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Efficient and Realistic Simulation of VANETs with JiST/SWANS

Elmar Schoch | C2C-CC Simulation Workshop | 29.03.2007

Requirements on Realistic Simulation of VANETs

- Realistic node mobility models
  - Highways with quasi 1D movement pattern, high node speed
  - Urban scenarios with complex road structure
  - Mutual influence of communication and node mobility
- Large number of nodes (>> 100)
- Realistic radio propagation in urban environments
  - with lots of buildings and obstacles
- Medium access mechanisms (802.11p, DSRC)
- Multi-hop message dissemination schemes
- Dedicated applications

JiST/SWANS - Overview

JIST

Java **i**n **S**imulation **T**ime

→ entirely Java-based simulator engine

- Developed at Cornell University
- Basic ideas:
  - Introduce virtual time semantics of simulations into JVM
  - Use Java's reflection capabilities and bytecode rewriting to decouple method calls
- Totally in Java
  - Type safety, garbage collection, platform independence

SWANS

Scalable **W**ireless **A**d Hoc **N**etwork **S**imulator

→ component library for ad hoc network simulations

- Runs atop of JiST
- Various implementations of radio propagation, node mobility, medium access, routing, transport and application
- Allows for integration of legacy Java networking apps

JiST/SWANS - Performance

- Comparison to well-known simulators
- Processing time

5×10^6 events	time (sec)	vs. baseline	vs. JiST
baseline	1.640	1.0x	0.8x
JiST	**1.957**	**1.2x**	**1.0x**
Parsec	3.705	2.3x	1.9x
ns2-C	5.151	3.1x	2.6x
GloMoSim	23.720	14.5x	12.1x
ns2-Tcl	160.514	97.9x	82.0x

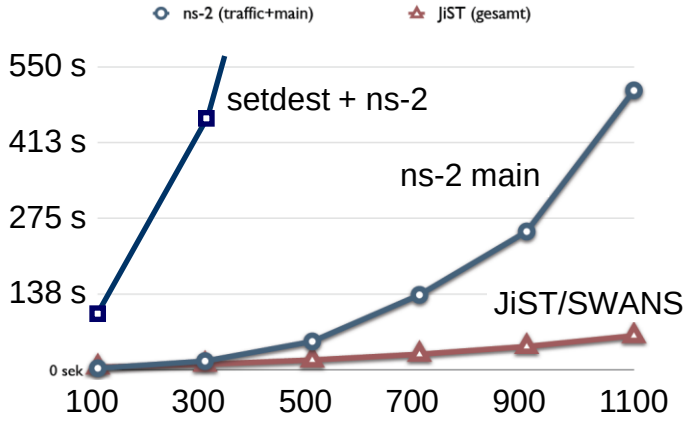
*

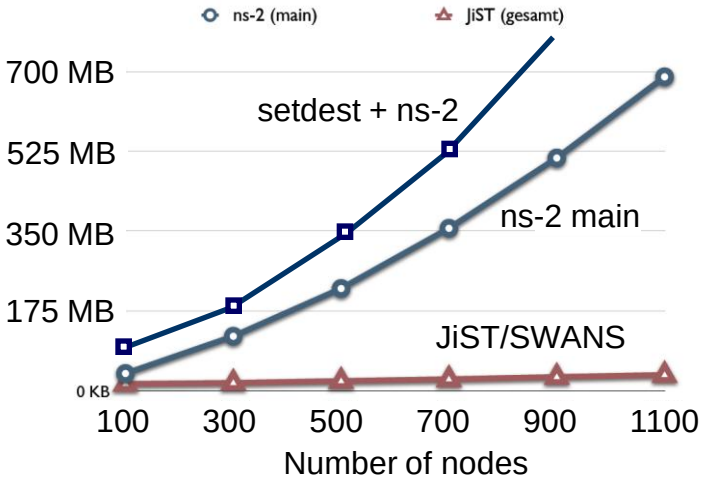
- Memory requirements

memory	entity	event	10K nodes sim.
JiST	**36 B**	**36 B**	**21 MB**
GloMoSim	36 B	64 B	35 MB**
ns2	544 B	36 B*	72 MB*
Parsec	28536 B	64 B	2885 MB

*

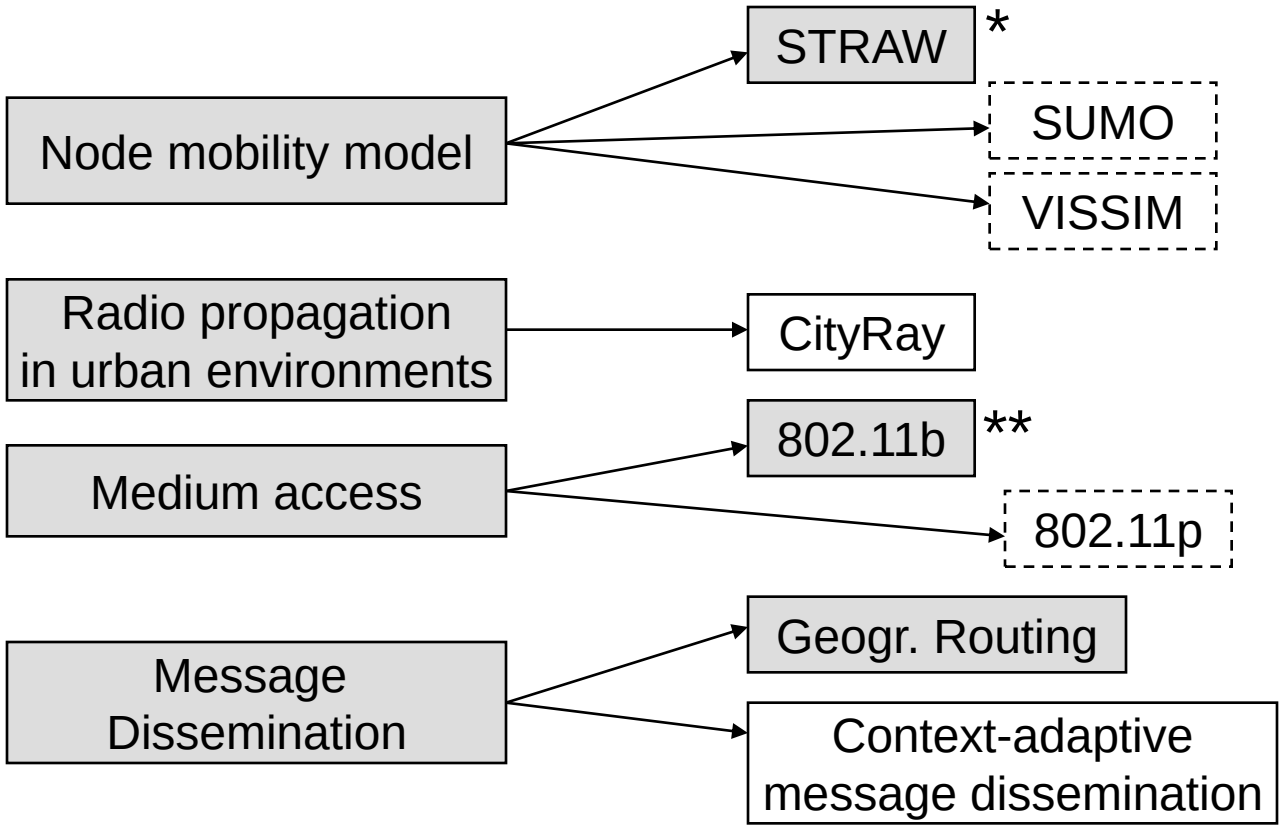
SWANS using georouting





[*] Source: JiST Documentation [**] without any simulation data

Simulation of VANETs … with SWANS

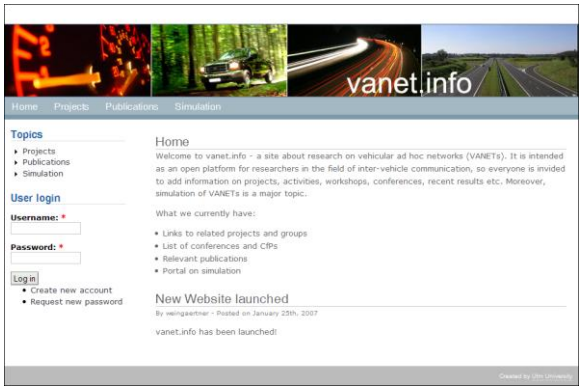


[*] by Northwestern University [**] Original SWANS

Extensions by Ulm University

DUCKS Execution Framework
- Supports simulation cycle:
  - setup simulations using config files
    thousands of simulations with 1 config
  - execute in parallel on multiple JiST servers
  - collect & evaluate results
    using a relational database and GUI-tool

Extensions of SWANS
- Geographic routing
  Geounicast, -broadcast, -anycast
- Various mobility support
  (e.g. replay of GPS traces)
- Various helper classes & bugfixes

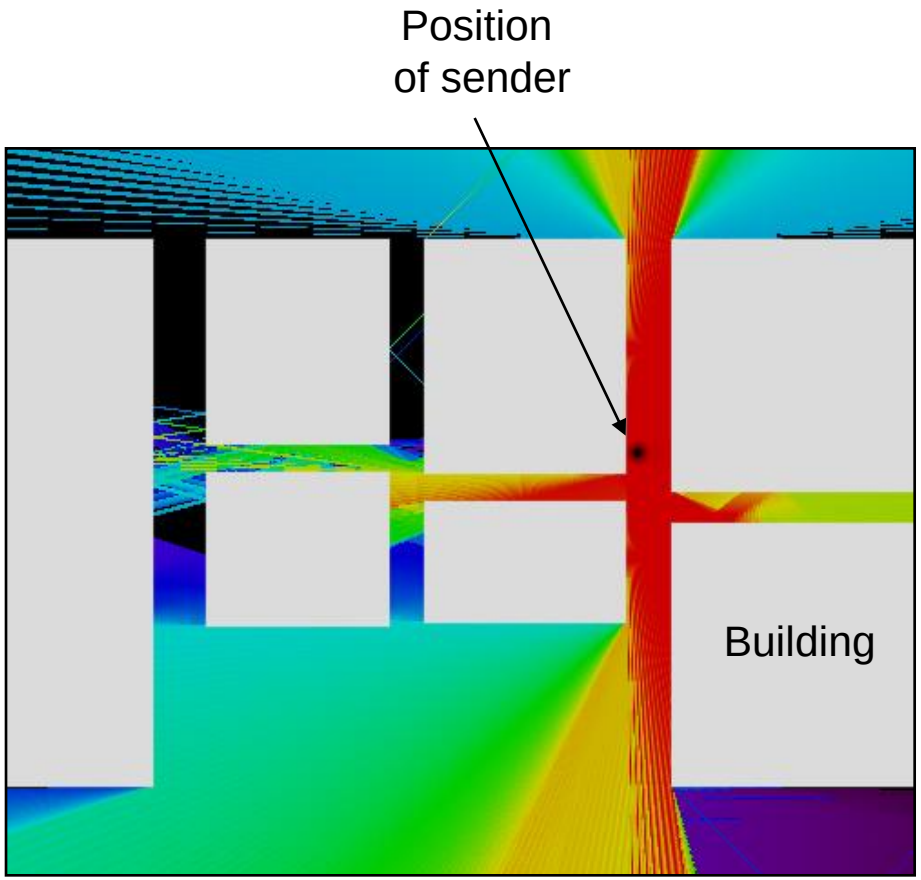


Soon available on
http://www.vanet.info

Extensions by Ulm University

Current activities
- Radio propagation model using raytracing
  - particularly relevant for evaluation of VANETs in urban scenarios
- Context-adaptive message dissemination
- Optimized geocast mechanisms

Plans
- Coupling with VISSIM (Micromobility)
- Integration & evaluation of security mechanisms



Outlook

Research topics to be addressed at our institute:

- Increase efficiency of radio model by high-performance real-time ray tracing methods developed at our institute
- Introduce security operations in simulation time semantics

Contact

Elmar Schoch
elmar.schoch@uni-ulm.de

Frank Kargl
frank.kargl@uni-ulm.de

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