Evaluating Streaming Strategies for Event Processing across Infrastructure Clouds

(joint work)

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Cloud versus Cloud

Too complex: do I need to become a sys admin?

What is the best programming model, what are the tools I need to make effective use of them?

It costs too much! And what if Amazon raises prices?

Performance: especially I/O, especially Big Data!

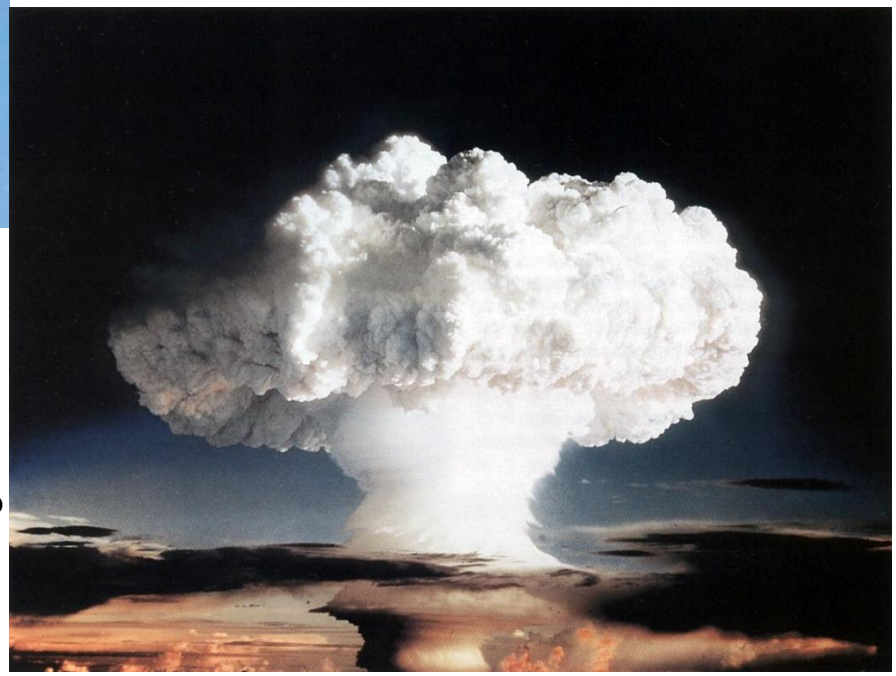
Custom user environments!

On-demand access!

Elastic computing!

Isolation!

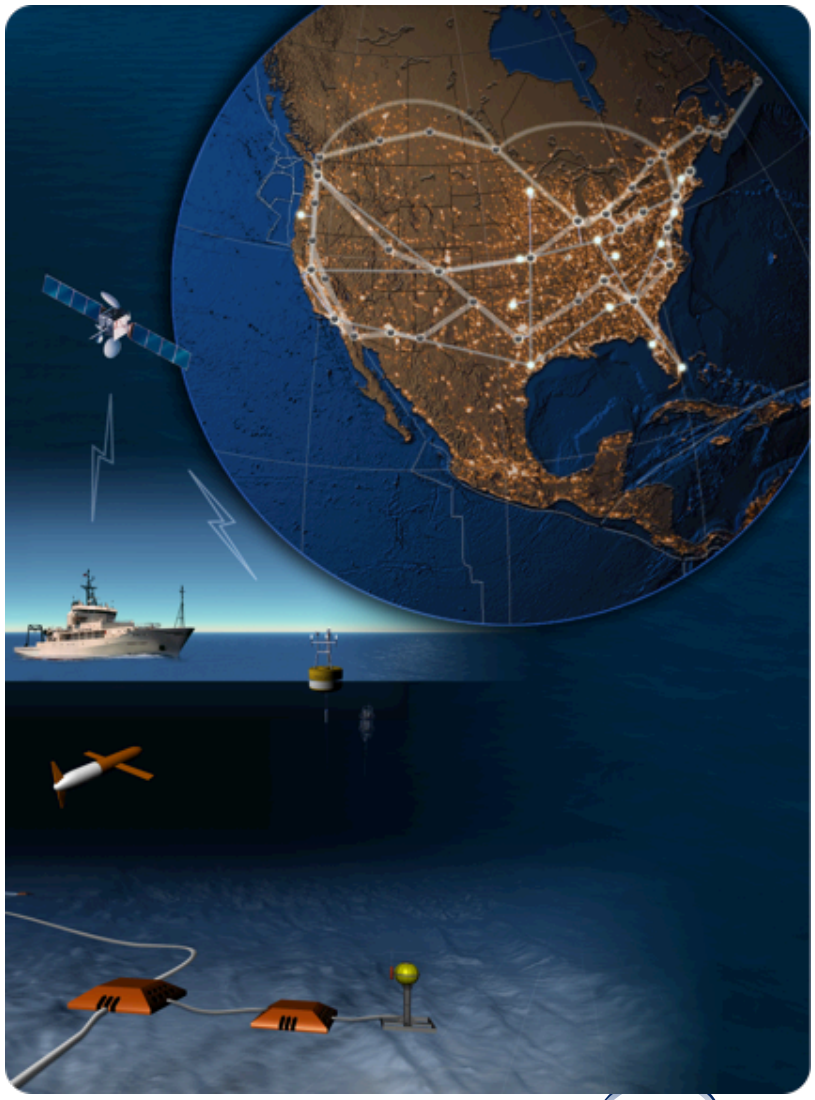
Capital expense -> operational expense!



Cloud Storage Basics

- Ephemeral/Transient Storage
  - Local virtual disk attached to an instance
  - Persists only for the lifetime of an instance
  - Included in the cost of an instance
  - Varying capacity, e.g., 160 GB-48 TB on AWS
- Persistent attached storage
  - Block storage volumes that can be attached to an instance
  - Lifetime independent of a particular instance, can be mounted by many
  - Price based on space and time used
  - E.g., AWS Elastic Block Storage (EBS), Azure drives
- Storage Clouds
  - Data storage as binary objects (BLOBs)
  - Price differs based levels of service, e.g., access time or reliability, space used and time
  - E.g., AWS Simple Storage Service (S3), AWS Glacier, Azure BLOBs, Google Cloud Storage

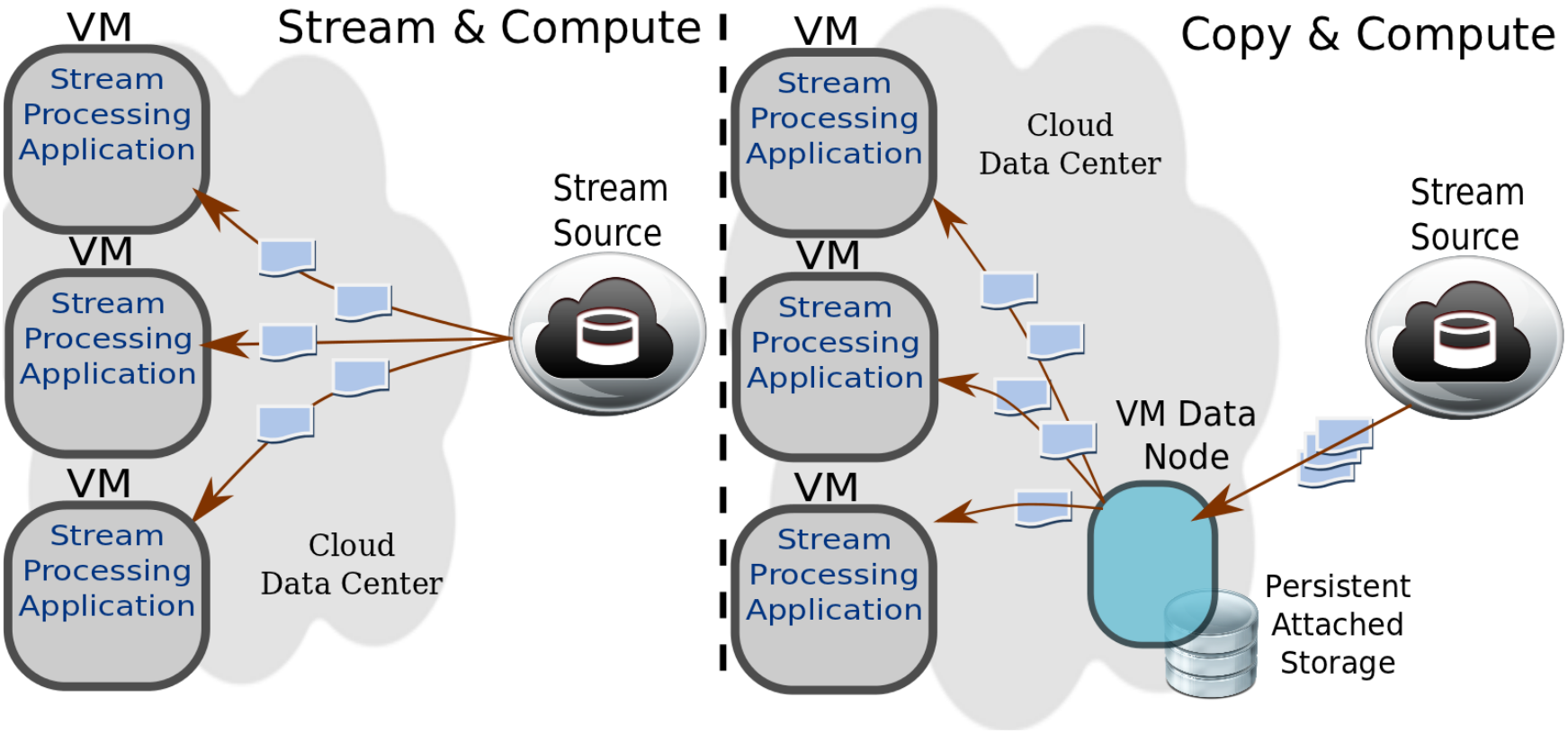
Streaming Applications



- Repeatedly apply an operation to a stream of data (time events)
- Examples:
  - Virtual Observatories: OOI, Forest project at ANL, IFC
  - Experiment processing: STAR, APS
- Requirements:
  - An “always-on” service
  - Real-time event-based data stream processing capabilities
  - Highly volatile need for data distribution and processing

ATLAS Data Analysis

Streaming Scenarios



Streaming Scenarios (2)

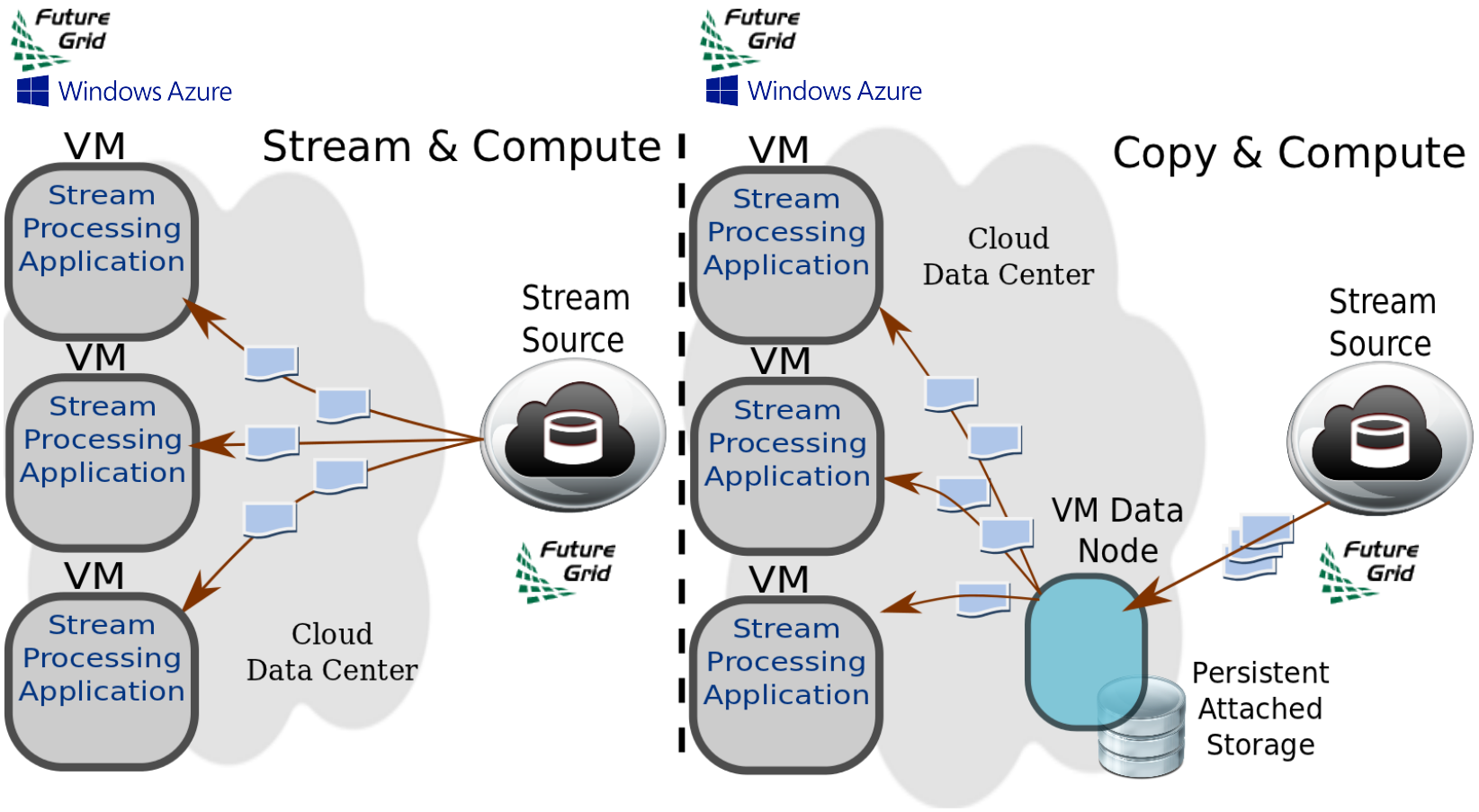
Stream&Compute (SC)

- Simpler model with fewer moving parts
- Potentially better response time
- Overlap computation and communication (potentially faster)
- Uses ephemeral storage (potentially cheaper)

Copy&Compute (CC)

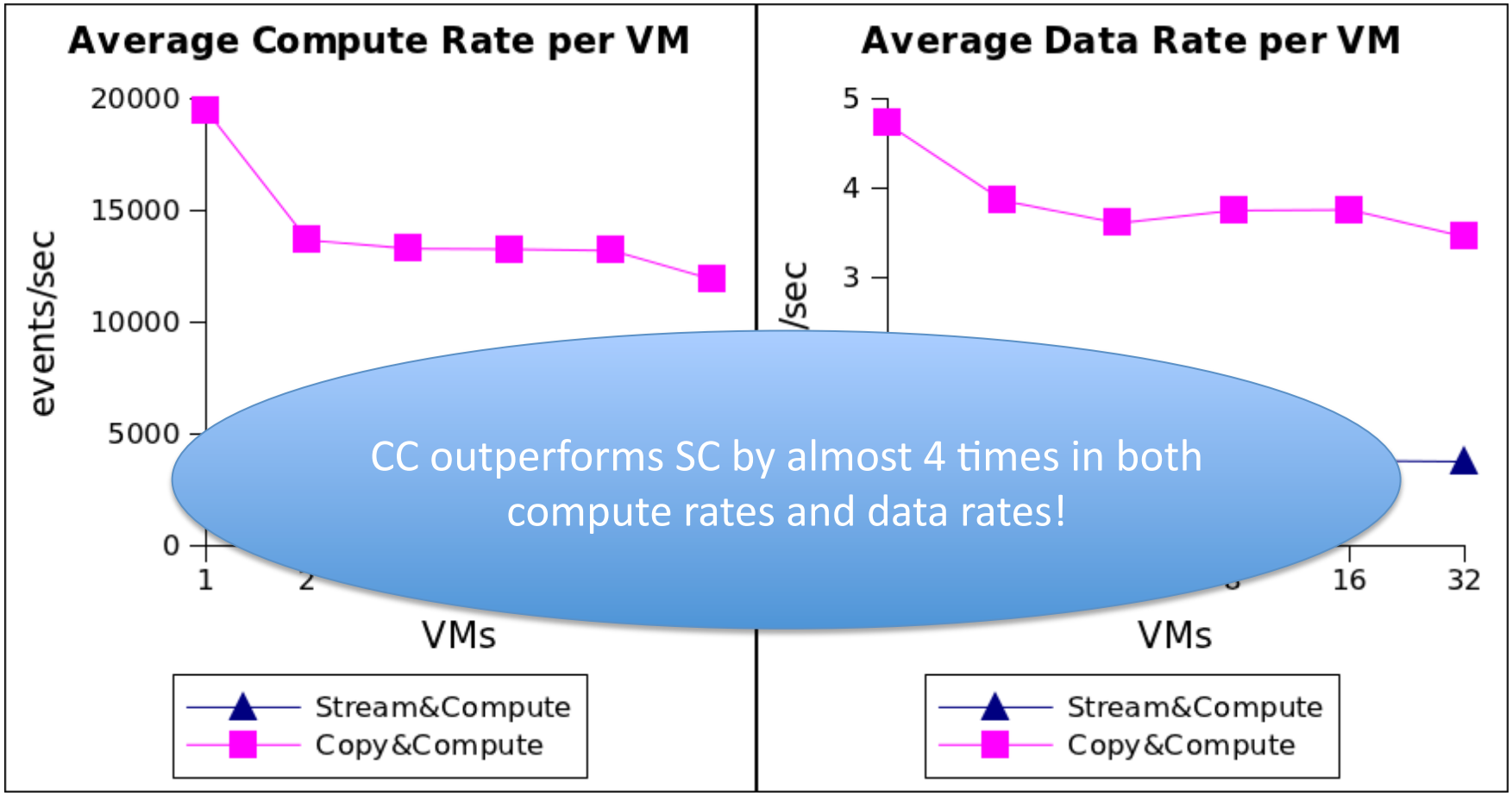
- Independent of network saturation
- Persistent storage: less liable to data loss

Experimental Configuration

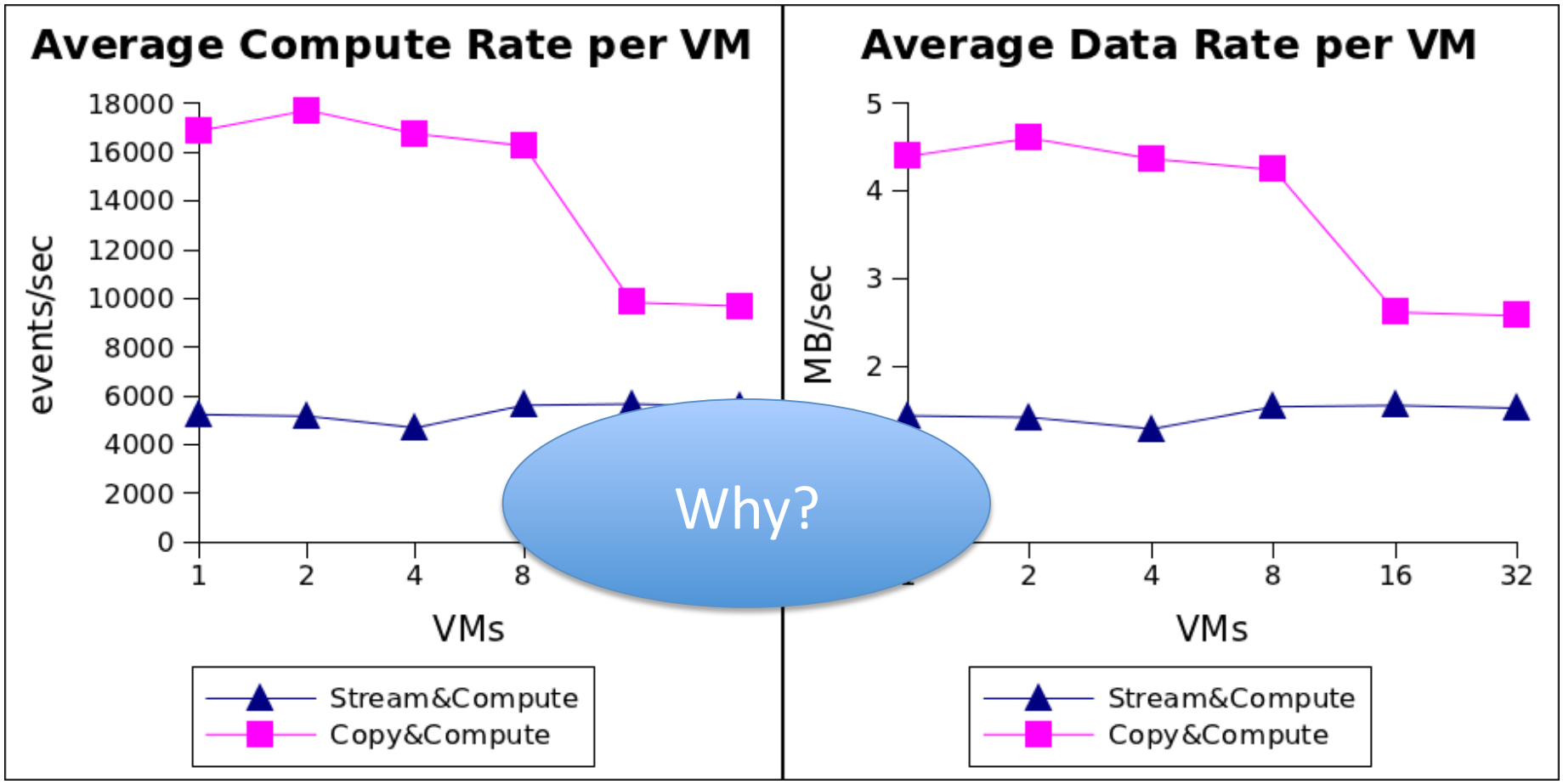


- *Compute rate: events processed per time unit*
- *Data rate: amount of data acquired per time unit*

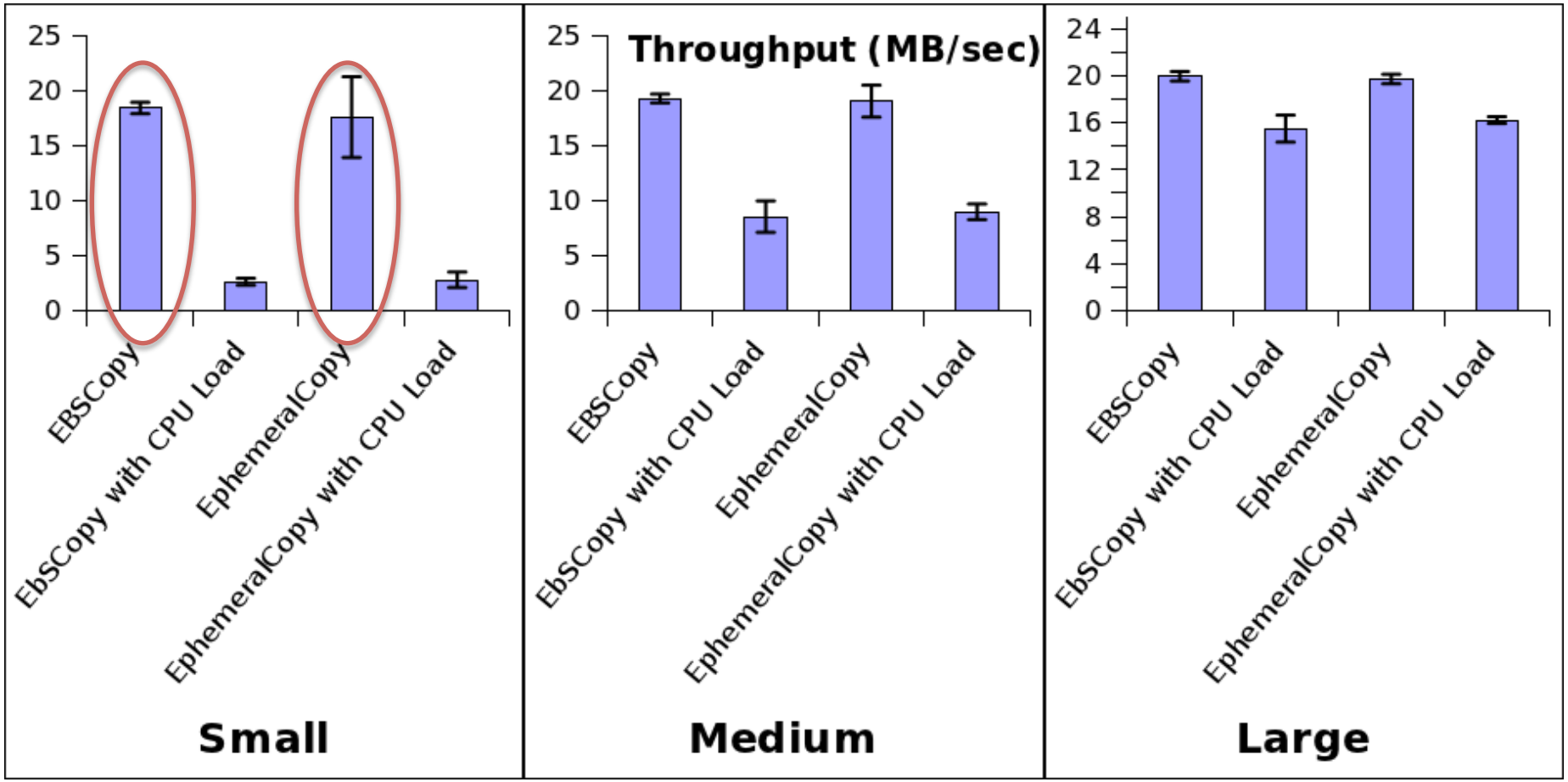
SC versus CC (FutureGrid)



SC versus CC (Azure)

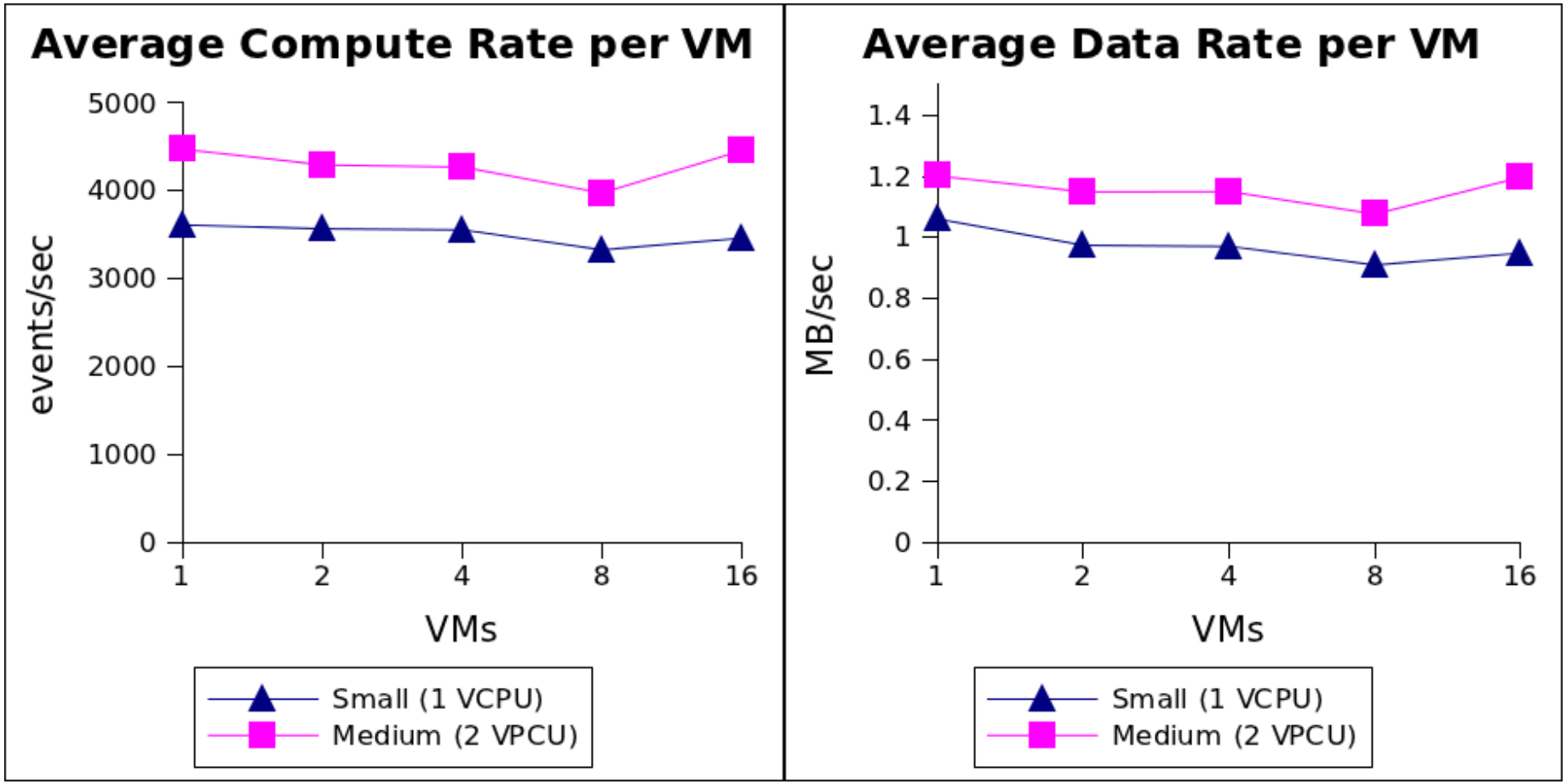


Data Throughput vs CPU Load

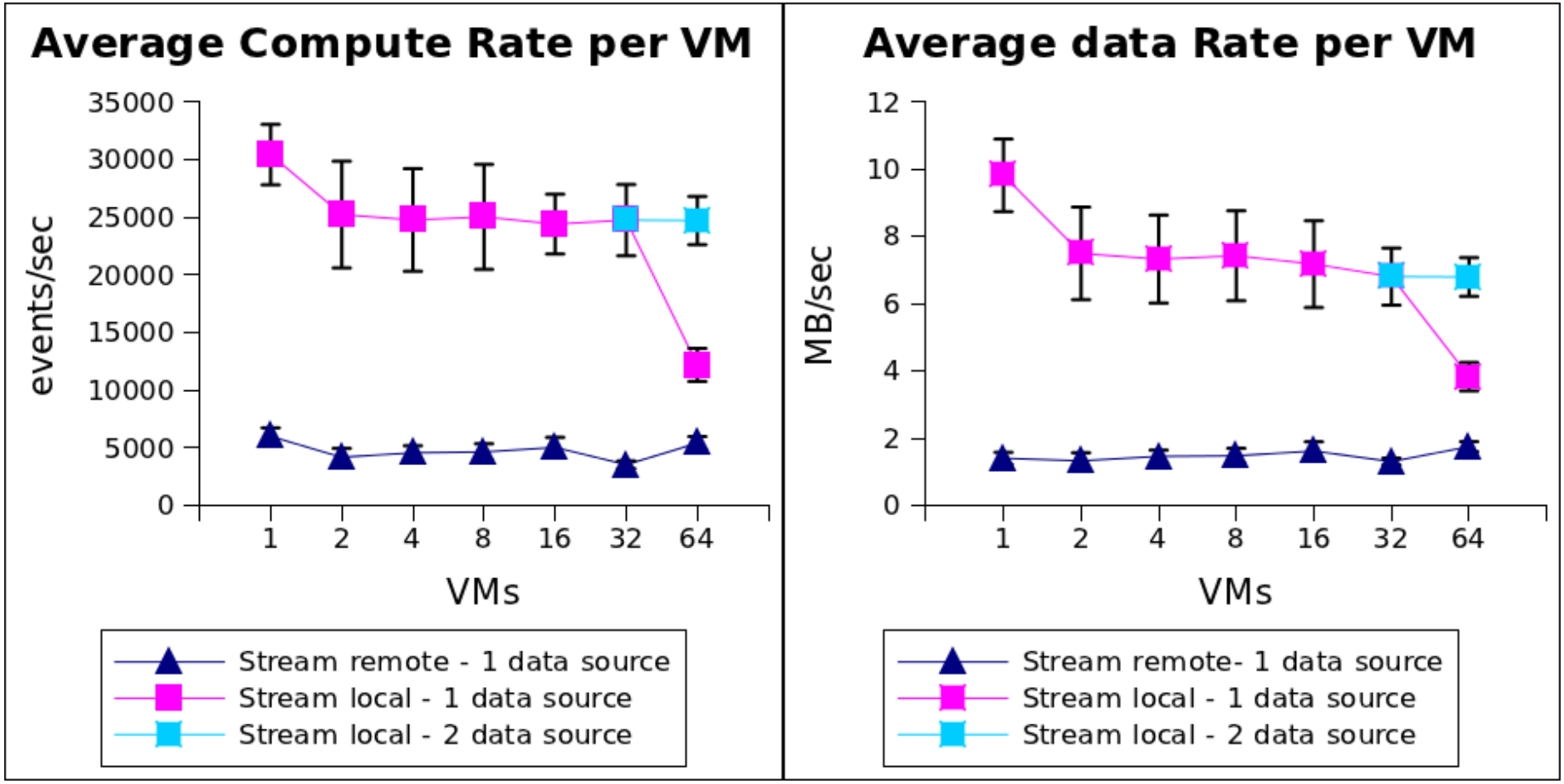


Multi-Core and Stream&Compute

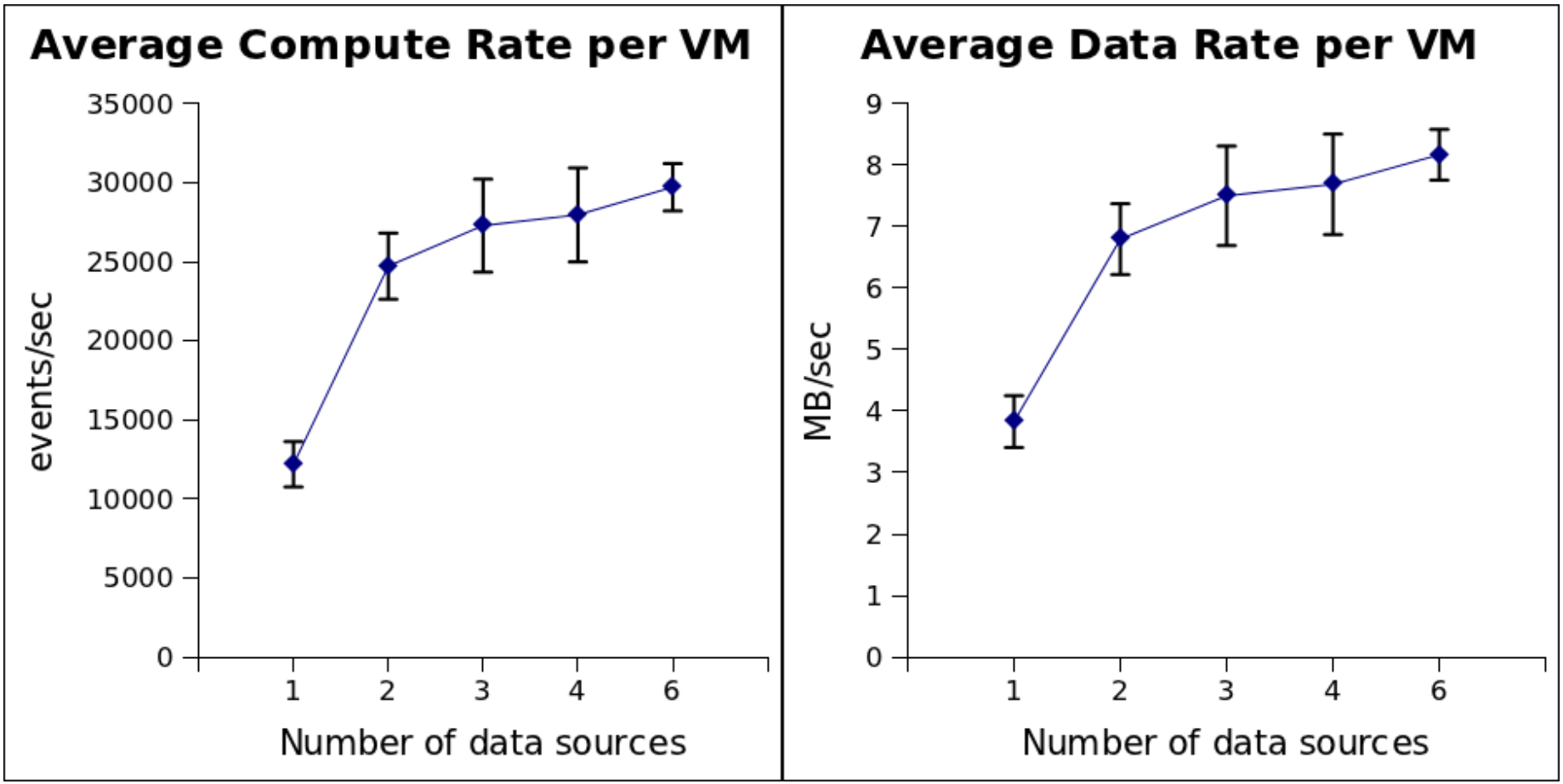
What is the impact of increasing the number of cores in instances on Stream&Compute?



Scalability for Stream&Compute



Scaling Data Sources



Cost

$$Total_{Cost} = \frac{TotalEvents}{CompRate_{Total}} * (N_{VMsData} + N_{VMsComp}) * VM_{Cost} + Storage_{Cost}$$

- Cost of instance: ~$0.1 per hour
- Cost of storage: ~$0.1 per 1GB month
- In our case (320M events & 5 GB attached storage)
  - Stream&Compute: $1.33
  - Copy&Compute: $0.48
  - Overall: SC is 2.77 times more expensive

Related Work

- Data management strategies for *large unstructured sets of static data* – we focus on dynamic time events
  - I/O Performance of Virtualized Cloud Environments, Ghoshal et al., DataCloud-SC '11
  - A Survey of Large Scale Data Management Approaches in Cloud Environments, S. Sakr et al. IEEE Communications Surveys and Tutorials
- Performance evaluations about data analysis in the clouds focus on the MapReduce processing paradigm - we focus on the stream processing model
  - On the Performance and Energy Efficiency of Hadoop Deployment Models, E. Feller et al., IEEE BigData 2013
  - Evaluating Hadoop for Data-Intensive Scientific Operations. Z. Fadika et al. CLOUD '12
- Stream processing studies – we focus on multi-site processing
  - GeoStreaming in Cloud, S. J. Kazemitabar et al. 2011
  - Scheduling processing of real-time data streams on heterogeneous multi-GPU systems, U. Verner et al., SYSTOR '12

Conclusions

- To stream or not to stream?
  - Not to stream!
  - Difference of ~4x in performance and ~3x in cost
- Amplification of virtualization performance trade-offs in the presence of remote traffic
- Hypervisor design
  - Need for controlled allocation of CPU to I/O processing
- *Paper: Tudoran et al., "Evaluating Streaming Strategies for Event Processing across Infrastructure Clouds", submitted to CCGrid*