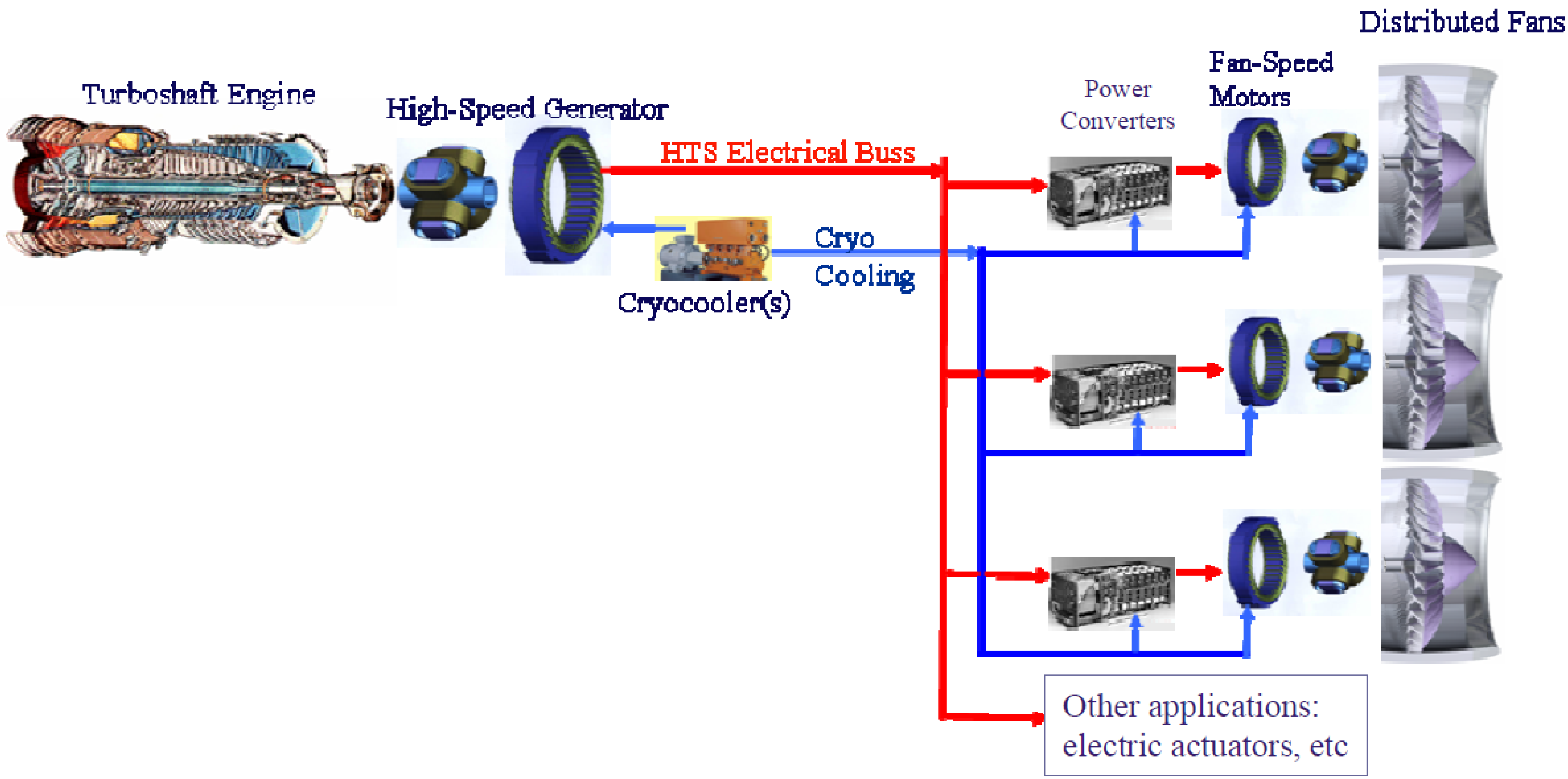
System Integration and Controls

Working Group, May 4, 2016

- Dionysios Aliprantis, Purdue
- Phil Ansell, UIUC
- Christopher Barth, UIUC
- Steven Boyd, US DOE
- Sam Chen, UIUC
- Kiruba Haran, UIUC
- Jim Heidmann, NASA
- Amy Jankovsky, NASA
- Irin Jose, UIUC
- Shengyi Liu, Boeing
- David Loder, UIUC
- Natari Madavan, NASA
- Tomas Modeer, UIUC
- Tim O'Connell, PC Krause & Assoc.
- Leslie Perkins, AFRL
- Ziaur Rahman, US DOE
- Eric Schneider, Rolls-Royce
- Dave Torrey, GE Global Research
- Melody Yi, UIUC
- Andy Yoon, UIUC
- Julia Zhang, Oregon State University
- Xiaolong Zhang, UIUC

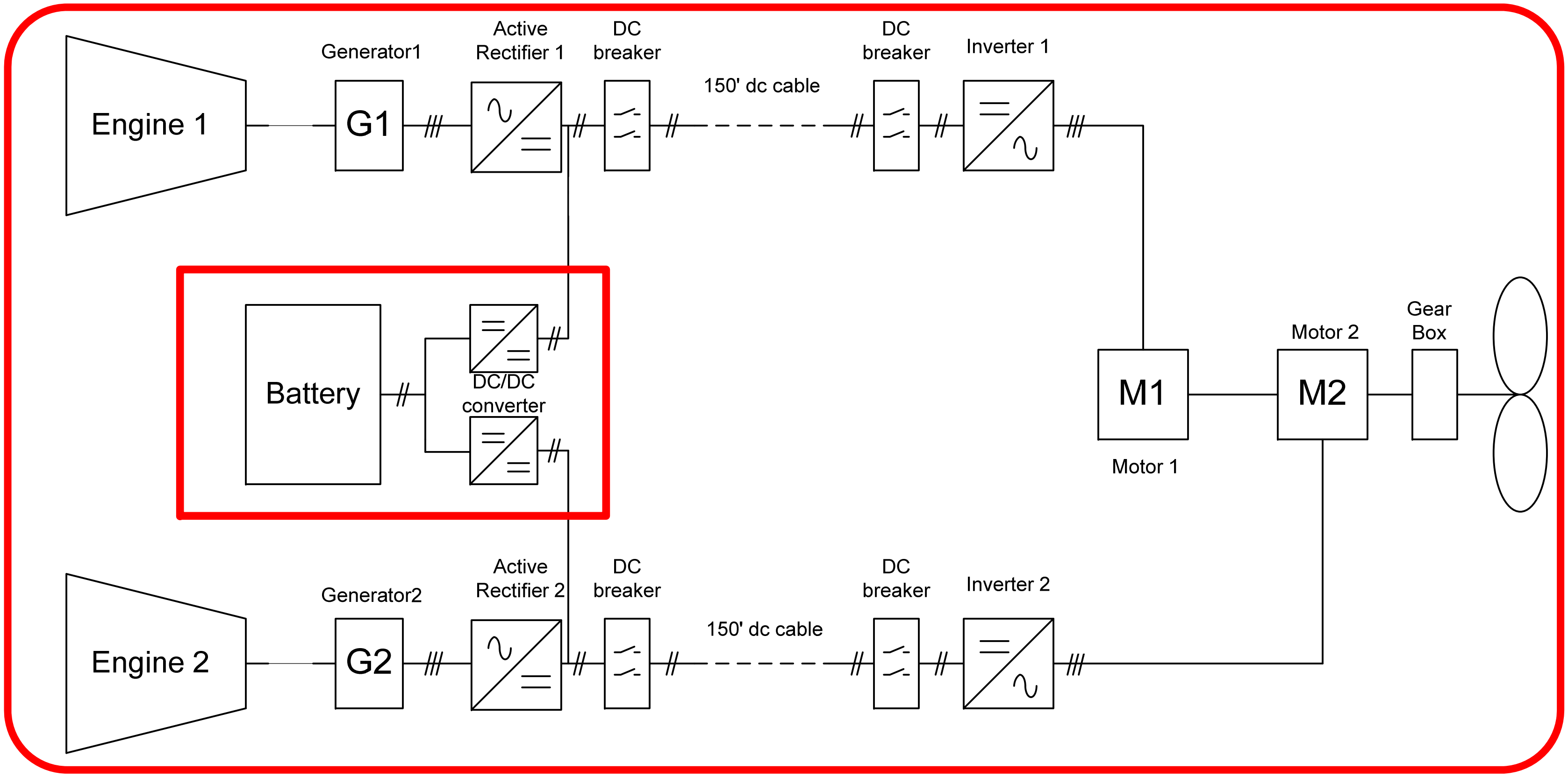
Turboelectric Distributed Propulsion



Source: Felder, Kim, and Brown, "Turboelectric distributed propulsion engine cycle analysis for hybrid-wing-body aircraft," AIAA 2009-1132.

Turboelectric Distributed Propulsion

1-3 MW
~2 kV (DC bus)
~9000 rpm (generator)
~2500 rpm (fan)



Source: Welstead and Felder, "Conceptual design of a single-aisle turboelectric commercial transport with fuselage boundary layer ingestion," AIAA 2016-1027.

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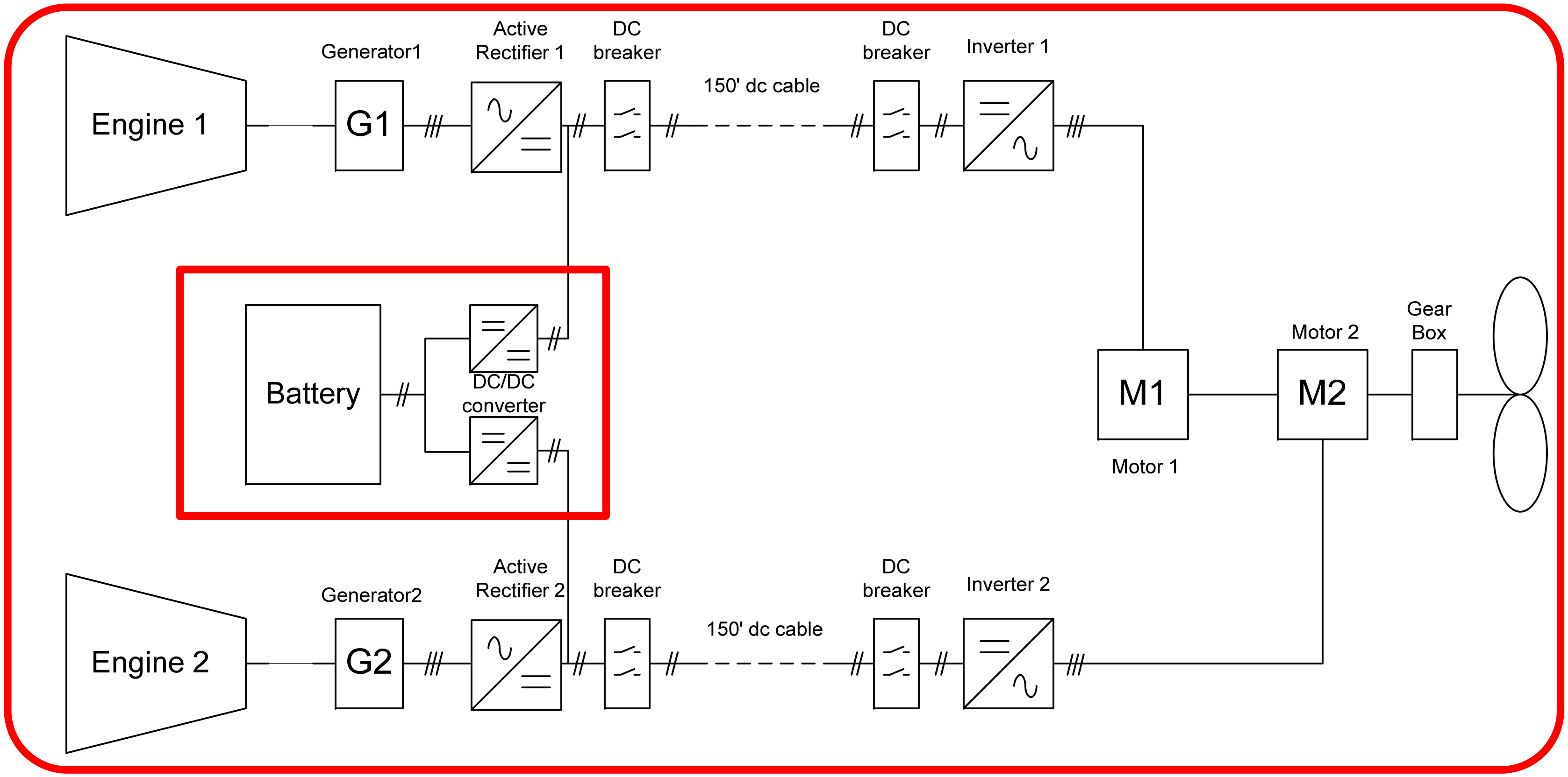

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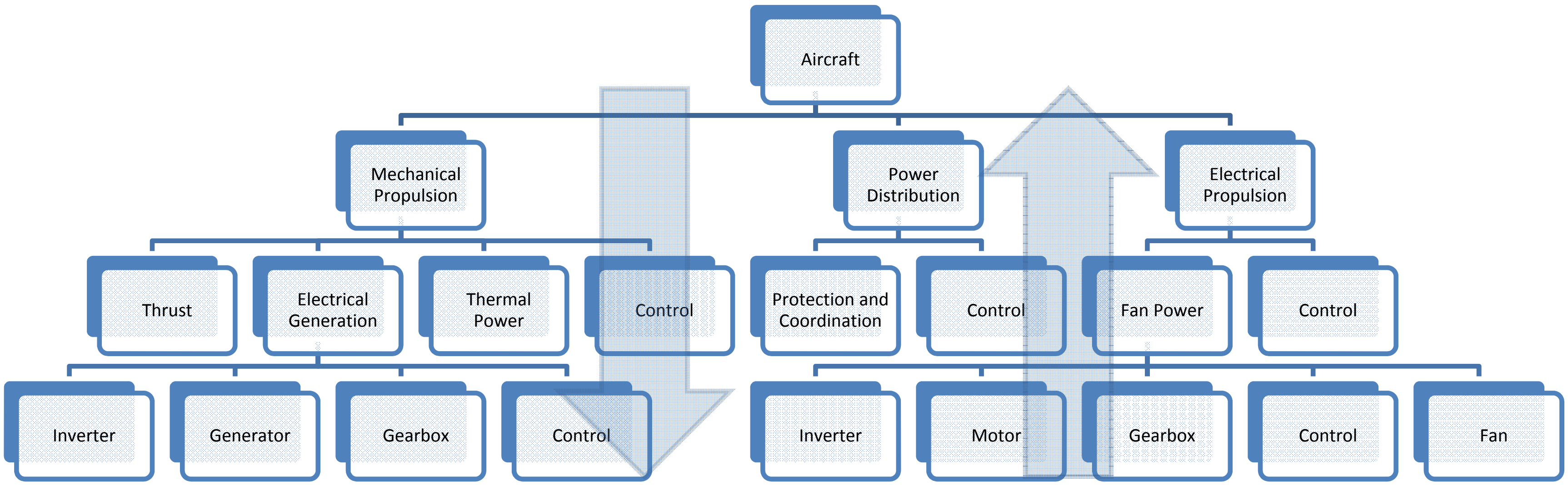
System Integration



- The aircraft is a system of systems
- System integration requires the flow of information in both directions; feedback is essential

System Integration – Top Down

- Aircraft architecture; power system architecture; thrust, propulsion, thermal architecture; risk and reliability management; redundancy; fault tolerance
- New system capabilities; reduced control surfaces, differential thrust, operational opportunities
- System level tools and models; separation of time scales; dynamic models vs. quasi-static models
- Component performance budgets; validation against technology roadmaps; need lines; requirements flow down (inc. efficiency versus weight)

- Global stability issues
- Power system protection
- Modularity, scalability

- Ground test beds, working up to altitude-related issues; model validation; robustness required to identify issues to be resolved
- Certification requirements
- Voltage versus power level
- Regeneration into the engine
- Cryo quenching issues

Questions to Answer

- AC vs DC, voltage level, frequency, protection constraints? Multiple voltage levels?
- How to define the trade space? Has the Navy developed a tool that might be applicable?
- What currently constrains the system, component issues or system issues?
- Kill the RAT?
- Kill the APU?
- Tools that incorporate reliability, fault tolerance predictions?
- Cross professional society standards? IEEE, AIAA, ASME, SAE (AE-7, Aerotech)

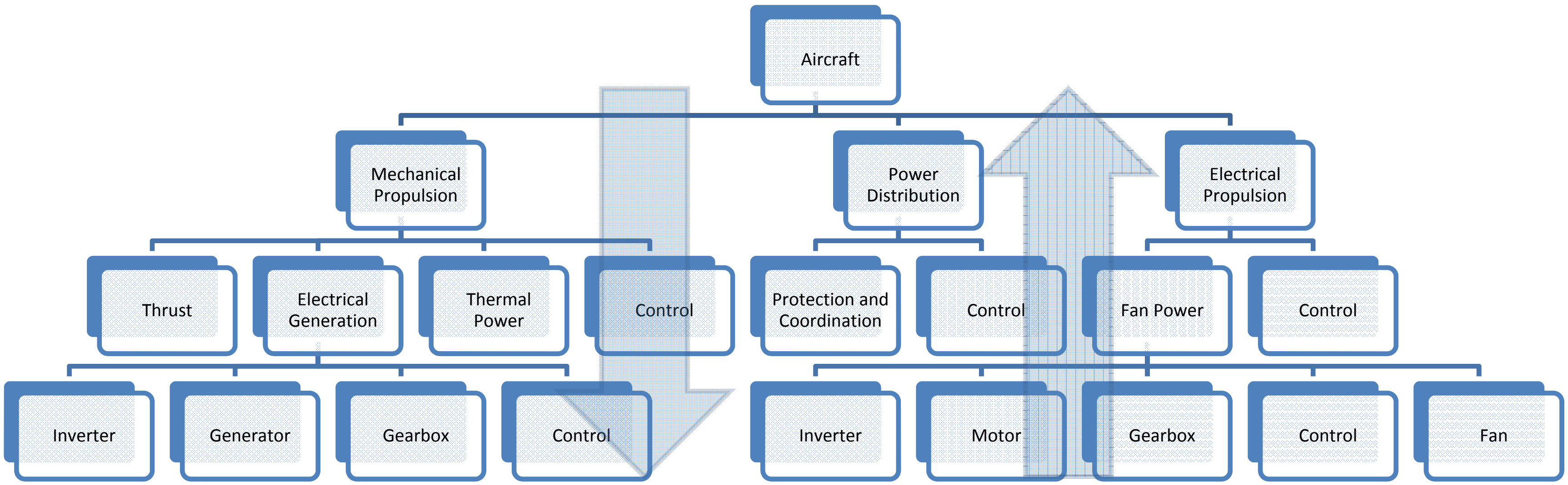
System Integration – Bottom Up

- Component sensitivities and impact on the larger system; component level models that feed the system level models
- Component integration opportunities; e.g. use the engine to relieve the electric machine of structural, bearings, thermal
- MIL-STD-704 that may need some evolution with regard to stability of DC bus
- Ground test beds, working up to altitude-related issues; model validation; robustness required to identify issues to be resolved
- Certification requirements

Educational Considerations

- Use NASA, national labs, etc. to engage students in large scale design activities
- Constrained optimization; there is only so much time in four years
- Large scale design projects as part of capstone design?
- Broad design challenges sponsored by professional societies

System Integration



- Road map or methodology?
- Generic or specific?
- How to codify?