The Bugs Framework (BF): A Structured, Integrated Framework to Express Software Bugs

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To achieve higher levels of assurance for digital systems, we need to answer questions such as does this software have bugs of these critical classes? Do two software assurance tools find the same set of bugs or different, complimentary sets? Can we guarantee that a new technique discovers all problems of this type? To answer such questions, we need a vastly improved way to describe classes of vulnerabilities and chains of failures. We present a descriptive Bugs Framework (BF) that will raise the current realm of best efforts and useful heuristics. We provide definitions of three weakness classes, and examples of applying our BF taxonomy to describe particular vulnerabilities.

Our Definitions, BF Taxonomy, and Examples

Buffer Overflow (BOF): The software can access through an array a memory location that is outside the array boundaries.

Injection (INJ): Due to malicious input with a language-specific special element, the software can assemble a command string that is parsed into an invalid construct.

Interaction Frequency Control (IFC): The software does not properly limit the number of repeating interactions per specified unit.

Examples

CVE-2014-0160 (Heartbleed): Input not checked properly leads to too much data, where a huge number of bytes are read from the heap in a continuous reach after the array end, which may be exploited for exposure of information that had not been cleared.

CVE-2015-0235 (Ghost): Incorrect calculation, (specifically missing factor) leads to array too small, where a moderate number of bytes are written to the heap in a discrete reach after the array end, which may be exploited for arbitrary code execution, eventually leading to denial of service.

CVE-2010-1773 (Chrome WebCore): Incorrect calculation, (specifically off by one) leads to a wrong index, where a small number of bytes are read from the heap in a discrete reach before the array start, which may be exploited for information exposure, arbitrary code execution or program crash, leading to denial of service.

Interaction Frequency Control (IFC): The software does not properly limit the number of repeating interactions per specified unit.

Examples

CVE-2002-0628: Failure to limit to a specified number the authentication attempts per authentication event by same or different user(s) may be exploited for credentials compromise (username or password) via brute force.

CVE-2002-1876: Failure to recognize repeated interactions that are rapid initiations of message exchange requests from authenticated users, leads to failure to properly limit them to a specified number per specified time interval, which may be exploited for resource exhaustion (consumption of all granted licenses) leading to denial of service.

CVE-2002-1018: Failure to limit the checkouts of a book to a single one per user may be exploited for resource exhaustion leading to denial of service.