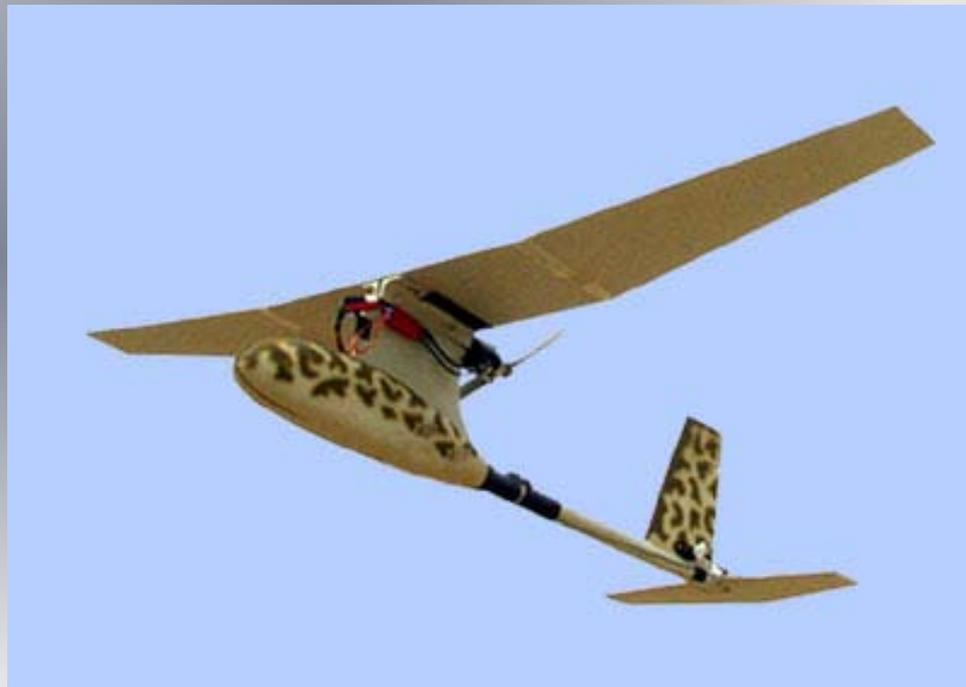




# **Technologies for Semi-Autonomous Unmanned Vehicles**

**Robots UAV and UGV Cooperation (A 50% solution now!)**



***Stephen Wilkerson Ph.D. P.E. Mr. Raymond Von Wahlde, Mr. Harris Edge,  
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# *UGV/UAV Cooperative Behaviors Overview*

- ***Ground System Capabilities***
  - *Strengths*
  - *Weaknesses*
- ***Air Systems***
  - *Strengths*
  - *Weaknesses*
- ***Behaviors Work***
- ***Networked Cooperation***
- ***Future UAV UGV systems***



# UGV Strengths

- **Large Systems**

- *Mission Package Weigh not Critical*
- *More Durable*
- *Power Not Critical*
- *Computing power not critical*
- *Can be made tough*
- *GPS signal good out doors*
- *Many sensors possible*
- *Low cost fuels*
- *Low cost chassis*
- *Potential to keep up with manned systems*
- *Many missions possible*

- **Small Systems**

- *Low Cost*
- *Many configurations possible*
- *Many missions possible*
- *GPS signal good out doors*
- *Hard to detect*
- *Expendable*
- *Many types of locomotion*
- *Less danger to operator*
- *Portable compensates for lack of mobility*
- *Possible in network of platforms fo augment forces*



# **UGV Weaknesses**

- **Large Systems**

- *Mobility Limited*
- *Sight Limited*
- *Expensive*
- *Easy to find*
- *Easier to kill*
- *Safe guarding operator is an issue*
- *For near term is a scarce resource*

- **Small Systems**

- *Sensor limited*
- *Power limited*
- *Mobility limited*
- *Computing limited*
- *Power limited*



# Army Ground Robotics Programs



Mini-Flail

Mine Clearing Robots



Panther



Humanitarian Demining



475 lb. Towing Capacity



Urbot – Man Portable robot for the Urban Environment



Ft. Indiantown Gap  
November 2001



Demo III Robotics Program



# ***UAV Strengths***

- ***Large Systems***

- ***Lots of sensors***
- ***Mobility not restricted***
- ***Long duration***

- ***Small Systems***

- ***Hard to detect***
- ***Very hard to shoot down***
- ***Capable of numerous missions***



# ***UAV Weaknesses***

- ***Large Systems***

- ***Can be shot down***
- ***Can be seen***
- ***Very expensive***

- ***Small Systems***

- ***Limited life***
- ***Limited energy***
- ***Everything must be small and light***
- ***Smaller and lighter can sometimes be expensive***
- ***More susceptible to weather effects***
- ***Limited sensor footprint***



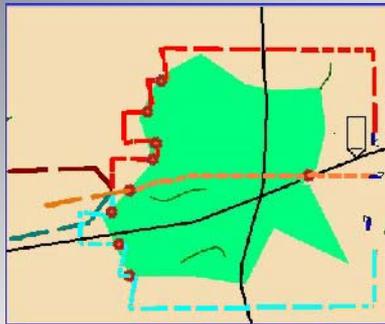
# US UAV Systems

- *Build a small UAV for testing at APG*
- *Numerous small UAVs already in service*
- *UAV/UGV cooperation is a new thrust*
- *Battlefield networking is a new area*



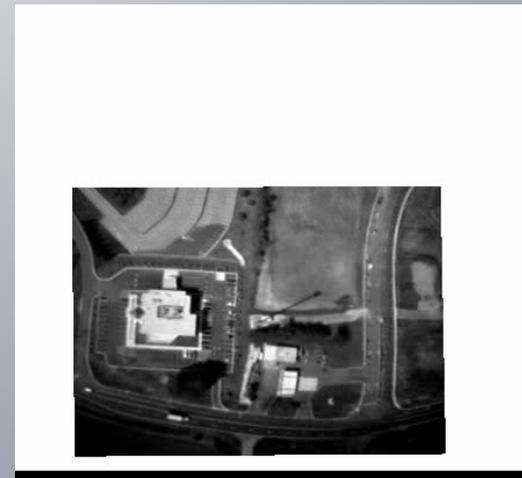
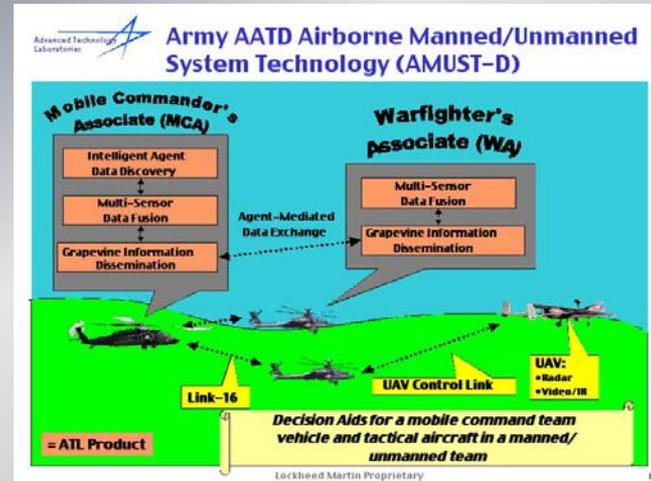


# Porting Behavior to Demonstration Platforms





# Porting Behaviors to UAVs





# Small UGV UAV Cooperative Networks



- **Networked assets**
- **UAV/UGV cooperation**
- **Off the shelf components**
- **Component integration**
- **Software development**
- **Hardware development**
- **Behavior algorithms**
- **Modeling and simulation**
- **Tactical behaviors**





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**The Weapons Analysis Branch  
Ballistics and Weapons Concepts Division  
The Army Research Laboratory**

**By**

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**Future applications for unmanned systems  
will only be limited by our imagination  
and ingenuity...**