# Pilot-Streaming: Design Considerations for a Stream Processing Framework for High-Performance Computing

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RADICAL, Rutgers, http://radical.rutgers.edu

# Motivation

There is a need to couple data sources, HPC, analytics! 20+ applications identified at STREAM16

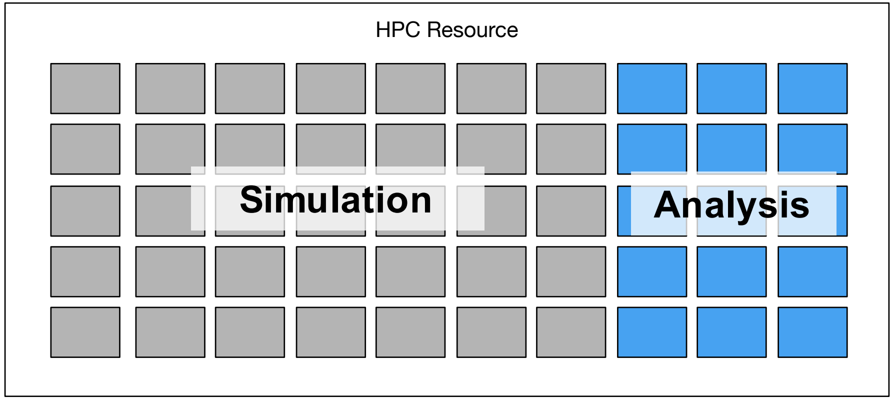
**Challenges:**

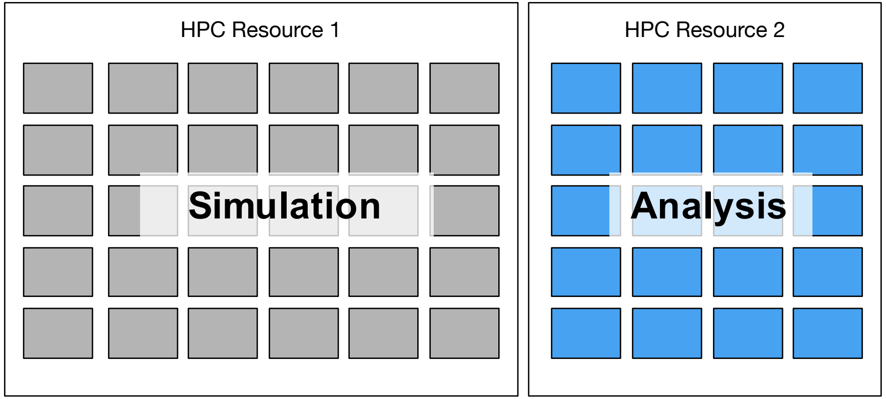
- Data applications and pipelines are **complex**
- **Scalability and Elasticity:** dynamic changes in resource demands
- **Scheduling and provisioning of resources:** right amount of resources at right time
- **Programming models:** HPC (MPI, OpenMP, GPU) vs. Big Data (Java, Python, R)
- **Interoperability:** Data sources sinks often in different environments (IoT, cloud, HPC, HPDC) than compute

**Current State:**

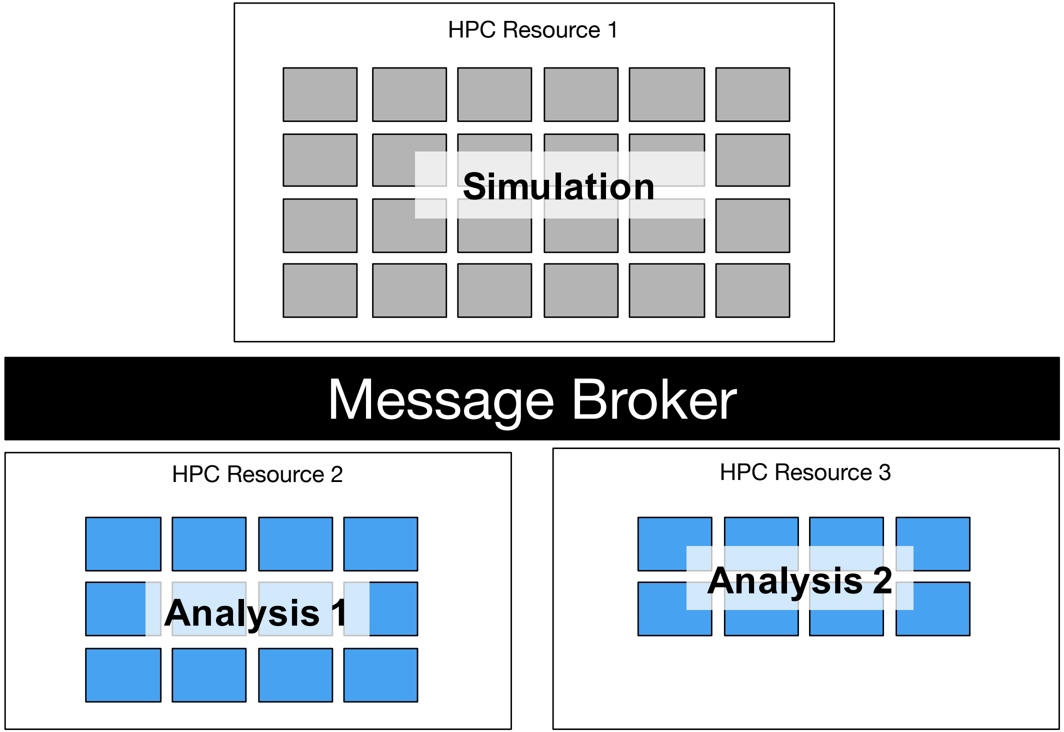
- Streaming (in sciences) often implemented on application-level (w/ limited re-use)
- Manifold landscape of streaming tools (Apache Open Source Tools, Cloud Tools)

# Workload Characteristics

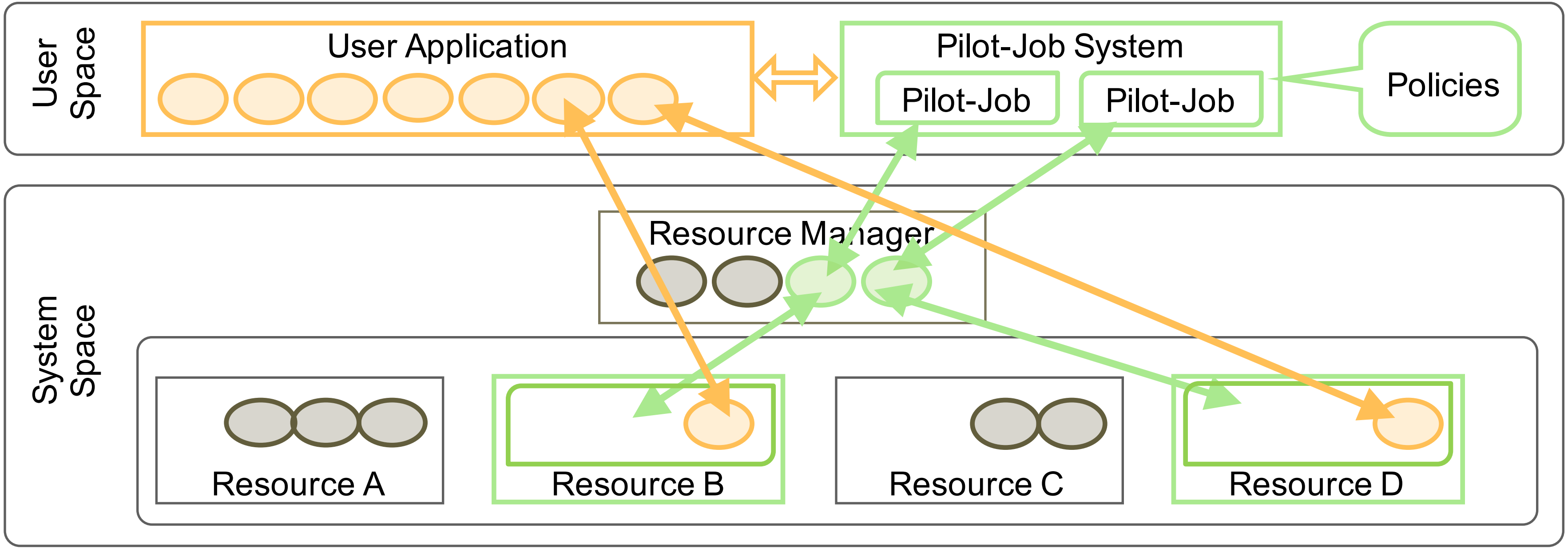




# Workload Characteristics

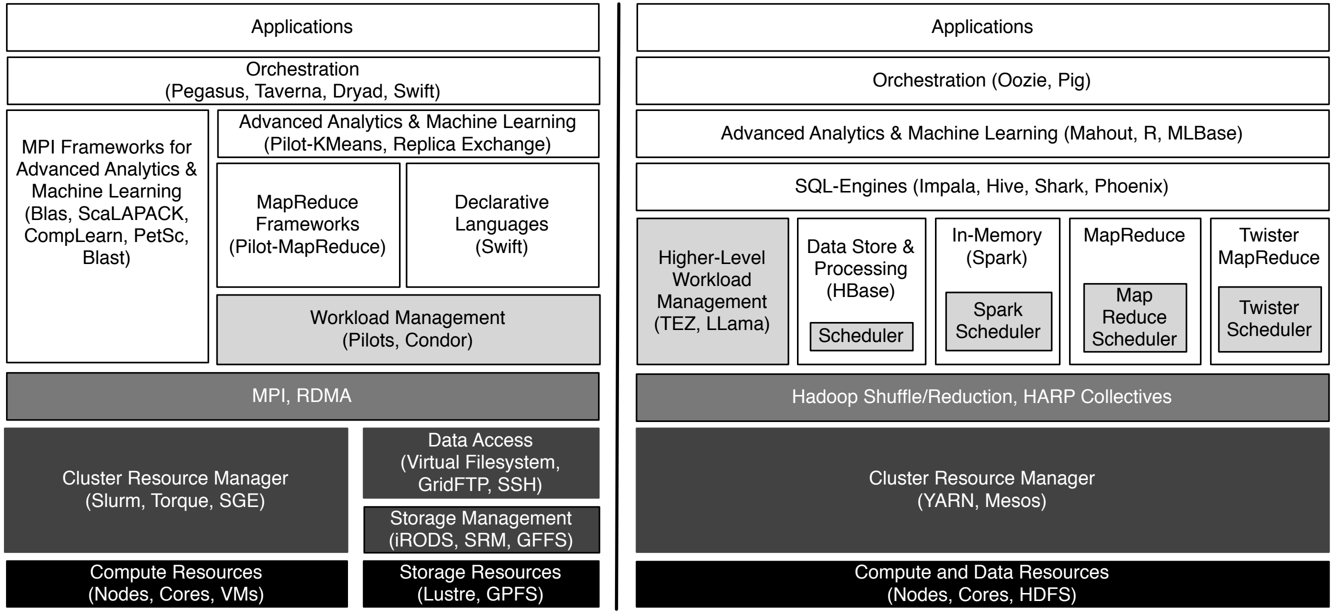


# Introduction Pilot Abstraction



http://arxiv.org/abs/1207.6644

# The Convergence of HPC and “Data Intensive” Computing



Applications

Orchestration (Pegasus, Taverna, Dryad, Swift)

MPI Frameworks for Advanced Analytics & Machine Learning (Blas, ScaLAPACK, CompLearn, PetSc, Blast)

Advanced Analytics & Machine Learning (Pilot-KMeans, Replica Exchange)

MapReduce Frameworks (Pilot-MapReduce)

Declarative Languages (Swift)

Workload Management (Pilots, Condor)

MPI, RDMA

Cluster Resource Manager (Slurm, Torque, SGE)

Data Access (Virtual Filesystem, GridFTP, SSH)

Storage Management (iRODS, SRM, GFFS)

Compute Resources (Nodes, Cores, VMs)

Storage Resources (Lustre, GPFS)

**High-Performance Computing**

Applications

Orchestration (Oozie, Pig)

Advanced Analytics & Machine Learning (Mahout, R, MLBase)

SQL-Engines (Impala, Hive, Shark, Phoenix)

Higher-Level Workload Management (TEZ, LLama)

Data Store & Processing (HBase)

Scheduler

In-Memory (Spark)

Spark Scheduler

MapReduce

Map Reduce Scheduler

Twister MapReduce

Twister Scheduler

Hadoop Shuffle/Reduction, HARP Collectives

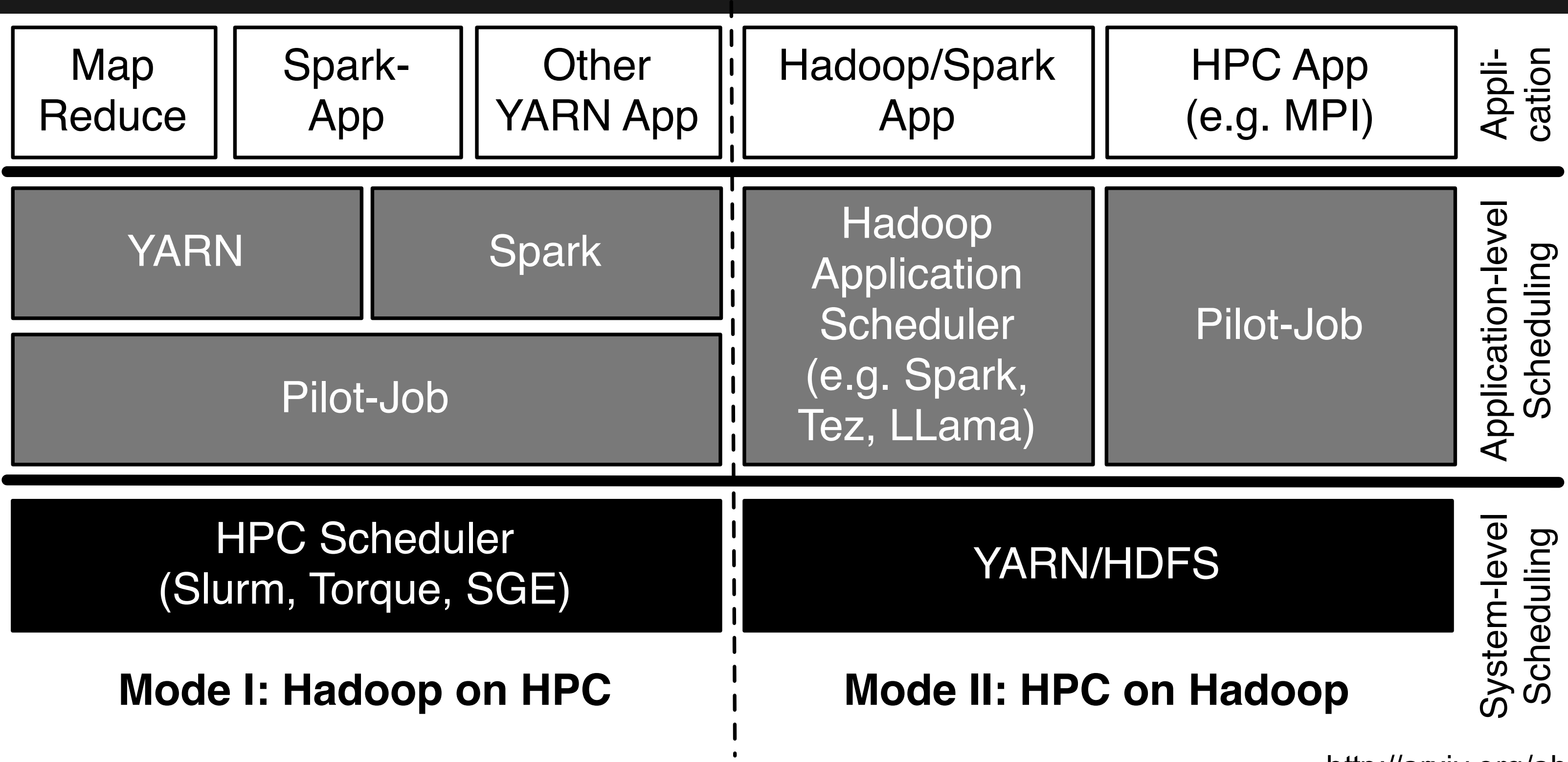
Cluster Resource Manager (YARN, Mesos)

Compute and Data Resources (Nodes, Cores, HDFS)

**Apache Hadoop Big Data**

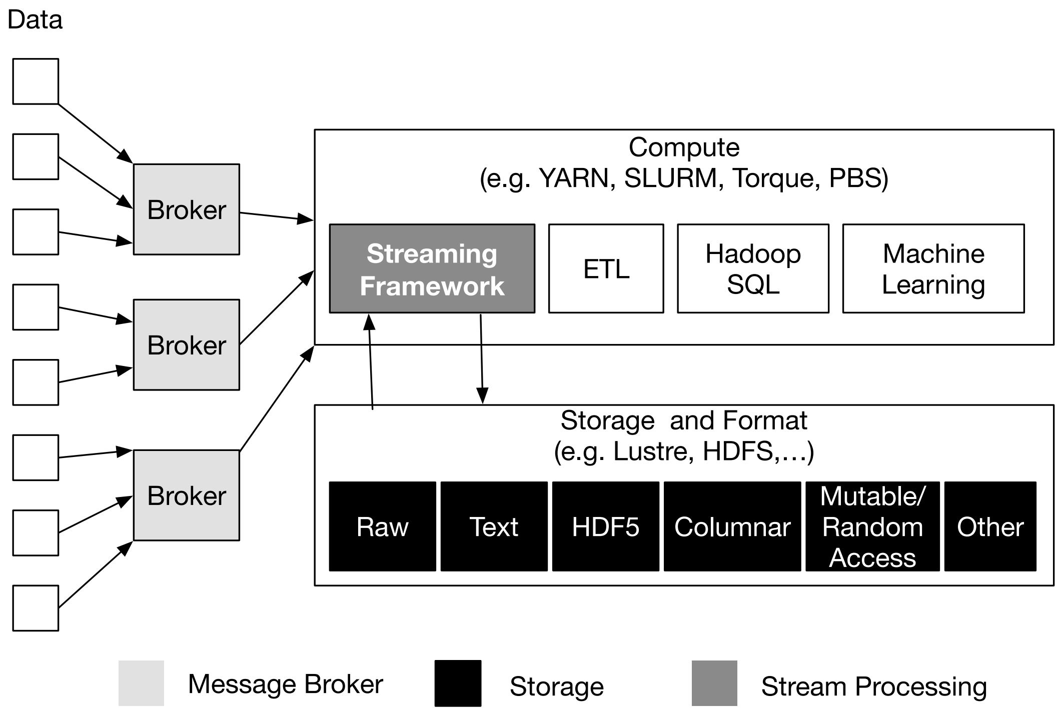
A Tale of Two Data-Intensive Paradigms: Data Intensive Applications, Abstractions and Architectures In collaboration with Geoffrey Fox (Indiana), http://arxiv.org/abs/1403.1528

# Pilot-Abstraction for HPC and Hadoop Interoperability



http://arxiv.org/abs/1602.00345

# Streaming and Batch Computing

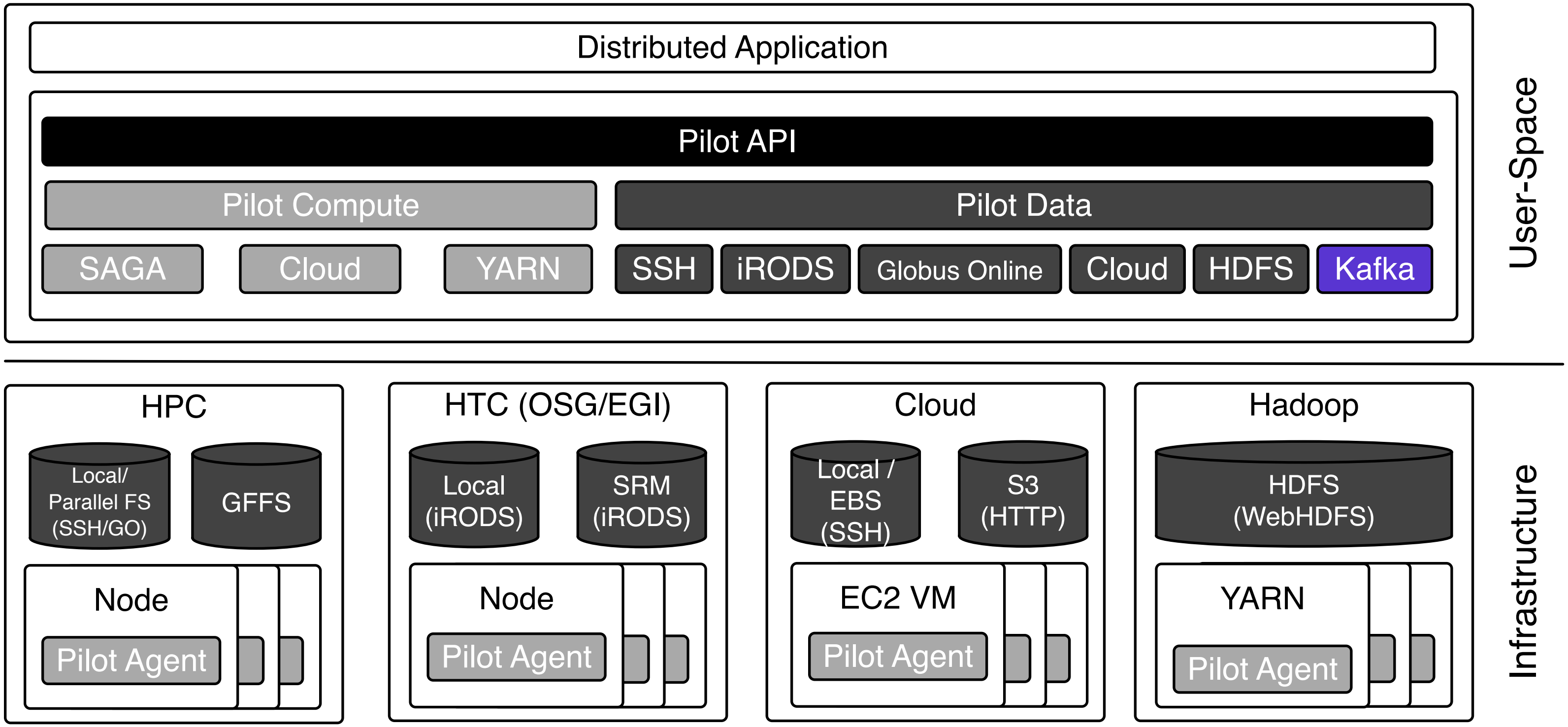


**Questions:**

- How to manage batch and streaming frameworks side-by-side?
- How to enable interoperability between different programming system/models/middleware/schedulers?
- How to enable elasticity?

http://dx.doi.org/10.5281/zenodo.47946

# Pilot-Streaming



# Conclusion

1. Pilot-Jobs enable the co-location of HPC/Simulations and Big Data Tools (Hadoop, Spark, higher-level tools)

2. Pilot-Streaming will support message-broker as data source/sink that enables the de-coupling of applications

3. Dynamic resource management provided by the Pilot-Abstraction is critical for stream environments

# Thank you!