AVIONIC SYSTEMS STANDARDISATION COMMITTEE

PACKAGING SYSTEMS SUBCOMMITTEE

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SIGNAL DATA CONCENTRATOR REQUIREMENTS

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Members of the Subcommittee

0 EXECUTIVE SUMMARY

This document has been prepared by the ASSC Packaging Working Group to provide guidance on the design and installation of Signal Data Concentrators (SDCs) for use in military aircraft. It is intended to be applicable both to future aircraft and to retrofits. As yet, it does not incorporate any practical experience gained by the use of SDCs.

An SDC is a device that translates information from a variety of sources on the aircraft into a standard digital form usable by the computing resources in avionic systems. It also converts data from the computing resources into formats desired by the aircraft systems.

An SDC as a whole is made up from a collection of standard elements, Line Replaceable Interface Modules (LRIMs), which are covered by these requirements. It gives the opportunity of 1st line maintenance at module level.

Although this requirements document has been prepared primarily for military application, much of the information is equally applicable to civil avionics, and wherever possible, commonality has been sought with the ARINC 655 Remote Data Concentrator.

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GLOSSARY

ARINC	Aeronautical Radio Inc.
EMH	Electromagnetic Hazards
EMP	Electromagnetic Pulses
IMA	Integrated Modular Avionics
LRIM	Line Replaceable Interface Module
RDC	Remote Data Concentrator
SAE	Society of Automotive Engineers
SDC	Signal Data Concentrator

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1 INTRODUCTION

1.1 The Need for SDCs

Signal Data Concentrators are primarily required to fulfil two functional requirements:

i An interface mass/complexity reduction function

A Signal Data Concentrator (SDC) comprises a small number (2-9) of common module types (typically analogue, digital, discrete etc [see below]), interconnected to a controlling module. These modules and their interconnections, are contained within an enclosure (the SDC). Functionally, the SDC is a bi-directional data converter, incorporating multiplexing and demultiplexing. SDCs interface to the aircraft Global Data Network, so providing the interface between the aircraft's IMA core and its sensors and actuators. Positioning SDCs near to signal sources permits reductions in aircraft wiring mass and complexity.

ii A core avionic protection function

The remote placement and interfacing capability of the SDC will provide protection of the core IMA system from external effects such as lightning and EMP and improved isolation of faults.

1.2 Scope

This requirements document has been prepared by the ASSC Packaging Working Group to provide:

i Information on the implementation requirements of SDCs for both future aircraft and retrofits (eg In-service updates)

ii Initial details of the internal implementation and specification of SDCs and their component parts.

1.3 Reference documents

ARINC 600, "Air Transport Avionics Equipment Interfaces"
ARINC 650, "Integrated Modular Avionics Packaging and Interfaces"
ARINC 655, "Remote Data Concentrator (RDC) Generic Description"
Def Stan 00-18 (Part 2), "Serial, Time Division, Command/Response Multiplex Data Bus"
Def Stan 00-55, "The Procurement of Safety Critical Software in Defence Systems"
Def Stan 00-56, "Safety Management Requirements for Defence Systems"

2 INTERCHANGEABILITY & ARCHITECTURE CONSIDERATIONS

2.1 Introduction

The concept of an SDC is that of a high speed, low latency, accurate input/output signal conversion function operating on a single lane of a process.

A Signal Data Concentrator within an IMA architecture (Figure 2) is a self-contained unit that provides an electrical interface between sensors/effectors (effectors may be actuators) and the global data network. Depending upon the application, the SDC may provide signal processing, filtering and local closed-loop control (in essence making sensors/effectors appear "smart" to the IMA system). The SDC will be located close to a group of sensors/effectors associated with multiple subsystems such that the number of wires and length (and therefore weight) of interface is minimised. The SDC protects the core avionics from the effects of the external environment, e.g. lightning strikes.

2.2 Equipment interchangeability

Interchangeability allows equipment supplied by different manufacturers to be used in various aircraft installations. This document identifies all the interfaces to a set of standard LRIMs.

The SDC enclosure will be application specific, but interchangeable standardised line replaceable common elements (LRIMs) will be used within these enclosures.

No adjustment should be necessary after replacement of an LRIM, other than loading the necessary installation-specific software and tables.

Subassemblies (LRIMs and SDCs) bearing the same part number and modification status shall be interchangeable without the need for adjustment of any kind.

2.3 Architecture considerations

2.3.1 System Level

Signal Data Concentrators allow a distributed architecture to be used for interfacing with the aim of reducing wiring mass/length. This will also give improved EMC performance and will allow isolation of faults at the periphery of the system from the core processing.

A Signal Data Concentrator will typically be implemented in the form of a small rack fixed to the aircraft (Figure 1). The SDC will be used to house a number of LRIMs containing the interfacing electronics.

The mechanical fixings for the LRIMs and the connections between LRIMs will be standardised, allowing different SDCs to be built for a wide variety of tasks from a set of standard LRIMs. It is a goal that LRIM packaging should be compatible both with rack mounting within an SDC and stand-alone mounting as a remote data concentrator.

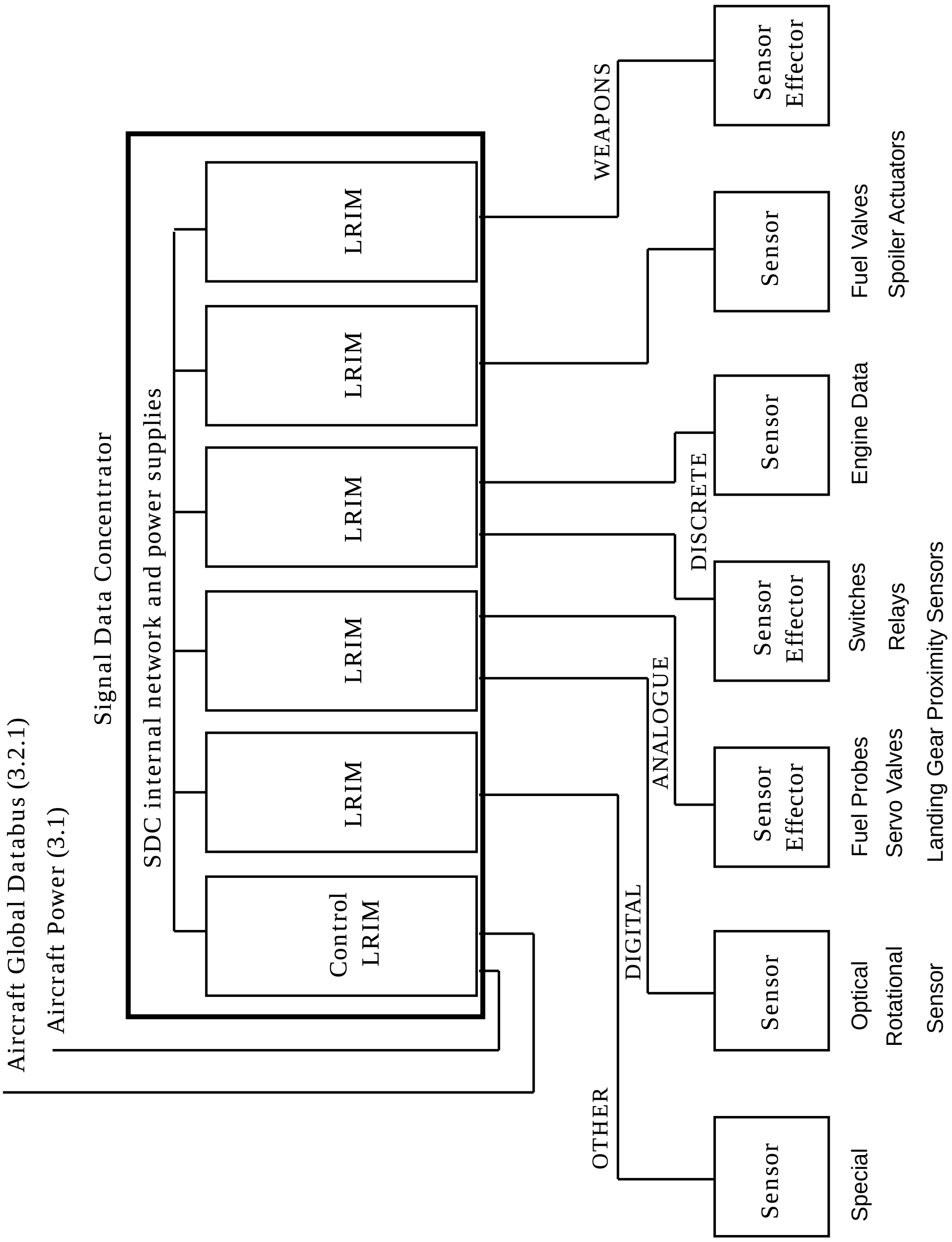

Figure 1: Signal Data Concentrator - Interface Block Diagram

2.3.2 System Partitioning

The SDC will provide interfaces to multiple functional subsystems with different levels of criticality. The SDC is a subsystem independent device whose task is to digitise sensor data and translate bus commands to effector control. Architecturally the SDC is a digital extension of the interface of the sensor. Redundancy is a higher level system design issue which will result in the use of separate SDCs for separate sensors and effectors for critical systems. EMH and TEMPEST requirements can be met by partitioning EMH classes between LRIMs.

2.3.3 Signal Data Concentrator Level

The SDC is a collection of LRIMs and the interfaces between LRIMs are identified within this document. The cabinet design for an SDC is not intended to be standardised. Aircraft wiring may be connected directly to the LRIMs, so the interface with aircraft wiring may be covered by the description of each LRIM type.

2.3.4 Line Replaceable Interface Module Level

The LRIM internal architecture shall meet the operational, performance and interchangeability requirements of this Requirements document. Specification of the LRIM internal hardware (i.e., type and number of CPUs, internal redundancy) or software (i.e., operating system programming language) are not within the scope of this document.

2.3.5 System Safety

If the SDC transfers flight critical and essential data, system safety is also a concern. A primary responsibility of the system designer/integrator is to assess the safety of the system architecture which includes the proposed SDCs. The system safety assessment can be accomplished by using the procedures described in SAE ARP 4761 Safety Assessment Process for commercial systems and Def Stan 00-55 and 00-56 for military systems.

3 FUNCTIONAL CHARACTERISTICS

3.1 Power

The SDC's power is supplied by aircraft power. Each SDC will have an internal power supply module that will provide the SDC with a full set of filtered and stabilised DC supply voltages. The SDC should have power transparency capability that can be used to preserve the integrity of a loaded program and status information during power interruptions. This allows the SDC to save all essential data before the total power failure, in order to be prepared for a possible warm start. These requirements shall be in accordance with system design philosophy.

3.2 Interfaces

The functional implementation of an SDC requires that the total 'input' bandwidth does not exceed the 'output' bandwidth, and care should be exercised to ensure that the number and types of LRIMs employed in the SDC, particularly when multiple SDCs are used within the platform, does not allow this to occur. Due consideration should be given to the design of the SDC to ensure that the per-channel latency can be maintained in a fully loaded system.

The SDC should be able to accommodate signals from the following:

3.2.1 Global Aircraft Data Network

The SDC will have a link to the global aircraft data network. This will allow communication of signals with software resident elsewhere in the system (eg in an IMA core processing rack), either as raw data (for a 'dumb' signal data concentrator) or as processed signals (where 'smart' SDCs or 'smart' sensors are used). It may also allow exchange of system management data such as configuration information, bit information, status and timing/synchronisation signals.

3.2.2 Analogue Interfaces

The SDC should be capable of accommodating analogue inputs and outputs with programmable characteristics.

3.2.3 Digital Interfaces

The SDC should be capable of accommodating other serial data buses with programmable interfaces, eg Def Stan 00-18 (Part 2).

3.2.4 Discrete Interfaces

The SDC should be capable of accommodating a variety of discrete input and output signals with programmable characteristics, eg Def Stan 00-18 (Part 4).

3.2.5 Frequency Modulated Interfaces

3.2.6 Power Switching

3.3 Initialization

An SDC is an autonomous unit and is not required to perform a specific initialisation sequence. It must, however, perform its internal initialisation within the time period defined by the system integrator and inhibit transmission until initialisation is complete.

4 PHYSICAL ATTRIBUTES

4.1 Introduction

The physical interfaces of SDCs are identified in this Requirements document and associated Annex B for the SDC connector attributes.

4.2 Environmental conditions

The SDC shall be capable of being located in any aircraft area including the harsh environment defined in ARINC Specification 650, Attachment 5, Area 4 (Landing Gear). Extreme environments, such as Area 9 (Engine mounted), should use the SDC with special environmental packaging, or should be avoided.

Conditions to be defined are listed in Annex A.

4.3 Cooling

It is a design goal that a combination of natural convection and conduction cooling be sufficient for proper operation at the maximum environmental temperature encountered at that aircraft location, however alternative mechanisms eg. heat pipes may be allowed for removing heat to the outer surface.

4.4 Size & weight

An SDC is to be made up from a number (eg 2-9?) of LRIMs compatible with ARINC 655 Size 1
(5" x 5" x 1"). Weight should be minimised.

4.5 Connectors

The connector between the SDC and the aircraft data network shall be designed to be compatible with an existing insert design, eg ARINC 600 Shell Size 1 inserts.

4.5.1 External connections

It is a design goal that all external cable connections can be connected directly to the LRIMs within an SDC without the need for an intermediate connector/wiring loom. Each

LRIM will have a connector to external wiring. The SDC connection to the main aircraft data network will be treated in the same way as any other signal, ie it will be connected via the external wiring connector on an LRIM. The connector to an LRIM should be float-mounted either on the SDC or on the SDC mounting bracket.
Keying should be provided to prevent the insertion of an incompatible SDC and the design should provide at least 256 key combinations.

Retention of the LRIMs within the SDC should ensure connector shell to shell bottoming. Connectors must have easy removal and installation features which encompass blind installations as access may be limited.

Annex B identifies all aspects of the LRIM interface connectors.

4.5.2 Internal connections

Each LRIM shall have connections to provide power and communications within an SDC. These shall be electrically separate from the external connections.

It is recommended that the use of front panel mounted connectors are limited to test or for other special purposes.

5 ELECTRICAL INTERFACES

5.1 Introduction

The electrical interfaces within an SDC are described in this section.

5.2 Electrical bonding & grounding

Electrical bonding and grounding of the SDC to the aircraft structure is achieved through a dedicated chassis ground (structure bond) connection and metal-to-metal contact. Electrical bonding and grounding of the LRIMs to the SDC is also achieved through a dedicated chassis ground.

The SDC and LRIMs should use the dedicated chassis ground connection to the internal circuitry for electrical bonding and not rely on mechanical contact between the SDC and the aircraft structure. The chassis ground should not be used as a current path return.

5.3 Power

Power to LRIMs shall be derived either directly from an aircraft supply or through a conversion function in another LRIM.

5.4 LRIM Location Identification

Internal discretes may be used for positional and functional identification and power status.

5.5 Inter-LRIM Communication

A standard method of communicating between individual modules will be provided and this is TBD. Point to point serial electrical links are preferred to a multi-drop databus, as good failure containment is required.

5.6 Other Interfaces

A data network interface will be provided to communicate with the core avionics. Interfaces to other subsystems such as armaments may also be provided.

5.7 Standard Interwiring

The standard interwiring shall be defined for each module.

6 SUPPORTABILITY

Supportability is project-specific and shall be in accordance with project policies, however, common supportability goals are defined herein.

6.1 General

6.1.1 Reliability

Reliability shall be such that the availability below can be achieved, however reliability will be commensurate with the ease with which repair may be affected.

6.1.2 Integrity

An SDC will cater for single lane operation only, but multiple subsystems may make use of the data, so correct operation and independence of functions must be ensured.

6.1.3 Availability

The system goal is a high probability of achieving a project-specific maintenance-free operating period.

6.2 Maintenance

The SDC should be designed to meet the project maintenance philosophy and optimise Life Cycle Costs.

In order to support this philosophy, the LRIMs will be replaceable at first line (i.e. on the aircraft) without special tools. A goal is to use no tools at all.

6.3 Testability

6.3.1 Built in test

The SDC should be designed to meet the project built in test philosophy.

ANNEX A ENVIRONMENTAL CONDITIONS

Temperature
Altitude
Humidity
Vibration
Gunfire vibration
Shock
Acoustic noise
Acceleration
Explosive decompression
Sand and dust
Salt mist
Fungus resistance
Ozone
Solar radiation
Rain
Contamination resistance
Explosive atmosphere
EMC
Lightning
Nuclear
Biological
Chemical

ANNEX B CONNECTOR ATTRIBUTES

The connector shall have the following attributes:

- High reliability
- High durability
- Cable strain relief
- Ruggedisation
- Replaceable contacts
- Easy assembly/disassembly
- Standard tools for assembly, installation & repair
- Blind mate
- Low weight
- Low cost
- Low mating force
- Small connector size
- Wire size
- Currents up to 10A
- Voltages up to 270V dc
- Insulation resistance
- Shielding
- EMC - filtering/transient protection
- Sealing

Design issues include:

- Connector layout,
- Pin assignments,
- Index pin coding,
- Connector insert types,
- Connector insert positioning,
- Contact types.

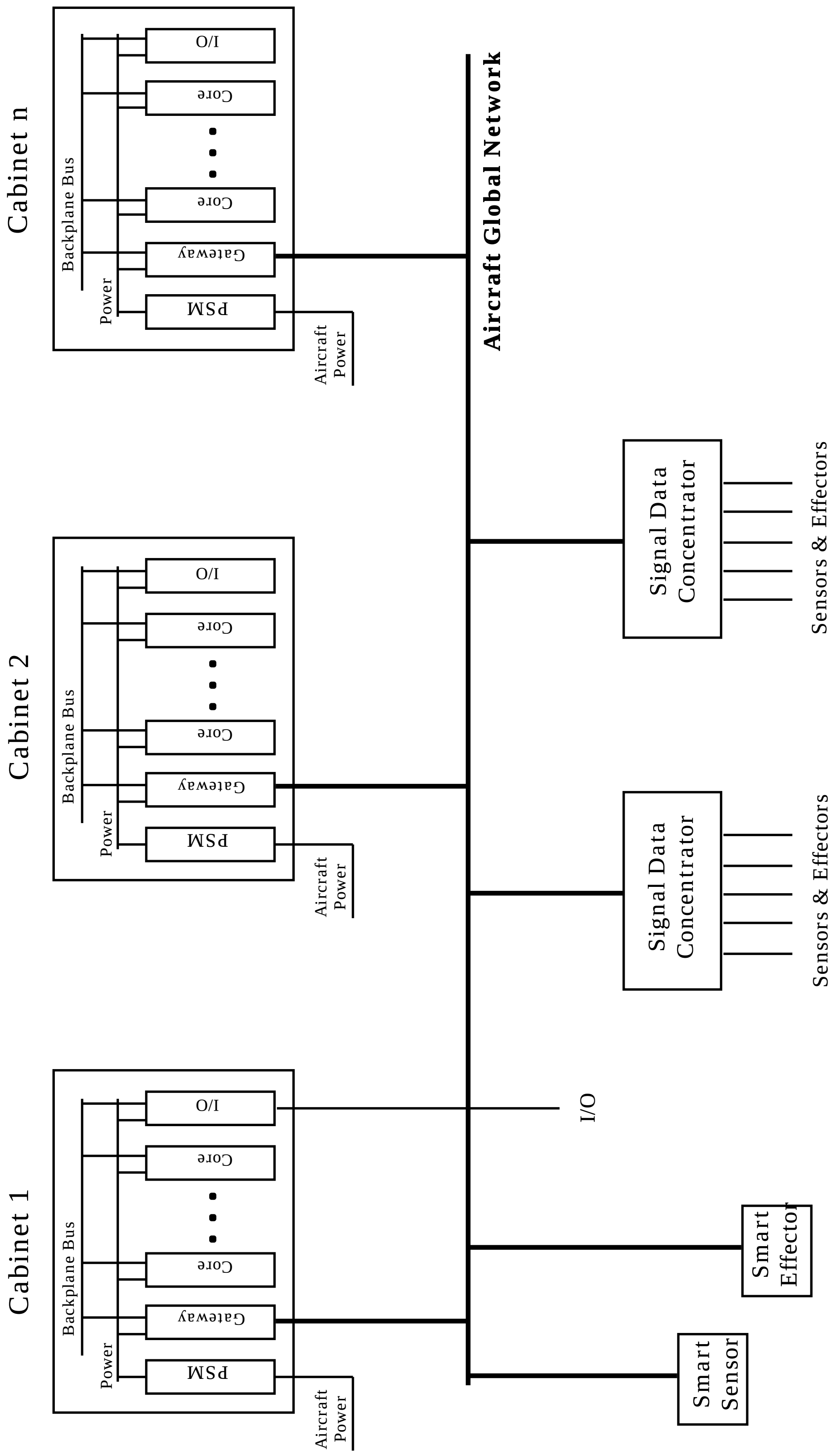

Figure 2: Typical Modular Architecture Elements