Data Stream Management Systems

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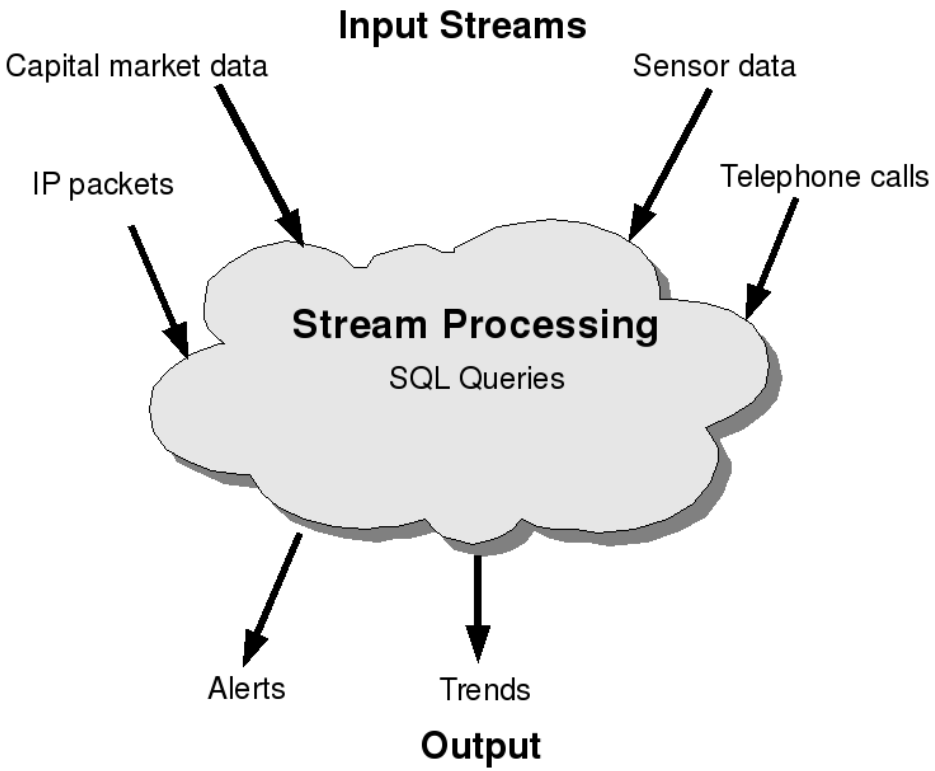
Introduction

- A data stream is an unbounded sequence of data that arrives at high speed.
- Stream processing applications require continuous and low-latency processing of data streams.
- In differents domains, such as computer networks, web logs, financial services, applications require traditionally the processing of large data streams.
- Real data traces of IP packets from an AT&T data source show an average data rate of approximately 400 Mbits/sec.



Processing a query over a data streams involves:

- running the query continuously over the data stream.
- generating a new answer each time a new data item arrives.

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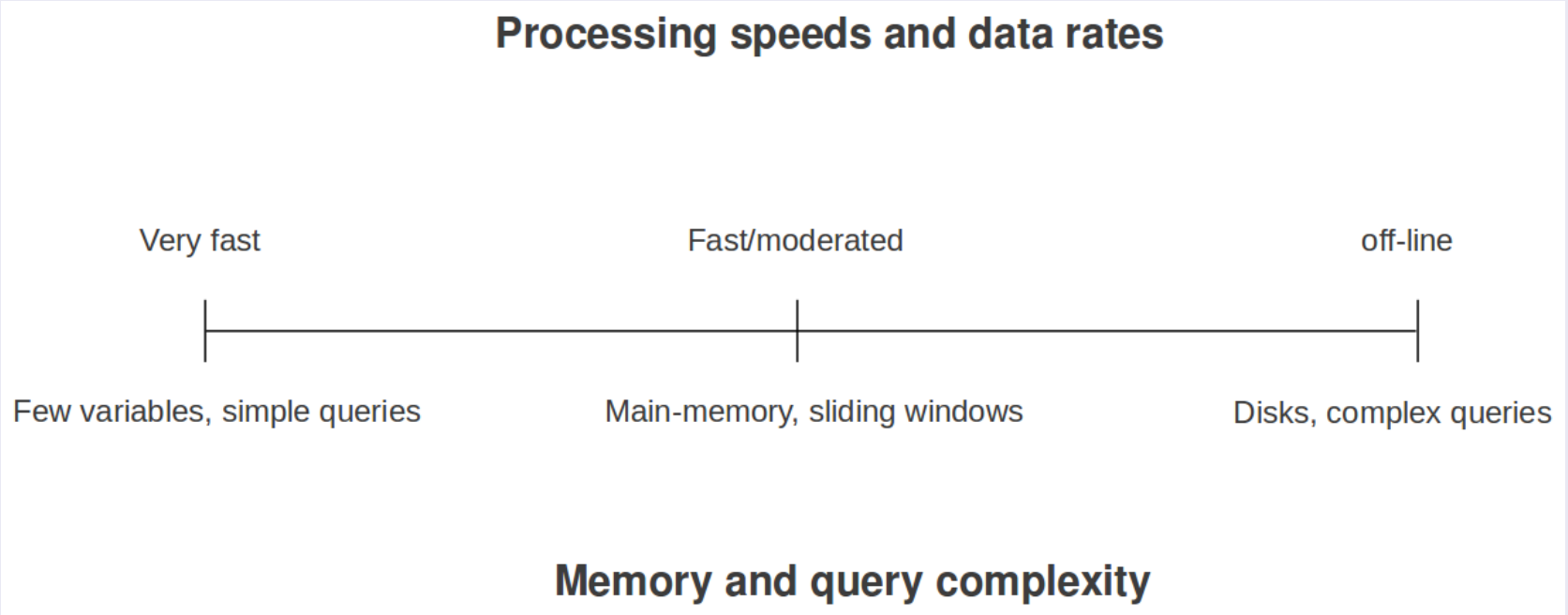
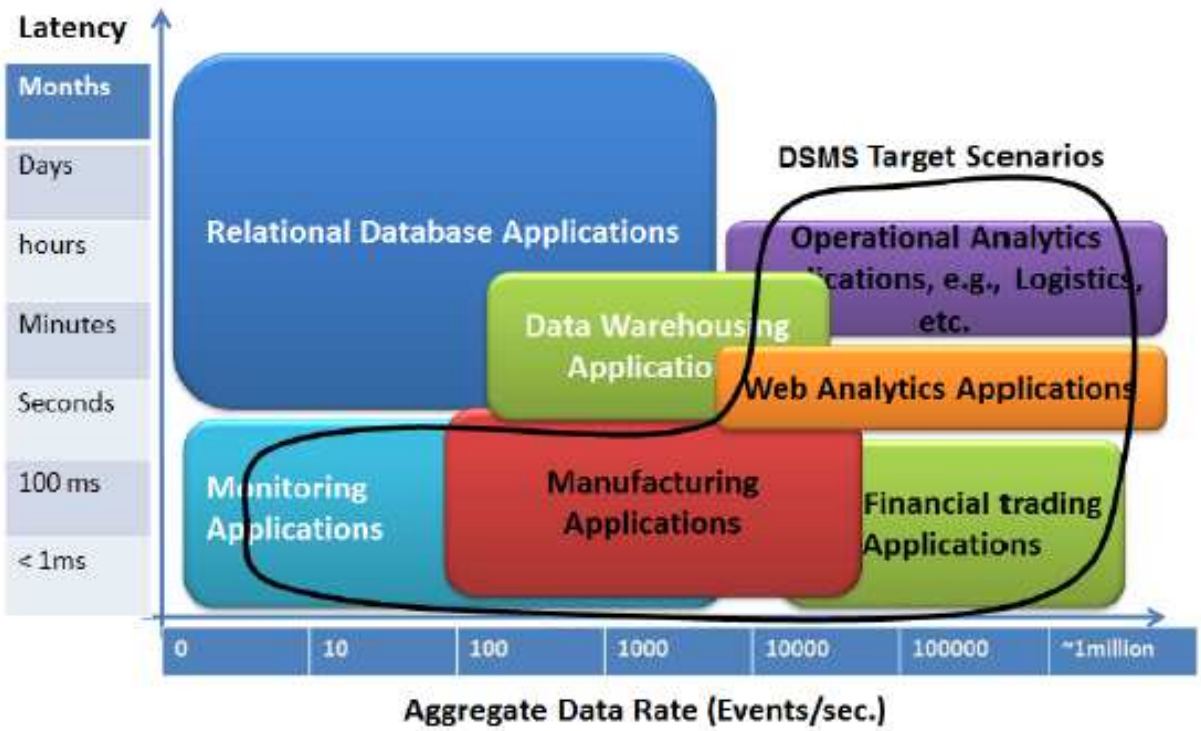
The requirements of data stream applications do no fit the DBMS data model and querying paradigm

Application requirements



DSMSs scenarios



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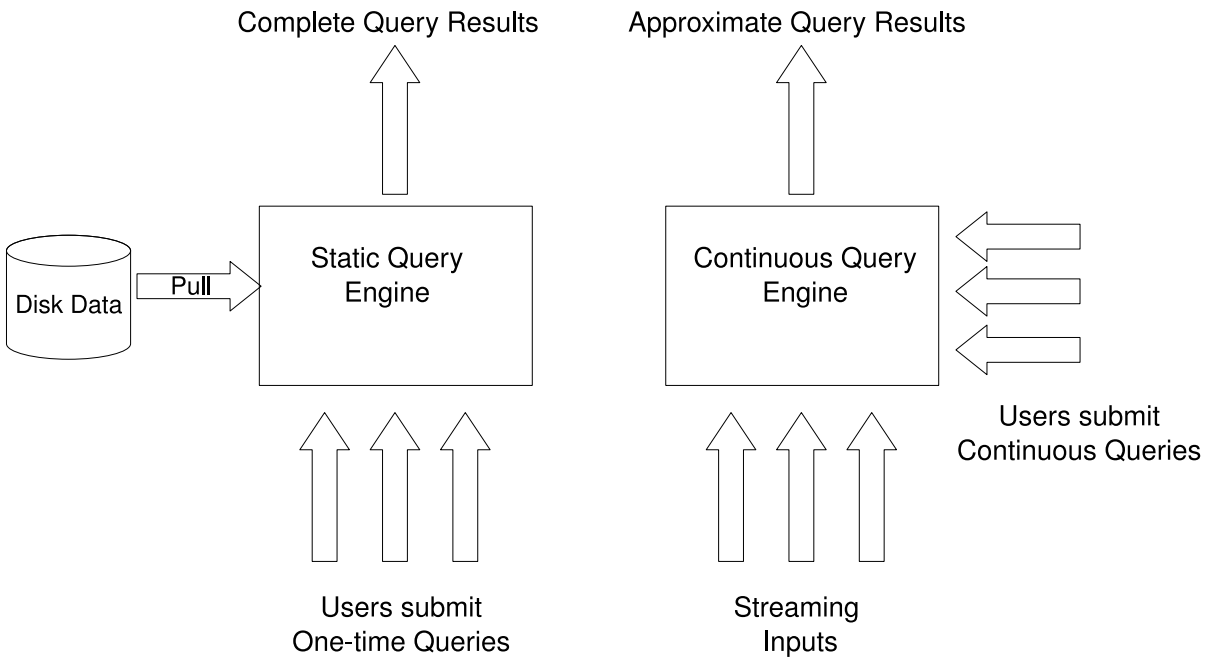
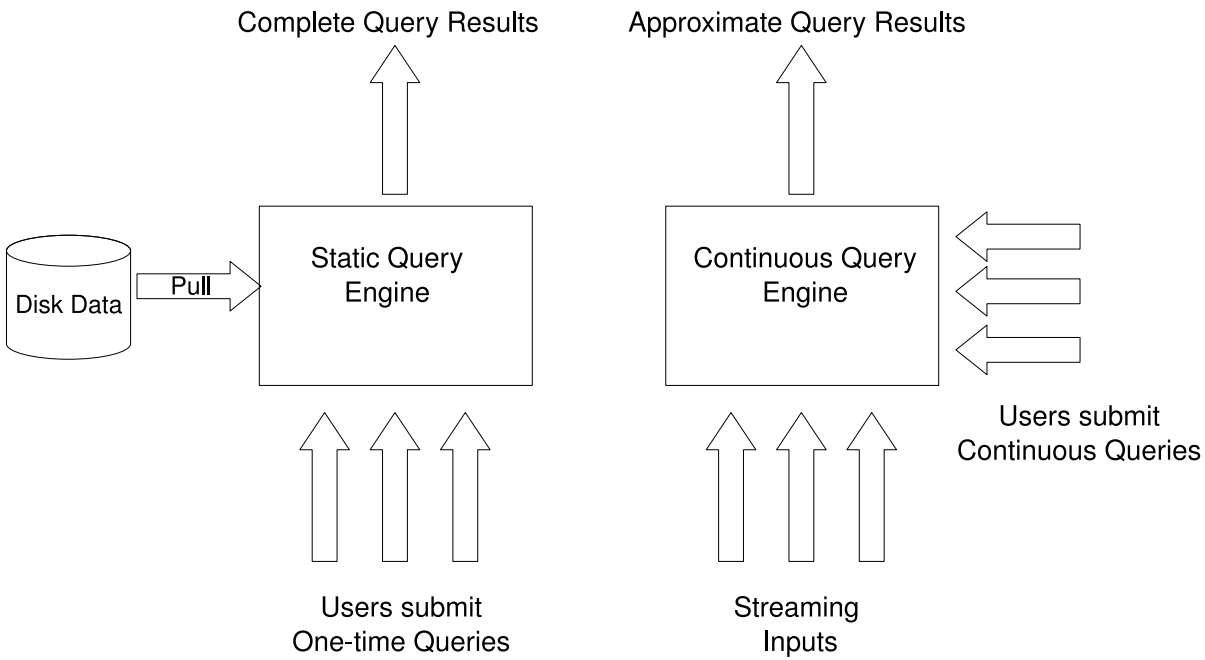
[1] taken from paper *Data Stream Management Systems for Computational Finance*

DBMS vs DSMS


Complete Query Results
Approximate Query Results
Disk Data
Pull
Static Query Engine
Continuous Query Engine
Users submit Continuous Queries
Users submit One-time Queries
Streaming Inputs

DBMS vs DSMS

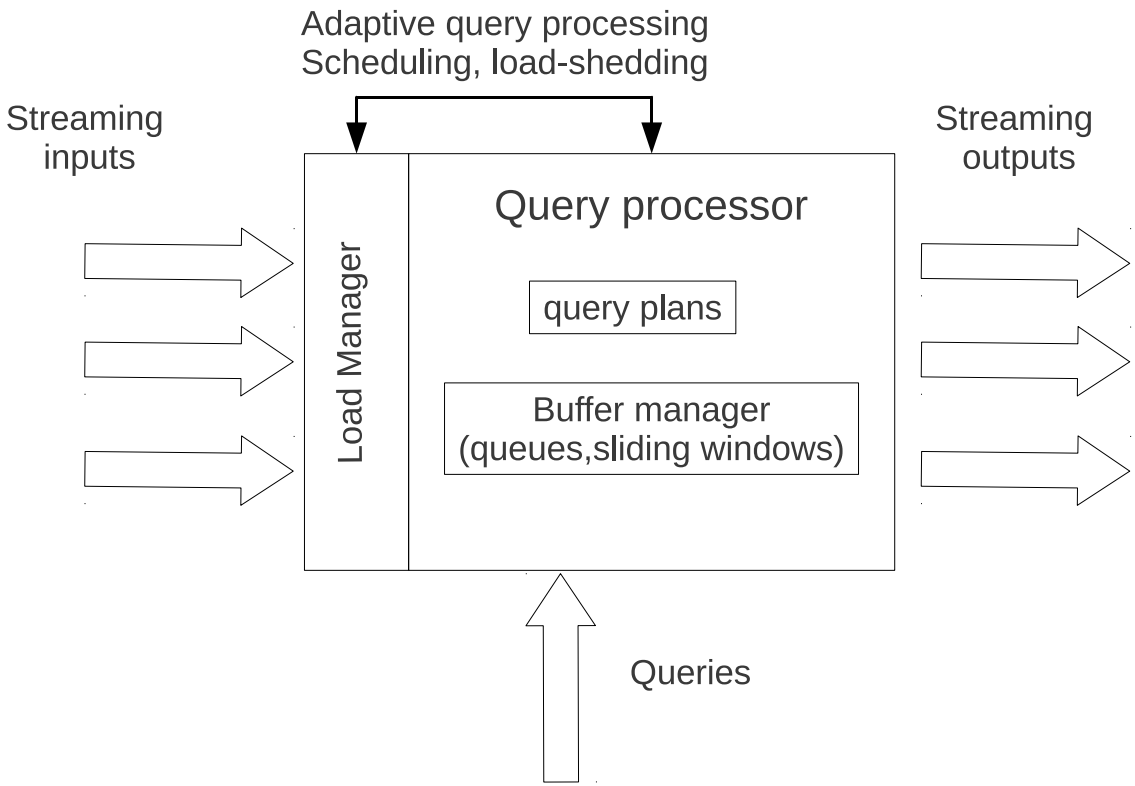


- Persistent queries
- Push-based processing
- Approximate answers

DBMS vs DSMS

	DBMS	**DSMS**
Data	persistent	streams,sliding windows
Data access	random	sequential, one-pass
Updates	arbitrary	append-only
Update rates	slow	high and bursty
Processing model	query-driven	data-driven
Queries	one-time	continuous
Query plans	fixed	adaptive
Query optimization	one-query	multi-query
Query answers	exact	approximate
Latency	relatively high	slow

DSMS architecture



Queries

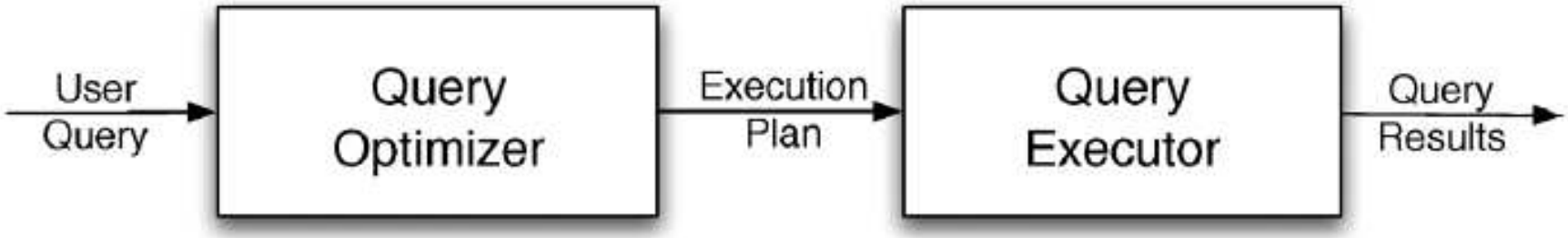
Traffic that passes through three routers R_1, R_2 y R_3 and has the same destination host within the last 10 minutes.

Select sum($S_1.size$)
From S_1[range 10 min], S_2[range 10 min], S_3 [range 10 min]
Where S_1.dest=S_2.dest and S_2.dest=S_3.dest

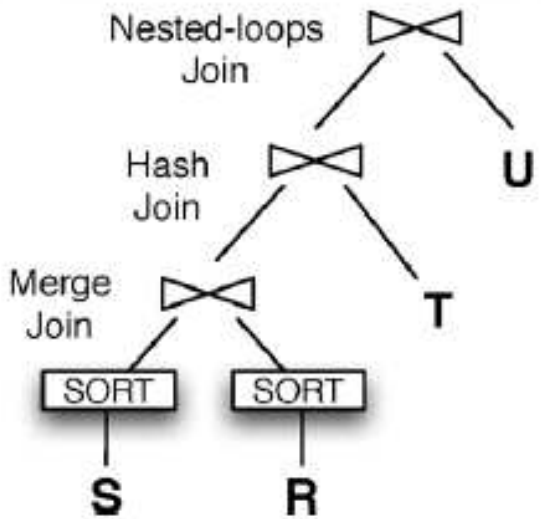
- Data are stored in sliding windows of size $W = 10$.
- Each tuple has a timestamp ts. Thus, a tuple is contained in the window iff $T - s.ts \leq W$.
- Update of tuples is performed by sliding the window $\rightarrow$ the removal of some tuples from the window and the addition of some new tuples arriving in the data streams.

The traditional join query operator has a blocking behaviour because to produce the first result it must see its entire input. Since data streams may be infinite, a blocking operator will never see its entire input not being able to produce any result.

Traditional join operator




```
SELECT *
FROM R, S, T, U
WHERE R.a = S. a
   AND S.b = T.b
   AND T.c = U. c
```

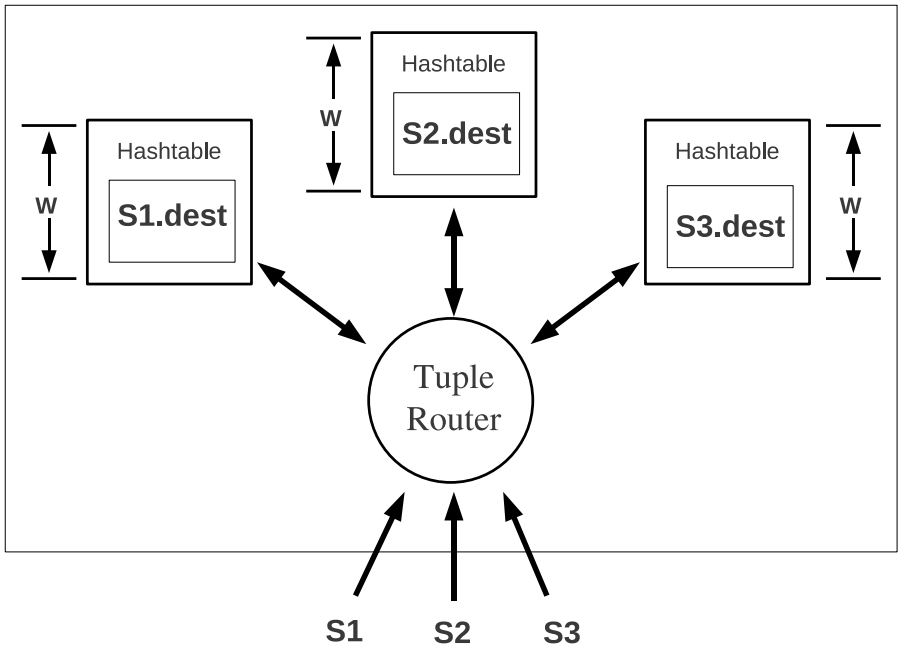


MJoin operator

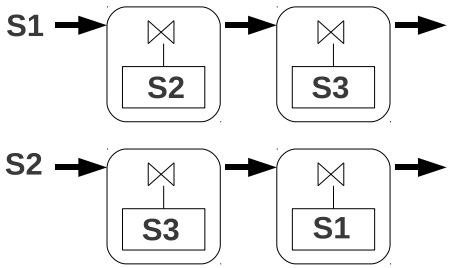
Example 3-way join query

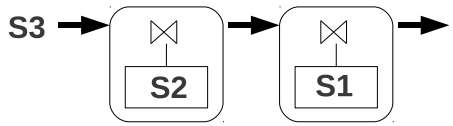
Select *
From S1[range 10 min],S2[range 10 min],S3[range 10 min]
Where S1.dest=S2.dest=S3.dest

MJoin Operator



Example of Probing sequences





Summary of DSMSs and their primary contributions

DSMS	**Primary contribution**
TelegraphCQ	Operators for adaptive query processing.
STREAM	Adaptive caching for continuous queries and query language.
Borealis	Techniques for fault-tolerance and load management.
DCAPE	Integrates local query optimization and distributed load balancing