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Ubiquitous Virtual Enterprises Application and Distributed Product Development Architecture

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Abstract

In this paper the order to use high-fidelity analysis and design tools at the design stage, designers need to communicate with domain experts and their applications and tools, which may be geographically dispersed over proper computing platforms and application integration but the technical issues such as distributed computing, application integrations, and their distributed product information properly sharing product development. In This paper presents distributed product development architecture for engineering collaborations across ubiquitous virtual enterprises. It provides an integrated framework for product development services to effectively communicate to realize true engineering application integration. The focus of this paper is to address three key issues. One is concerned with product information sharing and synchronization across virtual enterprises. Another is concerned with federations of product development services over the collaborative process. An Enterprise tools for engineering context using semantic web, and enterprise applications for providing more human-oriented collaborations services. A case study for developing a mobile phone is shown to validate the implementation of the proposed approach, which gives a great deal of possibilities for supporting a rich set of product development scenarios in ubiquitous environments.

Keywords: PDM - Product information management, Process management, Semantic web, Ubiquitous computing, Context awareness.

Introduction

An Enterprise Application Integrations Collaboration is becoming an important business practice, which has implications on the software product development to

design errors downstream re-engineering cost can be greatly reduced. Proper communications and transfer of knowledge can also result in cost saving innovation in the early stage of the enterprise product development. The most important issues in a distributed and collaborative product development are how to effectively manage the product information among participants. This implies that the synchronization of the shared product model can realize true virtual enterprise collaboration. Several approaches to collaborative product development have been proposed.

Related Work

Many researchers proposed P2P services in concurrent engineering environments. Kim et al. proposed a framework for sharing product information across enterprises in distributed tools. Lee et al. proposed a Web-enabled approach to feature based part and assembly modeling in a distributed environment. Giannini et al. proposed a product modeling tool named Product Manager, aimed at supporting networks of small and medium enterprises collaborating in the design of a unique final product. However, these works focused on data-centric engineering application integration rather than process-centric integration. The PDO is the next-generation enterprise that deals with business processes as valuable portfolio assets. Business Process Execution Languages for Web Services (BPEL4WS) and Web Service Choreography Interface (WSCI) are typical standard process models based on Web service collaborations. The focus of this paper is to address three key issues. One is concerned with product information sharing for product semantic synchronization across virtual enterprises. Another is concerned with process-centric engineering service federations for service choreography and orchestration. The third is related to the engineering context management using semantic web for providing human-oriented collaboration services.

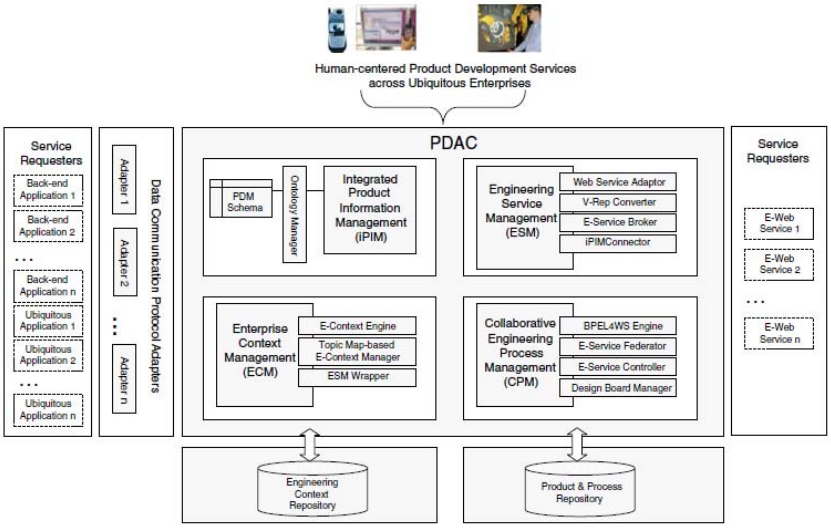

Figure 1: Architecture of PDAC.

Basic Structure of PDAC

PDAC support collaborative product development in multi disciplinary team engineering abs based on service oriented architecture. Web services and Web service federation standards are used for the registration, lookup, composition, and binding of product development services. PDAC consists of four integrated functional modules: Integrated product information management, engineering service management, collaborative engineering process management, and engineering context management modules as shown in Fig. 1. iPIM provides a gateway to fetch product data for information sharing and exchange among multiple participants across their virtual enterprises, thus achieving "shared understanding" of product data. iPIM has been built based PDM STEP Schema. The PDM Schema represents the intersection of requirements and data structures from a range of STEP Application Protocols. In particular, the product ontology represented by STEP-based XML schema is provided to meaningfully and schematically integrate distributed product information. Moreover, iPIM encapsulates the product models in two ways; one is based on detail models and the other is based on collaboration models. Detail models are original CAD models designed by partners. On the other hand, collaboration models are the lightweight visualization models corresponding to the CAD models with generic names. They are called V-Re. The main reason for maintaining two types of models lies in supporting Internet-enabled collaboration, efficient transmission, and sharing. ESM generates and manages Web service-based product development components.

Developments and Collaboration in ubiquitous environments

Collaborative and integrated product information management

As partners, suppliers and customers become increasingly interlinked in each phase of a product life cycle, a commonly shared product information model called iPIM is crucial to achieve product information interoperability.

The main three issues are:

1. How to seamlessly enterprise applications integrate multiple and heterogeneous product information in a distributed product development environment?

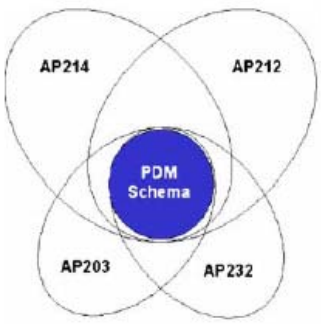

Figure 2: ISO PDM Schema.

2. How effectively and seamlessly enterprise integrate heterogeneous product development applications?
3. How to represent a lightweight model for supporting engineering collaboration and transmission?

The iPIM is based on ISO STEP PDM Schema and integration. The PDM Schema has been established to promote interoperability between STEP APs in the area of product data management. The STEP PDM Schema is a reference information model for the exchange of a central, common subset of the data being managed within a PDM system. It represents the intersection of requirements and data structures from a range of STEP application protocols, all generally within the domains of design and development of discrete mechanical parts and assemblies.

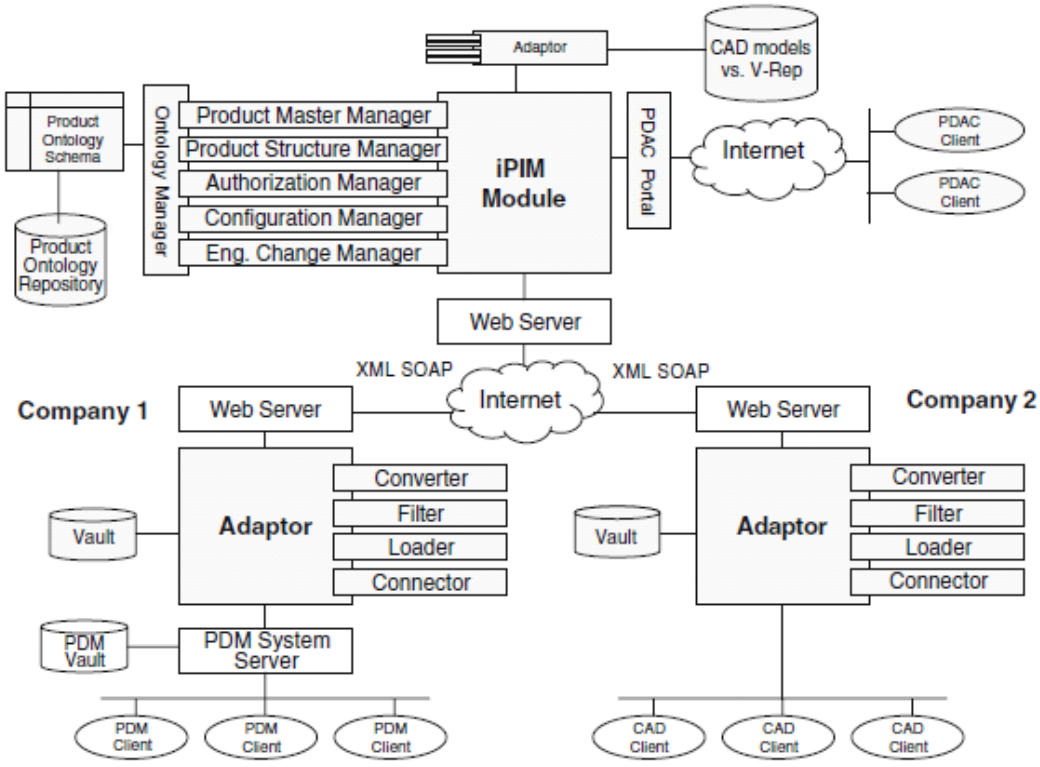

Figure 3: Product information sharing across virtual enterprises based on iPIM.

To minimize the product information loss and application integration technical issues to maintain naming consistency between the compressed geometry data and the original product information, we associate a generic face ID to the triangles of the tessellated model. Thus, each generic ID is used to maintain naming consistency among distributed engineering service components.

Interactions between product development services and engineering processes
The basic Engineering service integration requires more than the ability to conduct simple interactions by using standard enterprise integration protocols. The full potential of engineering web services as an integration platform will be achieved only when applications and engineering processes are able to integrate their complicated interactions. We propose the concept of BPEL-based engineering process templates to realize the integration of engineering applications and processes. A BPEL-based engineering process template is used to orchestrate and choreograph existing engineering services to provide a new engineering service. As shown in Fig. 5, when a new engineering Web service instance is created, it is advertised to the UDDI by registering the WSDL description. Well-defined process templates are stored in the process repository, from which they are fed into the engineering process orchestration and choreography broker. The design board may be empty or have some unreliable information in the initial stage, and take reliable information and exact geometric model as the design progresses. All design tasks can refer information on the design board. Thus, product information can be synchronized and valid regarding service choreography and orchestration since the process is the composition of the engineering services registered in the iPIM and ESM and the change or modification is notified to the participant who is in charge of the specific product information through engineering change management.

Engineering context management
The proposed virtual engineering service framework is a context-aware infrastructure that exploits semantic web technologies to support explicit context representation, expressive querying, and flexible reasoning of engineering service-related contexts. Using topic maps, a semantic web standard, to define context ontologies provides a foundation for interoperable engineering service environments where computing entities can easily exchange and interpret contexts based on explicit engineering context representations.

By representing engineering service-related contexts as easily interpreted semantic ontologies, the context-aware engineering service framework enables engineering applications to retrieve contexts using declarative queries and supports the inference of higher-level contexts from the basic contexts. Because context-aware applications must adapt to dynamically changing situations and activities, they need a detailed model of users' activities and surroundings that lets them share users' perceptions of the real world. For that reason, the context-related infrastructure consists of several context-aware collaborating components as shown in Fig. 7. The context acquisition and maintenance module discovers and gathers contexts from mobile devices such as PDA and cellular phone, people, location, and engineering services, RFIDs, barcode readers, and Bluetooth-enabled sensors. Then, it asserts gathered contexts into the context knowledge base. The context knowledge base also stores context ontologies given by users or gathered from context devices. The context knowledge base links the context ontology and contexts in a single semantic model and provides interfaces for the context query engine and context reasoning engine to manipulate correlated contexts. The context query engine provides an abstract interface for applications to

extract desired contexts from the knowledge base. Topic maps are a new ISO standard for describing knowledge structures and associations them with information resources. Dubbed “the GPS of the information universe”, topic maps consist of three basic concepts: topics, associations, and occurrences. Topics are the most fundamental concept in topic maps, which defines a subject. A topic may be lined to one or more information resources that are deemed to be relevant to the topic in some way. Such resources are called occurrences of the topic. Associations play a role in describing relationships between topics. Topic maps has a standard query language called topic map query language (TMQL). Other reasons for adopting the topic map are in the flexibility for explicitly representing contexts, easy merging of multiple contexts based on the public subject indicator (PSI), multiple viewing of contexts based on the scope representation, and having standard-based querying and reasoning language of contexts.

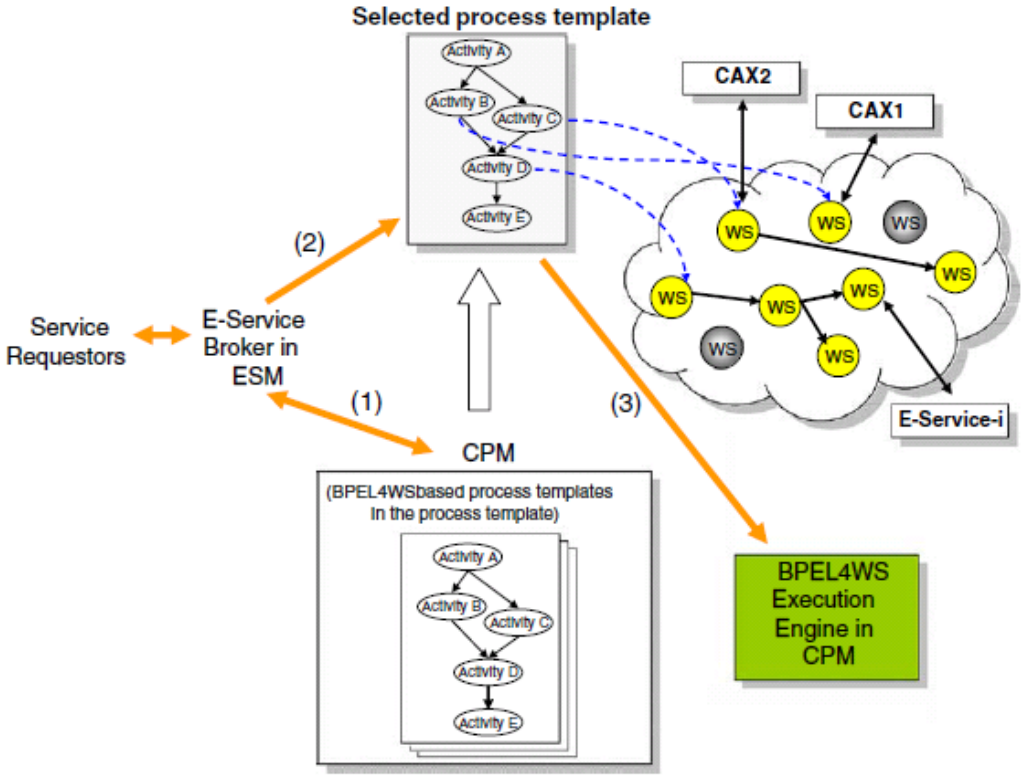

Figure 4: Federation and interaction of product development services by ESM and CPM.

System implementation

This section shows how PDAC can be utilized for providing virtual product development services in ubiquitous and context-aware environments. In particular, a

product development scenario for developing a mobile phone is shown for validating the implementation of PDAC. It also shows how engineering contexts can be effectively used for providing human-centered product development services. The scenario is based on the following two case studies: (1) Process-Centric Mobile Phone Design and (2) Collaborative Interactions for Resolving Conflicts in Ubiquitous Environments.

Conclusion

A ubiquitous environment to support applications collaborative product development has been presented in this paper for distributed collaborative environment. State-of-the-art 3D and IT technologies and their applications to facilitate product design have been explored through PDAC. PDAC integrates four function suites (iPIM, ESM, CPM, and ECM) to achieve enhanced product information synchronization, collaboration, and coordination across the shared process. The focus of this paper lies in three key issues. One is concerned with product information synchronization across virtual enterprises. Another is concerned with process-centric engineering service federations for service choreography and orchestration. The third is related to the engineering context management using semantic web for providing human-centered product development services.

In particular, product information shared among participants can be synchronized through the STEP PDM-based iPIM where consistency is maintained through engineering change propagation. When a change or modification is needed, an engineering change for the modification is propagated to the business partners such that the validity of the product information is always kept. In addition, conflicts are solved through the design board in which critical design data are registered and kept track of by the partners.

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