Examining Global High-Speed Point-to-Point Package Delivery: Recent Activities of the FastForward Study Team

Dana Andrews[1]
Andrews Space, Inc., Seattle, WA 98104

John R. Olds[2] and A.C. Charania[3]
SpaceWorks Engineering, Inc. (SEI), Atlanta, GA, 30338

Derek Webber[4]
Spaceport Associates, Bethesda MD 20817

Amaresh Kollipara[5]
Earth2Orbit, LLC, San Francisco, CA 94123

Kevin Bowcutt[6]
The Boeing Company, Huntington Beach, CA 92647-2099

Michael Beavin[7]
Office of Space Commercialization, U.S. Department of Commerce,, Washington, DC 20230

Kelvin Coleman[8]
FAA Office of Commercial Space Transportation, Washington, DC 20591

Bill Khourie[9]
Oklahoma Space Industry Development Authority, Burns Flat, OK 73624

Steve Landeene[10]
New Mexico Spaceport Authority, Las Cruces, NM 88001

Allison Odyssey[11]
Space Florida, Kennedy Space Center, FL 32899

Andrew Nelson[12]
XCOR Aerospace, Mojave CA, 93502

Frank Taylor[13]
Sierra Nevada Corporation (SNC), Poway, CA 92064

Chuck Lauer[14]
Rocketplane Global, Inc., Oklahoma City, OK 73159

[1] Chief Technology Officer, 505 Fifth Ave South, Suite 300.
[2] Principal Engineer, 1200 Ashwood Parkway, Suite 506.
[3] President, SpaceWorks Commercial, 1200 Ashwood Parkway, Suite 506.
[4] Washington D.C. Director, 5909 Rolston Road.
[5] Founder & Managing Partner. 2250 Bay Street Suite 107.
[6] Senior Technical Fellow, 5301 Bolsa Ave., Mail Code H45N-E406.
[7] Senior Program Analyst, 14th & Constitution Ave., NW, Rm 6818.
[8] Program Manager, 800 Independence Avenue, SW.
[9] Executive Director, 501 Sooner Drive - P.O. Box 689.
[10] Executive Director, 901 E. University Ave, Bldg 3 Suite C.
[11] Aerospace Engineer and Safety Manager, SPFL M6-306 Room 9030.
[12] Chief Operating Officer, P.O. Box 1163.
[13] Project Manager, 13855 Stowe Drive.
[14] Vice President of Business Development, 4300 Amelia Earhart Lane, Will Rogers Airport.

Robert Wetherall[15]
Lockheed Martin Space Systems - Valley Forge, King of Prussia, PA 19406

Jack Kennedy[16]
Virginia Commercial Space Flight Authority, Wise County, Virginia 24293

Both public and private organizations are currently determining how to develop, operate, and regulate new supersonic and hypersonic reusable vehicles. Many of these vehicles are being designed for very specific missions depending on various business models. Recently, there is a perception that solutions for suborbital spaceflight coupled with technologies for hypersonic research may enable future capabilities such as global high speed, point-to-point cargo delivery. Such a future transportation network could service important commercial centers around the globe with new and enhanced services, specifically better next-day and same day options. Such a network could consist of a global fleet of delivery vehicles within a network, with such service expanding as further generations of vehicles are introduced. Such a service could be an evolution of the current global fast freight businesses operated by companies like UPS, FedEx, and DHL. Decreasing door-to-door delivery times in an increment important to customers will demand significantly faster transportation systems relative to subsonic airliners. Such new capabilities will pose challenges in terms of technologies, economics, environmental impacts, regulation, and international policy. This paper summarizes recent activities of the FastForward study team. The FastForward study team is a diverse, ad hoc study group focused on common issues related to future global, high-speed point-to-point package delivery. The team is broadly supported across the aerospace industry, with key representatives from system providers (emerging and traditional), government agencies, commercial spaceports, and specialist consultants. The FastForward study team is focused on examining pre-competitive issues that are important for all parties, in order for all to understand the viability of such a service from multiple dimensions. A selection of issues critical to understanding this market includes the size of the market, location of operational sites, payload/range/speed requirements for the flight vehicles, and regulatory/policy hurdles. An overview is given of the FastForward Study Group.

Nomenclature

CABAM = Cost and Business Analysis Module
DES = Discrete Event Simulation
FF = FastForward
GHoST = Global Hypersonic Shipping Time
GMT = Greenwich Mean Time
SEI = SpaceWorks Engineering, Inc.

I. Introduction

The FastForward Study Group is a diverse, ad-hoc industry study group focused on common issues related to future global, high-speed point-to-point transportation (including passenger travel and fast package delivery). The team is broadly supported across the aerospace industry, with key members from flight system providers (both entrepreneurial and traditional aerospace hardware companies), future operators, government agencies, commercial aerospaceports, academic organizations, and specialist consultants. Members have backgrounds ranging from traditional aviation to space applications. The FastForward Study Group is focused on examining pre-competitive issues and questions key to understanding the technical and economic viability of future high-speed global transportation services based on either atmospheric or exo-atmospheric flight. These two emerging markets are

[15] Program Manager, 230 Mall Blvd.
[16] Officer (secretary of governing board).

related, and both share the goal of drastically reducing point-to-point travel times between distance points on the globe to a matter of hours.

Establishing a common understanding of the opportunities and challenges of these markets is critically important for all parties at an early stage (see Fig. 1). While specific implementation approaches and business strategies vary widely among the study team members, the goal of a safe, reliable, and affordable point-to-point commercial service is universally shared. Key FastForward study activities include market forecasting as a function of price and service class, identification of preferred locations and preferred characteristics of operational sites in the global network, establishment of payload, range, and flight speed requirements for the flight vehicles, identification of key technology prerequisites, and recognition of common regulatory and policy hurdles. The group also serves as an advocate for government policies and practices that would be favorable to engendering a strong U.S.-led market-driven business sector in ultra high-speed atmospheric and exo-atmospheric flight.

It is hoped such a forum can better define the suborbital market and explore preferred options for providing services (in a generic way -- i.e. flight frequencies, market size and price elasticity, preferred takeoff and landing destinations, required cargo capacity per flight, special handling requirements/limits). This type of information is a necessary pre-competitive part of everyone's future business plan. Collaborative subgroups of members are performing preliminary technical and economic analyses that will benefit all members. All members contribute reference documents, background material, and knowledge that is openly shared with the rest of the study group. Outside experts and guest speakers provide information to all group members (e.g. shippers, regulatory officials, etc.).

II. FastForward Study Group: Recent Activities

The FastForward Study Group was founded in 2008 and is managed by SpaceWorks Commercial of Atlanta, GA USA. For several years, there has been debate among those in the community as to the technical feasibility and financial viability of suborbital/orbital space tourism and high-speed global hypersonic point-to-point transportation. In August 2008, this interest led to the assembly of the FastForward (FF) study group, a pre-competitive collection of representatives from various stakeholder organizations that meets regularly to discuss the future possibilities of such a network. While the group has recently broadened its focus to take in passenger service, the first study efforts were targeted towards high-priority small package shipping.[1] The group's concrete products include technical papers and white papers on topics of PTP transportation for use by our members and the community at-large. Members meet regularly by telecon, supports a range of conference and panels, and use virtual collaboration tools to conduct business and exchange ideas. Currently, approximately 20 organizations are represented (by invitation) in the study group. Participation in the FastForward Study group is by invitation only. In order to have the most efficient discussion and dialogue with relevant parties, this approach has been taken. There is no fee to join and volunteer time is given by the study participants. Please contact the authors for information on joining the study group.

Participation in the study group includes access to the study's collaborative web site, email discussions, teleconferences, in-person meetings, etc. The team has set up a Google Group for discussion and file sharing (by invitation only): http://groups.google.com/group/fastforwardstudy. The group has held several teleconferences in 2008 and 2009 with both study group and external speakers. There has been one half-day face-to-face meeting on February 4, 2009 in Washington, D.C. (half-day workshop), just prior to the FAA's Commercial Space Transportation Conference. Another meeting is planned in 2009 during the International Symposium on Personal and Commercial Spaceflight (ISPCS) in Las Cruces, NM.

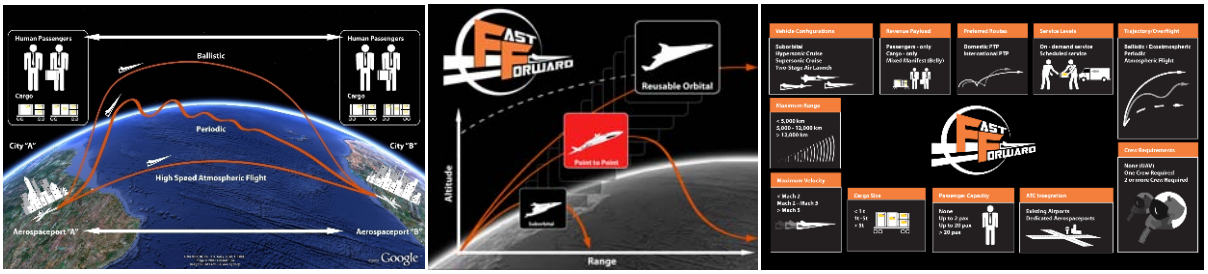

Figure 1. Point-To-Point (PTP), Evolutionary Path, and Options

Potential market approaches for high-speed global point-to-point travel are quite diverse, with several candidate options potentially leading to successful business models. These options includes various revenue payload options including: passengers (tourists, business travelers, VIPs), cargo (standard envelopes, freight, perishables), and mixed passengers/freight solutions (belly cargo). Another set of options includes the various destinations, such as: domestic service (e.g. east coast-west coast U.S.), international/global service (long distance transoceanic and transcontinental), and the potential to use a network of emerging international aerospaceports. Additionally, there are options for the type of service that would be offered, including: on-demand service (quick response flights taken when and where needed) and/or scheduled service (e.g. FedEx/UPS or airline type models). There are also a diverse set of preferred vehicle configurations represented by FastForward team members that could potentially work under some of the above mentioned models, but all must meet key requirements. These include the following:

- Economic Viability
  - What is the design market? Can it compete and make money?
- Technical Readiness
  - What are key technologies (propulsion, airframe, controls)
- Safety & Reliability
  - Can it achieve aircraft-like safety and reliability records?
- Environmental Impacts
  - What about SST downfalls: noise, land overflight, emissions?
- Regulatory & Legal
  - Can high-speed point-to-point overcome regulatory and legal hurdles: streamlined customs, liability, overflight of non-participatory countries, integration with ATC systems?

One can also begin to examine various city pair sets for such point-to-point services. Some of the FastForward study team members have been looking at potential city pairs defined in terms of three possible 'tiers' of cities in between which all possible routes would be flown. Tier 1, the base case, consisted of Los Angeles, New York, London, Cologne, Shanghai, Hong Kong, and Tokyo. The second tier added Mumbai, Dubai, and Sydney, and tier 3 added Buenos Aires, Sao Paulo, and Johannesburg. In all of these cases, routes are not flown between cities serving the same global region. For example, given the nature of existing regulations, a hypersonic New York – Los Angeles flight would be impossible. The other groupings without links to each other are London and Cologne; Shanghai, Hong Kong, and Tokyo; Mumbai and Dubai; and Buenos Aires and Sao Paulo. All other routes are potentially flows, subject to the constraints of the vehicle studied. The FastForward vehicle and these city groups, having already been selected, were used as the base case for some of the analyses members of the team have conducted. These city pairs are deemed to represent a good starting point for discussion within the Study Group.

Additionally there are several potential future aerospaceports that may serve as initial nodes in point-to-point delivery systems (outside of those city pairs just mentioned). These emerging Spaceports face a number of challenges that will need to be addressed if they are to become a part of the PTP network. A subgroup of the study group attempted to qualitatively assess some of the topic issues facing spaceports in such a network. The following are the initially identified top seven issues facing spaceports in terms of enabling point-to-point operations. An assumption was made that vehicles and technologies to deliver such point-to-point services were outside the control of the individual spaceport.

1. ACCESS:
   a. Airspace Management & Integration with the National Airspace System (NAS)
   b. Establishing Flight Corridors (noise, safety, Ec calculations, environmental compliance, etc.)
2. COHERENT LEGAL & REGULATORY FRAMEWORK FOR INTL OPERATIONS:
   a. Operate under LICENSE and INFORMED CONSENT
   b. Affordable Underwriter Market: Insurability of Operations
   c. Cooperative Regulation (FAA, EASA, CAA, etc)
   d. Legal Operating Frameworks amongst Domestic & Intl Spaceports (Pt to Pt Network)
3. COMMON SPACEPORT PROCESSES AND PROCEDURES:
   a. Fuel Handling and Storage, Equipment, Hazardous Matl., NEPA, etc.
   b. Streamlined Customs Issues for Passenger & Cargo Operations (for international service), etc.
4. AVAILABILITY OF SPACEPORT LOCATIONS:
   a. Investment in Spaceport Infrastructure in Multiple Locations to Create and Effective Network
5. MANAGING MILITARY AND COMMERCIAL OPERATIONS WITHIN SPACEPORTS

6. POTENTIAL ITAR ISSUES
7. POINT TO POINT BUSINESS MODEL VALIDATION:
    a. Showing Relative Advantages of Point to Point & Spaceports over Existing Cargo/Passenger Airports
    b. Ability to Realize Time Savings from Pt to Pt (Reduce Travel Time from City Center to Spaceport)

Overall, there are several specific current areas of investigation for some of the members of the FastForward Study Group. These include the following areas:

- Hypersonic or Supersonic Service?
    - Is supersonic service sufficient to meet market requirements?
    - Is exoatmospheric flight required?
- Market Size and Characteristics
    - Who are the likely customers and what will they ship?
    - What synergies exist between passenger and cargo service
- Identification of Emerging Spaceport Challenges with respect to PTP Services
    - Subgroup of spaceport members prioritizing segment issues
- Upcoming Study Products
    - White paper on PTP as a incremental stepping stone requiring commercial and government partnerships (Fall 2009)
    - Technical papers and panel sessions at SPACE 2009, IAF 2009 (including results from modeling and simulation)
    - Group workshop at ISPCS 2009 (Las Cruces, NM, USA)

III. Recent Modeling Efforts

In order to determine whether the whole transportation network is a feasible idea, estimates had to be made of market potential. This required building models to help quantify how hypersonic service compared with available subsonic services, as well as aiding in the vehicle design process by defining what levels of performance were required to represent significant advantages over that service. While these models have been mentioned in previous work written by the FF group, they have been further developed over the last year to make them both more flexible and more informative, and the purpose of this paper is to explain them in greater detail[1]. A summary of some of these models is given below.

The Global Hypersonic Shipping Time (GHoST) Calculator is a spreadsheet model developed to enable easy analysis of the time advantages achievable by a high-speed vehicle compared to existing commercial package service on a given shipping network. GHoST is maintained at SEI, and is currently utilized in support of the FastForward study group's efforts to understand the market potential of this type of global hypersonic service. The layout of GHoST is dominated by a complete list of all theoretically possible routes between any two cities, with each route's data occupying fifty cells in a single row. The routes are grouped by the tiers of service and, in effect, each of the three tiers is being analyzed in parallel within the same model. The GHoST Calculator gives an in-depth picture of the routes achievable for a high-speed transportation network, and how the performance of those routes compares to existing commercial priority shipping options. A user is presented with useful summary graphs, and also has their attention drawn to key individual routes they can inspect to make intelligent decisions about their input parameters. The use of the delivery day as a metric is well-suited to the business model of the priority package shipment industry. In short, SEI's GHoST Calculator is an ideal model to incorporate into any study of next-generation high-speed cargo transportation networks.

Once a flight schedule has been established for a desired service network, manually or using GHoST, this schedule can be used to determine the number of vehicles needed to support the network. The complexities of the service network, particularly the fact it is spread across a complete range of time zones, require a model that can keep track of the movements of every individual plane, and track its availability to carry another shipment. Discrete Event Simulation (DES) is a methodology designed to handle exactly these sorts of problems[2]. A DES model was built to simulate a week's worth of high-speed package delivery flights over the global network defined by the FastForward study group.

Both the GHoST calculator and the DES model were developed for the specific purpose of supporting the FastForward study group's efforts to build a business case for a global hypersonic shipping network. Outputs from GHoST were used to justify various revenue-related assumptions driven by knowledge of the speed advantages of

the service. The simulation was crucial in determining the number of vehicles that would have to be acquired, a significant driver of total program cost. As the FastForward group continues studying various scenarios, including passenger service, these models will continue to be relied upon for data. In fact, the group has adapted them to study whether a supersonic network would have similar advantages to the hypersonic baseline case. Both models can also be used in conjunction with financial models to help determine overall life cycle cost and financial value, as represented by calculations of Net Present Value (NPV)[3]. This work cumulatively represents a significant step forward in the modeling and understanding of high-speed global transportation networks from an industrial engineering and economic perspective.

IV. Observations and Future Work

Some specific lessons learned so far, within less than one year of the group's establishment, include the following:

1. Cargo Market May Not Be Large Enough By Itself
    a. SEI-C 2008 IAF paper --> Negative business case for initial simulation assumptions
    b. Caveat: market survey was very weak and notional, improvements called for
    c. Caveat: limited city pairs and only "scheduled" service considered
2. Passenger Market May Add Traffic, and Thus Lead to Economic Viability
    a. Princeton Space Express Team --> Found positive NPV for combined market
    b. Caveat: issues raised on some traffic and production assumptions
3. Supersonic Business Jet May Offer Advantages Over Hypersonic Vehicles on Some Routes
    a. SEI-C Initial Findings --> SSBJ more competitive on routes it supports
    b. Caveat: didn't consider a two-vehicle tiered market approach

The FastForward Study Group continues to investigate these and other issues with high-speed global point-to-point transportation. The group's overall intelligence on this subject is improving slightly with collaboration and data exchange within the group. Additional teleconferences and in person meetings are scheduled. Future technical papers and white papers will be released by the study group.

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