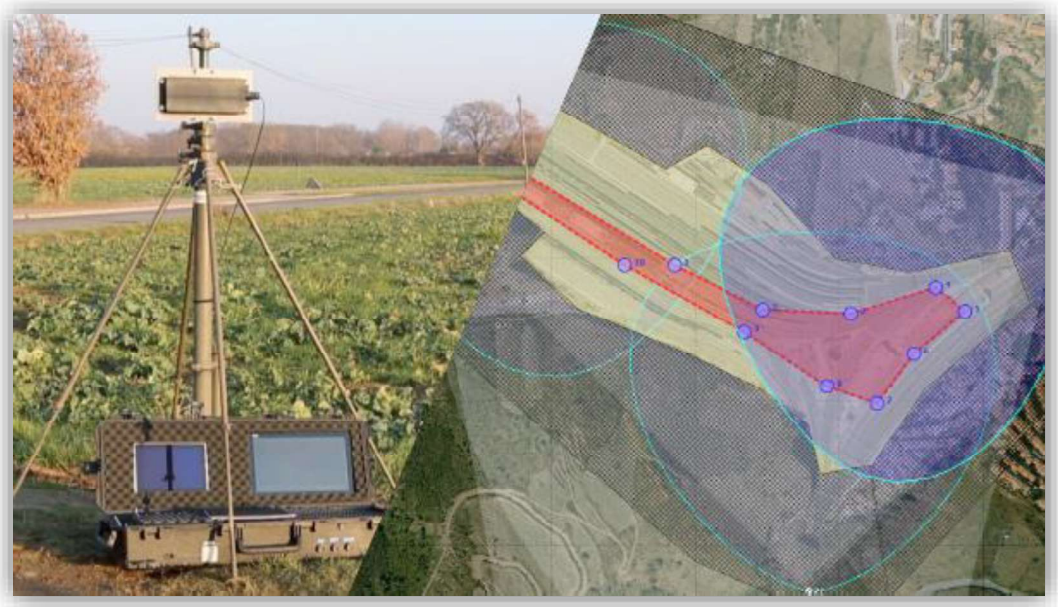
System Installation Guide

-

PSR-500 System



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Revision Table

Rev	Date	By	Change description
-	June 24th, 2016	J-P. Wasselin S. Laffont	Creation
A	June 28th, 2017	JP. Wasselin	General review + addition of troubleshooting section
	August 25th, 2017	JP. Wasselin	Add major step for launching PSR-500 Server in Service
	September 6th, 2017	JP. Wasselin	Add explanations for effect of traffic road on the PSR-500 radars system performances
	September 19th, 2017	F. Gayraud	Add chapter for CE anf FCC marking
B	December 5th, 2017	F.Martin	Add Web Services CAM_TRACKING (v1.3) & Usage of Dry Contacts for alerting (v1.4) new functionalities. Remove NetBooter Network Component (no more used). Remove §7 detail written in french.

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1. Objective of the document

This document aims at describing the full set of steps to perform to install and configure the PSR-500 system.

2. Applicable documents and references

2.1. Applicable documents

Document Name	Description
226-0098-036_Installation_Logiciels_Activation	Installation procedure of PSR-500 Systems Software: - Tracking - PSR-500 Installer
226-0102-036_Installation_Logiciel_PSR_IHM_Serveur	Installation procedure of PSR-500 Server : - PSR-500 Server

2.2. Acronyms

The following abbreviations and acronyms occur in this document:

CCS	Camera Control Software
COTS	Commercial On The Shelf
FMCW	Frequency Modulated Continuous Wave
PSR	Perimeter Surveillance Radar
GPS	Global Positioning System
IP	Internet Protocol
ONVIF	Standard Cameras Communication Protocol
PC	Personal Computer
PU	Processing Unit (for SU data)
PTZ	Pan Tilt Zoom
RCF	Rockwell Collins France
RPS	Remote Power Switch
SU	Sensor Unit (radar unit)
UDP	User Datagram Protocol
VMS	Video Management System

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3. Note for Installation operator

PSR-500 System deployment requires concepts and actions that shall be mastered in order to optimize the installation and the operational performances of the system.

Therefore, it is recommended to a **new installation operator** to follow this document **in its integrality** for the very first deployment.

A **seasoned installation operator** would rather directly refer to the Annex "**Quick PSR-500 System Installation guide**" of this document.

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4. PSR-500 System presentation

PSR-500 System is a radar system designed for surveillance and protection of critical site against all human intrusion. In option, the PSR-500 System can be coupled with a video camera to efficiently confirm visually the intrusion and identify the intruder while the deployed radars monitor the whole coverage zone.

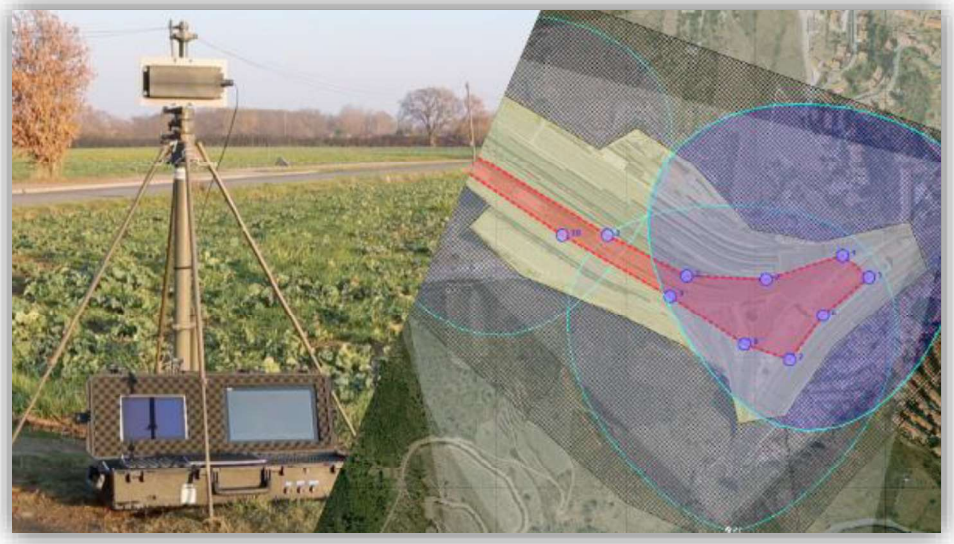

Figure 1: Aperçu du système PSR-500

In nominal operational conditions, each radar of the PSR-500 system is able to detect any human intrusion in a zone of 90° azimuth and 500m maximum range.
The figure below show a view of the detection area (Blue area) of a PSR-500 System radar for the detection of a human intrusion.

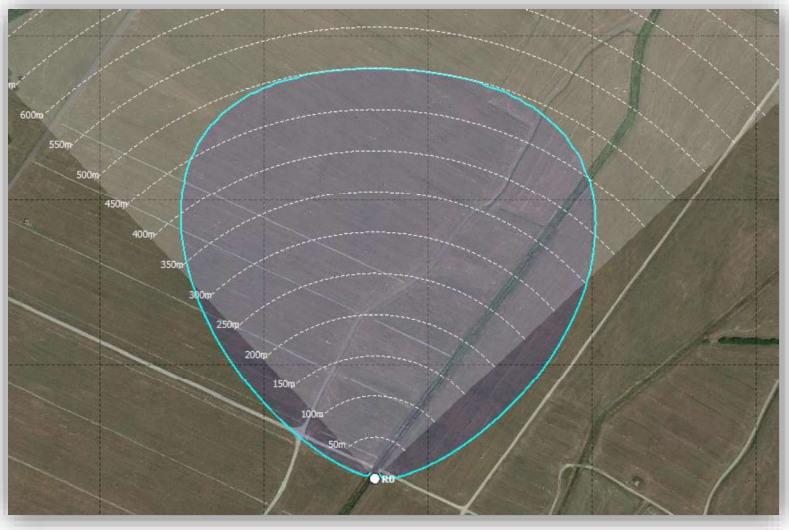

Figure 2: PSR-500 system radar detection area for human intrusion detection

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4.1. Possible System Architecture

The architecture of the PSR-500 System may substantially differ depending on the operational context and on possible equipment. Two general solutions of installation are possible:

- **Solution 1** = Independent standalone deployment
- **Solution 2** = Integration with an external hypervisor/supervisor

4.1.1. Standalone Deployment

The following scheme presents a system architecture example for a **standalone deployment** (solution 1) and for a 2 radars configuration. Yellow labels indicate PSR-500 system software products that are deployed over COTS products. Blue labels indicate PSR-500 hardware product.

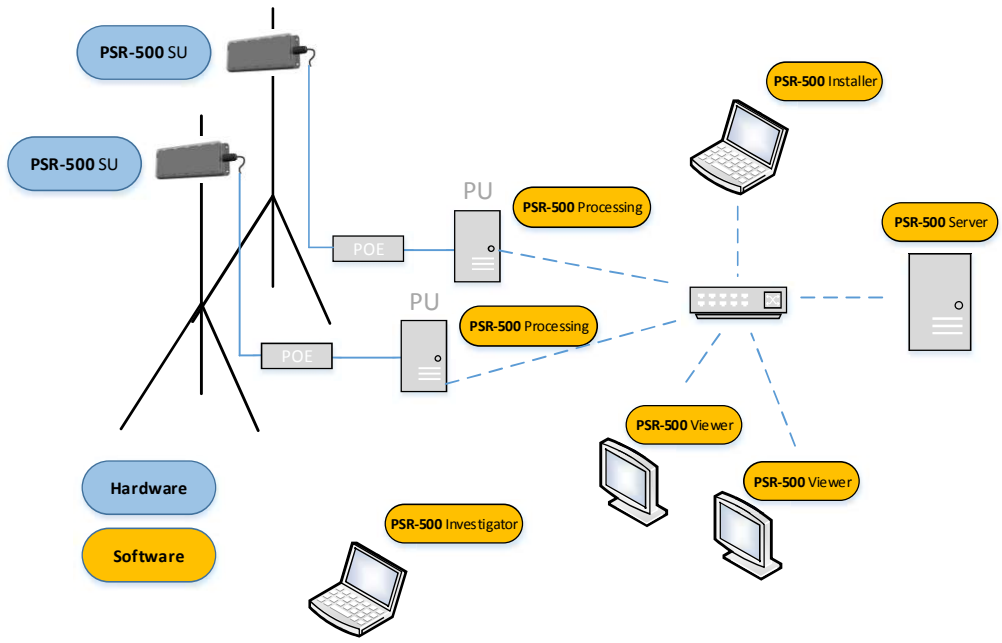

Figure 3 – Standalone System architecture of PSR-500 system (2 radars configuration)

The following components can complete the above architecture:

- Network components to perform automatic maintenance of the radars SU and PU
- CCS software to control PTZ camera (see below)

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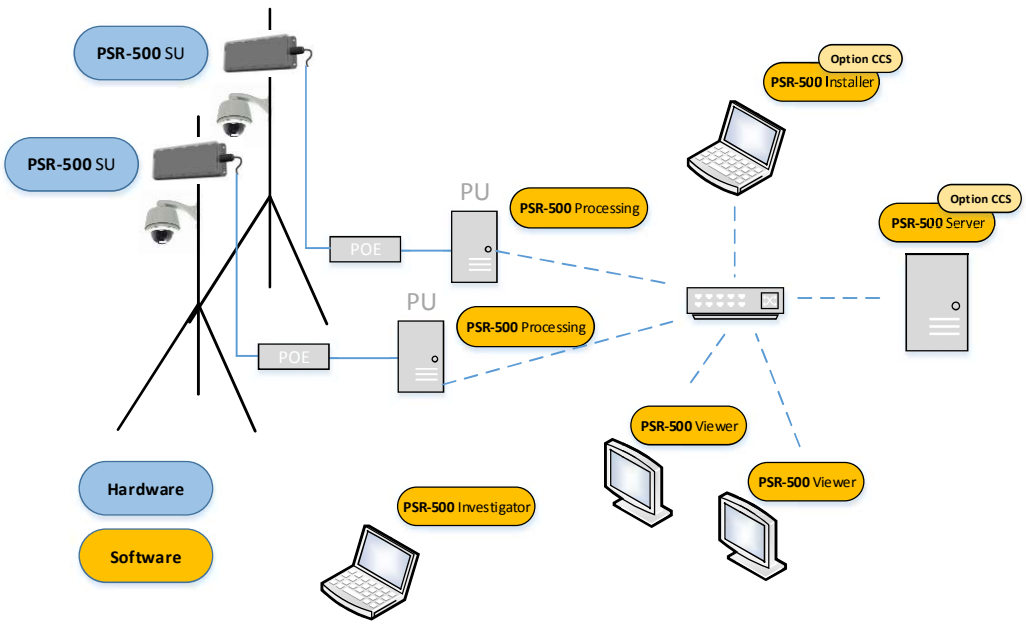

Figure 4: Standalone System architecture of PSR-500 system with CCS option

Note: Cameras may or may not be co-located with radars.

4.1.2. Integrated deployment

The scheme below presents a system architecture example for an **integrated deployment** (solution 2) in a two radars configuration. Yellow labels indicate PSR-500 system software products that are deployed over COTS products. Blue labels indicate PSR-500 hardware product.

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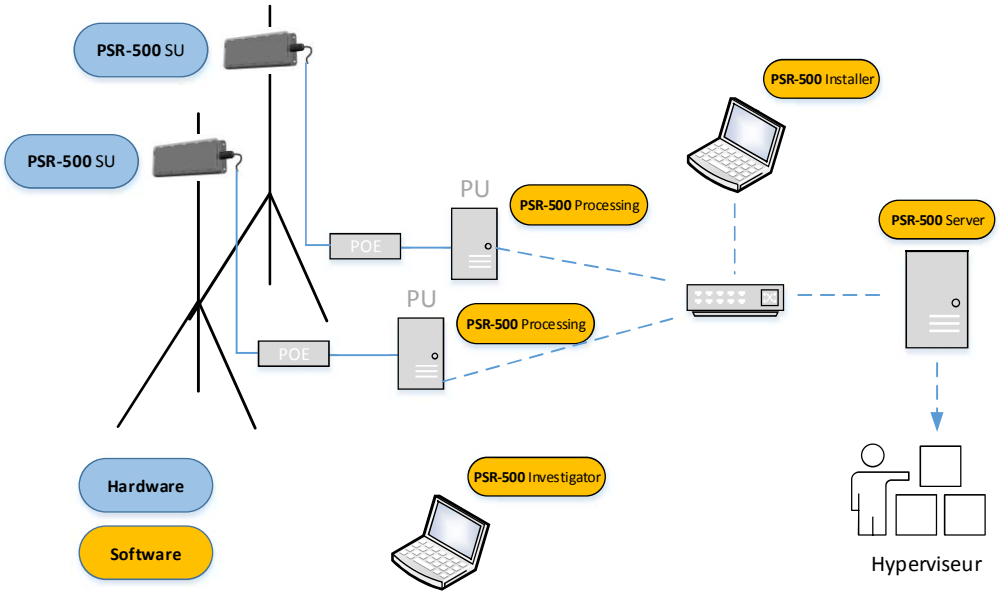

Figure 5: Integrated System architecture for PSR-500 System (two radars configuration)

Similarly to the standalone solution, additional components can complete the above architecture:

- Network components to perform automatic maintenance of the radars SU and PU
- CCS software to control PTZ camera (see below)

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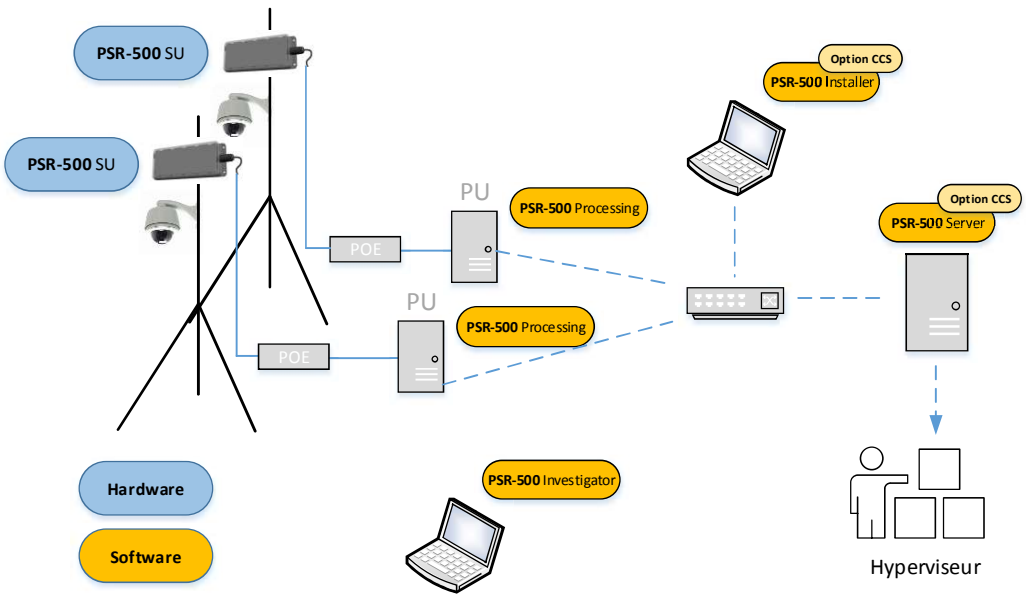

Figure 6: Integrated System architecture of PSR-500 System with CCS option

4.2. System elements definition

4.2.1. Sensor Unit (SU)

The Sensor unit is the radar. It is the active part of the system that illuminates the area with an FMCW waveform (Frequency Modulated Continuous Wave).
The Sensor Unit transmits the signal that is backscattered by the environment (human intrusion but also environment i.e. ground, vegetation, buildings …) and received by the antenna. The received signal is digitalized within the Sensor unit and delivered through Ethernet.

Note: Radar theory related to this technology will be reminded in the chapter dedicated to site radar implantation choice.

4.2.2. Processing Unit (PU)

The PU is the radar processing unit. The PSR-500 Processing software is the application running on each PU. This application aims at controlling each SU and extracts all useful information (human intrusion vs. environment) from the radar signal coming from the SU associated to the PU.

This software can be deployed on any PC with the following minimal characteristics:

- Processor double core Intel Core i7, cadenced at 1.3 GHz / 2.6 GHz Turbo - 3 MB Cache
- Gigabit Ethernet
- 4Go RAM

PSR-500 Processing SW is also in charge of :

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- cross-checking useful information with the radar's operation zones defined through the **PSR-500 Installer** SW
- broadcasting this information towards its clients.

Within the PSR-500 System, the three following software are clients listening to each PU:

- **PSR-500 Installer SW** only during the installation phase.
- **PSR-500 Server SW**
- **CCS SW module** in charge of steering PTZ camera that may be deployed over the site to protect

4.2.3. PSR-500 Installer

PSR-500 Installer SW is the application that supports and optimizes the entire installation phase of a new PSR-500 radars park on site**.** This application enables to:
- Reference a background map of the operating zone
- Define alerting (with different alerting levels) and exclusion zones (detections in this area are ignored **–** public ways for instance) common to all radars of the site.
- update System configuration of PU deployed on site
- display stats and alerts sent by each deployed radar in order to verify and validate their performances.
- Generate installation reports to support physical on site deployment
- Configure and test network equipment (network switch …) that will automatically maintain the SU/PU Park deployed thanks to the **PSR-500 server** SW.

PSR-500 Installer shall support the PSR-500 system deployment but shall not be used in operation phase.

4.2.4. PSR-500 Server

The **PSR-500 Server SW** is a basic system component that shall be deployed in any PSR-500 System.

The **PSR-500 Server SW r**etrieve a System configuration prepared through the **PSR-500 Installer** and then operates and automatically maintains the deployed radars park (thanks to dedicated network components).

Note: In case of a bug of the hosting OS (either physical or VM), the **PSR-500 Server SW** re-start automatically on the previous system configuration and restore automatically.

The **PSR-500 Server SW** offer the possibility to instantiate a web server that will collect all data gather by the application and make them available for an external client. The PSR-500 System can therefore be integrated into a third party platform.

Note: The PSR-500 Server SW does not allow creating a new system configuration (SUs + PUs) but it allows modifying an existing installation such as modifying the operation zones of the radars, or modifying the installation properties of some deployed components.

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The information collected and made available for an external client are (non exhaustive list):

- PSR-500 System components installation configuration (location and installation of the SUs, detection zones, exclusion zones, cameras) – CONFIG message
- Status of the PSR-500 System components (SU, PU, cameras, maintenance network components) – STATUS message
- The entire set of alarms received from all deployed radars – ALERTS message
- The camera tracking information – CAM_TRACKING_ACTIVITY message

Note: these messages are in read-only mode.

CONFIG and STATUS messages are available for the WEB client through HTTP request whereas ALERTS and CAM_TRACKING_ACTIVITY messages are periodically pushed to the WEB client every 333ms (delay configurable using the PSR-500 Installer SW) through a service-sent event.

The interface allows interaction with the système for what regards the camera through the following services:

- Camera Tracking (or stop tracking) of a dedicated alerts – CAM_TRACKING_FOLLOW_ALERT message
- Camera inhibition, for example to allow an hypervisor to (manually) track the camera instead of the PSR-500 system – CAM_TRACKING_INHIBIT message

4.2.5. PSR-500 Viewer

The **PSR-500 Viewer** is a User Interface that:

- Enables visualization of intrusions in real time
- Provides systems status in real time
- Continuously records all events (alarms, system status …)

4.2.6. PSR-500 Investigator

The **PSR-500 Investigator** is a User interface that enables:

- Visualization of all alerts detected by each radar (with detailed information for each alert) over a given period of time defined through the register analyzer window.
- False alarms and visual confirmation analysis
- Identification of masking zones thanks to the “Activity map” option

4.2.7. CCS Module (Camera Control Software) - Optional

In order to have an efficient visual confirmation, the **CSS** (Camera Control Software) module may be used to automatically steer a PTZ camera to the alerts raised by a radar.

The CCS module applies a fully configurable multi-target camera control philosophy.
One radar can control one or several cameras.
If selected, this module is used by PSR-500 Installer and PSR-500 Server SW in order to install and operate the cameras.

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5. Generals recommandations

5.1. Warnings

- Any changes or modifications of the PSR-500 system not expressly approved by ROCKWELL COLLINS may cause, harmful interference and void the FCC authorization to operate this equipment.
- This PSR-500 system must be professionally installed.
- This PSR-500 system complies with FCC's radiation exposure limits set forth for an uncontrolled environment under the following conditions:
    - Each SU of the PSR-500 system should be installed and operated such that a minimum separation distance of 20cm is maintained between the radiator (antenna) and user's/nearby person's body at all times.
    - Each SU of the PSR-500 system must not be co-located or operating in conjunction with any other antenna or transmitter.

5.2. Manufacturer address

For Europe:

Rockwell Collins France
6 avenue Didier Daurat
31701 Blagnac cedex
France

For USA:

Rockwell Collins
400 Collins Road N.E.
Cedar Rapids, IA 52498
USA

5.3. Regional area use

The PSR-500 system complies with Part 15 of FCC rules for USA area (frequency equipment between 5750MHz and 5850Mhz).
This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

—Reorient or relocate the receiving antenna.

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—Increase the separation between the equipment and receiver.

—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

—Consult the dealer or an experienced radio/TV technician for help

In EU configuration (frequency equipment between 5770MHz and 5870MHz), the PSR-500 system can be used in ETSA countries members except in Bielorussie, and with restrictions in Russia (refer to ERC 7030 recommandations).

5.4. Declaration of conformity

- The CE declaration of conformity is provided in annex.
- The PSR-500 system complies with Part 15 of FCC rules for USA.

6. System Installation

The three following phases are required to install the system:

- ✓ Phase 1 : **Deployment preparation** (cf §6.1)
- ✓ Phase 2 : **Radars and cameras installation** (cf §6.2)
- ✓ Phase 3 : **Deployment validation** (cf §6.5)

These 3 phases rely on the **PSR-500 Installer** SW.

The following document assumes that the **PSR-500 Installer** SW is located at <PSR-500_Installer_Directory>.

For installation procedure of the PSR-500 Installer SW, refer to document 226-0098-036.

6.1. Deployment Preparation

The deployment preparation phase is decisive of the PSR-500 system operation.
In order to optimize the performance of the system, this phase shall be realized with caution taking into account all specificities and characteristics of the environment in which all radar will be deployed.

When launching the **PSR-500 Installer**, the user will be guided to follow the 8 steps listed below through a wizard:

- **Step #1** : Import and reference a background map of the site
- **Step #2** : Define the site surveillance (operation zones, exclusion zone)
- **Step #3** : Add, position and configure one or several radars (SU+PU)
- **Step #4**: Add, position and configure one or several cameras*

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- **Step #5** : Add and configure maintenance network components
- **Step #6** : Generate the preliminary installation report
- **Step #7** : Visit the site and validate/update the foreseen installation
- **Step #8** : Add installation operators

*If CCS option is selected by user.

6.1.1. Step#1 : Import and reference a background map of the site

6.1.1.1. Background map import

The **PSR-500 Installer** uses « static » background maps. The first step is to retrieve the background map of the site on which the PSR-500 System will be deployed.
To import a static map in the application, two options are possible:

- **Option 1** = A map at format *png, *gif, *jpeg, *png is already available – the map needs to be north oriented, i.e. north on the top of the map.
    - Save this map in the following directory**:** <PSR-500_Installer_Directory>\PSR_Background_Maps.

- **Option 2** = No usable map of the site is already available. A solution consists in using « Google Earth pro » that allows to extract high resolution maps.
    - Download and install Google Earth Pro
    - Start « Google Earth Pro »
    - At first start, Enter your email address and password “GEPFREE”
    - Fin the place where you want to deploy the PSR-500 system

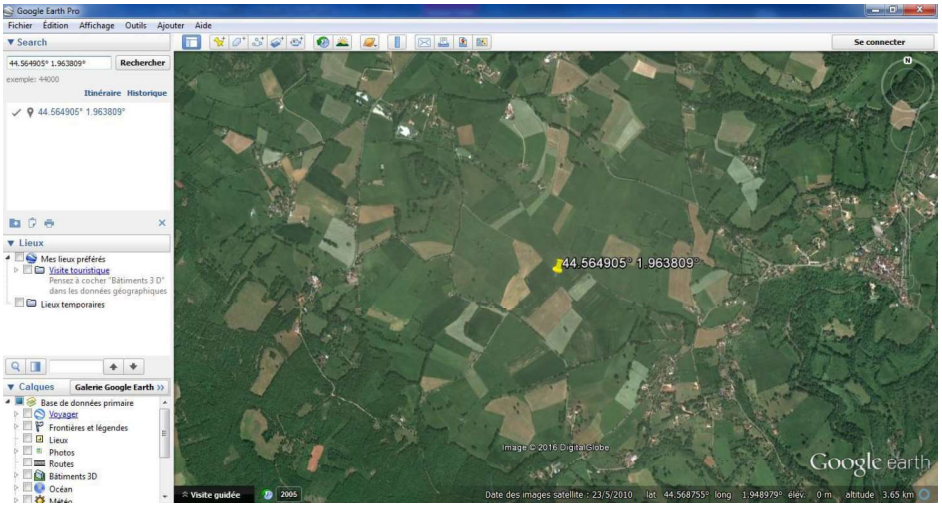

Figure 7: Locate the zone with Google Earth

- Use the « range tool » to ensure that the current zoom factor is enough to get at least 900m (PSR instrumented range) around the position where you plan to deploy the PSR. Indeed, Google Earth pro will only extract the map corresponding to the current zoom factor. (In case this is not respected, a part of the alerts raised by some radars may not be displayed on the map):

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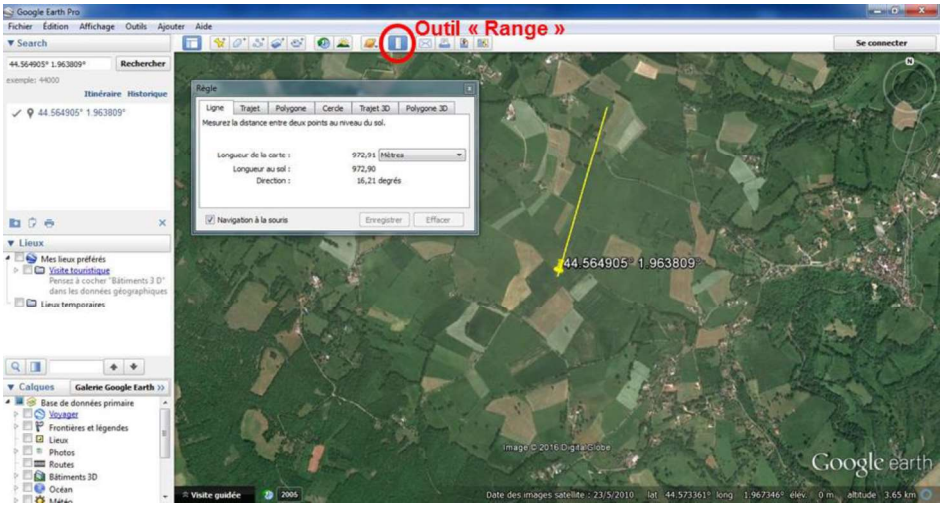

Figure 8: Google Earth scale factor

- Close the result of your research and any overlay option to minimize the number of indications on the map you will extract. Purpose is to get a map as clean as possible for extraction. Alerts raised by radars will be displayed on this map.

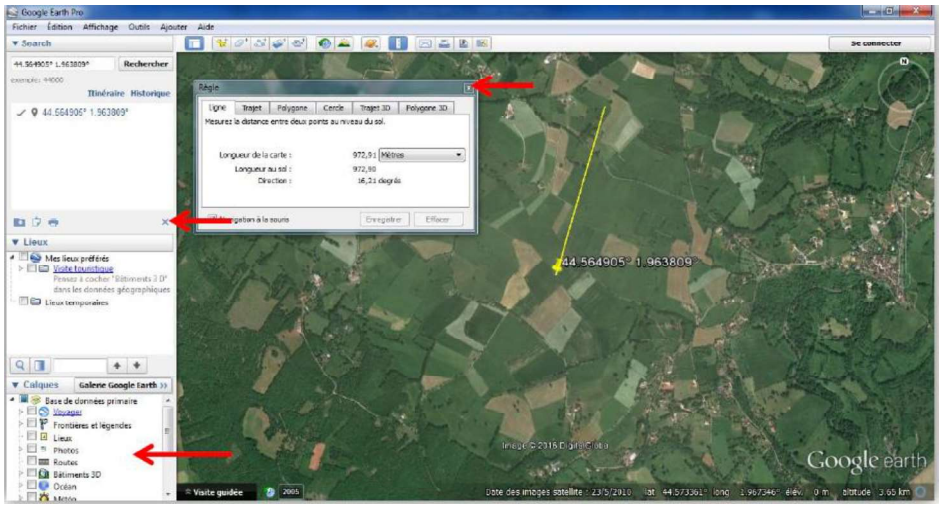

Figure 9: Close Option menus of Google Earth

- As previously mentioned, the **PSR-500 Installer** needs North oriented maps. Ensure the map is North oriented (i.e. North on the top of the map) clicking on the “N” button of the Google Earth compass.
  Warning: Google Earth extract function takes the map as it is at the moment of extraction.

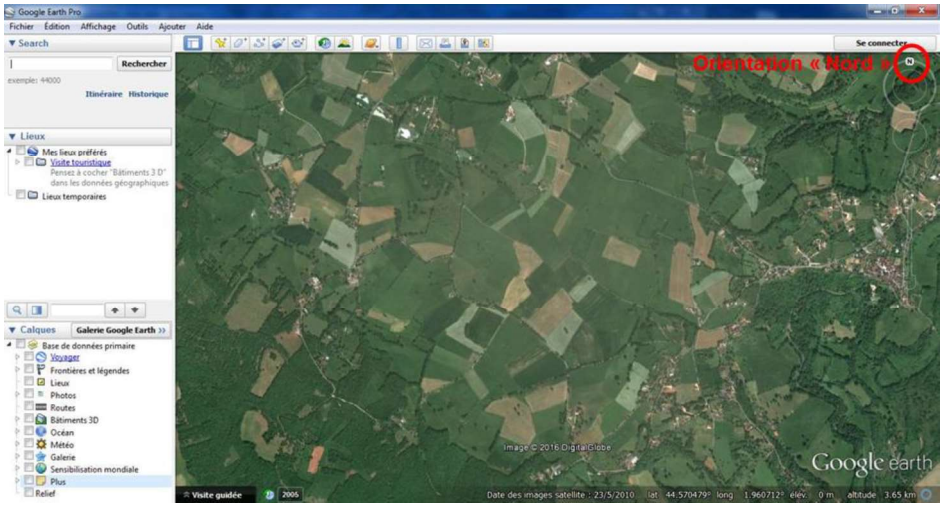

Figure 10: Google Earth map Nord oriented

- Click on the « Save map» button

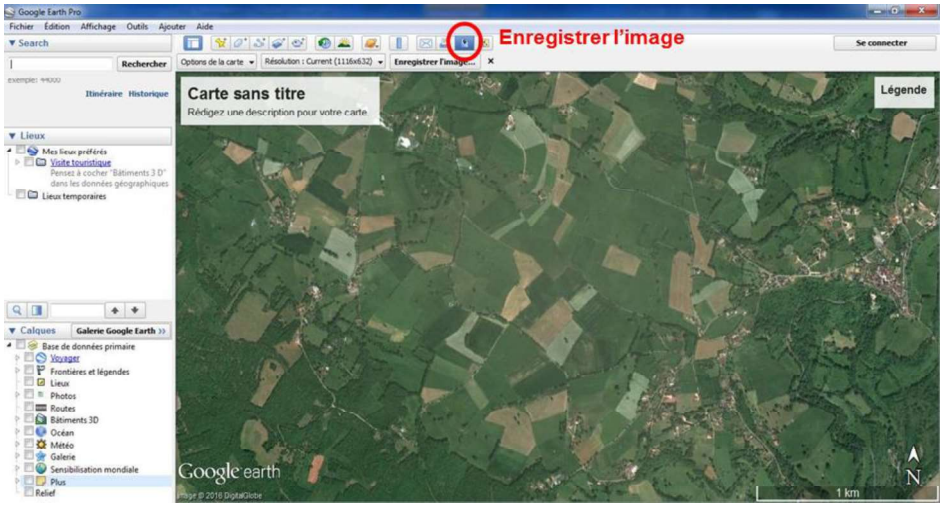

Figure 11: Save picture on Google Earth

- Unselect all overlaid options of the map clicking on « map options » so the map remains as clean as possible from any indication.

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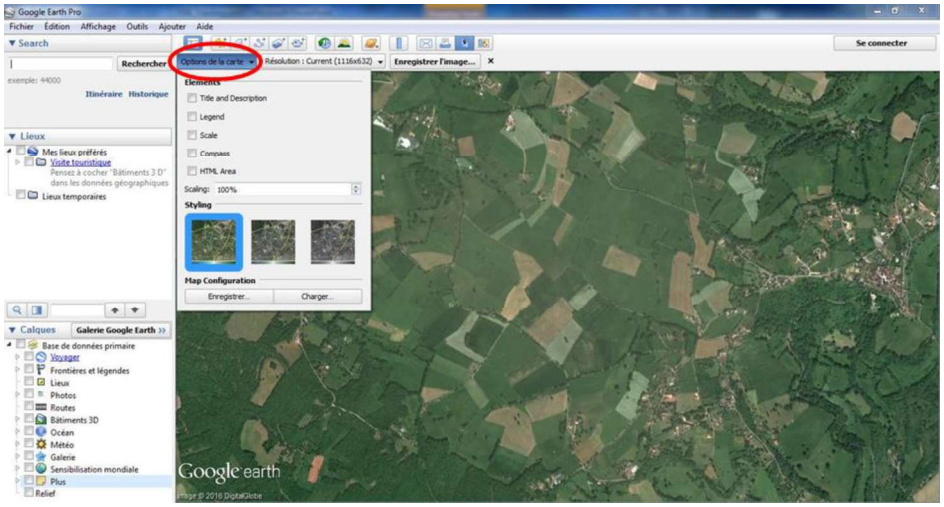

Figure 12: Unselect display options of Google Earth

- Select the highest resolution. Doing that, a high level of detail will remain even if you zoom in once in the PSR-500 Installer application. A high resolution is also necessary to have a precise deployment of each radar and therefore a higher accuracy of the geographical position of the alerts.

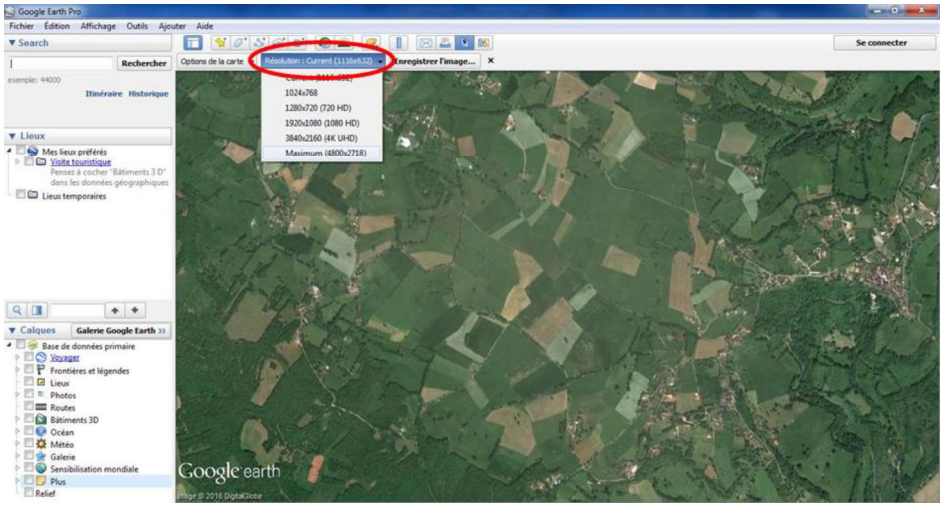

Figure 13: Selection of the picture resolution on Google Earth

- Save the map in the appropriate **PSR-500 Installer** directory (<PSR-500_Installer_Directory>\PSR_Background_Maps). Name the map and click on “Save”. Wait for the download to be completed.
-

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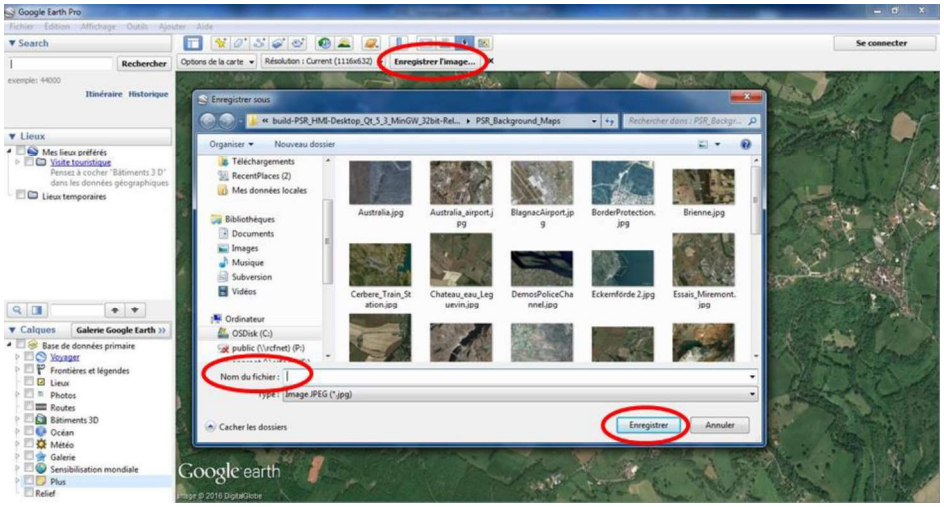

Figure 14: Save the map

6.1.1.2. Define map references in PSR-500 Installer application

- Start the **PSR-500 Installer** application, double clicking on application executable (PSR-500_Installer.exe)
- Enter a user login and a password.

Figure 15 – PSR-500 Installer – Authentification window

Note: By default, on Super-user can access this mode. Once first install performed, this user will be able to add "installation operator" user that will be allowed to access this mode and add new users. These "installation operation" users will be proposed in the drop-down menu of this window.

- Super-user credentials are the following :
    - User = rc-admin
    - Password = rcf_admin_31

- In the next window, user can either create or modify a system configuration. Click on Create in the « System Configuration » window to start the creation of a new system configuration.

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Figure 16: PSR-500 Installer – Creation of a new system configuration

- Provide a name for this new system configuration and click on « Start »

Figure 17: PSR-500 Installer – New System configuration name

- Select the map you want to use and click on « Open »

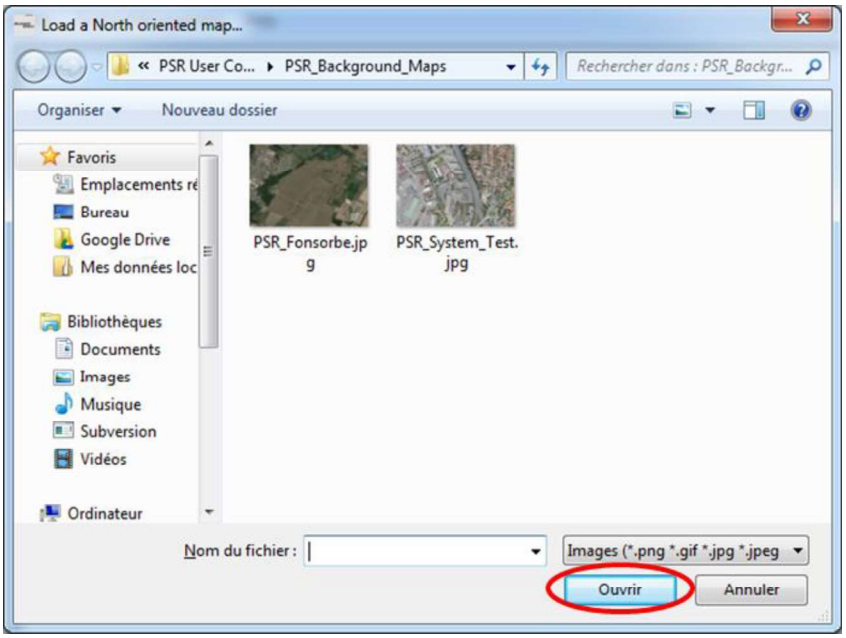

Figure 18: PSR-500 Installer – Select Google Earth map

- Confirm that the map is north-oriented by clinking on “Yes”

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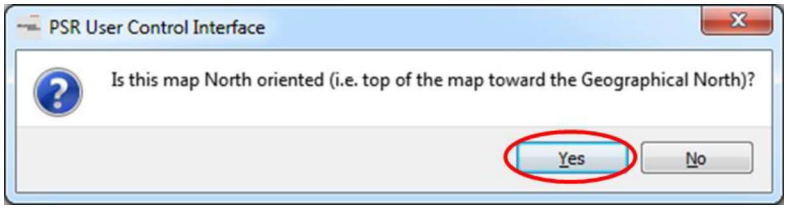

Figure 19: PSR-500 Installer – Confirm that the map is north-oriented

- Define map references with two known GPS coordinates. Two modes are proposed to define map references the background map :
  - **Mode I** = based on GPS coordinates of two references pointed on the map
  - **Mode II** = based on the GPS coordinates of the top left and bottom right corner of the map
- In our example, we follow mode I. Select Mode I if not already selected and click on « Start »

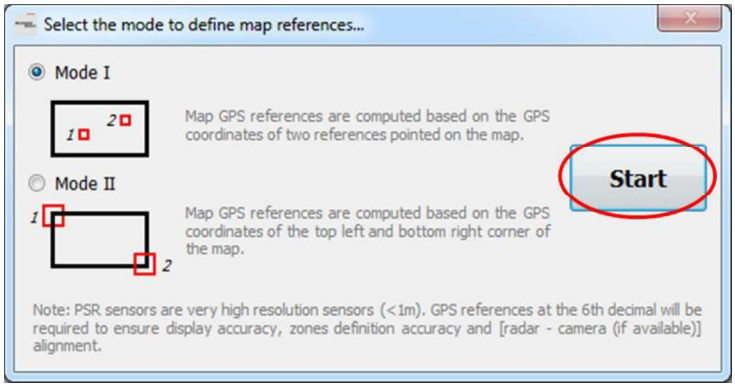

Figure 20: PSR-500 Installer – Select the mode to define map references

Note that references at the 6th decimal will be required according to PSR Sensors Units high resolution (1.5m). This reference definition phase has to be as much as precise as possible unless locations of alerts will not be positioned accurately on the map.

- Identify the point [Reference 1] by clinking on « OK », zoom in to be as precise as possible and define it on the map clicking on it. Use horizontal and vertical scroll bars to navigate on the map. Any click on the map will be taken by the application as the designation of the requested reference.

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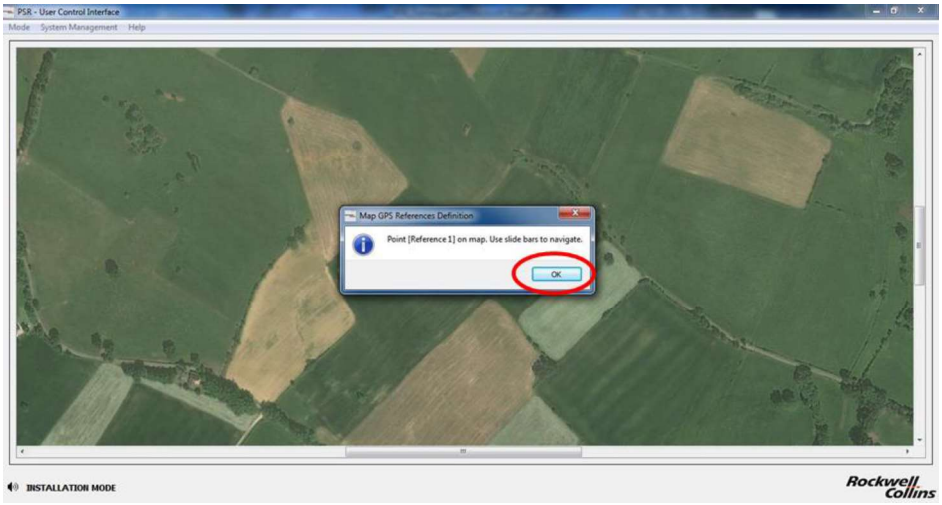

Figure 21: PSR-500 Installer – Identification of point [Reference 1] on PSR map

- Click « Yes » to confirm point [Reference 1]. If you get the wrong point, click “No” to come back to previous step.

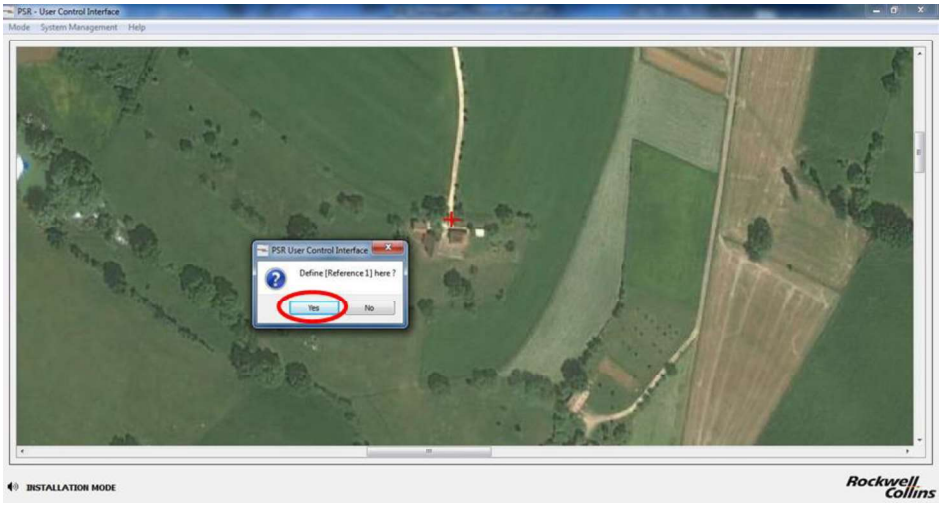

Figure 22: PSR-500 Installer – Validation du point [Reference 1] sur la carte

- You must now enter GPS coordinates of point [Reference 1] (latitude and longitude).

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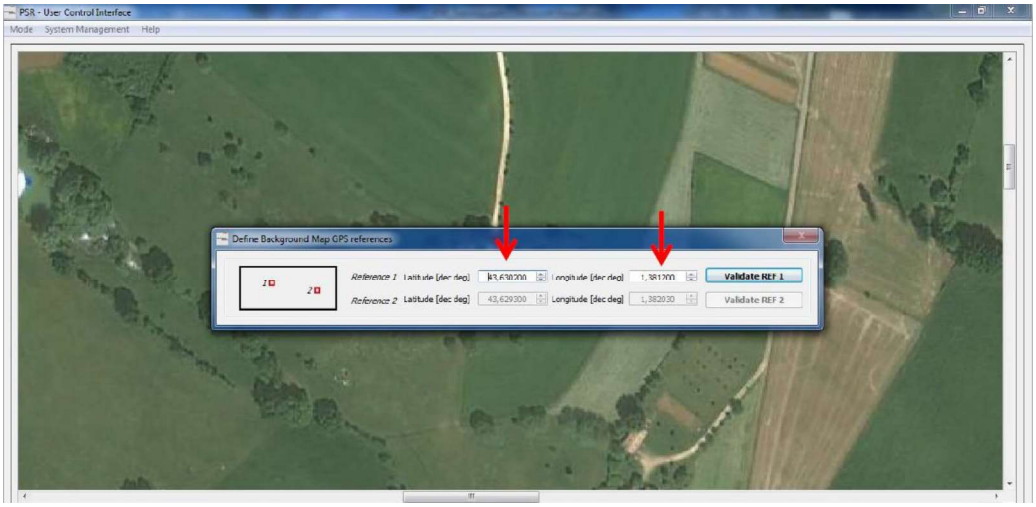

Figure 23: PSR-500 Installer – Enter GPS latitude / longitude of point [Reference 1]

- **If you imported your own map,** you should already know coordinates of the point. Register then as indicated in **Figure 23.** If you import your map from Google Earth, locate the point [Reference 1] on Google Earth map, as indicated on the following figure :

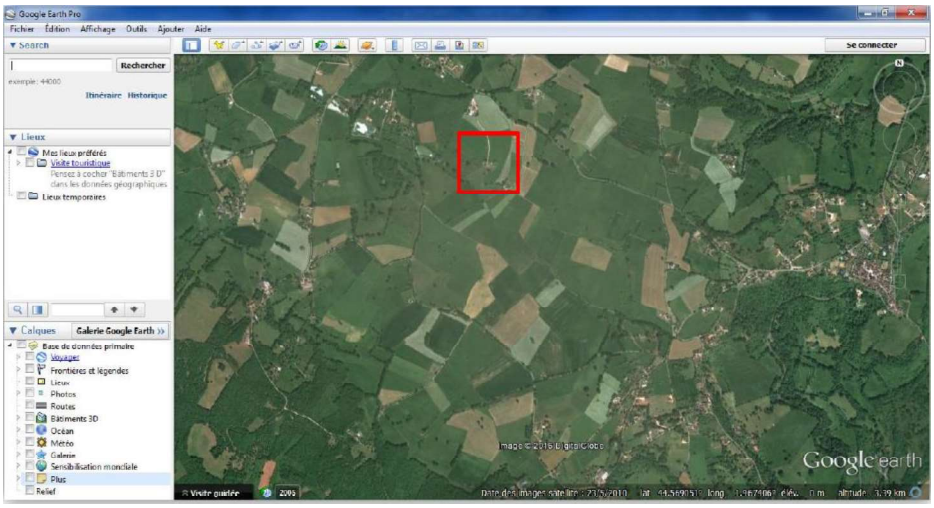

Figure 24: PSR-500 Installer – Localize point [Reference 1] on Google Earth

- Zoom in (to be as precise as possible) and recover the GPS coordinates of point [Reference 1] with “Pin” tool, as indicated on the following figure:

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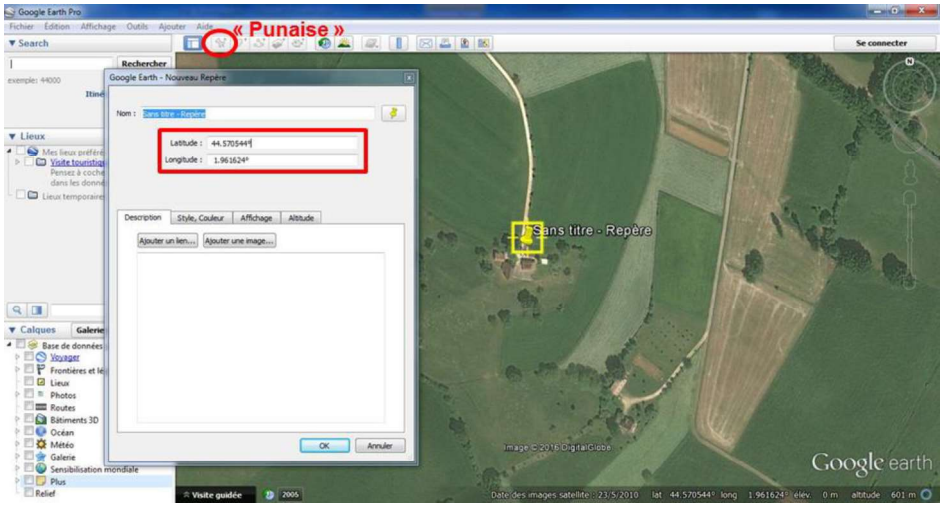

Figure 25: PSR-500 Installer – Get GPS coordinate with « pin » tool on Google Earth

- Getting back to **PSR-500 Installer**, enter the GPS coordinates of point [Reference 1] and click on « Validate REF 1 » :

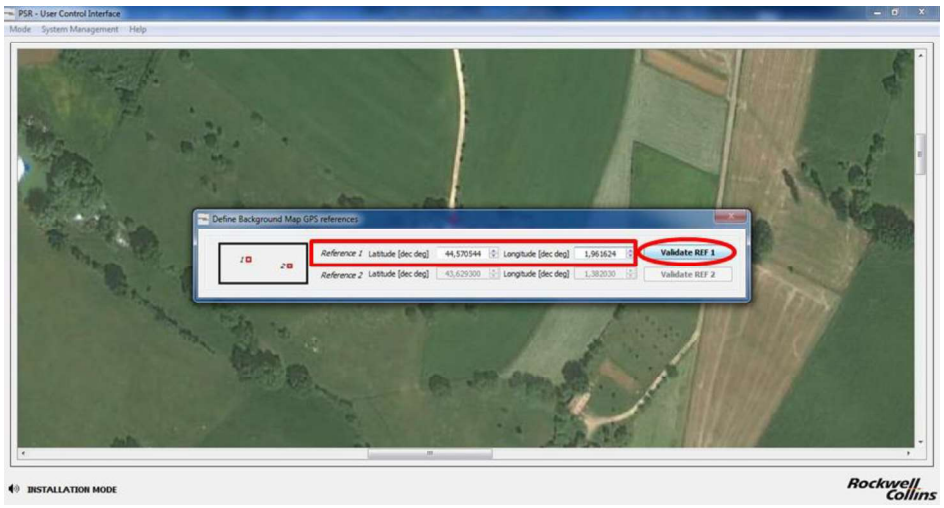

Figure 26: PSR-500 Installer – Validation of GPS coordinates of point [Reference 1] on the map

- Click on « OK » to identify point [Reference 2], zoom in to be as precise as possible and define it on the map clicking on it. Use horizontal and vertical scroll bars to move over the map.

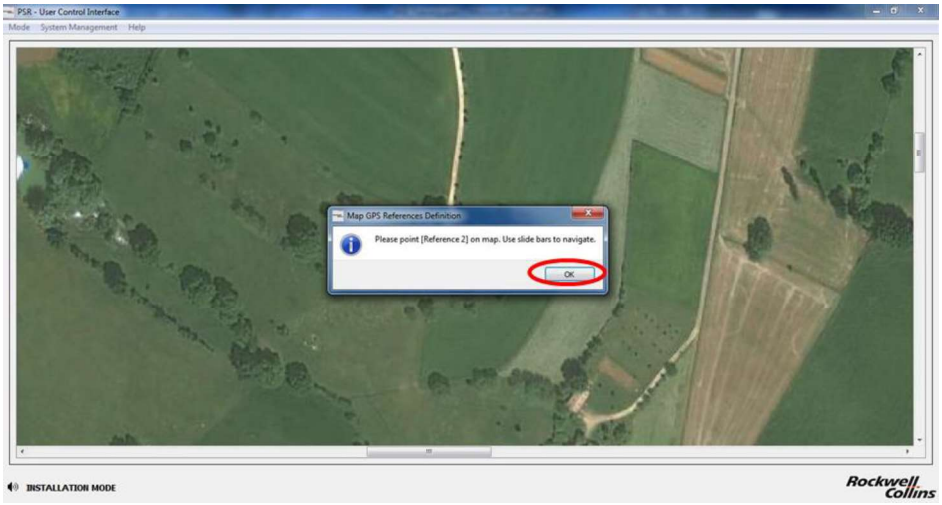

Figure 27: PSR-500 Installer – Identify point [Reference 2] on the PSR map

- Click « Yes » to validate point [Reference 2]. If you get the wrong point, click “No” to come back to previous step.

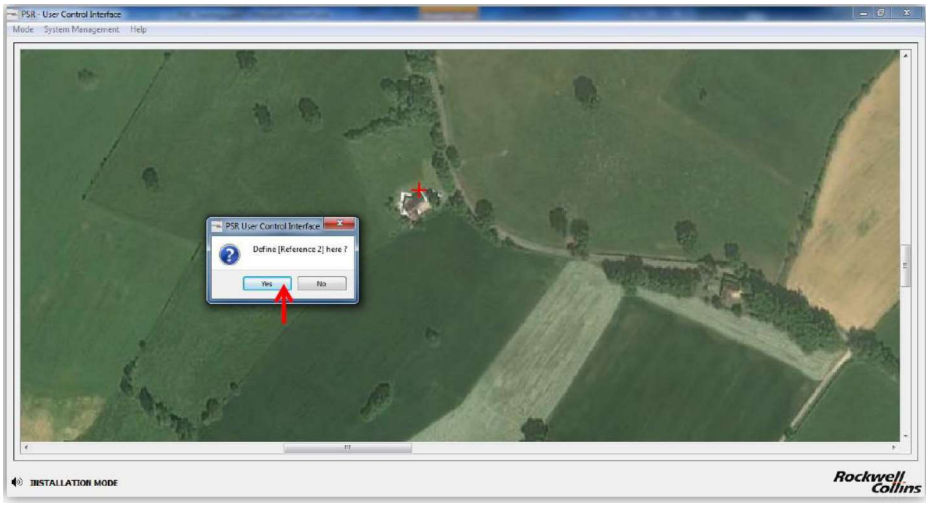

Figure 28: PSR-500 Installer – Validation of point [Reference 2] on PSR map

- You must now enter GPS coordinates of point [Reference 2] (latitude and longitude).

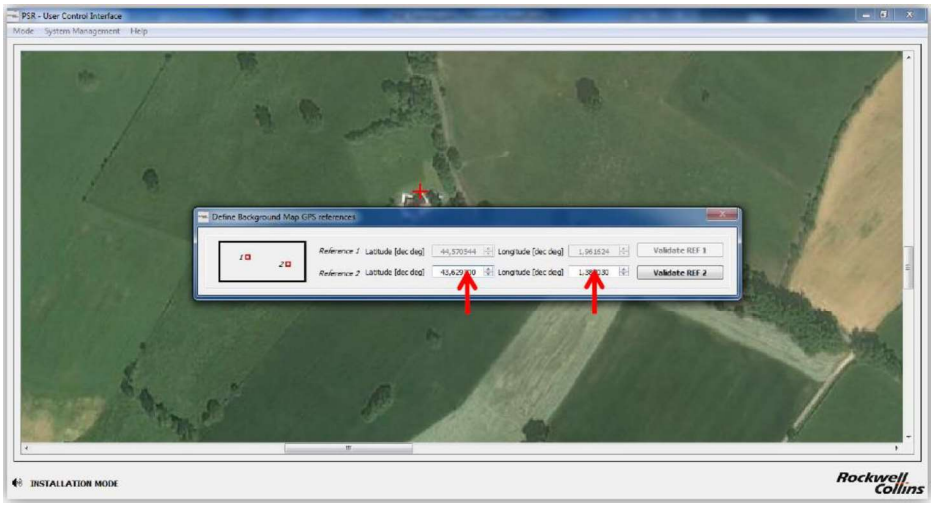

Figure 29: PSR-500 Installer – Save coordinates of point [Reference 2]

- **If you imported your own map,** you should already know coordinates of the point. Register then as indicated in **Figure 29.** If you import your map from Google Earth, locate the point [Reference 2] on Google Earth map, as indicated on the following figure :

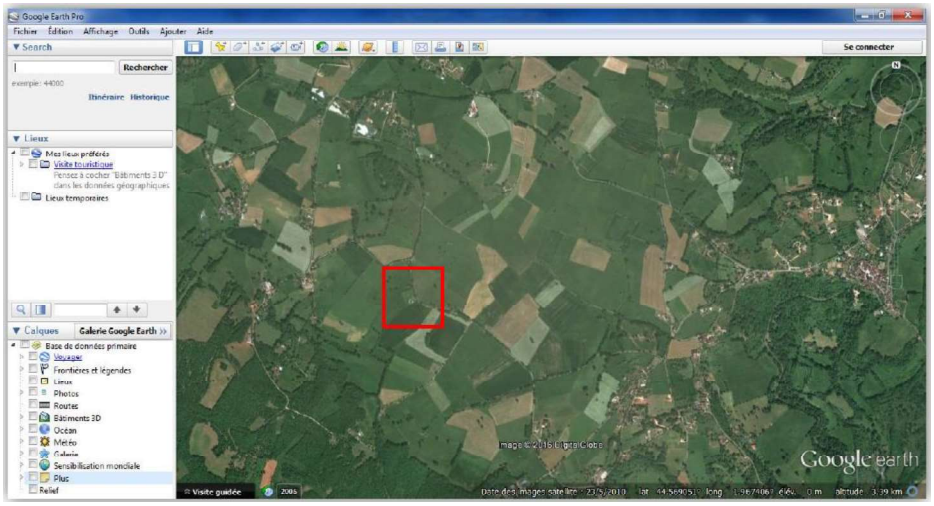

Figure 30: PSR-500 Installer – localize the point [Reference 2] on Google Earth

- Zoom in (to be as precise as possible) and recover the GPS coordinates of point [Reference 2] with “Pin” tool, as indicated on the following figure:

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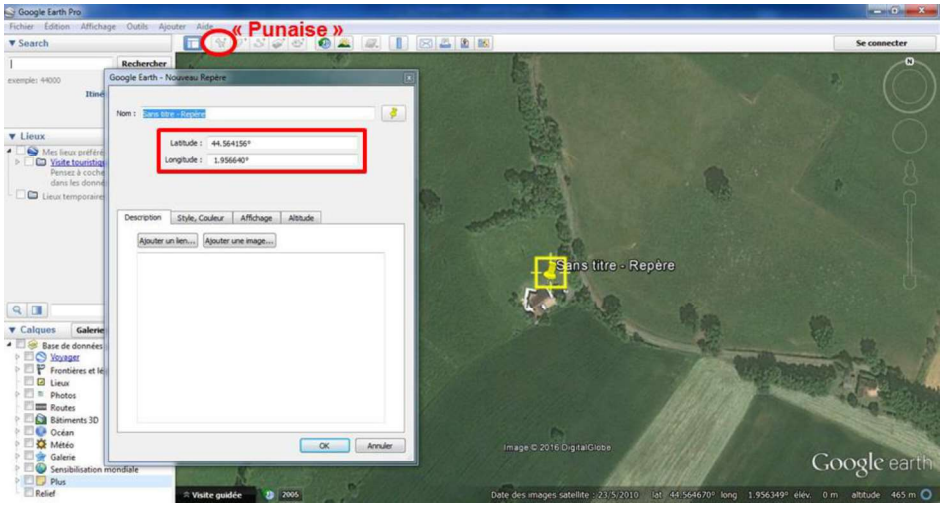

Figure 31: PSR-500 Installer – Get GPS coordinate with « pin » tool on Google Earth

- Getting back to **PSR-500 Installer**, enter the GPS coordinates of point [Reference 2] and click on « Validate REF 2» :

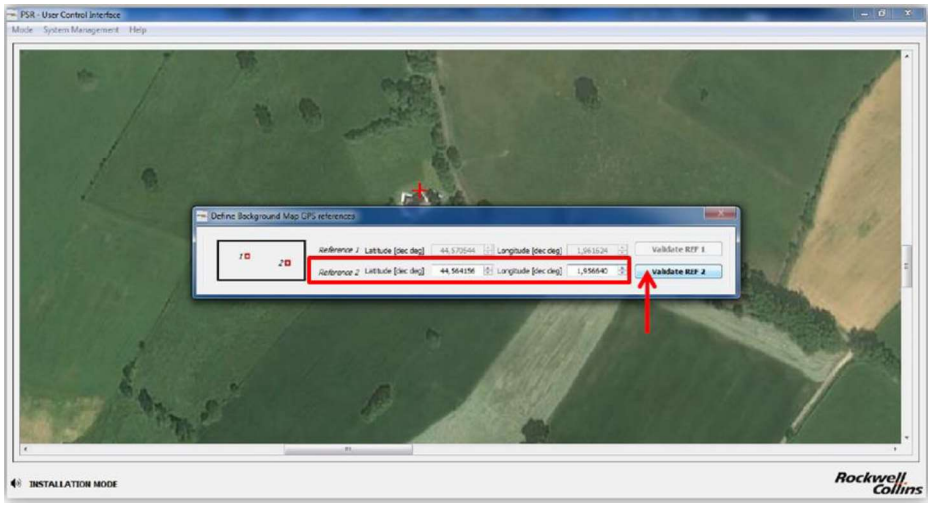

Figure 32: PSR-500 Installer – Validation of GPS coordinates of point [Reference 2] on the map

- Imported background map is now referenced. Click on “OK”.

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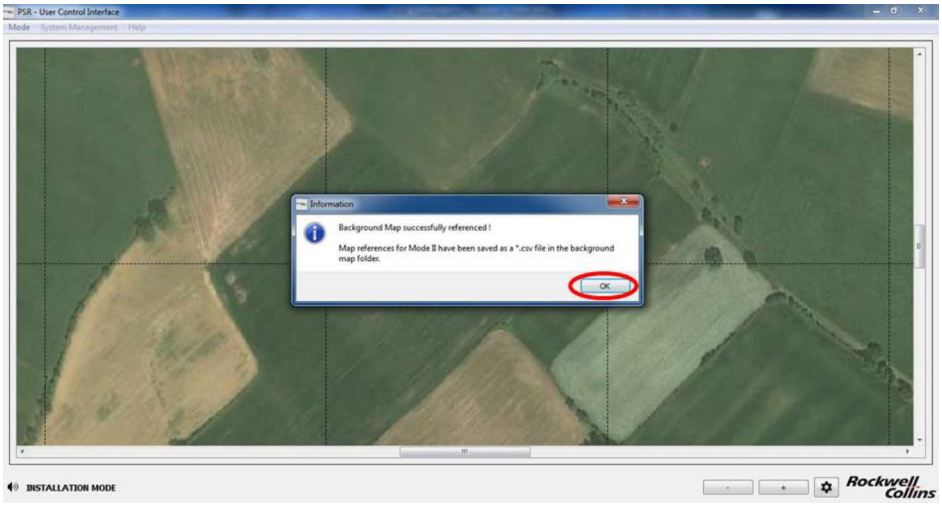

Figure 33: PSR-500 Installer – Map references correctly set up

Note: the navigation on the background map can either be done with the horizontal and vertical scroll bars or by keeping the mouse left button pressed at one point of the map and moving the mouse. The zoom level can be set up either through the mouse scroll wheel when the cursor is over the map or with button "+" and "-" in the bottom right-hand corner of the window.

6.1.2. Step#2 : Define site surveillance

The application automatically passes to this step at the end of step#1.

Before moving on to this phase, the installation operator shall be able to answer the following questions:

- How must be organized the surveillance of the site? Which zones must be secured?
- Is there any highly sensitive location and what would be the trajectories of the intrusions?
- Is there any area where the access is more critical than others? i.e. is there a reason to define two levels of alerts (caution and warning) ?
- Is there any area that the radar(s) deployed will have to ignore? (any authorized public activity on the site…)
    - Have the radar to still monitor these zone but without raising any alert to the operator (= corresponds to a "no zone"). The interest of such a setting is the reactivity of the system will be maximized in case of entrance into a forbidden zone.
    - Do we have to create exclusion zone(s) to avoid alerts on authorized and known activities? The interest of such a setting is to limit false alarms that may be raised at the edge of forest made of big branch trees.

Note:

- ***No zone** = Complete radar processing is performed BUT no information is forwarded toward the operator.*
- ***Exclusion zone :** Radar processing is not performed*

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Once all these questions are answered: the creation of zone of surveillance can start.

- Click on “Create zones” in the « Zone definition » window, cf. image below :

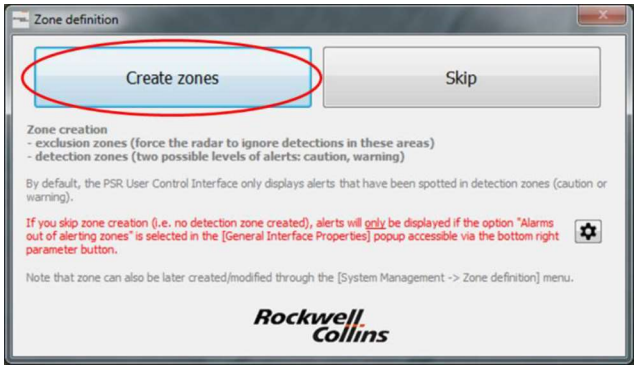

Figure 34: Zone definition – Create zones

- Through the displayed popup, read carefully the instructions that explain how to basically create a zone and click on “OK”.

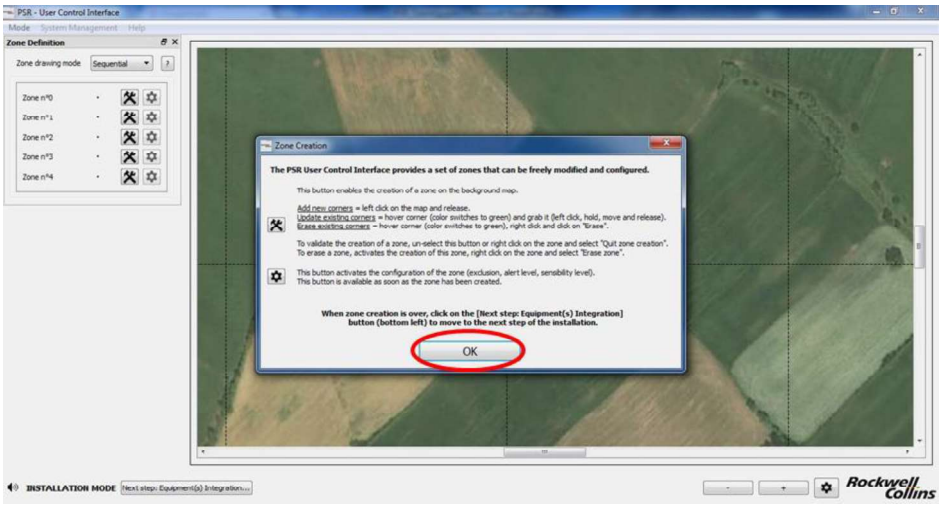

Figure 35: Zone Creation – Instructions to follow to create a zone

Note: The **PSR-500 Installer** application allows creating maximum 50 zones made of maximum 50 points each**.** One can create alerting zones (two levels are proposed) and exclusion zones.

Note : as previously explained, the PSR-500 system will only alerts if intrusion are located in an alerting zone. If the operator chose not to create any alerting zone, no intrusion alerts will be raised by the deployed radars.

- Creation of a first zone. By default, a new zone is a detection zone with the highest alerting level i.e. **“warning”.** By default, the « **sequential** » mode is activated meaning that each time you click on the map, a new corner will be added sequentially, whatever the position of the click. In this mode, you can not add a corner between two existing corners.

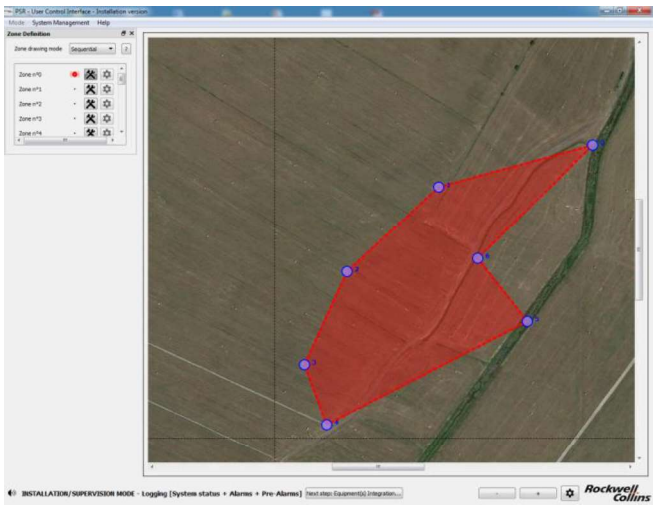

Figure 36: PSR-500 Installer – Creation of a first zone of surveillance

- If you need to refine the shape of a zone and add a corner between two existing corner, select the “Additional” mode and do it. An example is provided below with corner n°2

Figure 37: PSR-500 Installer – Add a point in an already defined zone

- We now leave the creation of this zone unselecting its “drawing” button. You can see that the corners have disappeared and that the color of the zone is less bright. It indicates that you have left the “zone editing” mode.

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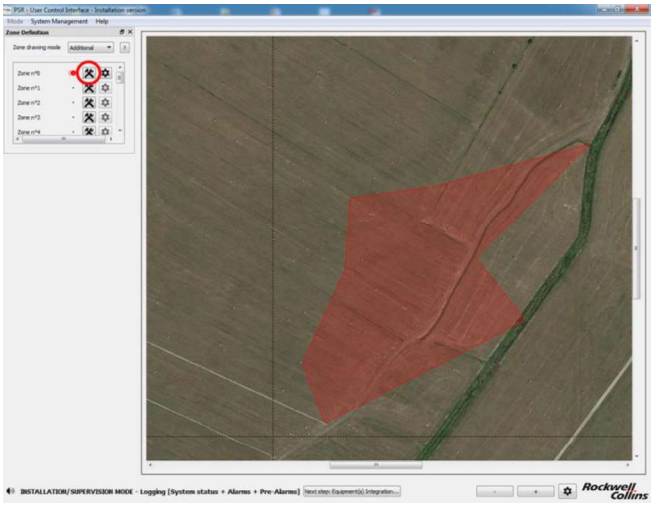

Figure 38: PSR-500 Installer – Exit of the zone creation mode

- To configure the properties of this zone, click on its « parameter » button as shown below. The zone is highlighted, indicating that parameters modification is in progress.

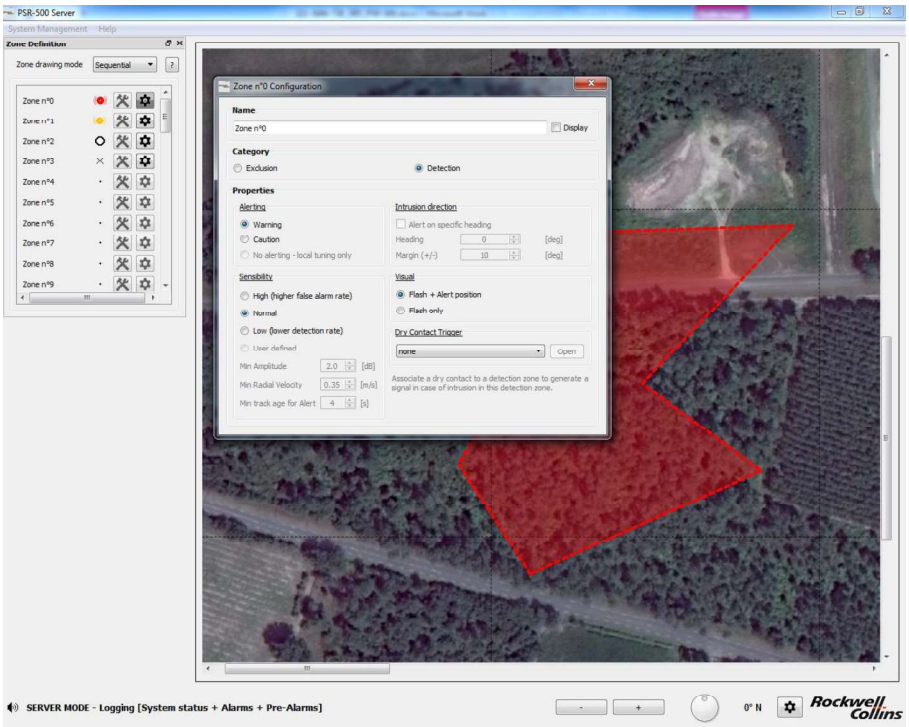

Figure 39: PSR-500 Installer – Configuration of the properties of the surveillance zone.

- In our example, the following parameters are selected :

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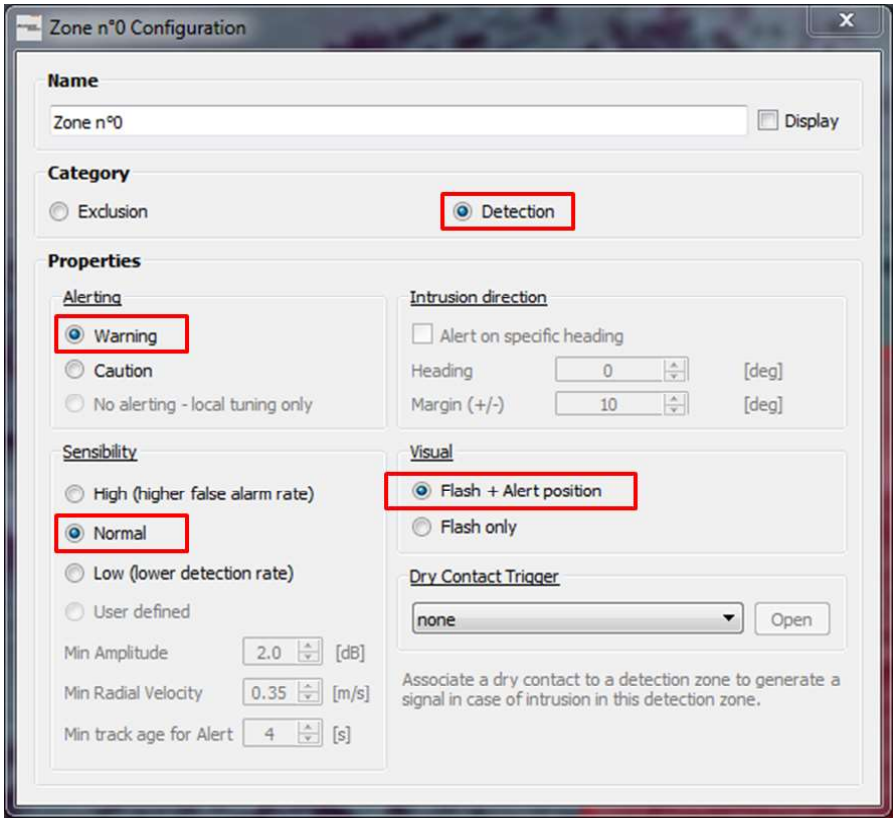

Figure 40: PSR-500 Installer – Configuration parameters of a surveillance zone

Note on alerting levels: two alerting levels are proposed to allow the operator to tune the site surveillance.

Note on sensibility: three levels are proposed. These levels will impact how each radar monitoring this area will filter detections: in minimum amplitude, in minimum radial velocity, and in minimum track age for alert

- The highest sensibility, the lowest parameters. The advantage is an increase of the detection probability, and the drawback is an increase of the false alarm probability.
- The lowest sensibility, the highest parameters. The drawback is a decrease of the detection probability, and the advantage is a decrease of the false alarm probability.

Note sur visual aspect : in our example, the zone is large enough to maintain the display of “Flash + Alert position” option (meaning that each intrusion in this area will be displayed as a triangle at the exact location of the intrusion and the zone background color will blink – flash only means that only the zone background color would blink – it can be useful to clean the display in case of small zones / dense activity).

- Create a caution zone next to the previous warning zone and an exclusion zone inside the warning zone:

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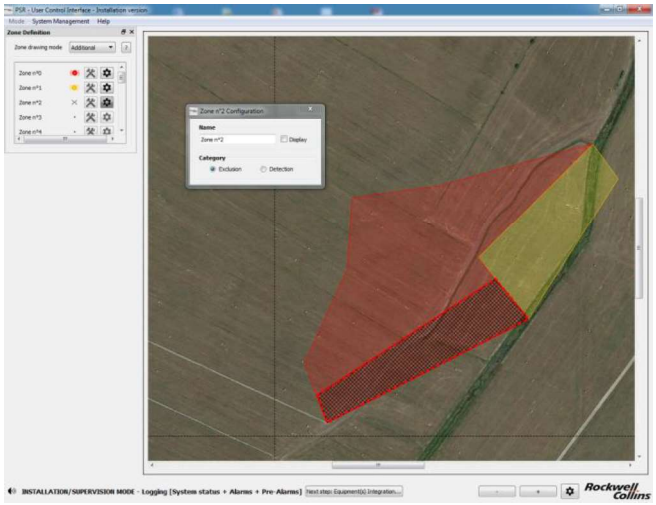

Figure 41: PSR-500 Installer – Addition of a caution zone and an exclusion zone

Note on zones:

- Exclusion zone prevails on any detection zone
- Warning zone prevails on caution zone
- Regarding the sensibility
  - The highest amplitude limit prevails
  - The highest radial velocity prevails
  - The lowest track age for alert prevails

- Once zone creation is over, click on the bottom button “Next step: Equipments integration…” to move to the next phase, as illustrated below:

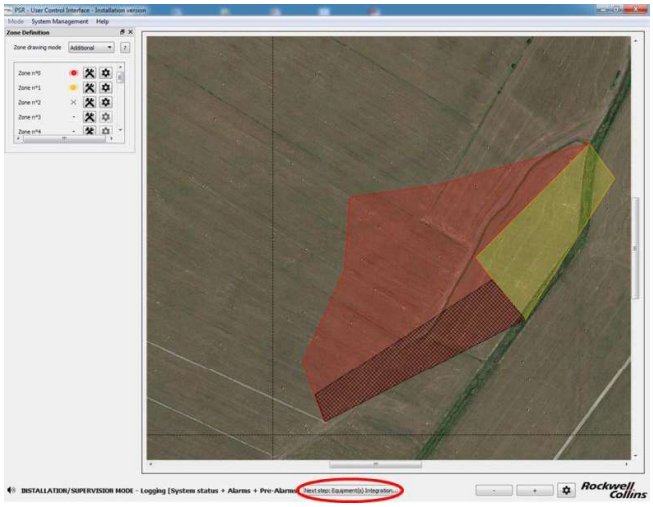

Figure 42: PSR-500 Installer – End of the zone creation

Association with a potential Dry Contact is treated in Step#5.

6.1.3. Step#3: Add, position and configure one or several radars (SU+PU)

The next step consists in adding, positioning and configuring one or several radars to better cover these areas.

- Click on « OK » in the « Information » window that automatically opens at the end of step#2.

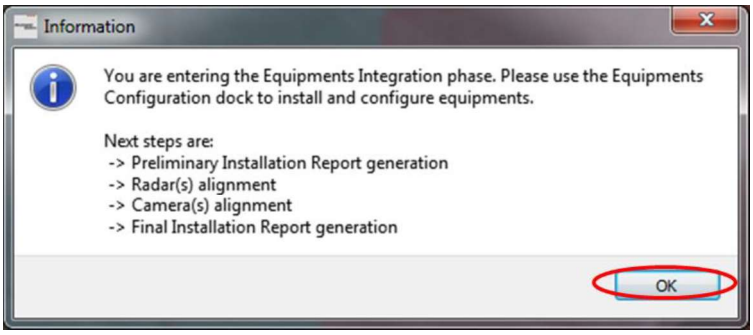

Figure 43: PSR-500 Installer – « Information » window at the end of step#2

- Add a radar clicking on the "+" button related to Radars (see below):

Figure 44: PSR-500 Installer – Add a radar

6.1.3.1. Rappels sur la technologie d'un radar Doppler

In order to maximize the detection performances of a PSR-500 System radar, it is necessary to understand some basics of Doppler radar technology.

Detection performances of a Doppler radar system are a trade-off (gain, loss) among many parameters. We call it **link budget**. This « link budget » will define the contrast of the target within its environment (environment noise and system noise).

The link budget inputs are:

- Radar & Signal processing characteristics

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- Antenna radiation pattern
- Target characteristics
  - Position within the antenna radiation pattern
  - Range
  - Radial velocity (Doppler effect)
  - Radar Cross Section (RCS)

The most important concepts to remind:

- **Range effect**
  - *The closer a given target is from a radar, the stronger its detectability is*
  - The farer a given target is from the radar, the weaker its detectability is

- **Radiation pattern effect**
  - The closer a target is from the axis of the antenna of a radar, the stronger its detectability is
  - The farer a target is from the axis of the antenna (on the main axes, in azimuth and in elevation, e.g. foot of the mast), the weaker its detectability is

- **Radar Cross Section (RCS) effect**
  - The Radar Cross Section (RCS) is a target property that defines how much energy a target will backscatter toward a RF source..
  - **RCS is independent from:**
    - Target range
    - Target position within antenna radiation pattern
  - **RCS depends on:**
    - Target nature (material…)
    - Target shape
    - Target masking
  - Therefore, human intrusion RCS will depend on:
    - Human position (standing, squating, crawling…)
    - Human masking (wall, vegetation…)
  - The stronger the RCS of a target is, the stronger its detectability is

Figure 45: RCS evolution depending on the target type

The following figures present the detection zone for a human intrusion (on the left) and for a car (on the right). Once can see the range, radiation pattern and RCS effects.

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