POWER OPTIMIZED MORE ELECTRICAL AIRCRAFT

European conference

Towards *e*Environment

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Honeywell

Objective

- The last few years Honeywell Aerospace has been developing aircraft power optimization technology in sense of More Electrical Aircraft (MEA) studies.
- High electrical load required from both defense & commercial applications influences the concept, configuration and architectures of future aircraft systems, engines, auxiliary and emergency power units.
- As follows from preliminary tradeoff studies, MEA systems and engines can be power optimized to achieve the highest performance, friendly environmental operation by reducing fuel burn and CO2-emission accordingly.
- Longer term, promising developments are expected in fuel cell technology that may enable further use of electric power on board, including emergency power sources and power storages.
- MEA benefits, such as improved mission performance, design flexibility and weight, operating and dispatch reliability, flight safety, manufacturing and maintenance cost reduction will be exploited.
- The adoption of MEA-concept will also enable better sensing an monitoring that makes MEA health detection and failure prediction more reliable.

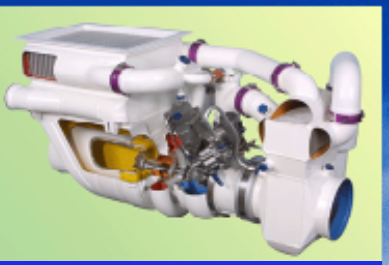
Integrated Power Management System

- More Electrical Integrated Power Management System (IPMS) is one Honeywell's most advanced design concepts for building next generation aircraft.

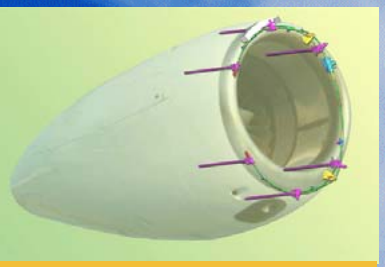
- This breakthrough technology eliminates much of the pneumatic and hydraulic power systems required in today's traditional heavy, maintenance-intensive PMS.

- More Electrical IPMS ensures such life-support functions as:
  - *Power Generation, Buffering, Storage & Control*
  - *Environmental & Thermal Management*
  - *Ice Protection Control*
  - *Main Engine Start*
  - *Electrical Flight Control Actuation*

Aircraft Power Management Subsystems

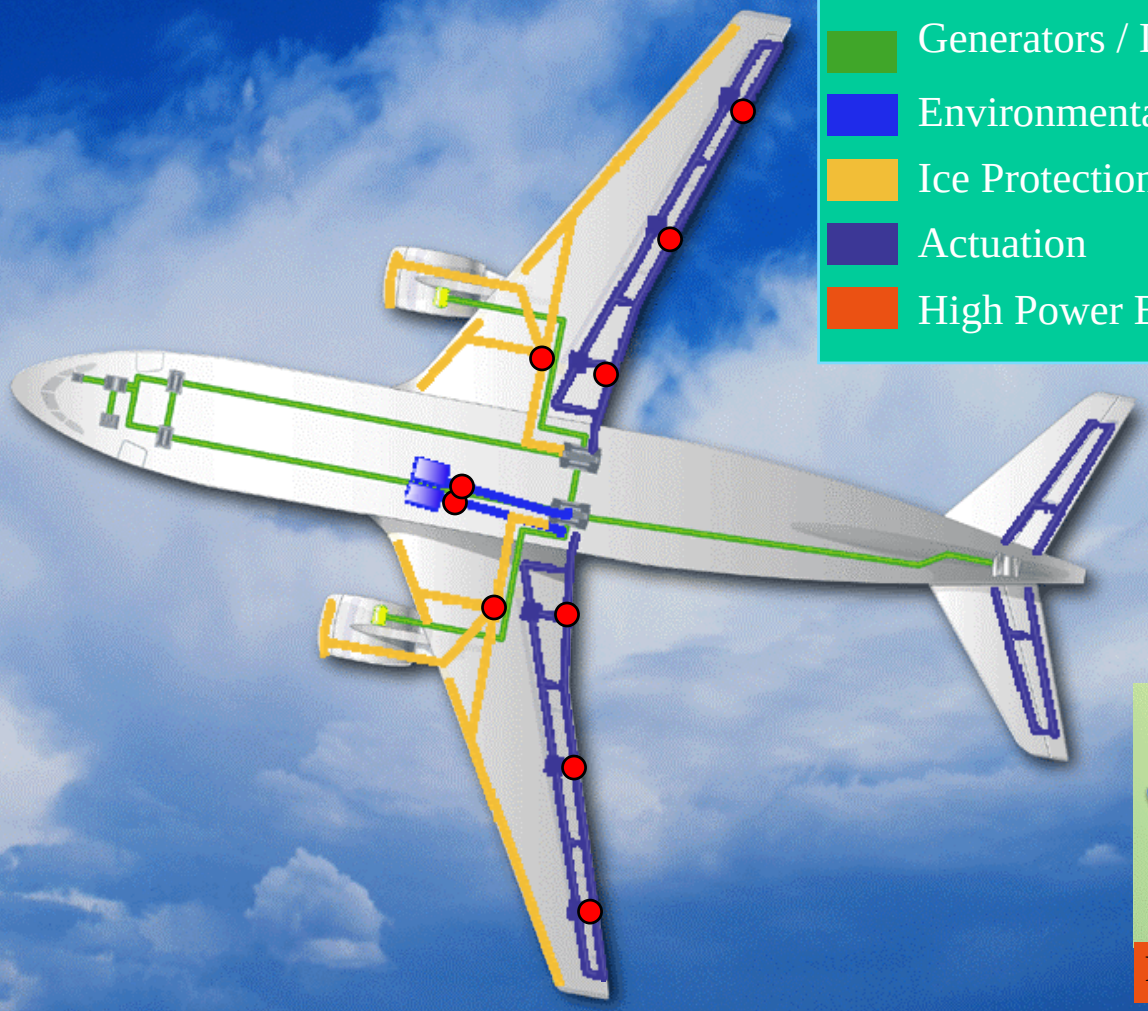


ECS

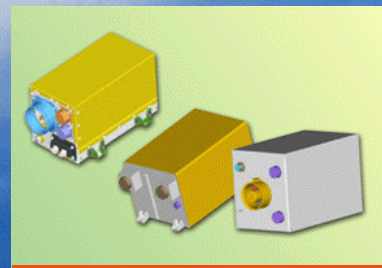


Ice Protection

EMA



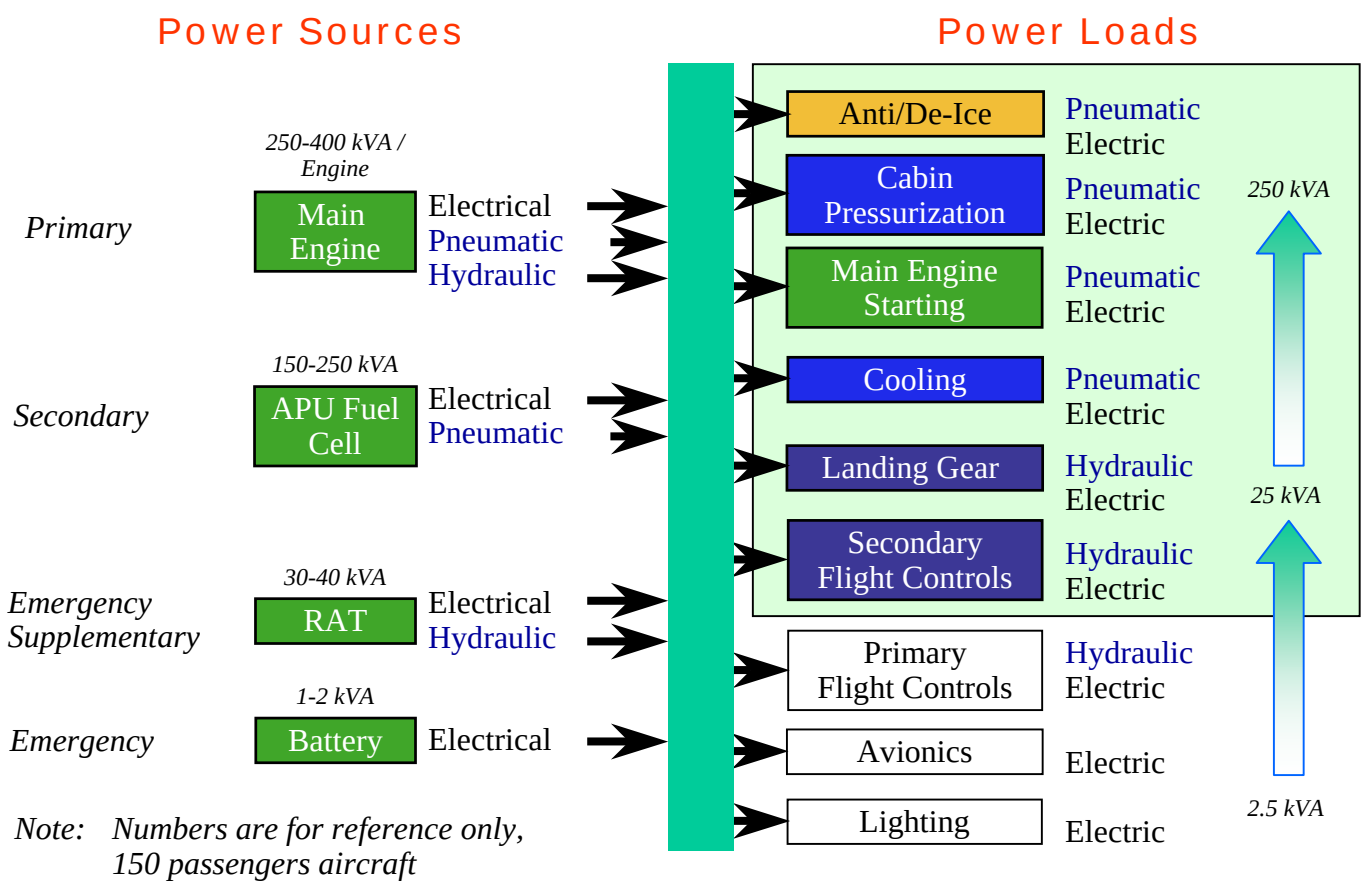
- Generators / Distribution
- Environmental Control System
- Ice Protection
- Actuation
- High Power Electronics



Power Elec

Traditional Power to More Electric Power

✈Shifting from traditional pneumatic and hydraulic power sources to the electrical power creates significant changes in both sizing and availability.



MEA Benefits

- As the next generation MEA - concept is adopted, IMPS components and subsystems MEA subsystem will deliver significant benefits industries, airlines and environment wide.
- IPMS solutions reduce fuel consumption, increase an overall aircraft performance and energy usage compared to traditional PMS architecture.
- Let's take for example just benefits caused by replacing traditional pneumatic Environmental Control & Wing Ice Protection Systems by electrical equivalents (applied to 150 passengers aircraft):
  - *Engine power off-takes reduce by a few hundreds %*
  - *Specific fuel consumption may reduce by a few %*
  - *Engine thrust increases by 10-15%*
  - *Aircraft single engine ceiling may lift up to 5,000-8,000 ft*
  - *Engine may operate cooler by 20-30C that increases its life*
  - *Ambient contamination by engines & APU may reduce by 15%*

More Electrical Engine

- More Electrical Engines (MEE) and their accessories have to be designed with different requirements in mind: *a lot of components, ducting and piping that traditionally cause the complexity of the nacelle installation can be significantly simplified and streamlined when going MEE*.

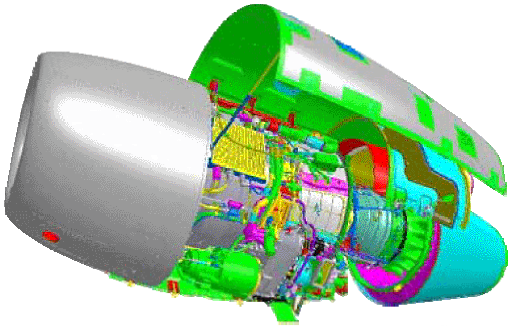
- As more of the mechanical accessories are converted to electrical, *it makes possible to envision the simplification or suppression of the engine gear box that opens the route to "gearless" engine*. From this point of view, embedded electrical generator solution looks very attractive.

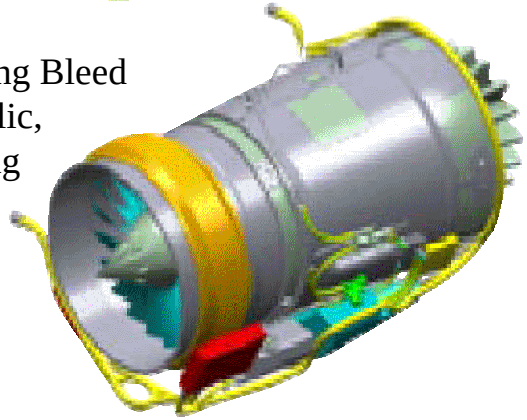
- For a new dedicated MEE thermodynamic cycle the engine operating line can be placed in the most advantageous location. *Extracting power from the lower pressure shafts provides the better operation under icing conditions and alleviates enrooted limitations when one engine is inoperative.*

- Next slide shows difference between traditional & MEE installations.

More Electrical Engine

Engine Installation Simplification





Removing / Simplifying Bleed Air, Air Start, Hydraulic, Fire Protection Ducting and Components

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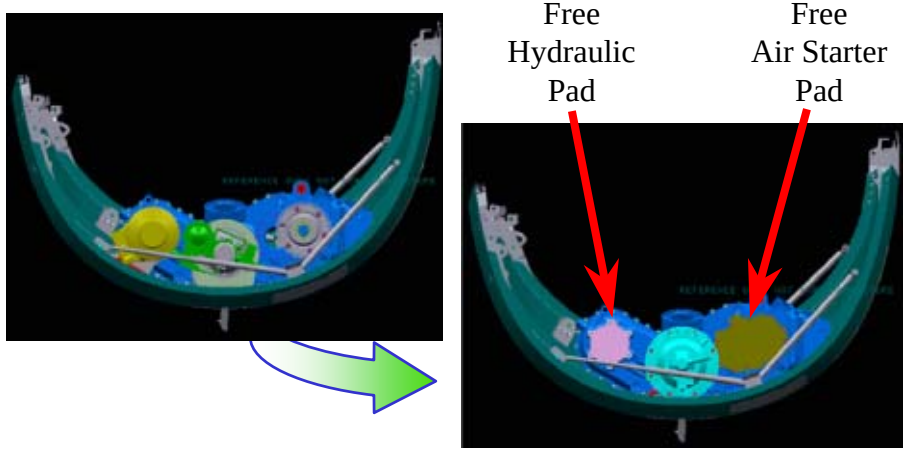
Transitioning Engines Accessories From Gear Driven to Electrical Driven

Additional Electrical Generators Needed But More Gear Box Pads Available



Enable Simpler Cleaner Engine Installation

Position Propulsion for Gearless / Oilless Solutions

Bleedless APU

- More Electrical /Bleedless Auxiliary Power Unit (BAPU) provides max available power: *at the min weight impact of 1 kg, BAPU supplies 75-80% more ground power compared to conventional bleed APU*
- BAPU configuration allows deleting dedicated bleed ducts, load control & surge valves, other mechanical items and 50% LRUs
- BAPU has a lowest ground part-power fuel burn: *for 150 passengers aircraft fuel saving exceeds 50 kg/hr compared to conventional bleed APU*
- Therefore, *CO2 emission at the ground operation will be reduced accordingly by more than 70 kg*
- BAPU reliability and maintainability significantly improved compared to conventional APU: *MTBF increases by 30% , corrective MTTR – by 15%*

Summary

- The future of MEA technology maturing continuous to open for aircraft Power Management improvements.

- MEA technologies are permanently evolving, and have a huge potential for improvement in weight, performance and cost at the component level while traditional systems and power sources are on the asymptote of their improvement & maturation curves.

- MEA “must have” enabler for emerging technologies like:
  - Optimization of turbo machine components (engine and APU) to operate over the different cycles made possible by MEA solutions
  - Optimized control electronics to achieve highest efficiency from every subsystems as well as overall aircraft level energy balance.
  - Transition to alternate and hydrogen fuels in turbo machines or fuel cells, which are game changing opportunities in Aerospace horizon to further optimize aircraft power, and operate friendly to environment.