Energy-efficient Electronic Paper Signage, the Key Driver of Smart City Mobility and Living

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ABSTRACT: *Interconnected digital signage is an important driver of enhancing the experience of living in a Smart City, as it creates a transparent and accessible platform to help a city translate information and communication technologies into better public services for citizens. But just as e-signage presents an opportunity for a city's development, it is not without its challenges: to enable a truly smart, and therefore sustainable and green urban living space, digital signs should 1. support energy saving features; 2. be implementable even at the most demanding of locations, power grid or no; and 3. feature superb visibility in all light conditions. Ticking all of these boxes are smart signs developed on electronic paper technology.*

Following is an overview of potential e-paper implementations in a Smart City as illustrated by examples of signage that Visionect, a high tech company developing the technology for smart and sustainable e-paper signs, has helped implement in the mobility sector across the globe.

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1. The Challenge of Smart Cities

While many definitions of the term 'Smart City' exist, in its most basic meaning a Smart City is taken to mean a city whose services have been made more efficient with the use of digital and telecommunication technologies for the benefit of its inhabitants and businesses [4]. Enabled by technological development and urban migration – numbers show that 78% of Europeans [1] and 54% of the total global population now live in cities, with this number expected to grow approximately 1.84% per year by 2020 alone [3] – the Smart City has emerged from the perfect storm of economic conditions and communication tools ushering in a new, interconnected way of living.

2. Smart Cities and Digital Signage

But this transition is not without its challenges. In addition to successfully linking and upgrading existing infrastructures, technologies and services, a true Smart City should venture beyond the mere use of information and communication technologies and translate into not only better public services for citizens, but also better use of resources and less impact on the environment – a demanding task when it comes to many key urban sectors, among them city mobility.

Key to a holistic Smart City approach that proves sustainable while also improving the management of urban flows, tailoring services to the individual and enabling real time responses to challenges, is smart digital signage deployed on electronic paper technology.

2.1 Digital Signage, the Tool of Integrated Infrastructures for a More Efficient Living Space

Bridging the gap between the theoretical – the information and tools available to make a service more efficient and user friendly – and the practical – the implementation of smart integrated solutions that result in a usable and transparent system – are smart e-signs, driving the development of modern, interconnected living.

Connected into a central system that updates across platforms and services, digital signage helps provide a seamless city experience, displaying real-time information on the go and ensuring the transparency and accessibility of this information. Think smart maps that update with traffic congestions, bus stops that display real-time arrival information, billboards that change with upcoming city events, and more.

2.2 Implementing a Sustainable Solution – Electronic Paper

When implementing a digital display solution in a city scheme, however, several important issues and questions should be considered. Is the digital signage well-suited to use outdoors? Will it showcase the message clearly? How will you power the displays installed on location? What is the environmental and monetary cost of implementing the e-sign?

Electronic paper technology has two key features that fit perfectly into the production of city information systems: visibility and low energy consumption. An electronic paper display will feature perfect readability also in less than ideal light conditions, such as under direct sunlight. An additional advantage is the fact that the screen will use electricity only when changing content and will use no power to retain an image already displayed.

This allows for a solution that has extremely low power consumption and is independent from the power grid. Powered by a rechargeable battery, these signs allow for cordless installation even at the most remote of locations, seamlessly integrating with the existing information kiosk, information panel, bus shelter or train stop. If running on a solar cell, e-paper even supports the creation of completely self-sustainable signage systems.

An affordable technology tailored to the user, e-paper signs connect through the cellular network, refreshing the information displayed in real-time in a hassle-free online process taking place at a central location and requiring very little extra effort and cost on the city operator's part – with even the most demanding of city services.

3. E-paper, Driving Smart Mobility

Widely cited as one of the most universal challenges faced by cities, the question of how to meet the rising demands for efficient mobility within the limitations of already existing (often outdated) infrastructure remains one that is of utmost importance to communities world over.

Driving the creation of intelligent transport and mobility solutions, electronic paper is the enabler of a city's transition into a complete Internet of Things (IoT) ecosystem, one that evolves through progressive strategies that transform urban living from analogue to truly interconnected.

3.1 Digitalization of Existing Content: Implementation of E-Paper Passenger Information in Ljubljana, Slovenia

In the initial step of updating city services while reducing congestion and pollution and streamlining city operations such as traffic and public transportation, a city will find it necessary to transition from traditional information systems – printed public

Figure 1. Digitizing existing city services: electronic paper displays with passenger information at Ljubljana's bus stops

transport schedules, maps, detours – to digitalized ones, realized on smart, effective displays. In this phase centralization is key, creating a platform that can be updatable from a single location and that lowers city maintenance expenses by avoiding the use of stick-on paper notices altogether.

This is how the City of Ljubljana, the EU Green Capital for 2016, digitized passenger information on its bus stops in the very heart of the city centre. Energy efficient, sustainable electronic paper displays running on Visionect technology show static bus schedules, as well as exact bus arrival times and passenger information – such as notifications about line detours or new routes. They feature minimal environmental impact by enabling extremely low power consumption.

3.2 Improving City Services: Sydney's Sustainable Eink Traffic Signs

After modernizing already existing infrastructures and services, the city has at its disposal a platform that makes it easy to improve these services by introducing advanced features and uses. In this way the city not only further integrates the data at its disposal across different key sectors, but also makes these sectors more appealing and user friendly, increasing the numberof citizens that actually use them. In urban mobility this is the public transport ridership, the number of people who forgo cars in favor of buses and trains, supporting green living and increasing public transport profitability.

In terms of digital signage, this phase means not only providing easily updatable static information, but also dynamic real-time information: not only bus schedules, but also estimated times of arrival, on-the-spot traffic updates or driving rules displayed on intelligent traffic signs.

Advanced digital traffic signs are exactly what the Australian Road and Maritime Services implemented on Sydney roads. A unique interconnected system of E Ink's electronic paper displays running on Visionect's platform was created to overcome the usual visibility, powering and connectivity issues of traffic signalization. The 100% self-sustainable traffic signs powered by solar energy communicate over the cellular network, 'waking up' for certain pre-scheduled windows of time when the content on the sign – denoting parking rules and the timeframe in which they hold true – is changed via the cellular network. Outside of the 'waking' time, the traffic signs use no power.

3.3 Advanced, Multi-Sector Services Creating an IoT Ecosystem

In the third step, the city can use smart signage to connect its services to the Internet, opening up a whole new horizon of usability and innovative personalized communication with citizens. In providing end users with customizable, user-triggered information, the transport and mobility sector can transcend its boundaries, integrating with other services at a city's disposal and fully connecting people, processes, data and events.

Responding to real-time and context-specific need for information, electronic paper signage in such a Smart City can be used to provide anything from tourist information, interactive wayfinding, weather updates, city-wide security notices, live social media feeds and more. The eink technology is remotely updatable, energy efficient, battery-powered and independent from the electrical grid – and as such installable at even the most demanding of locations.

Figure 2. Improved city services in Sydney - parking rules displayed on interconnected e-paper traffic signs

4. Future Implementations of Smart E Ink Signage

Just like the provision of mobility sector information in an interconnected city does not mean mobility alone, the use of electronic paper in a Smart City is not limited to just transportation and traffic.

Propelling an interconnected city forward, electronic paper signs provide the city's services with a level of transparency and usability benefiting both user and operator: the former because the content displayed is clear, provided in real time, and user- and event-triggered; the latter because an electronic paper sign goes the distance when it comes to energy efficiency, counting its battery lifetime in months and years and offering a green and cost efficient signage solution.

Electronic paper signage helps improve urban living by providing a successful communications tool between the city and its inhabitants, thriving without being a burden on existing city resources – no overtasking the power grid or city personnel, and all without having an adverse effect on the environment. A nonintrusive and elegant medium, eink signs emit no glare or light

pollution, enabling the technology to transcend its role of signage and become a medium of city innovation.

With technological advancements turning electronic paper into a thin, affordable, low power and versatile medium perfectly suited for creating the efficient cities of tomorrow, look for cordless displays that are able to flawlessly integrate every nook and corner of a town into a unified, IoT whole: from shopping bags with subtle, real-time ads, to interactive and customizable taxi signs, table tops that change with content uploaded and even fully programmable architectural surfaces.

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