GPU-Disasm: A GPU-based x86 Disassembler

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Evangelos Ladakis, Giorgos Vasiliadis, Michalis Polychronakis, Sotiris Ioannidis, George Portokalidis
First Impressions

GPU-Disasm: A GPU-based x86 Disassembler by Ladakis, Evangelos, Giorgos Vasiliadis, Michalis Polychronakis, Sotiris Ioannidis, and Georgios Portokalidis [PDF] (necoma-project.eu)

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my first response to this, as captured in a technical IRC channel:

if you have so much x86 binary that you need to accelerate disassembling it with GPUs, you have made bad life choices

permalink

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Think they were trying to come up with reasons why they need that NVidia GTX Titan card to play QuakeWorld on during lunch.

permalink  parent
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Outline

• Background
• Architecture
• Optimization
• Evaluation
• Conclusion
Disassembly

Software Reverse Engineering

- Mandatory when source code is not available
  - Bad guys
    - Find vulnerabilities
    - Bypass protection mechanisms
  - Good guys
    - Find malicious code
    - Debug and patching
    - Apply protection mechanisms

- Techniques
  - Linear
  - Recursive
Binary Stores

• Large number of binaries
  • 1.6 million Google play
  • 1.5 million app store

• Updated occasionally

From a security aspect:

• Analysis time and cost are essential
Motivation

• How can we build a fast and cheap Disassembler for large scale analysis?
• Can we use GPU’s to accelerate the decoding process?
• Why GPUs?
General-Purpose Programming on GPUs (GPGPU)

• Powerful co-processors for General Purpose Programming
• Commodity hardware, relative cheap
• Compute capabilities increasing
• Familiar API CUDA and OpenCL
GPU memory model

Grid

Block(0,0) (SM)
- L1/Shared
- Registers
- Thread (0,0)
- Thread (1,0)

Block(1,0) (SM)
- L1/Shared
- Registers
- Thread (0,0)
- Thread (1,0)

L2 Cache

Global Memory/Constant Memory
X86-ISA

- CISC architecture
- 1~15 Bytes instructions

Why x86?
- Widely used
- More challenges to address
- Applying to RISC is easier
GPU-Disasm Arch.

GPU-based Disassembler of the x86 architecture

Two modes:

• Linear disassembly
  o Each thread is assigned a binary

• Exhaustive disassembly
  o Each thread decodes one instruction of the same binary but from a different offset
Challenges

• Arbitrary accesses to Global
  o X86 nature

• Load balancing and correctness
  o Utilize threads fairly with same size buffers
  o Start disassembling where we left

• Large number of static and constant values
  o Fast memory interfaces are small in capacity
  o Store the most frequently used
GPU-Disasm Arch.

GPU-Disasm Components:

How to achieve high performance:
- Optimize transfers
- Optimize the Disassembly process
- Pipeline the operations
PCI Throughput

- PCI 3.0 throughput evaluation
PCI Throughput

- Maximum throughput on 16MB of data
Optimize Transfers

1. Pre-allocate page-locked I/O buffers to the host (*cudaMallocHost*)
2. Place I/O to single buffers
   - Greater of 16 MB for PCI max throughput
3. Minimize the PCI transfer API calls
Optimize Disassembly

- Store Look-up-tables to Constant & Shared mem.
- Pre-fetch input data to registers
- Improve cache hits in L2
  - Divide input into small buffers
  - Move threads as groups inside memory

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Correctness

• We keep a copy of old decoded bytes and the upcoming bytes

• So that we can continue decoding where we left
Evaluation

• Implementation in CUDA

• System:
  o GPU: NVIDIA GTX 770 $396
  o CPU: intel i7 $305
  o Total cost $1120

• Dataset from usr of ubuntu 12.04

• Performance measured in $Lines/sec$
Disassemblers Evaluation

- Single threaded, discard disk I/O
- Performance divergence due to output construction
GPU-Disasm on crafted bins

<table>
<thead>
<tr>
<th>Buffer Size (Bytes)</th>
<th>Average Hit Rate % (L1 to L2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>58.7</td>
</tr>
<tr>
<td>32</td>
<td>53.65</td>
</tr>
<tr>
<td>64</td>
<td>45.26</td>
</tr>
</tbody>
</table>

- Decode 2 Bytes Instructions
- Impact of L2 optimization
  - 25.85 % more performance
GPU-Disasm on Binaries

Comparing only the disassembly process

![Graph showing GPU speedup with different byte per thread values](image-url)
GPU-Disasm on Binaries

Comparing only the disassembly process

- Linear disassembly 2 times faster
- Exhaustive average 4.4 times faster
• After 1024 batch size, disassembly becomes the bottleneck
Hybrid (CPU & GPU)

- Hybrid has 7 CPU threads and the GPU
  - 1 thread is needed as the GPU controller
Power evaluation

• Metrics include CPU, RAM, and peripherals power consumption
  o Measured internally with sensors
Conclusion

• Presented a GPU-based implementation of an x86 disassembler
• 2 times faster in linear disassembly and 4.4 in exhaustive
• Similar power consumption with the CPU implementation
Thank you