INTRODUCTION TO VIRTUAL ENTERPRISES

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Introduction of STEP / PDM in SMEs
Monte Caparica, Portugal - 11 March 1999

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VIRTUAL ENTERPRISING: the way to global manufacturing and its challenges

The Virtual Enterprise paradigm
- a temporary alliance of enterprises that come together to share skills and resources in order to better respond to business opportunities and whose cooperation is supported by computer networks -
challenges the way manufacturing systems are planned and managed.

ENABLERS

OBSTACLES

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Virtual Enterprise

Extended Enterprise

?

Supply Chain Management

Networked Organization

Virtual Organization

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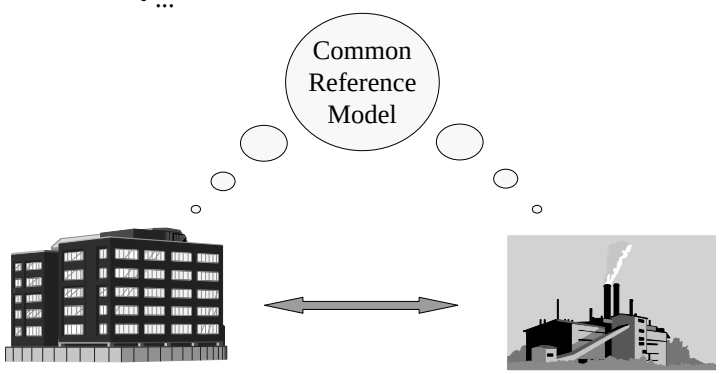
BASIC INFORMATION EXCHANGE IN A VIRTUAL ENTERPRISE

- Commercial information => EDIFACT
- **Product-related information => STEP**
- Quality-related information
- Business process related information => PIF ?
- ...



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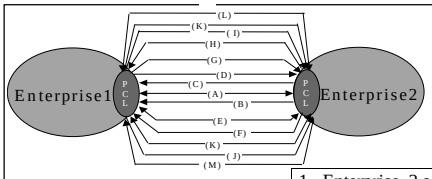
EXAMPLE OF INFORMATION EXCHANGE BETWEEN ENTERPRISES



1. Enterprise_2 searches a PART maker supplier;
2. Enterprise_2 identifies Enterprise_1 as a supplier;
3. Enterprise_2 sends PART design to Enterprise_1; (C)
4. Enterprise_1 and Enterprise_2 interactively analyze the project, exchanging STEP models; (E)
5. Enterprise_2 agrees with the design and sends a "design acceptance" to Enterprise_1; (F)
6. Enterprise_1 sends proposal for the PART production; (G)
7. Enterprise_2 evaluates the proposal and sends a "confirmation order" to Enterprise_1; (H)
8. Contract is signed and sporadic supply is planned; (A)
9. Enterprise_2 generates and order entry and sends it to Enterprise_1; (B)
10. Enterprise_1 sends an order and the project confirmation; (D)
11. Enterprise_2 can request "production follow up bulletins" from Enterprise_1; (I)
12. Enterprise_1 sends all exportat (process) and releases documentation with product; (J) (K)
13. Enterprise_2 receives and inspects the product;
14. Enterprise_2 sends a "reception report" to Enterprise_1 if any manufacturing problem is found in the product; (L)
15. Enterprise_2 sends the invoice for payment. (M)

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CLASSES AND LIFE CYCLE IN A VE

CLASSES OF VE

- DURATION
  - Single business
  - Long term alliance
- TOPOLOGY
  - Variable / dynamic nature
  - Fixed Structure
- PARTICIPATION
  - Single alliance
  - Various networks
- COORDINATION
  - Star-like structure
  - Democratic Alliance
  - Federation

VISIBILITY SCOPE

- Single level
- Multi-level

LIFE CYCLE & COOPERATION PROBLEMS

- CREATION
  - Partners search
  - Contracts
- OPERATION
  - Orders related interactions
  - Technical data interchange
  - Joint supervision
- DISSOLUTION

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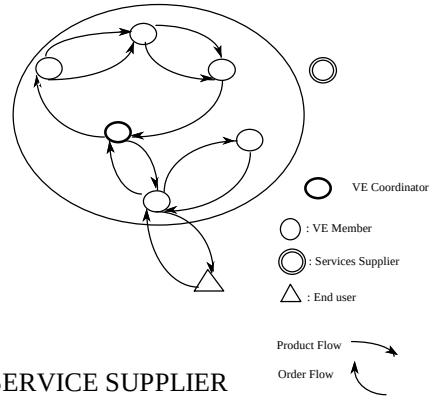
ENTERPRISE ROLES IN A NETWORKED ORGANIZATION

- VE COORDINATOR
- VE MEMBER

- CLIENT
- SUPPLIER

- NETWORK DIRECTORY SERVICE SUPPLIER
- ELECTRONIC COMMERCE SERVICE PROVIDER
- TECHNICAL ADVISE SERVICE PROVIDER



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COMPONENT TECHNOLOGIES

The implementation of a supporting infrastructure for VE can be based on a number of **component technologies** and **paradigms**:

- Interoperability and integration of standards - STEP, EDI, TCP/IP, KQML, …
- Integration of Workflow Management Systems
- Integration of advanced Information Management Systems
- Integration of Safety and authentication mechanisms
  - cryptography based on public/private keys, digital signature, definition of access rights, etc.
- Integration of MAS development environments
- Integration of legacy systems - PPC/MRP, CAD, …
- Infrastructures:
  - Internet/VAN, Federated / distributed DBMS, DB&WEB, DB&WFM, Middleware (CORBA, JAVA/RMI, DCOM, CGI, …)

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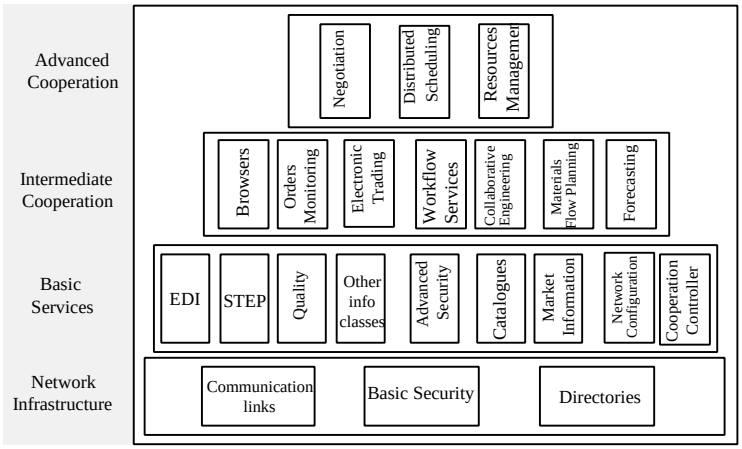
VE SUPPORTING INFRASTRUCTURE



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VE SUPPORTING PLATFORMS: The need for flexibility

- **Diversity of VE classes**, in terms of duration, topology, coordination policy, visibility scope, etc.
- **Diversity of roles** played by each enterprise, such as VE member, coordinator, client, supplier.
- **Diversity of internal management policies and socio-organizational structures** found in each company.
- **Diversity of rights and duties** that can be associated to each VE member.
- **Diversity of contract / subcontract forms**.
- **Participation** of a company **in multiple VEs**.
- **Evolution of support technologies**, **safety mechanisms** and the **legal framework** for electronic commerce.

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EXAMPLES OF PROJECTS ON VIRTUAL ENTERPRISES

- ✦NIIIP Program: LITE, SMART, SHIIP, AMMPLE, SPARS
- ✦IMS Program: Globeman 21, MISSION, etc.
- ✦ESPRIT Program: **PRODNET II**, VEGA, MARVEL OUS, TEMPO, TOCEE, X-CITTIC, PLENT, etc. etc.
- ✦INCO & ALFA Programs: **MASSYVE**, COSME-VE, **SCM+,** etc.

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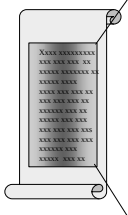
Esprit PRODNET II

Design and develop an open infrastructure to support Industrial Virtual Enterprises



- Focus on SMEs
- Adoption of standards: EDI, STEP, WfMC, Internet, …
- Federated information management and interoperability
- Cope with legacy systems
- Flexible and configurable coordination
- Monitoring the orders flow / contracts management
- Support safe communications and auditing
- Reengineer PPC functionalities to operate in a VE
- Imprecise and incomplete orders management
- Cope with socio-organizational impacts

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PRODNET II PARTNERS

CSIN - Construção de Software e Automação na Indústria Lda - Portugal

ESTEC - Estudos e Tecnologias da Informação, Lda - Portugal

LICHEN Informatique - France

ProSTEP GmHb - Germany

©

UNL - Universidade Nova de Lisboa Portugal

UvA - Universiteit van Amsterdam The Netherlands

UFSC - Universidade Federal de Santa Catarina - Brazil

UNINOVA - Instituto de Desenvolvimento de Novas Tecnologias -Portugal

MIRALAGO, S.A. Portugal

HERTEN - Engenharia de Moldes Brazil

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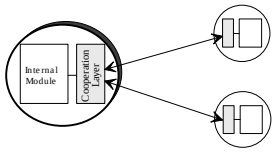
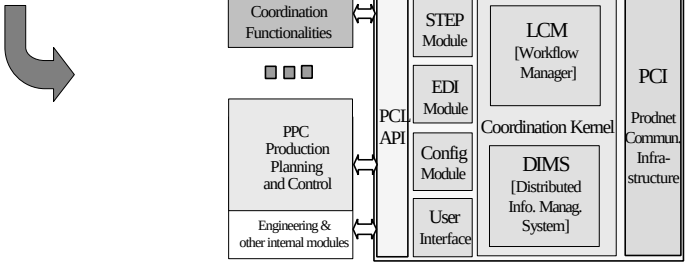
BASIC PRODNET ARCHITECTURE





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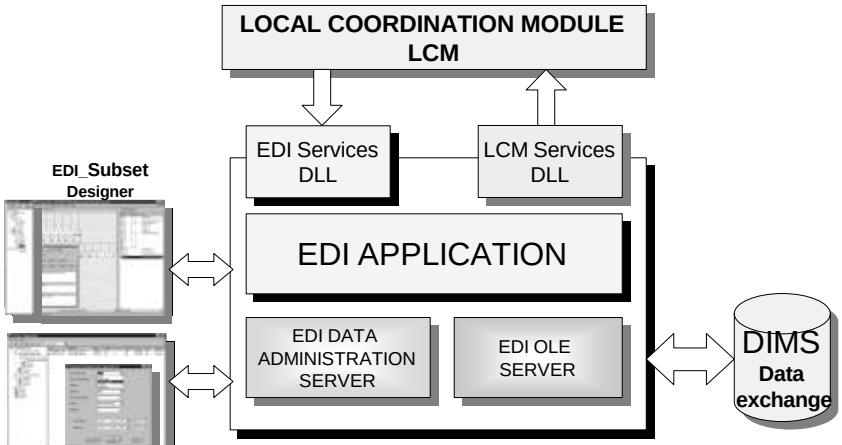
EDI : Integration of EDIFACT



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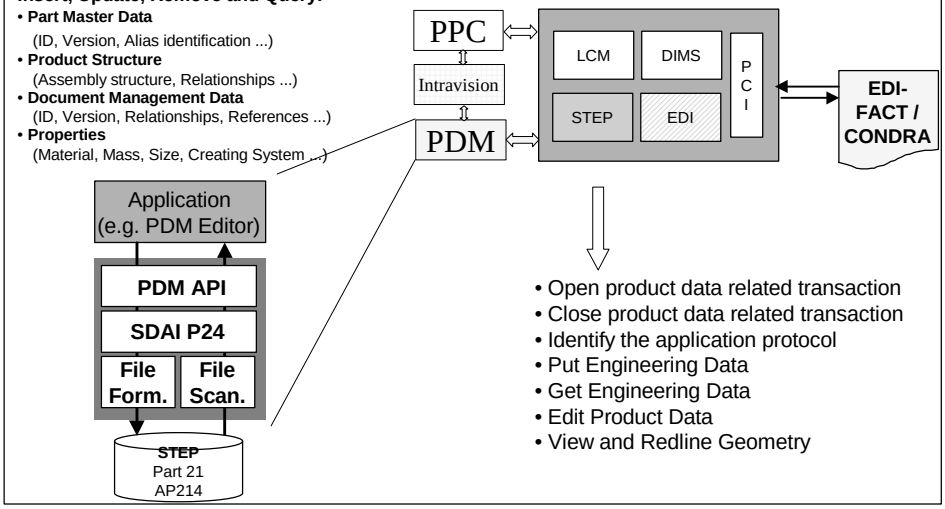
STEP : Integration of STEP/PDM

Insert, Update, Remove and Query:
- **Part Master Data**
  (ID, Version, Alias identification ...)
- **Product Structure**
  (Assembly structure, Relationships ...)
- **Document Management Data**
  (ID, Version, Relationships, References ...)
- **Properties**
  (Material, Mass, Size, Creating System ...)



- Open product data related transaction
- Close product data related transaction
- Identify the application protocol
- Put Engineering Data
- Get Engineering Data
- Edit Product Data
- View and Redline Geometry

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DIMS : Distributed Information Management System

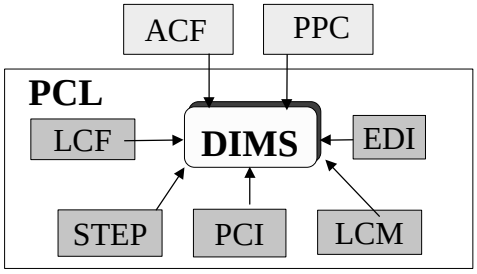
Modeling, representation, management and access to the data necessary to support both:

(1) intra-enterprise information exchange

(2) inter-enterprise information exchange

❶ **Intra-enterprise information**

Specific set of query-update service functions are developed for interaction with DIMS



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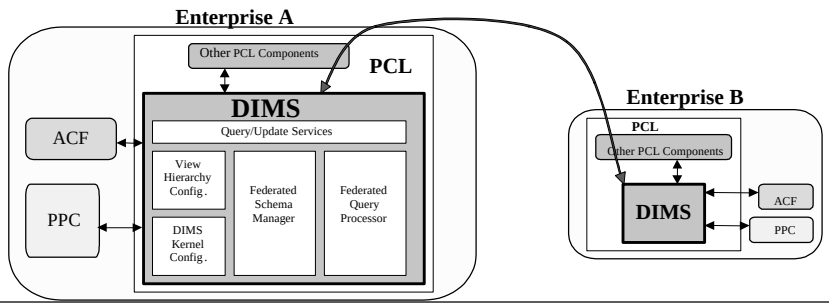
DIMS : Distributed Information Management System

❷ **Inter-enterprise information exchange** for secure interoperation among autonomous enterprises

- ✦ Federated cooperative architecture (no data-redundancy, no centralization of data/control)
- ✦ Provision of access rights based on individual *role* of every other enterprise
- ✦ Preserving the security/visibility of shared data



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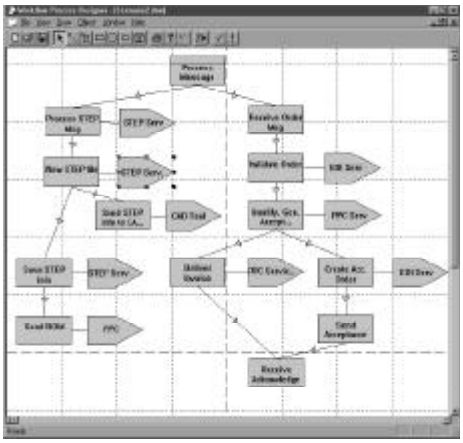
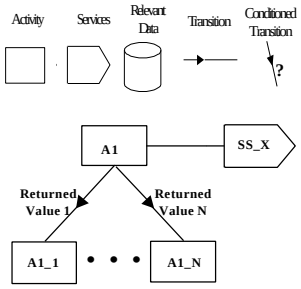
LCF : GRAPHICAL EDITION OF WORKFLOW





- Hierarchy and reusability of tasks; Sub-workflows
- Data Flow management
- Events
  - time-based
  - generated by a human operator (control / data input)
- Conditional Flows and Parallel execution
  - AND/OR splits and joins, conditioned transitions
- Synchronisation

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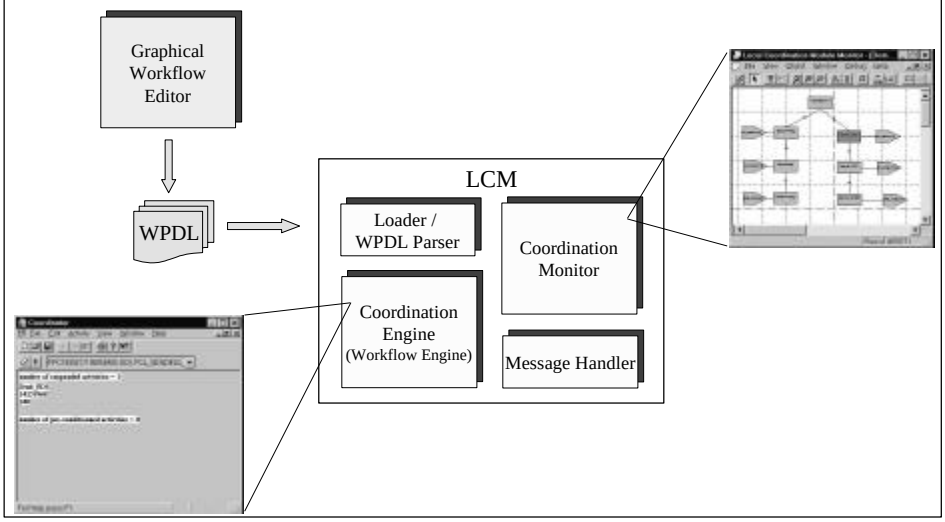
LCM : Local Coordination in PRODNET



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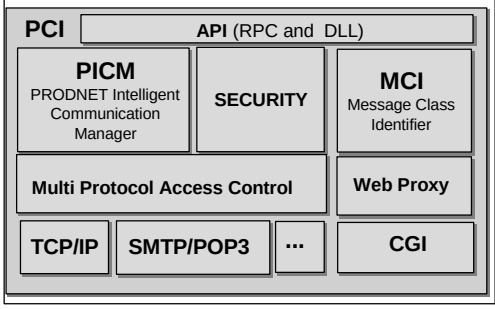
PRODNET Communication Infrastructure

ARCHITECTURE

⇨ Multiple Communication Resources Supported
⇨ Message Delivery under Quality Constraints
⇨ Message Privacy, Integrity and Authentication
⇨ Intelligent Communication Management



SECURITY

⇨ Symmetric and Asymmetric **Cryptography**
⇨ **Authentication** based on Signed Certificates
⇨ Follows Security (emergent) Standards
⇨ **Digital Signature** & Certificate Management
⇨ Tunable Security Level

INTEROPERABILITY

⇨ Secure Access from a Client Web Browser
⇨ Legated Messages Integration (e-mail)
⇨ Application Domain Independence

INFORMATION AUDITING

⇨Communication Events Logging
⇨ Registration of Security Exceptions
⇨ Evaluation of Communication Quality
⇨ Legal Conformity Awareness

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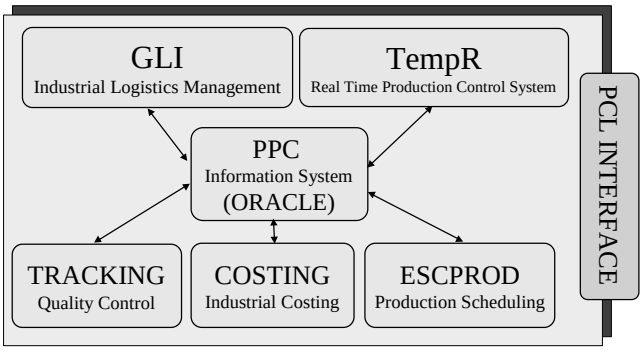
PPC



PPC Re-engineering

-Reactivity to network events
-EDIFACT / STEP compatibility
-Imprecise / incomplete orders management
-Quality-related information management in VE environment

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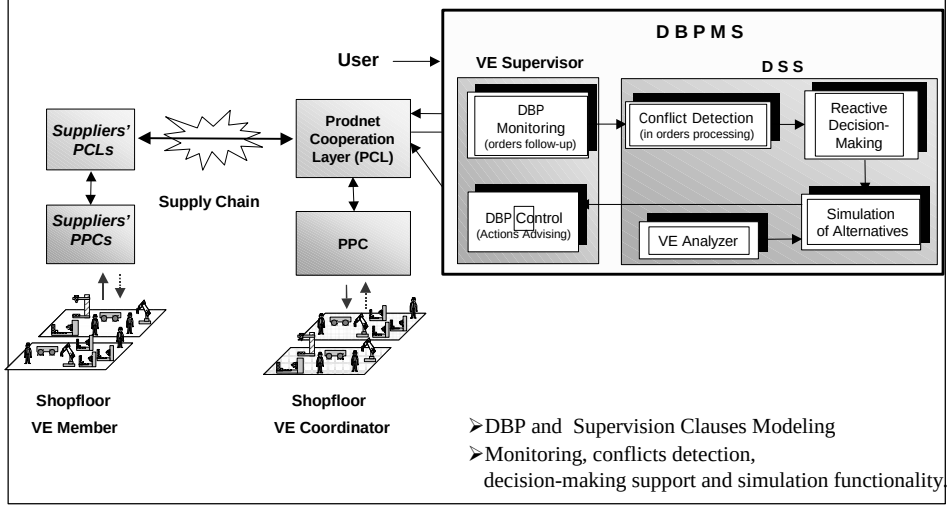
Advanced Coordination Functionality
Distributed Business Process Management System



- DBP and Supervision Clauses Modeling
- Monitoring, conflicts detection, decision-making support and simulation functionality.

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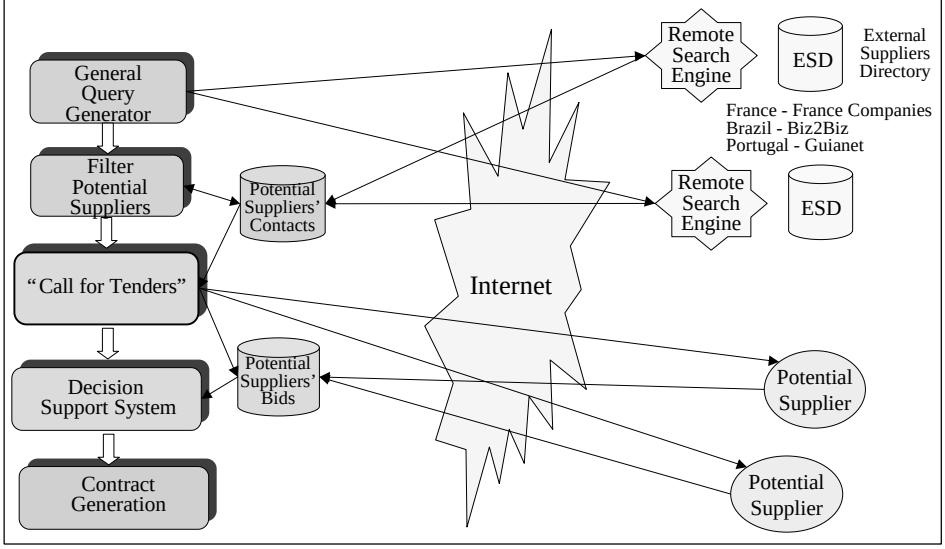
Partners Search Approach



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PRO-VE'99

IFIP/PRODNET Working Conference on INFRASTRUCTURES FOR INDUSTRIAL VIRTUAL ENTERPRISES

Porto, Portugal
27-28 October 1999

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CONCLUSIONS

- VE development: an opportunity and a challenge for industrial enterprises worldwide
- Basic supporting technologies are becoming available
- **STEP / PDM plays a major role in a Virtual Enterprise**
- **Interoperation between STEP and other standards (EDIFACT, etc.) is mandatory in a VE**
- **Configurability and flexibility** are major requirements for any VE-support infrastructure
- Large number of other technical and socio-organizational issues to support the life cycle of a VE

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