



*AGIFORS Revenue Management, Distribution
Study Group Conference 2017*

*San Francisco, USA
May 16 – 18, 2017*





Official Sponsors





May 16, 2017

Dear AGIFORS Conference Delegate,

Welcome to San Francisco, USA the location of the 2017 AGIFORS Revenue Management and Distribution Study Group Conference. The AGIFORS organization has a distinguished history of providing a forum for the top operations research and revenue management professionals to exchange thoughts and ideas.

This year's conference, hosted by United Airlines, continues our great tradition with an outstanding agenda of presentations on timely topics and leading edge concepts from airlines, academics and vendors. During our time together you will hear presentations on important research in the following areas: Revenue Management, Inventory Control, Forecasting, and Revenue Management Technologies.

Our focus is to make this time together productive and informative, as well as enjoyable. The conference organizes a number of events that provide opportunities for you to network with your peers to further discuss ideas and challenges. A complete schedule of each day's program and each evening's networking opportunities is provided inside.

We are pleased that you have joined us for this year's AGIFORS Revenue Management and Distribution Study Group Conference. We look forward to providing you a meaningful and memorable experience.

Sincerely,

Tassio Carvalho
AGIFORS RM Chair
tassio.carvalho@aa.com

Sunny Ja
AGIFORS RM Chair
shau-shiang.ja@aa.com



2017 AGIFORS RM Study Group - Conference Agenda

Tuesday – May 16

18:30 – 20:30 **Welcome Reception**
at Hyatt Centric Fisherman's Wharf
Sponsored by Sabre

Wednesday – May 17

08:00 – 16:00 Conference Registration

08:45 – 09:00 **Conference Overview**
Tassio Carvalho – AGIFORS Revenue Management Study Group

09:00 – 09:25 **Airline Update**
Sunny Ja – AGIFORS Revenue Management Study Group

09:25 – 10:00 **Optimization Models with Conditional Demand Forecast**
Wen Zhao - United Airlines

10:00 – 10:30 **Using Online Surveys to Develop Choice Set Generation Models**
Laurie A. Garrow – Georgia Institute of Technology

10:30 – 10:45 Coffee break

10:45 – 11:25 **Simultaneous Dynamic Pricing of Horizontally Differentiated Flights**
Michael D. Wittman – MIT

11:25 – 12:05 **Revenue Management with Ancillary Services: A New Optimization Approach**
Adam Bockelie – MIT International Center for Air Transportation

12:05 – 12:40 **Pricing Optimization & Automation – Quantum Pricing**
Raghuvir Nallapati - Etihad Airways

12:40 – 13:40 Lunch at Hyatt Centric Fisherman's Wharf
Sponsored by Infare

13:40 – 14:15 **How Should RM Management Think About User Influence?**
Bill Brunger - PODS Research LLC



14:15 – 14:50 **Subscription Revenue Management : Lock-in Customers
Lock-out Competition**
Sachin Goel - Optiontown

14:50 – 15:25 **The bid price - Swiss Army Knife of RM**
Jonas Rauch - Lufthansa German Airlines

15:25 – 15:40 Coffee break

15:40 – 16:15 **Update on the ATPCO Dynamic Pricing Working Group
Specifications**
Richard Ratliff – Sabre

16:15 – 16:55 **The future of airline pricing**
Thomas Fiig – Amadeus

19:00 – 22:00 **Networking Dinner Cruise**
Sponsored by Sabre & Optiontown

Thursday – May 18

08:30 – 09:05 **A Deeper Look into the Modelling and Implications of
Postponement in Customer Behavior**
Daniel Hopman – Emirates Airlines

09:05 – 09:40 **A Zero Displacement Cost Model for Segment/O&D Revenue
Management**
Landie Qiu – Revenue Management Systems

09:40 – 10:10 **Impact of Bid Price Floors and Freezes under Origin-
Destination Control with Cancellations and Overbooking**
Larry Weatherford – University of Wyoming

10:10 – 10:25 Coffee break

10:25 – 11:00 **Connecting Pricing Back to Inventory Control - a Systems
View**
Gert Hartmans – KLM

11:00 – 11:35 **Codeshare Alerts to Detect Misalignments between Partners**
Hunkar Toyoglu – Sabre Consulting



- 11:35 – 12:10 **A Benchmarking Study of Passenger Choice Based Optimization Algorithms on Real Airline Networks**
Mohammad Liaee – Sabre
- 12:10 – 13:10 Lunch at Hyatt Centric Fisherman's Wharf
Sponsored by Optym
- 13:10 – 13:45 **Dynamic Pricing vs Revenue Management under Competition: Single vs Repeated Games**
Guillermo Gallego - Hong Kong University of Science and Technology
- 13:45 – 14:20 **A New Approach to Choice-Based Revenue Management**
Virginie Lurkin - Ecole Polytechnique Fédérale de Lausanne
- 14:20 – 14:55 **Advanced Prediction Methods for Massive Airfare Datasets Using Apache Spark**
Josef Habdank – INFARE Solutions
- 14:55 – 15:10 Coffee break
- 15:10 – 15:40 **Competing for Customers When Some of Them Are Loyal**
Darius Walczak – PROS
- 15:40 – 15:50 **AGIFORS Introduction**
Laurie Garrow – AGIFORS President
- 15:50 – 16:00 **Closing Award Ceremony**
Tassio Carvalho & Sunny Ja – AGIFORS Revenue Management Study Group



Technical Program

Airlines

Optimization Models with Conditional Demand Forecast

Wen Zhao - United Airlines

Conditional demand forecast (CDF) is a new type of demand forecaster developed at United Airlines. It forecasts the total demand under different control and environmental conditions, such as the lowest available fare. We show how different optimizers can be used with conditional demand forecasts. Four well known optimizers are discussed: EMSRb, fare adjusted EMSRb, and two versions of dynamic programming. Numerical examples are used to demonstrate how these optimizers perform under different scenarios.

Connecting pricing back to inventory control - a systems view

Gert Hartmans – KLM

Changing technology and pricing strategies may lead to a disconnect between revenue management fundamentals of inventory control and the pricing and system features applied. We will cover revenue management system developments, competitive context and pricing developments to try and understand how we came to where we are now. Next describe how changes like Fuel surcharges, Low cost competitors, Changes in class combinability, Return versus one ways, Ancillaries, Fare Families or Branded Fares lead, etc to changes that affect Inventory Control (often negatively). From that, let's see if we can define a strategy taking all the possibilities of inventory control and system functionality into account that could provide a profitable strategy, and/or identify the limitations to profitability given an airlines structural position. Also let's look at how to aligning pricing with inventory control, and what technology is needed to support this.

Pricing Optimization & Automation – Quantum Pricing

Octavian Oancea, Raghuvir Konanki Nallapati, Bhaskara Guntreddy, Goutham Komirishetty - Etihad Airways

Nowadays, the processes of benchmarking and pricing implementation are primarily human-driven. To overcome the need for higher speed to market, as well as to more efficiently utilize the pricing human resource in defining and driving strategies, the initiative of a human-assisted pricing optimization system has been started by Etihad Airways, called Quantum Pricing. In partnership with Sabre Consulting, the development of Quantum Pricing has made possible to identify and generate fare changes and update them dynamically in ATPCO, with the ability to drive continuous price points for improved demand capture, differentiate price based on willingness to pay and various business rules, increase breadth of monitoring and consistency in response to competitors across the network. We will address the challenges we have faced in designing the solution as well as in driving the change from an organizational point of view.



The bid price - Swiss army knife of RM

Jonas Rauch - Lufthansa German Airlines

The bid price or a similar concept is at the heart of all Revenue Management methods, although it is not always visible and sometimes called differently. Despite its widespread use and the large body of scientific research there are many misconceptions about the bid price, especially among practitioners. As a result it is not used to its full potential, but instead often misused to pursue goals it is neither meant nor suited to achieve.

Besides a short reminder about its definition, this presentation focuses on the economic meaning and some interesting properties of the bid price. The second part covers implications for RM practice, including a number of potential applications apart from the core RM task of computing booking class availability

A deeper look into the modelling and implications of postponement in customer behavior

Daniel Hopman – Emirates Airlines

In the revenue management literature, it is typically assumed that when a customer arrives in the system, it either makes a purchase or is gone forever. In this paper, we provide an analysis of postponement behavior. Postponement, or waiting behavior, occurs when a customer makes one or more attempts before making their purchase. This calls for definitions of what waiting really is and propose these in this paper. We investigate several variables that may influence this behavior. We then use these findings to extend simulations from our earlier work and study the effects using three revenue management strategies. We also discuss what the implications are of postponement on forecasting demand.

Academic

Dynamic Pricing vs Revenue Management under Competition: Single vs Repeated Games

Guillermo Gallego -Hong Kong University of Science and Technology

In this talk we consider dynamic pricing (where any price can be chosen) vs Revenue Management (where only a menu of prices can be chosen). We seek a Nash equilibrium for both single games and infinitely repeated games. For single games, examples show that RM can sometimes have an advantage if the menu is decided ex-ante but the advantage disappears if the decision of the fare menu itself is part of the Nash equilibrium. In repeated games Folk's theorem applies and trigger strategies lead to cooperation provided the discount rate is sufficiently high.

Using Online Surveys to Develop Choice Set Generation Models

Laurie A. Garrow – Georgia Institute of Technology

In recent years, there has been growing interest in using discrete choice models to forecast demand for revenue management (RM) products. One of the key limitations with existing choice-based RM models is that they do not incorporate different choice set generation rules, e.g., they do not model how individuals filter or screen alternatives prior to making a decision. To



help address this limitation, we designed an online experiment to capture how individuals filter and screen alternatives. We ran this experiment on Amazon Mechanical Turk (AMT) and Qualtrics. We present preliminary results comparing responses obtained from AMT (a crowdsourcing Internet marketplace), Qualtrics (a traditional marketing survey panel), and an online survey conducted by the Resource Systems Group that recruited participants from airlines' frequent flyer databases. Based on these results, we offer a conceptual framework for how online surveys can be used to develop a choice set generation model. This research is supported in part by a NASA LEARN grant.

Simultaneous Dynamic Pricing of Horizontally Differentiated Flights

Michael D. Wittman – MIT International Center for Air Transportation

(Joint work with T. Fiig, R. Adelving, and P.P. Belobaba)

We consider the problem of an airline jointly pricing two or more flights with horizontally differentiated attributes, such as departure time. In a departure from past approaches using logit choice models, we use a Hotelling line (also called a locational choice model), to generate purchase probabilities for each flight. We then develop heuristics to dynamically modify the fares that would ordinarily be offered by an airline's RM system for each flight. Results from the PODS RM simulator show incremental revenue gains when the simultaneous pricing heuristic is used to jointly price two flights with a single attribute, compared to a dynamic pricing method (PFDynA) that prices each flight separately. The gains result from offering price-sensitive passengers discounts to book less-attractive flights, leading to greater availability on more-attractive flights for schedule-sensitive passengers.

Revenue Management with Ancillary Services: A New Optimization

Approach

Adam Bockelie and Peter Belobaba - MIT International Center for Air Transportation

As ancillary services provide an increasing proportion of total revenue, the need to integrate their revenues into airline revenue management (RM) systems grows. Previous attempts at ancillary-aware RM used "optimizer increment" heuristics with mixed revenue performance. We propose a new dynamic programming approach that explicitly accounts for ancillary services and passenger choice and is an optimal formulation under certain conditions. We also propose an ancillary marginal revenue transformation and forecasting method that can extend traditional RM methods to support ancillaries. We demonstrate the revenue and booking impacts of our proposals with the Passenger Origin-Destination Simulator.

Impact of Bid Price Floors and Freezes under Origin-Destination Control with Cancellations and Overbooking

Larry Weatherford – University of Wyoming

We have seen some results over the years where bid prices (or displacement costs) decline when a flight is close to departure. This could allow low-yield bookings at a time when high willingness-to-pay customers are shopping. This research will look at the effect of putting either a 'floor' or a 'freeze' on the bid prices to keep them from spiraling down close to departure. We will use PODS Network U10 (a large "international" network with 572 O&D markets with four airlines competing for passengers, including an LCC) to simulate the competitive effects when



one airline implements these floors/freezes when using one of three different O-D methods (ProBP, Unbucketed DP with a point estimate, and UDP with a vector estimate). This research builds on prior work by Adam Bockelie of MIT by adding the complexity of allowing cancellations and overbooking.

How Should RM Management Think About User Influence?

Bill Brunger - PODS Research LLC

Following up on last year's research, and using the PODS simulator as a diagnostic device, the author will look at some kinds of support and guidance that RM Management could give to Users in order to influence RM systems more effectively, and to counter known RM forecasting/system limitations.

A New Approach to Choice-Based Revenue Management

Virginie Lurkin - Ecole Polytechnique Fédérale de Lausanne

The objective of revenue management is to determine the number of products to sell at a particular price and at a particular time to maximize the operator revenue. Different approaches have been proposed to solve this problem including protection levels, products assignments, products availability, or pricing thresholds (called bid prices). Over the past years, there has been a growing interest in modeling customer choice behavior in revenue management problems. In this talk, we introduce a new formulation for Choice-Based Revenue Management in which the nonlinearity of the demand model, which is due to the random nature of the utility function, is circumvented with simulation.

Vendors

Update on the ATPCO Dynamic Pricing Working Group Specifications

Richard Ratliff – Sabre

In early 2016, ATPCO organized a new, standards setting body for dynamic pricing engines (DPE). Their objective is to develop an industry standard interoperability specification for airline (or vendor supplied) dynamic pricing engines (DPE's) for use in global distribution systems (GDS's), airline systems and other distribution channels. The group's design approach has emphasized maximizing reuse of existing travel distribution technical standards to minimize changes to current systems while providing support for both dynamically priced airfare increases (markups) and decreases (markdowns). The ATPCO working group is comprised of a coalition of about 20 airlines, GDS's, and marketing and technology providers.

Earlier this year, we announced the completion of an initial, end-to-end specification for airline DPE's. This presentation will describe the work-to-date including the latest proposed specifications.

Competing for Customers When Some of Them Are Loyal

Darius Walczak - PROS & Siddharth Prakash Singh - Carnegie Mellon University

We analyze a two-competitor dynamic pricing game introduced by Dudey (1992) and subsequently considered within the revenue management framework by Martinez-de-Albeniz and Talluri (2011). We allow a general distribution of customer valuation and expand the game



to include demand that is loyal to each airline, in addition to those customers who seek the lowest price in the market. The extension is particularly relevant in the airline industry where airlines often have demand that is price-sensitive but dedicated to a particular carrier. We research conditions for the existence and uniqueness of a pure-strategy Nash equilibrium and make a comparison to the case when the capacities of both competitors in the market are pooled.

The future of airline pricing

Thomas Fiig, Mathilde Gauchet, Remy Le Guen, and Stephane Lecourtois – Amadeus

Today, RMS's responsibility is to price the airline seat, while merchandizing is responsible for expanding the shopping basket (up-sell, cross-sell, and ancillary services); by providing more relevant and personalized offers – in accordance with the airlines commercial strategies.

This approach is inadequate, since RMS only has partial knowledge of the revenue streams and therefore the decisions of which products and prices to offer to the customers are driven by neither revenue optimization nor conversions. The long-term vision is to integrate RMS and merchandising into a central engine, that defines the product and price offerings. The price will cover all aspects of the deal, including seat reservations, taxes, ancillary services and other third party products. In this paper, we discuss how to price a general airline offering; the pricing challenges involved; and how we need to enrich classical RM science with new technologies such as Artificial Intelligence and Machine Learning, to reach this vision.

A Zero Displacement Cost Model for Segment/O&D Revenue Management

Landie Qiu – revenue management systems

Most traditional O&D network revenue management methods are based on either leg-based nesting and booking limits (EMSRb, VEMSRb and DAVN) or Bid Price (Heuristic and Deterministic). Leg-based EMSRb may not appropriately value long-haul connecting passengers who may provide more total revenue than local passengers. VEMSRb was developed to take total O&D fares into consideration and prioritize the wide variety of O&D fares by using a larger number of virtual classes. However, the following models argue that VEMSRb is too “greedy” for long-haul O&D passengers and it ignores the displacement cost of driving local passengers away. Therefore, DAVN, Heuristic Bid Price and Deterministic Bid Price models started to use EMSR values or Shadow Prices as displacement costs to calculate the net value for every O&D passenger for either prioritization or open/close decisions.

This ODC (zero displacement cost) model considers the possibility that connecting passengers may not displace local passengers. For example, if the flight is forecasted to have empty seats (Spoilage) at departure, there will be no displacement cost for taking a connecting passenger. For flights with demand greater than capacity (Spill), this model does take into consideration the displacement. Both concepts are applied in the proposed new Segment/O&D Revenue Management model. This new model uses historical data to dynamically forecast if displacement will occur on each flight at each NDO (Number of Days Out). Therefore, it may help airlines sell seats to higher-fare connecting passengers and also eliminate their displacement costs.

Codeshare Alerts to detect misalignments between partners

Xing Li, Hunkar Toyoglu, Joakim Kalvenes – Sabre Consulting

We present a novel tool, Codeshare Alerts, for the goal to systematically detect fare deviation and availability misalignment between operating carriers and their codeshare partners. This work



is motivated by airlines' need to prevent revenue dilution as result of inconsistent codeshare pricing and inventory controls. In partnership with Etihad Airways, Sabre has developed Codeshare Alerts which enables collection of data via a customizable shopping robot on Sabre GDS based on observed passenger booking patterns. Itineraries are analyzed against business rules and RBD mappings to generate pricing and inventory alerts. Actions are recommended at leg-level considering network-level revenue impact. Results from several airline customers show this tool to be accurate, scalable, and effective in reducing revenue spills in daily codeshare route operations. This tool is a quick-win practice to protect airline benefits from rapidly expanding codeshare partnerships.

A Benchmarking study of passenger choice based optimization algorithms on real airline networks

Goda Doreswamy, Mohammad Liaee, Atul Kumar Malik, Sylvia Zhu, Amol Deshmukh - Sabre Airline Solutions

The last 10 years have seen huge changes in the airline industry business environment due to entry of low cost carriers with simplified fare structures and distribution via internet that provided price transparency to the end passenger. All the traditional assumptions of independent passenger demand with clearly fenced fare structures got invalidated and necessitated modeling passenger choice in forecasting demand. The consideration of passenger choice in modeling spill and recapture estimation while evaluating control policies needs to be an inherent part of optimization algorithms.

This study leverages Sabre's simulation tool Airline planning and operations simulator (APOS) to evaluate multiple choice based optimization algorithms for revenue management decisions on real leg and O&D airline networks. Three enhanced optimization methods are benchmarked on a base case of DLP+EMSRb system that uses traditional demand forecasts.

- a. DLP_OD + EMSRcb (Choice based EMSRb)
- b. DLP_OD + Time DPCP (Choice based Time DP)
- c. Stochastic network optimization with spill and recapture based on Genetic algorithms

These methodologies model the interaction of demand across different available price points of a given itinerary as well as other itinerary options in the market conditional on the control policy.

Advanced prediction methods for massive airfare datasets using Apache Spark

Josef Habdank – INFARE Solutions

Developing and deploying a scalable prediction platform is a very challenging task that many big data practitioners are struggling with. The holy grail of data science/prediction infrastructure is to train the prediction models in real time as the data is collected and streamed into the data center, and serving the prediction results in an on-demand fashion via a service.

In this talk the speaker will go through a set of online machine learning tools that if used appropriately can be scaled to work on truly massive datasets with of billions or tens of billions of rows flowing through the system daily. The talk will cover dimensionality reduction, clustering and prediction using both simple tools such as linear regression as well as more advanced tools such as Markov Chains.



At Infare Solutions this framework is developed to be used on a massively multivariate time series, collecting a 1.5billion+ new airfares daily, as support tool for the airline Revenue Management systems.

Subscription Revenue Management : Lockin Customers Lock-out Competition

Sachin Goel - Optiontown

Air travel has been for too long, and still is, an impulsive one-time purchase often based upon the strongest influences at the booking moment. A slightly lower fare, a timing that seems thirty minutes more convenient, a new product, a new brand, a new gimmick. While Frequent Flyer Programs try to address this, even that is not a given these days. Consider the mobile phone industry; how often does a subscriber switch telephone service providers? Rarely, if ever!

Imagine locking-in even part of such loyalty into the airline business.

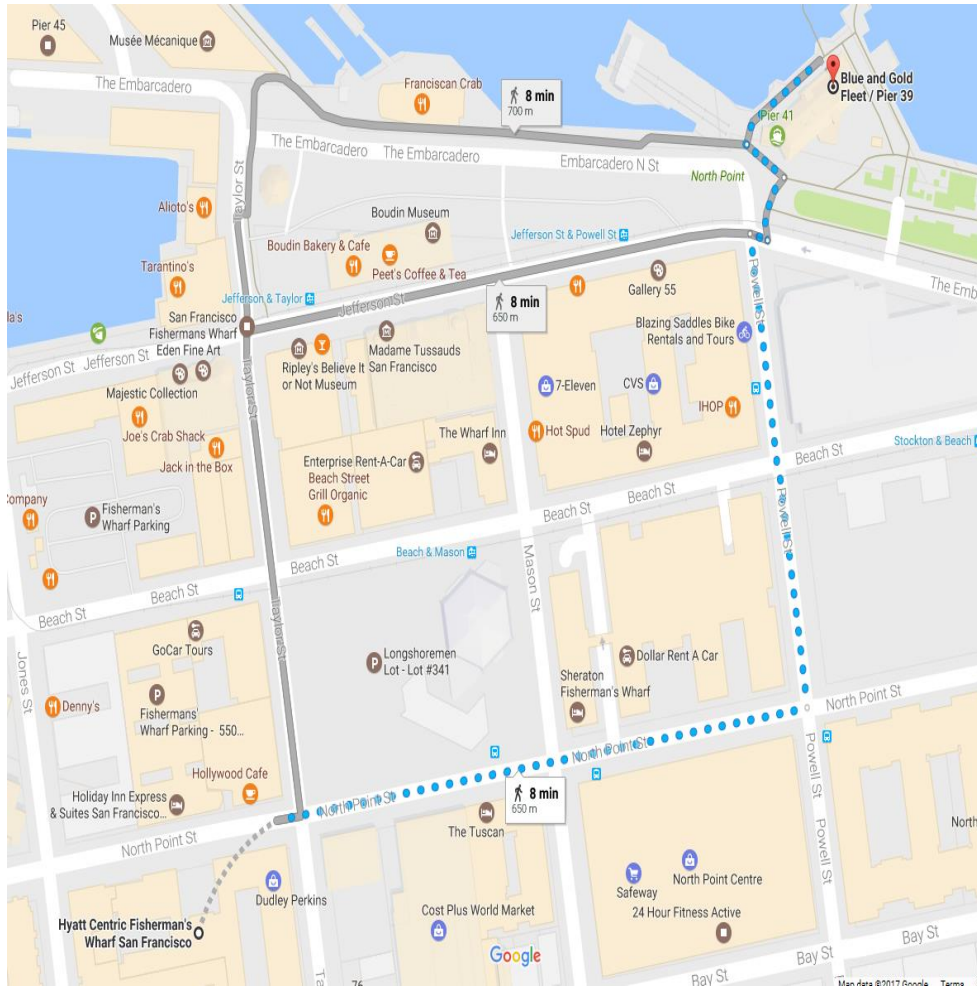
Imagine locking in your customers to blocks of 5, 10, 20 flights, or more! Imagine not having to win customers' loyalty on a trip-by-trip basis! Imagine securing up-front revenues, improving cash flow. Well now you can; over 20 airlines including British Airways, Singapore Airline-TATA JV (Vistara), Alitalia, Kenya Airways, Fly Dubai (to name a few), have launched a disruptive innovation - Flight Pass, developed by Optiontown. It helps in minimizing the cost, time and effort invested in the flight booking process. Compared to static, restrictive older airline coupon booklets, the new flight subscription can be customized by customers and revenue managed by airlines. So, a perfect win-win for both!

In subscription, the customer can lock-in a price for a number of trips and self-define all the terms like number of destinations, peak or off-peak travel periods, the lead-time for booking, the names of multiple passengers and so forth. Airlines can fully revenue manage the subscription pricing; the price per flight offered depends upon the conditions chosen by the customer and is dynamically calculated by subscription revenue management algorithms based on predetermined rules fed by the airline. Subscription increases customer's willingness to pay as they tend to pay more for greater freedom and premium features, flexibility and convenience. The benefits of a flight subscription can be shared with friends and family effortlessly. Flight pass is a light touch implementation with no capital expenditure and no IT development from the airline. Recently, the Kenya Airways Flight Pass took less than 30 days – from very first business meeting to the launch date (soup-to-nuts!) It is time to re-think the fundamental paradigm. Risk fighting for every single ticket sale or build subscribers paying you hundreds or thousands of dollars per month for years to come.



Dinner Cruise on 5/17

As part of the social program, we will have a networking cruise at Blue & Gold Fleet. <http://www.blueandgoldfleet.com/>



Blue and Gold Fleet Dinner Cruise

BOARDING at 6:45p, Cruise 7p – 10p

Leaving promptly @ 6:15p, Hotel Lobby

0.4 mile (650m) walk to **Pier 39, Gate #3**

Wear comfortable shoes

Warm, layered clothing



Conference Evaluation Form

Section I: Conference Content

Please answer the following questions

1=Strongly Disagree - 5=Strongly Agree

This conference met my expectations: 1 2 3 4 5

The pace of the conference was appropriate for the subject: 1 2 3 4 5

Because of this conference, I am better prepared for my job: 1 2 3 4 5

Please list any topics that you would have liked to discuss:

Section II: Presenters

Please answer the following questions

1=Poor - 5=Outstanding

Rate the presenters' overall knowledge of the subject: 1 2 3 4 5

Rate the presenters' ability to add value to the conference material: 1 2 3 4 5

Rate the presenters' ability to answer questions in a clear manner: 1 2 3 4 5

Rate the presenters' overall delivery: 1 2 3 4 5

Things I like about this conference:

Ways I would improve this conference:

Vote for the Best Presentations:
