Modelagem e Análise de Redes com o Conjunto de Ferramentas TANGRAM-II

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OBJECTIVE

➡ **Main Goals**

➥ Provide a flexible and intergrated environment
for performance/availability modeling, analysis and experimentation
of computer/communication systems

➥ General user interface: analytic modeling, simulation, measurements

➥ Develop a set of multimedia tools to aid in the modeling process and
collaborative work.

➥ Perform experimental work using the tools
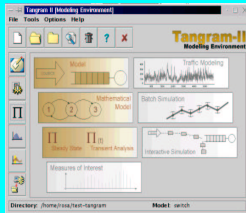(provide an environment for experimentation).

➡ **Developed for research and educational purposes**

➥ State of the art techniques

➥ Analytic solution techniques

➥ Simulation

➥ Measurements

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OUR LABORATORY

RIO Multimedia Server
(UCLA, UFMG, UFRJ)

TGWB
whiteboard
UFRJ, Bill Cheng

WWW.land.ufrj.br

TANGRAM-II

- **Modeling Environment**
- **Analitic solvers**
- **Simulators**
- **Traffic Engineering**
- **Traffic generators**

VivaVoz
VoIP tool

COMIT
real-time video tool

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MAIN FEATURES

▷ **Integrated environment**

▷ **Easy to use specification language: object-oriented, C-like**

▷ **Sophisticated state-of-the-art solution techniques**

        Analytic solutions   Simulation
        steady state, transient, reward-based   "regular", rare event, fluid
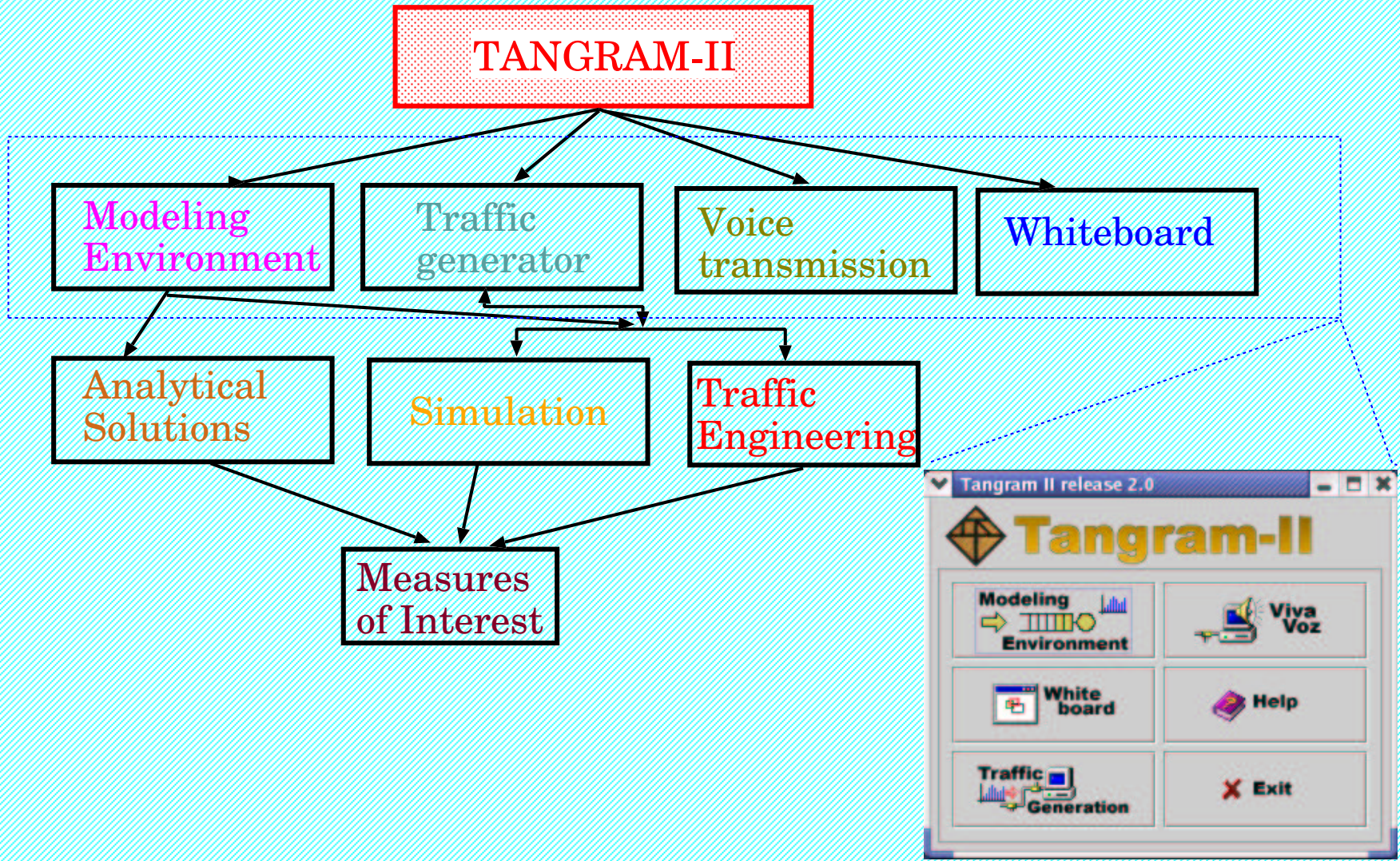   animation

▷ **Traffic engineering**

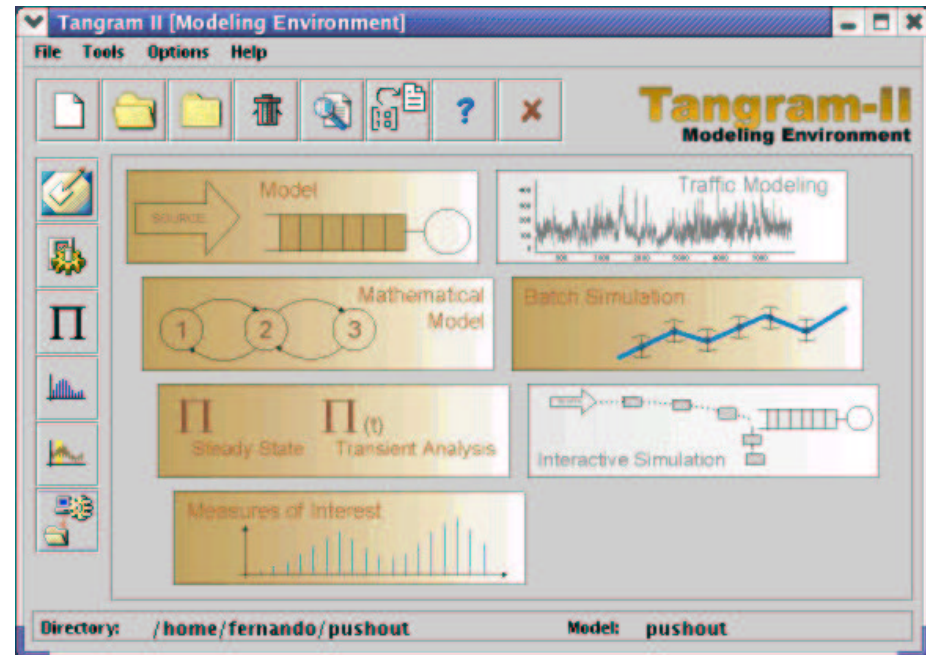▷ **Experimentation (active measurements) -> traffic generation**

▷ **Modular design -> include new modules**

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OVERVIEW OF TANGRAM-II
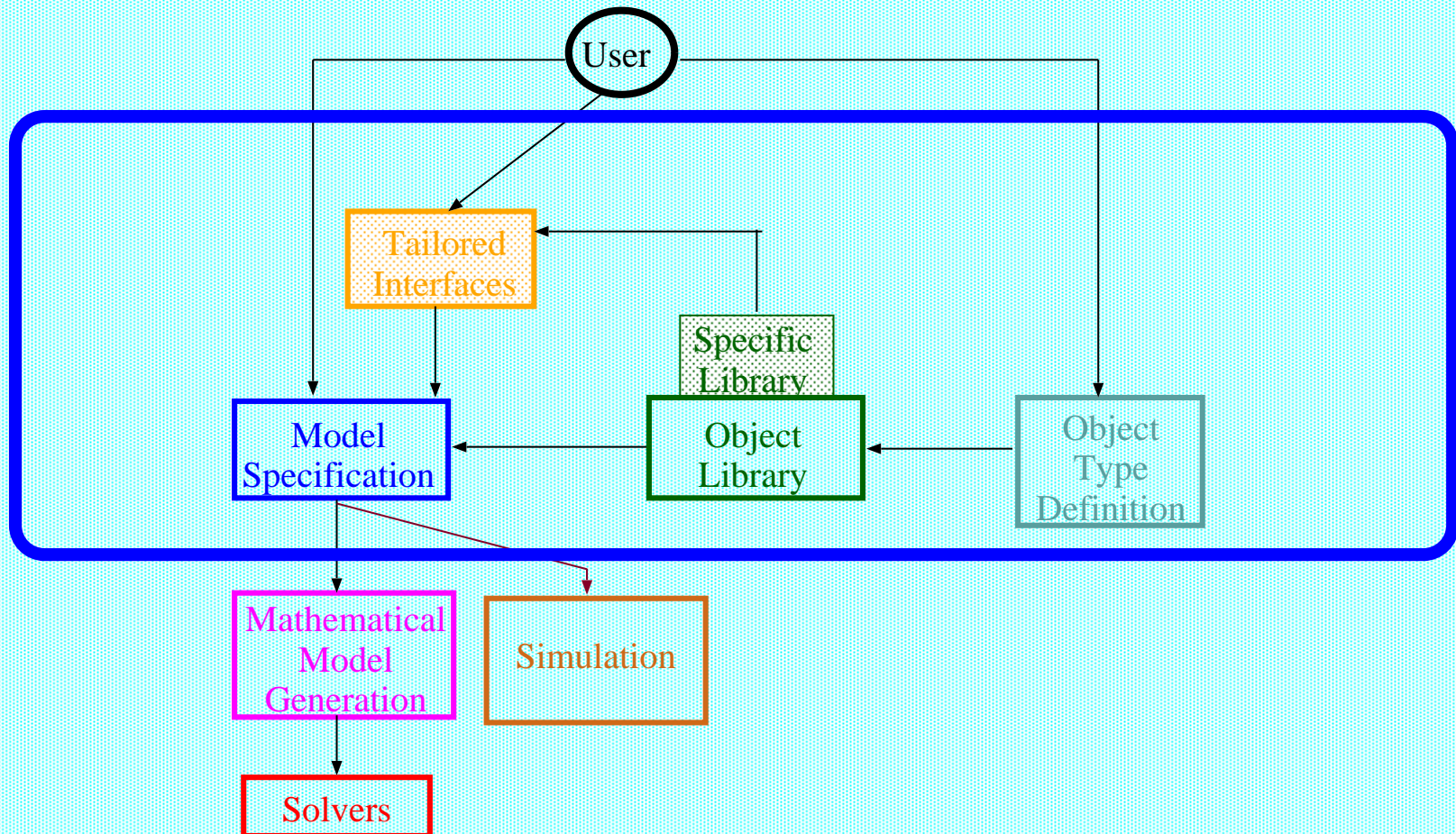
MODELING ENVIRONMENT

⇨ **Model specification**

⇨ **Model solution**

⇨ **Measures of interest**

- � Analytic solutions
  steady state, transient, reward-based

- ⇒ Simulation
  "regular", rare event, fluid, animation

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MODEL SPECIFICATION

User

Tailored Interfaces

Specific Library

Model Specification

Object Library

Object Type Definition

Mathematical Model Generation

Simulation

Solvers

MODEL SPECIFICATION

⇨ **Built on the top of TGIF (Tangram Graphics Interface Facility)**

⇨ **Modeling paradigm**

- The system is represented
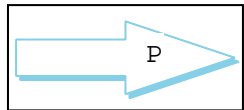 by objects which interact
  by sending and receiving
  messages

- The state of an object is represented by a set of buckets
  and the number of balls contained in each one

- The state of an object may be modified by an action that is
  taken after an event is executed or after receiving a message
  from another object

Model

OBJ 1 — M → OBJ 2
OBJ 2 — M → OBJ 4
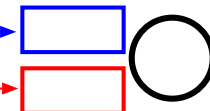OBJ 2 — M → OBJ 3
OBJ 3 ← M — OBJ 4

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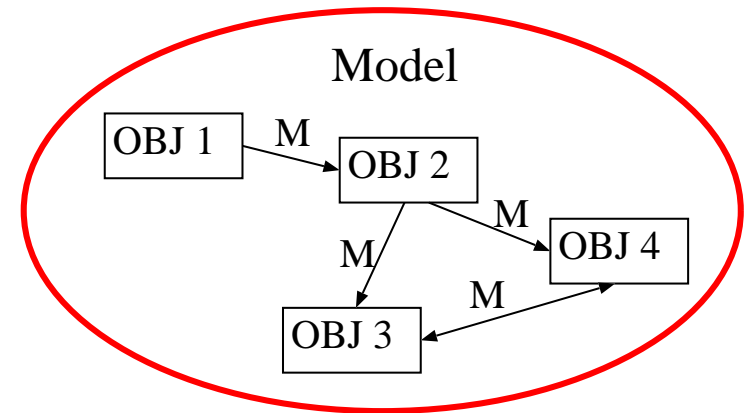
EXAMPLE

Este modelo representa um sistema com duas fontes Poisson e uma fila compartilhada com prioridades de atendimento e mecanismo de push-out.
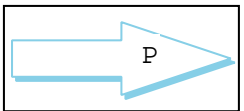
Poisson_Source1

```
                high_priority
      P
```

Server_Queue

```
msg_rec = port_in1
action = {
    /* Recebe o cliente da fonte 1 */
} : prob = 1-alpha;
{
    /* PUSH-OUT - Recebe o cliente da fonte 1,
       removendo cliente de menor prioridade
       se a fila estiver cheia */
} : prob = alpha;
```

State_vars=
  Queue1=0
  Queue2=0
  Cust_being_served=0

Poisson_Source2

```
                low_priority
      P
```

```
event = Packet_Generation(EXP, tx)
condition = (TRUE)
action=
{
    /* Envia mensagem para o servidor */
    msg(port_out, all, 0);
};
```

```
msg_rec = port_in2
action = {
    /* Recebe o cliente da fonte 2 */
    int q1, q2, total_q, cust_being_served;

    q1 = Queue1; q2 = Queue2;
    cust_being_served = Cust_being_served;

    total_q = q1 + q2;
    if (total_q < QUEUE_SIZE) {
        q2 = q2  + 1;
        if (cust_being_served == 0)
            cust_being_served = 2;
    }

    /* Modifica variáveis de estado */
    set_st("Queue2", q2);
    set_st("Cust_being_served", cust_being_served);
};
```

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SOLUTION METHODS

Steady State Analysis

Direct Methods

Iterative Methods

Non-Markovian models

GTH   block GTH   SOR   Jacobi Gauss-Siedel Power

SOLUTION METHODS

```
                        Transient
                         Analysis

         ┌──────────────────┼──────────────────┬──────────────┐

      Point           Expected                              Traffic
   Probabilities        Values          Distributions      Descriptors
 (exact, approx.)

     ┌──────┬──────┬──────┐          ┌──────┬──────┬──────┐
   Total    Mean   Lifetime  Total   Cumulative  Reliability  Operational  Cumulative
 accumulated time           time      time                    time        reward
  reward  to absorption      above a                                      (rates/impulses)
                             reward
                             level
```
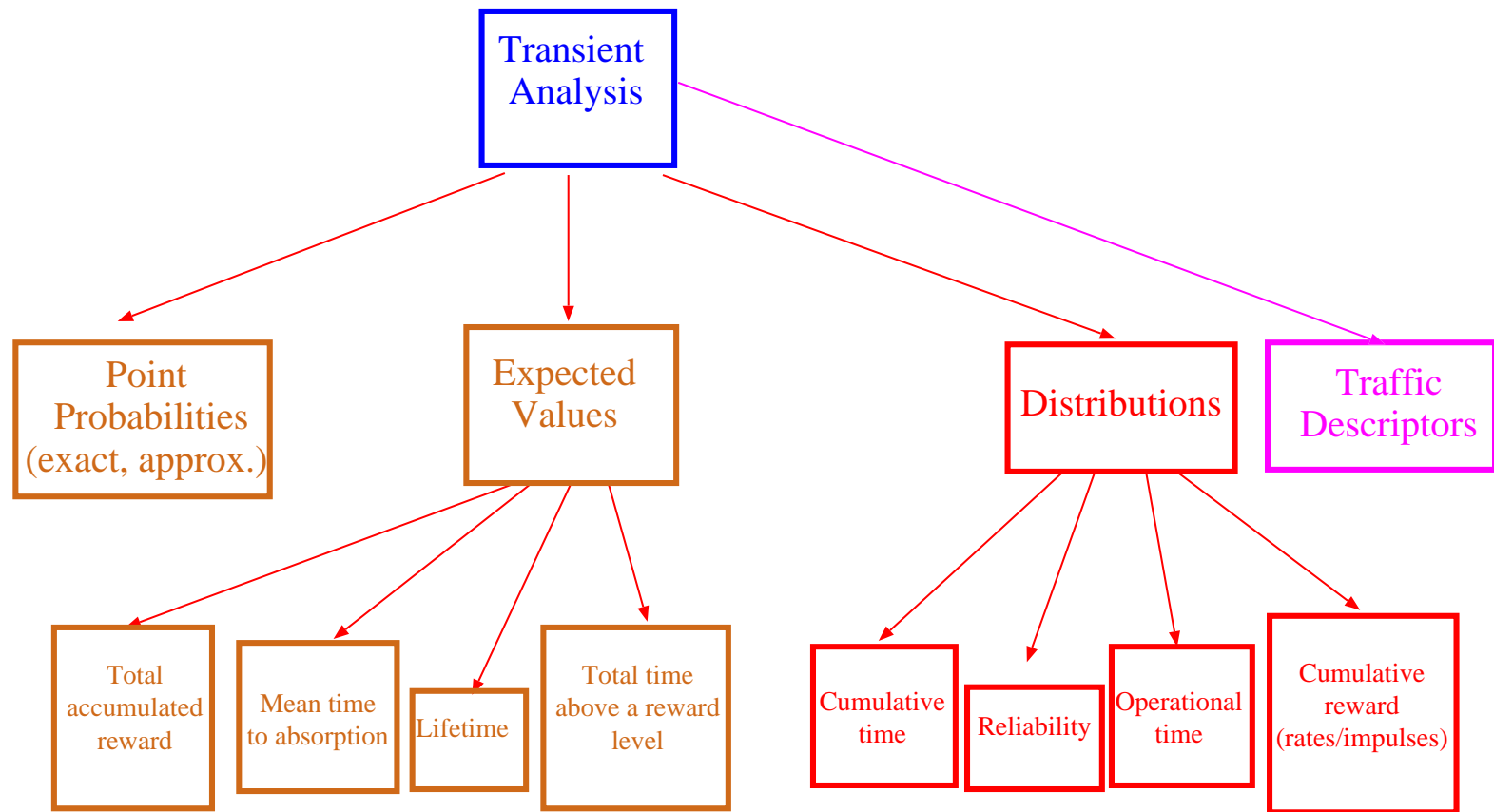
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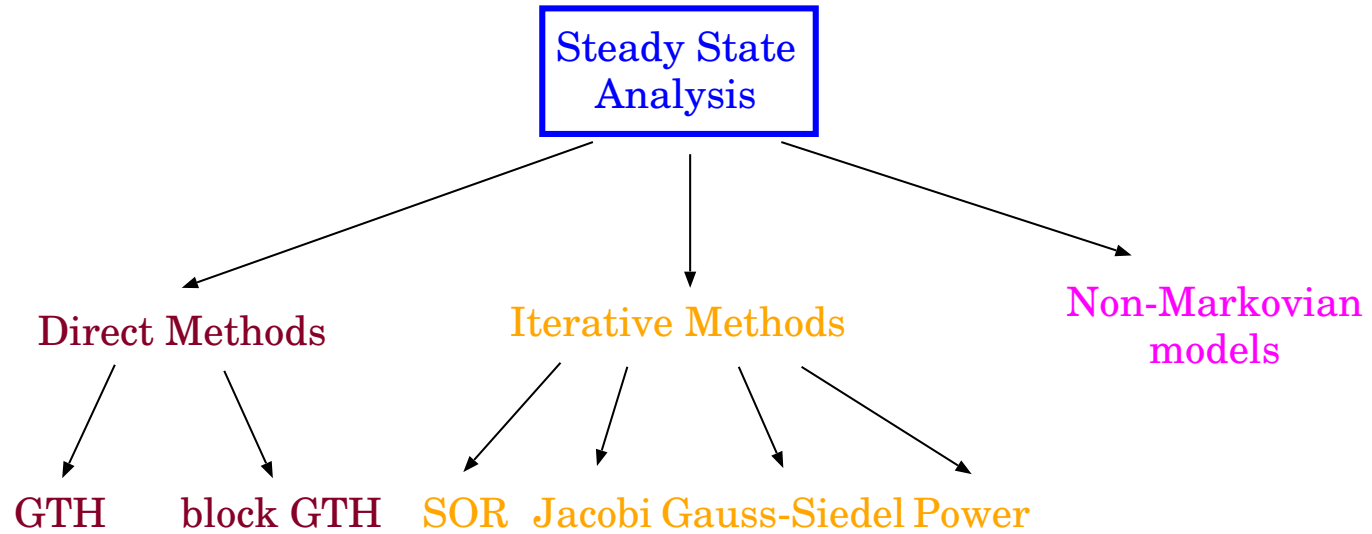
MATRIX VISUALIZATION

queue 2 PMF
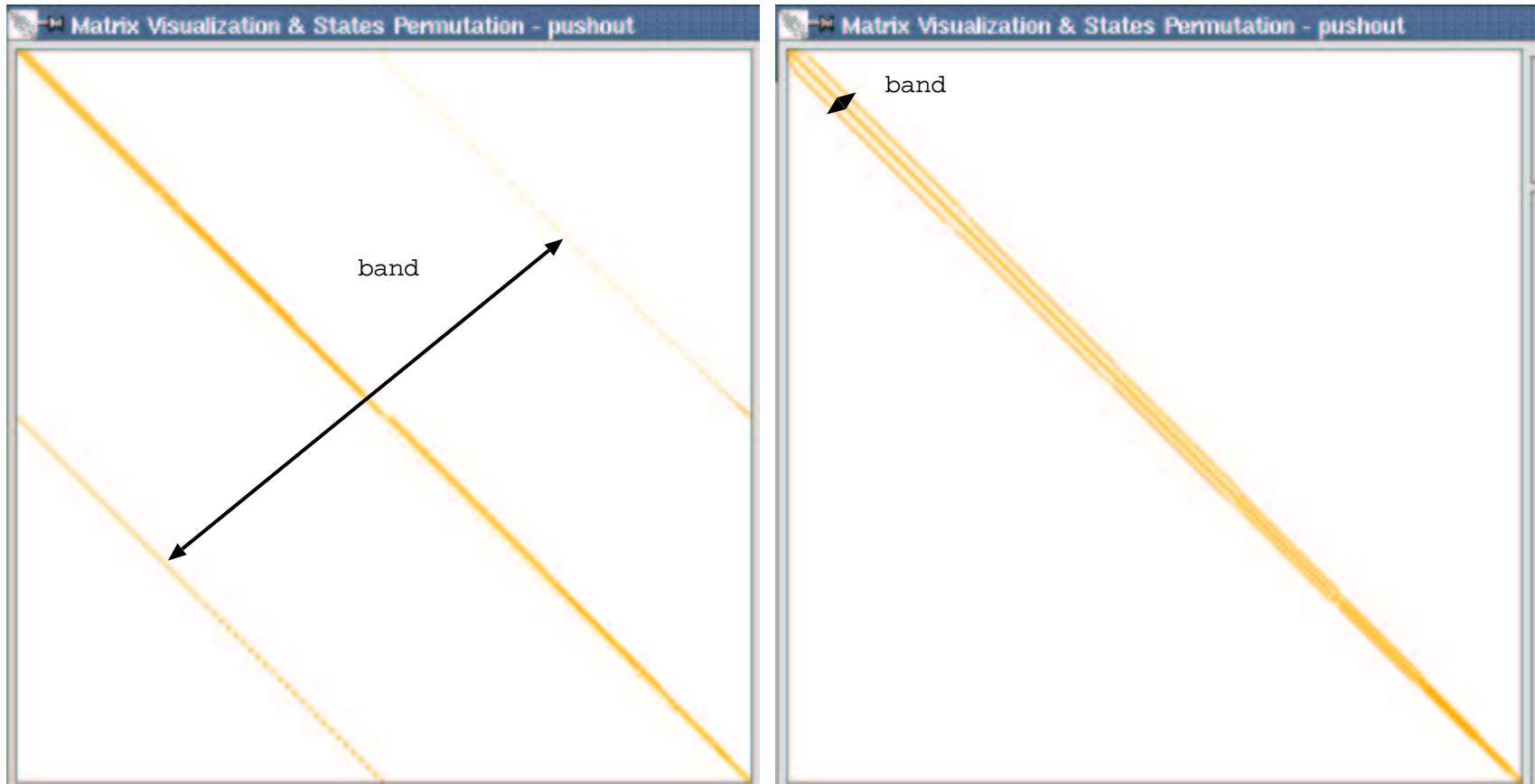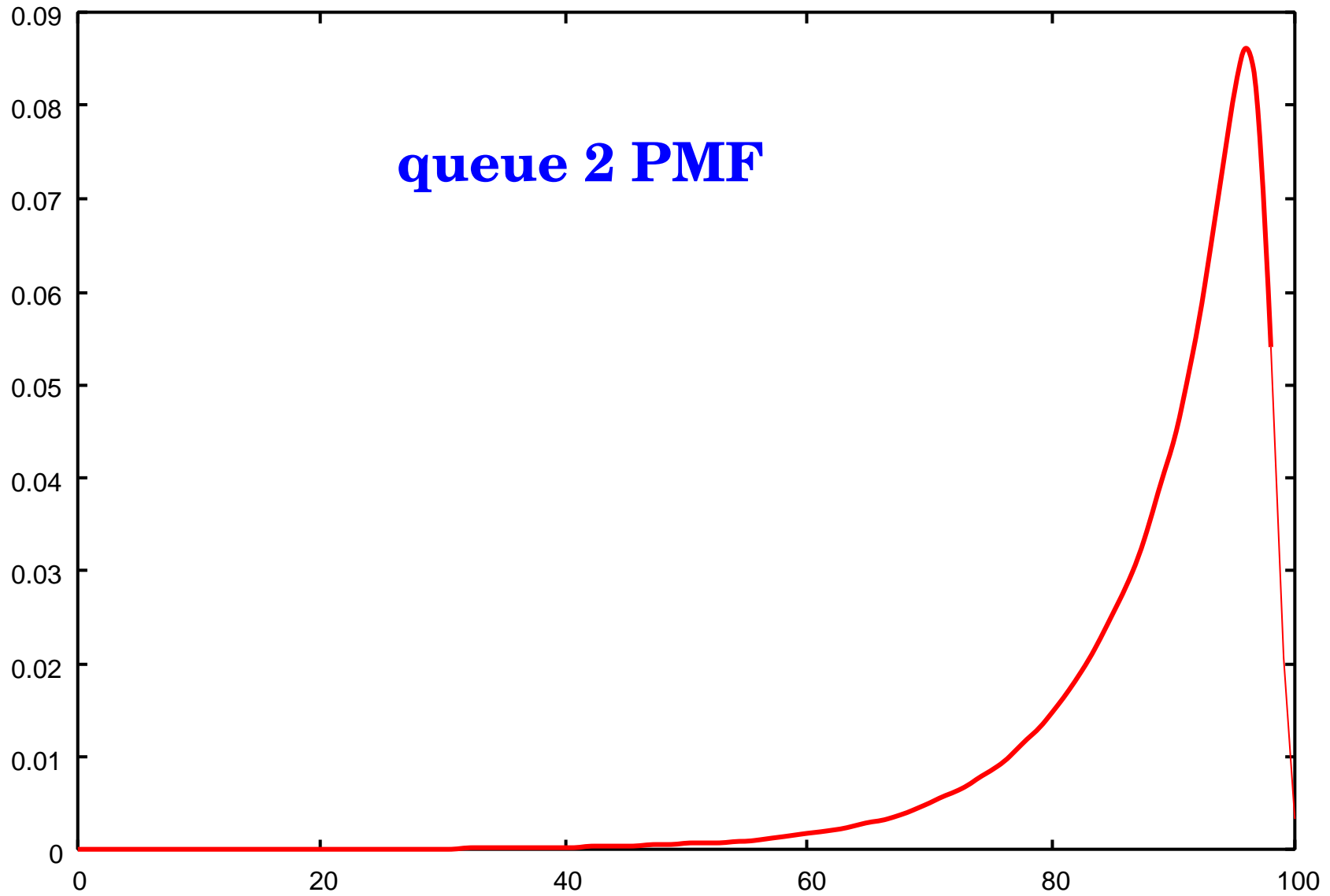
SIMULATION

➡ **Event driven simulation, rare event simulation, fluid simulation**

➡ **Same modeling specification language as analytical modeling + lots of extra features (check model)**

➡ **Other goodies:**

⊐ Different stop conditions

⊐ Confidence intervals
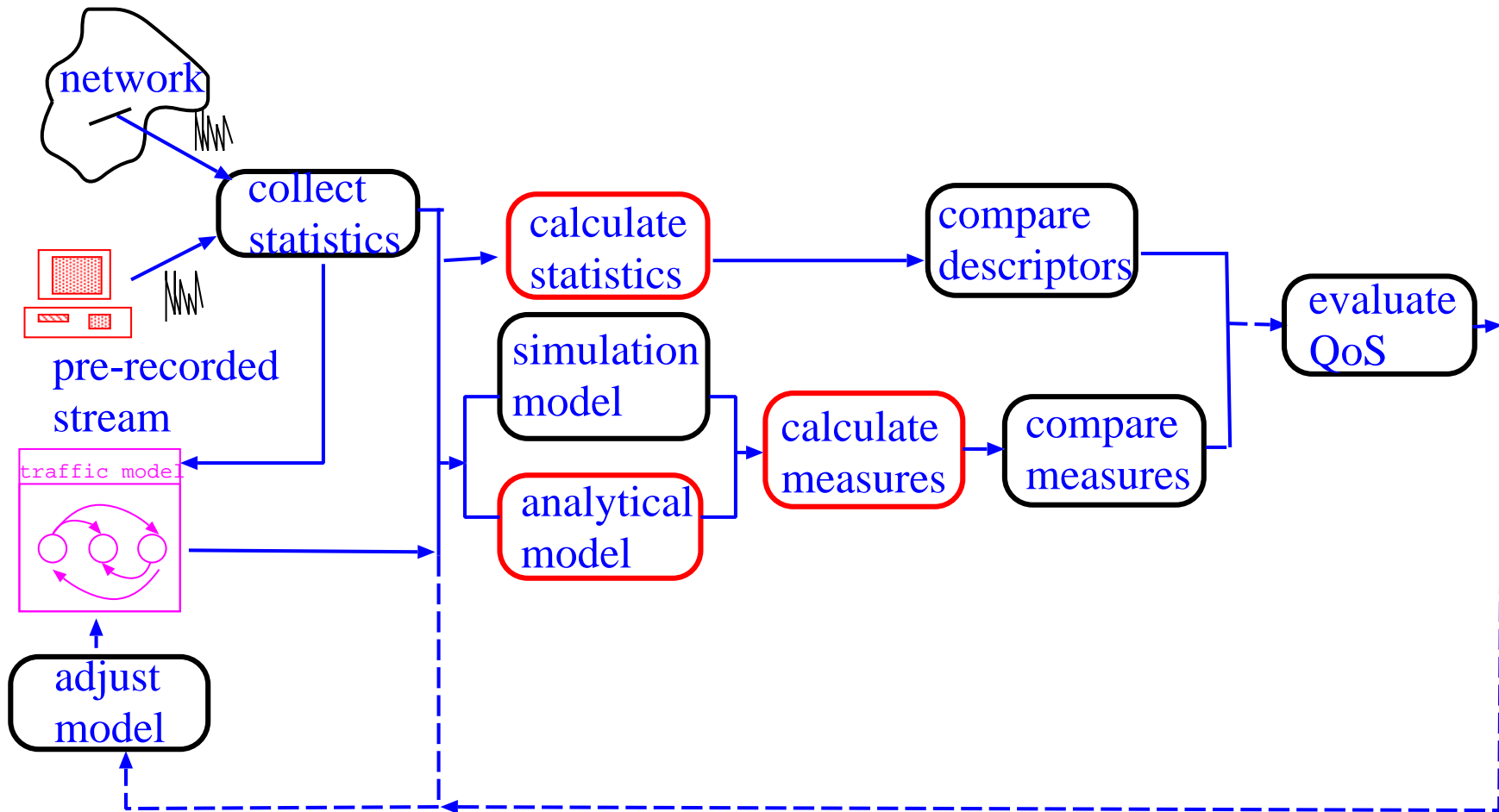
⊐ Interactive simulation

⊐ Animation

⊐ Read from real traces

⊐ Generate traces

⊐ Many distributions (including "long tail" distr.)

➡ **Notion of Reward -> measures of interest**

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TRAFFIC ENGINEERING

TRAFFIC ENGINEERING

name=Birth_Death
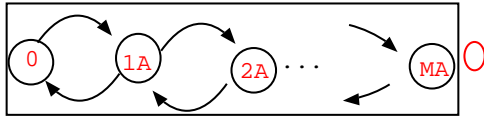
Initialization=
active_sources = 0
maximum = 20
alfa = 0.0712
beta = 0.1525
rate = 50
port_out = wire_1

Rewards=
 rate_reward=buffer
  bounds = 0, 4000
  condition= (active_sources> 0)
  value= (active_sources * rate) - C;
  condition= (active_sources == 0)
  value = -C;

Histogram model

Birth-Death model

Autocovariance

Time lag (ms)

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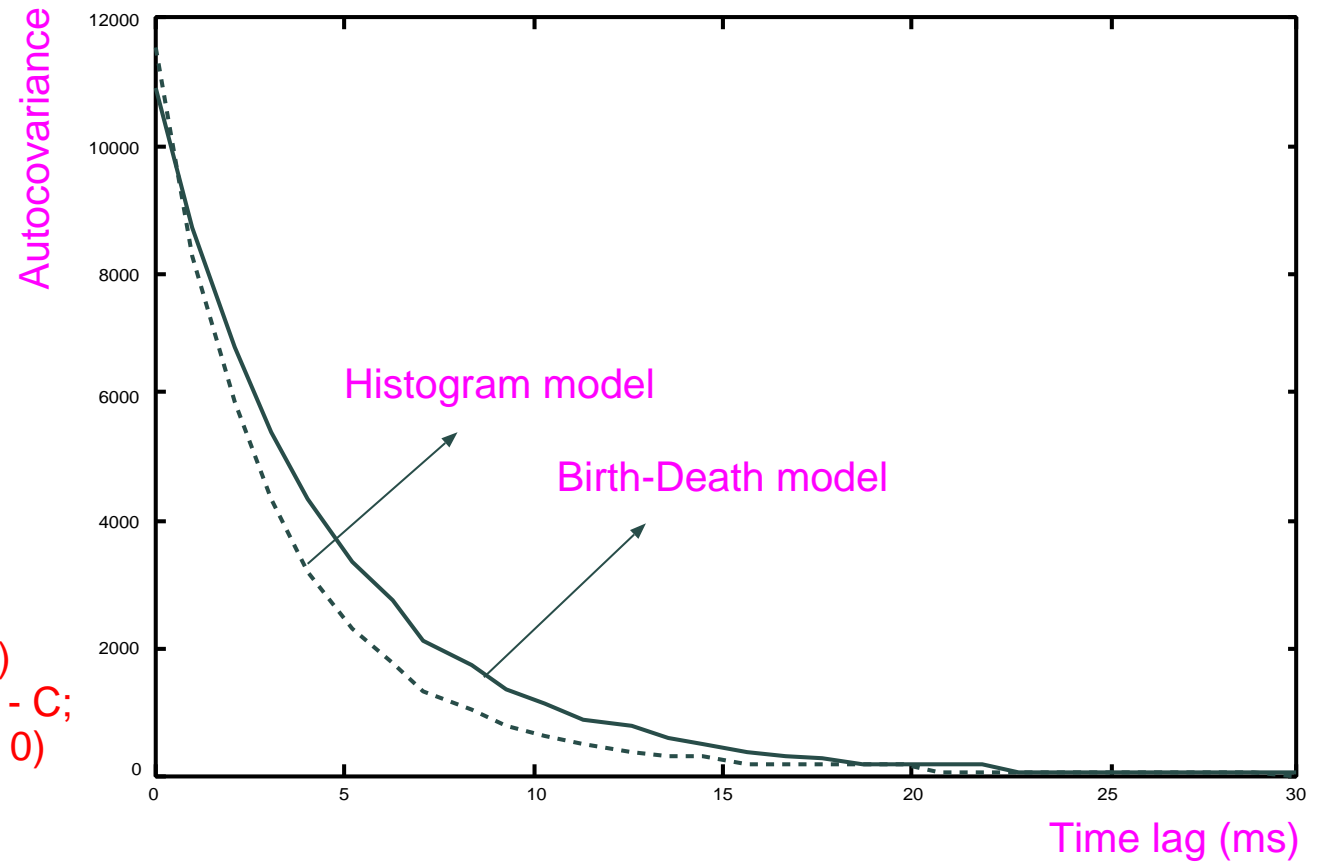
TRAFFIC GENERATION

⇨ **User can specify several traffic models to be generated (CBR, Traffic from models, traffic from traces)**

⇔ Analytical models

⇔ Burts:
- time between bursts (determ., expon.)
- number of bytes/burst
- packet size
- bursts are transmitted at board nominal rate

⇔ Trace file:
- time instant
- rate from the present instant till next
- warning if rate > capacity of the board

⇨ **IP, ATM**

TRAFFIC MEASUREMENTS

⇨ **Active measurements**

⇨ **Measurements:**

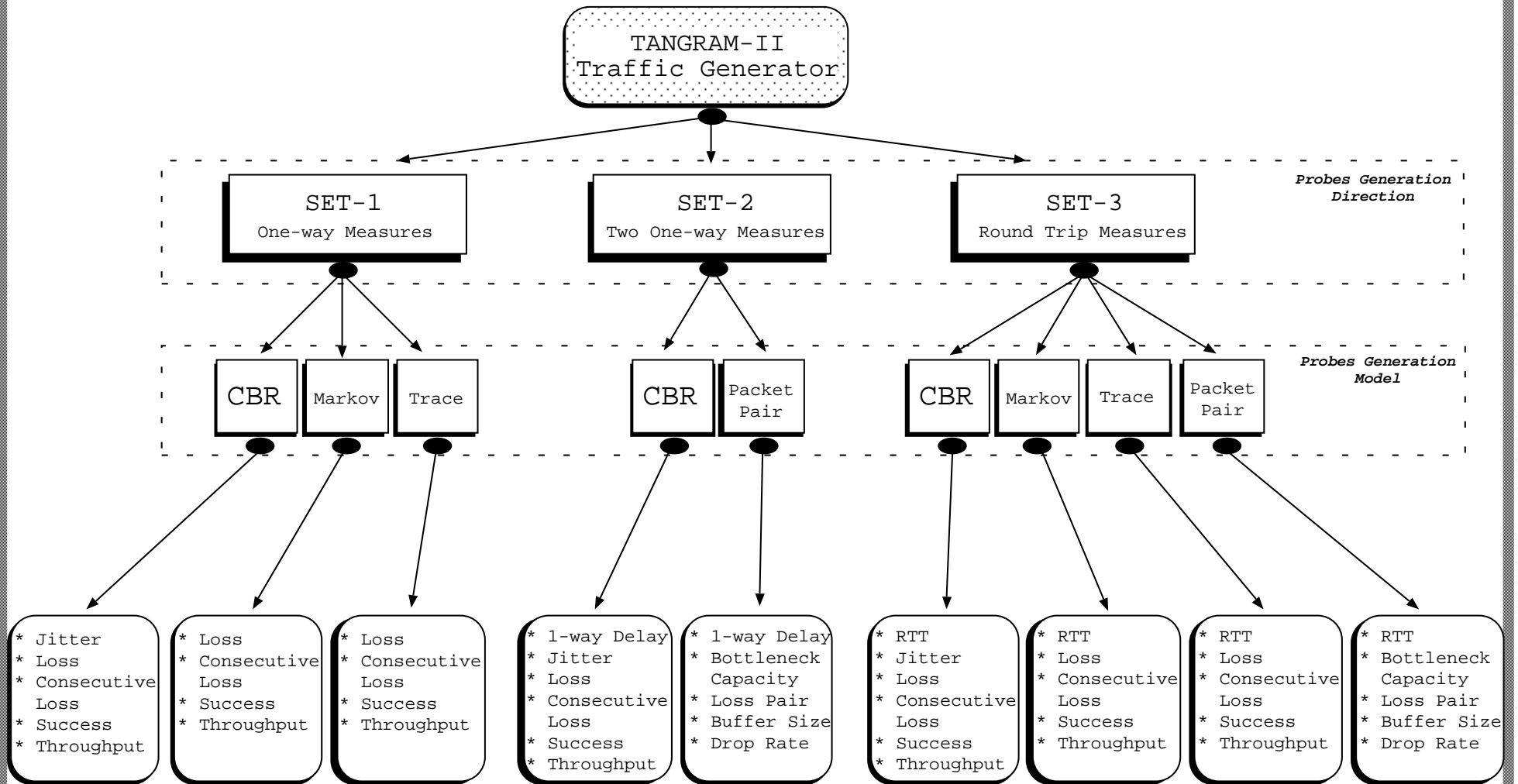- Jitter
- One-way delay
- Throughput
- RTT
- Loss measurements
- Capacity of the bottleneck

⇨ **State of the art algorithms**

TRAFFIC MEASUREMENTS

TANGRAM-II
Traffic Generator

| SET-1 One-way Measures | SET-2 Two One-way Measures | SET-3 Round Trip Measures | *Probes Generation Direction* |

Probes Generation Model

CBR — Markov — Trace — CBR — Packet Pair — CBR — Markov — Trace — Packet Pair

CBR (SET-1):
* Jitter
* Loss
* Consecutive Loss
* Success
* Throughput

Markov (SET-1):
* Loss
* Consecutive Loss
* Success
* Throughput

Trace (SET-1):
* Loss
* Consecutive Loss
* Success
* Throughput

CBR (SET-2):
* 1-way Delay
* Jitter
* Loss
* Consecutive Loss
* Success
* Throughput

Packet Pair (SET-2):
* 1-way Delay
* Bottleneck Capacity
* Loss Pair
* Buffer Size
* Drop Rate

CBR (SET-3):
* RTT
* Jitter
* Loss
* Consecutive Loss
* Success
* Throughput

Markov (SET-3):
* RTT
* Loss
* Consecutive Loss
* Success
* Throughput

Trace (SET-3):
* RTT
* Loss
* Consecutive Loss
* Success
* Throughput

Packet Pair (SET-3):
* RTT
* Bottleneck Capacity
* Loss Pair
* Buffer Size
* Drop Rate

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VIVAVOZ

⇨ **Routines to collect several statistics:**

- Jitter (expected value)

- number of consecutive packet losses
  - number of packets received between losses
  - packets out of order

- number of packets received between losses

- packets out of order

⇨ **Novel efficient algorithm for recovering lost packets**

⇨ **VVD**

  ⇨ **Experimentation (active measurements) -> traffic generation**

  ⇨ **Modular design -> include new modules**

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WHITEBOARD

⇨ **Every participant can modify the drawing canvas**

- ⇨ Implements a distributed algorithm for event ordering
  (based on a roll-back mechanism)

⇨ **Implements a reliable multicast library**

⇨ **Built on the top of a sophisticated graphic interface (TGIF)**

⇨ **Experimentation (active measurements) -> traffic generation**

⇨ **Modular design -> include new modules**

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WRAP-UP

➡ **A LOT of stuff**

➡ **We just scratched the surface**

➡ **Modeling + traffic engineering + measurements + tools**

➡ **Detailed manual, many examples, ...**

SEE DEMO

www.land.ufrj.br

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