P r e f a c e

The 1st Franco-Russian seminar 'Software Verification, Testing, and Quality Estimation' has been held in Institut Mines-Télécom, Paris, France, on November, 24-25, 2014. Together with the seminar another important event took place: the joint Franco-Russian Research Laboratory that will focus on the use of formal methods for dealing with issues concerning service validity and reliability. The laboratory members are the Institut Mines-Télécom, France, the Institute for System Programming, of the Russian Academy of Sciences, Moscow, Russia, and the Tomsk State University, Tomsk, Russia. One of the laboratory research directions is the quality estimation of web applications and services that nowadays becomes one of the main areas of software development. The key word here is 'quality' and thus, the title of laboratory **Qualipso** has been established.[1]

The seminar has been opened by the key persons of the organizing institutions, namely, David Sadek, Research Director of Institut Mines-Télécom, Viktor P. Ivannikov, Director of the Institute for System Programming of Russian Academy of Sciences, and Dmitriy V. Sukhushin, Vice-Rector for Strategic Development of Tomsk State University.

According to David Sadek, Director for Research of Institut Mines-Télécom, "this kind of action, that comes within our international partnerships policy, allows us to consolidate our existing cooperation with flagship teams and institutions in our own research and education areas, thereby contributing to the worldwide influence of Institut Mines-Télécom."

For Viktor P. Ivannikov, Director of the Institute for System Programming of Russian Academy of Sciences, "On the one hand, formal methods have begun to be really used in Software Engineering practically; on the other hand, France and Russia have deep traditions on different formal models and languages. This gives hopes in new innovations for our French –Russian joint cooperation".

For Dmitriy V. Sukhushin, Vice-Rector for Strategic Development of Tomsk State University, "The opening of the joint laboratory is the result of our long collaboration and mutual trust. This international joint laboratory provides new opportunities for its members encouraging the integration of the research in the international scientific society. We believe that the integration of our studies will contribute to our mutual competitive advantage aiming at being leaders in the priority research areas."

The first presentation was made by Professor Alexander K. Petrenko (Institute for System Programming). The speaker discussed the state of the art of the verification of operating systems (OS) and presented the variety of instruments and technologies developed at the Institute for System Programming which are used for the

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verification of various operating systems starting from microkernel real time OS up to core modules of Linux and its distributives that contain millions of interfaces. The facilities of a number of verification techniques have been demonstrated in the context of their use for microkernels which have more than 10000 lines in programming languages, for modules with up to 100000 lines, for libraries having from 1000 up to one million interfaces.

Professor Ana Cavalli (Institut Mines-Télécom, Institute Télécom SudParis) presented a number of methods and techniques for web systems testing and monitoring developed at the department of Network Software. This scientific group has been working in the area of using formal models for testing and verification for many years, they have developed many novel methods and applications and it is recognized throughout the world for their scientific results. One of applications, MMT, developed together with the Montimage enterprise is now used in many companies for monitoring the safety of web systems.

Professor Nina Yevtushenko (Tomsk State University) presented the lecture 'Nondeterministic FSMs in Model-Based Testing' underlining that this time formal models with nondeterministic behavior are widely used. The nondeterminism appears due to the following reasons, such as the specification optionality, abstraction level, limited controllability or/and observability, etc. The presentation contained a number of fault models developed for nondeterministic Finite State Machines (FSMs) and some methods for deriving complete test suites w.r.t. these models.

In the presentation «A TEFSM-based Framework for QoE Evaluation of OTT Services» by Diego Rivera (the paper authored by D. Rivera, N. Kushik, C. Fuenzalida, A. Cavalli, N. Yevtushenko), a new approach has been presented for modelling multimedia OTT services, integrating not only the functional aspects of the service but also non-functional variables, which are classified into objective, subjective and business-related. The functional requirements are modeled using a Timed Extended Finite State Machine (TEFSM), which is augmented with context variables representing non-functional requirements related to the quality metrics QoS, QoE, and QoBiz. Using the proposed model a provider can detect bottlenecks for a developed service in order to increase the revenue.

In his presentation, «Model-Based Testing for MANETs», professor Stéphane Maag (Institut Mines-Télécom, Institute Télécom SudParis,) noted that the conformance testing in network engineering is a crucial phase in the development of complex communicating systems. Whilst many model-based techniques have been developed for testing, their application to test wireless routing ad-hoc protocols still raises many issues. Special attention has been given to presenting the node self-similarity reducing the number of inconclusive verdicts often met in traditional model based testing.

The presentations by Svetlana Prokopenko "Locating a faulty component of an EFSM composition" and Maria Forotyanova "Test derivation based on tree FSMs and tree automata" (Tomsk State University) have been devoted to deriving tests for

an Extended FSM (EFSM) by the use of their *l*-equivalents. Given an Extended FSM, a tree FSM is derived such that its behavior coincides with the EFSM behavior for each input sequence of length up to *l*. Svetlana Prokopenko proposed to derive such *l*-equivalents for mutation EFSMs of the EFSM composition under the assumption that only one component EFSM can be faulty. If there exists a distinguishing (adaptive) input sequence for the derived *l*-equivalents then based on the response of a composition under test to this input sequence a faulty component can be located. Maria Forostyanova proposed a method for deriving a test suite for an EFSM based on its *l*-equivalent and presented the experimental results for TCP implementation (Windows). A Java implementation of this protocol has been mutated by the tool mJava and the fault coverage of a number of test suites has been determined w.r.t. the set of obtained mutants. The experiments clearly show that the fault coverage of a test suite derived based of a 8-equivalent of the corresponding EFSM almost coincides with that of test suites returned using the known FSM methods which are widely used for deriving high quality tests for protocol implementations.

Two close related presentations of I. Burdonov, A. Kossatchev “Building direct and back spanning trees by automata on a graph» and I. Burdonov, A. Kossatchev, V. Kuliamin “Parallel calculations by automata on direct and back spanning tees of a graph” (Institute for System Programming) addressed distributed computations for oriented graphs based on the message exchange between automata which are situated in the graph nodes. The proposed algorithm builds two spanning trees of the graph: *the direct spanning tree*, which has the root node as the tree root, and *the back spanning tree*, directed to the root. The complexity of the algorithm is evaluated. In the second part, a parallel computation algorithm for calculating the arbitrary function value on a multiset of values distributed on oriented graph nodes has been presented. The key idea of the algorithm is to use structural information on the graph that can be extracted by its parallel exploration and encoded into structures of direct and back spanning trees of the graph, which were constructed by the algorithm mentioned in the former part of the presentation.

The presentation of Natalia Kushik addressed the complexity reducing when solving problems of test derivation and quality evaluation. For this purpose, different ways are used such as proper heuristics, scalable representations and solving techniques for proper automata and FSM classes. In the second part of the presentation, some results of the complexity reducing when evaluating the software quality have been mentioned. These results have been obtained in the collaboration with N. Yevtushenko, A. Cavalli, J. Parra, C Fuenzalida, D. Rivera, J. Pokherel, W. Mallouli.

Nowadays a lot of attention is paid for deriving high quality tests for systems for which time aspects are important and there were three presentations on this subject. M. Gromov proposed some sufficient conditions for reducing the number of time variables in finite automaton along with preserving its behavior while G. Kidjarova proposed a scalable representation for comparing the performance of two timed

FSMs. The presentation of Alexandre Tvardovskiy ‘On the minimization of timed Finite State Machines’ addressed the problem of minimizing an FSM augmented with input and output timeouts, since almost all methods for deriving complete test suites are developed for reduced (minimal) timed machines, i.e., FSMs where every two states are not equivalent. If at some state no input is applied until the corresponding (input) timeout expires then the FSM can spontaneously move to another prescribed state. An output timeout describes the time that is necessary for executing a transition that is the number of time instances needed for producing an output after an input has been applied. The author proposed a technique for minimizing such machines and has shown that differently from classical FSMs, an FSM with timeouts can have several minimal forms which can be not pair-wise isomorphic.

The presentation of O. Konratyeva “Web Service Composition Quality Management with Timed Finite State Machines” (the paper O. Kondratyeva, N. Yevtushenko, A. Cavalli ”Solving parallel equations for FSMs with timeouts”) was devoted to using compositions of FSMs with timeouts for optimizing web services’ compositions. The authors derive the general solution for a parallel equation over FSMs with timeouts and propose a way to extract from it a solution that can minimize the time of the message exchange in the composition of web services modeled as such FSMs.

In the presentation of Vin Hoa La (the paper Vin Hoa La, Ana Cavalli “Intrusion-tolerant Routing in Wireless Sensor Networks”), the wireless Sensor Networks (WSNs) have been considered. The resource constraint characteristics of WSNs limit the secure design and development of security protocols for them whilst, sensor nodes usually operating in unattended and even harsh environments are prone to failures and are vulnerable to malicious attacks. In the presentation, two intrusion-tolerant routing protocols for WSNs, namely INSENS and ITSRP, were analyzed and it was shown by using the simulation and performance analysis that both of them are practical. The presentation K. Toumi, M. Aouidi, A. Cavalli “Modeling and security testing of services interoperability” has been devoted to the modeling of services interoperability and the application of active testing and monitoring techniques, based on passive testing, to the validation of secure interoperability properties. The application of the proposed techniques was illustrated by an industrial case study.

Most FSM based methods for test derivation are developed for initialized FSMs and the latter means that a reliable reset is assumed in an implementation under test in order to glue test sequences together. If the reset is rather expensive then the number of test sequences has to be reduced and when it is reduced to a single sequence and this sequence is called a checking sequence. Anton Ermakov (the paper A. Ermakov “Deriving checking sequences for nondeterministic FSMs”) proposes a method for deriving an adaptive checking sequence when the specification FSM is nondeterministic and the conformance relation is the reduction relation. The latter means that the behavior of a conforming implementation should be contained in the

behavior of the specification. A method returns an adaptive checking sequence that detects each nonconforming implementation that has not more states than the specification FSM under the conditions that the specification has a distinguishing sequence and a deterministic strongly connected submachine. The author notes that these conditions can be weakened for the case when the specification has a distinguishing test case and each state of the specification is definitely reachable from another state. The testing process is adaptive, i.e., the next input is determined based on the outputs produced for the previous inputs. Such adaptive distinguishing sequence can be shorter than a preset checking sequence.

In his presentation, Jorge Lopez (the paper J. Lopez, S. Maag, G. Morales “Scalable Evaluation of Distributed On-line Network Monitoring for Behavioral Feedback in Trust Management”) addressed the trust problem in collaborative systems which are growing in use and popularity and thus, trustworthy interactions of the different systems become a priority. The decision regarding with whom and how to interact depends on each system itself. The authors focus on providing trust verdicts by evaluating the behaviors of different agents, using distributed on-line network monitoring. This will provide trust management systems information regarding a trustee experience for systems based on so-called "soft trust". The authors propose a scalable evaluation method for any on-line network monitoring system by using the model of an extended finite state automaton (EFSA), and the known methods for reducing the time complexity of the evaluation algorithm.

Moreover, at the seminar meetings, joint events have been discussed which will be organized by the **Qualipso** research laboratory. Most papers presented at the seminar are published in the journal issue.

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The head of the Department of Network Software of Institute Télécom
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