Systems Engineering for Autonomous Systems
Defence Technology Centre

SEAS DTC

Rolls-Royce

Reduced Energy Power and Propulsion Concepts

Low energy use concepts, in air, sea and land domains are of key interest to MoD for future (and indeed current) platforms, particularly with regard to security of fuel supply, cost, and environmental impact. This project therefore examined what options are realistic for vehicle, propulsion and power systems on future autonomous vehicles, with a view to maximising utility through minimising energy use. A series of three workshops were run during which a range of vehicle applications, roles and attributes, were considered. Propulsion and power options for reduced energy use were then assessed for each vehicle type.
A large number of good options were identified, but these were very formative, and a series of trade and sensitivity studies would be required in order to assess whether these concepts are likely to yield significant benefits in their potential roles.

Aim

The aim was to identify and analyse (at a top level) conceptual options for reduced energy power and propulsion systems on selected autonomous vehicle applications in air, sea and land domains, with particular interest in whole system concepts.

Approach

The project was undertaken through a systems engineering approach to look at a number of vehicle applications where reduced energy power and propulsion concepts would be of most benefit, including multi-vehicle systems

Outcomes

A large number of interesting options were identified. These will need a series of trade and sensitivity studies to determine the overall benefits, before any technology programmes are launched

Driving requirements for reduced energy use

- Autonomous systems likely to perform more extreme missions, in particular very long endurance missions
- The fuel usage on these platforms is likely to be a major cost driver, and maximising energy economy could be a key enabler to maximising the utility of many autonomous systems
- For MoD there are additional concerns
  - Security of fuel supply
  - Cost of fuel
  - Environmental considerations

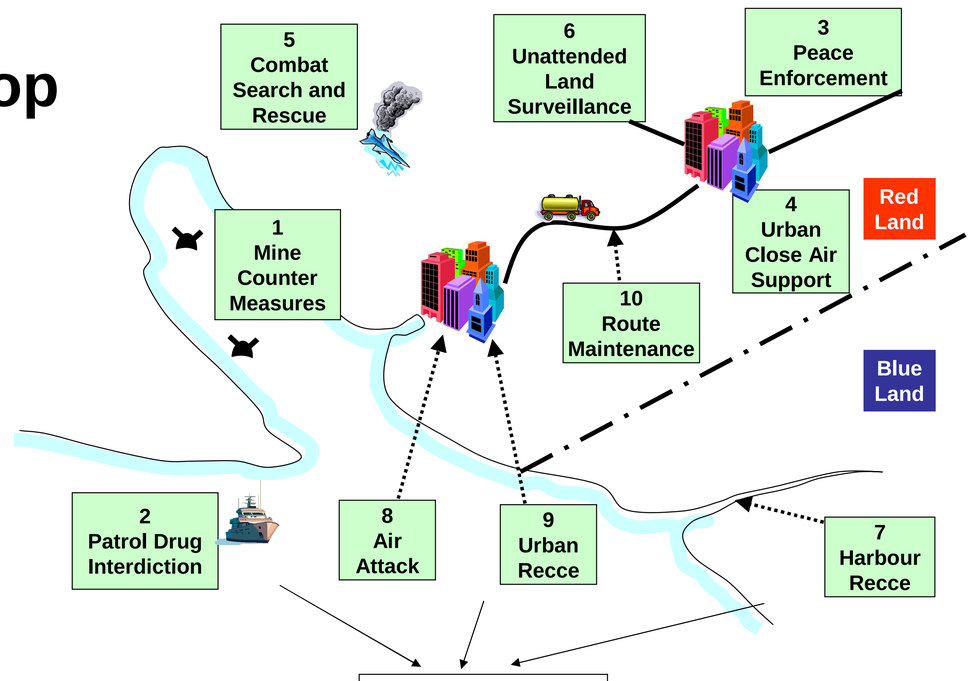
Key platform types

- Large area surveillance
- Small UAV for local area surveillance
- Building search UAV
- Perimeter search UGV
- Small USV
- Small UUV
- Loitering platform
- Disposable platform

Favoured and promising system options

- HALE is to use two vehicles.
  - SOFC powered HALE vehicle, optimised for on-station use, hybridised to cope with variable or rapid payload power changes.
  - Launch / transit vehicle powered by a conventional turbofan, also refueller for HALE.
- Hovering vehicle for the urban environment; low speed, high blade number rotor(s). Diesel powered, with fuel efficiency cashed in reduced vehicle size.
- Loiterer use a moderate vehicle operating at lowish altitudes. Propulsion could be gas turbine, piston engine or a hybrid PEMFC cycle.
- Building search UAV (perch and stare) is a very small vehicle powered by advanced high energy density batteries and high power density electric motors
- USV operation from a mothership with a robust launch and recovery system. Podded propulsion units for confined water operation with hybrid electric system, maybe a separate system for transit.
- UUV launch and recovery to a mothership was favoured with a robust system. For propulsion thrusters were preferred for both transit and loiter, and a hybrid electric system for power.
- Large UGV favours a wheeled vehicle, with a hybrid electric traction system. Fuel dump or other asset to refuel offers best energy efficiency and 24/7 presence, but more complex overall system.
- Small UGV needs to negotiate very cluttered, obstacle strewn terrain. Favoured concept is a wheeled vehicle if terrain is not too difficult, or a legged vehicle for mobility over difficult terrain. For power an electric system is favoured, maybe hybrid.

Workshop process

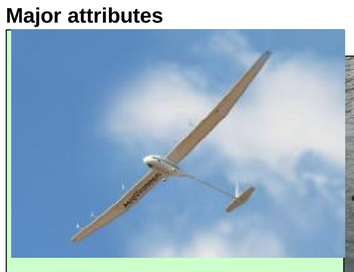


Establish key roles

Timeline of events
e.g. Basing / Launch / Transit / Operation / Recovery

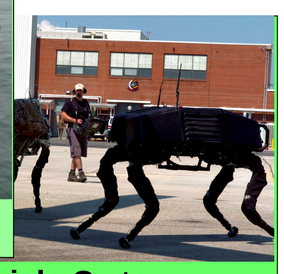
Identify Platform types and their attributes
All domains
- Major parameters
- Interactions with other assets

Baseline vehicle
Characteristics
Major attributes



Vehicle A

Vehicle B



Vehicle C etc

Options (Prime mover and system)
Timeline pros/cons
Timeline combinations
Propulsion concepts
Vehicle A
Vehicle B
Vehicle C etc

Top-level favoured / promising system options

Role extension
- What extra utility could be derived?

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SEAS DTC

DTCs : Industry and the science base working in partnership with UK MoD to develop innovative defence technology

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