PPEM016 - Initial Requirements Study into Intelligent Power Management

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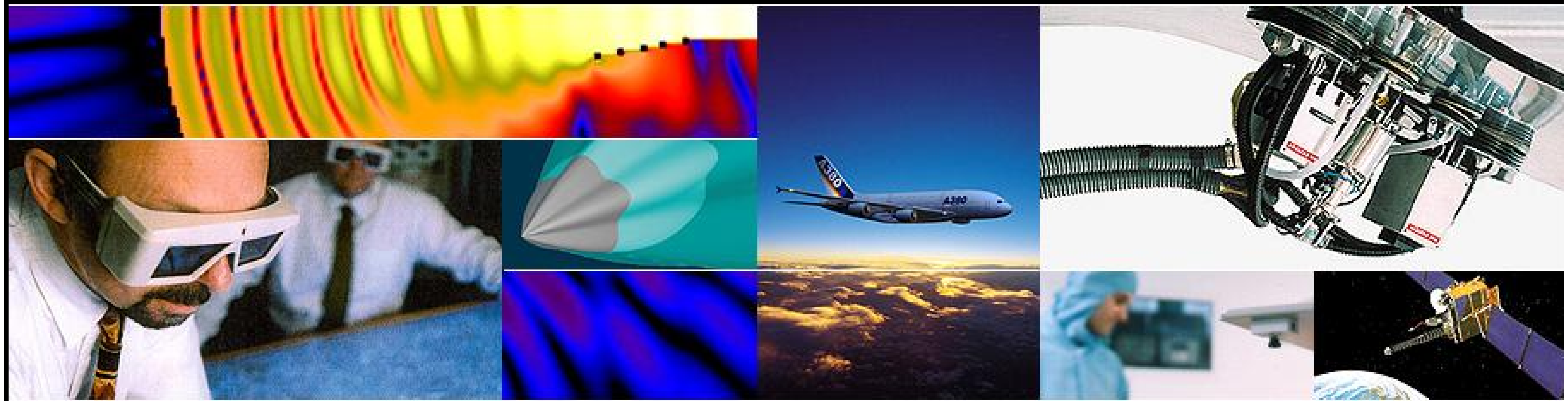
Ben Morley
BAE Systems Advanced Technology Centre

ben.morley@baesystems.com



Standard Definitions

Energy

The International System of Units defines the unit of energy to be: $m^2 \cdot kg \cdot s^{-2}$ which is measured in joules.

The Oxford English Dictionary defines energy to be:
"The property of matter and radiation which is manifest as a capacity to perform work"

The amount of energy used over time is given by the equation:
Energy (joule) = Power (Watts) x Time (seconds)

Power

The International System of Units defines the unit of power to be: $m^2\ kg\ s^{-3}$

which is measured in joules per second. (Rate of consumption of energy)

As an equation, electrical power is given by:

Power (Watts) = Current (amp) x Potential Difference (Volts)

What is Intelligent Power Management?

Operational Requirement (as proposed in PPEM016):

“An intelligent power management system monitors, predicts and optimises the use of a platforms available energy such that it can be converted into useful power, when and if, it is required by the system”.

PPEM016 Introduction

- Within PPEM016 Phase 1 BAE Systems ATC concentrated on capturing the non functional system requirements of intelligent power and energy management (IPM) in unmanned systems.

Why is this relevant?

- Advancements in capability tend to manifest themselves as additional platform sensors, active materials, increased computing requirements and missions that may demand persistence and endurance.

- Thus, as systems advance, the demand from these systems for ever greater energy requirements increases.

- Currently Available Solutions:
  1. Use more, larger and heavier energy sources.
     - à Problems with transportation, charging, storing, maintenance
  2. Reduction in systems capability
     - à Impacts upon mission duration, sensing & strike capability

Improving Power & Energy Management

How May We Improve This Situation?

1. Improvements to the energy efficiency of existing hardware
2. Improvements to the distribution of power through a system
3. Improvements to battery and source capacitance technology.
4. Develop novel and improved techniques on how to manage and allocate current and future available energy in an optimum way during mission planning and execution

PPEM016 Phase 1 concentrated its efforts on the 4th option.

Sample Key Questions Asked of Autonomy Experts

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1. Would you agree with the given definition of ‘Intelligent Power Management’?
2. Why is ‘Intelligent Power Management’ for UXV required? What type of functionality would an IPM system provide?
3. What level of ‘Intelligent Power Management’ capability do we currently have onboard our UXV’s (our baseline capability)?
4. What do you believe to be the next technological level of ‘Intelligent Power Management’ capability which would provide benefit to our UXV systems?
5. What do you foresee are the benefits of ‘Intelligent Power Management’ for UXV systems?
6. What do you foresee are the drawbacks of ‘Intelligent Power Management’ for UXV systems?

Outcomes: Perceived Benefits

Set of Non Functional System Requirements (see publications)

Series of Perceived Benefits of IPM:

1. Increased platform capability with regards to mission goals and objectives.
2. Potential reduction in platform weight and size.
3. Increase in platform monitoring capability.
4. Increased platform utilisation and availability.
5. Reduced platform overheads in charging, storing and obtaining power sources. Consequently this leads to a reduction in logistical overhead.
6. Reduction in the carbon footprint of the platform.

Outcomes: Perceived Drawbacks

1. *Safety:*
   - Concerns regarding inappropriate decision making leading to complete system failure
   - Concerns regarding overstretching a platform leading to complete power loss
   - Concerns regarding certification of autonomous power management systems
2. *Risk of Mission Failure*
   - Concerns regarding failing mission goals due to prioritising power management over mission objectives.
   - Concerns regarding platform availability & reliability due to intelligent power management
   - Concerns regarding the suitable and robustness of mission plans generated automatically when consideration is given to power management.
3. *Cost*
   - Concerns regarding the cost of implementing, certifying and proving intelligent power management systems upon autonomous vehicles.

Outcomes : Future Required Capability

The requirements capture exercise and proposed definition of IPM suggested a number of future systems capability requirements:

1. Sensing & Recording Capability

- Ability to sense the electrical power consumption of the components and subcomponents of the system under differing environmental conditions and operational parameters.
- Information (power usage, environmental conditions & mission/system parameters) to be recorded for later detailed analysis.

2. Prediction & Modelling Capability

- Modelling of electrical power usage at a system level.
- Accurate models of engine power usage do exist
- Require models which predict power usage based upon consideration of factors such as platform environment, status, component deterioration, sensor usage and mission requirements.

3. Decision Making Capability

- Ability to make or suggest decisions which determine the use of available energy in a more efficient or robust manner.

Recommendations for Future Work

- Baseline capabilities in intelligent power management should be created as outlined (previously) in order to provide the anticipated benefits.

- Undertake research to identify generic approaches to modelling platform power consumption under different environmental and platform states.

- Undertaken research into refinement techniques which will improve prediction models.

- Undertake an architectural evaluation of typical platforms & systems to assess the modifications required in order to implement and evaluate an intelligent power management system.

- Undertake an evaluation into the effectiveness of proposed models and refinement techniques using real world data.

Final Thoughts…

- The move towards a fully autonomous decision making capability (in the field of power management), will require addressing safety and certification issues in order to gain operator trust. The system must prove to be robust prior to being deployed on a real world platform.

- The first instantiation of intelligent power management on an operational platform will likely have a ‘human in the loop’ controller as the ultimate fail safe.

  The intention being that as the human controller becomes more familiar and trusting of the suggestions an IPM system makes - that a move to a more autonomous decision making capability can be implemented.

- In order to aid the creation of such a system, a full functional analysis should be undertaken in order to fully understand the system and its interfaces.

Questions