**An Open Source Tool for Reliability Evaluation Using Monte Carlo Simulation**

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**SUPPORTING MATERIAL**

**LIST OF ABBREVATIONS AND ACRONYMS**

CAIDI Customer Average Interruption Duration Index

CDF Customer Dmage Function

ECOST Expected Customer Interruption Cost

EENS Expected Energy Not Supplied

FMEA Failure Mode Effect Analysis

HTTP Hypertext Transfer Protocol

IEAR Interrupted Energy Assessment Rate

MCS Monte Carlo Simulation

SAIDI System Average Duration Index

SAIFI System Average Frequency Index

SOAP Simple Object Access Protocol

UI User Interface

XML Extensible Mark-up Language

WSDL Web Service Description Language

**SUPPORTING IMAGES**

Web application for reliability evaluation of distribution system using Monte Carlo Simulation technique was deployed on the Glass-fish web server using NetBeans IDE. After deployment, service was tested using SOAP-UI software [1]. Test results for primary indices, secondary indices, Customer Damage Function and Cost/ Worth Indices are listed below:

Sampling years for feeder-3 were provided as input for the SOAP project in XML format as shown in figure 1.

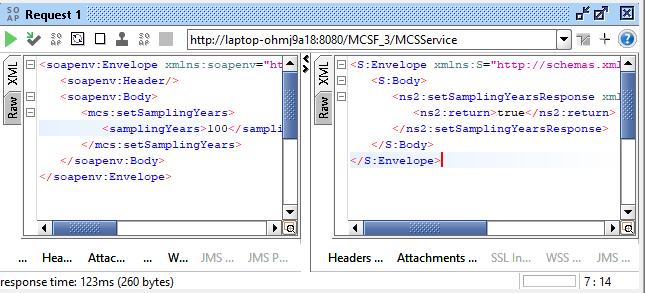


Figure 1: SOAP\_UI request for providing inputs

There are three primary indices that give information about reliability of a distribution system namely failure rate, repair time and unavailability. Failure rate gives the number of failures that are going to occur per year. Repair time specifies the time needed for the failed element to come back to UP state which thus inclues switching time. Unavailability specifies the duration for which the supply was inavailable to the customers. [2]-[5]

SOAP-UI response for primary indices using MCS service for feeder-3 of Bus2 of RBTS is as shown in figure-2, figure-3 and figure-4.

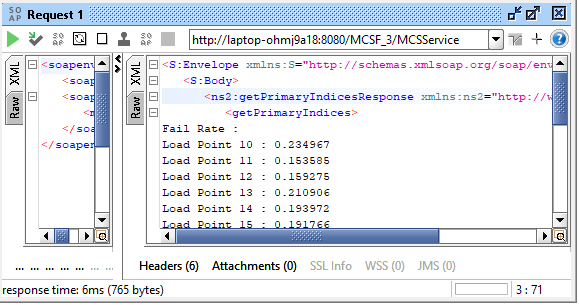


Figure 2: SOAP\_UI test response for failure rate of Feeder-3

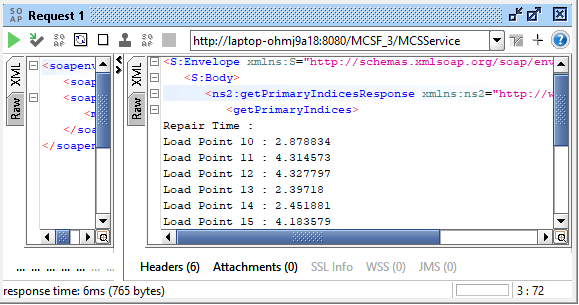


Figure 3: SOAP\_UI test response for Repair time of Feeder-3

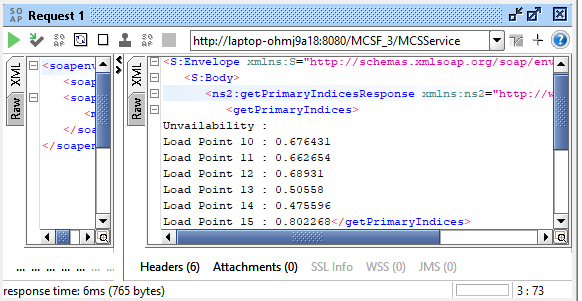


Figure 4: SOAP\_UI test response for Unavailability of Feeder-3

Secondary Indices were computed using Web service and MCS service was tested in SOAP-UI. The following results were obtained for SAIFI, SAIDI and CAIDI for feeder-3.

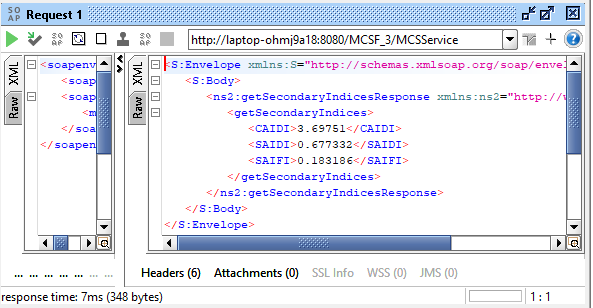


Figure 5: SOAP\_UI test response for Secondary Indices of Feeder-3

Customer damage function was calculated using the MCS service which is essential in evaluating cost/worth indices for feeder-3. Depending on the type of customer, CDF was computed [6]. SOAP-UI test response for CDF was obtained for each load point of feeder-3 as depicted in figure-6.

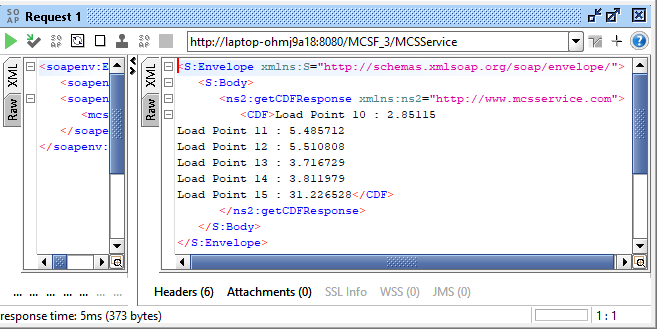


Figure 6: SOAP\_UI test response for Customer Damage Function of Feeder-3

Cost worth indices were obtaines [6] as shown in figure-7, figure-8, figure-9.

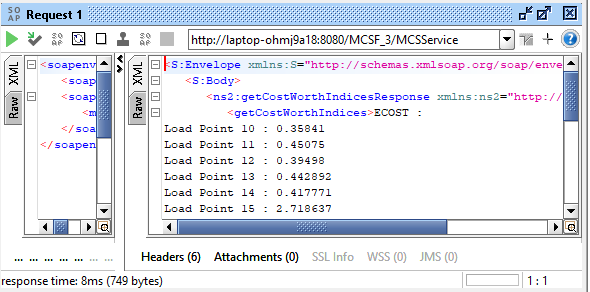


Figure 7: SOAP\_UI test response for ECOST of Feeder-3

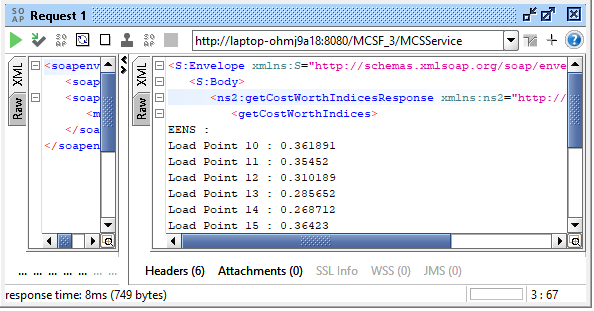


Figure 8: SOAP\_UI test response for EENS of Feeder-3

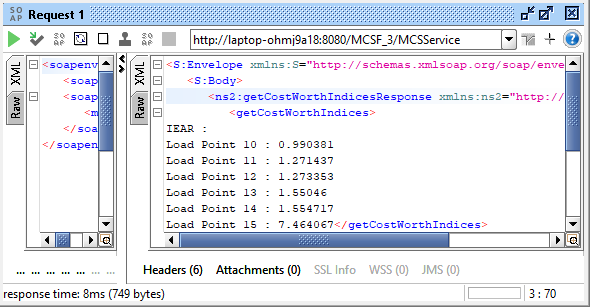


Figure 9: SOAP\_UI test response for Customer Damage Function of Feeder-3

**SUPPORTING REFERENCES:**

1. https://www.soapui.org
2. R. Billinton and R. N. Allan, Reliability evaluation of power Systems, 2nd ed. New York, NY, USA: Plenum, 1996.
3. Roy Billinton and Ronald N. Allan, Reliability evaluation of engineering systems: concepts and techniques, 2nd ed. Springer Science+Buisiness Media New York, 1992.
4. R. N. Allan, R. Billinton, I. Sjarief, L. Goel, K. S. So, “A Reliability test system for educational purposes - basic distribution system data and results,” IEEE Transactions on Power Systems, Vo1.6, No. 2, May 1991.
5. Roy Billinton and Satish Jonnavithula, “A test system for teaching overall power system reliability assessment*,”* IEEE Transactions on Power Systems, Vol. 1 1, No. 4, November 1996.
6. Roy Billinton and Peng Wang, “Distribution System Reliability Cost/Worth Analysis Using Analytical and Sequential Simulation Technique”, IEEE Transactions on Power Systems, Vol. 13, No. 4, November 1998.