Accelerating Innovation:

The Future of Smart Venues

intel in partnership with NTT

Team

AUTHOR
Kasia Hanson
Global Director, Video Safety and Security,
Safe Cities and Venues, Internet of Things Group, Intel Corp.

EXECUTIVE SPONSORS
Rick Echevarria
VP, GM, Enterprise Solution Sales at Intel

Bill Baver
Vice President | NTT SMART World

RESEARCH CONSULTANTS
Bridge Partners
Harbor Research
Markets and Markets
ABI Research

"With world-class technology and innovation, NTT has helped take the INDYCAR SERIES to the next level, growing the popularity of the sport and connecting with a new generation of fans."

Roger Penske
Founder and Chairman, Penske Corporation

"Whether the goal is helping to keep fans safe, reducing congestion or generating revenue opportunities, sporting events around the world are meeting today's challenges with smart venue technologies and solutions that enrich the fan experience while empowering facility owners and operators with key insights to help improve performance."

Kasia Hanson
Global Director, Video Safety and Security

Overview

People have enjoyed racing as a spectator sport since the days of ancient Greece, birthplace of the marathon. A chariot race is featured in Homer's Iliad. Over time, racing evolved to include animals other than humans: camels, dogs, pigeons, pigs, turtles, even snails. Then along came the Industrial Revolution and racing expanded again to include vehicles such as aircraft, boats, and motorcycles… but nothing drew a larger crowd than auto racing.

In 2016, 350,000 fans attended the 100 Year Anniversary of the Indy 500 at Indianapolis Motor Speedway, making it the largest crowd to watch a sporting event in history.[1] In 2015, 263,500 racing enthusiasts attended a motorsport race at Le Mans, France, good for third-highest attendance all-time.[2] Six of the ten largest crowds in sports history are for motorsport events.[3]

But even motorsport events have struggled in the era of COVID-19. Because of health and safety protocols, the 2020 Indy 500 took place with zero fans in attendance. In 2021, following the proper health and safety precautions, the event safely brought 135,000 fans back to the track, properly distanced at 40% capacity.[4] Technology from NTT and Intel enabled the safe return of fans every step of the way with solutions and services that increased public safety and improved the fan experience, bringing the race to life for those in attendance, as well as the millions of online fans following around the world.

The key to this enhanced fan experience is NTT Smart Solutions. The secure, distributed platform captures data via sensors in designated areas through video and sound. The platform also integrates historical data sources, such as traffic, weather, and social media to leverage cognitive analytics. Dynamic visual environments, exciting data-led content, and storylines enabled by machine learning and AI bring the race to life for fans on-site and online.

NTT Smart Solutions is an innovative data analytics solution that processes data from any device and delivers insights and predictions that venue owners and operators can utilize to help increase public safety and situational awareness at large events. These insights also inform better business decisions when it comes to generating revenue streams and maintaining sustainable business practices. NTT Smart Solutions are helping venues become safer, greener, and more intelligent as the fan experience continues to evolve beyond the bleachers.

Adapting to change has been a constant for organizations, big and small, but emerging from a once-in-a-lifetime pandemic and adjusting to a new, post-pandemic normal have proven to be especially trying for sports organizations. The sports industry has been severely impacted by the pandemic, having resulted in significant revenue losses, the need for cost containment strategies, the loss of key talent, as well as the unanticipated acceleration of digital trends already in motion. The result has been a dynamic shift in how sports organizations execute their digital and business strategies.

This eBook is intended to provide insight into how stadium owners and operators can transition from reactive to proactive measures to create smarter venues with off-the-shelf hardware and open-standards-based solutions that simplify integration and help lower long-term costs. NTT and Intel technologies can help leaders solve the challenges they face today and become stronger and more resilient in the future, improving public safety while engaging fans in new and exciting ways.

Introducing NTT Smart Solutions

An Innovative data analytics solution that processes data from any device and delivers insights and predictions. Although the platform has re-usable components, clients buy the use cases they need. For example:

CITY/CAMPUS

USE ANALYTICS
Use of amenities e.g., parks, litter bins

UNSAFE DRIVING
Road incident Response and prevention

TRANSPORTATION OCCUPANCY
Adjust service and inform travelers

TRAFFIC PREDICTIONS
Traffic trends for better planning and mobility

PUBLIC SAFETY
Unsafe situations, incident response and prevention

CROWD MONITORING
Situational awareness for planning purposes

MANUFACTURING

WORKER SAFETY MONITORING
Ensure correct PPE and no trespassing of yellow lines

HEALTHCARE

PATIENT OBSERVATION
Detect patients leaving their beds when It's unsafe to do so or asking for help

EVENTS/VENUES

OCCUPANCY AND CROWD MONITORING
Regulate spectator flows

FAN EXPERIENCE
Personalized viewing and accurate sports statistics

BUILDINGS

PEOPLE FLOWS
Energy efficiency and safety

HEALTH CHECKS
Non-intrusive temperature check

THE CLOSED LOOP

Real-time feedback can be used to alert the right personnel and influence the situation on the ground, e.g., pre-recorded audio announcements

PREDICTIVE INSIGHT

The system can deliver predictions to allow better decisions and prevent incidents

Benefits

Venues around the world are upgrading their operations to incorporate connected and intelligent technologies. Comprehensive video monitoring powered by high-capacity computing helps stakeholders realize several benefits to security and operations by adopting smart features and connectivity.

Enhanced Situational Awareness

NTT Smart Solutions provide reactive and predictive analytics to help organizations achieve situational awareness related to any confined structure or area, enabling customers to ingest data from multiple sources and glean valuable insights. Organizations can identify potential dangers and protect citizens and economic well-being with sensors that monitor the conditions within a local environment. Machine learning (ML) forms a distributed monitoring system for the venue, protecting citizens from potential dangers, operational failures, and malfunctions.

Improved responsiveness

Faster, more effective emergency response becomes possible via autonomous and intelligent infrastructure. For example, seismometers for early detection of natural events such as earthquakes and tsunamis can broadcast alerts to command centers, dispatching emergency services where needed. Additionally, optical sensors can be equipped with analytics that detect severe precipitation and/or the occurrence of rising water levels for early detection of flood conditions. Network-connected audio solutions offer low-latency delivery of warning, while community kiosks and digital signage are updated with critical instructions and information.

Public Safety

Venues can leverage digital security and monitoring solutions that transform operations, provide key insights, and enable new use cases. Organizations can enhance safety at events and other large gatherings by understanding when, how, and why crowds form. Considerations include crowd density, queue waiting times for public toilets, concessions usage, and more. This allows for the provision of needed security in crowded areas for requirements such as directing pedestrian traffic, as well as operational improvements such as automated dispatch of cleaning services based on number of people through a particular area.

Use Cases

INDYCAR

Using data to enhance the on-site and off-site fan experience.

The partnership between INDYCAR and NTT has created the NTT INDYCAR SERIES, one of the greatest series in all motorsports, which includes the iconic Indianapolis Motor Speedway and other venues. To bring in a new wave of advanced analytics in sports, they called upon NTT Smart Solutions.

NTT Smart Solutions faced a double challenge: offering an enhanced and revolutionary fan experience while simultaneously improving safety and security during the races. Thanks to AI and predictive analytics, NTT Smart Solutions transformed how sports organizations plan, compete, and make decisions in the digital world.

NTT continued its multi-tiered partnership with INDYCAR, signing a multi-year extension as the entitlement sponsor of the NTT INDYCAR SERIES. In doing so, NTT continued to deliver the smart technology backbone that enhanced the race experience for INDYCAR fans attending the 105th Running of the Indianapolis 500—and from wherever else they may have watched.

NTT remains committed to accelerating the future of smart communities and has developed an enhanced digital experience powered by real-time, data-driven insights, analytics, and machine learning that will enable race fans to enjoy the "The Greatest Spectacle in Racing" like never before across multiple channels and environments.

NTT Smart Solutions rely heavily on Intel software and hardware, including edge compute solutions and servers using Intel® Xeon® Scalable Processors, many of which were installed at the Indianapolis Motor Speedway. New features and enhancements this year include:

NTT Smart Venue. AI-enabled optical detection technologies, combined with real-time entry gate flow rate data, give the IMS operations and security teams better visibility into current and possible scenarios, enabling them to see a bigger, more real-time picture of the venue that includes visitor and vehicle traffic flow and congestion, social distancing, etc. These enhancements will allow the event teams to optimize their resources in real time with faster, more data-driven decision making to focus their resources on areas where race attendees can benefit the most. At-gate IMS personnel also now have mobile POS capabilities at their

"There are thousands of data points that come off the cars. We've been able to create platforms so venues can take that data and make real-time decisions with it."

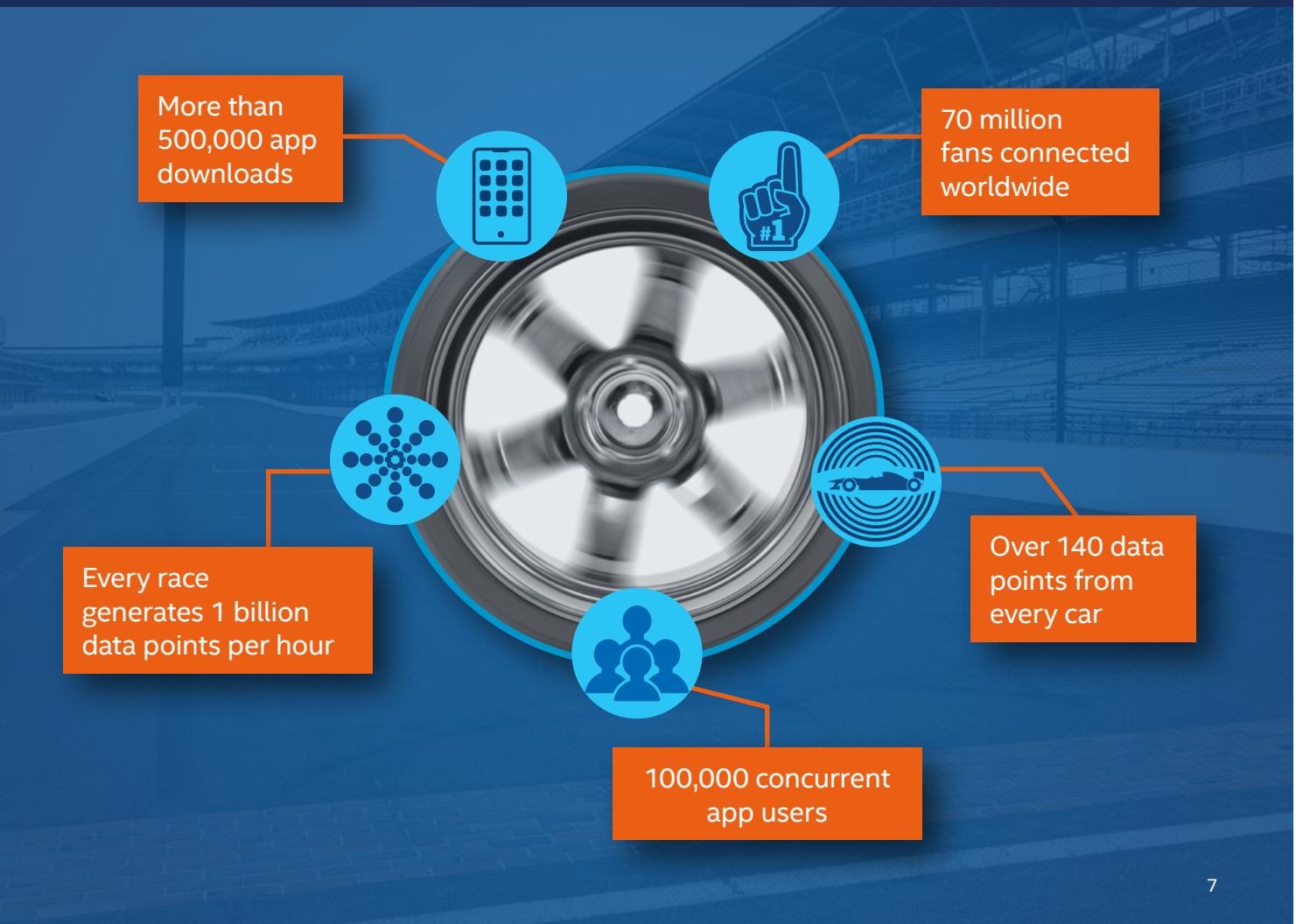
Jonathan Gibson, EVP for Marketing and Business Development for Penske Corporation

fingertips for digital ticketing and parking transactions. All help manage the event venue more safely and efficiently, providing a more positive and consistent experience for attendees at the world's largest sports venue, the Indianapolis Motor Speedway.

INDYCAR Data Experience. Powered by NTT, fans can now engage with more race and driver data than ever before via multiple channels, including the INDYCAR Mobile App, the IMS Media Wall (a 100-foot wide, high-resolution LED data display on Pagoda Tower) and more as they engage with real-time, data-driven racing insights powered by NTT. The multiple track views stay up to date with real-time leaderboards and provide access to more exciting, easily shareable data and stats coming from more than 140 different data points from each car and the track itself. Among other events highlighted by the data experience will be a live race view of all competitors, biggest movers, featured head-to-head battles, race team and pit stop performance impact, as well as highlighted race events such as the green flag, yellow flags, and the checkered flag.

INDYCAR Mobile App. Fans can now enjoy an enhanced user experience and virtually ride along with their favorite driver athletes and teams as they tear down the course at 200+ mph. With additional live, in-car cameras and new video feeds, users can see up to five drivers from a first-person perspective. In addition, fans this year will also get to enjoy live streaming and a more integrated INDYCAR Fantasy League and e-commerce experience. Global usage of the mobile app continues to expand, with usage during live racing events continuing to grow. The free app is available for year-round use around the world via download from the iOS App Store or Google Play.

Success Metrics



Tour de France

Turning the roads into a connected stadium

NTT created and implemented a reliable and accurate rider tracking system by collecting data from sensors on each of the rider's bikes and processing the data in the cloud.

184 riders start the Tour de France each year. That's 184 individuals in different positions, going at different speeds across the course, with differing skillsets and levels of fitness, with different equipment, and with different motivations and plans each day. Charting and explaining what is happening at any given point is difficult enough, let alone explaining what might be about to happen. There is rarely a self-contained venue in play. Races cover thousands of miles, outdoors and in inhospitable terrain.

Conditions are changeable; the weather isn't constant; road surfaces get damaged; mountain finishes get dangerous; and last-minute route changes sometimes must be made, with every decision having ramifications elsewhere across the ecosystem.

The initial objective was to create and implement a reliable and accurate rider tracking system so that the Tour—its participants and television viewers—no longer had to rely on inaccurate and selective location and time measurements to track where riders were in the race. Packets of rider data, including speed, longitude and latitude GPS signals, traveled through a moving mesh-network via sub-gigahertz shortwave radio to the broadcast motorbikes or circling plane. Data would then be multiplexed with the video feed and sent to the Big Data Truck at the finish line of each stage. From this point, NTT would process the data in the cloud with its own analytics engine before sending out real-time live speed and location data for all the riders to ASO's portfolio of broadcasters and digital channels via an API. With NTT now responsible for maintaining the network, the process, the various applications, and the security of it all, the Tour de France had entered a new information era.

At the Arrival and Departure villages, the NTT Media Wall provided an integrated big screen experience. Leveraging the NTT data analytics solution fans can followed the race live, viewing live footage accompanied by data-driven insights, creating a compelling live experience.

Alongside fan-focused innovations for 2021, NTT created a digital twin of the Tour de France to enable A.S.O. to digitally transform race operations. Leveraging a digital fabric of sensors, edge computing devices, networking technologies, and applications, the digital twin is an accurate model of the entire 3,400km of the race route as well as all other areas associated with the race. This allows

the race organizers to plan their operations on an accurate model, mapping specific areas and key locations. On race day they can track the race and all race vehicles in real time. This enables them to direct race operations with access to real-time data, providing them with full visibility of the entire race.

As the Tour passed through some of the most remote and rugged terrain in France, a challenge that they faced was providing race officials with access to real-time data and broadcast footage. Leveraging edge computing, NTT was able to provide critical information and visuals to the race vehicles, enabling them to have full visibility of the race even in areas where traditional networks can't provide coverage.

"Based on locations coming from the sensors, we can calculate a gradient, we can calculate relative wind direction and speed, we can cluster riders into groups so that we create a simplified picture of the race. We can calculate time gaps. The goal from the start was in being able to attract and retain younger, more digital-savvy fans. So, we went from quite a basic digital presence in 2015 to, now, a rich digital and social media capability – really being able to tell the Tour de France story in so many ways on so many different platforms to so many different audiences."

Peter Gray, SVP of NTT's Advanced Technology Group

Over three weeks, NTT turned the roads of France into the world's largest connected stadium, creating a revolutionary fan experience for those lining the route as well as fans across the world. The augmented reality application provided fans with a real-time view of the progress of the race on their mobile devices, integrating a 3D map with data insights and the ability to track individual riders at every stage.

- **Race Center.** The official live tracking site that provides race updates including rider live tracking data on letour.fr and on the official Tour de France Mobile application.
- **LeTourData.** Data-driven insights and AI predictions on twitter, Instagram and TV broadcast.
- **3D Tracker.** An immersive augmented reality app that provides 3D views of the stages.
- **Tour de France Fantasy by Tissot.** A fantasy sports game integrating data insights and machine learning (NTT predictor) to provide insights on the riders to watch.
- **NTT Media Wall.** A rich media display at the race villages featuring data insights and visualizations from LeTourData, and live race updates.

2020 Tokyo Olympics

Bringing fans closer to the sailing experience

In cooperation with Intel Corporation, NTT helped spectators at the Tokyo 2020 Olympic Sailing Competition get closer to the action with 12K resolution video that leveraged 5G technology.

NTT and Intel constructed a 164-foot floating screen that became a prevalent feature throughout the duration of the Competition and gave spectators the sensation of the racing being held right in front of their eyes. A similar broadcast was provided simultaneously at the Big Sight in Tokyo, the location of the Main Press Centre, providing the media with a more realistic viewing experience, as well.

In addition to improving the experience for spectators, athletes, and staff at the competition venue, this initiative was also able to provide a sense of safety and security in the midst of a global pandemic.

Source: World Sailing | Tokyo 2020 Olympics Games - Sailing Competition to benefit from Tokyo 2020 5G innovation

NTT and Intel

NTT

NTT believes in resolving social issues through its business operations by applying technology for good. NTT helps clients accelerate growth and innovate for current and new business models. Its services include digital business consulting, technology and managed services for cybersecurity, applications, workplace, cloud, data center and networks, all supported by a deep industry expertise and innovation. As a top 5 global technology and business solutions provider, NTT's diverse teams operate in 80+ countries and regions and deliver services to over 190 of them. NTT serves over 80% of Fortune Global 100 companies and thousands of other clients and communities around the world. For more information on NTT, visit www.global.ntt.

NTT's solutions, capabilities, best practices, and industry experience help customers transform across multiple industries. NTT's smart venue strategy is informed by these broader firm capabilities and is centered on three key pillars which are foundational to the business and digital transformation needs of venue owners and sports organizations:

- **Fan Engagement.** Solutions and services that bring sports fans closer to their heroes and to the live action—whether from home, online, or on-site.
- **Business Transformation.** Technology and infrastructure services and solutions to transform how sports organizations plan, operate events, make decisions, compete in the digital world, and ultimately identify and unlock fresh revenue streams.
- **Data and Intelligence.** Advanced analytics, robotics, AI and ML technologies that generate deep insights to drive business outcomes including enhanced fan engagement and experience, venue operations, athlete performance, sports strategy, tactics, and decision-making.

IIFX

The Innovation Institute for Fan Experience

(IIFX) is an unrivaled network of subject matter experts, thought leaders, technologists, futurists, and business leaders committed to overcoming challenges and providing a safer, more secure fan experience at sports and entertainment venues. With offices in the US, UK, and Canada, IIFX is quickly becoming the leading global authority on fan experience, delivering measurable revenue growth and maximized health, safety, and security through best practices, innovative technology solutions, and high-quality services.

For more info, visit IIFX.

NTT Solutions

Capabilities that evolve digital transformation

NTT partners with organizations across the globe to shape and achieve outcomes through intelligent technology solutions. Data-driven business decisions and enhanced customer experiences help companies big and small stay relevant, competitive, and innovative. NTT helps transform legacy infrastructures into integrated platforms for digital business, while facilitating modern work styles and providing powerful security against cyberthreats.

A more personalized customer experience

NTT delivers value for customers, employees and organization at every touchpoint, creating differentiated, intuitive, personalized, and hyper-automated experiences. NTT's advisory, consulting, managed, and outsourced services help reach more customers through accelerated acquisition, effortless consumption and brand promotion.

Reimagining the employee experience

The shift to remote and hybrid workstyles has forced a rethink of the workplace—where it is, what it looks like and, most importantly, who it's for. To attract and retain the best talent and ensure long-term success, organizations are accelerating their strategies that support workplace wellness, digital adoption, and the creation of physical spaces that promote activity-based working. NTT solutions help create a journey designed by workstyles to transform and optimize the employee experience.

Unlocking the digital experience

Digital evolution doesn't start with technology. It's about finding smarter ways of doing business in order to stay relevant, competitive and continuously innovate. NTT creates more value for businesses by accelerating business transformation and unlocking the potential of customer and employee experience, data and analytics, and multicloud application environments.

Driving cloud transformation

In today's fast-moving business environment, organizations are using cloud to enable their transformation into digital businesses. NTT helps advance these transformations with a portfolio of secure-by-design cloud solutions. NTT brings proven methodologies to plan, design, migrate, secure, operate and optimize the infrastructure that runs critical business applications to enhance agility and efficiency, and realize the potential of cloud for the entire organization.

Digitally transforming cybersecurity

As the threat and risk landscape shifts, cybersecurity leaders need to be confident their cybersecurity strategy, approach and posture will keep their business secure and compliant. NTT enables these digital journeys with intelligence-driven security by helping companies understand, manage and address cyber risks in real time across an increasingly hybrid IT environment.

Building the foundation for network modernization

NTT advances agility, transformation and automation for businesses through intelligent and secure network fabric. NTT networking services are secure by design, efficiently supporting and managing the most demanding, software-defined, high-performance hybrid environments.

Intel Technologies

NTT Smart Solutions rely on Intel software (Intel® Distribution of OpenVINO for deep learning inference) hardware, particularly Intel® Xeon® based servers and edge compute solutions. In some deployments Intel® NUC® (Mini PCs and Kits) are used to monitor occupancy and perform analytics that are then extracted by the NTT Customer Core, also running on Intel® processors.

Visionary stadium owners can simplify the path to safer, more efficient, and connected venues with an end-to-end solution based on Intel® technology. Intel powers every segment of the smart, connected world, from the device to the network to the cloud. Intel technologies and the vast set of ecosystem partners and solutions create a more vibrant, extensible, and sustainable way for venues to implement intelligent strategies. Additionally, Intel helps protect connected systems from the inside out with a foundation of security technologies designed to protect the entire device stack against a wide range of attacks.

Smart venues require high capacity, high reliability, and low latency, with some applications requiring greater levels of privacy when storing data locally. In addition, various services will require more compute and intelligence closer to the endpoint devices that are both generating and consuming data at the edge. Hence industry leaders are looking at both increasing the network's capacity and placing more compute and real-time analytics closer to the edge, where the data is collected and consumed. Moreover, there is a strong demand for efficient hardware accelerators to support AI solutions in an energy-efficient and real-time manner.

Edge Compute

Enhanced for IoT use cases, Intel processors come in a range of options for compute performance and power consumption, enabling the latest audio and visual quality for intelligent cameras and sensors. Intel offers a wide array of options for edge computing, including high-performance Intel® Core™ processors, and Intel® Xeon® Scalable processors. Intel® Xeon® Scalable processors are optimized specifically to run high-performance deep learning inference.

Learn more about edge computing.

Intel® Vision Products

With Intel® Vision Products, a portfolio of acceleration tools designed specifically for AI at the edge, venue owners can take advantage of near real-time information to help make better decisions in a timely manner. Intel® technologies enable innovative AI models and computer vision solutions that are high performance, low power, and easy to scale.

From smart cameras built on Intel® silicon, to edge compute devices (e.g., Network Video Recorders, gateways, video analytics appliances, etc.) powered by Intel® acceleration silicon, to the cloud—where training and analytics can run—Intel offers the industry's broadest portfolio of assets to cover Artificial Intelligence use cases from the camera to the cloud:

- Intel® Xeon® scalable processors: powerfully designed to handle the broadest range of AI workloads including vision and deep learning.
- Intel® FPGA: real-time, programmable acceleration for deep learning inference workloads.
- Intel® Movidius™ Myriad™ VPU: cutting edge solutions for deploying on-device neural networks and computer vision applications at ultra-low power.
- Intel® Vision Accelerator Design products: to meet the demands of computer vision applications at the Edge and to enable solution providers and their customers to take advantage of a wide spectrum of video analytics-based use cases. Based on Intel® Movidius™ VPUs and Intel® Arria® 10 FPGAs, the Intel® Vision Accelerator Design products provide powerful deep neural network inference for fast, accurate video analytics.

Intel® Distribution of OpenVINO™ Toolkit

The Intel® Distribution of OpenVINO™ Toolkit is a comprehensive toolkit for quickly developing multiplatform applications and solutions that emulate human vision. Based on Convolutional Neural Networks (CNNs), the toolkit extends Computer Vision workloads across Intel® hardware, maximizing performance. Venues can accelerate and deploy CNNs on Intel platforms with the Intel® Deep Learning Deployment Toolkit that's available in the OpenVINO™ toolkit and as a stand-alone download. Together with the new Intel® DevCloud for the Edge, OpenVINO addresses a key pain point for developers — allowing them to try, prototype and test AI solutions on a broad range of Intel processors before they buy hardware.

Connectivity

Intel-powered solutions help venue owners and operators simplify networking complexity and take advantage of edge-to-cloud computing. Intel-based edge computing nodes and MEC edge servers leverage the power of 5G with the help of Converged Edge Reference Architecture (CERA) to improve real-time data at the edge while also advancing connectivity and transmission to and from wireless networks. The key wireless connectivity technologies are cellular and Wi-Fi. In cellular, the options are side link (C-V2X, NR V2X) and direct link (UU).

Service Orchestration & Security

Keeping ITS software up to date is simplified with time-saving tools like remote device management and automated software deployment to devices at the edge. Intel processors feature multiple hardware-based security measures that help protect public and private data. Intel hardware includes chain of trust technologies for platform integrity: trusted execution environments that isolate applications. Dedicated cryptographic accelerators handle complex security calculations without taxing system resources.

Technologies that used to be separate are converging into unified systems that provide more insight to drive efficiency. Intel hardware and software have the performance and flexibility venue operators city leaders need to manage ever-growing demands and workloads.

Developer Tools

Intel® software package makes it simple to optimize edge solutions, including computer vision and deep learning applications for Intel® architecture. You can experiment, test, and create using the IoT Developer Program. Choose your architecture type, and then select from Intel, third-party, or open-source software. Whether building from scratch or customizing a ready-made reference implementation, we offer helpful resources to accelerate your development.

Learn more about the IoT Developer Program.

Getting Started

NTT and Intel® believe organizational leaders can successfully transform their venues by establishing clear priorities, encouraging active stakeholder participation, and ensuring methodical technology infrastructure planning.

NTT and Intel® are dedicated to helping you achieve your public safety goals. Our companies will partner with you to explore, evaluate, and implement Smart Venue solutions. Your journey can begin with small steps, such as a free assessment to evaluate your current state and pinpoint your most critical needs.

Learn more about NTT solutions powered by Intel technology by contacting us today:

NTT Sales: acceleratesmart@global.ntt

Intel Sales: Will Stewart, US Partner Sales, will.stewart@intel.com

Endnotes
1 IndyStar 350,000 fans for 100 year anniversary of Indy 500 2016
2 CNET 263,500 fans for Le Mans 2015 2015
3 Wikipedia List of sporting venues with a highest attendance of 100,000 or more 2021
4 Forbes 135,000 Fans Gather At Indy 500, World's Largest Sports Event During Pandemic 2021

*3rd-party technology, not Intel trademark

October 2021

Think big

Assess all the ways technology can facilitate meaningful change

Start small

Get going with projects and opportunities

Move fast

Learn, adjust, iterate

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