A Heterogeneous Approach for Wireless Network Simulations

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1. Motivation: System Simulations of Mobile Cellular Networks
2. Wireless Network Simulator: Overview
3. Choosing a Model of Computation: Specifics of Mobile Cellular
4. Application: Simulation of a 60 GHz Indoor System

System Simulations for Mobile Cellular Networks

a network operator...

has many users
must re-use the resources
wants to offer needs
buys

limited number of resources
causes interferences
to balance the scales
quality capacity

a Wireless Network Simulator (WiNeS)
Wireless Network Simulator (1)  
Overview

Wireless Network Simulator (2)  
Object-Oriented Analysis
Model of Computation (1)  Multiple Layer Model

Model of Computation can be different in each layer

Model of Computation (2)  Events on System Layer

event-tags need not to be totally ordered through all layers
Model of Computation (3)  

Channel Access

**parallel**
- one transmission channel
- many network elements

**ordered in time**
- multiple access technique
- logical control channels (e.g., a measure cycle)

**sequential**
- channel access as sequential process

**cyclic**
- an event cycle occurs

Model of Computation (4)  

Alternatives

synchronous timed system  
communicating sequential processes

discrete event MoC
- mutable system configuration possible
- overspecifies model if applied in all layers
- run-time scheduling (overhead \(=10\%\))
- sequential DE has performance limits
- parallelization hard to implement
- fits for random events
- works fine

synchronous language
- fast compile time scheduling
- number and order of events must not change
- mutable system configuration
- random activation
- fits for channel access
- not tried yet

CSP/\(\pi\)/Fusion-calculus
- automatic scheduling based on rendezvous
- mutable system configuration and concurrency inherent in the model
- non-determinism
- use event cycle to get determinism?
- not tried yet
Connection between Ptolemy and System-Modules

Ptolemy
- defines interfaces
- stars as scheduler interface

WiNeS-Core
- implements methods
- member defines interfaces

System-Module
- interface definitions in WiNeS-core are independent of MoC

MoC dependent
- MoC dependent
- star
- star calls methods in members

Application: 60 GHz System Module

- each room == one cell
- system simulations in Generic Office Environment
- radiowave prediction by incorporated on-line Radiowave Propagation Simulator (RPS)
- different activation and mobility models

research project:
campus network @ 60 GHz
60 GHz System Module (1) Layout

- **simulator configuration** (VEM)
- **RPC**
- **simulation** (Ptolemy 0.x)
- **system layer**

60 GHz System Module (2) System Configuration

- **Base-Stations:** HOFMap
- **Mobile Stations:** DEDynMap
- **system configuration**
- **element layer**
60 GHz System Module (3) On-line Animation and Trace

Simulation (C++-Ptolemy 0.x) — CORBA™ — animation (Java-Swing and PtPlot)

Summary and Future Work

- heterogeneous approach in three senses:
  - different mobile cellular systems are modeled in different system modules
  - use of a Multiple Layer Model allows for a different MoC in each model layer
  - Event-Cycle for channel access allows for different MoC on system layer and simplifies parallelization

- ready to use:
  - two system modules (GSM and 60 GHz indoor)
  - simulation control: Ptolemy 0.7.1 - Discrete-Event Domain
  - on-line animation written in Java™ and connected via CORBA™
  - simulator configuration via Ptolemy0.x-GUI

- plans:
  - simulation control which allows for concurrency (first choice: base on Ptolemy II - CSP / PI)
  - more generic GUI for animation/configuration (use of DIVA system visualization?)
  - new system modules: 3G-UMTS, 4G-research project (IBMS)