Designing a Workload Scenario for Benchmarking Message-Oriented Middleware

Kai Sachs*,
Samuel Kounev*†,
Marc Carter ‡,
Alejandro Buchmann*

* Databases and Distributed Systems Group, TU Darmstadt / Germany
† Computer Laboratory, University of Cambridge / UK
‡ IBM Hursley Labs, Hursley Park, Winchester / UK
Overview

I. Introduction
II. Workload Requirements and goals of the SPECjms benchmark
III. Application Scenario for SPECjms
IV. Implementation Details
V. Summary
Message Oriented Middleware (MOM)

- Used in many business domains
  - Financial services and enterprise applications
  - Health care
  - Supply chain
  - ...

- And in many technologies
  - Enterprise Service Bus (ESB)
  - Service Oriented Architecture (SOA)
  - Enterprise Application Integration (EAI)
  - ...

- Increasing importance **Need for benchmark**
Requirements of a MOM benchmark

- Scenario representative of real-world applications.
- Exercise all critical services provided by platforms.
- Not optimized for a specific product.
- Reproducible results.
- No inherent scalability limitations.
Current State of MOM Benchmarking

- Many proprietary benchmarks for MOM servers
  - Used for performance testing and product comparisons

However:

- These benchmarks do not meet all of the defined requirements
  Typically they...
  - concentrate on stressing individual MOM features, and
  - do not provide a comprehensive and representative workload for evaluating the overall MOM performance

- Currently no industry-standard benchmark for MOM Benchmarking → SPECjms 2007
What is SPECjms 2007?

- World’s first industry standard benchmark for MOM products supporting Java Message Service (JMS)

- Developed by the SPEC OSG-Java subcommittee with the participation of:
  - IBM
  - TU Darmstadt
  - Sun
  - Sybase
  - BEA
  - Apache
  - Oracle
  - JBoss
Goals of SPECjms 2007

I. Provide a **standard workload and metrics** for measuring and evaluating JMS-based platforms

II. Provide a **flexible framework** for JMS performance analysis
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Categories of Workload Requirements

- Representativeness
- Comprehensiveness
- Focus
- Scalability
- Configurability
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Representativeness

The goal:

- Allow users to relate the observed behavior to their own applications and environments.
- Should simulate the way platform services are exercised in real-life systems.

Therefore:

- It should be based on a representative workload scenario:
  - Communication style and the types of messages should represent a *typical transaction mix.*
Scalability

- Dimensions of scaling the workload:
  - **Horizontal scaling:**
    - De/Increase the number of destinations (queues and topics)
    - Keep the traffic per destination constant
  - **Vertical scaling:**
    - De/Increase traffic per destination
    - Keep the number of destinations fixed
- Preserve real-life relationships in modeled scenario

- **Additionally:** Support for freeform scaling, *e.g. user defined traffic per destination and number of destinations*
Configurability I

- Provide a flexible performance analysis tool:
  - Allows users to configure and customize the workload, e.g. for research purposes
- Produce and publish standard results e.g. for marketing purposes

Therefore:
- Need for a framework which supports
  - tuning,
  - analyzing and
  - optimizing performance of certain features / platforms
A benchmark framework should allow:

- precise configuration of workload and transaction mix
- to switch off business interactions (implies that interactions should be decoupled)

Providing such a configurability is a great challenge:

- **Freeform mode:**
  Design and implement interactions so that they can be run in different combinations depending on the desired transaction mix

- **Standard mode:**
  It has to be ensured, that the interactions always behave like defined in the application scenario
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The Application Scenario

- Represents a **supply chain** of a supermarket company.

- **Participants:**
  - Headquarters (HQ)
  - Supermarkets (SM)
  - Distribution Centers (DC)
  - Suppliers (SP).

- Based on the previously discussed requirements.
The Application Scenario

Why again a Supply Chain Scenario?

- Excellent basis for defining different interactions: Many destinations, use cases, ...
- Typical real word application
- Importance of performance (RFID!)
- Allows scaling the workload in a natural way:
  - *Horizontal*: e.g. scale the number of SMs
  - *Vertical*: e.g. scale amount of products sold per SM
Participants

Company HQ

Supermarkets

Distribution Centers

Supplier

Legend:
- = goods and information flow
- - - = only information flow
Participants - Supermarkets

Supplier

Company HQ

Supermarkets

--- = goods and information flow

----- = only information flow

Distribution Centers

Supermarket (SM)
- sells goods to end customers.
- manages its inventory.
- every supermarket offers different products.
- every supermarket is supplied by exactly one of the distribution centers.
**Participants - Distribution Center**

**Supplier**
- Supplies the supermarket stores which sell goods to end customers.
- Responsible for a set of stores in a given area.
- Is supplied by external suppliers.

**Company HQ**

**Supermarkets**

**Distribution Centers**

[Diagram showing relationships between Supplier, Company HQ, Supermarkets, and Distribution Centers with flow arrows indicating goods and information flow.]

Legend:
- \(=\) goods and information flow
- \(=\) only information flow

**Distribution Center (DC)**
- Supplies the supermarket stores which sell goods to end customers.
- Responsible for a set of stores in a given area.
- Is supplied by external suppliers.
Supplier (SP)
- deliver goods to distribution centers (based on an offer of the supplier).
- not every supplier offers the same products.
- offers either all products of a given product family or none of them.
Company HQ
• manages the accounting of the company.
• manages information about the goods and products.
• manages selling prices.
• monitors the flow of goods and money in the supply chain.
Business Interactions

The following interactions are part of the scenario:

1. Order / Shipment Handling (SM / DC)
2. (Purchase) Order / Shipment Handling (DC / SP)
3. Price Updates
4. Inventory Management
5. Sales Statistics Collection
6. Product Announcements
7. Credit Card Hotlists
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Example: Interaction 2

Purchase Order / Shipment Handling (DC & SPs)

- Point-to-Point and Publish/Subscribe communication.
- Inter company communication.
- Includes six steps
Interaction 2
Purchase Order / Shipment Handling

Suppliers

Supermarket Company

Company HQ

Distribution Centers

1. DC sends a call for offers.

--- = goods and info flow
------ = only info flow

Supergrocers
Interaction 2
Purchase Order / Shipment Handling

Suppliers

Supermarket Company

Company HQ

2. All SPs offering the requested products send an offer.

= goods and info flow

= only info flow

Distribution Centers
Based on the offers, the DC selects a SP and sends a purchase order to it.
Interaction 2
Purchase Order / Shipment Handling

4.a
SP sends an order confirmation to the DC

4.b
SP sends an invoice to the HQ

4.c
The SP dispatches a shipment to the DC.
5. The shipment arrives at the DC and confirmation is sent to the SP.
Interaction 2
Purchase Order / Shipment Handling

Suppliers

Supermarket Company

Company HQ

Supermarkets

Distribution Centers

6. The DC sends a message to the HQ (transaction statistics).

---

= goods and info flow

= only info flow
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19 different messages are defined:

- Three different sizes per message (small, medium, large) with a certain probability
- Acknowledgment mode:
  - Standard: AUTO_ACKNOWLEDGMENT (can be changed in several interactions)
- All messages types supported by the JMS Specification excepted ByteMessages
- (Non-)Persistent, (Non-)Transactional, Durable, ...
Message Types and Destinations

- Number of queues per location instance:

<table>
<thead>
<tr>
<th>Location</th>
<th>No. of queues</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM</td>
<td>3</td>
</tr>
<tr>
<td>SP</td>
<td>2</td>
</tr>
<tr>
<td>HQ</td>
<td>4</td>
</tr>
<tr>
<td>DC</td>
<td>6</td>
</tr>
</tbody>
</table>

- Number of topics:
  3 + one for every product family
Driver Framework

- Many locations represented by many event handlers (message consumers)
- Event handlers may be distributed across many physical machines.

- **Reusable driver framework** addresses this issues without any inherent scalability limitations.
- Plain Java
- **Maximum choice** in laying out workload to achieve maximum performance.
Driver Framework

- Node
  - JVM
  - Controller

- Node
  - JVM
  - Satellite
  - Agent

- Node
  - JVM
  - Satellite
  - Agent

- Node
  - JVM

- JMS server
A Flexible Framework for Performance Analysis

- Allows to **configure and customize** the workload / transaction mixes

- Provides **three different topologies** corresponding to three different modes in which the benchmark can be run:
  - Vertical
  - Horizontal
  - Freeform

- **Many features**
A Flexible Framework for Performance Analysis

Some features:

- Number of physical locations (HQ, SM, DC, SP) emulated.
- Number of agents representing a single physical location.
- Number of event handlers in an agent of each type.
- Number of driver instances for each interaction.
- Total number of invocations of each interaction (as an alternative to specifying a rate).
- Message size distributions for each interaction.
- The driver nodes on which agents are run.
- Number of JVMs run on each node and the way agents are distributed among them.
- Number of javax.jms.Connection objects shared amongst event handler classes within a single agent.
- ....
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The presented scenario models a set of interactions in the supply chain of a supermarket company.

These interactions are used as a basis in SPEC's new SPECjms benchmark.

SPECjms will be the world's first industry-standard benchmark for MOM products.

SPECjms can be used to stress and evaluate the different aspects of JMS performance.

SPECjms is more than a benchmark: Offers also a performance analysis tool for JMS-based infrastructures.
Thanks for your attention