UNITED KINGDOM CHAPTER

The Holy Grail of Supportability - Downtime

Availability is the outcome that equipment logistic support must deliver – *the ability to use a system when required*. It is the most commonly used measure of Support. Better, affordable availability is a universal objective but it is not generally well understood, frequently inappropriately specified, complex to measure, hard to forecast and can only be managed indirectly. Simple system-level availability metrics for required levels using standard rules-of-thumb are very often inappropriate and do not include all factors. In-service availability is often worse than desired and at greater cost than anticipated. **The common perception that availability is the appropriate key to delivering Support needs is misleading because it is an outcome.**

Measuring positive success is a natural approach but direct metrication and management of availability is very hard because it is the outcome of many complex interacting contributors that are difficult to separate and independently quantify. Improvement only comes from removing or reducing the causes and significance of unavailability. **Measures to improve availability must focus on the causes of unavailability which manifest as Downtime. Downtime should be the preferred means to identify, prioritise and direct management actions and to measure their success. The outcomes will be improved availability and cost.**

Direct measurement and management of Downtime is the Holy Grail of Support.

Definition of Supportability

Availability, reliability, maintainability and testability are well defined scientifically albeit that practical applications in Defence are often inappropriate simplifications of the complex reality. For example, although summarised as the ratio of Uptime / Uptime + Downtime, availability is usually expressed in terms of Mean Time Between Failure (MTBF) as the measure of Uptime with Mean Time to Repair (MTTR) to reflect Downtime. Unfortunately, MTBF does not always describe the usage between failures. Without getting too mathematical, that only applies if items fail in a Normal Distribution. Most systems fail randomly (exponentially) which means that nearly 2/3 fail by the MTBF, not half.

Similarly many causes of non-availability such as to repair bird strikes, weather or damage caused by operators or maintainers, and Battle Damage are excluded as non-attributable failures. For contractual reasons, these occurrences are always excluded from system design requirements. Planned combined maintenance and upgrade minimises time and effort as access, component replacement and functional testing activities can be combined but these are also usually excluded from availability definitions. In short, **classic availability and related definitions do not reflect all causes and consequences of non-availability**.

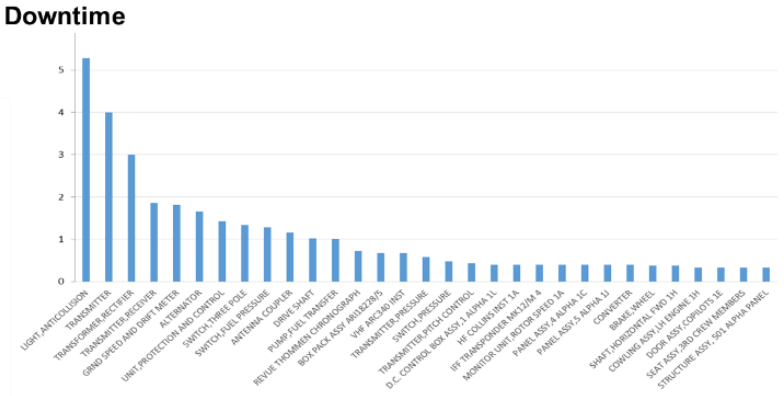
In contrast to ARM&T, there is no commonly accepted definition of Supportability. For this paper, ***Supportability is defined as the responsiveness to unreliability that prevents a system's use***. In other words, '***when there's a problem on a system, how quickly can its utility be restored?'***.[1] In many ways, it is a direct measure of system resilience.

System 'unsupportability' can be measured directly as the sum of all Downtime in an operating scenario for preventive and corrective maintenance, condition-based monitoring (CBM), and delay times. **It is the product of frequency of the event (which may be related to reliability and all non-attributable arisings)) and maintenance time (TTR, preventive maintenance duration, upgrade time) and includes Administrative & Logistic Delay Time awaiting resources.**

$$\textbf{Downtime} = \sum(\boldsymbol{TTR + PM\ Time + CBM\ Time + ALDT})$$

[1] Exeter University's academic definition is centred on the transition time from a State of Failure to a State of Functioning.

Software tools already exist that can perform these calculations using RCM, LSA and scenario data. The histogram below illustrates how Downtime calculated in this way is a single metric of time. It can be directly quantified for each maintenance activity and allocated to components and activities. The total area under the curve can be aggregated to a single number describing the whole System to inform Support decisions and priorities on how to deliver more affordable availability. It can be both calculated from projected design data and updated directly from in-service feedback.



A similar and related curve for the cost of each maintenance activity can be derived from the sources. Together, these provide the critical analysis outputs to drive Support improvement. The focus should be on the ~15% of activities and items that cause ~80% of Downtime and cost. Less effort can be expended on quantifying and improving the long thin tail where benefits will be smaller; any important issues will emerge from in-service data feedback.

Resilience

Recent developments in the unstable geostrategic environment have revealed the progressive hollowing out to deliver post-Cold War Peace Dividends that must be reversed to provide greater availability and improved resilience. This does not override the imperative of affordability to help meet the challenge of considerable additional defence spending.

Resilience is defined as the capacity to recover quickly from difficulties - to spring back into shape. This is almost synonymous with Downtime. The current vogue, especially from within industry as it is in their commercial interests, is that greater resilience comes from increasing spare parts inventory. In practice, system resilience is more complex with multiple factors. Excluding consumables and weapon stocks, the non-availability of spares typically accounts for less than 3% of system downtime whereas the biggest driver of downtime is preventive maintenance to ensure safety especially on aircraft.

Classic steady-state, cost-based resource optimisation is inevitably knife-edged. Solutions must become more tolerant to greater uncertainty from data variances and alternative unpredicted scenarios to enable risk-based perspectives. Individual and collective training exercises, surge, deployments, contingencies and potential conflicts all require different resource holdings. And all are potentially subject to unpredictable enemy action requiring commanders to make decisions on whether to surge to break interdictions or slow down to survive siege.

To add further complications, lessons from Afghanistan, Iraq and elsewhere revealed clearly that maintenance policies originally derived for stable peacetime training at predetermined locations will be inappropriate. Global deployments to new forward operating bases in host nations or in mobile carrier-based groups drive the need for variable repair and maintenance policies with different resource needs and supply chains; ie, different Support arrangements.

Contingency and war reserves must be restructured, rebuilt and almost certainly expanded to sustain platform availability but affordability remains the balancing factor. **However, reducing Downtime always means more operational availability and resilience of useable Systems.**

Downtime as a IPS Driver

Reducing Life Cycle Cost (LCC) to deliver specified availability requirements in defined usage patterns has been the underlying philosophy of ILS/IPS. This fundamentally economic perspective has been the primary driver throughout the Cold War and ever since.

The presumption, shared by industry suppliers, is that Support arrangements will be shaped and sized to meet the required operational availability demand. But there is little understanding of the relationship between task achievement and required availability. The acquisition of sufficient

platforms is the primary driver with downstream Support consequences to be addressed later. While useful to inform comparison of design and Support system choices, LCC predictions are rarely accurate and so are not credited with their full significance during acquisition when early program costs are more urgent and significant. At best, initial 5-year Support packages and early operating and support (O&S) cost estimates are included. Even these estimates are rarely tested for accuracy and risk as they are presumed to be contractable. Thus, Support affordability is only roughly estimated, often inaccurately with optimistic 'entry-ism' understatements to ensure project survival.

The previous white paper[2] showed that availability metrics are inadequate to predict, measure and manage system achievement and can be 'Emperor's New Clothes'. The logistics engineering interactions of design, usage and Support are too complex and dynamic, and typical simplifications erode or corrupt much of the important underpinning detail and weaken their credibility. Given global unpredictability, the focus should shift from attempting to estimate availability outcomes to identifying and then managing the root causes of unavailability for which Downtime is a primary consequence.

Managing Downtime should become the IPS driver to achieve the required balance of demanded availability and cost.

Summary

Historically, the fundamental economic objective of ILS/IPS activity has been to meet the specified level of availability in a given scenario for the minimum LCC. But in the emergent geostrategic environment, the hollowing out of military capability must be reversed to restructure, rebuild and almost certainly expand contingency and war reserves to sustain platform availability while affordability remains a balancing factor.

Increased affordable availability is a universal objective. Experience in many fields, and common sense, has shown that it is much easier and more cost-effective to identify and remove the causes of failure than to enhance success by further enhancing what is already good. Seeking improvement in availability is natural but direct metrication and management of availability is very hard because it cannot be directly adjusted. It is the outcome of many complex interacting contributors that are difficult to separate and independently quantify. Improvement only comes from removing or reducing the causes and significance of unavailability. Availability outcome metrics are inadequate to predict, measure and manage system achievement and can be 'Emperor's New Clothes'. Classic availability and related definitions do not reflect all the causes and consequences of non-availability.

The common perception that availability is the appropriate key to Support needs is mystique.

In contrast to ARM&T, there is no commonly accepted definition of Supportability but one could be the **responsiveness to unreliability that prevents a system's use**. In other words, '**when there's a problem on a system, how quickly can its utility be restored?'** It directly measures resilience.

Thus, Downtime should become the preferred measure of unavailability to identify, quantify and direct management action and measure success**. Reducing Downtime always means more operational availability and resilience of useable Systems.**

Downtime can be measured directly as the sum of all time that a system is unavailable in a particular operating scenario due to preventive and corrective maintenance, condition-based monitoring, and delay times. **It is the product of frequency of events (which may be related to reliability and all non-attributable arisings)), maintenance time (MTTR, maintenance duration, upgrade time) and Administrative & Logistic Delay Time for resources.**

Together with similar related information for the cost of each maintenance activity derived from the same sources, these 2 analysis outputs provide the critical information needed to drive Support improvement. Software tools already exist that can perform these calculations using RCM, LSA and scenario data.

Managing Downtime should be the IPS driver to achieve the required balance of demanded availability and cost. Direct measurement and management of Downtime is the Holy Grail of Support.

The next White Paper will explain how applying this approach in key IPS areas provide the Path to Effective, Affordable and Profitable Support.

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[2] The Mystique of Availability. Mystique can be defined as having *a reputation of mystery, glamour, and power that is impressive or baffling to those without specialized knowledge*. Many non-specialists have not studied the subject of availability sufficiently but believe and trust in it.