SMART-COM – Scalable Multi-Agent Adaptive Resolution Tools for Collaborative Outage Management (CFA-17-12547)

PI: Nathan Lau – Virginia Tech

Program: RC-6: Information, Instrumentation and Controls (II&C)

Collaborators:

Subhash Sarin & Mark Pierson – Virginia Tech

Shilo Anders, Matt Weinger, Ruth Reeves & Glenn Gobbel – Vanderbilt University Medical Center

ABSTRACT:

Nuclear power plant (NPP) outages involve thousands of personnel performing complex and interdependent activities to refuel, repair, maintain and upgrade a plant over 20-30 days every 18-24 months. An outage is a period of intense workload under time pressure. During an outage, incorrect or dis-coordinated activities can adversely affect downtime and plant safety. Utilities are experiencing increased cost pressures due to low natural gas prices as well as costly upgrades associated with licensing extensions and new equipment. Improving the outage process can significantly decrease costs, enhance revenue and safety, and help to sustain America's existing NPP fleet.

Perhaps the most challenging task for the Outage Control Center (OCC) is to manage the inevitable unplanned work (including new work and emergent issues) that arises unpredictably during an outage. To safely and efficiently integrate unplanned work in current work plans, the OCC must assess risk, reallocate resources, adjust schedules, and communicate revised work plans throughout the NPP. These activities, which are extremely information processing intensive, are predominately undertaken with prior generation logistics tools (e.g., email, manual document reviews) that do not effectively support real-time activity updates or information analysis, limiting the quality and timeliness of decision making.

Building on the effort of developing communication technology for an advanced OCC, we propose research and development of Scalable Multi-agent Adaptive Resolution Tools for Collaborative Outage Management (**SMART-COM**) to support adaptive decision-making in resource allocation and scheduling. The proposed research to develop SMART-COM, a suite of computer applications to support OCC performance during NPP outages, will contribute to scientific knowledge and engineering methods in visualization, data analytics, dynamic resource allocation, and adaptive scheduling. The research will address three **Specific Aims**:

I. Design, develop and evaluate a SMART-COM user interface that integrates and provides intuitive visualization of complex data from multiple sources to facilitate outage-related communication, coordination, resource allocation, and planning. We will conduct field observations and interviews of OCC personnel to produce design requirements and then prototype an *Outage Schedule Visualizer.*

II. Develop and evaluate applications that support conflict identification and risk mitigation in response to unplanned work using computational data analytics and machine learning to extract and synthesize diverse information sources. We will use advanced natural language processing algorithms to build and test an ontology for screening outage documentation in the face of unplanned work to identify new safety risks, resource conflicts and potential schedule overruns.

III. Develop and evaluate an outage work scheduling application that automatically assesses risk of completing the outage on time and recommends resource reallocation arising from unplanned work. We will use advanced scheduling algorithms to compute optimal resource allocation while minimizing risk of schedule overruns.