Imperial College London
Dept. of Computing
London, UK

Politecnico di Milano
EECS Dept.
Milan, Italy

Tools for Performance Evaluation of Computer Systems

Historical Evolution and Perspectives

G. Casale, Imperial College London, UK
M. Gribaudo, G. Serazzi, Politecnico di Milano, Italy

outline

- historical view
- tools categories & evolution
- ideas for the future

pre-history

history

Tool categories	*Years*	*Speed*	*Domains*	*CPU/mem*
Collection of libraries (early simulators)	60-70's	very slow (hw & sw)	unlimited	huge
Analytic exact approximate asymptotic	 70-00's 70-90's 80-10's	 fast very fast very fast	 limited large large	 high/huge low/high low/medium
New generation Simulators	90-10's	reasonable	unlimited	medium/high
Hybrid (sim+analytic)	90-10's	fast	some limitations	medium/high
Meta-tools	00-now	fast	unlimited	medium/high

simulators

- simulation: first technique used for evaluating the performance of hardware logic
- early 60's: simulators were collection of libraries, Fortran (like) language
- late 60's: simulation languages come (Simscript, GPSS, CSIM, ...)
- early 70's: successful commercial tools: Scert, Case
- 70's-80's ... ...
- then → … powerful systems come
- from 90's: simulators: → transients detection, parallel simulation, perfect simulation theory, optimization, coupling-from-the-past algorithm, evolutionary algorithm (... NS-2, NS-3, OmNet++, ..., ψ^2, Opedo, APNN, ..., Mathworks SimEvents, lp-rBm, MAPQN Toolbox, SPE.ED, ...)

SPECIFIC tools (evolution of the techniques)

- Markov models DTMCs, CTMCs ⟶ exact & approximate, PH-type distrib., Multiway Decision Diagrams,...(MARCA, Mobius, SHARPE, SMART, PRISM, …)
- Queueing Networks ⟶ new algorithms, non PF (fork/join, synchronism, constraints, ...) approximate/bounds/asymptotic multiclass, linear programming (BEST/1, RESQ, QNAP, CSIM, Tangram-II, JINQS, SHARPE, JMT, LQNS, MAPQN Toolbox, …)
- Petri Nets ⟶ Colored Petri Nets, Stochastic Well-formed Nets, Non-markovian SPN, Timed PN, Fluid Stochastic-Continuous-Hybrid PN, PNML support...(GreatSPN, SMART, PIPE2, PRISM, SMART, TimeNET, Oris, Romeo, FSPN, ...)
- Fault Trees ⟶ Repairable Fault Tree, Fuzzy Gates, Bayesian Network integration (SHARPE, RADYBAN, ...)
- Stochastic Process Algebra ⟶ EMPA, PEPA, stochastic π-calculus, Bio-PEPA, (PEPA-Workbench, Mobius, Two towers, ipc/Hydra, ...)
- ... ...

MULTIPURPOSE tools (evolution)

- multi formalism & multi solution techniques
  - Reduction of models to a common framework: CTMC, expolynomials distributions, Bayesian Networks, Abstract Functional Interface (Mobius, DEDS, Sharpe, RADYBAN…)
  - Integration of solutions with a compositional language: c-like, flow based (Smart, OsMoSys, …)
  - Integration of different approaches in single framework: simulation, asymptotical, numerical, batches of experiments..(JMT, GreatSPN, Tangram II…)
  - Availability of different analysis techinques for the same model: Reward computation, model checking (PEPA-Workbench , bioPEPA-Workbench)
  - non-linear search techniques for optimization: pattern search, response surface methodologies, evolutionary algorithms (Opedo, ...)
  - ... ...

new requirements: models

- workload and traffic
  - highly bursty arrivals
  - several classes of customers
  - highly heterogeneous resource demands
  - ... ...
- dimensions (large scale systems)
  - very large number of resources (hundreds)
  - huge number of customers (tens of thousands)
  - ... ...
- experiment manager
- interchange formats (PMIF2, PNML, ...)

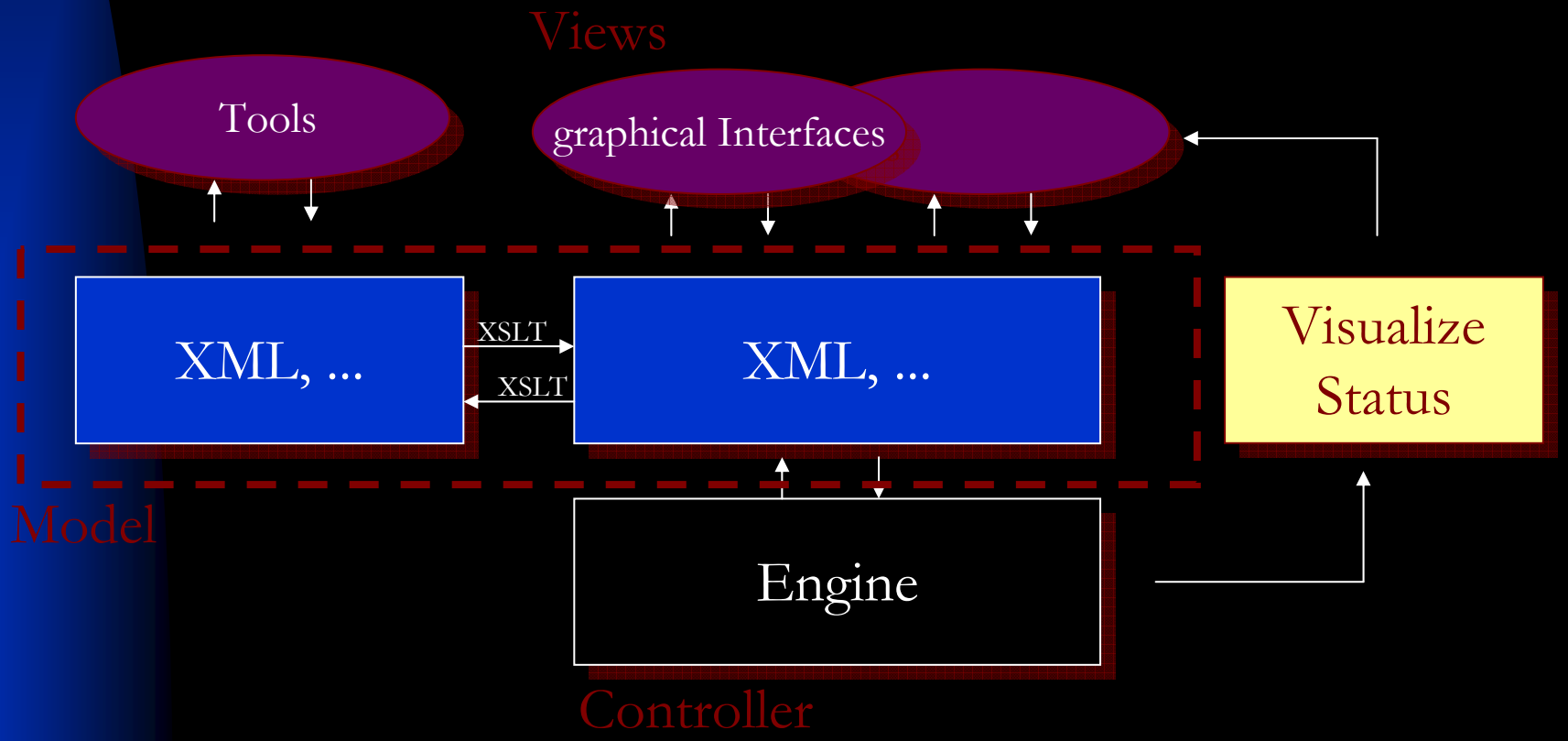
new requirements: analyses

- type of analyses
  - transients (fluid), trace
  - non PF networks: routing LD, finite capacity regions, synchronism, parallelism, priorities, preemption, correlations among events, ...
  - ... ...
- optimization
  - performance vs QoS vs energy consumption vs cost
  - dynamic reconfiguration
  - ... ...
- model validation
  - regression support
- ... ...

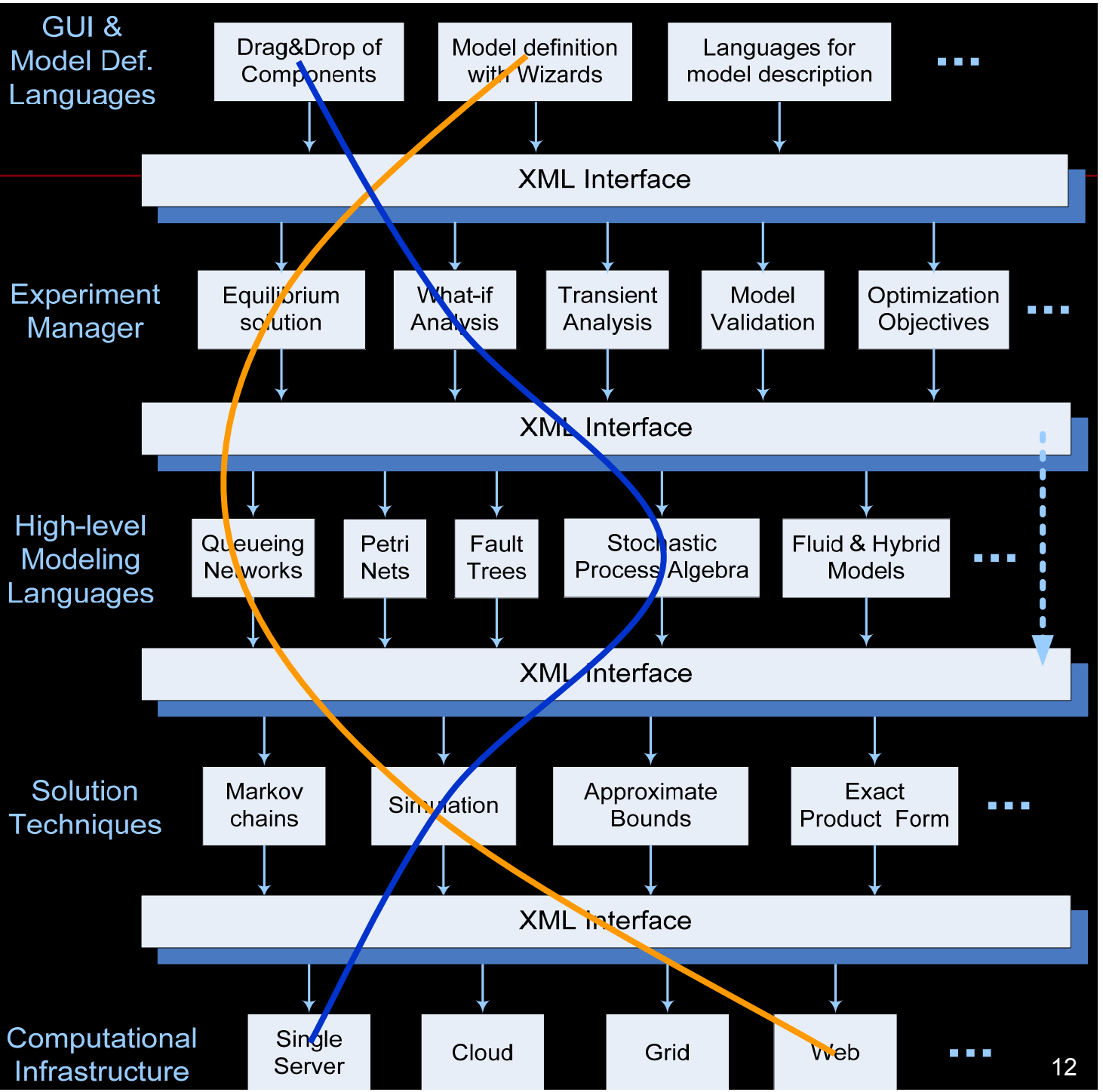
Ideas for the future

“Model-View-Controller” like pattern

- better reuse and isolation of components



p-platform for meta-tools



why meta-tools?

- public repositories with new algorithms immediately available (e.g., www.netlib.org linear algebra)
- new tools as composition of existing ones
- reuse of standard “de facto” models
- extreme flexibility to select the features that best matches the requirement of the project
- selection of the “top of the crop” in the market
- incremental upgrades (maximum scalability)
- the community may contribute easily with the availability of a public repository

…

- Kemper, P., Sanders, W.H., Modelling Techniques and Tools for Computer Performance Evaluation, Guest Editorial, *Performance Evaluation, vol.63, 6,* 521-608, 2006
- Casale G., Muntz R.R., Serazzi G., Ed.s, Special Issue on Tools for Computer Performance Modeling and reliability Analysis, *ACM Performance Evaluation review*, vol.36, n.4, 2009

- list of queueing tools http://web2.uwindsor.ca/math/hlynka/qsoft.html
- public repository for our community … : http://perflib.net
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Authors F. Airoldi, G. Bonomi, A. Calloni
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An Application of JMT to Model the Machine Repair Interference Problem ¶

Uploaded on March 10, 2010 (Updated on June 8, 2010)

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Repair Interference Problem is a problem found in production systems where machine can fail and they then need to be repaired by a limited capacity team. i.e. number of repairing teams is less than number of machines, so some failed machines need to wait in a queue to get fixed. Such a system is modeled using JMT, and different PI are studied.

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