
DEFENCE
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A Network Centric Infrastructure for Decision Support Based on Service Integration

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Defence Research and Development Canada

Canada

Outline

- Motivations
- Objectives
- System Characteristics
- Approach
- Methodology
- Technology & Implementation
- Conclusion

1. Motivations

- Air Force Command and Control System is based on:
  - Heterogeneous information sources kept in multiple platforms, application and databases.
  - Different islands of information.
  - Poor provision of internal sharing of data and services
- Insecure communication of information.
- Poor Decision Support System

1. Motivations

- Decision Support Systems (DSS) are extensively used to take decisions
  - *in defense organizations*
    - Example: Security and safety operations, mission planning, resource allocation, etc.
  - *in corporate world:*
    - Example: Market analysis, product distribution, resource and employee allocations, etc.

Motivations (contd.)

- A crucial drawback of these DSS consists of the guarantee of freshness for the collected information, because:
  - When a decision spans over a longer period of time, the original states of these retrieved information often change during the period of the validity of the decision.

    Ex. Weather condition alters during the rescue operation and brings difficulty to the rescue workers.

  - Architecturally, DSS integrates service/s with a one-time execution of a multi-task business process.

Motivations (contd.)

- **The solutions to this problem are:**
  - Periodically recalculate the decision from user's side irrespective of any change of information.
  - Depend on a Network Centric Infrastructure that will provide the following capabilities:
    - **Integrate and compose remote services.**
    - **Real-time and interactive display of the synthesized output.**
    - **Stay updated to the integrated remote services by service monitoring.**
    - **Leverage re-execution of the decision procedure only for a notified change in distant sources.**
    - **Provide an interface for the user application to subscribe to a decision that is always synchronized to actual state of remote information.**
    - **Program some analysis and optimization capabilities in the integrating services for the user application.**

This network centric architecture is often addressed as a middleware.

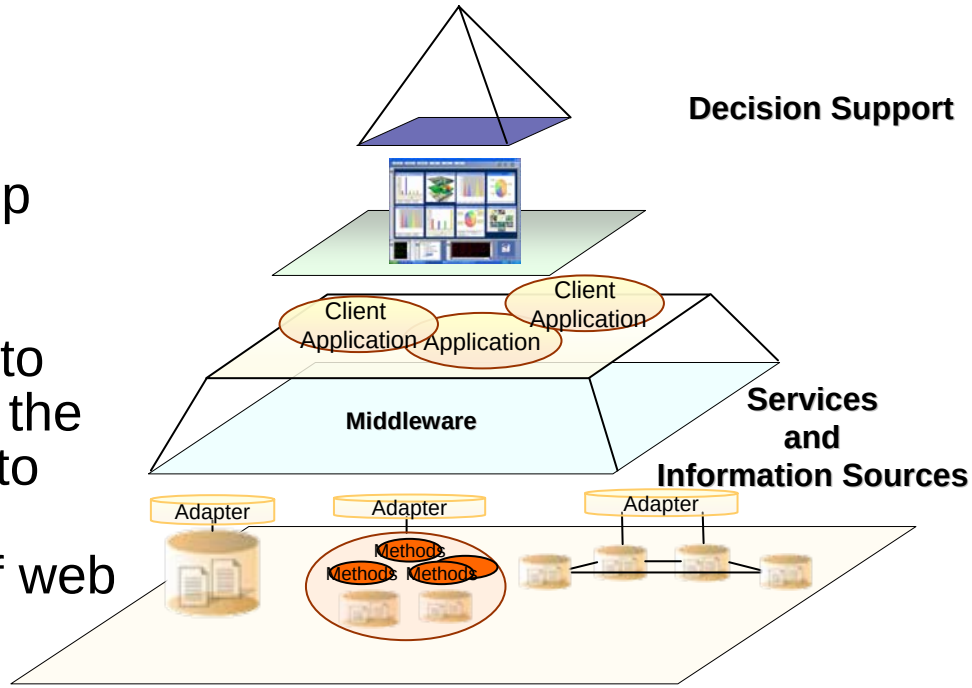
2. Objectives

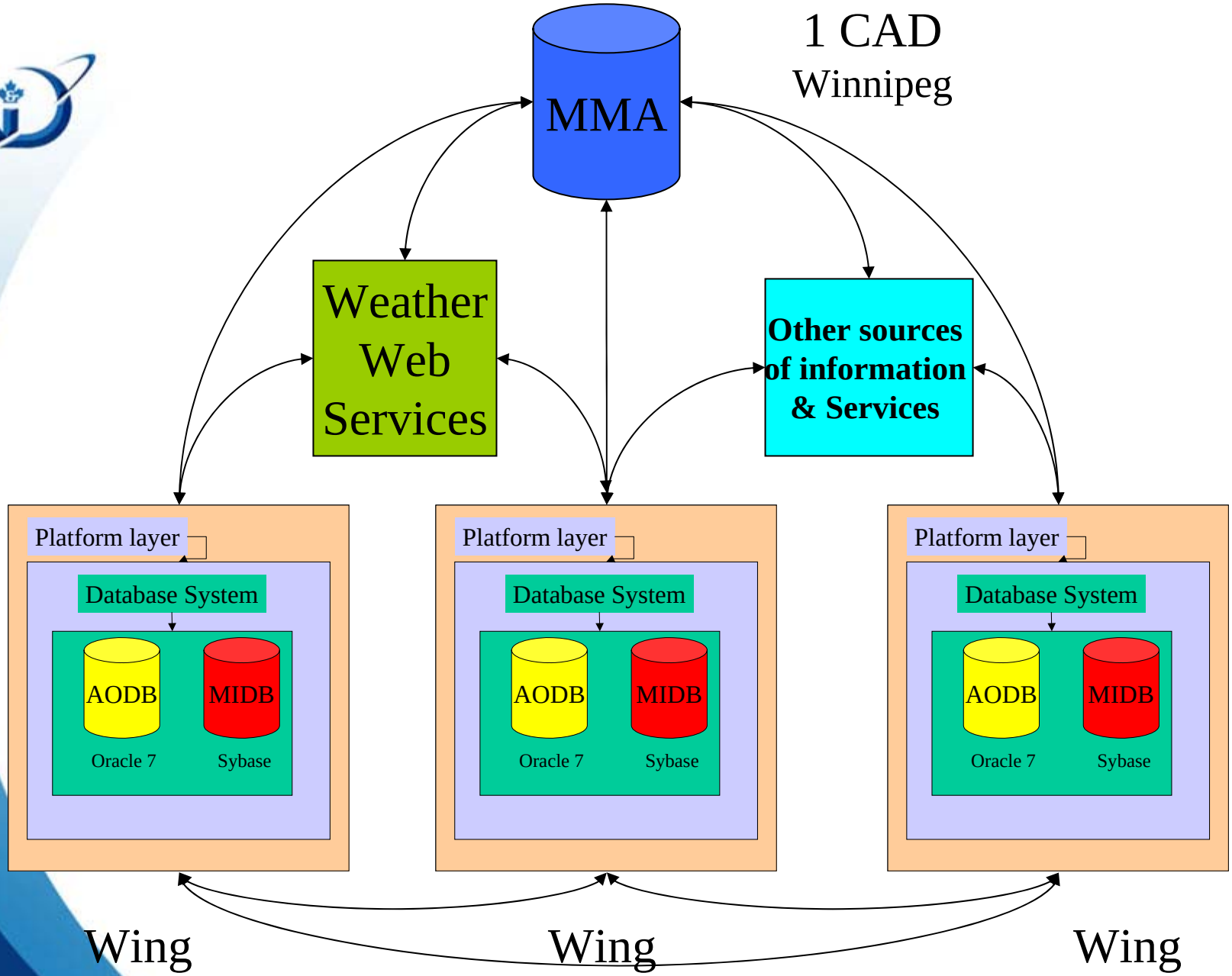
1. To identify a business case for the use of service integration as an infrastructure for distributed decision support.

2. To design the software capabilities needed to develop this middleware.

3. To demonstrate a procedure to upgrade the current status of the "Digital Cockpit" middleware to include almost real-time integration, and monitoring of web services.

4. Finally, to conclude with a partial standard based implementation of the system followed by the snapshots of user interface.




1 CAD
Winnipeg
MMA
Weather Web Services
Other sources of information & Services
Platform layer
Database System
AODB
MIDB
Oracle 7
Sybase
Platform layer
Database System
AODB
MIDB
Oracle 7
Sybase
Platform layer
Database System
AODB
MIDB
Oracle 7
Sybase
Wing
Wing
Wing

3. Systems characteristics & capabilities

- A network distributed middleware
- Present the synthesized information as a structured navigational big picture that offers the ability to drill into the details.
- Based on peer-to-peer architecture (publish-subscribe)
- Provides users with the ability to rapidly access data and to perform many sorts of statistics and calculations on it.
- Modular efficient service based integrated infrastructure to carry out efficient decision making in net-centric fashion.
- Is a software platform performing real-time integration/monitoring and re-execution of web services.

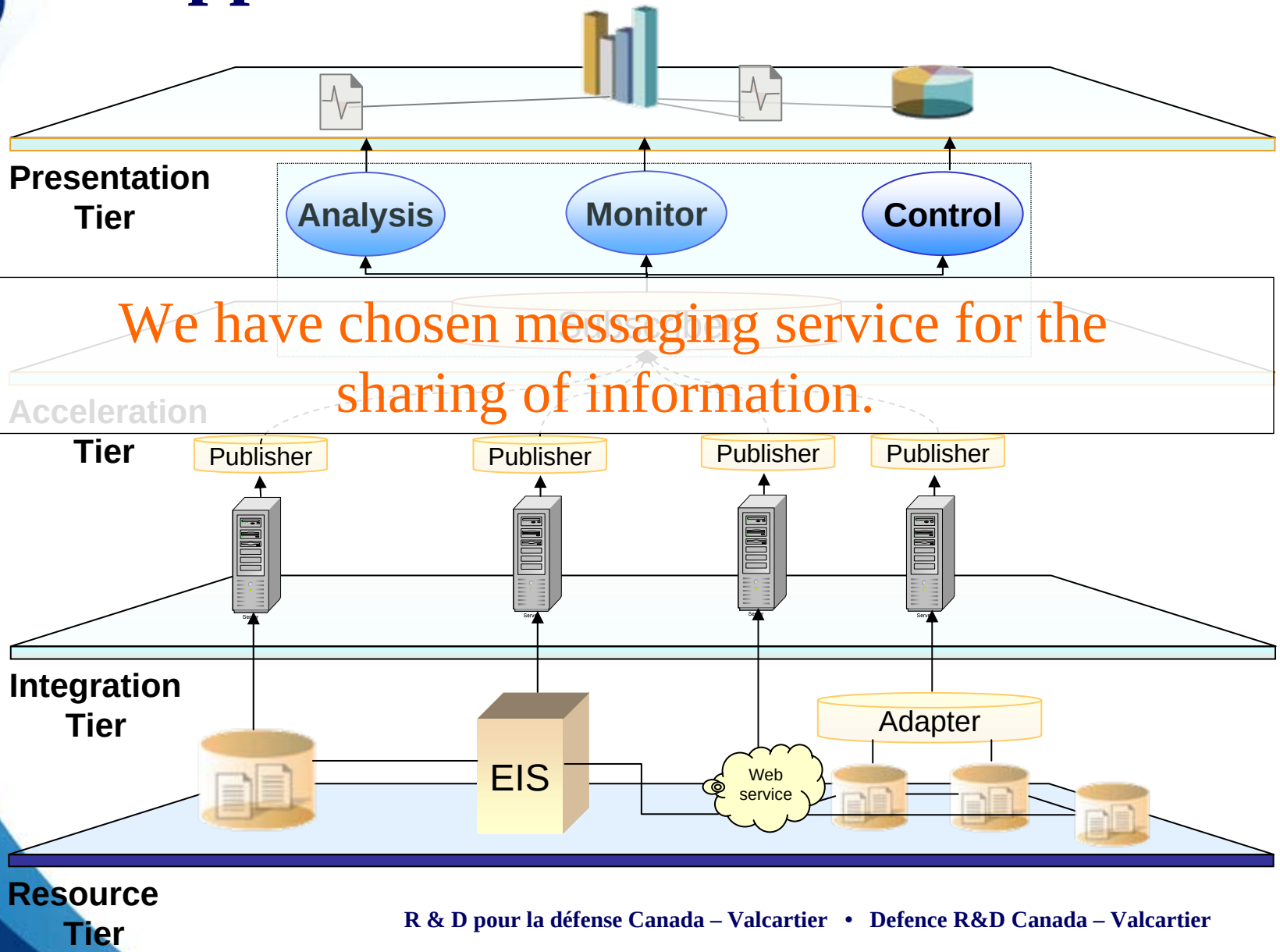
Competitive advantages of DC

- **Align strategy with execution:**
  - ✓**Highlight key performance indicators**
  - ✓**Help to make more accurate decisions.**
  - ✓**Improve organizational performance.**
- **Monitor key performance indicators :**
  - ✓**Proactively alert commander with relevant information.**
  - ✓**Identify trends**.
- **Create personal views of information with a DC**

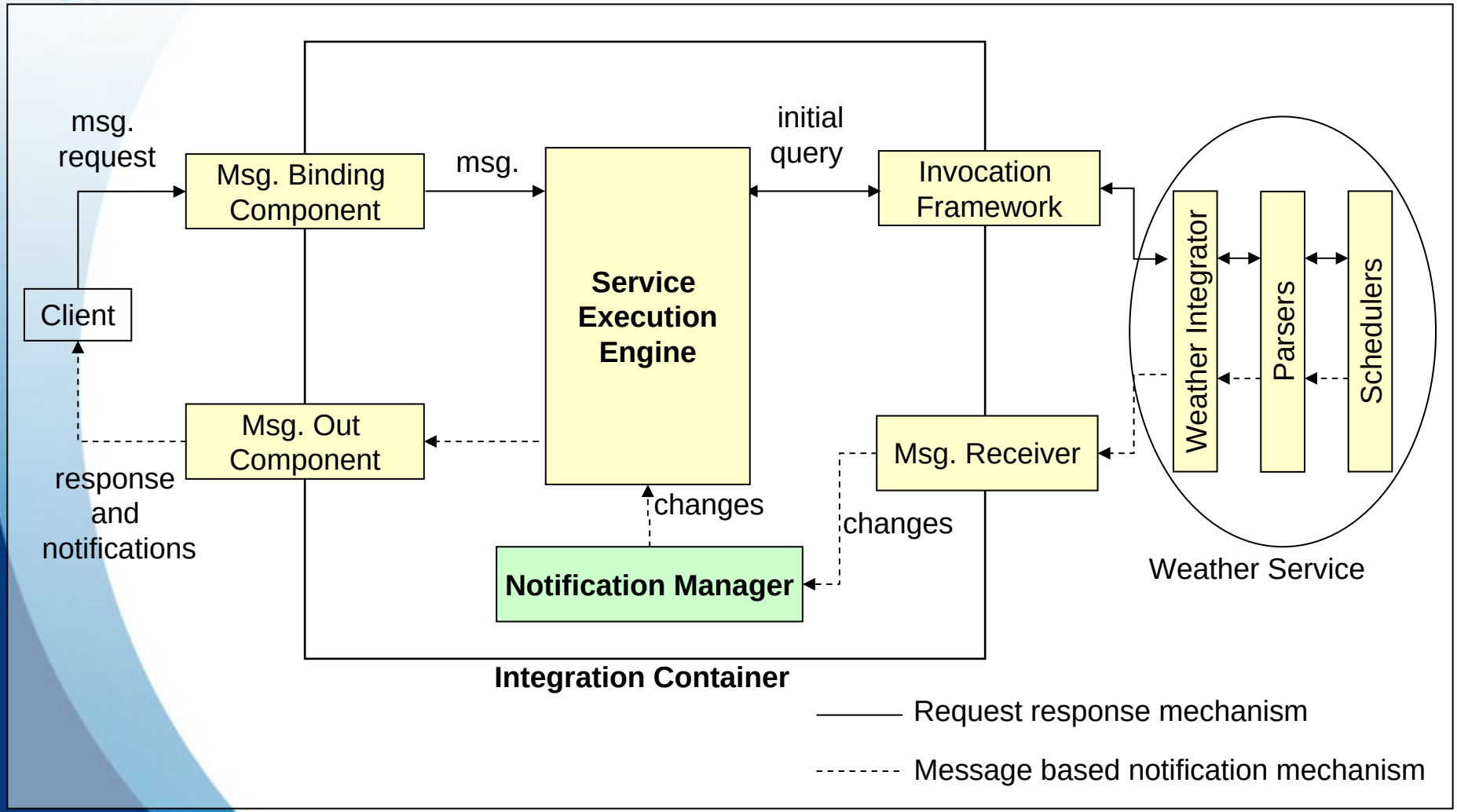
As a downstream result

- Extract useful information from large data sets and databases.
- Improve the decision-making process.
- Bridge the gap between planners and operations
- Link between available resources and mission objectives.
- Leverage the coherence and optimality in database management.

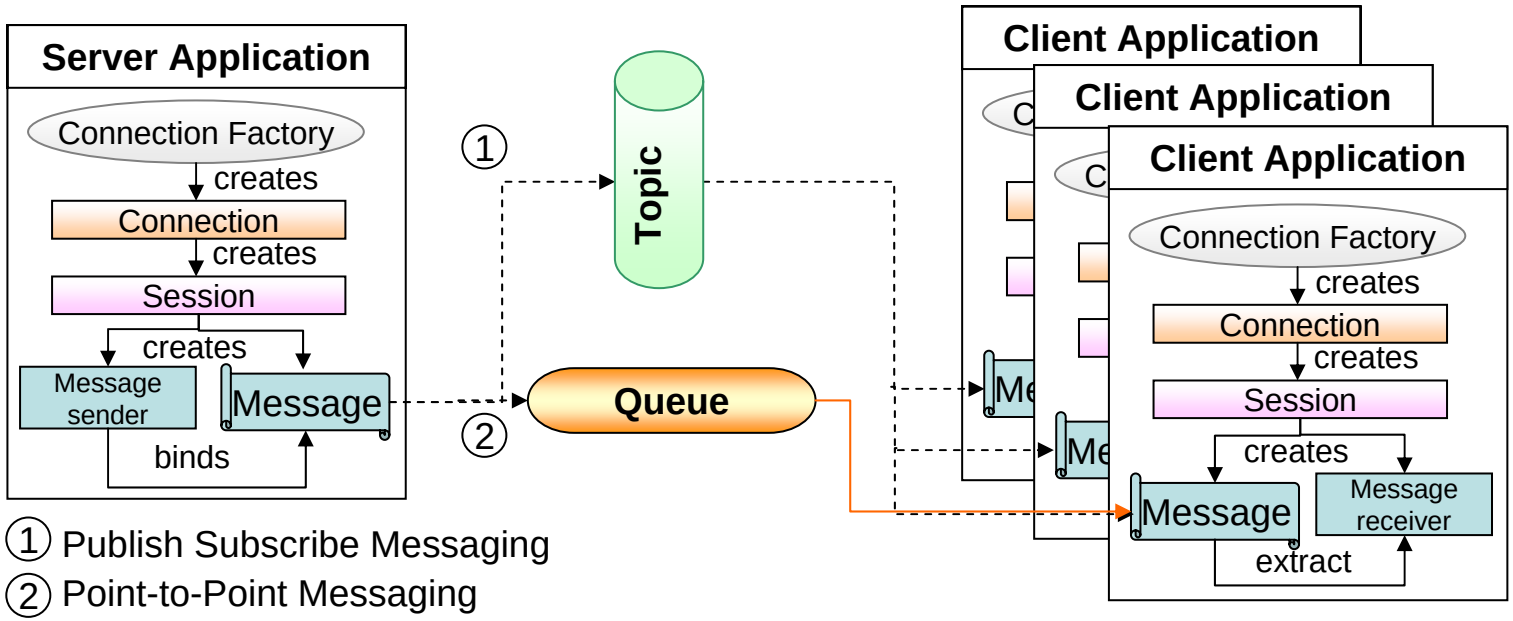
4. Approach


Presentation Tier
Analysis
Monitor
Control
We have chosen messaging service for the sharing of information.
Acceleration Tier
Publisher
Publisher
Publisher
Publisher
Integration Tier
EIS
Web service
Adapter
Resource Tier

Approach : Service Integration (contd.)



Approach: Java Message Service

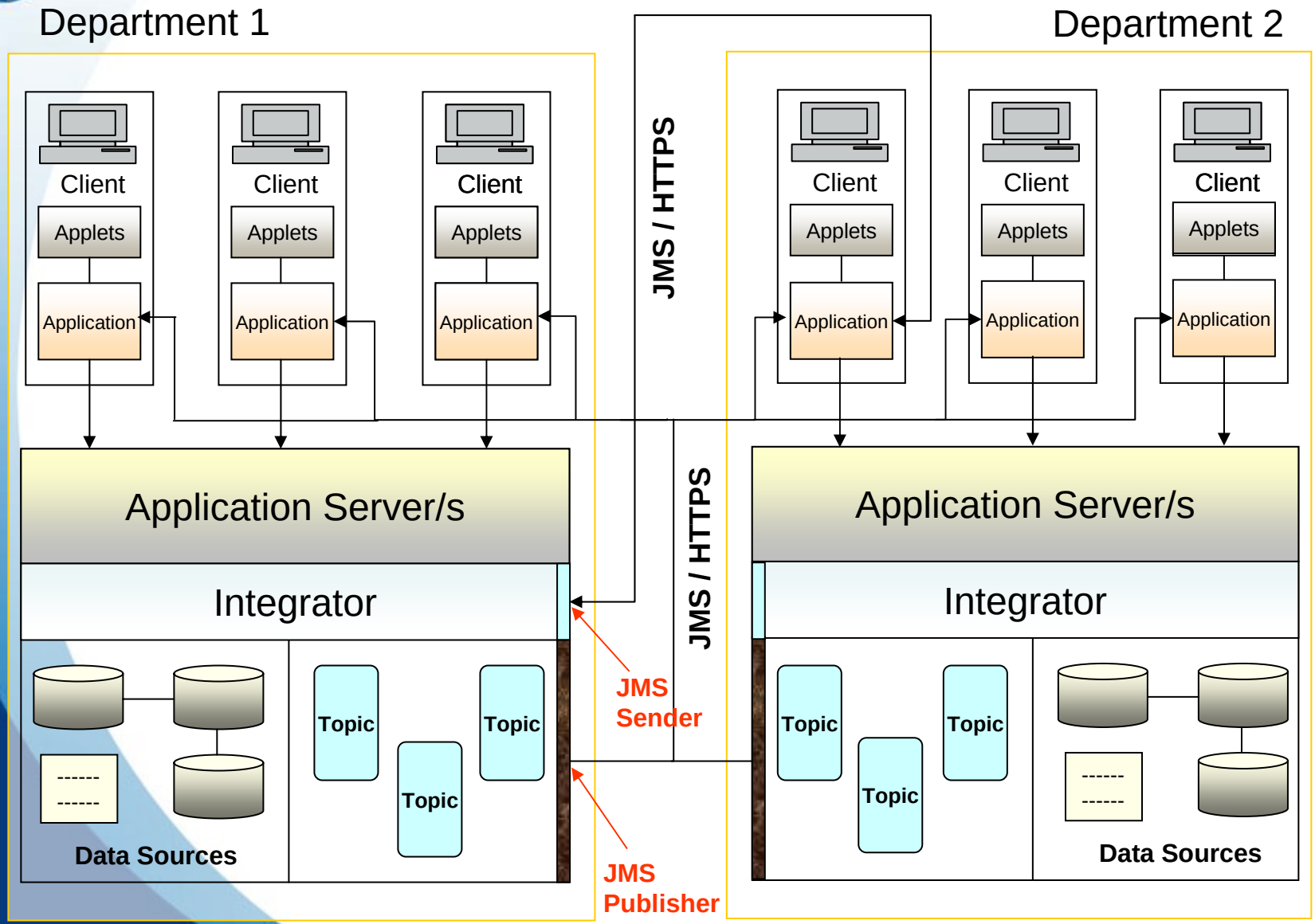


① Publish Subscribe Messaging
② Point-to-Point Messaging

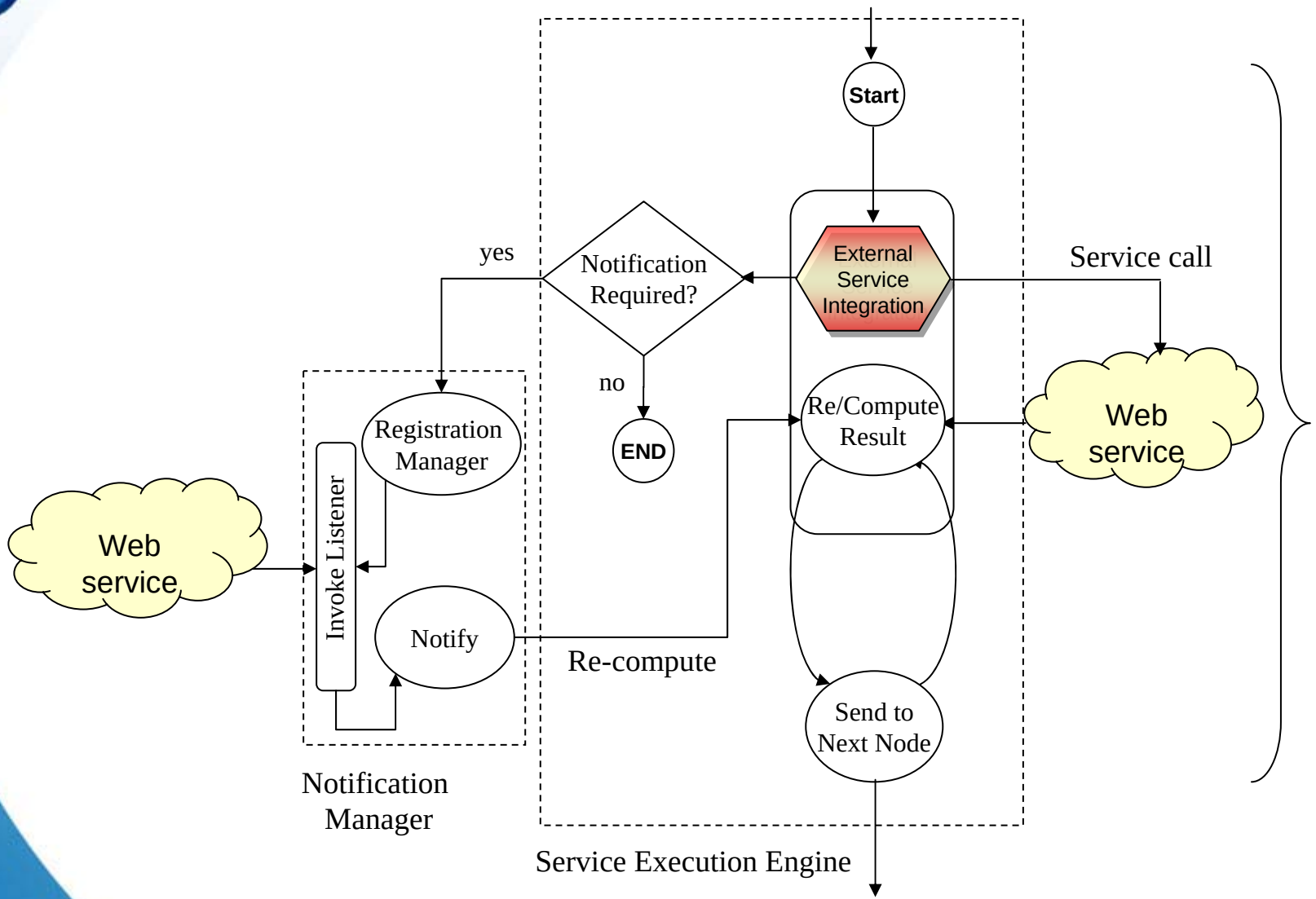
Message based communication:

- Asynchronous and loosely coupled.
- Real time notification.
- Cross-VM communication.
- Uniform environment.
- Quality control.
- Easy extensibility.

Approach: Data Integration

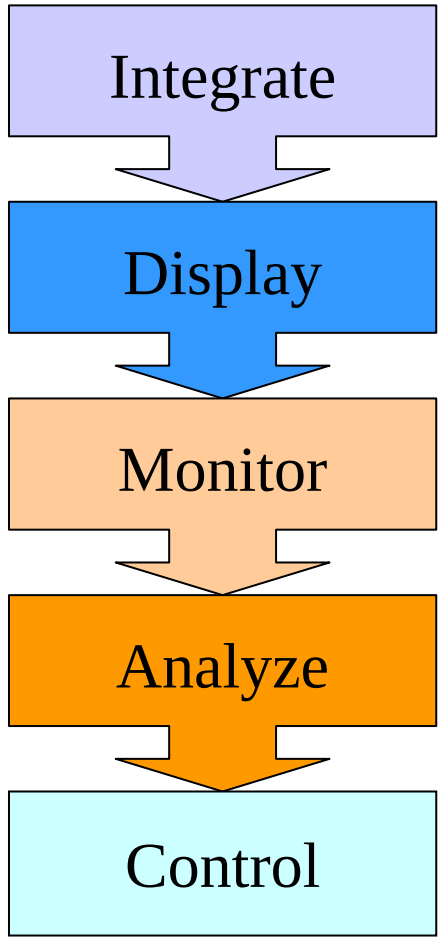


Service Integration Procedure:

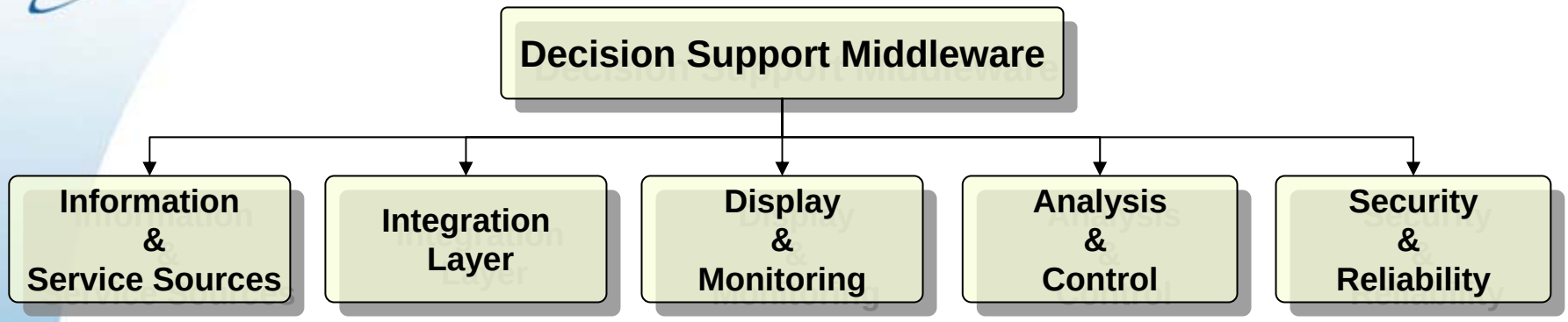


5. Methodology-System's overview

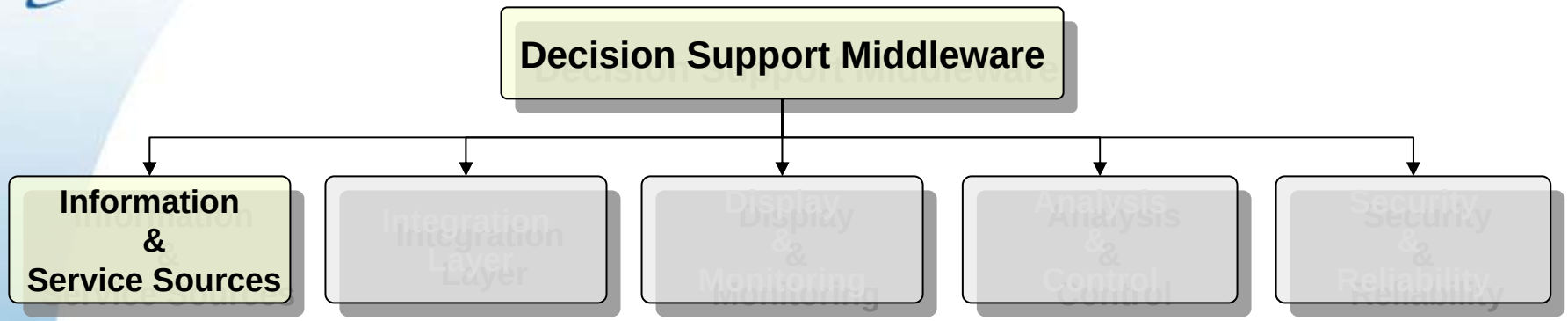
- Integrator: Connects all the sources of information within and across the organization.
- Display: Presents the synthesized information into a meaningful and structured format.
- Monitor: Allows the active monitoring of the information systems' state for the purpose of testing and responding to thresholds.
- Analyzer: Performs pattern and trend analysis, simulation of "what-if" scenarios etc.
- Controller: Enhance and optimize the used processes, methods and strategies.



6. Technology & Implementation Stack



Technology & Implementation Stack



Challenges

- Heterogeneity of sources.
- Distant location of storage of information.
- Absence of an integrated platform.

Used technologies

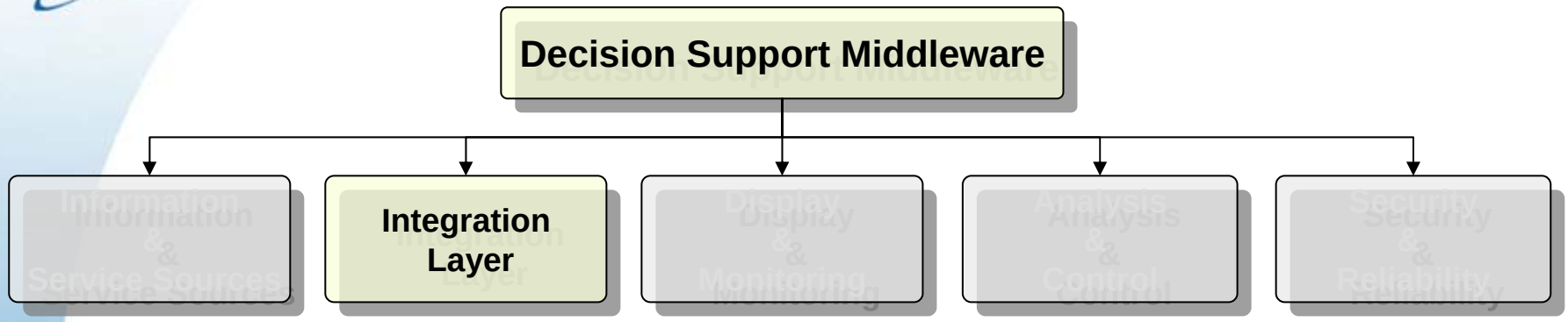
Data Sources

- Oracle database.
- Sybase database.
- MS-Access files.
- Legacy System.

Service Sources

- WSDL description.
- Proprietary XML schema.

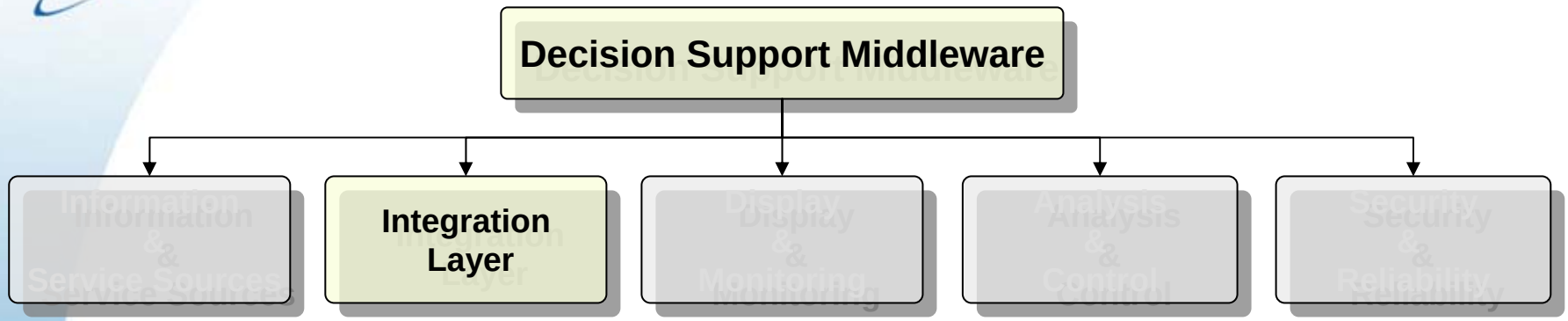
Technology & Implementation Stack



Application Server

Sun J2EE Server	+ Good documentation + Ease of use	- Not truly free license - Performance - Bad overall reputation
JBoss Application Server	+ Documentation + Relative ease of use + Community support	- Incompatibility with AXIS API
Apache Geronimo Server	+ Community support + Apache reputation + Most efficient free JMS Implementation (ActiveMQ) + ServiceMix JBI (JSR 208) Integration + Apache license + Professionally designed	- Poor official documentation (yet)
Jonas Server	+ Relative ease of use	- Small community - French-centric

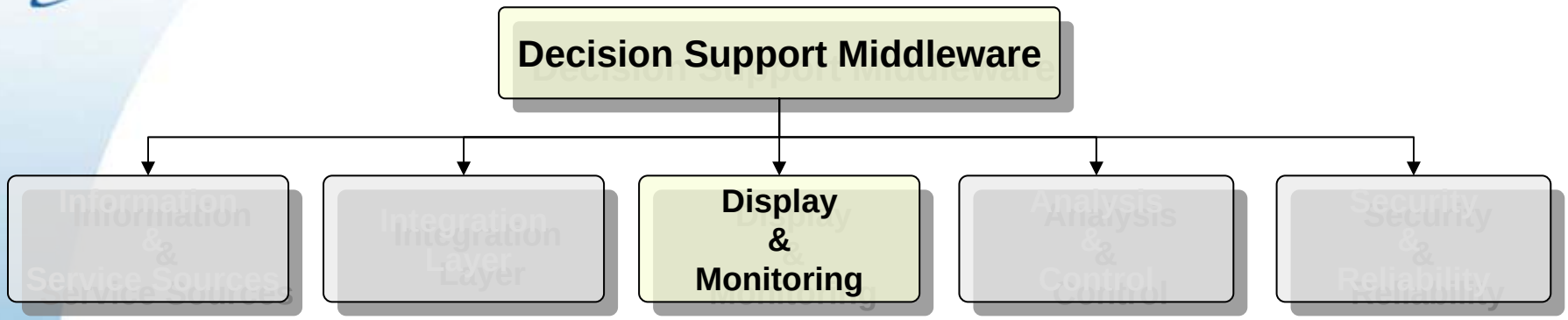
Technology & Implementation Stack



Service Execution

ActiveBPEL	+ Good documentation + Relative ease of use	- Hard to deploy on Geronimo - No WS-Notification support - Only SOAP over HTTP
Apache Twister	+ Community support + Apache reputation + Well designed	- Still not mature - Only SOAP over HTTP
Fivesight PXE	+ Integrated with ServiceMix / Java Business Integration (JBI) + WS-Notification support provided by ServiceMix (codeHaus) + Integration with Spring (Inversion Of Control) + Asynchronous support provided by JBI / JMS	- JBI : no documentation besides the JSR 208 spec - Poor PXE / ServiceMix documentation
IBM BPWS4J	+ Ease of use	- No updates - No support - Many limitations

Technology & Implementation Stack



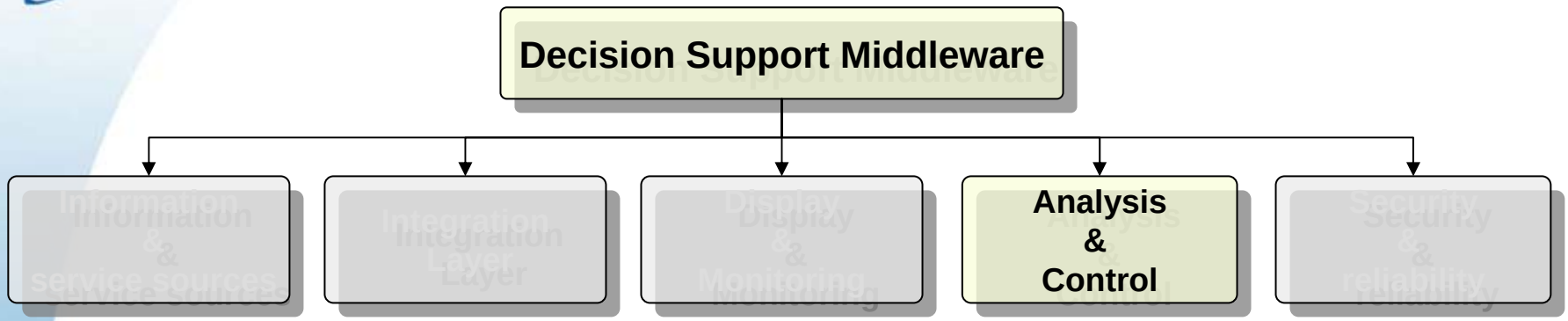
Challenges

- Graphical representation.
- Real time view & notification.
- Performance.

Used technologies

- Spring lightweight container :
  - Inversion of Control (IoC) paradigm
  - Flexibility
  - Maintainability
  - Unit-Testability
- AXIS and XFire SOAP Stacks :
  - Integration with Spring
  - Automatic generation of artifacts (WSDL..)
- jWeather METAR / TAF (Legacy Data) Parser.
- JFreeChart.
- Espresschart (Quadbase Inc.)
- Java3D.
- JMS API: Msg. communication.

Technology & Implementation Stack



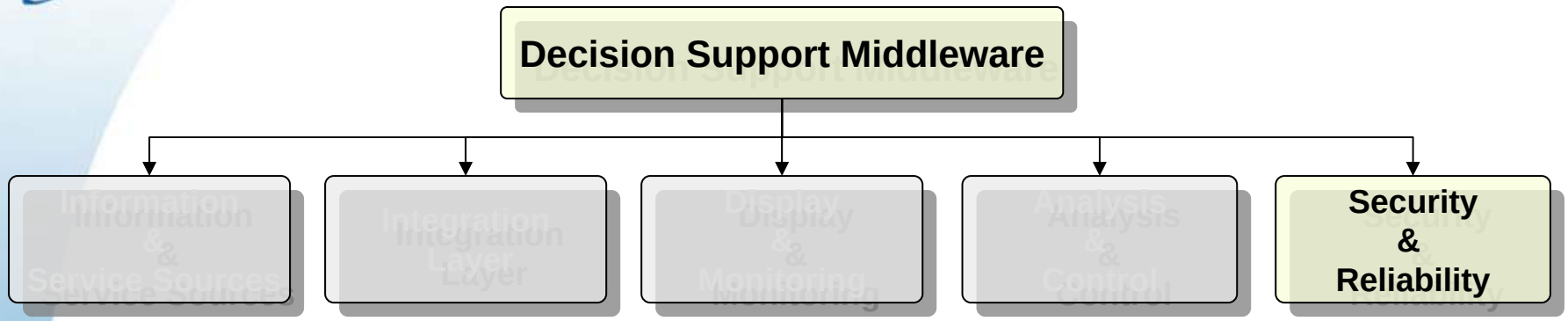
Challenges

- Understanding Scenarios.
- Suitable analysis and optimization algorithms.

Used technologies

- JFREEChart data analysis library.
- Jakarta POI.
- Game theory based decision support mechanism.

Technology & Implementation Stack



Challenges

- Distributed applications.
- Military applications.
- Traceability.

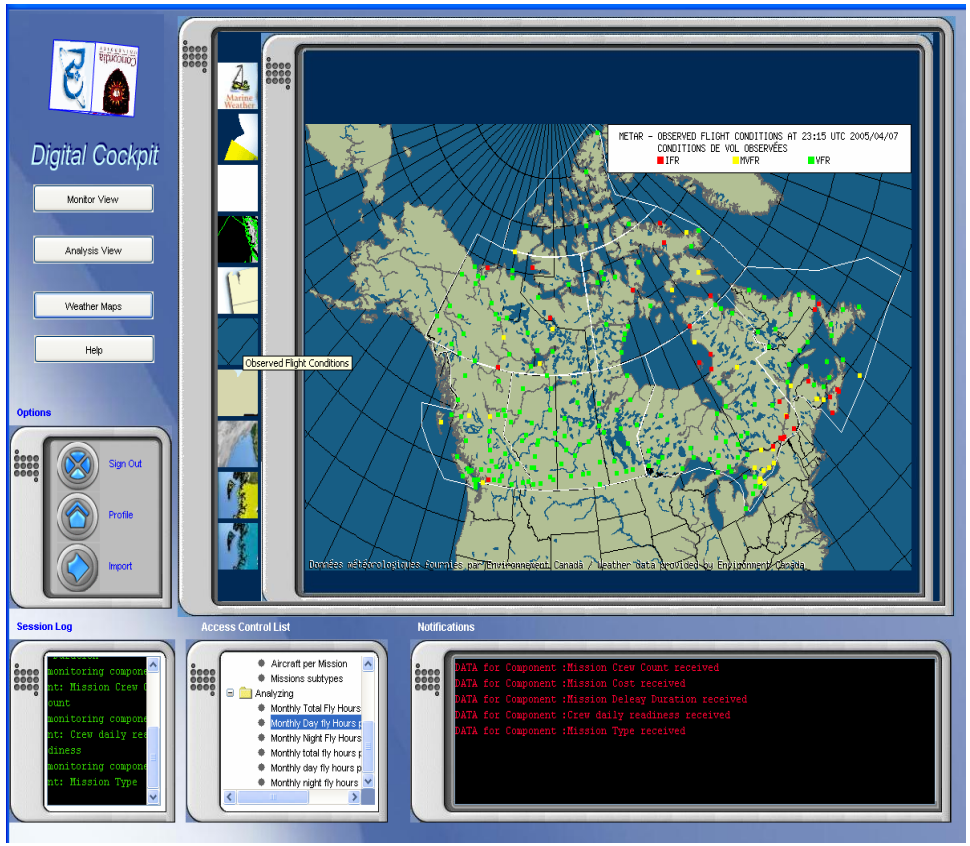
Used technologies

- Network and authorization protocols.
- Crypto-protocols.
- JSSE API.

User Interface

1. Graphical Presentation.
2. Weather Maps.
3. Missions View.
4. Real-Time Notification.
5. Analysis Scenarios.
6. Optimization Scenarios.
7. Operation Logging.
8. Authentication.
9. Access Control.

User Interface



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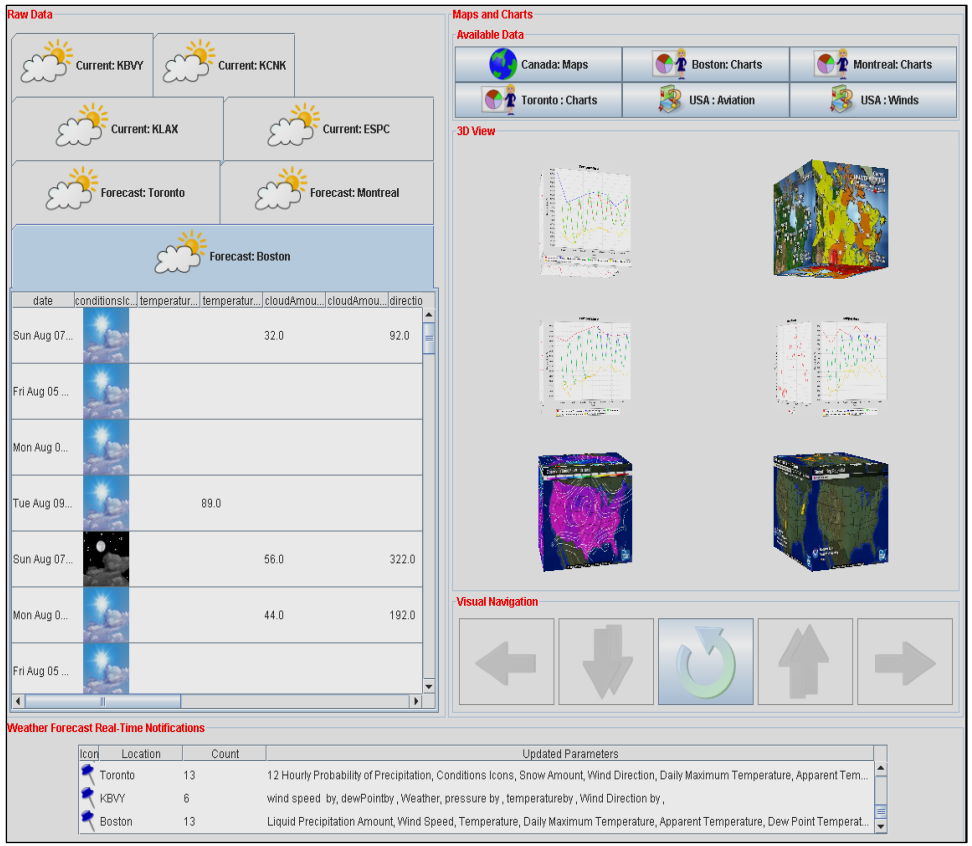
Weather Maps:

View the weather from the same digital cockpit window.

User Interface



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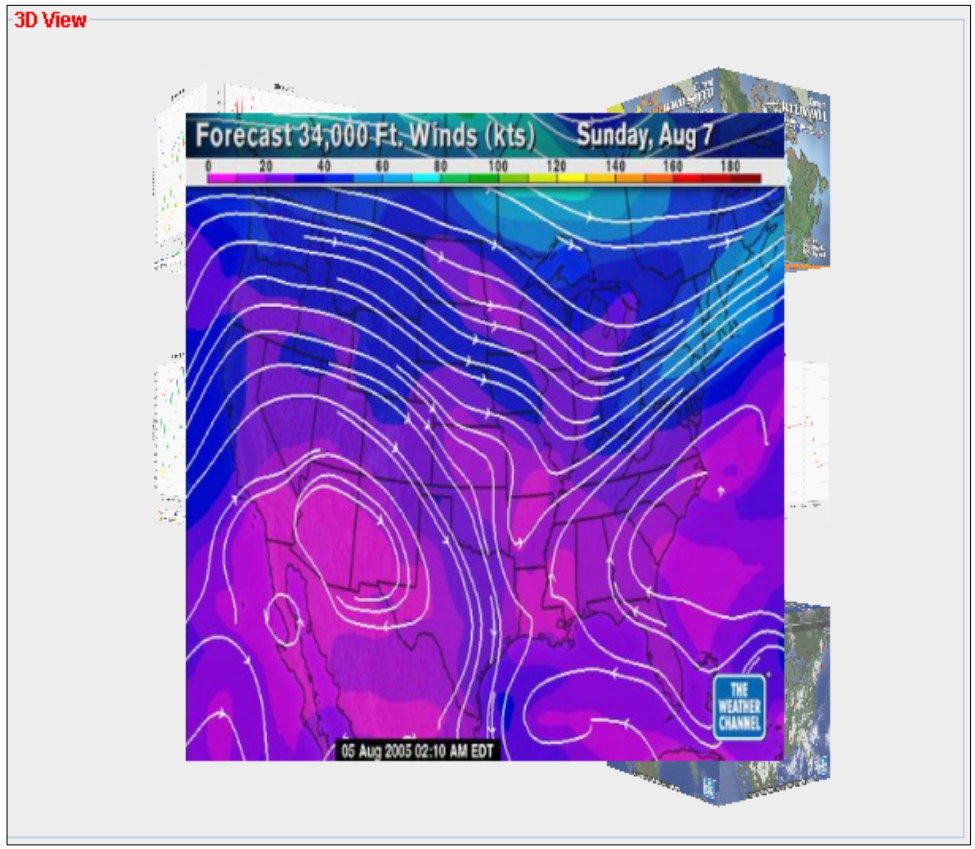
Weather Service:

Analyze weather information from distant weather service sources.

User Interface



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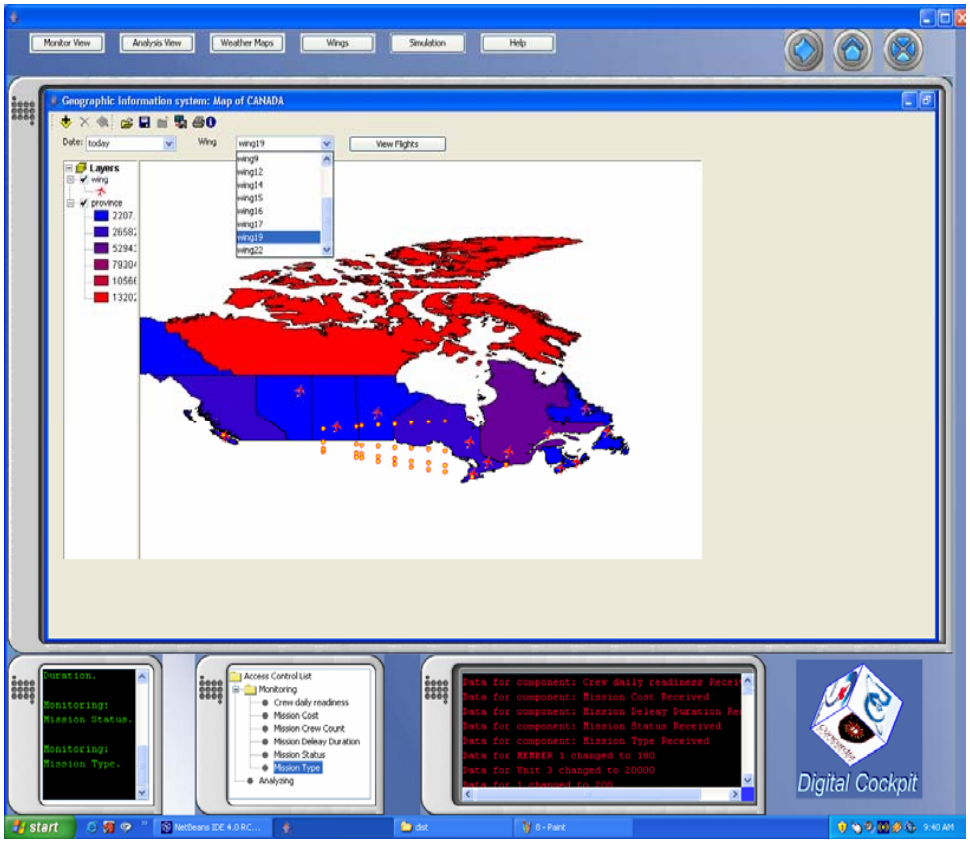
Weather Service:

Expanded view of a specific weather web service scenario.

User Interface



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Missions View:

See as events happening on the map of Canada (e.g. flights./ wings)

User Interface

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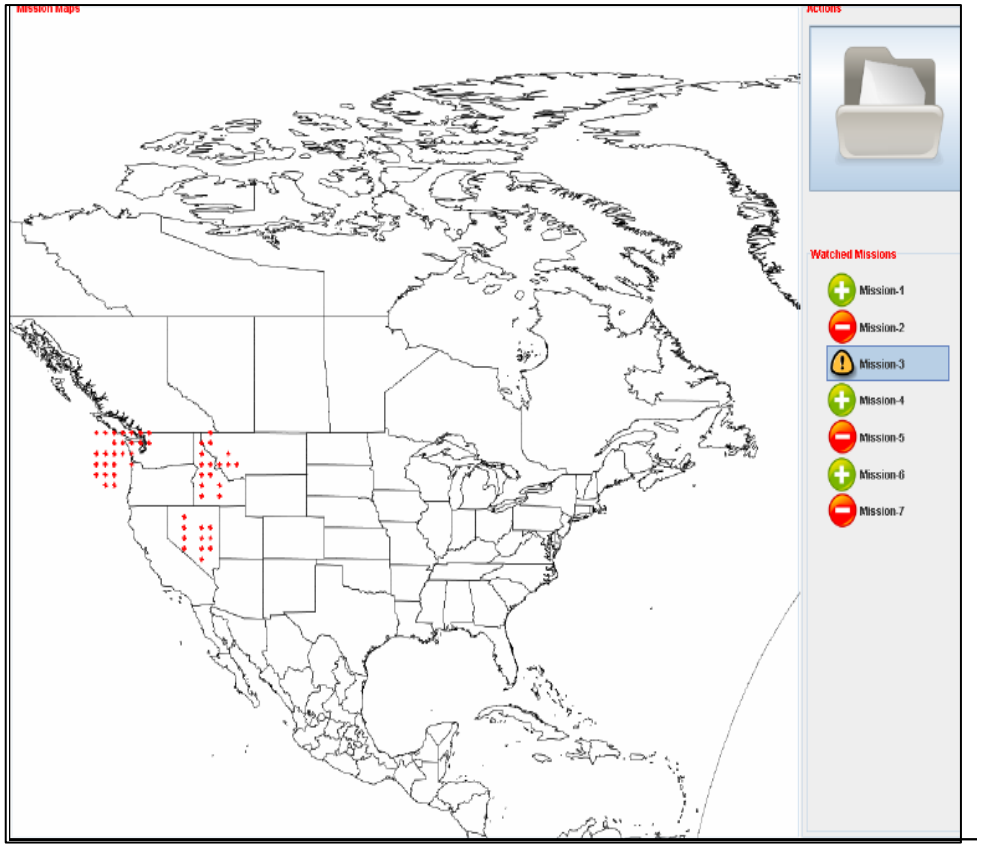
Analysis Scenarios:

Allows time-based prediction analysis.

User Interface



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note weather scenarios.

7. Conclusion

This paper presents a novel approach of service integration and monitoring that is based on:

- Open implementation standards.
- Event-based Asynchronous integration.
- Almost real-time notification over information changes.
- Scope of re-computation is identified independently from the integration style.
- Well-designed integration architecture.

Future Work:

- Quality of Service computation of web service re-execution.
- Developing cutting-edge decision support mechanisms.