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User-Friendly Approach to Capacity Planning studies with Java Modelling Tools

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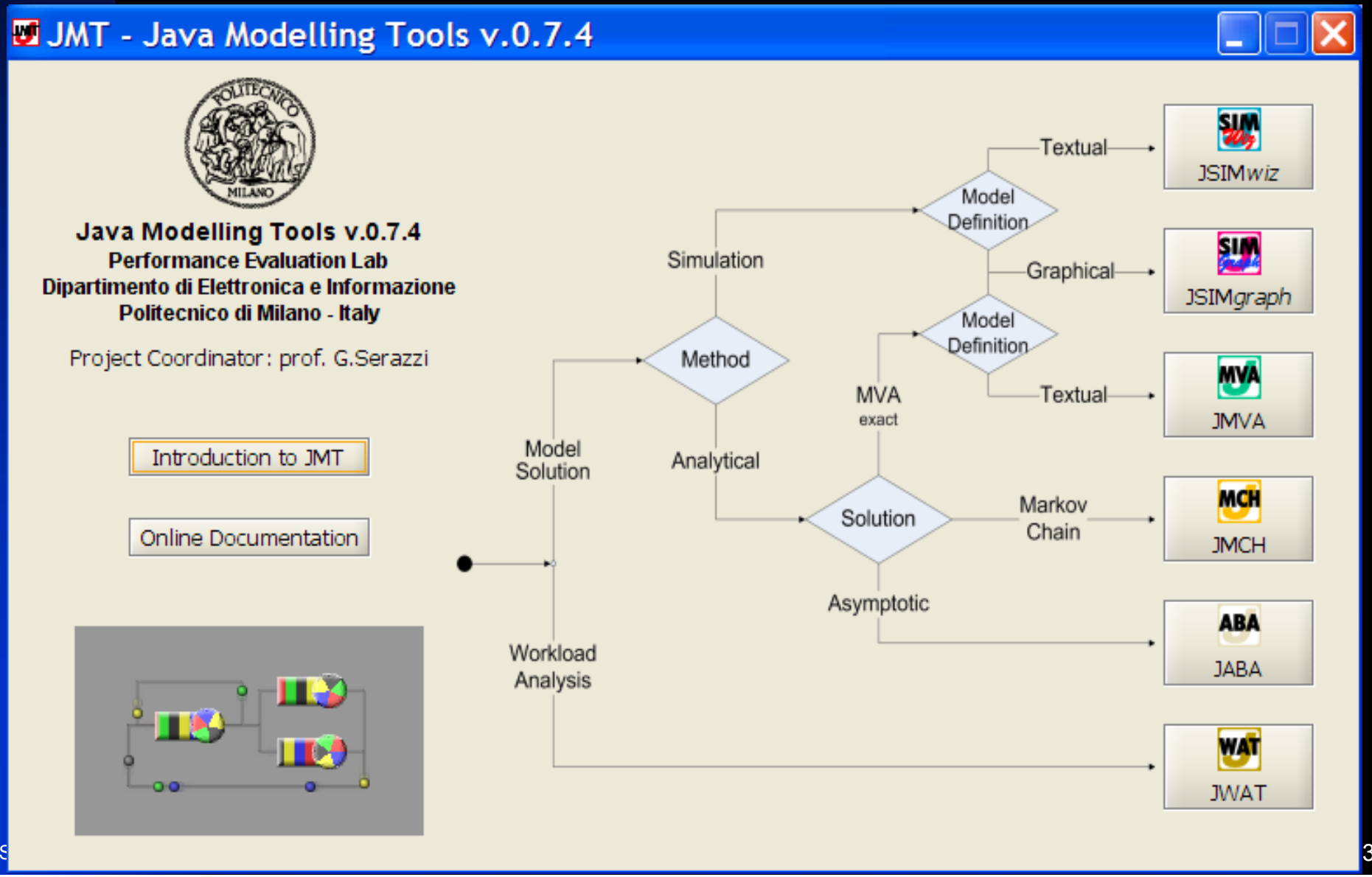
outline

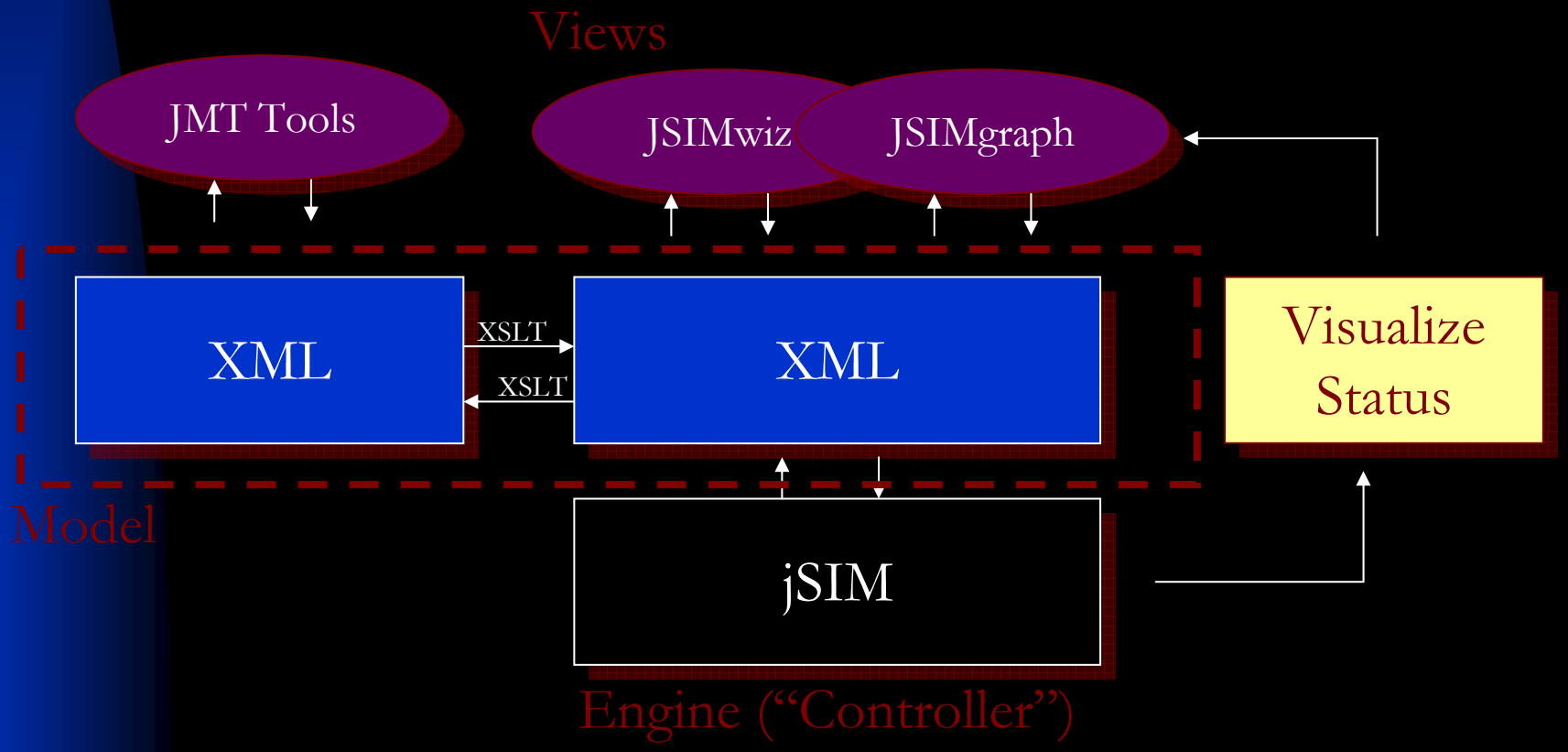
- the JMT suite of tools
- the JSIM simulator
- Case Study: optimal admission control policy

the JMT open source suite: six tools



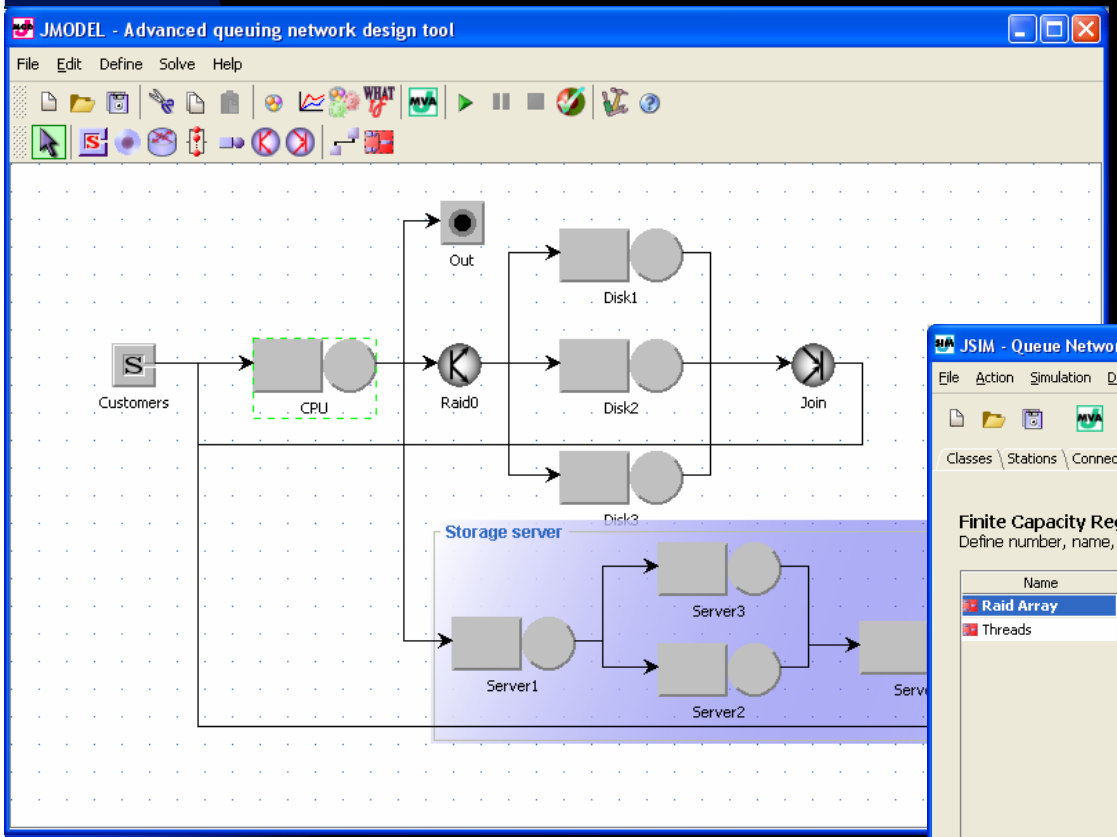
the JMT architecture

- "Model-View-Controller"-like pattern
  - Better reuse and isolation of components

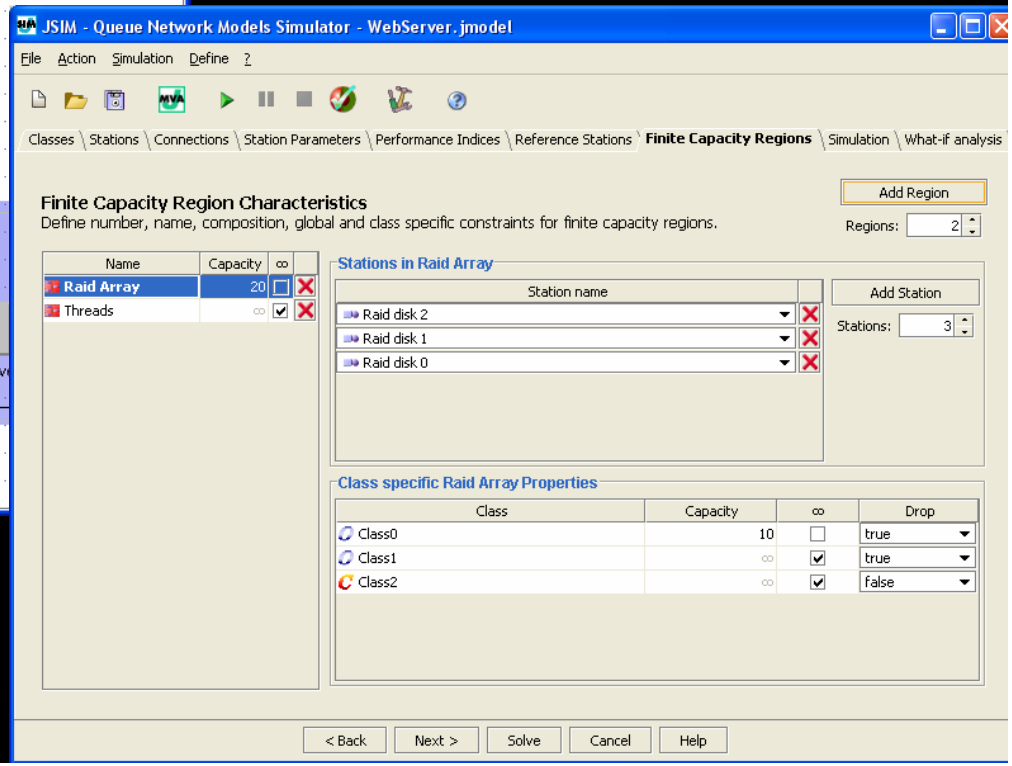


the JSIM simulator: two graphical interfaces

JSIMgraph



JSIMwiz

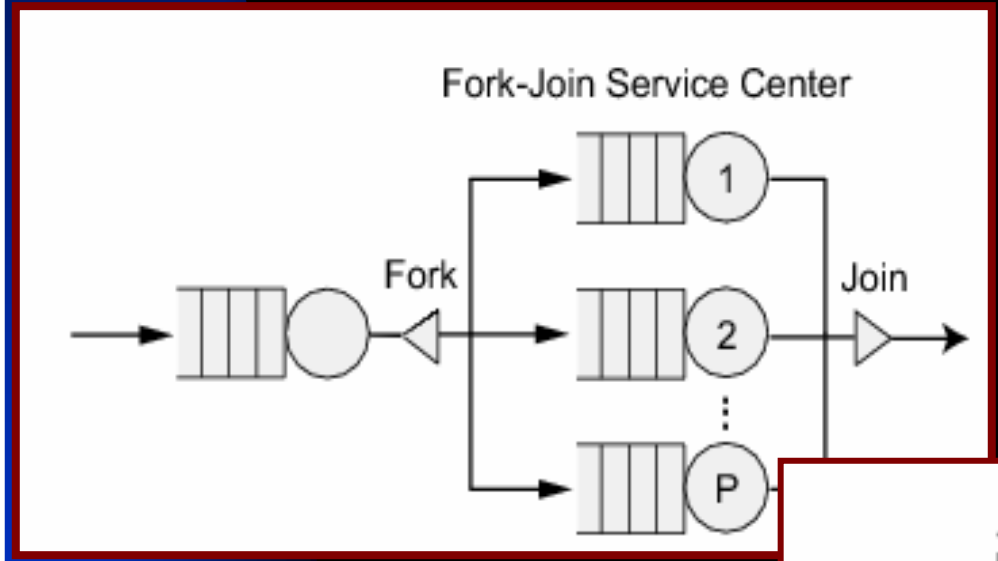


JSIM Engine

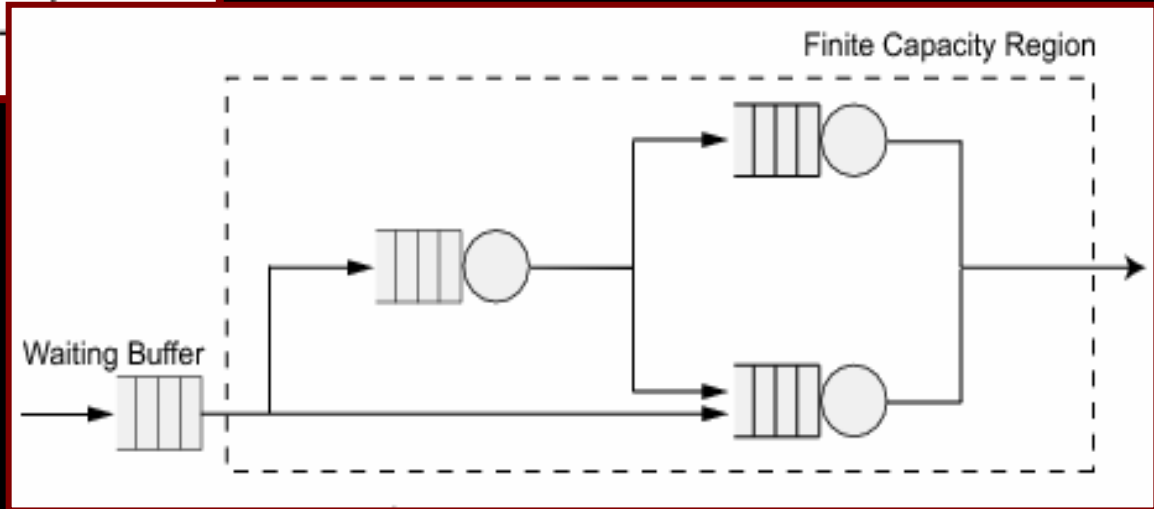
- discrete-event simulator for queueing networks
- several distributions (exp, Erlang, Pareto, burst/MMPP2, …)
- support for NPF features:
  - general arrival and service processes
  - Fork-Join centers
  - blocking and finite capacity regions
  - priority Classes
  - state-dependent routing:
    - route to least utilized center, to shortest queue
    - route to the center with shortest response time
    - fastest service time, round robin, random
- Logger component (debugging, processing of transient data, ...)

Fork-Join and Finite Capacity features

- Fork and Join components
  - fork node: jobs are forked into P tasks
  - Synchronization at the join node



- a group of queues can be tagged as a region with finite capacity
  - non-admitted jobs can be either in a FCFS waiting buffer or dropped



Statistical Analysis

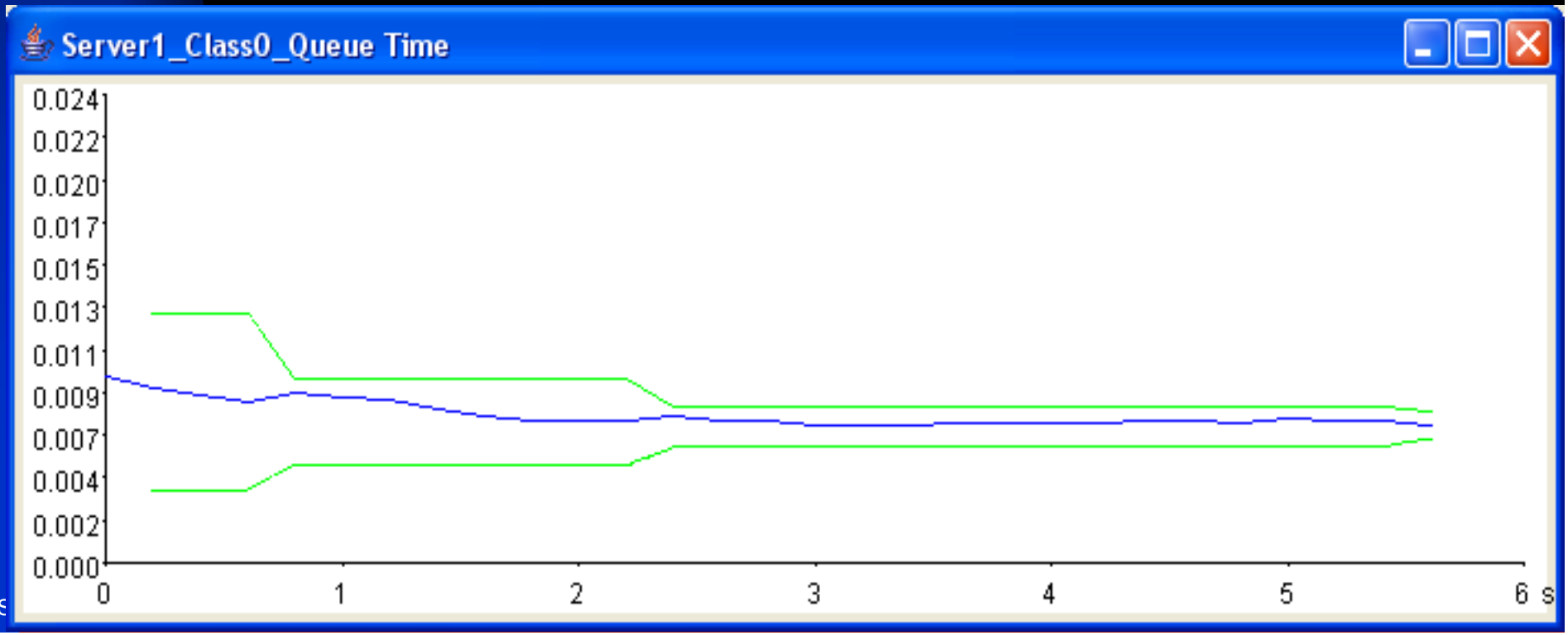
- Automatic removal of the initial bias
  - R-5 Heuristic
  - MSER-5 Rule (Marginal Standard Error Rule)
- C.I. generation using spectral methods
  - Spectral Analysis [Heidelberger & Welch, 1981]
  - Used also for run-length control

Arrival and Service Process

- Exponential insufficient for many models
  - Pareto, Hyperexponential, Erlang, Gamma, burst general/MMPP2, …
  - Custom distribution (external text file, from log, from Logger, future JWAT)
- Random number generation
  - Mersenne Twister
- Load-dependent service process
  - Server speed variable with the current queue-length
  - Building block for Hierarchical Modeling

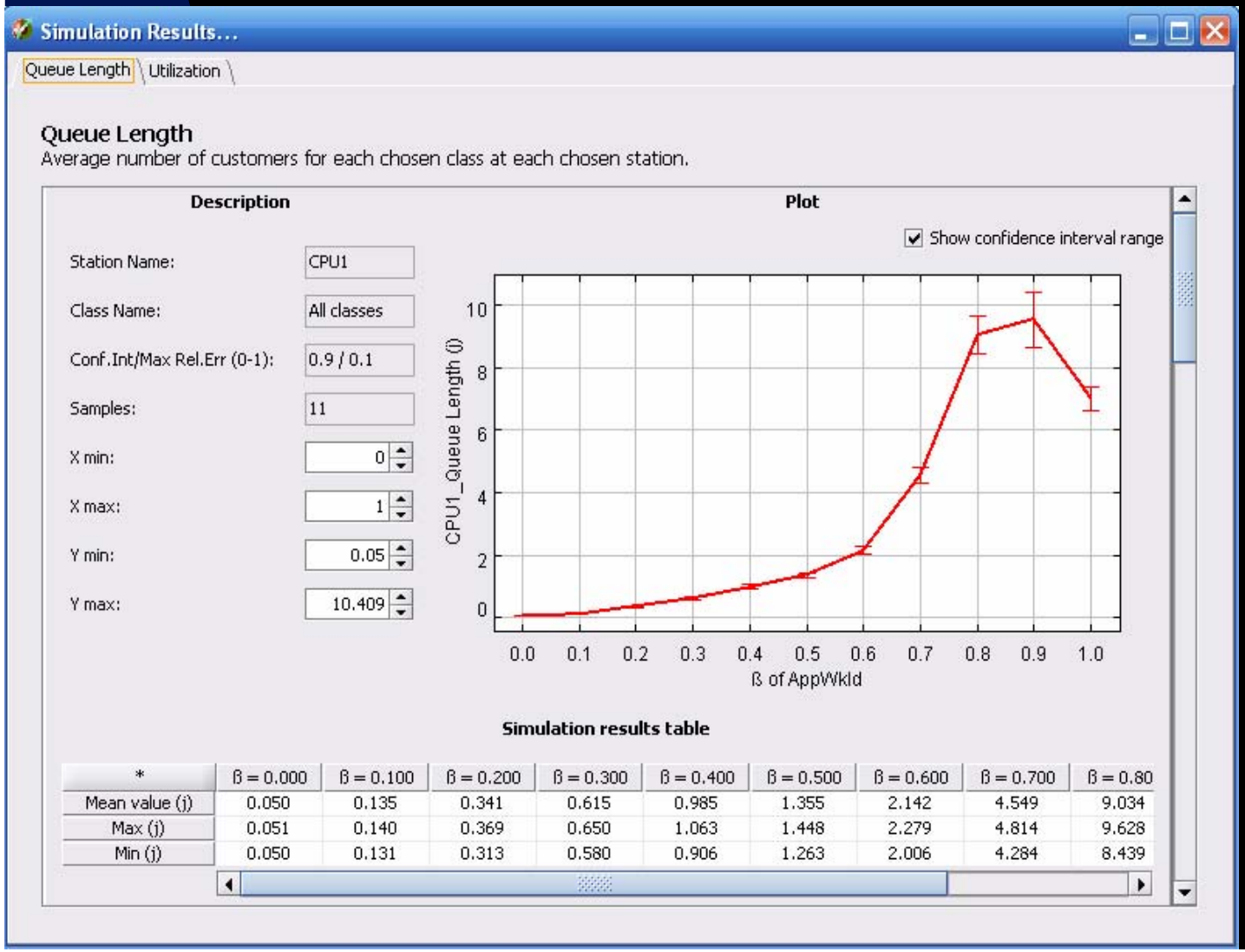
simplification of simulation experiments

- automatic maximum relative error control [Pawlikowski 1990]
  - ratio half-width marginal CI / estimated mean
- automatic removal of the initial bias (transient filtering)
- max n. of samples (long run analysis) and simulation time
- CI generation using spectral methods



What-if Analysis

simulations control parameters

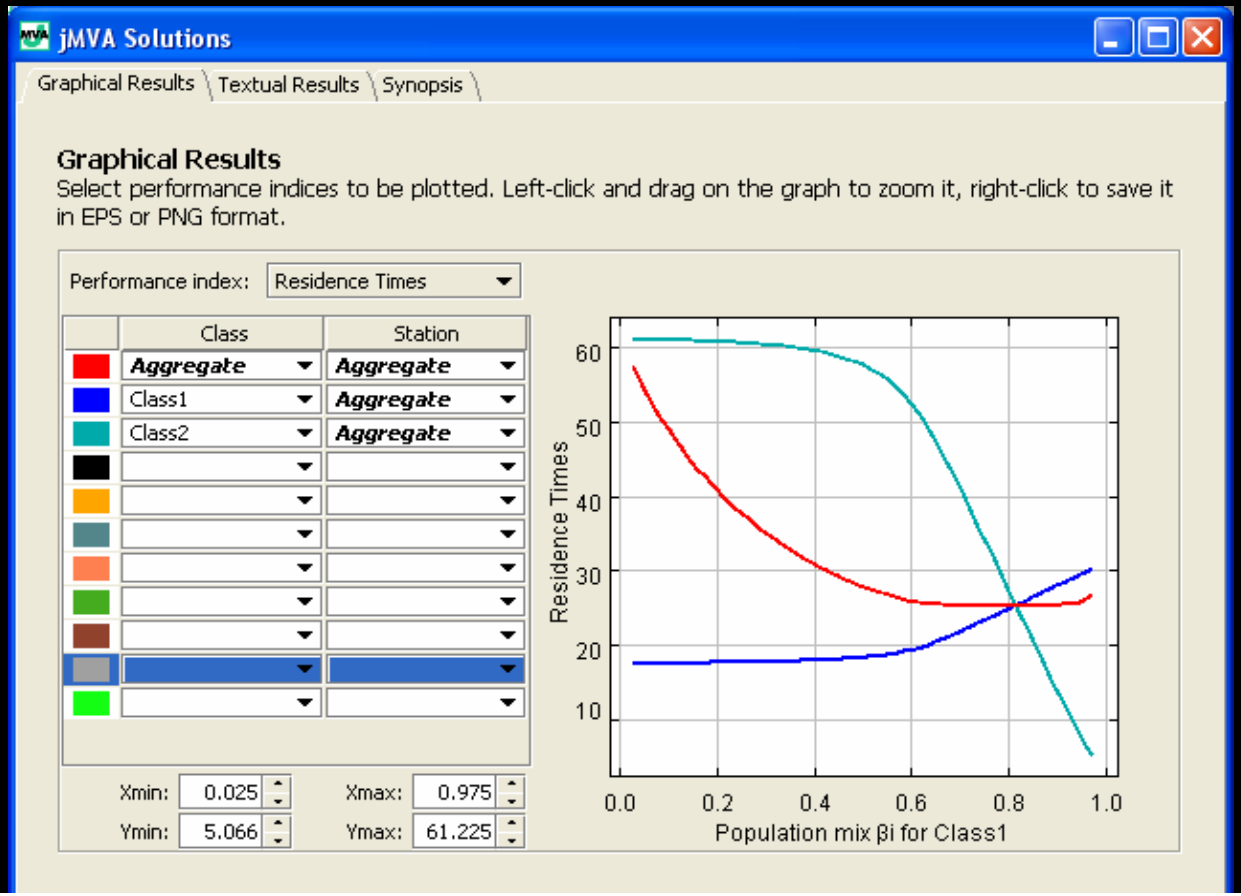


*	ß = 0.000	ß = 0.100	ß = 0.200	ß = 0.300	ß = 0.400	ß = 0.500	ß = 0.600	ß = 0.700	ß = 0.80
Mean value (j)	0.050	0.135	0.341	0.615	0.985	1.355	2.142	4.549	9.034
Max (j)	0.051	0.140	0.369	0.650	1.063	1.448	2.279	4.814	9.628
Min (j)	0.050	0.131	0.313	0.580	0.906	1.263	2.006	4.284	8.439

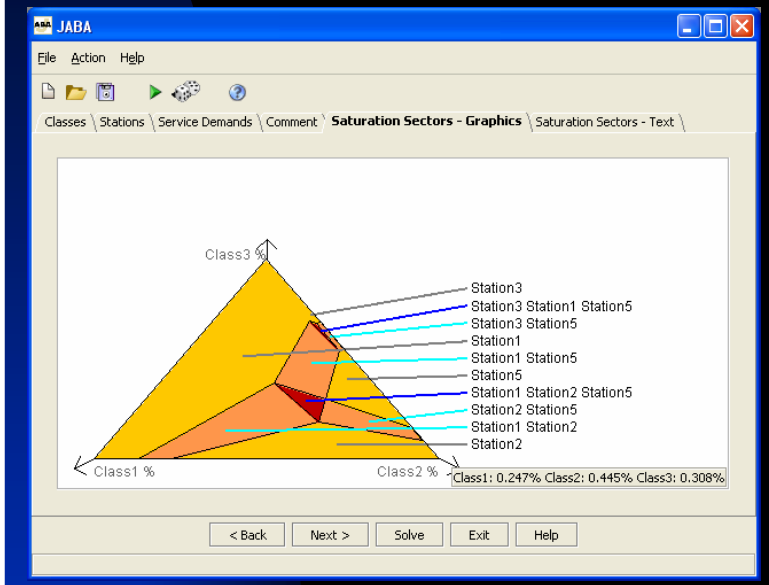
- arrival rate (cl.)
- customer numbers
- service demands
- pop. mix (2 class)

the JMVA analytic solver

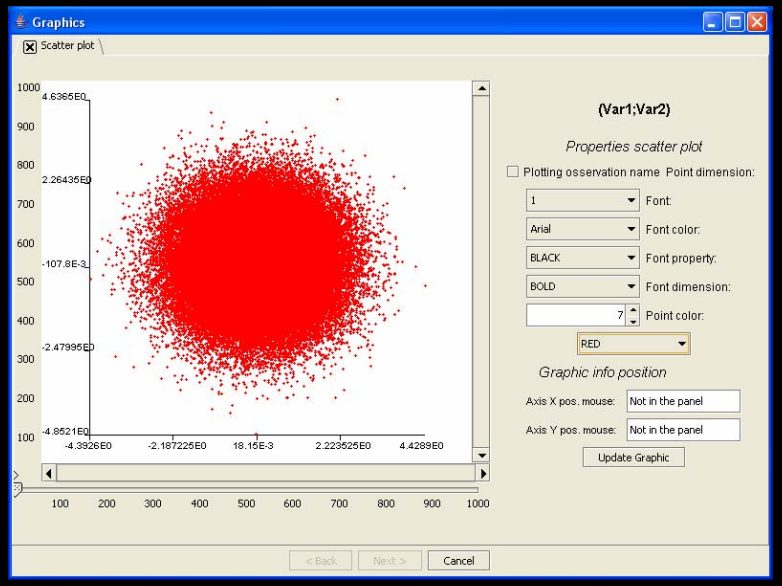
- Solve open/closed/mixed BCMP queueing nets
  - Native support for what-if analyses
  - Integrated with JSIMgraph (reuse models)



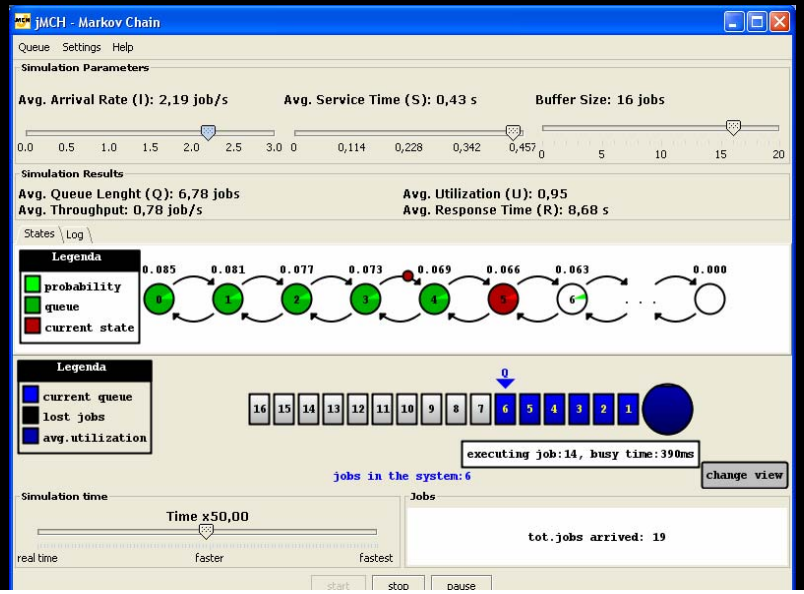
jABA/jMCH/jWAT



jABA



jMCH



jWAT

Case Study: maximization of throughput

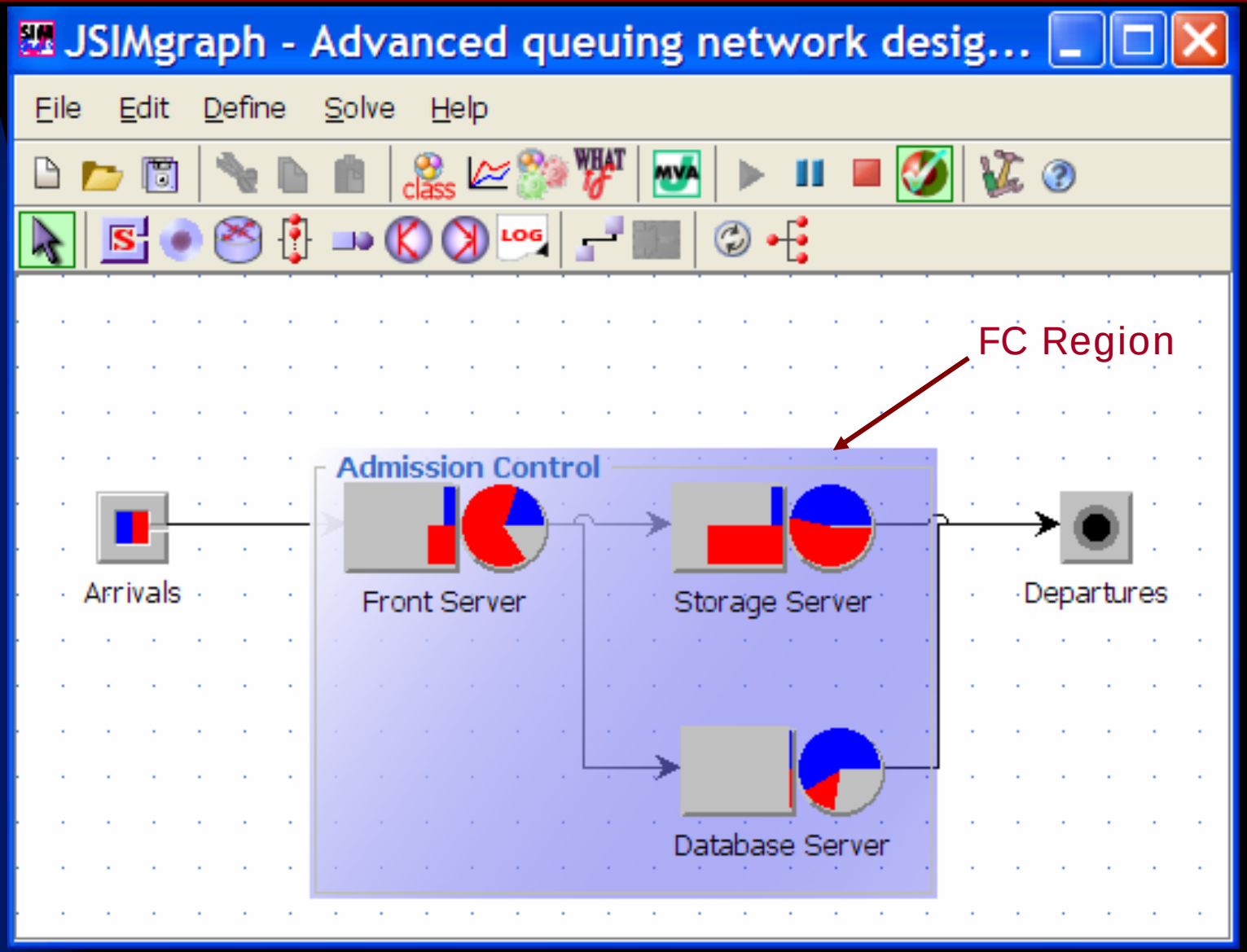
- Multi-tier system: Front Server, Storage Server, Database server
- Workload: two web services WS1 (class 1) and WS2 (class 2)
  - Finite Capacity Region with constant population of requests (N_1,N_2), $N_1+N_2=N=100$

Admission Control algorithm → BEST mix of requests WS1+WS2

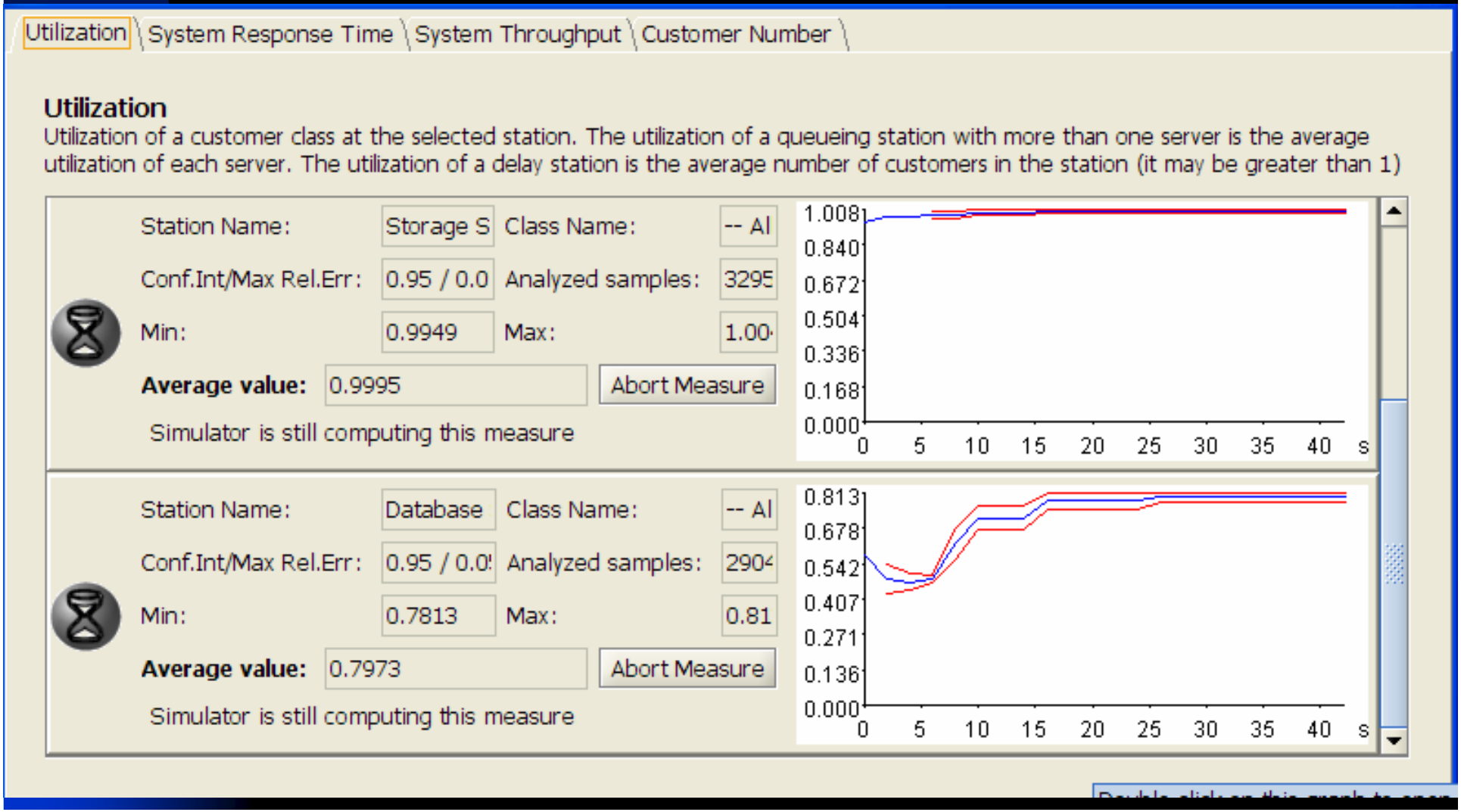
Parameters	*Web service WS1*	*Web Service WS2*
Front Server service demand D_{FS} [ms]	28.48	68.07
Storage Server service demand D_{SS} [ms]	69.15	55.18
Database Server service demand D_{DB} [ms]	86.86	13.95

bottlenecks

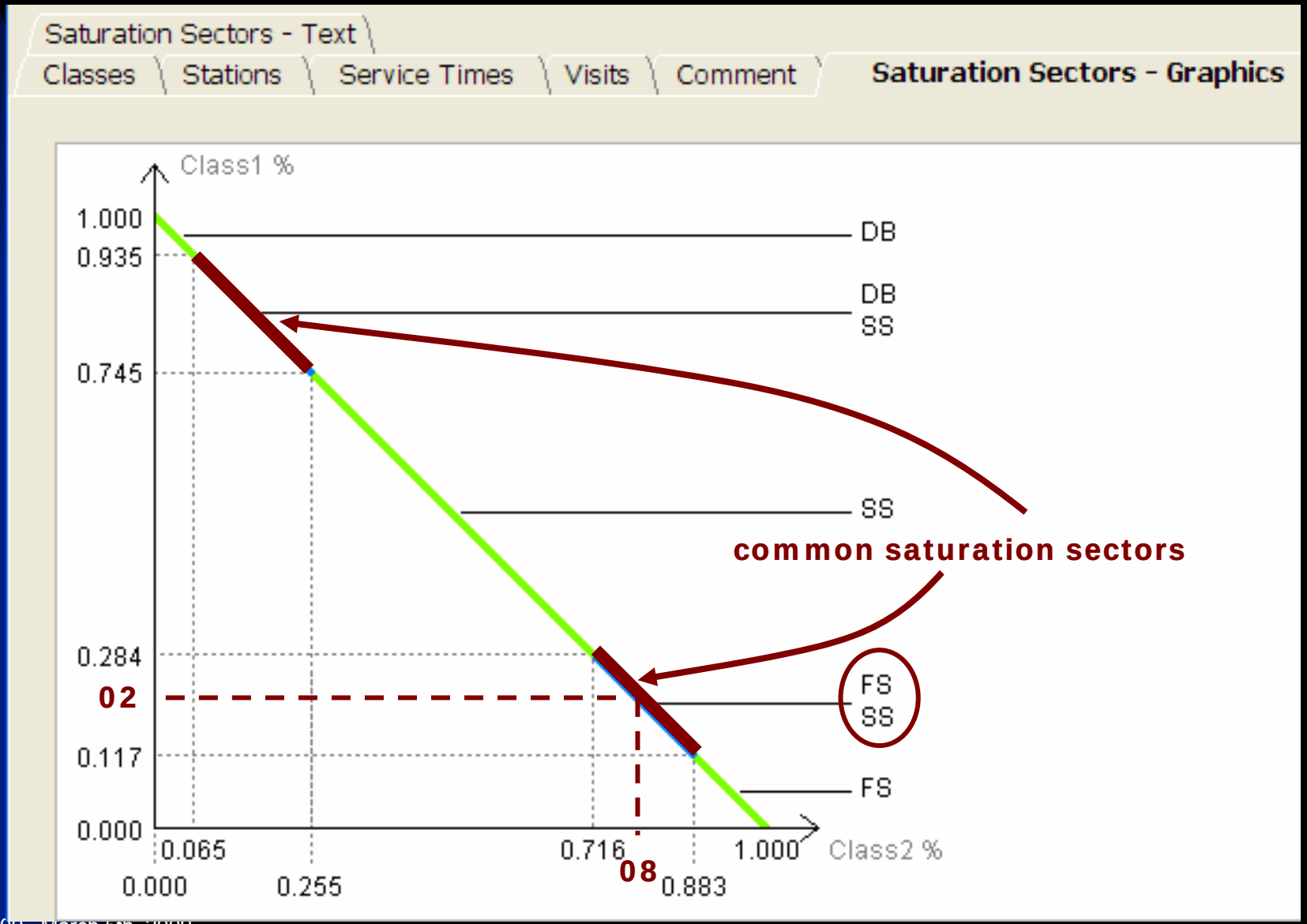
Case Study – JSIM Graphical interface



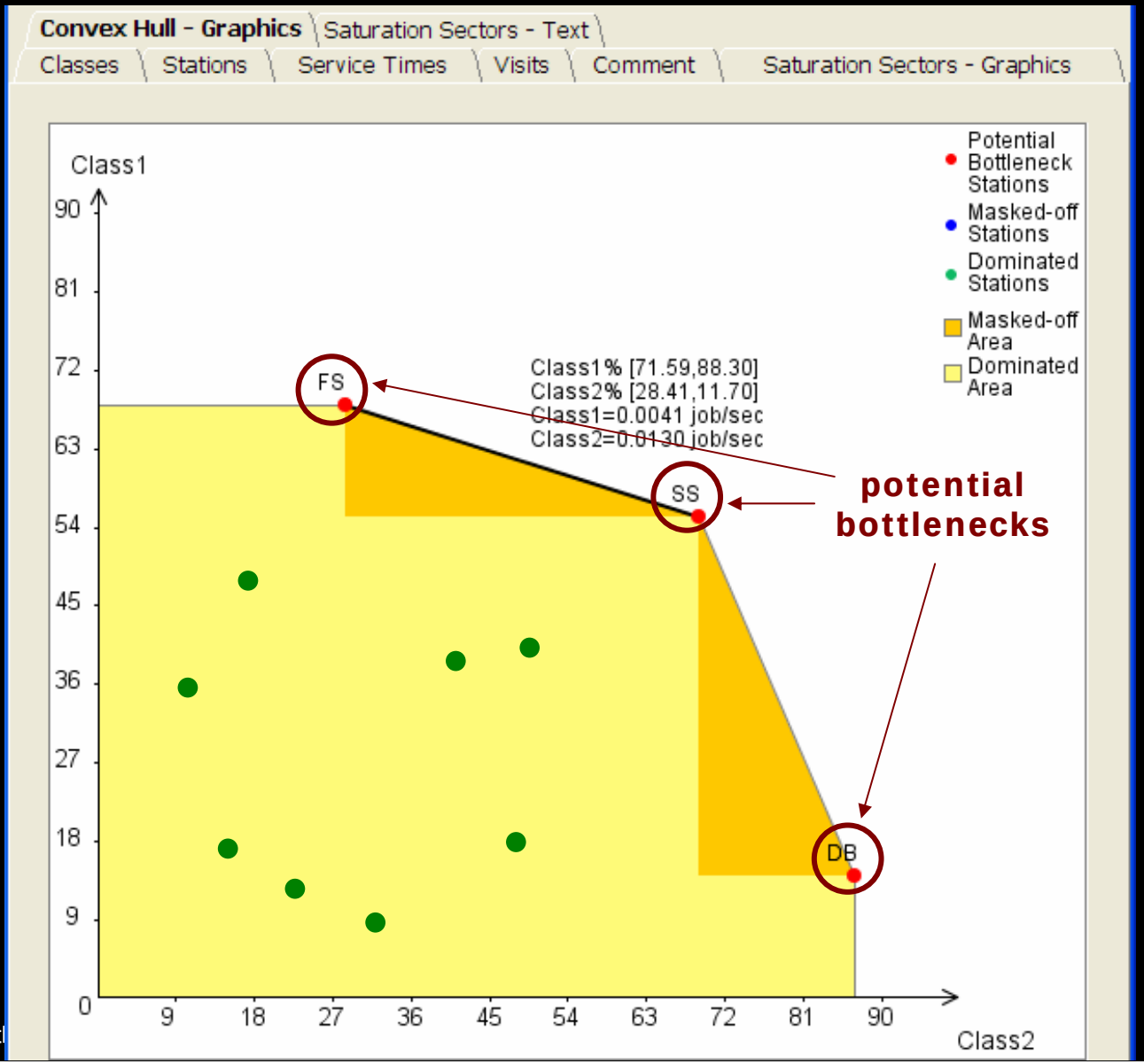
Case Study – JSIM simulation progress



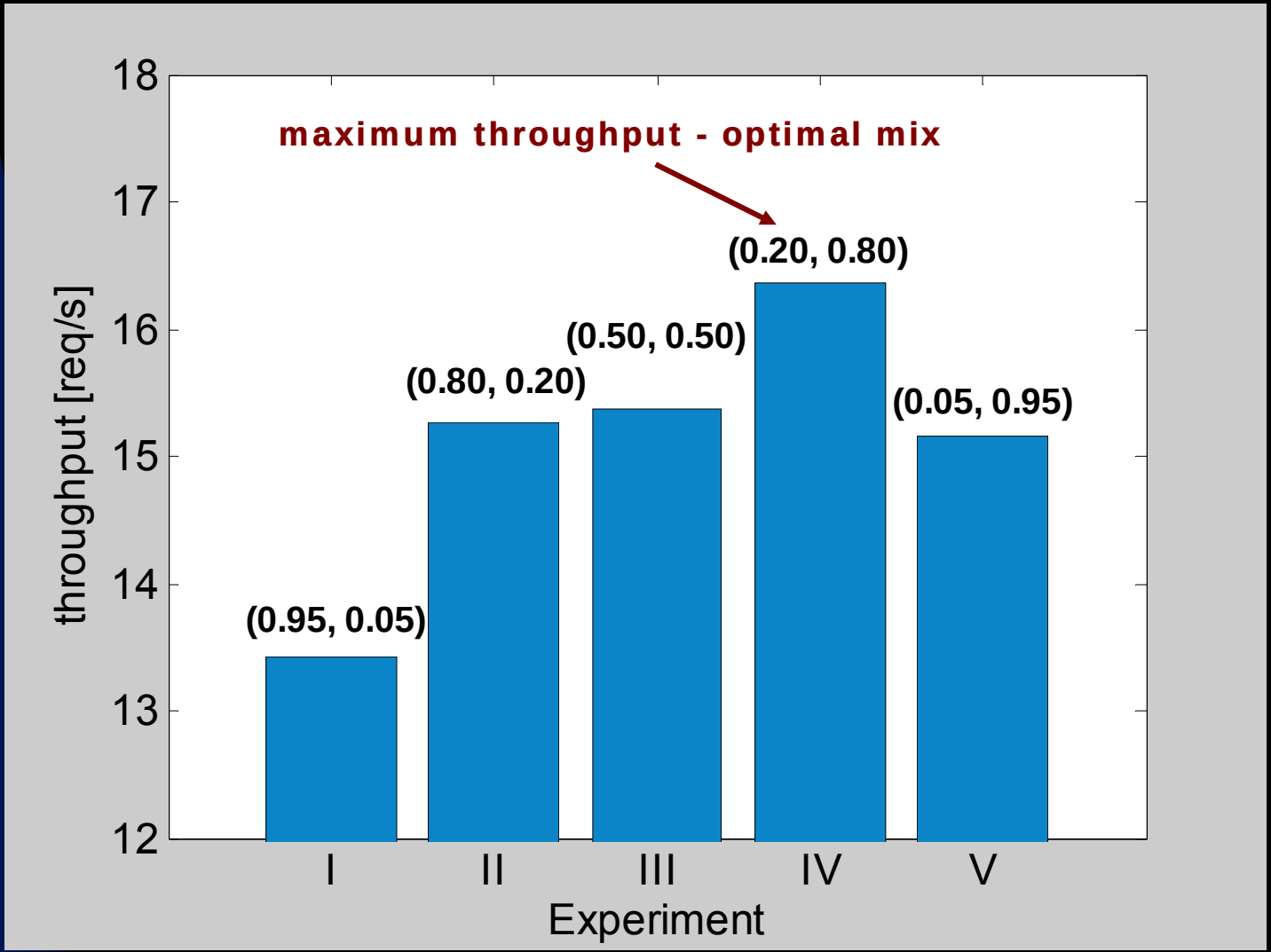
Case Study: JABA Asymptotic Analysis



Case Study: JABA convex hull



Case Study: throughput vs mix of requests



conclusions

- the project

http://jmt.sourceforge.net

> 11000 downloads since April 2006