



# US Navy Foreign Object Damage Reduction

**Presented to**  
FOD Drone Habitat and  
Safety Series  
24 March 2021

**Engine FOD is a \$2 Billion+ a year cost** for the civil aviation community.

This cost is assumed by the airlines and breaks down to approximately \$67 per movement (touch + go landing/takeoff)



NAVAIR

**Engine FOD is a \$130 Million a year cost** for the United States Navy and United States Marine Corps

PHASE 1:  
**Augment Existing Engine  
FOD Mitigation Efforts**

“Brute-force” methods



Process Review



Enhanced data collection  
and visualization



FOD Support Equipment &  
Personnel

PHASE 2:  
**FOD Data  
Generation**

Inform “Risk-Based” Operations  
Efforts in-progress through research



Airfield FOD Detection  
Radar Towers



Aircraft Engine Inlet Debris  
Monitoring System



Machine Learning & Analytic  
Development

PHASE 3:  
**Informed, Autonomous  
FOD Remediation**

Solutions achievable to mitigate  
Engine FOD in the future



Policy-Based Solutions



Airfield Solutions



Autonomous Solutions

# Main Site, Shore-Based Operations Approach

## 1. Aircraft Inlet Debris Monitoring Systems

Technologies such as electrostatic, laser, RFMIMO, engine speed sensor, blade dynamics

## 2. Data Stream

Wired and wireless communications that conform to airfield and operator security requirements

## 3. Manual Debris Mediation

Technologies such as sweeper trucks, blower systems, crack sweepers, pad eye cleaners, etc.

## 4. Airfield Debris Characterization

Such as millimeter wave radar, optical, drone, and others

## 5. Analytics and Edge Computing

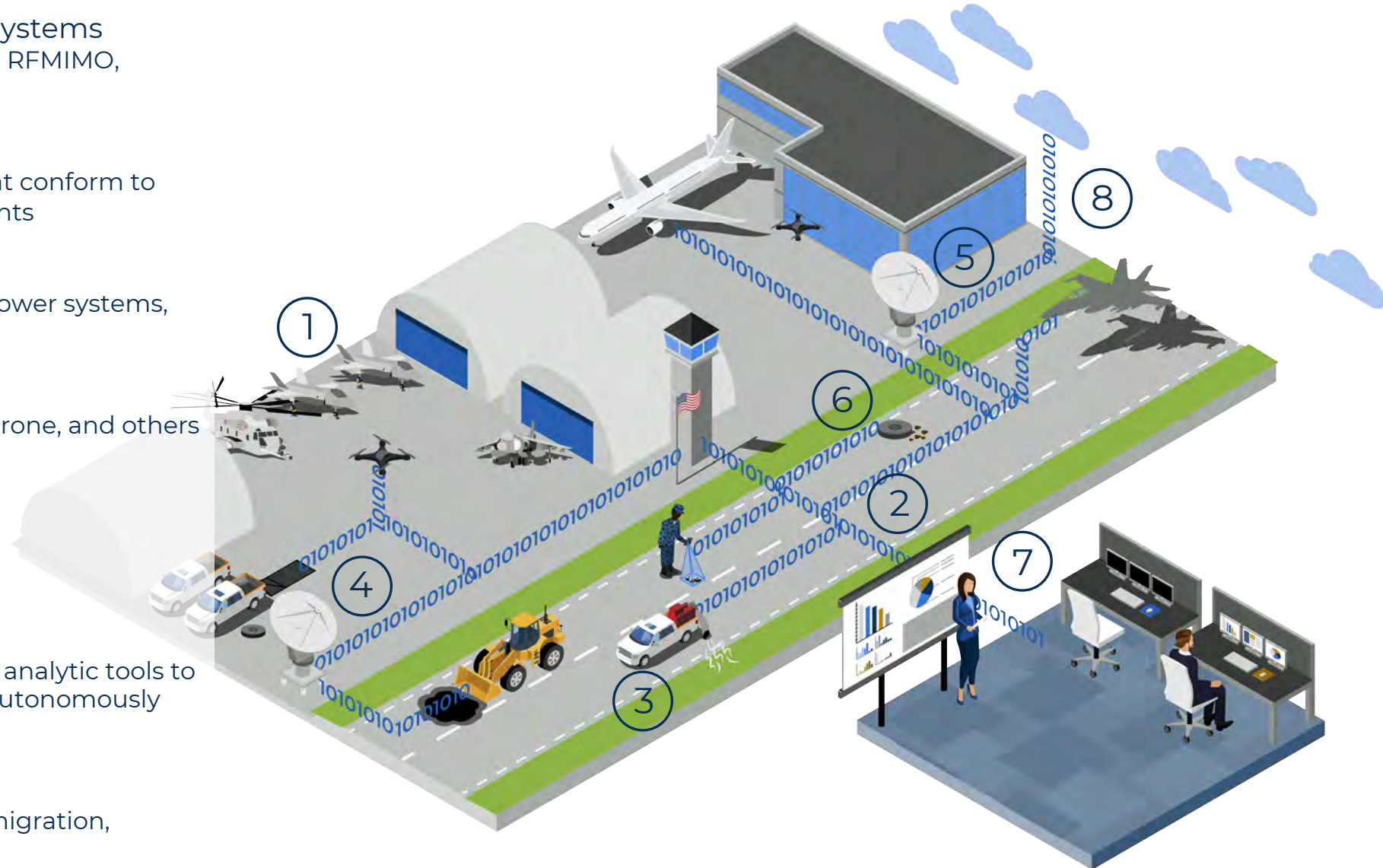
## 6. Automated debris remediation informed by Analytics

## 7. FOD Risk Coordinator

Empowered with machine learning and analytic tools to manage airfield FOD risks manually or autonomously

## 8. Contributory Factors

Sensor suites such as aircraft telemetry, wind/temperature/humidity data, bird migration, construction, etc.





MACH 2 UTILITY  
TOWING SYSTEM



VACTRON WET/DRY  
REMOVAL SYSTEM



FRICITION MAT  
DEBRIS REMOVAL  
SYSTEM



CRACK SWEEPER  
EXPEDITIONARY  
DEBRIS REMOVAL  
SYSTEM



CYCLONE<sup>2</sup>  
EXPEDITIONARY  
DEBRIS BLOWER



V10 MAIN BASE  
DEBRIS BLOWER



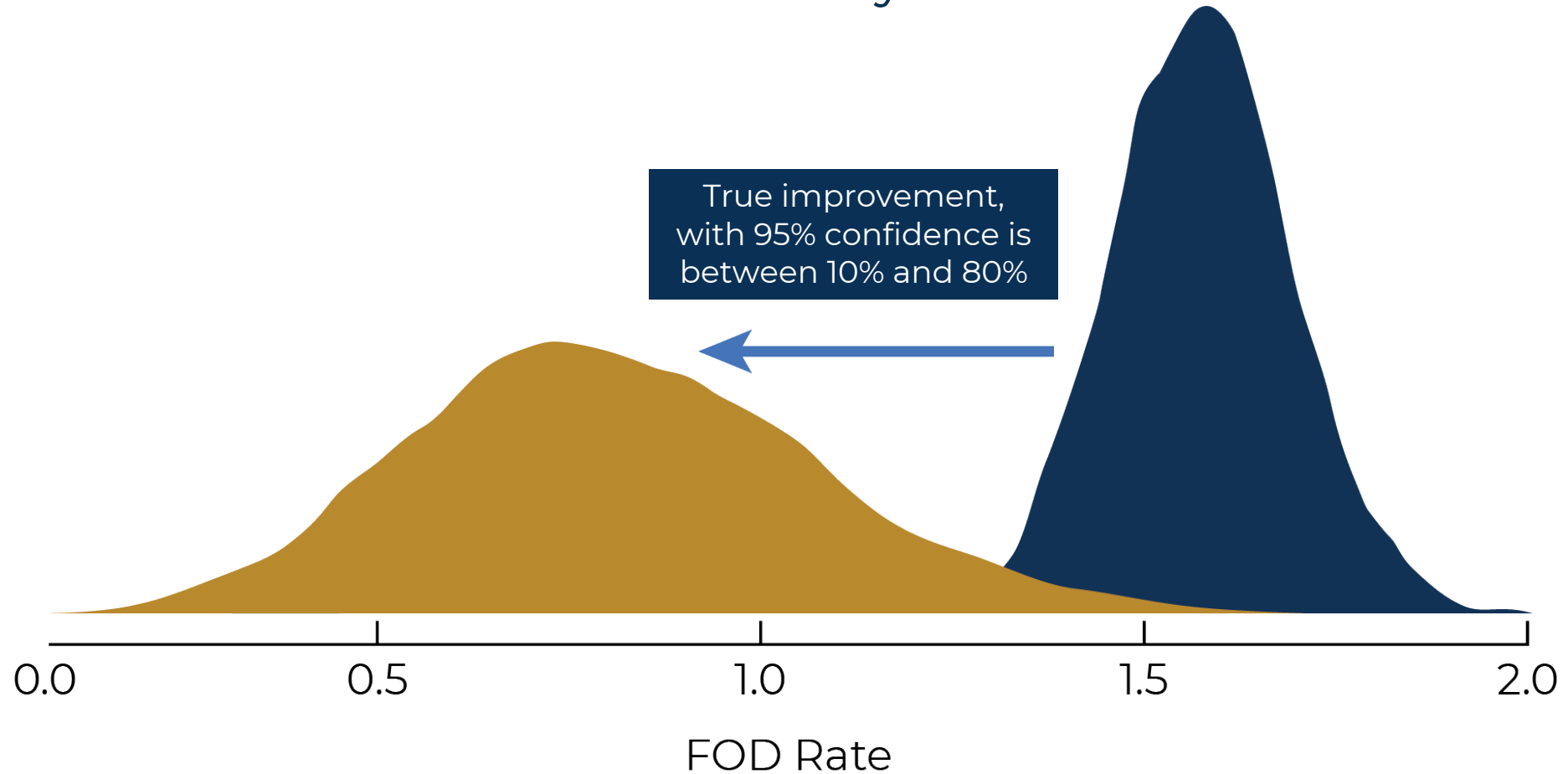
EGO BACKPACK  
EXPEDITIONARY  
DEBRIS BLOWER

# AVAILABLE EQUIPMENT

Research and Test has proven these items increase efficiency and effectiveness of debris mitigation via “brute force, labor intensive employment.”

# FOD Blower Impact

Estimated Monthly FOD Rate



Confidence interval will shrink as more data is collected



# FOD Blower

NAVAIR

ZERO  
**FOD**  
PMA-260 G



ZERO  
**FOD**  
PMA-260 G

# FOD Blower in Action





# FOD Sweeper Trucks

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ZERO  
**FOD**  
PMA-260 G 



# MOOG Radar Towers

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ZERO  
**FOD**  
PMA-260 G 10



# Questions

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