Financial Risk Management Analysis: Challenges, Changes and the Cloud

April 2016
Overview

- **Our End Customer**
  - Retail investors seeking retirement income for life

- **Issuers**
  - Life insurance companies

- **Product**
  - Variable annuities with living benefit rider
  - Cash flow logic described in prospectus
  - Contingent on market rates and policyholder behavior
Business Goals for Risk Management of Variable Annuities

- **Risk Management / Hedging**
  - Compute values and risk statistics for retirement savings policies
  - Analytics inform daily hedge decision-making
  - Assets under management have grown from $10 B in 2007 to $40 B in 2015

- **Valuation**
  - Support GAAP financial reporting

- **Capital Management**
  - MRM performed analytics for CCAR (capital requirements) in 2013, 2014
  - Computationally intensive, and original driver for cloud computing
  - Capital Management analytics have moved to another department

- **Support product development**
  - Evaluate new products and feature changes
Business process for hedging

- Calculate values and risk profile
  - Actual P&L: from full revaluation
  - Expected P&L: Risk sensitivities times market moves
  - Understand actual vs. expected P&L

- Identify hedge instruments (e.g., futures contracts) to offset selected market risks

- Constant demand for latest information

- Scale:
  - $40 B Book runs overnight on 8,000 cores
  - Higher compute capacity gives flexibility
Business process (con’t)

- Increasing demands from business side
  - Product complexity grows
  - Assets under management grow
  - Reporting deadlines shrink
  - Higher model resolution / fewer approximations

- Technical constraints
  - Internal grid: too small when it’s running / too big when it’s idle
Overview

- Multi-year evolution of the computational platform
  1: Internal data center migration
  2: Run a project on the cloud
  3: Run month-end batch on the cloud
  4: Run daily production on the cloud
  5: Decommission internal grid

- Considerations for internal vs. external capacity
Step 1: Internal data center migration

- Capacity expanded
  - 10x more cores…
  - …in 2 time zones (to cut operational risks)
  - …for more users (quota vs. "my hardware")

- Cut month-end batch from 4 weeks to 4 days

- Multi-department grid sharply increased utilization, driving down costs
Step 1: Internal migration (con’t)

- **Technical**
  - New data center: infrastructure new from bare metal up
  - New capabilities: fault-tolerant, pooled resources
  - Issue resolution: infrastructure, or application?

- **Organizational**
  - End-users pooled resources; from “my hardware” to quota
  - Migration was a Company-wide initiative
  - Resources stretched thin, so stay organized
  - Successful migration is win/win for IT and business users
Step 2: Run a project on the cloud

- Deliverable
  - CCAR Stress Tests mandated by the Federal Reserve
  - Needed 4x increase in capacity
  - High visibility project
  - Enabled critical mass of internal resources
  - Recognition for success

- Semi-annual project
  - Manual intervention feasible

- It doesn’t get better (or worse) for a pilot
  - Critical, highly visible, but tweakable
Step 2: Cloud Project (con’t)

- **Technical**
  - Modify architecture for larger, external grid
  - More complicated than adding execute nodes to existing grid
  - Incorporate Information Security requirements
  - Modified workload (different CPU / IO balance)
  - New stresses on network, schedulers
  - Managing results (output data) is important

- **Organizational**
  - More people and organizations involved
  - Establish roles / responsibilities
  - New cost model
  - Internal: cost and run-time scale with number of cores
  - External: cost scales with core-hours; cut run-time at fixed cost
Step 3: Run month-end batch on cloud

- Deliverable
  - Complete month-end runs faster

- From project to process
  - Increase reliability, stability, automation
Step 3: Month-end batch (con’t)

- Technical
  - Run internal, external grids in parallel; mitigates risk of down-time
  - Higher capacity cuts delivery time
  - Optimize ongoing process (vs. one-time project)

- Organizational
  - Build track record of success
  - Refine roles/responsibilities with more experience
Step 4: Run daily batch on cloud

- **Deliverable**
  - Reduce cost
  - Increased capacity enables model refinement

- **High demand for throughput, reliability**
  - Less room for manual intervention

- **Hedge on market opening** — markets don't wait
Step 4: Daily batch (con’t)

- **Technical**
  - Focus on reliability
  - Overnight batch has less recovery time vs monthly
  - Continue to optimize for reliability, cut expenses

- **Organizational**
  - Continue to refine roles / responsibilities
Step 5: Decommission internal grid

- Cost reduction
  - Measure workload in core-hours
  - Binding constraint: 8 hours for overnight runs
  - Internal: number of cores drives cost
  - Idle time has implicit cost
  - External: workload size drives cost, not core count
  - More cores / faster batch / same cost

- Simpler process: one environment vs two
Step 5: Decommission internal grid (con’t)

- Internal and external cost models are different

<table>
<thead>
<tr>
<th>Factor</th>
<th>Internal Grid</th>
<th>External Cloud</th>
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</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>Fixed</td>
<td>Variable</td>
</tr>
<tr>
<td>Cost</td>
<td>Based on grid size</td>
<td>Based on usage</td>
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<tr>
<td>Accounting</td>
<td>Capital Expense + Operating Expense</td>
<td>Primarily Operating Expense</td>
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</tbody>
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Lessons Learned

- Technical
  - Make long-term plan / show incremental progress
  - Seize opportunities
  - Optimize over the right time horizon
  - Performance changes with size; rewards monitoring
  - Schedulers do not fail gracefully

- Organizational
  - Principles of project management apply
  - Revisit roles / responsibilities as scope grows
  - Understand constraints, cost models
Questions?