ACCELERATE SNORT WITH HYPERSCAN

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Agenda

- Snort Overview
- Integrating Snort with Hyperscan
- Experiments and Demo
SNORT OVERVIEW
Snort Architecture

Open Source Intrusion {Detection, Prevention} System

- Cisco (previously Sourcefire) owns GPL
- Most widely deployed IPS/IDS in the industry
- Public Snort VRT rules targeting at hacking activities, intrusion attempts, malware and vulnerabilities, etc
- Single-threaded architecture in Snort 2.x (Multi-thread support in the coming Snort 3.0)
- First beta release of Snort 3.0 is expected at the mid of 2017
Snort Introduction

Network Traffic → Packet Decoder → Preprocessor → Detection Engine → Rules → Logging and Alerting System → Output Modules → Output Alert or Log
INTEGRATING SNORT WITH HYPERSCAN
Integration Overview

Two integrations: integration into Snort 2.9 series and Snort 3 aka Snort++

- Snort 2.9 integration (Intel)
  - Uses Hyperscan as multiple literal matcher aka “MPSE”
  - Uses Hyperscan as single literal matcher (!!)
  - Uses Hyperscan as regex matcher
  - Uses Hyperscan in http preprocessor
  - Not upstreamed – we ship patch at 01.org/hyperscan

- Snort 3 integration (Cisco)
  - Experimental – allows explicit regular expressions in the ‘multiple matcher’
Accelerated Snort

Network Traffic → Packet Decoder → Preprocessor (Http Preprocessor) → Detection Engine
- Single literal matcher
- PCRE prefilter
- Multiple literal matcher

Rules → Logging and Alerting System → Output Modules → Output Alert or Log
Detection Engine Integration

Multiple literal matching

- Fast pattern matching (for all rules):
  - Core component in detection engine
  - Only evaluate rules if the content is found in the payload
  - Significantly reduce the number of rules to evaluate and thus better performance
Detection Engine Integration

Multiple literal matching:

- Aho-Corasick algorithm (default)

- Replace AC with Hyperscan
  - Mainly use *large scale literal matcher* in Hyperscan
  - Bucketed super-character shift-or matcher as front end
  - Hashing and final confirm as back end
  - Based on Intel instructions: SSE + BMI
  - 500 literals: ~10Gbps, 5000 literals: ~4Gbps
Detection Engine Integration

Individual rule matching:

- Single literal matching:
  - Boyer-Moore algorithm (*default*)
  - Use Hyperscan *SIMD based single literal matcher*

- Regular expression matching:
  - PCRE (*default*)
  - Use Hyperscan’s *prefilter* support to handle patterns that Hyperscan doesn’t natively support
  - Scan with Hyperscan first, confirm with PCRE if Hyperscan has matched
  - Significant win when PCRE will backtrack, or when literal guard is weak
Detection Engine Integration

Multiple literal matching code snippet:

typedef struct __HyperscanContext {
    hs_scratch_t *scratch;
} HyperscanContext;

typedef struct __HyperscanPm {
    hs_database_t *db;
    HyperscanContext *ctx;
    HyperscanPattern *patterns;
    ...
} HyperscanPm;

typedef struct
    HyperscanCallbackContext_ {
    const HyperscanPm *pm;
    void *data;
    int (*match)(void *id, ...);
    int num_matches;
} HyperscanCallbackContext;
Detection Engine Integration

```c
static int HyperscanBuild(HyperscanContext *ctx,
    HyperscanPm *pm) {
    hs_compile_ext_multi(patterns,
        flags, ids,
        ext,
        num_patterns,
        HS_MODE_BLOCK, NULL,
        &(pm->db),
        &compile_error);

    hs_alloc_scratch(pm->db,
        &pm->ctx->scratch);
}

int HyperscanSearch(HyperscanPm *pm, ...) {
    HyperscanCallbackContext ctx;
    hs_scan(pm->db, (const char *)t, tlen, 0,
        pm->ctx->scratch, onMatch, &ctx);
    return ctx.num_matches;
}

static void HyperscanCleanup(int unused,
    void *data) {
    hs_free_scratch(contentScratch);
    contentScratch = NULL;
}

void HyperscanFree(HyperscanPm *pm) {
    hs_free_database(pm->db);
}
```
EXPERIMENTS AND DEMO
Performance

**CPU:** Intel(R) Xeon(R) CPU E5-2699 v4 @ 2.20GHz

**Hyper-threading:** disabled

**Turbo Boost:** enabled (Max 3.6GHz)

**NIC:** Intel Corporation Ethernet Controller XL710 for 40GbE QSFP+

**HugePage:** 4 * 1G

**Snort/DAQ/Rules:** Snort 2.9.8.3, daq 2.0.6, snortrules-snapshot-2983

**DPDK/Hyperscan:** DPDK 16.07, Hyperscan 4.3.1

**BreakingPoint:** Release 8.0.1
## Performance

### Average Throughput (Mbps)

<table>
<thead>
<tr>
<th>Rules</th>
<th>Snort/DPDK/Hyperscan</th>
<th>Vanilla Snort</th>
<th>Performance Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 rule &amp; direct forwarding</td>
<td>41,625.4535</td>
<td>4,294.8543</td>
<td>9.69x</td>
</tr>
<tr>
<td>0 rule</td>
<td>4,346.5399</td>
<td>1,720.2997</td>
<td>2.53x</td>
</tr>
<tr>
<td>8 pass rules</td>
<td>1,823.7223</td>
<td>841.8590</td>
<td>2.17x</td>
</tr>
<tr>
<td>VRT rule package</td>
<td>772.5730</td>
<td>91.4068</td>
<td>8.45x</td>
</tr>
</tbody>
</table>

Traffic containing HTTP and peer-to-peer file sharing
Performance

Average Throughput (Mbps)

<table>
<thead>
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<th>Performance Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 rule &amp; direct forwarding</td>
<td>9,897.0288</td>
<td>1,164.4064</td>
<td>8.50x</td>
</tr>
<tr>
<td>0 rule</td>
<td>1,918.4513</td>
<td>656.8847</td>
<td>2.92x</td>
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<tr>
<td>8 pass rules</td>
<td>666.9908</td>
<td>377.4932</td>
<td>1.77x</td>
</tr>
<tr>
<td>VRT rule package</td>
<td>314.3337</td>
<td>118.7311</td>
<td>2.65x</td>
</tr>
</tbody>
</table>

Traffic representing an enterprise network
CONCLUSIONS AND CALL TO ACTION
Conclusion

- **Hyperscan**
  - Contributes substantial speedups to Snort
  - Solid and mature for pattern matching intensive systems (IDS/IPS/FW...)
  - Delivers strong packet processing capability together with DPDK

- **Call to action:**
  - Stay in touch with us! Help us to improve Hyperscan for network solutions.
  - Welcome ideas on projects in various fields (text analytics, bioinformatics, etc)