OFFICE OF THE DIRECTOR OF NATIONAL INTELLIGENCE

# INTELLIGENCE ADVANCED RESEARCH PROJECTS ACTIVITY (IARPA) - Office of Smart Collection

## Great Horned Owl (GHO) Program

## Proposers' Day Overview Briefing

LEADING INTELLIGENCE INTEGRATION

Sam Wilson

August 15, 2011

# Agenda

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|---|---|---|
| **12:00 - 12:05pm** | **Security Overview** | **Kacarole Thornton** |
| **12:05 - 12:10pm** | **Introductory Remarks** | **Sam Wilson, GHO Program Manager** |
| **12:10 – 12:30pm** | **IARPA Overview** | **Dr. Ed Baranoski,<br>Smart Collection Director** |
| **12:30 - 2:00pm** | **Program Overview** | **Sam Wilson, GHO Program Manager** |
| **2:00 - 2:15pm** | **Department of Homeland Security Mission Interest** | **Dr. John Appleby, DHS<br>S&T Directorate** |
| **2:15 – 2:30pm** | **Break** | |
| **2:30 – 3:00pm** | **Q&A** | **Sam Wilson, GHO Program Manager** |
| **3:00 - 3:15pm** | **Contracting Overview** | **Sarah Wiley , IARPA Contracting** |
| **3:15 – 3:30pm** | **Contracting Agent** | **AFRL** |

# Disclaimer

- This presentation is provided solely for information and planning purposes.
- The Proposers' Day Conference does not constitute a formal solicitation for proposals or proposal abstracts.
- Nothing said at Proposers' Day changes the requirements set forth in a BAA.
- BAA supersedes anything presented or said at the Proposers' Day by IARPA

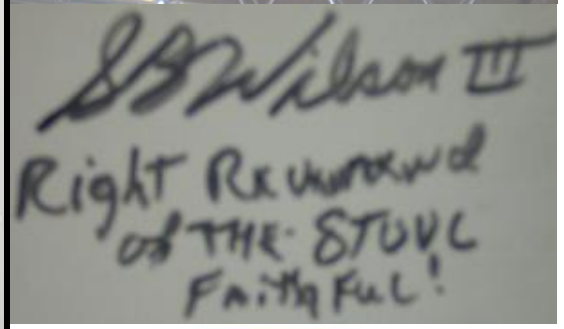
# Proposers' Day Goal

- Familiarize participants with IARPA's interest in GHO Program – *Please ask questions & provide feedback; this is your chance to alter the course of events.*

# Problem Statement

- Collecting intelligence data requires the ability to enter an area of interest without anyone knowing you are there
- **Sound is the number #1 signature that gives away the location of low altitude UAVs and gives away their presence**
- Endurance and payload are key factors
  - Battery powered fixed-wing UAVs are quiet but lack endurance and payload
  - UAVs with the desired payload and endurance capability are much harder to quiet
- This program will develop the technology that enables a new class of UAVs







# History

# GHO Program Vision

- The GHO program will deliver flying vehicles with unique capabilities
- Phase 1 focuses on developing 2 major sub-systems
- Successful proposals will address the metrics, especially the noise reduction, and push the envelope
- A multi-fuel capability is preferred for the system, but the system must be able run on readily available automobile fuels (gasoline or diesel)
- Thrust across the speed range from static to 100 knots is important, so the proposal shall address the flight speed performance.
- There will be a separate solicitation for Phase 2 to integrate the systems together into a flight vehicle

# Sources of audible noise

- **Power source** (other than batteries)
  - Piston engines provide impulsive mid-frequency output that requires a muffler
  - Turbofan exhaust creates signatures from heat and noise (velocity)
  - Smaller Engines have higher RPM which influences audibility and reduces efficiency
  - Gearboxes produce multi-frequency broadband sound output
- Propellers (or **propulsors**)
  - Propeller tip vortex is a high energy sound source
  - Propeller wake interacts with the airframe producing noise
  - Propeller RPM is driven by:
    - Smaller diameter propeller requires higher RPM to get efficiency but high noise
    - Lower propeller tip-speed produces lower RPM but is inefficient

# Enabling Technologies

- **Fuel to Electricity** device to quietly generate electricity
  - Eliminates all gearboxes
  - Must be able to restart in flight up to 30 minutes after shut down.

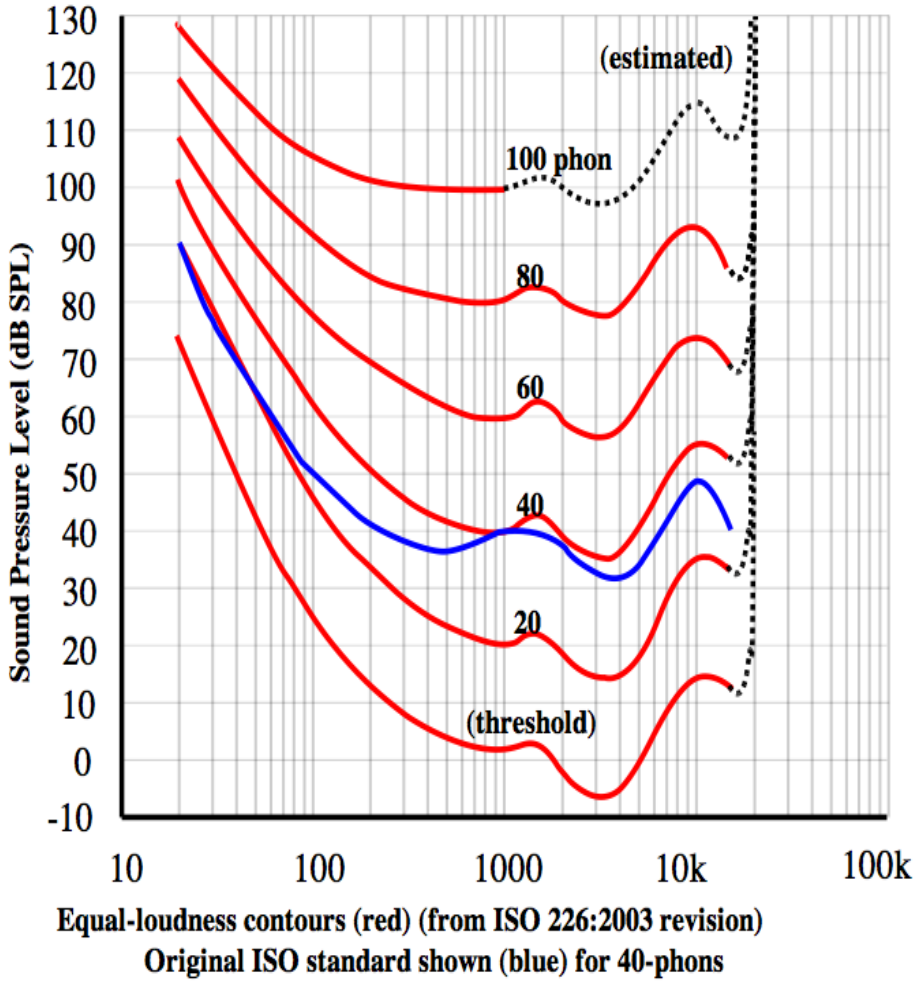
- **Electricity to Thrust** device to quietly propel the aircraft
  - Electric motors enable thrust to be used for flight control
  - Innovative motor architectures enable direct drive without gearboxes further reducing sound levels

# GHO Program Focus

- To prevent humans from hearing UAVs, **GHO focuses on reducing sound radiated from UAVs**
- Sound is a major metric in evaluating the success of the subsystem technologies and the program overall.
- Proposals must address:
  - How your team will make sound predictions and validate the predictions
  - How your team will make sound measurements to prepare for final government acoustic measurement

# Metrics for Sound

- Sound measurements often use standard sets of "phon" curves for equal loudness based on perceptual loudness judgments compared to 1,000 Hz
- For Phase 1, no emission should exceed the 60 phon curve (relative to ISO 226:2003), or 100 dB SPL at any frequency up to 100 kHz



# Sound Metrics in Phase 1

- All sound measurements will be normalized to 59 degrees Fahrenheit and 70% humidity. The measurement will be made at various operating points at 10 meters from the uninstalled propulsion subsystem in an anechoic space averaged over a continuous run time of 15 minutes and evaluated with ANSI compliant one-third octave band filters over the range 10 Hz - 15 kHz.

- The final testing will be performed by the Government at a government specified facility

# Metrics for Power Subsystem

- GHO defines **Power loading** as the ratio of the useful electrical power to the weight of the device needed to produce that power. Measurement is made while the device is running on a test stand. The weight includes:
  - Any mounting structure or treatments needed for noise reduction
  - Any pumps, inlets, nozzles, etc. needed for operation
  - Any fluids needed for cooling, lubrication, etc.

- The **Power produced** (by the system) is the usable electrical power output under representative load. Output should provide 4 kW at 100 volts. The measurement is performed while the device is operating on a test stand at the steady-state "continuous" power condition.

- **Fuel consumption** is the ratio of fuel flow in pounds/hour over the usable electrical power output in kilo-Watts. The system must be able to operate on fuel that is commercially available (gasoline or diesel)

# "Fuel to Electricity"- Power Metrics

| Figure of Merit | Phase 1 Metric | Eventual Goal | Other information |
|---|---|---|---|
| Power Loading | > 0.4 kW/lb | >0.6 kW/lb | Measured when run on a test stand. |
| Power produced | >4 kW @ 100v | >10 kW @ 100v | At steady state "continuous" power condition. |
| Fuel consumption | < 1.1 lb/kWh | < 0.8 lb/kWh | Measured fuel flow in pounds/hour over electrical power output in kilo-Watts. |
| Sound goal | <60 phon curve | <50 phon curve | At 10 meters in an anechoic space averaged 15 min. using ANSI one-third octave band filters over 10Hz–15kHz. |
| Cold restart | Up to 30 min. | after shutdown | Allows for battery-only operation |

# Metrics for Propulsor Subsystem

- Total **weight** of propulsor includes all structure, sound treatments, inlets, and nozzles required to produce thrust.
- **Input power** is the power required for steady-state running at design speed to produce the thrust.
- **Output thrust** is the thrust produced at steady-state design speed.
- **Propulsor thrust-to-weight** is thrust produced divided by total weight
- **Power consumption** is the ratio of electrical power consumed divided by thrust produced.
- Power consumption (above) times Fuel consumption (see Power metrics) yields TSFC (Thrust Specific Fuel Consumption)

# "Electricity to thrust"- Propulsor Metrics

| Figure of Merit | Phase 1 Metric | Eventual Goal | Other information |
|---|---|---|---|
| Total Weight | < 5 lb | < 4 lb | Requirement is weight of propulsor including all structure and sound treatments |
| Input Power | < 2 kW | < 2 kW | At airspeed up to 100 knots and rated output thrust. |
| Output Thrust | > 9 lbf | > 12 lbf | At airspeed up to 100 knots |
| Thrust to Weight (T/W) | > 2.0 | > 3.0 | Measured T/W of the propulsor. (Note: English units lbf/lb.) |
| Power consumption | < 0.3 kW/lbf | < 0.2 kW/lbf | Measured electrical power consumed over thrust produced |
| Sound goal | <60 phon curve | <50 phon curve | At 10 meters in an anechoic space averaged 15 min. using ANSI one-third octave band filters over 10Hz–15kHz. |

# Milestones and Waypoints

- Proposals must identify waypoints that will provide the Government with insight into the development of the key aspects of the components and systems. Waypoints will be reviewed on a quarterly basis.

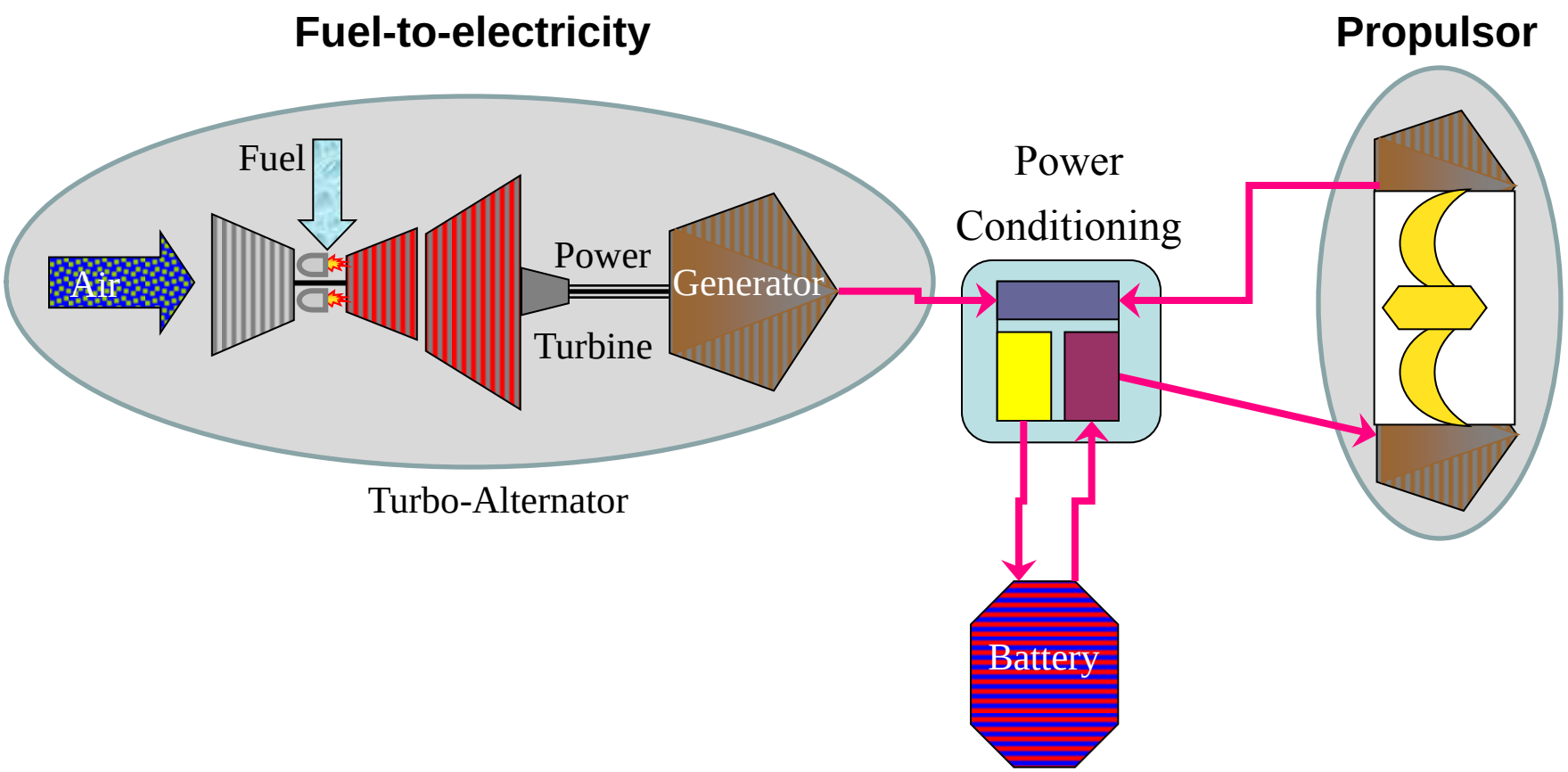
- Proposals must include a rationale, definition, metrics, and an evaluation plan for each waypoint. Waypoints must provide a clear measure of progress toward meeting the Program milestones.

- Proposals must address only one of the subsystems but you may propose to each subsystem.

# Program Milestones and Waypoints

| Date | Milestone/Waypoint | Metric/Demonstration |
|---|---|---|
| **Month 3** | Design review | • Show component subsystem design approaches (detailed design review)<br>• Provide expected performance with theoretical or modeled justification<br>• Provide expected noise performance of the subsystem proposed |
| **Month 6** | Initial component tests | • Finish fabrication of key components<br>• Perform partial subsystem tests (Performer-specified waypoints) |
| **Month 9** | Performance tests (conducted by performer) | • Assess progress against performer-defined waypoints<br>• Demonstrate performance showing values for the figures of merit |
| **Month 11** | Final Systems testing (conducted by the government) | • Acoustic testing (power & propulsor)<br>• Power testing (power)<br>• Thrust testing (propulsor) |

# Series Hybrid Propulsion
## Notional Concept



# Concept Example: Fuel-to-electricity

- Turbo-alternator eliminates all gearboxes
- Recuperated turbine, which increases the weight but:
  - Reduces sound by reducing exhaust heat & velocity
  - Increases fuel efficiency by capturing the waste heat
- Note: any approach must be easily restarted during flight after being turned off to allow for battery powered operation

# What is out-of-scope?

- The GHO Program will not fund research in:
  - Fuel cells
  - Storage batteries
  - Solar power systems
  - Gearboxes

# Eligibility Information

- Other Government Agencies, Federally Funded Research and Development Centers (FFRDCs), University Affiliated Research Centers (UARCs), and any other similar type of organization that has a special relationship with the Government, that gives them access to privileged and/or proprietary information or access to Government equipment or real property, are not eligible to submit proposals under this BAA or participate as team members under proposals submitted by eligible entities.

- Non-US organizations and individuals may be able to participate.
  - **Must comply with Non-Disclosure Agreements, Security Regulations, Export Control Laws, etc, as appropriate**
  - **Specific guidance for non-US participation will be provided in the BAA**

# Proposal Guidance

- Your proposal should include a full discussion of the technical approach that will be used to meet the program goals.
- Programmatic issues that should be addressed in the proposal:
  - Your team's current technical capabilities
  - Key resources needed (not currently available to your team), to include capital equipment and special expertise (teaming will likely play an essential role in providing special expertise). The risk in acquiring these key resources, and mitigation strategies, should be indicated as well.
  - A teaming plan along with the roles and responsibilities of each member of the research team
  - End of phase and some intermediate milestones are set, but it is expected that other intermediate milestones that are on the critical path of the proposed approach will be offered.
  - A schedule of all milestones including a clearly charted description of the various risk mitigation strategies that will be undertaken to achieve program goals

# Proposal Evaluation Criteria

- Overall Scientific and Technical Merit
- Effectiveness of Proposed Work Plan
- Relevance to GHO Program Goals
- Relevant Experience and Expertise
- Cost Realism

# Teaming

- Due to the many challenges presented by this program, both depth and diversity will be beneficial for overcoming these challenges.
  - Throughput. Consider all that you will need to do, and all the ideas you will need to test.
    - Make sure you have enough people and expertise to do the job
    - Sufficient resources to follow critical path while still exploring alternatives –risk mitigation
  - Completeness. Teams should not lack any capability necessary for success, e.g. should not rely on enabling technology to be developed elsewhere.
  - Tightly knit teams.
    - Clear, strong, management, and single point of contact
    - No loose confederations & no teaming for teaming sake
    - Each team member should be contributing significantly to the program goals. Explain why each member is important (i.e. if you didn't have them, what wouldn't get done?)
- Remember, you may be very accomplished, but can you do it all?

# Additional Information

- dni-iarpa-baa-11-12@ugov.gov for additional questions

- http://www.iarpa.gov/solicitation_gho.html for posting of Q&As