Security Modeling

Anna Vapen

TDDC90 Software Security
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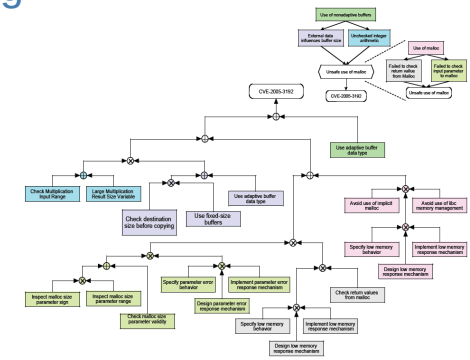

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1

Outline

- What is security modeling?
- Threat modeling
- Misuse cases
- Attack trees
- Vulnerability modeling

- ...and some practical exercises!

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2

What is security modeling?

- Draw security problems as diagrams and pictures
- Useful for:
  - Finding suitable security requirements
  - Finding possible attacks and their mitigations
  - Finding causes to vulnerabilities
  - ...and much more!

- Commonly used in SDL and several risk management methods

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3

Threat Modeling

Threat modeling

- Done early: During design and specification
- Typically part of risk management!
- Broad concept – can be done in many ways

- Threat modeling steps:
  - Identify critical assets
  - Decompose the system to be assessed
  - Identify possible points of attack
  - Identify threats
  - Categorize and prioritize the threats

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4

Threat Modeling (contd.)

Threat modeling

- Treat modeling usually contains:
  - Assets (examples below)
    - Personal information, passwords
    - Confidential data
    - Financial data
    - Source code
  - Entry points (examples below)
    - On the network level, each service is an entry point
    - Vulnerabilities in web servers, protocols, databases…
  - Threat scenarios

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Use Cases

Use- and misuse cases

- Helps defining how a system should work
- Parts of a use case:
  - Usage story: Describes actors in the system and their actions
  - Use case diagram
  - Traceability features (who made the use case, when was it made, which actor is most important, what actions are essential etc.)
- In the diagram and story:
  - Actors, e.g. user, system administrator
  - Actions, e.g. log in, encrypt message, delete account

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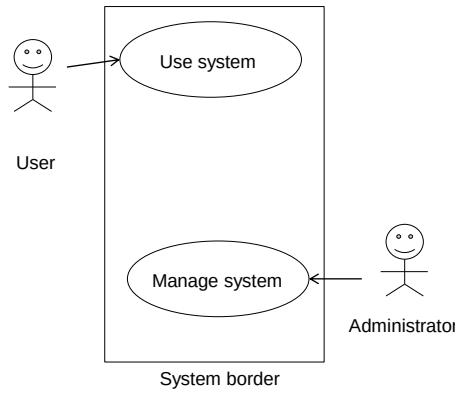
Simple Use Case

Use- and misuse cases

Use case diagram



Usage story:
The user uses the system. The administrator manages the system.

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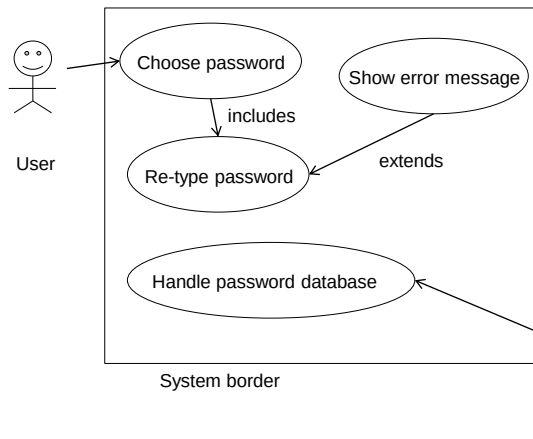
(Not so) Simple Use Case

Use- and misuse cases

Use case diagram



Usage story:
The user chooses a password for the system. The selection of password includes re-typing the password. If the password in wrongly typed the second time, an error message is shown. The administrator handles the password database.

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Simple Misuse cases

Syntax by Sindre and Opdahl

Use- and misuse cases

- Same as in use cases:
  - Positive actors and actions
  - Include and extend
- This is new for misuse cases:
  - Negative actors (attackers and other “misusers”) and actions
  - Threatens, detects and prevents

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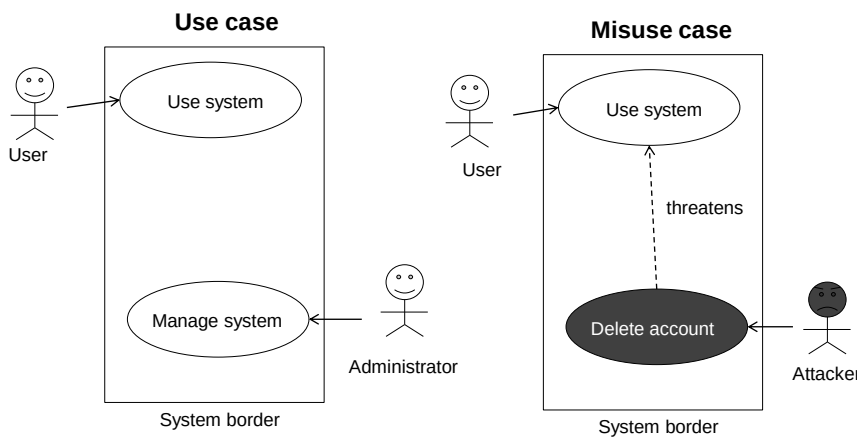
9

From Use Case to Misuse Case

Use- and misuse cases



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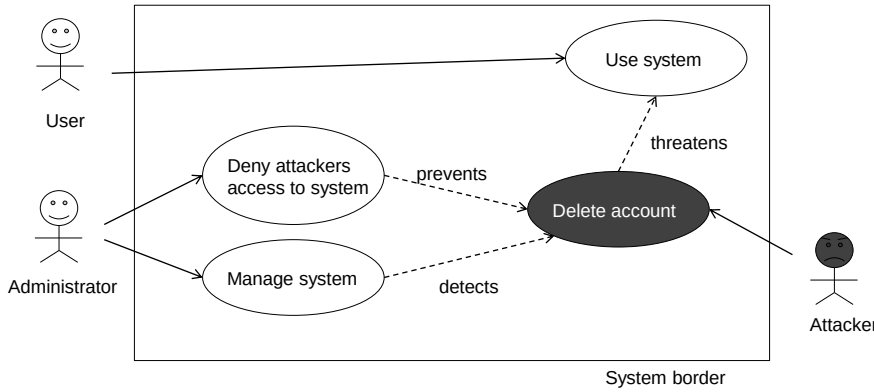
10

Misuse case: Simple Syntax

Use- and misuse cases



Extended Misuse cases

Syntax by Røstad

Use- and misuse cases

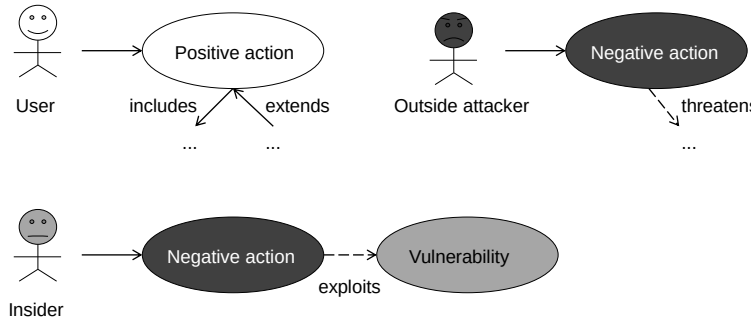
- Same as in use cases:
  - Positive actors and actions
  - Arrow labels: Include and extend
- Same as in simple misuse cases:
  - Negative actors (**outside** attackers) and actions
  - Threatens, ~~prevents~~ **mitigates** (detect is not used)
- New for extended misuse cases:
  - Insiders (e.g. good users gone bad, attackers with guest accounts)
  - Exploit and vulnerabilities

Extended Misuse cases (contd.)

Syntax by Røstad

Use- and misuse cases

- Let's look at our actors!



Note: Insiders can also do positive things.
Users and other positive actors can do things that lead to vulnerabilities!

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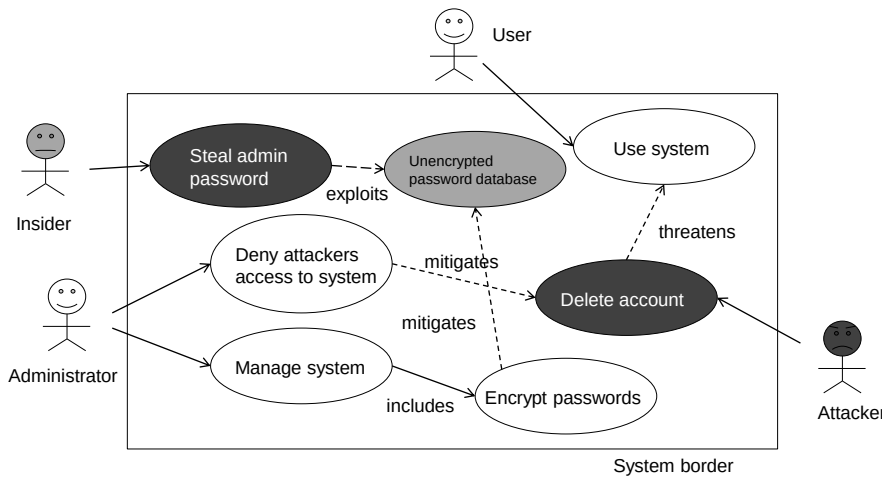
13

Misuse case: Extended Syntax

Use- and misuse cases



Note: Important to model **each** high-risk attack and its **mitigations**

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14

Exercise: Misuse Cases

Extended Syntax

Use- and misuse cases

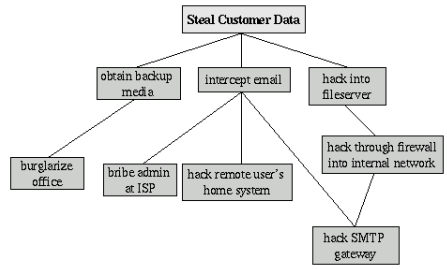
- In groups of 2-3 students
- Let's model the exploitation from the Pong-lab!
- You are the insider (already have a limited account)
- Your goal is to get root access
- ...you are also the administrator fixing the vulnerability

- *10 minutes modeling starts now!* ☺

Attack Trees

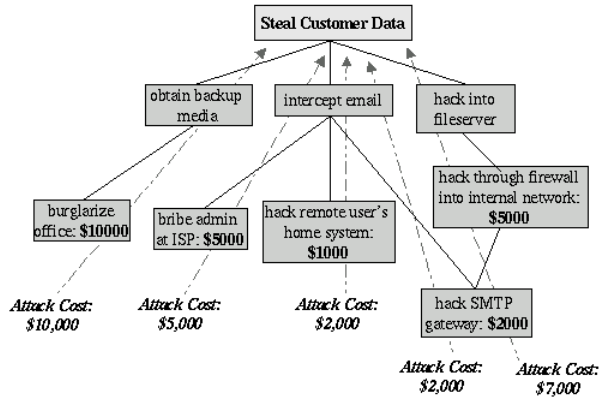
Attack trees

- Attack tree: visualization of possible attacks against a target
- Top node: Attack goal
- Sub-nodes: How to reach the attack goal



Attack Trees (contd.)

Attack trees



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17

Exercise: Attack trees

(Simple, no labels on edges)

Attack trees

- In groups of 2-3 students
- Let's model the attack against Pong
- *5 minutes fast brainstorming and modeling!*

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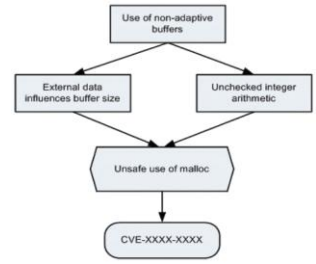
18

Vulnerability Modeling

Vulnerability modeling

- Method included in S³P
- Model vulnerabilities
  - Initial analysis
  - Identifying vulnerability causes
  - Constructing Vulnerability Cause Graphs (VCGs)



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19

Example: CVE-2005-3192

Vulnerability modeling

- Heap-based buffer overflow in Xpdf 3.01 (CVE-2005-3192)
- Xpdf: open-source viewer for PDF files
- User-supplied integers are not checked for overflow or underflow in buffer size calculations
- A remote attacker may execute arbitrary code in the context of a user running the application

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20

Example (contd.)

Vulnerability modeling

```
StreamPredictor::Stream Predictor(Stream *str, int predictor, int
    width, int nComps, int nBits) {
    nVals = width * nComps;
    pixBytes = (nComps * nBits + 7) >> 3;
    rowBytes = ((nVals * nBits + 7) >> 3) + pixBytes;
    predLine = malloc(rowBytes);
    memset(predLine, 0, rowBytes);
    predIdx = rowBytes;
}
```

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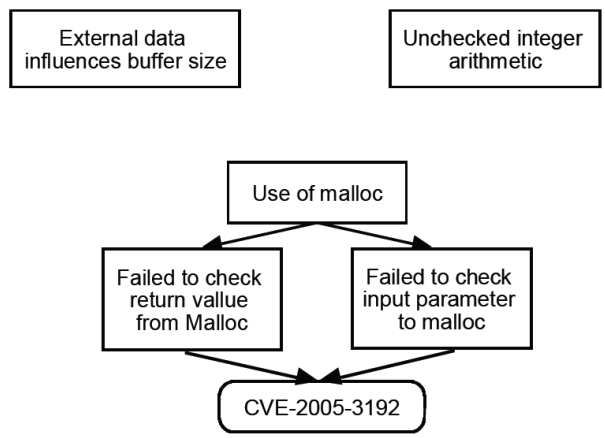
Modeling CVE-2005-3192

Vulnerability modeling



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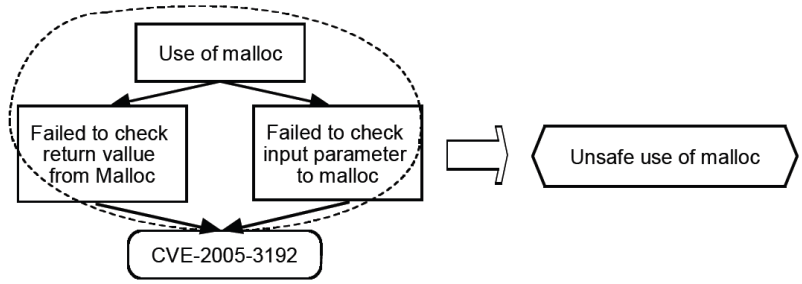
Modeling CVE-2005-3192

Vulnerability modeling



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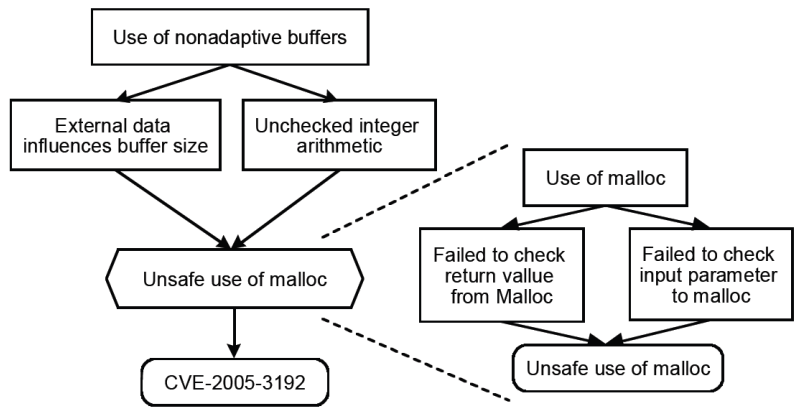
23

Modeling CVE-2005-3192

Vulnerability modeling



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24

Example: CVE-2005-2558

Vulnerability modeling

- Buffer overflow in MySQL
  - Stack-based buffer overflow in the init_syms function in MySQL 4.0 (several versions) allows remote authenticated users who can create user-defined functions to execute arbitrary code via a long function_name field.
- Analysis result
  - Unsafe string copy function
  - Function name (64 characters) copied into a buffer (size = 34)
  - Buffer size defined by MAX_FIELD_NAME instead of NAME_LEN

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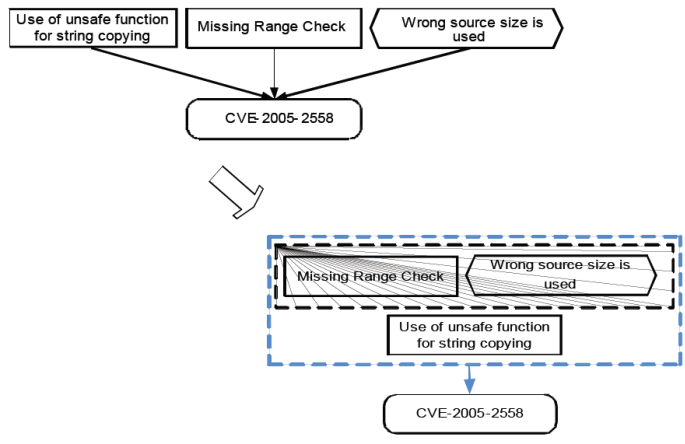
Modeling CVE-2005-2558

Vulnerability modeling



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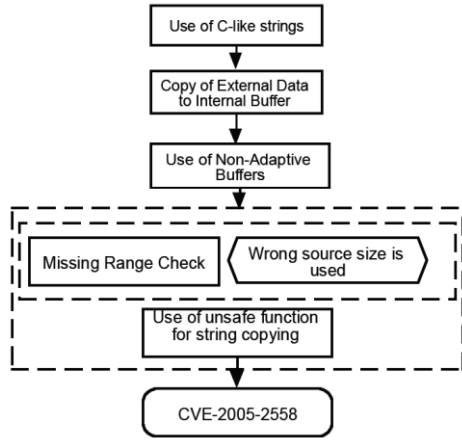
Modeling CVE-2005-2558

Vulnerability modeling



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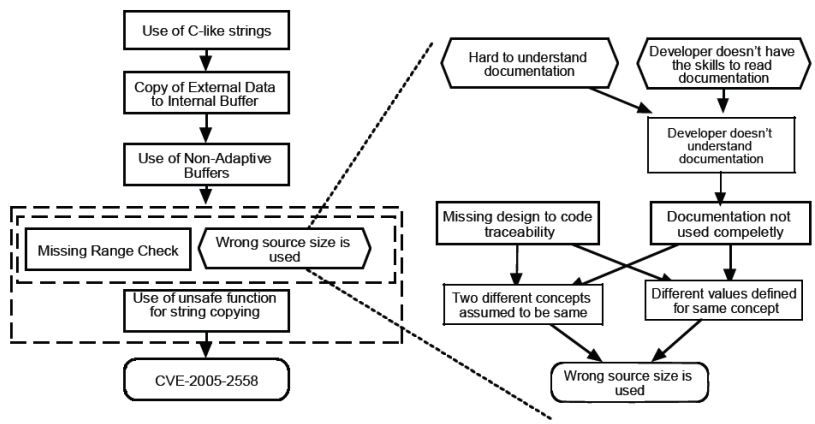
27

Modeling CVE-2005-2558

Vulnerability modeling



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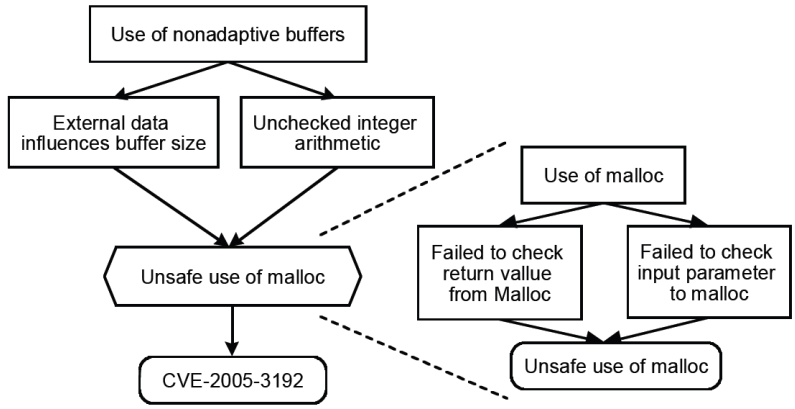
28

Modeling CVE-2005-3192

Vulnerability modeling



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29

Exercise: VCGs

Vulnerability modeling

- In groups of 2-3 students
- Let's model...

  the buffer overflow in Pong!

5 minutes modeling starts now!

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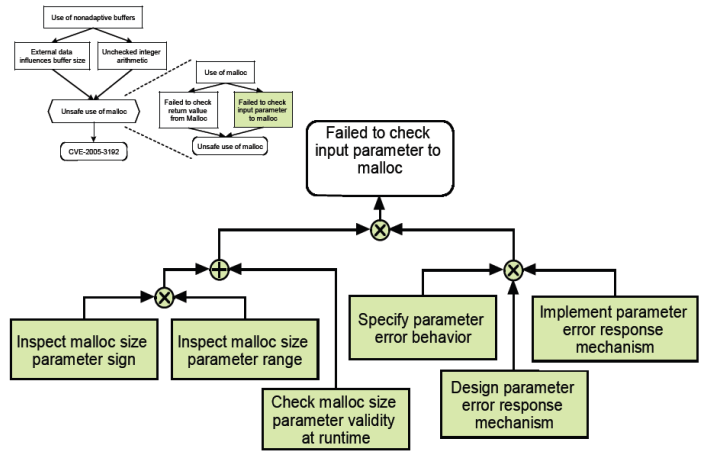
30

SAG

Vulnerability modeling



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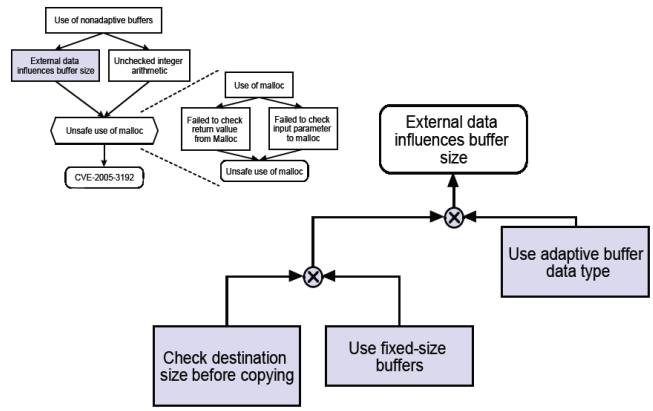
31

SAG

Vulnerability modeling



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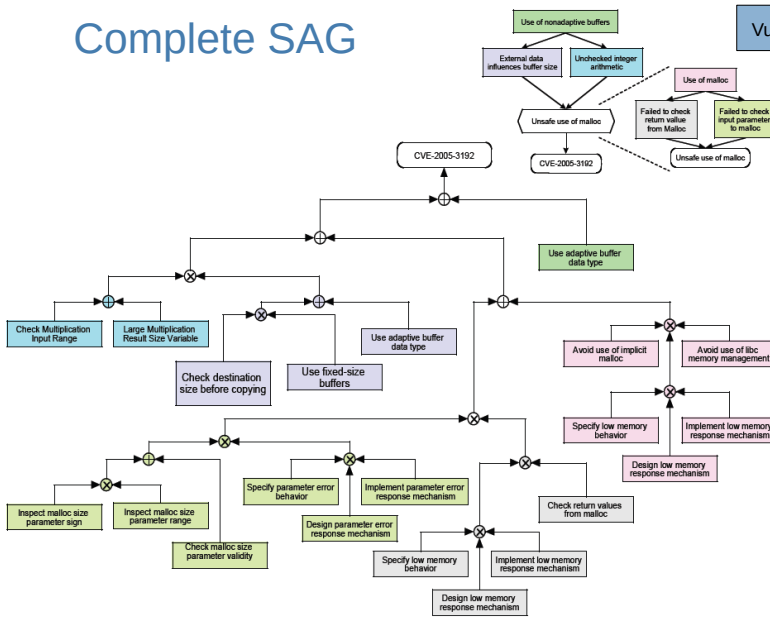
32

Complete SAG

Vulnerability modeling



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33

Summary

- Security modeling: Draw security scenarios
  - Pictures and diagrams helping you to fix security problems
- Modeling techniques seen today:
  - Threat modeling (broad concept)
  - Misuse cases
  - Attack trees
  - Vulnerability modeling: VCGs and SAGs

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34

Practical Information

- Only **two** lectures left!
  - Common Criteria guest lecture
  - Course wrap-up
- All other lecture slots in the schedule is extra time (not used)

- Labs must be passed at 16th December → finish earlier!
- Muddy card evaluation!
  - What do you like with this course? (Labs, lectures, people, contents, reading material, website, structure...)
  - Should something be improved? (We listen and apply fixes!)

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35