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DESIGN OF AN AUTOMATICALLY GENERATED RETARGETABLE DECOMPILER

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PART 1

INTRODUCTION AND MOTIVATION

Introduction and Motivation

- Decompilation
  - Reverse translation: binary executables => HLL code (C, Java, etc.)
  - Harder than compilation (a lot…)
- Motivation
  - Reverse engineering (how does it work?)
  - Cross-platform porting
  - Adding features to 3rd party SW
  - Recovery of lost source code
  - Finding bugs, vulnerabilities, malware, etc.
- Our focus
  - Retargetability, automation, high readability

PART 2

STATE OF THE ART

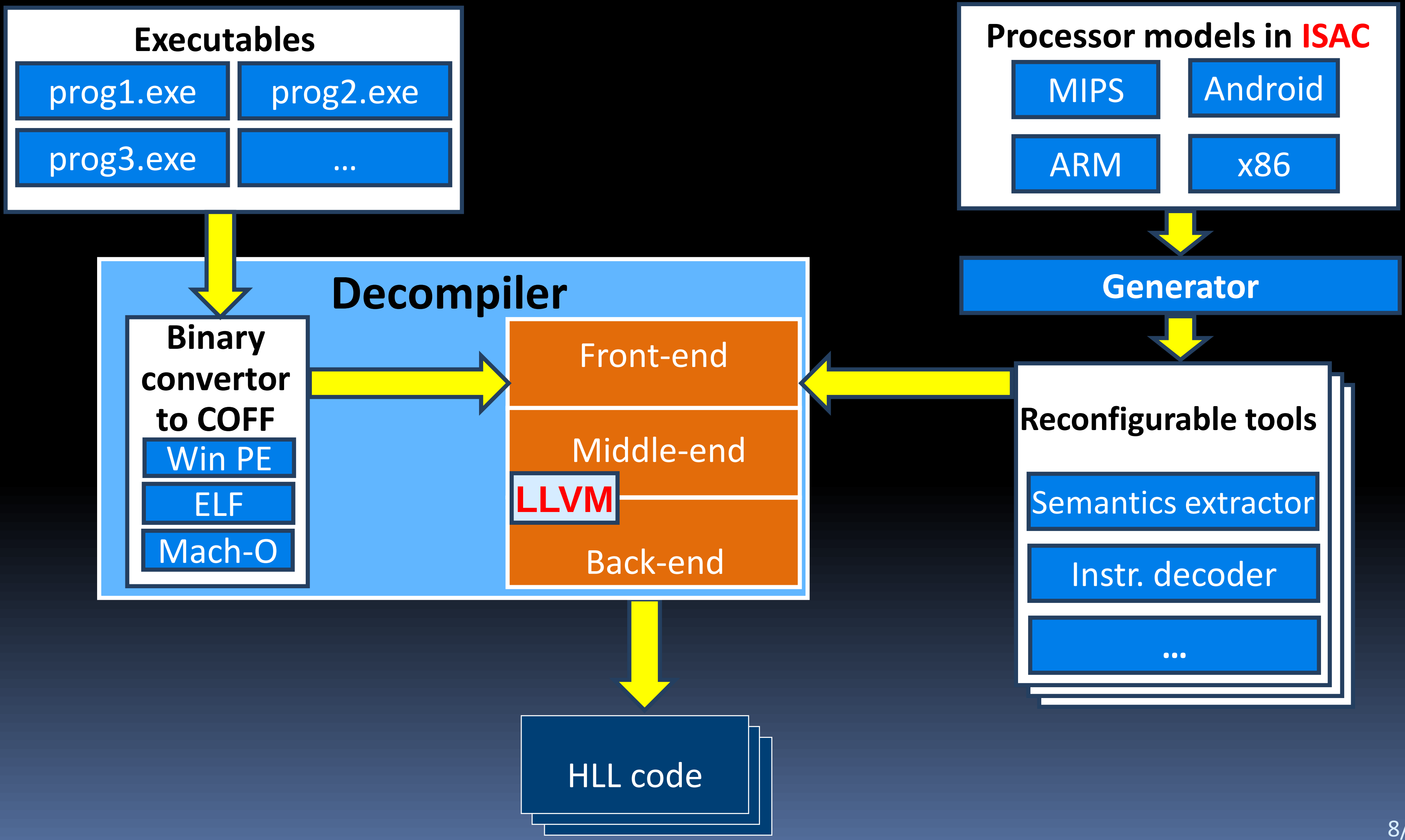
State of the Art

- Reverse engineering
  - Disassemblers, decompilers, …
- Single target architecture decompilation
  - Open problem for > 40 years (HP equivalent problem)
  - Several attempts (dcc, Boomerang, Hex-Rays, REC Decompiler)
- Retargetable decompilation
  - Reconfigurable (based on target platform description)
  - The PILAR System (1970, never completed)
  - No other similar projects

PART 3

RETARGETABLE DECOMPILER

Retargetable Decompiler



Retargetable Decompiler

- Developed within the Lissom project (BUT FIT)
  - In cooperation with AVG Technologies
- Exploitation of existing technologies
  - Architecture Description Language ISAC (BUT FIT)
  - LLVM Compiler System
- Reconfigurable, automatically generated
- Input
  - Platform-dependent binary application
  - Platform model in ISAC
- Output
  - HLL representation of the input application

Front-end

- Goal: Semantic translation of the input program
  - Platform-dependent format => internal COFF format => LLVM IR
- Platform dependent
  - Generated based on the architecture model (in the ISAC ADL)
- Tasks:
  - File format conversion (support of ELF, PE, Mach-O, DEX, E32, …) to COFF
  - Generic "disassembly" (based on formal models)
  - Static code detection (signature based detection, FLIRT, types)
  - Static analysis (code vs. data, control-flow analyses, etc.)
  - Compiler detection (for MS Windows and GNU/Linux)
  - …

Middle-end and Back-end

- Goal: HLL code reconstruction
  - LLVM IR => HLL independent IR => target HLL code
  - Uses existing optimizations and transformations + own passes
- Platform independent
  - Built on top of LLVM Compiler System
- Tasks:
  - Support of different HLLs (Python‘, C)
  - Recognition of high-level constructs (loops, IF statements, etc.)
  - Emission of the target HLL code
  - Post-processing

PART 4

EXPERIMENTAL RESULTS

Experimental Results

- Used platform: Sony PlayStation Portable (PSP)
  - video game hand-held console
  - dual-core processor based on MIPS-4000
  - executables are in the PRX format
- Used compiler: psp-gcc
  - from PSP SDK (4.3.2)
  - with enabled optimizations (-O2)

Experimental Results

- Original code:

```
#include <pspkernel.h>
#include "sum.h"

/* Initialization */
PSP_MODULE_INFO("template", 0, 1, 1);
PSP_MAIN_THREAD_ATTR(0x80004000);

int main(void)
{
    volatile int a = 3;
    int b;
    for (b = 1; b < 100; b++)
        a = sum(a, b);
    return a;
}
```

- Decompiled code:

```
# -------- Global Variables --------
  orange = 0
  banana = 0
  lemon = 0
# --------- Declarations -----------
  int sum(int, int)
# ------ Defined Functions ---------
  def main():
    orange = 3
    result = orange
    for i in range(0, 99):
      banana = result
      lemon = i + 1
      result = sum(banana, lemon)
    return result
```

PART 5

CONCLUSION

Conclusion and Future Work

- Retargetable decompiler
  - Reconfigurable, platform independent
  - No other similar solutions
  - Exploitation of existing technologies
    - ISAC ADL, LLVM Compiler System
- Result
  - Proof of concept: decompilation of a MIPS program (Sony PSP)
  - Produces highly readable HLL code (Python-like language)
- Future research
  - Static analysis (ABI detection)
  - Other HLLs (C, type information)
  - Testing on different architectures (x86, ARM, …)

DISCUSSION