Two decades of secure software development: shifting left, right, and down

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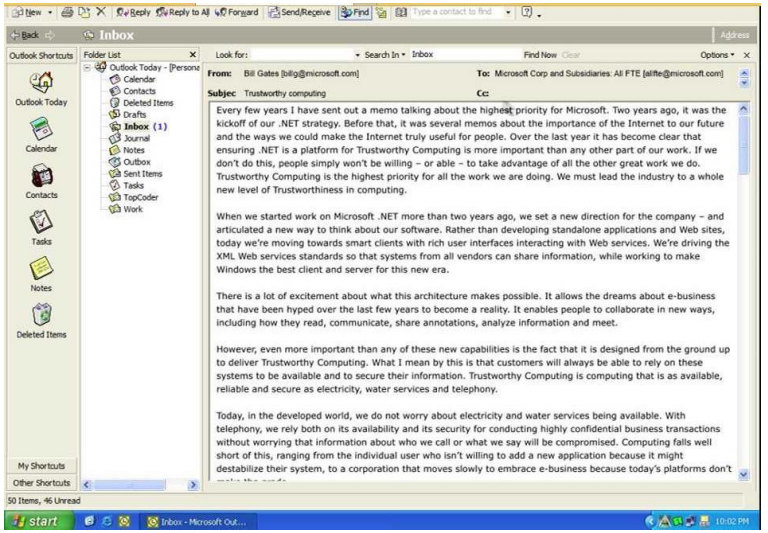
Early 2000s: cybersecurity becoming a problem

- **OWASP founded (2001)**

- **Bill Gates makes security a top priority for Microsoft (2002)**

Highest priority for Microsoft:
... trustworthiness ...
- Availability
- Security
- Privacy



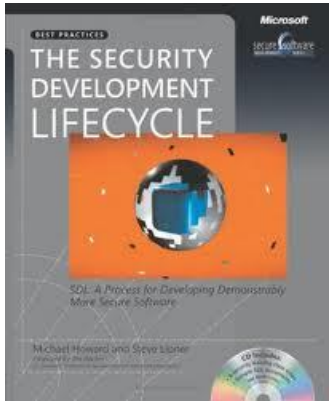
- **NWO project SAMASC started**
  (Security Analysis for Multi-Applet Smart Cards)

First efforts to tackle software security

(aka application security)

OWASP TOP10

OWASP Top 10 (2003)



SDL by Microsoft (2004)

20 years later

Legislation for software security
with e.g. EU Radio Equipment Directive (RED)
and Cyber Resilience Act (CRA)

to complement GDPR, NIS2, ….

CRA requires

products with digital elements shall:

(a) be made available on the market without known exploitable vulnerabilities;

20 years later: hard to see the forests for the trees

- lots of vulnerabilities (CVEs) and vulnerability categories (CWEs)

  E.g. buffer overflows, SQL injection, XSS, CRSF, SSRF, integer overflow, TOCTOU, XXE, LDAP injection, Xpath injection, CRFL injection, PHP remote file inclusion, HTTP response splitting, EAR, type confusion, insecure deserialization, missing authentication, use-after-free, double-free, NULL pointer dereference, use of default password, use of default cryptographic key,
  …, …, …, …, …,.. …, …, …, …, …,.. …, …, …, …, …,.. …, …, …, …, …,.. …, …, …,
  Insecure Setting of Generative AI/ML Model Inference Parameters (CWE-1434)

- lots of 'standards'

  Microsoft SDL, Touchpoints, BSIMM12, PCI SSLC,
  OWASP CLASP, OWASP SAMM, OWASP ASVS, OWAPS SCVS
  BSA Framework for Secure Software, IDA SOAR, ISA/IEC 62443,
  SafeCode Fundamental Practices For Secure Software Development,
  SafeCode SIC, SafeCode TPC, CNCF FSSCP, EO 14028,
  NIST SSDF, IR8397, SP800-52, SP800-160, SP800-161, NIST CSF, NIST LAB,
  …,
  EN 18031 (2025, for RED), EN 40000 (2026, for CRA)

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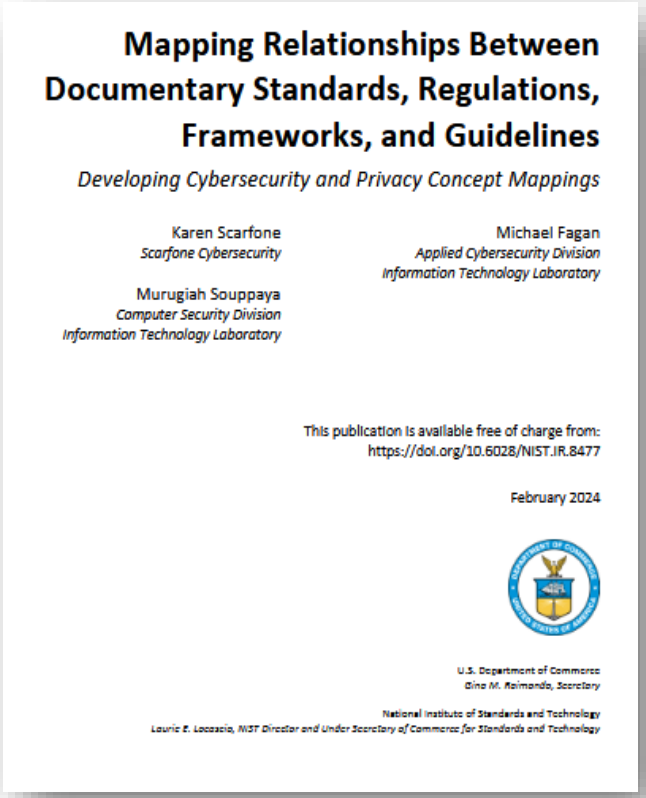
How to cope with ever more security standards?

In 2024 NIST released a methodology for mapping relations between security standards (IR 8477)



Mapping Relationships Between Documentary Standards, Regulations, Frameworks, and Guidelines

Developing Cybersecurity and Privacy Concept Mappings

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Computer Security Division
Information Technology Laboratory

This publication is available free of charge from:
https://doi.org/10.6028/NIST.IR.8477

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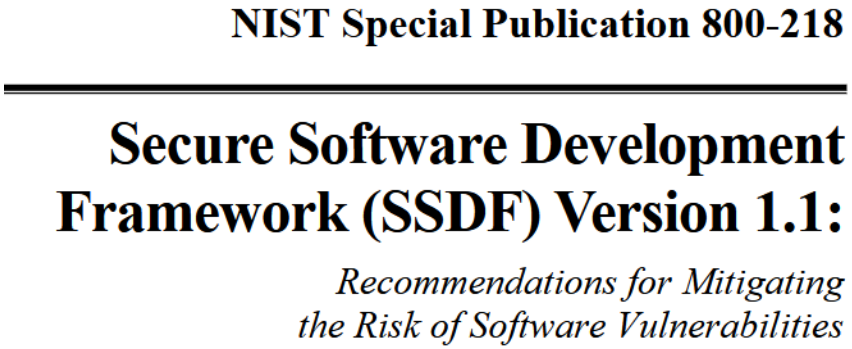
U.S. Department of Commerce
Gina M. Raimondo, Secretary

National Institute of Standards and Technology
Laurie E. Locascio, NIST Director and Under Secretary of Commerce for Standards and Technology

How to cope with ever more security standards?

Providing explicit cross-references to other standards helps



Recent example: NIST SSDF (2022)

combines detailed 'activities' and 'practices' from 25 other standards with explicit cross-references, incl.

Microsoft SDL, BSIMM12, BSA Framework for Secure Software, OWASP SAMM, OWASP ASVS, OWAPS SCVS, SafeCode Fundamental Practices For Secure Software Development, SafeCode SIC, SafeCode TPC, Payment Card Industry SSLC, NIST IR8397, SP800-52, SP800-160, SP800-161, NIST CSF, NIST LAB, CNCF FSSCP, EO14028, IDA SOAR, ISA/IEC 62443, ...

How to cope with ever more security standards?

Simply refer to other standards for the details,
as EN 18031 does to define security-by-design:

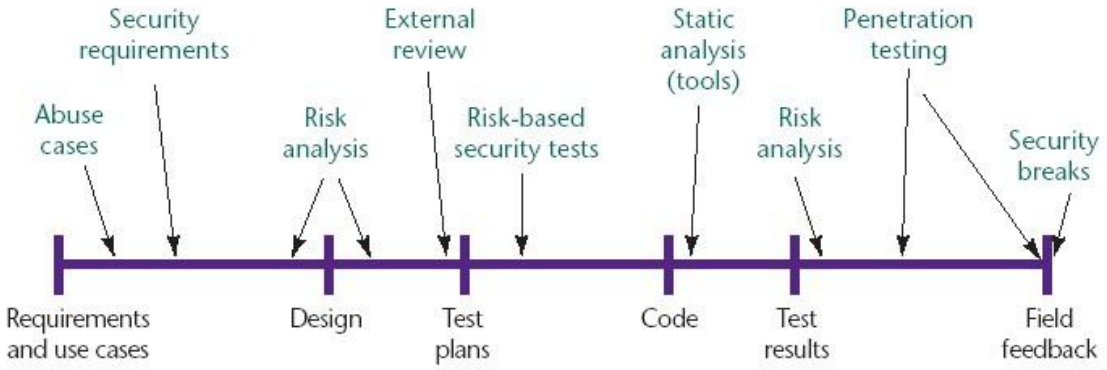
A.2.2 Security by design

Effective security management requires established security by design processes, which is not covered by this document which defines common security requirements for the equipment. Examples of security by design process standards which would aid in the ability to satisfy the security requirements include:

- IEC 62443-4-1[1]: Security for industrial automation and control systems – Part 4-1: Secure product development lifecycle requirements
- NIST 800-160[16]: Systems Security Engineering; Considerations for a Multidisciplinary Approach in the Engineering of Trustworthy Secure Systems
- NIST 800-218[17]: Secure Software Development Framework (SSDF)
- Microsoft Security Development Lifecycle (SDL)
- SAFECode Fundamental Practices for Secure Software Development
- GSMA FS.16 NESAS Development and Lifecycle Security Requirements

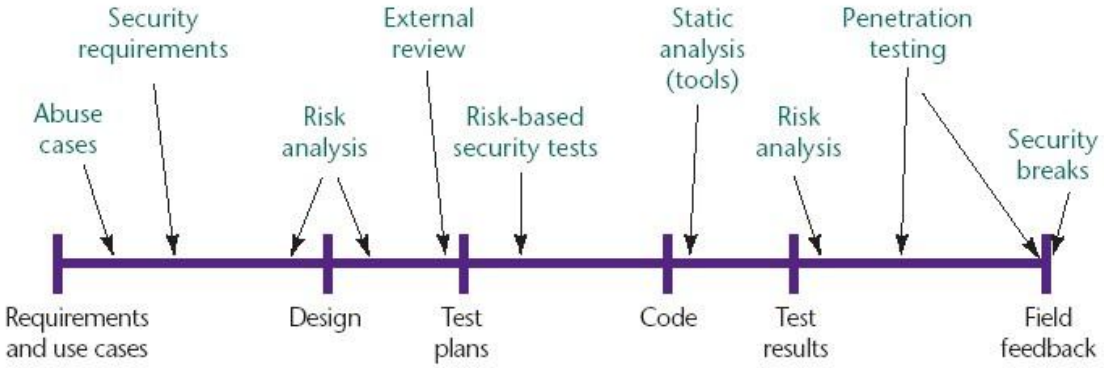
Broad distinction: process vs product

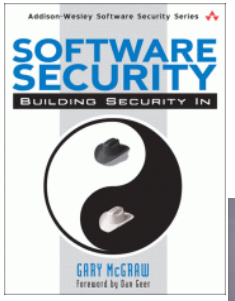
- Guidance for the software development *process*

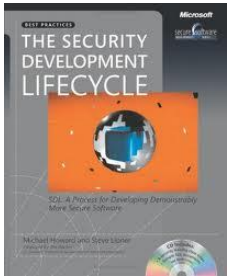


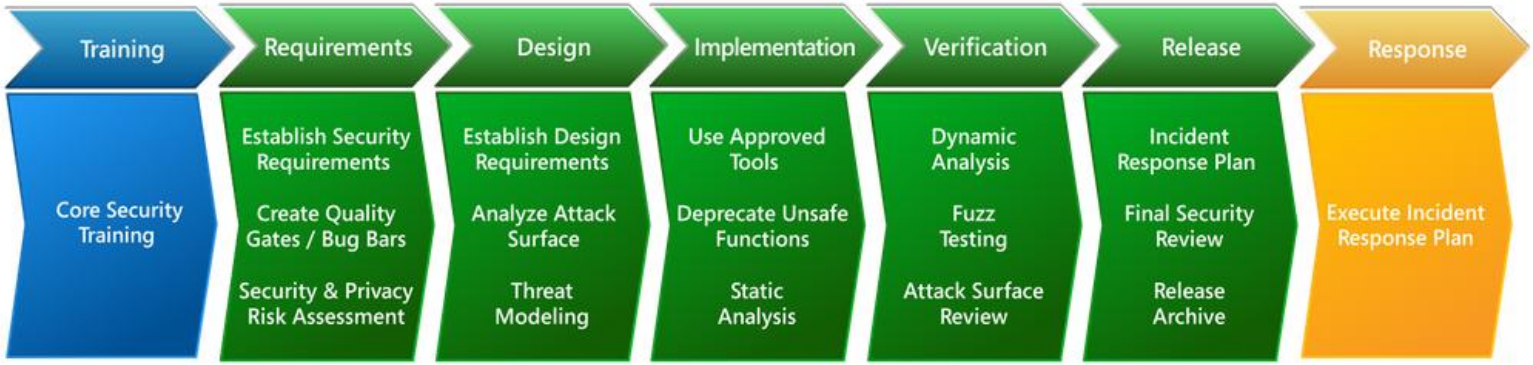
- Guidance for the software *product*
  - Negative advice – about common flaws
    - e.g. OWASP Top 10, CWE Top 25, ….
  - Positive advice – about how to avoid this
    - e.g. OWASP ASVS, OWASP SCVS, LangSec, …

Central idea for process: security activities *throughout* development lifecycle

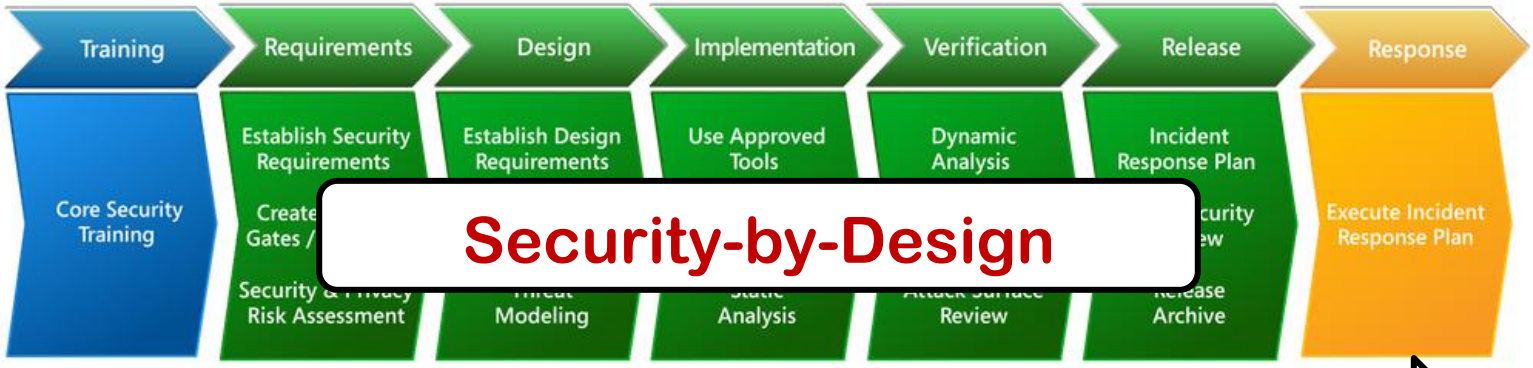








What's changed? New *slogans* & *trends*



Shifting Left

Thinking about security earlier

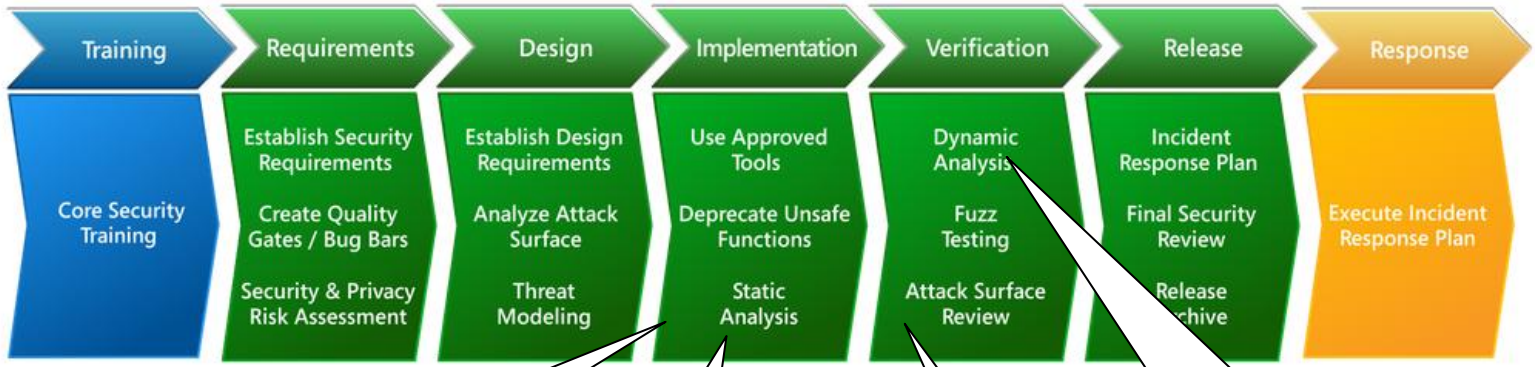
Shifting Right

Accepting & preparing for some insecurity: support for patching, monitoring, …

Shifting Down

Tackling security lower in tech stack: e.g. memory-safe languages, safer APIs, better authentication & update mechanisms in platforms.

What's changed? New *acronyms* & *tools*



SAST
(Static Application Security Testing)

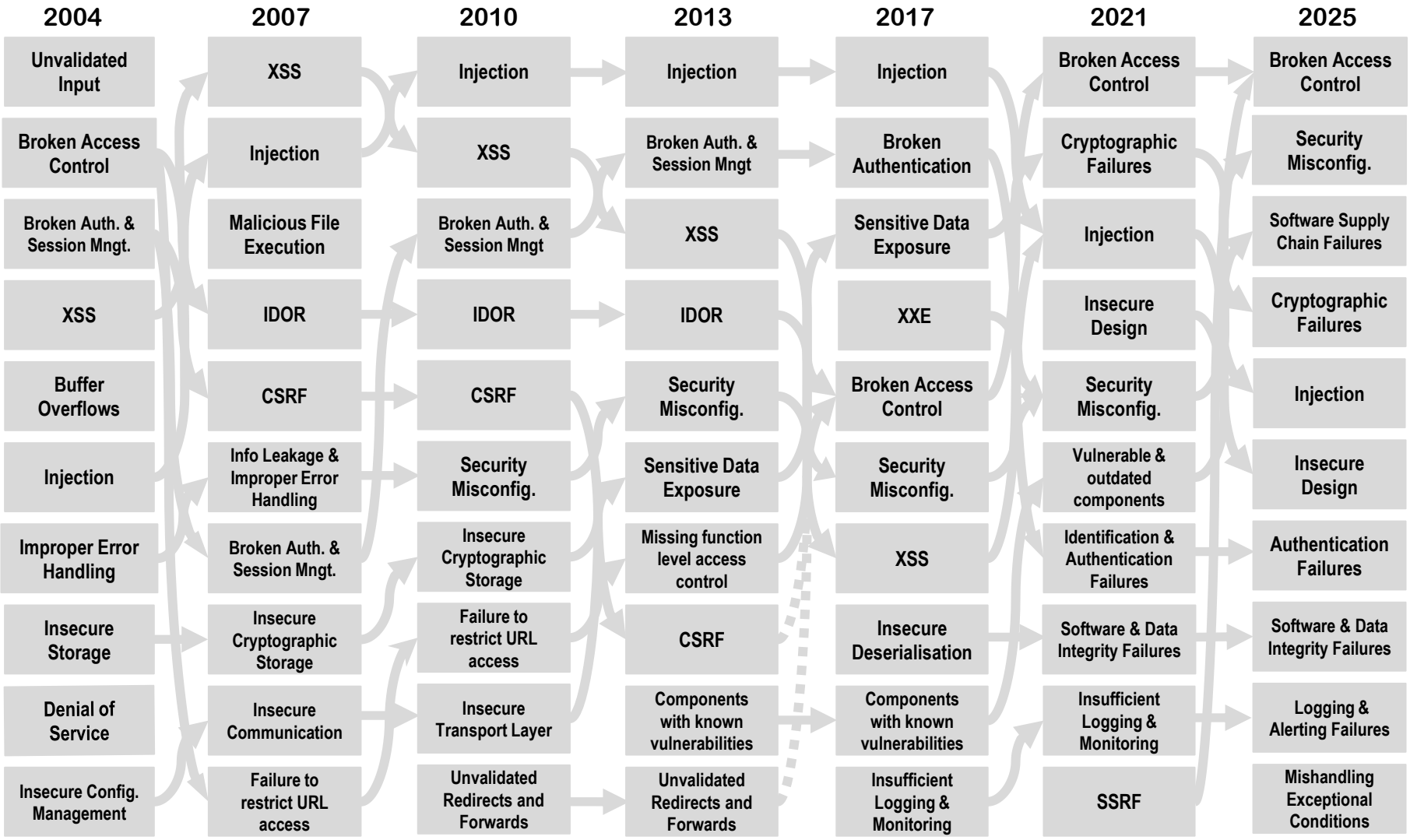
DAST
(Dynamic Application Security Testing)

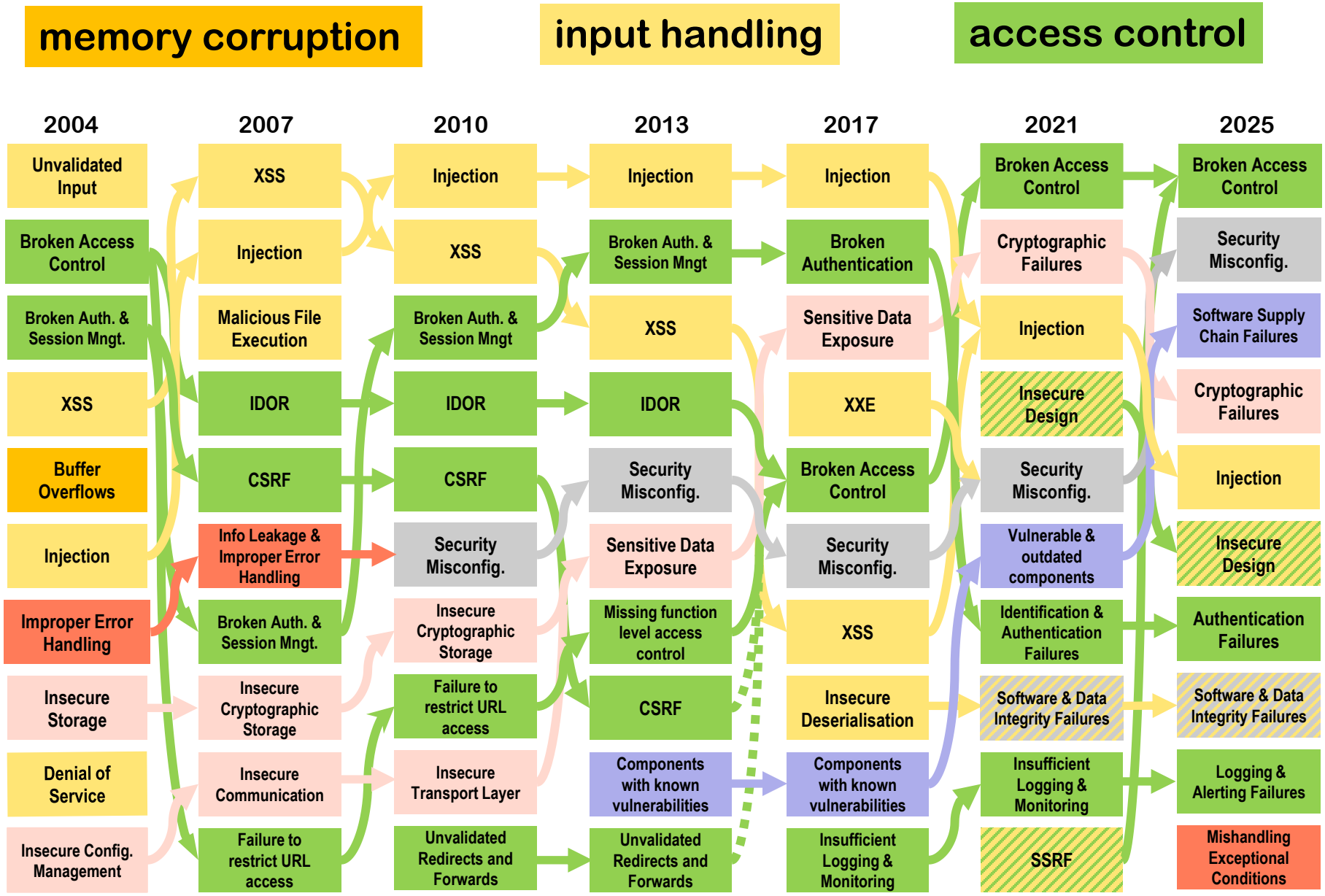
SCA
(Software Composition Analysis)
for ever more components

Secret Scanning
for credentials of
ever more services

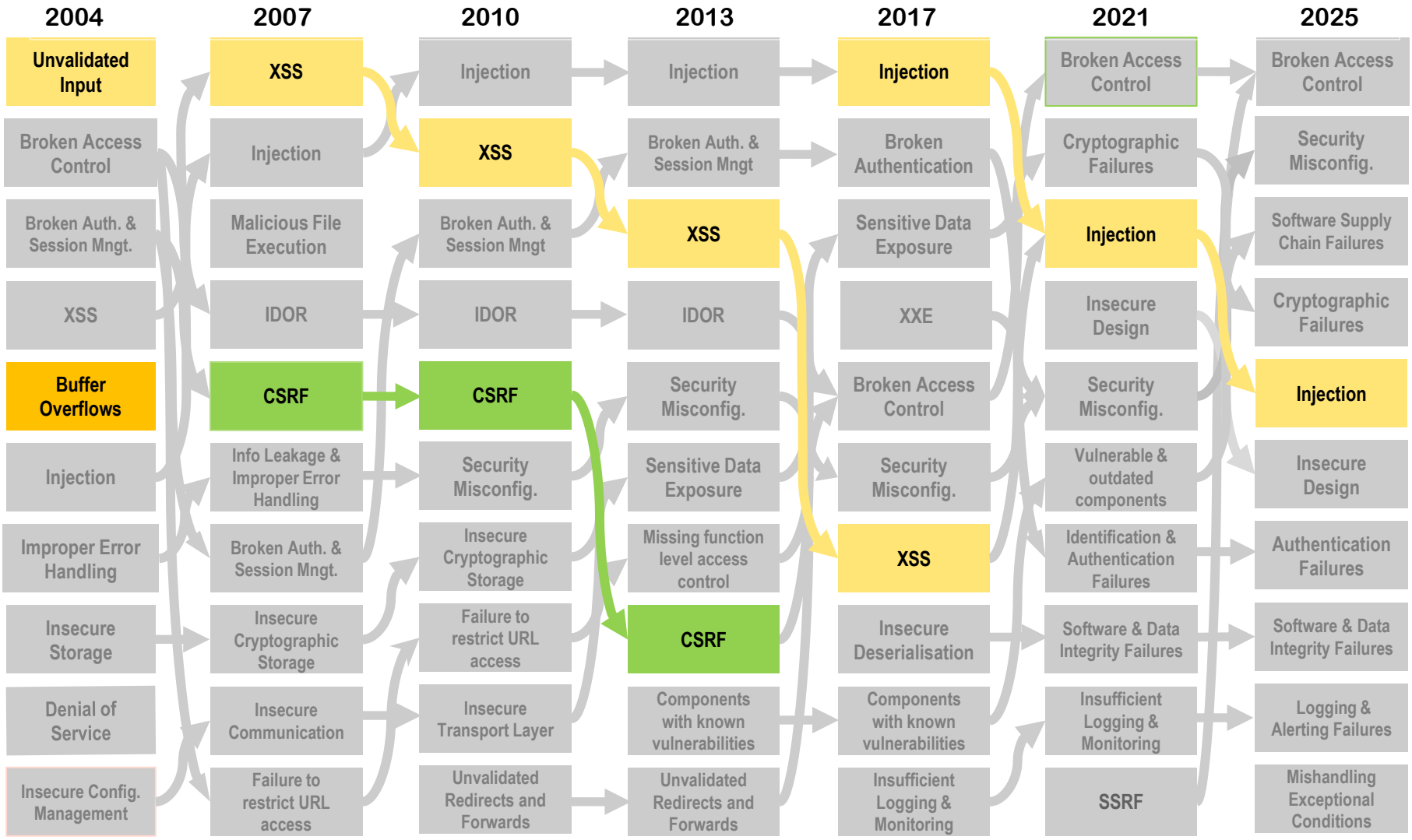
Have things improved?

Evolution of the OWASP Top 10

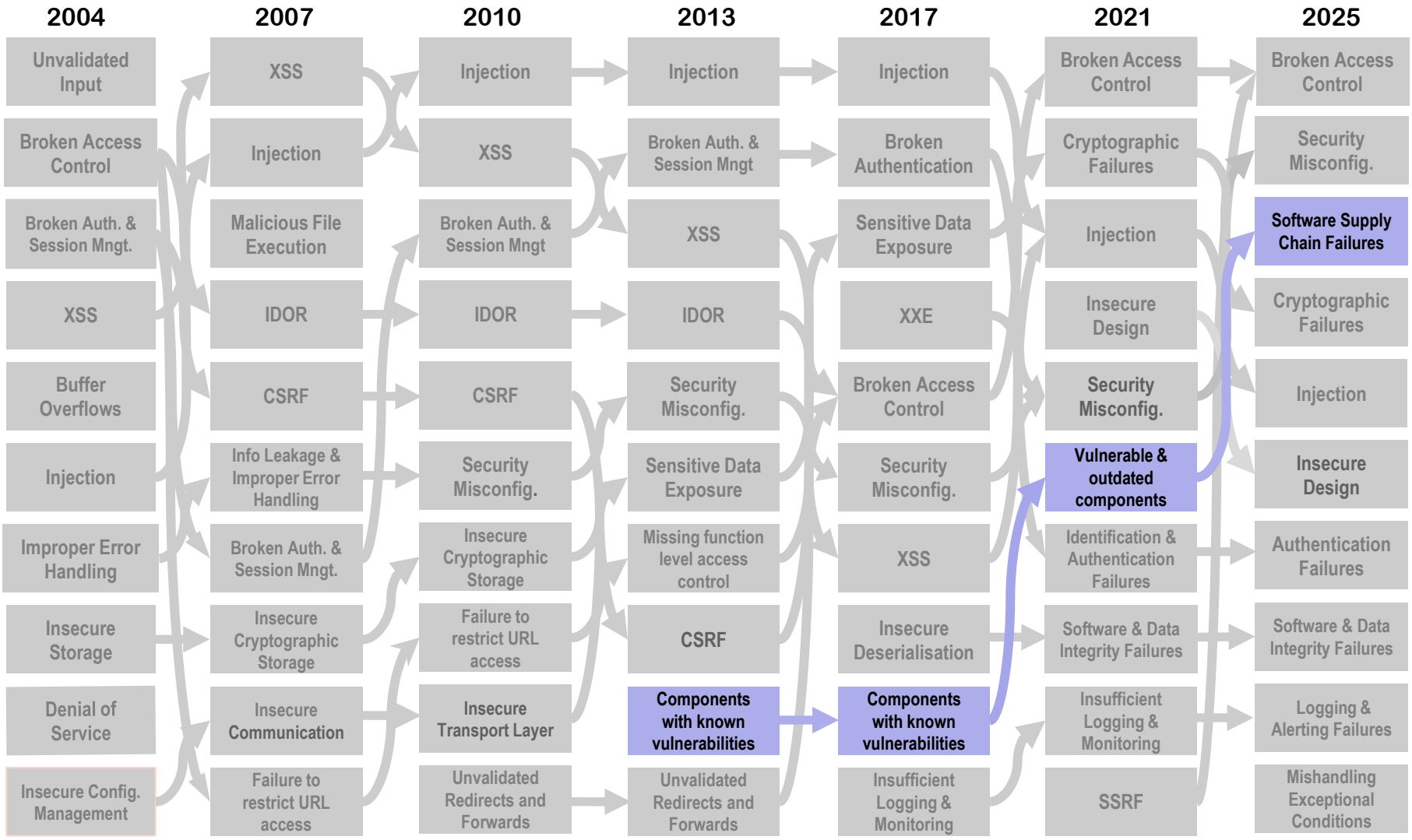



memory corruption
input handling
access control
2004
2007
2010
2013
2017
2021
2025
Unvalidated Input
Broken Access Control
Broken Auth. & Session Mngt.
XSS
Buffer Overflows
Injection
Improper Error Handling
Insecure Storage
Denial of Service
Insecure Config. Management
XSS
Injection
Malicious File Execution
IDOR
CSRF
Info Leakage & Improper Error Handling
Broken Auth. & Session Mngt.
Insecure Cryptographic Storage
Insecure Communication
Failure to restrict URL access
Injection
XSS
Broken Auth. & Session Mngt
IDOR
CSRF
Security Misconfig.
Insecure Cryptographic Storage
Failure to restrict URL access
Insecure Transport Layer
Unvalidated Redirects and Forwards
Injection
Broken Auth. & Session Mngt
XSS
IDOR
Security Misconfig.
Sensitive Data Exposure
Missing function level access control
CSRF
Components with known vulnerabilities
Unvalidated Redirects and Forwards
Injection
Broken Authentication
Sensitive Data Exposure
XXE
Broken Access Control
Security Misconfig.
XSS
Insecure Deserialisation
Components with known vulnerabilities
Insufficient Logging & Monitoring
Broken Access Control
Cryptographic Failures
Injection
Insecure Design
Security Misconfig.
Vulnerable & outdated components
Identification & Authentication Failures
Software & Data Integrity Failures
Insufficient Logging & Monitoring
SSRF
Broken Access Control
Security Misconfig.
Software Supply Chain Failures
Cryptographic Failures
Injection
Insecure Design
Authentication Failures
Software & Data Integrity Failures
Logging & Alerting Failures
Mishandling Exceptional Conditions

Downward trends, thanks in part to shifting down



Upward trends, due to more complex supply chain



Have things improved? Looking at CVEs

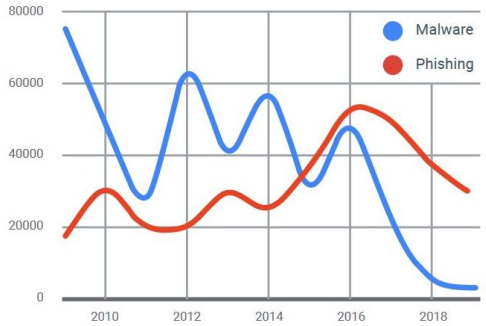
CWE TOP 25 [2010]	
1	Cross-Site Scripting
2	SQL injection
3	Classic Buffer overflow
4	Cross-Site Request Forgery (CSRF)
5	Improper Authorization
6	Security Decision based on Untrusted Input
7	Path traversal
8	Unrestricted Upload of File with Dangerous Type
9	OS command injection
10	Missing Encryption
11	Use of Hard-coded Credentials
12	Buffer Access with Incorrect Length
13	PHP file injection
14	Improper Validation of Array Index
15	Improper Error Handling
16	Information Leak through Error Message
17	Integer Overflow
18	Incorrect Calculation of Buffer Size
19	Missing Authentication
20	Download of Code without Integrity Check
21	Incorrect Permission
22	Allocation of Resources without Throttling
23	Open Redirect
24	Use of Broken or Risky Cryptography
25	Race Condition

CWE TOP 25 [2025]	
1	Cross-Site Scripting
2	SQL Injection
3	Cross-Site Request Forgery (CSRF)
4	Missing Authorization
5	Out-of-bounds Write
6	Path traversal
7	Use After Free
8	Out-of-bounds Read
9	OS command injection
10	Code injection
11	Classic Buffer Overflow
12	Unrestricted Upload of File with Dangerous Type
13	NULL pointer derefence
14	Stack-based buffer overflow
15	Deserialization of Untrusted Data
16	Heap-based Buffer overflow
17	Incorrect Authorization
18	Improper Input Validation
19	Improper Access Control
20	Exposure of Sensitive Information
21	Missing Authentication
22	Server-Side Request Forgery (SSRF)
23	Command Injection
24	Authorization Bypass wit User-Control Key
25	Allocation of Resources without Throttling

The good news

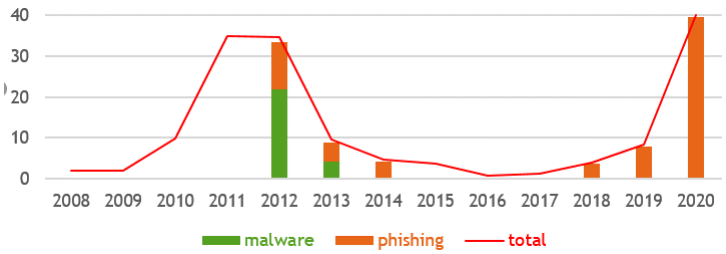
Software exploits no longer main root cause of problem

Malware vs phishing



[Source: Google Transparency Report]

Internet banking losses in Netherlands



[Source: Betaalvereniging]

The bad news?

AI is a major game changer in finding & exploiting software flaws

The Hacker News

Anthropic's Claude Mythos Finds Thousands of Zero-Day Flaws Across Major Systems

Ravie Lakshmanan Apr 08, 2026

We can no longer rely on security by obscurity for software flaws

Will this benefit attackers or defenders more? In short/long term

Will this replace SAST and DAST?