



# Predicting Software Reliability

Allen P. Nikora  
Software Quality Assurance Group,  
Quality Assurance Office  
Jet Propulsion Laboratory,  
California Institute of Technology  
[Allen.P.Nikora@jpl.nasa.gov](mailto:Allen.P.Nikora@jpl.nasa.gov)

This research was carried out at the Jet Propulsion Laboratory, California Institute of Technology, and was sponsored by the U. S: Air Force Operational Test and Evaluation Center (AFOTEC) through an agreement with the National Aeronautics and Space Administration.

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement by the United States Government or the Jet Propulsion Laboratory, California Institute of Technology.



# Outline

- Software Reliability Overview
- CASRE – Computer Aided Software Reliability Estimation
  - ◆ Overview
  - ◆ Features
  - ◆ Sample Output



# Software Reliability Overview

- Definition: “The probability that a software system will operate without failure for a specified time in a specified environment.”
- Many statistical models have been developed to estimate and predict software reliability during operational use from failure behavior observed during test:
  - ◆ Input
    - Time between subsequent failures, or
    - Number of failures observed in each test interval, and the length of each test interval
  - ◆ Output
    - Probability density function for time to next failure, or
    - Probability density function for number of failures that will be observed in next test interval.



# Software Reliability Overview (cont'd)

- Using model results:
  - ◆ Determine whether required reliability has been achieved (can the system be shipped?).
  - ◆ Predict the resources (e.g., testing time, number of testers, computing time) that will be required to achieve the required reliability.
  - ◆ Quantify impact if insufficient resources are available to achieve required reliability.



# CASRE – Computer Aided Software Reliability Engineering

## Overview

- ◆ Windows-based tool for estimating and predicting software reliability during test.
- ◆ Developed at JPL under sponsorship of U.S. Air Force Operational Test and Evaluation Center.
- ◆ Version 3.0 available at no charge from Open Channel Foundation:
  - [http://openchannelfoundation.org/projects/CASRE\\_3.0](http://openchannelfoundation.org/projects/CASRE_3.0)
- ◆ Awards:
  - 2002 - Space Act Award
  - 2003 - NASA Inventions and Contributions Board Award



# CASRE – Computer Aided Software Reliability Engineering (cont'd)

## Features

- ◆ Most popular models

### Time Between Failures Models

- Geometric
- Jelinski-Moranda
- Littlewood Verrall (Linear or Quadratic)
- Musa Basic
- Musa Okumoto (Logarithmic Poisson)
- Nonhomogeneous Poisson Process

### Grouped Data Models

- Generalized Poisson
- Nonhomogeneous Poisson Process
- Schneidewind Model
- Yamada S-Shaped Model

- ◆ Failure data trend analysis – determine if failure data exhibits reliability growth
  - Laplace Test
  - Running Arithmetic Average
  - Don't apply models to data that does not exhibit reliability growth



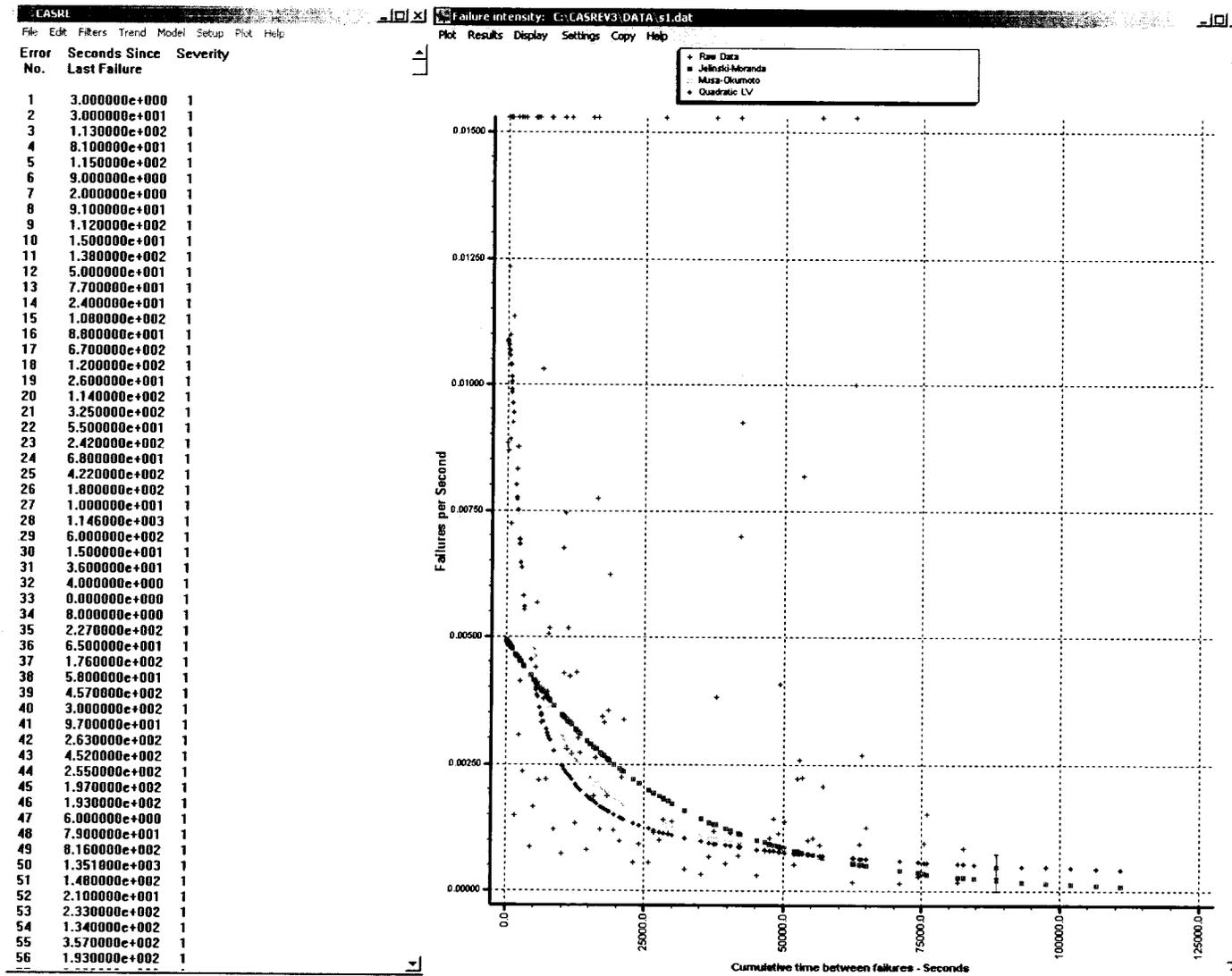
# CASRE – Computer Aided Software Reliability Engineering (cont'd)

## ■ Features (cont'd)

- ◆ Graphical display of results
  - ✦ Time between failures
  - ✦ Failure intensity
  - ✦ Reliability
  - ✦ Model applicability criteria
  - ✦ ...and more
- ◆ Goodness of fit
- ◆ Model ranking



# CASRE – Computer Aided Software Reliability Engineering (cont'd) – Sample Output



Estimated and Predicted Failure Intensity