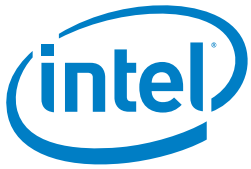

A Report on a Field Trial of Anonymous Video Analytics (AVA) in Digital Signage

ABSTRACT OR EXECUTIVE SUMMARY

Digital signs represent a growing advertising medium offering many advantages over traditional outdoor advertising, such as billboards and posters. Millions of digital signs are now in place in stores, restaurants, traffic hubs, college campuses, office buildings and many other locations. However, the audience for digital signage is largely unmeasured - compared to other media such as TV, radio, magazines and even other outdoor advertising (e.g., billboards), there is a shortage of reliable metrics telling us how many people watch them, when, for how long, demographics, etc. Better metrics will enable advertisers to evaluate and plan their purchases in digital signage making it possible for digital signage networks to obtain a larger share of overall advertising budgets.

Anonymous Video Analytics (AVA) technology provides a way to obtain detailed, cost-effective audience impression metrics. With AVA, a sensor attached to a digital sign sends data to face detection software which logs how long the individual viewed the sign and also classifies the viewer by age, gender, etc. AVA is completely anonymous—no images or video are recorded, and no personally identifiable information is ever collected—only statistical audience data is logged.

To better understand the potential of AVA, Intel conducted a field trial at the Venetian resort in Las Vegas gathering nearly 300,000 impressions in March – May of 2010. The trial took place using AVA technology on digital signs displaying dynamic (motion) content and static signs. Overall, the trial demonstrated that AVA is a reliable and accurate audience measurement system, proving effective in:

- Measuring the total viewing audience
- Measuring the differential in viewership between static and dynamic signs
- Measuring the differential in viewership by gender, age and time-of-day
- Identifying day-to-day variances in viewership
- Correlating viewership with point-of-sale activity
- Providing data that supports emerging standards for audience impression metrics (i.e., OVAB/DPAA standards) that can be used in establishing the cost of advertising, i.e., CPMs

The trial also provided detailed information for developing best practices in designing and implementing AVA, including:

- The impact of lighting conditions on the selection of a sensor
- Sensor positioning, field-of-view and depth-of-field considerations
- Processor requirements for simultaneously gathering AVA data while presenting dynamic imagery

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1. INTRODUCTION

The Growth of Digital Signage

The availability of low-cost, flat-panel LCDs displaying eye-catching video and computer-generated graphics has fueled the growth of a new industry: digital signage.

Digital signs are a fixture in stores, shopping malls, airports, train stations and many other public venues. You find them at the gas pump, inside elevators and in the backseats of taxis. They greet travelers in the hotel lobby and college students in the student union. They help you pass the time in a doctor's office or standing in line at the bank. They are even popping up in the work place—from lobbies to cafeterias.

Today, there are over two million digital signs installed around the world, viewed regularly by millions of people. Since it first appeared, digital signage has been viewed as an important venue for advertising.

A digital signage network—i.e., one designed with the appropriate screens, processors, content management software and connected via a high speed data network—offers many advantages over traditional "out of home" advertising vehicles such as static billboards and posters. Digital signage allows advertisers to:

- Display dynamic, moving images
- Quickly and cost-effectively change the creative based on time of day, new promotions, or audience impression metrics
- Drive point-of-sale (POS) results, particularly via digital signs located close to the point-of-sale
- Test marketing strategies to determine what is working

A number of major advertisers in the automobile, financial services, pharmaceutical and other industries have begun to allocate a portion of their marketing budgets to digital signage—also referred to in the advertising industry as "Digital Out of Home" (DOOH) or "Digital Place-based Media" (DPBM).

According to PQ Media's Global Digital Out-of-Home Media Forecast 2009-2014, advertising spending on U.S. DOOH networks increased 1.2 percent in 2009 to $1.4 billion. The uptrend is expected to continue at an accelerated rate from 2010 through 2014, generating a compound annual growth of 8.7 percent to $2.13 billion.[1]

The Role of Audience Impression Metrics

For digital signage to continue to grow as an advertising medium, accurate audience impression metrics are needed. Audience impression metrics provide a "common currency" enabling advertisers to evaluate their media buys and make decisions about which medium will be most effective in reaching and persuading the target audience. The metrics also provide the basis for how much it costs to advertise, typically expressed as a function of the cost per thousand viewers (CPM).

Advertisers are accustomed to getting this kind of data for radio, TV and print publications via third party auditing and research services. Some owners/operators of digital signage networks use these same third-party services to provide audience measurement estimates for their networks. Overall, however, this is the exception rather than the rule. Since the vast majority of digital signage networks are relatively small in size, they cannot justify the cost of obtaining audience measurement data. Even when audience measurement data is gathered, it is not necessarily comparable from one network to another due to differences in data collection methodologies.

The audience impression metrics needed generally fall into three areas:

- **Proof of Play:** Given the widely dispersed nature of digital signage, advertisers require detailed information regarding where their ads played, when, how often and for how long.

- **Audience size:** Advertisers require information about the size of the audience for their ads: the number of people who watched and for how long.
- **Audience Demographics:** Advertisers want demographic data, such as the age and gender breakdown of the audience.

What is Anonymous Video Analytics (AVA)?

Anonymous Video Analytics (AVA) is a cost-effective technology for gathering audience impression metrics. AVA involves attaching a sensor to the digital signage unit to capture data on the individuals viewing the signs. This data is analyzed in real time by software that uses pattern detection algorithms to categorize each viewer by age, gender, etc. As its name suggests, AVA is completely anonymous: it cannot identify an individual; no actual images are stored, and no personal information is collected. The only data that is stored is of an anonymous, aggregate, statistical nature. It is not possible to associate any single, stored data-point to an individual person.

The Intel Field Trial

To help gain a better understanding of the capabilities of AVA as a method of obtaining audience impression metrics, Intel conducted a field trial from March 1 through May 31, 2010 at The Venetian and The Palazzo Resort-Hotel-Casino in Las Vegas, one of the largest five-diamond resort complexes in the world.

The trial consisted of two digital signs displaying animated digital media and two signs using static, printed posters.

A total of eight digital sensors were used to feed impressions to face detection software measuring:

- how many people looked at the ads (notice)
- how long they looked at the ads (dwell time)
- when they viewed the ads (i.e., time of day)
- their gender and age bracket (demographics)

The hardware used in the field trial consisted of:

- **Interactive Digital Display Computer:** Independent, back to back Micro Industries 46 P Messenger computers with high brightness LCDs (1920x1080), 2.16GHz Intel Core 2 Duo Processors and mTG945 motherboards, running Windows XP Pro
- **Sensors:** Logitech webcams subsequently replaced by Axis M 1011 sensors (640x480)
- **Detection Software:** CognoVision's Anonymous Impression Metric System (AIM)
- **Content Management:** mCosm's Digital Signage Management System (mCast) and mCosm's Runtime Client

(For a complete description of the system used in the trial, see the Appendix.)

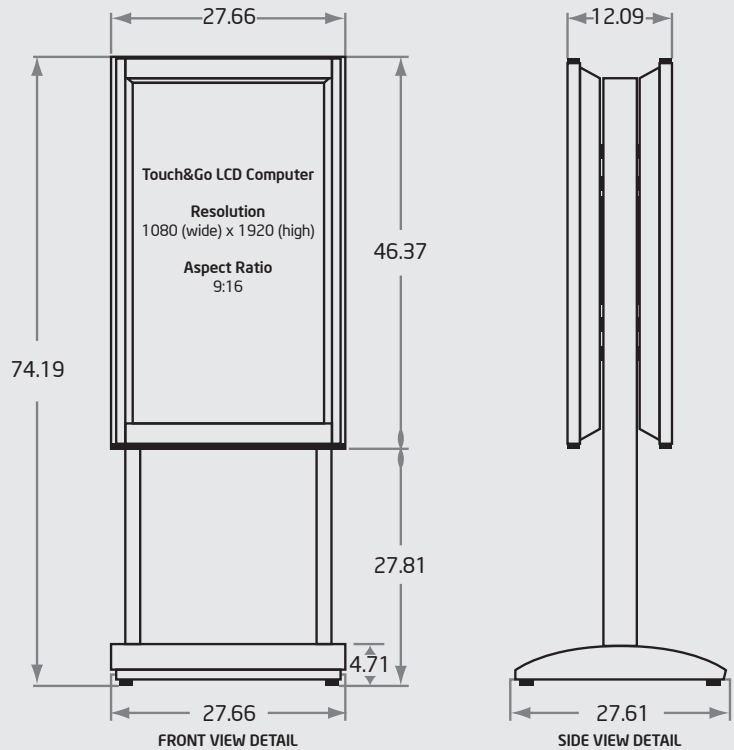
11. MEASURING THE AUDIENCE

Total Audience and Viewership: Static and Dynamic Signs

During the three months of the trial, (March 1 – May 31) the AVA technology captured nearly 300,000 impressions of individuals in the mall who viewed the four signs.

The AVA results show that viewers demonstrated greater interest in digital signs featuring dynamic, moving images.

Digital Lollipop Dimensions



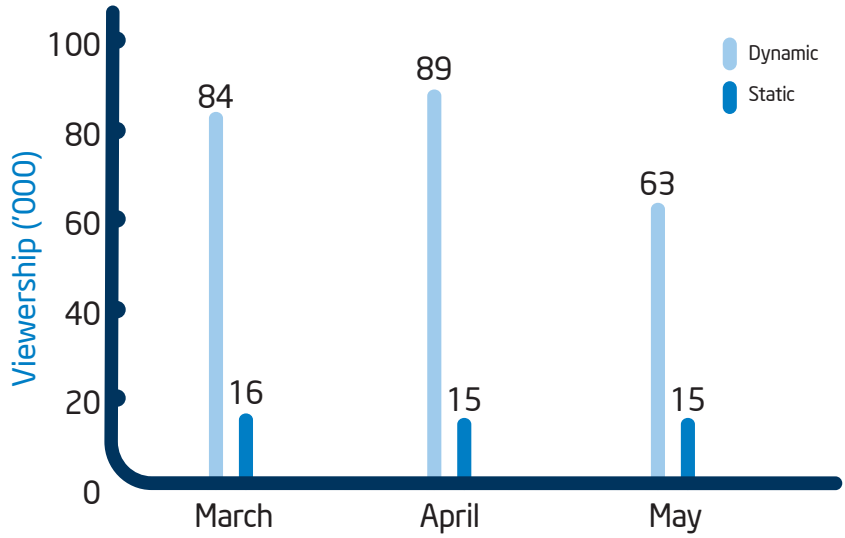
Animated digital content consistently attracted 4 to 6 times the number of viewers compared to the equivalent static posters. In addition, the exposure time of the digital signs was substantially longer.

Exposure Time

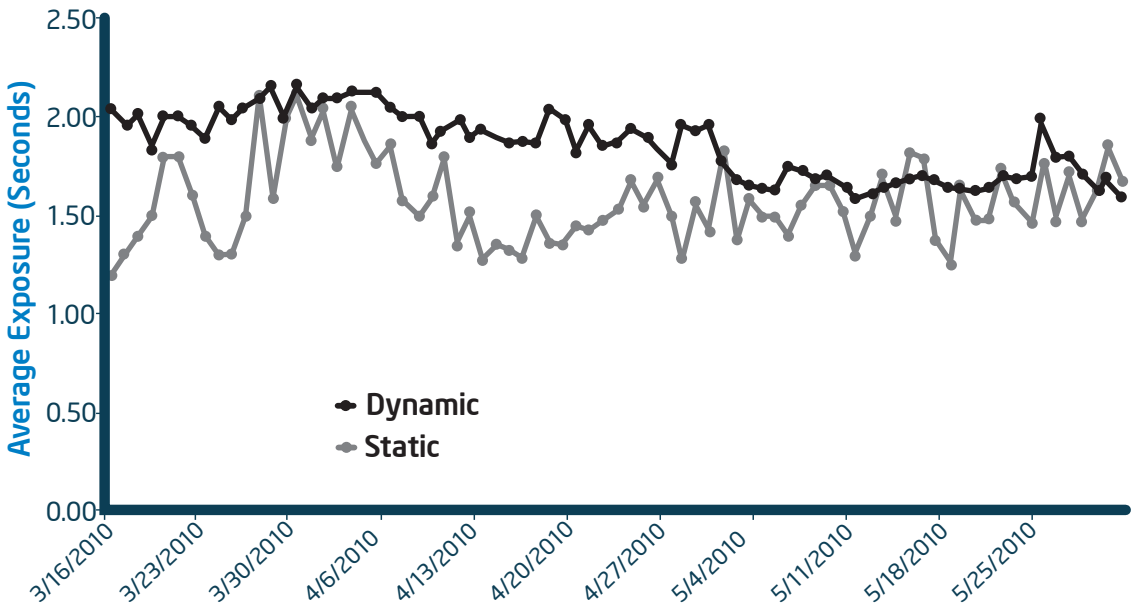
Exposure Time is the amount of time a viewer looked at the sign. Studies have found that pedestrian walking speeds are around 4.33 feet per second which would equate to an average Exposure Time for a guest in the field trial of 2.3 seconds to traverse the 14 to 4 feet viewing zone (10 ft. total) of the sensor.

In fact, the average viewer exposure time was 2.0 seconds and varied ± 0.3 seconds between screens over the measurement period.

Total Viewership by Month



Average Exposure per Day



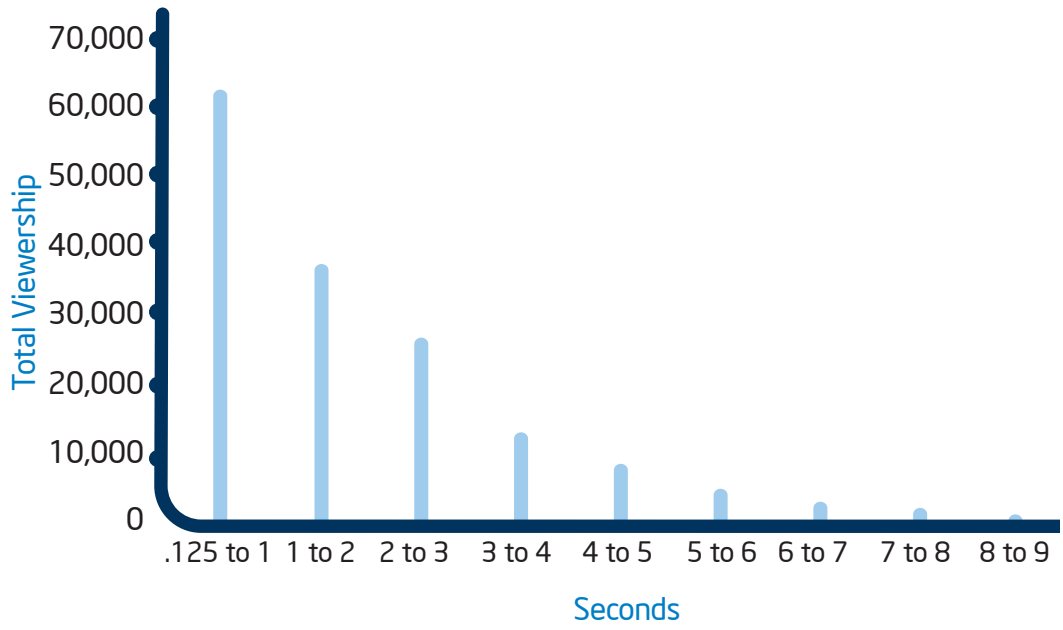
The data suggests that viewers consistently slowed down to take in the dynamic screens, spending 50% longer (2.0 seconds vs. 1.6 seconds) than for the static screens.

Breakdown by Audience Age and Gender

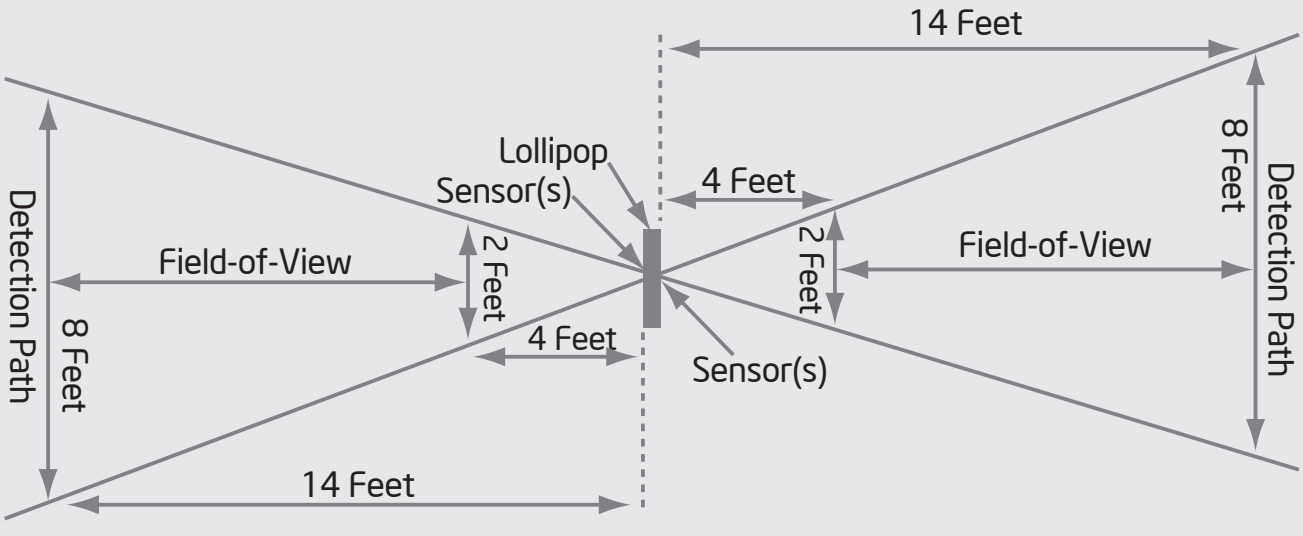
Demographic breakdowns of viewers are critically important to advertisers. The age and gender of viewers are two of the fundamental criteria used in making media buys.

Age: In the Intel field trial, the AVA technology identified nearly two-thirds of the audience in the young adult segment (16 – 35). Young adults outnumbered adults (36-65) by a 2-1 margin.

Exposure Range (in seconds)



Field-of-View

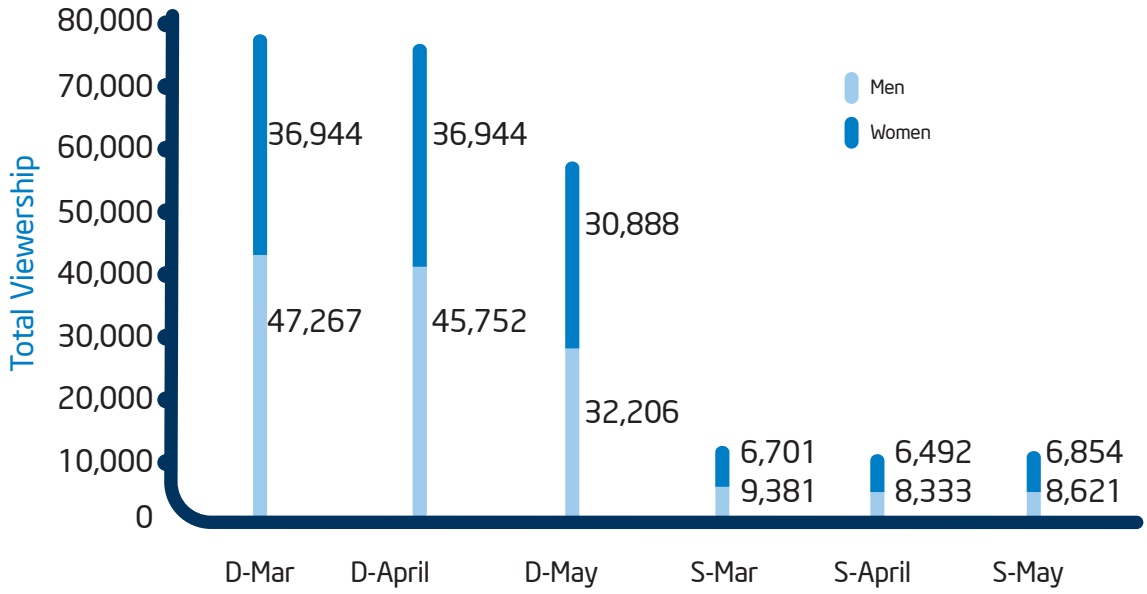


Gender: The gender breakdown roughly matched what is found in the population as a whole, with men slightly outnumbering women. When the gender breakdown was evaluated based on day of the week, it was found that the preponderance of men was more pronounced on weekdays than on weekends.

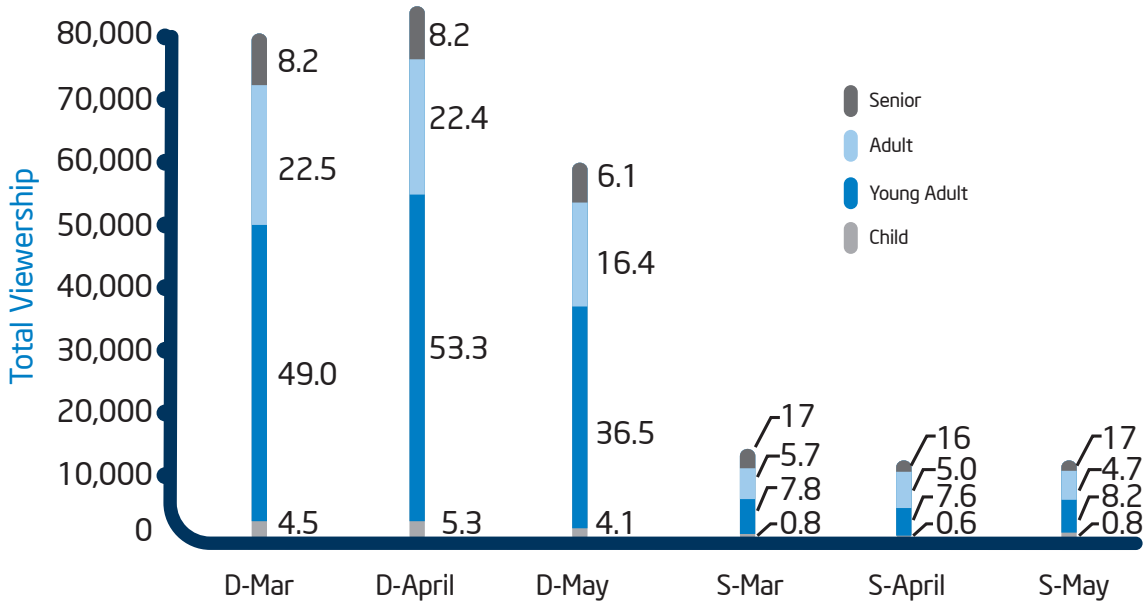
Variations in Audience Impression Metrics

One of the advantages of AVA is that it can capture time-based variations in audience impression metrics. This is

Viewership Profile by Gender by Month



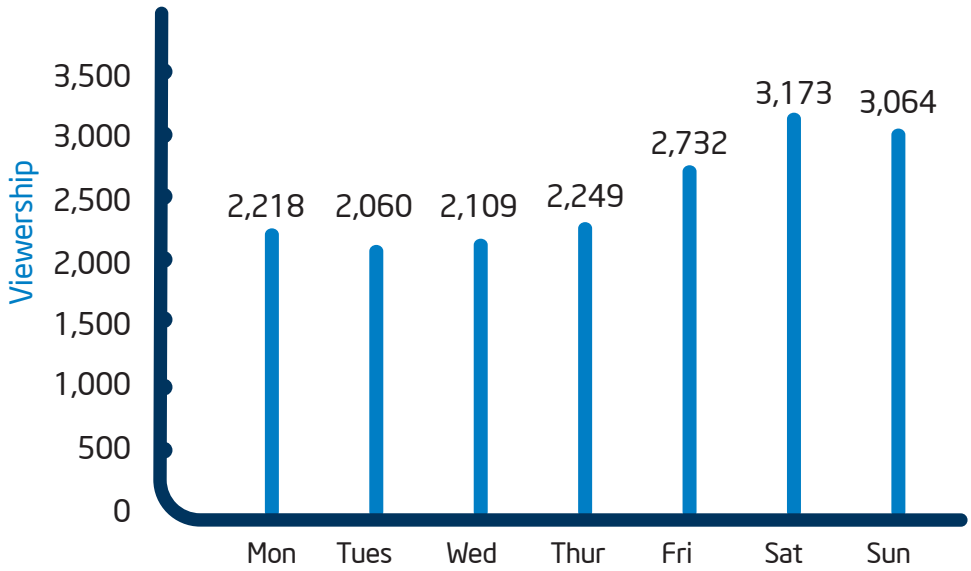
Viewership Profile by Age Group



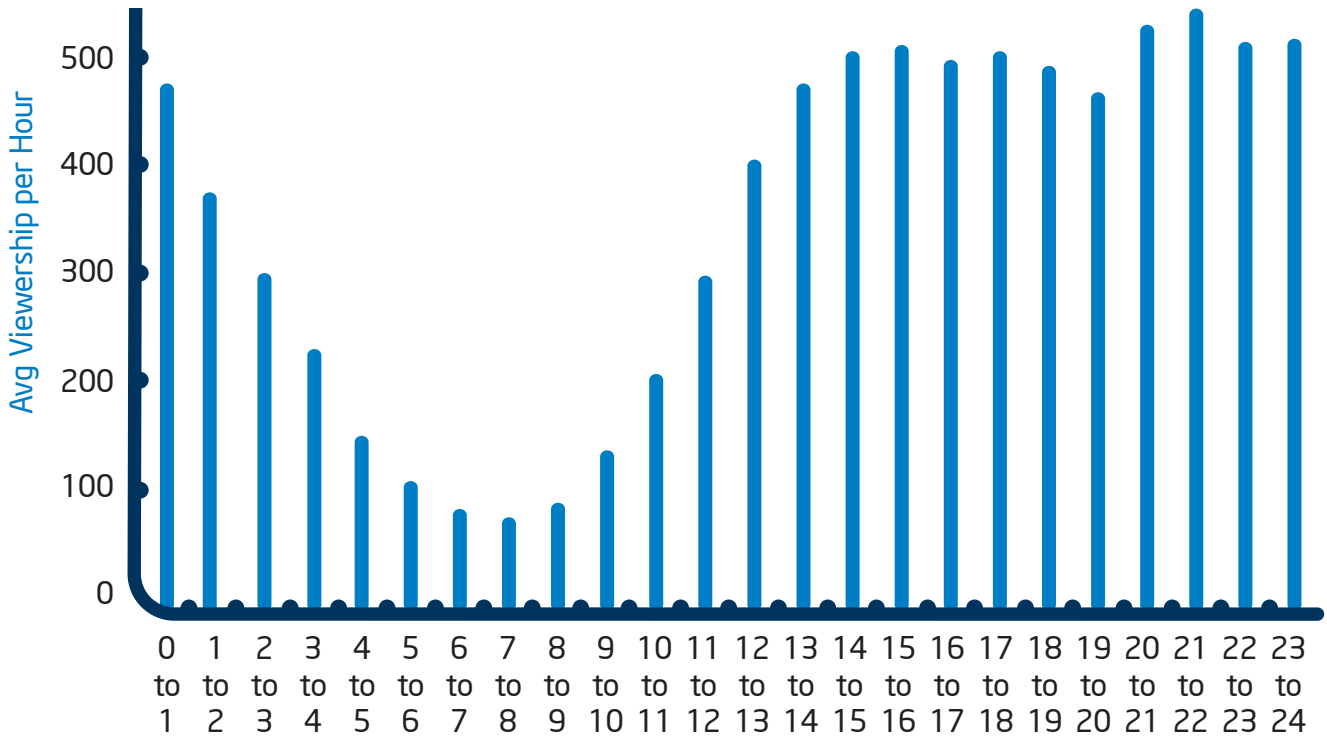
important for providing advertisers with detailed metrics for their specific creative. It can also provide the basis for time-based CPM pricing. The data gathered in the field trial showed significant variances by location, time of day, day of week, week of year, etc. This was true for total viewership, age and gender breakdowns.

Since it is likely that other digital signage networks will exhibit variances, this suggests that relying exclusively on sampling techniques (including time-limited AVA) will not lead to accurate audience impression metrics.

Average Viewership by Day of Week



Average Viewership by Hour of Day



POS Impact

Over a 14-day period in the field trial, dynamic and static posters featuring promotions for a bar and restaurant in the complex were tested and matched with the uptake for that promotion:

- Animated promotions were displayed from April 28th to May 4th (2 spots each out of 30 total spots) and same promotions were displayed using static signs from May 5th to May 11th

Interestingly, while the static posters were viewed an average of 3.5 times as often, the digital signs resulted in twice the uptake per viewer:

- The static themed bar promotion was viewed by 4 times the number of viewers versus the equivalent dynamic promotion (6.7% of the playlist length)
- The static restaurant promotion was viewed by 3 times the number of viewers versus the equivalent dynamic promotion (3.9% of the playlist length)
- However, the dynamic ads resulted in 2 times the uptake per viewer for both promotions versus the static promotion viewers

These results suggest that movement and engaging messaging intrigued viewers enough to act on the promotional retail offers. While this test was relatively small, it demonstrates the power of AVA to identify variations in the effectiveness of different creative.

III. CALCULATING ADVERTISING COSTS

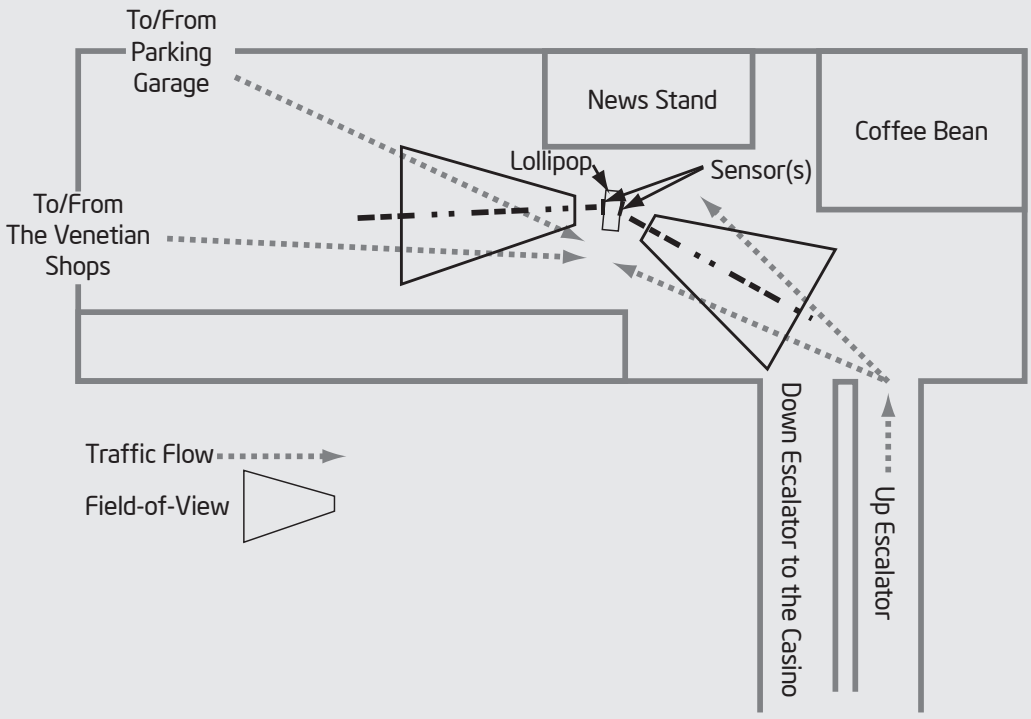
One of the primary goals of using AVA is to provide accurate audience impression metrics that make it possible for advertisers to evaluate their investment in one digital signage network vs. another or in digital signage vs. other advertising mediums (TV, radio, print, etc.)

Digital Signage vs. Outdoor & Broadcast

Measuring an audience for dynamic digital signage is different from measuring an audience for either TV/radio or traditional, static outdoor advertising (i.e., a billboard.)

- Outdoor advertising has traditionally relied on a metric based on total audience viewership. While this works for traditional, static advertising, it can produce an inaccurate result for dynamic digital signs because the length of the program (the loop of ads, or even just one ad) may be longer than the audience "dwell time." For example, if the dwell time of the audience is 10 seconds but the length of the dynamic digital signage program is 15 seconds, the "exposure opportunity" is reduced by one third. This reduces the total number of impressions delivered on behalf of the advertiser. TV and radio address this problem by relying on measures which count exposure of the audience for a specific time unit of programming.

Positioning the Sensor



- However, using a specific time unit of programming raises another difference, this time between broadcast and digital signage. In broadcast mediums, advertising is presented at set intervals and for fixed lengths (i.e., 15, 30, 60 seconds.) However, this uniformity does not exist in the digital signage world where there is no standard loop or even standard intervals. In effect, no single time unit is appropriate in digital signage.
- Finally, unlike TV, being within the proximity of a digital sign does not necessarily imply that there is an intention to view the sign (i.e., the person may pass by without looking). There needs to be some measure that evaluates "notice."

OVAB/DPAA Guidelines

To address these unique characteristics of digital signage, OVAB (Outdoor Video Advertising Bureau) recently renamed Digital Place-based Advertising Association (DPAA), developed a metric for out-of-home digital signage networks. This metric, the Average Unit Audience, is defined as:

> "The number and type of people exposed to the media vehicle with an opportunity to see a unit of time equal to the typical advertising unit."[2]

This metric—also known as "Opportunity to See" (OTS)—is based on three qualifying characteristics: Presence, Notice and Dwell Time.

- **Presence:** A person must be present in a location for which the vehicle is both visible and, where appropriate, audible.
- **Notice:** This is the additional qualifying characteristic that the viewer intended to look at the screen. To verify Notice in the Intel field trial, impressions were only counted when the system confirmed that the person looked at the screen for more than 0.125 seconds.
- **Dwell Time:** The Dwell time is the amount of time spent within the proximity of the sign by a person who has noticed the sign in this location. The dwell time makes it possible to calculate the exposures per time unit.

In the case of the Intel field trial, the 'message' or 'call to action' on the dynamic digital signs was visible during the entire 15 second animated ad. The average Exposure Time—the time it took to traverse the 10 feet within the field of view of the sensor—was 2.3 seconds. Thus, the average Exposure Time was sufficient for the viewer to see the message. This equates to an ad-view-per-exposure time unit of 1 for the field trial.

Calculating Advertising Costs

Applying the OVAB standard in the Intel field trial yields the following results:

Average number of viewers: 94,300 viewers per month per screen
Average 'Exposure Time': 2.3 seconds
Ad view per exposure time unit: 1
Playlist: 15 to 20 ads

Assuming a hypothetical $15 CPM for a 15 second ad, the cost of running an ad per screen at the field trial location would be $95 to $132 per month (using the exposure-per-time-unit of 1, dividing the average of 94,300 viewers per screen by the number of ads (15 or 20) and multiplying by the $15 CPM.

Because AVA captures metrics by hour, day, etc., the cost of advertising could be adjusted based on those factors. In the field trial, the variance ranged from prime-time hours when the audience measured 20% over the daily average to off-hours (i.e., 7-8 AM), when the audience measurement was approximately one-fourth the daily average.

Time-based CPMs may not be practical or desirable for all venues or advertisers, but the possibility does exist in digital signage, just as it does on broadcast mediums.

IV. BEST PRACTICES FOR AVA IMPLEMENTATIONS

One of the goals of the field trial was to develop best practices for AVA technology implementations. The key findings of the field trial focused on two areas: the sensor and the CPU

Choosing a Sensor

For AVA technology to be adopted broadly and found effective, the AVA sensor needs to be cost effective, able to adapt to a variety of lighting conditions, provide a reasonable field of view, and provide a depth of field that will allow an audience member to be detected from approximately five to twenty-five feet away from the display.

Currently available webcams and surveillance cameras offer low-cost deployment options for AVA sensors, but no single device is appropriate for all projects under all lighting conditions. In the testing period prior to the launch of the field trial, the following occurred:

From January 19th through March31, the AVA system counted:

- Digital signs: 300 viewers per screen per day
- Static signs: 70 viewers per screen per day.

This was recognized as being far below the expected audience traffic leading to a change in sensor technology. Analysis determined that the low light levels in the venue were resulting in performance challenges with the original sensor. Subsequently, the sensor technology was changed to use a sensor that functioned well in low light. As a result of the upgrade, the number of audience impressions increased substantially, while the ratio between viewers of digital and static signs remained comparable.

- The number of viewers of the digital signs increased 11 times from 300 to 3,200 viewers per screen per day.
- The number of viewers of the static signs increased 6 times from 70 to 420 viewers per screen per day.

Positioning the Sensor

During the field trial, different options were evaluated with respect to the positioning of the sensor.

Initially, the sensors were positioned parallel to the top of the sign. In this scenario, the average number of viewers was 2,615 per screen per day.

Later, the sensors were repositioned in the direction of maximum traffic flow and the average number of viewers increased more than 50% to 3,975 per screen per day.

In many cases, traffic flow may not be directly in front of a digital display so an externally mounted sensor that can be remotely repositioned may be preferable to an in-board sensor. Alternatively, coming up with sensor angling framework/ guidelines can provide "optimal sensor setup" instructions for varying scenarios.

Capturing Viewers with Opportunity to See

The AVA system should be able to count viewers who are looking at the display on an angle. CognoVision's Opportunity-To-See (OTS) module provided metrics to aid in this purpose during the field trial. The OTS module works by analyzing face-detection coordinates and motion vector history to determine the most common areas where people's faces have been found. It analyzes the motion paths of how people move and counts any individual who has been moving in a direction similar to those people whose faces were detected as a potential viewer:

- For individuals walking towards the display, if the system determines that they are moving in a similar fashion as viewers detected earlier, then the OTS count is incremented.
- If they are walking away from the display, in a general direction where people do not see the display, they were not counted.

A longer-term approach is to modify the face detection technology to specifically look for faces found at various angles. The OTS count capability was tested in May, and the ratio of OTS to viewers averaged 3.7:1.

As a result of the field trial, the following were identified as potential best practices/ guidelines for correct sensor placement and angling:

- The ability to install the sensor above or below a display
- The ability to secure the sensor angle and positioning so that the sensor does not move if it is touched after installation
- Clean aesthetics so the sensor looks like it is part of the display design - if the sensor is built into the physical display, design considerations must allow for adjustments to the sensor tilt to make final adjustments if needed
- Using sensors that can be positioned remotely would be a "nice-to-have" feature but also introduce potential mechanical points of failure and additional costs

Processor

The power of the processor is a significant consideration in any AVA deployment. Ideally, the CPU needs to be able to process 2.0 mega-pixel images at a 15 frame-per-second data rate. This will allow the system to detect individuals looking at the signage over a much broader area. In addition, while running AVA, the CPU also needs to be able to simultaneously display rich digital media (HD Video and high impact graphics) and be remotely managed and monitored.

In the near term, however, this is not practical since increasing the mega-pixel count exponentially increases the CPU performance requirements. For example, a Core 2 Quad operating at 3.0 GHz will not effectively support a 1280x960 resolution (1.2 Mega-Pixels) operating at 15 frames per second.

V. CONCLUSION

Equipping digital signs with anonymous video analytics capabilities—in a way that is compliant with emerging digital signage industry standards—makes it possible to provide actual audience measurement data. This data creates the "common currency" that enables advertisers to evaluate their purchases in digital signage against other mediums. It also provides a way for digital signage operators to optimize the design and management of their networks.

Overall, the trial demonstrated that AVA is a reliable and accurate measurement system, proving effective in measuring the total viewing audience while also pinpointing key demographic breakdowns and variations in viewership. The field trial was successful in providing data that can be used in the calculation of CPMs in compliance with OVAB/DPAA standards. The field trial also identified important issues with regard to sensor positioning, field-of-view and processor power that can be used in developing best practices/ guidelines for AVA implementations.

APPENDIX: HARDWARE USED IN THE FIELD TRIAL

The digital displays used the following components:

- **Hardware** (Micro Industries): Independent, back-to-back Touch & Go Messenger 46P digital display computers using a high-brightness LCD screen, an Intel 2.16 Core 2 Duo Processor, an mTG945 motherboard, Windows XP and an Axis M 1011 video sensor with 640x480 resolution.
- **AVA Software:** CognoVision's Anonymous Impression Metric System (AIM) has real-time face detection technology. AIM is built specifically for the purposes of audience measurement and retail intelligence and has been designed to respect people's privacy; no personal information is collected and no images or video are recorded.

- **Digital Signage Management System:** mCosm's (a subsidiary of Micro Industries) Digital Signage Management System creates, manages, schedules and deploys media to specific signs. mCosm's Runtime Client links the hardware to the applications, insures hardware and software security and allows the system to be managed and monitored remotely.
- **Remote Managed Services:** The digital signs used mCosm's Enterprise Management System, integrated with Intel's Active Management Technology (AMT) 4.0, to remotely monitor and manage all hardware and software activity on each Messenger digital display system. It immediately detects and diagnoses errors, then generates an automated alert that is sent to the mCosm Remote Support Team. AMT 1.0 was used to change configurations and remotely reboot the system when needed. Since The Venetian Las Vegas and The Palazzo Las Vegas are open 24 hours a day, the AMT's "soft-off" mode was not used during the field trial.
- **Monitoring Technology:** During the testing period, Logitech webcams were used and were then replaced with Axis sensors in early March.
- **Data Collection:** mCosm's Enterprise Management System captures system performance data from Windows; digital media proof-of-play from the mCast digital signage management system, and audience impression metrics from CognoVision's Anonymous Impression Metric system. The collected data is stored in a SQL Database. It is then correlated with audience impression metric data using CognoVision's web-based data analysis application.

A special thanks to John Curran of mCosm for his contributions to the field trial and analyzing critical data points.

[1] Bunn, Lyle. "Economic Upswing." Media Planet, Wall Street Journal Apr. 2010. 1 May. 2010 <http://pro.sony.com/bbsccms/assets/files/app/digsignage/articles/ziriscanvaswsjapril2010.pdf>.

[2] OVAB Audience Metrics Guidelines, 2008

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