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Radio Frequency Identification (RFID): A co-generation tool in Product Life cycle Management (PLM)

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Abstract*: Product life cycle management (PLM) and Radio Frequency Identification (RFID) when properly amalgamated aids product development throughout the lifecycle of the product design and narrows the gap between OEM (design team) and customer by providing real-time information about product failures thereby increasing product lifecycle. Therefore, this paper enhances the pros and cons of RFID in PLM as a co-generation tool and the benefits of using RFID in assembling critical components are elucidated. The PLM-RFID solution embraces a demand-focused supply chain representation by integrating suppliers, manufacturers, distributors, and retailers to share product movement data and feeds valuable inputs for new product development. To illustrate the benefits of PLM-RFID amalgamation in enterprise application we have developed middleware to facilitate data communication between RFID readers and PLM databases.

***Keywords*: PLM, RFID, Middleware, J2EE, EPC**

I. INTRODUCTION

This paper provides a summary and practical applicability of RFID technology combined with PLM issues, The product lifecycle management consist of different phases such as initial design, manufacturing, marketing, after-sales or creating new versions. In this case, PLM signifies managing product information related to the corresponding product and the lifecycle of the same. By fixing the RFID tag on the product or files and it can be tracked with the help of reader then the data to be sent to the database through the middleware with a unique product code called as electronic product code (EPC)

II. RADIO FREQUENCY IDENTIFICATION

RFID is an automatic data-capture technology that can be used to electronically identify, track, and store information about groups of products, individual items, or product components.

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There are three elements were employed in this technology: RFID Tags; RFID Readers; and a Data collection device, distribution system, and management system. RFID tags are of miniaturized computer chips programmed with information about the product or with a unique number that corresponds to information that is stored in a digital database. The tags can be located inside or on the surface of the product, file, item, or packing material to be tracked. RFID readers are interrogated with the tags or send signals to the tags and receive the responses as per backscattering technology. These responses can be stored with the reader for later transfer to a data collection system or instantaneously transferred to the data gathering structure (system). Finally, data collection systems consist of computers performing data processing software such as the J2EE platform, ORACLE 10g which typically are networked with a larger information management system. The RFID technology is the line of sight and faster response to the reader compared to the bar code technology. The following are problems with bar code technologies.

- Damaged or misprinted barcode labels
- Unacceptable date /life printed to manufactured goods label
- Erroneous pricing on product labels
- Erroneous ‘special’ pricing labels applied
- Wrong tray-end label applied (goods within tray incorrect)
- The human error leading to an incorrect number of trays dispatched RFID tags are basically classified into three

2.2 Active Tags

Active RFID tags, that have each an on-tag electricity source and an energetic transmitter, offer advanced overall performance. Because they're related to their personal battery, they maybe study at a much better variety – from numerous kilometers away. But they are larger and more high-priced. Active RFID tags are appropriate for manufacturing, including tracking components on a meeting line, or for logistics in most cases wherein the tag device could be reused.

2.3 Passive Tags

Passive tags are the maximum potential for the lowest cost, making them applicable for mass single-use packages. And it as no energy source and no on-tag transmitter, which offers them a variety of fewer than10-meters and makes them sensitive to regulatory and environmental constraints.

2.4 Read-only or Read -Write Tags

Chip tags may be read-only or read-write. A read-only memory chip has an identification code (Electronic Product Code) recorded at the time of manufacture or when allocated to an object. Read-only tags are much cheaper and are typically used in passive tags

III. ELECTRONIC PRODUCT CODE (EPC)

The EPC distinctively identifies items and facilitates tracking proper through the product's life cycle.[7] This makes it much like the Universal Product Code, with the principal exception that EPC was more often than not designed to be correctly referenced on networks. The EPC is the essential identifier of assets in a so-known as EPC Network. It essentially consists of the records about • The manufacturer of the tagged object.

• The product class or the nature of the tagged object.

• The actual (unique) item. This latter information is an advantage over "classical" barcodes. See Figure .1 a sample Electronic Product Code (EPC).

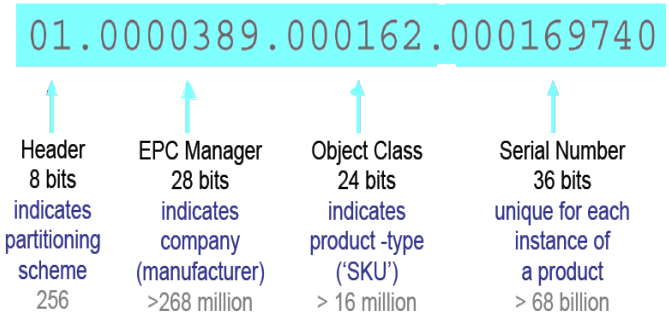

Fig. 1.The Electronic Product Code

3.1 Frequency limitation

There are some particular levels of frequency limitations are exist [8] as it will motive Interference with other nearby communication lines together with Radio alerts, Telephonic lines. Communication amongst RFID tags and readers is also exaggerated with the aid of the radio frequency used, which determines the rate of communications in addition to the gap from which tags can be studied. Higher frequency commonly manner longer study range. Low-frequency ("LF") tags, which function at less than one hundred thirty-five kilohertz (kHz), are as a consequence suitable for short-range makes use of, like animal identity and anti-robbery structures, which includes RFID-embedded automobile keys. Systems that perform at 13.56 megahertz (MHz) are characterized as excessive frequency ("HF"). Both low-frequency and excessive-frequency tags can be passive. Scanners can read multiple HF tags right away and at a quicker price than LF tags. A key use of HF tags is in touch with much less "smart cards," such as mass transit cards or building-access badges. The third frequency, Ultra-High Frequency ("UHF"), is pondered for widespread use by some major retailers, who are working with their suppliers to apply UHF tags to cases and pallets of goods. These tags, which operate at around 900 MHz, can be read at longer distances, which outside the laboratory environment range between three and possibly fifteen feet. However, UHF tags are more sensitive to environmental factors like water, which absorb the tag's energy and thus block their ability to communicate with a reader.Table.1gives the specified ranges used for the different tags.

Table.1: Frequency ranges used for RFID

Frequency Types	Frequency Range		Applications
Low frequency	125 kHz	1.5 feet, low reading speed	Access control, point of sale applications
High frequency	13.56 MHz	3feet, medium reading speed	Access control, item-level tracking
Ultrahigh frequency	860-930 MHz	up to 15 feet; high reading speed	Pallet tracking, supply chain management
Microwave frequency	2.45/5.8 GHz	3 feet; high reading speed	Supply chain management

IV. ANTICOLLISION TECHNIQUES

When RFID structures are operated we are able to in no way rule out the possibility of there being more than one transponder within the range of a single reader (like Hash tables in a Database gadget). When the reader sends out a command, this is processed by means of all of the transponders in the range of the reader. It is logical to expect that every one transponder will simultaneously attempt to ship a reply to the transmitted command again to the reader. In the substantial majority of instances, simultaneous information transmission through numerous transponders will lead to mutual interference, and consequently to statistics loss. Data loss resulting from a couple of accesses to a transmission channel is called collisions see Figure .2.

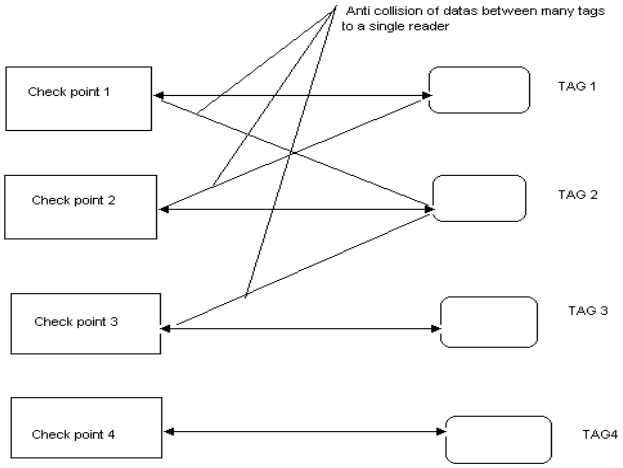

Fig. 2. The anti-collision diagram

4.1 Anti-collision procedures

For competitive reasons, system manufacturers are generally not prepared to publish the anti-collision procedures that they use. For this reason, little information is available on this subject in the technical literature. Therefore, it is impossible to deal comprehensively with this subject at this point.

An introductory overview and a concrete example of an anti-collision algorithm should provide the reader with at least the basic principles of the anti-collision procedure.
The anti-collision procedure can is classified into three groups.

1. Spatial domain anti-collision procedure
2. Frequency domain anti-collision procedures
3. Time-domain anti-collision procedures

4.2 Spatial domain anti-collision procedures

The fundamental precept underlying "spatial strategies" is the restrict of the reader's interrogation region. In the case of microwave systems, it's far possible to fit the reader with a tightly bundled directional antenna, which scans the place across the reader - in a similar manner to a torch in a darkish room - until a transponder is found by means of the "searchlight" of the reader. Another option is to seriously lessen the variety of a single reader but to atone for this via covering the area with a big quantity of readers. Such approaches were correctly carried out in big-scale marathon occasions to calculate the times of runners geared up with transponders.

4.1 Frequency domain anti-collision procedures

In this type of procedure, frequency multiplexor spread spectrum technologies are used for data transmission from the transponder to the reader. This type of anti-collision procedure is quite rare for reasons of cost. The transponders contain a multi-digit number, identical to the barcode on the suitcase tag. In practice, the suitcases are passed through a tunnel reader by a conveyor belt, whereby several suitcases may be within the reader's interrogation zone at the same time. The power supply to the transponder is supplied by inductive coupling at 125 kHz, and data transmission "from the transponder to the reader takes place on one of several frequencies in the range 2.7 - 4.2 MHz. The reader emits a continuous data stream, in which the frequencies currently occupied by a transponder are flagged. A transponder entering the reader's interrogation zone decodes this data stream and sends its identification number to the reader on an unoccupied frequency.

4.1 Time domain anti-collision procedures

Time-domain anti-collision techniques represent the most important institution of anti-collision techniques by means of a few margins. This organization is subdivided into strategies that are controlled with the aid of the reader (interrogator pushed) and people which can be managed through the transponder.

Transponder driven strategies perform asynchronously, because they may be now not controlled by means of a reader. One example of one of these procedures would be a set of transponders that transmit their identity numbers to a reader cyclically. The information transmission time is a fragment of the repetition time, so there are incredibly long pauses among transmissions. In addition, the repetition instances fluctuate slightly for man or woman transponders. Thus it's far exceptionally probable that two transponders will send their identity at specific times and the statistics transmission will no longer collide. A differentiation is made among "switched off' and "not switched" processes, depending upon whether a transponder is switched off through the reader after successful facts transmission.

Transponder pushed strategies are obviously very slow and inflexible. Therefore, maximum programs use procedures that might be managed by way of the reader. These procedures can be considered to be synchronous, due to the fact all the transponders are driven and managed by the reader concurrently. Interrogator driven tactics are &subdivided into lower and higher bound of symbolic expression.) In this case, we can also need to (partly) construct the challenge graph and perform the task mapping algorithm at runtime.

V. PRODUCT LIFECYCLE MANAGEMENT(PLM)

Taking data and utilizing the notion of the entire existence cycle technique to reduce value and maximize the productivity of the product with the proper place with proper time and proper records. It may be without difficulty identified via the curve call product lifecycle curve or otherwise known as S-curve, and it is proven in Figure 3.

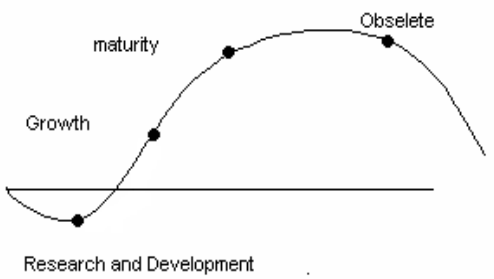

Fig. 3 The Product Life cycle curve

And the PLM helps the collaborative creation, management, dissemination, and use of product definition statistics and storing statistics from concept to cease of lifestyles of a product or plant and Integrating humans, approaches, business systems, and information.Difficulty in dealing with and retrieving information due to lack of collaboration. These can be the undesirable aspect consequences of PLMGain comfort by using tapping into industry-main PLM capabilities on an according to the to-usage foundation. Increase product high-quality, enhance marketplace responsiveness and sales-without big, upfront IT investments.

5.1 Core concepts focused on PLM

1. Universal, secure, managed access and use of product definition information
2. Maintaining the integrity of that product definition and related information throughout the life of the product or plant. Managing and maintaining business processes used to create, manage, disseminate, share and use the information. PLM is primarily about managing the digital representation of that information.

5.2 Benefits of the combined solution

To dramatically reduce administration time associated with restocking, shelf management, and other inventory control functions, to improve customer service through faster and easier self-service and return facilities;
•To enhance security within the library to reduce shrinkage;

•To provide library staff with more time to offer improved customer service and improve efficiency;
Some of the issues have been taken into consideration for a manufacturing company they are
•The entire product structure of the car
•The different component in the same assembly
•Date of delivery
•Maintenance and repair
•Recall issues up to 95 % of component
•Automatic identification of the customer's voice
•Redesign issues
•Product safety
The above issues can be solved with the help of PLM –RFID

5.3 Entire product structure of the car

The iterative nature of product development and evolution and its overall impact on product success requires close tracking and management of changes. BOM redlining - the ability to track changes, manage their impact, and ensure product competitiveness during product development - is an integral requirement to ensure streamlined PLM processes.
Bill of Material (BOM) is derived from the product shape that's utilized in production to collect all the items and records for building the very last product. Meet compliance necessities. Make greater knowledgeable production and inventory choices. You can use radio frequency identification (RFID) to benefit visibility via your price chain. From manufacturing to shipping, our solution will let you enhance supply chain management, asset monitoring as well as safety and get admission to manipulating t is proven in Figure 4.

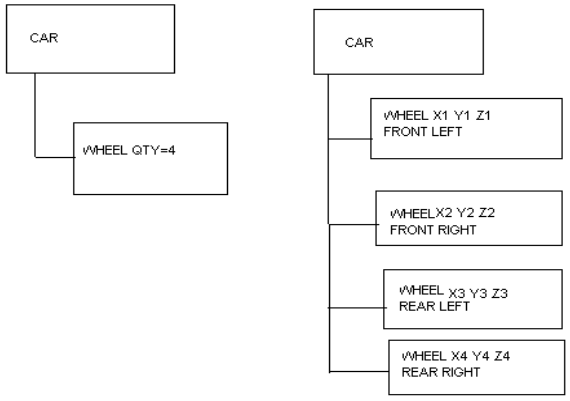

Fig. 4. The Product structure

PLM device has stored all issue details and additionally their tag numbers. These additives are connected to every other very last assembly to make it a final product. Every element has a tag quantity as well as the very last assembly. If the RFID reader can examine the tag id from the meeting as well as the additives within the assembly line, then it turns into easy for the back end system to check each the numbers and make sure that the right factor is at the meeting line. Otherwise, it will suggest the assembler there may be some foremost components that are lacking.

5.4 Different component in the same assembly

Many of the automobile producers might also produce exclusive variations of vehicles where just-in-time, simply-in-collection transport necessities are commonplace, automakers and their providers need to become aware of sub-assemblies to ensure they're set up in the right chassis. It is vital to make sure that the right issue receives into the proper product at the right time. And clean segregation of various components is possible with this device

5.5 Date of delivery

Some of the pharmaceutical manufacturers need to introduce new IT Service which is expected to be used extensively daily lives from the management of food, drugs, livestock, wastes, and environment to logistics, distribution and security services in contrast to the close future. The application of RFID is also watched in the healthcare application of RFID, such as u-Hospital, Telemedicine, and a lifetime of the pharmaceutical supply chain. From the manufacturing date to the run-out date.

5.6 Recall issues and deployment of components

An approach recommended for the recycle problems inclusive of Vehicle history is known handiest approximately and in a brief time period reminiscence manner, then the history and situation of components is not certifiable in this feature manner is lengthy and primarily based on subjective and time-ingesting manual inspection. Vehicle history is well known from the beginning History, age and situation of additives are certifiable Selection technique is a brief, wi-fi consultation primarily based on the automated acquisition of numerous project profile facts.

5.7 Automatic identification of the customer's voice

An OEM can manufacture the style of motors and promote it to the various consumer on the identical time they are able to able to supply upkeep of all these things, the sellers from the diverse area can deliver the restore, via fixing RFID inside the provider premises the OEM can without problems become aware of the product failure without the client voice and hold their picture, and they could make important remodel troubles. Brand photograph. Changing customer needs. Product commoditization. Intense opposition. If we want advanced product innovation strategies to shorten time to market and improve product splendor, Figure. Five indicates the proposed technique of the new architecture.

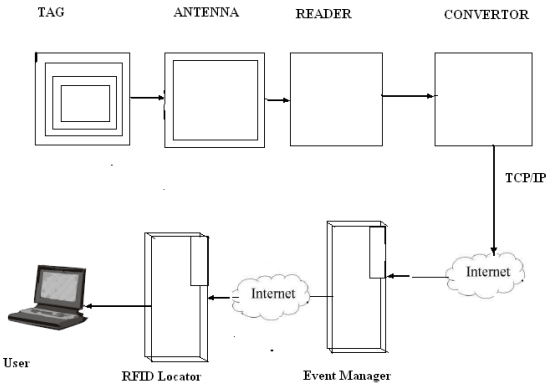

Fig.5.The Proposed combined solution

5.8 Redesign issues

As per PLM scenario a change can be made in a clear manner ,first the manufacturer get the change request from the various customer by feasibility study then they will made a change order ,

after the change order form the higher design officials it goes for the change activity A RFID tag is fixed over the object files of the details the production manager can easily access the stage of the file whether the file is in design team or the manufacturing by his own databases. The details of the redesigned workflow see Figure.6.

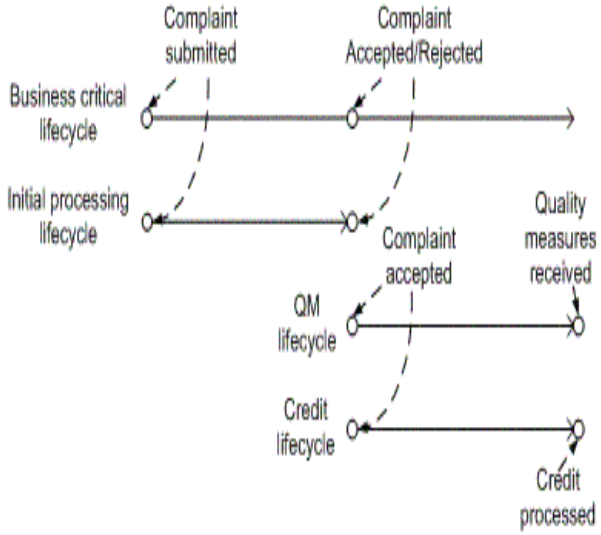

Fig. 6. The complaint system customer voice

5.9 Framework integration

A character with an authenticated consumer call and password can enter into the machine to view all of the statistics about the product shape the initial (conceptual layout) degree to recycling level of the product in order that the device seamlessly integrates the Oracle 10g database and the strategically located RFID reader positioned at the checkpoints at numerous departments with within the OEM, suppliers and also at the sales and service center. This paper well-known shows a case look at to expose how RFID acts as a cogeneration tool in the PLM arena. This case looks at demonstrates the ever-present presence and advantage of RFID technology no longer simplest within the records tracking and supply chain domain but additionally it aids the OEM to get the comments from the consumer (voice of customer) without engaging in any surveys or quality characteristic deployment strategies. The prototype machine has applied the usage of 3 tier-client server structure and type IV Java facts base connectivity (JDBC) motive force is used to connect the oracle 10g database. The middleware for performing the diverse workflow sports, integrating the inventory database was advanced the use of the J2EE framework which makes the software a web-enabled. The administrator can view the workflow activities and the stock inventory details in a dispensed environment.

VI. RESULT AND DISCUSSION

Figure 7 shows the login window where any authenticated user can view the data generated by the middleware based on his privileges. Table 2 shows the details of the connecting rod part which has passed through the various strategically placed checkpoints.

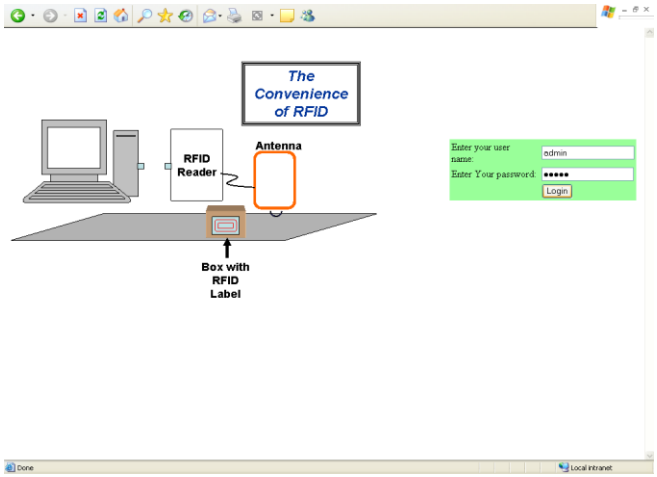

Fig. 7. Login Window

Table 2: Manufactrer Interface

Check point name	Check point id	Part no	Part name	Epc code	Check in time	Checkout time
Sales	s-1004	500-400-001	Connecting rod	01-000400-0000400-1	2019-10-25 10:45:02:01	2019-10-25 16:35:02:01

Similarly, an authenticated person from the manufacturing department can enter his user name and password to view his interface as listed in Table 3 In the same way, a person from inventory can view is interface to get his details and the person from quality can view his relevant details. Table 3 shows the salesperson interface which is in a remote location. The sample case study demonstrated using the prototype system developed with the help of the RFID toolkit from the VI Microsystems.

Table 3: Sales Interface

Check point name	Check point id	Part no	Part name	Epc code	Check in time	Checkout time
Design	d-1001	500-400-001	Connecting rod	01-000400-0000400-1	10/23/2019 10:30:02:01	10/23/2019 11:30:02:01
Manufacturing	m-1002	500-400-001	Connecting rod	01-000400-0000400-1	2019-10-23 14:30:02:01	10/23/2019 14:55:02:01
Inventory	i-1003	500-400-001	Connecting rod	01-000400-0000400-1	10/24/2019 10:30:02:01	10/24/2019 12:30:03:01
sales	s-1004	500-400-001	Connecting rod	01-000400-0000400-1	2019-10-25 10:45:02:01	2019-10-25 16:35:02:01

VII. CONCLUSION AND FUTURE WORK

This paper offers how Product existence cycle control (PLM) and Radio Frequency Identification (RFID) when well-amalgamated aids in product development for the duration of the lifecycle of the product design and narrows the space among OEM (layout group) and patron via supplying real-time statistics approximately product screw-ups thereby using increasing lifecycle of the product.

Therefore, this paper complements the usage of RFID in PLM as a co-era device and the use of RFID in assembling important additives is elucidated with software created the use of the J2EE framework and developing new business procedures primarily based on the entire lifecycle of the product throughout departments. The RFID solutions allow embracing a demand-driven supply chain model by connecting suppliers, manufacturers, distributors, and retailers to share product movement data.

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