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Paper Session II-A - Launch Site Payload Operations In The Coming Spaceport Era

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Launch Site Payload Operations In The Coming Spaceport Era

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Abstract

Following the completion of the International Space Station assembly, the development and initiation of 2nd Generation Reusable Launch Vehicle operations, the emergence of commercial space activity on a greater scale, and the evolution of the Cape Canaveral-Kennedy Space Center spaceport, the demands for launch site payload processing and operations can be expected to escalate geometrically in the years 2010 to 2025.

Access to space in this coming era must address the question of what payloads; human and otherwise, will be launched into space in order to plan for provisions that must be made to successfully process these payloads and integrate them into the space access system. In order to be ready to meet these needs for the payloads it is imperative that efforts begin to identify and define the parameters that will generate these needs.

This paper investigates and identifies the space system parameters that will define the potential payload fleet and associated architectures. It will also identify areas requiring analysis. The paper addresses technical, regulatory, operational, economic, and policy parameters and issues and also outlines initiatives in analytical evaluation of how such factors interact with spaceport development and operation.

Introduction

Let us consider the development and the evolution of the Kennedy Space Center and Cape Canaveral Air Force Station payload launch and landing operations in the period from approximately 2010 through 2025 and beyond. This paper deals with the payload operations in the Cape Canaveral area; however, the principles would apply to other large-scale spaceports. For the purposes of this paper we use the term “Spaceport Canaveral” to refer to this geographic area. This would include the Cape Canaveral area as well as that part of Merritt Island within the John F. Kennedy Space Center. However, it may be expected that some portions of Spaceport Canaveral may be physically removed from this immediate area or even from Florida. Such situations may involve local commercial facilities, distant operation or control of test activity at KSC or CCAFS, RLV landings at distant sites in planned or unplanned situations, and possible operation of space based range components.

It is natural to think of the spaceport in terms the launch vehicles and launch pads. During this era exciting new and improved launch vehicles are expected to supplement those of today. We also find it natural to consider the physical Spaceport Canaveral in terms of launch complexes, vehicle processing areas, and the range facilities. By payload operations we do not mean simply the payload operations accomplished by the NASA Kennedy Space Center at that site as performed today. We wish, rather, to consider all payloads whether they are government, corporate, academic, or military and whether they are human or non-human payloads.

It is all too easy to forget the basic purpose of the Spaceport Canaveral. Its purpose is not primarily to fly launch vehicles; rather it is to launch payloads into space as part of a transportation node that supports a specific mission. An important concern is that planning for these payloads and their operations must begin early in the development of Spaceport Canaveral. This not only involves attempts at defining the anticipated payloads but also understanding their launch site requirements. This includes defining their processing facilities and understanding how such facilities and operations are integrated into the spaceport's operations.

It is the purpose of this paper to examine the identification of areas needing definition such that payload prelaunch operations analysis and planning can be effectively undertaken. We also hope to discuss some aspects of analysis and definition in order to consider potential study efforts. Ultimately we hope to define a study concept that would form the basis for effective planning for Spaceport Canaveral payload activity.

Spaceport Canaveral Characteristics

We have chosen to look at the period from roughly 2010 through 2025 as that period will, in all likelihood, include the first major launch vehicle technological changes from the basic Atlas, Delta, Titan, Shuttle era of the 1970s through the first years of the 21st century. The 1970's were also an era when both range and payload operations did not undergo revolutionary change. Although by the year 2010 we optimistically look forward to a number of new launch vehicles, we anticipate that the improved Atlas and Delta vehicles will be operating on a regular basis and that the Space Shuttle will continue to provide RLV service. However, by the later years of the first decade of the 21st century we hope to see the Second Generation RLV fruits of the Space Launch Initiative as well as possible new entrepreneurial launch vehicles coming on line. New initiatives in range and spaceport technology can also be expected to have arrived and to be in operation. Therefore, the year 2010 makes a convenient initial milestone. The characteristics of Spaceport Canaveral then may involve a very diverse set of technologies as the legacy vehicles continue to fly in conjunction with new launch vehicles and new technology is brought into operation in place of the old. The choice of 2025 as an end point is somewhat arbitrary. However, technical, economic, and political factors prevalent more than a few decades in the future have not been readily discernable in the past. Also, if in the course of the study efforts it becomes critical and feasible to take a longer period under consideration it may readily be done by either extending the study or initiating a follow-on study.

An additional characteristic of the spaceport at this time may be limitations on geographic space. If the number of launch vehicle types increase, then the number of launch complexes may be expected to increase as well. Unlike airports, spaceports usually cannot use the same runway/launch complex for a wide variety of flight vehicles. The fact that launches are inherently dangerous means that danger areas around the launch complexes will preclude the construction of facilities on much of the land area of the spaceport.

Study Concept of Operations

Our approach is to develop a concept of operations for payload activity studies that results from a series of “environments” which will affect Spaceport Canaveral payload operations, most of which are not well defined at this stage in spaceport planning. Spaceport Canaveral will function by operating in response to a variety of such environments, including those such as mission mix, payload customer, payload type, launch vehicle architecture, regulatory, policy, marketing, technology, economic, local geographic, and international competitive environments. These environments will intersect and overlap as they affect Spaceport Canaveral activity.

The environments may be thought of as analogous to planes which intersect and whose interfaces define the boundary conditions of the universe of possible system states. Given “N” such environments we can consider the universe of potential factors affecting payload activity conditions at Spaceport Canaveral to be analogous to an “N” dimensional space. Also we may expect these operational environments to vary over the time period under consideration. Therefore, by incorporating a time component into our studies of these environments we may define a resultant analogous to a “state vector” such that at any given time from 2010 into the third decade of the 21st century we may define those forces impacting and affecting payload operations at Spaceport Canaveral.

Environments

The varying environments that interface and interact to contain the probable Spaceport Canaveral payload activity during the period under consideration can be considered to affect the operational flow defining the process. The anticipated mission mix will define the probable payload mix. This in turn will affect the launch vehicle architectures chosen to fulfill the mission. Both payload and launch vehicle environments define the anticipated support environment. The mission mix, then, acts as a forcing function on the spaceport configuration, infrastructure, and operation. While consideration of regulatory, policy, marketing, economic, and international environments would affect mission choice at a programmatic level, and thereby indirectly affect our proposed analyses, they are considered in these studies only as they affect the Spaceport Canaveral payload world as such. Specific environments would include, but are not limited to the following eight. It is probable that a number of others also may be relevant – hence the use of the term N-dimensional above.

Mission Mix Environment

For the period under consideration we will have to consider that Spaceport Canaveral would be providing support for commercial, civil government, possible international, as well as military missions. Commercial missions would involve a diverse number of customers and may involve both deployed satellites; space station utilization, resupply, and maintenance; as well as potential human cargoes in either a launch or a landing context. Civil government missions may focus on missions the private sector cannot perform such as advanced technology exploration missions. There may also be a wide variety of missions ranging from services such as weather surveillance to scientific and technology development flights. Military missions may involve both development and operational missions. Privatization and commercialization may also evolve to the point where they affect mission definition. During the later years of the time under consideration human spaceflight beyond Earth orbit may become a valid mission category.

Probable missions definition then, are an initial departure point in the analysis effort to define Spaceport Canaveral payload operations.

Payload Configuration Environment

Given that an environment can be specified that defines anticipated missions, through a study effort we can address the definition of probable payloads. Clearly, human payloads can be expected to increase sharply and we must determine the civilian-military nature of these as well as their roles in space. The traditional pilot/scientist role may be expanded to include tourists, technicians, or trades people. Human payloads may be flown to Low earth orbit and may also be taken beyond LEO and even to Lunar or planetary locations. It is interesting to note that large spacecraft such as the ISS and MIR required almost full-time human maintenance. If a need for very large planetary probes arises it may drive a requirement to include humans rather than exclude them.

Non-human payloads will include those currently flown such as civilian government, military, and corporate; however, Spaceport Canaveral studies must also address the possibility for payloads flown by other entities. Perhaps an academic consortium or an international consortium of countries with no feasible spaceport facilities of their own may become factors. Additional human infrastructure in space – either LEO or Lunar may foster a demand for orbital logistic payloads. Success in space science and space-based science may drive a requirement for more extensive scientific instruments of a variety of types, sizes, and operation. Far more extensive commerce in space may be the result of the many efforts to bring expanded space commerce into being. All of these will affect the demand for support and logistic facilities.

Launch Vehicle Environment

Although we may expect that toward the early years of the period beyond 2010 the legacy launch vehicles such as Atlas, Delta, Pegasus, and Shuttle would dominate the Spaceport Canaveral launch vehicle stable, the proposed study effort would have to consider the potential inclusion of second generation RLVs, the impact of the Space Launch Initiative, initiation of future military launch vehicles, potential entrepreneurial launch vehicles, possible fractional orbit vehicles, as well as the requirement for launch vehicle types we have not even considered.

In addition to providing the actual launch vehicles for our payload mix, we must also consider the impact of launch vehicle operational modes on payload-related activity. Will Spaceport Canaveral mix both development and operational launch vehicle operations and how will that affect routine payload activity? How will launch vehicle flight rate affect spaceport operations? Would more frequent launch vehicle flight operations impact ground operations by requiring unduly frequent Blast Danger Area closings? Would more frequent launch operations impact or overload data transmission facilities and impact routine payload test operations? There are a variety of launch vehicle-related impacts to spaceport and spaceport payload operations. The suggested study efforts should help to identify and clarify such impacts.

Government Policy and Regulatory Environment

The prediction of government policy and regulatory impacts is a vital area for spaceport planning; however it may be the most difficult environment to predict, given the nature of our society. Multiple agencies at the local, county, state, federal, and even international level will be involved. The policy environment will reflect political, economic, social, and other initiatives

that must be considered. The regulatory environment can certainly be expected to change between 2002 and 2010 and also between 2010 and 2025. It is likely that policy and regulatory impacts to spaceport operations will be greater in the 2010 to 2025 period than they are now. And yet, if we are to plan effectively for Spaceport Canaveral we must have some idea of how these areas may evolve. Significantly, four of six recommendations of the Interagency Working Group report on future management and use of space launch bases and ranges deal with policy issues¹.

Organizational Environment

Planning for roles and responsibilities will be a major area of spaceport planning. Questions to be answered include those such as: Who will operate Spaceport Canaveral? What does “operating” a spaceport mean (especially from a payload operations standpoint)? What organizations will operate on or with respect to the spaceport? What are the roles of the government: local, state, national, and international? What would be the roles of corporate, military, civil government, academic, and non-profit entities and how would they be organized? Will the organization scenario for Spaceport Canaveral be driven by organizational principles or by political considerations? Answering such questions, and many similar such questions, depends upon defining probable roles and responsibilities for a number of entities. Clearly, if the payload community in the period 2010 through 2015 is to be the passengers and cargo of space such questions will impact their operations at the spaceport.

The role of Spaceport Canaveral may evolve into that of a transportation node in a complex of transportation systems. If so, the integration of the spaceport into that system will also have an impact on the organizational climate in which the spaceport may operate.

Natural and Physical Environment

The physical boundaries of Spaceport Canaveral are currently limited both by the actual land area and by environmental policy. They may be functionally increased by distributed data and signal distribution such that payload test operations can be based at home locations that are quite distant from the spaceport; perhaps internationally or even aboard orbital stations in the not too far distant future. Potential sea-launch operations can also extend the functional spaceport area. The Spaceport Canaveral ground area, however, is limited and current regulatory policy would suggest that it is unrealistic to expect that more land area – either by eminent domain or wetland fill – is possible. However, study efforts may show more effective ways to utilize the areas and the wide variety of expected payloads would suggest that multi-mission, rather than mission-specific, facilities and support would be necessary.

Additionally, the function of the Spaceport Canaveral operation would be affected by weather factors. Planning for future operations needs to address the issue of weather impacts not only from the standpoint of describing expected weather but also from the standpoint of determining if there are initiatives we can pursue that would lessen the weather impact. Currently, for instance, moving or operating payloads in a ground environment can be impacted by lightning threat. Are there courses that can be followed to reduce such impacts? Hurricanes, while not having had considerable impact to Canaveral area facilities and programs, will continue to be a threat. May we take more effective action to prevent possible damage to payload operations and facilities?

The physical boundaries of Spaceport Canaveral may themselves vary over time as payload operations may occur both within the accepted area of the spaceport or within facilities

located “outside the gate” such that the operational boundaries may expand to take in commercial or academic facilities in support of payload prelaunch operations. Also, distributed data processing and handling may allow some aspects of the spaceport payload operations to take place at distant locations.

Spaceport Canaveral will exist within a complex physical context of a national airspace system, water transport, and human habitation spaces. Operation of the spaceport and its payload component will depend upon how these interact not only with Spaceport Canaveral and its launches but, in an RLV era, with landing operations and potential launch inclination angles over inhabited areas. The natural and physical environment may not vary as far as climate and weather, however it will as far as the spaceport interacts with sea transport, airspace, and population spaces.

Economic and Market Environment

While legacy civil space markets such as communication and various surveillance satellites, together with human and non-human science missions will continue to provide a major portion of the Spaceport Canaveral payload community, we hope to see an extension of commercial space operations. The determination of the characteristics of the commercial space spectrum will provide data that will be of value in planning for the payload operations at the spaceport. Additionally, significant capital expenditures will be required to support increased spaceport payload throughput in terms of increased support activity and facilities. Also a very significant factor would be the potential availability of government funding to support civil and military missions from the spaceport.

International Environment

Currently and in the past, operations at American spaceports have been almost entirely American in character. To be sure, there may be the occasional foreign communications satellite, foreign scientific experiment, or the non-U. S. citizen-astronaut. However, in general, the human or non-human cargo has been predominantly national. That may not be true in the Spaceport Canaveral of the future. If there are limited global spaceports and if there are even fewer RLV spaceports, then Spaceport Canaveral may have to take on some of the characteristics of a “hub” operation within a transportation system in the same sense as current hub airports. Significantly increased flight rates may mean significantly more nationally diverse payloads; both human and non-human. Both launch vehicle and payload developers might become multi-national entities – corporate and government. Additionally, there may also be a market for launching foreign boosters from the Spaceport Canaveral or adjacent waters.

Additional international factors may include treaties, customs, import and export considerations that would affect payload operations. Spaceport payload operations involving complex or scientific payloads may require a large complement of non-U.S. citizen support personnel.

Cross Environment Factors

Some factors may operate in a cross-environment mode. Such concerns as safety, security, advancing technology, scheduling, weather, quality assurance, and others may affect several or even all environments. There is, then, a body of study subjects that would affect the

definition of payload operational aspects in multiple situations rather than being considered environments themselves.

Proposed Approach

The study approach to identify and describe the probable Spaceport Canaveral payload operations universe envisions a multi-pronged and interactive strategy.

Study Effort

A series of algorithms may be postulated to outline the interaction among the several potential study efforts. A first algorithm anticipates that mission would drive payload and payloads would define launch vehicles and that both launch vehicles and payloads would define probable payload operational support requirements such that these would affect the universe of possible Spaceport Canaveral payload launch operations. A second notes that the organization as well as the natural and physical environments would each act directly upon the various payload operations possibilities and would function to also define the payload operational support for which we would ultimately need to plan. Government policy and regulatory as well as economic and marketing, and international environments act on the mission definition but also affect the possible payload operational support universes. This relationship is shown in Figure 1.

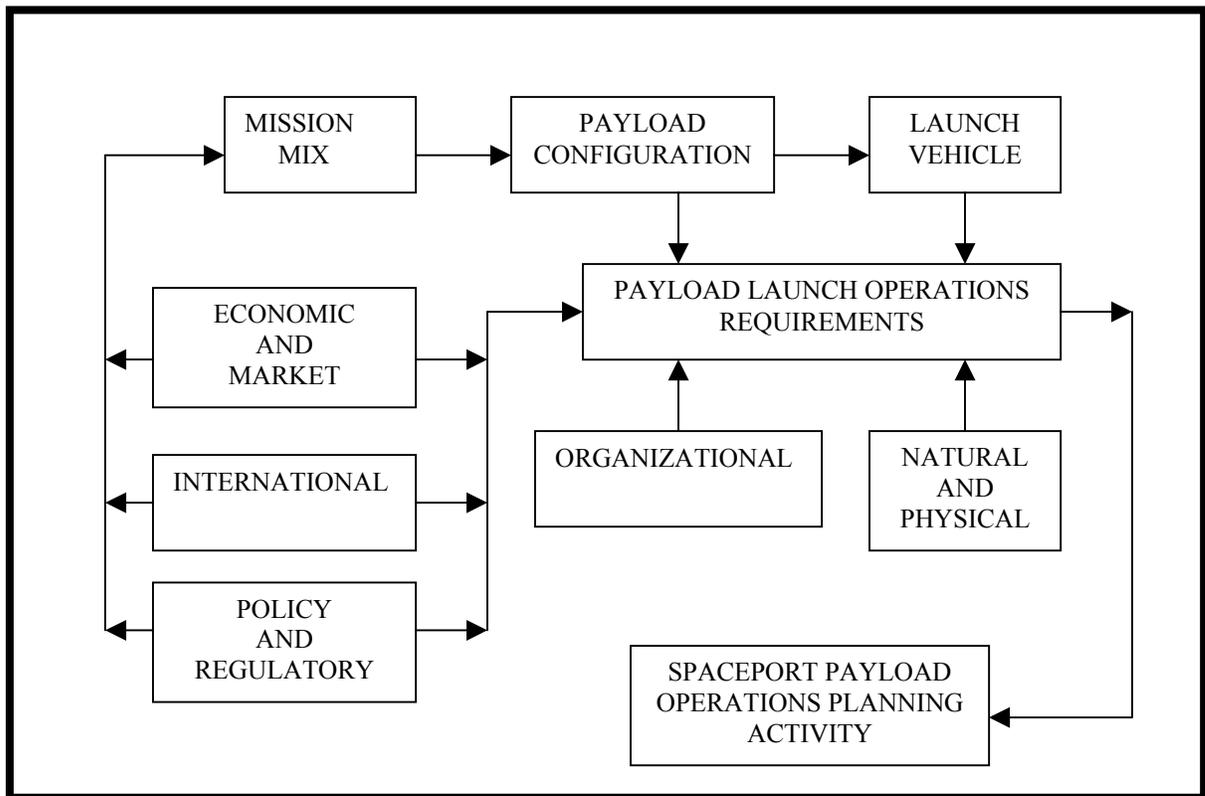


Figure 1. Relation of Study Environments to Spaceport Canaveral Payload Planning Working Group

The interactive nature of the various environments would suggest that the study approach involve initially separate analytical efforts which would then be integrated and an interactive effort show how they would interact to define possible Spaceport Canaveral payload operations requirements (1) over the time period in question and (2) ranges of probabilities for varying payload operational requirements.

It is also proposed that an Advanced Payload Launch Operations Working group (APLOWG) be established. Such a working group would be made up of the payload community as well as representatives of the spaceport community. The APLOWG would provide continual inputs to the Spaceport Canaveral payload planning effort and, thereby, enhance the efforts in that initiative. Representatives from a wide variety of organizations and a wide variety of technical, managerial, and policy disciplines would benefit by exchanging concepts, developing an understanding of significant issues, and by synergistic factors.

Summary

Planning for the second and third decades of the 21st century must begin in the first decade. This is clearly true in the field of spaceport payload operations and the study efforts discussed above provide a basis for such planning. This paper has developed an approach to developing the information and the cooperation that will ensure that such planning will develop effective and useful concepts. The physical and programmatic results will serve the payload operations function at Spaceport Canaveral during the critical years ahead.

However, there is an ancillary benefit to the studies suggested. The development of defined mission mix and payload configuration environments expected in the years ahead may serve as a forcing function to “define the possible” in terms of space operations. Instead of reactively responding to uncoordinated proposals and non-coherent policy initiatives as in the past, these studies may provide the keystone to that elusive structure we have been seeking for many, many years - a focused and coherent Space Policy.

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Reference

1. Report of the Interagency Working Group, The Future Management and Use of the U. S. Space Launch Bases and Ranges, OSTP/NSC, Washington, D.C., February 8, 2000