

Secure coding training
Secure development on all levels

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The goal of this presentation

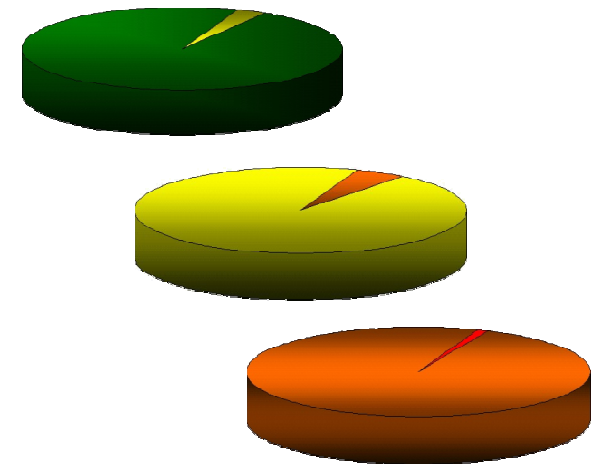


- A smooth introduction to the training
 - Why secure programming?
 - Cost of software bugs
 - Some spectacular programming mistakes
 - What levels (layers) should be differentiated when talking about secure applications
 - **Technologies** (*the main subject of the Day 1*)
 - *Functionality*
 - *Configuration*
 - **Coding patterns** (*the main subject of the Day 2*)
- This presentation is intended also for the project leaders
 - Let your people have resources to consume on learning secure programming!

Why the code is insecure?



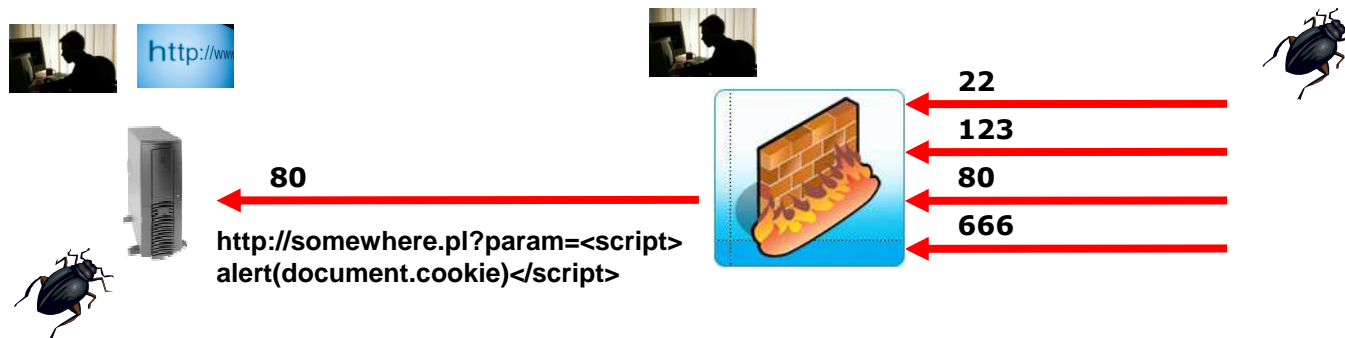
- We are not robots, we make mistakes
 - Let the software be 30 000 KLOC (30 millions lines) long
 - *Windows 2000 was of that size*
 - According to the Carnegie Mellon University's CyLab, 1 KLOC (1000 lines of code) contains up to 30 software bugs
 - Let's make some further assumptions:
 - *20 software bugs (of all kinds) in 1 KLOC*
 - *only 5% of them are security-related*
 - *only 1% of the latter give system access*
 - $30\ 000\ 000 * 0.02 * 0.05 * 0.01 = 300$
 - The attacker needs to find only 1 out of those 300...



Why the code does matter?



- It is the administrator who should take care of the system security, isn't it?
 - Appropriate server configuration
 - Firewall policies...



- The response must be “defence in-depth”

- We defend on every level



But are the software bugs expensive?



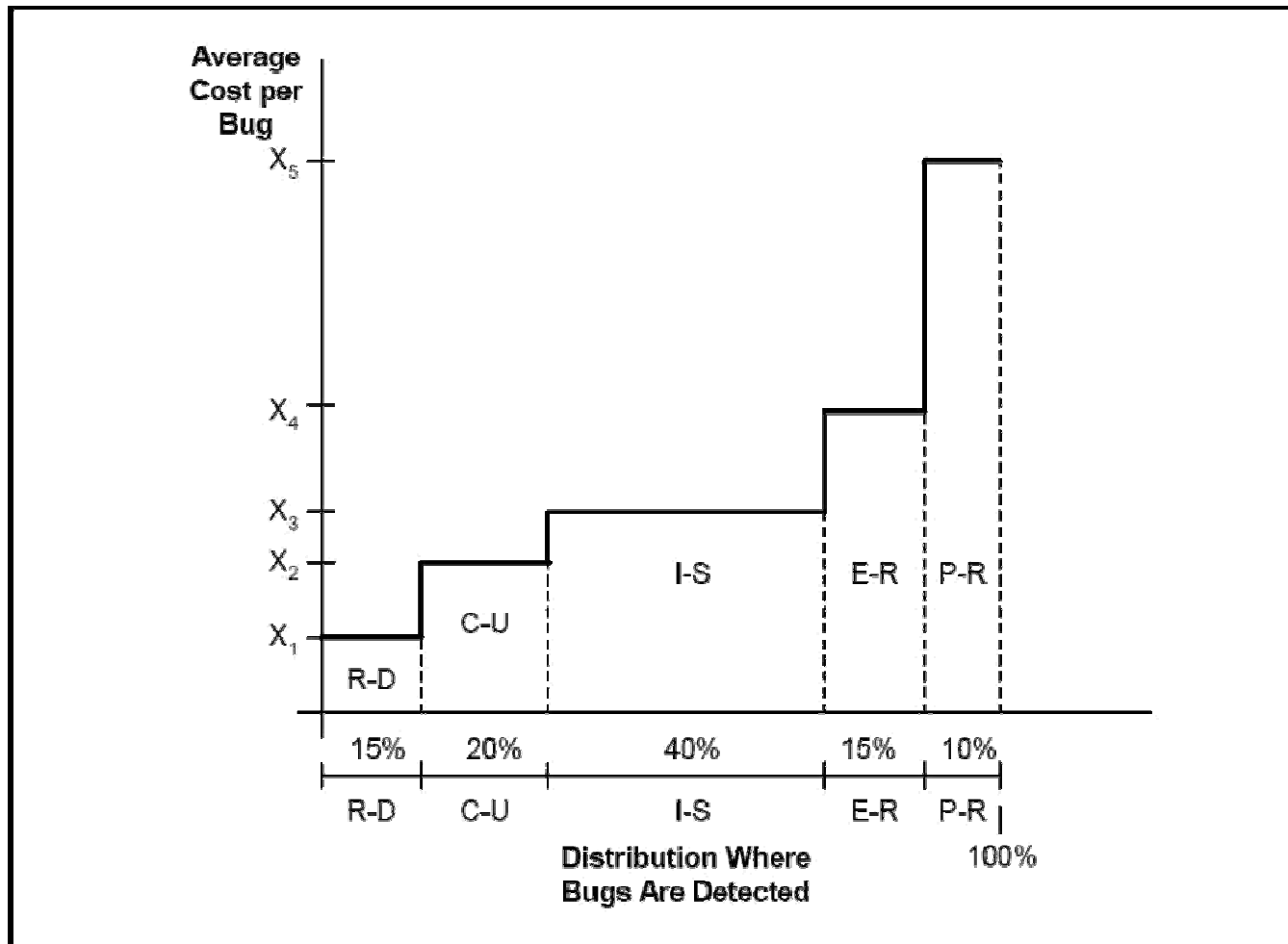
- NIST Report "The Economic Impacts of Inadequate Infrastructure for Software Testing" (2002)
 - <http://www.nist.gov/director/planning/upload/report02-3.pdf>
 - This is more general, not only security bugs
 - *But they are bugs as well...*

Table 7-5. Hours to Fix Bug based on Introduction Point

Stage Introduced	Stage Found				
	Requirements	Coding/Unit Testing	Integration	Beta Testing	Post-product Release
Requirements	1.2	8.8	14.8	15.0	18.7
Coding/unit testing	NA	3.2	9.7	12.2	14.8
Integration	NA	NA	6.7	12.0	17.3

NA = Not applicable because cannot find a bug before it is introduced

Another chart from the NIST report



Legend:

R-D: Requirements Gathering and Analysis/Architectural Design

C-U: Coding/Unit Test

I-S: Integration and Component/RAISE System Test

E-R: Early Customer Feedback/Beta Test Programs

P-R: Post-product Release

Were there any serious software bugs?



- Therac25 equipment
- Ariane 5 rocket
- Air-Traffic Control System in LA
- Mars exploration problems
- More:
 - http://computingcases.org/case_materials/therac/therac_case_intro.html
 - <http://www.cse.lehigh.edu/~gtan/bug/softwarebug.html>
- The specifics of security bugs
 - Example: MS Blaster (Lovesan)

- Cancer treatment with radiotherapy
- 1985-1987: many radiation overdosing, at least 5 people died
- Numerous errors in control software
 - Race condition error – if an operator worked too fast (!) several parameters could not be initialized properly
 - Source code from the previous version was applied, but the older version had additional hardware protections
 - Overflow error: a flag was incremented and accidentally zeroed
 - No one thought about an independent code review

- European Space Agency project for putting satellites into Earth orbit
 - 10 years, 7.000.000.000 USD
- 36.7 seconds after the launch, the first Ariane rocket crashed into the ground
 - The rocket cost: 500M USD
- Overflow error
 - 64-bit value (sideways velocity of the rocket) was intended to be saved into 16-bit variable
 - An error occurred in the primary working unit
 - The secondary unit took control, but the same error occurred

- A key part of NASA Mars exploration program
 - Worth 125M USD
- In 1999 it went too low and was never heard again
- Lack of conversion check
 - Two unit systems were used in the orbiter software: metric and English
 - In the routines managing the orbit change, someone forgot to assure appropriate conversion check
 - Too little tests
- Another Mars probe lost due to software errors
 - Mars Global Surveyor (2006, a series of errors started with two bad memory addresses)

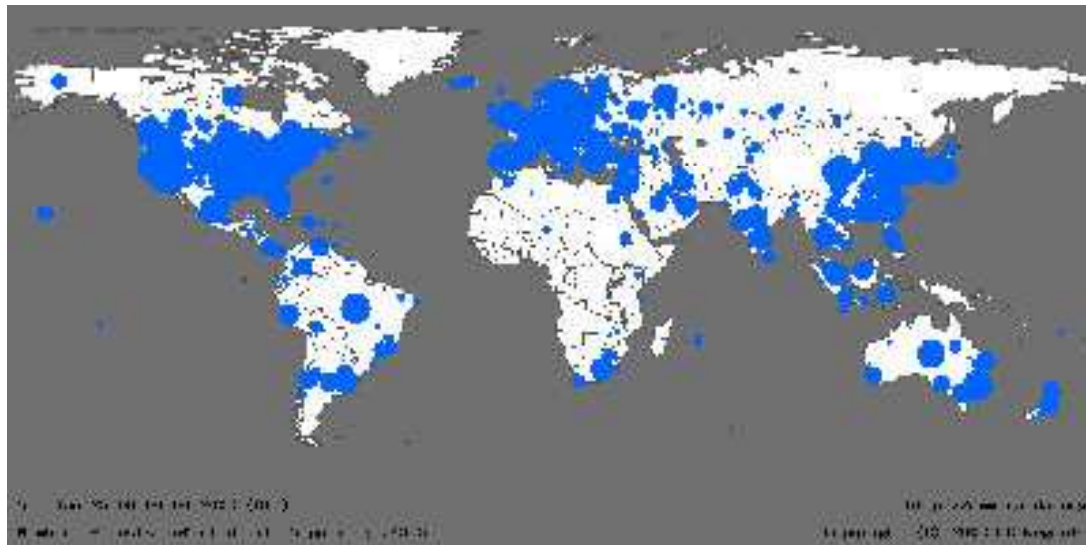
- In 2004, air-traffic control system in LA lost voice contact with about 400 airplanes
 - Happily, no one suffered – currently there are onboard anti-collision systems like TCAS
- The system unexpectedly shut down
 - Control unit contained a counter which measured milliseconds
 - The greatest number that could be stored in the system, was 2^{32} (2^{32} milliseconds is ca. 50 days)
 - There were special procedures to reset the software every 30 days, which apparently had not been done that time

- Security bugs have slightly different nature
 - Usually, they are more oriented on stealing data, money, research results
 - However, accessibility is one of the security facets...
- On the other hand, they introduce other threats
 - Loses on trust
 - May even kill whole enterprises
 - *Blue Security and Blue Frog antispam system case (2006)*

MS Blaster (Lovesan)



- An example of spectacular security bug
 - Microsoft DCOM RPC buffer overrun (found by our PSNC colleagues)
- MS Blaster virus (2003)
 - Ca. 25M computers infected (2005)
 - Direct loses: 1.500.000.000 USD



<http://www.security.nl/image/246>



<http://pl.wikipedia.org>

Top excuses for not writing secure code



- No one will do that!
- Why would anyone do that?
- We've never been attacked
- We're secure – we use cryptography
- We're secure – we use ACLs
- We're secure – we use a firewall
- We've reviewed the code, and there are no security bugs
- We know it's the default, but the administrator can turn it off
- If we don't run as administrator, stuff breaks

Should we care if the software will never be perfect?



- We should care – there is security economy!
 - The economic factors become more meaningful for everyone, including attackers
 - Your system is in danger when



Attack cost \leq Value of your data



- Therefore we should make the attacker's goal more difficult
 - Better security systems
 - Less software errors



Should the developer be security specialist then?



- Obviously not – everyone has got an own job
 - We do not expect the developers to learn about network attacks or exploiting vulnerabilities
- But we think we can expect the developers...
 - To know the basics of secure coding (including simple examples of attacks for better understanding)
 - To apply secure coding practices in their favourite programming language (or the one they have to work with)
 - To create well-commented and easy-to-understand code
 - To apply simple tools detecting the most obvious security flaws
 - Last but not least, a „secure coder” will be more competitive ;)

Security layers of secure programming



- Similarly to IT security as a whole, creating software may be divided onto layers
 - Defence-in-depth principle should be applied as well
- At least 4 layers might be differentiated
 - Technologies
 - Functionality
 - Configuration
 - Coding patterns
- Remember about other groups that do matter
 - Project leaders
 - System, network and server administrators
 - Users (awareness!)

● Technologies

- There are useful solutions which may help (e.g. HTTPS, SSL, VPN, PKI)
- You may apply them or not
- Will be mentioned quite thoroughly during Day 1

● Functionality

- Your application may lack necessary security-related functionality...
 - *Lack of character hiding when typing login passwords*
- ... or this functionality may be improperly implemented
 - *Too expressive error handling mechanism*
 - *Different error messages for bad username and bad password*
- A general subject for Day 1

● Configuration

- The user must be able to configure the application securely
- The default configuration must be carefully designed (apparent security/market usability tradeoff)
- Another general issue to be mentioned during Day 1

● Coding patterns

- Even the best functionality and the most secured configuration may be implemented in an insecure way
- The subject of the whole Day 2

- Software will contain vulnerabilities (including security bugs)
 - However their number should be minimized
- Software bugs will matter even if we have other layers properly secured
- There were many cases of spectacular software bugs
- Security economy encourages us not to make applications 100% secure (which is impossible), but to make breaking them cost-ineffective for attacker
- Secure programming is one of the layer of defense
 - Itself it may be divided into different layers: technologies, functionality, configuration, coding patterns