Samsung SmartSSD: Accelerating Data-Rich Applications

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Pushing intelligence to the data

Today’s Architecture

Overloaded

CPU

DRAM

FPGA/GPU

Large data transfers

PCIe

Limited to 4-8 SSDs per host

SmartSSD Acceleration

CPU offloaded: freed for business logic

Minimal data movement

Offloaded processes run near the data

High, scalable total internal bandwidth

Processing and bandwidth scales with data

Funnels traffic from multiple SSDs

TB-EB datasets

Performance ceiling

SmartSSD

SSD Controller

NAND Flash

FPGA accelerator

Performance scales with data

CPU Performance Ceiling

# SSDs / server

2x to 10x

# SmartSSD / server

Performance

Scalable Acceleration with SmartSSD
Samsung SmartSSD Technology Roadmap

- Roadmap to smaller FF (U.2) and greater integration with SSD controller

**Moves Data out of SSD for processing**

**Limited scalability:** Funnels 4 SSDs → 1 FPGA

**Internal Data Transfer**
- Adds Bandwidth and Processing without Funneling

**External FPGA**
- '2H'2018: HHHL AIC PoC
- 2H'2019: U.2 MP

**SmartSSD PoC**

**U.2 v1.0 SmartSSD**

**U.2 FF:**
- Scale Processing to 24 or 48 devices
- Greater Integration
- More Internal Bandwidth
Samsung SmartSSD: Proof of Concept

- **SmartSSD PM983F AIC** (announced Samsung Tech Day 2018)

**Add-in card to demo performance**

- PoC using PCIe add-in card
- Shown successfully integrated with Bigstream
- Several data-intensive workloads easily ported

**PoC Results**

- For I/O-bound workloads, SmartSSD showed 3x to 4x better performance with scalability

*VWAP: Volume Weighted Average Price*
SmartSSD Platform: Ecosystem Opportunities

Accelerated application frameworks

Accelerated storage services

Video Encoding
DB Acceleration
Search
ML

Acceleration platform

Comp/decomp
Encrypt/decrypt
Erasure Coding

Bring your own IP

Acceleration IP Kernels

Databases
VP9
H.265
Video
AI and ML
Storage & Virtualization

Connectors to Applications Frameworks

Base Acceleration IP

Acceleration Stack: IP Dev Toolchain: Runtime, Libraries, API, Drivers

Video
AI and ML
Storage & Virtualization

Drivers
Libraries
API
Runtime

Applications

Flash Memory Summit


COLLABORATE. INNOVATE. GROW.
Samsung SmartSSD for Accelerating Data-Intensive Loads

For I/O-bound workloads, SmartSSD shows 5-6x speedup, with scalability

Representative Workloads:
- Structured Data
- Rich Media
- Storage Services

<table>
<thead>
<tr>
<th>Block SSD</th>
<th>SmartSSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU</td>
<td>Low-QoS decomposition</td>
</tr>
<tr>
<td>Scalability</td>
<td>Limited to 4-8 SSDs/host</td>
</tr>
<tr>
<td>Accelerator</td>
<td>QAT funnels traffic from multiple SSDs</td>
</tr>
</tbody>
</table>

TPC-DS SF-200 Results

Lower is better

CPU based
SmartSSD

Block SSD | SmartSSD |
<table>
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<tbody>
<tr>
<td>CPU</td>
<td>Overloaded with serving and xcoding</td>
</tr>
<tr>
<td>Scalability</td>
<td>Limited to 4-8 SSDs/host</td>
</tr>
<tr>
<td>Accelerator</td>
<td>FPGA funnels traffic from multiple SSDs</td>
</tr>
</tbody>
</table>
Samsung SmartSSD Illustrative Perf. Profile (Row-based)

- **Before:**
- **After:**

### Step 0 Physical Plan Stage Run Time Summary

![Diagram showing run time summary](image)

- **Dynamic ID:**
  - 13 (-1, -1) XSD +
  - 12 (-1, -1) XSD +
  - 11 (-1, -1) XSD +
  - 10 (-1, -1) XSD +
  - 9 (-1, -1) XSD +
  - 8 (-1, -1) XSD +
  - 7 (-1, -1) XSD +
  - 6 (-1, -1) XSD +
  - 5 (-1, -1) XSD +
  - 4 (-1, -1) XSD +
  - 3 (-1, -1) XSD +
  - 2 (-1, -1) XSD +
  - 1 (-1, -1) XSD +
  - 0 (-1, -1) XSD +
  - **total XSD**

### Task Run Time per Executor

![Bar chart showing task run time](image)

**Tasks:***
- Tasks in stage 0, 9
- Tasks in stage 1, 10
- Tasks in stage 2, 11
- Tasks in stage 3, 12
- Tasks in stage 5
- Tasks in stage 6
- Tasks in stage 7
- Tasks in stage 8

**Time(s):**
- 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200

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**Collaborate. Innovate. Grow.**

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Thank You!