The Rise of Computational Storage
May 2019
India’s largest transaction platform, built on payments
Strategy – Follow the money journey

CUSTOMER JOURNEY

SEND MONEY

Spend Money

Manage Money

Grow Money

KEY USE CASES

P2P Money transfer
Gifting
Remittances
Group Payments

Utility Bills & Mobile Recharge
Offline Merchants
Online Merchants
In-App: AppStore

Banking as a Platform
Gold
Insurance
Mutual Funds
Loans
Credit
2nd-largest payments company within 2 years of launch

- 100+ M Registered Users
- 40 M Monthly Active Users
- 25 M Monthly Active Customers
- 1 M Merchant Network
- 180 M Monthly Transactions
- 48 Billion Annualized Transaction Processing Value

Flipkart accounts for <0.5% of our transaction volume
Fastest growing merchant network

- Live on 100 top online merchants
- Live at 1+ Million merchants across India
Innovation examples (1/4) – Open ecosystem approach

- All payment instruments supported
  - UPI
  - Debit Card
  - Credit Card
  - Wallet

- PhonePe wallet integrated with other wallets

- Partner with leading players to offer consumer use cases
Innovation examples (2/4) – In app platform

- **Autopay**: Initiate payments without second factor authentication
- **Works with both Credit and Debit Cards**

- **10+% of the consumer driven Redbus bookings happening through PhonePe**

- **Make hotel bookings within the PhonePe app**
- **Users can use goCash on the PhonePe platform**
Innovation examples (3/4) - Made for India POS device

- **Launched in Nov 2017**
  First of its kind innovation basis merchant insights

- **World’s cheapest POS ($10)**
  All payment methods supported, no data requirement from merchant side

- **First 5,000 POS distributed in 3 weeks**
  Initial launch of devices has been well received – plan to deploy 1 Mil devices across top 60 cities

- **Won NPCI RFP for proximity**
Innovation examples (4/4) – Gold marketplace

- First to offer a marketplace model
- Market leader with 60% share
- More than 1 Tonne worth of gold transactions
Data Center Trends

**STORAGE**
- Massive, Fast Data
- Domain Specific Compute Solutions
- Computational Storage
- SmartNICs
- GPUs
- End of Moore's Law

**NETWORKING**
- ETHERNET SPEEDS
- 10 → 40 → 100Gb+

**COMPUTE**
- # transistors per $ (2002-2015)
- End of Moore's Law
What Is Computational Storage?

Traditional Infrastructure

- PCIe increases storage I/O 6X+ vs. SAS/SATA
- All data moves to host for processing
- Host CPU / memory bottlenecks
- No compute parallelism
- Data-driven application performance challenges

Computational Storage

- Balanced compute resource & storage I/O
- Minimize data movement
- Multiple FPGAs, easily plug-in via storage
- Maximum compute parallelism
- Fits into existing, standard PCIe Storage slots
- Standardization (in process) for easy app integration

A New Paradigm to Scale Compute Resources with Storage Capacity
Parallelizing Workloads With Computational Storage

**GZIP Compression**

(Raw Performance CPU zlib vs. CS zlib, corpus.cantebury files, E5-2667v4)

GZIP uses Huffman Encoding which is inefficient on x86

- CPU Bound!
- 17X
- 6X

**Fuzzy Text Search (POC)**

(CPU vs. CSD agrep, Unindexed Text Data, Edit Distance = 8, E5-2637v3)

agrep = approximate grep which is inefficient on x86 with high edit distance

- CPU Bound!
- ~700MB/s
- 100X

Cohesively Unlock Compute & Storage I/O Bottlenecks
Ideal Targets:

- Fixed algorithms
- Bit-wise data comparison/manipulation (slow on x86)
- Compute required across the entire storage data set

**Evolutionary** integration through Flash storage (standard hardware)

**Revolutionary** impact through parallelization of workloads
Common Computational Storage Benefits:

- PCIe slot consolidation (Compute + Flash)
- Easily parallelize computation across multiple CSDs
- Same hardware can be used regardless of model
- Multiple models can be utilized simultaneously

Accelerator + Flash
Data Starts in Host DRAM

- Examples: GZIP, EC (RS), AES, SHA, transcoding...

Data Path Processing
Data Starts in Host DRAM (on Write) or CSD (on Read)

- Examples: in-line GZIP, AES, SHA, transcoding, AI inference
- Compute while data write to CSD or read from CSD

In-Storage Processing
Data Starts in CSD

- Examples: Database queries, fuzzy search, pattern matching...
- Compute locally on each CSD, return only return results back to CPU
- Save massive data movement
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*Applies to HDFS Spark*
Push down DB queries (compute intensive) to Computational Storage through MyRocks

Up to 71% latency reduction in query time vs. using Host x86 for queries
Definition of product types:
- CSD = Computational Storage Drive
- CSP = Computational Storage Processor
- CSA = Computational Storage Array

Management: Discovery, Security

Operation on data types: LBA (Logical Block Address), KV (Key-Value), File, Object, Persistent Memory
Computational Storage easily fits into existing PCIe SSD storage slots
Delivers immediate application level benefits with simple integration
Save expensive data movement and optimize server compute & memory resources
Industry-wide effort to standardize integration amongst multiple vendors
Thank You

**Shameless plug:** We are hiring, if you are passionate about solving large scale problems, love opensource and working with cool people, please reach out to us!