

Blueprint for Collaborative Application Architecture

Enterprises are under constant pressure to expand business capabilities, improve real-time information access, and provide richer user interactions. Globalization and new business models are breaking down traditional enterprise boundaries. Analytics and regulations are complicating information processing. And new Internet capabilities are raising customer expectations and demands on user interaction. Business must respond with a new generation of applications built for today's realities, delivering business value using the latest technologies.

The next generation of applications will integrate collaboration into business processes at new and fundamental levels and will foster new models of people working together to achieve common goals within the extended enterprise. However, next-generation applications require a next-generation architecture. In addition to the technical capabilities, the next-generation application architecture must integrate new models of the workspace, support collaboration across end-to-end business processes, extend current practices of service-oriented architecture (SOA) and Web 2.0 to new environments, and take advantage of new technology opportunities.

This paper, prepared for solutions architects, application architects, and enterprise architects, describes the application-level architecture for the next generation of collaboration applications in the context of their vocabulary and conceptual models. Beyond describing network platform capabilities as a set of core services, it also explains what kind of services they are, how they relate to SOA and other applications, how they support collaborative applications and business processes, and where they fit into the overall, end-to-end solution architecture.

We start with a review of what collaboration software is, what enterprises are trying to achieve with it, and different scenarios of its use. Then we discuss in detail the end-to-end architecture of the next-generation applications, which incorporates SOA, Rich Internet Applications (RIA), and collaboration. Next, we provide an application-level framework for integrating collaboration into business applications. Building on that, we present a sample business process, show how it could be improved with collaboration, and illustrate the application architecture for implementing it. Finally, we tie these architectural concepts to Cisco's network-as-a-platform vision, which encompasses intelligent network capabilities and the Service Oriented Network Architecture (SONA).

What Is Collaboration?

Collaboration and other types of groupware are used to bring people together for one reason or another: to socialize, to work together, to cooperate and contribute to the production of something, and to innovate. Many different goals can be achieved through the application of collaboration techniques:

- **Communications:** Basic transfer of information between parties such as voice, email, and text. This becomes much more complex when we consider the different ways we communicate, with whom, when, and what we know about them.

- **Publishing/feedback/information exchange:** Exchange of information between parties, such as a blog. Exchange is different than simply publishing information, because one goal is to solicit feedback about the information, and another is to build a network of related information and interested parties.
- **Building community:** Formation and management of a collection of participants, generally focused on a shared interest or affiliation. Community building is usually included with other goals, such as information exchange. A common example is generic or specialized social networks such as LinkedIn or Facebook.
- **Managing knowledge:** Collection, retrieval, and management of shared community knowledge. Common forms of knowledge management include document management systems and wikis. One key to knowledge management is the easy location and retrieval of information to authorized users. In collaborative environments, this often involves searching over a variety of different information sources and media types.
- **History and tracking:** Logging of information exchanges and other events of interest and the generation of reports. This goal is generally combined with other aspects of collaboration. Discussion forums are a good example.
- **Joint contribution to a work product:** Bringing groups together to produce a joint work product. One example is this paper, which was written and reviewed by several participants using a shared web-based mashup workspace. Another is an industry standard that may gradually include contributions from individuals for different companies around the world.

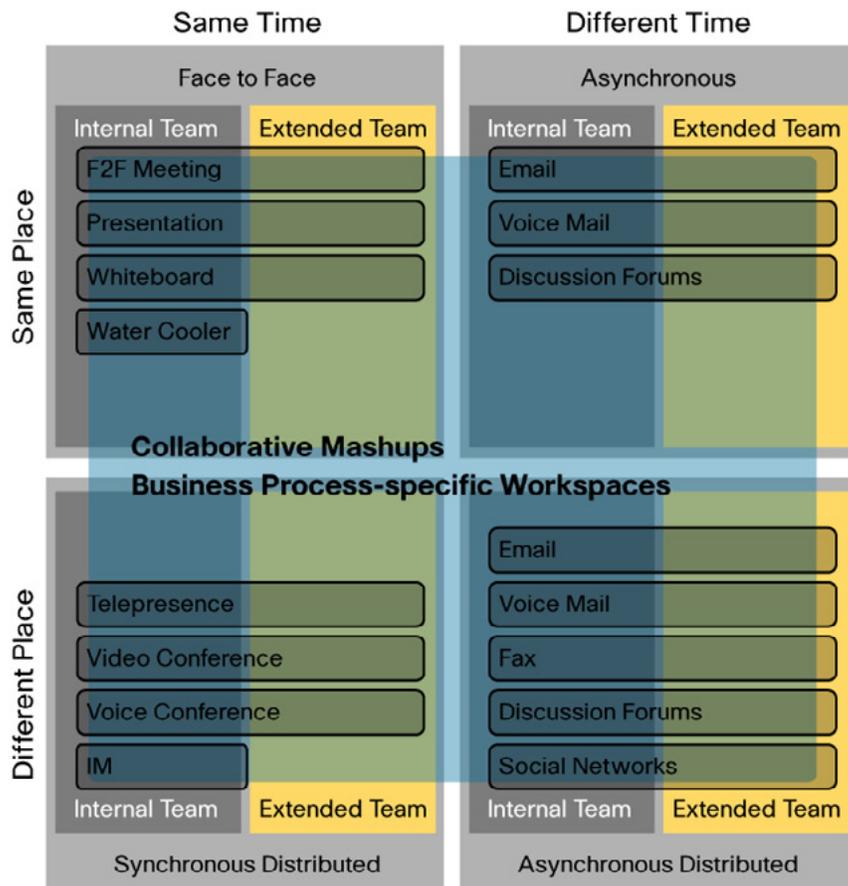
We can analyze collaboration along the two dimensions of time and space, where the cooperating parties may or may not be in the same time and place when trying to collaborate. The different scenarios are illustrated in Figure 1.

- **Same Time/Same Place (Synchronous):** This is the traditional face-to-face communications, dominated by meetings, presentations, and discussions. Various techniques and technologies such as brainstorming, whiteboards, and so on help to facilitate these activities, but they all rely on the immediate proximity of the participants.
- **Same Time/Different Place (Synchronous/Distributed):** People at different locations are trying to collaborate at the same time. The most widespread technologies for this scenario are the telephone and the audio conference call. New products have evolved to make these activities more productive such as video conferencing, webcasts, desktop application sharing, and virtual presence technologies. In addition, for one-on-one communications in near-real time, IM has become a popular alternative for limited bandwidth communications.
- **Same Place/Different Time (Asynchronous):** People working in the same office or company need to communicate but are not always present at the same time. This is the traditional realm of email and voicemail. To keep a record of what has transpired, and to expand the communications to additional participants, discussion forums, and knowledge harvesting tools such as wikis are also used today.
- **Different Place/Different Time (Asynchronous/Distributed):** People are working together on something, but not at the same time or the same place. This is often the case with people from different groups or organizations. Email and voicemail are useful, but limited. Discussion forums provide a better mechanism for tracking progress and include a broader group of participants. Social networks provide a mechanism for expanding the participant base and building relationships between them. Finally, collaborative workspaces such as Groove or Cisco WebEx Connect combine all of these features.

Let's illustrate these options by looking at a day in the life of a busy enterprise architect. Before leaving home, she uses her mobile device to scan her email for any critical messages that may have come in overnight. Once in the office, she logs into the corporate network and checks the calendar for today's meetings. First up is the weekly one-on-one with the boss (same time/same place) and then a teleconference with a project team (same time/different place). Next, it's the Architecture Review Board design review. Prior to the meeting, the design documents and models have been shared in a collaboration space and questions raised and answered (different place/different time). The preparation pays off when the actual review meeting is conducted using application sharing and a realistic live remote conferencing solution. With that over and the design approved, the architect returns to the office to add some thoughts to her blog before heading home to post comments on the wiki for the international standard she's contributing to.

With this scenario, we might ask, what is the architect's workspace? Is it the desktop or the laptop or the mobile device? Is it the application that runs on that device, or the environment accessed using it? The answer is yes to all. The idea of the workspace has changed dramatically to include whatever device we're using, from whatever location we're in, to whatever application we want, to support whatever work style that suits the task at hand. The next generation of collaboration-enhanced applications and architecture must support and embrace this evolving definition of the workspace.

Figure 1. Types of Collaboration



Given this understanding of what collaboration is, why is it so important in today's business environment?

Why Collaboration?

New technologies, industry trends, new applications, different environments, global competition ... it never ends. But businesses must keep up. These factors align to three major themes driving business transformation: the impact of the empowered user, the demand for secure, real-time information, and the concept of a borderless enterprise.

- **Empowered users** refers to the increasing demand from customers, patients, employees and partners to use new collaboration capabilities, such as mobility, personalization, and social networking, to communicate within their workplaces and communities. Enterprises are challenged to deliver new tools and capabilities that meet the expectations of their empowered users, while simultaneously coping with the growing issues of technology complexity, support, security, and compliance associated with them.
- **Real-time information** gives enterprises the opportunity to make better, faster decisions and to optimize processes. In addition, the increasing demand for consumer-like services in the enterprise requires virtual, secure, real-time information to support an architecture of participation and collaboration. Achieving this “architecture of participation” in a secure and efficient way is a major challenge, however, as real-time infrastructures have significant cost and complexity associated with them. The virtualization of resources and people across organizations provides a key opportunity to deliver new levels of cost-effectiveness and productivity.
- **Borderless enterprises** are required to compete and scale globally, engage with partners, and foster innovation. Tomorrow’s interactions will occur across an enterprise that is distributed, operates 24 hours a day, requires a global talent pool, and increasingly conducts business from client locations, home, or in venues outside the traditional office building.

Enterprises are looking at collaboration applications and technologies to address these three drivers.

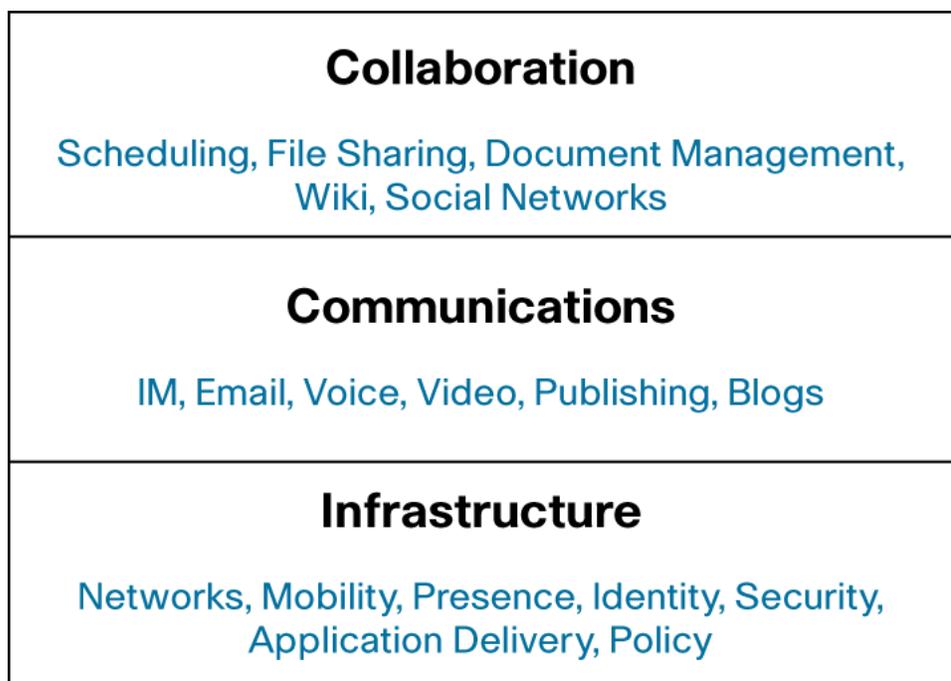
- Users are empowered when they have better communications and access to information and can use them as they see fit. Collaboration technologies enable users to create and manage their own information and communities without the constant involvement of a central, controlling organization. Users are empowered to be more productive by communicating and exchanging information and ideas with a broader range of people, especially those whom they feel could add value.
- In addition, collaborative applications can make real-time information available to this new class of empowered users and provide for the proper protection, sharing of, and innovation with, this information. And because the information can be shared with the user community, its accuracy can be more easily verified and corrected. For example, Wikipedia is comparable in accuracy to the Encyclopaedia Britannica, and also more extensive and up-to-date. Within Cisco, wiki creation and interaction is very active. In less than one year, Cisco wikis add approximately 130,000 unique wiki pages and have 1.2 million page edits.
- The collaborative community can be defined to support a particular set of goals, including expanding the boundaries of the enterprise to include partners, customers, employees, and other interested parties. Collaboration is enabling new business models, such as virtual companies and partner ecosystems, that accelerate and extend business processes and streamline product development and delivery.

How do enterprises meet the requirements to make best use of collaboration? Like most things, it's a combination of technology, applications, architecture, and business process and strategy.

- **The business strategy** defines, from a business perspective, the objectives, markets, positioning, and desired outcomes of the company in light of the industry and technology trends and drivers.
- **The applications** provide the information and capabilities to achieve the desired business outcomes.
- **The technology** enables the applications and provides the underlying capabilities, functions, and optimizations necessary for the applications to meet their required qualities of service.
- **The architecture** ties all of these together by defining how the applications are constructed, how they use the technologies to provide application capabilities, and how those capabilities support the business.

With an understanding of the goals, scenarios, workspaces, and requirements for collaboration, we can construct an architecture for providing those capabilities in business applications. Figure 2 illustrates a high-level, layered architecture for collaboration in applications.

Figure 2. Generic Collaboration Architecture Layers



Starting from the bottom, the underlying Infrastructure layer provides the networking and execution platform capable of meeting QoS, performance, reliability, and bandwidth requirements for the applications.

The Communications layer contains the set of capabilities needed to provide the collaborative environment required by the application. A combination of IM, voice, video and email can be augmented with infrastructure capabilities such as security, mobility, presence, and identity to provide a rich, aware, collaboration experience. In addition, information publishing technologies can communicate information out to a community of interest.

The Collaboration (top) layer provides the application-level capabilities that support the collaborative community. For example, where a blog is designed mostly to publish ideas, it is limited in collaboration. However, a wiki is designed to publish information and to support a community that jointly contributes to the content. It requires additional capabilities such as storing and locating files, managing entitlements, concurrency, and replication and synchronization.

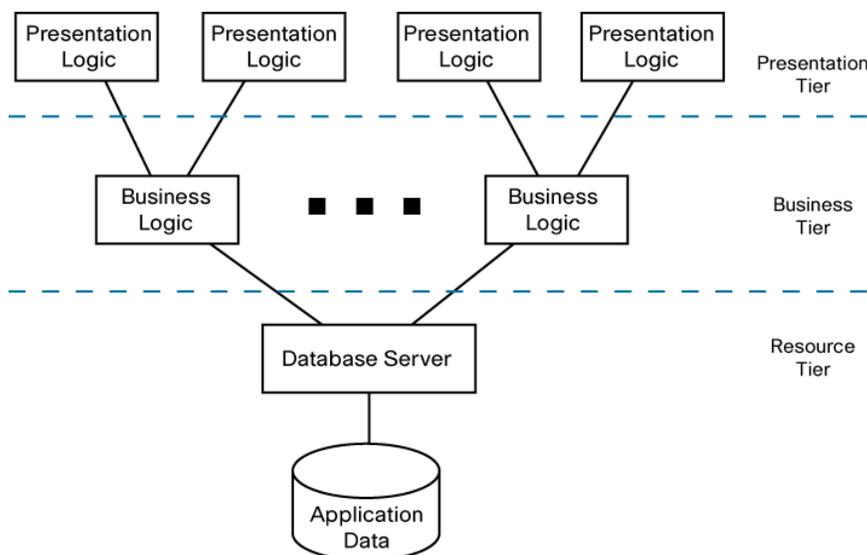
The Collaboration layer provides capabilities such as file sharing, calendaring and scheduling, document management, address books, and more to support information exchange, knowledge creation and management, and the operation of communities and social networks. These are not the end business applications, but capabilities that are built into and exploited by business applications that use collaboration to meet business goals, such as empowered users and borderless enterprises.

Let's take a look at the end-to-end architecture of business applications and see how to fit these collaboration capabilities into an overall application.

Architectural Considerations

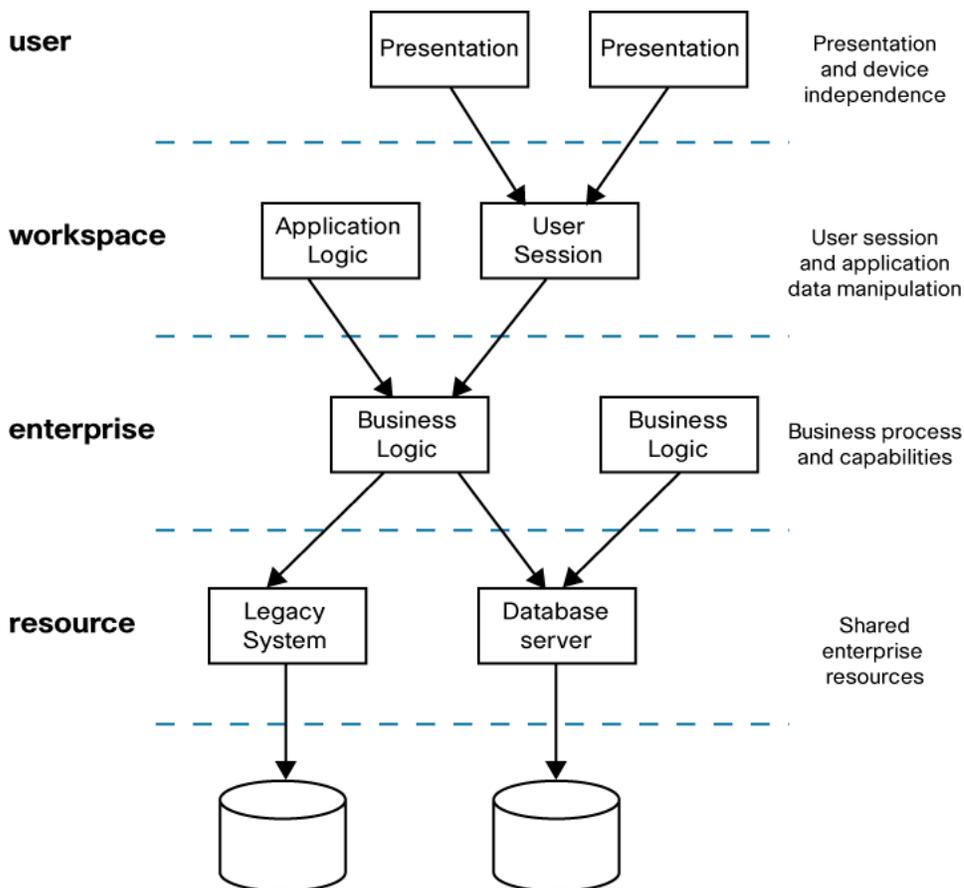
Next-generation applications require an architecture that enables the next-generation workspace, one that accommodates the desktop, laptop, mobile devices, dedicated devices, disconnected operations, and all of the work styles and interactions that go with them. These collaboration, Web 2.0, and Enterprise 2.0 applications rely on multitiered, distributed applications with rich user interactions. Recent distributed applications rely on the three-tiered architectures as shown in Figure 3.

Figure 3. Three-tiered Architecture



The traditional three-tiered architecture applies the important architectural concept of separation of concerns, specifically separating presentation from logic and logic from data. The three-tiered architecture was the predominant style for early web applications, but it ran into problems with the need for better scalability and support of multiple devices. The problem was that the architecture did not separate out the logic used by a single user during their interactive session from the shared logic used to implement business functions and manage resources. The new requirements of the next-generation workspace require more tiers. To support the more advanced architecture style of collaborative applications, the n-tiered architecture shown in Figure 4 is required.

Figure 4. n-tiered Architecture



Tiers have the general responsibility for mediating the flow of data into and out of the system and through the components that make it up. Each tier has a specific set of roles and responsibilities, and the boundaries between tiers are carefully constructed to achieve the overall architectural goals, such as support for multiple devices and channels, collaborative workspaces, scalability, service level agreements, and so on. The responsibilities of these tiers are as follows:

- **The User Tier** is where the system interacts with a single user of the system through a specific presentation. It is responsible for device-specific presentation such as that needed for a web browser. The boundary between the user and workspace tier provides for device independence, allowing the application to support multiple devices such as a browser and a smart mobile telephone, each of which would have its own user tier. The user tier manages user interface details for a single presentation.
- **The Workspace Tier** is responsible for user interaction and the application experience. It is where the system provides the virtual workspace and supports multiple interactions with a single user. It is responsible for application-level logic such as coordinating and maintaining a user session, manipulating the user data associated with that session, and for interactions with the enterprise tier. The workspace tier coordinates and maintains integrity of multiple, concurrent activities for the same user; provides a user experience that is consistent across virtual workspaces and different devices; maintains the user session; executes processes that do not require access to enterprise resources; and puts and gets data to and from the enterprise.

The boundary between the user tier and workspace tier provides another advantage. It not only provides a consistent user experience across devices, but also allows the same workspace processing to be used with multiple different devices. In other words, by moving device specifics into a separate tier, we can achieve both reuse of application-level logic and, just as important, consistency of operation across multiple devices. This is handled in the workspace tier using capabilities such as presence and device identification. The workspace tier takes the most advantage of the capabilities provided by the collaboration and communication layers described above.

Together, the user and workspace tiers support all of the interaction between the system and a single user (or other external partner). There is one instance of a user tier and workspace tier for each user of the system. In contrast, the enterprise and resource tiers together provide resources and services to all users of the system. There is only one instance of the enterprise and resource tiers, which is shared by all users.

- **The Enterprise Tier** is responsible for implementing business processes and entities and for making their functions available via service-oriented interfaces. The enterprise tier maintains the integrity of enterprise resources, enforces system-level business rules, provides the scope and control for two-phase commit transactions, and provides enterprise services to requestors. The boundary between the workspace and enterprise tier provides a clear separation between the enterprise and the resources required to support a single user. This break allows enterprise resources to be better managed and protected. It also provides a clear access point for all enterprise services, so that they can be shared and reused by multiple applications and users.
- **The Resource Tier** is responsible for the management and access of shared enterprise resources. The resource tier provides access to shared resources of the enterprise, provides access to enterprise data and databases, and provides access to legacy systems. The boundary between the resource and enterprise tier provides a separation between the technology specifics of the resources and the enterprise's use (as well as the service's representation) of them. This allows changes in the resources or enterprise tiers to occur independently, without disruption of the other.

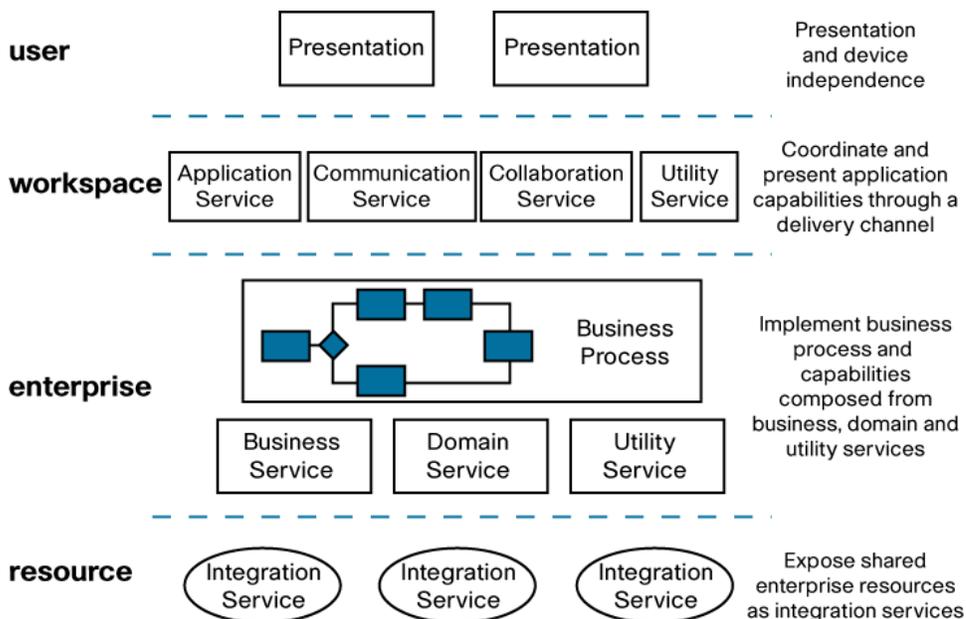
Tiers and SOA Services

With the introduction of SOA and collaboration services, it is important to understand the relationship between these two types of architecture. SOA is an architectural style in which business-aligned services are the fundamental concept for the design, implementation, and deployment of enterprise solutions.

N-tier architectures describe the overall, end-to-end function of an enterprise solution in terms of the logical distribution of responsibilities.

These two concepts of SOA and tiered structure are compatible and complementary. Services can be present in most of the tiers of the n-tier architecture. However, a common mistake in SOA circles is to misunderstand the relationship between service type and the roles and responsibilities of the tiers and to focus only on the business processes. Figure 5 illustrates how the different types of services line up with the tiers of an n-tiered architecture.

Figure 5. Services in an n-Tiered Architecture



Let's look at each tier in Figure 5, its responsibilities, and the types of services that are used to implement them. Starting at the top, the presentation tier is not implemented with services. Next is the workspace tier, which is responsible for coordinating and maintaining all activities for a single user, and being the intermediary between the presentation channel and the enterprise. In other words, the tier is responsible for coordinating and presenting business capabilities through a virtual workspace. It fulfills a user request in the most effective manner based on presentation device, user role, user context, and user preferences. The workspace tier is responsible for providing a rich user experience. This requires a variety of different functions, many of which can be implemented as services. Some typical services at this tier are profile, presentation, navigation, session state management, presence, and location. The tier is also responsible for the user specific "application" logic. Collaboration, application, and utility services are commonly used in this tier.

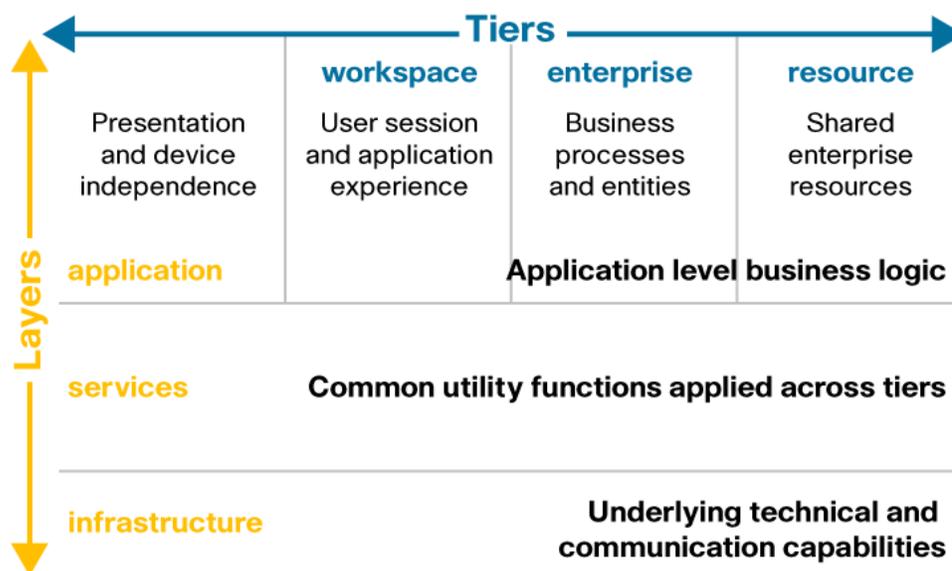
The enterprise tier is where we traditionally think of SOA capabilities. It is responsible for the implementation of enterprise capabilities and processes, and for the enforcement of enterprise rules and policy. This is where traditional business processes are executed, and where the services that compose them are located. So in this tier are a variety of business-oriented services.

The resource tier is responsible for the shared resources, and for presenting those resources to the enterprise tier. In SOA, we want those resources presented as services, so this is where integration services are generally implemented.

Layers and Tiers

It is worth pausing here to clear up a common misconception about application architecture, the difference between layers and tiers. Figure 6 shows the relationship between them.

Figure 6. Layers and Tiers



The logical separation for architectural **layers** is chosen based on the need to separate infrastructure capabilities (for example, communications) from technical services (for example, logging or error handling)—and especially from business logic.

The logical separation for architectural **tiers** is designed to support distribution, scalability, and reuse. Logical tiers can be mapped to different physical computer network topologies. For example, it is entirely possible for all tiers to reside on the same machine, or in more complex distributed environments, a single logical tier might run on a load balanced farm of servers.

Two layers are particularly important to understand in relation to SOA. Infrastructure is the lowest layer and provides the communications capabilities, platforms, optimizations, and other things necessary to meet required qualities of service. Typically, the functions in this layer are obtained as part of a platform or application server product set. The separation of infrastructure into a separate layer isolates the application logic from changes in the underlying platform and products.

The Services layer provides utility functions that are useful in more than one tier and by more than one family of applications. Functions in the services layer include logging, configuration, XML parsing, and collaboration. Services are self-contained functions that provide shared access to resources and capabilities. The main distinguishing characteristic of the services layer is that it provides common utility functionality (rather than business functionality) across the tiers.

Some of the services at this layer may be provided directly by the infrastructure. In fact, the trend is that more and more application-level and service-level functions are being implemented in the infrastructure and presented as service capabilities. This trend allows for optimization, coordination, and integration of the services. In addition (and as part of this trend), the services layer often provides a higher-level, application-focused interface that simplifies use of the infrastructure layer and insulates the application from technology specifics.

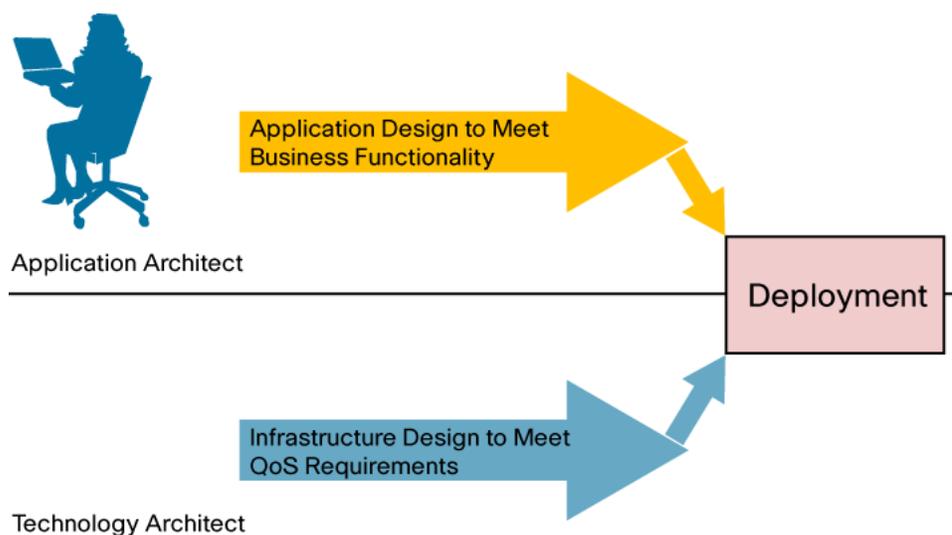
Technology Architecture

Even the most elegant application architecture is not useful if it cannot meet the service levels required by the business. These include performance, bandwidth, reliability, redundancy, and security.

However, from an architectural perspective, we want to separate these service-level concerns from the logical structure of the application, and from the business logic. This kind of separation allows us to support different service levels with the same application. The application architecture is designed to describe the common structure of applications. The technology architecture is concerned with meeting the service levels of the application.

Of course, the application and technology architectures are closely related. The application architecture is designed to utilize the technology architecture to achieve the desired architectural qualities and service levels, but in a way that hides the technology details. This goal at an enterprise architecture level is illustrated in Figure 7.

Figure 7. Intersection of Application and Technology Architecture



The goal is to focus the skills and efforts of the application architects and designer on meeting the business goals and requirements of the application. In other words, we want to define the logical structure and behavior of the application in terms of business features and application services, and then to have that application run on the appropriate platform to achieve the performance, security and redundancy that supports the overarching business function.

At the same time, we want the technology architects and designers to devise the best, most efficient and cost-effective platform possible that meets performance and other business requirements, now and in the future. That is, they should define the systems, storage, networks, and data centers to meet a range of application requirements and to expose any necessary aspects as a set of application concepts and capabilities (not technology features) such that the application will automatically take advantage of them just by following the architectural patterns.

Then, at the appropriate time, we make the specific decisions on how to deploy it. For example, we may have two different enterprise platforms, one with 99.9 percent reliability, and the other with 99.99 percent reliability. The higher-reliability platform is five times more expensive to provision and operate, so we want to provide no more of the higher-reliability platform than we need. But how accurately can that be predicted? What applications need what level of reliability? What happens when that changes?

One proven solution is to design the application architecture to be able to use either platform. The use of the technology platforms to achieve particular reliability levels is built into the reference application architecture such that the application designer needs only to follow the architectural

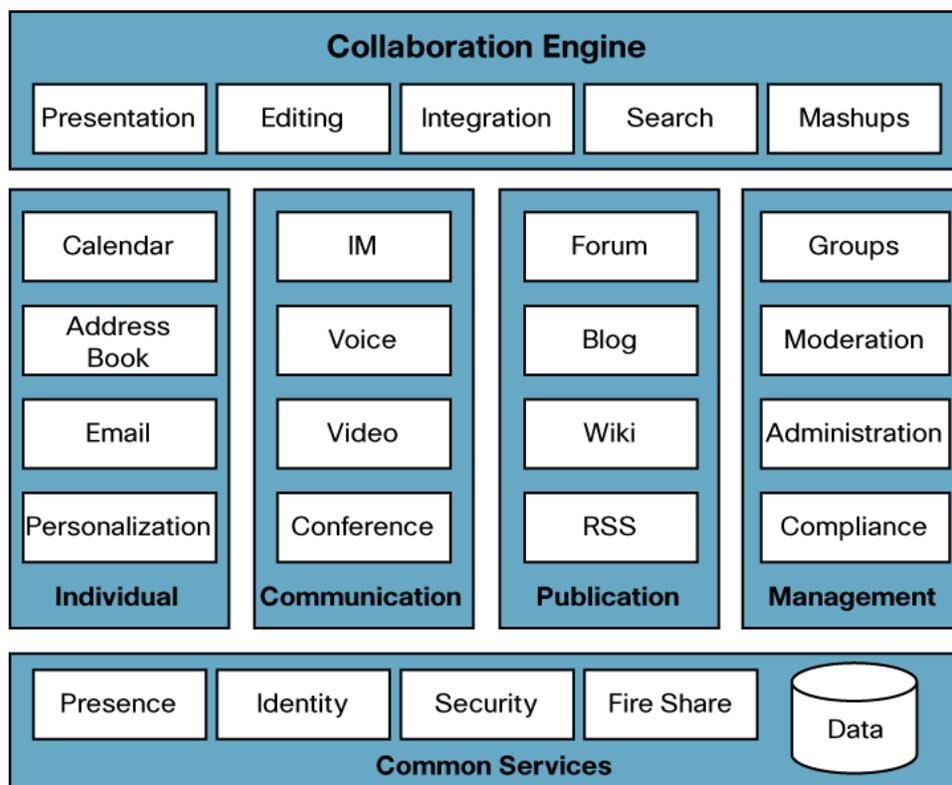
patterns and standards without worrying about the specifics. Then, a decision on which platform to use can be made at deployment time. Even better, some of the application can be provisioned on the higher reliability platform to support higher service-level agreements (such as those for Gold and Institutional customers), with the remainder placed on the less expensive platform. As enterprise policies and service levels change, the application can be reallocated as required without any changes to the application code.

An emerging, advanced variation is to have a platform that can dynamically allocate a virtual infrastructure to meet service levels based on policies that are set at runtime.

Collaboration Framework

The application layer capabilities to support collaborative applications can be represented in terms of a collaboration framework that defines and groups the different capabilities together and shows the relationships between them, as illustrated in Figure 8. The framework provides a common and consistent way to structure collaboration within an application.

Figure 8. Collaboration Framework



The framework consists of capabilities in the following areas:

The collaboration engine provides the underlying features for the collaborative community, including:

- **Presentation and editing:** Common presentation components for building user interfaces, including common editing, spell checking, and other capabilities that can be shared across applications such as a blog and wiki.
- **Search:** Integrated search capabilities that allow search across all of the different community features, storage, and media types.

- **Integration:** Connection between the different collaboration capabilities, such as use of address books within IM or chat and population of address book from groups.
- **Mashups:** Facilities needed to easily design and combine different capabilities into composite applications.

Personal productivity applications for individual users include:

- **Address book:** Lists of contacts integrated with IM and other applications and with administration of groups.
- **Calendar:** Personal and group scheduling.
- **Email:** Integration with email services including tracking, indexing, and archiving.
- **Personalization:** Customization and storage of personal preferences.

Communications capabilities are key to collaboration. Standard communications capabilities include:

- **IM:** The ability to send brief, asynchronous messages to others and, through the use of presence services, to know whether a recipient is online or not.
- **Video:** Allows for the display of video information and the use of real-time video to enable video conferencing, web cams, and so on.
- **Voice:** Synchronous verbal communications including traditional telephones and newer voice-over-IP systems.
- **Conferencing:** Use of voice and video in a virtual conference between two or more participants, as well as shared whiteboards, presentations, and desktop and application sharing.

Publication and collaborative knowledge capabilities support different formats for exchange of ideas and discussion. All of these should include RSS capabilities and use common editing capabilities.

Mechanisms include:

- **Forums:** Members can post and comment on information in a setting that maintains a history of postings and comments.
- **Blogs:** Members can post and comment on information in an archived setting intended to foster a community, with capabilities for linking to other blogs and related information.
- **Wikis:** Environments for collaborative knowledge exchange and harvesting, intended to produce a single version of common knowledge that is based on the combined contributions of community members.

Community management services are mechanisms for administering and managing the community, including:

- **Groups:** Creation of groups of selected members and the definition of roles and entitlements within groups.
- **Moderation:** Features to support the oversight and moderation of publication mediums.
- **Administration:** Tools to manage and report on all aspects of the community including resource utilization of collaborative features.
- **Compliance:** The ability to manage and monitor compliance with specific policies.

Common application services for collaboration are shared with other groups within the collaboration framework, within mashups, or other applications. These include:

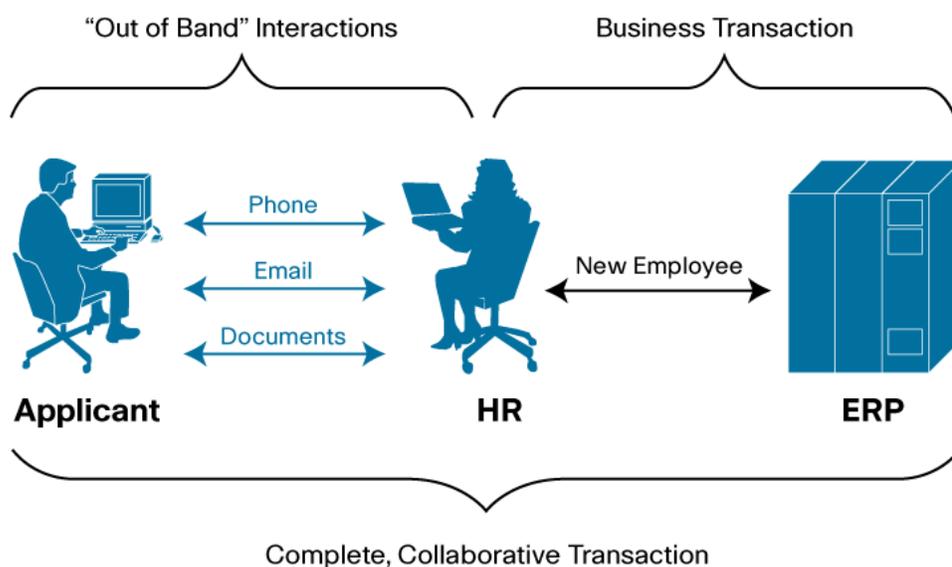
- **Identity:** Provides a secured identity and role of each participant.
- **Presence:** Provides current information about location and status of participants.
- **Security:** Provides for authentication, authorization, encryption, and other services as required.
- **File Share:** Enables participants to share files with other members of the community, and to apply entitlements, and reporting to the file access.
- **Data:** Stores community data such as entries in blogs, forums, and wikis.

Collaborative Business Processes

New collaboration capabilities have the potential to enhance and extend business processes and particularly the management, monitoring, reporting, and optimization of business. Today, process management and automation is limited by the capabilities of business process management (BPM) and transactional systems. There may be a significant amount of manual activities in a business interaction that the software cannot yet handle.

Consider an example from a Human Resources transaction for bringing on a new employee as shown in Figure 9. The HR person has many interactions with the potential employee including email exchanges, telephone conversations, and the exchange of documents. For example, HR may have posted a job listing to which the applicant responded with an email and electronic resume. After a few email exchanges, the HR person phones the applicant for a qualifying interview and to set up subsequent interviews. Later a job offer is sent, terms are negotiated, and the offer is amended and accepted. Finally, HR executes a "new employee" transaction. In most cases, none of these exchanges are tracked or preserved. With today's technologies, only the final step of the overall transaction is recorded, managed, and optimized. Or even if the system has workflow to manage some of the manual tasks, it cannot easily collect and integrate the data from the human interactions, which are not associated with the business transaction and are not subject to analysis and continual improvement activities.

Figure 9. Collaborative Transactions



Improving the Transaction

Let's look at how the HR transaction could be managed differently using new collaboration technologies, as illustrated in Figure 10.

First, the hiring manager posts a job listing on an internal wiki. The new hire's future peers review and edit the posting to include subject matter and other information. Many people have different ideas about what the responsibilities of the new position ought to be, so the wiki provides a way for them to debate these ideas and agree on a final set of responsibilities. The overall debate is easy to review, and each person can participate at their convenience. HR reviews and edits the posting to conform to corporate guidelines, add generic content, and align it with job categories. Because only HR has the authority to finalize the job posting, policy-based access controls determine who can create, edit, see, approve, and finalize content.

Next, the overall hiring transaction starts with the posting of the job listing on one or more electronic boards. The applicant's initial email and documents are received and logged. The resume is reviewed and entered into a document management system. Each subsequent interaction between HR and the applicant is logged, including the data that each email contained. The voice conversations, too, are logged along with their contents. Given today's requirements for auditing and compliance, and potential legal liabilities, it is more important than ever to have all communications and every aspect of the hiring process tracked, recorded, and integrated together.

HR sets up an interview schedule using the shared calendar, address book, and scheduling capabilities of the collaborative workspace. As the organization is distributed globally, some interviews are in person while others are done by video conferences or telepresence. Before each interview, the interviewer retrieves the resume from the document management system. Afterwards, interviewers enter their comments into a discussion forum on the wiki. Again this provides a transparent forum to debate and compare the pros and cons of each candidate, while keeping track of why a particular decision was reached. In due time, the stakeholders cast their votes for their preferred applicant using the community voting capabilities of the collaborative workspace. An offer is then made to the chosen applicant, who accepts the offer, and the "new employee" business transaction on the ERP system is executed as the final part of the overall "hire new employee" enterprise transaction.

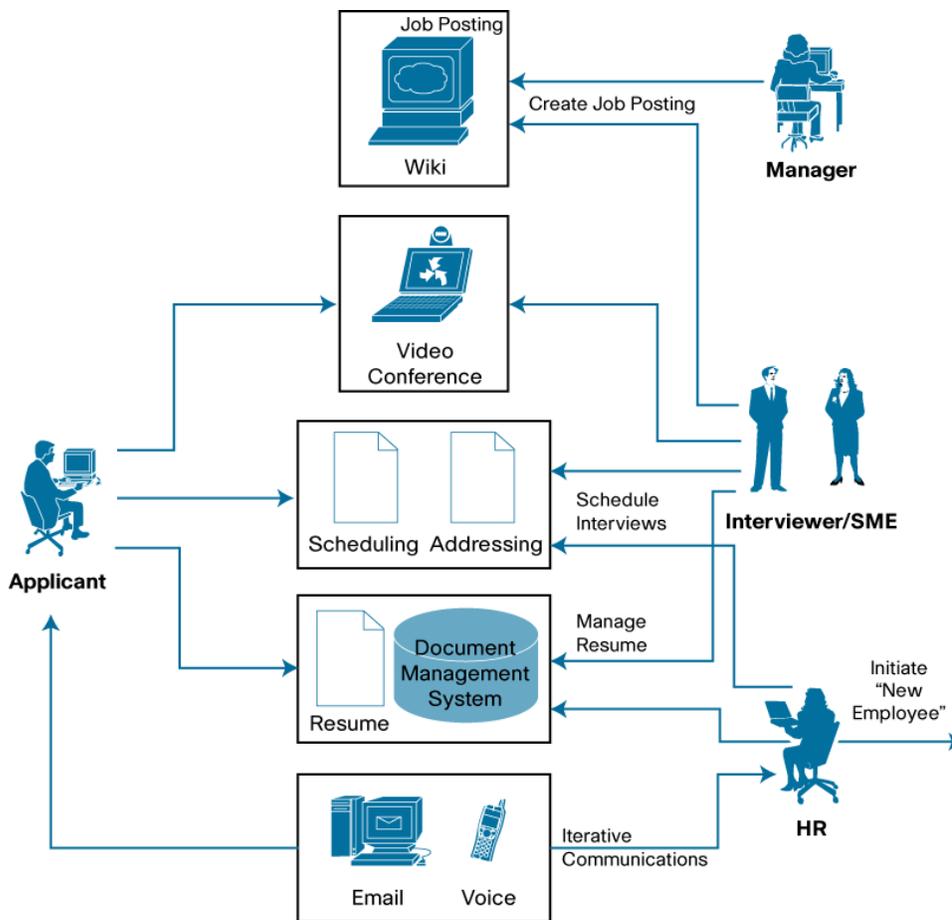
Using the tracking and history of the collaborative workspace, the organization can manage and optimize the hiring process by analyzing the transaction including all the human interactions between the candidates, HR, and the hiring organization. Auditing of the process is enhanced with the ability to search the contents of any interactions. Questions of auditing or propriety can be dealt with thoroughly by examining the complete, long running, combined human and automated enterprise transaction.

This collaborative workspace also supports corporate governance requirements. Appropriate participation in the process and legitimate access to different aspects of data are managed through policy-based access. For example, depending on the country, HR must know and track various demographic details of each candidate such as age, race, and gender; however, this information cannot influence whether an applicant is chosen for interviews. Policies define what information is available to which roles, and are automatically enforced by the collaborative workspace environment.

At the end of the new process, the right job position was created to best support the overall requirements of the organization. All participants understood and acceded to the rationale for the particular roles and responsibilities. Interviews were effectively conducted across geographies and

time zones. The candidate was selected through a transparent process that removed any doubts about qualifications or favoritism, and performance metrics were applied to refine the process.

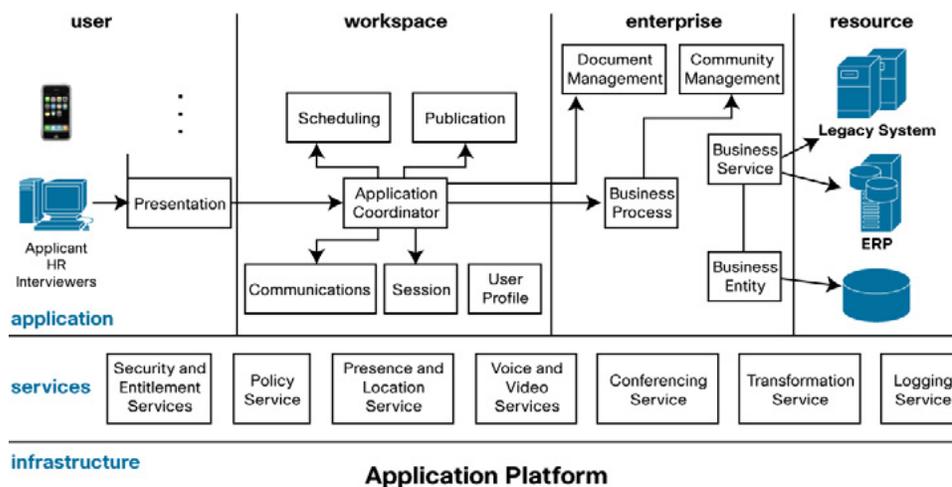
Figure 10. Improved Collaborative Application



Enhanced Collaboration Application Architecture

Now, let’s see how this new collaboration transaction model can be implemented using the n-tiered application architectural style described earlier. Figure 11 illustrates a high-level conceptual architecture to support the new HR application, showing the end-to-end structure of the application from presentation through different layers of logic and to the backend systems. This also represents an overall end-to-end application flow.

Figure 11. High-Level Collaboration Application Architecture



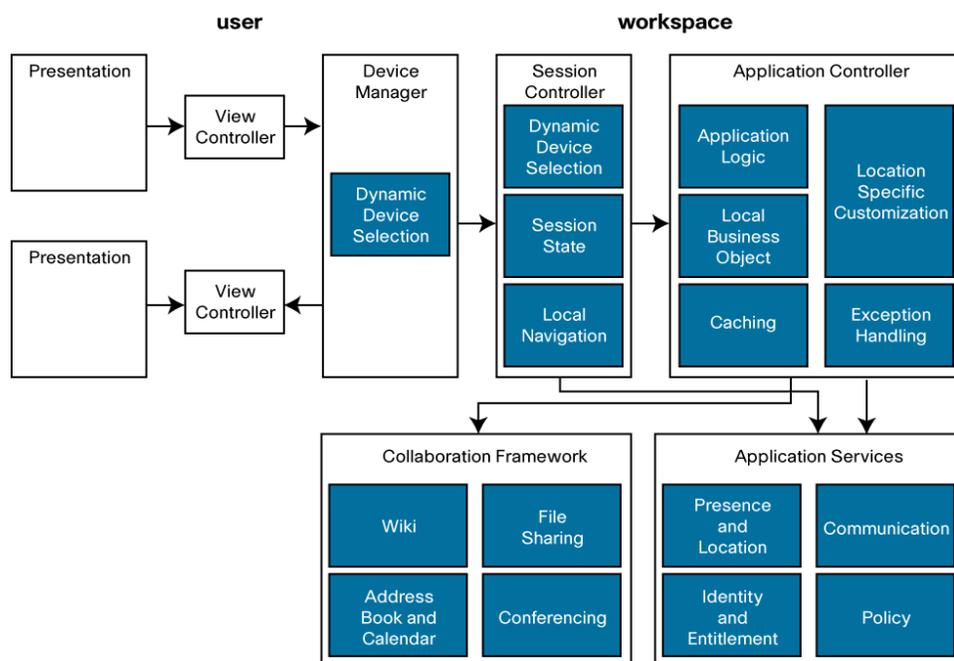
On the left of the figure are the different users, such as HR, the interviewers, and the applicant, and the different presentation devices that they may use during their different interactions.

Many of the collaborative capabilities reside in the workspace tier. The primary implementation of the user experience and application logic is the application coordinator, which takes care of managing the user session and integrates the publishing, scheduling, and communications services to provide the required application interactions.

The overall HR transaction is managed by a business process in the enterprise tier that maintains the state of the transaction, logs transaction information, and interfaces to the ERP system through a business service. Because the enterprise tier is responsible for implementing business policies and managing enterprise access to shared resources, management of the collaborative community and document management take place here.

Existing systems (such as ERP) and data are contained in the resource tier and exposed to the enterprise tier through a variety of integration techniques such as EAI or SOA. The tiers exist at the application layer of the architecture. The set of services shown in the underlying layer support all of the tiers of the application. And both layers are in turn supported by the application platform, which is a combination of application servers, infrastructure, networks, and so on.

As most of the collaboration capabilities are implemented in the workspace tier, let's examine the next level of detail of the collaboration application workspace architecture, as illustrated in Figure 12.

Figure 12. Workspace Detail for Collaborative, RIA User Experience

Presentation

Starting at the left of the figure are the different presentations that may be used during the different interactions of the overall transaction. Each is managed by a view controller that executes the input and output of each page to the device. View controllers pass control to the next controller for the next page based on navigation rules implemented in the session controller.

Each type of device may have a different presentation, designed to optimize the user experience given the size, resolution, and capabilities of the device and the bandwidth serving it. For example, a mobile device may have a presentation based on WAP and WML controlled by a Java Server Page (JSP), whereas a web page may be implemented as part of an RIA using AJAX technologies and XML and implemented with Java Server Faces (JSF) or some other RIA framework.

The user layer supports device-specific presentations, but the overall architecture provides a user experience that is transparent and consistent across the different devices. And perhaps more important, the architecture allows the same application and session logic to be used regardless of the device. This is handled in the workspace tier using the device manager which relies on capabilities such as presence, location, device identification, application delivery, and context.

Session Controller

The session controller is responsible for maintaining and managing the user's session. This involves authenticating the user at login using the security services, logging out or timing out the user, keeping context between user interactions, applying user profile policies and preferences, and specifying the navigation from one page to the next for these interactions based on policies, preferences, entitlements, and application requirements.

Application Controller

The application controller is the heart of the workspace, responsible for implementing application-specific logic, such as managing interactions with the document management system to retrieve, annotate, and store resumes. In the implementation of application logic, the controller has to handle

the creation of local versions of business objects, such as a “candidate,” caching of information to support rich interfaces, and exception handling. Customizations at the application or presentation level also may take place here. For example, the display of dates or times could be converted to local formats. The application controller is a primary user of the different collaboration and application services. For example, this function would take advantage of location services.

Collaboration Framework

The collaboration framework (described earlier) provides an integrated set of collaboration capabilities in the form of services. The HR application uses a wiki to create the specific job postings and to comment on applicants. The address book and calendar are used to schedule interviews. The file sharing service allows interviewers to share additional information with the applicant, and the applicant to post examples of past work. Conferencing supports voice and video conferences between participants.

Application Services

Application services provide additional capabilities to the application controller, which are more general in nature than those in the collaboration framework. Presence and location provide information on the current location and status of the different participants in the transaction. The communications capabilities support voice and video communications and the logging of these interactions and their content.

Identity and entitlement provide for the secure authentication and identity of the participants and the application of policies for what data and operations a participant is entitled to see, modify, or perform. Policy services allow the specific device, location, application, entitlement, and other policies to be pushed down into the infrastructure for enforcement.

Application Architecture Describes a Logical Structure

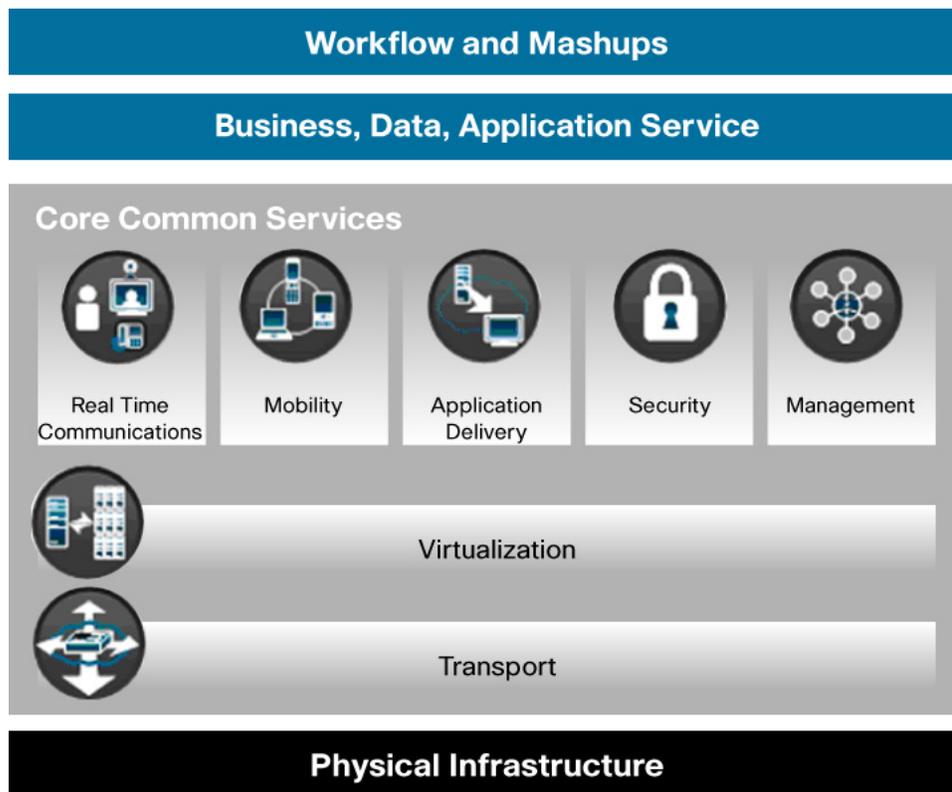
These “application architectures” are not technologies or products. Instead they describe the logical structure of the application in terms of application concepts, provided by application-level services. There are some obvious links to technical capabilities, but the application architecture is only concerned with interfaces to those technologies, not the technical details. When discussing platform capabilities with an application or enterprise architect, it is important to understand this distinction.

Technology Enablers

Now that we have laid out the application-level architecture, we need to understand how it will be implemented to meet service level requirements. As illustrated earlier in Figure 2, the collaboration capabilities are built on top of layers of communications and network capabilities. The Cisco Service-Oriented Network Architecture (SONA) framework provides all of the collaboration, communication, and network services needed to support the collaboration architecture and to meet whatever service level the enterprise demands.

Figure 13 illustrates how the Cisco SONA framework supports the collaboration application layers. Cisco SONA Core Common Services provide infrastructure and communication capabilities as a set of integrated services that support the application layer and the business, data integration, and application services implemented there. Finally, these application-level services are combined into business processes through BPM workflows and mashups that are used to create collaborative business processes and applications.

Figure 13. Cisco SONA Platform



This framework includes three interconnected layers. Primary is the Core Common Services Layer, in which an extensive library of network-based service categories works together to create capabilities that can be used by the applications layer, which contains all types of business applications used across the enterprise.

At the Physical Infrastructure Layer, Cisco designs, tests, and validates sets of modular, connected infrastructure elements organized by places in the network (PINs). These branch, campus, and data center reference solutions form a quick starting point for understanding how network-based services can be deployed with business applications in a variety of industries.

The Core Common Services Layer is distinctive to Cisco in the breadth and depth of integrated services throughout an enterprise-class network. This layer comprises seven major core service groups, which deliver consistent and robust capabilities throughout the network. The Core Common Services Layer provides the following groups of functions:

- **Real-Time Communication Services** offer session and media management capabilities, contact center services, as well as presence functions. Needless to say, these are of particular importance to enable the collaboration application framework.
- **Mobility Services** offer access to location information and also offer device and presence dependent services. Location and preference information can greatly enrich the richness of collaborative applications.
- **Application Delivery Services** are concerned with performance optimization based on application awareness; they consist of a rich set of acceleration, compression, and protocol optimization capabilities.

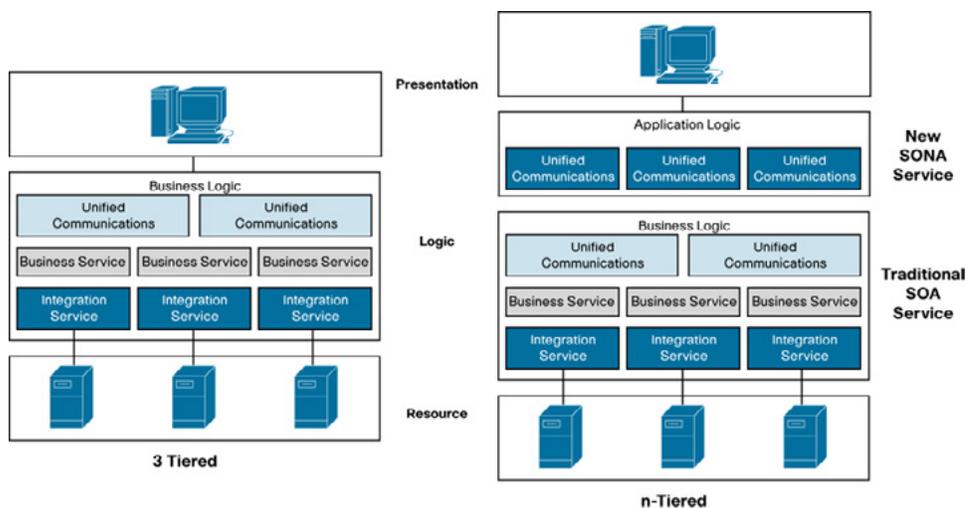
- **Security Services** help protect the infrastructure, data, and application layers from constantly evolving threats and also offer access-control and identity functions. Especially in tiered architectures and SOA, policy-based security models are of vital importance to fully support the vision of the borderless enterprise.
- **Management Services** offer configuration and reporting capabilities.
- **Virtualization Services** deliver abstraction between the physical and functional elements in the infrastructure, allowing for more flexible and reliable service operation and management. Virtualization capabilities play a key role in providing seamless interworking between on-premise and on-demand “cloud based” resources.
- **Transport Services** are concerned with resource allocation and deliver of the overall QoS requirements of the application (end-to-end availability, latency, jitter, and packet-loss guarantees) as well as routing and topology functions. Innovative applications that combine traditional business application elements with real-time communication and collaboration functions may have strict service-level agreement requirements that need to be consistently and reliably enforced end to end.

Next-Generation SOA

The Cisco SONA framework is designed to provide network-based services and a network infrastructure in support of next-generation collaborative and SOA-based enterprise solutions. To demonstrate how tiers and infrastructure work together in the next-generation collaboration application architecture, Figure 14 shows two different implementations of a sample SOA solution for a bank. The example on the left shows the typical view of SOA in the industry today, where business processes, such as Customer Service, are supported by a layer of business services, such as Account, Customer, and Loan, which are supported by a service-based integration layer connecting to the applications.

If we position this SOA approach with tiers, we see that all of the typical SOA services occupy the logic tier of a typical three-tiered architecture. But we know from experience that the three-tiered approach is not effective at providing rich user interaction experiences or integrating new collaboration technologies into applications.

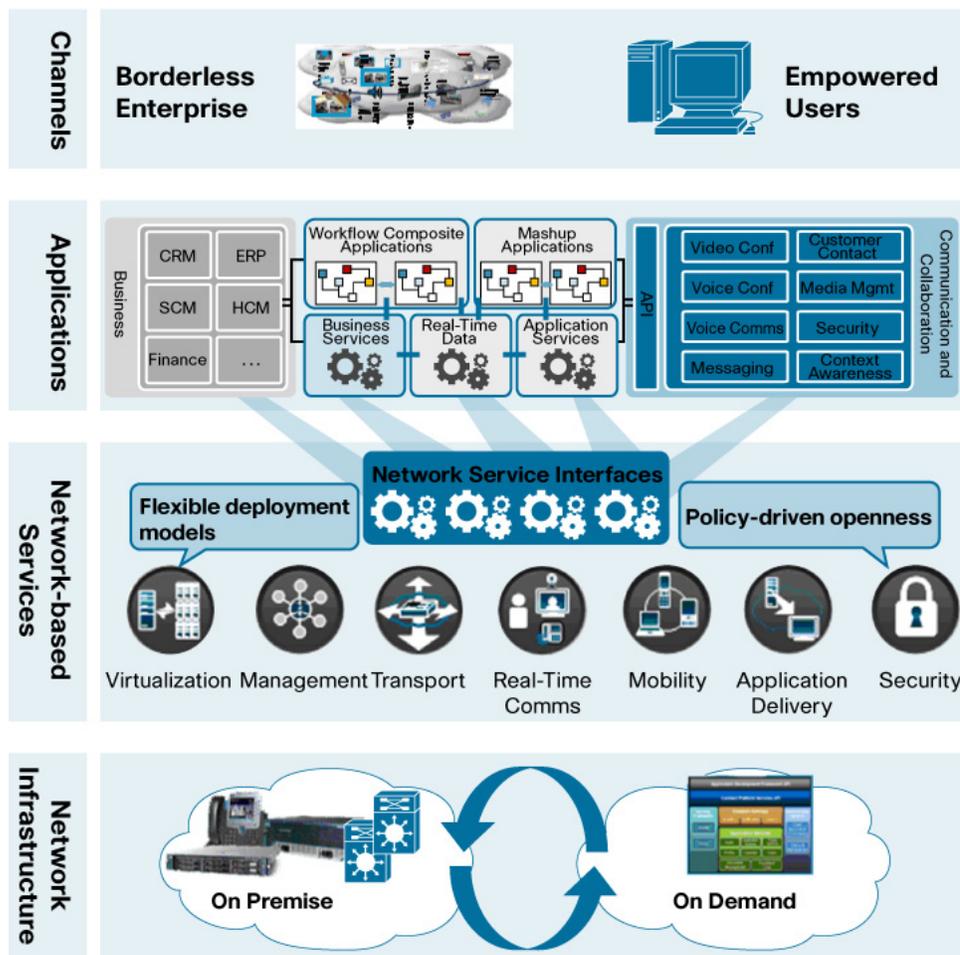
Figure 14. SOA and Tiers



As an alternative, the n-tiered example on the right breaks the logic into the two types, application logic and business logic. The application logic is implemented in the workspace tier as a set of application services, such as collaboration, and unified communications that enrich application capabilities and user interaction. These services enable the next generation of collaborative applications with reusable capabilities and represent an important evolution in thinking about SOA based on the lessons of other application architectures. Instead of only thinking about business services, we can now consider services to provide rich user experiences and fit them into our architecture corresponding to proven architectural principles and the roles and responsibilities of the application tiers.

These are exactly the types of services that the Cisco SONA framework provides. Figure 15 shows the overall Cisco Collaboration Architecture using SONA services. The basic network infrastructure provides the fundamental capabilities, such as routing and switching, needed for secure and available communications in accordance with the required qualities of service. End-to-end connectivity is maintained with a variety of session control tools that provide the ability to establish, tear down, and modify sessions between identified entities and different access devices.

Figure 15. Cisco Collaboration Enterprise Architecture Overview



On Demand or On Premise

Software as a Service (SaaS) represents a key industry trend. While enterprises want to benefit from the openness, cost efficiency, and reach of SaaS, they must consider performance and security in mission-critical business applications. Cisco technology gives enterprises the ability to seamlessly utilize and integrate on-premise and on-demand resources to maximize benefits for any set of considerations.

Technology deployment options give you flexibility with the ownership and operating costs associated with collaboration capabilities. Presence and location, for instance, are optimally served by the network infrastructure given its reach and incumbency. Data sharing, instant messaging, and chat might be considered for off-premise delivery, as long as they're still part of a trusted global delivery network.

Integrated Network-Based Services

Operating seamlessly within this distributed infrastructure is a set of network services, including virtualization, management, transport, real-time communications, mobility, application delivery, and security. These are the SONA common core services described earlier. Together, these services reside in an integrated network services layer that provides the foundation for optimally supporting emerging applications through the use of service-based interfaces. Two important aspects to this layer are its flexibility with respect to deployment and its flexibility as governed through policy.

Deployment flexibility is delivered through network-based virtualization, allowing you to optimize resources and utilize them where they are needed the most. For example, it could be cost-effective to avoid the need to engineer the on-premises voice and video conferencing system to the largest possible expected number of participants, and instead taking advantage of on-demand capacity whenever required, yet allow users of the on-premises and on-demand sessions to share the same experience, interface, and capabilities. Flexible deployment is easy with network-based services, such as virtualization and session management, and with shared web service-based presentation layers. Implementing Cisco SONA principles, the network acts as a robust, highly secure global delivery platform that easily links the on-premises and on-demand solutions. No longer confronted with an either-or choice, enterprises are free to exploit either deployment model where it benefits them the most.

Policy-driven solutions grow more attractive as enterprises increasingly rely on collaborative, multimodal electronic communications between employees, customers, and partners. With the heightened emphasis on security and compliance, enterprises look for easy-to-use, policy-driven solutions to manage, enforce, and audit access to their portals, content management systems, instant messaging (IM), voice, video, conferencing, and other channels. Cisco provides a standards-based, policy-based entitlement and access control solution that externalizes authorization from the core collaboration capabilities using agents that intercept traffic flowing through these channels. Policies can be configured to allow and deny access based on the identity and presence attributes of the users, the channel of communication, the resource being accessed, the content of the message being communicated, and other environmental variables such as time of day.

Applications Layer

The applications layer supports a variety of different application types. Standard enterprise and COTS applications are supported directly with the network services. Collaboration-enabled applications are supported by the collaboration services that are part of the Cisco SONA core

services (unified communications, conferencing, content and media management, security, and so on). In addition, the network services support a set of SOA-based business services, integrated real-time data services, and application services.

Any of these services can be combined into composite applications. Two primary types of composites exist:

- Those that are based on workflow implement business processes and combine automated and human interactions into long-running business transactions.
- Those that support rich user interactions and interfaces, based on Web 2.0 technologies, are assembled using mashups.

These mashups and workflows are used together to create collaborative applications that support the borderless enterprise and that empower users, customer, employees, and partners.

This unique Cisco approach allows the “network platform” to further enrich and enable these composite applications by accelerating applications, establishing end-to-end sessions with deterministic QoS, providing virtualization services to enhance application availability and scalability, offering valuable location and presence information to applications, and helping to secure this open enterprise infrastructure. And, since these composite applications are network based, they can operate very consistently and reliably across the whole network, with true functional integrity that helps ensure their reusability and enables continued innovation.

Cisco TelePresence is a successful example of an innovative, composite collaboration application. It uses network services such as session establishment and QoS to ensure the strict SLAs required for the virtual face-to-face meeting experience, security tools to safeguard sensitive exchanges, and storage services to comply with regulations when required.

Given that these core services can greatly enrich collaborative applications, their value still depends on their ability to provide highly reliable infrastructure to the enterprise. These new network-based services cannot compromise network availability or manageability. Rather, they should result in an overall technology infrastructure that is easier to manage and able to fix itself whenever possible. Many of these collaboration and application services are easier to scale, manage, and reuse when they reside in the network. Cisco is offering collaboration capabilities as robust plug-and-play services whose functions will merge into a homogeneous, intelligent network cloud that works transparently and reliably from end to end.

Conclusion

Industry trends are converging on the next generation of applications. Users both inside and outside the enterprise are demanding more empowerment. Business decision makers require more and better access to real- or near-time information. The boundaries of the enterprise grow porous as globalization marches on.

A next-generation architecture is required to support next-generation applications. Composite application models such as SOA and Web 2.0 mashups are major advances in application architecture. New platform-based services provide next-generation capabilities. When properly aligned, n-tiered architecture models, new application-level services, SOA, and mashups can create this new generation of end-to-end collaborative applications with rich user interaction experiences, robust performance, and high security.

An important advance in architecture is the separation of application logic from business logic. Combined with the provision of collaboration capabilities as services to enhance the application

logic, this development provides a unified SOA approach to application composition for both business processes and rich, collaborative interactions. At the same time, these next-generation applications must meet all requirements for performance, reliability, scalability, security, and so on. Fortunately, the implementation of these application-level services in the infrastructure itself make that possible. In other words, the network is becoming more and more the platform, and Cisco is at the leading edge of this innovation.

The Cisco SONA framework provides the needed alignment between the application services and the technology infrastructure. The solution it makes possible features on-demand and on-premise flexibility, based on network systems, integrated network functions, communication and collaboration services, and driven by policy. In this way Cisco continues to make the complex infrastructure more and more transparent.

Successful collaborative applications will be aligned to the business and built on the right architecture, using the right capabilities as services, on top of the right technology platform. Cisco SONA provides the integrated platform and application-level services to enable collaborative applications in a highly secure, scalable, reliable, performing environment for the next generation of collaborative applications.

For more information visit <http://www.cisco.com/go/architecture>.



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