SENSURION

AEROSPACE

Minneapolis - Denver - Washington, D.C.

Impact of weather on and with UAVs

Captain Joe Burns

Unmanned Systems $$s will drive integration!

Emerging, Commercially Available Unmanned Aircraft are Becoming Prevalent and Accepted

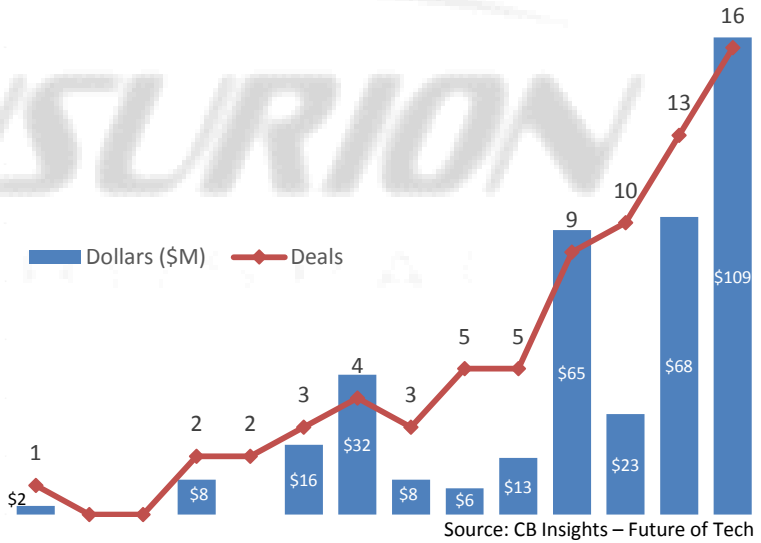
- Advances in technology have led to smaller, inexpensive unmanned aircraft which are replacing the need for expensive and risky manned aircraft operations
- Markets for more frequent aerial-based operations for industries that traditionally couldn't justify the high price tag for manned aircraft services are opening up
- The effect of these advances will result in billions of dollars in savings for industry

UAS Market Size

Various entities have generated economic impact analyses and size estimates of the future UAS market:

- Teal Group
  - $91 billion globally over a decade (2014 base year)
  - Non-military market shifting from 11% to 14%
  - Global UAV expenditures growing from $6.4B to $11.5B
- AUVSI - 100,000 jobs and $82 billion in economic activity in the first 10 years post integration
- BI Intelligence – 2015-20 growth in commercial / civilian UAS at 19% CAGR

Drone Investment Activity (2012Q1 to 2015Q2)

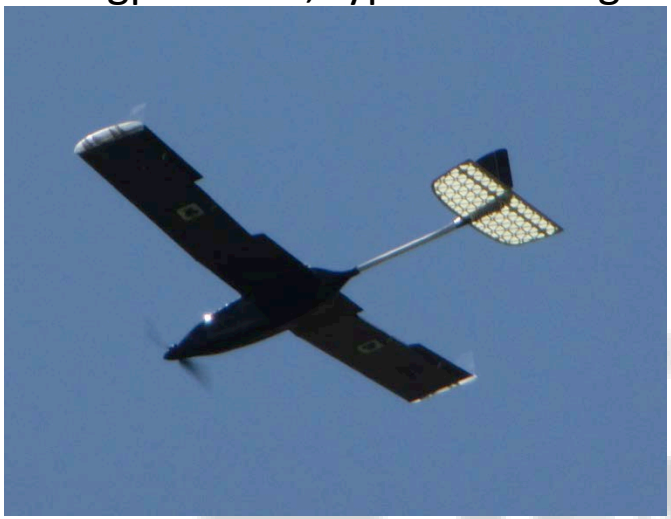


Source: CB Insights – Future of Tech

Investors are acknowledging commercial market opportunity

Typical sUAS Types

Magpie MP-1, typ. Fixed wing



- Conventional Fixed wing Design
- Hand, rail, gear takeoff
- Flight durations 60-120 mins
- Multiple Payload options
- Best BLOS candidate
- 0-60 kts, stall speeds 10 kts
- 20 kt max l/d
- Full autoflight avionics
- Variety of landing systems

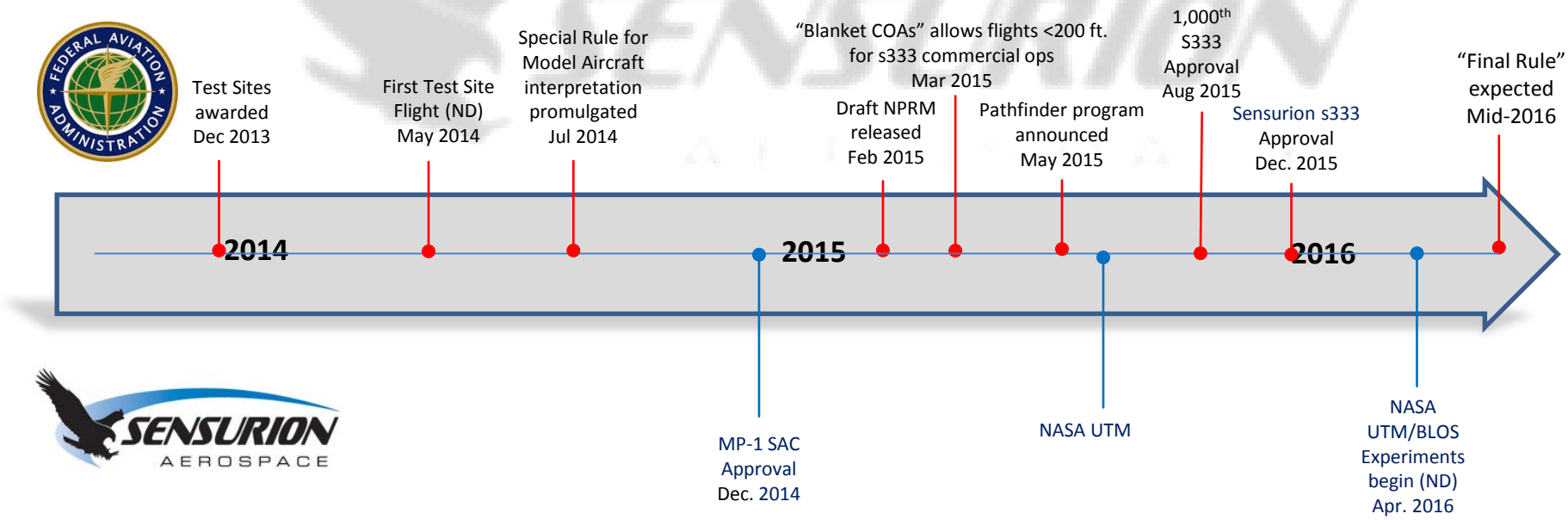
Discus MP-4, typ. Multirotor

- Multirotor designs
- Ease of flight
- Flight duration <30 mins
- Visual/EO sensors
- 0-20 kts speed
- Strong reliance on GPS
- Manual flown
- Limited autoflight
- About 90% current vehicles

Industry is Progressing Alongside FAA's Regulatory Process

US Regulatory Picture Improving Significantly while Some Hurdles Remain

- In previous years the FAA approached UAS commercialization with resistance, banning all flights for commercial purposes and issuing cease-and-desist letters
- Great industry and political pressure supported by the opportunity cost of falling behind competitively on a global scale and losing business efficiencies has led to continued movement towards commercialization as a reality, which is where we find ourselves today
- Hurdles remain:
  - Current regulatory environment only allows for flights within the operator's visual line of sight
  - Airspace authorization (COA) process for flights higher than 200 ft. above ground are very inefficient
  - Still very restrictive operating parameters and inefficient rulemaking by exemption process



Early Adopter Focus Industries

Oil & Gas

- Exploration
- Geophysical Survey
- Drilling
- Transit / Pipeline
- Refinement
- Security.

Critical Infrastructure

- Power lines, Powerplants
- Wind turbines
- Ports
- Communication network
- Fire / Police / EMS
- Search & Rescue.

Training

- FAA Test Ranges
- Universities
- Other flight schools
- Flight Safety / other training companies
- Corporate flight offices

Public Safety

- Reduce Helicopter operations
- Better aerial imagery and access
- “Dash & Loiter” mission profiles
- Data management

Safe integration of UAS in the NAS

- Background and Sensurion philosophy– FAA D.O. and W/B Captains at major US carriers. Also ran new tech (Nexgen), Line Operations, Training, Tech Pubs, Standards, and Flight Test operations.
- Safety a part of culture due to extreme number of ops and moving parts. Repeatablity in everything. Expectations are for 100% mission completion - want to move this culture to Unmanned Operations. UAVs are not disposable – safety!
- Tools not toys!
- When getting SAC, FAA stated manuals a lot like Airline!
- UAVs must integrate into Manned airspace procedurally, be surveilled, and encompase sense and avoid ultimately

UAV Structural comparisons

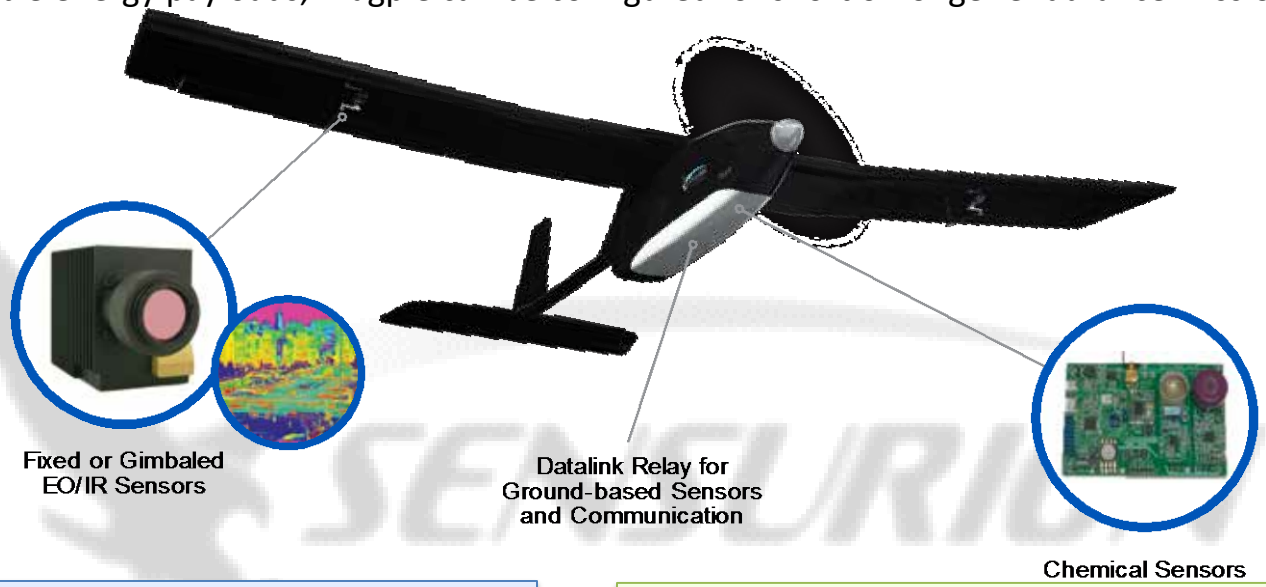
- Wing loading:
  - A380=136 lbs/sq-ft
  - C-172=11 lbs/sq-ft
  - Magpie=1.875 lbs/sq-ft
- Thrust to weight:
  - A380=0.35
  - C-172=0.21
  - Magpie= 1.0
- Stall speeds
  - A380=120kts
  - C-172=47kts
  - Magpie=8kts
- Major difference – rapid micro Mems on UAVs, low mass, high T/w

UAV Weather requirements

- Today, most s333's require a weather briefing prior to operation – where are they getting it?
- Today's ops are line of sight and limited to DAY-VFR
- 500' Ceiling, clear of clouds, usually 20kts winds
- LiPo batteries 0F-105F temps
- No icing, precip
- Most flight times limited 20-120 minutes
- BLOS will mandate IFR weather briefings, including airspace, geofencing, Positive ATC control etc. How will we sense conditions on UA? How to detect inflight icing?

Sensurion Products – Sensors & Data

- Sensurion sensor packages can be included for most data collection missions
- With its variable energy payloads, Magpie can be configured for short or longer endurance mission profiles



Sensor Options

- Airborne, fixed-point, & mobile sensors
- Optical
  - High-Definition optical imaging
  - Infrared (IR) / Enhanced IR
- Chemical / Radiological / Toxicity
- Atmospheric
  - Temperature / Pressure / Humidity
  - Wind direction / speed
  - Turbulence / Ride Quality

Data Management

- Cloud-based data management
- Atmospheric plotting
- Winds aloft profiling
- Plume modeling
- Carbon output monitoring
- Traffic monitoring
- Emergency communication provision

UAV Weather inputs

- MDCRS
- TAMDAR
- Radiosonde replacement?
- Corridor profiling
- UAV weather downlink
- Datalinks for weather?
- Can UAVs fill low altitude gap? – of course!

Thank you!

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