Writing by design, Part 2
Writing Good Specifications

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E.F.C. LaBerge

Requirement Documents

- You will be (or are in the process of) writing one
- May be combined with a system design document…
- …the Iridium Air Interface Spec is the best example I've ever seen.
- (I'll try to get a partial copy)
- Follow the rules I gave earlier
  - Audience
  - Purpose
  - Write by Design

Specifications = Requirements

- In a spec or requirements document the purpose to to clearly describe what the product will do…
- …without describing how the product will do it…
- …unless the method is specifically determined by a stakeholder
- A good spec will let two competing teams create different, compliant designs
- Your audience is the people (engineers) who will actually design and build the equipment
- Specifications are formal writing, and have some well-established guidelines, particular about language
- Short sentences and short, well-enumerated paragraphs are normal

Defining the "requirement verbs"

- "shall", "will", "must", "should", "may"
- Use "shall" for mandatory items that will be tested
- "Will" is frequently used to describe intent or establish context; not for requirements
- "Must" is frequently used to describe user actions, but occasionally used as a synonym for "shall"
- "Should" indicates a desired action or function or a recommended but not required attribute.
  - "Shoulds" may become requirements due to higher level documents: "shall perform all the recommended actions in document xxx".
- May is permissive, and is generally used to specifically allow certain implementation options.

Example requirements

2.2.5.1.3 Transfer Delay Performance

For the purpose of computing transfer delay statistics, the *mean transfer delay* is the arithmetic average of the transfer delay of all blocks delivered by the system. The *95th percentile* transfer delay is the 95th percentile of the delivery time for all blocks submitted to the system.

Text uses "is" for definitions

Note: *These definitions are subtly different. Undelivered blocks, if any, can be viewed as an infinite delay. Undelivered blocks are not included in the computation of mean transfer delay. Undelivered blocks are included in the computation of 95th percentile transfer delay.*

Clearly delineated explanatory text

2.2.5.1.3.1 Chapter 4 SARPs-Compliant Systems

An AMS(R)S subnetwork conforming to Chapter 4 SARPs shall provide transfer delays not greater than the following for a standard 128-octet block:

Simple statement of requirement

Use of table

AMS(R)S Priority Level	Direction	Mean	95th Percentile
Lowest	To-aircraft	40 s	110 s
Lowest	From-aircraft	60 s	110 s
Highest	To-aircraft	12 s	15 s
Highest	From-aircraft	40 s	80 s

Source: *Minimum Aviation System Performance Standards for the Aeronautical Mobile Satellite Service (AMS(R)S) as Used in Aeronautical Data Links,* DO-270, RTCA: Washington, D.C., 2001

Requirements example

2.2 MINIMUM PERFORMANCE REQUIREMENTS - STANDARD CONDITIONS

2.2.1 VDL Mode 2 Physical Layer Requirements

All Class X and Class Y transceiver equipment shall meet the VDL Mode 2 physical layer requirements contained in the following subparagraphs.

2.2.1.1 Transceiver Requirements

Unless otherwise stated, all transceiver requirements shall be applicable under room temperature (25° C) condition and with the transceiver tuned to any 25 kHz channel from 118.000 megahertz (MHz) to 136.975 MHz.

2.2.1.1.1 Tuning Range and Channel Increments

The transceiver shall be tunable to any 25 kilohertz (kHz) channel, from 118.000 MHz to 136.975 MHz (760 channels) as defined in SARPS / ICAO-Annex 10-Volume III-Part I.

NOTE: *Manufacturers should note that in the future, part or all of the frequency band 108.000 to 117.975 MHz may become available for air-ground communications.*

"shall meet … subparagraphs". Instead try "The following subparagraphs contain requirements…"

Complete, simple, unambiguous requirement, with source reference

This "shall" defines test conditions, not functional performance

Clearly identified clarification text

Source: *Minimum Operational Performance Standards for Airborne VDL Mode 2 System Operating in the Frequency Band 118-136.975 MHz (DRAFT),* ED-92A, Eurocae: Paris, 2002

RTCA SC222/WP052 30 Sept 2010

2.2.2 Standard Operating Conditions

2.2.2.1 Standard Operating Environment

At the AMS(R)S system level, the standard operating conditions for the purpose of determining system performance shall be as established by the traffic model defined in [Appendix D?].

The satellite subnetwork shall meet its allocated requirements during straight and level flight in oceanic airspace. For the purpose of .this document, *oceanic airspace* is defined as airspace along national or international air routes that is beyond [160 nmi] from a land-based VHF radio station providing AMRS communications. [4]

2.2.2.2 Standard Data Message

The standard data message shall consist of [one ACARS block of 220 character bytes of user input data] of controller or pilot-defined information, along with associated checksums and protocol headers defined by the SBB and other intermediate systems.

Note: The intent of the standard data message definition is to establish a test condition for system delay. There is no requirement to partition longer transactions s into [220 byte] segments.

2.2.2.3 Standard Services

2.2.2.3.1 Basic ACARS

The SBB safety service shall support RCP240 as defined in GOLD by means of Basic ACARS capability. This service shall be equivalent to that currently supported by Inmarsat's "Classic Aero" service.

Operational requirement captured in system specification

Technical details removed to an appendix

Minimum performance reference to GOLD document

Requirement establishing how the system will be evaluated

Tabular Form

2.3.1 Data Services

ID	Title	Requirement	Reference / Source
D10	RCP240 CPDLC TT	The **SYSTEM,** if used for RCP240 applications, **SHALL** provide a **TWO-WAY TRANSIT DELAY** of 100s or better for 95% of all CPDLC messages transmitted by the ATSP as measured in a 1-month period.	GOLD B.2.1.2
D20	RCP240 CPDLC ET	The **SYSTEM,** if used for RCP240 applications, **SHALL** provide a **TWO-WAY TRANSIT DELAY** of 120s or better for 99.9% of all CPDLC messages transmitted by the ATSP as measured in a	GOLD B.2.1.2

Functional Requirements

- What actions must your "verb phrase" perform
  - Use "shall" to denote requirements
  - Use "should" to denote desirable attributes that are optional
- Describe "what" not "how", unless "how" is absolutely essential to the function
  - Do not write the requirement to require your design…
  - …recognize that there are other options.
    - …shall provide Category III accuracy at all runways
    - …shall provide lateral and vertical guidance information, basic airport data and auxiliary data when appropriate
    - …shall include fast forward, rewind, and record functions

Performance Requirements

- How well must the function be performed?
- Performance requirements must be quantitative
  - …shall complete processing in 1 second
  - …shall have a vertical error of less that +/-2 ft, 95% of the time.
  - …shall provide a probability of detection of 95% with a signal level of -105 dBm.
  - …shall service at least 100 simultaneous users
  - …shall operate as specified between -55 C and +70 C
- When you establish the requirement, sketch out the test method as well.
- If you can't envision a test, it isn't a requirement.

Test Requirements

- Set the conditions and procedures for testing that a requirement is met.
- Generally, test requirements are pass/fail, and are not designed to quantify performance.
- Quantifying performance falls in the realm of engineering tests, part of assuring that the design works as intended.
- …standard test conditions shall be 70 F, no vibration, 30-50% relative humidity
- …tests shall be conducted every ten channels across the tunable range of the radio
- …the receiver shall meet the requirements of 2.4.1 95% of the time in a 1200 second sample.

Verification

- Test: a repeatable, quantifiable measurement of some characteristic of the equipment or system, usually a performance requirement
- Demonstration: a repeatable qualitative indication that the equipment has some characteristic or performs some function
- Inspection: a repeatable qualitative, usually visual examination of the product, usually for some physical characteristic (color, texture, etc)
- Analysis: a mathematical extrapolation of system performance based on the design details which may be used to satisfy a performance requirement that requires an extremely long time to test.

General outline

- Introduction, including purpose and scope, an overview of the system being specified, reference documents and a rough road map to the specification document
- A list of related specifications that will be referred to in your design: e.g. USB, Bluetooth, 802.xx, etc.
- Functional Requirements, "do this", "don't do that"
- Performance Requirements, which must contain quantifiable, testable values
- Test Requirements indicate how the device or system is to be tested and performance and functions verified.
- Design Requirement indicate specific, usually standardized process that must be employed in the design, development, assembly, and verification
- Installation Requirements (?)

Summary

- Follow directions
- Use the verbs
- Organize your document
- It's not a requirement if it isn't testable!
- It's not a requirement if it isn't testable!
- Requirements are what the product has to do, not how the product has to do it…
- …unless necessary for standardization.