DOOH AUDIENCE IMPRESSIONS

MEASUREMENT METHODOLOGIES AND MODELS

version 1.4

Quividi

www.quividi.com

INTRODUCTION AND OVERVIEW

Quividi is the largest independent international digital out-of-home audience measurement provider in the world, measuring billions of advertising audience impressions every month.

This document serves as a technical disclosure of Quividi's audience measurement model and methodology for:

1. Advertisers:

- Digital (online) media buyers who wish to evaluate and execute digital out-of-home campaigns alongside other digital media.

- Out-of-home (classic) media buyers who wish to evaluate and execute Quividi-enabled out-of-home campaigns alongside other out-of-home media.

2. Publishers:

- Digital out-of-home media owners (publishers) that use Quividi over direct as well as programmatic channels.

- Digital out-of-home publishers that do not yet use Quividi and are looking for a DOOH audience measurement solution – often because they are enabling programmatic trading.

3. Accreditors: audience auditors who wish to evaluate Quividi's model and methodology for the purposes of measurement accreditation.

The content is divided into 3 sections:

1. What is an Audience Impression? In this section, we describe the technical qualities of an audience impression, independent of measurement method and medium (cross-platform).

2. How does Quividi Measure Audience Impressions? In this section, we describe the technical parameters of Quividi's computer vision technology for measuring cross-platform audience impressions.

3. How does Quividi Compare to Other Methods? In this section, we contrast Quividi's level of accountability with other measurement methods, notably those using mobile data.

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1. WHAT IS AN AUDIENCE IMPRESSION?

In this section, we define what is an audience impression, describe its technical qualifications and detail our rationale in the context of international standardization efforts by the major buyers and sellers of media, both online and in out-of-home.

The definition of an audience impression used in this document is independent of Quividi's measurement methodology and can be used to qualify impressions for other digital media (cross-platform) and for other non-Quividi detection methods as well.

1.1. HISTORICAL CONTEXT

At the time of this writing, online ad measurement standards are incompatible with out-of-home due to their assumption that each ad, desktop or mobile, video or display, is exposed to precisely 1 individual: the user of the device. By contrast, in out-of-home, ads are often seen by more than 1 individual, or could inversely be seen by no-one (for instance at night). Furthermore, the campaign calendar used in classic OOH means that audience is reported on an aggregate basis (e.g. per week).

The digitization of out-of-home and programmatic transformation are driving these seemingly disparate standards to converge. Here we will demonstrate that they agree on one fundamental thing: when we count audience impressions, we are looking to come as close as possible to the actual number of viewers of the ad.

We will compare the primary standards drivers:

1. 3MS (Making Measurement Make Sense) for Online
2. ESOMAR for Classic OOH
3. DPAA for Digital OOH

1.1.1. 3MS: ADVERTISING MEASUREMENT ONLINE

A global consortium of the major buyers and sellers of digital (online) media started in 2014, called Making Measurement Make Sense (3MS), has been guiding the evolution of audience metrics in order to unify all digital channels into 1 common cross-platform audience currency.



Figure 1: Founded by American Association of Advertising Agencies (4A's), the Association of National Advertisers (ANA), and the Interactive Advertising Bureau (IAB). The Media Rating Council (MRC).

Their first major initiative was to create a new standard for advertising impressions, which was dubbed the "Viewable Impression". The qualities of a viewable impression, the viewability condition, has 4 parts:
1. It must be measured client-side in the browser
2. 50% of more of the ad content's pixels must be shown on the screen (unobstructed)
3. For 1 second for display ads (banners) and 2 seconds for video ads
4. It must filter out invalid traffic (bots) and sophisticated invalid traffic (ad fraud)
Today, advertising online is traded based on this model.

1.1.2. ESOMAR: ADVERTISING MEASUREMENT IN CLASSIC OOH

The ESOMAR out-of-home guidelines was published in 2009 in consortium with the major global buyers and sellers of out-of-home. It is almost identical in principle and in spirit to the 3MS standards, except it was addressed to the needs of OOH. Instead of the term "viewability", ESOMAR uses the term "visibility". Instead of the word "impression", they use the word "contact".



Figure 2: Published in 2009 by ESOMAR Research, the American Association of Advertising Agencies (4As), China Association of National Advertisers (CANA), FEPE International, European Association of Communications Agencies (EACA), Media Rating Council (MRC), Outdoor Advertising Association of America (OAAA) and the World Federation of Advertisers (WFA).

ESOMAR introduces the concept of visibility adjustment, which is to take a more easily available metric like raw traffic numbers, aka circulation, and to discount it to only the portion of traffic which had a reasonable likelihood to see the ad. The resulting metric is called the "Visibility Adjusted Contact" (VAC). Most of OOH globally is traded on VAC or a regional derivative.

1.1.3. DPAA: ADVERTISING MEASUREMENT IN DIGITAL OOH

In parallel with the activities of the "classic" out-of-home industry, the Digital Place-Based Advertising Association also published standards for digital out-of-home which reflect the spirit of the standards established online and in classic OOH. Their term for a currency is the Average Unit Audience (AUA), which is to say the screen audience during an average ad play. Again, great care is taken by the DPAA to describe a model where what is being counted is the actual audience, discounted from a larger, less qualified, traffic number.

1.2. A PEEK INTO THE FUTURE

While the previously mentioned standards use slightly different jargon, they are united in their desire to get as close to the actual number of viewers for an ad as possible. Quividi's audience measurement methodology and model is a proposal that is both future-safe and compliant with the state-of-the-art in audience measurement standards today.

1.2.1. FUTURE-SAFE CROSS-PLATFORM METRIC

The latest roadmap published by 3MS has a currency based on human-valid, in-target impressions next.

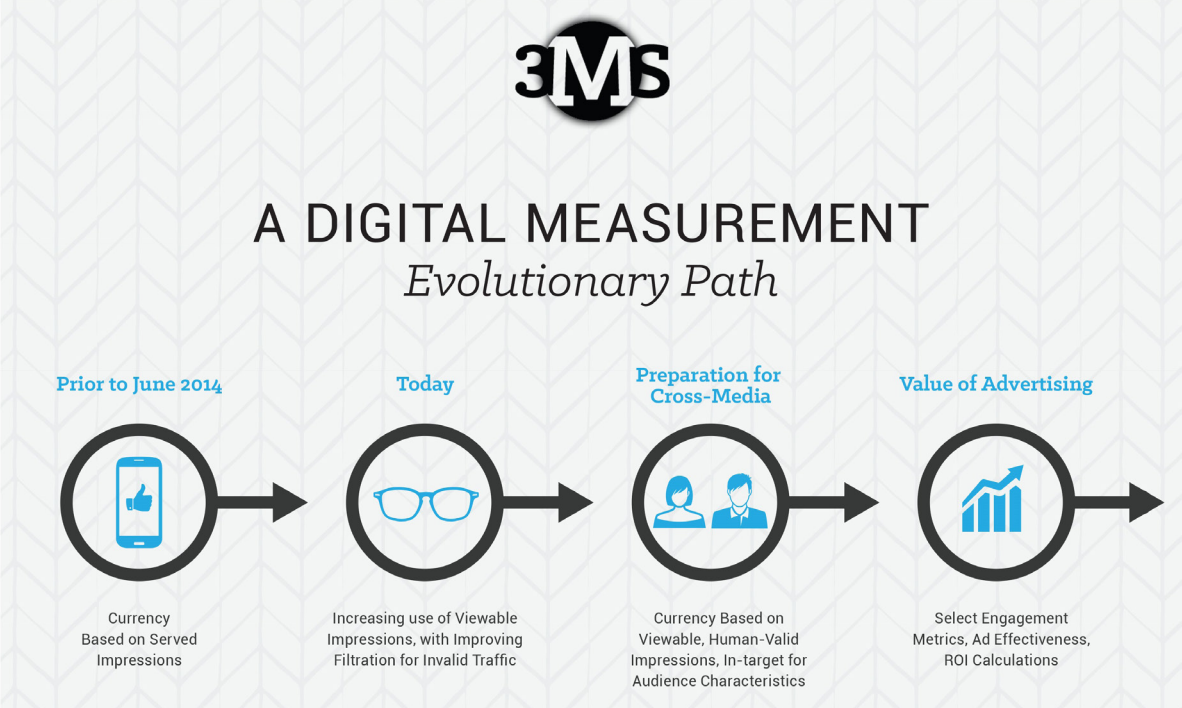


Figure 3: 3MS Roadmap for advertising measurement.
Quividi is already ready for cross-media and is also working in the field of ad effectiveness and ROI.

The model and methodology described in this document, meets or exceeds the highest requirements of all the standards that were just listed and fits into their respective roadmaps. This makes the model and methodology described in this whitepaper future-safe.

1.2.2. HUMAN VALIDITY

The 3MS is working to unify audience currency across media platforms via human-validity and viewability. The DPAA encountered the human-validity problem, while determining its programmatic standards. Both say the same thing: if the ad is shown and no one is there to see the ad, it does not count. If many people see the ad, it counts for as many impressions.



Figure 4: Buyers only want to pay for real human beings that saw their ad. Online and DOOH are coming at it from different perspectives.

INVALID TRAFFIC FILTRATION	IMPRESSION MULTIPLIER
Online ad impressions are expected to be displayed to 1 person at a time due to the personal nature of desktop or mobile ads. If the ad never appeared on the screen or are due to bots, the ads don't count. 3MS coined this as "Invalid Traffic Filtration".	In DOOH, ads routinely reach more than 1 person. The DPAA coined this as the "Impression Multiplier". This is essentially quantifying human-valid ads. If no one is there, the ad does not count.

1.3. THE DEFINITION OF AN AUDIENCE IMPRESSION

An ad is considered viewable in DOOH if it is qualified from two reciprocal perspectives: the audience's, focused on their qualified presence in front of a screen, and the screen's, which is focused on the qualified exposure of the advertisement in question. Both conditions at the same time for 1 second or more for a particular ad is qualified as an audience impression.



Figure 5: The definition of a DOOH audience impression in DOOH used in this document.

1.3.1. QUALIFIED AD EXPOSURE

An ad exposure is qualified to be viewable if the ad is playing correctly as intended (no video aberrations or dropped frames) and, simultaneously, if the display is powered on and displaying the ad on its surface.

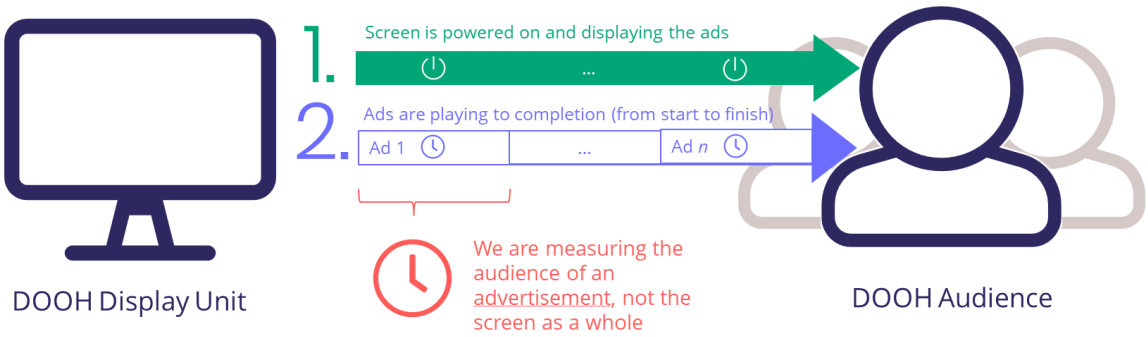


Figure 6: For an ad exposure to be Qualified, it needs to be playing the correct content and simultaneously the screen must be powered on and displaying that content.

If there is no audience presence, then the exposure is not qualified for audience impressions. This means advertisers only pay for human-valid impressions and do not pay for ad exposures when no one was there.

1.3.2. AUDIENCE PRESENCE VS NOTICE

A long-standing debate between ad buyers and sellers is the definition of what is being bought and sold. Is it when the ad was noticed or when the ad was played in their presence?

While the spirit of all advertising measurement standards is to arrive to as close as the count of individuals that saw a particular ad as possible, this can be biased to a degree by the quality of the ad creative content. This is why we distinguish between notice (aka attention) and qualified presence (aka an impression) which we define as the angle of head rotation (120°).

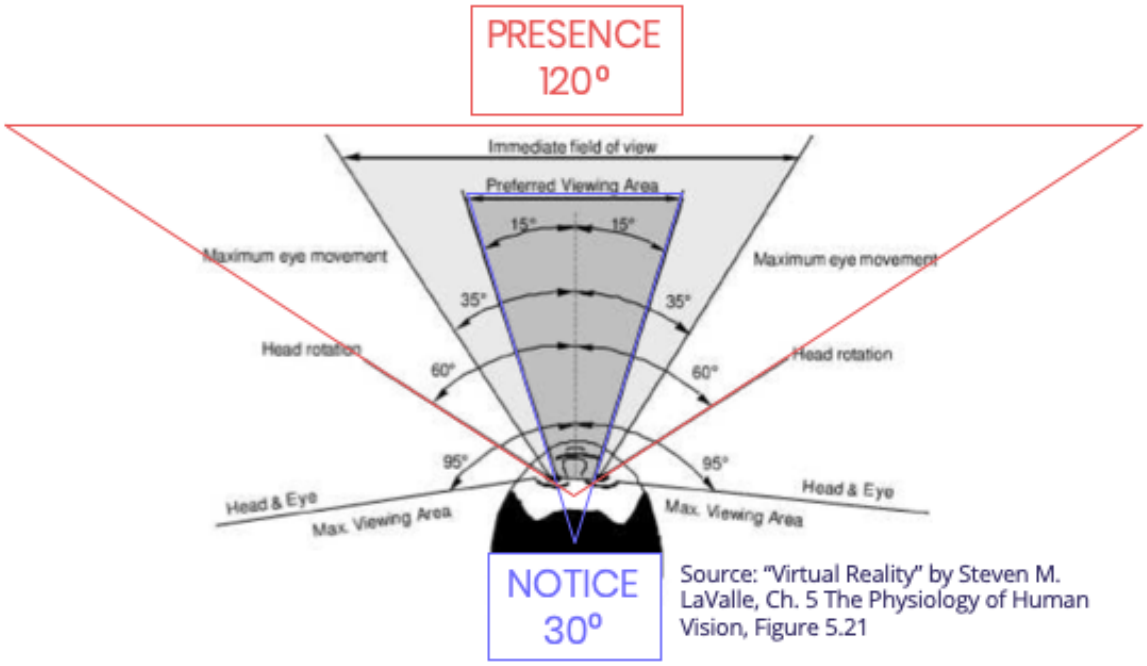


Figure 7: Two different ways of counting audience.
Presence is based on the opportunity to see while Notice is based on the quality of the audience interaction.

The standard today is to trade based on Audience Presence, but to qualify that presence to be as close to the actual audience as possible. Online advertising standards qualified that presence via the Viewability Condition; OOH via the Visibility Adjustment.

Notice, being a function of the creative execution of the ad, is a separate domain of ad effectiveness measurement compared to the advertising transaction audience currency. For example, a campaign that uses a poor ad creative that does a poor job at communicating should pay the same price for the media as someone that uses that media more effectively.

This isn't to say that data about the quality of notice is an ad isn't a key metric to help

design better creative and get more value for the media investment. Quividi provides notice via its Attention metric. We are just saying that it is not the basis of the audience currencies nor online, nor out-of-home.

1.3.3. FIELD OF VIEW AND VIEWING ANGLE

When the audience is said to be facing the screen, we say the screen is “In View”; otherwise, it is “Not In View”. A person’s facing direction is important because they cannot see an ad that is behind them. A person’s field of view is up to 120° wide centered on their facing direction. Everything within the field of view is considered “In View”, else it is “Not In View”.

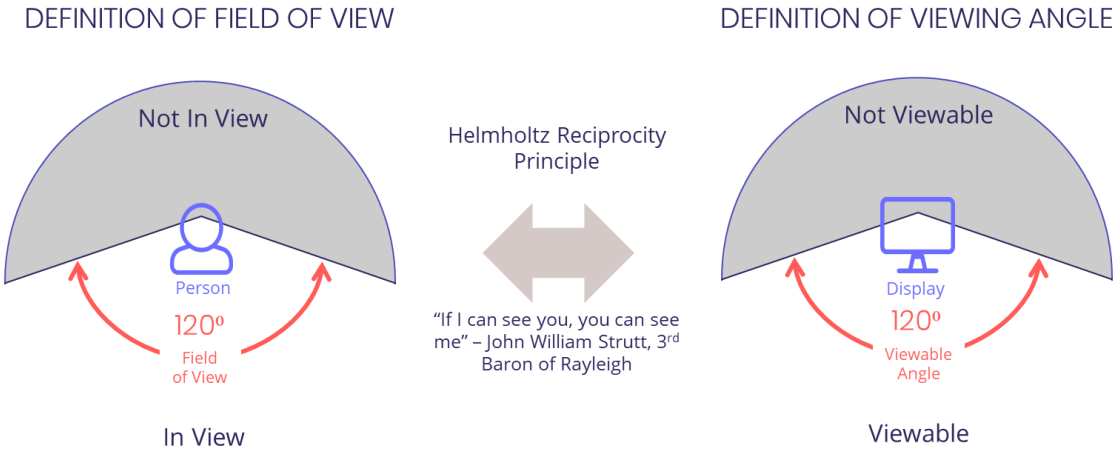


Figure 8: The angle of field of view of the audience corresponds to the viewing angle of the display

A screen has a viewable angle which corresponds to the audience field of view due to Helmholtz reciprocity principle. Note, the viewable angle is the lesser of the two between 120 degrees and the display technology’s own viewing angle. Additionally, as explained later, occlusions in the field of view such as opaque walls, columns and even people will affect the viewable angle.

1.3.4. AUDIENCE PRESENCE AND THE SCREEN’S VIEWING DISTANCE

A larger screen can be seen from further away than a smaller screen, which means a larger screen area has a larger viewing distance than a smaller screen. Since there are no public viewing distance standards in out-of-home, we have worked to determine a universal formula which may survive scrutiny across media (out-of-home and online).

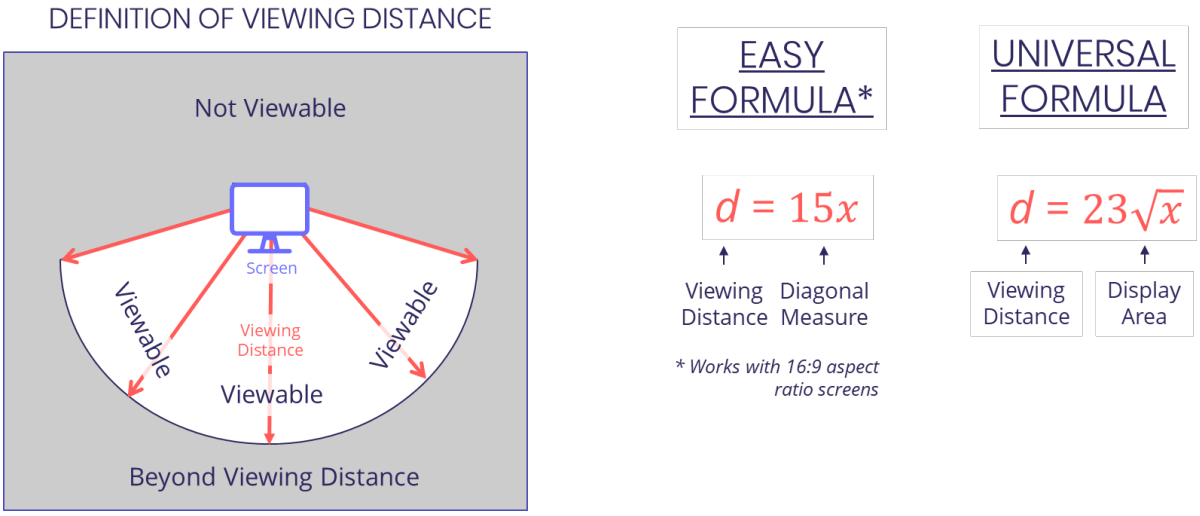


Figure 9: The radius formula is based on Federal Highway Administration (FHWA) standards and directives.

The formula to calculate the viewability distance for a screen is to multiply the square root of the display area by 23. A shorthand version for 16:9 aspect ratio screens is to multiply the diagonal measure of the screen by 15. We based our formula on the Federal Highway Administration (FHWA) standards and directives for road traffic signage, which is used the world over.

EASY FORMULA*

$d = 15x$

Viewing Distance Diagonal Measure

VIEWING DISTANCE (CROSS-PLATFORM)

	Mobile	PC	TV	LED
Diagonal (d)	5 in	15 in	50 in	152 in
Area (*a*)	± 10 in²	± 100 in²	± 1000 in²	± 10000 in²
Radius (*r*)	6 ¼ ft (1.92 m)	18 ¾ ft (5.77 m)	62 ½ ft (19.2 m)	190 ft (58.5 m)

Figure 10: The formula scales well to other types of screens as well as demonstrated in this table.

1.4. DOOH AUDIENCE IMPRESSIONS ILLUSTRATED

Using the definition of an audience impression elucidated earlier in this document, we illustrate it using some basic scenarios.

1.4.1. FACING DIRECTION: TOWARDS NOT AWAY

One of the fundamental questions regarding what constitutes an impression pertains to facing direction. We do not consider someone who is facing away from the screen a member of the audience.

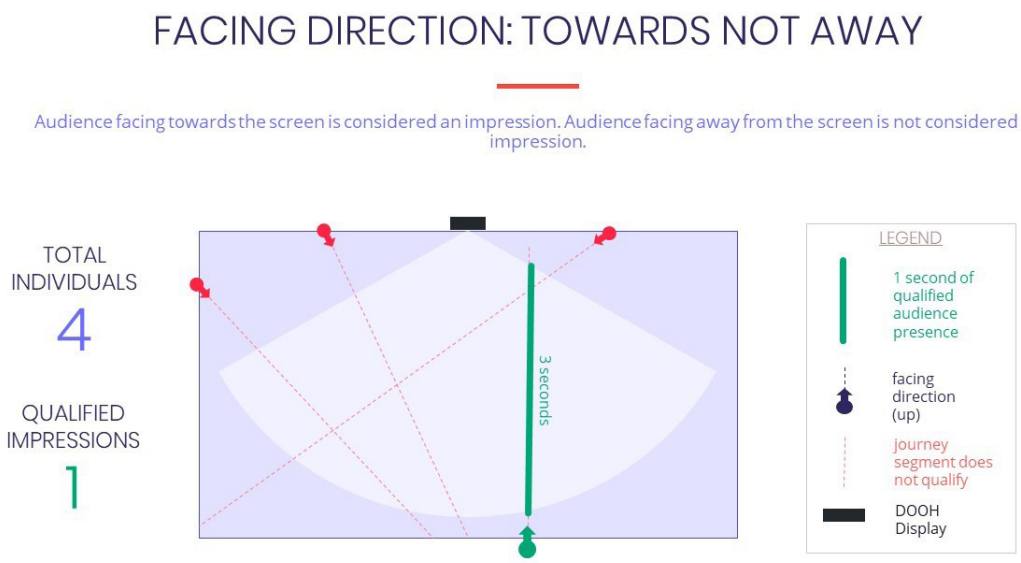


Figure 11: In this diagram only 1 out of 4 individuals that crossed into the viewability zone qualified as facing towards (in green).

1.4.2. PERPENDICULAR CROSS-TRAFFIC

Audience which is perpendicular to the screen is considered viewable if the screen is within view and not otherwise. This means that cross-traffic has qualified presence for only the part of the journey where the screen is in view.

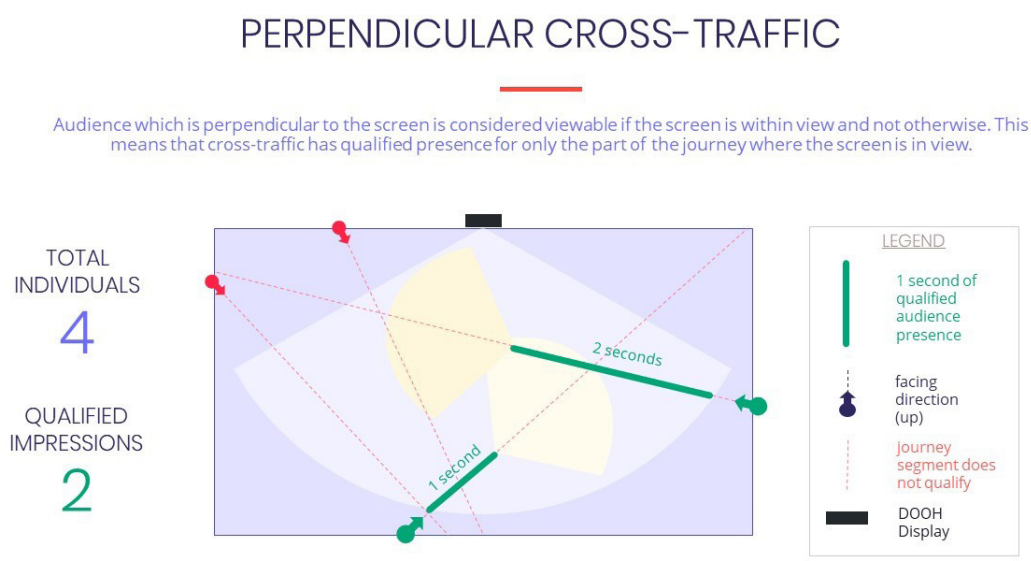


Figure 12: A person walking perpendicular to the screen, only has the screen in view for part of their journey. Once the screen is not in view, we cannot include them in audience presence.

Note, this does not consider the fact screens that are perpendicular to foot traffic also have higher rates of occlusion (humans temporarily occluding other humans). This is the next scenario.

1.4.3. CUMULATIVE UNOCCLUDED DURATION

For an ad to be considered viewable, the audience needs qualified presence and the ad needs to be exposed on the screen (both) without occlusions for a cumulative duration of at least 1 second. If there is something blocking the view of the screen, the ad is not considered viewable. A temporary interruption in viewability along an individual's path for a small occlusion like a column does not disqualify an ad from being viewable in whole. It only interrupts the viewing duration which is evaluated cumulatively.

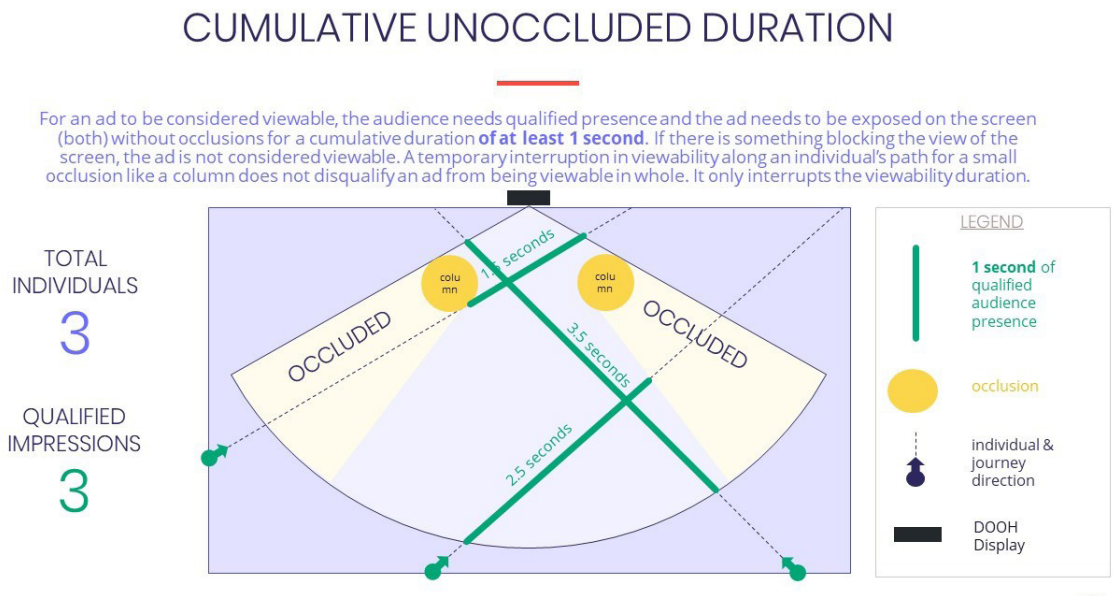


Figure 13: Here all 3 individuals qualify as impressions since they are all unoccluded for at least 1 second.

In a cross-traffic scenario, individuals would have their view of the screen occluded temporarily, and if it was particularly busy some might never have a clear view of the screen.

2. HOW DOES QUIVIDI MEASURE AUDIENCE IMPRESSIONS?

Quividi reports audience impressions, as defined above, using its flagship computer vision software platform that runs on commodity hardware and that integrates into the DOOH display unit and its content management software. That is a mouthful. We will break it down in this section.

2.1. QUIVIDI SETUP

Quividi's software and its corresponding requirements (e.g. a camera) are setup by a DOOH publisher. This section will explain the moving parts and operational parameters that contribute to the performance of Quividi's detection.

2.1.1. HARDWARE REQUIREMENTS

Quividi is hardware agnostic which means it can run on virtually any computer, on Windows or Linux, Intel or ARM. It can run using virtually any camera (built-in, USB or IP cam). It is integrated with virtually any DOOH CMS (3rd Party) and reports back securely over virtually any internet connectivity method.

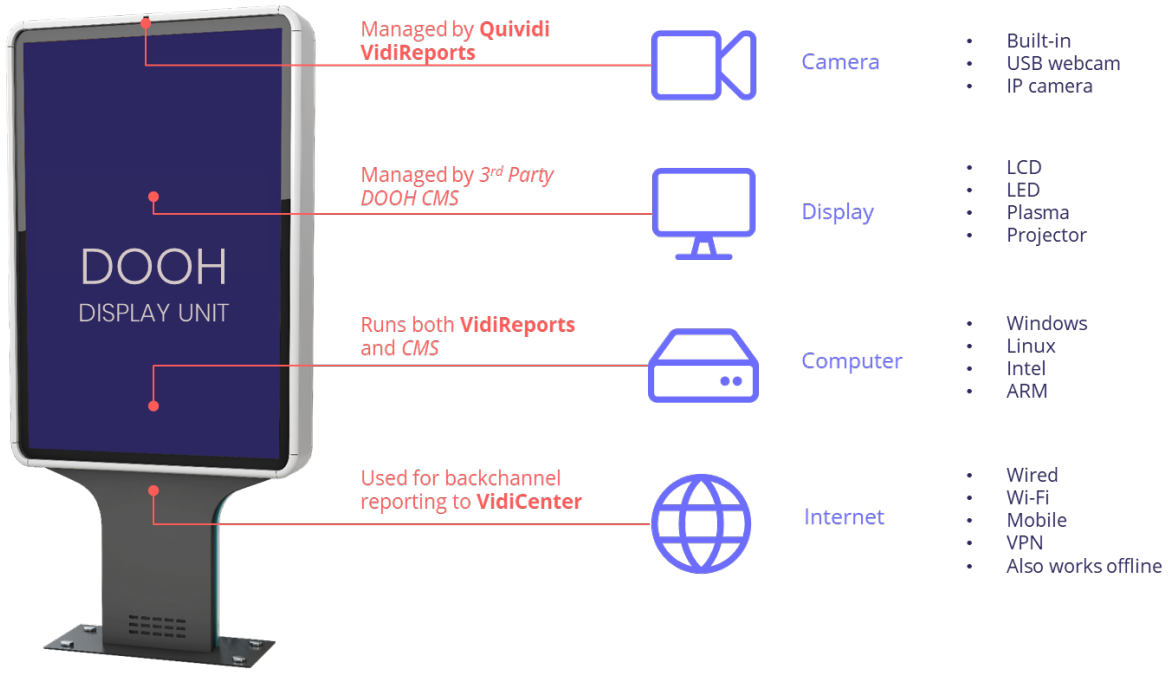


Figure 14: The pieces of the puzzle to setup and operate a fully-measured digital out-of-home display unit.

2.1.2. QUIVIDI AD MEASUREMENT DATA FLOW

Quividi has 2 main components: VidiReports and VidiCenter. VidiReports runs on the edge on the DOOH display unit's computer. It processes the camera video stream using its face detection algorithm and combines it with real-time proof of play data from a 3rd party DOOH CMS player which is then uploaded securely to VidiCenter, a tamper-proof web-based analytics dashboard.

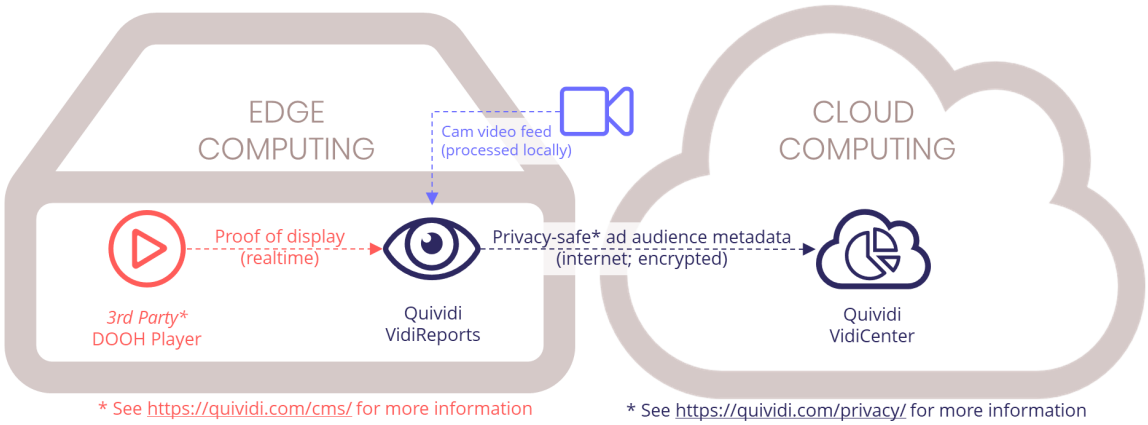


Figure 15: Illustration of software entities (DOOH Player, VidiReports and VidiCenter) and the secure data flow between them.

Quividi communicates with the 3rd Party CMS using a protocol that acts as an accountability handshake between the audience measurement platform (Quividi) and the content management system (3rd Party). Both Quividi and the CMS get each other's data which means they can act as a redundant verification against the other. Not all CMS's support this 2-way reporting, however. If they do not, Quividi acts as the sole reporting data source.

2.1.3. DETECTION ZONE DEPTH: CAMERA FIELD OF VIEW

For optimal face detection, cameras should be placed at eye-level and should remain within 15° of tilt up or down. Lighting also affects detection characteristics. For example, an off-the-shelf webcam will miss much of the audience if there the audience is not well lit, and the screen is in the dark.

A pixel resolution does not always match to the same detection distance. For example, 2 cameras may have identical resolutions, but one is a regular web cam and the other is a wide-angle camera. They may have the same pixels, but one uses the pixels in depth while the other does in width. This means the wide-angle camera cannot see as far and the typical web cam cannot see as wide.

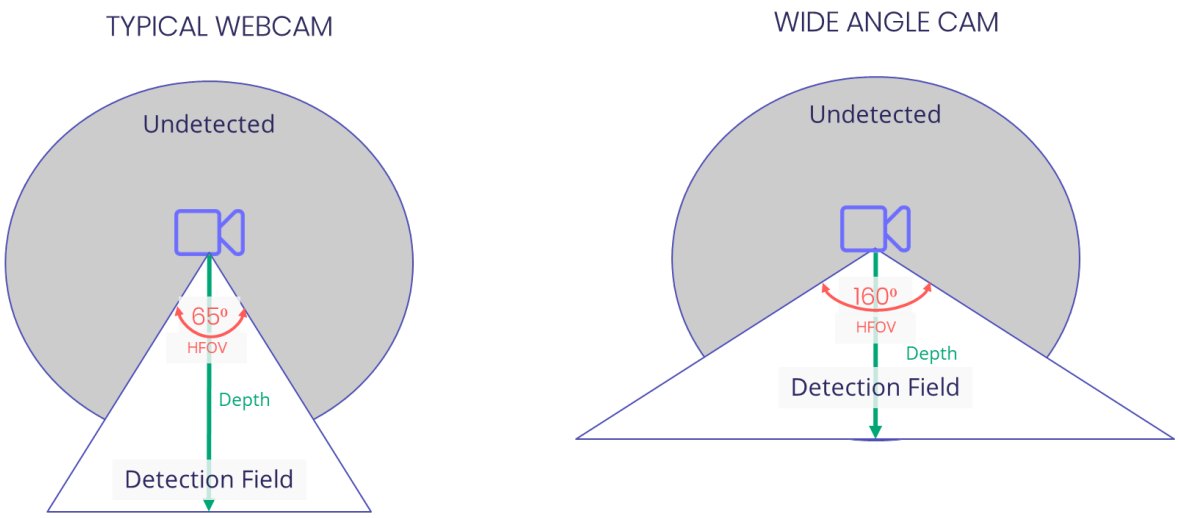


Figure 16: A side-by-side comparison of cameras that have similar pixel resolutions, but different FOVs (field of view).

2.1.4. DETECTION ZONE DEPTH: CAM RESOLUTION (&CPU)

Quividi software requires a minimum amount of computer power at the edge in order to process the video from the camera to detect the audience and report it back to cloud. The biggest driver of computer requirements is the resolution of the video from the camera, which is itself tied to the maximum detection distance of the measurement system.

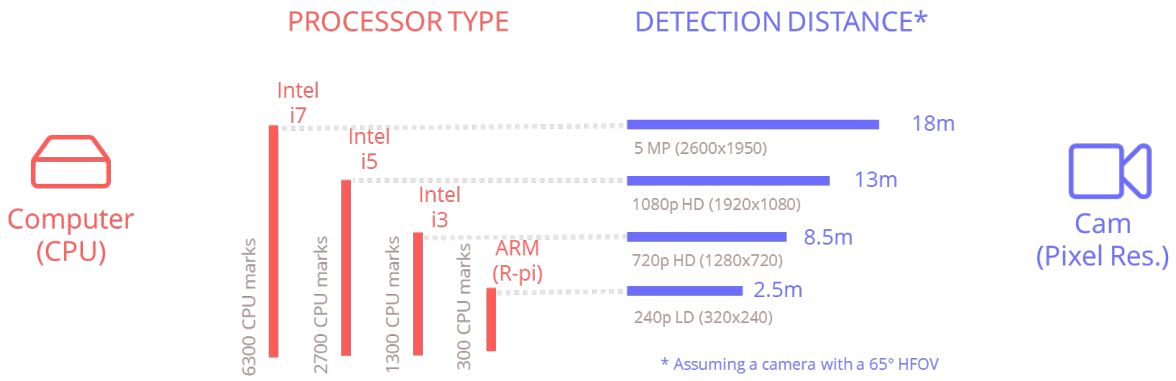


Figure 17: Longer detection distances means higher resolution cameras which means requires higher CPU horsepower.

VidiReports needs to process a minimum of 8 video frames per second for proper detection. Some computers are configured to not use the full resolution of their cameras in order to conserve computer resources.

2.2. PRIVACY-SAFETY

Quividi doesn't store any uniquely identifiable data, image or video. It only stores anonymous data that describes the size, the demographics and the engagement of an audience.

Quividi has been certified by ePrivacy and has received the ePrivacySeal.



Figure 18: "After an extensive technical and legal review the product „VidiReports" of QUIVIDI has been certified by ePrivacy and received the ePrivacyseal." -- https://www.eprivacy.eu/en/customers/awarded-seals/company/quividi-sas/

For more information, please refer to Quividi's privacy site: https://quividi.com/privacy/

2.3. AUDIENCE METADATA

This section describes the metadata generated by Quividi's measurement technology.

2.3.1. FACE DETECTION AND ATTENTION

A face is detected if it is well lit and not occluded (even partially), it is within the field of view and detection distance of the camera (based on the FOV and fixed resolution of the camera), and it is facing up to 45 degrees either left or right from the center of the camera.

Since Quividi's qualifications for a Watcher are stricter compared to the audience impression standard (90 vs 120 degrees), Quividi's detection is a suitable "ground truth" metric from which to derive the audience impression metric.

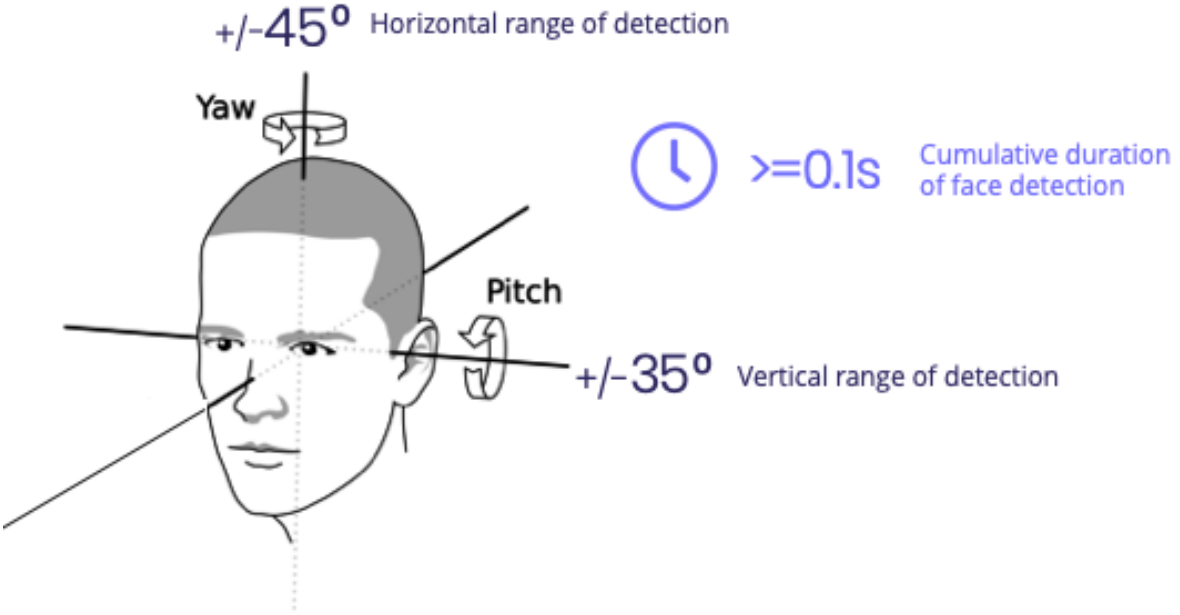


Figure 19: An illustration of the parameters Quividi uses to measure audience impressions. The yaw (horizontal range) of detection is +/- 45 degrees and the pitch (vertical range) of detection is +/- 35 degrees with respect to the camera.

When a face is detected, this is called a Watcher in Quividi's system. There are some mechanisms such as masks and algorithms that can detect and filter out false positive faces such as faces on posters in the background. Quividi VidiReports measures attention by measuring the cumulative duration of successive detections of the same face.

Quividi uses a technique to track the same person as they enter and exit the detection zone that does not use biometrics or recognition. If the same person exits and comes back, Quividi detects them as a new person.

2.3.2. AD AUDIENCE METADATA EXPLAINED

With its computer vision audience detection technology, Quividi tracks key information about the audience of a particular advertisement exposure. This is used to qualify detected audience which is then adjusted to estimate actual audience impressions. Below are the dimensions of privacy-safe audience metadata tracked by Quividi.

Content		Behaviour		Demographics		Impressions	
Content	Campaign	Attention	Dwell	Gender	Age	Detected	Estimated
The media file that is playing including start time, duration and other info.	The ad campaign the content belongs to. Can link back to the advertiser.	Cumulative duration of the detected audience in the notice state. This represents audience engagement.	Cumulative duration of the detected audience in the presence state.	Classifies audience members as either a male or female.	Classifies audience members into age groups (12-17, 18-24, 25-34, 35-44, 45-54, 55-64, 65+).	Watchers Quividi's "ground truth". They are a verified and pre-require measurable attention.	The verified detection metric is adjusted to the actual audience impressions for that ad.

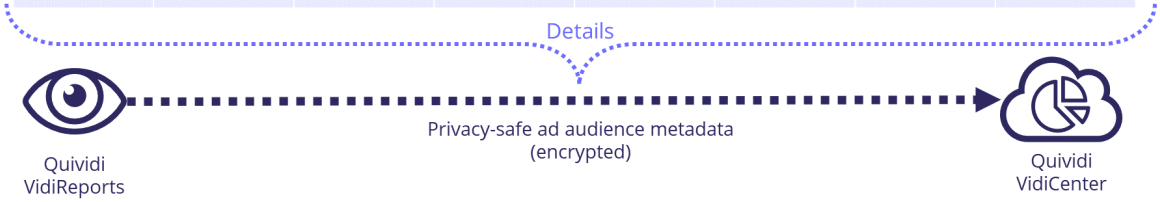


Figure 20: A view into the data tracked by Quividi for the purposes of audience impression measurement.

2.3.3. KNOWN ACCURACY OF QUIVIDI DETECTION

Quividi's VidiReports has high enough accuracy levels to be used as a key audience data source by discriminating DOOH publishers. The following accuracy levels are based on Quividi's own analysis, which is repeated periodically using industry standard data sets. This is auditable but has not yet been audited by a third party.

Detection	Attention	Gender	Age Class*
96%	95%	88%	75% - 95%

* VidiReports Pro has 75% age class accuracy and VidiReports Expert has 95% accuracy +/- 10 Years.

2.4. DOOH CLIENT-SIDE MEASUREMENT

A key aspect of Quividi's measurement mechanism which makes it cross-platform is the integration with the content management system which is playing the ads. This gives Quividi the ability to measure audience impressions for a specific ad as it is playing and also fulfills the requirement online that ad measurement be performed locally.

2.4.1. LOCAL CMS INTEGRATION

Quividi's measurement system inherits the features of the 3rd Party CMS it integrates with. By integrating with this data stream, Quividi is able to scope measurement to the airtime of a single ad play. The protocol of live data exchange between the CMS and Quividi is illustrated below.

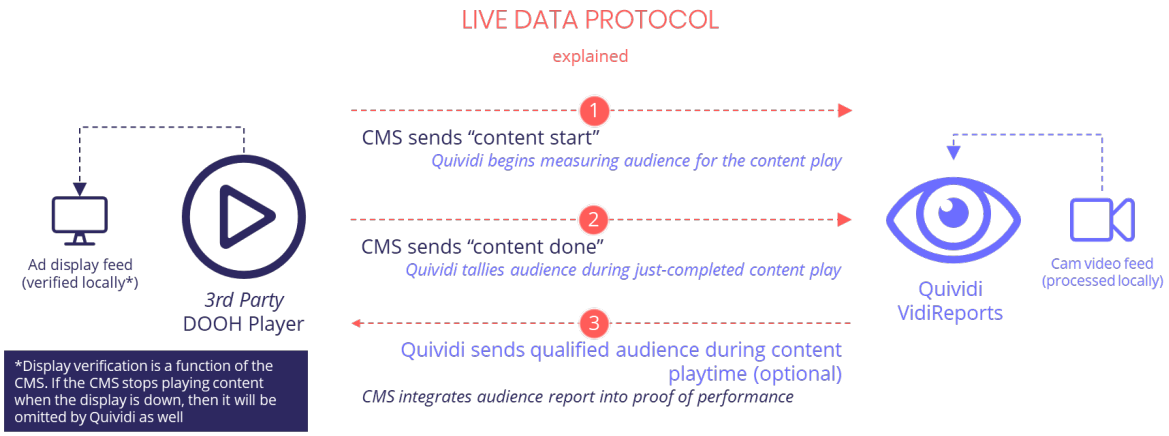


Figure 21: The protocol of live data exchange between the DOOH CMS Player and Quividi VidiReports. If the CMS supports receiving audience reporting (step 3), its reporting can later be verified against Quividi's.

2.4.2. CONTENT INTELLIGENCE

A key advantage of CMS integration is access to audience notice metrics such as attention. Without data from the DOOH player, Quividi VidiReports provides screen-level analytics where content analytics is only available by averages. This permits marketers to have unprecedented levels of content intelligence data.

Marketers that have access to content-level analytics data for their content have a distinct advantage over those with screen-level data due to the fact they can see changes in audience dynamics like second-by-second attention drop-off. This isn't even possible online.



See case study at https://quividi.com/case-studies/aldo-pandora/

Figure 22: Here we illustrate how Quividi helped Aldo see the different performances of ad creative executions compared to their targeted audience. For more information, visit https://quividi.com/case-studies/aldo-pandora/

2.4.3. LIVE API FOR PROGRAMMATIC (PRE-BID)

Another important client-side usage of audience impressions is for programmatic real-time bidding (RTB). Programmatic SSPs can also make use of Quividi audience data in the construction of their RTB bid requests. This is provided via a dedicated API which is built around the dynamics of DOOH programmatic.

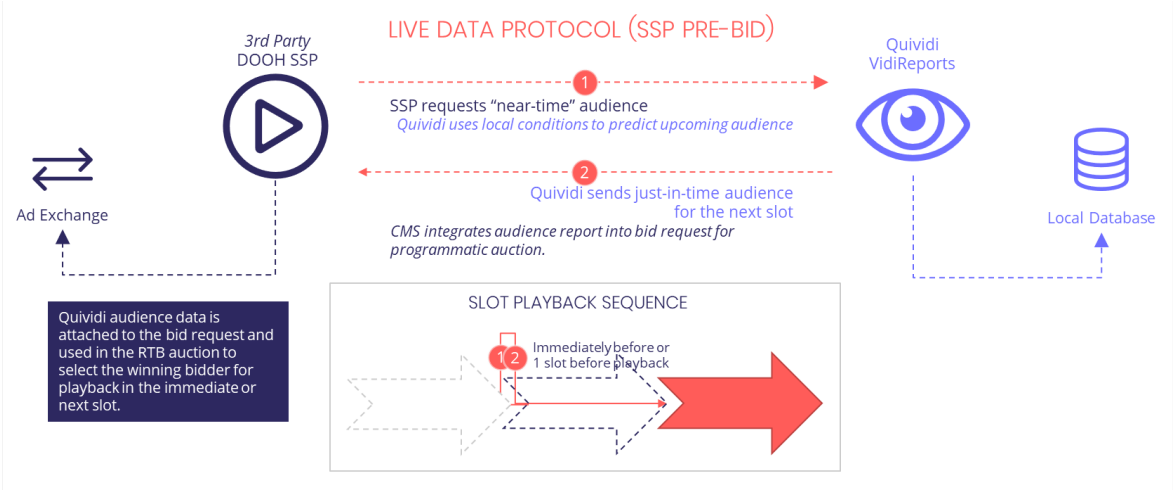


Figure 23: The protocol of live data exchange between the DOOH SSP and Quividi VidiReports. The DOOH SSP uses the audience report from Quividi to build its bid request for programmatic RTB auction.

For example, most RTB auctions are for the current ad slot, but in DOOH it may be auctioning the next slot in the playback sequence. Quividi's API allows for these types of near-time queries. The pre-bid audience report is generated using a local database of current and historical data and is far more dynamic (sub-second granularity) than server-side equivalents (hourly granularity).

2.5. SERVER-SIDE MEASUREMENT

Not all CMSs and SSPs have integrated with Quividi's client-side measurement APIs and instead they employ a server-side approach to audience reporting. We explore these approaches in this section.

2.5.1. SERVER-SIDE DATA STITCHING

Data stitching involves matching the raw playlog data from the CMS and raw audience data by times and locations. This approach is not employed by Quividi due to its challenges (huge server computing power required and inaccuracies in the output).

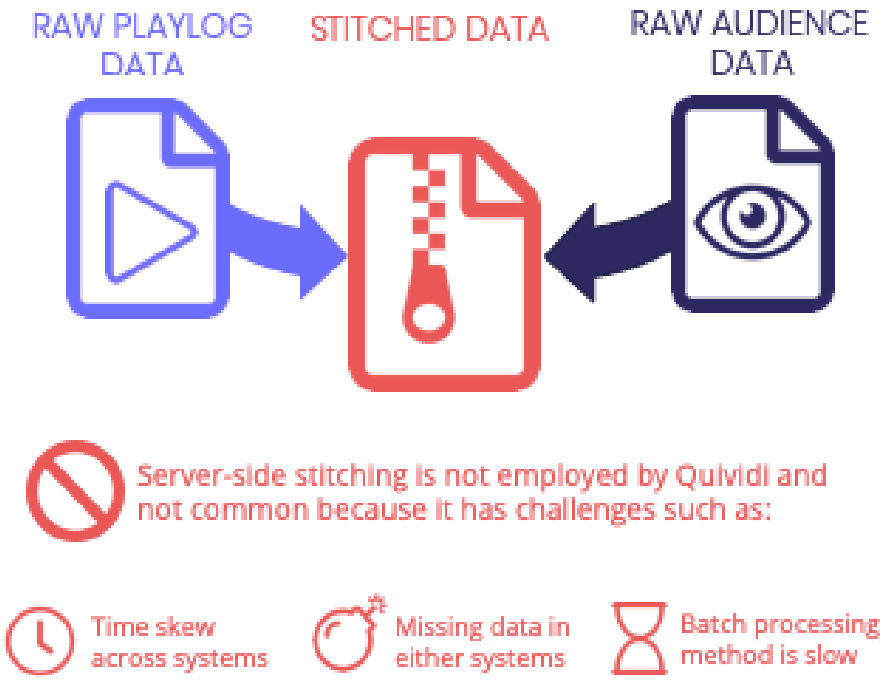


Figure 24: Illustrates why Quividi does not recommend employing data stitching.

2.5.2. AUDIENCE EXPORT FOR PROGRAMMATIC (AUA)

The preferred technique of server-side audience measurement is to use historical averages of a location across a time period as an “audience impression multiplier” on the served impression.

Average of aua	hour							
location_id	8	9	10	11	12	13	14	15
43581	0,000	0,347	1,083	2,258	4,932	4,855	3,971	3,904
49330	1,797	3,031	2,537	2,265	2,189	1,985	1,905	2,031
50743	1,246	1,643	1,943	1,895	1,775	2,103	2,596	2,082
48338	0,783	1,261	2,314	1,648	1,386	1,302	1,649	1,984
48235	0,011	0,314	0,690	2,112	4,452	3,764	2,383	2,035
50749	0,947	1,404	1,756	1,787	1,650	1,673	1,787	1,834
52670	1,265	1,768	1,963	1,927	1,867	1,555	1,441	1,604
48345	0,818	1,356	1,751	1,798	1,631	1,554	1,549	1,602
52673	1,034	1,274	1,371	1,371	1,213	1,246	1,312	1,396
53156	0,534	1,178	2,852	0,891	1,005	1,452	2,316	0,945

Figure 25: In the above example, a 15 second advertising running at 10AM on screen 48338 will likely generate 2.314 audience impressions when it will run. This number can further be broken down by gender and age group.

The Average Unit Audience (AUA) Export is provided on a per location, per week-hour basis and it is further segmented into genders (male, female) and each gender into age groups (<17, 18-24, 25-34, 35- 44, 45-54, 55-64, 65+). It depends on the content duration.

2.5.3. SAMPLING AND SERVER-SIDE EXTRAPOLATION

With a sufficient sample size and proper random selection methods, measured locations’ data can be extrapolated to non-measured locations to give them audience coverage as well. The extrapolated locations audience are modeled after the averages of the sampling locations. This approach, with the right sampling size, guarantees that the extrapolated results for each screen will be +/-20% of reality in 95% of the cases.

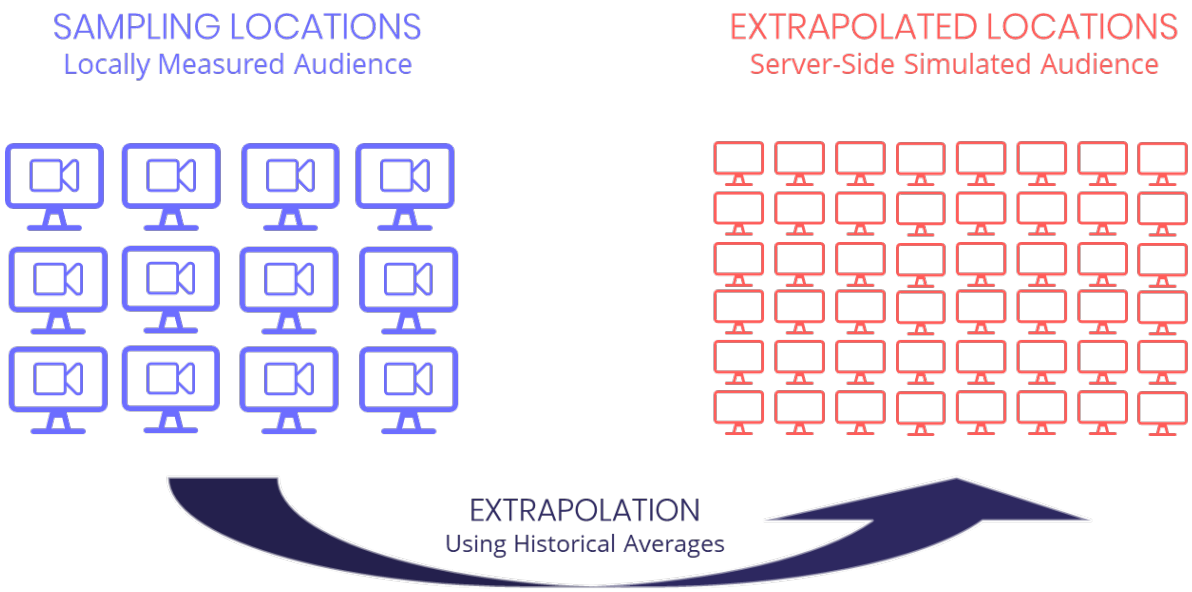


Figure 26: Illustration of extending the coverage of a measurement solution by employing server-side extrapolation.

2.6. ADJUSTMENT FROM DETECTION TO IMPRESSION

Due to natural or commercial limitations, it is non-trivial to adapt any measurement technology so its detection zone is a perfect match for the viewability zone of the DOOH display unit. In the case of a mismatch between zones, a formulaic adjustment is necessary to transform the metric from the detection mechanism, in this case Quividi, to the cross-platform human-valid ad audience impression metric.

2.6.1. VIEWABILITY ZONE VS DETECTION ZONE

The viewability zone is part of the definition of what makes an audience impression. Quividi's detection zone, in contrast, is based on the limits of detection technology. They are different metrics. It is possible, for example, for an audience impression to be valid and yet beyond detection.

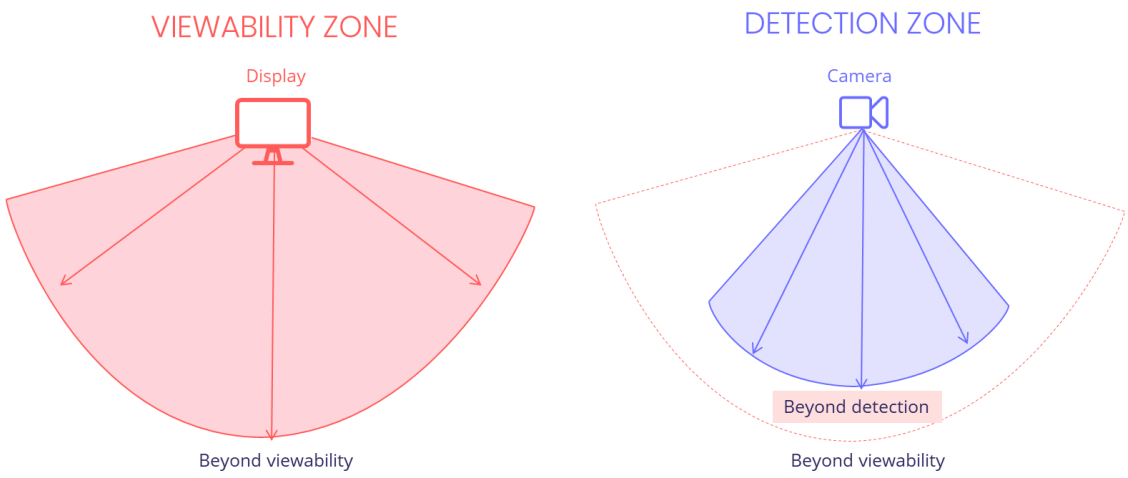


Figure 27: In this illustration, the detected audience will always be inferior to the actual audience (impressions). Typically, if adjustments are necessary, it is because the detection zone is inferior to the viewability zone. The inverse is rare.

2.6.2. CONVERSION BY ADJUSTMENT FACTOR

To compensate for differences between the detection zone and viewability zone, Quividi's detection metric, Watchers, is multiplied by an adjustment factor to convert it into audience impressions. The mathematical model behind this adjustment factor is based on journey mapping.

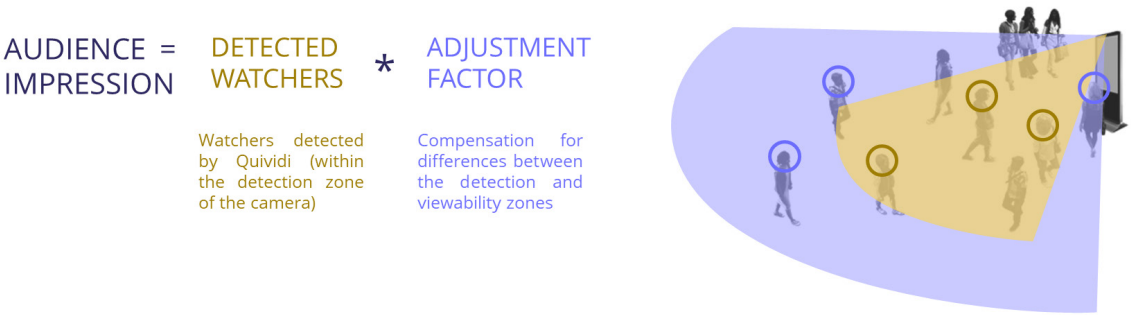


Figure 28: Quividi estimates live audience impressions by multiplying its live detection metric (Watchers) by an adjustment factor.

2.6.3. JOURNEY MAPPING CONVERSION MODEL

Quividi's proprietary conversion model adjusts its detection metric (Watchers) in real-time into the human-valid audience impression metric that best evaluates the total actual audience of a display.

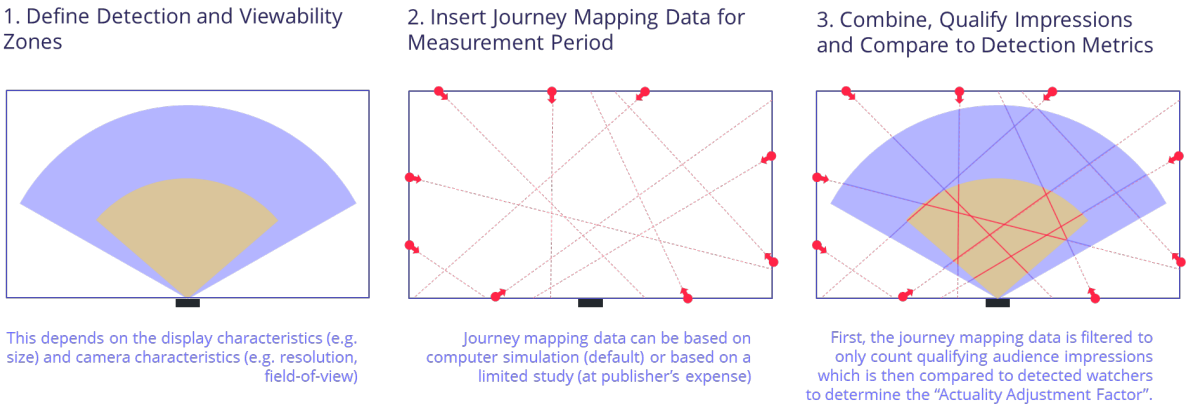


Figure 29: The layers of Quividi's proprietary journey mapping conversion model. This conversion model takes into account the characteristics of the display and of the camera, as well as the field of view of each watcher.

Quividi has developed a sophisticated journey mapping simulating engine, that adapts to every venue and simulates the traffic that would pass by the display and will be detected in the camera detection zone. The resulting journey mapping and detection data are compared to create the conversion model.
The conversion adjustment factor is calculated both for the audience number, as well as their dwell time and attention time.

2.6.4. REAL-TIME CONVERSION BY ADJUSTMENT FACTOR

Due to the nature of the modeling, it is possible for Quividi to provide live reporting of cross-platform human-valid audience impressions in real-time despite any limitations in detection technology.

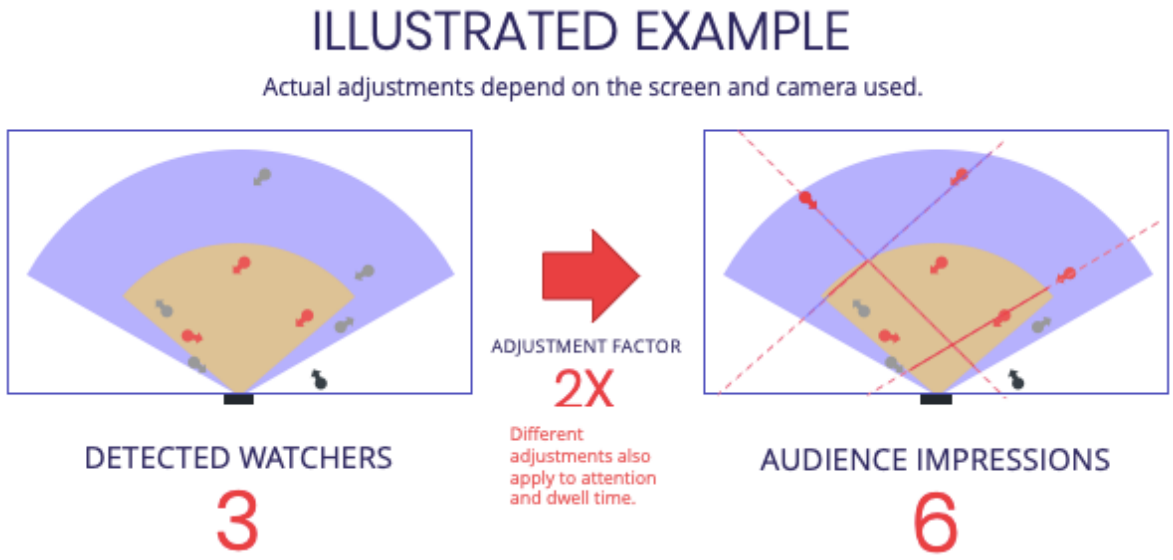


Figure 30: This illustrates how the adjustment factor obtained from Quividi's journey mapping conversion model transforms the detection metric (Watchers) into cross-platform human-valid audience impressions.

3. HOW DOES QUIVIDI COMPARE TO OTHER METHODS?

Much emphasis is put by the standards on the qualifications of measurement systems themselves are not all equal with regards to transparency and accountability. For the historical reasons mentioned earlier, legacy out-of-home measurement has some catching up to do to be at the level of data fidelity delivered digitally.
For example, for much of OOH today, only audience modeling is used and there is no verification of actual audience delivery. It is assumed that if the media was showing, that the audience from the plan was delivered as-is. This has not been acceptable for online ads since viewability was introduced in 2014.
So how can we rate measurement frameworks in a cross-platform way? Enter the Accountability Checklist!

3.1. ACCOUNTABILITY CHECKLIST

We can compare OOH measurement methods against an ideal set of requirements to deliver advertiser accountability which we have grouped into 3 dimensions of assessment. In total, the checklist is 10 points long as described below. The following section will look at this checklist in detail.



PROVIDER ORGANIZATION

1. Independence
2. Auditability
3. Transparency
4. Responsibility

AUDIENCE DATA MODEL

5. Recency
6. Density
7. Fidelity

MEASUREMENT MECHANISM

8. Precision
9. Integration
10. Verification

Figure 31: The 10-point accountability checklist illustrated.

PROVIDER ACCOUNTABILITY

3.1.1. INDEPENDENCE

An independent measurement provider is clear of biases from either the buyer or the seller of the media it is measuring.

Accountable	Questionable
Third party data direct from provider to the media buyer	Self-reported data from media seller to the media buyer

3.1.2. AUDITABILITY

An auditable measurement provider keeps a paper trail of the underlying data used to estimate audience impressions for verification purposes.

Accountable	Questionable
Paper trail to detect tampering; diagnose mismatches	Tampering can occur undetected; diagnostics impossible

3.1.3. TRANSPARENCY

The model and methodology used by the provider is disclosed for scrutiny by the stakeholders in the transaction.

Accountable	Questionable
Methodology is disclosed, shared with a wide audience and can be tested independently	Methodology is a black box and is highly secretive and restricted to a limited group

3.1.4. RESPONSIBILITY

The provider has undertaken significant steps and investments to ensure all data throughout the chain is privacy-safe and protects consumer rights around the world.

 Accountable	 Questionable
Privacy-safe technology and legal framework compliant with the latest international requirements	Data is used ad hoc without thought of legal the liability risks of violating consumer privacy law

MECHANISM ACCOUNTABILITY

3.1.5. PRECISION

The mechanism measures the audience of an ad playing while it is playing with sub-second accuracy.

 Accountable	 Questionable
The audience is being measured at the same time as the ad play	The audience being measured is transformed into an average audience per ad play

3.1.6. INTEGRATION

The measurement mechanism works in lock-step with the playback mechanism using a robust protocol.

 Accountable	 Questionable
Client-side co-measurement with the CMS using a robust protocol	Server-side CMS reconciliation and correlation of ad play logs and audience totals

3.1.7. VERIFICATION

The playback mechanism verifies the display is working and stops playback reporting if the display is not.



Accountable



Questionable

The CMS performs industry standard verifications such as display health and does not play or report content until the display health is restored	There are no verifications performed to see if the ad being played on the PC is really shown on the screen

MODEL ACCOUNTABILITY

3.1.8. RECENCY

The model uses data that was recently measured or otherwise has a reasonable degree of recency.



Accountable



Questionable

Based on live data “actuals” that are collected in real-time or in near-time	Based on historical data “averages” that are aged an hour, a day, a week, a month, ...

3.1.9. DENSITY

The model has sufficient detection data volume compared to the final audience impression volume that any adjustments or extrapolations are statistically significant.



Accountable

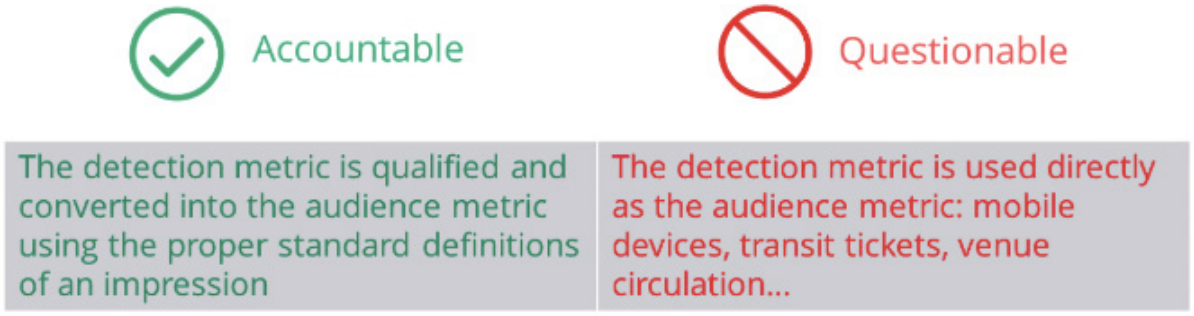


Questionable

Full coverage (every site is measured) and granularity (measurement is sub-second)	Sample sites and extrapolation; Audience totals per hour, per day, per week, ...

3.1.10. FIDELITY

The model is based on cross-platform human-valid audience impressions instead of a raw reporting of the detection metric. Data fidelity is explained in more detail.



3.2. MORE ON AUDIENCE MODELING

For audience impression measurement, audience modeling is not very common online – unless you count fraud detection and filtration as a type of audience modeling. On the other hand, audience modeling is a standard foundation in an out-of-home audience measurement system.

The concepts of recency, density and fidelity are helpful tools to contrast and evaluate measurement methods. We will explain them in more detail in this section.

3.2.1. WHAT IS DATA RECENCY?

An important consideration for comparing audience measurement methods is the data's recency. When was the data measured? Is it based on live data measured locally in parallel with the ad being played? Or is it based on historical studies and averages?

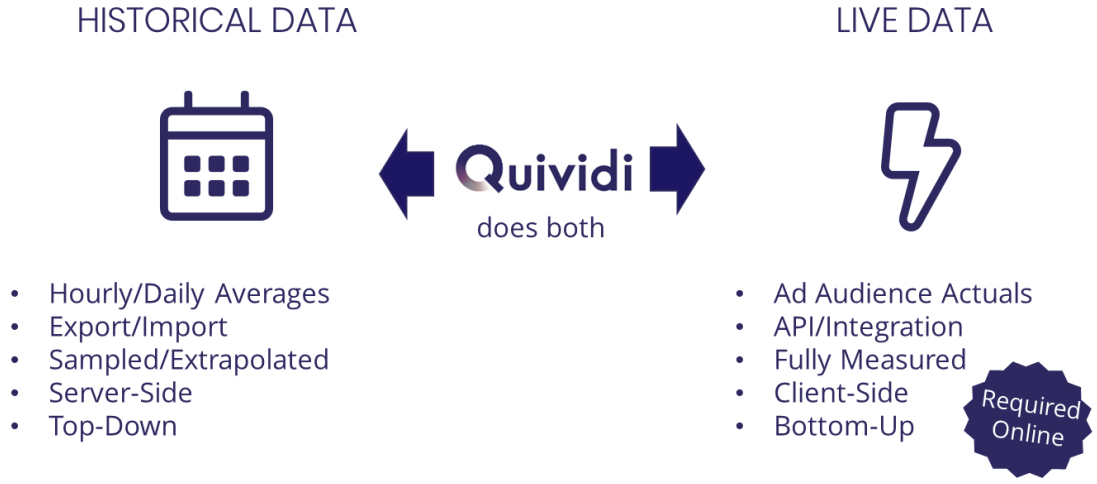


Figure 32: On the left we have data based on what was collected server-side in the past. On the right, we have data based on what is collected locally, and in the present.

3.2.2. WHAT IS DATA DENSITY?

When we use the metaphor of density, we mean the ratio of "hard" detection data to "soft" audience data. Hard data comes from the detection model. Soft data is extrapolated or otherwise engineered from the hard data.

• Maximum Density: the detection model is perfect and can account for 100% of the audience.

• Minimum Density: the minimum statistically representative sample size needed to make a predictive audience model.

• Medium Density: somewhere on a spectrum between Maximum and Minimum Density. This is where all out-of-home measurement sits. Quividi's model approaches maximum density.

Data density 3 component parts which are factored together to get overall density. They are:

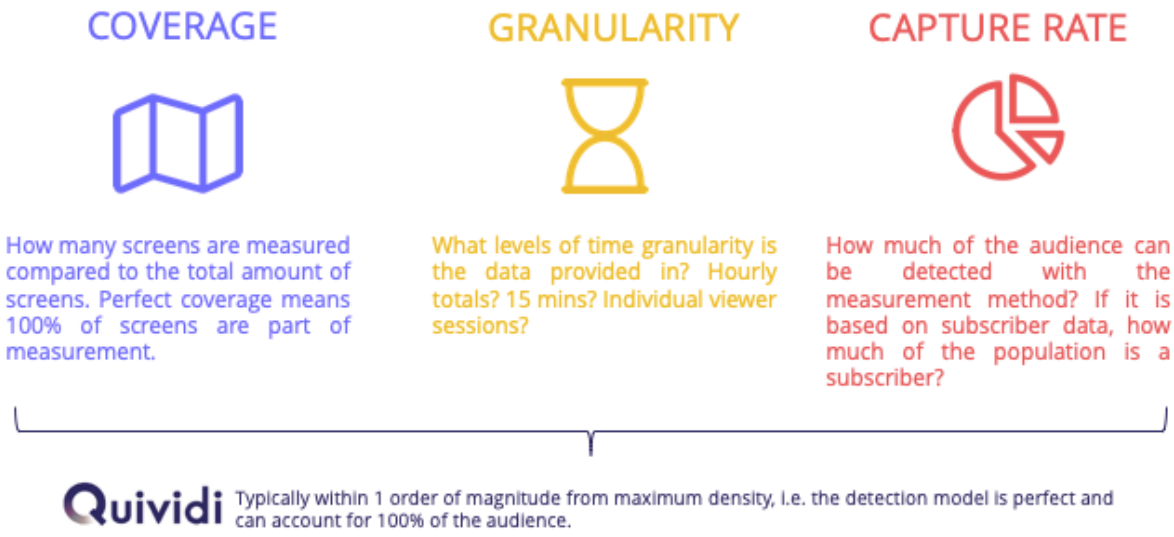


*Figure 33: The 3 dimensions of data density. They are measured in percentages between full (100%) and none (0%). Overall density is the product of the 3 coefficients: coverage * granularity * capture rate.*

3.2.3. WHAT IS DATA FIDELITY?

Is the audience impression metric being reported actually audience impressions (true to the definition) or are they reporting a detection metric disguised as an audience metric (mobile devices, circulation)?

For example, out-of-home was historically traded on circulation numbers (and in geographies, still is). The ESOMAR standard set the standard that circulation was not sufficient, and the audience has to be qualified to approach the actual audience (individuals that saw the ad) as closely as possible.



Figure 34: How close is the measured metric to the human-valid cross-platform audience impression?

For mobile data, are device access logs being used as audience or is a reasonable effort being made to transform them into a qualified audience? For example, is geofencing being used to ensure the detected mobile devices are within the viewability zone of the display?

3.3. COMPARISON TO MOBILE MEASUREMENT

A popular modern alternative method to Quividi for quantifying audience in OOH/DOOH is to use mobile device or user detection. In this article, we will compare the two.

3.3.1. MOBILE DATA SOURCES

There are 3 main mobile data sources:

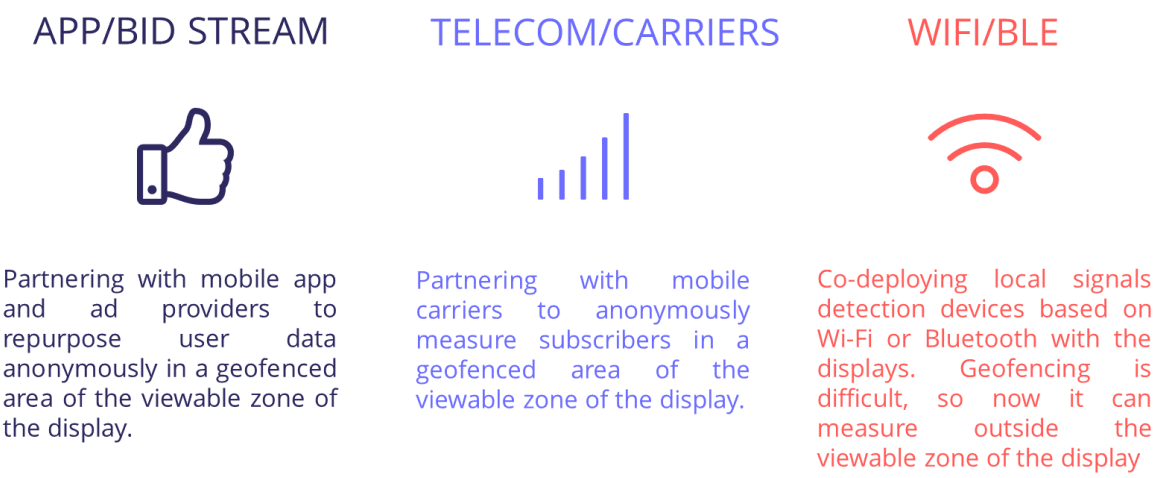


Figure 35: 3 main classes of mobile data providers.

These mobile data sources are quite different in nature and have their own advantages and disadvantages. Bid stream data, for example, is by far the most common, but it carries with it some pitfalls. We evaluate it, and other mobile data sources, along the following 5 areas of advertiser accountability.

3.3.2. MOBILE DATA DENSITY

With the exception of passive Wi-Fi based measurement, mobile data suffers from data density problems. This is because any particular data provider only captures a subset of the audience, e.g. a telecom only has their own subscribers' data. In locations where foot traffic is relatively low, this sub-sampling may be below the limit of statistical significance. App/bid stream data in particular suffers from low data density.

3.3.3. MOBILE DATA FIDELITY

There is a real challenge converting mobile device data to human-valid, cross-platform impressions for a few reasons. First, if it uses bid stream data, then it is susceptible to the same ad fraud as online ads. Second, it is difficult to discern whether the owner of the mobile device is facing the screen or not. Third, it is difficult to geofence mobile data to ensure the owner is within the viewable zone. This is particularly true with local mobile measurement solutions like those based on Wi-Fi which can detect through walls and floors, and GPS-based positioning which does not work indoors.

3.3.4. MOBILE DATA RECENCY

Typically, mobile data such as bid stream or carrier data is gathered after the fact and used as historical data. This is related to the fact that it is difficult to get privacy-clean data to the point of playback in real- time.

3.3.5. MOBILE-CMS INTEGRATION

To date, Quividi has not encountered a mobile measurement provider of any type that has a mechanism of integration with the CMS which permits it to perform per-content audience impression reports. It would be nearly impossible to implement this, except for via Wi-Fi or Beacons.

3.3.6. MOBILE DATA PRIVACY

Bid stream data and data from telecom carriers are particularly vulnerable to data privacy risks because they are repurposing data that was not originally intended for audience measurement. This means they may not have the legal or technical framework in place to guarantee complete privacy-safety.

Apple and Google are taking privacy counter-measures such as resetting device network MAC addresses to prevent apps from tracking their users. There is a tug-of-war between tracking systems, anti-tracking systems, and privacy protection agencies and legislations, so this will likely evolve in the future.

3.3.7. COMPARISON GRID

Below is a consolidated view of the accountability checklist for Quividi compared to 5 mobile data types:

- Passive Wi-Fi: sniffs for Wi-Fi enabled devices without offering a hotspot.

- Hotspot Wi-Fi: provides Wi-Fi access via a hotspot and uses sign-ups as data.

- Bluetooth: a BLE beacon in reverse mode captures Bluetooth-enabled devices.

- App/Bid Stream: Data from mobile apps or mobile ad providers that have access to the mobile user's geolocation.

- Mobile Carrier: geo-fenced mobile subscriber data of that carrier, anonymized.

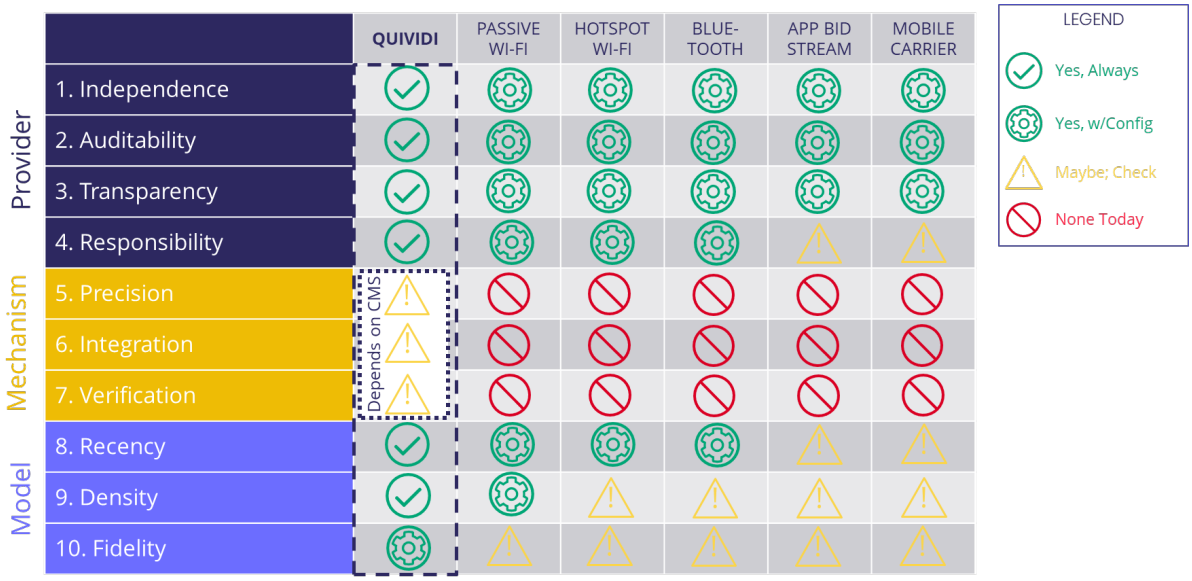


Figure 36: If combined with a market-leading CMS, Quividi scores a perfect 10/10 in the accountability checklist.

3.4. COMBINING QUIVIDI WITH MOBILE DATA

While it has limitations when it comes to measuring audience impressions, mobile data is uniquely suited to solving other marketing measurement problems. In this section we review 3 data problems that are best solved by combining mobile data with Quividi data.

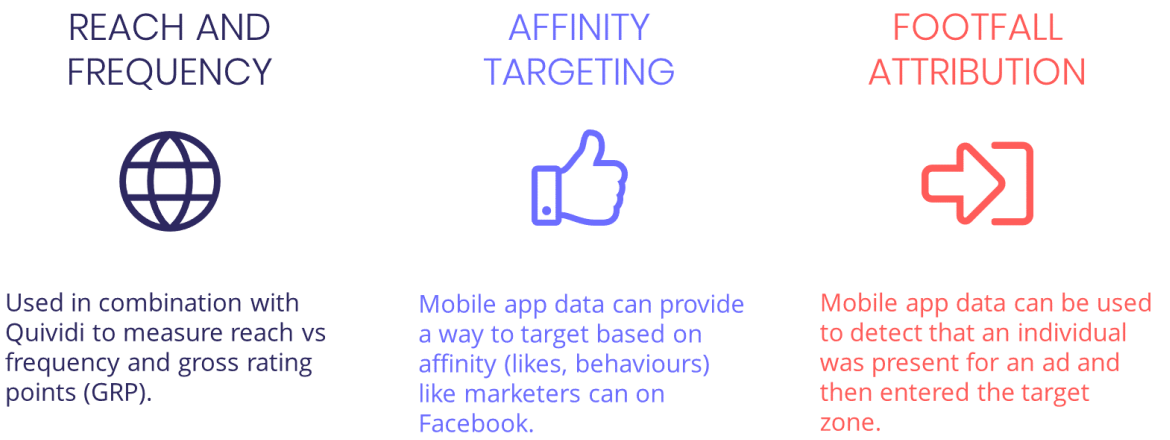


Figure 37: Marketing problems that are best solved with mobile data. In these 3 cases, mobile data is combined with Quividi data such as impressions or attention to measure based on marketing objectives.

3.4.1. AUDIENCE REACH AND FREQUENCY

Marketers may want to strike a balance between reaching many people (reach) and playing an ad to the same people multiple times (frequency). This requires to know the total number of unique audiences. Broadcast media, where audience is not sold in CPMs, commonly uses GRPs (ie gross rating points), which is the percentage of the total population that saw an ad.

In order to calculate reach and frequency (and potentially GRPs), you need two data sets:

1. Audience impressions

2. Total venue traffic

The total venue traffic, which can be provided by mobile data with some extrapolation, is used as the ceiling of individuals that can be reached and it can also be used to compare that venue with the total local population. The audience impressions provided by Quividi are then compared to the total venue traffic to determine the frequency and the reach. If mobile data providers also keep track of individual users over several weeks, this reach and frequency can be calculated over longer periods of time.

3.4.2. AUDIENCE AFFINITY TARGETING

Mobile app data can provide a way to target based on affinity (likes, behaviours) like marketers can on Facebook. For instance, people detected in stadiums could be expected to be sports fans. These are called 'personas'. However, as we've seen earlier, mobile data isn't precise enough to ensure that a specific persona is currently watching a specific display.

By mixing proven audience impressions provided by Quivid with personas visiting a venue, you could statistically infer the best locations and times in the week to hit a specific persona and estimate the number you'll be reaching.

We suggest you do your due diligence on the privacy-safety of this combined data before using it.

3.4.3. STORE FOOTFALL ATTRIBUTION

For retailers advertising on D/OOH, mobile data providers offer to calculate attribution of their campaign, by measuring the lift that the campaign generated in footfall to their stores, making sure that, in this lift calculation, they ignore the people that have passed by the D/OOH display and would have gone to the store anyway.

The challenge however is that the estimation of the audience passing-by a display is imprecise because of the low data density and fidelity (particularly indoors). That's where Quividi can provide a very robust estimate of this audience impression to fine tune the model and can help as well better estimate the extrapolation factor that the mobile data providers need to ingest in their own models.

Mobile data sources such as telecom carrier data offers further advantages because it allows one to profile and target individuals based on where they have been, e.g. at the competitor's store.

APPENDIX – GLOSSARY OF TERMS

Accreditation
In the field of audience measurement, this is the result of an audit and review of the audience provider's model and methodology for accuracy and compliance with audience measurement standards.

Actuality Adjustment
A mathematical transformation which convert a detection metric into an estimated actual audience number for an advertisement.

Advertising Content
Media files which are paid to be played on a third party media owner's display units for the purposes of achieving an advertiser's campaign objectives.

Advertising Transaction
At the macro level, this is the advertising insertion order which details the commercial and operational parameters of an ad campaign. At the micro level, this is the individual ad play which is the actualization of the insertion order by execution.

Audience Currency
This is the atom of accountability in the advertising transaction and represents the actual viewers of the ad content, both prospectively during planning, and then retrospectively during reporting. The ad industry at large is moving towards a universal cross-media audience currency.

Audience Impression
This is the viewing by an individual of a particular advertising content play. An individual can only qualify for one impression per ad content play, but may generate many audience impressions if they see many ad contents.

Auditing
The process of reviewing a model and methodology comprehensively in order to identify issues of compliance, veracity and accuracy. This process is expensive and time consuming, so it happens infrequently, e.g. annually or less frequently.

Average Unit Audience (AUA)
A model of audience measurement created by the DPAA which is able to convert venue circulation numbers into an average audience for each ad play.

Bottom-Up Measurement
A methodology of measurement which uses always-on detection technology local to the display unit to feed a real-time or near-time audience model. This is the opposite of Top-Down Measurement.

Circulation
A raw count of human bodies that frequent a venue or the wing of an establishment. The major OOH markets have abandoned circulation as an audience currency for a more qualified count, e.g. VAC or AUA. Circulation is used in Top-Down Measurement.

COMMB
Canadian Out-of-home Marketing and Measurement Bureau uses as their currency a qualified circulation metric which it calls Reliable Opportunity-to-See:
• Outdoor circulations include only those vehicles driving toward an advertising face.
• Circulations for COMMB outdoor products must adhere to industry-approved visibility distances.

Content
This is a media file, either a motion video or a still image, which is to be played on a device. This whitepaper focuses exclusively on advertising content.

D/OOH
This means out-of-home and also digital out-of-home. Used in the context where we mean the wider out-of-home market, which includes digital.

DOOH
Digital out-of-home is the fastest growing segment of the out-of- home market. Instead of a billboard, it uses a screen and the internet to deliver many advertising contents in the same physical space.

DPAA
Digital Place-Based Advertising Association is an international industry association focused on DOOH. They created an industry currency called the Average Unit Audience (AUA).

ESOMAR
ESOMAR is a membership organization representing the interests of the data, research and insights profession at an international level. A consortium of major international buyers and sellers of OOH worked with ESOMAR to establish a currency for OOH called the Visibility Adjusted Contact (VAC).
Human-Validity
This is an up-and-coming standard online which qualifies ad impressions as human audience impressions and disqualifies bot- driven or otherwise non-human traffic.

Geopath
Established in 1933, Geopath, originally the Traffic Audit Bureau for Media Measurement Inc., is a not-for-profit organization governed by a tripartite board comprised of advertisers, agencies, and media companies. Geopath's historical mission was to audit the circulation of out of home media in the United States. Geopath uses LTS or Likelihood-to-see as their established audience currency.

IAB
The Interactive Advertising Bureau (IAB) is an advertising business organization that develops industry standards, conducts research, and provides legal support for the online advertising industry. They worked within 3MS to establish Viewable Impressions as the digital audience currency.

Likelihood-to-see (LTS)
A more qualified version of opportunity-to-see which counts the individuals which have a high probability of seeing the ad. This is typically calculated by using circulation and discounting it via a model created from visibility studies.

Occlusion
An obstacle between the screen and the viewer interrupting their viewing of the ad on the screen.

Out-of-home (OOH)
In this document, OOH is meant as the legacy out-of-home industry sometimes referred to as Classic OOH. This does not include DOOH.

MOVE (OMA)
MOVE is the audience service of OMA in Australia. They use Likelihood-to-see as their currency.

MRC
The Media Rating Council is a US trade body which accredits audience measurement systems in the US, but also globally. They are one of the founding members of the online digital standards consortium 3MS, the ESOMAR standard and the DPAA standard.

Opportunity-to- see (OTS)
This term is somewhat vague and is therefore used as an equivalent to a raw circulation number, though it is often scoped to the area in front of the billboard or screen. Another word for OTS is traffic.

Route UK
Route is the audience service in the UK for the OOH industry. They use as their currency the Realistic OTS (ROTS) and it is derived from visibility studies and traffic intensity models.

Served Impressions
These are ad exposures which were played on the target device. They are not necessarily qualified as viewable impressions (which requires the screen be on, the ad be showing, etc.) or audience impressions (which requires they be viewable and at least one person is present, facing the ad).

Top-Down Measurement
This measurement approach uses a large neutral data set such as venue circulation or census data and the starting point for an audience model. Typically, the model qualifies a part of the circulation as having a reasonable, realistic or likely opportunity to see the ad.

Unoccluded
There is a direct line of sight between the audience and the screen with no obstacles in between.

Visibility Adjusted Contact
This is the standard currency established internationally with ESOMAR in 2009. It explicitly uses a top-down measurement approach.

Viewable Impression

This is the standard currency established internationally with 3MS in 2014. It explicitly requires a bottom-up measurement approach.

Viewability
This is the condition where we say the ad can be seen by the audience.

Watcher
Quividi's detection metric. It is a detected face.

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