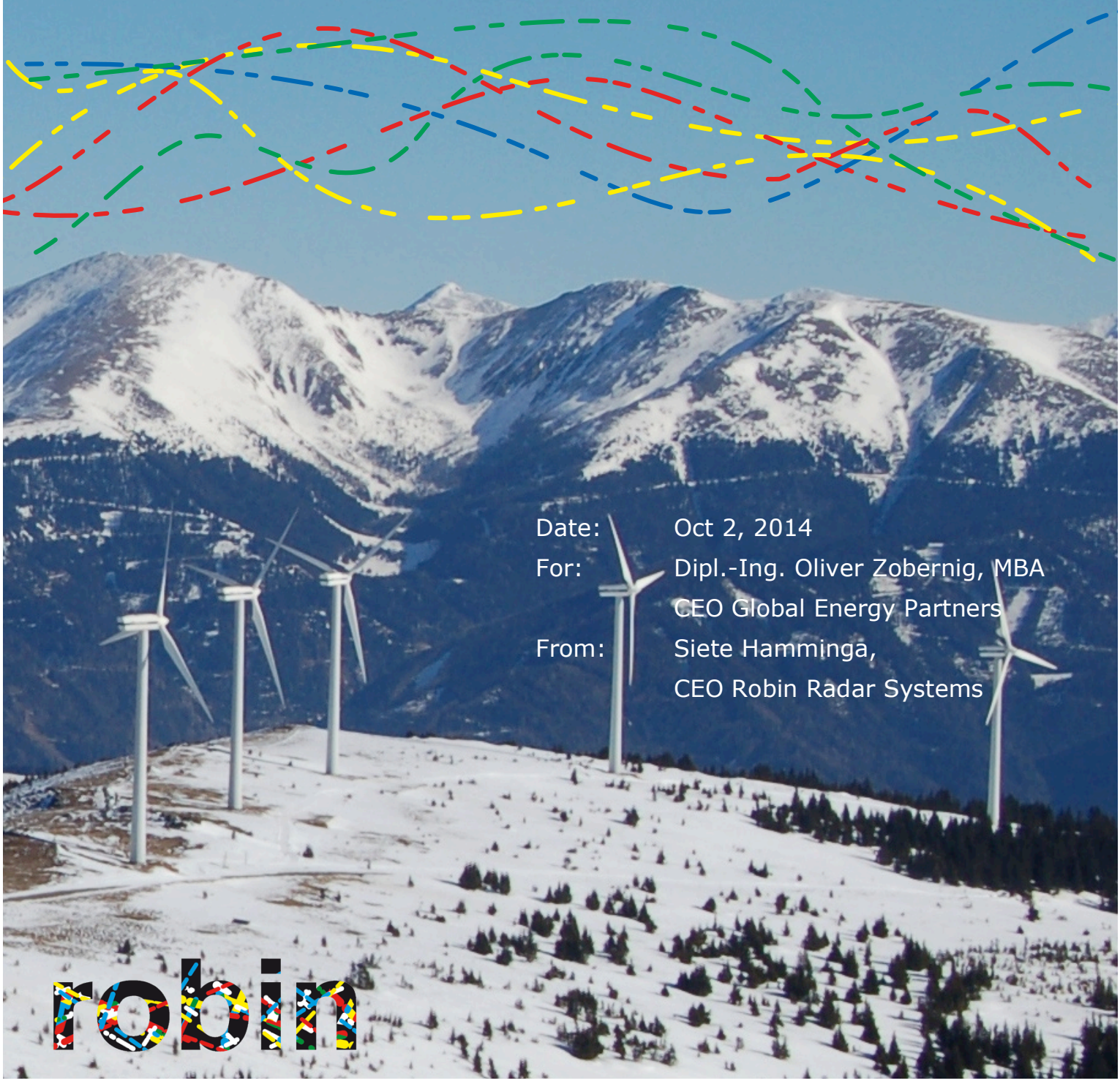
BUDGETARY QUOTATION

Radar Based Bird Monitoring in Austria



Date: Oct 2, 2014

For: Dipl.-Ing. Oliver Zobernig, MBA
CEO Global Energy Partners

From: Siete Hamminga,
CEO Robin Radar Systems

Content

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Situation

Impact on bird populations is recognised by regulation that requires an *Appropriate Assessment* for any project that could interfere. In the event a project is likely to interfere with habitats or species, it may still be allowed to go ahead under two conditions: it must be in the public interest and the implementers of the project must take steps to mitigate any negative effects.

Customer need

Global Energy Partners (hereafter "GEP") is an Austrian based company that develops and operates wind energy and hydropower plants. GEP is currently in the final stage of permitting a six turbine wind farm in Carinthia, Austria. Authorities require measures for bird protection and GEP therefore wants to suggest the use of bird radar. Mr Oliver Zobernig requests customer references, technical specifications and preliminary insights in cost concerning leasing or buying a system. This document serves that purpose.

Radar Capabilities

Bird monitoring has traditionally been done by human observation. Radar is not a substitute, but it does offer unique complementary capabilities. A human observer is able to monitor only one direction at a time, estimating a bird's location and height at a range of 1 kilometre in good visible conditions at day-time. Radar can detect birds at distances up to 10 kilometres, all around, day and night. It automatically detects and logs hundreds of birds simultaneously including their size, speed, direction, flight path and location in meters accurate. This data enables the identification of patterns such as;

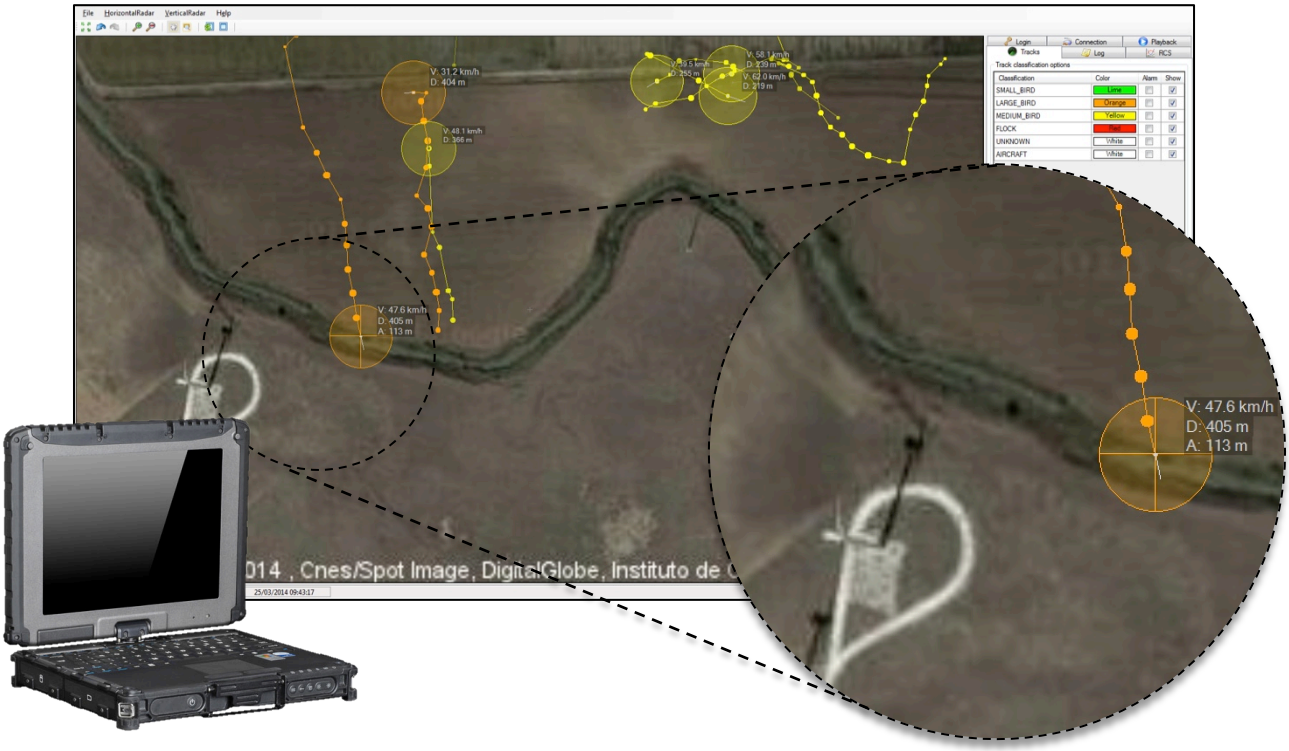
- migration routes
- seasonal occurrence
- key areas (breeding, feeding, wintering, night roosts etc.)
- macro and micro avoidance behaviour
- barrier effects
- the impact of specific weather conditions
- the effectiveness of mitigation policies

Unique Tools & Benefits

Bird radar information is used in real time as well as for data analysis over a period of time. The next four paragraphs describe Robin specific software applications that were created in close harmony with users.

See bird movements in real time (The "Visualizer")

The "Visualizer" displays bird movements in real time on a map. Users can orientate by using a Google background or customized map with important landmarks and zoom in on a specific bird track that represents its flight path. These tracks have different colours to distinguish small, medium and large birds from one another. The circle at the end of the track is the birds' present location. The size of the circle reflects the size of the bird. The figures next to it show its speed in meters per second, height and exact distance from the radar. All this information is continuously logged in the database.



Some of the many relevant features are:

- The Visualizer contains a playback-mode to travel through the full database and review earlier events.
- If a network connection (Wifi, fixed internet or wireless 4G network) is available, the Visualizer (like the other tools) can be used remotely. That means either on a desktop in a comfortable office or on a ruggedized laptop somewhere around the wind farm.
- The observation tab offers the unique possibility to add observations. For example ornithologists that want to validate and enrich radar information by matching tracks with their own visual observation, identify its species and add that information into the database.
- All information is logged into the database for later analysis. (See "Report Viewer" in the next paragraph)

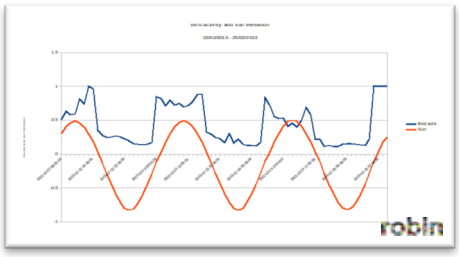
Convert data into graphs (the "Report Viewer")

Bird monitoring with radar is not a goal on its own. Customers need to convert the information into periodic reports, for example in the form of environmental impact assessments. To support this, Robin developed a unique tool.

All track data is stored in the PostgreSQL database. The tool generates basic graphs from the database. This not only involves track information, but also system uptime graphs and weather information. Furthermore the tool enables database snapshotting for export to advanced COTS database analysis tools.

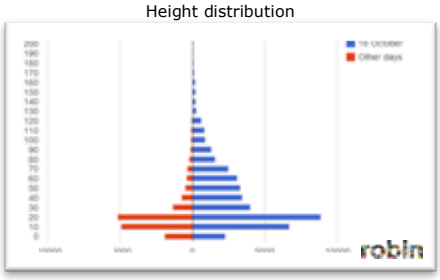
The report Viewer is web-based meaning that as long as there is an internet connection (either fixed or a wireless 4G network), the tool can be used remotely on a desktop in a comfortable office environment. The possibilities are numerous. Two examples of generated graphs are shown below:

Bird activity versus sun elevation

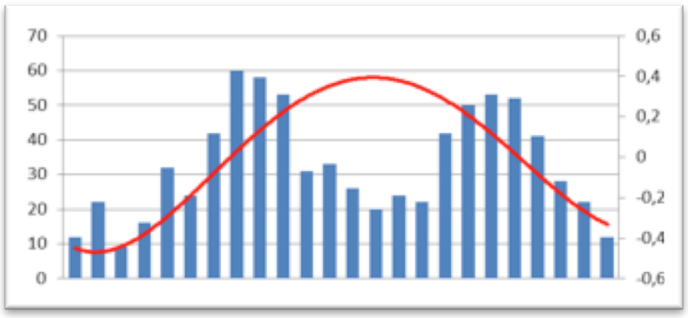


Direction distribution

Height distribution



Bird movements per hour



Hot spot analysis

Control the system from a distance (The "Remote Monitor")

The remote monitor is used to monitor the current state of the system. It automatically performs checks on various components of the system and shows the results in a graphical user interface. The tool is used to recover from minor system failures by restarting the applicable (sub-) system or even by rebooting a server from a distance.

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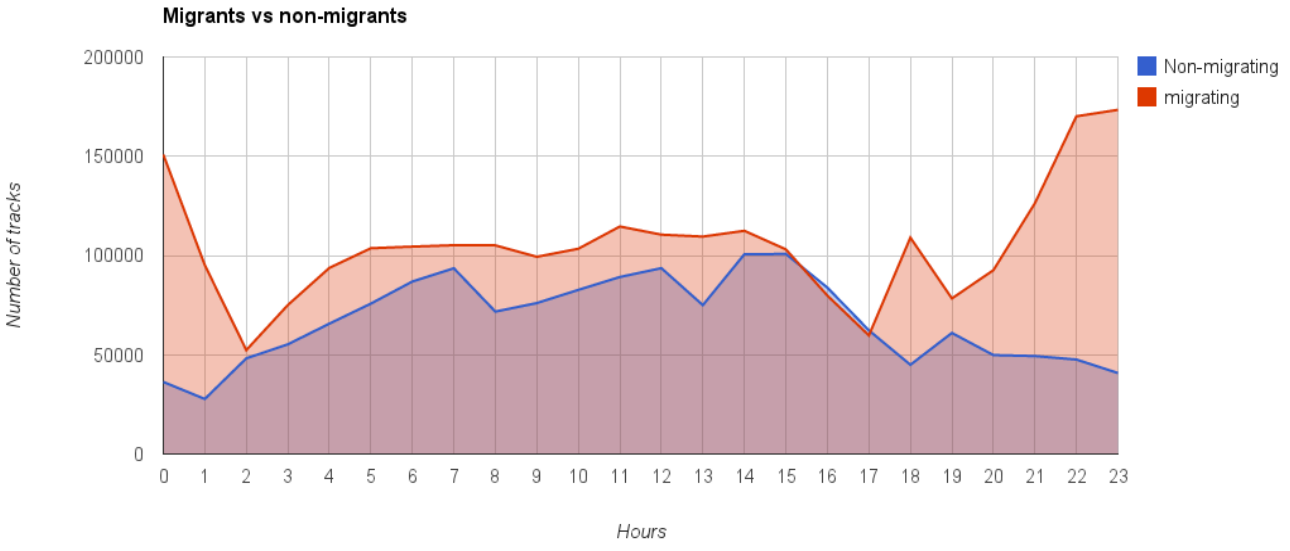
Mitigate impact by Automatic Windmill shutdown

Robin developed a module that enables the system to switch off turbines based on live bird information. This can be done for single turbines well as groups. The module has two operating modes that can run either separately or in parallel:

1. The first mode continuously measures the number of birds per minute that enters a specific radius around the turbine. When this number passes a pre-defined threshold, the system generates a shutdown command for that particular turbine. The definition of this threshold is often the result of local surveys and requires fine-tuning after installation.

2. The second mode detects the start of overnight migration. It generates a density grid and is able to distinguish between single birds, local migration and overnight mass-migration. After detecting an overnight mass migration event, the system will shut down (part of) the wind farm automatically.

From a technical point of view, the windmill shutdown module is a plug-inn that forms a direct interface to individual wind turbines. The Robin radar system feeds it's outgoing PLC that delivers a dedicated active/shutdown (high/low) signal for each turbine. It also provides a 'heart beat'-signal to confirm the radar is alive and connected. This PLC can be part of the wind farm SCADA system.



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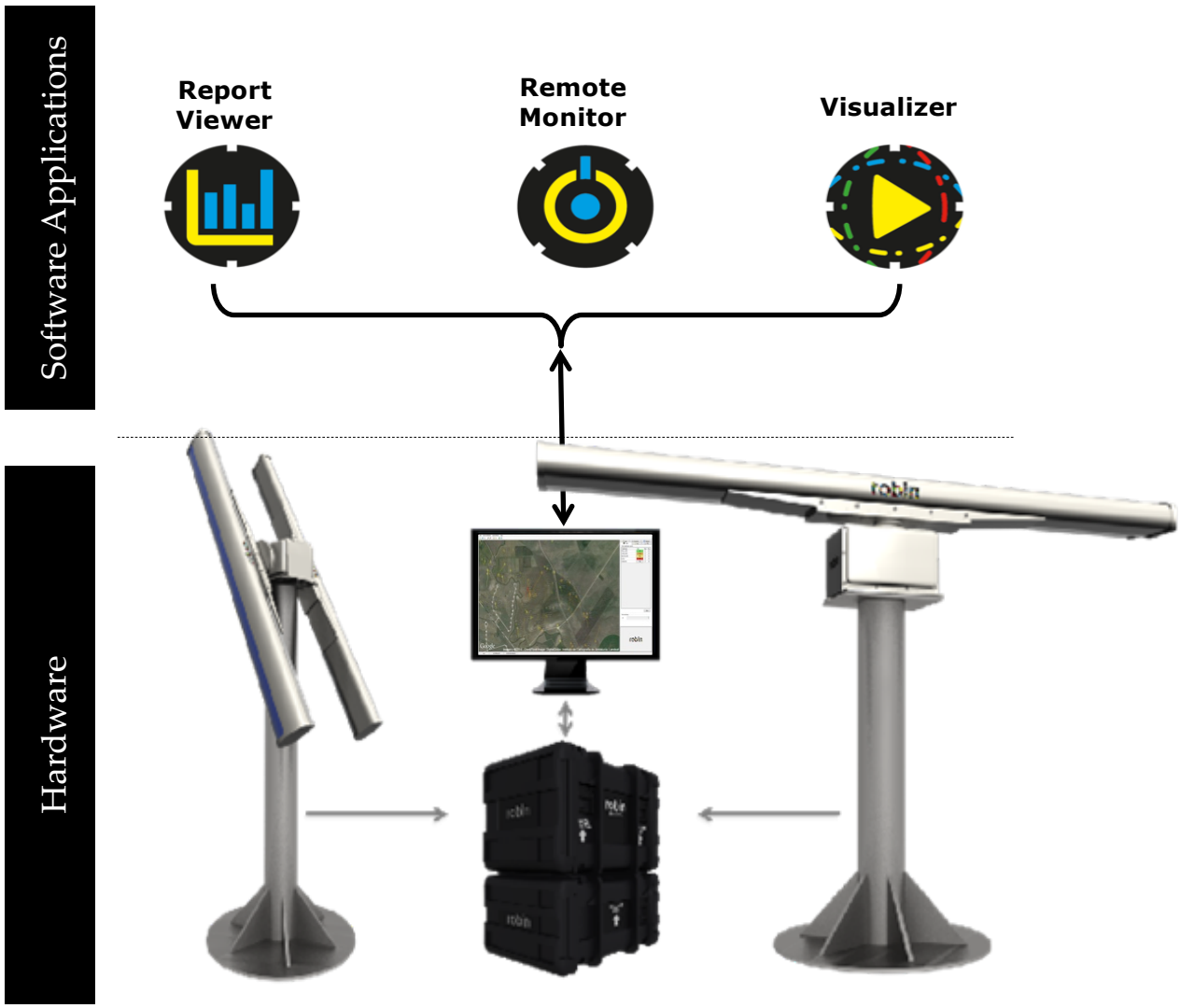
Systems

Robin Radar offers a number of different configurations ranging from mobile to stationary systems and from two to three dimensional bird information. This document describes the 3D flex configuration, either trailer based or stationary.

Overview of system

The figure below provides an overview of the main components of the suggested configuration. It comprises of a horizontal S-band radar, a shock proof 19 inch rack containing the core of the system and finally a laptop or desktop screen to interface with three different applications as described in previous paragraphs.



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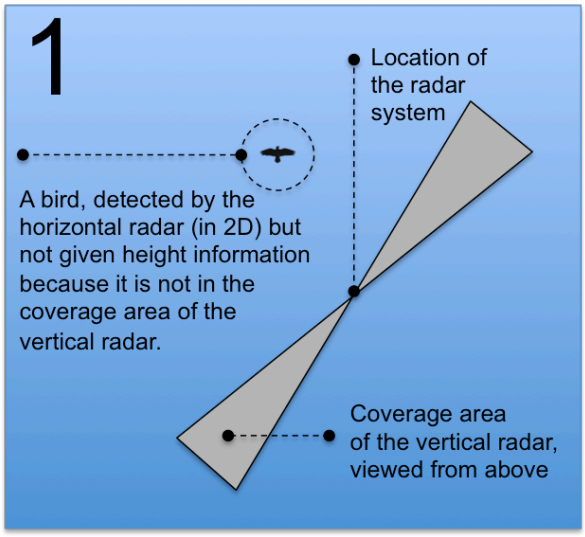
Unique 3D capabilities

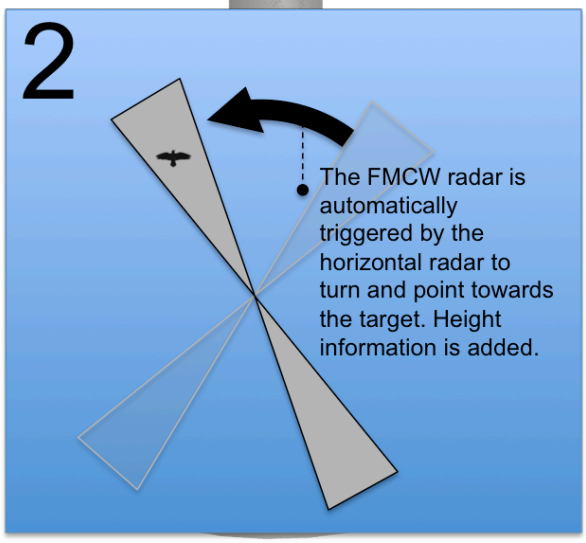
The 3D Flex configuration has marked the next generation in the industry. This configuration combines a 60kW horizontal S-band radar with all the flexible capabilities of the world's only purpose built avian radar: Robin's FMCW radar.

The input of both radars is combined in the data processing centre where 30 years of applied science is put into action. 3D coverage and high detection rates enable the capture of hundreds of bird movements simultaneously, providing unprecedented details of individual bird movements and their context.

What makes the FMCW radar unique is its ability to operate in different modes:

- In the "Staring Mode" the radar stands still and 'stares' at a target without loosing it out of sight. Traditional radars transmit a pulse while turning and then 'listen' to its echo. Robin's FMCW radar has two beams. One is continuously transmitting and the other is continuously receiving (FMCW stands for "frequency modulated continuous wave"). While doing so, it can measure the birds wing-beat frequency as one important variable to distinguish categories of species.
- In the "Scanning mode" its turns both vertical and horizontal at the same time. This means it can move towards a target to add height information and does not have to wait until a bird flies through its beam (or not). To clarify, please take a look at the two-steps below;





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Extreme Mobility

The trailer-based version is specifically designed as compact as possible for use in Europe. The height of the trailer is less than four meters (3,85 m) as required by European law and it can be towed by any vehicle with a towing weight of 2.500 kg. Drivers in European countries require a category 'BE' licence. It can typically be gotten in a one-day training course including exam.

Setting up the trailer, between arriving at location and being operational, takes 30 to 60 minutes. The trailer has an automatic levelling system: it measures its position and automatically adjusts its 'feet' for stability.

The shelter houses the computer rack and facilitates a compact workplace facing the window. An airco & heating unit controls the climate inside the shelter. If no power is available, the included power generator provides electricity.

Requirements for a stationary system

For continuous bird monitoring a stationary radar is recommendable. In that case masts and a shelter will be provided. For a stationary system, the infrastructure requirements are:

- The location of the radar needs to have a solid underground and a clear line of sight towards the area of interest
- The energy consumption of the entire system (three computers, a horizontal and a vertical radar) is 1 to 1,5 kW (230 AC) depending in the wind speed and computer capacity. When starting up the system, the peak power is 4 kW.
- During operations the temperature is controlled by the airco unit (included) and kept between 15 and 25 degrees Celsius. If the system is not operational, surrounding temperatures between 5 and 65 degrees Celsius are permitted.
- In order to control the system remotely a stable Internet connection is needed with a symmetrical capacity of at least 2Mbit.

Health & Safety

The effect of radar emission on humans has been thoroughly researched by ICNIRP (the International Commission of Non Ionizing Radiation Protection). Radiation is measured in terms of its heating effect on water at a certain distance. The unit for this is W/m^2. Typical guidelines state that prolonged exposure is not advisable for values above $10W/m^2$. As a reference: typical radiation of a kitchen magnetron at a short distance is $50W/m^2$. The guidelines from our sensor suppliers are more strict and stay below the 10 W/m^2 norm. Guidelines from the supplier advice however not to stay within a radius of 7,4 meters for more than four hours. Other precautions concern the mechanical danger; to prevent being hit by the turning radar. Therefor pre-cautions concern:

1. The moving parts of the radar (antennas) need to be placed in a way that people cannot reach them without the use of tools.
2. When working within a ten meter radius of the radar for a longer periode of time (>4 hours), the radar should be switched of.

Radar Specifications

Frequency:	S-band (horizontal) and X-band (vertical)
Rotation Speed:	The horizontal radar is modified to rotate 48 times per minute (48 RPM) while emitting a pulse every 0.05 microseconds. This leads to a higher update rate enabling the world's most advanced tracking abilities.
Range:	Large birds and flocks can be detected up to 10 km (radius) and at a height of 2 km.
Detection capability:	Due to its relatively small wavelength, the S-band is able to detect objects of 5 centimetres and bigger.
Resolution:	The S-band scanning radar has a resolution of about 25 meters at 10 kilometres range.
Side lobe suppression:	Due to its smart design the antenna used provides space for extreme side lobe suppression (-34dB). This prevents that objects outside the main radar beam can lead to severe and confusing reflections.

Limitations of Bird Radars

As the European market leader we feel responsible for addressing limitations as well as capabilities of bird radars. We call this our "be real" approach. Limitations of radar are:

- Like any other technology, a bird radar is an enabler. Radar is a tool that provides unique data that requires experts to convert into information, reports, conclusions or policies. That is why Robin works together with ornithologists and ecologists who are specialized in this filed of work.
- Radar is a monitoring tool. It does not deter birds. Deterrence requires other means like acoustic devices, green laser or gas canons.
- Radar does not see everything. It cannot see trough or behind physical objects like buildings. Coverage depends on terrain, detection range depends on the size

of the birds and capabilities degrade in extreme weather conditions like heavy rain or snow.

- Radar distinguishes birds into categories, not species. The FMCW radar has the capability to measure wing-beat frequencies of isolated targets within its range. These frequencies can be used as one of many variables (like air speed, RCS and shape of its flight path) to categorise in more detail. This requires a data base of (human) validated local bird species.
- When talking about 3D coverage, please be aware that we combine two sensors. The horizontal radar identities birds in 2D and the vertical radar adds height information providing 3D information in the overlapping coverage area of the two sensors. Height information is added target by target.

Budgetary Quotation

The tables below provide a budgetary quotation for leasing and buying a 3D flex system in -and excluding a trailer base. It also states the option of a refurbished system. This option is referring to cooperation with Eesti Energia who has a used system available. When of interest, more information about this possibility will be provided.

Comparing Options

	Purchase - New System			Purchase - Refurbished system		
item	price			price		
System	€	485.000	once	€	275.000	once
Trailer (optional)	€	48.000	once	€	48.000	once
SW maintenance & update	€	28.250	per year	€	28.250	per year
HW maint & product support	€	18.000	per year	€	18.000	per year

	Lease		
item	price		
Down payment	€	150.000	once
Lease	€	7.000	per month
SW maintenance & update	€	28.250	per year
HW maint & product support	€	18.000	per year
Buy option after 5 yrs	€	54.134	once

Minimum Lease period is 12 months
All prices are in Euros and ex VAT

Active Support

Our goal is that Kigali Airport becomes our ambassador in the African Continent. We belief that takes an approach in which we establish intimate customer relations, be transparent and provide quality service way beyond the delivery of systems. We understand that choosing the best solution for your specific needs is one thing. Implementing it into effective use and maintaining the system in good health is another.

Training

Extensive training is provided as part the system delivery and included in the price. The training consists of a theoretical training, an on job user training and a technical training. During these sessions users are familiarised with the supplied manuals, system documentation and Quick Reference Cards. During the first part of the training, the focus is on basic components and functions. The second part of the training is customised to the specific needs of Kigali Airport and how you want to use the system, analyse data and adjust the settings to local conditions.

Documentation

Every system is delivered with the following documentation in English language:

1. Robin Visualiser Manual
2. Robin Remote Monitor Manual
3. Robin Report Viewer Manual
4. Installation Guidelines
5. Service & Maintenance Guide
6. User Manual
7. Quick Reference Cards
8. All sub-component manuals from suppliers

Helpdesk

An English-speaking customer helpdesk is available in the Rwanda time zone from 9:00 to 17:00. Provided the radar is connected to the Internet (either fixed or via a 4G wireless network) the helpdesk can enter the system by using the Remote Monitor.

Remote Diagnostics

The Robin Service Team can check the state of the different system components and perform diagnostics from our office in The Netherlands. If needed it can be used to recover from minor system failures by restarting the applicable (sub-) system or even by rebooting a server from a distance. If we are unable to provide the necessary support remotely, one of our service engineers will be sent over to fix the problem.

Local Maintenance & Repair

The Robin System has relatively little maintenance requirements. Except for keeping the machinery clean, the moving parts need little attention. This first-line-support is executed by the owner of the system. Second and third line support will be executed by Robin and/or certified local third parties. The second line maintenance concerns regular inspections. The third line maintenance refers to repair components or replacing 'end-of life' components. Visits will always be planned in conjunction with the customer and reported afterwards.

Quality

Proven technology

Currently there are 17 Robin systems operational in Europe. This is both in aviation as well as in wind farms. Examples of Robin Radar Systems used in European wind farms are:

- Eesti Energia using a stationary 3D flex system in a windfarm at Kihnu Island, Estonia
- EVN using a stationary 3D flex system in a windfarm in Kvarna, Bulgaria
- Acciona Energy using a mobile system for permanent surveys in Tarifa, Spain
- Nina using a mobile system for temporary surveys around Norway
- 3Gs using a mobile system for site assessments at multiple locations in Poland

We would be happy to arrange an introduction to these customers to learn from there experience or try to arrange a site visit.

Future proof hardware

Our design philosophy is based on delivering systems that are future proof. Robin invests significantly in R&D resulting in continuous software updates and new features, based on the same hardware as submitted in this proposal. As a Robin customer you benefit from these updates as part of the service and licence agreement.

Embedded Quality

The quality of the system is secured in multiple ways. Many tests (on part, subassembly and end assembly level) are executed during production. Each system is field tested before delivery and undergoes both a strict Factory Acceptance Test and Site Acceptance Test in cooperation with the customer.

Secondly ROBIN is in an accreditation trajectory to receive an ISO 9001 quality certificate. This assures a process of continuous improvement to be executed throughout the entire organization and our suppliers. ROBIN uses state of the art tools to manage software versions and modifications and has a large, partly automated, software test set.

Certifications

The system will be accompanied with a CE certification in which Robin Radar Systems declares that the system meet the following guidelines:

- 2OO6/95/EC and adjustments
- R&TTE guideline 1999/5/EC and adjustments;
- FAA AC 150/5220-25

In order to test the systems on these guidelines, the following harmonized European norms are used:

- EN 301 489-V1.9.2/ EN 301489-3 V1.4.1 & EN 301 489-32 V1.1.1
- EN 61000-3-2 (2006) + A1 (2005) + A2 (2009)
- EN 61000-3-3 (2008)
- EN 61010-1:2010

Up-time

The system is in at least 95% of the time able to operate. This up-time is defined as time in which the system is operational or could have been operational. This last category refers to a number of situations that fall under 'up-time' although it does not monitor birds. Those situations are:

1. Planned maintenance
2. Power outage
3. Emergency stops (unless caused by technical failure)
4. Critical weather conditions (for example: the radar automatically switches off during very high wind speeds)
5. User actions (human failure, waiting time or stops on purpose a.o.)
6. Failures that due to redundancy in the systems do not lead to loss of data
7. System tests

Warrantee

The warrantee on Robin systems is one year. The warranty period starts at successful completion of the Site Acceptance Test (SAT) or automatically three months after installation. During the warranty period, all defects are repaired that occur given normal use.

Terms & Conditions

The Nederland ICT Terms and Conditions apply to all offers and contracts by Robin Radar. The Nederland ICT Term and Conditions are filed with the Chamber of Commerce under number 30174840. A copy is provided both in hard –and soft copy.

Disclaimer

Buyer acknowledges and agrees that the ROBIN system(s) is/are innovative products subject to on-going further development. No guarantee, express or implied, is made as to the ability of any ROBIN system to monitor all bird traffic. ROBIN accepts no liability for any damage suffered by Buyer as a result of missing or incorrect data from the ROBIN system(s).

Validity

This document represents a preliminary proposal. No rights can be obtained.

About Robin Radar

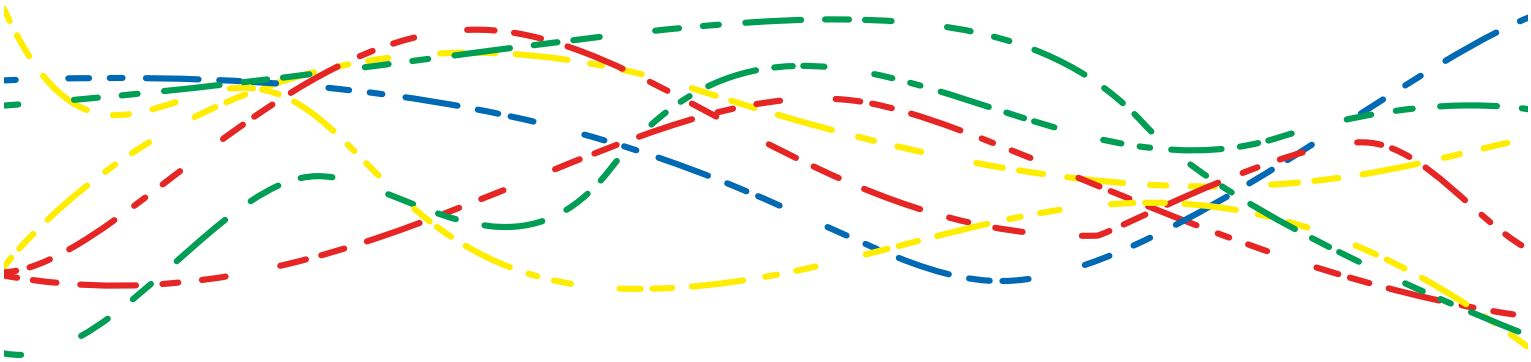
Robin stands for 'Radar Observation of Bird INtensity' and originated in the eighties as a project within the Dutch Research Institute TNO. In cooperation with the Royal Dutch Air Force and later the European Space Agency (ESA), they started developing unique algorithms to use radar for bird strike prevention.

In the summer of 2010 this thirty years of applied science was made available. At that time Robin was spun out to pursue market leadership as an independent company. Robin marked the next generation in the industry by launching its FMCW radar. Since then the company quadrupled in size and wins 8 out of 10 tenders.

In 2012 two funds invested in Robin Radar. The Mainport Innovation Fund comprises of KLM, Schiphol Airport, Rabobank and Technical University of Delft. The other fund is Inkef Capital, a 100% daughter of ABP. With an invested capital of € 292 billion (March 31, 2013), ABP is one of the largest pension funds in the world.

Robin is the only company in the World that is entirely dedicated to bird radars for use in both wind farms and aviation. It's mission is to increase flight safety for humans, bats and birds.

"You can't manage it,.. if you can't measure it."



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