Digital signage: the right information in all the right places

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This ITU-T Technology Watch Report highlights digital signage as an innovative medium for targeted information, entertainment, merchandising and advertising. Advancements in display technologies, falling manufacturing costs and a retail boom in emerging economies are contributing to the economic uptake and rapid spread of large-scale high-definition display networks. The report identifies trends to making digital signage more interactive and pervasive and describes why interoperability and global standards are key to tapping the medium's full potential.

The rapid evolution of the telecommunication/information and communication technology (ICT) environment requires related technology foresight and immediate action in order to propose possible ITU-T standardization activities as early as possible.

ITU-T Technology Watch surveys the ICT landscape to capture new topics for standardization activities. Technology Watch Reports assess new technologies with regard to existing standards inside and outside ITU-T and their likely impact on future standardization.

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This report was written by Franck Dupin, CEO and founder of Innes, and Martin Adolph of the ITU Telecommunication Standardization Bureau. Innes is a provider of digital signage, Web TV and IPTV technologies and services, based in Rennes, France (http://www.innes.fr/).

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Please send your feedback and comments to tsbtechwatch@itu.int.

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I. Introduction

The global advertising landscape has seen a dramatic transformation over the past decade. While traditional print advertisements in newspapers and magazines have witnessed a decline that threatens the existence of some print news media outlets, market share and interest in interactive advertisement on web, mobile and other innovative media has skyrocketed.

The advent of affordable, interconnected, high-definition flat digital displays has enabled content providers, including advertisers, to replace static screens by timely targeted content delivered to the audience. Digital signage, the topic of this report, "*is a network of digital displays that are centrally managed and addressable for targeted information, entertainment, merchandising and advertisement*".[1]

While digital signage is now found in many different scenarios (e.g. traveller information at airports, pedestrian guidance in buildings, cafeteria menus), the highest revenue comes from, and hence the major focus of the industry is on, digital out-of-home (DOOH) advertising. Digital signage is not to be confused with television, broadcasting or a PC running a PowerPoint presentation in an infinite loop.

The content either follows a pre-arranged linear playlist with clearly defined time slots for different content elements, or a dynamic playlist evolving according to many criteria including user (inter-)action. Content changes can also be triggered by location information or environmental sensors.

Digital signage incorporates different technologies relying on a set of standards: displays, network infrastructure for content delivery, communication protocols, and software and hardware for management and playback of content. Propelled by advances in the field of display technologies (e.g. touch-screen), radio-frequency identification (RFID) and near-field communication (NFC), personalization of content and user interaction become increasingly relevant. Other trends include customized application programming interfaces (APIs) and Software-as-a-Service (SaaS) models that allow digital signage network operators to set up their networks and control and monitor campaigns via a remote location or the web.

The fact that most digital signage solutions are proprietary systems impedes the integration of various applications across different networks or vendors. As long as products from different vendors do not interoperate, it will remain challenging and costly to build and expand large-scale digital signage networks.

This Technology Watch Report gives an overview of digital signage technologies and their major applications, assesses the latest trends in DOOH and outlines the need for interoperable standards for digital signage products.

[1] POPAI: *Digital Signage Standard Terminology*. Rev. 1.0, October 2010, http://popai.com/docs/DS/POPAI%20DigSignage%20Standard%20TermsRev%201_0.pdf

2. Market, content and applications

First the good news: the global market for digital signage technology is expected to rise dramatically within the next five years. The research arm of Allied Business Intelligence (ABI Research) projects that spending on digital signage systems, including displays, media players, software and installation/maintenance costs, will more than triple from close to USD 1.3 billion (2010) to almost USD 4.5 billion (2016).[2] Global Industry Analysts, another market research firm, even forecasts global spending of USD 13.8 billion by 2017.[3] This rapid growth is associated with falling costs and increasing market penetration in the post-recession period. Furthermore, advances in areas such as LED and touch technologies provide businesses with unique and cost-effective ways of displaying information more impressively and more efficiently than ever.

While the United States represents the largest regional market, developing economies in Asia, Latin America and the Middle East are seen as major contributors to the predicted uptake of digital signage. Many cities in countries including Brazil, China, India, Malaysia, Singapore, Thailand and the UAE are witnessing a retail boom spurred by economic growth, increasing incomes and rising standards of living. Digital signage installations in the areas of retail, financial systems, hospitality and transportation could accompany and fuel this transition.

With the technology now mature and increasingly widespread, design and selection of the content displayed is a key factor in achieving the desired effects. Crafting and conveying an appealing and appropriate message that engages the consumer, far from being a trivial task, is a skill involving aspects of market research, psychology, aesthetics and business. In many digital signage applications, it is essential that content is regularly updated and adapted to the market environment.

While the playback of audio messages is an option, the predominant media used in digital signage networks are visual, as sound may be perceived as noise by consumers and staff present in the vicinity of the audio sources. The presentation of content with audio requires more bandwidth, more processing power and higher-quality end terminals. This can overload the communications infrastructure and limits responsiveness in content delivery.

The content reproduced with digital signage can be as diverse as its source. It is typically produced by marketing and sales professionals, professional audiovisual/web advertising agencies and freelancers, based on aggregator services (e.g. RSS feeds or feeds developed by ICT service providers) or generated by the user (e.g. by the secretary).

These market segments have distinct complex value chains involving a range of actors which are described and depicted below.

2.1 Point of Wait: corporate, education, hospitality, healthcare and banking

Modern office buildings, such as the one housing the ITU Telecommunication Standardization Bureau in Geneva, Switzerland, use digital signage solutions to display relevant information to visitors and staff. Point of Wait networks target consumers who are waiting to receive a product or service. Information may include the time and place of upcoming meetings, a news ticker, financial and weather updates or simply content designed to create a pleasant ambience. Hospitals, medical practices, banks, museums (see Box 1), universities, sport stadiums, hotels and restaurants are just some of the locations in which Point of Wait installations are often to be found.

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2 ABI *Research*: *Digital Signage Revenue to Approach $4.5 Billion in 2016*. 31 May 2011, http://www.abiresearch.com/press/3687-Digital+Signage+Revenue+to+Approach+$4.5+Billion+in+2016

3 Global *Industry* Analysts: *Global Digital Signage Systems Market to Reach $13.8 Billion by 2017*. 25 August 2011, http://www.strategyr.com/pressMCP-6741.asp

Box 1: ITU's brand new ICT Discovery – an example of innovative use of digital signage in museums

Visitors are equipped with a mobile tablet serving as an audiovisual guide to their exploration of ITU's ICT Discovery. The tablet is not only an audio guide, but a tool enabling visitors to interact with the exhibition. When the tablet is held in proximity to the RFID reader associated with a given display, additional background information is presented to the visitor on the tablet. In addition, visitors can hear the sound of the video through the headphones plugged into the tablet.

Source: http://itu.int/ictdiscovery/

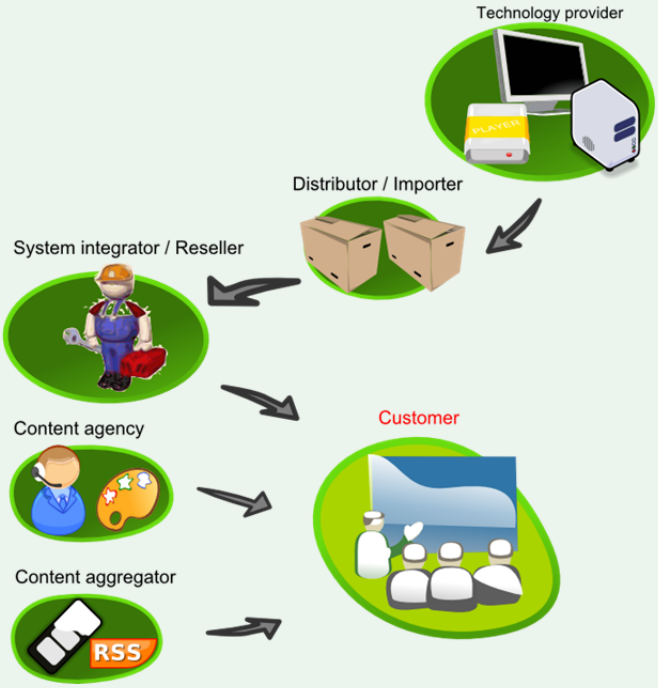
An important role in the Point of Wait value chain is played by the system integrator/reseller, who collaborates with architects and building owners to adapt existing digital signage solutions to customer needs (see Box 2).

2.2 Point of Sale: ads, kiosks, branding TV

Point of Sale networks comprise digital signage that consumers encounter close to a product or service for sale. Such installations are designed to deliver a measurable return on investment (ROI). Big retail chains are using digital signage to cross-promote products, personalize and improve the customer experience and educate customers about the availability of products and services. This may include digital kiosks and screens in retail chains and shopping malls, placed where the shopper is sure to see them.

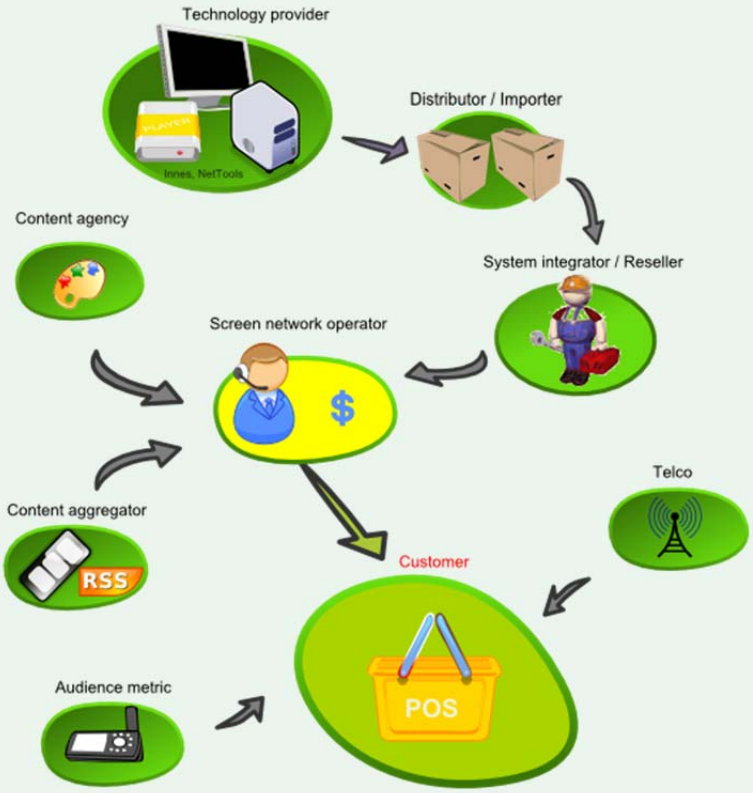
The branding and advertising strategies are developed and implemented by advertising agencies or operators of large display networks, as illustrated in Box 3.

Box 2: Example of a Point of Wait scenario and its value chain



Source: Innes

Box 3: Example of a Point of Sale scenario and its value chain

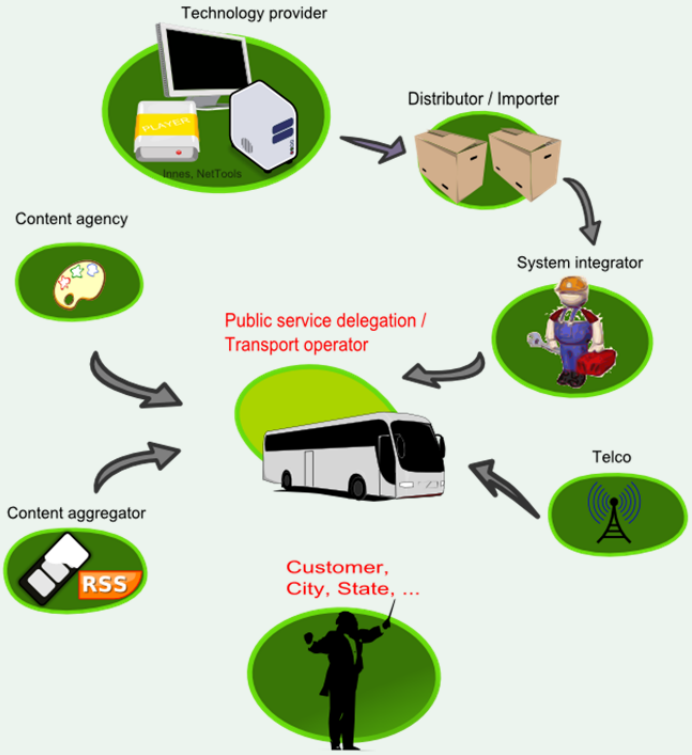


Source: Innes

2.3 Point of Transit: traveller information and advertising on the go

Consumers are on-the-go viewers.[4] Train stations, airports, buses and taxis… digital signage is pervasively used in and on all modes of public transportation to meet the needs of on-the-go viewers, providing real-time, location- and context-aware traveller information and advertising. Unlike the previously described scenarios, Point of Transit installations must meet stringent safety requirements and standards[5] , withstand a high temperature range (e.g. -25°C/+75°C) and be resistant to vibration. Such projects are therefore often implemented in close collaboration with transport operators and public authorities.

Box 4: Example of a Point of Transit scenario and its value chain



Source: Innes

The same digital signage system that carries retail advertising in shopping malls or traveler information in subways may also be used for emergency communication and mass notification. Intruder messages, national warnings and earthquake or hurricane evacuation instructions can be sent instantly to displays within a large-scale digital signage network.

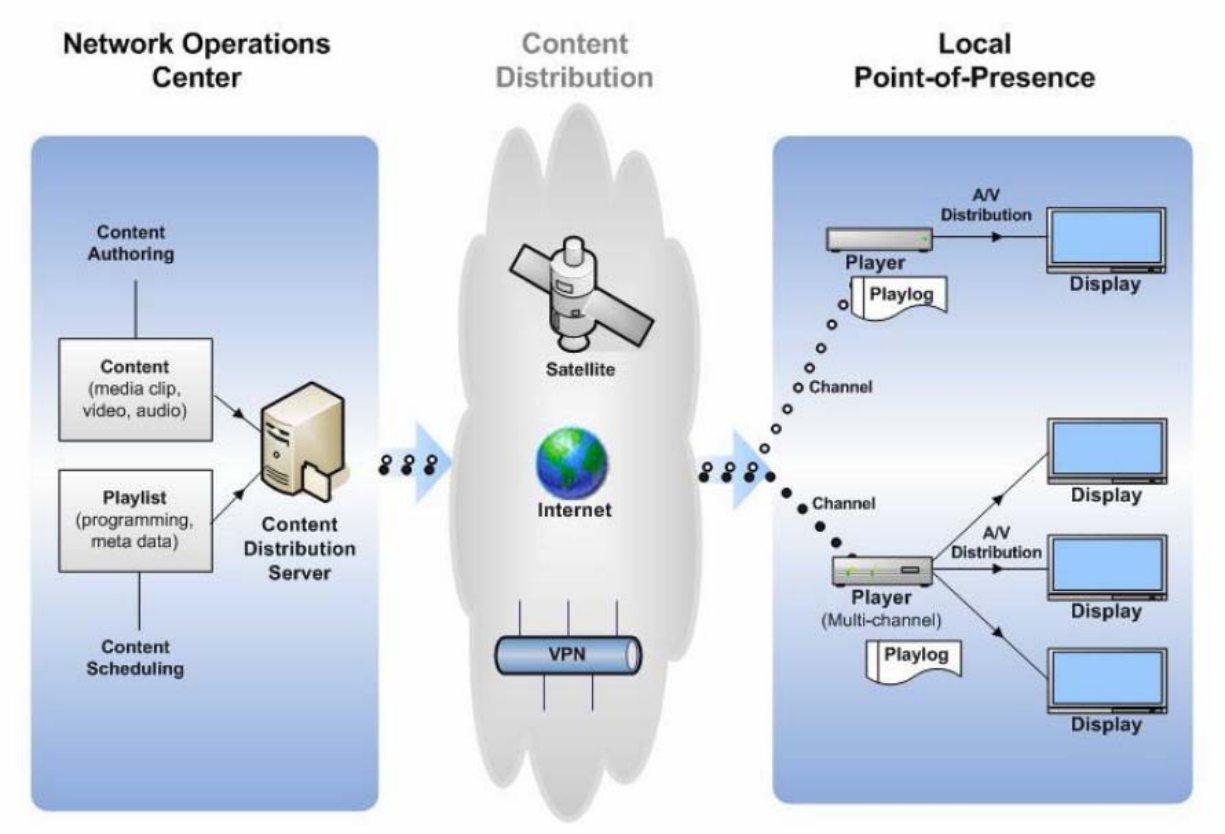
[4] Keith Kelsen: *Unleashing the Power of Digital Signage*. Focal Press, February 2010, http://www.focalpress.com/books/broadcast/unleashing_the_power_of_digital_signage.aspx

[5] For instance, CENELEC EN 50155: *Railway applications - Electronic equipment used on rolling stock*

3. Overview of digital signage technology

Digital signage systems are composed of different elements, typically including one or several displays, one or more media players and a content management system / content delivery systems. The latter are often catering for multiple media players and displays throughout a digital signage network. A reference system as defined by POPAI (see section 5.1) is depicted in Figure 1.

Figure 1: POPAI digital signage reference system



Source: POPAI

The majority of digital signage solutions in place today are based on the Internet Protocol (IP), which may include a combination of wired and wireless networks. These connections need to be managed using quality of service / experience (QoS, QoE) and security features. This will enable achievement of the installation's intended purpose of impacting the consumer.

One may imagine the consequences of a hacker or competitor gaining access to digital signage servers or media players, e.g. remote alteration of content or other scenarios. Standardized state-of-the-art authentication mechanisms are part of the security measures needed to block unwanted access and data traffic.

Technologies from the related field of IPTV can add broadcasting features to digital signage networks.

3.1 Display – the digital sign

Over the past decade, display technologies have seen major advances in resolution and drastic cost reductions. Heavyweight, cumbersome and power-hungry CRT screens have essentially vanished from the scene and made way for ultra-flat LED, LCD and plasma panels in all sizes and resolutions, which can be deployed in any of the scenarios described earlier. Other application-specific parameters include casing, mounting

(e.g. standing/wall-mounted) and layout (e.g. multi-screen). Outdoor settings may make brightness control and dust, heat and water resistance indispensable.

But development does not stop here: scientists and display engineers keep pushing the limits to further reduce cost and increase performance, quality of experience and energy efficiency. Displays based on organic LEDs (OLEDs) are becoming increasingly dominant in the small to medium screen size device segment (smartphones, portable digital media players and laptops), and will make their way to larger indoor and outdoor panels once manufacturing is profitable.

Recent developments in 3D have been highlighted in a previous Technology Watch Report.[6] It appears reasonable to assume that "glasses-free 3D" screen technology will have a significant impact on digital signage if it succeeds in the consumer electronics market.

Remote management of displays can be advantageous, in particular to manage on-off behaviour, colour settings, audio volume, etc. It can be observed that an increasing amount of functionality is being added to displays, in many cases incorporating full set-top box functionalities, IP connectivity, etc. This means that the implementation of digital signage terminals is now easier than it used to be, especially if they build upon already defined technologies, e.g. functionality made available for IPTV services (ITU-T H.721).

3.2 Media players

As one might imagine, the role of the media player is not limited to presenting the right content on the right display at the right time. Media players used in digital signage also offer interfaces for remote monitoring and configuration services (such as those defined by the Video Electronics Standards Association (VESA)). They are responsible for managing proof-of-display log files and implement audience measurement or user interaction capabilities. Finally, they have to be capable of providing support for the most common multimedia formats, unicast as well as multicast protocols.

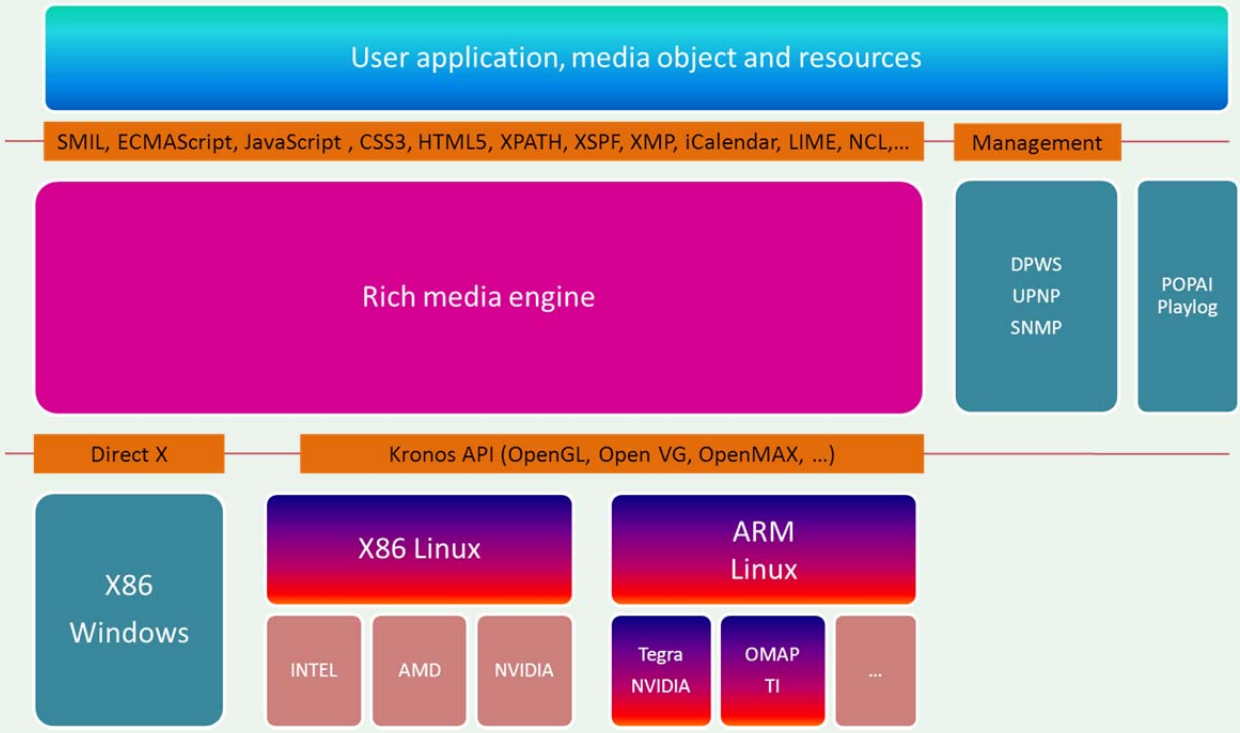
The offline characteristics of media players enable scheduled caching and downloading of media content and related resources (e.g. subtitles for a video, font-type for textual animation), based on a set of rules (e.g. "do not update content during office hours"). Media player behaviour and performance can be managed by the head-end equipment using a pre-established communication protocol.

A distinction is generally drawn between software and hardware media players. A software player runs on a PC, whereas the hardware option is a dedicated external box or a module integrating directly into a dedicated slot in the housing of the display. Software players are often "rich media" technology based, which enables them to use the resources of advanced graphics processing units (GPU) with interfaces for DirectX/Media Foundation (Microsoft Windows) or OpenGL in Unix environments. The architecture of a software media player is illustrated in Figure 2.

The use of open interfaces to mediate and manage media objects and resources, such as ECMAscript (JavaScript), ITU-T H.761 LIME and ITU-T H.762 Ginga/NCL, can provide efficient re-use of the same content, playing experience and interactivity across a wide variety of terminals. Thus, standards-based solutions can increase the ROI in implementing digital signage systems.

[6] ITU: *Trends in Video Games and Gaming*. ITU-T Technology Watch Report, September 2011, http://www.itu.int/en/ITU-T/techwatch/Pages/video-games-standards.aspx

Figure 2: Architecture of a software media player



Source: Innes

3.3 Content management systems / content delivery systems

Management and delivery of content to the media player is organized in the head-end through dedicated systems that have the ability to create, change and delete play schedules and to transfer these lists and the associated content. Content is stored internally or externally (see Section 4.2 on cloud-based digital signage) and described through metadata.

The systems are capable of meeting the requirements of different application scenarios and appear for the most part in the form of robust and feature-rich “thick clients”. More complex systems can assign and manage roles to different classes of user (e.g. editors, contributors, freelancers) and allow for compositions combining remote and local content.

In addition to content-related features, content management systems also implement tools for statistical analysis, audience profiling and log file auditing.

4. Trends in digital signage

Falling hardware costs mean that large-scale public display networks are becoming commonplace in many settings. However, the full potential of digital signage as an innovative interactive medium, as compared to traditional static media, has to some extent remained untapped. Some argue that the advantages need to be exploited in order to achieve the commercial breakthrough of digital signage technologies.

4.1 Increasing pervasiveness, interactivity and consumer engagement

One way of increasing interactivity is via the consumer's mobile device: with almost six billion mobile-cellular subscriptions worldwide, many of them including access to high-speed 3G services, mobile devices are virtually ubiquitous.[7] All handsets feature at least some basic interfaces, including SMS, and short-range radiocommunication technologies such as Bluetooth and NFC.[8] If the Point of Wait/Sale/Transit is equipped with the same interface, an SMS or the proximity of a consumer and handset can trigger an event on the display or handset, e.g. start a video clip or issue a coupon. Integration of information from the consumer's social network application (e.g. Facebook) running on a smartphone could customize the information presented on the digital sign, and enable, for instance, targeted promotion.

Many products in supermarkets and department stores now carry RFID tags for logistical purposes. Nutritional data on a food item and the item's expiry date can easily be displayed on digital signage installations with RFID tag reader features, making such installations a part of the so-called Internet of Things.[9]

The EU-funded PD-NET research project is a forum for the discussion of application stores ("app stores"), "digifieds" (a digital public notice area, derived from digital classifieds) and other ideas that could contribute to making digital signage as impactful as radio, television or the web.[10]

4.2 Biometric recognition of consumers

Biometric recognition and its incorporation in digital signage is another hot topic.[11] Under discussion is technology that can track heat paths (e.g. to show a consumer's movement around a retail environment). Gaze tracking can be used to identify the area of a sign, which the consumer spends most time looking at.[12] Biometrics can help identifying and distinguishing between frequent customers (previously enrolled) and first-time customers – priceless information for marketers.

More controversial are biometric recognition technologies capable of determining the age, gender and ethnicity of passers-by. An earlier Technology Watch Report looked at biometric recognition, security and privacy concerns and related standardization activities.

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7 ITU: *The World in 2011 – ICT Facts and Figures*. October 2011, http://www.itu.int/ITU-D/ict/facts/2011/material/ICTFactsFigures2011.pdf

8 Near Field Communication interface and protocol (NFCIP-1) are standardized in ISO/IEC 18092:2004, http://www.iso.org/iso/catalogue_detail.htm?csnumber=38578

9 More information about ITU standardization activities on the Internet of Things, at http://itu.int/en/ITU-T/techwatch/Pages/internetofthings.aspx

10 *See* http://pd-net.org/

11 See, for instance, NTT Technical Review*: Image Processing Techniques for Measuring Advertising Effectiveness of Digital Signage.* December 2009, https://www.ntt-review.jp/archive/ntttechnical.php?contents=ntr200912sf2.html

12 The Economist: Facial monitoring: *The all-telling eye.* 19 October 2011, http://www.economist.com/node/21533362

Microsoft Surface[13] is an example combining some of the features addressed above that gives a hint to what the future of digital signage could look like. Five infrared cameras embedded in the housing of a flat panel display are capable of recognizing and locating the fingertips of users touching and interacting with the display. Natural user interfaces (NUIs) like these enable users not only to passively consume but to actively participate and engage with the medium.

4.3 An experience for all senses?

NTT Japan has taken the idea of engagement somewhat[14] further and launched digital signs equipped with aroma-emitting devices in order to strengthen the impact of marketing communications. Branded as Kaoru Signage (aroma signage), the product combines digital signage and NTT's Kaori Tsushin (fragrance communication) online service, which instructs specified web-connected devices to emit mood-heightening aromas. The strength of the fragrance can be adjusted to meet the requirements of the scenario. A broadband connection enables video, sound and fragrance settings to be transmitted to multiple locations. NTT believes that aromas increase the chances of passers-by seeing the sign, remembering the product being advertised and eventually buying it.[15]

4.4 Cloud-based digital signage

The cloud computing paradigm has been seeing a breakthrough in a wide area of applications over the last couple of years (as reported by ITU-T Technology Watch in March 2009 [16]). Many digital signage service providers are following the trend and offering digital signage Software as a metered and managed Service (SaaS model), payable per hour of use or number of operations. SaaS has emerged as a popular solution because it is reliable and cost efficient and can be deployed rapidly on digital signage networks of any size.

5. Digital signage standards landscape

A relatively young discipline, digital signage suffers from a lack of standards and interoperability, as the majority of systems in use are closed and proprietary. Some argue that the lack of standards represents a barrier to be overcome in order for digital signage to become an advertising medium as relevant as television or the web.

To enable end users to combine products and services from different manufacturers and operators and use a wide variety of terminals with different characteristics, several industry initiatives have been formulated to define technical specifications for interoperable digital signage solutions. The work being done under these initiatives and related ITU-T standardization activities are described in this section.

5.1 POPAI – The Global Association for Marketing at Retail

In recognition of the importance of digital signage to marketing and advertising strategy, POPAI, an international trade association for the marketing at retail industry, created a Digital Signage Group to promote the

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13 ITU: *Standards and Biometrics*. ITU-T Technology Watch Report, December 2009, http://itu.int/oth/T230100000D

14 See http://www.microsoft.com/surface/

15 NTT: *NTT Com to Market Aroma-Emitting Digital Signage*. August 2008, http://www.eu.ntt.com/en/about-us/newsroom/news/news/article/ntt-com-to-market-aroma-emitting-digital-signage-ntt-com.html

16 ITU: *Distributed Computing: Utilities, Grids & Clouds*. ITU-T Technology Watch Report, March 2009, http://itu.int/oth/T2301000009/en

adoption of digital signage technologies and applications.[17] Among the group's activities is research including the definition of needs and standards and implementation of research for consumer impact, ROI and measurement of effectiveness. Some outcome documents are available on the group's website – see Table 1.

Table 1: POPAI documents on digital signage

Title	Version	Hyperlink
Digital Signage Standard Terminology	1.0 (Oct 2005)	http://popai.com/docs/DS/POPAI%20DigSignage%20Standard%20TermsRev%201_0.pdf
Digital Signage Content		http://popai.com/membership-community/communities/digital-signage/digital-signage-content-standards/
Screen-Media Formats	2009	http://popai.com/docs/DS/ScreenFormat%20Standards%20Draft%20rev097.pdf
Request for Information (RFI) Working Template	2008	http://popai.com/docs/DS/RFI_Doc_02-03-08final.xls
Digital Signage Device RS-232 Control Standard	1.0 (Jun 2006)	http://popai.com/docs/DS/POPAI%20Digital%20Signage%20Device%20RS-232%20Standard-Rev%201-1.pdf
Digital Signage Playlog Standards	1.1 (Aug 2006)	http://popai.com/docs/DS/POPAI%20Digital%20Signage%20Playlog%20Standards%20-%20Version1.1a.pdf
Digital Control Commands		http://popai.com/docs/DS/Display%20Control%20Commands.pdf

5.1.1 POPAI Digital Signage Playlog specification

A playlog is a record of information created from the digital signage media players reflecting the content played, system performance and other data. A well-defined playlog format provides necessary information for digital signage network users to audit, monitor and act on the intelligence. A standardized format provides credibility to digital signage users by ensuring the required information is present and by making the sharing of such information easier among digital signage service providers. [18]

5.1.2 POPAI Screen-Media Formats

This industry standard establishes a baseline set of standard formats for media intended for use in digital signage applications. The baseline consists of support for all the formats listed as 'standard' profiles. By establishing a set of standard formats, content can be provided in these formats to multiple distinct networks in the expectation that each network can and will display the content accurately. Performance above the baseline is encouraged to support formats shown in the 'extended' profiles. The standard lists a variety of codecs for audio, video, still image and vector graphics, as well as container formats. The list includes MPEG-1, MPEG-2, MPEG-4, ITU-T H.264, JPEG (ITU-T T.81 | ISO/IEC 10918) and Flash.[19]

HTML5, the emerging language for structuring and presenting web content, references IETF's RFC 4281 [20], which can be therefore considered as more universal than the POPAI Screen-Media Formats.

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17 See http://popai.com/membership-community/communities/digital-signage/

18 See http://popai.com/docs/DS/POPAI%20Digital%20Signage%20Playlog%20Standards%20-%20Version1.1a.pdf

19 See http://popai.com/docs/DS/ScreenFormat%20Standards%20Draft%20rev097.pdf

20 IETF: *The Codecs Parameter for "Bucket" Media Types*. IETF RFC 4281. http://tools.ietf.org/html/rfc4281. Obsoleted by IETF: *The 'Codecs' and 'Profiles' Parameters for "Bucket" Media Types*. IETF RFC 6381. http://tools.ietf.org/html/rfc6381

5.2 Intel Open Pluggable Specification

Microprocessor giant Intel positions its products on the digital signage market and promises to "*deliver rich multimedia content while enabling remote management, advanced security, energy savings, and lower TCO*" (total cost of ownership).[21] Intel created the open pluggable specification (OPS) to address digital signage market fragmentation. The objective of OPS, which is accompanied by two design guides, is to simplify device installation, usage, maintenance and upgrades and to implement scalable digital signage applications that interoperate with other equipment.[22]

5.3 Open Digital Signage / W3C SMIL

Some vendors promote openness in digital signage networks to facilitate growth of the sector and support novel applications and business models. According to them, an "open" digital signage network would satisfy at least three criteria:[23]

1. It supports deployment of platform-independent contents and applications.
2. It allows the public to easily purchase time and schedule contents on it.
3. It is built from components that comply with a common standard and can be expanded or replaced without limitation.

One standard in line with these criteria is SMIL (pronounced *smile*), created and maintained by the World Wide Web Consortium (W3C).[24] SMIL defines scheduling ("Synchronized"), video, audio, images, text ("Multimedia"), multi-zone screen layout ("Integration") in an XML-based text file format ("Language"), and is increasingly supported by leading digital signage solution providers.[25]

5.3.1 Hybrid formats, e.g. SMIL + CSS 3 + ECMAscript (JavaScript)

In some application scenarios, the possibilities offered by SMIL might not be sufficient to meet customer demand. Companies such as Innes[26] have experimented with blending the strengths of SMIL 3.0 (the latest SMIL release) and other web technologies, also separating the semantic structure of the content from the presentation semantics, a paradigm pursued by HTML5.

The proposed solution is based on the structure of SMIL but entrusting the presentation layer to CSS 3 (Cascading Style Sheets 3), a standard most commonly known for adding formatting to web pages. In addition, it provides JavaScript support and a device API to better address the specific needs of each digital signage project. Other features of HTML5, such as forms, help to make digital signage applications more immersive and interactive. The web technologies combined in this solution are well known to content creators and designers and are supported by the majority of authoring software solutions.

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21 See http://www.intel.com/p/en_US/embedded/applications/digital-signage

22 The Open Pluggable Specification is available at http://www.intel.com/p/en_US/embedded/applications/digital-signage/ops. Access to the design guides may require registration.

23 See http://www.opendigitalsignage.org/

24 See http://www.w3.org/TR/smil/

25 See http://www.a-smil.org/, "Advocacy for SMIL as an open standard for digital signage"

26 Franck Dupin, CEO and founder of Innes, a provider of digital signage, Web TV and IPTV technologies and services, has co-authored this report.

5.4 Digital signage privacy standards of the Digital Signage Federation

As highlighted in the previous section, consumer engagement and interaction are considered unique selling points (in particular for applications in advertising) and therefore key drivers of growth for the digital signage industry. Interactivity is achieved through the use of RFID and integration of social networks and personal mobile devices, and may even include biometric recognition (see Section 4.1). It is understandable that these trends also raise privacy concerns, which need to be taken seriously and addressed through policies, guidelines and technical standards. The Digital Signage Federation (DSF), a global industry association, has taken on the issue and published a set of privacy and transparency guidelines.[27]

5.5 ITU-T Study Group 16

The ITU-T membership considers digital signage as an area that can leverage the technology, functionality and standards defined for IPTV and that has significant potential for commercial application. ITU-T has been spearheading global IPTV standardization activities for over five years. The members of ITU-T's lead group on multimedia coding, systems and applications (Study Group 16) are rapidly advancing in their efforts to draft a "Framework for Digital Signage Services" (ITU-T Draft Recommendation H.FDSS [28]) addressing the high-level requirements, architecture and mechanisms for dealing with digital signage content, networks, middleware, metadata and terminal devices. Many of the functionalities and building blocks defined in the IPTV suite of ITU-T Recommendations can be used to implement Digital Signage functionality – for example, the ITU-T H.721 set-top box terminal device specification, ITU-T H.761 LIME, ITU-T H.762 Ginga/NCL, and the audience measurement text in the final stages of preparation.[29]

The current draft draws upon some of the specifications outlined above and presents a number of cases of digital signage use (see also the presentations from the ITU workshop on digital signage, held in December 2011 in Tokyo, Japan[30]).

5.5.1 ITU Interoperability events

Interoperability is part of the mission of ITU. Conformity to standards does not imply interoperability of equipment, services and systems, but significantly increases its probability. ITU is successfully organizing and facilitating a series of "*ITU Interop events*" (for more information see http://itu.int/interop). A key theme of these events is IPTV, which has thus far been addressed on five occasions (Brazil, India, Singapore, Switzerland and the UAE – see Figure 3) to test ITU-T's IPTV suite of standards on the equipment of various vendors in order to demonstrate seamless global interoperability.

Given the similarities between digital signage and IPTV, the global reach of the market and the call for interoperability expressed by manufacturers and content producers alike, ITU may consider the organization of Interop events for digital signage. This presumes, however, the readiness and availability of test cases and a series of global digital signage standards.

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27 See http://www.digitalsignagefederation.org/industrystandards

28 See http://www.itu.int/ITU-T/workprog/wp_item.aspx?isn=8049

29 See http://itu.int/ITU-T/workprog/wp_item.aspx?isn=6963, http://itu.int/ITU-T/workprog/wp_item.aspx?isn=7394

30 See http://itu.int/ITU-T/worksem/iptv/201112

Figure 3: ITU IPTV Interop event in Geneva, Switzerland, 2010

Source: ITU

5.6 Other associations and initiatives

5.6.1 Digital Place-Based Advertising Association

Founded in 2006, the Digital Place-Based Advertising Association, or DPAA, exists to drive consistent growth for its industry through collaboration among advertisers, agencies, place-based digital and video networks and their suppliers. In 2011, DPAA published a specification defining advertising units for digital place-based advertising, e.g. delivered through digital signage.[31] Standard advertising units aim at an optimum playback of a variety of advertisement formats across networks of displays with different sizes and features. While a wide choice of sizes and content formats is a strength and a unique selling point of digital signage as an advertising medium, it can also add complexity and inefficiency, which is addressed in this standard.

5.6.2 Japan

The Digital Signage Consortium (DSC), a Japanese industry consortium with some 130 members, established in 2007, has published three guidelines and guidebooks addressing design and performance issues of digital signage systems.[32]

[31] See http://www.dp-aa.org/StandardAdvertisingUnit.php

[32] See http://www.digital-signage.jp/

6. Conclusion

No longer limited to New York's Times Square, the London Stock Exchange or the commercial areas of Shinjuku, Tokyo, digital displays are becoming increasingly omnipresent at Points of Wait, Sale and Transit.

Many of them are part of extensive networks of connected displays that are managed centrally and addressable for targeted information, entertainment, merchandising and advertising – an emerging medium described as digital signage.

While the number of service providers and manufacturers of digital signage components and solutions is increasing, the associated standards ecosystem appears to be rather incomplete. Some groups and initiatives are calling for interoperability to facilitate the rollout of large-scale digital signage networks, foster innovative applications and avoid vendor lock-in. These groups include advertising industry associations, technical suppliers, national interest groups and a number of formal standards development bodies, such as ITU-T.

ITU-T Study Group 16 has taken an important first step by starting work on a "Framework for Digital Signage Services". Recognizing that a useful foundation has been laid for the similar IPTV application space of IPTV, much work remains to be done in order to achieve an all-embracing digital signage suite of standards. This suite would also include screen-media formats and associated advertising units, network requirements, security and privacy enhancing solutions, test cases, etc. Extensive collaboration with the digital signage industry and its interest groups should contribute to taking the next steps without duplication of effort.

There should be a particular focus on identifying links to related technologies (e.g. IPTV, cloud computing) and on leveraging the full potential of the medium: interactivity, pervasiveness and context awareness, and its integration into the Internet of Things.

Given its previous experience in the related domain of IPTV, ITU-T could consider organizing similar events to demonstrate seamless global interoperability of digital signage products of different vendors.

List of abbreviations

API	Application programming interface
BRICS	Brazil, Russia, India, the People's Republic of China and South Africa
CRT	Cathode ray tube
CSS	Cascading style sheets
DOOH	Digital out-of-home
DPAA	Digital Place-based Advertising Association
DSC	Digital Signage Consortium, Japan
DSF	Digital Signage Federation
GPU	Graphics processing unit
ICT	Information and communication technology
IETF	Internet Engineering Task Force
IPTV	Internet Protocol television
ITU	International Telecommunication Union
ITU-T	ITU Standardization Sector
LCD	Liquid crystal display
LED	Light-emitting diode
NFC	Near field communication
NUI	Natural user interface
OLED	Organic LED
OPS	Open pluggable specification
QoE / QoS	Quality of experience / Quality of service
RFC	Request for comments
RFI	Request for information
RFID	Radio-frequency identification
ROI	Return on investment
SaaS	Software-as-a-Service
SMIL	Synchronized Multimedia Integration Language
TCO	Total cost of ownership
UAE	United Arab Emirates
USD	United States dollar
VESA	Video Electronics Standards Association
W3C	World Wide Web Consortium
XML	Extensible Markup Language

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