30th ANNUAL FIRST CONFERENCE
KUALA LUMPUR
June 24-29, 2018
30 YEARS OF INCIDENT HANDLING

"Moving to the Left": Getting Ahead of Vulnerabilities by Focusing on Weaknesses

Jim Duncan, Juniper Networks SDL Program

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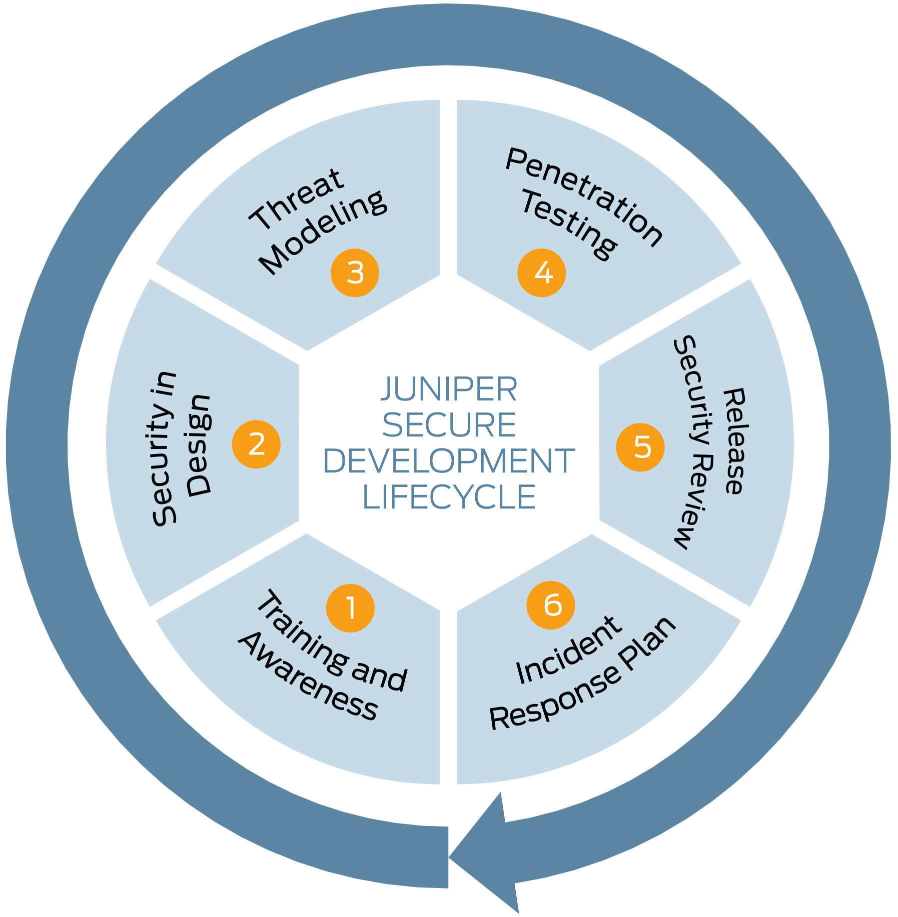
Agenda

- Problem Statement
- Vulnerabilities vs. Weaknesses
- The Common Weakness Enumeration (CWE)
- Example CWE Entry: CWE-119
- Weaknesses as Bug-Tracking Data
- Tips’n’Tricks for assigning CWE labels
- Futures, Prognostications, Recommendations
- Questions?

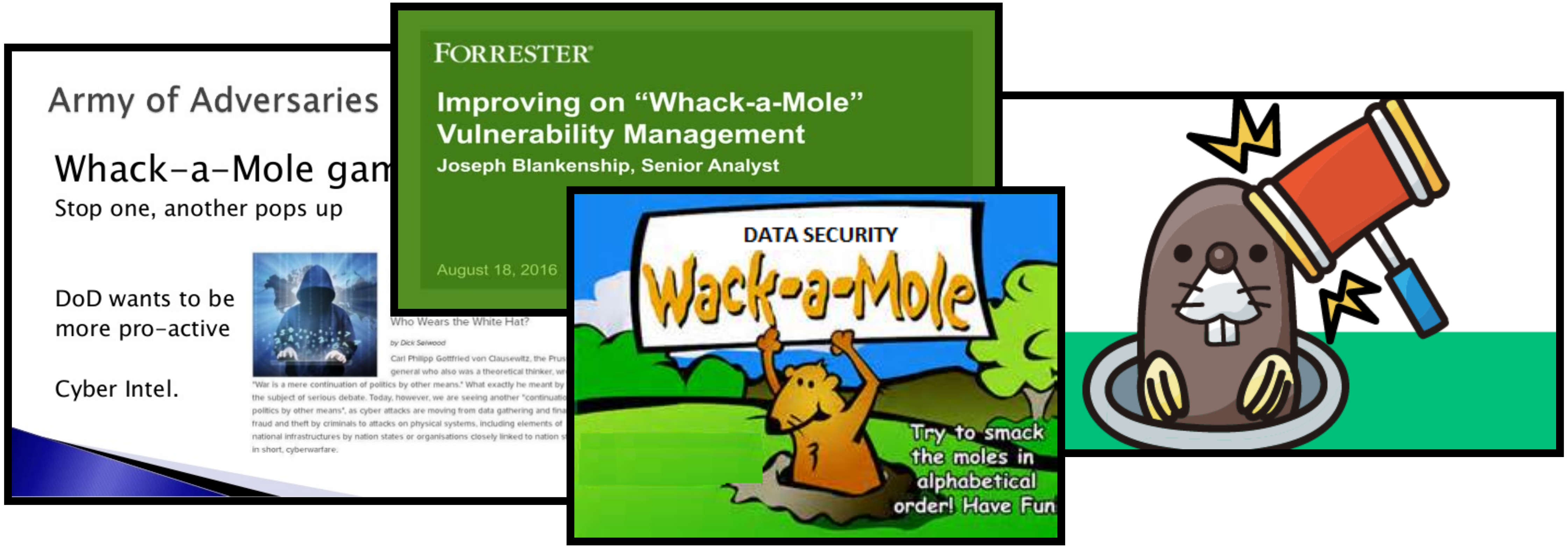
Juniper's Secure Development Lifecycle

- Mission: Improve the resilience of Juniper products through the application of distinct *practices* within Juniper's existing engineering processes
- Intended to be lightweight and minimally disruptive
  - "Self-inserting" with low impact
- Broad mission across all Juniper development
  - Program formally started in 2013
- The SDL is not simply desirable
  - Required by a growing number of our customers
  - An obligation on behalf of the Internet community
- SDL Functional Goal: ***Vulnerability Containment***
  - Keep product security vulnerabilities inside Juniper
  - Vulnerabilities are much more expensive after they escape



Problem Statement

Vulnerability Chasing is “Whack-a-Mole”



Army of Adversaries

Whack–a–Mole gam

Stop one, another pops up

DoD wants to be more pro–active

Cyber Intel.

Who Wears the White Hat?

by Dick Selwood

Carl Philipp Gottfried von Clausewitz, the Prus
general who also was a theoretical thinker, wr
"War is a mere continuation of politics by other means." What exactly he meant by
the subject of serious debate. Today, however, we are seeing another "continuatio
politics by other means", as cyber attacks are moving from data gathering and fina
fraud and theft by criminals to attacks on physical systems, including elements of
national infrastructures by nation states or organisations closely linked to nation s
in short, cyberwarfare.

FORRESTER

Improving on “Whack-a-Mole” Vulnerability Management

Joseph Blankenship, Senior Analyst

August 18, 2016

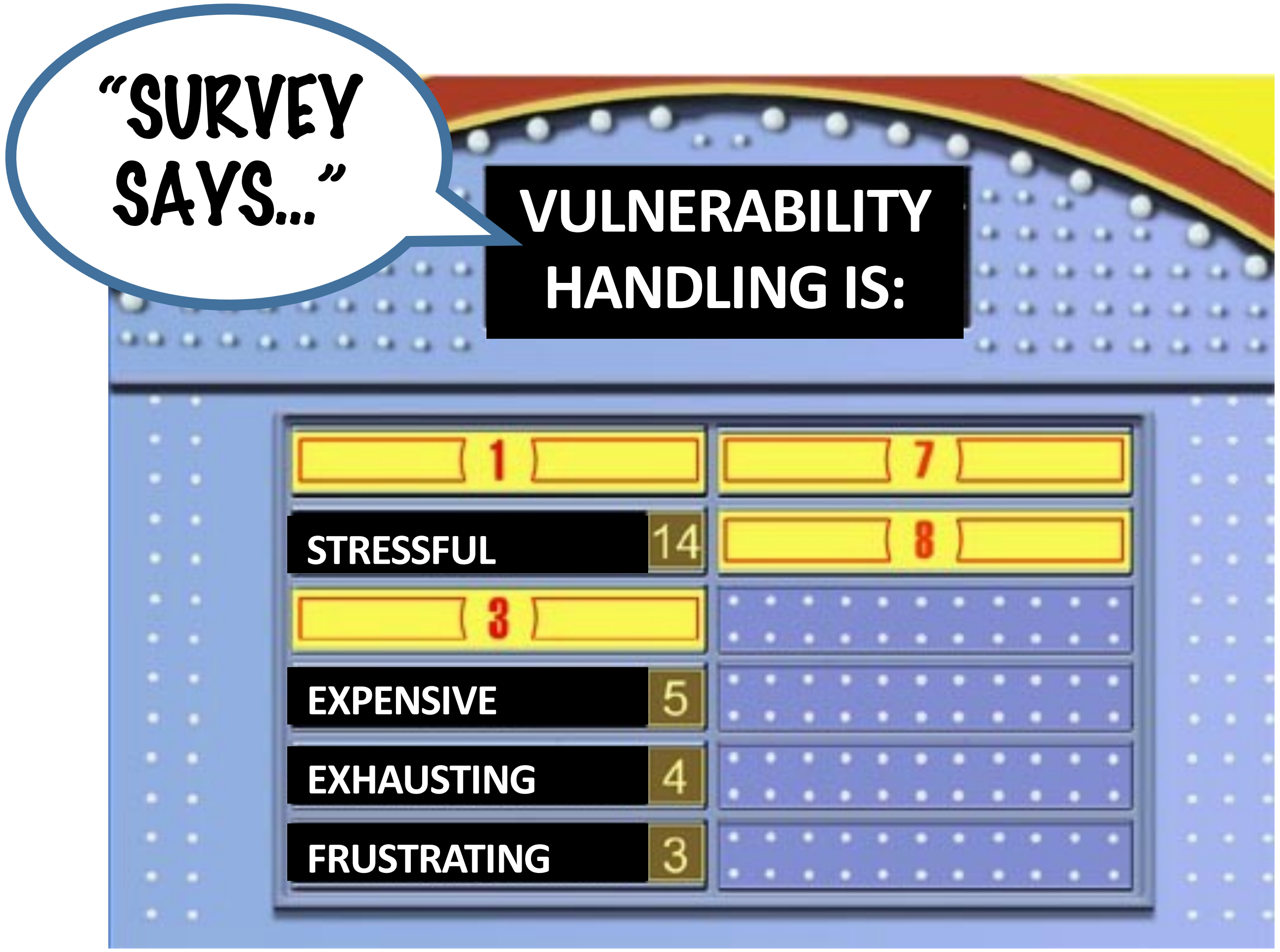
DATA SECURITY

Wack-a-Mole

Try to smack the moles in alphabetical order! Have Fun

- **This is a common thread;** that probably means something important.
  - (By the way, those are **gophers**, not moles. But I digress...)

Hazardous to IR Teams and Our Community



- **No surprise that endless reactive work wears us down**
- Causes long-term damage
  - Staff health, relationships
  - Team dynamics
  - Team-to-team relationships
  - Personal burn-out
  - Career burn-out
  - Industry burn-out?
- Which did you choose?

Weakness Mitigation is Proactive

"Work smarter, not harder."

- Weaknesses are the constituent elements of vulnerabilities.
  - Weakness resolution eliminates multiple vulnerabilities.
  - Resolution of weaknesses contributes to **persistent resilience**.
- Unfortunately, it brings its own challenges to the effort:
  - No immediately obvious result; difficult to measure effectiveness.
  - Pays no direct dividend; difficult to justify resources.
  - Immature area of study; nascent topic, much remains to be figured out.
- More to follow on all these points...

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Vulnerabilities vs. Weaknesses

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Essential Terminology & Key Concepts

- **A *vulnerability* depends upon one or more *weaknesses*.**
  - In other words, *weaknesses* are the constituent elements of *vulnerabilities*.
- **The existence of a *weakness* does not constitute a *vulnerability*.**
  - A weakness may be provably identified in some code, but it may not be vulnerable for various reasons. (e.g., unreachable instruction)
- **A vulnerability is *actionable*; it violates a security policy.**
- **But a weakness only has the *potential* to violate a security policy.**
- There are more, but these are essential
- *Any questions before we continue?*

Implications and Misunderstandings

- Weaknesses are an abstraction; they are not well understood.
- Multiple weaknesses may be identified in one snippet of code.
  - Various disparate weakness labels may all be correct; never exclusive.
  - Many individual weaknesses can be argued to be *the best possible label*.
- *Weakness* is similar, but not identical, to the concept of *root cause*.
  - This conflict causes enormous confusion (and occasional conflict)
    - Root cause is generally unitary, atomic, exclusive.
    - Weaknesses are multiplex.
- Code runs fine with weaknesses, but fails with a vulnerability.
- Not confined to code; weaknesses happen in design and elsewhere.

The Common Weakness Enumeration (CWE)

CWE Common Weakness Enumeration
A Community-Developed Dictionary of Software Weakness Types

- Virtual smörgåsbord of weakness labels, both discrete and abstract.
  - Discrete labels, e.g.: **CWE-193: Off-by-one Error** or **CWE-369: Divide by Zero**
  - Both are members of **CWE-682: Incorrect Calculation**
  - CWE-682 is a member of **CWE-189: Numeric Errors**
  - CWE-189 is a member of **CWE-699: Development Concepts**
- These parent-child relationships are not exclusive
  - It's more like "It takes a village…": aunts, uncles, grandparents, neighbors!
- Which one do you use? <u>It depends on the goal you have in mind</u>.

Weakness Classification and Heirarchy

- *Weakness Base* is the fundamental entity in the compendium.
  - **CWE-552: Files or Directories Accessible to External Parties**
- *Weakness Variant* is more specific.
  - **CWE-553: Command Shell in Externally Accessible Directory**
- *Weakness Class* is a higher-level abstraction.
  - **CWE-668: Exposure of Resource to Wrong Sphere**
- *Category* is a broad set of weaknesses with a common characteristic.
  - **CWE-361: 7PK – Time and State**
  - "7PK" is The Seven Pernicious Kingdoms, a foundational reference for CWE.

Additional Weakness Groupings & Terms

- *Compound Elements*: Closely associated independent weaknesses
  - Based on interaction or co-occurrence, e.g., *Composite* or *Chain* weaknesses
- *Composite*: Simultaneous weaknesses that create a vulnerability.
  - **CWE-352: Cross-Site Request Forgery (CSRF)**
- *Loose Composite*: Appears to be individual, but isn't. (Ignore for now.)
- *Chain*: Serialized weaknesses that create a vulnerability.
- *Named Chain*: A chain so frequent that it deserves its own moniker.
  - **CWE-692: Incomplete Blacklist to Cross-Site Scripting**

And More Weakness Groupings & Terms

- *View*: A useful way of considering CWE content, e.g., a *Slice* or *Graph*
- *Implicit Slice*: membership based on common shared characteristic:
  - **CWE-919: Weaknesses in Mobile Applications**
  - **CWE-701: Weaknesses Introduced During Design**
- *Explicit Slice*: membership based on some external criterion:
  - **CWE-604: Deprecated Entries**
  - **CWE-630: DEPRECATED: Weaknesses Examined by SAMATE**
- *Graph*: membership based on heirarchical relationships:
  - **CWE-1026: Weaknesses in OWASP Top Ten (2017)**
  - **CWE-868: Weaknesses Addressed by the CERT C++ Secure Coding Standard**

Confusing Adjectives: Primary v. Resultant

- *Primary Weakness*: Initial critical error (possibly a root cause) that exposes subsequent weaknesses after it.
- *Resultant Weakness*: Exposed following an earlier weakness.
- Example:
  - **CWE-190: Integer Overflow** may cause a size error allocating a buffer.
  - **CWE-120: Buffer Overflow** occurs because of the preceding size error.
- This relationship is described as
  - ”CWE-190 **is primary to** CWE-120,” or
  - “CWE-120 **is resultant from** CWE-190”.

What’s The Purpose of All This?

- For immediate resolution/mitigation, focus on *Base Weaknesses*.
- Nitpick with *Variants* if necessary, maybe *Chains* and *Composites*.
- For long-term improvement/refinement, look at *Class* and *Category*.
- Constrain with *Views*, especially *Slices*. <u>Important</u>! (more on this later)

- What does all this look like in practice?

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Example CWE Entry: CWE-119

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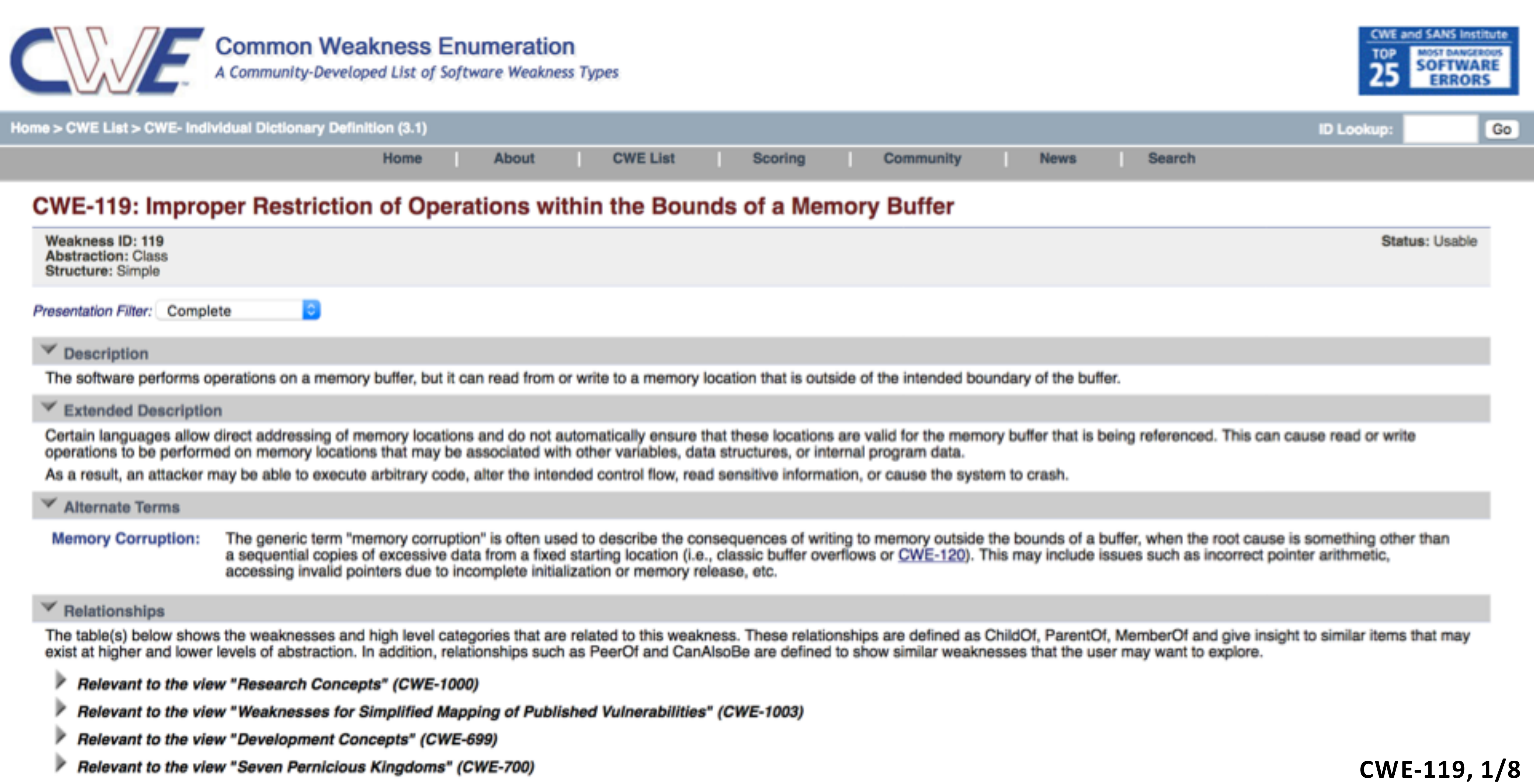

Common Weakness Enumeration
A Community-Developed List of Software Weakness Types
CWE and SANS Institute TOP 25 MOST DANGEROUS SOFTWARE ERRORS
Home > CWE List > CWE- Individual Dictionary Definition (3.1)
ID Lookup:
Go
Home | About | CWE List | Scoring | Community | News | Search

CWE-119: Improper Restriction of Operations within the Bounds of a Memory Buffer

Weakness ID: 119
Abstraction: Class
Structure: Simple

Status: Usable

Presentation Filter: Complete

Description

The software performs operations on a memory buffer, but it can read from or write to a memory location that is outside of the intended boundary of the buffer.

Extended Description

Certain languages allow direct addressing of memory locations and do not automatically ensure that these locations are valid for the memory buffer that is being referenced. This can cause read or write operations to be performed on memory locations that may be associated with other variables, data structures, or internal program data.

As a result, an attacker may be able to execute arbitrary code, alter the intended control flow, read sensitive information, or cause the system to crash.

Alternate Terms

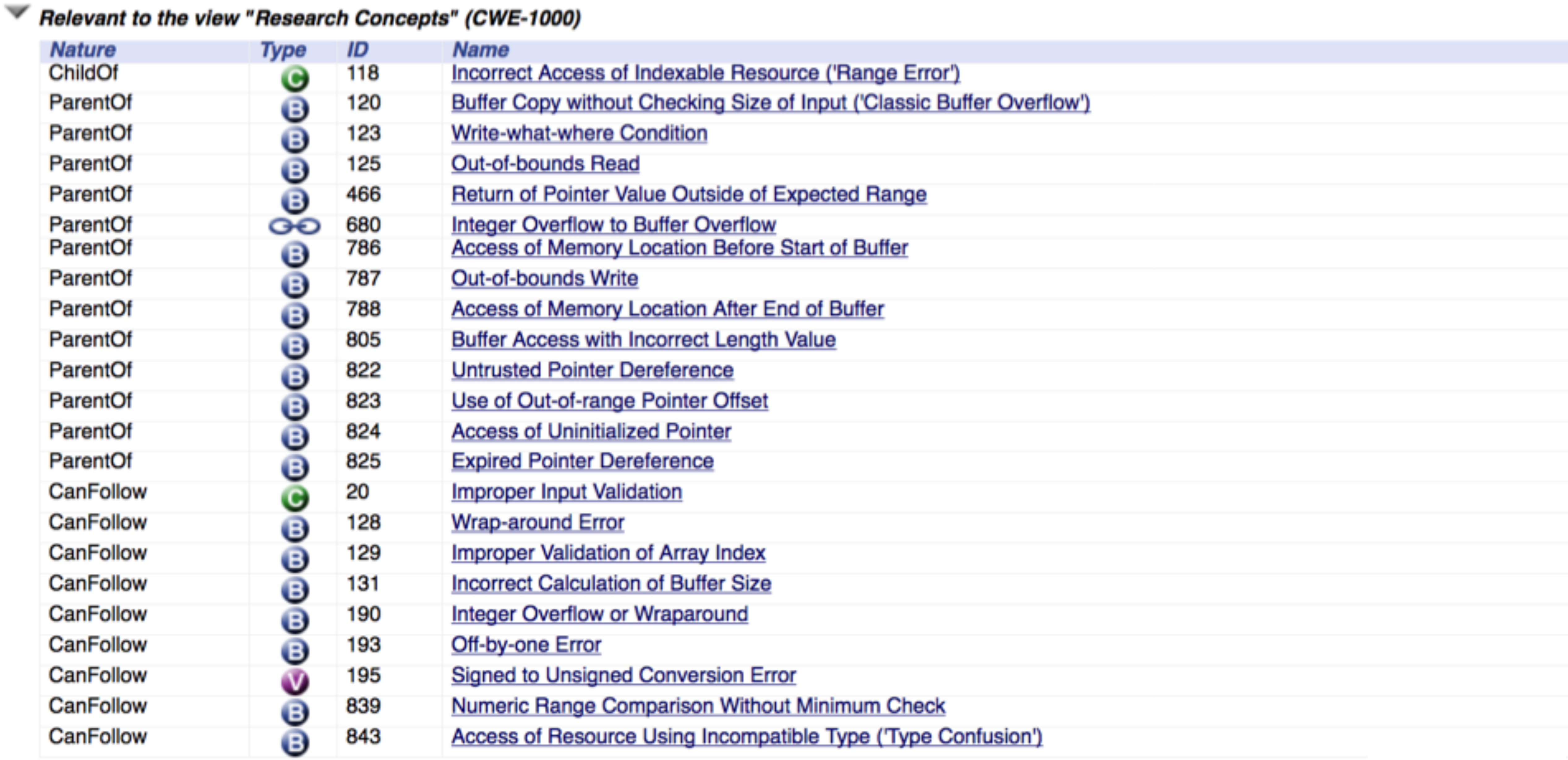
Memory Corruption: The generic term "memory corruption" is often used to describe the consequences of writing to memory outside the bounds of a buffer, when the root cause is something other than a sequential copies of excessive data from a fixed starting location (i.e., classic buffer overflows or CWE-120). This may include issues such as incorrect pointer arithmetic, accessing invalid pointers due to incomplete initialization or memory release, etc.

Relationships

The table(s) below shows the weaknesses and high level categories that are related to this weakness. These relationships are defined as ChildOf, ParentOf, MemberOf and give insight to similar items that may exist at higher and lower levels of abstraction. In addition, relationships such as PeerOf and CanAlsoBe are defined to show similar weaknesses that the user may want to explore.

- ***Relevant to the view "Research Concepts" (CWE-1000)***
- ***Relevant to the view "Weaknesses for Simplified Mapping of Published Vulnerabilities" (CWE-1003)***
- ***Relevant to the view "Development Concepts" (CWE-699)***
- ***Relevant to the view "Seven Pernicious Kingdoms" (CWE-700)***

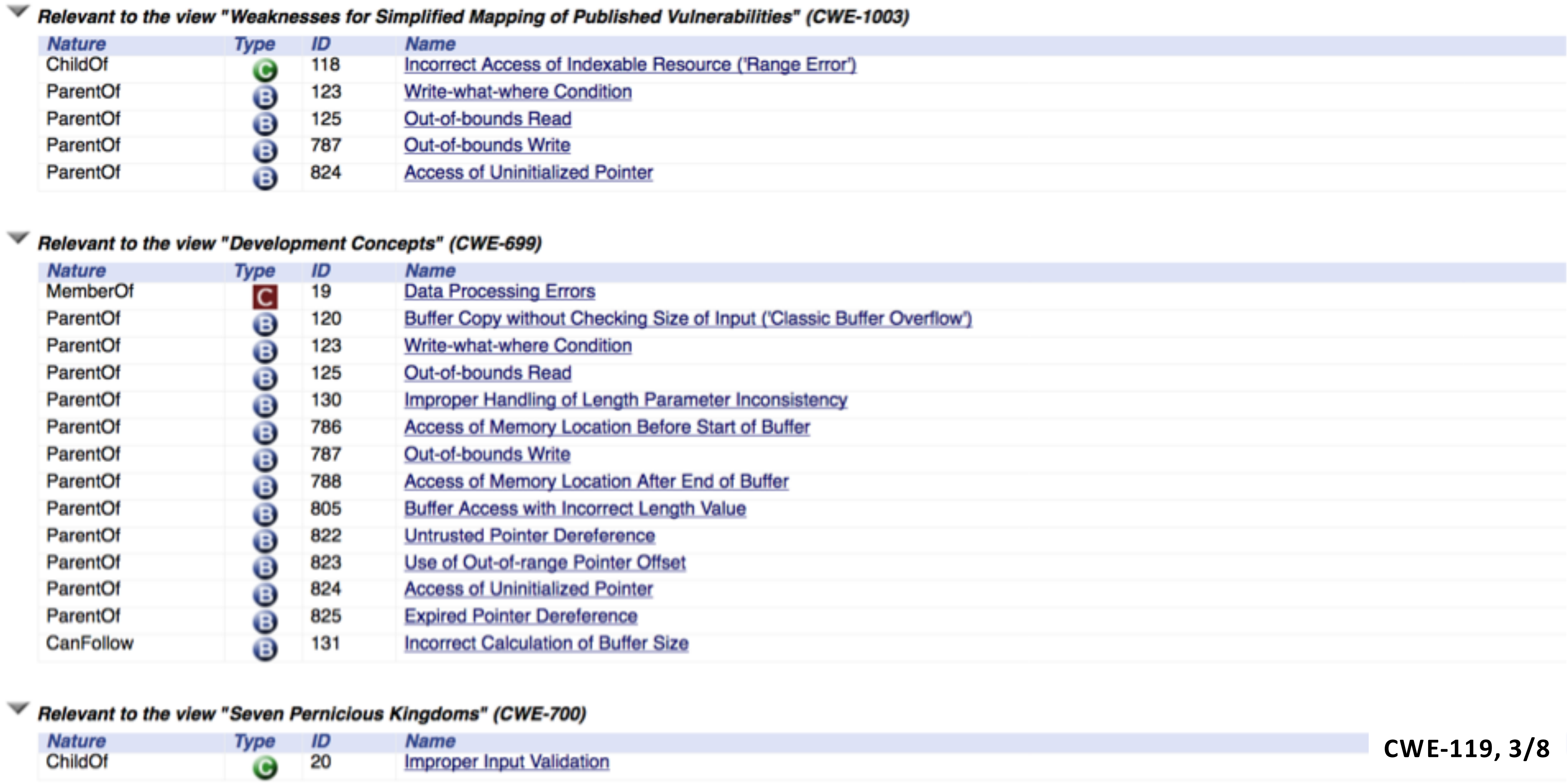
CWE-119, 1/8



Relevant to the view "Research Concepts" (CWE-1000)

Nature	Type	ID	Name
ChildOf	C	118	Incorrect Access of Indexable Resource ('Range Error')
ParentOf	B	120	Buffer Copy without Checking Size of Input ('Classic Buffer Overflow')
ParentOf	B	123	Write-what-where Condition
ParentOf	B	125	Out-of-bounds Read
ParentOf	B	466	Return of Pointer Value Outside of Expected Range
ParentOf	🔗	680	Integer Overflow to Buffer Overflow
ParentOf	B	786	Access of Memory Location Before Start of Buffer
ParentOf	B	787	Out-of-bounds Write
ParentOf	B	788	Access of Memory Location After End of Buffer
ParentOf	B	805	Buffer Access with Incorrect Length Value
ParentOf	B	822	Untrusted Pointer Dereference
ParentOf	B	823	Use of Out-of-range Pointer Offset
ParentOf	B	824	Access of Uninitialized Pointer
ParentOf	B	825	Expired Pointer Dereference
CanFollow	C	20	Improper Input Validation
CanFollow	B	128	Wrap-around Error
CanFollow	B	129	Improper Validation of Array Index
CanFollow	B	131	Incorrect Calculation of Buffer Size
CanFollow	B	190	Integer Overflow or Wraparound
CanFollow	B	193	Off-by-one Error
CanFollow	V	195	Signed to Unsigned Conversion Error
CanFollow	B	839	Numeric Range Comparison Without Minimum Check
CanFollow	B	843	Access of Resource Using Incompatible Type ('Type Confusion')

CWE-119, 2/8



Relevant to the view "Weaknesses for Simplified Mapping of Published Vulnerabilities" (CWE-1003)

Nature	Type	ID	Name
ChildOf	C	118	Incorrect Access of Indexable Resource ('Range Error')
ParentOf	B	123	Write-what-where Condition
ParentOf	B	125	Out-of-bounds Read
ParentOf	B	787	Out-of-bounds Write
ParentOf	B	824	Access of Uninitialized Pointer

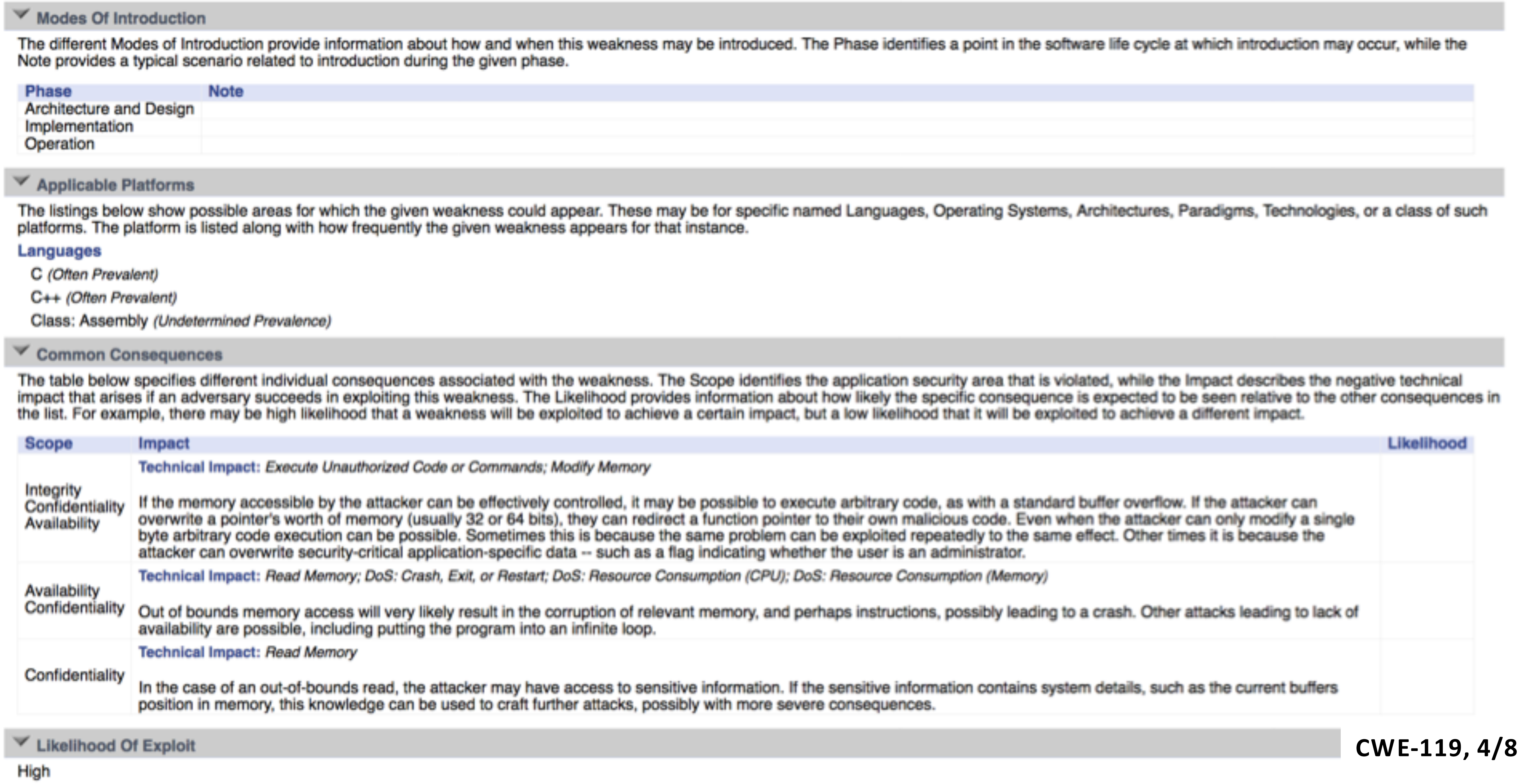
Relevant to the view "Development Concepts" (CWE-699)

Nature	Type	ID	Name
MemberOf	C	19	Data Processing Errors
ParentOf	B	120	Buffer Copy without Checking Size of Input ('Classic Buffer Overflow')
ParentOf	B	123	Write-what-where Condition
ParentOf	B	125	Out-of-bounds Read
ParentOf	B	130	Improper Handling of Length Parameter Inconsistency
ParentOf	B	786	Access of Memory Location Before Start of Buffer
ParentOf	B	787	Out-of-bounds Write
ParentOf	B	788	Access of Memory Location After End of Buffer
ParentOf	B	805	Buffer Access with Incorrect Length Value
ParentOf	B	822	Untrusted Pointer Dereference
ParentOf	B	823	Use of Out-of-range Pointer Offset
ParentOf	B	824	Access of Uninitialized Pointer
ParentOf	B	825	Expired Pointer Dereference
CanFollow	B	131	Incorrect Calculation of Buffer Size

Relevant to the view "Seven Pernicious Kingdoms" (CWE-700)

Nature	Type	ID	Name
ChildOf	C	20	Improper Input Validation

CWE-119, 3/8



Modes Of Introduction

The different Modes of Introduction provide information about how and when this weakness may be introduced. The Phase identifies a point in the software life cycle at which introduction may occur, while the Note provides a typical scenario related to introduction during the given phase.

Phase	Note
Architecture and Design	
Implementation	
Operation	

Applicable Platforms

The listings below show possible areas for which the given weakness could appear. These may be for specific named Languages, Operating Systems, Architectures, Paradigms, Technologies, or a class of such platforms. The platform is listed along with how frequently the given weakness appears for that instance.

Languages

C *(Often Prevalent)*

C++ *(Often Prevalent)*

Class: Assembly *(Undetermined Prevalence)*

Common Consequences

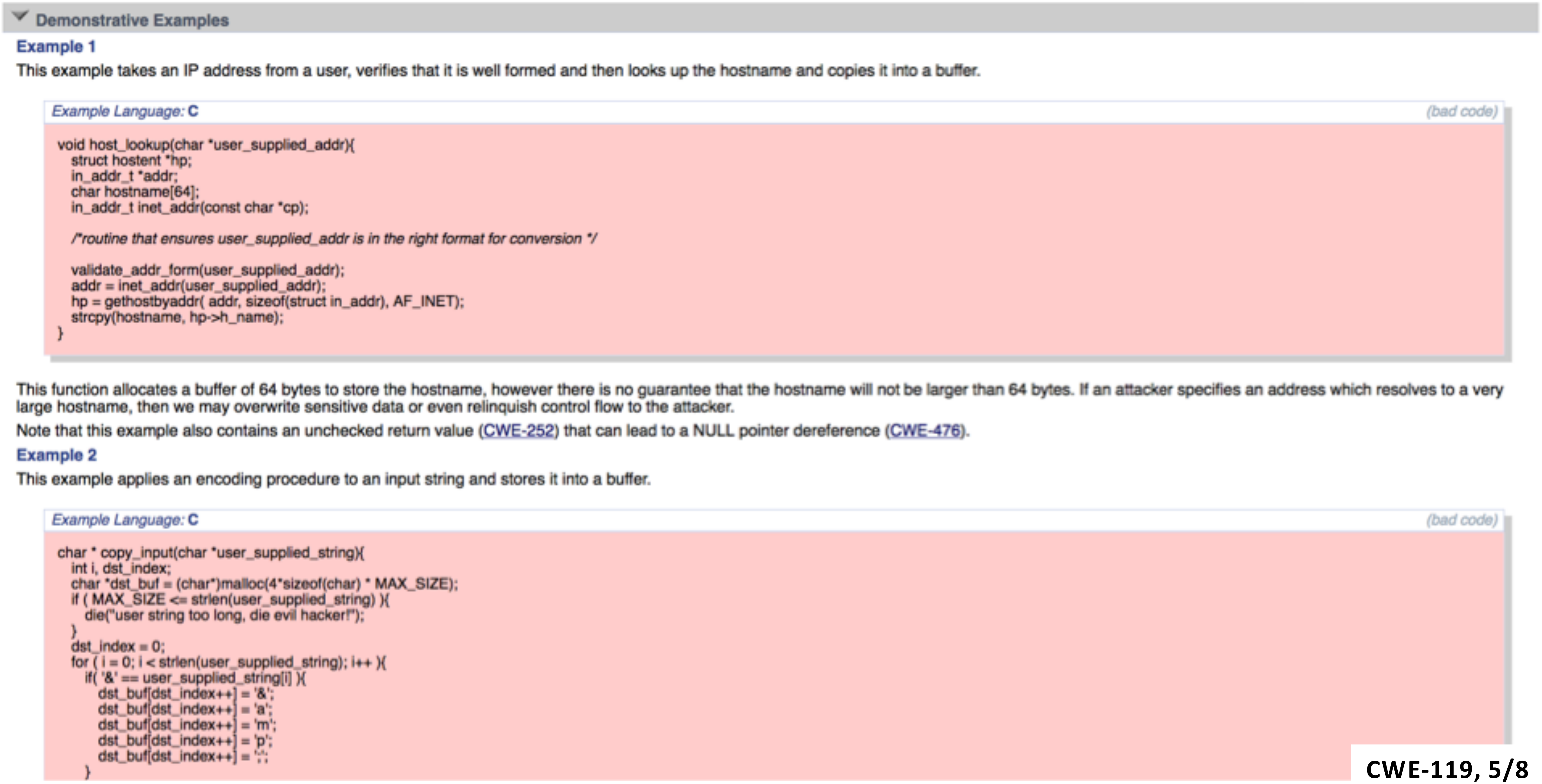
The table below specifies different individual consequences associated with the weakness. The Scope identifies the application security area that is violated, while the Impact describes the negative technical impact that arises if an adversary succeeds in exploiting this weakness. The Likelihood provides information about how likely the specific consequence is expected to be seen relative to the other consequences in the list. For example, there may be high likelihood that a weakness will be exploited to achieve a certain impact, but a low likelihood that it will be exploited to achieve a different impact.

Scope	Impact	Likelihood
Integrity Confidentiality Availability	**Technical Impact:** *Execute Unauthorized Code or Commands; Modify Memory* If the memory accessible by the attacker can be effectively controlled, it may be possible to execute arbitrary code, as with a standard buffer overflow. If the attacker can overwrite a pointer's worth of memory (usually 32 or 64 bits), they can redirect a function pointer to their own malicious code. Even when the attacker can only modify a single byte arbitrary code execution can be possible. Sometimes this is because the same problem can be exploited repeatedly to the same effect. Other times it is because the attacker can overwrite security-critical application-specific data -- such as a flag indicating whether the user is an administrator.	
Availability Confidentiality	**Technical Impact:** *Read Memory; DoS: Crash, Exit, or Restart; DoS: Resource Consumption (CPU); DoS: Resource Consumption (Memory)* Out of bounds memory access will very likely result in the corruption of relevant memory, and perhaps instructions, possibly leading to a crash. Other attacks leading to lack of availability are possible, including putting the program into an infinite loop.	
Confidentiality	**Technical Impact:** *Read Memory* In the case of an out-of-bounds read, the attacker may have access to sensitive information. If the sensitive information contains system details, such as the current buffers position in memory, this knowledge can be used to craft further attacks, possibly with more severe consequences.	

Likelihood Of Exploit

High

CWE-119, 4/8



Demonstrative Examples

Example 1

This example takes an IP address from a user, verifies that it is well formed and then looks up the hostname and copies it into a buffer.

Example Language: **C** *(bad code)*

```
void host_lookup(char *user_supplied_addr){
  struct hostent *hp;
  in_addr_t *addr;
  char hostname[64];
  in_addr_t inet_addr(const char *cp);

  /*routine that ensures user_supplied_addr is in the right format for conversion */

  validate_addr_form(user_supplied_addr);
  addr = inet_addr(user_supplied_addr);
  hp = gethostbyaddr( addr, sizeof(struct in_addr), AF_INET);
  strcpy(hostname, hp->h_name);
}
```

This function allocates a buffer of 64 bytes to store the hostname, however there is no guarantee that the hostname will not be larger than 64 bytes. If an attacker specifies an address which resolves to a very large hostname, then we may overwrite sensitive data or even relinquish control flow to the attacker.

Note that this example also contains an unchecked return value (CWE-252) that can lead to a NULL pointer dereference (CWE-476).

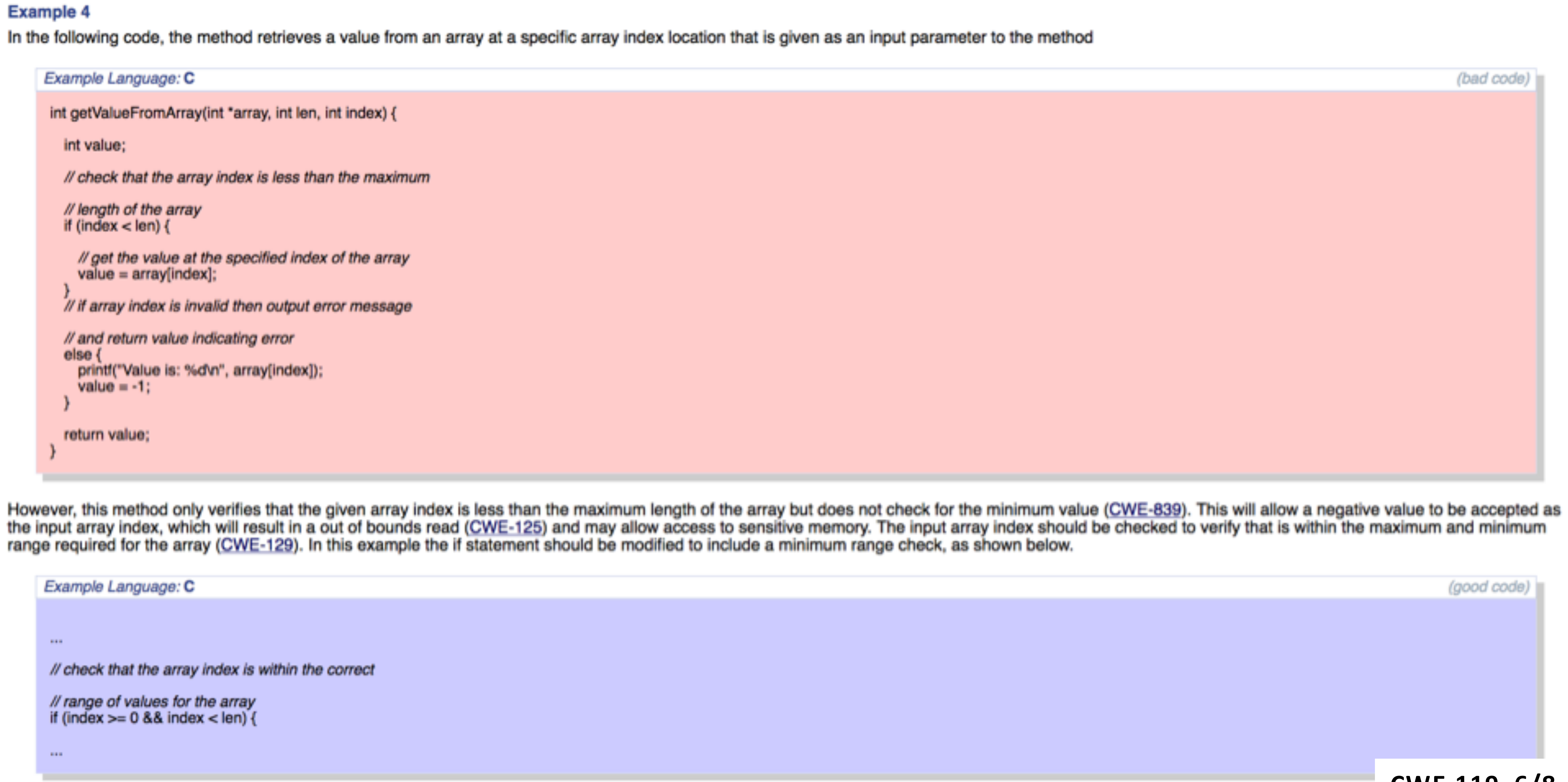
Example 2

This example applies an encoding procedure to an input string and stores it into a buffer.

Example Language: **C** *(bad code)*

```
char * copy_input(char *user_supplied_string){
  int i, dst_index;
  char *dst_buf = (char*)malloc(4*sizeof(char) * MAX_SIZE);
  if ( MAX_SIZE <= strlen(user_supplied_string) ){
    die("user string too long, die evil hacker!");
  }
  dst_index = 0;
  for ( i = 0; i < strlen(user_supplied_string); i++ ){
    if( '&' == user_supplied_string[i] ){
      dst_buf[dst_index++] = '&';
      dst_buf[dst_index++] = 'a';
      dst_buf[dst_index++] = 'm';
      dst_buf[dst_index++] = 'p';
      dst_buf[dst_index++] = ';';
    }
```

CWE-119, 5/8



Example 4

In the following code, the method retrieves a value from an array at a specific array index location that is given as an input parameter to the method

Example Language: **C** *(bad code)*

```
int getValueFromArray(int *array, int len, int index) {

  int value;

  // check that the array index is less than the maximum

  // length of the array
  if (index < len) {

    // get the value at the specified index of the array
    value = array[index];
  }
  // if array index is invalid then output error message

  // and return value indicating error
  else {
    printf("Value is: %d\n", array[index]);
    value = -1;
  }

  return value;
}
```

However, this method only verifies that the given array index is less than the maximum length of the array but does not check for the minimum value (CWE-839). This will allow a negative value to be accepted as the input array index, which will result in a out of bounds read (CWE-125) and may allow access to sensitive memory. The input array index should be checked to verify that is within the maximum and minimum range required for the array (CWE-129). In this example the if statement should be modified to include a minimum range check, as shown below.

Example Language: **C** *(good code)*

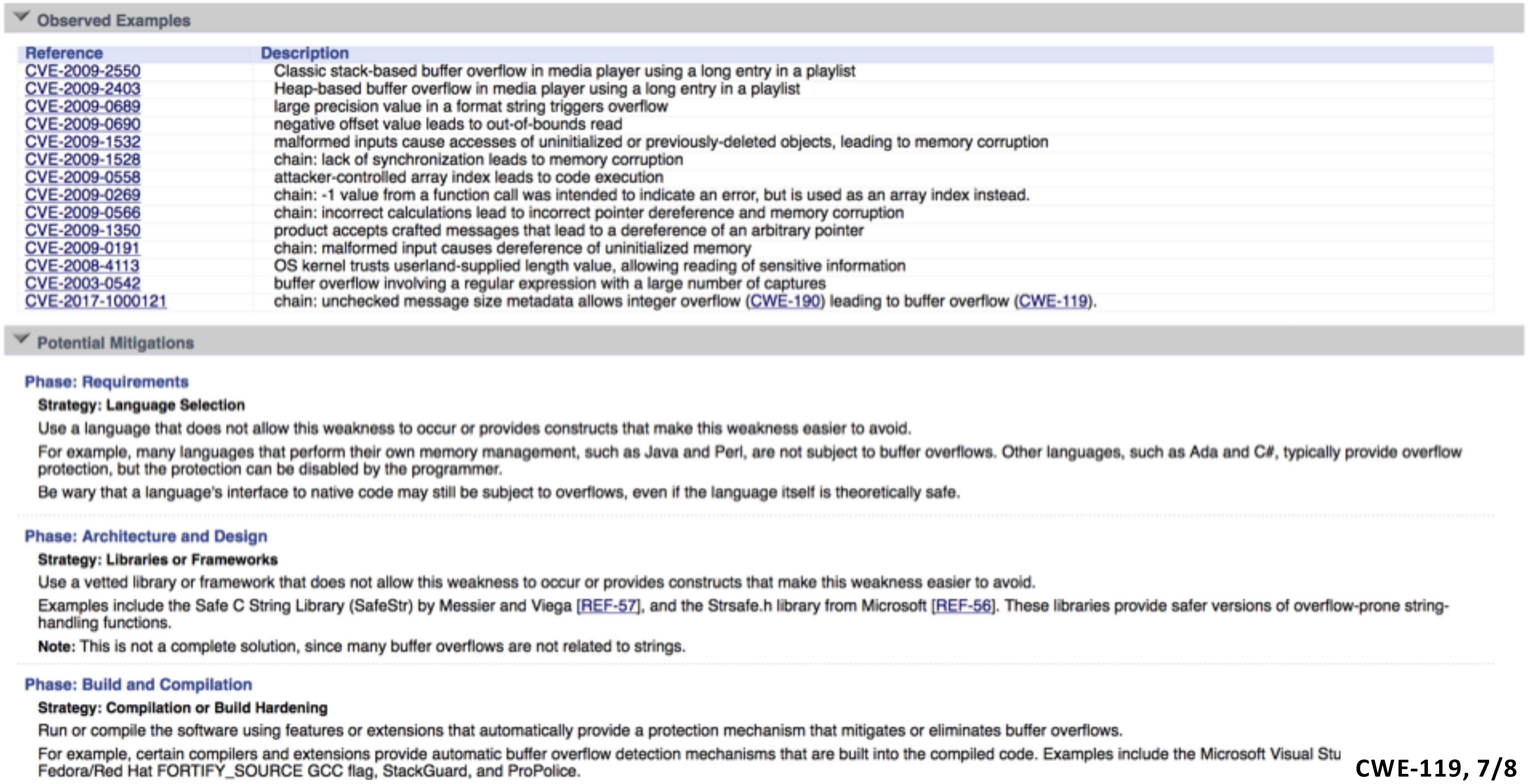
```
...

// check that the array index is within the correct

// range of values for the array
if (index >= 0 && index < len) {

...
```

CWE-119, 6/8



Observed Examples

Reference	Description
CVE-2009-2550	Classic stack-based buffer overflow in media player using a long entry in a playlist
CVE-2009-2403	Heap-based buffer overflow in media player using a long entry in a playlist
CVE-2009-0689	large precision value in a format string triggers overflow
CVE-2009-0690	negative offset value leads to out-of-bounds read
CVE-2009-1532	malformed inputs cause accesses of uninitialized or previously-deleted objects, leading to memory corruption
CVE-2009-1528	chain: lack of synchronization leads to memory corruption
CVE-2009-0558	attacker-controlled array index leads to code execution
CVE-2009-0269	chain: -1 value from a function call was intended to indicate an error, but is used as an array index instead.
CVE-2009-0566	chain: incorrect calculations lead to incorrect pointer dereference and memory corruption
CVE-2009-1350	product accepts crafted messages that lead to a dereference of an arbitrary pointer
CVE-2009-0191	chain: malformed input causes dereference of uninitialized memory
CVE-2008-4113	OS kernel trusts userland-supplied length value, allowing reading of sensitive information
CVE-2003-0542	buffer overflow involving a regular expression with a large number of captures
CVE-2017-1000121	chain: unchecked message size metadata allows integer overflow (CWE-190) leading to buffer overflow (CWE-119).

Potential Mitigations

Phase: Requirements

Strategy: Language Selection

Use a language that does not allow this weakness to occur or provides constructs that make this weakness easier to avoid.

For example, many languages that perform their own memory management, such as Java and Perl, are not subject to buffer overflows. Other languages, such as Ada and C#, typically provide overflow protection, but the protection can be disabled by the programmer.

Be wary that a language's interface to native code may still be subject to overflows, even if the language itself is theoretically safe.

Phase: Architecture and Design

Strategy: Libraries or Frameworks

Use a vetted library or framework that does not allow this weakness to occur or provides constructs that make this weakness easier to avoid.

Examples include the Safe C String Library (SafeStr) by Messier and Viega [REF-57], and the Strsafe.h library from Microsoft [REF-56]. These libraries provide safer versions of overflow-prone string-handling functions.

Note: This is not a complete solution, since many buffer overflows are not related to strings.

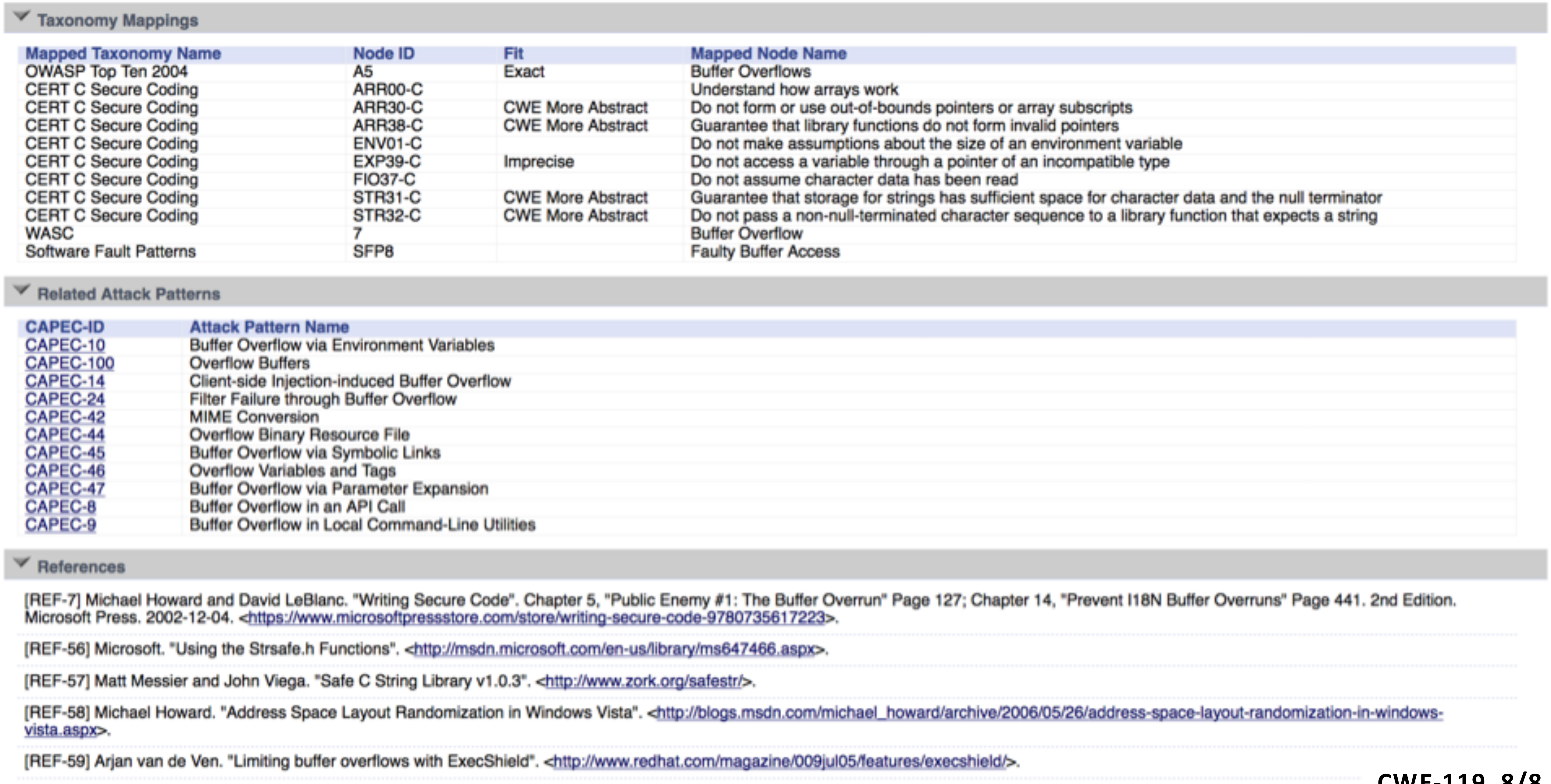
Phase: Build and Compilation

Strategy: Compilation or Build Hardening

Run or compile the software using features or extensions that automatically provide a protection mechanism that mitigates or eliminates buffer overflows.

For example, certain compilers and extensions provide automatic buffer overflow detection mechanisms that are built into the compiled code. Examples include the Microsoft Visual Stu
Fedora/Red Hat FORTIFY_SOURCE GCC flag, StackGuard, and ProPolice.

CWE-119, 7/8



Taxonomy Mappings

Mapped Taxonomy Name	Node ID	Fit	Mapped Node Name
OWASP Top Ten 2004	A5	Exact	Buffer Overflows
CERT C Secure Coding	ARR00-C		Understand how arrays work
CERT C Secure Coding	ARR30-C	CWE More Abstract	Do not form or use out-of-bounds pointers or array subscripts
CERT C Secure Coding	ARR38-C	CWE More Abstract	Guarantee that library functions do not form invalid pointers
CERT C Secure Coding	ENV01-C		Do not make assumptions about the size of an environment variable
CERT C Secure Coding	EXP39-C	Imprecise	Do not access a variable through a pointer of an incompatible type
CERT C Secure Coding	FIO37-C		Do not assume character data has been read
CERT C Secure Coding	STR31-C	CWE More Abstract	Guarantee that storage for strings has sufficient space for character data and the null terminator
CERT C Secure Coding	STR32-C	CWE More Abstract	Do not pass a non-null-terminated character sequence to a library function that expects a string
WASC	7		Buffer Overflow
Software Fault Patterns	SFP8		Faulty Buffer Access

Related Attack Patterns

CAPEC-ID	Attack Pattern Name
CAPEC-10	Buffer Overflow via Environment Variables
CAPEC-100	Overflow Buffers
CAPEC-14	Client-side Injection-induced Buffer Overflow
CAPEC-24	Filter Failure through Buffer Overflow
CAPEC-42	MIME Conversion
CAPEC-44	Overflow Binary Resource File
CAPEC-45	Buffer Overflow via Symbolic Links
CAPEC-46	Overflow Variables and Tags
CAPEC-47	Buffer Overflow via Parameter Expansion
CAPEC-8	Buffer Overflow in an API Call
CAPEC-9	Buffer Overflow in Local Command-Line Utilities

References

[REF-7] Michael Howard and David LeBlanc. "Writing Secure Code". Chapter 5, "Public Enemy #1: The Buffer Overrun" Page 127; Chapter 14, "Prevent I18N Buffer Overruns" Page 441. 2nd Edition. Microsoft Press. 2002-12-04. <https://www.microsoftpressstore.com/store/writing-secure-code-9780735617223>.

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[REF-59] Arjan van de Ven. "Limiting buffer overflows with ExecShield". <http://www.redhat.com/magazine/009jul05/features/execshield/>.

CWE-119, 8/8

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Weaknesses as Bug-Tracking Data

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Case Study: CWE Implemented in GNATS

- Initial implementation: One drop-down field next to SIRT data.
  - Advantage: match-as-you-type provides rapid lookup and completion.
  - Disadvantages: only one possible label, feeble support for novices.
- Better implementation supports a list of CWE labels with priority.
  - Constrained to one value, lots of time spent on finding best possible CWE.
  - Multiple values provides cache and depth, better holistic understanding.
  - Also would include a grouping function for trending support and refinement.
- Immediate benefit: CWE link helps developer understand flaw.
  - Varies among entries, but many have deep, broad explanations, suggestions.
  - Includes recommendations for recognizing good and bad examples.

Weakness Data as SDL Deliverable

- Roll-up of weakness groups produces trends in pentest findings
  - Exposes areas of good performance and others needing remediation
  - Feeds back into Training practice, Security in Design practice
  - Identifies areas for focus by development teams and leadership
- Annual internal ”Top Ten Weaknesses” Report
  - Long-term trending of bug reports across all products
  - Data is compared and contrasted with industry results (OWASP, SANS/CWE)
- Future goal: automatic reporting of CWEs from static code analysis
  - Caveat: to be tagged; static analyzers produce ”stilted” results

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Tips'n'Tricks for Assigning CWE Labels

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Researcher? Or Developer? Start Here!

- If you are the executive of some organization, you care about **impact**.
  - E.g., denial of service, data exfiltration, log errors causing compliance failures
  - "Research Concepts" provides a useful constraint for filtering selections
- If you are a software/hardware vendor, you care about **cause**.
  - E.g., buffer overflow, trust boundary failure, poor entropy, authorization flaw
  - "Development Concepts" should be your default constraint (but not solid)
- *If I had this to do over again, I would have started with this emphasis.*

Use the Search and Filter Functions Well

- Prefix search terms with “inurl:definitions” to constrain to CWEs only.
  - E.g., “Search: `inurl:definitions entropy↩`”
  - Otherwise, you’ll hit matches from all over the CWE web site.
- Select the appropriate ”Presentation Filter” near the top, left side.
  - I almost always use “Complete”, but that may be overwhelming.
  - Other choices are “Basic”, “High Level”, “Mapping-Friendly”.
- Or simply jump directly to the CWE of interest.
  - The jump field is located in the top-right corner of every page.
  - Enter only the numeric part of the CWE identifier.

Can’t Decide on the Best CWE?

- Try widening your search, then narrowing again.
  - Move up to one of the parents, then peruse the children.
  - No result? Move back and try a different parent. “Lather, rinse, repeat.”
- Apply reverse engineering to CWE itself.
  - Browse the CVE and CAPEC links; both have links back into CWE.
  - Warning: NVD/CVE links to CWE are alarmingly general, sometimes wrong!
  - Note that just like CVSS, different vendors correctly have different CWEs.
- Don’t forget the References; sometimes a deeper study is needed.
- Third-party tools, e.g., CWEvis, may be helpful.
  - I have no current experience with CWEvis due to browser issues

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Futures, Prognostications, Recommendations

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Why Fix Weaknesses? The Code Works Fine!

- Consider this conversation:
  - Development Manager: “How did you spend your day?”
  - Developer: “I found and resolved two weaknesses in our main code.”
  - Manager: “Did you finish your feature requests?”
  - Developer: “No, but I fixed these two weaknesses.”
  - Manager: “Was the code running fine before?”
  - Developer: “Yes, of course, but it was weak. I fixed these weaknesses!”
  - Manager: “!!!!!”....
- Major awareness is needed all across the industry.

Customers/Auditors Shifting Focus to CWE

- Customers (and specifically their auditors) are moving beyond requirements that specific CVEs be fixed; they are now tracking CWEs.
  - Considerable confusion; recall that this is all new to most participants.
  - Note that "CVE/CWE" may be an example of "**CWE-193: Off-by-one Error**". ;-)
- This brings up a whole new set of complications.
  - How do we audit this? How do we measure compliance?
  - What about multiple weaknesses? Do we look at chains and composites, too?
  - When does this become legally important, as in "acceptable to the trade"?

What’s Next?

- We should expect/request better metrics, more exploration of trends.
  - PhD dissertation ideas? FIRST Metrics SIG? Other SIGs? Maybe a CWE SIG?
  - Better input/management of label determination, parentage, peers.
  - Awareness needed for weakness science and improvement of terminology.
- CWE needs broader community support and more infrastructure.
  - How do I suggest a new CWE label with sensitivity implications?
  - Broad areas are missing, e.g., IP violations; What else should be addressed?
- More ideas? Email me! jduncan@juniper.net

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Questions?

Thank You!

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