How to use Parquet

as a basis for ETL and analytics

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Outline

- Storing data efficiently for analysis
- Context: Instrumentation and data collection
- Constraints of ETL

Storing data efficiently for analysis

Why do we need to worry about efficiency?

Producing a lot of data is easy

Producing a lot of derived data is even easier.
Solution: Compress all the things!

Scanning a lot of data is easy

1% completed

… but not necessarily fast.
Waiting is not productive. We want faster turnaround.
Compression but not at the cost of reading speed.

Interoperability not that easy

We need a storage format interoperable with all the tools we use

and

keep our options open for the next big thing.

Enter Apache Parquet

Parquet design goals

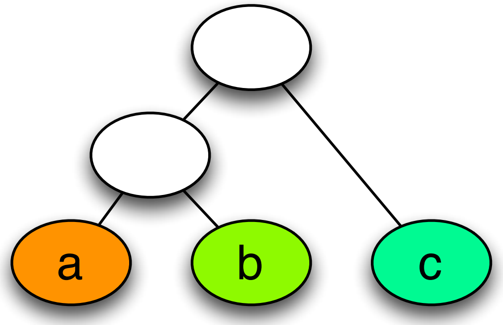
Interoperability

Space efficiency

Query efficiency

Efficiency

Columnar storage



Nested schema

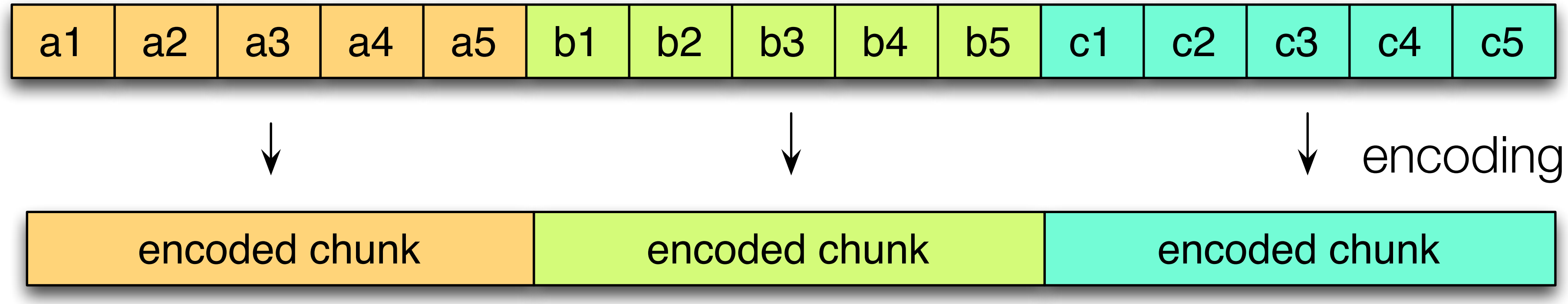
Logical table representation

a	b	c
a1	b1	c1
a2	b2	c2
a3	b3	c3
a4	b4	c4
a5	b5	c5

Row layout

a1	b1	c1	a2	b2	c2	a3	b3	c3	a4	b4	c4	a5	b5	c5

Column layout



a1	a2	a3	a4	a5	b1	b2	b3	b4	b5	c1	c2	c3	c4	c5

Properties of efficient encodings

- Minimize CPU pipeline bubbles:
  highly predictable branching
  reduce data dependency

- Minimize CPU cache misses
  reduce size of the working set

The right encoding for the right job

- Delta encodings:

for sorted datasets or signals where the variation is less important than the absolute value. (timestamp, auto-generated ids, metrics, …) Focuses on avoiding branching.

- Prefix coding (delta encoding for strings)

When dictionary encoding does not work.

- Dictionary encoding:

small (60K) set of values (server IP, experiment id, …)

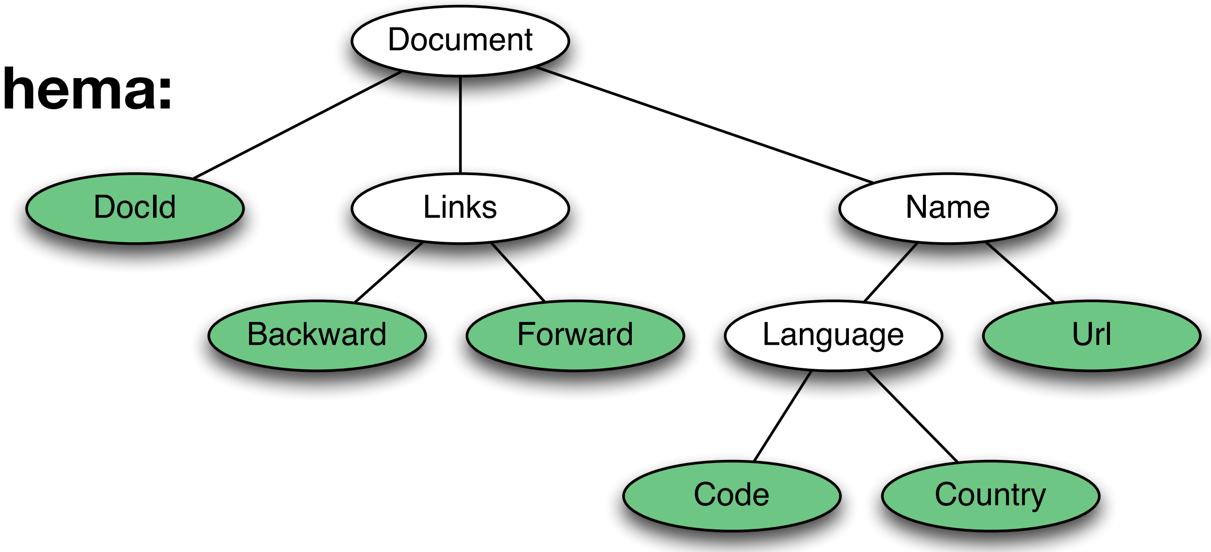
- Run Length Encoding:

repetitive data.

Parquet nested representation

Borrowed from the Google Dremel paper

Schema:

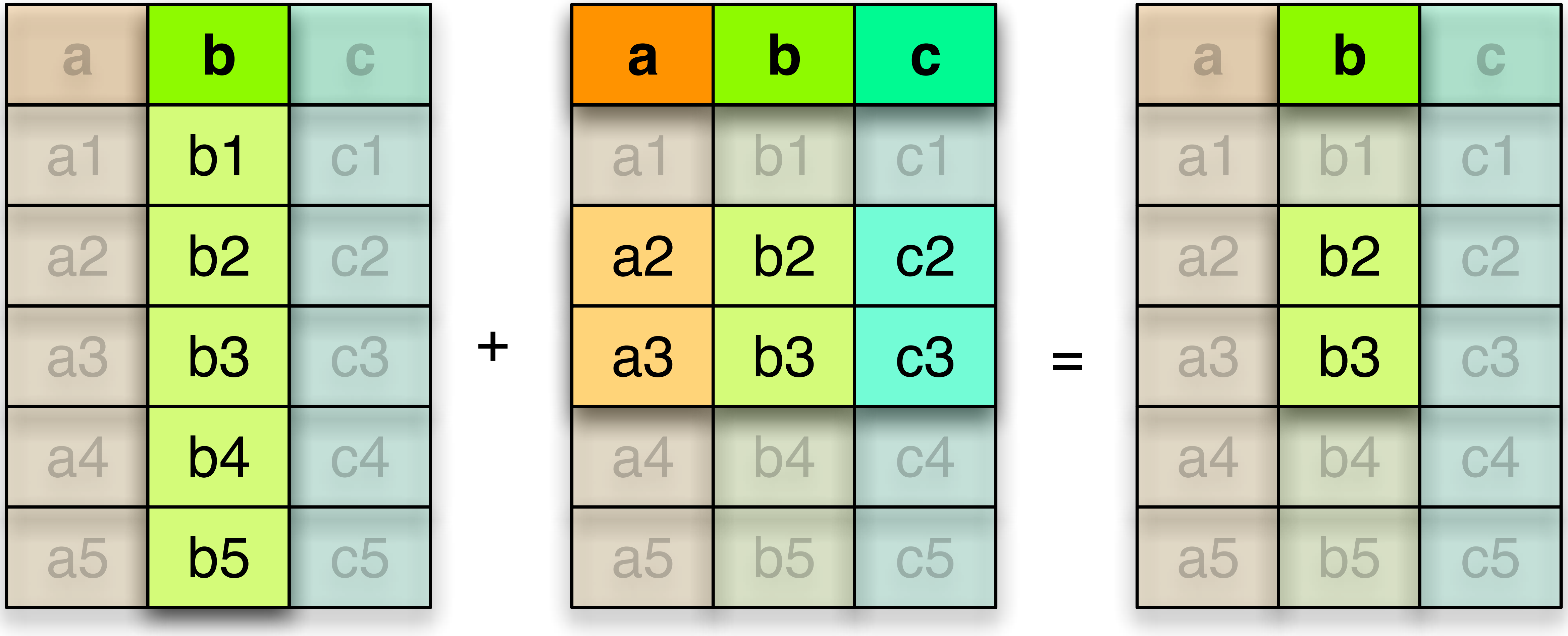


Columns:
docid
links.backward
links.forward
name.language.code
name.language.country
name.url

https://blog.twitter.com/2013/dremel-made-simple-with-parquet

Statistics for filter and query optimization

Vertical partitioning
(projection push down) + Horizontal partitioning
(predicate push down) = Read only the data
you need!



a	b	c
a1	b1	c1
a2	b2	c2
a3	b3	c3
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a5	b5	c5

+

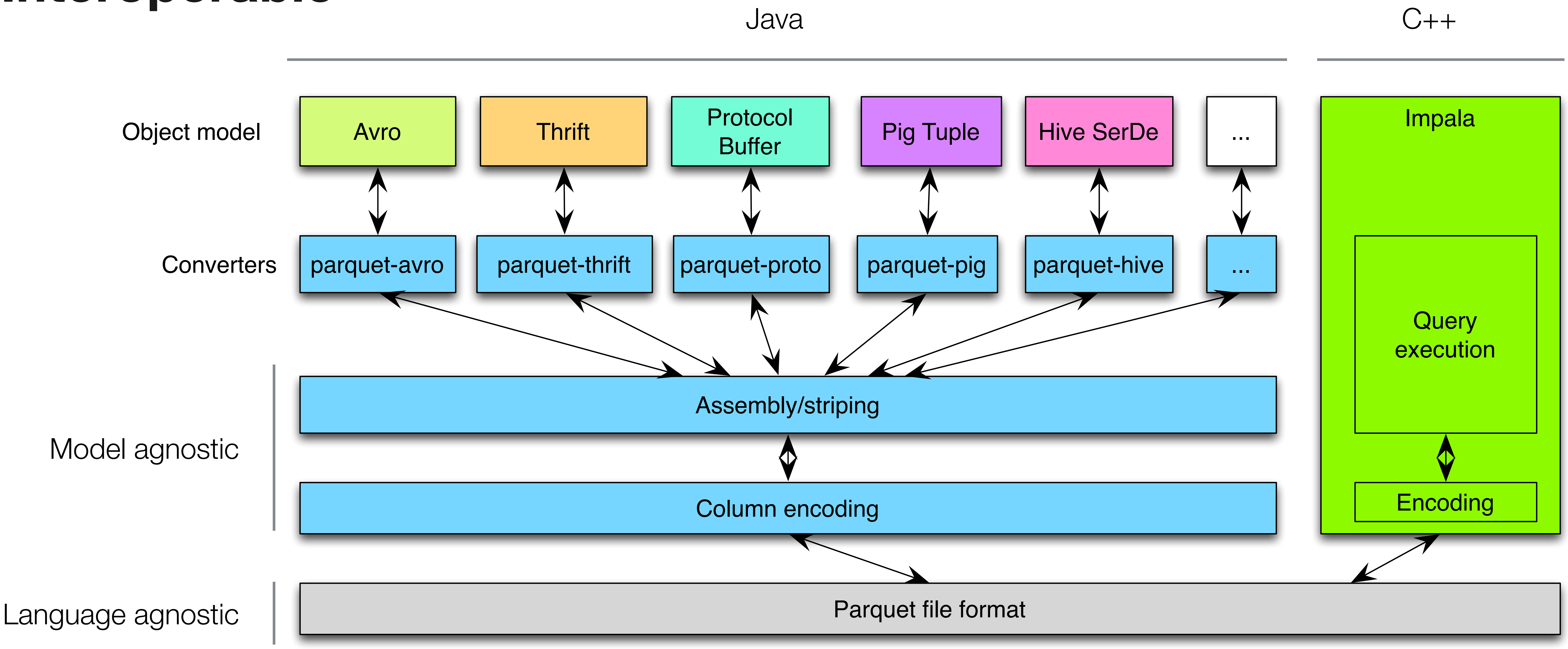
a	b	c
a1	b1	c1
a2	b2	c2
a3	b3	c3
a4	b4	c4
a5	b5	c5

=

a	b	c
a1	b1	c1
a2	b2	c2
a3	b3	c3
a4	b4	c4
a5	b5	c5

Interoperability

Interoperable



Frameworks and libraries integrated with Parquet

Query engines:

Hive, Impala, HAWQ,
IBM Big SQL, Drill, Tajo,
Pig, Presto, SparkSQL

Frameworks:

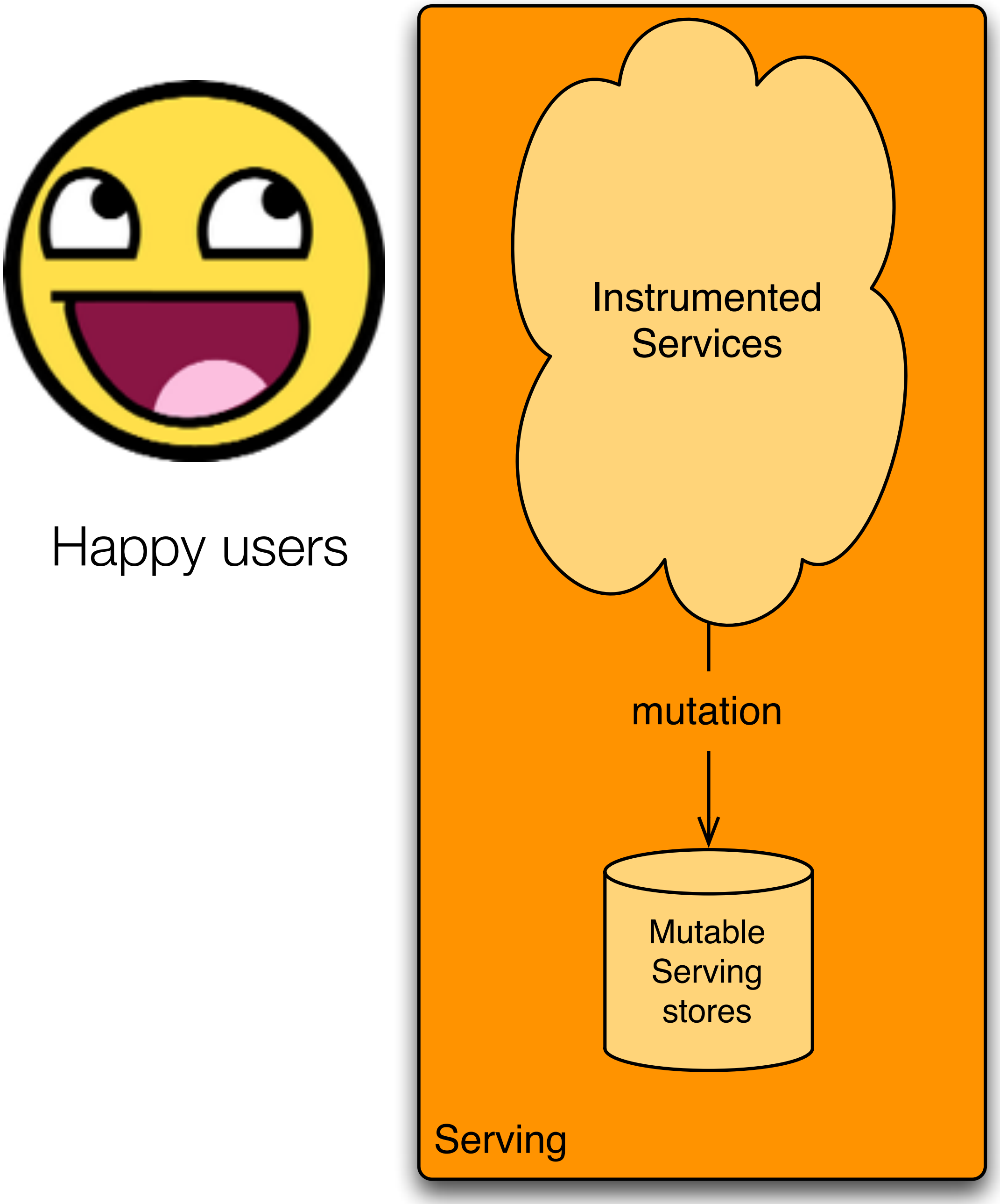
Spark, MapReduce, Cascading,
Crunch, Scalding, Kite

Data Models:

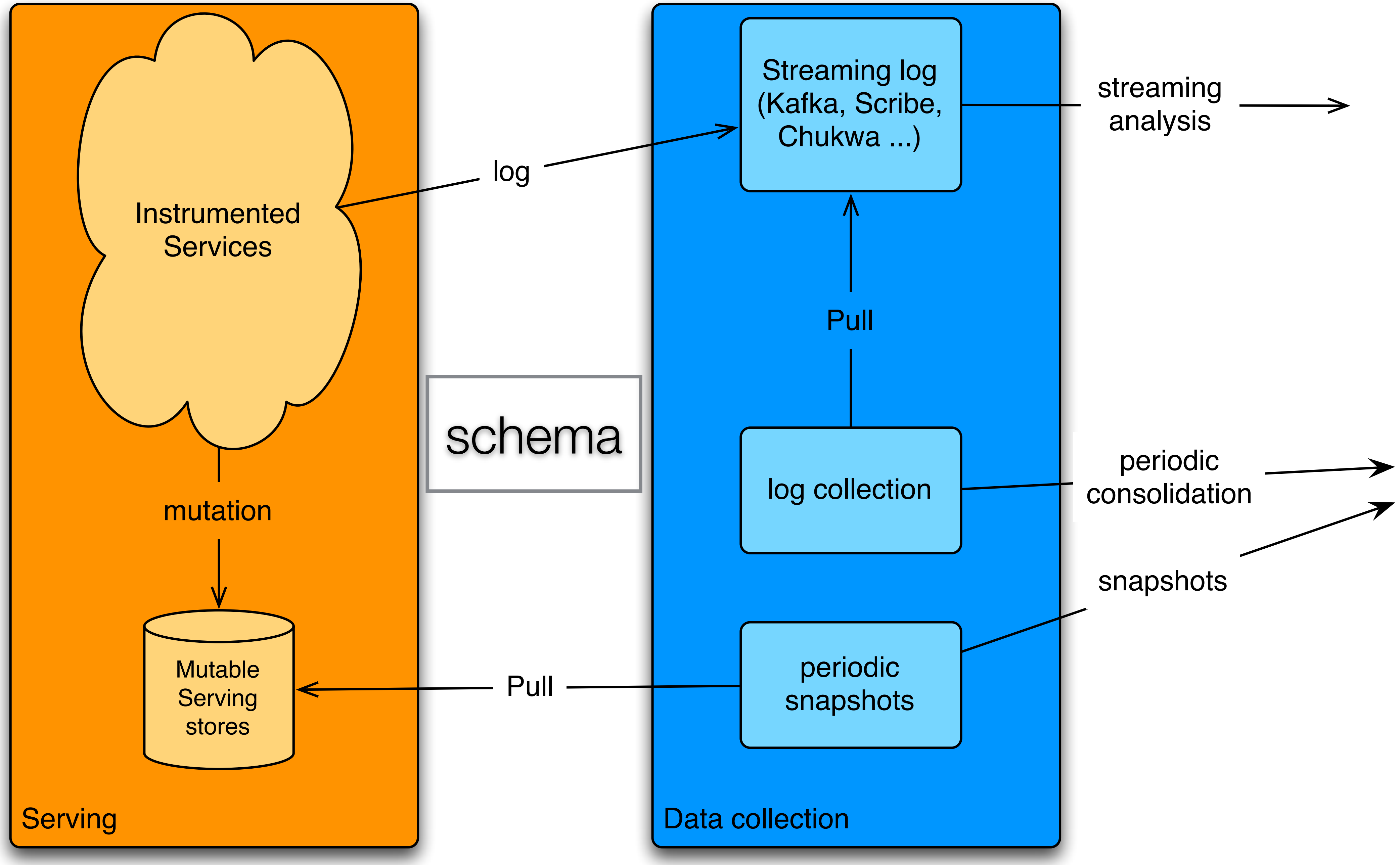
Avro, Thrift, ProtocolBuffers,
POJOs

Context: Instrumentation and data collection

Typical data flow



Typical data flow



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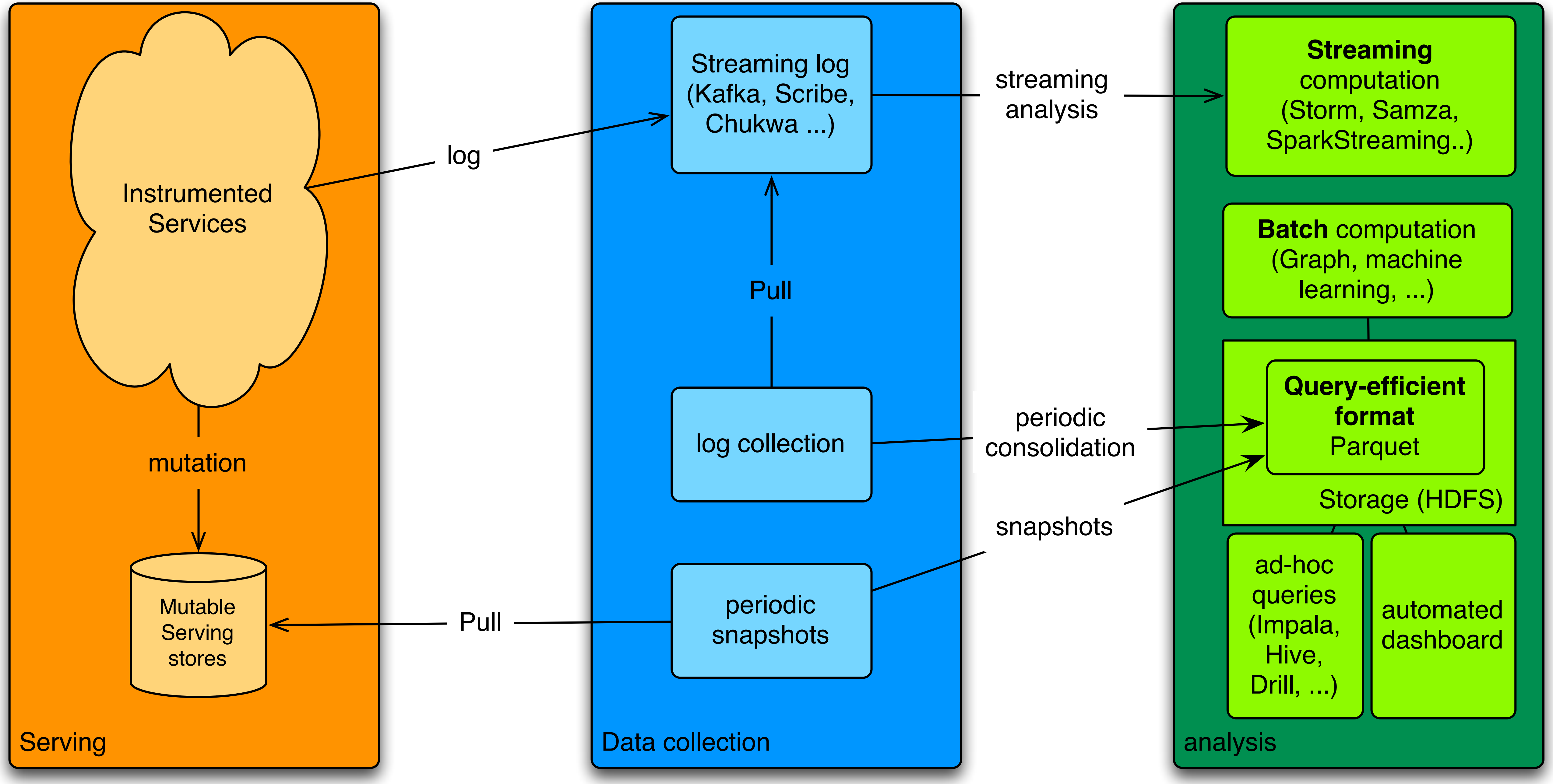
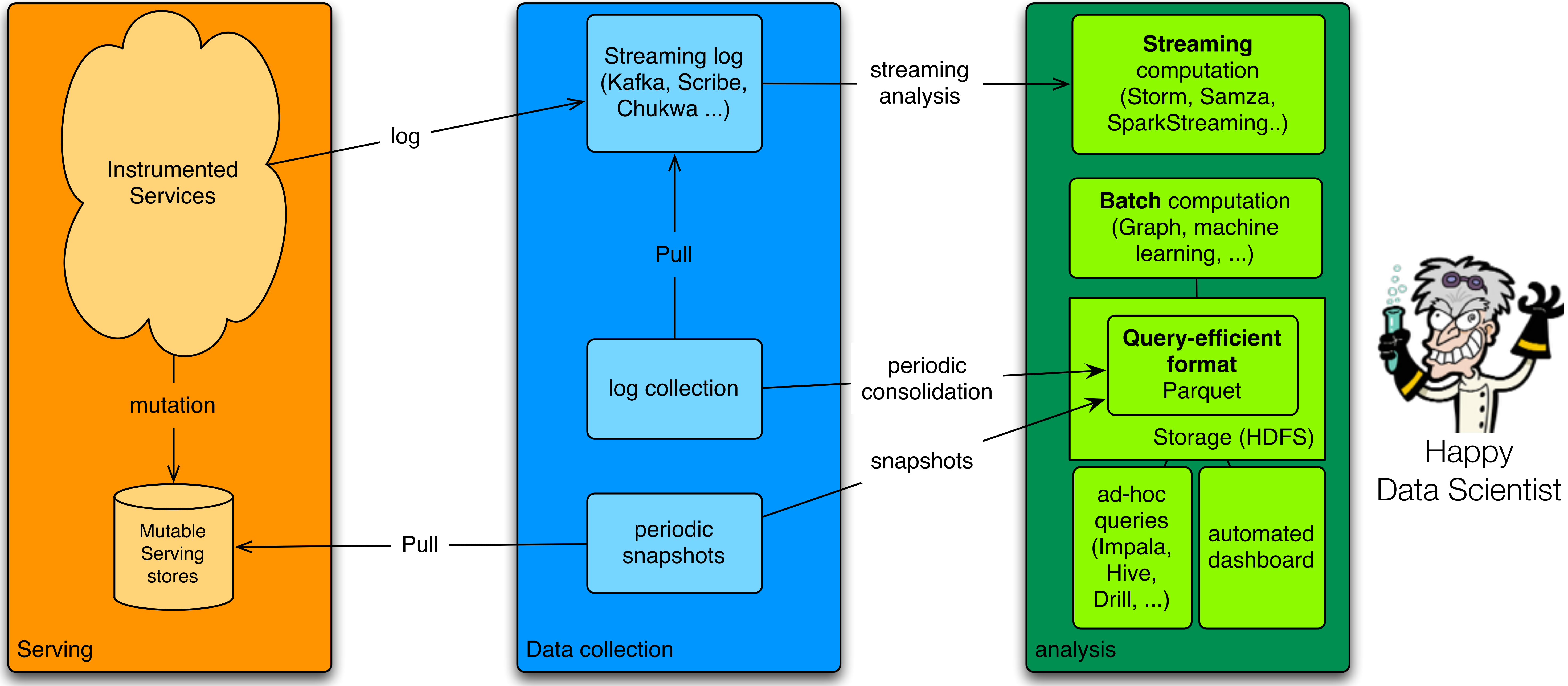

Instrumented Services
mutation
Mutable Serving stores
Serving
log
Pull
Streaming log (Kafka, Scribe, Chukwa ...)
Pull
log collection
periodic snapshots
Data collection
streaming analysis
periodic consolidation
snapshots
Streaming computation (Storm, Samza, SparkStreaming..)
Batch computation (Graph, machine learning, ...)
Query-efficient format Parquet
Storage (HDFS)
ad-hoc queries (Impala, Hive, Drill, ...)
automated dashboard
analysis

Typical data flow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automated dashboard
analysis
Happy Data Scientist

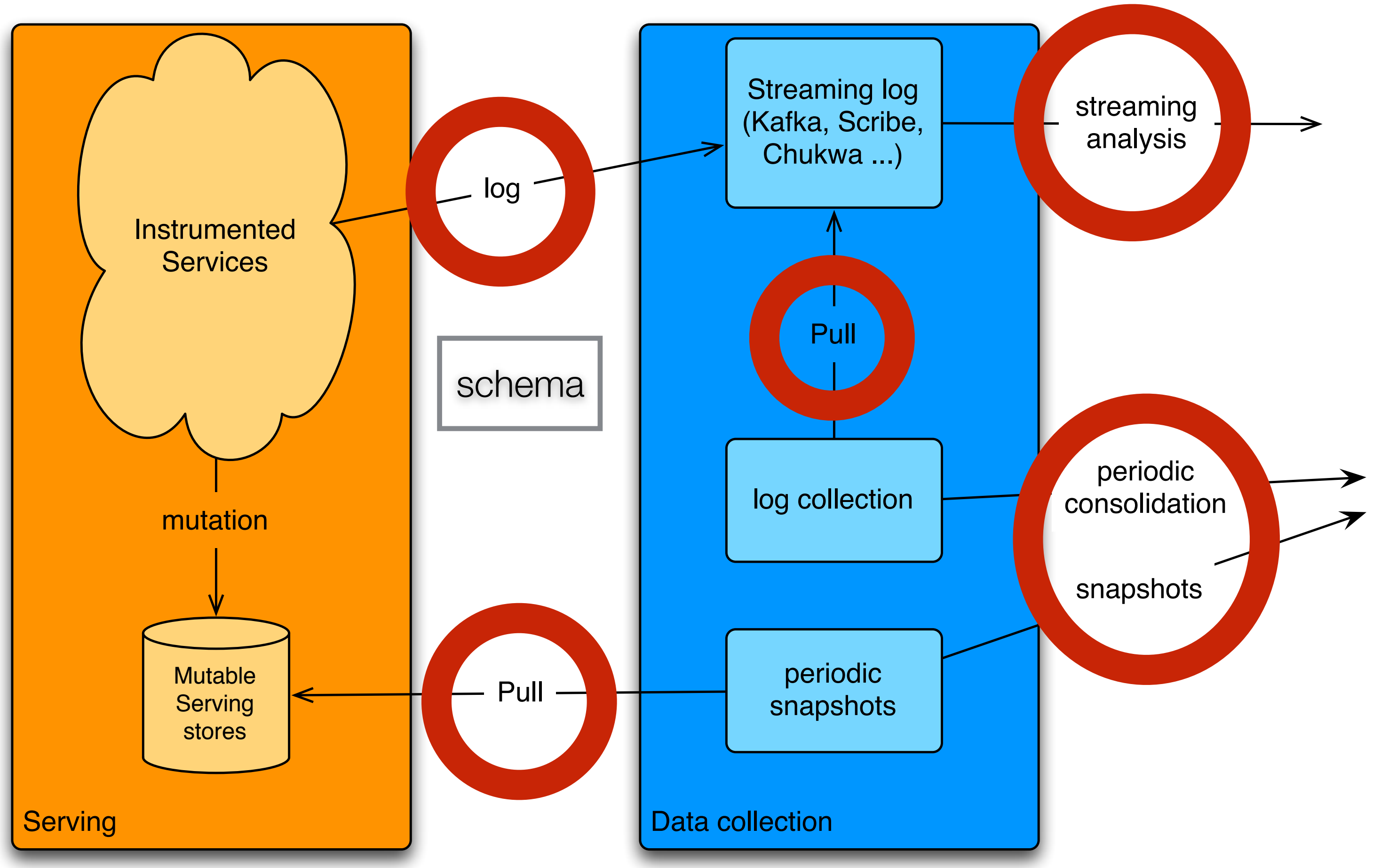
Schema management

Schema in Hadoop

Hadoop does not define a standard notion of schema but there are many available:

- Avro
- Thrift
- Protocol Buffers
- Pig
- Hive
- …

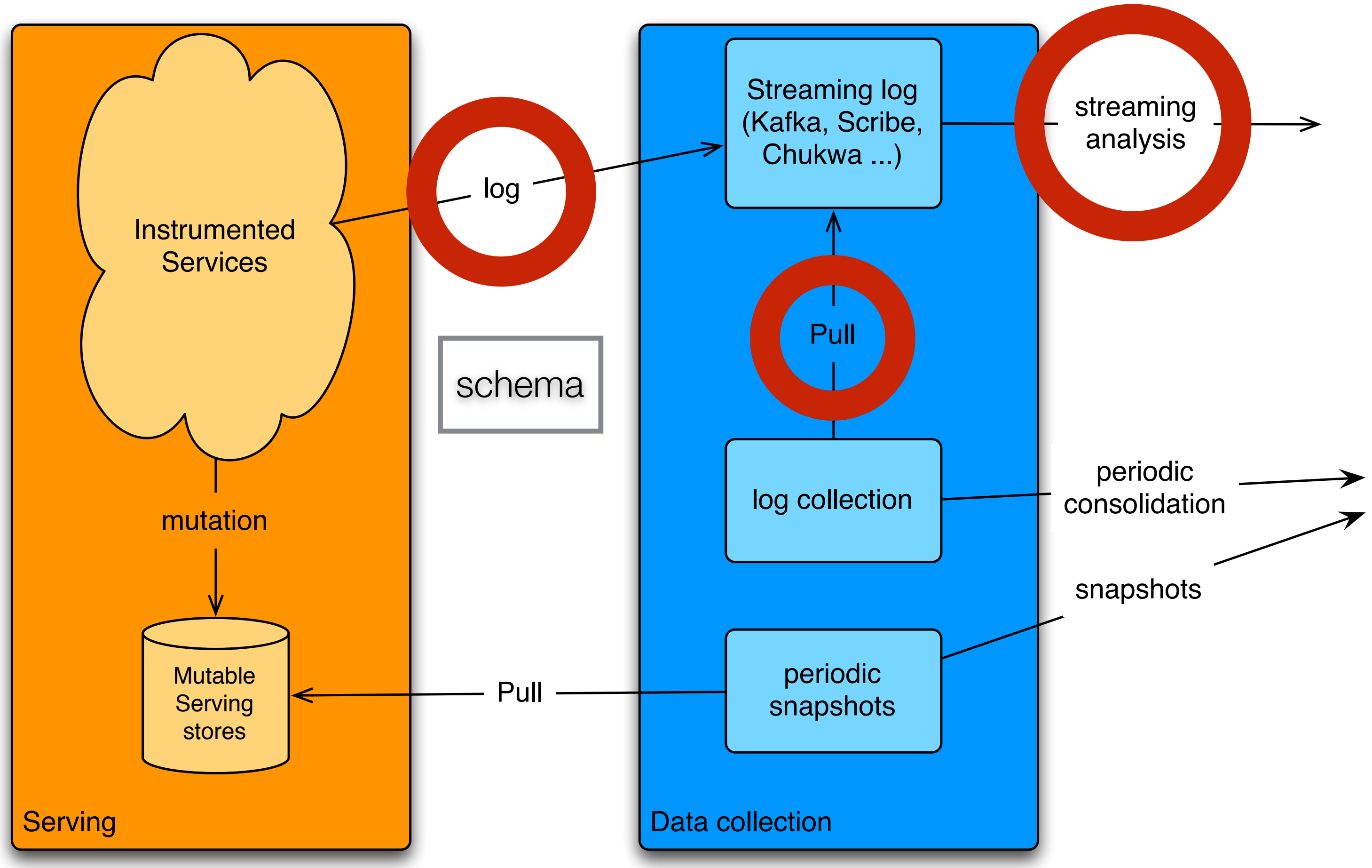
And they are all different



What they define

Schema:
Structure of a record
Constraints on the type

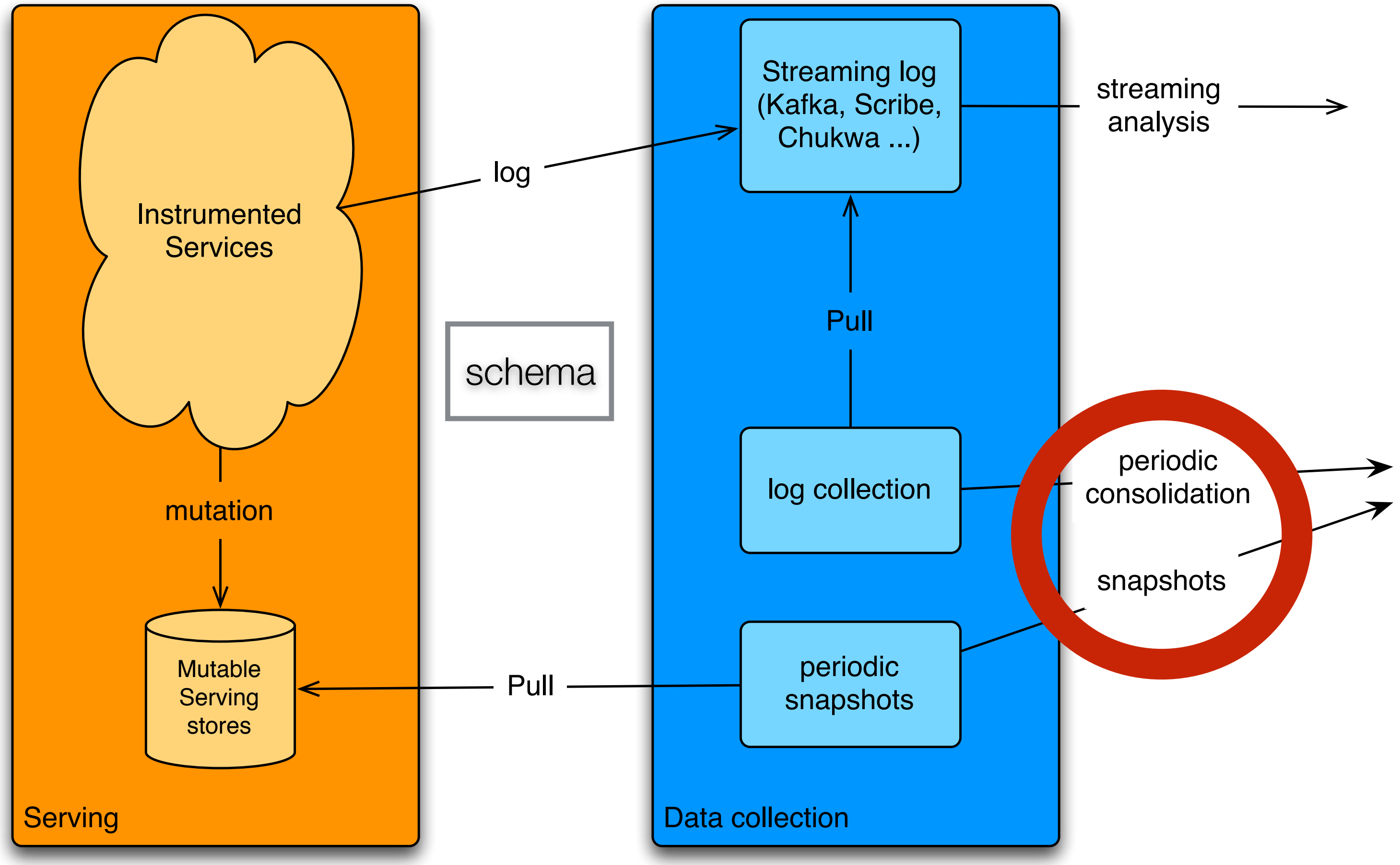
Row oriented binary format:
How records are represented one at a time



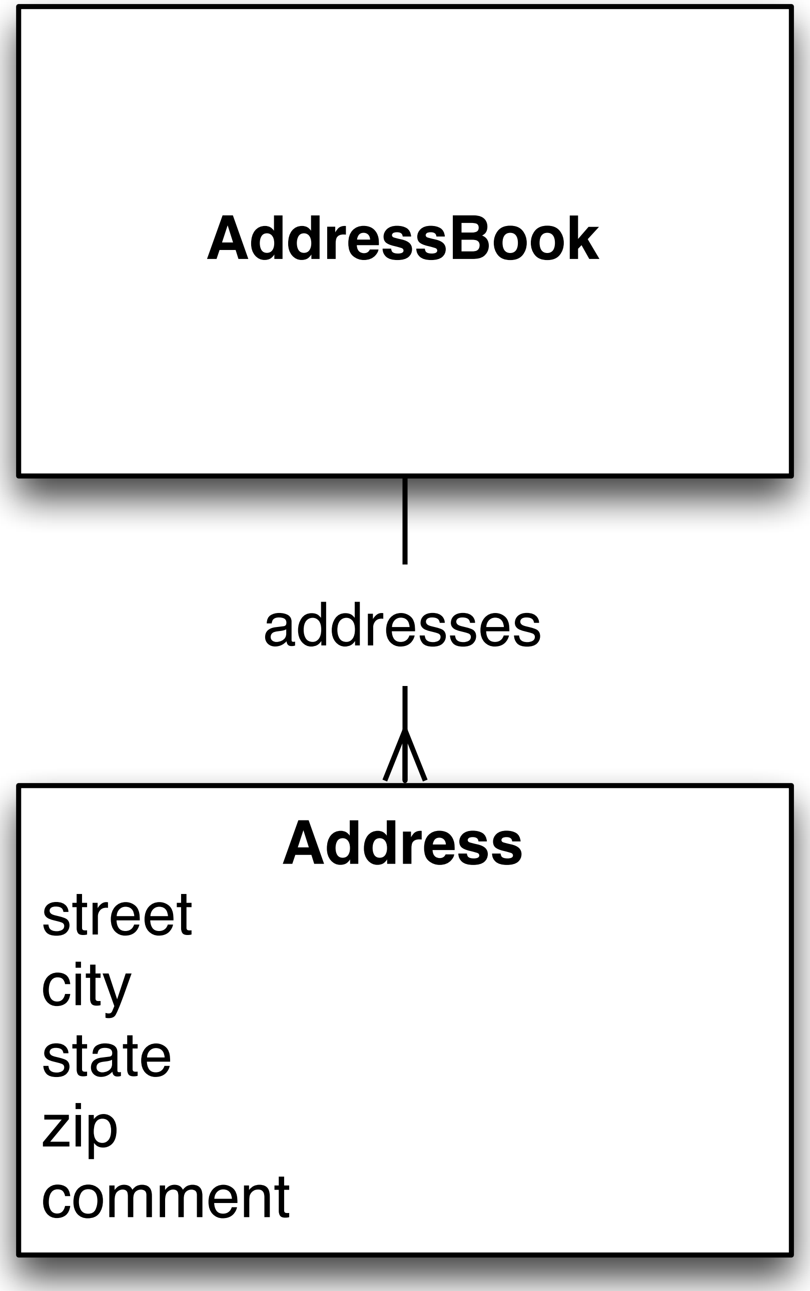
What they *do not* define

Column oriented binary format:

Parquet reuses the schema definitions and provides a common column oriented binary format



Example: address book



AddressBook

addresses

Address

street
city
state
zip
comment

Protocol Buffers

```
message AddressBook {
  repeated group addresses = 1 {
    required string street = 2;
    required string city = 3;
    required string state = 4;
    required string zip = 5;
    optional string comment = 6;
  }
}
```

Lists are repeated fields

Fields have ids and can be optional, required or repeated

- Allows recursive definition
- Types: Group or primitive
- binary format refers to field ids only => Renaming fields does not impact binary format
- Requires installing a native compiler separated from your build

Thrift

```
struct AddressBook {
  1: required list<Address> addresses;
}
struct Addresses {
  1: required string street;
  2: required string city;
  3: required string state;
  4: required string zip;
  5: optional string comment;
}
```

explicit collection types

Fields have ids and can be optional or required

- No recursive definition
- Types: Struct, Map, List, Set, Union or primitive
- binary format refers to field ids only => Renaming fields does not impact binary format
- Requires installing a native compiler separately from the build

Avro

```
{
  "type": "record",
  "name": "AddressBook",
  "fields" : [{
    "name": "addresses",
    "type": "array",
    "items": {
      “type”: “record”,
      “fields”: [
        {"name": "street", "type": “string"},
        {"name": "city", "type": “string”}
        {"name": "state", "type": “string"}
        {"name": "zip", "type": “string”}
        {"name": "comment", "type": [“null”, “string”]}
      ]
    }
  }]
}
```

explicit collection types

null is a type
Optional is a union

- Allows recursive definition
- Types: Records, Arrays, Maps, Unions or primitive
- Binary format requires knowing the write-time schema
  ➡ more compact but not self descriptive
  ➡ renaming fields does not impact binary format
- generator in java (well integrated in the build)

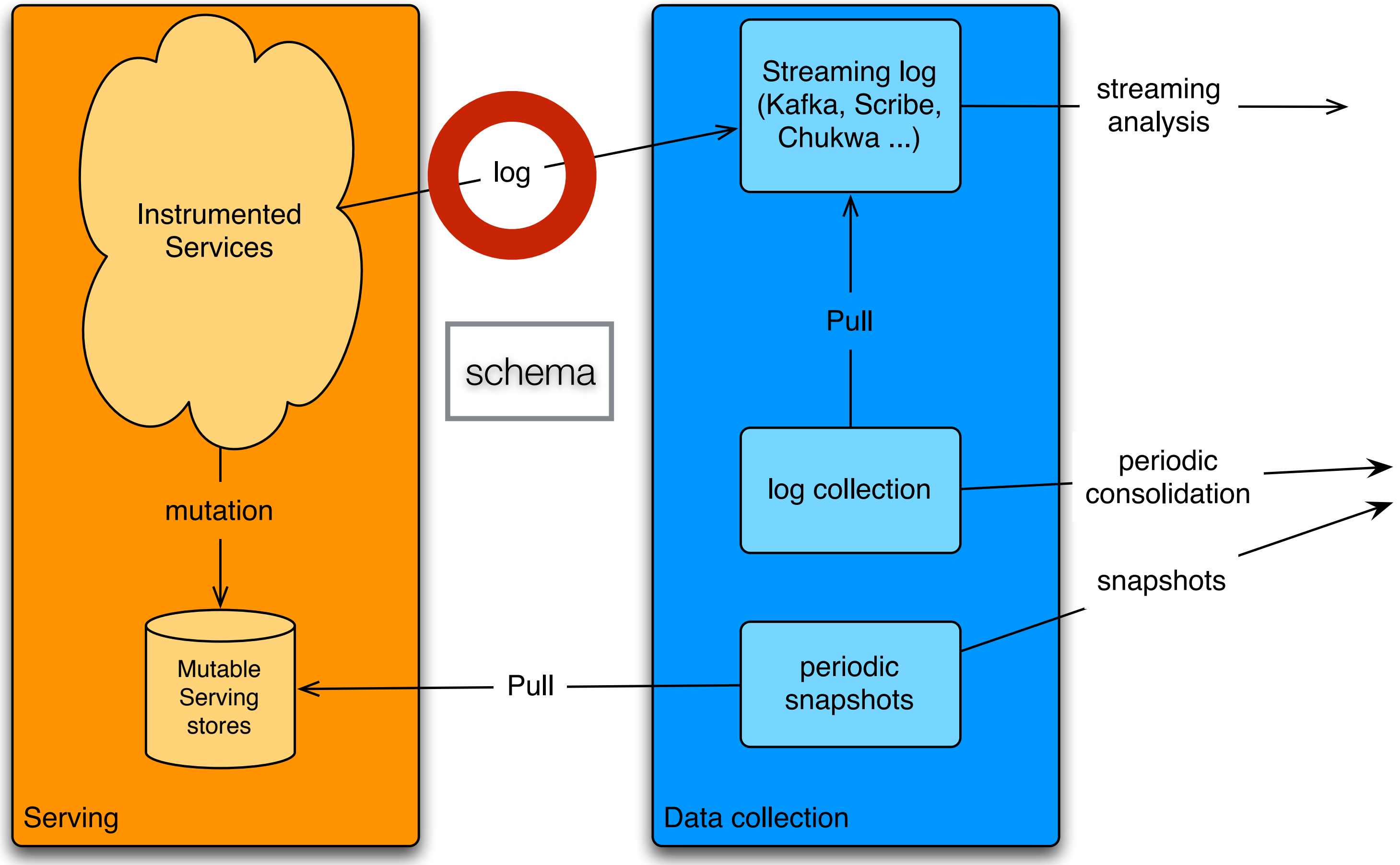
Requirements of ETL

Log event collection

Initial collection is fundamentally row oriented:

- Sync to disk as early as possible to minimize event loss

- Counting events sent and received is a good idea

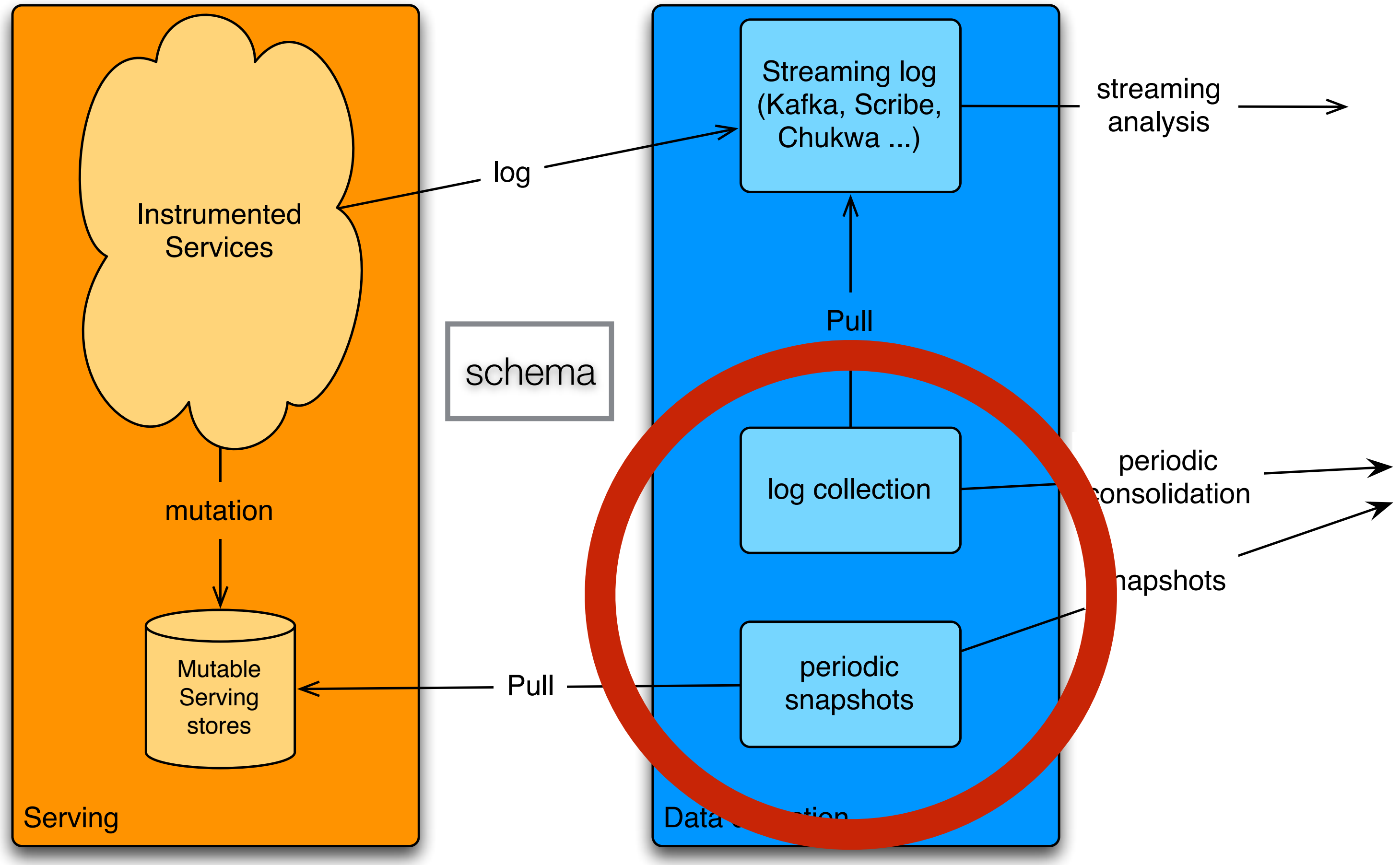


Columnar storage conversion

Columnar storage requires writes to be buffered in memory for the entire row group:

- Write many records at a time.

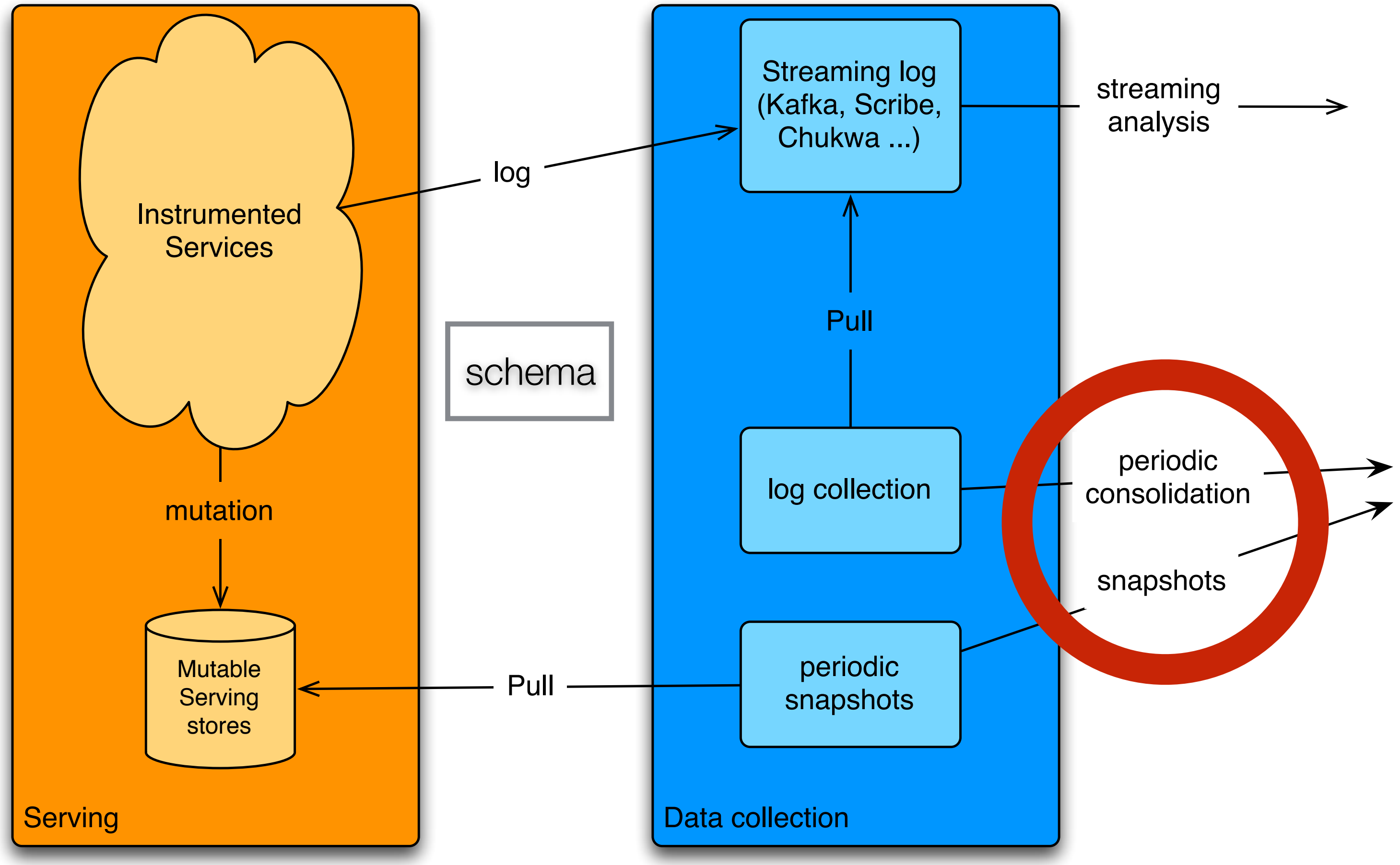
- Better executed in batch



Columnar storage conversion

Not just columnar storage:

- Dynamic partitioning
- Sort order
- Stats generation



Write to Parquet

MapReduce:

OutputFormat	ProtoParquetOutputFormat	ParquetThriftOutputFormat	AvroParquetOutputFormat
define schema	setProtobufClass(job, AddressBook.class)	setThriftClass(job, AddressBook.class)	setSchema(job, AddressBook.SCHEMA$)

Scalding:

```
// define the Parquet source
case class AddressBookParquetSource(override implicit val dateRange: DateRange)
  extends HourlySuffixParquetThrift[AddressBook](“/my/data/address_book", dateRange)
// load and transform data
 pipe.write(ParquetSource())
```

Pig:

```
STORE mydata
    INTO ‘my/data’
    USING parquet.pig.ParquetStorer();
```

Hive / Impala:

```
create table parquet_table (x int, y string) stored as parquetfile;
insert into parquet_table select x, y from some_other_table;
```

Query engines

Scalding

loading:

```
new FixedPathParquetThrift[AddressBook](“my”, “data”) {
  val city = StringColumn("city")
  override val withFilter: Option[FilterPredicate] =
    Some(city === “San Jose”)
}
```

operations:

```
p.map( (r) => r.a + r.b )
p.groupBy( (r) => r.c )
p.join
…
```

Explicit push down

Pig

loading:

```
mydata = LOAD ‘my/data’ USING parquet.pig.ParquetLoader();
```

operations:

```
A = FOREACH mydata GENERATE a + b;
B = GROUP mydata BY c;
C = JOIN A BY a, B BY b;
```

Projection push down happens automatically

SQL engines

	Load	query
Hive	create table as …	SELECT city FROM addresses WHERE zip == 95113
Impala		
Presto		
Drill	optional. Drill can directly query parquet files	SELECT city FROM dfs.`/table/addresses` zip == 95113

SparkSQL	val parquetFile =
	sqlContext.parquetFile(
	"/table/addresses")
		val result = sqlContext
		.sql("SELECT city FROM addresses WHERE zip == 95113”)
		result.map((r) => …)

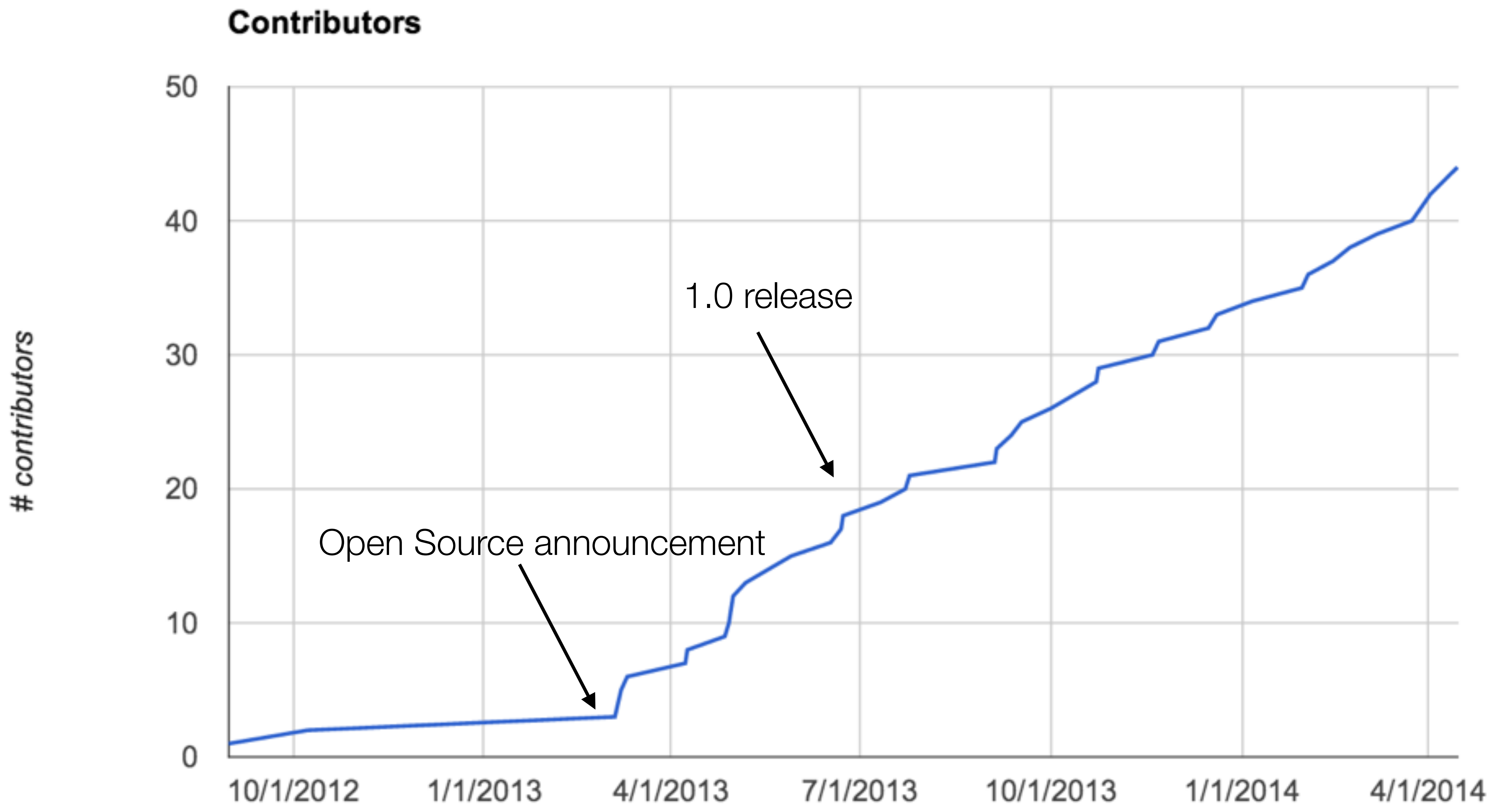
Projection push down happens automatically

Community

Parquet timeline

- Fall 2012: Twitter & Cloudera merge efforts to develop columnar formats
- March 2013: OSS announcement; Criteo signs on for Hive integration
- July 2013: 1.0 release. 18 contributors from more than 5 organizations.
- May 2014: Apache Incubator. 40+ contributors, 18 with 1000+ LOC. 26 incremental releases.
- Apr 2015: Parquet graduates from the Apache Incubator

Thank you to our contributors



Get involved

@ApacheParquet

Mailing lists:

- dev@parquet.apache.org

Github repo:

- https://github.com/apache/parquet-mr

Parquet sync ups:

- Regular meetings on google hangout

Questions

@ApacheParquet

SELECT answer(question) FROM audience