



Drone dependence on GPS

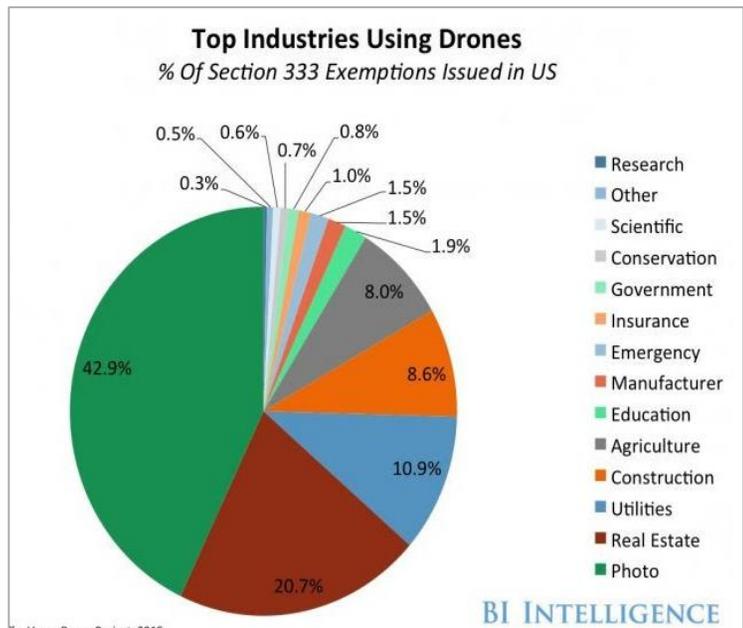
Presentation to PNTAB
June 2019
Captain Joe Burns CEO Airo Group, Inc.



Growth in the Drone Economy

Commercial Drone Technology

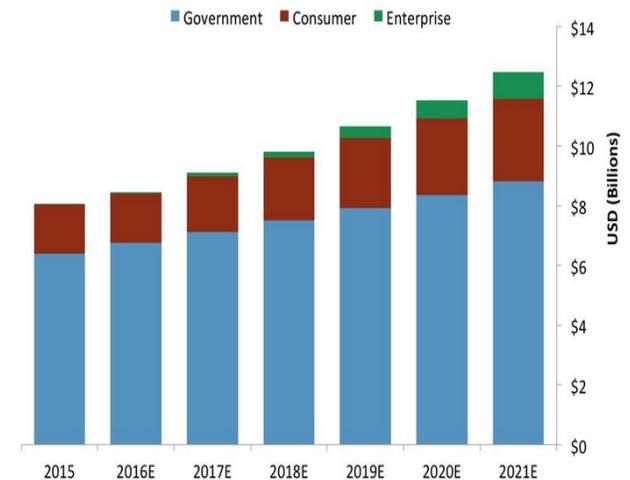
- Commercial usage of drones is gaining steady momentum as multiple industries are working with drones as part of their daily regular business functions.
- The market for commercial and civilian drones growing at a compound annual growth rate (CAGR) of 19% between 2015 and 2020, compared with 5% growth on the military side, according to BI Intelligence, Business Insider's premium research service.
- Sophisticated drones could soon be doing thousands of everyday tasks like fertilizing crop fields on an automated basis, monitoring traffic incidents, surveying hard-to-reach places, and transporting various types of cargo
- The impact of commercial drones could be \$100 billion and a 100,000 job boost to the U.S. economy by 2025, according to [AUVSI](#)
- The impact of Air Taxi drones (UAM) at over \$15B annually



Whether you call them Unmanned Aerial Vehicles (UAVs), Miniature Pilotless Aircraft or Flying Mini Robots, drones are rapidly growing in popularity. They are still in the infancy stage in terms of mass adoption and usage, but drones have already broken through rigid traditional barriers in industries which otherwise seemed impenetrable by similar technological innovations.

Over the past few years, drones have become central to the functions of various businesses and governmental organizations and have managed to pierce through areas where certain industries were either stagnant or lagging behind. From quick deliveries at rush hour to scanning an unreachable military base, drones are proving to be extremely beneficial in places where man cannot reach or is unable to perform in a timely and efficient manner.

Estimated Investment In Drone Hardware
Global



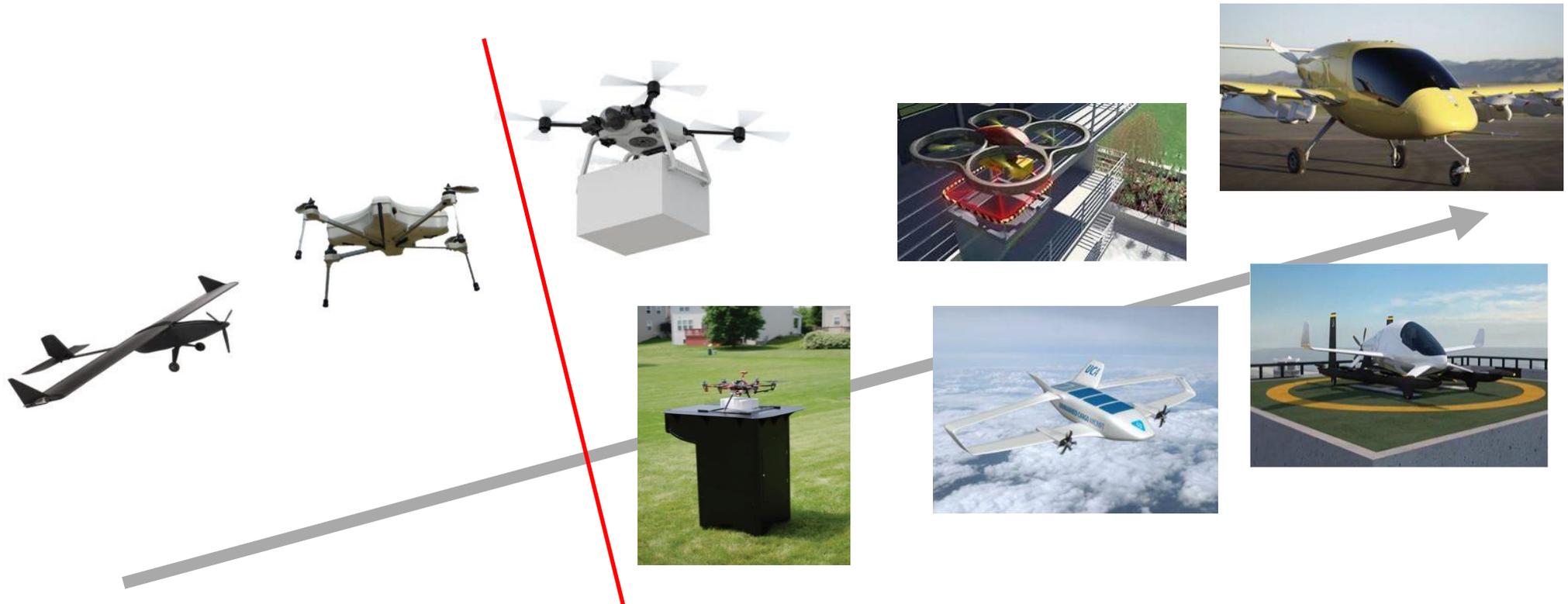
Source: IHS Jane's Intelligence Review, 2015; BI Intelligence Estimates, 2016



Drones in use today



Real Drone Growth



- 333 Exemption
- FAR 107
- Local Photos

- Fortune 500
- BVLOS
- Local Cargo

- "Big" Cargo
- Flying Cars
- Autonomous Air Taxi



GPS use in Drones

Where is GPS used?

Basic Navigation – Positioning

Relative Navigation – Position Speed
Velocity Altimetry

Surveillance (Tracking) – ADS-B or
4G/5G

Inertial updating (IMU)

Remote Autonomy

Precision Nav – RTK or PPK – cm level

Relative to ground object – delivery

Airspace Restrictions

Obstacle Avoidance

Drone Navigation Systems

“Eyedar”

GPS/GNSS

EO/IR Cameras

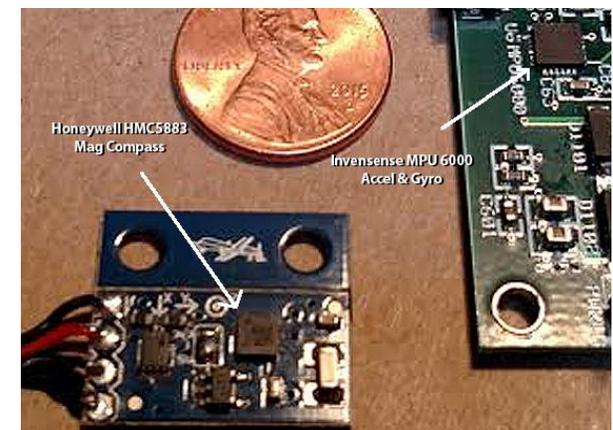
LIDAR

RADAR

RadioNavigation

Ultrasonic

Inertial



Typical UAV IMU



GPS future use in Drones (UAM)

GPS considerations?

FAR 49 CFR 23 standards

TSOs C-129,145,146,196

WAAS

RTK at landing pad sites

Triple redundancy with INS

Total Autonomy w/AI

Other sensors as backup

Drone spectrum requirements

C2 – 433*/800/900mhz

2.4/5.8ghz

RTK – 433*/800 mhz/5G

Air VHF

ADS-B – 978 or 1090mhz

GPS- L1

4G or 5G secondary telemetry

SATCOM – L, Ka, Ku, C

Drone GPS must be Protected, Toughened, and Augmented!



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