Cadet/midshipman/faculty summer research project

Project Title: The Interaction of Water Drops with Flames

Organization: NAVY, Naval Research Laboratory

Location: Washington, DC

Project Description:

We seek to understand the fire suppression behavior of water mist and the individual drops as they interact with flames in various configurations. We are interested in the effect of varying water drop size distribution, drop number density, mist delivery configuration, and flame environment including flow field and degree of flame radiation. Modeling studies are coordinated with various laboratory studies to assist in the interpretation of the experimental observations and further explore areas that are difficult to conduct in the lab. The project will bring an improved understanding of water mist fire suppression capabilities in order to expand this key technology to a greater number of DoD arenas requiring fire protection.

Background or Skills Required:

The position requires good communication skills along with sound computational skills. Various mathematical approaches will be utilized including the use of software packages such as FLUENT. A working knowledge of FLUENT, experience in UNIX, and knowledge of FORTRAN are recommended but NOT required. It is more important that the candidate have strong computer and programming skills and a sound background in math and physics.

Number of Academy Cadets/Midshipmen you can accommodate: one position for cadet or faculty

Number of Academy Faculty you can accommodate: one position for cadet or faculty

Requested Duration: Ten to twelve weeks

Security Clearance Required: yes

Cadet/midshipman/faculty summer research project

Project Title: Analysis of next generation technologies for high performance computing

Organization: Arctic Region Supercomputing Center at the University of Alaska Fairbanks

Location: Fairbanks, Alaska

Project Description: (one page or less)

For analysis of next generation technologies, ARSC seeks to better understand how to utilize current and future state of the art tools of high performance computing. This includes concentration on acceleration and multicore technologies with their associated software tools and libraries. These studies tend to operate at the leading edge of the HPC industry, where different technologies are introduced but not yet understood in detail.

For 2008-2009, areas of interest in next generation technologies include hardware acceleration and multicore technologies. Topics include the scalability of multiple cores per microprocessor for computational performance, in which there can be contention for access to system components such as memory and the high-speed interconnection network. ARSC is also examining new generations of hybrid processors and systems, where traditional general-purpose microprocessors might cooperate with vector processors, graphics accelerators, or massively multi-threaded processors.

Study of next generation technologies requires detailed understanding of the specific systems in which these technologies exist, and often includes low-level benchmarking and performance analysis. At the same time, ARSC examines macro-level behavior in real-world high performance computing applications of interest. Efforts in this area are intended to be useful to system designers, programmers, and scientists.

Background or Skills Required: (half page or less)

Strongly desired: Experience in Unix/Linux programming environments.
Desirable, not required: background in mathematics (including linear algebra) or computer engineering.
Required: Good skills in computer programming and use of different programming tools and languages.

Number of Academy Cadets/Midshipmen: up to 4

Number of Academy Faculty: up to 2

Requested Duration: (in weeks) 3 or more. Note that start dates after May 11 are easier to accommodate since that is when UAF's summer sessions start. End dates should be before August 14.

Security Clearance Required: none, but proof of citizenship is required. For non-US citizens, a current visa is required.

Cadet/midshipman/faculty summer research project

Project Title: YP Boat

Organization: Naval Air Systems Command (NAVAIR), Applied Aerodynamics and Store Separation (AASS) Branch

Location: Patuxent River, MD

Project Description: NAVAIR is discussing options with the United States Naval Academy (USNA) to use one of the Academy's Yard Patrol (YP) boats as an at-sea test bed for ship airwake measurement and experimentation. Plans include computational and experimental testing at both model scale and full scale. The results of testing may be used for validation of Computational Fluid Dynamics (CFD) ship airwake predictions, analysis of ship's anemometer position error, understanding of rotor downwash effects and airwake flow control. The candidate for this summer research project will create a geometric model of a YP boat, generate a computational grid, and run CFD solutions to predict the flowfield in the vicinity of the boat for a range of relative wind angles. He/she will gain an understanding of the level of geometric detail necessary for ship airwake predictions, the importance of grid refinement near key areas of the boat, and the issues associated with using High Performance Computing for these types of computations. The work will be supervised by a member of the AASS Branch experienced in ship airwake predictions. The candidate will write a report on the investigation and present the results to members of the AASS Branch.

Background or Skills Required: Experience in CFD, including generation of grids and running CFD solutions on Linux-based High Performance Computing machines. Experience with one or more of the following codes is desirable but not essential: Gridgen, Gridtool, VGRID, Cobalt, USM3D.

Number of Academy Cadets/Midshipmen: 1

Number of Academy Faculty: 0

Requested Duration: 6 (in weeks)

Security Clearance Required: None

United States Naval Academy Midshipman/Faculty Summer Research Project

Project Title: Investigation of Cavity Flow Field Effects on Store Loads

Organization: United States Naval Academy

Location: HPC Maui, HI

Project Description: (one page or less)

1. Stores released from bomb bays have been an area of interest to the store separation community for years. Cavity flow is essentially unsteady, yet stores released from bomb bays must separate in a predictable manner. Previous research has extensively explored the unsteady nature of the flow in terms of the bay acoustics. Other research has explored the changes in the flow field as the store traverses the cavity in the vertical direction. The general consensus is that the flow is unsteady in the cavity, but that the effects of the unsteadiness can be mitigated through the use of devices such as spoilers and ejector mechanisms. That is because, despite the degree of unsteadiness in the flow, the store separation event must be essentially repeatable if there is any hope of obtaining a flight clearance. Interestingly, both of these cavity flow mitigation devices seem to point to the cavity shear layer as the major contributor to adverse flow separation characteristics. This project will investigate the ability of various CFD techniques to capture the effects of the cavity flow on a store near the shear layer. In past studies, Euler codes have done a better job at predicting store loads despite the obvious limitations of such an approach. Furthermore, while the flow in the bay is certainly unsteady, the shear layer dynamics may be closer to steady, at least in terms of their effect on the store. It may turn out that a full unsteady, time-accurate approach must be taken, or that lesser computational intense methods are adequate for store separation purposes which has implications for stores released from bays in the future, such as on the F-35 and P-8 aircraft. Along these lines, wind tunnel data exists for a cavity termed the NICS cavity. This wind tunnel data represents quasi-steady force and moment history on the store as it is moved along a horizontal traverse of the cavity at different depths. This project will assess the ability of different CFD techniques to match the wind tunnel data, as it is hypothesized that the substantial changes on the store loads observed in the wind tunnel data for the stores moved along the horizontal traverse of the cavity are due primarily to the structure of the shear layer. This project will also use post processing and visualization tools of the CFD data to enhance our understanding of the shear layer dynamics.

Background or Skills Required: (half page or less)

Geometry preparation will be accomplished in GRIDTOOL. The student should arrive with the relevant geometry on a government laptop running the LINUX operating system. It is anticipated that the NICS geometry and the store geometry will have been provided to the student in advance of the internship. Some geometry manipulation may still be necessary to completely close the geometries. Basic skill in using GRIDTOOL is required prior to the internship.

Unstructured grid generation will be accomplished using VGRID. The student should have had some experience using VGRID on practice geometries prior to the internship. Continued expertise in the use of VGRID will be under the tutelage of the faculty rep on-sight during the internship.

Flow solutions will be accomplished using the flow solver, USM3D. This code has been compiled and installed on the HPC facility in Maui during FY2008. The student should have a general knowledge of how to use USM3D but may have very limited experience in its actual use. It is anticipated that they will be introduced to using USM3D in the serial mode on small problems prior to the internships. Instructions on use of the parallel version will be accomplished on site during the internship.

This project is geared toward an advanced student who has a substantial amount of time to pursue research on this topic following the internship.

The CREATE program is currently developing a software tool called KESTREL. If the code were available in time for the internship, it would be desirable to use KESTREL on these projects.

Number of Academy Cadets/Midshipmen: 1

Number of Academy Faculty: 1

Requested Duration: (in weeks) 3 weeks

Security Clearance Required: none

United States Naval Academy Midshipman/Faculty Summer Research Project

Project Title: Investigation of POD Interference effects on the F-18C Aircraft

Organization: United States Naval Academy

Location: HPC Maui, HI

Project Description: (one page or less)

1. This project is a continuation of a project which began last year. In FY2008, the effects of the ATFLIR POD on the store separation characteristics of the F18C were investigated using CFD analysis of a GBU-31 adjacent to the POD as part of a USNA Trident Scholarship research project. After graduation, the student was able to transfer the project to HPC Maui and make significant progress on improving the store separation characteristics of the F-18C using the increased resources available at that location. Elements of the POD that adversely affected the motion of the store after release were identified and a geometric change to the POD was developed that improved the store separation characteristics somewhat. Furthermore, the resources of an HPC center made possible an investigation on the drag effects on the aircraft where force and moment data on the store alone was only possible previously. In a continuing effort, this project will attempt to further those advances by investigating related geometries that will be developed based on the work accomplished last year. Furthermore, the initial work was limited to the GBU-31 adjacent to the targeting POD. It is not known whether the same phenomena affecting the GBU-31 also affects stores in different weight classes. This project will investigate the ATFLIR POD effects on the GBU-32 and GBU-38, and whether the geometric changes proposed last year would be beneficial for these other store configurations. Furthermore, only a relatively few number of geometric changes to the POD were able to be investigated in the time available last year, and this project will continue efforts to improve the shape of the aft end of the POD with the goal of not only improving the store separation characteristics but also reducing the wave drag on the aircraft.

Background or Skills Required: (half page or less)

Geometry preparation will be accomplished in GRIDTOOL. The student should arrive with the relevant geometry on a government laptop running the LINUX operating system. It is anticipated that the NICS geometry and the store geometry will have been provided to the student in advance of the internship. Some geometry manipulation may still be necessary to completely close the geometries. Basic skill in using GRIDTOOL is required prior to the internship.

Unstructured grid generation will be accomplished using VGRID. The student should have had some experience using VGRID on practice geometries prior to the internship. Continued expertise in the use of VGRID will be under the tutelage of the faculty rep on-sight during the internship.

Flow solutions will be accomplished using the flow solver, USM3D. This code has been compiled and installed on the HPC facility in Maui during FY2008. The student should have a general knowledge of how to use USM3D but may have very limited experience in its actual use. It is anticipated that they will be introduced to using USM3D in the serial mode on small problems prior to the internships. Instructions on use of the parallel version will be accomplished on site during the internship.

This project is geared toward a student who has some amount of time to pursue research on this topic following the internship possibly has a course elective. Depending on the time available, it can be scaled by limiting the extent of new geometry manipulation required.

The CREATE program is currently developing a software tool called KESTREL. If the code were available in time for the internship, it would be desirable to use KESTREL on these projects.

Number of Academy Cadets/Midshipmen: 1

Number of Academy Faculty: 1

Requested Duration: (in weeks) 3 weeks

Security Clearance Required: none

United States Naval Academy Midshipman/Faculty Summer Research Project

Project Title: Validation of CFD Ability to Predict Store Separation Characteristics for the F18C with the ATFLIR or LITENING POD Attached.

Organization: United States Naval Academy

Location: HPC Maui, HI

Project Description: (one page or less)

1. Wind tunnel data exists which indicates that there are substantial differences between the effects of the ATFLIR POD and the LITENING POD on an adjacent GBU-32 store. It is not well understood why this substantial difference should exist, nor is it known if CFD can adequately predict the differences. This project will utilize CFD to investigate these configurations. Comparison to existing wind tunnel data will be used as the metric to assess the efficacy of the CFD analysis. It is anticipated that post-processing of the CFD solutions using shock capturing techniques will shed light on the cause of the differences on the flow field due to the two different PODS and may indicate potential avenues of remediation. This project is best accomplished in conjunction with the other F-18C POD study as they will use substantially similar geometry and will run the flow solver at similar conditions. The primary difference between this study and the other one is the focus on the LITENING POD and the comparison to the LITENING POD wind tunnel data in this study.

Background or Skills Required: (half page or less)

Geometry preparation will be accomplished in GRIDTOOL. The student should arrive with the relevant geometry on a government laptop running the LINUX operating system. It is anticipated that the NICS geometry and the store geometry will have been provided to the student in advance of the internship. Some geometry manipulation may still be necessary to completely close the geometries. Basic skill in using GRIDTOOL is required prior to the internship.

Unstructured grid generation will be accomplished using VGRID. The student should have had some experience using VGRID on practice geometries prior to the internship. Continued expertise in the use of VGRID will be under the tutelage of the faculty rep on-sight during the internship.

Flow solutions will be accomplished using the flow solver, USM3D. This code has been compiled and installed on the HPC facility in Maui during FY2008. The student should have a general knowledge of how to use USM3D but may have very limited experience in its actual use. It is anticipated that they will be introduced to using USM3D in the serial mode on small problems prior to the

internships. Instructions on use of the parallel version will be accomplished on site during the internship.

This project is geared toward a student who has some amount of time to pursue research on this topic following the internship possibly has a course elective. Depending on the time available, it can be scaled by limiting the extent of new geometry manipulation required.

The CREATE program is currently developing a software tool called KESTREL. If the code were available in time for the internship, it would be desirable to use KESTREL on these projects.

Number of Academy Cadets/Midshipmen: 1

Number of Academy Faculty: 1

Requested Duration: (in weeks) 3 weeks

Security Clearance Required: none

Cadet/midshipman/faculty summer research project

Project Title: Computational prediction of bacterial protein subcellular localization

Organization: Biotechnology HPC Software Applications Institute

Location: Fort Detrick, Maryland

Project Description: We are developing a protein function annotation pipeline that will be used for genome-wide annotation of new bacterial pathogens. Protein subcellular localization is an important step in the analysis of a variety of secretion systems that bacteria utilize to invade their hosts and is of large interest to a wider biodefense community. Specifically, our users from the Naval Medical Research Center suggested that we add the tools for computational prediction of the protein subcellular localization to the pipeline.

A comprehensive analysis of the available open source computational tools for protein localization will be performed, including, but not limited to, the widely used tools such as TMHMM, SignalP and PSORTb. The most appropriate software will be downloaded and installed locally on our server and subsequently ported to the HPC environment to be included in the pipeline.

Background or Skills Required: The collaborator on this project should have computer programming experience in the Unix environment. Proficiency in Perl and C/C++ is mandatory. Bioinformatics background and high performance computing is a plus.

Number of Academy Cadets/Midshipmen: 1

Number of Academy Faculty: 0

Requested Duration: 4-6 weeks

Security Clearance Required: NAC preferred

Cadet/midshipman/faculty summer research project

Project Title: Genome browser for viewing multiple genome alignments

Organization: Biotechnology HPC Software Applications Institute

Location: Fort Detrick, Maryland

Project Description: As part of the genome sequence analysis pipeline being developed at BHSAI, we need a genome browser for viewing multiple genome alignments along with annotations. This software can be based on the open source SynBrowse (www.synbrowse.org) framework, with additional capabilities to visualize multiple genomes and their annotations. The multiple genome alignments will be produced using open source software such as mauve (http://gel.ahabs.wisc.edu/mauve/). This browser will help the users perform comparative analysis of newly sequenced bacterial genomes and identify modifications or novel regions that affect pathogenicity or drug resistance. This project will help a graduate student with computational background gain hands-on experience in developing bioinformatics software.

Background or Skills Required: Previous programming experience with Perl is a must. Familiarity with BioPerl is desirable, but not necessary. Previous experience with developing Web applications and Apache Web Server are also desirable. Background in bioinformatics will be helpful.

Number of Academy Cadets/Midshipmen: 1

Number of Academy Faculty: 0

Requested Duration: 6-8 weeks

Security Clearance Required: No

Cadet/midshipman/faculty summer research project

Project Title: Predict relative receptor-ligand binding affinity using free energy simulations

Organization: Biotechnology HPC Software Applications Institute

Location: Fort Detrick, Maryland

Project Description: Receptor-ligand interactions are fundamental in biological system. Understanding these interactions will not only help us to study the connections among biological molecules but also provide us a tool to design novel ligands and inhibitors for therapeutic purpose. Binding affinity is one the most important parameters to characterize a receptor-ligand interaction. The ability to predict binding affinity using *in silico* methods has been a goal for decades.

Many methods have been developed to predict the binding affinity of a receptor-ligand complex. The challenges facing such predictions are accuracy and sensitivity. Using free energy simulations to estimate the binding affinity difference (i.e., relative binding affinity) between two similar ligands to a common receptor is one of the most accurate methods. Although the methodology of this approach was established years ago, there are still technical challenges that need to be overcome. At BHSAI, we have been developing automated protocols to run free energy simulations on DoD HPC platforms. The aim of this project is to perform case studies using the developed tools and to compare results with other methods (e.g., scoring functions).

Background or Skills Required: General understanding of computational chemistry. Background in chemistry, biochemistry, or biophysics. Familiar with UNIX/Linux operating system. Experience with Perl or other scripting language is a plus.

Number of Academy Cadets/Midshipmen: 1

Number of Academy Faculty: 1

Requested Duration: 4-6 weeks

Security Clearance Required: NAC

Cadet/midshipman/faculty summer research project

Project Title: Effects of solvents and system sizes on protein dynamics in molecular dynamics simulations

Organization: Biotechnology HPC Software Applications Institute

Location: Fort Detrick, Maryland

Project Description: Various methods have been developed to treat solvents either implicitly or explicitly in molecular dynamics simulations of proteins. However, the effects of different solvent treatments on protein dynamics have not been carefully studied. It is of interest to study the relationship between time scales of the protein motion obtained by implicit and explicit solvent simulations. The rate of contact formation between end residues of small peptides Cys-(Ala-Gly-Gln)n-Trp (n=1-6) have been studied both experimentally and by simulations in explicit solvent (Lapidus et al. Proc. Natl. Acad. Sci. U.S.A. vol 97 p 5584 (2001), Yeh and Hummer J. Am. Chem. Soc. vol 124 p 6563 (2002)). Recently, we performed extensive simulations of the peptides with different implicit solvent models available in CHARMM MD simulation program to calculate the end-to-end contact formation rate. The results were compared with those obtained simulations in explicit solvent. Structural properties such as distributions of end-to-end distances and dihedral angles were also examined. AMBER is another popular MD simulation program. AMBER offers many choices for protein force fields and implicit solvent models. We plan to perform a series of simulations of the Cys-Ala-Gly-Gln-Trp peptide with different combinations of force fields and implicit solvents. This study will give us better ideas on the effect of implicit versus explicit solvents and the protein force fields on structure and dynamics of proteins observed in simulations with AMBER. The results from this study will provide useful guidelines for the choice of the implicit solvent model and the protein force field in future simulations with larger proteins. If time permits, we will investigate the system size effects on protein dynamics in molecular dynamics simulations in explicit solvent.

Background or Skills Required: Familiarity with UNIX/Linux operating systems. Background in computational chemistry, physics, or biophysics. Experience in molecular dynamics simulations will be a plus.

Number of Academy Cadets/Midshipmen: 1

Number of Academy Faculty: 1

Requested Duration: 4-6 weeks

Security Clearance Required: NAC

Cadet/midshipman/faculty summer research project

Project Title: Neutral Gas Transport Modeling for Vacuum Electronics

Organization: Air Force Research Laboratory, High Power Microwave Division

Location: Kirtland AFB, New Mexico

Project Description: (one page or less)

Outgassing of materials in vacuum electronics causes many problems and failure modes and must accounted for in the design, experimentation, and modeling of these devices. The purpose of this research is to improve algorithms that model the transport of neutral particles after they have been removed from the surface in a vacuum electronic device by RF fields or electron/ion bombardment. DSMC is capable of modeling neutral transport in this regime but is expensive computationally, numerical diffusion in the fluid limit is larger than the real diffusion of the particles, and charge exchange makes the fluid limit most likely not valid. Gas density produced by electron/ion bombardment or RF fields is a reasonably high pressure near the surface (0.01-0.1 Torr) after initial out-gassing and expands into the vacuum of the device. Gas is formed of impurities found in the metal and cathode such as hydrogen, atomic & molecular oxygen, carbon, etc and is ionized as well to form a low density plasma. Some papers state that DSMC/MCC/EM-PIC have problems in different pressure and velocity distribution regimes. During the period of the research, the goal is to determine what are those regimes and how can the algorithms be improved to be accurate and computationally efficient in the regimes associated with vacuum electronics.

Background or Skills Required:
Experience with the theory or development of Direct Simulation Monte Carlo, Monte Carlo Collision, fluid, or other neutral particle transport models in a rarefied gas or plasma.

Number of Academy Cadets/Midshipmen: 0

Number of Academy Faculty: 1

Requested Duration: 3 weeks

Security Clearance Required: No

Project Title: C4ISR Center for Live/Virtual/Constructive (L/V/C) Environments REF: CERDEC DHPI Proposal for Virtual Electronic Battlefield (VEB) and its Stimulation of the PM C4ISR OTM Live Experimentation Venue

Organization: RDECOM CERDEC's PM C4ISR OTM

Location: Fort Monmouth and Fort Dix, NJ

Project Description: Product Manager C4ISR On-The-Move is an RDECOM CERDEC organization chartered to perform integrated C4ISR System of Systems (SoS) Live/Virtual/Constructive (L/V/C) technology demonstrations in order to support critical Science and Technology initiatives and Major Acquisition Programs on a year-round basis. PM facilities include a relevant field environment at Fort Dix, NJ, integration and simulation laboratories at Fort Monmouth NJ that leverage High Performance Computing capabilities (e.g. the H.A.L.L.E DHPI), and distributed connectivity via multiple networks. As an Army capital investment, PM C4ISR OTM supports both DoD and industry technology development efforts by providing a "test/assess-analyze-fix" environment in which systems supporting Future Force initiatives, or being considered for acceleration into the Current Force, can be matured and evaluated in a relevant, structured, low-risk manner. Activities conducted at PM C4ISR OTM's lab or field sites are constructed as opportunities to expose systems to conditions not ordinarily available within their development environments, with the goals of evaluating the system against specific performance criteria, facilitating validation of Technology Readiness Levels, and serving as a Technology Transition Venue. PM C4ISR OTM executes RDECOM's C4ISR OTM integrated SoS Event each summer at Ft Dix. These integrated events focus on the exploration of C4ISR systems integration and the impact that integrated C4ISR systems have upon force effectiveness.

From Apr through Aug of 2008, RDECOM, CERDEC, and PM C4ISR On-The-Move executed the largest C4ISR and Networking Technology Demonstration to date, referred to as C4ISR On-The-Move Event 08 (E08). More than 100 live communications, sensor, and battle command systems were integrated into a SoS. The live systems were complemented by a Brigade-sized element in virtual and constructive simulation and instrumented via a robust suite of automated data collection tools. PM C4ISR OTM will expand upon the work accomplished during C4ISR OTM E08 in C4ISR OTM Event 09, which will be executed at the Fort Dix facility Jun – Sep 2009. Modeling and Simulation for all PM events will be executed from the Center for L/V/C Environments, Myer Center, Ft. Monmouth, and as with E08 will employ the H.A.L.L.E. DHPI to stimulate the live environment.

Background or Skills Required: As a member of the Center for L/V/C branch, the candidate will be working side-by-side with experienced systems engineers as part of the overall L/V/C experimentation effort. Specific tasks would vary, but may include:

- Maintenance and execution of the High-Performance-Computing Army Laboratory for Live/Virtual/Constructive Experimentation (H.A.L.L.E.) supercomputer;
- Distributed stimulation of live experimentation environments including C4ISR OTM events at Ft Dix, utilizing HPC and non-HPC assets;
- Stimulation of the Live entities with a simulated C4ISR representation of the full FCS Combined Arms Battalion, and threat assets not represented in the Live environment;
- Interpretation of architecture artifacts and Network Centric Warfare constructs in order to implement the simulation component of the L/V/C experiment;
- Identifying data reduction and analysis tools that can be used on HPC assets to perform computationally intensive data reduction during the analysis phase of the experiment.

Specific skills or helpful background would include:

- Computer Science or Systems Engineering;
- Knowledge of web services and programming languages (C++ or .NET or Java)
- Knowledge of AIX or Linux, HLA, DIS, and integrated M&S simulation architectures;
- Familiarity with OF OneSAF simulation, MATREX, and QUALNET or OPNET modeling environments;
- Knowledge of Design of Experiments methods.

Number of Academy Cadets/Midshipmen: 1

Number of Academy Faculty: 1

Requested Duration: 4-8 weeks

Security Clearance Required: Secret

Project Title: C4ISR Integrated Event Design and Analysis (IED&A)
REF: CERDEC DHPI Proposal for Virtual Electronic Battlefield (VEB) and its Stimulation of the PM C4ISR OTM Live Experimentation Venue

Organization: RDECOM CERDEC's PM C4ISR OTM

Location: Fort Monmouth and Fort Dix, NJ

Project Description: Product Manager C4ISR On-The-Move is an RDECOM CERDEC organization chartered to perform integrated C4ISR System of Systems (SoS) Live/Virtual/Constructive (L/V/C) technology demonstrations in order to support critical Science and Technology initiatives and Major Acquisition Programs on a year-round basis. PM facilities include a relevant field environment at Fort Dix, NJ, integration and simulation laboratories at Fort Monmouth NJ that leverage High Performance Computing capabilities (e.g. the H.A.L.L.E DHPI), and distributed connectivity via multiple networks. As an Army capital investment, PM C4ISR OTM supports both DoD and industry technology development efforts by providing a "test/assess-analyze-fix" environment in which systems supporting Future Force initiatives, or being considered for acceleration into the Current Force, can be matured and evaluated in a relevant, structured, low-risk manner. Activities conducted at PM C4ISR OTM's lab or field sites are constructed as opportunities to expose systems to conditions not ordinarily available within their development environments, with the goals of evaluating the system against specific performance criteria, facilitating validation of Technology Readiness Levels, and serving as a Technology Transition Venue. PM C4ISR OTM executes RDECOM's C4ISR OTM integrated SoS Event each summer at Ft Dix. These integrated events focus on the exploration of C4ISR systems integration and the impact that integrated C4ISR systems have upon force effectiveness.

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Background or Skills Required: As part of the summer research project, the cadet would be part of the IED&A branch, working side-by-side with experienced systems engineers and analysts, as part of the overall experimentation effort. Specific tasks would vary, but might include:

- Development of experimentation plans that support the collection of data required to address a specific objective (e.g., the impact of network configuration on system-of-systems performance);
- Support in the execution of defined experimentation plans, either as part of the experiment control team or as a player within the experimental environment;
- Development and testing of automated data collection and/or reduction tools employing the computational assets of CERDEC's High-Performance-Computing Army Laboratory for Live/Virtual/Constructive Experimentation (H.A.L.L.E.) supercomputer;
- Technical documentation of experimentation activities and/or support in data reduction activities.

Specific skills or helpful background would include:

- Computer Science or Systems Engineering degree program;
- Ability to develop software in C++, C# and/or Java; familiarity with Windows and/or Linux development environments;
- Working knowledge of test and experimentation approaches and techniques;
- Working knowledge of communications, intelligence/surveillance/reconnaissance and/or battle command systems.

Number of Academy Cadets/Midshipmen: 1

Number of Academy Faculty: 1

Requested Duration: 4-8 weeks

Security Clearance Required: Secret

Project Title: C4ISR Systems Engineering and Integration (SE&I)
REF: CERDEC DHPI Proposal for Virtual Electronic Battlefield (VEB) and its Stimulation of the PM C4ISR OTM Live Experimentation Venue

Organization: RDECOM CERDEC's PM C4ISR OTM

Location: Fort Monmouth and Fort Dix, NJ

Project Description: Product Manager C4ISR On-The-Move is an RDECOM CERDEC organization chartered to perform integrated C4ISR System of Systems (SoS) Live/Virtual/Constructive (L/V/C) technology demonstrations in order to support critical Science and Technology initiatives and Major Acquisition Programs on a year-round basis. PM facilities include a relevant field environment at Fort Dix, NJ, integration and simulation laboratories at Fort Monmouth NJ that leverage High Performance Computing capabilities (e.g. the H.A.L.L.E DHPI) , and distributed connectivity via multiple networks. As an Army capital investment, PM C4ISR OTM supports both DoD and industry technology development efforts by providing a "test/assess-analyze-fix" environment in which systems supporting Future Force initiatives, or being considered for acceleration into the Current Force, can be matured and evaluated in a relevant, structured, low-risk manner. Activities conducted at PM C4ISR OTM's lab or field sites are constructed as opportunities to expose systems to conditions not ordinarily available within their development environments, with the goals of evaluating the system against specific performance criteria, facilitating validation of Technology Readiness Levels, and serving as a Technology Transition Venue. PM C4ISR OTM executes RDECOM's C4ISR OTM integrated SoS Event each summer at Ft Dix. These integrated events focus on the exploration of C4ISR systems integration and the impact that integrated C4ISR systems have upon force effectiveness.

From Apr through Aug of 2008, RDECOM, CERDEC, and PM C4ISR On-The-Move executed the largest C4ISR and Networking Technology Demonstration to date, referred to as C4ISR On-The-Move Event 08 (E08). More than 100 live communications, sensor, and battle command systems were integrated into a SoS. The live systems were complemented by a Brigade-sized element in virtual and constructive simulation and instrumented via a robust suite of automated data collection tools. PM C4ISR OTM will expand upon the work accomplished during C4ISR OTM E08 in C4ISR OTM Event 09, which will be executed at the Fort Dix facility Jun – Sep 2009. Modeling and Simulation for all PM events will be executed from the Center for L/V/C Environments, Myer Center, Ft. Monmouth, and as with E08 will employ the H.A.L.L.E. DHPI to stimulate the live environment.

Background or Skills Required: During the summer research project, the cadet would be part of the SE&I branch, working side-by-side with experienced systems engineers as part of the overall integration effort. Specific tasks would vary, but may include:

- Development of integration software ("middleware") components;
- Development and/or execution of system or system-of-systems test plans;
- Participation in live experimentation activities involving tactical C4ISR systems;

- Technical documentation of architectures, data flows and test results;
- Hands-on integration of hardware and software on tactical vehicles (e.g. HMMWVs) and other technology platforms (e.g. robotics, UASs).

Specific skills or helpful background would include:

- Computer Science or Systems Engineering;
- Ability to develop software in C++, C# and/or Java;
- Familiarity with Windows and/or Linux development environments;
- Working knowledge of test and experimentation approaches and techniques;
- Working knowledge of C4ISR systems.

Number of Academy Cadets/Midshipmen: 1

Number of Academy Faculty: 1

Requested Duration: 4-8 weeks

Security Clearance Required: Secret

Project Title: C4ISR Resources and Facilities Management (R&FM)
REF: CERDEC DHPI Proposal for Virtual Electronic Battlefield (VEB) and its Stimulation of the PM C4ISR OTM Live Experimentation Venue

Organization: RDECOM CERDEC's PM C4ISR OTM

Location: Fort Monmouth and Fort Dix, NJ

Project Description: Product Manager C4ISR On-The-Move is an RDECOM CERDEC organization chartered to perform integrated C4ISR System of Systems (SoS) Live/Virtual/Constructive (L/V/C) technology demonstrations in order to support critical Science and Technology initiatives and Major Acquisition Programs on a year-round basis. PM facilities include a relevant field environment at Fort Dix, NJ, integration and simulation laboratories at Fort Monmouth NJ that leverage High Performance Computing capabilities (e.g. the H.A.L.L.E DHPI), and distributed connectivity via multiple networks. As an Army capital investment, PM C4ISR OTM supports both DoD and industry technology development efforts by providing a "test/assess-analyze-fix" environment in which systems supporting Future Force initiatives, or being considered for acceleration into the Current Force, can be matured and evaluated in a relevant, structured, low-risk manner. Activities conducted at PM C4ISR OTM's lab or field sites are constructed as opportunities to expose systems to conditions not ordinarily available within their development environments, with the goals of evaluating the system against specific performance criteria, facilitating validation of Technology Readiness Levels, and serving as a Technology Transition Venue. PM C4ISR OTM executes RDECOM's C4ISR OTM integrated SoS Event each summer at Ft Dix. These integrated events focus on the exploration of C4ISR systems integration and the impact that integrated C4ISR systems have upon force effectiveness.

From Apr through Aug of 2008, RDECOM, CERDEC, and PM C4ISR On-The-Move executed the largest C4ISR and Networking Technology Demonstration to date, referred to as C4ISR On-The-Move Event 08 (E08). More than 100 live communications, sensor, and battle command systems were integrated into a SoS. The live systems were complemented by a Brigade-sized element in virtual and constructive simulation and instrumented via a robust suite of automated data collection tools. PM C4ISR OTM will expand upon the work accomplished during C4ISR OTM E08 in C4ISR OTM Event 09, which will be executed at the Fort Dix facility Jun – Sep 2009. Modeling and Simulation for all PM events will be executed from the Center for L/V/C Environments, Myer Center, Ft. Monmouth, and as with E08 will employ the H.A.L.L.E. DHPI to stimulate the live environment.

Background or Skills Required: As a member of the Resources and Facilities Management branch located at Fort Dix, the cadet will be responsible for hardware fabrication/integration of Army tactical and commercial vehicles and C4ISR hardware. The cadet will work side-by-side with experienced engineers to plan, prepare, and execute a subset of the SoS activities needed for the summer experiment. Specific tasks would vary, but may include:

- Specialized fabrication and integration of hardware to meet Experimentation needs;
- Coordination of Frequency Management and RF spectrum related issues with external organizations;
- Management of the CERDEC Range 1 Complex;
- Coordination of ranges and experimentation requirements with Fort Dix, Maguire AFB, and Lakehurst NAES;
- Coordination of Safety/Security releases.

Specific skills or helpful background would include:

- Mechanical or Systems engineering;
- Ability to convert broad concepts and ideas into a viable physical implementation to meet the needs of the experiment, while considering schedule and material availability constraints;
- Operation of tactical vehicles to support conduct of experiments;
- Knowledge of testing and experimentation of C4ISR equipment.

Number of Academy Cadets/Midshipmen: 1

Number of Academy Faculty: 1

Requested Duration: 4-8 weeks

Security Clearance Required: Secret

Cadet/midshipman/faculty summer research project

Project Title: Sensitivity Analysis for Signature Propagation

Organization: US Army Corps of Engineers – Engineer Research & Development Center

Location: Hanover, NH

Project Description: (one page or less)

The Engineer Research and Development Center, with the support of the High Performance Computing Modernization Program Office, has built high-fidelity simulation platforms for signature propagation. These modeling tools are used to predict how both sound and ground vibrations travel in a wide variety of very realistic circumstances.

The focus of the Summer 2009 project will be to understand and apply experiment design to develop an analytical study of how predictions for sound and ground vibration propagation is influenced by the values used for environmental variables.

The selected participants will learn the following which will directly and indirectly support their undergraduate studies: (1) design of experiments, (2) numerical modeling, and (3) use of a wide variety of computing platforms to accomplish numerical simulations.

Background or Skills Required: (half page or less)

Strong interest in understanding high-fidelity modeling and simulation
Completed coursework in Calculus & Differential Equations

Number of Academy Cadets/Midshipmen: 1 - 2

Number of Academy Faculty: 1

Requested Duration: (in weeks): 10

Security Clearance Required: None

Cadet/midshipman/faculty summer research project

Project Title: Source Localization Experiments

Organization: US Army Corps of Engineers – Engineer Research & Development Center

Location: Hanover, NH

Project Description: (one page or less)

The Engineer Research and Development Center, with the support of the High Performance Computing Modernization Program Office, has built high-fidelity simulation platforms for noise and ground-vibration propagation. We are exploiting this test bed to figure out where the sources of noise or ground vibrations are, based on the measurements at the sensors.

The focus of the Summer 2009 project will be to use our “wall of sound” as a source signal, and make experimental measure of the resulting noise field and ground vibrations on the ERDC laboratory site in order to experimentally demonstrate and validate our HPC-based source localization technology.

The selected participants will learn the following which will directly and indirectly support their career objectives: (1) design of experiments, (2) record-keeping and technical documentation in a modern computer-driven environment, and (3) being part of an accomplished and experienced team focused on collecting and understanding noise and ground vibration propagation data.

Background or Skills Required: (half page or less)

Strong interest in understanding high-fidelity modeling and simulation
Completed coursework in Introductory Physics

Number of Academy Cadets/Midshipmen: 1 - 2

Number of Academy Faculty: 1

Requested Duration: (in weeks): 10

Security Clearance Required: None

Cadet/midshipman/faculty summer research project

Project Title: Deployment and extension of Kestrel software framework for advanced aerospace vehicles

Organization: Air Force Research Laboratory, Air Vehicles Directorate

Location: Wright-Patterson AFB, OH

Project Description:

Kestrel is an integrating software product that facilitates design evolution and hardware acquisition of advanced military air vehicles. A particularly attractive feature is seamless coupled multi-physics simulation capability for aerodynamics, dynamic stability and control, structures, propulsion, and store separation. This attribute holds the potential to revolutionize development of fixed-wing aircraft in flight regimes ranging from subsonic through supersonic flight, including maneuvers, multi-aircraft configurations, and harsh operational conditions. This modular software employs a python infrastructure to allow addition of new physics capabilities as needed. Extensive effort has been invested to simplify portability and to exploit new architecture efficiencies targeting next generation peta-flop architectures envisioned for the 2010+ time frame. The proposed project will advance the application of Kestrel to applied problems of interest to the Air Vehicles directorate. The software will first be built and verified on local systems at WPAFB through standard certification procedures. Subsequently, the Kestrel suite of tools will be exploited to examine the aero-elastic response of advanced high altitude long endurance sensorcraft configurations.

Background or Skills Required: Computational fluid dynamics background is preferred.

Number of Academy Cadets/Midshipmen: One Cadet

Number of Academy Faculty: none

Requested Duration: 6 weeks

Security Clearance Required: none

Cadet/midshipman/faculty summer research project

Project Title: C4I Future Concept

Organization: PEO C4I PMW 760

Location: San Diego CA 92110-3127

Project Description:

Navy C4I has been delivering complex technologies to meet Navy and Joint warfighter requirements. The C4I capabilities provided are normally delivered more rapidly delivered than large ship or aircraft programs, but are rarely able to keep the pace with technology that the users desired. As an example, when sailors upgrade their home computers to the latest version of Microsoft, they often do not see that same upgrade onboard ship for several years. As American teenagers begin using commercially-provided Instant Messaging as part of their daily lives, sailors are still waiting to see an established real-time collaboration tool. Today ships are deployed with bandwidth per sailor less than what is typical with a cell phone. The average afloat network is almost 7 years old and it takes years vice months to get new network technology fielded in the Fleet. Radios support only one waveform each, which means there are over 800 variants installed in the Fleet, some of which are over 30 years old.

In the meantime, the national threat landscape has forced a shift to a lighter, more agile, better “connected” military. According to the National Defense Strategy, “Uncertainty is the defining characteristic of today’s strategic environment.” The old method of providing multiple systems with dedicated hardware and applications is too expensive and time consuming to meet rapid warfighting requirements.

In order to effectively support the warfighter in this dynamic and unpredictable environment, the Program Executive Officer, Command, Control, Communications, Computers and Intelligence (PEO C4I) has embarked on an aggressive plan to change not only its technical model, but also its business approach. Its program managers and staff are evaluating and leveraging commercial trends toward standardization, consolidation and service-oriented architecture (SOA). Through this approach, PEO C4I will gain better access to innovative technologies and be able to deploy enhancements more quickly.

PEO is looking for advanced C4I capabilities, and methods to more rapidly field these capabilities, for increased responsiveness to Fleet readiness requirements, increase supportability and standardization, increase system interoperability and network security and increase Joint alignment. Methods to achieve the overarching goal of providing a more agile, integrated C4I capability for the Navy include:

- Reduction of applications and servers, with increased server utilization
- Transforming application programs into community of interest (COI) providers
- Increasing bandwidth utilization and capacity
- Implementing a C4I rapid capability process similar to the submarine community's Acoustic Rapid COTS Insertion (ARCI) model
- Capitalizing on acquisition innovation

The specific effort would be to look at both C4I capabilities and processes to gain advantage for fielding C4I that affords a better warfighting capability, and more streamlined processes for a more rapid delivery of capability

Background or Skills Required: C4I, commercial best practices, etc.

Number of Academy Cadets/Midshipmen: 1-3

Number of Academy Faculty: 1-2

Requested Duration: 4 weeks

Security Clearance Required: None

Cadet/midshipman/faculty summer research project

Project Title: Utilizing Experimental Design for Modeling High Power Microwave Systems

Organization: Air Force Research Laboratory, High Power Microwave Division

Location: Kirtland AFB, New Mexico

Project Description: (one page or less)

The research project will focus on identifying and developing experimental design methods for reducing full factorial run matrices of simulations which are used to model or optimize High Power Microwave (HPM) systems. Modern high performance computing software for modeling HPM systems incurs a significant computational cost with each high fidelity simulation. The complexity of HPM systems also results in a large number of factors that must be examined to compare the performance of the hardware and modeled HPM system as well as predict the performance of future HPM systems. The high fidelity models employed are deterministic and non-linear in nature. Advanced statistical methods may need to be tailored to account for the non-linear nature of the models and devices. This project will involve investigating several candidate experimental design approaches to maximize the utility of HPM simulations for the particular application, provide a more in-depth analysis approach of the simulation results, and reduce the number of simulations required to model an HPM system.

Background or Skills Required:
Prior experience in statistically theory or analysis associated with Design of Experiments, Bayesian Experimental Design, Analysis of Variance, Optimization theory and other experimental design approaches.

Number of Academy Cadets/Midshipmen: 2

Number of Academy Faculty: 1

Requested Duration: 3 or more weeks

Security Clearance Required: No

Cadet/midshipman/faculty summer research project

Project Title: Assessment of Covariance Information as a Reliable Error Ellipsoid for Orbit Track Generation

Organization: AFRL/RDSM (HSAI-SSA)

Location: Maui High Performance Computing Center

Project Description: If certain assumptions are met, covariance information produced in the orbit determination process is a statistical representation of the orbit error ellipsoid. Meaningful error ellipsoids are critical to a variety of space situation awareness applications such as track association, laser clearing house, conjunction analysis, etc. This research project will investigate how representative the covariance is of the actual error distribution in some operationally relevant scenarios. To achieve this, simulated measurements from radar and optical systems will be generated with random noise and then orbit tracks will be derived from that data. HPC assets will be used to conduct Monte Carlo analyses of the observation and track generation. The resulting solution distribution will then be compared to the covariance information to assess whether covariance-based error ellipsoid is representative of the actual error distribution. Additional analysis will investigate the impact of the number of observations and the presence of systematic errors in the tracking data.

Background or Skills Required: Astrodynamics, basic programming (Matlab, C++, or Fortran), linux knowledge a plus

Number of Academy Cadets/Midshipmen: 1

Number of Academy Faculty: 0

Requested Duration: (in weeks) 5

Security Clearance Required: None

Project Title: System Identification Using High Resolution Simulations of Full Aircraft
Organization: USAF/46 SK
Location: Eglin AFB
Project Description:
Numerical simulations are an important tool for predicting aircraft performance and have been very useful in the industry for cruise conditions. CFD has even advanced to the stage that performance can be computed in off-design regimes that are difficult to investigate using wind-tunnel or flight testing as evidenced by the great strides in the last few years in the area of massively separated flows. Unfortunately, the applicability of CFD in the stability and control arena has been limited due to the large number of flow conditions that must be predicted, including dynamic motions. A fast and efficient means of extracting the maximum amount of data from a limited set of simulations is required to enable CFD to make a significant impact on Stability and Control problems.
Recent research by the Seek Eagle Office and USAFA personnel has shown that System Identification holds great promise in this field. The proposed project will support DoD Challenge project, *C3S-- Stability and Control Test and Evaluation Process Improvements through Judicious Use of HPC Simulations*, to develop and apply high resolution simulations of full aircraft stability and control and apply System Identification to the results. The method will combine the Delayed Detached-Eddy Simulation turbulence model, unstructured grids, and overset grids to predict full aircraft stability and control including control surface deflections. System identification along with prescribed maneuvers will be used to efficiently explore the aircraft envelope. The baseline CFD solver, *Cobalt*, will be used for the flow simulations and the systems identification tools include several *MATLAB* and *EXCEL* based packages.
Background or Skills Required: Due to the complex nature of the problem, experience with the CFD solver *Cobalt* is required, as well as the ability to post-process simulations using *Fieldview*.
Number of Academy Cadets/Midshipmen: 1
Number of Academy Faculty: 1 – someone currently on the DoD Challenge project
Requested Duration: 4-6 weeks
Security Clearance Required: None.

Project Title: Stability and Control Test and Evaluation Process Improvements
Organization: AFRL/DESM and USAF Academy
Location: Maui High Performance Computing Center
Project Description:

Numerical simulations are an important tool for predicting aircraft performance especially with respect to cruise conditions, and now Computational Fluid Dynamics (CFD) methods have advanced in capability to also address off-design regimes. Unfortunately, the applicability of CFD in the acquisition process has usually been confined to "post-diction" after a problem has been discovered in flight test as opposed to "pre-diction" in the design phase. Current simulations have been limited to static configurations with no control surface movements and independent of the vehicle mass/inertial properties. These simulations don't capture many undesirable vehicle traits generally due to nonlinear aerodynamic effects such as vortex-boundary layer, shock-shock, and shock-vortex-boundary layer interactions, and few current codes are capable of simulating given enough grid and time step resolution if the designer knew where to look for these phenomena in the aircraft envelope.

To address these deficiencies, the proposed project will support the DoD Challenge project, C3S-- *Stability and Control Test and Evaluation Process Improvements through Judicious Use of HPC Simulations*, to develop and apply high resolution simulations of full aircraft stability and control. The proposed approach is to combine the demonstrated capabilities to perform full aircraft simulations at flight Reynolds numbers that include aircraft motion with well-developed flight test techniques for gathering the necessary data across the flight envelope through the use of aircraft maneuvers and post processing of the aircraft response using nonlinear system identification techniques. Although the prescribed aircraft motions and virtual 6 DOF maneuvers will be inspired by flight test techniques, they will take advantage of the tighter control possible with CFD to increase the efficiency of the maneuvers. Also, more complex maneuvers may be envisioned with CFD than is possible with flight test. For example, with CFD the possibility exists to determine damping and cross derivatives individually since arbitrary (non-flyable) dynamic maneuvers are possible. The current research will culminate in a "virtual flight test" method that may be used to directly examine the classical dynamic aircraft responses, which define flying qualities and have certification requirements. The ultimate goal is to develop a methodology for efficiently and accurately screening for nonlinear aerodynamic phenomena such as spin, tumble, lateral instabilities, limit-cycle oscillations, and tail buffet of full aircraft using a combination of static-steady and unsteady single points, rigid body motion unsteady solutions, and 6 DOF simulations that include aeroelastic effects.

Background or Skills Required: Due to the complex nature of the problem, experience with the CFD solver *Cobalt* is required, as well as the ability to post-process simulations using *Fieldview*.
Number of Academy Cadets/Midshipmen: 1
Number of Academy Faculty: 1 – someone currently on the DoD Challenge project
Requested Duration: 4-6 weeks
Security Clearance Required: None.