Reverse Engineering for Input Modeling
Input Parameter Model Inference from Network Traces

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Combinatorial Testing

Testing is an essential task in any secure software development lifecycle. **Combinatorial Testing** combines

- mathematical coverage guarantees
- small test sets
- flexible extensions (constraints, budgeting, . . .)

Typical Workflow

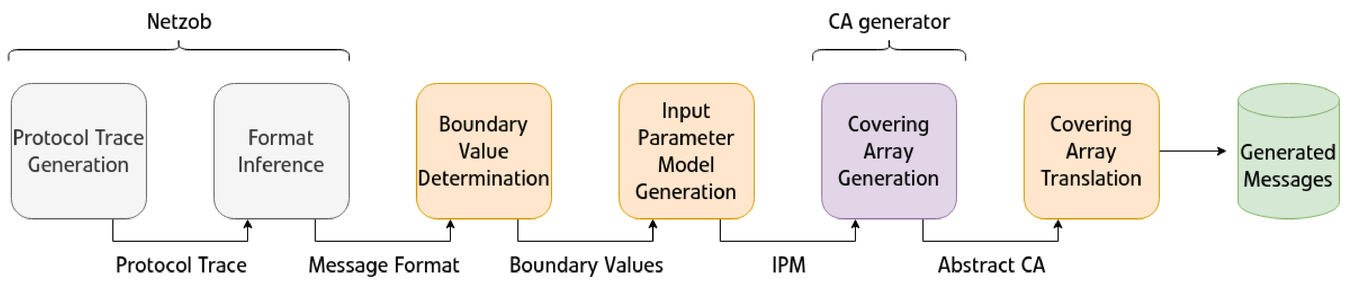
1. Input modeling: Generate model of parameters & values
2. Test generation: Construct combinatorial test set (Covering Array [CA])
3. Test translation: Transform abstract test cases to concrete messages
4. Test execution: Submit messages to target, record response
5. Test oracle: Decide whether test was handled correctly

Combinatorial testing requires a model (IPM) of input parameters, their values, and potentially existing constraints.

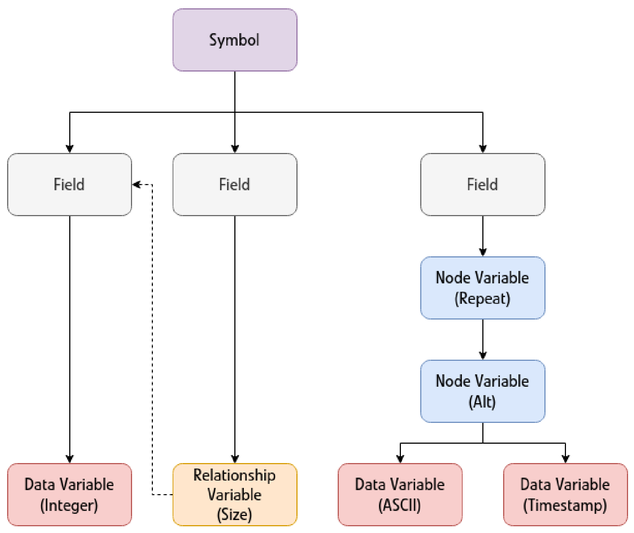
- Additional effort to create and maintain
- Often not available in practice
- Must reverse engineer to test proprietary protocols

Thesis Contribution

- First work to combine protocol reverse engineering based on network traces with input parameter modeling
- Translates generated test cases to concrete protocol messages
- Open Source implementation based on Netzob
- Identifies avenues for future work, e.g. shortcomings of model definitions



Message Format



Netzob protocol message format (“Symbol”): Tree made up of fields, each containing

- Node variables, encapsulating other nodes
  - Repeat child node
  - Alternative between child nodes
  - Concatenation of child nodes
- Leaf variables, contain concrete data
  - Data variables, primitive data types
  - Relation variables, based on other fields

Primitive data types

Integers, strings, IPs, . . .

Modeled using **boundary values**

1. Partition domain of parameter based on semantics
2. Identify values at boundaries of partitions, e.g. min, -1, 0, 1, max
3. Mark *negative* (invalid) values, e.g. larger than allowed

Node variables

Repetition, choice, concatenation

Modeled using **metaparameters**

- Number of repetitions
- Which alternative to select for a node

State of research: Coverage definition lacking

- Split metaparameter test set from value test set, combine later
- Nested node variables result in huge model or incomplete coverage
- Additional research required to solve identified shortcomings

Summary

- Combinatorial testing is an efficient & effective black-box testing method
- Offers mathematically guaranteed coverage and small test set sizes
- Requires input parameter model, often not available in practice
- Approach: Reverse engineering to infer input parameter models
- Pluggable mechanism allows choice of test set generator
- Translates generated test sets to concrete protocol messages

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