The Federative Principle in Business Architecture

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Abstract. The article is based on the idea that the federative principle, which has proven itself as a behavioral pattern in natural organisms and successful communities, can also be a course of action for globally operating companies. This enables smaller units to do their jobs as autonomously as possible without jeopardizing the general objective, while at the same time increasing the system's overall benefits and reducing costs. If the federative principle is accepted as strategic behavior, the applications and IT structures themselves must be subject to this principle and designed federatively.

1 The Federative Principle

The shared characteristic of all federative behavior is the principle of maintaining each member's independence while obligating them to perform for the common good according to their ability.

As an entrepreneurial principle, federalism promotes the clear and differentiated expansion of corporate networks and processes. As a structural and organizational element, it protects the smaller entity against the larger higher-level entity without depriving it of the support it needs to accomplish its tasks and granting it a large degree of freedom in its activities.

Federalism is therefore the structural and organizational principle by which basically independent, autonomous entities join forces to form a higher-level whole in order to combine a required level of uniformity with the kind of *diversity* that is indispensable if the organization wants to be successful. Federative behavior is natural for all living things, from the basic building blocks of life to functioning social structures [8].

Federative Businesses

Business are successful when they are sufficiently — not necessarily optimally — aligned with the general conditions prevailing in their economic environment. *Uniformity* of syntax and semantics is a sufficient prerequisite for efficient communication, the trust-based exchange of information, orientation towards shared goals, and the development and manufacture of products that fit together seamlessly. The *diversity of their parts* is the necessary prerequisite for maintaining their organization's adaptability to the continuous changes and demands of their economic environment. Diversity ensures survival. A business acting federatively — and the federation itself — profits from its network when the overall benefits increase and the overall costs drop.

Federatively organized companies are characterized by a central and shared interest in forming a joint value creation network that leaves the individual members as much freedom as possible. Federative organizations are led by a company that is close to its markets. All related companies operate within a space comprising shared processes, standards, guidelines and ethical norms [8].

Federative corporate processes are distributed over different autonomous units. From a given point in their value creation network, they affect any other point and its process. Federative processes accelerate the development, production and market introduction of goods and services, lower costs by allowing the partners to focus on their core competencies, and increase flexibility in the design and adaptation of corporate processes.

2 Business Architecture: Vision and Reality

Business architecture is built on a vision of the current and future core competencies. Basically, the business architecture takes into consideration the strategy of the company, its long-term goals and objectives, and its technological and external environment.

The Unified Business Architecture

The unified business architecture starts with a single database which contains all the information the businesses, partners and customers need. It is based on the joint supply of services and portlets (graphical user interface modules), which can be combined via a network to new solutions or portals. It builds on the cross-company orchestration of automated and intellectual services through workflows (see Figure 1).

Business functions, applications, processes or components are available in the form of web services. Their interfaces are specified in a uniform standard and can be activated network-wide using a standardized message format [6].

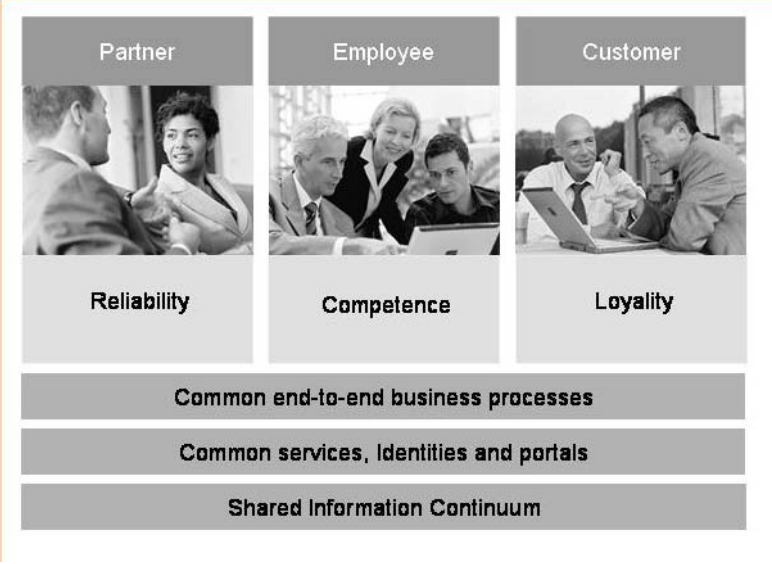

Fig. 1. The fiction of a unified enterprise encompasses a standardized platform for all applications together with an all-encompassing data model and a single shared database in a network of customers, suppliers, and the employees of the company itself

Business Architecture in Reality

Today's large companies have grown as a result of a variety of organizational activities — activities which both shaped the IT environment and, vice versa, were initiated by it. There are many systems and solutions, each of which is aimed at a particular service. Many solution variants, often from the same manufacturer, and proprietary interfaces make integrating and improving these systems cumbersome. If you look at an end-to-end value creation chain as a virtual organization, the number of product and manufacturer combinations increases exponentially.

The unified enterprise will always be a fiction. Business concerns depend on country culture. And people want to be different. Business and IT solutions even have different views on the same matter. That's why it's important to respect the natural heterogeneity and deal with it.

While headquarters that tighten the links to their divisions and subsidiaries increase the power and shorten the response time of their organization as a whole, they also increase the likelihood that factors from outside the business or from company units affect their organization more directly.

In accordance with the German proverb that you should never go to see the prince unless he summons you, federative units look for solutions independently and try to avoid disturbing the higher-ranking system if it can be avoided. The growing corporate trend of freeing yourself from overly close relationships with your own departments and partner companies goes hand in hand with the maturing of

technological standards (such as service-oriented architectures) which support this trend on the information technology side.

3 Federative Integration and Interoperation

Traditionally, companies manage their processes and transactions for the more part within their own corporate borders: a business process starts and ends within the company. Interactions with the outside world are handled via letters, phone calls, fax, e-mail or »Electronic Data Interchange« (EDI). Technical advances notwithstanding, people continue to be the main transmitters of information at the company's borders. But besides a time delay, each human intervention also generates costs.

To continue to be part of a global and federative value creation network, companies will — indeed, will have to — design machine-to-machine interfaces in accordance with federative principles and implement them at their borders to the outside world.

Applications that support business processes across the company's borders or which integrate services from different departments of a company or from various other companies will shape the coming years of IT. Such applications include various application services (production planning systems, order processing, warehouse management, etc.) or databases.

The central motivation for the current development of so-called web services is the need for an uninterrupted flow of information across technical and organizational borders combined with the reuseability of applications in a far-ranging network.

Web services are modular, encapsulated IT functions with their own data sovereignty which can in turn use other web services to perform complex tasks on the internet or intranet within new solutions. Web services are nothing but applications, frequently legacy systems, which are addressed by a client via a message in SOAP format over HTTP, i.e. over a network.

The widespread use of web services therefore has the potential to integrate and, if necessary, adapt many different applications (services) on different platforms quickly and efficiently over IT networks.

Today, there are frequent requests for integration on the basis of standard solutions from companies like SAP, Siebel, PeopleSoft or Oracle. Such solution packages, which are referred to as *best-of-breed*, enjoy wide popularity. However, combining these standard solutions into a total system will in most cases result in multiple different databases for similar or even the same content, and these databases must constantly be reconciled with each other (Fig. 2).

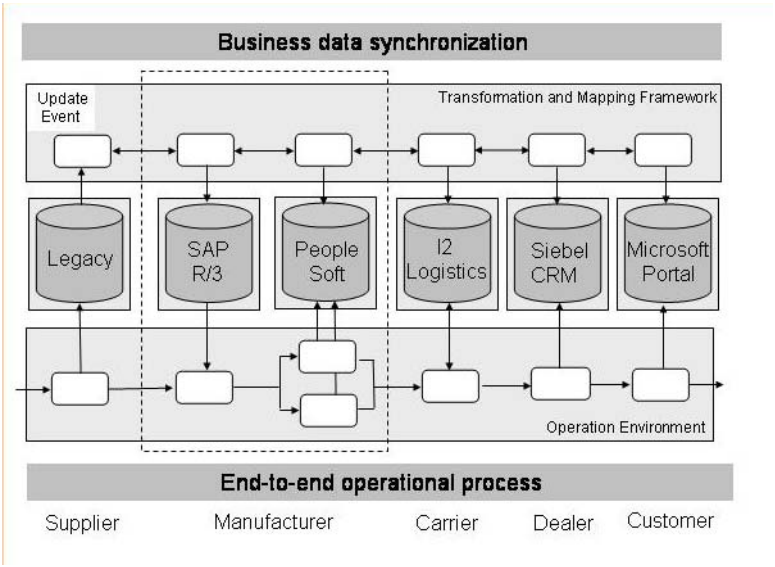

Fig. 2. Synchronization of databases in enterprise applications. The best-of-breed ideology of the past did away with the ideal of a shared operational database, necessitating mechanisms for synchronizing the data management systems of different products

There is good reason for the multiple storage of information, namely the problem of data overlaps. A CRM solution needs customer data every bit as much as an ordering system does. Even different versions of products from the same manufacturer may feature different versions of customer information, although the customer himself is always the same.

Having their own data is an important characteristic of autonomous, federative systems and their services. The merging of databases would signify the loss of power by individual partners as well as a weakening of the applications in the whole value creation network. In addition, it would result in an unjustifiable watering-down of the overall semantics and subsequently lead to a »loss of culture«.

Deciding whether or not the information about a customer in one system is really the same as that in another system is difficult and makes no sense without also taking the applications that use this information into account. This is the real reason why integrations at the database level are almost always unsuccessful. You cannot view data separately from the programs that process it, and you cannot see programs separately from their data.

As a result, the workflow for the business must always be accompanied by a more or less complex workflow for the synchronization of the virtual database. For example, whenever a customer's address changes, this synchronization process ensures that this is communicated to all the systems involved in the process (on-demand synchronization).

Data synchronization is therefore the price we have to pay for autonomous services or standalone standard solutions. This synchronization process reconstructs quasi-permanently the shared database of the *unified enterprise* (Fig.1.)

Integration at the data level is rarely satisfactory, as the remote effects on dependent sub-solutions are simply too extreme. Synchronizing different data inventories via messages is the better choice in most cases, particularly when not all sub-solutions can be freely controlled. As is customary in real business processes, you must define in a special process *when* synchronizing certain data is advisable or necessary in order to make the overall system consistent.

Since services are generally developed and run separately, they may (e.g. during reporting) contain or use similar but partly inconsistent data about one and the same real object, such as a specific customer. In this case, it is unavoidable that the data for a real object is inconsistent at a given moment in time (Fig. 3). Each program therefore constructs its own model of reality [9].

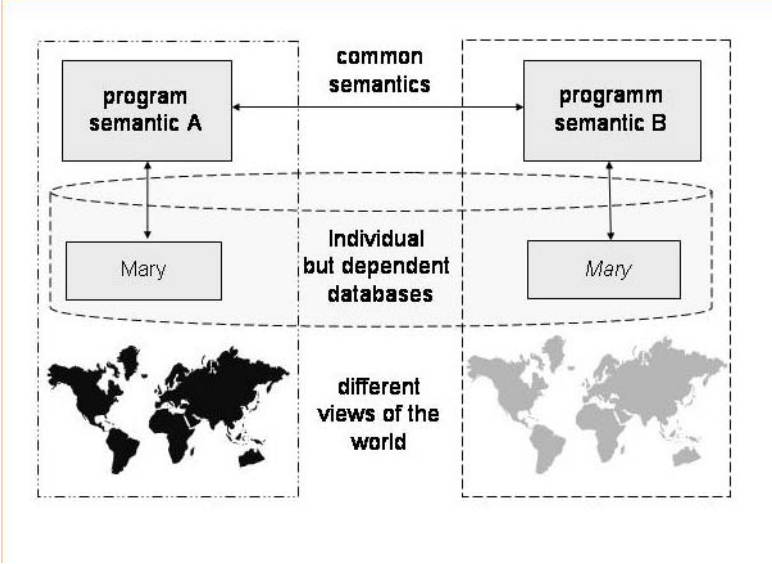

Fig. 3. Federative integration of different world views by messages. Program with semantic A and program with semantic B use information from the same scenario of real applications, such as information about the same customer. To ensure an efficient and consistent workflow, data should be synchronized at regular intervals

4 The Principles of Service-Oriented Architecture

First and foremost, service-oriented architecture (SOA) is an organizational concept for the communication and exchange of IT services. SOA is based on the heterogeneousness of technologies and suppliers with respect to services, and most of all on the autonomy of the partners in the network. Since web services are a technical implementation of the federative principle, they are useful for setting up an SOA [3].

To use and account for services there must be prior agreements (security, service level agreements).

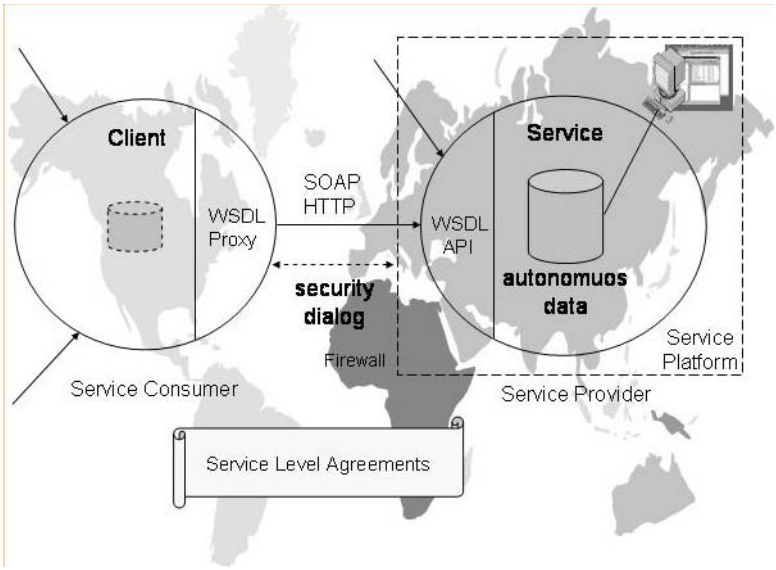

Fig. 4. The principle of a service-oriented architecture (SOA). To be able to activate a service via the network, its interface is defined via WDSL. The service manages its own data autonomously. The communication between services depends on the infrastructure on which the service and its consumer operate. Since a service is not normally »owned« by the consumer, service level agreements are needed

A service-oriented architecture has the following distinctive features:

- It often spans wide geographic distances.
- It includes areas with different security mechanisms.
- It uses different platforms for its services.

The major characteristics of services in a service-oriented architecture (Fig. 4) include:

- The communication of services is based exclusively on the explicit transmission of messages. The communication takes place asynchronously via queues.
- A service can be activated at any time.
- A service in an SOA hides the data and the type of data management it uses from the client.
- The implementation of the service itself is hidden from the client as much as possible.
- The communication of services is not controlled by a central entity.
- In SOA applications, partial failures can occur without this being made known automatically to other services. To counteract the possible effects of such failures, other technologies must be deployed, e.g. transaction management, persistent queues, redundant distribution of services or failover mechanisms.

- Services send and receive messages (via URLs) which are subject to a type scheme. Unlike OO classes, services are not an abstraction of data structures and functions under a clear-cut identifier.

  The asynchronous communication of services requires the following:
- The correlation between sent and received messages via identifiers, i.e. replies that arrive after a long period of time must be assigned to the process and the context information that triggered them.
- The definition of UNDO processes (compensations) for long transactions that have failed. These are workflows which attempt to reset changes; otherwise, a switch from the automated to the intellectual level is required (business activity monitoring, portals).
- A mechanism for handling services that cannot be reached (mobile devices, system failures, etc.).

5 The Choreography of Services

The commercial success of a company depends on how well its internal workflows are synchronized with the preferences and processes of consumers, customers, suppliers and others so that each transaction is immediately communicated to all affected parties [2]. The foundation for such a business model is the integration of all participants into a universal network which they can all use from anywhere, with any access device, and — especially important — also via voice communication.

The »choreography« is the protocol which negotiates between the processes of different partners at the system borders. It documents the partner system's behavior when certain system conditions are present, such as the queries possible at this point or the responses expected now or in the future (see Fig. 5).

Many things happen at the same time and nevertheless affect each other. Such a system is embedded into its global environment and is not ascertainable as a rule.

Consistent end-to-end processes do not exist. All companies are linked to each other via choreographies. These choreographies require standardized behavior, but this does not imply that the implementation of an internal process is standardized as well. During the development process, the external choreography is translated into any suitable programming language, to which the necessary data definitions and message formats are then added. The resulting workflow program is then compiled and executed directly in machine language.

Of course, many companies don't want to divulge all the details of their internal processes to other parties and would rather design these details freely to best meet their internal requirements. In such cases, the confidential process flows are encapsulated rather than divulged to an outside business partner.

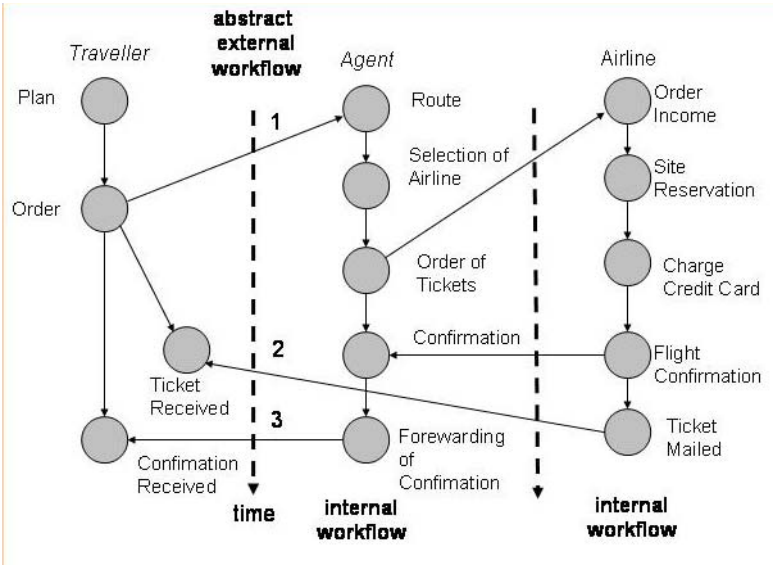

Fig. 5. Choreography of services. The principle of workflows is based on the external orchestration of services in accordance with the specifications of the abstract process, which can be compared as a protocol with the use cases of UML. The abstract process serves primarily the development of the consumer component in coordination with the service provider's possible responses, but in many cases it is a development tool for the service itself

Industry supporting federative interoperation

In the industrial area the new term of adjusted IT has emerged, meaning IT has to enable not to follow business demands. Unlike their earlier behavior IBM, Microsoft, and SAP extend their business through a common however refined nonproprietary orchestration technology today. Together they define standards for Web Services and Business Process Execution Language (BPEL).

- ESA [10] and the NetWeaver Middleware of SAP enable integration of packaged process solutions with solutions of providers like PeopleSoft, Siebel, Oracle. SAP co-operates with IBM and Microsoft on bridges for interoperation between platforms using meta directories.
- Microsoft renewed BizTalk for BPEL and will deliver a Web Services Framework named Indigo. Indigo supports ad-hoc workflows and Business Activity Monitoring in Office Tools.
- IBM Web Service Interaction Framework supports different service interoperation protocols and provides process patterns for 12 different lines of business.

All three vendors decline distributing their specific architecture on various computing platforms. They focus on standards of interoperation of federated IT solutions now.

6 The Modern Enterprise and its Federative Infrastructure

With the rising number of internal and external interactions and the growing variability of these relationships, the organization's complexity increases accordingly. At the same time, operational performance requires more and more coordination.

Traditional hierarchical organization structures are too slow to respond to rapidly changing requirements. The hierarchical organization is characterized by the physical and personal separation of conceptual, controlling and monitoring tasks — of planning and execution. The processes are designed to be broken down into standardized work steps, with the focus on increasing productivity in individual sectors of the company through specialization, which is practiced predominantly in manufacturing areas.

Typical features of modular organizations include weak interdependencies between the modules and strong interdependencies within them [5]. In turn, the intended effects include fewer relationships between the modules and intensive relationships within them. The analogy to the increasing modularity in software development is plain to see. Modular forms of organization are prerequisites for the federation [8]. The performance increase resulting from the distribution of software services in a network is equivalent to the savings in transaction costs in modular, federative organizations [1].

At the beginning of industrial production was the division of labor with individual workers specializing in certain tasks. In a next step, the focus shifted from the company's own production to its relationship with the outside world. The performance of a company was no longer measured exclusively in operational terms, but was viewed as a link in a value creation chain.

Federatively organized companies take this a step further by moving the focus from their concrete work to strategic areas. The responses a company can provide to the business opportunities currently presented by the market have moved to the forefront.

Managers have recognized that they stand to benefit particularly strongly from using their employees' intelligence, experience and initiative whenever the simple tasks can be delegated to technology. They realize that it makes a lot more sense to demand from their employees what machines cannot provide: initiative, ways of dealing with exceptions, recognizing new opportunities, abstracting information, imagination, and most of all the courage to act.

Looking at it this way, automated workflows are designed to relieve alert, creative and responsible employees from routine activities, involve them only when something goes wrong and help bring about a new type of enterprise. Workflows will eventually disappear into the background and become routine, as is already the case in the automation of invoice checking.

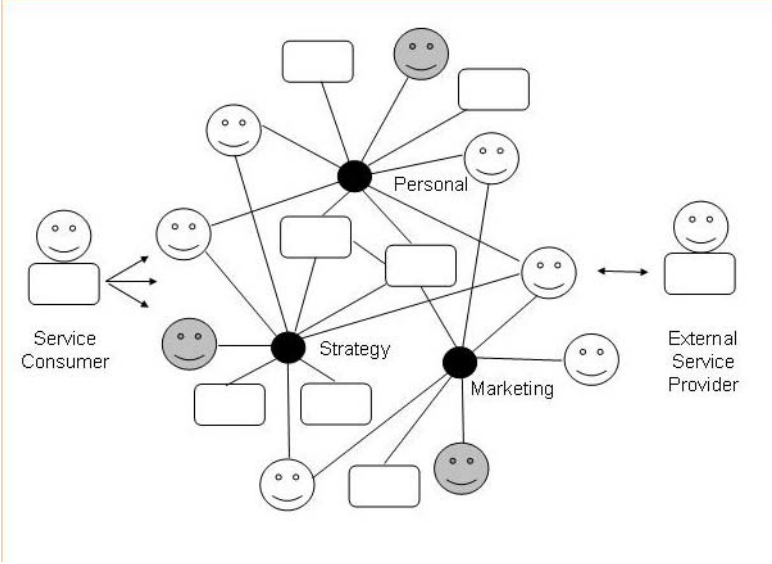

Fig. 6. Symbiotic network of intellectual and automated services. The increasing use of tools and applications leads to a federalization of the organization. Within a company, the services are provided by both parties both intellectually and fully automated in a symbiotic mix. Employees use services via portals, and business partners access them directly via programs or indirectly via portals on the extranet

The new paradigm of automated services which are at their core controlled via workflows and integrated via messages can and must be expanded to the services provided by people. A service node bundles both types of services (see Fig. 6). This does not make the people equivalent to technical applications. Rather, they carry the responsibility, act as partners for service level agreements and perform those services which cannot be provided automatically [7].

By merging portal functions with communication functions, observers are able to detect irregularities in a process's structure or execution which arrive at the portal in the form of messages. These can then be straightened out immediately with the responsible party. The observer sees in the portal window whether or not he or she is available, clicks a button and is immediately connected.

Whenever conflicts occur, they can interfere immediately and use their knowledge, imagination and politeness to save the company both money and trouble. Consequently, this clear trend towards more qualified employees leads to further automation of routine processes through workflow technology.

The service nodes indicated are the leftovers of earlier organizational units or departments. Companies become borderless in their internal and external interactions. The federative principle can be applied recursively in both technical and intellectual applications. The result is a sensitive federation in value creation for customers and enterprises.

7 Future Outlook

When you look at the history of computer technology you will notice that each newly found paradigm claimed to be universal. Looking back, all technologies left their mark and are to some extent still used to this day as tools for solving problems. One development that had a huge effect on the architecture of solutions was the invention of the relational database model. With the introduction of browsers on stationary and mobile terminals, the solutions have become increasingly independent from the underlying databases.

Today we are facing the beginning of another modularization of the application architecture involving workflows and service interfaces. The workflow technology provides a flexible tool for combining all kinds of loosely linked components and thus meets the needs of enterprise software.

From the workflow's point of view, the choreography is the most important tool for integrating additional services and their internal workflows. These integrated services can be of different types and have different origins. The integrated solution is *per se* heterogeneous. This makes the workflow a bridge between proven technologies and creates new opportunities for system integration and cooperation in federative enterprises.

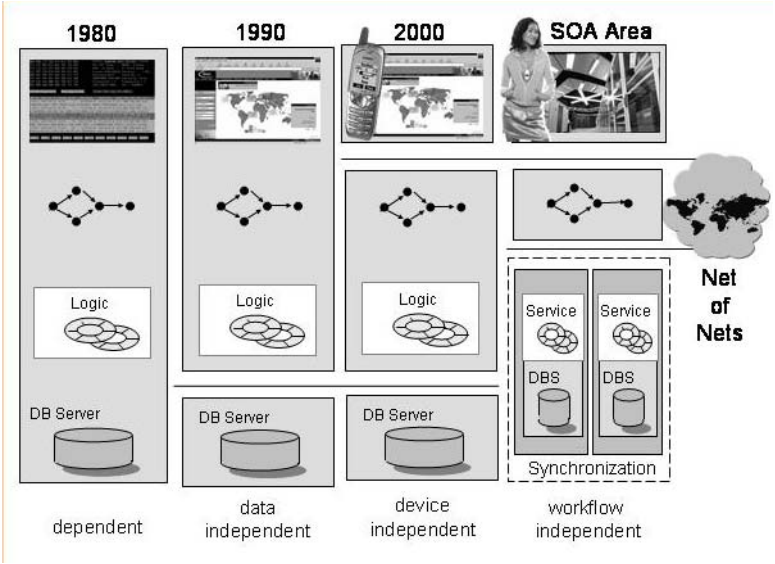

Fig. 7. Outlook: Permanent synchronization of federative services. In the future, solution architectures will be segmented differently. These solutions will have components (services) which cross organizational boundaries and reuse the services of contract partners. The data storage of these services will be continuously synchronized, making the direct re-integration of stored data unnecessary. Services are the successors of objects; they are their corrective element. Federative enterprises provide services and are nodes in the global grid of the future

Figure 7 shows a wider modularization of the architecture of applications in the form of orchestrated services. Similar to the introduction of relational databases in the 1990s, the development described can lead to a deregulation of the market for standard solutions. The core of the technology will consist of the orchestration of services and of background processes for synchronizing their data storage. The standardization of workflow and communication technologies will create completely different markets for solutions.

In future corporate networks, the federative principle will possibly become the guiding principle for the behavior of individual companies and subsequently for the integration of all intellectual and automated services on the basis of a corresponding IT infrastructure.

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[i] All figures except Figure 2 are taken from [8]