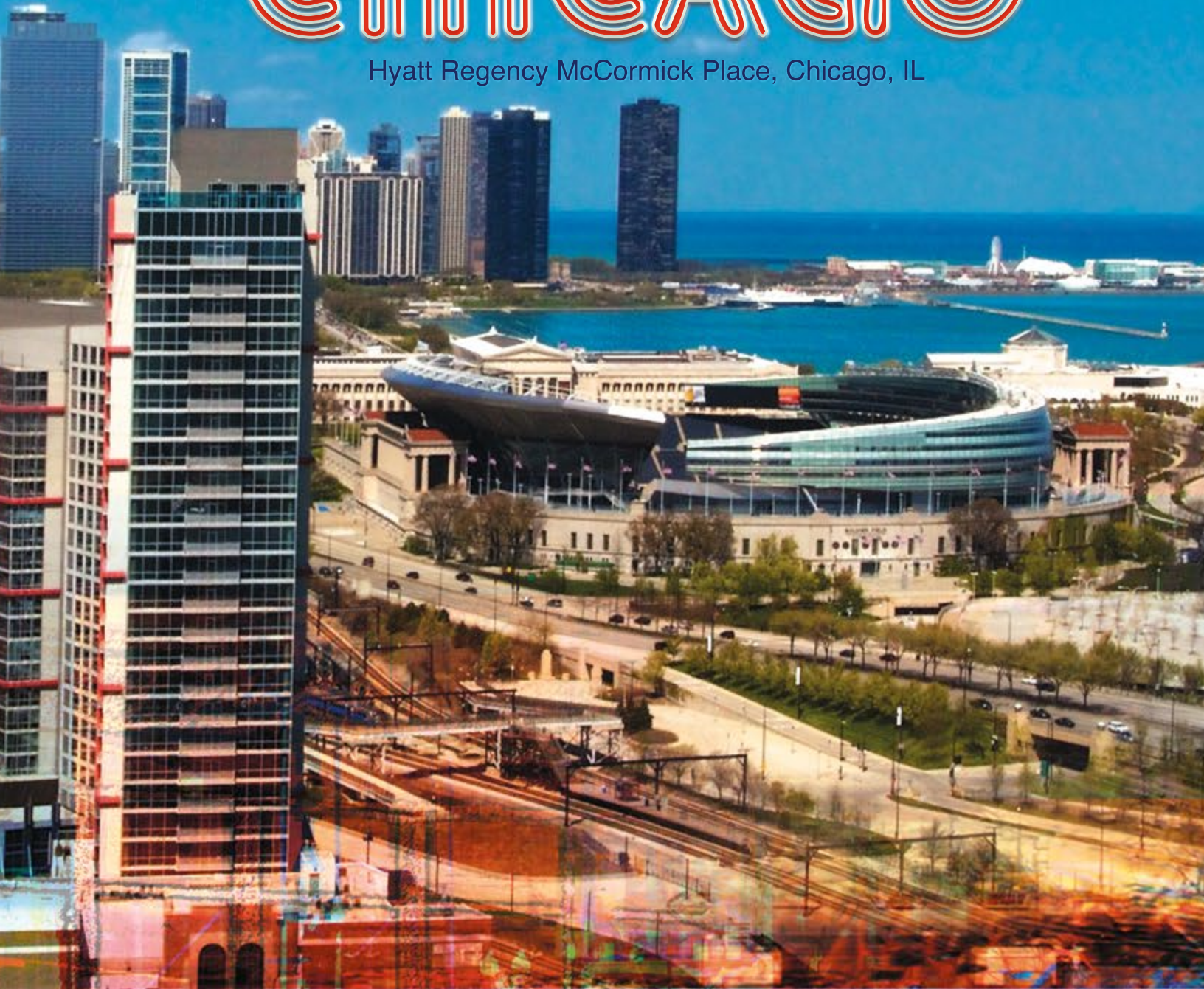FEDERAL AVIATION ADMINISTRATION

10th USA/EUROPE
Air Traffic Management R&D Seminar

JUNE 10-13, 2013 CHICAGO, IL

EUROCONTROL

ATM 2013 CHICAGO

Hyatt Regency McCormick Place, Chicago, IL

Jointly sponsored by Federal Aviation Administration and EUROCONTROL

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⭐ Hyatt Regency McCormick Place

Car Rental

⊗

MAIN ENTRY NORTH

Coffee Breaks Tracks 1&2
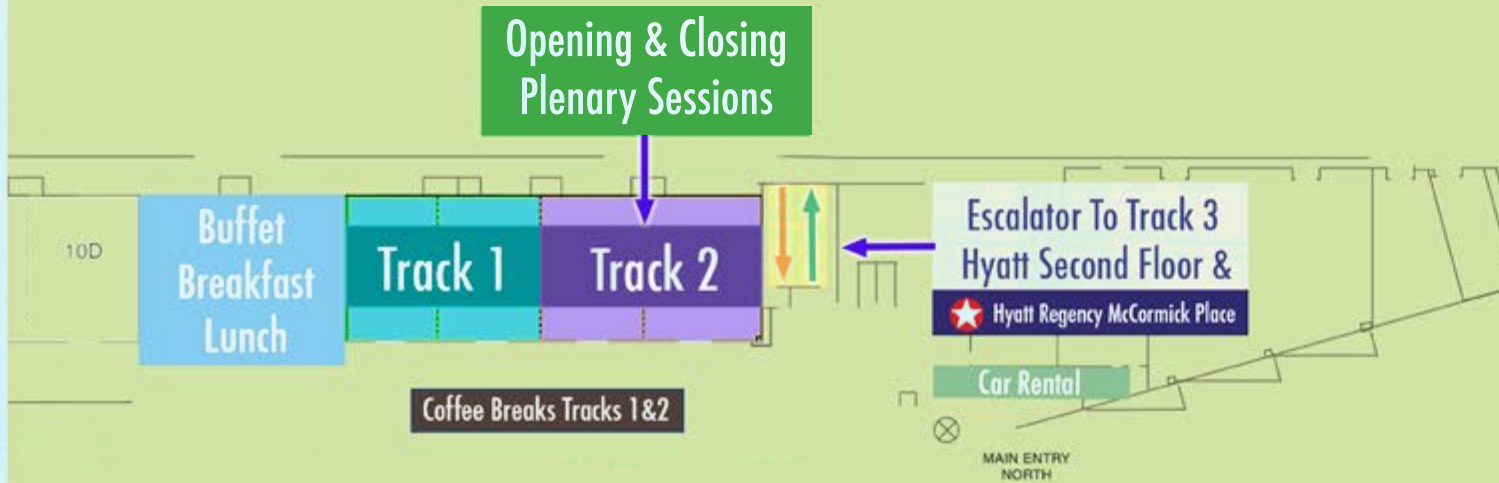
Conference Center Second Floor

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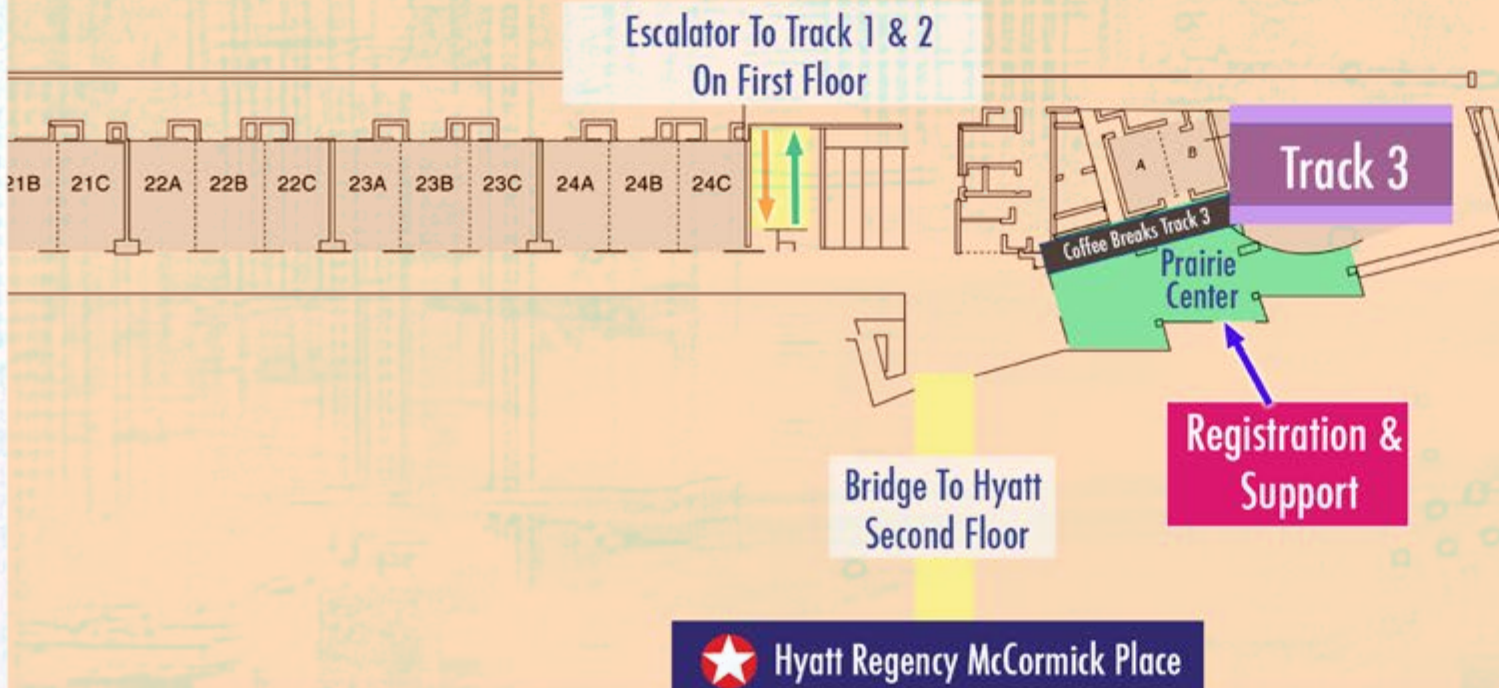
ATM2013 Seminar AT-A-GLANCE

Sunday

6:00 PM		Early Registration / Networking (Prairie Center)

Monday 10th

6:30 AM	bf	Breakfast / Registration

Plenary - Opening Session

7:45 AM	Welcome and Logistics - Sabrina Saunders-Hodge, FAA (US Chair) & Colin Meckiff, EUROCONTROL (Europe Chair)
8:00 AM	Greetings & NextGen Update–Steve Bradford, FAA
8:10 AM	Greetings & SESAR Update–Bo Redeborn, EUROCONTROL
8:20 AM	Keynote Speaker (EU)–Xavier Fron, EUROCONTROL
9:05 AM	Keynote Speaker (US)–John Hansman, Massachusetts Institute of Technology
9:50 AM cb	Coffee Break

	Track 1 — Grant Park 12AB		Track 2 — Grant Park 12CD		Track 3 — Prairie Center	
	Environment Chair: Jim Hileman		**Surveillance and Nav** Chair: Dirk Kuegler		**Human Factors** Chair: Eric Neiderman	
10:15 AM	333	Bo Zou	170	Sebastian Timar	237	Miwa Hayashi
11:00 AM	301	Hamsa Balakrishnan	189	Ralf Mayer	222	Charles Morris
11:45 AM	292	Terence Thompson			193	Maik Friedrich
12:30 PM lu	Chair: Jim Hileman		Chair: Dirk Kuegler		Chair: Eric Neiderman	
2:00 PM	239	Volker Grewe	281	Thomas Dautermann	208	Lynne Martin
2:45 PM	212	Banavar Sridhar	184	Busyairah Ali	215	Savita Verma
3:30 PM cb	Dynamic Airspace Chair: Giovanni Andreatta		Finance & Policy Chair: Natesh Manikoth		Chair: Marc Burgois	
4:15 PM	229	Jerry Welch	326	Lu Hao	192	Hartmut Helmke
5:00 PM	285	Hartmut Fricke	226	Felipe Moreno-Hines	246	Hussein Abbass
5:45 PM adj	Adjourn					

Tuesday 11th

5:30 AM		5K MORNING RUN - Optional (Interested runners should meet in hotel lobby)
6:30 AM	bf	

	Track 1 — Grant Park 12AB		Track 2 — Grant Park 12CD		Track 3 — Prairie Center	
	ATM as a Complex System Chair: Midori Tanino		**Air-Ground Integration** Chair: Billy Josefsson		**Trajectory and Queue** Chair: Eric Hoffman	
7:45 AM	255	Ian Levitt	169	Jane Thipphavong	233	Laurel Stell
8:30 AM	288	Pablo Fleurquin	245	Paul Diffenderfer	350	M. Ghasemi Hamed/D. Gianazza
9:15 AM	342	Travis Gaydos	274	Todd Callantine	217	Stephane Mondoloni
10:00 AM	263	Massimiliano Zanin			198	Richard Alligier
10:45 AM cb	Weather Chair: Craig Wanke		Chair: Billy Josefsson		Chair: Miquel Angel Piera Eroles	
11:15 PM	177	Lara Shisler	299	David Wing	182	Christopher Wynnyk
12:00 PM	232	David McNally	249	Laurence Mutuel	242	David De Smedt
12:45 PM	211	Emilien Robert	349	Michael McCormack	325	James Jones
1:30 PM lu	Lunch/Adjourn					

Wednesday 12th

6:30 AM	bf	

	Track 1 — Grant Park 12AB		Track 2 — Grant Park 12CD		Track 3 — Prairie Center	
	Airport Chair: Sandy Lozito		**Safety & Resilience** Chair: Dirk Schaefer		**Performance** Chair: Joe Post	
7:45 AM	300	Alex Nakahara/Tom Reynolds	302	Henk Blom	318	Yi Liu
8:30 AM	316	Michael Schultz	247	Jessica Holland	223	Len Wojcik
9:15 AM	320	Hartmut Fricke	335	Michael Seelhorst	283	Gonzalo Tobaruela
10:00 AM cb	Chair: Sandy Lozito				Chair: Joe Post	
10:30 AM	220	Gautam Gupta	265	Seth Placke	183	Marco Enriquez
11:15 AM	180	Stephen Atkins	277	Olga Gluchshenko	317	Husni Idris
12:00 PM lu	Network Chair: Nicolas Durand		Separation Chair: Mark Weber		Chair: Mark Hansen	
2:00 PM	230	Christine Taylor	243	Arthur Richards	334	Dimitris Bertsimas
2:45 PM	270	Luis Delgado	264	Cyril Allignol	163	Eric Feron
3:30 PM cb			Separation + UAS Chair: Mark Weber		Chair: Mark Hansen	
4:00 PM	315	Gaëtan Marceau	199	Eri Itoh	244	Scot Campbell
4:45 PM	216	Justin Pearson	321	Xavier Prats	205	Norma Taber
5:30 PM adj	Adjourn					

Thursday 13th

6:30 AM	bf	Breakfast

Plenary - Closing Session: ICAO Global Harmonization Forum

7:45 AM	Results & Impacts of the ICAO 12th Air Navigation Conference
	Integration and Harmonization of NextGen and SESAR into the Global ATM Framework
	Plenary Talk: Steve Bradford, FAA & Michael Standar, SJU
9:00 AM cb	Coffee Break

ATM Research Around the World

9:30 AM	Electronic Navigation Research Institute (ENRI)–Yutaka Fukuda Deputy Director, ATM Department, ENRI
10:00 AM	Brazil Dep. of Airspace Control (DECEA)–Colonel Leandro Costa de Andrade, Director, Airspace Control Institute (ICEA)
10:30 AM	Airservices Australia–Greg McDonald, Senior Operational Specialist
10:45 AM	Chicago O'Hare (ORD) Modernization Program–Jim Chilton, Program Manager and Kevin Markwell, Support Manager
11:15 AM	Best Paper Awards & Closing–Sabrina Saunders-Hodge & Colin Meckiff
11:45 AM adj	Lunch and Adjourn (Program Committee Members Meet in Prairie Center)
1:15 PM	Load buses for O'Hare Modernization Program Tour–Optional (Register at Support Desk by Wednesday)
1:30 PM	Depart Hotel for Chicago O'Hare Modernization Program Tour–Optional (Register at Support Desk by Wednesday)
5:30 PM	Return to Hyatt Regency McCormick Hotel from Chicago O'Hare Modernization Program Tour

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Full Program

Plenary – Opening Session

Time	
7:45 AM	**Welcome and Logistics** **Sabrina Saunders-Hodge** *(US Chair)* & **Colin Meckiff** *(Europe Chair)*
8:00 AM	**Greetings & NextGen Update** **Steve Bradford**, *FAA*
8:10 AM	**Greetings & SESAR Update** **Bo Redeborn**, *EUROCONTROL*
8:20 AM	**Keynote Speaker (EU)** **Xavier Fron**, *EUROCONTROL*
9:05 AM	**Keynote Speaker (US)** **R. John Hansman**, *Massachusetts Institute of Technology (MIT)*
9:50 AM	**Coffee Break**

❖ *Sabrina Saunders-Hodge – Federal Aviation Administration (FAA)*

Sabrina Saunders-Hodge is the Manager of the Research and Development Integration Division within FAA's NextGen Advanced Concepts and Technology Development directorate and is responsible for supporting NAS evolution through the integration of research and development to refine NAS operational requirements and influence NAS operational improvements and sustainments. Within this role she is responsible for managing the FAA's Unmanned Aircraft Systems (UAS) and Improved Multiple Runway Operations (IMRO) R&D portfolios. Over the past twenty years Ms. Saunders-Hodge has worked in the field of satellite communications, contributed to the development of ICAO's global plan for transitioning to future communications, navigation, surveillance and air traffic management (CNS/ATM) systems for civil aviation, co-managed the oversight of FAA/European cooperative research and development initiatives, and worked on the development of operational concepts for technology enhancements within the NAS. Ms. Saunders-Hodge holds a B.S. and M.S. in Computer Science from The University of Maryland and Johns Hopkins University respectively.

❖ *Colin Meckiff – EUROCONTROL*

Colin, the Programme Manager for EUROCONTROL, has been at the EUROCONTROL Experimental Centre since 1991, initially as project manager then programme manager with various responsibilities. He has been involved in many large European programmes such as PHARE, FP and TEN-T. He was the first EUROCONTROL employee to be seconded to the FAA in Washington from 2006 – 2008. Colin is currently Head of Unit in charge of long-term and innovative research in the directorate SESAR and Research, an activity which involves working directly with a large number of European universities and research centres. As part of this work he is involved in the organisation of a number of international scientific events such as the EUROCONTROL-FAA Seminars and the SESAR Innovation Days. Prior to joining EUROCONTROL Colin spent ten years in UK industry specialising in systems design and communication technologies. He holds Bachelor and Doctorate degrees in engineering.

❖ *Steve Bradford – Federal Aviation Administration (FAA)*

Steve Bradford is the Chief Scientist for Architecture and NextGen Development in the FAA's NextGen Office. In this role he has participated in the development of the Joint Planning and Development Office's (JPDO) NextGen Concept, the RTCA NAS Operational Concept and the ICAO ATMCP Global Concept. He is the Chairman of the Technical Review Board which monitors technical decisions related investments and the Enterprise Architecture. He also works with elements of the FAA and the JPDO to develop midterm plans and five year budget requests to implement NextGen. He has a leading role in several new activities with SESAR Joint Undertaking, and has led several co-operative international efforts via action plans with EUROCONTROL. Previous activities include leading efforts to validate future concepts and developing the FAA's NAS Enterprise Architecture. Prior to his current position, Mr. Bradford was the Manager of the NAS Concept Development Branch and conducted early analysis of Free Flight Concepts.

❖ *Bo Redeborn – EUROCONTROL*

Bo Redeborn is the Principal Director Air Traffic Management, EUROCONTROL. He started his training as an Air Traffic Controller at the Swedish ATS Academy in 1972 and was subsequently employed by the Swedish Civil Aviation Authority. Within this organisation he later took up managerial functions with increasing responsibility. He joined EUROCONTROL in February 2004 as Director ATM Strategies and was appointed to his current position as Principal Director ATM on 1st January 2011. He is responsible for overseeing the organisation's ATM policy and development and for managing high level strategic relations with key ATM partners. He also heads the Directorate of SESAR and Research which encompasses the activities delivering EUROCONTROL's contribution to the SESAR Joint Undertaking Work Programme.

❖ *Xavier Fron – EUROCONTROL*

Xavier is the Head of Performance Review Unit, EUROCONTROL. He has conducted ATM R&D programmes during 15 years, both in the French Civil Aviation Authority and as head of R&D at the EUROCONTROL Experimental Centre in the 80's and 90's. He also managed implementation of radar and display programmes. Since 1998, he has been heading EUROCONTROL's Performance Review Unit, which has pioneered ANS performance review since 1998. The PRU's main task is now to support the Performance Review Body (PRB) and the European Commission under the Single European Sky in setting binding performance targets, monitoring achieved performance against those targets, and taking corrective measures where required. Xavier graduated from Ecole Polytechnique in Paris and Ecole Nationale de l'Aviation Civile in Toulouse.

❖ *R. John Hansman – Massachusetts Institute of Technology (MIT)*

R. John Hansman is the T. Wilson Professor of Aeronautics and Astronautics at the Massachusetts Institute of Technology (MIT), where he is the Director of the MIT International Center for Air Transportation. He conducts research in the application of information technology in operational aerospace systems. Dr. Hansman holds six patents and has authored over 250 technical publications. He has over 5,700 hours of pilot in-command time in airplanes, helicopters and sailplanes including meteorological, production and engineering flight test experience. Professor Hansman chairs the US FAA REDAC as well as other national and international advisory committees. He has been elected to the National Academy of Engineering, is a Fellow of the AIAA, and has received numerous awards including the AIAA Dryden Lectureship in Aeronautics Research, the ATCA Kriske Air Traffic Award, a Laurel from Aviation Week & Space Technology, and the FAA Excellence in Aviation Award.

Track 1 – *Monday, June 10, 2013*

Environment and Energy Efficiency – *Session Chair: Jim Hileman*

Time	Paper Number	Title of Paper	Authors	Presenter
10:15 AM	333	Evaluating Air Carrier Fuel Efficiency and CO_2 Emissions in the U.S. Airline Industry	Bo Zou Mark Hansen Matthew Elke	Bo Zou *University of Illinois at Chicago*
11:00 AM	301	Airport Characterization for the Adaptation of Surface Congestion Management Approaches	Tom Reynolds Melanie Sandberg Harshad Khadilkar Hamsa Balakrishnan	Hamsa Balakrishnan *Massachusetts Institute of Technology AeroAstro*
11:45 AM	292	Environmental Impacts of Continuous-descent Operations in Paris and New York Regions: Isolation of ATM/Airspace Effects and Comparison of Models	Terence Thompson Sofia Souihi Bruno Miller Charles Murphy Stephen Augustine Tyler White	Terence Thompson *Metron*
12:30 PM		Lunch		
2:00 PM	239	Climate cost functions as a basis for climate optimized flight trajectories	Christine Frömming Volker Grewe Patrick Jöckel Sabine Brinkop Simone Dietmüller Hella Garny Michael Ponater Eleni Tsati Sigrun Matthes	Volker Grewe *German Aerospace Center (DLR)*
2:45 PM	212	Energy Efficient Strategies for Reducing the Environmental Impact of Aviation	Banavar Sridhar Neil Chen Hok Ng	Banavar Sridhar *NASA Ames*
3:30 PM		Coffee Break		

Dynamic Airspace and Capacity Management – *Session Chair: Giovanni Andreatta*

Time	Paper Number	Title of Paper	Authors	Presenter
4:15 PM	229	Sector Workload Model for Benefits Analysis and Convective Weather Capacity Prediction	Jerry Welch John Cho Ngaire Underhill Richard DeLaura	Jerry Welch *MIT Lincoln Laboratory*
5:00 PM	285	Analysis of Airspace Complexity Factors Capability to Predict Workload and Safety Levels in the TMA	Markus Vogel Kati Schelbert Trevor Kistan Hartmut Fricke	Hartmut Fricke *Dresden University of Technology*
5:45 PM		Adjourn		

PAPER # 333: ❖ *Bo Zou* — *University of Illinois at Chicago*

Bo Zou is currently an Assistant Professor in Transportation at the University of Illinois at Chicago. Prior to joining the UIC faculty, he was a doctoral student and then research engineer in the National Center of Excellence for Aviation Operations Research, at the University of California, Berkeley. Dr. Zou has been involved in a number of aviation research projects sponsored by the FAA, NASA, the International Council on Clean Transportation, and the City of Chicago. Research areas cover various economic, operational, and environmental issues in air transportation systems. He was a core member of the FAA's Total Delay Impact study, the research outcome of which had attracted broad public attention and been widely reported by the US mainstream media. Dr. Zou has articles published in Transportation Research Parts A, B, E, ASCE Journal of Infrastructure Systems, and Journal of Air Transport Management. He also contributed two book chapters, and served as a reviewer for multiple academic journals in transportation. Dr. Zou is a member of the World Conference on Transport Research Society and the Institute for Operations Research and the Management Sciences, and is active in Transportation Research Board aviation committee activities.

PAPER # 301: ❖ *Hamsa Balakrishnan* — *Massachusetts Institute of Technology AeroAstro*

Hamsa Balakrishnan is an Associate Professor of Aeronautics and Astronautics at the Massachusetts Institute of Technology (MIT). She received a Ph.D. in Aeronautics and Astronautics from Stanford University. She was a recipient of the NSF CAREER Award in 2008, the Kevin Corker Award for Best Paper of ATM-2011, the AIAA Lawrence Sperry Award in 2012, and the inaugural CNA Award for Operational Analysis in 2012. She is an Associate Fellow of the AIAA. Her research interests address various aspects of air transportation systems, including algorithms for air traffic scheduling and routing, integrating weather forecasts into air traffic management, minimizing aviation-related emissions, and air traffic surveillance.

PAPER # 292: ❖ *Terence Thompson* — *Metron*

Terence R. Thompson - Dr. Thompson has participated in all aspects of Metron's environmental work since 1992. He is a principal investigator for FAA, EUROCONTROL, NASA, NextGen, and SESAR projects related to strategic and tactical methods for mitigating environmental impacts across noise, emissions, and climate domains. He is a member of the NextGen JPDO Environmental Working Group (EWG), and serves on the Advisory Board of the Partnership for Air Transportation Noise and Emission Reduction (PARTNER). Dr. Thompson holds a Ph.D. in Biophysics from the University of Rochester Medical School. Sofia Souihi – Ms. Souihi leads environmental analysis for Thales ATM in Rungis, France. She is active in SESAR activities, particularly with regard to data, methods, and tools for evaluating environmental benefits associated with SESAR validation exercises. She holds a Master's degree in Engineering, Innovative Technologies and Entrepreneurship from the École Polytechnique in Palaiseau (Paris), France and a Master's degree in Science and Executive Engineering from the École de Mines in Paris, France.

PAPER # 239: ❖ *Volker Grewe* — *German Aerospace Center (DLR)*

Dr. Volker Grewe studied mathematics at the University Augsburg, Germany and got a Ph.D. in physics/meteorology in 1997 (Chemistry and Dynamics of the Northern Hemisphere ozone layer) from the Ludwigs-Maximilians University Munich. Since 1993 he has been working at the DLR-Oberpfaffenhofen. In 1999-2000 he worked at the Columbia University and NASA-GISS, New York. During sabbaticals and as a visiting scientist he worked at: NASA/GISS (New York), NCAR (Boulder), NASA/Ames Mountainview, CICERO (Oslo). His scientific topics are: Climate-Chemistry Modelling, Impact of Air (and surface) traffic on climate, and Evaluation of air traffic climate change mitigation options.

PAPER # 212: ❖ *Banavar Sridhar* — *NASA Ames*

Dr. Banavar Sridhar is the NASA Senior Scientist for Air Transportation Systems. His research interests are in the application of modeling and optimization techniques to aerospace systems. Dr. Sridhar received the 2004 IEEE Control System Technology Award for his contributions to the development of modeling and simulation techniques. He led the development of traffic flow management software, Future ATM Concepts Evaluation Tool (FACET), which received the NASA Software of the Year Award in 2006 and the FAA Excellence in Aviation Research Award in 2010. He is a Fellow of the IEEE and the AIAA.

PAPER # 229: ❖ *Jerry Welch* — *MIT Lincoln Laboratory*

Jerry D. Welch holds a B.S. and M.S. (1960) from MIT and a Ph.D. (1973) from Northeastern University in electrical engineering. He is a Senior Staff member in the Surveillance Systems Group at MIT Lincoln Laboratory in Lexington, Massachusetts (1962-present). He helped establish the team that developed the Mode S beacon system for the FAA. He initiated the Traffic Alert and Collision Avoidance System surveillance program. He organized an Air Traffic Automation Group that helped establish programs in Terminal ATC Automation and Runway Status Lights. Dr. Welch is a member of the American Institute of Aeronautics and Astronautics.

PAPER # 285: ❖ *Harmut Fricke* — *Dresden University of Technology*

Hartmut Fricke studied Aeronautics and Astronautics at Technische Universität (TU) Berlin from 1985-1991 and completed his doctor thesis in ATM (ATC-ATFM Interface) as a research fellow in Flight Operations, Airport Planning in 1995. In 2001 he finished his Habilitation on "Integrated Collision Risk Modeling for airborne and ground based systems". This included HIL experiments with an A340 full flight simulator in cooperation with EUROCONTROL Experimental Center (EEC). As Head of the Institute of Logistics and Aviation, and Professor for Air Transport Technology and Logistics at TU Dresden, Hartmut was appointed Member of the Scientific Advisory "Board of Advisors" to the Federal Minister of Transport, Building and Urban Affairs in Germany. He is also a member of various international review committees and symposia of Eurocontrol, FAA, PWH, IREASE, CEAS and a member of the industrial advisory board for air transportation systems of the German Aerospace Centre (DLR). In 2012 he was elected scientific expert to DFG, German Research Foundation for the domain "system technologies", in 2013 dean of the faculty of transportation and traffic sciences of TUD. In 2013 he also received the status of External Expert for the SESAR Joint Undertaking, which is in control of Europe's ATM R&D programme Single European Sky ATM Research (SESAR).

Enhanced Surveillance and Navigation – *Session Chair: Dirk Kuegler*

Time	Paper Number	Title of Paper	Authors	Presenter
10:15 AM	170	Assessing the Benefits of NextGen Performance Based Navigation (PBN)	Sebastian Timar George Hunter Joseph Post	Sebastian Timar *Saab Sensis*
11:00 AM	189	Operational Demonstration of a Performance-Based Separation Standard at The Hartsfield-Jackson Atlanta International Airport - Implementation and Benefits of Equivalent Lateral Spacing Operation (ELSO) Departures	Ralf Mayer Dennis J. Zondervan Remi L. Gottheil Graham K. Glover	Ralf Mayer *MITRE*
12:30 PM		LUNCH		
2:00 PM	281	3D-Precision Curved Approaches: A Cockpit View on ATM	Robert Geister Thomas Dautermann Vilmar Mollwitz Christian Hanses Hayung Becker	Thomas Dautermann *German Aerospace Center (DLR)*
2:45 PM	184	ADS-B: The Case for London Terminal Maneuvering Area (LTMA)	Busyairah Ali Arnab Majumdar Washington Ochieng Wolfgang Schuster	Busyairah Ali *Imperial College London*
3:30 PM		COFFEE BREAK		

Finance and Policy – *Session Chair: Natesh Manikoth*

Time	Paper Number	Title of Paper	Authors	Presenter
4:15 PM	326	How Airlines Set Scheduled Block Times	Lu Hao Mark Hansen	Lu Hao *University of California, Berkeley*
5:00 PM	226	Assessing the NextGen Avionics Business Case from the Airline Perspective: The Implications of Airline Responses to Changes in Operational Performance	Felipe Moreno-Hines Deborah Kirkman	Felipe Moreno-Hines *MITRE*
5:45 PM		ADJOURN		

PAPER # 170: ❖ *Sebastian Timar* – *Saab Sensis*

Sebastian Timar is currently a Senior Systems Engineer at the Saab Sensis Corporation's Seagull Technology Center in Campbell, CA. Prior to working for Saab Sensis, he was employed as an Aerospace Systems Research Engineer at NASA Ames Research Center. His publications include "Analysis of s-turn approaches at John F. Kennedy Airport," published at the 31st Digitial Avionics Systems Conference in Williamsburg, VA. His research interests include: systems analysis, design, modeling, simulation and control, and data fusion and mining. Sebastian currently lives in Santa Cruz, CA.

PAPER # 189: ❖ *Ralf Mayer* – *MITRE*

Ralf H. Mayer is a Principal Simulation Modeling Engineer at The MITRE Corporation's Center for Advanced Aviation System Development in McLean, Virginia. He supports the Federal Aviation Administration's Performance-Based Navigation Policy and Support Group and concentrates his efforts on developing and evaluating advanced aircraft navigation procedures and Air Traffic Control separation standards. He received a Ph.D. degree from Purdue University in experimental physics and is an author of over 30 scientific journal publications. Dr. Mayer holds commercial pilot and flight instructor certificates and served on the staff of Purdue University's Aviation Technology Department before joining CAASD. His research interests include measurement techniques, performance evaluation, agent-based simulation, and Monte-Carlo modeling.

PAPER # 281: ❖ *Thomas Dautermann* – *German Aerospace Center (DLR)*

Thomas Dautermann received his undergraduate degree from the Technical University of Kaiserslautern, Germany followed by a Masters and Ph.D. degree from Purdue University, West Lafayette, Indiana. He is currently employed by the German Aerospace Center (DLR), Germany as a research scientist working in the field of Satellite Navigation and Air Traffic Management.

PAPER # 184: ❖ *Busyairah Ali* – *Imperial College London*

Busyairah Syd Ali joined the Air Traffic Management Group at the Centre for Transport Studies, Imperial College London as a Ph.D. research student on 30th November 2009. In her research she is investigating the impacts of a new surveillance technology called Automatic Dependant Surveillance Broadcast (ADS-B) on Air Traffic Management operations. Busyairah completed her M.Sc. in Software Engineering at the Faculty of Computer Science and Information Technology, University of Malaya, Malaysia in August 2009, where she also worked as a research assistant. Before that she worked as an Operation and Maintenance Engineer for Air Traffic Control Systems at Kuala Lumpur International Airport for five years from 2003-2007. Her research interests include ATC surveillance systems, radio communication systems and flight data processing systems.

PAPER # 326: ❖ *Lu Hao* – *University of California, Berkeley*

Lu is a Ph.D. Candidate in the Department of Civil and Environmental Engineering at the University of California, Berkeley working under Professor Mark Hansen. She has an undergraduate degree in civil engineering from Tsinghua University, Beijing, China, and a Masters in civil and environmental engineering from University of California, Berkeley. Her main research interest is in the behavior of airline scheduling and the impact and potential improvement for aviation system through scheduling. Her research addresses the impact of historical flight time distribution on airline scheduling, especially scheduled block time and the consequent flight performance.

PAPER # 226: ❖ *Felipe Moreno-Hines* – *MITRE*

Felipe Moreno-Hines leads a group of Economic and Business Case Analysts at the MITRE Corporation's Center for Advanced Aviation System Development (CAASD) in McLean, Virginia, where he has worked his entire professional career. From his initial days analyzing airline economics and financial performance at CAASD, Felipe has played a prominent role in the development and elevation of the "user perspective" in MITRE's work program. Most recently, Felipe supported two FAA Program acquisitions by translating abstract security and safety operational concepts to outcomes with relevance to stakeholders. Previously, Felipe led corporate initiatives to assess the market potential of very light jets (VLJs); explore the use of Real Options Analysis techniques for valuing investments in aviation; and assess the viability of multi-modal transportation planning and analysis. Another area in which Felipe is a passionate contributor is system performance measurement, on which he has collaborated with numerous FAA sponsors. In the international arena, he has performed cost-benefit analyses of Global Navigation Satellite Systems for Australian, Chinese, and several Asian-Pacific air navigation service providers. Felipe authored and presented "A Methodology to Assess the Market Potential of VLJ-Based Air Taxi Services" at the Digital Avionics System Conference (DASC, 2007) and co-authored "The Impact of September 11, 2001 on U.S. Aviation," published in Air Traffic Control Quarterly (2003). He holds a B.A. in Economics with a Certificate in Markets and Management from Duke University (1999), and a Masters in Business Administration from the Robert H. Smith School of Business, University of Maryland (2007). Felipe lives in Herndon, Virginia, with his wife and two sons aged 4 and 2, respectively.

Track 3 – Monday, June 10, 2013

Human Factors – *Session Chairs: Eric Neiderman, Dirk Schaefer, Marc Burgois*

Time	Paper Number	Title of Paper	Authors	Presenter
10:15 AM	237	Usability Evaluation of the Spot and Runway Departure Advisor (SARDA) Concept in a Dallas/Fort Worth Airport Tower Simulation	Miwa Hayashi Ty Hoang Yoon Jung Gautam Gupta Waqar Malik Victoria Dulchinos	Miwa Hayashi *NASA Ames*
11:00 AM	222	Validation of the Time Based Separations concept at London Heathrow Airport	Peter Choroba Charles Morris John Peters	Charles Morris *National Air Traffic Services*
11:45 AM	193	Which data provide the best insight? A field trial for validating a remote tower operation concept.	Maik Friedrich Christoph Möhlenbrink	Maik Friedrich *German Aerospace Center (DLR)*
12:30 PM		LUNCH		
2:00 PM	208	An Investigation of Flight Deck Data Link in the Terminal Area	Sandra Lozito Lynne Martin John Kaneshige Victoria Dulchinos Shivanjli Sharma	Lynne Martin *NASA Ames*
2:45 PM	215	Human Factors Evaluation of Conflict Detection Tool for Terminal Area	Savita Verma Huabin Tang Debbi Ballinger Thomas Kozon Amir Farrahi Fay Chinn Estela Buchmann John Walker Darrell Wooten Jacob Pfeiffer Diane Carpenter Ronald Lehmer	Savita Verma *NASA Ames*
3:30 PM		COFFEE BREAK		
4:15 PM	192	Increased Acceptance of Controller Assistance by Automatic Speech Recognition	Hartmut Helmke Heiko Ehr Matthias Kleinert Friedrich Faubel Dietrich Klakow	Hartmut Helmke *German Aerospace Center (DLR)*
5:00 PM	246	Computational Red Teaming for Correction of Traffic Events in Real Time Human Performance Studies	Hussein Abbass Rubai Amin Jiangjun Tang Mohamed Ellejmi Stephen Kirby	Hussein Abbass *Canberra campus of The University of New South Wales (Australian Defence Force Academy)*
5:45 PM		ADJOURN		

PAPER # 237: ◈ *Miwa Hayashi* — NASA Ames

Dr. Miwa Hayashi is a human factors researcher at NASA Ames Research Center, Aviation Systems Division, located in Moffett Field, California. At Ames, she has been assisting development and evaluation of Spot and Runway Departure Advisor, a proposed tower controller decision-support tool, since 2011. In addition, she also helped a series of human-in-the-loop simulator evaluation studies for an en-route controller tool called Efficient Descent Advisor. She received a Ph.D. degree in Humans and Automation from Massachusetts Institute of Technology, Department of Aeronautics and Astronautics in 2004. In addition, she received a M.S. degree in Aerospace Engineering from the University of Texas at Austin in 1997. Her research interests include: design and evaluation of user interface, task analysis, cognitive modeling, human error analysis, and eye-movement analysis. She holds a private pilot license with instrument rating.

PAPER # 222: ◈ *Charles Morris* — National Air Traffic Services

Charles Morris is a technical leader in the Approach and Wake Concepts Team in SESAR Development at the NATS Corperate and Technical Centre at Fareham, UK. He is currently the NATS lead for the SESAR P06.08.01 project. His research focus is ATM concept development and validation with sixteen years of leading research into approach operations at NATS focused on operational improvements for Heathrow and Gatwick operations.

PAPER # 193: ◈ *Maik Friedrich* — German Aerospace Center (DLR)

Maik B. Friedrich studied computer science at the Otto - Friedrich University in Bamberg. He earned a Ma. Sc. at the Computer Science department from the Otto -Friedrich University in Bamberg, Germany in 2008. His major field of study is cognitive modeling in the area of air traffic control. He works within the DLR research group Remote Tower and in the domain of airport airside traffic management with the focus on concept operations and validation. Since 2008, he has been running software simulations and coordinating operational exercises at diverse research projects, like RAiCe or RAiCon. Validating concepts of remote surveillance is a major part of his work, especially in the VICTOR project funded by Iport. Since 2010 he works together with the local ANSPs TTC & DFS in the field of remote Tower operations.

PAPER # 208: ◈ *Lynne Martin* — NASA Ames

Not Available

PAPER # 215: ◈ *Savita Verma* — NASA Ames

Savvy Verma has an M.S in Human factors from San Jose State University that was obtained in 2001. She also has degrees in System Analysis and Business Administration. She has worked at NASA Ames Research Center for the last 12 years. Her previous assignments include evaluation of Very Closely Spaced Parallel Runways, Datalink, Human Performance Modeling, and Surface Operations. Recently, she was the Human Factors lead for the Tactical Conflict Detection and Resolution tool in the terminal area. Currently, she has started working on a new project on the human factor assessment of a scheduling tool being designed to mitigate disturbances.

PAPER # 192: ◈ *Hartmut Helmke* — German Aerospace Center (DLR)

Prof. Hartmut Helmke works for DLR, the German Aerospace Center. In 1989 he joined DLR's Institute of Flight Guidance in Braunschweig and started to work on different Expert System applications. He received his Diploma degree in Computer Science from the University Karlsruhe (Germany) in 1989 and his doctor degree (Ph.D.) from the chemical engineering faculty of the Technical University of Stuttgart in 1999. Since 1999 he has concentrated on Controller Assistant Systems, especially Arrival Management of the Arrival Manager 4D-CARMA. He leads DLR's research program "Arrival, Departure and Ground Management" and the AcListant project which integrates automatic speech recognition with assistant systems. He has been an assistant professor for Computer Science since 2001 and author of several text books on software engineering and programming languages. His research interests include "Robust Scheduling" and "Active Listening Assistants" which is the subject of his talk.

PAPER # 246: ◈ *Hussein Abbass* — The University of New South Wales (Australian Defence Force Academy)

Hussein is a Professor with the School of Engineering and Information Technology, University of New South Wales at the Australian Defence Force Academy in Canberra, Australia, for the last 14 years. He leads the Air Transport research focus area. He is a fellow of the Operations Research Society (UK), a fellow of the Australian Computer Society, a Senior Member of the Institute of Electrical and Electronic Engineering, a graduate of the Australian Institute of Company Directors, and hold two Bachelor degrees, two Masters and a PhD. Hussein published close to 200 papers, graduated 15 PhD students, and was an investigator on projects totaling $15m. Hussein is an Associate Editor for 6 international journals and is a member of the publication committee for the Air Traffic Control journal. During his academic career, Hussein taught a wide range of operations research, artificial intelligence, capability development, strategy and human experimentation subjects. Examples of current projects in his laboratories include real time collision risk estimation, system level assessment of ATM in the 2 Australian FIRs, and Computational Red Teaming for Human Performance Studies. His main project that inspires him currently is on Brain Traffic Integration, where he is designing concepts and systems to integrate brain signals from human operators into the air traffic control environment.

Air Traffic Management as a Complex System – *Session Chair: Midori Tanino*

Time	Paper Number	Title of Paper	Authors	Presenter
7:45 AM	255	Modeling Delivery Accuracy for Metering Operations to Support RNAV Arrivals	Ian Levitt Leslie Weitz Michael Castle	Ian Levitt *Federal Aviation Administration (FAA)*
8:30 AM	288	Data-driven modeling of systemic delay propagation under severe meteorological conditions	Pablo Fleurquin Jose Ramasco Victor Eguiluz	Pablo Fleurquin *Institute for Cross-Disciplinary Physics and Complex Systems*
9:15 AM	342	Analysis of Conflict Detection Performance for Trajectory-Based Descent Operationst	Travis Gaydos Elida Smith Liya Wang Bill Lao	Travis Gaydos *MITRE*
10:00 AM	263	Synchronization Likelihood in Aircraft Trajectories	Massimiliano Zanin	Massimiliano Zanin *Innaxis*
10:45 AM		COFFEE BREAK		

Weather in Air Traffic Management – *Session Chair: Craig Wanke*

Time	Paper Number	Title of Paper	Authors	Presenter
11:15 AM	177	An Operational Evaluation of the Ground Delay Program Parameters Selection Model (GPSM)	Lara Shisler Christopher Provan David Clark William Chan Shon Grabbe Kenneth Venzke Christine Riley Dan Gilani Ed Corcoran	Lara Shisler *Mosaic Air Traffic Management*
12:00 PM	232	Operational Evaluation of Dynamic Weather Routes at American Airlines	David McNally Kapil Sheth Chester Gong Paul Borchers Jeff Osborne Desmond Keany Brennan Scott Steve Smith Scott Sahlman Chuhan Lee Jinn-Hwei Cheng	David McNally *NASA Ames*
12:45 PM	211	Comparison of Operational Wind Forecasts with Recorded Flight Data	Emilien Robert David De Smedt	Emilien Robert *EUROCONTROL*
1:30 PM		LUNCH/ADJOURN		

PAPER # 255: ❖ *Ian Levitt – Federal Aviation Administration (FAA)*

Ian Levitt earned a B.S. in applied mathematics from Stevens Institute of Technology in 1999, and a Ph.D in mathematics from Rutgers University in 2009, where he conducted research in Extremal Combinatorics. He is currently a mathematician at the Federal Aviation Administration's William J. Hughes Technical Center in Atlantic City, NJ, working for the Engineering Development Services group (ANG-C33). He has been involved in ADS-B research, standards, and testing and development since 1999. He is currently working in concept and standards development for Interval Management, most recently leading the development of the ASPA-FIM SPR and AS-PA-FIM MOPS under RTCA and EUROCAE.

PAPER # 288: ❖ *Pablo Fleurquin – Institute for Cross-Disciplinary Physics and Complex Systems*

Dr. Pablo Fleurquin is a Physics Ph.D. student at the Institute for Cross-Disciplinary Physics and Complex Systems in Palma de Mallorca, Spain. Prior to starting his Ph.D. he completed his undergraduate studies in Industrial Engineering at the University of Montevideo (Uruguay) in 2009, and was employed as a quantitative analyst in CLC Logistics Consulting. He is also a member of the ComplexWorld Ph.D. programme, a research network within the Single European Sky ATM Research project (SESAR). Although under the scope of Physics the research done is genuinely interdisciplinary tying together areas of Computer Science, Operational Research and Physics. Research interests include: Complex Systems, Agent-based modeling and Data Mining.

PAPER # 342: ❖ *Travis Gaydos – MITRE*

Travis Gaydos has been a modeling and simulation engineer with MITRE CAASD for the past 5 years working on concept development of NextGen initiatives. His recent focus has been on analyzing trajectory based operations and arrival/departure airspace concepts.

PAPER # 263: ❖ *Massimiliano Zanin – Innaxis*

Massimiliano Zanin holds the position of Researcher at INNAXIS Foundation and Research Institute, Madrid, Spain, and at the Centre for Biomedical Technology at the Universidad Politécnica de Madrid, Spain. His researches focused on the use of complex networks and data mining techniques in the study of several real-world systems, including air transport, and biomedical applications.

PAPER # 177: ❖ *Lara Shisler – Mosaic Air Traffic Management*

Lara Shisler is a Principal Analyst with Mosaic ATM in Leesburg, VA, where she is managing projects related to TFM, including the integration of weather with ATM decision making. She has over 15 years of experience supporting research and development activities in Air Traffic Management for the FAA and NASA, both at Mosaic ATM and Metron Aviation. Prior to that, Ms. Shisler worked as an Operations Research Analyst for two major air carriers, one passenger and one cargo. Ms. Shisler received an M.S. in 1991 in operations research and management science from George Mason University in Fairfax, VA. Her B.S. in mathematics was received in 1989 from The College of William and Mary in Williamsburg, VA.

PAPER # 232: ❖ *David McNally – NASA Ames*

David McNally is a principal investigator in Air Traffic Management at NASA Ames Research Center. He has 18 years of experience in research, development, human-in-the-loop simulation, and operational testing of trajectory automation tools for en route air traffic control. His research areas include conflict probe and trial planning for en route radar controllers, direct route advisories, air/ground data link communication, and automation for efficient routing around convective weather. Mr. McNally is the lead inventor of the Dynamic Weather Routes (DWR) concept and prototype system. He was the lead author of NASA's research program in separation assurance for NextGen. He is the author or co-author of 33 technical publications. He holds a BS in Mechanical/Aeronautical Engineering and an MS in Mechanical Engineering, both from the University of California at Davis. In 2010 Mr. McNally received the NASA Outstanding Leadership Medal for his technical leadership in Air Traffic Management research.

PAPER # 211: ❖ *Emilien Robert – EUROCONTROL*

Emilien Robert got his Ph.D. in 2005 from the National Institute of Physic of Grenoble, France, and started to work on behalf of Airbus as a Flight Management Engineer. In 2007, he worked on behalf of ATR as a Navigation Engineer and broadened his experience in the field of Navigation equipment and sensors. These two work experiences gave him a strong background on Navigation as well as on avionics and on board equipment. Emilien joined Eurocontrol in 2010 as a Navigation expert and is involved in 4D-Trajectory Based Operations and Performance Based Navigation.

Air-Ground Integrated Concepts – *Session Chair: Billy Josefsson*

Time	Paper Number	Title of Paper	Authors	Presenter
7:45 AM	169	Evaluation of the Controller-Managed Spacing Tools, Flight-deck Interval Management and Terminal Area Metering Capabilities for the ATM Technology Demonstration #1	Jane Thipphavong Harry Swenson Jaewoo Jung Kevin Witzberger Melody Lin Jimmy Nguyen Lynne Martin Michael Downs Terry Smith	Jane Thipphavong *NASA Ames*
8:30 AM	245	Automated Integration of Arrival/ Departure Schedules	Paul Diffenderfer Zheng Tao Gaea Payton	Paul Diffenderfer *MITRE*
9:15 AM	274	Simulations of Continuous Descent Operations with Arrival-Management Automation and mixed Flight-Deck Interval Management Equipage	Todd Callantine Michael Kupfer Lynne Martin Thomas Prevot	Todd Callantine *San Jose State University*
10:45 AM		COFFEE BREAK		
11:15 AM	299	Pilot and Controller Evaluations of Separation Function Allocation in Air Traffic Management	David Wing Thomas Prevot Timothy Lewis Lynne Martin Sally Johnson Christopher Cabrall Sean Commo Jeffrey Homola Manasi Sheth-Chandra Joey Mercer Susan Morey	David Wing *NASA Langley*
12:00 PM	249	Initial 4D Trajectory Management Concept Evaluation	Laurence Mutuel	Laurence Mutuel *Thales*
12:45 PM	349	Feasibility of a Networked Air Traffic Infrastructure Validation Environment for Advanced NextGen Concepts	Michael McCormack Alexander Gibson Matthew Underwood Lana Miller Noah Dennis James Grisham	Michael McCormack *NASA Langley*
1:30 PM		LUNCH/ADJOURN		

PAPER # 169: ❖ *Jane Thipphavong* – NASA Ames

Jane Thipphavong is a research engineer in the Aviation Systems Division at NASA Ames Research Center. Her research interests are in terminal area operations and arrival scheduling. She received her B.S. in Operations Research and Industrial Engineering at Cornell University and M.S. in Management Science and Engineering at Stanford University.

PAPER # 245: ❖ *Paul Diffenderfer* – MITRE

Paul A. Diffenderfer served as an air traffic controller, staff specialist, supervisor, and mid-level manager for the Federal Aviation Administration prior to his retirement in 2009. He served 17 years of his 26 year FAA career in Atlanta, Georgia at the Atlanta Tower and Approach Control. He is currently working on developing future air traffic control tower and approach control concepts as an Aviation Systems Engineer at MITRE's Center for Advanced Aviation System Development (CAASD) in McLean, VA. Mr. Diffenderfer received a B.S. in Mechanical Engineering and Aviation Technology from LeTourneau University, Longview, TX. Mr. Diffenderfer is an Airline Transport Rated pilot and Certified Flight Instructor with over 40 years of general aviation flying experience.

PAPER # 274: ❖ *Todd Callantine* – *San Jose State University*

Dr. Todd Callantine has conducted human-systems integration research at NASA Ames Research Center since 1996. He has primarily studied advanced air traffic management concepts in the Airspace Operations Laboratory, and currently serves as a principal investigator for NASA's ATM Technology Demonstration-1. He holds B.S. and M.S. degrees from Stanford University and a Ph.D. in Industrial & Systems Engineering from the Georgia Institute of Technology.

PAPER # 299: ❖ *David Wing* – NASA Langley

David Wing is a principal researcher of Air Traffic Management at NASA Langley Research Center. He received a Masters degree in Aeronautical Engineering from the George Washington University. His NASA career spans over 23 years of research in propulsion aerodynamics and Air Traffic Management. He is a recognized authority on self-separation concepts, has led several HITL simulation studies, and has authored or co-authored over 20 publications on self-separation related topics. He holds a private pilot's license with an instrument rating.

PAPER # 249: ❖ *Laurence Mutuel* – *Thales*

Dr. Laurence H. Mutuel earned a M.S. and a Ph.D. in aerospace engineering from the University of California at Los Angeles in 1996 and 2000, respectively. She currently serves as Thales Avionics, Inc. technical lead for all its US research programs, including NextGen, from the Washington DC and Seattle area offices. In this role, she is responsible for providing technical and operational guidance on all programs involving Thales Avionics in the United States and in particular ensuring linkage and synergy with Thales involvements in Europe, including the SESAR program. From 2008 to 2011, Dr. Mutuel oversaw Thales Avionics contribution to SESAR for the navigation and communication domains during the program definition and the launch of the first system projects, including Airborne Initial 4D Trajectory Management. She is an AIAA senior member, and a past recipient of Amelia Earhart fellowship and an active contributor to several RTCA and AEEC standardization groups.

PAPER # 349: ❖ *Michael McCormack* – NASA Langley

Michael J. McCormack is an electrical engineering and computer science undergraduate at the University of California, Berkeley. He is a former business owner and who has performed a number of research-based internships throughout his undergraduate studies. He is the Operations Manager of the 2013 NASA Aeronautics Academy at Langley Research Center, and he currently studies the potential benefits of cloud computing concepts applied to air traffic management alongside Langley Research Center and Ames Research Center. He is an In December 2012, he completed TFT circuit design research and development work at Qualcomm MEMS Technologies. In 2012, he was a member of the Aeronautics Academy at NASA Langley Research Center, and in the summer of 2011, he performed a research internship with the Jet Propulsion Laboratory.

Trajectory and Queue Management – *Session Chairs: Eric Hoffman, Miquel Àngel Piera Eroles*

Time	Paper Number	Title of Paper	Authors	Presenter
7:45 AM	233	Regression Analysis of Top of Descent Location for Idle-thrust Descents	Laurel Stell Jesper Bronsvoort Greg McDonald	Laurel Stell *NASA Ames*
8:30 AM	350	Statistical Prediction of Aircraft Trajectory: Regression Methods vs Point-mass Model	Mohammad Ghasemi Hamed David Gianazza M. Serrurier Nicolas Durand	Mohammad Ghasemi Hamed/ David Gianazza *École Nationale de l'Aviation Civile (ENAC)*
9:15 AM	217	Improved Trajectory Information for the Future Flight Planning Environment	Stephane Mondoloni	Stephane Mondoloni *MITRE*
10:00 AM	198	Ground-based Estimation of the Aircraft Mass, Adaptive vs. Least Squares Method	Richard Alligier David Gianazza Nicolas Durand	Richard Alligier *École Nationale de l'Aviation Civile (ENAC)*
10:45 AM		COFFEE BREAK		
11:15 AM	182	2011 Trajectory Based Operations Flight Trials	Christopher Wynnyk Paul MacWilliams Mahesh Balakrishna Thomas Becher	Christopher Wynnyk *MITRE*
12:00 PM	242	Controlled Time of Arrival Feasibility Analysis	David De Smedt Jesper Bronsvoort Greg McDonald	David De Smedt *EUROCONTROL*
12:45 PM	325	En Route Speed Control Methods for Transferring Terminal Delay	James Jones Michael Ball David Lovell	James Jones *The University of Maryland*
1:30 PM		LUNCH/ADJOURN		

PAPER # 233: ❖ *Laurel Stell* – *NASA Ames*

Dr. Laurel Stell is an Aerospace Engineer at the NASA Ames Research Center, Moffett Field, California. Her research involves statistical analysis and modeling to understand and improve air traffic operations, from local aircraft trajectory prediction to system-wide analysis of NAS performance. She earned her Ph.D. in applied mathematics from Cornell University and is nearing completion of an M.S. in statistics from Stanford University.

PAPER # 350: ❖ *Mohammad Ghasemi Hamed* – *École Nationale de l'Aviation Civile (ENAC)*

Mohammad Ghasemi Hamed is a Ph.D. student at the MAIAA lab of ENAC and is currently studying statistical and machine learning methods (probabilistic and possibilistic) for the ground based aircraft trajectory prediction problem. He received his engineering degree from ENSEEIHT (2010). He also has a M.Sc. graduate degree (2010) in Artificial Intelligence from the University of Paul Sabatier in Toulouse and an undergraduate degree in computer engineering from the University of Shahid Beheshti in Tehran, Iran. His research interests include: learning with uncertain data, regression and time series modeling, uncertainty in the aircraft trajectory prediction. He currently lives in Toulouse, France.

PAPER # 350: ❖ *David Gianazza* – *École Nationale de l'Aviation Civile (ENAC)*

David Gianazza received his engineer degrees (1986, 1996) from the french university of civil aviation (ENAC) and his M.Sc. (1996) and Ph.D. (2004) in Computer Science from the "Institut National Polytechnique de Toulouse" (INPT). He has held various positions in the french civil aviation administration, successively as an engineer in ATC operations, technical manager, and researcher. He is currently associate professor at the ENAC, Toulouse.

PAPER # 217: ❖ *Stephane Mondoloni* – *MITRE*

Dr. Mondoloni is a Senior Principal Simulation Modeling Engineer at the MITRE Corporation since 2008 and has over 19 years of experience in Air Traffic Management research. His current research interests include ATM performance evaluation, trajectory-based operations and future flight planning. In this latter area, he has contributed to the development of the ICAO FF-ICE Concept since its inception. Dr. Mondoloni received his Aeronautical and Astronautical Engineering Bachelors, Masters and Ph.D. degrees in 1987, 1989, and 1993 from the Massachusetts Institute of Technology.

PAPER # 198: ❖ *Richard Alligier* – *École Nationale de l'Aviation Civile (ENAC)*

Richard Alligier is currently a Ph.D. student at the MAIAA lab of the the French University of Civil Aviation (ENAC). He received his engineering degrees (IEEAC, 2010) from the ENAC and his M.Sc. (2010) in computer science from the University of Toulouse, France. His research interests include: aircraft trajectory prediction, and machine learning techniques.

PAPER # 182: ❖ *Christopher Wynnyk* – *MITRE*

Christopher M. Wynnyk earned his M.S. in Electrical Engineering from Rensselaer Polytechnic Institute in Troy, NY, and his B.S.E. in Electrical Engineering from Princeton University in Princeton, NJ. He is a Senior Multi-Discipline Systems Engineer at The MITRE Corporation's Center for Advanced Aviation System Development (CAASD) in McLean, VA. Prior to this, he worked as a research scientist at General Eletric's Global Research Center in Niskayuna, NY. His research interests include Performance Based Navigation (PBN), numerical weather prediction, computational finance, and embedded systems.

PAPER # 242: ❖ *David De Smedt* – *EUROCONTROL*

David De Smedt obtained a Masters degree in Science of Civil Engineering at the Vrije Universiteit Brussel in 1997. He holds a current Airline Transport Pilot License (ATPL) with Airbus A320 Type Rating and has 2500 hours of airline pilot experience, operating A320 aircraft for Sabena and DutchBird. He joined Eurocontrol in 2007 where he currently works as a Senior Navigation Expert. His areas of work are 4D-Trajectory Based Operations, Performance Based Navigation and Avionics.

PAPER # 325: ❖ *James Jones* – *The University of Maryland*

James Jones is a Ph.D. candidate in the Department of Civil and Environmental Engineering at the University of Maryland. Prior to pursuing his Ph.D, James held positions at Northrop Grumman and the RAND Corporation. He holds a B.S. in Engineering from Swarthmore College and an M.S. in Electrical Engineering from the University of Maryland.

Track 1 – *Wednesday, June 12, 2013*

Integrated Airport/Airside Operations – *Session Chair: Sandy Lozito*

Time	Paper Number	Title of Paper	Authors	Presenter
7:45 AM	300	Estimating Current & Future System-Wide Benefits of Airport Surface Congestion Management	Tom Reynolds Alex Nakahara	Tom Reynolds *MIT Lincoln Laboratory* Alex Nakahara *Northrop Grumman*
8:30 AM	316	Boarding on the Critical Path of the Turnaround	Michael Schultz Thomas Kunze Hartmut Fricke	Michael Schultz *TU Dresden, IFL*
9:15 AM	320	A Methodology to Assess the Safety of Aircraft Operations when Aerodrome Obstacle Standards cannot be met	Hartmut Fricke Christoph Thiel	Hartmut Fricke *Dresden University of Technology*
10:00 AM		Coffee Break		
10:30 AM	220	Performance Evaluation of Individual Aircraft Based Advisory Concept for Surface Management	Gautam Gupta Waqar Malik Leonard Tobias Yoon Jung Ty Hoang Miwa Hayashi	Gautam Gupta *UARC - NASA Ames*
11:15 AM	180	Investigation of NASAs Spot and Runway Departure Advisor Concept at PHL, CLT, and LAX Airports	Stephen Atkins Brian Capozzi Andrew Churchill Alicia Fernandes Christopher Provan	Stephen Atkins *Mosaic Air Traffic Management*
12:30 PM		Lunch		

Network and Strategic Traffic Flow Optimization – *Session Chair: Nicolas Durand*

Time	Paper Number	Title of Paper	Authors	Presenter
2:00 PM	230	Designing Coordinated Initiatives for Strategic Traffic Flow Management	Christine Taylor Craig Wanke	Christine Taylor *MITRE*
2:45 PM	270	Effect of radii of exemption on ground delay programs with operating cost based cruise speed reduction	Luis Delgado Xavier Prats	Luis Delgado *Technical University of Catalonia*
3:30 PM		Coffee Break		
4:00 PM	315	Strategic Planning in Air Traffic Control as a Multi-objective Stochastic Optimization Problem	Gaétan Marceau Pierre Sav´eant Marc Schoenauer	Gaétan Marceau *INRIA Saclay*
4:45 PM	216	Airspace Sectorisation using Constraint-Based Local Search	Pierre Flener Peter Jägare Justin Pearson	Justin Pearson *Uppsala University*
5:30 PM		Adjourn		

PAPER # 300: *Tom Reynolds* – *MIT Lincoln Laboratory*

Tom G. Reynolds is in the Air Traffic Control Division at MIT Lincoln Laboratory with particular interests in the development of advanced technologies and operations for improving efficiency and mitigating environmental impacts of aviation. He has a Ph.D. in Aerospace Systems from MIT, has worked on the research staff at MIT and the University of Cambridge, has won several national awards for his air transportation system research (including the AIAA Orville & Wilbur Wright Graduate Award) and was a UK Fulbright Scholar.

PAPER # 316: *Michael Schultz* – *TU Dresden, IFL*

Michael Schultz studied business and engineering at Technische Universität Dresden (TUD, 2002) and holds a Ph.D. degree in Aviation Technologies (2010). During several internships at Siemens Financial Services and BMW Group Research Innovation Center, he gained experiences in the field of economic risk analysis, quality engineering, system design, and numerical simulation. After two years of employment at the automotive industry, he became the chair of Air Transport Technology and Logistics at TUD. As an expert of stochastic modeling, agent-based approaches, and complex system behavior, his academic and industrial projects particularly focus on future air traffic management procedures, passenger dynamics, airport performance, and reliable system design. Currently his research addresses both consideration of uncertainties in ATM procedures and dynamic optimization of the aircraft turnaround. Besides his research activities he coordinates the SESAR WP-E project UTOPIA and leads the turnaround research group at the Institute of Logistics and Aviation.

PAPER # 320: *Hartmut Fricke* – *see Bio for Paper 285, Page 7*

PAPER # 220: *Gautam Gupta* – *UARC - NASA Ames*

Dr. Gautam Gupta received a B.Tech. in Civil Engineering from the Indian Institute of Technology Bombay, India, and both M.S. and Ph.D. in Transportation Engineering from University of California, Berkeley. He is currently a scientist at UARC, NASA Ames Research Center. Over the last five years, Dr Gupta has been involved in NASA research on improving airport surface operations. He has developed methods for optimizing airport operations and to evaluate fuel and emissions due to taxiing operations. He has been a co-architect of NASA's surface operations tool SARDA. As a part of the SARDA team, Dr Gupta has received two NASA Ames Honor Awards in 2010 and 2012. He has also co-authored a paper on SARDA, which recently won the technical excellence in publication award from the Aeronautics Directorate at NASA. His research interests include airline operations and planning, airline economics, and large scale optimization problems in transportation.

PAPER # 180: *Stephen Atkins* – *Mosaic Air Traffic Management*

Dr. Stephen Atkins is Vice President and a Principal Analyst at Mosaic ATM in Leesburg, VA. He co-founded Mosaic ATM in 2005 to advance the science of air traffic management and develop practical solutions to complex aviation problems. Stephen previously worked as a researcher at NASA Ames Research Center, where almost 15 years ago he began studying airport surface traffic management well before it became a popular topic. He is an inventor of NASA's Surface Management System which continues to be used as a research platform and which paved the way for today's airport surface automation technologies. Stephen continues to focus on airport surface operations and is also interested in weather impacts on aviation, techniques for managing uncertainty, and how local, regional, and national traffic management should be coordinated. Dr. Atkins received all of his degrees from the Department of Aeronautics and Astronautics at the Massachusetts Institute of Technology.

PAPER # 230: *Christine Taylor* – *MITRE*

Dr. Christine Taylor is a Lead Simulation and Modeling Engineer at the MITRE Corporation. Her primary research focus is in the development of decision support systems for traffic flow management and specializes in the application of optimization approaches in complex systems. She holds a B.S. from Cornell University and M.S. as well as a Ph.D. degree in aeronautical engineering from the Massachusetts Institute of Technology.

PAPER # 270: *Luis Delgado* – *Technical University of Catalonia*

Since 2007 Luis Delgado is assistant professor at the Technical University of Catalonia (UPC) in Barcelona. He holds a Computer Science Engineering from the same university and an Aeronautical Engineering Master's Degree by the National School for Civil Aviation (ENAC) located in Toulouse. He received his Ph.D. in Aerospace Science and Technology in April 2013 from UPC. Research interest include: Air traffic and delay management, trajectory optimization and the introduction of UAS in non-segregated airspace.

PAPER # 315: *Gaétan Marceau* – *INRIA Saclay*

Gaetan Marceau is a Ph.D. candidate in computer science in the TAO team at INRIA Saclay Ile-de-France, working in the "Laboratoire de Recherche en Informatique" of the University Paris-Sud. His thesis is also co-supervised and co-funded by Thales Air Systems France, a major actor in the development and deployment of operational Air Traffic Control Centers. Research interests include: optimization, artificial intelligence and control theory in Air Traffic Management.

PAPER # 216: *Justin Pearson* – *Uppsala University*

Justin Pearson is an Associate Professor at the Department of Information Technology at Uppsala University, Sweden. He received his Ph.D. in Electronic Engineering in 1996 from the University of Kent at Canterbury, UK. He is a member of the ASTRA research group on constraint programming at Uppsala University. His research interests include all aspects of combinatorial optimisation, especially constraint programming.

Track 2 – Wednesday, June 12, 2013

Safety and Resilience – *Session Chair: Dirk Schaefer*

Time	Paper Number	Title of Paper	Authors	Presenter
7:45 AM	302	Modeling Potential Hazards Within Agent-Based Safety Risk Analysis	Henk Blom Sybert Stroeve Tibor Bosse	Henk Blom *National Aerospace Laboratory (NLR)*
8:30 AM	247	Optimizing the Next Generation Collision Avoidance System for Safe, Suitable, and Acceptable Operational Performance	Jessica Holland Mykel Kochenderfer Wesley Olson	Jessica Holland *MIT Lincoln Laboratory*
9:15 AM	335	Impacts of reporting rules and facility consolidation on recorded operational errors in TRACONs	Michael Seelhorst Mark Hansen	Michael Seelhorst *University of California, Berkeley*
10:00 AM		COFFEE BREAK		
10:30 AM	265	Assuring Safety of NextGen Procedures	Seth Placke Nancy Leveson Cody Fleming	Seth Placke *MIT Complex Systems Research Lab*
11:15 AM	277	Performance based approach to investigate resilience and robustness of an ATM System	Olga Gluchshenko Peter Foerster Christopher Provan	Olga Gluchshenko *German Aerospace Center (DLR)*
12:30 PM		LUNCH		

Separation – *Session Chair: Mark Weber*

Time	Paper Number	Title of Paper	Authors	Presenter
2:00 PM	243	4-D Trajectory Optimizers for Conflict Avoidance Using Speed Advisories	Arthur Richards Oliver Turnbull	Arthur Richards *Bristol University*
2:45 PM	264	A New Framework for Solving En-Route Conflicts	Cyril Allignol Nicolas Barnier Nicolas Durand Jean-Marc Alliot	Cyril Allignol *École Nationale de l'AviatioCivile (ENAC)*
3:30 PM		COFFEE BREAK		
4:00 PM	199	Applying Flight-deck Interval Management based Continuous Descent Operation for Arrival Air Traffic to Tokyo International Airport	Eri Itoh Kazuhiko Uejima	Eri Itoh *Electronic Navigation Research Institute (ENRI)*

Unmanned Aircraft Systems (UAS) Integration – *Session Chair: Mark Weber*

Time	Paper Number	Title of Paper	Authors	Presenter
4:45 PM	321	Maintaining Separation Between Airliners and RPAS in Non-segregated Airspace	Enric Pastor Marc Perez-Batlle Xavier Prats Pablo Royo Raul Cuadrado	Xavier Prats *Technical University of Catalonia*
5:30 PM		ADJOURN		

PAPER # 302: *Henk Blom – National Aerospace Laboratory (NLR)*

Henk Blom is a Professor at the Delft University of Technology as well as the Chair of Air Traffic Management Safety and Principal Scientist at the National Aerospace Laboratory NLR, both in The Netherlands. He received his B.Sc and M.Sc degrees from the University of Twente in 1975 and 1978 respectively and his PhD from the Delft University of Technology in 1990. Dr. Blom has over twenty five years experience in exploiting the theory of stochastic modeling and analysis based computational intelligence for safety risk analysis and multi-sensor data fusion with application in air traffic management. He is the author of over one hundred referenced articles in scientific journals, books and conference proceedings, and of the volume: "Stochastic Hybrid Systems, Theory and Safety Critical Systems" by Springer, 2006. He has organized and coordinated several European collaborative research projects, such as ARIBA, HYBRIDGE and iFly. Dr. Blom is also an IEEE Fellow.

PAPER # 247: *Jessica Holland – MIT Lincoln Laboratory*

Jessica Holland completed aeronautical engineering and aviation flight operations degrees at Daniel Webster College and currently is an associate staff member at MIT Lincoln Laboratory. Ms. Holland led research under the FAA's legacy TCAS Operational Performance Assessment Program, conducted operational optimization of the new Airborne Collision Avoidance System, ACAS X, and is the test director for the upcoming proof-of-concept flight test. She also is an instrument rated, commercially licensed single and multi-engine pilot and flight instructs part-time in a variety of aircraft including vintage tail-draggers. Through MIT and other professional societies, Ms. Holland participates in educational outreach programs to encourage interest in science, technology, engineering, math, and aviation.

PAPER # 335: *Michael Seelhorst – University of California, Berkeley*

Michael Seelhorst is fourth year Ph.D. student in Civil & Environmental Engineering at UC Berkeley and a researcher at NEXTOR. He earned a M.S. in Civil & Environmental Engineering from UC Berkeley in 2010 and a B.S. in Aerospace Engineering from Georgia Tech in 2009. His research interests include airline operations, air traffic management, and transportation economics.

PAPER # 265: *Seth Placke – MIT Complex Systems Research Lab*

Seth Placke is a Master's Candidate under Prof. Nancy Leveson in the Engineering Systems Division at the Massachusetts Institute of Technology. Prior to attending MIT Seth received his B.S. in Mechanical Engineering from North Carolina State University where he was Park Scholar. Seth is always seeking to understand the context in which engineering takes place and his research interest include: systems engineering, system architecture, controls and system safety. He currently lives in Boston, MA.

PAPER # 277: *Olga Gluchshenko – German Aerospace Center (DLR)*

Olga Gluchshenko is currently a researcher at the DLR - German Airspace Center and Institute of Flight Guidance in Braunschweig (Brunswick), Germany. Prior to working for DLR, she was employed as a researcher at the Fraunhofer Institute for Industrial Mathematics (ITWM) in Kaiserslautern, Germany. Publications include papers on Traffic Flow Management, ATM Planning Systems, Location Theory, and Automatic Parallel Generation of Tetrahedral Grids. Research interests include: Air Traffic Management and Airport Management Systems, Resilience and Robustness in ATM Context and discrete optimization. Olga currently lives in Braunschweig, Germany.

PAPER # 243: *Arthur Richards – Bristol University*

Dr Arthur Richards is an academic in the Department of Aerospace Engineering at the University of Bristol, UK. His research considers trajectory optimization for high performance control, including air traffic, autonomous air vehicles and spacecraft.

PAPER # 264: *Cyril Allignol – École Nationale de l'Aviation Civile (ENAC)*

Cyril Allignol is an assistant professor at ENAC, the French School for Civil Aviation. He graduated from ENAC as an engineer in 2006, and received a Ph.D. in computer science from the University of Toulouse in 2011.

PAPER # 199: *Eri Itoh – Electronic Navigation Research Institute (ENRI)*

Eri Itoh received a Ph.D. from the Department of Aeronautics and Astronautics at the University of Tokyo in 2008. She started to work at Air Traffic Management Department in Electronic Navigation Research Institute (ENRI), in Tokyo, Japan, in 2008, and currently holds the position of senior researcher. She has been a doctoral researcher at EUROCONTROL Experimental Center in France since October 2007 through March 2008, and a visiting fellow with The University of Tokyo from April 2012 through March 2013. She conducted research collaboration with the National Aerospace Laboratory NLR in the Netherlands for 5 years since 2008. She joins the International Council of Aeronautical Science (ICAS) group as a program committee member since 2010, and currently takes a year sabbatical as a visiting scholar at NASA Ames research center in USA.

PAPER # 321: *Xavier Prats – Technical University of Catalonia*

Dr. Xavier Prats is an Aeronautical Engineer from the National School for Civil Aviation (École Nationale de l'Aviation Civile, ENAC) located in Toulouse (France). He also holds a degree in Telecommunications Engineering from Telecom Barcelona (Escola Tècnica Superior d'Enginyeria de Telecomunicació de Barcelona, ETSETB), which belongs to the Technical University of Catalonia (Universitat Politècnica de Catalunya, UPC) in Barcelona (Spain). He earned both degrees in 2001. Furthermore, he received his Ph.D. in Aerospace Science and Technology from UPC in 2010. His research interests include improving the performance and efficiency of the Air Traffic Management (ATM) system and the flexible, reliable and cost-efficient Unmanned Aircraft Systems (UAS) operations in civil airspace. He has been working with UPC since 2001 and currently, he is an assistant professor at the School of Telecommunications and Aerospace Engineering of Castelldefels (Escola d'Enginyeria de Telecommunicació i Aeroespacial de Castelldefels, EETAC). He co-founded the ICARUS research group and is currently leading the Air Transportation research activities within it.

Track 3 – *Wednesday, June 12, 2013*

ATM Performance Measurement and Management
Session Chairs: Joe Post, Mark Hansen

Time	Paper Number	Title of Paper	Authors	Presenter
7:45 AM	318	Ground Delay Program Decision-making using Multiple Criteria: A Single Airport Case	Yi Liu Mark Hansen	Yi Liu *University of California, Berkeley*
8:30 AM	223	Flexibility Metrics and Their Application to Departure Queue Management	Len Wojcik Stephane Mondoloni Seli Agbolosu-Amison Paul Wang	Len Wojcik *MITRE*
9:15 AM	283	Enhancing Cost-Efficiency and Reducing Capacity Shortages: Strategic Planning and Dynamic Shift Management	Gonzalo Tobaruela Arnab Majumdar Peter Hendrickx Washington Ochieng Wolfgang Schuster	Gonzalo Tobaruela *Imperial College London*
10:00 AM		Coffee Break		
10:30 AM	183	Identifying Temporally Persistent Flows in the Terminal Airspace via Spectral Clustering	Marco Enriquez	Marco Enriquez *MITRE*
11:15 AM	317	Estimating Airspace Capacity Based on Risk Mitigation Metrics	Husni Idris Ni Shen	Husni Idris *Engility Corporation*
12:30 PM		Lunch		
2:00 PM	334	Air Traffic Flow Management at Airports: A Unified Optimization Approach	Michael Frankovich Dimitris Bertsimas	Dimitris Bertsimash *Massachusetts Institute of Technology*
2:45 PM	163	Airport Gate Scheduling for Passengers, Aircraft, and Operation	Sang Hyun Kim Eric Feron Aude Marzuoli John-Paul Clarke Daniel Delahaye	Eric Feron *Georgia Institute of Technology*
3:30 PM		Coffee Break		
4:00 PM	244	Markov Model for Cost and Benefits Analysis of Air Traffic Technologies	Vineet Mehta Scot Campbell Kavitha Chandra Ngaire Underhill Richard DeLaura	Scot Campbell *MIT Lincoln Laboratory*
4:45 PM	205	Benefits Analysis of a Departure Management Prototype for the New York Area	James DeArmon Norma Taber Hilton Bateman Lixia Song Tudor Masek Daniel Gilani	Norma Taber *MITRE/CAASD*
5:30 PM		Adjourn		

PAPER # 318: *Yi Liu – University of California, Berkeley*

Yi Liu is a Ph.D. candidate in the Department of Civil and Environmental Engineering at the University of California, Berkeley working under Dr. Mark Hansen. She has an undergraduate degree in Hydraulic and hydropower engineering from Tsinghua University in China, a Masters in Geotechnical Engineering from Hong Kong University of Science and Technology. She joined the aviation club in summer 2010. Her main research interest is in air traffic management and airport surface operations management.

PAPER # 223: *Len Wojcik – MITRE*

Len Wojcik is a Group Leader at the MITRE Corporation's Center for Advanced Aviation System Development (CAASD) in McLean, Virginia. He has worked at MITRE for more than 30 years on systems engineering, modeling and analysis for the U.S. and Republic of China governments. Len also worked at the Flight Safety Foundation and the Office of Technology Assessment of the U.S. Congress. Len is co-editor of the book, "Enterprise Dynamics Sourcebook" (Boca Raton: CRC Press, 2013).

PAPER # 283: *Gonzalo Tobaruela – Imperial College London*

Gonzalo Tobaruela (Madrid, Spain, 1987) graduated as an aerospace engineer specialized in aircraft design from Technical University of Madrid, Spain in 2011. He developed his thesis at Boeing Research & Technology Europe before joining the Centre for Transport Studies at Imperial College London as PhD candidate, being the assessment of the impacts of SESAR deployment on airspace capacity the main field of his research. Within his PhD, he joined Eurocontrol Maastricht Upper Area Control Centre as a visiting researcher in September 2012.

PAPER # 183: *Marco Enriquez – MITRE*

Marco Enriquez is a Senior Applied Mathematician at the MITRE Corporation's Center for Advanced Aviation System Design (CAASD) in McLean, Virginia. He holds a Ph.D. in Applied Mathematics from Rice University and a B.S. in Computer Engineering from Tufts University. His research interests include numerical analysis, optimization theory and computational frameworks supporting such topics.

PAPER # 317: *Husni Idris – Engility Corporation*

Husni Idris received a bachelor of science and a master of science in mechanical engineering, a master of science in operations research and a Ph.D. in human factors and automation, all from the Massachusetts Institute of Technology, in Cambridge, Massachusetts, USA. He is currently a Principal Research Engineer at Engility Corporation, in Billerica, MA, USA. He has been a principal investigator on a number of research projects with the NASA Ames and NASA Langley research centers, related to air traffic management. His research interests include concept engineering, human factors, and benefits assessment for air traffic management automation. He has led projects in airport surface operations, collaborative and distributed traffic flow management, and trajectory planning for flexibility and complexity. He has over thirty related publications.

PAPER # 334: *Dimitris Bertsimas – Massachusetts Institute of Technology (MIT)*

Dimitris Bertsimas is currently the Boeing Professor of Operations Research and the co-director of the Operations Research Center at the Massachusetts Institute of Technology. In addition, he is the managing partner of Aviation Edge LLC, a company that specializes in the use of analytics for aviation problems. He received a B.S. in Electrical Engineering and Computer Science at the National Technical University of Athens, Greece in 1985, a M.S. in Operations Research at MIT in 1987, and a Ph.D. in Applied Mathematics and Operations Research at MIT in 1988. Since 1988, he has been with the MIT faculty. His research interests include analytics and their applications in a variety of industries including aviation. He has co-authored more than 150 scientific papers and he has co-authored three graduate level textbooks. He is currently department editor in Optimization for Management Science and former area editor in Operations Research in Financial Engineering. He has supervised 51 doctoral students and he is currently supervising 12 others. He is a member of the National Academy of Engineering, and he has received numerous research awards including the Farkas prize (2008), the Erlang prize (1996), the SIAM prize in optimization (1996), the Bodossaki prize (1998) and the Presidential Young Investigator award (1991-1996).

PAPER # 163: *Eric Feron – Georgia Institute of Technology*

Eric Feron is the Dutton-Ducoffe Professor of Aerospace Engineering at Georgia Tech, Atlanta, Georgia, and a consulting Professor at Ecole Nationale de l'Aviation Civile, Toulouse, France. His research focuses on the application of control theory, operations research and computer science to aerospace engineering. His past contributions include the definition of early airport departure management procedures (1999) and avionics for aerobatic unmanned aerial systems (2001). He is currently involved with defining and optimizing passenger-centric performance metrics for the air transportation system.

PAPER # 244: *Scot Campbell – MIT Lincoln Laboratory*

Scot Campbell is currently a Technical Staff member of the weather sensing group at MIT Lincoln Laboratory in Lexington, MA. He received a B.S. degree in Aeronautical and Astronautical Engineering from the University of Illinois at Urbana-Champaign in 2003. In addition, he received M.S. and Ph.D. degrees in Aerospace Engineering from the University of Illinois at Urbana-Champaign in 2006 and 2010 respectively. His current research involves the development of decision support tools to enhance next-generation air traffic management.

PAPER # 205: *Norma Taber – MITRE/CAASD*

Norma Taber is currently a Lead Multi-Discipline Systems Engineer at The MITRE Corporation's Center for Advanced Aviation System Development (CAASD) in McLean, Virginia. She has devoted almost 30 years to enhancing air traffic control and traffic flow management operations from initial concept development through technology transfer for implementation in operational systems, frequently serving as a "translator" and integrator on teams of systems engineers, mathematicians, operational experts, software developers, and human factors experts. She holds a Bachelor of Arts in mathematics from Albion College, Michigan, and a Bachelor of Science as well as a Master of Science in systems engineering from Washington University in St. Louis, Missouri.

ICAO Global Harmonization Forum

7:45 AM	**Results & Impacts of the ICAO 12th Air Navigation Conference**
	Integration & Harmonization of NextGen and SESAR into the Global ATM Framework **Plenary Talk:** **Steve Bradford**, *FAA* & **Michael Standar**, *SJU*
9:00 AM	Coffee Break

ATM Research Around the World

9:30 AM	**Electronic Navigation Research Institute (ENRI)** **Yutaka Fukuda,** *Deputy Director, ATM Department*
10:00 AM	**Brazil Dept. of Airspace Control (DECEA)** **Colonel Leandro Costa de Andrade**, *Director, Airspace Control Institute (ICEA)*
10:30 AM	**Airservices Australia** **Greg McDonald,** *Senior Operational Specialist*
10:45 AM	**Chicago O'Hare (ORD) Modernization Program** **Jim Chilton**, *Program Manager* and **Kevin Markwell**, *Support Manager*
11:15 AM	**Best Paper Awards & Closing** **Sabrina Saunders-Hodge** & **Colin Meckiff**
11:45 AM	Lunch and Adjourn *(Program Committee Members Meet in Prairie Center)*
1:15 PM	**Load buses for O'Hare Modernization Program Tour** Optional (Please register at Seminar Support Desk by Wednesday)
1:30 PM	**Depart Hotel for Chicago O'Hare Modernization Program Tour** Optional (Please register at Seminar Support Desk by Wednesday)
5:30 PM	**Return to Hyatt Regency McCormick Hotel from Chicago O'Hare Modernization Program Tour**

Steve Bradford.....*see Bio in Opening Plenary section, Page 5*

Michael Standar – *SESAR Joint Undertaking*

Michael Standar is the Chief of Strategies and External Relations at the SESAR Joint Undertaking based in Brussels, Belgium. He became Chief of Air Traffic Management in July 2011 and was promoted to his current position in January 2012. He was an active Swedish member of ICAO Air Traffic Management Operational Concepts panel, (ATMCP) developing the ICAO Global ATM Operational Concept Document, which continued into the Air Traffic Management Requirements and Performance Panel (ATMRPP). In the early 1990s, he was offered a post at the Swedish CAA headquarters, later the LFV Air Navigation Services service provider. There, he was promoted first to Head units for ATM operational developments and operational support and later head of the business area of LFV′s ATM Support & Development before taking up duties as LFV Director for ANS Business Development.

Yutaka Fukuda – *Deputy Director, ATM Department*

Mr. Fukuda is the Deputy Director of the Air Traffic Management Department at the Electronic Navigation Research Institute (ENRI). ENRI is responsible for research and development in the field of ATM in Japan, supporting the Japan Civil Aviation Bureau (JCAB). Mr. Fukuda was Project Manager of Trajectory Based Operations (TBO) Research at ENRI. He has studied airborne collision avoidance systems, arrival management, flexible route systems in oceanic airspace, conflict detection systems, and trajectory management after joining ENRI in 1986. He was a Visiting Researcher at NASA Ames Research Center in 1995 where he studied strategic conflict resolution method. Mr. Fukuda received his Master of Science degree in Electronics from Tokyo Institute of Technology in 1986, and his Bachelor of Science degree in Electronics from Tokyo Institute of Technology in 1984.

Colonel Leandro Costa de Andrade – *Department of Airspace Control (DECEA)*

Brazilian Air Force (BRAF) Colonel Leandro Costa de Andrade was born in Rio de Janeiro and was commissioned on February 1983. Col. Leandro is a transport pilot with more than 1,800 flown hours. Col. Leandro was a pilot instructor for the T-6, T-27 (Tucano) operational pilot, and flight instructor for the C-95 (Bandeirante). Col. Leandro's main assignments include: Chief of Data Processing Division, 5th Air Transportation Squadron; Chief of Computer Section, Development Division; Officer, Operations Directorate at CISCEA (Commission for Implementing the Airspace Control System); and Officer, DECEA's Technical Guidance Division. Col. Leandro is a graduate from the Aeronautical Technology Institute (ITA), Computer Engineering, and has an MBA from prestigious Brazilian post-graduate FGV school in Projects Management and one MBA from Catholic University of Rio Grande do Sul state, in Computer Technology. His military decorations include: Military Silver Medal and Santos Dumont Medal.

Greg McDonald – *Senior Operational Specialist*

Greg McDonald is an Air Traffic Controller with in excess of 30 years experience in all facets of the craft. Since 1998 has been involved in the Australian ATM Strategic Plan and implementing efficiencies for airlines including AUSOTS flex tracks. His work managing the Tailored Arrivals program in Australia has lead to his interest in improving ground based trajectory prediction to efficiently manage the increasing air traffic. He is currently researching how currently deployed equipment (FANS) can be employed to improve ground prediction and processing.

Jim Chilton – *Program Manager for the O'Hare Modernization Program (OMP)*

Jim Chilton is currently employed by DMJM Aviation Partners, the Program Manager for the O'Hare Modernization Program (OMP). Jim has worked on the Program since May 2004, first as the Senior Project Manager for the South Airfield projects, and now as the Program Manager. Prior to moving to Chicago, Jim worked for Edwards and Kelcey as the Program Manager for the Manchester Airport Capital Improvements Program in New Hampshire. Jim retired from the Army Reserves after completing commands of a Combat Heavy Engineer Battalion and Area Support Group. Jim has a Bachelor's of Science degree in Civil Engineering from Norwich University; a Master's of Business Administration degree from Western New England College; and a Master's of Strategic Studies from the United States Army War College. Jim is a registered Professional Engineer. He and his wife, Barbara, reside in Grayslake, IL. They have two children.

Kevin Markwell – *Support Manager for Plans and Procedures at O'Hare Air Traffic Control Tower (ATCT)*

Kevin Markwell is currently the Support Manager for Plans and Procedures at O'Hare Air Traffic Control Tower (ATCT) and has 35 years of air traffic experience with the Federal Aviation Administration (FAA). He has worked most of his career at O'Hare ATCT as an air traffic controller, Area Supervisor, Assistant Manager for Training, Area Manager, Operations Manager and as the Support Manager for Plans and Procedures. In 2000, Kevin left O'Hare Tower temporarily to work in Air Traffic Manager at Midway ATCT. In his current position, he is responsible for interpreting and developing air traffic procedures including traffic flows on runways throughout the O'Hare Modernization Project.

Sabrina Saunders-Hodge.....*see Bio in Opening Plenary section, Page 5*

Colin Meckiff.....*see Bio in Opening Plenary section, Page 5*

List of Attendees

Hussein Abbass
Canberra campus of The University of New South Wales (Australian Defence Force Academy)

Natalia Alexandrov
NASA Langley

Richard Alligier
École Nationale de l'Aviation Civile (ENAC)

Cyril Allignol
École Nationale de l'Aviation Civile (ENAC)

Colonel Leandro Costa de Andrade
Department of Airspace Control (DECEA)

Giovanni Andreatta
University of Padova

Pierre Andribet
EUROCONTROL

Stephen Atkins
Mosaic Air Traffic Management

Sofia Azevedo
Diretora Gabinete de Comunicação e Imagem

Hamsa Balakrishnan
Massachusetts Institute of Technology AeroAstro

Nicolas Barnier
École Nationale de l'Aviation Civile (ENAC)

Collin Beers
National Aerospace Laboratory (NLR)

Dimitris Bertsimas
Massachusetts Institute of Technology

Henk Blom
National Aerospace Laboratory (NLR)

Marc Bourgois
EUROCONTROL

Guy Boy
Florida Institute of Technology

Steve Bradford
Federal Aviation Administration (FAA)

Jesper Bronsvoort
Airservices Australia

Todd Callantine
San Jose State University

Scot Campbell
MIT Lincoln Laboratory

Peter Choroba
EUROCONTROL

David Clark
MIT Lincoln Laboratory

Thomas Dautermann
German Aerospace Center (DLR)

Thomas Davis
NASA Ames

David De Smedt
EUROCONTROL

Luis Delgado
Technical University of Catalonia

Paul Diffenderfer
MITRE

Nicolas Durand
École Nationale de l'Aviation Civile (ENAC)

Mohamed Ellejmi
EUROCONTROL

Marco Enriquez
MITRE

Eric Feron
Georgia Institute of Technology

Thomas Feuerle
TU Braunschweig

Pablo Fleurquin
Institute for Cross-Disciplinary Physics and Complex Systems

Hartmut Fricke
Dresden University of Technology

Maik Friedrich
German Aerospace Center (DLR)

Xavier Fron
EUROCONTROL

Yutaka Fukuda
Electronic Navigation Research Institute (ENRI)

Travis Gaydos
MITRE

Mohammad Ghasemi Hamed
École Nationale de l'Aviation Civile (ENAC)

David Gianazza
École Nationale de l'Aviation Civile (ENAC)

Olga Gluchshenko
German Aerospace Center (DLR)

Volker Grewe
German Aerospace Center (DLR)

Gautam Gupta
UARC - NASA Ames

R. John Hansman
Massachusetts Institute of Technology (MIT)

Lu Hao
University of California, Berkeley

Miwa Hayashi
NASA Ames

Olaf Heinzinger
European Aeronautic Defence and Space Company N.V. (EADS)

Hartmut Helmke
German Aerospace Center (DLR)

James Hileman
Federal Aviation Administration (FAA)

Jacco Hoekstra
Delft University of Technology

Eric Hoffman
EUROCONTROL

Jessica Holland
MIT Lincoln Laboratory

Tim Hughes
AIRWAYS

Husni Idris
Engility Corporation

Gokhan Inalhan
Istanbul Technical University

Eri Itoh
Electronic Navigation Research Institute (ENRI)

William Johnson
NASA Langley

James Jones
The University of Maryland

Frank Ketcham
University of California, Berkeley

Paul Krois
Federal Aviation Administration (FAA)

Jim Kuchar
MIT Lincoln Laboratory

Dirk Kuegler
German Aerospace Center (DLR)

Bruno Lamiscarre
École Nationale de l'Aviation Civile

Patrick Lelievre
Airbus SAS

Ian Levitt
Federal Aviation Administration (FAA)

Yi Liu
University of California, Berkeley

David Lovell
The University of Maryland

Sandra Lozito
NASA Ames

Natesh Manikoth
Federal Aviation Administration (FAA)

Gaétan Marceau
INRIA Saclay

Ralf H. Mayer
MITRE

Michael McCormack
NASA Langley

Greg McDonald
Airservices Australia

David McNally
NASA Ames

Colin Meckiff
EUROCONTROL

Vineet Mehta
University of Massachusetts Lowell

Bernard Miaillier
EUROCONTROL

Christoph Moehlenbrink
German Aerospace Center (DLR)

Stephane Mondoloni
MITRE

Felipe Moreno-Hines
MITRE

Charles Morris
National Air Traffic Services

Laurence Mutuel
Thales

Alex Nakahara
Northrop Grumman

Eric Neiderman
Federal Aviation Administration (FAA)

Bart Klein Obbink
National Aerospace Laboratory (NLR)

Italo Oliveira
General Electric Global Research

Enric Pastor
Technical University of Catalonia

Justin Pearson
Uppsala University

David Perez
Innaxis

Miquel Àngel Piera Eroles
Universitat Autònoma de Barcelona

Seth Placke
MIT Complex Systems Research Lab

Joseph Post
Federal Aviation Administration (FAA)

Xavier Prats
Technical University of Catalonia

Bo Redeborn
EUROCONTROL

Tom Reynolds
MIT Lincoln Laboratory

Arthur Richards
Bristol University

Emilien Robert
EUROCONTROL

John Robinson
NASA Ames

Melanie Sandberg
MIT Lincoln Laboratory

Sabrina Saunders-Hodge
Federal Aviation Administration (FAA)

Dirk Schaefer
EUROCONTROL

Michael Schultz
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Wolfgang Schuster
Imperial College London

Michael Seelhorst
University of California, Berkeley

Lara Shisler
Mosaic Air Traffic Management

Sofia Souihi
Thales

Banavar Sridhar
NASA Ames

Michael Standar
SESAR Joint Undertaking

Laurel Stell
NASA Ames

Akbar Sultan
NASA Langley

Busyairah Syd Ali
Imperial College London

Norma Taber
MITRE/CAASD

Midori Tanino
Federal Aviation Administration (FAA)

Christine Taylor
MITRE

Thomas Teller
MIT Lincoln Laboratory

Jane Thipphavong
NASA Ames

Terence Thompson
Metron

Sebastian Timar
Saab Sensis

Gonzalo Tobaruela
Imperial College London

Karlin Toner
Joint Planning and Development Office (JPDO)

Savita Verma
NASA Ames

Craig Wanke
MITRE

Mark Weber
MIT Lincoln Laboratory

Jerry Welch
MIT Lincoln Laboratory

David Wing
NASA Langley

Len Wojcik
MITRE

Marilyn Wolfson
MIT Lincoln Laboratory

Christopher Wynnyk
MITRE

Zhao Yifei
National ATM Key laboratory of Operational Safety

Dave Young
EUROCONTROL

Massimiliano Zanin
Innaxis

Andres Zellweger
Aviation Consultant

Bo Zou
University of Illinois at Chicago

Abstracts

Environment and Energy Efficiency — *Session Chair: Jim Hileman*

PAPER # 333: ❖ *Bo Zou* — *University of Illinois at Chicago*

Evaluating Air Carrier Fuel Efficiency and CO2 Emissions in the U.S. Airline Industry

We employ ratio-based, deterministic, and stochastic frontier approaches to investigate fuel efficiency among 15 large jet operators (mainline airlines) in the U.S. Given the hub-and-spoke routing structure and the consequent affiliation between mainline and regional carriers, we consider not only fuel efficiency of individual mainline airlines, but also the joint efficiency of each mainline and its regional subsidiaries, as well as efficiency in transporting passengers from their origins to destinations. We find that: 1) airline fuel consumption is highly correlated with, and largely explained by, the amount of revenue passenger miles and flight departures it produces; 2) depending on the methodology applied, average airline fuel efficiency for the year 2010 is 9-20% less than that of the most efficient carrier, while the least efficient carriers are 25-42% less efficient than the industry leaders; 3) regional carriers have two opposing effects on fuel efficiency of mainline airlines: higher fuel per revenue passenger mile but improved accessibility provision; 4) the net effect of routing circuity on fuel efficiency is small.

PAPER # 301: ❖ *Hamsa Balakrishnan* — *Massachusetts Institute of Technology AeroAstro*

Airport Characterization for the Adaptation of Surface Congestion Management Approaches

Surface congestion management has received increased attention worldwide, largely due to its potential to mitigate operational inefficiencies and environmental impact. Most prior efforts have focused on demonstrations of a proposed congestion management approach at a particular airport, and not on the adaptation of a particular approach to a range of airport operating environments. This paper proposes a methodology for generic adaptation of surface congestion management approaches. Data and case studies from Boston Logan International Airport, New York's LaGuardia Airport and Philadelphia International Airport are used to illustrate the diversity in operating environments. The paper then proposes techniques for characterizing airport surface operations using site surveys and operational data. Finally, it shows how these characterizations can be used for the adaptation of a given congestion management approach to different airports.

PAPER # 292: ❖ *Terence Thompson* — *Metron*

Environmental Impacts of Continuous-descent Operations in Paris and New York Regions: Isolation of ATM/Airspace Effects and Comparison of Models

In order to better understand SESAR and NextGen metrics and models for environmental impact assessment, we analyze the differences in effects of a selected ATM improvement (CDO/CDA) on European and U.S. performance using similar regional data sets and the same analytical methods and models. We have: (1) analyzed one day of traffic for both the Paris (CDG and ORY) and New York regions (LGA, JFK, and EWR); (2) compared the relative benefit pools for reduction of environmental impacts (fuel/CO2, noise, and NOx) in the two regions; (3) estimated the fuel, noise, and air-quality impacts in the two regions using the same modeling techniques; and (4) compared the fuel estimates obtained from 3 different models (NIRS, AEM-III, and IFSET). We find that both absolute and relative CDO/CDA benefits differ substantially for the Paris and New York regions due to significant differences in current traffic intensity, as well as the current distribution of level segments in flight trajectories. The effects estimated focus only on ATM- related trajectory changes, with fleet-composition effects removed from the analysis.

PAPER # 239: ❖ *Volker Grewe* — *German Aerospace Center (DLR)*

Climate Cost Functions as a Basis for Climate Optimized Flight Trajectories

Climate cost functions are a measure for the climate impact of individual aviation emissions in dependency of the emission location, altitude, time and weather situation during emission. To determine the climate change contribution due to an individual emission as function of emission location, altitude and time, four-dimensional climate cost functions are computed. Therefore the ECHAM5/MESSy Atmospheric Chemistry model (EMAC) has been employed. The emitted trace species are transported by means of the Lagrangian advection scheme ATTILA. To evaluate the climate impact from several emission locations and dates within one simulation, a new submodel (AIRTRAC) has been developed. Chemical changes of ozone, methane and water vapor, as well as contrail formation and aging caused by a particular emission are computed directly on air parcels. For each emission location and date, the changes of radiatively active species and the corresponding radiative forcings are computed, from which the climate cost functions are derived. The climate cost functions form the basis for the optimization of air traffic flight trajectories with respect to minimum climate impact. Typical weather situations are considered and differences in climate impact are investigated. The North Atlantic flight corridor is considered for route optimization.

PAPER # 212: ❖ *Banavar Sridhar – NASA Ames*
Energy Efficient Strategies for Reducing the Environmental Impact of Aviation

The main goal of Air Traffic Management (ATM) is to enable safe operation of air traffic while accommodating the demand and doing it efficiently with minimum disruption to schedules. The impact of aircraft emissions on the environment adds an additional dimension to the planning of aircraft operations. This paper describes a new simulation capability to analyze the relationship between air traffic operations and their impact on the environment. This is the first simulation to integrate all air traffic in the US based on flight plans, aircraft trajectory calculations based on predicted wind data, contrail calculations based on predicted temperature and humidity data, a common metric to combine the effects of different types of emissions, and algorithms to generate alternate trajectories for aircraft traveling between city-pairs. The integrated simulation is used to evaluate the energy efficiency of contrail reduction strategies. The aircraft trajectories are varied from their baseline flight plans to reduce contrails in three different ways: changes to altitude, optimal changes to planned route, and three-dimensional change of trajectory. The method is applied to three different scenarios: a single flight between a city-pair, all flights between 12 city-pairs, and all flights in the US airspace. Results for the 12 city-pairs show that contrail reduction involving horizontal route change only is not fuel efficient, the three-dimensional trajectory change produces the best results at a computational cost, and changes to the altitude only produces good results as well as the ability to add airspace capacity constraints. For the scenario of all flights in the US airspace, initial results based on one month data show that contrail reduction strategies involving altitude changes applied to medium and long-range flights on days with high-contrail activity provide the maximum environmental benefit for a small reduction in energy efficiency.

Dynamic Airspace and Capacity Management – *Session Chair: Giovanni Andreatta*

PAPER # 229: ❖ *Jerry Welch – MIT Lincoln Laboratory*
Sector Workload Model for Benefits Analysis and Convective Weather Capacity Prediction

En route sector capacity is determined mainly by controller workload. The operational capacity model used by the Federal Aviation Administration (FAA) provides traffic alert thresholds based entirely on hand-off workload. Its estimates are accurate for most sectors. However, it tends to over-estimate capacity in both small and large sectors because it does not account for conflicts and recurring tasks. Because of those omissions it cannot be used for accurate benefits analysis of workload-reduction initiatives, nor can it be extended to estimate capacity when hazardous weather increases the intensity of all workload types. We have previously reported on an improved model that accounts for all workload types and can be extended to handle hazardous weather. In this paper we present the results of a recent regression of that model using an extensive database of peak traffic counts for all United States en route sectors. The resulting fit quality confirms the workload basis of en route capacity. Because the model has excess degrees of freedom, the regression process returns multiple parameter combinations with nearly identical sector capacities. We analyze the impact of this ambiguity when using the model to quantify the benefits of workload reduction proposals. We also describe recent modifications to the weather-impacted version of the model to provide a more stable normalized capacity measure. We conclude with an illustration of its potential application to operational sector capacity forecasts in hazardous weather.

PAPER # 285: ❖ *Hartmut Fricke – Dresden University of Technology*
Analysis of Airspace Complexity Factors' Capability to Predict Workload and Safety Levels in the TMA

Research on airspace complexity metrics with the aim of characterizing traffic with respect to air traffic controllers' cognitive workload has been ongoing for the last 40years (complex-ity factors, dynamic density). Nevertheless, simplesector load based on aircraft count remains the key planning figure in ATM & ATFM. The proposed complexity factors lack a commonmodel of causation (pre, peri, post controller intervention), which leads to case-specific workload dependencies. Motivated by EUROCON-TROL's research in Single European Sky and recent THALES advances studying the introduction of dynamic density metrics in an operational ATFM environment, this study analyzes the predictive capabilities of complexity metrics towards (1) controller workload and (2) the level of safety (collision risk). By means of average-filtering and time-shifting, a linear prediction model's coefficient of determination was improved significantly. For simulated controller workload, a local optimum is situated at the current timeframe ($r^2 \sim 0.7$). For radar-data based collision risk, the bestprediction looks 130 s into the future ($r^2 \sim 0.5$). This observation is coherent with the findings for simulation-based collision risk (150 s, $r^2 \sim 0.5$).

PAPER # 170: ❖ *Sebastian Timar* – *Saab Sensis*

Assessing the Benefits of NextGen Performance Based Navigation (PBN)

NextGen is the ongoing transformation of air traffic control technologies and procedures in the United States. Two key components of NextGen are Performance Based Navigation (PBN) and the Optimization of Airspace and Procedures in the Metroplex (OAPM). PBN leverages state-of-the-art navigation technologies, such as satellite-based Area Navigation (RNAV) and Required Navigation Performance (RNP), to improve airport access, shorten flight paths, and increase en route efficiency. OAPM is a systematic and expedited approach to implementing PBN procedures and airspace changes. The Federal Aviation Administration (FAA) is seeking to quantify the benefits of Performance Based Navigation (PBN). The approach is to identify all PBN benefit mechanisms, develop explicit models capturing those mechanisms, and conduct simulations to quantify their impacts under representative operating conditions. In support of this effort, we investigated the throughput impact of implementing PBN to mitigate metroplex inefficiencies. Metroplex inefficiencies identified in this study involved individual or multiple airports, typically occurred in the terminal airspace domain, and impacted both departures and arrivals. PBN capabilities included RNAV Standard Instrument Departure (SID) and Standard Terminal Arrival (STAR) procedures, and RNP Approval Required (AR) final approach procedures. The investigation included simulations to evaluate the throughput impacts of RNAV SIDs or STARs in addressing metroplex inefficiencies. We formulated simple, generic queuing system-based models of the baseline SIDs or STARs capturing the inefficiency, and the RNAV SIDs or STARs mitigating the inefficiency. We then extended the models to represent instances in the Northern California metroplex. Results show that RNAV SIDs and STARs demonstrated significant increases in throughput compared with baseline SIDs and STARs, particularly at saturated traffic demand levels. This paper describes the modeling assumptions, methods, and results including the quantitative throughput impacts and their sensitivity to traffic level, traffic distribution, and the in-trail separation minima.

PAPER # 189: ❖ *Ralf Mayer* – MITRE

Operational Demonstration of a Performance-Based Separation Standard at The Hartsfield-Jackson Atlanta International Airport - Implementation and Benefits of Equivalent Lateral Spacing Operation (ELSO) Departures

Performance-Based Navigation (PBN) represents a cornerstone of the Federal Aviation Administration (FAA) Next Generation Air Transportation System (NextGen). Improvements in aircraft navigation precision associated with PBN operations enable the development of advanced spacing concepts that evolve currently applicable separation standards. The Equivalent Lateral Spacing Operation (ELSO) concept was developed to advance the current 15-degree divergence requirement for independent parallel as well as successive departures and enables reduced-divergence departure operations. The concept was first presented at the Ninth ATM Seminar in 2011. The Hartsfield-Jackson Atlanta International Airport (KATL) implemented reduced-divergence Area Navigation (RNAV) departure procedures based on this concept on 20 October 2011. This paper outlines the standard concept and reviews KATL's designs of RNAV ELSO procedures. It also describes the implementation approach taken to demonstrate the standard concept and presents the methodologies developed to characterize associated operational changes and estimate resulting benefits. For the 2011 level of departure demand, the results indicate a net average operator benefit of $44.00 per KATL departure and a net annual operator benefit of $19.2 million at the airport. Successful operational demonstration of the ELSO concept at KATL paves the way for regulatory changes that adopt the concept as a separation standard.

PAPER # 281: ❖ *Thomas Dautermann* – *German Aerospace Center (DLR)*

3D-Precision Curved Approaches: A Cockpit View on ATM

Pre-defined curved approach procedures represent an essential measure for noise abatement and may reduce the risk of controlled flight into terrain (CFIT) for today's aviation considerably. In addition, a Ground Based Augmentation System (GBAS) supports the desired accuracy for the desired flight path. While the lateral guidance during current curved approach procedures is usually based on a position solution provided by satellite navigation systems in conjunction with inertial navigation systems, the vertical guidance is still based on measurements of a barometric altimeter. This type of approach with vertical guidance is supposed to enhance the situational awareness for pilots compared to non-precision approach procedures and reduce the risk for controlled flight into terrain. However, the accuracy of the barometric vertical guidance is inferior compared to precision approach procedures, temperature dependent and requires the correct pressure setting. Therefore, novel curved approach procedures are supposed to rely solely on satellite navigation augmented by either a ground based or satellite based system and only optionally by inertial measurement systems. Such coupled (hybrid INS and GNSS) systems are usually highly integrated and monitored by a flight management system. Therefore, the requirements for the equipment of aircraft that are conducting such approach procedures are very stringent. Using only GBAS could relax those requirements. In this work, an option for precision curved approach procedures was investigated and tested in flight trials. This option is based on a GBAS. In general, different possibilities are imaginable to enable GBAS based curved approaches. For instance, GBAS could only serve as means to enhance the navigation performance to achieve stringent RNP requirements. Alternatively, GBAS could serve as the sole means to enable a curved approach. This option is described in this paper. The option which utilizes the GBAS functionality to broadcast desired (curved) flight paths, the Terminal Area Path (TAP) functionality was investigated in this work. For this, simulator trials were performed to evaluate different means of flying these procedures in terms of guidance displacement sensitivity and means of displaying deviation information. Based on the results of the simulator trials, flight trials were conducted. Results from flight trials are presented in this manuscript to show how this method for conducting curved approaches can be applied.

PAPER # 184: ◈ *Busyairah Ali* – *Imperial College London*
ADS-B: The Case for London Terminal Maneuvering Area (LTMA)

EUROCONTROL in collaboration with various Air Navigation Service Providers (ANSPs) in Europe and in the United Kingdom established the CASCADE program to coordinate the implementation of Automatic Dependent Surveillance Broadcast (ADS-B) applications. In this program, the CRISTAL initiative provides data from validation trials in each country, to test the ADS-B technology in real scenarios where the operational needs exist. The ADS-B system is expected to play a key role to facilitate some of the safety-critical functions envisioned under the future operational concepts, including self-separation and Air Traffic Control based separation with reduced separation minima. ADS-B is a very complex system, highly dependent on the navigation and communication systems. A rigorous, clear and comprehensive assessment method is required to ensure that it is safe to operate in any particular context. This paper proposes a comprehensive framework to evaluate ADS-B data (from the NATS CRISTAL project) to determine its capability to meet the accuracy, integrity, latency, availability and update rate requirements to support the relevant safety-critical applications. In the proposed framework, the Global Positioning System (GPS) data from the aircraft navigation system are used as the reference data to validate ADS-B data accuracy as recorded by ground stations. The framework begins by decoding both sets of data (ADS-B and GPS) into the ASCII format. Both sets are then correlated based on the time and horizontal position, the most challenging task in the data evaluation process. The performance evaluation is carried out in terms of accuracy, integrity, latency, availability and update rate. The results show that 66.7% of the aircraft meet the requirement to support 3NM separation with horizontal position error less than 150 meters while the update rate analysis shows an inconsistent value for majority of the aircraft assessed. The key challenges in this analysis and errors identified in each dataset are also discussed in this paper.

Finance & Policy – *Session Chair: Natesh Manikoth*

PAPER # 326: ◈ *Lu Hao* – *University of California, Berkeley*
How Airlines Set Scheduled Block Times

Scheduled block time (SBT) setting is a crucial part in airlines' scheduling. Interviews with the airline and relevant work in ground transportation have shown that SBT and the historical block time distribution have a close relationship. A better understanding of this relationship is a major goal for the FAA and the airlines because the benefits includes less cost, more efficient operations and better performance in the National Airspace System. This paper investigates this relationship with empirical data and multiple regression models. The historical block time information is aggregated to individual flight level to keep track of the performance of the flight over a time period. The distribution of the flight time for a flight is depicted by the difference between every 10th percentiles. We found that departure delay plays a minor role in setting scheduled block-time, and that SBTs have decreasing sensitivity to historical flight times towards the right tail of the distribution. Airlines tend to act "optimistically" and are willing to experience delays in trade of a shorter SBT. We also include OD pair information in the model and found longer SBT is set for larger airports, as padding for busy traffic. Taking the heterogeneity in the behavior across airlines into consideration, we further decompose the dataset to study specific airlines. The historical flight time distribution has similar effect on SBT for different airlines, and low cost carriers tend to set a shorter SBT than legacy carriers. For legacy carriers, we found that American Airlines values level of service provided the most, whereas United Airlines has a really aggressive behavior to cut SBT. Legacy carriers also set a shorter SBT for flights between their own hubs, to avoid the disruption of early arrivals.

PAPER # 226: ◈ *Felipe Moreno-Hines* – *MITRE*
Assessing the NextGen Avionics Business Case from the Airline Perspective: The Implications of Airline Responses to Changes in Operational Performance

The Next Generation Air Transportation System (NextGen) is expected to improve flight efficiency in the National Airspace System (NAS). However, some of these benefits will only be realized at the pace with which operators equip their fleets with the required enabling avionics. To accurately assess the prospects of voluntary equipage, policymakers must understand the value of NextGen improvements as seen from the airlines' perspective. Traditional cost-benefit valuation methods are not well suited for providing this perspective. The MITRE Corporation (MITRE) conducted research to better understand how airlines perceive NextGen, and how they internalize changes in flight performance in their operations. This understanding was pursued through interviews with airline managers and with regression analysis of historical airline operational data. We observe the pervasiveness of block time management in response to operational changes for a subset of airlines, and the impact of this response on various aspects of airline operations. The results of this research will be used to incorporate airline response into operational modeling and benefit valuation methodologies.

PAPER # 237: ◈ *Miwa Hayashi* – *NASA Ames*

Usability Evaluation of the Spot and Runway Departure Advisor (SARDA) Concept in a Dallas/Fort Worth Airport Tower Simulation

Spot and Runway Departure Advisor (SARDA) is a decision-support tool proposed to aid air traffic control tower controllers in reducing taxi delay and optimizing the runway sequence. The purpose of the present paper was to evaluate the tool's usability to ensure that its claimed performance benefits are not being realized at the cost of increasing the work burden on controllers. The study analyzed workload ratings and questionnaire responses collected during a human-in-the-loop simulation experiment and assessed the effects of the SARDA advisories on the controllers' cognitive resources (e.g., workload, spare attention) and satisfaction. The results showed that SARDA reduced the controllers' workload and increased their perceived spare attention. SARDA also made workload and attention levels less susceptible to the effects of increases in the traffic load. The questionnaire responses suggested that the controllers generally were satisfied with the ease of use of the tool and the intended benefits of the SARDA concept, but with slight reservations. Sharing high-level reasoning behind SARDA's optimization process with the controllers may help the concept to gain more trust from them.

PAPER # 222: ◈ *Charles Morris* – *National Air Traffic Services*

Validation of the Time Based Separations Concept at London Heathrow Airport

Headwind conditions on final approach cause a reduction in the landing rate which impacts not only the achieved capacity, but also the predictability of operations, time and fuel efficiency, and the environment (emissions). The ground speed reduction in headwind conditions results in an increase in the time spacing between each arrival pair for distance-based separations. The Time Based Separation (TBS) concept changes the separation rules on final approach from distance based to time based to stabilize the time spacing between arrival pairs across headwind conditions in order to recover the lost landing rate currently experienced. This paper presents the key results of the final research phase of the validation of the TBS concept. This validation has been conducted in the framework of the SESAR Development phase project P06.08.01 Flexible and Dynamic Use of Wake Turbulence Separations. The work in P06.08.01 started in 2010 and is about to be finalized in February 2013 achieving pre-industrial development (V3) maturity level. The project has developed and assessed both the generic TBS concept and a local adaptation of the concept to the London Heathrow operating environment. The scope of this paper is focused on the validation of the concept for London Heathrow (LHR) airport covering the real-time simulation results and the wake turbulence safety data analysis results.

PAPER # 193: ◈ *Maik Friedrich* – *German Aerospace Center (DLR)*

Which data provide the best insight? A field trial for validating a remote tower operation concept

This paper describes the validation of a Remote Tower Control workplace. The study shows how Air Traffic Control Officers (ATCOs) observe traffic from a Tower Control Working Position at Airport Erfurt-Weimar (ERF) in comparison to a Remote Controller Working Position. The validation exercise targets low traffic density airports. Shadow-mode trials were used to cover perceptual, operational and human factors aspects of a Remote Tower System, including a live video panorama and a German Aerospace Center (DLR) research aircraft. The aircraft was used to fly different maneuvers within the aerodrome. These maneuvers allow insights on the detectability of an aircraft within different distances from the tower and the gathering of operation information about an aircraft status. In addition, a Deutsche Flugsicherung (DFS) vehicle was used to position static objects on the airfield to determine the detectability of these objects for different distances to the Control Tower (RTO-camera system). Eight ATCOs from the DFS participated in the validation exercise. Time-synchronized questionnaires for the controller working position remote (CWP-remote) and the controller working position tower (CWP-tower) were applied, addressing operational relevant questions to the ATCOs. The results reveal that the information sources play a different role at the CWP-remote than for the CWP-tower. The results are discussed taking performance and subjective data into consideration. Further, the implications for the consolidation of functional requirements and system specifications for a future remote tower system are worked out.

PAPER # 208: ◈ *Lynne Martin* – *NASA Ames*

An Investigation of Flight Deck Data Link in the Terminal Area

Abstract— The Next Generation Air Transportation System (NextGen) and Europe's Single European Sky ATM Research (SESAR) concepts require an increased use of trajectory-based operations, including extensive strategic air traffic control clearances. The clearances can be lengthy and complex, which necessitates data link communications to allow for message permanence and integration into the autoflight systems (i.e., "autoload" capability). This paper examines the use of flight deck data link communications for strategic and tactical clearance usage in the terminal area. A human-in-the-loop simulation was conducted using a high-fidelity flight deck simulator, with ten commercial flight crews as participants. Data were collected from six flight scenarios in the San Francisco terminal airspace. The variables of interest were ATC message modality (voice v. data link), temporal aspect of the message (tactical v. strategic) and message length. Dependent variables were message response times, communication clarifications, communication-related errors, and pilot workload. Response time results were longer in data link compared to voice, a finding that has been consistently revealed in a number of other simulations [1]. In addition, strategic clearances and longer messages resulted in a greater number of clarifications and errors, suggesting an increase in uncertainty of message interpretation for the flight crews when compared to tactical clearances. The implications for strategic and compound clearance usage in NextGen and SESAR are discussed.

PAPER # 215: ◈ *Savita Verma* – *NASA Ames*

Human Factors Evaluation of Conflict Detection Tool for Terminal Area

A conflict detection and resolution tool¬, Terminal-area Tactical Separation-Assured Flight Environment (T- TSAFE), is being developed to improve the timeliness and accuracy of alerts and reduce the false alert rate observed with the currently deployed technology. The legacy system in use today, Conflict Alert, relies primarily on a dead reckoning algorithm, whereas T-TSAFE uses intent information to augment dead reckoning. In previous experiments, T-TSAFE was found to reduce the rate of false alerts and increase time between the alert to the controller and a loss of separation over the legacy system. In the present study, T-TSAFE was tested under two meteorological conditions, 1) all aircraft operated under instrument flight regimen, and 2) some aircraft operated under mixed operating conditions. The tool was used to visually alert controllers to predicted Losses of separation throughout the terminal airspace, and show compression errors, on final approach. The performance of T-TSAFE on final approach was compared with Automated Terminal Proximity Alert (ATPA), a tool recently deployed by the FAA. Results show that controllers did not report differences in workload or situational awareness between the T-TSAFE and ATPA cones but did prefer T-TSAFE features over ATPA functionality. T-TSAFE will provide one tool that shows alerts in the data blocks and compression errors via cones on the final approach, implementing all tactical conflict detection and alerting via one tool in TRACON airspace.

PAPER # 192: ◈ *Hartmut Helmke* – *German Aerospace Center (DLR)*

Increased Acceptance of Controller Assistance by Automatic Speech Recognition

Situation awareness of today's automation relies on sensor information, data bases and the information delivered by the operator using an appropriate HMI. The situation is mostly influenced by voice communications between controller and pilots. Hence, voice communication is an important part for the human operator to implement his plans. Voice communication runs independent and in parallel to the process the automation performs to understand the situation. Therefore, the automation, specifically the support system, is not aware of agreements between human operators. Even worse, the operators have additional effort to inform the support systems about their communication, i.e. their intents. This additional effort can be avoided by using automatic speech recognition systems (ASR). Nowadays, ASR is used in many applications, e.g. Siri® in Apple's iPhone®. This paper focuses on the integration of ASR with DLR's arrival manager 4D-CARMA. ASR improves situation awareness of both assistant system and controller. As the controller is responsible for his advisories he sometimes deviates from the recommendations of the automation. The automation often needs at least 40 seconds until it recognizes the deviations from the plan if radar data is available only. Trials performed at DLR's Institute of Flight Guidance have shown that ASR can reduce this deviation time of an Arrival Manager (AMAN) by approx. 90% down to 5 seconds.j As a side-effect, the combination of ASR and AMAN also improves the performance of ASR. The AMAN provides context information about the current and estimated future situations. It creates hypotheses on controller intents and predicts which advisories the controller will probably transmit via voice. First trials have shown that this approach can reduce the word error rate by up to 80%. This can foster the use of ASR in ATM.

PAPER # 246: ◈ *Hussein Abbass* – *The University of New South Wales (Australian Defence Force Academy)*

Computational Red Teaming for Correction of Traffic Events in Real Time Human Performance Studies

In human performance studies using real-time air traffic simulation, the human performance analyst faces challenges to ensure that certain events and scenario characteristics will occur during the experiments. While some events, such as specific categories of conflicts, can be designed in the scenario, the interaction of the humans can undo these events early in the simulation. This poses a challenge and the objective of the experiment can become difficult to meet. Computational Red Teaming (CRT) is a computational environment that attempts to play devil advocates. A CRT is designed and used in this paper to monitor, re-steer and adjust traffic events in these real-time air-traffic simulation environments. The approach was able to correct events successfully, when possible. In situations were the time to correct events is greater than the time remaining for the experiments or when the constraints of the scenario do not allow certain steering requests to be issued or accepted, those events can't be recreated. Therefore, analysts are advised to avoid designing events closer to the end of the session to allow for the CRT to take corrective actions if the session does not evolve as planned.

ATM as a Complex System – *Session Chair: Midori Tanino*

PAPER # 255: ◈ *Ian Levitt* – *Federal Aviation Administration (FAA)*

Modeling Delivery Accuracy for Metering Operations to Support RNAV Arrivals

Interval Management (IM) is a future airborne spacing concept that aims to provide more precise inter-aircraft spacing to yield throughput improvements and greater use of fuel-efficient trajectories in arrival and approach environments. To participate in an IM operation, an aircraft must be equipped with avionics that provide speeds to achieve and maintain a desired spacing interval relative to another aircraft. It is not expected that all aircraft will be equipped with the necessary avionics, but rather that IM fits into a larger arrival management concept developed to support the broader mixed-equipage environment. Arrival management concepts are comprised of three parts: a ground-based sequencing and scheduling function to develop an overall arrival strategy, ground-based tools to support the management of aircraft to that schedule, and the IM tools necessary for the IM operation (i.e., ground-based set-up, initiation, and monitoring, and the flight-deck tools to conduct the IM operation). The Federal Aviation Administration is deploying a near-term ground-automation system to support metering operations in the National Airspace System, which fall within the first two components of the arrival management concept. The near-term system will include sequencing and scheduling functions and tools to help air traffic controllers in managing aircraft to meet their scheduled times of arrival (STAs) at meter points. This paper presents a methodology for determining the required delivery accuracy at the meter points in order to achieve desired flow rates, adequate separation at the meter points, and to enable aircraft to meet their STAs while remaining on their RNAV arrivals, which will reduce costly vectoring and holding. An example based on operations at Phoenix airport is presented to illustrate the analysis framework in a real-world context.

PAPER # 288: ◈ *Pablo Fleurquin* – *Institute for Cross-Disciplinary Physics and Complex Systems*

Data-driven Modeling of Systemic Delay Propagation Under Severe Meteorological Conditions

The upsetting consequences of weather conditions are well known to any person involved in air transportation. Still the quantification of how these disturbances affect delay propagation and the effectiveness of managers and pilots interventions to prevent possible large-scale system failures needs further attention. In this work, we employ an agent-based data-driven model developed using real flight performance registers for the entire US airport network and focus on the events occurring on October 27 2010 in the United States. A major storm complex that was later called the 2010 Superstorm took place that day. Our model correctly reproduces the evolution of the delay-spreading dynamics. By considering different intervention measures, we can even improve the model predictions getting closer to the real delay data. Our model can thus be of help to managers as a tool to assess different intervention measures in order to diminish the impact of disruptive conditions in the air transport system.

PAPER # 342: ◈ *Travis Gaydos* – MITRE

Analysis of Conflict Detection Performance for Trajectory-Based Descent Operations

The evolution of time-based metering introduces greater amounts of Trajectory-Based Operations (TBO) in order to improve meter fix delivery accuracy and flight efficiency. Many TBO concepts have been proposed to yield those benefits; among them is the Three-Dimensional Path Arrival Management (3D PAM) concept of operations. 3D PAM operations are accomplished via ground-based automation that provides speed and path advisories to assist controllers in meeting the meter schedule. On-board capabilities enable pilots to accept and efficiently execute the advisory-based clearance. The result is an increased amount of near-idle thrust descent operations and increased use of closed-loop clearances (with full availability of the speed profile and path for each flight). However, these changes, as beneficial as they are, impact how operations are predicted today by fielded en route medium-term conflict detection support capabilities (i.e., time horizon of 3 to 20 minutes). In order to be effective, the current conflict detection automation must be adapted to best support controllers. This paper describes an analysis completed to determine the performance of fielded en route medium-term conflict detection capabilities given these TBO operations and how it may be better adapted via parameter changes. Results show that parameter changes alone will not provide an acceptable level of conflict detection performance due to a high number of false alerts. While more complex changes, in terms of implementation, are less desirable, they may be needed in order to provide an acceptable level of conflict detection performance, with respect to missed and false alerts, for a 3D PAM operations environment as well as for other TBO concepts of operation.

PAPER # 263: ◈ *Massimiliano Zanin* – *Innaxis*

Synchronization Likelihood in Aircraft Trajectories

In the continuous effort for ensuring increasing levels of safety, it is of utmost importance to understand the reasons behind the occurrence of operational errors. In this contribution, we propose the use of the Trajectory Synchronization Likelihood metric for the analysis of two types of events: situations resulting in a reduced separation between aircrafts, and situations that might have resulted in similar conditions but were solved on time. Results indicate that unsolved events are associated with highly synchronized pairs of aircraft, which have been deviated from the usual expected trajectories. This opens new way for the development of more effective automated safety systems, capable of detecting in real time events that are known to have a high probability of resulting in a conflict.

PAPER # 177: ❖ *Lara Shisler* – *Mosaic Air Traffic Management*

An Operational Evaluation of the Ground Delay Program Parameters Selection Model (GPSM)

The results of an operational evaluation of an Air Traffic Management (ATM)-Weather integrated tool, the Ground Delay Program (GDP) Parameters Selection Model (GPSM), are presented. A shadow evaluation was conducted in 2011, followed by an operational evaluation in 2012. The execution of these evaluations required collaboration and joint support across various agencies and organizations, including the National Aeronautics and Space Administration (NASA), the Federal Aviation Administration (FAA), the National Weather Service (NWS), Mosaic ATM, and MIT Lincoln Laboratory, along with the participation of the National Airspace System (NAS) user community. The shadow evaluation in 2011 showed that ground delays issued during the initial GDP could have been reduced by 20% if GPSM's recommendations had been used operationally. These promising results led to an operational evaluation the following year. Despite challenges related to unexpected weather patterns, weather sensor outages, and slow user acceptance, analytical results show that GPSM provided benefits when used in operational decision making. On days where GPSM recommendations were closely followed, ground delays were on average 20% lower relative to days where recommendations were not followed, consistent with expectations set in 2011. The gap between planned and observed arrival rates fell by 29% relative to the preceding three years.

PAPER # 232: ❖ *David McNally* – *NASA Ames*

Operational Evaluation of Dynamic Weather Routes at American Airlines

Dynamic Weather Routes (DWR) is a search engine that continuously and automatically analyzes in-flight aircraft in en route airspace and proposes simple route amendments for more efficient routes around convective weather while considering sector congestion, traffic conflicts, and active Special Use Airspace. NASA and American Airlines (AA) are conducting an operational trial of DWR at the AA System Operations Center in Fort Worth, Texas. The trial includes only AA flights in Fort Worth Center airspace. Over the period from July 31, 2012 through October 31, 2012, 45% of routes proposed by DWR and evaluated by AA users, air traffic control coordinators and flight dispatchers, were rated as acceptable as proposed or with some modifications. The wind-corrected potential flying time savings for these acceptable routes totaled 470 flying min. DWR identified reroutes offering an additional 4,066 min of potential flying time savings for AA flights, but these routes were not evaluated due to staffing limitations. A sector congestion analysis shows that in only three out of 83 DWR routes rated acceptable by AA staff were the flights predicted to fly through a congested sector inside of 30 min downstream of present position. This shows that users considered sector congestion data provided by DWR automation and in nearly all cases did not accept routes through over-capacity sectors.

PAPER # 211: ❖ *Emilien Robert* – *EUROCONTROL*

Comparison of Operational Wind Forecasts with Recorded Flight Data

The behavior of an aircraft adjusting its speed in order to meet a Required Time of Arrival at a given fix in its flight plan strongly depends on the accuracy of the predicted time of arrival at that fix. Thus, assessing the accuracy of such predictions is a key element in the research on time based operations in Air Traffic Management. The accuracy of a predicted Time of Arrival at a given fix will depend on the weather forecast that is available in the cockpit. For thousands of flights over a one year period, the forecasted winds that were uplinked from the ground to the aircraft have been compared with the winds measured by the aircraft. Given the large number of flights, a statistical approach was possible and the distributions (standard deviations and mean values) of the wind speed difference, wind direction difference and resulting groundspeed difference were computed. Additionally, results have been analyzed from two different perspectives. First, a waypoint-based analysis has been performed for which the statistics have been computed for all the waypoints of all the flights. The impact of different elements, e.g. flight of phase, wind magnitude, waypoint altitude, season, aircraft tail number and forecast latency has been assessed. It seems that the wind magnitude and the forecast latency are the main drivers. Secondly, a trajectory-based analysis has been performed for which the data along a complete descent profile has been averaged for each flight, to obtain an idea of the impact of the wind forecasts on the average ground speed uncertainty during descent. This analysis has shown that the difference in average ground speed during descent that would result from applying the measured winds instead of the forecasted winds in the trajectory computations, is below 12 knots for 95% of the time.

PAPER #169: ❖ *Jane Thipphavong* – *NASA Ames*

Evaluation of the Controller-Managed Spacing Tools, Flight-deck Interval Management and Terminal Area Metering Capabilities for the ATM Technology Demonstration #1

NASA has developed a suite of advanced arrival management technologies combining time-based scheduling with controller- and flight deck-based precision spacing capabilities that allow fuel-efficient arrival operations during periods of high throughput. An operational demonstration of these integrated technologies, i.e., the ATM Technology Demonstration #1 (ATD-1), is slated for 2016. Human-in-the-loop simulations were conducted to evaluate the performance of the ATD-1 system and validate operational feasibility. The ATD-1 system was found to be robust to scenarios with saturated demand levels and high levels of system delay. High throughput, 10% above baseline demand levels, and schedule conformance less than 20 seconds at the 75th percentile were achievable. The flight-deck interval management capabilities also improved the median schedule conformance at the final approach fix from 5 to 3 seconds with less variance.

PAPER #245: ❖ *Paul Diffenderfer* – *MITRE*

Automated Integration of Arrival/Departure Schedules

At airports where there is a dependency between arrival and departure operations, existing procedures often result in inefficient coordination between the arriving and departing flights, compromising airport throughput. With two key changes the throughput can be improved without affecting safety: integrating the arrival and departure streams and increasing communication between the Tower and the Terminal Radar Approach Control (TRACON). The airports include those that conduct arrival and departure operations to crossing or converging runways, or conduct same runway operations such as Ronald Reagan Washington National Airport (KDCA) or London's Gatwick Airport (EGKK). Typically at these types of airports, a static interval is set between arriving flights so that the airport's Tower Controller can depart aircraft in the gaps. The static interval is maintained even without any waiting departures and is usually adjusted only with verbal coordination between the Tower and TRACON. At these airports, throughput can be improved by providing dynamic spacing guidance to Approach Controllers that accounts for the departure queue. The MITRE Corporation's Center for Advanced Aviation System Development (CAASD) is investigating methods to provide automated arrival spacing guidance. A research prototype called the Automated Integration of Arrival/Departure Schedules provides automated arrival spacing guidance for Approach Controllers. The guidance communicates arrival intervals depending on the type and order of departure aircraft queued at or taxiing to the dependent runway. It provides an indication to use minimum arrival spacing when there are no queued departures. MITRE has conducted fast-time and Human-in-the-Loop (HITL) simulations to assess the feasibility of this solution in terms of adherence to spacing guidance and workload impacts. Controllers achieved a high level of conformance to guidance and workload levels were within a safe range. This paper reviews the shortfalls of relevant current operations, the proposed solution and prototype, and presents preliminary results of MITRE's simulation.

PAPER #274: ❖ *Todd Callantine* – *San Jose State University*

Simulations of Continuous Descent Operations with Arrival-Management Automation and mixed Flight-Deck Interval Management Equipage

Air traffic management simulations conducted in the Airspace Operations Laboratory at NASA Ames Research Center have addressed the integration of trajectory-based arrival-management automation, controller tools, and Flight-Deck Interval Management avionics to enable Continuous Descent Operations (CDOs) during periods of sustained high traffic demand. The simulations are devoted to maturing the integrated system for field demonstration, and refining the controller tools, clearance phraseology, and procedures specified in the associated concept of operations. The results indicate a variety of factors impact the concept's safety and viability from a controller's perspective, including en-route preconditioning of arrival flows, useable clearance phraseology, and the characteristics of airspace, routes, and traffic-management methods in use at a particular site. Clear understanding of automation behavior and required shifts in roles and responsibilities is important for controller acceptance and realizing potential benefits. This paper discusses the simulations, drawing parallels with results from related European efforts. The most recent study found en-route controllers can effectively precondition arrival flows, which significantly improved route conformance during CDOs. Controllers found the tools acceptable, in line with previous studies.

PAPER #299: ❖ *David Wing* – *NASA Langley*

Pilot and Controller Evaluations of Separation Function Allocation in Air Traffic Management

Two human-in-the-loop simulation experiments were conducted in coordinated fashion to investigate the allocation of separation assurance functions between ground and air and between humans and automation. The experiments modeled a mixed-operations concept in which aircraft receiving ground-based separation services shared the airspace with aircraft providing their own separation service (i.e., self-separation). Ground-based separation was provided by air traffic controllers without automation tools, with tools, or by automation with controllers in a managing role. Airborne self-separation was provided by airline pilots using self-separation automation enabled by airborne surveillance technology. The two experiments, one pilot-focused and the other controller-focused, addressed selected key issues of mixed operations: the impact of mixed operations on controller performance at four stages of NextGen implementation and the limits to which pilots with automation tools could take full responsibility for separation from ground-controlled aircraft. Results indicate that the presence of self-separating aircraft had little

impact on the controllers' ability to provide separation services for ground-controlled aircraft. Performance was best in the most automated environment in which all aircraft were data communications equipped, ground-based separation was highly automated, and self-separating aircraft had access to trajectory intent for all aircraft. In less automated environments, reduced trajectory intent exchange and manual air traffic control limited safely achievable throughput and negatively impacted the maneuver efficiency of self-separating aircraft through high-density airspace. Flight crews of self-separating aircraft prevented separation loss in all conflicts with detection time greater than one minute. Pilots indicated a preference for at least five minute's alerting notice and trajectory intent information on all aircraft. When ground-managed aircraft intent was available, self-separating aircraft benefited from fewer conflict alerts and fewer required deviations from trajectory-based operations.

PAPER #249: ◈ *Laurence Mutuel – Thales*

Initial 4D Trajectory Management Concept Evaluation

Results are presented from the evaluation of Initial 4D (I4D) Trajectory Management concept developed under the Single European Sky ATM Research (SESAR) framework as a key feature associated with the first step towards the SESAR target concept named "Time-Based Operations". The objective of this first step is to synchronize trajectory information between Air Traffic Control (ATC) (Controllers and their supporting automation) and Aircrafts (Flight Crews and their supporting aircraft avionics) so that the arrival sequence can be optimized. The shared common view of the trajectory is translated into an agreed 3D route and a time constraint. The implementation of the I4D concept is distributed over aircraft avionics systems and ATM automation systems across navigation and communication domains. The I4D first flight trial was performed on 10 February 2012 following a series of activities in simulator to assess the concept and prepare all actors for the flight. The Airbus A320 Test Aircraft took off from Toulouse-Blagnac airport (France) to Stockholm Arlanda (Sweden) and tested all I4D key elements over six flight legs. The avionics modifications included an advanced Flight Management System (FMS), a onboard digital communication unit and the cockpit displays; ATM automation systems supported Ground-Ground coordination among the relevant Air Navigation Service Providers (ANSPs) and integrated down-linked aircraft trajectory information. Avionics interoperability was tested through the use of two independently developed FMS. The technical and operational feasibility of the concept was demonstrated from both the crew and the controllers standpoints. In addition, key performance requirements such as tolerance on the mutually agreed time constraint were met with a significant margin on all legs where it was applied. The analysis of the validation exercise led to the publication of a series of recommendations for the improvement of the concept and the evolution of the systems, identifying further investigations to be performed in flight test or simulation and highlighting short-term actions to be taken in datalink communication and navigation standardization groups.

PAPER #349: ◈ *Michael McCormack – NASA Langley*

Feasibility of a Networked Air Traffic Infrastructure Validation Environment for Advanced NextGen Concepts

Next Generation Air Transportation System (NextGen) applications reliant upon aircraft data links such as Automatic Dependent Surveillance-Broadcast (ADS-B) offer a sweeping modernization of the National Airspace System (NAS), but the aviation stakeholder community has not yet established a positive business case for equipage and message content standards remain in flux. It is necessary to transition promising Air Traffic Management (ATM) Concepts of Operations (ConOps) from simulation environments to full-scale flight tests in order to validate user benefits and solidify message standards. However, flight tests are prohibitively expensive and message standards for Commercial-off-the-Shelf (COTS) systems cannot support many advanced ConOps. It is therefore proposed to simulate future aircraft surveillance and communications equipage and employ an existing commercial data link to exchange data during dedicated flight tests. This capability, referred to as the Networked Air Traffic Infrastructure Validation Environment (NATIVE), would emulate aircraft data links such as ADS-B using in-flight Internet and easily-installed test equipment. By utilizing low-cost equipment that is easy to install and certify for testing, advanced ATM ConOps can be validated, message content standards can be solidified, and new standards can be established through full-scale flight trials without necessary or expensive equipage or extensive flight test preparation. This paper presents results of a feasibility study of the NATIVE concept. To determine requirements, six NATIVE design configurations were developed for two NASA ConOps that rely on ADS-B. The performance characteristics of three existing inflight Internet services were investigated to determine whether performance is adequate to support the concept. Next, a study of requisite hardware and software was conducted to examine whether and how the NATIVE concept might be realized. Finally, to determine a business case, economic factors were evaluated and a preliminary cost-benefit analysis was performed.

Trajectory and Queue Management – *Session Chairs: Eric Hoffman, Miquel Àngel Piera Eroles*

PAPER # 233: ❖ *Laurel Stell* – *NASA Ames*

Regression Analysis of Top of Descent Location for Idle-thrust Descents

In this paper, multiple regression analysis is used to model the top of descent (TOD) location of user-preferred descent trajectories computed by the flight management system (FMS) on over 1000-commercial flights into Melbourne, Australia. In addition to recording TOD, the cruise altitude, final altitude, cruise Mach, descent speed, wind, and engine type were also identified for use as the independent variables in the regression analysis. Both first-order and second-order models are considered, where cross-validation, hypothesis testing, and additional analysis are used to compare models. This identifies the models that should give the smallest errors if used to predict TOD location for new data in the future. A model that is linear in TOD altitude, final altitude, descent speed, and wind gives an estimated standard deviation of 3.9-nmi for TOD location given the trajectory parameters, which means about 80\% of predictions would have error less than 5-nmi in absolute value. This accuracy is better than demonstrated by other ground automation predictions using kinetic models. Furthermore, this approach would enable online learning of the model. Additional data or further knowledge of algorithms is necessary to conclude definitively that no second-order terms are appropriate. Possible applications of the linear model are described, including enabling arriving aircraft to fly optimized descents computed by the FMS even in congested airspace.

PAPER # 350: ❖ *Mohammad Ghasemi Hamed* – *École Nationale de l'Aviation Civile (ENAC)*

Statistical Prediction of Aircraft Trajectory: Regression Methods vs Point-mass Model

Ground-based aircraft trajectory prediction is a critical issue for air traffic management. A safe and efficient prediction is a prerequisite for the implementation of automated tools that detect and solve conflicts between trajectories. Moreover, regarding the safety constraints, it could be more reasonable to predict intervals rather than precise aircraft positions. In this paper, a standard point-mass model and statistical regression method is used to predict the altitude of climbing aircraft. In addition to the standard linear regression model, two common non-linear regression methods, neural networks and Loess are used. A dataset is extracted from two months of radar and meteorological recordings, and several potential explanatory variables are computed for every sampled climb segment. A Principal Component Analysis allows us to reduce the dimensionality of the problems, using only a subset of principal components as input to the regression methods. The prediction models are scored by performing a 10-fold cross-validation. Statistical regression results method appears promising. The experiment part shows that the proposed regression models are much more efficient than the standard point-mass model. The prediction intervals obtained by our methods have the advantage of being more reliable and narrower than those found by point-mass model.

PAPER # 217: ❖ *Stephane Mondoloni* – *MITRE*

Improved Trajectory Information for the Future Flight Planning Environment

The impact on ATM performance of improved trajectory-related information exchange was determined. This was first evaluated on trajectory prediction accuracy with a follow-on impact on conflict detection and resolution and flow management performance. The trajectory prediction model was validated against operational data to ensure validity of the impact of variability in parameters. The distinction between pre- and post-clearance trajectories enabled an assessment of the impact of open versus closes clearances. Uncertainty was shown to be reducible to one-third of present levels with closed clearances and improved data exchange. Normalized conflict detection performance was sensitive to the transitioning state of flights, significantly more than to airspace. Resulting improvements in resolution were shown to reduce conflict-induced perturbations by up to 3.5 nautical miles per flight hour. The combined reduction in uncertainty and conflict-induced perturbations were evaluated against alternative TFM strategies. An example illustrated reductions in fuel of 60 pounds per flight, 2.2 minutes of ground delay and 50 seconds of airborne delay per flight.

PAPER # 198: ❖ *Richard Alligier* – *École Nationale de l'Aviation Civile (ENAC)*

Ground-based Estimation of the Aircraft Mass, Adaptive vs. Least Squares Method

This paper focuses on the estimation of the aircraft mass in ground-based applications. Mass is a key parameter for climb prediction. It is currently not available to ground-based trajectory predictors because it is considered a competitive parameter by many airlines. There is hope that the aircraft mass might become widely available someday, but in the meantime it is possible to estimate an equivalent mass from the data already available, assuming the thrust to be known (maximum climb thrust for example). In this paper, we compare the performances of two mass estimation methods proposed in recent publications. Both methods estimate the aircraft mass by fitting the modeled energy rate (i.e. the power of the forces acting on the aircraft) with the energy rate observed at several points of the past trajectory. The first method, proposed by Schultz et al., dynamically adjusts the weight parameter so as to fit the energy rate, using an adaptive sensitivity parameter to weight each observation. The second method, introduced in one of our previous publications, estimates the mass by minimizing the quadratic error on the observed energy rate, taking advantage of the polynomial expression of the modeled power when using the BADA model. The robustness of both methods to the observation errors is assessed, using simulated data with various distributions of the noise added to the observed state variables. The results show that both methods are able to find mass estimates that are very close to the "actual" mass, with slightly better performances for the least squares method.

PAPER # 182: ❖ *Christopher Wynnyk* – *MITRE*
2011 Trajectory Based Operations Flight Trials

This paper presents findings from the Federal Aviation Administration (FAA) 2011 Trajectory Based Operations (TBO) flight trials, performed November 30, 2011 to December 22, 2011 at Seattle-Tacoma International Airport (KSEA). The flight trials evaluated the operational concept of meeting metering times into the terminal area using the Required Time-of-Arrival (RTA) function available in modern Flight Management Systems (FMSs). The trial objectives were to test the concept on a large scale, streamline the process of assigning an RTA, and facilitate an in-depth evaluation of the utility of RTA as a flow management tool for Air Traffic Control (ATC)and operators. Findings show that the Boeing 737 Next Generation (B737NG) aircraft equipped with GE Aviation FMSs are capable of meeting the technical performance expectations of RTA. A total of 833 Alaska Airline (ASA) revenue flights participated in the trials, with 595 aircraft (71%) executing an RTA to completion, and 575 of those 595 (96.6%) arriving within a 30 second tolerance. The trials identify several areas where additional research, standardization, and automation enhancements are needed for RTA to be operationally viable.

PAPER # 242: ❖ *David De Smedt* – *EUROCONTROL*
Controlled Time of Arrival Feasibility Analysis

Previous research studies and operational trials have shown that using the airborne Required Time of Arrival (RTA) function, an aircraft can individually achieve an assigned time to a metering or merge point accurately. This study goes a step further and investigates the application of RTA to a real sequence of arriving aircraft into Melbourne Australia. Assuming that the actual arrival times were Controlled Time of Arrivals (CTAs) assigned to each aircraft, the study examines if the airborne RTA solution would work. Three scenarios were compared: a baseline scenario being the actual flown trajectories in a two hour time-span into Melbourne, a scenario in which the sequential landing slot times of the baseline scenario were assigned as CTAs and a third scenario in which the landing slots could be freely redistributed to the inbound traffic as CTAs. The research found that pressure on the terminal area would sometimes require aircraft to lose more time than possible through the RTA capability. Using linear holding as an additional measure to absorb extensive delays, up to 500NM (5%) of total track reduction and 1300kg (3%) of total fuel consumption could be saved in the scenario with landing slots freely distributed as CTAs, compared to the baseline scenario. Assigning CTAs in an arrival sequence requires the ground system to have an accurate trajectory predictor to propose additional delay measures (path stretching, linear holding) if necessary. Reducing the achievable time window of the aircraft to add control margin to the RTA function, had a negative impact and increased the amount of intervention other than speed control required to solve the sequence. It was concluded that the RTA capability is not a complete solution but merely a tool to assist in managing the increasing complexity of air traffic.

PAPER # 325: ❖ *James Jones* – *The University of Maryland*
En Route Speed Control Methods for Transferring Terminal Delay

In this paper, we present an approach for transferring delay away from the terminal to the en route phase of flight. We propose a multi-objective integer programming model designed to assign delays to flights well in advance of the terminal. The IP model weights an objective of fuel savings and throughput to assign controlled times of arrival to flights 500 nmi from the airport. A series of trade studies is performed to evaluate our concept. First, the model is tuned by developing a Pareto Frontier to identify weight factors on our objective function. We demonstrate that the model can effectively transfer delay en route. This transfer holds up even with relatively moderate carrier compliance. We go on to demonstrate that this delay transfer yields significant fuel savings benefits on a per flight basis.

PAPER # 300: ❖ *Alex Nakahara* – *Northrop Grumman*

Estimating Current & Future System-Wide Benefits of Airport Surface Congestion Management

Air traffic is expected to continue to grow in the future and improved methods for dealing with the increased demand on the system need to be designed and implemented. One method for reducing airport congestion is surface congestion management. The concept generally involves determining a limit to how many aircraft can efficiently taxi to departure runways, and then holding "excess" aircraft at the gate or in the ramp area with engines off instead of releasing them onto the active movement area during periods of high departure demand. This results in reduced congestion and taxi time, with jet fuel and emissions savings. In order to determine the appropriateness of deploying surface congestion management, estimates of the potential benefits at a wide range of airports into the future are necessary to assist with investment analysis decisions. To overcome challenges associated with the resulting wide spatial and temporal scope, a multi-fidelity modeling approach has been developed where high fidelity models are developed and executed for a small number of key airports, and these are used to inform, validate and extrapolate medium and low fidelity models which are applied to ever-broader sets of airports. Application of these models produce estimates of fuel savings from surface congestion management of 2.2-3.9 billion gallons across the top 35 US airports over the period 2010-2030, with a value of $5.5-9.5 billion. Additional benefits in the form of reduced climate and air quality-impacting emissions have also been estimated to have similar orders of magnitude to the fuel savings.

PAPER # 316: ❖ *Michael Schultz* – *TU Dresden, IFL*

Boarding on the Critical Path of the Turnaround

Due to the fact that the boarding is always on the critical path of the aircraft turnaround, efficient boarding strategies are an essential for a reliable turnaround progress. Since the boarding time mainly depends on the amount of passengers, arrival rate, passenger boarding sequence and aircraft type we investigate different boarding scenarios on three reference aircraft: Airbus A320 (single aisle), Boeing B777 and Airbus A380 (both with a twin aisle configuration). The proposed microscopic approach of modeling the passenger behavior is primarily based on the asymmetric simple exclusion process, where the passenger motion is defined as a one dimensional, stochastic, and time/space discrete transition process. The provided analysis focuses on substantial boarding strategies and the scenarios are evaluated with common statistical criteria (e.g. expected value, variance, quantiles). In the context of both reliable boarding progress and delay compensation during the turnaround our results basically emphasize the use of an additional door for the boarding process (20 - 25 % savings), followed by a change of the boarding strategy (10 - 15 % savings), and the potential application of different seat layouts (3 % savings). First validation checks are performed against measurements of field trials with Airberlin. These tests point out the high reliability of the proposed stochastic aircraft boarding model.

PAPER # 320: ❖ *Hartmut Fricke* – *Dresden University of Technology*

A Methodology to Assess the Safety of Aircraft Operations when Aerodrome Obstacle Standards Cannot Be Met

When Aerodrome Obstacle Standards cannot be met as a result of urban or technical development, EASA in-line with ICAO allows proving an equivalent level of safety by carrying out an aeronautical study. However, detailed guidance in doing so is not provided. This paper aims at filling this gap with a proposed safety assessment methodology to value obstacle clearance violations around airports. It was applied for a safety case at Frankfurt Airport where a tower elevating 4 km out of threshold 25R violates severely obstacle limitation surfaces. The model refers to a takeoff and landing performance model (TLPM) computing precisely aircraft trajectories for both standard and engine out conditions at ground proximity forming the model's reference data: The generated tracks are used to estimate collision risk considering stepwise EASA/FAA, EU-OPS & ICAO clearance criteria. Normal operations are assessed with a probabilistic analysis of empirical takeoff / landing track data generating the local actual navigation performance (ANP) at site. The ANP leads through integration to collision risk for an aircraft with any obstacle. This step passed, the obstacle is tested for clearance within a "5-step-plan" against all performance requirements for landing climb, and takeoff climb. The methodology so delivers a comprehensive risk picture: The presented safety case for Frankfurt Airport showed an equivalent safety level despite the violation of standards: The collision risk during both normal and degraded performance operations was found to be still within ICAO Collision Risk Model (CRM) limits requiring only limited risk mitigation measures. The presented work should complement ICAO Doc. 9774 Appendix 3.

PAPER # 220: ❖ *Gautam Gupta* – *UARC - NASA Ames*

Strategic Planning in Air Traffic Control as a Multi-objective Stochastic Optimization Problem

Surface operations at airports in the US are based on tactical operations, where departure aircraft primarily queue up and wait at the departure runways. NASA's Spot And Runway Departure Advisor (SARDA) tool was developed to address these inefficiencies through Air Traffic Control Tower advisories. The SARDA system is being updated to include collaborative gate hold, either tactically or strategically. This paper presents the results of the human-in-the-loop evaluation of the tactical gate hold version of SARDA in a 360? simulated tower setting. The simulations were conducted for the east side of the Dallas/Fort Worth airport. The new system provides gate hold, Ground Controller and Local Controller advisories based on a single scheduler. Simulations were conducted with SARDA on and off, the off case reflecting current day operations with no gate hold. Scenarios based on medium (1.2x current levels) and heavy (1.5x current levels) traffic were explored. Data collected from the simulation were analyzed for runway usage, delay for departures and arrivals, and fuel consumption. Further, Traffic Management Initiatives were introduced for a subset of the aircraft. Results indicated that runway usage did not change with the use of SARDA, i.e., there was no loss in runway throughput as compared to baseline. Taxiing delay was significantly reduced with the use of advisory by 45% in medium scenarios and 60% in heavy. Observed gate-holds were less than 15 minutes in all but one scenario, and even in this scenario 95% of the aircraft had a gate hold of less than 15 minutes. Arrival delay was

unaffected by the use of advisory. Total fuel consumption was also reduced by 23% in medium traffic and 33% in heavy. TMI compliance appeared unaffected by the advisory.

PAPER # 180: ◈ *Stephen Atkins* – *Mosaic Air Traffic Management*
Investigation of NASA's Spot and Runway Departure Advisor Concept at PHL, CLT, and LAX Airports

NASA has developed the Spot and Runway Departure Advisor (SARDA), which plans spot crossing times and runway sequences to more efficiently manage departures on an airport surface, and extensively studied the concept and algorithms in the context of Dallas/Fort Worth International Airport. This paper reports on a study of the SARDA concept at three new airports – Philadelphia International Airport (PHL), Charlotte-Douglas International Airport (CLT), and Los Angeles International Airport (LAX). The investigation of SARDA at these new airports included both fast-time simulation experiments as well as a human factors evaluation. A fast-time simulation was developed for PHL, CLT, and LAX airports, capable of simulating both baseline operations and operations with NASA's SARDA concept in use. Multiple traffic scenarios were simulated at each airport and metrics detailing the differences between the SARDA and baseline operations analyzed. Results supported the conclusion that SARDA provides substantial benefits at all three airports. To complement the simulations, structured interviews were conducted with retired air traffic controllers who had experience at the focus airports. The human factors study provided a qualitative, alternative investigation into how SARDA would operate at these airports, and identified issues not observable through the simulations as well as additional concept and algorithmic requirements related to off-nominal situations.

Network and Strategic Traffic Flow Optimization – *Session Chair: Nicholas Durand*

PAPER # 230: ◈ *Christine Taylor* – *MITRE*
Designing Coordinated Initiatives for Strategic Traffic Flow Management

This paper develops an approach for automation-assisted design of strategic traffic management strategies. The goal of strategic traffic flow management is to develop traffic management initiatives that mitigate potential large-scale congestion in the future when the imbalance cannot be effectively managed with tactical measures. Thus, despite the inherent uncertainties in the demand and capacity forecasts at longer look-ahead times, decisions regarding National Airspace-wide behavior are necessary. As such it is desirable to develop a decision support system that provides quantitative feedback on predicted traffic impact and aids in developing effective solutions. This paper proposes a framework to address this need by simulating and evaluating the effectiveness of proposed strategies across a variety of metrics. Using a realistic example taken from historic data, we explore the traffic management design space by varying the parameters associated with different management initiatives. The results are compared to those obtained using a naïve heuristic optimization approach and recommendations on requirements for future design approaches are provided.

PAPER # 270: ◈ *Luis Delgado* – *Technical University of Catalonia*
Effect of Radii of Exemption on Ground Delay Programs with Operating Cost Based Cruise Speed Reduction

When a ground delay program (GDP) is defined, a radius of exemption is typically set to exclude from having to realize ground delay aircraft departing from greater distances than the selected radius distance. A trade-off exists when defining this radius: big radii distribute the required delay among more aircraft and reduce the airborne holding delay close to the destination airport, while the probability to realize unnecessary delay increases if the program is canceled before planned. In order to overcome part of this drawback, a cost based cruise speed reduction strategy aiming at realizing airborne delay was suggested by the authors in previous publications. By flying slower, at a specific speed, aircraft that are airborne can recover part of their initially assigned delay without incurring extra cost if the GDP is canceled before planned. In this paper, the effect of the exemption radius is assessed when applying this strategy and a case study is presented by analyzing all the GDPs that took place at Chicago O'Hare International Airport during one year. Results show that by the introduction of this technique, more delay can be saved. Thus, it is possible to define larger radii of exemption, reducing partially the drawbacks associated with smaller radii.

PAPER # 315: ◈ *Gaétan Marceau* – *INRIA Saclay*
Strategic Planning in Air Traffic Control as a Multi-objective Stochastic Optimization Problem

With the objective of handling the airspace sector congestion subject to continuously growing air traffic, we suggest to create a collaborative working plan during the strategic phase of air traffic control. The plan obtained via a new decision-support tool presented in this article consists in a schedule for controllers, which specifies time of overflight on the different waypoints of the flight plans. In order to do it, we believe that the decision-support tool shall model directly the uncertainty at a trajectory level in order to propagate the uncertainty to the sector level. Then, the probability of congestion for any sector in the airspace can be computed. Since air traffic regulations and sector congestion are antagonist, we designed and implemented a multi-objective optimization algorithm for determining the best trade-off between these two criteria. The solution comes up as a set of alternatives for the multi-sector planner where the severity of the congestion cost is adjustable. In this paper, the Non-dominated Sorting Genetic Algorithm (NSGA-II) was used to solve an artificial benchmark problem involving 24 aircraft and 11 sectors, and is able to provide a good approximation of the Pareto front.

PAPER # 216: ◈ *Justin Pearson* – *Uppsala University*
Airspace Sectorisation using Constraint-Based Local Search

Airspace sectorisation provides a partition of a given airspace into sectors, subject to geometric constraints and workload constraints, so that some cost is minimised. Using the constraint programming paradigm, we define plug-and-play airspace sectorisation constraints and use them to model declaratively a problem of free-form static airspace sectorisation starting from a regular mesh of cells. We design a local search (meta-)heuristic that operates on the model and we compare it with the existing NEVAC Sector Builder Algorithm.

PAPER # 302: ◈ *Henk Blom – National Aerospace Laboratory (NLR)*
Modeling Potential Hazards Within Agent-based Safety Risk Analysis

One of the first steps in safety risk assessment of an ATM operation is to identify as many potential hazards as is possible. All these potential hazards have to be analysed upon there possible contribution to safety risk of the operation considered. In an agent-based safety risk assessment of ATM operations there are two approaches towards the assessment of the safety risk impacts of hazards. The direct way is to incorporate the hazard in the agent-based model, and to assess this agent-based model on safety risk by conducting Monte Carlo simulations. The alternative is to avoid the modelling of a potential hazard in the agent-based model, and instead assess the impact of the hazard on safety risk through sensitivity analysis and bias and uncertainty assessment. Because agent-based modelling and simulation of hazards may reveal emergent behaviour that remains invisible through sensitivity analysis, there is a need to know for each hazard how to model it in an agent-based approach. Hence the aim of this paper is to identify the types of agent-based model constructs for potential hazards in ATM. This study leads to the identification of 38 model constructs that are able to capture about 98% of the hazards considered in an agent-based model. The paper also shows how these agent-based model constructs relate to modelling approaches in various other aviation domains, such as system reliability, human performance simulation, Human Reliability Analysis, and aircraft trajectory simulation. The model construct 'multi-agent situation awareness' captures by far the highest percentage of hazards (41%). This model construct does not correspond to any of these four well established modelling areas.

PAPER # 247: ◈ *Jessica Holland – MIT Lincoln Laboratory*
Optimizing the Next Generation Collision Avoidance System for Safe, Suitable, and Acceptable Operational Performance

The Traffic Alert and Collision Avoidance System (TCAS) is mandated worldwide on large commercial aircraft and has been shown to substantially reduce the risk of mid-air collision. However, the logic used to select pilot advisories is difficult to modify and does not easily support new surveillance inputs. The next generation system, called Airborne Collision Avoidance System (ACAS X), currently addresses many of the design limitations of TCAS. ACAS X is optimized with respect to a cost function. The system was initially optimized to increase safety and decrease alerts. Recent work has focused on tuning ACAS X to also meet operational suitability and pilot acceptability performance metrics. An iterative tuning process reduced the operational impact on the air traffic system and improved acceptability of alerts. This paper summarizes a fifteen-month effort that resulted in substantial improvements. Compared with TCAS, ACAS X reduces collision risk by 59%, lowers the alert rate by 59%, and issues 28% fewer disruptive alerts. ACAS X also resolves encounters with simpler alert sequences and issues less than half as many reversal and altitude crossing advisories.

PAPER # 335: ◈ *Michael Seelhorst – University of California, Berkeley*
Impacts of Reporting Rules and Facility Consolidation on Recorded Operational Errors in TRACONs

This paper focuses on the occurrence of aircraft separation minimum violations as documented in the form of operational errors (OEs) at terminal radar approach control (TRACON) facilities. Poisson regression was used to analyze the daily count of OEs at various facilities. The occurrence of OEs was found to increase approximately with the square of daily traffic at TRACON facilities. At TRACON facilities, where separation violations are not automatically reported, an increase in reporting was seen after a new severity metric was introduced in 2007. It was also found that large, consolidated TRACON facilities tend to behave like a sum of several smaller facilities rather than a single larger facility with respect to the occurrence of OEs vs daily traffic. Weather effects such as visibility and wind were found to influence the occurrence of OEs as well. The model prediction for TRACON facilities is very good for the most severe OE types and very poor for the least severe OE types, indicating many unobserved factors contributing to the reporting of the least severe OE types in the terminal environment.

PAPER # 265: ◈ *Seth Placke – MIT Complex Systems Research Lab*
Assuring Safety of NextGen Procedures

This paper introduces an innovative approach to analyzing safety in the next generation of air traffic management systems. The proposed method is based on systems and control theory and is able to capture system design and component interaction causes that are increasingly frequent in accidents. The new methodology is applicable during the entire design lifecycle from early concept selection through final certification. Hazard analysis of a completed NextGen concept, In-Trail Procedure, is demonstrated as well as use in the early concept development of Trajectory Based Operations.

PAPER # 277: ◈ *Olga Gluchshenko – German Aerospace Center (DLR)*
Performance Based Approach to Investigate Resilience and Robustness of an ATM System

Resilience is a fundamental property of the natural ecosystem that enables quick recovery after numerous disturbances occurring frequently. This vital ability of the ecosystem makes resilience a very desirable property of man-made socio-technical systems. The European ATM System, which in future will be set up to achieve the performance targets given by SESAR, is such a socio-technical system. A lot of contradictory definitions of the term resilience in different domains fall into two big categories with semantical meanings of "resilience" or "robustness". Currently, in the ATM Context exists a definition of resilience from the safety science perspective only. This paper will apply a new definition of resilience and

robustness on the ATM System to help realizing the agreed performance targets under the influence of disturbances. To follow this approach, a clear differentiation between both terms has to be carried out. The aim of this conceptual paper is to present a developed framework that incorporates concepts of robustness, resilience and relevant terms such as disturbance, stress and perturbation. This is complemented by an according decision-making chain. Furthermore, this paper suggests some qualitative and quantitative forms of measures of resilience and robustness and provides a structured approach for the investigation of both terms. By incorporating the presented terminology in order to identify new methods to increase resilience or robustness, a new modeling approach will be introduced. This will be complemented by an according algorithm. The structure of the modeling approach divides the ATM System into two - a sociological and a physical dimensions. The sociological dimension shall enable to reveal improvement potential in the context of operational rules of particular stakeholders, adapting resources and finding alternative ways to achieve the given performance targets.

Separation – *Session Chair: Mark Weber*

PAPER # 243: ❖ *Arthur Richards* – *Bristol University*
4-D Trajectory Optimizers for Conflict Avoidance Using Speed Advisories
This paper extends 4-D trajectory optimizers to resolve conflicts through "speed advisories", separating high-level decision making from the detailed trajectory optimization. Details of Mixed Integer Linear Programming (MILP) and collocation optimizers are briefly reviewed before the additional constraints are developed to force resolution only through speed changes. Results for a multi-sector area over Wales and North-West England illustrate how the method can be used. A brief evaluation of the computational complexity of the method is shown. This paper describes results from the SUPEROPT project that is part of SESAR WorkPackage E, which is addressing long-term and innovative research.

PAPER # 264: ❖ *Cyril Allignol* – *École Nationale de l'Aviation Civile (ENAC)*
A New Framework for Solving En-Route Conflicts
The en-route conflict resolution problem has been modeled in many different ways, generally depending on the tools that were proposed to solve it. For instance, with purely analytic mathematical solvers, models tend to be very restrictive (constant speeds, linear trajectories...) to respect the inherent limitations of the technology. This paper introduces a new framework that separates the model from the solver so as to be able to: first, enhance the model with as many refinements (e.g. wind and trajectory uncertainties) as necessary to comply with operational constraints; second, compare different resolution methods on the same data, which is one of the crucial aspects of scientific research. To this aim, our framework can generate a benchmark of conflict resolution problems built with various scenarios involving a given number of aircraft, different levels of uncertainties and number of maneuvers. We then compare two different optimization paradigms, Evolutionary Algorithm and Constraint Programming, which can efficiently solve difficult instances in near real time, to illustrate the usefulness of our approach.

PAPER # 199: ❖ *Eri Itoh* – *Electronic Navigation Research Institute (ENRI)*
Applying Flight-deck Interval Management based Continuous Descent Operation for Arrival Air Traffic to Tokyo International Airport
Aiming to realize Continuous Descent Operation (CDO) in high-density air traffic, Flight-deck Interval Management (FIM) is seen as one of the promising applications in the Aircraft Surveillance Applications System (ASAS). In the FIM application, an aircraft's arrival time at an airport is estimated while it is in flight, and its airspeed is controlled to achieve an assigned time spacing between its immediately preceding aircraft at the runway threshold. In order to evaluate the performance of the FIM application, this paper simulates CDO based on the FIM application for arrivals at Tokyo International Airport. A medium-fidelity aircraft model, which includes Vertical/Lateral NaVigation (VNAV/LNAV) autopilot modes, an engine system, and a Total Energy Control System (TECS), is implemented in a fast-time simulation. Potential CDO arrival routes at Tokyo International Airport are proposed. The simulation results evaluate the accuracy of FIM-based time spacing and fuel consumption. Wind estimation errors are considered in this paper.

Unmanned Aircraft Systems (UAS) Integration – *Session Chair: Mark Weber*

PAPER # 321: ❖ *Xavier Prats* – *Technical University of Catalonia*
Maintaining Separation Between Airliners and RPAS in Non-Segregated Airspace
When an airliner and a Remotely Piloted Air System (RPAS) have conflicting courses that may compromise the minimum safety separation between them, how much in advance should the RPAS start the separation manoeuvre? Which is the optimal heading change that will guarantee the desired separation distance with a minimum reaction time? These same questions can be asked if it is the airliner that performs the separation manoeuvre. In this paper the time reaction margins for both aircraft are analysed assuming they are equipped with Automatic Dependent Surveillance (ADS) systems able to exchange aircraft intents. Due to their small cruise speeds, RPAS manoeuvres must be initiated well before the airliner ones. This leads to some safety buffer in case the RPAS cannot comply with the required change of trajectory or if it becomes suddenly unresponsive (due to an internal failure or because a lost-link situation). The paper also assesses the operational point of view by simplifying the reaction times and conflict geometries by grouping them in a small set of cases, regarding the severity of a loss of separation event.

ATM Performance Measurement and Management — *Session Chair: Joe Post*

PAPER # 318: ❖ *Yi Liu — University of California, Berkeley*

Ground Delay Program Decision-making using Multiple Criteria: A Single Airport Case

In this paper, we develop Ground Delay Program (GDP) models using continuum approximation. Both early GDP cancellations and GDP extensions are considered in the models. We then identify and define four performance criteria for GDP: capacity utilization, predictability, efficiency and equity. Using the proposed GDP models, we represent the trade-offs between the performance goals and relate these to the GDP decisions on planned clearance time, scope and early cancellation policy. Each flight operator may prefer a different point on the performance trade-off curves and correspondingly opt for different GDP plans. The decision-making process is formed as a utility optimization problem in our work. Specifically, we employ a linear utility function to illustrate how the trade-off curves could be used by flight operators to select their preferred GDP decisions. The research would lead to improved GDP decision-making, in which traffic managers and flight operators can make informed trade-offs based on their assessment of the importance of different performance criteria.

PAPER # 223: ❖ *Len Wojcik — MITRE*

Flexibility Metrics and Their Application to Departure Queue Management

Flexibility for operators is a Key Performance Area (KPA) for Air Traffic Management (ATM). This paper presents a framework for development of operator flexibility metrics, with a first test-case application to management of departure queues. Through the use of virtual queuing (VQ) in departure operations, operators are provided with additional flexibility in prioritizing flights for departure. VQ allows flights whose delays are more expensive to skip ahead in the departure queue, while other flights with less expensive delays move back. Operators are expected to benefit significantly from the additional flexibility of VQ because the cost of departure queuing delays can vary widely among different flights due to differences in delay already accumulated, different number and types of passengers, and considerations such as crew time limits. Flexibility metrics derived from delay recovered with VQ relative to physical queuing (PQ) are compared under a variety of operational scenarios. These scenarios include: non-linear delay costs, variable costs by aircraft type, flexibility across all flights and flexibility constrained to intra-operator exchanges, as well as small physical queues at the departure runway end. Flexibility measures have been defined that are not dependent on the specifics of the operator business case (i.e., cost structure or decision criteria). This is accomplished through a comparative assessment of flexibility metrics derived from fast-time simulations assuming a variety of operator cost functions and optimization objectives. Results show that metrics can be normalized to allow operators, based upon their cost-structure and optimization objectives, to infer a value of improved flexibility. Results also indicate that constraining exchanges to intra-operator and including small physical queues at the departure runway end substantially reduce the flexibility performance of VQ, which implies that operational mechanisms to permit inter-operator exchanges and to reduce the size of small physical queues.

PAPER # 283: ❖ *Gonzalo Tobaruela — Imperial College London*

Enhancing Cost-Efficiency and Reducing Capacity Shortages: Strategic Planning and Dynamic Shift Management

This paper analyses the relationship between capacity and cost-efficiency at an en-route Air Traffic Control Centre level. It develops a set of cost-efficiency metrics to describe the centre planning process, and compares these results to cost-efficiency values. In order to understand the effect of the new tools and procedures implemented at the centre on its cost-efficiency, statistical analysis of the operational data before and after implementation is undertaken. The results show that the introduction of a dynamic shift management enabled by staff planning automation tools, along with a flexible roster and an appropriate planning process can simultaneously enhance capacity and cost-efficiency. These improvements are mapped to the SESAR Operational Improvements, to assess the feasibility of the programme to achieve its capacity and cost-efficiency improvement targets.

PAPER # 183: ❖ *Marco Enriquez — MITRE*

Identifying Temporally Persistent Flows in the Terminal Airspace via Spectral Clustering

Given a specified amount of flight trajectory data, data reduction and clustering methods (e.g., Principal Components Analysis and k-means) have become established tools for identifying flows (i.e., a group of similar flight trajectories). However, most flow identification algorithms in the literature rely solely on spatial clustering, without considering the temporal dimension. Temporal characterization of flows is important, as it: enables identification of salient air traffic features, provides a basis for scenario ("what-if") analyses, and allows for a more robust distillation of large and time-varying air traffic datasets. To address this shortcoming, this work proposes a methodology for identifying flows which persist over an arbitrary time span. This process leverages a generic Spectral Clustering framework, building upon the methodologies established by Enriquez and Kurcz [4]. This algorithmic approach produces robust results, while remaining easy to implement and being computationally inexpensive. We present two examples to show the promise of this algorithm. First, the algorithm is used to automatically identify days in which irregular air traffic patterns occur in the Miami International Airport (MIA) terminal airspace. Second, we use this algorithm to help identify the minimum required number of new Performance Based Navigation (PBN) arrival and departure procedures in the National Airspace (NAS), based on six months of historic data.

PAPER # 317: ◈ *Husni Idris* – *Engility Corporation*
Estimating Airspace Capacity Based on Risk Mitigation Metrics

Airspace capacity is a key parameter in the air traffic management system. Numerous metrics for estimating it have been proposed including simple ones such as aircraft count and sophisticated ones representing traffic complexity. In this paper, an approach is presented for estimating airspace capacity that addresses two main factors: (1) the risk element in determining capacity, represented by the tradeoff between capacity and the ability to mitigate the risk of violating traffic management constraints, and (2) the cognitive element in determining capacity, represented by the control strategy used by different control schemes such as human control, automation control, or automation assisted control. The approach is demonstrated using a risk mitigation metric, called adaptability, which estimates the number of feasible trajectories that are available to an aircraft, using a certain control strategy, to avoid violating traffic management constraints. Using this metric, the tradeoff between adaptability and capacity to absorb delay that exists in current human control behavior was identified through analysis of historical track data of two airspace sectors. This metric was also used to compare alternative control strategies in a simulated metering situation involving separation assurance and meeting required times of arrival at a fix. The comparison highlighted the higher capacity and adaptability levels that can be achieved with more efficient control strategies relative to human control. Thus, the presented analysis demonstrates the potential of risk mitigation metrics such as adaptability to estimate airspace capacity limits that achieve desired levels of risk mitigation under different control strategies and automation schemes.

PAPER # 334: ◈ *Dimitris Bertsimas* – *Engility Corporation*
Air Traffic Flow Management at Airports: A Unified Optimization Approach

We present a novel integer optimization approach to optimize in a tractable and unified manner the airport operations optimization problem (AOOP). This includes solving the entirety of key air traffic flow management (ATFM) problems faced at an airport: a) selecting a runway configuration sequence, i.e., determining which runways are open at which times and in which mode they operate; b) assigning flights to runways and determining the sequence in which flights are processed (i.e., when they take off or land); c) determining the gate-holding duration of departures; and d) routing flights to their assigned runway and onwards within the terminal area and the near-terminal airspace. The key contribution of this paper is the modeling of these problems, which until present have been studied in isolation, under a framework which is both unified and tractable. This allows the possibility of obtaining system-optimal solutions in a practical amount of time. Furthermore, the approach is implemented on historic datasets from both Boston Logan International (BOS) and Dallas/Fort Worth (DFW) airports. Computational experience indicates that significant improvements can be achieved from this optimization, and that computational tractability is such that real-world implementation is possible.

PAPER # 163: ◈ *Eric Feron* – *Georgia Institute of Technology*
Airport Gate Scheduling for Passengers, Aircraft, and Operation

Passengers' experience is becoming a key metric to evaluate the air transportation system's performance. Efficient and robust tools to handle airport operations are needed along with a better understanding of passengers' interests and concerns. This paper is concerned with airport gate scheduling for improved passenger experience while ensuring robust air-side operations. Three metrics accounting for passengers, aircraft, and operations are presented. Trade-offs between these metrics are analyzed, and a balancing objective function is proposed. Numerical simulations show that the balanced objective can improve the efficiency of traffic flow in passenger terminals and on ramps, as well as the robustness of gate operations.

PAPER # 244: ◈ *Scot Campbell* – *MIT Lincoln Laboratory*
Markov Model for Cost and Benefits Analysis of Air Traffic Technologies

A critical step in the design and development of new tools and systems for air traffic management is the estimation of potential benefits of the added technology. The current methodology of estimating the added benefit of a new tool is based on a combination of simulation and field observations, requiring either an extensive model of the system or a fielded prototype. This paper contributes a Markov model for benefits estimation, which allows for quick assessment of benefit uncertainty and rapid evaluation of different operational scenarios. In this paper, a Markov model is employed to estimate the benefits of a strategic departure management tool. The model probabilities are derived from a historical archive of Route Availability Planning Tool (RAPT). Monte Carlo simulations are performed to estimate the range of benefit for uncertainties in model parameters and technology performance accuracy. Using this model we also provide an illustration of how different decision procedures can be accommodated, and their impact on benefits.

PAPER # 205: ◈ *Norma Taber* – *MITRE/CAASD*
Benefits Analysis of a Departure Management Prototype for the New York Area

Integrated Departure Route Planning (IDRP) is a decision support tool being developed and prototyped by MITRE's Center for Advance Aviation System Development (CAASD) to explore new concepts and capabilities for departure management. IDRP provides demand estimates for departure fixes and routes in terminal airspace, including identification of specific flights impacted by capacity constraints, their route information, and accurate estimates of their expected take-off times. In general, IDRP benefits accrue when there is contention for departure resources (runways, fixes, routes, sectors), plus the feasibility of off-loading or otherwise balancing demand as a means of mitigating delay. This scenario is common in the New York area, where the prototype has been installed since 2009. In 2011 and 2012, field evaluations were conducted at tower, terminal, and center facilities. These evaluations allowed the capture of "use cases"—instances of essential applications of the tool. These use cases were later examined via offline replay, and led to benefits analyses in which a queuing model was employed to compare scenarios with and without IDRP. The modeling suggests significant benefits are attributable to IDRP.

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ATM 2013 5K FUN RUN

Tuesday June 11, 6:15 AM
Meet at the East end of 18th Dr (south side)

This is a great opportunity to enjoy an early morning run with your colleagues while taking in the spectacular Chicago Skyline as well as the Lake Michigan shoreline.

Route Details

- We gather and start at the east end of E 18th Dr (green pin)

- Run along the Lakefront Trail (highlighted blue line)

- Two main road crossings
  1. E Waldron Dr
  2. E Solidarity Dr

- Turn around when we reach Queen's Landing (yellow pin), where you may also see Buckingham Fountain across the S Lake Shore Dr

- Run along the same way back, until you reach our departing point

- Route signs will be provided on the day of run

- Prizes for participants

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