SOA Best Practice Report -

Information Services Architecture for Responsive Process Management

Business process management is evolving to incorporate dynamic response to events. Widely referred to as responsive process management, the emerging approach makes use of a closed loop pattern in which high quality and currency operational data supports visibility, sensing and concomitant responses to complex events executed through core business capabilities. In this environment the information services architecture must also evolve to provide a broader set of information that complements the transactional business process perspective. This paper discusses best practice in information services architecture that enables and supports the highly dynamic process management environment.

Introduction

We explore the evolution of architecture beyond transactional SOA and outline architectural approaches for responsive business process management.

Some readers may be familiar with the sudden drop in share prices on the New York Stock Exchange one afternoon in May 2010. At around 2:45 p.m. Procter & Gamble stock had fallen 37% on the New York Stock Exchange[1]. Other stocks had huge drops in their price at that time, including Apple and 3M. The 21.5% drop in 3M's stock alone represented a 143-point decline in the Dow. On the floor of the New York Stock Exchange, stone-faced traders huddled around electronic boards and televisions, silently watching and waiting. Traders' screens were flashing numbers non-stop, with losses shown in solid blocks of red numbers.

Computer trading intensified the losses as programs designed to sell stocks at a specified level kicked in. Traders use those programs to try to limit their losses when the market is falling. And the selling only led to more selling as prices fell. The unusual movements triggered a "circuit breaker." This slowed the timing of trades and isolated the NYSE from other exchanges.

Charlie Smith, chief investment officer at Fort Pitt Capital Group said “I think the machines just took over. There's not a lot of human interaction. We've known that automated trading can run away from you, and I think that's what we saw happen today.”

Once the circuit breakers kicked in, the market recovered and all the stocks involved improved to near the start point. After the event there were several theories put forward for the run. According to some sources, a trader entered a "b" for billion instead of an "m" for million in a trade possibly involving Procter & Gamble. According to the NYSE, the Nasdaq stock exchange misprinted a quote of $39.37 a share, even though the stock was really trading at $56.

But James J. Angel, a professor at Georgetown University commented that the real cause was probably the circuit breaker. Because they are independent and unintelligent they can't distinguish between different scenarios and simply slow up the trading as a mechanism to correct problems. But they do slow up ALL trading and the slow motion simply magnifies normal activity.

If the NYSE had implemented a responsive business process, there would probably have not been a problem at all. In a responsive business process rules would have been preset to identify unusual behaviors both in individual transactions as well as in aggregate. It's perfectly possible that traps could have spotted an out of context pattern such as a "b" rather than an "m" at the outset and requested verification. Or similarly spotted the sharp price differential. But even if the run started, circuit breakers could have been applied just to those stocks that were affected, and the overall drop in the DOW avoided.

But there were good reasons why the NYSE was unable to respond. Like every other enterprise on the planet they operate rigid systems architectures that were not designed to provide dynamic response to events. But following these events there is now pressure on for a rewrite of the rules.

Like all architectural change, moving to responsive business process architectures is a journey rather than a quick fix. There are big questions around what type of response is required in what situations? How do you manage the rules governing dynamic responses and will they conflict with existing business process rules embedded deep in the application layer? Could NYSE have ensured that rules were available to address this particular set of events? How do you set rules for unpredictable future events? What governance should be exerted over ongoing rules changes?

Welcome to the world of responsive process management. In this paper we explore the evolution of architecture beyond transactional SOA and outline architectural approaches for responsive environments. We provide guidance on how to establish a strategic approach to the information architecture that delivers high value whilst taking advantage of tactical opportunities that establish practical experience and deliver feedback.

Evolution of the Service Architecture

Over the past few years SOA has become synonymous with business agility. And there is good reason for this because SOA breaks the mould of old style, monolithic systems. Whilst the benefits of SOA may have been over hyped, a significant number of enterprises are quietly implementing the architectural pattern. They recognize that systems and business processes are inherently more adaptable when they are architected as loosely coupled components and services with a high level of separation of concerns.

But SOA per se is not the end goal; it is a critical first step in a broader architectural landscape. For those organizations that have persisted and established the essential SOA foundations of technology infrastructure, backbone services and cultural reorientation to

shared services, there is now the opportunity to enhance the range of business value, making use of patterns that extend the SOA with intelligent monitoring and response.

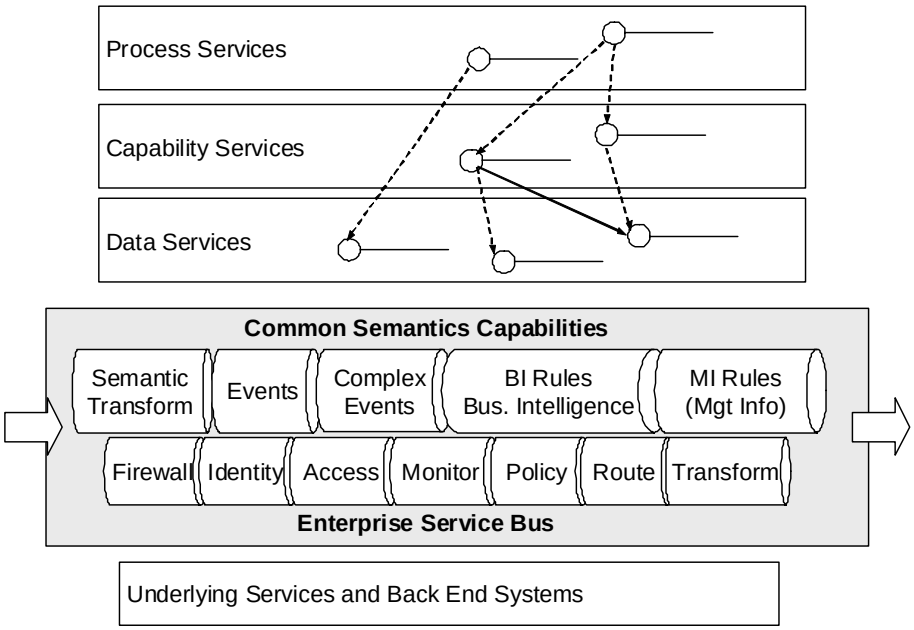


Figure 1 – Extending the Service Architecture

Figure 1 illustrates how the basic service architecture creates separation of service behaviors, and channels all messages and interactions across a standard enterprise service bus. The bus may be viewed as a pipeline onto which we can add new capabilities to manage events and rules, and we illustrate a number of real time capabilities that may be added to the basic bus capabilities that operate on a common set of semantics.

Those organizations that have a) mandated all message traffic onto a common service bus and b) achieved some standardization of message level data will potentially be able to use these real time capabilities to make business processes more responsive to events at either individual transaction level or in aggregate.

Closed Loop Business Response Pattern

For most enterprises improvements in business responsiveness still relies upon conventional business intelligence systems including techniques such as query, reporting, OLAP, analytics, data mining, business performance monitoring and predictive analytics. Traditionally, these functions have been based either directly on operational systems, or more commonly on a data warehouse or data mart, which assembles and restructures data from one or more operational data stores. Figure 2 summarizes.

Even with full functionality for query, reporting and analysis, the traditional view of business intelligence only gives us a partial, out of date picture of the process, lacking a broader system purpose and context for management control and action.

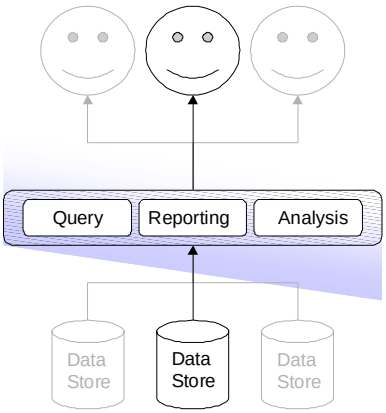


Figure 2 – Conventional Business Intelligence

In contrast, Figure 3 shows how business process response may be implemented as a control loop. The response to analysis of events and performance may be automated or semi-automated in an appropriate combination of rules and alerts. Managers use tools to process and interpret information; they then act upon this information by setting rules and alerts to monitor and respond. If management intervention doesn't work in the expected way, then this should trigger further analysis and adjustment. This management feedback and learning loop is a key element of true business intelligence but executed on the business operation in near real time.

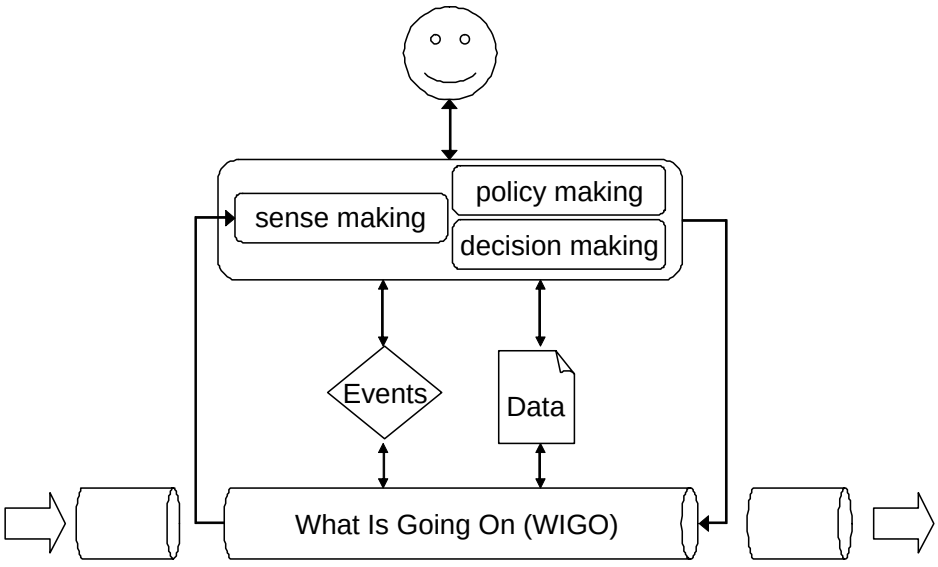


Figure 3 – Closed Loop Business Response Pattern

In the NYSE case we can imagine how triggers on combinations of preset demand levels and price variation could have been set to generate alerts and put trades on slow/query/manual status.

Because we know about the NYSE case, it is more straightforward to consider the business process response to that particular event. The bigger questions are how do you predict the events and situations that should be identified and managed and how do you ensure the right information is available on the bus to be able to respond?

Modeling the Responsive Business Process

Modeling business processes is widely undertaken in a systematic manner using BPMN or a similar notation. The purpose is to describe the requirement for a business process in terms of its behaviors and the data requirements. The models are frequently constrained to the As-Is or To-Be perspective which sensibly encourages business modelers and the business sponsors to consider the future requirements. Yet, whilst there is widespread awareness of the need for business agility in general, most To-Be modeling processes will be driven by known requirements for change - the impending M&A, new product lines, new technologies and so on. It is relatively uncommon for modelers to consider how the process may need to respond to, as yet, unforeseen events and situations.

Perhaps this is because modeling the To-Be process is difficult enough without further complication. Or in most enterprises business managers operate on a 12 month cycle and genuinely cannot forecast beyond that horizon. Or there is an assumption that response to events will be more easily managed in the new, loosely coupled service architecture.

Modeling business information and data certainly should also be undertaken in a structured manner. And enterprises taking SOA seriously will, we hope, be developing information model(s) to drive the specification of information services. Data modelers are more likely to consider future needs because they will usually consider data generalization as an important technique for stabilization and reuse. However like their process modeler peers they will typically get little guidance from business sponsors.

The problem is that future needs are typically framed by asking business sponsors "what's going to happen next year or the year after?" And, as discussed above, that is almost always unproductive. We need to consider business process and data models as the mechanism that allows us to explore how the process needs to operate as a continuously evolving and responsive environment. We must ask questions that sponsors will find easier to answer and crucially that allows the modeler to provide the process, service and/or solution architect with guidance on the range of responses the business process may need to support. Figure 4 illustrates a modeling approach for this discovery process.

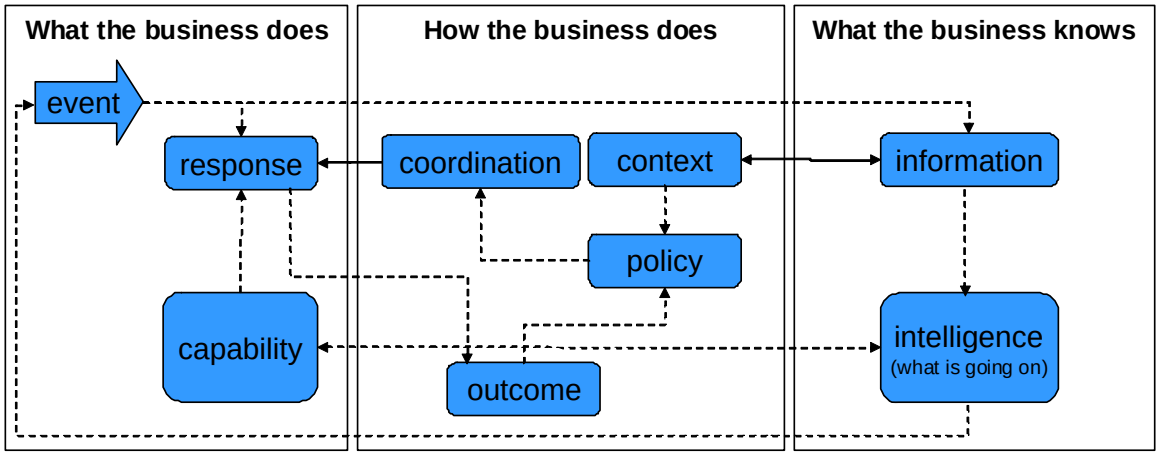


Figure 4 – Modeling the Responsive Business Process and Data

By modeling all three dimensions together we can develop realistic requirements for the agile business process. Let's explore each of these in turn.

WHAT the Business Does

So we start with a simple model of what the business does. All activity is the response to some simple or complex event, supported by some capability. This translates very easily into a service-oriented model in which the event/response pairs are represented by use cases, and the capabilities represented by services.

An unresponsive business is one that simply ignores events for which it doesn't have a routine response. A responsive business is one that has some capability to respond effectively to a much broader range of demand-events. Events don't simply arrive with a unique label, the way they might do in a well-controlled and self-contained computational model. What this points to is that identifying and interpreting events is a non-trivial problem from a business point of view.

We need to analyze the range of events and the types of response that may be required and the capabilities that can deliver them. Table 1 below uses the NYSE example to illustrate how simple and complex events and the range of response types need to be analyzed together in order to develop a richer picture of the responsive business process.

Event Category	Atomic Events	Responses	Complex Events	Responses
Simple/Atomic:	Price variation > threshold By domain?	Alert and process normally Place on query Cancel	Number of alerts in period > alert threshold Trade volume > threshold Sister exchange shut down Macro economic event All of these by domain?	Slow trading process Scale capacity Limit trading to n domains Cease trading temporarily

Table 1 – Example Exchange Event Model

Some comments and conclusions on this very simplified picture:

- Responses to both atomic and complex events may be considerably enhanced by rules based response to event triggers such as thresholds at both levels. Even more useful would be triggers by domain. What would be needed here is a semantic model that allows similar events in disparate domains to be correlated so that concerted action can be taken if appropriate. For example coordinated thresholds across bond, commodity and security markets, which have entirely different vocabularies, allowing concerted responses to abnormal events across exchanges.
- The combined analysis of atomic and complex events and responses provides the opportunity to enhance the business model and process. Knowing which is triggered first is often vital to making the correct response. Registering the significant macro economic event prior to individual prices breaking thresholds will be key to making an appropriate response.
- The example of the significant macro economic event indicates that the relationship between atomic and complex events is not necessarily omni-

directional in which complex events are always the result of analyzing many atomic events.

- The scope of information available to the process will almost certainly need to be extended in order to track complex events. In the NYSE example, the status of sister exchanges and information on external macro economic events is required. Of course the human operators of the trading system may be aware of these events, but they will only be able to take coarse grained action such as shutting the exchange. In contrast preset rules may be able to respond more effectively on a fine grained basis taking appropriate action for individual transactions.

HOW the Business Does

What makes each business unique is the particular set of strategies and policies it adopts within its chosen contexts. The second model dimension of business response examines policy, context, coordination and outcomes – how the business operates.

The genuinely responsive business will systematically decouple the HOW from the WHAT.

- **Separating policy from response** – providing a generic response capability that is separate from the rules to be used.

  In our exchange scenario we would anticipate an architecture that separates the rules layer from the exchange life cycle management capabilities. This will allow flexibility of both policy and response. It might also be a very effective implementation strategy, but any pre-existing hard coded rules would need to be removed or circumvented to avoid conflict.

- **Separating context from information** – establishing generic information that can be used in potentially many different contexts.

  There is currently considerable debate in the NYSE regarding audit trail information and the role of the exchange in identifying transactions that are potentially non compliant with regulatory requirements. This is a complex matter that involves identifying relationships between seemingly unrelated transactions executed on different exchanges using profoundly different semantics. In addition there is a user requirement to maintain anonymity of the end customer in order to protect broker – customer relationships. This is a very interesting application where a semantic layer external to the exchange could add meaning to the audit trail records that would a) maintain the anonymity essential to the exchange and trading processes, whilst b) marking up the records with generic data to permit regulatory and other rules based responses in real time.

- **Separating coordination from capability** – establishing the potential to vary the organization responsible for delivering the service.

  Apropos policies regulating the NYSE audit trail, this may well be a case for an independent third party or indeed the SEC to operate the semantic layer capability – in order to maintain separation of concerns.

This level of decoupling may enable flexibility of response from common capability services and common information architecture that support varying, context sensitive

behaviors triggered by a wide range of differentiating characteristics such as exchange, trade type, class of broker, historical context etc. Regulatory compliance and management of abnormal trade behaviors are just two examples where real time, rules based responses may be highly effective.

What the Business Knows

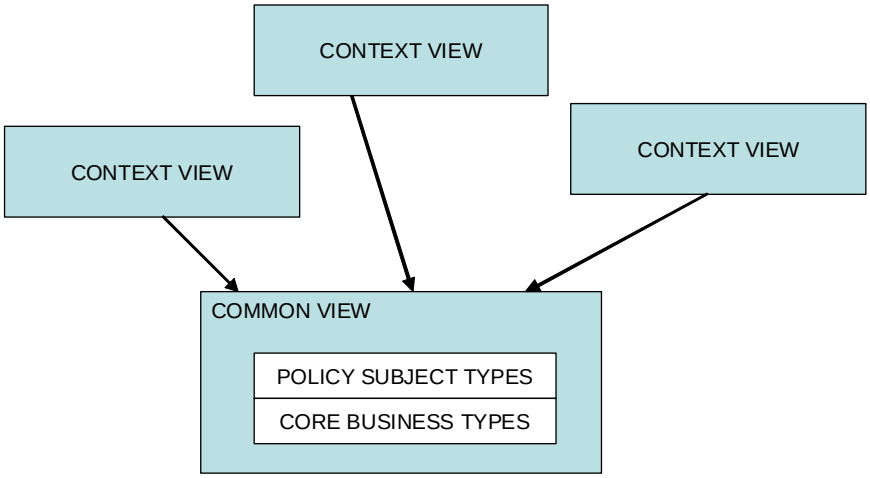


Figure 5 – Establishing the Common Information View

The third model dimension relates to the structure of the business information required to support events, responses and capabilities in the responsive business process.

Most readers will be familiar with data modeling techniques. Whilst these form a perfectly adequate foundation to reach understanding for conventional business process design they need to be exercised within a broader framework specific to the responsive business process.

As discussed there is a need to decouple information from the context in which the information is being used. Our objective should be to create a common view of information required by the business processes that is independent of disparate back end systems and or the wider message ecosystem that will inevitably have a plethora of vocabularies. The common view will be important in improving information consistency in the business process. But in the context with the responsive business process it enables a generic rules set that is independent of specific applications and enables common rules for a given domain or set of related business processes.

The rationalization of rules is certainly a growing problem for many enterprises as they incorporate rules into multiple layers including disparate back end applications, the ESB, the complex events processor and the business process layers. The governance of the rules themselves and avoidance of mutually exclusive or conflicting rules becomes a formidable issue.

An effective architectural approach to rules is to base event trigger responses on a semantic layer that establishes a common vocabulary that can be managed by a single rules set. In the exchange audit trail case the common vocabulary would be directly driven by published regulatory rules.

As shown in Figure 5, clear separation of context and common views enables a triage of what information needs to be common, and what can continue as context. The Context View models any situation specific perspective. This may reflect a specific vocabulary that relates to an application, a corporate entity or indeed a business process. The common view represents an intersection of disparate contexts that is necessary for the purpose of one of more business processes.

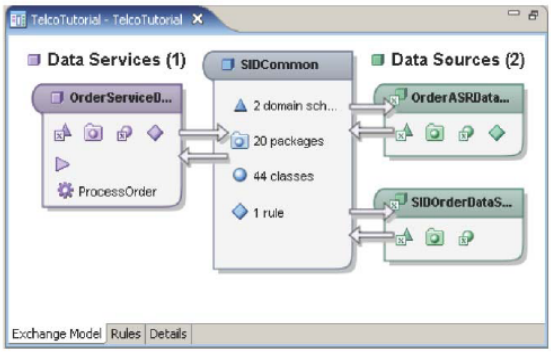
Also in Figure 5 we suggest further classification of information to assist in this process. The diagram illustrates two sub types of the common view.

- The core business type represents information that supports the transactional aspects of a business process. E.g. clearing member organization, identify of firms involved in execution and so on.
- The policy subject type represents information required to detail rules that monitor policy compliance. Unique order identifier, terms of the order or cancellation, market participant symbol and so on.

This approach suggests that the scope of the common information view may frequently need to be expanded beyond the conventional transactional perspective, to accommodate a broader set of events and rules set, but at the same time the complexity of the broader scope should be contained because it is detailed only for the common view.

This framework provides a structured approach to determining what information needs to be common and which can remain as a context view.

The Progress Software DataXtend Semantic Integrator (DXSI) provides a model based approach to data integration. The central concept underlying DXSI is that common semantics or vocabulary are managed independently of existing data sources and facilitate rules based mappings between one or more existing data sources against the common view. This approach breaks the dependencies created by point to point integration and allows consistent data services to be defined and published from disparate sources. The common view approach is also effective in limiting the impact of change in existing data sources and in the common view.



DXSI generates run time data services that can be used anywhere a Java object can be invoked. To implement the data services into the target environment the DXSI Workbench generates wrapper code that instantiates the entities and invokes methods in an exchange model and Java classes. The SI Workbench generates this wrapper code for JavaBeans, SDOs and XMLBeans, which can be deployed in the application and Web servers including Apache Tomcat, BEA WebLogic, IBM WebSphere Application Server, IBM WebSphere Process Server, RedHat JBoss Application Server, Oracle Application Server and Progress Sonic.

The DXSI Workbench includes a test environment that provides import of test data and snapshots of transformations that aid debugging. Multiple versions of models can be managed.

Implementation Considerations

It will be clear from the foregoing that information architecture is a critical success factor for responsive process management. Making the right information available for intelligence based systems at the right time with appropriate quality, consistency and currency has always been a major challenge. Such data types are typically widely distributed and inconsistent and hard to access. Most enterprises will have established intelligence data strategies such as a data warehouse and may have adopted tactical, situation specific solutions to source data for CEP solutions.

Whilst this may satisfy immediate, known requirements, this is likely to be sub optimal in terms of organizing responses for unplanned events.

What's required is an architecture led solution that facilitates, over time, a canonical model approach that will impose the minimum overhead for tactical solutions while delivering components of a more broadly based information architecture. There are key principles that can facilitate this approach:

- Restrict the coverage of the common model to only those parts of the business that are clearly required to be consistent across a significant part of the enterprise or ecosystem.
- Manage a triage between common and context data domains to avoid growth in the common view and the inevitable management overhead.
- Mandate use of common model components in all situations.
- Establish a transformation (semantic layer) service that implements the common model mandate in all relevant message traffic.

Summary and Conclusions

The business value of SOA may be realized from better structure and loosely coupled components, but the genuinely strategic value will be realized when the foundation that SOA provides is utilized to deliver dynamic business processes.

The critical success factor for realizing business value in this area is decoupling of context and policy from information and response. An effective architectural solution is to progressively implement a common view as a semantic layer that integrates disparate vocabularies and enables a common rules set. This will profoundly alter the nature of process change and response in an organization, enabling dynamic responses that are tailored and unique to the situation in a manner that has full governance and management.

There will be many situations where responsive business processes can be implemented very rapidly in a situation specific manner with minimal architectural work. These situations should be managed as pathfinding and learning activities, but very rapidly integrated into a coordinated strategic initiative. The potential for proliferation is vast, and the situation specific nature of tactical responsive process solutions may seriously limit wider strategic opportunities.

Just as SOA has been widely misunderstood, responsive processes will also be subject to considerable confusion. Good communication and education is essential.

Ten immediate actions:

1. Identify key areas for responsive business process that can deliver early business value
2. Run pathfinder and measure results
3. Assess business opportunity and value from responsive business processes
4. Implement common "enterprise" service bus. Mandate all messages onto bus. Grant no policy waivers.
5. Implement semantic layer on top of the ESB.
6. Develop common model capability to support specific business process solution deliveries, and progressively integrate into a broader common model.
7. Establish extended classification of information architecture.
8. Define types of rules and rules classification for each layer.
9. Establish strong management of distributed policy and rules before it becomes a problem. Do not allow proliferation.
10. Extend current governance criteria to include review of extended process and data models for responsive business processes.

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This paper was commissioned by Progress Software Inc.

References

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[1] New York Times, New York Daily News and Huffington Post, May 6/7/8th 2010

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