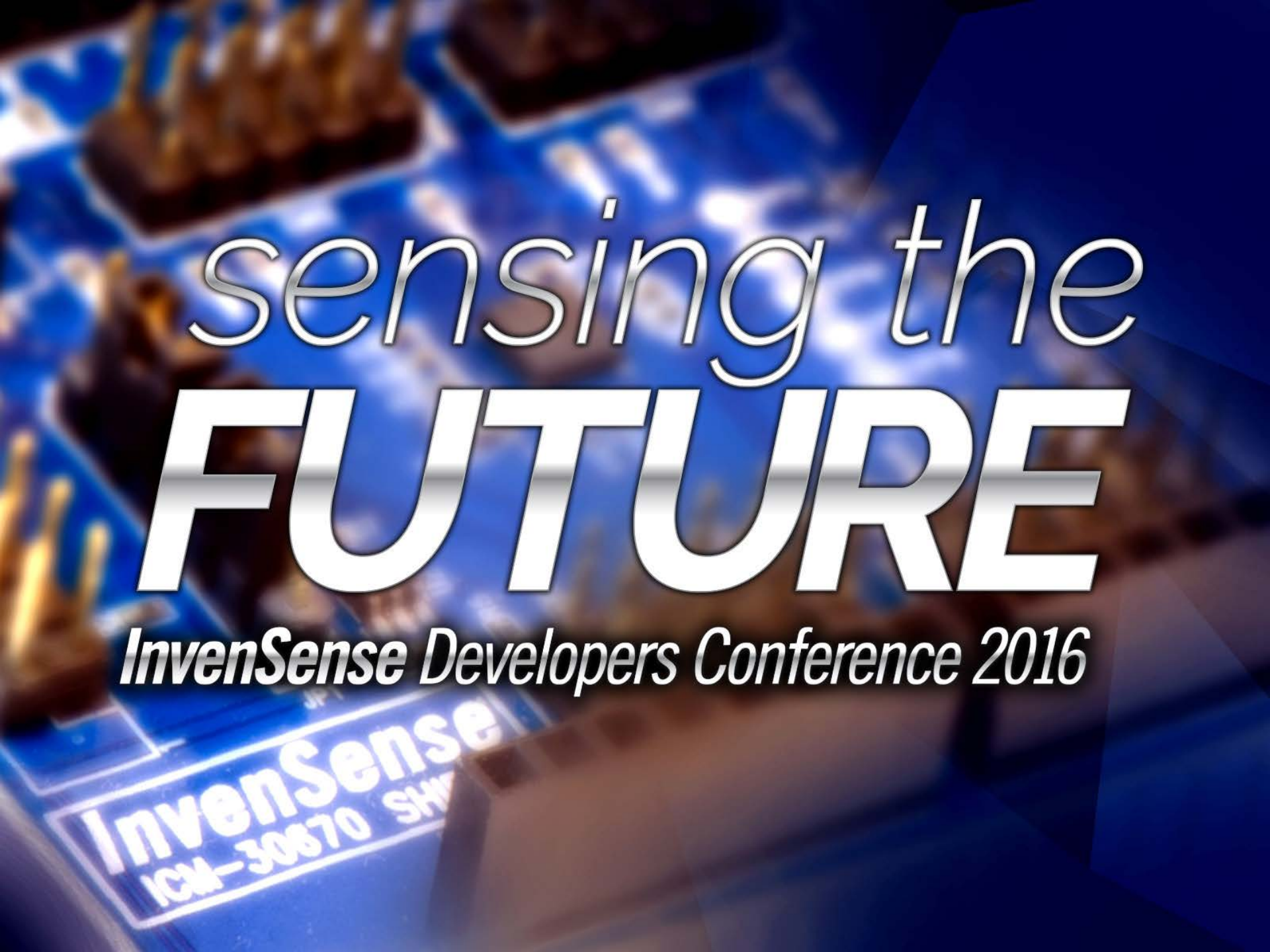
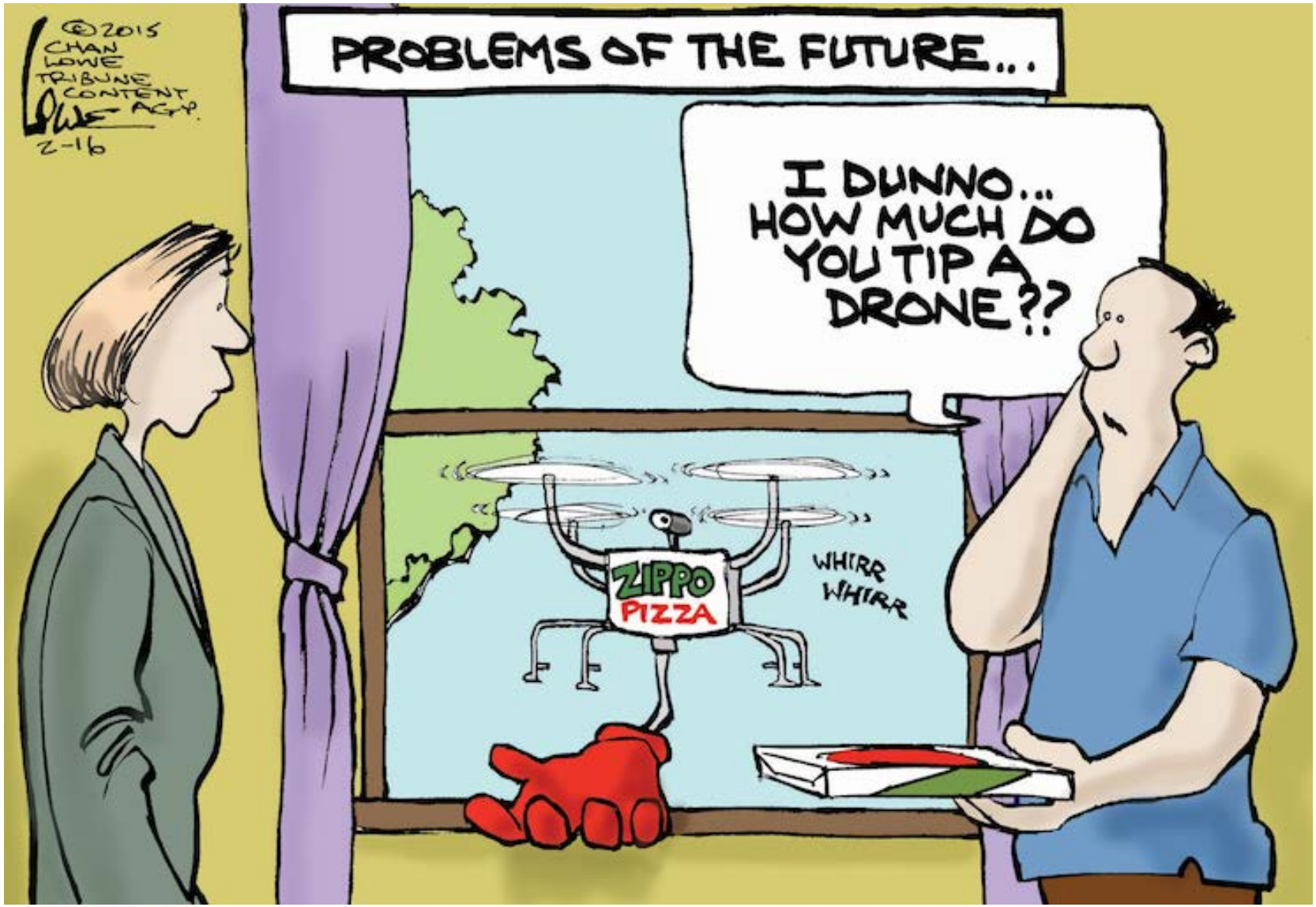

sensing the
FUTURE
InvenSense Developers Conference 2016
InvenSense
ICM-30670

Volocopter

“The Drones Are Coming”

- The Atlantic

Sanchayan Sinha, Dir Product Management and Drone Enthusiast


©2015 CHAN LOWE TRIBUNE CONTENT AGY.
2-16
PROBLEMS OF THE FUTURE...
I DUNNO... HOW MUCH DO YOU TIP A DRONE??
ZIPPO PIZZA
WHIRR WHIRR

INVN @ DRONES : CY2016

sensing the FUTURE

50 M Units

HIGHEST

DRONE : MARKET GROWTH

sensing the FUTURE

2020:0.8M

Prosumer

- DJI Phantom 4
  - 4K Video w/ Gimbal
  - 5350mAh
  - 28 minutes flight time

2020:1.2M

2016:5M

Consumer

- Parrot bebop
  - 1920x 1080p Video
  - 2700mAh
  - 25 minutes flight time

2020:9M

2016:36M

Toy

- SkyViper
  - 720p camera
  - 650mAh
  - 4 to 6 minutes

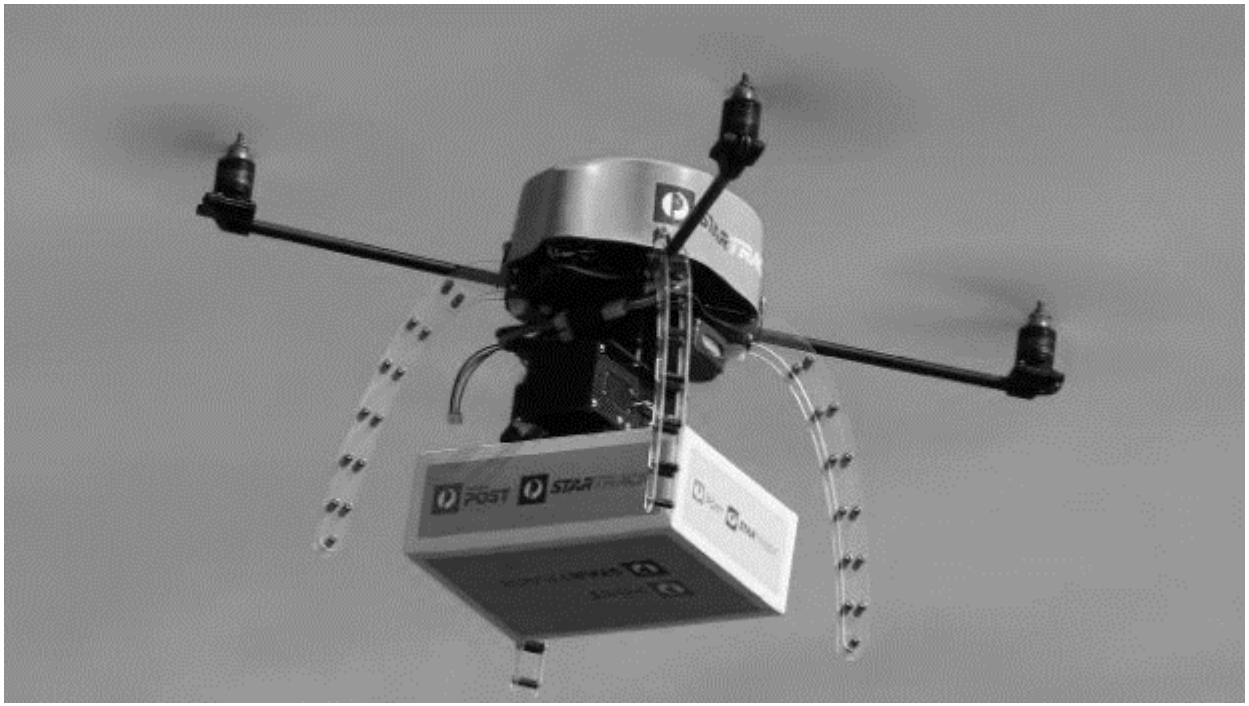
2020:53M

Source : Various sources/estimates

COMMERCIAL DRONES

sensing the FUTURE

FAA estimates 600,000 Commercial drones by 2017



“Only 320,000 airplanes are registered in the US”

- AP

COMMERCIAL DRONE MARKETS

sensing the FUTURE

How will drones impact business?

Predicted commercial applications and market value by industry

Infrastructure
Investment monitoring, maintenance, asset inventory
$45.2bn

Agriculture
Analysis of soils and drainage, crop health assessment
$32.4bn

Transport
Delivery of goods, medical logistics
$13.0bn

Security
Monitoring lines and sites, proactive response
$10.5bn

Entertainment & Media
Advertising, entertainment, aerial photography, shows and special effects
$8.8bn

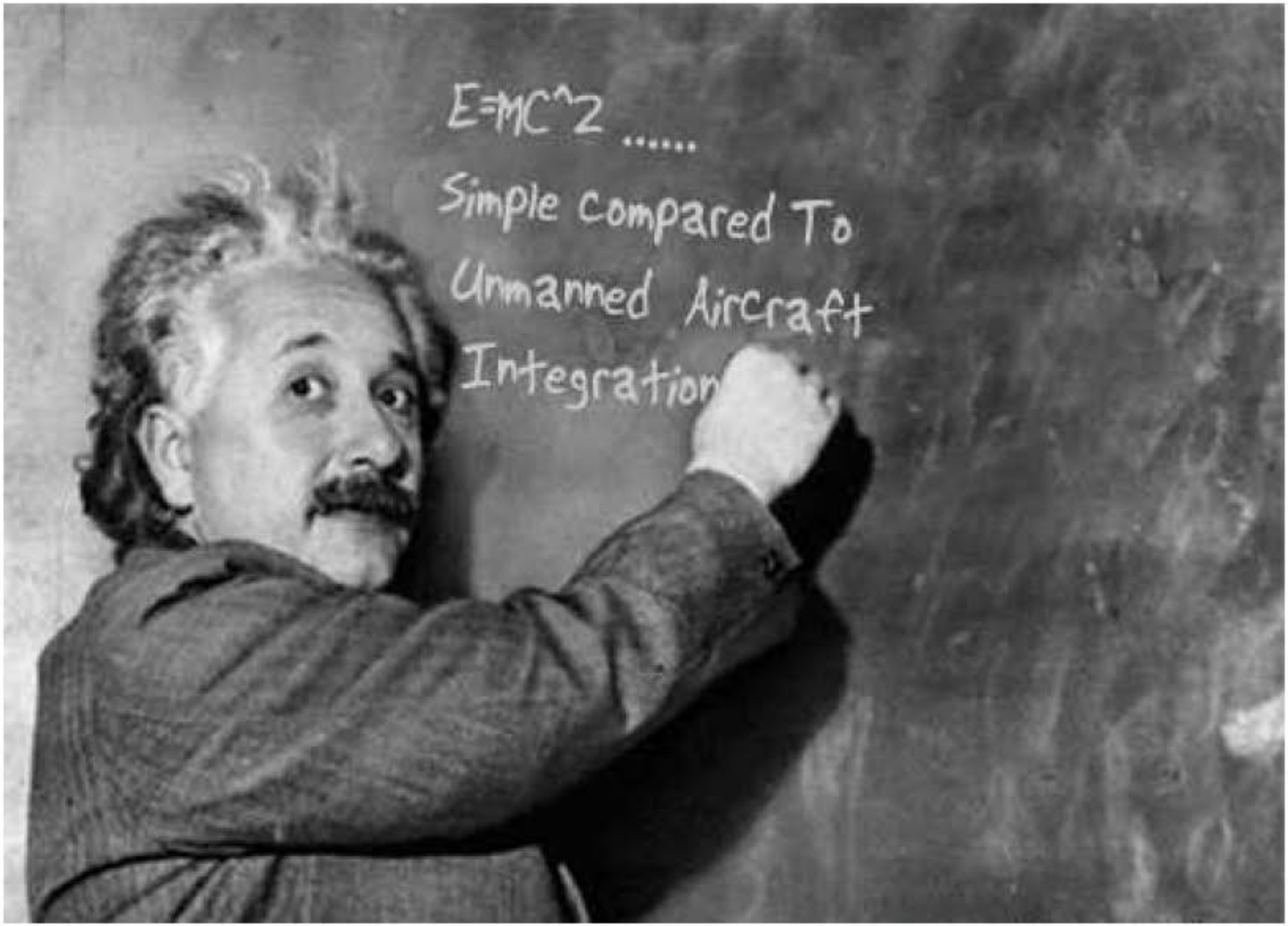
Insurance
Support in claims settlement process, fraud detection
$6.8bn

Telecommunication
Tower maintenance, signal broadcasting
$6.3bn

Mining
Planning, exploration, environmental impact assessment
$4.3bn

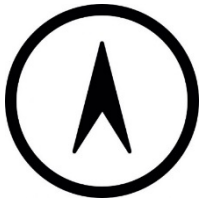
Source : PWC, 2016

Analysis by Einstein



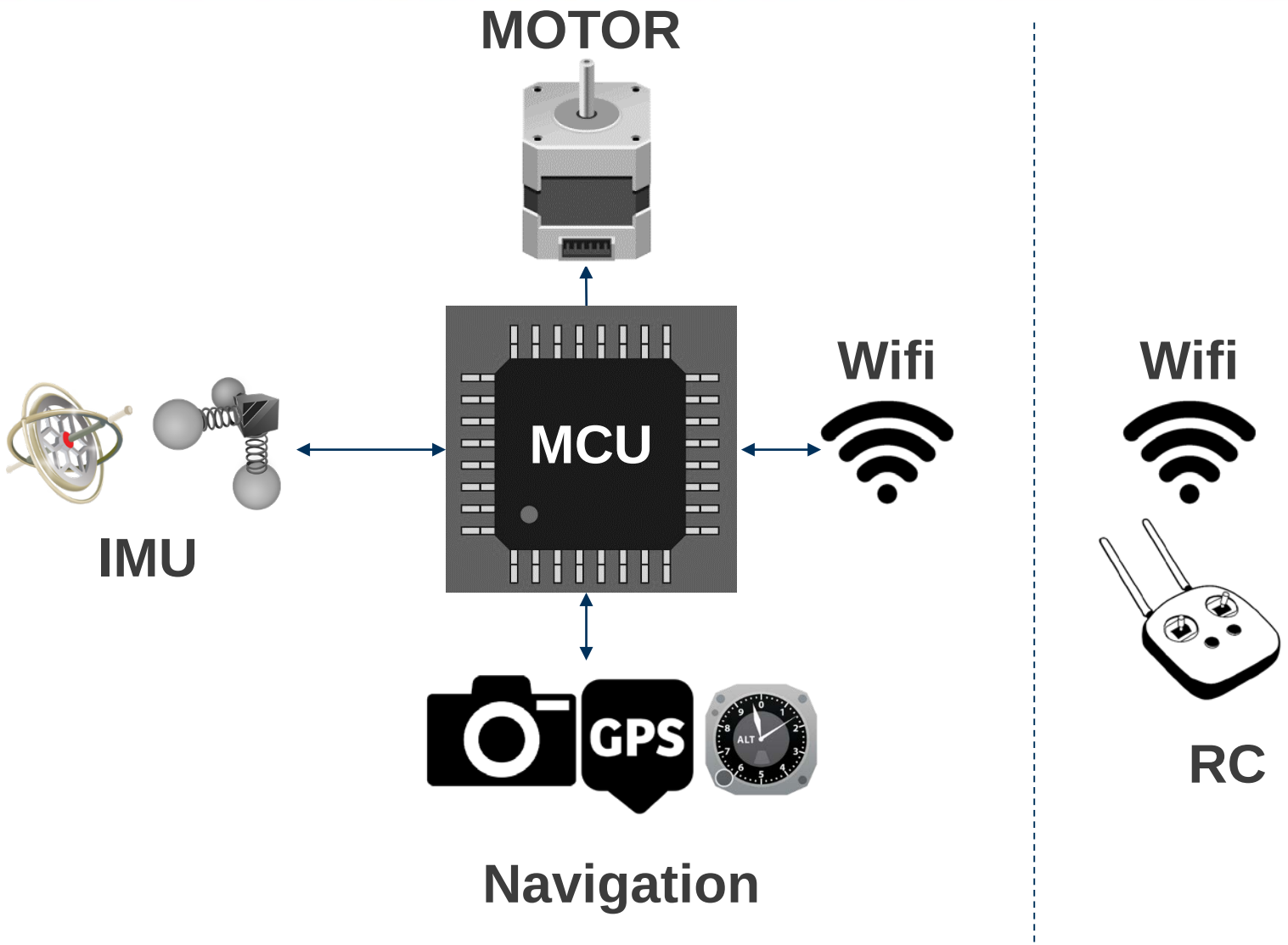
DRONE : PRINCIPAL SENSORS

sensing the FUTURE

	Flight Control	Navigation	Gimbal	RC
				
Prosumer	2x 6 Axis (1 Backup) 1-2x Pressure		1x 6 Axis	1x Mic
Consumer	1x 6 Axis 1x Pressure 1x u-Mic	1x 6 Axis	1x 6 Axis	
Toys	1x 6 Axis 1x Pressure			

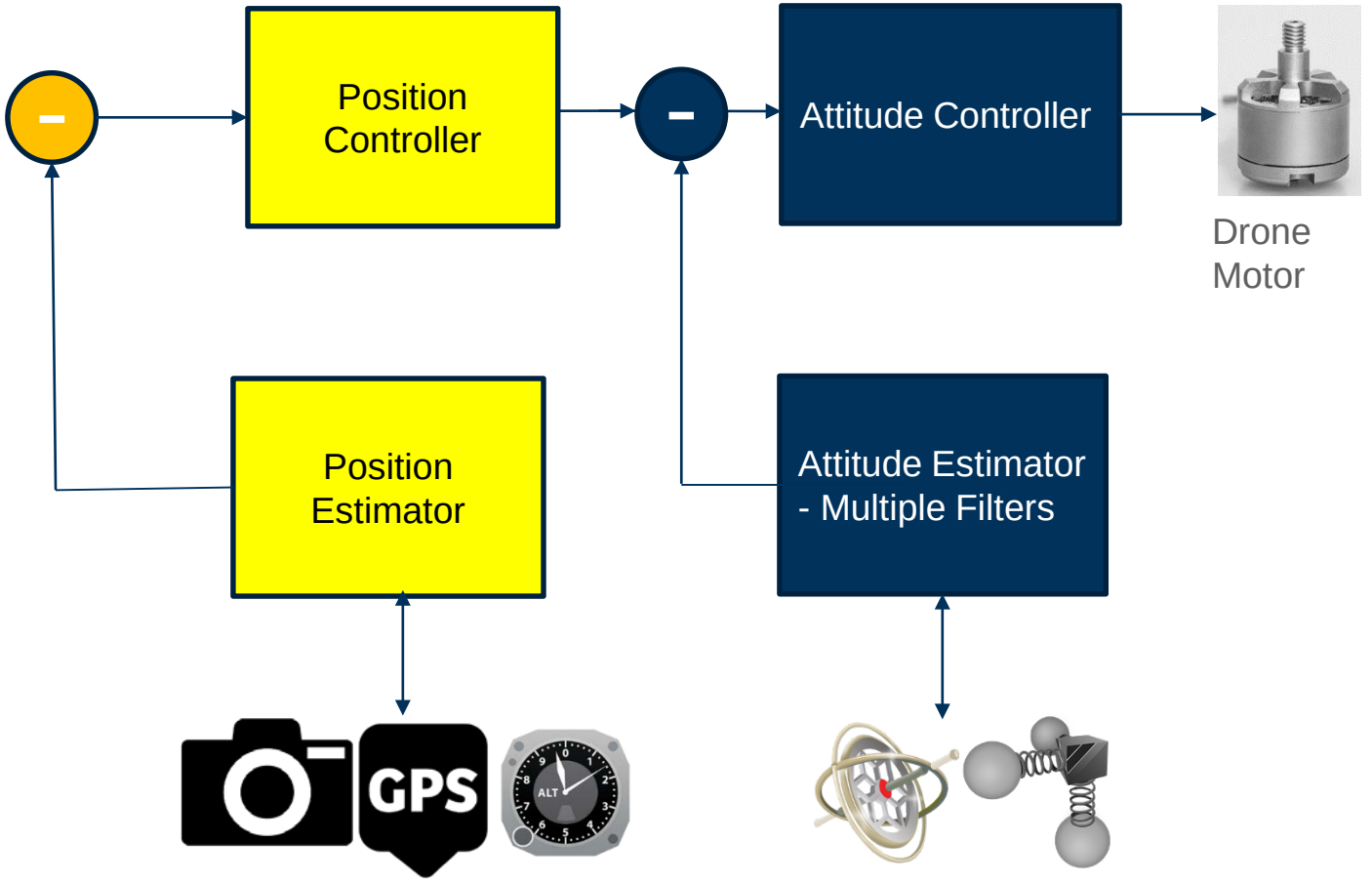
DRONE : HW ARCHITECTURE

sensing the FUTURE



DRONE: FLIGHT CONTROL LOOPS

sensing the FUTURE



DRONE : FULL STACK

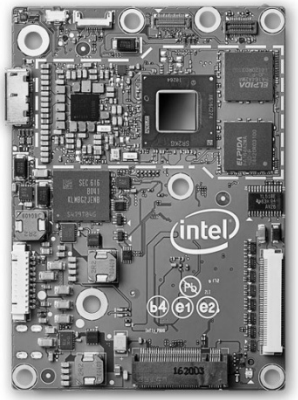
sensing the FUTURE

Supporting Systems	• Airspace Regulation • Design and Sim tools • Drone marketplace • Training
Analytics	• Vertical specific insights • Machine Learning
Image Processing	• 3D Models • Computer Vision
Control and Image Capture	• Flight Controller/OS • Mission and flight planning • Fleet Management
Drone Platform	• Airframe Manufacturer • Drone Packaging
Hardware Components	• Vision/Cameras • Power/Propulsion Systems • Sensors

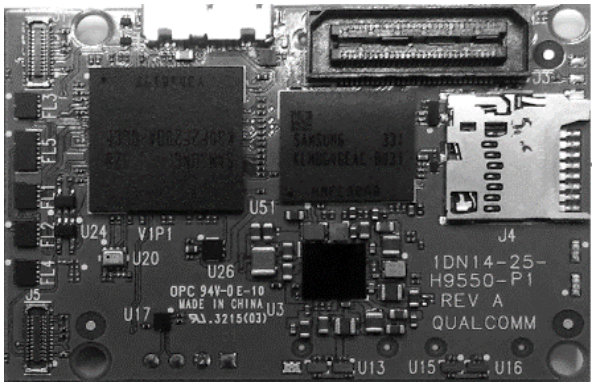
Source: http://www.balderton.com/news/a-primer-on-drones-and-uavs-part-1

HOW TO BUILD A DRONE : FC (1/2)

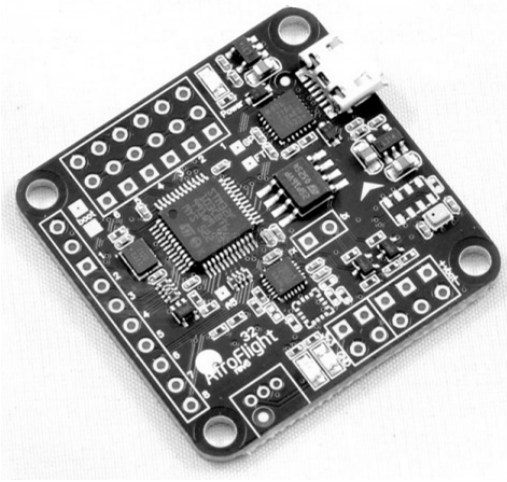
sensing the FUTURE



INTEL AERO



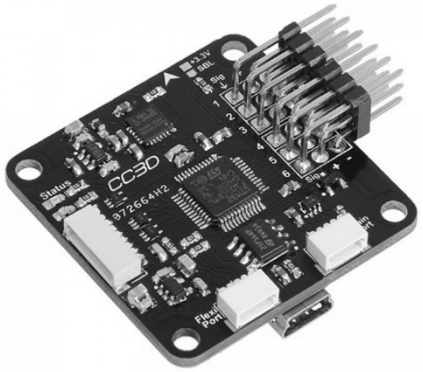
QUALCOMM FLIGHT



NAZE32

PIXHAWK

DJI A3/A3PRO & GPS-COMPASS



CC3D

HOW TO BUILD A DRONE : FC (2/2)

sensing the FUTURE

Flight controller	Features
CC3D	STM32 32-bit MCU at 90MIPs with 128KB Flash and 20KB RAM 6-axis MEMs gyros and accelerometer
NAZE32	32-bit processor running at 72MHz
MultiWii Lite V1.0	FTDI/UART TTL socket for debug, upload firmware or LCD display I2C socket for extend sensor Separate 3.3V and 5V LDO voltage regulator MPU6050 6 axis gyro/accel
DJI Naza-M Lite	Advanced Attitude Stabilize Algorithm Intelligent Orientation Control (IOC) Built-in Gimbal Stabilization Function Multiple Flight Control Mode/Intelligent Switching Support Futaba S-Bus and PPM Receiver
3DR Pixhawk	Fully Autonomous Operations when using GPS Mission Planner Ground Station Safety Fail safes

HOW TO BUILD A DRONE : AIRFRAME

sensing the FUTURE

HEXACOPTER

QUADCOPTER

OCTACOPTER

HOW TO BUILD A DRONE : PROPELLER

- Key criteria :
  - Length & Pitch
- Shorter Pitch → Higher Torque
- Longer Pitch → Higher Speed
- Longer Props → Better Efficiency

Tip : For racing drones pick a small motor and small pitch

HOW TO BUILD A DRONE : BATTERY

sensing the FUTURE

- Key Criteria :
  - Max continuous Current draw = Battery Capacity (Ah) x Discharge rate (C)
- Higher discharge rate → Faster rotor speeds
- Higher discharge rate → Shorter Flight Time
- Larger batteries → Increased Weight
- *Tip: Pick one with high C and over 3000mAh*

Source: Google Images

HOW TO BUILD A DRONE : MOTOR

sensing the FUTURE

- Sizing a motor
  - Calculate Weight (W) of Multi-copter
  - Thrust = 2 x W
  - Thrust per Motor = (2 x W)/4
  - Checkout Thrust tables of motor, to pick the right one

BRUSHLESS DC MOTOR

The voltage (V)	Paddle size	current (A)	thrust (G)	power (W)	efficiency (G/W)	speed (RPM)
8	Carbon Fibre Prop 6x3	6.4	240	51.2	4.7	11910
12	Carbon Fibre Prop 5x3	7.5	310	90.0	3.4	20100
	Carbon Fibre Prop 6x3	11.5	440	138.0	3.2	16300

WHAT CAN YOU BUILD : SOME IDEAS

sensing the FUTURE

1. Build a differentiated FC with better CPU + Sensor
2. Build an outdoor navigational unit for one of the FC's
3. Build a temperature/vibration controlled IMU
4. Build a gesture controller to replace a RC
5. Build an anti-collision kit for one of the FC's

https://www.invensense.com/solutions/drones/

Thank You