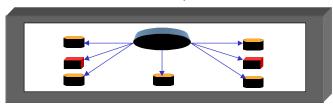*Executive Information Systems, Inc.*

Distributed Knowledge Management Systems and Enterprise Knowledge Management Modeling

By

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What is the Knowledge Management System (KMS)?

‣ The Knowledge Management System (KMS) is the on-going, persistent interaction among agents within a system that produces, maintains, and enhances the system's knowledge base. This definition is meant to apply to any intelligent, adaptive system composed of interacting adaptive agents.

‣ An agent is a self-directed object. The self that directs it is its hierarchical network of rules.

‣ An adaptive agent is an agent able to modify its rules in response to changes in the environment.

The Knowledge Base and Knowledge

‣ A system's knowledge base is: its set of remembered data; its validated rule network in the form of propositions and models (along with metadata related to their testing); its refuted propositions and models (along with metadata related to their refutation); its metamodels; and (perhaps, if the system produces such an artifact) the software it uses for manipulating these.

‣ A knowledge management system, in this view, requires a knowledge base of rules to begin operation, and to govern its own behavior. It enhances its knowledge base with the passage of time because it is a self-correcting system, and tests its knowledge base against experience.

Data, Information, Knowledge, and Wisdom

‣ What is the difference between data, information, knowledge, and wisdom?

‣ To begin with, organizational data, information, knowledge, and wisdom, all emerge from the social process of an organization, and are not private. In defining them, we are not trying to formulate definitions that will elucidate the nature of personal data, information, knowledge, or wisdom. Instead, to use a word that used to be more popular in discourse than it is at present, we are trying to specify intersubjective constructs and to provide metrics for them.

Data, Information,
Knowledge, and Wisdom (Two)

‣ A datum is the value of an observable, measurable or calculable attribute. Data is more than one such attribute value. Is a datum (or is data) information?

‣ Yes, information is provided by a datum, or by data, but only because data is always specified in some conceptual context. At a minimum, the context must include the class to which the attribute belongs, the object which is a member of that class, some ideas about object operations or behavior, and relationships to other objects and classes.

Data, Information, Knowledge, and Wisdom (Three)

‣ Data alone and in the abstract therefore, does not provide information. Rather, information, in general terms, is data plus conceptual commitments and interpretations. Information is data extracted, filtered or formatted in some way (but keep in mind that data is always extracted filtered, or formatted in some way).

‣ Knowledge is a subset of information. But it is a subset that has been extracted, filtered, or formatted in a very special way. It is information that has been subjected to, and passed tests of validation.

Data, Information,
Knowledge, and Wisdom (Four)

‣ Common sense knowledge is information that has been validated by common sense experience. Scientific knowledge is information (hypotheses and theories) validated by the rules and tests applied to it by some scientific community.

‣ Wisdom, lastly, has a more active component than data, information, or knowledge. It is the application of knowledge expressed in principles to arrive at prudent, sagacious decisions about conflict situations.
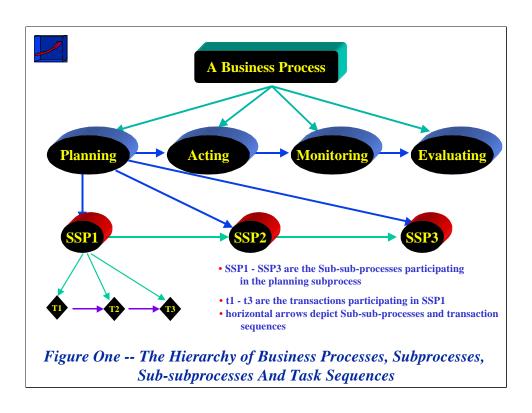
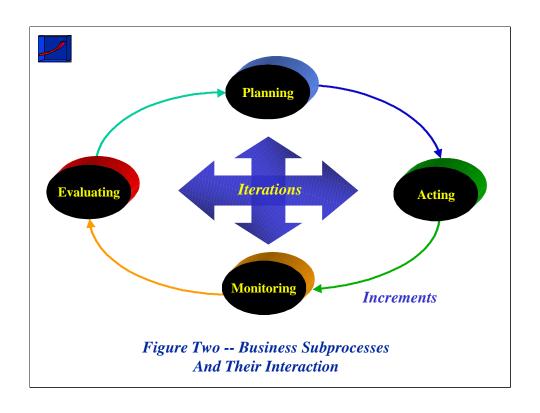## *Organizational Knowledge*

‣ Organizational knowledge in terms of this framework is information validated by the rules and tests of the organization seeking knowledge.

‣ The quality of its knowledge then, will be largely dependent on the tendency of its validation rules and tests to produce knowledge that improves organizational performance (the organization's version of objective knowledge).

Business Processes

‣ A Business Process is a hierarchical network of interrelated, purposive, activities of intelligent agents that transforms inputs into valued outcomes.

‣ Business Process activities may be viewed as sequentially linked. A linked sequence performed by one or more agents sharing at least one objective is a task.

‣ A linked sequence of tasks is a sub-subprocess (SSP).

‣ A cluster of tasks, not necessarily performed sequentially, often performed iteratively and incrementally is a subprocess.

‣ Finally a cluster of subprocesses is a business process.

A Business Process

Planning → Acting → Monitoring → Evaluating

SSP1 → SSP2 → SSP3

T1 → T2 → T3

- SSP1 - SSP3 are the Sub-sub-processes participating in the planning subprocess
- t1 - t3 are the transactions participating in SSP1
- horizontal arrows depict Sub-sub-processes and transaction sequences

Figure One -- The Hierarchy of Business Processes, Subprocesses, Sub-subprocesses And Task Sequences

*Figure Two -- Business Subprocesses
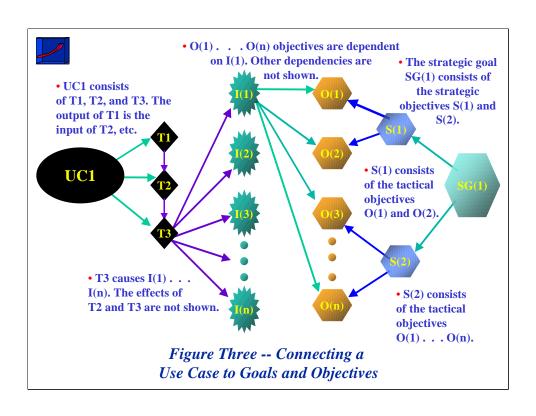And Their Interaction*

Business Subprocesses

‣ Planning means: setting goals, objectives, and priorities, making forecasts, performing cost/benefit experiments, and revising or reengineering a business process.

‣ Acting means: performing the business process.

‣ Monitoring means: tracking and describing the business process.

‣ Evaluating means: assessing the performance of the business process as a value stream.

Use Cases and Business Processes

‣ An Information System Use Case is defined by Jacobson as "A behaviourally related sequence of transactions performed by an actor in a dialogue with the system to provide some measurable value to the actor."

‣ A behaviorally related set of information system use cases, in turn, constitutes an information systems application supporting a business process through its sub-subprocesses, and subprocesses. This application may or may not extend over the four subprocesses, depending on its scope.

• O(1) . . . O(n) objectives are dependent on I(1). Other dependencies are not shown.

• UC1 consists of T1, T2, and T3. The output of T1 is the input of T2, etc.

• The strategic goal SG(1) consists of the strategic objectives S(1) and S(2).

• S(1) consists of the tactical objectives O(1) and O(2).

• T3 causes I(1) . . . I(n). The effects of T2 and T3 are not shown.

• S(2) consists of the tactical objectives O(1) . . . O(n).

Figure Three -- Connecting a Use Case to Goals and Objectives

The Knowledge Management Process and Knowledge Management

‣ The Knowledge Management Process (KMP) is an on-going persistent interaction among human-based agents who aim at integrating all of the various agents, components, and activities of the knowledge management system into a planned, directed process producing, maintaining and enhancing the knowledge base of the KMS.

‣ Knowledge Management is the human activity within the KMP aimed at creating and maintaining this integration, and its associated planned, directed process.

The Knowledge Management Process and Knowledge Management (Two)

‣ A good way to look at the human activity called knowledge management is through the concept of the SSP. In an SSP a human-based agent, within the KMS, participates in the KMP to get an outcome from the KMS that has value for the agent. The KMP can be represented as a set of SSPs each classified within one of four business sub-process categories: planning, acting, monitoring, and evaluating.

‣ *A way of decomposing knowledge management activity then, is in terms of the SSPs that constitute it.*

Distributed Knowledge Management Systems (DKMS)

‣ A DKMS is a system that manages the integration of distributed objects/components into a functioning whole producing, maintaining, and enhancing a business knowledge base.

‣ A business knowledge base is the set of data, validated models, metamodels, and software used for manipulating these, pertaining to the enterprise, produced either by using a DKMS, or imported from other sources upon creation of a DKMS.

‣ A DKMS, in this view, requires a knowledge base to begin operation. But it enhances its own knowledge base with the passage of time because it is a self-correcting system, subject to testing against experience.

‣ The DKMS must not only manage data, but all of the objects, object models, process models, use case models, object interaction models, and dynamic models, used to process data and to interpret it to produce a business knowledge base.

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Distributed Knowledge Management Systems (DKMS) (Three)

‣ It is because of its role in managing and processing data, objects, and models to produce, enhance, and maintain a knowledge base that the term Distributed Knowledge Management System is so appropriate.

‣ Two ways to look at the DKMS are in terms of its architecture, and its use cases. Let's proceed to examine its architecture, and then its use cases.
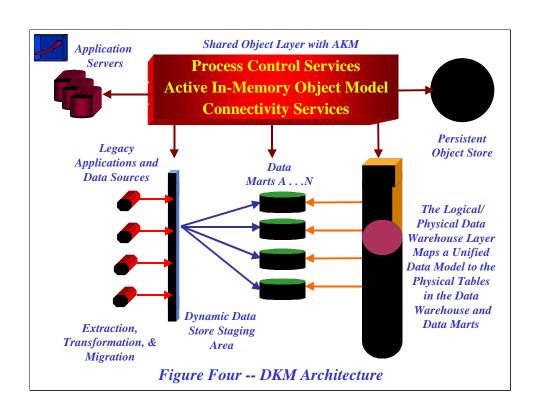
Distributed Knowledge
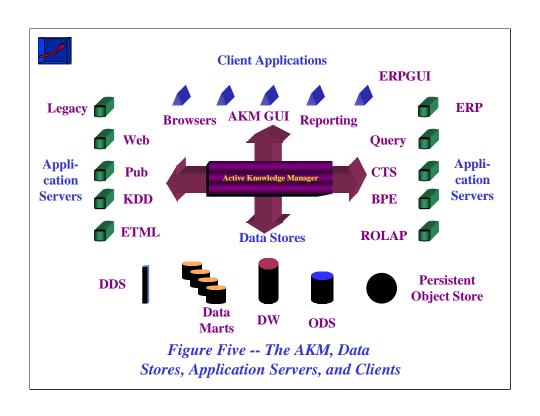## *Management Architecture (DKMA)*

‣ An evolving O-O/Component-based architecture

‣ Top - Down and Bottom-Up data warehousing architectures may be viewed as two-tier architectures utilizing clients and local or remote databases

‣ More recent data warehousing architectures may be viewed as adding Middleware and Tuple layers to earlier architectures to provide the capability to manage warehouse systems integration through unified logical views, monitoring, reporting, and intentional DBA maintenance activity. But this

Distributed Knowledge
Management Architecture (DKMA) (Two)

‣ form of management still doesn't provide automatic feedback of changes in one component to others

‣ DKMA may be viewed as adding an object layer to earlier architectures to provide integration through automated change capture and management

‣ The object layer contains process distribution services, an in-memory active, object model, and connectivity to a variety of data store and application types. The layer requires an architectural component called an Active Knowledge Manager (AKM).

Application Servers

Shared Object Layer with AKM

Process Control Services
Active In-Memory Object Model
Connectivity Services

Persistent Object Store

Legacy Applications and Data Sources

Data Marts A . . .N

The Logical/ Physical Data Warehouse Layer Maps a Unified Data Model to the Physical Tables in the Data Warehouse and Data Marts

Extraction, Transformation, & Migration

Dynamic Data Store Staging Area

Figure Four -- DKM Architecture

*Figure Five -- The AKM, Data
Stores, Application Servers, and Clients*

DKM Architecture and the AKM

‣ An AKM provides Process Control Services, an Object Model of the Distributed Knowledge Management System (DKMS) (the system corresponding to the DKM architecture), and connectivity to all enterprise information, data stores, and applications

  ‣ Process Control Services:

    ‣ In memory proactive object state management and synchronization across distributed objects
    ‣ Component management
    ‣ Workflow management
    ‣ Transactional multithreading

DKM Architecture and the AKM (Two)

‣ In-memory Active Object Model/Persistent Object Store is characterized by:

- ‣ Event-driven behavior
- ‣ DKMS-wide model with shared representation
- ‣ Declarative and procedural business rules
- ‣ Caching along with partial instantiation of objects
- ‣ A Persistent Object Store for the AKM
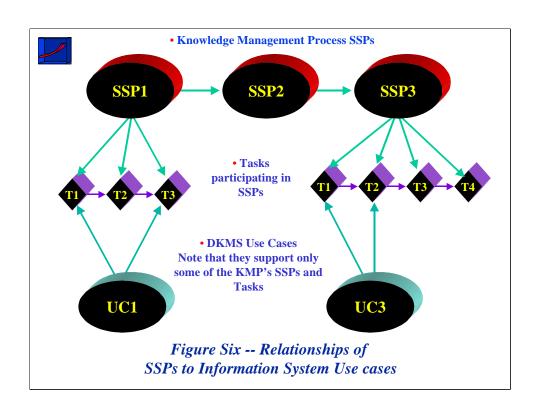- ‣ Reflexive Objects

DKM Architecture and the AKM (Three)

‣ Connectivity Services should have:

  ‣ Language APIs: C, C++, Java, CORBA, COM

  ‣ Databases: Relational, ODBC, OODBMS, hierarchical, network, flat file, etc.

  ‣ Wrapper connectivity for application software: custom, CORBA, or COM-based.

  ‣ Applications include all those mentioned earlier in Figure Five

The DKMS and its Use cases

‣ Business Process SSPs are supported by information system use cases: one or more of which constitutes an application.

‣ When a DKMS is viewed functionally as an application, it is viewed as a set of use cases supporting various SSPs and tasks within the four sub-processes of the KMP.

‣ The next figure illustrates this partial support relationship.

Figure Six -- Relationships of SSPs to Information System Use cases

The DKMS and its Use cases

‣ Here are two side-by-side lists.
  ‣ A List of SSPs and a list of
  ‣ DKMS Use Cases
‣ These also illustrate the point of partial support of DKMS use cases for KMP SSPs

Enterprise KMP
Subprocesses, SSPs, and DKMS Use Cases

- *Knowledge Management Process*
- *Planning*
- Action planning
- Authority/role assignment planning

- *DKMS*
- *Planning*
- Develop KM Hierarchy of Goals and Objectives
- Specify Tactical Objectives
- Specify Actions, Action Sequences, and Strategies
- Select and Evaluate Candidates for KM Positions

Enterprise KMP Subprocesses, SSPs, and DKMS Use Cases (Two)

‣ *Acting*
 ‣ Mapping Information and Knowledge Resources
 ‣ Implementing KM Technology Base
 ‣ Knowledge Discovery
    ‣ Model Formulation
    ‣ Knowledge Validation
	‣ *Acting*
	 ‣ Locate, Select, describe resources needed to develop & establish knowledge base
	 ‣ Develop physical architecture of DKMS
	 ‣ Formulate Rule Networks (Models)
	 ‣ Prepare Data for Validation
	 ‣ Validate Models

Enterprise KMP Subprocesses, SSPs, and DKMS Use Cases (Three)

- Knowledge Base Integration and Enhancement
  - Of External Knowledge
  - Of Internal Knowledge

- Selecting Information and Knowledge Resources for Integration
- Validating selected resources prior to integrating them
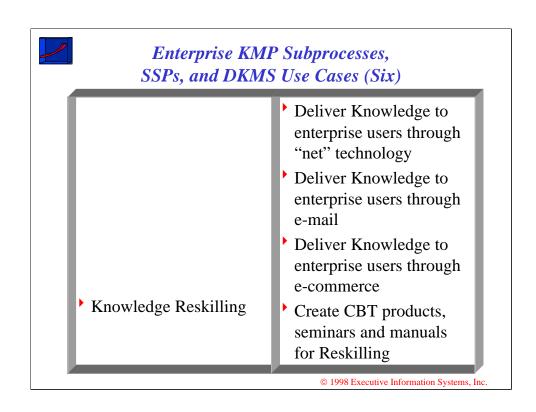- Integrating Validated resources through ETML

Enterprise KMP Subprocesses, SSPs, and DKMS Use Cases (Four)

‣ Knowledge Base Maintenance	‣ Batch entering, cleaning, consolidating, updating ‣ Maintaining analytic, data and other models in knowledge repository ‣ "Fixing Bugs" ‣ Updating Software ‣ Providing Secure Access ‣ Securing the knowledge base from accidents ‣ Performance Tuning

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Enterprise KMP Subprocesses, SSPs, and DKMS Use Cases (Five)

‣ Knowledge Base Development through Inference

‣ Compute facts, objectives, predictive values, effects of enterprise activities, forecasts, targets of company marketing and selling activity from models in knowledge base through inference.

‣ Compute the above through Complex Adaptive System simulation

Enterprise KMP Subprocesses, SSPs, and DKMS Use Cases (Six)

‣ Knowledge Reskilling	‣ Deliver Knowledge to enterprise users through "net" technology ‣ Deliver Knowledge to enterprise users through e-mail ‣ Deliver Knowledge to enterprise users through e-commerce ‣ Create CBT products, seminars and manuals for Reskilling

Enterprise KMP Subprocesses, SSPs, and DKMS Use Cases (Seven)

‣ *Monitoring* ‣ Descriptive Knowledge Retrieval	‣ Query for descriptive knowledge about conceptual models, graphical models, analytical models, data models, object-related models, in language model or frameworks, methods and techniques, methodologies, software applications, validation criteria, and other descriptive knowledge

Enterprise KMP Subprocesses, SSPs, and DKMS Use Cases (Eight)

- Impact-related Knowledge Retrieval
- Predictive Knowledge Retrieval
- *Assessing*
- Retrieving and Assessing Knowledge about Actual and Forecast Gap between goals and reality

- Query for impact-related knowledge about the previous list of knowledge types
- Query for predictive knowledge about the previous list of knowledge types
- Assess business outcomes against tactical objectives

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Enterprise KMP Subprocesses, SSPs, and DKMS Use Cases (Nine)

‣ Retrieving and Assessing Knowledge about Actual and Forecast Benefit/Cost Ratios

‣ Assess forecast outcomes against forecast tactical objectives

‣ Assess benefits and Costs of Past and Current Business Activities in terms of Impact outcomes

‣ Assess benefits and costs of future business activities and future business outcomes

Enterprise Models for Knowledge Management

‣ An Enterprise Knowledge Management Model (EKM) is a network of rules that enables an agent to anticipate and predict events and interaction patterns in the enterprise KMS and KMP and in its environment.

‣ The EKM is made up of rule patterns that an agent can use to describe, understand, and explain interaction patterns, in order to anticipate and predict future interaction patterns.

‣ The agent learns to anticipate and predict better by adding, removing, and changing these rule patterns based on the enterprise's experience, its knowledge validation criteria and other competing models emerging from the enterprise's knowledge and knowledge management processes.

The DKMS and the EKM

‣ The relationship of the DKMS to an EKM is one of mutual feedback and virtuous circularity over time.

‣ At any point in time the DKMS use case:

> ‣ Specifying Actions, Action Sequences, and Strategies related to Management of Kn processes requires EKM rules to compare likely outcomes of alternatives

> ‣ Selecting and Evaluating Candidates for Kn and KM Positions requires EKM rules to compare predicted candidate performance

The DKMS and the EKM (Two)

‣ Developing physical and electronic architecture of KM system requires EKM rules to forecast impact of changes in architecture on enterprise bottom lines (profitability, expansion, etc.)

‣ Formulating Rule Networks (Competing Models) requires EKM rules to provide new alternatives

‣ Preparing Data for Validation requires EKM rules on integrating new data

The DKMS and the EKM (Three)

‣ At any point in time the DKMS use case:

   ‣ Validate Models requires EKM validation rules

   ‣ Validating selected resources prior to integrating them requires EKM validation rules

   ‣ Integrating Validated resources through ETML requires EKM rules for Data Preparation

The DKMS and the EKM (Four)

‣ Computing facts, objectives, predictive values, effects of enterprise activities, forecasts, targets of company marketing and selling activity from models in knowledge base through mathematical inference requires EKM rules to derive these consequences from antecedent conditions

‣ Computing the above through Complex Adaptive System simulation requires EKM rules on which to base Cas simulation.

The DKMS and the EKM (Five)

‣ At any point in time the DKMS use case:

  ‣ Querying for impact-related knowledge presupposes using EKM rules to derive such knowledge

  ‣ Querying for predictive knowledge presupposes using EKM rules to derive such knowledge

  ‣ Assessing business outcomes against tactical objectives presupposes using EKM rules to do the assessment

The DKMS and the EKM (Six)

‣ Assessing forecast outcomes against forecast tactical objectives presupposes using EKM rules to derive forecasts

‣ Assessing benefits and Costs of Past and Current Business Activities in terms of Impact outcomes presupposes using EKM rules to derive such knowledge

‣ Assessing benefits and costs of future business activities and future business outcomes presupposes using EKM rules to derive forecasts

The EKM and the DKMS

‣ At any point in time the EKM Requires the
DKMS Use Case:

  ‣ Developing KM Hierarchy of Goals and
  Objectives to plan EKM development

  ‣ Specifying Tactical Objectives to plan EKM
  Development

  ‣ Specifying Actions, Action Sequences, and
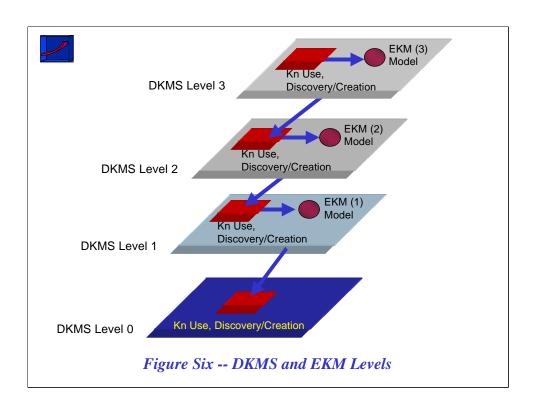 Strategies to plan new actions needed to improve
  the EKM

The EKM and the DKMS (Two)

- ‣ Selecting and Evaluating Candidates for Kn and KM Positions to acquire personnel to improve the EKM
- ‣ Formulating Rule Networks (Models) to revise or competitively test the EKM
- ‣ Preparing Data for Validation to revise or competitively test the EKM
- ‣ Validating Models to revise or competitively test the EKM

The DKMS, the EKM and Levels

‣ The EKM and the DKMS have this complex relationship because both operate at different hierarchical levels

- ‣ If Level 0 is the level of Cas interaction at which Kn and other business processes operate, it is also the level at which an EKM (formulated at level 1) is needed to permit the DKMS to support knowledge use and knowledge creation at level 0.

- ‣ At level 1 however, the DKMS must support Knowledge Discovery involving adaptation of the EKM, while at the same time in order to do this it must rely on an EKM, formulated at level 2, about change in the original EKM.

- ‣ At level 2 however, the DKMS must support Knowledge Discovery involving adaptation of the EKM about change in the original EKM, while at the same time in order to do this it must rely on an EKM, formulated at level 3, about change in the level2 EKM, and so on.

Figure Six -- DKMS and EKM Levels

The End

‣ The EKM is one of the continuously improved outcomes of the DKMS.

‣ Yet the DKMS at any level of analysis is also an outcome of a higher level EKM.

‣ This means that if the EKM is to be developed, it must be developed hand-in-hand with the DKMS, and similarly development of an effective DKMS is equally reliant on development of an effective EKM.

‣ The EKM is the intelligence behind the DKMS

‣ But the DKMS is the tool for developing that intelligence.