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Integrated Resource Management

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Introduction

The 45th Space Wing is responsible for providing range and launch processing support services to its customers using the launch site at Cape Canaveral Air Station and the Eastern Range. At the same time, funding for providing this support and maintaining the necessary infrastructure continues to be constrained. Government and contractor manning for operating the Eastern Launch Site and the Eastern Range has declined by roughly ten percent in the last five years. The government, along with industry, is being asked to do more with less and do it faster. New customers no longer spend four to five years introducing a launch program. Instead, a new commercial customer may expect to make a launch date two years after initial program introduction. To accomplish the 45th Space Wing's mission of "Ensure National Strength Through Assured Access To Space" and achieve its vision: "To be the World's Premier Gateway To Space" require that the funding and resources the Wing does receive be used as efficiently and effectively as possible. Effective and efficient use of the Wing's resources to accomplish its mission depends upon information—information about those resources and how they are to be used.

In the summer of 1996 the commander of the 45th Space Wing, in a positive approach to improving the way the Wing uses information to manage its resources and serve its customers, chartered a government-contractor team to examine this subject. That team developed a concept called integrated resource management. This paper, while solely the product and opinion of the authors and not the official position of the U. S. Air Force, is a reflection of that team's deliberations and subsequent innovative efforts by the commanders and members of the 45th Space Wing and its contractors.

Current Resource Scheduling

Spacelift customers, whether Department of Defense, national, civil or commercial customers, come to the 45th Space Wing because the Wing provides the resources they need to complete their missions. The resources the Wing provides to customers can be grouped into three broad categories: facilities such as processing facilities and launch complexes, processing and launch support such as security and fire protection services, and range services that include the use of range instrumentation and other systems. These resources are almost entirely maintained and operated by contractors. The largest Wing managed contracts are the Launch Base Support (LBS) contract and the Range Technical Services (RTS) contract. The LBS and RTS contracts have about the same manning and together consume a majority of the Wing's budget. The LBS contractor maintains most Cape Canaveral Air Station facilities and also provides varied support services such as fire protection and special lighting. The RTS contract is focused on providing traditional range services and therefore maintains and operates the radars, telemetry, communications, and similar systems. At less than one tenth the manning of the LBS and RTS contracts, the Range Visual Instrumentation Technical Services (RVITS) contract and the Launch Operations Support contract (LOSC), are roughly equal in size. The RVITS contract provides audiovisual services and optical metrics while the LOSC primarily operates and maintains spacecraft processing facilities.

There are also several small or short-term contracts that provide specific services such as radiographic inspection of solid rocket motors. In addition, NASA and the Air Force have agreed to share certain services provided by their respective contractors so that some resources are provided to Wing customers via contracts managed by NASA at the Kennedy Space Center. There are a variety of such NASA managed services including environmental services provided by the Base Operations Contract (BOC) and electromagnetic analysis provided by the Payload Ground Operations Contract (PGOC). Also, each of the major government launch booster programs (Titan, Atlas and Delta) functions through contracts initiated by the Air Force Space And Missile Systems Center (SMC), but monitored on site by the 45th Space Wing through its Space Launch Squadrons. The booster program contractors use and maintain a great deal of government furnished equipment (GFE). Much of this equipment is specific to the booster involved, but significant numbers of items, such as hydrosets, are generic in nature and could be useful resources to other customers. Finally there are some resources requested through the Wing and provided to customers by other national ranges or government organizations. In summary, the resources provided to Wing customers are generated and maintained by a variety of contractors. These resources are allocated or "scheduled" by several offices and processes.

Understanding terminology is the key to discussing 45th Space Wing planning and scheduling. Planning is the process of identifying a step by step series of actions or tasks, often over a long time horizon. Scheduling commonly refers to establishing specific timing for tasks or actions that have been previously planned and is usually for a shorter time period than a plan. Each Wing customer, as part of the customer's normal work process, prepares a detailed plan of the numerous steps that must occur to prepare booster and spacecraft and complete a successful launch. The customer also schedules these steps by establishing detailed timing for these tasks, usually in two-week increments. This schedule is often published in a "72 hour, 11 day" Gantt chart format. The Wing, in supporting a customer, does not schedule in the same sense a customer does. It does not plan a series of tasks and then set the timing for these tasks. The Wing, instead, responds to the customer's requests for support needed to fulfill his own schedule. The Wing accomplishes this by allocating the resources needed to meet the customer requirements. The customer determines the timing, unless the resource is not available or is already fully scheduled by other customers. In that case the Wing must decide which customer should have the resource and propose at what times the resource would be available. Therefore, when the Wing "schedules" resources, whether the customer's activity is a launch or a minor processing evolution, it is allocating resources in response to the customer's plan and schedule and the resource's availability.

Wing resources are allocated through a number of offices and processes. The two main Wing scheduling offices are Air Force Range Scheduling which directly oversees the RTS scheduling function and the LBS Cape Support office which handles requests for LBS support and passes requests to several other contractors, including the RVITS contractor. The LOSC also operates a scheduling function that principally interacts with the various payload customers who use the spacecraft processing facilities. Each of the contractors also has an internal scheduling function that plans and schedules its own work and interacts with the appropriate Wing scheduling office. The Wing scheduling offices generally work on the straightforward basis of request and allocate.[1] A user requests the support that a resource can provide and, if the resource is available when

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[1] *A prime exception is the allocation of a launch date, which in effect grants the use of many resources directly tied to the launch. Historically launch dates were also allocated in the same way as other resources with Range Scheduling allocating the date and resolving conflicts. Currently the allocation of a launch date starts with Range Scheduling but requires the approval of multiple commanders in the Air Force and a government board. This process can take anywhere from a few days to months to schedule a launch date.*
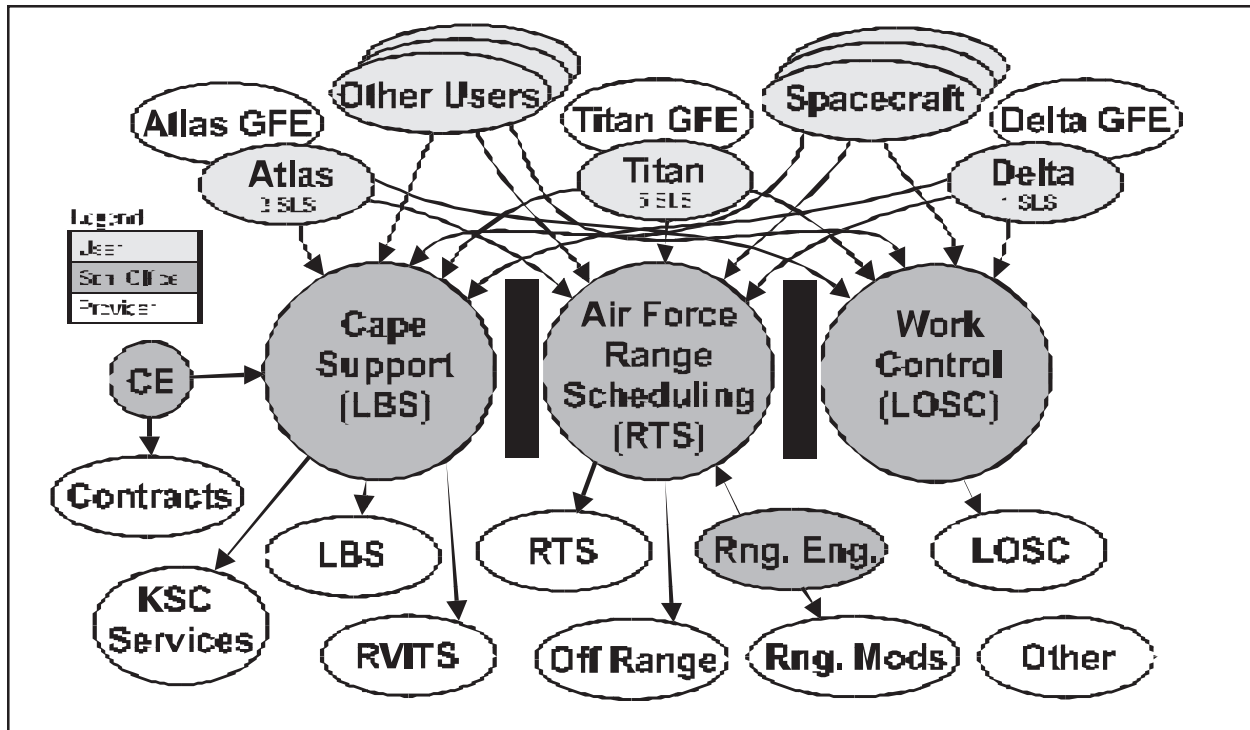
Figure One: Current Resource Scheduling

needed, it is allocated to the requester. If the resource is not available, the scheduling office works with users and the organization providing the resource to find an alternative solution. Facilities are allocated through a much more convoluted process that involves many offices. The information used during the allocation process is transmitted via paper documents, often faxed, telephone calls, and continual scheduling meetings.

Because there are many resource users, varied resource providers, and limited information, Wing resource allocation or "scheduling" is a disjointed process. Resource users include all the Wing's customers and the internal organizations and Wing contractors who also use the same resources. These users have diverse methods of planning and scheduling their own activities. At the same time, as described above, there are numerous organizations that provide resources. Each of the resource providers has its own way of organizing data about its resources, automated to various degrees. Each resource user has an agenda focused on its own mission and shares little information about the timing of its needs beyond a two-week horizon. There is limited information readily available to the user concerning the resources, other than a direct response to the request for the resource with nothing usually available concerning other users' needs for the resource or planned maintenance. The various scheduling offices have little need to share information and operate largely independent of one another. Figure One graphically depicts this situation. While the 45th Space Wing and its customers have been eminently successful in accomplishing their missions, the need to do more with less and do it faster requires that we find a way to use the resources we have more effectively and efficiently. One approach would be to place all Wing resources under a single contract in much the same fashion as NASA has done by placing all Shuttle processing under a single contract. That single contractor would integrate the use of the Wing's resources to obtain efficiencies. Indeed, for much of the history of the Eastern Range, most of the functions of the RTS and LBS contracts were performed under a single contract. However, this single contract approach, while offering efficiencies, has disadvantages in that it reduces

competition, ignores the multiplicity of Wing users, and can not practically encompass all resources. An alternative is to use information technology to share information between resource providers and users to obtain the same results: integrated resource management.

Integrated Resource Management: A Foundation for Planning & Scheduling

The underlying idea of Integrated Resource Management (IRM) is the sharing of information. To effectively manage the Wing's resources we must share timely and complete information about what the user wants to do (the user tasks) and information about the resources that are available to the user. Information about the user tasks includes understanding what the task is, who is involved, when it is to be done, and what support is needed from the Wing. Information about the resources includes what the resources are, their capabilities, and their availability. The information must be shared with all the organizations and agencies involved in generating, managing and using the resources: the customers or users, the commanders, the contractors who generate the resources and the offices that monitor and control the resources. The basic premise of IRM is that better information sharing will enable the various parties involved in the resource allocation process to make better decisions about those resources. A second premise is that efficient sharing of information can only be achieved with information technology.

Integrated resource management envisions a system of separate databases that hold and share information about user tasks and resources. It would encompass all resources requested of or through the 45th Space Wing. Resources would include any support facility, equipment, vehicle, unit, service, or location that may be necessary for user mission accomplishment. Information about each resource would include its unique identification, its capabilities, its status, and availability. The availability data would show how the resource was committed for future use. Information about the user tasks would include the identification of that task, its relationship to other user tasks, its timing and duration, and the specific support needed for that task. The support requirement would reference the appropriate section of the Universal Documentation System (UDS)[2] data that described the specific resources required. The UDS data would also be held in a database. Communication between databases would occur via standard means of describing user tasks and resources that would allow any type of computer system and database to participate. It would be a system in the sense that its separate databases would interact with each other in defined ways. See Figure Two.

The Integrated Resource Management approach does not aim to solve specific resource allocation problems. Instead it seeks to provide information to all involved so that they have a better basis for collectively solving their problems or avoiding them altogether. The information would be shared with the resource providers, allowing them to better anticipate the users needs. Users would see the projected availability of resources, allowing them to adjust their changing schedules to that availability. The various Wing scheduling offices responsible for allocating the re-

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[2] *The Universal Documentation System is a long established method for users to communicate their requirements to any national range. It provides a structured format for users to describe their requirements and for the ranges to describe how those requirements will be met. Its main limitation, besides its current paper basis, is its lack of information about the timing of user requirements. IRM specifically addresses that limitation.*
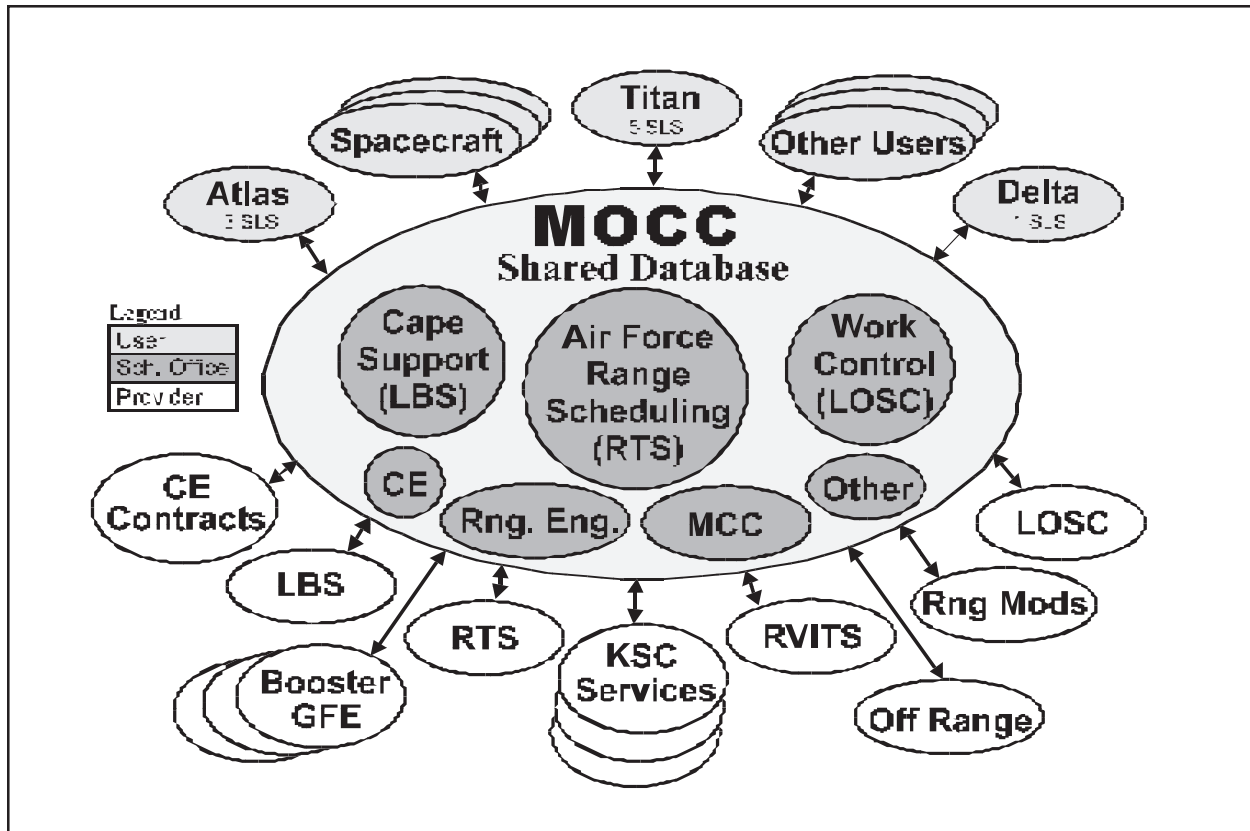
Figure Two: Integrated Resource Management

sources would have the detail needed to allow them to make decisions based on a more complete picture. Commanders and managers would have a broad overview of resource status and user needs to aid resource management. IRM provides the necessary framework for this communication.

This IRM approach is possible because much of the information necessary already exists or soon will exist in an automated form. Every user, before beginning work on a spacecraft or booster, creates a plan or program flow showing the many steps necessary to complete his mission. These plans may have thousands of tasks showing the work the user must do and are invariably created in some automated planning system. The same program flow then becomes a schedule, usually in an automated system, once the timing is set. After the required support is identified for each task in the user's automated plan and the timing set in an automated system, the user data needed for the IRM approach would be available. This user data is the same information that the user must develop and maintain to do his job, and it is generally already in some automated form.

Resource information is already in an automated form or soon will be. Today every company is in the information management business, and that is especially true of the companies providing resources for the 45th Space Wing. These companies either have, or will have, automated work control systems to do their jobs. These work control systems are essentially databases that help the company bring together people, material, equipment, and procedures at the right time and place (schedule) to do the right task for the customer. For the companies managing and maintaining resources for the Wing, their work control systems will, by their nature, have to contain the type

of resource information needed for the IRM approach because these companies will need the same information to do their jobs. These automated work control systems should be able to provide information about the resource, its status and availability, without requiring extra effort by the contractor since the contractor must collect and maintain that same information anyway.

Since the user and resource data exists in automated form in various computer systems, the key to making integrated resource management work is the ability to communicate between different types of computer systems and databases. The commercial world has already addressed a similar problem of allowing computer systems to communicate about specific business subjects such as invoices and purchase orders. Their solution is electronic data interchange (EDI). EDI is the computer-to-computer exchange of business information by means of standardized transaction sets that have been developed and used over the years in the private sector. These standards have been established as the ANSI X12 standards and the United Nations EDI for Administration, Commerce and Transport (UN/EDIFACT) standards for a wide array of subjects ranging from student loan applications to railcar schedules. The federal government has also embraced EDI as a way to streamline the acquisition process. Commercial EDI provides a means of communicating between the various computer systems in IRM. Like a EDI transaction set, a user task data interchange standard and a resource data interchange standard would consist of a set of data elements related in a hierarchical fashion. For example the data set for a spin balance machine would include elements on its capacity and rotation speed as well as its status and a unique identifier. Its set would be part of a larger data set for the facility in which it was located. Since the data is in simple text format, any computer system compatible with the standard could send and receive data about those resources. By using user task and resource data interchange standards, IRM can work with the wide variety of systems that will contain the data.

The IRM approach would work as follows: Before any flight hardware was delivered, a user would prepare an automated plan or program flow of the many tasks necessary to accomplish his mission. Customers do this already. As part of the UDS process, each task in the program flow would have the necessary Wing support specified and the resources to provide that support identified. The user would specify the timing of the tasks in the program flow and share it electronically with all the resource providers, the various Wing scheduling offices, commanders and managers, and, where appropriate, even other users. As the customer began processing, he would update this program flow to create his work schedule and the updated information would be shared electronically with all required parties. Since the scheduled program flow shows what support the user needs and when he needs it, the scheduled program flow becomes a set of requests for support. The contractors providing the requested resources can then respond to these requests by committing resources to the customer by electronic reply so that the user can even see the response directly in his automated planning and scheduling system. At the same time, the resource provider would be sharing information electronically with all interested parties that the specific resource availability had changed since it was now committed to the requesting user for the period needed. A user with a changing schedule would update his changed requests for support the same way and would also have the benefit of seeing the availability of resources as he plans how to adjust his schedule before he makes the request. Finally, the user and the resource provider could both indicate the actual use of the resource, providing a clear, automated feedback path for billing for the resource. With IRM, the process would work just as it does now—request and allocate, but with much more complete and timely information. By tying the process directly into the user's and resource provider's own systems, it becomes easier to use and more responsive than the current manual methods of requesting support.

For each user request, the resource provider organization must commit to provide the resource to the user. Since this is an automated process, the various scheduling offices would normally only monitor the transactions, but their intervention would be needed in two cases. First, if a

user requested support that did not match the resources available; then it would be necessary for the appropriate scheduling office to understand the user's request and determine the correct resource. The second case would be the more common situation where there is insufficient resource so that the scheduling office must resolve the conflict between users to determine which user gets the resource. Again this process matches the current one,[3] except that all of the parties would have more complete information for setting priorities. The IRM approach does not suggest what the priorities should be for resolving conflicts, only that complete information should be shared with all parties and that the basis for decisions should be clear to all.

It will be important to preserve the integrity of data in several ways: First, only the author of a particular request or response should be able to change it. This assurance eliminates a possible source of confusion. Next, classified and proprietary data must be protected. Fortunately, considerable data has been declassified in recent years so that the use of aliases and similar techniques should eliminate the need for certified systems capable of handling classified data. Policies and commercially secure systems would protect proprietary data. Finally, the record of what happened must be preserved. Today it is difficult for anyone to analyze how Wing resources are used because little data is preserved and it is kept in diverse ways, often only on paper. A complete automated record of how resources are used may be the greatest benefit of IRM since it would support analysis that could help to optimize the use of future Wing funding.

Implementation: A Long Term, Incremental Process

Integrated resource management implies a large-scale computer system that would cost many millions of dollars to create. However such an approach, besides being impractical, is unnecessary. As noted above, the necessary data, for both user tasks and resources, is or will be available in an automated form. Every user already has some type of automated planing and scheduling system. Wing contractors are beginning to establish robust work control systems. The LOSC, awarded in October of 1995, already has such a system. The winner of the Visual Information Technical Services Contract (VITSC), which will be awarded this year to replace the RVITS contract, is also expected to have an automated system. The winners of other future contracts, to be awarded in 1998, will also undoubtedly have comprehensive work control systems. Thus by 1998 most launch processing support or facility resource data will be available in automated form in contractor systems. Data on range services such as radars and telemetry is already being automated by the Range Standardization and Automation (RSA) program[4], which is upgrading range systems to include automated control links. Most of the resource data necessary for IRM will be available in the next two years.

Phase IIA of the RSA program will provide another element that can make IRM possible in the near future. The RSA IIA contract plans to deliver a replacement for the current range scheduling computer system, hopefully in 1998. The replacement scheduling system will be based on a pow-

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[3] Again, the current prime exception is the setting of launch dates, which has a more involved process for settling conflicts between users. It is possible that the sharing of information under IRM may make such an approval process less necessary.

[4] RSA is now often referred to as the SpaceLift Range System (SLRS), though the program name remains unchanged.

erful database and will include automated links to the range systems. The RSA IIA scheduling system could provide the central "glue" to connect the distributed IRM databases together. It would only need to accept and resend data about resources and user tasks through the user task and resource data standards interface. It would also act as the central repository of records for analysis and handle such functions as assuring that all resources had unique identifiers. These capabilities could readily be included within the RSA IIA scheduling system that is still to be built. Using this approach could make IRM a reality at low cost in the near future.

The 45th Space Wing is taking some immediate, interim actions to improve resource management. These efforts are first steps in implementing the IRM concept of sharing information. The Wing is establishing a Maintenance Operations Coordination Center (MOCC) that will consist of several Air Force members collocated with Range Scheduling, Cape Support and LOSC Scheduling. Collocating these scheduling offices with the MOCC will stimulate interactions and a synergy that can only enhance resource management. The first job of the MOCC will be to serve as a single point for information on resource status. To aid the MOCC in this task the Wing is developing an intranet-based status reporting system that will allow first line supervisors to report the status of systems and equipment to all interested parties. Making the database that underlies the status system mirror the resource data interchange standard will enable the status system to be used as both a testbed and a springboard for implementing the IRM concept.

Finally IRM, through the user task and resource data interchange standards, offers the potential for even wider impact. The Space and Missile Systems Center (SMC) is seeking to find a means to monitor and manage the government furnished equipment used and maintained by the various booster contractors. By using the resource data interchange standard approach to obtain the needed information directly from the contractor computers, SMC could not only meet its needs at low cost but also make that data readily available to the Wing. At the same time the Air Force is in the process of developing replacements for its civil engineering information system and its maintenance information systems over the next two years. Coordinating with these systems would make it possible for contractors to use the resource data interchange standard to communicate with these new systems.

Conclusion

Integrated resource management will share information about user tasks (who wants to do what, when and the support required) and resources (status, availability and capability) with all interested parties (commanders, users, resource providers and scheduling offices) to enhance the resource scheduling decisions of all concerned. It can be achieved by building on the automation inherent in user planning and scheduling systems and in Wing contractor work control systems, and by using task and resource data interchange standards similar to commercial EDI standards. By using the planned RSA IIA scheduling system and by building on interim steps, much of what IRM promises can be in place in the next two years at little added cost.