

DESIGNING MULTI-CLUSTER APPLICATIONS

LUCAS BEELER

GRIDGAIN SYSTEMS, INC.

WHO AM I?

- Professional Services Architect at GridGain Systems
- A post-sales role—I help customers design and build GridGain-based applications
- Worked at GigaSpaces in the same role before joining GridGain
- This presentation is the result of hard-won experience designing and building systems for my largest clients
- The approach I'm going to present may seem antithetical to received wisdom about "correct" or "best practices" IMDG application design





WHAT IS THIS TALK ABOUT?

- Building multi-cluster applications
 - Single applications whose functionality is implemented over multiple IMDG clusters
- A **cluster** is a distributed in-memory data grid that supports collocated processing
- An application is a deployable set of code artifacts that deliver a coherent, unified collection of business functions; when these artifacts are executed, they run over a cluster
- We usually think of deploying a code artifact—like a JAR—to a cluster, but here we're talking about deploying multiple artifacts to multiple clusters
 - We do this for separation of concerns and orthogonal evolution and scalability



AGENDA

- Conceptual overview of modern IMDG functionalities
- An example single-cluster application and its limitations
- The advantages of transitioning our application to a multi-cluster design
- Case study implementations
- Question & answer



FUNCTIONS AN IMDG APPLICATION MIGHT PERFORM...

- In-memory caching of data in its native object form (obviously!)
 - No ORM
- Analytics
 - Type classification (what kind of a thing is this?)
 - Domain-specific performance analysis (how well did that work?)
 - Statistical learning
- Stream data ingestion and ETL operations
- Event processing ("reactive programming", "triggers")
- Provide a local mirror of SaaS data—possibly in a different form—or push data to a SaaS service
- Integrate data many sources in a unified queryable store



HOW DO IMDGs ACCOMPLISH SUCH A RANGE OF TASKS?





Image from and may be copyrighted by IBTech QNB A.Ş and Hazelcast, Inc.

HOW DO IMDGs ACCOMPLISH SUCH A RANGE OF TASKS?





Image from and may be copyrighted by GigaSpaces, Inc.

HOW DO IMDGs ACCOMPLISH SUCH A RANGE OF TASKS?

Data Advo Clust	Grid Compute Grid Service SQL Grid Inced File Streaming Dat System Struct	d ta ures
Signite and center	C++ SQL Integrations Hadsop/Sperit Tools Log In Javed	oc Examples Adkis Question
SQL Contracted ICC.	Machine Learning	Q Search
COMPUTE GRID Ignite Compute Skill Daminuted Compress	Overview & Apache Ignite Machine Learning (ML) is a set of simple, scalable and efficient tools that allow	THELE OF CONTENTS



"IMDGs, in general, suffer from a caching stereotype. GridGain smashes that stereotype by offering a general purpose compute grid. If you need an IMDG and a super-computer all in one then take a look at GridGain Systems." (Mike Gualtieri, Forrester)

In-Memory Computing S U M M I T Strik

Images from and are copyrighted by GridGain Systems, Inc., the Apache Software Foundation, and Forrester Research

AN APPLICATION: LET'S IMAGINE...

- We're a regional bank
 - We have 12 branch offices and 104,000 customers
- We do all the things that commercial banks do:
 - We take deposits: cheques, cash, electronic direct deposit, etc.
 - We allow withdrawals: cash, cheques, debit card, etc.
 - We issue credit cards associated with a processing network (e.g., Visa or MasterCard)
 - We make loans
 - We manage relationships with our customers and would like them to engage with *more* of our products
 - Assume we're US-based: we comply with both state and federal banking regulations







CAN WE TALK ABOUT HOW AWESOME THIS IS?

- Yeah, we process transactions.
- But also...
 - When a customer uses his or her ATM/debit card to get cash at a foreign cash point, we push a notification to our cloud CRM system
 - If that customer doesn't already have our SkyPoints[™] Airline Rewards MasterCard (issued in conjunction with Alaska Airlines and Emirates), we send him or her a spiffy marketing email
 - The system provides us with rich primitives for building functionality—amazing!
 - Class StreamReceiver and StreamTransformer
 - Compute, service, and event processing APIs make it easy to implement a rules engine



HOW DID WE IMPLEMENT THIS?

We followed "best-practices" design protocols for clustered IMDG applications

- Assume that inside the grid, one important datatype is a CustomerTransaction POJO
- Shared-nothing for maximum collocation
 - All cluster nodes are identical in configuration and can complete our entire business workflow within a single memory image
 - There is no shared state between nodes, so network movement between nodes is necessary
 - We can stream FedWire transaction receipts to the same node where the final CustomerTransaction POJO that corresponds to the receipt will be stored and ETL them "in-place" from FedWire XML to CustomerTransaction POJOs
 - Nodes holding CustomerTransasction instances of importance for marketing purposes can transform them into a REST JSON message and push that message out directly, from their local memory images, to our cloud-hosted, SaaS CRM service
 - If we want to increase total system capacity, all we have to do is **add another node**



SO WHAT'S ON EVERY NODE?

- We followed "best-practices" design protocols for clustered IMDG applications—"shared nothing"
 - CustomerTransaction POJO instances
 - FedWire StreamReceiver
 - Visa Processing Network StreamReceiver
 - ACH StreamReceiver
 - Audit Database CacheStoreAdapter
 - Cloud CRM Pusher Service
 - Branch Terminal Query Service
 - Settlement Processing Query Service



COOL. BUT WHAT HAPPENS AT MIDNIGHT EASTERN TIME?



In-Memory Computing

IT'S MIDNIGHT. LET'S ADD EXTRA CAPACITY...





SO LET'S LEAVE "SHARED NOTHING" BEHIND...

• We will have multiple clusters (physical or logical) made up of different kinds of nodes

- Often called "subclusters"
 - "Shared nothing," uniform provisioning and horizontal scaling (add another node) will still apply within a subcluster. It's just that now we have multiple subclusters.
- What we give up
 - DevOps isn't simple anymore—we no longer have just one cluster node image; we have several
 - We can no longer scale the entire system by adding a node, instead we scale along different scaling axes
 - Each subcluster represents a different scaling axis
 - We can't complete our entire business process without sharing data between nodes and performing network operations—we've broken shared nothing across the entire cluster.
- We'll talk about what we **gain** over the next few slides



WHAT WILL WE DO?





HOW WILL WE DO IT?

<bean class="org.apache.ignite.lgniteConfiguration">

```
<property name="userAttributes"></property name="userAttributes">
```

```
<map>
<map>
<entry key="role" value="fedAchReceiver"/>
</map>
</property>
```

•••

•••

</bean>



IMMEDIATE ADVANTAGES

- All FedWire and ACH ETL operations are separated from nodes that store data
 - Queries don't slow down when FedWire and ACH message volume is high
- We can bring down our Ingestion Subcluster and upgrade our FedWire and ACH ETL logic without affecting our Data Subcluster at all
 - No data movement, no rebalancing, no network saturation
 - Data cluster never enters an intermediate topology state
 - This is "orthogonal evolution"



ORTHOGONAL SCALABILITY





ORTHOGONAL SCALABILITY





ORTHOGONAL SCALABILITY





CASE STUDIES: DESIGN THEMES

MARTINFOWLER.COM

Intro Videos Design Agile Refactoring FAQ About Me All Sections = Thought

CQRS



Martin Fowler 14 July 2011

CQRS stands for **Command Query Responsibility Segregation**. It's a pattern that I first heard described by Greg Young. At its heart is the notion that you can use a different model to update information than the model you use to read information. For some situations, this separation



Image from and may be copyrighted by Martin Fowler or ThoughtWorks, Inc.

- Customer is a large wealth management firm:
 - About \$1 trillion in assets under management
 - Actively trades in financial markets to help institutional investors like pension funds grow wealth over time
 - Had a requirement that queries had to be very fast (on the order of microseconds) to feed other enterprise systems
 - However, trade tickets arrive in the cluster via a queue in a primitive format that is useless for data consumers without enrichment







Customer is one of the largest fitness center operators in the US

- About 300 gym clubs and 4 million members
- A decision was taken to move customer engagement management (marketing campaigns, etc.) and subscription management (billing, etc.) from internal, on-premise systems into a cloud-based SaaS CEM/subscription management provider
 - Lowers costs: software engineers are expensive, as is hardware and the people who maintain it. It was cheaper to pay a fee to the SaaS provider than it was to maintain the staff required to develop, operate, patch, and maintain internal systems for the same purpose.
 - Subscription management is an ancillary business activity. The company would much rather devote its time to improving quality of its facilities, creating innovative subscription offers, pricing tiers, etc.



However...

- The customer had concerns about 24-7 availability of data stored by the SaaS provider. The SaaS data is crucial to business functions and cannot be unavailable, even in the event of network disruptions, DDoS attacks, outages, etc.
- Outages do happen, even for very well maintained web providers: both Netflix and Gmail have suffered recent, high-profile outages
- The SaaS provider has its own data model. This model is not fully compatible with the customer's internal business object model.
- The SaaS provider only supports storing certain kinds of data that match its data model. If you can't express your data within the constraints of the SaaS provider's model, you're out of luck.
- Hence, a lot of business data still had to be kept on-premises
- The customer wanted the ability to join on-premise data with SaaS hosted data by querying a single, internal system







CASE STUDY THEMES

- In both cases, interacting with external systems was critical to the business functions of the system
 - The time required to communicate with external systems (e.g., the WAN link to the cloud SaaS provider) dwarfed any time costs associated with local data movement, so by breaking shared nothing, we weren't going to degrade performance
- In one case, compute-intensive ETL operations were required
 - The time required to complete these computations were several orders of magnitude greater than network movement time
 - The same is true for other compute-intensive tasks like machine learning and statistical classifaction
 - Sometimes, you can't do HTAP in one cluster; you need a multi-cluster design



A CAPABILITY-MATURITY MODEL FOR IMC

Multi-Cluster Applications

Collocated Computation Run code and services "on

Run code and services "on top of" the data objects over which they operate

Caching Objects

Fronting a database for speed, scale

