R&S®ARDRONIS

Automatic **R**adio-controlled **Dron**e **I**dentification **S**olution

Countering Drones Early On

2nd Jan 2017

YingSin Phuan
Product Management
Signal Analysis

ROHDE&SCHWARZ

Radio-controlled drones monitoring and countermeasures

Agenda

- Eye in the sky
  - Current trends
  - News and threat scenarios
- Micro-UAVs overview
  - Facts + figures
  - Specifications
- Comprehensive Solution: R&S®ARDRONIS
  - Highlights
  - Key features
  - Applications
  - Competence
  - Marketing strategies
  - Roadmap

Eye in the sky

Current trends – what drones capable for

"Drone Dangers"

Source: CBS News – Government officials are concerned about a surge in drones flying near sensitive sites (AUGUST 4, 2015)

- Drone intended for legitimate purposes are being use increasingly for criminal activities (e.g. cross-border drug smuggling). Public awareness for possible risks has been intensely raised.
- CBS News transportation correspondent Kris Van Cleave reported four drone sightings near airports in the New York metropolitan area within one weekend; these drones are relatively **small** and **very difficult to spot** even if you scan through the entire area.

Eye in the sky

Current trends – how drones are affecting our lives

Drone can smuggle drugs/ weapons …

Mexico, Jan. 2015: a drone carrying > 6 lb. of Meth crashed near the U.S.-Mexican border

Drone can spy on your privacy/ technology …

Drone can interfere with air travel - near collision …

London Heathrow: planes have narrowly missed catastrophic collisions with drones

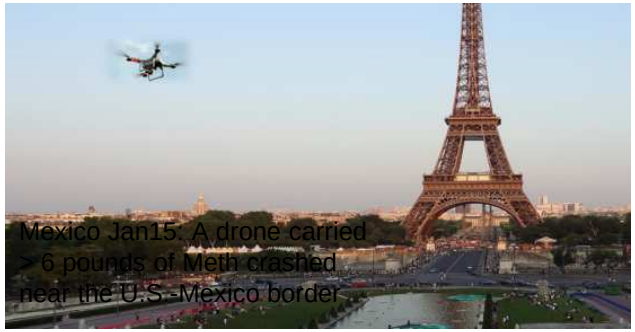
Drone can disturb events and cause harm …

Belgrade, Oct. 2014: Serbia vs. Albania, soccer match canceled after drone used to fly flag over the field incites a riot

Eye in the Sky

Current Trends – how drones are affecting our lives

Drone can endanger public life …



Mexico Jan15: A drone carried > 6 pounds of Meth crashed near the U.S.-Mexico border

Drone can shoot …

Several tests have been carried out. Drones can shoot and kill from the air

Jul. 2015: A video of handgun-firing drone published on YouTube triggers federal FAA probe

Drone can appear at sensitive sites, critical infrastructure and government facilities …

Micro-UAVs overview

Facts + figures

- Affordable, easy to use, capable of carrying payloads of some 100 g to a few kg
- More than 300.000 drones are sold worldwide every month
- The commercial drones market is expected to reach > 8.5 billion euros in global spending by 2025
- Around 0.5 to 1 million drones were sold for Christmas last year in the USA alone

Micro-UAVs overview

Facts + figures

- > 90 % of drones operate in the ISM band (2.4 GHz) using FHSS/DSSS, Wi-Fi or Bluetooth®
- Radio Links:
  - Radio control (RC) of drones (uplink)
  - Telemetry data and/or video (return channel of drones)
- Freq. band:
  - ISM band: 2.4 GHz, 5.8 GHz
  - Rarely in use: 433 MHz, helping to overcome longer distances than with 2.4 GHz
  - Outdated frequencies for RCs: 27 MHz, 35 MHz, 72 MHz (using PCM or analog coding)
- Video data is normally streamed on 2.4 GHz/ 5.8 GHz (ISM), either WiFi or analog PAL/ NTSC
- Safe flights with redundant control systems (e.g. remote control and GPS-based “failsafe” mode)
- Some are equipped with a “first person view” (FPV) solution and additional GPS navigation

Micro-UAVs overview

Specifications

Radio control via FHSS/DSSS	Radio control via Wi-Fi	Radio control via Bluetooth®	Autonomous flight
• **Widespread (> 80 %)** • Range: <1 km (w/o booster); 3 km (with booster) • Some standards include telemetry data (downlink), e.g. Jeti, Graupner	• Range: 80 m to 100 m (up to 2 km with booster) • Some are equipped with a FPV and additional GPS navigation	• Low-cost models • Limited range with approx. 60 m	• Via GNSS (predefined waypoints)

DJI Phantom

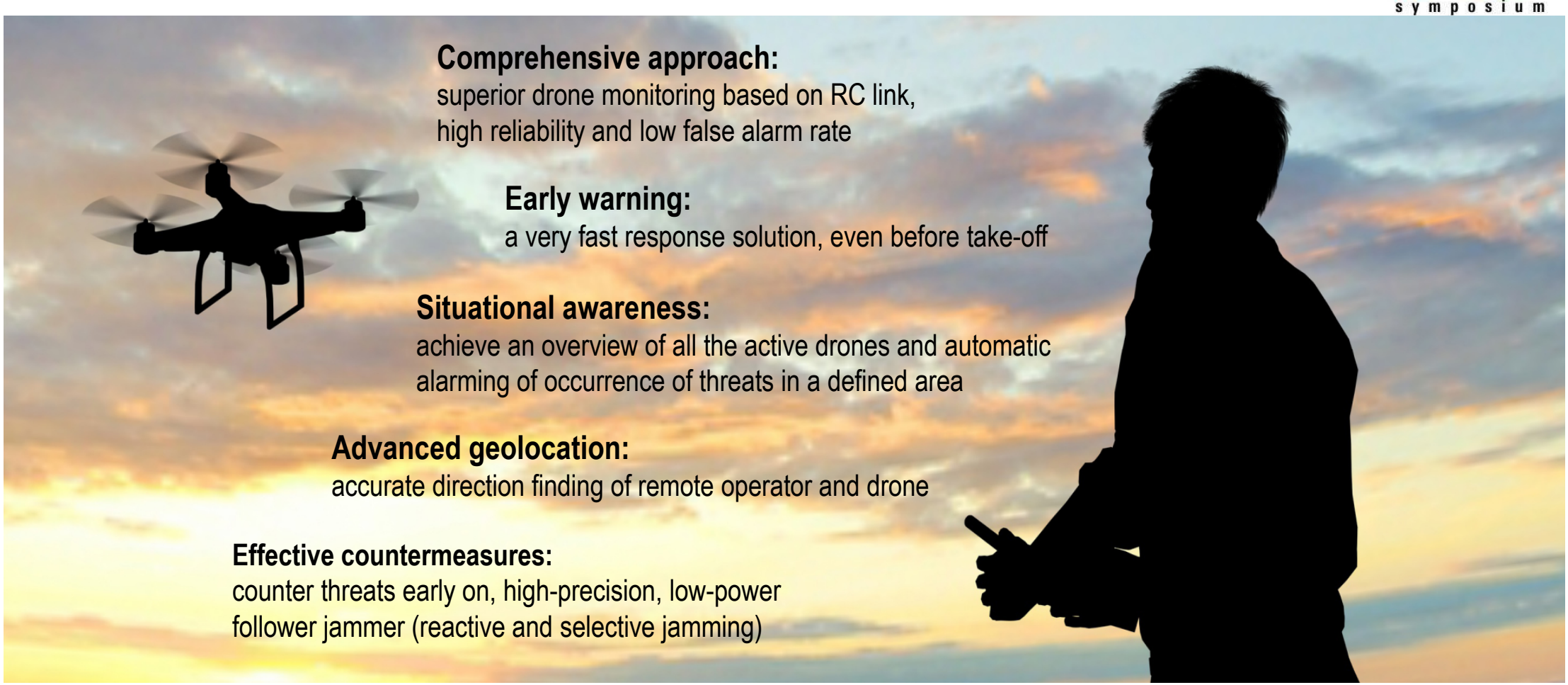
Yuneec Typhoon

Parrot Bebop

Walkera QR W100S

Hexo +

R&S®ARDRONIS highlights



Comprehensive approach:
superior drone monitoring based on RC link,
high reliability and low false alarm rate

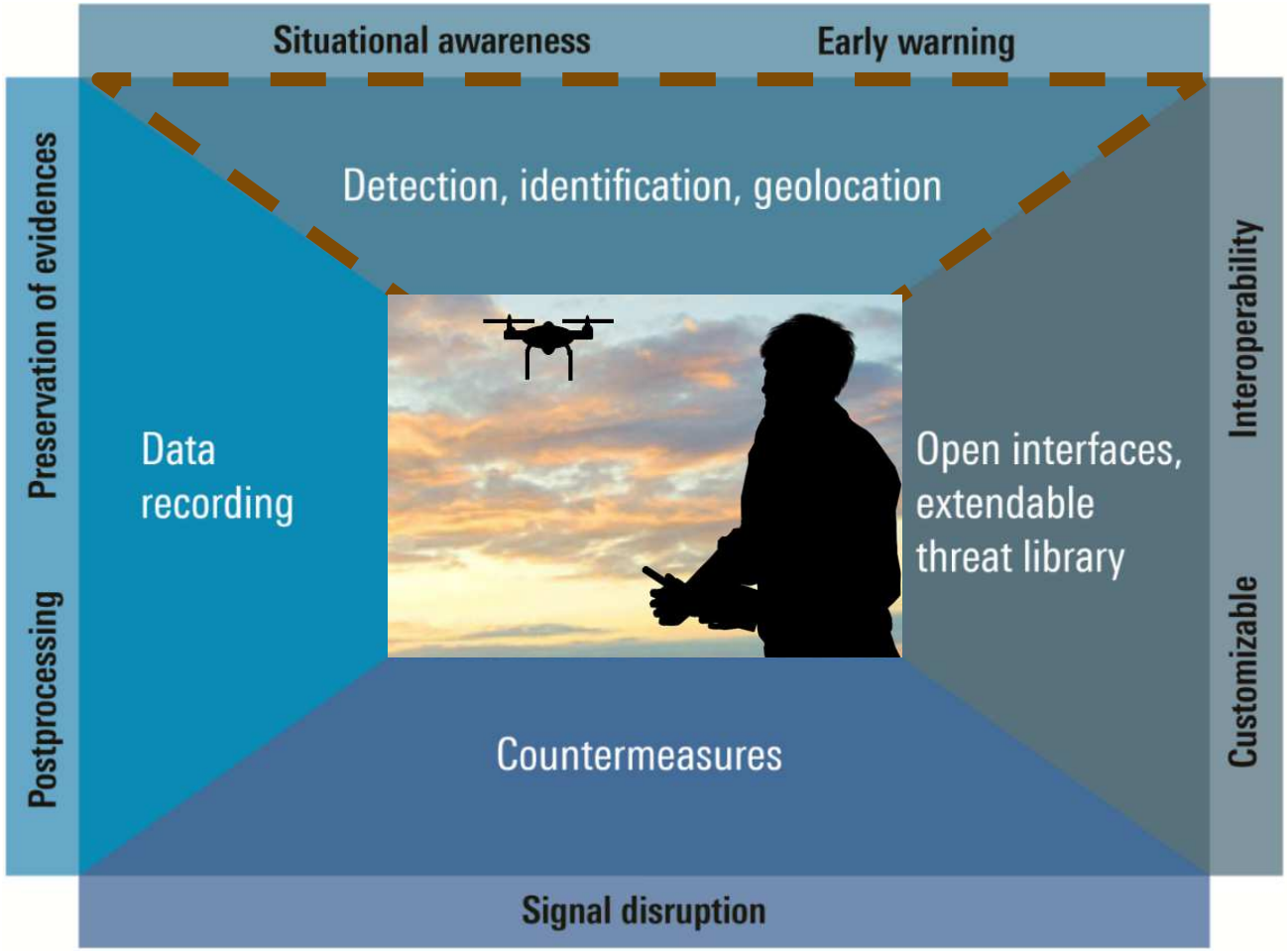
Early warning:
a very fast response solution, even before take-off

Situational awareness:
achieve an overview of all the active drones and automatic alarming of occurrence of threats in a defined area

Advanced geolocation:
accurate direction finding of remote operator and drone

Effective countermeasures:
counter threats early on, high-precision, low-power follower jammer (reactive and selective jamming)

R&S®ARDRONIS - automatic radio-controlled drone identification solution



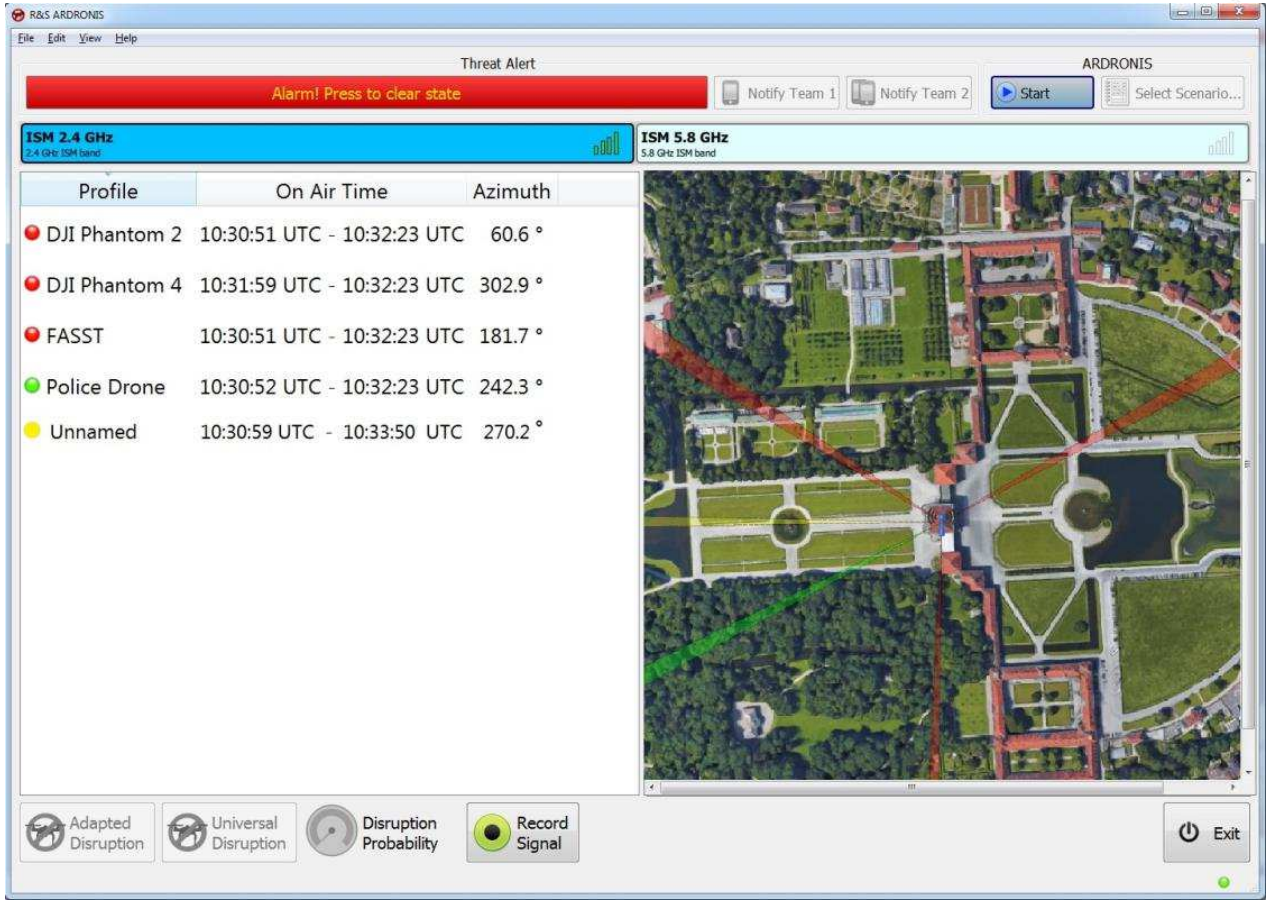
R&S®ARDRONIS Mission!

- A comprehensive, reliable solution to counter threats arising from FHSS/DSSS and Wi/Fi controlled drones
- Detection, identification, direction finding, locating, recording and jamming
- A highly automatic integrated operational workflow

Highly automatic integrated operational workflow

Key features

- High level of automation
- Ergonomically designed, easy-to-use GUI
- Automatically triggered alarm/ notification when RC profiles are being detected and display of the video link
- Automatically check for video downlinks once a remote control has been identified

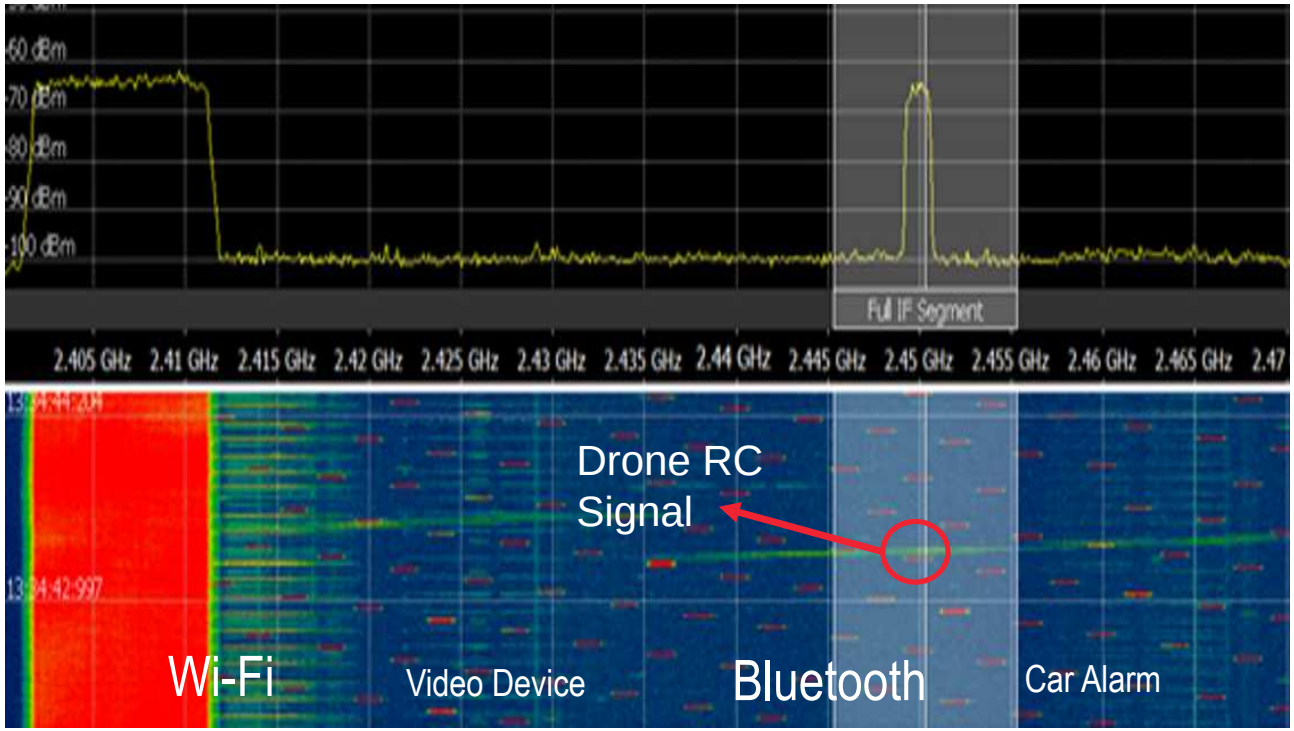


User friendly R&S®ARDRONIS GUI

Effective detection and identification

Key features

- Monitoring the spectrum for RC signals
  - **Automatic sequencer:** automatically step through a list of (predefinable) frequency bands, e.g. 433 MHz, 2.4 GHz, and 5.8 GHz
  - **Smart search:** find the best analysis window for ideal detection within congested ISM band
- Powerful FHSS detector for RC signals, hop analysis, classification of hop parameters with the minimum hop duration = 350 µs
- Automatic identification and classification based on defined profiles based on hop parameters (e.g. hop-length, mod. type or symbol rate)
- Reliable separation of drone RC signal among other hopping devices even in the congested ISM band with other communication signals



Densely occupied ISM Band

Effective detection and identification

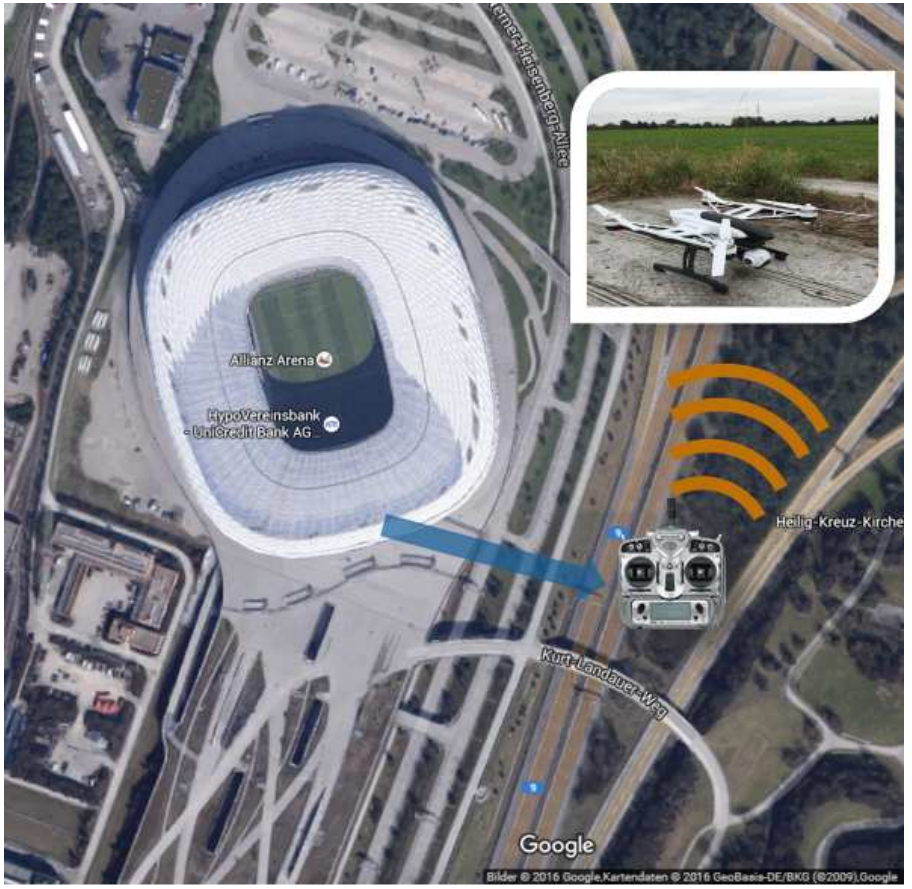
Key features

- Detection coverage is tentatively the distance covered by the radio control link under the similar propagation conditions (depending on power)
  - Remote control with 100 mW (EU Standard): ~1 km
  - Remote control with booster: ~3 km
- Display video link if transmitted via PAL/ NTSC and Wi-Fi
- Automatic identification based on defined profiles (with the relevant RC technical parameters). The identification result can be sorted into :
  - Black list (i.e. threat)
  - White list (i.e. owned drones)
  - Unnamed (i.e. new/ unknown drones)

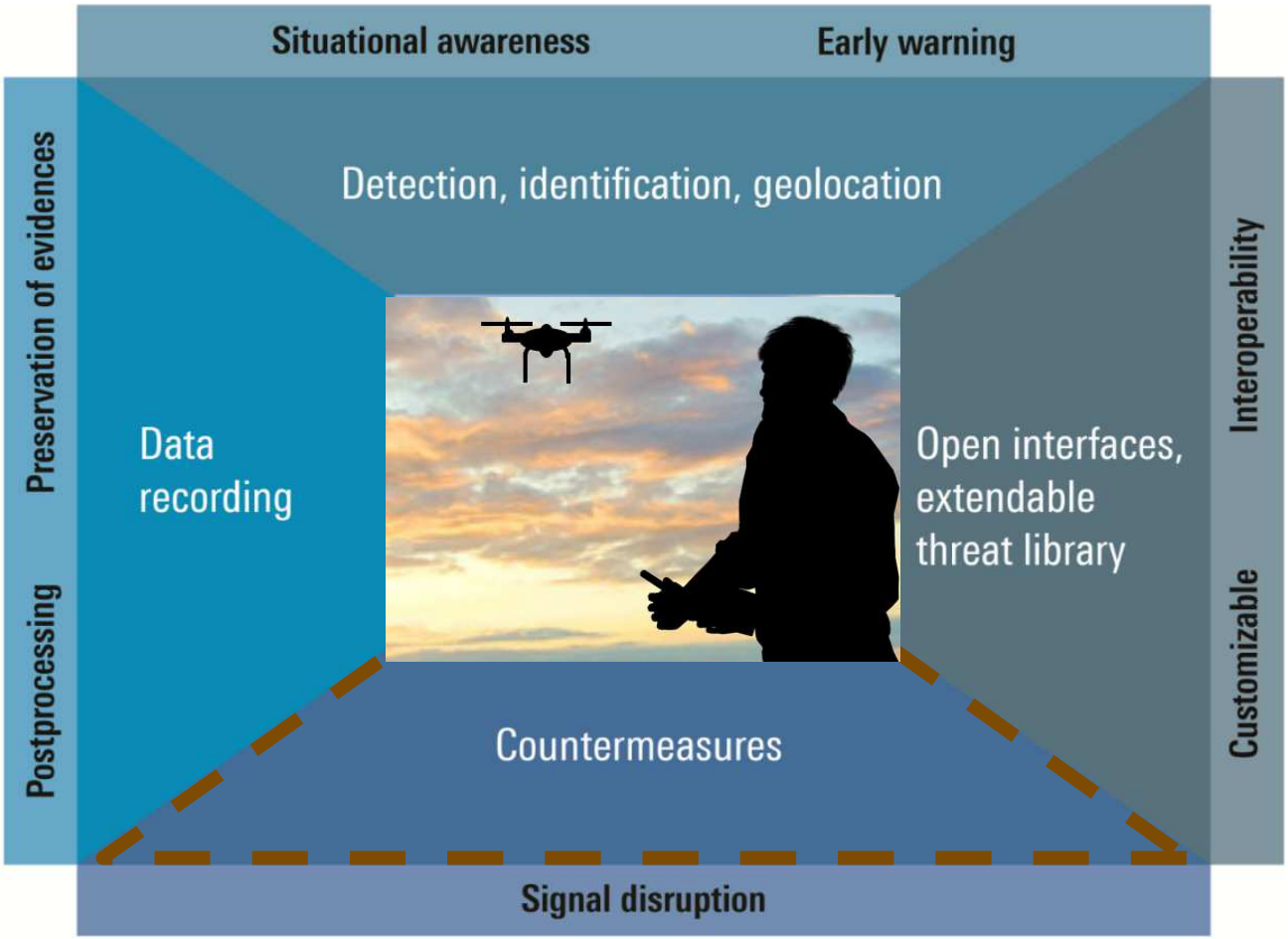
Accurate direction finding

Key features

- Direction finding of the remote control operator and drone, depending upon the existing up- and downlink
  - Remote control operator (uplink)
  - Drone (telemetry downlink/ video link)
- Advanced DF antenna: multi-element direction finding antennas with superior DF accuracy, sensitivity and immunity to reflections
- High performance DF: the fast DF scanning, bearings of targets can be taken in several frequency ranges simultaneously
- The wideband direction finder allows fast, automatic direction finding of FHSS signals with high probability of intercept



R&S®ARDRONIS - automatic radio-controlled drone identification solution



Countermeasures

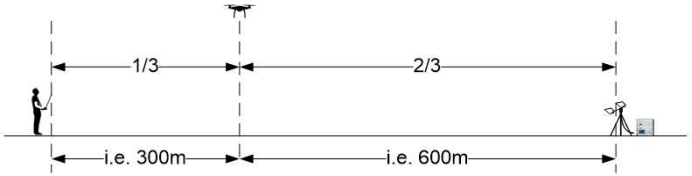
Key features

- The aim is to disrupt the connection between the remote control and the drone
- Most drones have a selectable “failsafe” mode in case they lose their control signal, this “failsafe” mode can be:
  - Safe landing at current position (i.e. controlled landing)
  - Return to home (i.e. power on position or remote control position) – GPS guided
  - Reprogram to a fix position
- For FHSS/DSSS controlled drones: every single signal burst contains the full control information, thus each single burst will be jammed
- For Wi-Fi controlled drones: the Wi-Fi connection will be interrupted

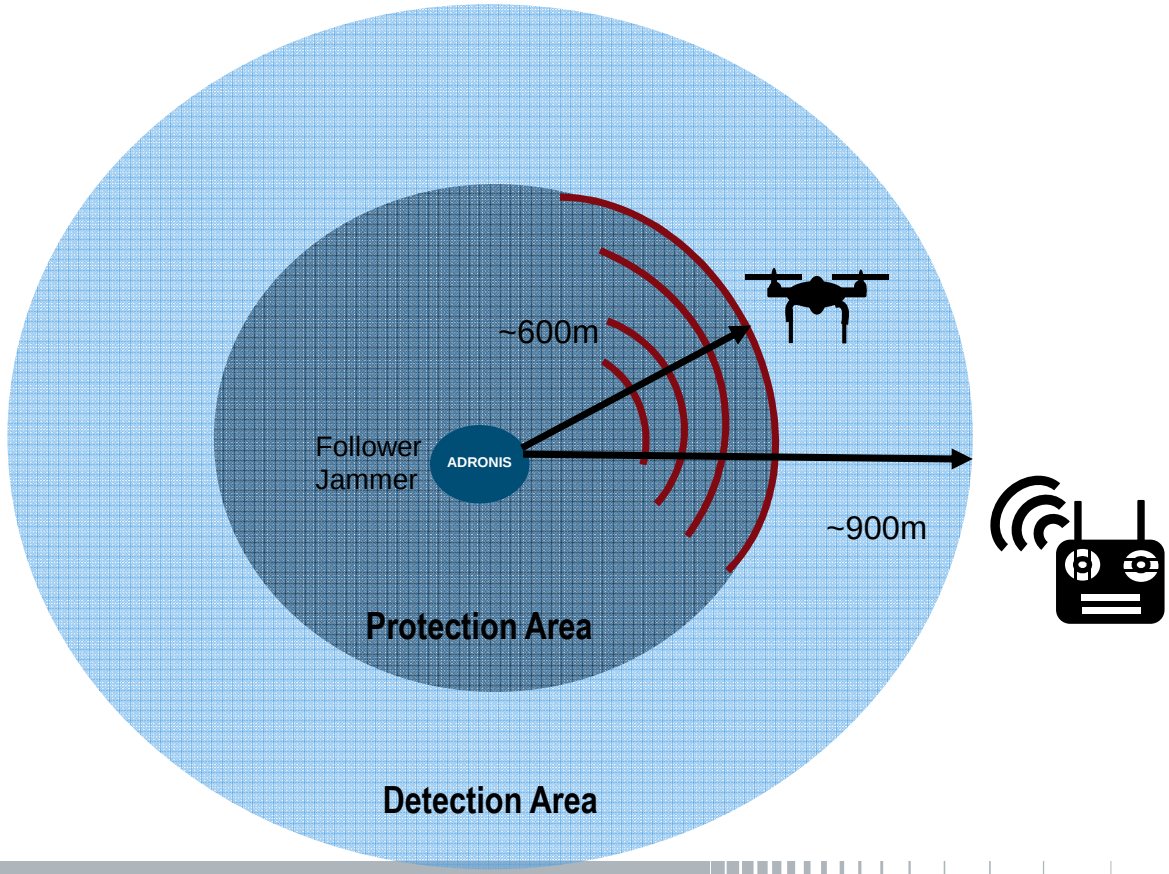
Countermeasures

Key features

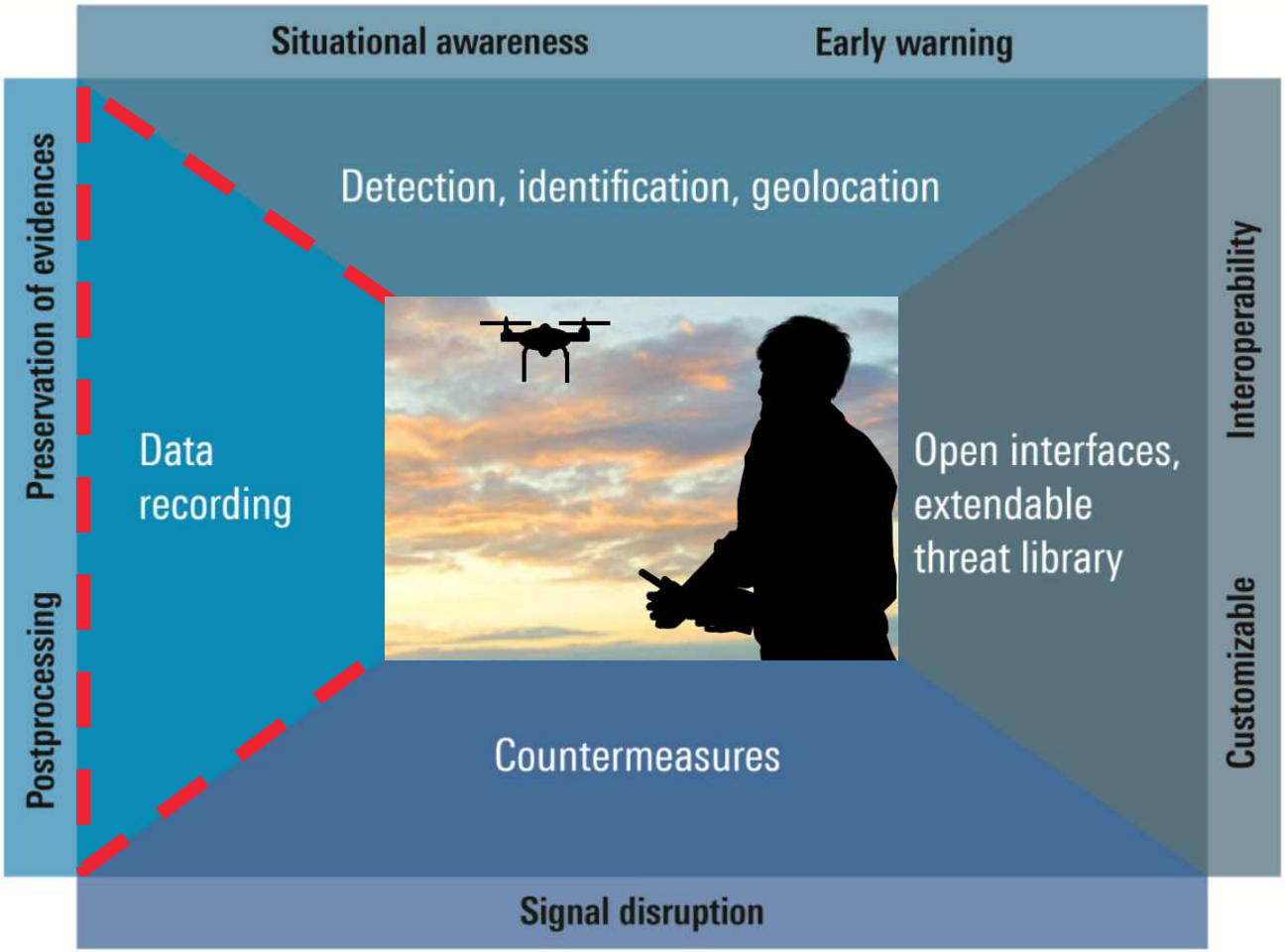
- Highly effective, fast and reliable jamming of every single RC hop (signal disruption) with low power output ~500 mW until 2x 2 W
- Follower jammer technology (reactive and selective jamming) with no disturbance of other communications signals within the same ISM band (e.g. Wi-Fi, Bluetooth®), complementing the barrage jammer
- The profile of all identified RC signals will be automatically configured to the jamming solution
- Default: “Universal profile” working well in 2.4 GHz ISM band or upload of a specific profile
- Successfully demonstrated to and selected by German authorities as effective countermeasure for different radio controlled drones (FHSS)



With this low power approach (500 mW), jamming is possible from about 2/3 of the distance to the remote control under line-of-site conditions



R&S®ARDRONIS - automatic radio-controlled drone identification solution



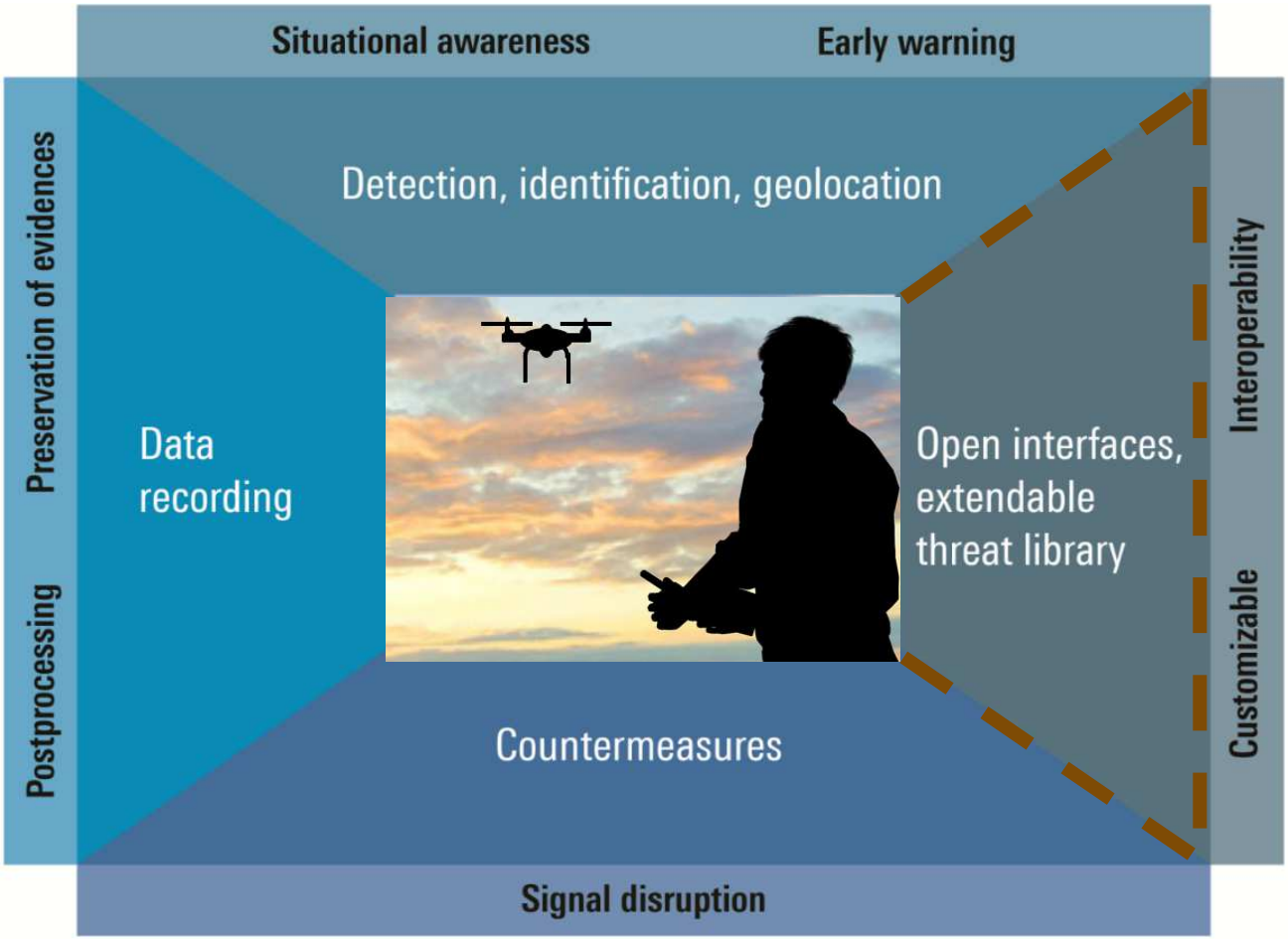
Preservation of evidence

Key features

- Data recording (an automatic smart-recording solution) that makes it possible to collect evidence:
  - Recording of complete scenario (WB)
  - Recording of individual burst (NB)
  - Recording of event log file
  - Recording of video image
- Optional postprocessing:
  - Detailed technical analysis of the remote control used, after identification of the radio events
- Decoding of the video downlink PAL/ NTSC and Wi-Fi
- Achieving the position of the remote operator

Collection of evidence

R&S®ARDRONIS - automatic radio-controlled drone identification solution

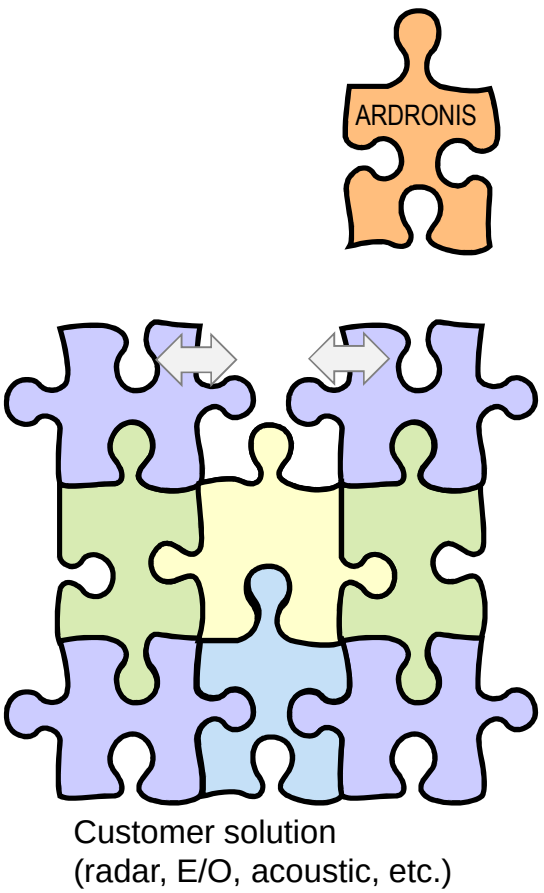


Open interface, extendable threat library

Key Features

- Open Interface, customizable and interoperable
  - XML interface allows integration into third-party solution
  - Users can integrate R&S®ARDRONIS into their custom approach, e.g. radar, E/O (electro-optical), infrared, acoustic

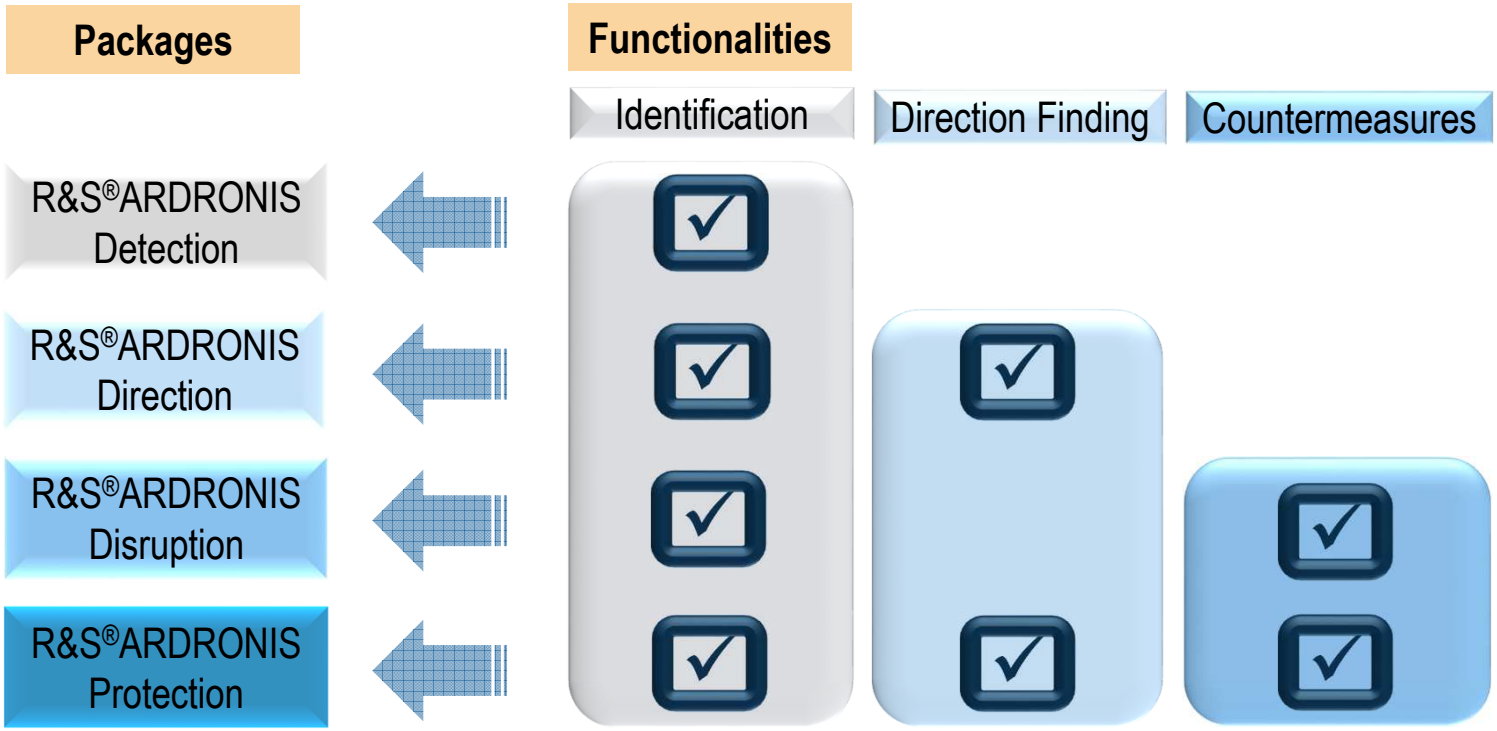
- Extendable database/ threat library
  - The profile library of remote control is constantly extended
  - The library can also easily be extended by the operator by training the new profile



R&S®ARDRONIS

Applications

- The key functionalities of R&S®ARDRONIS include: identification, direction finding and countermeasures
- These functionalities are categorized in four packages to meet users' specific technical requirements



- Identification
- Identification + direction finding
- Identification + countermeasures
- Identification + direction finding + countermeasures

R&S®ARDRONIS

Configuration/ setup

Packages	Functionalities
R&S®ARDRONIS Detection	Identification
R&S®ARDRONIS Direction	Identification + direction finding
R&S®ARDRONIS Disruption	Identification + countermeasures
R&S®ARDRONIS Protection	Identification + direction finding + countermeasures

Configuration

R&S®ARDRONIS competence

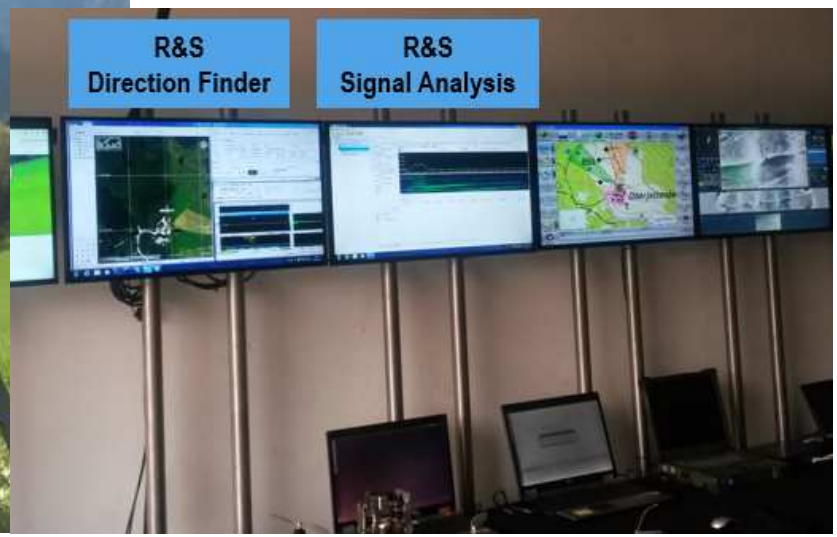
Successful trials

Successful trials

Rohde & Schwarz carries out various live demos/ field trials

- Multiple real-threat scenarios in cooperation with German authorities
- Trial for French police

Anti-drone technology trial:
May 4, 2015, in Germany



R&S®ARDRONIS competence

Protecting an important event

Committed events

Rohde & Schwarz has successfully provided a counter-drone solution in real scenarios

- Protection of important summit and VIP event at Schloss Elmau, G7 Summit (June 2015)

R&S®ARDRONIS competence

Protecting a VIP, US President Barack Obama

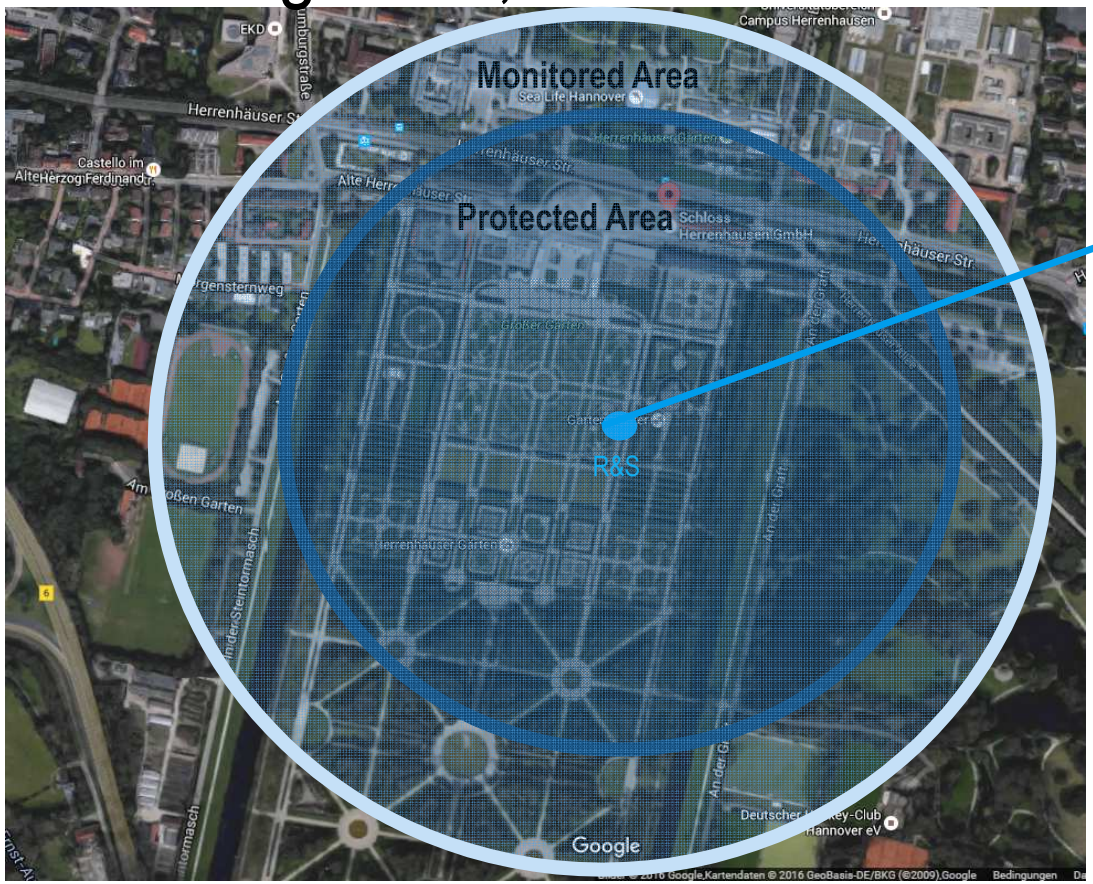
Rohde & Schwarz made a valuable contribution to the security of President Obama during his visit to Schloss Herrenhausen, Hannover (April 24, 2016)

Committed events

- Countering any unforeseen security risk caused by drones during important event

R&S®ARDRONIS competence

Protecting a VIP, US President Barack Obama



R&S®ARDRONIS marketing strategies

Market opportunities

The commercial UAV (drones) market expected to reach over **8.5 billion** euros in global spending by 2025

> 300,000 Radio-Controlled Micro Drones are sold worldwide every month

From a statistic conducted in USA (2012-2015):

- >500 incidents in sensitive sites and critical infrastructure
- 2 incidents at nuclear reactors, materials and waste facilities
- 15 incidents at Department of Defense installations
- 28 incidents at locations related to energy
- 62 incidents at unidentified government facilities

There is an **urgent** need for drones monitoring and countermeasures solution in the market.

The targeted market opportunities are:

- Airport security
- Protection of important and public events (i.e. summit meeting, VIP event, crowded festival)
- Industrial facilities (i.e. high-tech industries, IP protection company, private building)
- Governmental facilities and sensitive sites
- Protection of sport venues (i.e. stadium, indoor arena)

R&S®ARDRONIS marketing strategies

AOC Webinar

Protecting the Sky: Threats of Micro-UAVs

Thursday, May 19, 2016 8:00:00 PM CEST - 10:00:00 PM CEST

Protecting the Sky: Detection, Direction Finding, and Countermeasure for Threats Imposed by Radio-Controlled Micro-UAVs

WEBINAR DETAILS

Today, more than 300,000 Radio-Controlled Micro Unmanned Aerial Vehicles (commonly referred to as "drones") are sold worldwide every month. It was expected that around 500,000 to 1 million micro-drones were to be sold for Christmas last year in the US alone. The increasing amount of affordable civilian drones capable of carrying payloads of some 100g up to a few kg leads to an emerging threat ranging from simple disturbances (privacies), spying or even incur severe destructions (terror attacks). These might include disturbing public events, important summits, endangering air traffic (drone sighting near airport), threatening governmental facilities, sensitive sites, industrial facilities (i.e. high-tech industries) as well as illegal smuggling contraband into correctional facilities and cross border.

Speaker

Yingsin Phuan

Yingsin Phuan currently works as Product Manager for signal analysis products at Rohde & Schwarz in Munich. In her current role she is responsible for the entire signal interception workflow, from online signal monitoring solutions to offline technical signal analysis solutions.

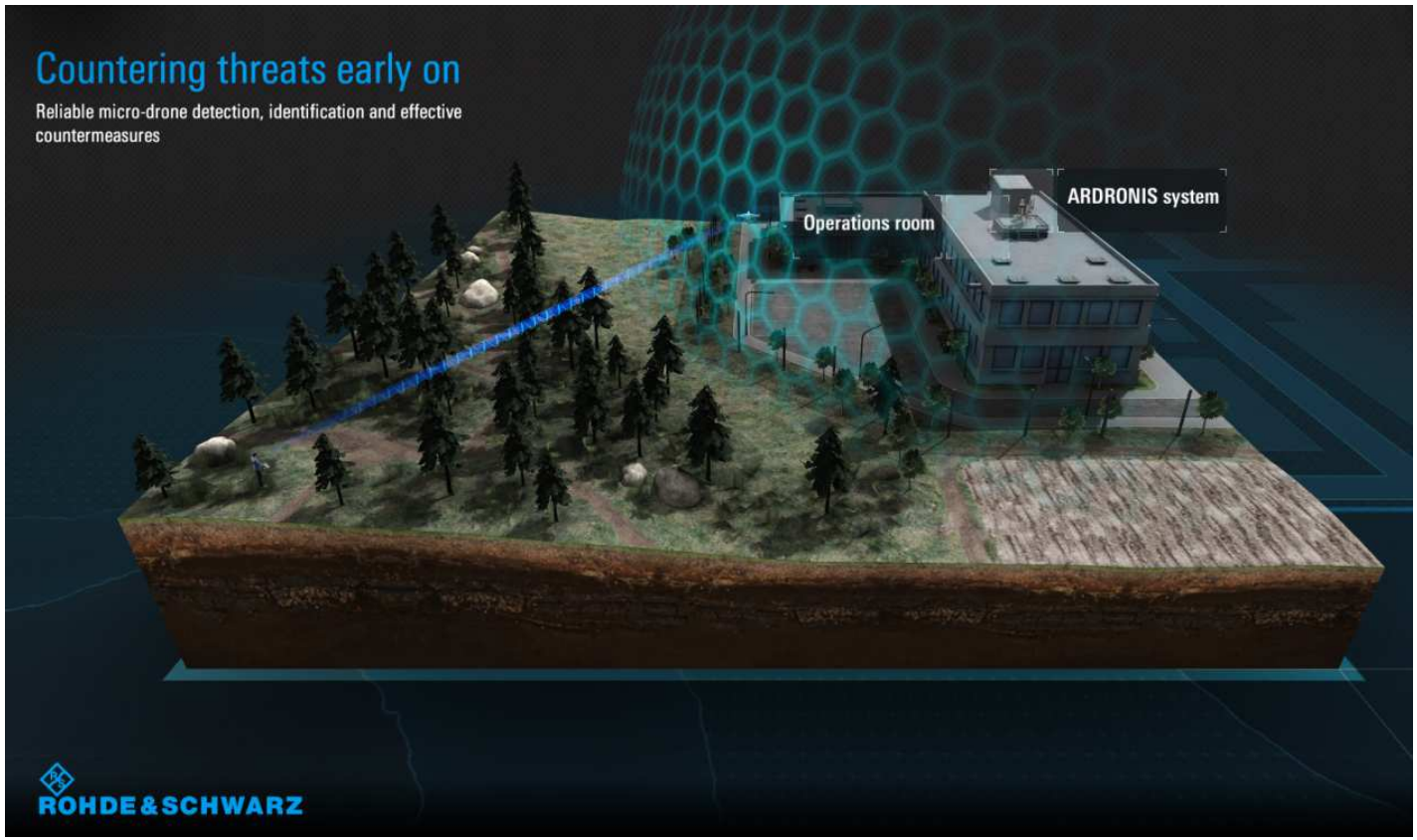
Phuan holds a Master of Science in Communications Engineering from Technological University of Munich, and double Bachelors degrees in Electronics Engineering/ Business from Nanyang Technological University, Singapore

Know more

- In the seminar, the technical approach for countering the threats posed by drones to protected environments was explained:
  - Monitoring the spectrum for relevant signals
  - Identification and classification of frequency agile RC signals
  - Direction finding
  - Possible defensive countermeasures
- Great response to AOC webinar, with more than 473 registered participants
- Overwhelming Q&A section, with 53 questions
- Webinar Link

R&S®ARDRONIS marketing strategies

RS interactive demo module

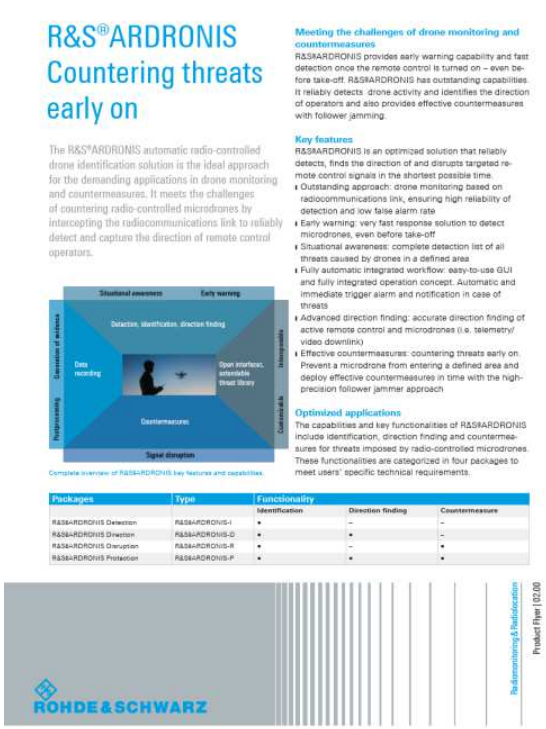


- The interactive presentation illustrates customer scenarios, visualizes the typical applications and also shows our competence about R&S®ARDRONIS
- Navigation “Monitoring&Surveillance => Spectrum Monitoring => Drone Detection”, which includes:
  - 4 chapters: detection, direction finding, disruption and overview
  - Operation rooms: key features
  - R&S®ARDRONIS system: descriptions in four packages
- The current software version can be downloaded in the sales web or obtained from 8VT6

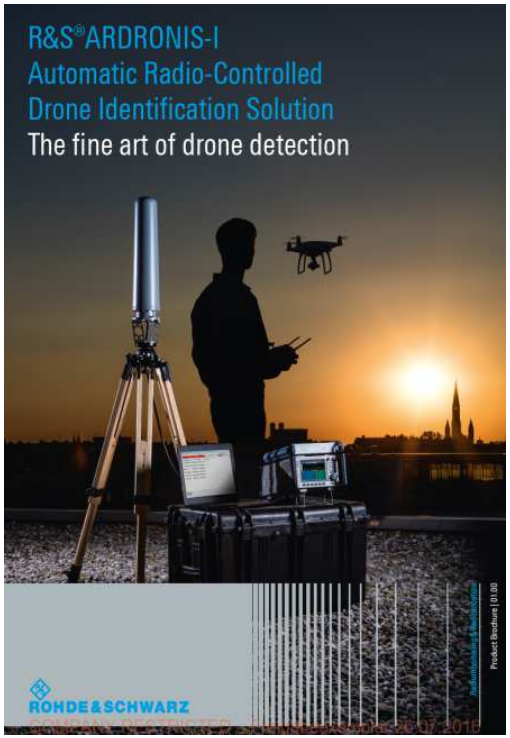
R&S®ARDRONIS marketing strategies

Sales tools

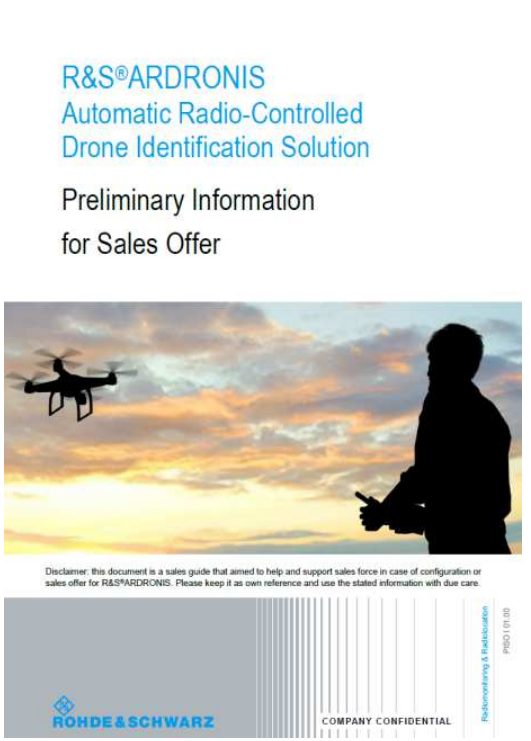
Product Flyer



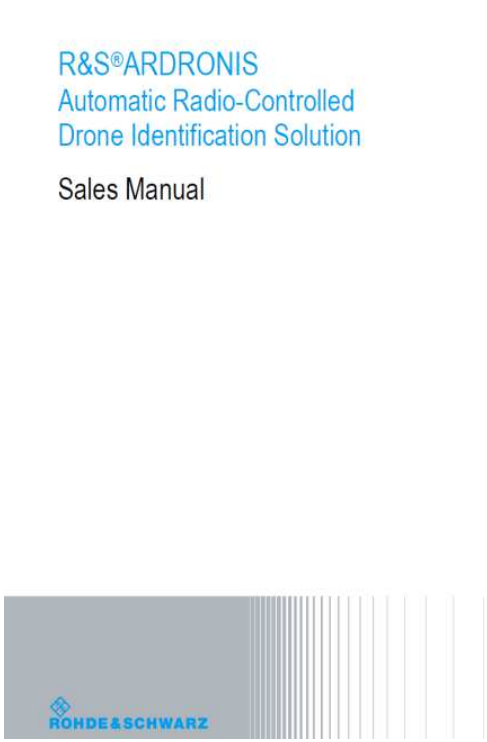
R&S®ARDRONIS-I Brochure



Preliminary Info (PISO)



Sales Manual - FAQ



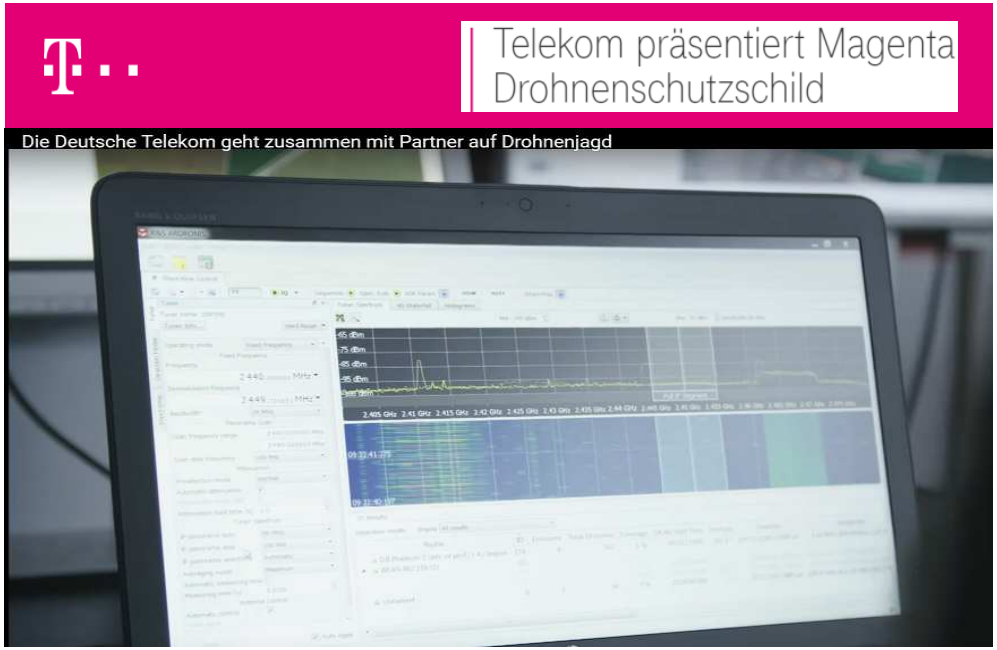
* Product flyer is now available in the sales web. Various sales tools will be made available soon.

R&S®ARDRONIS marketing strategies

Publication

- **Video:**
  - Danger from the air? ESG presented the Drones Defense System integrated together with R&S®ARDRONIS (Link)

- Telekom has selected Rohde & Schwarz! Germany's Deutsche Telekom is to launch a drone defense system this year designed to guard airports, stadiums, car test tracks and critical infrastructure (Link)



R&S®ARDRONIS marketing strategies

Publication

- **Press release:**
  - INDO DEFENCE 2016: Counter-microdrone solution enhances Rohde & Schwarz portfolio of communications and intelligence systems (Link)

ROHDE&SCHWARZ

press RELEASE

INDO DEFENCE 2016: Counter-microdrone solution enhances Rohde & Schwarz portfolio of communications and intelligence systems

At the 7th INDO DEFENCE in Jakarta, Rohde & Schwarz will demonstrate its comprehensive portfolio of integrated communications and radio reconnaissance solutions. The R&S ARDRONIS counter-microdrone solution from the German electronics company will be presented for the first time in Asia. The system enables users to identify microdrone control signals early on, and locate the drone's operator and disrupt the control link. Another highlight to be showcased at INDO DEFENCE is R&S NAVICS, a new, VoIP-based switching system for naval communications that offers innovative technology and a state-of-the-art, intuitive user interface.

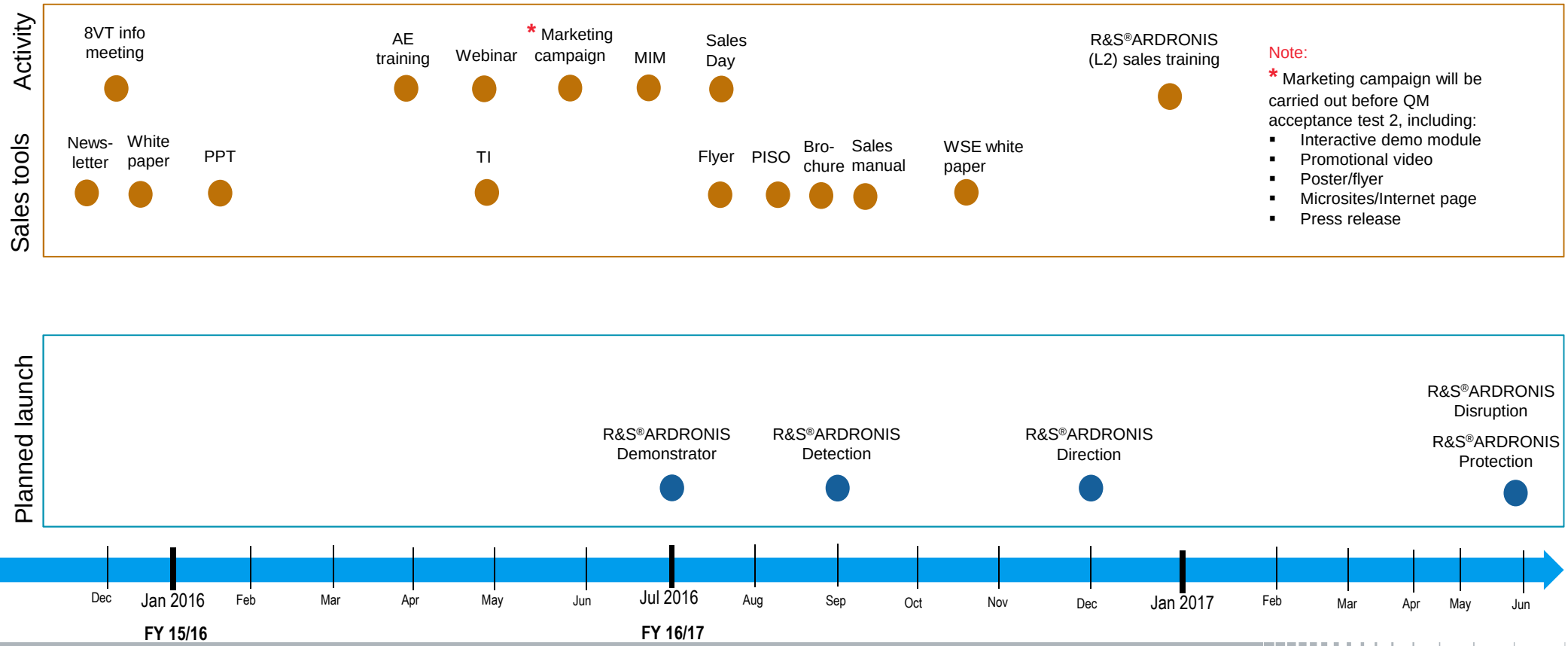
Munich, October 26, 2016 — In Jakarta, Rohde & Schwarz will present itself as a single-source supplier of integrated solutions for secure communications and radio intelligence. R&S ARDRONIS is an innovative solution for microdrone communications detection and disruption. In addition to effectively counteracting microdrone activity, this solution also offers the capability of integration into higher-order networked systems or flexible security systems. The threats arising from drones affect, for example, critical infrastructures, VIPs and public events. They range from violation of privacy and industrial espionage to severe attacks. For example, drones can interfere with air traffic control (ATC) signals, seriously jeopardizing airport safety. The R&S ARDRONIS solution is optimized for countering the threats arising from radio-controlled microdrones.

- Protection of G7 summit and President Barack Obama: Detect and defend against radio-controlled drones with R&S ARDRONIS from Rohde & Schwarz (Link)

R&S®ARDRONIS marketing strategies

Planned timeline

Marketing strategies



R&S®ARDRONIS roadmap

Ongoing developments and continuous feature extensions with the planned availabilities:

- Automatic sequencer via automatic search for RC signals by sequentially stepping through all the relevant frequency bands (Q4 2016)
- Decoding of video downlink, which includes PAL/ NTSC and Wi-Fi (Q2 2017)

Designation	Type	Planned Availability*	Remarks
Packages			
R&S®ARDRONIS Detection	R&S®ARDRONIS-I	Q3 2016	
R&S®ARDRONIS Direction	R&S®ARDRONIS-D	Q4 2016	
R&S®ARDRONIS Disruption	R&S®ARDRONIS-R	Q2 2017	Wideband smart exciter (R&S®WSE)
R&S®ARDRONIS Protection	R&S®ARDRONIS-P	Q2 2017	Wideband smart exciter (R&S®WSE)
Options			
Wi-Fi option	R&S®ARDN-WF	Q2 2017	Detection, DF of Wi-Fi controlled drones
Location option	R&S®ARDN-LC	Q2 2017	Control of multiple stations

* Planned availability is subject to change.

R&S®ARDRONIS
Introduction

Thank you for your time,
and for your attention!