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

Edmundo de Souza e Silva
Rosa M.M. Leão
Flavio Duarte, Fernando Silveira Filho, Bruno Ribeiro,
Ana Paula Silva, Kelvin Reinhardt, Jorge Allyson de Azevedo
Guilherme Jaime, Daniel Menasche, Antonio Augusto Rocha

Universidade Federal do Rio de Janeiro
COPPE/PESC, DCC/IM
OBJECTIVE

Main Goals

- Provide a flexible and integrated 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
INTRODUÇÃO

OUR LABORATORY

BIO Multimedia Server (UCLA, UFMG, UFRJ)

RIO Multimedia Server (UCLA, UFMG, UFRJ)

TANGRAM-II

WWW.land.ufrj.br

TGWB whiteboard

UFRJ, Bill Cheng

VivaVoz

VoIP tool

COMIT

real-time video tool

Modeling Environment

Analitic solvers

Simulators

Traffic Engineering

Traffic generators

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

- Traffic engineering

- Experimentation (active measurements) -> traffic generation

- Modular design -> include new modules
OVERVIEW OF TANGRAM-II

- Modeling Environment
- Traffic generator
- Voice transmission
- Whiteboard
- Analytical Solutions
- Simulation
- Traffic Engineering
- Measures of Interest
MODELING ENVIRONMENT

- **Model specification**

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

- **Measures of interest**
INTRODUÇÃO

MODEL SPECIFICATION

User

Tailored Interfaces

Model Specification

Specific Library

Object Library

Object Type Definition

Mathematical Model Generation

Simulation

Solvers

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

**EXAMPLE**

```
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;
    }
}
```

```
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);
}
```
SOLUTION METHODS

Steady State Analysis

- Direct Methods
  - GTH
  - block GTH

- Iterative Methods
  - SOR
  - Jacobi Gauss-Siedel
  - Power

- Non-Markovian models
SOLUTION METHODS

Transient Analysis

Point Probabilities (exact, approx.)

- Total accumulated reward
- Mean time to absorption
- Lifetime

Expected Values

- Total time above a reward level

Distributions

- Cumulative time
- Reliability
- Operational time

Traffic Descriptors

- Cumulative reward (rates/impulses)
MATRIX VISUALIZATION

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MEASURES

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
INTRODUÇÃO

TRAFFIC ENGINEERING

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network

collect statistics

calculate statistics

pre-recorded stream

simulation model

calculate measures

analytical model

compare measures

evaluate QoS

adjust model

compare measures

calculate descriptors
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;
User can specify several traffic models to be generated (CBR, Traffic from models, traffic from traces)

- Analytical models

- Bursts:
  - time between bursts (deterministic, exponential)
  - 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
- RTT
- Loss measurements
- Throughput
- Capacity of the bottleneck

State of the art algorithms
TRAFFIC MEASUREMENTS

TANGRAM-II
Traffic Generator

SET-1
One-way Measures
- CBR
- Markov
- Trace
- Jitter
- Loss
- Consecutive Loss
- Success
- Throughput

SET-2
Two One-way Measures
- CBR
- Packet Pair
- Jitter
- Loss
- Consecutive Loss
- Success
- Throughput

SET-3
Round Trip Measures
- CBR
- Markov
- Trace
- Packet Pair
- RTT
- Jitter
- Loss
- Consecutive Loss
- Success
- Throughput

Probes Generation
Direction

Probes Generation
Model
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
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
A LOT of stuff
We just scratched the surface
Modeling + traffic engineering + measurements + tools
Detailed manual, many examples, ...

SEE DEMO
www.land.ufrj.br