

11TH ICCRTS  
COALITION COMMAND AND CONTROL IN THE NETWORKED ERA

Towards Shared Awareness and Self-Synchronization in a Coalition Environment

Coalition Interoperability  
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# **Towards Shared Awareness and Self-Synchronization in a Coalition Environment**

## **Abstract**

In order to be innovative, defense organizations need to be adaptive. Traditional Command & Control structures and concepts are too rigid to allow for the necessary agility of today's geo-political environment. Coalition Forces are undergoing permanent transformation as organization, technology and concept of operations are continuously evolving. The emergence of the new concept of "collaborate and connect" fosters the flexibility to do things in new ways or to undertake new things to do, particularly new ways to achieve desired ends. Particularly, the ability to alter defense processes when necessary as the situation and/or environment changes. This paper will explore how the adoption of Internet standards and an Enterprise Services Architecture (ESA) enables interoperability within a coalition environment and reduce the time to change. In particular, the ability of organization to rapidly compose and model in a single page collection of role-specific internal and external data that provide actionable information to facilitate rapid understanding and decision making through a guided sequence of suggested steps. This approach shows a path towards the Network Centric Warfare objective of shared awareness and self-synchronization.

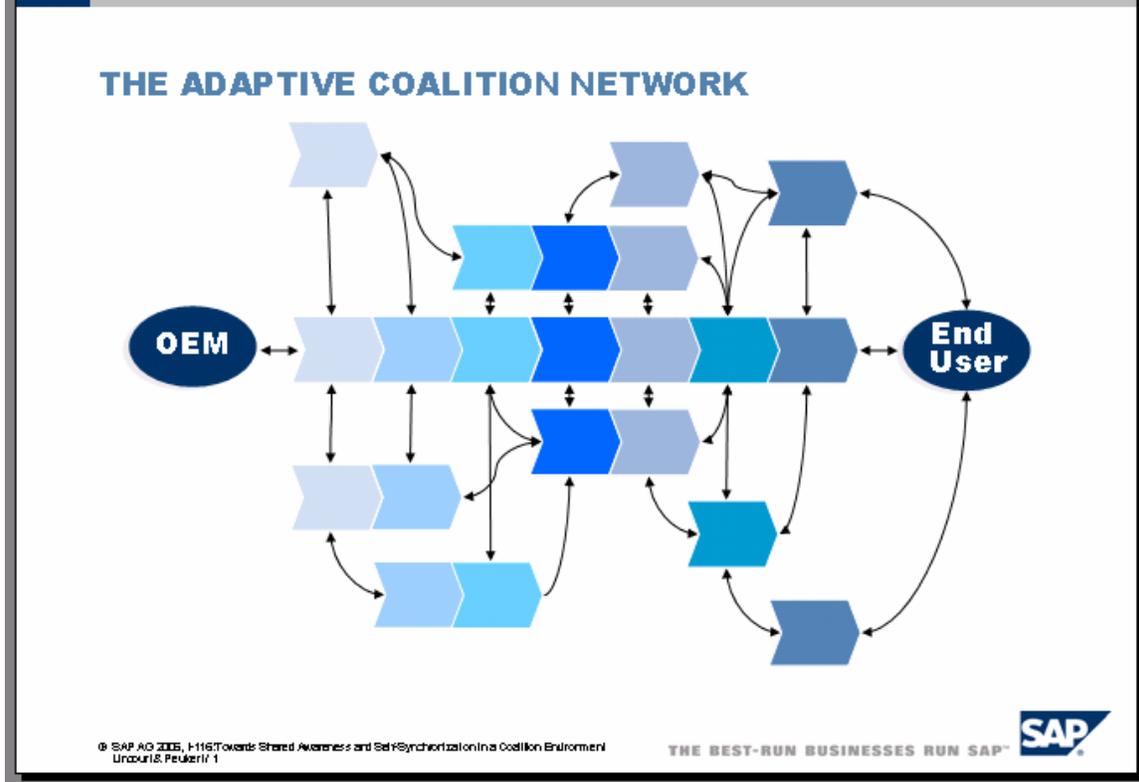
## **Introduction**

Joint and Coalition Forces are undergoing permanent transformation as organization, technology and concept of operations are continuously evolving. They are by their nature fluid and dynamic as a response to the geo-political realities and the continuous learning that occurs. Each operation is rarely the same as the previous one and tends to evolve as the operation proceeds and members rotate in and out of the coalition or the operation.

This mix of capability provides an opportunity for the coalition to do things in new ways or to undertake new things to do, particularly new ways to achieve desired ends. Particularly, the ability to alter defense processes when necessary as the situation and/or environment changes. In other words, put in practice new concepts such as "collaborate and connect".

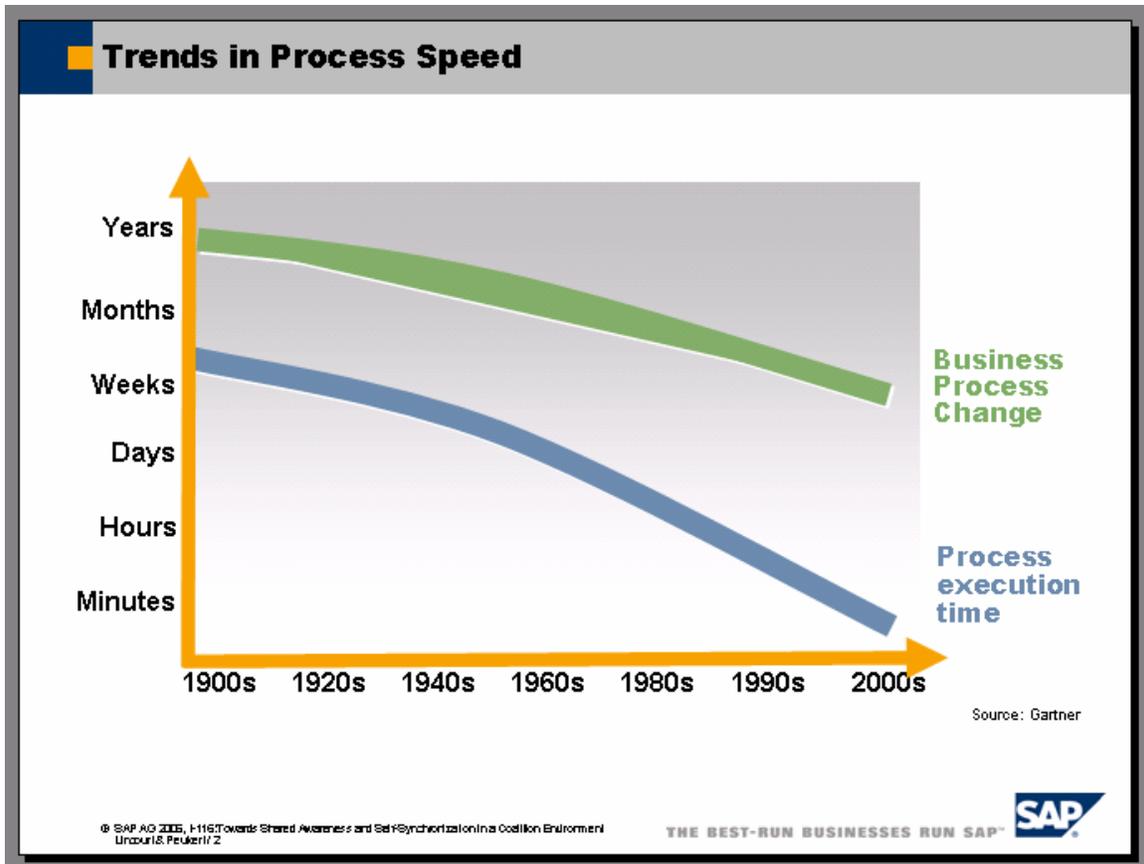
Each participant brings various capabilities to the table that need to interoperate. Often, nations provide specialists to the mix and "outsource" their service and products to other members. Invariably, this relationship is different from the previous rotation and will certainly be different from the next one.

## In an Operation: Partners will Join and Leave the Coalition



**Figure 1** – *In an Operation: Partners will Join and Leave the Coalition*

More than ever, success in implementing the concept of “collaborate and connect” rides on the ability of the underlying IT infrastructure to adapt rapidly to these evolving operational needs. The coalition needs a robust, cost-effective way to leverage and extend a heterogeneous collection of enterprise applications to support new requirements and enable innovation. It is increasingly costly and inefficient to stitch together new business processes that span disparate applications or cross-organizational boundaries or that require analytics and collaboration. For coalitions to enable adaptability, they must ensure that enterprise applications are flexible building blocks of future defense systems. A clear blueprint for evolving existing architectures is needed.



**Figure 2 – Trends in Process Speed**

The mid-1990s answer to these problems, enterprise application integration (EAI), has proven to be costly to implement and even harder to change over time as they were hampered by unsuccessful data standardization efforts without a proper understanding or consideration of the underlying defense processes. More recently, Web services enabled a large step forward toward flexibility across a heterogeneous landscape. However, current implementations have yet to unlock the true power of Web services. Most Web services today expose functionality of individual applications and are too fine-grained to be efficient building blocks for coalition-wide business processes. Creating new value from existing IT assets calls for new answers. SAP's answer is Enterprise Services Architecture, an open architecture for adaptive defense solutions, enabled by the SAP NetWeaver™ platform. Building on the benefits of Web services, it delivers on the promise of services-oriented architectures, enabling rapid adaptability and process change. With Enterprise Services Architecture, coalitions and its members have a cost-effective blueprint for composing innovative new applications by extending existing military IT systems, while maintaining a level of flexibility that makes future process changes cost-effective. Enterprise Services Architecture will move IT architectures step-by-step to dramatically higher levels of adaptability and interoperability and help coalitions move closer to the vision of shared awareness and self-synchronization.

## Interoperability through an Enterprise Services Architecture

Any answer to the challenges of enabling interoperable and flexible defense processes spanning heterogeneous landscapes must emphasize long-term adaptability and cost reduction. And it must leverage the same infrastructure, whether the integration methods are between applications within a country or service, across coalition members, or some combination of the above.

A Web service represents a self-contained, self-describing piece of application functionality that can be found and accessed by other applications using open standards. A Web service is self-contained, because the application using the Web service does not have to depend on anything other than the service itself, and self-describing, because all the information on how to use the service can be obtained from the service itself. The descriptions are centrally stored and accessible through Web-standards-based mechanisms to all applications that would like to invoke the service. In summary, Web services answer the need for a standardized and vendor-agnostic way to cope with heterogeneity and to create interoperability and compatibility among the coalitions various applications.

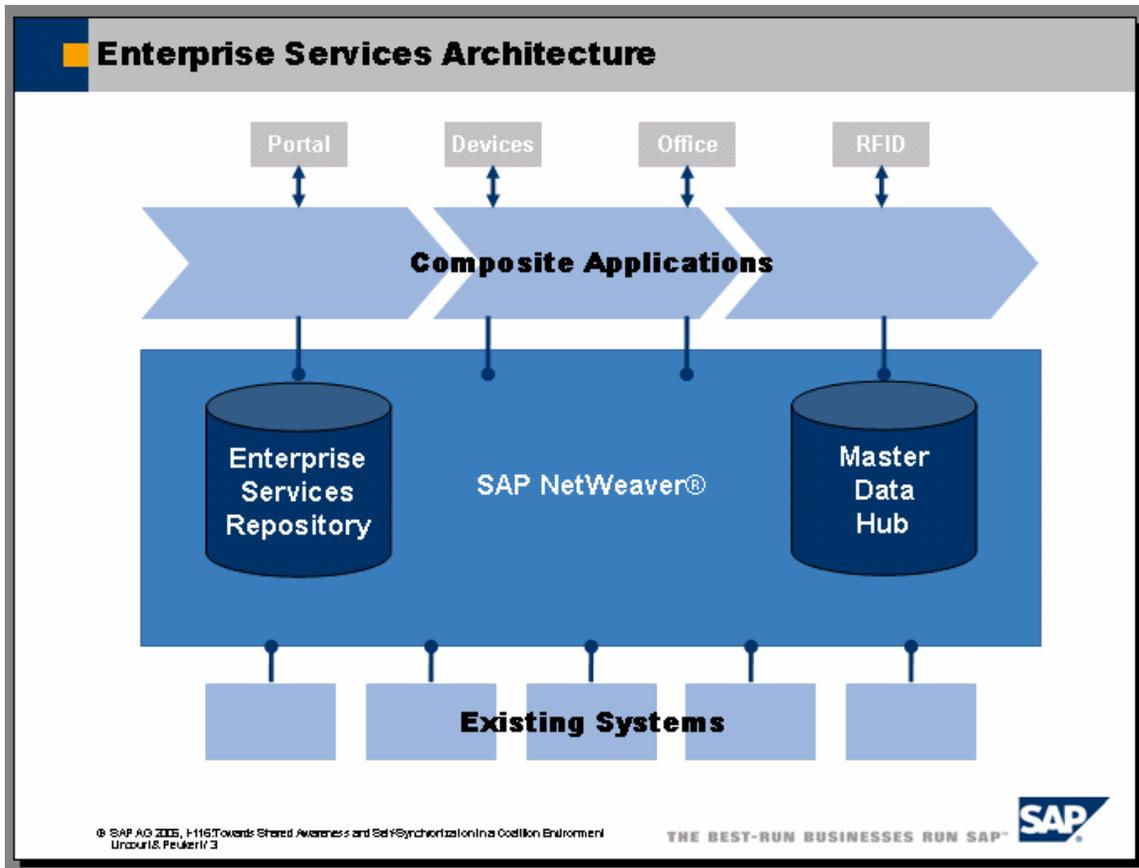
Instead of requiring programmers to establish and maintain links between applications, Web services are loosely coupled with time effectiveness boundaries, making connections simpler and more flexible and allowing application architects to more easily find and understand services offered by other cooperative applications. Applications can access a Web service across a network using mechanisms based on Web standards. Web services provide a standards-based way for an application to expose granular functionality such as “delete air task order,” which would remove an order from one particular system. To do this, Web services make use of highly standardized interfaces and a common vocabulary to hide how the underlying functionality is implemented.

Web services begin to answer the challenges faced by coalition members:

- **Heterogeneity** – The ability to communicate with other applications using standards-based mechanisms simplifies connectivity across heterogeneous landscapes. Web services can easily be discovered for use by applications that require them, as standardized catalogs of services are developed. Similarly, the abstraction of functionality provided by Web services is very useful in heterogeneous environments inherent in coalition operations, since it serves to conceal the differences between systems on a technical level. Since Web services hide implementation details of the underlying applications, a developer “using” Web services to build a new solution needs no knowledge of the structure of the applications that deliver the service. By the same token, he or she can feel secure that his or her solution using the Web service will not be impacted if the underlying applications change.
- **Reuse** – Web services also provide preliminary answers to the issues of flexibility and reuse. Changes can be made in the underlying implementation or in the program calling the Web service, as long as the behavior of the Web service stays the same. This provides the basis for combining and reusing Web services without creating a spaghetti-like maze of unmanaged complexity.

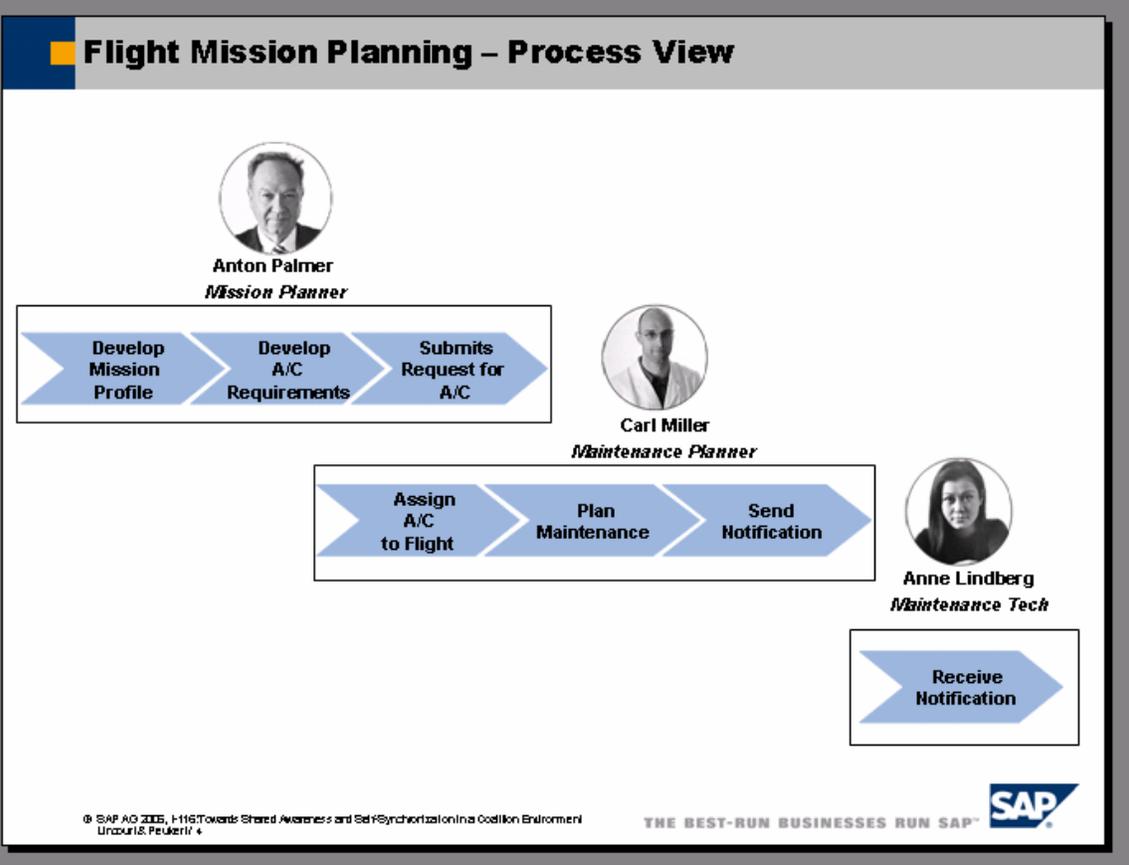
Today, Web services are largely being used to expose functionality delivered by single applications. An example could be a Web service to delete an order in one particular system – a task that might be a single step in a larger process. However, Web services are too granular to be efficient building blocks for coalition defense scenarios. The process of canceling an air task order illustrates this point. From a business perspective, the directive to cancel an air task order encompasses several cross-functional and cross-application activities, including sending a confirmation to the requesting organization, removing the order from the air plan, releasing materials allocated to the order such as ammunition and fuel, notifying the maintenance organization who was preparing the aircraft, notifying the assigned air crew, and changing the order status to “inactive” or deleting it from various systems. Each of these activities may be a Web service offered from different systems. The ability to build a complex end-to-end solution to cancel an air task order would be a very powerful enterprise-level defense service. Clearly, efficiently developing new defense solutions that leverage existing applications calls for defense-level building blocks that aggregate the benefits of multiple Web services.

Enterprise Services Architecture is SAP’s open architecture for adaptive defense solutions. The fundamental premise of Enterprise Services Architecture is the abstraction of process activities or events, modeled as enterprise services, from the actual functionality of enterprise applications. Aggregating Web services into defense-level enterprise services provides more meaningful building blocks for the task of automating coalition-scale defense scenarios. Enterprise services allow coalition members to efficiently develop composite applications, defined as applications that compose functionality and information from existing systems to support new defense processes or scenarios. All enterprise services communicate using Web services standards, can be described in a central repository, and are created and managed by tools provided by SAP NetWeaver™.

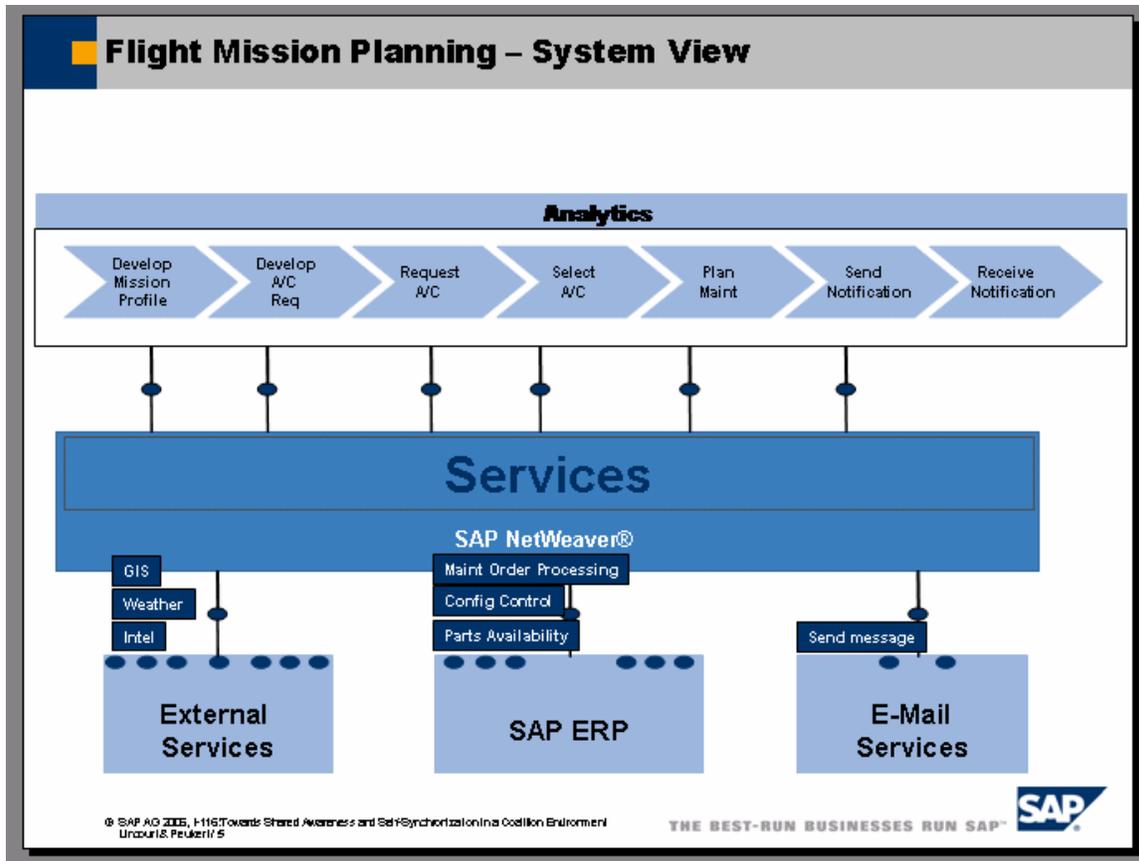


**Figure 3 – Enterprise Services Architecture**

As Figure 4 and 5 show, preparing an aircraft involves multiple applications such as Geographical Information Systems (GIS), intelligence, weather, enterprise e-mail systems and enterprise resource planning (ERP) systems where the air task order resides to plan and execute the activities to ready the required resources to conduct the air task. Typically, coalition members act as human integrators, sitting in front of many different applications, transferring information from one to the next by copying and pasting and retyping information, making process-flow decisions as needed. The applications, when they are communicating, are hardwired through brittle connections that are expensive to maintain and inhibit innovation.



**Figure 4 – Flight Mission Planning – Process View**



**Figure 5 – Flight Mission Planning – System View**

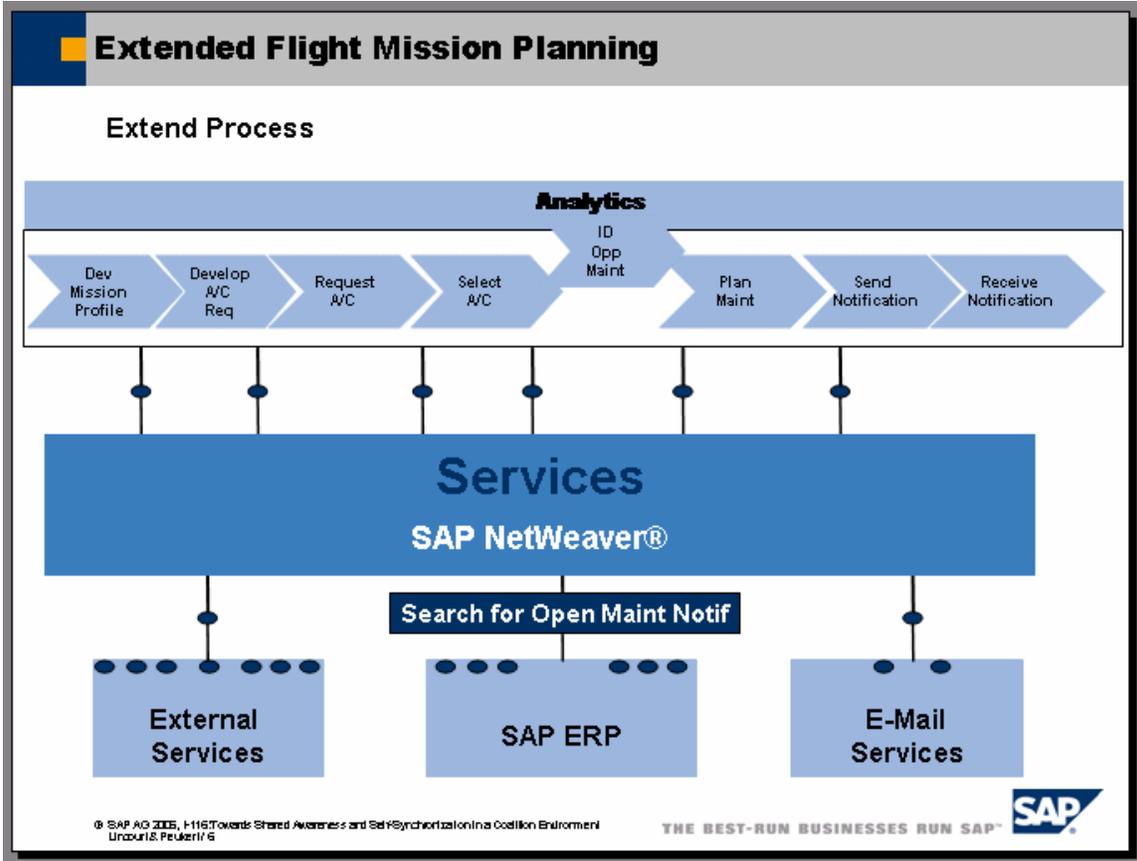
With an Enterprise Services Architecture, a composite application can use enterprise services to automate the flow of information from application to application. Each user in the scenario has a role-based interface that provides exactly the information and functionality required to meet his or her goals. The process is defined, controlled, implemented, and managed at a business level, with SAP NetWeaver providing the environment to construct enterprise services to control the flow of information from one enterprise application to the next.

The key characteristics of Enterprise Services Architecture listed are crucial to implementing defense scenarios like the air task order:

- Enterprise Services Architecture extends the benefits of Web services to enterprise business scenarios by aggregating existing systems functionality into business-level enterprise services.
- Enterprise services are modeled from an “outside-in” perspective. While the core set of enterprise services identified by a coalition member may be substantially enabled by legacy or enterprise applications (including those from SAP), they are not defined or constrained by SAP or any other vendor’s applications. In other words, Enterprise Services Architecture defines or models services “outside-in” for any application that is based on events relevant to the coalition’s processes, not necessarily on an existing application or implementation.

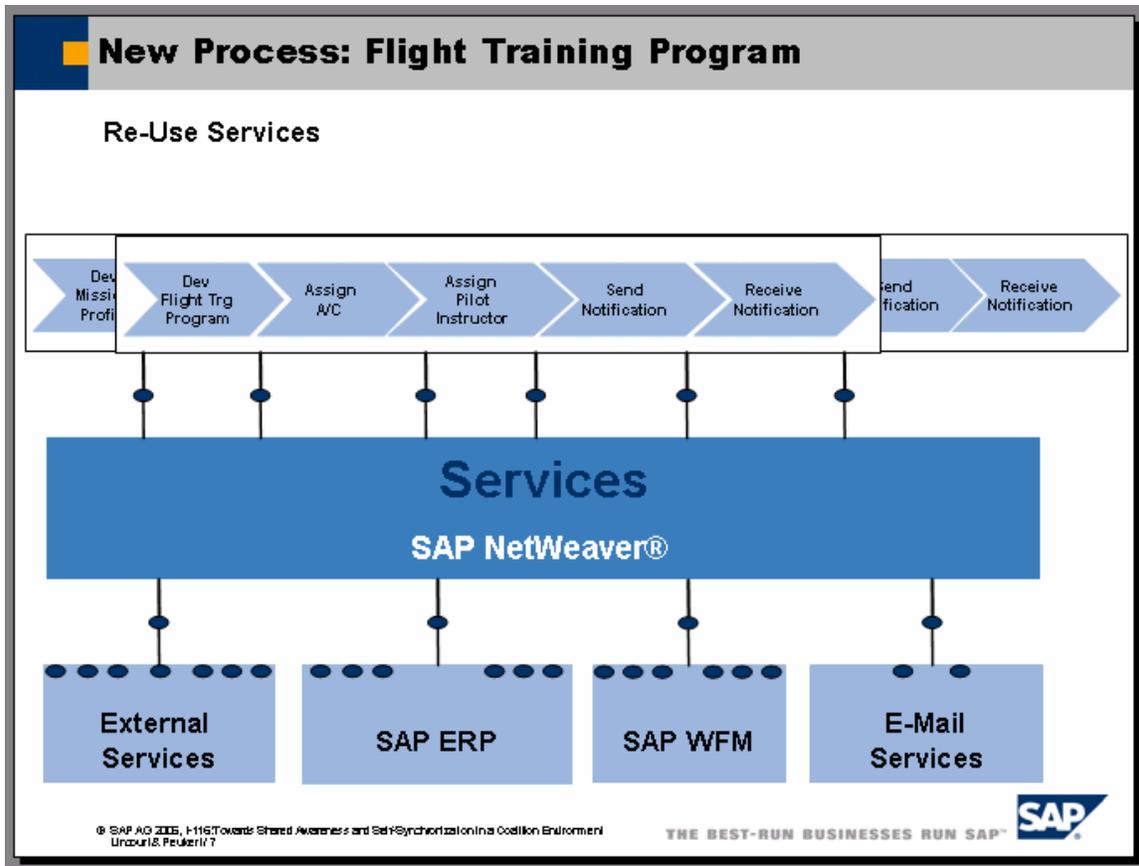
- Enterprise Services Architecture offers a blueprint for coalition-wide defense process evolution with complete investment protection. Enterprise Services Architecture is a blueprint for a coalition member's entire IT landscape.
- Enabled by SAP NetWeaver, Enterprise Services Architecture offers a gradual path to flexible, service-centric system landscapes. Enterprise Services Architecture allows for a gradual and non-disruptive transition of existing applications and architecture to higher levels of flexibility and value.
- Enterprise Services Architecture allows new and innovative defense processes to be developed, deployed, and changed independently of existing applications. "Consumers" of enterprise services are isolated from changes in applications that "provide" the service. Enterprise Services Architecture leverages an abstraction layer between the way an enterprise service is used, and the way the corresponding functionality is implemented within a coalition application. This abstraction allows composite applications or custom user interfaces (UIs) using the service, or its so-called "consumers," to be decoupled from the applications "providing" the service. As a result of the decoupling, coalition members can leverage the rich functionality and best defense practices of coalition applications to support new, innovative defense solutions, and yet evolve these solutions independently of changes in the underlying applications.

The following figure illustrates that composed processes can be easily extended to incorporate additional services. In this case, the ATO process is extended to provide the maintenance planner with the means of scheduling opportunistic maintenance while the aircraft is being mission readied.



**Figure 6 – Extended Flight Mission Planning**

Similarly, the following figure illustrates how web services used in one composite application can also be used in a different one. In the illustrated scenario, many web services from the ATO are recomposed with other web services to create a new composite for the scheduling of flight training programs.



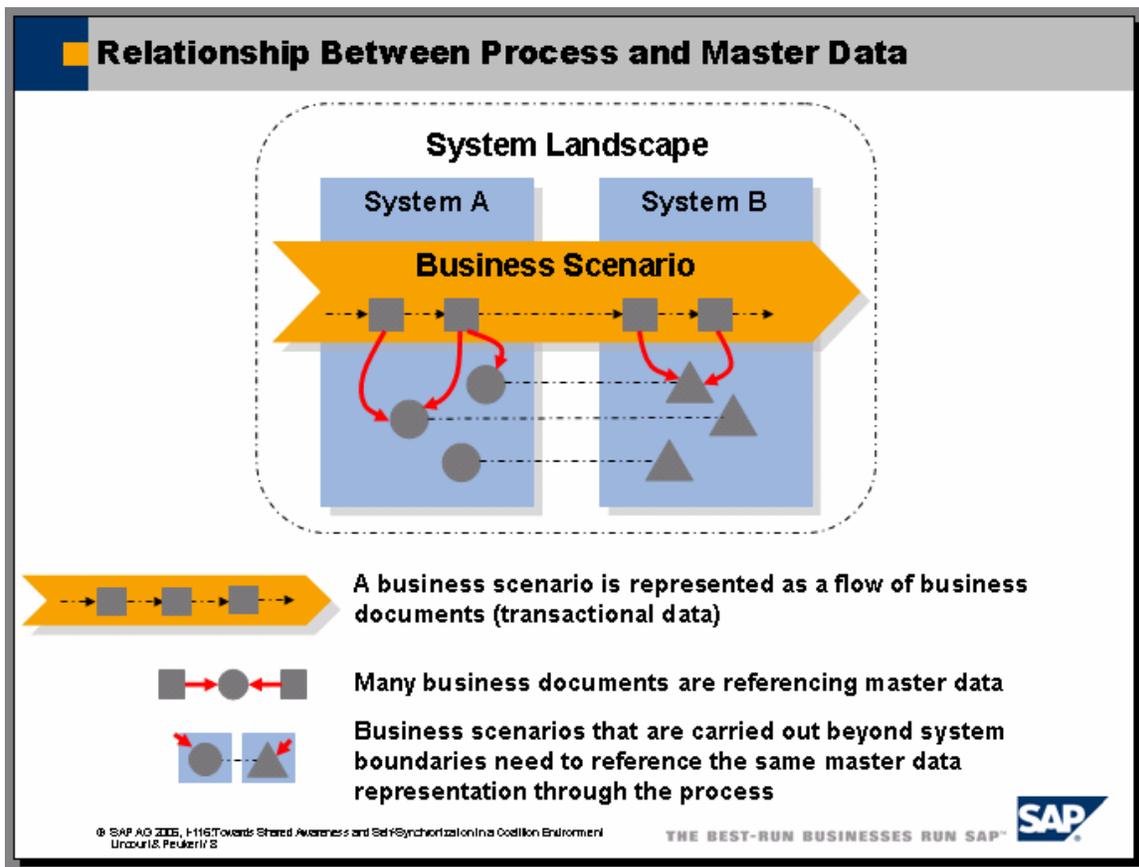
**Figure 7 – New Process: Flight Training Program**

Enterprise Services Architecture will drive a positive cycle – once core applications are abstracted into reusable components by a layer of enterprise services, it will create composite applications that will carry less risk and take less time, thus leading to new services that also become reusable throughout the enterprise. As early composite applications become the building blocks for their more complex successors, they create the potential for modeling business solutions without the long development costs of previous generations of software. New categories of applications that leverage services-oriented architectures, business intelligence, and collaboration become possible once SAP NetWeaver is deployed as an integration platform in addition to a next-generation application platform. Now instead of just enabling efficiency, IT can now become an enabler of change. Solution implementation then falls away as a barrier to change, enabling innovation.

## Master Data Unification and Distribution

Coalition and Joint operations demand that participants share consistent information about their resources such as people, organizations, weapon systems, etc. Yet in most organizations today, this information contains significant discrepancies. As coalition members continue to implement stand-alone IT solutions, data silos proliferate, with the

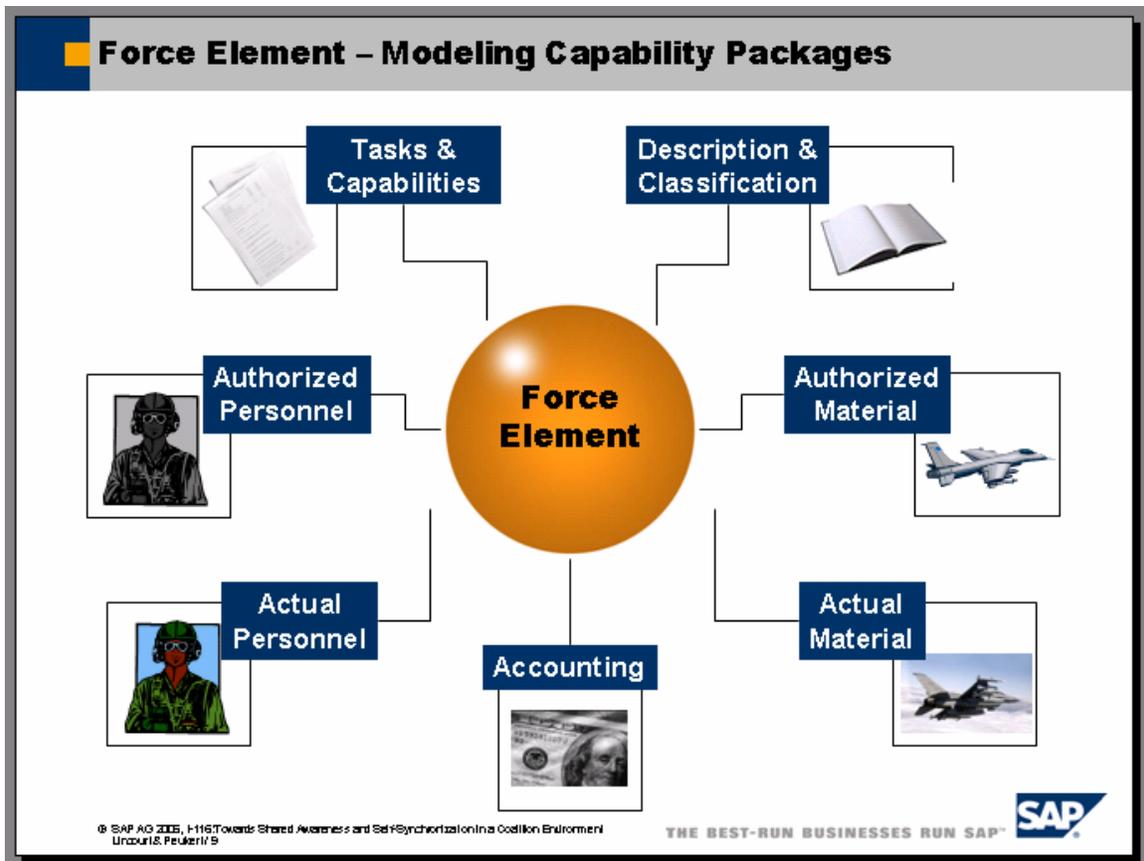
inevitable result that data grows independently – and often in conflict. Running accurate reporting is also difficult when the information that commanders at all levels need to analyze resides in several different and separate systems. Decisions and processes based on unsynchronized master data lead to greater risk of errors and potentially loss of life. For example a logistics assistance request for a critical component on an aircraft may be unanswered by a coalition member due to a misunderstanding of the part number. To that end, Countries that participate in the NATO Codification System follow common standards and techniques to assign NATO Stock Numbers (e.g. NSNs) to items of supply in their defense inventory. The National Codification Bureau (NCB) within each country centrally assigns their national NSNs. The assignment of an NSN fixes the identity of each distinctive item of supply. All NSNs are uniform in composition, length, and structure.



**Figure 8 – Relationship Between Process and Master Data**

While the NSN and other NATO agreements greatly reduce the risk of out-of-sync information when coalition members syndicate their information through enterprise services, it is not sufficient. Coalition members need to unify and distribute master data from disparate systems into a central repository. Using a flexible capability-based data model, data unification is made possible by a master data hub that supports an open, service-oriented architecture to facilitate the distribution of synchronized master data between the coalition members.

Most efforts around master data management center on individual pieces of master data such as the NSN described above or perhaps the ship-to address of a deployed unit. Coalition forces often omit to manage the relationships between the various master data elements along with the temporal validity period for these relationships. In establishing a master data hub, coalitions should implement a representation of its master data based on the concept of capability packages. For example, a flight sortie called for in an Air Task Order requires a number of aircrafts each requiring specifically qualified aircrew, fuel, ammunition, etc. In other words, the aircraft by itself is not a sufficient description of the capability package. Rather, an intricate resource model describes the required components of the capability package in terms of people, equipment, materiel, facilities, money, etc. Similarly, a linked model describes the available resources to fulfill the requirements.

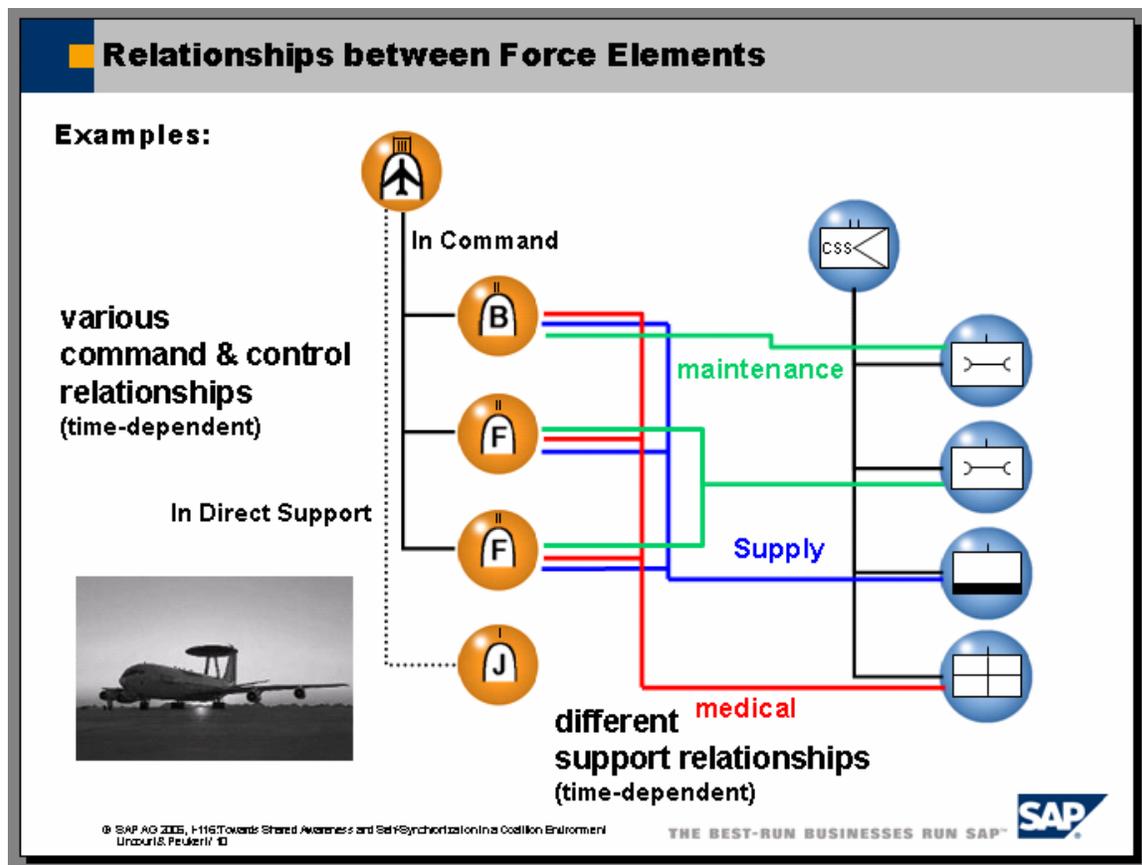


**Figure 9 – Force Element – Modeling Capability Packages**

The Force Element in SAP for Defense & Security solution portfolio is central in this capability-centric data model. It provides the essential means of describing the components of the capability package and ties together all of the necessary relationships to the various other master data element.

This Force Element Definition as well as the time dependent relationships between the Force Elements are as valid in the Command & Control area as in the area of Resource Management (e.g. logistic, personnel, financial, etc) Systems. The high art of Shared Awareness and Self-Synchronization lies in ensuring a consistent Master data definition across these domains.

Individual capability packages do not exist in isolation but in a complex network with other capability packages. These packages are linked by command and support relationships that vary over time. For example, the master data hub would unify and distribute the command relationship information that a small specialized unit is “attached” to another larger unit for a 24 hour period. However, the support relationship for maintenance of the specialized unit remains the same and no change to the master data needs to be distributed.



**Figure 10 – Relationships between Force Elements**

As important as the traditional master data element themselves, the relationships between them must also be unified and distributed in a similar way.

The master data hub is then capable of delivering clean, accurate, consolidated, and synchronized data to all authorized users throughout the entire coalition. Data unification leads to permanent harmonization of master data, using a master data hub strategy to

maintain data and distribute the data to other systems. Using global attributes, coalition members can be assured that all systems receive the same master data during distribution. Thereafter, individual members can enrich these distributed objects with additional attribute values in the target systems. SAP NetWeaver allows users to maintain a complete object definition, including object dependencies, in a centralized server for master data. Using the master data hub, coalition members can execute distribution in a controlled, visible, and traceable manner, supported with active status management of each distribution step.

Master Data unification and distribution enhances reporting and analysis across the coalition by providing harmonized, reliable data to analytical systems and applications. With reliable analytics and accurate reports at their fingertips, commanders can make decisions more confidently.

## **Next Generation Analytics**

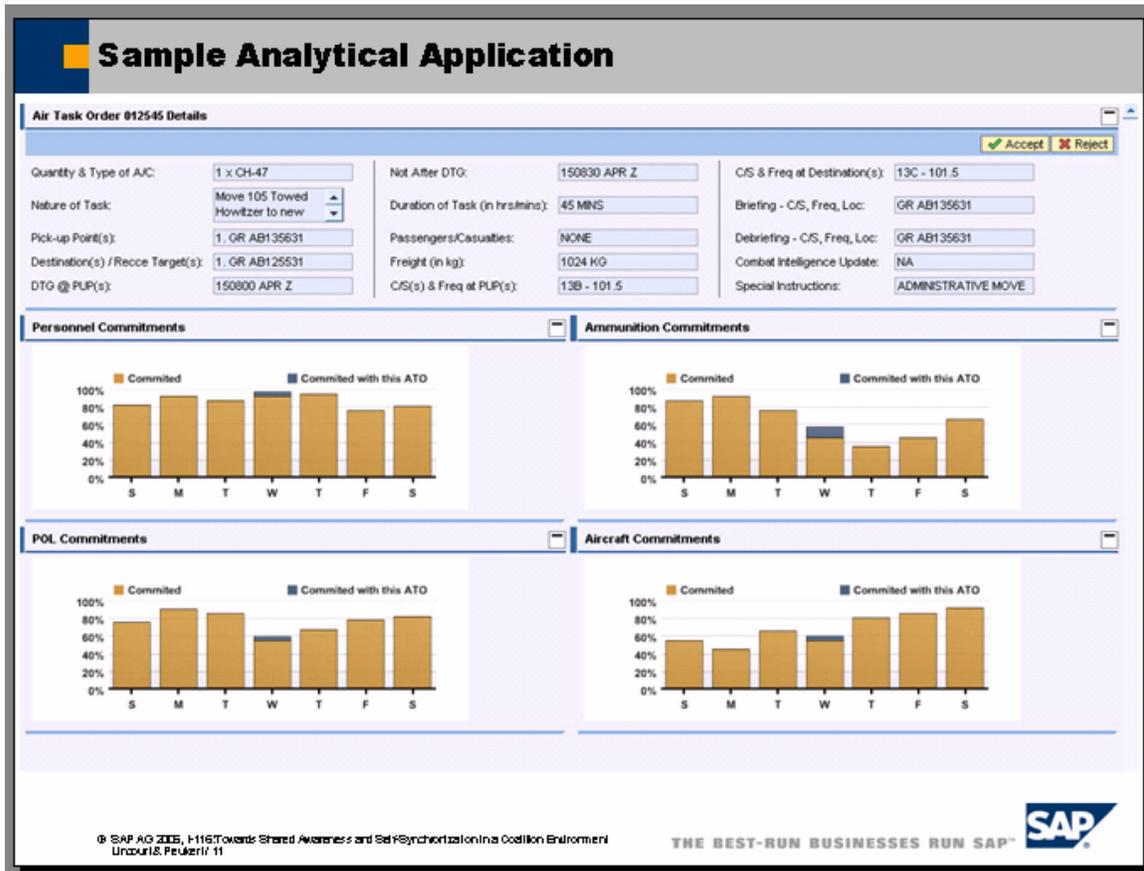
When it comes to aligning execution with strategy, most coalitions struggle with a persistent disconnect between what commanders want and what coalition personnel in headquarters or units are able to do on a daily basis. One of the main culprits for this is inadequate analytical applications that are disconnected from strategy and provide information out of context. After all, even the most insightful business intelligence is of little use when personnel have no way of applying it. To actually drive strategy down to the business process level where the work of the coalition gets done, there is a need for next-generation analytics that deliver timely, relevant information and enable easy access to collaborative and transactional services.

By extending strategic goals and objectives to critical decision making points across business processes. These analytics applications empower users to take action guided by strategy-aligned insights. And this is achieved through a composite application approach that combines loosely coupled services in a flexible manner to achieve objectives that are defined by the coalition and its members.

SAP Analytics synthesizes internal and external data and delivers actionable insight to the end user in the context of the process being executed. For each step in a process that requires a decision, SAP Analytics assists the decision maker in weighing options in the context of the overall strategy. Where decisions require additional cross-functional input, the application invokes the collaboration tools required to communicate with colleagues and relevant stakeholders. Once a decision is made, the appropriate transactional elements are made available to complete the process. Rather than stepping outside of the process to access separate analytical information systems, the user is guided along and presented with the relevant transactional options so that the appropriate strategy-aligned actions can be taken.

SAP Analytics is delivered in the form of composite applications. This means that it leverages Web services and other technology components in the coalition's existing military IT infrastructure to solve problems in a flexible and timely manner. Assembled rather than coded, composite applications are able to interact with business logic components in real time without hard-wired integration or complex customization. The

composite applications that comprise SAP Analytics synthesize data from several sources and unite analytics, transactions, and collaboration into a single process flow.



**Figure 11 – Sample Analytical Application**

Ultimately, SAP Analytics empowers the commander in analyzing the situation, making the right decision, and taking the appropriate action to meet it's intent.

With a focus on reusing components and data from the existing system landscape, SAP Analytics delivers on the promise of ESA – the blueprint for service-based, enterprise-scale business solutions that offer the increased levels of adaptability, flexibility, and openness required for shared awareness and self-synchronization. By leveraging services as a composite application, SAP Analytics focuses on the business logic of analysis rather than the technical connectivity issues required delivering timely information to users when they need it. The end result is intelligent defense processes that integrate analytics, collaboration, and transactions so that the entire coalition can work in unison to achieve strategic objectives.

## Conclusions

With Enterprise Services Architecture, coalition members can build new applications by extending existing systems that support operational needs while maintaining investment protection. Enterprise services provide efficient, reusable, business-level building blocks with which to compose defense solutions delivered as composite applications. Rather

than being forced to follow the traditional cycle of “rip and replace,” composite applications will free coalition members to extend the lifespan of their legacy applications and mix and match underlying components from SAP and other vendors.

Composite applications can be built, deployed, extended and adapted more quickly and cost-effectively than traditional software. First, a composite application can be built with no knowledge of the architecture, interfaces, and development platforms of the underlying applications that deliver the functionality, since enterprise services are a standards-based abstraction. Second, composite applications that “use” an enterprise service are now isolated from changes in the underlying applications and systems. In the past, when an individual piece of application functionality was changed, all interfaces and applications that touched this component would have to be changed as well. For solutions that crossed member boundaries and touched systems and processes from other coalition members, the complexity increased exponentially. These barriers to new defense processes are significantly reduced. Finally, composite applications can be easily deployed across heterogeneous landscapes, following the same approach both within and across member’s boundaries.

Today, Enterprise Services Architecture enables adaptive defense solutions, which can be developed rapidly, deployed easily across heterogeneous landscapes, and adapted quickly and efficiently as operational needs change. As defense organizations progressively adopt Enterprise Services Architecture, it becomes possible to leverage and integrate existing IT assets into innovative new defense processes, while still maintaining a level of flexibility that makes future process changes cost-effective. Coalition members can at last reconcile the inflexibility of current architectures with their Commander’s requirement that IT support operational needs quickly and efficiently. Organizations can now deliver flexible solutions with a sustainable long-term cost structure without trading off efficiency and adaptiveness.