Application Interface
Eagle Tracking Engine®

System	Eagle Tracking Engine®
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1. APPLICATION OVERVIEW

1.1 Introduction

EagleTrackingEngine is a software system for video surveillance with multiple cameras. The system measures trajectories of people visible in the tracking area. The measured trajectories are provided online to 3rd party applications via a network interface.

EagleTrackingEngine employs multiple stereo cameras for (pseudo) 3-dimensional measurements of trajectories. A person measurement includes location within a two-dimensional ground plane, and a 3-dimensional bounding box (a cuboid) approximating person's volume. A time-stamped series of such measurements forms a trajectory.

Trajectory measurements are streamed online to 3-rd party client applications via an Ethernet interface. The stream of measurements is organized into messages. Each message corresponds to one of tracking events, such as: a new track being created, an existing track being extended or finished.

Each message is sent as a separate UDP datagram (packet) according UDP/IP transport protocol.

1.2 Tracking cycle

1.2.1 Track start

Track start message is sent when a person is detected in a tracking area. For each trajectory the track-start message is sent once.

At the start, the tracked person is given a unique identification number, referred to as track-id.. This number will be used by the system to identify the trajectory as long as the followed person *remains visible in the tracking area.* It may happen, that a person with a known track-id temporarily leaves the tracking area and reenters it later. At the reentry, the system will assign a different track-id number. Track id number will not be reused between persons. The system does not guarantee any specific order of the assigned track-id numbers.

1.2.2 Track step

Track-step message is sent periodically with a fixed interval as long as the tracked person remains visible in the tracking area. The track-step message uses the track-id number to identify the person being tracked.

The system guarantees sending track-step messages with a fixed periodicity, but does not guarantee timely delivery. Message arrival will largely depend on network latency and throughput parameters.

1.2.3 Track stop

The track-stop message is sent when the system stops tracking a person. This happens due to the following reasons:

- the tracked person leaves the tracking area
- the tracked person gets occluded by some other person or object
- the tracked person does not satisfy minimum height criterion (for example when the person bends or sits down).

1.2.4 Simultaneous trajectories

The system can track multiple persons at the same time. When tracking multiple people, the tracking-related messages: track-start, track-stop, track-step will be generated simultaneously in order corresponding to the order of people appearing and disappearing in the tracking area.

2. APPLICATION INTERFACE

2.1 Physical Interface

2.1.1 Physical layer

Connection type:	Ethernet
Physical link:	Cat 5 Ethernet cable with two RJ45 connectors or wireless Ethernet connection IEEE 802.11b/g standard.
Bandwidth:	10 Mb/s (megabit per second)
Transport layer:	UDP / IP (User Datagram Protocol)

2.1.2 Transport layer

Protocol:	UDP / IP (User Datagram Protocol)
Mode	Broadcast
IP broadcast port	to be defined
IP subnetwork	to be defined
SPI Scout IP address:	to be defined

2.1.3 Application layer

Protocol:	Custom SPI-Comm protocol using UDP packets
Granularity	single UDP packet per tracking event
Message size	variable
Formatting	selectable JSON or XML encoded structure, formatted as text with UTF8 encoding
Frequency:	variable, approx 20 messages/trajectory/second

2.2 General message formatting

The SPI Comm can be configured to encode tracking messages using either JSON or XML data exchange format. Both formats deliver the same content.

XML configuration

XML version	1.0
Encoding	UTF-8
Element attributes	allowed, but discouraged

JSON configuration

JSON version	1.0
Encoding	UTF-8
Definition	See: http://www.json.org

Number formatting

Decimal separator	dot
Thousands separator	not used
Notation	ordinary decimal notation
Example	10230.45

(ten thousands two hundred thirty and fort five hundreds)

Time formatting

Time will be formatted using the following encoding (derived from ISO 8601standard)

Syntax yyyymmdd**T**hhuuss.rrrrrrrr

yyyy	4 digits, year
mm	2 digits, month within the year
dd	2 digits, day within the month
T	fixed literal "T"
hh	2 digits, hour within the day
uu	2 digits, minute within the hour
ss	2 digits, second within the minute
rrrrrrrr	9 digits, microseconds within the second

Example 20101004T121931.556875
represents 4 October 2010, UTC time 12:19:31 and 556875 microseconds.

Time reference will be UTC (zero offset time zone). Consequently, time zone suffix will be omitted from formatted time representation.

2.3 JSON Message definition

A message is defined as a JSON structure with the following fields – name/value pairs:

Field Name	Value Type	Description
format	string	Identifies message format
version	unsigned int (32 bit)	Identifies message format
message code	unsigned int (32 bit)	Message type
track id	unsigned int (32 bit)	Unique id of the tracked person
position xy	array of 2 floats (each float is 32bit)	2D position of a person, relative to the system reference
height	floating-point number	Height of a person
timestamp iso utc	formatted string	Timestamp of the event, in coordinated universal time (UTC) reference, formatted as ISO time string.
bbox xyzxyz	array of 6 floats (each float is 32bit)	Size and position of a 3D bounding box of the tracked person, relative the system reference.

The following sections provide detailed definition of JSON message fields.

2.3.1.1 Format

JSON field name	"format"
Value range	fixed value "spi-comm"
Type	string
Description	Indicates communication protocol version.

2.3.1.2 Version

JSON field name	"version"
Value range	fixed value: 2
Type	numeric, unsigned integer, 32 bit
Description	Indicates version of communication protocol version

2.3.1.3 Message code

JSON field name	"message code"
Value range	1001, 1002, 1003
Type	numeric, unsigned integer, 32 bit
Description	Type of message. Encoding: 1001 Track-start message 1002 Track-step message 1003 Track-stop message.

2.3.1.4 Track id

JSON field name	"track id"
Value range	0-4294967296
Type	numeric, unsigned integer, 32 bit
Description	Trajectory identifier.

2.3.1.5 Position XY

JSON field name	"position xy"
Value range	approx. (-10.0…10.0) - depending on tracking area
Type	array of two floating-point numbers
Description	The (x,y) coordinates of person position, relative to system coordinate system. **Unit**: meter.

2.3.1.6 Height

JSON field name	"height"
Value range	approx. (0…3.0) - depending on tracked person
Type	floating point number
Description	Height of the tracked person, non-negative. **Unit**: meter.

2.3.1.7 Bounding box

JSON field name	"bbox xyzxyz"
Value range	approx. (-10.0…10.0) - depending on tracking area
Type	array of six floating-point numbers
Description	This field indicates a 3-dimensional bounding box of the tracked person. The bounding box is given as two 3D dimensional points, in the following order: x_min x-coordinate of box minimum corner y_min y-coordinate of box minimum corner z_min z-coordinate of box minimum corner x_max x-coordinate of box maximum corner y_max y-coordinate of box maximum corner z_max z-coordinate of box maximum corner **Unit**: meter.

2.3.1.8 Timestamp

JSON field name	"timestamp iso utc"
Value range	"yyyymmddThhmmss.uuuuuu"
Type	string
Description	Timestamp of the event in UTC reference.

2.3.1.9 Example

An example message formatted as a JSON structure:

```
{
   "bbox xyzxyz":        [0.66, -0.13, 0.0, 0.96, 0.60, 1.54],
   "event type":         1001,
   "format":             "evs-comm",
   "position xy":        [0.59, 0.18],
   "height":             1.54,
   "timestamp iso utc":  "20101004T121931.213125",
   "track id":           0,
   "version":            2
}
```

Notice that the format specification does not define the order of the fields in the structure. The client/receiver application should not assume any specific order of the fields in the message.

2.4 XML Message definition

Messages are encoded as composite XML elements, using the following syntax:

```
<evs_data>
    <format>       spi-comm                          </format>
    <version>      Unsigned integer number           </version>
    <time_utc>     Time of measurement               </time_utc>
    <message_code> Unsigned integer number           </message_code>
    <track_id>     Integer number                    </track_id>
    <x>            Floating-point number             </x>
    <y>            Floating-point number             </y>
    <h>            Floating-point number             </z>
    <bbox>
        <x_min>    Floating-point number   </x_min>
        <y_min>    Floating-point number   </y_min>
        <z_min>    Floating-point number   </z_min>
        <x_max>    Floating-point number   </x_max>
        <y_max>    Floating-point number   </y_max>
        <z_max>    Floating-point number   </z_max>
    </bbox>
</evs_data>
```

Element tag	Value	Description
evs_data	XML struct	Represents whole message
format	spi-comm	Fixed literal indicating format family
version	2	Fixed value
time_utc	Text	Time of measurement,
message_code	Unsigned integer	Message code
track_id	Integer number	Trajectory indentificator
x,y,h	Floating numbers	Person location(x,y) and height(h), meters
bbox	XML struct	Encapsulates person 3D bounding box
x_min, y_min, z_min	Floating number	3D coordinates of bounding box minimum point
x_max, y_max, z_max	Floating-pt. numbers	3D coordinates of bounding box maximum point

The following sections provide detailed description of XML message definition.

2.4.1.1 Format

XML tag name	"format"
Value range	fixed value "spi-comm"
Type	string
Description	Indicates communication protocol version.

2.4.1.2 Version

XML tag name	"version"
Value range	fixed value: 2
Type	numeric, unsigned integer, 32 bit
Description	Indicates version of communication protocol version

2.4.1.3 Message code

XML tag name	"message_code"
Value range	1001, 1002, 1003
Type	numeric, unsigned integer, 32 bit
Description	Type of message. Encoding: 1001 Track-start message 1002 Track-step message 1003 Track-stop message.

2.4.1.4 Track id

XML tag name	"track_id"
Value range	0-4294967296
Type	numeric, unsigned integer, 32 bit
Description	Trajectory identifier.

2.4.1.5 Position and height

Position (x,y) and height (h) are represented by the following XML elements

XML tag name	"x"
Value range	approx. (-10.0…10.0) - depending on tracking area
Type	floating-point number
Description	The X coordinate of person location within the SPI Comm coordinate system. **Unit**: meter.

XML tag name	"y"
Value range	approx. (-10.0…10.0) - depending on tracking area
Type	floating-point number
Description	The Y coordinate of person location within the SPI Comm coordinate system. **Unit**: meter.

XML tag name	"h"
Value range	approx. (.0 – 3.0) - depending on tracked person
Type	floating-point number
Description	Measured height of a person, non-negative, usually within 0-3 meters range.

2.4.1.6 Bounding box

Bounding box approximates 3D dimensions of a tracked person as a 3D rectangular cuboid. The bounding box is represented as en XML structure with **bbox** element tag. The bbox XML structure encapsulates 6 elements – representing (x,y,z) coordinates of two points that define the cuboid.

XML tag name	"bbox"
Type	XML struct
Description	Encapsulates coordinates of 3D rectangular cuboid (6 elements)

XML tag name	**Description** (all values in meters)
x_min	floating-point number, x-coordinate of minimum cube vertex
y_min	floating-point number, y-coordinate of minimum cube vertex
z_min	floating-point number, z-coordinate of minimum cube vertex
x_max	floating-point number, x-coordinate of maximum cube vertex
y_max	floating-point number, y-coordinate of maximum cube vertex
z_max	floating-point number, z-coordinate of maximum cube vertex

2.4.1.7 Timestamp

XML tag name	"time_utc"
Value range	"yyyymmddThhmmss.uuuuuu"
Type	string
Description	Timestamp of the event in UTC reference. See general rules of time formatting.

2.4.1.8 Example

An example message formatted as an XML structure:

```
<evs_data>
    <format>       spi-comm                          </format>
    <version>      2                                 </version>
    <time_utc>     20101004T121931.213125            </time_utc>
    <message_code> 1001                              </message_code>
    <track_id>     0                                 </track_id>
    <x>            0.59                              </x>
    <y>            0.18                              </y>
    <h>            1.89                              </z>
    <bbox>
        <x_min>    0.66                    </x_min>
        <y_min>    -0.13                   </y_min>
        <z_min>    0.0                     </z_min>
        <x_max>    0.96                    </x_max>
        <y_max>    0.60                    </y_max>
        <z_max>    1.89                    </z_max>
    </bbox>
</evs_data>
```

3. REFERENCE COORDINATE SYSTEM

3.1 Temporal reference

All timestamps are expressed in UTC reference (Universal Coordinate Time), which is independent of local time zone and daylight settings.

The SPI Comm applications can be time-synchronized with external systems using NTP network protocol.

3.2 Spatial coordinate system

The SPI Scout system is using a 3-dimensional, right-handed, Cartesian coordinate system. All coordinates are expressed in meters. The X and Y axes define the ground plane of the coordinate system, the Z axis is the vertical axis.

The coordinate system is chosen such that the center point (0,0,0) is visible at one of the cameras. The value range for the X and Y coordinates depends on the size of the visible area. In a typical configuration the X and Y coordinates fall into range from -10.0 to +10.0 meter. The Z-plane is chosen such that Z=0 corresponds to the ground floor. The value range for the Z coordinates is 0.0 to 3.0 meters.

3.2.1 Bounding box measurement

Bounding box is a 3-dimenisonal cuboid, defined by two characteristic points: (a) the minimal point and (b) the maximal point – as indicated in the Figure 1. The height of the bounding box corresponds to the height of the person.

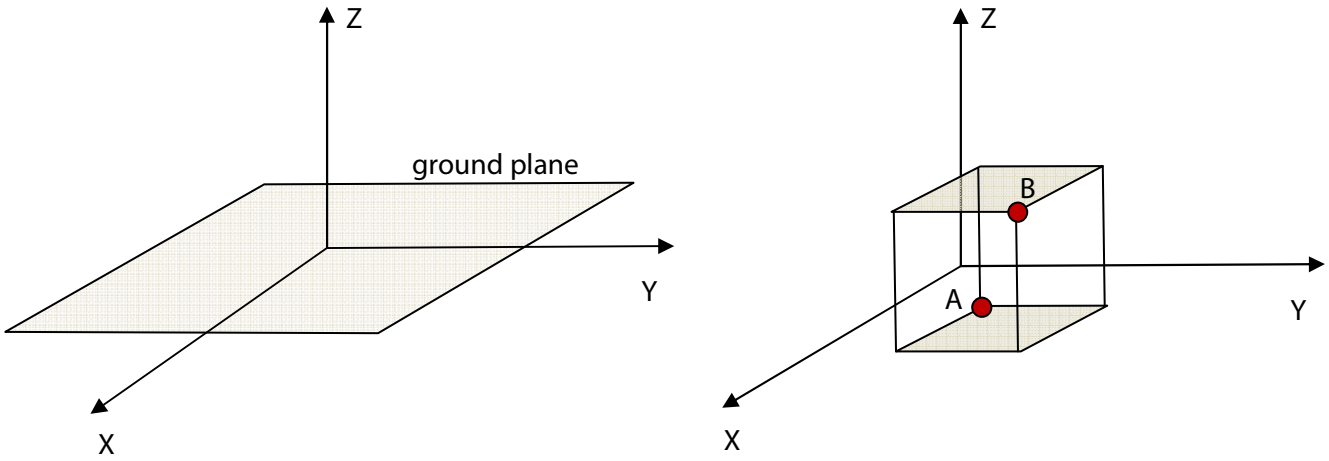

Figure (Left) Coordinate system and ground plane.
(Right) Bounding box definition, A – minimum point, B – maximum point.