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Consisting of:

Coordinator:	Multitel asbl (MULT)	Belgium
Participants:	Gruppo Torinese Trasporti (GTT)	Italy
	Institut Dalle Molle d'Intelligence Artificielle Perceptive (IDIAP)	Switzerland
	Institut National de Recherche en Informatique et en Automatique (INRIA)	France
	Régie Autonome des Transports Parisiens (RATP)	France
	Thales Communications (TCF)	France
	Thales Italia (THALIT)	Italy
	University of Vienna (UNIVIE)	Austria

1 Executive Summary

In this deliverable, we formulate the scenarios of interest for end-users through a human-centred ontology of events structured from primitive perceptive features to complex human behaviours. The scenarios of interest for end-users have been extracted from the deliverable D2.1. We define the primitive and composite events that will be studied in the different scenarios during the project and especially used in WP6 *Behaviours recognition and interpretation for monitoring applications*.

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2 Introduction

The objective of this deliverable is, (1) to delineate the primitive perceptive features that can be extracted from sensors and which are sufficiently meaningful for understanding behaviours of interest expressed by end-users, and (2) to define how these features can be efficiently exploited to recognise audio/video patterns and can be used to answer the end user's requirement in term of behaviour categories of interest.

The primitive events correspond to general abstractions of behavioural cues changes coupled with actions of interest; these events constitute prototypes for each action which will be suitable to cover the variability within a given action category while reliably distinguishing it from others. Composite events correspond to natural descriptions of behaviour allowing meaningful scene analysis with emphasis on social human interaction between person and within the environment.

This deliverable is structured as follows; in the next section, we first present the different categories of behaviour of interests which have been defined by the project end-users. Then, we present in Sec. 4 different perceptive behavioural features which have been established by human observers within data collected at GTT premises. Finally, we describe in Sec. 5 a human centred ontology of scenarios of interest which can be used to define the previously presented scenarios and to automatically formulate them within audio/video data stream analysis.

3 Behaviour categories of interest

This section presents the functional and operational requirements of the system, described in terms of scenarios of interest from the end-user point of view. These requirements have been summarized from D2.1 *End user requirement and system objectives*.

In the next sub-section, we first introduce the general end-user requirements that are applicable to all the categories and the system as a whole. We then present the detailed requirements of each scenario by category.

3.1 General end-user requirements

In D2.1 *End user requirement and system objectives*, RATP and GTT have described end user requirement and system objectives general requirements which explain that the final VANAHEIM system should be user-friendly and easy to use for human operators, while protecting privacy of the subway passengers. In addition, we can identify four additional general goals to address and related behavioural areas:

> 1 – Safety for preventing accidents in subways. Typical examples are (1) suicide, (2) people on tracks, (3) people blocking the escalator and blocking human flows and (4) large density of people occurring in small areas or close to the tracks.
>
> 2 – Security of goods in order to prevent expenses in maintaining and repairing infrastructures typically caused by vandalism (on vending machines and windows), graffiti and thefts.
>
> 3 – Security of people by preventing feelings of insecurity while travelling typically caused by violence towards employees, customers, the presence of agitated groups, pickpockets and terrorists.
>
> 4 – Crime prevention for reducing the rate of forbidden activities such as fraud, begging, non-motivated alarm triggering, drug dealing…

Next sections now introduce more well-defined scenarios of interest that were identified by the joint analysis of GTT and RATP missions, combined with three aspects/categories of the VANAHEIM System (VS), namely the autonomous stream selection (WP4, Sec. 3.2), the real-time applications for human monitoring (WP5/T6.1, Sec. 3.3) and the collective behaviour building (T6.2/T6.3, Sec. 0).

3.2 User requirement for autonomous sensor selection

The first scenario to address is the autonomous sensor selection. The scenario can be defined as providing security operators with video wall/loudspeakers in the control room that are automatically managed by an intelligent system, allowing to autonomously detecting the most interesting/relevant/abnormal/ video streams to display on the video wall and audio streams to play on loudspeaker.

3.3 User requirement for real-time applications for human monitoring

The second scenario to address consists in monitoring people through the subway stations. The goal and, thus, the user requirements for real-time applications for human monitoring mainly concern the following items:

- protecting real estate, infrastructures, technological systems and equipments as well as their assets, in order to avoid intentional deeds (Theft or damage);
- protecting rolling stock both while moving and standing;
- deterring possible crimes and/or interference of people working in stations or transiting;
- assisting and protecting company personnel working in direct contact with the public, in critical overcrowding, protest and turmoil situation;

- managing and preventing dangerous situations in order to reduce/remove the risk of robbery, theft, bag-snatching and harassment in stations;
- actually performing the task of protecting people and places, thus guaranteeing a secure environment.

Real-time applications have been defined as analysis of audio-video data providing immediate information and knowledge to operators on pre-defined scenarios detected by the system, which can be useful to manage problems without any delay. These applications should concern the detection of the critical safety/security situations that can slow down or interfere with the everyday use of public transportation (event detection applications), as well as the reporting of useful information extracted from the data streams (situational reporting).

Taking into account the project targets three specific levels of monitoring (individuals, groups of people and crowd/people flow), next sub-sections detail the end-user scenario for real time applications which are related to these three levels, and which are summarized below:

- Abandoned and stolen luggage scenario
- Group detection scenario
- People arguing, entering in conflict scenario
- Crowd/Flows of people scenario
- Monitoring equipment scenario
- and Situational reporting scenario

3.4 Additional behavioural scenarios from DoW

In the VANAHEIM DoW, several additional studies have been described as interesting behaviours to recognise, such as head pose and body shape.

The head pose scenario should allow us to understand what this person intends to do given the objective or the place at where she/he looks. This understanding can give us in many contexts more information about that person and what she/he is planning to do (Pick pocketing …)

The body shape scenario should provide an automatic system for obtaining detailed information about the objective person. The shape should allow us to understand what this person is making: such as jumping over a turnstile, left-luggage detection, fighting, vandalism, blocking exit, running, selling items…

4 Primitive perceptive behavioural features

Sec. 4.1 first introduces 11 general visual cues that have been used by human observers to analyse and understand, and can be used to infer more complex scenarios on people behaviours in the subway. Sec. 4.2, then shows first results about the frequencies of these behaviours in different settings.

4.1 Behaviour catalogue

The behaviours described from Sec. 4.1.1 to 4.1.11 are the behaviour catalogue to be used for manual annotation of behaviour.

The behaviour catalogue was created by 20 observers describing 3 hours of videos in plain language (ad-lib sampling). A semantic analysis then was used to derive categories. After a first operationalisation of the categories a first coding run was done in ANVIL by all researchers and reliability was calculated. After inspection of the reliabilities, categories were refined and recoded. This procedure was done iteratively until reliability stabilised. The catalogue indicates the reliability for each track for human observers and can be used as a benchmark for machine analysis. Reliabilities for the single categories will be available when the new material is coded.

These visual cues have been extracted by researchers from UNIVIE after observing videos already collected at GTT metro stations. Reliability tests have shown this catalogue to be valid, with an average Cohen's Kappa[1] >0.77.

Categories are described in detail to avoid ambiguities for the annotators. Each section describes a class of behaviours that are exclusive (i.e. cannot occur at the same time in one person). The subheadings in grey stand for behaviours categories annotated, and the subheadings delineate the behaviours included in the categories. This set-up of the catalogue allows continuous recording of the behaviour.

4.1.1 Sex (Cohen's Kappa: 0.98)

The knowledge of sex can help us to identify if it is about a male, female or mixed-sex group. There are several possible criteria to distinguish the sex: body height, body shape, face, posture, gait, clothes and hair styles**.**

4.1.2 Age of the group (Cohen's Kappa: 0.98)

Defining the age of the group can give us additional information about the group (A group of young person, a group of adult person, a mixed age group …). There are several possible criteria to distinguish the age: body proportions (the ratio of the head to limbs to trunk), face shape, body height, hair colour, posture, and gait.

4.1.3 Size of the group (Cohen's Kappa: 0.98)

The size of the group is determined by human observer into 12 levels from 1 to 10, above 10 people and when this cue is not applicable. The size of the group can also be modified by the age or the sex of group members: female, male, mixed sex (group members are female and male). There are several possible criteria to distinguish a group: Communication within the group members (minimum with one other person); the bodies of the group members are oriented to each other; spatial proximity or body contact within the group members, similar walking speed within the group members and/or

[1] Cohen's Kappa is a statistical measure of inter-annotator agreement for qualitative items. It is more robust than percent agreement, since it takes into account the agreement occurring by chance.

coordinated walking behaviour if it's obvious that one person is in a group it can be coded, even if the spatial distance is bigger.

Automatic vision process can discriminate the size of the group within 3 levels: Small (1,2,3,4,5 persons), Large (6,7,8,9,10 persons), crowd (more than 10 persons) and not applicable. Groups in term of computer vision can be detected by large moving regions with coherent motion travelling all together (they are detected in a close neighbourhood). People detector can also be used to estimate the number of group members.

4.1.4 Setting (Cohen's Kappa: 0.62[2])

The visual cues characterising people behaviour can be interpreted differently according to the location (settings) where behaviours is occurring. The point of view of each camera can supply us a different angle to observe the scene. These different settings can give us different way.

4.1.5 Prospect (Cohen's Kappa: 0.49[3])

Unrestricted field of view within two meters radius of the semicircle (about 180°) in front of the focused person; objects which can be overlooked as well as persons generally aren't a restriction of the view

4.1.6 Refuge (Cohen's Kappa: 0.85)

The focused person stands still (see also def. "to stand still"), moving (see also def. "to stand moving") or supported (see also def. "to stand supported") orientated with the back not more than one meter away from a wall or another backing surface.

4.1.7 Locomotion and posture (Cohen's Kappa: 0.77)

Locomotion and posture can be described in four categories.

to stand-still includes

to stand
The legs and the upper body are stretched; the feet touch the ground and are maximum as wide as the width of the hip from each other apart; there is no locomotion

to straddle
The feet are spread wider than the width of the hip

one-legged
Only one foot touches the ground and the other doesn't

crossed-over
Both feet touch the ground, the legs are crossed over

free leg
The whole body weight is transferred of one stretched leg, in contrast to the "one legged" stand touches the second foot the ground too

to stand-moving includes

to teeter
Move or balance unsteadily; sway back and forth; the body weight is alternating from the ball of the toes to the heel

[2] Cohen's Kappa: 0.62 before final revision of definition; final reliability analysis in progress.
[3] Cohen's Kappa: 0.49 before final revision of definition; final reliability analysis in progress.

to sway
The body weight is alternating from one foot to the other while standing (see also def."to stand)

to flap
The upper body is rotated around the longitudinal axis in both directions

to pounce around
Behave in a ridiculous, ineffective, or posturing way; the person goes maximum of three steps in one direction forward or backward, stands still (see def. to "stand – still") or turns around (see also def. "to turn around") and goes again maximum of three steps in another direction; the turn is mostly under a 180 degree

to step back
During standing (see also def. "to stand") the right or the left foot optionally goes one step behind, the other foot follows; afterward stand still

to stand-supported includes

to lean against something or somebody
One part of the body touches another person or an object to transfer its body weight vertically upon

to rest on something – upper limb
One or both hands or arms are lying horizontally on another person or on an object; the weight is transferred upon

to rest on something – lower limb
One foot is standing angled on a higher surface; the other foot is mostly stretched

to stand with crutches
The upper body is rested, with the assistance of the upper limb, on one or two crutches

to walk includes

to walk
To move at a regular and fairly slow pace by lifting and setting down each foot in turn, never having both feet off the ground at once

to walk with crutches/walking aids
A limited method of movement with different aids (walking stick, crutches); normal step sequence, one foot after the other could be not possible

4.1.8 Left or Right Limb (Cohen's Kappa: 0.88)

Left or Right Limb can show the following behaviours.

manipulation of mobile objects includes

to inspect an object in the hand
To look at something closely; therefore an object, which is holding one hand, by raising the bended arm up, is being led to the front of the upper body (breast height); happens in combination with a supination of the forearm; the eyes are looking at the object and the head could be bended

to clench an object between the upper body and one arm
An object is placed between an abducted arm and the rib cage

to clench an object between the feet
The feet are moved together (adducted and maybe internal rotated) and hold an object in this position

to rummage around
One hand is leading into a hollow object, where it is doing movements

to take an object out

One hand is moving into a hollow object B, the fingers of this hand overlaps an object A; this object is taken out of the object B

to put an object in
One hand is leading an object A into a hollow in an object B; afterward there is no contact between the hand and the object A

to fold an object
An object is folded, so that its surface is smaller than before

to give over an object/to get an object
Focused person is giving an small or bigger object to another person

to put an object from one hand to the other
Object (full or almost enfolded from one hand)is leading from one hand to the other hand

to look at a watch
The wrist is being led in front of the body (breast height); the head is being bent and the eyes looks at an object which enfolds the wrist (watch)

to phone
One arm leads the hand, which is holding the object (mobile phone) towards the ear; when the object touches the ipsilateral ear, it is being held on this position while the lips and the mouth are in motion

to throw an object
Propel something with force through the air by a movement of the arm and hand

to catch an object
Intercept and hold (something that has been thrown) an object with one hand

To position an object on the body
To bring an object with the help of one upper limb to a carrying position on the back or on the shoulders; the hands are free (see also def. “to carry an object”) or to bring an object with the help of one upper limb from a carrying position (without hands) to a carrying position (with a hand)

to replace the bag
To bring the object (bag) with the help of one upper limb into the regular position back

manipulation of underground railway equipment includes

manipulation of the vending machine
The eyes are looking at the vending machine; the hand is being led to the automate (with or without an object); the hand or the object is in touch with the automate; the hand is being moved back (with or without an object)

manipulation of the barrier
An object (the ticket) is being inserted into the ticket machine next to the barrier, by what the barrier opens

to handle an elevator
To push the button of the elevator

to hold on the hand trail from the moving stairs
The hand is lying on the hand trail

arm posture includes

akimbo
One hand is lying on the hip and the elbow is turned outward

arms (or hands) are folded in front of the upper body
Both arms are bent; the forearms are crossed and clinging to the upper body; the palms of the hands lying on the upper arm or between upper arm and upper body
One arm is bent, the underarm is clinging to the upper body and the hand clasp the elbow of the other stretched arm

The hands are crossed together in front of the body (the fingers are crossed, one hand overlaps the other hand, the other wrist or the other forearm)

to put the hand/hands in the pocket (coat, jacket, trousers)
One arm is as much bent, so that the hand is pushed into the pocket of the coat, the jacket or the trousers

arms (or hands) are folded behind the upper body
The arms are retroverted; the fingers are crossed or one hand overlaps the other hand, the other wrist or the other forearm

to place the hand/arm on something
The hand/arm is placed on a carried object and is lying there without noticeable movements

to rest the head on one limb
The head is lying on the palm of the hand (for some seconds) or on the bent first phalanges of the fingers from one hand; the elbow of the supporting limb is touching the object or a part of the body below (see also def. "to rest on something – upper limb")

body contact includes

to shake hands
The right, opened hand is hold toward another person; this person clasps the hand and holds it/shake it for a short moment (sometimes the left hand)

to hold hands
Two or more people clasp each other by hand

to walk arm in arm
Two ore more people are walking beside each other; the arms next to the other people is going around the others back; the palm of the hands are lying on the hip of the other person
Two or more persons are walking beside each other; the arm next to the other persons is bent; the arms are linked

to touch another person
To touch another person on his shoulder, back, head or arm

to give a hug
To hold someone tightly in one's arm; the arms enfold the body of another person; the upper bodies are in touch

To gesticulate

To support verbal communication with a movement of a part of the body (hand, fingers or arm)

other

Focal person shows another behavior as described above

not visible

Focal person cannot be observed (restricted visibility because of the camera view or because of other people)

4.1.9 Shoulder left (Cohen's Kappa: 0.81)

Shoulder left can show the following behaviours.

to carry a bag

A bag is carried on the shoulder; if the bag is carried cross over the upper body, the side with the bag is coded (not the strap)

to carry only a backpack

A backpack (see also def. " backpack") is carried on the back; there is no additional object present

no bag

not visible

Focal person cannot be observed (restricted visibility because of the camera view or because of other people)

4.1.10 Facial behaviour (Cohen's Kappa: 0.55[4])

Facial behaviours cover the following behaviours.

to eat or drink

to eat

Some fingers are holding an object; this is led to the mouth; the mouth opens and the whole object or a part of the object is led into the mouth; the mouth closes (masticatory and swallow movement)

to drink

Some fingers are holding an bucket filled with some liquid; this is led to the mouth; the head is bent to the back; the mouth opens, then the liquid flows into the oral space; the mouth closes; then head goes back and the fingers lead the bucket away from the mouth

to blow one's nose, to spit, to vomit

to blow one's nose

To clear one's nose of mucus by blowing through it into a handkerchief

to spit

To eject saliva forcibly from one's mouth (without help of the limbs)

to vomit

To eject matter from the stomach through the mouth

to talk/to laugh

to talk

The lips and the tongue are in motion, the face is orientated towards another person

to laugh

To make spontaneous sounds and movements of the face and the body that are the instinctive expressions of lively amusement; the corner of the mouth are bent upward

to phone

not observed

not visible

Focal person cannot be observed (restricted visibility because of the camera view or because of other people)

4.1.11 Gaze direction (Cohen's Kappa: 0.55[5])

Viewing direction is directed, when the object or the group member is located less than 2 meters away; the face of the focused person is orientated towards another person or an object; if the face gives not enough

[4] Cohen's Kappa: 0.55 before final revision of definition; final reliability analysis in progress.
[5] Cohen's Kappa: 0.55 before final revision of definition; current reliability in progress.

information, the posture of the body can help.

to look straight forward
Focused person looks straight forward, the eyes are not focused on objects, underground railway equipment or group members

group member
Focused person directs his view at another person

object
Focused person directs his view at an object, which is not a part of the underground railway equipment (maximum distance of two meters)

underground railway equipment
Focused person directs his view at an object, which is part of the underground railway equipment (maximum distance of two meters)

read
A object (book, newspaper or electronic reading device; no mobile phone) is held with one or two hands and is being placed in a field of vision; the eyes are looking for a longer time at this object (minimum 5 seconds), a shortly look up do not interrupt the coding

look around
Focused person looks around; can happen together with movements of the head; the eyes are not focused on objects, underground railway equipment or group members; the focused person changes the direction, one point of view is holding for a maximum of one second

other
Focal person shows another behavior as described above

not visible
Focal person can not be observed (restricted visibility because of the camera view or because of other people)

These behavior categories will be used for the manual annotation of the behavior of people in the different underground settings. In the next section we show some results of a pilot study regarding differences in behaviors in different settings.

4.2 Preliminary behaviour coding results

The following data is based on the observation of the behaviour of 96 male and 75 female subjects in two settings: ticket hall and platform. We coded material from 11 stations in the Torino underground, with camera views the platforms (see example screenshot in Figure 1-(a)) and on the ticket hall (see example screen shot in Figure 1-(b)).

(a) Platform setting. (b) Ticket hall setting.

Figure 1 Behaviour settings used in experiments.

This resulted in continuously recorded 90 person minutes. Continuous recording means that all the behaviours one person shows are recorded at any given time. Since each person is visible in one given camera view only for a certain amount of time, the time each person is observed varies. Therefore we had to control for the amount of data each person contributes. We did so by calculating the percentage of time a person showed a behaviour, rather than working with the raw total amount of time this behaviour was shown (thus the y-axis {*duration*} in the following figures corresponds to percentage of observation time a person showed a given behaviour). We also looked at sex differences, but since sex recognition is beyond the means of automatic processing, these results will not be incorporated (see appendix p. 30 for sex differences results). Instead we concentrate on differences between settings, i.e. ticket hall and platform. Only significant results will be illustrated in graphs in the following.

In accordance with the behaviour setting theory we found differences between the settings in behaviours: walking occurs more often in the hallway than on the platform, where people are more likely to stand with support (i.e. lean on the walls) or take up a crooked posture (Figure 2). People manipulate objects they carry around more often in the hallway than on the platform, where they more often take on arm postures (Figure 3). They are also more likely to put objects on the floor in the ticket hall (Figure 4). People are more likely to communicate on the platform than in the ticket hall (Figure 7).

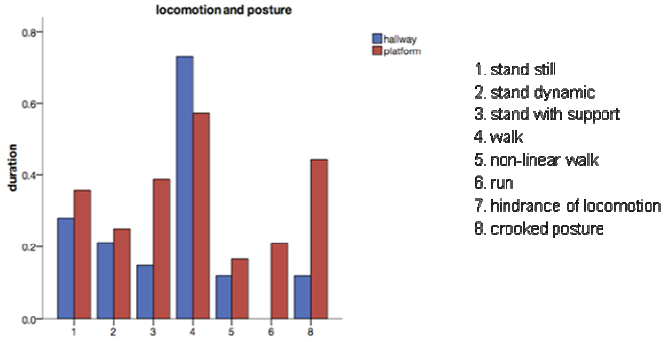


Figure 2 Locomotion and posture (hallway/platform).
On the platform people more often stand with support (3), experience a hindrance of locomotion (6) or take on a crooked posture (8). In the hallway people walk (4) more often.

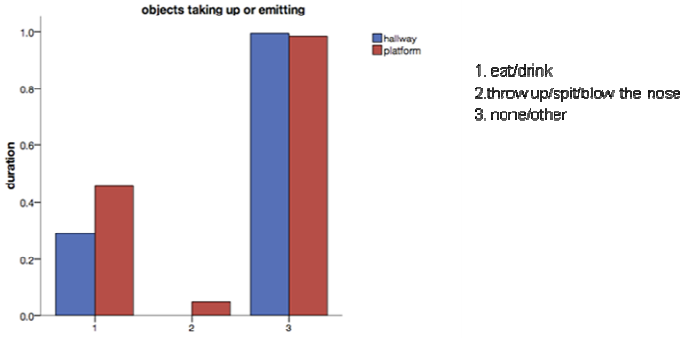


Figure 3 Objects taking or emiting (hallway/platform).

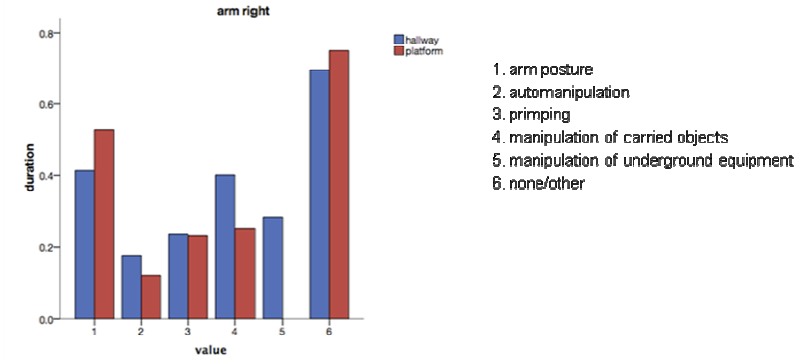


Figure 4 Arm right (hallway/platform).
On the platform people take on arm postures (1) more often, whereas in the hallway manipulation of carried objects (4) and underground equipment (5) occurs more often.

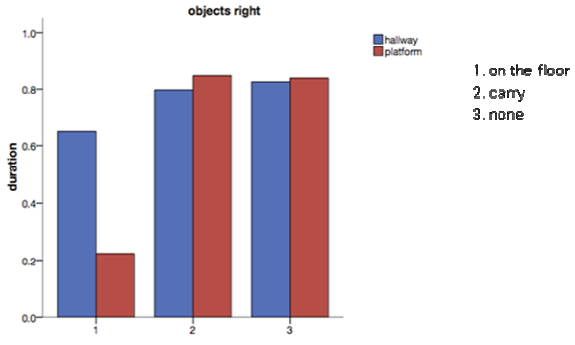


Figure 5 Objects right (hallway/platform).
People are more likely to put objects on the floor in the hallway (1).

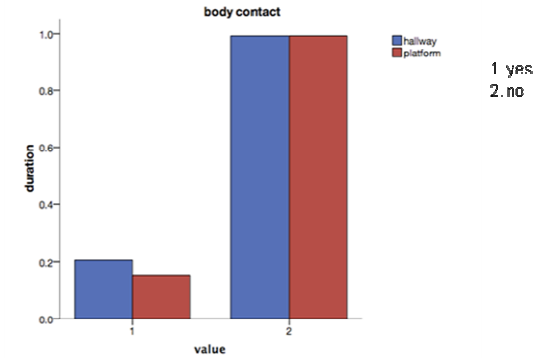


Figure 6 Body contact (hallway/platform).

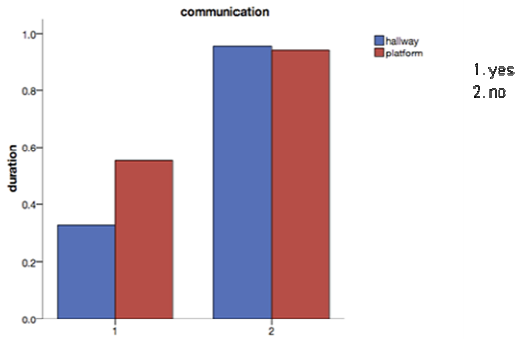


Figure 7 Communication (hallway/platform).
People communicate more often on the platform (1).

Based on the findings generated with these basic descriptors of human behaviour, the scenarios can be described. Furthermore, the insights gained on differences in behaviours shown in the different settings can be utilized to describe behaviour settings. Knowledge about the quality of the behavior settings can then be integrated into the algorithm to detect behaviours that are unusual for any given setting.

5 Human-centred ontology of scenarios of interest

This section now presents a general language which can help users (end-users and video content analysis developers) to describe their scenarios of interest. The goal of this language is to enable an automatic process to recognise directly the predefined behaviours within the recorded videos. For example, the scenarios described by end users in Sec. 3 should be formulated using this language and if possible, together with the visual cues presented in Sec. 4.

5.1 Terminology

This section enumerates and defines all the vocabulary describing the data used in different video analysis algorithms which can process either the scene viewed by different sensors (audio, video) or only observed by video cameras.

5.1.1 Scene Analysis Terminologies

Scene: the physical space where a real world event occurs and which can be observed by one or several video cameras. A scene without any physical object of interest is called an empty scene.

Physical object: a real world object in the scene. There are two types of physical objects: physical object of interest (or mobile object) and contextual object.

Physical object of interest: a physical object moving in the scene whose class (e.g., person, group, crowd and vehicle) is predefined by end-users and whose motion cannot be foreseen using a priori information. It is usually characterized by a semantic class label, 2D or 3D features (e.g. a 3D location), width and height, a posture, a trajectory, a direction, a speed, a list of blobs, an initial tracking time, a reference to the camera in the scene which is best seeing it (in the case of a multiple camera configuration), and an identifier. The identifier can either be defined locally on the current image, globally on the video sequence or globally on a scene (in a multi camera configuration). For example physical object of interest can be a person, a group or a crowd which are tracked to understand their behaviour in the scene.

Contextual object: a physical object attached to the scene. The contextual object is usually static and whenever in motion, its motion can be foreseen using a priori information. For instance, the movements induced by a door, an elevator, the water coming out of a fountain, the leaves of a tree, a chair and a luggage can be foreseen.

Tracked target: corresponds to the detection and tracking of a physical object of interest by vision or audio analysis algorithms through video and audio streams acquired by sensors.

ROI: Region Of Interest; a ROI is a region in the image which has been indicated as interesting by users. This region can be described with a single position or a polygonal region.

Oscillating movement: a movement that ‘always’ stay around a position (the integration of the speed is NULL) e.g. tree branches, sea and crowd in a soccer game.

5.1.2 Video Analysis Terminologies

PTZ: a Video camera that can Pan, Tilt and Zoom.

Image: an array of pixel generated at a time by a video camera (e.g., composite, CCD, CMOS, PTZ, omni directional). An image is characterized by a timestamp (year, month, day, hour, minute, second, millisecond) and can correspond to a frame interleaved or not. An image can be of the following type: colour, black and white, infrared and with different compression levels.

Video sequence: temporal sequence of images which are generated by a video camera. A video sequence can be represented as a live stream (e.g., composite signal, MJPEG stream), as a file (e.g., a MPEG4 encoded file) or as a sequence of files (e.g., a sequence of JPEG files).

Blob: 2D image region that has been segmented based on regions (e.g., homogeneous in motion, colour, energy or texture information) or contours (e.g., using a shape model). This region can be defined as a set of pixels (not necessarily connected) or as a polygon delimiting its contour. It can be characterized by 2D features such as a colour histogram, a density, a 2D width and height. A blob made of only connected pixels can be called a connected blob.

Moving region: a blob that has been created following a motion criteria (e.g., either optical flow or reference image subtraction).

Bounding box: a 2D box containing a physical object in an image; this box is represented by the width, the height and the middle point of the bounding box (located at half width and half height). The 2D referential in the image is defined by the top-left point in the image with 'x' a left to right axis and with 'y' a top to bottom axis.

Video event: a generic term to describe any event, action or activity happening in the scene and visually observable by cameras. Video events of interest can be either predefined by end users or learned by the system. Video events are characterized by the involved objects of interest (including contextual objects and zones of interest), their starting and ending time and by the cameras observing them. Examples of events are "detection of a vehicle inside a zone", "detection of an abandoned bag", "a meeting between two people"... We distinguish four types of video events i.e. primitive state, composite state, primitive event and composite event which are classified into two categories i.e. state and event defined below:

- A **state** is a spatio-temporal property of a physical object valid at a given instant or stable on a time interval. A state characterizes one or several physical objects of interest (e.g. person, crowd and vehicle) with or without respect to other physical objects.
    - A **primitive state** is a state which is directly inferred from visual attributes of physical objects computed by perceptual components. Usually, visual attributes have a numerical value and can correspond to general physical object properties for most of video understanding applications. For example: "A person stays inside a zone".
    - A **composite state** is a combination of states. This is the most complex granularity of states. We call **components** all the sub-states composing the state and we call **constraints** all the relations involving its components and its physical objects. For example: "Person *p1* is close to machine *m* and person *p2* stays inside zone *z*".
- An **event** is one or several change(s) of state values at two successive time instants or on a time interval.
    - A **primitive event** is a change of primitive state values. Primitive events are more abstract than states but they represent the finest granularity of events. For example: "Person *p* moves from zone *z1* to zone *z2*".
    - A **composite event** is a combination of states and events. This is the most complex granularity of events. Usually, the most abstract composite events have a symbolical/Boolean value and are directly linked to the goals of the given application. We call **components** all the sub-states/events composing the event and we call **constraints** all the relations involving its components and its physical objects.

Raw signal sample: a sample (for example an image, or a segment of audio) of the input signal processed by the analysis algorithm.

Ground truth data: data given by a human operator and which describe real world expected results (e.g., physical objects, events) at the output of a video understanding algorithm. These data are supposed to be unique and to correspond to end user requirements even if in many cases, this information can contain errors (annotation bias). These data can be written in a XML or MPEG7 format.

Annotation: an information associated to a video clip including ground truth data plus other types of information about technical difficulties (e.g., shadows) and recording conditions (e.g., weather conditions) of the video clip under consideration. These annotations can provide several types of information for false or incorrect results (e.g., wrong classification, wrong detection).

Reference data: data supposed to be constant and unique, corresponding to a functionality of a video understanding task and used to evaluate the output of a video understanding algorithm at a given task level. Reference data include ground truth data, data given by a video expert and data computed from all annotation and contextual information. For instance, the 3D position of a person is a reference data computed from the bounding box given by a video expert and the calibration matrix. In addition, rules should be given to video experts in order to define as objectively as possible particular data. For instance, for a partially occluded person, one can choose to draw the bounding box the full object (including any hidden parts) or only its visible part.

5.2 Hierarchy of the ontology

At INRIA, we use the ”protégé” software developed at Stanford University (US) to build the hierarchy of concepts used to describe some of the ontology for video event detection.

The event ontology is the set of concepts defining the activities which will be studied during VANAHEIM project. These concepts structure the definitions (the knowledge base provided by users) which have been listed in the previous section. The event ontology populates these concepts with various instances which can occur in a subway. These instances correspond to the VANAHEIM audio/video scenarios such as buying_ticket, queuing_at, taking_train, validating_ticket, etc. The ontology contains also the relationships between these concepts.

The event concepts which are presented in this ontology are defined relatively to the model of the observed scene. This scene model contains all the descriptions of the scene geometry and scene equipment including the sensors, the walls, the seats, the floor, the posters, the railways-tracks and the areas of interest predefined by end-users.

Physical_Object

- Contextual_Object
  - Door
  - Equipment
    - Booth
    - Escalator
    - Map
    - Poster
    - Seat
    - Ticket_Vending_Machine
    - Validation_Machine
  - Wall
  - Window
  - Zone
    - Corridor
    - Entrance_Zone
    - Exit_Zone
    - Hall
    - Platform
    - Surveillance_Zone
    - Ticket_Vending_Machine_Zone
    - Tracks
    - Validation_Zone
- Physical_Object_of_Interest
  - Crowd
  - Group
  - Person
  - Portable_Object
    - Baggage
  - Vehicle
    - Train

Primitive_State

- PS_One_Obj_of_Interest
  - One_Group
  - group_width_variation
  - quick_split
  - Trajectory_Variation
- One_Person
  - running
  - walking
- PS_Generic
  - erratic_trajectory
  - moving
  - speed_increase
  - stopped
- PS_One_Obj_of_Interest_One_Equipment
  - close_to
  - far_from
- PS_One_Obj_of_Interest_One_Zone
  - inside_zone
  - outside_zone
- PS_Two_Obj_of_Interest
  - close_to_person
  - following
- PS_Audio
  - Train_puts_breaks_on
  - Shouting
  - Music
  - Blast
  - Silence
  - Constant_noise

Composite_State

- Video
  - fighting
  - stays_at
  - stays_close_to
  - stays_far_from
  - stays_inside_zone
  - stays_outsize_zone
  - waiting
- Video_Audio
  - person_close_to_train_arrival
- Audio
  - Environmental_noise

Primitive_Event

- PE_One_Physical_Object_Of_Interest
  - starts_moving
  - starts_running
  - stops
- PE_One_Physical_Object_of_Interest_One_Equipment
  - moves_away_from
  - moves_close_to
- PE_One_Physical_Object_of_Interest_One_Zone
  - changes_zone
  - enters_zone
  - leaves_zone
- PE_Two_Physical_Objects_of_Interest
  - moves_away_from_POI
  - moves_close_to_POI
- PE_Audio
  - Start_loud_noise
  - End_loud_noise

Composite_Event

- CE_Audio_Video
  - Person_Close_To_Person
  - People_Entering_In_Conflict
  - Person_interacting_with_Person
- CE_Video_Monitoring
- CE_Metro_Monitoring
  - buying_ticket
  - crossing_zone
  - queuing_at
  - taking_train
  - Validating_ticket
  - Station_use
    - Monitoring_equipment
    - Situational_reporting
- CE_Video_Surveillance
- CE_Crowd
  - Overcrowding
  - rapid_increase_of_crowding_level
- CE_Generic
  - abandoned_luggage
  - access_to_forbidden_area
- CE_Group
  - group_staying_in_zone
  - Vandalism_against_ticket_machine
- CE_Person
  - following_someone
  - Vandalism_against_ticket_machine_one_man
- CE_Audio
  - Train_arrival
  - Train_departure
  - Public_announcement
  - Crowd_noise
  - Fighting_sound
  - Arguing

5.3 Mobile object information

This part gathers all information describing a mobile object and that can be automatically computed by a video process. This information can be summarized/formulated through an .xml specification file (.xsd); appendices provide respectively an example of .xsd specification file (p.32) that will be updated for VANAHEIM purpose, and an example of corresponding .xml file result (p.36).

mobile_object_id. The identifier label.

mobile_object_type. The class where the object belongs to. This can be Person, PersonGroup or Luggage.

start_time. First moment on time on which the object is seen.

end_time. Last moment on time on which the object is seen.

trajectory_type. The class where the object's trajectory belongs to depending on its points of entry and exit as currently implemented by INRIA. We are planning to add a subtype in this field which allows to characterise portions of the existing trajectory path. This subtype of the trajectory could give us more information on its shape.

trajectory_topology. The class where the object's trajectory belongs to according to the characterisation implemented by IDIAP.

localisation. This field would include the main area where the mobile object evolves. We are working to find the best way to define this area.

shape_type. The label best describing the object's shape such as lying, standing, sitting depending on the object's ratio height/width. Other information can be provided such as the change of shape.

size. The label best describing the object's size depending on the object's surface, for instance, small, medium, large.

involved_events_id. All occurring Events where the identified object is involved.

significant_event. The most significant event among all events where the mobile object is involved. This could be for instance the most frequent event. For the Caretaker project, we have so far defined the following Event types: inside_zone, stays_inside_zone, group_inside_zone, group_stays_inside_zone, close_to; and the following Contextual objects: Platform, Vend-ingMachine1, VendingMachine2.

5.4 Contextual object Information

This part gathers all information describing a contextual object and its evolution in time. This information can be manually provided by end-users or provided by a video process.

contextual_object_id. The identifier label for the contextual object.

contextual_object_type. The class where the contextual object belongs to.

start_time. First moment on time on which the contextual object has an interaction.

end_time. Last moment on time on which the contextual object has an interaction.

involved_events_id. All occurring Events where the identified contextual object is involved. This field could also contain Events like 'Machine_out_of_order' or 'Empty_Platform'.

significant_event. This could be for instance the most frequent event.

rare_event. This is the most rare event.

event_histogram. Gives the frequency of appearance for all involved events.

involved_mobile_objects_id. All mobile objects detected together with the contextual object of interest.

histogram_mobile_objects. Gives the frequency of appearance for all involved mobile objects.

user_origin. mean location where the objects are coming from.

user_destination. mean location where the objects are going to.

use_duration. Percentage of occupancy or use of a contextual object. For istance the contextual object has a 10% of use over the observation time.

mean_time_of_use. Average time of interaction between the user and the contextual object.

user_density. How many people are interacting with the contextual object. This information could be refined using the date and time interval (rush hour).

5.5 Events Information

This part gathers all information describing Events and their relationship either with mobile or contextual object.

event_id. The identifier label for the detected Event.

event_type. The class where the Event belongs to.

start_time. First moment on which the Event is detected.

end_time. Last moment on which the Event is seen.

involved_mobile_object_id. The identifier label for the object involved in that event.

involved_contextual_object_id. The name of the contextual object involved in that event.

situation. Key Labels for the Situation field are still to be defined. These could include: empty, one person, few people, many people, crowded, very crowded.

5.6 Event description language

This section last provides some examples of scenario that can be described by subway managers using the proposed event ontology and a video event description language such as the one proposed in [Vu2003]. Within VANAHEIM, we will extend this language to be able to better manage the uncertainty of the scenario.

Event Representation

A video event is mainly constituted of five parts:

1. Physical objects: all real world objects present in the scene observed by the cameras (Mobile objects, contextual objects, zones of interest)
2. Components: list of states and sub-events involved in the event.
3. Forbidden Components: list of states and sub-events that must not be detected during the event
4. Constraints: Symbolic, logical, spatio-temporal relations between components or physical objects
5. Actions: a set of tasks to be performed when the event is recognized.

Example "EmployeeVendingTicket_Attack" scenario model

This scenario describes an employee, who is vending metro's tickets, which was attacked by a robber.

```
composite-event (EmployeeVendingTicket_attack,
   physical-objects ((employee : Person), (robber : Person))
   components (
    (e1: primitive-state inside_zone (employee, "Back"))
    (e2: primitive-event changes_zone (robber, "Entrance", "In front"))
    (e3: primitive-state inside_zone (employee, "Safe"))
    (e4: primitive-state inside_zone (robber, "Safe"))   )
    Constraints ((e2   during    e1)
                 (e2 before   e3)
                 (e1 before   e3)
                 (e2 before   e4)
                 (e4 during   e3)  )
```

Example '' Vandalism'' event model

This scenario describes a person who envisages attacking a ticket vending machine.

```
CompositeEvent (vandalism, physical-objects:
                        {(p: person), (z: VendingMachineZone),
                              (Eq: TicketVendingMachine)})
                              components
{
(c1: PrimitiveEvent enters_zone(p,z))
(c2: PrimitiveEvent moves_close_to(p,eq))
(c3: CompositeEvent stays_at(p,eq))
(c4: PrimitiveEvent goes_away_from(p,eq))
(c5: PrimitiveEvent moves_close_to(p,eq))
(c6: CompositeEvent stays_at(p,eq))

}
Constraints {(c1; c2; c3; c4; c5; c6)}
```

Example '' inside_zone'' & ''changes_zone'' event models

This event describes a person who enters inside a zone which was beforehand predefined.

```
Primitive-state (inside_zone,
physical-objects((p: Person), (z : Zone))
constraints((p in z))  )
```

This event describes a person who enters inside a first zone then a second one.

```
Primitive-event(changes_zone,
Physical-objects((p : Person), (z1 : Zone), (z2 : Zone)))
Components (
        (e1 : primitive-state inside_zone(p, z1))
        (e2 : primitive-state inside_zone(p, Z2))
)
        Constraints ((e1 before e2))
)
```

Example '' Abandoned Luggage'' event model

This event describes a person who abandoned a luggage in predefined zone.

```
CompositeEvent (Abandoned_Luggage,
   Physical-objects ((P1: Person), (Luggage: Portable_Object) )
   Components (
    (e1: primitive-event moves_away_from (P1, Luggage))
    (e2: primitive-event waiting (Luggage))

    Forbidden-components ((f1: primitive-event moves_close_to (P2, Luggage))
    Constraints ((e2->duration > Th_abandoned_luggage ))
)
```

Example '' Stolen_Luggage'' event model

This event describes a person who stole a luggage.

```
CompositeEvent (Stolen_Luggage,
   Physical-objects ((P1: Person), (Robber: Person), (Luggage: Equipment) )
   Components (
    (e1: composite-event abandoned_luggage (P1, Luggage))
    (e2: primitive-event moves_close_to (Robber, Luggage))
    (e3: primitive-event stays_at (Robber, Luggage))
    (e4: primitive-state moves_away_with (Robber, Luggage))
          Constraints (sequence (e1; e2; e3; e4))
```

Example '' Group_Blocking'' event model

This event describes a group of person who are blocking a predefined zone.

```
CompositeEvent (Group_Blocking,
   Physical-objects ((G: Group), (Z: Zone) )
   Components (
    (e1 : primitive-event inside_zone (G, Z)) )
   Constraints (e1->duration > Th_Group_Blocking))
```

Example '' People_Entering_In_Conflict '' event model

This event describes two persons entering in conflict.

```
CompositeEvent (People_Entering_In_Conflict,
   Physical-objects ((P1: Person), (P2: Person))
   Components (
    (e1: primitive-event moves_close_to (P1, P2))
    (e2: primitive-event fighting (P1, P2)))
   Constraints (sequence (e1; e2))
```

Example '' People Queuing at Equipment '' event model

This event describes 3 persons queuing at a ticket vending machine.

```
CompositeEvent (Queuing_at_Equipment,
   Physical-objects ((P1: Person), (P2: Person), (P3: Person), (Z1: Zone_close_to), (Z2: Middle_Zone), (Z3:
Far_Zone), (Eq: Equipment))
```

```
   Components (
    (e1: primitive-state inside_zone (P1, Z1))
    (e2: primitive-state inside_zone (P2, Z2))
    (e3: primitive-state inside_zone (P3, Z3))
)
   Constraints ((e1->duration > Th_Time_Queing)
                (e2->duration > Th_Time_Queing)
                (e3->duration > Th_Time_Queing)
                 (distance Z1->Eq > 1 m)
                 (distance Z2-> Eq > 3 m)
                 (distance Z3-> Eq > 5 m))
```

For all these scenarios, the events are detected when all the components are realised.

This event description language is designed to define the scenarios which have to be recognized on-line. Collective behaviours are not modelled directly with this language because the collective behaviour recognition process is an off-line data-mining process analysing the events which have been recognized on-line and stored in the data-base. For instance, the collective behaviour waiting-time-in-the-hall can be computed by statistically analysing the waiting events which have been recognized on-line. The collective behaviours still need to be defined depending on the on-line events that the VANAHEIM partners will have managed to recognize.

5.7 Modelling Activities of Interest

The methodology to model the activities of interest is composed of 4 steps:

- The first step consists in collecting videos representative of activities (called positives samples) and videos representative of similar but different activities that we do not want to recognize (negative samples).
- The second step is to propose an event model to understand the visual cues (i.e. the invariance within the video) which characterize the positive samples but which are absent from the negative samples.
- The third step is to adapt and run video processing algorithm to extract the visual cues from representative videos (both negative and positive samples).
- The fourth step is to verify whether the visual cues of step three are matching the event model from step two.

If the results are not satisfactory the process needs to be reiterated.

6 Conclusion

The scenarios summarized in this document will become the reference for the research performed during the duration of VANAHEIM project. The first part of the document has described the scenarios targeted by end-users. The second part has studied the visual cues that a human operator can observe in a video to describe people behaviour. Finally, the last part has described a formal scenario representation language for a computer to be able to recognize automatically scenarios within a video. Depending on the material (audio, video) collected at the end-users sites and the performance of VANAHEIM video processing, these three different parts may be updated during the project.

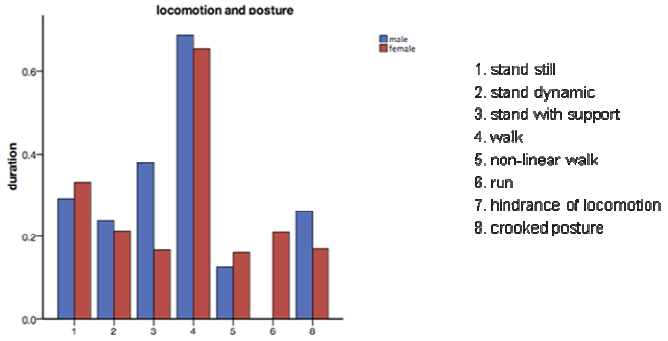
The remaining work consists in studying which scenarios can be effectively recognised by automatic video processing in order to:

- extract automatically the visual cues that have been proposed by human observers.
- detect the targeted scenarios and address end-user goals.

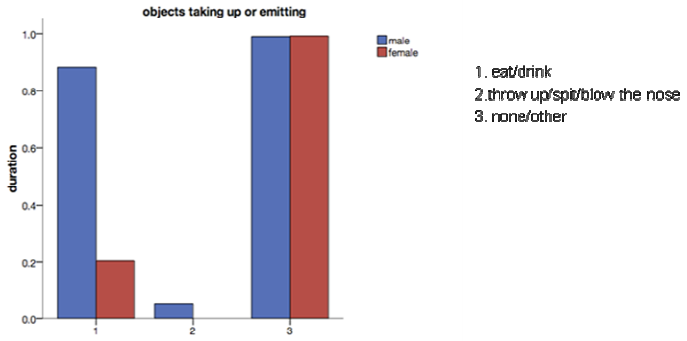
7 Bibliography

[Vu2003] T. Vu, F. Brémond and M. Thonnat, Automatic Video Interpretation: A Novel Algorithm for Temporal Scenario Recognition. The Eighteenth International Joint Conference on Artificial Intelligence (IJCAI'03), Acapulco, Mexico, 9-15 August 2003.

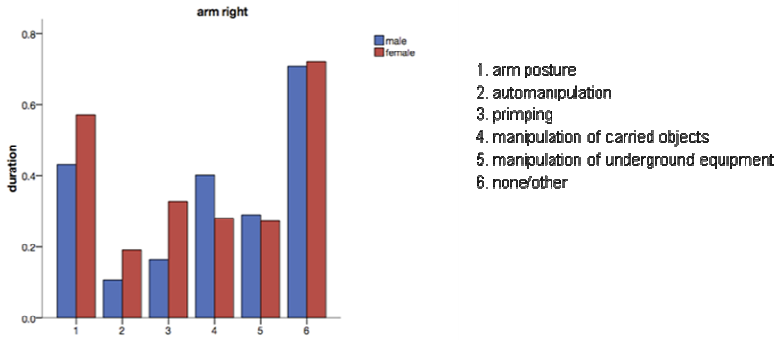
8 Appendix – Behaviours coding results by sex



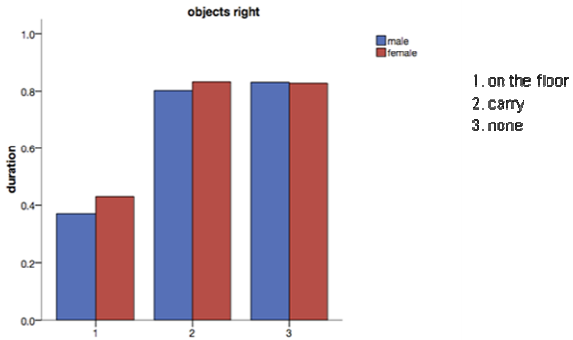
(a) locomotion and posture (male/female).



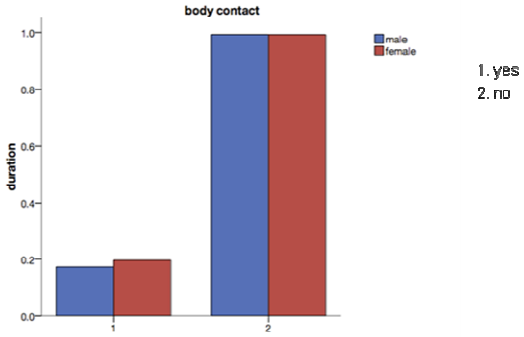
(b) objects taking up or emitting (male/female).



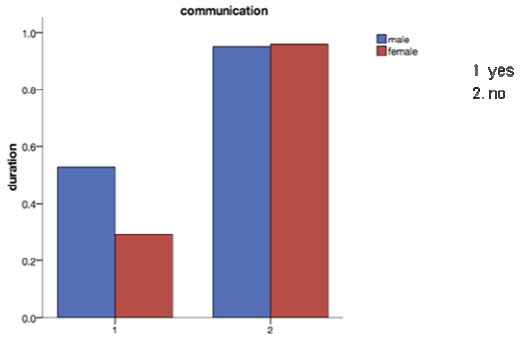
(c) arm right (male/female).



(d) objects right (male/female).



(e) body contact (male/female).



(f) communication (male/female).

9 Appendix –Example of INRIA .xsd specification file

```
1   <?xml version="1.0" encoding="utf-8"?>
2   <xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
    elementFormDefault="qualified">
3     <xs:element name="VANAHEIM">
4       <xs:complexType>
5         <xs:choice>
6           <xs:element ref="Timestamps" />
7           <xs:element maxOccurs="unbounded" ref="SUVideoFrame" />
8           <xs:element maxOccurs="unbounded" ref="MobFrame" />
9         </xs:choice>
10        <xs:attribute name="version" type="xs:decimal" />
11      </xs:complexType>
12    </xs:element>
13    <xs:element name="Timestamps">
14      <xs:complexType>
15        <xs:sequence>
16          <xs:element maxOccurs="unbounded" ref="frame" />
17        </xs:sequence>
18        <xs:attribute name="nbFrames" type="xs:integer" />
19      </xs:complexType>
20    </xs:element>
21    <xs:element name="frame">
22      <xs:complexType>
23        <xs:attribute name="id" use="required" type="xs:integer" />
24        <xs:attribute name="msec" use="required" type="xs:integer" />
25        <xs:attribute name="timestamp" use="required" type="xs:integer" />
26      </xs:complexType>
27    </xs:element>
28    <xs:element name="SUVideoFrame">
29      <xs:complexType>
30        <xs:sequence>
31          <xs:element ref="ListMobileObjects" />
32          <xs:element ref="ListActivities" />
33        </xs:sequence>
34        <xs:attribute name="frameID" use="required" type="xs:integer" />
35        <xs:attribute name="timeDay" use="required" type="xs:integer" />
36        <xs:attribute name="timeHour" use="required" type="xs:integer" />
37        <xs:attribute name="timeMin" use="required" type="xs:integer" />
38        <xs:attribute name="timeMonth" use="required" type="xs:integer" />
39        <xs:attribute name="timeMs" use="required" type="xs:integer" />
40        <xs:attribute name="timeSec" use="required" type="xs:integer" />
41        <xs:attribute name="timeYear" use="required" type="xs:integer" />
42      </xs:complexType>
43    </xs:element>
44    <xs:element name="ListMobileObjects">
45      <xs:complexType>
46        <xs:sequence>
47          <xs:element minOccurs="0" maxOccurs="unbounded" ref="Mobile" />
48        </xs:sequence>
49      </xs:complexType>
50    </xs:element>
51    <xs:element name="ListActivities">
52      <xs:complexType>
53        <xs:sequence>
54          <xs:element minOccurs="0" maxOccurs="unbounded" ref="Activity" />
55        </xs:sequence>
56      </xs:complexType>
57    </xs:element>
58    <xs:element name="Activity">
```

```
59      <xs:complexType>
60        <xs:sequence>
61          <xs:element ref="TimeStart" />
62          <xs:element ref="TimeEnd" />
63          <xs:element ref="ListActivityPhysicalObjects" />
64          <xs:element ref="ListActivityCameraCtrl" />
65        </xs:sequence>
66        <xs:attribute name="AText" use="required" type="xs:string" />
67        <xs:attribute name="AType" use="required" type="xs:string" />
68        <xs:attribute name="ID" use="required" type="xs:integer" />
69        <xs:attribute name="confidence" use="required" type="xs:decimal" />
70        <xs:attribute name="name" use="required" type="xs:string" />
71        <xs:attribute name="type" use="required" type="xs:string" />
72      </xs:complexType>
73    </xs:element>
74    <xs:element name="TimeEnd">
75      <xs:complexType>
76        <xs:attribute name="frameID" use="required" type="xs:integer" />
77        <xs:attribute name="timeDay" use="required" type="xs:integer" />
78        <xs:attribute name="timeHour" use="required" type="xs:integer" />
79        <xs:attribute name="timeMin" use="required" type="xs:integer" />
80        <xs:attribute name="timeMonth" use="required" type="xs:integer" />
81        <xs:attribute name="timeMs" use="required" type="xs:integer" />
82        <xs:attribute name="timeSec" use="required" type="xs:integer" />
83        <xs:attribute name="timeYear" use="required" type="xs:integer" />
84      </xs:complexType>
85    </xs:element>
86    <xs:element name="ListActivityPhysicalObjects">
87      <xs:complexType>
88        <xs:sequence>
89          <xs:element maxOccurs="unbounded" ref="ActivityPhysicalObject" />
90        </xs:sequence>
91      </xs:complexType>
92    </xs:element>
93    <xs:element name="ActivityPhysicalObject">
94      <xs:complexType>
95        <xs:attribute name="ID" use="required" type="xs:integer" />
96        <xs:attribute name="dynamicObjectID" use="required" type="xs:integer"
    />
97        <xs:attribute name="name" use="required" type="xs:string" />
98        <xs:attribute name="type" use="required" type="xs:string" />
99      </xs:complexType>
100   </xs:element>
101   <xs:element name="ListActivityCameraCtrl">
102     <xs:complexType />
103   </xs:element>
104   <xs:element name="MobFrame">
105     <xs:complexType>
106       <xs:sequence>
107         <xs:element minOccurs="0" maxOccurs="unbounded" ref="Mobile" />
108       </xs:sequence>
109       <xs:attribute name="frameID" use="required" type="xs:integer" />
110       <xs:attribute name="nbMobiles" use="required" type="xs:integer" />
111       <xs:attribute name="timeDay" use="required" type="xs:integer" />
112       <xs:attribute name="timeHour" use="required" type="xs:integer" />
113       <xs:attribute name="timeMin" use="required" type="xs:integer" />
114       <xs:attribute name="timeMonth" use="required" type="xs:integer" />
115       <xs:attribute name="timeMs" use="required" type="xs:integer" />
116       <xs:attribute name="timeSec" use="required" type="xs:integer" />
117       <xs:attribute name="timeYear" use="required" type="xs:integer" />
118     </xs:complexType>
119   </xs:element>
120   <xs:element name="Mobile">
121     <xs:complexType>
```

```
      <xs:sequence>
        <xs:element ref="TimeStart" />
        <xs:element minOccurs="0" ref="Track" />
        <xs:element ref="Blob" />
      </xs:sequence>
      <xs:attribute name="confidence" use="required" type="xs:decimal" />
      <xs:attribute name="mobileID" use="required" type="xs:integer" />
      <xs:attribute name="subType" use="required" type="xs:string" />
      <xs:attribute name="type" use="required" type="xs:string" />
    </xs:complexType>
  </xs:element>
  <xs:element name="Track">
    <xs:complexType>
      <xs:sequence>
        <xs:element maxOccurs="unbounded" ref="ParentMobile" />
      </xs:sequence>
      <xs:attribute name="numParent" use="required" type="xs:integer" />
    </xs:complexType>
  </xs:element>
  <xs:element name="ParentMobile">
    <xs:complexType>
      <xs:attribute name="confidence" use="required" type="xs:decimal" />
      <xs:attribute name="frameID" use="required" type="xs:integer" />
      <xs:attribute name="mobileID" use="required" type="xs:integer" />
      <xs:attribute name="timeDay" use="required" type="xs:integer" />
      <xs:attribute name="timeHour" use="required" type="xs:integer" />
      <xs:attribute name="timeMin" use="required" type="xs:integer" />
      <xs:attribute name="timeMonth" use="required" type="xs:integer" />
      <xs:attribute name="timeMs" use="required" type="xs:integer" />
      <xs:attribute name="timeSec" use="required" type="xs:integer" />
      <xs:attribute name="timeYear" use="required" type="xs:integer" />
    </xs:complexType>
  </xs:element>
  <xs:element name="Blob">
    <xs:complexType>
      <xs:sequence>
        <xs:element ref="CameraViews" />
        <xs:element ref="Info3D" />
        <xs:element ref="Uncertainty3D" />
        <xs:element ref="Properties" />
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="CameraViews">
    <xs:complexType>
      <xs:sequence>
        <xs:element minOccurs="0" maxOccurs="unbounded" ref="Info2D" />
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="Info2D">
    <xs:complexType>
      <xs:attribute name="camID" use="required" type="xs:integer" />
      <xs:attribute name="frameID" use="required" type="xs:integer" />
      <xs:attribute name="length" use="required" type="xs:decimal" />
      <xs:attribute name="nbMovPix" use="required" type="xs:integer" />
      <xs:attribute name="orientation" use="required" type="xs:decimal" />
      <xs:attribute name="timeDay" use="required" type="xs:integer" />
      <xs:attribute name="timeHour" use="required" type="xs:integer" />
      <xs:attribute name="timeMin" use="required" type="xs:integer" />
      <xs:attribute name="timeMonth" use="required" type="xs:integer" />
      <xs:attribute name="timeMs" use="required" type="xs:integer" />
      <xs:attribute name="timeSec" use="required" type="xs:integer" />
      <xs:attribute name="timeYear" use="required" type="xs:integer" />
```

```
      <xs:attribute name="width" use="required" type="xs:decimal" />
      <xs:attribute name="xCenter" use="required" type="xs:decimal" />
      <xs:attribute name="xCog" use="required" type="xs:decimal" />
      <xs:attribute name="xSpeed" use="required" type="xs:decimal" />
      <xs:attribute name="yCenter" use="required" type="xs:decimal" />
      <xs:attribute name="yCog" use="required" type="xs:decimal" />
      <xs:attribute name="ySpeed" use="required" type="xs:decimal" />
    </xs:complexType>
  </xs:element>
  <xs:element name="Info3D">
    <xs:complexType>
      <xs:attribute name="h3D" use="required" type="xs:decimal" />
      <xs:attribute name="l3D" use="required" type="xs:decimal" />
      <xs:attribute name="orientation" use="required" type="xs:decimal" />
      <xs:attribute name="w3D" use="required" type="xs:decimal" />
      <xs:attribute name="x" use="required" type="xs:decimal" />
      <xs:attribute name="xSpeed" use="required" type="xs:decimal" />
      <xs:attribute name="y" use="required" type="xs:decimal" />
      <xs:attribute name="ySpeed" use="required" type="xs:decimal" />
      <xs:attribute name="z" use="required" type="xs:decimal" />
      <xs:attribute name="zSpeed" use="required" type="xs:decimal" />
    </xs:complexType>
  </xs:element>
  <xs:element name="Uncertainty3D">
    <xs:complexType>
      <xs:attribute name="m11" use="required" type="xs:decimal" />
      <xs:attribute name="m12" use="required" type="xs:decimal" />
      <xs:attribute name="m13" use="required" type="xs:decimal" />
      <xs:attribute name="m21" use="required" type="xs:decimal" />
      <xs:attribute name="m22" use="required" type="xs:decimal" />
      <xs:attribute name="m23" use="required" type="xs:decimal" />
      <xs:attribute name="m31" use="required" type="xs:decimal" />
      <xs:attribute name="m32" use="required" type="xs:decimal" />
      <xs:attribute name="m33" use="required" type="xs:decimal" />
    </xs:complexType>
  </xs:element>
  <xs:element name="Properties">
    <xs:complexType />
  </xs:element>
  <xs:element name="TimeStart">
    <xs:complexType>
      <xs:attribute name="frameID" use="required" type="xs:integer" />
      <xs:attribute name="timeDay" use="required" type="xs:integer" />
      <xs:attribute name="timeHour" use="required" type="xs:integer" />
      <xs:attribute name="timeMin" use="required" type="xs:integer" />
      <xs:attribute name="timeMonth" use="required" type="xs:integer" />
      <xs:attribute name="timeMs" use="required" type="xs:integer" />
      <xs:attribute name="timeSec" use="required" type="xs:integer" />
      <xs:attribute name="timeYear" use="required" type="xs:integer" />
    </xs:complexType>
  </xs:element>
</xs:schema>
```

10 Appendix – Example of INRIA .xml result file

```
1   <?xml version="1.0" encoding="UTF-8"?>
2   <VANAHEIM version="2.00">
3     <SUVideoFrame frameID="50" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="610">
4       <ListMobileObjects/>
5       <ListActivities/>
6     </SUVideoFrame>
7     <SUVideoFrame frameID="51" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="730">
8       <ListMobileObjects/>
9       <ListActivities/>
10    </SUVideoFrame>
11    <SUVideoFrame frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810">
12      <ListMobileObjects>
13        <Mobile mobileID="1" confidence="0.28" type="VEHICLE:89-OTHER:10"
    subType="VEHICLE:100|OTHER:100">
14          <TimeStart frameID="49" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="35600"/>
15          <Blob>
16            <CameraViews>
17              <Info2D camID="4" xCenter="236.00" yCenter="341.00"
    xCog="236.00" yCog="341.50" width="682.00" length="472.00"
    orientation="0.00" nbMovPix="145304456" xSpeed
18  ="0.00" ySpeed="0.00" frameID="62" timeYear="2026" timeMonth="8"
    timeDay="16" timeHour="5" timeMin="41" timeSec="40" timeMs="80"/>
19            </CameraViews>
20            <Info3D x="2.92" y="-10.52" z="0.00" w3D="9.63" h3D="2.79"
    l3D="10.00" orientation="0.00" xSpeed="0.00" ySpeed="0.22" zSpeed="0.00"/>
21            <Uncertainty3D m11="-0.00" m12="-0.00" m13="-0.00" m21="0.00"
    m22="-0.00" m23="-0.00" m31="0.00" m32="-0.00" m33="0.00"/>
22            <Properties/>
23          </Blob>
24        </Mobile>
25      </ListMobileObjects>
26      <ListActivities>
27        <Activity ID="0" name="v_Inside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
28          <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
29          <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
30          <ListActivityPhysicalObjects>
31            <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
32            <ActivityPhysicalObject type="STATIC_ZONE" ID="13" name="ERA"
    dynamicObjectID="0"/>
33          </ListActivityPhysicalObjects>
34          <ListActivityCameraCtrl/>
35        </Activity>
36        <Activity ID="1" name="Vehicle_Stopped" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Vehicle_Scenario">
37          <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
38          <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
39          <ListActivityPhysicalObjects>
40            <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
```

```
41          </ListActivityPhysicalObjects>
42          <ListActivityCameraCtrl/>
43        </Activity>
44        <Activity ID="2" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
45          <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
46          <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
47          <ListActivityPhysicalObjects>
48            <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
49            <ActivityPhysicalObject type="STATIC_ZONE" ID="0"
    name="Left_FWD_Passenger_Zone" dynamicObjectID="0"/>
50          </ListActivityPhysicalObjects>
51          <ListActivityCameraCtrl/>
52        </Activity>
53        <Activity ID="3" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
54          <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
55          <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
56          <ListActivityPhysicalObjects>
57            <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
58            <ActivityPhysicalObject type="STATIC_ZONE" ID="1"
    name="Right_FWD_Passenger_Zone" dynamicObjectID="0"/>
59          </ListActivityPhysicalObjects>
60          <ListActivityCameraCtrl/>
61        </Activity>
62        <Activity ID="4" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
63          <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
64          <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
65          <ListActivityPhysicalObjects>
66            <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
67            <ActivityPhysicalObject type="STATIC_ZONE" ID="2"
    name="Left_AFT_Passenger_Zone" dynamicObjectID="0"/>
68          </ListActivityPhysicalObjects>
69          <ListActivityCameraCtrl/>
70        </Activity>
71        <Activity ID="5" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
72          <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
73          <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
74          <ListActivityPhysicalObjects>
75            <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
76            <ActivityPhysicalObject type="STATIC_ZONE" ID="3"
    name="Right_AFT_Passenger_Zone" dynamicObjectID="0"/>
77          </ListActivityPhysicalObjects>
78          <ListActivityCameraCtrl/>
79        </Activity>
80        <Activity ID="6" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
81          <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
```

```
82          <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
83          <ListActivityPhysicalObjects>
84            <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
85            <ActivityPhysicalObject type="STATIC_ZONE" ID="4"
    name="Right_FWD_Cargo_Zone" dynamicObjectID="0"/>
86          </ListActivityPhysicalObjects>
87          <ListActivityCameraCtrl/>
88        </Activity>
89        <Activity ID="7" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
90          <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
91          <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
92          <ListActivityPhysicalObjects>
93            <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
94            <ActivityPhysicalObject type="STATIC_ZONE" ID="5"
    name="Right_AFT_Bulk_Zone" dynamicObjectID="0"/>
95          </ListActivityPhysicalObjects>
96          <ListActivityCameraCtrl/>
97        </Activity>
98        <Activity ID="8" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
99          <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
100         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
101         <ListActivityPhysicalObjects>
102           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
103           <ActivityPhysicalObject type="STATIC_ZONE" ID="6"
    name="Right_AFT_Cargo_Zone" dynamicObjectID="0"/>
104         </ListActivityPhysicalObjects>
105         <ListActivityCameraCtrl/>
106       </Activity>
107       <Activity ID="9" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
108         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
109         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
110         <ListActivityPhysicalObjects>
111           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
112           <ActivityPhysicalObject type="STATIC_ZONE" ID="7"
    name="Right_FWD_Transporter_Zone" dynamicObjectID="0"/>
113         </ListActivityPhysicalObjects>
114         <ListActivityCameraCtrl/>
115       </Activity>
116       <Activity ID="10" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
117         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
118         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
119         <ListActivityPhysicalObjects>
120           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
121           <ActivityPhysicalObject type="STATIC_ZONE" ID="8"
    name="Right_AFT_Transporter_Zone" dynamicObjectID="0"/>
122         </ListActivityPhysicalObjects>
```

```
123         <ListActivityCameraCtrl/>
124       </Activity>
125       <Activity ID="11" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
126         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
127         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
128         <ListActivityPhysicalObjects>
129           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
130           <ActivityPhysicalObject type="STATIC_ZONE" ID="9" name="GPU_Zone"
    dynamicObjectID="0"/>
131         </ListActivityPhysicalObjects>
132         <ListActivityCameraCtrl/>
133       </Activity>
134       <Activity ID="12" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
135         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
136         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
137         <ListActivityPhysicalObjects>
138           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
139           <ActivityPhysicalObject type="STATIC_ZONE" ID="10"
    name="Left_Refuelling_Zone" dynamicObjectID="0"/>
140         </ListActivityPhysicalObjects>
141         <ListActivityCameraCtrl/>
142       </Activity>
143       <Activity ID="13" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
144         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
145         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
146         <ListActivityPhysicalObjects>
147           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
148           <ActivityPhysicalObject type="STATIC_ZONE" ID="11"
    name="Waiting_Zone1" dynamicObjectID="0"/>
149         </ListActivityPhysicalObjects>
150         <ListActivityCameraCtrl/>
151       </Activity>
152       <Activity ID="14" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
153         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
154         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
155         <ListActivityPhysicalObjects>
156           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
157           <ActivityPhysicalObject type="STATIC_ZONE" ID="12"
    name="Waiting_Zone2" dynamicObjectID="0"/>
158         </ListActivityPhysicalObjects>
159         <ListActivityCameraCtrl/>
160       </Activity>
161       <Activity ID="15" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
162         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
163         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
```

```
164         <ListActivityPhysicalObjects>
165           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
166           <ActivityPhysicalObject type="STATIC_ZONE" ID="14"
    name="Jet_Bridge_Park" dynamicObjectID="0"/>
167         </ListActivityPhysicalObjects>
168         <ListActivityCameraCtrl/>
169       </Activity>
170       <Activity ID="16" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
171         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
172         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
173         <ListActivityPhysicalObjects>
174           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
175           <ActivityPhysicalObject type="STATIC_ZONE" ID="15"
    name="Jet_Bridge_Evolution" dynamicObjectID="0"/>
176         </ListActivityPhysicalObjects>
177         <ListActivityCameraCtrl/>
178       </Activity>
179       <Activity ID="17" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
180         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
181         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
182         <ListActivityPhysicalObjects>
183           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
184           <ActivityPhysicalObject type="STATIC_ZONE" ID="16"
    name="Gear_Stop" dynamicObjectID="0"/>
185         </ListActivityPhysicalObjects>
186         <ListActivityCameraCtrl/>
187       </Activity>
188       <Activity ID="18" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
189         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
190         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
191         <ListActivityPhysicalObjects>
192           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
193           <ActivityPhysicalObject type="STATIC_ZONE" ID="17"
    name="Arrival_Preparation" dynamicObjectID="0"/>
194         </ListActivityPhysicalObjects>
195         <ListActivityCameraCtrl/>
196       </Activity>
197       <Activity ID="19" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
198         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
199         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
200         <ListActivityPhysicalObjects>
201           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
202           <ActivityPhysicalObject type="STATIC_ZONE" ID="18"
    name="BL_Gear_Access" dynamicObjectID="0"/>
203         </ListActivityPhysicalObjects>
204         <ListActivityCameraCtrl/>
205       </Activity>
```

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206       <Activity ID="20" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
207         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
208         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
209         <ListActivityPhysicalObjects>
210           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
211           <ActivityPhysicalObject type="STATIC_ZONE" ID="19"
    name="Air_Conditioning_Access" dynamicObjectID="0"/>
212         </ListActivityPhysicalObjects>
213         <ListActivityCameraCtrl/>
214       </Activity>
215       <Activity ID="21" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
216         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
217         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
218         <ListActivityPhysicalObjects>
219           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
220           <ActivityPhysicalObject type="STATIC_ZONE" ID="20"
    name="RefuellingPlatform_Area" dynamicObjectID="0"/>
221         </ListActivityPhysicalObjects>
222         <ListActivityCameraCtrl/>
223       </Activity>
224       <Activity ID="22" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
225         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
226         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
227         <ListActivityPhysicalObjects>
228           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
229           <ActivityPhysicalObject type="STATIC_ZONE" ID="21"
    name="Fuel_Panel_Access" dynamicObjectID="0"/>
230         </ListActivityPhysicalObjects>
231         <ListActivityCameraCtrl/>
232       </Activity>
233       <Activity ID="23" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
234         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
235         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
236         <ListActivityPhysicalObjects>
237           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
238           <ActivityPhysicalObject type="STATIC_ZONE" ID="22"
    name="Potable_Water_Access" dynamicObjectID="0"/>
239         </ListActivityPhysicalObjects>
240         <ListActivityCameraCtrl/>
241       </Activity>
242       <Activity ID="24" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
243         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
244         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
245         <ListActivityPhysicalObjects>
```

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246           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
247           <ActivityPhysicalObject type="STATIC_ZONE" ID="23"
    name="Lavatory_Vacuum_Access" dynamicObjectID="0"/>
248         </ListActivityPhysicalObjects>
249         <ListActivityCameraCtrl/>
250       </Activity>
251       <Activity ID="25" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
252         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
253         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
254         <ListActivityPhysicalObjects>
255           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
256           <ActivityPhysicalObject type="STATIC_ZONE" ID="24"
    name="Lavatory_Gravity_Access" dynamicObjectID="0"/>
257         </ListActivityPhysicalObjects>
258         <ListActivityCameraCtrl/>
259       </Activity>
260       <Activity ID="26" name="v_Outside_Zone" confidence="1.00"
    type="PRIMITIVE_STATE" AType="NOTURGENT" AText="Zone_Scenario">
261         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
262         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
263         <ListActivityPhysicalObjects>
264           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
265           <ActivityPhysicalObject type="STATIC_ZONE" ID="25"
    name="Pneumatic_Access" dynamicObjectID="0"/>
266         </ListActivityPhysicalObjects>
267         <ListActivityCameraCtrl/>
268       </Activity>
269       <Activity ID="27" name="Vehicle_Stopped_Inside_Zone" confidence="1.00"
    type="COMPOSITE_STATE" AType="NOTURGENT" AText="Vehicle_Scenario">
270         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
271         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
272         <ListActivityPhysicalObjects>
273           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
274           <ActivityPhysicalObject type="STATIC_ZONE" ID="13" name="ERA"
    dynamicObjectID="0"/>
275         </ListActivityPhysicalObjects>
276         <ListActivityCameraCtrl/>
277       </Activity>
278       <Activity ID="28" name="Vehicle_Arrived_In_Zone" confidence="1.00"
    type="COMPOSITE_STATE" AType="URGENT" AText="Vehicle_Scenario">
279         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
280         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
281         <ListActivityPhysicalObjects>
282           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
283           <ActivityPhysicalObject type="STATIC_ZONE" ID="13" name="ERA"
    dynamicObjectID="0"/>
284         </ListActivityPhysicalObjects>
285         <ListActivityCameraCtrl/>
286       </Activity>
```

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287       <Activity ID="29" name="Vehicle_Arrived_In_ERA" confidence="1.00"
    type="COMPOSITE_STATE" AType="URGENT" AText="ERA_Scenario">
288         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
289         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
290         <ListActivityPhysicalObjects>
291           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
292           <ActivityPhysicalObject type="STATIC_ZONE" ID="13" name="ERA"
    dynamicObjectID="0"/>
293         </ListActivityPhysicalObjects>
294         <ListActivityCameraCtrl/>
295       </Activity>
296       <Activity ID="30" name="Vehicle_Arrived_And_Stopped_In_Zone"
    confidence="1.00" type="COMPOSITE_EVENT" AType="URGENT"
    AText="Vehicle_Scenario">
297         <TimeStart frameID="52" timeYear="2009" timeMonth="2" timeDay="1"
    timeHour="14" timeMin="20" timeSec="5" timeMs="810"/>
298         <TimeEnd frameID="0" timeYear="1970" timeMonth="1" timeDay="1"
    timeHour="1" timeMin="0" timeSec="0" timeMs="0"/>
299         <ListActivityPhysicalObjects>
300           <ActivityPhysicalObject type="OBJECT" ID="1" name="V_01"
    dynamicObjectID="0"/>
301           <ActivityPhysicalObject type="STATIC_ZONE" ID="13" name="ERA"
    dynamicObjectID="0"/>
302         </ListActivityPhysicalObjects>
303         <ListActivityCameraCtrl/>
304       </Activity>
305     </ListActivities>
306   </SUVideoFrame>
307 </VANAHEIM>
```