The state of Spark in the cloud

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Outline

1. Intro
    1. PaaS Cloud
    2. BigBench
2. Part I – Scalability
    1. Hive vs. Spark
3. Part II – Additional experiments
    1. Versions, Concurrency, 10TB
4. Summary

Motivation

- 2016 **SQL-on-Hadoop paper** and presentations
  - Focused on Hive, due to **SparkSQL** not being ready to use in PaaS
  - Used benchmark (TPC-H)

- Early 2017, **BigBench** testing Hive and Spark and TPC-TC paper
  - New code available in May for MLlib2 compatibility

- **Goals:**

Evaluate the current out-of-the-box experience of Spark v2 in PaaS cloud

  - Using Hive as baseline

Platform-as-a-Service Spark

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- Simplified management
- Cloud-based managed Hadoop services
  - Ready to use Spark, Hive, …
- Deploys in minutes, on-demand, elastic
- *Pay-as-you-go* pricing model
- Decoupled compute and storage
- Optimized for general purpose
  - Fined tuned to the cloud provider architecture

Surveyed PaaS services

- Amazon Elastic Map Reduce (EMR)
  - **Released:** Apr 2009
  - **OS:** Amazon Linux AMI (RHEL-like)
  - **Spark 2.1.0 and Hive 2.1 (Tez)**
  - **VM: M4.2xlarge (32GB RAM)**

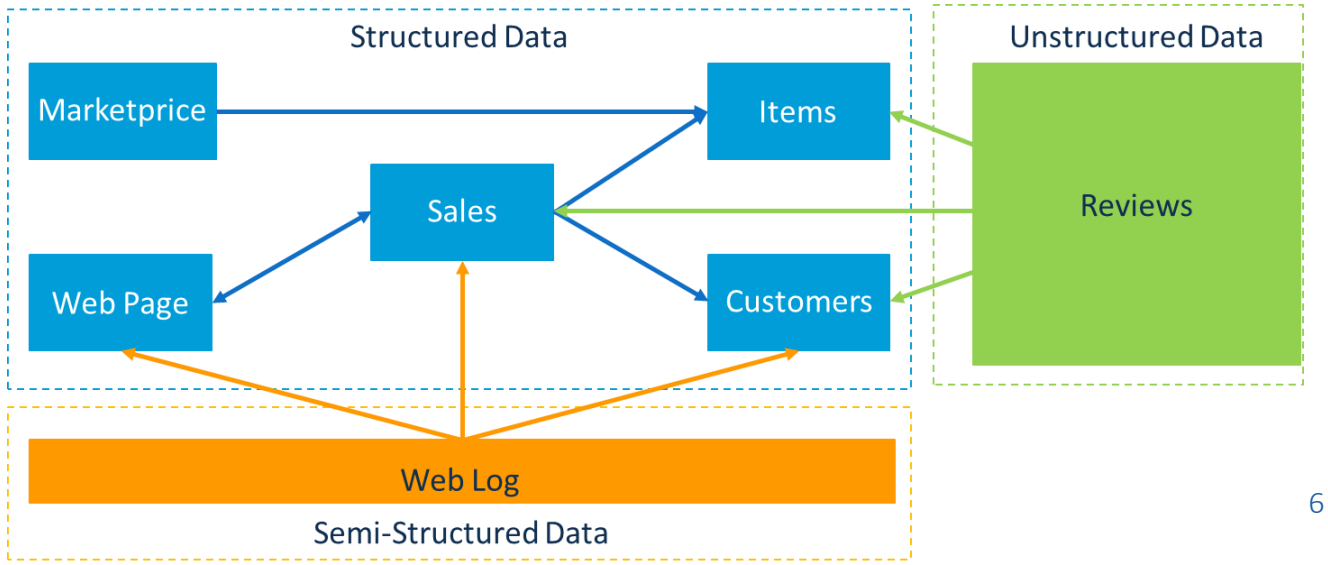
- Google Cloud DataProc (GCD)
  - **Released:** Feb 2016
  - **OS:** Debian 8.4
  - **Spark 2.1.0 (preview),** Hive 2.1 (M/R)
  - **VM: n1-standard-8 (30GB RAM)**

- Azure HDInsight (HDI)
  - **Released:** Oct 2013
  - **OS:** Ubuntu 16.04 (HDP-based)
  - **Spark 2.1.0 and 1.6.3, Hive 1.2 (Tez)**
  - **VM: D4v2 (28GB RAM)**

- Target deployment **128-cores**:
  - **16** data nodes with 8-cores each
  - Master node with 16-cores
  - Decoupled storage only
    - EBS, WASB, GCS

What is **BigBench** (TPCx-BB)

- End-to-end application level benchmark specification
  - result of many years of collaboration of industry and academia
- Covers most Big Data Analytical properties (3Vs)
- 30 business use cases for a retailer company
  - Merchandizing,
  - pricing,
  - customers …
- Defines data scale factors
  - 1GB to PBs



```
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /___/ .__/\_,_/_/ /_/\_\   version 2.1.0
      /_/
```

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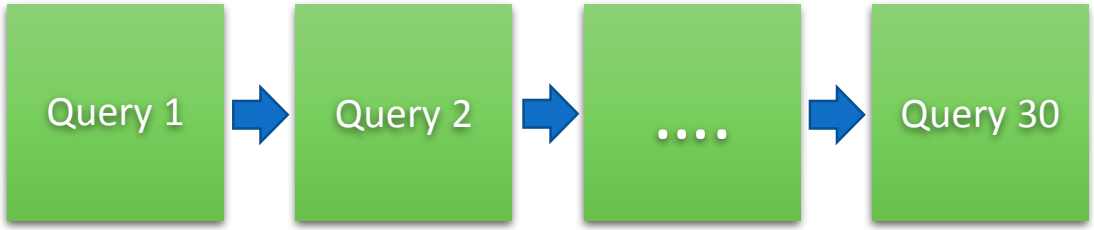
Sequential Hive vs Spark 2.1

Queries 1-30 on Spark 2.1 (power runs)



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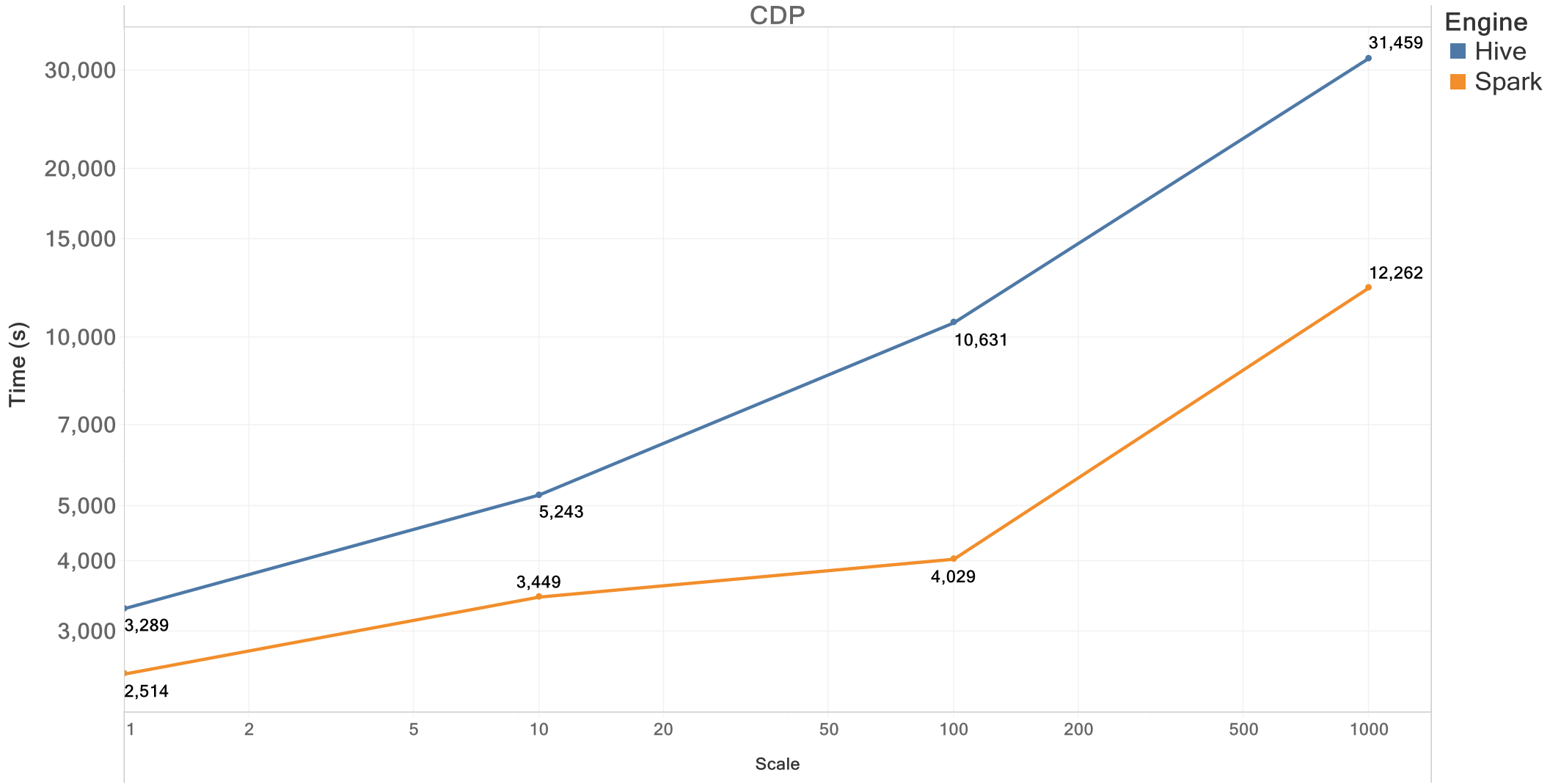
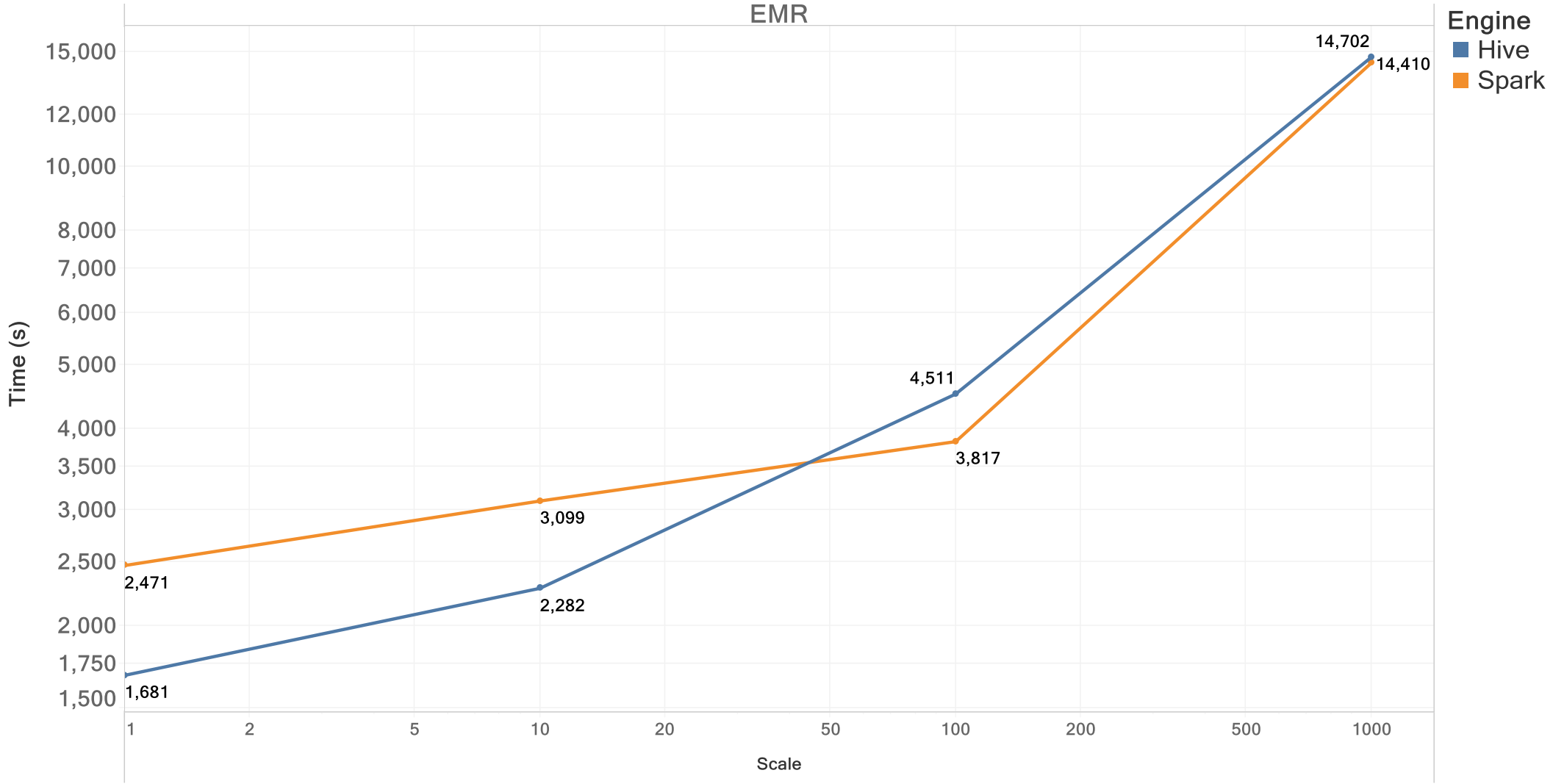
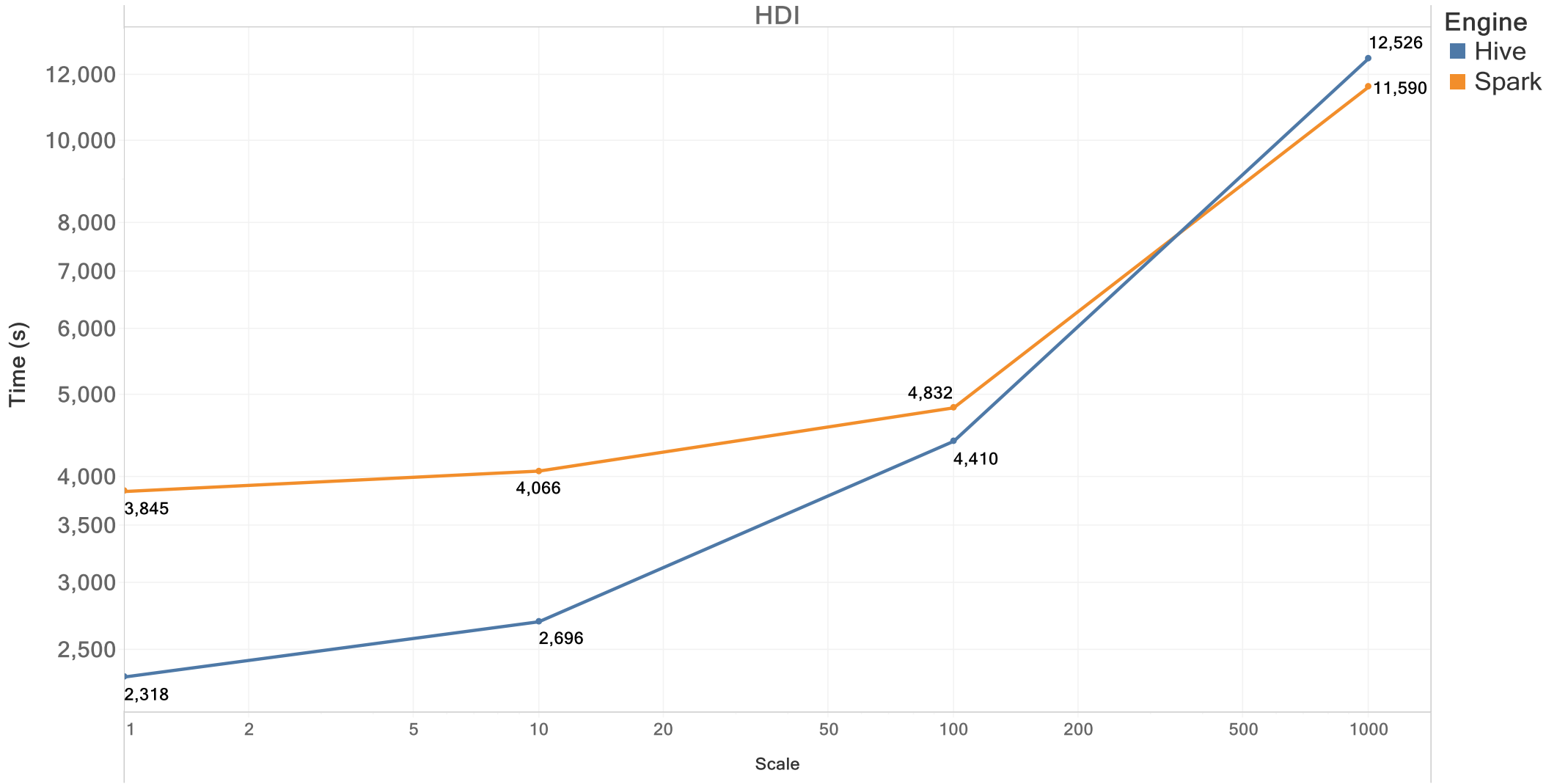
BB 1GB-1TB Scalability Dataproc: Hive 2.1 (M/R) vs Spark 2.1



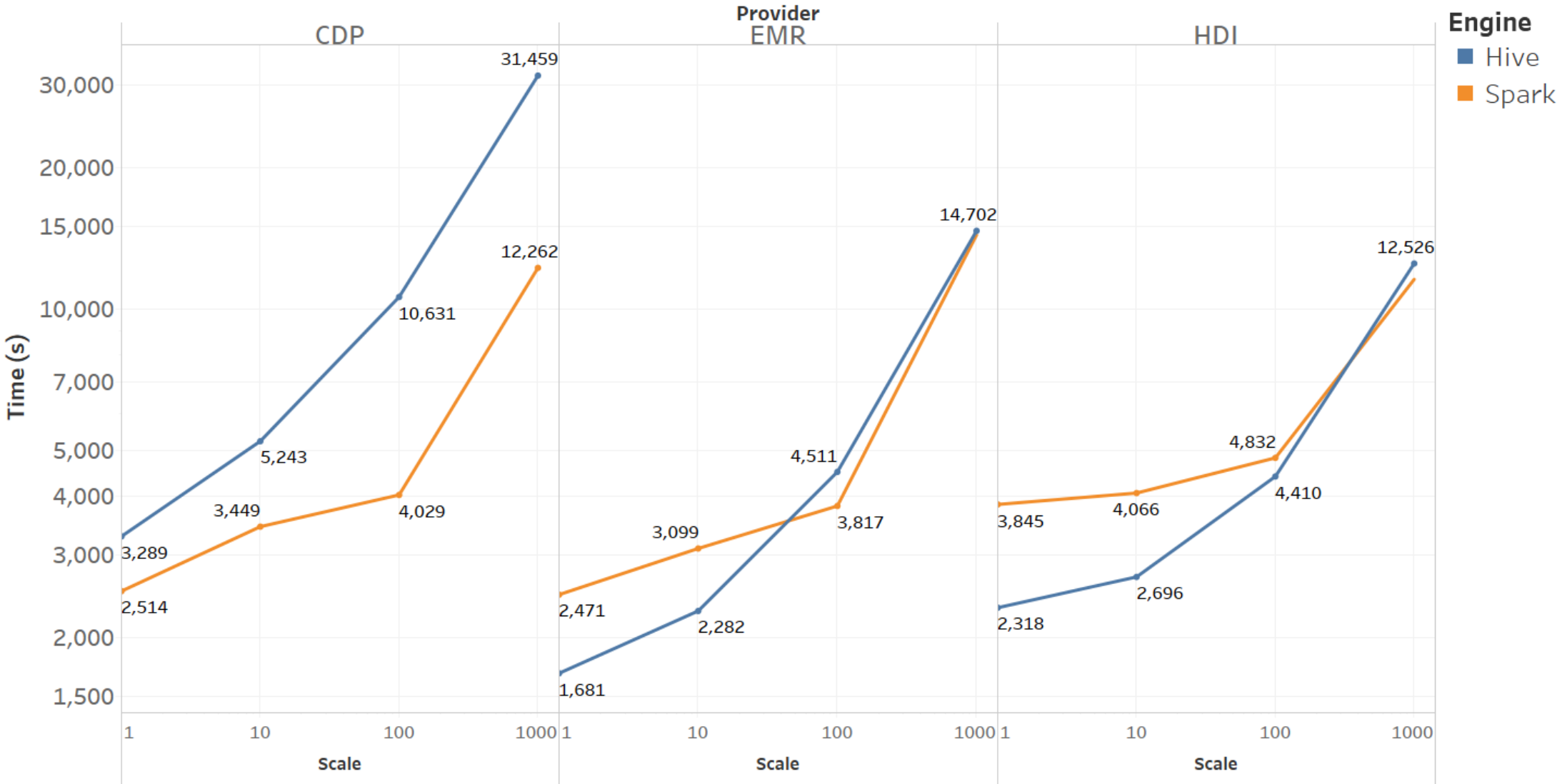
BB 1GB-1TB Scalability EMR: Hive 2.1 (Tez) vs Spark 2.1



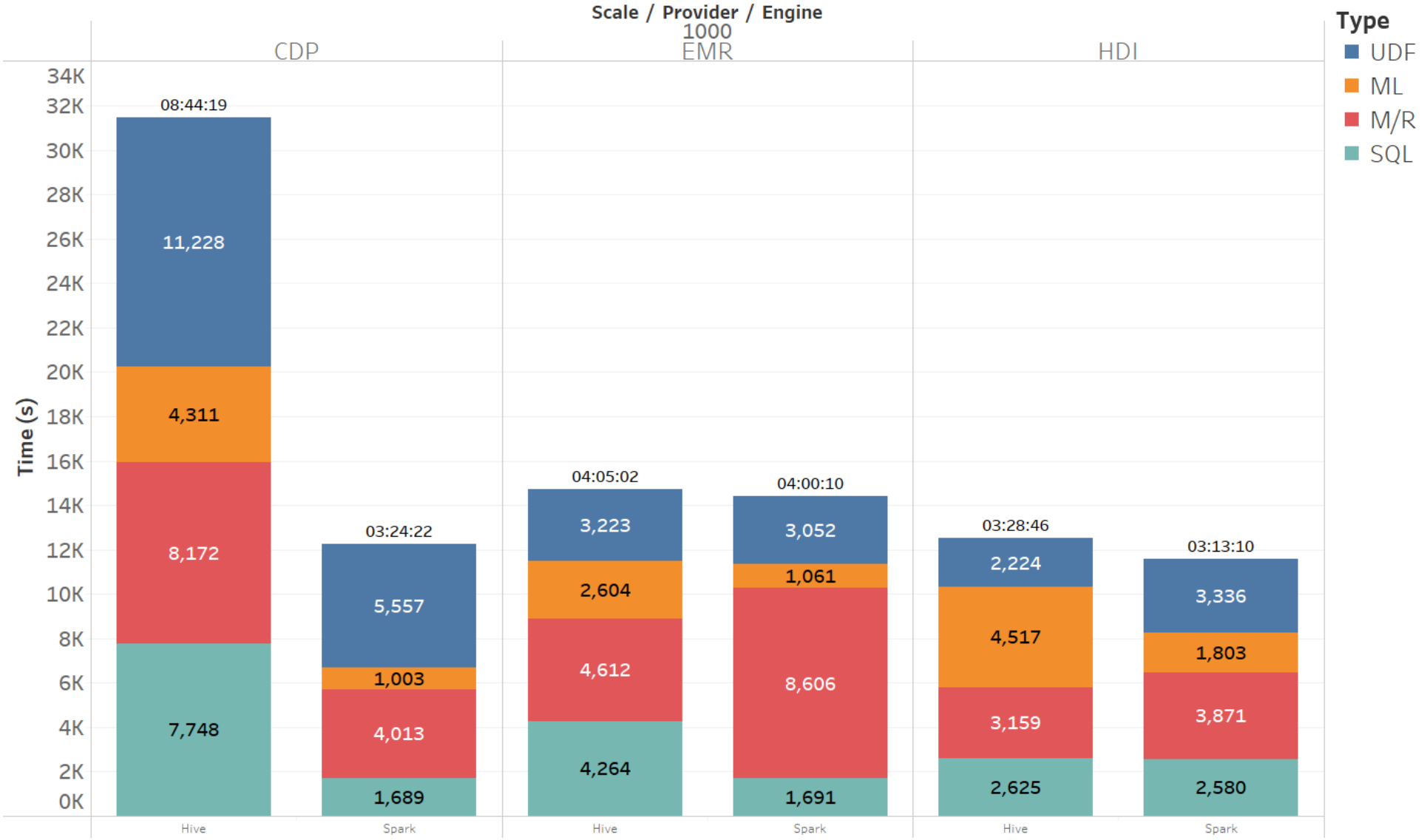
BB 1GB-1TB Scalability HDI: Hive 1.2 (Tez) vs Spark 2.1



BB 1GB-1TB Scalability: Hive vs Spark 2.1
All providers

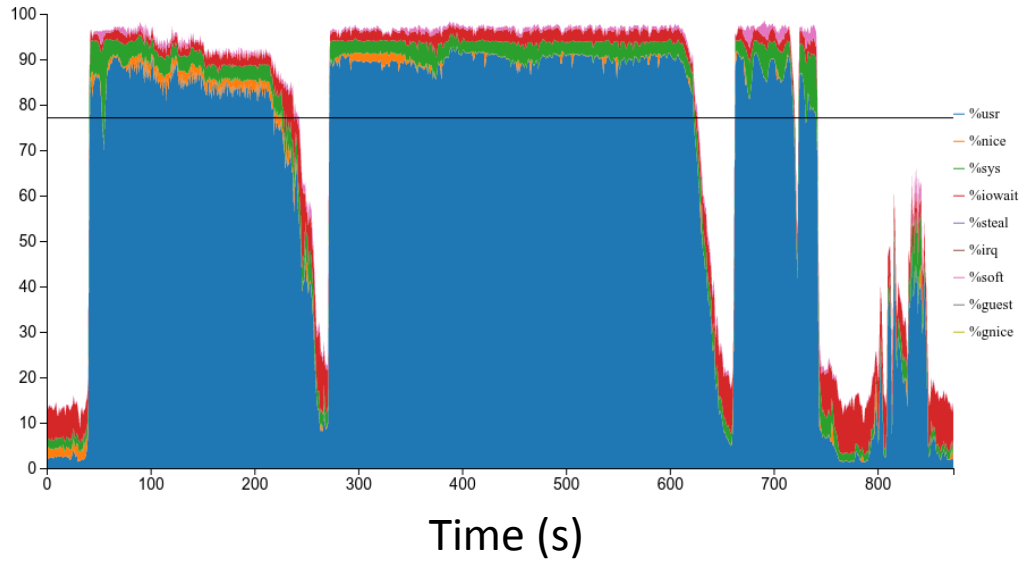


BB 1TB Power runs : Hive vs Spark 2.1 (ALL)



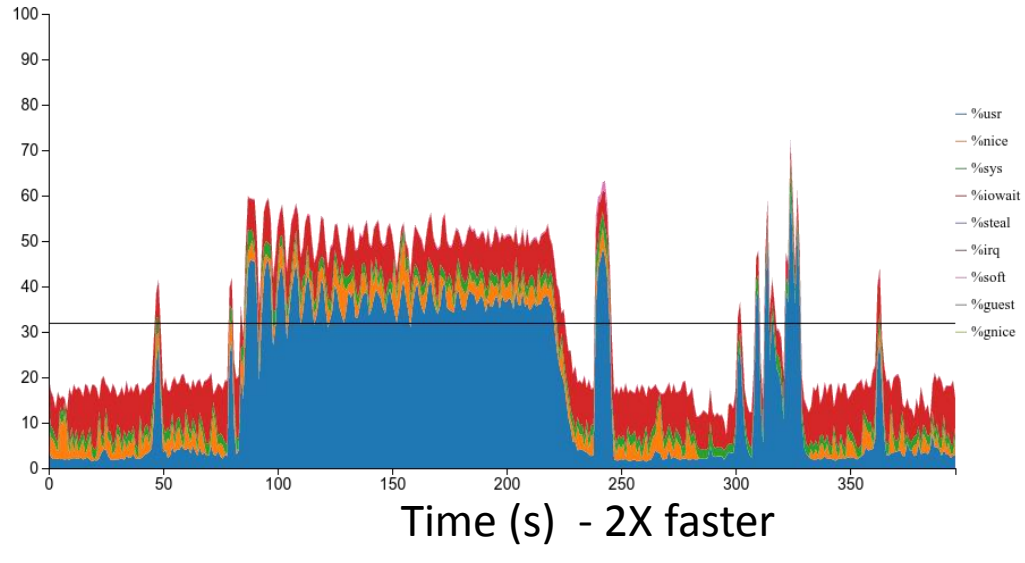
CPU % Q5 (ML) in Hive and Spark (HDI)

- Hive (MLlib2)



Time (s)

- Spark (MLlib2)

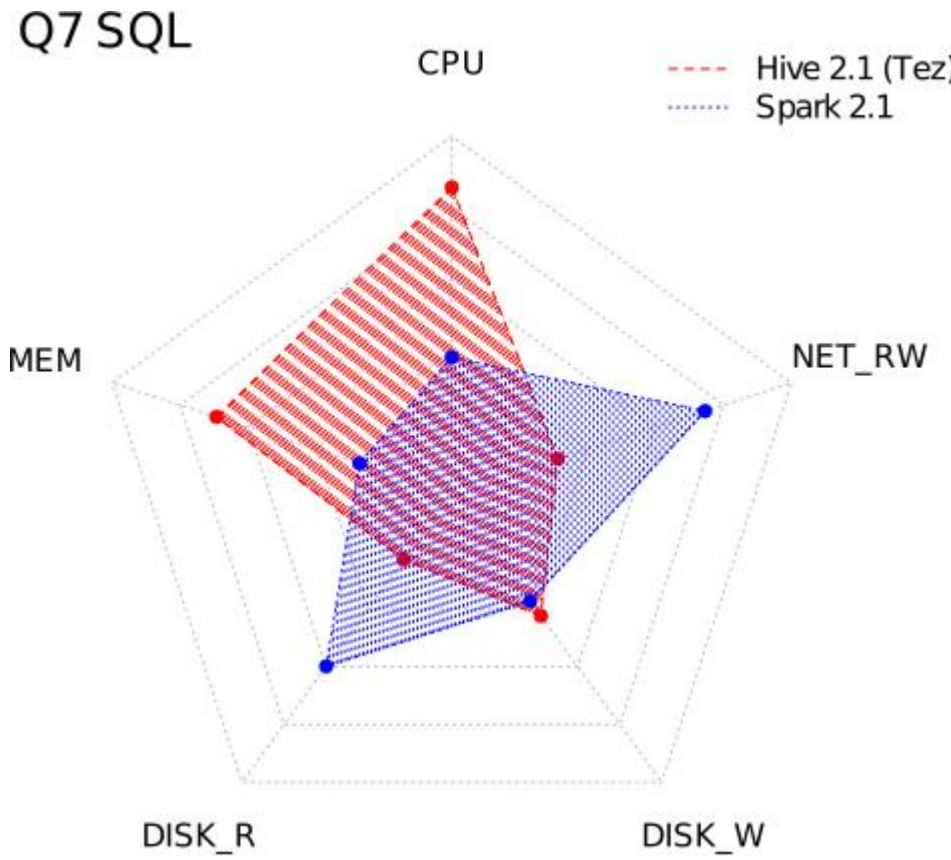


Time (s) - 2X faster

%usr %nice %sys %iowait %soft

Radar charts – query characterization

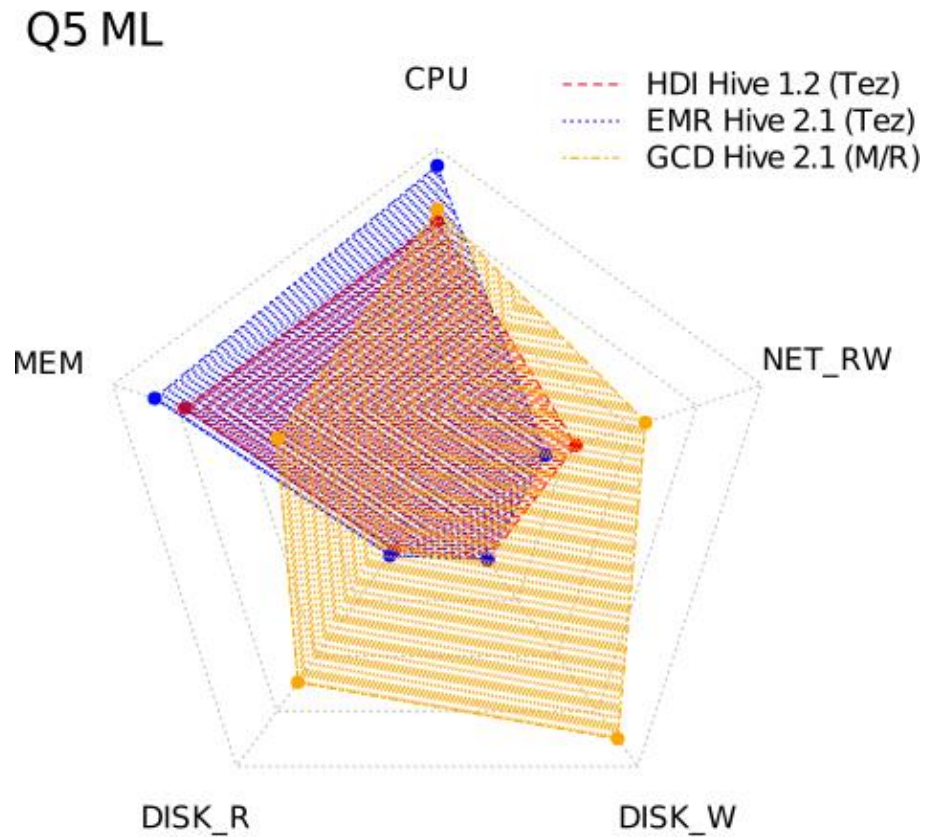
- Useful for **displaying multivariate** data (5 resources)
- Quickly identify similarities and differences.
- From example
  - Hive and Spark
  - Only Disk Write is similar
  - Hive consumes more MEM and CPU
  - Spark read more from disk (DISK_R)
    - And moderately more network



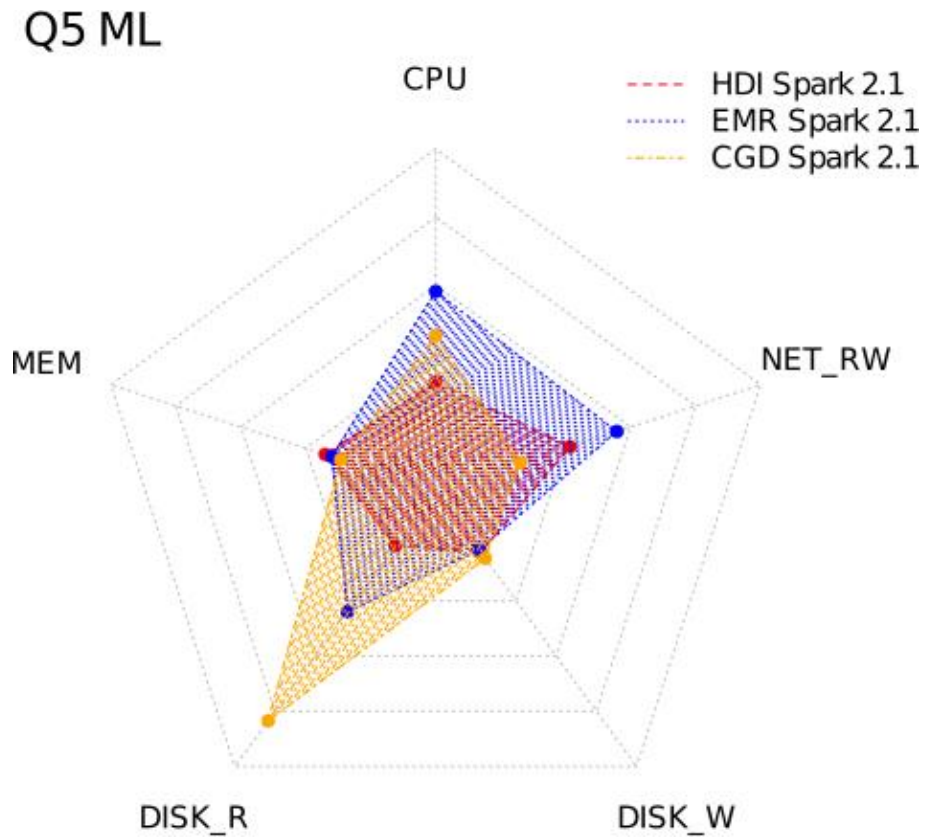
Sample radar chart for Q7 in EMR at 1TB

BB 1TB Query 5 (ML) providers comparison

Hive (MLlib2)



Spark (MLlib2)



Other comparisons:

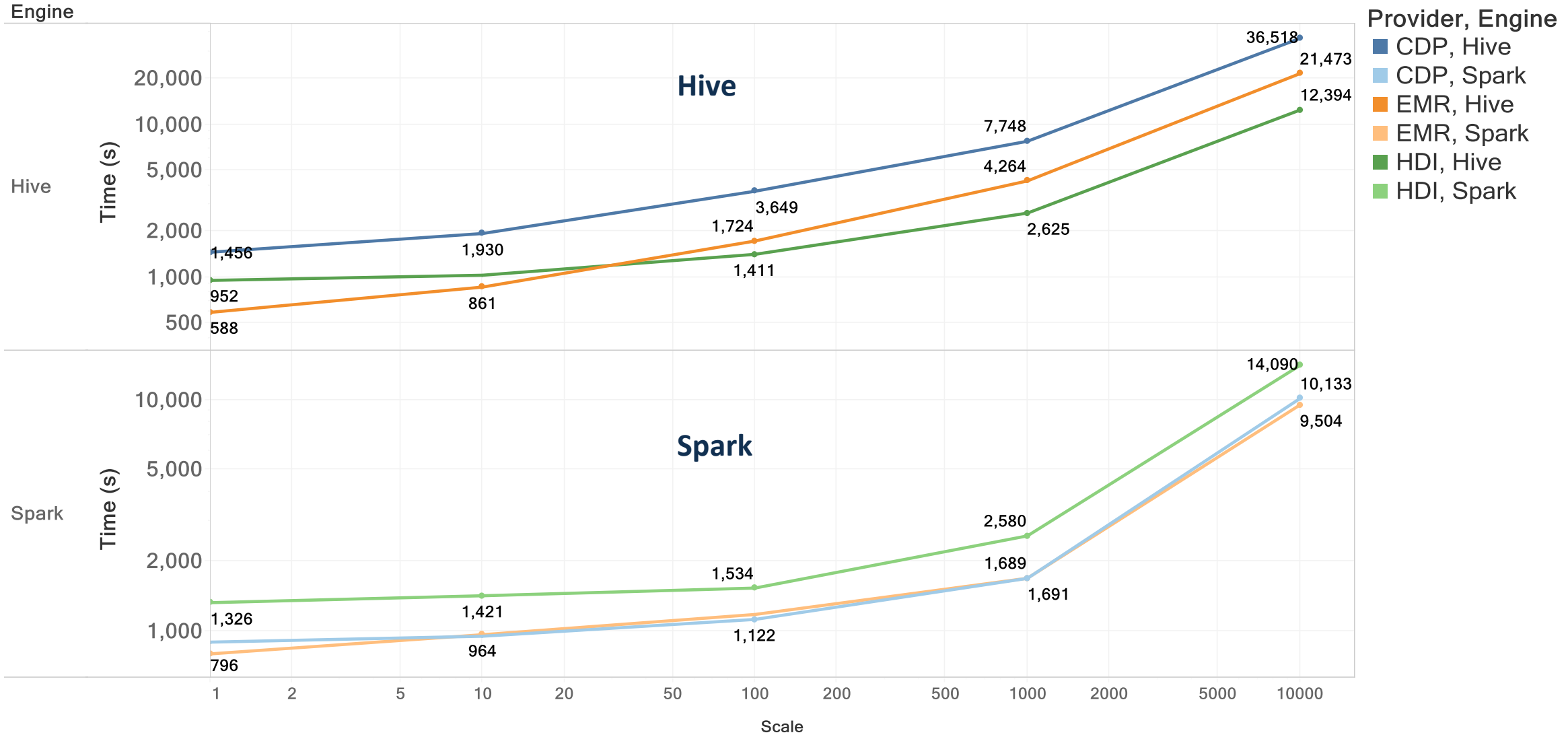
10TB SQL-Only

2.0.2 vs 2.1.0

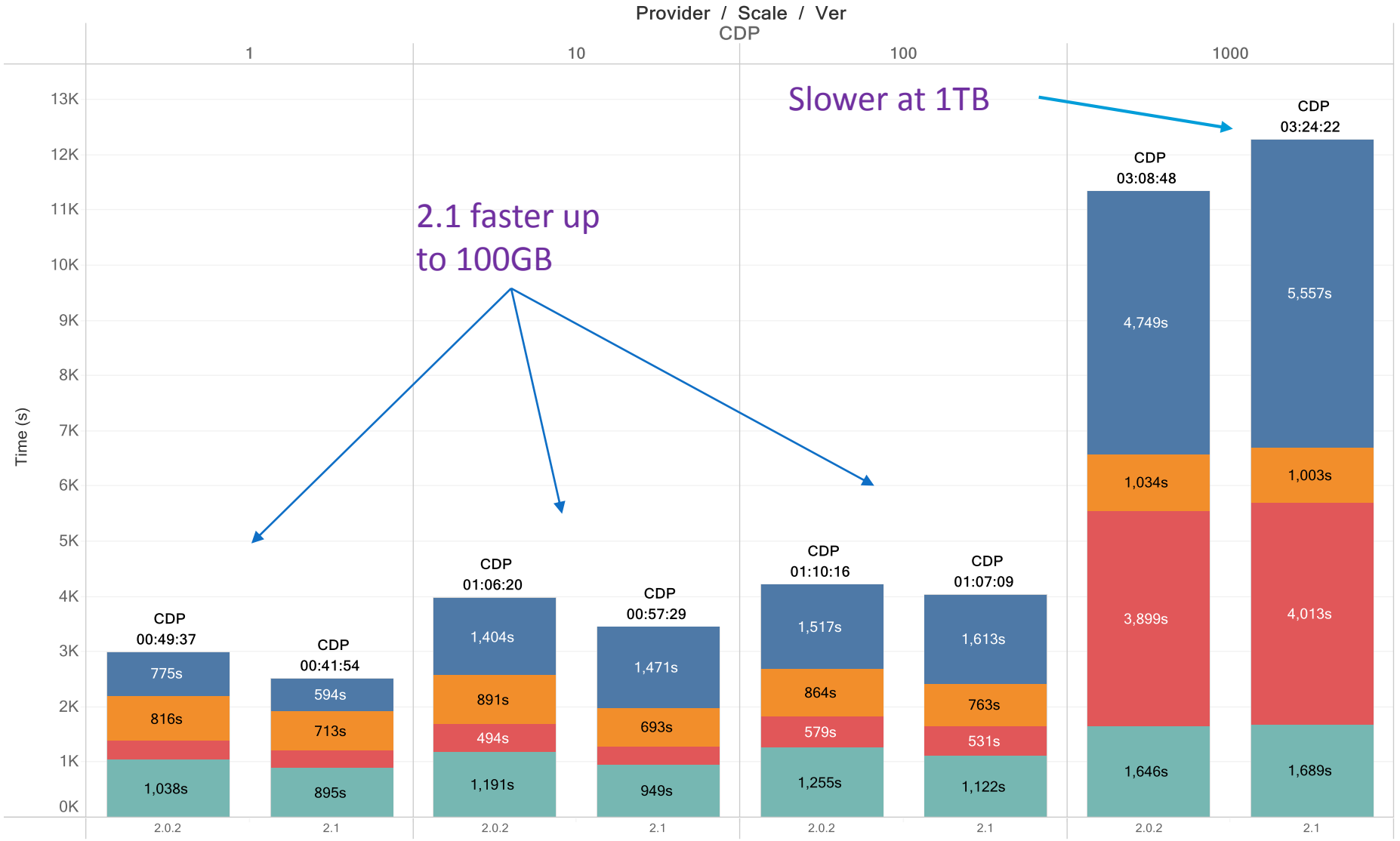
1.6.3 vs 2.1.0

MLlib v1 vs v2

BB 1GB-10TB Scalability SQL-only queries



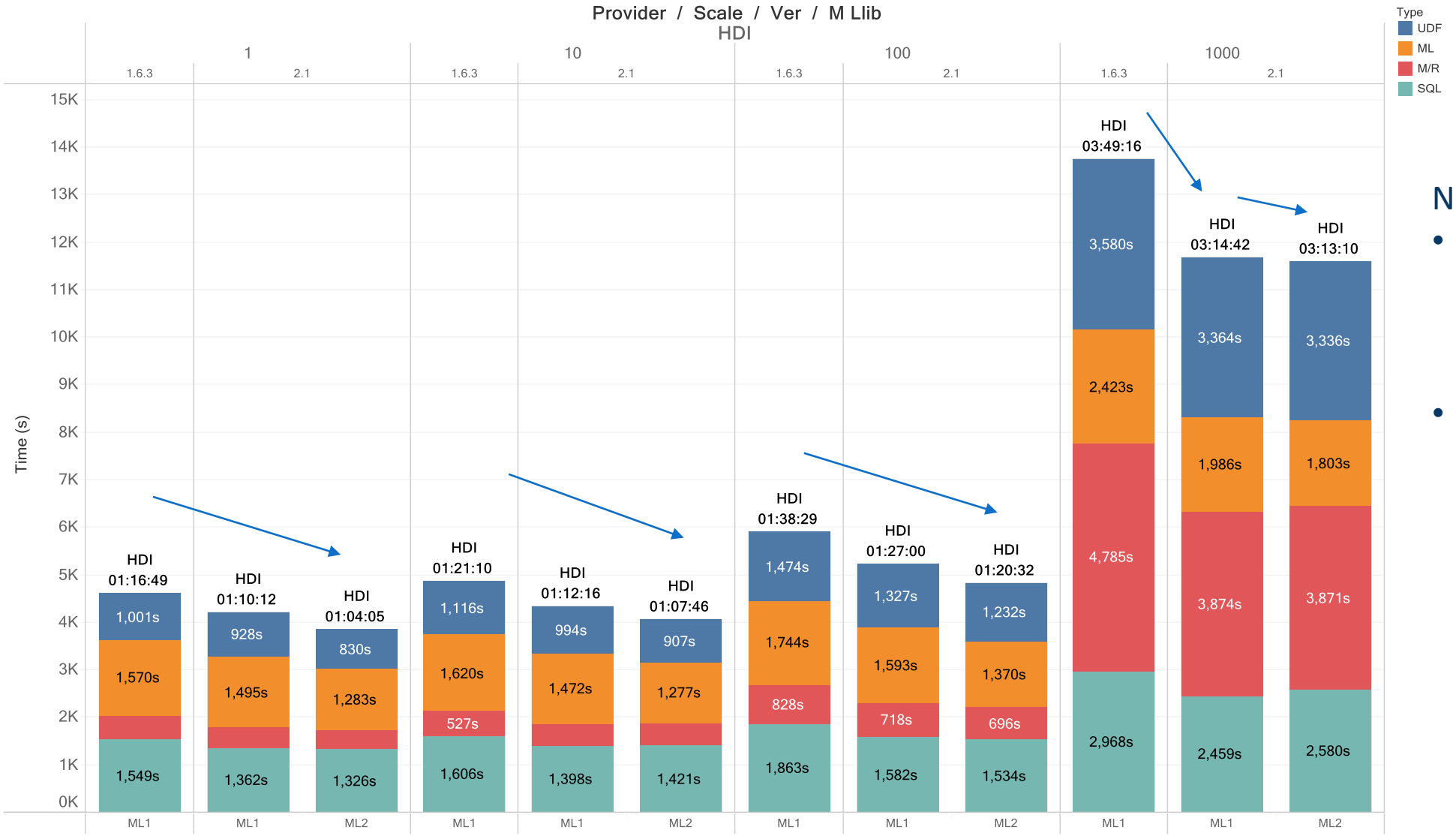
BigBench 1GB-1TB: Spark **2.0.2** vs **2.1.0** (CDP)



Notes:
Spark 2.1 a bit faster at small scales, slower at 100 GB and 1 TB on the UDF/NLP queries

BigBench 1GB-1TB: Spark 1.6.3 vs 2.1.0

MLlib 1 vs 2.1 MLlib 2(HDI)

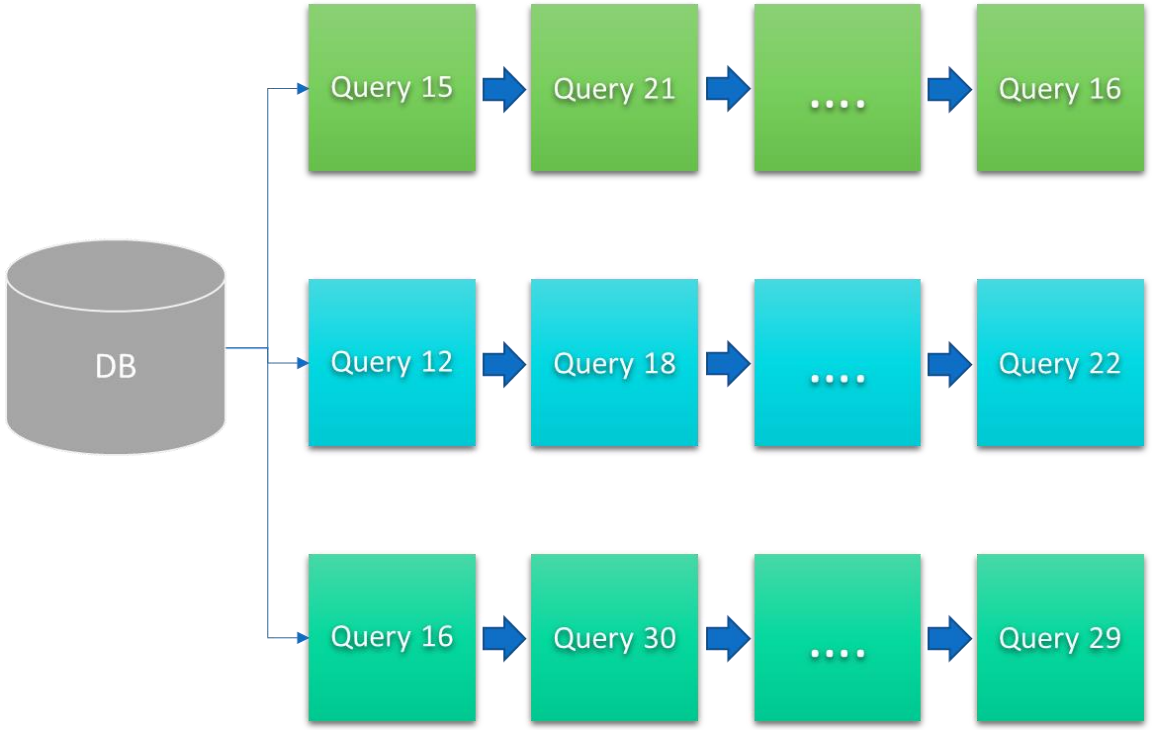


Notes:

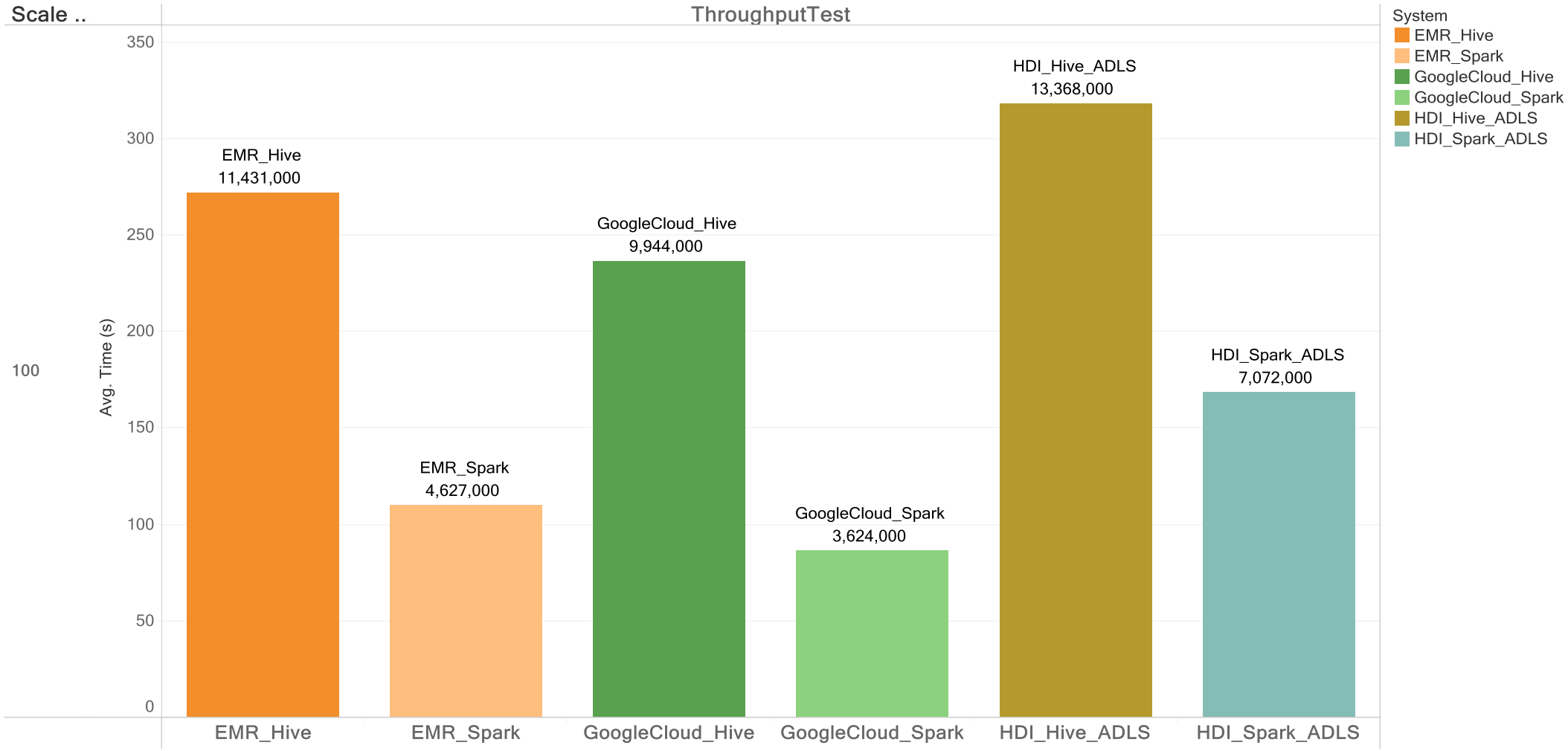
- Spark 2.1 is always faster than 1.6.3 in HDI
- MLlilb 2 using dataframes over RDDs is only slightly faster than V1.

Concurrency runs (throughput)

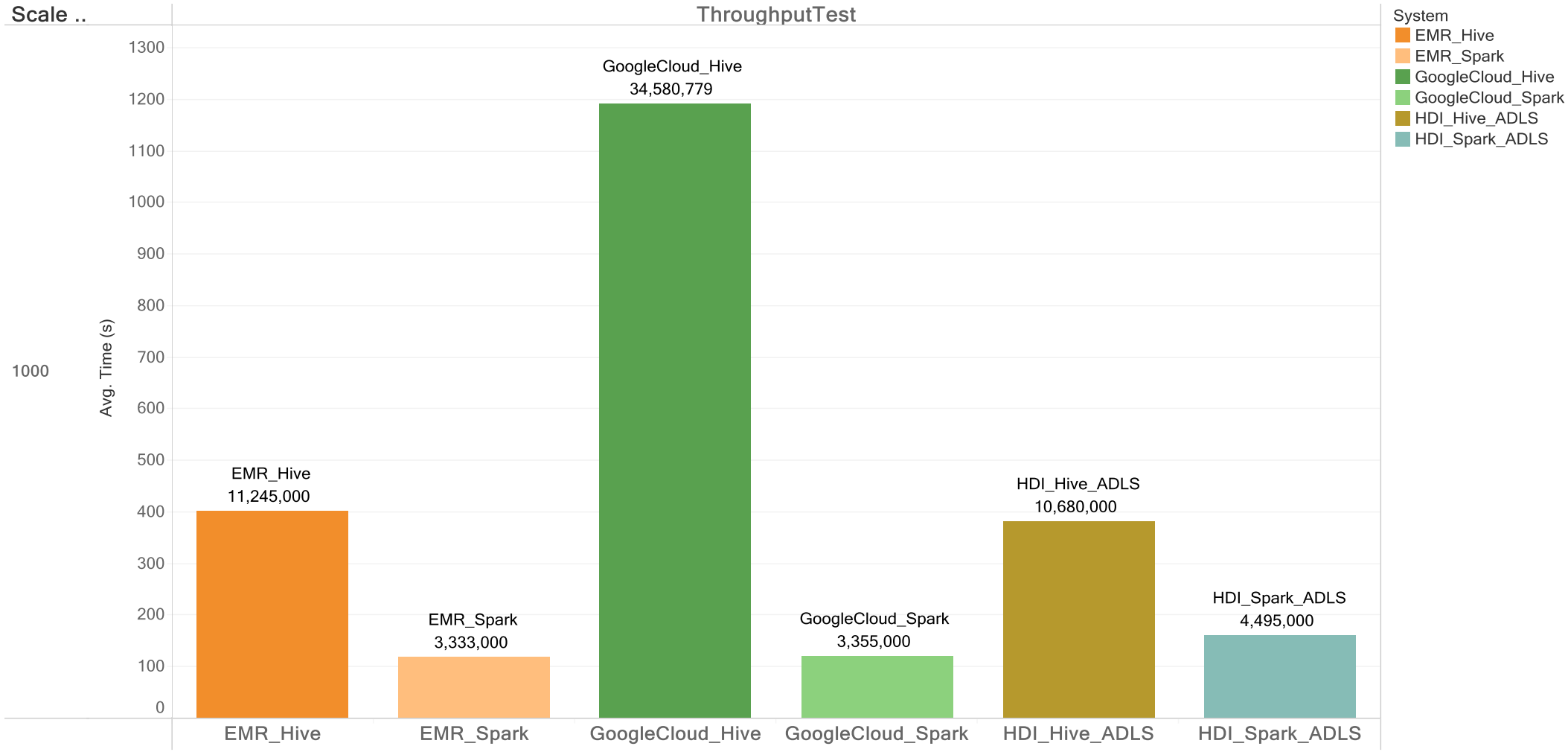
SQL-only: 100GB – 1TB 512-core cluster



BB Throughput at 100GB 8 streams SQL-only (512-cores)



BB Throughput at 1TB 4 streams SQL-only (512-cores)



Conclusions

- All providers have up to date (2.1.0) and well tuned versions of Spark
  - They could run BigBench up to 1TB on medium-sized cluster,
    - [Almost] Out-of-the box
- Performance similar among providers for similar cluster types and disk configs
  - Difference according to scale (and pricing)
- Spark 2.1.0 is faster than previous versions
  - Also MLlib 2 with dataframes
  - But improvements within the 30% range
- Hive (+Tez + MLlib) are still slightly faster than Spark at lower scales for sequential
- But Spark significantly faster at high data scales and concurrency
- BigBench has been useful to stress a cluster with different workloads
  - Highlights config problems fast and stresses scale limits
  - Helpful for tuning the clusters

Resources and references

BigBench and ALOJA

- **BigBench Spark 2 branch** *(thanks Christoph and Michael from bankmark.de)*:
  - https://github.com/carabolic/Big-Data-Benchmark-for-Big-Bench/tree/spark2
- Original BigBench Implementation repository
  - https://github.com/intel-hadoop/Big-Data-Benchmark-for-Big-Bench
- ALOJA benchmarking platform
  - https://github.com/Aloja/aloja
  - ALOJA fork of BigBench (adds support for HDI and fixes spark)
    - https://github.com/Aloja/Big-Data-Benchmark-for-Big-Bench

Papers and slides

- https://www.slideshare.net/ni_po
- Characterizing TPCx-BB Queries, Hive, and Spark in Multi-Cloud Environments – N. Poggi et. Al
  - TPC-TC 2017
- The State of SQL-on-Hadoop in the Cloud – N. Poggi et. al.
  - IEEE Big Data 2016
  - https://doi.org/10.1109/BigData.2016.7840751

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Thanks, questions?

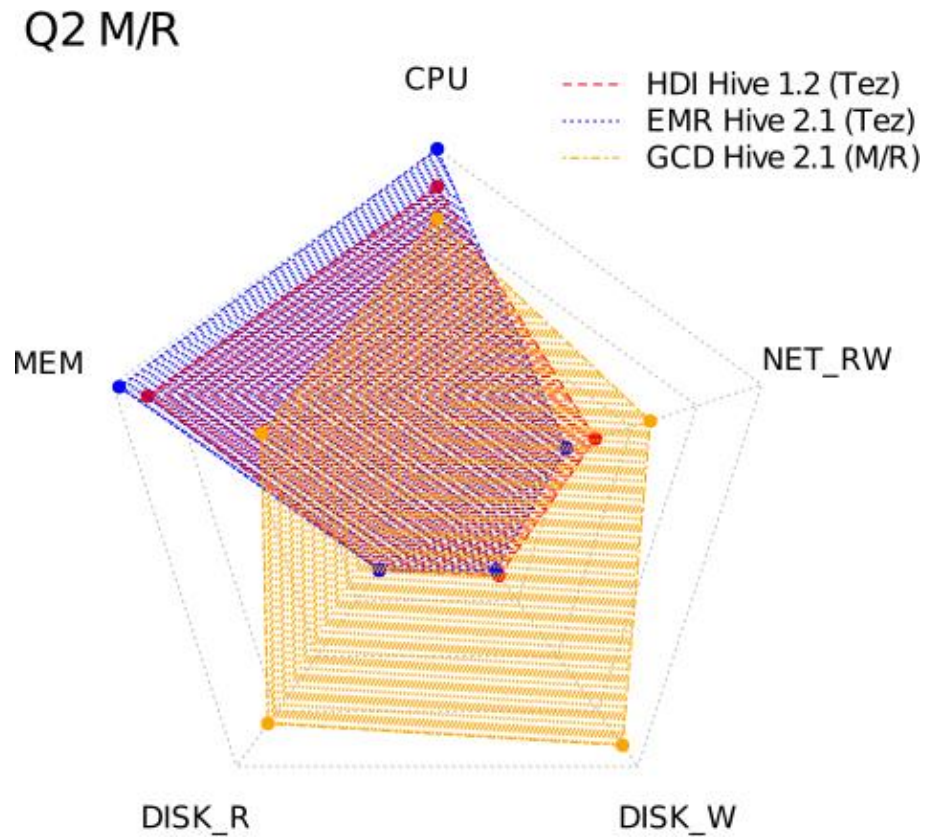
Follow up / feedback : Npoggi@ac.upc.edu

Twitter: ni_po

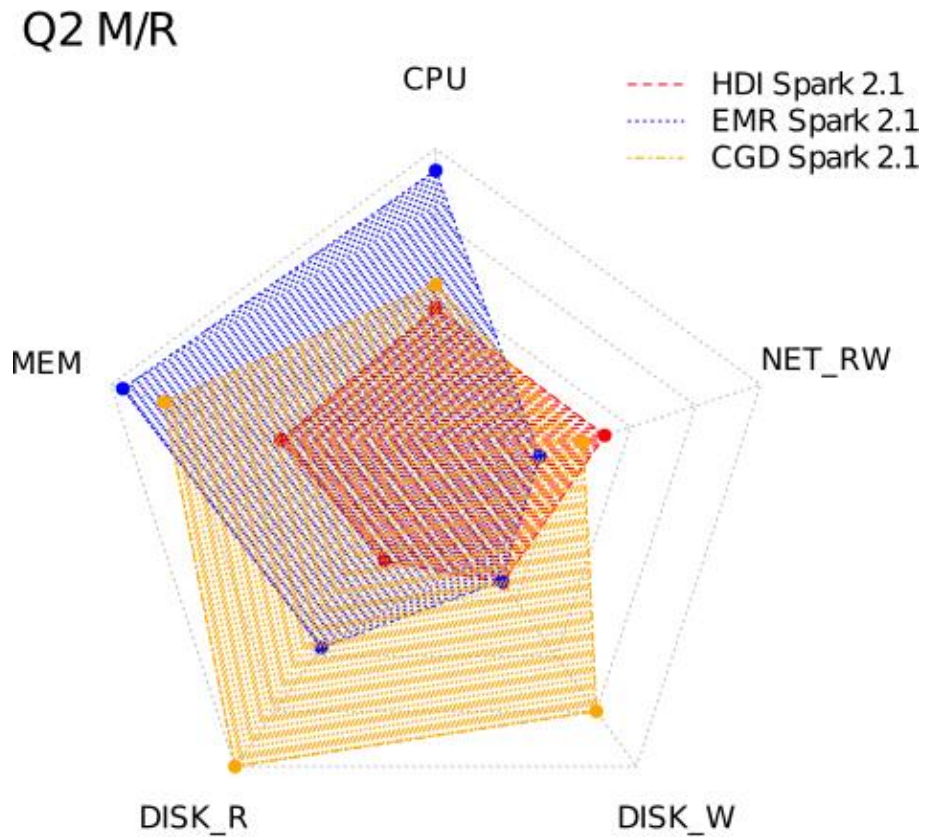
Extra slides

BB 1TB Query 2 (M/R) providers comparison

Hive



Spark



Spark config

	EMR	CDP	HDI
Java version	OpenJDK 1.8.0_121	OpenJDK 1.8.0_121	OpenJDK 1.8.0_131
Spark version	2.1.0	2.1	2.1.0.2.6.0.2-76
Driver memory	5G	5G	5G
Executor memory	5G	**10G**	4G
Executor cores	4	4	**3**
Executor instances	**Dynamic**	**Dynamic**	20
dynamicAllocation enabled	TRUE	TRUE	FALSE
Executor memoryOverhead	Default (384MB)	1,117 MB	Default (384MB)