BUILDING THE AUTONOMOUS FUTURE

Anil Nanduri
VP and GM, Drone Group
TECHNOLOGY INFLECTIONS

AUTONOMOUS SYSTEMS

5G

ARTIFICIAL INTELLIGENCE
UAV MARKET SEGMENTS

**MILITARY / DEFENSE**
- ISR
- Targeting
- Search & Rescue
- Communications
- Relay

**CIVIL**
- Search & Rescue
- Environment and Wildlife Management
- Law Enforcement & Public Safety

**COMMERCIAL**
- Construction
- Inspection
- Agriculture
- Oil & Gas
- Insurance
- Deliveries

**PROSUMER / HOBBYIST**
- Film and media
- Real estate
- Professional entertainment
- Private Security
- Marketing / sales

**CONSUMER / TOY**
- Recreational photo and videography
- Personal entertainment/FP flying
- Drone Racing
- Action sports

**Unit Volumes**
- Low
- High

**Data Requirements**
- Low
- High
Marvel at the infinite possibilities of Intel drone workflows and the profound impact they can have on improving efficiency and reducing costs.
INSPECTING SITES, ASSETS, AND INFRASTRUCTURE

UNESCO WORLD HERITAGE SITE
Hwahongmun Gate of Suwon
Hwaseong Fortress built in 1796, South Korea
2,200 images, 20GB of Data

BRIDGE INSPECTIONS
Daniel Carter Beard Bridge
640m in length crossing Ohio River
2,500 images, 22GB of Data

OIL & GAS PLANT
Cooper Basin in South Australia
4 flare tips, 9 flights, 600 images total (RGB & thermal)
NASA AMES WIND TUNNEL INSPECTION, JULY 20, 2019

9 automated flights, 1,704 images, 26GB Data

One Intel® Falcon 8+ Drone

Permission to fly under Wide Area Airspace Authorization and coordination with Moffett ATC
FAÇADE FLIGHT PLAN WITH INTEL® MISSION CONTROL SOFTWARE, HIGH RES INSPECTION PHOTOS
THE DATA-CENTRIC WORLD

OVER HALF OF THE WORLD’S DATA WAS CREATED IN THE LAST 2 YEARS.

LESS THAN 2% HAS BEEN ANALYZED.

Source: Data Age 2025, sponsored by Seagate and data from IDC Global DataSphere, Nov. 2018
THE POWER OF DATA

ASSET INPECTION AND MONITORING
CHANGE DETECTION
PREDICTIVE MODELS
COMMERCIAL DRONES: AUTONOMY ACCELERATES DEPLOYMENT

2. Auto Take-off
3. Mission Execution
4. Auto Landing & Charging
5. Reports and Analyses

UTM – Airspace & Real Time Monitoring
Fleet Management
Safety/Contingencies
Security
AI/ML Inference
## Achieving Autonomy

<table>
<thead>
<tr>
<th>Level 0</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
<th>Level 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Automation</td>
<td>Human Assisted</td>
<td>Partial Automation</td>
<td>Conditional Automation</td>
<td>High Automation</td>
<td>Full Automation</td>
</tr>
</tbody>
</table>

**Human Dependency**

- **Level 0**: No Automation - TRAINEED & SKILLED PILOT
- **Level 1**: Human Assisted - TRAINEED PILOT
- **Level 2**: Partial Automation - BASIC PILOT
- **Level 3**: Conditional Automation - OPERATOR MONITORING ONSITE
- **Level 4**: High Automation - REMOTE OPERATOR MONITORING
- **Level 5**: Full Automation - NO OPERATOR
# Achieving Autonomy

<table>
<thead>
<tr>
<th>Level 0</th>
<th>No Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual flight and operation</td>
<td></td>
</tr>
<tr>
<td>Visual line of sight</td>
<td></td>
</tr>
<tr>
<td>No onboard flight safety</td>
<td></td>
</tr>
<tr>
<td>Operator knowledge &amp; adherence to restrictions, conditions, weather</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 1</th>
<th>Human Assisted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual flight and operation</td>
<td></td>
</tr>
<tr>
<td>Autopilot assist - GPS and navigation aids</td>
<td></td>
</tr>
<tr>
<td>Safer VLOS</td>
<td></td>
</tr>
<tr>
<td>Adherence to altitude restrictions and geo-fence</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 2</th>
<th>Partial Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Routine flights automated</td>
<td></td>
</tr>
<tr>
<td>Pre-defined waypoint flying BVLOS capable</td>
<td></td>
</tr>
<tr>
<td>Pilot supervision and control when necessary</td>
<td></td>
</tr>
<tr>
<td>Automated airspace authorization</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 3</th>
<th>Conditional Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automated flight and operation – human in the loop</td>
<td></td>
</tr>
<tr>
<td>Waypoint flying with adaptive safety systems</td>
<td></td>
</tr>
<tr>
<td>Safe integration of BVLOS in controlled airspace</td>
<td></td>
</tr>
<tr>
<td>Automated airspace authorization</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 4</th>
<th>High Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-drone operations at moderate scale</td>
<td></td>
</tr>
<tr>
<td>‘Nest’ automated to support takeoff/landing/charging</td>
<td></td>
</tr>
<tr>
<td>Safe integration of BVLOS in controlled airspace</td>
<td></td>
</tr>
<tr>
<td>Low density UAV coordination</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 5</th>
<th>Full Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-managed automated flight and operation</td>
<td></td>
</tr>
<tr>
<td>Operation in dynamic &amp; high density airspace</td>
<td></td>
</tr>
<tr>
<td>Integration of weather services</td>
<td></td>
</tr>
<tr>
<td>ATM integration for congestion avoidance</td>
<td></td>
</tr>
</tbody>
</table>

*Human Dependency* |

**TRAINED & SKILLED PILOT** |

**TRAINED PILOT** |

**BASIC PILOT** |

**OPERATOR MONITORING ONSITE** |

**REMOTE OPERATOR MONITORING** |

**NO OPERATOR**
REGULATION AND POLICY CRITICAL TO FURTHER AUTONOMY OF UAV SYSTEMS

Adoption and standardization of UTM system to enable safe low-altitude airspace

Decision on a UAS Remote Identification and tracking to further enhance safety and ATM

Standards and regulations for BVLOS operations
INTEL DRONE LIGHT SHOW

A new form of art and storytelling – allowing creativity to come to life - with the sky as our canvas, and flying lights as ink

A spectacular experience where the night-sky is illuminated with 3D shapes and dynamic formations choreographed to music

A smoke-free and noise-free way for audiences to enjoy a night-sky entertainment

100s/ 1000s of preprogrammed drones flying in unison – all controlled by one pilot
LIGHT SHOWS WORKFLOW

Site Planning

Concept and Design

Animation, Testing, and Validation

Show Setup

Execution
INTEL DRONES SHOOT FOR THE MOON
HONORING THE 50TH ANNIVERSARY OF THE APOLLO 11 MOON LANDING

300 Intel® Shooting Star™ drones
Permission to fly over NASA controlled airspace!
In partnership with Studio Drift, and to music performed live by Duran Duran
INTEL DRONES SHOOT FOR THE MOON
INTEL’S 50TH ANNIVERSARY & A CURRENT GUINNESS WORLD RECORD: 2,066

JULY 2018
LIGHT SHOW FLEET EVOLUTION

2015  |  2016  |  2017  |  2018
---|---|---|---
100 | 500 | >1000 | >2000

AUTONOMY MANAGING INCREASED COMPLEXITY
THANK YOU