



# International Council on Systems Engineering Colorado Front Range Chapter

## “Raytheon’s SE expertise and experience was instrumental in winning GPS,” says Terry Plymell, Director of Systems Engineering

On Feb. 25, 2010 the U.S. Air Force selected Raytheon Company for an initial contract of \$886 million to develop a new element of the Global Positioning System to improve the accuracy of information from GPS satellites. The bulk of the work will be done at the company’s facilities in Aurora, Colorado.

GPS, a satellite-based radio navigation system for the military and the public, comprises three major segments: the user segment, the space segment, and the control segment, which includes a master control station and ground antennas." The OCX concept was created to separate the control and space segments," Canty said. "Technologies were evolving so rapidly and were so critical to execution that specialized skills were needed. The GPS wing saw the same need for specialized expertise on GPS OCX." The contract represents the first two development blocks of the advanced control segment (OCX), which will have a significant impact on GPS capabilities. The OCX system will include anti-jam capabilities and improved security, accuracy and reliability and will be based on a modern service-oriented architecture to integrate government and industry open-system standards.

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## President’s Corner

Dear Fellow Colorado Front Range Chapter Members,

We are now just a short time away from the INCOSE International Symposium 2010 (IS2010)—the 20<sup>th</sup> anniversary event! I’ve personally had the opportunity to speak with the Project Leader, Jack Stein, and he has shared many of the exciting plans with me including top-notch technical papers, tutorials, tours (Northwestern University Feinberg Biomedical School of Medicine and Fermilab National Accelerator Laboratory (my personal favorite as a physicist by education)), and special events such as the banquet at the Navy Pier Grand

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Ballroom. Chicago is also a terrific place to visit (for the family as well) with its many museums, waterfront activities, and cultural events. Of course, if you can't make it to this fine event for our Systems Engineering community, we have the IS2011 symposium coming to Denver in just one more year!

As our program year comes to an end, so does my current role as your chapter President. I have elected to take the role as Past President, a one-year position starting at the beginning of our next chapter program year (August 1) since I have served our chapter and INCOSE as President for two program years (and to remain in line with the terms of our other Presidents). As my Presidency ends, I'd like to share a little with you about my thoughts and experiences. I've been so appreciative of our joint efforts as a chapter to accomplish much, and the strong teamwork and support of our Executive Committee (EXCOM) as they have enabled our chapter functions. Just look at the growth we've seen in a few years. Many of you have taken steps to start learning Model-Based Systems Engineering, and even joined our Challenge Team. Some of you have stepped out and offered your assistance to INCOSE's IS2011 Event Specific Project Team. You've been supporting our youth as judges at FIRST Robotics competitions, and spoke about Systems Engineering at career fairs (Cherry Creek School District). You may have had the chance to

engage our young Systems Engineers as we jointly hosted meetings with our student chapter at the Air Force Academy. Our Ambassador Program, which is intended to exchange information with other professional organizations, has really been successful, where we've seen growth in participation across these organizational boundaries. And of course, look at the recognition that INCOSE has given us for our accomplishments since 2006--one Silver Circle Chapter Award, three Gold Circle Chapter Awards, and the Director's Award for Most Improved Chapter. I hope to see more momentum in the coming years as we continue to pursue our individual and community growth in Systems Engineering, and I'm sure our incoming President will find it quite an exciting year ahead as the symposium approaches.

Thank you for allowing me to serve as your chapter President, and for the growth and opportunity that you have provided to me personally. I will look forward to more good years ahead with INCOSE, and I hope to see many of you in the coming year at our chapter meetings, tutorials, and events, and of course at our own home-town symposium event, IS2011!

Fondest regards and respects,

Leslie Koshigoe, President  
INCOSE, Colorado Front Range Chapter ■

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## News and Notable

### Systems Engineer Guides Constellation

Thomas, a **systems engineer** who has been with NASA for 30 years, has been the deputy Constellation program manager since 2007. He is currently assigned to the Marshall Space Flight Center in Huntsville, Ala., but will divide his time between Marshall and Johnson in Houston, where Constellation is based. ■

### INCOSE Version 3.2 of the Systems Engineering Handbook Available on Connect

A new version of the INCOSE Systems Engineering Handbook is now available for download on INCOSE Connect in the Products Area. The primary purpose of the Version 3.2 update was to:

- Bring the handbook into alignment with the latest 2008 version of ISO/IEC 15288 international standard
- Resolve inconsistencies in Version 3.1, primarily in the areas of terminology, figure-to-figure & figure-to-text consistency
- Consolidate related process information throughout the text to remove the multiple treatment of topics

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"We are excited to partner with the Air Force to provide the best-value GPS control system for the future," said Lynn Dugle, president of Raytheon's Intelligence and Information Systems business.

"Raytheon's broad experience in delivering satellite-to-ground command and control systems will ensure that our nation's military and civil GPS users worldwide are provided new capabilities."

"Raytheon is proud to deliver innovative technologies to help the Air Force meet its mission of protecting GPS operational services," said Bob Canty, GPS OCX vice president and program manager for Raytheon." The advanced control segment is a critical program for our nation's combat forces, coalition partners, as well as domestic and international civil users. By selecting Raytheon, the Air Force recognizes our experience and commitment to take GPS to the next level." Raytheon's teammates on this work include The Boeing Company, ITT, Braxton Technologies, Infinity Systems Engineering and the Jet Propulsion Laboratory.

Terry Plymell, Senior Manager, Systems Engineering for Raytheon in Aurora, Colorado, answered our questions about the role of Systems Engineering at Raytheon and with respect to the GPS OCX contract.

**Question:** What does the term 'Systems Engineering' (SE) mean within Raytheon and within the GPS OCX program?

**Answer:** Systems Engineering is a multi-faceted discipline, involving human, organizational, and various technical variables that work together to create complex systems.

At Raytheon and within GPS OCX, the entire process of developing a system – from initial user need, through design, development, delivery, support, and eventual disposal – are part of the Systems Engineering function.

**Question:** How important was Raytheon's SE expertise in winning this contract?

**Answer:** Raytheon's SE expertise and experience was instrumental in winning GPS. It was one of three technical areas scored as part of the selection process.

**Question:** What weight was given to SE in proposal evaluation?

**Answer:** The proposal evaluation computation includes various factors including the technical areas. SE was one of three equally weighted technical areas scored as part of the selection process.

**Question:** What is the role of SE in the GPS OCX work?

**Answer:** System Engineers translate mission needs to system requirements. They decompose and derive additional requirements to fully specify what needs to be built. They work with the software, hardware, integration, and test engineers to ensure that those requirements are implemented correctly and properly validated and verified. The SEs are ultimately responsible for ensuring the system needs all mission and operational needs.

**Question:** Where does SE fit in the GPS OCX program management structure?

**Answer:** SE resides throughout the GPS organization, with centralized oversight provided by the Systems Engineering and Integration Team (SEIT). The organization places systems engineering throughout the program to ensure the systems engineering process and technical delivery of the system is ensured. The core team of system engineers resides within the System Engineering and Integration Team (SEIT). This team is responsible for the entire system, system engineering processes and technical delivery across the engineering lifecycle. The SEs within the development teams ensure compliance with the overall system engineering efforts and are responsible development level system engineering. Systems engineering also resides within the System

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Integration team. This team is responsible for integrating the ground system that we build with the spacecraft, user equipment, and other GPS external systems.

**Question:** What is the Importance of SE certifications for the SE staff?

**Answer:** Raytheon recognizes certification as a growing industry trend and sees the training and knowledge gained through achieving SE certifications as beneficial to programs. Currently, Raytheon has internal processes and training that are part of the skills and competencies required for system engineers. Raytheon has multiple training programs focused on the details of system engineering expertise with a core training called the Principles of Systems Engineering.

**Question:** Will training and education of the SE staff play a role in contract execution?

**Answer:** Training and education will play a role in contract execution. Training and education associated with general system engineering practices is part of the core competencies for systems engineering professionals on the program. In addition, there is training associated with specific processes and methods employed on the GPS program.

**Question:** How does Raytheon train its SEs?

**Answer:** Raytheon hires individuals with technical degrees for SE roles. Raytheon provides its SEs with classroom type training to supplement their formal education. For example, all Raytheon SEs must complete the Principles of System Engineering course. Additional SE training is accomplished "on the job", through computer based training, formal training classes and as part of educational benefits within the company. Real world system engineering experience is valued in addition to the training and formal education.

**Question:** Our INCOSE chapter supports elementary / middle school / high school activities related to

SE education (robotics, career fairs, ...) How did you become an SE?

**Answer:** This question is answered by the SEIT lead for GPS. "I got my formal education in mechanical engineering. My interests were broader than designing individual parts or mechanisms therefore I gravitated toward SE roles. Early in my career I was given and accepted an opportunity in an SE organization."

**Question:** How should we be training future generations of SEs?

**Answer:** Training future generations of systems engineers should train people on systems thinking or being able to analyze the larger aspects of a system when making technical decisions is critical to future success. Fundamental technical skills to include science, math, engineering, physics and others are core to the based knowledge of a SE. In addition understanding operations research, model and simulation, and systems dynamics through large system interaction is important (e.g. macroeconomic systems is a good foundation for understand dynamics in large systems). Providing only the SE education without the basis and technical depth of a specific engineering discipline may result in SEs without the technical depth necessary for success.

**Question:** Are Model Base System Engineering (MBSE) ideas going to used in GPS OCX? If so, how?

**Answer:** Raytheon is following its Integrated Product Development System (IPDS) as the core of its development efforts. There are architecture and development techniques as well as other elements of MBSE that are included as part of IPDS.

**Question:** How does this award impact our community, now and in the future?

**Answer:** This award provides additional jobs for well educated, technical individuals. These jobs are challenging and attract qualified individuals to our community. It also provides an opportunity to advance individual professional growth. Hopefully the example and enthusiasm provided by Raytheon GPS employees will encourage more young people in our community to pursue technical careers. ■

## Chapter Activities

### May 2010 Chapter Meeting

Chapter member Jeff Hayden spoke to a group of 11 members at the Siemens Facility in Highlands



Kip Tarpley

**Jeff Hayden Receives a Thank You Gift After Presentation From Chapter President Leslie Koshigoe**

Ranch on the topic of “Architectures for Space Communications Networks.” Jeff gave us a brief history of the NASA space communications network and then described the communication architecture for upcoming NASA Lunar Missions. He described the progression of steps used in developing a communication architecture and related these steps to the DODAF process and diagrams.

Space communications architecture concepts play a key role in the development and deployment of NASA's future exploration and science missions. Once a mission is deployed, the communication link to the user needs to provide maximum information delivery and flexibility to handle the expected large and complex data sets and to enable direct interaction with the spacecraft and experiments. In human and robotic missions, communication systems need to offer maximum reliability with robust two-way links for software uploads and virtual interactions. Identifying the capabilities to cost effectively meet the demanding space communication needs of 21st century missions, proper formulation of the requirements for these missions, and identifying the early technology developments that will be needed can only be resolved with architecture design. This pres-

entation describes the development of evolvable space communication architecture models and the technologies needed to support Earth sensor web and collaborative observation formation missions; robotic scientific missions for detailed investigation of planets, moons, and small bodies in the solar system; human missions for exploration of the Moon, Mars, Ganymede, Callisto, and asteroids; human settlements in space, on the Moon, and on Mars; and great in-space observatories for observing other star systems and the universe. The resulting architectures enable the reliable, multipoint, high data rate capabilities needed on demand to provide continuous, maximum coverage of areas of concentrated activities, such as in the vicinity of outposts in-space, on the Moon or on Mars.

Jeff Hayden retired as an aerospace systems engineer for Lockheed Martin Astronautics in Denver. He had worked on NASA's network design for the CSOC program's Integrated Operations Architecture focusing on implementing Internet Protocols at the science instrument and on-board the spacecraft. He has described new spacecraft architectures that would operate in an Internet environment. Mr. Hayden has also performed initial spacecraft system designs for Stardust, Genesis, and Space Based Laser. Jeff's original expertise was as an instrument designer. In the sixties, he designed miniature mass spectrometers flown on Aerobee sounding rockets and on the Atmosphere Explorer C, D, and E satellites for the University of Minnesota. He designed the prototype for the Upper Atmosphere Mass Spectrometer for the Viking missions in the early '70's. While at Lockheed Martin, he performed the instrument system designs for the Net Flux Radiometer for Galileo Probe and for the Gamma Ray Spectrometer for Mars Observer.

### April 2010 Chapter Meeting

At our meeting on April 8, Dr. Sunil Cherian of Spiraee, Inc. spoke about current status and emerging developments in the SmartGrid sector. This topic is of great interest to the chapter as it helps educate us about our MBSE Challenge topic. Dr. Sunil Cherian will present the current status and emerging developments in the SmartGrid sector. His presentation will focus on the challenges and opportunities facing the electric power industry in

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developing and deploying advanced grid management technologies to deal with the rapid growth of distributed generation, renewable energy, demand response, energy storage, and electric vehicles. The coming transformation of the electric power system requires a paradigm shift from a passively controlled network with unidirectional power flow to an active network with bi-directional power flows where millions of intelligent nodes respond to power flow variations, economic signals, and a multitude of local or regional optimization criteria without disrupting power balance at any time. Dr. Cherian will present Spirae's highly scalable smart grid architecture for managing distribution networks with high penetration of distributed energy resources and conclude with project examples from the US and Europe.

Dr. Sunil Cherian is the founder and CEO of Spirae, Inc. based in Fort Collins, Colorado. Spirae develops infrastructure solutions for distributed energy and smart grid applications and co-owns and operates the InteGrid Test and Development Laboratory in collaboration with Colorado State University.

Prior to Spirae, Dr. Cherian founded Sixth Dimension, Inc. for providing networking technologies for the energy industry and served as its CEO from 1997 until 2002. Sixth Dimension was acquired by Comverge in 2003. Before beginning his entrepreneurial activities, Dr. Cherian served as Acting Director for the Colorado Manufacturing Extension Center and as Product Realization specialist for the Mid America Manufacturing Extension Center, both at Colorado State University.

Dr. Cherian has extensive experience in distributed energy applications including renewables integration, aggregated distributed generation for peak shaving, wholesale trading, and congestion management; load aggregation and workflow management for demand response; and service delivery infrastructures for Energy Service Providers. He has been actively involved in the creation of the GridWise Alliance that promotes the adoption of innovative IT solutions for the transformation of the electric power system as envisioned by the US DOE. He also serves on the Boards of the Northern Colorado Clean Energy Cluster and Colorado Cleantech Industry Association.

## March 2010 Chapter Meeting

The March Meeting featured a remote presenter, Dr. Manas Bajaj who talked about SysML Parametrics. His talk was of great interest to the chapter because of our activity with the Challenge Team and modeling that we will be doing as that work proceeds.

Leslie reported from the meeting that Dr. Bajaj expressed an interest in supporting our Challenge Team work and that one attendee was prompted to join the Challenge Team. One person who attended was from a local school district, where the students are already participating in modeling type efforts. It was good to see his interest. He mentioned that he is with the Littleton School District, and also has a robotics team.

SysML is emerging as a standard language for enabling model-based systems engineering. This presentation focuses on Parametrics – one of the four pillars of SysML – which enables system engineers to specify fine-grained relationships between diverse models, compose system-level analysis models (cost, performance, and other measures-of-effectiveness), and orchestrate simulations directly from the SysML model. System engineers can now compute system metrics, perform trades, and verify requirements from the earliest stages of system development. Integration with detailed design and simulation tools (such as CAD and CAE) allows system engineers to quickly wrap external and legacy models as SysML objects, perform integrated execution, and evaluate system MoEs through the development process.

Manas Bajaj, PhD is Director and Product Architect at InterCAX, LLC ([www.InterCAX.com](http://www.InterCAX.com)) where he heads the technology and commercialization team. Dr. Bajaj's industrial and research experience spans over 10 years across several organizations—NIST, NASA, Rockwell Collins, IBM, GE, Sandia, Lockheed Martin, and InterCAX in USA. His research interests are in the realm of MBSE, computer-aided design and engineering (CAD/CAE), next generation modeling and simulation methods, and open standards in the context of product and system lifecycle management. He earned both his PhD and MS in Mechanical Engineering from Georgia Tech, and a B.Tech. in Ocean Engineering and Naval Architecture from Indian Institute of Technology (IIT), Kharagpur, India. ■

## Interdisciplinary Team Developing Revolutionary Model Interpretation Tools

[Reprinted Courtesy of the A. James Clark School of Engineering and *Engineering@Maryland Magazine*, University of Maryland, College Park, MD]

Pancreatic cancer is the fourth leading cause of cancer death, killing about 32,000 Americans per year. While survival rates approach 40 percent if cancers are removed early, there is no reliable screening test, and the vast majority of cases are not diagnosed until it is too late.

To understand the course of pancreatic cancer and other diseases, physicians, scientists and engineers build complex disease models and test diagnostic and therapeutic approaches against them. Modeling is likewise used to understand and predict the performance of critical manmade systems, such as aerospace control systems. A major new National Science Foundation grant seeks to find ways to improve and understand such models and strengthen our ability to treat disease and build safer aircraft.

The multidisciplinary, five-year, \$10 million grant, "Next Generation Model Checking and Abstract Interpretation with a Focus on Embedded Control and Systems Biology," is led by Carnegie Mellon University and brings together researchers from the University of Maryland, City University of New York, New York University, SUNY Stony Brook, Cornell University and NASA's Jet Propulsion Laboratory.

For the \$1.8 million Maryland portion of the grant, the Clark School's Steve Marcus, electrical and computer engineering (ECE) and Institute for Systems Research, is co-principal investigator; Rance Cleveland, computer science and ISR, is principal investigator; and Tongtong Wu, epidemiology and biostatistics, is co-principal investigator. "One of the most rewarding aspects of this type of grant is the ability to work on projects with faculty from other disciplines," says Marcus. "Together we can achieve things that none of us could accomplish individually."

The consortium will build on the success of model-checking and abstract interpretation (MCAI), established methods for automatically verifying properties of digital circuit designs and embedded software. They will extend MCAI methods to systems with com-

plex continuous dynamics and probabilistic behaviors—including pancreatic cancer, atrial fibrillation and automotive and aerospace control systems.

"Part of the Clark School's strategic plan is to encourage the identification and development of resources that we can effectively use to solve major societal issues," says Marcus. "One of the applications is to focus on biological problems, such as the early detection of disease." Working with physicians at the University of Pittsburgh Medical Center, team members will analyze data and study ways to use technology to predict the onset of pancreatic cancer.

By promoting collaboration across disciplines and across institutions, Marcus says the grant "opens up new research vistas" for faculty and students. This spring, five graduate students from ECE and computer science will work together to combine techniques from both disciplines. "Students have a unique opportunity to attend meetings and work jointly with many outstanding researchers," says Marcus. "They can begin to build their professional reputations." And when it comes to applying to graduate schools and for faculty positions, Marcus notes, "They will have unique portfolios." ■

## From the Editor

First and foremost, congratulations to the Raytheon Company on the award of the GPS OCX contract. This month features an interview with Terry Plymell, Senior Manger, Systems Engineering for Raytheon in Aurora, Colorado. The topic is the role of Systems Engineering in the award and execution of this contract.

Many INOCSE chapters (including ours) are working on MBSE Challenge Projects to use MBSE in a real world setting. The product of these projects are formal models of a complex system that link requirements to system architecture to detail design. So what can one do with a system model built using, for example, SysML? The Institute for Systems Research at the University of Maryland is working to answer this question as part of a team led by Carnegie Mellon University as described on this page. The team is extending model-checking and abstract interpretation techniques used in digital circuit design.

Have a great summer and I'll see you in the fall. ■

## Welcome New Colorado Springs Area Director

We would like to welcome our new Colorado Springs Area Director, Michael Renzelman. Michael Renzelman works primarily in the areas of technical and full spectrum intelligence, information operations, and military space operations. This includes over 10 years of technical and joint combat military experience in the areas of operations management, systems integration, and systems engineering. In the fall of 2008, he finished his Masters of Science in Space Systems Operations Management: Technical Engineering, with Webster University. This spring, he was chosen as a candidate for beta testing of the new certification with the Object Management Group of Systems Modeling Professionals. While he considers himself experienced in the areas of systems integration, operations, and reliability; his current interest is in building greater understanding and technical expertise in the areas of systems modeling and simulation, and how these skills could help in the overall integration of all parts of the project life cycle.■

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Minimize impact to the INCOSE CSEP/ASEP certification exam

Version 3.1 of the INCOSE Systems Engineering Handbook remains the sole basis for the INCOSE CSEP/ASEP exam until further notice. An announcement will be made when Version 3.2 can also be used. For planning purposes, an exam update is currently scheduled for late April 2010, after which time both Version 3.1 and 3.2 may be used.■

### FAA Awards NextGen Systems Engineering Contract To CSSI.

[Air Transport Intelligence News](#) (3/8, Croft) reported the FAA issued a \$280 million contract to CSSI, "the first in a series of up to six contracts the agency plans to award this spring and summer under its Systems Engineering 2020 (SE2020) portfolio." The contracts will "represent the largest set of awards in the FAA's history." The FAA says the SE2020 is "a systems engineering research and development programme that has a spending cap of \$7 billion." CSSI, "a small woman-owned company in Washington DC," will take the lead for over 10 subcontractors to perform engi-

neering work for the FAA's next generation air transportation system.■

**Systems Engineers** have the **Best Job** in America according to [research](#) done by Focus.com.■

Register for online courses from **Colorado State University** that can be applied to a Systems Engineering Master's Degree or certificate. Online courses offer you flexibility to fit your schedule and you do not have to be admitted to register. Learn more about your [systems engineering options](#).■

## Colorado Front Range Chapter Officers

President	Leslie Koshigoe
Past President	
Vice President	Dennis Andis
Treasurer	Jerry Huller
Secretary	Carl Terry
Membership Director	Scott Frisch
Technical Program Director	Lonnie VanZandt
Denver Area Director	
Colorado Springs Area Director	Michael Renzelman
Boulder Area Director	Trace Baker
Communications Director	Kirk Moen
Newsletter Editor	<a href="#">Kip Tarpley</a>
Webmaster	Dave Casler

## Up Coming Activities

**Monthly Meetings** - more info [here](#)

Meetings Resume in the Fall

### Other Meetings

#### 20th Anniversary INCOSE International Symposium 2010

Dates: Mon 12 July - Thu 15 July 2010

Location: Chicago, IL

#### 21st INCOSE International Symposium 2011

Dates: Mon 20 June - Thu 23 June 2011

Location: **Denver, CO**

## For More Information

**Email:** [Leslie Koshigoe](mailto:Leslie.Koshigoe@incose.org)

**Snail Mail:** INCOSE Colorado Front Range Chapter  
P.O. Box 631201  
Highlands Ranch, CO 80163-1201

### Links:

International Council on Systems Engineering -  
[www.incose.org](http://www.incose.org)

Colorado Front Range Chapter - [www.incoseco.org](http://www.incoseco.org)

## Call for Articles

The next newsletter, the Fall 2010 issue, will be published in May. If you have any material for that issue, please email [me](mailto:kirk.moen@incose.org) by the end of September 2010.

## Change of Address

If your email address changes, please send the change to our Communications Director, [Kirk Moen](mailto:kirk.moen@incose.org).

## Welcome New Chapter Members

Ryan Biondo  
Joseph Bobinis  
Jeffrey Brown  
Don Buck  
Miguel Dominguez  
Steve Eckmann  
Paul Edney

Robert Halverson  
Donald Heckel  
Bing Huo  
Irvin Jones  
Mark Laney  
Richard Messenger  
Kevin Pfitzinger  
Michael Renzelman  
David Stader  
Kevin Sullivan  
William Wood  
Gary Yale

## Chapter Members with INCOSE Certifications

We would like to acknowledge our chapter members who have achieved the Certified Systems Engineering Professional status. The members are:  
Bradley Darnell  
Linda Davis

Terry J. Dembroski  
Dr. Daniel Gleason  
Mark Griffith  
Kris Howard  
Jerry Huller  
Michael J. Johnston  
Jack E. Kleinert  
Judy Moldenhauer  
Daniel Porpora-ASEP  
William Reese  
James Teaff  
Carlton L. Terry-ACQ  
Stephen R. Turley  
Gary Yale-ACQ