



Minneapolis - Denver - Washington, D.C.

Weather needs for UAS

Joe Burns CEO

Sensurion Company Highlights



- Uniquely positioned as a vertically integrated sUAV platform and services provider
 - FAA-certified UAVs, avionics and sensor platforms
 - UAVs as-a-service (“UaaS”)
 - UAV-enabled data management solutions
- Seasoned management team from major airlines, aerospace companies and the US military with deep relationships with the FAA and NASA
- Designed and engineered two distinct UAV sensor platforms
 - Magpie: Fixed wing aircraft
 - Sentinel: Commercial grade drone with unlimited persistence capability from tethered operations
- Partnerships with IBM Bluemix and Watson and Amazon Web Services
- History of providing security and safety professional services to commercial and governmental agencies and successfully transitioned to being a provider of products and software/data services
- Extensive weather operational experience

UAS Weather Needs – Our perspective

Sensurion Background:

- Extensive manned aircraft experience
 - Major Airlines, GA, Military
 - Pilots, Operations, Management
 - Technology – Avionics, Airframes, Weather, Security, Communications, etc.
 - Entrepreneurial Businesses
 - Weather Dissemination, Forecasting
 - Weather Observation / Collection
 - Weather Uplink and Downlink, Displays, Communications
 - R&D
 - Weather Radar Systems
 - Weather uplink, downlink, and cockpit displays
 - Turbulence, Icing, Winds, Deicing
 - Data Observations & Collection From Aircraft

We understand how hard it is to operate aircraft safely and reliably – what it takes to do that, and how the manned aviation industry achieved those goals.

The UAS industry still has a long way to go in all three of those areas, and can learn a lot from the manned aviation industry – if it will...

SENTINEL MP-4 / MP-4T



SENTINEL

MP-4/MP-4T Multi-Rotor Specifications

Model #:	MP-4/MP-4T
Endurance:	27 min/indefinite (MP-4T)
Weight:	6.5 lbs.
Payload:	3 lbs.
Powerplant:	Electric/LiPo or tethered power — ground-battery/power
Body Diameter:	39 inches
Tether Height:	Up to 200 feet
Datalink:	Configurable to operating environment, location, regulations
GCS:	Autoflight programming, graphical flight data, payload status/data, datalink, data storage, networking and weatherproof

- Sentinel MP-4 / MP-4T
 - Multirotor aerial sensor platform
 - Commercial utility UAV for numerous applications
 - Simple to fly and program
 - Manual or flight planning route
 - GPS/WAAS centimeter precision positioning
 - Tethered up to 100M
 - Tethered unlimited flight time
 - Can launch / recover from small area

FAA Certified UAV: MAGPIE MP-1



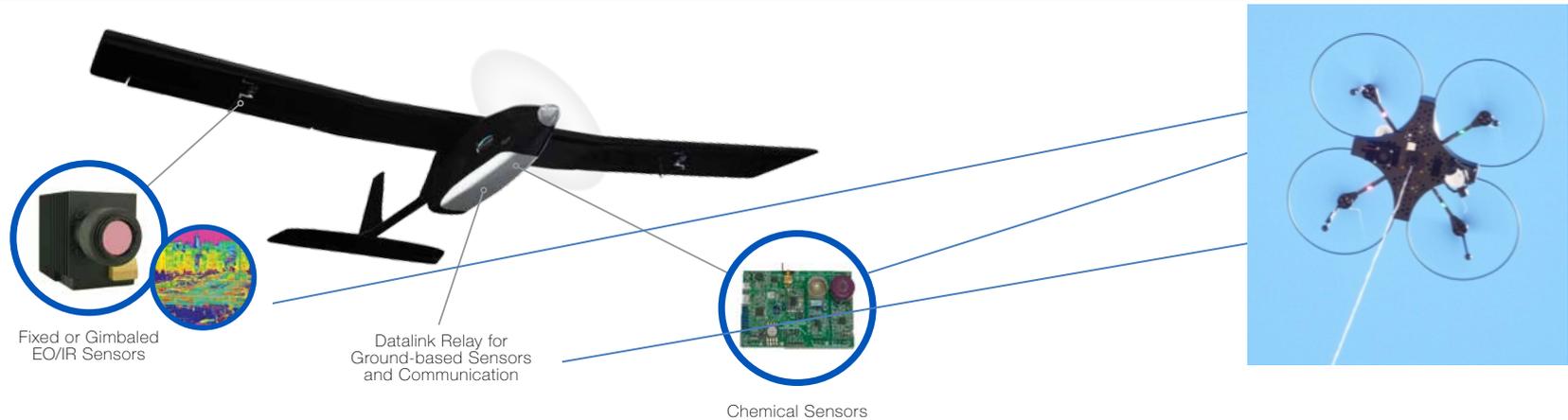
MAGPIE

MP-1 Fixed-Wing Specifications

Model #:	MP-1
Endurance:	1.5 hours
Weight:	10–15 lbs.
Payload:	Up to 5 lbs.
Powerplant:	Electric/LiPo
Wingspan:	95.75 inches
Length:	62.50 inches
Landing Options:	Skid, wheels, skis
Datalink:	Configurable to operating environment, location, regulations
GCS:	Autoflight programming, graphical flight data, payload status/data, datalink, data storage, networking and weatherproof

- Fixed-wing Commercial utility UAV
 - Configurable Sensor Platform
- FAA Certifications Include:
 - 1st Special Airworthiness Certificate through FAA Test Range
 - 333 waiver for commercial operations
 - Registered (N#)s
 - Numerous COAs – airspace approval
 - FAA approved manuals
 - Operations
 - Maintenance
 - Training
 - Safety Checklist

sUAV-Based IoT Sensors & Data Management



Sensors

- ❑ 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
 - ❑ Lighting Systems
 - ❑ RF detection / Radio Relay

Data Management

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

How is “Weather” Relevant to sUAS Operations?

- Regulatory Requirement for certain operations
- Planning
 - Can I successfully conduct the mission? Safely?
 - Can I stay within required altitude, geofencing, and other limits for entire mission?
 - Can I successfully recover aircraft at the end of the mission period?
 - What impact will weather have on my mission duration capability?
- Direct Operational Impacts
 - Managing challenging or near-limit conditions
 - Reacting to changing conditions
- Contributing Data Back Into the Weather System
 - Alert other operators of changing conditions
 - AMDAR-type observation input to forecast models

Weather Impacts on Practical sUAS Operations

- Scale Factors of sUAS vs Part 23 Aircraft Make Them Much More Susceptible to Turbulence and Wind Shear:
 - Wing loading is much lower
 - Mass is much lower
 - Wing/Rotor Spans are Much Shorter
- Stall and cruise speeds much lower than Part 23 and Part 25 – winds have a dramatically increased impact
 - Cruise speeds top out about where Part 23 begins
- Many lower boundary wind speeds can exceed forward flight speeds – thus creating a no-return scenario
- Many sUAS have Precipitation Restrictions

Weather Impacts on Practical sUAS Operations

- Most UAS are not intended for flight into IMC
 - Icing, precip, loss of Vis/CAVU all potential issues
 - Ability to maintain VLOS is key to planning and executing many missions
 - How do we characterize ground-to-air “visibility”
- Lower boundary layer atmospheric hard to measure, much less model
- Dramatic wind shifts/shear from surface to 500’ for small UAS
- Effects of weather on ground-based (versus aircraft-based) operator

Weather Impacts on Practical sUAS Operations

- Temperature susceptibility of Li-Ion battery packs
- Effects of turbulence & winds on mission duration
 - Deviation limits can significantly vary impacts on mission duration
- Increasing levels of sUAS autonomy will require reduced weather uncertainty
- Tethered UAS Systems Present Additional Considerations, Including Lightning and Static Buildup
- A briefing is required – but where do the pilots get one?
 - FSS is not yet equipped to handle UAS briefing request
 - Typical sUAS operator will have limited weather training – will need simple, intuitive tools in the field

So... What Weather Information Will Be Needed - *Specifically?*

- **Currently available WX information, tailored for sUAS users**
- **New products that provide much higher spatial and temporal resolution in the boundary layer area, including:**
 - Winds, Turbulence and “Gustiness Factors”
 - We need to look at “Gusts” differently than classical turbulence in low-altitude, sUAS Ops contexts
 - Indexing Gusts/Turbulence to a radically different scale of airframe/limits
 - Visibility – referenced to VLOS-type operations
 - Probability of exceeding specific limit factors:
 - Max Winds versus aircraft return speeds
 - Gusts, Turbulence, Shear – Controllability AND Battery Life
 - Temperature & Density Altitude
 - Visibility variations
 - Precipitation / Icing
 - Variations in altimeter setting during a mission
 - Lightning/Static Buildup

So... What Weather Information Will Be Needed?

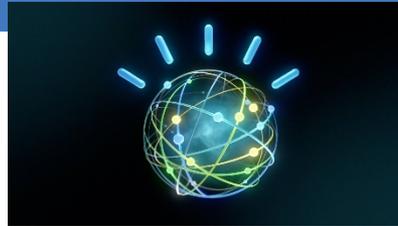
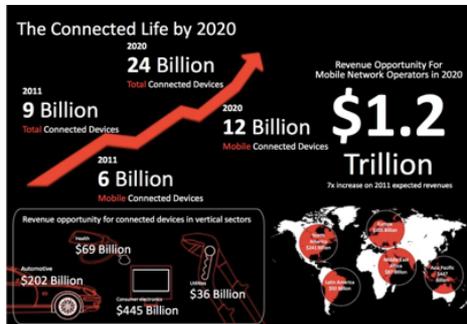
- **Leverage the UAS platforms themselves as a key part of the solution**
- **Real-time observations of boundary layer conditions**
 - **Nowcasting**
 - **Research & modeling**
 - **Calibrate model metrics for individual aircraft types**
- **Interaction between turbulence, deviation limits/range, and vehicle performance**
- **Terrain and vegetation database updates**

Sensurion Presents: sUAS Digital Solutions Powered by IBM Watson IoT

Sensurion Platform: Drone – Payload – Communications – Certified Operations

Internet of Things (IoT) – SaaS - Analytics – Mobility – Asset Management Standards

The number of connected devices is exploding

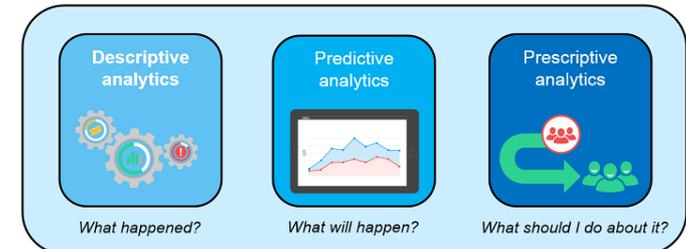


Mobility taking center stage

SaaS opens up the market to SMB

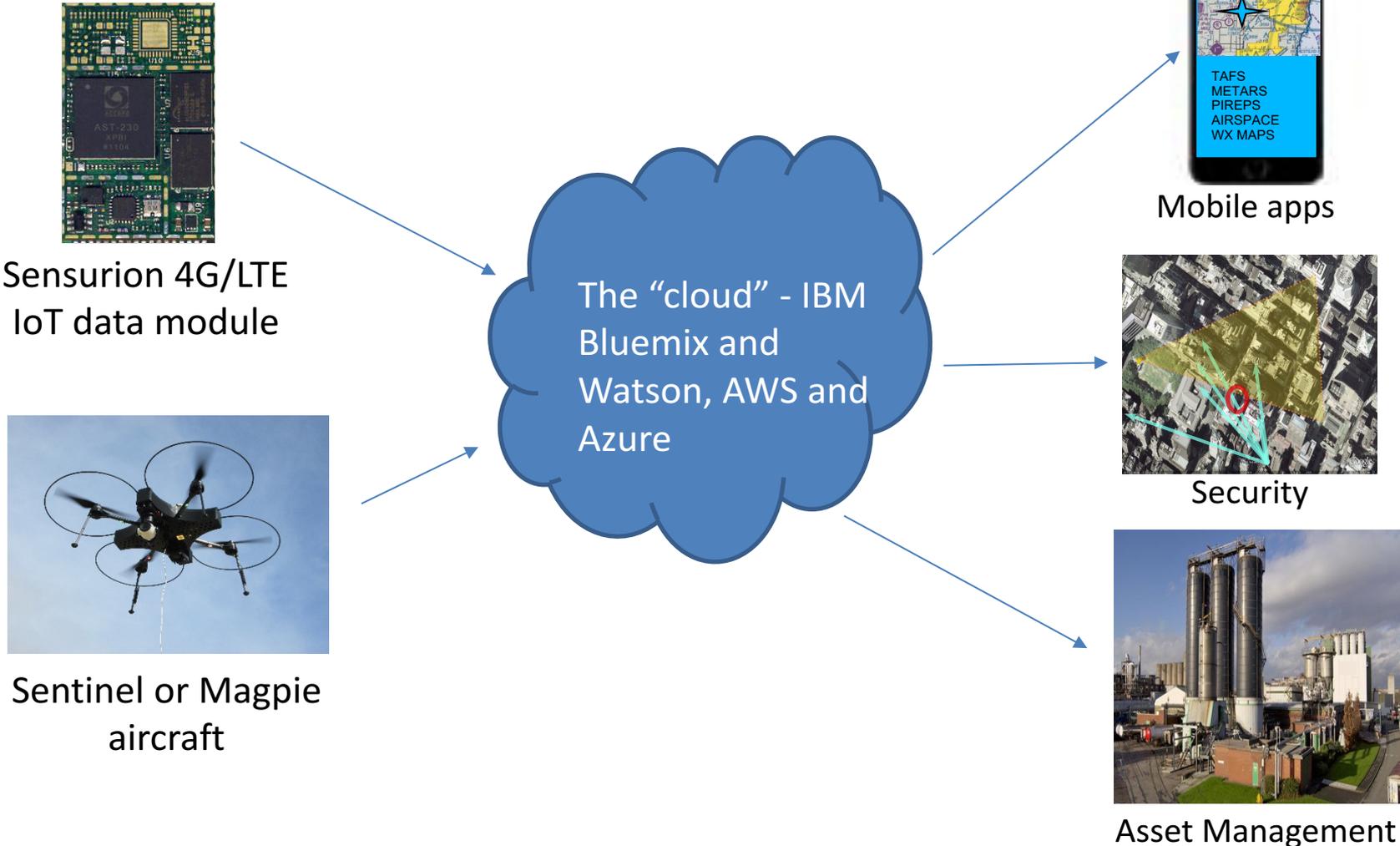


Big Data and advanced analytics



IBM Watson IoT 4

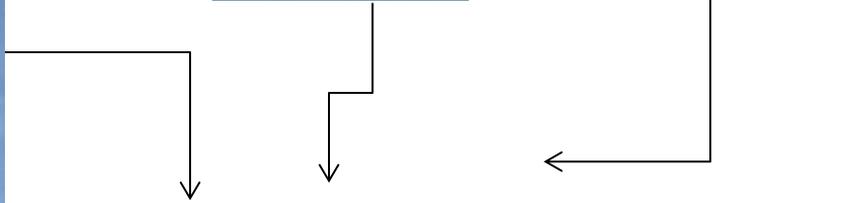
UAV-Enabled Data Solutions



UAVs as a Weather-Collection Platform – “Micro” AMDAR/MDCRS



Sensurion MP-1 or MP-4





SENTINEL

TETHERED UAS



RAPID RESPONSE PAYLOADS

EO / IR Cameras
Communication Relay
Aerial Lighting

sensurion.com

Thank you!



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QUICK DEPLOYMENT



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