Cel szkolenia:

As a developer, your duty is to write bulletproof code. However...

What if we told you that despite all of your efforts, the code you have been writing your entire career is full of weaknesses you never knew existed? What if, as you are reading this, hackers were trying to break into your code? How likely would they be to succeed?

This advanced course will change the way you look at code. A hands-on training during which we will teach you all of the attackers’ tricks and how to mitigate them, leaving you with no other feeling than the desire to know more.

It is your choice to be ahead of the pack, and be seen as a game changer in the fight against cybercrime.

Participants attending this course will:

- Understand basic concepts of security, IT security and secure coding
- Realize the severe consequences of unsecure buffer handling
- Understand the architectural protection techniques and their weaknesses
- Have a practical understanding of cryptography
- Understand essential security protocols
- Understand some recent attacks against cryptosystems
Learn about XML security
Learn about typical coding mistakes and how to avoid them
Be informed about recent vulnerabilities in various platforms, frameworks and libraries
Get practical knowledge in using security testing techniques and tools
Learn how to set up and operate the deployment environment securely
Get sources and further readings on secure coding practices

Audience:
C and C++ developers, software architects and testers

Plan szkolenia:

- IT security and secure coding
  - Nature of security
  - What is risk?
  - IT security vs. secure coding
  - From vulnerabilities to botnets and cybercrime
    - Nature of security flaws
    - Reasons of difficulty
    - From an infected computer to targeted attacks
- x86 machine code, memory layout and stack operations
  - Intel 80x86 Processors – main registers
  - Intel 80x86 Processors – most important instructions
  - Intel 80x86 Processors – flags
  - Intel 80x86 Processors – control instructions
  - Intel 80x86 Processors – stack handling and flow control
  - The memory address layout
  - The function calling mechanism in C/C++ on x86
  - Calling conventions
  - The local variables and the stack frame
  - Function calls – prologue and epilogue of a function
  - Stack frame of nested calls
  - Stack frame of recursive functions
- Buffer overflow
  - Stack overflow
    - Buffer overflow on the stack
    - Overwriting the return address
Exercises – introduction

Exercise BOFIntro

Exercise BOFShellcode

Protection against stack overflow

 Specific protection methods
 Protection methods at different layers
 The protection matrix of software security
 Stack overflow – Prevention (during development)
 Stack overflow – Detection (during execution)
 Fortify compiler option (FORTIFY_SOURCE)
 Exercise BOFShellcode – Using the Fortify compiler option

Stack smashing protection

 Stack smashing protection variants
 Stack smashing protection in GCC
 Exercise BOFShellcode – Stack smashing protection
 Effects of stack smashing protection

Address Space Layout Randomization (ASLR)

 Randomization with ASLR
 Practical weaknesses and limitations to ASLR
 Circumventing ASLR: NOP sledding

Non executable memory areas – the NX bit

 Access control on memory segments
 The Never eXecute (NX) bit

Buffer overflow

 The protection matrix of software security
 Return-to-libc attack – Circumventing the NX bit protection
 Circumventing memory execution protection
 Return-to-libc attack

Return oriented programming (ROP)

 Exploiting with ROP
 ROP gadgets
 ROP mitigation
 Mitigation techniques of ROP attack

Heap overflow

 Memory allocation managed by a doubly-linked list
 Buffer overflow on the heap
Steps of freeing and joining memory blocks
- Freeing allocated memory blocks
- Case study – Heartbleed
  - TLS Heartbeat Extension
  - Heartbleed – information leakage in OpenSSL
  - Heartbleed – fix in v1.0.1g
- Protection against heap overflow

Practical cryptography
- Rule #1 of implementing cryptography
- Cryptosystems
  - Elements of a cryptosystem
- Symmetric-key cryptography
  - Providing confidentiality with symmetric cryptography
  - Symmetric encryption algorithms
  - Modes of operation
  - Symmetric encryption with OpenSSL: encryption
  - Symmetric encryption with OpenSSL: decryption
- Other cryptographic algorithms
  - Hash or message digest
  - Hash algorithms
  - SHAterred
  - Hashing with OpenSSL
  - Message Authentication Code (MAC)
  - Providing integrity and authenticity with a symmetric key
- Random number generation
  - Random numbers and cryptography
  - Cryptographically-strong PRNGs
  - Weak PRNGs in C and C++
  - Stronger PRNGs in C
  - Generating random numbers with OpenSSL
  - Hardware-based TRNGs
- Asymmetric (public-key) cryptography
  - Providing confidentiality with public-key encryption
  - Rule of thumb – possession of private key
  - The RSA algorithm
    - Introduction to RSA algorithm
- Encrypting with RSA
- Combining symmetric and asymmetric algorithms
- Digital signing with RSA
- Asymmetric encryption with OpenSSL
- Digital signatures with OpenSSL

- Public Key Infrastructure (PKI)
  - Man-in-the-Middle (MitM) attack
  - Digital certificates against MitM attack
  - Certificate Authorities in Public Key Infrastructure
  - X.509 digital certificate

- Security protocols
  - Secure network protocols
  - Specific vs. general solutions
  - The TLS protocol
    - SSL and TLS
    - Usage options
    - Security services of TLS
    - SSL/TLS handshake

- Cryptographic vulnerabilities
  - Protocol-level vulnerabilities
    - BEAST
    - FREAK
    - FREAK – attack against SSL/TLS
    - Logjam attack
  - Padding oracle attacks
    - Adaptive chosen-ciphertext attacks
    - Padding oracle attack
    - CBC decryption
    - Padding oracle example
    - Lucky Thirteen
    - POODLE

- XML security
  - Introduction
  - XML parsing
  - XML injection
    - Injection principles
Exercise – XML injection
Protection through sanitization and XML validation
XML parsing in C++

Abusing XML Entity
XML Entity introduction
Exercise – XML bomb
XML bomb
XML external entity attack (XXE) – resource inclusion
Exercise – XXE attack
Preventing entity-related attacks
Case study – XXE in Google Toolbar

Common coding errors and vulnerabilities
Input validation
Input validation concepts
Integer problems
Representation of negative integers
Integer ranges
Integer overflow
Integer problems in C/C++
The integer promotion rule in C/C++
Arithmetic overflow – spot the bug!
Exercise IntOverflow
What is the value of abs(INT_MIN)?
Signedness bug – spot the bug!
Integer truncation – spot the bug!
Integer problem – best practices
Case study – Android Stagefright

Injection
Injection principles
SQL Injection exercise
Typical SQL Injection attack methods
Blind and time-based SQL injection
SQL Injection protection methods
Command injection
Command injection exercise – starting Netcat
Case study – Shellshock
- Printf format string bug
  - Printf format strings
  - Printf format string bug - exploitation
  - Exercise Printf
  - Printf format string exploit – overwriting the return address
- Printf format string problem - best practices
- Some other input validation problems
  - Array indexing – spot the bug!
  - Off-by-one and other null termination errors
  - The Unicode bug
- Path traversal vulnerability
  - Path traversal - weak protections
  - Path traversal - best practices
- Log forging
  - Some other typical problems with log files
- Common coding errors and vulnerabilities
  - Code quality problems
    - Dangers arising from poor code quality
    - Poor code quality - spot the bug!
    - Unreleased resources
    - Type mismatch – Spot the bug!
    - Exercise TypeMismatch
  - Memory allocation problems
    - Smart pointers
    - Zero length allocation
    - Double free
    - Mixing delete and delete[]
- Use after free
  - Use after free - Instance of a class
  - Spot the bug
  - Use after free - Dangling pointers
  - Case study - WannaCry
- Common coding errors and vulnerabilities
  - Improper use of security features
    - Typical problems related to the use of security features
    - Password management
- Exercise – Weakness of hashed passwords
- Password management and storage
- Brute forcing
- Special purpose hash algorithms for password storage
- Argon2 and PBKDF2 implementations in C/C++
- bcrypt and scrypt implementations in C/C++
- Case study – the Ashley Madison data breach
- Typical mistakes in password management
- Exercise – Hard coded passwords

- Sensitive information in memory
  - Protecting secrets in memory
  - Sensitive info in memory - minimize the attack surface
  - Your secrets vs. dynamic memory
  - Zeroisation
  - Zeroisation vs. optimization – Spot the bug!
  - Copies of sensitive data on disk
  - Core dumps
  - Disabling core dumps
  - Swapping
  - Memory locking - preventing swapping
  - Problems with page locking
  - Best practices

- Insufficient anti-automation
  - Captcha
  - Captcha weaknesses

- Improper error and exception handling
  - Typical problems with error and exception handling
  - Empty catch block
  - Overly broad catch
  - Exercise ErrorHandling – spot the bug!
  - Exercise – Error handling
  - Case study - "e;#iamroote;e; authentication bypass in macOS
    - Authentication process in macOS (High Sierra)
    - Incorrect error handling in opendirectoryd
    - The #iamroot vulnerability (CVE-2017-13872)
    - Information leakage through error reporting
- Time and state problems
  - Time and state related problems
  - Serialization errors
  - Exercise TOCTTOU
  - Best practices against TOCTTOU
  - Problems with temp files
  - Requirements for creating temp files
  - Requirements explained
  - Creating temp files on POSIX systems
  - Creating temp files portably
  - Deleting temp files

- Security testing techniques and tools
  - General testing approaches
  - Source code review
    - Code review for software security
    - Taint analysis
    - Heuristic-based
    - Static code analysis
      - Static code analysis
      - Exercise – Static code analysis using FlawFinder
  - Testing the implementation
    - Manual vs. automated security testing
    - Penetration testing
    - Stress tests
    - Binary and memory analysis
      - Exercise – Binary analysis with strings
    - Instrumentation libraries and frameworks
      - Exercise – Using Valgrind

- Fuzzing
  - Automated security testing - fuzzing
  - Challenges of fuzzing
  - Exercise – Fuzzing with AFL (American Fuzzy Lop)

- Deployment environment
  - Assessing the environment
  - Password audit
  - Exercise – using John the Ripper
Testing random number generators
Exercise - Testing random number generators
Configuration management
  - Configuration management
Hardening
  - Hardening
  - Network-level hardening
  - Hardening the deployment - server administration
  - Hardening the deployment - access control
Patch and vulnerability management
  - Patch management
  - Vulnerability repositories
  - Vulnerability attributes
  - Common Vulnerability Scoring System – CVSS
  - Vulnerability management software
Principles of security and secure coding
  - Matt Bishop’s principles of robust programming
  - The security principles of Saltzer and Schroeder
Knowledge sources
  - Secure coding sources - a starter kit
  - Vulnerability databases
  - Recommended books – C/C++

Wymagania:

General C/C++ development

Poziom trudności

Certyfikaty:

The participants will obtain certificates signed by SCADEMY (course completion).

Prowadzący:
Authorized SCADEMY Trainer

Informacje dodatkowe:

Training come with a number of easy-to-understand exercises providing live hacking fun. By accomplishing these exercises with the lead of the trainer, participants can analyze vulnerable code snippets and commit attacks against them in order to fully understand the root causes of certain security problems. All exercises are prepared in a plug-and-play manner by using a pre-set desktop virtual machine, which provides a uniform development environment.

SCADEMY together with online application security educational platform AVATAO (more about AVATAO [www.avatao.com](http://www.avatao.com)) for each of participant SCADEMYs authorized training adds the 30 days business AVATAO trial holds the following package:

- 30-day customized free trial