Outline of the UPPAAL of *Formal Methods For Specification and Analysis of Communication Protocols*

This session introduces UPPAAL, which is a toolbox designed for Timed Automata in respect of modeling, simulation and verification. It performs especially well in safety-critical real-time communication protocols, where constraints of temporal aspects play a critical role, because of its dedication to concurrent non-deterministic systems. As for the interface, UPPAAL has a user-friendly interface, which is graphical and platform-independent.

In the following part, the syntax of UPPAAL is presented. On the base of an extension of FSMs by utilizing timers, aka Time Automata, UPPAAL specification language manages to convert the infinite execution sequences in continuous-timed systems into a temporal region with only finite states. The quantitative evaluation of temporal properties is, consequently, realized. UPPAAL simulates a system by means of a finite number of parallel processes represented by corresponding FSMs. In the FSM, each state is characterized by global and local variables and/or temporal counters, whose properties ought to be held while this state is active in order to avoid deadlock situation. Once certain conditions on variable values or timers are satisfied, actions appended to each transition are executed at a random instance within the condition-validated period. When interleaved executions may cause undesired collision between writing and reading tasks, the intermediate states, labeled as committed, should be performed as atomic action. Communication between FSMs is realized through exchange of unstructured messages on bidirectional channels, while structured signals are exchanged through global variables in a collision-free situation.

The formalism of UPPAAL is further explained by the specification of Go-Back-N ARQ protocol. The system is specified by three instances of process templates, Tx, Rx and Ch, which accordingly stand for the transmitter, receiver and unreliable channel. The communication actions are not responsible for the transfer of any numerical values, which are, on the other hand, conveyed by the global variables ns and nr. And to prevent collision between tasks concerning these global data, local variables, l_nr and l_ns, are used by Tx and Rx, to temporarily store sequence numbers related to exchanged signals. States and
processes are then described in detail to elaborate the communication mechanism. How the unreliability of the channel is also mentioned; it is presented as the non-deterministic choice between correct signal forwarding and silent signal consumption.

Then the author introduces related tools and application examples. UPPAAL is capable of graphical system specification, simulation and validation of systems with user-defined time properties. In the case of a timelock, a guided simulation will function as resolution to the inconsistencies in the specification. As for the application, UPPAAL is well suited for the investigation of hard bounds of temporal property.

The evaluation of UPPAAL is finally given. It is helpful in evaluating the effect of timer values on real-time communication protocols and extremely useful in fixing the timer values to a range that secures functional correctness.