

## **Sprekers en panelleden**

**Prof. dr. Jan Karel Lenstra** is algemeen directeur van het Centrum Wiskunde & Informatica en hij is als hoogleraar verbonden aan de Technische Universiteit Eindhoven.

**Prof. dr. Tony Donn  ** is deeltijd-hoogleraar Diagnostiek van Fusieplasma's aan de Technische Universiteit Eindhoven en interim-directeur van het Fundamenteel Onderzoek der Materie (FOM) Instituut voor Plasmafysica.

**Dr. Peter Eecen** is leider van de groep A  rodynamica binnen de Sectie Windenergie van het Energieonderzoekscentrum Nederland (ECN).

**Ir. Peter Vaessen** is expert in HVDC en SmartGrids en actief betrokken bij de ontwikkeling van de technologische strategie van KEMA. Hij is voor het Ministerie van Economische Zaken en de EU betrokken bij het opzetten van onderzoeksprogramma's die gericht zijn op de toekomstige energievoorziening .

**Dr. Rob Aalbers** is programmaleider bij de sector Marktordening van het Centraal Planbureau (CPB). Hij houdt zich vooral bezig met de vormgeving van klimaatbeleid, regulering van netwerken, en de kosten en baten van mitigatie en adaptatie.

**Maria Henneman** is de drijvende kracht achter Maria Henneman Media Management BV. Zij verdiende (inter)nationaal haar sporen als journaliste en media- en beleidsadviseur.

**Prof. dr. Niek Lopes Cardozo** is voorzitter van de Stichting Fundamenteel Onderzoek der Materie (FOM) en voltijd-hoogleraar Science and technology of nuclear fusion aan de Technische Universiteit Eindhoven. In 2003 ontving hij de Koninklijke/Shell Prijs voor duurzame ontwikkeling en energie.

**Prof. dr. Wim Sinke** is stafmedewerker bij ECN Zonne-energie en deeltijdhoogleraar Duurzame Energiesystemen aan de Universiteit Utrecht. Hij is voorzitter van het European Photovoltaic Technology Platform. In 1999 ontving hij de Koninklijke/Shell Prijs voor duurzame ontwikkeling en energie.

**Ir. Sjef Peeraer MBA** is eigenaar en oprichter van het energie-innovatieburo SP Innovation en directeur van het energiebedrijf Atoomstroom

**Prof. dr. ir. Gijs van Kuik** is oud-hoogleraar windenergie aan de Technische Universiteit Delft. Hij is wetenschappelijk directeur van het Delft University Wind Energy Research Institute (Duwind) en voormalig president van de European Academy for Wind Energy.

## **'Energie, Wiskunde & Informatica'**

Donderdag 11 november 2010, 12.30 – 17.00 uur  
Amsterdam, Science Park 123, Turingzaal

Om 17.00 uur feestelijke opening van het vernieuwde CWI-gebouw

### Programma

Dagvoorzitter: prof. dr. ir. Barry Koren

12.30 Ontvangst ( incl. broodjeslunch)

13.25 Welkom prof. dr. Jan Karel Lenstra

13.30 Beheersing van een brandend fusieplasma:  
een multidisciplinaire wetenschappelijke uitdaging prof. dr. Tony Donné

14.00 Ontwikkeling van ontwerpsoftware voor  
windenergie toepassingen: rotor- en parkaërodynamica dr. Peter Eecen

14.30 Transport en distributie van elektriciteit: de uitdaging ir. Peter Vaessen

15.00 Pauze

15.30 Innovatief klimaatbeleid: hoe moet de overheid innovatie  
van duurzame energiebronnen stimuleren? dr. Rob Aalbers

16.00 Paneldiscussie o.l.v. Maria Henneman  
Vraagstelling: Waarin moet Nederland investeren voor toekomst met duurzame energie?

#### Panelleden:

prof. dr. Niek Lopes Cardozo  
prof. dr. Wim Sinke  
ir. Sjef Peeraer  
prof. dr. ir. Gijs van Kuik

17.00 Feestelijke opening van het vernieuwde CWI-gebouw door prof. dr. Jos Engelen  
(bestuursvoorzitter NWO), dr. ir. Peter van Laarhoven (bestuursvoorzitter CWI) en prof. dr.  
Jan Karel Lenstra (algemeen directeur CWI).

18.00 Afsluiting

## Deelnemerslijst CWI in Bedrijf 11 november 2011

Naam	Organisatie	Functie
Aalbers, dr. Rob (R.)	CPB	Spreker CWI in Bedrijf
Bakkeren, ir. Chiel (M.R.)	De kwantitieve dienst	Eigenaar/adviseur
Bentinck, ir. S.A.	UvA/huisvestingsOntwikkeling	Directeur
Berg, van den drs. Mieke (M.M.)	Science Park Amsterdam	Communicatiemanager
Blankers, Karin (C.W.)	CWI	Communicatieadviseur
Bloemhof, ir. Gabriel (G.A.)	KEMA	
Blom, drs. Kees (C.L.)	CWI	Wetensch. programmeur SEN5
Blom, ir. Gerard (G.)	Deltares Software Centre	Unitmanager Kennis
Boer, de Edwin (E.)	CWI	Manager FA
Boer Rookhuizen, mr. Herman (H.)	Nikhef	Detector R&D/engineer
Boeve, ir. Eddy (E.)	Freelancefirm	Resultant
Bohte, dr. Sander (S.M.)	CWI/MAC	Scientific staff member MAC4
Bosman, dr. Peter (P.A.N.)	CWI	Scientific staff member SEN4
Bouman, M.Sc. Niek (N.J.)	CWI	PhD Student PNA5
Bouwman, ir. Sonja (S.)	KEMA	Consultant
Broekhuis, Dick (D.G.C.)	CWI	Financial Controller
Brouwer, Margriet (M.W.)	CWI	Project, Finance & Control
Brussaard, prof.dr. P.J.	Universiteit Utrecht	Emeritus hoogleraar
Croes, mr. R.	Stichting GreenICT	
Crommelin, dr. Daan (D.T.)	CWI	Scientific staff member
Dasselaar, drs.ing. Maarten (M.R.)	Agentschap NL / Innovatie	Adviseur
Dekker, drs. Ron (R.J.P.)	NWO/Instituten, Financiën & Infrastructuur	Directeur
Donné, prof. dr. Tony (T)	TUE/FOM Instituut voor Plasmafysica	Spreker CWI in Bedrijf
Dorresteyn, MSc Willem (W.H.)	ACE@Science Park	
Duijnhouwer, drs. I.D.C.		
Ebert, prof.dr. Ute (U.)	CWI	Groupleader MAC3
Eecen, dr. Peter (P.)	ECN	Spreker CWI in Bedrijf
Eggermont, drs. Lisette (L.)	PricewaterhouseCoopers	Accountants/manager
Emde Boas, van dr. Peter (P.P.)	Bronstee.com Software & Services BV	
Engelen, prof.dr. Jos (J.)	NWO	Bestuursvoorzitter
Frank, prof.dr.ir. Jason (J.E.)	CWI	Groupleader MAC1
Garrel, van ir. A.	ECN/Wind Energy	Scientific Researcher
Golo, dr.ir. Nataša (N.)	NWO/Chemische & Exacte Wetenschappen	Programmamanager Smart Energy Systems
Grimminck, drs. J.J.	NWO	Voorlichter/Communicatieadviseur
Grünwald, prof.dr. Peter (P.D.)	CWI/PNA	Scientific staff member PNA6
Haverkort, ir. Willem (J.W.)	CWI (MAC)/FOM Rijnhuizen	PhD student
Heijden, van der Marlin (M.Y.)	CWI/P&O	P&O, juridisch adviseur
Hemker, prof.dr. Piet (P.W.)	CWI	CWI Fellow
Henneman, Maria (M.)	Maria Henneman Management BV	Discussieleider
Heydenreich, dr. Markus (M.O.)	CWI/Univ. Leiden	Scientific staff member PNA5
Hollander, den prof.dr. Frank (W.Th.F)	Mathematisch Instituut Univ. Leiden	Bestuurslid CWI
Honing, Nicolas (N.F.)	CWI	PhD Researcher
Keijzer, ing. Richard (R.A.)	Automatiserings Gids	Redacteur Technologie
Kik, drs. Annette (A.C.)	CWI	Communicatie-adviseur
Klint, prof.dr. Paul (P.)	CWI/SEN	Clusterleider
Konijn, dr. ir. J.	Nikhef	
Koren, prof.dr.ir. Barry (B.)	CWI/MAC	Dagvoorzitter CWI in bedrijf
Kuik, van prof.dr.ir. Gijs (G.)	TUD/Duwind	Panellid
La Poutre, prof.dr.ir. Han (H.L.)	CWI	Groupleader SEN4
Laarhoven, van prof.dr. Peter (P.)	TNT	Group Director Strategy
Laurent, prof.dr. Monique (M.)	CWI	Groupleader PNA1
Lenstra, prof.dr. Jan Karel (J.K.)	CWI	Algemeen directeur CWI
Liere, van prof.dr.ir. Robert (R.)	CWI	Groupleader INS3
Lopes Cardozo, prof.dr. Niek (N.)	FOM/TUE	Panellid
Lunenburg, van Irma (I.J.M.)	CWI	P&O internationaal intermediar
Manegold, dr. Stefan (S.)	CWI	Scientific staff member INS1

Mei, van der prof.dr. Rob (R.)	CWI	Clusterleader PNA
Mol, Wim (W.)		
Mombers, dr. C.A.M.	STW	Adjunct Directeur
Nes, dr. Niels (N.J.)	CWI	Manager ITF
Nieland, dr. Henk (H.M.)		
Nieuwland, prof.dr. Gerke (G.Y.)	FEW-VU	
Nool, drs. Margreet (M.)	CWI	Scientific programmer MAC3
Noordam, prof.dr. Bart (L.D.)	Universiteit van Amsterdam	Decaan
Noot, drs. Han (H.)	CWI	Scientific programmer SEN4
Nuis, drs. Jan (J.)		
Ong, Ay (A.L.)	CWI	Manager Bibliotheek
Oortmerssen, van prof.dr.ir. Gerard (G.)	ICTRegie	Directeur
Oosterlee, prof.dr. Kees (C.W.)	CWI	Group leader
Oudega, prof. Bouke (B.)	VU/FALW	Decaan VU/FALW
Pauwels, dr. Eric (E.J.E.M.)	CWI	Scientific staff member SEN4
Peeraer, ir. Sjef (S.)	Energie-innovatieburo SP Innovation	Panellid
Poot, de dr. Henk (H.J.G.)	Novay	Wetenschappelijk onderzoeker
Pothof, Ivo (I.W.M.)	Deltares/Industrial Hydraulics	R&D trekker Duurzame energie en water
Rademacher, dr. Jens (J.D.M.)	CWI	Scientific staff member MAC3
Regts, M.Sc. G.	CWI	OIO
Riele, te dr.ir. Herman (H.J.J.)	CWI	Scientific staff member PNA5
Rijn, van Arjen (A.J.)	Nikhef	
Robijn, dr. M.L.M.	NWO	Cluster Instituten/beleidsmedewerker
Rutten, prof.dr. Jan (J.J.M.M.)	CWI	Scientific staff member SEN3
Schäfer, Guido (G.)	CWI/VU Amsterdam	Scientific staff member PNA1
Schilder, drs. Angelique (A.T.A.P.)	CWI	P&O manager
Schlichting, ir. R.G.V.	Schlichting Industrial Solutions	Eigenaar/consultant
Schorro, Raymond	NWO	
Sebel RA, Jan (J.L.)	PricewaterhouseCoopers	Accountant/partner
Sietsma, Floor (F.A.G.)	CWI	PhD student SEN1/PNA2
Sinke, prof.dr. Wim (W.)	ECN/UU	Panellid
Straub, drs. J.	Science Park Amsterdam	Projectmanager
Sutherland, drs. Marga (M.I.C.)	CWI	Communicatiemanager
Temme, dr. Nico (N.M.)		
Thierens, dr.ir. Dirk (D.)	Universiteit Utrecht/CWI	Scientific staff member
't Hoen, ir. Paul (P.P.)	ICTRegie	
Vaessen, ir. Peter (P.)	KEMA/Min. EZ	Spreker CWI in Bedrijf
VanderLichte, P.	Dutchill	Eigenaar
Vermin, Willem (W.J.)	SARA/HPCV	Adviseur
Verwer, prof.dr. Jan (J.G.)	CWI	CWI-Fellow
Vlug, drs. Hetty (H.)	Gemeente A'dam/Projectbureau Zuidoostlob	Directeur
Vogel, drs. Patricia (P.G.)	NWO	BOO/coördinator instituten
Vos, drs. Johan (J.J.A.)	UvA/FNWI	Directeur Marktonwikkeling
Vos, drs. Jos (J.)	X/OS Experts in Open Systems BV	Directeur
Vuik, prof.dr.ir. Cees (C.)	TUD/ Numerieke Analyse	Hoogleraar
Weerdt, de dr. Mathijs (M.M.)	TUD/Software Technologie	Universitair docent
Werkhoven, ir. L.D.C.	Agentschap NL/EG Liaison	Adviseur
Wildvank, Mario (M.J.)	Software Improvement Group BV	Algemeen directeur
Witlox, ing. Arie (A.M.)	Nikhef	THD/Manager Beheer en Onderhoud
Zwaan, dr. Marcel (M.)	Shell International E&P	Projectleader EOR reservoir surveillance

## Dynamical Systems and Numerical Analysis

Group leader: Jason Frank

Jason.Frank@cwi.nl

The group engages in fundamental research on analytical, stochastic and computational methods for continuous dynamical systems (ordinary and partial differential equations). Applied research addresses problems in atmosphere and ocean sciences, phytoplankton dynamics and vegetation patterns, energy technology and electromagnetics. Specific research projects include computational methods for internal waves, statistical accuracy of climate simulations, stochastic subgrid scale modeling of convection processes, traveling waves and pattern formation, and electrical power network dynamics in the presence of decentralized generation and storage.

### Highlights

- Publication in Nature on phytoplankton growth (2006, Sommeijer and Pham Thi), and in PNAS on metastability and regime changes in atmospheric datasets (2006 and 2009, Crommelin).
- Co-initiation of the national mathematics research cluster NDNS+ (Nonlinear Dynamics and Natural Systems) and NISB (the Netherlands Institute for Systems Biology); leader of the BRICKS project (Verwer), Mathematics Research Strategy and Master Plan for Mathematics committee chairs (Doelman).
- Arjen Doelman was appointed director of the Lorentz Center, Leiden (2009).
- Peter van Heijster awarded Stieltjes Prize for best dissertation (2010) and awarded Rubicon grant for research abroad.
- Svetlana Dubinkina showed the response to topographic forcing in climate simulations depends on the conservation properties of the numerical discretization used.
- The successor to the famous Handbook of Mathematical Functions (Abramowitz & Stegun) was edited by Nico Temme and others.



### Energy projects

- Existing electrical power distribution networks are set up in a hierarchical structure, centered around large scale production at centralized facilities. The proliferation of decentralized generators in the forms of rooftop solar panels and small wind turbines, as well as the expected introduction of local storage options is a challenge to network operators. In a project starting in 2011 we will study the dynamics of power networks with stochastic local production and demand, and distributed storage.



## Scientific Computing and Control Theory

Group leader: Kees Oosterlee  
C.W.Oosterlee@cwi.nl

Scientific Computing enables us to investigate phenomena that are difficult, expensive or simply impossible to study otherwise. In MAC2 we work on mathematical models for the improvement of the technology for future energy resources, as well as on models for financial and economic decision making. Numerical analysis plays an important role in this work. Application areas for our work include electrical engineering, ship hydrodynamics, sustainable energy, computational tomography, economic decision making and financial engineering.

Systems and Control Theory is a major factor in the effective functioning of technological systems, in the modelling and control of biological systems as well as in the mathematical analysis of physical systems. It can be applied to control problems in engineering and biology, like in mechanical and manufacturing systems, communication and biological networks.

### Highlights

- Leading the European C4C project on the coordination of pilotless planes, electronic signs on highways to avoid traffic jams, unmanned submarine vehicles, communication and complex copy machines.
- Development of highly efficient option pricing methods and new hybrid financial derivative models that are now commonly used in the Dutch financial industry.
- The book *Advanced Computational Science and Engineering*, edited by Koren (MAC2, CWI) and Vuik (TU Delft) was published.
- Jeroen Wackers was awarded the ECCOMAS 2008 award for the best PhD thesis in computational fluid dynamics.



### Energy projects

- Four PhD students are working on future energy resources, like optimization of wind parks, nuclear fusion and Gen IV nuclear energy.



## Database Architectures

Group leader: Martin Kersten  
Martin.Kersten@cwi.nl

The research activities of the group center around the design and development of system architectures, data management algorithms, data structures, and optimization techniques to cope with the data explosion happening in many fields of science, information systems and data warehouses for business intelligence. Innovations at all levels of the software architecture of database management systems (DBMS) are called for to cope with the scalability, performance, extensibility and fault tolerance requirements.

### Highlights

- MonetDB – the group's open-source database system for high-performance applications in data mining, OLAP, scientific databases, XML Query, text and multimedia retrieval – reached its download count of 100,000 users from all over the world for research, education and business solutions in 2009.
- Three spin-off companies – MonetDB BV, VectorWise BV and Spinque BV (together with the Interactive Information Access group) – have been established to bridge the gap between science and deployment.
- The group received the VLDB 10-year Best Paper Award for its pioneering work on database architectures, in particular hardware-aware database technology and the column store model, and its impact on the database community.
- Other awards: SIGMOD 2009 best paper award (runner up), several Best Paper Awards, ICTRegie Award 2006.





## Interactive Information Access

Group leader: Lynda Hardman  
Lynda.Hardman@cwi.nl

Dataspace refer to all information associated with an entity, e.g. a person or an enterprise. Information within a dataspace is scattered, fragmented and administratively controlled by different bodies, but needs to be organized to be delivered succinctly, compactly and informatively to users. The research goal is to advance scientific knowledge on interactive information access to dataspace, with models, methods and tools focused on discovery, exploitation and human interaction with semi-structured elements. The ultimate goal is to redesign information access tools in a way that users feel that they, rather than the system, are in control of the search process.

### Highlights

- Active in e-humanities and the cultural heritage domain. The MultimediaN culture project won the first prize at the Semantic Web Challenge, with a web-based system to support intelligent access to heterogeneous artwork collections.
- We initiated new user tasks in the information retrieval benchmark and test collection building activities: enterprise search, expert finding, entity ranking, and related entity ranking, taken up by many research groups worldwide.
- In the successful EU project Vitalas, we have shown empirically how the implicit meaning derived from users interacting with a news photo archive can be exploited to improve search effectiveness, to build highly effective automatic 'concept detectors', and to create new insights in what users do when enhanced with linked open data.
- In the life sciences, the group just started the European Fish4knowledge project, helping marine biologists to research fish behaviour by giving them efficient access to thousands of hours of video footage shot by 10 underwater cameras mounted on a coral reef in Taiwan.
- Spin-off company Spinqe has introduced the new paradigm of 'Search by Strategy' into the market. Spinqe demonstrated effective search by winning the PatOlympics, and has recently been awarded the Best Presentation Award at the Third Workshop on Exploiting Semantic Annotations in Information Retrieval.





## Multi-Agent and Adaptive Computation

Group leader: Han La Poutré  
Han.La.Poutre@cw.nl

The research focuses on the design and implementation of adaptive solutions for dynamic and decentralized decision making. The group works in the areas of computational intelligence, multi-agent systems, and sensor networks. Application domains include energy networks, transportation logistics, health care logistics, and market simulation.

### Highlights

- DEAL project for more efficient road transport (fewer empty trucks on the way back) through auctions with intelligent agents and online dynamic route optimization, anticipating future events.
- LifeWatch project: research on automatic recognition of individual whales by means of sensors.
- International and national roles in strategy committees for ICT research for sustainable energy systems, EIT ICT Labs, ERCIM Working Group on Image and Video Understanding, coordination of BRICKS (now ended), and EU projects.
- Project SUPPORT on container and truck logistics at the Rotterdam harbour terminal.
- Several Best Paper Awards.



### Energy projects

- Project IDeaNeD (Intelligent and Decentralized Management of Electricity Networks and Data), in cooperation with TU/e, KEMA, Phase to Phase, and electricity companies.
- Project CES (Computational Energy Systems) on smart grid management and smart energy management in homes, in cooperation with KEMA and ECN.



## Algorithms, Combinatorics and Optimization

Group leader: Monique Laurent  
Monique.Laurent@cwi.nl

This group focuses on developing new efficient algorithmic methods for problems in combinatorics, optimization and algorithmic game theory, motivated by real-world applications like transportation planning, timetabling, scheduling, network routing, traffic control, the Internet, and social networks.

### Highlights

- The group's work for the Dutch Railways (NS) was used to design the 2007 timetable and is still important for the current timetable; it won the Franz Edelman Award in 2008.
- Lex Schrijver received the Spinoza Prize; next to research it is used for the DisWis project, which develops courses in discrete mathematics for high schools and won the 2008 SIGMA Prize.
- Foundation of the spin-off company Safiro, which provides programming services, e.g., to schedule internships of medical students.
- New upper bounds for the famous kissing number and for graph coloring and graph drawing, with applications in geometry and telecommunications.
- Development of decentralized mechanisms to improve the performance of traffic networks.
- Several books, including Constraint Logic Programming using ECLiPSe of Apt and Wallace, and the three volumes work Combinatorial Optimization - Polyhedra and Efficiency of Schrijver.





## Probability and Stochastic Networks

Group leader: Bert Zwart  
Bert.Zwart@cwi.nl

Many real-life systems and processes are dynamic and essentially stochastic. Examples can be found in areas like communication and information systems, biology, economics and logistics. This group develops and studies stochastic and statistical models that yield fundamental understanding and enable control and optimization of such systems. Analysis of these models relies on techniques from fundamental probability theory, queuing theory, stochastic scheduling, spatial stochastics and stochastic geometry.

### Highlights

The group plays a national role in its research field:

- Proposal for Mathematics cluster 'Stochastics – Theoretical and Applied Research' (STAR) was awarded by NWO (Van der Mei).
- ICT Innovation Platform (IIP) 'Vitale ICT Infrastructuur' (co-founded by CWI, TNO-ICT and UT) was formally recognized by ICTRegie (Van der Mei).
- Key role player in the new national research cluster on stochastics (STAR), and the Stieltjes institute.
- Co-founder of the center of excellence E-Quality.
- Several prestigious prizes for group members, such as the Dantzig Prize in 2005, the Erlang prize in 2008, and an IBM faculty award.
- Prestigious grant for ESF Research Networking Programme 'Random Geometry of Large Interacting Systems and Statistical Physics'.
- co-initiator of the national Pricing and Revenue Management (PreMa) seminar series (with VU Amsterdam and ORTEC), a national platform for knowledge exchange between academia and industry.
- Research on communication networks, revenue management and logistics, such as planning ambulances.
- Organized the Mathematics for Industry 2010 conference, hosted by CWI.





## Cryptography and Information Security

Group leader: Ronald Cramer  
Ronald.Cramer@cw.nl

This group's work on the construction of practical cryptosystems as well as the work on cryptanalysis of popular much used systems is in line with the strong need for higher security in the ever expanding digital world. They also research fundamentally new ways to achieve security, including secure multi-party computation and quantum cryptography. In addition, there is special focus on interplays with algebra, number theory, geometry, combinatorics, probability theory, complexity theory, formal methods, quantum physics and information theory, as advances in modern cryptography increasingly rely on deeper understanding of these interplays.

### Highlights

- Marc Stevens attack on the hash-function 'cracked' the world-wide https-security, which caused the world-wide withdrawal of MD5 (a technique used for https) from the Internet.
- Factoring large numbers in the Number Field Sieve Project, e.g. the RSA-512 code used for internet security in 1999, which attracted a lot of media attention worldwide; factoring RSA-768.
- Group leader Ronald Cramer was member of De Jonge Akademie (KNAW); his Cramer-Shoup encryption scheme is an ISO standard.
- Several Best Paper Awards, e.g. at EUROCRYPT 2009 / 2010 and CRYPTO 2009.
- Large ERC grant for the invention of leakage-resilient cryptography (Krzysztof Pietrzak) – theory for the design of crypto systems that are secure against side-channel attacks (e.g. physical attacks).





## Algorithms and Complexity

Group leader: Harry Buhrman  
Harry.Buhrman@cwi.nl

Our group focuses on quantum computing, learning theory, complexity & information theory and computational biology. We design and analyze new algorithms and communication protocols, study fault tolerance, and develop quantum cryptographic protocols. Our group also works on statistical and machine learning, prediction and model selection. We focus on the realistic situation in which all models are wrong, yet some are useful. Within this context we mainly study information-theoretic approaches such as the Minimum Description Length (MDL) principle. We address the origin of early proteins and the genetic code, researching the robustness and fault tolerance in the genetic code. Application areas include DNA sequences, computation devices and the evolutionary origin of the sleeping sickness parasite. We collaborate with various international experimental groups.

### Highlights

- Initiator of quantum communication complexity.
- Developing the polynomial method for quantum computation.
- Quantum fingerprinting scheme.
- Quantum cryptographic protocols in the bounded storage model.
- No-go theorem for quantum position blurring that NP-complete problems are dense (under standard complexity theoretical assumptions).
- A resolution of the AIC-BIC dilemma in statistics, relating to the fundamental question of how one should measure the complexity of a statistical model.
- The group has obtained stronger upper bounds on the level of noise that a quantum computer can tolerate during its operations.
- The group produced quantum proofs for classical theorems; they can be applied, for instance, to error-correcting codes.
- The group was involved in the successful attempt to reopen the case against Lucia de Berk, who had been convicted of murder due to incorrect statistics.
- Google might teach computers the meaning of words – with help of a compression method based on Kolmogorov complexity; the software can also discover new relations between, e.g., different DNA sequences, the origin of new diseases, authors of texts or music, and so on – without any prior knowledge.
- The group was awarded 2 Vici grants, 2 Vidi grants and 3 Veni grants; Peter Grünwald was awarded the Van Dantzig prize 2010.





## Visualization and 3D Interaction

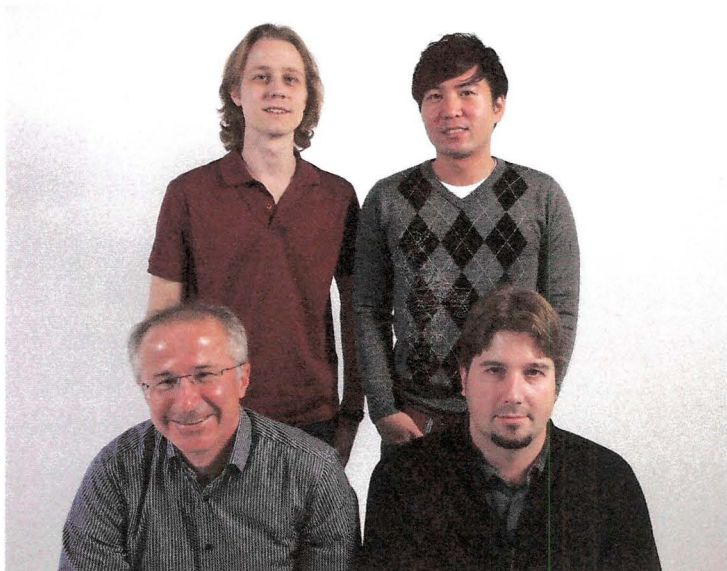
Group leader: Robert van Liere  
[Robert.van.Liere@cwi.nl](mailto:Robert.van.Liere@cwi.nl)

Our goal is the development of quantitative methods for assessing the quality of interactive data visualizations. Central to the group's vision is the notion of model driven visualization, in which only features of interest are extracted from data and their properties are used for visualization analysis. We apply model driven visualization to research automated template matching methods for cryo-electron microscopy applications and functional data analysis methods for imaging mass spectrometry applications.

Since research in interactive visualization is by definition multidisciplinary, the group combines the development of basic methods of interactive scientific visualization with practical questions in structural biology, e.g. coral morphology from CT data, structural cell biology from CET data, and protein identification from imaging mass spectrometry data. Close collaborations with research groups at FEI Optics, AMOLF and TUE have been established.

### Highlights

- Foundation of the spin-off company PS-tech, developing and applying the Personal Space Station (virtual reality desktop systems) further.
- 3D Visualization and measurements of corals, used by biologists to protect biodiversity.
- New visualization methods for high resolution mass spectrometry.





## Foundation of Software Engineering

Group leader: Frank de Boer  
F.S.de.Boer@cwi.nl

This research group develops models, methods, and tools for engineering and analysis of software intensive concurrent systems, including object oriented and component based systems, compositions of distributed services, and multi-core programming. Developing solid mathematical foundations on which such technology is based is integral to SEN3's approach.

### Highlights

- Development of the formal coordination language Reo, with fundamental results in theoretical computer science and applied results in applications, tool support and compositional Quality of Service (QoS) modelling.
- Participation in several EU projects, such as EU STREP projects 'COMPAS' and 'Credo' (coordinated by De Boer).
- Knowledge transfer to industry (e.g. Almende).
- Spin-off company Adaptive Planet in 2002, based on component-based software.
- The third edition of the book Verification of sequential and concurrent programs, authored by K.R. Apt, F.S. de Boer and E-R. Olderog, has been published by Springer.





## Multiscale modelling and nonlinear dynamics

Group leader: Ute Ebert  
[Ute.Ebert@cwi.nl](mailto:Ute.Ebert@cwi.nl)

The group develops basic methods in nonlinear dynamics, pattern formation, scientific computing, and multiscale modelling and applies them to practical problems. Nonlinear partial differential equations play a central role; methods include numerical analysis and scientific computing as well as model reduction and analysis of coherent structures. The scope is extended to hybrid models coupling stochastic particle and deterministic density approaches and to stochastic differential equations.

Most applications are in multiscale plasma modelling: transient discharges in lightning and other atmospheric discharges and closely related phenomena in plasma technology and pulsed electric power, as well as fusion physics. Other applications include population and vegetation dynamics in ecology.

### Highlights

- Explanation of the evolution of sprites – giant lightnings above thunderclouds, published in Nature Geoscience; much media attention.
- The first group to explain reconnections in lightning; 3D simulations of interacting streamer discharges as well as 3D reconstruction in experiments.
- Studying X-rays and gamma radiation from lightning, air purification with discharges for highway tunnels and hospitals, and environmentally friendly high voltage switches for power plants – as a partner in two large programs: 'Building on Transient Plasmas' (STW) and 'Active control of magneto-hydrodynamic modes in burning plasmas' (FOM).
- Close collaboration with experimental plasma physics and high voltage electrical engineering at Eindhoven University of Technology.



### Energy projects

- Energy production: Fusion energy: Stability analysis for fusion plasmas.
- Energy transport: New switching technology for high voltage switch-gear.
- Energy saving: Efficient discharge lamps for beamers, cars, highways, tunnels, soccer stadia, ... Efficient air cleaning of traffic exhaust, of volatile organic components, bacteria etc.



## Life Sciences

Group leader: Gunnar Klau  
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The Life Sciences group at CWI develops mathematical and computational techniques to help understand the overwhelming complexity of living systems. It is an interdisciplinary team of mathematicians, computer scientists, theoretical biologists, and bio-informaticians performing fundamental research on algorithms, theory, models and simulations for a wide range of biological topics. Research concentrates on modeling and simulation of biological processes and the analysis of biological data using discrete algorithms.

We carry out highly interdisciplinary research and therefore maintain strong links to cooperation partners from biology and biomedicine, including the Dutch Cancer Institute (NKI) and the VU University Medical Center (VUMC) Amsterdam. CWI is also one of the three partners within the Netherlands Institute for Systems Biology (NISB) and hosts the modelling core group of the Netherlands Consortium for Systems Biology (NCSB).



### Highlights

- Unique combination of mathematical, computational and theoretical biology research.
- One of the four founders of the Netherlands Institute for Systems Biology (NISB).
- Hosting the NCSB modelling core group, an interdisciplinary group of researchers developing innovative computational models of biological systems, which are studied by experimental partners.
- Cancer research with mathematics.
- CWI Lectures on Life Sciences with Turing Award winner Richard Karp as speaker, marking the start of the group in 2009.
- Development of open source software tools, such as CASS (construction of phylogenetic networks), the Cell Behavior Ontology, VirtualLeaf (support for modeling plant tissue growth), the Tissue Simulation Toolkit (tissue patterning and development), BioNet (a Bioconductor package for integrated, functional analysis of biological networks), and planet lisa (software tools for solving combinatorial problems in biology).

### Energy projects

- Biofuels I: Simulation model to predict lignin structure for wood engineering.
- Biofuels II: Computational modeling to facilitate metabolic engineering of Cyanobacteria.



## Distributed and Interactive Systems

Group leader: Dick Bulterman  
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The group's focus is the study of how users (and user agents) interact in distributed, time-constrained environments. We study: languages for capturing user interaction, languages that contain temporal specifications, network architectures and systems for time-sensitive media delivery and open-source interfaces to (possibly linked) webs of data. Combining both analytic and experimental approaches, the group studies models for interactive media object synthesis based on socially-driven service-oriented architectures and low-level distribution of media content on non-monolithic, distributed rendering architectures. Our application areas include social sharing of multimedia content and the development of frameworks for the semantic web.

### Highlights

- EU and national projects: the group has had a long and successful history of collaboration in the EU's ESPRIT and Framework 6/7 programmes, as well as in ITEA and Senter/Novem projects. Currently, we are involved in the FP7 Project TA2: Together Anywhere, Together Anytime.
- Spin-off companies: members of the group have been active in a number of Dutch spin-off companies, including Oratrix, CharToon and Epictoid. We have also had strong industry collaboration with Dutch companies ranging from Philips and TNO to the Dutch library for the blind and GyPSii.
- Open source software: during the past 20 years, the group has been a seminal contributor to the Ambulant open-SMIL player, we were primary developers of the Python and ABC languages, and we have contributed to nearly a dozen W3C standards.
- Best-paper awards: during the past 5 years, the group has received best paper awards in four conferences and has been nominated for two others.
- Books: members of the group have authored leading books in their fields, including *The Evolution of TV Systems, Content, and Users Towards Interactivity* by Pablo Cesar, and Dick Bulterman's book *SMIL3.0: Interactive Multimedia for Web, Mobile and DAISY Talking Books*
- W3C Web involvement: Dick Bulterman is co-chair of W3C synchronized multimedia working group, Ivan Herman is W3C activity lead for the semantic web and Steven Pemberton current/past-chairs of the XHTML and XFORMS working groups. Members of the group have been active in more than 10 W3C working groups during the past decade.





## Software Analysis and Transformation

Group leader: Paul Klint  
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Research focuses on the question how the development and renovation of large, industrial, software systems can be supported and improved. Focal points are program analysis and understanding, program refactoring, domain-specific languages (DSLs), and large-scale program transformation.

### Highlights

- NWO TOP-GO subsidy awarded for the project 'A big future for small programs' on DSL design and implementation.
- NWO Jacquard project awarded on Computational Auditing.
- The ATEAMS research team was officially created, a joint CWI/INRIA research group that is part of this research group and focuses on software analysis and transformation.
- First, alpha, releases of the new meta programming language Rascal were completed.
- Successful spin-off company the Software Improvement Group (SIG), founded in 2000, won the Innovator Award 2007 and the ICTRegie Award 2008.

