

# ERCIM NEWS

The background of the cover features a stack of several Tic Tac Toe boards. The boards are arranged in a perspective view, with some in the foreground and others receding into the background. The boards are yellow and have black grid lines. The pieces are blue 'X's and red 'O's. A blue, cube-like structure made of parallel lines is positioned on top of the boards, partially obscuring the 'ERCIM' part of the title.

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**Special:**  
**Games**  
**Technology**

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# ERCIM-Led MUSCLE Network of Excellence: Approved and Poised to Embark on Ambitious Four-Year Research and Integration Program

by Eric Pauwels

The European Commission signed the contract for the FP6 Network of Excellence MUSCLE (Multimedia Understanding through Semantics, Computation and Learning) on 23 February, thereby giving this ERCIM-led consortium of 42 scientific groups the final go-ahead to embark on an ambitious four-year research and integration program.

As the Network's expanded acronym indicates, MUSCLE aims to facilitate high-level access to multimedia databases by systematically incorporating machine learning into an integrated approach to multimedia data mining. The original impetus for this initiative stems from the realisation that we urgently need new tools to intelligently index and explore the vast quantities of multimedia documents currently being amassed. As the enormous size of these collections precludes comprehensive human annotation, the only viable alternative is the development of reliable machine perception and understanding, and in particular, the automatic creation of semantically rich metadata that can be used as input for subsequent high-level processing. Indeed, enriching multimedia databases with additional layers of automatically generated semantic meta-data, as well as the artificial intelligence to reason about these (meta)data, seems the way forward in mining for complex content, and it is at this level that MUSCLE will focus its main effort. This will enable users to move away from labour-intensive, case-by-case modelling of individual applications, and allow them to take full advantage of generic adaptive and self-learning solutions that need minimal supervision.

The scientific work has been divided up into workpackages (WP), which collectively constitute the Joint Program of Activities (JPA). Each WP covers a different but complementary component in the overall research strategy. The Single Modality WP groups together all the research that is restricted to a single sensor modality (ie audio, video, speech). This well-established approach

is augmented by the work done in the Cross-Modal Integration WP, where the focus is on performance improvement that can be achieved by combining different but synergistic modalities. For instance, visual interpretation of a sports video can be improved by taking into account the accompanying audio stream (eg crowd cheering). The WP on Machine Learning addresses the possibility of learning data-models automatically instead of having to hand-code them. A typical application would be the automatic classification of music into classical or modern based on a number of illustrative examples. The WP on Computation Intensive Methods investigates how sophisticated computational techniques can assist in exploring complicated models or estimating uncertainty. Using numerical simulation to determine parameter confidence intervals is a case in point. Finally, the WP on Human Computer Interfaces looks at the role of human computer interfaces in the exploration or visualisation of complex datasets, while the Meta-Data Representation WP concerns itself with the internal representation of acquired information.

## Two Grand Challenges

To encourage close coordination of effort and durable scientific integration, MUSCLE will set itself two 'Grand Challenges'. These are ambitious research projects that involve the entire spectrum of expertise represented within the consortium and as such, will act as focal points. The first challenge addresses natural high-level interaction with multimedia databases. This project will work on querying of multimedia databases at a high semantic level. Think

Ask Jeeves for multimedia content: one can address a search engine using natural language and it will take appropriate action, or at least ask intelligent, clarifying questions. This is an extremely complicated problem and will involve a wide range of techniques: natural language processing, interfacing technology, learning and inferencing, merging of different modalities, federation of complex meta-data, appropriate representation and interfaces and so on. The second challenge is more related to machine perception and addresses the problem of detecting and recognising humans and their behaviour in videos. At first glance, this might seem rather narrow but it has become clear that robust performance will rely heavily on the integration of various complementary modalities such as vision, audio and speech. Applications are legion: surveillance and intrusion detection, face recognition and registration of emotion or affect and automatic analysis of sports videos and movies, to name just a few.

The research plans outlined above cover only part of the MUSCLE mission. In addition, strong emphasis will be placed on networking and dissemination, as the European Commission intends NoEs to be important players in a Europe-wide drive towards durable integration and collaboration. To this end, MUSCLE has planned a number of initiatives. First, there will be an annual post-doctoral fellowship scheme extending and complementing the ERCIM model. As is the case for the latter, applications will be open to talented young researchers from across the globe. The consortium will also set up a Web-based infrastructure to facilitate electronic



collaboration between different teams and support access to multimedia databases for benchmarking or testing purposes. In the same vein, MUSCLE will host a multimedia preprint server, offering authors the opportunity to publish their research results in media-rich format, which will do better justice to the content. Input from industrial and

commercial parties will be solicited through the setting up of an Application Forum. Finally, in order to maximise its impact on the European and global research scenes, MUSCLE will pool resources with other Networks and Integrated Projects active in the area of Semantic-based Knowledge Systems.

For more information, the reader is invited to visit the MUSCLE Web page.

**Links:**

<http://www.cwi.nl/projects/muscle>

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## DELOS — A New Network of Excellence on Digital Libraries under FP6

by Costantino Thanos

**A new Network of Excellence for Digital Libraries, known as DELOS, has been launched by the European Commission under the Sixth Framework Programme. DELOS will build on the initial work of two very successful previous activities also sponsored by ERCIM and aimed at promoting research in the Digital Library field under the Fourth and the Fifth Framework programmes: the DELOS Working Group 1996-99, and the first DELOS Network of Excellence 2000-2003.**

Digital libraries represent a new infrastructure and environment that has been made possible by the integration and use of a number of IC technologies, the availability of digital content on a global scale and a strong demand from users who are now online. The DELOS 10-year grand vision is that "Digital Libraries should enable any citizen to access all human knowledge any time and anywhere, in a friendly, multi-modal, efficient and effective way, by overcoming barriers of distance, language, and culture and by using multiple Internet-connected devices".

The main objective of the DELOS NoE is to define and conduct a joint program of activities (JPA) in order to integrate and coordinate the ongoing research activities of the major European research teams in the field of digital libraries for the purpose of implementing the DELOS digital library grand vision.

Specific technical objectives of the DELOS NoE are to:

- develop a common architectural digital library infrastructure that can be customized to meet the requirements of different applications
- provide a common foundation for several forms of information seeking, searching and querying in digital

libraries, so that it may become possible for all members of society to be provided by digital library systems in a cohesive way

- establish a sound framework for expressing and managing unconventional information manipulations that are critical in many applications
- establish a theoretically motivated and empirically supported frame of reference for designers and researchers in the field of user interfaces and visualization techniques
- develop mechanisms for the preservation of complex and dynamic objects
- provide a theoretical and practical framework for the evaluation of digital libraries and their components.

Other important objectives of DELOS are to:

- network and structure European research on digital libraries, so as to consolidate an emerging community
- contribute towards improving the effectiveness of European research in the digital library field
- provide a forum where researchers, practitioners, and representatives of interested applications and industries can exchange ideas and experiences
- contribute towards improving international cooperation in digital library research areas.

The major milestones for the DELOS NoE are:

- the DELOS portal, which will maintain and make accessible the collection of all the results and reports produced by the Network. It will also provide information on the most recent research results in the field of digital libraries as well as the latest information about relevant international projects, initiatives, conferences, etc
- a cross-referenced survey of the technologies in use and the state of the art in all the DL-related fields, which will be made available to the research community
- a reference architecture of a Digital Library Management System (DLMS). This will be jointly defined by the Network participants
- one or more DLMS prototypes, implemented according to the reference architecture, and developed jointly by the Network participants.

The Joint Program of Activities is organized into seven research clusters and is composed of three types of activities — integration, research and dissemination: Digital Library Architecture, coordinated by the Swiss Federal Institute of Technology and the University for Health Informatics and Technology, Tyrol; Information Access and

Personalization, coordinated by the University of Athens; Audio/Visual and Non-traditional Objects, coordinated by the University of Florence and the Technical University of Crete; User Interfaces and Visualization, coordinated by the University of Rome 1; Knowledge Extraction and Semantic Interoperability, coordinated by UKOLN, University of Bath; Preservation, coordinated by the University of Glasgow; Evaluation, coordinated by the University of Duisburg.

In order to coordinate the dissemination effort of the wide range of activities carried out by the Network, a Virtual D-Lib Competence Center (VDLCC) will be established. In addition to providing support for the dissemination of the Network activities, the Center will provide education, training and technology transfer to research, memory institutions and industrial organizations in the field of digital libraries. The Virtual D-Lib Center will be implemented by the coordinated efforts of three institutions participating in the Network, strategically located in Europe: ISTI-CNR in Italy, UKOLN

(University of Bath) in the UK, and Netlab (University of Lund) in Sweden.

The Network is managed administratively and financially by ERCIM and scientifically by the Institute for Information Science and Technologies of the Italian National Research Council (ISTI-CNR).

**Link:**

<http://www.delos.info>

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## A Belgian Member for ERCIM

Belgium is officially part of ERCIM since January 2004. After a decade of effort, this finally closes the curious 'hole' in ERCIM's map of Europe.

Belgium has no independent research center similar to CWI, SICS, or INRIA, and nothing similar to the 'grandes écoles' in France. There are mainly universities, which are responsible for both education and research. They are organized independently by the French and Flemish communities. Research is coordinated by the FNRS (Fonds National de la Recherche Scientifique) for the French community and the FWO (Fonds voor Wetenschappelijk Onderzoek) for the Flemish community.

The Belgian membership is jointly sponsored by FWO and FNRS. This enables all Belgian research institutions to participate fully in ERCIM activities. The FWO has designated Bart De Moor of the Katholieke Universiteit Leuven as Belgian member of the Board of Directors, for an initial two year term. The FNRS has designated Peter Van Roy of the Université catholique de Louvain (UCL) as Belgian member of the Executive Committee, also for a two year term. Benoît Michel of UCL will be the first Belgian local editor of ERCIM News.

## ERCIM PhD Fellowship Programme

**ERCIM offers 18-month fellowships in leading European information technology research centres. Fellowships are available for PhD-holders from all over the world. Next Deadline for Applications: 30 April 2004.**

The PhD Fellowship Programme has been established as one of the premier activities of ERCIM. Ideally, a fellow will work in two ERCIM institutes, thus contributing not only to the work done locally, but also to cohesion between ERCIM partners and to the cross-fertilisation and cooperation between research groups working in similar areas in different laboratories. The fellowship scheme also helps young scientists to become involved in one of the ERCIM Working Group initiatives, to improve their knowledge of European research structures and networks and to gain more insight into the working conditions of leading European research institutions.

A preliminary list of topics includes but is not restricted to scientific fields covered by the ERCIM Working Groups:

- Applications of Numerical Mathematics in Science
- Constraints Technology and Applications
- Control and System Theory
- Dependable Software-Intensive Systems
- Digital Libraries
- E-Learning
- Environmental Modelling
- Formal Methods

- Health and Information Technology
- Image and Video Understanding
- IT and Mathematics applied to Interventional Medicine
- Matrix Computations and Statistics
- Rapid Integration of Software Engineering Techniques
- Semantic Web
- Soft Computing
- User Interfaces for All.

**Conditions**

Applicants must:

- have a PhD degree or be in the last year of the thesis work
- be fluent in English
- be discharged or get deferment from military service
- start the grant before October 2004
- have completed their PhD before starting the grant.

The fellow will receive a monthly allowance which may vary depending on the country. In order to encourage the mobility, a member institute will not be eligible to host a candidate of the same nationality.

**How to apply**

Applications must be submitted online.

**More information:**

<http://www.ercim.org/fellowship/>



# Semantic Web Emerges as Commercial-Grade Infrastructure for Sharing Data on the Web

by Eric Miller

In February 2004, the Wide Web Consortium announced final approval of two key Semantic Web technologies, the revised Resource Description Framework (RDF) and the Web Ontology Language (OWL). RDF and OWL are Semantic Web standards that provide a framework for asset management, enterprise integration and the sharing and reuse of data on the Web. These standard formats for data sharing span application, enterprise, and community boundaries — all of these different types of 'user' can share the same information, even if they don't share the same software.

This announcement marked the emergence of the Semantic Web as a broad-based, commercial-grade platform for data on the Web. The deployment of these standards in commercial products and services signals the transition of Semantic Web technology from what was largely a research and advanced development project over the last five years, to more practical technology deployed in mass market tools that enables more flexible access to structured data on the Web.

Semantic Web-enabled software using RDF and OWL include:

- Content creation applications: Authors can connect metadata (subject, creator, location, language, copyright status, or any other terms) with documents, making the new enhanced documents searchable
- Tools for Web site management: Large Web sites can be managed dynamically according to content categories customized for the site managers
- Software that takes advantage of both RDF and OWL: Organizations can integrate enterprise applications, publishing and subscriptions using flexible models
- Cross-application data reuse: RDF and OWL formats are standard, not proprietary, allowing data reuse from diverse sources.

Many specific examples of commercial applications and enterprise scale implementations of these technologies are detailed in the RDF/OWL testimonial page, RDF Implementation and OWL Implementation pages (see Links).

## How the Semantic Web Pieces Fit Together - XML, RDF and OWL

The design of Semantic Web is more characteristic of Web Evolution than Revolution. The Semantic Web is made through incremental changes, by bringing machine-readable descriptions to the data and documents already on the Web. XML, RDF and OWL standards enable the Web to be a global infrastructure for sharing both documents and data, which make searching and reusing information easier and more reliable as well.

W3C's Semantic Web Activity builds on other work such as those defined by W3C's XML and URI Activities. Its focus is

to develop standards and technologies, which use XML for syntax and URI for naming, that facilitate the sharing and reuse of data on the Web.

At the foundation, XML provides a set of rules for creating vocabularies that can bring structure to both documents and data on the Web. XML gives clear rules for syntax; XML Schemas then serve as a method for composing XML vocabularies. XML is a powerful, flexible surface syntax for structured documents, but imposes no semantic constraints on the meaning of these documents.

RDF — the Resource Description Framework — is a standard way for simple descriptions to be made. What XML is for syntax, RDF is for semantics — a clear set of rules for providing simple descriptive information. RDF Schema then provides a way for those descriptions to be combined into a single vocabulary. RDF is integrated into a variety of applications including:

- library catalogs
- world-wide directories
- syndication and aggregation of news, software, and content
- personal collections of music, photos, and events.

In these cases, each uses XML as an interchange syntax and URIs for naming. The RDF specifications provide a powerful framework for supporting the exchange of knowledge on the Web.

RDF is a standard a way for simple descriptions to be made; RDF Schema provides a way for those descriptions to be combined into a single vocabulary. What's needed next is a way to develop subject - or domain - specific vocabularies. That is the role of an ontology. An ontology defines the terms used to describe and represent an area of knowledge. Ontologies are used by people, databases, and applications that need to share subject-specific (domain) information - like medicine, tool manufacturing, real estate, automobile repair, financial management, etc. Ontologies include computer-usable definitions of basic concepts in the domain and the relationships among them. They encode knowledge in a domain and also knowledge that spans domains. In this way, they make that knowledge reusable.

OWL — the Web Ontology Language — provides a language for defining structured, Web-based ontologies which delivers richer integration and interoperability of data among descriptive communities. Where earlier languages have been used to develop tools and ontologies for specific user communities (particularly in the sciences and in company-specific e-commerce applications), they were not defined to be compatible with the architecture of the World Wide Web in general, and the Semantic Web in particular.

OWL builds on RDF and RDF Schema to add the following capabilities to ontologies:

- ability to be distributed across many systems
- scalability to Web needs
- compatibility with Web standards for accessibility and internationalization
- openness and extensibility.

OWL builds on RDF and RDF Schema and adds more vocabulary for describing properties and classes: among others, relations between classes (eg disjointness), cardinality (eg 'exactly one'), equality, richer typing of properties, characteristics of properties (eg symmetry), and enumerated classes.

The W3C Web Ontology Working Group is comprised of industrial and academic expertise, lending the depth of research and product implementation experience necessary for building a robust ontology language system. OWL is based the DAML+OIL language, which was developed by an international team funded by the US Defense Advanced Research Projects Agency (DARPA) and the European Commission's Information Society Technologies program. The release of the OWL recommendations represent the maturation of this previous work shaped by the members of the World Wide Web Consortium.

### Future Work — W3C launches phase 2 of Semantic Web Activity

With the recent publication of the revised RDF and the new OWL specifications we are seeing a growing number of application developers applying these technologies in new and innovative application areas. In March 2004, the W3C Membership approved two new Working Groups, the Best Practices and Deployment and RDF Data Access to facilitate this development and ease the sharing of data located across distributed collections.

The newly chartered Semantic Web Best Practices and Deployment Working Group is focused on providing hands-on support for developers of Semantic Web applications. This Working Group will help application developers by providing them with 'best practices' in various forms, ranging from engineering guidelines, ontology/vocabulary repositories to educational material and demo applications.

The RDF Data Access Working Group whose focus will be to evaluate the requirements for a query language and network protocol for RDF and defined formal specifications and test cases for supporting such requirements. A recommended query language will reduce redundancy and enhance interoperability as SQL did for relational databases and help make it as easy to 'join' data on the Web as it is to merge tables in a local relational database.

With these two new Working groups being chartered through January 2006, the W3C Semantic Web Activity will continue to foster many more developments and through the Semantic Web Interest Group investigate additional areas of standardization that will strengthen the Semantic Web.

*Eric Miller is the W3C Semantic Web Activity Lead and a Research Scientist at MIT's Computer Science and Artificial Intelligence Laboratory.*

#### Links:

Semantic Web Home Page: <http://www.w3.org/2001/sw/>  
RDF Home Page: <http://www.w3.org/RDF/>  
RDF Core Working Group Home Page:  
<http://www.w3.org/2001/sw/RDFCore/>  
Web Ontology Working Group Home Page:  
<http://www.w3.org/2001/sw/WebOnt/>

## VoiceXML 2.0 gives Voice to the Web

VoiceXML 2.0 has been recently published as a W3C Recommendation. A W3C Recommendation is the equivalent of a Web standard, indicating that this W3C-developed specification is stable, contributes to Web interoperability, and has been reviewed by the W3C Membership, who favor its adoption by the industry.

VoiceXML 2.0 is an XML language for writing Web pages you interact with by listening to spoken prompts and jingles, and control by means of spoken input. The goal of VoiceXML 2.0 is to bring the advantages of Web-based development and content delivery to interactive voice response applications.

VoiceXML 2.0 allows developers to create audio dialogs that feature:

- spoken prompts (synthetic speech)
- output of audio files and streams
- recognition of spoken words and phrases
- recognition of touch tone (DTMF) key presses
- recording of spoken input
- control of dialog flow
- telephony control (call transfer and hangup).

VoiceXML 2.0 has been carefully designed to give authors full control over the spoken dialog between the user and the application. The application and user take it in turns to speak: the application prompts the user, and the user in turn responds.

VoiceXML 2.0 makes it easy to rapidly create new applications and shields developers from the low level and implementation details. It separates user-interaction from service logic.

The adoption rate of VoiceXML 2.0 is already industry wide, as the implementation evidence is very important, with at least eight known implementations in both prototype and fully released products. A complete list of current implementors is available at <http://www.w3.org/Voice/2004/vxml-ir/>.

#### Links:

<http://www.w3.org/Voice/>  
<http://www.w3.org/TR/2004/REC-voicexml20-20040316/>  
<http://www.w3.org/Voice/Guide/>



## W3C Mobile Web Standards lined up at 3GSM 2004

W3C's results in Multimodal Interaction, Voice Browsing, Device Independence, and Multimedia Messaging were presented at the over 29,000 visited 3GSM 2004 Congress, from 23 to 26 February 2004, in Cannes, France.

Starting with a workshop in 1998, W3C develops interoperability standards for the Mobile Web, and two with significant present and future impact challenges are currently addressed: multimodal access and single authoring.

W3C's Multimodal Interaction Activity works on standards that bring interoperability to writing multimodal Web services. W3C Multimodal Interaction standards will enable a new class of exciting mobile applications that combine today's Web technologies with tomorrow's mobile technologies including voice recognition (via Speech Interface Framework, including Speech Recognition Grammar Specification, Speech Synthesis Markup Language, and VoiceXML 2.0), handwriting recognition and gestures (via InkML).

W3C's Device Independence Activity is working on standards that will significantly lower the cost of authoring Web content to be adapted to specific mobile devices or user preferences. It enables efficient multi-channel publication by single authoring. Making a device-independent Web requires improved communication between user devices and Web servers. CC/PP 1.0 provides a standardized format of the description of information that will allow Web-enabled devices to effectively communicate their capabilities to the desired server.

In addition, much of the work done in W3C Working Groups allows for profiling and adaptations of specifications to suit the needs of diverse devices. Today, SMIL (SMIL Basic) is at the heart of 3GPP's Multimedia Messaging Service (MMS), and the mobile versions of SVG (Tiny) and XHTML (XHTML Basic and Modularization) are in widespread use in mobile applications. All of these specifications allow for rich content experiences, and leverage the power and extensibility of the XML standard.

Early 2004 W3C announcements, with three W3C specifications reaching Recommendation status - CC/PP 1.0, VoiceXML 2.0, Speech Recognition Grammar - bring the advantages of Web-based development and content delivery to interactive voice response applications.

### Links:

<http://www.w3.org/2002/mmi/>  
<http://www.w3.org/2001/di/>  
<http://www.w3.org/2004/02/3GSM-2004.html>

## Last W3C Recommendations

- VoiceXML 2.0, 16 March 2004, Jim Ferrans, Andrew Hunt, Bruce Lucas, Brad Porter, Ken Rehor, Steph Tryphonas, Scott McGlashan, Daniel C. Burnett, Jerry Carter, Peter Danielsen
- Speech Recognition Grammar Specification (SRGS), 16 March 2004, Andrew Hunt, Scott McGlashan
- OWL Web Ontology Language Overview, 10 February 2004, Deborah L. McGuinness, Frank van Harmelen
- OWL Web Ontology Language Guide, 10 February 2004, Michael K. Smith, Chris Welty, Deborah L. McGuinness
- OWL Web Ontology Language Reference, 10 February 2004, Guus Schreiber, Mike Dean
- OWL Web Ontology Language Semantics and Abstract Syntax, 10 February 2004, Peter F. Patel-Schneider, Patrick Hayes, Ian Horrocks
- OWL Web Ontology Language Test Cases, 10 February 2004, Jeremy J. Carroll, Jos De Roo
- OWL Web Ontology Language Use Cases and Requirements, 10 February 2004, Jeff Heflin
- Resource Description Framework (RDF): Concepts and Abstract Syntax, 10 February 2004, Graham Klyne, Jeremy J. Carroll
- RDF Semantics, 10 February 2004, Patrick Hayes
- RDF Primer, 10 February 2004, Frank Manola, Eric Miller. This specification supersedes Resource Description Framework (RDF) Model and Syntax Specification published on 22 February 1999
- RDF Vocabulary Description Language 1.0: RDF Schema, 10 February 2004, Dan Brickley, Ramanathan V. Guha
- RDF/XML Syntax Specification (Revised), 10 February 2004, Dave Beckett
- RDF Test Cases, 10 February 2004, Jan Grant, Dave Beckett
- Namespaces in XML 1.1, 4 February 2004, Andrew Layman, Richard Tobin, Tim Bray, Dave Hollander
- Extensible Markup Language (XML) 1.1, 4 February 2004, François Yergeau, John Cowan, Tim Bray, Jean Paoli, C. M. Sperberg-McQueen, Eve Maler
- Document Object Model (DOM) Level 3 Validation Specification, 27 January 2004, Ben Chang, Joe Kesselman, Rezaur Rahman
- Composite Capability/Preference Profiles (CC/PP): Structure and Vocabularies 1.0, 15 January 2004, Hidetaka Ohto, Johan Hjelm, Graham Klyne, Mark H. Butler, Luu Tran, Franklin Reynolds, Chris Woodrow

An exhaustive list of all W3C Technical Reports:  
<http://www.w3.org/TR/>

ERCIM is the European host of W3C.

## IST-FET announces the Launch of Four New Research Initiatives in IST-Call 3 to be published in May 2004

The Future and Emerging Technologies (FET) is the nursery of novel and emerging scientific ideas of the EU's Information Society Technologies (IST) FP6 programme. FET's mission is to promote research that is of a long-term nature or involves high risks, compensated by the potential of a significant societal or industrial impact.

In 2004 FET is planning to launch new research initiatives, as part of the IST third Call for proposals. The four new initiatives, still subject to change, that are expected to be launched on 22nd May 2004 with closure on 22nd September 2004, are the following:

### 1. Bio-inspired Intelligent Information Systems

'Reverse engineering' / decoding of the brain or of other large assemblies of neurons could provide the knowledge for the design and development of truly intelligent information systems. This initiative reinforces and complements previous FET initiatives in neuro-IT. The objective is to explore new avenues in the design of intelligent information systems that attribute meaning to complex patterns of sensory stimuli and generate sequences of elementary actions that satisfy high-level goals. The systems should show autonomous growth in perceptual, motor and cognitive abilities, and their performance must be assessed in realistic scenarios. Three research foci are targeted: (1) characterisation of computational properties, structure and other physical constraints of large assemblies of interconnected neurones for new IT architectures and design; (2) study of natural mechanisms of evolution, development and plasticity that support self-construction, and self-repair of artificial or hybrid (biological/artificial) intelligent information processing systems; (3) integrated control architectures that generate and exploit world- and/or self-awareness.

For more information, see:  
<http://www.cordis.lu/ist/fet/bioit.htm>

### 2. Emerging Nanoelectronics

Many effects characteristic of molecular and other nanometer-scale structures have recently been discovered or demonstrated, paving the way for technological developments complementing those on the mainstream semiconductor platforms. This initiative complements mainstream IC developments with advanced research in hybrid and molecular electronics. It prepares the bases for an extension of IC technology beyond the limits of CMOS scaling and for industrial research and development programmes on non-CMOS nanometre technologies in information society applications. Three long term-directions are targeted: (1) hybrid molecular electronic with the aim of incorporating new molecular-scale developments on nanometer scale semiconductor platforms; (2) one-dimensional structures such as nanotubes or nanowires and their potential in realising devices, functions, interconnections, etc; and (3) the understanding of electrical characteristics of single molecules and the development of reproducible functions with systems of components at that scale.

For more information, see:  
<http://www.cordis.lu/ist/fet/nid.htm>

### 3. Global Computing

Global computing refers to computation over "global computers". These are computational infrastructures available globally and able to provide uniform services with variable guarantees for communication, co-operation and mobility, resource usage, security policies and mechanisms, etc., with particular regard to exploiting their universal scale and the programmability of their services. As the scope and computational power of global infrastructures continues



to grow, in order to harvest their potential benefits, a vision needs to be realised which goes well beyond incremental and disconnected improvements of diverse (and often incompatible) implementations. The objective is to define innovative theories, computational paradigms, linguistic mechanisms and implementation techniques for the design, realisation and deployment of global computational environments and their application and management.

For more information, see:  
<http://www.cordis.lu/ist/fet/gc.htm>

### 4. Quantum Information Processing

Quantum computers hold the promise for solving efficiently some computationally hard problems, like e.g. large integer factorisation or the simulation of quantum systems. Recent technological and experimental advances have given rise to an effort to build a quantum computer that would exploit quantum phenomena such as entanglement, up to now not accessible to experiments. This initiative focuses on approaches that lead to systems successfully implementing quantum algorithms on small-scale systems - including writing, processing and reading of qubits. Work on developing few qubit applications is highly encouraged, for example in the area of metrology or simulators of quantum systems. Theoretical work should aim at further developing quantum information theory. Specific problems to be addressed include physical aspects of quantum information for elucidating concepts such as multi-particle entanglement, work on communication complexity, relation with classical computational complexity theory, etc.

For more information, see:  
<http://www.cordis.lu/ist/fet/qipc.htm>



All four initiatives will be implemented using only the so-called new instruments, ie integrated projects and networks of excellence.

#### Important Dates

- The call for proposals for these initiatives will be published in mid-May at: [http://fp6.cordis.lu/fp6/calls\\_activity.cfm?ID\\_ACTIVITY=124](http://fp6.cordis.lu/fp6/calls_activity.cfm?ID_ACTIVITY=124)
- The deadline for proposals is planned to be on 22 September 2004 at 17:00.

A FET information event on the initiatives will be held in Brussels on 3-4 June 2004. Further information on this event will be published soon at the FET website: <http://www.cordis.lu/ist/fet/home.html>.

## IST-FET launches a New Web Facility for the Submission of Ideas for New Promising Research Directions in FP6 and in FP7

Since June 2003, FET has launched a new web facility for Researchers ('open forum on ideas for future research initiatives'), where they can both submit their ideas for new promising, long term Research Initiatives and support and comment on those that have already been submitted. Some of these are likely to receive EC funding either within the next IST Work Programme 2005/2006, or in the coming 7th FP of the EU. Participation to this Open Forum is strongly encouraged!

#### Link:

<http://www.cordis.lu/ist/fet/id.htm>

## European Science Foundation calls for Proposals in ICT Fields

**ERCIM and the European Science Foundation, through its Physical and Engineering Sciences Committee (PESC), recognising that they share common interests, have developed closer links at the policy level and now seek to expand these links into the support of science networking. PESC's remit covers physics, chemistry, mathematics, information and computer sciences and the engineering sciences.**

PESC's activities can be separated into three broad areas:

- giving expert scientific advice on strategic issues, including undertaking independent review of major research and infrastructure programmes and proposals,
- initiating strategic science activities, such as ESF Scientific Forward Looks, which are foresight exercises ([www.esf.org/fllooks](http://www.esf.org/fllooks)), and ESF Collaborative Research Programmes (EUROCORES – <http://www.esf.org/eurocores>), which are major transnational basic research funding programmes
- networking activities, which provide funds for European scientists to network over a range of timescales.

In this latter category, three 'instruments' are available:

- *Exploratory Workshops* enable scientists to come together to discuss topical and emerging issues, usually with the objective of identifying future directions and collaborations. An annual ESF-wide call for proposals is made, with a closing date of 1 May, for events to be held in the following year. PESC normally supports at least 10 of these events at an average budget of 10-14k€ each (see <http://www.esf.org/workshops>).
- *Scientific Programmes* are long term activities on specific themes, and typically bring together research groups working in 7 to 10 countries. These activities are funded on an a la carte basis by ESF Member Organisations, and have an average budget of 100k€ pa over 5 years. PESC normally recommends between 4 and 6 new programmes each year. PESC operates a two-stage application procedure, with outline proposals being sought in October (see: <http://www.esf.org/programmes>).

- *Scientific Networks* are normally interdisciplinary and are aimed at coordinating activities to stimulate and consolidate the community in particular fields. There are two ESF-wide closing dates (31 May and 30 November) each year. Normally between 2 and 4 new Networks are supported in the PESC area each year, with funding on average at 75k€ pa over 3 years. (see: <http://www.esf.org/networks>). The Networks scheme is presently closed to new proposals.

PESC has supported a small number of Workshops, Networks and Programmes in various branches of Information and Computer Sciences, but would welcome an increased number of proposals.

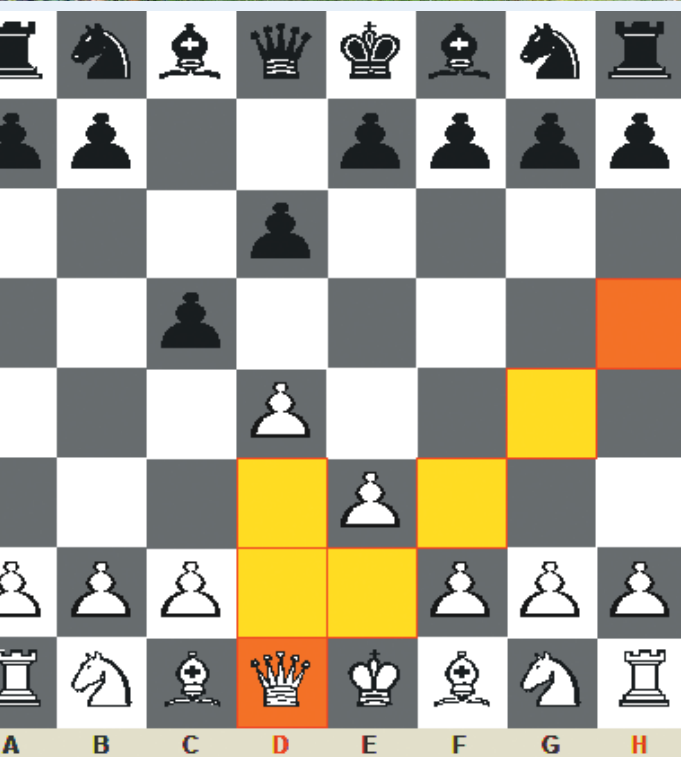
*The European Science Foundation is the European association of over 76 major national funding agencies devoted to scientific research in 29 countries.*

#### Links:

ESF: <http://www.esf.org/>

PESC and ESF: <http://www.esf.org/psc>

To be informed of PESC news, programmes and closing dates, ask [psc@esf.org](mailto:psc@esf.org) to join the PESC electronic mailing list.



# Games and Life

by Milan Mares

The word 'game' has many specific meanings: sport, childish play such as sand castles, chess and other table games, poker, roulette, as well as mathematical models of a special type of multicriterial optimisation or decision-making under uncertainty, computer animations whose running can be influenced by external entries, and many others. They use various sorts of tools, from a sheet of paper and a pencil up to sophisticated supercomputers. All of them display a common principle, however – they simulate, relatively cheaply and relatively safely, situations which could in reality be much more expensive or dangerous. Of course, an extreme roulette player or F1 pilot might be an exception to this, but are they still really playing a game? People cannot exist without games, which is the main reason why the concept of the game is so widespread and why it deserves serious attention.

The contributions included in this issue are representative of a 'games technology' theme. They range from the mathematical background of theoretical models, via their attractive applications, to the description and characteristics of technical (in this case, computer-based) instruments. Those presented were selected from exactly thirty papers delivered to the editors, and we aim in this issue to represent the most obvious trends of recent game-related research. We have organised them into several main clusters.

The first of these, which we may call the 'classical' group, includes several contributions devoted to specific models of game theory. They deal with the mathematical representation of conflict of interest, optimisation under uncertainty, or finding rules for balanced cooperation. In a certain sense, a counterpart to this group is formed by a few papers looking at new types of entertainment computer games. The other contributions are distributed somewhere between these two extreme positions.

Another group is connected with sophisticated analysis of gaming methods, and the development of algorithms for the simplification of social communication in non-standard situations or among somehow exceptional partners. We can see that simulating reality through a game opens qualitatively new links between people who are in some sense isolated. It can also simplify the process of learning – the idea of schola ludus formulated by J. A. Comenius in the seventeenth century gains qualitatively new features.

A similar philosophy, though formulated in the language of technical communication (eg cellular phones technology or data networking), can be found in the background of the contributions devoted to game-based methods for the organisation of communication networks and behaviour within



them. Even here the technology, supported by game theory, simplifies situations in which face-to-face contact is difficult or impossible.

New methods of graphical representation form a new and promising field of development (technical, as well as methodological and conceptual), offering flexible techniques for displaying complex environments in real time. This direction of research and development offers more than increasingly commercially attractive computer entertainment games. The procedures created for the games have had far-reaching consequences in other 'serious' scientific and intellectual fields in which a high level of graphical representation is desirable. This group may also include the models of virtual reality supported by game-theoretical approaches to optimisation problems, and in a wider sense it relates to the game-theory-inspired progress of technology.

Unfortunately, no results included among the contributions looked at the vagueness (fuzziness) observable in real conflict or decision-making situations, and randomness was mentioned very rarely.

Editing this issue was a challenge in the sense that we dare to attempt to forecast the near future of this attractive field of mathematical and computer sciences. There may be no other branch of science and technology in which development will progress so rapidly, and consequently there is a great deal of uncertainty in any forecast. Nevertheless, some general trends can be identified. The most spectacular of these is the progress towards reality in the models being produced, regardless of whether they relate to technical representation or methodological principles. In the computer representation of games, this trend can be observed in the continuous improvement of graphical software, real-time communication between man and computer, the dynamics and flexibility of the game, utilisation of modern communications technology and the ability to manage enormous quantities of data. In the mathematical models of game processes, basic models have been extended to special cases, including rather marginal or rare phenomena, and attention has been paid to extreme social — not strictly gaming — phenomena. If future development reinforces this trend, then we can expect further extension of applications of the gaming approach to contribute to an understanding not only of ourselves, but also of reality and its management.

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# Enabling Computers to Play Games like Humans

by Stephen McGlinchey

Producing Artificial Intelligence (AI) systems for real-time computer games can often be a challenging problem for game developers. To make a positive contribution to the gaming experience, an AI player should play a game with an appropriate level of ability or "skill" and it should also appear to be convincing, ie, it should behave in a similar way to a human player. Some recent research done at the University of Paisley has focussed on achieving these goals by using adaptive AI techniques to learn from human players. The trained AI can then be used to control game 'bots', producing behaviour of a similar fashion to the game players that they were trained on.

AI in games is normally designed with one specific game in mind. Scripting is often used, defining sets of rules to govern the AI's behaviour, and these rule sets are often, large, complex and can be expensive to create. A major disadvantage of scripted AI is that no matter how many rules are created, it can be difficult to achieve convincing behaviour that enhances the gaming experience.

AI players can be written with different objectives in mind. Some developers aim to produce AI players that are most likely to succeed in a game, and this is interesting as an AI problem. Others aim at producing AI players that will make the gaming experience more enjoyable to the human player, and this normally means that the AI behaviour and performance should be similar to that of a human player, providing game players with believable interaction with artificial opponents or team-mates etc. Two aspects of game AI that affect the experience of playing the game are:

- the level of performance
- the style of play.

For many games, it is important that the AI system can play the game at a level appropriate to that of human ability. This is true especially if the computer player is an opponent; there is little enjoyment in playing against an opponent that is too easy or too difficult to beat. The style of play of an AI player should also (in many applications) be similar to that of a human. Even if an AI player can match the performance level of a human player, if it behaves in an inhuman fashion, then

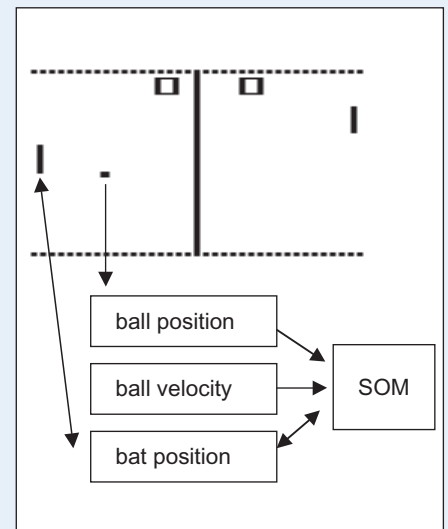
the gaming experience is less convincing, less immersive and ultimately less enjoyable. Motion of AI players should avoid being unrealistically jerky or smooth, and avoid super-human reactions to events in the game.

Recent work done by researchers at the University of Paisley has tackled the problem by using data recorded from human players to train an AI system. The resulting AI should then mimic the data that was used to train it. One researcher has termed this technique 'Game Observation Capture' (GoCap) and it has been described as 'motion capture for AI.'

There are many computational AI techniques available that could be used at the core of such a system, and our research has produced promising results with Kohonen's Self Organising Map (SOM), which is a widely used and well-understood neural network.

The game of 'pong' is a simple real-time game that is familiar to almost everyone. We have used pong to test the effectiveness of our AI learning system because it provides scope for differing styles of human. A simple AI pong player would be trivial to create, although to create one that played in the style of a human is a greater challenge. The figure shows the capture of game data: the ball's position and velocity and the player's bat position. This data is recorded once every frame.

Once the SOM has been trained, it can be used during a game to generate the oppo-



An AI opponent for the game of "pong".

nent's play by supplying only the ball's position and velocity at the network's inputs. Based on the supplied data, the SOM can be used to produce a target position to move the bat to.

The system is successful in playing in a similar style to that of the original player, and also plays with a similar level of skill. Some quirks observed in the human's play are also seen in the AI trained on that player, making the AI convincing. Future research will aim to apply this method to different games and more difficult problems, including modern games such as real-time strategy (RTS) and 3D shooters. This work is applicable not only to computer game AI, but also in other application areas such as digital actors, intelligent character animation, and in simulation.

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# Game Artificial Intelligence that Adapts to the Human Player

by Pieter Spronck and Jaap van den Herik

While the audiovisual qualities of games have improved significantly over the last twenty years, game artificial intelligence (AI) has been largely neglected. Since the turn of the century game development companies have discovered that nowadays it is the quality of the game AI that sets apart good games from mediocre ones. The Institute of Knowledge and Agent Technology (IKAT) of the Universiteit Maastricht examines methods to enhance game AI with machine learning techniques. Several typical characteristics of games, such as their inherent randomness, require novel machine learning approaches to allow them to deal with game AI.

Most commercial computer games contain computer-controlled agents that oppose the human player. 'Game AI' encompasses the decision-making capabilities of these agents. For imple-

low. Typically the agents are inflexible and make mistakes, caused by the static nature of their scripts. Reviewing game AI implementations in general, we find that developers deal with the low quality

When game AI adapts during gameplay (which is called "online learning"), it can only learn from observing actual encounters between the human player and the computer-controlled opponents. In general not many such encounters take place over the course of a game. 'Regular' machine learning techniques (such as evolutionary learning, neural networks and reinforcement learning) are difficult to apply to game AI, because they need an inconveniently large number of observations. Moreover, they are not suited to deal with the large amount of randomness that is characteristic for commercial games.

One of the solutions IKAT introduced to the problem of online learning in games is the novel technique called 'dynamic scripting'. Dynamic scripting is an online learning technique that is computationally fast, effective, robust and efficient. It maintains several rulebases with domain knowledge, one for each opponent type in the game. These rulebases are used to generate new scripts for every new opponent encountered. When rules are extracted from the rulebase to form a new script, those rules that seemed to work well in earlier encounters have a higher chance of being selected than those that seemed to evoke inferior behaviour. The selection probabilities are updated after every encounter, which allows the rulebase to optimise quickly the generation of scripts that perform well, regardless of the tactics exhibited by the human player.

Dynamic scripting has been tested in the state-of-the-art commercial roleplaying



Combat between adaptive AI (the white team) and manually developed AI (the black team).

menting game AI, especially for complex games, developers usually resort to rule-based techniques in the form of scripts. Scripts have the advantage that they are easy to understand and can be used to implement fairly complex behaviour.

'Smart' game AI endows agents with intelligent tactical behaviour, able to outwit even the best human players. Unfortunately, even in state-of-the-art games the quality of the game AI is fairly

of game AI by pitting the human player against agents that are simply physically stronger, and not against agents that play the game intelligently.

Current research at the IKAT investigates methods of enhancing complex game AI with automatic learning capabilities. Agents controlled by adaptive game AI are able to correct their own mistakes, and can change their behaviour to deal successfully with previously unseen human-player tactics.



game NEVERWINTER NIGHTS. It was used to control several different characters in a team that was pitted against a team of similar characters, driven by manually designed game AI (illustrated in the figure). Dynamic scripting was shown to be surprisingly successful, even against opponents that switched regularly between very different (but all strong) tactics. Even without any initial knowledge at all, dynamic scripting caused the team it controlled to outperform convincingly its opponents after about 30 encounters on average.

IKAT continues to investigate dynamic scripting, by applying it to different

types of games, such as real-time strategy games. The research is also extended to other forms of online learning in games, such as learning using a data store that contains gameplay experiences as a model to predict the results of selected actions.

Because many game players find the AI of modern games unsatisfactory, using machine learning to create stronger game AI is a worthwhile pursuit. However, it should be noted that too strong game AI might not be entertaining, especially not for novice players. Since the aim of commercial games is providing entertainment, the game AI

should scale transparently in accordance with the observed experience level of the human player. Adaptive game AI can provide that. So, adaptive game AI not only benefits the strong players because it gives them new challenges, but also the weaker players because they may achieve victory without the feeling that the game just let them win.

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## Games with Wireless Dynamically Changing Input/Output Units

by Anthony Savidis and Constantine Stephanidis

In the context of the European Information Society Technology Project 2WEAR the Voyager development framework has been developed to implement interactive pervasive applications with dynamically composed User Interfaces. The focus of the work is on pervasive games using handheld devices.

Our work considers the following scenario: a user carries a very small processing unit, eg the size of a credit card, with an embedded operating system (eg Linux) and wireless short-range radio networking (eg Bluetooth™). Additionally, the user may optionally collect any number of wearable wireless gadgets. Once the processing unit is switched on, the system boots and seeks

in-range devices capable of hosting interaction. When such devices are detected, they are appropriately employed to support interaction. If at some point some devices move out of range (ie are lost), the system attempts to use the remaining available devices to maintain interaction. If this does not suffice, the dialogue is considered as 'stalled'. Alternatively, as new devices come into range (ie are

discovered), the system attempts to engage those devices either to revive the dialogue from a 'stalled' state, or to optimise it further by offering a better interaction alternative.

To support the previous scenario, ambient devices embed and run special-purpose Voyager software that allows clients remotely and dynamically to

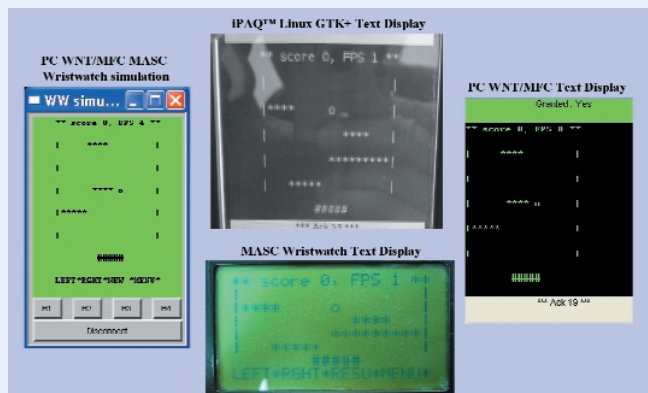


Figure 1: Alternative output configurations for the Break Out game board display. Below centre: the textual display of the MASC Ltd. Wristwatch, a wearable Voyager-enabled ambient device.

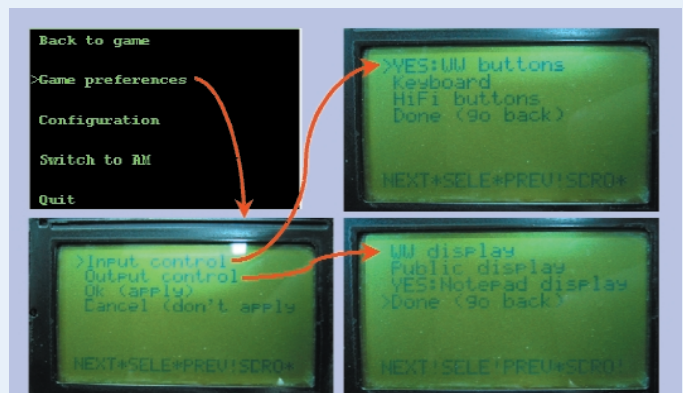


Figure 2: The game input/output style configuration dialogue. Once the 'Back to game' option is chosen, Voyager will try to activate the preferred pair of input and output control styles.

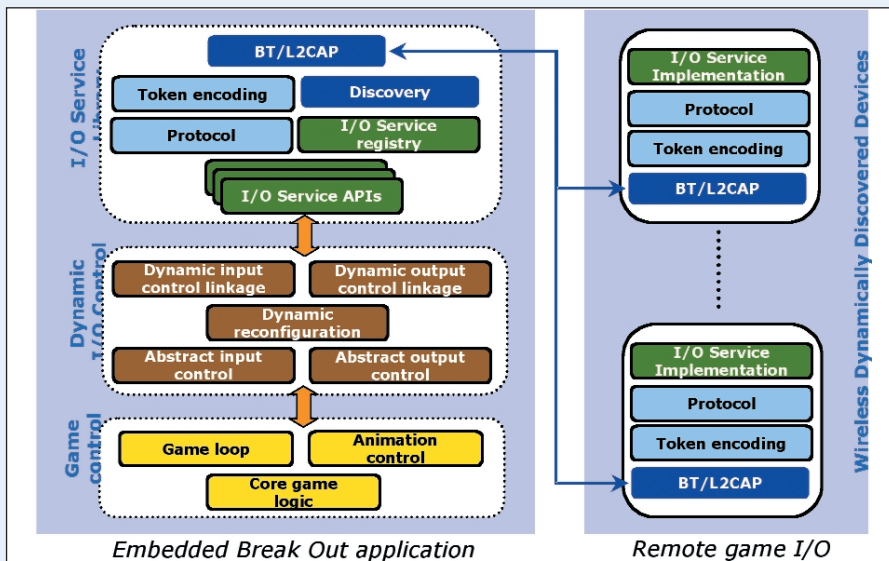


Figure 3: The run-time architecture of the Break Out game: the various software components of the Break Out application running on the user pocket machine (left), and the software structure of remote I/O services (right).

discover, recognise, grant, control, and release such devices ‘on the fly’. Through the Voyager development framework, we have implemented the ambient Break Out game, a variant of the famous ‘break out’ game developed in the early 60s, known to be the first ever action-based computer game. We have chosen this game partly because of its simplicity, but mainly because its graphical stages can be easily translated to textual alternatives. Its implementation as a Voyager application has resulted in the delivery of a user interface that is dynamically reconfigurable, either automatically or on user demand, for both the main game board and typical non-game dialogues. In Figure 1, snapshots and

photos of alternative output configurations for the game board are shown. Transitions between such configurations are either automatic (ie Voyager tries to revive or optimise the dialogue) or manual (ie the user updates the configuration preferences and requests explicit re-configuration). The game configuration dialogue allows the user to choose the most preferable input and output game styles. Where the available ambient devices allow multiple game styles, the user may easily switch among the viable alternatives, using the dialogue illustrated in Figure 2.

The run-time performance of the Break Out game is very slow due to the severe

run-time overhead of wireless communication. To avoid buffer overflows, explicit flow control had to be implemented within event posting (from ambient input devices to the Break Out client) and output requests (from the Break Out client to the ambient output devices). This flow control introduced a significant communication overhead, although users can still play the game normally, since the animation speed of the game is adapted dynamically to the total time it takes to remotely display and receive the event-processing acknowledgement. This communication overhead is naturally expected to diminish as new generations of BT chipsets are manufactured.

Finally, in Figure 3, the run-time architecture of the Break Out application setup is illustrated. The Break Out application is split into three key packages: (i) The I/O service library, delivered as a collection of C++ proxy APIs for remote-device I/O services; (ii) the dynamic I/O control package, which implements logical I/O control (eg left, right and textual platform display) while enabling the particular employed I/O services to change on the fly; and (iii) the main game control, implementing the main loop and animation control, while relying upon logical I/O control.

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## A Framework for Bidding in Procurement Auctions

by Jesús Palomo, David Rios Insua, Fabrizio Ruggeri

Increasing competition in the current economy is forcing companies to formally evaluate the risks of participating in an auction in order to avoid undercapitalisation. Scientists at the University Rey Juan Carlos, Madrid, and IMATI-CNR, have developed a general framework for addressing the issue of bid formulation in procurement auctions.

The Statistics and Decision Sciences group at the Rey Juan Carlos University (Spain) headed by Prof. David Ríos Insua, and the IMATI-CNR (Italy) headed by Prof. Fabrizio

Ruggeri, have participated in the ‘Metodi e sistemi di supporto alle decisioni’ project with Snamprogetti-ENI, a company that frequently participates in auction processes to obtain

construction contracts, eg for oil plants. The goal of this project is to improve their current approach to bid formulation by considering all the inherent uncertainties in the process.

Among other things, this involves providing models for internal risks (cost uncertainty), external risks (abnormal unforeseen events) and economic risks (uncertainty regarding winning the auction).

Auctions have become the most common market mechanism for allocating contracts in the modern economy. Auctions are seen as more democratic, and as such are particularly desirable for the dispersion of public contracts, and are also seen as more efficient, in the sense that the contract will be awarded to the company that values the contract most. We shall consider the case of price-sealed bid auctions, which is the type most commonly used in procurement processes.

The process currently used by the company involves numerous assumptions and allows too many decisions to rely on intuition. Furthermore, the accepted methods do not take advantage of information obtained from previous auctions (forecasting errors, experts' biases etc). These deficiencies have motivated the extension of traditional project management methods. For a given auction, the proposed framework is conceived as a sequential process, with the various uncertainties being modelled one at a time. We begin by estimating project costs with a dynamic model that allows for additional input from experts. Then, since abnormal events may arise during the development of the contract, thereby entailing additional project costs, we provide models to forecast the probability of such events, their effects, and their combined (interactive) effects. Having an appropriate cost (or sometimes duration, or performance) forecast, the company is then ready to submit a bid. As the company needs to win the auction to execute the project, a bidding strategy is developed to maximise the expected utility of the bidder. Finally, once the project is finished and the actual data arrive, we update the distributions using Bayes' rule, to incorporate the knowledge for iterations in future proposals.

The process therefore needs only to incorporate the following in order to significantly improve bid formulation:

- forecasting cost methods under normal circumstances
- forecasting cost methods under abnormal circumstances
- bidding methods.

The first step is to decompose the basic activity costs of a given project and to formulate a model for each accordingly; the project manager has beliefs about the activity cost, and asks for an expert's opinion about that cost. Specifically, the expert provides either a point estimation or an interval (symmetric or asymmetric). Using this information, the manager will then update his beliefs. The manager may also be curious about the expert's forecasting abilities, and who may need to produce a quantitative estimate of this success rate. The project cost forecasting distribution is obtained by aggregating the cost distributions of all the basic activities involved in the project.

So far, the estimation of the total cost only accounts for normal circumstances, but external risks such as labour strikes, storms and raw materials delays could also affect the project. The goal is to model the effect of such events on the basis of cost and duration, estimating the probability of the unforeseen events and finding the distribution of the gravities together with their expected values. Next, we obtain the general or total gravity by combining, either according to the sum or maximum aggregation rule, these individual gravities. Finally, we estimate the additional cost due to these events. Again, the expert's opinion will be a valuable source of information, but there exist various ways in which the expert can convey his opinion, depending on project time constraints and his statistical training – from full specification of all intersections of possible events, to just specifying the most basic events.

Last, we must consider the economic risks associated with the auction

process. We now apply game theory methodology to improve the bidder's chances of winning the auction. We apply the project cost forecasting distribution obtained earlier, which accounts for internal and external risks, to formulate an optimal bidding strategy that will maximise the expected utility of the bidder. A unique Bayesian Nash equilibrium, assuming pure strategies, can be computed in the symmetric case, in the asymmetric case where bidders are risk neutral, and in the asymmetric case where bidders are risk averse, assuming an independent private values model.

This methodology has been successfully applied in offshore oil plant auctions and is currently being implemented in a decision support system with a user-friendly Web interface. We are currently working on extending the approach for duration estimates; a very relevant activity given that shorter delivery times are a key issue in assigning contracts, and control of the delivery time of sub-contractors is important for companies.

**Links:**  
<http://bayes.escet.urjc.es/~sgrande/baytime/>

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# Multi-Agent Technology Applied to Real Time Strategy Games

by Marco Remondino

**Multi agent technology has been successfully used to model and simulate social systems; thanks to the increased power of modern computers, it can also be implemented in strategy games.**

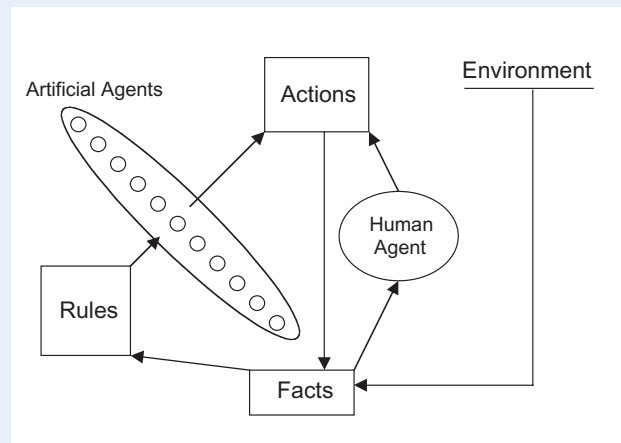
At the Department of Computer Science, University of Turin, Italy, we are currently studying the field of computer simulation in collaboration with the Department of Applied Economics. Our main objective is to demonstrate that multi-agent techniques can be used successfully in several social and industrial applications, and first of all in real-time strategy games. Future plans include a working example based on this approach and a framework to develop games using multi-agent systems.

Computer simulation has been described as a third way to represent social models; in particular, it can constitute a powerful alternative to two other major symbol systems: verbal argumentation and mathematical notation. However, owing to its high portability, through programs or specific tools, and its capacity to describe complex behaviour starting from simple interacting entities, computer simulation has a great advantage over the other two. Computer programs can be used to model both quantitative and qualitative theories. Since real time strategy games are becoming increasingly intricate, and take place in dynamic worlds in which complex decisions, often based on partial knowledge must be made, the artificial intelligence behind them can be modelled with agent-based techniques, already used in social simulation. The degree of freedom in modern strategy games makes them a perfect field of application and testing for agent-based techniques, which often explore complex aggregate behaviour even when applied to real situations, like social, anthropological and economical simulations.

The actual trend in AI for games is to use schedule-based finite state machines (FSMs) to determine the behaviour of

the player's adversaries. Although the results are satisfactory, FSMs are by their nature very rigid and behave poorly when confronted with situations not envisaged by the designer. An agent-based approach could deliver more realistic and less deterministic behaviour: agents could self-organize, producing intelligent aggregate behaviour, capable

of puzzling the human player and of presenting different paths of evolution at every match. Some of them can even use advanced techniques, such as stop loss. We can now work on designing and developing a sort of real time strategy game, in which the main objective is to become richer and richer, and where one of the agents is indeed a human player, while the others are computer driven entities trying to pursue the same target.



**Two Classes of Agents — artificial and human — interacting in the same environment.**

of puzzling the human player and of presenting different paths of evolution at every match.

Strategy games are those in which the player, who must manage and control military units, workers, resources and so on, has to make decisions and complete tasks (construction, conquest, organization, etc.) in order to reach a main objective. The environment can sometimes be changed by the actions taken by the player himself, or other actors, who can also be human players or, more frequently, artificial entities, managed by some form of AI. There are mainly two classes of strategy games: Turn Based and Real Time. Our research is currently focused on the latter, in which many actions (issued by different entities) take place in parallel. There is much similarity here with the actions of real time simulators of real world situations,

Some of them can even use advanced techniques, such as stop loss. We can now work on designing and developing a sort of real time strategy game, in which the main objective is to become richer and richer, and where one of the agents is indeed a human player, while the others are computer driven entities trying to pursue the same target.

Previous research has shown that network-based simulations, in which human agents act side by side with artificial entities, are feasible. As an example, we have ported the 'Prisoner's Dilemma' game to a working program that employs random acting agents and asks the user which decision she/he will take, step by step. In Figure 1 shows what can be done in a hybrid system in which artificial agents interact with a human being. The same artificial environment is shared by two classes of agents: those driven by

artificial rules, coded by the programmer, and those controlled by human player(s). Both classes observe "brute facts", that can be exogenous (ie coded in the environment) or endogenous (ie produced by the agents' actions) and decide on which action they should perform. Artificial agents will have a set of rules, which can be static, ie coded 'a priori' by the programmer, or dynamic. Dynamic rules can evolve according to previous experience; this can be done employing advanced AI derived techniques, which try to mimic human thought processes, such as neural networks, genetic algorithms, classifier systems and so on.

We are currently studying the use of hybrid approaches (agent based and process based), which have the advantage of allowing intelligent agents to self-organize according to deterministic structures, just giving simple rules. This would guarantee that their behaviour is consistent with that observed in the real world, and is quite independent of programming choices. Games using such approaches could also deal with unforeseeable situations that were not implemented as possible ways of evolution. The main drawback of using such methods for simulating AI in a game is that these techniques are heavy on CPU resources. However, in the last seven

years, we have witnessed the rise of dedicated graphics hardware (3D cards) which now, thanks to the integration of transform and lighting, pixel and vertex processing etc., leave just the management of the basic computing functions and of the AI component to the CPU.

It is our intention now to produce a working framework for this approach, which could be used as an example and, at the same time, as the starting point for practical research in this field.

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## An Intuitive Game in an Intelligent Ubiquitous Environment

by Jaana Leikas, Hanna Strömberg, Antti Väättänen and Luc Cluitmans

**A new group game, developed for an intelligent environment by VTT Information Technology, explores people's movements when they interact with the application and with each other in the game. The user interface blends in with the surroundings, utilises human senses diversely and provides a wealth of experiences.**

Conventional virtual reality games try to make the user interface transparent or invisible through the use of head-mounted displays and data gloves. We have succeeded in creating a new kind of group game that involves not only human-computer interaction, but also human-human interaction in the interactive virtual space. In our game, Nautilus, the view chosen by the player is a step forward in game design. The solution offers players a highly personal experience through controlling the game with their own body movements. The user interface blends in with the surroundings and integrates the player's movements into the game, thus weakening the boundaries between the room and the interactive virtual space. In the game, the players do not wear virtual reality devices.

### Designing the Intelligent Environment

The Nautilus game is designed for location-based entertainment (LBE) such as amusement parks. It is expected to last

only five minutes in order to enable a large number of groups to experience it each day, and is designed for small groups of players, aged between 8-13 years, with no previous experience of computer games.

The environment is based on intelligent movement sensing. The metaphor for controlling the user interface is simple and the interaction is familiar to everyone: a pressure-sensitive floor allows the users to control a virtual vehicle (a submarine) both by making movements with their body and by moving in different directions in physical space. The intelligent game environment combines the pressure-sensitive floor system, a real-time 3D-graphics engine and special-effects devices within a teamwork application.

The intelligent environment allows several players to move freely on the floor at the same time and to work as a group. The players do not have any predetermined roles in the game or

specific positions in the room. They do not need to have any special clothing or virtual reality devices. Moving as a group in different directions on the floor moves the vehicle in corresponding directions in the virtual world. Waving arms up and down or jumping rapidly makes the submarine ascend and standing still makes the submarine descend. These movements allow the players to move in any direction in the virtual world.

The development work relied heavily on a User-Centred Design (UCD) approach. The scenarios created during the design characterised the players, the desired activities, events and effects of the virtual world, as well as the intelligent environment for intuitive movement sensing. The design solutions were evaluated with users at every step of the iterative process. The methods used in the evaluation were qualitative and included interviews, observation and video recordings. Also, usability experts carried out usability inspections of the

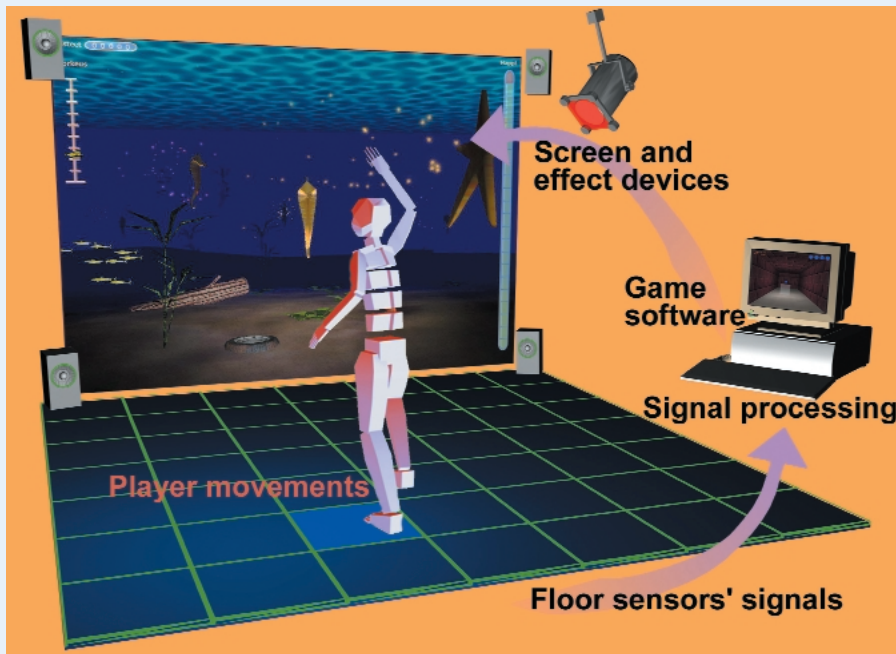


Figure 1: The intelligent environment for intuitive movement sensing. In this environment it is possible to test human-machine as well as human-human interaction in a group by utilising movement detection.

prototypes during different phases of the design. In addition, a test game was created and tested with end-users to verify the functionality and relevance of the floor system and the user interface of the application.

#### Natural and Intuitive User Interface

Through the user interface, users can interact intuitively and naturally with the environment and with each other. The interface solution comprises a pressure-sensitive floor system, a real-time 3D-graphics engine, and special-effects

devices (sounds and lights). The system is based on 49 pressure-sensitive floor tiles and one host computer (a PC, which also runs the application software). Each of the floor tiles contains a microcontroller board and four sensors (one at each corner), giving 196 sensors in total.

Since the tile controllers do not take any action unless explicitly requested by the host, the host is responsible for timing the sampling. The driver software that is responsible for retrieving the data from the controllers has several tasks. First, it

should fulfil its primary task: retrieving the sensor data and making that data available for other software components running on the host PC. There are several additional issues that require special care, however: accurate timing, controller-malfunction checking, timeout checking, preventing different controllers from sending data simultaneously, defining an API that defines how programs can access the driver and so on.

Along with the rest of the system, a program was developed that displays a map of the floor. The map allows one to track people moving on the floor. The map shows each sensor re-presented by a coloured square, where the colour indicates the pressure change measured by the sensor.

#### Future Work

The intelligent environment developed is suitable for testing applications that support interactions in a group. Compared with other methods of human-machine interaction, this intelligent movement-sensing environment allows the user to use his or her whole body in an original but natural way. This kind of user interface is a step forward in the challenging work of creating systems and applications with hidden user interfaces.

The environment will be further developed and tested with different applications by human-factors experts at VTT Information Technology's virtual reality studio. The environment will be connected to both virtual reality and ubiquitous computing design ideas that aim to create an interactive and natural environment with a shared player experience. Several business application opportunities can be envisaged in this area, such as solutions for intuitive learning and evaluation of teamwork capabilities.

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Figure 2: Observing a group of children playing the game.

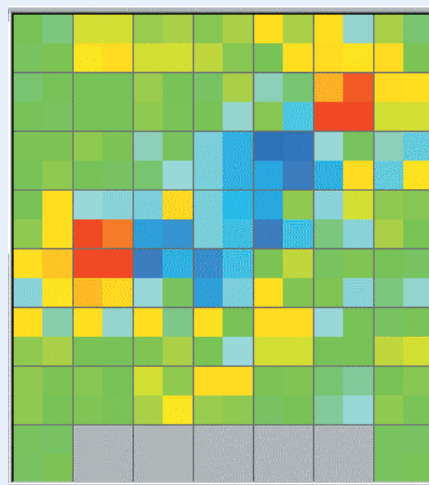


Figure 3: Visualisation of floor tile activity.



# ContextControl – Game Based Interaction

by Holger Diener

Having highly complex menu and dialogue structures in applications contradicts good operability and deters beginners and occasional users. Intuitive computer games use concepts, which makes game functionality easy to grasp. ContextControl is an example of a new kind of user interface based on these computer game concepts. These Game Based Interfaces support and motivate users as they work and learn with applications.

In order to be as competitive as possible, today's applications offer a huge amount of functionality. The resulting highly complex menu structures can make it difficult to find menu items, thus contradicting good operability. Experts may manage with such applications, but an important group of potential users - beginners and occasional users - are deterred. The user's motivation to explore these applications is suppressed by the vast number of possibilities.

Since users only need a limited set of functionality for certain tasks, these problems can be overcome with new structures and concepts for user interfaces, which rearrange the application functionality. Computer games are a good starting point for such an approach, since they constantly employ new ideas in order to present and mediate their functionality (eg level systems, customisability, semi-transparency, virtual characters).

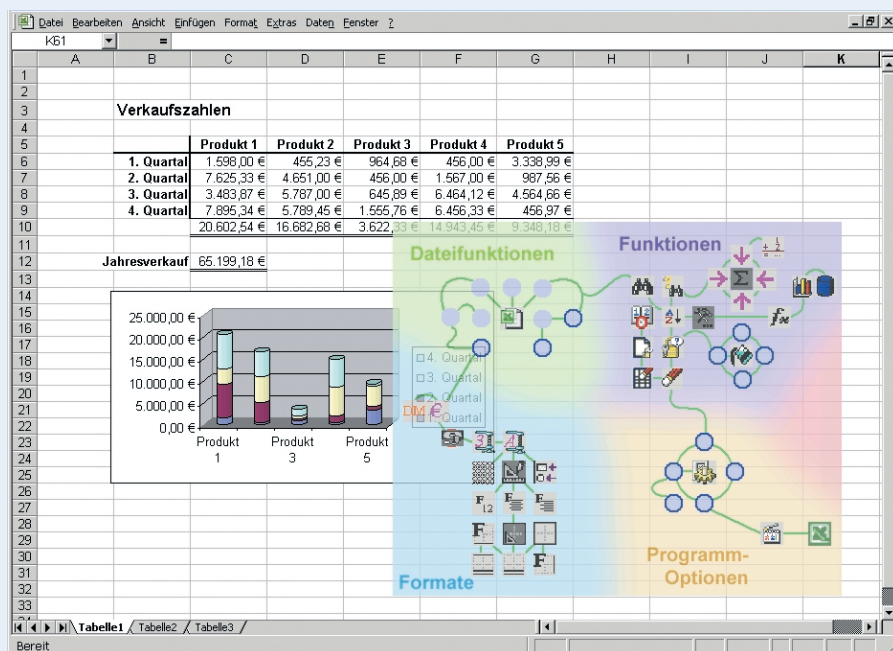
ContextControl is a Game Based User Interface that uses the level and customisability concepts of games in order to make working with applications as easy as playing games. In games, players can only access the functionality appropriate to their level of ability. They start with small sets of items or a limited range of options, and as they become more experienced and successful within a game, they gain access to more and more items and options.

This level concept can be used in applications as well. Users are first presented with a restricted interface that accesses only a small part of the functionality, meaning the interface is smaller and easier to understand. Once familiar with this functionality, users can request more functions for interaction. In this way, they can learn the application step by step.

In the case of different user-interface levels, it is important to carry over old and familiar structures of functionality into the next level, since changing the structure would only confuse users. For this reason, ContextControl provides tool areas instead of tool bars, within which buttons can be arranged more freely. Tool areas and sets of functionality can be changed simply by clicking a menu button.

Using tool areas also allows more room for additional information. Background images can provide information about existing functionality, animated tool tips provide active help in understanding buttons and icons, and animations can show previews of results. Together with the concept of customisability, which is also widely used in games, functionality in ContextControl can be organised to meet the requirements of special user groups, workflows and tasks. The level system can be used to train users with applications, and levels can be redesigned according to users' skills. Tool areas can also be used to represent different steps within a given workflow, with each offering only the necessary functionality for a certain step. Changing the tool area then changes the set of functionality according to the next step in the working process.

Using the level concept and allowing customisability wherever possible make ContextControl an interface that supports and motivates users as they work and learn with applications. ContextControl is opened using CTRL + the command used to open the standard context menu. This allows fast access to functions near the actual working area. As a semi-transparent window, ContextControl also allows observation of the working area while choosing the



ContextControl tool area for MS Excel.

functionality. As long as the CTRL-key is held down, functions can be chosen from ContextControl to perform a series of actions. This decreases the number of mouse clicks.

The easy exchange of background images and therefore information makes it very easy to generate content for learning systems with ContextControl.

Another field of application is the generation of user interfaces for training-on-the-job applications.

Future research will further explore how the functionality of applications can be simplified based on user preferences and work process requirements. Simplifying the user interface automatically would be one aim for research work. In addition

we will investigate the use of other game concepts including story-telling, characters and metaphors.

**Link:**

<http://www.igd-r.fraunhofer.de>

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## Dramatic Gaming

by Jarmo Laaksolahti

**In contrast to action games, the motivating factor for playing this game is not necessarily to win it, but to explore the social and emotional relations between characters.**

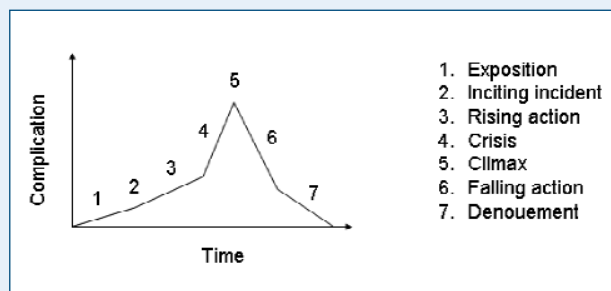
Action games have established themselves as the dominating genre in contemporary computer gaming. However, as gaming is taken up by new segments of the population (eg elderly people), other genres taking the interests of these segments into account need to be explored. Researchers at the Swedish Institute of Computer Science (SICS) are currently looking at interactive drama, where the focus is on experiencing a story rather than on action.

According to Aristotelian dramatic principles, a drama consists of several parts or phases as depicted in Figure 1. The vertical axis represents time and the horizontal axis represents unresolved conflicts and unsettled emotions (complication). In the exposition phase, complication rises slowly as the viewer gets to know the characters and the situation. An inciting incident then adds momentum to the story leading to a quick rise of complication eventually building to a climax where the drama peaks. During the climax complications are resolved after which the level of complication rapidly drops.

The team at SICS are working on an interactive multi-character game prototype based on these dramatic principles. The scenario focuses on three teenage girls arranging a party for their friends and classmates. The basic idea is that the player takes on the role of one character,

and interacts with the other computer-controlled non-player characters (NPCs) in the scenario. The task of the player is to arrange an invitation list for the party together with the NPCs. The game is realised as a simulated dialogue between the player and the NPCs in the game. Players interact with the NPCs by typing sentences on the keyboard. NPCs in turn make use of gaze, facial expression, gesture and body posture as well as synthesised speech in a synchronised

Dramatic principles manifest themselves in the game since the game keeps track of the level of complication and attempts to turn events in a direction that roughly fulfils a dramatic arc. As the 'story' of the game is intended to be one of changing friendships between the characters, we decided to use the social model to also model complication. Thus the game aims to manage the development of social relationships over the course of the gaming session. At the



**Figure 1:**  
A dramatic arc.

fashion to express themselves. The game is turn-based, in that during each turn either the player or an NPC is able to say something. NPCs are equipped with a model of social relations based on sociological theory that partly determines their behaviour in the world. At any given moment an NPC's relation towards another NPC or the player can range from 'very positive' to 'very negative'. Depending on how the player acts or reacts, relations will change and events will unfold in different ways.

beginning of the game, relationships between characters are somewhere on the positive side of the scale. As the game progresses the game will attempt to push events in a direction that makes the social relationships first become negative (increasing complication) and then either return to neutral/positive or remain in the negative range as the game ends, thus reflecting a more permanently changed relation.

In order to choose between different courses of action, the game evaluates the

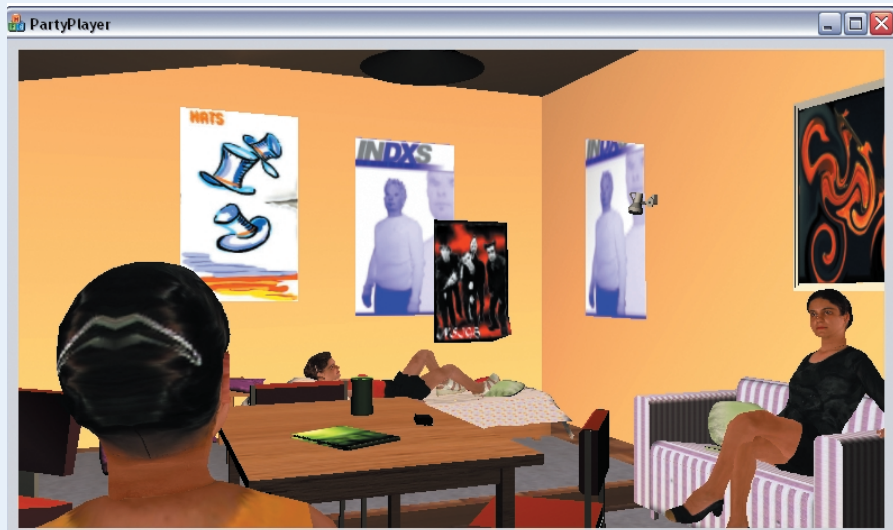


Figure 2: The party game.

dramatic consequences of each turn before it is executed. If it is detected that a turn may have dramatically undesirable effects, eg the dramatic arc becomes too distorted, the turn instead passes to another character. The procedure is repeated until a dramatically pleasing turn is found, or if none exists, until all characters have been tried. In the latter

case the least undesirable turn is chosen for execution.

Compared to traditional planning techniques such as searching for ways to combine scenes into desirable plot paths, anticipation as described here is a more passive way of planning. Instead of actively searching for the best path the

main concern for our anticipatory system is to detect and avoid undesirable states.

In contrast to action games, the motivating factor here is not necessarily to win the game, but instead to explore the social and emotional relationships between characters. Thus instead of monster-bashing, the goal of the game is to navigate a socio-emotional web and find a path through it. This requires both sensitivity and attentiveness to social and emotional cues from players. Seen in this light, the task of compiling the invitation list for the party becomes more of a pseudo-task than the real task of the game.

This research is conducted at the Swedish Institute of Computer Science within the HUMLE laboratory. Many of the components used in the prototype have been developed within the EU-funded MagiCster project.

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## Generating Multimedia Presentations: It's All in the Game

by Frank Nack and Lynda Hardman

**In a time when the human attention span seems to grow ever shorter, computer games are able to keep people focused for hours. Compelling storylines and interactive environments draw players into the game. At CWI these elements are applied to the generation of multimedia presentations.**

Online information systems, such as the Web site of the Rijksmuseum in Amsterdam (<http://rijksmuseum.nl/>), provide users with a huge amount of information in the form of texts, photos, video and animation. The Rijksmuseum site displays, for example, 1200 of its top exhibits, with links connecting and associating objects from many different departments of the museum's vast collection. For instance, a painting of a nineteenth-century landscape could be associated with its seventeenth-century fore-runner. Access is via four categories:

artists' names, themes, encyclopaedic terms and a systematic catalogue.

The challenge for the designer of such a media-based information environment is to foresee the circumstances and presuppositions of the user at the time of accessing the information. The designer's vision might be an informative and graphical experience, but it is impossible to cover all presentational aspects of dynamic systems when neither the individual user's requirements nor the requested material can be predicted in advance.

A solution to this problem is the automatic generation of multimedia presentations. The aim is to present the right information for a particular user in a compelling way. In particular, the aspect of an appealing presentation relates research in automatic presentation generation to that of game design.

Computer and video games can be extremely engaging, and their magnetic effect is all too familiar. The reason for this is that game development focuses on what players experience as they work their way through the game. The goal for





Figure 1: Presentation in the storyteller style.



Figure 2: Presentation in the encyclopaedia style.

the game designer is to make this experience as compelling as possible. The two main aspects of user experience are to keep players engaged with the goals they follow and the appropriate environment they can follow them in. The strategies used in game design to achieve these two aspects are the carving of an engaging storyline and the provision of a highly interactive environment.

The storyline is a carefully constructed net of events that tries to create a self-contained, internally consistent world. The navigation of the user through the story world is important, because it is direct interaction with the material that provides immersion, just as immersion provides the grounds for motivation and concentration to achieve the goal. A game is, therefore, a skilful exploitation of narrative structures that give players the perception of free will, even though at any time their options are actually quite limited.

It is in particular the strategy of narration and interactivity we wish to adopt and integrate in our approach towards automatically generated user-adapted multimedia presentation. A potential solution for the Rijksmuseum is, for example, to identify typical categories of users and provide ways of communicating in a form tailored to each individual group.

The storyteller presentation style, for example, establishes a non-interactive presentation, where the system presents

the relevant material in the form of a narrated story. The system should be able to present in various styles, such as prosaic, documentary, or voyeuristic. The storyteller style serves the needs of a user who does not wish to explore the repository of the Rijksmuseum independently, but wishes rather to be guided based on a few submitted preferences such as artist, style, image or epoch. Figure 1 presents a stage within a presentation about Vermeer, where the highlighted image (top left) is the current focus of an audio narration.

On the contrary, if the user wishes to take a more active role in investigating the repository, the encyclopaedia style might be more applicable. Here the system presents the relevant information in a simple, concise manner to facilitate fast and highly interactive information retrieval. This style expects users to know exactly what they want. The main goal for the system in this style is, therefore, to offer access options without restricting user interaction. Figure 2 displays a snapshot of a presentation about Vermeer in the encyclopaedia style.

In this way we can generate non-permanent presentations of non-static spaces, where the abstract, stylised and non-real presentation is a feature. In our approach towards automated multimedia presentation, the 'experience' is provided by the narrative and appropriate presentation aesthetics. This requires, however, that the various levels of event and context

need to be made as explicit as possible. In our research we address four aspects:

- modelling domain-dependent and domain-independent discourse to steer the presentation generation process
- investigating the dependencies of the user and domain models in the generation process
- investigating the characteristics of media types for presenting information to the user
- investigating to what extent graphic design knowledge can be included in the generation process.

In addition, we are also investigating the contribution of Web and Semantic Tools to this research.

Part of the research described here was funded by the Dutch national Token2000/CHIME and NWO/NASH projects. The authors wish to thank in particular Katharina Schwarz, who provided the interface study from which the images in this article are taken.

#### Links:

<http://www.cwi.nl/ins2>

Katharina Schwarz: An investigation on the relationship between the user model and graphic representations for the automated generation of multimedia presentations. Diploma Media System Design, University of Applied Sciences Darmstadt, Germany, 2003: [http://www.visitkatharina.com/thesis\\_kat.pdf](http://www.visitkatharina.com/thesis_kat.pdf)

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# Experimenting with the Social Construction of Reality: A Game for the Autistic Mind

by John Harpur, Maria Lawlor and Michael Fitzgerald

**Asperger Syndrome (AS) is a neurobiological disorder named for a Viennese physician, Hans Asperger. Persons with AS show marked deficiencies in social skills, have difficulties with transitions or changes and prefer sameness. They often have obsessive routines and may be preoccupied with a particular subject of interest. An assistive technology project is exploring game design and game play to deliver a social skills learning system.**

Asperger syndrome (AS) is an autistic spectrum disorder, characterized by social skill deficits. The Asperger Syndrome Social Education for Teenagers System (ASSETS) is a computer game-based system for developing social cognitions and skills in adolescents with AS. The content is based around interaction with social scenarios that arise commonly in adolescence. Computer game-based learning in principle offers a means for: (a) creating standardized scenarios eliminating bias (or testing for it), (b) adapting content and interactions to the actual social skill proficiency level exhibited by a subject, (c) issuing appropriate feedback to the subject, therapist, and parent, and (d) a means for maintaining a user's attention and curiosity about the subject matter. The project involves mental health professionals, computer scientists, speech and language therapist, parents and national organizations working with AS individuals. It was begun in autumn 2002. Since then work has focused on developing a social skills curriculum that could be administered by computer but also supported by existing resources (eg parents and teachers).

The objective is a game-based social skills learning system defined by scenario rehearsal and a cast of eleven characters. Several of the cast are historical characters suspected of having AS. The system design is distinguished by four components. The first two are theoretical in the broad sense while the latter provide empirical input to 'power' the system. The objective is to have each character possess a set of (i) situation induced beliefs and (ii) interest induced beliefs. In addition, each character's interactions can be assessed for appro-

priateness by using a variation on (iii) computer adaptive testing applied to a large sample of typical teenagers. Characters can receive personality traits through (iv) a bank of psychometric tests that measure communication efficacy and self-esteem.

The initial orientation of the project was based on scenario rehearsal through



**Classroom scenario B: The girl is rejecting the offer firmly but politely. She has established distance between them.**

video modeling of problematic scenarios for those with AS and then encouraging the subjects to work through a comic book 'game' to see if they could identify a range of communication skills and their appropriateness. More recently, with additional funding, a game engine and environment is being created that will give remove many of the constraints of the prototype. In particular, video-based learning imposes tight constraints on the control logic that can be operated in 'play'.

The current collection of characters is created in Maya, the 3D modeling package, and then exported to the DirectX file format. The overhead with this approach is high, as almost all properties aside from the character mesh, one colour and one texture (map) have to be engineered in the application environment. A second issue, was how large a mesh per character? Currently we fix an

upper limit of 6000 polygons with back face culling enabled before export. We are fortunate in having the services of an excellent texture artist. The objective at this stage is the production of an advanced prototype for submission to a games publishing company.

Following the prototype, the structure of play is based on problem solving. In this case, the problem involves working out what to say to another character, when to say it and how to behave. It is planned to have a speech component to deal with utterances, but at present 'sayings' can be dealt with by menu. Character interactions are derived from what typical adolescents have reported of how they would interact in these circumstances. Moreover, their responses can be ranked across a number of measures. Comparing AS responses to typical

responses, the system has a measure of (a) the current communicative deficits of the user, and (b) over time it can assess if they are improving. The play is driven by rewards and punishments. If a user is successful, then he picks up bonus points and can choose a recreation task. On the other hand if the user is unsuccessful, then he reverts to a lower level and has to retrain again – *Snakes and Ladders*.

Apart from the computational tasks that must be overcome, the central pedagogical issues are two fold. Will they learn anything useful from it? Will they be motivated to return again and again? Many people with AS have normal to above average intelligence, so mastering the mechanics of play is unproblematic.

However, they are not very adept at anthropomorphizing, ie attributing human like qualities to objects. Consequently, as the project rolls onward, we need to build in windows for third party inputs which will further inform the system’s assessment of the user, and adjust his game play accordingly. In their simplest form these could be online questionnaires for completion by parents and teachers about the subject’s social performance.

This is an assistive technology project which is exploring certain aspects of game design and play to deliver a curriculum and lesson plan. Prototyping and pen-and-paper trials have been very useful and provided high quality user

feedback. It will take two years before the first major evaluation is ready however.

The project is supported by Enterprise Ireland, Health Research Board, Intel (Ireland), Microsoft (Ireland), Irish Autism Alliance and ASPIRE.

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## Stability in Labour Market Games

by Katarína Cechlárová, Robert W. Irving, and David F. Manlove

Scientists from P.J. Šafárik University and the University of Glasgow have investigated a new form of stability in labour markets. This has produced some unexpected results and some challenging open problems.

Labour markets are typical examples of games. On one side, firms seek the best possible employees, and on the other side each prospective employee wishes the best possible job. Various criteria to be satisfied by a matching of workers to firms have been proposed. David Gale and Lloyd Shapley introduced the notion of *stability* in their paper published in 1962 and indeed, many years later Alvin Roth discovered in 1984 that exactly this notion forms the basis of a large centralised scheme for allocating medical students to hospitals in the USA, called the National Resident Matching Program (NRMP), which has been in use since 1952. Through an ongoing collaboration, motivated by practical matching schemes, we have investigated a new form of stability in labour markets, namely *exchange-stability*.

The simplest case of a labour market arises when each firm has just one vacant position. Gale and Shapley adopted an amusing name and description for this version of the problem. An instance of the so-called 'Stable Marriage Problem'

(SM) involves a set of  $n$  men and a set of  $n$  women. Each person has a preference list in which he/she ranks all the members of the opposite sex in strict order. A matching  $M$  is a one-one correspondence between the men and women. If  $(m,w) \in M$  for some man  $m$  and woman  $w$ , then  $m$  is the *mate* of  $w$  and vice versa. We say that a (man,woman) pair  $(m,w)$  is a *blocking pair* of  $M$  if each of  $m$  and  $w$  prefers the other to his/her mate in  $M$ . A matching that admits no *blocking pair* is said to be *stable*. Stability ensures that a matching cannot be undermined by two people who could form a private arrangement to their mutual benefit.

An example instance of SM is given by the preference lists in Figure 1 (the entries are shown in decreasing order of preference). The reader may verify that, here, matching  $M_1$  admits several blocking pairs, including  $(m_1, w_2)$  and  $(m_2, w_1)$ , whilst matching  $M_2$  is stable. Gale and Shapley showed in their seminal paper that every instance of SM admits at least one stable matching, and they gave an efficient algorithm for finding such a matching. Their algorithm is as amusing as the problem name, since it simulates a courtship process between the men and women.

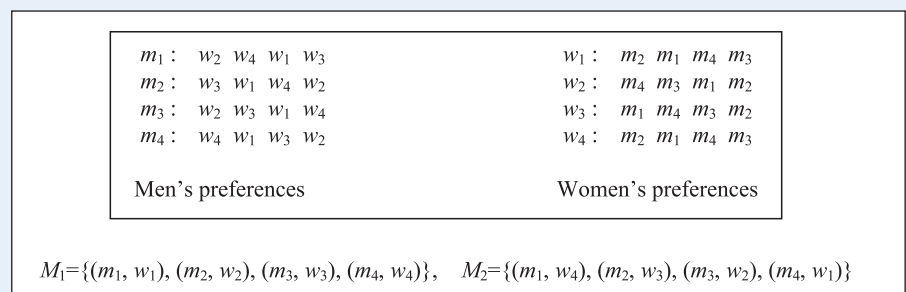


Figure 1: An instance of the stable marriage problem and two of its matchings.



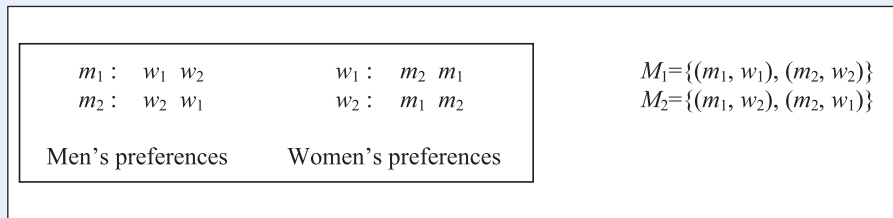


Figure 2: An instance of the stable marriage problem with no exchange-stable matching.

When applied to labour markets in practice, the basic Stable Marriage problem has many generalisations. For example, in the context of the NRMP, a given hospital will have many positions in general. Furthermore, the Scottish counterpart of the NRMP, called the 'Scottish PRHO Allocation scheme' (SPA), has to take into account the fact that typically a student seeks two posts that are to be allocated in different half-years. However the stability concept can be generalised to extensions such as these. Moreover, efficient algorithms exist for finding stable matchings in such settings. In applications of this kind, typically the number of participants is very large (30,000 per year for the NRMP), so it is of great interest to analyse the computational complexity of proposed algorithms.

In 1995, an alternative notion of stability, so-called *exchange-stability*, was introduced by José Alcalde. A matching  $M$  in an instance of SM is *exchange-stable* if there is no *exchange-blocking pair*. This is a pair of participants of the same sex, each of whom prefers the other participant's mate in  $M$  to his/her own mate in  $M$ . In contrast to classical Gale-Shapley stability, there are instances of SM that do not admit an

exchange-stable matching, such as the one in Figure 2. The reader may verify that, here, matching  $M_1$  admits the exchange-blocking pair  $\{w_1, w_2\}$ , whilst matching  $M_2$  admits the exchange-blocking pair  $\{m_1, m_2\}$ .

In a recent collaboration (funded by Slovak Agency for Science contract 'Combinatorial Structures and Complexity of Algorithms', by Engineering and Physical Sciences Research Council grant GR/R84597/01, and by Nuffield Foundation award NUF-NAL-02), we have shown that, somewhat surprisingly, the problem of deciding whether an instance of SM admits an exchange-stable matching is NP-complete. That is, there is no polynomial-time algorithm for this problem unless  $P=NP$ . However, for a weaker form of exchange-stability, so-called *man-exchange-stability*, in which exchange-blocking pairs are only permitted to contain two men, every instance of SM admits at least one man-exchange-stable matching, and such a matching may be found efficiently. Analogously, one may define *woman-exchange-stability*, with similar results.

Some practical motivation for considering exchange-stability may be drawn from the following real-life scenario. Recently, two students participating in the SPA scheme discovered that, if they could have exchanged their assigned hospitals with each other, then they would each have ended up with a more favourable assignment. Naturally the hospitals to which the students were matched would not have permitted the exchange (for if they were to have agreed, it would have implied that the original matching contained a blocking pair with respect to classical stability, whereas the primary consideration of SPA is to produce a matching that is stable in the classical sense). However when such a situation arises, it can adversely affect the level of confidence that the participants have in the fairness of the matching scheme.

We therefore close with the following problem linking classical stability and exchange-stability: it is an open question as to whether the problem of finding a stable matching that is man-exchange-stable is solvable in polynomial time.

**Links:**

- [http://www.nrmp.org/about\\_nrmp/how.html](http://www.nrmp.org/about_nrmp/how.html)
- <http://www.nes.scot.nhs.uk/spa/front.htm>
- <http://www.dcs.gla.ac.uk/~davidm/TR-2003-142.pdf>

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## 'Large' Games and their Multiple Applications

by Andrzej Wieczorek

A recent project at the Institute of Computer Science of the Polish Academy of Sciences looked at games and models with infinitely many participants, constructed in a manner allowing for practical applications.

'Large' games include finitely many types of infinite populations whose members have the same characteristics (strategy sets and preferences over possible outcomes), and finitely many

large players ('atoms'). The reported studies concern:

- theoretical foundations, including a definition of a 'large' game and results on the existence, properties

and procedures (static or dynamic) for finding the equilibria of a game

- applications of the former to models of labour markets, household economies, the global economy,

spatial allocation of species, general elections and road traffic, and

- computer packages to search for equilibria in selected models.

Mathematical game theory deals with the modelling of various schemes, which describe the actions - and their consequences - of several decision subjects (eg single persons, teams and societies, but also animals, their populations or even automata and specialised computer programs). Game theory analyses such schemes, with special attention paid to situations arising after a choice by the respective subjects regarding their actions. Some of these situations are called equilibria; in these situations there is no decision subject who, knowing that the situation has taken place, is able to find out that a different previous action would have made him better off.

The decision subjects are usually called players (or sometimes coalitions). Players choose their strategies, and a choice of strategies by all players leads to a concrete situation; various situations are evaluated, in a (possibly) different manner, by the players. Mathematically, such evaluations are done by means of preference relations or utility functions.

Classical game theory, the roots of which are usually associated with the names of John von Neumann and John Nash, has dealt with games with finitely many players, as is usually the case in real-world situations.

However, the number of decision subjects in the real world is so large that in many extended decision schemes it does not make much sense to take into account the precise characteristics of each subject involved; rather it makes sense to introduce a procedure of aggregation (of the description of the subjects' characteristics) in a manner allowing for efficient analysis, eg by means of appropriately constructed computer programs. Mathematical ways of constructing such aggregation (especially when the influence of individual actions on the overall outcome is negligible) are based upon the assumption that the number of decision subjects is

infinite and one can observe only a distribution of their strategy choice, rather than any actual choice made by an individual.

The first mathematical models of decision schemes with infinitely many participants were created in the 1960s. These models tended to be fairly general, and knowledge of the characteristics of all participants was generally assumed. Their advantage, implied by generality, is the possibility of deeper understanding of the case being modelled, usually economic and social phenomena; however, due to the amount of data necessary (including the characteristics of each individual), it is difficult to apply such models directly to specific 'everyday' problems.

Various games and models with infinitely many participants, constructed in a manner allowing for practical applications, are being studied at the Institute of Computer Science of the Polish Academy of Sciences. This work falls within the scope of research projects sponsored by the Polish Council for Scientific Research (KBN). Games and models of this kind, usually referred to as 'large', take into account the activity of a number of types (obviously finite in real applications) of infinite populations, and a number of 'large' players (also called 'atoms'), whose decisions have a significant influence on the final outcome of a game. It is also assumed that all players in a given population have the same characteristics and therefore the same strategy sets and preferences over the set of final outcomes, also depending on their individual choice of strategy.

The theoretical part of the research included the construction of a 'large' game, formulation of the concepts of equilibria and other solutions (which in some sense are optimal), a study of conditions implying the existence of equilibria and their properties, and algorithms for finding such optimal solutions.

In choosing practical applications for study, we looked at those for which the occurrence of a large number of decision makers is typical (in some cases

'atoms' are also present). These included:

- labour markets
- household economies
- the global economy
- spatial allocation of species
- general elections
- transportation networks.

For instance, in the model of spatial allocation of species, two special cases have been studied in detail - a single population model and a two-population 'predator-prey' model. Members of each population choose their habitation (which is a point in a given set on the plane). Individual preferences depend on the distance of the chosen habitation from an 'ideal' reference point and also on the parameters of distribution of one's own (and the other) population. The obtained theorems guarantee the existence of equilibria and give a characterisation of the set of all equilibria. Under some assumptions, equilibria are given by distributions on circles (one or two, depending on the number of populations) with given radii and centres in the 'ideal' point; the mean of those distributions being simply the 'ideal' point.

Computer packages have been constructed to find equilibria in the models of household economies and the spatial allocation of species. Finally, it is worth noting that attacking and efficiently solving the problems of game theory with large databases (as well as their applications) is closely related to the increased power of contemporary computers and to the creation of new computation techniques.

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# Exploring the Video Game as a Learning Tool

by Francis Emmerson

**Computer and video games are as relevant a cultural medium as books, film and television for many of today's young people. As such, they have the potential to be used as a highly effective means of delivering a wide range of educational and training material.**

For those who have not been successful in a traditional educational setting, games can provide both an attractor to return to learning and a new environment in which the learner can feel comfortable and empowered.

Often, time and cost are a barrier to experimenting with video game-learning, an area where it can be difficult to explore the potential benefits without actually creating a purpose-built game to test hypotheses. The customisation of existing commercial games through the use of freely available development tools (a process known as modding) can provide an excellent means of creating applications that can assist the study of video games as a means of delivering learning material, without requiring the time and money that is needed to create a game from scratch.

Modding is efficient for a number of reasons:

- fundamentally, it is far less labour intensive than the process of design and production from scratch
- the skills that are required to create a mod are more likely to be available within an organisation than the skills that would be required to create a convincing video game from first principles
- it helps us to create 'credible' games. Today's games players can be a highly critical audience – by using a mod of an already accepted game, we reduce the risk of colouring our results by using sub-standard applications
- testing times are greatly reduced, as the game we are building our mods for will have undergone a rigorous testing programme before being launched as a commercial product.

Research into games and learning at IC CAVE at the University of Abertay has explored a number of areas, including:

- general skills acquisition – eg literacy, numeracy (The Discovery Game)
- life skills acquisition – eg interpersonal relationships, understanding democracy
- role play to promote discussion and understanding – eg crime and criminality, health and safety (Design Against Crime).

Our initial developments have centred on creating levels using the PC game Deus Ex (published by Eidos). In all

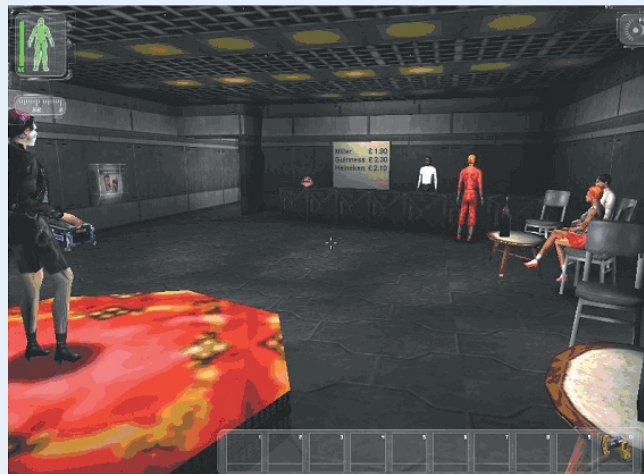


Image taken from The Discovery Game.

these instances, it has been our approach to tackle these topics in a meaningful way that aims to keep the game fun whilst maintaining the integrity of the learning material.

Technically at least, mod creation is an activity that is accessible to many; the development tools that are used are often more akin to high level productivity applications than programming environments. Ultimately the success of the mod as a learning application will be down to the creator's skill in understanding both the nature and appeal of video games and how best to integrate learning content so that it is delivered as effectively (and seamlessly) as possible.

In order to really understand the possibilities of video games as a learning tool, we must start creating our own games that properly address the topics that we wish to communicate with the learner. Yes, it is possible to integrate existing games, as they are, into a curriculum in order to understand some aspects of the appeal of games in a learning context. However, in doing so, we are not fully exploring the possibilities of the game itself as a learning tool. Unless we begin to start making our own games that actually

incorporate our specific learning material we will not be able to develop the techniques required to allow us to integrate learning content into the game itself.

It is also clear that the time and money required to develop a commercial quality video game is prohibitive to most organisations, and so, we find ourselves

in a position whereby our ability to gather meaningful data can be hindered by our inability to create meaningful applications.

Modding provides the opportunity to start to explore the possibilities of video games as a learning tool in time and cost effective way.

**Link:**

<http://www.iccave.com/web/site/ResearchApplications/GamesAndLearning.asp>

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# Mobile Gaming with Peer-to-Peer Facilities

by Mika Pennanen and Kari Keinänen

For today's rapidly growing mobile environments, VTT Information Technology has carried out research in order to provide middleware for the development of network games and other applications for various end-user devices (PDAs, mobile phones etc) and wireless networks (WLAN, Bluetooth etc). The key point is the addition of network facilities to existing applications, rather than the development of new applications.

During the last decade, sales of mobile devices such as mobile phones have boomed worldwide. This is particularly true for 'smart phones', which feature calendars, e-mail, pictures, music and other applications (games, browsers etc), and belong to the fastest-growing new category of mobile phone. Only two years after the world's first third-generation mobile networks were launched, consumers in Japan are already embracing services such as video conferencing on models with built-in cameras and large colour screens.

The wireless game industry is in a state of rapid growth. With the new technologies that are pushing the boundaries for mobile communication, we will see the game industry grow beyond its current revenue boundaries. Much of this will be due to the release of high-speed wireless data-transmission technologies, peer-to-peer (P2P) technology and Java-based games. These technologies will allow game designers to make products resembling those available on the wired Internet, naturally with respect to the restrictions of small mobile devices. These more sophisticated games will spread more widely than the current WAP and SMS games that are currently on the market.

One of VTT's research areas is peer-to-peer technology and wireless networks. The basic idea in peer-to-peer technology is that two computing devices (peers) share resources and information with each other, having equal capabilities and responsibilities and with neither being specifically a client or server.

In using P2P-style communication in wireless networks, private networks and IP addresses can cause some problems. Most of these occur while dealing with

Network Address Translators (NATs), because private IP addresses cannot be seen from public or other private networks. Usually the solution can be found in a 'well-known' Internet server with a permanent IP address, which can 'introduce' the other two nodes.



Figure 1: Pool application on iPAQ.

VTT's solution for P2P addressing problems in mobile gaming is Boris Object Request InfraStructure, known as BORIS for short. BORIS is a trader that introduces a simple and straightforward solution to the problems of resource naming and discovery. BORIS can also be used in areas other than gaming. Applications can exploit each other through BORIS middleware, which acts as an 'introducer' in pure P2P style without centralised or 'well-known' servers.

IP addressing is not the only problem in P2P communication. As there are no central servers, problems have also arisen in controlling the information. Katherine Mieszkowski of Salon made an interesting comment on this: "P2P is a particularly comical new coinage for a business model since the phrase starkly points out that there's no middleman - so how can anyone possibly make any money?"

However, P2P is a great asset, useful for applications requiring high computing capacity. In P2P, some tasks, such as extensive calculations, can be distributed into more powerful devices like desktop PCs. Applications on low-capacity mobile devices can exploit specific application-wide (and chargeable) services such as a distribution of computing capacity.

A general-purpose environment for the development of network games for mobile devices has been created in VTT. As an application, a Java-based game of pool for mobile devices (iPAQ) was demonstrated (see Figures 1 and 2). The VTT's demonstration uses peer-to-peer technology with a WLAN ad-hoc network.

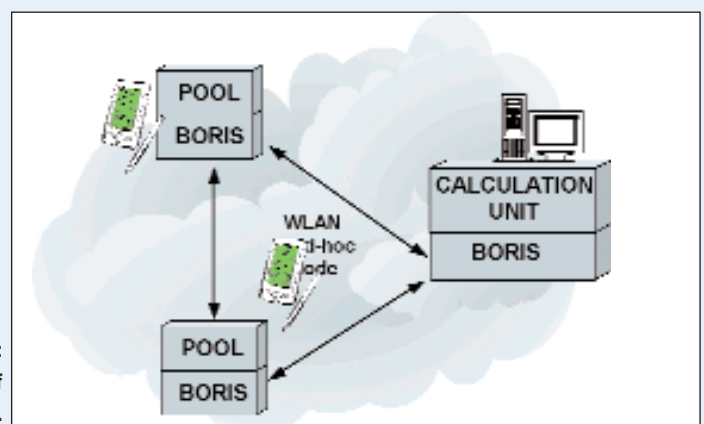


Figure 2:  
Architecture of  
Pool demo.

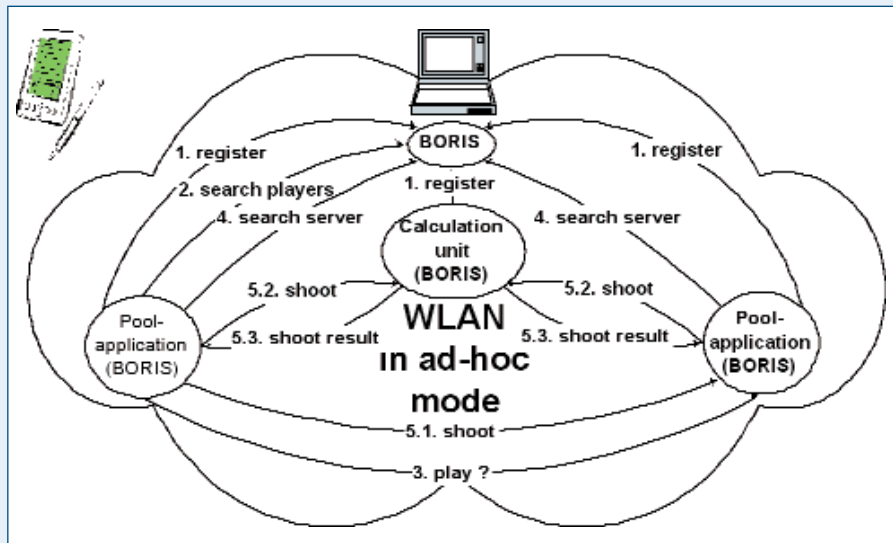


Figure 3: Pool demo communication.

In this demonstration, applications of Pool are registered using the BORIS registration service (see Figure 3). Depending on device's capacity, information on registered applications or services can be maintained by a local

device or a device behind the network. After registration, players can find names and locations of other players through BORIS. When a player is found, a P2P-style Pool game can be played between two iPAQ devices.

Due to the lack of floating-point units on the iPAQ devices used, and the heavy calculation required to determine the ball positions in Pool, the demonstration also contains a remote Pool calculation unit, which can be used to increase the utility of the game on low-capacity mobile devices.

Future work will concentrate on extending these solutions and demonstrating them on several different mobile devices with different OSs and various wireless network technologies. Furthermore, we plan to extend and implement the business scenario with payable services for device users.

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## Auctioning for Bandwidth in Communication Networks

by Bruno Tuffin and Patrick Maillé

Pricing has become a topic of great interest in the networking community. Among the different pricing schemes, auctioning for bandwidth seems a relevant possibility. Researchers from INRIA and GET/ENST Bretagne, all members of the ARMOR project-team are looking at pricing telecommunication networks; game theory is the main tool of the auctioning scheme they are developing.

The Internet is experiencing a steady increase in traffic due both to the growing number of subscribers and to applications becoming more and more demanding in terms of bandwidth. An increase in network capacity is not always a viable solution, since the expansion has to be predicted, and because of the potential cost (especially at the access networks) if not the difficulty (eg for radio access). It will also be necessary to have service differentiation, as the Internet deals with applications having very different quality of service (QoS) requirements. For instance, telephony tolerates few losses but no delay, whereas the opposite is true for e-mail. Finally, the current flat-rate pricing

scheme that has been adopted by most countries is unfair, since big users pay as much as small ones.

To cope with these problems, usage-based and/or congestion-based pricing schemes have been designed. Non-cooperative game theory is a major tool in representing the selfish behaviour of Internet users, who try to maximise their own utilisation at the expense of the community as a whole. By associating a pricing scheme with the architecture to be developed, the designer can provide incentives to encourage fair use of the network and to optimise the service provider's revenue or the social welfare. On the other hand, designers need to be

aware of the trade-off between engineering efficiency and economic efficiency. For example, traffic measurement helps in improving the management of a network but is a costly option.

Auctioning is a possible solution to differentiating services among users. The authors have developed a so-called multi-bid auction scheme that can be seen as an extension of the progressive second-price auction designed at Columbia University, with the advantage of reducing the signalling overhead since there is no need to send the bid-profile to all users anymore. Briefly, the scheme works as follows. Consider a single link of the network. When users

start their applications, they submit a bid representing how much they would be willing to pay for a given amount of bandwidth. Thanks to this bidding process, the demand is known, the market-clearing price can be computed and bandwidth can be allocated. The total cost charged to each user/player follows the exclusion-compensation principle that lies behind all second-price mechanisms: each user/player pays for the loss of utility he imposes on other users. Important properties such as individual rationality (users pay no more than the amount they have bid for the allocated bandwidth), incentive compatibility (players should better reveal their true valuation of the bandwidth), and efficiency (in terms of benefits to the

community), can be proved. Moreover, adjusting the number of bids that players can make allows the trade-off between complexity and efficiency to be controlled. The authors are currently working on extending this scheme to a whole network and to the case of inter-provider peering.

This research is a sub-activity of INRIA's ARMOR project-team at IRISA (Rennes, France), with five people from both INRIA and GET/ENST Bretagne involved in pricing issues, and the two authors dealing with auctioning. ARMOR is more generally interested in the identification, conception or selection of the most appropriate architectures for the implementation of

communication services, as well as the development of mathematical tools to perform these tasks. The group is also coordinating an INRIA ARC (cooperative research action) called PRIXNET, focusing on pricing in collaboration with INRIA's MAESTRO project-team, the University of Versailles-St Quentin, France Telecom and IBM.

**Links:**

<http://www.irisa.fr/armor/>  
[http://www.irisa.fr/armor/lesmembres/Tuffin/proposition\\_pricing.html](http://www.irisa.fr/armor/lesmembres/Tuffin/proposition_pricing.html)  
<http://www.irisa.fr/armor/Armor-Ext/RA/prixnet/ARC.htm>

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## Motion Planning in Virtual Environments and Games

by Mark Overmars

**In games and other virtual environments, computer-controlled entities need to move around in natural ways. They must plan their routes amidst obstacles and other moving entities. Motion-planning techniques that originate from robotics have been adapted and effectively applied in such environments.**

In its simplest form, the motion-planning problem requires a collision-free path to be computed for a moving body between start and goal positions. Motion planning was traditionally studied in the area of robotics in order to plan the motion of robot arms and robot vehicles. In recent years these techniques have been increasingly used in virtual environments and games. In such applications, computer-controlled entities move around and consequently their motion must be planned. In particular, we can distinguish the following types of motion:

- *navigation*: entities must find a route to a particular goal while avoiding collisions with obstacles and other entities
- *animation*: the internal (often articulated) movements of the entities must be computed, and must match the navigation through the environment

- *manipulation*: entities manipulate objects in the environment, whose trajectories must be computed in relation to the manipulation itself.

Virtual environments and games offer a challenging problem setting because of the following aspects:

- *complexity*: scenes are very complex, with up to a million obstacles
- *dynamic*: scenes tend to be dynamic, ie obstacles can appear or disappear (for example when opening a door or when a fire starts)
- *real time*: motions must be computed in real time, since one cannot temporarily stop the entities
- *multiple degrees of freedom*: a reasonably accurate structure of the human body has over a hundred degrees of freedom, and the combined motion of these must be planned
- *multiple entities*: multiple entities often move in the same environment,

and must avoid each other and behave as a group

- *natural motion*: to give the user the feeling of immersion, the resulting motions must be natural, that is, visually convincing.

Although a lot of research has been done on motion planning, current techniques cannot adequately solve these problems.

### Navigation

The traditional approach in games is to script all motion. That is, the designer creates all possible motions for the entities beforehand, and only small deviations from these paths are allowed during the game. This clearly limits the behaviour of the entities and is a lot of work on the part of the designers, who must take every potential situation into account. In some types of games, in particular real-time strategy games, this is often combined





**Figure 1: A scene from the game Command and Conquer Generals. Five units are ordered to move to the same spot but the motion planner sends one along a different route, leading to instant death for that unit.**

with some A\* approach on a grid that is laid on top of the world. Such an approach is limited to motion in a plane and can lead to unnatural behaviour, particularly when there are multiple moving entities (see Figure 1).

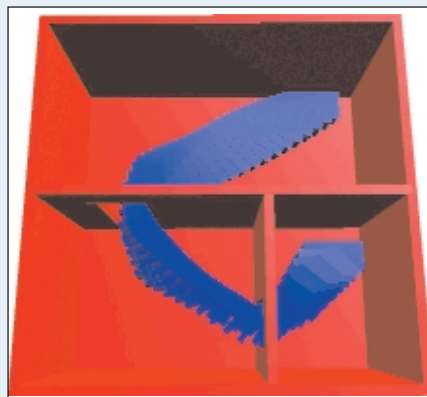
Our approach is based on the probabilistic roadmap (PRM) technique, developed in robotics. The idea is to automatically build a roadmap of all possible motions during a preprocessing phase. Once this roadmap is available it can be queried for particular motions. Although preprocessing is relatively expensive, during the game it allows motion queries to be answered almost instantaneously, even for complex environments. The planner can then easily handle instances with many degrees of freedom, as in Figure 2.

We are currently extending the approach to deal with dynamic changes within scenes, and to deal with highly articulated structures. A prime challenge here is to effectively combine the internal motion of the entities (ie the motion of their arms and legs) with their external motion through the environment.

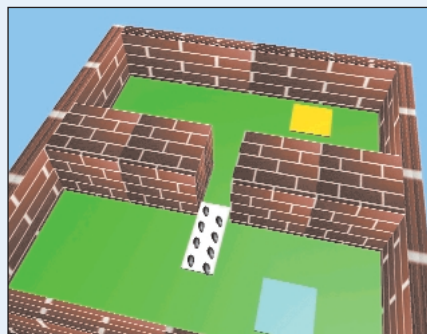
**Multiple Entities**

As indicated in Figure 1, a challenging problem in virtual environments and games is the simultaneous motion of multiple entities. The traditional approach for this is to use flocking techniques, combined with goal searching based, for example, on A\* algorithms. The basic idea of flocking is that entities adapt their motions to each other. They try to stay close to other entities (but not too close) and align their motion to that of nearby entities. In large open areas this leads to natural behaviour, as can be

observed in schools of fish or flocks of birds. When there are many obstacles however, the group tends to break up and entities follow different routes to the goal, with not all of the entities necessarily reaching it successfully.



**Figure 2: A table must move from one room to another through two doors. Combined translation and rotation is required for this. Even though the problem has six degrees of freedom, solutions are computed almost instantaneously.**



**Figure 3: A flock of sheep moving inside a deformable rectangle. The deformable rectangle can easily get through the hole (by getting longer) and the sheep will stay inside it.**

In our work we concentrate on keeping the group of entities coherent, ensuring they stay together and follow the same route to the goal. One way we achieve this is by using a deformable rotating rectangle to model the group as a whole. We plan the motion of the deformable rectangle using the PRM approach, and then apply a form of social potential field to steer the motion of the individual entities in the rectangle. This approach results in natural group motion (see Figure 3).

**The MOVIE Project**

The EU Information Society Technologies project MOVIE (Motion Planning in Virtual Environments) studies the use of sophisticated motion-planning techniques in virtual environments and games, and deals with all the aspects mentioned above: real-time planning in complex, dynamic environments, entities with multiple degrees of freedom, and planning the simultaneous motion of multiple entities. The project is also looking at simple manipulation problems. Because of the application domain, the quality of the resulting motion is of crucial importance. The MOVIE project commenced in January 2003, and is a collaboration between Utrecht University in the Netherlands, Tel Aviv University in Israel, and CNRS-LAAS and the company Kineo-CAM in France.

**Links:**  
<http://www.give.nl/movie>

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# An Accessible Two-Player Multi-Modal Board Game

by Dimitris Grammenos, Anthony Savidis and Constantine Stephanidis

A multi-modal chess game has been designed and implemented for play between any two players, including people with disabilities (sight-impaired, blind and hand-motor impaired), either locally on the same computer, or remotely over the Internet.

Most computer games are quite demanding in terms of the motor and sensor skills needed for interaction control, while they require specific, usually quite complex, input devices and techniques. This fact renders computer games virtually inaccessible to people with disabilities, and in particular to blind people and those with severe motor impairments of the upper limbs. From a technical point of view, two main approaches can be adopted in order to address the accessibility issue:

- Games are developed to be compatible with the use of assistive technologies, such as screen readers, mouse emulators and virtual keyboards. Practically, this is applicable only to non-action games, which do not rely upon fast reflexes and user reactions.
- The development of special-purpose games, optimally designed for people with disabilities, such as audio-based games for the blind, switch-based games for the motor-impaired etc.

The first approach typically suffers from low interaction quality, and still only achieves limited accessibility. The second approach, while the most promising from the point of view of quality, has two key drawbacks: firstly, the cost of developing high-quality games is prohibitive given the limited size of the potential target group, and secondly, there is the problem of segregation between able and disabled gamers, which could lead to potential social exclusion.

In this context, we pursue the development of universally accessible multi-player board games exhibiting the following key properties:

- they are designed to optimally fit individual gamer abilities, requirements and preferences
- they can be shared remotely or locally
- versions are developed for alternative platforms.

Board games represent a well-defined, physically constrained, static game world that can be directly rendered through alternative modalities. They are based on thinking rather than reflex-based reaction. This fact can compensate for any physical disabilities and also allows for longer interaction times.

The underlying vision is that through these games people will be able to have fun and compete on an equal basis, interacting easily and effectively irrespective of individual abilities, skills and preferences.

## Current Developments and Future Work

We have developed a fully functional prototype of a two-player chess game that can be played locally or through the Internet. A variety of alternative I/O modalities and interaction techniques can co-exist in its user interface. Input is supported through the mouse, the keyboard, single- or double-switch scan-



Figure 1: Presenting the possible moves for a selected item (those are also spoken to the blind user).

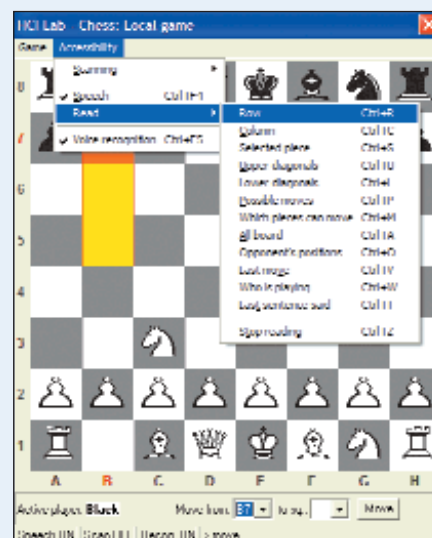


Figure 2: The alternative modalities and accessibility options offered in the configuration menu.

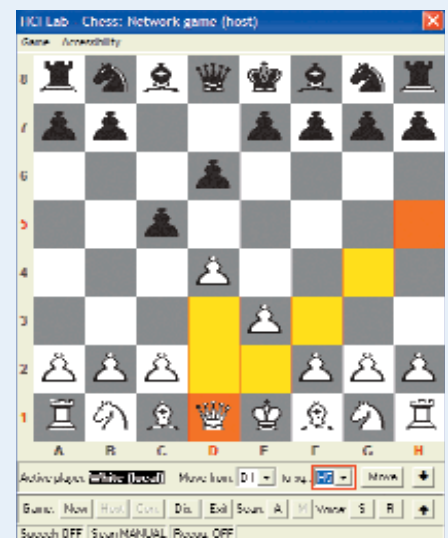


Figure 3: Playing the game through switch-based scanning, while competing an able user through the network.

ning, and speech. Output can be both visual and auditory. The game board, the pieces and the text can be enlarged. Furthermore, for the blind and the sight-impaired, additional facilities are offered for accessing oral descriptions of the board or its parts (eg possible moves, opponent positions, neighbouring pieces, diagonals etc).

Ongoing work includes the support of a Braille display and 3D sound for the description of the position of the pieces, as well as the integration of additional input devices. An accessible online chat facility is under development so that players can communicate with each other when playing through the Internet. Support for multilingual user interfaces is also being added.

Based on experiences from this first development, we are currently working on defining a component-based framework for universally accessible multi-player board games.

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## Games and Automata for Synthesis and Validation

by Erich Grädel

**Infinite two-person games provide a natural model for non-terminating reactive systems. Not only synthesis and validation of reactive programs, but also many other tasks arising in the construction and verification of computing systems, can be solved via the construction of winning strategies in games. GAMES is a European research training network that develops the algorithmic theory of infinite games and provides game-based formal verification methods.**

A simple model of infinite games, where two players move a token along the edges of a graph and thus produce an infinite path, has turned out to be extremely useful in numerous applications, from the synthesis of reactive controllers, to the evaluation of logical formulae and database queries, and the verification of formal specifications written in temporal logics. Such a game is specified by a game graph (the arena of the game) and a winning condition that singles out those infinite plays that are won by the first player (the others are won by the opponent). Infinite games of this form have a long tradition in mathematics. The classical theory of infinite games, as developed in descriptive set theory, links determinacy of games - the question of whether one of the two players has a winning strategy - with the topological properties of the winning conditions. However, the classical theory does not have an algorithmic content and studies different questions to the algorithmic theory of infinite games being developed in computer science.

The importance of games for computer science comes from the fact that games capture in a natural way the aspect of

interaction. Infinite games, as described above, model in a faithful way reactive programs that are characterised by their nonterminating behaviour and perpetual interaction with their environment.

In this framework, a software module can be understood as an agent playing an infinite game with its environment, according to a finite strategy. Thus, specifying a module amounts to formally describing a game, synthesising a module amounts to computing a winning strategy and verifying a module against a specification amounts to checking that a strategy is indeed a winning strategy. For the theory of infinite games as it is used in computer science, algorithmic aspects are obviously of central importance. It is not sufficient to know that a winning strategy exists. We are interested in efficient constructions of a winning strategy, and in minimising the complexity of the strategy itself.

The algorithmic theory of infinite games is intimately connected to two other fields - automata theory and logic. Automata provide a conceptually simple yet general model for state-based information processing systems. Logical systems (in

particular modal and temporal logics) are used for the specification of the desired non-terminating behaviour of a system and the winning condition of the associated game. Logical formulae can often be conveniently represented by automata and evaluated by games. Recent research has demonstrated that games and automata, in combination with modal, temporal, and fixed-point logics, are the basis of practical methods with industrial-scale applications.

GAMES (Games and Automata for Synthesis and Validation) is a European Research Training Network that includes research groups from seven European universities (Aachen, Bordeaux, Edinburgh, Paris, Uppsala, Vienna, Warsaw) and one university from the USA (Rice). The goal of the network is to develop the algorithmic theory of infinite games and to provide specification and validation methodologies based on the interplay of automata theory, mathematical logic, and infinite games. More specifically, the research objectives are the following:

- *Foundations: games, automata, and logic:* The combination of infinite games with automata theory and



applied logic constitutes a mathematical theory with enormous potential for practical applications. To exploit this potential, challenging problems concerning the mathematical foundations of infinite games and the interplay between automata, games, and logics must be solved and a deeper integration of concepts from automata, games, and logics is needed.

- *Reactive computation:* The network wants to exploit the potential of infinite games as a model of reactive computation and to devise game-based

methods for the automatic synthesis and testing of reactive controllers.

- *Verification:* New Frontiers. Model-checking techniques have been applied with great success to the verification of hardware. One of the big challenges for this network is to extend the verification methodology so as to deal with broader classes of systems, including important classes of software systems.
- *Web technologies:* queries and protocols: Mobile computing, e-Business, and the Web have dramatically changed the way in which data are

stored and manipulated. New technologies have emerged, with a strong demand for better foundations and efficient algorithmic strategies, and with new validation and security problems. The GAMES-network develops automata- and game-based techniques for query evaluation and the new validation tasks in this area.

**Link:**

<http://www.games.rwth-aachen.de>

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## Story Mechanics as Game Mechanics: Applying Story Analysis Techniques to Game Artificial Intelligence

by Chris R Fairclough

**In the new millennium computer games seem to be more accepted than ever, just another element of modern culture. However, there could be something different about their potential that fundamentally separates them from other media. The interactivity of the medium has been harnessed to a certain degree, and games publishers are wary of games that are overly interactive as this involves a lot more play-testing, but the new medium has the possibility of blurring the boundary between artists and the art they create.**

The research field of Artificial Intelligence (AI) has encompassed a series of more or less discrete approaches including neural networks, genetic algorithms, expert (rule-based) systems, machine learning techniques such as reinforcement learning, and case-based (memory-based) reasoning. These are based on cognitive and biological theories and most are good at certain specialised types of tasks, much like different parts of the brain, and different people, are good at certain types of tasks. When it comes to creativity, however, all of these techniques are left in the dust by the human mind, and it is generally assumed that creative AI is a holy grail that is not, and perhaps should not, be possible in the near future. I would contend that it is a generalised AI, that can operate in many domains, that is the far off dream of researchers, but a creative system that operates in a strictly

limited domain is within the grasp of today's technologies. This sort of creative system would need a combination of a variety of different techniques working together to simulate a human's creative processes within a specific domain, and thus extend the programmer-as-artist's effective reach, into the control of the reaction of the artwork to its audience.

The gameAI group at Trinity College Dublin is researching the use of academic AI techniques in computer games. In my current work, the story analysis approach of Vladimir Propp has been built on to create a storytelling system which works on the principle that new stories can be created by combining story elements from different stories, and retelling old stories with different characters and different causal chains of events. This is achieved using a case-

based reasoning system, and an expert system, combined within a story director agent. The story director has as input, a case library of story structures, the current state of a game world including the player state and non-player character (NPC) states, and a history of previously played out story events. The output is a continuously updated list of story goals, each of which are played out in a dynamic, flexible way by the NPCs. NPCs autonomously react to the player and other NPCs in a consistent manner, remembering events and executing social simulation behaviour. The story goals are assigned to NPCs based on the dynamic state of these social (and anti-social) models, so that the type of goal to be executed is consistent with the character state. In this way, a consistent, causal, chain of events is seen by the player as the driving force of a plotline that is generated on the fly.

The opinion that stories and games are fundamentally incompatible is out of date, after the success of many games that blend the two to create something that is different to both concepts. Half Life 2, Fable, Doom 3, and more games are coming out that will set new standards in story-based game A.I. There is also a new breed of multiplayer online games that pose a different challenge to game developers: How to create the same immersive story-based gameplay found in successful single player games within a huge, multiplayer, non-linear game world. In this context a story cannot be completely pre-scripted while allowing the freedom of movement and action inherent in these games. The encoding of

story telling techniques in the game engine, at a game mechanics level, is necessary to allow the NPCs in such a game to behave consistently with all the players they encounter, while still engaging with them at a story level. To accomplish this task, it seems, a sophisticated A.I. director needs to operate on both the server and client side, to monitor each player's actions, and coordinate the NPCs goals in a consistent manner.

Of course, perhaps the players of these online games don't want some AI-generated plot director interfering with their nicely planned out objective – directed gameplay, and maybe the series of events that naturally occur between players and

NPCs, based on the character interactions alone, can be viewed as a story, but - the age-old folktale and mythical plot structures that haunt human culture from ages past have manifested themselves in every new medium that comes along, so I, for one, don't expect these online worlds to suffer any other fate.

**Links:**

TCD gameAI page:  
<http://www.cs.tcd.ie/Brian.MacNamee/GameAI/>

Michael Mateas' Interactive Story Links:  
<http://www.quvu.net/interactivestory.net/links.html>

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## Strategy-Proof Routing in Wireless Ad Hoc Networks

by Paolo Santi

**Research at CNR Institute for Informatics and Telematics (IIT) in Pisa studies an application of Game Theory to the problem of preventing strategic behaviors when routing messages in wireless ad hoc networks.**

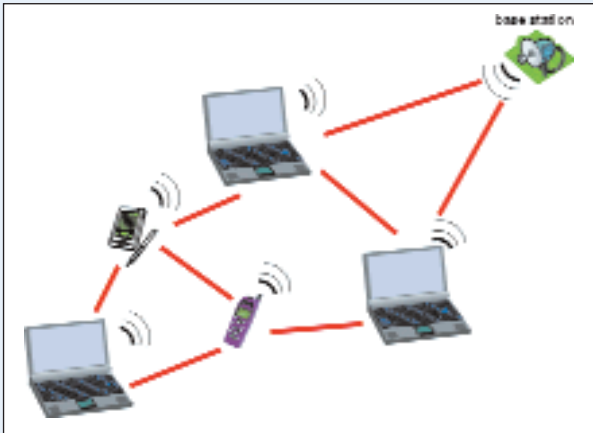
Ad hoc networks (multi-hop wireless networks) are expected to revolutionize wireless communications in the next few years by complementing more traditional networking paradigms (Internet, cellular networks, satellite communications); they can be considered as the technological counterpart of the concept of 'ubiquitous computing'. However, in order for this scenario to become reality, several issues must be adequately addressed. One of these issues is how to stimulate cooperation among the network nodes. In fact, the nodes of an ad hoc network are usually owned by different authorities (private users, professionals, companies, and so on), and a voluntary and 'unselfish' participation of the nodes in the execution of a certain network-wide task cannot be taken for granted. Concepts borrowed from the theory of Mechanism Design can be used to tackle this problem. Mechanism Design is the branch of Game Theory that studies how to design protocols that stimulate players (in our case, network nodes) to behave 'unselfishly', cooperating to the achieve-

ment of a global goal. A distributed protocol with this feature is called strategy-proof.

One of the fundamental tasks any ad hoc network must perform is routing. Since the network is in general multi-hop, a routing protocol is needed in order to discover and maintain routes between far away nodes, allowing them to communicate along multi-hop paths. Unless carefully designed, routing protocols are doomed to perform poorly in presence of 'selfish' node behaviour. In general, a network node has no interest in forwarding a packet on behalf of another node, since this action would only have the effect of consuming its resources (energy, and available bandwidth). Thus, if many of the nodes act selfishly (as may well be the case when nodes are owned by different authorities), only a few multi-hop communications will take place, and the network functionality is compromised. Thus, the definition of strategy-proof routing protocols for ad hoc networks is of fundamental importance.

In our research, which is a joint activity with Stephan Eidenbenz at Los Alamos National Labs, USA, we have developed and studied a protocol for strategy-proof route discovery and packet forwarding in ad hoc networks. In particular, we have considered a reference application scenario in which the network is used to provide a certain wireless service (eg, internet access). In principle, ad hoc networking could be used to increase the service coverage: instead of requiring each customer to be directly connected to the base station, customers could be allowed to reach the base station along multi-hop paths, using the wireless devices (laptop, PDA, and so on) of other customers as intermediate nodes (see Figure). This way, the area in which the service is available could be much larger than the radio coverage area of the base station.

In order to implement such an ad hoc network successfully, intermediate nodes must be motivated to act 'unselfishly', relaying packets on behalf of others. Typically, intermediate nodes



**A multi-hop wireless network for internet access. The base station provides internet access to the network nodes through multi-hop wireless paths (red lines).**

receive compensation in the form of monetary payment for their “unselfish” behavior, which at least covers the cost that a node incurs by forwarding packets.

Our proposal is to use a protocol that implements a fully distributed, reverse, second-price single-item auction with reserve price. The basic idea is simple: when new customers want to access the service, they issue a 'connection request', stating the maximum amount that they are willing to pay (the reserve price). The

connection request represents maximum commitment of the customer: if the connection actually takes place for less than the declared price, the customer only pays this amount. In this way, the customer has full control of the maximum amount of money that he will have to pay in order to send the packets. By using a second price auction mechanism (second-price auctions are necessary to ensure strategy-proofness), the minimum path to the destination is identified and, if the amount of money

the sender should pay is below the reserve price, the transaction takes place.

After having formally investigated and proved that our protocol is strategy-proof, we are now working on its implementation and simulation. We are also investigating the overall economic efficiency and feasibility of our incentive-based system.

Besides the activity described here, our research group collaborates in the field of ad hoc networking protocols with the University of Modena and Reggio Emilia, Italy, and the School of Electrical and Computer Engineering, Georgia Tech., USA. In the field of combinatorial auctions theory, we have ongoing activities with the Department of Computer Science, Carnegie Mellon University, USA, and the Department of Economics, University of Siena.

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## An e-Negotiation Tool to Support e-Democracy

by David Rios Insua, Julio Holgado and Raúl Moreno

**Scientists at the Statistics and Decision Sciences Group, University Rey Juan Carlos, Madrid, argue that game theoretic solution concepts can be very helpful in developing negotiation systems, which in their turn could be crucial in forthcoming electronic democracy systems.**

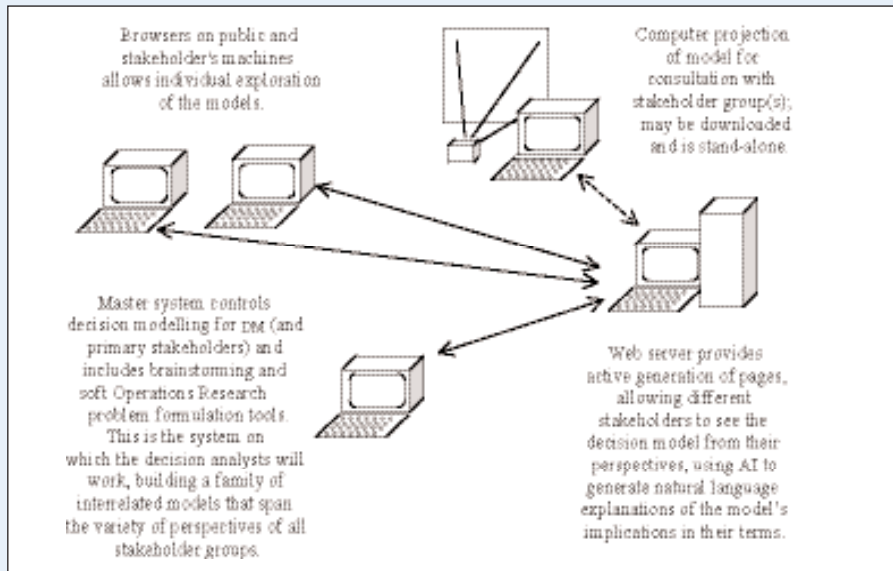
Democracy is the basis of modern society, and the freedom, fairness and equity that it promises have been cherished and fought for over the centuries. With the growth of the Internet and pervasive telecommunications, it now faces a new and positive challenge – that of making the transition to an era of electronic democracy, or e-democracy for short. In essence, this will involve voting by phone or text message, on the web, or through interactive television. There are moves across Europe and elsewhere to explore new ways of voting, initiatives to develop mechanisms of e-government, and in general expectations that our democratic institutions will adapt to the new Information Society.

Despite the excitement accompanying the rise of technology, many of the current visions for its use are almost entirely conventional. Political discussion and debate may become more inclusive through the growth of electronic discussion fora, opinion polling may become easier, faster and cheaper via the web, and voting need not involve a cross on a piece of paper but rather a click on a Web site or the sending of a text message. To a large extent, e-democracy is simply envisioned as articulating well-established political and democratic procedures through the mechanisms of modern information and communications technology. Mechanisms exist, however, that could enable a much more substantive implementation of demo-

cratic ideals. It is now possible for the public to be more closely involved in societal decision making as pursued, for example, in the European Science Foundation 2003-2006 program, TED (Towards Electronic Democracy - Internet-based complex decision support, see the URL below), which includes several ERCIM groups such as University Rey Juan Carlos, CNR Institute of Applied Mathematics and Information Technology (IMATI) and Trinity College, Dublin.

The purpose of TED is to develop an Internet-based architecture for group-decision support, as outlined in the figure below. One potential application is in participatory budgets, allowing resi-





dents of a city to decide how the city budget is to be spent. The decision analysis would be undertaken for the problem owner (eg the mayor, the governor or a CEO) by a team of analysts, using a master system which would support the whole process – computer-aided brainstorming, soft modelling techniques and various quantitative techniques such as risk analysis tools, multi-objective utilities and so forth. Throughout the process, several models could be fed onto a server to be accessed by stakeholders and the public

at large, allowing them to undertake their own explorations supported by the same tools and to arrive at their own conclusions. The level of access would vary according to the particular stakeholder and the stage of the decision process. Initially, the server could provide pages simply stating that an issue was being addressed, and perhaps inviting comments and submissions via e-mail or through a bulletin board. Later, pages could be developed actively allowing users to interact with part or all of the model and to explore the implications of

their individual perspectives and value judgements. These explorations would remain private if the problem owner or stakeholder wished, but more usefully, could provide the decision maker (DM) with a summary.

Once the stakeholders and the problem owner have conducted and communicated their decision analysis, which up to this point has been kept private, an electronic negotiation system could support a negotiation process. Such a search may be guided by one of many game theoretic solution concepts. Among them, we have opted for the balanced increment solution, which will lead our negotiation algorithm (ENS, see the URL below).

Our basic tenet is that including and communicating with all stakeholder groups would provide better quality and more transparent decisions.

**Links**  
 TED: <http://bayes.escet.urjc.es/ted>  
 ENS: <http://bayes.escet.urjc.es/ens>

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## Game Technology in Virtual Reality Development

by Jukka Rönkkö

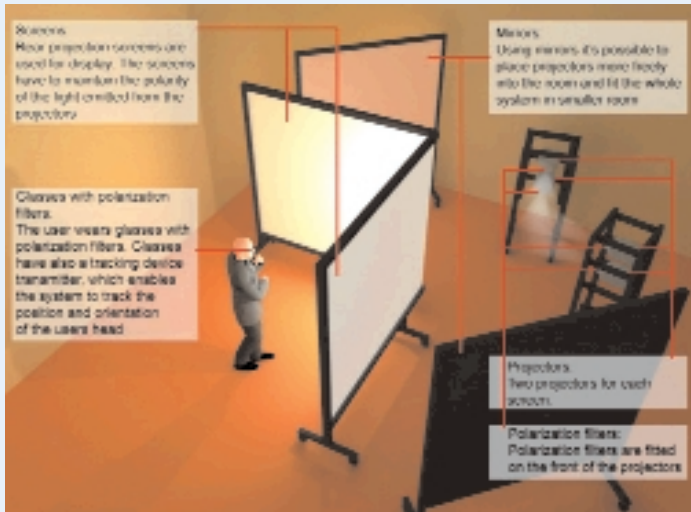
**VTT Information Technology, Product Information Management group has built a virtual reality platform based on game engine technology and off-the-shelf PC hardware.**

Game technology can be beneficial in developing tools for constructing virtual-reality applications. For example, game engines can offer software technology for efficient 3D real-time rendering on off-the-shelf PCs. The pipeline from 3D-content creation tools to virtual reality has also traditionally been problematic. However some game engines offer plugins for commonly used 3D-modelling packages as well as other tools to help with content production for 3D. Taking advantage of recent developments in game technology within the context of

virtual reality is therefore an interesting possibility.

In recent years, the advances in PC graphics hardware and game software have been remarkable. Games have pushed the need for quality 3D graphics into the mainstream. As the games market has grown to overtake the film industry in revenue, so has the demand increased for tools that will speed up the development and content production. This has led both to in-house custom solutions, and to more generic game-engine-approach, middleware solutions

that provide connectivity between commonly used 3D-modelling tools and the game platform. These platforms also include software libraries for game development. Sometimes game engines have been designed specifically for certain types of games (eg indoor or outdoor), or impose other requirements on the content that can be used. Some solutions hide the details of graphics rendering to such a degree that it is not possible, for example, to programmatically interfere with the perspective projection calculations. However, if the possible limitations are kept in mind and



**Figure 1:**  
The display configuration of the low-cost VTT Information Technology Lumeportti virtual reality system.

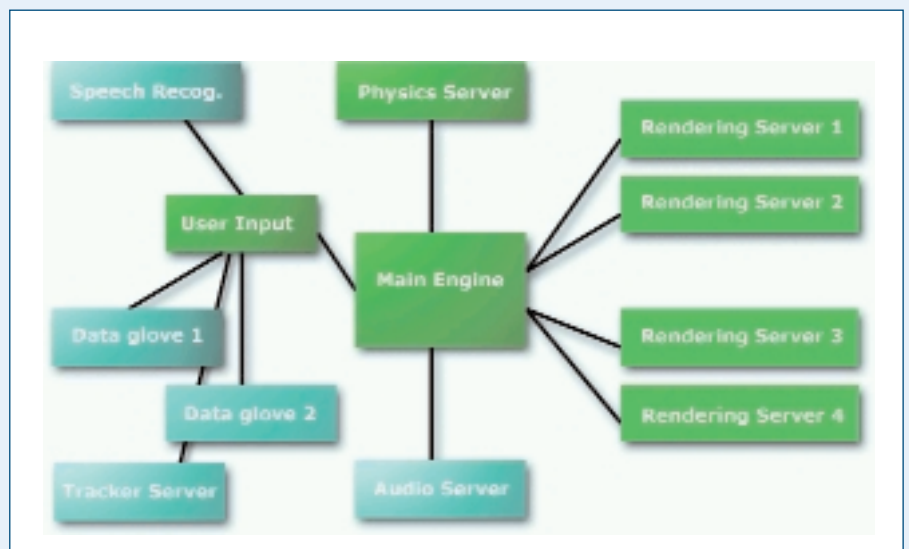
of the system. Our software platform acts like glue between different components and orchestrates various actions over the network – like rendering – that take place in different computers.

Due to the flexibility of the system, we have been able to test various game engines as rendering components. According to our experiences, some engines excel in raw triangles-per-second performance better than others and some offer more refined visual features, such as finer material definitions and shadows. Both of these types of engines have their optimal field of usage;

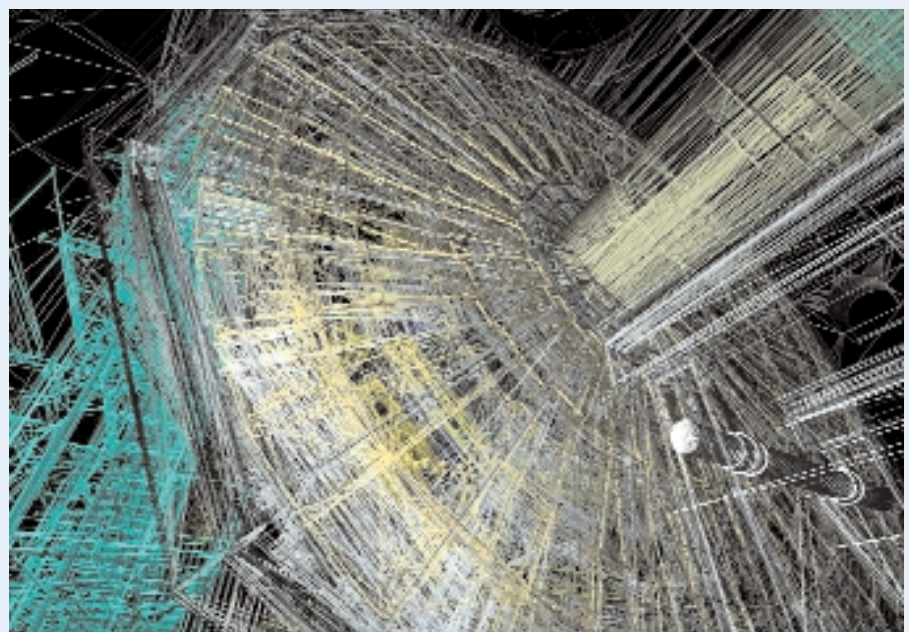
appropriate tools are selected, it is possible to use game technology to construct quite useful and general-purpose virtual reality systems.

Within the soon-to-be-completed View of the Future EU project, we have developed a scalable virtual-environment software platform running on the Windows XP operating system, on ordinary PCs equipped with graphics cards suitable for 3D game play. The system has mainly been used to run the VTT Lumeportti system, which has two rear-projection screens and five 2.0GHz Pentium 4 PCs with GeForce4 128MB graphics cards. The platform makes possible the use of various input technologies, including position and orientation tracking, data-glove input with basic gesture recognition, space-mouse input and speech recognition. Feedback to the user is provided via stereoscopic real-time graphics, and audio. The system utilises passive stereo, that is, two projectors project the image for each wall. The image is separated for each eye by using polarisation filters in front of the projector lenses and by polarisation glasses for the users.

It is intended that the system will act as a test bed for different technologies as well as enabling us to develop applications for real needs. The structure is modular in the sense that the main functionalities of the system – for example rendering – are located behind a well-defined software interface and can be run as a separate process. In this way it is possible to change the implementation of different components without affecting other parts



**Figure 2:** VEView virtual reality system architecture.



**Figure 3:** ATLAS detector parts visualised using a wire frame rendering option to demonstrate the complexity of the model as well as to show occluded parts.

for instance, a lot of raw polygon performance is good for CAD visualisation, while fine visual features are required by architectural visualisation applications. Our experiences also show that not all game platforms are suitable for the virtual-reality cluster-type rendering approach, and a certain amount of flexibility and access to the internals of the engine may be required.

We have used our system in the fields of architectural and CAD visualisation, as well as for training. As an example we built a visualisation application for the demands of the ATLAS project in CERN. ATLAS is a detector station in a new particle accelerator known as LHC

(Large Hadron Collider). ATLAS is an example of a vastly complex construction project, as the detector is the size of a five-storey building. Our tool is valuable for clear communication during the construction process. It is used to visualise the CAD-originated detector parts and discuss different assembly options. The application utilises a space mouse for navigation as well as controlling the visibility of the various structures. For this application, we used the Cipher game engine in the implementation of the rendering component of our virtual reality system. Cipher suited this purpose fairly well, as the ATLAS models were brought from CAD to 3DS MAX even before the use of our tool.

From 3DS MAX it is relatively straightforward to export the scene to Cipher and to our system.

In the near future we are interested in continuing the development of our virtual reality system with the help of game technology. We are interested in pursuing more interactive solutions for CAD visualisation as well as assembly training.

**Links:**

<http://www.vtt.fi/tte/projects/vr-cluster/>  
<http://www.view.iao.fhg.de/>

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## Opponent Models in Games

by Jeroen Donkers and Jaap van den Herik

**The Institute of Knowledge and Agent Technology (IKAT) of the Universiteit Maastricht is well known for its research in game-playing programs. An important domain of investigation is the development of methods that allow the use of opponent models. In contrast to human beings playing games such as Chess or Checkers, most computer programs that play these games do not take into account the peculiarities of an opponent. By introducing opponent models, computer game-playing becomes more human-like, thereby improving their artificial intelligence.**

The use of opponent models is a practice that even children can master. The game of TicTacToe provides a good illustration. At a certain age, a child learns that the game can best be played using a set of four rules (two knowledge rules and two heuristic ones). The two knowledge rules are: (1) make three-in-a-row, if you can, and (2) prevent the opponent from making three-in-a-row, if there is such a threat. The heuristic rules are: (3) take the middle square if it is unoccupied, and (4) take a corner square, if it is unoccupied. This strategy offers the child an advantage over other children who are still unaware of it. However, when time passes, all other children will have learned the strategy and games tend to end in a draw. At a certain point in time, the child will discover that if the opponent uses the strategy of the four rules, it can be exploited. The move sequence in the figure illustrates this clearly.

In game-playing it is often assumed that the opponent has a similar (though opposite) goal and uses a similar strategy. This assumption has led to the development of the famous Minimax procedure by John von Neumann in 1928. Since the arrival of modern (fast) computers, a large number of very efficient algorithms have been developed on the basis of this procedure as well as many enhancements (such as a-b Search), resulting in computers playing Chess at world champion level or even better. There are, however, situations in which the Minimax (a-b) procedure does not lead to the best possible play because it does not use any knowledge of the actual opponent.

From the beginning of game-playing by computers (in the 1950s), several methods have been proposed that incorporate knowledge of the opponent, but none of these methods were ever applied successfully. In 1993, two research

groups (Technion in Haifa, Israel and IKAT in Maastricht, The Netherlands), simultaneously and independently invented a method, called Opponent-Model Search (OM Search), which incorporates an explicit model of the opponent. A strong prerequisite of this method is that it requires a highly accurate opponent model – basically, the method requires explicit knowledge on how the opponent evaluates every position in the game. It makes the method hard to apply in practice. Since then, several variants of the method have been proposed and deeply investigated. One of these variants was developed in 2000 at IKAT and is called Probabilistic Opponent-Model Search (PrOM Search). PrOM Search uses an extended opponent model that includes uncertainty on the opponent. The uncertainty in the model allows it to be successful even with less strict knowledge of the





While we designed an educational language game to be affiliated with a language tutorial on television, the findings can also be applied to eLearning, interactive advertising, intelligent packaging and hybrid media (printed communication connected to digital media).

Our design problem was to meet technical, usability, game design and pedagogical needs. Entertaining applications designed to accompany digital television programs were found to be a focal point, based on our extensive study of mobile entertainment and digital television. We studied the technical development of different (mobile) digital television systems and have pointed out the possibilities inherent in using educational entertainment to motivate users to learn and to participate in a mobile situation. The base of the project is a new digital television multiplex offering 20 Mbit/s bandwidth around Finland and a satellite connection for interactive added-value services abroad. Common (television programs) and user-specific (educational multimedia) content would be linked together and used in mobile 'always on, always with' situations.

**Educational Entertainment**

The digital leisure games market is culturally and economically significant. Game interaction models are increasingly used to develop design methods in areas where games have been used as gateways to content, eg education, advertising and information distribution (utility games). Entertainment will be used in new areas like intelligent packaging, where it is believed that entertaining content will be amongst the first content genres to be implemented. Along with new market areas, entertainment will become a general design method more than a separate content market.

In order to provide competitive and enthralling entertainment for emerging mobile generations, one has to understand what makes successful mobile entertainment. In addition to studying the trends of both mobile entertainment and digital television in Europe and comparing community and gaming possibilities on the Internet, we considered personalisation, localisation and pervasive computing schemas. In educa-



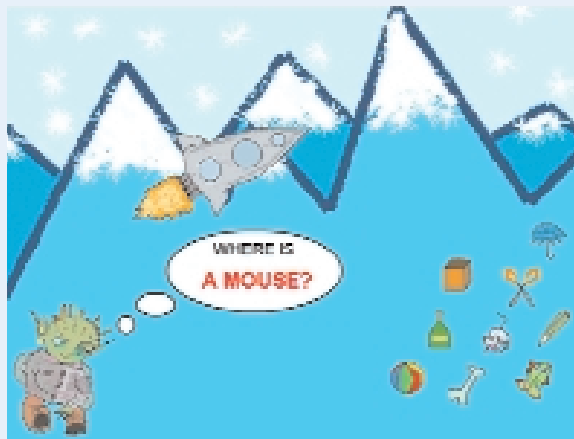
**Figure 1: Mobile television terminals.**

tional games there are pedagogical, technical usability and game design aspects to cover. The player is immersed in the game world as an active participant, but is simultaneously an external observer of the educational content. In educational games, the content is embedded in the game but is clearly separate from the game world. In other words, the game

create interactive content by themselves.

- Language programs could carry out social and interactive exercises using add-on games.
- Television quiz shows would enable the real-time participation of players at home, while animated series like Moomin or Pokemon, from which games and other spin-off products have already been created, could easily attach interactive games or the collectable right to the television programs.

We have also identified the importance of smooth and continuous connection between the television program and add-on entertainment. The add-on game should be developed side-by-side with the actual program in order for it to provide the greatest benefit. It was pointed out that social communication between users is an essential aspect of play. Mobile digital television allows users to make use of broadcast, broadband, wireless and local area networks. In



**Figure 2: Screen shot from the game 'At a Venture'.**

world can be imaginary, but the educational content must follow the definitions specified in the relevant syllabus.

**Findings**

We have highlighted the following possibilities:

- School teachers can enrich classes, eg creating animations and sending them to a television program. Location-based services would offer even wider possibilities for creating local user innovations.
- Television broadcasters could create opportunities for young people to participate in youth programs and

the future, mobile entertainment will be even more social, cooperative and interactive, anywhere, anytime and in a more strongly peer-to-peer fashion. Media integration will shape the forms of both entertainment services and terminals. Upward trends include adaptability, pervasive computing, networking, versatile mobile access and user-centred design.

**Links:**  
<http://www.vtt.fi/tte/mobtv>  
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# Introducing Discrete Simulation into Games

by Inmaculada García, Ramón Mollá and Emilio Camahort

Computer games have traditionally followed a scheme of continuous simulation, coupling the rendering phase with the simulation phase. Using a discrete event simulator as a game kernel allows pure discrete simulations, pure continuous simulations and mixed simulations. Discrete simulators support rendering and simulation phase independence while still maintaining the game structure and functionality, changing only the event management. This allows us either to execute the video game in less powerful computers or to improve the game quality.

Most of the computer-game source code currently available corresponds to non-commercial, low-quality, free games. They lack internal organisation, employ rudimentary simulation techniques and are not representative of the current level of technology. Only a few commercial computer games have their source code published (eg DOOM, QUAKE, Serious Sam).

There also exist video-game kernel toolkits such as 3D GameStudio, Crystal Space, Genesis 3D, The Nebula Device and so on, but these are mainly rendering kernels and follow the same continuous simulation scheme. A continuous coupled simulation model has many disadvantages. Firstly, all objects in the scene are simulated and rendered even though many objects will never generate events. The number of simulation steps is the same for all objects. Consequently, fast objects are insufficiently simulated while slow objects are over-simulated. This is not controlled by the programmer and depends on variables that can change during the game, including available

computer power, world complexity, other active tasks in system or current simulation and rendering load. Secondly, the object priority for simulation and events execution order depends on the object's situation in the scene, which can produce erroneous simulations. Thirdly, the simulation events are artificially synchronised, meaning they are not executed in the very moment they happen. Lastly, each new simulation cycle requires the entire world to be rendered, although many frames will never be shown on the screen. Up to 70% rendering power may be wasted on current technology.

## A Discrete Simulation Video-Game-Kernel

Our goal is to modify a video-game continuous kernel to make it discrete, while decoupling the simulation and rendering phases. To achieve that goal (see Figure 1) we have adapted the discrete event simulator (DESK) to work as a video-game kernel (this new kernel is called GDESK), and integrated GDESK into Fly3D SDK.

Any video game created using Fly3D may be translated to use DFly3D. This requires changing videogame objects like avatars, characters or weapons. The remaining objects are static and do not need to be translated. Only the simulation modelling must be changed. Object behaviour and object interaction with other objects must be modelled by message passing.

## DFly3D Rendering Process

DFly3D allows the simulation and rendering processes to run independently. The rendering process now generates only as many renders as screen refreshes, thus avoiding rendering frames that are never shown on the screen. It also adapts the number of renderings to the system load, assuring quality of service (minimum number of renderings per screen refresh).

Discrete decoupled systems can avoid unnecessary renderings in systems with low computer power (simulation time and render time is larger than the refresh interval). The render object can decide to

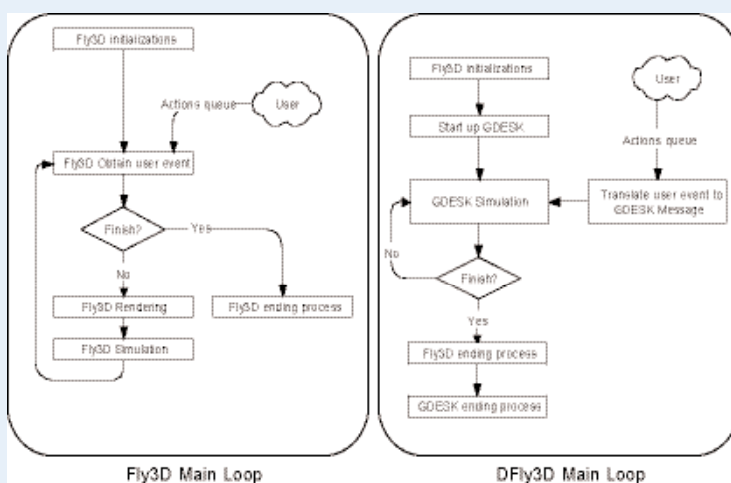


Figure 1: DFly3D and Fly3D main loops

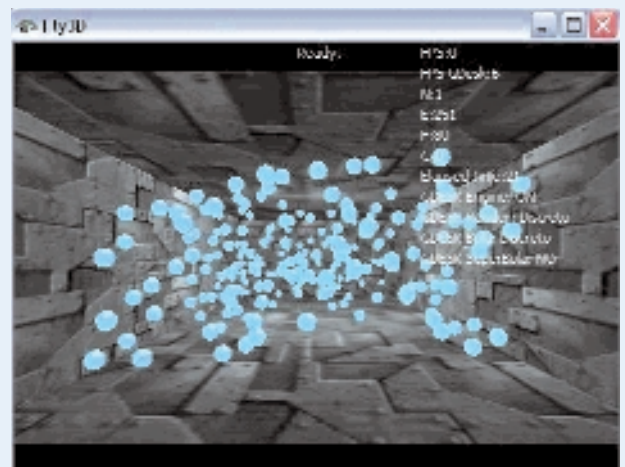


Figure 2: Videogame execution.



generate a render event in a refresh interval if it knows that there is a possibility that the frame will be shown on the screen. Alternatively, it can decide to put off the render until the next refresh interval and continue simulating.

### Results

Our results show that when using the Fly3D kernel, an increase in the simulation load produces a decrease in the rendering process, causing the game screen refresh rate (SRR) to decrease as well. Similarly, an increase in the rendering load produces a decrease in the simulation time.

Using the DFly3D kernel, the video-game time is not completely shared by rendering and simulation. Hence, the DFly3D kernel allows the SRR to be tuned while the system is not collapsed. The frame generation ratio may be fixed to any value under SRR ensuring no flicker effect.

The time spent rendering a frame depends directly on the complexity of the scene. Our experiments show that the rendering time in DFly3D is lower than that in Fly3D. DFly3D avoids unnecessary renderings, and then delivers the computing power thereby freed up to other tasks, or uses it to improve artificial intelligence and collision detection

accuracy, to increase realism etc. Every object can be sampled at its own independent rate, thus distributing computer power accurately. This means the kernel may be used in very low-power machines such as PDAs or mobile phones. It uses a very small amount of memory, while reducing the event overhead to lower than 0.05%.

#### Link:

<http://www.sig.upv.es/>

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## Adversarial Constraint Satisfaction by Game tree Search

by James Little and Ken Brown

**How players taking part in specially configured games can solve real-world optimisation problems.**

Many decision problems can be modelled as adversarial constraint satisfaction (CS), which allows us to integrate methods from AI game playing into traditional CS backtracking search. In particular, by using the idea of opponents, we can model both collaborative problem solving, where intelligent participants with different agendas must work together to solve a problem, and multi-criteria optimisation, where one decision maker must balance different objectives. To date in our research we have focused on the case where two opponents take turns to instantiate constrained variables, each trying to direct the solution towards their own objective. We represent the process as game-tree search and as a consequence, we develop variable and value ordering heuristics based on game playing strategies. We have evaluated the performance of these algorithms on general-sum graph colouring games, for both multi-participant and multi-criteria optimisation.

As a motivating example, consider planning university committee meetings.

Each committee has possible meeting times, and each room on campus has limited availability. Researchers want to cluster meetings together, to leave more time for research. Administrators want to minimise travel time, preferring to locate the meetings close to the administration block. How should the University produce a schedule? The approach considered in this paper would appoint two agents, one for each interest group, and have them take turns choosing rooms and times for individual meetings, in the hope that the interplay between their choices would produce a fair settlement. The agents would clearly bring their own objectives to the problem. If the university prefers a particular balance, it could appoint agents with appropriate negotiating skills.

Our research ultimately has two main objectives: (i) to provide assistance for self-motivated decision makers in possibly adversarial situations, and (ii) to provide a convenient framework for modelling and solving multi-criteria constrained optimisation problems.

Within the context of one particular game scenario, for (i) we propose configurations of the constraint-based searcher for play against known opponents. For (ii) we show how to configure both players to achieve desired results.

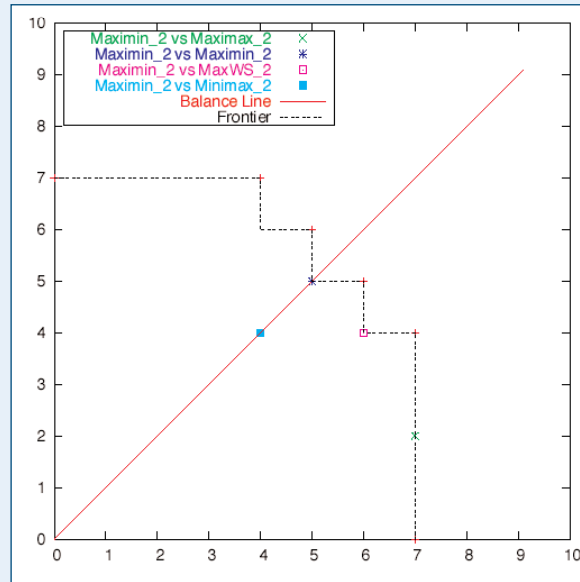
### What is the Game

The game starts with a set of variables each with a domain of possible values. Players take turns to choose a variable and assign a value to it. All the variables must be assigned values, consistent with the constraints, for the game to terminate. The rules of the game are represented by the constraints on the variables, which prevent certain combinations of variable/values being chosen as the game proceeds. Each player has their own objective, reflected in their strategies for assigning values to variables. The different objectives considered are of two types: (1) maximise the number of nodes coloured with a specific colour; and (2) maximise the sum of weights, where each node has a unary function mapping colours to integer weights.

A position in the game corresponds to some of the variables assigned values consistent with the constraints. As a game, we could expect it to terminate without necessarily assigning all variables with values and still be able to calculate a payoff for each player. Therefore we need to modify the game to include backtracking and allow players to collaborate in allowing another move to be chosen. At a terminal position, each player calculates their payoff indicating how well they have satisfied their objectives. How the player plays the game has a bearing on these eventual payoffs. A variety of strategies have been investigated for the players to use, based on the well-known Minimax algorithm.

### Experiments & Results

For the multi-participant games, we ask and answer four questions: what strategy should I play if (a) I want to beat my opponent's score in individual games; (b) I want to achieve, on average, a higher score than my opponent; (c) I want to get as close to my optimal score as possible; and (d) I want to maximise my own score given that my opponent



Results for one game, Red versus Blue.

has achieved a particular score. For the multi-criteria problems, we ask how should we configure the two players (e) to achieve a result close to being Pareto optimal, or (f) to bias or balance the performance?

The figure shows the results of one game with a variety of different playing strategies. The results are measured with respect to the Pareto frontier and a balance line, indicating how well each

objective does relative to the other. The experiments are run on 50 different graph colouring games all of 16 nodes and the results are averaged across them.

### About the Research

The research has been carried out at the Cork Constraint Computation Centre (www.4c.ucc.ie) which is funded by the Science Foundation Ireland (www.sfi.ie). The centre's focus is on making Constraint Technology more accessible and easier to use, predominantly using techniques from Artificial Intelligence. This research has been carried out for 9 months and has resulted in a published workshop paper at

CP03 and a submission to ECAI04. We are now seeking funding to investigate this approach further and would like to form relationships with other research groups, especially in the areas of Game Theory and Agents.

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## Interactive Storytelling: the Rise of a New Game Genre?

by Marc Cavazza

The development of computer games involves sophisticated programming techniques but has long been characterised by a marked preference for empirical solutions, when it came to supporting gameplay. This is best exemplified by considering the Artificial Intelligence (AI) problems most games' genres are faced with.

In the early days of game development, 'AI' referred to all behavioural aspects, rather than to the techniques known to the academic world. This situation has evolved rapidly over the past few years. Several AI techniques are now used routinely in computer games. In addition, more people embrace the idea that the future of gaming, in particular the

development of new genres and new interaction modalities will largely depend on AI techniques.

Interactive Storytelling is probably the best illustration of an AI concept that would open the way for new games genre. The idea behind interactive storytelling is to reconcile narrativity with

interaction. Films tell great stories, whose pace and suspense have been carefully authored; but it is impossible for the spectator to have any influence on the action. On the other hand, some computer games are highly interactive, and see much of the action being driven by the user. However, they lack the ability to organise their progression

according to the narrative elements spectators have learned to recognise and enjoy.

The technical solution to this problem consists in generating the story in real-time, which makes possible to propagate the consequences of user interaction, while retaining the overall logic of a baseline plot. Because at the most abstract level a story can be described as a sequence of actions, it will come as no surprise that Planning is the main AI technique supporting Interactive Storytelling systems.

An interactive story presents itself as a real-time 3D animation featuring autonomous characters (see Figure). However, unlike with a traditional animation, the user is allowed to intervene in the story and modify its course.

Our group has been involved in Interactive Storytelling research for the past four years and has developed an approach known as character-based interactive storytelling. In this approach, the baseline story is decomposed into roles for each character. These roles are formalised as Hierarchical Task Networks (HTN), which are powered by a simplified HTN planning system. To turn a story into a narrative, the sequence of actions has to be properly staged: each terminal action executed by the planner actually controls a real-time animation.

We have developed our system on top of a commercial game engine, Unreal Tournament 2003™, which provides sophisticated visualisation as well as an excellent development environment.

We have developed several Interactive Storytelling prototypes, most of them inspired from the 'sitcom' genre. The rationale being that, besides altering the story ending, the generation of situation is an important validation for a research prototype. In these systems, we define several characters each having a specific role. In our latest system one character wants to organise a party, so the HTN corresponding to that role comprises various sub-tasks, such as finding the venue, inviting friends, finding drinks and food, etc. Her actions can however



**The Interactive Storytelling System in Action.**

be contrasted by other characters which compete for the same resources (eg for other characters' attention, etc). Action failure produces situations that can be dramatised, while at the same time they drive the story to a different path. The user can interfere with the action either by physical intervention (eg removing certain objects from the set) or by talking to the characters. Using speech recognition, the spectator can formulate advice or information that will alter the characters' intentions or even the relationships between characters.

Recently, we have explored scalability issues in Interactive Storytelling, which constitute a major limitation to the development of Interactive Storytelling into a usable technology. We have investigated the impact on the HTN size and on the number of characters on the overall story complexity, by measuring the number of situations generated, as well as the total narrative duration. At this stage, the system can operate in real-time a cast of up to eight characters and generate stories up to six minutes long. This measure of technical robustness does not incorporate any judgement of the artistic quality of the narrative so generated. This is why, at the current stage of this research, the average proportion of 'interesting' stories (as could be rated by a spectator) probably does not exceed

15%. However, this early stage is only devoted to developing a basic technology that would support experiments and the identification of aesthetic problems.

Interactive Storytelling, as a long-term endeavour, is largely present in popular culture as being the future of entertainment, for instance through the Sci-Fi vision of the Holodeck™. Although the development of new media is always difficult to anticipate, the re-introduction of narrative and high-level interaction in gaming has a significant potential to develop next-generation entertainment technologies. This could even extend the population of gamers across gender and age barriers.

**Link:**  
On-line publications:  
<http://wheellie.tees.ac.uk/users/f.charles/publications/publications.htm>

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# NetAttack — First Steps towards Pervasive Gaming

by Irma Lindt and Wolfgang Broll

While console and desktop-based computer games are becoming ubiquitous in our everyday lives, computer games that sense their physical environment are still quite rare. Most current computer games tie their players to a single room, preventing them from the outdoor experience offered, for example, by many children's games. A sensible way of integrating computer games into our physical environment is to use Augmented Reality (AR) technology. Augmented Reality enhances our physical world with synthetic objects, transforming our physical world into a pervasive game experience.

The first graphical computer game – a simulation of noughts and crosses called Tic-Tac-Toe – was written by A.S. Douglas in 1952. Based on the limited capabilities of early computers, the user interface of Tic-Tac-Toe was quite simple: the CRT display had a resolution of 35x16 pixels and the player placed his nought or cross using a mechanical telephone dialer.

Since then, desktop- and console-based games have developed into sophisticated 3D environments, and can respond to user input in real time. They have become a huge market and a driving force of the computer industry, and the development

of new computer games often goes hand in hand with the development of computer technology. As a logical consequence, computer games will also follow the latest trend of pervasive computing.

There are already numerous games that run on mobile devices such as cellular phones or handhelds, but only a few of these can sense their physical environment. NetAttack is a new type of indoor/outdoor Augmented Reality game that makes the actual physical environment an inherent part of the game itself.

The game experience depends on whether you choose to be an indoor or an

outdoor player. The indoor player sits in front of a desktop computer and supports the outdoor player with valuable information, such as where to find hidden items, how to delay or disadvantage competing teams and what to do next to win the game (Figure 2). The outdoor player, equipped with a backpack full of technology, rushes around a predefined game field trying to collect items. The game time is limited and ensures the game is fast-paced.

The goal of the game is to destroy the central database of a big (virtual) corporation. In order to achieve this goal, teams must compete for items that will finally allow them to compose a secret password, thereby enabling them to destroy the database. Actions and moves depend on individual position, the competing teams and communication within a team.

## Implementation

We have implemented NetAttack based on our AR framework using laptop computers and personal displays. Outdoor players are equipped with GPS receivers, inertial trackers and video cameras to determine their positions and orientations. Computer-vision tracking is used to refine the GPS-tracking data. Data from various sensors are merged using sensor fusion to obtain the necessary precision. Head-sets support communication between the players of each team.



Figure 1: Outdoor player looking for a virtual game item.



**Figure 2: Indoor player with a map of the game area and an overview of the collected game items. A yellow dot within the map indicates the current position of the outdoor player.**

NetAttack is implemented as a distributed application. The various components communicate via events and a TCP/IP-based high-level protocol. A central component guarantees consistency and allows the configuration of the game. Before starting to play the game, the outdoor game area must be modelled and the game levels configured. The configuration is done with XML. For each game

level, variables such as the game area, number and position of the game items and the playing time may be defined.

### Experiments

Initial experiments with volunteers (students and researchers from our institute) have been conducted on our campus. In our current set-up, two teams compete, each consisting of one outdoor

and one indoor player. The hidden 3D items are distributed over the campus (Figure 1). Currently the outdoor experience is limited to a designated area on the campus that provides sufficient wireless network coverage. On several occasions during the year, the game will also be made available to the public.

### Future Work

We plan to continue developing and improving the current version of the game, providing easier and more powerful configurations and authoring possibilities, and extending the actual playing area. In addition to wider WLAN coverage, a version based on mobile phones (GPRS or UMTS) is anticipated. Other extensions are the use of alternative input and display devices, including but not limited to PDAs.

**Link:**  
<http://www.fit.fraunhofer.de/projects/netattack>

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## Sequencing Animations Intelligently

by Stéphane Assadourian

**One of the main problems to tackle for Artificial Intelligence (AI) in 3D first person shooters/sneakers is that non-player characters (NPCs) are constantly taking actions. These creatures should show flexibility and consistency in their general activity, and the ability to react to decisions based on the changing environment. Whenever a change of action is required, it causes a change of animation and therefore the possibility of a failure to achieve a believable behaviour.**

We will take the common example of a patrolling NPC that can go into a sitting idle state. Developers simply rely on motion blending to handle transitions. The purpose here is to understand why, where blending fails, sequencing works well.

### Transition versus Sequence

Most systems rely solely on motion blending, which establishes a smooth transition between two animations. It is a black box and there is no need to know the starting or the ending animation. Motion blending provides a transition between two not so different animations (eg dying while jumping). The idea is to change the current animation so that it

becomes the next one. Transitions should be used when the animation we want to play is so important that we will blend it into the current one, not even finishing it. Transitions mark a clear opposition to the concept of terminating an action, which is exactly what a sequencer does. It takes several animations and plays them from beginning to end. Blending and sequencing are two different methods which should work together as they encompass all the game needs and both add realism to it (see Table 1).

### Behaviour Execution

There is often a natural sequence of actions in real life. Indeed, we let most of

our actions terminate, particularly those 'dangerous' ones, for instance pouring wine into a glass. Table 2 shows the three layers used to describe the actions of the creatures.

You must know all the actions the creature can perform and how to play the animations (eg once, looped). They must not be too long because you are going to de-synchronize decision and action by letting every action terminate.

Delaying the most current behaviour has a price, and you would end up completely de-synchronized if your animations were too long. Cutting an

action down to smaller ones (start/loop/end) allows flexibility.

(action) layer. The layout of our AI system is shown in Figure 1.

**AI System Layout**

The sequencer interfaces the behaviour (decision) layer and the animation

There are two main advantages to adopting such a layout:

- behaviour code can be kept as simple as it should be thanks to the sequencer

Motion blending deals with...	Sequencing deals with...
Transitions	Sequences
Reactions	Actions (behavior-driven)
Do not allow termination, play when requested	Make sure action terminates.

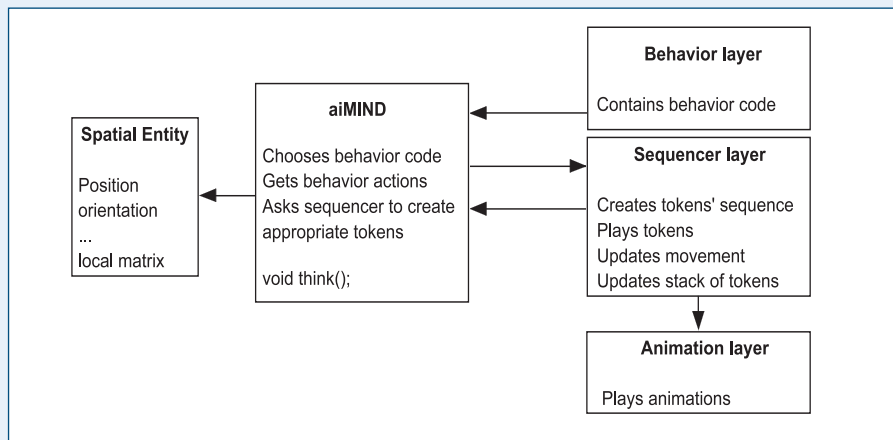
Table 1: Conceptual differences between blending and sequencing.

Design language	AI language	Animation language
Sit Idle Half Turn	idle_sit (loop), idle_stand (loop), half_turn (once), sit2stand (once), stand2sit (once)	idle_sit.anm, idle_stand.anm, turn180.anm, sit2stand.anm, stand2sit.anm
Walk Run	start_walk (once) loop_walk (loop) end_walk (once) start_run (once) loop_run (loop) end_run (once)	start_walk.anm, loop_walk.anm, end_walk.anm, start_run.anm, loop_run.anm, end_run.anm
Orientate	same as walk, run	no extra work.
<b>Behavior layer</b>	<b>Sequencer layer</b>	<b>Animation layer</b>

Table 2: Three different languages and layers describe the actions of the creature.

	Before	After	Actions
Current Behavior	Idle	Patrol	
1 <sup>st</sup> Token	idle_sit (loop)	idle_sit (once)	Sit Idle
2 <sup>nd</sup> Token		sit2stand (once)	Stand up
3 <sup>rd</sup> Token		walk_start (once)	Start walking
4 <sup>th</sup> Token		walk_cycle (loop)	Orientate
5 <sup>th</sup> Token		walk_cycle (loop)	Move forward

Table 3: Contents of the stack before and after a switch of behaviour, from idle to patrol.



The artificial intelligence system.

- it is easy to create the logic of transition.

The behaviour asks the mind for high-level actions. The mind then asks the sequencer to assess the current one. The sequencer breaks this action into tokens and then asks the animation layer to play the sequence it has come up with, until it ends.

**De-synchronize Decision and Action**

By allowing your creature to terminate the current action of behaviour A when behaviour B tells it to do something else, we are de-synchronizing decision and action.

In our example, the creature sits in idle state and suddenly decides it needs to move to a patrol point. Table 3 shows the contents of the sequencer when a behaviour switch occurs.

The animation system is playing an idle\_sit animation, which is looped. The behaviour suddenly wants a movement action to be performed. As the sequencer receives the order, it finishes playing idle\_sit, then inserts a sit to stand animation immediately after it. Such a sit to stand transition done purely by blending would clearly look strange.

**Conclusion**

The algorithm has only been briefly presented but has been implemented and a demo is available. It complements motion blending, which can produce poor results when used alone, mainly because it should be used in all the cases where the behaviour must not drive, but certainly not when the behaviour is executing as designed.

Playing animations with fluidity is one very important key to believable AI, and sequencing them is an invaluable addition.

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# gViz Project – Visualization Middleware for Grid Users

by Julian Gallop

**gViz is one of the projects supported by the UK e-science programme. It aims to investigate the additional requirements to exploit visualization facilities on behalf of Grid users and sets out to provide visualization middleware to support this.**

gViz began in August 2002 and was introduced in the article ‘Visualization Middleware for e-science – a new project in the UK e-science programme’ in ERCIM News issue 51.

## Grid-Enabling Existing Visualization Systems

One strand in the project, being carried out by the University of Leeds, aims to build on an existing visualization system, enabling users to make effective use of the Grid’s computational resources. Initially this is being done using the Iris Explorer dataflow visualization (from NAG).

The first stage predated the gViz and demonstrated how Iris Explorer could be used to wrap calls to the Globus library.

computations, which may start and finish during a single session, or long running computations, which implies that the visualization session will need to connect to and disconnect from an already running computation.

This gViz strand is described in more detail in [Wood03].

## Use of XML for Visualization

Another strand of the project aims to use XML to support visualization and data analysis.

One aspect of this is to support the transfer and reuse of a visualization application. A language SkML has been designed to describe the module invocations and data flows. This graph-based

data. This is an opportunity to set up mechanisms to enable visualization and data analysis systems to access the wide range of data already available, ideally without substantial change to those systems.

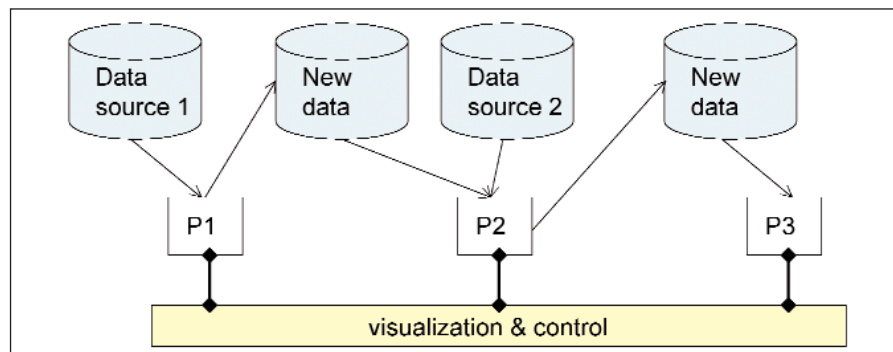
One result of these developments is that a visualization session could use a chain of processing elements, possibly with different data analysis systems and possibly in different locations on the Grid, according to the best use of resources. The figure illustrates this. For more detail of some of the ideas on using XML in the gViz project, see [Duce2002].

## Applications

Within the project, certain applications will be used as testbeds and these include pollution monitoring, heart modelling (in computational biology) and climate prediction.

## Partners

The academic partners are University of Leeds (lead partner), University of Oxford, Oxford Brookes University and CCLRC Rutherford Appleton Laboratory. Industrial partners are IBM UK, NAG Ltd. and Streamline Computing.



A possible processing chain.

The second stage built on that and allowed the user to employ Iris Explorer’s dataflow mechanisms to allocate modules to appropriate Grid resources, allowing a better user interface and better performance.

A further stage designed a Grid-based computational steering library which allows a wider range of applications to access the Grid through Iris Explorer. In addition it allows a visualization session to support the steering of short running

language can be mapped to the command language of particular visualization systems. This has been tested so far with Iris Explorer. In addition, an interactive graph editor has been written to support manipulation of the SkML language.

XML is also an appropriate tool for describing data about data. Increasingly, managers of significant data holdings are using XML as a descriptive mechanism. It can also be used to describe legacy

## Links:

[Duce2002]:  
<http://ewic.bcs.org/conferences/2002/euroweb/session3/paper1.htm>

[Wood2003]  
<http://www.nesc.ac.uk/events/ahm2003/AHMCD/pdf/030.pdf>

Project website:  
<http://www.visualization.leeds.ac.uk/gViz/>

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# Virtual Prints: A Novel Interaction Concept for Virtual Environments

by Dimitris Grammenos, Alexandros Mourouzis and Constantine Stephanidis

Virtual Prints (ViPs) are an intuitive interaction concept for supporting orientation, navigation and wayfinding, as well as a number of additional functions in Virtual Environments. In the context of the 'VIEW of the Future' Project, a prototype software mechanism instantiating the concept was implemented and systematically evaluated by both experts and end-users. As a result, the utility of the concept and the usability of the software implementation were validated and improved.

In the real world, every living organism is constantly leaving traces of its existence through its interaction with the physical environment. Deer leave their spoor on the soft forest soil, dolphins carve foam traces on the surface of the sea, flies leave annoying black spots on windows and young children put their handprints on freshly painted house walls.

In contrast to real environments, Virtual Environments (VEs) do not allow their 'inhabitants' to leave any trace behind and suffer from an 'extreme cleanness syndrome'. Walk into your house after

leaving your children alone for the weekend and you may instantly realise that a wild party took place while you were away. Walk into a virtual chat room seconds after a meeting of two hundred people has finished and it will appear exactly as if no-one had ever been there before.

In this context, we have proposed the concept of Virtual Prints (ViPs) as the interactive digital analogue of the traces that people leave behind in real life. The basic idea is that as a user moves through a VE, Virtual Footprints (FootViPs) are left behind, and every time interaction

with an object occurs, the user's Virtual Fingerprints (FingerViPs) are 'imprinted' on it. Both FootViPs and FingerViPs can be time-sensitive and gradually fade as real or virtual time goes by. Virtual Fossils (FossilViPs) are special marks that, upon user request, can be permanently left on the environment, or on any object, and which can be considered as a kind of 'personal' landmark.

ViPs can support orientation, navigation and wayfinding in VEs, but can also be used for other purposes, including locating other participants in multi-user environments, finding places where the user or somebody else has been before, supporting social navigation, training and creating tutorial sessions, developing virtual tours and visualising and tracking the path of users or moving objects. Furthermore, the user-tracking and visualisation mechanism can be employed to support user-based evaluation of VEs (eg path analysis, replaying user actions, providing statistics related to distance travelled or least/most visited areas, finding neglected or underused interactive elements, etc).



Figure 1: Accessing information related to a Virtual Footprint.



Figure 2: Interacting with a Virtual Footprint.



Figure 3: The virtual world (as seen from above) augmented with the visualisation of user paths.



Figure 4: Interacting with Virtual Fingerprints (on the red ball).

A particular advantage of ViPs is that they can be used in any VE in combination with any other existing navigation support approach, since they do not require any alterations of the virtual space and are not attached to a specific input interface metaphor or device. Furthermore, the fact that ViPs have a real-life analogue with which humans are



very familiar renders them intuitive and potentially easy to use.

In the context of the 'VIEW of the Future' project (IST-2000-26089), funded by the European Commission in the framework of the Information Society Technologies (IST) Program, part of the envisaged ViPs mechanism was implemented and integrated in a prototype VE. Several evaluation sessions have been conducted employing various methods (expert-based review, cooperative evaluation, user-based studies), on the one hand to assess the

software's usability and on the other hand to further study the concept in terms of intuitiveness and required or potential functionality. In general, the findings of these studies reinforced the hypothesis that ViPs are an intuitive and powerful concept. Moreover, the related software instantiation has proved to be handy and easy to both learn and use as a tool for navigation, wayfinding and annotation.

In conclusion, the studies provide strong evidence that a fully functional ViPs mechanism can significantly increase the

usability of VEs. The next step is to further develop the envisaged software mechanism, integrate it into existing VE systems in diverse application domains and assess its impact on the usability of such environments. Since the ViPs concept is also directly applicable to Augmented Reality, experiments using the relevant technology are also planned.

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## OpenMASK: an Open-Source Middleware for Virtual Reality

by Bruno Arnaldi and Stéphane Donikian

**OpenMASK is a platform for the development and execution of modular applications in the fields of animation, simulation and virtual reality.**

The modelling of an interactive application with several dynamic entities that evolve in complex virtual environments requires communication between different models. These can include environment models, mechanical models, motion control models, behavioural models, interaction models, sensor models, geometric models and scenarios.

The main features provided by OpenMASK are its ability to:

- interact with a virtual environment using various devices (sensors, data gloves, haptic devices etc) in a local or distant 3D cooperation (collaborative work)
- integrate different computation modules (mechanical simulators, human motion, behavioural models etc) using high-level abstractions

- automatically distribute computations on a network of workstations
- show results in an immersive environment (Reality Center, Workbench etc) or on a standard display by using a visualisation module based on Performer (Sgi) or OpenGL (Fraunhofer Institute).

One of the main objectives of OpenMASK (Modular Animation and Simulation Kit, and Multi-threaded Animation and Simulation Kernel) is to provide a common run-time and conception framework for the creation of virtual reality applications. In OpenMASK, the unit of modularity is the simulated object, which can implement any preceding models and could be the result of code generation provided by a dedicated tool (see Figure 1).

### OpenMASK Kernel

Objects can communicate by simultaneously using data-flow and asynchronous mechanisms. Object activation can be performed by the kernel of the platform on a regular basis (giving the object a simulation frequency), on a reactive basis (when the object receives events), or by a combination of the two. The

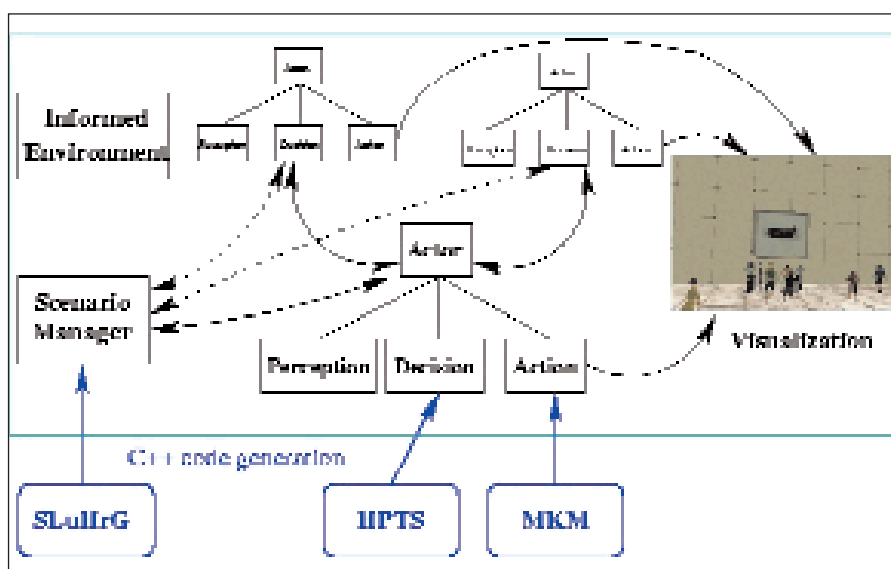


Figure 1: Architecture of an application including several autonomous characters.

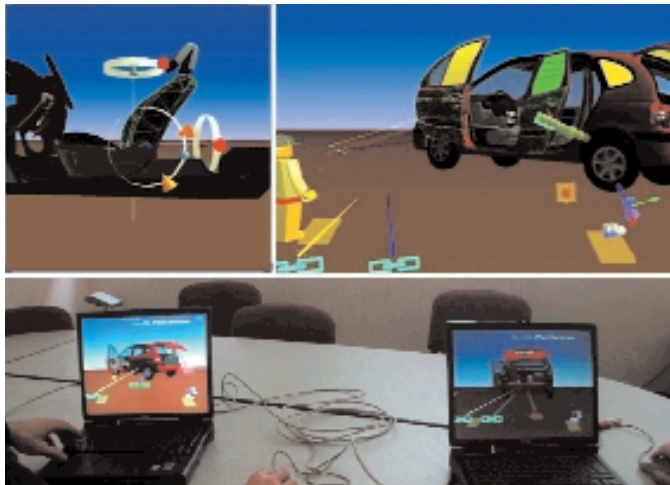


Figure 2: Awareness of constrained interactions, and shared interaction upon a car mock-up.

same framework can therefore be used in a natural way for reactive as well as proactive objects.

Building an OpenMASK application consists of composing simulated objects by organising them all in a simulation tree. The main advantages of this approach are the component reusability between applications and the automatic generation of modules produced by dedicated tools. Once the application has been built, the last step before achieving any result is to choose the run-time kernel to be used. Indeed, the conceptual framework presented here is a solid foundation for many different run-time constraints, as it has been designed to enable both offline and online simulation, and multi-threaded execution. OpenMASK comes with multi-site (for distributed applications, eg distributed virtual reality, distributed simulation) and/or multi-threaded (for parallel computations) kernels.

**Collaborative Work**

Generic adapters are provided to make simulated objects interactive and to allow them to communicate in a generic way with interaction tools. Collaborations between distant users within 3D virtual environments are possible thanks to the OpenMASK distribution capabilities, which allow simulated objects to be distributed among several processes. Thus several users can share simultaneous interactions with the same interactive object.

**OpenMASK-φ : Physical Cooperative Experience**

OpenMASK-φ is a new contribution to OpenMASK, and concerns the integra-

tion and interaction of different physical simulation engines and force-feedback devices for cooperative virtual reality applications. Thanks to three software components, one can simply and effectively integrate various physical simulators such that they can coexist in the same virtual world. A number of simulators have already been successfully integrated, including CONTACT Tolkit (Inria I3D team), ODE (Open Dynamics Engine) and DYNAMO (Eindhoven University). This feature is vital if one is to take advantage of the specificities of each simulator. We have also demonstrated the integration of various haptic devices such as the Virtuouse 6D from the Haption Company and the Spidar (Tokyo University).

Since a number of users are able to physically interact on local or distant sites inside the same virtual world, they can,

example, sense the weight of a virtual object in their hands and cooperate in its manipulation even if they are hundreds of kilometres apart.

**Current Projects Involving OpenMASK**

OpenMASK is well suited for the development of virtual reality applications. It is currently in use in several research projects with academic and industrial partners such as Bayesian learning of virtual humans (ROBEA project with E-MOTION and EVASION INRIA Grenoble Research Teams), distant cooperation in distributed virtual environments (with Renault in the Perf-RV National Research Network on Virtual Reality), crowd simulation including thousands of pedestrians (with AREP and SNCF) and virtual training (with GIAT Industry).

OpenMASK is available under an open-source license and currently operates on Linux and Unix systems (production of Windows and MAC OS X versions is in progress).

Link: <http://www.openmask.org>

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Figure 3: Direct immersive manipulation with the haptic device Virtuouse 6D and multi-user manipulation on laptops.

# GeneSyS: Monitoring and Management of Distributed Systems

by Balázs E. Pataki and László Kovács

Application development is moving from monolithic systems towards distributed architectures based on middleware technologies (eg GRID). This kind of application requires a sophisticated monitoring framework that provides information on all levels from the hardware over the network up to the application level. The goals of the EU Information Society Technologies 'GeneSyS' project are the specification, development and standardisation of an open, standards-based, open-source monitoring and management framework.

GeneSyS (Generic System Supervision) commenced in March 2002 with the goal of specifying and developing a new system-monitoring and management middleware for distributed systems and applications. Besides specification and development, the project intends to help GeneSyS become a standard or recommendation for system supervision based on Web Services technologies.

The need for such a framework arises from the fact that distributed applications are gaining an increasingly wide acceptance. Driven by global players, the introduction of Web Services has pushed interest in distributed applications further. In order to reflect the requirements of different areas within the architecture, the GeneSyS consortium consists of academic and industrial partners from a number of domains. The partners are EADS Space Transportation (France), RUS/HLRS (Germany), NAVUS GmbH (Germany) and ERCIM member SZTAKI (Hungary).

## Drawbacks of Existing Monitoring Systems

The major drawbacks of most supervision tools are their closed and proprietary nature and their limited view of a specific domain of monitoring as a network. The main problems can be summarised as follows:

- the application programming interfaces are not open, ie they are neither documented nor publicly available

- the inter-agent protocols are often not open standards-based and use an encoding scheme which depends on the operating system
- most existing supervision solutions target a specific domain of monitoring, such as network monitoring or

visualisation application and the communication bus. GeneSyS has the following building blocks:

- *Supervised Entity*: the resource (hardware, network, software) that is supervised by GeneSyS. It can be a Monitored Entity resource, which provides information about its internal status, or a Controlled Entity, which provides a command interface enabling its internal state to be manipulated.
- *Delegate Agent*: the component that is able to produce monitoring data for a given Monitored Entity, as well as controlling the Controlled Entity resource with commands coming from the Supervisor Agents.
- *Supervisor Agent*: this component is able to consume monitoring data coming from a Delegate and is also used for sending control commands to the Delegate agent to affect (eg restart, reconfigure) the Supervised Entity. A typical human-managed Supervisor combines both monitoring and control functionality and inter-

faces with a human operator by means of a graphical supervision console.

- *Core*: this is the component that provides publishing and discovery services to agents. It acts as a directory service provider. Every agent should register with the Core and publish its component information to be queried by other agents.
- *Repository*: the GeneSyS Repository is capable of archiving supervision data in persistent storage and retrieving it upon request.

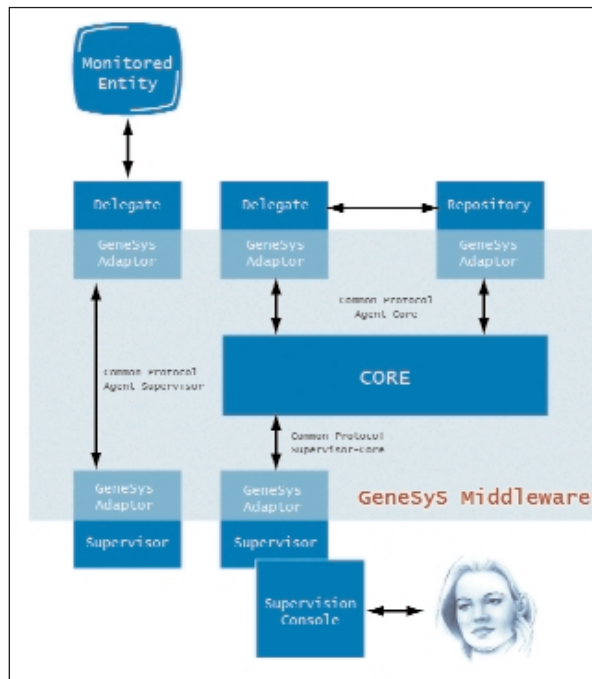


Figure 1: Components of the GeneSyS Architecture.

database monitoring, or are designed to monitor a specific commercial application

- existing systems follow an inflexible architecture in which the transportation core, monitoring agents and data visualisation consoles are not well separated.

## Architecture

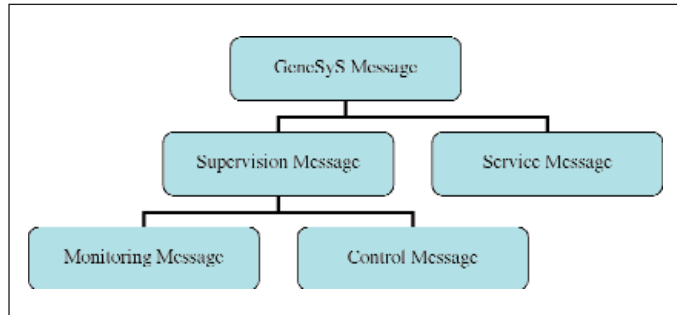
To achieve a high level of flexibility, the monitoring tools are separated from the



The GeneSyS components are connected by the GeneSyS Messaging Protocol (GMP), which defines communication between Agent and Supervisor, and Agent and Core. The protocol itself is implementation-neutral and depends neither on languages nor operating systems. In GeneSyS version 1.0 the GMP has been implemented for the Simple Object Access Protocol (SOAP) with a message interchange format based on XML.

**Validation Scenarios**

GeneSyS architecture is evaluated using real, mission-critical applications. GeneSyS V1 was validated in the context of EADS’s Preliminary Design Review (PDR) application. This involves up to several hundred remotely connected engineers who review engineering documents of the Automated Transfer Vehicle (ATV). The ATV’s mission is to provide transportation services to the International Space Station. The PDR requires audio-video communication between the engineers and access to the Engineering Document Database (EDB). In this scenario GeneSyS has been successfully evaluated and proved to be a vital tool for providing awareness of the status of the underlying systems for application and system administrators.



**Figure 2:**  
Layout of the GeneSyS Messaging Protocol.

The forthcoming version of GeneSyS (version 2.0) is designed to be used in new areas. The Web Servers Monitoring (WSM) scenario will use GeneSyS to supervise typical Web server configurations consisting of HTTP servers, database servers, applications servers and scripts. In this scenario, GeneSyS will introduce the concept of supervised entity dependency, which will allow easier root cause analysis of problems coming from the execution of dependent systems.

**Future Plans**

The first version of GeneSyS and its specification are available in open-source form at SourceForge. The GeneSyS concept has been introduced to standardisation bodies such as the World Wide Web Consortium (W3C) and the Organization for the Advancement of Structured Information Standards

(OASIS) for evaluation. Ongoing discussions target the realisation of a Web Services-based system-monitoring recommendation based on or incorporating ideas from GeneSyS.

The next version of GeneSyS – currently under development – targets the security of communication between agents, a more consistent supervision console architecture, events-based monitoring and the introduction of intelligent agents, which will be able to decide and report autonomously in case of exceptional situations.

**Links:**  
 Project home page: <http://genesys.sztaki.hu>  
 Department of Distributed Systems at SZTAKI: <http://dsd.sztaki.hu>

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## New Crossbar Directly Switches Variable-Size Packets

by Manolis Katevenis and Nikos Chrysos

**Networks carry variable-size packets, but router crossbars can only switch them after segmentation into fixed-size cells. This situation will soon change, with the development of a new architecture designed to remove the inefficiencies associated with packet segmentation and reassembly (SAR).**

The Internet carries information in packets whose size varies from 40 bytes to a few kilobytes. Variable-size packets are also used in the majority of communication across the whole spectrum, from WAN, MAN, LAN, and cluster interconnects to storage, server, computer I/O, processor-memory interconnects, embedded systems, and networks-on-a-chip.

These ubiquitous networks are formed by interconnecting switches or routers, which are in turn usually built around a crossbar switch at their core. Crossbars allow multiple, simultaneous transfers of information, as shown in Figure 1, and are thus replacing old-time buses, which preclude any such parallelism.

Figure 1 shows a 3x3 switch with buffer memories at the inputs (each containing three per-output queues), as in the usual contemporary architectures. The crossbar is configured to pair inputs with outputs. Choosing a ‘good’ configuration is crucial and complicated: some configurations are inefficient (eg not pairing output C to input 2), while others are unfair. When the crossbar configura-

tion is changed, all input-output pairings also change, and consequently, crossbars inherently operate on fixed-size cells.

To route variable-size packets, we segment them into fixed-size cells, get the cells through the crossbar, and then reassemble the original packets at the outputs. This introduces inefficiencies; for example, a 65-byte packet in a system employing 64-byte cells costs as much as a 128-byte packet. To make things worse, crossbar configurations are often imperfect, because the complex scheduling

not allowed. The new architecture relaxes these dependencies by placing small buffer memories at each crosspoint, as shown in Figure 2.

Each output scheduler now chooses a packet from one of the non-empty buffers in its column; such choices are independent. Similarly, each input scheduler independently chooses to forward traffic to one of the non-full buffers in its row. In the long run, some buffers will empty and others will fill up, thus indirectly coordinating the sched-

observation radically changes the entire system.

Without SAR, the second reason for crossbar speedup is also eliminated. Hence, the new switches can handle line rates as fast as the fastest crossbar that can be built, that is, line rates about three times higher than the old crossbars permitted. Further, cost is greatly reduced because output buffer memories, which were used to hold the cells that accumulate at the outputs due to speedup, and were also used for packet reassembly, are no longer necessary.

FORTH is one of the pioneers working on this architecture and advocating its adoption. Our research group on Packet Switch Architecture, comprising about eight people in the Institute of Computer Science, Crete, Greece, is completing the design and layout of a buffered crossbar CMOS chip, containing roughly 150 million transistors, that directly switches variable-size packets. Our results can be found at the link below.

#### Switch Architecture in Europe

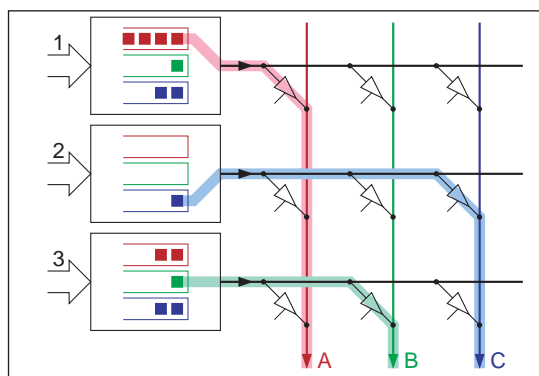
Packet Switch and Router Architecture is becoming increasingly important, as interconnection networks now constitute the backbone of all emerging information and communication systems, and the switch and router market is growing quickly. We foresee the emergence of commodity switches – low-cost, universal building blocks – that will alter the router market in the same way as PC clusters based on commodity processors altered the supercomputer market. In the last couple of years, about a dozen European organisations (research centres, universities and industry) that are heavily involved in R&D in this area have strengthened their cooperation, working towards radically improved switch and interconnection architectures, and towards a leading European presence in this crucial infrastructure area.

#### Link:

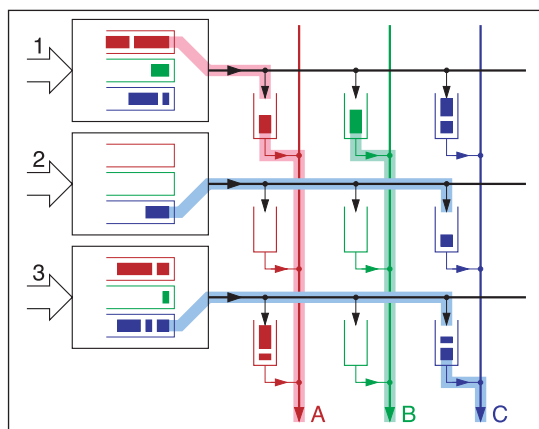
<http://archvlsi.ics.forth.gr/bufxbar/>  
<http://archvlsi.ics.forth.gr/swarc/>

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**Figure 1: A crossbar switch allows parallel communication paths between arbitrary input-output pairs.**



**Figure 2: Small buffer memories at the crosspoints allow distributed scheduling decisions. An important by-product is that operation with variable-size packets now becomes feasible.**

problem must be solved in just a few tens of nanoseconds. To compensate for these two inefficiencies, crossbars must switch cells faster than their rate of arrival. This ratio is called the crossbar ‘speedup’ factor; commercial products use speedups in the range of three, implying that the fastest lines that can be handled are about three times slower than the fastest crossbar that can be built!

#### Distributed Scheduling

In the last five years, a new crossbar architecture that improves scheduling efficiency has been investigated. In Figure 1, decisions at the outputs (ie choose an input to read from) are interdependent, because input conflicts are

uler decisions. This new architecture has become feasible because we are now able to integrate several MBytes of RAM inside crossbar chips; this allows much simpler and more efficient crossbar scheduling, and thus removes one of the two reasons for using crossbar speedup.

#### Variable-Size Packets

In the last few years, three research groups have observed that this new architecture is also capable of operating directly on variable-size packets, without segmentation and reassembly (SAR). Given the scheduler independence, there is no need to change configurations in synchrony and hence no need for a single, common, fixed cell size. This

# N2NSOFT Network Simulator — Simulation and Optimisation of Large IP Networks

by Dohy Hong and François Baccelli

N2NSOFT is a technology company that branched off from INRIA and now provides services and software solutions for the design and optimisation of internet protocol (IP) network architectures. N2NSOFT has developed software tools allowing one to simulate large and complex IP networks. Today we can simulate up to ten million parallel flows while taking into account the main IP protocol features.

In current IP networks, decentralised protocols (eg adaptive algorithms like TCP) introduce an end-to-end correlation and complex interaction between traffic and network. Consequently, it is no longer sufficient to understand or optimise each network component separately, ie outside the global context of the network. N2NSOFT proposes a new

quality of services for each application (response time for Internet games, voice and video over IP, goodput obtained 90% of time etc).

Our methodology is based on a flow-level simulation developed by the INRIA research group TREC. This approach avoids packet-level event

The technical background to this research was presented at the main conference in this domain, INFOCOM 2002 and 2003, by F. Baccelli and D. Hong (Flow Level Simulation of Large IP Networks, Interaction of TCP Flows as Billiards). This technology has been validated by collaborations with major network companies: it has already been used with success for the dimensioning of large xDSL access networks and in the design of dynamic routing algorithms in core networks. N2NSOFT has the exclusivity of the commercial exploitation of this patented methodology.

At present we are developing tools for core and access networks, including various types of scheduling mechanisms in routers and a number of application and traffic profiles (HTTP, P2P, FTP, Video etc). We have also integrated and mixed packet-level algorithms (eg for WiFi integration on mixed wired-wireless networks), and hope to extend our framework to a wide variety of technologies such as FTTH, GPRS, UMTS etc.

We believe a need has arisen to understand and optimise large, complex IP networks, and that this need is not satisfied by existing tools. Currently there is a critical need to optimise access networks. In the future, with the increase of Internet traffic, it may not be optimal to over-provision even the core network. We need to keep pace with the fast evolution of new technologies (UMTS, VDSL, FTTH etc) and new applications (P2P, internet games, Video on Demand etc) and design a network solution that will deliver the best guarantee to customers.

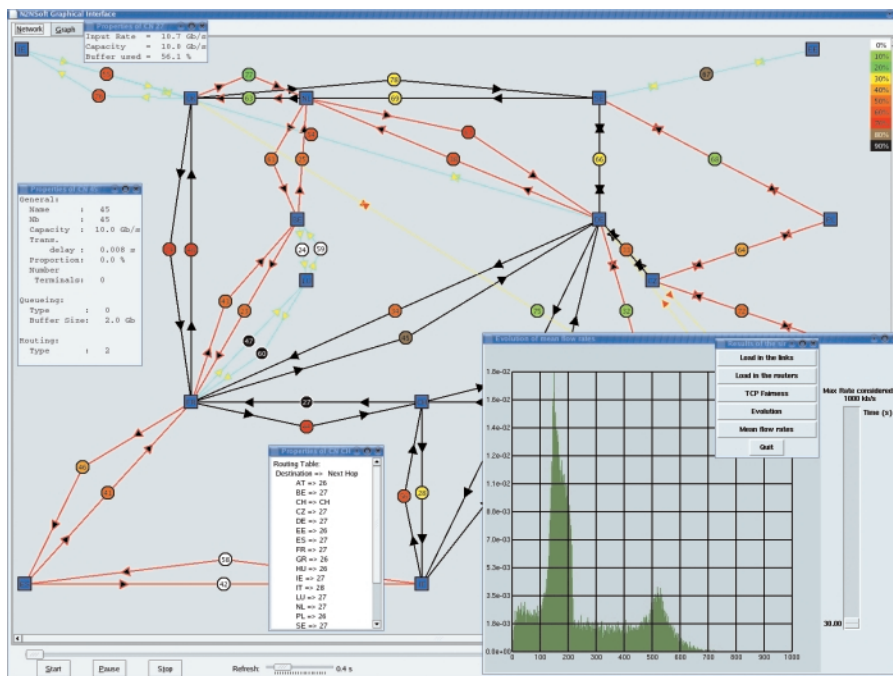


Figure 1: A prototype of a graphical user interface to monitor the network link states: utilization and buffering.

approach that would allow one to develop both a global understanding of a complex network and an optimisation that takes into account the end-to-end interaction of IP traffic. This is based on the fine description of the whole network and traffic configurations, and delivers for each type of subscriber a statistical guarantee of SLA (service level agreements) in the network, and a statistical

simulation, which does not scale with the size of the network or the number of flows being simulated. Our approach allows one to simulate networks up to ten thousand times larger than can be handled by existing software tools. This offers new possibilities and an end-to-end vision on large networks.



Our approach offers relevant solutions and enables a global large simulation approach, because we take into account the main and detailed features of IP protocols, including feedback mechanism of TCP. In an increasingly competitive environment, we can help our customers to design and offer rational solutions with guaranteed performance.

Our main clients are telecom manufacturers, operators, ISPs, IAPs, companies providing services, and more generally network professionals who need to design, test, understand, predict or optimise IP network architecture. We would like to develop partnerships with companies willing to exploit our tool in specific domains: with telecom manufacturers and operators because we can offer a

new tool, or with software and service vendors because we can provide a complementary tool to their current products.

**Link:**

<http://www.n2nsoft.com>

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## Connecting Wireless Sensor Networks with the Internet

by Adam Dunkels, Thiemo Voigt and Juan Alonso

**Wireless sensor networks enable numerous advanced monitoring and control applications. In this project scientists at SICS are connecting sensor networks with the Internet.**

Networks of tiny sensors make it possible to monitor, unobtrusively and for long periods of time, natural phenomena such as sensitive wildlife habitats or deep oceans. Home automation, volcano exploration, and monitoring of patients in hospitals are some of the other applications that can be enhanced using wireless sensor networks.

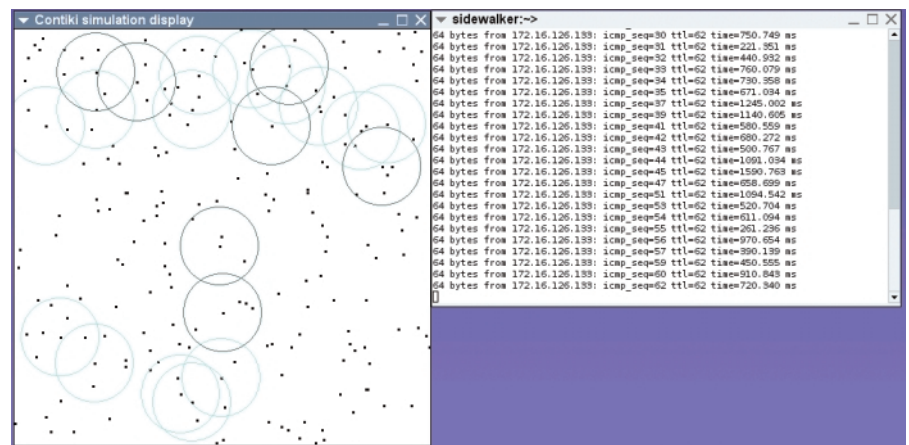
A wireless sensor network consists of a large number of tiny sensor nodes, each of which is equipped with a radio transceiver, a small microprocessor and a number of sensors. These nodes are able to autonomously form a network through which sensor readings can be propagated. Since the sensor nodes have some intelligence, data can be processed as it flows through the network.

For many applications, the sensor networks cannot operate in complete isolation; there must be a way for a monitoring entity to gain access to the data produced by the sensor network. By connecting the sensor network to an existing network infrastructure such as the global Internet, a local-area network, or a private intranet, gaining remote access to the sensor network is straightforward.

At SICS we are looking at using TCP/IP, the Internet protocol suite, for communi-

cation within the sensor network. This enables the sensors to be easily integrated into TCP/IP networks. There are, however, a number of problems that currently prevent TCP/IP from being directly applicable to sensor networks.

networks, it is not possible to manually configure the addresses and we cannot rely on a central server. Instead, we have designed a spatial IP address assignment scheme, whereby each sensor constructs its IP address from



The Contiki network simulator.

We are developing mechanisms in order to solve these problems. These include:

- *Tiny TCP/IP implementation:* it has often been said that the TCP/IP protocol stack is too heavy to be squeezed into such a tiny system as a wireless sensor. Our  $\mu$ IP TCP/IP implementation, however, is small enough to be useful in such systems.
- *Spatial IP address assignment:* In IP networks, each host is required to have an IP address. In large-scale sensor

its physical location. Since most sensor applications already require the sensors to keep track of their location, this mechanism does not increase the complexity of the system.

- *Shared context header compression:* For TCP/IP, the overhead created by headers can be quite large, particularly for small messages. For example, a four-byte data message would have a header overhead of nearly 90%. We are developing a header compression

mechanism that utilises the special conditions in sensor networks in order to reduce the header overhead to only a few bytes for messages carrying sensor data.

- *Application overlay networking:* The address-centric routing in IP does not match the data-centric applications of sensor networks very well. We are developing an application overlay network structure that lets distributed applications run on top of the network and decide how to process the packets.
- *Distributed TCP caching:* The TCP/IP protocol suite was developed for networks with very low error rates and does not work well in error-prone wireless networks. To remedy this, we are experimenting with a mechanism

that lets the sensor nodes help each other in caching data segments. If segments are lost because of errors on the radio channel, neighbouring sensor nodes are able to re-transmit the lost segments.

Furthermore, we have developed Contiki, an operating system for small sensor nodes that includes the \_IP TCP/IP stack and implements the above mechanisms. We have ported Contiki to a number of different hardware platforms and have developed a simulation environment that lets us run multiple instances of Contiki as processes on a PC. This simulates wireless communication and lets the simulated nodes communicate with the outside network

using TCP/IP. Additionally, the simulator provides a graphic representation of the sensor network as shown in the Figure.

We have taken the first step towards bringing TCP/IP communication into the realm of sensor networking. Subsequently, this will enable us to integrate sensor networks into the Internet.

**Link:**  
The DTN/SN project at SICS:  
<http://www.sics.se/cna/dtnsn/>

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## Automated Production of Fully Functional Applications with OlivaNova Model Execution

by Oscar Pastor, Juan Carlos Molina and Emilio Iborra

**OlivaNova Model Execution (ONME)** is an implementation of OO-Method, an object-oriented methodology for the development of applications. It was created at the Technical University of Valencia, in the context of a successful cooperation between academia and industry.

The idea of generating code from models has been implemented in a variety of ways with relative success. Normally, the process is based on the use of some UML-compliant diagrams. The amount of code automatically produced from those diagrams is relatively small compared to that of a fully functional application. Consequently, hand-coding is still the most significant phase in the process of applications development.

Such implementations can be catalogued as MDCG (Model-Driven Code Generation) tools, because models are used to assist developers in the task of programming applications. In other words, models can be seen as guidelines but are never considered to be true 'programming artefacts'.

ONME's proposal goes one step further. It constitutes a real Model-Based Code Generation (MBCG) set of tools. Unlike Model-Driven tools, in Model-Based

Code Generation tools, models play a central role in the development of applications, and can be regarded as true programming artefacts. While it is true that MBCG tools have been successfully

applied in certain domains like real-time and embedded systems, the goal of OlivaNova Model Execution is to provide an MBCG solution for information systems in general.

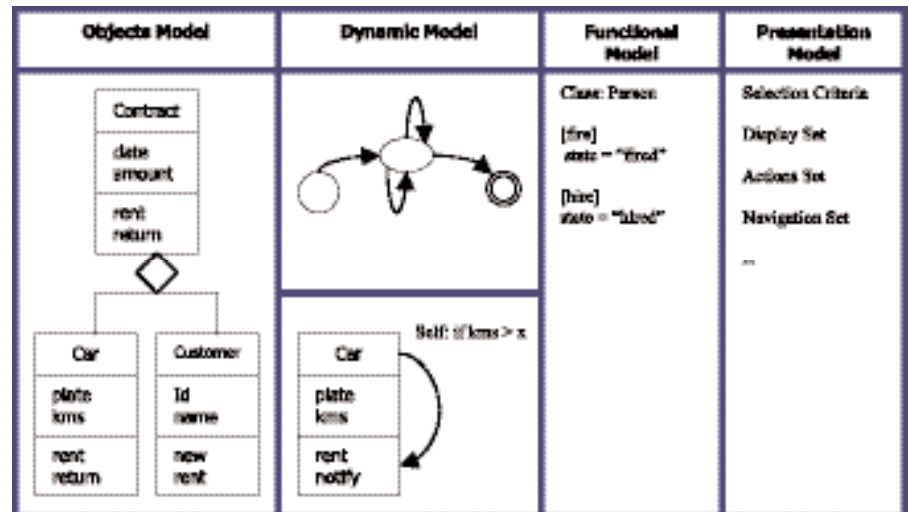


Figure 1: OO-Method's four views.

The technical background is simple yet powerful. The relevant conceptual primitives required to specify an information system are precisely defined. A set of UML-compliant diagrams that represent them is provided, conveniently complemented with the required textual information. This provides a kernel of UML modelling constructs, where the huge variety of concepts provided by UML is reduced to a precise subset of conceptual primitives. Every conceptual primitive has its corresponding software representation counterpart. The implementation of this set of mappings between conceptual primitives and their corresponding software representations is the core of what in ONME terms is called 'The Programming Machine', a Conceptual Model Compiler.

ONME began in 1995 as a research project led by Prof. Dr. Oscar Pastor at the Technical University of Valencia, and funded by private software firm Consoft. The aim of the project was to provide an implementation of the OO-Method. In 1999, CARE Technologies was created as a spin-off from the research project, and developed OlivaNova Model Execution. The cooperation between CARE and the Technical University of Valencia has been continuous and fruitful ever since, constituting a great example of productive technology transfer between academia and industry. High-quality research and PhD dissertations have been developed in this shared context, and the continual improvement of the product's technical quality from an industrial point of view is a fundamental goal of the project.

**Fundamentals of the OO-Method Approach**

The OO-Method focuses on clearly separating the Problem Space (the 'what') from the Solution Space (the 'how'). The definition of a problem (the abstract description of an application, represented in the corresponding Conceptual Schema) can occur independently from any concrete reification (concrete implementation of a solution).

The formalism behind the OO-Method is OASIS, an object-oriented formal specification language for information

systems. This formal framework provides a sound characterisation for the conceptual constructs required to specify an information system. Its two main components are the Conceptual Model and the Execution Model.

The Conceptual Model is divided into four complementary views: the objects view, the dynamic view, the functional view and a fourth view to specify user interfaces. These four views allow all the functional aspects of an application to be

properly represented at a higher level of abstraction (the Conceptual Schema).

**Conclusions and Further Work**

The OO-Method is fully supported by the ONME Execution tools. OlivaNova Modeler allows Conceptual Models to be defined. It manages a high-level repository of OASIS formal specifications that can be validated to ensure they are correct, complete and non-ambiguous. OlivaNova Transformation Engines implement the Execution Model

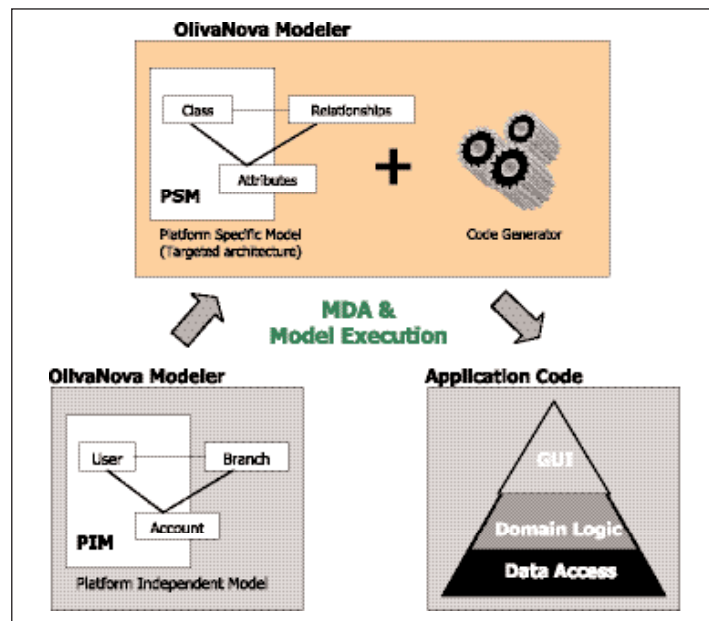


Figure 2: MDA and model execution.

described in an abstract manner by means of a set of conceptual constructs (also called conceptual primitives or conceptual patterns) that have clear, precise semantics. Most of these conceptual patterns have a UML-based graphical syntax, which hides the complexity and the formalism of the underlying OASIS specification.

The Execution Model defines the behaviour of objects belonging to the specified system (Conceptual Schema) at execution time. The rules governing the conversion of the Conceptual Schema into its corresponding software representation, fully dependent on the target technological platform, are defined in the context of the Execution Model. The Model Compiler implements the set of mappings that relate conceptual patterns to software representations, under the assumption that any programming decision has a conceptual counterpart that can be obtained and

for different platforms and programming languages by assigning the quoted coding pattern (a software representation) to each conceptual pattern, so as to automatically produce applications that are functionally equivalent to the conceptual models used as input.

In essence, this constitutes a full, operative implementation of the modern MDA proposal where, in terms of MDA terminology, an automated environment is provided for PIM-PSM transformations, with the Conceptual Schema being the PIM and the resulting software process the PSM.

OO-Method and its implementation as ONME allow for the rapid and automated development of applications directly from models. It has been successfully applied in industrial contexts such as warehouse management, utilities management and a billing system for a water supplier firm, apart-



ment rental and time-sharing and a managerial accounting system.

Future work in cooperation with the OO-Method research group at the Technical University of Valencia will include:

- decorating Conceptual Models with so-called design models so as to produce applications that not only work as specified but also meet appearance requirements
- raising the level of abstraction to include Requirements Models as a step

prior to the definition of Conceptual Models, and automating the generation of Conceptual Models from Requirements Models

- including an Organisational Modelling layer on top of the Conceptual Modelling layer and automating the generation of Requirements Models (or even Conceptual Models) directly from Organisational Models
- defining quality metrics to assess the quality of Conceptual Models.

**Links:**

<http://www.care-t.com>  
<http://oomethod.dsic.upv.es>

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## MarineXML: Towards Global Standards for Marine Data Interoperability

by Brian Matthews

In a partnership with international agencies, the European 'Marine XML' project will demonstrate that XML can be used to support marine observation systems.

Our management of the marine environment and marine risks is restricted by the lack of interoperability between the huge diversity of data formats, proprietary data management systems, numerical models, and visualisation tools. Different studies, instruments, programs, and data centres collect, process, analyse and archive data on the marine environment in such different ways that exchanging and comparing information between them to build a unified picture of the world's seas and oceans becomes a difficult task. Consequently, opportunities to better monitor and manage the marine environment are missed.

The aim of EU Marine XML project is to demonstrate that the Extensible Mark-up Language (XML) technology from the World-Wide Web Consortium (W3C) can be used to improve data interoperability for the marine community, and specifically in support of marine observing systems, whilst not rendering investment in existing systems obsolete. MarineXML is a partnership with international agencies, such as the International Oceanographic Commission (ICES-IOC) and the Global Ocean Observing System (EuroGOOS), and government departments and organisations responsible for data standards clustered around the North Sea (UK, Belgium, the Netherlands, Germany and

Norway). Their participation will ensure that the research meets the needs of key stakeholders with interests in global ocean observing systems.

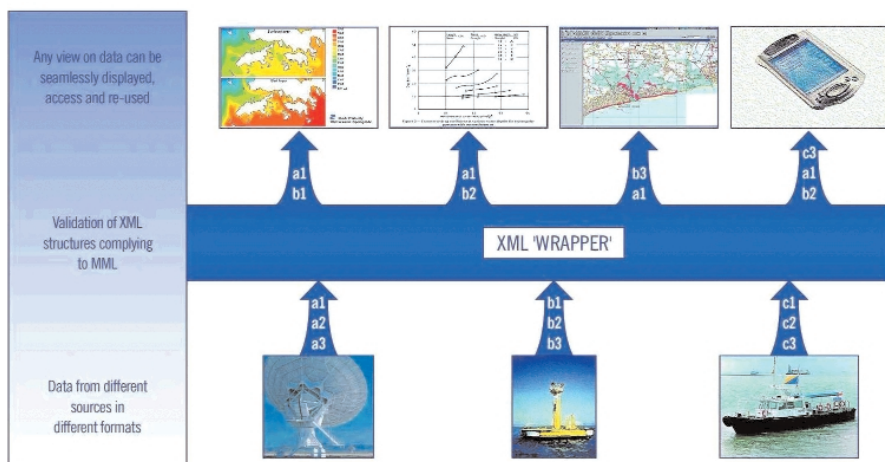
The objectives of the project are:

- to produce a prototype marine data ontology framework for interoperability
- to produce working demonstrations of the data interoperability framework
- to develop a prototype 'Marine Markup Language' (MML)
- to advance the standardisation of a Marine Mark-up Language.

The project is demonstrating that XML technology can be used to develop a framework that improves the interoperability of data for the marine community. The MarineXML Project will not result in the creation of a full MML specification but the project is addressing the underlying framework issues of interoperability between existing and emerging standards. It will provide a technical basis for the development of full specification, and look to standardisation post project through the IOC/ICES working group on XML for marine applications.

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Exchanging marine information through an XML layer.

# Agents and Middleware Applications from Seventeen European Projects

by László Kovács

**EUTIST-AMI (European Take-Up of Essential Information-Society Technologies – Agents and Middleware) is a cluster of seventeen application projects that are testing the benefits and potential of agent and middleware technologies applied in real industrial environments.**

The EUTIST-AMI initiative started in July 2001 with the participation of thirteen European projects, and later expanded to include four more projects. The cluster is funded by the European Union within the Fifth Framework Program and is coordinated by ENEA (Italy) in collaboration with LogOn (Germany), CSIC (Spain), SZTAKI

projects through effective dissemination activities.

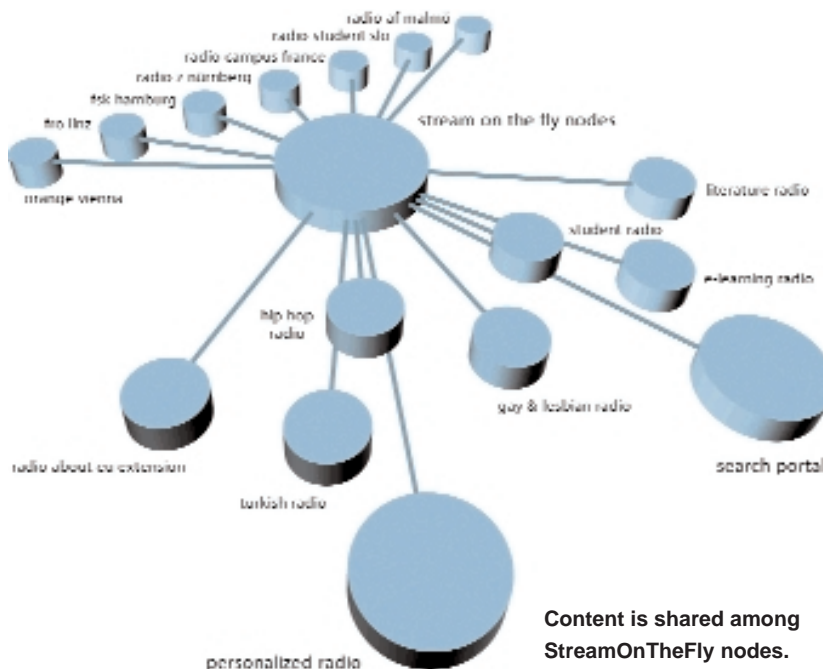
One of the projects, called 'StreamOnTheFly' (PVL (Austria), SZTAKI (Hungary) and Team Teichenberg (Austria)), supports radio stations broadcasting from and to anywhere in the world.

Local, regional and Internet-based radio stations from all over Europe are expected to join the network.

The repository of the content (see Figure) is shared among a number of regional nodes. These exchange data frequently, and form a worldwide network with no central point that would be sensitive to attack or overload.

The listener is able to tailor automated content packaging for personalised audio content, and may choose between web/WAP/GPRS access. Content selection is based on the options of notification, personal and collaborative filtering. It facilitates time-independent, personalised access to quality audio content that is enriched with audio-specific metadata.

The aim of the 'MODA-ML' project (a project of an Italian consortium led by ENEA) is to streamline the textile/clothing supply chain through the use of XML document exchange. This involves integrating legacy systems with human operators using the Internet. In this framework, large and small companies can be viewed as distributed resources in the overall process.



(Hungary), DFKI (Germany) and Tokapi (the Netherlands). The aim of each project within the cluster is the implementation of agent and middleware technology-based applications in various industrial fields, in order to improve production processes. Each project represents an example in which these technologies are used to solve problems concerning different industrial areas. The cluster ensures the spread of information, knowledge and the results of the

A distributed digital library has been designed and implemented for the support of community radio stations. This framework, developed by the StreamOnTheFly project, provides a common background for preparation, archiving, exchange and reuse of radio programs and supports radio personalisation. The architecture is based on a decentralised and self-organising network, which uses a new common metadata schema and exchange format, and automatic metadata replication.

based on a protocol compatible with the ebXML specifications (MSH)

- demonstration software to assist in the creation of test messages (MCM)
- a development and maintenance methodology for families of XML documents, aimed at simplicity of use.

The MODA-ML software and XML documents are freely available as a non-proprietary format for data exchange. Aiming to rapidly lead to a European standard for the exchange of information in the textile/clothing industry, MODA-ML is involved in the TexSpin Workshop activities, promoted by CEN (European Committee for Standardisation) and led by Euratex (European association of industry trading associations of the textile/clothing sector).

The 'WAVE' project (CS-SI, APFA (France)) has developed a training simulator for welders. The aim of the 'Welding trAining in a Virtual Environment' project was to improve welding training efficiency by using distributed virtual environments. It consists of two modules. The welding platform is the main WAVE training tool. It is a robust motorised piece of furniture offering a large screen display system and equipped with genuine welding tools. These tools enable the trainee to simulate welding exercises and navigate within the interface of the platform. The other module is the control centre, which is the trainer's essential tool. It enables trainees to be monitored and supervised and their progress to be analysed during a training course.

The WAVE server is the storage centre for teaching information. It contains the reference database that describes each exercise in detail, defines each user and keeps a record of all trainee results. The server ensures that messages are transported and managed between the welding platforms and the control centres.

These three examples of the EUTIST-AMI projects demonstrate some of the possible industrial applications of the agents and middleware technologies. The three-year period EUTIST-AMI cluster will conclude in the summer of 2004.

**Link:**  
<http://www.eutist-ami.org>

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## EVERGROW, a European Research Project on the Future Internet

by Kersti Hedman

**The goal of EVERGROW, an European 'integrated project', is to lead the way to a completely new Internet within a few decades.**

The project began with a scientific conference in Stockholm on Friday 30 January 2004. The goal of the project is to build the science-based foundations for the global information networks of the future. Not only will networks soon provide us with access to all the world's knowledge, but society as a whole will become network-based, from private life and business to industry and the processes of government. The demands on the future Internet will be high. We can already see how the complexity of the Internet is continually increasing, and we know a great deal about the problems this will cause. Above all, a number of today's highly manual processes must be automated, such as network management, network provisioning and network repair on all levels.

This new project brings together the best research groups in three main areas: complex systems, peer-to-peer systems

and experimental networking. At the scientific workshop, researchers described the tools to be employed and the plans for their deployment in two large measuring programs. These will be launched to chart Europe's network topology and network traffic patterns with an unparalleled resolution in time and space.

Other activities to come out of the workshop included new 'message-passing' algorithms offering the power to optimise the behaviour of extremely large systems, new results in coding theory that take advantage of these algorithms, and the latest developments in both structured and unstructured peer-to-peer services.

EVERGROW will be financed by the EU over four years, and is coordinated by the Swedish Institute of Computer Science (SICS) in Kista, Sweden. It is

lead by Prof. Erik Aurell, SICS, and Prof. Scott Kirkpatrick, of the Hebrew University in Jerusalem, Israel.

Participants include researchers from more than twenty universities and institutes in Europe, Israel and Egypt, and corporations such as Ericsson, IBM, TeliaSonera and France Telecom. Four of the partners are members of ERCIM: Ecole Polytechnique Fédérale de Lausanne in Switzerland, Université Catholique de Louvain in Belgium, Universidad Rey Juan Carlos in Spain and the Swedish Institute of Computer Science in Sweden.

**Links:**  
<http://www.evergrow.org/>

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## SOFSEM 2004: 30<sup>th</sup> Anniversary

by Julius Stuller

The 30th anniversary of SOFSEM (SOFTware SEMinar) took place in Merin (near Prague), Czech Republic, from 24-30 January, 2004 – the year in which the Czech Republic and other central European countries join the EU.

SOFSEM is the foremost Czech-Slovak conference in the field of theory and practice of computer science, being at the same time the most important joint activity of the Czech and Slovak ERCIM members CRCIM and SRCIM. SOFSEM, being an annual event, is organised in the Czech Republic two years out of every three, and in Slovakia every third year. As in previous years, SOFSEM 2004 was sponsored by ERCIM, involved researchers from ERCIM institutes in its scientific program, and helped to advertise ERCIM in the central European region through a small exhibition.

SOFSEM is a national conference with a strong international flavour. The proceedings are traditionally published in Springer's 'Lecture Notes in Computer Science' series. In addition to Czech and Slovak participants, it is attended by researchers from other central European and EU countries. Its aim is to foster cooperation among professionals from academia and industry working in various areas of computer science.

To avoid excessive diversity among conference participants and to facilitate close professional interaction, the thirtieth anniversary SOFSEM conference was organised in four parallel tracks, with topics narrow enough to attract a community of researchers who share specific fields of interest. The following four tracks were selected:

- Computer Science Theory (track chair and general conference chair: Peter Van Emde Boas, University of Amsterdam, Netherlands)
- Database Technologies (Jaroslav Pokorný, Charles University, Czech Republic)
- Cognitive Technologies (Peter Sincák, Technical University of Kosice, Slovakia)

- Web Technologies (Julius Stuller, Institute of Computer Science, Czech Republic).

The program consisted of a series of ten invited talks by prominent professionals and researchers, over forty contributed talks and talks describing work-in-progress and applications (these were selected by the program committee from 112 submitted papers), and the Student Research Forum. The schedule was tailored such that the 112 participants, of whom 44 were from the Czech Republic, were afforded a unique opportunity to interact with each other. As usual, SOFSEM provided an ideal framework for discussions and meetings, for establishing contacts, and for socialising. Many young computer scientists and students profited from this occasion.

The 30th SOFSEM also provided the organisers with the ideal opportunity to recognise the SOFSEM 'father' and the organiser of the first SOFSEMs, Professor Jozef Gruska. The Bolzano Medal of the Academy of Sciences of the Czech Republic was personally awarded to Prof. Gruska by the president of the Academy, Prof. Helena Illnerova.

The organisers wish to thank the many sponsors of the 30th SOFSEM, without whom they could not have organised such a successful event. In particular, the contribution from ERCIM has presented a sensitive part of the overall conference sponsorship. The next conference, SOFSEM 2005, will be organized in Slovakia.

### Link:

<http://www.sofsem.cz>

### Please contact:

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## INTERACT 2003

The IFIP TC-13 (Human-Computer Interface) biannual flagship conference INTERACT 2003 took place from 1-5 September 2003 at the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland.

INTERACT 2003 was the ninth conference in the series of IFIP TC13 INTERACT international conferences; it is the first time that this conference was held in Switzerland. The conference was hosted by the Swiss Informatics Society (SI) which is the largest academic Informatics society in Switzerland with more than a thousand members. The conference had a total of 472 attendees from 34 countries. Its three-day technical program included full papers, short papers, panels, interactive experiences, posters, and keynote speeches, and in addition a two-day program including tutorials, workshops, and doctoral consortiums.

The INTERACT 2003 proceedings are available from IOS press under the title 'Human-Computer Interaction INTERACT-03' edited by Matthias Rauterberg, Marino Menozzi and Janet Wesson. The proceedings include the 82 full papers (selected from 241 submission), 64 short papers (selected from 125 submissions) as well as abstracts relating to accepted submissions in other categories. The details are 1156 pages, ISBN: 1 58603 363 8, price: US\$201 from <http://www.iospress.nl>.

The conference chairs were Prof. Matthias Rauterberg (University of Eindhoven) and Prof. Helmut Krueger (ETH Zurich). Chairs of the International Program Committee were Markus Stolze (IBM, Zurich) and Fabio Paterno (CNR, Pisa).

The next INTERACT conference will be INTERACT 2005, which will be held in fall 2005 in Rome.

### More information:

<http://www.interact2005.org/>

## CALL FOR PARTICIPATION

**ESSLLI 2004 — 16th European Summer School in Logic, Language and Information****Nancy, France, 9-20 August, 2004**

The ESSLLI Summer Schools are organized under the auspices of FoLLI, the European Association for Logic, Language and Information.

The main focus of ESSLLI is on the interface between linguistics, logic and computation. The school has developed into an important meeting place and forum for discussion for students, researchers and IT professionals interested in the interdisciplinary study of Logic, Language and Information.

In previous editions of ESSLLI the courses covered a wide variety of topics within six areas of interest: Logic, Computation, Language, Logic and Computation, Computation and Language, Language and Logic. Since the 14th edition of ESSLLI, special emphasis is given to the interface between the basic areas (Logic, Language, and Computation) offering about 50 courses, organized into three interdisciplinary areas (Language & Computation, Language & Logic, and Logic & Computation), at a variety of levels (foundational, introductory, advanced), as well as a number of workshops.

*Foundational courses* aim to provide truly introductory courses into a field. The courses presuppose absolutely no background knowledge. In particular, they should be accessible to people from other disciplines.

*Introductory courses* are intended to equip students and young researchers with a good understanding of a field's basic methods and techniques, and to allow experienced researchers from other fields to acquire the key competences of neighboring disciplines, thus encouraging the development of a truly interdisciplinary research community.

*Advanced courses* are intended to enable participants to acquire more specialized

knowledge about topics they are already familiar with.

*Workshops* are intended to encourage collaboration and the cross-fertilization of ideas by stimulating in-depth discussion of issues which are at the forefront of current research in the field. In these workshops, students and researchers can give presentations of their research.

In addition to courses and workshops there are evening lectures, a student session and a number of satellite events (to be announced later). The aim of the student session is to provide Masters and PhD students with an opportunity to present their own work to a professional audience, thereby getting informed feedback on their own results. Unlike workshops, the student session is not tied to any specific theme.

**Important Dates**

- Early Registration: from mid March to 1 May.
- Late Registration: from 2 May to July.
- Important: on-site registration won't be possible.

**More information:**

<http://esslli2004.loria.fr/>

## CALL FOR PARTICIPATION

**CRIS 2004 — 7th International Conference on Research in Information Systems****Antwerp, Belgium, 12-15 May 2004**

CRIS 2004 is aimed at promoting scientific discussion and information exchange on research information systems. CRIS 2004 continues the tradition of encouraging the sharing of experiences among developers, producers and users of research information systems. CRIS 2004 is further intended to foster discussion on novel approaches and ideas on international dialogue, pan-European cooperation, and the transfer and use of information related to CRIS.

**Topics**

- *CRIS supporting the research & development and innovation processes* —

national and international information policies, eg supporting an European research area, grant management, CRIS as a benchmark service, knowledge exchange, national and international cooperation, trans-disciplinary research.

- *Benefits of CRIS to researchers and other users* — reasons why researchers should provide their information for CRIS, long-term preservation of data, researchers' needs, research transparency, including research not publicly available; users: scientists, students, administrators, decision-makers, brokers, journalists etc.
- *Demands on CRIS for quality* — criteria of quality: data input and validation, integrity, completeness, relevance to the present, managing data volumes, added value in comparison to personal information systems, CRIS as a basis for data analyses, bibliometrics, scientometrics.
- *Technological developments* — data models, interoperability among different kinds of research information systems, information portals, methods to deal with heterogeneous distributed data, harvesting, data mining, advantages of a semantic web.
- *From information to knowledge* — mapping of data, knowledge management beyond databases and document systems, integration of knowledge-based CRIS into business systems, expert advisor and decision support systems, assisted user interfaces.

**About euroCRIS**

euroCRIS has been established in Europe to be the internationally recognized point of reference for all matters relating to CRIS: Current Research Information Systems.

euroCRIS serves its membership and the global research community by advancing the field of CRIS through life-long professional development, the sharing of knowledge, and by fostering a sense of true community.

**More information:**

<http://www.eurocris.org/conferences/cris2004/>

## CALL FOR PAPERS

**EMISA 2004 — Information Systems in E-Business and E-Government****Luxembourg, 6-8 October 2004**

The 'Gesellschaft für Informatik' (GI) special interest group EMISA will be celebrating its 25th anniversary in 2004. To highlight this event, the EMISA group has decided to organize its annual conference for the first time in Luxembourg. The main theme of the conference is 'Information Systems in E-Business and E-Government'. Several aspects of this theme will be examined with a special focus on how the new concepts in IS electronic networking can be used efficiently by small and medium-sized enterprises in order to open up new market opportunities. Although the GI and hence EMISA are originally German-speaking professional associations, the conference will benefit from the multilingual culture of Luxembourg. Contributions may be presented in German or English. Simultaneous translation will be provided in English for the German presentations in order to encourage international participation.

**Topics**

Papers on the following topics are welcome:

- Virtual Enterprises
- B2B - Electronic Commerce
- Knowledge Management
- E-Learning
- One Stop Administration / Portals
- Socio-technical Systems
- Enterprise Wide Architectures
- Modelling and Analysis of Business Processes
- Workflow and Workgroup Computing Systems
- Integration
- Standardization
- Security.

**Important Dates**

- 1 June 2004: Submission Deadline
- 5 July 2004: Notification of acceptance
- 27 August 2004: Deadline of camera-ready copy.

**More information:**  
<http://emisa.crpgl.lu/>

## CALL FOR PARTICIPATION

**ECDL 2004 — 8th European Digital Library Conference****Bath, UK, 12-17 September 2004**

ECDL 2004 is the 8th in the series of European Digital Library Conferences. ECDL has become the major European forum focusing on digital libraries and associated technical, organisational and social issues.

Digital library research brings together a number of disciplines and practitioner communities, creating a stimulating environment for debate and an opportunity for establishing collaboration. ECDL provides a forum for the exchange of ideas between scientific disciplines and fosters joint initiatives with application communities. Involvement of researchers and practitioners from computing and information science disciplines is well established at ECDL. Increasingly these disciplines are engaging in discussion and co-operation with other groups concerned with knowledge management.

ECDL 2004 encourages involvement from a wide range of disciplines and looks forward to continuing contributions from usability experts, educationalists, developers of eLearning systems, and from those working within the eScience and GRID communities. The continued success of ECDL rests on the exchange of ideas and experience between these groups.

**Important Dates**

- 5 April 2004: Submission deadline for papers, panels, workshops, tutorials
- 19 May 2004: Submission deadline for posters and demonstrations.

**More information:**  
<http://www.ecdl2004.org/>

## CALL FOR PARTICIPATION

**TTCN-3 User Conference 2004****Sophia Antipolis, France,  
3-5 May 2004**

Join the TTCN-3 revolution:

- sharing experiences
- for newcomers and experts alike
- hearing how TTCN-3 is used today
- seeing the latest tools
- tracking future TTCN-3 developments
- learning about TTCN-3 with focussed tutorials
- meeting the TTCN-3 community.

The aim of this international conference is to provide opportunities to bring together practitioners and re-searchers in the field of testing communicating systems using the test specification and implementation language TTCN-3 (Testing and Test Control Notation).

This first ever TTCN-3 User Conference deals with the practical aspects of TTCN-3 at work. It is intended as a forum for anybody involved with and/or affected by TTCN-3: testers, designers, developers, managers, students, researchers and standard makers. This conference specifically targets practical results in applying and using TTCN-3 for testing Internet related systems, services and protocols, mobile communication systems, middleware platforms, object- and component-based systems, IT systems, Web services and embedded systems.

The first day of the conference (3 May) is the education track with tutorials for both beginners and advanced users. The second and third days (4-5 May) are devoted to the (invited) conference presentations and tool demonstrations.

The TTCN-3 User Conference 2004 (including the tutorials) is free of charge

**More information:**  
<http://www.ttcn-3.org/>



ERCIM News is the magazine of ERCIM. Published quarterly, the newsletter reports on joint actions of the ERCIM partners, and aims to reflect the contribution made by ERCIM to the European Community in Information Technology. Through short articles and news items, it provides a forum for the exchange of information between the institutes and also with the wider scientific community. This issue has a circulation of over 9000 copies.

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## EVENTS

### CALL FOR PARTICIPATION

## ICEC 2004 — 3rd International Conference on Entertainment Computing

Eindhoven, The Netherlands,  
1-3 September 2004

This conference series is the first established and most prestigious conference in the new emerging field of entertainment computing. Worldwide leading experts from academia and industry will present their newest insights, products and demonstrations.

Based on the very successful first international workshop (IWEC 2002) and the second international conference (ICEC 2003), the next ICEC 2004 has been set up as an international forum to exchange experience and knowledge among researchers and developers in the field of entertainment computing. Different submission types are invited that present scientific ideas or improvements to existing techniques in the broad multi-disciplinary field of entertainment and edutainment applications.

#### Topics

Research topics include, but are not limited to:

- advanced interaction design, eg haptic interfaces
- aesthetics, ontology and social reflection
- ambient intelligence for entertainment
- art, design and media
- augmented, virtual and mixed reality
- avatars and virtual action
- computer games and game based interfaces
- education, training, and edutainment technologies
- evolutionary platforms/hardware
- graphics techniques
- human factors of games
- human sciences, violence and entertainment
- in-car/flight/train entertainment systems
- intelligent board games
- interactive digital storytelling, and interactive television
- mobile entertainment via eg mobile phones, PDAs etc
- modeling

- narrative environments and virtual characters
- networking (technical and social)
- new genres, new standards
- novel hardware devices
- pervasive entertainment and game-playing
- robots and cyber pets
- simulation applications of games, and military training
- social computing and presence
- sound and music
- sport and entertainment
- video games
- visual media engineering
- wearable computers and sensors for entertainment.

#### More information:

<http://www.icec.id.tue.nl/>

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## MFCS 2004 — 29th International Symposium on Mathematical Foundations of Computer Science


Prague, Czech Republic,  
22-27 August, 2004

The series of MFCS symposia, organized alternately in the Czech Republic, Poland and Slovakia since 1972, has a long and well-established tradition. The MFCS symposia encourage high-quality research in all branches of theoretical computer science.

The topics include algorithms and data structures, automata, grammars and formal languages, complexity theory (structural and computational), computational biology, computational geometry, concurrency theory, cryptography and security, databases and knowledge-based systems, foundations of programming, formal specifications and program development, machine learning, models of computation (parallel and distributed computed, fixed parameter tractability, quantum computing, and other), semantics and logics of programs, and theoretical issues in artificial intelligence.

#### More information:

<http://mfcs.mff.cuni.cz/>

 **SINTEF** — SINTEF has pooled all its ICT research resources into one institute: SINTEF ICT as of 1 January this year. The new institute, having approximately 250 employees, comprises research groups within electronics, cybernetics, computer science and applied mathematics. SINTEF Telecom and Informatics, the former Norwegian member of ERCIM, is part of the new institute. The profile of SINTEF ICT matches closely the ideal profile of ERCIM. Technology contract research has long been a male dominated area. SINTEF ICT is proud to announce that about 25 percent of its research staff are female. Their participation adds an extra dimension to the content and quality of the work being done. For more information, see <http://www.sintef.no/>.

 **Italian Institute of Technology** — Vittorio Grilli, currently General Accountant of Italy, is to be the Commissioner of the newly founded Italian Institute of Technology (IIT), to be located in Genoa. IIT has been established by the Italian Ministries of Education, Universities and Research and of Economy and Finances and aims at becoming an international centre of excellence for scientific research in advanced technology, attracting contributions from researchers and experts from the world of research and promoting technological development and training in high technology. Within the broader spectrum of research in Italy, IIT will be a centre of innovation, adding variety and richness to the panorama of research as well as promoting open effective channels of communication with both industry and other research institutions. For more information, see <http://www.iit.it>.

 **FORTH** — **Stelios C. Orphanoudakis** has been elected as the new Chairman of the Board of Directors of the Foundation for Research and Technology-Hellas (FORTH) and assumed his new position, succeeding Prof. Eleftherios Economou, on 28 January 2004. Stelios Orphanoudakis, President of ERCIM, continues to represent FORTH on ERCIM's Board of Directors.




**Constantine Stephanidis**

has been elected as the new Director of the Institute of Computer Science, Foundation for Research and Technology – Hellas (ICS-FORTH), succeeding Stelios Orphanoudakis, as of 28 January 2004. Constantine Stephanidis continues to represent FORTH on ERCIM's Executive Committee and to lead the ERCIM Working group 'User Interfaces for All'.

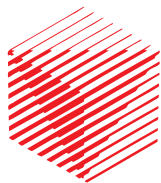


**Vassilis Dougalis** has been elected as the new Director of the Institute of Applied and Computational Mathematics, Foundation for Research and Technology – Hellas (IACM-FORTH), succeeding Prof. Ioannis Papadakis, as of 28 January 2004.



 **CWI** — **The Centre for Mathematics and Computer Science has started a new pilot theme on multimedia delivery.** The Convergent Media Interfaces group is working on new methods for designing, transporting and rendering multiple multimedia objects like audio, video, text and images over heterogeneous networks and appliances. One of the major challenges of the theme is to present the same content on networks using widely different protocols and devices, ranging from UMTS to the Internet. The initial application area is the creation and distribution of medical multimedia content. Convergent Media Interfaces is led by Dick Bulterman. He was involved in the development of SMIL, a language for creating multimedia presentations. It can synchronize audio or video streams with text and images. SMIL is a W3C Recommendation and has been applied in media players like GRiNS, Quicktime, Realplayer and CWI's open source AMBULANT player.

 **CWI - The Dutch government has allocated €48 million to three major ICT projects in which CWI participates.** The funding is part of the 800 million euros subsidy programme Bsik to stimulate the Dutch knowledge economy. CWI acts as coordinator for the 'BRICKS' project, in which several Dutch research organisations participate. The project reinforces Dutch computer science research in fields like parallel and distributed computing, simulation, intelligent systems, algorithms and formal methods. The BRICKS research themes offer both fundamental challenges and solutions to practical problems. 'MultimediaN' deals with the storing, handling and access of multimedia data. CWI researchers bring in their expertise of databases, computer vision and multimedia presentations to the project. Goal of 'Virtual Laboratory e-Science', the third project selected for funding, is to establish a Dutch e-Science environment using high performance networking and grid computing. CWI participates in the areas of visualisation and user interfaces.



ERCIM – The European Research Consortium for Informatics and Mathematics is an organisation dedicated to the advancement of European research and development, in information technology and applied mathematics. Its national member institutions aim to foster collaborative work within the European research community and to increase co-operation with European industry.



ERCIM is the European Host of the World Wide Web Consortium.



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