SAP ARCHITECTURE BLUEPRINT

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AUTHORS:

Joern Keller,

Klaus Kopecz,

Christian Hissler,

Jürgen Kollomi

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Retail Demand Management Foundation - RTLDMF

PROJECT NAME/CPROJECT TITLE: **DMF1.0/DMF1.1**

SPONSOR/PROJECT INITIATOR: **DR. DIETMAR SADDEI**

PROGRAM/PROJECT LEAD: **WILIAM CHIMITT**

LEAD ARCHITECT: **JOERN KELLER**

DEVELOPMENT: ☒ SAPLabs Scottsdale, Walldorf, St. Ingbert

☐ Partner/ISV _____

Document History		
Version	Date	Status (Comments)
0.9	22-October-2007	Draft version – Not Released
1.0	07-October-2007	First version
1.1	06-December-2007	New diagrams to be in synch. with Architecture Bluebook. Textual enhancements.
1.2	18-Dec-07	Restructured

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I MARKET AND PRODUCT BACKGROUND OF PROJECT/PROGRAM

Planned release date:	DMF 1.0 in June 2008 (first internal release) DMF 1.1 in March 2009 (first official release)	
Underlying SAP NetWeaver release:	NW 7.01 SAP_BS_CO	
Used SAP NetWeaver stacks:	☒ ABAP	☐ J2EE/Java EE 5
Target platform (OS, DB):	DMF1.0: All A platforms according to the SAP platform standard DMF1.1: All A, B & C platforms according to the SAP platform standard	

Targeted market segments / sub-segments:

- Retail Industry, especially the segments Grocery and Hardlines

Use cases targeted by the project/program:

Retail Demand Management Foundation (DMF) follows the strategic intend of Trading Industries to have one central instance for Demand Modeling and Demand Forecasting. SAP DMF will play a unique and central role within the overall Retail Solution Portfolio.

Besides a high quality, the aspect of imperative uniqueness to avoid conflicting business decisions is a key requirement. Multiple planning applications shall reuse the same demand forecast and shall feed Demand Influencing Factors (like sales promotions) back into the central forecast application.

The business success of Retail customers heavily depends on the quality of Demand Forecasts which drive essential parts of their business. One corner stone for SAP to enable this success is the integration of the product portfolio of the acquired company Khimetrics into the SAP Retail Business Suite:

- Integrate the Forecasting and Modeling Engines with the Retail Business Suite and rebase this product (DF) from a proprietary platform to NW7.01 (DMF1.0)
- Support an easy integration of the new “SAP Replenishment” with the Retail Business Suite and the Demand Forecast via rebasing them from the SCM platform to DMF 1.1
- Support an easy integration of the “SAP Promotions Planning” with the Retail Business Suite and the Demand Forecast via rebasing them from a proprietary platform to NW7.01 and DMF 1.1
- Support an easy integration of the SAP Demand Management applications (“Regular Price Planning & Optimization”, “Markdown Planning & Optimization” and “Promotion Optimization”) with the Retail Business Suite and the Demand Forecast via rebasing them from a proprietary platform to NW7.01 and DMF1.2 (will be described in a future document).
- Provide a foundation which serves as a common data layer for reuse data to be leveraged by SAP Demand Management applications and a DMF based “Replenishment” solution
  - Eliminate double effort for data synchronization with ERP
  - Eliminate efforts for data synchronization between DMF and Replenishment (reuse of

common DB schema and instance)

- Provide one set of common calculation engines with coherent algorithms and respective persistency layer

- Provide open interfaces (eSOA) to allow other applications, like FIP, MAP to communicate with the Demand Management Foundation. Especially time series interface to serve as a Time Series Server.

Retail Planning Applications face different challenges compared to Manufacturing Industries:

- Retail specific and lean Master Data layout
- Flexible mass maintenance UIs
- Data Volumes are higher by at least a factor of 10^3
- Fast data access required for time consuming mathematical calculations

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Strategic goals SAP wants to achieve with the project/program:

- Create the Foundation for Retail specific Demand Management solutions to be offered in the market based on the concept of a Unified Demand Forecast
- Reduction of TCO and TCD (Total Cost of Development) when compared to current solution
- Beat key competitors like Oracle-Retek, DemandTec, SAS, Manugistics and i2
- Support lighthouse customers like the HomeDepot with a solution that can handle 100.000.000 active Store and Product combinations

Mandatory software capabilities to address goals, use cases, and target market:

- Provide basic reuse data for Demand Management applications
- Create Demand Model based on:
    - Sales History data (including transaction counts and price) or a flat Consumption Time Series (DC forecast or incomplete customer data)
    - Demand Influencing Factors (Sales Promotions, Customer specific Time Series, Weather information, Correction Values set by a user)
- Calculate Demand Forecasts based on the Demand Model
- Interaction with other systems through remote interfaces (RFC and eSOA services)
    - Master Data feed by leading master data system
    - Sales History feed by a BI system
    - 3rd party forecast provider systems (ISVs)
- Support various deployment options to be able to adapt to typical customer scenarios and system landscape variations

II ARCHITECTURE

The architecture is driven by the target to integrate and rebase the existing product Demand Forecast 7.0 (DF) which has been developed by SAP Labs Scottsdale (Khimetrics) with the SAP Retail product portfolio. As the DF 7.0 product consists of C++ functionality and proprietary DB access functionality, a rebase to the ABAP NW7.01 stack has been decided in August 2007.

Significant parts of the existing DF 7.0 product will be re-implemented in ABAP to improve overall product standard compliance and deployment options. The key assets of the DF product are so called science modules which have been developed in C/C++ technology. Within these modules intensive mathematical calculations (Demand Model and Demand Forecast) take place. So the decision was taken to keep these modules in C/C++ technology.

The next decision that had to be taken was how the science modules shall be integrated with the NW ABAP stack. They will be stored on the local file system of each cluster node as 'passive' modules and will be called out of the ABAP stack via synchronous RFC calls. This means that the process control and DB access remains in the ABAP stack and the science modules take care of calculations only.

II.a Important Aspects

II.a.i Total Cost of Ownership

Today, the retail component landscape is widespread. It is comprised of ERP, SCM, BI, SAP Demand Management (SAP DM), SAP Promotion Merchandising Layout (SAP PML), POS Applications and Workforce Management (WFM).

The introduction of DMF as a reuse component will reduce the TCO for the customer because it will be the base for the future Replenishment solution (successor of F&R), SAP Promotions (successor of SAP PML), SAP Price Optimization and SAP Markdown Optimization (successors of SAP DM). Potentially, WFM could be integrated in the future as well.

II.a.ii Deployment

It shall be possible to install DMF on one application system (one DB) together with Replenishment, Promotion Planning, and Price & Markdown Optimization functionality. Further investigations are in progress to evaluate the benefit of joint deployments with ERP, SCM, BI and WFM.

The aimed target is to establish a less complex system landscape and the reduction of necessary DB licenses.

II.a.iii Development Technology and Interfacing

Most parts of DMF will be implemented in ABAP technology. This allows, for instance, a reuse of NetWeaver load balancing capabilities via Server Groups. The database schema will be implemented in the ABAP Data Dictionary (DDIC).

In DMF 1.0 the external communication will be done via RFC function modules. To allow integration of DMF with ISV systems and customer specific systems in an easy and harmonized way, Enterprise Services will be offered for external communication in DMF1.1.

II.a.iv Architecture Documentation

A detailed Architecture Bluebook will be provided and published in the SAP Architecture Library.

II.b Main Architecture Concepts and Decisions

II.b.i NetWeaver Add-On

DMF will represent a reuse component for the new applications SAP Price Optimization, SAP Markdown Optimization, SAP Promotions and Replenishment. These applications will be built “on top” of DMF, meaning that these are directly accessing DMF resources via well defined internal interfaces (no RFC).

The following figure depicts how the new applications will be deployed on-top of DMF:

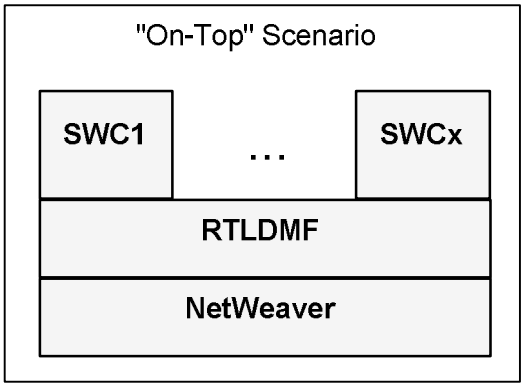

Figure 1: “On-Top” scenario. “SWC” = Software Component.

There are additional planned consumers of the DMF demand forecast, namely FIP on ERP (Fresh Item Procurement), MAP on BI (Merchandise & Assortment Planning) and WFM (Workforce Management). As these scenarios are implemented by various combinations of SAP components, it was decided to build DMF as a pure NetWeaver Add-On. This provides the potential to achieve the required flexibility. A new software component RTLDMF has been created on an independent development system.

The following figure depicts how the new applications will be deployed remotely to DMF:

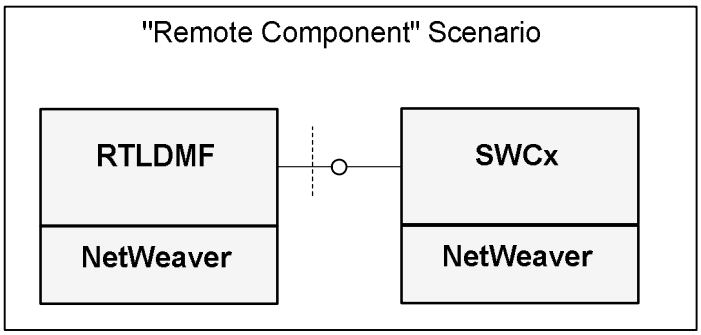

Figure 2: “Remote Component Scenario”. “SWC” = Software Component.

II.b.ii Multi-Component Environment

DMF depends almost completely on external feeds of master data as well as historical sales information. Therefore, well-designed interfaces are a key element of the DMF architecture.

Within an SAP environment, master data will be transferred from ERP to DMF. To be able to calculate a Demand Forecast it is also necessary to import historical time series from an SAP BI system.

Generally, an open interface strategy is pursued, because DMF shall be deployable also within non-SAP environments. Therefore Enterprise Services will be provided.

To ensure the ability to handle mass data, lean and object specific RFC interfaces will be provided as well. Within SAP, RFC technology is the most efficient communication method for mass data transfer.

II.b.iii Data Storage Paradigm

As several application “on top” of DMF shall be able to share data objects, it has to be clarified what the concrete tasks and offerings of DMF are. The following principles will be applied:

- Objects that are of interest for more than one of the consuming applications will be part of DMF. DMF always stores complete objects even if certain nodes or elements are specific for one consuming application only.
- If an object is stored within DMF and this object is supplied from an external system (like ERP), then DMF is responsible for providing all necessary inbound infrastructure.
- Consuming application specific access to DMF objects (view specific access) will be provided by DMF. DMF implements an abstract factory pattern which allows handling the access to different views of a DMF object in a consistent (but still highly performing) way.
- Technical checks are done within the DMF access layer. Application specific checks and business logic have to be implemented by the consuming applications themselves.

II.b.iv Load Balancing

Generic ABAP Load Balancing Engine to handle any type of parallelizable task: Science requests as well as inbound processing requests can be handled in a unified way by this central component. The Generic ABAP Load Balancing Engine leverages NetWeaver features like load balancing using server groups. This follows the overall strategy to reuse as many NetWeaver features as possible.

II.b.v Scientific Calculation Engine

The before mentioned “Science Modules” will be used for Demand Modeling and Demand Forecasting and will be implemented in C++ technology. Here we can leverage already done investments in code development and establish the required high performance environment. C++ modules communicate with the ABAP stack via the RFC protocol.

Furthermore DMF will provide the ability to do mathematical calculations via transient services. One requirement is the ability to provide an ad-hoc forecast simulation service.

II.b.vi User Interfaces

DMF will make use of three different types of user interfaces:

- Generated Customizing screens (IMG)
- SAPGui Technology
    - The ported Exception Handling User Interface from F&R (this UI will be replaced by a new WebDynpro UI in a subsequent release of DMF)
    - Selection Screens to allow background job scheduling via standard SAP background job scheduling functionality (SE36)
- WebDynpro ABAP technology for any new UI development

II.b.vii Technical Decisions driven by Consuming Applications (on-top Scenario)

Time series storage and deployment scenarios are heavily influenced by the Replenishment scenario.

This scenario requires the processing of huge volumes of data (Forecast Time Series) within a restricted time frame. A detailed analysis showed that the database has to be seen as an essential bottleneck when it comes to scalability considerations. Two important consequences are derived:

- Time series cannot be stored by employing a pure transparent data model. A mixed approach has been chosen, where the wealth of information is stored and retrieved in a BLOB-like, unstructured representation
- Whenever a customer wants to use DMF within the Replenishment scenario, it must be deployed on the same application system as the Replenishment component. In other words, remote communication must not be used. From a development perspective, Replenishment will be developed on the same development infrastructure as DMF.

III PLANNED DMF RELEASES

III.a Internal Release DMF 1.0

There will be a first, purely internal shipment of DMF which will be used for testing against performance and data throughput requirements. The following picture depicts the main building blocks of DMF1.0:

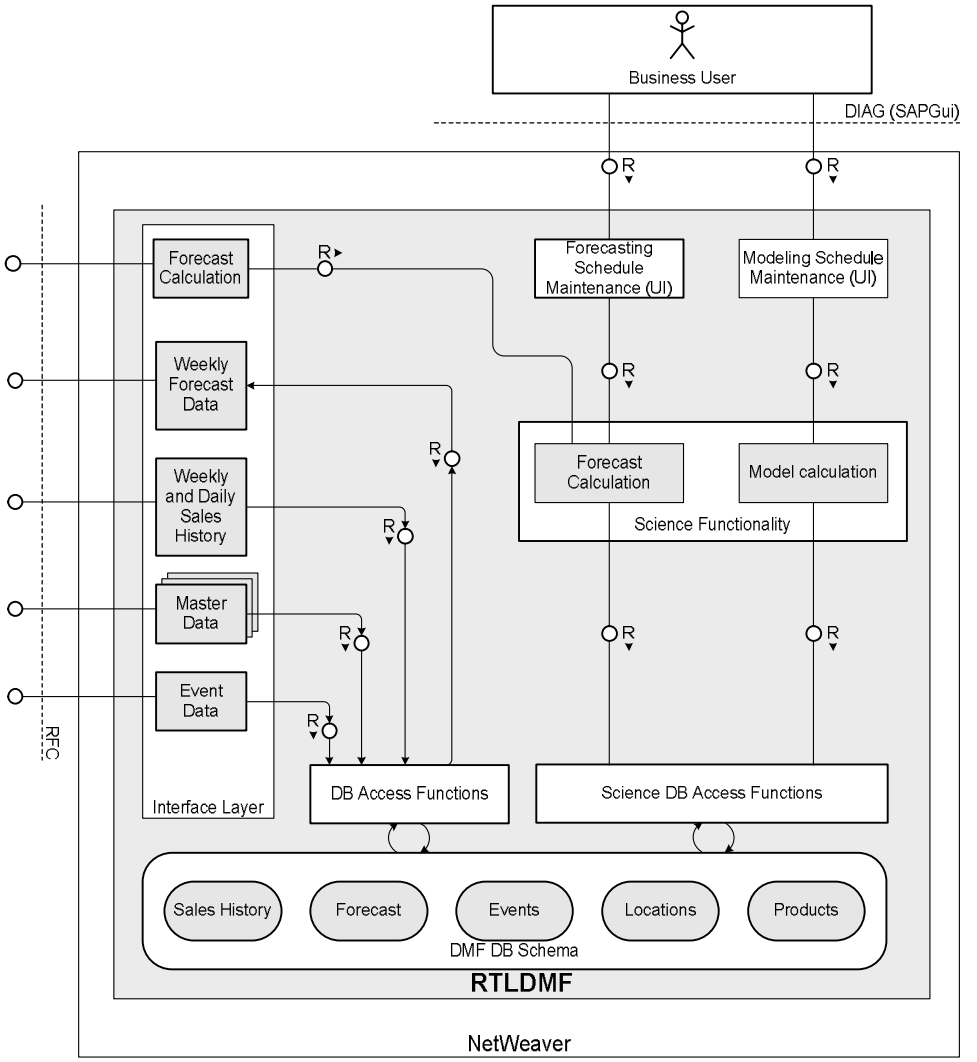

Figure 3: Architecture of DMF 1.0

THE FOLLOWING SECTIONS DESCRIBE THE FUNCTIONAL AREAS IN MORE DETAIL

III.a.i Load Balancing

The modeling and forecasting services provided by DMF are extremely resource intensive. Parallelization of work is essential, for example, modeling the entire enterprise in a reasonable amount of time. The Load Balancer is designed to decompose large requests such as enterprise wide modeling into tasks that can be executed in parallel.

III.a.ii Science Functionality

All forecast and optimization activities must be based on a common understanding of consumer buying behavior which will be represented by a “Demand Model”.

Future Forecasts are based on the mandatory Demand Model including the knowledge of future Demand Influencing Factors such as Sales Promotions or Sales Price.

The science modules are C/C++ executables which mainly create the Demand Model and calculate the Demand Forecast.

Modeling Process Execution:

- By Hierarchy: Modeling can be executed at any level of the product and location hierarchy
- By ProdLoc: Modeling can be executed for a list of locations and products

Forecasting Process Execution:

- By Hierarchy: Forecasting can be executed at any level of the product hierarchy and a list of locations. The forecasting result will be stored in the Time Series Database of DMF.
- By Location-Product: Forecasting can also be executed for a list of location-products. In this case the forecast calculation horizon can be specified on location-product level. The forecasting result will be stored in the Time Series Database of DMF.
- What-if: This is Forecast Simulation functionality. It shall support the business user in his decision phase when creating promotions. Via the interface parameters Event Calendar information can be provided and the functionality returns the respective Forecast values. No data will be stored in the database.

III.a.iii Database Model

The database model will cover all common objects of DMF like master data, science specific model data, system configuration data and time series data like sales history or forecast result data. All DB models do not strictly follow the object model and are optimized for specific access of the consumers like the science modules and Replenishment functionality.

III.a.iv Object Model

The object models represent the view of the exchanged business objects. Most objects models will differ heavily from the data base model. The strategic intend is to make the DMF object models compatible with ERP object models as most of the DMF data will have its source in ERP. Of course DMF object model will only represent a DMF-specific projection of the ERP object models. By considering existing and creating new eSOA Business Objects, the AP alignment provided the PIC process is established.

III.b First official Release DMF 1.1

DMF1.1 will be the first release which will be available to customers. DMF 1.1 itself will not be a product. Instead DMF 1.1 will be sold as part of a complete business application like Replenishment, Promotion Planning or Price/Markdown Optimization. Main improvement areas compared to the first version of DMF are as follows (see Figure 4):

- Additional data sources like additional Time Series, Location-Product master data object and additional Demand Influencing Factors (DIF) to extend the forecasting options for consuming applications.
- Enterprise SOA layer to communicate or exchange data with consuming and data provider systems via standardized communication protocols.
- Data staging to improve performance regarding initial data upload (master data, time series). Inbound data that are basically provided by an ERP or BI system will first be temporarily saved into staging tables without any consistency check. In a subsequent step the data will be validated and posted into the DMF database tables.
- Finalization of harmonized data model for common reuse objects which have to be aligned with ERP and eSOA models.

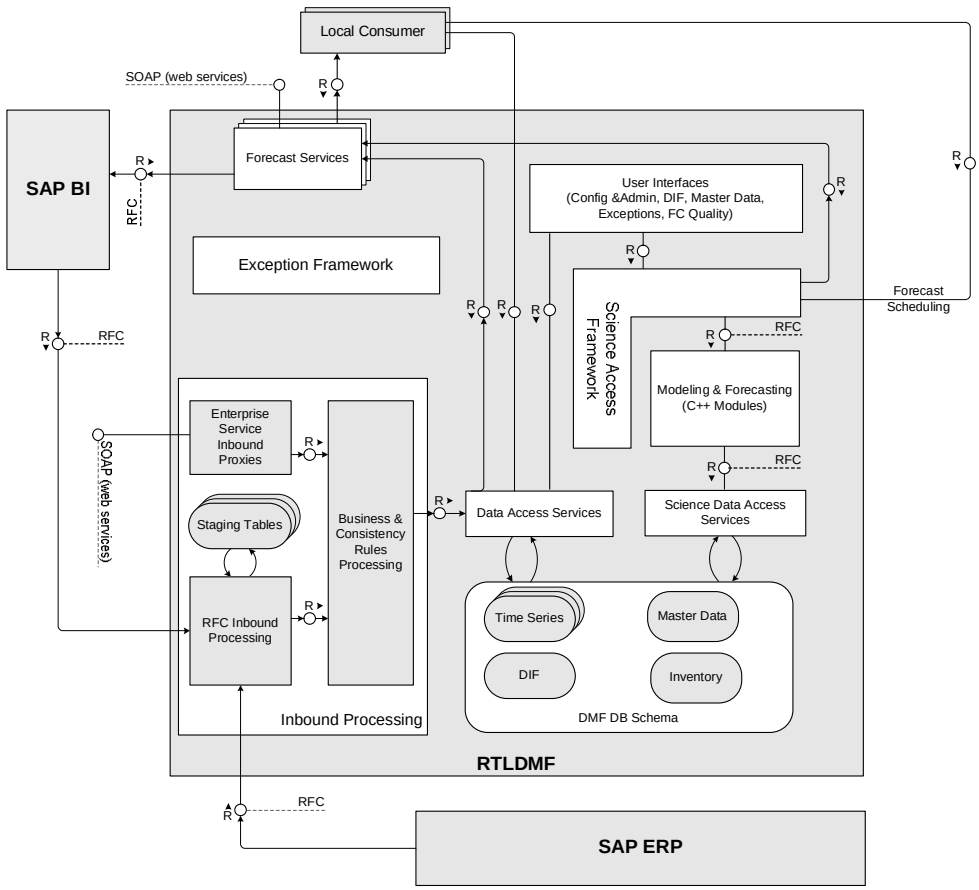

Figure 4: Architecture of DMF1.1

IV HIGH LEVEL PROCESS DESCRIPTION

IV.a Model Calculation Request

The demand model describes the buying behavior of customers. In a decomposition step products per location and products per Demand Group (group of products which cannibalize each other and have the same seasonality) are grouped together in separate tasks. The load balancer executes these tasks using parallel asynchronous RFCs to speed up the whole Demand Model calculation. The status of the task processing will be logged. The creation of the demand model is the most time consuming process as high data volumes will be processed by the science modules during that time.

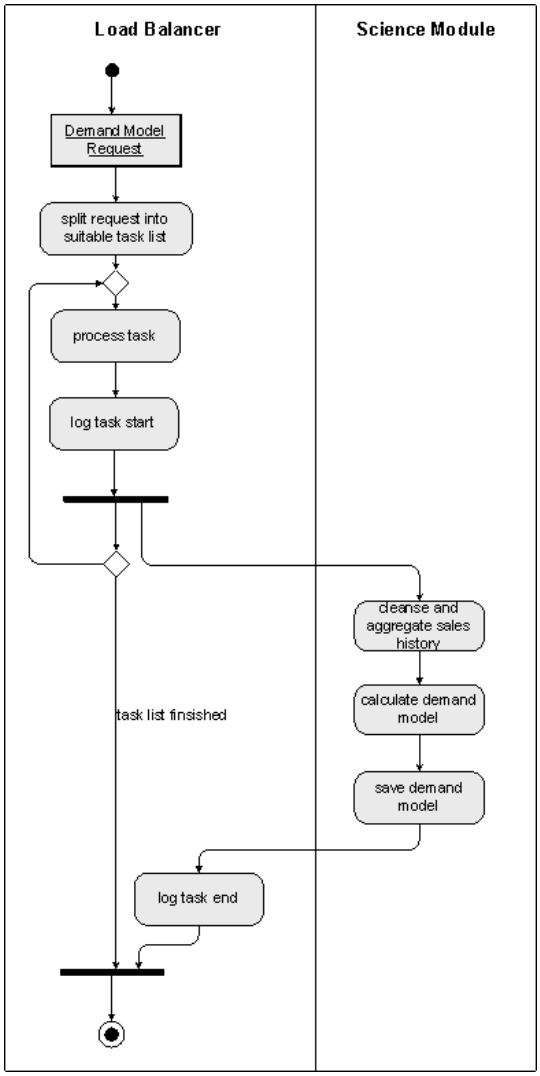

Figure 5: Model Calculation Request

IV.b Forecast Calculation Request

Demand Forecast calculation can only take place after the Demand Model has been calculated (see Figure 5). This calculation is typically requested by the Replenishment application. All Demand Forecast Calculation results will be stored to the data base. New calculation requests will overwrite already existing Demand Forecast values.

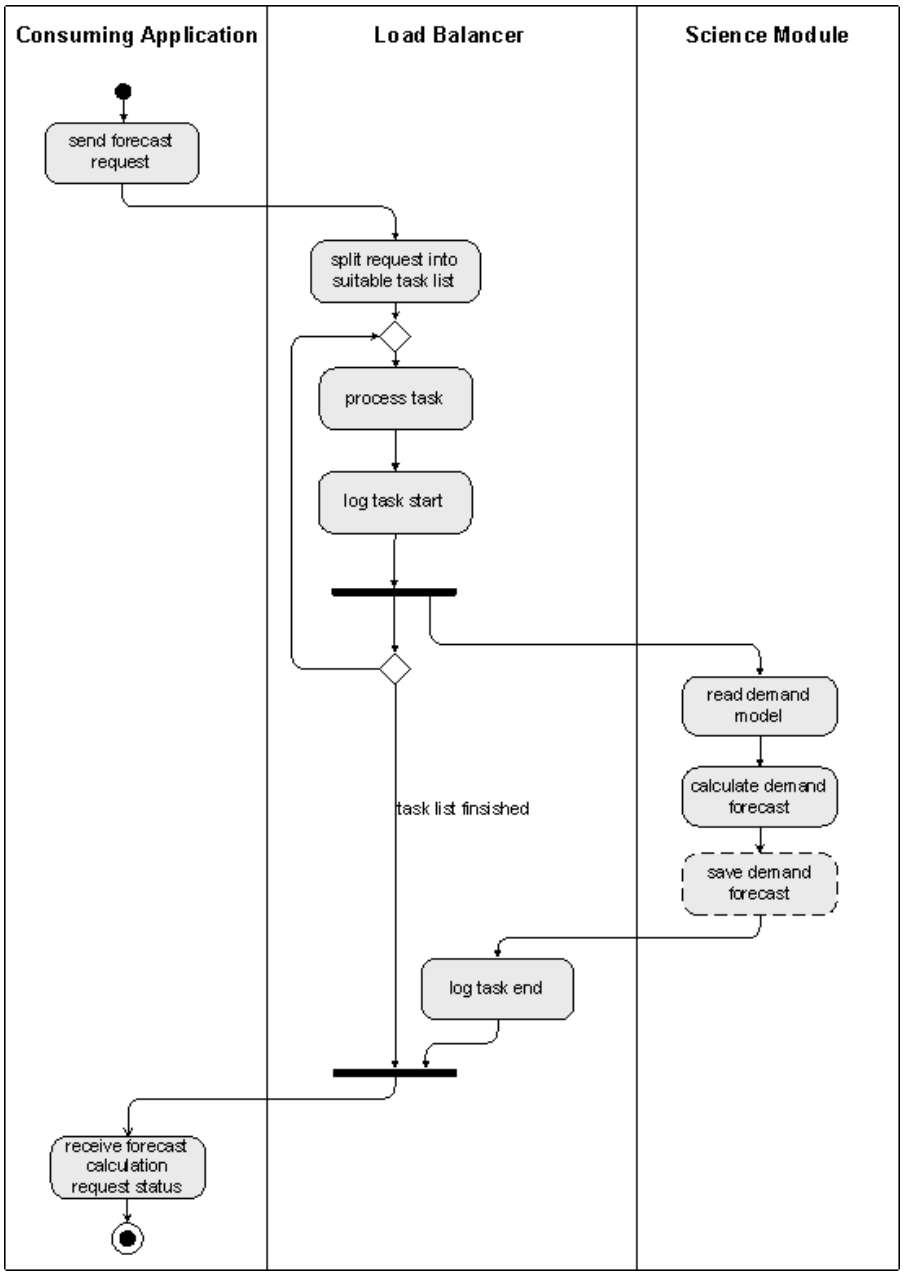

Figure 6: Forecast Calculation Request – "What-if-Forecasts" will not be persisted

V OPEN ISSUES, OUTLOOK AND RISKS

V.a Open Issues and Outlook

- Use of Business Suite reuse component SAP_BS_CO
- Use of LiveCache Technology
- Promo development as a potential ABAP composite will require more Enterprise Services

V.b Risks

- Performance issue because of processing of huge volumes of sales data which is typically comprised of two years of history on the level of product/ location/ day.