

A Stateful Fuzzer for the TCP/IP Stack of the Real-Time Operating System Zephyr

Report

Valentin Huber

Institute of Applied Information Technology

Zürich University of Applied Sciences ZHAW

contact@valentinhuber.me

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1 Introduction

2 Related Works

- *Stateful Greybox Fuzzing* [1]:

In this paper, we argue that protocols are often explicitly encoded using state variables that are assigned and compared to named constants [...] More specifically, using pattern matching, we identify state variables using enumerated types (enums). An enumerated type is a group of named constants that specifies all possible values for a variable of that type. Our instrumentation injects a call to our runtime at every program location where a state variable is assigned to a new value. Our runtime efficiently constructs the state transition tree (STT). The STT captures the sequence of values assigned to state variables across all fuzzer-generated input sequences, and as a global data structure, it is shared with the fuzzer.

Built on LibFuzzer

- *StateAFL: Greybox fuzzing for stateful network servers* [2]: compile-time probes observing memory allocation and I/O operations; state inference based on fuzzy hashing of long-lived memory areas.
- *Ijon: Exploring Deep State Spaces via Fuzzing* [3]: Manual annotations of code, to manually add entries to an AFL-style map (set/inc at calculated offset), include state information (variable values) in how edge coverage is calculated, and store the max value a certain variable reaches during execution for the fuzzer to then maximize.
- *SandPuppy: Deep-State Fuzzing Guided by Automatic Detection of State-Representative Variables* [4]: Ijon [3], but automatic (initial run capturing variable-value traces, analyze along with source code, add Ijon-style instrumentation, repeat during fuzzing)
- *The Use of Likely Invariants as Feedback for Fuzzers* [5]: run for 24 hours, record variable values and relationships between them, then add a feedback that rewards when the generated assertions are violated
- *Ankou: guiding grey-box fuzzing towards combinatorial difference* [6]: take combination of executed branches into consideration, reduce to manageable adaptive fitness function
- *FuzzFactory: domain-specific fuzzing with waypoints* [7]: framework to add custom feedbacks like number of basic blocks executed, amount of memory allocated, etc.
- *ParmeSan: Sanitizer-guided Greybox Fuzzing* [8]: Use sanitizers checks as fuzzing targets
- *Fuzzing with Data Dependency Information* [9]: Use execution of new data dependencies as feedback

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