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Predictive Modeling for Navy Readiness Based on Resource Investment in Supply Support and Maintenance

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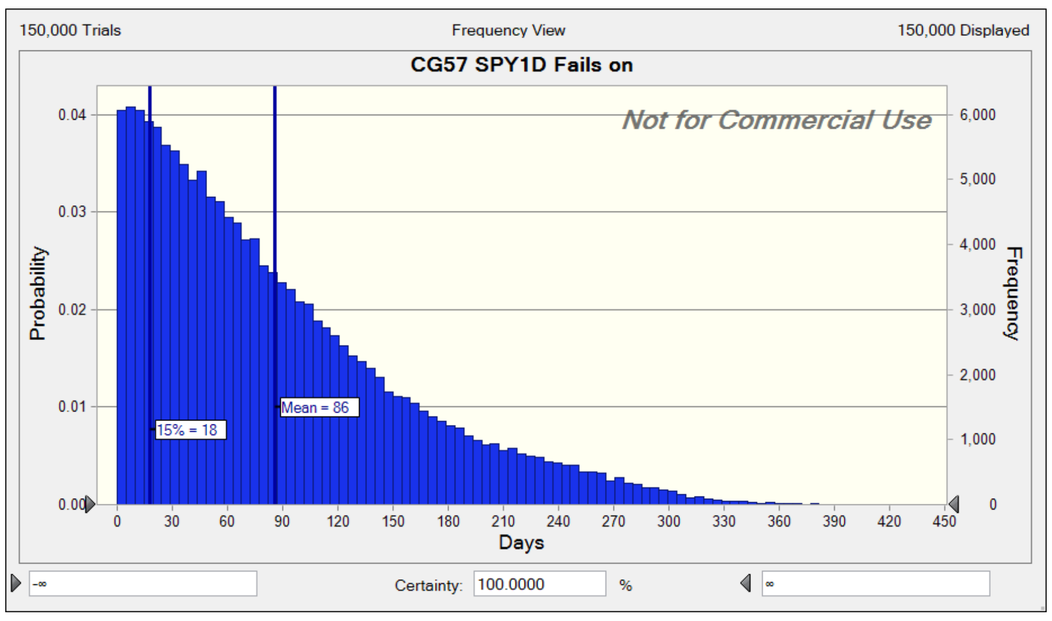
Predictive Modeling for Navy Readiness Based on Resource Investment in Supply Support and Maintenance

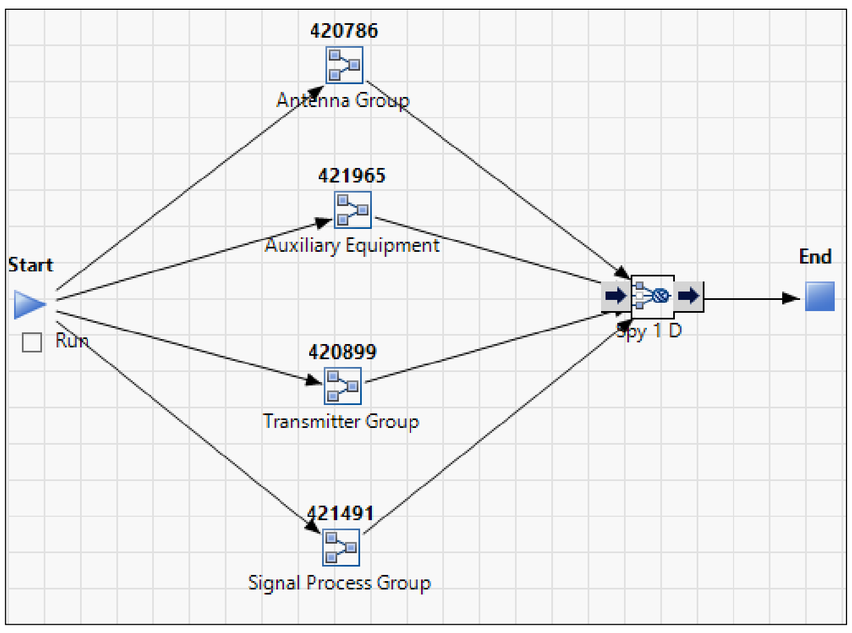
Naval Postgraduate School

Objective

- The objective of this research project is to develop models to determine self-sustaining stock levels of critical parts, for key ship systems, in order to operate for at least T_1 days without resupply, with a risk no greater than β_1 that part shortage will cause system failure
- These models are developed for both a single deployed ship and multiple deployed ships in a battlegroup.



Days to first SPY-1D failure in the battlegroup with all other sources of failure



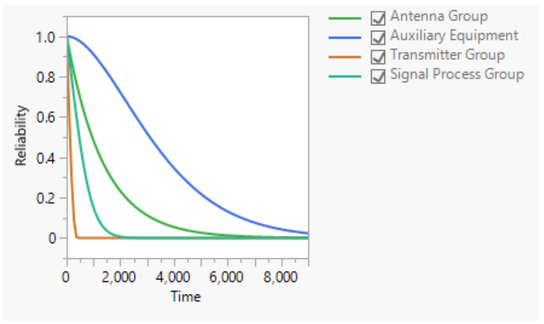
SPY-1D high-level reliability block diagram

Approach

- Identify the subset of parts most likely to cause system failure
- Build and run a simulation model of the critical subsystems containing those parts to model system endurance as the time-to-first-failure of any of these critical subsystems
- Calibrate findings using Reliability Block Diagrams and validate model against historical data
- Extend the simulation model to assess the impact of additional spare parts
- Conduct a simulation search to estimate the smallest number of spares that would be needed for a single ship to obtain a system endurance of 90 days at least 85% of the time
- Use the single-ship model to examine a battlegroup with multiple ships to determine the level of sparing that would allow the battlegroup to reach the same endurance target
- Compare battlegroups that pooled spare-and-redundant parts with battlegroups that did not pool spare-and-redundant parts

Findings and Recommendations

- For a single-ship E_s, we found that in a simplified model consisting of 51 more-likely-to-fail parts of the SPY-1D radar, an E_s target of 90 day endurance with 85% probability could not be met without additional spares. However, the addition of just 41 additional parts would achieve that target.
- For a multi-ship E_s that contained 3 SPY-1D radar we found that, if the three ships did not share spare parts, the battlegroup would fall well short of the endurance target. Without pooling, 354 additional spare parts (118x3) were required so that *all three* SPY-1D lasted at least 90 days with an 85% probability, far more than the single-ship requirement of 123 (41x3) additional parts.
- However, with pooled spares and cannibalization of redundant parts across the battlegroup, we found that the battlegroup could meet the endure target with just 9 additional spare parts (123 + 9 = 132).



Component reliability functions of SPY-1D system

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