HPC on Wall Street
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HPC, Cloud, Linux and Capital Markets Systems

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Risk Analysis on the Cloud: An End-User Perspective

Jeffrey Smart, Ph.D.

Introduction

- Business overview
- Risk Management challenge
- Compute platform
- Adding capacity
- Cost models
- Migration to the cloud
- Conclusions

Business Overview

- The Customer
  - Individual investor seeking retirement income for life
- The Product – Variable Annuity
  - Cash flow logic described in prospectus
  - Actual cash flows linked to market performance & policyholder decisions
  - Broadly similar to mortgage-backed securities
- The Issuers
  - Insurance companies
  - About $133 billion issued in 2015 (reference in appendix)

The Risk Management Challenge

- Financial Risk Management
  - Perform Monte Carlo scenarios to understand risks in the book
  - Rebalance hedges to offset risks
  - Time-sensitive!

- General comments
  - Classic financial batch / hedging / asset-liability management problem
  - Better analytics => understand risks => better hedges => lower P&L volatility
  - Better platform => lower expenses

The Compute Platform

- The computational platform must grow with the business
- Demand grows…
  - Products get more complex
  - The book gets larger (new sales)
  - Regulatory demands grow (including CCAR)
  - Reporting deadlines shrink
- ...and Supply must follow
  - Add internal capacity
  - Migrate to the Cloud

Adding capacity

Alternative	Pro	Con
Internal capacity	Experience via internal expansion	Initial capital expense Spikes in demand => low utilization
Run on cloud	Vast capacity Expense based on actual usage	Extend policies and procedures to run externally Expertise to build / operate cloud environment

Cost models

Internal grid

- Number of cores drives both:
  - Cost
  - Processing time
- Cut processing time in half?
  - Double the grid size (and cost)
  - No rebate for idle time

Cloud

- Size of workload drives cost
- Grid size drives compute time
- Pay for actual usage
  - 1k cores for 12 hours
  - 12k cores for 1 hour

Migration to the Cloud

- Project – CCAR analytics (Fed requirement)
- Month-end batch – Build experience
- Daily batch – Higher throughput
- Optimize and evolve – Business and technology innovations

Conclusions

- Cloud computing is a reliable and cost-effective platform for financial batch applications.

- There are a lot of moving parts – important to choose the right partners.

Appendix

- Reference for 2015 variable annuity issuance on Page 3:
  - Source: LIMRA Secure Retirement Institute U.S. Individual Annuities Sales Survey
  - http://www.limra.com/uploadedFiles/limra.com/LIMRA_Root/Posts/PR/_Media/PDFs/2015-Top-20-Rankings.pdf

Analytic Throughput: The Difference Maker

September 2016

Scott Jeschonek
Director of Cloud Products

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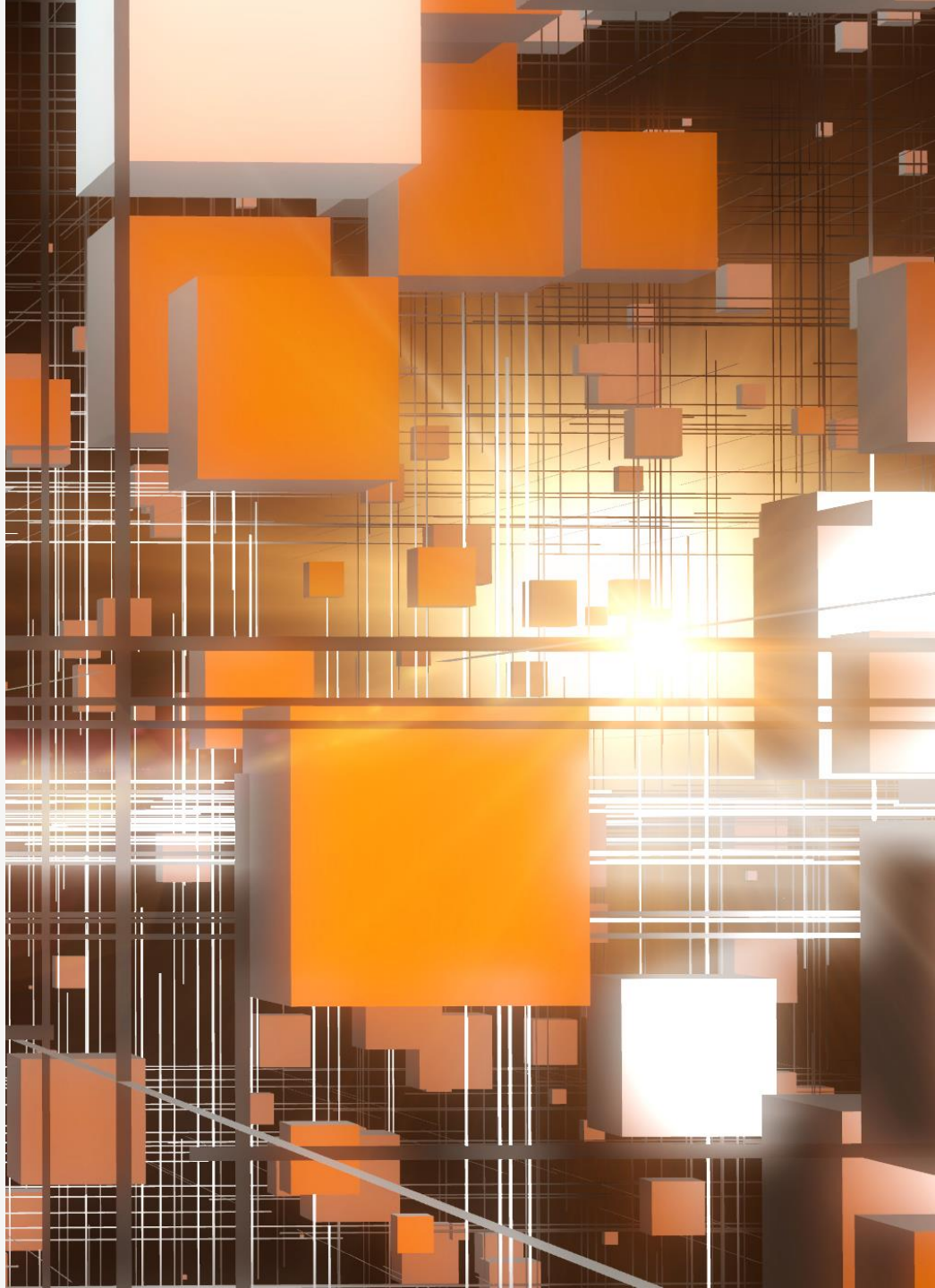


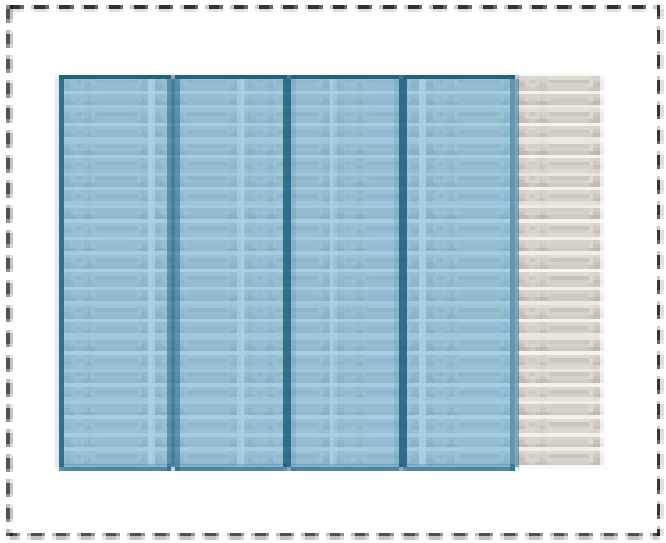
Analytic Throughput Defined

- Total analytic capacity available to your organization
- How many simultaneous jobs can you run
- How fast can you complete those jobs (and free that analytic capacity)
- How quickly can you add new capacity for your teams?
- The greater the Analytic Throughput, the greater the decision-making capacity

Examples of relevant Analytic workloads

- Volatility Modeling / Risk analysis
- Value-at-Risk modeling
- Portfolio rebalancing
- Monte Carlo Simulations
- Pricing analysis
- Near-real-time and batch activity

Computational Dimensions of Analytics



- Grid compute cluster
- 100s or 1000s of cores
- Scheduler sets up jobs based on available resources
- Jobs execute, access data, process, write results

KEY DIMENSIONS

Throughput – The rate of job processing
Capacity – The maximum number of concurrent jobs

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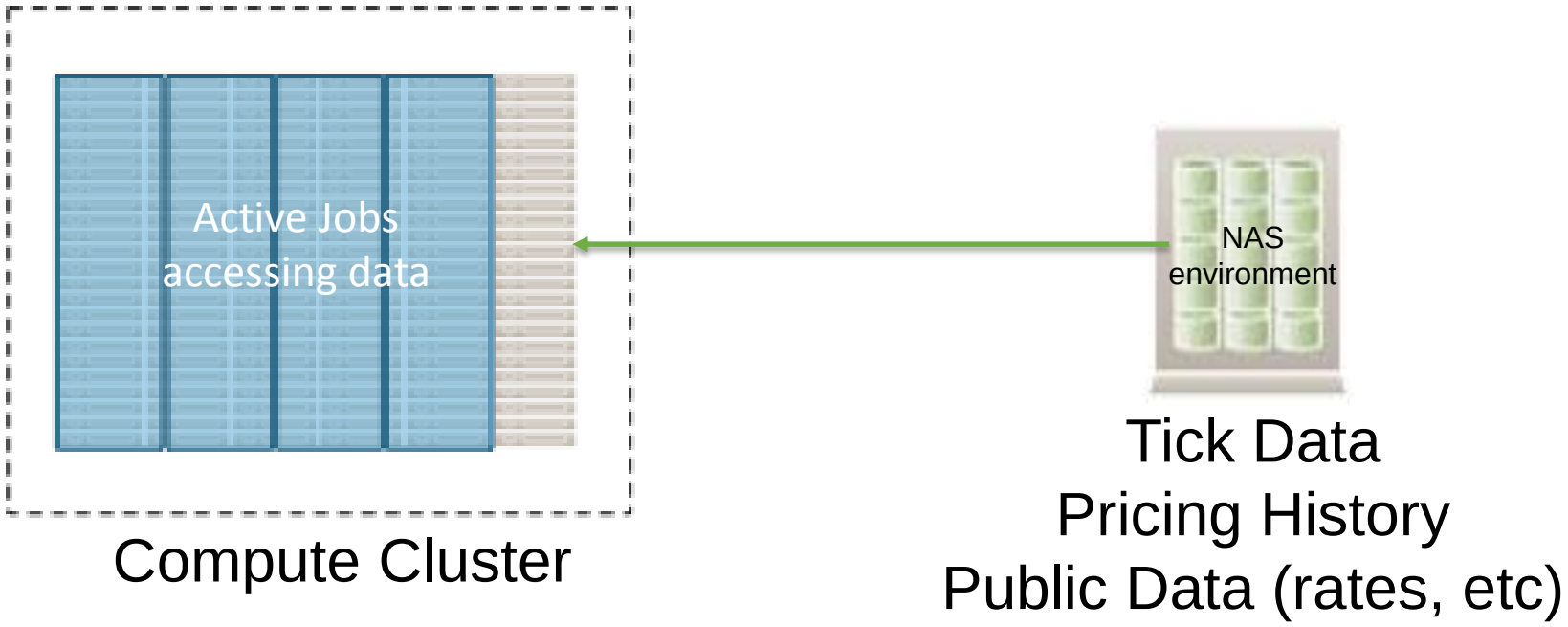
Analytic Latency: Negative Pressure on your Analytic Throughput



- Reduced capacity to run new jobs

- Less jobs = less information = less decision-making capability and increased risk (or lower alpha)

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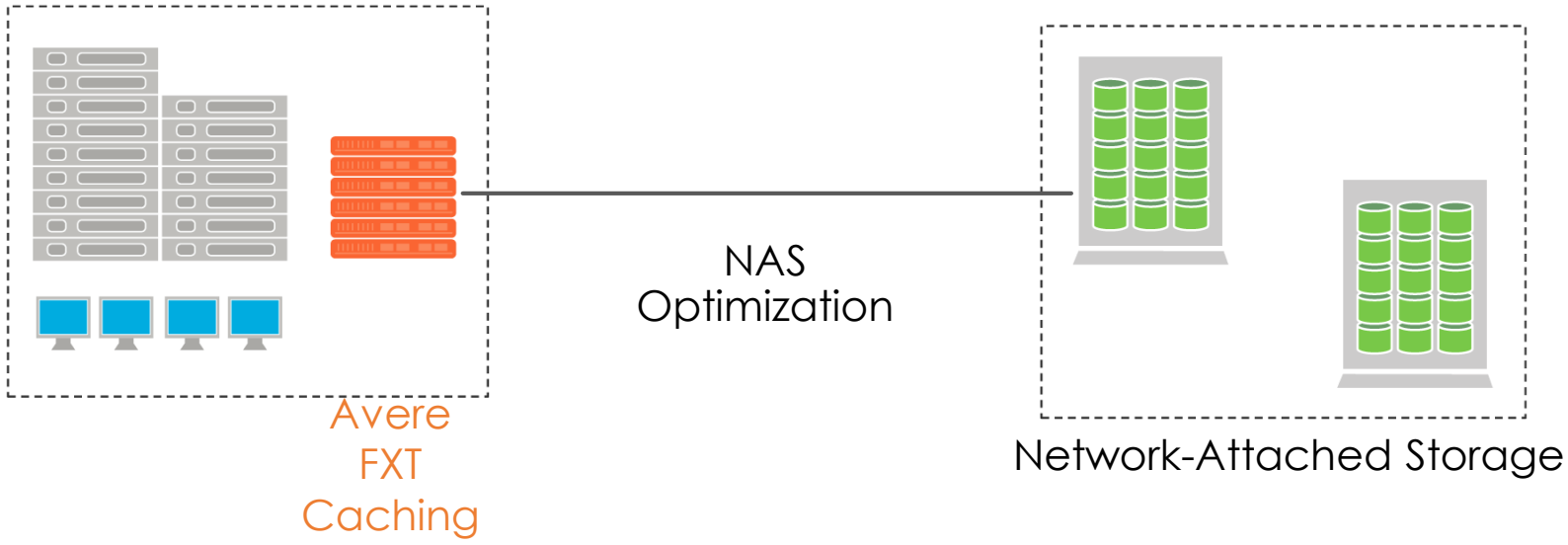
Sources of Analytic Latency

- **Network** – Insufficient bandwidth between cluster, data sources, scheduler, etc
- **Cluster** – Underpowered servers based on the demands of any given job
- **Data** – Access times between cluster and data source

Our focus is data:

1. Increased access demands outstrip storage capabilities, slowing responses, increasing latency
2. Network latency between cluster nodes and storage

Address Latency by locating data close to compute



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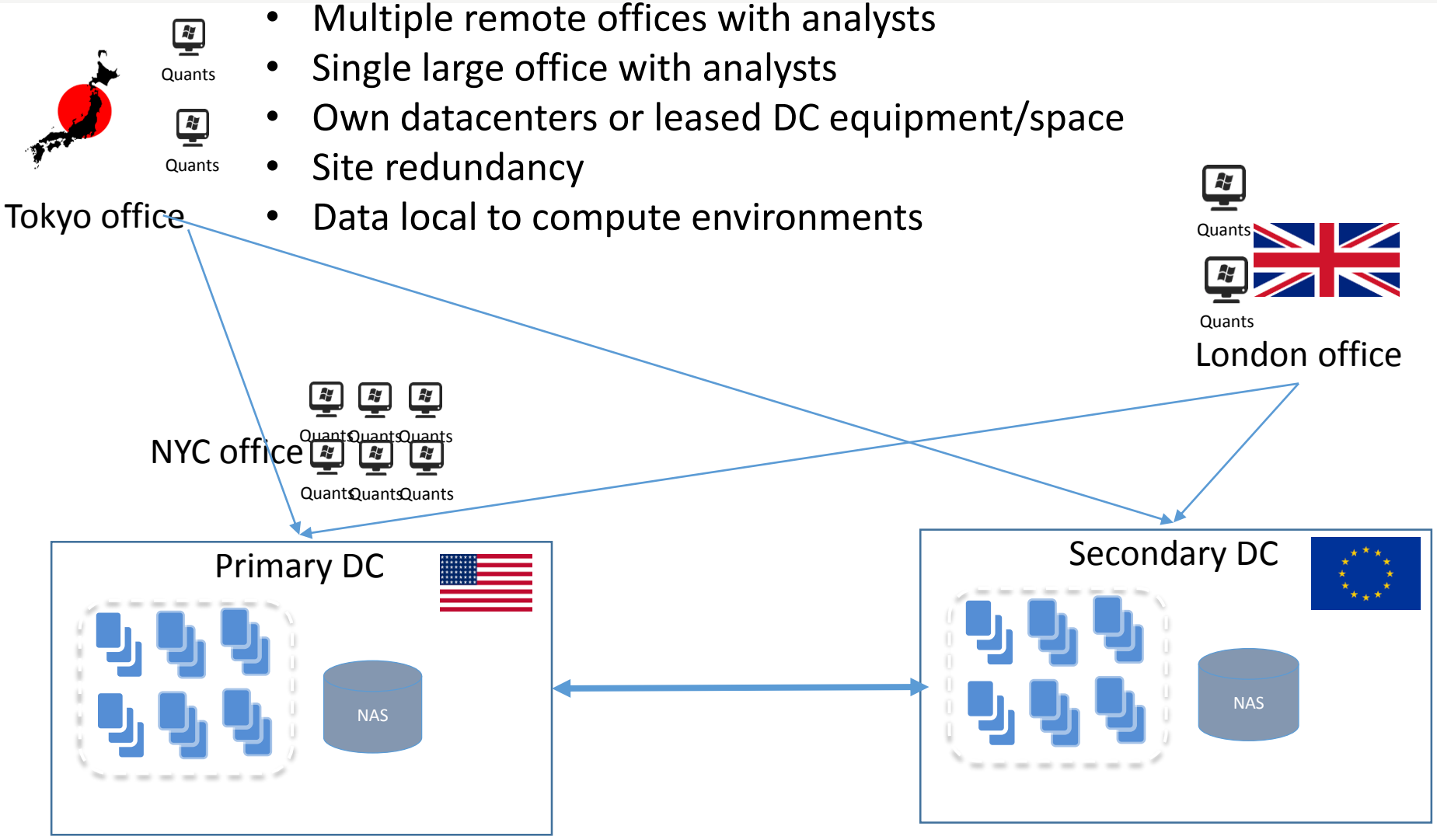
Capacity Decisions

Do you add to your physical data center?

Do you use one or more of the public clouds?

Expanding your capacity in the face of increased demands

- Multiple remote offices with analysts
- Single large office with analysts
- Own datacenters or leased DC equipment/space
- Site redundancy
- Data local to compute environments



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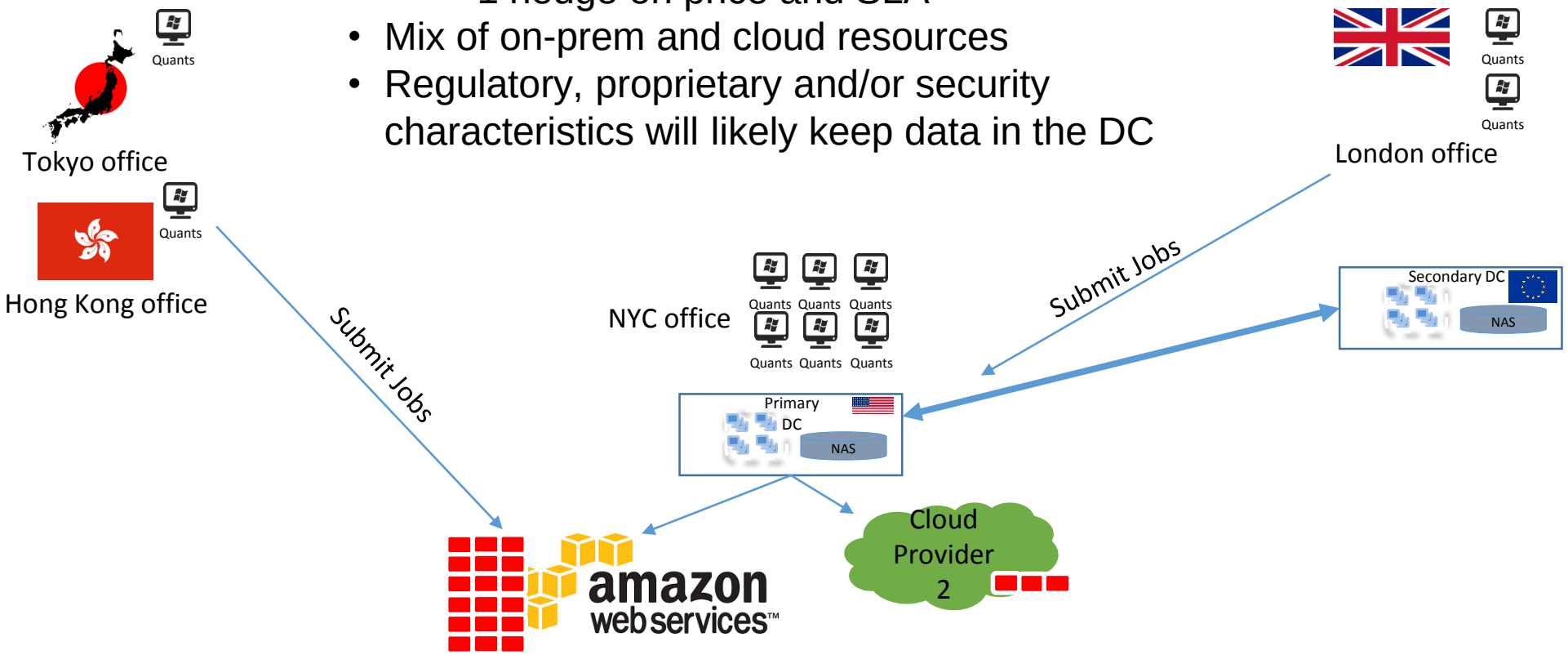
Hybrid Cloud

- Adoption of one or more cloud providers
  - > 1 hedge on price and SLA
- Mix of on-prem and cloud resources
- Regulatory, proprietary and/or security characteristics will likely keep data in the DC



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Processing Destined for Cloud Computing

High Core Count Applications:

Computationally intensive: Monte Carlo simulations, Back-testing, Batch

Read-heavy workloads: Reading in large amounts of historical market data

Batch or burst usage model: Running simulations overnight

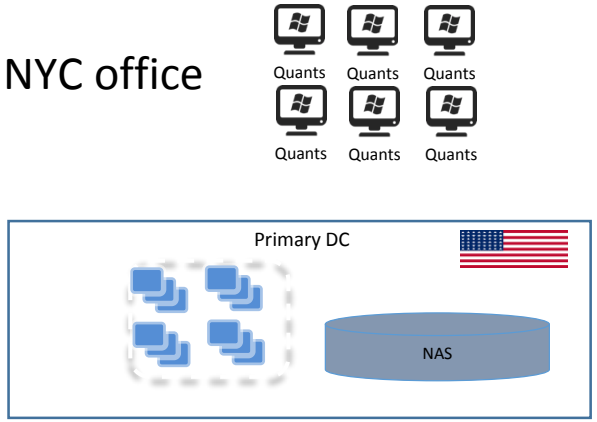
Evolving to an on-demand pricing/risk option: Near real-time pricing execution

One Practical Approach to Leveraging Public Cloud

Locate “parity” work in cloud compute:

- Batch
- Back-testing
- Simulation work

Use Cloud Services where applicable (e.g., Query Engines, Machine Learning)



Use local DC in two ways:

1. Until current assets are retired

2. Ongoing R&D / Best-in-Breed technology facility…tech that is ahead of the public cloud lifecycle

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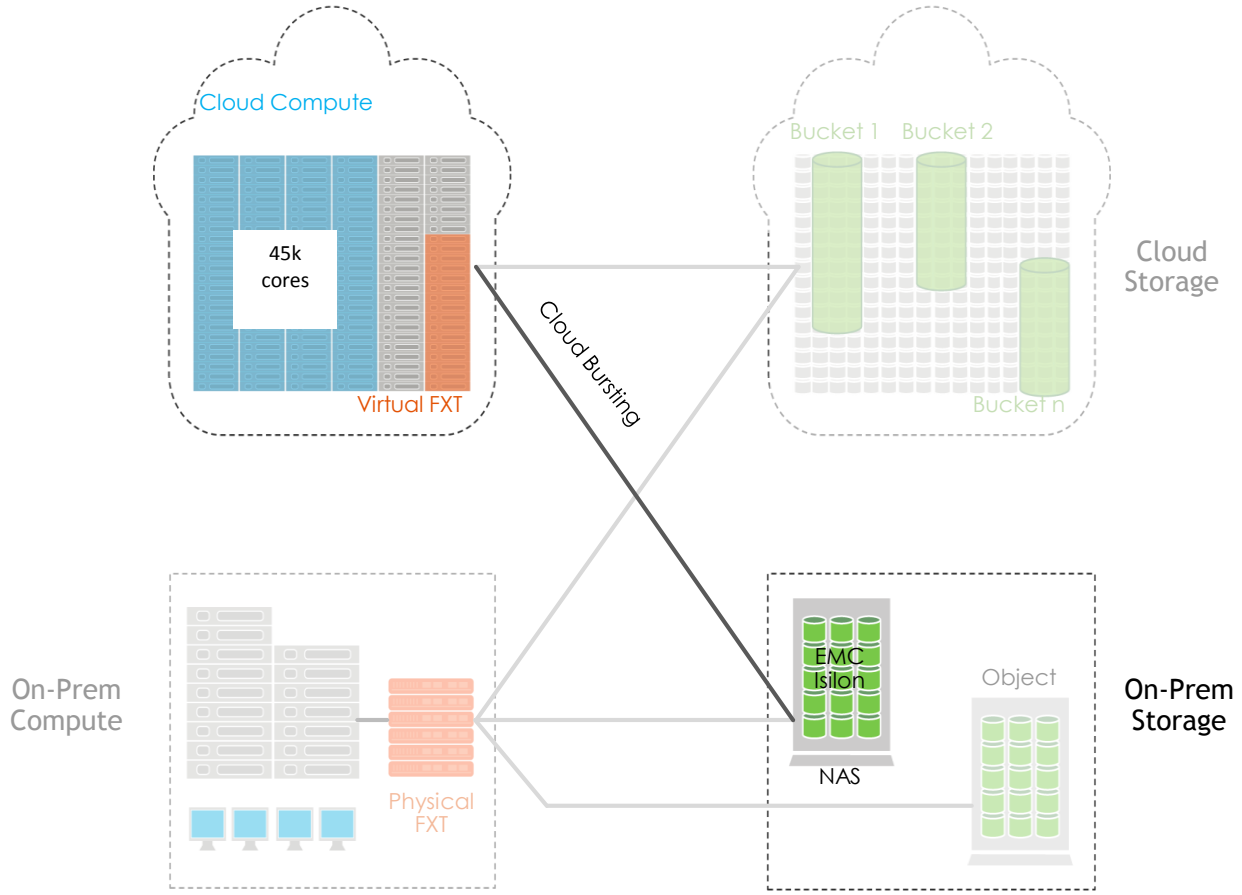
FS Use Case: Market Risk Analysis with Cloud Bursting



Customer Challenges

- Simulation complexity increasing
- Run 10-100x more simulations
- Finish models in less time
- Reduce $/simulation

Avere Benefits

- vFXT provides scalable file system for cloud
- Scale to more than 45k compute cores
- Auto-caching of data from on-prem storage
- Cloud economics: zero footprint, easy to turn on/off, pay only for what you use

Actual Customer Results

- 45k cores used in Major Cloud Provider

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Summary: Avere Systems Technology Increases your Analytic Throughput

Increase your alpha potential and limit your downside risk

- Run more analytical workloads in less time with the same storage footprint
- Optimize your workload location based on its business value, not framework configuration
- Compliment and extend your existing physical datacenter by using one or more public clouds, basing decision on price/performance

Optimize your physical infrastructure to reflect your competitive advantage

- By accelerating access to data and making access available to a larger number of concurrent assets
- By moving lower-priority workloads to either lower-priority assets or to public clouds

Increase your flexibility by limiting data gravity

- Make data available to compute environments wherever they may be
- Store your data where it makes the most regulatory or competitive sense

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Keeping Pace with Growing High Performance Computing Needs

SUSE Linux Enterprise Server for High Performance Computing

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HPC in Banking & Financial Services Rely on SUSE

- **Risk modeling** in determining aggregate risk in financial portfolios
- **Fraud detection** in real time as millions of transactions are processed between disparate systems
- **High-frequency trading** applications to execute trades milliseconds before competitors
- **Pricing and regulatory compliance** applications
- **Big data applications and predictive analytics**

Banking & Financial Services firms running SUSE Linux Enterprise Server

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The SUSE HPC Stack

- **It's SUSE Linux Enterprise Server**
- **New!** ***Ceph File System*** supported
- **New!** Available as part of ***Intel HPC Orchestrator***
- **New!** ***Microsoft Azure*** Test Drive includes SLES for HPC
- Recent developments:
  - ARM64 partnering with Cavium, ARM, and Applied Micro
  - Microsoft Azure w/SLES 12: RDMA and Infiniband
  - Latest hardware enablement (Intel, POWER)

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Partnering with Intel on OpenHPC Project

Intel distributes **SUSE Linux Enterprise Server for High Performance Computing** as part of the ***Intel HPC Orchestrator***

SUSE is the commercial Linux supported by the Intel HPC stack

- Delivers a fully supported stack for HPC workloads
- Accelerates research/innovation and time to insight
- Aligns new optimized components driven by the broader **openHPC.community**
- Simplifies ongoing maintenance and support

https://www.suse.com/promo/intel-suse-hpc-stack

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The OpenHPC Ecosystem

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Thank you!

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