CS Whitepaper1: Tunnel for your DC

Case Study:
CS Smart Connected Device Delivers Operational Transparency:

High Speed RFID Tunnel in high volume, high value merchandise distribution center

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Executive Summary

The Challenge was to provide a custom solution enabling both real-time operational information, and global, enterprise-level data analytics. The Customer was a successful high volume, high value merchandise distribution center in the consumer product wholesale business who wanted to expand within its existing facility to enhance its overall production. A secondary goal of the project was to improve the DC's overall productivity, and efficiency through improved business intelligence of the operation.

The Solution was to design an integrated system with phased implementation. Key elements have already been operating for over a year at a beta-site, including monitoring with traditional Commercial off the Shelf handheld RFID Tag readers, and a custom Internet-accessible high speed RFID scan tunnel. All of the data can be viewed in real-time locally or globally via the web. The solution is fully integrated with CS /Microsoft-Cloud-based Data Analytics Tools.

The Result is that even though only a fraction of the items are being tagged at the factory, the Tunnel has been providing a sample of the shipments passing through enabling the verification of a significant fraction of the shipments. Using manual intervention, the system has demonstrated that incorrectly packed cartons can be intercepted from being shipped to retailers. Operating for over 5 Quarters to date, the tunnel has detected numerous incorrect shipments, including incorrect packing plans, and unexpected errors from the suppliers. Overall, it has provided Operational Transparency -- a real-time-accessible view of continuing operations in the facility.

Operational Transparency:

- A Cloud-Based System enables seamless tracking of individual items, and shipments, from the factory, through the Distribution Center, to the Retail shelf.
- Applying Data Analytics Tools to the real-time data stream and various data aggregations enhances Enterprise-level Business Intelligence.

Challenge: Transformation and Expansion:

- A successful high volume, high value merchandise distribution center in the consumer product wholesale business wanted to expand within its existing facility to enhance its overall production.

- A secondary goal of the project is to improve the DC's overall productivity and efficiency through improved business intelligence of the operation.

Background:

Off the rack / shelf garments, the industry segment is in the process of transitioning from traditional clipboard and pencil means of production monitoring. Today, most of the monitoring is via laser bar codes printed on paper tags attached to the individual items, and also printed on paper labels attached to the shipping cartons. The use of the laser bar codes results in a degree of opaqueness when one or more individual items are packed for shipment. As a result the industry for the past few years has begun to introduce tags RFID Tags operating at paper-penetrating radio frequencies.

The process of the Distribution Center involves packing and shipping to the retail stores, cartons containing one or more individual items ordered by the retailer. Volume shipments of diverse lines of garments and other consumer products arrive at the Distribution Center from factories located around the world [primarily East Asia]. The incoming shipments are unpacked, and individual items [typically as garments on a hanger] are placed into overhead rail-based temporary classified storage [aka the Warehouse], by hand and with information entered by hand.

Customers' orders are received and processed, and paper "Packing Lists" are generated by a mainframe-based system. Human Pickers, using the paper lists, search the Warehouse for the requisite items and assemble on a "Trolley" [short section of rail, hanging from rollers riding on the overhead rails], a "Kit" ready for packing. Each of the one or more individual Kits, on a given trolley, are verified by hand scanning their Laser Barcodes, and then assigned and conveyed by hand to one of several Packing Stations. Packers take the Kit off the trolley, one item at a time, and place the specified items in a shipping carton. The carton is closed and a packing list, and an exterior bar coded shipping label is attached. A complete shipment may include multiple cartons, possibly packed at several stations. The resultant shipment is placed by hand onto the master conveyor belt which carries the cartons to the shipping area.

The stream of cartons aggregating the production of several packing locations passes through a laser bar code reader, which is used to control the dispatch of the individual cartons to various side branches of the conveyor using timing. An automated scale provides some detection of errors through comparing weights of the shipments. After arrival at the end of each branch line, the cartons are aggregated into pallet loads for shipment to an individual retailer. Pallet loads are eventually loaded into trucks through shipping docks to transport them to the retail stores.

Mistakes are quite commonplace and include:

- Errors in the incoming shipment;
- Placing an item into the wrong section of the Warehouse;
- Picking the wrong item[s] when assembling the Kit;
- Pack Plan Errors
- Packing Errors:
    - Missing an item from the kit;
    - Including an extra item in the Kit [adding an item from the next Kit on the same trolley];
- Sending the shipment to the wrong loading dock for inclusion in the wrong pallet load

Most errors are only detected when the shipment is unpacked for sale by the retailer. The cost to the distribution center is substantial, as a make-up shipment, has to be assembled, packed and shipped. The retailer then experiences a delay in stocking and potentially unavailable items for their customers, while the make-up shipment is in transit. In a worst-case scenario, a popular missing item might be back-ordered all the way through the supply chain to the factory in East Asia, and the delay in delivery to the retailer, might miss the important selling season.

Clearly, the entire supply chain would benefit from the ability to track an individual item from the factory through the Distribution Center to the display shelf in the retailer. DC shipment errors would be drastically reduced and the retailer would receive the appropriate quantities of each of the various SKU's which they had requisitioned. Overall costs would be lowered and so profitability would increase.

Approach:

CS designed an integrated system-based solution to be phased in to meet at the customer's newest Distribution facility. CS has already implemented key elements at this beta-site. The solution incorporates both traditional, commercial off the Shelf handheld RFID Tag readers, and a custom Internet-accessible, high speed RFID scan tunnel all integrated with CS /Microsoft-Cloud-based Data Analytics Tools.

Technology:

Smart Connected Devices:

In *How Smart, Connected Products Are Transforming Competition,* published in the November 2014 Harvard Business Review, Michael E. Porter, James E. Heppelmann, provide a definition of the Smart Connected Device as,

"Smart, connected products have three core elements: physical components, "smart" components, and connectivity components. Smart components amplify the capabilities and value of the physical components, while connectivity amplifies the capabilities and value of the smart components and enables some of them to exist outside the physical product itself."

High Speed Conveyor RFID Tunnel

The principle Smart Connected Device for the DC transparency solution is a High Speed Conveyor RFID Tunnel optimized for identifying objects moving on a conveyor, or similar device. The Tunnel through its physical components [i.e. its unique geometry and materials, key mechanical elements, and method of construction], optimizes the "reading" of the information stored in the multiple RFID Tags, located in fast moving cartons. The Smart Component [i.e. the Tunnel's Commercial off the Shelf RFID Reader] connects to a Cloud Accessible Database, using its Connectivity Components [i.e. a local embedded webserver locally networked over a wireless, wired or fiber, Ethernet].

As the carton enters the tunnel, the Reader interrogates the RFID tags attached to each item within the carton. As the carton exits the Tunnel, this information is transmitted by the Reader to the Cloud-based master database. The Cloud-based logic compares the individual sku's in the carton to the master packing list [retrieved from the master database] and in turn based on the laser bar code printed on the shipping label attached to exterior of the carton at the time of packing. A match is recorded, while a miss is both recorded, and can be used by the conveyor system's master controller, to divert the carton to a remediation station. At the remediation station the carton can be re-read using hand-held scanners, and if necessary opened and the appropriate corrections made.

Ideally, with this approach no errors, detectable with the RFID technology, should exit the distribution facility. At the minimum, the tunnel provides a real-time sample of the stream of cartons passing through the distribution facility's conveyor.

Microsoft/ComponentSoft Cloud-Based Data Analytics

ItemSight®, CS's System Analysis Tools are founded on the industry standard data base, and traditional Business Intelligence Tools deployed on the scalable storage and processing Cloud-based platform. At the detail level, Real-time Streaming Data from the Tunnel can be viewed locally or globally through the web portal, carton, by carton or even sku, by sku. This data can be aggregated over any time period to see evolving trends or diagnose events. Tunnel Data owners can use the framework to create their own custom Business Intelligence Logic to monitor and analyze operations. Finally, using the Big Data Analytic Tools, Enterprise-wide, the owner of the Tunnel Data can

review it in the aggregate, with the capability to a drill back down to the individual retail shipment, carton or even sku.

Beta Test RFID Tunnel as Installed on Distribution Center Conveyor:
with a typical carton entering the tunnel

Sample Data & Analysis:

At the beta test site for the Tunnel, the conveyor travels at more than three feet per second, taking less than 2 seconds to traverse the Tunnel. At that operating speed, the Tunnel can handle over 1000 cartons per hour or more than 10,000 cartons on a busy day. Since the Tunnel was placed in service in late 2013, more than one half million cartons have passed through the Tunnel with nearly 40% containing RFID- tagged items.

Snapshot of Logfile & discussion

```
|2013-11-19T15:30:43.119| MessageReceived: CartonBarcode(Sequence#='79', Barcode='00008281280236509228') | Frame='790000828128023650922 8' (Len=22)
|2013-11-19T15:31:10.466| MessageReceived: CartonBarcode(Sequence#='80', Barcode='??????????????????????') | Frame='80??????????????????????' (Len=22)
|2013-11-19T15:31:11.636| MessageReceived: CartonBarcode(Sequence#='81', Barcode='00008879220236509797') | Frame='810000887922023650979 7' (Len=22)
CARTON | ?????????????????????? | Qty=2  Expected=N/A          | DB2Time=N/A   | Timer=0.023 | T0=2013-11-19T15:31:10.466 | T1=T0+0.500 [0.015] | T2=T0+3.500 [N/A]
  PRODUCT | (NOPLAN) | (NOTAGTYPE)      | SKU=00887922419291 | Qty=2
    ITEM  1 |  0.000 | 30343631C828F2428FA6AECA | SKU=00887922419291  Serial= 11000000202 | urn:epc:tag:sgtin-96:1.0887922.041929.11000000202
    ITEM  2 |  0.023 | 30343631C828F2428FA6AE8C | SKU=00887922419291  Serial= 11000000140 | urn:epc:tag:sgtin-96:1.0887922.041929.11000000140
CARTON | 00008879220236509797 | Qty=0  Expected=2          | DB2Time=0.038 | Timer=N/A   | T0=2013-11-19T15:31:11.636 | T1=T0+0.500 [0.015] | T2=T0+3.500 [0.010]
  PRODUCT | FAIL     | RFIDTAG          | SKU=00887922419291 | Qty=0   Expected=2   | SB MO200
          ERROR |  | PRODUCT QTY: SKU='00887922419291' Qty=0 Expected=2
           EXCLUSION | 30343631C828F2428FA6AECA | TagNotUnique | In another carton (CartonID=??????????????????????)
           EXCLUSION | 30343631C828F2428FA6AE8C | TagNotUnique | In another carton (CartonID=??????????????????????)
|2013-11-19T15:32:55.065| MessageReceived: CartonBarcode(Sequence#='82', Barcode='00008879220236488740') | Frame='820000887922023648874 0' (Len=22)
|2013-11-19T15:33:44.549| MessageReceived: CartonBarcode(Sequence#='83', Barcode='00008879220236509803') | Frame='830000887922023650980 3' (Len=22)
CARTON | 00008879220236509803 | Qty=20  Expected=20         | DB2Time=0.032 | Timer=1.465 | T0=2013-11-19T15:33:44.549 | T1=T0+0.500 [0.015] | T2=T0+3.500 [N/A]
  PRODUCT | PASS     | RFIDTAG          | SKU=00887922419307 | Qty=20  Expected=20  | SB MO200
    ITEM  1 |  0.000 | 30343631C828F2828FA6AE88 | SKU=00887922419307  Serial= 11000000136 | urn:epc:tag:sgtin-96:1.0887922.041930.11000000136
    ITEM  2 |  0.003 | 30343631C828F2828FA6AE33 | SKU=00887922419307  Serial= 11000000051 | urn:epc:tag:sgtin-96:1.0887922.041930.11000000051
    ITEM  3 |  0.053 | 30343631C828F2828FA6AE86 | SKU=00887922419307  Serial= 11000000134 | urn:epc:tag:sgtin-96:1.0887922.041930.11000000134
    ITEM  4 |  0.177 | 30343631C828F2828FA6AE4E | SKU=00887922419307  Serial= 11000000078 | urn:epc:tag:sgtin-96:1.0887922.041930.11000000078
    ITEM  5 |  0.314 | 30343631C828F2828FA6AE8B | SKU=00887922419307  Serial= 11000000139 | urn:epc:tag:sgtin-96:1.0887922.041930.11000000139
    ITEM  6 |  0.327 | 30343631C828F2828FA6AE62 | SKU=00887922419307  Serial= 11000000098 | urn:epc:tag:sgtin-96:1.0887922.041930.11000000098
    ITEM  7 |  0.737 | 30343631C828F2828FA6AE5D | SKU=00887922419307  Serial= 11000000093 | urn:epc:tag:sgtin-96:1.0887922.041930.11000000093
    ITEM  8 |  0.782 | 30343631C828F2828FA6AE8D | SKU=00887922419307  Serial= 11000000141 | urn:epc:tag:sgtin-96:1.0887922.041930.11000000141
    ITEM  9 |  0.858 | 30343631C828F2828FA6AE7F | SKU=00887922419307  Serial= 11000000127 | urn:epc:tag:sgtin-96:1.0887922.041930.11000000127
    ITEM 10 |  1.022 | 30343631C828F2828FA6AE27 | SKU=00887922419307  Serial= 11000000039 | urn:epc:tag:sgtin-96:1.0887922.041930.11000000039
    ITEM 11 |  1.123 | 30343631C828F2828FA6AE07 | SKU=00887922419307  Serial= 11000000007 | urn:epc:tag:sgtin-96:1.0887922.041930.11000000007
    ITEM 12 |  1.127 | 30343631C828F2828FA6AE6C | SKU=00887922419307  Serial= 11000000108 | urn:epc:tag:sgtin-96:1.0887922.041930.11000000108
    ITEM 13 |  1.141 | 30343631C828F2828FA6AE25 | SKU=00887922419307  Serial= 11000000037 | urn:epc:tag:sgtin-96:1.0887922.041930.11000000037
    ITEM 14 |  1.237 | 30343631C828F2828FA6AE74 | SKU=00887922419307  Serial= 11000000116 | urn:epc:tag:sgtin-96:1.0887922.041930.11000000116
    ITEM 15 |  1.243 | 30343631C828F2828FA6AE45 | SKU=00887922419307  Serial= 11000000069 | urn:epc:tag:sgtin-96:1.0887922.041930.11000000069
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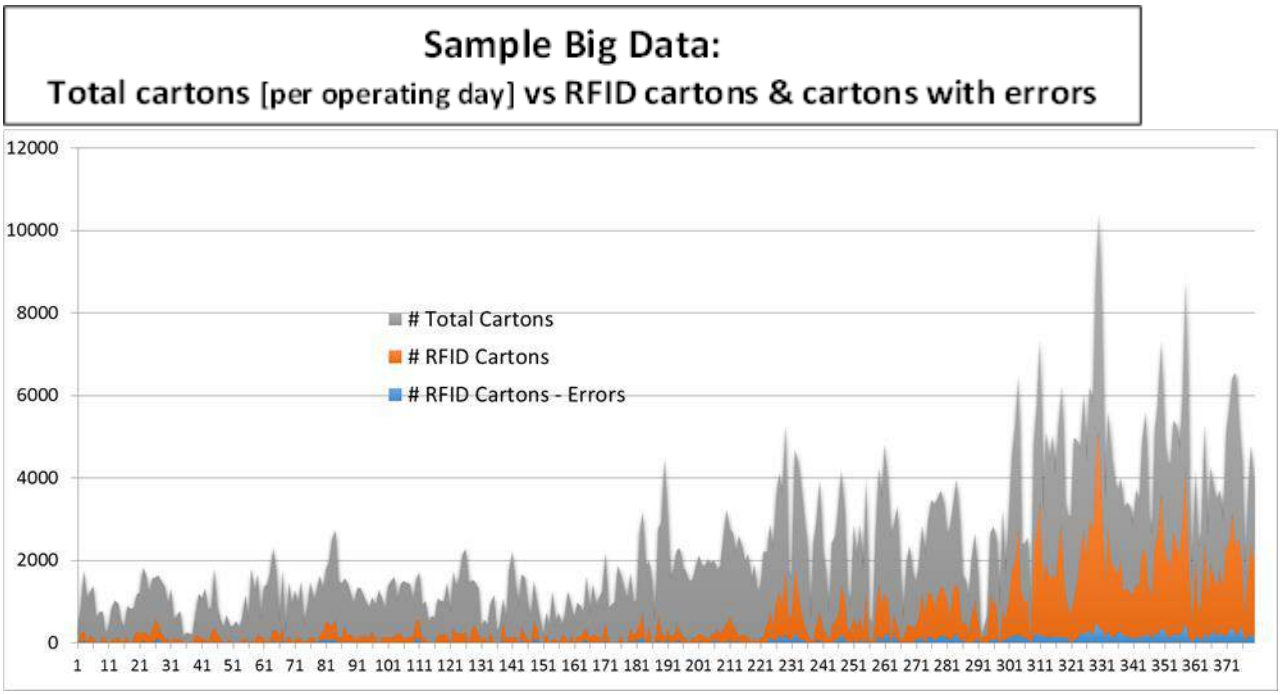
Shown above is a sample of the continuously available Log File of the ItemSight® program. Color-coding [red indicates an error as detected by the RFID Tunnel] allows rapid classification of the status of a carton on the conveyor.

Sample of Big Data Analytical Portal View & discussion



Shown above is a sample of the types of analytical outputs which are available through the portal. The graph shows the number of total number cartons processed on a given operating day [in grey] vs RFID-tagged cartons [orange] and cartons with a detected error [blue].

Results:

Despite lack of complete adoption of factory RFID tagging of individual garments, the Tunnel provides a sample of the shipments passing through enabling the verification of a significant fraction of the shipments. Using manual intervention, the system has demonstrated that incorrectly packed cartons can be intercepted from being shipped to retailers.

Operating for over 5 Quarters to date, the tunnel has detected numerous incorrect shipments, including incorrect packing plans, and unexpected errors from the suppliers. Overall, it has provided Operational Transparency -- a real-time-accessible view of continuing operations in the facility.

Technical Resources:

CS Smart Connected Devices, Cloud-based Big-Data Analytics:

The goal is to deliver a Cloud-Based System enabling seamless tracking of individual items and aggregated shipments from the factory, frequently offshore to the retail shelf. Enabling the tools of Data Analytics.