



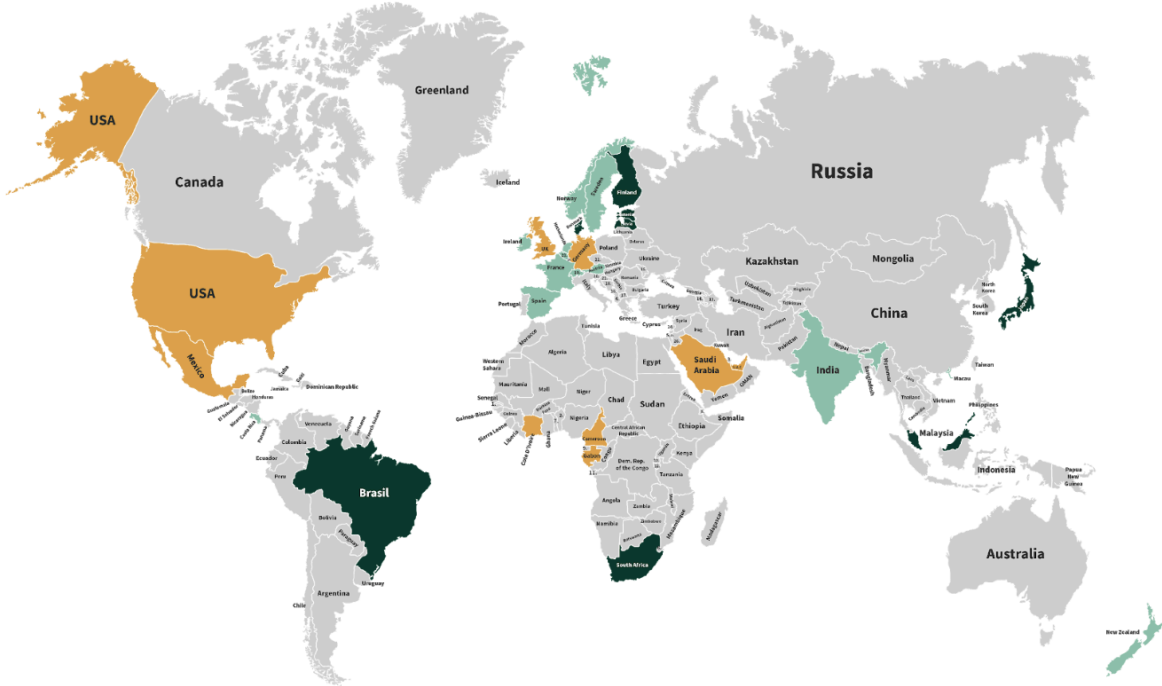
**“Audience measurement for
Out-of-home media”**

Measurement Methodology

Executive summary

AllUnite is a global advertising technology platform that provides audience measurement solutions for media owners, agencies, and advertising companies. AllUnite (D)OOH solution combines hardware and software for data collection, processing, and visualisation using innovative technologies: **Wi-Fi**, **2D LiDAR**, and **3D LiDAR**. It includes progressive methodologies, integrated with the best additional data sources (Telco, SDK, mobility data) for providing live data for every location, including traffic flow and demographics, impressions, reach, and frequency with any temporal granularity. Continuous research and development of new technologies allow implementation of AllUnite solutions in a wide range of environments and locations: both indoors and outdoors, analog and digital, measuring pedestrian and vehicular traffic.

AllUnite Global Presence



Together with our clients and partners in OOH industry, AllUnite continues working on the new business cases:

- Master service agreement with JCDecaux Datacorp for the global roll-out of AllUnite products
- Audience Measurement for Brazil (joint project between JCDecaux and Clear Channel) and several European countries
- Traffic and impressions measurement projects in Denmark, Germany, Mexico, Spain, South Africa, India and many more
- ROI/Conversion measurement: screen-to-store (Westfield, Spain, Denmark, the UK, Baltics, Hong Kong)
- Roadside audience measurement with direction and speed of movement (the Baltics)
- High-precision traffic measurement: drive-to-shelf/aisle (Dubai) with 3D LiDAR technology
- High-precision traffic measurement for data calibration (the Netherlands) with 3D LiDAR technology
- Analog inventory (Gabon and Ivory Coast) with a battery solution

Clients get **24/7 access to the live traffic flow** surrounding an individual panel or a network of panels via analytics.allunite.com.

Additionally, AllUnite provides separate interfaces for the client's partners with environment specific metrics that serve their needs.

AllUnite collaborates with leading technology and data partners specializing in mobile network analytics (Telco), big data and AI-driven decision support, SDK Providers, and audience measurement. This ensures a comprehensive, robust, and advanced solution for accurate out-of-home audience measurement.

Every technology AllUnite works with is developed to comply with the strict privacy regulations in different countries (GDPR, CCPA). AllUnite works with the best International & European law firms to ensure the highest level of user privacy protection by design and by default.

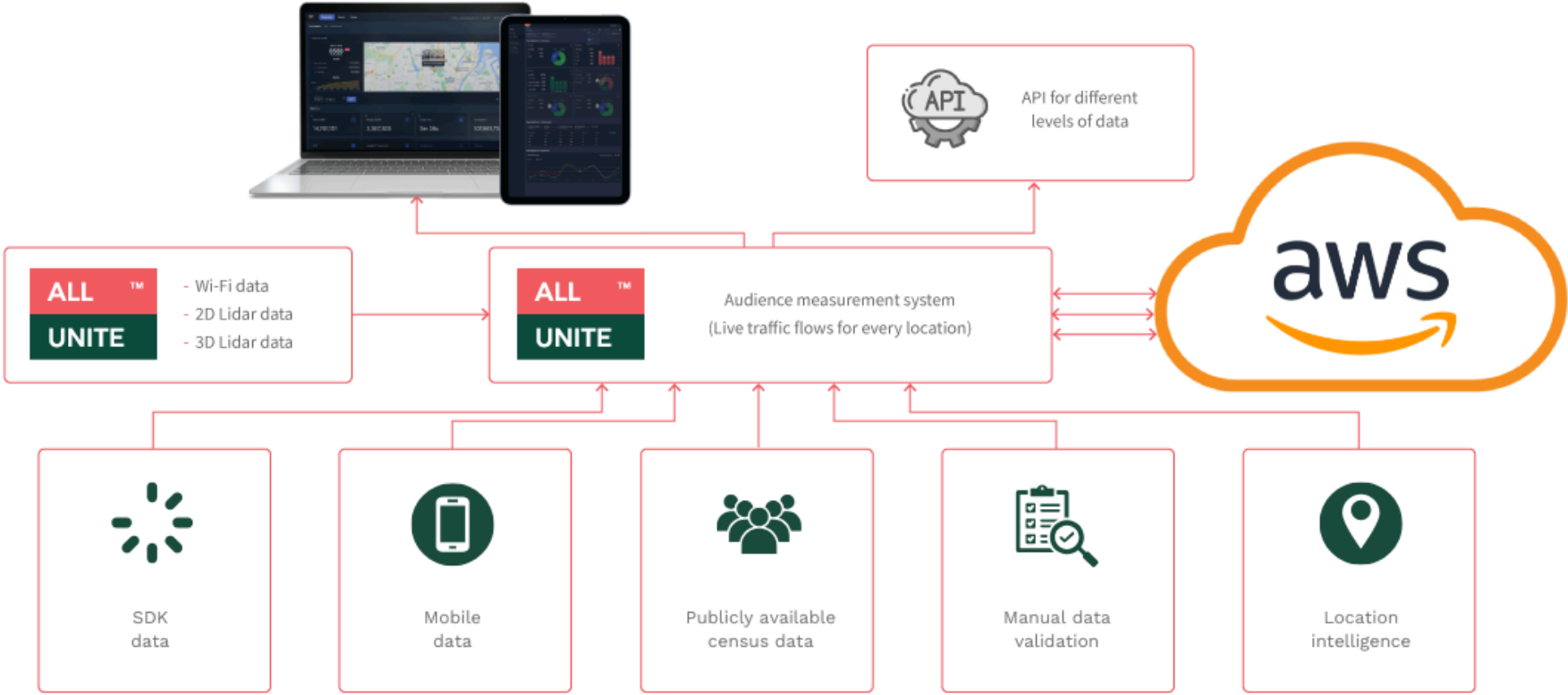
AllUnite does not collect any personally identifiable information from the MAC addresses; all collected data are hashed and encrypted and presented as aggregated statistics. AllUnite can provide the list of completed legal assessments at request.

The secret of AllUnite's success is the **ability to generate a return-on-investment** for the clients based on:

- Improved inventory managed based on real-time data (accounting for the traffic fluctuations - monthly, seasonal, holidays)
- Demographics for real-time reach data for audience targeting
- Implementation of programmatic buying that allows tapping into digital budgets

Solution overview

Our comprehensive AllUnite platform provides a unified methodology for understanding people's behaviour in real-time by combining data from various sources. The Wi-Fi sensors installed at the sample of locations serve as a source of real-time data. With this cross-category methodology, users can access hourly and frame-level data visualisation and reporting for OOH screens across different environments, including roads, malls, metros, and airports. The platform utilises several data sources, such as Telco Data, SDK data, panel data, census data, external data sources, and state-of-the-art technologies to provide this unified data.



Data Collection

2.1.1 Methodologies for creating a representative owned dataset

To create an owned dataset that is representative of the universe to be measured and that delivers on the reporting requirements on a scale that is robust and agile enough to give us the reliability, granularity and flexibility and still have detailed and real insights about people behaviour, AllUnite uses the following:

- **Primary Data Sources:** These data streams provide real-time, location-specific insights and serve as the foundation for audience measurement:
 - **Wi-Fi Sensors** – Capturing anonymized device signals (hashed MAC addresses) to monitor foot traffic patterns, dwell time, and unique visitor counts.
 - **2D & 3D LiDAR Sensors** – High-precision sensors used for vehicular and pedestrian traffic measurement, detecting movement speed, direction, and density.
 - **Manual Counting** – On-ground validation conducted periodically to calibrate automated data sources and ensure accuracy in traffic and audience estimates.
- **Secondary Data Sources** -These external datasets enrich, validate, and scale the primary data to achieve comprehensive audience measurement:
 - **SDK Data** – Aggregated third-party app data providing additional insights into mobility trends and behavioral patterns.
 - **Telco Data** – Mobility analytics from telecom providers, offering large-scale, privacy-compliant movement data to supplement and cross-validate sample-based insights.
 - **Census & Government Data** – Publicly available demographic datasets used for validation, ensuring representative audience profiling.
 - **External Datasets** – Additional data sources such as road traffic statistics from the Department of Transport, real-time transit data (e.g., bus API), and other relevant public datasets to refine traffic flow models.

- **Data fusion** is used to combine data from different sources, including demographic data, location-based data, and real-time data from Wi-Fi sensors and 2D Lidar. By combining these different data sources, we can gain a more comprehensive and accurate understanding of audience behaviour, preferences, and attitudes.
- **Synthetic dataset with hourly granularity that is updated daily.** Based on the all data sources mentioned above and real-time data from Wi-Fi sensors on the sample of locations, we create a synthetic dataset using GANs to supplement the sample data and fill in the gaps of missing data. The combination of data from various sources such as Wi-Fi sensors, Vodafone, transport companies, external datasets and adsquare data (SDK as a part of data source) can provide real-time and up-to-date information on traffic and behaviour patterns. Additionally, the inclusion of reference surveys can provide additional context and validation for the generated synthetic data.
- **Triangulation approach.** Data triangulation is used to validate and verify the accuracy of the data. This involves comparing and cross-validating data from different sources to ensure that it is consistent and accurate. Overall, **data fusion** and **data triangulation** are essential components of our platform, as they ensure that the audience measurement data we provide is accurate, reliable, and comprehensive. By combining and validating data from different sources, we can provide our clients with the insights they need to make informed decisions about their OOH advertising campaigns. them.
- **Artificial Intelligence and Machine Learning (ML).** AllUnite uses ML models such as regression, GAN, Monte Carlo simulations, and other techniques to predict OOH metrics for new locations and provide valuable insights for advertisers.
- **Spatial algorithms.** We use spatial algorithms to analyse and visualise the data, identifying trends and patterns in footfall and dwell time, as well as demographics.
- **Unified methodology.** Our unified methodology for understanding people's behaviour in real-time involves combining data from various sources, such as Wi-Fi sensors, Vodafone data, reference surveys, and synthetic datasets. The resulting data are available through the holistic AllUnite platform. The Wi-Fi sensors serve as the baseline and primary source of real-time data, while Vodafone data and reference surveys provide additional context and depth to the analysis. Synthetic datasets are used to fill in any gaps in the data. Overall, our approach enables a comprehensive and integrated understanding of people's behaviour, using Wi-Fi sensors as the foundation for real-time data collection.

AllUnite main methodologies

1. Traffic Models

1.1. Unified methodology

AllUnite’s unified methodology integrates multiple data sources, including Wi-Fi sensors, mobility analytics, reference surveys, panel data, and synthetic datasets, to provide a comprehensive real-time understanding of audience behavior. Wi-Fi sensors serve as the primary data source, capturing live traffic and dwell-time data, while mobility analytics and surveys add depth and demographic validation.

For locations without sensors, synthetic datasets are generated daily at an hourly granularity, ensuring full market coverage. These datasets are created using Generative Adversarial Networks (GANs), which combine multiple data inputs to predict traffic flow, audience demographics, and movement patterns. This approach allows for real-time traffic predictions and ensures accurate, scalable audience measurement across all locations.

1. **Wi-Fi sensors:** These are live sensors located at roadside locations that can detect Wi-Fi signals from passing vehicles. This data can provide information about the volume of traffic, the speed of vehicles, and the types of vehicles passing by.
2. **SDK Data** – Provides anonymized movement patterns and demographic insights, including age, gender, and income.
3. **Mobility Analytics Data** – Segments traffic by road sections and movement direction, tracking routes, frequency, and volume.
4. **Census data:** This is a public dataset that provides demographic information about a population, such as age, gender, income, education level, and occupation. This data can be used as additional input to the GAN model to improve the accuracy of the generated data.

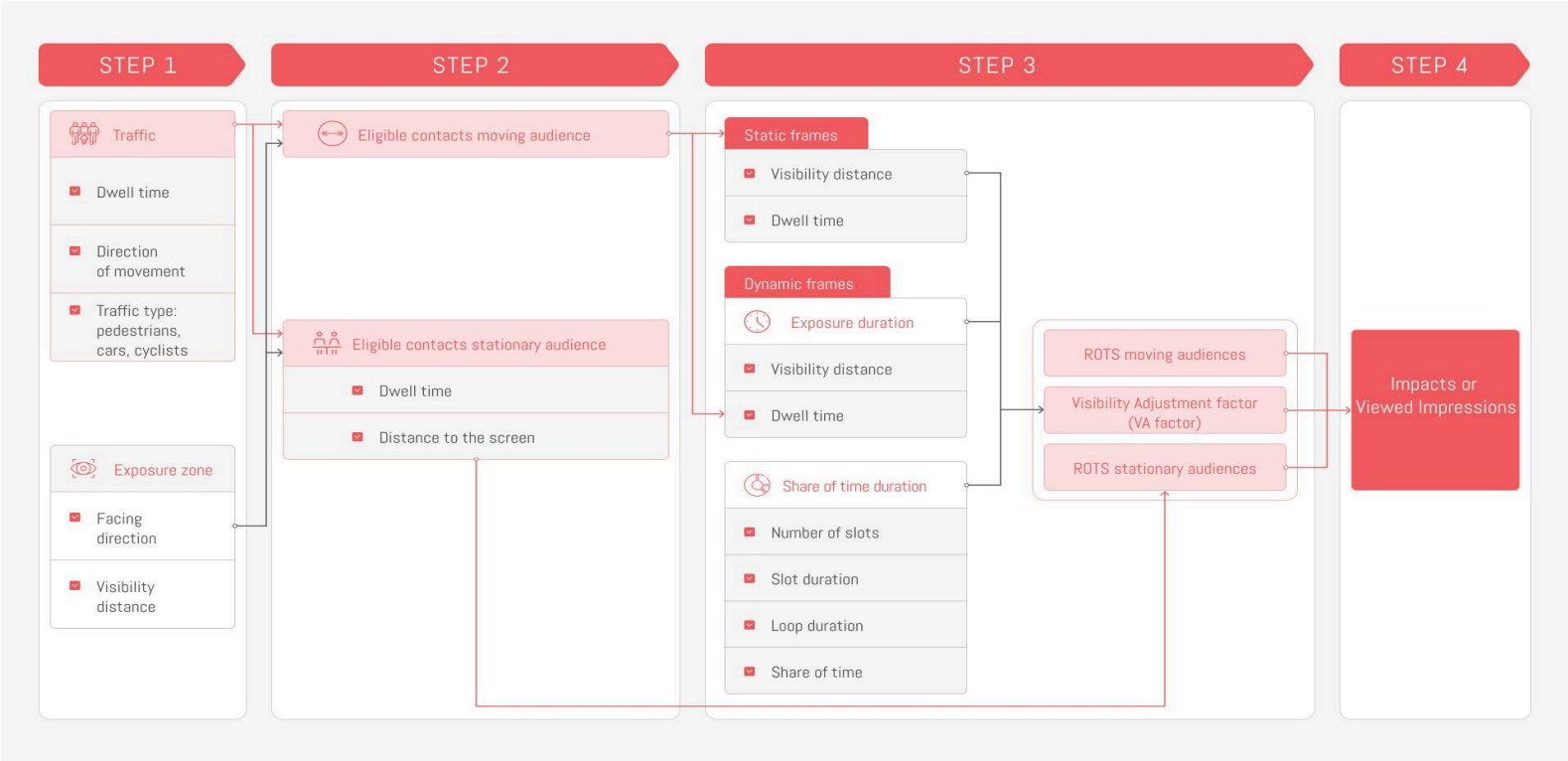
1.2. Roadside

The model involves the installation of Wi-Fi sensors on a sample of roadside locations. We will integrate all the primary datasets mentioned above, including Telco/SDK data, census data, and external data sources, to create a comprehensive model. Additionally, to enhance the

model's accuracy and relevance, we can include the latest roadside statistics if available in particular country. By using GAN to predict the frame audience with all necessary metrics, such as total traffic, unique traffic, frequency, demographics, dwell-time, and calculating accurate ROTS, this model will enable us to generate a synthetic dataset for all other roadside locations. This synthetic dataset can be created daily, with hourly granularity for the previous day's data and used to predict live traffic, resulting in real-time data for all locations.

2. Impression model

The scheme of the AllUnite impression model



2.1. Visibility Adjustment Factor Calculation

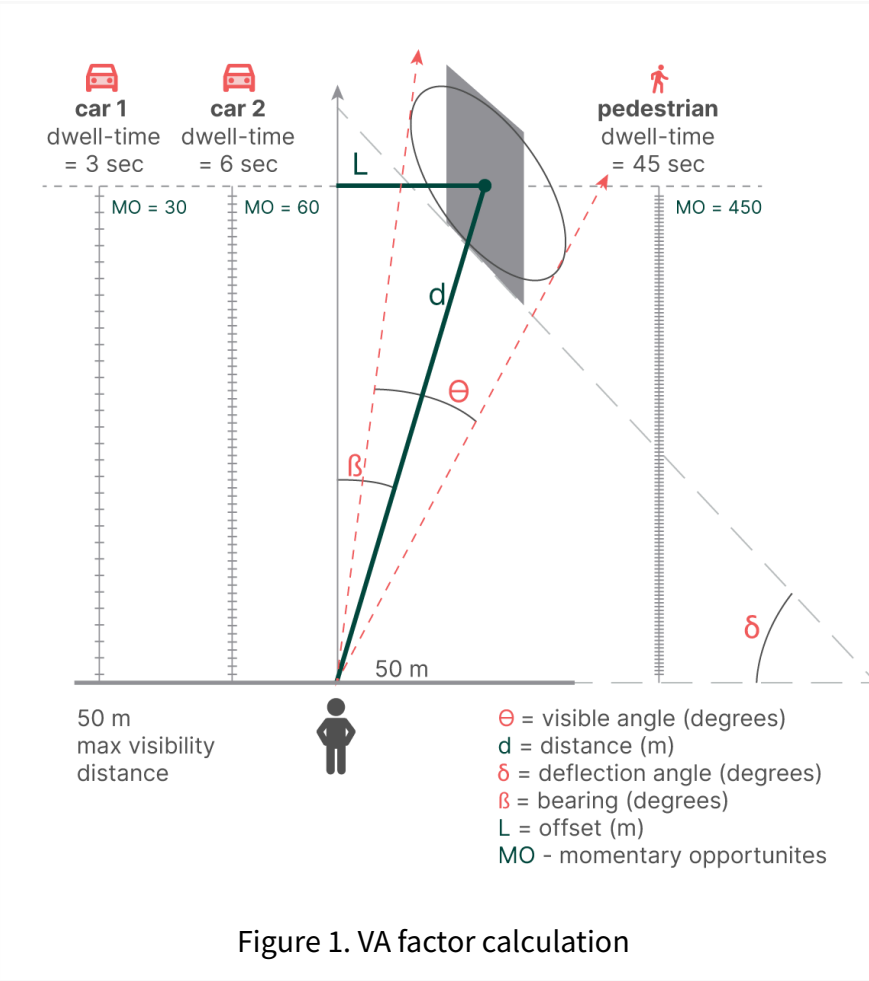
The Visibility Adjustment factor (VA factor) is determined through the use of the Route methodology (or AllUnites proprietary algorithm), which takes into account various factors such as the distance to the frame, dwell time near the frame, deflection angle, azimuth of the frame, visible angle, and offset.

Additionally, the Wi-Fi methodology is employed to calculate dwell time near the screen, which eliminates the need for information on the speed of movement.

The AllUnite model utilises dwell-time data from sensors installed at locations with Wi-Fi sensors and models the dwell time for locations without sensors based on the mode of transport from mobility analytics technology.

The model dedicates traffic by road segments and calculates momentary opportunities every 0.1 seconds to determine the probability of seeing the screen at that moment.

Figure 1 illustrates this process.



3. Impression calculation

3.1 Conversion traffic into ROTS

The first step is to exclude individuals who cannot see the frame due to distance, direction, or obstacles. ROTS is determined by visibility distance, facing direction, and movement patterns, calculated using Wi-Fi data and partner sources.

The AllUnite model defines a visibility cone, typically a 120° section perpendicular to the display, accounting for surrounding obstacles. Movement direction is derived from Wi-Fi sensor data and transport models, ensuring accurate audience measurement. Traffic is allocated to road segments to determine the number of individuals likely to see the frame.



ROTS is calculated as the traffic inside the Visibility cone (blue area) and Obstacles area (purple area)



The direction of movement Model example (define the people going in and out from the underground station)

3.2 Calculating viewable impressions

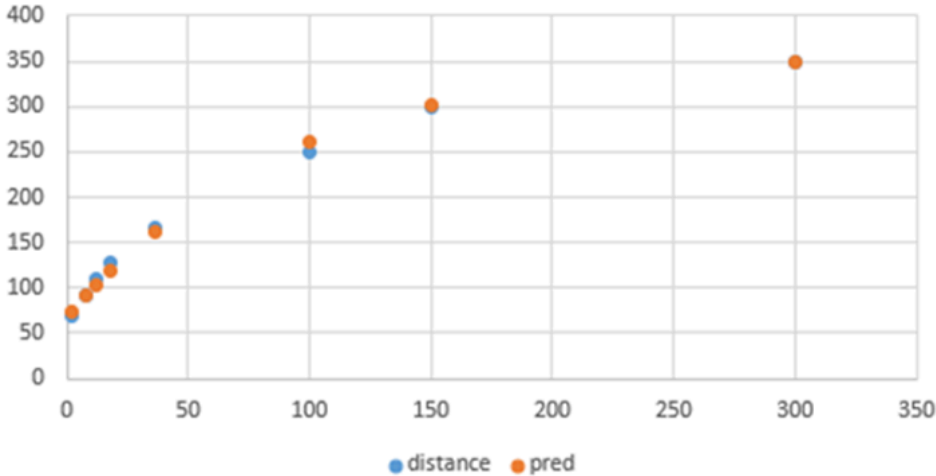
The audience is splitted by moving and stationary based on the dwell time. It’s important to know the distance to the screen for both types of audiences to calculate the correct number of impressions.

3.2.1 Calculating viewable impressions for moving audiences.

Firstly, to calculate viewable impressions for moving audiences (ImpressionsFlow), we determine the visibility distance, which is the distance at which people can see the advertisement on the screen, based on the size of the screen.

$$VisibilityDistance(surface) = A * (1 - e^{-k*surface}) + VisibilityDistance_{min}$$

Where $A = 300m$, $VisibilityDistanceMin = 66.7$, $k = 0.01$



Exposure duration (DE) is equal to dwell time near the screen.

To calculate the viewable impressions for a moving audience we calculate the Engagement coefficient (EC). We use EC =1 for static frames.

For dynamic frames:

$$EC = \frac{\max(DE-2X, 0)+DS}{DS}$$

where $X = 1$, DS – slot duration

Total impressions flow (viewable impressions for moving audience) is calculated:

$$ImpressionsFlow = EligibleContactsMovingAudience * EC$$

3.2.2 Calculating viewable impressions for stationary audiences

Viewable impressions for stationary audiences are calculated in every time bracket and for eligible traffic in every exposure zone.

Exposure zone - the physical area from which a frame is visible. It is linked to the frame’s visibility distance and facing direction.

Primary exposure zone - the physical area around the screen from which a frame is visible and with a limited radius of 15 metres. People in the primary exposure zone are supposed to have a bigger number of impressions than people staying within a longer distance.

Secondary exposure zone - the physical area around the screen from which a frame is visible and with a limited radius from 15 to 30 metres. People in the secondary exposure zone are supposed to have fewer impressions than people staying in the primary exposure zone.

Tertiary exposure zone - the physical area around the screen from which a frame is visible and with a limited radius from 30 to 50 metres (or 30-70 depending on the environment and screen size). People in the tertiary exposure zone are supposed to have fewer impressions than people staying in the secondary exposure zone.

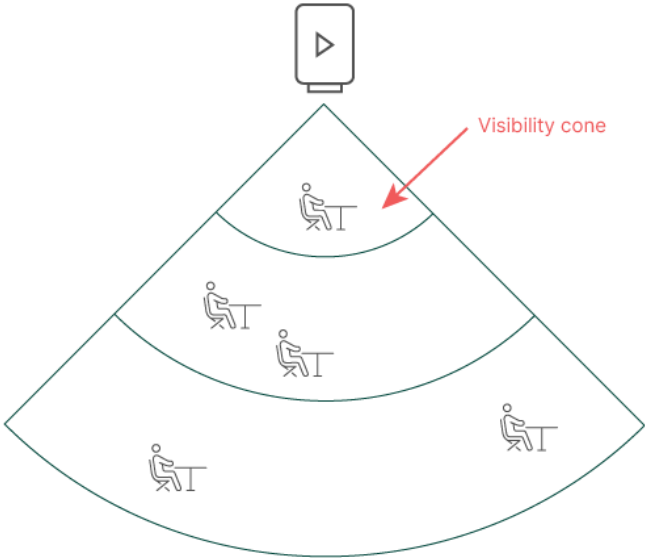


Figure 3. Example of screen exposure zones

$$ImpressionsDwell_i = \sum_{dwell\ bracket} \frac{min_{bracket} + max_{bracket}}{2} * \frac{PrimaryVisibilityDistance}{ExposureZoneMax_i} * EligibleTraffic_{bracket,i}$$

where bracket = (0; 5], (5; 10], (10; 15], i = 1, 2, 3 (three exposure zones), PrimaryVisibilityDistance = 15 metres

Total ImpressionsDwell are equal to the number of impressions in each exposure zone.

$$ImpressionsDwell = \sum_{i=1}^3 ImpressionsDwell_i$$

3.2.3 Calculating viewable impressions

The total number of viewable impressions for the screen is equal the sum of the impressions for moving audience (ImpressionsFlow) and impressions stationery audience (ImpressionsDwell):

$$ViewableImpressions = ImpressionsFlow + ImpressionsDwell$$

3.3 Calculating viewed impressions

Once we have the viewable impressions, we apply the visibility factor, and the DAM (digital attraction multiplier) if relevant to obtain viewed impressions. When having the dwell time and distance to the screen, it is possible to apply different visibility factors per groups of people with different dwell time and different distances to the screen; Otherwise, we use the location’s generic visibility factor which integrates the typical distribution of the different traffic types.

$$ViewedImpressions = ViewableImpressions \times \min(VisibilityFactor \times DAM, 1)$$