

Virtual Building Environments II

Final Project Report

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1 Summary

Virtual Building Environments (VBE) II project was funded mainly by Tekes as a part of SARA Technology Program (72.3%), other funding came from the participating companies (13.0%) and VTT (14.7%). The project started 1.3.2005 and ended 31.5.2007.

The project plan defined VBE II project as an opportunity for Finnish Real Estate and Construction Cluster (RECC) to establish an international competitive advantage in the design, construction and operation of buildings. Technical Research Centre of Finland (VTT) and Tampere University of Technology (TUT) worked together to promote opportunities and overcome technological and organizational challenges.

The project consisted of a 7 work packages, and their detailed results are reported in separate WP reports. This final report contains only the main results of the whole project. The full list of VBE II documents is in Appendix 2.

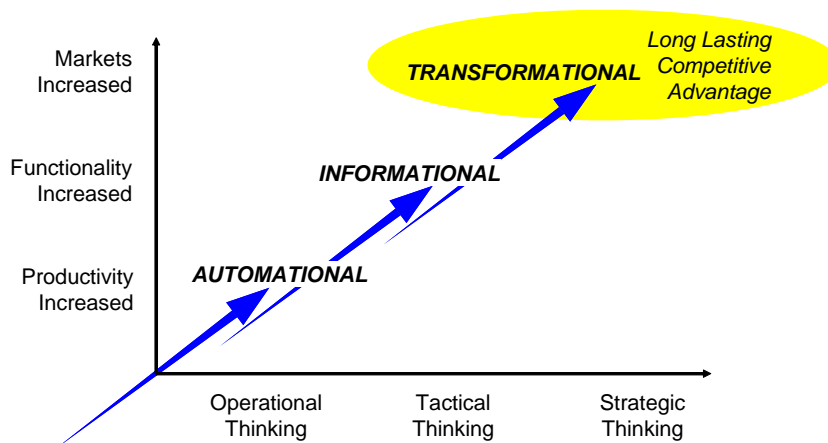


Figure 1: VBE Business Effects

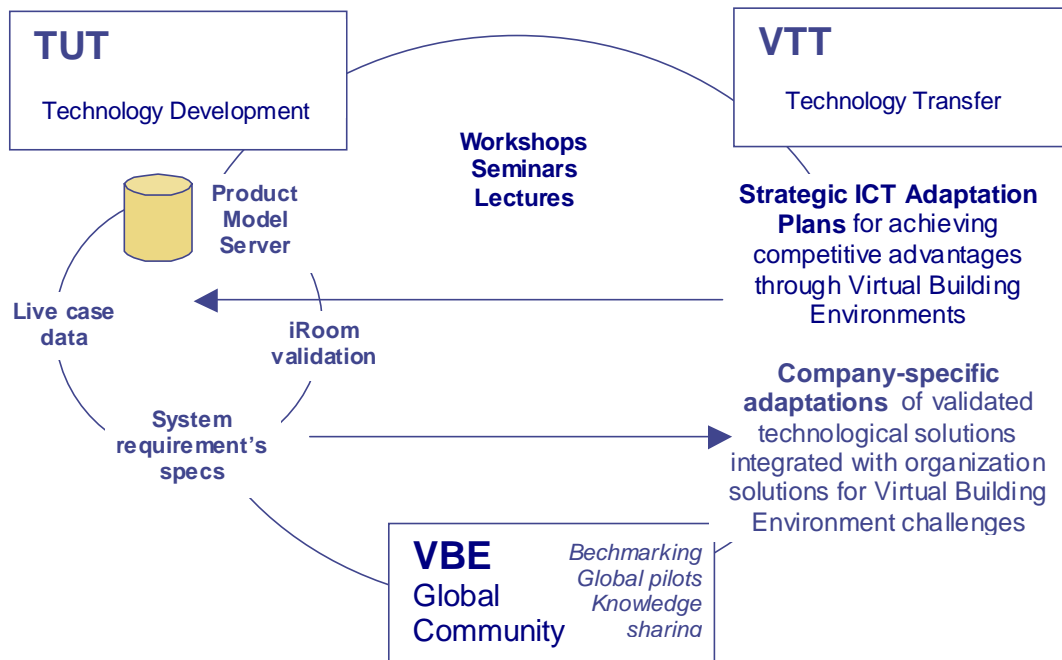


Figure 2: TUT/VTT Collaboration in VBE II project

2 Project Goals

Original goals for the participating RECC companies
<p>The use of VBE methods will provide clear competitive advantage:</p> <ul style="list-style-type: none"> • Useful methods to evaluate the potential benefits and measure the achieved benefits of the VBE methods • Clear understanding of the possibilities and problems of the existing and emerging VBE technologies combined to the defined strategy how to implement the new technologies • Advanced decision making support for building projects and company processes
Original goals for the participating research organizations
<p>Significant research results and new research areas:</p> <ul style="list-style-type: none"> • Development of methods to measure and benchmark VBE benefits • Development of data transfer and sharing technologies • Development of VBE based decision support methods and measuring their efficiency • Development of model based real estate and facility management processes
Original goals for the Finnish RECC industry
<p>Influence on the whole RECC industry in Finland:</p> <ul style="list-style-type: none"> • Measurable evidence of the efficiency of the VBE methods • Establishing a critical mass of organizations that are able to utilize Virtual Building Environment efficiently

3 Organization and Resources

18 participating companies and other organizations formed the Steering Group of VBE II (see appendix 1). The Steering Group nominated from its members the Steering Committee, which consisted of 9 representatives (see the list below). The people in charge of the tasks reported to the WP Leaders. The WP leaders reported to the Project Manager, who reported to the Steering Committee, Steering Group and Tekes, Figure 3.

Steering Committee Members:

- Ilkka Romo, Chairman, Confederation of Finnish Construction Industries RT (in the later phases of the project Skanska Oy)
- Jarmo Forss, HUS Kiinteistöt Oy
- Auli Karjalainen, Senate Properties
- Tapio Koivu, VTT
- Pekka Metsi, Pöyry Building Services Oy
- Aarne Seppänen, Ruukki Construction
- Jukka Suomi, Tekla Oyj
- Ari Törrönen, NCC Rakennus Oy
- Mika Lautanala, Tekes (in the later phases of the project Kari Hiltunen and Virpi Mikkonen represented Tekes in the Steering Committee)
- Arto Kiviniemi, Project Manager, VTT
- Jiri Hietanen, Project Secretary, TUT

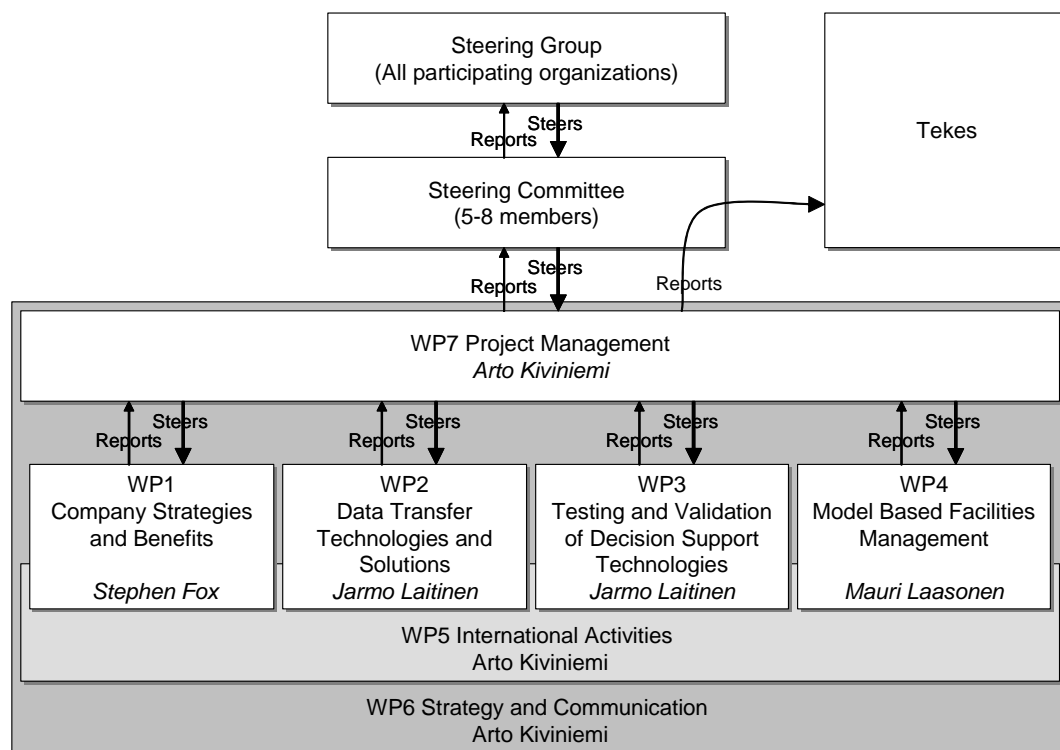


Figure 3: Project Organization

The Project Manager was Research Professor, Ph.D. Arto Kiviniemi from VTT Materials and Building. Other key resources at VTT Building and Transport were Chief Research Scientist, Ph.D. Kalle Kähkönen, Senior Research Scientist, Ph.D. Stephen Fox, Research Scientist Tiina Järvinen, Research Scientist Tiina Koppinen and Research Scientist Tarja Mäkeläinen. At VTT Information Technology the key resources were Senior Research Scientist Jukka Rönkkö and Research Scientist Jussi Markkanen.

At Tampere University of Technology the key resources were: Prof. Dr. Jarmo Laitinen, Research Scientist Jiri Hietanen, Chief Research Scientist Dr. Mauri Laasonen, Research Scientist Sakari Lehtinen, Research Scientist Salla Kuusela, Research Scientist Tero Karlakari, and Ph.D. student Timo Saari.

4 Work Packages, Tasks and Outputs

VTT was responsible of the technology transfer tasks and overall project strategy, communication and management. TUT's main responsibilities were the technology development tasks.

WP1 Company Strategies and Benefits

WP1 Leader: Stephen Fox, VTT

The main focus was in the company strategies: how to use the VBE technologies to achieve competitive advantage. WP1 evaluated (1) the state-of-the-art of VBE tools and skills in the participating companies, (2) the goals and (3) a feasible way to move towards those goals with measurable steps.

WP1.1 Company-specific audits of existing VBE tools, skills, priorities and steps

Method: Interviews, data collection and analysis in participating companies.

Planned deliverables: Data collection of existing VBE tools and skills in the participating companies.

Documented results: VBE Audit Method developed, data collection completed and VBE2 Workshop #1 organized (see Appendix 2). No public documents because the data is confidential and was used only in reports for each company.

WP1.2 Company-specific VBE reports

Method: Analysis of the data collected in WP1.1.

Planned deliverables: Company specific strategic VBE reports including 1) existing VBE tools and skills, 2) prioritization of VBE opportunities, 3) steps to achieve the prioritized goals, and 4) technological and organizational challenges.

Documented results: A confidential report issued to each VBE2 company.

WP1.3 Measurement of VBE benefits

In charge: Stephen Fox

Method: The VBE measurement method will be used to take those company-specific measurements that are necessary to keep VBE implementation on track. The method will be developed further from the VBE I method in co-operation with Center for Integrated Facility Engineering (CIFE) at Stanford University. The main objective of further development will be to make the measurement method easy to understand and simple to use for company personnel.

Planned deliverables: A systematic and validated method to measure VBE benefits in the companies and company-specific reports of the results of these measurements. At least one international conference or journal paper of the method.

Documented results: Measurement Method v.2 developed and documented, see Appendix 2, WP1.

WP1.4 Synthesis from the company-specific findings

In charge: Stephen Fox

Method: Conclusions and general recommendations from the company specific analysis.

Planned deliverables: Public report of the conclusions and recommendations of implementing VBE in the RECC companies. At least one international conference or journal paper of the findings.

Documented results: Three journal papers: “Complementary use priorities: different organizations’ priorities for the use of inter-organizational building information models”, “Evaluating potential investments in new technologies: carrying out assessments of critical performance factors prior to the application of investment evaluation techniques” and “Mediation of research question concepts: counteracting threats to reliability and validity in multi-national evaluation research”, see Appendix 2, WP1 Company Strategies and Benefits.

Additional results: VBE Traffic Light System; symbols, which can be used to illustrate the use of BIM and different analysis and simulations in the processes. The symbols were used in WP3.5 and the system was delivered to the participants as a set of magnetic symbols, Visio Stencil and symbols in GIF format, see Appendix 2, WP1 Traffic Light System. The system will be distributed freely on VBE web site in the future.

WP2 Data Transfer Technologies

WP2 Leader: Jarmo Laitinen, TUT

Project plan identified moving from IFC file exchange to shared data utilizing IFC model servers as a crucial part of developing VBE technologies further. Project tested SABLE server and its API in WP2. However, the model server technology is not yet on the level needed in real construction projects. One special element for the iRoom and other visualization purposes was the development of a 3D component, which can be used in client applications using the specified visual interface to the data.

As the most significant results in WP2 became the data transfer use cases, WP2.2, which was also the most active international activity in VBE II project. The main result, Model View Definition (MVD) was adopted by IAI as the official method to document use cases. In addition, Jiri Hietanen was nominated as the International MVD Coordinator for IAI.

WP2 in general is documented in detail in two reports “WP2 Data Transfer Technologies; Final Report” and “WP2 TTY osuuden arviointi” (in Finnish), see Appendix 2, WP2.

WP2.1 Technology review and VBE platform

In charge: Jiri Hietanen, TUT

Method: Analysis of existing VBE applications and technologies and their shortcomings related to the company strategies.

Planned deliverables: Documentation of the state-of-the-art VBE applications and technologies, and a roadmap for further development. At least one international conference or journal paper of the technologies.

Documented results: State-of-the-art report and “The Useful Minimum” paper, see Appendix 2, WP2.1.

- WP2.2 Structuring and documentation of data transfer use cases
In charge: Jiri Hietanen, TUT
Method: Analysis and synthesis of project data transfer needs between different tasks from company cases.
Planned deliverables: Specification for model-based use cases in the RECC processes defining the data content for client applications and further IFC development.
Internationally accepted format for describing use-cases. Two use-cases: Architecture ⇔ Structural design and Architecture ⇔ Quantity take off.
Documented results: Development of MVD methodology and documentation of several data exchange use cases, see Appendix 2, WP2.2. In addition, Jiri Hietanen was nominated as the International MVD Coordinator for IAI.
- WP2.3 Requirements for interactive 3D visualizations
In charge: Kalle Kähkönen, VTT
Method: Analysis of different end-user requirements for interactive 3D visualizations of buildings based on the data collected in WP2.2.
Planned deliverables: Specification of end-user requirements for interactive 3D visualizations.
Documented results: Results of this WP are available only in Finnish; two documents: questionnaire “Visualisoinnin käyttäjävaatimukset” and VTT working paper “Vuorovaikutteinen 3D - Tarpeet talonrakennushankkeissa”, see Appendix 2, WP2.3.
- WP2.4 IFC interface for interactive 3D visualizations
In charge: Jiri Hietanen, TUT
Method: Analysis of the two-way data-transfer needs between 3D visualizations and IFC models based on data collected in WP2.2 and WP2.3, IFC specifications and SABLE API for IFC model servers.
Planned deliverables: Specification for two-way data exchange between interactive 3D solution and IFC files/model servers.
Documented results: Two documents: “Specification for two-way data exchange between interactive 3D solutions and IFC files/model servers” and “Interactive 3D visualization UPnP methods specification”, see Appendix 2, WP2.4.
- WP2.5 Technical solutions for interactive 3D visualizations
In charge: Jukka Rönkkö, VTT
Method: Development of software components for interactive 3D visualizations based on the specifications defined in WP2.3 and WP2.4.
Planned deliverables: Prototype application to demonstrate and test interactive 3D visualizations in the iRoom environment. At least one international conference or journal paper of the results in collaboration with WP2.3 and WP2.4.
Documented results: Prototype 3D viewer application, several documents and two conference papers: “Case Digitalo – A Range of Virtual and Augmented Reality Solutions in Construction Application” and “Lightweight 3D IFC Visualization Client”, see Appendix 2, WP2.5.

WP3 Decision Support Technologies

WP Leader: Jarmo Laitinen

WP3 focused in utilizing decision support technologies in RECC processes, and validating their benefits. One of the main technologies was iRoom; a multi-screen presentation technology enabling synchronization of presentation of data from multiple software applications, and thus providing multiple simultaneous views to the complex project data and helping project participants to understand and create a shared view of the problems and solutions.

WP3 in general is documented in detail in two reports “WP3 Decision Support Technologies: Final Report” and “WP3 TTY osuuden arviointi” (in Finnish). In addition, on chapter in the nD book published by Salford University (only the list of contents included in VBE II documentation), see Appendix 2, WP2.

WP3.1 Design of technical solutions for decision support

In charge: Jarmo Laitinen, TUT

Method: Analysis and synthesis of WP2.1, WP 2.2 and WP4.2 results and data content from decision support viewpoint, including the iRoom technologies.

Planned deliverables: Specification for implementation to visualize the selected data sets for efficient decision support. At least one international conference or journal paper of the methods and findings.

Documented results: Three project leaflets (Aurora II, TUT Administrative Building and TUT Virtual Building Laboratory) and presentation of Senate’s Projects in the International TWN workshop, see Appendix 2, WP3.1.

WP3.2 Company-specific adaptations of decision support technologies

In charge: Jarmo Laitinen, TUT and Jukka Rönkkö, VTT

Method: Development of decision support software prototypes to support the visualization of selected company-specific data sets and use-cases.

Planned deliverables: Prototype applications to demonstrate, test, and validate the company-specific data sets and use-cases.

Documented results: Document “Company data in iRoom environment; Technical Framework”, see Appendix 2, WP3.2.

WP3.3 Testing of the company-specific integrated solutions

In charge: Jarmo Laitinen, TUT

Method: Validation of the business cases using the prototypes developed in WP3.2.

Planned deliverables: Documented benefits of the developed methods in the selected company-specific business cases. At least one international conference or journal paper of the methods and findings.

Documented results: Several documented case studies and presentations, one thesis (only a summary included in VBE II documentation), see Appendix 2, WP3.3.

WP3.4 Development of VBE decision support facilities and services

In charge: Jarmo Laitinen, TUT and Jukka Rönkkö, VTT

Method: Development of the VBE decision support platform to a useful working environment in real projects.

Deliverables: Reference environment to facilitate the company processes in the Virtual Building Environments.

Documented results: Some documents related to WP3.4 are included in WP2.5 results, see Appendix 2, WP2.5.

WP3.5 Requirements management and critical decision points

In charge: Arto Kiviniemi, VTT

Method: Analysis of the critical decision making points and possibilities to use requirements model in a selected decision making process.

Planned deliverables: Documentation of the identified critical decision points and crucial information for the decision making, and their relation to the requirements model.

Documented results: VTT Working Paper and presentation “Requirements Management and Critical Decision Points” and a process diagram in Visio format, see Appendix 2, WP3.5.

WP4 Model-based RE/FM Business Processes

WP Leaders: Mauri Laasonen, TUT and Tiina Järvinen, VTT.

WP4 focused in 1) capturing these processes and data needs for the models, 2) recognizing RE/FM business cases to demonstrate the possible benefits, and 3) possible needs for extensions of the current IFC specifications.

WP4 in general is documented in detail in two reports “WP4 Model-based Real Estate and FM Business Processes: Final Report” and “Edellytykset suunnittelun rakennusmallien hyödyntämiselle ylläpidon tietojärjestelmissä” (in Finnish), see Appendix 2, WP4.

WP4.1 Documentation of model-based RE/FM processes

In charge: Mauri Laasonen, TUT

Aim: The identification and documentation of added value of building models to the building owners and to find out the requirements of building owners of data content of building models.

Method: Interviews of the participating building owners and facility managers to identify the data needs for the real estate and FM business processes.

Planned deliverables: Documentation of model based real estate and facilities management processes and their data content.

Documented results: Document “Model-based Real Estate and FM Business Processes” and some data content documents, see Appendix 2, WP4.

WP4.2 Model specification for RE/FM processes

In charge: Mauri Laasonen, TUT

Aim: The tentative definition to the use of BIM based methods to real estate business. Process is focused to the key subjects that are important in the interviewees.

Method: Formal specification based on analysis and synthesis of WP4.1 data.

Planned deliverables: Specification for model based RE and FM data transformation process and demonstrations. The implementation of the specification is included in WP3. At least one international conference or journal paper of the specification.

Documented results: One conference paper “Maintaining Data In Building Model-Based Facility Management Systems”, VTT report “Kiinteistöjen huoltokirjamenettely rakennuksen tietomallia hyödyntäen – Kiinteistön tietomallin käyttö kiinteistöliiketoiminnassa” (in Finnish, abstract in English) and some specification documents, see Appendix 2, WP4.

WP4.3 Specification of the usage of as built model in FM (Facilities Management)

In charge: Tero Karlakari, TUT

Planned deliverables: Specification for as built information and process description.

Aim: The extension of use cases of data transformation to existing buildings.

Method: Specification of the required information and model content from design

and construction made by BIM for model based FM. Pilot test validation in a real project.

Deliverables: Specification for as built information and process description.

Documented results: Some specification documents, see Appendix 2, WP4.

WP5 International Activities

WP Leader: Arto Kiviniemi

International co-operation started already in the VBE I project through the International VBE Network with CIFE and Lawrence Berkeley National Laboratory. The collaboration has expanded with CIFE and CSIRO (Commonwealth Scientific and Industrial Research Organization, Australia) in the International iRoom network. Additional co-operation has been prepared with the University of Salford (UK). The VBE II project will continue, foster and expand the international VBE network, and develop international methods to benchmark the VBE results. The proposed international workshops and journal papers can be shared by different WP5 tasks.

WP5.1 International VBE benchmarking methods

In charge: Stephen Fox, VTT

Activities: International collaboration in developing methods to measure the VBE benefits.

Planned deliverables: At least two international workshops about the VBE benchmarking methods and at least one international conference or journal paper jointly with the international partners.

Documented results: Exceeded plans, three journal papers in review process:

- “Complementary Use Priorities: Different Organizations’ Priorities for the Use of Inter-Organizational Building Information Models” by Stephen Fox (VTT)
- “Evaluating Potential Investments in New Technologies: Carrying Out Assessments of Critical Performance Factors Prior to the Application of Investment Evaluation Techniques” by Stephen Fox (VTT)
- “Mediation of Research Question Concepts: Counteracting Threats to Reliability and Validity in Multi-National Evaluation Research” by Stephen Fox (VTT)
- Main collaboration in this area with CIFE at Stanford University
- Details in the reports VBE2_WP1_End_Report.pdf and VBE2_WP5_results.pdf.

WP5.2 International VBE platform

In charge: Arto Kiviniemi, VTT

Activities: International collaboration in developing an integrating R&D platform for the VBE research. The platform will be based on IFC model server technology and SABLE API, see WP2.

Planned deliverables: At least two international workshops about the integrated VBE platform and at least one international conference or journal paper jointly with the international partners.

Documented results: Exceeded plans, three international VBE workshops, one published journal paper and 8 reviewed conference papers:

- July 2005, CIB-W78 Conference in Dresden, Germany: Session “Managing Multiple Model Space”, chaired by Arto Kiviniemi.
- June 2007, CIB-W78 Conference in Maribor, Slovenia: Session “Managing the multiple model space” chaired by Arto Kiviniemi
- June 2007, CIB-W78 Conference in Maribor, Slovenia: Session “Data Origins & Data Exchange” chaired by Vladimir Bazjanac, LBNL
- List of papers and other details in the report VBE2_WP5_results.pdf.

WP5.3 International iRoom network

In charge: Jarmo Laitinen, TUT

Activities: International collaboration in developing decision support technologies for the VBE research, see WP3.

Planned deliverables: At least one international workshop about the decision support using VBE technologies and at least one international conference or journal paper jointly with the international partners.

Documented results: No international iRoom workshop, but organized two workshops around the topic for the participating organizations. In addition, one conference paper:

- September 2006, ECCPM Conference in Valencia, Spain: “Study on utilizing the iRoom environment in building information model presentation”
- Details in the reports VBE2_WP3_TUT_End_Report.pdf and VBE2_WP5_results.pdf.

WP5.4 International visiting researchers

In charge: Arto Kiviniemi, VTT

Activities: Identify suitable collaboration topics and researchers who can contribute to the goals of VBE II project, and help in travel and accommodation during their visits in Finland.

Planned deliverables: At least three international visiting VBE researchers in Finland during the VBE II project.

Documented results: As planned. Four visits by three international visitors:

- Dr. Vladimir Bazjanac from LBNL as a visiting Professor at VTT in Autumn 2006
- Dr. John Taylor from Stanford University as a Visiting Researcher at VTT in Autumn 2005
- Doctoral candidate Ju Gao as a Visiting Researcher at VTT in Spring 2005 and Spring 2006.
- Details in the report 2007.09.02_VBE2_WP5_results.pdf.

WP6 VBE Strategy and Communication

WP Leader: Arto Kiviniemi

The goals of WP6 were 1) to develop the VBE strategy in collaboration with the Steering Committee and WP all leaders, 2) ensure sufficient and frequent communication between all project participants, and 3) ensure sufficient publicity of the project results on the international scientific forums.

WP6.1 Development of the VBE strategy

In charge: Arto Kiviniemi, VTT

Activities: Agreed workshops with the Steering Committee and WP leaders.

Updating the VBE strategy memorandum with the agreed goals.

Planned deliverables: Updated VBE strategy memorandum and the agreed goals as a part of VBE II phase 2 project plan (WP7.4)

Documented results: As planned with the exception that the project plans for VBE II phase 2 was finalized in February 2007. However, the project was not approved for funding by Tekes.

WP6.2 Workshops for the participating organizations

In charge: Arto Kiviniemi, VTT

Activities: Three workshops for participating organizations. Preliminary schedule: August 2005, February 2006 and August 2006.

Planned deliverables: Workshop arrangements and presentations in the project Intranet.

Documented results: As planned, although schedule different than originally planned: Three workshops for participating organizations and one international workshop:

- December 15th, 2005: VBE Implementation
- February 10th, 2006: International Model View Definition Workshop
- June 1st, 2006: Steering Group Workshop
- August 7th, 2006: Technology Map Workshop

WP6.3 Public project seminars

In charge: Arto Kiviniemi, VTT

Activities: Two public seminars of VBE II projects and results. Preliminary schedule: November 2005 and November 2006.

Deliverables: Seminar arrangements, public invitations and presentations in the public project web site.

Documented results: Exceeded plans, four public seminars arranged, although schedule different than originally planned:

- Interactive 3D Seminar on April 25th, 2006 in Luna Auditorium at Spektri Business Centre
- 1st VBE – BuildingSmart Finland Seminar on January 31st, 2007 in Luna Auditorium at Spektri Business Centre
- 2nd VBE – BuildingSmart Finland Seminar on March 15th, 2007 in Building Information Institute
- VBE Tulosseminaari – Business Forum on May 15th, 2007 in Wanha Satama in connection with ARMI Conference.

WP6.4 Project web site

In charge: Arto Kiviniemi, VTT

Activities: Frequently updated project information in the web and email notices to the participants about major updates in the web. All persons in charge of a WP are responsible to update their WP information on the project web site.

Planned deliverables: Project Intranet and public web site.

Documented results: As planned, the VBE II web site has been used as the project document storage for all participants. The public results will be moved on the open part of the site when the project participants have checked the final content.

WP6.5 Conference and journal papers

In charge: Arto Kiviniemi, VTT

Activities: To select the appropriate international forums for VBE II project papers in collaboration with the people in charge of the WPs.

Planned deliverables: At least ten papers of VBE II WPs in international conferences and/or journals. Each person in charge of a WP is responsible of their individual papers.

Documented results: Exceeded plans. In total four journal papers: 1 published (joint VTT/TUT effort), 3 in the review process (VTT) and 11 reviewed conference papers (9 from VTT and 2 from TUT). In addition, about 30 international presentations by the VBE II team. Details in the report 2007.09.02_VBE2_WP5_results.pdf.

WP6.6 Educational material of the project

In charge: Arto Kiviniemi, VTT

Activities: To select and edit appropriate educational material VBE II project papers in collaboration with the people in charge of the WPs.

Planned deliverables: Public educational material of the VBE II results.

Documented results: Failed to deliver. No systematic educational material, although several papers and presentations which will be public and have been used for example in internal education at VTT.

WP7 Project Management

WP Leader: Arto Kiviniemi, VTT

The goal of project management was to ensure sufficient communication between the Steering Committee and all work packages, and that the project results fulfill the goals set in the final project plan.

WP7.1 Approval of the final project plan

In charge: Arto Kiviniemi, VTT

Method: Recording the feedback from the Steering Committee in the first meeting and the necessary changes to the project plan.

Planned deliverables: Approved, final project plan, Steering Committee meeting minutes documenting the approval for Tekes.

Documented results: As planned, approved project plan in the first meeting.

WP7.2 Reporting to the steering committee

In charge: Arto Kiviniemi, VTT

Method: Collecting the reports from all WPs and preparing a Steering Committee report at least one week before each Steering Committee meeting. Recording and reporting the feedback from the Steering Committee and necessary actions to the WPs. All persons in charge of a WP are responsible for the individual WP reports.

Planned deliverables: Project reports to the Steering Committee and Steering Committee meeting minutes.

Documented results: As planned, approved reports in all SC meetings.

WP7.3 Reporting to Tekes

In charge: Arto Kiviniemi, VTT

Method: Collecting the reports from all WPs and preparing a Tekes report in connection to all invoices for Tekes.

Planned deliverables: Project reports to the Tekes.

Documented results: As planned, approved reports in all SC meetings.

WP7.4 Preparations for VBE II phase 2: 2007-2008

In charge: Arto Kiviniemi, VTT

Method: Approval of the project plan and budget for VBE II project phase II (2007-2008) in the Steering Committee.

Planned deliverables: Project plan and funding application for VBE II project phase II (2007-2008) to Tekes in autumn 2006.

Documented results: As planned with the exception that the project plans for VBE II phase 2 was finalized in February 2007. However, the project was not approved for funding by Tekes.

WP7.5 Approval of the results and end report

In charge: Arto Kiviniemi, VTT

Method: Approval of the final project report in the last Steering Committee meeting.

Planned deliverables: Approved, final project report for Tekes.

Documented results: As planned, approved end report in the last SC meeting.



Appendix 1

Appendix 1: Project team and participated companies

VTT Key Resources:

Building Informatics Team

Research Professor, Ph.D. Arto Kiviniemi
Chief Research Scientist, Ph.D. Kalle Kähkönen,
Senior Research Scientist, Ph.D. Stephen Fox
Research Scientist Tiina Järvinen
Research Scientist Tiina Koppinen
Research Scientist Tarja Mäkeläinen

Virtual Reality Team

Senior Research Scientist, Jukka Rönkkö
Research Scientist Jussi Markkanen

TUT Key Resources:

Professor, Dr. Jarmo Laitinen
Research Scientist Jiri Hietanen
Research Scientist Sakari Lehtinen
Chief Research Scientist Dr. Mauri Laasonen
Research Scientist Salla Kuusela
Research Scientist Tero Karlakari
Ph.D. student Timo Saari

Companies

Consolis Oy Ab
Finnmap Consulting Oy
HUS-Kiinteistöt Oy
Insinööritoimisto Olof Granlund
Instakon Oy
JP-Talotekniikka Oy
Jyväskylän koulutuskuntayhtymä, kiinteistöliikelaitos
Lemcon Oy
Lonix Oy
Lujatalo Oy
NCC Rakennus Oy
Rakennusteollisuus RT ry
Ramboll Finland Oy
Ruukki Construction
Senaatti-kiinteistöt
Skanska Oy
Tekla Oyj
TocoSoft Oy

Appendix 2

Appendix 2: VBE II Documents

WP1_Company_Strategies_and_Benefits

- 2006_CM&EV25I3289_Interorganizational_use_of_BIM.pdf
- VBE2_WP14_Public_Report_20061106.pdf
- VBE2_WP1_BIM_technological_challenges.pdf
- VBE2_WP1_CM&EV25I3289.pdf
- VBE2_WP1_End_report.pdf
- VBE2_WP1_Framework_for_Business_Effects.pdf
- VBE2_WP1_Increasing_sales_and_profits.pdf
- VBE2_WP1_Measurement_Method.pdf
- VBE2_WP1_VBE_Audit_Method.pdf

WP1_Traffic_Light_System

- VBE2_Traffic_Lights.vsd
- VBE2_Traffic_Lights.vss
- VBE2_Traffic_Light_Symbols.vsd
- VBE2_Traffic_Light_System.pdf

VBE2_Traffic_Light_Symbols

- 30 TrafficLight-symbols, all in 4 different colors = 120 files
- VBE2_Traffic_Lights.vss
- VBE2_Traffic_Lights_symbols.vsd

WP2_Technologies_and_Solutions

- VBE2_WP2_TTY_osuuden_arviointi.pdf
- VBE2_WP2_TUT_End_Report.pdf

WP21_Technology_review_and_VBE_platform

- VBE2_WP21_State_of_the_Art.pdf

WP22_Structuring_and_documentation_of_data_transfer_use_cases

- 20050224_New_approach_to_IFC_view_definitions_@_Madrid.pdf
- 20050531_View_definition_harmonization_implementers_@_Oslo.pdf
- 20051014_View_definition_harmonization_@_Beijing.pdf
- 20051110_QualityControl_and_Responsibilities.pdf
- 20060201_View_definition_harmonization_@_Oslo.pdf
- 20060404_MVD_Proposal_@_Munich.pdf
- 20060404_Practical_Proposal_@_Munich.pdf
- 20060406_MVD_@_IC_Munich.pdf
- 20061030_IDM-MVD_@_Washington_DC.pdf
- 20061030_MVD_Status_Report_@_Washington_DC.pdf
- 2006_IAI_IFCModelViewDefinitionFormat.pdf
- 2006_The_Useful_Minimum.pdf
- 20070212_MVD_Status_Report_@_Sophia_Antipolis.pdf
- VBE2_WP22_ConstructionType_BLIS_060811.pdf
- VBE2_WP22_Model_View_Definitions.pdf
- VBE2_WP22_MVD_ArchDesign_To_QTO_V1.pdf
- VBE2_WP22_MVD_ArchToStruct_V3.pdf
- VBE2_WP22_MVD_Extensibility_V2.pdf
- VBE2_WP22_MVD_StructDesign_To_StructAnalysis_V1.pdf
- VBE2_WP22_Tietomallien_hyodyntaminen_rakennesuunnittelijan_rajapinnoissa.pdf

Struct_to_Analysis

- Structural to Analysis General Description.pdf
- General\Diagrams\Structural to Analysis General Diagrams.pdf

Appendix 2

- General\Documents\VBE2-208.pdf - VBE2-263.pdf (useita dokumentteja)
- Ifc binding\Diagrams\Structural to Analysis Ifc Binding.pdf
- Ifc binding\Documents\VBE2-012.pdf - VBE2-162.pdf (useita dokumentteja)

WP23_Requirements_for_interactive_3D_visualizations

- VBE2_WP23_Tulosraportti.pdf
- VBE2_WP23_Visualisoinnin_kayttajavaatimukset.pdf

WP24_IFC_interface_for_interactive_3D_visualizations

- VBE2_WP24_3D_Specification.pdf
- VBE2_WP24_Interactive_3D_Visualization_UPnP_Methods_Specification.pdf

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- 2007_Case_Digitalo-abstract_@_CIB-W78_Maribor.pdf
- 2007_Light_Weight_IFC_Visualization_Client_@_CIB-W78_Maribor.pdf
- IFC_TrainingModel.ifc
- VBE2_WP25_IFC_Viewer.zip
- VBE2_WP25_nDRoom_Concept.pdf
- VBE2_WP25_SABLE-IFC-3D_POC.pdf
- VBE2_WP25_SableClient_software.pdf
- VBE2_WP25_Software_Technical_Overview.pdf
- VBE2_WP25_Software_Usage_Notes.pdf

WP3_Validation_and_Company_Data

- 2006_nDbook_content_list.pdf
- VBE2_WP3_TTY_osuuden_arviointi.pdf
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WP31_Design_of_technical_solutions_for_decision_support

- 20060523_Project_Experiences_@_Senate_TWN_Conference.pdf
- VBE2_WP31_Aurora_A4.pdf
- VBE2_WP31_TUT_Adimin_A4.pdf
- VBE2_WP31_Virtual_Building_Lab_A4.pdf

WP32_Company-specific_adaptations_of_decision_support_technologies

- VBE2_WP32_Industry_Data_Framework.pdf

WP33_Testing_of_the_company-specific_integrated_solutions

- 2006_iRoom_in_BIM_Presentations_@_ECCPM_Valencia.pdf
- VBE2_WP33_Ankkahovi.pdf
- VBE2_WP33_iRoom_model.pdf
- VBE2_WP33_JAO.pdf
- VBE2_WP33_Kaskisaari.pdf
- VBE2_WP33_Kapyla.pdf
- VBE2_WP33_Salla_Kuusela_Thesis_Summary.pdf
- VBE2_WP33_Senate_Properties_Process.pdf
- VBE2_WP33_TUT_admin_building.pdf
- VBE2_WP33_TUT_lab.pdf

WP34_Development_of_VBE_decision_support_facilities_and_services

- No documents

WP35_Requirements_management_and_Critical_Decision_Points

- VBE_Traffic_Lights.vss
- VBE2_WP35_Critical_Decision_Points_Diagram.vsd
- VBE2_WP35_Critical_Decision_Points_Presentation.pdf
- VBE2_WP35_Critical_Decision_Points_Report.pdf

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- 2006_Maintaining_Data_in_BIM-based_FM_@_CIB-W70_Trondheim.pdf
- VBE2_WP4_Abstract_of_Real_Estate_BIM.pdf
- VBE2_WP4_Data_transformation_process.pdf
- VBE2_WP4_Essential_data.pdf
- VBE2_WP4_Examples_of_data_content.pdf
- VBE2_WP4_Kiinteistojen_huoltokirjamenettely_tietomallia_hyodyntaen.pdf
- VBE2_WP4_tiedonsiirto.pdf
- VBE2_WP4_tietosisalto.pdf
- VBE2_WP4_TTY_loppuraportti.pdf
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WP5_International_Activities

- VBE2_WP5_End_Report.pdf

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- 20050224_New_approach_to_IFC_view_definitions_@_Madrid.pdf
- 20050531_View_definition_harmonization_for_implementers_@_Oslo.pdf
- 20050720_Integration_of_Multiple_Product_Models_@_CIB-W78_Dresden.pdf
- 20050720_Integration_of_Multiple_Product_with_IFC_Model_Servers_@_CIB-W78_Dresden.pdf
- 20050720_Multi-model_Environment_Links_between_Objects_@_CIB-W78_Dresden.pdf
- 20051012_Vera_Program_@_IAI_Beijing.pdf
- 20051014_View_definition_harmonization_@_Beijing.pdf
- 20051110_QualityControl_and_Responsibilities.pdf
- 20051115_Customer_Requirement_Management_@_Abu_Dhabi.pdf
- 20051117_Customer_Requirement_Management_@_Dubai.pdf
- 20051119_Customer_Requirement_Management_@_Bahrain.pdf
- 20060201_View_definition_harmonization_@_Oslo.pdf
- 20060314_Building_Information_Models_in_the_Finnish_RECC_@_CRC_Australia_Keynote.pdf
- 20060315_HUT600_@_Sydney.pdf
- 20060315_Latest_Finnish_Projects_@_Sydney.pdf
- 20060321_Adopting_Innovation_@_Melbourne.pdf
- 20060323_Adopting_Innovation_@_Brisbane.pdf
- 20060324_Adopting_Innovation_@_Brisbane.pdf
- 20060330_Supporting_Decision_in_Construction_Project_Management_@_Nordic_Construction_IT_Seminar.pdf
- 20060404_MVD_Proposal_@_Munich.pdf
- 20060404_Practical_Proposal_@1_Munich.pdf
- 20060406_MVD_@_IC_Munich.pdf
- 20060523_Project_Experiences_@_Senate_TWN_Conference.pdf
- 20060523_VBE-BIM_Status_Overview_@_Senate_TWN_Conference.pdf
- 20060615_Ten_Years_of_IFC_Development_@_CIB-W78_Montreal_Keynote.pdf
- 20060622_Adopting_Innovation_@_IAI_London.pdf
- 20060824 ICT in Building and Construction_@_VTT_Scientific_Board.pdf
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- 2005_Integrated_Product_Models_for_Built_Environment_@_Yamaguchi_University.pdf
- 2005_Integration_of_Multiple_Product_Models_@_CIB-W78_Dresden.pdf
- 2005_Integration_of_Multiple_Product_with_IFC_Model_Servers_@_CIB-W78_Dresden.pdf
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- 2007_SW_Development_Approaches_and_Challenges_of_4D_PM_@_CIB-W78_Maribor.pdf

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- 2007_ICT_barometer.pdf
- BIM_Slide_Show.pdf
- Danish_IFC_Exchange_Test_April_2006.pdf
- EON_touchlight.wmv
- EON_TouchLight_web.pdf
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- What_is_the_NBIMS.pdf

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- 2005_Taylor_and_Levitt_Aligning_innovations.pdf
- 2005_Taylor_Dissertation.pdf
- 20061117_Bazjanac_Tampere_GST-E+demo.pdf
- 2006_Bazjanac_BIM_Basics_@_Brisbane.pdf
- 2006_Bazjanac_BIM_Cost+Energy_Estimation_@_Dresden.pdf
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- 2006_CIFE_Case_Report_Aurora_II_Project.pdf
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- 20070327_ICT_barometri_esitys.pdf
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- 20050512_Rakennuttamisprosessin_tietoverkot_@_RIL.pdf
- 20050906_Tuotemallien_hyodynt.,minen_liiketoiminnassa_@_RTS.pdf

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- 20050929_Tuotemallinnuksen_hyodyt_rakennussuunnittelussa_@_SAFA-ATL.pdf
- 20051114_Mallintamisen_ja_IFC-tiedonsiirron_tilanne_maailmalla_@_ProIT.pdf
- 20051121_VBE_status_@_SARA_johtoryhma.pdf
- 20051201_Tuotemallit muuttavat_rakennusprosessin_Rakennuttajakoulutus_Dipoli.pdf
- 20060310_Kansainv.,linen_tuotemallistandardointi_@_RTS.pdf
- 20060502_Mallintaminen_valtaa_maailmaa_@_Tekla.pdf
- 20060522_Design_in_20xx_@_VTT.pdf
- 20060926_Integroidut_tietomalli_@_Terasrakenneseminaari.pdf
- 20061010_VBE_esitys_@_HYSK_Ihannesairaala.pdf
- 20061013_Suunnittelun_tulevaisuudesta.pdf
- 20070208_Rakentamisen ICT_tulevaisuus_@_RTT_koulutus.pdf
- 20070508_Tuotemallintaminen_@_CMU.pdf

WP6_VBE2_Seminars

20060425_Interactive_3D

- 20060425_VBE2_Interactive_3D.pdf
- Hietanen.pdf
- index.htm – selainkäyttöliittymä Interactive 3D seminaarin aineistoon
- Interactive_3D.pdf
- Kahkonen_&_Ronkko.pdf
- Kokko.pdf
- Woodward_English.pdf
- Woodward_Suomi.pdf

Larsson

- EON Realityn esittelyaineisto

Photos

- Seminaarin valokuvat

20070131_Suomen_buildingSMART

- 2007.01.31_Ohjelma.pdf
- Tuotemalliseminaari_2007_A-konsultit.pdf
- Tuotemalliseminaari_2007_Finnmap.pdf
- Tuotemalliseminaari_2007_Granlund.pdf
- Tuotemalliseminaari_2007_Kiviniemi.pdf
- Tuotemalliseminaari_2007_Lemcon.pdf
- Tuotemalliseminaari_2007_NCC.pdf
- Tuotemalliseminaari_2007_Senaatti.pdf
- Tuotemalliseminaari_2007_Tekes.pdf
- Tuotemalliseminaari_2007_Tekla.pdf
- Tuotemalliseminaari_2007_Tocosoft.pdf

20070515_Tulosseminaari

- Company_Strategies_and_Benefits.pdf
- Decision_Support_Technologies.pdf
- PreSeed-palvelut_Sitra.pdf
- Ratkaisuja IFC-mallien visualisointiin.pdf
- Requirements_management_and_critical_decision_points.pdf
- Teknologian_valmiusaste.pdf
- Tutkimusyhteistyö_Suomen_Akatemia.pdf
- VBE2_tulosseminaarin_ohjelma.pdf
- VBE2_tulosseminaarin_raportti.pdf
- VBE2_yleiskuvaus.pdf

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- Yritysten_tutkimushankkeet_Tekes.pdf

Photos

- Seminaarin valokuvat

WP6_VBE2_Workshops

20051215_VBE_Implementation

- Sharing_Building_Product_Models.pdf
- Workshop_program.pdf
- WP1_presentation.pdf

20060210_MVD_Workshop

- Aurora2.pdf
- IFC_Model_View_Definitions_and_IDM.pdf

20060601_Steering_Group_Workshop

- WP1_Company_Strategies.pdf
- WP2_Data_Transfer.pdf
- WP3_Case_Kapyla.pdf
- WP3_Decision_Support.pdf
- WP4_Mallipohjaisen_kiinteistoliiketoiminnan_organisointi.pdf
- WP4_Model_based_RE_Business_Processes.pdf
- WP4_Tilanneraportti.pdf
- WP4_Tuotemallin_kaytto_kiinteistoliiketoiminnassa.pdf
- WP5_&_6.pdf

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- VBE_ideas.pdf
- VBE_Kartta.pdf
- VBE_kartta_PowerPoint.pdf

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- VBE Kartta.vss
- VBE_Kartta_Visio2002.vsd
- VBE_Map_Visio2002_English.vsd

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- VBE2_Final_Project_Plan.pdf
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- 20050926_OR_Muistio_01.pdf
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- 20050926_WP7_report.pdf
- 20051025_Executive_Status_Report.pdf
- 20051025_WP_reports.pdf
- 20051031_JR_Muistio_02.pdf
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- 20051212_JR_Muistio_03.pdf
- 20060110_Executive_Status_Report.pdf
- 20060110_WP_reports.pdf
- 20060206_JR_Muistio_04.pdf
- 20060206_WP3_presentation.pdf
- 20060331_Executive_Status_Report.pdf
- 20060331_WP_Reports.pdf
- 20060411_JR_Muistio_05.pdf
- 20060411_WP23_Presentation.pdf
- 20060531_Executive_Status_Report.pdf
- 20060531_WP_Reports.pdf
- 20060607_JR_Muistio_06.pdf
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- 20060923_WP_Reports.pdf
- 20061002_JR_Muistio_07.pdf
- 20061119_Executive_Status_Report.pdf
- 20061120_WP_Reports.pdf
- 20061124_JR_Muistio_08.pdf
- 20070114_Executive_Status_Report.pdf
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- 20070313_JR_Muistio_09.pdf
- 20070527_Executive_Status_Report.pdf
- 20070530_JR_Muistio_10.pdf

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- VBE2_WP1_End_Report.pdf
- VBE2_WP2_TTY_osuuden_arviointi.pdf
- VBE2_WP2_TUT_End_Report.pdf
- VBE2_WP3_TTY_osuuden_arviointi.pdf
- VBE2_WP3_TUT_End_Report.pdf
- VBE2_WP4_TTY_loppuraportti.pdf
- VBE2_WP4_TUT_End_Report.pdf
- VBE2_WP5_End_Report.pdf