

## **The Data Organization**

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### **The Data Warehouse Conceptual Data Model**

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## **Biography**

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He has built data warehouses for clients such as Pacific Bell (Financial), Genentech (Personnel), GE Leasing (Sales), SGI (Personnel), PPFA (Healthcare), Brobeck (Personnel), BofA (Merger and Acquisition), Clorox (Financial), Leapfrog (Financial) and Intuitive Surgical (Quality Assurance).

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## 1. INTRODUCTION

The *Conceptual Data Model* document describes the data warehouse conceptual data model, its organizing principles and analysis. This document will specifically deal with the requirements surrounding the organization and completeness of the data warehouse.

### 1.1 Purpose of the Document

The *Conceptual Data Model* describes the data warehouse conceptual data model, its organizing principles and analysis. The goals of document are:

- To enable the conceptual model to be the framework for business intelligence
- To provide a framework for consistent business measurement
- To create a common framework for mapping the data definitions.
- To simplify the data stored in the data warehouse

This document will specifically deal with the requirements surrounding the organization and completeness of the data warehouse. This document describes the results of the policy decisions that created the data model, the decomposition and organization of the business data.

The document represents the end of the first phase of creating an enterprise data warehouse. The development phases are:

- Conceptual Data model – this document
- Logical Enterprise data model
- Physical data model
- Implemented database

## **1.2 Scope of the Document**

The scope of the document is limited to the conceptual data model for the data warehouse required for business intelligence reporting. The level of detail is at the entity level and the relationships between the entities and the business process measurements. The resulting conceptual data model consists of boxes (entities) and arrows (relationships) with descriptions of the contents of the boxes. Detail below this level is given in the logical data model document and the physical database engineering document.

## **1.3 Organization of the Document**

INTRODUCTION specifies the purpose, scope and organization of this document.

OVERVIEW describes the background of the conceptual data model and the organization of the data collected by the business processes.

CONCEPTUAL MODEL PROCESS describes the business processes that the data warehouse supports.

BUSINESS MEASUREMENTS describe the types of process measurements (facts) that are in the conceptual data model.

OPERATIONAL ENTITIES describe the entities that are part of the day to day business operational processes.

ORGANIZATIONAL ENTITIES describe the entities that are used by the business to organize the operational processes.

## 2. OVERVIEW

The conceptual model for the data warehouse describes a model of the business.

A conceptual data model shows how the business sees its information. A conceptual data model represents the semantics of an organization's data. The meaning of the data comes from the set of business processes that create and use the data. The views of these business processes are consolidated into a single conceptual schema that is the superset of all of those external views of the data by generalizing and aggregating the underlying data entities.

This model of the business yields insights for managing change. The model also gives the preconditions for the effective and efficient storage of the business data.

### 2.1 Purpose

The objective of the data warehouse is to consolidate all of the measurements of the business processes of a company so that the data is of high quality and consistent. In this way, reports of the company's status from different points of view can be compared without having to resolve inconsistencies in the data.

### 2.2 Data Warehouse Goals

The goals of the data model are:

- **Completeness** – the logical data model should include all the Visa relevant enterprise data. The model should identify all the synonyms that the business uses for the same data concept and the homonyms that are used for different data concepts.
- **Non-Redundancy** – recording the same data more than once requires extra processing to keep the various copies in step and leads to consistency problems if the copies get out of step. Conceptually, the logical data model is a minimum cover set of the business data.
- **Data Integrity** – the rules in the data model should accurately reflect the rules that apply to the business data. The resulting data model is a powerful tool in enforcing correct practice and maintaining data quality.
- **Data Reusability** – This requirement is often expressed in terms of its solution: as far as possible, data should be organized independently of any specific application.

- Stability and Flexibility – Limit data model changes because of changes in data sources, processing and company policy (data independence).
- DBMS Query Optimization – every DBMS uses an optimizer to restructure complex SQL queries for faster execution. This optimizer assumes that the database is a relational algebra and that the relational calculus applies. If this assumption is not true, then the results returned by the optimizer will be invalid.

### **2.3 Assumptions**

The following assumptions were made during the creation of the data model:

- All of the business data can be stored in a data warehouse
- All of the application business objects can be created by projecting (sub setting) and joining (composition) the logical/conceptual data model entities
- The data model does not include data required for database auditing, database authorization, application security, application configuration, application processing, workflow processing, batch processing control, messaging control, etc.

## 2.4 Benefits

The benefits of creating a conceptual data model (data architecture) are realized in business process improvements in three areas.

In the business performance area, the benefits are:

- Alignment of IT business case with business strategy
- Consistency and integrity of information
- Improved cross application business intelligence reporting

In the area of OLTP application development, the benefits are:

- Improved technical adaptability and scalability
- Improved interoperability of OLTP applications
- Detailed models provide a common frame of reference across major business areas
- Improved ability to address critical enterprise-wide issues like security
- Easier upgrade and exchange of architecture platform components (plug and play)

In the area of cost avoidance, the benefits are:

- Reduced risk because architectural issues have been identified earlier
- More reuse lowers software development and support costs
- Reduced rework lowers software maintenance costs



## 2.5 Risks

There are risks associated with not having, creating and using data architecture, but data architecture is too strategically important to follow a sporadic development process.

The business has to pay up-front for the right to exercise options in the future. In the past, the business has often settled for cheaper, less permanent solutions, rather than focusing on options that provide increased future maneuverability.

Data architecture requires new technical expertise, understanding and viewpoints. It may be difficult to reach agreement on common, business-wide models and standards, which are necessary to ensure interoperability. Independent-minded business units may not wish to participate in collaborative efforts, particularly since long-term realignment of business functions and responsibilities could be a result.

Data architecture requires commitment from the application development teams. Business process automation projects have often sacrificed planning and engineering rigor to show progress quickly. This approach has avoided architectural issues, sacrificed the repeatable development process and deemphasized as-built documentation completeness.

Application development must keep its eyes on the future and its basic principles rather than near-term objectives and achievements. Without the data architecture, the multiple OLTP application will probably never become interoperable or establish and adhere to open and flexible standards. Continuing negative consequences will impact application support's ability to provide flexible services and responses to the business, and respond to unknown and endemic systems integration problems and needs.

### 3. CONCEPTUAL MODEL OVERVIEW

A conceptual data model consists of a data model diagram and metadata that describe the symbols and lines on the data model diagram. The data model diagram shows boxes and lines. The boxes represent the master data entities and the lines show the relationships between the master data entities. (Data Modeling Essentials, 3rd Edition, G. Simsion and G. Witt, Morgan Kaufman, San Francisco, 2005)

#### 3.1 Conceptual Model Diagram

To create the conceptual data model, the universe of business data (very top level) needs to be divided into non overlapping subsets that are the entities of the nouns identified in the business processes. The key requirements of this decomposition (classification) are

- that all the business data fit into one and only one of the data entities
- that all the business data views and subtypes are included, for example, Client, Merchant, etc. are all types of Customer
- that the organization of the data entity is separated from its descriptive data, for example, the company org chart exists even though there are no positions or company business units

The process entities are business process measurements (sales, purchases, process events) and master data entities. The business process measurements are the data recorded while executing business processes:

- sales process money measurements
- buy process money measurements
- inventory process time measurements
- labor process time measurements.

The master data entities are the things that each business process measurement is related to:

- Business Operational entities
  - Worker that completed the task that resulted in the business process measurement
  - Customer that bought the goods, service or information
  - The Inventory item that fulfilled the customer's sales order
  - Supplier that created the inventory item
- Enterprise organizational internal entities
  - Position (business unit) that is credited with the sales
  - Product is the list of goods, services, or information that the Customer may order
  - Task completed in the business process
  - Date of the business process measurement taken

The data model in Figure 1 shows the three business process measurements (in yellow), all the business operational data and the enterprise organizational data that are required for business intelligence reporting. Each business process measurement is related to each entity. The relationships between entities are not shown.

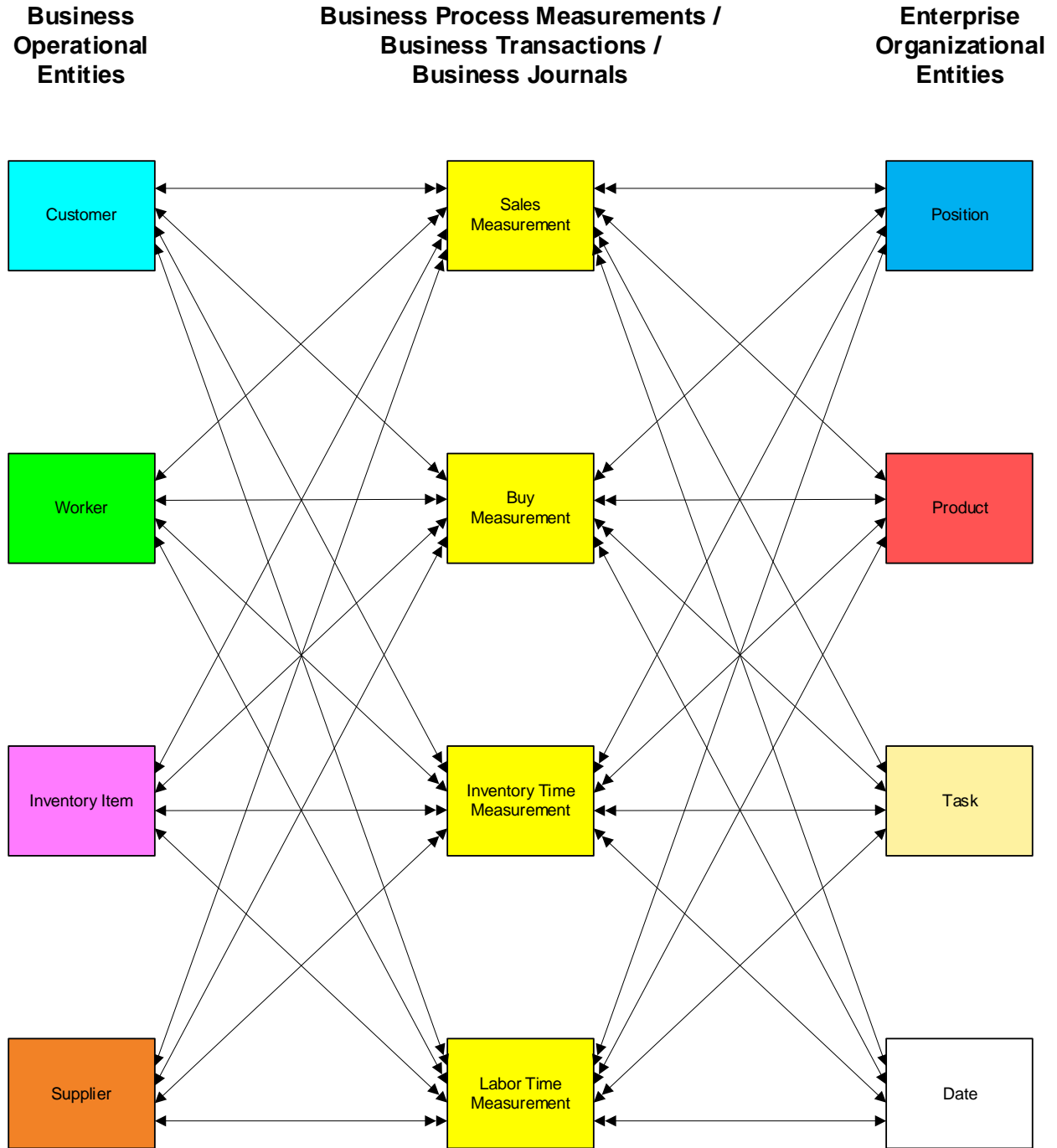


Figure 1: Conceptual Data Model

The data model is organized into three columns:

- The operational business data are in the left column
- The business process measurements (facts) are in the center column
- The organizational business data are in the right column.

Each line represents a relationship between the entities. One arrowhead represents one item and two arrowheads represent many items.

A restriction of the data model diagram is that redundant relationships have been removed. A redundant relationship is a relationship that can be deduced from two or more other relationships. When redundant relationships have been removed from the data model diagram, there are no relationship loops in the data model diagram.

If this conceptual model is agreed to, then data capture applications, data processing applications, data marts and subject areas are all subsets of the conceptual model and can be expressed as views on the data model.

## **4. BUSINESS PROCESS MEASUREMENTS**

The business measurements describe the facts that the company records as it creates, sells and delivers its products and services. These facts are the company's view of its transactions with its customers, suppliers, and employees.

### **4.1 Sales Measurement**

#### **4.1.1 Definition**

The Sales Measurement items are the measurements of money and quantity that the business makes during the sales order process. The sales order process is a sequence of events (documents, states, etc.) that records the quantity and price of a product, from the initial sales opportunity until the product is paid for and available to the customer. The business chooses the points in the sales order process at which the measurements are made.

#### **4.1.2 Data Vocabulary**

The Sales Measurement is also known by other names (synonyms that use all the attributes of sales measurement) and subtypes (subset of the attributes of sales measurement when all the data are not known) that describe the state of the Sales Measurement during the different stages of the sales order process. For example:

- Billing
- Booking
- Invoice
- One Time Service
- Order
- Payment
- Revenue
- Sales Measurement
- Usage
- Quote

### 4.1.3 Components

The attributes of Sales Measurement are the data values that describe an item in the entity:

- Sales Date
- Description
- Sold quantity
- Sold price
- Cost price
- Shipping Address
- Source document – the accounting document involved (e.g., Invoice Number)
- Reference document – the customer’s document involved (e.g., Customer’s Purchase Order).

### 4.1.4 Relationships

A single Sales Measurement item is related to each subject area:

- Customer – who purchased the Service
- Employee – who sold the Service
- Inventory – which inventory item was used
- Supplier – who provided the product
- Position – which department made the sale
- Product – which product was purchased
- Activity – how the task was completed for the sales measurement

## 4.2 Buy Measurement

### 4.2.1 Definition

The Buy Measurement items are process measurements that the business makes during the purchase process. The purchase process is a sequence of events (documents, states, etc.) that records the quantity and price of an inventory item, from the initial purchase request until the inventory item is paid for and used by the business. The business chooses the locations in the purchasing process at which the measurements are made.

### 4.2.2 Data Vocabulary

The Buy Measurement is also known by other names (synonyms that use all the attributes of buy measurement and subtypes that use a subset of the attributes of buy measurement) that describe the state of the buy measurement item during the purchase process. For example:

- Buy Transaction
- Purchase Order
- Purchase Requisition.
- Received Inventory

### 4.2.3 Components

The attributes of the Buy Measurement are the data values that describe a line item in the entity:

- Purchase Date
- Description
- Purchase quantity
- Purchase price
- Shipping address
- Source document – the business accounting document involved
- Reference document – the supplier's document involved.



#### 4.2.4 Relationships

A single Buy Measurement item is related to each entity:

- Customer – who purchased the Service
- Worker – who ordered the Service
- Inventory – which inventory item is the Service
- Supplier – who provided the Service
- Position – which department authorized the purchase
- Product – which product was purchased
- Task – what task was completed for the purchase order.

## **4.3 Inventory Time Measurement**

### **4.3.1 Definition**

The Inventory Time Measurements are measurements of the time an inventory item spends doing a task during the course of purchasing, creating and fulfilling the inventory needs. A set of time measurement events is a time card that records the tasks (state changes) as the inventory item navigates the business processes.

### **4.3.2 Data Vocabulary**

The inventory time measurement entity is also known by other names (synonyms that use all the attributes of time measurement and subtypes that use a subset of the attributes of time measurement) that describe the state of the process events during the different stages of the business process. For example:

- Supply Chain time card
- Manufacturing Process time card
- Provisioning Order
- Work Order.

### **4.3.3 Components**

The components of the inventory time measurement are the data values that describe an event in the entity:

- Event Date
- Start Time
- End Time
- Time interval
- Description
- Used quantity
- Source document – the business accounting document involved
- Reference document – the customer's document involved.

#### 4.3.4 Relationships

A single Inventory Time Measurement item is related to each entity:

- Customer – who was the work done for
- Worker – who did the work
- Inventory – which inventory item was used
- Supplier – who was the supplier involved
- Position – which department authorized the work
- Product – which product was created
- Task – what task was completed for the event

## **4.4 Labor Time Measurement**

### **4.4.1 Definition**

The Labor Time Measurements are measurements of the time a worker spends doing a task during the course of buying, creating and selling products. A set of time measurement events is a time card that records the tasks (state changes) as the worker navigates the business processes.

### **4.4.2 Data Vocabulary**

The time measurement entity is also known by other names (synonyms that use all the attributes of time measurement and subtypes that use a subset of the attributes of time measurement) that describe the state of the process events during the different stages of the business process. For example:

- Employee time card
- Process time card
- Provisioning Order
- Work Order.

### **4.4.3 Components**

The attributes of time measurement are the data values that describe an event in the entity:

- Event Date
- Start Time
- End Time
- Time interval
- Labor Cost
- Description
- Used quantity
- Source document – the business accounting document involved
- Reference document – the customer’s document involved.

#### 4.4.4 Relationships

A single Time Measurement item is related to each entity:

- Customer – who was the work done for
- Employee – who did the work
- Inventory – which inventory item was used
- Supplier – who was the supplier involved
- Position – which department authorized the work
- Product – which product was created
- Activity – what task was completed for the event

## 5. OPERATIONAL ENTITIES

The operational entities are the entities that the company uses in its day to day operations that create, market, sell and deliver its products and services. These entities are the company's view of the external entities such as customers, suppliers, workers, and inventory items.

### 5.1 Customer

#### 5.1.1 Definition

The Customer entity identifies and describes all those entity occurrences that pay for or are expected to pay for our products. Customers are our view of the entities that send us money for goods, services, or information. Or they sent us money in the past. Or we expect them to send money in the future. These Customers can be individuals, other businesses, governments, the business itself, its subsidiaries, etc., In fact, anyone that pays for our products. If you don't expect to get money from them, they are not customers. In healthcare, the insurance companies and the government are the customers.

To facilitate processing and record keeping, there are special Customers that represent classes of entities. Examples of these occurrences are:

- The default Customer – the Customer used when the customer identifier is not provided to the data warehouse by the OLTP application
- The unknown Customer – the Customer used when the customer identifier is not known by the person entering the data
- The cash Customer – the Customer used when the customer contact person sends cash but refuses to identify himself or the Customer.
- The self-Customer – the Customer used when our inventory is used by our business.

### 5.1.2 Data Vocabulary

The Sales Measurement is also known by other names (synonyms that use all the attributes of sales measurement) and subtypes (subset of the attributes of sales measurement when all the data are not known) that describe the state of the Sales Measurement during the different stages of the sales order process. For example:

- Invoice
- Billing
- Booking
- One Time Service
- Order
- Payment
- Quote
- Revenue
- Sales Measurement
- Usage

### 5.1.3 Components

The attributes of Customer are the data values that describe an item in the Customer entity:

- Customer Address – the postal address for the Customer
- Customer Authorization – the data used to access the Customer
- Customer Balance History – the free minutes and storage quota for the Customer
- Customer Bill Info – the billing cycle and payment method for the Customer
- Customer Contact – the people who can be contacted about the state of the Customer
- Customer Contact Email – the Customer contact’s email addresses
- Customer Contact Phone – the Customer contact’s phone numbers
- Customer Contract History – the history of the customer’s contracts/subscriptions
- Customer Identification – the numbers that identify the Customer, i.e., IRS number, bank account number, credit card number, export permit number, etc.
- Customer Location History – the geographic location of the Customer
- Customer Marketing Profile History – the demographic properties of the Customer
- Customer Status History – the history of the Customer’s status in the sales process
- Customer Relationship – the relationships that exist between different Customers.

### 5.1.4 Relationships

A single Customer item can be related to many business measurements in:

- Sales Measurement
- Buy Measurement.
- Inventory Time Measurement
- Labor Time Measurement



## 5.2 Worker

### 5.2.1 Definition

Worker is a business object that contains the identification and description of all the people who provide labor during the business processes. They can be full time employees, part time employees, contractors, temporaries, etc.

To facilitate processing and record keeping, there are special Employees that represent classes of employees. Examples of these classes are:

- The default employee – the employee used when the employee identifier is not provided to the data warehouse by the OLTP application
- The unknown employee – the employee used when the employee identifier is not known by the person entering the data.

### 5.2.2 Data Vocabulary

The worker is also known by other names (synonyms) that describe the state of the employee during the sales process. For example:

- Agent
- Associate
- Customer Account Rep
- Provider
- Sales Person
- Employee.

### 5.2.3 Components

The attributes of Worker are the data values that describe a person in the Worker entity:

- Worker Name
- Worker Address
- Worker Email
- Worker Identification
- Worker Phone
- Worker Relationship
- Worker Status History.

### 5.2.4 Relationships

A single employee can be related to many business measurements items in:

- Sales Measurement
- Buy Measurement.
- Inventory Time Measurement
- Labor Time Measurement

## 5.3 Inventory Item

### 5.3.1 Definition

Inventory is a business object that contains the identification and description of all the goods and information purchased, used, or created by the business during the product creation process.

Inventory items are things that we have spent money to acquire and may be offered for sale during the lifetime of our company. In healthcare, inventory consists of the people that receive the services.

To facilitate processing and record keeping, there are special Inventory identifiers that represent classes of entities. Examples of these classes are:

- The default Inventory item – the identifier used when the Inventory item is not provided to the data warehouse by the OLTP application
- The unknown Inventory item – the identifier used when the Inventory item is not known by the person entering the data.

### 5.3.2 Data Vocabulary

The Inventory entity is also known by other names (synonyms) that describe the Inventory items as seen by different business units. For example:

- Asset
- Inventory
- Provisioning Target
- Network Equipment.

### 5.3.3 Components

The attributes of Inventory are the data values that describe an Inventory item in the entity:

- Inventory Name
- Inventory Identification
- Inventory Status History.

### 5.3.4 Relationships

A single Inventory item can be related to many business measurements in:

- Sales Measurement
- Buy Measurement.
- Inventory Time Measurement
- Labor Time Measurement

A single Inventory item can be related to many items in:

- Inventory organization.

## 5.4 Supplier

### 5.4.1 Definition

The Supplier is a business object that contains the identification and description of all the suppliers that interact with us at the start of the product creation process. Suppliers are the entities that we send money to for goods, services or information. Or we sent them money in the past. Or we expect to send them money in the future. These suppliers can be individuals, other businesses, governments, the business itself, subsidiaries, etc. In banking, the suppliers are the deposit accounts.

To facilitate processing and record keeping, there are special Suppliers that represent classes of entities. Examples of these classes are:

- The default supplier – the supplier used when the supplier identifier is not provided to the data warehouse by the OLTP application
- The unknown supplier – the supplier used when the supplier identifier is not known by the person entering the data
- The cash supplier – the supplier used when the supplier contact person accepts cash but refuses to identify himself or the supplier
- The self-supplier – the supplier used when product is provided by our company to us, for example during a charge back process.

### 5.4.2 Data Vocabulary

The supplier entity is also known by other names (synonyms) that describe the state of the supplier during the purchasing process. For example:

- Alternate Source.
- Prospective Supplier
- Vendor.

### 5.4.3 Components

The attributes of supplier are the data values that describe a supplier in the supplier entity:

- Supplier Name
- Supplier Identification
- Supplier Address
- Supplier Contact
- Supplier Contact Email
- Supplier Contact Phone
- Supplier Contract History
- Supplier Status History
- Supplier Performance History
- Supplier Profile
- Supplier Relationship – the relationships that exist between different suppliers.

### 5.4.4 Relationships

A single supplier can be related to many business measurements in:

- Sales Measurement
- Buy Measurement.
- Inventory Time Measurement
- Labor Time Measurement

## **6. ORGANIZATIONAL ENTITIES**

The organizational entities are the entities that the company creates and organizes to facilitate the operational processes. These areas are the business organization, the products or services, the processing tasks and the date or financial calendar.

### **6.1 Position**

#### **6.1.1 Definition**

Position is a business object that contains the identification and description of all the functional divisions of the company. The fundamental or indivisible level of a business unit is position within the company (e.g., Chief Operating Officer, Knowledge Manager, etc.).

To facilitate processing and record keeping, there are special position that represent classes of entities. Examples of these classes are:

- The default Position – the Position used when the Position identifier is not provided to the data warehouse by the OLTP application
- The unknown Position – the Position used when the Position identifier is not known by the person entering the data.

#### **6.1.2 Data Vocabulary**

The Position entity is also known by other names (synonyms) that describe the organization of the business. The synonyms usually describe the Position at a different level of abstraction. For example:

- Business Unit
- Division
- Department.

### **6.1.3 Components**

The attributes of business unit are the data values that describe a business unit in the entity:

- Position Name
- Position Identification
- Position Status History.
- Position Location
- Business Relationship

### **6.1.4 Relationships**

A single Position can be related to many business measurements in:

- Sales Measurement
- Buy Measurement.
- Inventory Time Measurement
- Labor Time Measurement



## 6.2 Product

### 6.2.1 Definition

Product is a business object that contains the identification, description, specification and prices of all the products that we have sold in the past, are currently selling, or plan to sell in the future.

There is always a price for a product even if the price is zero. These products can be goods, services, or information. The products include shipping services, handling services, and third-party services such as taxes that are resold for government suppliers.

To facilitate processing and record keeping, there are special products that represent classes of Product. Examples of these classes are:

- The default product – the product identifier used when a product identifier is not provided to the data warehouse by the OLTP application
- The unknown product – the product identifier used when the product identifier is not known by the person entering the data.

### 6.2.2 Data Vocabulary

The Product entity is also known by other names (synonyms) that describe the products for various business units and processes within the company. For example:

- Bundle
- Deal
- Item
- Offer
- Package
- Promotion
- Shipping
- Tax.

### **6.2.3 Components**

The attributes of Product are the data values that describe an item in the entity:

- Product Name
- Product Identification – such as SKU, part number, etc.
- Product Owner
- Product List Price
- Product Specification
- Product Status History
- Product Bill of Materials – the relationship between products.

### **6.2.4 Relationships**

A single product can be related to many business measurements in:

- Sales Measurement
- Buy Measurement.
- Inventory Time Measurement
- Labor Time Measurement

## 6.3 Task

### 6.3.1 Definition

Task is a business object that contains the identification and description of all the processes (activities or tasks) that have been used by the business in the past, are currently used by the business or are planned to be used by the business. These processes can be processes, functions, tasks, activities, etc. An example of business tasks is the documentation provided for the ISO 9000 certification.

To facilitate processing and record keeping, there are special tasks that represent classes of activities. Examples of these classes are:

- The default activity – the activity used when the activity identifier is not provided to the data warehouse by the OLTP application
- The unknown activity – the activity used when the activity identifier is not known by the person entering the data.

### 6.3.2 Data Vocabulary

The Task entity is also known by other names (synonyms) that describe the activity for various business units within the company. For example:

- Function
- Sales Process Task
- Activity
- Transaction Status
- Manufacturing Step
- Fulfillment function.

### 6.3.3 Components

The attributes of Task are the data values that describe an item in the entity:

- Task Name
- Task Identification
- Task Relationship
- Task Status History.

### 6.3.4 Relationships

A single Task can be related to many business measurements in:

- Sales Measurement
- Buy Measurement.
- Inventory Time Measurement
- Labor Time Measurement

A single Task can be related to many items in:

- Process Organization.

## **6.4 Date**

### **6.4.1 Definition**

The Date is a business object that contains the identification and description of all the days on which the business plans to perform product. These days are the list of all the dates in the calendar.

### **6.4.2 Data Vocabulary**

The Date entity is also known by other names (synonyms) that describe the portions of the calendar during the business process. For example:

- Calendar
- Date
- Fiscal Quarter
- Quarter
- Fiscal Calendar.

### **6.4.3 Components**

The attributes of Date are the data values that describe the business cycle in the calendar entity:

- Date Description
- Day Description
- Week Description
- Month Description
- Quarter Description
- Year Description.

#### **6.4.4 Relationships**

A single date can be related to many business measurements in:

- Sales Measurement
- Buy Measurement.
- Inventory Time Measurement
- Labor Time Measurement