Chapter 2.
Key Features and Functional Architecture of
Operational Business Intelligence System

2.1 Introduction

The use of business intelligence (BI) in the organizations has been increasing
day by day for their strategic and tactical decision making. Today, it is difficult to find
a successful enterprise that has not leveraged BI technology for its business [1].
Business is dynamic that runs on daily operations. The term dynamic refers to
changes in decision making with respect to time and the term operations means
managing day to day business events inorder to make business more functional.

Operational BI is one of the fastest growing areas of BI [14]. Operational BI
provides information to the user in current time as opposed to traditional BI. The
importance of low level decision making tools in the organizations has been
increasing for the last few years. Every growing business demands a low level
decision making tool for handling business operations efficiently and effectively.

The objective of this chapter is to present key features, functional architecture
and methodology for developing business requirements of the proposed Operational
BI system.

2.2 Relevant Work

A business intelligence system was first proposed [6] by Hans Peter Luhn in
1958 and defined intelligence as “the ability to apprehend the interrelationships of
presented facts in such a way as to guide action towards a desired goal.” Business
intelligence (BI) is evolved out of decision support systems (DSS) which began in
1960s.

Colin White [14] was described Operational BI refers to the application of BI
methods and technology to the vast number of low-level decisions to be taken in the
daily operations of a business.

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 a) 1st Int. Conf. on Advanced Computing Methodologies (ICACM-2011), December 9-10,
b) Int. Conf. on Advances in Engineering, Science and Management (ICAESM - 2012),
Ulrich Christ [10] was described the difference between operational system and a data warehouse in three different aspects which are volatile, detailed and high granular data and current value. The term volatile means the change in data at much higher frequencies than contents of a data warehouse. In addition, mentioned that operational system provides detailed and highly granular data. The current valued means that they contain no (or little) historical data.

Claudia Imhoff [11] was described the differences between strategic, tactical and operational levels of BI in terms of business focus, users, time frame and data for metrics. In addition to this, explained the business focus of Operational BI system as to manage daily operations and integrate BI with operational systems.

Liya Wu et al. [42] were presented the SOA based conceptual architecture for BI on that consist of five layers such as data sources, ETL layer, data warehouse, business views (or logical model layer) and BI front end analytic applications.

Thilini Ariyachandra et al. [43] were studied different type of data warehouse architectures based on measures of information quality, system quality, individual impacts and organizational impacts in order to find the most successful architecture.

Wayne W. Eckerson [13] was described Operational BI is set abstract levels of process framework that includes analyze, monitor, facilitate and execute process.

2.3 Key Features

Operational BI system is a combination of operational and analytical systems. The key features of the proposed system are envisaged in figure 2.1.

![Figure 2.1. Key features of Operational Business Intelligence System](image)
2.3.1  **Low latency and reduced action time**

Business demands timely information for decision making. In order to make timely decisions the business information system has to provide right information to the users and respond instantly for right benefit. So speed is critical for operational system. Claudia Imhoff [11] was described Operational BI system is known as Business Process Intelligence or Real Time Data Warehousing which focuses on providing real-time monitoring of business processes. The traditional BI system can be transformed into an Operational BI system by reducing action time. Reduction of data latency in the system can be achieved by introducing real time integration between operational data sources and Operational BI engines. Therefore, an Operational BI system should have a low latency and reduced action time as one of the key characteristic feature.

2.3.2  **Access to Lowest Granularity Data**

Lots of data is lying in operational data sources and business process. The data derived from operational sources and business processes is known as operational data. Money is hidden in operational data. Thus, the proposed business information system could have an ability to measure the business value of an attributes from the smallest level of transaction or event information from operational data. The users of Operational BI system can access as lowest detail data as possible in the given window of time that typically ranges in minutes or even seconds.

The granularity of the data depends on the type of services and business processes offered by an organization. So, there is a great need of information to the user for their decision making which requires access to lowest granularity of data. The very purpose of Operational BI system is to satisfy the business needs of an enterprise to run business smoothly on day to day basis. Access to lowest granularity of data can be achieved by implementing drill down reports and operational OLAP reporting tools which are the major components of the proposed system. Thus, access to lowest granularity of data is identified as one of the key features of the proposed system.

2.3.3  **Real-time Alerts**

The users of business information system want to know how the business is performing in current time to react fast. Operational BI system has to react faster to business needs and to anticipate business problem in advance before they become major issues. Operational BI system speed is critical and users of the system want to
know how the business is performing on day to day or hourly or even minute to minute basis. Therefore the proposed system shall have a real time alerts notification monitoring as one of the key features.

2.3.4 Faster Query Response Time

The proposed system has to provide quick response to the users for the given query. The query may be normal SQL or search on a specific key word. The proposed system has to process user queries as fast as possible so that the changes in the system behavior can be traced. The assumption here is that query response time is smaller than the changes in the system performance to be measured and is independent of data arrival rate. Faster query response is obtained by introducing data compression, in-memory analytics and dynamic search functionalities. Data compression functionality can be introduced within the system that basically reduces the size of data stored in database. The reduction of data size allows handling of larger data sets in lesser amount of time which intern allows faster query response.

The advancements in hardware and software technology in terms of multi-core, 64-bit processor, virtualization, row and column wise storage, main memory resident database algorithms, in-memory analytics which provides higher performance to the proposed Operational BI system. In-memory analytics will perform by loading entire data into main memory which supports faster query response time that allows BI and analytic applications to support faster business decisions. Thus, faster query response can be identified as one of the key features of the proposed system.

2.3.5 More Ad hoc Querying Capability

An Ad-hoc query is a query that cannot be determined prior to the moment it is issued. The user will supply a keyword, data source and the conditions to the system inorder to get information which is in contrast to any query performed routinely or in predefined manner. The proposed system has to construct SQL query dynamically by the user specified parameters with the help of query tools or self-service reporting tools. This functionality can be achieved by the help of in-memory analytics, operational OLAPs, self-service reporting tools and dynamic query builder functional modules. Operational OLAP refers extending OLAP features to operational data. So, ad-hoc query functionality is one of the key features of the system.

2.3.6 Support for Streaming SQL

This feature is optional to the proposed system which depends on the rate at which operational data arrives to the system for analysis. This feature is required only
when the user want to execute queries on fast moving data. Mostly network monitoring and data streaming systems will receive data continuously which require to run queries when data is in motion for critical monitoring and analysis of data. Streaming SQL facilitates to run SQL queries on fast moving data that provides ability to run a complex analysis and querying capabilities against a huge live data generated from operational systems. Streaming SQL functionality can be implemented by introducing data in motion algorithms. Thus the functionality of Streaming SQL is identified as an optional key feature of the proposed system.

2.3.7 SLAs and KPIs Measurement

According to Claudia Imhoff [11] Operational BI applications generally cause changes to operational procedures or processes. The changes are usually needed to ensure that the operational BI information is optimally used. Multiple business processes are involved in the business and these processes need to measure various SLAs as per the business requirements. The performance of the business is measured on specific KPIs. Therefore the proposed system shall include SLAs and KPIs modules inorder to measure business performance on near real time basis. In addition, the proposed system can have a provision to configure operational parameters which are interested for measurement. Configuration of operational parameters is not one time task and is continuous because business is dynamic. Hence, the configured parameters are no longer remains same which will change from time to time. So, the proposed system should have a facility to configure parameters and the system shall able to affect these values dynamically. The parameters which are interested for measurement and their values are stored in files and these files will reside in main memory of the computer system. These files can be updated dynamically as and when there is a change in parameter values. The configured parameters values are compared with dynamically computed values on continuous basis. Operational BI system provides key performance metrics of an enterprise from their configured parameters. So, the proposed system can help corrective action as soon as the threshold limits of parameters exceeds. Hence, SLAs and KPIs measurement is one of the key features of the proposed system.

2.3.8 Flexible to integrate to the existing Business Processes

Operational BI is defined as measurement of business monitoring system. Every business will have at least one or more business processes. These business processes are to be integrated to Operational BI system inorder to measure various operational parameters. Business process can have sequence of events arranged in a
proper order either in serial or parallel that depends on the type business process. In
general, business processes need to govern certain business rules. This feature can be
implemented in the proposed system by introducing the functionality of business rules
engine and work flow modules.

2.3.9 Detailed and Timely Information

Traditional BI systems are data centric and historic in nature. So they do not
have a provision to offer sufficient information in current time to make the right
decision to the users who manages business operations on daily basis. Thus, there is a
great need of low level decision making tools to the organizations to run business on
daily basis. The proposed system should have capability to produce detailed and
timely information to the users for low level decision making. Business is dynamic in
nature. Thus, the information requirements to the user also changes with respect to
time. So there is a great need of detailed and timely information to the user to take
accurate and fast decisions. This requires the system should have BI and data analysis
tools for slicking, dicing, filtering and probing. Inorder to present information to the
user requires data visualization functionality in a simple, presentable and easily
understanding form. Hence, the system includes various types of reports such as
normal reports, comparison charts, bar graphs, hierarchical chart and dashboards.
Self- service reporting tools also are part of the proposed system inorder to get
bespoke reports as per the user requirement for detail and timely information.

Operational BI allows the user to make decisions based on what is happening
now rather than past. The proposed system can access data from operational data
sources on real time basis, generates knowledge and presents to the users on real time
for their decision making. The detailed and timely information to the users of the
system can be summarized as follows:

- Operational information – what are the services being provided by an
  enterprise and how to help business users to gain better access on these
  services.
- Performance information – this provides how well services and business
  processes are being provided against benchmarks or agreed standards and
  targets.
- Search information – users will have a quick search facility to find
  required information based on certain key words and important terms.
- Reporting information—the user will be provided summary information in the form of reports, dashboards through multiple channels that include emails, SMS, MMS alerts in near real time/real time.

Portal provides a common interface to various users of the system and acts as a single entry point for both user requests as well as system response. This acts as information dissemination tool. The users can login into the system and access various resources such as reports, dashboards and other business applications in terms of operational, performance, search and reporting information for their decision making. Thus, detailed and timely information is one of the important key features of the proposed system.

2.4 Holistic View of Operational BI System

A holistic view of Operational BI system is presented from the identified key features of the system that consists of set of abstract layers. The functionality of each abstract layer is grouped into set of individual functional modules. In addition, the key features of the proposed system are mapped to their equivalent functional modules.

2.4.1 Abstract Layers of Operational BI System

A holistic view of Operational BI system is shown in figure 2.3 which consists of set of abstract layers such as data sources, data services, Operational BI Engine, service delivery, delivery channel and user access layers.

![Figure 2.2. Holistic view of Operational Business Intelligence System](image-url)

Figure 2.2. Holistic view of Operational Business Intelligence System
The various functional modules associated to each layer are depicted against that layer which is shown in figure 2.3. The functionality of each abstract layer can be achieved by combining set of individual functional modules as a group. These individual functional modules are derived from the salient features of the system as described in previous section. The functionality of each layer of holistic view of Operational BI system is envisaged below:

*Data sources* layer consists of various operational sources, back office and front offices system that includes ERP, SCM, CRM and legacy applications.

*Data services* include data integration between operational systems and operational business engines. In addition, this data storage for incremental databases which are extracted from operational sources that holds dynamic data. Similarly data warehouse to store static data of organization. Moreover, this includes data compression services.

*Metadata* functional module will hold the data that describes and controls the system overall. This contains all details of business applications and organization management which are placed in a central repository.

*Business services* layer includes functionality of business rules, workflows, logging and monitoring. Business services include the configuration of business, process and operational parameters to be measured which includes SLAs/KPIs of an organization.

*Operational BI engines* layer is the crux of the overall system which include core functionalities of various engines that include OLAP cubes, OLAP aggregates, Ad-hoc querying, Alert engine, Analytics engine, SLAs and KPIs management, logging and monitoring, workflow, business rule engine, streaming SQL, searching and in-memory computing.

*Service delivery* layer consists of portal and reporting tools. Delivery channels include browser, Email, SMS, MMS, mobile client and command terminal.

*Operational BI users* include front line business users, operational users, business managers, IT users, finance users, analytics and executives. The users will receive information from the system in the form of alerts, emails, SMS and MMS and can access available resources via portal as per their access privileges.
2.4.2 Key Features versus Functional Modules

The identified key features of Operational BI system are mapped with their equivalent functional modules. Few functional modules may be repetitive inorder to achieve the full functionality of the key feature of the system. However, while implementation of the system these modules consider as single individual module which share across the system functionality.

Table 2.1. Key features of Operational BI versus functional modules

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Key Features of Operational BI</th>
<th>Equivalent Functional Modules of Operational BI</th>
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</table>
| 1.    | Low latency and reduced action time | • Real time integration of operational business process and operational data sources  
|       |                                 | • In-memory analytics  
|       |                                 | • Data compression  
|       |                                 | • Alert notification to reduce decision latency |
| 2.    | Access to lowest granularity data | • Drill down reporting  
|       |                                 | • Operational OLAP reporting |
| 3.    | Real-time alerts or message notifications | • Alerts notification and monitoring modules |
| 4.    | Faster query response time | • In-memory computing  
|       |                                 | • Data compression  
|       |                                 | • Operational OLAPs  
|       |                                 | • Dynamic search |
| 5.    | More ad hoc querying capability | • In-memory computing  
|       |                                 | • Operational OLAPs  
|       |                                 | • Self service reporting tools  
|       |                                 | • Dynamic query builder |
| 6.    | Support for Streaming SQL | • Data streaming algorithms  
|       |                                 | • Streaming SQL |
| 7.    | Configurable operational performance measurements | • KPIs/ SLAs management  
|       |                                 | • Dynamic configuration of operational parameters  
|       |                                 | • Dynamic computation of operational parameters  
|       |                                 | • Real time monitoring  
|       |                                 | • Dashboards |
| 8.    | Flexible to integrate the existing business processes and workflows | • Business rules  
|       |                                 | • Workflow |
| 9.    | Detailed and timely information to the users | • Analytics Engine  
|       |                                 | • Logging and monitoring  
|       |                                 | • Portal  
|       |                                 | • User and security  
|       |                                 | • Data visualization  
|       |                                 | • Self service reporting tools |
2.5 Functional Architecture

According to Sjaak Brinkkemper et al. [94] functional architecture modeling is essential for identifying the functionalities of the software product and translating them into modules, which interact with each other or with third party products. The functional architecture reflects a software product's architecture from a usage perspective that resemble the functions performed in the individual user context, or the enterprise functions of the customer organization that are supported by the software product. A module of the software product represents a set of sub-modules which correspond to lower level functions that interoperate to implement the corresponding functionality.

Bass et al [166] was described the design of a functional architecture which is influenced by the four main factors. 1) All the requirements set by the stakeholders, functional and non-functional, determine what kind of functionalities are going to be incorporated, as also technical restrictions that have to be taken under consideration. 2) The developing organization affects the architecture, with regard to earlier versions of the product, or available design patterns to be used, or already known data such as an existing database. 3) The technical environment that includes software engineering techniques or industry standards available, available design tools and development platform which can influence the architectural decisions. 4) The background and expertise of the architect influence the selection of architectural techniques to be followed.

Figure 2.3 shows the logical architecture of the system that consists of set of abstract layers which are identified from the key features defined in Section 2.3.

![Figure 2.3. Logical architecture view of Operational BI layered system](image)

The various abstract layers of the proposed system are data sources, data services, analytics engine, business services, alert engine, reporting engine, metadata management, user and security and portal. Each abstract layer consists of various sub-functional modules and all these sub-modules constitute to the total system.
The logical architecture is further extended into full blown functional architecture of the proposed system which is shown in figure 2.4. The functionality of each layer is further breakdown into set of modules and each module will met sub-functionality of the system.

**Figure 2.4. Functional architecture of Operational BI system**

### 2.5.1 Data Sources

The bottom layer of Operational BI system has set of data sources which act as input to the Operational BI system as shown in figure 2.5.

**Figure 2.5. Data sources**

This layer consists of one or more data sources that include ERP/CRM, text files, XML files, data files, legacy systems, emails, internet repositories and other applications. These data sources may be internal or external to the system. The data
source may be either structured or unstructured data. The unstructured data sources can be transformed into structure data source to form a common conceptual schema for further analysis of the data.

2.5.2 Data Services

Figure 2.6 shows the data services layers. The main function of data services layer is to managing the collection, loading, storing, compression, transformation, analysis and dissemination of data.

![Data Services Diagram]

**Figure 2.6. Data services**

Data integration is the process of the standardization of data definitions and data structures by using a common conceptual schema across a collection of data sources. Data integration provides suitable integration between data source to data services layer that also combines data residing in multiple sources and provide a unified view of data to the users of the system. Mostly, operational data sources are integrated on real time basis with business intelligence systems.

Data warehouse is a collection of data designed to support management decision making and contain a wide variety of data. It presents a coherent picture of business conditions at a single point in time. It holds all historic data of an organization.

Data storage module provides storage of operational data. Operational data is extracted from different data sources. The extracted data can be stored either in main memory or flash memory or even secondary storage memory in the form of incremental databases. The advantage for storing the data in main memory is to achieve in-memory analytics for real time processing of data and response.

Ad-hoc query module provides environment to run query that cannot be determined prior to the moment the query is issued. Ad-hoc query is dynamically constructed SQL and is created in order to get information when need arises. This is in contrast to any query which is predefined and performed routinely. In order to run ad-hoc queries efficiently the system must require resources such as huge amount of main memory and very fast devices as temporary disk storage.
Streaming SQL module facilitates to run SQL queries on fast moving data obtained from operational system. Streaming SQL provides ability to run a complex analysis and querying against a huge live data generated from operational systems. Streaming SQL uses standard SQL, except that streaming SQL queries run forever, processing data as they arrive over specified time windows. The required functionality is obtained by implementing suitable streaming SQL algorithms.

OLAP stands for online analytical processing and is another name for multidimensional analysis. The basic operations of OLAP are Slice, Dice, Drill Down/Up, Roll-up and Pivot. Consolidation involves the aggregation of data that can be accumulated and computed in one or more dimensions. Drill-down is a technique that allows users to navigate through the details. The functionality of slicing includes take out a specific set of data of the cube and view whereas dicing provides the slices from different viewpoints. Pivot provides rotation of data axes to provide an alternative presentation of the data.

Data compression module provides compression of OLAP cubes data using one or more compression techniques. The data compression can be implemented using one of the following techniques called B-Tree or Bitmap. The compression of data facilitates not only the reduction of data size but also faster data access, faster query response with large volumes of data.

2.5.3 Analytics Engine

Analytics engine is an important tool in BI and as well as Operational BI systems. The various functional blocks of analytics engine are shown in figure 2.7.

![Figure 2.7. Analytics engine](image)

The major functionality of analytics layer is to extract knowledge from the operational data and operational business process. This engine also works as per the predefined schedule to extract knowledge from historical data that is from data warehouse. Analytics engine builds quantitative processes for a business to arrive at optimal decisions and to perform business knowledge discovery from historical data and as well as operational business process. This functionality includes various data mining algorithms, incremental mining algorithms, mining models, decision models and other analytic services. Other analytical services include statistical analysis,
process mining, predictive analytics, predictive modeling, event processing and business process modeling. Data mining engine consists of a set of functional modules such as characterization, association and correlation analysis, classification, prediction and cluster analysis.

### 2.5.4 Metadata Management

Metadata is often defined as "data about data". This is one of the important functional blocks in BI/Operational BI system. Metadata holds the data that describes and controls the system overall. The details of metadata include data definitions, data models, data mapping, tables - records, segments and entities, columns, keys, indexes, cubes and reports. In addition to this it controls handling of data and describes: rules, transformations, aggregations and mappings. It also describes the data services, control of operation, data warehousing, OLAP, analytics, operational system and reports. Metadata management includes the life cycle of activities covering collection, storing, querying, reporting and maintaining metadata repository for future use.

### 2.5.5 Business Services

The business services layer covers the functionality of various modules such as workflow, KPIs/SLAs management, business rules definition, logging and monitoring. Figure 2.8 shows business services layer of the proposed system. KPIs/SLAs module includes configuration of various key performance indicators and service level agreements of business operational measurements. The functionality of workflow module includes configuration of business processes and execution.

![Figure 2.8. Business services](image)

Business rules module facilitates configuration of business rule definitions and change of these configurable values from time to time. Logging modules facilitate to record various login activities of users. Monitoring module provides measurement of various operational and business performance parameters configured in the system against dynamically computed aggregates from operational data sources. The output of the monitor is available to the users in the form of reports and dashboards.

### 2.5.6 Alert Engine

Alert engine is one of the most important functional blocks of Operational BI system. It generates alerts on near real time / real time basis. Alert engine receives
input messages from operational business processes and operational data sources of the system. The message formats are pre-defined XML templates. The structure of message template essentially contains header and body sections. The message header contains elements like template id, source id, and message id whereas the body of the message contains contents of alert information.

Alert engine parses the incoming messages, fetches data from the configuration files and checks with dynamically computed values. The system generates an alert when threshold limit of the configured parameter values exceeds. Message composer dynamically selects the suitable message template and then composes message. This message will send to the dispatcher. Dispatcher will push these alerts or messages to a web based persistent communications channel and finally deliver to the right decision maker to notify the issue. This module may also be known as event monitoring and notification. The detail design of event monitoring and notification engine is provided in section 3.6 of Chapter 3.

2.5.7 Reporting Engine

The report engine includes customizable reports which can present high-level findings as well as enable a user to drill down to find specific details. The major functional modules in reporting engine are shown in figure 2.9. This module includes standard report templates that provide the user to create customizable reports.

![Figure 2.9. Reporting engine](image)

The reports module consist infrastructure for strategic reporting to serve the strategic management as well as operational reporting for low level decisions of business operations. Dashboard is a panel where all information is presented via graphical display in the simplest way possible. Specifically, it reports key organizational performance data on a near real time basis. There may be multiple reports on a single dashboard with this users can gain at-a-glance understanding of key trends and metrics. The users can manage dashboard reports in a user friendly environment interms of filter information, deeper analysis and drill down of the data.

Data visualization module provides visualization and analysis of real time data. The functionality of this module includes detection, representation and transformation of data. This module supports production, presentation, and dissemination of the
results of an analysis to communicate information in the appropriate context to a variety of audiences as described by James J. Thomas et al. [40]. Data visualization facilitates knowledge discovery through information synthesis, which is the integration of data based on their meaning rather than the original data type. Daniel Keim et al. [48] was described, visual analytics is more than just visualization and can rather be seen as an integral approach to decision-making, combining visualization, human factors and data analysis.

2.5.8 User and Security

All users of the system are defined and maintained in the database. User groups will be created based on broad category of functional usage and access on various sub-modules functionality. Users will be mapped to one or more user groups. Users are assigned to roles. Roles are mapped to user groups. So each user can access application modules based on their role. The functionality of this module includes user creation, group creation, assigning application functionality to the groups, role creation, assigning roles to groups, and activation and deactivation of users. User access on application functionality is controlled in a data driven manner that uses Role based access control (RBAC). A two factor authentication is implemented for application login that improves better security to the proposed system.

2.5.9 Portal

Portal provides a common interface to various users of the system and acts as a single entry point for incoming requests. The major modules of Operational BI Portal are shown in figure 2.10.

![Figure 2.10. Major modules of Operational BI Portal](image)

It acts as information dissemination tool. The users can login and access resources such as reports, dashboards and other business applications and services as per their access privileges. In addition, all the functional modules can also be registered in the database for better security and access control.
2.5.10 Advantages of the Proposed Functional Architecture

The following are the advantages of the proposed functional architecture of Operational BI system:

- Modular in nature – All the functional modules identified in the system will meet specific functionality. So group of modules will meet the specific functionality of the system. Thus the proposed system is highly modular in nature. Hence, these modules can be reused across the system.

- Maintenance is simple – Any change in the functional requires then corresponding changes are to be made in specific module or modules. Hence, maintenance of the system is simple.

- Scalable - All modules are loosely coupled and highly modular in nature. Hence, the proposed functional architecture is highly scalable for small, medium and even enterprise level.

- Simple to introduce additional functionality - New functional requirements can be introduced into the system by suitably identified functional modules by alerting existing modules or building new modules.

2.6 Methodology for Developing Business Requirements

Requirements engineering is the first phase for any software project or product development. Requirements engineering is difficult that is the basis for entire software development life cycle. The better understanding on the requirements of the product helps to build a better system. A methodology for developing business requirements of Operational BI is shown in figure 2.11 which are identified from their key feature of the proposed system.

![Figure 2.11. Holistic view of Operational BI requirements methodology](image-url)
Developing requirements for Operational Business Intelligence system can be classified into five different levels. The requirements of each level are independent of other levels that facilitate multiple business analysts can develop requirements in parallel and combine later.

The following are the key business requirements of Operational BI System:

- Business context: Business services, stakeholders, mapping
- Operational requirements: Operational parameters of the business processes, services and activities in terms of key process areas for interesting measurements.
- Functional and user requirements
- Informational requirements and
- Knowledge and other requirements.

The proposed methodology of requirement development for Operational BI system is different from traditional approaches of Data warehouse and Business Intelligence systems.

2.6.1 Business Context

Business context requirements mean knowing about business specific information of an organization in terms of domain, core business services offerings, business process associated with different business services that are important to the business to run, stakeholders and their mapping within and outside the business. The core business services are the business services being offered by an organization which associates one or more business processes.

- Business Services
- Stakeholder
- Business Services mapping

The business context requirements should identify the actors such as people, organizations and systems that play a significant role in the business process of an organization. The business context requirement includes the business domain specific requirements that are belonging to the business areas of interest including business process, key stakeholders and mapping between them.

The business context diagram is a block diagram that outlines all the major entities within and outside the organization together with the relationships between them. Sometimes a single business context diagram can be drawn for small and mid-
sized organizations and where as separate context diagrams will be drawn for different divisions in the organization for the enterprise organization.

2.6.1.1 Business Services
In this the requirements of core business services of an organization will be made in details including its sub-services if any. The interdependences between sub services and other services will be identified. The business process that is associated to each business service/sub-service is also examined. In addition to this the requirements of critical activities that are associated to each business process will be studied that must be performed to meet the organizational objective(s) while remaining solution independent.

2.6.1.2 Stakeholders
In any business, stakeholders will be the major actors of the business services operation and management for smooth running of business. In this all the stakeholders that are associated to the organization either directly or indirectly will be identified. The stakeholders of an organization will be classified as category. The category of stakeholder based on their business functions, services and process that are associated instead of expressing directly. The requirements of each category of stakeholders will be studied with reference to business context. Analyze the stakeholders; if two stakeholders share all of the same business services, then they should be combined. If however, they use one or more services differently than the other, then keep them separate.

2.6.1.3 Business Services Mapping
In this business services mapping with stakeholder category will be made. Next, link every stakeholder to the business with an interaction representing the business service they use, or the business service they provide to the business. Once you have done this for all stakeholders, and exhausted all business services, look at the stakeholders once again. The outcome form business context requirements will be business context diagram, list of core business services of an organization, stakeholder’s category and mapping between business services with stakeholders.

2.6.2 Operational Requirements
Operational requirements are the second level requirements of an Operational BI system. Well written Operational BI system requirements can save lot of time for building the effective system. A requirement is an attribute of a product, service or system that necessarily to produce an outcome(s) that satisfies the needs of a person,
group or organization. Requirements therefore define “the problem.” In contrast, “the solution” is defined by technical specifications. Defining requirements is the process of determining what to make before making it. Operational requirements include broadly two types known as system requirements and performance measuring requirements. System requirements include operating system, network and protocols whereas performance measuring requirements include performance of the business units, business processes, the business dimensions and SLAs and KPS are to be measured. In addition to this the details how drill-down and roll-up analyses are done. It records critical measurements or facts and business dimensions along which the facts are normally analyzed.

2.6.3 Functional and User Requirements

The third level of Operational BI requirements addresses about functional and user requirements, which describe the tasks that user, must be able to perform using BI System. These are best captured in the form of use cases, which are stories or scenarios of typical interactions between the user and the system. User requirements are stated from the use’s point of view that describes what is needed for the user to do.

2.6.4 Information Requirements

BI systems are an information systems and require study the information requirements of the organization and they are classified into the following four types viz data sources, data transformation, data storage and information delivery.

2.6.4.1 Data Sources

Operational systems are the major source of generating transactions. This operational data is an important to the business intelligence system that comprises data warehouse. The information sources to Operational BI systems are different from operational systems, applications and legacy systems. This includes all the details of the source data bases that exist within the organizations. The data is collected from these data sources, merge, integrate, transform the data appropriately and finally populate the data warehouse. Typically, the requirements definition document should include the following information:

- Available data sources such as database(s), flat files, XML files and information repositories such as WWW.
- Data volumes and data integrity
- Data structures within the data sources
- Location of the data sources
- Operating systems, network, protocols, and client architectures
- Data extraction procedures
- Availability of historical data

2.6.4.2 Data Transformation
After identification of all possible list data sources to the data warehouse system and then required to determine how the source data will have to be transformed appropriately into the type of data suitable to be store in the data warehouse. This requirement includes the details of transformation that involve mapping of source data to the data in the data warehouse. Indicate where the data about your metrics and business dimensions will come from. Describe the merging, conversion, and splitting that need to take place before moving the data into the data warehouse.

2.6.4.3 Data Storage
From your interviews with the users, you would have found out the level of detailed data you need to keep in the data warehouse. You will have an idea of the number of data marts you need for supporting the users. Also you will know the details of the metrics and the business dimensions. When you find out about the type of analyses the users will usually do, you can determine the types of aggregations that must be kept in the data warehouse. This will give you information about additional storage requirements. Operational BI requirements definition document must include sufficient details about storage requirements. Prepare preliminary estimate on the amount of storage needed for detailed and summary data. Estimate how much historical and archived data to be in the data warehouse.

2.6.4.4 Information Delivery
The very objective of an operational BI system is to react faster to business needs and to anticipate business problems in advance before they become major issues. For this kind of system requires tighter integration between the BI system and operational system. A collaborative flat form is required to facilitate information delivered form both operational system and as well as BI system. So in this the information delivery requirements of the system will be studies. By the use of in-memory analytics can be used to implement low latency or zero latency system.
Information delivery requirements tell about how information will be delivered to the various types of users in the business and is also called information access requirements. Information delivery requirements must contain the following requirements on information delivery to the users:

- Drill down analysis
- Roll-up analysis
- Drill through analysis
- Slicing and dicing analysis
- Ad hoc reports

2.6.5 Knowledge and Other Requirements
In this level, the business domain knowledge requirements will be studied with reference to the business context of the business organization. It is important to specify the knowledge to be mined, as this determines the data mining function to be performed. Kinds of knowledge requirements include concept description, association, classification, prediction and clustering. Also Meta data, Meta patterns or Meta rules or Meta queries, requirements and background knowledge of the business domain requirements will be studied.

2.6.6 Advantages of Proposed Methodology
The proposed methodology for requirements development has the following advantages over traditional BI or warehouse systems.

- Proposed methodology is based on the business context of the system from which the relation between various business services and the key stakeholders of an organization can be related. Hence, this methodology supports delivery of right information to right user for right time which is an important objective of an operational BI system.

- Operational requirements of the BI system are included. Hence, it supports business performance and monitoring of SLAs/KPIs.

- The proposed requirements are level wise and independent. Hence, multiple analysts can work independently for gathering business requirements and later these requirements can be summarized as a whole.
2.7 Applications of Operational BI

Operational BI system works on near real time or real time basis. Thus, the proposed system will provide both operational and analytical information to all the users of the system on fly. Moreover, the proposed system provides knowledge to the users of the system for their decision making in current time as well as past. Hence, Operational BI can find their use in all most organization for their decision making, to name a few.

- Financial analytics
- Market analytics
- Sales analytics
- Human resource analytics
- Order management fulfillment Analytics
- Vertical (or industry specific) Analytics
- Service analytics
- Contact center analytics
- Supply chain analytics
- Airlines
- News
- Stock market
- Banking and Insurance

2.8 Conclusion

In this chapter, the key features of Operational BI system are presented which is combination of operational and analytical systems. In addition, a holistic view of the proposed system is presented that consist of abstract layers from the key features of the system. Further, mapping between the key features of the system with their equivalent functional modules are presented.

The logical architecture view of Operational BI system is presented from the identified key features of the system that consists of set of abstract layers. The logical architecture has nine different layers namely data sources, data services, analytical engine, metadata management, business services, alert engine, reporting engine, user and security and portal. Further, the logical architecture is extended into a full functional architecture of the proposed system. The functionality of each logical layer is further divided into sub-functional module and explained the functionality each sub module. All these sub-modules constitute the total system.

A methodology for requirements development of Operational BI system is presented which is based on the context of the business of an organization and the key features of the system. The proposed methodology consists of five different types of requirements namely business context, business services, operational, functional and user, informational and knowledge requirements. This methodology works on level wise. Thus, multiple analysts or teams can work in parallel for gathering business
requirements on level wise further these requirements can be summarized as a whole that represent total business requirements of the system. Finally, applications of Operational BI are presented.