An Approach to the Analysis of Performance, Reliability and Risk in Computer Systems

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Introduction

- Evaluation of Computer Systems
- Performance
  - Comparing alternatives, Determining the impact of a feature or unit, System tuning, Identify relative performance, debugging performance, etc.
- Reliability
  - Formal Engineering: formal specification, formal verification, etc.
  - Comparing by graphs: Reliability, Risk, Fail mass, etc.
  - Analytics: Time to fail, Waiting time, Markov Chains, etc
  - Warranties
- Uncertainty Studies
  - Uncertainty statistics
  - Uncertain programming
  - Uncertain Risk and reliability
  - Fuzziness
- Some applications
  - ReliaSoft, Weibull, Sandra, etc.
  - From the Academic to the Industry: EMSI

The meaning of a Reliable Systen.

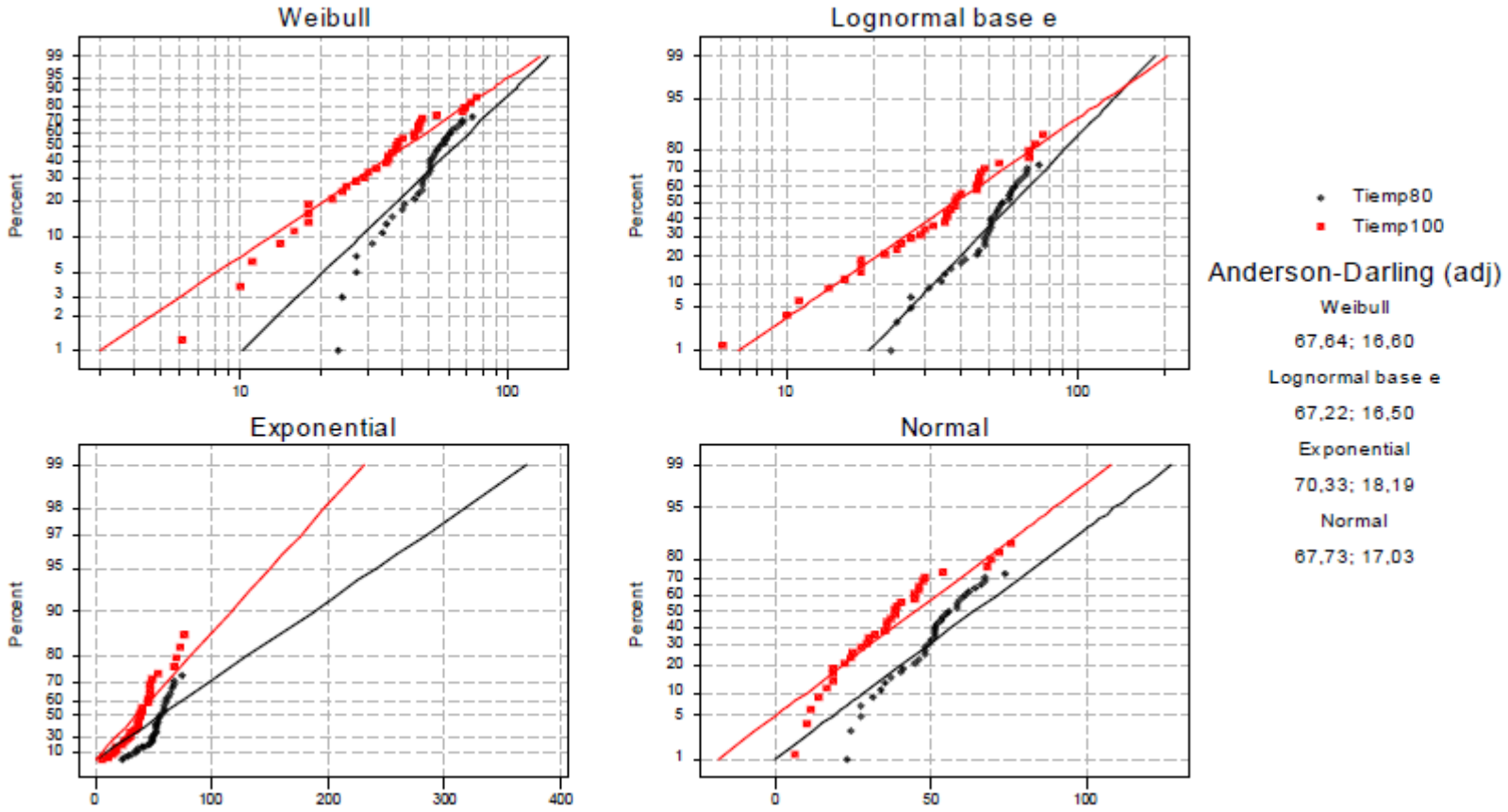
Reliability: "the ability of a system or component to perform its required functions under stated conditions for a specified period of time" (Wikipedia)

Reliability engineering for complex systems requires a different, more elaborated systems approach than reliability for non-complex systems / items. Reliability engineering is closely related to system safety engineering in the sense that they both use common sorts of methods for their analysis and might require input from each other. Reliability analysis have important links with function analysis, requirements specification, systems design, hardware design, software design, manufacturing, testing, maintenance, transport, storage, spare parts, operations research, human factors, technical documentation, training and more.

Most industries do not have **specialized reliability engineers** and the engineering task often becomes part of the tasks of a design engineer, logistics engineer, systems engineer or quality engineer. Reliability engineers should have broad skills and knowledge.

The meaning of a Reliable System

Classical distributions of Time to fail and their classification by AD method.



Figures by eMath Proyect Founded by MECD government of Spain

EMSI 2.0
First Configuration of a System

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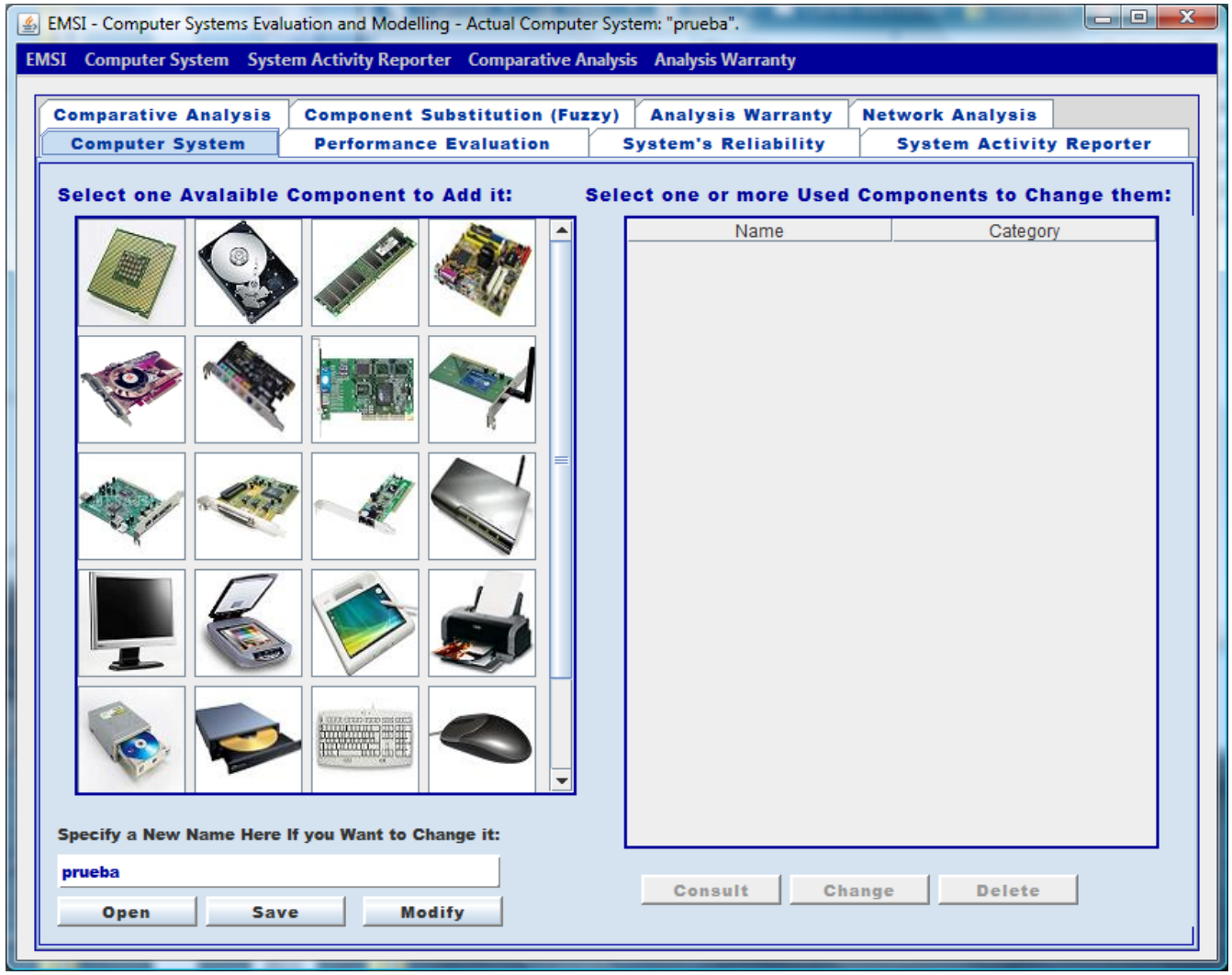
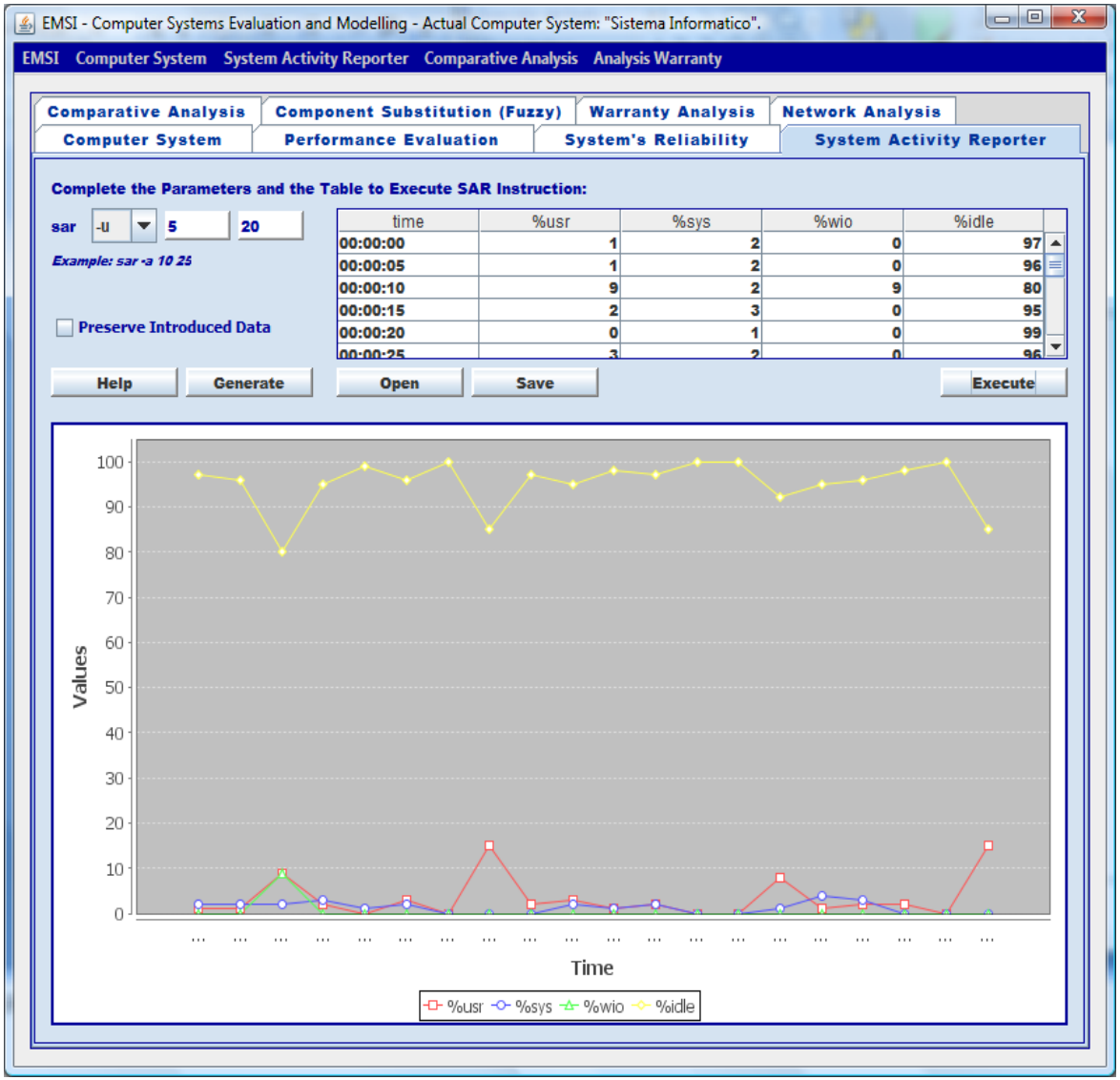
First Configuration of a System



EMSI 2.0
Monitoring and design

- System Activity Reporter Module
- Based on SAR
- Analytics and desing of new monitors with specific goals
  - LA triplets →load average processing
  - Time to fail modeling by Stochastics Process
  - Etc.

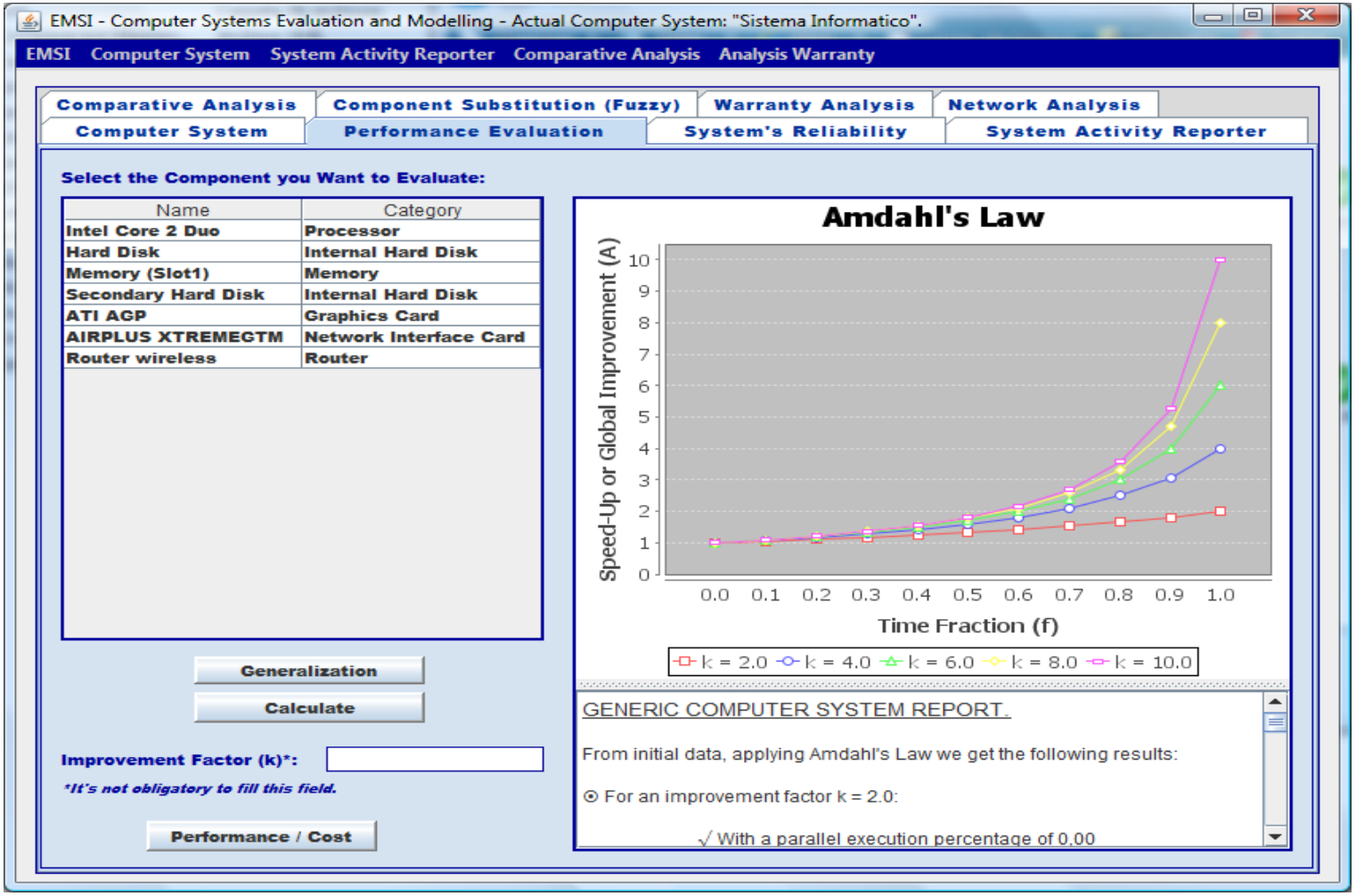
EMSI 2.0
Monitoring and design



EMSI 2.0
Performance Evaluation

- Time and load analysis by classical laws (Amdahl law, statistics distributions, etc.)
- Measure of speed and time execution
- Optimization
- Measure of isolate and global speed
- Reporting

EMSI 2.0
Performance Evaluation



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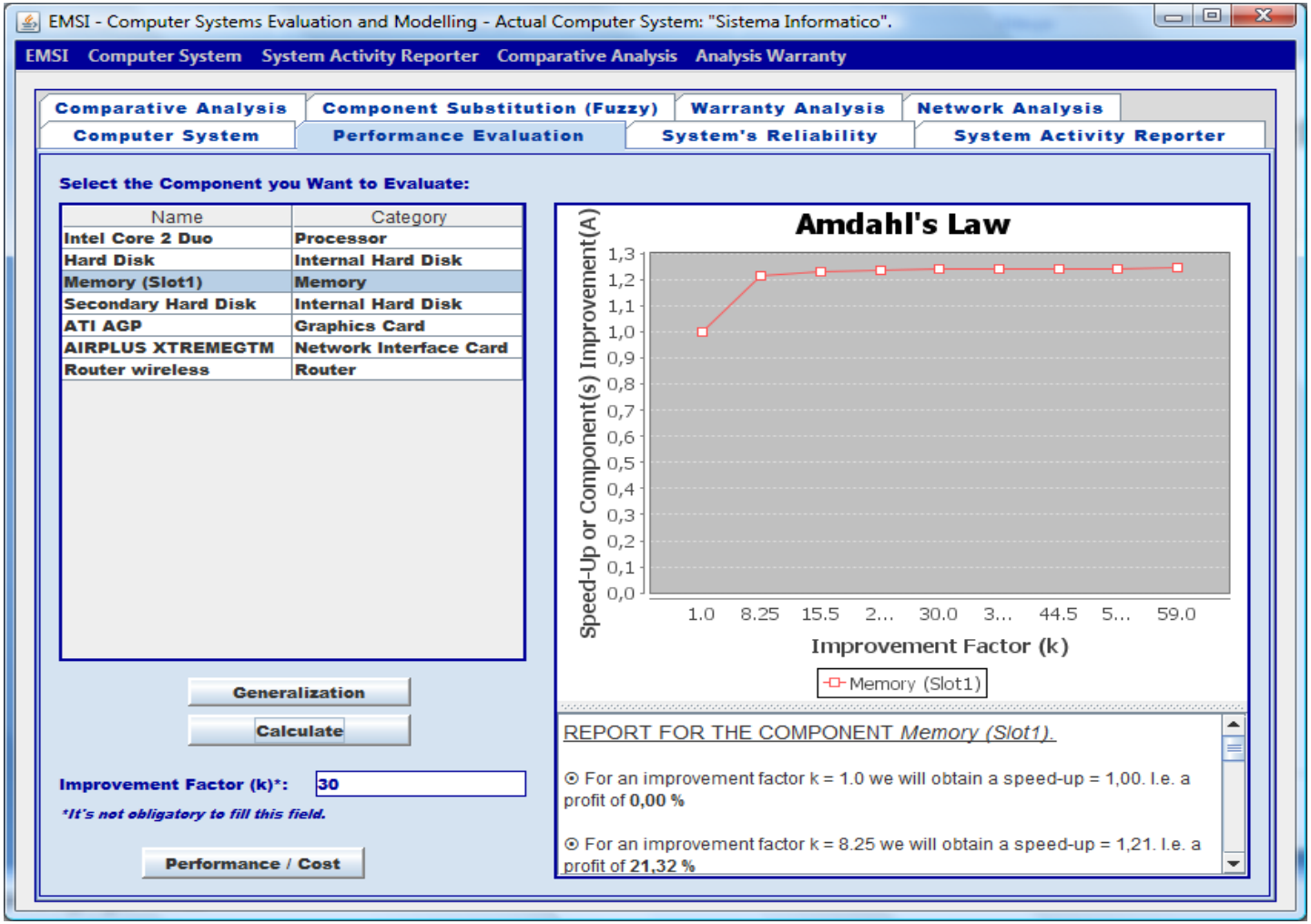
Performance Evaluation



EMSI 2.0
System Reliability

- Module ***"System's Reliability"***
- T = time to fail

  $\mathbf{R(t)=P\ (T > t) = 1 - F_T(t)}$,
- The user choose a suitable distribution per each device or the whole system
- 4 structures*
  - K paralel: $(R_{sist}(t)=1-(1-R_{dev}(t))^k$
  - K serial: $(R_{sist}(t)=(R_{dev}(t))^k$
  - K out of N: $(R_{sist}(t)=1-(1-R_{dev}(t))^k$
  - Other compositions, etc.
- EMSI provides playoffs by percentages and graphs

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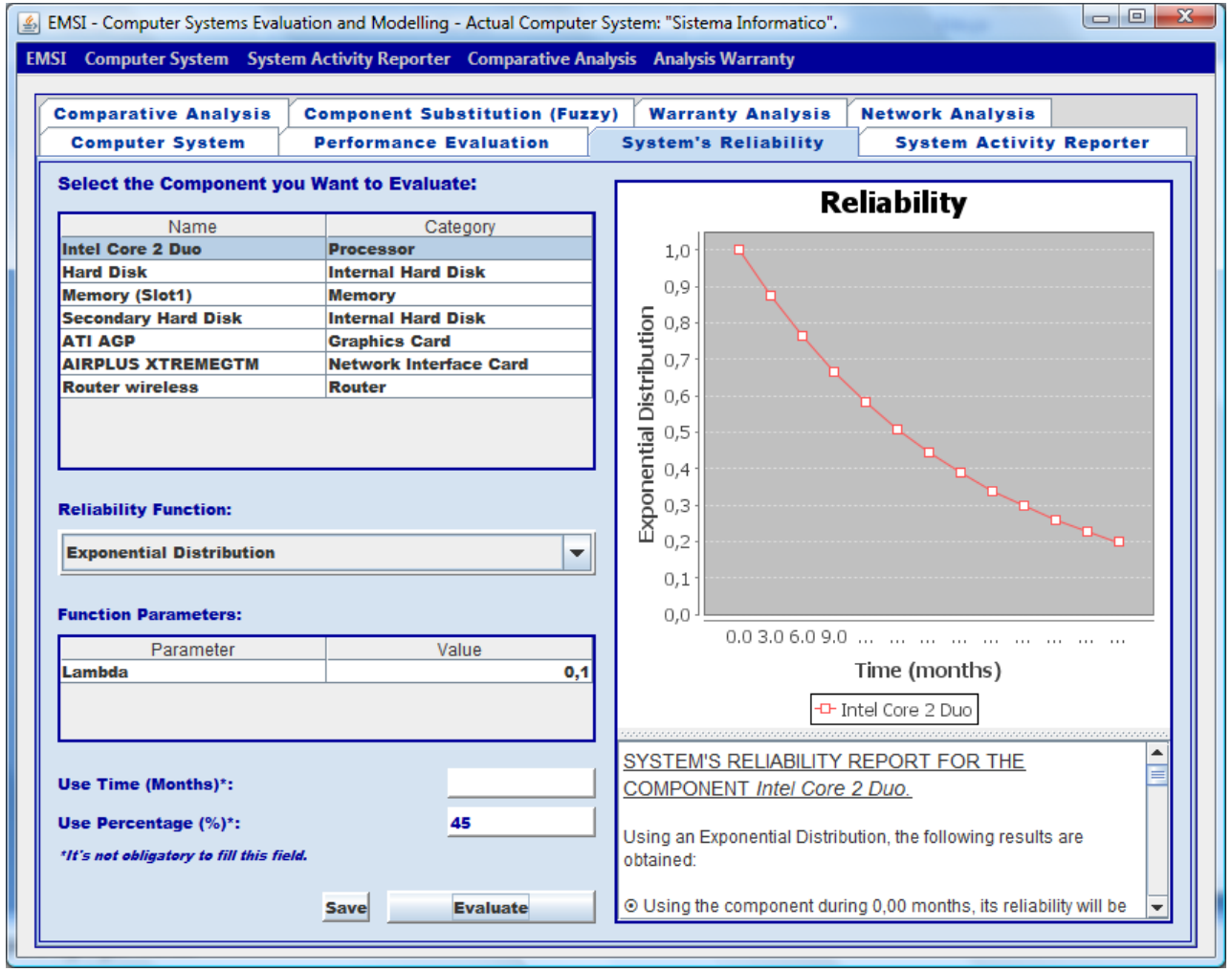
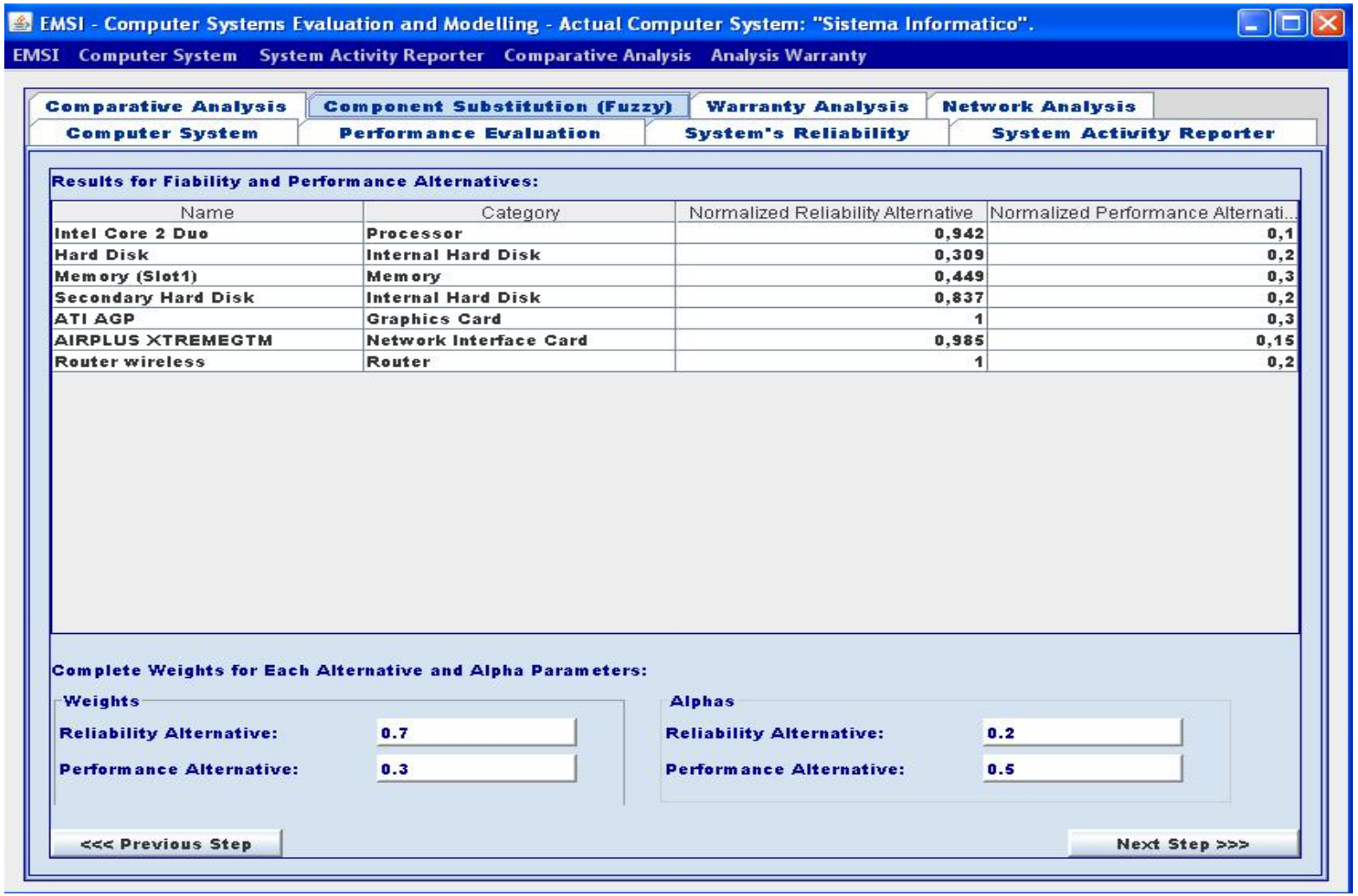
System Reliability



EMSI 2.0
Fuzzy Multi-criteria Decision Making

- Module ***"Component Substitution (Fuzzy)"***
- Reliability ⟷ Performance
- Expert decisions, Aid system
- MCDM (*Multiple Criteria Decision Making*).
  - First approach: Risk and Confidence Analysis for Fuzzy Multicriteria Decision Making. WANG, Wei; FENTON, Norman. *Knowledge-Based Systems, vol.* 19. (2006).
  - New approach: Fuzzy Multi-Criteria Group Decision Making Algorithm (D. Ruan et al.), Journal of Universal Computer Science, vol. 15, no. 1 (2010).

EMSI 2.0
Fuzzy Multi-criteria Decision Making



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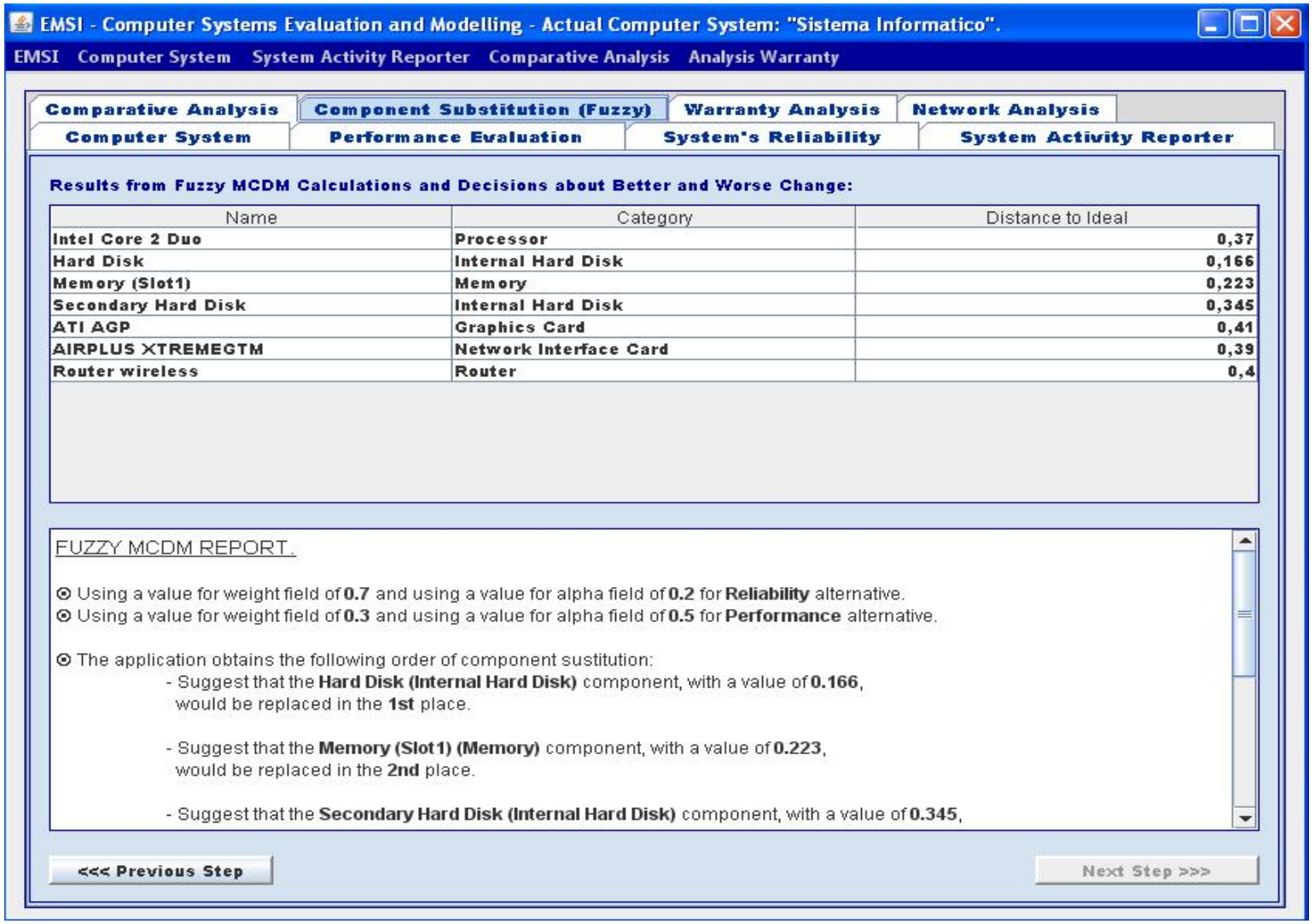
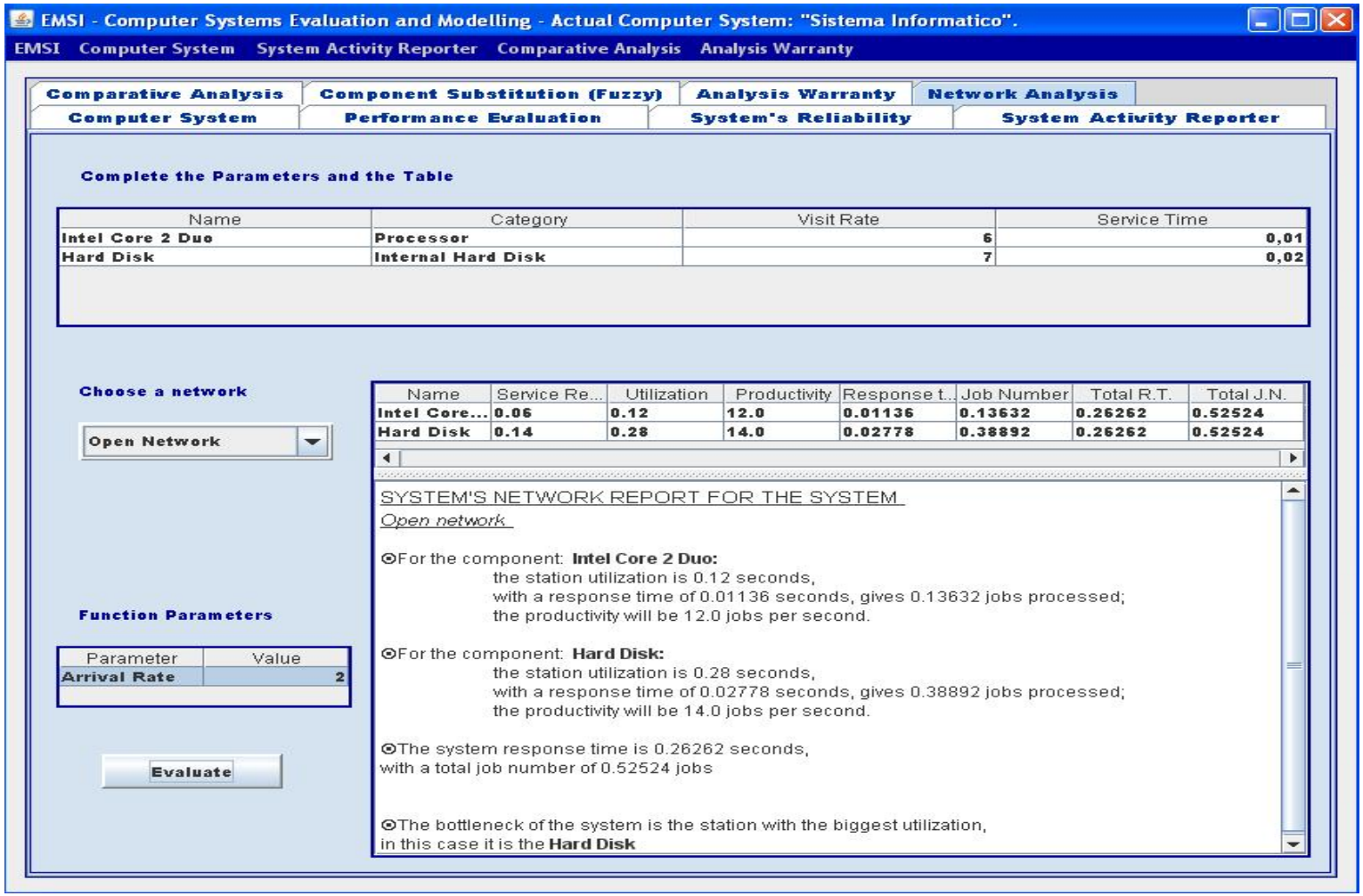
Fuzzy Multi-criteria Decision Making



EMSI 2.0
Operational Analysis

- Module "**Network Analysis**"
- Network analysis of transactional, interactive and batch systems
- Transport nets
  - Flow capacity, etc.
- Stochastic Processes and Markov Chains
  - Remaining Lifetime, Stopping times, Counting of events, etc.
- Performance results and reports

EMSI 2.0
Operational Analysis



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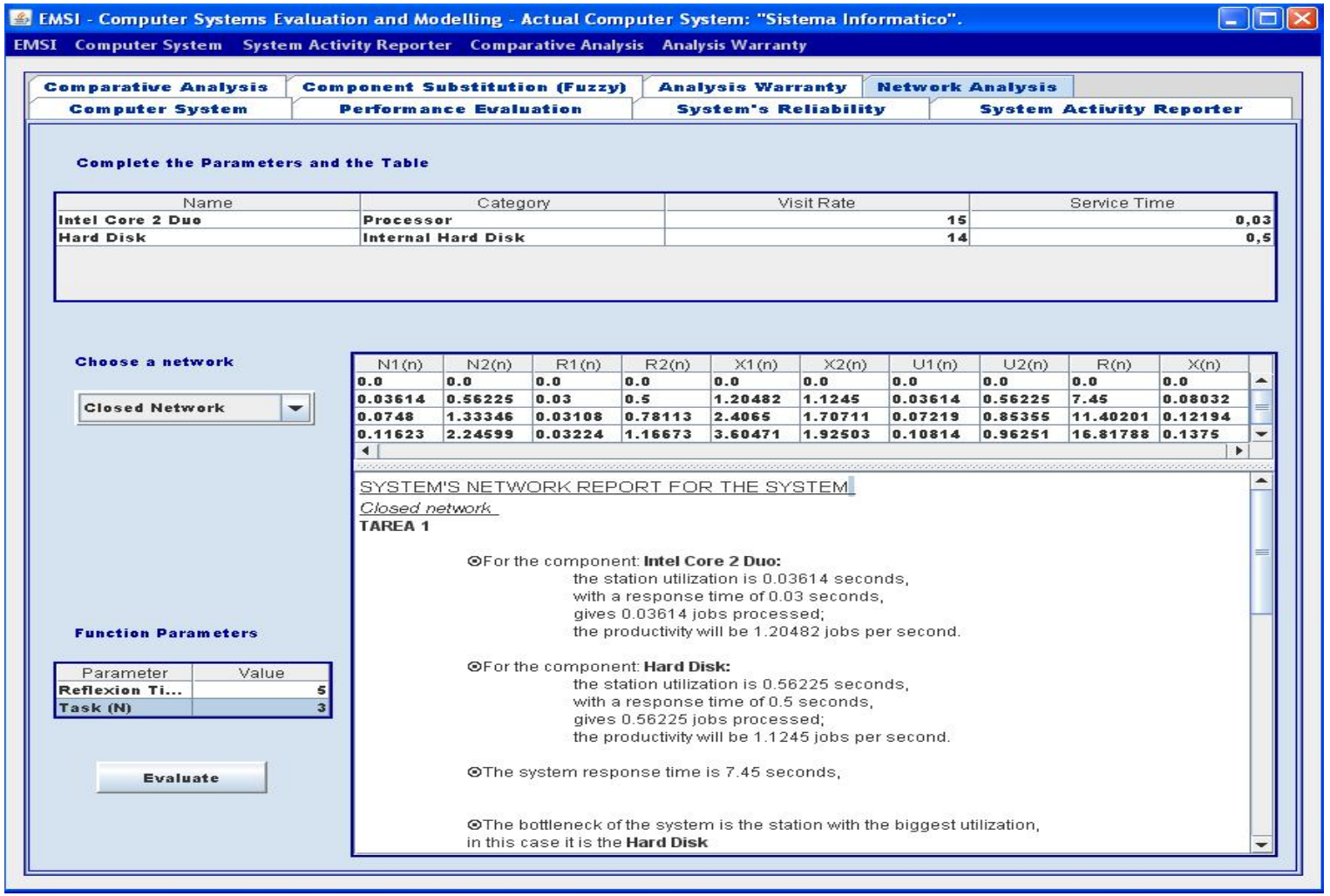
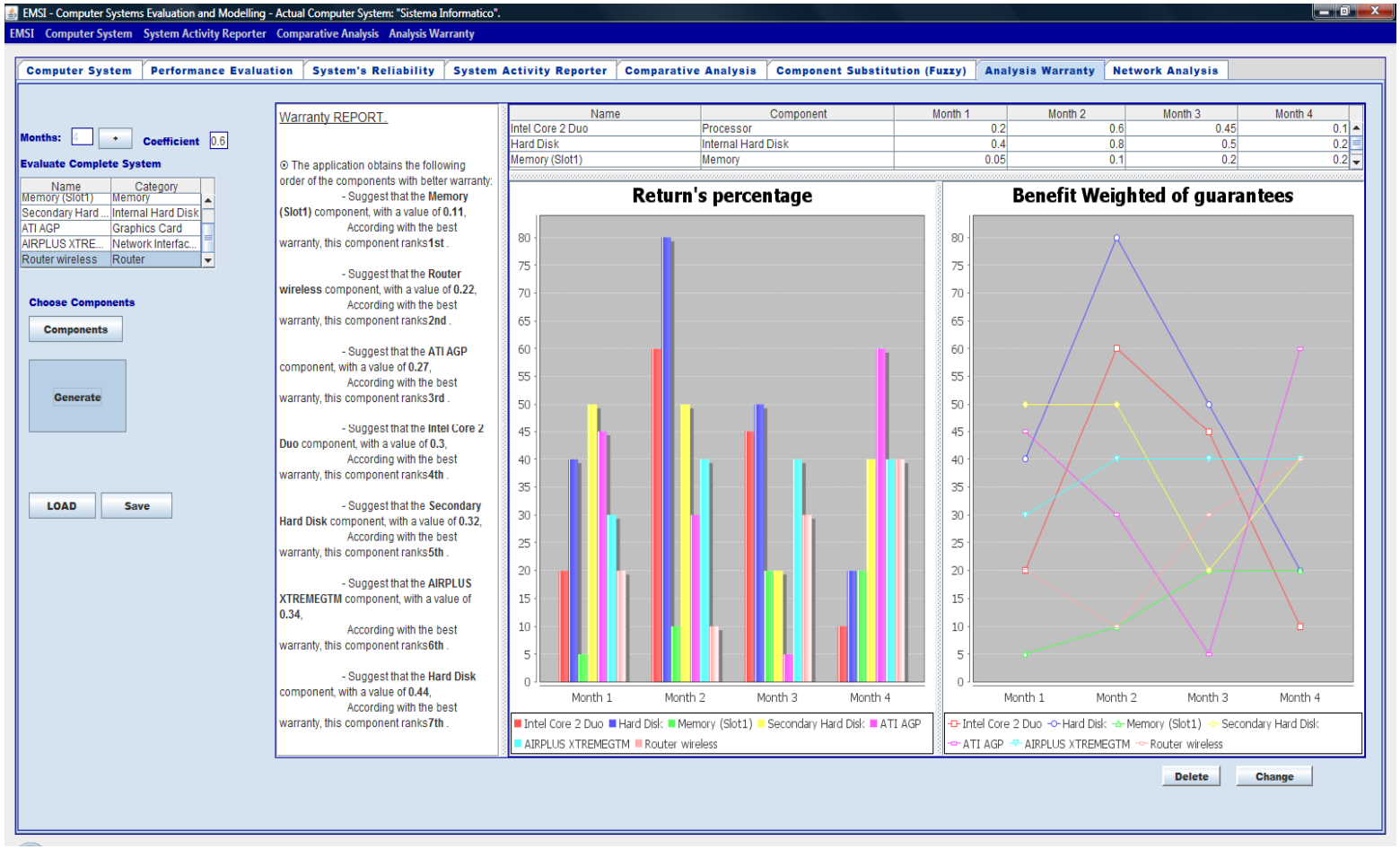


EMSI 2.0
Warranty Analysis

- Module **"Warranty Analysis "**
- Main goal: calculation of warranty period for any item: component or device.
- Uncertainty techniques for solving this evaluation (Hurwitz, and other related)

EMSI 2.0
Warranty Analysis



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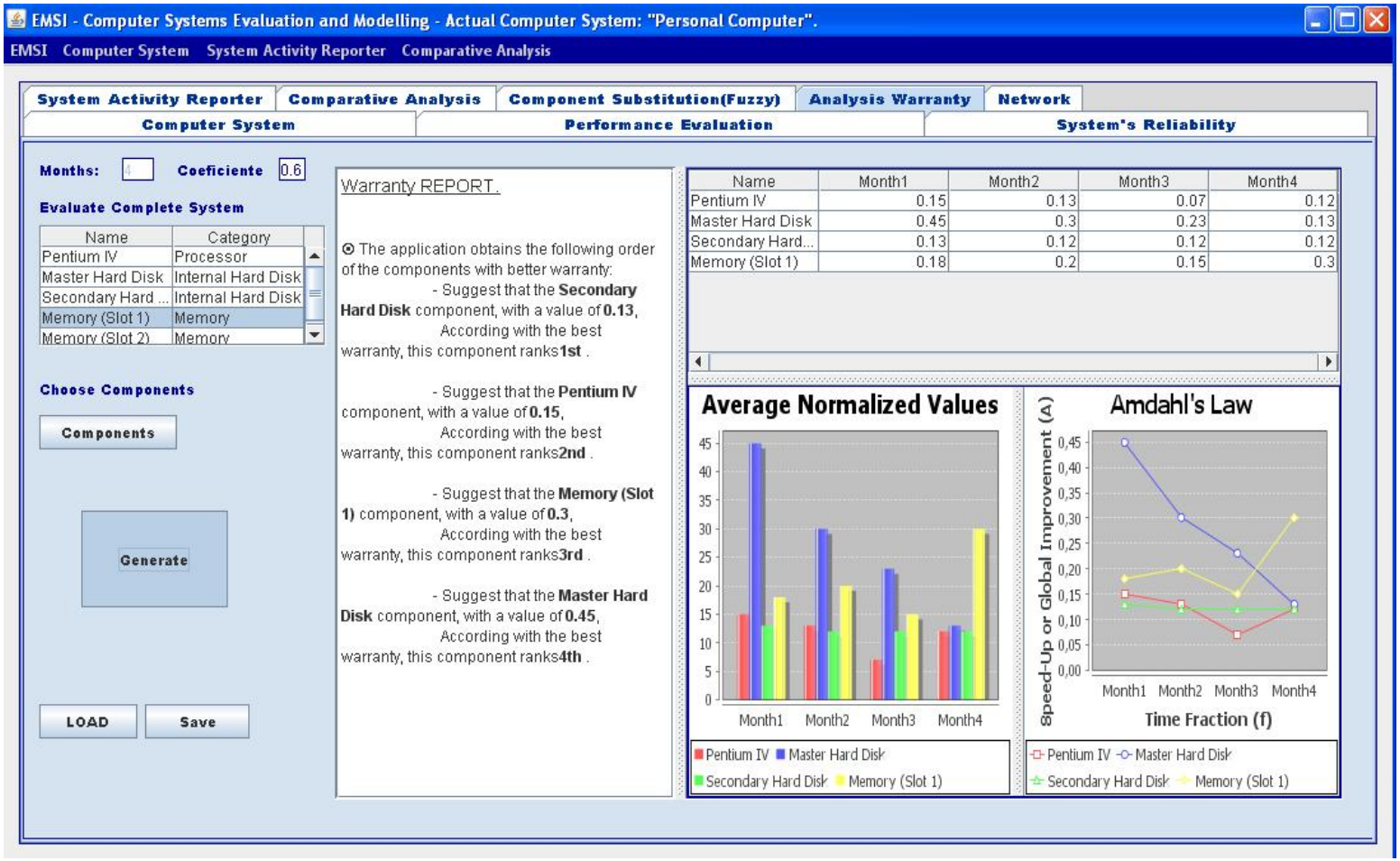
Warranty Analysis



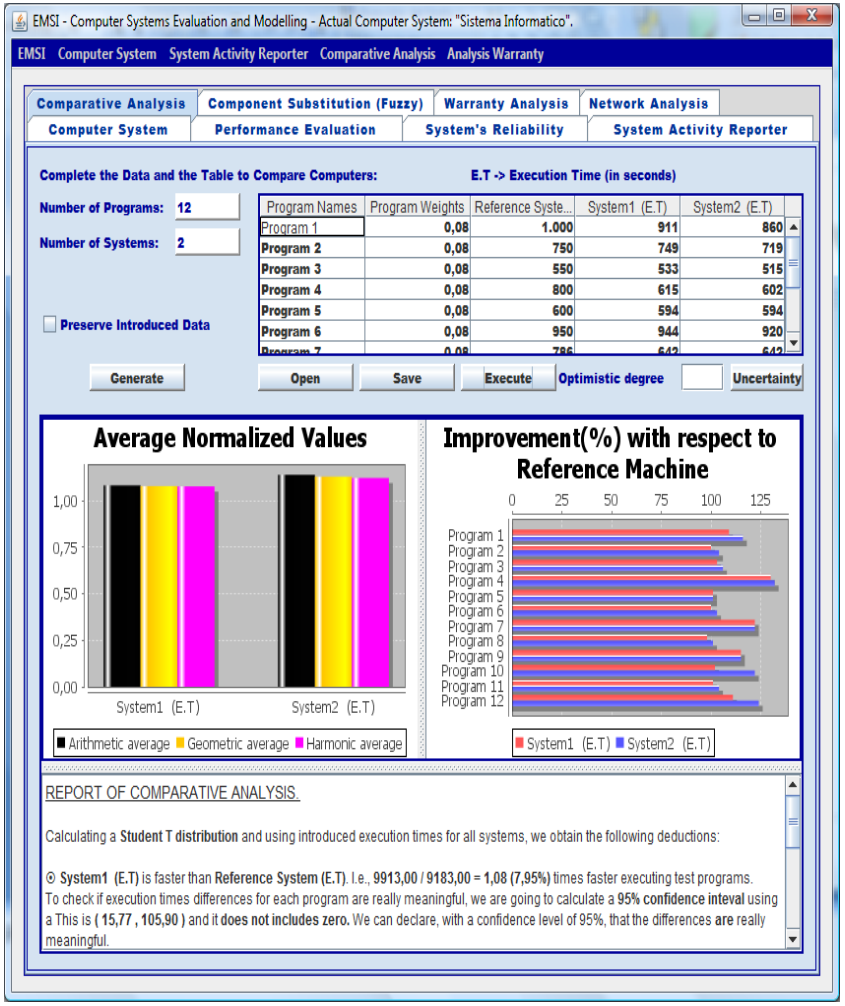
EMSI 2.0
Comparative Analysis

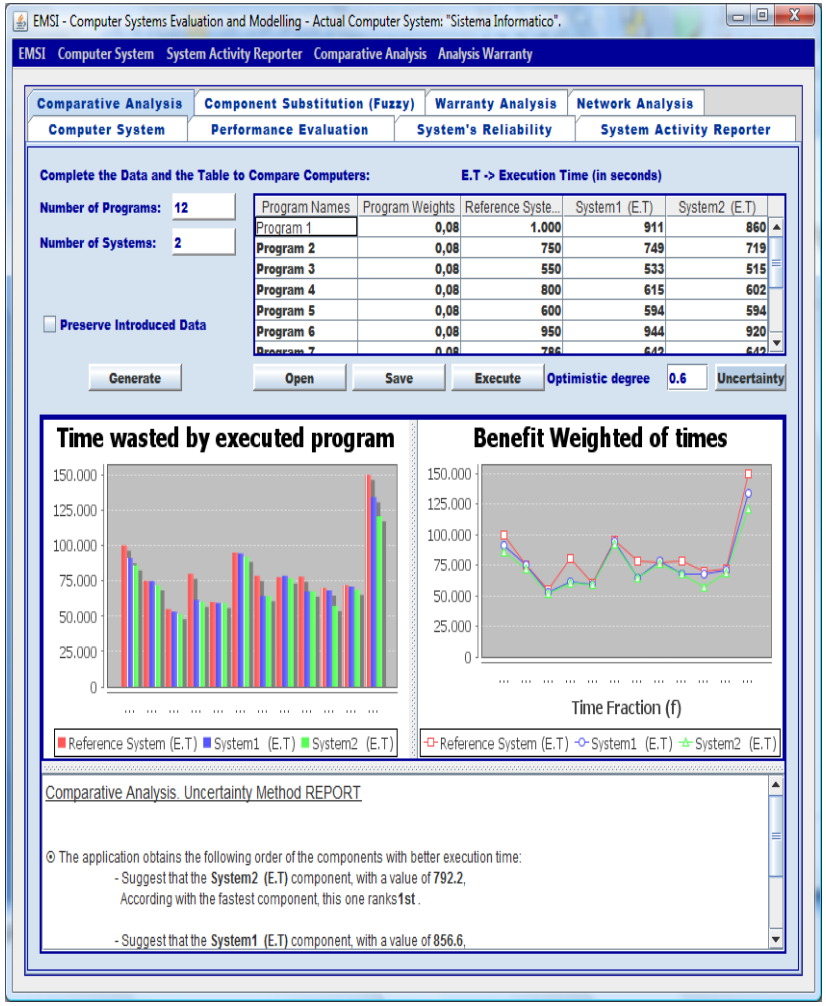
- Module ***'Comparative Analysis'***
- Avalaible for comparing two similar devices or two (or more) systems

Based on time of execution of a test set of procedures

- Measuring and comparing data (by monitoring)
  - Two ways: classical statistics techniques and uncertainty techniques

EMSI 2.0
Comparative Analysis





EMSI 2.0
Where we are and where we go

- Testing in labs of UCM
  - On mobile technologies and mobile devices
    - www.tecnologiaUCM.es
- At present, Academic use only
- Author tools for making e-learning tutorials (by TTS Knowledge Force)
- Professional use after some debugs and development of some functionalities:
  - Module "Formal Requirements" for checking all specifications of the system are running well.
  - Design of specific monitors to control the stability of the load.
  - Development of net structures at Reliability module
  - Evaluation of the binomial Reliability-Performance by FMCDM
  - Increase the functionality of Operational Analysis by adding some studies (already done on the paper) about the behavior of the task into the network and the network itself

- Thank you!