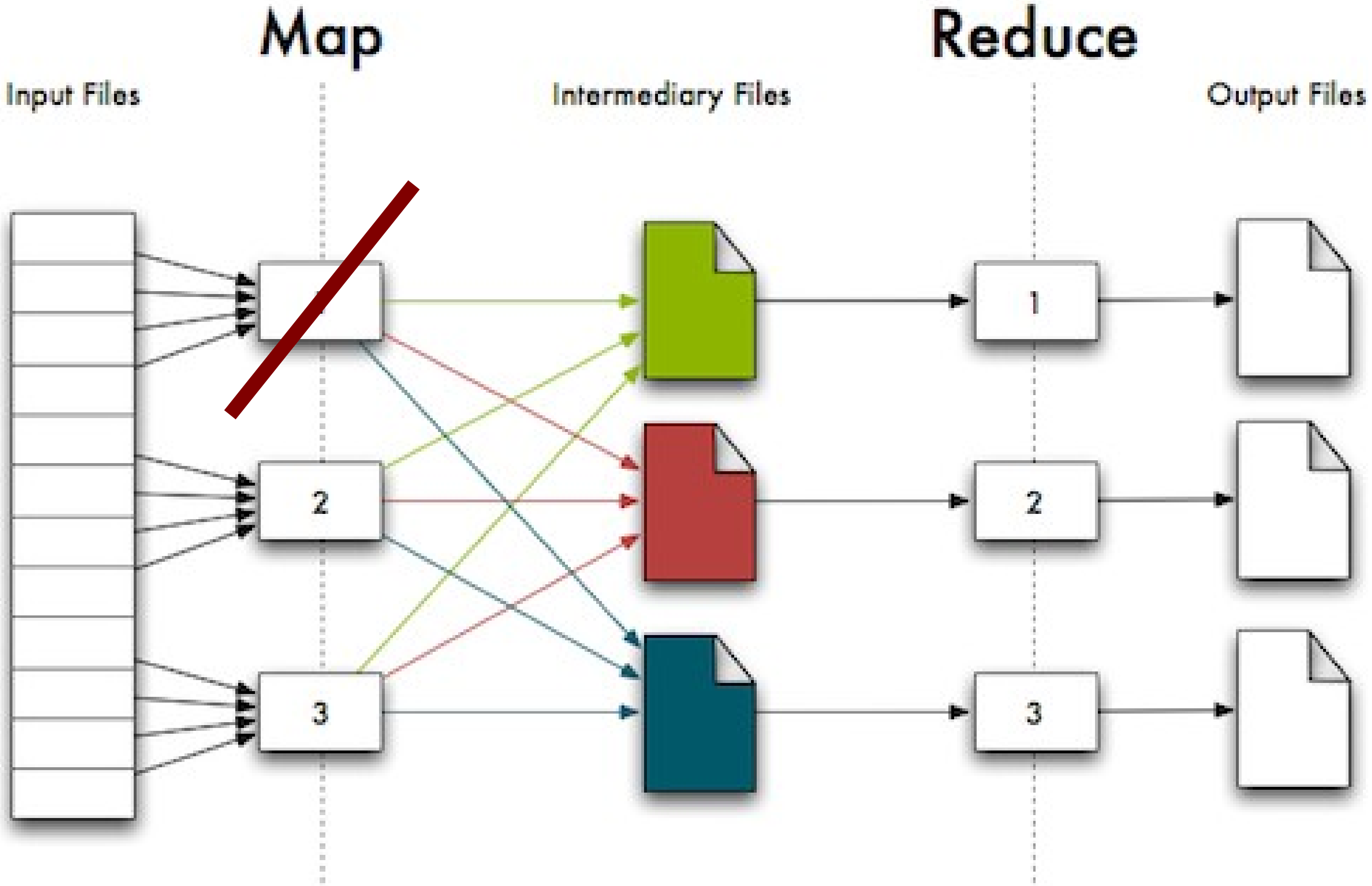
- Redundancy
- Know your user
- Fail-Soft (or Fail-Safe)
- Audit Trail
- Correctness from the start

Flashback: MapReduce



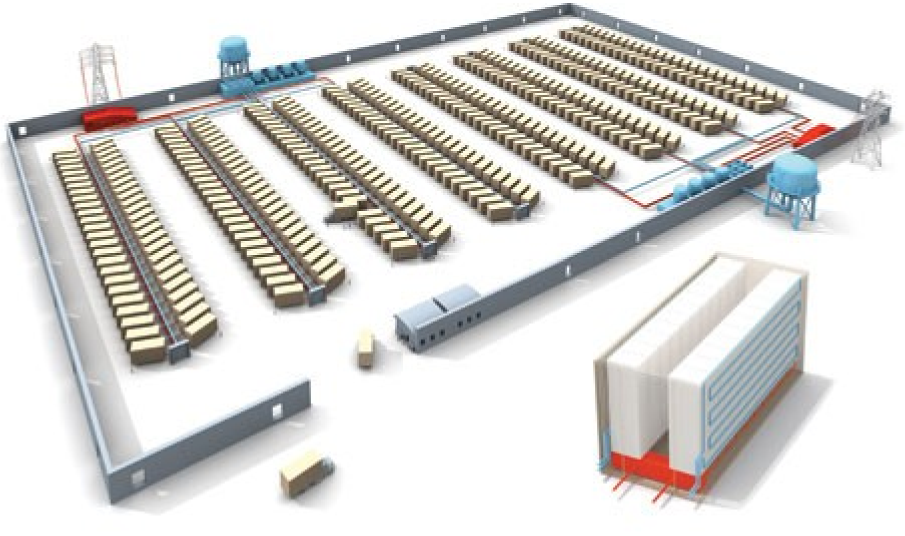
source: blog.maxgarfinkel.com

Failure?



Is this even an issue?

Warehouse Scale Computing



iClickers!

Let's say you have... 50,000 servers. Each server has four disks. On average, how often do you get a disk failure?

A. Once per year
B. Once per month
C. Once per week
D. Once per day
E. Once per hour

iClickers!

Failure rate of disk is 2%-10% per year. Let's assume 4%. In one year, 4% of 200,000 disks fail = 8,000 disks. There are 8,760 hours in a year.

A. Once per year

B. Once per month

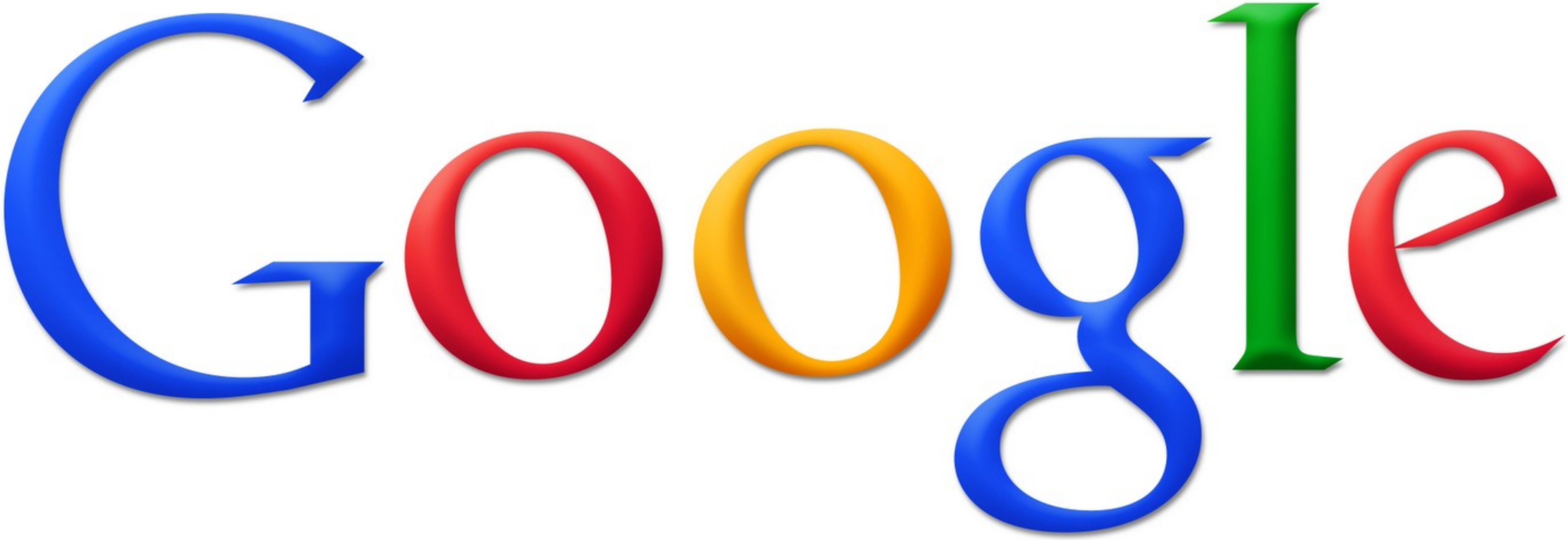
C. Once per week

D. Once per day

[✓ E. Once per hour]

Warehouse Scale Computing

Google is estimated to have **900,000** servers.



Is failure even an issue? **Yes.**

Redundant redundancy

- How do they deal with a worker failing?

- Answer: **redundancy**

- When a worker fails, one of its “superiors” (a scheduler node) assigns a new worker to complete its task

Redundant redundancy

- How do they know a worker has failed?

- Answer: **redundancy**

- Workers are programmed to periodically report to their superiors

- If a worker falls “silent”, it is no longer capable of operating

Redundant redundancy

- How can they always replace downed workers?
- Answer: **redundancy**
- Hundreds of thousands of possible replacements
- What is the result of all of this?

Redundant redundancy

- How can they always replace downed workers?

- Answer: **redundancy**

- Hundreds of thousands of possible replacements

- What is the result of all of this?

- Answer: When was the last time Google search was down?

Safe Browsing

- Let's say you visit some website... like Facebook

- How do you know it's really Facebook, and not some evil site that only looks like Facebook?

Safe Browsing

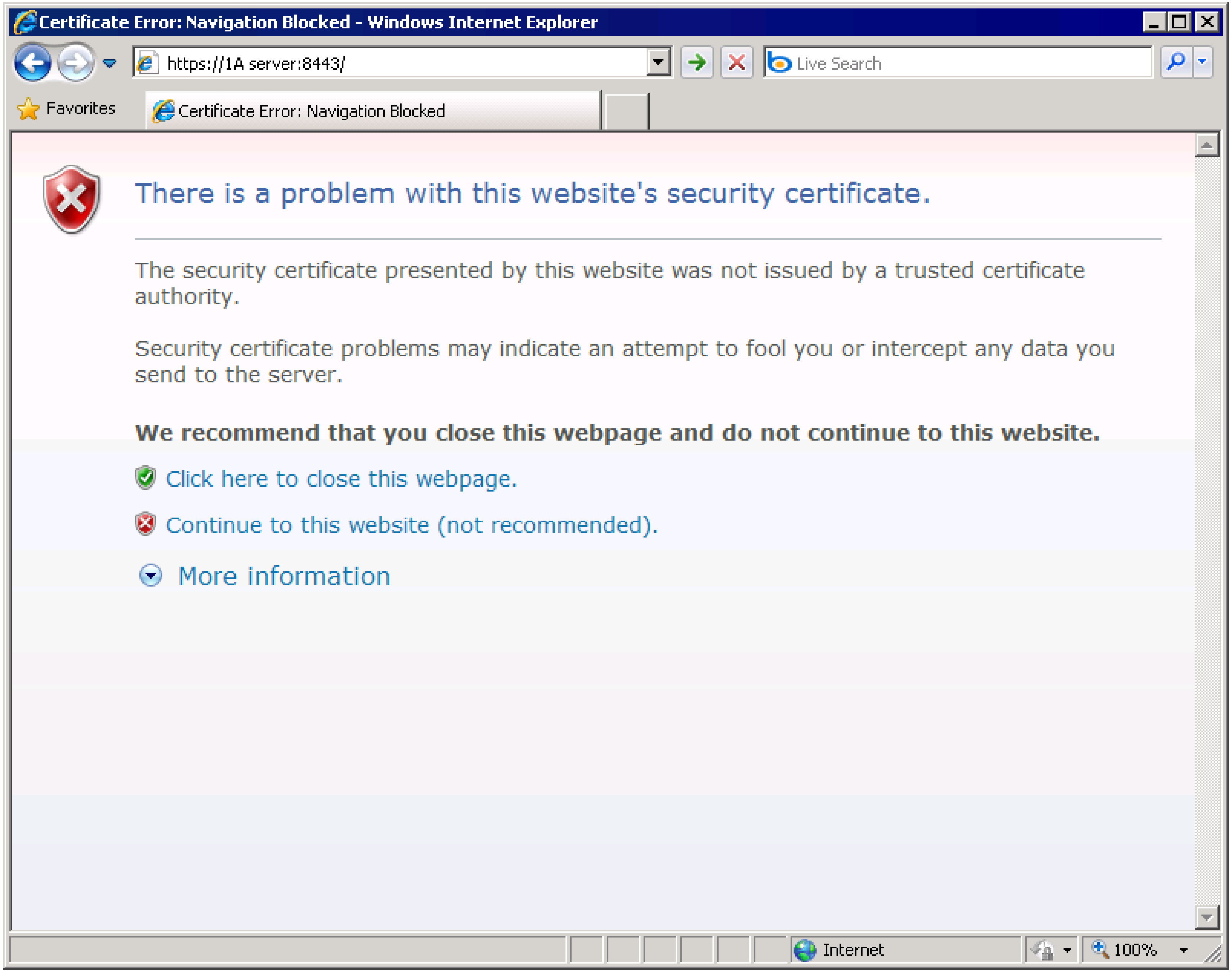
- Answer: Website certificates

- Verify through a trusted 3rd party that website displays correct certificate

- What if website has been certified by 3rd party that is not necessarily trusted?

- What if we can't receive the certification at all?

Fail-Safe Defaults



Certificate Error: Navigation Blocked - Windows Internet Explorer
https://1A server:8443/
Live Search
Favorites
Certificate Error: Navigation Blocked

There is a problem with this website's security certificate.

The security certificate presented by this website was not issued by a trusted certificate authority.

Security certificate problems may indicate an attempt to fool you or intercept any data you send to the server.

We recommend that you close this webpage and do not continue to this website.

Click here to close this webpage.

Continue to this website (not recommended).

More information

Questions?