Availability

Definitions

- **Reliability** is the probability an item (e.g., system, subsystem, or component) will perform its intended function with no failure for a stated period of time (or number of demands or load) under stated environmental conditions. Other words, reliability is the probability an item will be in an **uptime** state (i.e., fully operational or ready to perform) for a stated mission.

- **Maintainability** is the probability that a failed item will be restored or repaired to a specified condition within a period of time. Other words, maintainability is the probability an item in a downtime state will be returned to an uptime state within a given period of time.

- **Availability**, a function of Reliability and Maintainability (R&M), is the probability a repairable item will perform its intended function at a given point in time (or over a specified period of time) when operated and maintained in a prescribed manner. Other words, availability is the probability of an item's mission readiness, an uptime state with the likelihood of a recoverable downtime state.

- <u>Note</u>: It is availability and not reliability that addresses **downtime** (e.g., time for maintenance, repair, and replacement activities). It is important to determine if the management question or system requirement is limited to reliability (only uptime) or if it pertains to availability (uptime with recoverable downtime in the near term).

Types of Availability

- As with reliability and maintainability, availability can be either a demonstrated (descriptive) or predictive (inferential) measure of performance—and as with any probability measure, its value is in the interval [0, 1], cannot be less than zero and cannot be greater than one.

- **Demonstrated availability** = (uptime) / (uptime + downtime) = (uptime) / (total required time).

- **Predictive availability** has three types as listed below. Each type uses different definitions for uptime and downtime, especially on the amount of detail to describe downtime (see next page).

    - Inherent availability

    - Achieved availability

    - Operational availability

- In regards to time and the mission, **predictive availability** has three types:

    - Point (instantaneous) availability at time t.

    - Average (interval, mission) availability during the time period from t_1 to t_2.

    - Limiting (steady-state, asymptotic) availability is the fraction of time that a repairable item is in an uptime state as time becomes large assuming a limit exists.

- **Inherent availability** is based solely on the failure distribution (reliability math model) and the repair distribution (maintainability math model). Inherent availability is an important design parameter and is one type of effectiveness metric used in trade studies.

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Downtime and Uptime Differences by Predictive Availability Type

Inherent Availability (A_{inh})[1,2]	Achieved Availability (A_a)[1,2]	Operational Availability (A_O)[1,2]
… is the probability that an item (e.g., system) when used under stated conditions …		
…in an *ideal support* environment will operate satisfactorily at a stated time. Downtime …		…in an *actual* environment will operate satisfactorily at a stated time. Downtime …
Includes: • Corrective or unscheduled maintenance actions, ❖ This makes the mean time to repair (**MTTR**).	Includes: • Corrective or unscheduled maintenance actions, • Preventive or scheduled maintenance actions, ❖ These two make the mean system downtime ($\bar{\mathbf{M}}$).	Includes: • Corrective or unscheduled maintenance actions, • Preventive or scheduled maintenance, • Logistics delay time, and • Administrative delay time actions. ❖ These four make the mean time to restore (**MTR,** also denoted as $\bar{\mathbf{M}}'$).
Excludes: • Preventive or scheduled maintenance actions, • Logistics delay time, and • Administrative delay time.	Excludes: • Logistics delay time, and • Administrative delay time.	
Notes: [1] <u>Uptime</u> differences: Inherent availability uses the mean time between failure (**MTBF**). Achieved availability and operational availability use the mean time between maintenance (**MTBM**). [2] From a system design point of view and especially in regards to collecting the required input data, inherent availability is easier to determine than achieved availability, and achieved availability is easier to determine than operational availability. Operational availability involves resources and trade-offs external to the design engineering organization.		