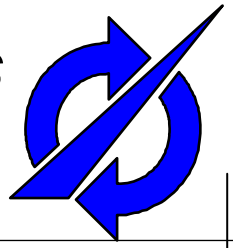


A Contribution for the Discussion "The Future for Industrial Engineers"

*Prof. Alexander V. Smirnov (*smir@iias.spb.su)

Deputy Director for Research - from1998
Head of Computer-Aided Integrated Systems Laboratory *(CAIS Lab) - 1994,*
St.Petersburg Institute for Informatics and Automation
of the Russian Academy of Sciences (*SPIIRAS*) – from 1978

Outline

SPIIRAS

- Facts about Prof. Alexander SMIRNOV

- Introduction
- Flexible Supply Network Self-Configuration: Scenario
- Service-Oriented Business Network
- Context-Driven Knowledge Management
- Conclusion

Prof. A. Smirnov: Some Professional Facts

SPIIRAS

- PhD in Technical Cybernetics from St.Petersburg State University of Electrical Engineering (1984)
- D.Sc. in Mathematical Modeling from St.Petersburg Institute for Informatics and Automation of Russian Academy of Sciences (1994),
- a Full Professor from the Russian Government (1998).

- Expert #EX2002B022896 (Reviewer / Evaluator) of European Commission: Directorate -GIS – Research; International Aspects; Innovation and SMEs; NEST, FET, IDEAS (2001 – now)

- A member of the Technical Committee
  - IFAC TC 5.1 on Manufacturing Plant Control *(from 1998);*
  - IFIP TC5 WG5.1 on Global Product Development for the Whole Life-Cycle *(from 2009).*
  - IEEE ComSoc TC on Situation Management *(from 2008);*
  - IEEE SMC TC on Self-Organization and Complex Distributed Systems *(from 2007);*

St.Petersburg Institute for Informatics and Automation (SPIIRAS)

SPIIRAS

- **Russian Academy of Sciences (RAS)**
- Founded in 1724
- The research umbrella organization of the Russian Government
- 363 units (Research Institutes and Centers)
- 112,000 personnel: 55,100 Researchers (10,000 D.Sc., and 26,000 Ph.D.)

- **St.Petersburg Institute for Informatics and Automation (SPIIRAS)**
- Founded in 1978
- Only 1 Russian Academy of Science Institute operating in Northwest Russia in Computer Science discipline
- 178 Personnel: 137 Researchers (33 D.Sc., and 59 Ph.D., 34 Ph.D. students)
- Grants Ph.D and Dr.Sc. (Technical) degrees

URL: http://www.spiiras.nw.ru

SPIIRAS Location

SPIIRAS Research Directions

SPIIRAS

- **Fundamentals of the Informatization of the Society and Regions, Regional Information and Computer Networks and Systems, Information Security**
- **Theoretic Fundamentals of Developing Hardware and Software Complexes aimed at Real Time Information Processing**
- **Fundamentals, Models and Methods of Information Processes Study in Complex (Socio-, Eco-, Bio-,Geo-, etc) Systems**
- **Theoretic Fundamentals of Developing Information Technologies for Intelligent Automation Systems for Control, Manufacturing and Research, including the applicability to nanotechnologies**

SPIIRAS Structure

Scientific Council

DIRECTOR
Yusupov Rafael M., RAS Cor.member

SPIIRAS Dissertation Council for Doctor of Sciences Degree

Deputy-Director for Research
Smirnov Alexander V. Dr.Sci.Prof.

Deputy-Director for Research
Sokolov Boris V. Dr.Sci.Prof.

Deputy-Director for Research
Popovich Vasily V. Dr.Sci.Prof.

Deputy-Director for Information Security
Moldovyan Alexander A. Dr.Sci.Prof.

Deputy-Director for Maintenance
Tkach Anatoly F.,PhD.

Scientific Secretary
Backuradze Dmitry V., PhD.

Assistant to Director for International Research Cooperation
Podnozova Irina P., MS

Service Departments

Post-Graduate Courses

Scientific Library

Information Service Group

Quality Management Bureau

SPIIRAS and Gymnasium of K. May History Museum

LABORATORIES

Distributed Computational Structures
Torgashev Valery A., Dr.Sci.,Prof.

Object-Oriented Geo-Information Systems
Popovich Vasily V., Dr.Sci., Prof.

Software Engineering and Software Systems
Skirtil Viacheslav I., PhD.

Computer and Information Systems and Problem of Information Protection
Vorobyov Vladimir I., Dr.Sci.,Prof.

Department of Problems of Information Security
Moldovyan Alexander A. Dr.Sci.Prof.

Cryptology
Moldovyan Andrey A., Dr.Sci.Prof.

Security of Information Systems

Computer Aided Integrated Systems
Smirnov Alexander V.,Dr.Sci.Prof.

Intelligent Systems
Karsaev Oleg V., PhD.

Information Technologies for Systems Analysis and Modeling
Sokolov Boris V., Dr.Sci.Prof.

Research Automation
Alexandrov Viktor V., Dr.Sci.,Prof.

Applied Informatics
Yusupov Rafael M., RAS Cor.Member

Information Technologies for Control and Robotics
Timofeyev Adil V. V.Dr.Sci.,Prof.

Information-Analytic Technologies for Economics
Lysenko Igor V., Dr.Sci.,Prof.

Speech and Multimodal Interfaces Laboratory
Ronzhin Andre L., PhD.

Biomedical Informatics
Roudnitsky Sergey B., Dr.Sci.

GROUPS

Modeling and Information Support of Nanotechnologies
Losev Gennady M., PhD.

Computer Security
Kotenko Igor V., Dr.Sci.,Prof.

Educational Information Technologies
Grigorijva Alla I., PhD.

Problems of Society Informatization
Zabolotsky Vadim P., Dr.Sci.

Interdisciplinary Informatics
Tylupyev Alexander L. , PhD.

Information Technologies for Clinical Biophysics
Pavlovski Vladimir F. , PhD.

SPIIRAS Affiliated Innovation Centers

JSC "SPIIRAS - Scientific and Technical Bureau of Computer Science" (SPIIRAS-STBCS)

Intelligent Logistics' Technologies Research and Consultancy Center

SPIIRAS Basic Departments

SPIIRAS

- **Basic department «Research Automation» at St.Petersburg State Electrical Engineering University (1979)**
- **Basic department “Applied Informatics” at St.Petersburg State University of Air Space Instrumentation (2002)**
- **Basic department "Neuroinformatics and Robotics" at St.Petersburg State University of Air Space Instrumentation (2004)**
- **Basic department "Medical and Technical Systems and Vital Activity Security” at North- West State Correspondence Technical University (2005)**
- **Affiliated department “Mechanics of Controlled Motion” at St.Petersburg State University (1981)**

CAIS Laboratory: Current and Recent European Public Grants & Projects (1)

SPIIRAS

- Context-Based Retrieval in Digital Libraries *(The Swedish Institute, 2007-2009)*
- ILIPT - Intelligent Logistics for Innovative Product Technologies (*European Community – Research Program on Information Society Technologies, 2004-2008*).
- ***Due to this project SPIIRAS was the first (and currently the only one) Russian organization involved into EU 6th FP projects related to the business area***
- ***SPIIRAS was a leader of Knowledge Management Platform development for flexible supply network configuration***
- Knowledge Supply for Regional and Inter-Regional Networks of Small and Medium-Size Enterprises *(Swedish Foundation for International Cooperation in Research and Higher Education, 2003-2007)*

CAIS Laboratory: Current and Recent European Public Grants & Projects (2)

SPIIRAS

- IMS-NoE – Intelligent Manufacturing Systems (*European Community – Research Program on Information Society Technologies,* 2003-2005)
- ***Due to this project SPIIRAS was the first (and currently the only one) Russian organization involved into IMS Program***
- CE-Net - Concurrent Enterprising (*European Community – Research Program on Information Society Technologies,* 2001-2004)

CAIS Laboratory: Current and Recent Collaboration with Industrial Partners (1)

SPIIRAS

- **Nokia**
  - Distributed Information Management in Smart Space *(2008-2009)*
  - **SPIIRAS' Smart Meeting Room (2008-2009) – University Program**
  - **PhD Student Support for Smart Space Application Development:**

    a Case Study (2009) – University Program

- **Festo *(Germany)***
  - Ontology-Based New Order Code Generation for Corporate Product Data Management System *(2005-2008)*
  - Context-Based Intelligent Customer Surface for Software *(2006-2007)*
  - Ontology-Based Intelligent Access to Documents and Catalogues *(2003-2005)*

CAIS Laboratory: Current and Recent Collaboration with Industrial Partners (2)

SPIIRAS

- **Ford**
  - Ontology Modeling and Knowledge Integration for Supply Chain Management and Product Lifecycle Management *(Ford Research Lab & Fellow Office, Dearborn, USA, 2001-2008)*
  - External Logistics Network Configuring for Russian Assembly Plant *(Ford Motor Company – Russia, St.Petersburg, Russia, 2001-2003)*
  - Customer-Oriented Management of Vehicles Supply Chain Using Fuzzy Coalition Games *(Ford Research Center, Aachen, Germany, 1999–2000)*
  - Configuration and Optimization of Global Production Networks in Order to Improve Investment Efficiency over Total Facility Life-Time *(Ford Research Center, Aachen, Germany, for 1996-1999)*

CAIS Laboratory: Current and Recent Russian Grants & Projects (1)

SPIIRAS

- **Theoretical Bases and Intelligent Models for Management Decision Support in Flexible Networked Organizations** ***(Presidium of Russian Academy of Sciences – Research Program on Intelligent Information Technologies, Mathematical Modelling, System analysis and Automation, 2009-2011, project 213)***
- Context-Driven Methodology for Distributed Intelligent Decision Support System Development in Open Information Environment *(Presidium of Russian Academy of Sciences – Research Program on Mathematical Modelling and Intelligent System, 2006-2008, project 2.35)*
- Theoretical Foundations for Multi-Agent Context Management Technology in Open Information Environment *(Department of Nanotechnologies and Information Technologies of Russian Academy of Sciences – Research Program on Fundamental Basis of Information Technologies and Systems, 2006 – 2008, project 1.9)*

CAIS Laboratory: Current and Recent Russian Grants & Projects (2)

SPIIRAS

- **Conceptual and Scenario Models of Self-Contextualised Decision Support Systems** ***(the Russian Foundation for Basic Research, 2008-2010 - grant № 08-07-00264)***

- Methodology for Development of Multi-Agent Intelligent Systems for Distance Learning *(the Russian Foundation for Basic Research, 2007-2008 - the grant № 07-01-00334)*
- Methodology and Models of Intelligent Management of Configurations of Distributed Information Systems with Dynamic Structures *(the Russian Foundation for Basic Research, 2006-2008 - the grant № 06-07-89242)*
- Methodological and Mathematical Foundations of Context-Driven Intelligent Decision Support Systems Development *(Russian Basic Research Foundation, 2005-2007 – grant 05-01-00151)*

CAIS Laboratory: Research Collaboration History with USA DoD

SPIIRAS

- Ontology-Driven Information Integration from Heterogeneous Sources for Operational Decision Making Support *(US ONR and US AFRL, 2005-2006 – CRDF' project RUM2-1554-ST-05):*
  - *Case Study – Humanitarian Logistics.*

  Due to this project SPIIRAS was the first (and the only one) Russian organization involved into joint research of US ONR and AFRL

- Mathematical Basic of Knowledge Discovery and Autonomous Intelligent Architectures: Knowledge Fusion in the Scalable Infosphere *(US AFRL, 2000-2003 – ISTC' project 1993P):*
  - *Case Study – Mobile Hospital Configuration*

CAIS Laboratory: Innovation Management Models

SPIIRAS

- *Open Innovation* is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology.
  - [Chesbrough H., Open Business Models: How to Thrive in the New Innovation Landscape, Boston, Harvard Business Scholl Press, 2006.],
- *Democratizing Innovation* means that users of products and services – both firms and individual consumers – are increasingly able to innovate for themselves.
  - [Von Hippel E., Democratizing Innovation, Boston, MIT Press, 2006.],
- *Triple Helix Model* shows that competition leadership is achieved by those who use the partnership between government (state), business and science (academia)
  - [Etzkowitz H., L. Leydesdorff., The Dynamics of Innovation: from National Systems and “Mode 2” to a Triple Helix of University-Industry-Government Relations, In: Research Policy, 2006, 29.].

Prof. A. Smirnov: Classes (in English)

SPIIRAS

- ***2004 – Present***

  Affiliated Professor, Jönköping University (Sweden), School of Engineering

- *MS' courses - Information Logistics, 5 credits; Enterprise Modeling, 5 credits*
- *PhD course (from Nov. 2009): Enterprise Knowledge Modeling, 7,5 credits*

- ***1999 – 2000***

  Visiting Professor, University of Michigan (USA), Department of Industrial and Manufacturing Systems Engineering

- *MBA & MS' course - Management Information Systems, 5 credits*

Prof. A. Smirnov: Classes (in Russian)

SPIIRAS

- ***1995 - Present***

  Full Professor (part-time), St.Petersburg State Electrical Engineering University, Department of Research Automation

- *MS' course – Corporate Knowledge Management*

- ***1995 – 2004***

  Full Professor (part-time), St.Petersburg State Polytechnic University (SPPU), Department of Economics and Management in Machine-building

- *MS' course -.Information Technologies in Production Management*

Prof. A. Smirnov:
PhD Thesis defended (in Russian)

SPIIRAS

- PhD in Computer Science, Alexey M. Kashevnik – Context-Driven Knowledge Management for Personalized Support Communication of Enterprise Network Participants (2008)
- PhD in Computer Science, Andrew A. Krizhanovsky – Mathematical Basis and Software for Ontology Construction Based on Wiki-Sources (2008)
- PhD in Computer Science, Nikolai G. Chilov – Models for Intelligent Decision Support in Virtual Enterprise Configuration (2005)
- PhD in Computer Science, Michael. P. Pashkin – Agent-based Knowledge Logistics for Information Support of Decision Making (2005)
- PhD in Computer Science, Irina O.Rakhmanova – Group Decision Making for Quality Evaluation of Organization and Technical Solution. (2000)

Prof. A. Smirnov: Some MS Thesis defended (in Russian)

SPIIRAS

- ***MS in Computer Science – 6***
  - *Alexey M. Kashevnik – Development of User Profile Information Models and Software for Intelligent Access to Information Sources (2005)*
  - *MS in Computer Science, Anna Komarova – Development and Using of Knowledge Map for Intelligent Access to Information Sources (2005)*

- ***MS in Industrial Management & Economics - 3,***
  - *Nikolai G. Chilov – Models for Global Production Network Configuration (1998)*
  - *Kostantin V. Ivanenko – Models for Individual Tour Itinerary Creation (1998)*
  - *Nikolai V. Novikov – Models and Prolog-Based Software for Enterprise Direct-Costing (1996)*

- ***MS in Production Engineering – 1***
  - *, Pavel A. Turbuin – Models for Technological Complex Engineering (1996)*

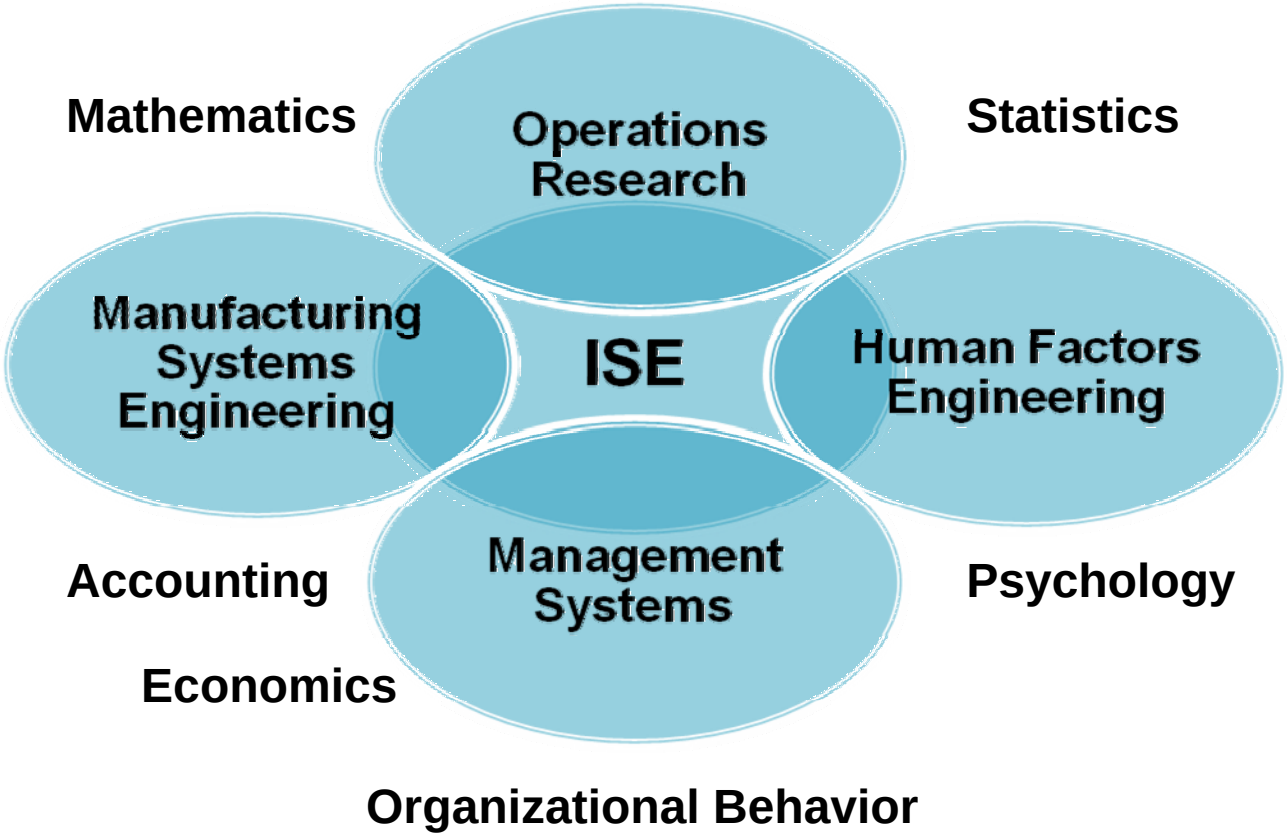
Introduction: Who is Industrial Engineer?

SPIIRAS

"An Industrial & System Engineer is one who is concerned with design, installation, and improvement of integrated **systems of people, material, information, equipment, and energy** by drawing upon specialized **knowledge and skills** in the mathematical, physical, and social sciences, together with the principles and methods of engineering analysis and design to specify, predict, and evaluate the results to be obtained from such systems"

Source: Womack J. and D. Jones, Lean Thinking. NY: Simon & Schuster, 1996

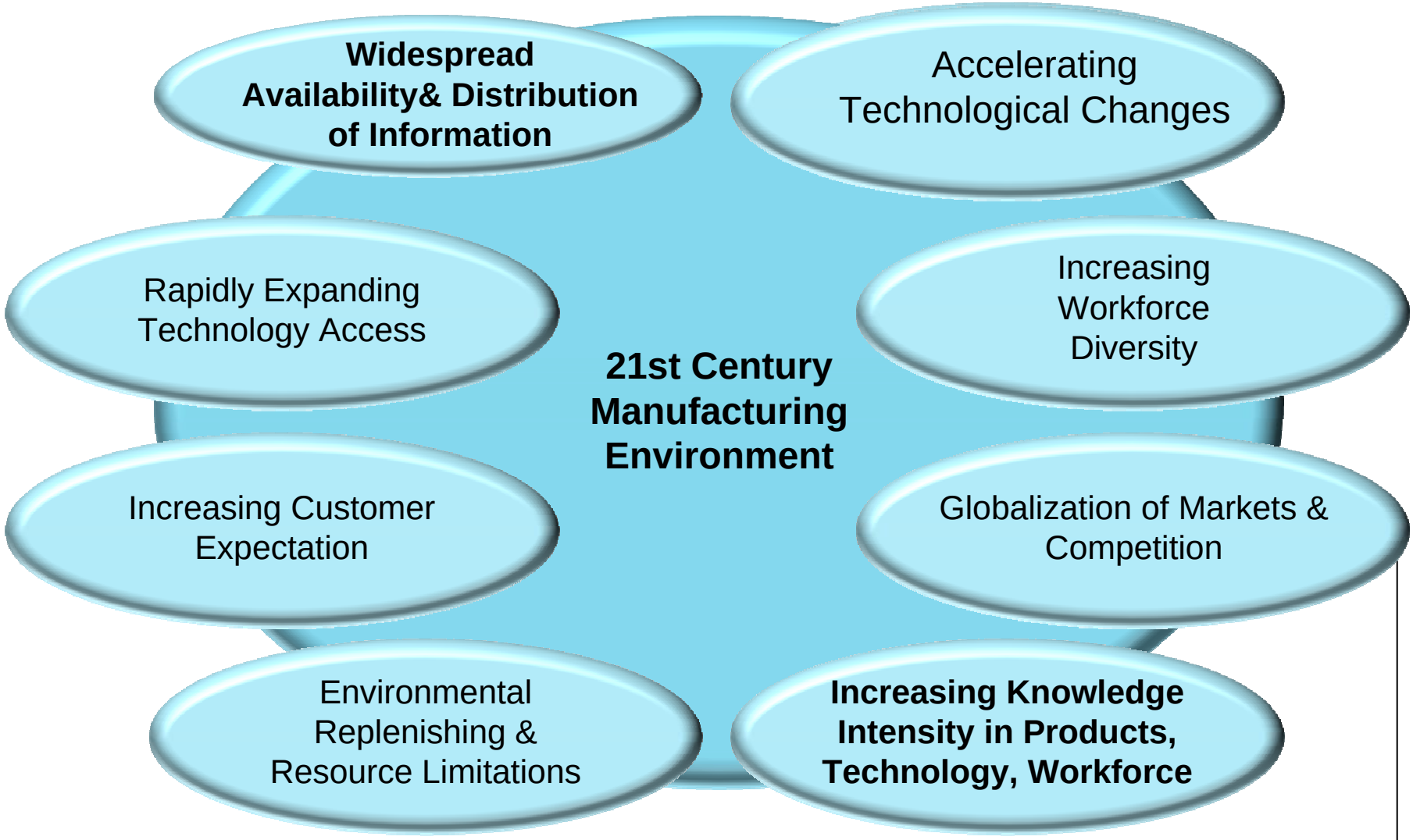
Introduction: Current Portrayal of Industrial & System Engineering



Source: Salvendy G. Handbook of Industrial Engineering: Technology and Operational Management. Wiley-IEEE, 2001. 2796 pages

Introduction: Forces Shaping the 21st Century Manufacturing Environment

SPIIRAS

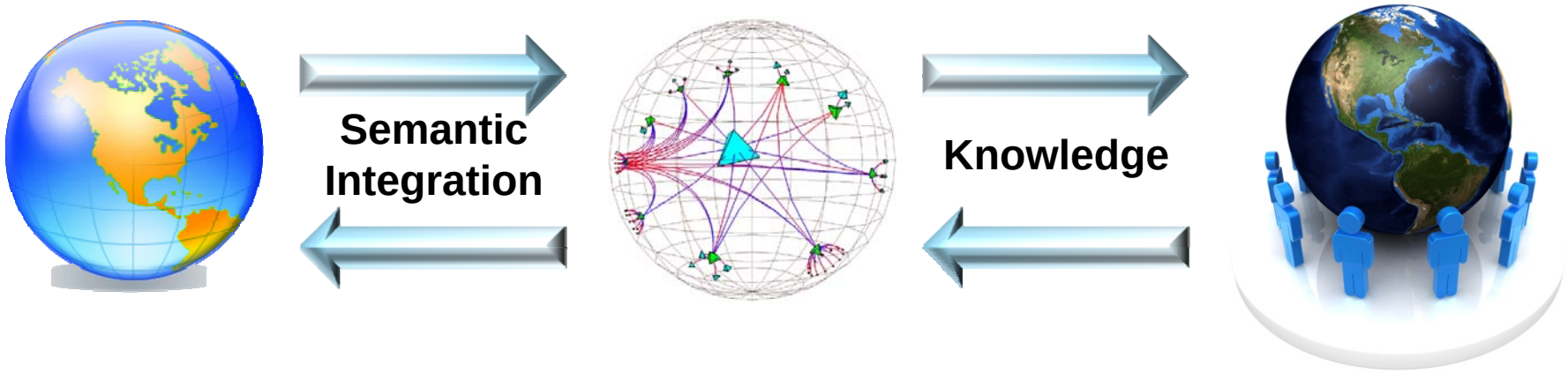


Source: Integrated Manufacturing Technology Roadmapping Project // imtr.ornl.gov

Introduction: Using Cyberspace to link Physical World Information to Communities

SPIIRAS

Physical World **Cyberspace** **Communities**



Source: Internet of Things: an early reality of the Future Internet. Workshop report. Prague, May 10, 2009

Introduction: Characteristics of Manual and Knowledge Work (by Drucker)

SPIIRAS

Manual Work	Characteristics	Knowledge Work
Materials-based	*Work Base*	***Information-based***
Overt Behaviors	*Working*	Covert Behaviors
High	*Visibility*	Low
Direct & Immediate	*Linkages to Results*	Indirect & Delayed
Concentrated	*Knowledge*	***Distributed***
Position & Politics	*Balance of Power*	Politics & Profession
Linear-Sequential	*Nature of Work*	Non-Linear-Parallel
Prefigured	*Responses*	***Configured***
Others	*Source of Standards*	Worker
Worker	*Focus of Control*	Work
Management	*Locus of control*	Worker
Compliance	*Measure of Performance*	Contribution
Instrument	*Role of the Worker*	***Agent***

Source: Nikols F. The Shift to Knowledge Work. www.nikols.us

Introduction:
Core Message

SPIIRAS

To be successful in the future we have to go

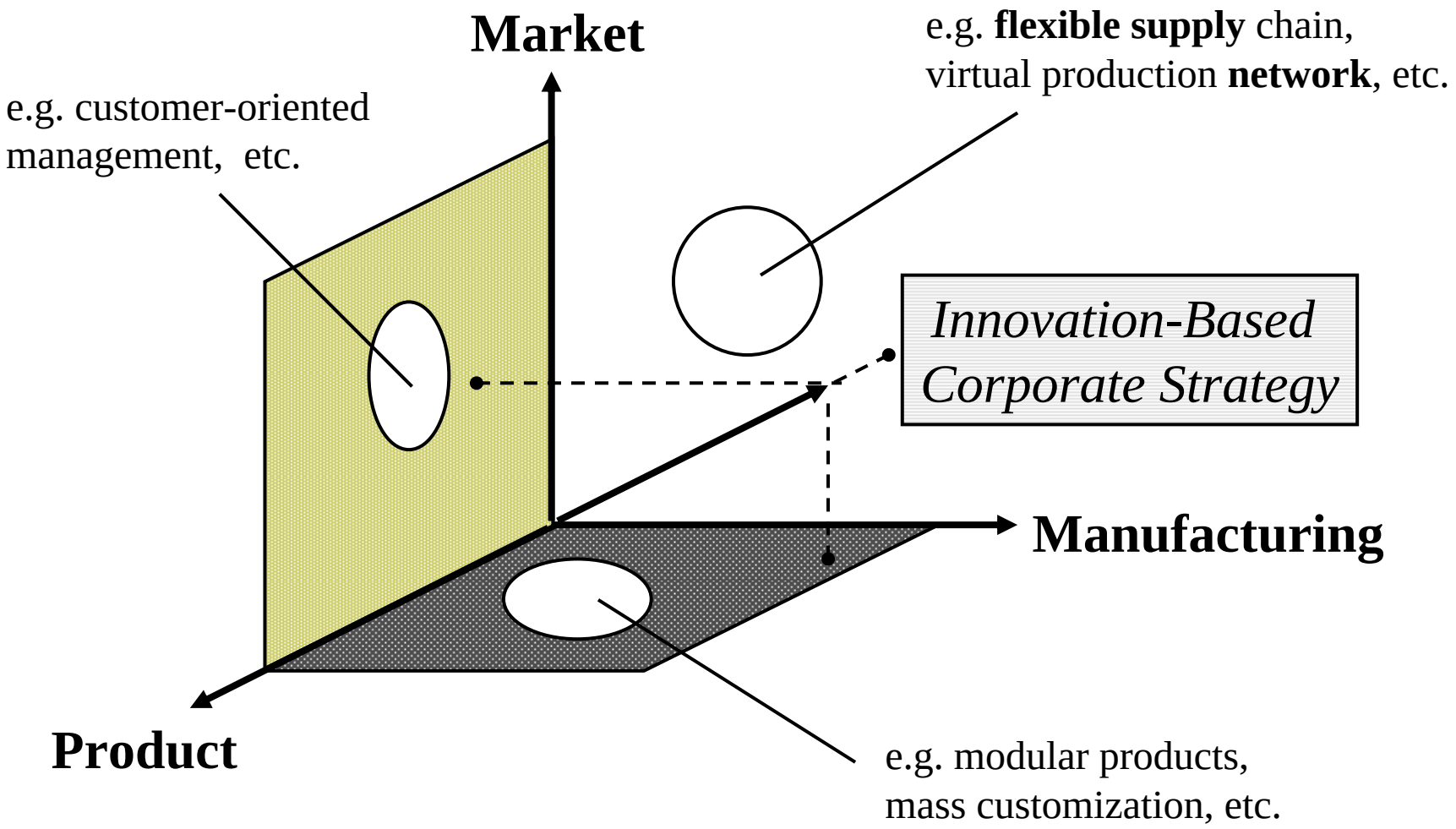
"from Basic Research

through Technology Transition

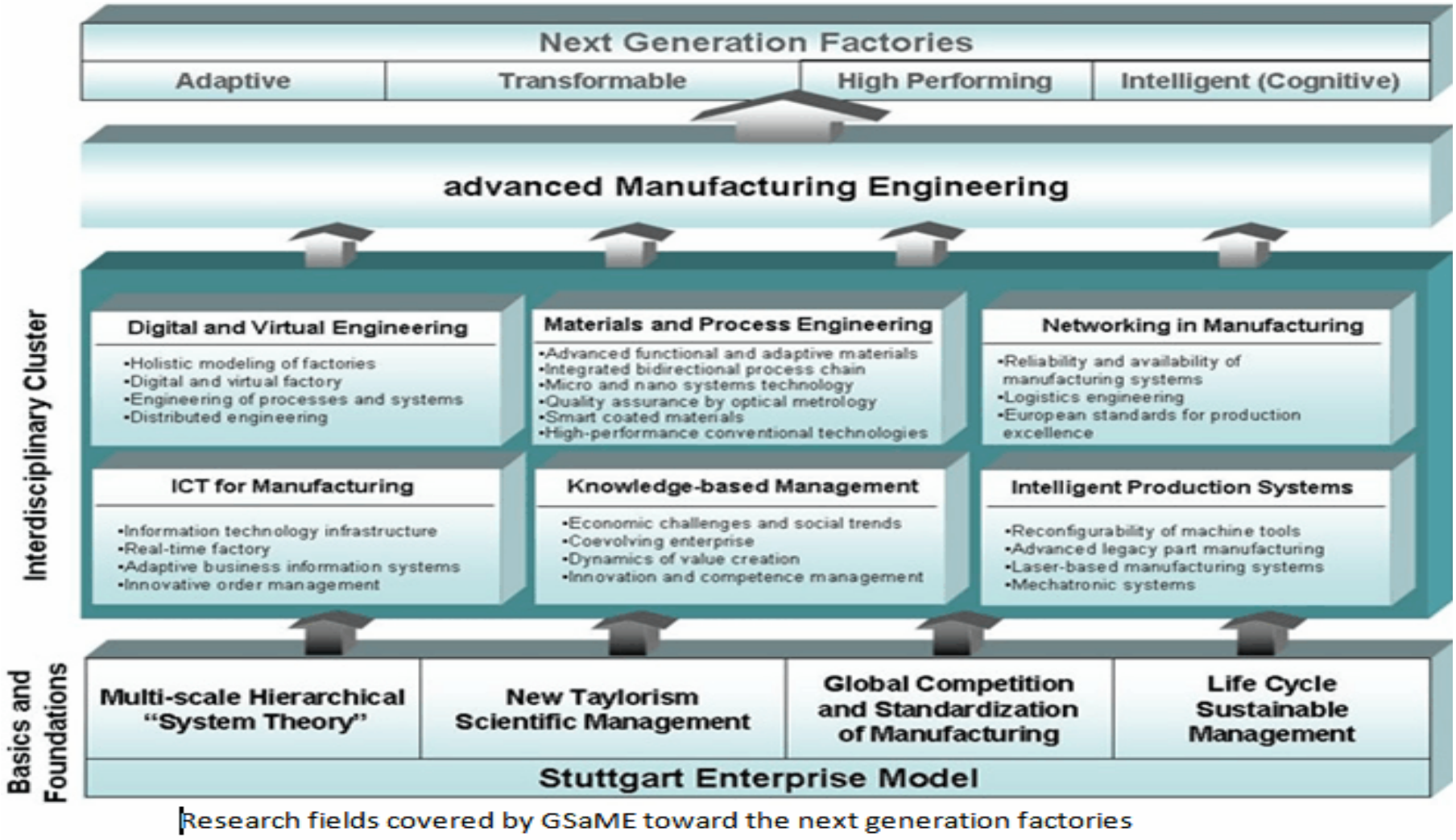
(Innovative Technologies and Organizational Concepts)

to Consumer Needs

Introduction:
Advanced Model for Competition



Introduction: Next Generation Factories



Research fields covered by GSaME toward the next generation factories

Source: the Graduate School for Advanced Manufacturing Engineering, GSaME. http://moly.gsame.eu/info/gsame

Introduction: Current Needs

SPIIRAS

- Axel Weber, Bundesbank Presedent

  (interview to FT, April 22, 2009):

  - Compared with the UK Germany was probably “too focused on industrial production”
  - Modern manufacturing was “not very labour intensive process… ***A more balanced composition between services and manufacturing is desirable***”

Introduction: Several New Industrial Engineering & Management Directions

SPIIRAS

- User-centered innovation processes offer great advantages over the manufacturer-centric innovation development systems that have been the mainstay of commerce for last years (*Open Innovation & Democratizing Innovation & Triple Helix Model*)

- Modern global companies have to build a supply chain network strategy that provides maximum flexibility and can optimally respond to changes in external costs (*Flexible Supply Chain Management*) *

- *Self-organisation* is autonomous organization of services into a service network to be accessible and retrievable

Introduction: Flexible & Self-Organizing Supply Networks and Enabling Technologies

SPIRAS

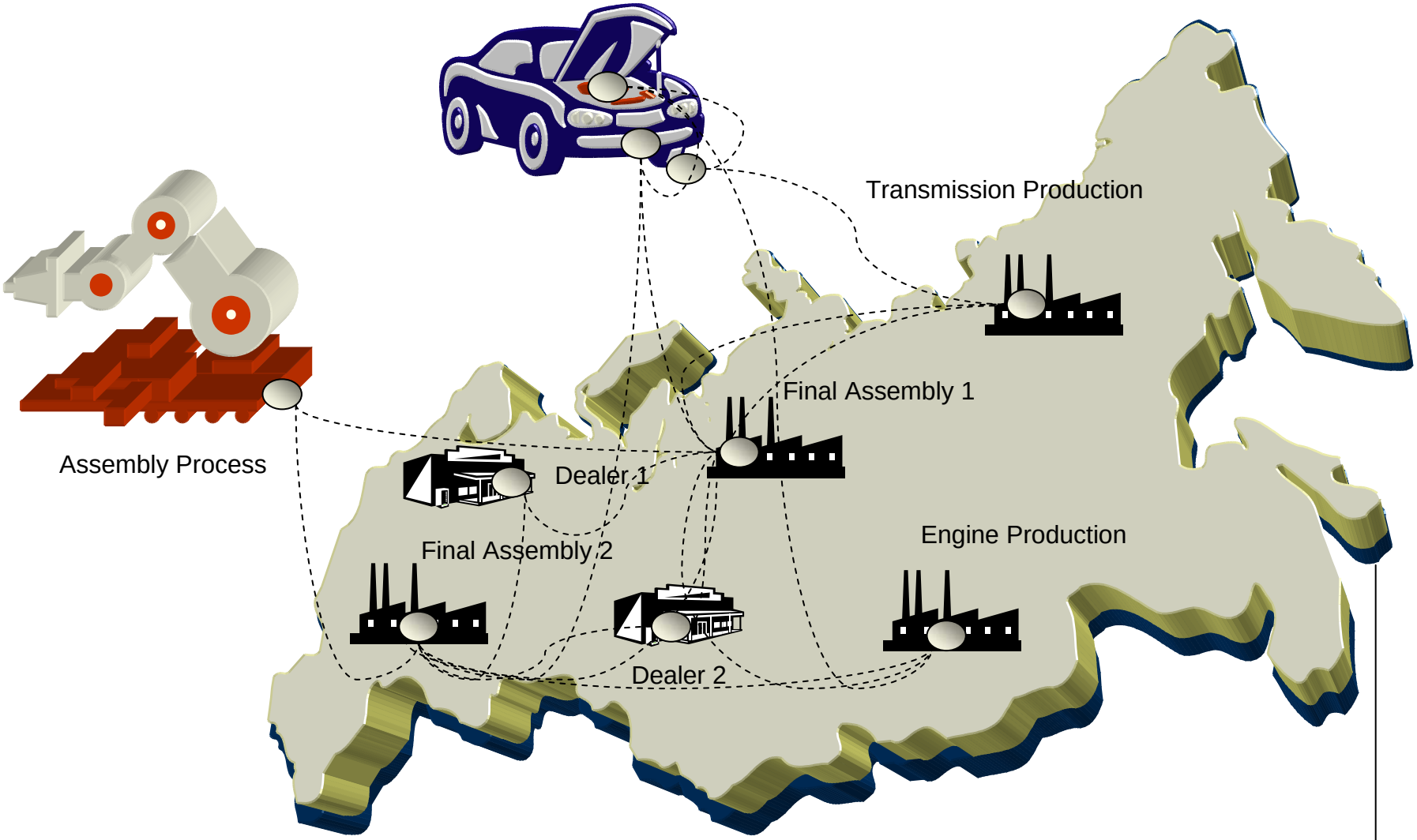
- *Flexible & Self-Organizing Supply Networks* exploit information and network technologies to integrate widely dispersed human *decision-makers*, networking *sensors*, and *resources* into a highly adaptive, comprehensive *network-centric environment* to achieve shared *situation* awareness and *unprecedented mission* effectiveness by efficient linking *knowledgeable components & services* in the business environment.
- Knowledge is critical core competency for future. *Only 20% of a firm's knowledge is effectively used by today's organizations.*
- Different consumers (decision makers) of information look at it from *different contexts (aspects)*

New Technologies in Digital Business Environment

- Sensor Networks (Data Gathering)
- RFID (Identification)
- GPS (Localisation)
- Wi-Fi & Mobile Phones (Communication)
- Portable & Embedded Devices (Data Processing)

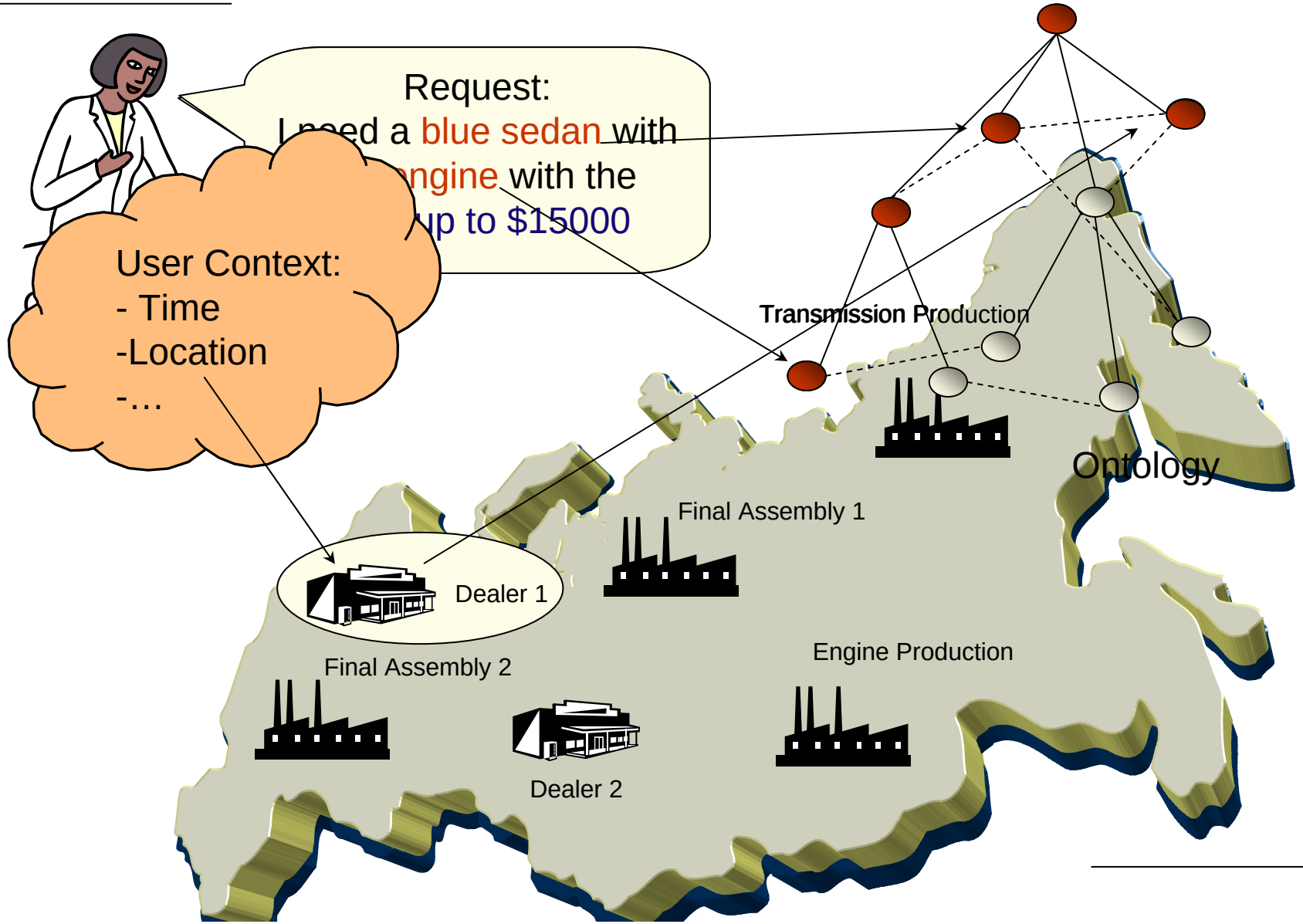
Flexible Supply Network Self-Configuration: Scenario

SPIIRAS



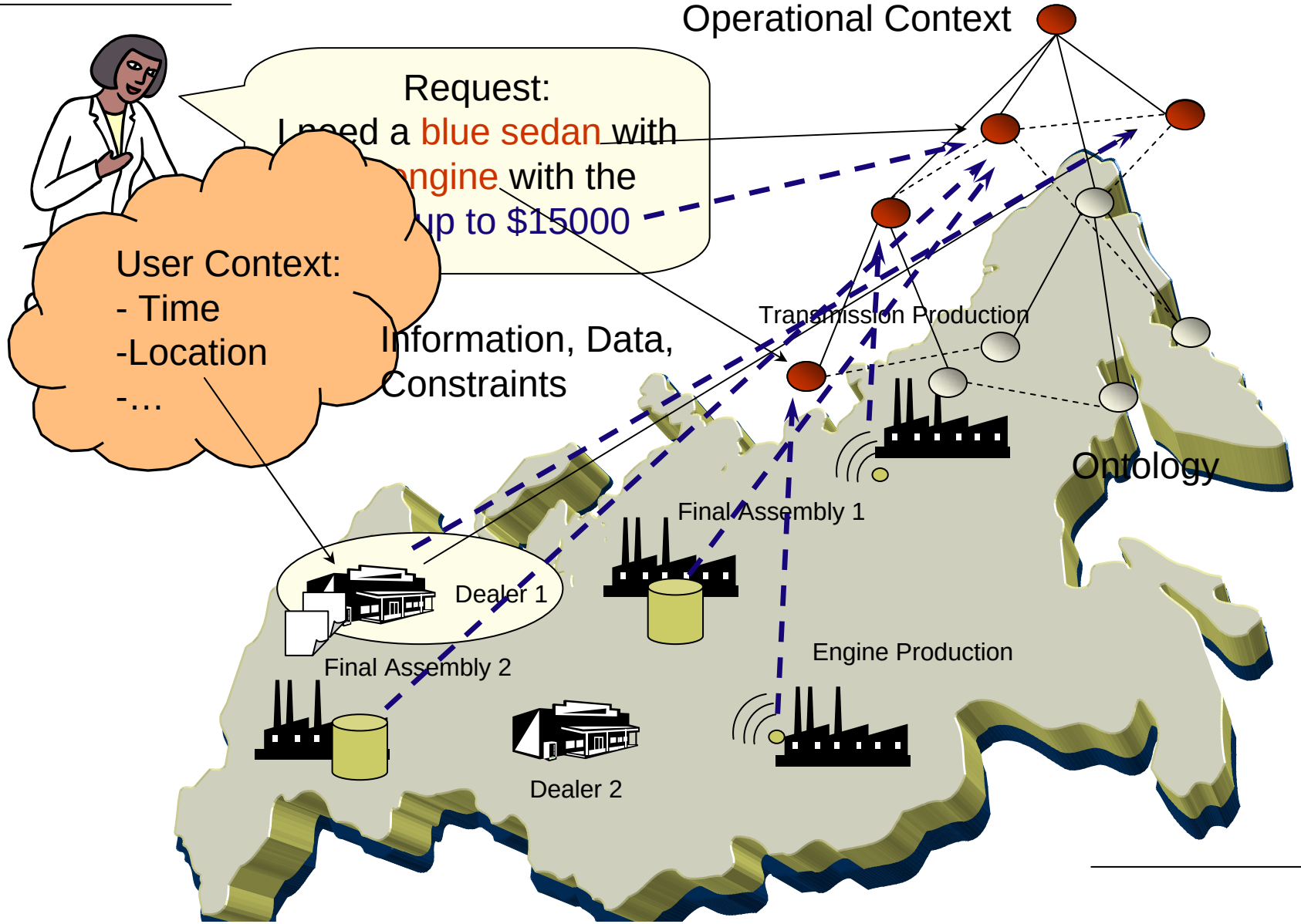
Flexible Supply Network Self-Configuration: Scenario

SPIIRAS



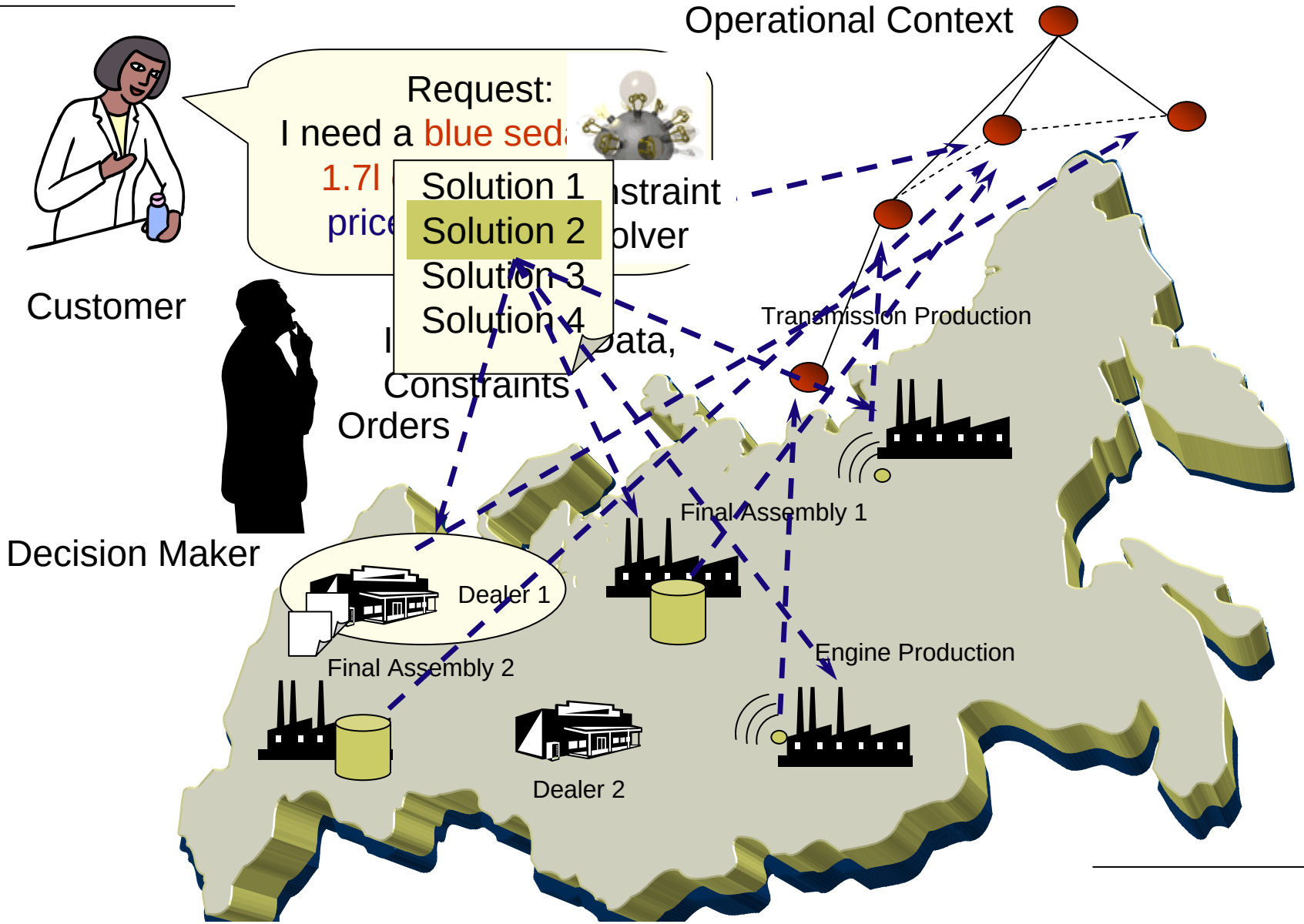
Flexible Supply Network Self-Configuration: Scenario

SPIIRAS



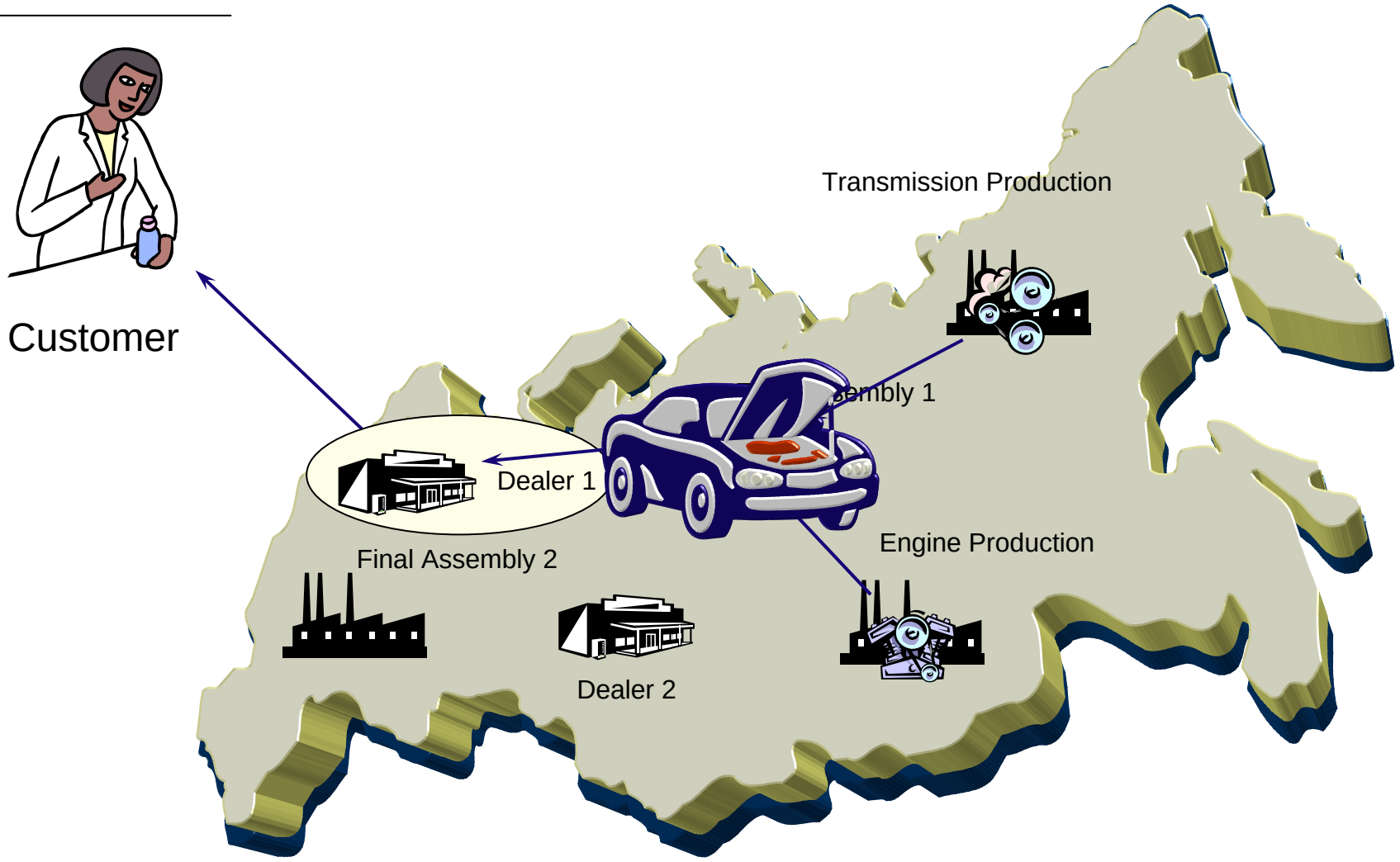
Flexible Supply Network Self-Configuration: Scenario

SPIIRAS



Flexible Supply Network Self-Configuration: Scenario

SPIIRAS



Service-Oriented Business Network: Supply Networks and Knowledge Logistics

SPIIRAS

- Distribution Channel (Supply Network):
  - A Channel describes how a company gets in touch with its customers. Its purpose is to make the *right quantities* of the *right* ***products*** *or* ***services*** available at the *right place*, at the *right time* to the *right people* (Pitt *et.al*., 1999)

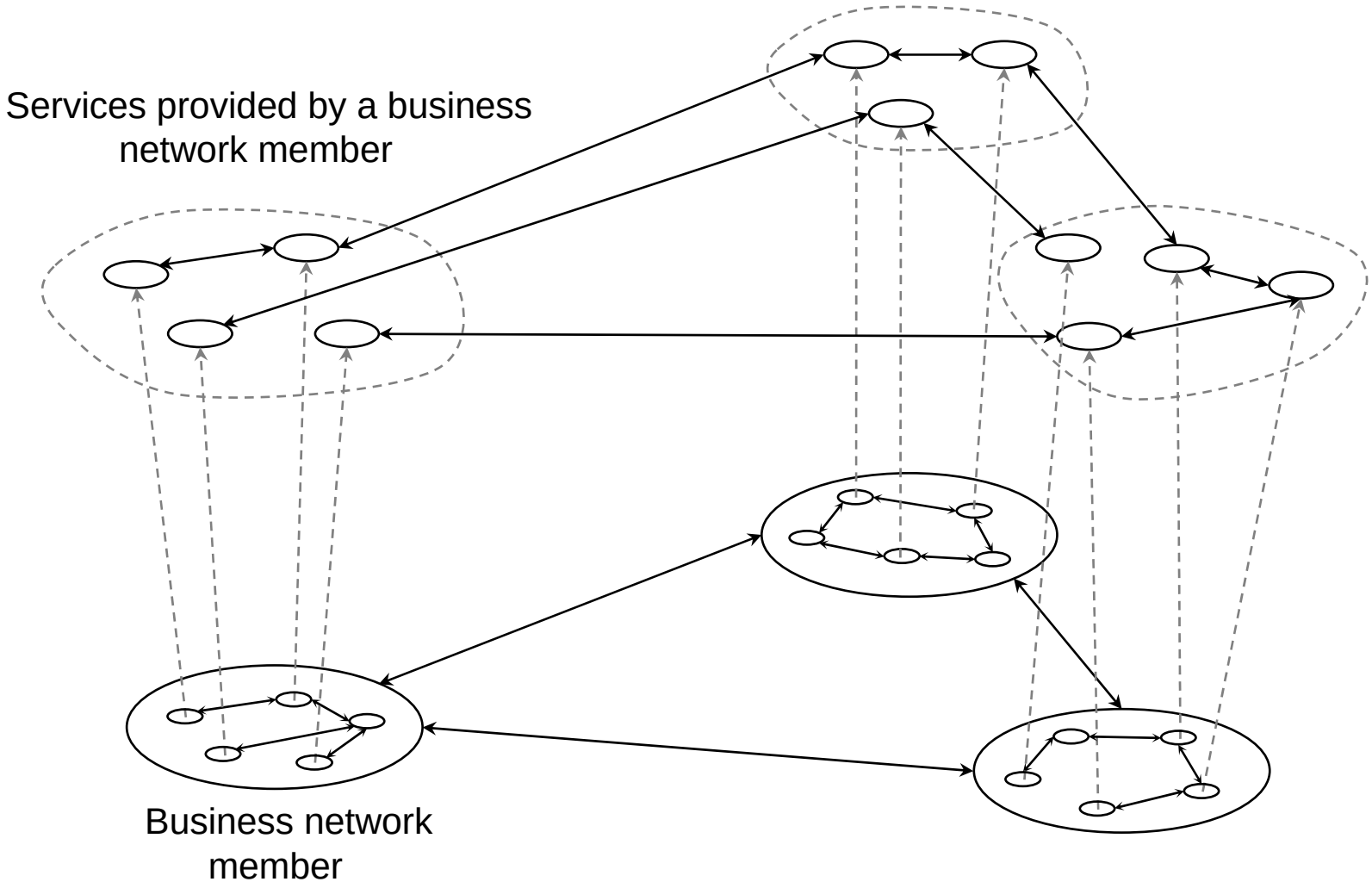
- **Knowledge Logistics** Aim:
  - Acquisition, integration, and transfer of the *right knowledge* from *right sources* in the *right* ***context*** to the *right person* in the *right time* for the *right purpose* *(Smirnov et al., 2003)*

Resource:

- Pitt. L., Berthon P., and J.-P. Berthon (1999). Changing Channels: The Impact of the Internet on Distribution Strategy. Business Horizons, March-April.
- Smirnov A., Pashkin M., Chilov N., Levashova T. Haritatos F. (2003) Knowledge Source Network Configuration Approach to Knowledge Logistics. International Journal of General Systems, 2003, 32 (3), pp. 251—269.

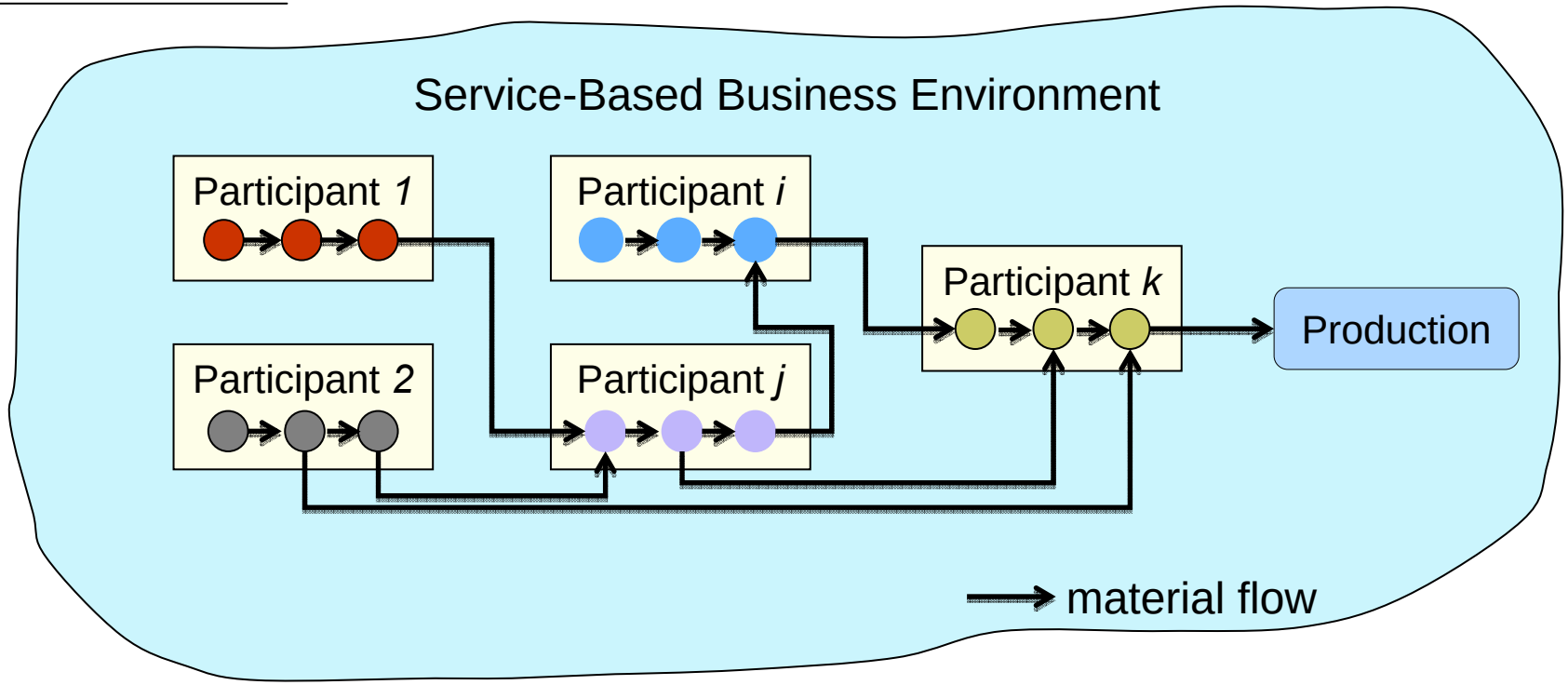
Service-Oriented Business Network: Services of Members

SPIIRAS



Service-Oriented Business Network: Reference Model and Information Technologies

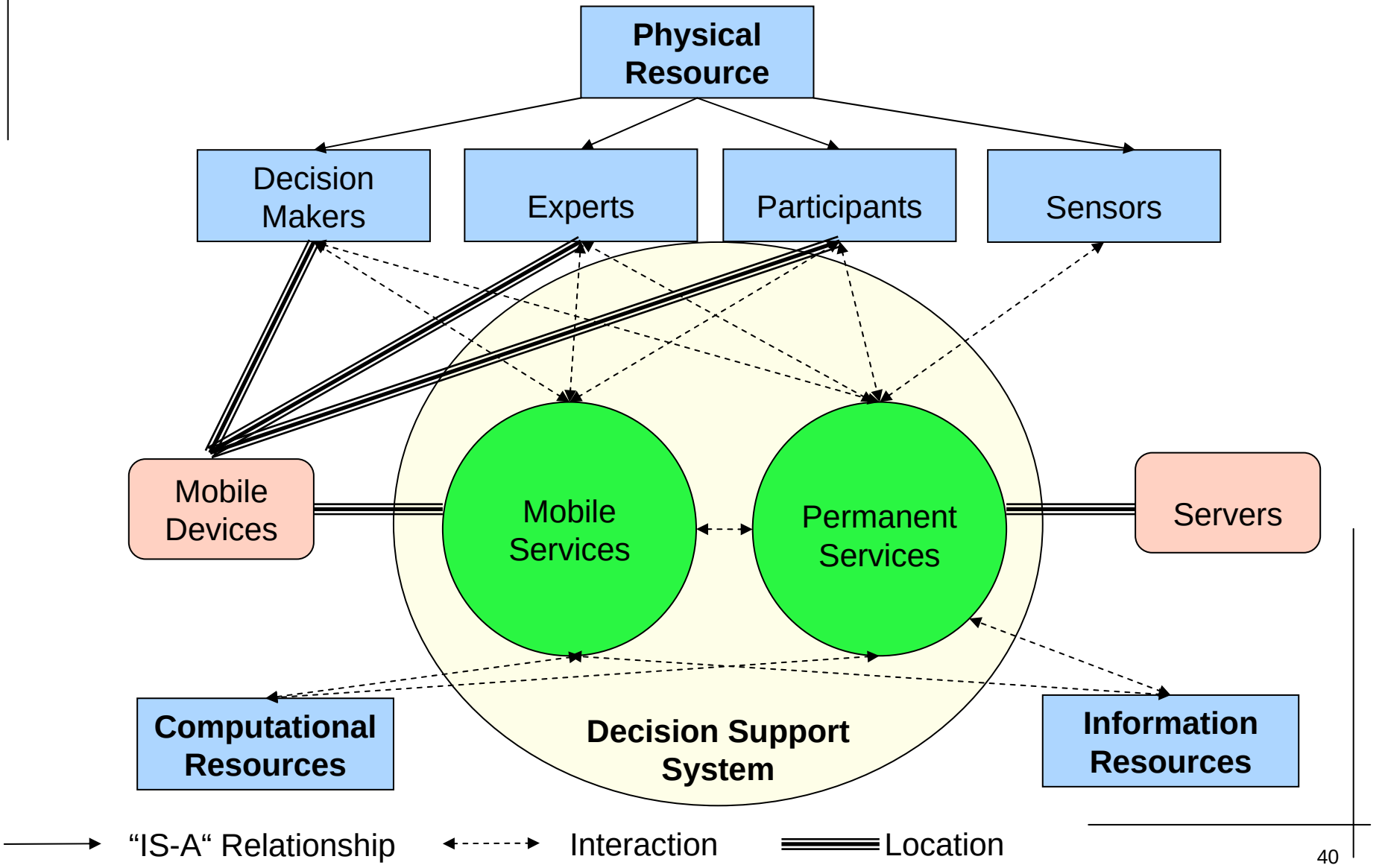
SPIIRAS



- Social networks: Who knows whom? => *Virtual Communities*
- Knowledge networks: Who knows what? =>*Human & Knowledge Management*
- Information networks: Who informs what? => *Semantic-Driven Interoperability*
- Work networks: Who works where? => ***Services Network Self-Organization***
- Competency networks: What is where? => *Competence Management & Profiles*

Service-Oriented Business Network: Resources and Services

SPIIRAS

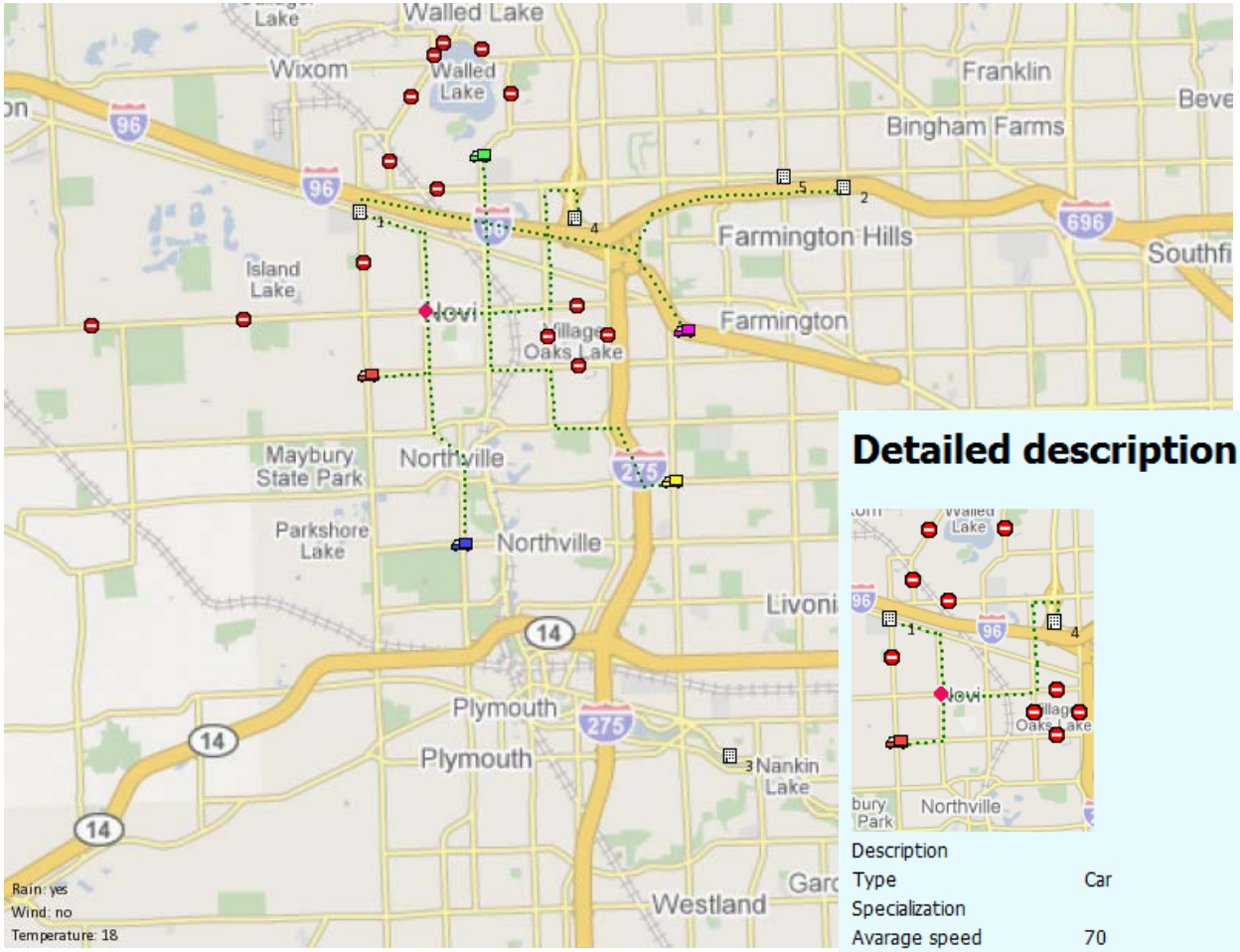


Service-Oriented Business Network: Lifecycle Phases of Self-Configuring Network

SPIIRAS

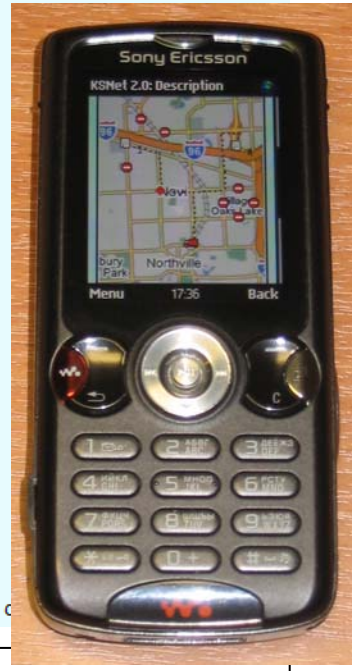
Lifecycle phase	Tasks
Community creation (once, however companies can join and leave on a continuous basis in the created network)	Application Ontology Information resource representation
Network configuration (continuous, initiated by orders)	Solution search
Integration	Knowledge acquisition and organization
Operation	Information acquisition and organization

Service-Oriented Business Network: Example of the Solution Presented to Logistics Manager



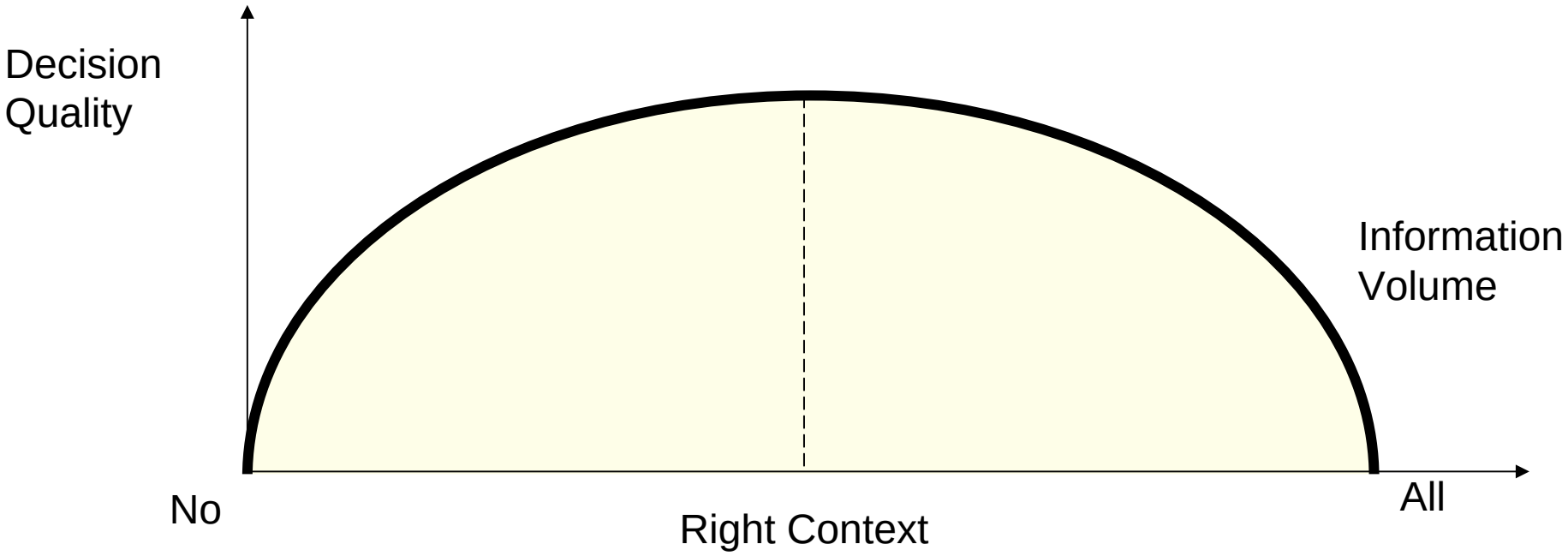
Detailed description of truck

Description	
Type	Car
Specialization	
Avarage speed	70
Cost	1500
Staff	2
Capacity	1
Path	location -> central depot -> warehouse 1 -> c



Context-Driven Knowledge Management: Motivation

SPIIRAS



Theorem 1: 50% of the problems in the world result from *people using the same words with different meanings.*

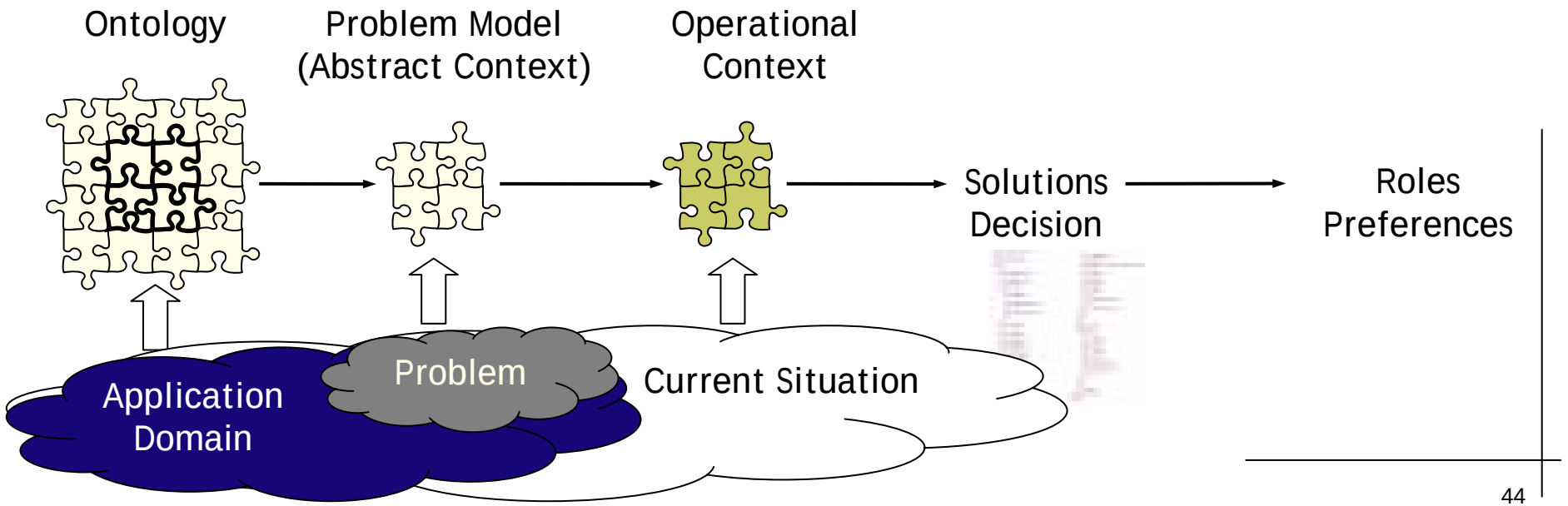
Theorem 2: the other 50% of the problems results from *people using different words with the same meaning.*

Source: Kaplan S. The Words of Risk Analysis, *Risk Analysis*, Vol.17, N 4, August 1997

Context-Driven Knowledge Management: Levels of Integration

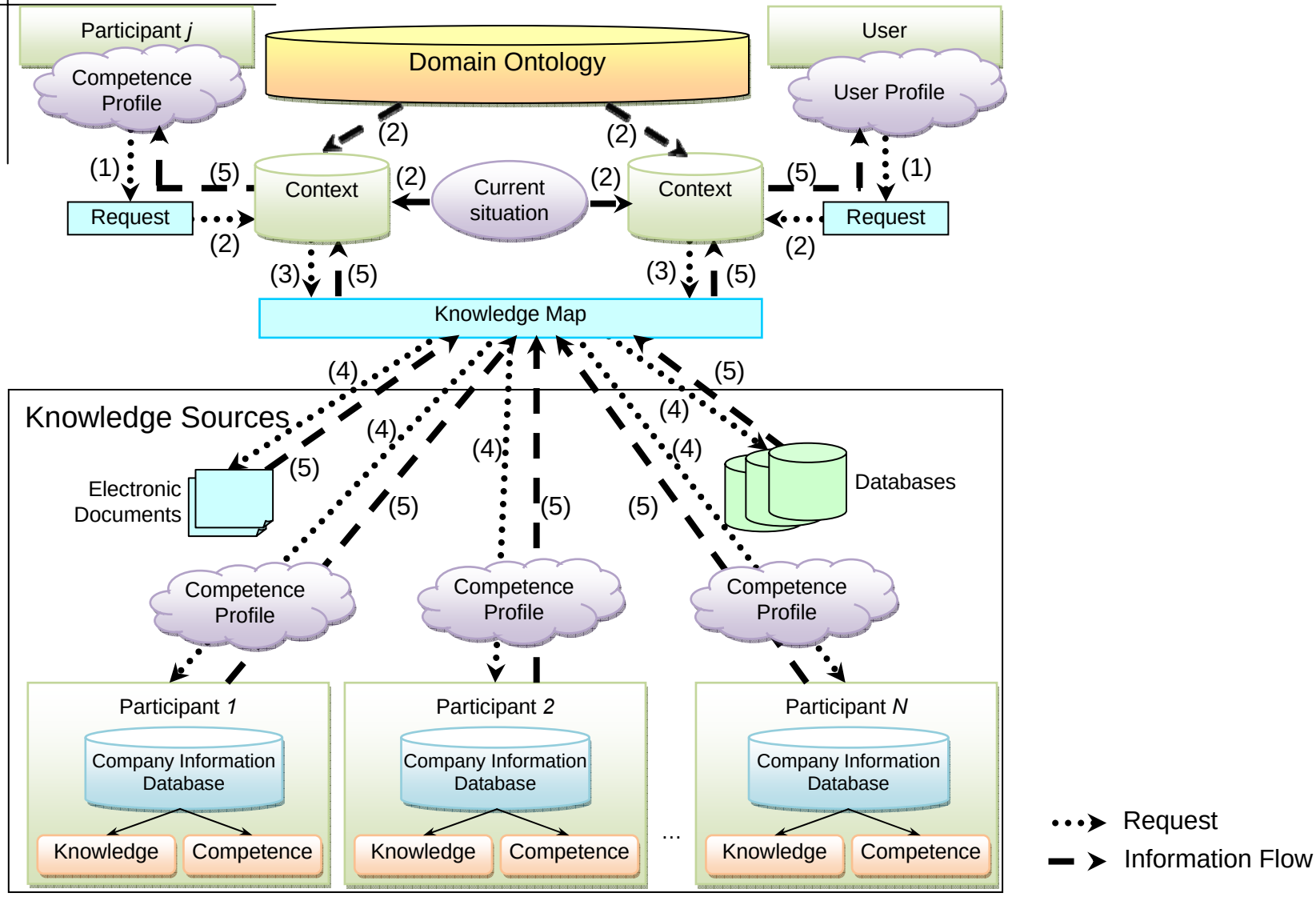
SPIIRAS

- Domain level
  - Integration of heterogeneous knowledge describing the domain knowledge
- Task level
  - Integration and formalization of tasks and problem-solving methods
- Context level
  - Integration of information and knowledge relevant to the problem or situation
- Decision level
  - Comparison of decisions and solutions by roles



Context-Driven Knowledge Management: Platform Architecture

SPIIRAS



Conclusion

SPIIRAS

- In the future an **Industrial Engineer** would be a **Knowledge Worker** with high competence in the new areas:
  - Innovation Management,
  - Service-Oriented Business Network Engineering & Management,
  - Semantic Technologies (Knowledge Management, Enterprise Knowledge Modeling, Ontology Management…)
  - etc.

Thank you!

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