



Nokia IMPACT IoT Platform

Smart City Applications

Application note

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Enabling smart, safe and sustainable cities

To connect the various disparate segments of the Internet of Things (IoT) ecosystem and improve outcomes, cities need to adopt a horizontal platform that is capable of handling everything – from device management and data collection, to event processing and end-to-end security – while allowing for the delivery of applications that respond to a city's unique needs.

The Nokia IMPACT IoT Platform addresses a fragmented and complex IoT ecosystem comprised of disparate applications and devices. Its common, horizontal platform provides services for all IoT applications and verticals. This simplifies and accelerates the deployment of high quality IoT services, streamlines services and creates a foundation for strategic expansion.

Smart cities are gaining traction around the globe

Thriving urban areas are among the most coveted places to call home, thanks to their energy, culture and innovation. In 2014, more than half of the world's population (54 percent) was living in a city. By 2050, it is predicted that this will increase to two-thirds.¹

As appealing as metropolitan living may be, cities are far from perfect. Very real problems exist and, if cities fail to adequately address them, they have the potential to deter new businesses and residents from moving in.

To improve the quality of life in urban areas, many cities are attempting to harness the power of the Internet of Things (IoT) to combat crime, increase efficiency, drive economic growth and improve accessibility. Some urban centers are already using information and communication technology (ICT) to assist in the achievement of these lofty goals.

Early experiences have taught that, to fully harness the power of the IoT, cities must be able to break down existing silos and combine massive quantities of data from multiple sources. For example, smart parking initiatives won't only impact traffic patterns – they'll also create efficiencies for the public transportation system. If this kind of holistic approach is adopted, cities can reap the benefits.

¹ United Nations, 2014 Revision of World Urbanization Prospects; <https://esa.un.org/unpd/wup/publications/files/wup2014-highlights.pdf>

In search of the killer app

According to ABI Research, only about 20 percent of the IoT value chain is in “connectivity”, with 77 percent of revenues characterized as “value-added services”, such as platform revenues, device management, device connectivity, cloud services, system integration, analytics, professional services and application development.²

The proliferation of endpoints is creating a whole range of opportunities for new applications. These endpoints constitute the foundation of sensor networks that enable monitoring and remote control of daily life objects in homes, offices, cities and cars.

Municipalities around the globe are already deploying a broad variety of innovative services and applications to streamline their own operations and to change the urban experience for city dwellers and visitors. Technology empowers cities to respond quickly to demographic and economic shifts.

The Nokia IMPACT IoT Platform is pre-integrated with a number of applications, including video analytics, smart parking and smart lighting.

Video Analytics

With thousands of cameras providing live feeds from across the city, networks and video processing centers can get bogged down watching irrelevant footage. Building larger teams of surveillance staff doesn't necessarily help. The fact is, traditional video recognition technology can't be practically applied in highly variable and complex online situations, like a live city environment with its train stations, bus shelters, airports and other public areas.

The Nokia IoT Video Analytics solution leverages machine learning, pattern recognition, and behavioral knowledge to anticipate what's relevant, based on the prescribed video surveillance task. This adaptive video anomaly detection spots unexpected changes in video images over time, identifies and predicts how subjects and phenomena evolve, and can intelligently shift cameras during critical observations.

Beyond enhancing situational awareness, the Nokia IoT Video Analytics solution can also prioritize streams for their anticipated relevance, automatically allocating network resources, based on dynamic application needs. The least relevant streams are cut off at the source ensuring network availability for the most critical ones.

Real-time monitoring and analytics

As the cost of video equipment continues to decline, many cities are blanketing urban areas with cameras – in an effort to enhance public safety, crowd control and traffic management.

² M2M and IoT Opportunities and Challenges in the End of 2014, ABI Research

With cameras streaming thousands of hours of video footage – using not only a lot of network bandwidth, but also a significant amount of server space – is anyone really looking at it?

Existing video analytics solutions have some drawbacks, including false positives. These are caused because real scenes – like what cameras located in cities produce – are too complex for traditional object recognition software. What is required is an intelligent platform that can proactively detect, select and track only relevant video streams for a variety of surveillance tasks.

The Nokia IoT Video Analytics solution, in effect, turns cameras into IoT sensors. The software derives abstract information vectors from each video feed (e.g., motion, direction, velocity, density, etc.), then uses machine learning technology – developed by Nokia’s Bell Labs – to analyze these vectors in real time, establishing patterns, identifying anomalies and generating alerts. As a result, only a fraction of the massive set of video streams needs to be handled, transmitted and stored.

The Nokia IoT Video Analytics solution is better in real life situations, where crowds of people and/or poor lighting limits visibility and where traditional rules-based solutions are inadequate. For example, a camera that is monitoring a highway could be programmed only to transmit a video feed when unusual activities occur, such as slow-moving (or stopped) traffic, the presence of a pedestrian, an accident, or a vehicle travelling in the wrong direction is detected. Another example could be a video feed from a public area, such as a street lined with shops. The Nokia IoT Video Analytics solution can detect anomalies caused by traffic accidents, speeding vehicles, wrong way traffic, or large public crowds.

Flexible deployment models

Existing cameras feed video footage into a gateway, which aggregates the data. The Nokia IoT Video Analytics solution supports cloud, edge and on-premises deployment models and can receive data using virtually any licensed and unlicensed wireless technology available, including 3G, 4G/LTE and Wi-Fi. This is advantageous when looking to establish a long-term relationship with a communications service provider (CSP), who might be reluctant to commit to the maintenance of an existing network using a specific technology.

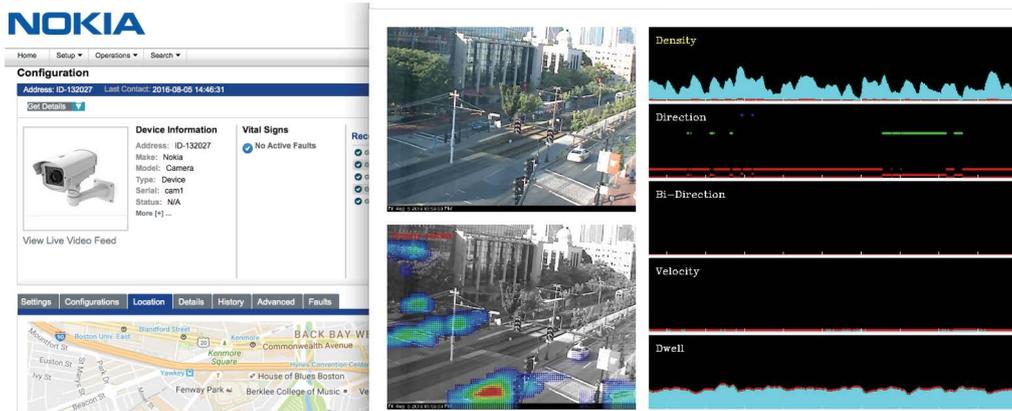
Using the Nokia IoT Video Analytics solution, in parallel with the Nokia IMPACT IoT Platform, your video monitoring solution is agnostic to video resolutions, camera brands and networking options.

The Nokia IoT Video Analytics solution includes these components:

- A management dashboard that displays various video feeds, as well as detailed maps, lists of alarms and more. Agents can easily access and share information with various departments, without the need for specialized knowledge

- Analytics functionality, with details on established patterns and trends, identified anomalies and alerts
- Integration with the Nokia IMPACT IoT Platform, which provides data collection and management, integration into existing wireless networks, and device management for parking space sensors (secure provisioning and communication).

Figure 1. Nokia IoT Video Analytics solution dashboard



Features

- Machine learning establishes baseline values, then generates alarms when anomalies are observed
- Scales from a single gateway connected to up to 100 cameras, to a centralized server cluster with support for up to 10,000 cameras
- Agents can click on camera icons and maps displayed in the management dashboard, drilling down to more detailed information, including the location of the camera, the type of alarm/alert being generated, etc.
- Analytics are extensible through plug-in integration with third-party analytics, such as Bosch IVA, Cogvis, Videmo, AgentVI and IPS (Axis ACAP)
- Cost-effective solution for integration with large, third-party video walls.

Benefits

- Wireless-connected cameras provide lower deployment costs and greater flexibility, even for temporary events
- Edge video analytics keeps cameras simple, reduces bandwidth in the network and optionally allows breaking out traffic to local control rooms
- Analytics software supports different use cases and can be easily adapted to different customer needs

- Differentiated solution that leverages existing network investments
- Easily replicated across customers; can be offered as a managed service
- Reduced video surveillance costs
- Improved network capacity
- Significant bandwidth savings
- Improved security
- Possible revenue generation opportunities.

Smart Parking

Although cities only occupy two percent of the world's land mass, they have an enormous impact on our planet. Cities consume more than two-thirds of the world's energy and account for more than 70 percent of global CO² emissions.³ In many cities, automobiles are one of the main contributing factors to rising emissions.

One of the inefficiencies associated with city driving is finding a parking spot. In fact, a traffic study completed in San Francisco, California, reported that 30 percent of all congestion in that city is caused by frustrated drivers, looking for a place to park their car.⁴

Some cities have taken matters into their own hands:

- In San Jose (California) the city has deployed IoT technology to track air quality, traffic flow and more⁵
- In Pisa (Italy) an intelligent guidance system lets drivers find an available parking space and pay for it using their smart phone.⁶

Multi-component solution reduces congestion

The Nokia IoT Smart Parking solution provides a simple and effective solution that is integrated with existing parking space sensors (and/or video cameras). Drivers are directed to the closest available parking space (or to one that was pre-booked), then are provided with a cashless payment system. Additional value added services (VASs) can also be offered, such as car wash and repair services.

3 Cities have the power to change the world, C40; http://www.c40.org/why_cities

4 San Francisco transit agency says drivers seeking parking account for 30 percent of traffic, but data questioned, Chris Roberts, San Francisco Examiner, September 17, 2013; <http://archives.sfexaminer.com/sanfrancisco/san-francisco-transit-agency-says-drivers-seeking-parking-account-for-30-percent-of-traffic-but-data-questioned/Content?oid=2580026>

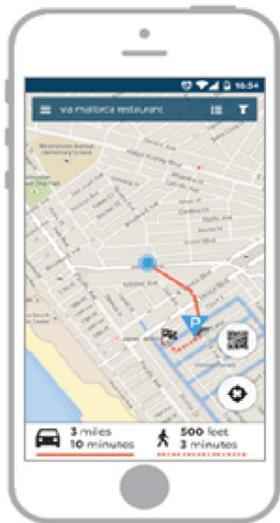
5 San Jose's smart city will use real-time data to monitor air quality and more, Sarah Silbert, Engadget, June 11, 2014; <https://www.engadget.com/2014/06/11/intel-san-jose-smart-city/>

6 Parking made easy: Smarter parking project in Pisa kicks off, Deutsche Telekom, June 24, 2014

The Nokia IoT Smart Parking solution includes these components:

- A mobile application (available on both the iOS and Android operating systems), which provides drivers with real-time parking availability and functionality that allows for booking, rebooking, cashless payment (e-wallet/credit card) and receipt generation
- A management dashboard to monitor the status of individual parking lots, including occupancy rates, vehicles with expired tickets, etc.
- Analytics functionality, with details on parking trends like utilization/occupancy rates, demand, violations and enforcement requirements
- Configuration settings, allowing for the creation and modification of listings, prices, availability and hours of operation
- Integration with boom barriers, LCD information screens and indoor navigation functionality
- Integration with the Nokia IMPACT IoT Platform, which provides data collection and management, integration into existing wireless networks, and device management for parking space sensors (secure provisioning and communication).

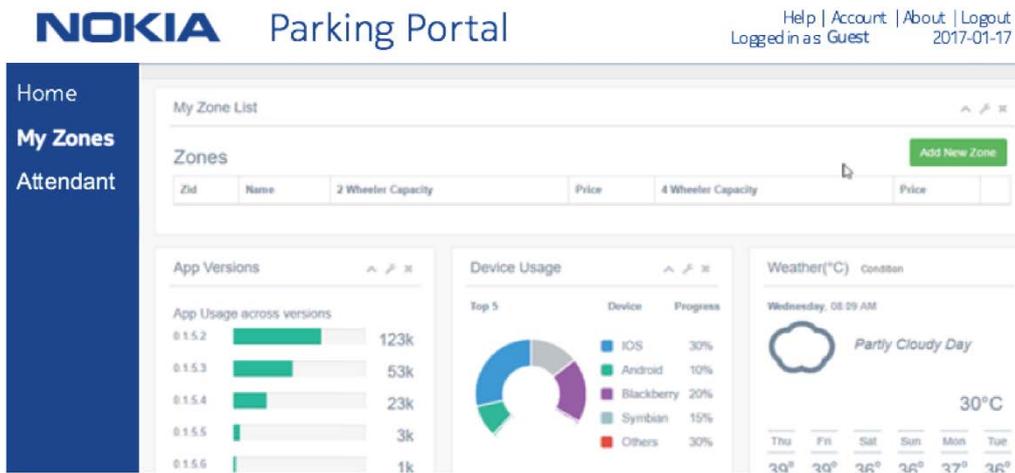
Figure 2. Nokia IoT Smart Parking solution mobile application



Measure parking occupancy with video analytics

Because the Nokia IMPACT IoT Platform is a horizontal platform – capable of handling multiple applications– integration with other applications will be possible in the future. For example, the Nokia IoT Smart Parking solution, combined with the Nokia IoT Video Analytics solution, will be capable of combining information from video feeds with data from parking space sensors, allowing for the prediction of parking utilization rates, reporting of anomalies and other issues in real time.

Figure 3. Nokia IoT Smart Parking solution management dashboard



Features

- Supports industry-leading surface- or sub-mounted parking space sensors
- Mobile app for drivers with real-time parking lot availability
- Mobile app facilitating booking, rebooking, cashless transaction (e-wallet/ credit card) and e-receipts
- Management dashboard to monitor individual parking lot status (occupied/ booked/paid/unpaid/free)
- Analytics to show parking trends – utilization, occupancies, demands, violations and enforcements
- Configuration page to create and modify parking lot listings, prices, availability and operational hours
- Integration with boom barriers, LCD information screens at each zone or parking level, indoor navigation (future).

Benefits

- Reduced time spent finding parking, resulting in reduced traffic congestion, lower fuel consumption and fewer emissions
- Improved parking space utilization
- Increased revenue for law enforcement
- Enhanced analytics capabilities, providing details on revenue, current versus historic occupancy rates, total number of spaces available and more
- Track parking meter status and violations, in real time.

Smart Lighting

Electric street lights are ubiquitous in cities around the world, enhancing visibility and safety for residents and tourists alike. In Amsterdam (The Netherlands), city employees can remotely adjust street lighting in public spaces, resulting in improved security, enhanced safety and reduced energy consumption. Colored lighting can also be used to control the flow of traffic and pedestrians. Motion detectors are used to register if lighting needs to be brighter.⁷

Because outdoor lights are a major source of energy consumption for every city, as traditional lights are replaced with more energy-efficient light-emitting diode (LED) technology, some cities are also using this transition as an opportunity to consider smart lighting solutions.

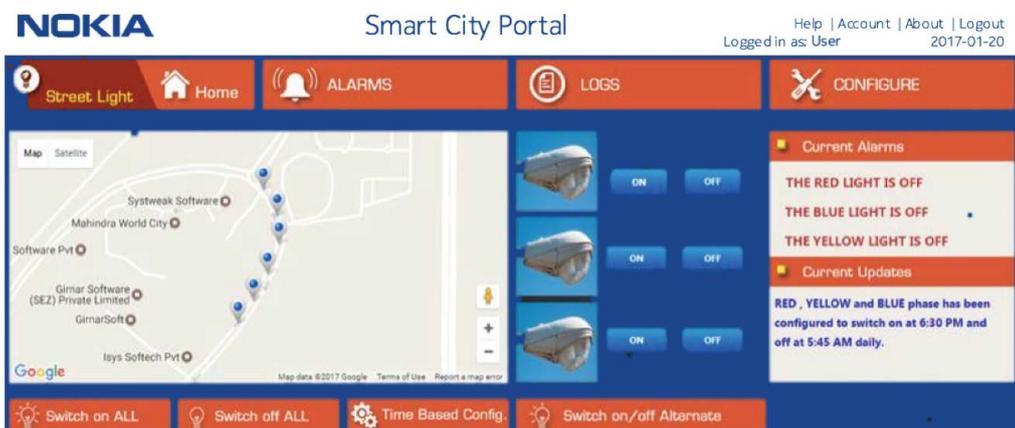
Lighting control and energy optimization

The Nokia IoT Smart Lighting solution provides energy monitoring and dynamic control capabilities. When used in parallel with the Nokia IMPACT IoT platform, the solution is agnostic to street light types and networking options.

The Nokia IoT Smart Lighting solution includes these components:

- A management dashboard to monitor individual street lights, showing the location of each light on a map, as well as each light's status (on/off)
- Configuration settings, allowing for remote control of each light's operation, luminosity level (for LED lights) and name of each light point
- Analytics functionality, with details on the energy consumption of each street light
- Integration with the Nokia IMPACT IoT Platform, which provides data collection and management, integration into existing wireless networks, and device management for light sensors (secure provisioning and communication).

Figure 4. Nokia IoT Smart Lighting solution management dashboard



7 Citizens & Living, Smart Light, Amsterdam Smart City website; <https://amsterdamsmartcity.com/projects/smart-light>

Features

- Geo-location of street lights displayed on dashboard
- Time-based configuration for cut and restore
- Alternate lighting options (e.g., red/yellow/blue)
- Configuration options for the luminosity level (for LED lights).

Benefits

- Reduced maintenance costs
- Decreased energy consumption (up to 30 percent possible, based on feedback from existing deployments)
- Optimized up-time of street lights, with enhanced ability to rectify faulty lights and manage inventory in real time
- Enhanced life of existing street lights
- Lowered carbon emissions (up to 30 percent possible, based on feedback from existing deployments).

Summary

A smart city can't be genuinely connected if each component operates as its own distinct entity. Rather than striving to create specific, individual solutions, cities must examine multiple issues that affect the city and its people as a whole.

Early experiences have taught that, to fully harness the power of the IoT, cities must be able to break down existing silos and combine massive quantities of data from multiple sources.

The Nokia IMPACT IoT Platform addresses a fragmented and complex IoT ecosystem comprised of disparate applications and devices. Its common, horizontal platform provides services for all IoT applications and verticals. This simplifies and accelerates the deployment of high quality IoT services, streamlines services and creates a foundation for strategic expansion.

About Nokia

Nokia brings the Internet of Things (IoT) to life for smart cities, creating the seamless fabric that stimulates economic growth and enables a more livable and better connected society.

Nokia is uniquely positioned to help governments, communications service providers (CSPs) and large enterprises deliver on the promise of smart cities. Our solutions are designed to provide a shared, secure and scalable platform that ensures the best use of urban resources and data to enable the human possibilities of smart, safe and sustainable cities.



Working with an open partner ecosystem including diverse organizations – technology vendors, application developers, CSPs, system integrators, utility companies, research institutions and others – Nokia continuously explores new systems, applications, content, devices and services.

Our solutions combine the IoT, cloud and security technologies with shared connectivity and data. We enable cities to leverage their network together with the IoT to offer innovative new smart city applications for their citizens, advance eco-sustainability initiatives, and create new opportunities for business development.

Learn more

Visit our web page on the [Nokia IMPACT IoT Platform](#) to learn more about our IoT solutions.

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