Taking a COTS-Based Approach
to Implementing Enterprise GIS

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An Esri White Paper

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Introduction

ArcGIS® 10 represents a significant milestone in geographic information system (GIS) technology. At version 10, ArcGIS is a complete system for geographic information. It is easier and more powerful than previous releases, and it is designed to be pervasive—people can access the system through a variety of clients regardless of their experience with GIS.

With this release, ArcGIS provides the tools, capabilities, and capacity to implement enterprise GIS using commercial off-the-shelf (COTS) software. The potential cost savings and improvements to efficiency are significant. This white paper provides a framework for planning a COTS-based enterprise GIS based on the real-world implementation experiences of the Esri Professional Services team.

The release of ArcGIS 10 represents a major platform advance. Along with the technology evolution in version 10, there is a changing pattern of GIS implementation. By harnessing the ArcGIS system at 10, many Esri users are finding that a COTS approach to implementing enterprise systems puts capabilities in their hands much faster and with less expense than did previous generations that required greater amounts of custom development.

Organizations that have adopted a COTS approach have seen additional benefits beyond cost and schedule reductions, including

- The system does not require specialized knowledge to maintain or improve.

- The system can evolve as the COTS software evolves, resulting in continual improvements.

- The organization can rely on standard technical support when a problem arises.

A COTS approach to implementing enterprise GIS has three elements: philosophy, technology, and methodology.

Philosophy of a COTS Approach

The fundamental premise of a COTS approach is to exploit all the power and functionality the commercial software has to offer, minimizing custom development. This is sometimes referred to as "going with the grain" of the software; in other words, use COTS software where needed functions already exist and implement that capability as designed. COTS systems put the emphasis on *what* the system needs to do, not *how* the system will do it.

The COTS approach has a number of key tenets:

■   Meet business goals by leveraging COTS.
■   Configure and extend COTS; avoid developing custom software.
■   Consider COTS software capability when reengineering business processes.
■   Start up quickly and evolve with improving COTS capabilities.
■   Engage system users early and often to improve the system iteratively.

The COTS approach is illustrated on the spectrum of patterns for implementing IT systems shown here:

These three patterns are really a blend, and systems can be anywhere along the spectrum. The COTS philosophy is based on the idea that there is great benefit to users in keeping systems as far to the right on this diagram as possible. COTS systems can have some custom development, but in such a system, the emphasis is on *configuration*, not customizat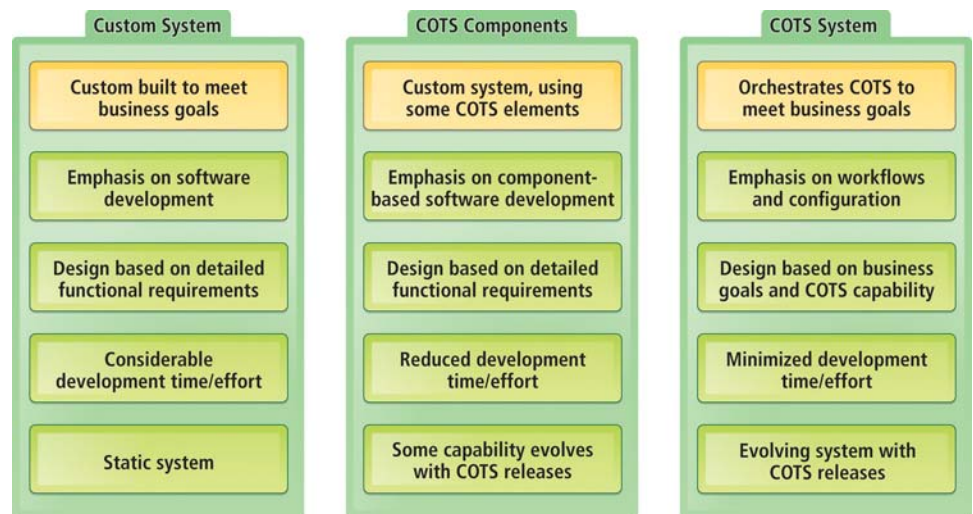ion; development is minimized and often lightweight. ArcGIS 10 greatly improves users' ability to configure and "skin" with light development, keeping systems on the COTS side of the diagram.

A Different Way of Thinking

Implementing the COTS approach requires fresh thinking, leadership, and agility. This can be challenging in environments where there is a history of procurements to build custom systems. One key difference is that the COTS approach is predicated on a focus on business goals instead of a list of detailed feature functions. This allows the organization to select the COTS solution that best meets business goals and to implement the COTS solution rapidly with the grain for best results.

This approach asks users to consider new business processes. COTS solutions provide new workflow capabilities based on industry best practices, which are often better than legacy business processes. Traditional systems procurements often fall into the trap of re-creating old workflows out of new software, usually because people and organizations resist change. It takes leadership, communication, and follow-through to overcome the tendency to stick with the familiar (and usually less efficient) legacy workflows.
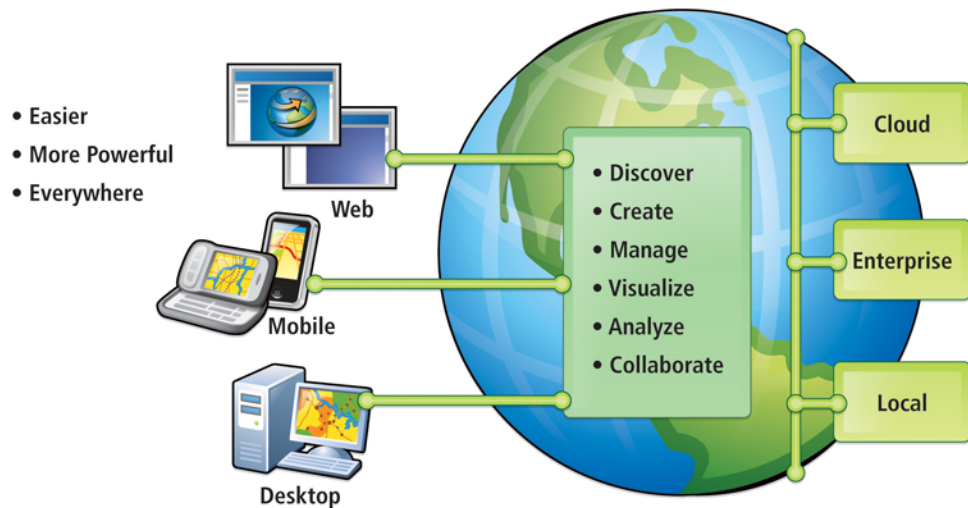
An additional trap that users must avoid is the temptation to customize rather than configure. Even when a system has been proclaimed a COTS implementation, the best intentions of many people often push systems toward customization. The trade-offs of custom development must be kept in mind during the decision-making process to avoid moving a COTS-based system into a custom- or component-based implementation. Many heavily customized COTS systems cannot be easily scaled or extended because there is inadequate design documentation; the technology on which it is based is no longer supported; resources with needed skill sets are no longer available; or the COTS, as opposed to custom, modules are not clearly delineated, creating dependencies between components that minimize the potential for reuse.

Custom System	COTS Components	COTS System
Custom built to meet business goals	Custom system, using some COTS elements	Orchestrates COTS to meet business goals
Emphasis on software development	Emphasis on component-based software development	Emphasis on workflows and configuration
Design based on detailed functional requirements	Design based on detailed functional requirements	Design based on business goals and COTS capability
Considerable development time/effort	Reduced development time/effort	Minimized development time/effort
Static system	Some capability evolves with COTS releases	Evolving system with COTS releases

Technology: ArcGIS 10 Empowers COTS Implementations

The ArcGIS 10 system is a springboard for COTS-based systems. Prior to ArcGIS 10, development was expected on large systems and routine on smaller ones as well. With the ArcGIS system now working across many different devices and powered by servers in many environments, the user experience can be significantly tailored to each type of user through configuration rather than customization. In other words, one can orchestrate the system to meet the needs of a business or operating unit. *Simple* and *ready to use* are prevailing principles.

ArcGIS 10
A Complete System for Geographic Information

- Easier
- More Powerful
- Everywhere

Web

Mobile

Desktop

- Discover
- Create
- Manage
- Visualize
- Analyze
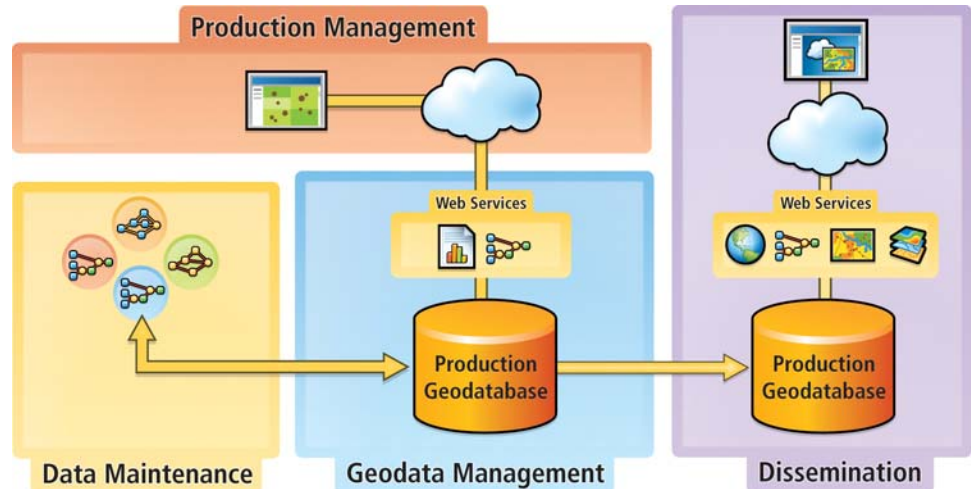- Collaborate

Cloud

Enterprise

Local

Because the system can communicate between all sorts of clients, information can be quickly shared between field users, data stewards, GIS analysts, and end users. By standardizing and sharing workflows and production tools and imposing business rules such as quality checks into the system, users can maximize efficiency and repeatability. This can be done with COTS at ArcGIS 10.

Enterprise GIS System Pattern at ArcGIS 10
Power to configure how content is produced, shared, and used

Map & Data Products

Web Publishing

Field Edits Crowdsourcing

Authoritative Content Producers

Basemaps (ArcGIS.com)

Configurable & Shared
- workflows
- production tools
- business rules

There are a number of key technical aspects of ArcGIS 10 that allow configuration with minimal development for new systems:

■ **Geodata management** capability including many types of replication-enabling data-sharing patterns

■ **Data maintenance** enhanced at version 10 to include templates, workflows, and shared production environments

■ **Dissemination** via Web services and consumer-friendly Web interfaces such as Silverlight®, Flex™, and JavaScript™

■ **Production management,** which is the ability to provide transparency into the information generation and management life cycle

Geodata Management Best Practices

The geodatabase is the heart of a GIS, and its design is essential to the successful implementation of a COTS-based system. By emphasizing end-use information products, the data model can be defined in practical terms and implemented more rapidly. Often, geodatabase design efforts can be mired in the theoretical possibilities of what might be needed in the future. Worse, data modeling can become the mission instead of a means of creating a model to serve a purpose. As with the larger COTS approach philosophy, data modeling is best accomplished with the end goals clearly stated and reinforced.
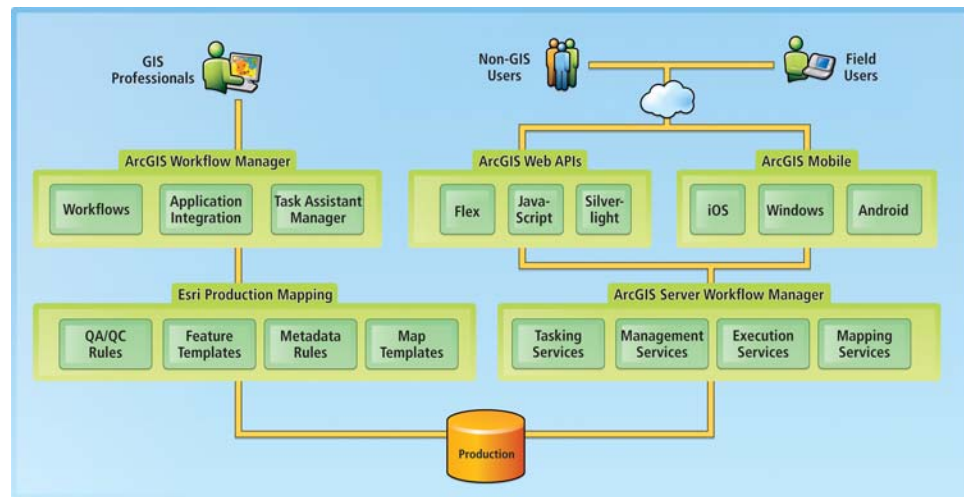
Because of the great evolution of ArcGIS Server and powerful and flexible clients, many GIS users now avoid integrating at the RDBMS level. Instead, departments or business units can develop a smart, focused data model for their areas of responsibility, and information can be integrated at the client via Web services. This is a federated philosophy that fits closely with the COTS approach.

Geodatabase replication options allow users to implement ArcGIS 10 out of the box to support a variety of user types and data stewardship roles. Whether editors are connected or disconnected, they can contribute content to the authoritative database. Replication also supports mirrored dissemination databases, which can be optimized for providing Web services.

Data Maintenance   GIS organizations build and manage critical, authoritative, and trusted geographic information to support their work. Data editing has been a staple of Esri® technology; however, a trend toward templates, shared business rules, workflows, and remote editing has enabled COTS to support a wide variety of data maintenance environments with flexibility and agility. Non-GIS and field users are now able to provide data edits or change nomination via the Web, and authoritative analysts can configure and share business rules, workflows, and quality checks that are unique to their businesses.
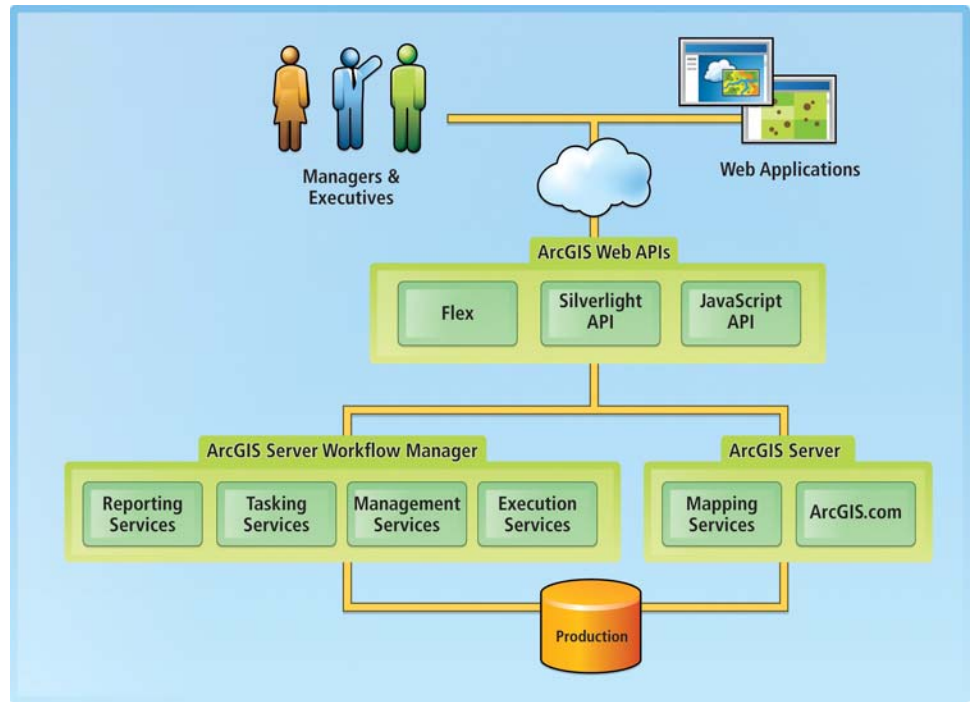

Non-GIS and field users are now able to provide data edits or change nomination via the Web (ArcGIS Server APIs), and authoritative analysts can configure and share business rules (Esri Production Mapping), workflows (ArcGIS Workflow Manager), and quality checks (ArcGIS Data Reviewer) that are unique to their businesses.

Content Dissemination   One of the core missions of ArcGIS 10 is to provide a collaborative environment for users to discover and share each other's data and services. As a result, the software has evolved to enable a COTS approach to sharing content. Many devices and systems can access GIS content. With the rich publishing options, including standards-based services (Open Geospatial Consortium, Inc.® [OGC®]), search/discovery services, and the ability to link services to and from ArcGIS.com, users can implement with the grain of the system rapidly and with dramatic results. Because of the fast, lightweight development patterns evolving with Flex, Silverlight, JavaScript, and mobile platforms, COTS-based user applications are quick to create, lightweight, and template based, unlike their heavy, code-based predecessors.
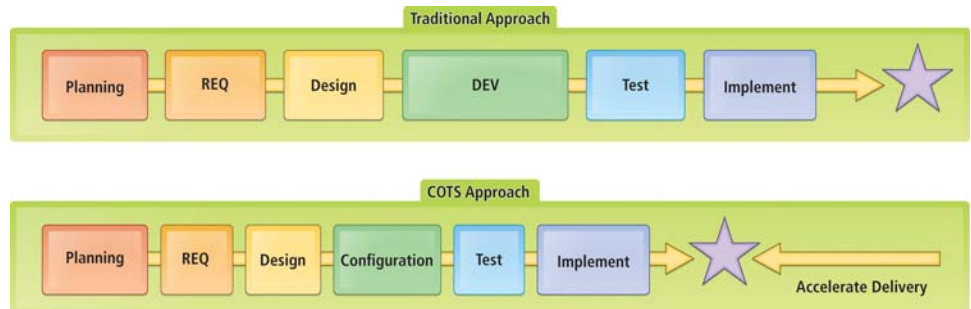
Production Management   Because ArcGIS includes rules and workflow management stored in the geodatabase, it is easier than ever to provide reporting and transparency on the state of the system, including status of active work, spatial reports on work, data and mapping overviews, and changes within the database. Source documents and historically produced map products can now be associated with geographic areas and accessed for traceability and history. Production management applications can also provide role-based access and permissions, allowing selective management and assignment of tasks via Web and mobile clients and providing GIS and non-GIS users with access to critical system information and tasks.

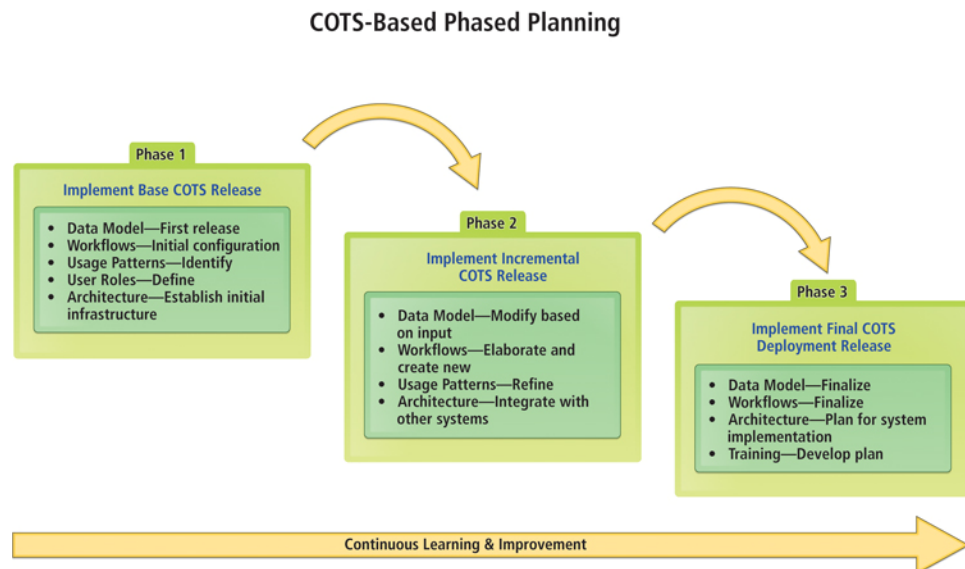**Project Methodology: Managing COTS Implementations**

The third aspect of a COTS approach is the method for managing implementation work. Generally, COTS system implementations follow the same basic steps of traditional IT system development (waterfall, spiral, or other methods); however, the activities in each step differ with the COTS approach.

One of the most notable differences is the ability to get functionality in the hands of users early and often. By utilizing COTS, much of the functionality is ready for users to exercise quickly. This leads to better acceptance by end users and dramatically improved feedback when compared to the traditional approach of doing a needs assessment and gathering requirements, where end users have less understanding of the capability of the new system. The COTS approach relies on users to provide feedback continually and participate actively in the configuration of the system.

Planning   During the planning of a GIS system, the COTS approach puts the focus on business objectives and goals. With the fundamental technology a given, the planning team is able to focus on what the technology needs to accomplish, not how it will work. Because future releases of COTS software will continually improve the system, planning for these releases is an important part of a COTS approach. COTS systems are not hindered by significant custom code, so future versions of the COTS platform are much easier to adopt than in custom systems.
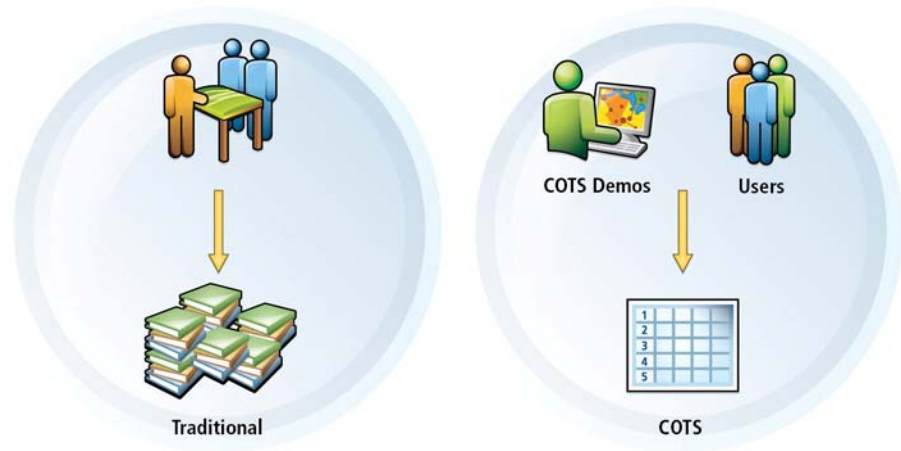
Planning also considers rollout plans that provide multiple iterations of COTS software and configuration, allowing heavy user interaction and validation of capabilities as they evolve. The initial deployment allows users to validate the fundamental COTS capability along with first versions of data models and basic workflows. By engaging the users early, the following iterations can consider end-user input from their hands-on experience with the new system.

COTS-Based Phased Planning

Requirements and Design   In a COTS system, requirements are satisfied by COTS functionality designed around best practices developed and tested by many organizations over time. Understanding COTS capability and how it impacts the system's business requirements is critical to efficiently implementing with the grain of the software. By embracing the platform, the requirements can leverage proven, low-risk technology. Therefore, the requirements phase in a COTS approach documents what the workflows and configurations need to accomplish.
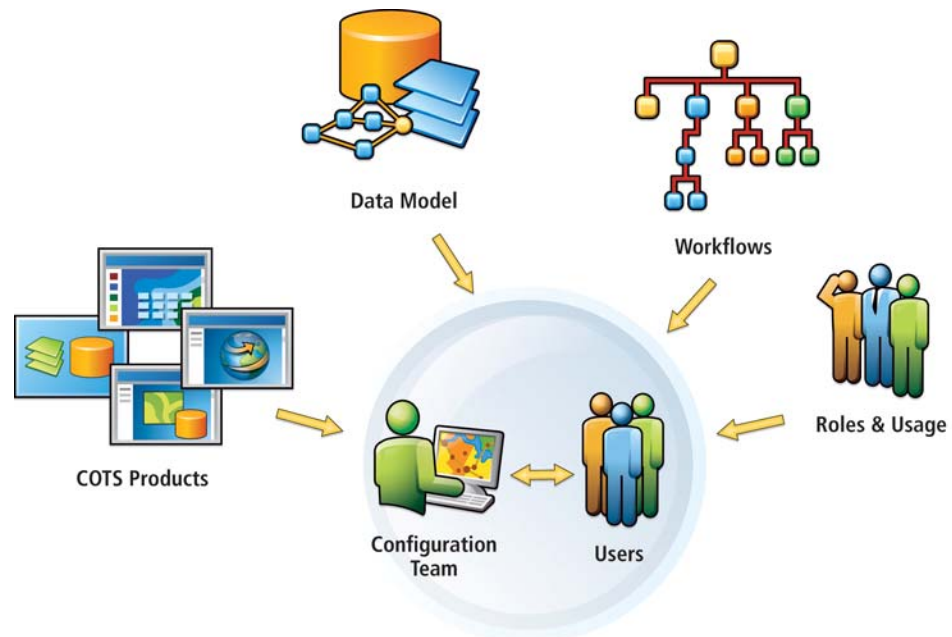
Many users have found success in the requirements phase by using COTS demonstrations to illustrate a vision for the system. By showing this vision up front (which is only feasible in a COTS-based system), stakeholders and end users can immediately contribute to the workflow and configuration requirements to meet the business processes and outputs required by the system.

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This interactive, demo-based approach merges the requirements definition and design work by capturing the interactions and feedback of the users to guide rapid adjustments and improvements to the system. During design, concept demos evolve into prototypes and laboratory environments. Pairing end users with COTS experts allows the system to be designed collaboratively, with a focus on identifying user roles, workflows, areas to focus efficiencies, and end-user access points. In the design phase, future COTS capability is considered, and trade-offs can be made between creating custom elements versus allowing next-release functionality to be part of the architecture.

Development: Configuration, Not Customization

The difference between a COTS approach and a traditional approach is most dramatic during the development phase. Development under the COTS approach means the active configuration of the software based on user input and feedback. If there is any application coding, it occurs in this step, but the goal is to minimize or eliminate custom code. A good rule of thumb is that 90 percent or more of the effort in developing the system should be on configuration by users and/or COTS experts. These people focus on roles or usage patterns, workflows required to create end information products, and the underlying data model.
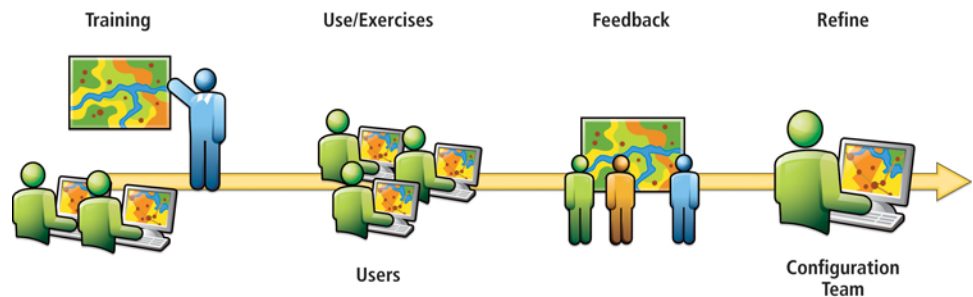
When development is required, the most common area is in the Web dissemination functions, where starter templates and rapid development environments (Flex, Silverlight, JavaScript) accelerate and simplify programming. Because these applications are the skin around the user interaction points, it is not difficult to change these applications when the system is moved to the next version of the COTS platform.

Testing: Engaging Users in System Validation

Testing of a COTS system also varies significantly from custom systems. With a custom system, implementation testing usually has a heavy functional aspect, where each requirement is carefully tested. Under a COTS approach, because the basic feature functions are provided via widely used COTS software, testers can focus on exercising the workflows and user scenarios. This is often done by real users and can double as training on use of the new system.

Due to the end-to-end workflow-style testing environment, testing of a COTS system is often termed "user validation." Users from a variety of roles representing many business processes are engaged to test the system capability on the types of tasks they will accomplish. Feedback is focused on system efficiency, workflow refinement, and quality of the final information product. Because a COTS system can be quickly deployed and improved over phases, these frequent user validation sessions also create the inputs for future phases of configuration-based development.

Implementation/ Deployment

One of the real strengths of a COTS-based system is that it will continually evolve and improve, both by configuration and by releases of the underlying COTS product. Therefore, the decision of when to deploy a COTS system is based on passing a threshold of configuration where all the required outputs can be created and the essential workflows are operational. Because the system will continue to improve, the decision to move into deployment is less of an event than with a custom system, where system acceptance means the end of development and users are "stuck" with the system as accepted.

During a COTS-style deployment, there are a number of considerations:

■ Future COTS releases need to be anticipated and upgrades planned.

■ The human element of the new system needs to be considered and managed. Changing workflows and business processes can mean new roles for staff and, at times, structural changes within the organization.

■ COTS platform training can be used to learn fundamental capabilities, and many staff may already be trained in the COTS software. This means that training staff for a COTS system is easier than with custom systems. It is also easier to find staff with needed skills when the system is COTS-based given the common use of the software in other organizations and inclusion in many university programs. Also, many users become familiar with the system and its workflows during user validation.

■ As with any system, security, IT regulations, administration roles, and general system upkeep need to be planned before or during this stage.

Summary

The COTS approach is becoming more prevalent with the capabilities available in ArcGIS 10. The methods for implementing a COTS-based system are different from those for implementing custom systems, and it often takes a shift in thinking to move to a COTS-based, configuration-centric pattern. Users that have embraced this philosophy are seeing many benefits, including

■ Minimized cost to implement GIS systems

■ A shorter schedule with immediate value to users

■ Reduced risk, given that the system is built on software used by thousands of organizations

■ Lowered maintenance costs from reduced maintenance and support of custom code

■ Increased capability over time with future COTS functionality

■ Wider range of qualified people to use and maintain the system

More Information

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About Esri

Since 1969, Esri has been helping organizations map and model our world. Esri's GIS software tools and methodologies enable these organizations to effectively analyze and manage their geographic information and make better decisions. They are supported by our experienced and knowledgeable staff and extensive network of business partners and international distributors.

A full-service GIS company, Esri supports the implementation of GIS technology on desktops, servers, online services, and mobile devices. These GIS solutions are flexible, customizable, and easy to use.

Our Focus

Esri software is used by hundreds of thousands of organizations that apply GIS to solve problems and make our world a better place to live. We pay close attention to our users to ensure they have the best tools possible to accomplish their missions. A comprehensive suite of training options offered worldwide helps our users fully leverage their GIS applications.

Esri is a socially conscious business, actively supporting organizations involved in education, conservation, sustainable development, and humanitarian affairs.

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