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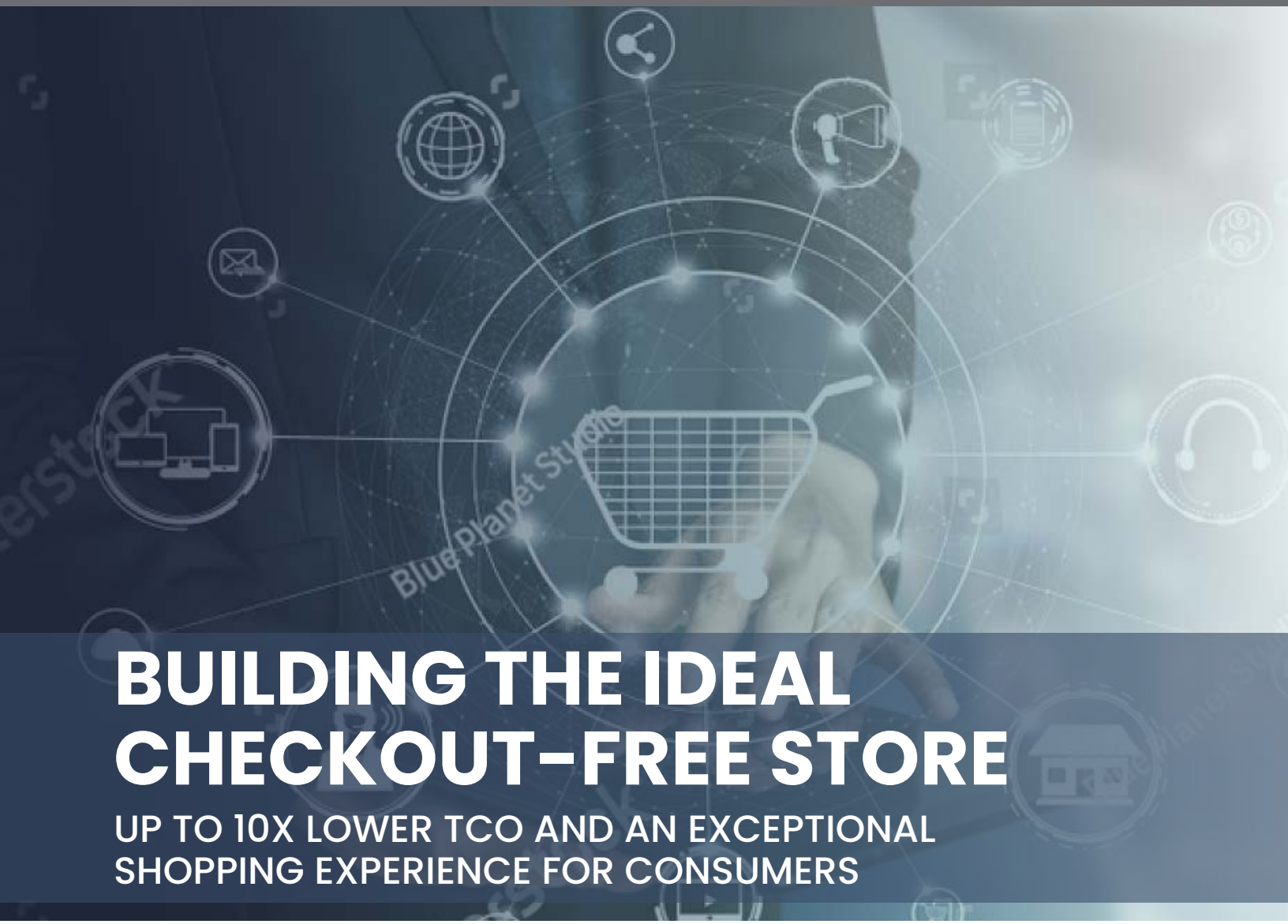


BUILDING THE IDEAL CHECKOUT-FREE STORE

UP TO 10X LOWER TCO AND AN EXCEPTIONAL SHOPPING EXPERIENCE FOR CONSUMERS

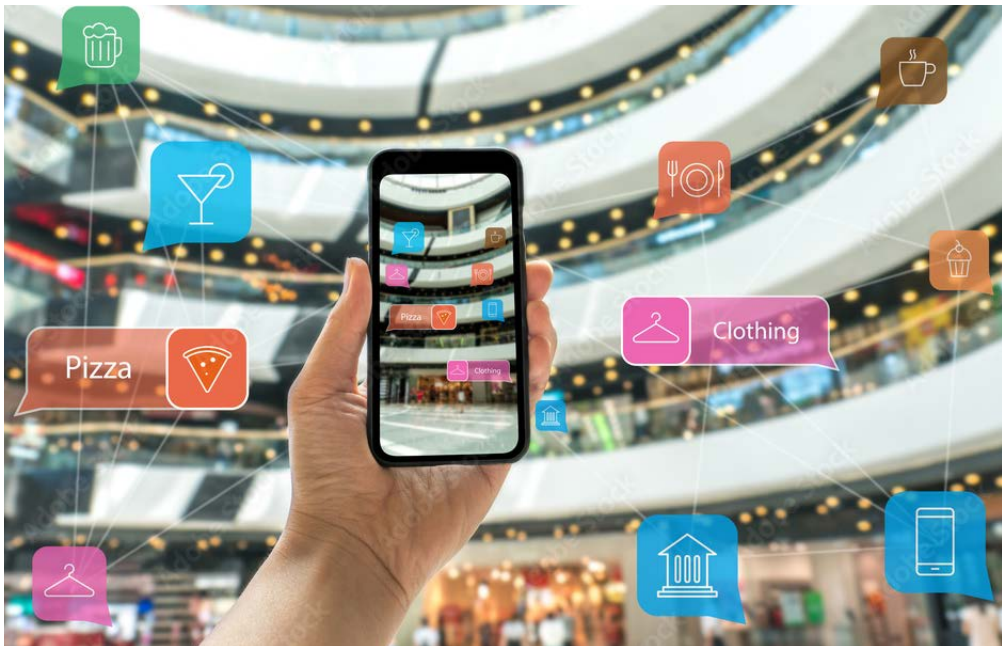
TECHNICAL ANALYSIS

Introduction

Checkout-free shopping has become the new rage in brick-and-mortar stores. Pioneered by Amazon, this trend encompasses a rapidly growing number of retailers across the globe, including Carrefour, Sainsbury, 7-11, Circle-K, and others. Checkout-free shopping promises greater benefits for both shoppers and retailers. A shopper has the convenience of getting what they need and simply walking out, with a receipt sent to their smartphone. This in turn, improves a retailer's profitability by gaining a greater understanding of customer behavior in real time, leading to enhanced inventory management, minimizing lost revenue, and lowering labor cost.

The foundation of a seamless checkout-free shopping experience is a set of sophisticated, compute-intensive AI models that map a customer's journey through the store and answer the question of "Who picked up what?". Because these AI models analyze multiple video feeds from the cameras deployed throughout a store, they tend to be both extremely data-intensive, as well as extremely (AI) compute intensive. Thus, the default option has been to use multiple sets of power-intensive GPUs such NVIDIA T4's housed in Xeon Gold class servers. However, this implementation cannot be scaled out (e.g., many stores) due to cost-prohibitive capital expenditure (CAPEX) as well as the high total energy consumed by the GPUs and servers.

The Kinara Ara-1 Edge AI processor, when combined with an efficient host SoC such as a single NVIDIA T4, delivers a solution that lowers the total cost of ownership (TCO) by an order of magnitude, both by reducing CAPEX and significantly reducing power use.



The Business Case for Checkout-Free Shopping

According to a recent Harvard Business Review article (date and article name), the average American consumer spends nearly 118 hours annually waiting in line while shopping. Even so, shoppers in convenience stores, airports, stadiums, and commercial buildings are the least likely to wait. These shoppers place a premium on time; they must catch a flight, go back to the game, or are expecting a quick turnaround. Waiting results in lost revenue and a less than optimal shopping experience for the customer.

The average American consumer spends nearly 5 days a year waiting in line

Shoppers expect fast, easy, and frictionless ways to shop. Checkout-free shopping offers just that, by allowing the shopper to pick what they need and walk out of the store without standing in line for any checkout. This also offers increased profitability for retailers–accurately recording revenue, minimizing lost revenue, and lowering labor costs–while delighting their customers with a convenient shopping experience that they have full control over.

Lower cost of sensors, cameras, and computing systems, along with considerably increased accuracy of AI models, make CFR solutions a reality. Led by Amazon, several leading retailers have already adapted this store format and the trend is growing. However, challenges to scale the solution remain.

Who Picked Up What (in the store)?

The key question to be answered by any checkout-free system is "Who picked what from the store?" Answering this question allows the retailer to bill customers for the in-store purchases.

To answer this question, retailers must install overhead cameras on the ceiling every 10 sq. ft., to enable the system to follow the customer's journey throughout the store. The AI models analyze the multiple video feeds to identify the product picked up from the shelf (or put back) and provide an association of these products and actions to a specific shopper.

Four key AI models are required to analyze video feeds from the cameras.

- Person Detection and Tracking
- Person Re-identification
- Pose Estimation
- Product Classification

The Person Identification model identifies the person walking into the store. Due to GDPR compliance and other privacy requirements, the system must blur a person's face as they walk into the store. Therefore, the system uses other attributes like attire, gender, and height, to identify the person.

The checkout-free system then uses the Person Tracking model to track the person as they move from one camera zone to the next.

The Pose Estimation model determines if the person picked up a product from the shelf or put a product back on the shelf.

Finally, the fourth AI model, Product Classification, kicks in to identify the product that's been picked up or put back.

Stitching these customer actions, from the time they enter the store to when they exit, helps answer the question "who picked up what from the store?"

Hurdles to Achieving Scale Deployment

There are multiple approaches to using AI models to process the camera video feeds. A typical convenience store is roughly 2,000 sq. ft. With cameras installed overhead every 10 sq ft, the store would require 200 cameras. These cameras then generate video streams at 1080p resolution and 30 frames per second.

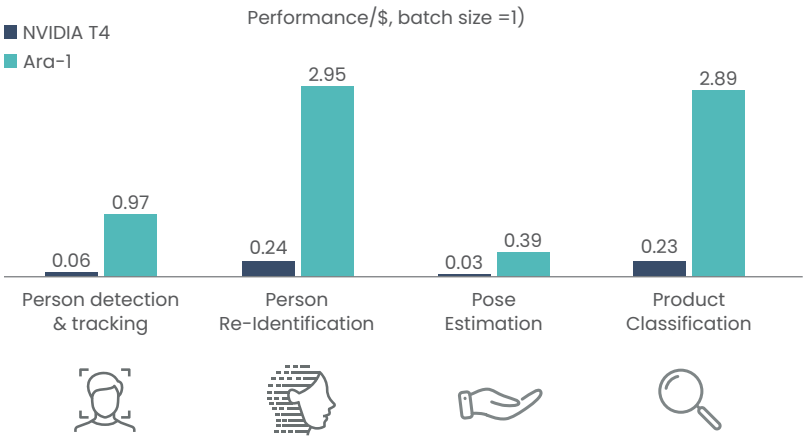
One approach to run the AI models on this data would be to upload the video feeds to the cloud. However, uploading video feeds from 200 cameras to the cloud is extremely expensive and requires vast amounts of always available network bandwidth. Once the data is uploaded, cloud computing to run AI models using GPUs is also very expensive. Finally, network reliability could adversely impact the accuracy of the results. Cloud-based deployment could be an option to prototype the solution, but not a realistic production solution.

Cost for a cloud-based approach to checkout-free retail stores becomes untenable at scale

Edge AI Processors For Lowest CAPEX at Scale

The optimal CAPEX solution is an Edge AI processor that enables all AI models to run at the source (i.e., in the cameras) eliminated the cost and latency of cloud-based approaches while reducing the need for multiple premium, power hungry GPUs and servers. This solution does on-device processing of the camera feeds and eliminates the need for expensive Power over Ethernet (PoE) switches. Only the inferred meta-data and a few key images must be transferred over the network and not the entire video feed, resulting in extremely reduced network traffic.

Kinara Ara-1 Edge AI Processor vs. additional NVIDIA T4 GPU



>10X
improvement in performance/$

The Kinara Ara-1 Edge AI processor makes checkout-free shopping a reality by delivering optimal performance and power to run the essential AI models for Person Identification and Person Tracking, Pose Estimation, and Product Identification.

The Ara-1 Edge AI processor delivers up to a 10x improvement in inference performance/watt over GPUs. Furthermore, running at only 2.5 Watts, the Ara-1 Edge AI processor and host SoC can be integrated into the camera module without the need for active cooling. Kinara AI has committed to building partnerships with an in-depth technical understanding of what it takes to build out next generation checkout-free retail system and help achieve total cost of ownership benefits at scale.

The Ara-1 Edge AI processor delivers up to a 10x improvement in inference performance/ watt over GPUs

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KINARA | LEADING EDGE AI

Kinara delivers unrivaled edge AI solutions to accelerate and optimize real-time decision making. Our AI accelerators power smart edge devices and gateways that demand responsive AI computing at high energy efficiency. The Kinara AI team, based in Silicon Valley as well as Hyderabad, India, includes Silicon Valley innovators, technology experts from Stanford University, and a world-class hardware and software development group. The company derives its name from the Hindi word for 'edge' and reflects the commitment we make to our customers to build extremely innovative edge devices for retail, smart cities, industry 4.0, and automotive.

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