Availability – the simplified academic view

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Introduction

Availability is a systems performance parameter that is misused and misunderstood across the world of defence acquisition.

The introduction of a repair capability that will restore a system to an operational state means that we can use availability as a systems performance measure. Availability depends on both reliability and maintainability; I will also show how the effectiveness of the support chain is a major factor in measuring and predicting operational availability.

The academic approach to measuring and predicting availability states that there are three types of availability – inherent, achieved, and operational. All of which will be discussed in this article. Within some defence organisations there are up to 40 different definitions of availability; something which over-complicates a quite straightforward subject.

Definition

We can begin with the general observation that:

$$Availability = \frac{Uptime}{Uptime + Downtime}$$

The above equation is only useful from a historical standpoint in which, over a period, total uptime and total downtime will allow us to calculate the percentage of time the system was available. In the acquisition space our focus should be on being able to predict availability. Indeed, many of the requirements documents produced contain availability requirements.

Availability is the probability that a system or component is performing its required function at a given point in time or over a stated period when operated and maintained in a prescribed manner [Ebeling, Chapter 11.1].

Concepts

There are three different forms of steady state availability which depend on the definitions of uptime and down time – these are discussed in the following narratives.

Inherent Availability

Inherent availability (Ai) is based solely on system failure and repair time distributions. Consequently, Ai can be viewed as a system or component design parameter on which we can base reliability and maintainability trade offs during the design trade off process. When predicting Ai, we must be careful to understand that we are only considering corrective maintenance time and must not include preventive maintenance time yet. The inherent availability equation is as follows:

$$Inherent\ Availability = \frac{MTBF}{MTBF + MTTR\ (Corrective)}$$

To be of value, the Mean Time Between Failure (MTBF) must be correctly calculated to reflect the failure distribution being considered.

Achieved Availability

Achieved availability (Aa) brings into consideration the preventive maintenance dimension. Clearly, during the design process, we need to consider the maintenance periodicity. If preventive maintenance is carried out too frequently it can have a negative effect on Aa despite having a positive effect on MTBF. Very short preventive maintenance intervals resulting in frequent downtimes will detrimentally affect system availability, so the preventive maintenance interval must be balanced against factors such as MTBF and safety to arrive at an optimal position. The achieved availability equation is as follows:

$$Achieved\ Availability = \frac{MTBF}{MTBF + MTTR\ (Corrective + Preventive)}$$

Operational Availability

Operational availability (Ao) brings into consideration all supply (logistic) and maintenance delay times as part of the unscheduled downtime. This is useful when there is queuing for spares, backorders or maintenance. Consequently, this knowledge is also very useful when undertaking trade offs for spares ranging and scaling or for establishing repair channels. From a product design standpoint inherent or achieved availability is of more interest because spares and repair capability sit outside product design. However, from a support solution perspective the entire landscape is important to be able to achieve an optimal solution. The operational availability equation is as follows:

$$Operational\ Availability = \frac{MTBF}{MTBF + MTTR\ (Corrective + Preventive) + MTTS}$$

Discussion Points

If, as we can see from the foregoing, availability is a relatively straightforward concept, why is it that various Government departments throughout the world have so much difficulty with understanding it? Why is it that stated acquisition requirements contain unachievable operational availability targets? When, for instance, an aircraft spends 25% of its life on the ground undergoing preventive maintenance, is it not understood that the maximum Ao that can be achieved is 75% (with no failures or logistic delays)?

There appears to be a fear of telling the truth about operational availability because advertising the true figures puts the design community in a poor light. This should not be the case. There needs to be a realisation that, in the case of an aircraft for instance, there are very sound airworthiness reasons why the aircraft undergoes significant periods of preventive maintenance. The same can be said for submarines and ships.

It is interesting to note that in the civil air world operational availability is measured in a very different way. Despatch reliability is used as a measure of how often the aircraft leaves the departure gate on time with the support system being designed to accommodate this system performance parameter. Could a modified version of despatch reliability apply in the military system performance world?

The foregoing is a personal view: Pennant International would welcome additional and alternative comments and views from all quarters.

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