SESAR U-Space Workshop

20 April 2017, the Hague
The Global UTM Association

GOAL: Safe and secure integration of drones into national airspace systems

TACTIC: Interoperability Blueprint
System of Systems
- Architecture
- Common Protocols
- International ID
Why Should There Be a Global Standards Body?

- Why are global standards useful?
- Who do global standards benefit?
The Drone Industry Is Booming

Today:

- Drones are a heavy-duty tool
- One operator per drone
- Must fly within visual line of sight
- Creating efficiencies & revenue streams even at this stage
USE CASE: Bridge Inspections

TODAY:
- Traditional method still used today
- Several workers in a bucket truck
- Relies on human senses

ALSO TODAY:
- More efficient, effective
- One worker & one drone
- Uses sensors to gather data
Operating Across Multiple Jurisdictions
Bridge Inspection in the Near Future

- Autonomous flights
- Sensors guide the drone
- Widespread adoption
- Simplified access to multiple jurisdictions
Drones Are Poised to Transform the Economy

But first, we must address two standardization challenges:

1. How all the technologies communicate among each other
2. How to harmonize our regulatory approaches with the technology
Harmonizing Means Integrating

1. Airspace regulations
2. Wireless network infrastructure
3. Aerial robots, payloads, software
Unmanned Traffic Management Is a System of Systems

Providing the blueprint for drones to interact on an international airspace network

- Common languages
- Social contract
- IP addresses of the sky

www.utm.aero
UTM Enables a Global NETWORK of Aerial Robots

Common protocols will allow drones to connect across:

- Information space
- Regulatory jurisdictions
- Technologies
- Market demands
GOAL: Safe and secure integration of drones into national airspace systems

TACTIC: Interoperability Blueprint System of Systems
- System of Systems Architecture
- Common Protocols
- International ID
Our Members
GUTMA’s First Three Working Groups

- **Overall Architecture**
  Whitepaper publication next week!

- **Data Exchange**
  Open Source Project in progress

- **Registration Identification**
  Launched in April
Let’s Be Clear

Regulators create the rules

Industry creates the technology

Regulators can use industry-driven approaches as they define regulations
Bridge Inspection in 5-10 years
The Future of the Aerial Robotics Network
Contact

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Opening Remarks

Florian Guillermet, SESAR JU Executive Director

20 April 2017, the Hague
First things first

Thank you!
Drones will be part of our future

Controlled airspace
- Manned aviation in controlled airspace:
  - Hrs: 33M
  - Kms: 20B
- Unmanned aviation in controlled airspace:
  - Hrs: 7M
  - Kms: 4B

Controlled + Uncontrolled
- Manned aviation often in uncontrolled airspace:
  - Hrs: 2M
  - Kms: 0.6B
- Unmanned aviation often in uncontrolled airspace:
  - Hrs: 7M
  - Kms: 4B
- Long endurance surveying & monitoring:
  - Hrs: <0.1M
  - Kms: <0.1B
- Remote infrastructure & rural usage:
  - Hrs: 20M
  - Kms: 1B
- Leisure usage:
  - Hrs: 80M
  - Kms: 1B

Protected Sites

Very low level "VLL" airspace (initially at 150m or 500 ft)

SESAR U-SPACE WORKSHOP
Not working in isolation

NASA

FAA

EASA

ICAO - OACI - ICAO
Our journey in 2017

What is U-Space?
- Today
  - First exploration projects announced

When will it be rolled-out?
- June
  - Helsinki conference

How?
- October
  - Initial trial locations announced
Two objectives for today

Hear from you if....

1. You now understand better what “U-Space” is (and isn’t!)

2. We have been “radical enough” in our approach

... before we move on with the next stage of our activities
Wishing you a good workshop ...
SESAR U-Space Workshop
The U-Space Vision

Julie Ibalot, Master Planning Expert, SESAR JU
Ludovic Legros, Programme Manager, SESAR JU

Why U-Space?
Significant value at stake for Europe

**U-Space enabled**

- **Uses in rural, low level context**
  - Value: ~€6.5B
  - Airtime: ~20M Hrs

**U-Space enabled**

- **Uses in populated, low level context**
  - Value: ~€4B
  - Airtime: ~250M Hrs

**Uses in controlled & uncontrolled airspace**

- Value: ~€4B
- Airtime: ~7M Hrs

70% of the value can only be fully unlocked with U-Space
Europe must act now

5 years window of opportunity before other regions in the world likely complete most critical activities
Some needs for U-Space
Mapping and surveying
Infrastructure Inspection
Delivery of medical assets
What is U-Space?
U-Space is ...

“U-Space is a set of **new services** and specific procedures designed to support safe, efficient and secure access to airspace for **large numbers of drones**.

These services rely on a high level of **digitalisation and automation** of functions, whether they are on board the drone itself, or are part of the ground-based environment.

**U-Space provides what is needed to enable and support routine drone operations**, as well as a clear and effective interface to manned aviation, ATM/ANS service providers and authorities.”

*Source: A blueprint for U-Space, draft version 0.9*
U-Space

- All operating environment
- All types of airspace
- All kinds of missions
- All categories of drones
- All drone users
U-Space is a set of services

Before operation
- e-registration
- e-identification

Flight preparation
- flight planning
- flight approval
- capacity management
- geofencing
- meteorological information

Flight execution
- tracking
- airspace dynamic information
- assistance for conflict detection
- interfaces with ATM/ATC

Post flight
- recording
- playback
How does U-Space operate?
How will U-Space be roll-out?
Services, automation, connectivity

Level of drone automation increases
Vehicle to vehicle, Vehicle to infrastructure

U1 U-Space foundation services
U2 U-Space initial services
U3 U-Space advanced services
U4 U-Space full services

SESAR U-SPACE WORKSHOP
What could be the services?

U1 - U-Space foundation services
- e-registration
- e-identification
- geofencing

U2 - U-Space initial Services
- flight planning
- flight approval
- tracking
- airspace dynamic information
- procedural interface with ATC

U3 - U-Space enhanced Services
- capacity management
- assistance for conflict detection

U4 - U-Space full services
- integrated interfaces with manned aviation
- additional new services
By 2019?

Operational
- U1
  - U-Space foundation services
    - e-registration
    - e-identification
    - geofencing

Demo
- U2
  - U-Space initial Services
    - flight planning
    - flight approval
    - tracking
    - airspace dynamic information
    - procedural interface with ATC

Exploration
- U3
  - U-Space enhanced Services
    - capacity management
    - assistance for conflict detection.

- U4
  - U-Space full services
    - integrated interfaces with manned aviation
    - additional new services

SESAR U-SPACE WORKSHOP

Operational Demo Exploration
Thank you very much for your attention!
Creating the EU drone ecosystem

Matthew Baldwin, Deputy Director-General, DG MOVE, European Commission

20 April 2017, the Hague
Panel discussion: is our vision future proof?

Benoit Curdy, Global UTM Association

Andrew Charlton, Drone Alliance Europe

Christian Struwe, Drone Manufacturer Alliance Europe

Peter van Blyenburgh, UVS International

Moderated by Koen De Vos, Senior Expert, European Commission DG MOVE
NETWORKING LUNCH
Have your say on the SESAR mobile app

The SESAR mobile application will help you stay up to date with the latest activities at various events organised by the SESAR JU and even on a daily basis.

The app includes several interactive features such as, the possibility of personalising your own agenda during SESAR JU events, chatting with SESAR stakeholders, interaction polls, surveys and much, much more.

The mobile app will also allow us to provide you with last minute announcements, changes, and important information during the event.

Get started today by downloading the app!

App Store
Google Play
HTML 5

In case you experience any problems with downloading/accessing the mobile app, contact us.
Disruptive technologies—Flying Robots

CLARA OTERO
Director Systems Innovations
NXP Semiconductors

SESAR U Space workshop
Den Haag, April 20th, 2017
Safe & Secure Mobility – 90% Innovation Through Electronics

Seamlessly Connected Mobility Experience
- One hour per day in the vehicle
- Enjoying Life

ADAS Towards Self-Driving
- 1.3M global road fatalities every year
- Saving Lives

Energy Efficiency
- US mandates 163 grams / mile and 54.5 MPG by 2025
- Reducing CO₂
From Automotive to Safe & Secure Mobility

More than doubling the semi content per vehicle

Tomorrow:
Self-Driving Robots with end-to-end Services
ENABLING THE SECURE CONNECTED CAR

Secure Connected, Self-Driving Cars will Save >1,3M Road fatalities globally

NXP Offers Complete Secure ADAS System…. 

SENSE
Radar Vision Secure V2X

THINK 
Processing Sensor Fusion Security

ACT
Powertrain Chassis Braking

BIG DATA 
Digital Networking Infrastructure Security
Connected UAV
Cooperation,
Autonomy,
Sense and avoid
technologies
VEHICLE-TO-EVERYTHING (V2X) COMMUNICATIONS
BASED ON IEEE802.11p standard

INTELLIGENT TRANSPORT SYSTEMS (ITS)
Avoiding road accidents
Improving traffic flow / CO₂
Enabling autonomous driving

IEEE802.11p is derived from IEEE802.11a/g (today’s WiFi standard in computing)
VEHICLE-TO-EVERYTHING
USE CASE EXAMPLES

Typical V2V
Hazardous location warning
Slow vehicle warning
Stationary vehicle warning
Emergency brake light
Emergency vehicle warning
Motorcycle approaching indication

Typical V2I / I2V
Probe Vehicle (Floating Car) Data
Signal traffic light phase and time
Road works warning
In-vehicle signage
Cooperation: Dedicated Short Range Communication
802.11p + Security

RELIABLE dedicated communication up to 3 KM
MULTIPLE Communication links at once.
Super light weight “Anti Collision Transponder”.
Best receiver sensitivity also for
  ▪ Non-Line-of-Sight and Mobility conditions
    (differential speeds up to 500km/h)
  ▪ line of sight range up to 3 KM
Software defined radio supporting over the air updates
as well as global standards
Automotive quality

APPLICATIONS:

• REAL TIME Video transmission up to 3 KM
• SECURE Remote Control of the UAV (avoiding unauthorized access)
  Low latency direct communication 802.11p
• Drone to Person communication
  “Selfie Drone” follows me at specified altitude & distance and makes
  movies of me while I am windsurfing etc.
• UAV authentication to local authorities via secure V2X & SMX
  avoid UAV misuse by terrorists at a public events/ in cities to carry
  explosives.
SECURING V2X COMMUNICATIONS

SECURITY

WAS THE MESSAGE NOT MODIFIED?
DID IT REALLY ORIGINATE FROM CAR A?
CAN I TRUST CAR A?

CAR AND MESSAGE AUTHENTICATION REQUIRED TO PREVENT TRAFFIC DISRUPTION OR IMPersonATION

PRIVACY:

CAN OTHERS TRACK ME WHILE DRIVING?

HIGH DEGREE OF ANONYMITY (IDENTITY HIDING) REQUIRED TO PREVENT TRACKING

Seeing around corners
Emergency Vehicle Warning
Hazard Warning
SECURING V2X COMMUNICATIONS
MESSAGE AUTHENTICATION VIA DIGITAL SIGNATURES

Authentication via digital signature

Based on
Hash function $\rightarrow$ unique identifier for message
Public-key crypto - two keys (private/public)

IEEE (US) & ETSI (EU) standards mandate
Elliptic Curve Digital Signature Algorithm
RSA signatures too long
Comparable security strength of
RSA3072b $\sim$ ECC256b $\sim$ AES128b

<table>
<thead>
<tr>
<th>TX</th>
<th>RX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation</td>
<td>Signature generation</td>
</tr>
<tr>
<td>Rate</td>
<td>Low: $\leq 20 / s$</td>
</tr>
<tr>
<td>Security level</td>
<td>High: protection of private keys (car identity)</td>
</tr>
</tbody>
</table>

Public key exchange (can be part of message)

Hello! $\rightarrow$ sign $\rightarrow$ Hello! $\rightarrow$ verify $\rightarrow$ Hello!

TX 1 $\rightarrow$ N
RX N $\rightarrow$ 1
Sense and Avoid: Radar
Stamp size Radar Sensors

- Collision Avoidance
  - Buildings
  - Wires
  - Other Drones
  - Birds
- Measuring altitude
- Typically 1-3 Radars per drone

Dolphin one-chip Radar Frontend as key component in Drone Radars

- Small size
- Low weight
- Low power consumption

Prototype available at InnoSenT

Note: permission of FAA & FCC pending on use of 76-81GHz spectrum by UAV's
Sense and avoid: Vision systems

One SW Platform from Smart Sensors to Fusion Unit


• mC Families with true automotive reliability
• High Performance/Power, and True Safety
• Guaranteed Security and Connected Network
• Ecosystem of SW and Tools (mCAL-Linux-Safe OS)
UAV
Security and safety
A geofence is a virtual boundary around a real-world geographical area (e.g. airport). Rules to avoid no-flying zones.

1. Receiving of trusted geofencing data

2. Safety: GPS (global positioning system) or RFID (radio frequency identification) to enforce a given geo-fence

⇒ Required: joint definition of
   1. Unique UAV-ID for Authentication of UAV in the cloud
   2. Trusted Geo-fencing Data (Encrypted Data)
   3. Secure Data Upload: Secure Communication between UAV and (national) Server
   4. Central flight log

Source: Synergy World
Summary NXP Technologies for UAV

UAVs can be fully powered by NXP

- Sense and avoid: Secure Drone2X, RADAR, Sensor Fusion, Bolometer, Vision Processing, LIDAR
- Application processors: Secure Microprocessors, High Speed Interfaces, Vision Processing
- Battery: Power MOSFET, Smart Charging, Wall Plug Adapter, TVS Protection, Battery Cell Monitoring, Battery Tagging/Authentication, Wireless Charging
- Enrollment/activation: Secure ID, NFC, BTLE, Secure Element
- Interfaces: CAN, CAN FD, Ethernet, HDMI ESD protection, USB, SPI, I2C, Mixed Signal MCU
- BLDC Motors: Microcontrollers, Motor Control SW, Power MOSFET, Gate Drivers
- Application processors: Secure Microprocessors, High Speed Interfaces, Vision Processing
- Infrastructure: Secure Drone2X, RADAR, Vision processing, Secure Microprocessor, Satellite Uplink

www.nxp.com/UAV

Comments
- Current portfolio fits very well with current Drone BOM
- Future drone generations can benefit from NXP’s Secure Drone2X communication and RADAR, registration/activation
Summary

Connected UAV require state of the art technologies

- Autonomy: Radar, V2X communication, Vision, Sensor fusion, IR, high accuracy positioning.
- Security: Registration, authentication
- Safety: Geofencing, limp home, Safe operational
- Privacy: Video encryption, privacy preserving video analysis.
Mobile networks for safe integration of Unmanned Aerial Vehicles (UAV) in the airspace

Michiel Dirven
Head of Customer Business Team
Nokia
Providing mission and business critical services

Networking solutions for all components

- LTE radio and Core network: Real-time data and video applications for enhanced situational awareness
- Secure IP/MPLS over microwave and optical: Providing more bandwidth to support mobile broadband applications
- End-to-end security: For all network layers, applications and devices
- Professional services: For meeting the specific needs of critical communications customers
- Industry-specific: Devices, applications, and interworking functions for legacy systems
Today UAVs are operated manually

- Pilot controls UAV manually via peer2peer radio link
- UAVs are not connected to the Internet
- UAVs position cannot be monitored remotely
- UAVs cannot exchange data towards cloud resources
- No centralized intelligence
Today mobile networks are not optimized for UAVs

- Networks are deployed for ground-level coverage – 1.5 m above a ground
- Coverage and mobility are limited in altitude
- Mobile Network connected UAVs may suffer from interference
Targets for mobile network design to enable connected Unmanned Aerial Vehicles (UAV)

- Mobile networks reconfigured and optimized to support connectivity for UAVs and users on the ground.
- UAVs can be controlled and monitored.
- Mobile networks will bring scalability.
- Seamless connectivity, significant improvements in applications and data transfer from UAVs.
Nokia Multi Access Edge Computing (MEC) enables UAV Control and beyond

Low latency communications between UAVs and infrastructure

Nokia Multi Access Edge Computing
• Vehicle to anything (V2X) communication
• Low latency communication
• Data analytics platform
• Video analytics algorithms
UTM Architecture based on Multi Access Edge Computing (MEC)

Mobile LTE/Cellular Network

- LTE Mobile Base Stations
  - Pilot app LTE + proprietary C2
  - UTM modem LTE + proprietary C2
- User data

UTM modem LTE + proprietary C2

User data

UTM modem Generic Internet access + proprietary C2

Generic Internet access

Authorities
- Web- or app-based via generic Internet access

Clouds
- UTM
- Service Provider Cloud(s)
- UAS Vendor A Cloud
- UAS Vendor Z Cloud
- Map services

NOTE: central operator cloud not shown
Connecting society: Internet of Drones is the future

- Agriculture surveillance
- Smart grids
- Factory intralogistics
- On duty drones for first responders
- Private and hobby use
- Climate monitoring
- Railway monitoring
- Driverless cars
- Connected home
- Driverless buses
- Driverless trucks
Next-generation network for mission-critical and smart city services

2016: Nokia selected by Dubai government security networks operator Needa

Create safe and smart city for residents and visitors

Applying IoT for emergency services support, e-government, transportation and healthcare

5G-ready, mission-critical network

High-bandwidth voice, video and other data applications for mission-critical services IoT
Drones in SmartCities U-Space

Food for Thought

U-Space Workshop, The Hague, April 20th, 2017
Andreas Lassak, Deutsche Telekom AG

LIFE IS FOR SHARING.
What to talk about...

SESAR
reTHINK
mySMARTLife
U:CON
Current initiatives Running

European Drones Outlook Study
Unlocking the value for Europe

November 2016

Current initiatives Running

Goal

* Drone specific addendum to ATM Master Plan

Ambition

* All kinds of environments (1)
* All types of missions
* All types of users (2)
* VLOS & BVLOS
* Above VLL (3)

Impact

* Disrupt ATM with new technologies
* Open path to broad drone usage
* Make airspace accessible practically for everybody

(1) Urban, Sub-Urban, Rural, regardless of the density of population
(2) Civil - especially open and specific categories, Commercial & Leisure, Military, State & Public
(3) Very Low Level
Current initiatives Running

**reTHINK**

- Support personal data agnostic business cases
- Emancipated communication of Things and Humans
- Easier cooperation between Things and Humans

**Goal**
- Ecosystem for Cross Domain Communication

**Ambition**
- From Silos to Hyperties
- Context related Identities in one Service
-Bring & Manage Own Identities

**IMPACT**
- Support personal data agnostic business cases
- Emancipated communication of Things and Humans
- Easier cooperation between Things and Humans
Current initiatives Running

**Goal**

- Transition of EU cities towards a new concept of Smart Life and Smart Economy

**Ambition**

- Reduce CO2 of cities
- Renewable energy sources
- Environmentally friendly
- Refurbishment of buildings
- Clean transport
- Supporting ICT solutions

**IMPACT**

- Develop concept of Smart People in „Inclusive Cities“
- Enable Smart Economy

H2020 EU co-funded lighthouse project

mySMARTlife

T-Systems

(1): Project Cities: Nantes, Hamburg, Helsinki
Current initiatives Running

**U:CON**

- Project Cities: Nantes, Hamburg, Helsinki
  - Save integration of drones into airspace
  - Economic
  - Boost Smart Drone Economy

**Goal**
- ConOps development
- System Requirement
- Prioritization of aspects

**Technology**
- Partner

**Ambition**
- Showcase the connection of drones via standard mobile networks with a UTM-demonstrator by end of 2017.

**IMPACT**
- Save integration of drones into airspace
- Economic
- Boost Smart Drone Economy

(3) Project Cities: Nantes, Hamburg, Helsinki
### Relevant Smart City Drone Use Cases

#### Real Time Traffic & Transport Mgt.
- Accident clearance and SAR Mission support
- Ad-hoc infrastructure (e.g., Network Nodes or Hyper Lightning Spots)
- Personal public short range transport (Ehang, Airbus...)
- Delivery of goods

#### Security & Safety
- Fast Crime Scene Clearance
- Risky Area Patrolling
- Suspect Observation
- Smart Home reaction unexpected occasions (e.g., Intrusion detection -> automatic lift up of observation drone -> online video link to security control center)
**Conclusio**

- Impact social life
- Implement disruptive technologies
- Relate to digital transformation of cities and society
- Generate new businesses with new business models
- Have European relevance
- Overcome barriers faster
- Enable more investment
- Avoid interface clashes
- Increase level of security already by design
- Increase public acceptance

**RECOMMENDATION**

Evaluate if a closer cooperation could be beneficial for all parties
Autonomous drones

20 April 2017, the Hague
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URBAN AIR MOBILITY: FLYING CARS
Building the future of flight.

The World Forum, The Hague, Netherlands

April 20th 2017
AIRBUS’s Experience in the Field of UAVs

DEFENSE & SPACE
SESAR View of RPAS use of AirSpace (in 2050)

DEFENSE & SPACE

All flight statistics represent primary area of airspace

**Controlled airspace**

- Manned aviation in controlled airspace:
  - Hrs: ~33M
  - Kms: ~20B

- Unmanned aviation in controlled airspace:
  - Hrs: ~7M
  - Kms: ~4B

**Uncontrolled airspace**

- Manned aviation often in uncontrolled airspace:
  - Hrs: ~2M
  - Kms: ~0.6B

**Very low level "VLL" airspace (initially at 150m or 500 ft)**

- Densely populated usage:
  - Hrs: ~250M
  - Kms: ~15B

- Remote infrastructure & rural usage:
  - Hrs: ~20M
  - Kms: ~1B

- Leisure usage:
  - Hrs: ~80M
  - Kms: ~1B

**Long endurance surveying & monitoring**

- Hrs: <0.1M
- Kms: <0.1B

**Protected Sites**

*URBAN Air Mobility*
Urban Air Mobility will become a Premium Offering to a Mass Market Solution

Exponential market growth is predicted beyond 2030
Example of Traffic Density in 2035: Urban Air Mobility

DEFENSE & SPACE

Traffic over the SF Bay Area (11 am Pacific, 23Feb2017)

~5000 vehicles flying over SF Bay Area at any given time of day

Projected UAS traffic over the SF Bay Area In 2035
Ongoing demonstration in Urban Last mile delivery

SKYWAYS
Urban last-mile delivery solution
Airbus' Skyways project aims to provide efficient, seamless delivery of small parcels to students and facilities via drones across the National University of Singapore’s campus.

Pilot Case A
Delivery of parcels on the NUS campus through Skyways network.

Pilot Case B
Delivery from parcel tower to ships. This use case will be explored upon successful completion of pilot case A.

Drones will operate using defined 'aerial corridors'.

1. The Skyways drone is an octocopter that carries air transport containers loaded on its underside.

2. The drone flies a fully automated route, landing on a designated landing pad.

3. Once landed, the drone is unloaded automatically.

4. End customers receive a delivery notification on their mobile phone to come pick up the parcel at the parcel station.

Source: Airbus Helicopters
Infographic: BeBez/Safranviz
E-VTOL Start-Ups are Developing UAM Prototypes

DEFENSE & SPACE

E-VOLO

XTI-TRIFAN

LILIUM

JOBI Aviation

E-HANG 184

AURORA

XV-24A LightningStrike

Vertical Take-Off/Landing Experimental Plane
AIRBUS Demonstrators

VAHANA – Target Demo Flight in 2018

CityAirbus – Target Demo Flight in 2019
Pop.Up – A *Flying Car* Concept Study

Presented at the 87th Geneva International Motor Show 2017 with a strong interest by the car industry
Altitude band for traffic segregation and to meet performance and safety needs

DEFENSE & SPACE

Selection of the altitude band according to:

- vehicle performance
- safety reasons
- segregate from drones, helicopters and other manned traffic

Ensure specific drone VLL route network to de-conflict with UAM approach paths to helipads
Airbus fully committed to fill the gap:
Providing technology / connectivity
From long term vision ….
…To short term actions
Next Steps

REGULATION

SAFETY

ENVIRONMENT

UTM DEFINITION

SAFE INTEGRATION

STANDARDS

SOCIAL ACCEPTANCE

ETC.
Questions?
Autonomy

System Abilities
• Adaptability
• Cognitive Ability
• Configurability
• Decisional Autonomy
• Dependability
• Interaction Ability
• Manipulation Ability
• Motion Ability
• Perception Ability

Autonomy

System Abilities
• Adaptability
• Cognitive Ability
• Configurability
• Decisional Autonomy
• Dependability
• Interaction Ability
• Manipulation Ability
• Motion Ability
• Perception Ability

Decisional Autonomy

Description

• The ability of the robot to act autonomously
• Nearly all systems have a degree of autonomy
• It ranges from the simple motion of an assembly stopped by a sensor reading, to the ability to be self sufficient in a complex environment.

Decisional Autonomy Levels

Level 0  - No autonomy
Level 1  - Basic action
Level 2  - Basic decisional autonomy
Level 3  - Continuous basic decisional autonomy
Level 4  - Simple autonomy without environment model
Level 5  - Simple autonomy with environment model
Level 6  - Task autonomy
Level 7  - Constrained task autonomy
Level 8  - Multiple task autonomy
Level 9  - Dynamic autonomy
Level 10 - Mission oriented autonomy
Level 11 - Distributed autonomy
Decisional Autonomy Levels

Level 0 - No autonomy
Level 1 - Basic action
Level 2 - Basic decisional autonomy
Level 3 - Continuous basic decisional autonomy
Level 4 - Simple autonomy without environment model
Level 5 - Simple autonomy with environment model
Level 6 - Task autonomy
Level 7 - Constrained task autonomy
Level 8 - Multiple task autonomy
Level 9 - Dynamic autonomy
Level 10 - Mission oriented autonomy
Level 11 - Distributed autonomy
Decisional Autonomy Level 4-5

Level 4 - Simple autonomy without environment model

The system uses perception to make moment to moment decisions about the environment, and so controls interaction with the environment in order to achieve a predefined task.

Level 5 - Simple autonomy with environment model

Decisional Autonomy Level 4-5

Level 4 - Simple autonomy without environment model
The system uses perception to make moment to moment decisions about the environment, and so controls interaction with the environment in order to achieve a predefined task.

Level 5 - Simple autonomy with environment model

Perception
Perception
Situational Awareness
Predefined Task

- **GRID MISSION**: Best for 2D maps
- **DOUBLE GRID MISSION**: Best for 3D models
- **CIRCULAR MISSION**: Best for single 3D models
Predefined Task
3D Modeling
Vertical Mapping
NDVI Maps
Decisional Autonomy Levels

Level 0  - No autonomy
Level 1  - Basic action
Level 2  - Basic decisional autonomy
Level 3  - Continuous basic decisional autonomy
Level 4  - Simple autonomy without environment model
Level 5  - Simple autonomy with environment model
Level 6  - Task autonomy
Level 7  - Constrained task autonomy
Level 8  - Multiple task autonomy
Level 9  - Dynamic autonomy
Level 10 - Mission oriented autonomy
Level 11 - Distributed autonomy
U-Space Workshop

Michael Drobac
Small UAV Coalition
Drone Alliance Europe
Akin Gump Strauss Hauer & Feld LLP
Autonomous UAS Operations

Perspective from the U.S.
Small UAV Coalition

Verizon Ventures

Intel

PrecisionHawk

Kespry

AIRMAP

Google

Amazon Prime Air

Fresh Air Educators

T-Mobile

Walmart

Flirtey

agi

PROVEN.cc

Linking the World

Aerwaze
Commercial applications represent the long-tail of the UAS industry.

- One report estimates the value of the global market for UAS solutions at more than $127 billion.

Support and advocate for law and policy changes that embrace and encourage industry growth, including:

- Development and implementation of UTM framework.
- Routine operations BVLOS, over people, and at night – with varying degrees of autonomy – without waiver/approval process.
- Carriage and delivery operations.
- Flexible spectrum use policies to leverage commercial mobile networks, satellite and unlicensed.
- National standard for UAS regulations that promotes safety and enables innovation.
Current US Regulatory Framework

* Small commercial rule (Part 107) implemented August 2016 – just the first step:
  * Remote pilots must pass Aeronautical Knowledge Test.
  * Maximum altitude of 400 ft AGL (except 400 feet above structures).
  * 55 lb limit (not waivable).
  * Waivers required for operations BVLOS, at night, over people, and to operate multiple UAS per pilot.
Looking Ahead

* **Additional Rulemakings**
  * Draft rule for operations over people scheduled to be released by end of 2016 – stalled indefinitely due to “national security concerns.”
  * Piecemeal approach means next planned rulemaking (expanded operations, including BVLOS) stalled as well.

* **Remote Identification Aviation Rulemaking Committee (ARC)**
  * Multistakeholder body tasked with developing standards for remotely identifying and tracking UAS within 3 months.
  * Safety and security key to integration, but remote identification only part of the puzzle.
An unmanned traffic management system (UTM) will enable highly automated – even completely autonomous – operations BVLOS, over people, and at night.

Commercial-grade communications (cellular, satellite, etc.) ensure reliability and security; leverage existing, ubiquitous network architectures.

UTM will incorporate remote identification and tracking and “no fly zones” over sensitive fixed sites.

No anonymous flying – commercial and recreational operators must participate.
NASA has been for years working with industry on UTM R&D.

FAA will have safety oversight, but private sector will build and manage system.

Congress directed FAA to establish two year UTM pilot program to begin by April – has it?

Phased implementation can and should begin before pilot program ends.

Remote identification ARC, other safety and security initiatives must move in parallel to development of new regulations to remove prohibitions and restrictions.

Technology continues to outpace regulation, inhibiting industry growth and innovation.
Autonomy In Action

* Intel drone light shows around the US (and the world) about more than just entertainment – vanguard of autonomous operations.
* First US Drone 100 show in Palm Springs, CA with FAA exemption.
* Eight weeks of daily shows during the 2016 holiday season at Disney World – 300 drones choreographed for 12 minutes.
* In October 2016, one remote pilot operated 500 Intel Shooting Star drones during a choreographed light show in Germany – using a single laptop.

Lady Gaga performed against a backdrop of 300 Intel Shooting Star drones during 2017 Super Bowl Halftime Show.
Next Steps and Opportunities

- FAA Reauthorization – Catalyst for Action
  - Authorities expire September 30. Congress should:
    - Direct FAA to implement a UTM system in a phased approach.
    - Direct FAA to expedite development of more forward-leaning framework to expedite safe integration.
    - Streamline waiver processes and authorization of expanded operations critical to integrating autonomous UAS.
    - Establish a national standard for UAS regulations.

- Drone Advisory Committee (DAC)
  - Tasked with identifying and proposing actions to the FAA to address issues affecting UAS integration into the NAS.
  - Three task groups under DAC Subcommittee: Airspace Access, Roles and Responsibilities, and Funding.
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Autonomous drones: Q&A

20 April 2017, the Hague
Closing remarks

Florian Guillermet, Executive Director, SESAR JU

20 April 2017, the Hague
Survey results

Do you now better understand what U-Space is?

a. Yes  92%
b. No  8%

Have we been radical enough in our approach?

a. Yes  67%
b. No  33%
Thank you very much for your attention!