ICEIMT: History and Challenges

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Abstract ICEIMT was initiated as a multiactivity event to meaningfully address and partially solve a precise set of problems. The history behind the original activity is reviewed in the context of the problem set. Now, as ICEIMT continues ten years later, the problem set has evolved to be immensely more difficult. That new agenda is defined.

1 HISTORY OF ICEIMT: THE PROBLEM

Around 1986, the highest levels in the United States government recognized a problem with profound economic consequences, and resolved to address it. American competitiveness was considered low and decreasing, especially in the manufacturing sector. Most of the preliminary work on identifying underlying causes was done at the research consortium SEMATECH. That body was funded at two billion dollars to try to rescue the strategically important semiconductor industry from the Japanese threat. SEMATECH sponsored a supplier's working group, representing the majority of the world's information technology infrastructure suppliers. The group had a special legal exclusion from antitrust restrictions and high-level visibility in both the administration and board rooms.

The problem was seen as revolving around enterprise integration, the ability to quickly and cheaply get all the models, metrics and control software interfaced, collaborating and optimized. The threat from the Japanese was not they did this well, but that their tight, stable vertical enterprises made the components far less dynamic, so each new enterprise just reused the infrastructure from the older one. There was far less innovation in the Japanese approach, but that was more than compensated by an ability to focus on continuous improvement of processes. Some industries, like semi-

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conductors, automobiles and consumer electronics especially benefited from this structurally competitive asymmetric advantage.

The goal was set to build infrastructure capability that would accommodate the "American" business model of many relatively independent suppliers, each innovating in processes and underlying software. The notion was to task the U. S. research establishment to develop integration frameworks and methods that could match the Japanese approach in speed but also accommodate diversity and innovative dynamism. That innovativeness was seen as the societally rooted competitive advantage that would save the day.

A second order problem was that the US research establishment was demonstrably unable to deliver this sort of result for structural reasons. The primary agency for such research was the (then named) Advanced Research Projects Agency (ARPA). ARPA had been established in 1957 as the owner of the nation's high risk, high payoff research problems. Some notable successes had resulted, and ARPA was the focus for information technology research. But by 1986, ARPA had had some spectacular failures, costing billions directly with astounding opportunity costs. Several studies in industry and the intelligence community suggested a structural barrier in the highly inbred advisory "invisible college," named ISAT, which influenced research directions and rough distribution of funds. ISAT (Information Science and Technology panel) was — and still is — populated by power brokers from major research universities and dominated by a mutual back-scratching protocol. The collapse of artificial intelligence, robotics and high performance computing initiatives was directly traced to this structural problem.

The National Science Foundation (NSF) was unable to address the problem. NSF's mission at the time was to subsidize university research under heavy peer review at the graduate student level. But the peer review process is highly departmentalized. The enterprise integration problem was seen as large and interdisciplinary, not amenable to decomposition into graduate student sized portions.

The suppliers and intelligence community raised the visibility of these problems to an attentive White House.

Meanwhile, the European Union was struggling with a similar problem and structural inadequacy.

European enterprises of the time tended to be in between those of the American and Japanese types in terms of centralization and stability, but with no inherent advantage over either other than guaranteed home markets (and at the time, subsidies). No European firm was a significant player in information infrastructure; all such infrastructure was controlled by American-owned multinationals.

The European Union's research initiatives had been spectacular failures, more publicly so than in the US. The structural problem here was that research initiatives were intended as comprehensive, interdisciplinary efforts. But in practice, the teams (composed by law of universities and business from different countries) divided the work up and proceeded independently. Each partner "owned" the results of the effort. Sharing even among partners was poor. Reporting and commercialization was usually below a useful critical mass.

Senior policy makers of the USA and EU decided to explore breaking these research barriers by creating a Joint Research Organization of some kind. ARPA, the NSF and the National Institute of Standards and Technology (NIST) represented the US in developing collaboration protocols, which were established in 1988. In 1990, meetings were held in San Francisco and Washington to explore the tactics of enterprise integration collaboration. Key US and EU projects were selected and "action officers" designated: Kurt Kosanke for the EU and Ted Goranson for the USA. Large working meetings to shape the collaboration were held in Daytona Beach in January 1990 and in Berlin the next July. A final planning meeting was held in Brussels in January of 1992.

Traction for collaboration was built around the general superiority of modeling theory in the EU. Several hundreds of millions were planned. Deep relationships with suppliers were committed. A tacit agreement was reached to develop a European infrastructure industry

A multi-tiered initiative was constructed under the rubric of ICEIMT. Significant consensus work was done within the suppliers' working group to define problems, candidate solutions and reasonable commercialization strategies. To address futures, four facilitated workshops were held among the research community; two in Austin, Texas, USA in February, two in April in Nice, France.

Products of the effort were a book edited at some cost by a US based consortium, a conference in Hilton Head, South Carolina in June, and detailed, closed briefings to the supplier and defense communities. These latter had profound impact on the future of information infrastructure. A major step toward object-oriented infrastructures directly resulted. The origin of the enterprise resource planning market can be traced to associated decisions and technology transfer. And major technical alliances that persist today were initiated.

The intended pan-Atlantic joint research organization did not emerge.

2 NEW PROBLEMS IN THE MARKET

A second ICEIMT was initiated by the EU at the five-year mark. This ICEIMT is the third.

Ten years after ICEIMT defined the enterprise integration problem it will be worthwhile to revisit how things have changed in the decade since the problem was defined as a matter of national survival.

The Japanese are no longer the threat they once were. Their system has collapsed because of a structural weakness in the banking system that should have been anticipated. They are now joining the rest of the world in their enterprise structures and inheriting the enterprise integration problem. The drivers for enterprise integration today are primarily ones of company rather than national survival, though manifest destiny is that much less complex manufacturing will flow to emerging economies. So domestic manufacturing needs to be more agile than lean, more niche than mass oriented and more proximity and service centered.

The bottom line of this dimension is that the situation is worse today than ten years ago. A decade ago, the problem was at the center of a national emergency. Now it is not. ARPA has become DARPA, the "Defense" ARPA, with a narrowly focused operationally military focus. No one in the USA government owns or openly cares about the problem. (Some well-funded intelligence and experimentation agencies are working identical problems but to date have steered clear of the civil industrial marketplace for reasons noted below.)

The supplier situation is different and far, far more complex. Europe is now a major player in Enterprise Resource Planning and CAD-led Product Data Management. Microsoft was not a player a decade ago, but is now, bringing to the sector a level of monopolistic rancor not part of the prior scene. In particular, the internet and web are central parts of the environment now. Vendors are significantly less driven by customer satisfaction than by winning strategic positions. Most major architectural decisions are now guided by strategic advantage for the supplier than the user.

The users have less clout than before for another reason as well, the balkanization of enterprise integration communities. Back in the days before computers and models, expertise was stored in implicit ways, largely in tacit knowledge, rules of thumb and in trusted managers. Once models became a way of making these explicit, the various communities in the enterprise tended to coalesce around what knowledge they "owned" and could use as leverage to do their job better. Suppliers identified niches within the enterprise based on these functions. As a result, we now have enterprises that consist of warring infrastructures, methods and metrics. We now have Enterprise Resource Planning, Customer Relations Management, Supply Chain

Management, Activity Based Costing Management, Knowledge Management, Product Data Management and on and on.

The voice of the user to integrate these systems has been muted to essentially nothing. And now the problem of enterprise integration is not merely to integrate functions by their processes, we have to integrate enterprise integration infrastructures as well. On the supplier side, this introduces new competitive dynamics. After all, an enterprise does not buy and champion enterprise integration tools, senior managers do. Market forces drive the supplier to speak to that manager's concerns. We are in the unhappy state that the very existence of effective models has increased the dis-integration of the enterprise. The existence of functional frameworks for model integration has had the unexpected result of fragmented and cannibalized integration markets.

At the same time, enterprises have become enormously more complex in the past decade, the products much more sophisticated and interdisciplinary and the speed of change is at unparalleled levels.

One other success of enterprise integration has engendered new problems. The original impetus came from the operation side of the enterprise to balance the management of production with the management of capital and capital-driven assets. Since then, emerging business models (fluid supply chains and agile virtual enterprises) have allowed for the independent management of capital and production. Unfortunately, the legacy of enterprise modeling in industrial engineering has unduly influenced the targeting of the frameworks. Instead of growing to handle both functions (capital and production), it has inexplicably stayed with the latter.

In short, the difficulty of the problem has grown in complexity and difficulty faster than the solution has evolved.

3 NEW TECHNICAL PROBLEMS

In addition to the problem set increasing, there are new technical barriers as well.

The first ICEIMT looked at integration strategies in general. An enterprise can be integrated at the level of basic services, at the level of applications, or at the level of models. The first was the default at the beginning of ICEIMT and was deemed inadequate. The goal is to integrate at the level of models — in fact this can be used as a definition of enterprise integration. A baseline for model-centric integration was that component of the CIMOSA architecture that related different models, model views and generic types.

But the market at that point was obsessed with application integration. The reason was straightforward: most of the research and vendor attention

had responded to the so-called "software crisis," wherein most applications or application synthesis projects failed. The result was a collection of techniques for software engineering through modularity, encapsulation and reuse under the aegis of "object orientation." The market is sustained by selling applications, not models, and the supplier working group guessed that something like model integration could be accomplished by dual use of application integration technologies. The standards community was quite ready to respond because application integration standards were well understood with an established constituency.

The industry knew that the compromise would result in immediate progress but serious barriers in the longer term. In fact, the situation today is far worse than ten years ago because of this compromise. Markets and many business practices blur the concepts of process and object. Because of encapsulation, object-oriented models by definition lack the sort of visibility and "zoomable auditability" which formed the original desiderata. So today, enterprise modelers have to work around an unfriendly legacy that they helped create.

And the goals of enterprise integration have escalated in several dimensions:

- The original ICEIMT scope concerned coordination and optimization of operations and related resources. Businesses now are used to thinking in terms of strategic planning integrated to operations. Some rudimentary integration of this type exists in terms of qualitative metrics (accounting dollars) in the form of activity based costing. Models are very much more complex than flat numbers, so integration from strategic to operational domains is a tough problem, but one expected by astute managers. The gains would be substantial if such a thing could be accomplished. This called the "vertical integration" issue. (The current ICEIMTs first workshop touched on this issue in a targeted way by addressing the merger of knowledge management and enterprise integration. See the report from that workshop for some concrete recommendations.)
- The original ICEIMTs range of the business life cycle made assumptions that you knew what you were going to make, and how and to whom you were going to sell it. The engineered system only addressed how it was made in most cases. Today's ICEIMT agenda must address the whole life cycle of operations, from discovering markets, designing products and services, and creating and supporting them. This is the "horizontal" expansion of the integration scope. (Both horizontal and vertical expansions sweep in a greater variety of model types, view and uses. But they also necessitate for the first time the explicit modeling of soft items: uncertainties, unknowns, unknow-

ables, social and cultural collaborative dynamics, and certain types of trust. These are difficult problems)

- Originally, the ICEIMT user community was content with "batch" engineering. In the assumption that the world would not change very much, one would model, integrate and optimize an enterprise. Then it would be operated in that mode for some long period without change. After some period, a re-engineering would occur for some other static period. Almost no one will accept that today. The world is dynamic. Conditions change, you discover mistakes you made in the original models and assumptions, you improve your processes, you change and evolve products, and you swap your partners at will. The need for continually evolving systems has redefined enterprise integration problem in a more ambitious, demanding way.

4 NEW APPROACHES

The original ICEIMT defined a spectrum of approaches that ranged from model-centric to language-centric. The model-centric approach was deemed less capable but more realistic at the time. Since then, significant work has been done on ontologies and ontology languages, and the language-centric approach seems to now dominate the agenda. Examples are the process specification language and the unified enterprise modeling language.

As noted above, the modularity-by-object philosophy was adopted as a compromise with existing market trends. It is a manifestly inadequate approach for the expanded agenda (and perhaps even its original, smaller scope). Since the first ICEIMT, workable notions of "features" are used in product data management versions of enterprise modeling. And even within the programming community, features are being grafted onto object oriented programming through the new strategy of "aspect"-oriented programming. Quite probably, some abstraction of models into enterprise value features (or something similar) will be developed as the language-based mechanism for enterprise model integration.

The old ICEIMT agenda was satisfied to stick to process features that can be explicitly, unambiguously represented. The new agenda requires modeling of partial, uncertain or unknown facts. There are few techniques for accomplishing this, but they are well known and all the subjects of experiments.

In response to the need for dynamism and distributed federation, the "activity" of models is likely to change. In the original ICEIMT vision, it was sufficient to have "passive" models, representations of processes that simply captured some superficial behavior. The new generation will certainly use

some notion of agents (active models) that reflect some of the cause and effect mechanics of the underlying processes.

Ten years ago, three types of repository strategies were defined, with a simple unified approach at one end and a more difficult federated one at the other. First generation integration relied on everyone using the same methods, the models being all collected in the same location under single control. Next generation integration is expected to relax that somewhat, with the models being distributed, the methods being varied somewhat, and controlled more locally — ideally by the same person that owns the process of interest — the federated model.

5 SUMMARY

The original ICEIMT defined a response to an extremely important problem that was not being adequately addressed by market forces or government agencies. It did a good job, engaging with suppliers and users finding a practical balance among emerging trends, valuable benefits and tolerable tradeoffs. The world changed as a result.

Now, ten years later, market forces and government agencies depend even more heavily on the reborn ICEIMT. The situation is very much more difficult, and solutions likely more valuable. Some technical barriers and challenges exist that did not before.

Almost certainly, the same practical radicalism is required. Smooth evolution from first generation solutions will be inadequate.

6 REFERENCES

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