Cloud Based Supply Chain Management Using Radio Frequency Identification

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Abstract: The cloud based Supply chain management integrates all the activities associated with moving goods from raw material stage to full fledge product to the end users, by linking all the partners in the chain using cloud platform. The cloud computing platform is the paradigm for providing the information technology services where resources are retrieved from internet through web based tools and applications. Radio frequency identification is used to track the product within certain range and stage. The major key participants are warehouse manager, retailer, manufacturer, distributor, and customer. The cloud platform enables the users to use enterprise software from anywhere in the world. This paper encompasses enterprise software Supply chain management in brief, how RFID is used to improve the quality of SCM by product tracking and it covers the cloud platform on which the supply chain management software is deployed.

Index term: Radio Frequency Identification, Cloud computing, supply chain Management, EPC, Software as Service, Platform as Service, Infrastructure as service

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I.   INTRODUCTION

This paper primarily focuses on the enterprise software supply chain management whose intent is to deliver the economic value and enhanced customer via synchronized management of physical goods and its associated information from source to destination.[7]As the information flow is increasing and multinational firms are progressing very fast there is a necessity of Cloud based SCM which provides the massive computing power that offers software, infrastructure, platform on demand by pay as you use basis through internet. RFID is used to trace the product within the supply chain and store the relevant information regarding product. The RFID is mainly used in logistics and transportation and enhances the productivity in supply chains.

II.   CLOUD COMPUTING BASICS

Definition: Cloud computing is Internet based Computing, whereby shared resources, Software, hardware and infrastructure are provided to Computers and other devices on-demand, like electricity [9]

Basically cloud computing involves the model for delivering the hosted services over internet. The cloud services are divided into three categories: Software as Service, Platform as Service, and Infrastructure as Service. The cloud can be either public cloud which provides services to anyone or private cloud which provides services to limited number of people.

In platform as service cloud provides the computing platforms like typically including operating system, programming language execution environment, database, and web server.[4] In the SaaS model, cloud providers install and operate application software in the cloud and cloud users access the software from cloud providers. Cloud vendors manage the cloud infrastructure and platform where the application runs for cloud users.

The usage of cloud computing technology is increasing rapidly. Corporate firms are using it as the enormous amount of data is accessed and flows day by day in the corporate companies also the amount of information flow is increasing.   It provides pay-as-you-go scheme, dynamic resource allocation and reallocation, efficient resource utilization.

III.   SUPPLY CHAIN MANAGEMENT

The main motive of Supply Chain Management is customer satisfaction by making him as the key participant in the process of product development. The successful SCM increases the profit by reducing working capital and creates trustworthy relations between all the users. [7]It is a useful tool in accomplishing corporate strategic planning and objectives.SCM provides the transparency in the product development process by linking all the key participants in the network and adds some value to supply chain.

Supply Chain Management is the collaborative process to meet the needs of end customer effectively. The SCM contains three flows as shown below [9]

- Material Flow: The information flow is related to the product flow in the supply chain. It contains the product flow from supplier to customer and reverse product flow, recycling and servicing.[9]
- Information Flow: The information flow deals with the information about all the key participants and product tracking.[9]
- Financial Flow: The financial flow encompasses the credit terms and payment schedule.[9]

A.   Modules in SCM :

The Supply Chain Management contains following modules. [7]

• Inventory management
• Transportation service procurement
• Materials handling
• Inbound transportation
• Transportation operations management
• Warehousing management

IV. RFID

Radio frequency identification is the device or hardware used to track or identify the objects within a certain range.[3]The RFID tags are attached to objects for identification and they are identified by the RFID reader and noted. The RFID writer is used to write data about product in tags.[5] The comparison of RFID with barcode-based solutions are it can operate without having sight contact, the ability to detect and capture number of tags simultaneously, the additional data storage of the product on tag, the resistance against water and dust and the fully automated capturing without human intervention. It is possible to uniquely identify individual products, along with type and manufacturer of a product.

A. RFID Components

1. RFID Tag
2. RFID Reader/writer/Interrogator
3. RFID Controller

1. RFID Tags

RFID tag gets attached to an item or product, Tags can be read-only or writeable depending on the ability to write data in it. [2]The tags with battery are known as active tags and other tags without battery are known as passive tags.[3] Depending on frequency they are classified as high and low frequency.

2. RFID Reader/writer/Interrogator

RFID an interrogator, which consists of an antenna and some electronic modules receiving the data from the tags, and a controller,[2]The RFID interrogator reads the data from the RFID tag and transmits it to the Controller.[3] Most of the passive RFID tags are also powered by the interrogator. It must be installed in the area where the RFID tags should be read, they do not require a line of sight with the RFID tag. Advanced interrogator can read of many RFID tags in place and is capable of doing data encryption and decryption on the fly.

3. RFID controller

RFID controllers can be a PC or a workstation processing the received data.[2] It finally process the data received by the RFID interrogator. The type of RFID controller depends on the complexity of the actual RFID system, the

amount of captured data and the complexity of the data processing.

TABLE1
Types of RFID Based on tags [2]

Type	Description
Read only	Allowed to read only
Writable	Can write data
Active tag	Without battery
Passive tag	With battery
High Frequency	MHZ to GHZ
Low Frequency	KHZ to MHZ

V. Proposed System

The supply chain starts with the raw material and finally ends on the final product which is delivered to the consumer. The RFID tag is applied to the product or item also the necessary information about the product is saved onto tag like product id, type etc RFID reader is present at the site of key participants like at manufacturer end it will read the raw material and note the change in the raw material. Each and every RFID tag has unique identification which is known as EPC (Electronic Product code).

Proposed system gives the suitable supply chain solution to the corporate firms by increasing profit. The usage of RFID in it enhances the effectiveness of supply chain by tracking the product and maintaining its phase information thus by ultimately providing the customer satisfaction. [5]The RFID is far more beneficial than its counterparts like barcode as it is not affected by environmental factors. The modifications are noted without any human intervention.

[4]The software as service model of cloud paradigm is used in supply chain. As the proposed system is deployed on the cloud, the users or key participants not need to take care about the resource allocation, security and space. The primary focus is on data and data flow. The supply chain can be accessed from anywhere in the world through internet.

VI. RFID IN PROPOSED SYSTEM

[8]The RFID tag is applied to product and raw material. Each key participant has RFID reader present at their location which will read products or raw material which were attached with tag within certain range.[8] When the product moves from manufacturer to supplier the RFID reader at the manufacturer's location will note about the change that particular product is departed from manufacturer's location and the reader which is placed at supplier's location will note that product is arrived at the supplier's site thus the product location is tracked using RFID.

VII.   FEATURES OF PROPOSED SYSTEM

A. SOCIAL NETWORKING

Each and every key participant involved in the supply chain have their separate account where individual are allowed to store their personal data and can view other key participants involved in the supply chain who are already registered. One can send request and can send data to registered user. He can view the notifications about new registrations. Transparency is maintained in the whole process of supply chain and good communication between key participants is maintained.

B. MANUAL ENTRIES REDUCTION:

[6] Supply chain deals with the enormous amount of data so the data entries in the database need to be handled carefully and it takes time, but as RFID is integrated in the proposed system the process of data updating in database becomes automated   without   human intervention and less time consuming.

C. NOTIFICATION ON GMAIL:

The notification about the processing orders between the key participants is also noted on the personal gmail account of the receiver key participants. If   one participant sends the notification to the other, but the receiver has not logged into proposed system even then he will get the notification on his Gmail account ,so that he can login to the system for further details.

D. PRODUCT TRACKING

The location of the product is tracked by using RFID. The key participant can see the product progress and the necessary details about the product. The RFID is enabled to read and write data about the product.

E. DETECTION OF MISSING & DEFECTED PRODUCT

The missing and defected product can be detected using RFID. If the particular product is dispatched from one location but if it is not received at its intended destination then the missing product is detected and the error is send to source.

VIII.   SYSTEM FLOW

The key participants involved in the system are warehouse manager, manufacturer, supplier and customer. The process of supply chain starts with the product manufacturing. The manufacturer will tag the product with RFID reader. The warehouse manager will provide the raw material to manufacturer. The supplier

will supply the intended product to customer as shown in the fig1 below.

Fig 1:Cloud based SCM using RFID

IX.   SYSTEM DEFINITION

A supply chain system consists of nodes participating in producing, transforming and/or moving a good or service from suppliers to customers. The interrelations between nodes are constituted by the possible flows of goods at locations. Supply chain system is defined as a directed graph.
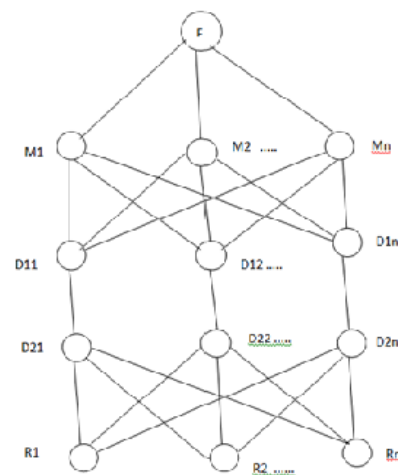

Fig2:System Definition

F: firm.
M: Manufacturing at facilities.
D: Distribution center Storage.
R: Demand Points.

SYSTEM IS DEFIINED AS FOLLOW:
SC= (N, F ,STB ,TTB ,IR) where,
N=Set of all nodes.

F=Set of all possible flows of goods.

STB=Stay table (Input to the System).

TTB=Trace table

IR=Intermediate Result at each stage.

$N=\{n_1, n_2, n_3, \ldots, n_n\}$

$IR=(ir_1, ir_2, \ldots \ldots ir_n)$

Such that, $TTB \subseteq STB$

$F \subseteq N \times N \times G \times TM$

Each f is a 4-tuple f= (n_j, n_k, g, tm) with flow of good g from n_j to n_k using the transportation mean

$Tm \in TM$

The following integrity constraints must hold.

1) Let, •n =$\{m|(m,n) \in F\}$ the set of input nodes of n; then at least one n ∈ N exists with |•n|=0.Thus, at least one node has no incoming flows, i.e., it represents a

real source of goods.

2) Let n•=$\{m|(n,m) \in F\}$, the set of output nodes of n; then at least one n exists with |n•|=0 . Thus, at least one node has no outgoing flows, i.e., it represents

a final destination of goods.

3) For all n∈ N:|n•|+|•n|≥1; the graph is weakly connected.

STB (Stay Table) is used to store the RFID Reader Output as follow:

STB = (TAG, LOC, ST, ET, CNT) where,

STB = Stay Table.

TAG =Set of tag,

LOC = Location of reader,

ST = START TIME the time when the tag enters the location,

ET = END TIME the time when the tag leaves the location.

TAG = $\{t_1, t_2, t_3, \ldots \ldots t_n\}$ where; n=No of tags in whole system.

LOC = $\{l_1, l_2, l_3 \ldots \ldots l_n\}$ where ;n=No of location in the factory.

CNT = Total no of tags read by reader.

TTB (trace table) is derived from stay table.

The stay records for each tag compose a trace record that gives us movement history with time information for the tag. We will use trace records instead of stay records for storing RFID data in the central server.

TTB = (LOC,ST,ET)

TagID : $L_1[S_1, E_1] \rightarrow L_2[S_2, E_2] \ldots \ldots \rightarrow L_n[S_n, E_n]$

The symbols used in the system definition are as follows:

Symbol	Definition
D	Distribution center Storage.
M	Manufacturing at facilities.
F	Firm
R	Demand Points.
N	Set of all nodes
F	Set of all possible flows of goods
STB	Stay table
IR	Intermediate Result
TTB	Trace table
TAG	Set of tag
LOC	Location of reader
ST	Start time
ET	End time
CNT	Total no of tags read by reader.

X.   CONCLUSION

The proposed system provides the RFID based supply chain software using software as service model of cloud computing. It also provides better access to resources, minimizes cost, increases profit by providing efficient SCM solution.

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