



Figure 1: Overview of the five project areas in 3gERP

#### 4.1. Project Area A: Requirements Definition

The initial 18 months of the project will be used to:

- Develop a **categorization** with a structured overview of as-is transaction- and reporting practice involving taxation, order to cash scenarios, business documents, reporting requirements, accrual accounting, cost accounting and inter company costs across borders (Granlund & Mouritsen, 2003), including on a general level global requirements for data security, trustworthy computing, protection of personal and business data, etc.
- Identify the **general immediate changes in accounting standards**, including those emanating from the new International Accounting Society, the US GAAP and from the Sarbanes-Oxley legislation requiring improved corporate governance.
- Research **IT trends** in the next 5-10 years (e.g. more widespread use of RFID-tags, other types of ubiquitous computing, mobile applications, embedded software, and 'unlimited' wireless bandwidth), affecting future ERP IT-architecture and business solutions.

Initially the issues will be explored with MBS and MBS business partners in Denmark. Later nine other countries (Brazil, China, India, Japan, Poland, Russia, Spain, UK and US) will be investigated in order to identify the different types of requirements (by law, regulations and norms) and the type of changes. In each country, the research team will have a preliminary workshop with a local researcher, a local representative responsible for localization, one/two MBS implementation partners and possibly also a mature MBS customer. After the collection of the data from the ten countries, a preliminary prototype of the taxonomy of all requirements will be developed. This will then again be presented and discussed on a second visit/workshop in the ten countries, double checking on specific requirements and gaining insight on the structure of the prototype.

On the basis of these studies, and at the end of phase 1, the results (deliverables) from project area A will be a

- **Categorization** of all types of requirements and challenges relating to transaction data and business reporting including 'Key Performance Indicators' using a multi-dimensional taxonomy framework.
- Set of ideas and suggestions for **guidelines** for how to handle the global standardization and localization requirements for future ERP-systems for SMEs
- Basis for the development of the **configuration** with a **Graphical User Interface (GUI)** enabling handling of the market/industry/enterprise variances and dynamics in the future architecture due to be further developed in the second phase of the 3gERP project

## 4.2. Project Area B: Future Business Information Requirements

This project area is focused on future requirements for ERP systems regarding all transaction oriented business processes and business reporting pertaining to 1/ International accounting standards harmonization currently in process, 2/ The development of data reporting languages such as XBRL in relation to any type of management reporting, and 3/ The trends in new management tools including but not limited to concepts such as for example the Balanced Scorecard, Value-based management, and even non-financial data.

It is characteristic that IT has been used for accounting purposes for almost half a century, and there is still massive criticism of the ineffectiveness of 1/ managerial reporting in providing proper management information, 2/ financial reporting in providing all stakeholders of an organization a relevant picture of the current profitability and the future possibilities for achieving profit and growth. Amongst others reasons, there are constant attempts to enforce improved regulation from legislative bodies like the Sarbanes-Oxley legislation in the US emphasizing transparency and corporate governance. If a global ERP-system is to be developed, it is important to be able to meet these requirements. In the same way, international bodies like International Accounting Standards Board, e.g. through their 2005 International Financial Reporting Standards report are raising new reporting demands on the enterprises. These and many other developments are changing the requirements for the accounting and ERP-systems, and it is important that enterprises can modify their systems easily to reflect these new developments.

This area is of key importance since major changes are likely to come. But it is also important for achieving a lower TCO as experiences with 1st and 2nd generation ERP systems show that many corporations never implemented sophisticated accounting and/or other management tools – often because the technological system configurations in place did not allow for a sufficiently detailed tracing of data (Dechow & Mouritsen, 2004; Dechow & Mouritsen, forthcoming)

## 4.3. Project Area C: Future IT Architecture for a Global ERP system

This project area will focus on reflecting the requirements uncovered in Project Areas A and B in the form of an overall systems architecture facilitating fast and easy (ultimately automatic) component updates at all system levels and the seamless integration of operations management tasks across multiple enterprises. Beyond reflecting the requirements uncovered in Project Areas A and B, key goals for the architecture are enabling

- explicit representations of application-level processes (and, as hitherto, data) as fundamental system components;
- *safe* dynamic updating/upgrading of components in ERP systems, ranging from user-specific business procedures or report functions to replacement and enhancement of kernel modules;
- decentralized interoperation across multiple organizations (e.g., for supply chain management)
- Static and dynamic verification of components against system requirements (e.g., security, resource usage) and business rules.

The required activities are to be carried out within 2 Ph.D. projects, where one is to focus on the first 3 goals, the other on the last goal.

At the core of dynamic updating as well as migration, is *check pointing*: capturing the run-time state of a running process, saving it and, possibly, restarting it or replacing it by another process. Technologies and tools for check pointing of application-level processes is part of Project Area D. The system architecture, however, also aims at supporting check pointing of kernel modules *at run-time*; that is, without a need for down time.

The integration of components with executable content (application-level processes and kernel modules) provides great expressiveness and high configurability, but is necessarily associated with security problems: Do new or updated processes comply with the stipulated business rules? Can new kernel modules be trusted by the rest of the system? This will be addressed by leveraging *language-based security*, which, in contrast to methods that treat components as black boxes (such as operating system style security mechanisms, including cryptographic techniques), provide *end-to-end* system guarantees for how components behave individually and as part of a system. Language-based security comprises type systems, abstract interpretation, model checking, proof-carrying code, safe code rewriting, and run-time verification. See Morrisett, 2003, for an introduction to language-based security for low-level systems.

#### 4.4. Project Area D: Tools and Technology

This project area is tightly integrated with Project Area C. Its fundamental objectives are producing key innovative tools and technology for realizing and validating the systems architecture developed in Project Area C, specifically:

- Process specification languages and tools for capturing, managing, and analyzing ERP relevant processes as identified in Project Areas A and C, e.g. contracts, work flow processes, production schedules, supply chain management processes;
- Reporting languages and incrementalization technology for automatic transformation of business analysis functions to operate in real time in a transactional environment.

Each of these sub areas is to be carried out within a Ph.D. project.

Even though processes at all levels, including inter-organizational business processes, intra-organizational work flows, multi-party contracts, salary agreements, production plans, etc., are omnipresent in a company, their *system representation* and *management* may be ad-hoc, spread across multiple subsystems or nonexistent. Having an explicit, formal representation of processes (process language) is a *conditio sine qua non* for their *automated* processing, which in turn is key to developing, adapting and deploying processes in a continuously changing business environment. A staggering number of industry standards exist, primarily in the context of Service-Oriented Architecture, which, though, are either specialized, inexpressive and/or without support for safe optimization and advanced life-cycle management (such as check pointing). (See Cutler and Denning (2004) for a snapshot of web service related standards.) There is also ample computer science literature on the mathematical theory of very expressive process models, but less so on their adequacy for modeling and implementing business processes, not to mention tool or methodological support for (business) process design, verification and validation. This part of the project area will leverage: domain-specific languages; timed process calculi based on CCS (Milner, 1989), CSP (Hoare, 1985),  $\pi$ -calculus (Milner, 1999), Petri nets, Join-Calculus; temporal logics (e.g., LTL, CTL, LOTOS) for next generation ERP systems. In particular, it will build on our work in compositional contract specification, Andersen et al., 2004.

Business data analysis deals with analyzing (aggregating, filtering, interpreting) large collections of data, including ex-post events (things that have happened) such as payments, production data, etc., and ex-ante events (remaining parts of processes) such as remaining contract obligations, production schedules, and salary agreements. Such analyses are increasingly needed to operate in real-time in a transactional setting: financial, production and business intelligence statements should reflect all registered business events as quickly as possible. This sub area addresses high-level declarative specification of analysis functions in an event-based setting and their automatic incrementalization to turn them into efficient online algorithms. The drivers of this work will be programming language based incrementalization techniques (see Ramalingam and Reps, 1993 for a literature survey until 1993, Citeseer for the period after) and the business analysis requirements as identified in Project Areas A and B. Note that Complex Event Processing (Luckham and Frasca, 1998) is related, but

Online Analytical Processing (OLAP) is not: in OLAP, analysis is performed on a snapshot of the transactional data, not in real time on the transactional data themselves.

#### 4.5. Project Area E: Organizational Implementation and Partnership Models

This project will focus on exploring the future **implementation practices** that need to be developed by MBS and business partners in order to facilitate low-cost, low-maintenance implementations, maintenance and support of 3<sup>rd</sup> generation ERP systems. Tools to facilitate implementation will be developed.

Secondly we shall work on developing **business models** both for MBS and for MBS partners. It is important to realize that in most cases, an enterprise is not just buying an ERP-license. In most cases enterprises hire consultants to help it solve specific business problems within e.g. accounting, logistics, etc. This means that the enterprise buys a solution to business problems where the ERP-system is a small but still very crucial component. How the business models should be designed is crucial to the viability of a future ERP-system. Finally, we shall investigate the strategic role and **division of work between MBS and MBS partners** responsible for selling and implementing the solutions.

### 5. Expected Results

On the **academic** side, it is expected that the project will lead to significant scientific contributions in the form of theories and specific empirical insight within the following areas

- **Guidelines** for how to design the architecture for a global ERP system adaptable to local market, industry and enterprise needs
- Reports on current as-is reporting practices and guidelines for **requirements for technology supporting international harmonization** of reporting standards
- Definition of **tools** that allow for fast and easy updates of taxonomies in ERP systems
- **Guidelines, tools and techniques** for how ERP-vendors can work with partners in order to substantially reduce TCO when implementing ERP systems in user enterprises
- Low ERP development costs combined with high configurability through application of **versatile domain-specific languages** for high-level process specification;
- High system performance by development and application of **automated incrementalization techniques** (enabled by the use of domain-specific languages).
- **A systems framework** enabling distributed (both in a systems and organizational sense) data and process management, facilitating configurability (specifically for localization and adaptation to certain industry sectors) and efficient upgradeability throughout the vendor chain.

In this way, the 3gERP project will in a significant way leverage and supplement the research strategies of the Department of Informatics at CBS, DIKU and the other institutions (ESADE and Said business schools) collaborating in the project. Joint publications will be pursued across the research institutions. **It is worth noting the fairly unique collaboration between business schools and computer science** in order to achieve the extremely ambitious objectives.

The academic results will be published especially in the form of international journal publications and conference papers. The planned scientific minimum output would be 10 – 15 international journal publications, more than twice as many conference papers, one book and last but not least seven **PhD theses**.

On the **business side**, there are two sets of objectives. Firstly, it is expected that the 3gERP project will contribute to developing a very advanced global ERP-system, which can achieve a significant market share in the market place and in that way contribute to maintaining and further increase the employment in MBS in Denmark. Secondly, it is expected that the research insights will be used in industries in Denmark enhancing their possibilities of competing in the global market place. For a further discussion of business potential see section 10 and 11 of this application.