

# White Paper

# t<sup>3D</sup> terra

Sector 44/2  
Live View  
2010-05-05 04:03

**Geo-Referenced Video**

- Extract real world coordinates
- Digital Terrain Model (DTM)
- Measure size of objects
- Object Detection

N48°07'15" E11°34'43"

**Digital Terrestrial Radio**

- Send own position
- Receive target position
- Send distress call

**Radar**

- Show targets & tracks in 3D model
- Extract real-world coordinate position

**Auto PTZ control**

- Autotrace targets
- Latency compensation for manual control

**Sensor status (fence)**

**Virtual video walls**

**Type and position of own troops**

**Track (GPS)**

**Mob. Navigation**

- Tactical maps
- Driver assistance
- Target positions
- Live video

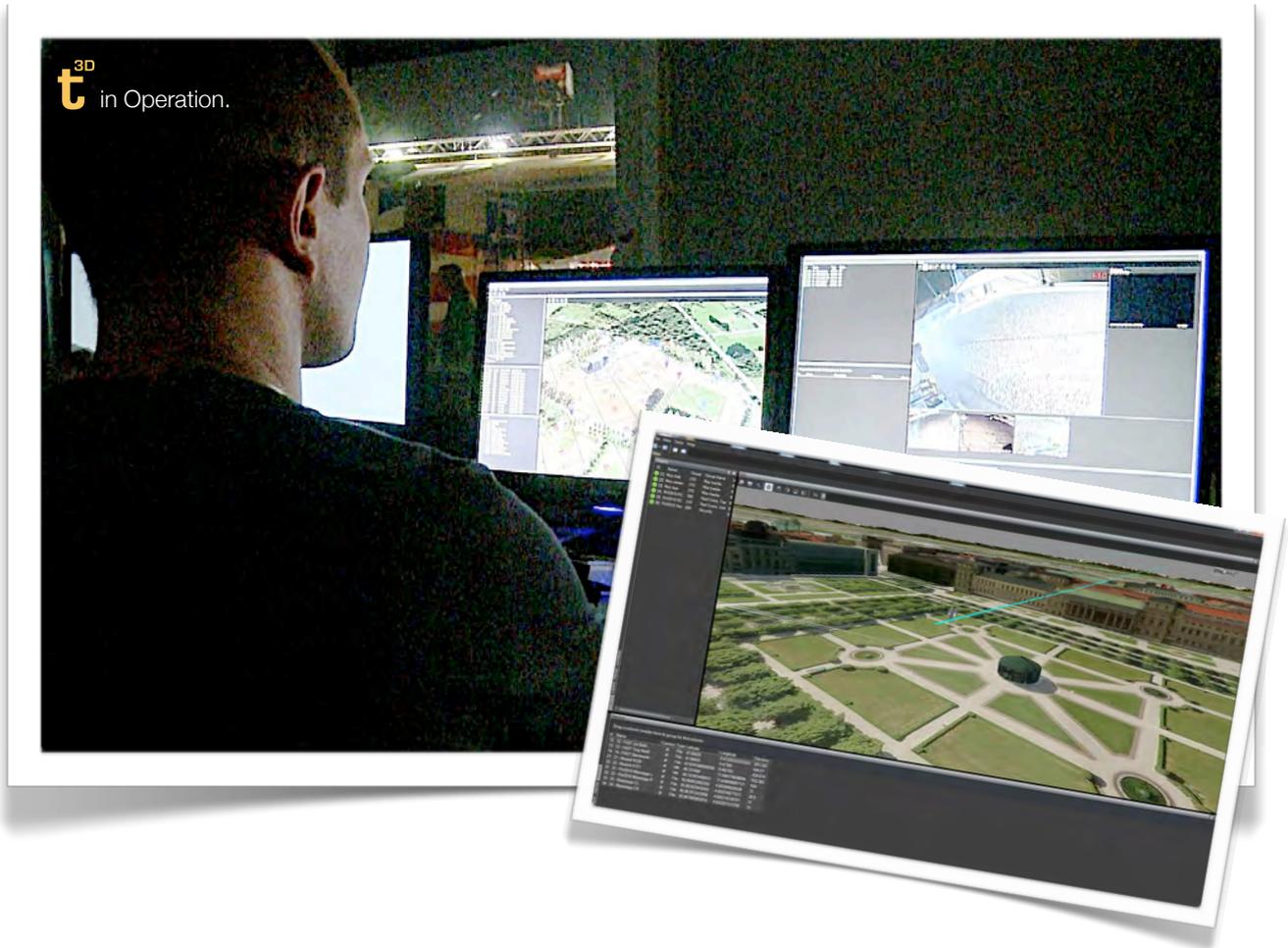
**Need to see more?**

White\_Paper\_terra3d\_1.2

# Table of content

|   |           |
|---|-----------|
| <b>What is terra 3D?</b>                    | <b>3</b>  |
| Introduction                                | 3         |
| System Architecture                         | 4         |
| <b>3D Engine</b>                            | <b>5</b>  |
| Introduction                                | 5         |
| Video Sensor Calibration                    | 6         |
| Object & Distance Measurement *             | 6         |
| Fixed and PTZ Camera Coverage *             | 6         |
| Find closest objects *                      | 7         |
| View shed- and Line of Sight Analysis *     | 7         |
| Virtual Tours *                             | 7         |
| Live and Playback Avatars *                 | 8         |
| Live and Playback Virtual Video Walls *     | 8         |
| Target position evaluation *                | 8         |
| AirMosaic Layer *                           | 9         |
| GIS Interface (static and dynamic Layers) * | 10        |
| <b>Geo-Referenced 3D Video</b>              | <b>10</b> |
| Introduction                                | 10        |
| FAST Camera Calibration                     | 10        |

|  |           |
|--|-----------|
| Supported Video Resolutions  | 10        |
| Plug-in Interface for 3rd Party Video Analytics *                      | 10        |
| Object Measurement *   | 11        |
| Automated Camera Hand-Over *   | 11        |
| Automated Dome Camera Tracking *                                       | 11        |
| Direct PTZ control *   | 11        |
| 3D PTZ control *   | 11        |
| Centralized Sensor Alarm Zone Definition *                             | 12        |
| Extract World Coordinates  | 12        |
| Day Image Overlay *  | 12        |
| <b>Interfaces &amp; Intelligences</b>                                  | <b>13</b> |
| Video, Audio, Sensors  | 13        |
| Rules Engine   | 13        |
| Video Object Analysis  | 14        |
| Mobile Navigation  | 14        |
| Multimedia Evidence Recorder   | 14        |
| Mobile Networks  | 15        |
| Terrestrial Trunked Radio  | 15        |
| Software Development Kit (SDK)   | 16        |
| <b>Traditional 2D video / Terra 3D geo-referenced video comparison</b> | <b>17</b> |



**t**<sup>3D</sup> in Operation.

## What is **t**<sup>3D</sup> terra 3D?

### Introduction

**t**<sup>3D</sup> is a comprehensive and unique approach that coordinates the interaction between people, technologies, and responses.

**t**<sup>3D</sup> is a real-time 3D visualization & coordination system that integrates multiple data sources in the world coordinate system enabling remote access to a myriad of sensors and virtual fly-through(s). It offers accurate and shared situation awareness.

**t**<sup>3D</sup> allows the operator to move through time and space, seeing synchronized multimedia content and sensors status in a geospatial context.

**t**<sup>3D</sup> offers multiple sensing modes for agility and for persistent, ubiquitous coverage.

**t**<sup>3D</sup> implements collaborative control of reconnaissance, surveillance and target acquisition assets, so that the realtime information can be made available to command and control (C2) and the personnel in the field.

## System Architecture



The Acquisition Server interfaces supports several kinds of sensors. It manages the configuration of the peripheral devices and controls the device status permanently. The incoming data is analyzed and recorded into the multimedia storage device according to configuration. The embedded 3D model allows geospatial analysis and provides information about position, size and speed of objects, even over several sensors. The embedded Video Analytics module uses the 3D Model to provide better results and less false alarms.

The Management Server hosts all site wide information and controls the whole installation. Updates at the 3D GIS model or the configuration database are automatically distributed from here to all network entities. Furthermore the Management Server is involved in real time operations by analyzing and combining the information delivered from Acquisition Servers and their peripheral devices. The Management Server stores all data created and acts as a centralized repository for reports, first evidence and other kinds of information logging.

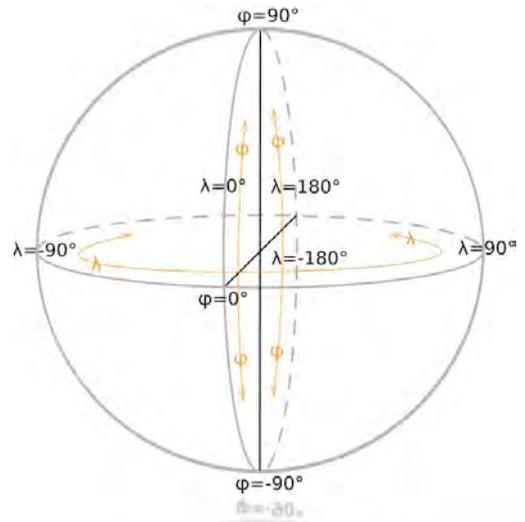
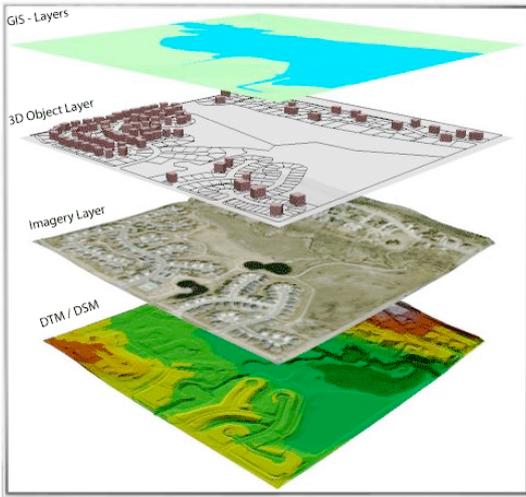
An SDK is available for **t<sup>3D</sup>** integration in 3<sup>rd</sup> party applications such as C2 solutions, alarm management- or video object detection systems, etc.)

The client server architecture offers:

- **Centralized resource management:** given that the server is the centre of the network, it can manage resources that are common to all users, for example: the centralized user database avoids problems caused by redundant and inconsistent data. For the nature of operation this DB is mirrored to the acquisition server(s) enabling them to run even when the connection to the management server would be interrupted.
- **Improved security:** as the number of entry points giving access to data is not so important
- **Server level administration:** the system offers efficient centralized administration
- **Scalable network:** thanks to this architecture it is possible to remove or add clients without affecting the operation of the network and without the need for major modifications

## 3D Engine

### Introduction



**t**<sup>3D</sup>'s multi-resolutional layer architecture represents the fundamental principle of geography and allows to allocate and show the location of every incident that may appear. This Geographical Information System (GIS) and its unique image geo-reference algorithms allocate longitude, latitude and height to any pixel of an image representing the surface of the earth.

**t**<sup>3D</sup> is based on a referenced ellipsoid (WGS84) a form of an oblate spheroid to most nearly approximate Earth's shape.

**t**<sup>3D</sup> takes sensor data from radar, video, IR, microwave fences, etc. and shows the status in a 3-dimensional context. Video object detections are converted into 3D allowing to estimate the speed, direction and size of an object.



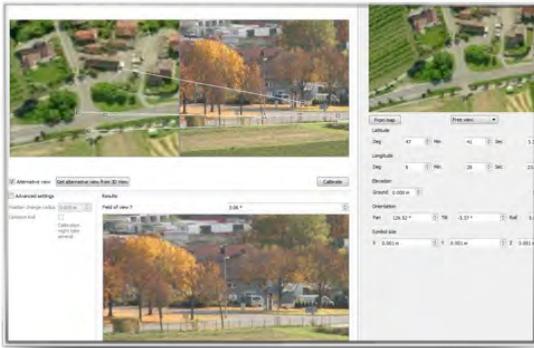
The real-time **t**<sup>3D</sup> rendering engine brings complete situation awareness to the operator showing patterns in the data he or she might otherwise not see!

**t**<sup>3D</sup> is able to handle existing sensor and communication infrastructures. It creates maps and displays content from data of various sensor sources and external GIS.

Multi-sensor platform alarm verification intelligence: the system is able to verify an alarm event using other sensors in the vicinity of the alarm location. Sensors can be classified as detectors and verifiers to improve alarm management functionality and to improve the false alarm rate. Example: A radar detects an object in an alarm area. The closest PTZ camera(s) with line of sight to the alarm area automatically turns towards the alarm-zone and shows the detected object. Immediately the advanced motion object tracking is enabled showing the moving object and its track.

With this geographic knowledge command & control C2 can make faster and better decisions.

## Video Sensor Calibration

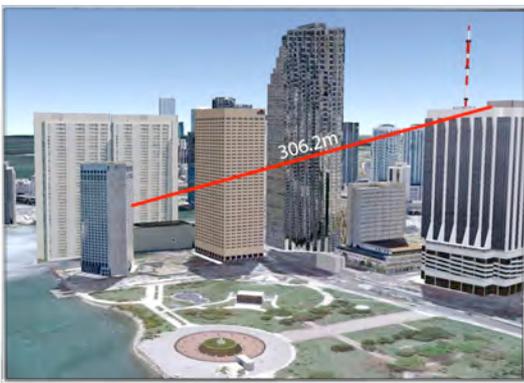


The patent pending method simplifies the 3D calibration of a video feed. The installer draws lines between position in the video image and allocations in the 3D model.

There is no need to enter any lens parameters at all.

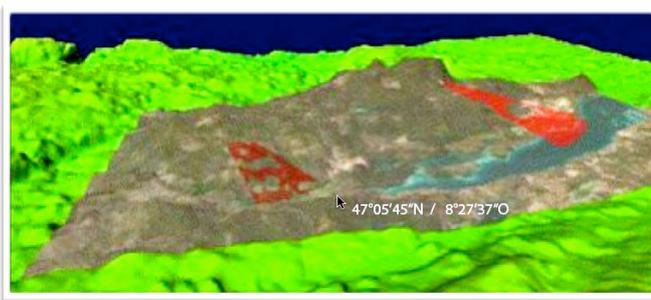
Even lens distortions are semi automatically evaluated.

## Object & Distance Measurement \*



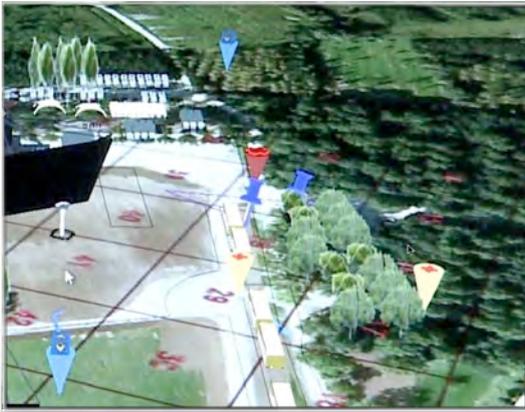
Measure distance, height and depth in the 3D model.

## Fixed and PTZ Camera Coverage \*



Based on the digital surface- or terrain model, terra 3d shows the current area of sight of all geo-referenced cameras. This function is available for both fixed and PTZ cameras.

## Find closest objects \*

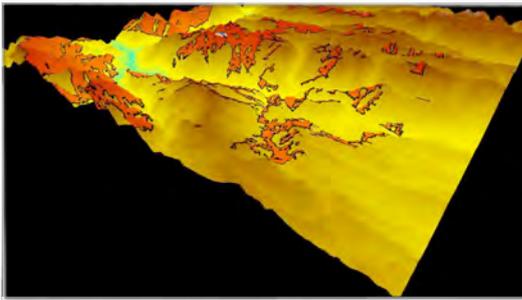


Find support teams that are closest to the incident location with the click of a mouse button.

## View shed- and Line of Sight Analysis \*

(Sniper position evaluation)

(Sniper position evaluation)



Comprehensive view shed analysis using loaded elevation grid data from a user-specified location, height above ground, and radius to be calculated.

If the building layer is active or in the presence of a digital surface model (DSM) the shades of buildings are also represented. This feature is also handy in the planning phase of a security surveillance installation.

## Virtual Tours \*



A virtual camera flies along a predefined path or behind an avatar through the 3D model. Live footage from nearby cameras is shown on the video split screen. Detected and tagged objects are displayed live in the 3D model.

### Live and Playback Avatars \*



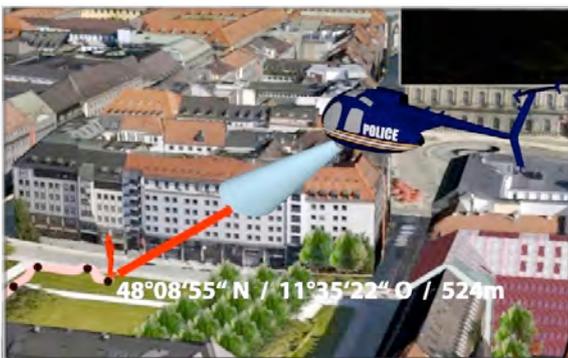
Display the positions and type and ID of all tagged objects in the field. The two red painted individuals in the example on the left have been located by a city surveillance camera. The officer and the two vehicles are equipped with Tetra radios with built-in in GPS. The model displays live or playback scenarios synchronized with any multimedia content as shown on the right image above. Travels through space and time become reality.

### Live and Playback Virtual Video Walls \*



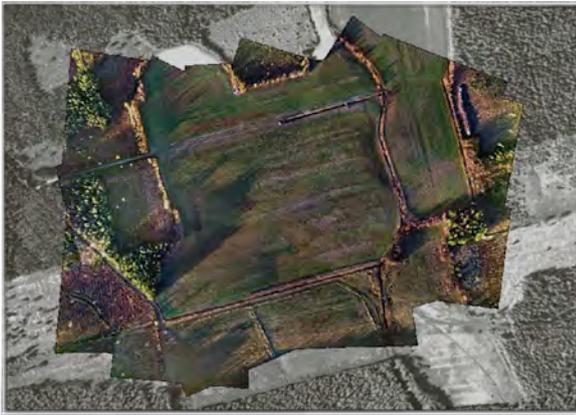
Dynamic virtual video wall, attached to a moving avatar (Helicopter), shows the live video from the helicopter. The scene can be stopped, played back or replayed. The 3D model shows at any time the video content and the position of the helicopter and the target in relation to the ground. The virtual video wall is always oriented towards the

### Target position evaluation \*

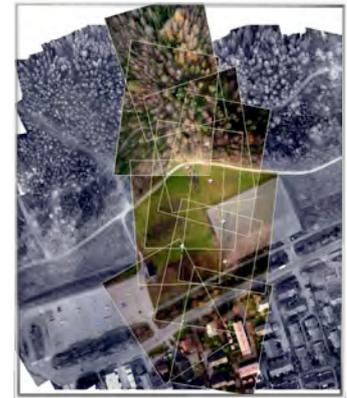


Based on the 3D position of the helicopter and the relative vector to the ground of the surveillance camera the system calculates the position of the target in real world coordinates. These target coordinates can be sent to tactical navigation systems or other devices such as Tetra radios for interception on the ground.

## AirMosaic Layer \*



AirMosaic (color) with indication of single aerial images, orthoimage backdrop. This imagery can be imported & updated dynamically. The imagery is either generated by 3rd party or t3d AMS.



Geo-referenced spatial imagery can be shown in the 3D model. FAST offers an optional air reconnaissance solution including:

|  <b>Ground Station Software:</b> |  <b>AMS (Aerial Mapping System)</b> |
|---|--|
| - Geo-referencing   | - Auto pilot   |
| - Mosaicing & stitching   | - Wireless up- and down-link   |
| - Flight mission planning   | - Fully automated flight process   |
| - Flight mission control  | - Easy to operate  |



 AMS (Aerial Mapping System) automatically collects aerial images and processes them to an aforementioned geospatial image to be displayed as overlay in the 3D model.

The overall system includes highly integrated hardware and software and can be operated by a single person.

It is the ideal Aerial Mapping System used in all phases of a project, from planning to execution.

## GIS Interface (static and dynamic Layers) \*

**t**<sup>3D</sup> is capable to show 3rd party GIS information in separate layers on the 3D model.

Overlay modes:

a) static

The overlay is loaded for permanent use and is replaced manually if needed. Typically this mode is used to show strategic maps or operational plans, Hydrants, Buildings, Addresses etc.

b) dynamic

The overlay overwrites existing older imagery. This feature is typically used for airborne reconnaissance missions where the data is transmitted live to the ground.

## Geo-Referenced 3D Video

### Introduction

Every pixel of a video source is real-time geo-referenced - in other words - for every pixel representing a part of the ground the system allocates latitude, longitude and height. When moving the cursor over a video image these parameters are displayed in realtime.

### FAST Camera Calibration



A unique patent pending method allows the calibration of an installed fix or PTZ camera within a minute. Automatically focal length, roll angle, optical distortion, sight of view are calculated. It is not necessary to enter any lens data.

### Supported Video Resolutions

There are no restrictions in video resolution.

### Plug-in Interface for 3rd Party Video Analytics \*

A plug-in interface allows integration of any 3rd party video analytics.

## Object Measurement \*



Measure object size directly in a video feed. This feature is also available over the plugin interface for 3rd party video object analytics.

## Multi Camera Tracking & Automated hand-over \*



An event (example: radar) triggers a PTZ or dome camera for tracking. All cameras with line of sight to the tracked object or a subset of it are following the tracked object. Either fixed cameras or a PTZ cameras can be the masters for the process.

### Automated Camera Hand-Over \*

Before an object is out of sight of a camera, the next available camera takes over and continues the tracking. If no other camera can see the object other sensors such as radar may take over.

### Automated Dome Camera Tracking \*

Triggered by an event or manually by an operator a PTZ or dome camera can detect a target object and follow it as long as it is in the line of sight of the camera.

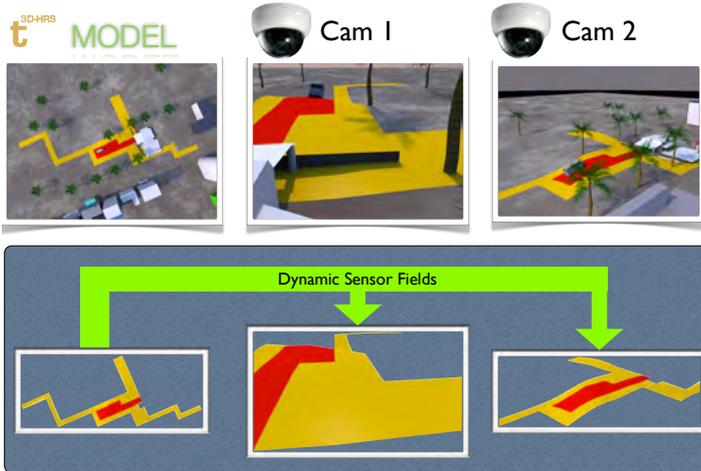
### Direct PTZ control \*

Define the area of interest in a video image and let the system control the PTZ cameras in accordance. No more issues in remote camera control caused by latency.

### 3D PTZ control \*

Define the area of interest in the 3D model and let the system control the PTZ cameras in accordance. No more issues in remote camera control caused by latency.

## Centralized Sensor Alarm Zone Definition \*



Alarm-, warning- and other zones are defined in the terra 3d model. For each sensor terra 3d reshapes these sensor field polygons and sends this meta data to the sensors. This way video object-, acoustic- or even radar sensors work with the same set of alarm-zones.

The definition of alarm zones is no longer restricted to a technician - now even the system operator can define them dynamically - if authorized.

## Extract World Coordinates

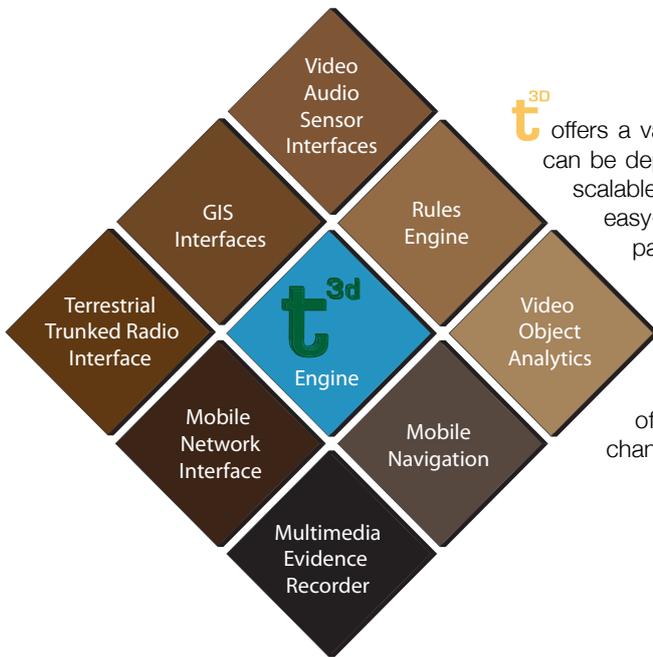
Any position seen in a video feed is allocated to its real world coordinates. With the click of the mouse you may extract this information and send it to another application or directly to a team in the field as a target.

## Day Image Overlay \*



Geo-referenced video allows the overlay of night vision images over stored daylight background for a complete situation awareness. Both images are geo-referenced and therefore all advanced functions such as object dimension measurement, extraction of real world coordinates or automated PTZ camera control are available. The transparency of the overlaid video can be manually adjusted.

## Interfaces & Intelligences



**t<sup>3D</sup>** offers a variety of sensor, communication and multimedia interfaces. It can be deployed in existing infrastructures allowing a customizable and scalable solution to converge physical security sub-systems into one easy-to-manage system. Its ability to integrate and manage third-party systems suits the needs of end-users by consolidating information from various sources and presenting it in a 3 dimensional context that is meaningful and draws an operator's attention to the most critical information.

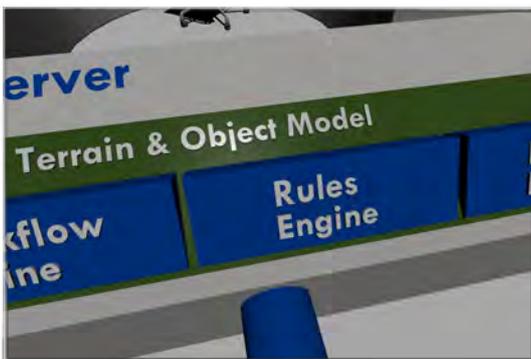
The end result is an integrated, cost-effective solution that offers actionable 24/7 surveillance without requiring wholesale changes to existing infrastructure.

### Video, Audio, Sensors



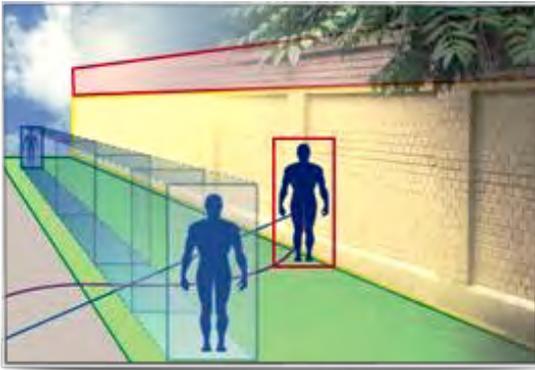
**t<sup>3D</sup>** supports a variety of CCTV cameras, video and audio encoders and other sensors such as radar devices. It's architecture lets easily integrate new sensors if required.

### Rules Engine



The programmable rules engine analyses the realtime meta data from connected sensors and issues messages to the operator and/or starts predefined countermeasures if a predefined condition applies. Example: A target has been detected by a radar and automatically verified by video object detection. The system automatically positions the nearest dome camera towards the intruder and activates auto tracking. The 3D model shows the intruder as Avatar and its movement is continuously tracked.

## Video Object Analysis



The integrated geo-referenced multi sensor 3D video object detection technology is designed for indoor and outdoor use. It operates with any type of imagery coming from a connected video feed. Any position of an object is projected into the 3D model where absolute speed, direction and size of the object are calculated. Based on this information a very precise prediction where the object may appear in any future time is possible.

The technology includes automated alarm-verification methods using other sensors to reduce the false alarm rate.

A plugin interface for 3<sup>rd</sup> party video object analytics is available.

## Mobile Navigation



Real world target coordinates can be extracted either from the geo-referenced video or the 3D model and sent to a dispatch or direct to any tactical mobile navigation system.

## Multimedia Evidence Recorder



Multimedia content from various sources is authenticated and encrypted and can be recorded. The information is valid to be used as evidence in courts.

**Mobile Networks**



You may use a iPhone to get guidance to a target position.



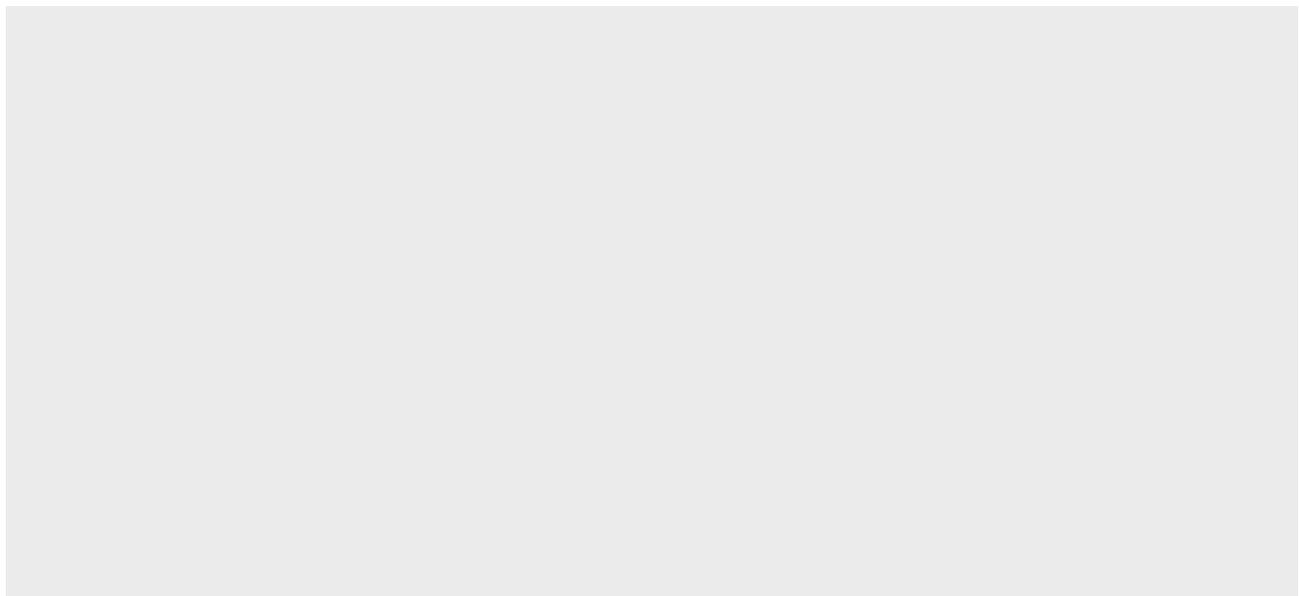
**Terrestrial Trunked Radio**



Today's modern Trunked Radio Systems with built-in GPS receivers allows to navigate even in rough outdoor environments.

**t<sup>3D</sup>** can send target positions to specific units or groups and receives position information of each device for track recording and display (Avatar) in 3D.

**t<sup>3D</sup>** can easily be integrated in existing communication systems like Tetrapol.



## Software Development Kit (SDK)

A powerful set of development tools allow the efficient integration of terra 3d into other applications.

The SDK includes sample code and supporting documentation.

Features:

The SDK includes a 3D Model control, a data model for live data and history data and a calibration control to georeference video cameras.

- 3D Model visualization:



- display of all GIS layers
- objects with history tracks
- sensor information, e.g. live video
- 3D Model navigation:
  - move
  - pan, tilt, zoom
  - goto position
- calibration control



- lists of layers, objects, sensors, places
- virtual tours

## Traditional 2D video / Terra 3D geo-referenced video comparison

| Feature   | 3 D, geo-referenced video | 2D traditional video    |
|---|---------------------------|-------------------------|
| 3D PTZ control (select target area in 3D model, compensates video latency)  | yes                       | no                      |
| Automated camera hand-over  | yes                       | no                      |
| Automatically zoom onto an object detected by other sensors like radar, laser etc. by one or more video sensors (cameras)                               | yes                       | no                      |
| Centralized alarm zone definition and automated dynamic upload to video and other sensors   | yes                       | no                      |
| Create a 3D track of a detected object in video and show it in a 3D model   | yes                       | no                      |
| Direct PTZ control (video in video, compensates video latency)  | yes                       | partly (approximation)  |
| Display live and recorded multimedia content in a 3D model synchronized with object tracks for debriefing or case evaluation                            | yes                       | no                      |
| Dynamic split screen - show closest video sources to a fix or moving position, object or alarm position identified in video                             | yes                       | partly (pre-definition) |
| Extract speed, orientation, size of a seen object in video  | yes                       | no                      |
| Find closest object(s) from a defined position in video   | yes                       | no                      |
| Fly to allocated position in a 3D or 2D map identified in a live or recorded video image  | yes                       | no                      |
| Multi camera tracking   | yes                       | no                      |
| Multi sensor correlation: Automatically verify an alarm based on its position with other video sensors for further reduction of the alarm failure rate. | yes                       | no                      |
| Night over day video image overlay  | yes                       | no                      |
| Object and distance measurement in video  | yes                       | no                      |
| Object classification: include kinematics elements, object- size, -speed and -direction   | yes                       | no                      |
| Reduce false alarm rate with AUTOMATED multi sensor correlation   | yes                       | no                      |
| Show actual line of sight for each sensor in 3D model   | yes                       | no                      |
| Show operator only content of interest  | yes                       | partly (pre-definition) |

Protect Inc.  
**FAST**

Hausmatt 2  
CH-6405 Immensee  
Switzerland