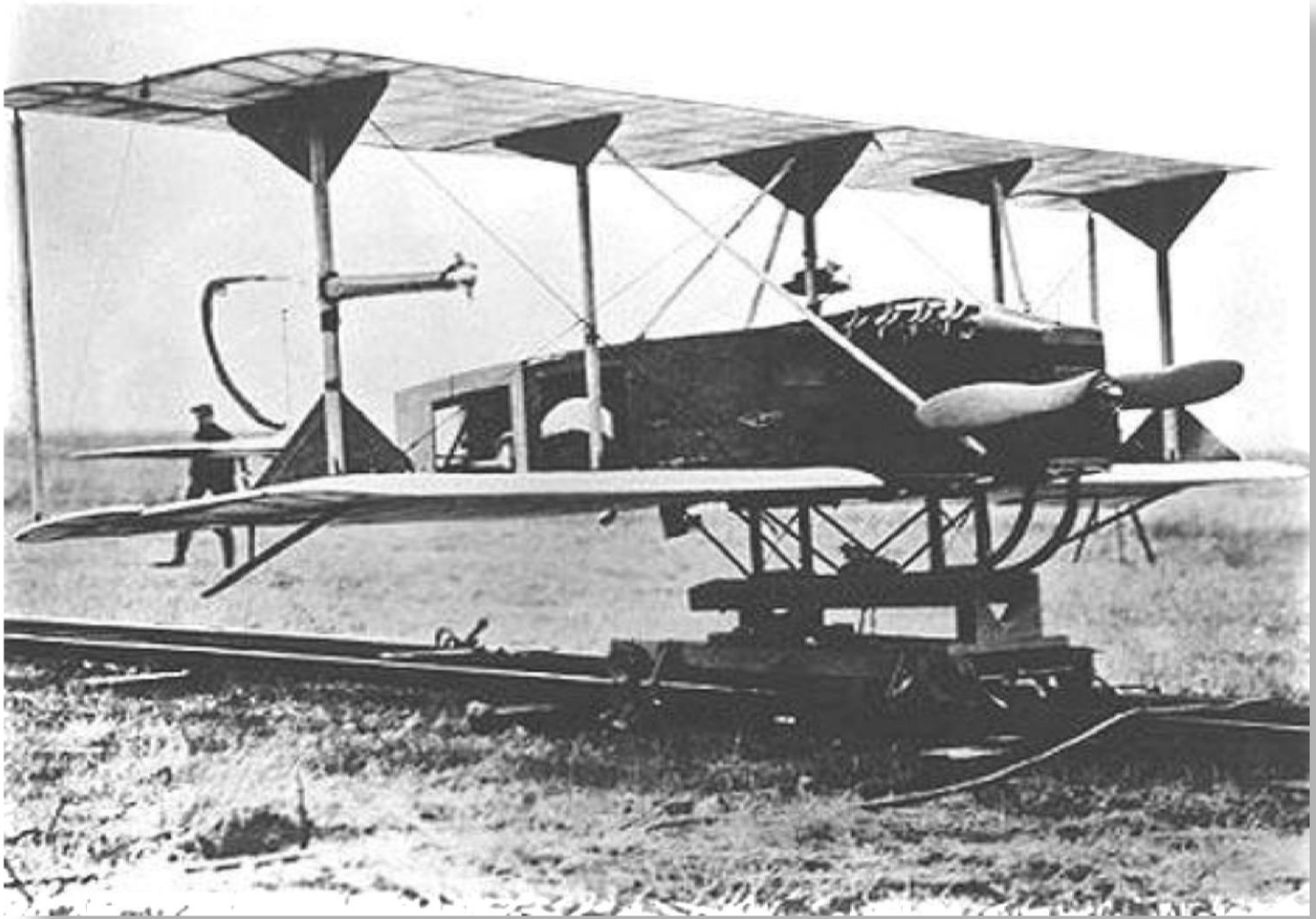
Unmanned air vehicles

Phil McLachlan FIET




K-4227
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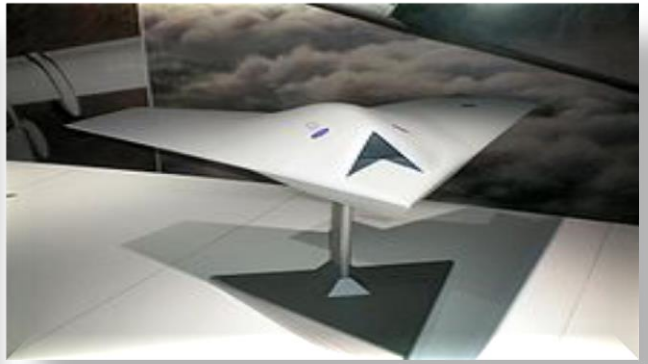
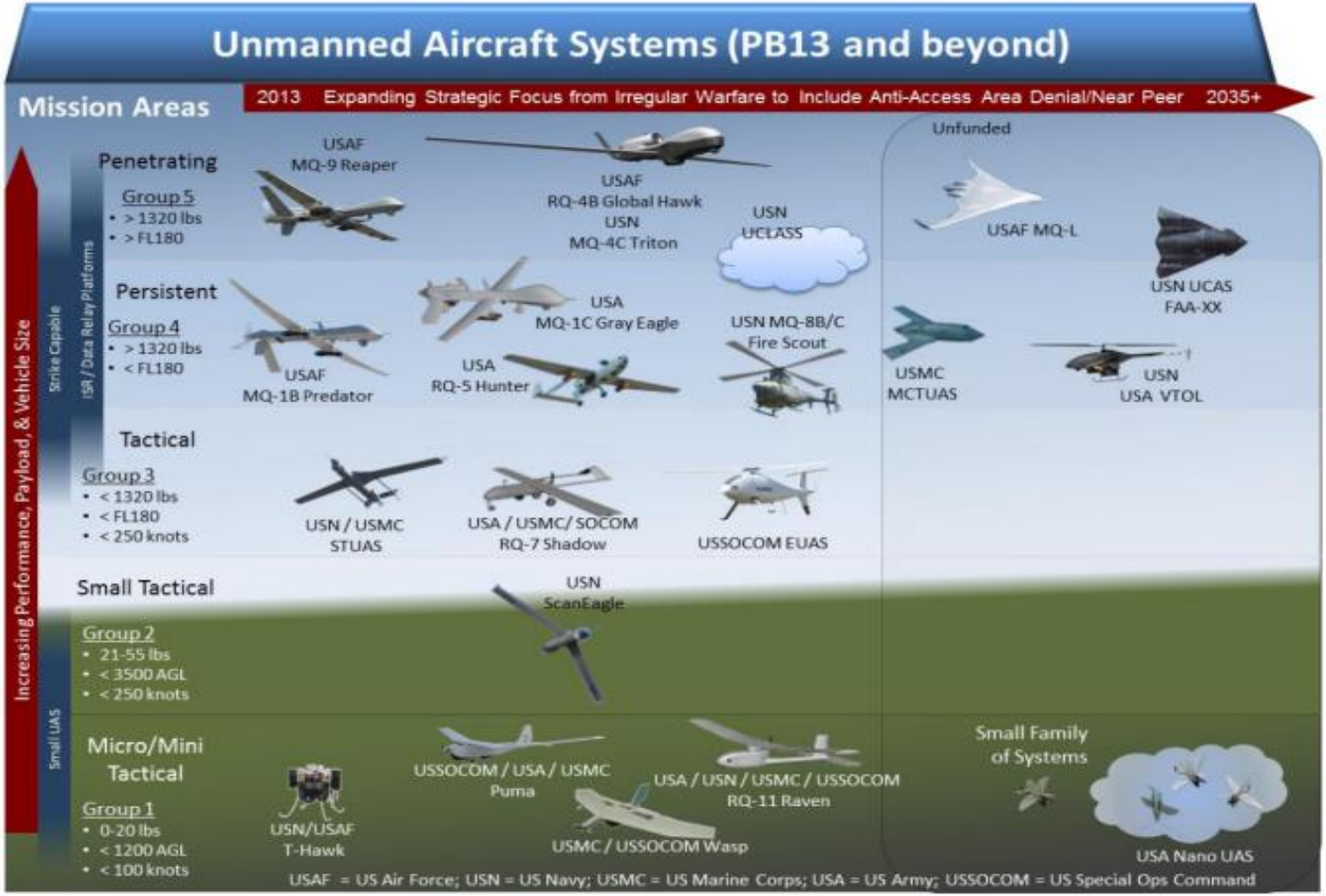
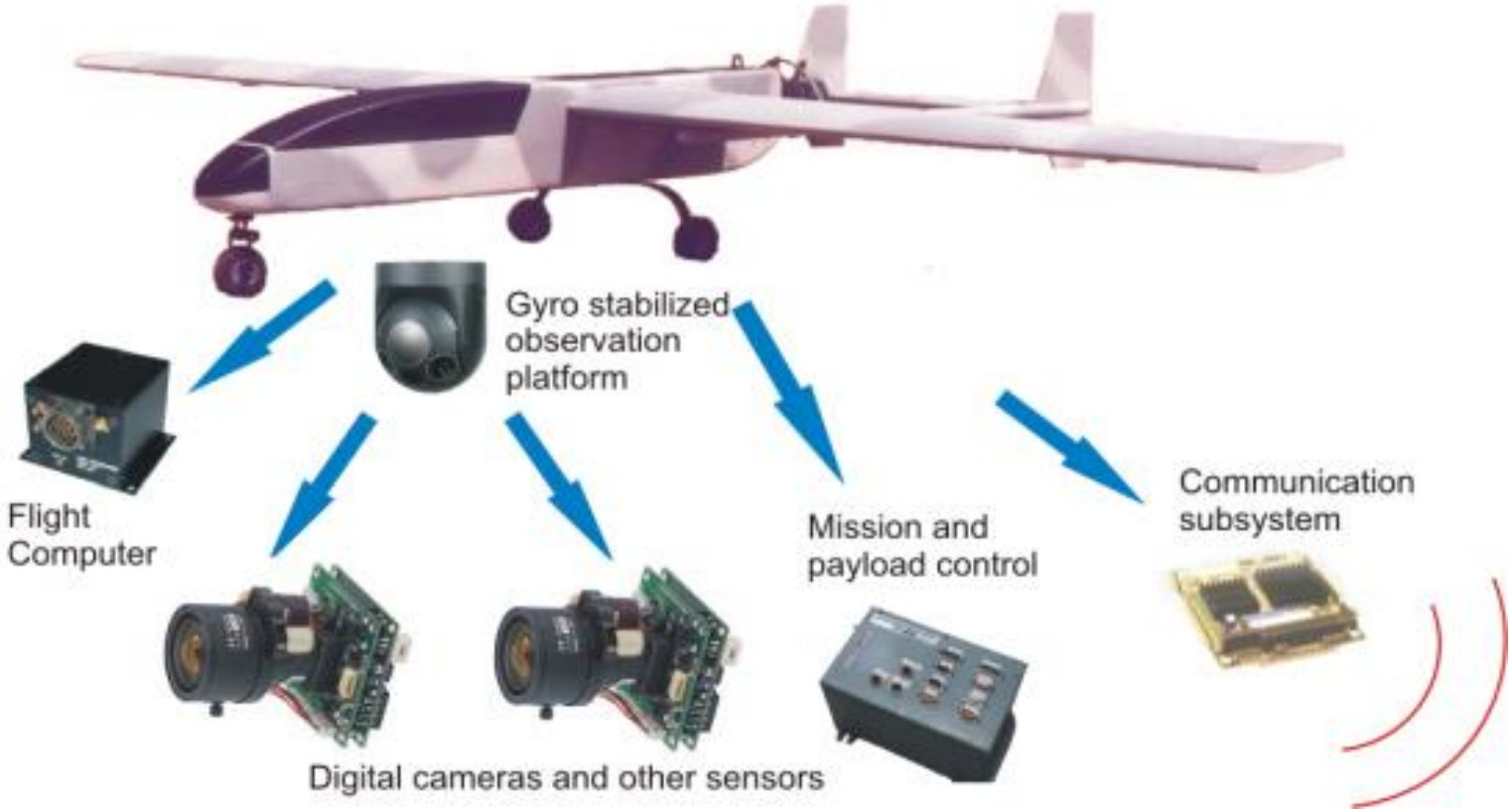



Unmanned Aircraft Systems (PB13 and beyond)
Mission Areas
2013 Expanding Strategic Focus from Irregular Warfare to Include Anti-Access Area Denial/Near Peer 2035+
Increasing Performance, Payload, & Vehicle Size
Strike Capable
ISR / Data Relay Platforms
Small UAS
Penetrating
Group 5
• > 1320 lbs
• > FL180
USAF
MQ-9 Reaper
USAF
RQ-4B Global Hawk
USN
MQ-4C Triton
USN
UCLASS
Unfunded
USAF MQ-L
USN UCAS
FAA-XX
Persistent
Group 4
• > 1320 lbs
• < FL180
USAF
MQ-1B Predator
USA
MQ-1C Gray Eagle
USA
RQ-5 Hunter
USN MQ-8B/C
Fire Scout
USMC
MCTUAS
USN
USA VTOL
Tactical
Group 3
• < 1320 lbs
• < FL180
• < 250 knots
USN / USMC
STUAS
USA / USMC/ SOCOM
RQ-7 Shadow
USSOCOM EUAS
Small Tactical
Group 2
• 21-55 lbs
• < 3500 AGL
• < 250 knots
USN
ScanEagle
Micro/Mini
Tactical
Group 1
• 0-20 lbs
• < 1200 AGL
• < 100 knots
USN/USAF
T-Hawk
USSOCOM / USA / USMC
Puma
USA / USN / USMC / USSOCOM
RQ-11 Raven
USMC / USSOCOM Wasp
Small Family
of Systems
USA Nano UAS
USAF = US Air Force; USN = US Navy; USMC = US Marine Corps; USA = US Army; USSOCOM = US Special Ops Command

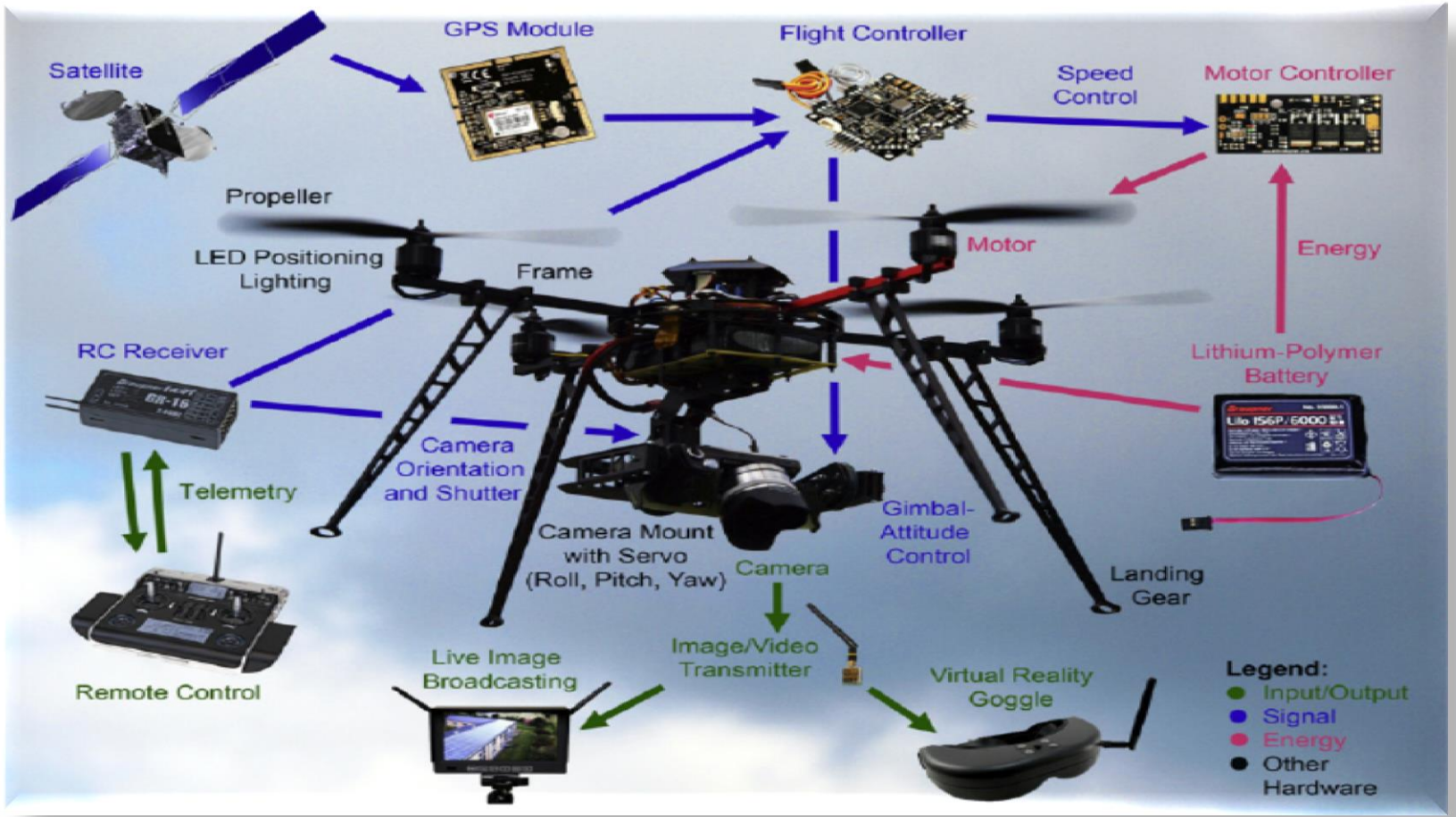
JANUARY
2014

20YY
Preparing for War in the Robotic Age


Gyro stabilized
observation
platform
Flight
Computer
Mission and
payload control
Communication
subsystem
Digital cameras and other sensors


ARMY


X-47B
45
UNIT


Satellite
GPS Module
Flight Controller
Speed Control
Motor Controller
Propeller
LED Positioning Lighting
Frame
Motor
Energy
RC Receiver
Lithium-Polymer Battery
Camera Orientation and Shutter
Telemetry
Camera Mount with Servo (Roll, Pitch, Yaw)
Gimbal-Attitude Control
Camera
Landing Gear
Remote Control
Live Image Broadcasting
Image/Video Transmitter
Virtual Reality Goggle
Legend:
Input/Output
Signal
Energy
Other Hardware

RISKS

- Mid-air collisions with manned aircraft

- Harm to people

- Damage to property, in particular, sensitive infrastructure


remote pilot
commercial
registration
flying
hobby
400 feet
part 107
knowledge test
preflight inspection
drone
safety
aviation
technology
daylight
visibility
USA
rules
business
visual contact
airworthiness
air space
regulations
certification
visual observer
exemptions
law
unmanned aircraft
model aircraft
industry
limitations
weather

EUROPE

- **European Commission**
  - 150K jobs in 10 years
  - Strict rules on safety
  - Protect the citizens rights, surveillance, monitoring
  - Tough controls to ensure security
  - Guaranteed third party liability and insurance

- **EASA Safety approach**
  - Open category
  - Specific Operation
  - Certified

- **CAA**
  - Certification authority <150Kg
  - CAP 722, Edition 6, Mar 2015
  - Dronecode

USA

Milestone announcement
22 June 2016

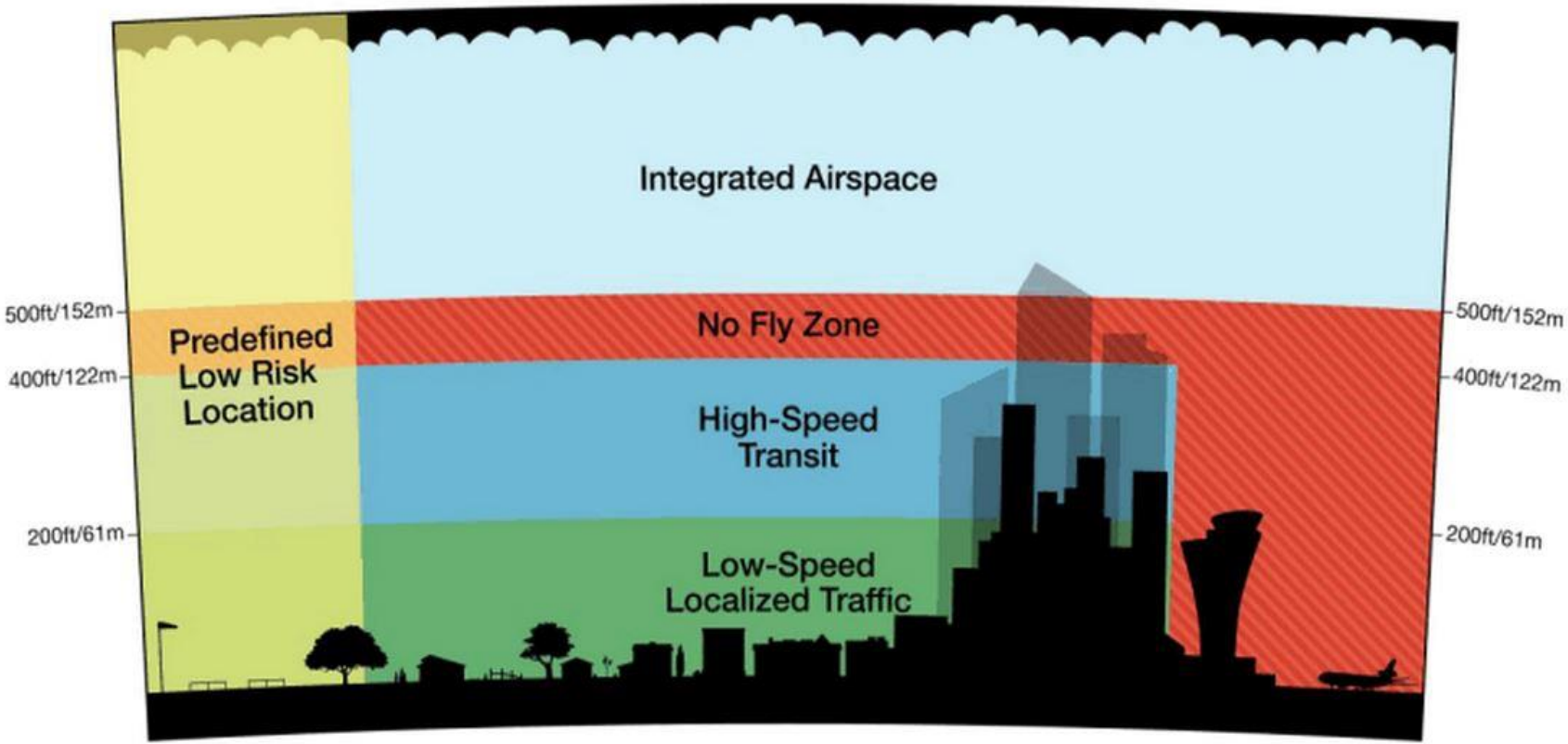
"$82B, 100,000 jobs in a decade"

- Small drones <55lb
- Visual Line of Sight in day and twilight
- Speed and over flight restrictions – waivers from online portal
- Pilot certificate > 16 years old, tested every two years
- Operators responsible for safety – visual checks, comms
- All pilots given 'privacy' training

Dronecode

- **D**on’t fly near airports or airfields
- **R**emember to stay below 400ft (120m) and 150ft (50m) away from buildings and people
- **O**bserve your drone at all times
- **N**ever fly near aircraft
- **E**njoy responsibly

Airspace Design for Small Drone Operations



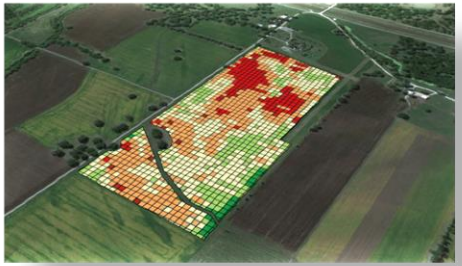

pwc

“Clarity From Above” *May 2016*

	($ B)
Infrastructure	45.2
Agriculture	32.4
Transport	13
Security	10
Media & Entertainment	8.8
Insurance	6.8
Telecommunication	6.3
Mining	4.4
Total	$ **127.3 Billion**


CYBERHAWK
DRONE

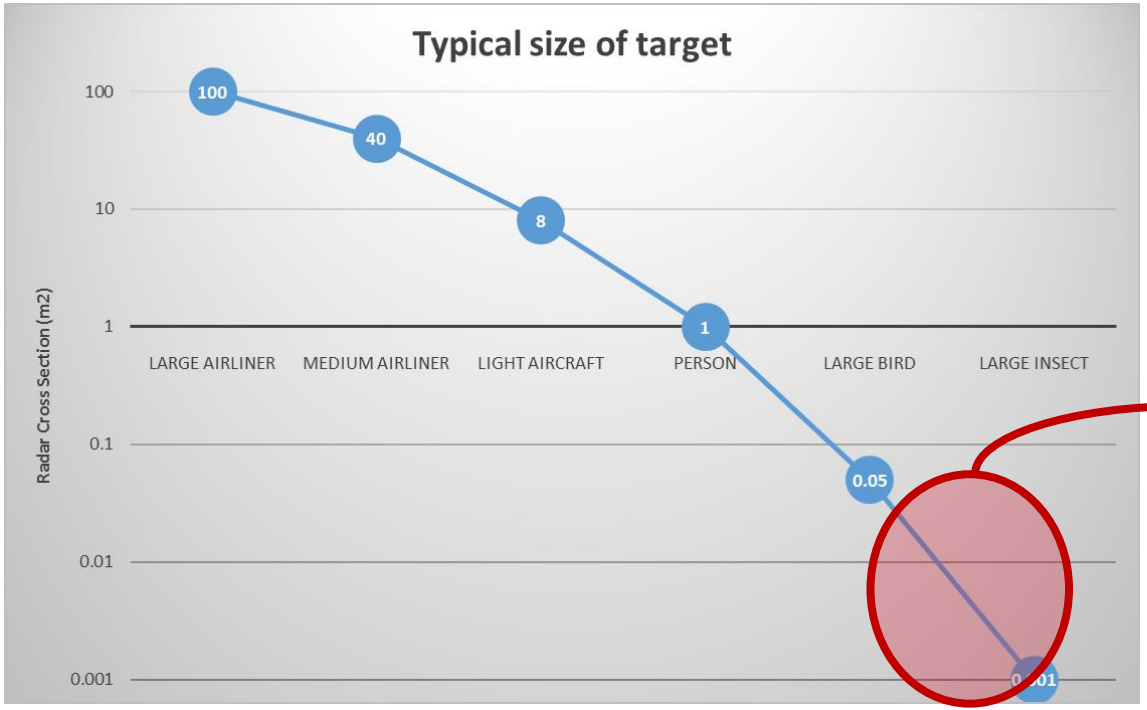

amazon
PrimeAir




Rotor blades
Central drum
Video glasses
Antenna
Camera
Remote control

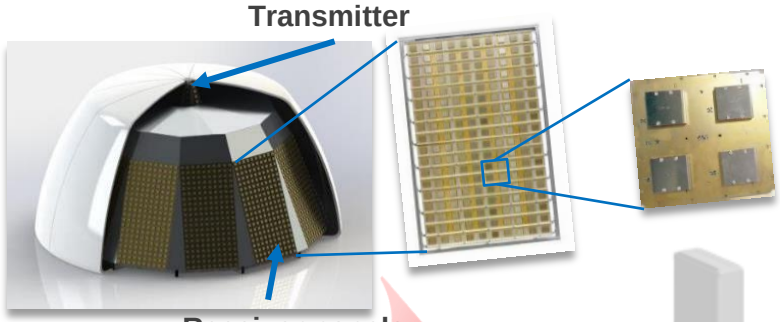
The detection challenge

Drone targets - Small, low and slow



Holographic Radar

Software based, scalable radar – wide application



3D Airport Primary Radar

3D Infill Radar

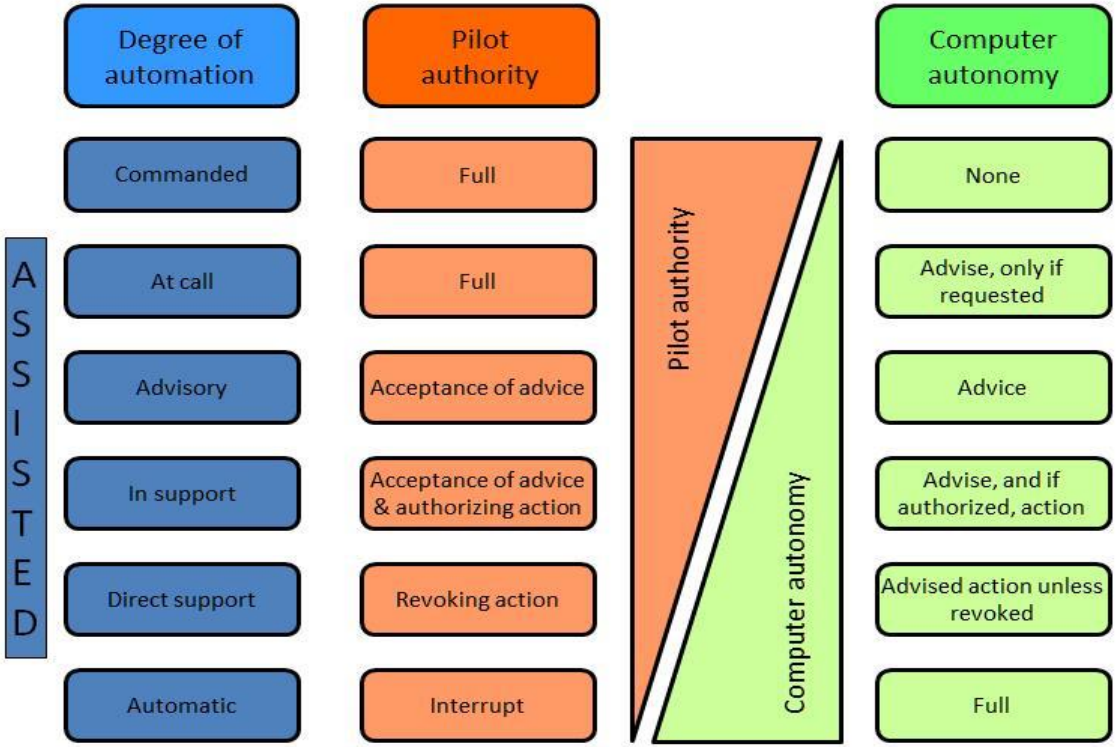
3D Drone Detection
(strategic asset protection)

Holographic radar for drone detection and tracking

- “Floodlight” transmit, planar array of receivers
- Digital beamforming on receive
- Detection of 0.01m^2 target to 5km
- 3D location and tracking
- 90° sector coverage
- No moving parts
- 0.25s update rate (variable, can be increased)
- Continuous staring at all targets, all the time – very fine Doppler resolution
- Micro-Doppler resolves rotor motion, distinguish from birds

Drone tracked incoming from 5km

Autonomy

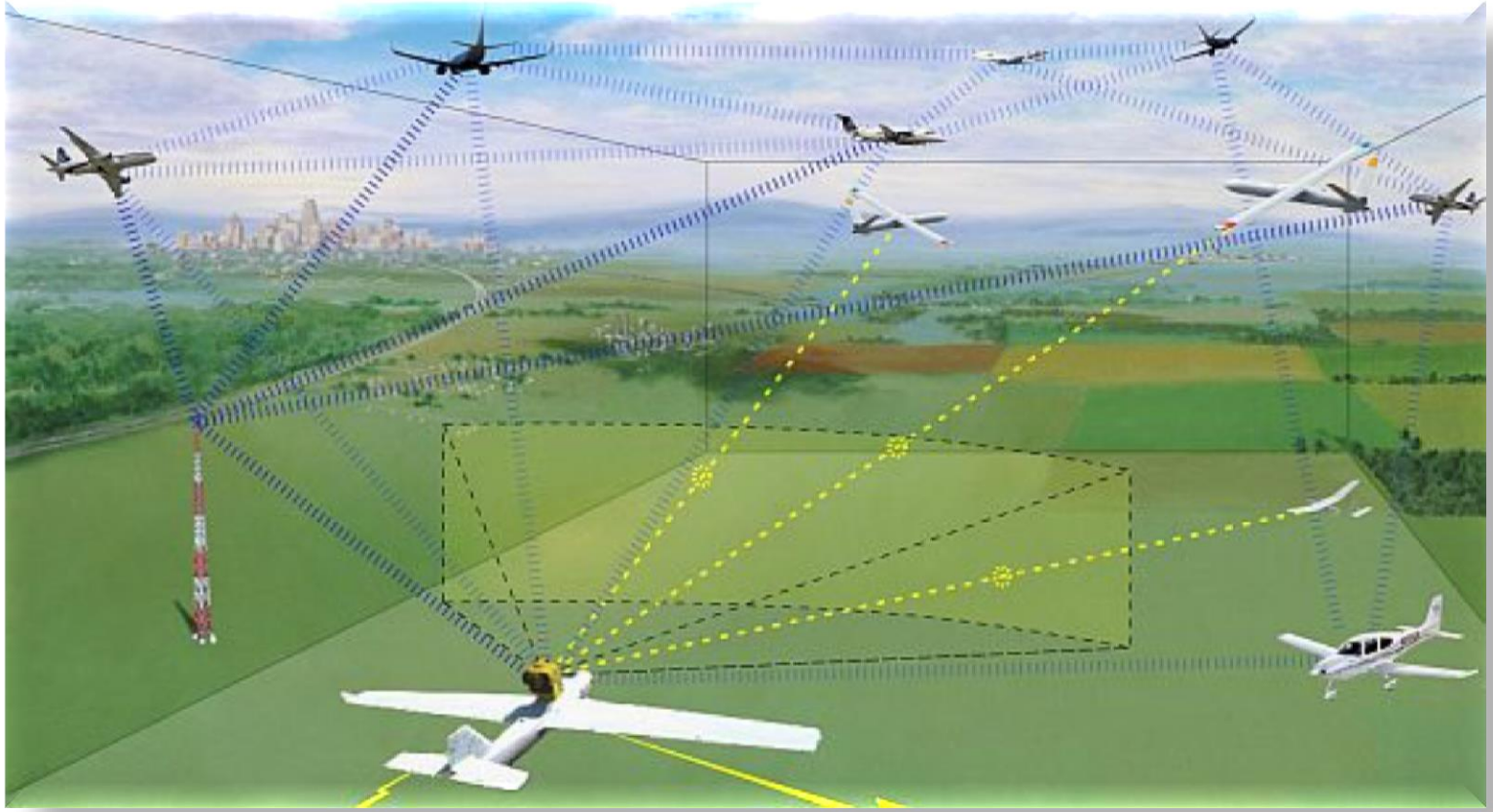

Degree of automation
Pilot authority
Computer autonomy
Commanded
Full
None
At call
Full
Advise, only if requested
Advisory
Acceptance of advice
Advice
In support
Acceptance of advice & authorizing action
Advise, and if authorized, action
Direct support
Revoking action
Advised action unless revoked
Automatic
Interrupt
Full
ASSISTED
Pilot authority
Computer autonomy

How can we sense an impending collision?

!!!

We need to exchange information, either visually, electronic telemetry, noise, etc.

When we have information about each other, we can negotiate our paths.




sense and avoid
moving objects
static objects
MANNED AIRCRAFT
ITS
CAS SEPERATION ZONE
CAS
400 FT
ITS
ITS
30m
20m
10m
ITS
Collaborative collision avoidance ITS
CAS
Onboard collision avoidance CAS
UAS


VECTOR HAWK
AERIAL
MARLIN
UNDERSEA


© Airbus

Drones are an increasing part of everyday life, but they are not taking over the world.

Phil McLachlan FIET