

Concept Developed by Parimal Kopardekar, NASA

## National Unmanned Aerial System Standardized Performance Testing and Rating (NUSTAR)<sup>1</sup>

### **Background**

Many manufacturers are developing unmanned aerial/aircraft systems. However, to date there is no consistent and standardized performance assessment available for these systems. The manufacturer provides specifications and capabilities, which are self-reported, and no independent assessment is available. Similar to JD Power's car ratings, and consumer reports assessments for various products; performance verification and assessment of Unmanned Aircraft Systems (UAS) would be beneficial to the prospective users, would provide consistent data to seek certification based on standardized tests, and identify manufacturers areas for improvement.

NASA conducted a workshop to discuss capabilities needed to enable low altitude airspace and UAS operations. NUSTAR will complement NASA's UAS Traffic Management initiative and could offer credible and comprehensive self-regulatory structure for small unmanned aerial systems. NASA researcher Parimal Kopardekar originated NUSTAR concept. However, NASA researchers will provide the consulting, advice, and guidance to make the NUSTAR a reality. It is expected that NUSTAR will be built, maintained, operated by an outside NASA entity. NUSTAR is not a NASA funded program but a NASA originated construct.

NUSTAR is targeted to serve 55 lb and below unmanned aircraft systems and their operators.

### **Goals**

The overall objective of the NUSTAR Capability is to offer standardized tests and scenario conditions to assess performance of the UAS. The following are goals of the NU-STAR:

1. Create a prototype standardized tests and scenarios that vehicles can be tested against
2. Identify key performance parameters of all UAS and their standardized measurement strategy
3. Develop standardized performance reporting method (e.g., consumer report style) to assist prospective buyers
4. Identify key performance metrics that could be used by judged towards overall safety of the UAS and operations
5. If vehicle certification standard is made by a regulatory agency, the performance of individual UAS could be compared against the minimum requirement (e.g., sense and avoid detection time, stopping distance, kinetic energy, etc.)

NUSTAR will be an independent performance assessment national capability.

The following paragraphs provide the initial set of performance data, specifications, and types of scenarios that will be used in NU-STAR. These will be further enhanced by contributions from academicians, industry, subject matter experts, and researchers from various government and non-government organizations.

NUSTAR will have the capability to collect the following data (this data set will be expanded based on discussions with industry, FAA, insurance companies, ASTM and other standards, NTSB, NIST)

1. Stopping distance under detection of obstacle under normal and off-nominal conditions (e.g., fog, smoke, moving objects)
1. Wind susceptibility (at what speeds and type of winds, does a vehicle become uncontrollable)
2. Kinetic energy when it falls from various altitudes (5 ft to 50 ft)
3. Battery life under various conditions (pay load, distance, temperature, etc)
4. Time to terminate
5. Collision detection time and distance under various conflict geometries (acute, obtuse, head-on, right-angle, climbing, and descending)
6. Maximum range
7. Maximum altitude
8. Noise footprint at different speeds and altitudes
9. Ability to communicate (single or dual) under tunnel, narrow corridors, between buildings, etc.
10. Ability to operate (safely) under GPS and communication denied environment
11. Ease of use for the operator
12. Energy and forces as vehicles fall from various heights and speeds
13. Others

The following specification data will be collected

1. Vehicle manufacturer, model, make, and year
2. Type of vehicle (e.g., multi-copter: how many copters, fixed wing, or hybrid)
3. Type of battery
4. Battery life
5. Weight
6. Pay load capacity
7. Operations type (e.g., precision agriculture, delivery, search and rescue)
8. Data collection (e.g., camera, etc?)
9. Takes off from ground or land on ground
10. Lost link or inconsistent link operation
11. Performance under off-nominal conditions related to vehicle subsystem failures
12. Cyber security considerations

13. Performance under off-nominal conditions related to communication and GPS denied environment.
14. Usability
15. Others

The following is a list of initial scenarios (which will be expanded based on all stakeholder discussions):

1. Narrow corridor operations between two tall walls
2. Operations with strong head wind, tail wind, etc.
3. Operations where unexpected pop up moving objects appear at various distances and angles
4. Operations under rain, fog, smog, sand storms, etc.
5. First 50 feet ascend and last 50 feet descent under presence of (simulated) moving objects such as people, soccer ball, pets, etc.
6. Demonstration of geo-fencing
7. Response to loss of link, GPS, low power, etc safety critical scenarios
8. Ground Control Station design and performance: what does operators see, how many vehicles could be managed at a time with one operator, how easy is it to be sure that missions and contingency plans are identified and executed, overall usability ratings of their GCS, validation of flight plans, access to only authorized personnel.

### **Product**

The goal is to ensure that key performance data of a vehicle is made available, based on standardized tests. Further, create and adopt a standard, or self-regulation, that may provide operational guidance based on NUSTAR rating. For example, NUSTAR rating 5 would contain autonomous software, hardware, and sensors that allow vehicle to operate autonomously all the way to the door steps in a safe manner. It can abort the flight in case obstacle avoidance is not possible. NUSTAR rating 1 would mean visual line of sight and manual operations.

Additional use of NUSTAR will be conducting forensics type of tests to investigate incidents and accidents where we could recreate the key events and learn from incidents and accidents.

It will also be like NHTSA collecting data of the automobile vehicles, NUSTAR will also serve as a data keeper of the drone performance.

NUSTAR capability, a national asset, is expected to be created through collaboration with many stakeholders and will consist of standardized battery of scenarios, performance characteristics, data collection approaches so that the drone industry could self-regulate itself and provide guidance to consumers, insurers, and manufacturers regarding vehicle performance and their potential applications in different geographical areas.

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As of December 2015, the State of New York had decided to invest about \$70M in developing the capability as part of the New York Upstate Revitalization Initiative. The NUSTAR capability will be housed somewhere in the central regional of New York. However, other entities in different locations are also considering investing in the NUSTAR construct.