Possible Collaborative ‘Domain’ Projects:

Japanese Private and/or Public Institutions
+ JAIST School of Information Science’s
Domain Engineering and Digital Rights Group: DEDR

- JAIST/DEDR has some interesting things to offer.
- It is in the <u>DOMAIN ENGINEERING</u> area of software engineering:
  - the orderly,
  - manageable, and
  - believable

  development of

  - trustworthy,
  - dependable
  - software

  — on time, at cost — the right software:

  - verifiably correct and
  - and customer-validated.
- The attached document outline some ideas on
  - possible joint collaboration
  - centered around the first phase of a triptych of software engineering
    * <u>DOMAIN ENGINEERING</u>,
    * requirements engineering and
    * software design;
  - and based on using formal approaches
    * that allow careful interactive analysis
    * validation
    * and verification

  of designs.
- There is another JAIST/DEDR supporting document:
  - On Domains and Domain Engineering

    Prerequisites for Trustworthy Software

    A Necessity for Believable Project Management

  It provides substantial evidence.

The DEDR Group @ JAIST
DEDR: Domain Engineering and Digital Rights
JAPAN ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY 1990

Version 3: March 7, 2006

Possible Collaborative 'Domain' Projects: Japanese Private and/or Public Institutions + JAIST/DEDR*

The Domain Engineering and Digital Rights Group
Graduate School of Information Science
Japan Advanced Inststitute of Science and Technology
1-1, Asahidai, Tatsunokuchi
Nomi, Ishikawa, Japan 923-1292

bjorner@gmail.com

April 28, 2006

Abstract

In this note we suggest a number of alternative, collaborative projects within the broader research and engineering area of domain theory and domain engineering.

The common denominators are: The collaborators (i.e., partners), including the proposing JAIST/DEDR Group, each have their own vested interest in one or another facet of the proposed joint topic of R&D; the goal of the project can thus be defined both as the sum of the goals of each partner as well as the sum-total of their working together: namely an increased, mutually beneficial awareness of engineering by academia, and an increased awareness of academic research approaches and results by industry.

Expected outcome of the joint R&D are: (i) Sizable precise descriptions (in English and Japanese) of selected (i.e., chosen) domains, their formalisation and analysis; (ii) example software package or sub-system development for selected applications and related to the chosen domain descriptions; (iii) and increased awareness in the Japanese IT community of the benefits of strict domain engineering, related requirements engineering and trustworthy software.

The DEDR Group @ JAIST
DEDR: Domain Engineering and Digital Rights

*The JAIST School of Information Sciences's Domain Engineering and Digital Rights Group

Contents

1 Background

The background for this proposal is the emergence of a new technically sound and scientifically fascinating approach to software development: From domain models via requirements to software design. This approach is illustrated especially by Vol. 3 [3] in the series:

1. *Software Engineering, Vol. 1: Abstraction and Modelling.* Texts in Theoretical Computer Science, the EATCS Series. Springer, 2006.
2. *Software Engineering, Vol. 2: Specification of Systems and Languages.* Texts in Theoretical Computer Science, the EATCS Series. Springer, 2006.
3. *Software Engineering, Vol. 3: Domains, Requirements and Software Design.* Texts in Theoretical Computer Science, the EATCS Series. Springer, 2006.

We also refer to a document:

4. *Domains and Domain Engineering. Prerequisites for Trustworthy Software. A Necessity for Believable Project Management.* JAIST/DEDR Document, March, 2006

We assume that the reader has access to at least the latter document:

- *Domains and Domain Engineering ...*[1]

The books can be provided by Maruzen (`http://www.maruzen.co.jp/home/`).

2 Prior Evidence

Needless to say, we would not put forward this document unless we represent some strong previous and successful projects of the kind mentioned in the next section. Our reference list includes:

2.1 Ministry of Finance, Vietnam

2.1.1 MoFIT/UNU-IIST

Over a three year period in the mid-1990s UNU-IIST, the UN University's International Institute for Software Technology, www.iist.unu.edu, collaborated with the Vietnamese Ministry of Finance on domain engineering, requirements capturing and suggesting a computing system architecture for the problem described in the next section. That problem is formulated generically.

2.1.2 General

A ministry of finances perception of the nation in which it serves is that it is hierarchically organised: the state (s), the (non overlapping) provinces (p_i), the (non overlapping) districts (within provinces, d_{i_j}), and the (non overlapping) communes (cities, townships, villages, etc., $c_{i_{j_k}}$) within provinces — such that all provinces "make up" the state ($\{p_1, p_2, \ldots, p_i, \ldots, p_p\} =$

[1] http://www.ldl.jaist.ac.jp/dedr/domain.ps

s), all districts of a province "make up" that province ($\{d_{i_1}, d_{i_2}, \ldots, d_{i_\iota}, \ldots, d_{i_d}\} = p_i$), and all communes of a district "make up" the district ($\{c_{i_{\iota_1}}, c_{i_{\iota_2}}, \ldots, c_{i_{\iota_i}}, \ldots, c_{i_{\iota_c}}\} = d_{i_\iota}$).

Now the main functions of a ministry of finance wrt. the taxation and budget departments and the treasury are as follows:

- Annually an order is issued — by the ministry of finance taxation department — whereby the corresponding taxation departments of each province (of the state), each district within each province (of the state), and each commune within each district (etc., etc.) are to assemble, gather, obtain, by census or otherwise, statistical data, that is "the assessment data". These data represent "best guesses" of the basis for tax revenue (such as personal income, sales (for sales tax purposes), fees (for services rendered by province, district or commune authorities), etc.). From the communes this kind of data is communicated (perhaps in simplified, summary form) to the district of that commune, and likewise from district to province, and to state. These communications must take place before certain dates ($D_{a_{c\to d}}, D_{a_{d\to p}}, D_{a_{p\to s}}$).
- More or less simultaneously an order is issued — by the budget department of the ministry of finance — whereby each ministry (m_μ, incl. the ministry of finance, m_f) is to set up a budget, B_{m_μ}, for next year's activities (i.e., expenditures) E_{m_μ}. The ministry of finance sets an initial ceiling I_{m_μ} (of so many millions of, say, dollars) for respective ministries' expected incomes. The various ministries contribute their (possibly negotiated) budgets for next year to the ministry of finance by a certain date $D_{\to m}$. A twist to this budgeting process may occur if the ministry of finance judges, well before $D_{\to m}$, but after $D_{a_{p\to s}}$, that the assessment data warrants either a downward (pessimistic), or an upward (optimistic), adjustment of the income I_{m_μ}. The submitted budget B_{m_μ} must balance within the possibly adjusted set income ceiling I_{m_μ}. The various ministries also have "shadow" budget departments in each province, district and commune.
- The parliament then negotiates and eventually, in time for the next year, passes the national budget, B_s, as assembled from all ministries' individual budgets B_{m_μ}.
- The budget B_s is subdivided into province, district and commune expenditures.
- Finally, the next fiscal year arrives, and the ministry of finance taxation department requests the taxation departments (of provinces, districts and communes) to regularly gather all relevant taxes and regularly send appropriate proportions of these taxes to the corresponding commune, district, province and state treasuries. Thus some proportion of a commune tax revenue goes to that commune's treasury, and the rest to the district treasury. As districts, independently of communes, also gather taxes, their income derives from these taxes and from the communes, and its outlay goes locally, to the district treasury and the treasury of its province, and so on.

2.1.3 References

- Do Tien Dung, Le Linh Chi, Nguyen Le Thu, Phung Phuong Nam, Tran Mai Lien, and Chris George. *Developing a Financial Information System.* Technical Report 81, UNU-IIST, P.O.Box 3058, Macau, September 1996.
`http://www.iist.unu.edu/newrh/III/1/docs/techreports/report81.pdf`

Abstract: This document describes the work done in the UNU/IIST MoFIT project during the period April–September 1996 by five Fellows from Vietnam (four from the Ministry of Finance, one from the Institute of Information Technology). The eventual aim of the project is to describe a complete financial information system. The first part of the project concentrated on the taxation system, the Vietnamese Government's main revenue collecting system. It includes a domain analysis in two parts, an informal narrative and a formal model; a prototype of part of that system developed from the formal specification and used to test it; a description of the security aspects of the system; an extension of the formal model describing the security aspects; and a description of taxation policies, particularly those likely to change in the immediate future. The formal components are written in the RAISE specification language, RSL using the RAISE development method.

- Do Tien Dung, Chris George, Hoang Xuan Huan, and Phung Phuong Nam. *A Financial Information System.* Technical Report 115, UNU-IIST, P.O.Box 3058, Macau, July 1997. `http://www.iist.unu.edu/newrh/III/1/docs/techreports/report115.pdf`[2]
Abstract: In this document we continue the work started in "Developing a Financial Information System", UNU/IIST Research Report 81. That document concentrated on the taxation system and on its detailed development. Here we take a broader view, sketching the taxation system and also the budget, treasury and external aid and loan systems. Then we show how these may all be combined, allowing not only "vertical" communication within each system but also "horizontal" communication between components of different systems. We thus provide a top-level specification of a national financial information system.

2.2 Railway Computing Systems, China

With the Chinese Ministry of Railways UNU-IIST, over a four year period, 1993–1996, carried out a domain–requirements–software design study for a train running map system for the ZhengZhou–WuHan north–south artery. A train running map is a two dimensional diagram. Horizontal lines designate train stations. The horizontal, say the t, dimension denote time. The vertical dimension denote lines between stations such that if two adjacent horizontal lines designate stations s_i and s_j, then the space between these horizontal lines denotes the rail line(s) between s_i and s_j. Let us assume s_i above s_j. A train traveling from s_i and s_j is now denoted by a specific slanting, i.e., a diagonal line, "the train", proceeding from "north–west" to "south-east". ' 'The train" traveling from s_j and s_i is therefore denoted by a specific slanting, i.e., a diagonal line proceeding from "south-west" to "north-east". Steeper slants denote faster trains. Usually a running map depicts many trains. In the period t_0 (leftmost edge) to t_N there might typically be 30-40 trains in either direction. The map is "crowded". A delayed train shows up skewed, with a slower gradient than its scheduled diagonal. Rescheduling a train means to both move the scheduled diagonal to the right and to change its gradient. When moving "the train" its gradient may cross other train gradients on the line — which may not be feasible if it is a single line. Hence a running map system is a rescheduling system for quickly moving "trains" around subject to rules & regulations.

[2]Partly published in *Requirements Targeting Software and Systems Engineering*, LNCS 1526, Springer-Verlag, 1998.

2.3 Radio Communications, The Philippines

With the Philippine government's Advanced Science and Technology Institute (ASTI), UNU-IIST carried out a joint R&D project on a radio communications based telephone system 1994–1996. It was subsequently completed by ASTI in Manila.

Simplifying — but see the reference below — the system was built up around a central radio station and a number of (40) local, inexpensive radio stations (placed in the vast island country of The Philippines). Think of the 1+40 stations organised as a simple one level tree, the root is the central station, the immediate subtree leaves are the 40 local stations. Order these 1–40. Number the root 0. Now communication is like a conveyour belt that winds its way from the root to the first station and back, then from the root to the second station, and back, and so on, from the root to the 40th station and back, and then all over again: $0 - 1 - 0 - 2 - 0 - 3 - 0 \cdots\ 0 - 39 - 0 - 40 - 0 - 1 - 0 - 2 - 0 \cdots$. Telephone calls are now digitally time multiplexed so that a call from any subscriber (attached to some station i (0..40)) to some other subscribed (attached to some station j (0..40)) is chopped into "zillions" of small packages and placed on the conveyour belt suitably marked with sender and receiver information. The project was then to specify this domain: the equipment, the arrangement of telephone messages, their dial up and connection, etc., and then to establish requirements to a dependable software control systems and its design.

- Roderick Durmiendo and Chris George. *Formal Development of a Digital Mutiplexed Radio-Telephone System*. Research Report 67, UNU-IIST, P.O.Box 3058, Macau, Feb 1996. `http://www.iist.unu.edu/newrh/III/1/docs/techreports/report67.ps.gz`
  Abstract: This paper presents a formal development of a Radio Telephone System by a sequence of correctness-preserving refinements. We follow several steps of refinement from an abstract applicative specification which is validated against the properties and behavior of a basic telephone service, to a specification involving a central station and a number of remote stations communicating synchronously by means of radio channels. Particular features of the development are the decomposition of the basic telephone service into separate layers for the phones and the communication network, and the introduction of finite communication resources. We verify that the decompositions preserve correctness and that the resources are allocated and released correctly. The work was carried out with the RAISE specification language and its associated method, using the RAISE tools.

3 Possible Project Topics

As can also be gleaned from [4] we suggest joint R&D projects around domains, requirements and advanced software for either one or more of the following areas, with one or more selected areas giving rise typically one collaborative project:

3.1 Administrative Forms Processing

Public and private institutions, enterprises, businesses, industries, are becoming increasingly dependent on semi-automated document handling systems. These systems have grown piecemeal, from simple document text processing to "office" products, etc. Many issues of generality, of safe and secure transfer of documents, etc., are given short shrift[3]. It is about time to reconsider the issues from basic principles.

Topics: Documents of all kinds and forms dominate the public and private administration. Templates serve as the basis for filling in applications, surveys, questionnaires, invoices, budgets, accounts, and other forms of simple documents. Meta-templates serve to aggregate simple documents into aggregate documents (transacted invoices into accounts, merging accounts and budgets into audits, etc.). Document handling further involves such issues as who maintains (keeps) masters, who is allowed to edit and copy documents, documents only being accessible to properly authorised persons. Documents may also belong to the so-called digital rights domain: video clips, photos, music, movies, books, etc.

Of interest to: Public and private administrators and administrations, hospitals, banks, insurance companies, taxes and excise departments of the ministry of finance, etc., etc., and the providers of IT services, equipment and software for this infrastructure segment of society.

Goals: There are several concurrent goals: (i) To develop a common theory of documents, a theory manifested in the form of well-written narrative descriptions in Japanese (and English) as well as formalised in for example CafeOBJ. (ii) To develop portable software modules that handle one or another kind of document handling facet (creation, editing, copying, distribution, shredding) and also protection (copyrights (digital rights management), access authorisation (security), and secure availability). (iii) Possible industry standardisation proposals. (iv) New electronic (incl. mechatronics) "gadgets" for document handling.

We refer to:

4. *Domains and Domain Engineering ... Appendix E*[4]. JAIST/DEDR Document, March, 2006

and to:

5. Dines Bjørner, Kazuhiro Ogata, et al.: *Towards a Theory of Documents*[5]. JAIST/DEDR Document, March, 2006
6. Y. Arimoto, D. Bjørner, X. Chen, J. Xiang: *Alternative Models of Gunter/Weeks/wright's "Models and Languages for Digital Rights"*[6]. JAIST/DEDR Document, March, 2006

[3]Merriam-Webster defines 'short shrift' by: barely adequate time for confession before execution, little or no attention or consideration, quick work – usually used in the phrase make short shrift of

[4]http://www.ldl.jaist.ac.jp/dedr/domain.ps

[5]http://www.ldl.jaist.ac.jp/dedr/documents.ps

[6]http://www.ldl.jaist.ac.jp/dedr/digitalrights.ps

3.2 Air Traffic

Aircrafts cruise the air lanes. Air traffic becomes increasingly denser. Air traffic control becomes increasingly more serious.

Topics: We propose to domain model the aircraft airspace of airports, air lanes, and air traffic control centers (terminal towers, approach towers, regional and continental control centers) — i.e., of their entities, functions, events and behaviours. Included in this modelling is also the modelling of the supporting technologies (radar, tactical collision avoidance systems, etc.), the management and operation of air space, the (ICAO and local aviation authority) rules and regulations, their scripts, and the spectrum of from diligent via sloppy and delinquent to outright criminal behaviour of humans acting in the air traffic domain (pilots, controllers, etc.).

Of interest to: Civil aviation authorities, airlines, air traffic controllers, airports, pilots, passengers, etc. — as well as to the aircraft and the IT + software industry providers of technology.

Goals: There are several concurrent goals: (i) To develop a common theory of air traffic, a theory manifested in the form of well-written narrative descriptions in Japanese (and English) as well as formalised in for example CafeOBJ. (ii) To develop portable software modules that handle one or another kind of air traffic control. (iii) Possible industry standardisation proposals. (iv) New electronic (incl. mechatronics) "gadgets" for air traffic control.

We refer to:

7. Dines Bjørner: *Software Systems Engineering — From Domain Analysis to Requirements Capture: An Air Traffic Control Example. 2nd Asia-Pacific Software Engineering Conference (APSEC '95)*, Brisbane, Queensland, Australia (IEEE Computer Society, 1995)

8. Kristian Kalsing: *Specification of Air Traffic Control*[7]. Software Verification Research Centre, School of Information Technology, The University of Queensland, Australia, October 3, 1999.

[7] http://www.ldl.jaist.ac.jp/dedr/airtrafficcontrol.ps

3.3 Airports

Increasingly, around the world, air traffic grows by "leaps and bounds". Airports are becoming congested. New airports are being rapidly built. China expects, according to industry sources, to open one new airport every month for the next 10 years! Airport management, including the training of airport service and support staff becomes acute.

Topics: An airport can be seen as a work flow system where people (passengers, aircraft crews, gate staff, etc.), aircraft, aircraft supplies (luggage, catering, gasoline), aircraft cleaning, aircraft mechanical etc. check, information (tickets, boarding cards, luggage tabs, passenger lists, revised timetables, etc.), etc., flow and interact. We propose to domain model airports, including the entities of an airport, the functions, the events and the behaviours. Included in this modelling is also the modelling of the supporting technologies (check in counters, boarding card machines, luggage tab machines, baggage conveyor belts, etc.), the management and operation of airports, the spectrum of from diligent via sloppy and delinquent to outright criminal behaviour of humans acting in the airport domain (passengers, gate staff, etc.).

Of interest to: Passengers, airlines, airports, civil aviation authorities, aircraft crews, suppliers (catering services, cleaning services, etc.), the software houses providing airport software packages, etc.

Goals: There are several concurrent goals: (i) To develop a common theory of airports, a theory manifested in the form of well-written narrative descriptions in Japanese (and English) as well as formalised in for example CafeOBJ. (ii) To develop portable software modules that handle one or another kind of airport operation. (iii) Possible industry standardisation proposals. (iv) New electronic (incl. mechatronics) "gadgets" for airports.

9. Anders Dinesen and Ibrahim Alameddine: *Towards Domains, Requirements, Software Design. Descriptions for Airport Management Applications*[8]. This is an undergraduate student term project (1/5'th weekly load) Dept. of IT, Technical University of Denmark, August 8, 2000

[8] http://www.ldl.jaist.ac.jp/dedr/airport.ps

3.4 Financial Service Industry

E-Banking, the handling of insurance payments and claims processing and buying and selling securities instruments (stocks, bonds, etc.) over the Internet, etc., calls for an overhaul of our understanding of the whole financial service industry.

Topics: We propose to comprehensively domain model not only the individual transactions within banks, insurance companies, stock (etc.) brokers and traders, the stock exchanges, portfolio management, credit card companies, etc., but more importantly, on the basis of sufficiently detailed models of the former, to domain model, on one hand, the interactions between these "players", between banks, between insurance companies, etc., and between banks and insurance companies, between banks and securities instrument brokers and traders, between banks and credit card companies, etc., and, on the other hand, between "the market": consumers, retailers, wholesalers, producers, distributors and banks, etc., etc.

Of interest to: (i) Each and everyone of all the commercial players of the financial service industry: banks, insurance companies, stock (etc.) brokers and traders, the stock exchanges, portfolio management, credit card companies, etc., (ii) private citizens (the users, the clients, customers, of these services), (iii) "the market" (retailers, wholesalers, producers, distributors), (iv) public and private regulatory agencies (state and federal savings & loan regulatory agencies, federal and state exchange commissions, etc., etc.), involved ministries (finance, trade, industry, citizens protection, etc.), "the public at larger", and politicians (eager to profile themselves as champions of either industry or consumers, "or both"!), and the software houses providing financial software packages, etc.

Goals: There are several concurrent goals: (i) To develop a common theory of the financial service industry, a theory manifested in the form of well-written narrative descriptions in Japanese (and English) as well as formalised in for example CafeOBJ. (ii) To develop portable software modules that handle one or another kind of financial service transactions (or other). (iii) Possible industry standardisation proposals. (iv) New electronic (incl. mechatronics) "gadgets" for the financial service industry.

3.5 Health Care

Health costs are soaring. Freedom of choice with respect to selecting private physician, clinic and hospital is spreading, specialisation of treatment and treatment places (locations), etc., and all this within a framework of increased differentiation of and collaboration between private and public health insurance.

Topics: We propose to comprehensively domain model the flow of people, information, material, and monitoring & control within the health care sector at large: from citizens (healthy or sick), via private physicians, treatment clinics, hospitals, pharmacies, the pharmaceutical industry, providers of health care equipment, etc., to the national boards of health, the ministries of health, etc. Special models, embedded within the larger model, might focus on (1) patient medical records (in preparation for electronic patient journals, EPJ)[9], (2) hospitalisation plans, (3) the interaction between analytical instruments (X-Ray machines, CTM (computer tomography machines) and MRS (magnetic resonance scanners), etc.) and patient medical records (cum EPJ), etc.

Of interest to: Patients, medical professionals, pharmacists, clinics, hospitals, national boards of health, etc., the pharmaceutical industry, ministry of health, the software houses providing health care software packages, etc.

Goals: There are several concurrent goals: (i) To develop a common theory of the health care, a theory manifested in the form of well-written narrative descriptions in Japanese (and English) as well as formalised in for example CafeOBJ. (ii) To develop portable software modules that handle one or another kind of health care transactions (or other). (iii) Possible industry standardisation proposals. (iv) New electronic (incl. mechatronics) "gadgets" for the health care sector.

10. Dines Bjørner: *Domain Modelling some Healthcare Sector Concepts*[10]. Vastly incomplete internal draft report. Dept. of IT, Technical University of Denmark, September 14, 2000

[9]See also project proposal 1: Administrative Forms Processing.
[10]http://www.ldl.jaist.ac.jp/dedr/healthcare.ps

3.6 Manufacturing

Agile manufacturing, the ability to "turn around" and respond quickly to new or changed production orders, including the production of systems involving many co-ordinated producers, is becoming an everyday issue.

Topics: We propose to comprehensively domain model the flow of people, information, material, and monitoring & control within the manufacturing companies and between these, as well as between these and suppliers of product parts (incl. raw materials) and consumers of products, and also the related supply chain of delivery services. More specifically we propose to model manufacturing floors (of loosely or tightly coordinated machines, conveyour belts or delivery fork lifts, etc., and their interfaces to the supply and end-product warehouses), order processing departments, etc., etc. As part of requirements for agile manufacturing we propose to model the coordination (by agents and brokers) of how orders for agile production of complex systems are resolvable through collaboration between otherwise competing manufacturers.

Of interest to: The manufacturing industry in terms of individual manufacturers and the industry as a whole (Keidanren[11] and METI[12]), the distribution (trucking) companies, industry research centres in industry, at universities, and at government level, and the software houses providing manufacturing software packages.

Goals: There are several concurrent goals: (i) To develop a common theory of the manufacturing industry, a theory manifested in the form of well-written narrative descriptions in Japanese (and English) as well as formalised in for example CafeOBJ. (ii) To develop portable software modules that handle one or another kind of manufacturing company and/or industry transactions (or other). (iii) Possible industry standardisation proposals. (iv) New electronic (incl. mechatronics) "gadgets" for the manufacturing industry.

We refer to Appendix D in:

4. *Domains and Domain Engineering ... Apendix D*[13] JAIST/DEDR Document, March, 2006

and to:

11. Dines Bjørner: *Production Planning, Monitoring & Control, A Domain Model, a Set of Requirements and a Set of High-level Software Designs*[14]. JAIST/DEDR incomplete $\boxed{\text{draft}}$ Document, March, 2006

[11] http://www.keidanren.or.jp/
[12] http://www.meti.go.jp/english/
[13] http://www.ldl.jaist.ac.jp/dedr/domain.ps
[14] http://www.ldl.jaist.ac.jp/dedr/manufacturing.ps

3.7 "The Market"

The concept of e-market is alluring. We all transact simple purchases over the Internet: buying airline tickets, books, records, movie DVDs, etc. We are also beginning to acquire, rent, or otherwise, music and movies: paying for their rendering on suitable devices in our possession. A sizable variety of software packages are offered. But do also these packages together constitute or reflect a proper understanding of the market?

Topics: We propose to comprehensively domain model the market in terms of consumers, retailers, wholesalers, producers, distribution services and the interface to credit and bank card payment services. Included in such a comprehensive model is the modelling of functions like inquiring as to what is available, offering "deals", submitting and accepting orders, sending, accepting, invoicing, paying, rejecting, and "repairing" purchased merchandise (between buyers [consumers, retailers, wholesalers] and sellers [retailers, wholesalers, producers]). Included is also the modelling of agents acting on behalf of potential buyers or sellers, and brokers acting on behalf of potential buyers and sellers. Auctioning and the management of digital rights licenses and their use are yet further matters that, together with the previous functionalities illustrate the depth and breadth of "the market".

Of interest to: Consumers, retailers, wholesalers, producers, distribution services, credit card companies, banks, market (fair trade) associations, consumer protection organisations, ministry of trade, the software houses providing e-market systems, etc.

Goals: There are several concurrent goals: (i) To develop a common theory of "the market", a theory manifested in the form of well-written narrative descriptions in Japanese (and English) as well as formalised in for example CafeOBJ. (ii) To develop portable software modules that handle one or another kind of market transactions (or other). (iii) Possible industry standardisation proposals. (iv) New electronic (incl. mechatronics) "gadgets" for "the e-market".

We refer to:

4. *Domains and Domain Engineering ... Appendix F*[15]. JAIST/DEDR Document, March, 2006

and to:

12. Dines Bjørner: *Domain Models of "The Market" — in Preparation for E-Transaction Systems*[16]. In: Practical Foundations of Business and System Specifications (Eds.: Haim Kilov and Ken Baclawski) Kluwer Academic Press, The Netherlands, December 2002

[15] http://www.ldl.jaist.ac.jp/dedr/domain.ps
[16] http://www.ldl.jaist.ac.jp/dedr/themarket.ps

3.8 Transportation

Transportation, as financial services and health care, count as the prime infrastructure components whose quality strongly influence a country's or a region's welfare. Transportation takes many forms, i.e., there are many sub-infrastructures that can each be tackled more or less separately — and some of these will be covered in Sects. 3.8.1–3.8.5. But we can also speak of the generic domain of transportation: transportation nets and traffic.

Topics: We propose to model the entities, functions, events and behaviours of transportation nets and traffic, that is, of multi-modal segments (roads, rail lines, air lanes, shipping lanes) and multi-modal junctions (street intersections, railway stations, airports, harbours), their composition into multi-modal nets, the projection of multi-modal nets onto single modality nets (road nets, rail nets, air lane nets, shipping lane nets), the functions of enlarging, reducing or "repairing" (incl., maintaining) segments, junctions and sub-nets, the events of segments, junctions and sub-nets (impassable, closed, disconnected, etc.), and the behaviours of nets and traffic. Included in this overall model is the modelling of support technologies (such as traffic monitoring and control [junction semaphores, railway line signals, etc.], etc.), management & organisation (of segment and junction maintenance, traffic, etc.), and rules & regulations (and their scripts, for net maintenance, traffic, etc.).

Of interest to: Any of the stake holders in any of the road, rail, air traffic or shipping domains.

Goals: There are several concurrent goals: (i) To develop a common, generic theory of transportation, a theory manifested in the form of well-written narrative descriptions in Japanese (and English) as well as formalised in for example CafeOBJ. (ii) To serve as a basis for developing requirements for software that may be common to, i.e., shared by the domain models covered in Sects. 3.8.1–3.8.5: net maintenance, traffic timetables, etc. (iii) To otherwise serve as a common reference point for the domain models covered in Sects. 3.8.1–3.8.5.

We refer to:

4. *Domains and Domain Engineering ... Appendix C*[17]. JAIST/DEDR Document, March, 2006

3.8.1 Air Lines

Will be skipped in the present edition of this document.

[17] http://www.ldl.jaist.ac.jp/dedr/domain.ps

3.8.2 Container Shipping

Topics: We propose to model the entities, functions, events and behaviours of container shipping: containers, container ships, container (harbour) terminals, the stowage of containers aboard ships and in (harbour or port) terminal pool areas, the processing of shipping requests (bills of lading, way bills),

Of interest to: Container shipping lines, container terminal ports, removal companies arranging for the transport of goods, as well as software houses and operations research companies providing IT and logistics consultancy and software support.

Goals: There are several concurrent goals: (i) To develop a common theory of container logistics, a theory manifested in the form of well-written narrative descriptions in Japanese (and English) as well as formalised in for example CafeOBJ. (ii) To develop portable software modules that handle one or another kind of containers transactions (order processing, stowage, etc.). (iii) Possible industry standardisation proposals. (iv) New electronic (incl. mechatronics) "gadgets" for container shipping.

3.8.3 Freight Logistics

Will be skipped in the present edition of this document.

3.8.4 Road Nets and Traffic

Will be skipped in the present edition of this document. But see:

13. Dines Bjørner: *Transportation Nets: A Domain Model, a Set of Requirements and a Set of High-level Software Designs*[18], JAIST/DEDR incomplete $\boxed{\text{draft}}$ Document, March, 2006

[18]http://www.ldl.jaist.ac.jp/dedr/transportnets.ps

3.8.5 Railways

Train traffic, in Europe, China, Japan and the United States is considered a main provider of overland freight transport and, still in many places, passenger transport. Road congestion, on free and toll ways are such that, with the above, the demands on moving certain forms of transport away from roads and onto rails is socially increasing.

Topics: We propose to model the entities, functions, events and behaviours of railway systems: lines with their signalling and stations with their intricate rail arrangements (leading to issues of interlocking), the monitoring and control of train traffic, the setting of signals and switches, and so on. Included in these models are models of supporting technologies reflecting real time embedded systems (signals, interlocking, etc.), management & organisation, rules & regulations, etcetera.

Of interest to: Railway infrastructure owners and operators, train operators, passengers, freightors, regulatory agencies, etc., as well as software houses and operations research companies providing IT and logistics consultancy and software support.

Goals: To develop a common theory of railways, a theory manifested in the form of well-written narrative descriptions in Japanese (and English) as well as formalised in for example CafeOBJ. (ii) To develop portable software modules that handle one or another kind of railway planning and operations. (iii) Possible industry standardisation proposals. (iv) New electronic (incl. mechatronics) "gadgets" for railways.

We refer to:

4. *Domains and Domain Engineering ... Appendics C and F*[19]. JAIST/DEDR Document, March, 2006

and to:

14. Dines Bjørner:

1. *Towards a TRain Book*[20]. This document suggests a number of domain models for a variety of railway facets. It is part of an ongoing domain theory "Grand Challenge" effort: TRain.

We also wish here to refer to the above-mentioned TRain "Grand Challenge" effort:

- The Railway Domain: `http://www.railwaydomain.org/`

[19] http://www.ldl.jaist.ac.jp/dedr/domain.ps
[20] http://www.ldl.jaist.ac.jp/dedr/thetrainbook.ps

4 Project Modalities

How do we foresee these projects being

- formulated,
- funded,
- **carried out**, and
- *propagated?*

Well, that's what the whole thing is all about!

Let us just suggest a few ideas concerning how possible joint projects may be **carried out**:

- Group(s) at the industrial (or institutional) partner(s) work[s] on their application domain specific requirements and software designs — all the while regularly communicating requirements and assumptions about the domain to the other partners.
- The DEDR Group at JAIST works at on the domain model: (i) Carefully expressed (i.1) narratives and (i.2) terminologies (including ontologies) expressed in Japanese (i.1–2:J) and English (i.1–2:E), (ii) their formalisation in (ii.1) CafeOBJ (and possibly also (ii.2) either VDM or RAISE), and (iii) the analysis, with proofs of propositions, lemmas and theorems of the formalisations.
- The industry (institutional) and JAIST partners meet regularly, it is suggested, typically once every 7 weeks[21], for two–three days, presenting their work to each other, discussing shortcomings, improvements and possibly revise project plans.
- Each project period is suggested to be 12 months.
- The joint project is suggested reviewed yearly, 9 months into each period.
- A full project is suggested to last for 2–3 periods.
- The project is suggested to yearly *propagate* its work at open, three day workshops — at the end (i.e., at the end of the 12th month) of each project period.

5 Closing Remarks

We shall carry forward this document, together with those of [1,2,3,4] and [5] to possible meetings during the spring of 2006 with potential partners in the kind of joint R&D suggested in this note.

We hope that something very beneficial to the otherwise very successful Japanese society can be achieved.

The DEDR Group @ JAIST

[21] Thus there are 6 full working weeks between the weeks where the groups meet.