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CRUSER · NEWS

Consortium for Robotics and Unmanned Systems Education and Research

FROM TECHNICAL TO ETHICAL...FROM CONCEPT GENERATION TO EXPERIMENTATION

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UCS key to interoperability, rapid technology insertion, and open marketplace for innovation

by Edward Lundquist, elundquist@mcri.com

DoD is promoting an open architecture approach to addressing the high costs and difficulties associated with adding or upgrading capability to closed "proprietary" unmanned systems, led by the UAS Control Segment (UCS) Working Group (WG). If interoperability and rapid technical insertion is the "holy grail" for unmanned and robotic systems operators, then UCS is the "Rosetta Stone."

For roboticists and designers of unmanned systems, that means that UCS should be specified, so that everything within the system can work with everything outside of the system. "With UCS, when someone comes up with a new application that addresses a requirement or closes a capability gap, we can readily assimilate that into our systems," says Rich Ernst, who leads the OSD development of the UCS architecture.

"Traditionally, different companies use different systems, different processes, different interfaces, different everything, and they are all point-to-point solutions," said Ernst. "But we can expand opportunities for industry by using our interface in the service oriented architecture; and opening up opportunities for small companies and large companies to come to the table and compete. That way we can easily and efficiently add capabilities to all of those systems without exhausting our resources with the integration cost for any one of them."

This effort is benefiting the Navy today as it develops the common control system (CCS) for the Unmanned Carrier Launched Airborne Surveillance and Strike—or UCLASS—that will provide a control system for both the air vehicle and its sensors from both a carrier at sea and ashore.

But there's more to it than the technical architecture.

"By breaking control system software in to functional pieces, upgrading, replacing or adding new capability now involves changing the piece, not the entire software. And if created to work with UCS, that piece or application should work with other systems also adapted with use UCS," Ernst says.

"We're leveraging the work with UCS to make a common control system to control multiple air vehicles from the same system," said Kevin Davis, requirements officer for the CCS and common standards and interoperability (OPNAV N2/6 F23). "I think of it as a business model to open up a traditionally closed, stove-piped control system acquisition, making it easier to adopt that control for multiple air vehicles."

Ernst sees the challenge as being holistic. "There is an entire ecosystem that goes beyond the typical technical and business structure."

With the UCS business model, there will be many innovative applications being developed and made available through an "app store" repository. Small companies and even individuals who come up with a new, better solution can make their product available; and users can select them through the app store for use on their system.

"Now the market can respond to what the users like, not just what the big OEMs make available," Ernst says.

***LAST CHANCE* - FY14 STEM Outreach Activities**

By **30 Nov**, answer a few questions about STEM Outreach Activities in your organization: https://survey.nps.edu/231434/lang-en

Director's Corner

Thank you to all those who participated in the September 2013 Warfare Innovation Workshop. We had nearly forty team members from across campus, with visitors from aligned DoD commands and industry. The final report will be available before the end of the month, and will include selected concepts to begin the third CRUSER Innovation Thread - guiding program activities into FY15. Also, thank you to all those who made CRUSER's third full program year a success. The FY13 Annual Report has just been completed and sent back to Washington DC. Well done everyone, and I look forward to great things as we start FY14!

Lyla Englehorn, CRUSER Director of Concept Generation

Overview of the Kansas Unmanned Systems Conference

by Joel Anderson, Development Director
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The Kansas Unmanned Systems Conference was held over a three day period from October 14-16 at the Hilton Garden Inn located in Manhattan, Kansas.

Monday, Tuesday and Wednesday were filled with interesting presentations and a lot of great conversation and interaction amongst conference attendees. We had over 150 participants despite the Government shutdown and had a wide variety of folks representing a myriad of functional areas for unmanned systems, precision agriculture, services, advanced manufacturing and beyond.

Monday's kick off saw over 25 exhibits and posters and proved to be a great venue for interaction, discussion, engagement and collaboration. The exhibits and posters remained in the foyer for the duration of the conference and served as a rallying point for folks during breaks and before and after formal conference events. We had an international colleague from Hungary present a poster on some very interesting weather/meteorological efforts under development.

MG Tafanelli, the Kansas Attorney General, provided a very insightful scene setter and was followed by Michael Toscano who gave a great Key Note to start things off on Tuesday. Michael remained at the conference as an active participant in discussions, presentations, panels and roundtables.

The lead in presenters captured key issues coming out of the AUVSI Economic Impact report from March as did the concurrent break out sessions which covered numerous presentations on applications and technologies associated with this industry. Panel discussion centered on Airspace, Policy, Applications and Industry issues and each focused on three particular questions that present challenges or create opportunities for us all in integrating unmanned systems into the National Airspace System and in meeting some difficult solution gaps in our future.

Mayor Bob Dixson of Greensburg, Kansas gave a moving presentation as our evening speaker on Greensburg and their efforts to rebuild through innovation for a sustainable future following a catastrophic EF5 Tornado on May 4, 2007. His presentation was a true highlight of the conference as it underscored the essence of the good people of Kansas and our nation.

Amy Hopkins of Northrop Grumman provided the Key Note for Wednesday morning and identified key issues, challenges and opportunities for the future.

Round table discussions resulted in some great deliverables and recommendations for the future. These discussions culminated an action packed three days of interactive engagement, discussion, collaboration and partnering amongst those that participated.

In closing, I would like to share a comment made during the last day of the conference: *"What is our 'Beacon of Hope'; what is that lightening rod that we can use to energize our youth of today to want to embrace STEM education and career opportunities? When I was a kid it was landing a man on the moon. When I was a kid it was world hunger in the form of Bangladesh, Ethiopia. The story continues.... What do our kids have today? Text messaging? Their next Facebook post? For me, I want to solve world hunger. Not trying to be flippant, but I truly want to solve world hunger. I want to make sure that we are good stewards of our environment. Unmanned systems may be one of those rods that provide an enabling capability to solve some of our most daunting challenges and may serve to energize our youth of today. There are others out there waiting for us all. A world population expected to exceed 9 Billion people by 2050. Water resources becoming a critical global issue. New and renewable sources of energy. Let's find those lightning rods and get engaged. Let's find that Beacon of Hope. Let's energize ourselves and our youth for the future."* (Joel D. Anderson; Kansas Unmanned Systems Conference 2013)

We look forward to seeing you at next year's conference.

Graph Algorithm for Wireless Relay Planning

by Raymond Moberly, Department of Mathematics, San Diego State University

SDSU Mathematics was a first-time participant in JIFX 13-4. Innovations for wireless communication were presented and ideas from anticipated collaborators were gathered. Several assessments were made about the opportunities to transition the author's computer modeling effort to a true field experiment.

The optimal positioning of aerial relays, for tactical operation communications, is an improvement upon the "everyone is a relay" strategy typically employed in a Mobile Ad-Hoc Network (MANET). Whereas the MANET rapidly adapts to the changing positions of deployed military forces, a coordinated set of aerial relays can do so more controllably. The author's work proposes that a limited set of relays can be optimally placed to offer relay connectivity for a moderately large number of ground troops. The algorithm currently finds those optimal placements.

The current model assumes that the number of nodes and the number of available relays are both given quantities. The mobility renders any optimal solution as transitory, but an assumption is that the solution remains optimal for longer than the time required to compute the optimal solution. Each ground node is assumed to have an equivalent cost function, simplified to consider only the distance (thus the necessary power to transmit) to the aerial relay. The author's experience with related communications problems, suggests that this hyper-graph algorithm could easily be written to consider individualized cost functions, a cost function that is the sum of the ground transmission powers, or a weighted sum in any combination.

Novel work by other information theorists, Gao et al. uses hyper-graphs to solve wireless networking problems that maximize secrecy; the hyper-graph work of Ausiello et al considers that there is a criterion by which one hyperpath can be measured and judged to be better or worse than another path. Once the network topology has been specified as a hyper-graph, the geometries and coordinates of the nodes themselves are not needed for the optimization calculation; the optimization is entirely a discrete problem. The full white paper on graph algorithms can be requested from the author.

Unmanned Aerial Vehicles (UAVs) are a pivotal technology in this second decade of the new millennium. Time aloft for prototype UAVs has increased substantially in recent years. JIFX engages leading edge research in flight planning and payloads for both fixed wing and rotary wing UAVs.

As mentioned earlier, JIFX 13-4 motivated further experimentation but it allowed certain in-the-field reality checks for the progression. (1) The NPS facility at McMillan Airfield, Camp Roberts, CA offers a great combination of available spectrum and airspace, but the spectrum congestion at JIFX offers a challenge to an experiment intending to show the possibilities of reduced network and relay power levels. Spectrum scheduling is a part of the coordination effort, but the larger portion of the Camp Roberts base, 66 square miles, appears to be open to JIFX participants with the support and even the assistance of the base hosts. (2) While spectrum coordination offers experimentation opportunities on many frequencies, the unlicensed bands (e.g. UHF WLAN routers) tend to be popular among the UAV payloads. (3) Flight autonomy is a reality; fixed wing and rotary wing aircraft can, with minimal intervention, remain on-station to serve as wireless relays. Coordinated flights of multiple UAVs is an exciting cutting-edge activity at JIFX, but not necessarily the best next step for the author's work on graph algorithms. The concept and testing can advance to the next level on the ground before needing the aerial lift.

As modeled, the graph algorithm achieves as much as 50% better power utilization by optimally placing aerial wireless relays to support ground-based troops. Future experiments at JIFX will experimentally verify the modeling and theory. The JIFX experimentation range provides this author with opportunities to put communication and information theory to the test. Related work on improving security through optimal network path planning is being presented at this month's Milcom conference in San Diego, entitled: A Thinner Thinnest Path using Directional Transmissions in a Network. The discrete optimization using a hypergraph algorithm is a common element of the related works.

82nd Military Operations Research Society Symposium - Call for Papers

MORS, the Military Operations Research Society, is holding its 82nd Symposium at the Hilton Mark Center in Alexandria, VA from 16-19 June 2014. The live session, which is held from 16-19 June, is supplemented by a "virtual" session held from 4-6 June. The virtual session will be held via DCO (Defense Connect Online) and will support those that cannot make the trip to the live symposium.

As the Chair of the Distributed Working Group 2 – Unmanned Systems, I and my Co-Chairs will be seeking papers related to unmanned systems as used in land, sea and airborne roles. Please consider this invitation to submit abstracts for the upcoming Symposium. The formal "Announcement and Call for Presentations" will be released in the next few weeks and complete details on the Symposium can be obtained from the MORS website: www.MORS.org.

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Upcoming CRUSER Monthly Meeting

Wed 11 Dec, 1200-1250 (PDT)

Root 242, VTC, or dial-in 831-656-6681

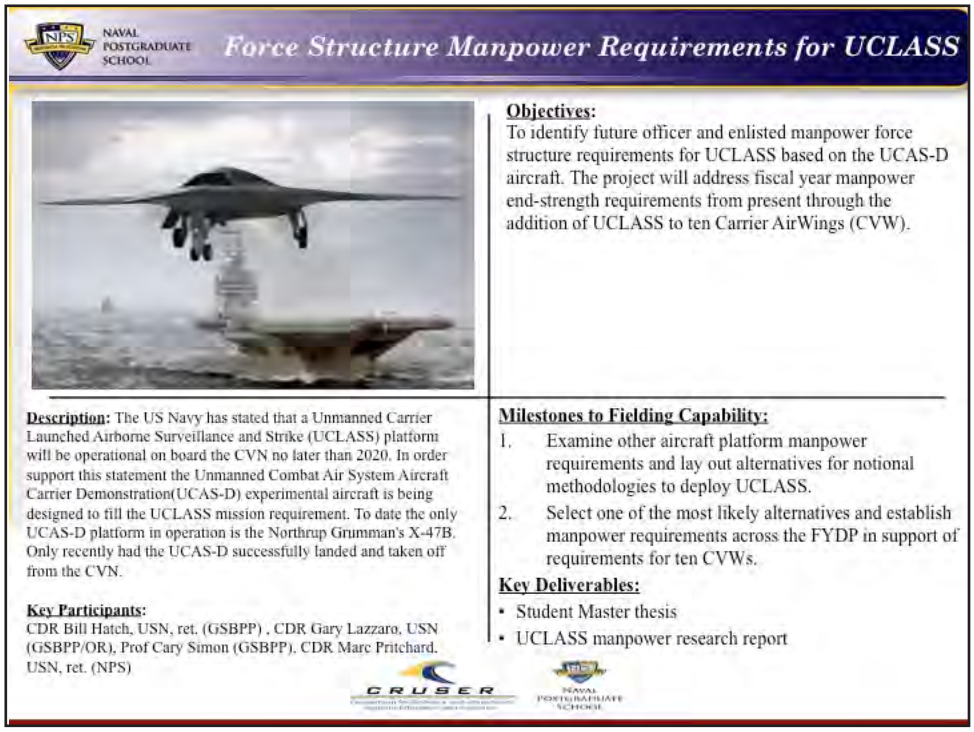
contact us at cruser@nps.edu for the passcode

Short articles of 300-500 words for CRUSER News are always welcome - cruser@nps.edu

- Unmanned Systems/Robotics research
- New Program/Systems/Projects
- Other aspect of Unmanned Systems/Robotics

Force Structure Manpower Requirements for UCLASS

by CDR Bill Hatch, USN (ret), NPS Faculty, wdhatch@nps.edu



This research takes the opportunity to address the challenges of integrating Unmanned Carrier Launched Airborne Surveillance and Strike (UCLASS) aircraft with a carrier-based air wing. The interaction of UCLASS aircraft with traditional air wing asset management planning and flight deck cycles calls for a systematic analysis of the issues of integration. The issues will address manpower as it relates to maintenance, watch standing, and emerging cultural changes in Naval aviation as part of carrier based flight operations and related mission effectiveness. This research will be conducted by examining DoD, various service specific policy and lessons learned, accepted manpower policy as its basis for future manpower estimates.

In response to Warfighter demand, the Department of Defense has continued to invest aggressively in developing unmanned systems and technologies. That investment has seen unmanned systems transformed from being primarily remote-operated, single-mission platforms into increasingly autonomous, multi-mission systems. The fielding of increasingly sophisticated reconnaissance, targeting, and weapons delivery technology has not only allowed unmanned systems to participate in shortening the "sensor to shooter" kill chain, but it has also allowed them to complete the chain by delivering precision weapons on target. The Unmanned Systems Roadmap addresses the benefit of these systems and technologies into the resultant combat capability by mapping specific unmanned systems to their contributions to Joint Capability Areas (JCAs) such as Battlespace Awareness, Force Application, Force Support, and Logistics. http://www.acq.osd.mil/psa/docs/UMSIntegratedRoadmap2009.pdf (DoD FY2009-2034 Unmanned Systems Integrated Roadmap, March 2009).

UCLASS are expected to provide global intelligence, surveillance, reconnaissance and strike capability. The strategy also reflects efforts to increase global range, persistence, and network connectivity to the carrier. The research will highlight the following features- carrier based, operation and maintenance regarding unmanned operations. Integration of UCLASS with a carrier-based air wing also brings challenges and issues that will be analyzed.

This research approach will be to develop UCLASS manpower. It will analyze the current methods being used to provide Unmanned Autonomous Vehicles (UAV) and related systems manpower requirements will be conducted, then a comparative analysis of an existing F-18 and other Squadron Manpower Documents (SQMD) as a baseline to develop alternative UCLASS notional squadron(s). The results will be used to develop current and future UAV manpower estimates. The research will include NPS manpower researchers and a Manpower Systems Analysis (MSA) 847 curriculum student thesis.

Press Release – FAA Releases Unmanned Aircraft Systems Integration Roadmap (7 Nov 13)

WASHINGTON –The U.S. Department of Transportation's Federal Aviation Administration (FAA) today released its first annual Roadmap outlining efforts needed to safely integrate unmanned aircraft systems (UAS) into the nation's airspace. The Roadmap addresses current and future policies, regulations, technologies and procedures that will be required as demand moves the country from today's limited accommodation of UAS operations to the extensive integration of UAS into the NextGen aviation system in the future... **http://www.faa.gov/news/press_releases/news_story.cfm?newsId=15334**

UAS Roadmap: http://www.faa.gov/about/initiatives/uas/media/UAS_Roadmap_2013.pdf

UAS Comp Plan: http://www.faa.gov/about/office_org/headquarters_offices/agi/reports/media/UAS_Comprehensive_Plan.pdf