HEADS UP

November 2016

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Agenda

- About Robin Radar...
- About Drones...
  - Capabilities
  - Threats
  - Counter measures

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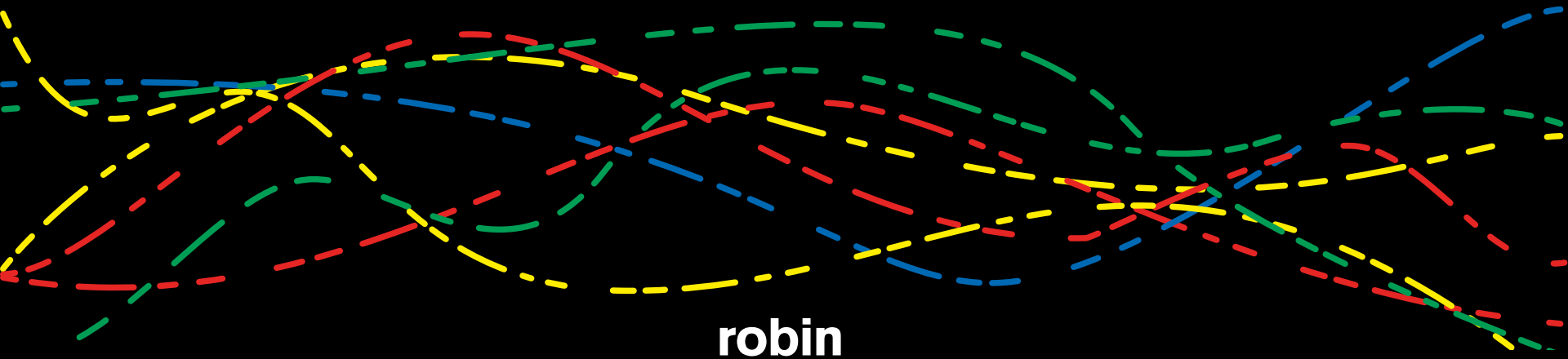
ABOUT ROBIN

Detection of Small Targets



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Shareholders in Robin

Amsterdam Airport Schiphol

KLM

TU Delft

Rabobank

ABP

Installed Base - 2015

- Amsterdam Schiphol Airport
- Eindhoven Airport
- Royal Netherlands Air Force, Wier
- Royal Netherlands Air Force, Millingen
- Imares, Zandmotor
- Test Location I, Maasland
- Test Location II, Robin Radar Office

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Installed Base - 2016














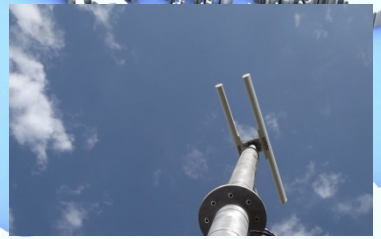


Detection, tracking and classification
of small non-cooperative targets
by combining affordable radars
with smart software

BIRD MONITORING IN WINDFARMS

BIRD STRIKE PREVENTION IN AVIATION

DRONE DETECTION IN SECURITY

...into Drone Detecton

2014 In preparation of the Nuclear Summit, existing counter measures are tested,...with disappointing results

2015 The Ministry of Justice calls for solutions. 38 companies respond. Robin Radar Systems becomes nr 1

Initial operations to protect world leaders during the G7 in Elmau, Germany

2016 Launch of “Elvira” Drone Detection Radar

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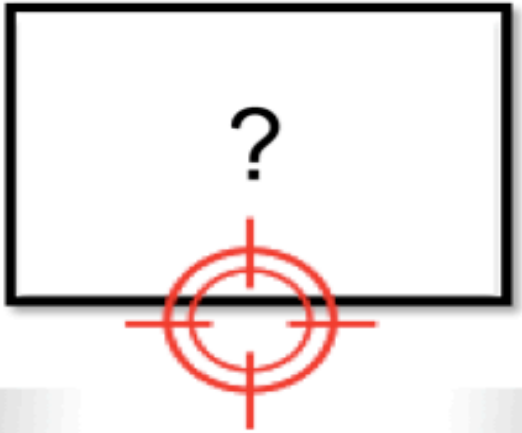
Positioning

PERSONAL
DRONE DETECTION SYSTEMS

PROFESSIONAL
DRONE DETECTION SYSTEMS



MILITARY
DRONE DETECTION SYSTEMS

LOW END SOLUTIONS

HIGH END SOLUTIONS

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Specifications

Detection range: 3 – 9 km
Classification range: 1.100 meter
Beam width: 10° x 10°
Azimuth resolution: 1°
Range resolution: 3,2 meter
Technology: FMCW
Frequency: X Band 9650 MHz
Power (EIRP): 4 Watt
Rotation speed: 45 RPM, update rate 0,75 Hz
Size (W*D*H): 0,9*0,9*0,8 meter (excl foot)
Weight: 83 kg
Power: 230 VAC
Communication: Ethernet

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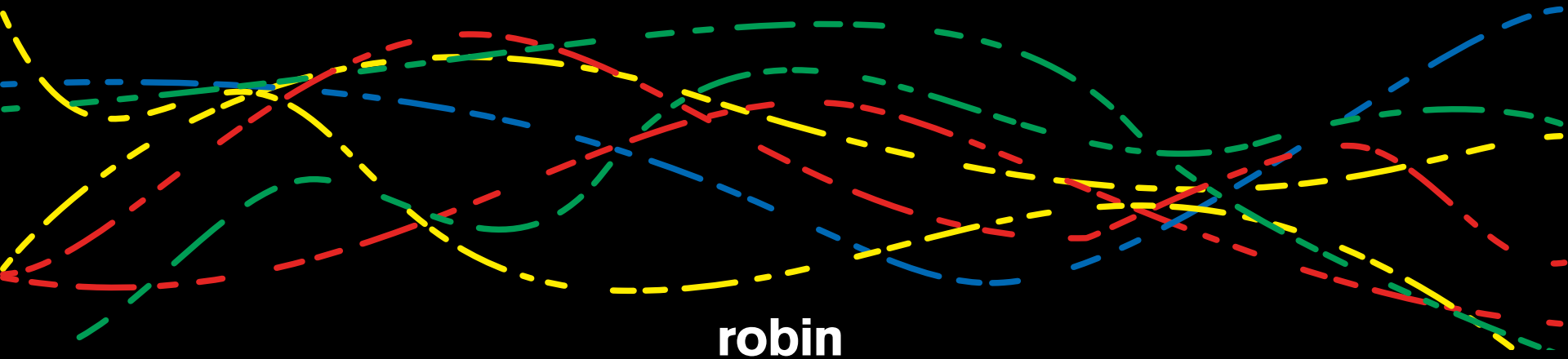
CAPABILITIES

what drones can do these days...



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Drones have become...

- Affordable
- Rapidly improving
- High Tech sensor platforms
- Easy to get
- Easy to fly

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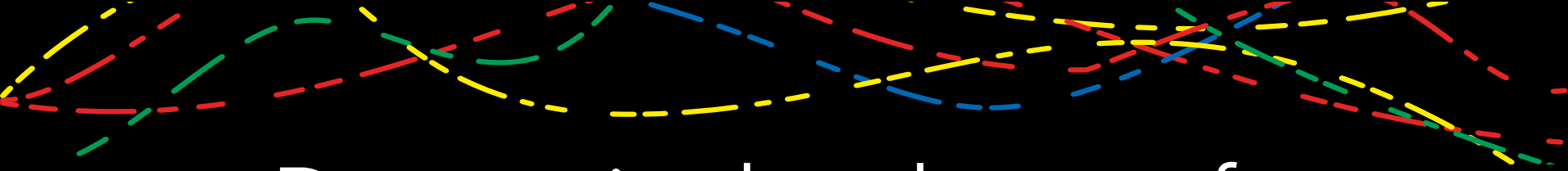
World wide

..... 'e

sold…

e v e r y month



Drones in the shape of...

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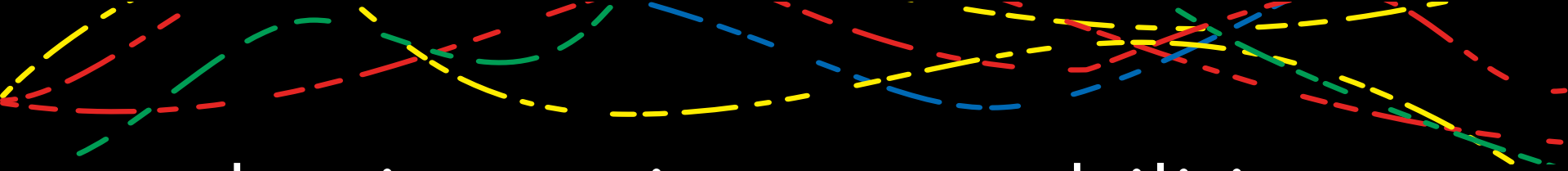

..having unique capabilities..

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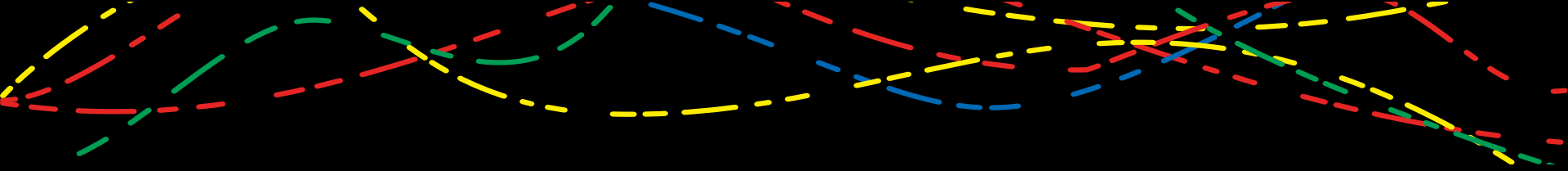

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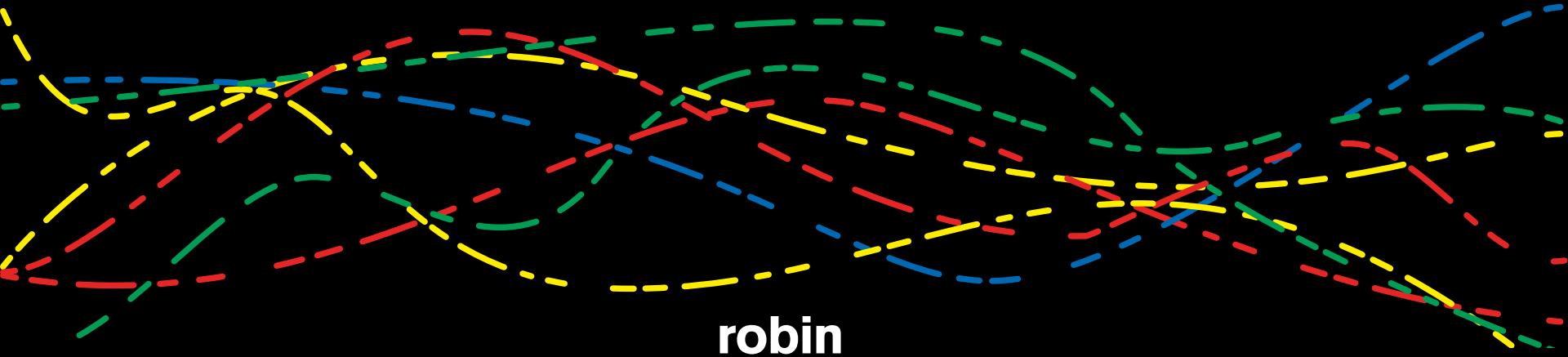
THREATS

what drones can do these days..



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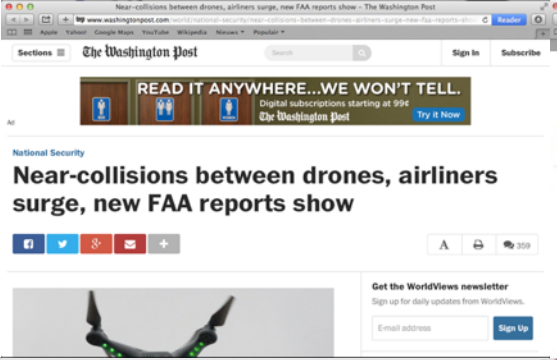
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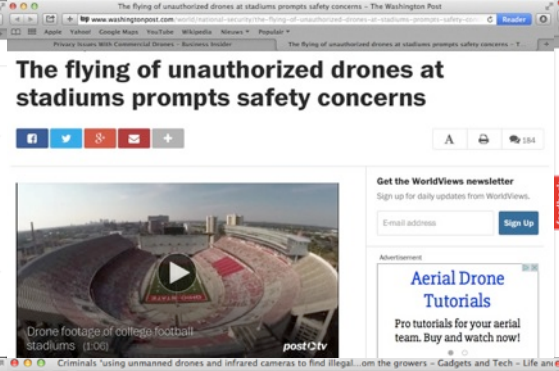
The flying of unauthorized drones at stadiums prompts safety concerns
Drone footage of college football stadiums (1:00)
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TECHNOLOGY
ONE-MINUTE READ
Drones being used 'to harass people and commit crime'
123inkt.nl
Police warn that unmanned drones are already being used for 'nefarious purposes'
Unmanned drones are raising privacy and security concerns as police


The Telegraph
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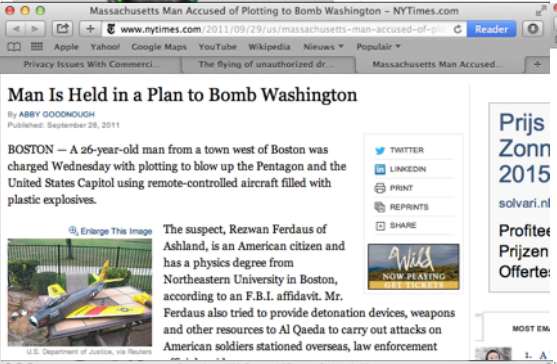
Students 'planned terror attack using remote control planes'
Police have carried out raids in Germany and Belgium targeting a suspected Islamist plot by aeronautics students at the University of Stuttgart to use remotely controlled planes for a terrorist attack.


Massachusetts Man Accused of Plotting to Bomb Washington – NYTimes.com
www.nytimes.com/2011/09/29/us/massachusetts-man-accused-of-pl
Man Is Held in a Plan to Bomb Washington
By ABBY GOODNOUGH
Published: September 28, 2011
BOSTON — A 26-year-old man from a town west of Boston was charged Wednesday with plotting to blow up the Pentagon and the United States Capitol using remote-controlled aircraft filled with plastic explosives.
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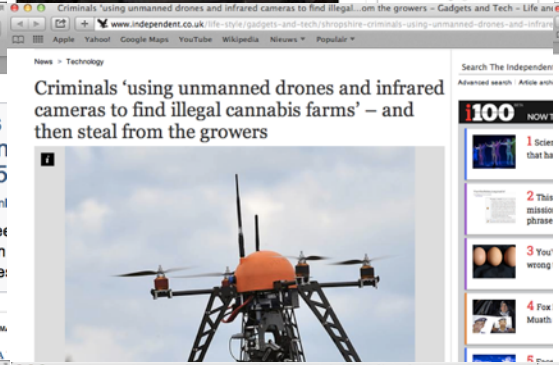
U.S. Department of Justice, via Reuters
The suspect, Rezwan Ferdaus of Ashland, is an American citizen and has a physics degree from Northeastern University in Boston, according to an F.B.I. affidavit. Mr. Ferdaus also tried to provide detonation devices, weapons and other resources to Al Qaeda to carry out attacks on American soldiers stationed overseas, law enforcement


Criminals 'using unmanned drones and infrared cameras to find illegal...om the growers – Gadgets and Tech – Life and
www.independent.co.uk/life-style/gadgets-and-tech/shropshire-criminals-using-unmanned-drones-and-infrar
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Criminals 'using unmanned drones and infrared cameras to find illegal cannabis farms' – and then steal from the growers
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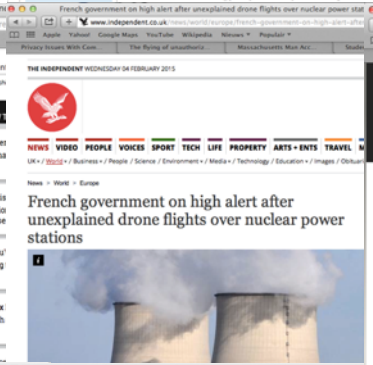
French government on high alert after unexplained drone flights over nuclear power stat
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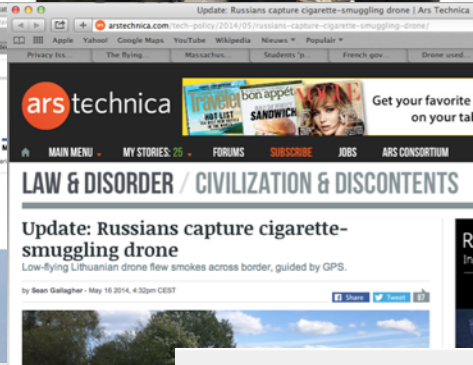
French government on high alert after unexplained drone flights over nuclear power stations


Update: Russians capture cigarette-smuggling drone | Ars Technica
arstechnica.com/tech-policy/2014/05/russians-capture-cigarette-smuggling-drone/
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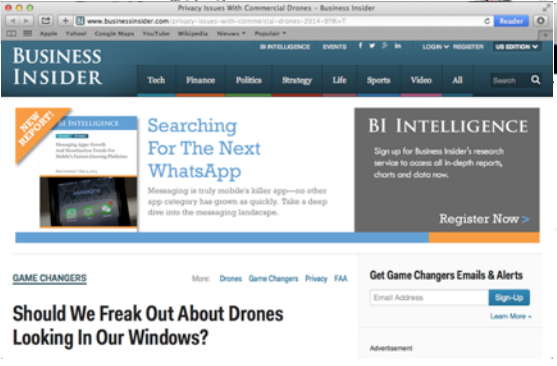
Update: Russians capture cigarette-smuggling drone
Low-flying Lithuanian drone flew smokes across border, guided by GPS.
by Sean Gallagher - May 16 2014, 4:32pm CEST


Privacy Issues With Commercial Drones – Business Insider
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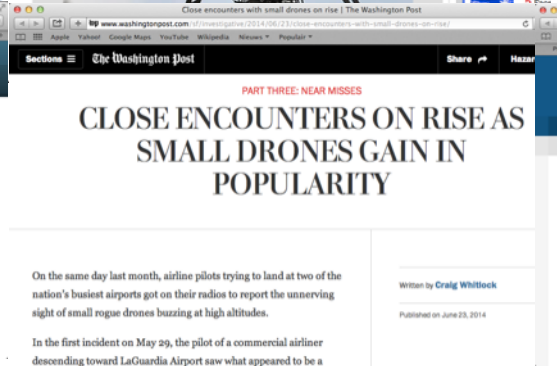
Close encounters with small drones on rise | The Washington Post
www.washingtonpost.com/sf/investigative/2014/06/23/close-encounters-with-small-drones-on-rise/
Sections
The Washington Post
PART THREE: NEAR MISSES
CLOSE ENCOUNTERS ON RISE AS SMALL DRONES GAIN IN POPULARITY
On the same day last month, airline pilots trying to land at two of the nation's busiest airports got on their radios to report the unnerving sight of small rogue drones buzzing at high altitudes.
In the first incident on May 29, the pilot of a commercial airliner descending toward LaGuardia Airport saw what appeared to be a
Written by Craig Whitlock
Published on June 23, 2014


Drone used in attempt to smuggle drugs into Melbourne prison, say police | Aus
www.theguardian.com/world/2014/mar/10/drone-used-in-attempt-to-smuggle-drugs-
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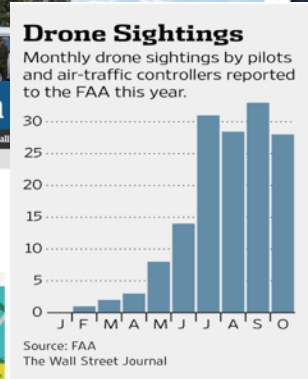
Australia news
Drone used in attempt to smuggle drugs into Melbourne prison, say police
A man has been charged following reports of a drone flying over Metropolitan remand centre in Ravenhall
Guardian Sustainable Business


Drone Sightings
Monthly drone sightings by pilots and air-traffic controllers reported to the FAA this year.
30
25
20
15
10
5
0
J F M A M J J A S O
Source: FAA
The Wall Street Journal

..ook in Nederland actueel..

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..threats in the form of..

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Issue = need

The wide spread availability of rapidly improving drones pose new threats. This results in a need for counter measures







Threat Scenario’s

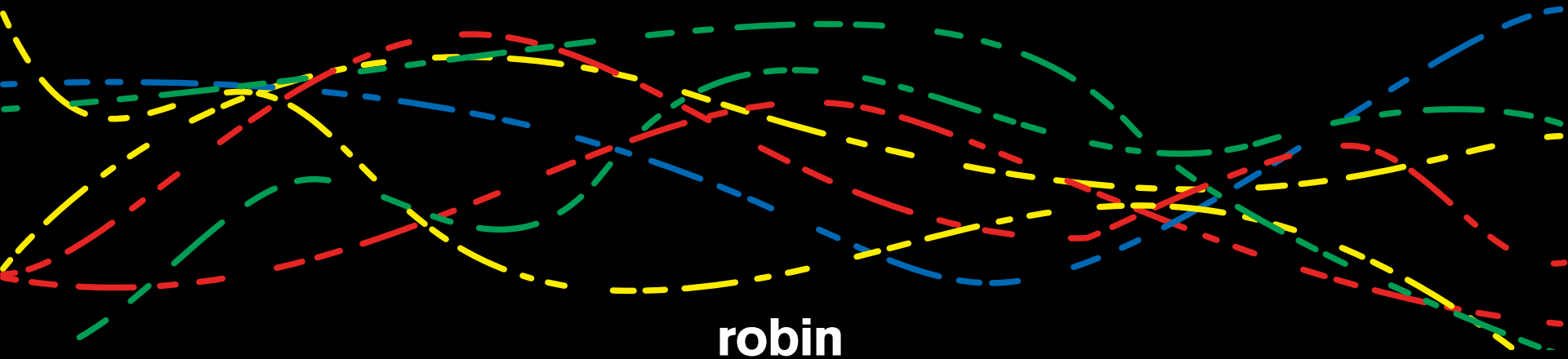
- Public Statements
- Violation of Privacy
- Endanger Flight Safety
- Illegal Transportation
- Military and Market Intelligence
- Terrorist Attacks

Markets & Customers

- Airports
- Prisons
- Nuclear Power Plants
- Electricity companies
- Royal Palaces
- ..

COUNTER MEASURES

challenges, capabilities and limitations



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General Challenge

Intervention
The ability to take appropriate actions to mitigate risk

Identification
The ability to identify what type of drone it is, as input for threat analysis

Classification
The ability to distinguish drones from other small objects like birds

Concept of Operations
Balancing threat with collateral damage within a legal framework

Detection
The ability to detect non-cooperative small targets

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Complicating factors

Distinct Drones from birds and Friendly from Enemy

Swarms of co-operative drones

Unattended / autonomic flying

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DETECTION

Human Surveillance
Passive Electro-optical / infrared
Acoustic
Active Radar
Radio FInding
Wi-Fi Sniffing

INTERVENTION

Jamming
Spoofing
Hacking
Laser
High Power Microwave
Water canons
Shooting nettings
Counter drones
Falcons
Guns
Missile systems

LIMITATIONS

hinder to other communications
autonomous flight
Time to reload
parallelism
Collateral damage
Range
Accuracy
Price
Ease of use
Organizational fit

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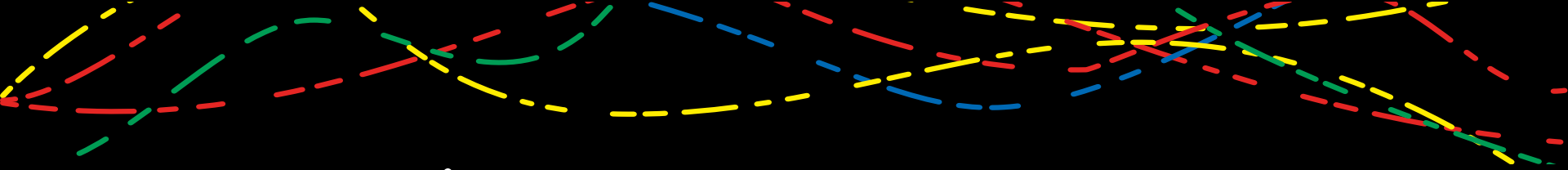

..creative counter measures..

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My Observations

1. Drone's are hyped: their impact on short term is over estimated, but underestimated for the long term
2. The market for counter measures is immature; most propositions are a facade to win time
3. Counter measures will mature... AFTER a serious incident results in customer budgets
4. Winning solutions will be 'systems of systems'; a flexible combination of different sensors and counter measures

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THANK YOU

November 2016

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Characteristics

Detection Methods	Range	Position accuracy	Classification	Autonomous targets	Multiple targets	Low visibility conditions	Price
Human surveillance	**	***	*****	✓	✗	✗	****
Passive Electro-optical / Infrared	***	****	****	✓	✗	✗	*
Acoustic	*	**	**	✓	✓	✓	***
Active Radar	****	****	***	✓	✓	✓	**
Electronic Support Measures (ESM)	*****	**	***	✗	✓	✓	***

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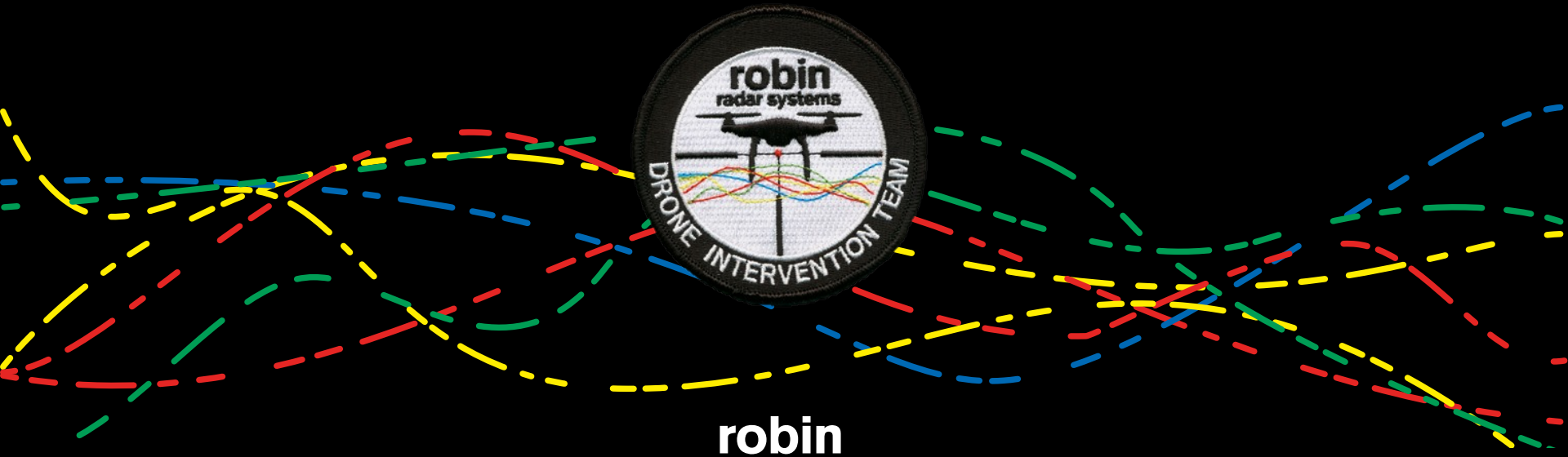
DRONE DETECTION

By Robin Radar Systems



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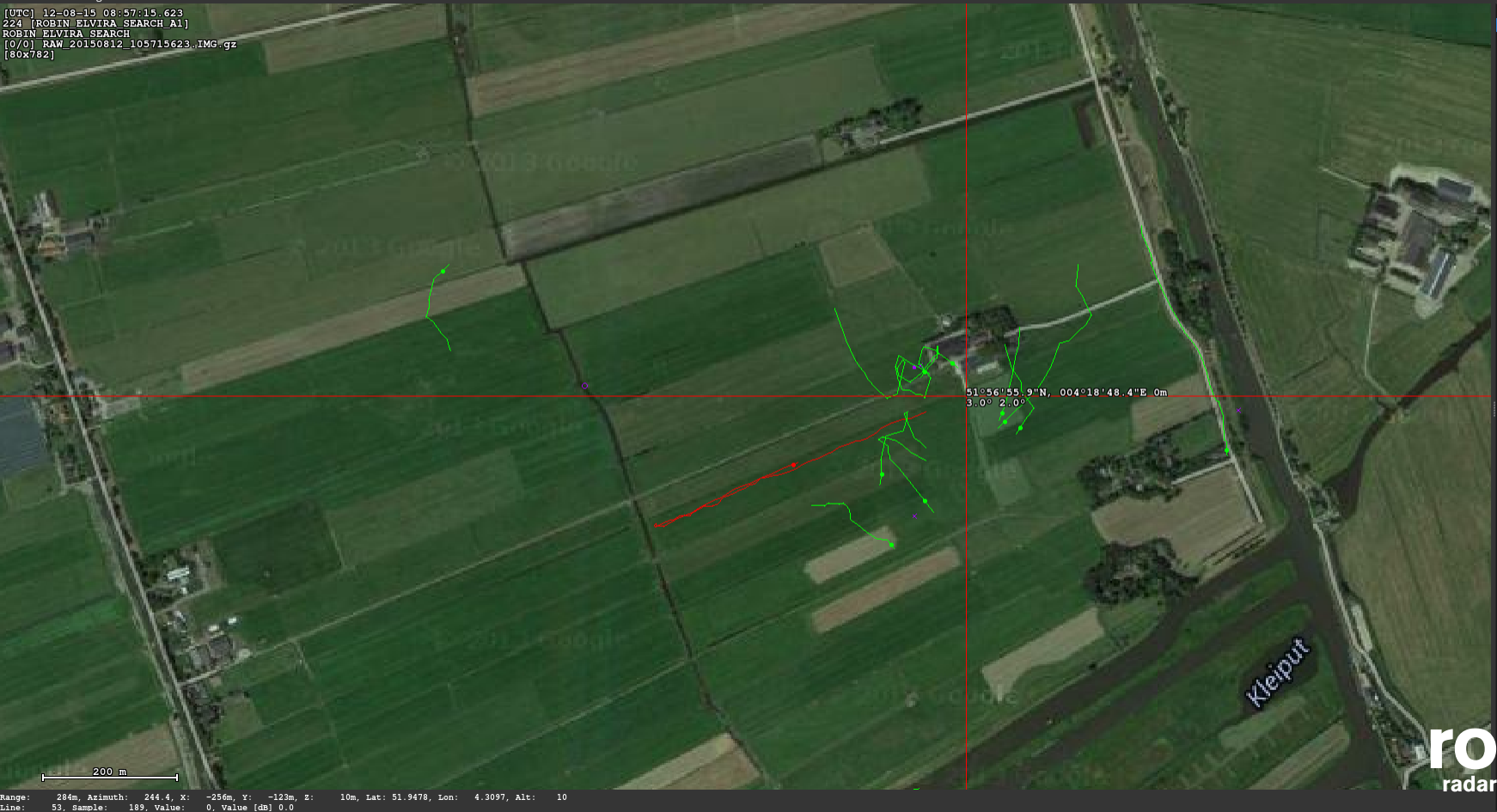
Elvira Radar

File Settings Windows Help

Raw A/D Data | Antenna | Range Doppler | Filtered Range Doppler | Filtered 3D | Sensors | Alarms | Geometry | Raw Radar Image | Filtered Radar Image

Filtered Radar Image



- Google maps
- Raw Image
- Doppler bins
- Unassociated plots
- Tracks
  - Classification color
    - DEFAULT
    - DRONE
    - OTHER
    - SUSPEC…
  - Track label
  - Score
  - Small icon
  - Properties
  - Estimates
  - Plots
  - Covariance
  - Altitude
  - Velocity
  - AirSpeed
  - PredictionInfo
  - WarningInfo
- Decoration

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Range: 284m, Azimuth: 244.4, X: -256m, Y: -123m, Z: 10m, Lat: 51.9478, Lon: 4.3097, Alt: 10
Line: 53, Sample: 189, Value: 0, Value [dB] 0.0

Elvira Radar

File Settings Windows Help

Raw A/D Data | Antenna | Range Doppler | Filtered Range Doppler | Filtered 3D | Sensors | Alarms | Geometry | Raw Radar Image | Filtered Radar Image

Filtered Radar Image

- Google maps
- Raw Image
- Doppler bins
- Unassociated plots
- Tracks
  - Classification color
    - DEFAULT
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    - OTHER
    - SUSPEC…
  - Track label
  - Score
  - Small icon
  - Properties
  - Estimates
  - Plots
  - Covariance
  - Altitude
  - Velocity
  - AirSpeed
  - PredictionInfo
  - WarningInfo
- Decoration
  - Show center
  - Show range rings
  - Use nautical miles
  - Show scalebar
  - Show metadata
  - Show weatherdata
  - Show noise level
  - Show logo

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Range: 365m, Azimuth: 240.6, X: -318m, Y: -179m, Z: 13m, Lat: 51.9473, Lon: 4.3088, Alt: 13
Line: 53, Sample: 243, Value: 84, Value [dB] 0.2


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Classification color
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DRONE
OTHER
SUSPEC...
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PredictionInfo
WarningInfo
Decoration
Show center
Show range rings
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Operational at G7