Office of Naval Research Global - U.S. Navy Project

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- New generation of naval shipboard power systems (SPS) will likely adopt the direct-current (DC) architecture that can be regarded as a DC microgrid
- SPS are burdened by a variety of pulsed power loads (PPLs), e.g. radars, sonars, railguns, electromagnetic launch&recovery systems, etc., which are usually connected to the common DC bus
- PPLs can cause large voltage deviations in the DC bus, trigger the activation of protection devices or, in the worst case scenario, cause the blackout of the whole microgrid
- The objective of this project is to investigate way how advanced power electronics technologies can be put to use in order to optimally integrate the energy storage systems such as batteries and supercapacitors banks and mitigate the adverse effects of the PPLs – main focus is on coordinated control design

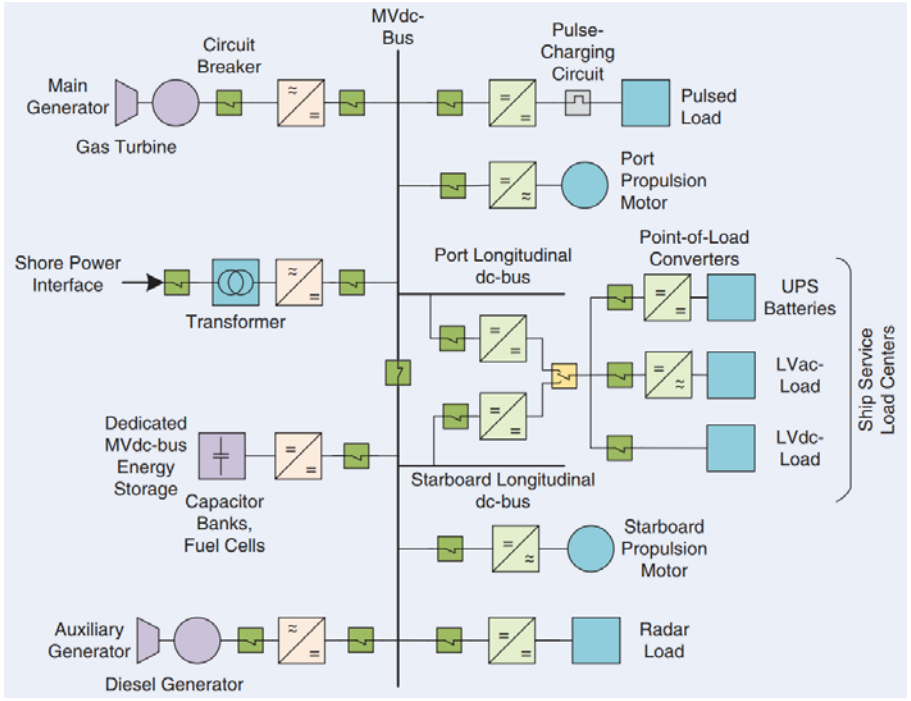

Fig. 1. General architecture for the U.S. Navy SPS.

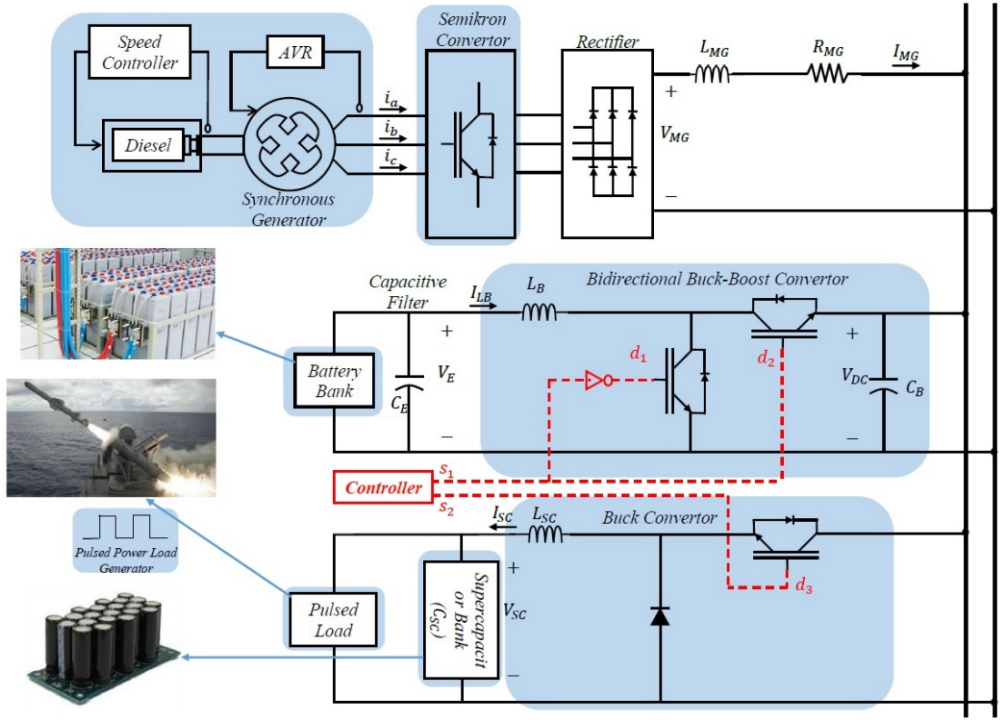

Fig. 2. Navy SPS case study investigated in this project.

Performance objectives

1. Ensure that the performance requirements of shipboard power systems (SPS) defined by the relevant standards are respected
2. Recharge the power buffers as fast as possible to maximize the PPL availability during critical missions
3. Minimize the transient response times of the state variables after the application of PPLs

Methodology

1. Develop the dynamical model of the SPS with PPLs, considering the PPLs as disturbances
2. Design model predictive controllers (MPC) for DC/DC converters that interface the energy storage systems to the SPS, with multiobjective control capability and strong disturbance rejection capability
3. Examine the suggested control method by experimentally implementing the proposed controller in the power hardware in the loop setup (generator is simulated in real time, while the DC microgrid is implemented in real hardware)

Fig. 3. Power hardware in the loop experimental setup.