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Main research interests

- **Systemic modelling and Complex Industrial Systems**
(formal methods for component-based design; real-time systems, embedded systems)
- **Algorithmics for Mobile Communications**
(performance evaluation and QoS optimisation; power control for mobile communication networks [UMTS])

Education

- 2001 – 2006** PhD in Computer Science, *École Polytechnique*, supervisor — Daniel Krob.
Thesis entitled “*A Framework for Studying Complex Industrial Systems: An Example Based on the UMTS Infrastructure*”
Defended on the 30th of June 2006 at École Polytechnique.
- 2000 – 2001** DEA Algorithmique (MSc in Computer Sciences), *Écoles Normales Supérieures Ulm and Cachan, Universities Paris 6 and 7, École Polytechnique* — grade “Très Bien” (top grade).
- 1993 – 1998** 5 years of university studies diploma (MSc) in Mathematics, *University of St. Petersburg* — Average 4.6 out of 5.
- 1989 – 1993** Certificate of majority (High school diploma), *Lyceum of Mathematics and Physics of St. Petersburg*.

Professional experience

- since 2006** Post-doc CNRS, later Université Joseph Fourier (since Oct. 2007), *Distributed and Complex Systems (DCS) team of the VERIMAG laboratory*, formalisation of the BIP compositional framework developed in the laboratory: development of the the Algebra of Connectors, study of the expressivity of the model.
- 2003 – 2004** Internship student (9 months internship), *UMTS Architecture team at Alcatel CIT*, implementation of the 16QAM modulation in the Link Level simulator, performance evaluation of Hybrid-ARQ in the context of HSDPA.
- 2001** Internship student (6 months DEA internship), *UMTS Architecture team at Alcatel CIT*, performance evaluation and development of Outer Loop Power Control algorithms.
- 1998 – 2000** Consultant, *International Systems Technologies Ltd (London)*, CNC administration of OneWorld (Entreprise Resource Planning (ERP) system by JDEdwards): troubleshooting, object management, package building and deployment. Development of several client applications using Visual C++ and SQL.
- 1996 – 1998** Programmer, *Tor Co-operative Enterprise (St. Petersburg)*, Development (Visual C++, MFC) of the interface of QuickField system (<http://www.quickfield.com>), as well as the installation utility.

1. *Power control algorithms for 3G mobile communication networks.* In the context of the 3rd generation mobile communication networks such as UMTS, all users share the same radio spectrum for their communications. Signals from different users are code separated ([Mul04, Spr02, HT01]). Consequently, power control involves a trade-off between providing a guarantee of QoS for a given user on one hand, which implies increasing transmit power, and reducing power consumption and interference to other users on the other, which in turn is obtained by reducing the said transmit power. My contribution to this project consisted in

- analysing one existing industrial solution (Alcatel-Evolium Release 3) in order to determine a relation providing the optimal values of different parameters of the algorithm,
- analysing and optimising an advanced solution (Alcatel-Evolium Release 4) in order to ensure faster convergence of the algorithm,
- development of a new algorithm for multi-service situation.

This project was supervised by P. Agin (Alcatel-Evolium, France). Along with the probabilistic analysis, it involved a development of the relevant software modules for a Link Level Simulator for subsequent verification by simulation of the full radio transmission chain.

2. *Optimal Hybrid ARQ control schemes for HSDPA.* In the context of High Speed Downlink Packet Access (HSDPA; cf. [Mul04]) service, an emphasis is put on transmitting available data as fast as possible. Therefore an opportunistic scheduling and coding approach is adapted. Whenever a block of data cannot be received correctly, it has to be retransmitted. Turbo coding algorithm with coding rate $1/3$ is used with subsequent puncturing to adapt to the necessary transmitting rate. This allows at retransmission to send a set of bits different from the one used at first transmission. This technique is called *Incremental Redundancy* ([Per00b, Per00a]). Another technique — *Constellation Rearrangement* — consists in using different symbol constellations to map blocks of bits to complex symbols ([Enh01, Fur01]). Finally, a third technique called *Chase Combining* consists in adding the new received soft decision bits to the old ones rather than replacing them ([Cha85]). A *control scheme* defines the sequence of different parameters for each of these three techniques to be utilised at consecutive retransmissions. My contribution to this project consisted in a combinatorial analysis of all such control schemes to propose the optimal ones, and an implementation of the relevant software modules in the Link Level Simulator for subsequent verification by simulation. This project was supervised by P. Agin and N. Billy (Alcatel-Evolium, France).

3. *Performance analysis of demodulation protocols in the context of spatial diversity.* In the context of spatial diversity, when the Binary Phase Shift Keying (BPSK) modulation is used to transmit chains of bits. The receiver obtains several copies $(b_i, r_i)_{i=1}^N$ of the transmitted information bit (b_i) each accompanied by a reference value (r_i). The Bit Error Rate (BER), i.e. the conditional probability that the bit is decoded as 1 under the condition that the transmitted value is 0, can then be expressed as $P(U - V < 0)$, where U and V are two quadratic forms over alphabets $\Delta = \{\delta_1, \dots, \delta_N\}$ and $X = \{\chi_1, \dots, \chi_N\}$, where for all $i = 1, \dots, N$, both δ_i and χ_i represent mathematical expectations of probability distributions related to different b_i and r_i ([Bar87, Pro95]). The formulæ obtained in this context present a symmetrical nature in terms of these variables, and therefore can be analysed by methods of algebraic combinatorics (Schur functions, Young tableaux; see [Ful97, Mac99, Knu70, DKT00, KV05]). My contribution to this project consisted in generalising this approach to the probability of the type $P(U - V < \varepsilon)$, which corresponds to a non-zero threshold for the decision algorithm. A quadratic numerically stable algorithm was proposed for calculating the coefficients of the Taylor decomposition of this probability, as well as a combinatorial interpretation in terms of Young tableaux and a bijection between those tableaux and 0–1 matrices. This project was supervised by D. Krob (École Polytechnique, France).

4. *Systemic modelling.* The word “system”, although frequently appearing in both industrial and academic context, does not really possess a strictly defined meaning. Indeed, different systems (dynamic, Hamiltonian, synchronous, etc.; see in particular [Fli81, BCE⁺03]) are considered by different researchers and engineers according to the nature of their particular problem. These approaches give rise to different models (finite automata, statecharts, hybrid systems, etc.; [Bro97,

ACH⁺95, Hen96, Sev01]) and different modelling, specification, and verification tools (MathLab, Esterel, Scade, UML, etc. ;) characterised by extremely low interoperability due to a lack of common semantics. In this framework, we propose a low level model generalising the Turing machine in order to admit an input/output functionality, a temporal hierarchy (to reflect the differences in the operating speeds of different components), and continuous behaviour (as opposed to the discrete one). Our model allows to reunite most “classical” systems as they can be represented as its special cases. It also introduces a new calculability theory on real numbers. This growing project is supervised by D. Krob (École Polytechnique, France).

5. *Formalisation of the BIP compositional framework.* BIP [GS05, BBS06] is a compositional framework modelling systems on three layers: Behaviour, Interactions, and Priorities. This approach provides a powerful and flexible way for modelling component-based heterogeneous real-time systems, encompassing at the same time different paradigms of communication (broadcast, rendezvous), operation (synchronous, asynchronous) etc. A programming language implementing this model and a number of related tools have been developed in the laboratory.

We have developed the Algebra of Connectors, formalising hierarchical composition of components of a system, its semantics both in terms of interactions and in terms of causality relation between these. We have also exhibited a number of applications of this algebra. Presently, we are working on a notion of expressiveness for component-based models. This project is supervised by J. Sifakis (VERIMAG, France).

Publications

- [1] Simon Bliudze. Outer loop power control. Internship report, Alcatel CIT, October 2001. confidential.
- [2] Simon Bliudze. *A Framework for Studying Complex Industrial Systems: An Example Based on the UMTS Infrastructure.* PhD thesis, École Polytechnique, 91128 Palaiseau cedex, France, June 2006. <http://www-verimag.imag.fr/~bliudze>.
- [3] Simon Bliudze, Nicolas Billy, and Daniel Krob. On optimal Hybrid ARQ control schemes for HSDPA with 16QAM. In *Proc. of IEEE Int. Conf. on Wireless and Mobile Computing, Networking and Communications*, volume 1, pages 121–127, August 2005.
- [4] Simon Bliudze and Daniel Krob. Towards a functional formalism for modelling complex industrial systems. *ComplexUs, Special Issue: Complex Systems – European Conference – November 2005 – Selected Papers – Part 1*, 2(3–4):163–176, 2004/2005.
- [5] Simon Bliudze and Daniel Krob. Performance evaluation of demodulation with diversity — a combinatorial approach III: Threshold analysis. In Camil Demetrescu, Robert Sedgewick, and Roberto Tamassia, editors, *Proc. of the 7th Workshop on Algorithm Engineering and Experiments and the 2nd Workshop on Analytic Algorithmics and Combinatorics*, pages 195–205. SIAM, January 2005.
- [6] Simon Bliudze and Daniel Krob. A combinatorial approach to evaluation of reliability of the receiver output for BPSK modulation with spatial diversity. *Electronic Journal of Combinatorics*, 13(1):31 pages, January 2006. paper #R2.
- [7] Simon Bliudze and Daniel Krob. Modelling of complex systems I — A functional approach: Time, data and systems. Technical report, LIX, École Polytechnique, 2007. http://www.enseignement.polytechnique.fr/informatique/chaire-systemes-complexes/IMG/pdf/modelling_of_complex_systems1.pdf.
- [8] Simon Bliudze and Joseph Sifakis. The algebra of connectors — Structuring interaction in BIP. In *Proceedings of the EMSOFT’07*, pages 11–20, Salzburg, Austria, October 2007. ACM SigBED.
- [9] Simon Bliudze and Joseph Sifakis. The algebra of connectors — Structuring interaction in BIP. *IEEE Transactions on Computers - Special Issue on Programming Models and Architectures for Embedded Systems*, 2008. (To appear).
- [10] Simon Bliudze and Joseph Sifakis. Causal semantics for the algebra of connectors. *Formal Methods in System Design*, 2008. (Submitted).

Teaching

2001 – 2004	Teaching assistant at <i>University Paris 7 — Denis Diderot</i> for classes in <ul style="list-style-type: none"> • Compilation, • Logic and circuits, • Algorithmics, • Programming (1 class in 2002–03 + 2 classes in 2003–04).
2003 – 2004	Teaching assistant at <i>École Française de l'Électronique et de l'Informatique (EFREI)</i> for a “Compilation” class.
2002 – 2003	Teaching assistant at <i>École Polytechnique</i> for “The fundamental programming and algorithmics” class.
2001 – 2003	Teaching assistant at <i>Pôle Universitaire Léonard de Vinci</i> for classes in “Data Mining” and “Relational Databases”.
1999	A number of courses at the <i>JDEdwards Training Centre (Val de Fontenay, France)</i> on different technical aspects of OneWorld such as technical administration, development etc. 2 to 5 days each.

Administrative responsibilities

2008	Member of the program committee of the <i>1st Interaction and Concurrency Experience (ICE'08)</i> – Reykjavik, Iceland http://ice08.dimi.uniud.it/
2003 – 2005	Contest area supervision (Staff supervisor in 2005) at the ACM programing contest sponsored by IBM (South-Western Europe Regional Contest), <i>École Polytechnique</i> . http://www.acm.polytechnique.fr/2005/
Since 2004	Webmaster of the Union of Viêt Vu Dao Clubs in Paris. http://www.vietvudao-paris.com
December 2003	Organisation of the colloquium <i>Journées GRM</i> . http://www.liafa.jussieu.fr/~grm/journees/
2003 – 2004	Local organiser (LIX) of seminar <i>Graphes, Réseaux et Modélisation</i> (Graphs, Networks and Modelling). http://www.liafa.jussieu.fr/~grm/seminaire/

Miscellaneous

June 2005	First Aid Training certificate (Attestation de formation aux premiers secours, AFPS).
June 2004	Instructor certificate (Certificat d'aptitude à la fonction d'animateur, CAFA) — Viêt Vu Dao black belt (2 dang since 2005).
June 2000	Economics and Commercial French Language certificate (Certificat pratique de la langue française économique et commerciale de la CCIP).
1988 – 1993	A number of City Olympics in Mathematics diplomæ, St. Petersburg.
Languages	Trilingual: Russian (native), English, and French.
Sport	Viêt Vu Dao, aikido, badminton.
Other interests	Reading, contemporary music and dance, martial arts, travelling.

References

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- [BCE⁺03] A. Benveniste, P. Caspi, S. A. Edwards, N. Halbwachs, P. Le Guernic, and R. de Simone. The synchronous languages twelve years later. *Proc. of the IEEE, Special Issue on Embedded Systems*, 91(1):64–83, 2003.
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- [GS05] Gregor Gößler and Joseph Sifakis. Composition for component-based modeling. *Science of Computer Programming*, 55(1–3):161–183, 2005.
- [Hen96] Thomas A. Henzinger. The theory of hybrid automata. In *Proceedings of the 11th Annual IEEE Symposium on Logic in Computer Science, LICS'96*, pages 278–292. IEEE Society Press, 1996.
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- [Per00a] 3rd Generation Partnership Project (3GPP). *Performance Comparison of Chase Combining and Incremental Redundancy for HSDPA*, November 2000. Technical Specification TSGR1 #17(00)1428.

- [Per00b] 3rd Generation Partnership Project (3GPP). *Performance Comparison of Hybrid-ARQ Schemes*, October 2000. Technical Specification TSGR1 #17(00)1396.
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