

Motivation

Traditional reliability methods are increasingly challenged in developmental testing (DT): increasingly complex systems and limited test time.

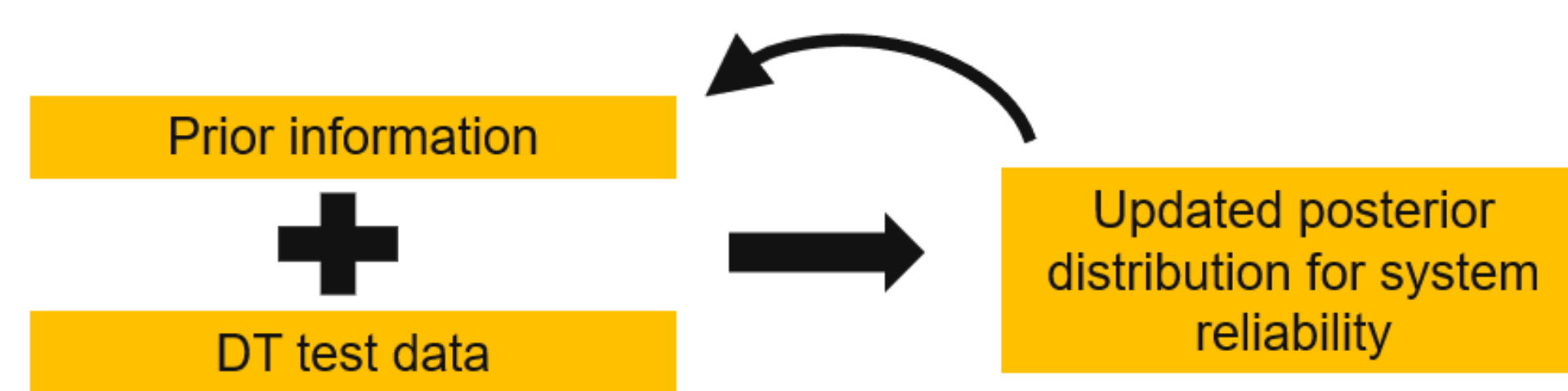
Bayesian methods can combine data consistently across test segments and include additional information beyond the test.

Given their promise, Bayesian reliability methods could be more widely applied.

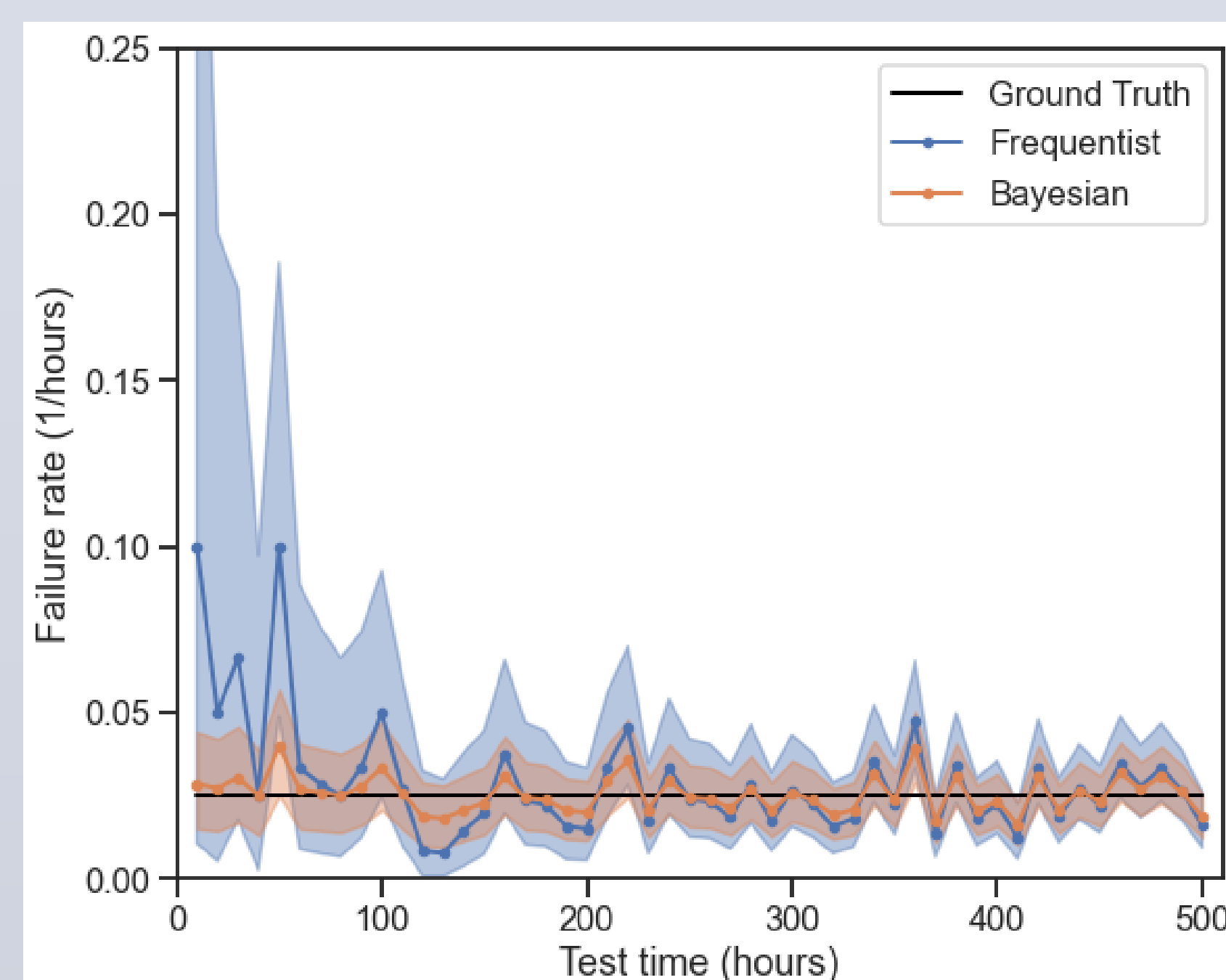
Study goal: provide a set of recommendations to assist the practical use of Bayesian reliability methods in DT.

Bayesian Reliability Analysis

Bayesian reliability analysis combines **prior information about the system** with **test data** to obtain a **probability distribution for a reliability metric**, e.g., a system failure rate.



E.g., Bayesian analysis provides a more precise estimate of failure rate in notional system with limited test data.



Subject Matter Expert (SME) Interviews

The study consisted of interviews with 12 SMEs at IDA and in Service test organizations.

Key Lessons Learned

Reliability analysis should be focused on reducing program risk.

- It is important to make reliability more than a “box-checking exercise.”
- Reliability assessments should highlight the impact of reliability shortfalls on mission success.

Reliability analysts should attempt to be involved in the program as early as possible

- Early involvement provides analysts with necessary background.
- Early involvement enables analysts to influence test planning and data storage strategy, which will benefit future analysis.

Useful analytic tools are straightforward to understand and communicate.

- Any complex method, e.g., Bayesian analysis, should be used only if it provides a clear benefit over more standard methods.

The experience and knowledge of the service test organizations is valuable.

- Army: U.S. Army Combat Capabilities Command, Data Analysis Center; and the Army Test and Evaluation Command (ATEC)
- Navy: Operational Test and Evaluation Force (OPTEVFOR)
- Air Force: Air Force Operational Test and Evaluation Center (AFOTEC)
- Marines: Marine Corps Operational Test and Evaluation Activity (MCOTEA)
- OSD/DTE&A: STAT Center of Excellence (STAT COE)
- Caveat: these organizations are often focused on OT rather than DT.

Best Practices

Overarching perspective: the goal of reliability analysis is to help DT programs make more informed decisions within a complex and constrained test environment.

Many of these best practices are common sense to experienced analysts.

Working with the Decision-Making Environment

1. Explain how reliability impacts program goals, e.g., mission, cost.
2. Get early visibility into programs.

Determining Analytic Goals

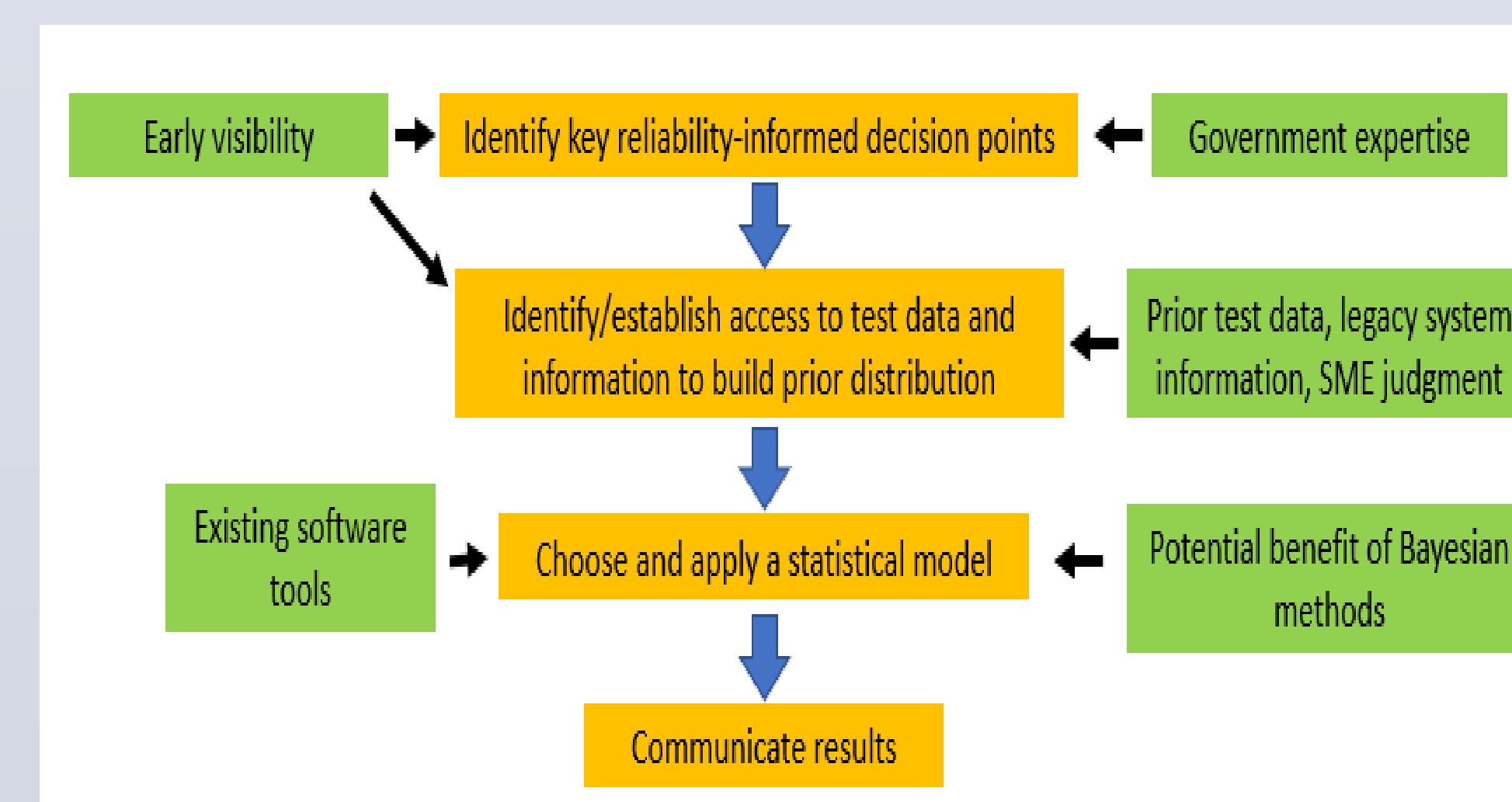
1. Follow a risk reduction approach.
2. Access government expertise, e.g., OTAs.

Choosing a Bayesian Method

1. Use Bayesian method only if it provides a clearly identifiable benefit over standard methods.
2. Access government expertise, e.g., OTAs.

Applying the Model

1. Exploit existing software tools.
2. Focus on credibility of the prior distribution.
3. Communicate results in relatable terms.



Summary

This study identified best practices to guide the analyst in the application of Bayesian reliability analysis in DT programs.

The study combined SME interviews with a review of Bayesian models in the literature to identify best practices.

The practices focus on enabling the analyst to inform relevant decisions in a complex and constrained DT test environment.

Selected References

1. M. Ambroso, A. Kelley, and A. Wilson. Reliability Basics: Key Reliability Concepts for DT&E. IDA Paper NS-P-4925 (2013).
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