WHITEPAPER:

Next-Gen Edge Camera Platforms Drive Traffic Control Solutions Forward

Smart Cities Confront Rapid Urbanization

Growing Smart Cities are learning to harness next-gen edge camera platforms for their modular hardware and software characteristics. The benefits are seen in critical Smart City systems like in Smart Traffic Management, which gives city managers and urban developers deep visibility into traffic and its patterns over a wide range of use cases that impact everyday lives.

Traffic congestion impacts all aspects of cities in more ways than most people think. Drivers have daily commutes. Chicago drivers lose 155 hours a year to traffic, nearly an entire straight week.[1] Truckers move goods and services to households and businesses. Traffic congestion clogs up deliveries and can add 20-250% to costs.[2] First responders are impacted. Traffic can delay fire trucks, EMS, and other first responders from getting to people in distress while increasing the average monetary damage at the emergency.[3] And the externalities don't stop, traffic congestion can make regional economics more expensive. Even just a 4.5 minute delay one-way begins to slow job growth.[4] And the urbanization causing these circumstances is expected to increase.

By 2050, urban areas will absorb 70% of the growing global population (city dwellers surpassed non-city dwellers in 2010). Increasing population density will continue to add pressure to the top urbanization challenges: lack of infrastructure to serve citizens, and the environmental issues that will ensue following population increase. In parallel, the necessity of more transportation will continue to contribute more to global pollution, increase risk in public road safety, and further pressure businesses and economies. These are forecasts that urban developers must consider, and ones that, over the last few decades, Smart City planners have been building solutions for.

Smart City Ecosystems

The idea of Smart Cities met its first major milestone as Amsterdam's 1994 Digital Cities project—they provided freenet, freely available internet that grabbed over 100K users in the first months.[5] This was the era of modems, not 5G or even WiFi, and it was considered the first online community. Interest was so high that modem supplies ran out. It is an ideal illustration of the principles of Smart Cities because the technology today that defines Smart Cities, like IoT sensors, Cloud computing, and AI, weren't around to overshadow them.

Smart Cities aim at improving the lives of people in urban areas, so it begins with the citizens, their productivity, and their community as first principles. These principles encompass quality of life, government efficiency, health and wellness, economic development, sustainability, public safety, and citizen mobility. Smart Cities are also defined by how they achieve these principles. The overarching idea

---

[1] inrix.com/scorecard/
[2] ops.fhwa.dot.gov/congestion_report/chapter2.htm
[3] www.lpbeland.com/uploads/7/8/7/5/7875420/trafficfires_.pdf
[4] www.jstor.org/stable/26145853
[5] waag.org/en/project/digital-city-dds/

is to engage citizens, solicit feedback about issues, and use technology to overcome the traditional barriers to community involvement, just as Amsterdam's project demonstrated how the internet can overcome the counter-intuitive isolation caused by growing communities. It also demonstrated that people really desire community. It's what people have been doing forever.

What Smart Cities bring to the mix is governance efficiency and effectiveness. A smart city is a governance system of several urban management systems. It's an amalgamation of systems that have grown integrated over time, a big system of systems. And for each city, it's a different mix. Some cities like Los Angeles approach their traffic monitoring by deploying tens of thousands of cameras, whereas Manila, with its own unique set of traffic challenges, decides to partner with ride-share services to access anonymized traffic data from connected devices. Today, these methods and more are deployed in the most advanced Smart Cities and blend multiple data sources together to offer the most complete real-time version possible.

"Smart" connotes some machine intelligence, and today that usually means data gathering, some sort of processing, and then a course of action. Generally, this means that Smart Cities are crafting policies, deploying technology, and devising channels for change. Citizen engagement is key, but because of technology, that feedback does not need to be intrusive, IoT sensors can passively collect data on citizen behaviors. Policies can help to protect data privacy—as it stands, many municipalities do not yet share their data despite its huge potential as a lucrative revenue stream. (Although, there are private companies who mirror municipality sensors with their own, collecting and selling the same data.)

Smart City systems are complex, and getting around to the most impactful initiatives is top priority. Improving any of these "city created services" will have significant cross-cutting impacts: energy management, waste management, parking, lighting, and traffic.

Intelligent Traffic Systems: Cross-cutting, High-impact, Priority

City officials recognize that addressing traffic congestion will help to alleviate many cross-cutting negative impacts. These include physical impacts (accidents, pollution, fuel consumption), time and costs (lost opportunities, lost productivity, government investment), and community impacts (increased stress levels, public health vectors). The idea is simple: by understanding traffic in real-time and responding with appropriate resources, traffic congestion can be reduced or controlled and managed more effectively and efficiently. More so, real-time data helps urban planners to anticipate traffic bottlenecks and avoid them in their future designs.

Smart Cities therefore turn to Intelligent Traffic Systems (ITS) which are used to gather real-time data and optimize traffic controls. They have expanded the city's assortment of low-tech measuring devices and traditional methods for managing traffic congestion, with data-centric edge camera platforms that uses AI and ML to break down and optimize traffic patterns.

Traffic pattern insights help city managers to:

1. **Reduce traffic congestion by optimizing traffic routes and times;**
2. **Reduce traffic congestion by optimizing commuter demand for parking, and parking inventory (people searching for parking increase congestion up to 30%);**
3. **Inform mass transit planning (metros, rail, buses);**
4. **Inform urban development zoning and planning.**

ITS has been so insightful, cities like Los Angeles, which plan to increase their intersection controllers by 1,500 units, are banking on future innovations to help them overcome their traffic problems.[6] The

[6] www.govtech.com/fs/los-angeles-to-install-intelligent-traffic-signal-controllers-in-hopes-of-improving-safety.html

greatest innovation would be a universal orchestration of data partners within a Smart City ecosystem, one that marries digital infrastructure with an integrated transport system, enabling maximum visibility and traffic control. Imagine data from every connected car, bike, scooter, share-driver, traffic signal, speed sensor, radar device, municipal vehicle, traffic camera, all feeding a digital infrastructure that overcomes siloed data and truly moves the needle on congestion and emissions.

To begin a fully integrated journey, ITS must not only perform basic functionality, they need to be future-proofed. Next-gen platforms need to provide a single modular edge platform that can support a number of challenging use cases, all while satisfying the current and future needs with a secure and stable operating system for at least a 10 year lifespan. Understandably too, it's expensive to install these systems, the list of use cases are growing, and municipalities want to ensure return on investment.

Next-Gen Edge Camera Platforms

From a technical standpoint, Smart Cities are like massive IoT networks. ITS draw from multiple sensor subsystems, accessing intelligent infrastructure and connected vehicle data. Conceptually, these subsystems feed into a larger central system that stores and analyzes data. However, in practice, urban dynamics are too intense to be adequately monitored by a centralized system while providing real-time responses. These are the exact circumstances that next-gen edge camera platforms are designed to help overcome.

Edge Camera Platform Advantage

Edge camera platforms overcome two challenges that hinder older non-modular traffic control systems from scaling with urban growth—latency and sensor drawbacks.

Systemic Latency: Edge machine vision systems address the challenges of sending large volumes of image data to central systems for processing by conducting image processing near the camera itself.

One critical scenario that requires speed is checking license plates against a watch list. Automated License Plate Recognition (ALPR) applies Optical Character Recognition (OCR) to captured license plate images to identify plates included in a hot list of vehicles. The processing takes place near the sensor device, such as a nearby control box, at "the edge of the network," enabling real-time identification to alert authorities instantaneously.**Vision Sensor Drawbacks:** Video, infrared (IR) cameras, and radar are the primary machine vision sensors used in ITS, each with its strengths and drawbacks. Video is limited by occlusion, bad weather, low road-vehicle contrast, and challenging lighting conditions but can be easily understood by humans. Thermal cameras (IR) are limited by thermal shadows, hot weather, and low temperature contrasts between the vehicle and roadway; however, they can penetrate inclement weather. Radar is also becoming a prominent sensor type due to its ability to overcome many weather conditions that hinder other sensors, but it has limitations due to its narrow field of view.

Next-gen edge camera platforms, such as the JADAK Allegro platform, are sensor agnostic. They are capable of accommodating video/AI-based sensors (supporting a suite of AI algorithms), tracking radar sensors, LIDAR sensors, or combinations thereof without the need for redesign. Additionally, modular units benefit from economies of scale, while their low cost facilitates adoption.

Use Cases and Deployment Types

Overcoming these challenges has opened a slew of possible use cases and deployment types. Edge cameras are being deployed on side-fire trucks, over-the-lane positions, bridge mounted, mobile vans, mobile trailers, tripods, and rotatable mounts. In these positions, they easily support the following traffic monitoring and enforcement use cases:

1. **Traffic Statistics**
2. **Red-Light Cameras**
3. **Spot Speed Cameras**
4. **Average Speed Monitoring**
5. **Automatic License Plate Recognition (ALPR) / Automatic Number Plate Recognition (ANPR)**
6. **Bus Lane**
7. **Stop Sign**
8. **Yellow Box/Bock The Box**
9. **Distracted Driver**
10. **Close Follow**
11. **Red X**

More use cases means more data points too. Edge camera platforms play a key role in Smart City traffic data collection which benefits the future of Smart Cities through a positive data network efficiency. Or, as more cameras record more traffic data, more found patterns lead to better insights to optimize traffic away from congestion, and help enforce laws that improve public safety. While the future is unknown, the general trend will be more data sharing and integration as edge computing continues to crop up in areas where data analysis can be used to keep people safe and improve their quality of life.

Next-Gen Edge Camera Platform Specifications

- **Next-gen edge camera platforms need to satisfy infrastructure, data, evidence, compliance, and weather requirements, including:**
- **One or multiple AI based object and event detection and recognition algorithms for the target use cases**
- **Integrated computers with CPU and GPU**
- **Modular and support multiple cameras with various resolutions**
- **Optional IR LED (inline), Visible LED (inline or offset), Xenon (offset)**
- **Detecting and recording bi-directionally across multiple lanes of traffic**
- **Capturing clear image and video evidence under all lighting conditions and weather variables**
- **Supporting 24x7 operation**
- **Automatically identifying object or events of interest in the monitored lanes and capture an evidence package upon detection**
- **Include all the image, video and metadata required for the specific use case(s)**
- **Allowing for clear recognition of the vehicle license plate, plate state, make/model/color, and additional data elements**
- **Complying with the high-performance requirements such as over 98% detection and ANPR rates and fast set-up times**

Specialized Engineering Capabilities Streamline the Development of Edge Computing for ITS

Many Smart City ITS system manufacturers require edge computing applications, but the burden of customized engineering can add a unwanted learning curve that many are challenged to take on internally. Partnerships with experienced engineering teams like those at JADAK that are domain experts in vision-based AI devices, easily can overcome these adoption hurdles. JADAK has been a leader in machine learning for over two decades, improving accuracy, reducing errors and increasing speed with customized machine vision, RFID and barcode solutions.

Unlike off-the-shelf solution providers, JADAK takes an engineer-to-engineer approach to their customers' challenges—working directly with them to get a deep understanding of the challenge and use cases, then creating purpose-driven application solutions that are a precise fit. Solutions that optimize performance and budgets while raising efficiencies. But, of course, that's just half the challenge. They also provide sub-system support—hardware, system, firmware, software, and workflow consulting to ensure that the solution is deployed and integrated in a way that maximizes long-term effectiveness and ROI.

About JADAK

JADAK, a business unit of Novanta, is a market leader in machine vision, RFID, barcode, printing, and color and light measurement products and services for original equipment manufacturers. The business designs and manufactures custom embedded detection and analysis solutions that help customers solve unique inspection, tracking, scanning and documenting challenges. JADAK is based in Syracuse, New York, with sales and technical locations across the globe. For more information, visit www.jadaktech.com.

About Novanta

Novanta is a trusted technology partner to OEMs in the medical and advanced industrial technology markets, with deep proprietary expertise in photonics, vision and precision motion technologies. For more information, visit www.novanta.com.