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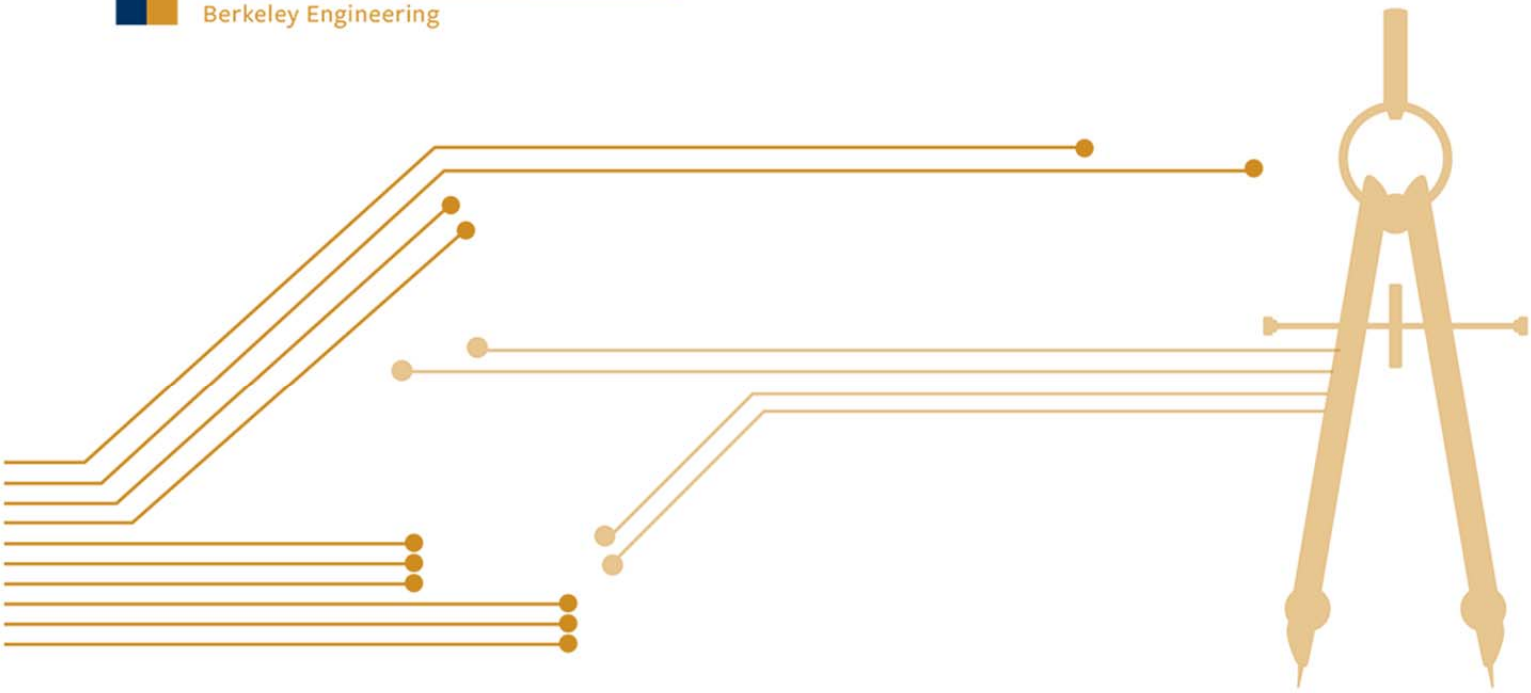

Future of Self Checkout

A landscape study

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Abstract

"People have said when checkout is working really well, it will feel like stealing. You grab a pair of shoes and you just walk out."

- Michael Chui, Partner, McKinsey Global Institute

Who would not like an ideal shopping experience – imagine that you walk into a store, browse products, compare pricing, read reviews, drop the products in your cart and walk out. This is not inconceivable in the not-too-distant future.
This report covers the current state and the future of retail checkout, which is at an inflection point and is ripe for a disruptive change in the near to mid term horizon. It outlines the pain points for the consumer and the retailer, and identifies an existing business opportunity as recognized by industry players. It covers the technologies in action, their potential for disruption, industry players in the game, challenges to overcome, and the authors' opinion on the winners and losers in the retail self checkout industry. Besides, it also covers a handful of case studies of industry players, both incumbents and disruptors that sheds some light on the players who are positioned to capitalize on the huge opportunity.

Keywords

Retail, Self-checkout, RFID, barcode, Digimarc, Scandit, NCR, Skip

Abbreviations

POS	Point Of Sale
NRF	National Retail Federation
AIDC	Automatic Identification and Data Capture
CPG	Consumer Packaged Goods
SNR	Signal to Noise Ratio
GTIN	Global Trade Item Number (Managed by GS1 standards)
RBR	Retail Banking Research
GS1	Global Standards One (an organization that manages standards)
ROI	Return On Investment

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1. INTRODUCTION

"People have said when checkout is working really well, it will feel like stealing. You grab a pair of shoes and you just walk out." That's how Michael Chui, a partner at the McKinsey Global Institute, describes the retail-checkout experience in your not-too-distant future [1].

The way we pay for goods and services at stores and restaurants is changing as the traditional POS (Point Of Sale) counters gets replaced by new technologies. Many stores and small businesses are already using tablets or mobile phones that swipe debit or credit cards. Purchases can now take place anywhere in the store thanks to mobile payment technologies such as Apple Pay, Samsung Pay. While this is the tip of an iceberg - a much bigger change in the overall checkout experience is coming - it illustrates the industry's recognition of an existing opportunity, and that big players are responding with a variety of solutions to radically change the consumer experience of retail checkout.

An ambitious concept, Touchless commerce [2], showcased by Toshiba in NRF (National Retail Federation)'s Big Show in New York City in early 2015 combines 3D and facial recognition to quickly scan consumers face and the content of the basket and immediately charges the consumer. As presented in the show, the scanning would be limited to 8-10 items in a supermarket basket and is far from achieving the required identification targets to make the technology realizable. Sometime in the future, as such technologies cross the barriers of adoption, we will essentially see an end to the concept of checkout.

We would like to imagine a future where in we could walk into a store, shop, and just walk out of the store with a filled cart fully paid for. While this requires disruptive innovations in POS solutions, mainly from scanning and payment systems, the latter has seen significant improvements and the former remains the key bottleneck in eliminating long lines at checkout.

In this report, we will share our findings from our study and analysis of the retail self-checkout landscape.

2. RETAIL CHECKOUT

Key bottleneck in the checkout experience is in data capture (scanning) and identification, often referred to in the industry as Automatic Identification and Data Capture (AIDC). Barcodes are the classic example of AIDC technology that has been successfully adopted in retail.

In this section, we will briefly cover the evolution of check out experience in the last half a century following which we will share the current state of the industry.

i. A BIT OF HISTORY

Retail checkout without barcode is almost unimaginable today. First use of barcode commercially dates back to 1974 in a store in Ohio [7]. Small businesses before barcodes spent an enormous time with inventory maintenance, as summed up in Figure 1: Benefits of barcode.

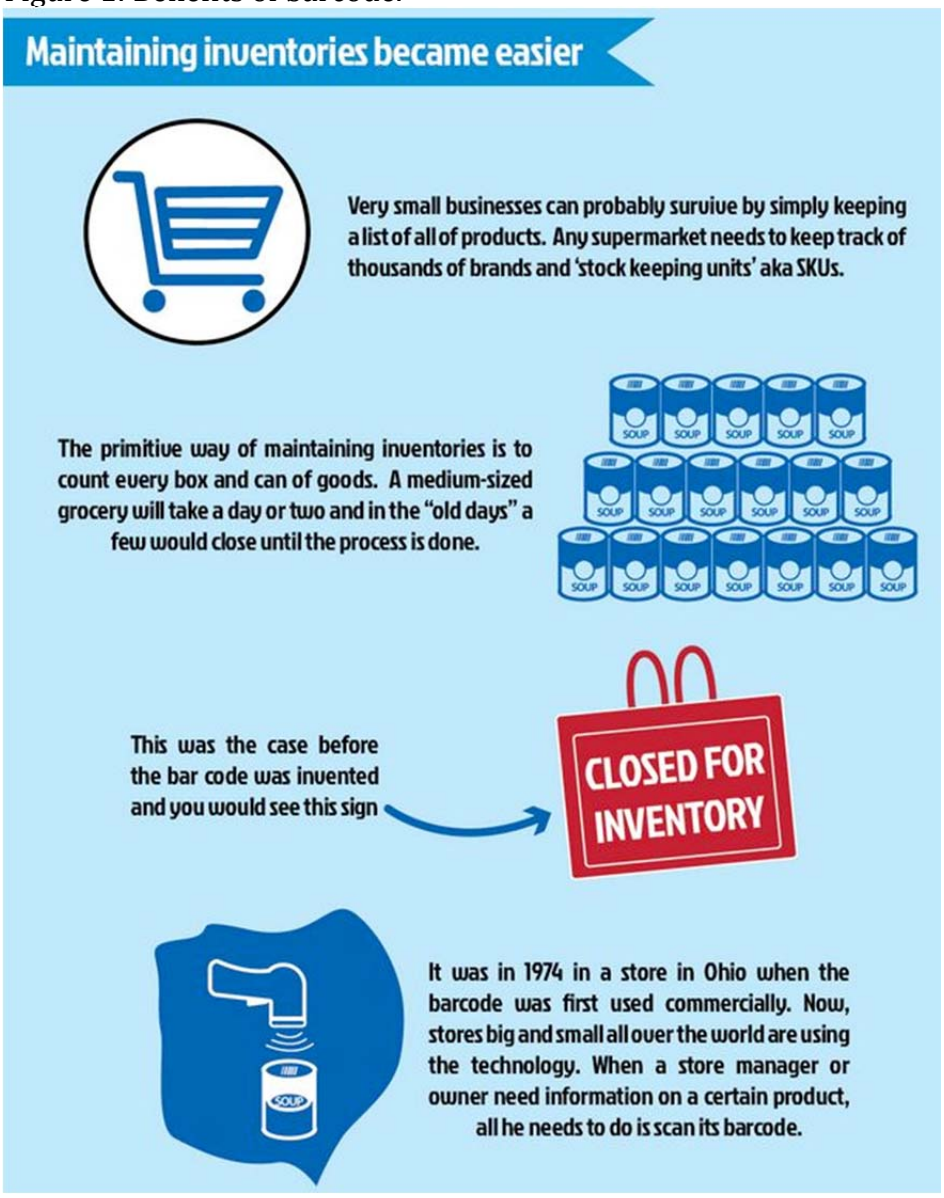


Figure 1: Benefits of barcode [7]

Over time, barcodes got adopted from inventory management into the front of the line retail POS thereby enhancing the checkout experience for the customers, and enabling the scalability of retail stores to support a large number of transactions. Figure 2: Evolution of checkout shows the technologies used historically at checkout. As we can see, the biggest disruptor so far, was the bar code and was invented about 40years ago. The figure shows that the recent evolutions have all been incremental in their value proposition, and we can say that the next big thing after barcodes was the self-checkout counter. The checkout industry is ripe for a disruption. Some of the key players in this game are mentioned in the next subsection including the technologies that they are evaluating for the next generation products.

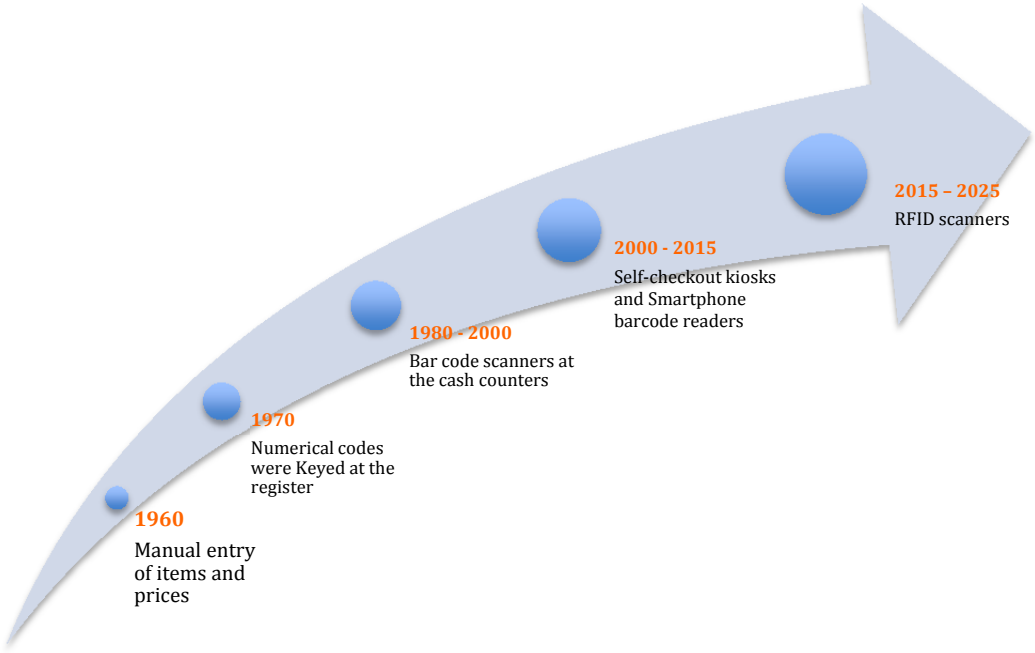


Figure 2: Evolution of checkout

ii. INDUSTRY TODAY AND KEY PLAYERS

In this report, we focus more on the retail self-checkout landscape rather than retail checkout as a whole. Thus, we identified the players in the self-checkout business. In Figure 3: Industry players in , we show the key players that include incumbents as well as disruptors. In specific, Horizon 1 companies (firms with stable products and steady market share with little growth) constitute the incumbents with NCR being the market leader. IBM was also a key player in retail self-checkout business and appears here as Toshiba after the sale of the retail business division to Toshiba.

As seen in Figure 3: Industry players in , there are a bunch of disruptors with different approaches to solve the long check out line problem. Scandit follows the natural evolution, an obvious next step, with the advent and widespread adoption of smartphones. It is essentially a smart phone based bar code scanning and integration into the retail checkout system.
Digimarc on the other hand, developed a radically new barcode technology based on image watermarking and is showing good promise of a large-scale adoption. Also, there are other small players such as shelfX that take us a step towards unmanned POS at the shelf level. Skip, is betting on the next big radically disruptive RFID technology. Apart from there, there are moonshots such as Toshiba's idea of basket/cart level image recognition based checkout and facial recognition based payment that will essentially completely remove the concept of checkout from the stores. We do not cover Toshiba's idea in this report since we believe that it is way far in terms of technical feasibility.

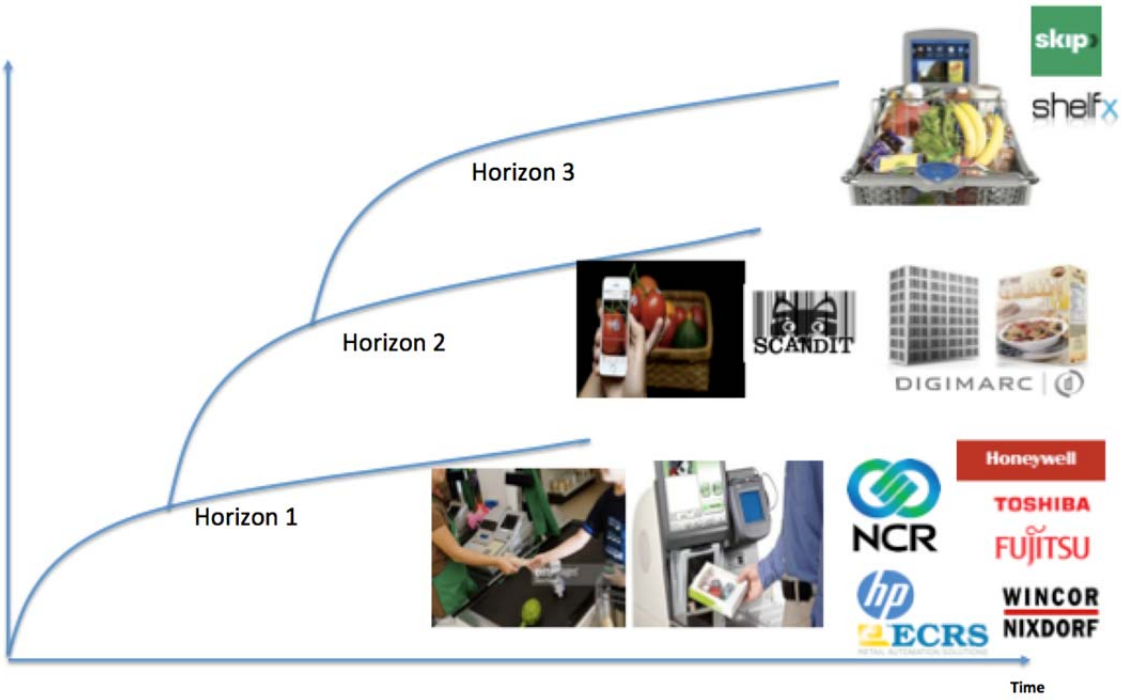


Figure 3: Industry players in self-checkout

Skip, Scandit, shelfX and Digimarc are relatively smaller companies in the self-checkout business. The dominant players in the self-checkout terminal business are shown in Figure 4: Self checkout terminal shipments worldwide (210,000), 2014, which obtained from a recent market share data by Retail Banking Research (RBR).

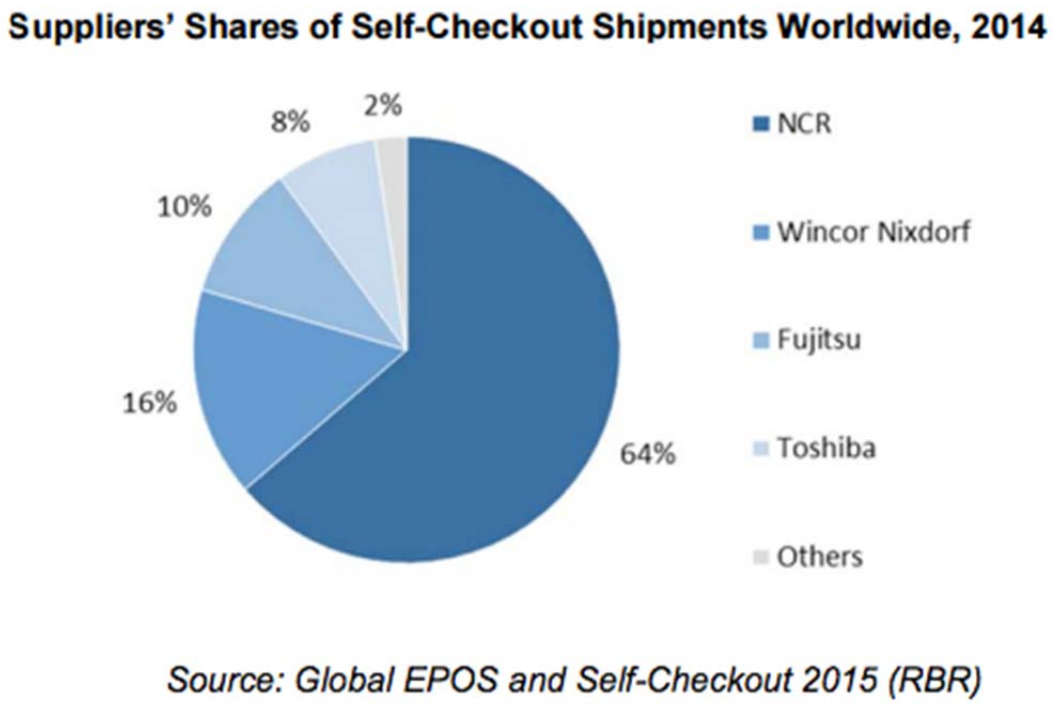


Figure 4: Self checkout terminal shipments worldwide (210,000), 2014

3. PAINPOINTS AND OPPORTUNITY

Checkout is the last opportunity for the retailer to make an impression on the consumer. Long lines at checkout could ruin the entire experience even though the consumer had the best possible shopping experience until then. The problem of long lines and the resulting frustration of the consumer needs no significant data for justification since most of us have the first hand experience.

The key pain point is the impact to the retail business. As shown by the retailcustomerexperience.com stats in Figure 5: Customer pain points and impact to business, brick-and-mortar stores are losing customers/business due to long checkout lines. A survey of US internet users by eMarketer shows at least about 30% of the participants indicate that they would go back to brick-and-mortar stores if smooth and quick self-checkout options existed. Also, a Harris poll data from 2013 showed that a staggering 88% of US adults want their retail checkout experience to be faster.

All the noted survey results indicate a clear hole or an opportunity to improve the experience. A different VDC survey of the retail organizations, shown in Figure 6: Retailers response to checkout clearly indicates that organizations are responding to this pressing need. 85% of surveyed businesses are considering upgrading their POS scanning systems.

Figure 5: Customer pain points and impact to business

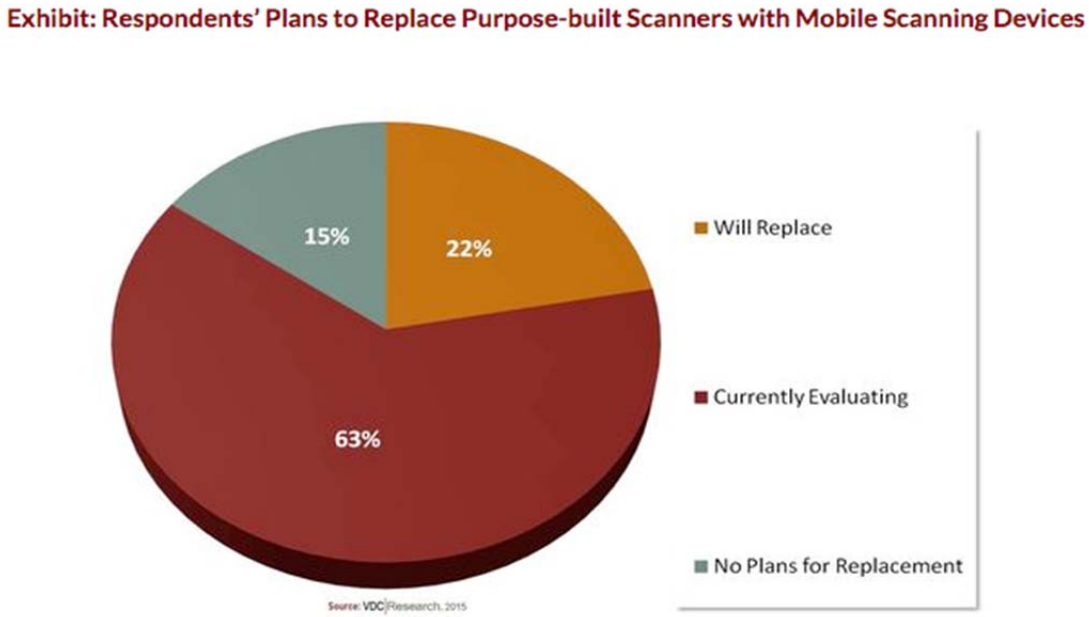


Figure 6: Retailers response to checkout pain point

Since, brick-and-mortar retail is about a $22 trillion business globally and the scanning portion of checkout costs about 0.4% of sales (based on data used by Digimarc covering top 120 supermarket/hypermarket chains globally), the business opportunity is $88 billion for completely eliminating scanning from the checkout flow. This presents an attractive opportunity for businesses to improve efficiencies.

In the next section, we will discuss the key technologies that are being explored to tap this large opportunity.

4. TECHNOLOGIES

i. Barcode

Barcodes are considered as one of the greatest inventions of the 20th century. One of the original forms of the bar code, when it was invented back in 1948 by Norman Woodland, was inspired by Morse code, essentially a vertical extension of the dots and lines in Morse code. Later on it took the form of circular bulls eye shaped pattern in order to make it robust against orientation. Eventually, when it was commercially implemented in 1974, it had taken the form that we see today. There are many different kinds of barcodes such as the retail Universal Product Code (UPC), the postal code and many more as shown in [10].

Technology

Barcode technology works of off a principle called Symbology carrying encoded data. This encoding allows the scanning device to know when a digit or character starts and when it stops, similar to a binary representation. We recognize barcodes as an array of parallel lines alternating between white and black lines. Barcode technology provides a simple and inexpensive method of recording data or information in a number of applications.

The line or linear barcode technology is sometimes referred to as 1D encoding. While we are most familiar with these barcodes, there are more complex codes that employ the use of dot matrixes to store and identify far more information. These are referred to as 2D barcodes; one popular form of 2D barcodes is the QR code. 2D barcodes are comprised of miniature dots, like the old dot matrix printers, which create patterns that are read in the scanning process. The key difference between the two technologies is the scanning technique. Linear barcodes are decoded by laser scanners, which use reflected light to measure the width patterns of alternating white and black lines. However, the 2D barcodes require an image capture device.

The popularity and potential of 2D barcodes has enabled a large-scale adoption of image scanners in checkout kiosks.

Barcodes ushered a revolution in checkout and inventory control besides many other industries. Today, it is difficult to image life without them. They will continue to have a long life due to the level of adoption that they have reached – according to GS1, there are more than 5 billion scans per day.

A radical new speedy checkout solution cannot easily ignore the fact that barcodes are here to stay for long and are not easily replaced. Hence, there are many companies such as Scandit that leverage this fact and use the power of smartphones to have increased level of customer engagement and faster checkout.

A few examples of a large variety of bar codes are illustrated in Figure 7: Sample types of barcodes.

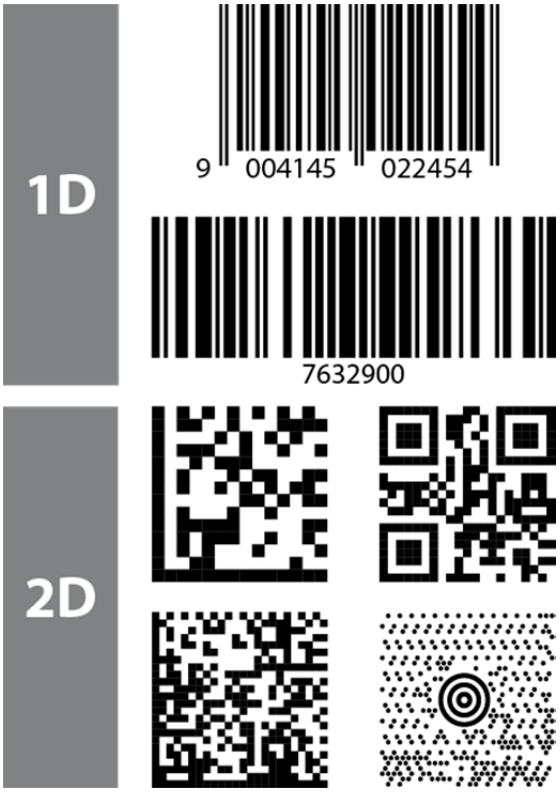


Figure 7: Sample types of barcodes

Key Benefits

Proven technology and deep rooted
No adoption challenges for technology that works with barcodes
Established ecosystem

ii. Digimarc Barcode

Digimarc Barcode [3] is a radical improvement to traditional barcode functionality that is faster, more reliable and more versatile than today's UPC/EAN symbol. In addition, it occupies zero space on the package. With Digimarc Barcodes, product packages can be scanned with Digimarc-enabled POS image scanners at checkout significantly faster than traditional UPC barcode scanners.

In the next two subsections, we cover some details on the technology behind the new barcode and the key benefits of the technology.

Technology

Image watermarking, a proven technology that has been deployed in large scale with exceptional robustness in different verticals, enables this amazing new barcode technology [4]. The Digimarc Barcode is built on a Fixed Code Direct Sequence Spread Spectrum robust image watermark technology utilizing a template that is rotation, scale, and translation invariant.

A key innovation enabling the use of print watermarking in Consumer Packaged Goods (CPG) for detection with imaging-based barcode readers is a color and illumination model that maximizes Signal to Noise Ratio (SNR) while operating under a well behaved visibility constraint model. The watermark is imperceptible, allowing significant redundancy on a package enabling printing on all sides of the package without affecting the aesthetics.

In watermarking with Fixed Coding, the package artwork, or Cover Work, has no bearing on how the message is mapped to the watermark. During watermark detection the original Work is not available, so the Cover Work is a noise source for the watermark detector. Although the Cover Work is a significant source of noise in terms of its comparative amplitude with the watermark, it can be mitigated through the use of high-pass filtering. In the case of digital imagery, smooth contours and tonally flat regions of the image are places where a high-pass filter can be used to great advantage for watermark recovery, less so for edges and busy textures.

Code embedding is how the watermark is combined with the cover work using the procedure illustrated in Figure 8: Code Embedder. In the figure, the message can be assumed to be a product identifier such as Global Trade Item Number (GTIN) that is used in UPC barcode and the key refers to the spreader. The figure shows updated workflow of the package cover design (which is software oriented) prior to printing.

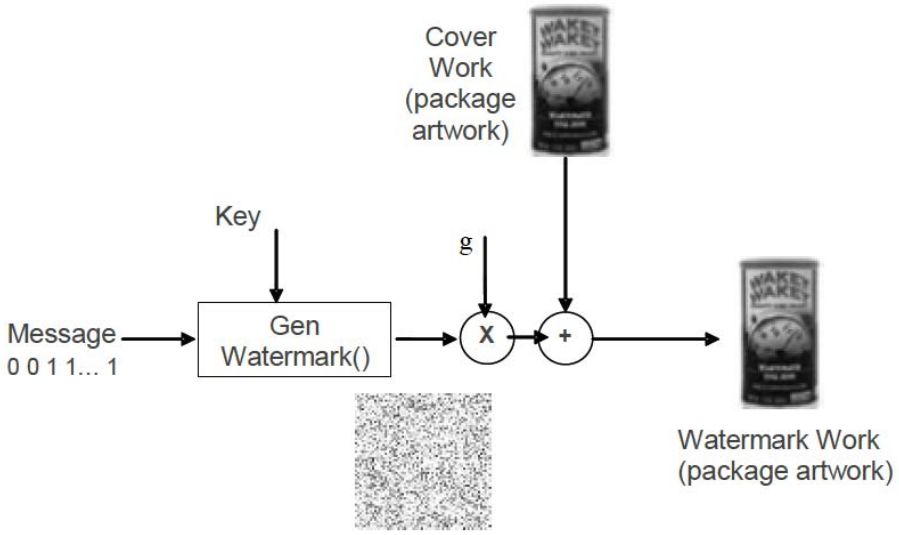


Figure 8: Code Embedder

Code detector as shown in Figure 9: Code Detector is the technique used during scanning and automatic identification of the product. This would require an image capture capability on scanner, which also happens to be a requirement for supporting 2D barcode scanning. The high pass filtering, as shown in Figure 9: Code Detector eliminates the cover work and leaves behind a noisy embedded code that is then correlated against the spreader code (generated from the Key). Slicer would spit out the message bits that constitute the identifier such as GTIN that uniquely tags the product.

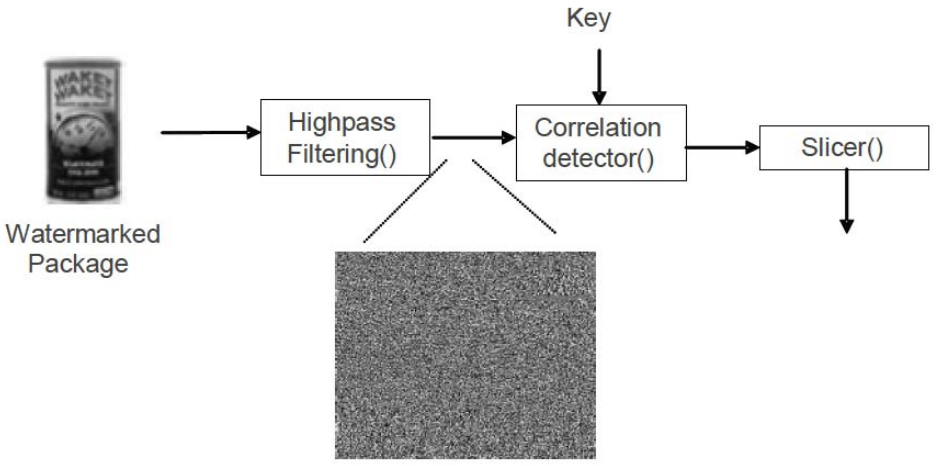


Figure 9: Code Detector

The massive footprint of linear barcodes ensures their longevity. Central to the design of Digimarc Barcodes is its ability to coexist with existing overt symbologies (barcode). However, as retail stores and their suppliers continue the adoption of imaging-based barcode scanners, their ability to leverage the benefits of Digimarc Barcode will grow.

Key Benefits

- Orientation (speedy scan) – Due to the nature of the barcode which is by design robust against orientation, and due to the imperceptibility of the watermark allowing for significant printing redundancy on all sides of the package, package orientation with respect to the scanner is no longer a requirement.
- Customer Engagement – Side benefit of orientation agnostic scan ability is that clerks at check out counters can better engage with customers. Besides, Digimarc-enabled barcode scanning app on smartphones can directly engage customers with the products and help with advertising and cross-selling opportunities. They could continue engaging with the product related interactive mobile content even after leaving the store.
- Cost – Has little to no impact to existing printing and scanning solutions since it can essentially reuse the same workflow as today's barcode based solutions. The only change to the work flows is a few software upgrades
- Aesthetics – Allowed package cover designers more flexibility since the barcode does not impose a design constraint such as space and shape limitations.

iii. RFID

RFID is a radical technology that can completely disrupt retail checkout if it solves some of the technological challenges that it is facing today.

Technology

Radio Frequency identification (RFID) uses electromagnetic waves to identify and track labels that are attached to products. Passive tags harness the energy from nearby RFID readers to transmit electronically stored information to the reader. It is a well-established technology in large scale in asset tracking and inventory management.

RFID tags (constitute a small chip and an antenna) can carry similar information as the barcodes about the products. They remove the requirement of line of sight and short range between the tag and the scanner. RFID tags can be scanned at distances of a few meters. They can be read or written to, which is a radical new capability compared to barcodes which can only be read.

RFID technology has been available for more than fifty years. It has only been recently that the ability to manufacture the RFID devices has fallen to the price point where they can be used as a "throwaway" device. Alien Technologies recently sold 500 million RFID tags to Gillette at a cost of about ten cents per tag [11].

One reason that it has taken so long for RFID to come into common use is the lack of standards in the industry. Most companies invested in RFID technology only use the tags to track items within their control; many of the benefits of RFID come when items are tracked from company to company or from country to country.

Some common problems with RFID are reader collision and tag collision. Reader collision occurs when the signals from two or more readers overlap. The tag is unable to respond to simultaneous queries. Systems must be carefully set up to avoid this problem. Tag collision occurs when many tags are present in a small area; but since the read time is very fast, it is easier for vendors to develop systems that ensure that tags respond one at a time.

Besides that above, tag costs have remained a key barrier to adopting this technology to the POS scanning use case. Figure 10: RFID factory selling price trend shows the projected costs of tags as predicted back in 2011 by VDC. These costs are not significant in carton level scanning, however, item level tagging and identification requires the cost to come down to a penny or a fraction there of. Based on the figure, one can see that the trend is in the right direction and price is closing in to make it viable.

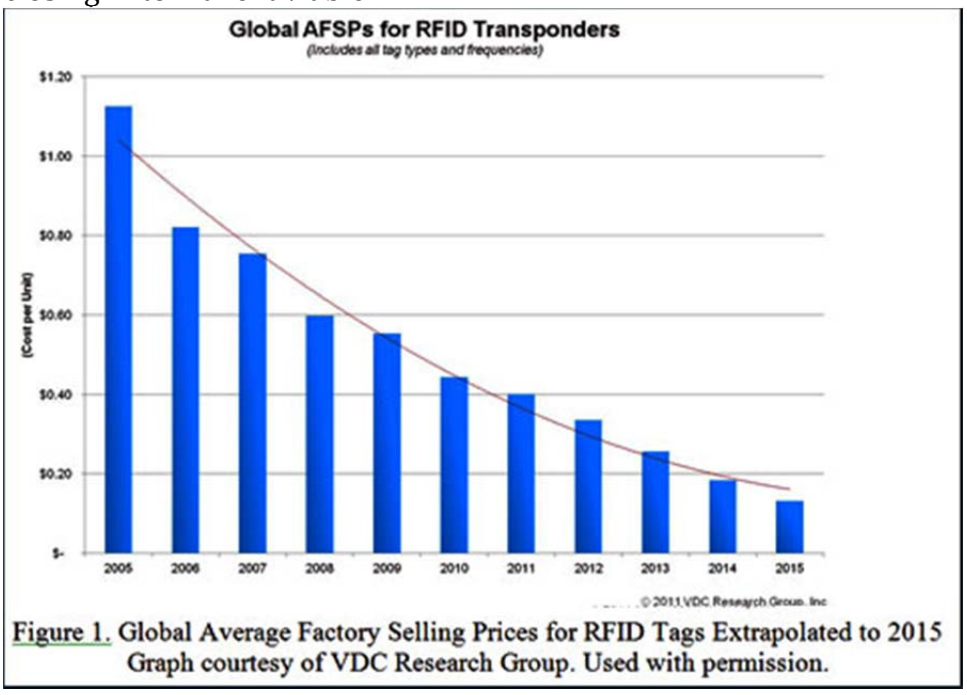


Figure 1. Global Average Factory Selling Prices for RFID Tags Extrapolated to 2015
Graph courtesy of VDC Research Group. Used with permission.

Figure 10: RFID factory selling price trend

Key Benefits

No alignment/orientation requirement such as in barcodes
Simultaneous scanning of numerous products
Read/Write capability helps with reducing shrinkage
Integration with billing and inventory management
Scan distance requirement will be relaxed

5. CASE STUDIES

i. NCR: The market leader

Overview

The NCR Corporation is the global leader that makes self-service kiosks, point-of-sale terminals, automated teller machines, check processing systems, barcode scanners, and business consumables. The Company operates through four segments: Financial Services, Retail Solutions, Hospitality and Emerging Industries. The Company provides retail and hospitality oriented technologies, such as point of sale terminals and point of sale software, bar-code scanners and other retail-oriented software and services to retailers, restaurants, food service companies and entertainment and sports venues across the world. The Company provides self-service kiosks and related operating software to the retail, hospitality and travel industries. Its kiosk solutions support retail self-service functions, including self-checkout, way finding (locating products or navigating through large, complex buildings and campuses), digital signage, bill payment and gift registries. It provides self-check in/out kiosk solutions to airlines, hotels and casinos that allow guests to check-in/out without assistance. . With its software, hardware, and portfolio of services, NCR enables more than 550 million transaction everyday.

Self-checkout systems and technology from NCR are large parts of what make NCR the global leader in the retail self-service and point of sale. At the core of the NCR SelfServ Checkout architecture is the patented NCR SelfServ Checkout Transaction Broker (TB) technology. The TB enables the CEA to control the retailer's native POS so that the back office sees the self-checkout lane as just another POS lane.

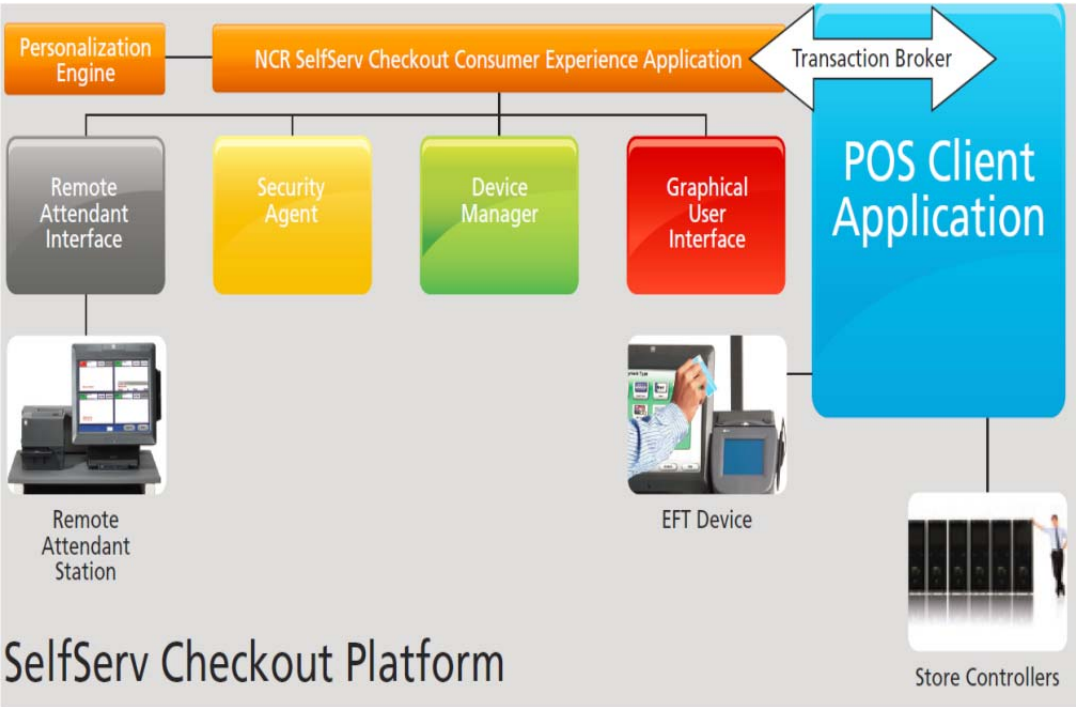


Figure 11: NCR self checkout platform

The technology provides seamless POS integration, intuitive user interface, hi res LCD, touchscreen, hi-fi audio, animation, non-barcoded item look-up, "follow me" lights, Bi-optic scanner with LEDScan Advisor, integrated EAS Tag deactivation, wired/wireless scanner, security scale for weight verification, item integrity via self –learning weight database, remote attendant station, high availability service.

Customers

NCR self-checkout serves 233 retailers and constitutes of Australian, European and U.S. chains. Currently NCR has 100K+ SCO units deployed. Some of the leading customers are:

- Walmart in US
- The retailer Land is the leading premium supermarket chain in Saint-Petersburg : NCR solution increased its capacity
- Globus hypermarkets in Germany and the Czech Republic, now in Russia
- Coles supermarket in Australia (749 stored in the country) - around 4,000 units in over 500 stores in 2013
- Auchan, one of the Italy's leading hypermarkets has 450 SCO lanes in 51 hypermarkets
- Dansk Supermarked, #1 grocery retail group in Denmark deployed SCO
- IKI is the second largest grocery chain in Lithuania

Value Proposition

Leverage existing barcode based ecosystem

Incremental enhancements to self-checkout kiosks

As retailers respond to volatile consumer spending, they will expand the number of aisles dedicated to self-checkout.
Self-checkout (SCO) offers retailers an effective means of reducing costs and improving customer service. A four-unit SCO kiosk allows large retailer to reduce headcount and reallocate employees to higher impact customer service based tasks.

Self-checkout ASP (4 units):	$60,000
Headcount Reduction	4
SG&A Reduction @ $30K each	$120,000
Payback Period (years)	0.5

ii. Scandit: Leveraging the smartphone boom

Overview

Scandit Barcode Scanner SDK transforms smartphones, tablets and wearable devices into enterprise-grade barcode scanning tools for consumers. The Demo app showcases the barcode scanning performance of the Scandit Barcode Scanner SDK. The scanner enables the customer to check in to store begin shopping, customer is shown specials there and can scan items in cart, customer can add items via smart search, can review /change items before leaving and finally scans a QR code at checkout and payment is made at the kiosk.

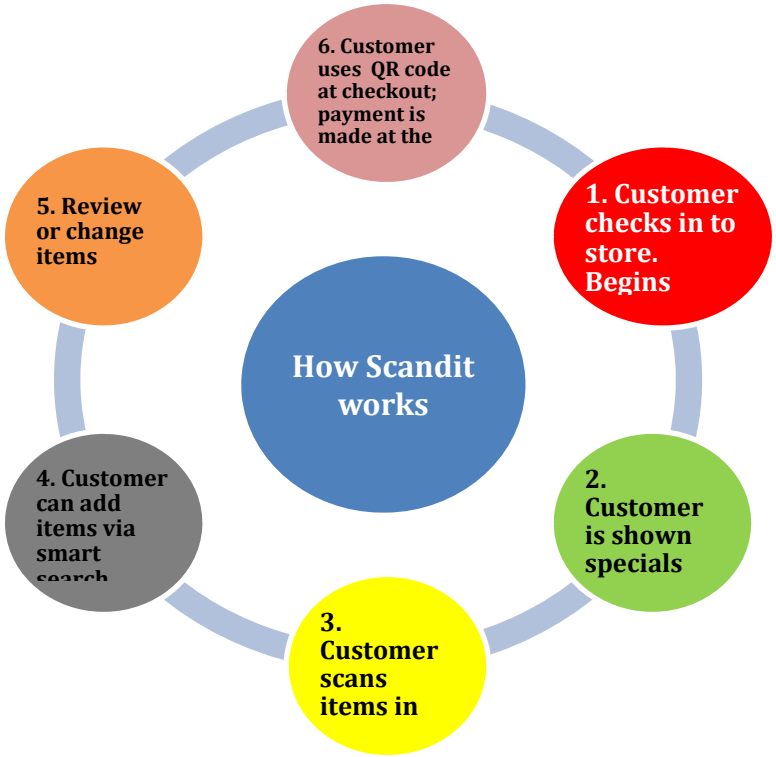


Figure 12: Scandit work flow

Customers

Scandit has added North American retail and supply chain markets, with the addition of several recognized brands to its customer base. The company is now working with Party City, Saab, Shell, Priority Payment Systems, Florida Healthcare and American Woodmark. Capital One and Saks Fifth Avenue are few names among rapidly growing list of organizations taking advantage of Scandit's disruptive and groundbreaking solution.

Value Proposition

Leverage existing barcode based ecosystem
Higher levels of customer engagement
Coupons, advertising and cross selling via apps

Expected ROI can be estimated using simple calculations as shown in the following example

Self-checkout SDK (500 units):	$4000
Payment KIOSK price 4@ $2K	$8,000
Headcount Reduction	4
SG&A Reduction @ $30K each	$120,000
Payback Period (Months)	1.2

iii. Digimarc: Radical identification and capture

Overview

Digimarc, a Beaverton, Oregon based company, is a pioneer in content identification across all forms of content, including audio, video, packaging, and imagery. They develop solutions, license intellectual property, and provide development services to global business partners across a wide range of industries. Digimarc holds a large and growing intellectual property portfolio that spans the breadth and depth of innovation in digital watermarking and content identification, with over 800 issued US and foreign patents.

Although barcodes are mission-critical enablers of the retail industry, supporting faster checkout times, more accurate pricing, and reliable inventory control, they have some obvious limitations. One significant drawback is the requirement that items be correctly positioned prior to scanning, a characteristic that contributes to delays in checkout lines and frustration on the part of both cashiers and customers. Other obvious limitations include the devotion of considerable package real estate to the visually disruptive standard black and white vertical bars, lost revenues from barcode swapping fraud, and difficulty scanning soiled, wrinkled, damaged, or otherwise obscured traditional barcodes. Despite these limitations the barcode has had profound positive effects on the processes and economics of the retail industry.

Digimarc has identified key pain points of the well-established bar code technology and have delivered a new solution that would provide tremendous benefits over existing technology. It has engineered a significant improvement in the means of identifying and processing CPGs at checkout, which obviates the limitations of traditional barcodes.

Figure 13: Digimarc watermark encoding is a sample of how Digimarc barcodes are imperceptibly embedded into packaging.

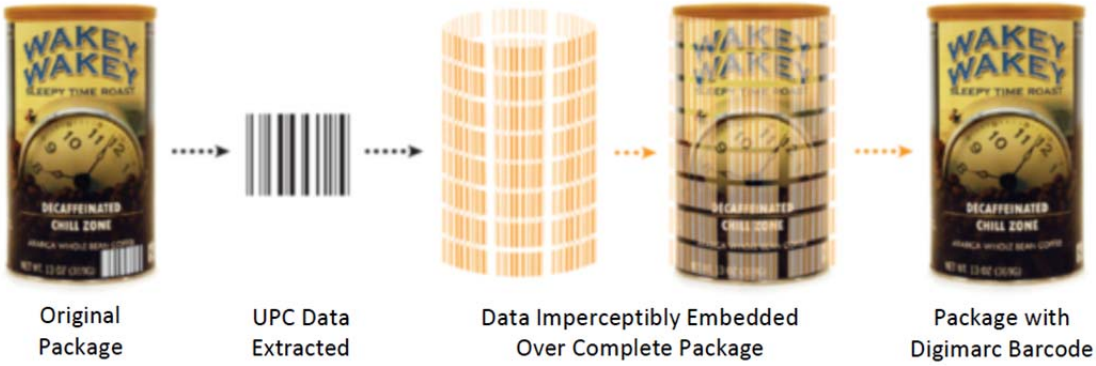


Figure 13: Digimarc watermark encoding

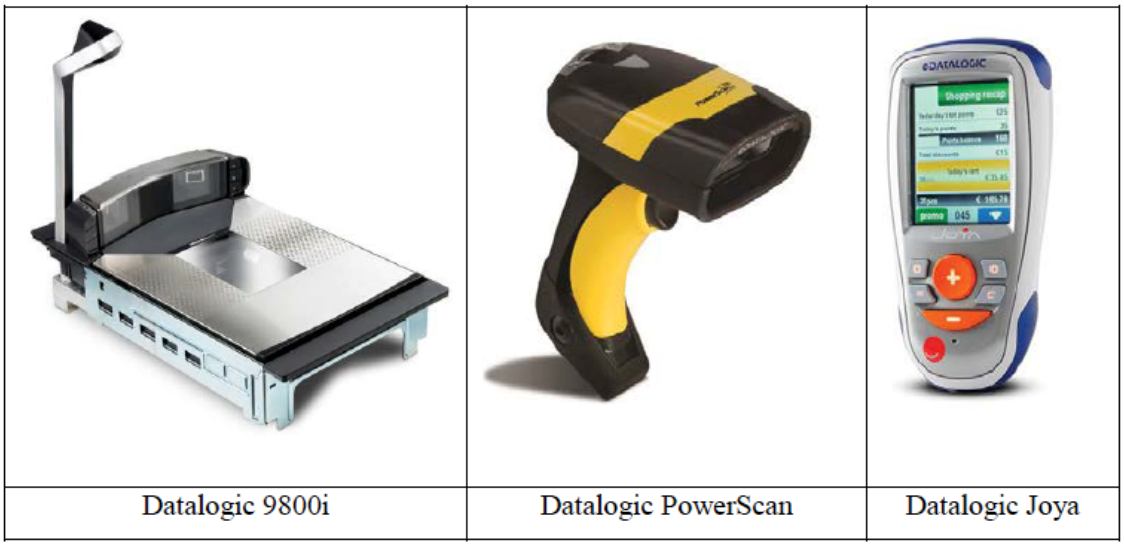
Earlier section with description of Digimarc barcode technology covers the technology in greater detail and the related benefits.

Customers and Partners

Key customers include Kraft Heinz Company, Wegmans and New Seasons Grocers.

Leveraging the high growth in adoption rates of image scanners in retail POS, Digimarc partnered with key players in the scanning business to adopt Digimarc barcode scanning capabilities into their current products by means of a software upgrade thereby reaching out a sizeable retail market. Some of its key partners are NCR, Datalogic, HP and Toshiba.

Figure 14: Datalogic devices with integrated Digimarc barcodes illustrates some of the data capture devices that are Digimarc barcode scan ready.



Datalogic 9800i	Datalogic PowerScan	Datalogic Joya

Figure 14: Datalogic devices with integrated Digimarc barcodes

Value Proposition

Digimarc barcode is a patented technology that beats traditional barcode technology in scan speed and robustness. It offers a graceful upgrade path for all the key players in the ecosystem – companies offering package printing and data capture solutions.

As part of an ROI evaluation tool, Digimarc has published a whitepaper [6] that demonstrated the expected ROI for an example large chain retailer. For this hypothetical company with $2.5B in sales, and 40000 SKUs with 25% of private label SKUs, below table shows an estimated ROI and the timelines. Detailed calculations can be found in [6].

Table 1: ROI of the hypothetical retailer

	Private label adoption	Complete adoption
Payback period	9months	3months
ROI 1st yr	30%	400%
ROI 10yr	267%	1700%

[6] also performs a detailed estimate of savings for the top 120 companies that are in supermarket, hypermarket type businesses. The expected savings are about $3 billion with the large-scale adoption of Digimarc technology. Table 2: Labor cost savings expected in the $3 trillion business (top 120 supermarket like retail

segments). Table 2: Labor cost savings expected in the $3 trillion business (top 120 supermarket like retail segments) shows an estimated savings solely due to faster scan rate and not accounting for the benefits of better customer engagement.

Table 2: Labor cost savings expected in the $3 trillion business (top 120 supermarket like retail segments)

Annual Labor Cost Savings from 33% Improvement in Scanning Rate (USD in millions)			
Segment	Scan Time Reduction	Addressable Scanning Labor Costs	Annual Labor Cost Savings
Primary Market			
Supermarkets	25%	$5,588	$1,397
Hypermarkets/Supercenters	25%	$5,877	$1,469
Secondary Market			
Cash & Carry/Warehouse	25%	$655	$164
Discount	25%	$353	$88
Drugstore/Pharmacy	25%	$214	$53
Total			$3,172

Most recently, Digimarc achieved a critical milestone by establishing collaboration with GS1 US, the industry standards organization that manages identification technologies such as UPC barcode and RFID/EPC, towards establishing an industry standard using Digimarc barcode technology. You can read more about this in [5].

iv. Skip: RFID, the final destination?

Overview

Skip is a startup that develops technologies to power the next generation of retail. They use novel RFID technologies to drastically improve the efficiency of inventory, security, analytics, and checkout for retailers and warehousing. The technology behind it is patent-pending.

Skip is built upon two key RFID technologies. The first is a patent-pending read method that works within the existing RFID protocol yet enables RFID tag reads ~1000x faster than the next fastest method. The second is a patent-pending localization method that locates RFID tags 20x more accurately than traditional methods (10cm vs. 2m).

A consumer can sign up at a Skip enabled retailer by registering for an RFID embedded Skip card or downloading the Skip app and linking their preferred method of payment. Once registered the consumer can simply pick up the items they wish to purchase and walk out of the store to complete their purchase. No waiting. No lines.

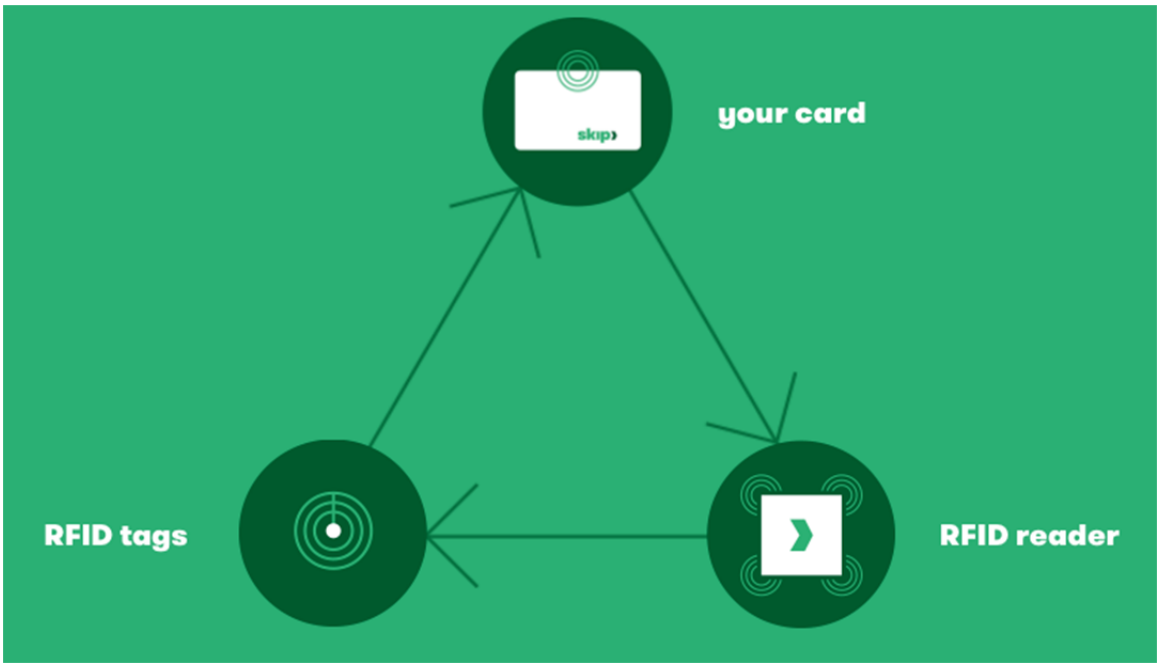


Figure 15: Skip operation

They are solving the challenges of RFID technology with regards to scalability in simultaneous multi-tag read speeds and the ability to identify and locate tags within a certain volume. They use multi-antenna [8] receiver to localize the identified objects, first of which is an RFID enabled Skip card (which is unique to a consumer) and next of which are the products in the cart. RFIC localization to within a certain volume near the person is the key technique used for understanding consumer-product interaction for better analytics. It is also likely how the products in a cart are associated with the consumer. The general operation and flow is shown in Figure 15: Skip operation.

Besides checkout, Skip is also targeting inventory management to minimize markdowns and out-of-stocks. The company still seems to be in an early stage and might need to solve the problem of reliable RFID detection in order to be successful in RFID based checkout business.

Customers

Walmart, Macy's, American Apparel and others - 30 early adopters.

Value Proposition

Faster RFID tag read capability than existing technologies
More precise RFID based tag localization than existing technologies
Eliminate check out lines completely
Provide rich analytics on product-consumer interaction

6. KEY HURDLES FOR ADOPTION

Just like any new disruptive technology faces adoption challenges, the solutions considered here have certain challenges to overcome and implicit benefits over other technologies. We briefly describe these issues here by categorizing them into three kinds – technology, regulatory and societal.

i. Technology

While smart phone based scanning solutions have the convenience of avoiding long lines, the key challenge is with solving the theft problem. Besides, customers may not necessarily be eager to take on the job of the checkout clerk on a regular basis. Sustainable adoption is under question unless there are some incentives beyond the short lines for the consumer to continue to adopt this solution.

Digimarc based codes have to overcome the adoption challenges with the manufacturers, package-printing companies and checkout data capture solution vendors. While there is sufficient traction with data capture solution vendors, more needs to be done to push the adoption from the packaging side. Recent partnership with GS1 US will enable widespread education and knowledge of the benefits of this technology and will likely cause the adoption rates upstream to shoot up.

RFID is the most promising in terms of the efficiency improvement across the value chain since it is already fairly heavily adopted in distribution, tracking and inventory management leaving only the last stage of POS. Cost of tag is still a barrier that is stopping the technology to go from carton level tags to item level tags. If the cost problem is solved, this will turn out to be the best solution for both retailers and customers since theft concerns are implicitly handled by this solution.

ii. Regulatory

RFID would be the main technology that is impacted by regulatory issues. Some of these issues are to do with the impact of radiations on food products, environment issues surrounding disposal or recycling of the RFID tags. These need to be studied further from the standpoint of sustainability and environmental impacts.

Other technologies do not have this barrier.

iii. Societal

All the technologies are primarily addressing the problem of slow scanning speeds. Obvious byproduct of success of such technologies is the reduction in jobs due to improved efficiencies. The cost benefit of adopting some of these technologies such as RFID could be prohibitively expense for small size and mid sized retail businesses.

While Digimarc helps with better engagement of retailers with customers, smartphone based scanning solutions and RFIDs removes the human interactions and personal touch from the shopping experience. This would bode well with certain categories/age-groups of customers while not so with certain other groups.

7. CONCLUSIONS

Reviewing the landscape of retail checkout industry, we have identified a clear business opportunity and the key players that are vying for a portion of the pie. We also evaluated the key technologies that are under consideration to tap the opportunity.

Due to the increasing frustration of the consumer and the resulting impact to the business, retailers who do not respond to this pressing need would be severely impacted. Solution providers in the self-checkout technology business and data capture/identification in general need to innovate and come up with a radically new approach to the checkout problem in the near to medium term horizon to tap the ~$88 billion opportunity.

Based on the publicly available information about various players, we believe there will be some winners and some losers based on the strategic decisions made by them going forward. Following, Table 3: Expected outcomes, is our expectation on the future of few of the key players, and also the strategic steps they should take in order to avoid obsolescence.

Table 3: Expected outcomes

Company	Future	When	Remarks
NCR	Leadership position will be challenged by disruptive technology.	5 Years	Will need to innovate or acquire to maintain leadership and market share
Toshiba	May eventually abandon market	5-7 years	IBM self-checkout acquisition did not pan out. No visible innovation agenda
Scandit	Acquisition target by NCR	3 years	Complements existing technology

Digimarc	Best suited to displace barcode technology in near term	2-4 years	Acquisition target by current market leaders
Skip	Potential major winner	5 years	Success dependent on RFID adoption. Funded by Microsoft

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