

USER'S MANUAL

*Software Architecture Risk Assessment
(SARA) Tool*

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USER'S MANUAL

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The User's Manual provides the information necessary for the user to effectively use the SARA Tool

1 GENERAL INFORMATION

This manual helps the user in 2 ways.

- When the user needs to use the tool for conducting risk analysis or producing architectural metrics of architectural description models and product line architecture models developed using UML. .
- When the user wants to deploy the tool in his PC .

To work with the SARA Tool the user needs to have architectural model artifacts developed using either StarUML or UML-RT model development tools.

1.1 System Overview

The SARA tool provides estimates for maintainability-based risk, reliability-based risk, and requirements-based risk. The tool also provides several of architectural level metrics related to size, coupling, and complexity. The tool extends our earlier Architectural-level Risk Assessment Tool (ARAT) by providing support for more architectural models such as Product line architectures It also provides different perspective of risk assessment other than reliability-based risk such as risk based on maintainability or requirements. The tool can be extended to support performance-based risk, and other forms of risk assessment at the architecture level.

The current version of the tool provides software developers and analysts with the ability to quantitatively analyze the following architectural risk factors

- Maintainability-based Risk
- Reliability-based Risk
- Requirements-based Risk
- Architectural metrics based on size, coupling, and complexity

1.2 Pre-requisites for the SARA Tool

This tool analyzes UML architectural models described using class diagrams, sequence diagrams, and state charts. The tool accepts architectural models from two different UML modeling tools, an open source tool, and a commercial tool. These tools are StarUML or UML-RT. StarUML is an open source UML model development tool [3] that supports the newly adopted UML 2 version of UML. UMLRT is a commercial UML modeling tool developed by IBM Rational that is suitable for developing and simulating UML models for real-time systems [4].

Models developed using StarUML can be extracted into XMI files which contain the model information. These xmi files can then be imported into SARA for conducting risk analysis. For UML-RT, we developed script code using a scripting language supported by UML-RT to extract the model information and produce a text file contain in the model information. This text file can then be imported into the tool for conducting risk analysis.

The SARA tool expresses several metrics and risk factors calculated from the imported UML models in terms of bar charts using a commercial tool called Espress chart Manager. This tool

needs to be installed before using the SARA for risk analysis. The tool can be down loaded and installed free for 30 days.

The possible inputs for the SARA tool are as follows:

- XMI file generated from StarUML containing architectural information (class diagrams, sequence diagrams and state chart diagram)
- .txt input file generated from UML-RT script containing architectural information (class diagrams, sequence diagrams and state chart diagram)
- .txt input file for Initial Change Probabilities (ICP) estimation(optional)
- Start Express chart Manager before running the SARA Tool. This is the commercial tool used for visualizing the analysis results using bar charts.

1.3 Repository set up before starting with tool

1. Place the directories “khader” and “input” provided along with the tool in the C: directory.

For the methodologies used in the implementation of the SARAT please refer to the references provided in [1].

2 Overview of the Steps supported by SARA

This section briefly describes and depicts graphically the steps and overall flow of data in the SARA Tool. We describe briefly the user-oriented steps and the description of the method used to store and maintain data.

Figure 1 shows a diagram of the steps and the data flow supported in the tool. These steps are briefly described as follows:

Step 1: The initial step is uploading the input files.

For Maintainability Risk analysis of UML models developed with the StarUML, the input files needed are as follows:

1. An XMI file exported by StarUML containing the architecture model description based on sequence diagrams, class diagrams and state charts.
2. A text file .txt file prepared by the user which contains the error or change reports of the components of the architecture (optional). This file is optional since the tool provides analysis based the worst case where all components will changes with probability one.

For reliability-based risk analysis and requirements-based risk analysis of UML RT models, the following input file is needed:

1. A text file produced by UML-RT script that contains the architecture description based on sequence diagram, class diagrams and state charts. There are two

different scripts in UML-RT that can be used to produce the text file, one for reliability-based risk analysis and one for requirements-based risk analysis

Step 2: Preprocessing the data model

In this stage the imported data file is parsed to extract the elements of the architectural model .

Step 3: The extracted data is used to compute the metrics. So the data is stored into the file system repository maintained by the tool.

Step 4: Change Propagation Analysis

The Change Propagation Metrics are computed by using the extracted data stored in the repository.

Step 5: Size of Change Analysis

The Size of Change Metrics are computed by using the extracted data stored in the repository.

Step 6: Initial Change Probability

The number of components present in the design model are extracted from the previous step. Here we have three options.

1. parsing the .txt input file for change or error reports and computing the Initial change probabilities(ICP). Adaptive ICP is computed using change reports and Corrective ICP using error reports.

2. setting the ICP by the user by checking one of the following options:
 - a. worst case scenario i.e. setting to 1.0
 - b. accepting user direct input
3. Parsing the state chart diagram data from XMI input file and computing Cyclomatic Complexity. Use this data in place of ICP

Step 7: Maintainability Risk

Finally Maintainability Risk factors are computed using the research methodology described by Walid Abdelmoez in his Ph.D dissertation [2]. The risk factors are displayed for each component and are shown in bar chart using the espress chart in tool.

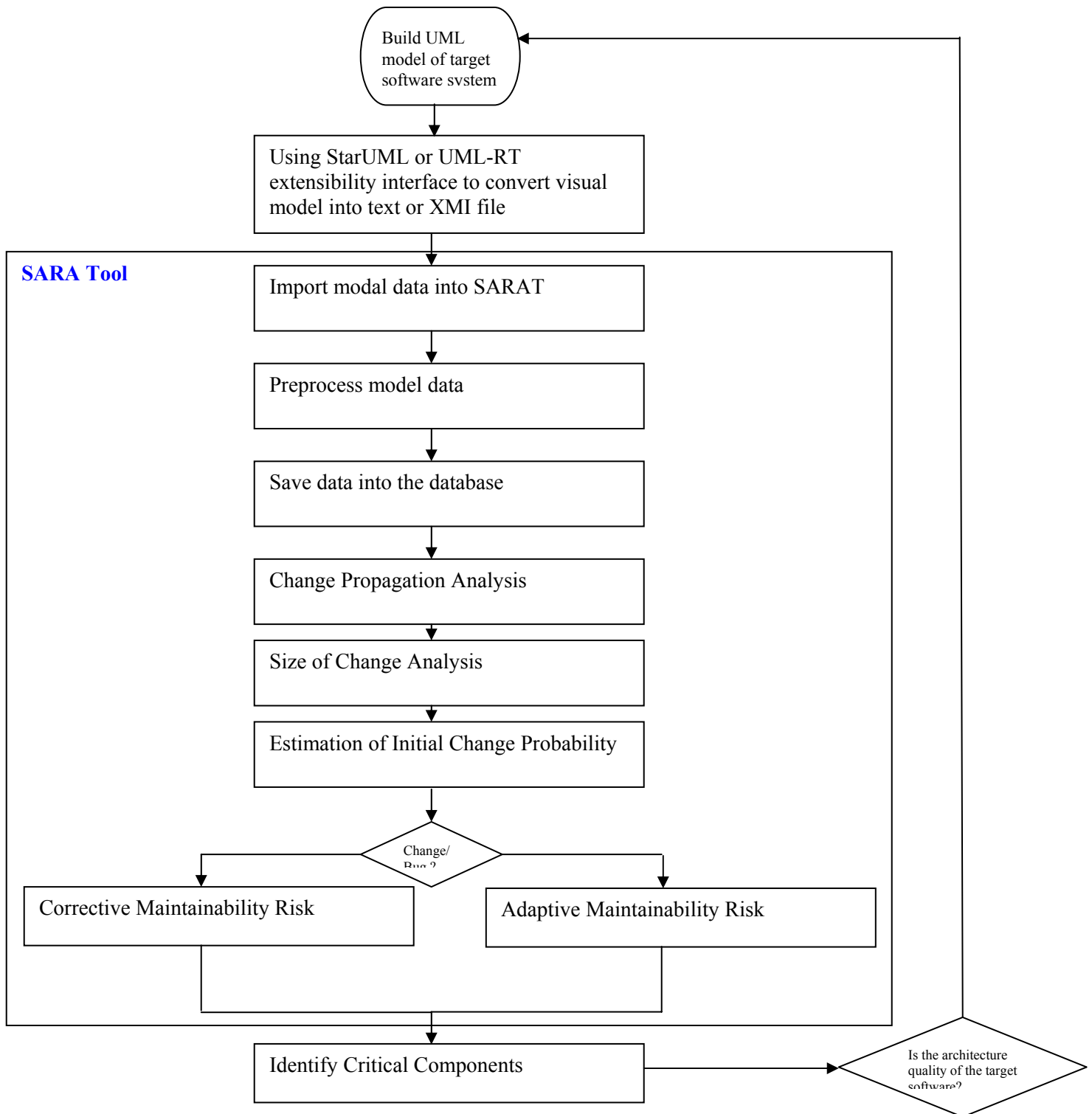


Figure 1 Overall Process flow chart for SARA Tool (Maintainability Risk)

3 GETTING STARTED

This section provides a general walkthrough of the system from initiation through exit.

MyFrame1.java is the main class of the SARA Tool. After executing the main program the user will get the display of GUI as shown in figure. This is the user interface with which user is going to interact with the Tool. This section is to give the complete description of the Menus presented and their purpose. Before going to the next section let us have a look at the frames displayed in the GUI.

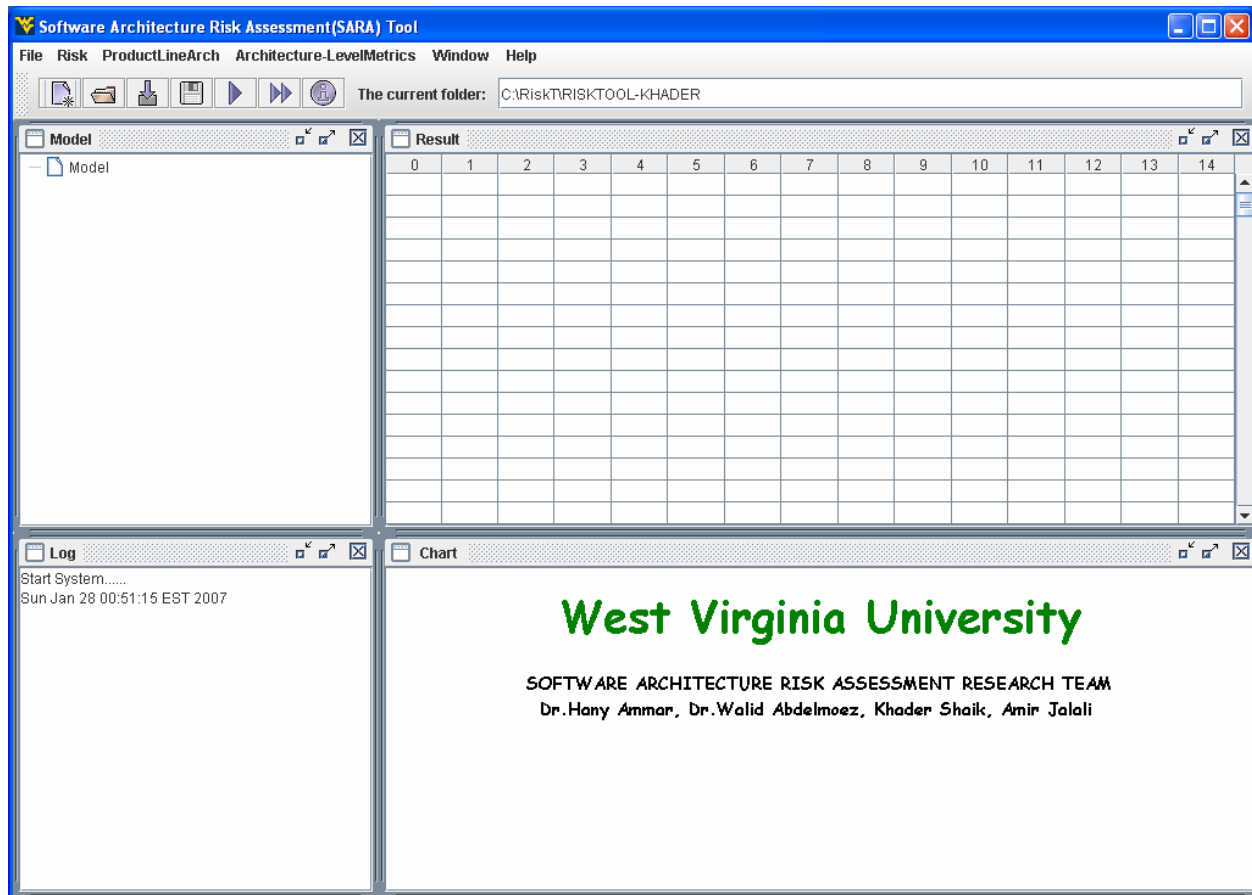


Figure 2

The complete Frame is divided into 4 parts.

- Model Frame
- Result Frame
- Log Frame
- Chart Frame.

Model Frame: This frame provides information about the type of model he is working on, hierarchy of the files uploaded. It provides information for target software systems management, for instance, user can analyze many different software systems simultaneously. This is especially useful when the user wants to compare multiple solutions of UML models for the same target system.

Result Frame: To display the output/result of the different modules in tabular format. The size of the table is limited here to 14*14. This is one of the limitation of the tool. If the number of components in the system design exceeded this then the tool give error.

Log Frame: The left lower frame is a log window; it records every user action applied to the SARA Tool system. In case some accidental actions happen, the user can follow the log to reverse the user action, and erase the error made by the accident.

Chart Frame: To display the results in the chart format . It supports both 3-D and 2-D charts. It allows user to analyze the results by focusing into different styles provided by Express chart API.

3.1 System Menu

This section describes in general terms the system menu first encountered by the user

The system has the following menu sections:

File Menu

1. **New Model:** This creates a separate work space area for a new model to be imported and analyzed.
2. **Open Model :** Opens an existing model, uses an existing work space area.
3. **Import Architecture Description File:** This module is to import the input files into the system. It has 3 sections mentioned as below:
 - a. XMI file for StarUML: Importing .XMI file for Maintainability-Based Risk estimation produced using StarUML
 - b. .txt file for UMLRT-CP: Importing .txt file for Maintainability-Based Risk estimation using UMLRT
 - c. .txt file for UMLRT-EP: Importing .txt file for Reliability-Based Risk estimation using UMLRT
4. Delete: for deleting particular model
5. Save: for saving the model
6. SaveAs: for saving the saved the model with different name

7. Exit: To exit the tool

Risk Menu

- i. Maintainability Risk:
 - a. Analysis using StarUML:
 - i. *Change Propagation: for computing the Change Propagation Metrics*
 - ii. *Size of Change: for computing Size of change metrics*
 - iii. *Compute Maintainability Risk: for computing Maintainability Risk factors*
 - 1. *Corrective maintainability Risk: Compute Maintainability Risk factors based on bugs*
 - 2. *Adaptive maintainability Risk : Compute Maintainability Risk factors based on changes*
 - b. Analysis using UMLRT
 - i. *Change Propagation: for computing the Change Propagation Metrics*
 - ii. *Size of Change: for computing Size of change metrics*
 - iii. *Compute Maintainability Risk: for computing Maintainability Risk factors*

1. *Corrective maintainability Risk: Compute Maintainability Risk factors based on bugs*

2. *Adaptive maintainability Risk : Compute Maintainability Risk factors based on changes*

c. Import file for initial change probabilities (ICP):

i. Import file: for importing .txt file which contains error and change reports. This has to be done after computing CP and SC and before estimating the Maintainability-based risk.

ii. Choose options: This is a frame for setting Initial Change Probabilities if data is not available to the user. It giving two options to the user.

1. choosing the worst case scenario ,i.e setting all the probabilities to 1.0

2. providing separate frame for entering user defined probabilities component wise.

d. Compute Initial Change Probability(ICP):

i. Corrective ICP : Computing corrective ICP w.r.t bugs report imported from c.i section

ii. Adaptive ICP : Computing corrective ICP w.r.t changes report imported from c.i section

- e. Cyclomatic Complexity(StarUML): This estimates the cyclomatic complexity for the given model. This is the alternative for ICP for estimating Maintainability-based risk. This metric is computed using state chart diagrams for the classes in the in the architecture description file.
- ii. Reliability Risk
 - a. Analysis using UMLRT
 - i. Error Propagation: for calculating the error propagation metrics. It displays the result in separate frame . it is integrated from different application.
 - ii. setComponentSeverity: setting the component severity levels for the given model.
 - iii. Compute Reliability risk: for computing the reliability-based risk factor for each component.
 - iii. *Requirement Risk:*
 - a. *Analysis using UMLRT*
 - i. *Select Severity : takes the input file(test6.txt), process it and presents the scenario level complexities and their optional severities.*

ProductLineArch. Menu

- i. *Create PLA Instances: Here the user needs to import the XMI PLA description file, then he creates the user requested number of instances and store in the repository.*
- ii. *Compute CP, SC & Maintainability Risk Factors: computes the CP, SC and Maintainability risk factor for each Product Line instance.*
- iii. *Display Results : for displaying the final results in both table and Chart Formats.*

Help

- i. *Index: provides the help window for the user*
- ii. *About : Just know about the SARA Tool*

3.2 Exit System

This is used by the user to exit from the system.

An example of the navigation through each function with a case study is shown in next chapter:

4 NAVIGATION

This section describes and depicts the navigation paths to functions noted using screen snapshots. The navigation snapshots provided in this section leads the user to use the each function in correct sequence. We assume that user has learned about the tool from chapter 3.

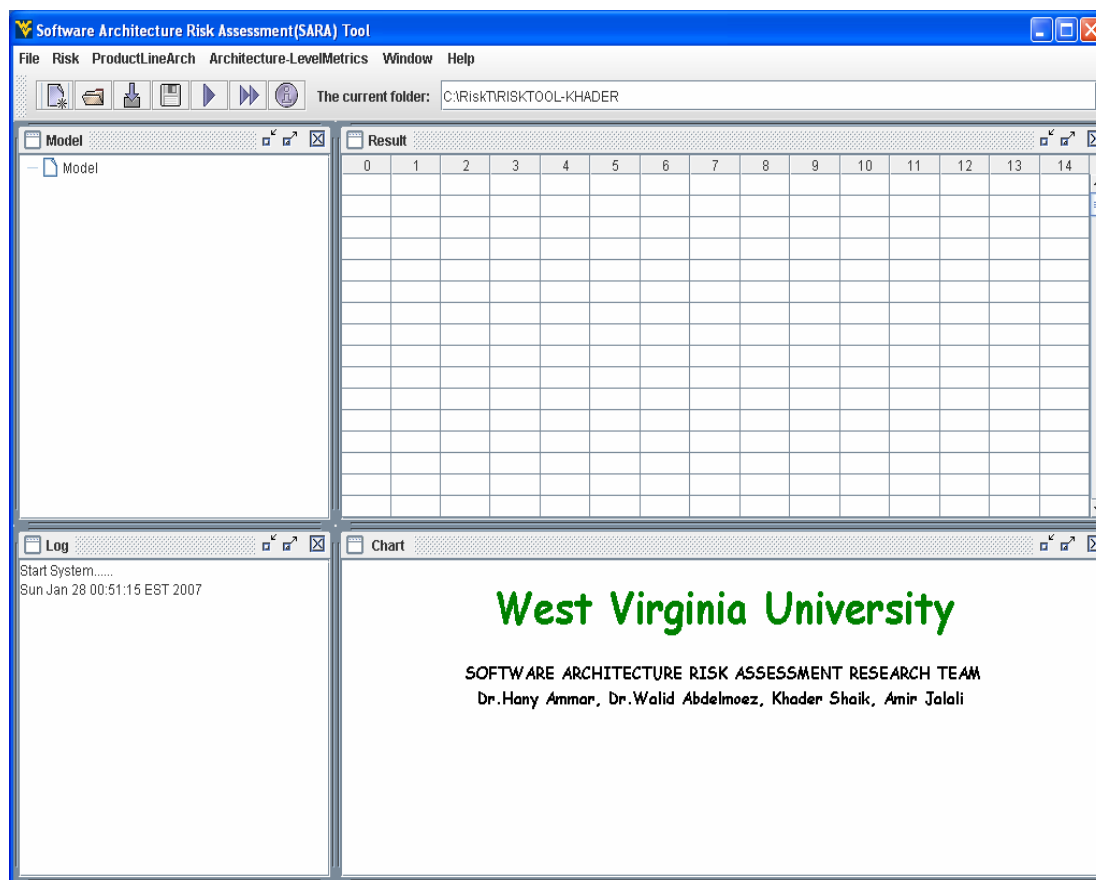


Figure 3

4.1 Maintainability-Based Risk Module

Analysis Using StarUML: The CM1 Case Study

The following snapshots show the step-by-step navigation of the module:

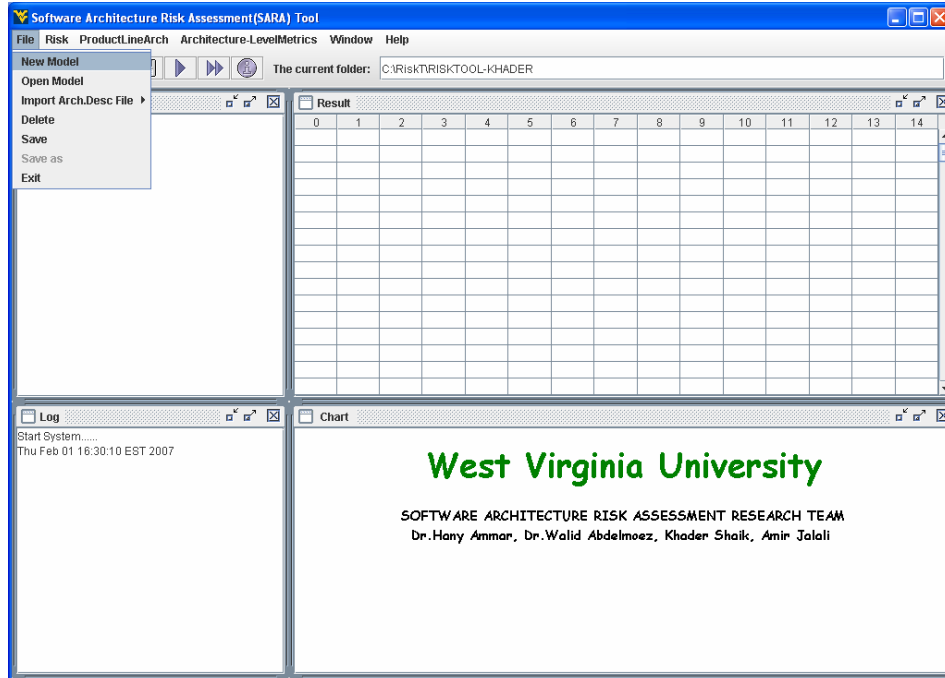


Figure 4 Create New Model

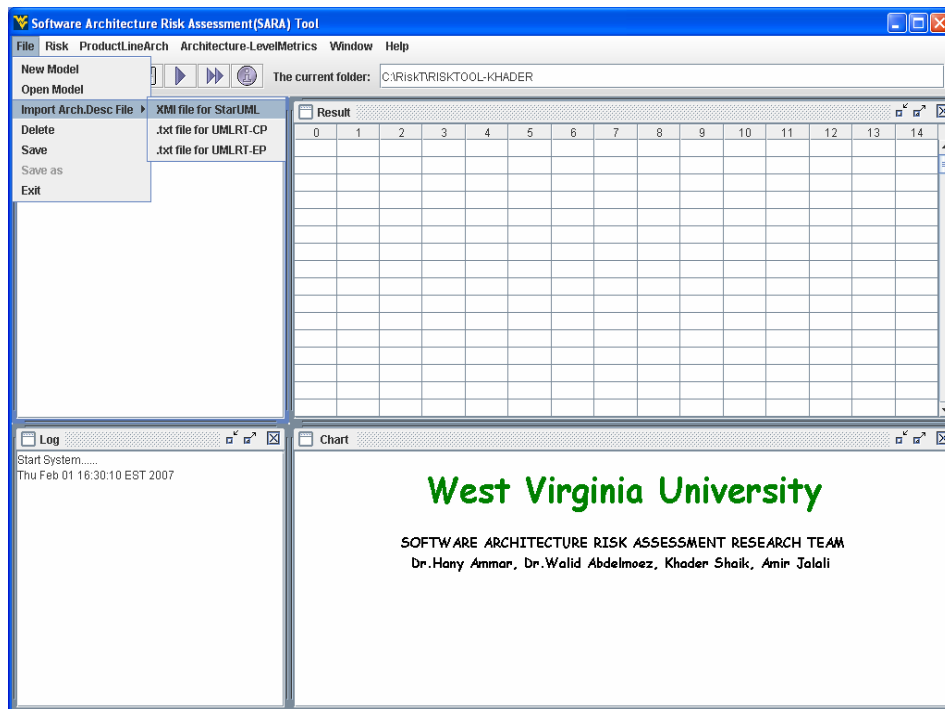


Figure 5 Import XMI file for Maintainability Risk

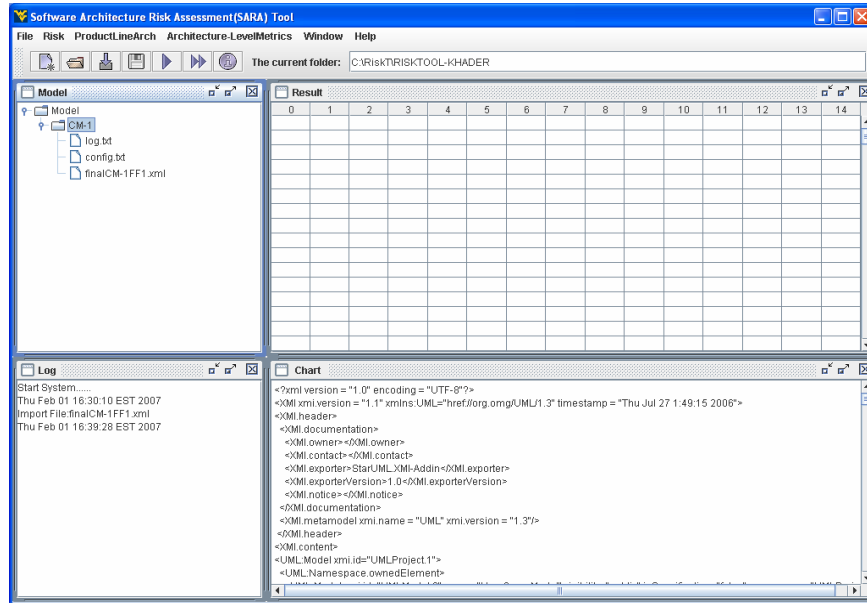


Figure 6 After importing file

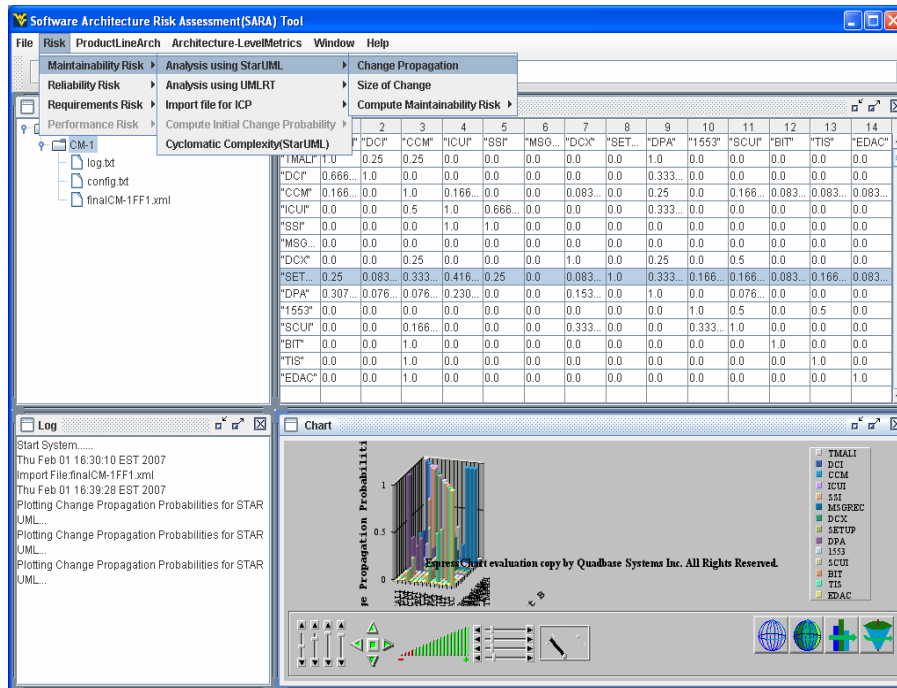


Figure 7 Compute Change Propagations Metrics

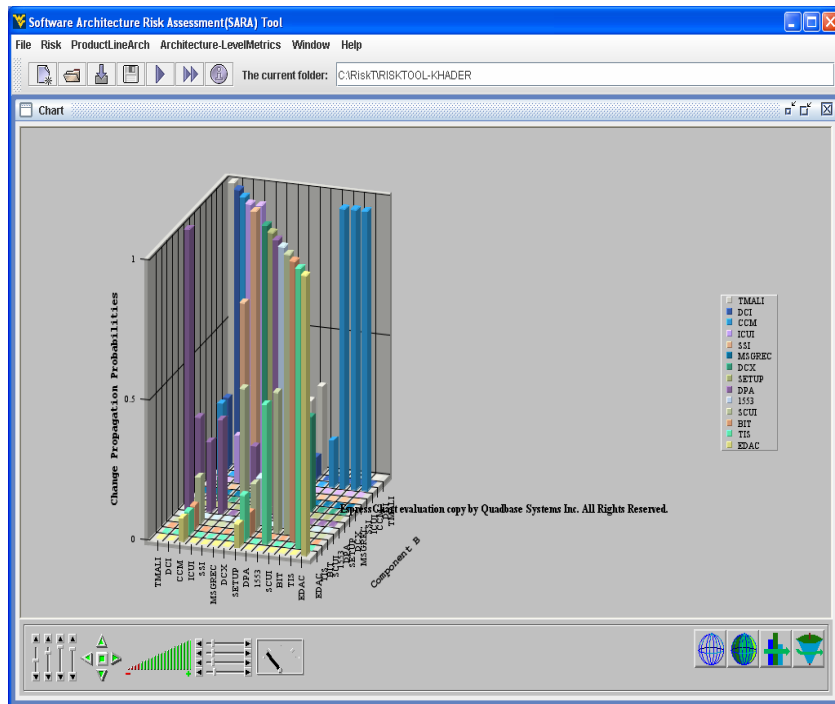
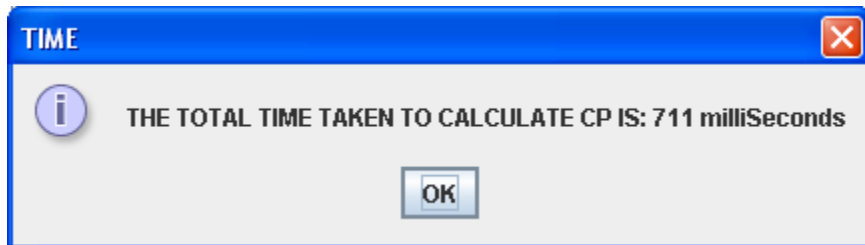


Figure 8

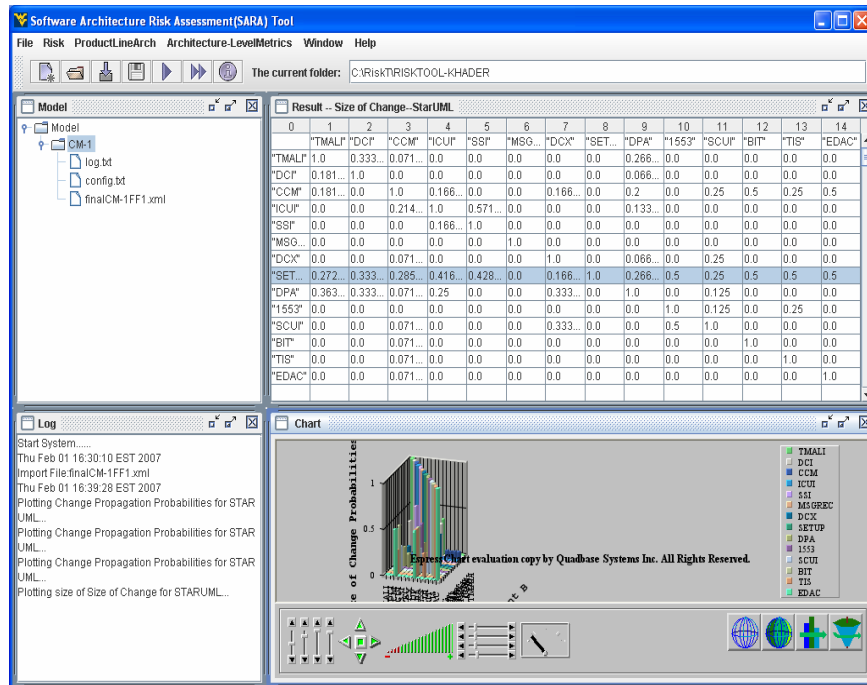


Figure 9 Size of change metrics calculation

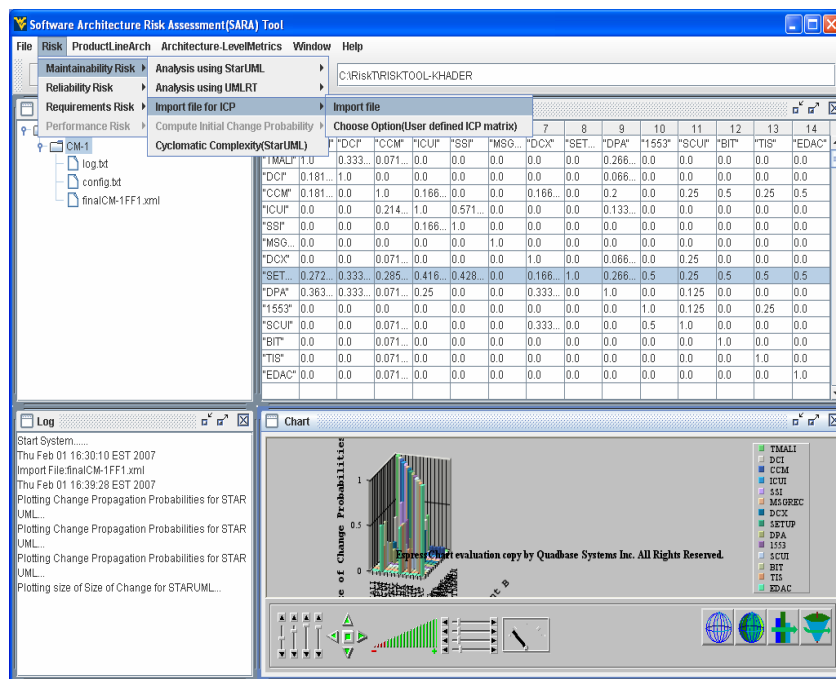


Figure 10 Import file for ICP:

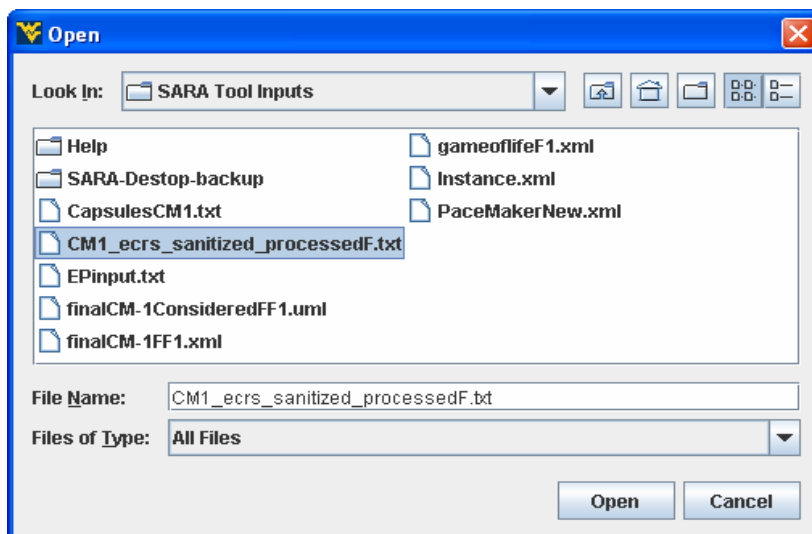


Figure 11

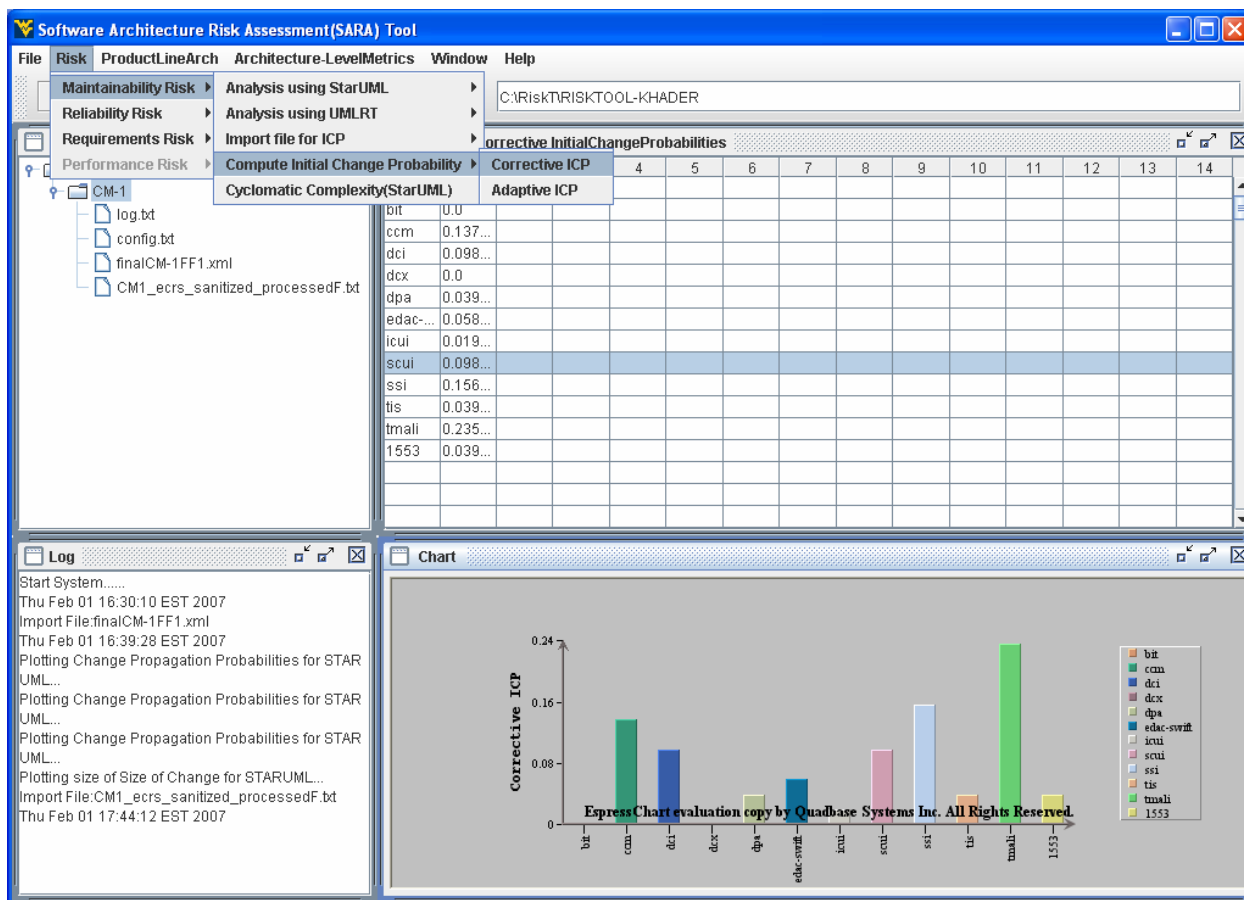


Figure 12 Compute Corrective ICP

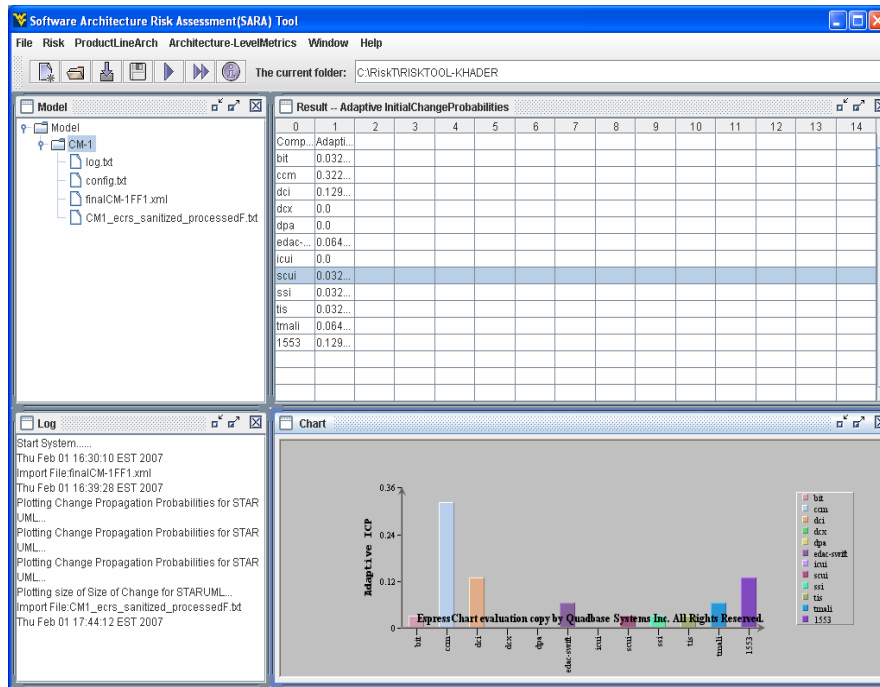


Figure 13 Compute Adaptive ICP

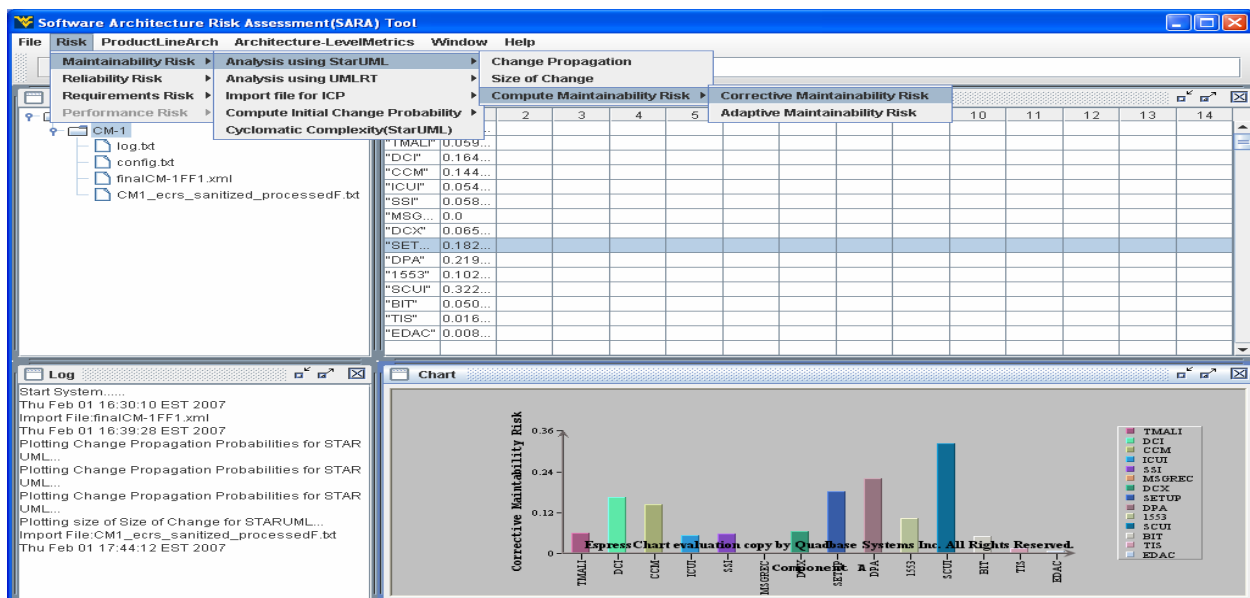


Figure 14 Compute Corrective Maintainability Risk

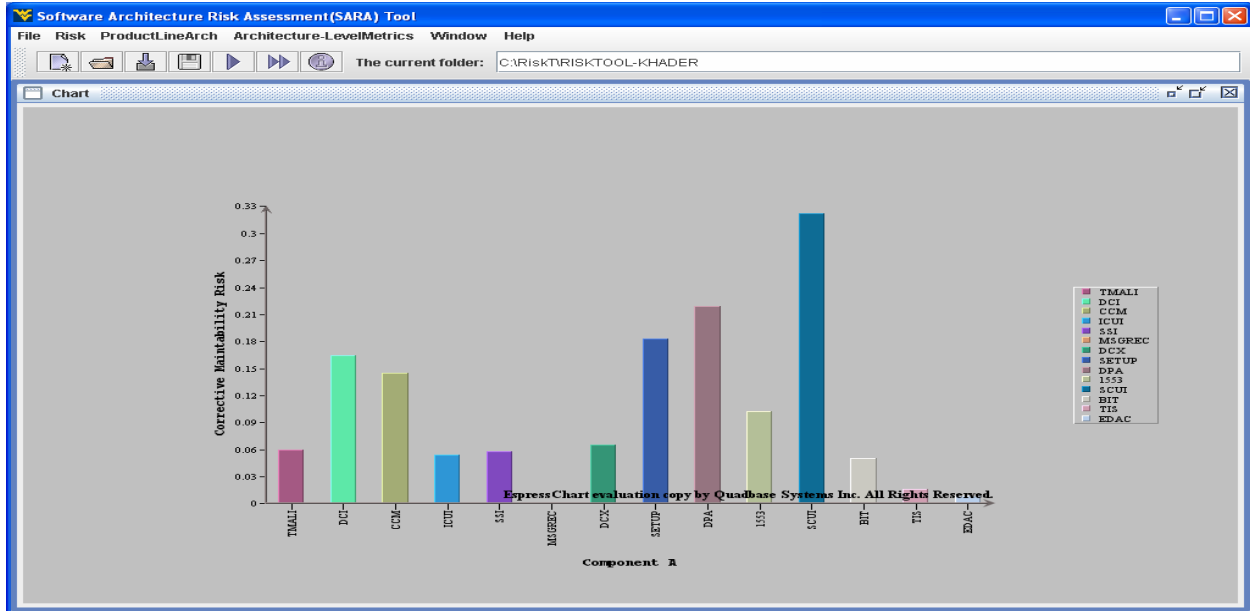


Figure 15

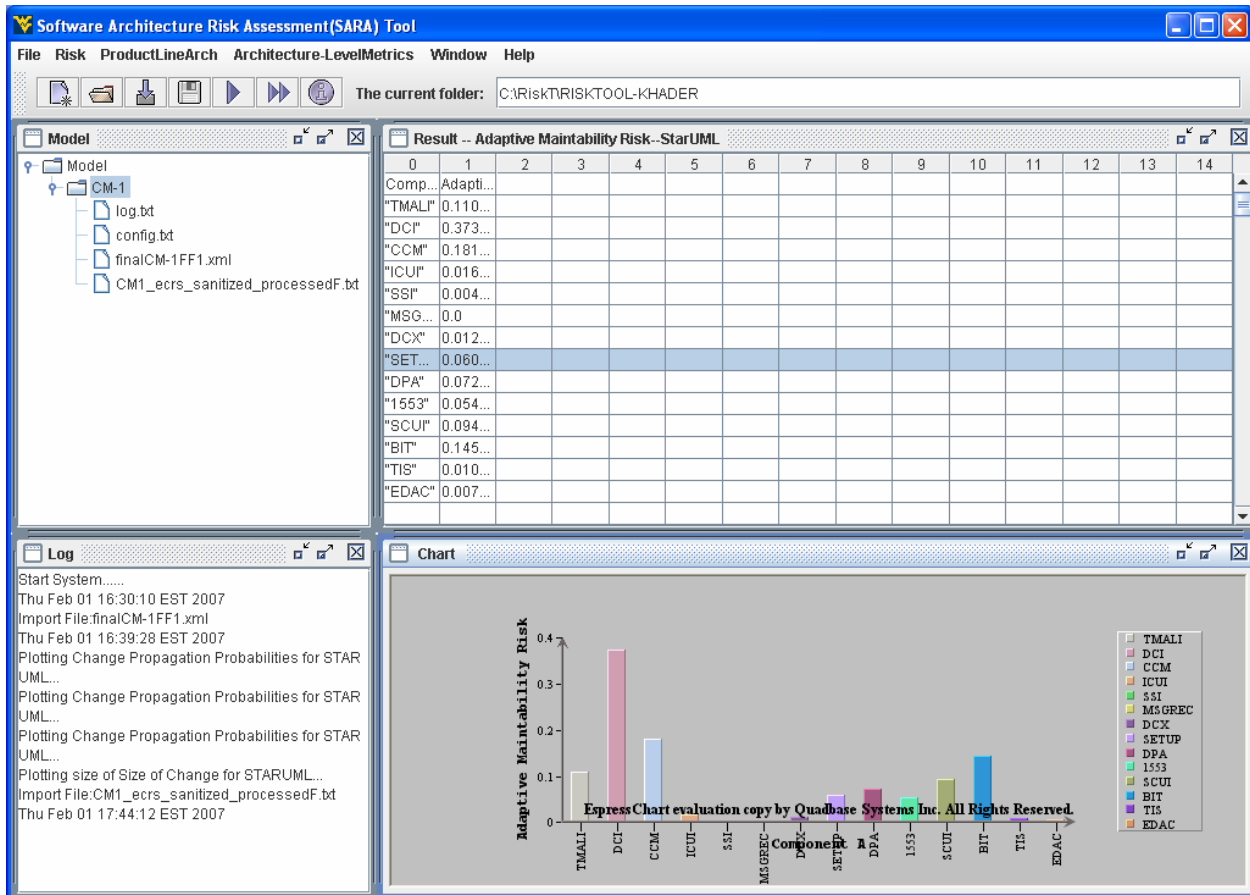


Figure 16 Compute Adaptive Maintainability Risk

Analysis Using UMLRT: CM1 case study

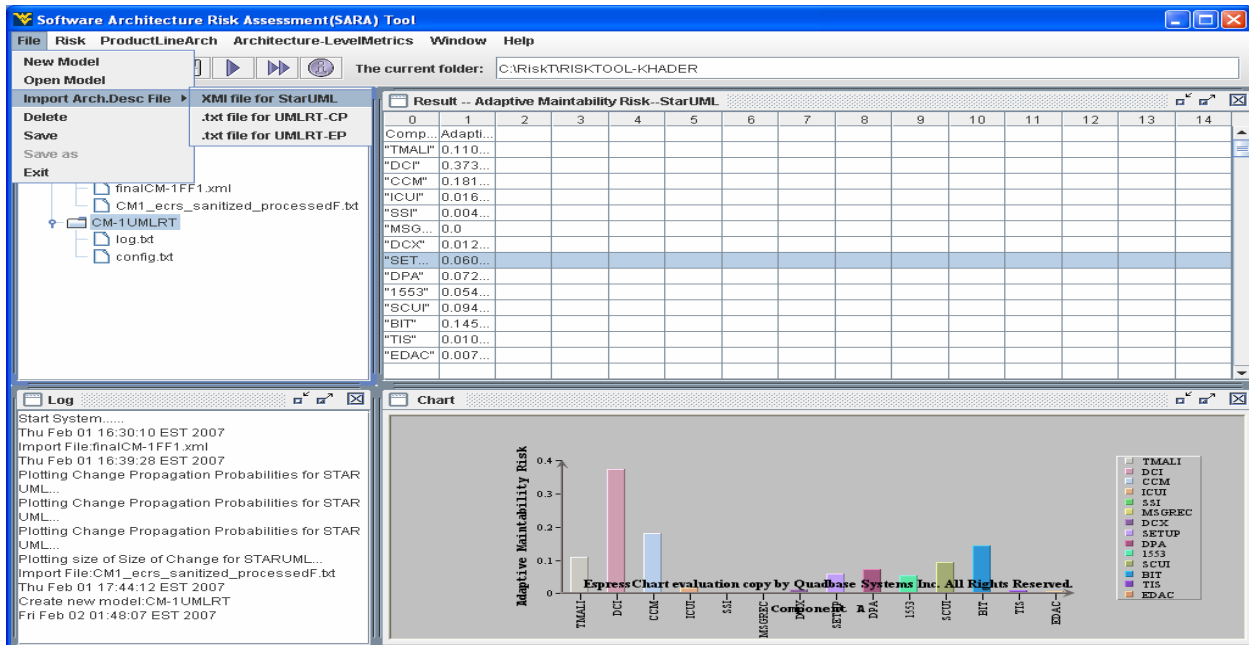


Figure 17 Import file

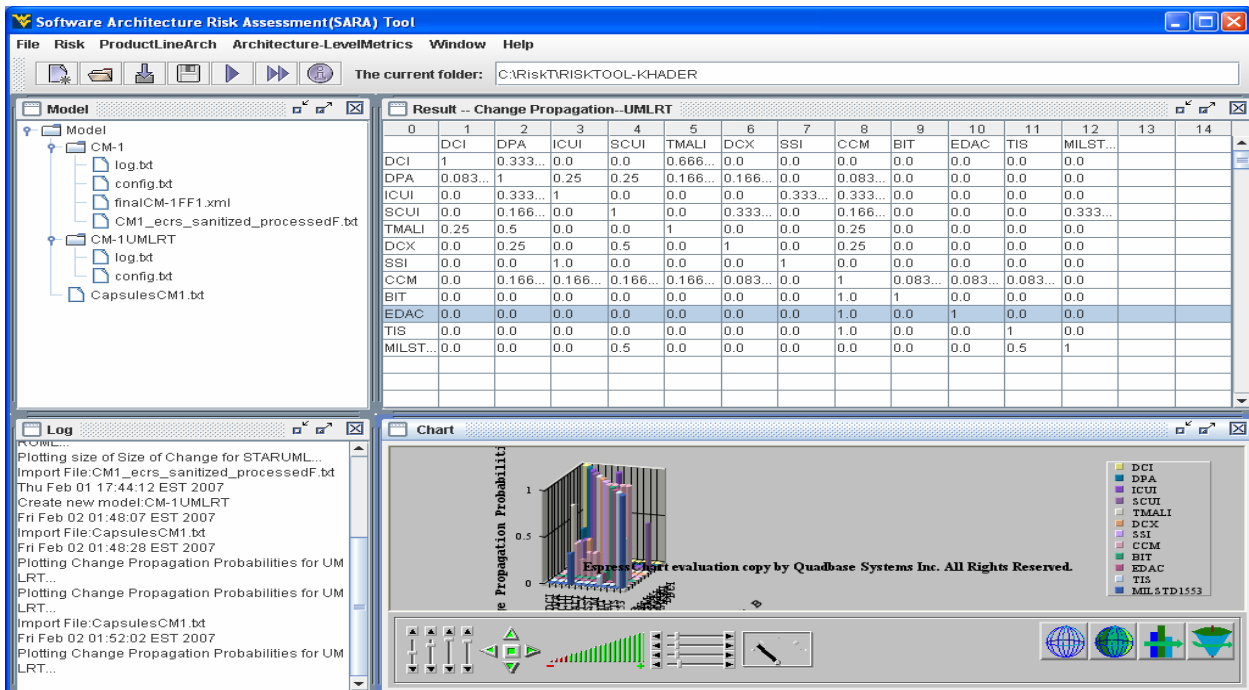


Figure 18 Compute Change Propagation

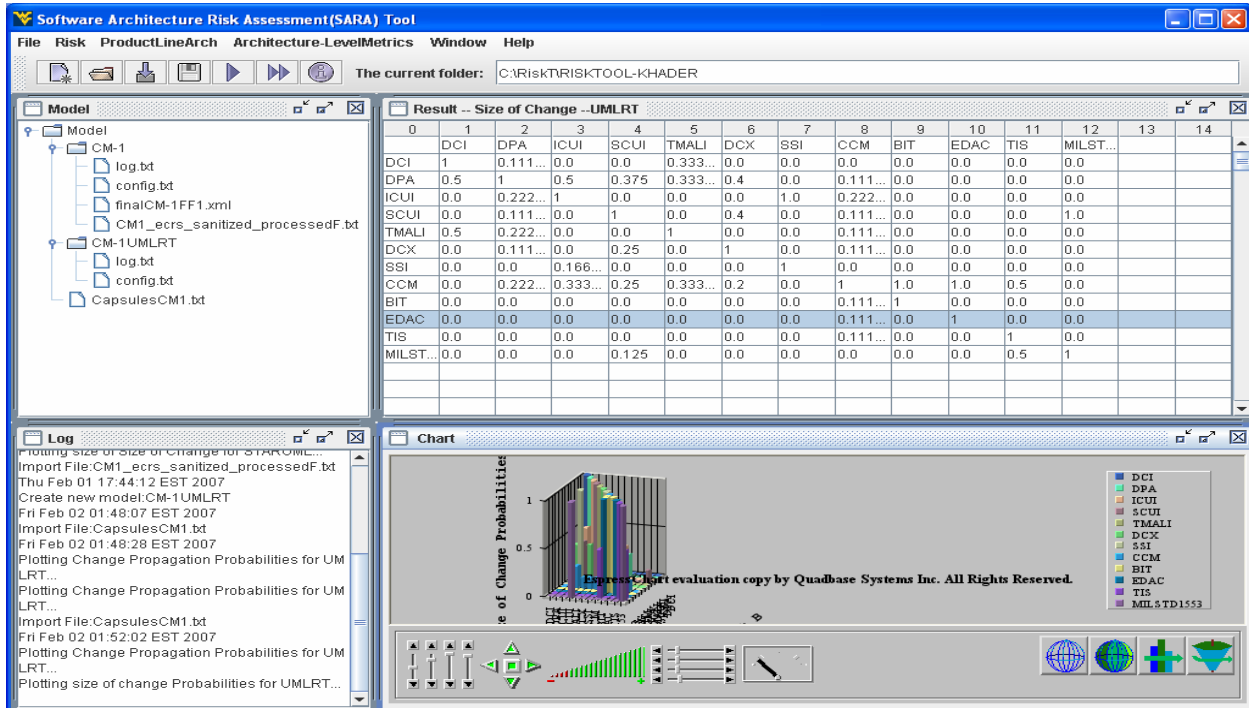
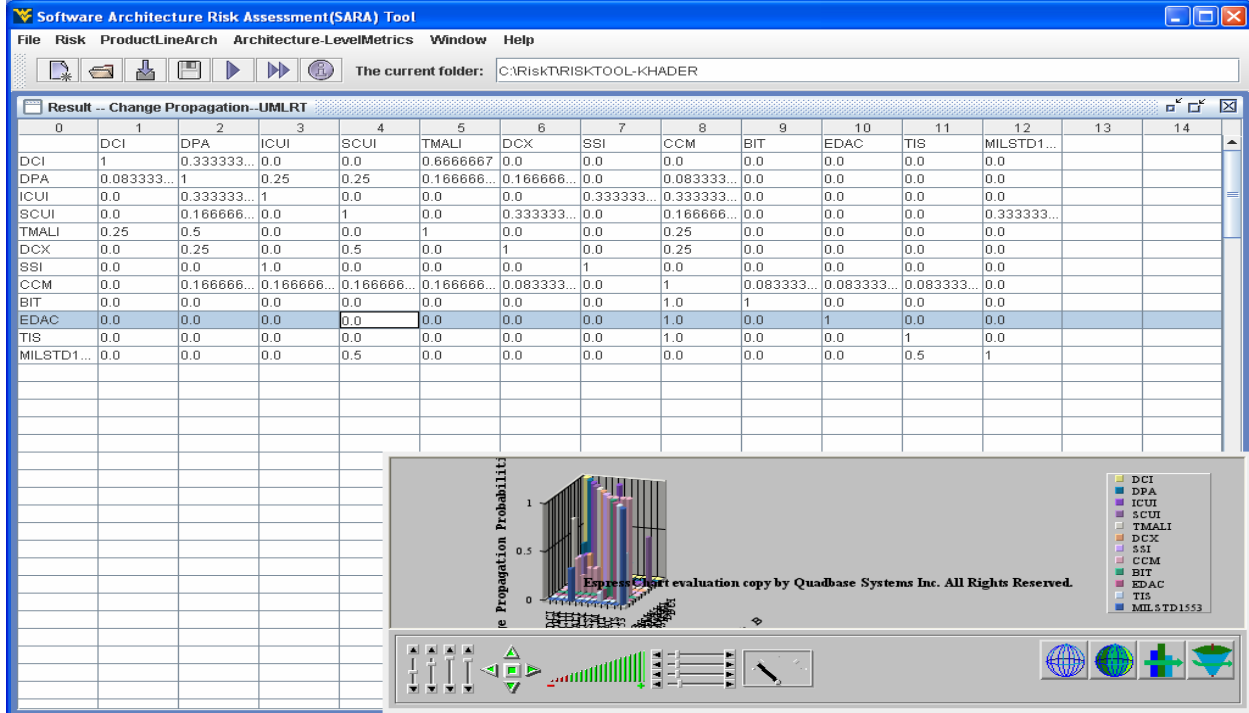


Figure 19 Size of Change:

Setting the value of Initial Change Probability

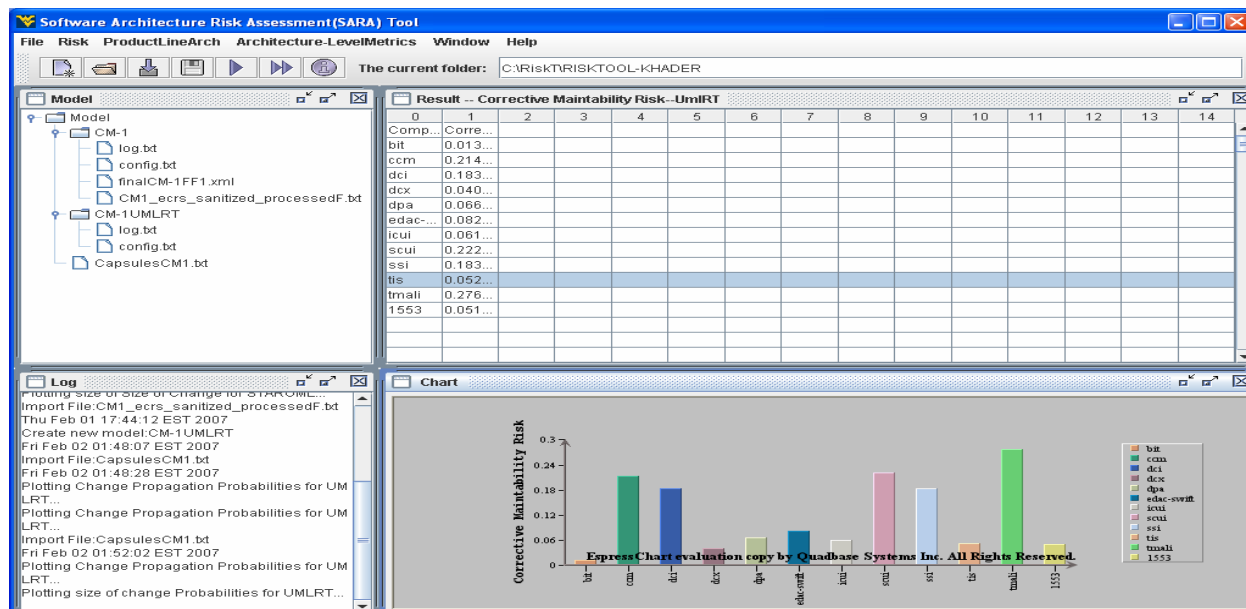
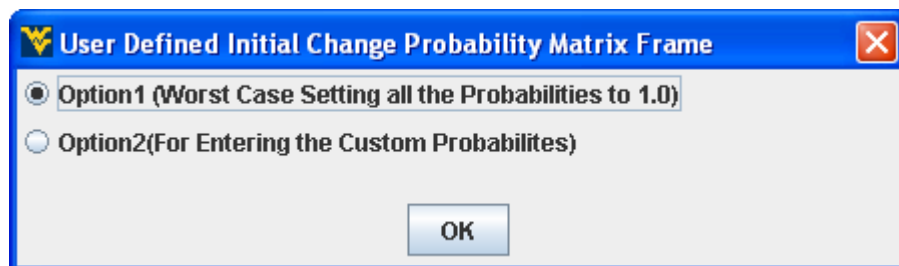


Figure 20 Compute Maintainability Risk

4.2 Reliability Risk Module

Analysis using UMLRT:

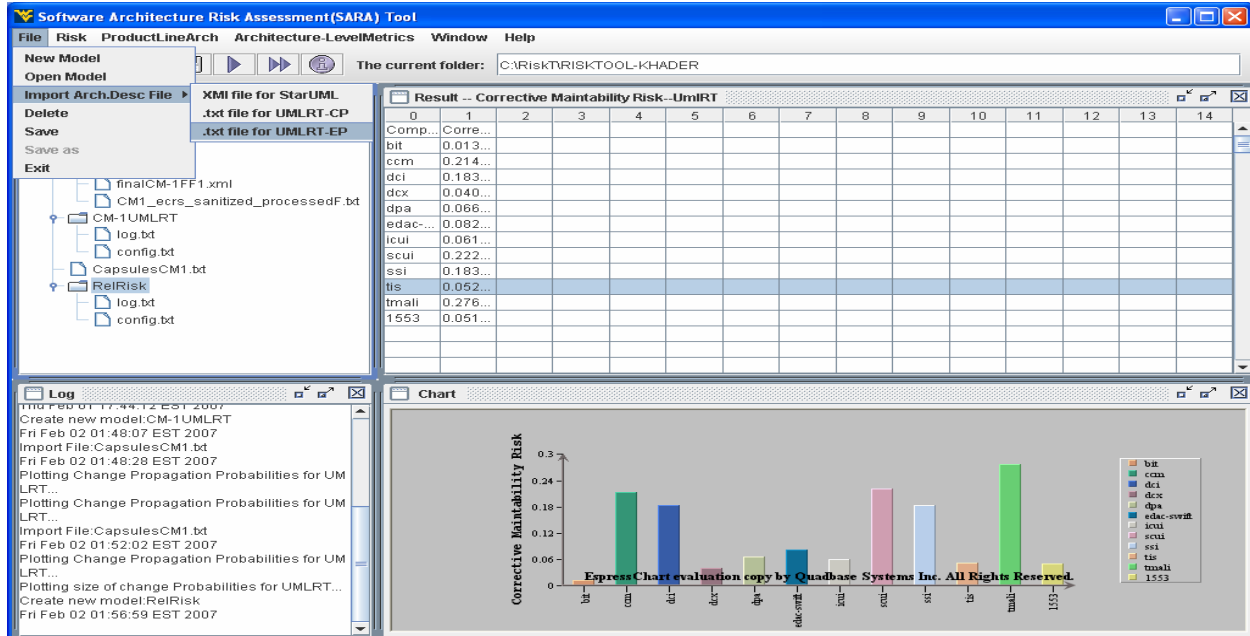


Figure 21 Import IEP file

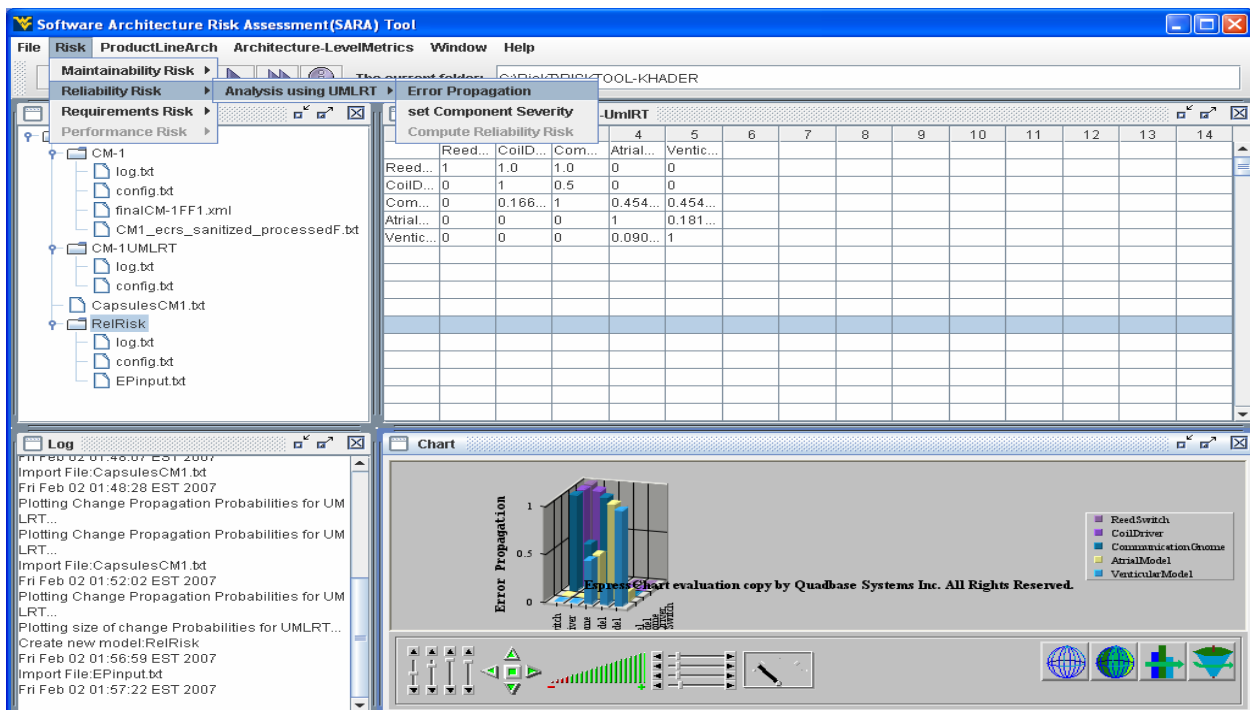


Figure 22 Error Propagation:

Set Component Severity: Minor = 0.25, Major = 0.5, Critical = 0.75, and catastrophic = 0.99

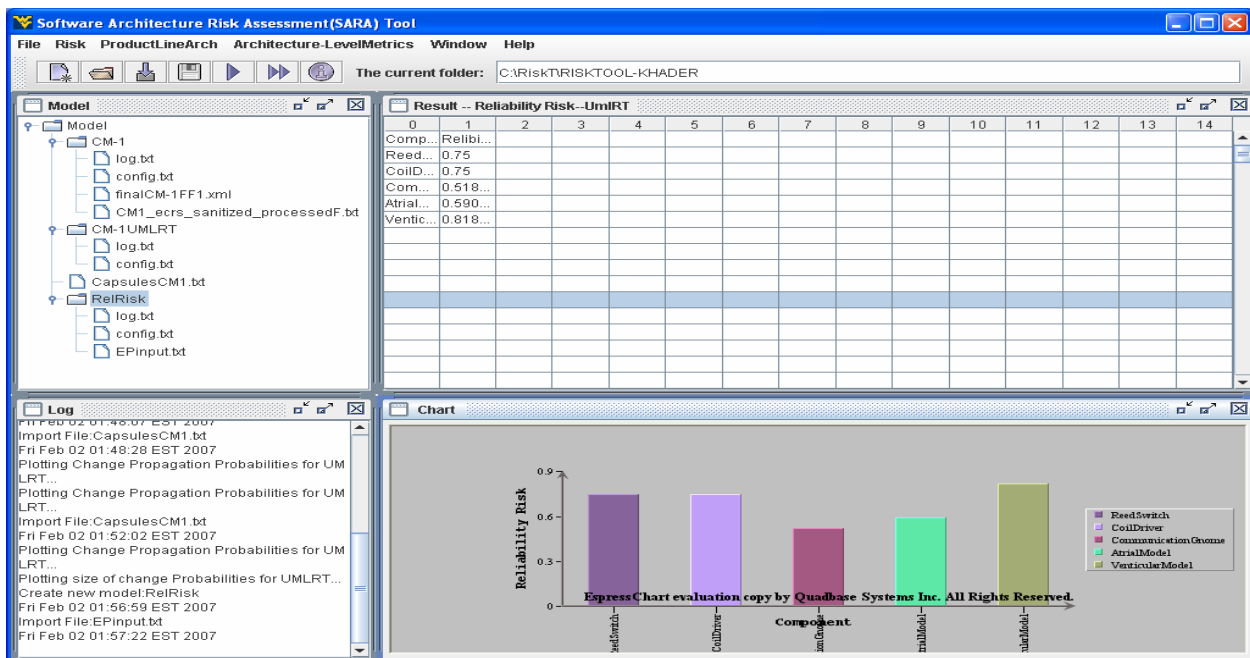


Figure 23 Compute Reliability Risk:

4.3 Requirement Risk Module

Analysis using UMLRT:

The screenshot shows the 'Software Architecture Risk Assessment (SARA) Tool' window. The 'Result' pane displays a table with the following data:

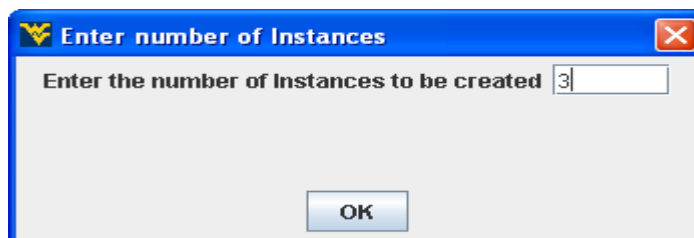
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---------------------------|--------------|------------|----------|---|---|---|---|---|---|----|----|----|----|----|
| Scenario | Failure M... | Complexity | Severity | | | | | | | | | | | |
| TransferS..._4_initScui | | 0.0519481 | Minor | | | | | | | | | | | |
| TransferS..._5_initTmall | | 0.0649351 | Minor | | | | | | | | | | | |
| TransferS..._6_initIcui | | 0.0779221 | Minor | | | | | | | | | | | |
| TransferS..._7_mode... | | 0.0909091 | Minor | | | | | | | | | | | |
| TransferS..._9_waitFor... | | 0.116883 | Minor | | | | | | | | | | | |
| TransferS..._10_getEv... | | 0.12987 | Minor | | | | | | | | | | | |
| TransferS..._11_events | | 0.142857 | Minor | | | | | | | | | | | |
| TransferS..._12_nullEv... | | 0.155844 | Minor | | | | | | | | | | | |
| TransferS..._13_setNu... | | 0.168831 | Minor | | | | | | | | | | | |
| ChBound..._Vwait | | 0.010101 | Minor | | | | | | | | | | | |
| ChBound..._5_initIcui | | 0.10101 | Minor | | | | | | | | | | | |
| ChBound..._6_read | | 0.121212 | Minor | | | | | | | | | | | |
| ChBound..._7_readD... | | 0.141414 | Minor | | | | | | | | | | | |
| ChBound..._8_ccmC... | | 0.161616 | Minor | | | | | | | | | | | |
| ChBound..._11_icuiC... | | 0.222222 | Minor | | | | | | | | | | | |
| ChBound..._12_write | | 0.242424 | Minor | | | | | | | | | | | |
| HBSeque..._3_initIcui | | 0.181818 | Minor | | | | | | | | | | | |
| HBSeque..._5_icuiHB... | | 0.363636 | Minor | | | | | | | | | | | |
| HBSeque..._6_write | | 0.454545 | Minor | | | | | | | | | | | |

Figure 24 Select severity (after importing test6.txt file)

4.4 PLA Module:

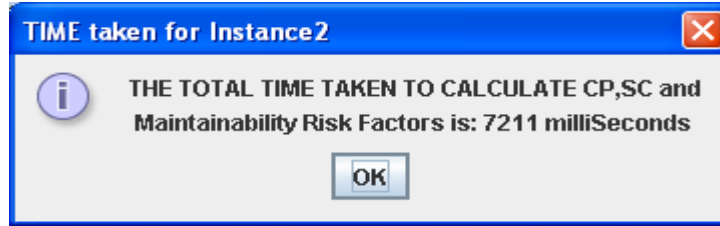
Create Instance:

User need to enter the number of instances to be created after importing the PLA XMI file as shown in the snapshot below

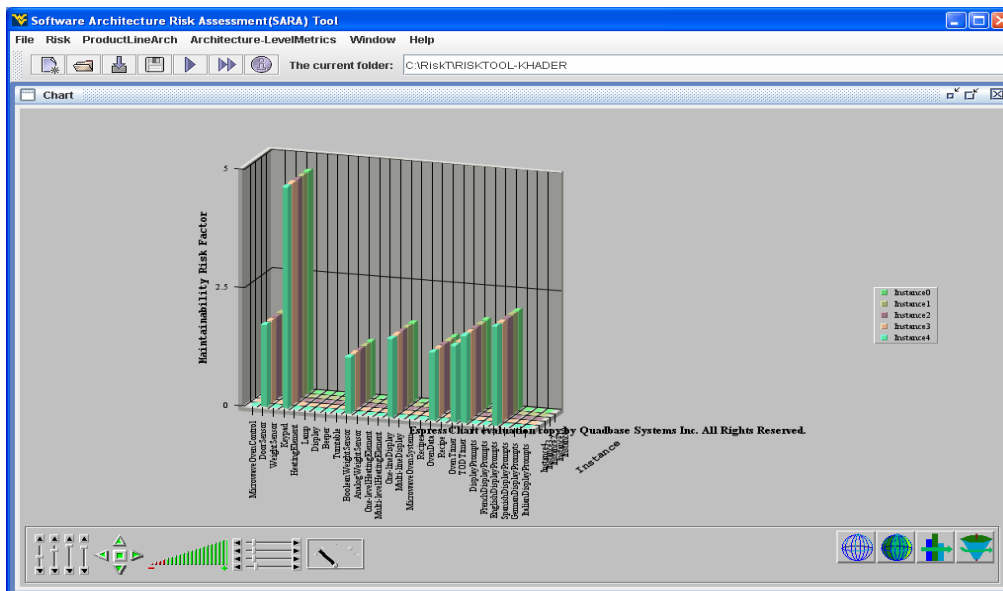
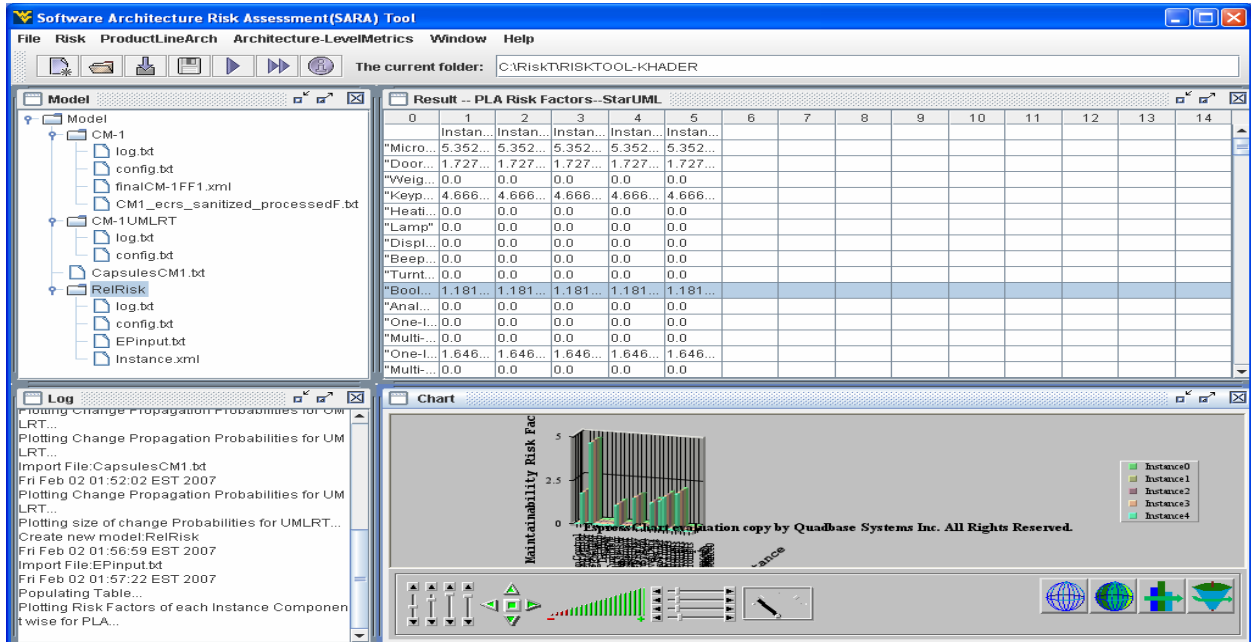


Compute metrics and maintainability risk factors:

Computation is done at back end and the time taken for each instance is provided as shown in the snapshot below



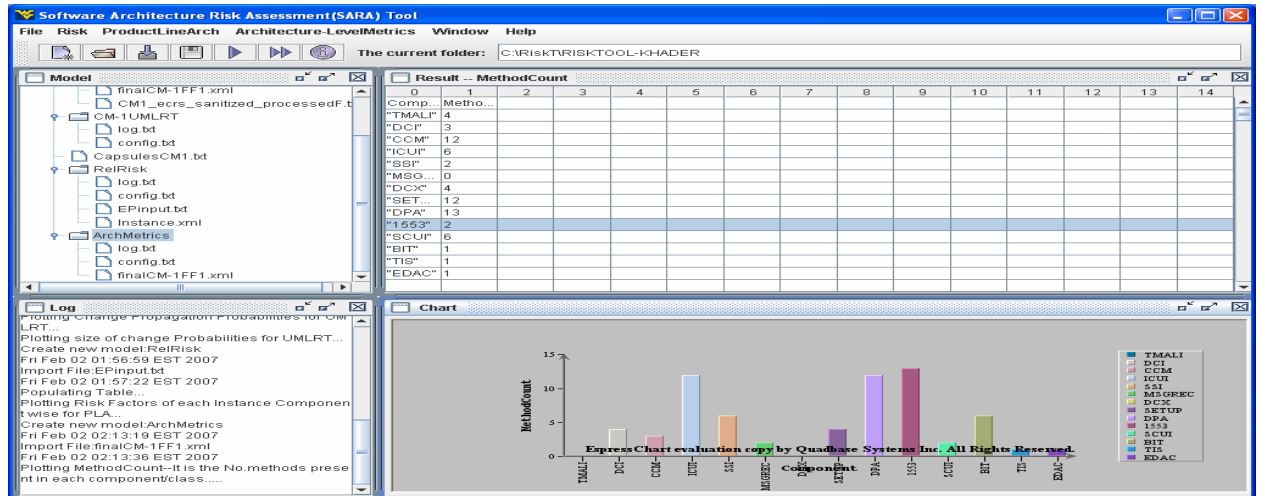
Display Results: For 5 Instances



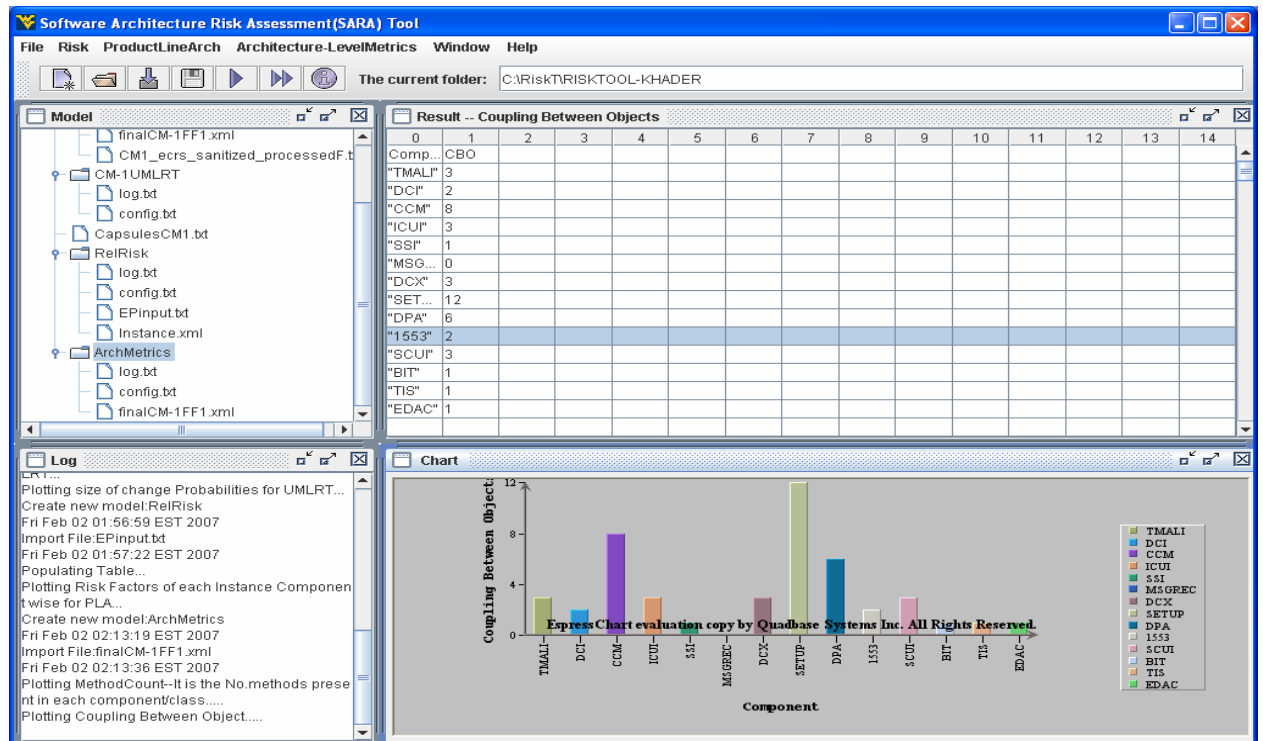
4.5 Architecture-level metrics Menu

After importing XMI file

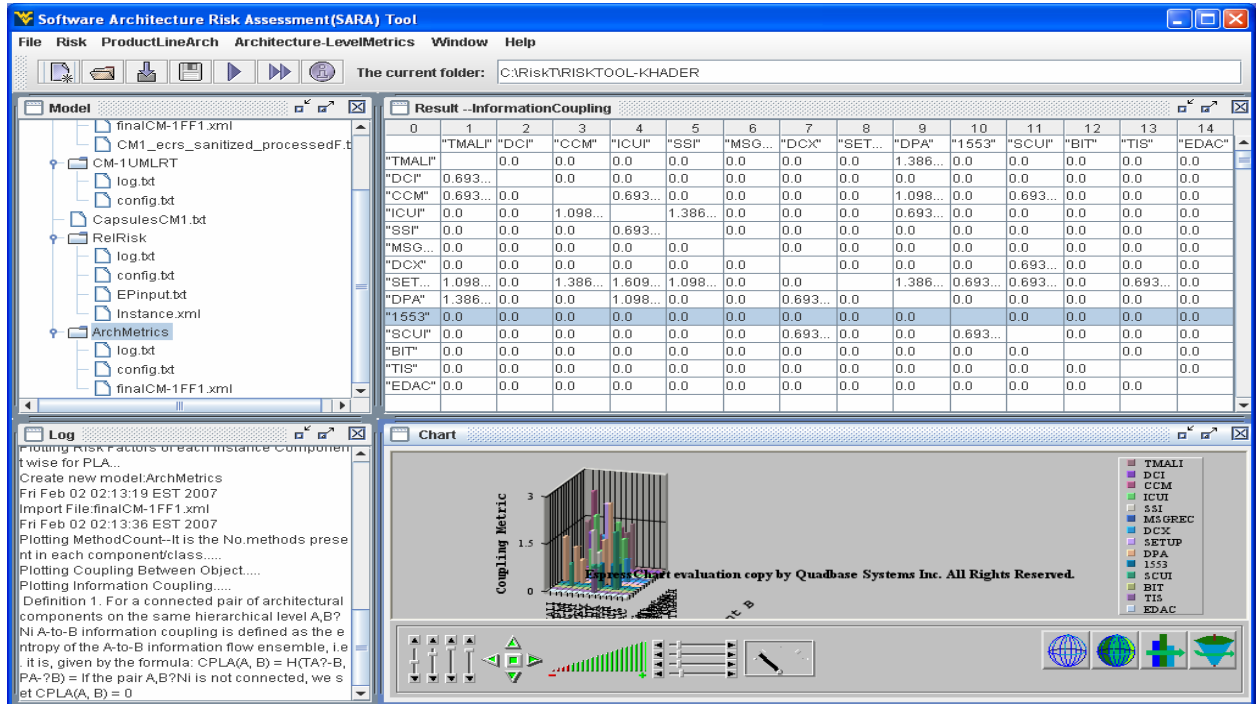
Size Metrics: Method Count



Coupling metrics: CBO

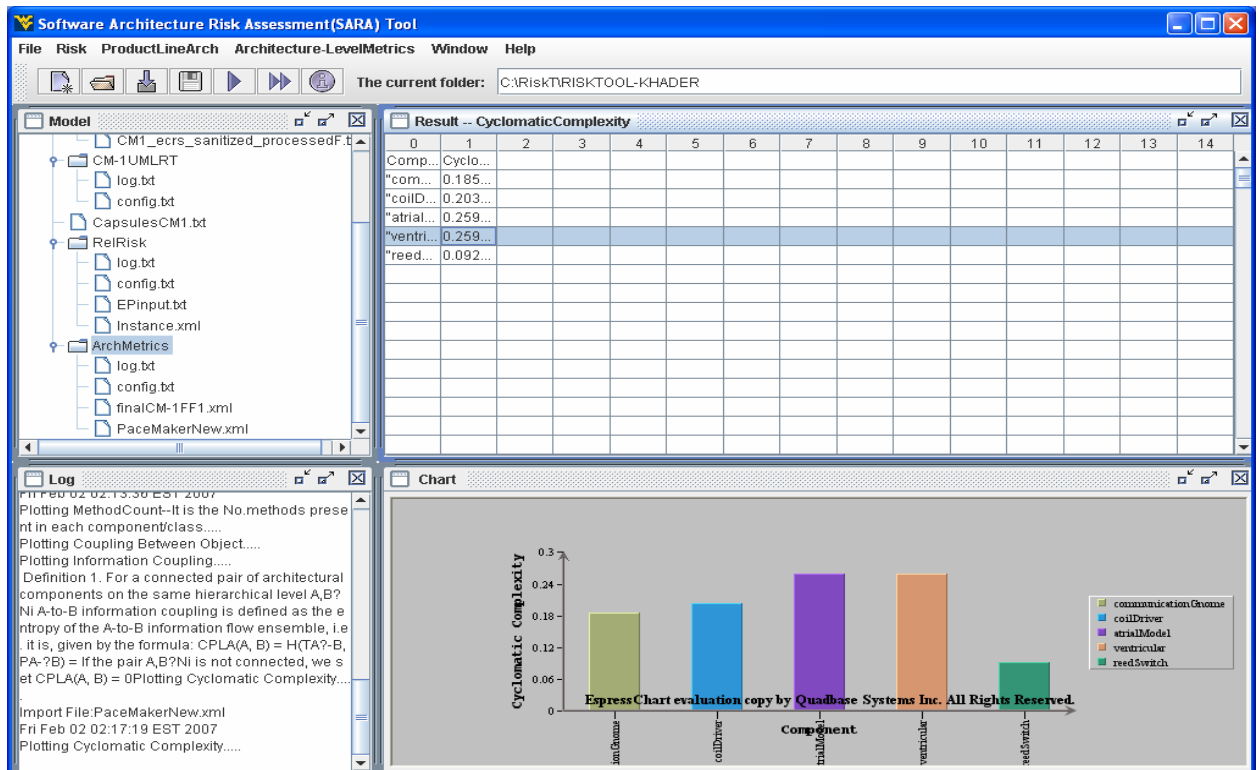


Information Coupling:

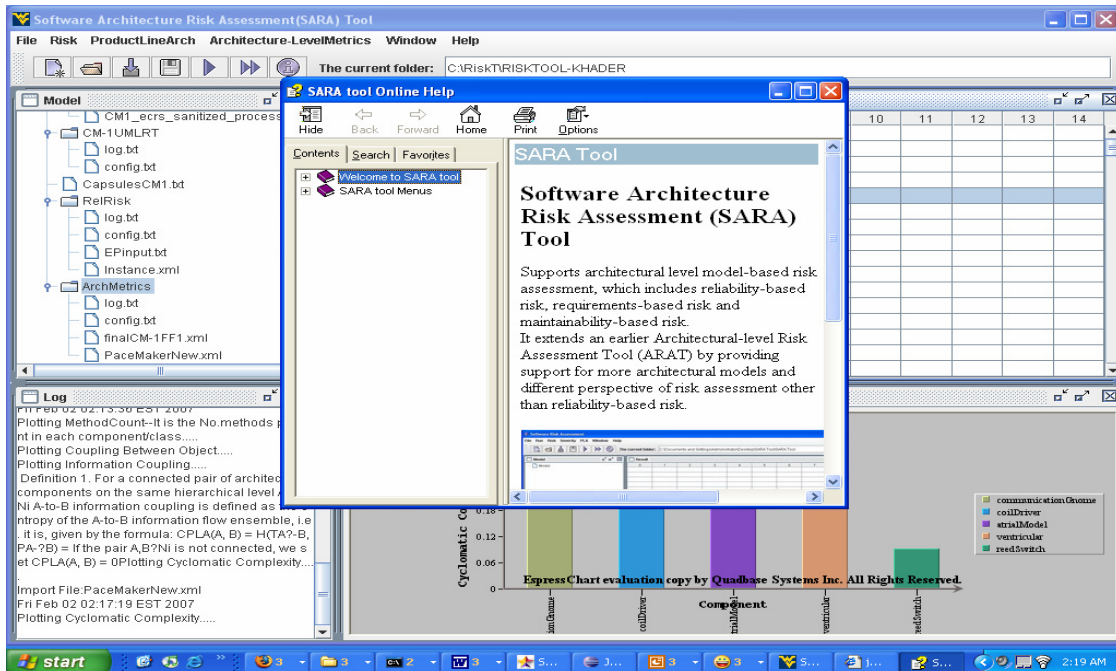


Complexity: Cyclomatic Complexity

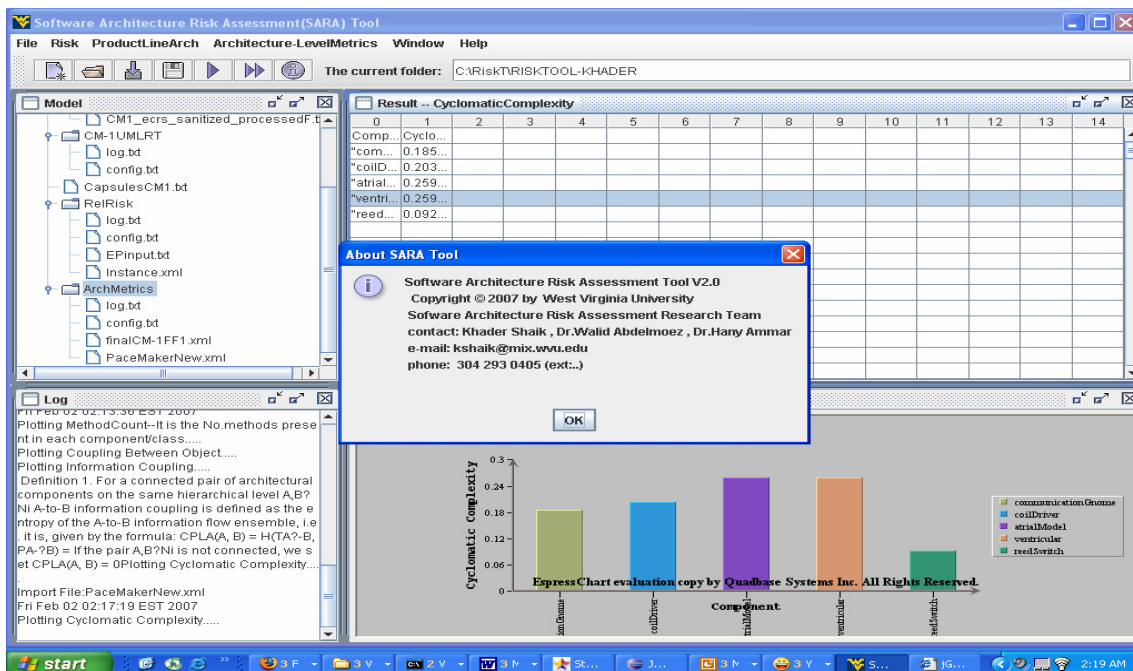
Note: Need state chart diagrams in the XMI file for this section



Help Menu: Index



About:



5 REFERENCES:

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