The Consultative Committee for Space Data Systems

Recommendation for Space Data System Standards

SPACECRAFT ONBOARD INTERFACE SERVICES—RFID TAG ENCODING SPECIFICATION

RECOMMENDED STANDARD

CCSDS 881.1-B-1

BLUE BOOK

October 2017

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DOCUMENT CONTROL

Document	Title	Date	Status
CCSDS 881.1-B-1	Spacecraft Onboard Interface Services—RFID Tag Encoding Specification, Recommended Standard, Issue 1	October 2017	Original issue

CONTENTS

CONTENTS (continued)

1 INTRODUCTION

1.1 PURPOSE

This document provides a **Recommended Standard** for the utilization of Radio Frequency Identification (RFID) protocol and communication standards in support of inventory management activities associated with space missions. Relevant technical background information can be found in *Wireless Network Communications Overview for Space Mission Operations* (reference [D1]) and in *RFID-Based Inventory Management Systems* (reference [D2]).

The recommended standards contained in this report enable member agencies to select the best option(s) available for interoperable RFID-based tag encoding in the support of inventory management applications. The specification of a **Recommended Standard** facilitates interoperable communications and forms the foundation for cross-support of information systems between separate member space agencies.

1.2 SCOPE

This **Recommended Standard** is targeted towards providing an augmented namespace definition in support of RFID-based applications.

1.3 APPLICABILITY

This **Recommended Standard** specifies protocols that enable interoperable wireless inventory management systems that utilize RFID technologies.

NOTE – Inclusion of any specific wireless technology does not constitute any endorsement, expressed or implied, by the authors of this **Recommended Standard** or the agencies that supported the composition of this **Recommended Standard.**

1.4 RATIONALE

From an engineering standpoint, mission managers, along with engineers and developers, are faced with a plethora of wireless communication choices, both standards-based and proprietary. This CCSDS RFID tag encoding **Recommended Standard** provides guidance in the selection of naming conventions necessary to achieve interoperable information exchange in support of RFID-based applications.

1.5 DOCUMENT STRUCTURE

This document provides a normative recommendation for an RFID naming schema that supports the expanded operations of International Space Station (ISS) inventory management systems. More information on space mission use cases addressed by RFID technology can be found in annex E of reference [D2].

Section 2 provides an overview of the basis for the tag encoding.

Section 3 provides a normative description for the recommended standard tag encoding schema.

Annex A provides the Implementation Conformance Statement (ICS) proforma.

Annex B discusses security, Space Assigned Numbers Authority (SANA), and patent considerations pertaining to RFID-based inventory management systems.

Annex C provides an informative tag-encoding example.

Annex D is a list of informative references.

Annex E is a glossary of abbreviations used in this document.

Annex F provides the ECMA-113 Latin/Cyrillic encoding definition table.

1.6 CONVENTIONS

1.6.1 BIT NUMBERING

In this document, the following convention is used to identify each bit in an *N*-bit field. The first bit in the field is defined to be ‘bit *N*-1; the following bit is defined to be ‘bit *N*-2’, and so on up to ‘bit 0’, as shown in figure 1-1.

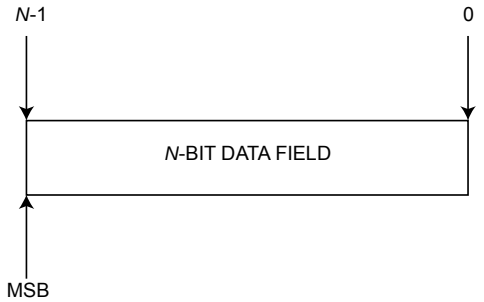

Figure 1-1: Bit Numbering Convention

In accordance with modern data communications practice, spacecraft data fields are often grouped into 8-bit ‘bytes’, which conform to the above convention.

1.6.2 NOMENCLATURE

1.6.2.1 Normative Text

The following conventions apply for the normative specifications in this **Recommended Standard**:

a) the words ‘shall’ and ‘must’ imply a binding and verifiable specification;

b) the word ‘should’ implies an optional, but desirable, specification;

c) the word ‘may’ implies an optional specification;

d) the words ‘is’, ‘are’, and ‘will’ imply statements of fact.

NOTE – These conventions do not imply constraints on diction in text that is clearly informative in nature.

1.6.2.2 Informative Text

In the normative section of this document (section 3), informative text is set off from the normative specifications either in notes or under one of the following subsection headings:

– Overview;

– Background;

– Rationale;

– Discussion.

1.7 ACRONYMS

A glossary of terms including common acronyms is provided in annex E.

1.8 REFERENCES

[1] Space Assigned Numbers Authority (SANA). http://sanaregistry.org/.

[2] *8-Bit Single-Byte Coded Graphic Character Sets: Latin/Cyrillic Alphabet*. 3rd ed. ECMA-113. Geneva: Ecma International, December 1999.[1]

[1] Equivalent to *Information Technology—8-Bit Single-Byte Coded Graphic Character Sets—Part 5: Latin/Cyrillic Alphabet*. 2nd ed. International Standard, ISO/IEC 8859-5:1999. Geneva: ISO, 1999.

2 OVERVIEW

2.1 GENERAL

This **Recommended Standard** specifies tag-encoding options that augment, yet remain compatible with, a legacy ISS Inventory Management System (IMS) tag encoding schema established for early flight experiments. This standard will enable more efficient, flexible, and expanded utilization of RFID technology for applications such as Autonomous Logistics Management (ALM) on ISS. The tag encoding schema will allow various multinational operational and experimental applications, including inventory and asset management, sensors, and navigation assistance onboard ISS as a precursor to a more advanced standard for exploration.

2.2 TAG FIELD DESCRIPTIONS

The fields in the proposed standard are designed to represent a hierarchy of information, in which the values encoded in each successive field in the hierarchy may be re-used within different levels of the hierarchy. The order of hierarchical field namespace structure, from most significant to least significant is

{Database-ID, Owner-ID, Program-ID, Object-ID, Serial-ID}.

Figure 2-1 illustrates how the current IMS tag encoding schema maps onto the hierarchical field structure.

Owner / Program name	Database-ID	Owner-ID	Program-ID		Unique-ID (Serial Number ID)					Owner-ID	Object-ID	
	byte 0	*byte 1*	*byte 2*	*byte 3*	*byte 4*	*byte 5*	*byte 6*	*byte 7*	*byte 8*	*byte 9*	*byte 10*	*byte 11*
IMS	I	X	C	P						J		
IMS Russian	I	X	0	0						R		
coffee	I	X	F	2								
coffee	I	X	F	3								
food BOB	I	X	F	E								
SF Tucker/Kimmel	I	H	R	F						J		
CHeCS BPECG hardware	I	X	C	B						J		
SF Water Kits	I	X	W	M	S					J		
SD4 Bara medical	M	H	M	S								
MCT Sam Hussey/GRC	M	M	C	T								
EV4 testing	I	E	V	J								
R2 testing	I	R	2	T	E	S	T					
		<---	B	A	R	C	O	D	E	--->		

Figure 2-1: IMS RFID Tag Encoding Schema

The field designated as Database-ID, which comprises Byte 0, represents the organization responsible for defining and administering the namespace to which the tag belongs. This field is the most significant field in the hierarchical structure of the RFID naming convention, and as such, it is mandatory to use only values designated (see table B-1). Strictly speaking, a namespace owner need not maintain the remainder of the recommended hierarchical structure of the standard, and as such, SANA registries are not required for the remaining fields in the standard. In the current ISS utilization, the Database-ID is identified with the

particular database in which the tagged item is recorded and tracked. Currently only the values ‘I’ (Inventory Management System) and ‘M’ (Medical) are utilized.

The field designated as Owner-ID, which comprises Bytes 1 and 9, represents the organization that owns the physical asset to which the tag is attached. This field is the second most significant field in the hierarchical structure specified in this standard. This implies that tags with different Database-ID designations may reuse and redefine Owner-ID values utilized within other Database-ID designations.

The field designated as Program-ID, which comprises Bytes 2 and 3, represents sub-organizations (such as programs) of the owner organization. This field is the third most significant field in the hierarchical RFID naming conventions specified in this standard. This implies that tags with different {Database-ID, Owner-ID} designations may reuse and redefine Program-ID values utilized within other {Database-ID, Owner-ID} designations.

The field designated as Object-ID, which comprises Bytes 10 and 11, represents classes of objects (e.g., medical equipment, food, tool, etc.) to which RFID tags will be affixed. This field is the fourth most significant field in the hierarchical RFID naming conventions specified in this standard. This implies that tags with different {Database-ID, Owner-ID, Program-ID} designations may reuse and redefine Object-ID values utilized within other {Database-ID, Owner-ID, Program-ID} designations. Values in the range

[0 : 32767]

can be assigned at the database manager’s discretion; values in the range

[32768 : 65535]

will be maintained (see table B-2) to promote tracking of common items across unique databases.

The field designated as Serial-ID, which comprises Bytes 4 through 8, represents unique objects to which RFID tags will be affixed. This field is the least significant field in the hierarchical RFID naming conventions specified in this standard. This implies that tags with different {Database-ID, Owner-ID, Program-ID, Object-ID} designations may reuse and redefine Serial-ID values utilized within other {Database-ID, Owner-ID, Program-ID, Object-ID} designations.

2.3 EVOLUTION OF THE BOOK

This **Recommended Standard** addresses RFID tag encoding for inventory management applications. As space-related applications arise that cannot be fulfilled based on the recommendations of this Recommended Standard, evolution of this book will be considered. Methods to extend or adapt previous recommendations will be considered with preference over adoption of new standards, providing the resulting performance and cost are advantageous relative to those associated with adoption of one or more new standards.

3 RFID TAG ENCODING RECOMMENDED STANDARD

3.1 OVERVIEW

This section presents the recommended standard naming specification for RFID tag encoding (96-bit) RFID tags to provide the basis for information interoperability.

The **Recommended Standard** pertains to RFID systems that provide stored data only, as opposed to sensor telemetry. Applications are considered where no direct active tag power is required, which necessitates short-range communication and Interrogator-Talk-First (ITF) protocols. (See references [D1] and [D2] for supporting technical background.)

Figure 3-1 depicts the logical layout of the 96-bit RFID tag IDentification (ID), and figure 3-2 shows the bit-wise mappings of the fields; while table 3-1 defines the 5 proposed logical data fields encoded on each tag and the allowable range of values for each field.

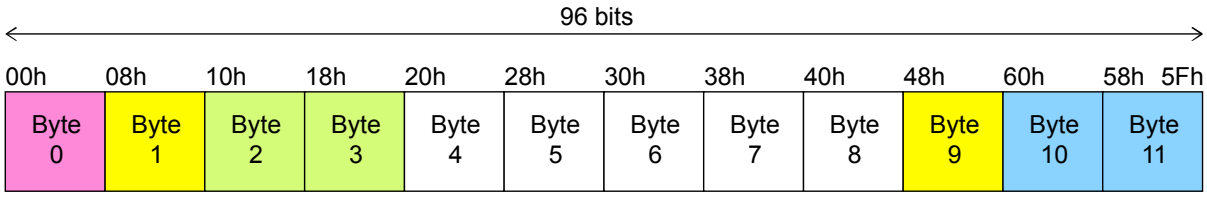

Figure 3-1: 96-Bit Tag ID Logical Layout

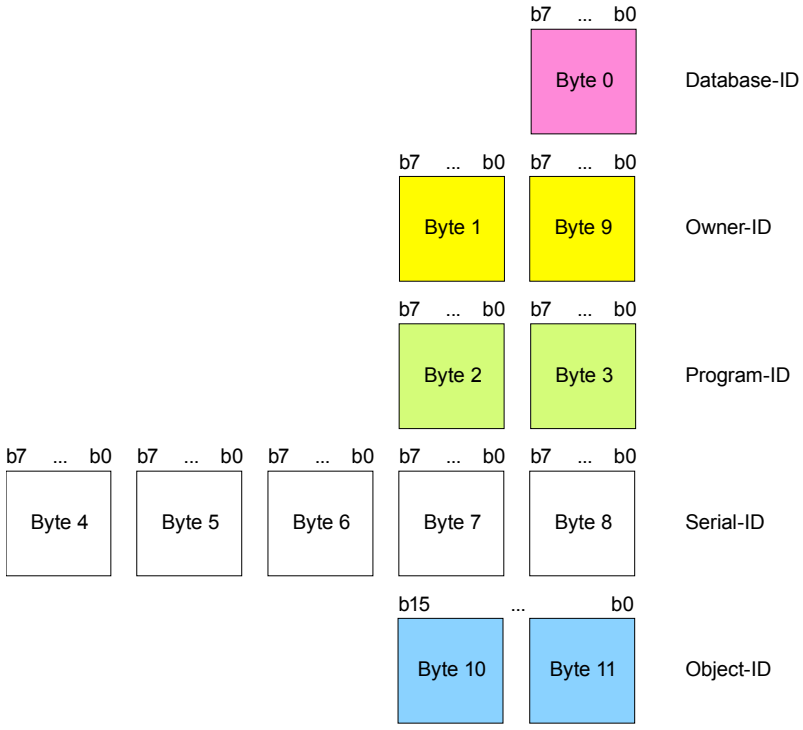

Figure 3-2: Bitwise Mapping of the Fields

3.2 RFID TAG ENCODING

For interoperable onboard spacecraft or internal-vehicle inventory management utilizing 96-bit wireless RFID tags, the tag encoding shall follow the format specified in table 3-1**.**

Table 3-1: 96-Bit RFID-Tag Field Specification (Normative)

Tag ID Field Address	Field Type	Field	Description	Namespace Administrator
00_h – 07_h	8-bit ECMA-113 character	Database-ID	ID of the database	SANA Registry (See table B-1)
08_h – $0F_h$	8-bit ECMA-113 character	Owner-ID Byte 0	Byte 1 of 2-byte Owner-ID	Program-ID Owner
10_h – 17_h	8-bit ECMA-113 character	Program-ID Byte 0	Byte 1 of 2-byte Program-ID	Program-ID Owner
18_h – $1F_h$	8-bit ECMA-113 character	Program-ID Byte 1	Byte 2 of 2-byte Program-ID	Program-ID Owner
20_h – 27_h	8-bit ECMA-113 character	Serial-ID Byte 0	Byte 1 of 5-byte Serial-ID	Program-ID Owner
28_h – $2F_h$	8-bit ECMA-113 character	Serial-ID Byte 1	Byte 2 of 5-byte Serial-ID	Program-ID Owner
30_h – 37_h	8-bit ECMA-113 character	Serial-ID Byte 2	Byte 3 of 5-byte Serial-ID	Program-ID Owner
38_h – $3F_h$	8-bit ECMA-113 character	Serial-ID Byte 3	Byte 4 of 5-byte Serial-ID	Program-ID Owner
40_h – 47_h	8-bit ECMA-113 character	Serial-ID Byte 4	Byte 5 of 5-byte Serial-ID	Program-ID Owner
48_h – $4F_h$	8-bit ECMA-113 character	Owner-ID Byte 1	Byte 2 of 2-byte Owner-ID	Program-ID Owner
50_h – $5F_h$	16-bit integer	Object-ID	[0 – 65535]	Program-ID Owner [0 : 32767] SANA Registry (See table B-2) [32768 : 65535]

ANNEX A

IMPLEMENTATION CONFORMANCE STATEMENT PROFORMA

(NORMATIVE)

A1 INTRODUCTION

A1.1 OVERVIEW

This annex provides the Protocol Implementation Conformance Statement (PICS) Requirements List (RL) for an implementation of RFID Tag-Encoding specified in *Spacecraft Onboard Interface Services—RFID Tag Encoding Specification,* CCSDS 881.1-B-1, October 2017. Completing the RL in accordance with the instructions below generates the PICS for an implementation. An implementation shall satisfy the mandatory conformance requirements referenced in the RL.

The RL in this annex is blank. An implementation's completed RL is called the PICS. The PICS states which capabilities and options have been implemented. The following can use the PICS:

- the implementer, as a checklist to reduce the risk of failure to conform to the standard through oversight;
- a supplier or potential acquirer of the implementation, as a detailed indication of the capabilities of the implementation, stated relative to the common basis for understanding provided by the standard PICS proforma;
- a user or potential user of the implementation, as a basis for initially checking the possibility of interworking with another implementation (it should be noted that, while interworking can never be guaranteed, failure to interwork can often be predicted from incompatible PICSes);
- a tester, as the basis for selecting appropriate tests against which to assess the claim for conformance of the implementation.

A1.2 ABBREVIATIONS AND CONVENTIONS

The RL consists of information in tabular form. The status of features is indicated using the abbreviations and conventions described below.

Item Column

The item column contains sequential numbers for items in the table.

Description Column

The description column contains a brief description of the item. It implicitly means ‘is <item description> supported by the implementation?’

Reference Column

The reference column indicates the relevant subsection of *Spacecraft Onboard Interface Services—RFID Tag Encoding Specification*, CCSDS 881.1-B-1 (this document).

Status Column

The status column uses the following notations:

M mandatory.

O optional.

N/A not applicable.

O.*i* qualified optional—for a group of related optional items labeled by the same numeral *i*, the logic of their selection is defined immediately following the table.

C.*j* conditional—the requirement on the capability (‘M’, ‘O’, or ‘N/A’) depends on the support of another optional item. The numeral *j* identifies a unique conditional status expression defined immediately following the table.

Values Allowed Column

The values allowed column contains the list or range of values allowed. The following notations are used:

Range of values:	<min value> … <max value>
example	2 ... 16
list of values:	<value1>, <value2>, … , <valueN>
example	3, 6, 9, … , 21
N/A	not applicable

Item Support or Values Supported Column

In the item support or values supported column, the support of every item as claimed by the implementer shall be stated by entering the appropriate answer ('Y', 'N', or 'N/A') or the values supported:

Yes yes, item supported by the implementation.

No no, item not supported by the implementation.

range or list of values supported.

N/A not applicable.

A1.3 INSTRUCTIONS FOR COMPLETING THE RL

An implementer shows the extent of compliance to the Recommended Standard by completing the RL; that is, the state of compliance with all mandatory requirements and the options supported are shown. The resulting completed RL is called a PICS. The implementer shall complete the RL by entering appropriate responses in the support or values supported column, using the notation described in A1.2. If a conditional requirement is inapplicable, N/A shall be used. If a mandatory requirement is not satisfied, exception information must be supplied by entering a reference X*i*, where *I* is a unique identifier, to an accompanying rationale for the noncompliance.

A2 PICS PROFORMA FOR RFID TAG-ENCODING

A2.1 GENERAL INFORMATION

A2.1.1 Identification of PICS

Date of Statement (DD/MM/YYYY)	
PICS Serial Number	
System Conformance statement cross-reference	

A2.1.2 Identification of Implementation Under Test (IUT)

Implementation name	
Implementation version	
Special configuration	
Other information	

A2.1.3 Identification of Supplier

Supplier	
Contact point for queries	
Implementation name(s) and versions	
Other information necessary for full identification, e.g., name(s) and vendor(s) for machines and/or operating systems; System name(s)	

A2.1.4 Identification of Specification

CCSDS 881.1-B-1	
Addenda implemented	
Amendments implemented	
Have any exceptions been required? (Note: A YES answer means that the implementation does not conform to the Recommended Standard. Non-supported mandatory capabilities are to be identified in the PICS, with an explanation of why the implementation is non-conforming.)	Yes _____ No _____

A2.2 RFID TAG-ENCODING

To be classified as CCSDS RFID Tag-Encoding compliant the following tag encoding rules must be followed:

a) All fields (Database-ID, Owner-ID, Program-ID, Object-ID and Serial-ID) must be valid and present in the order specified.

b) All character fields (Database-ID, Owner-ID, Program-ID and Serial-ID) must be encoded per the ECMA-113 / ISO 8859 Part 5 Standard for encoding Latin and Cyrillic characters. See annex F for the ECMA-113 / ISO 8859 Part 5 allowable Latin and Cyrillic character sets.

c) The Database-ID must be defined in the SANA RFID-TAG Database-ID Registry.

d) The Object-ID must be an integer between [0 – 65535].

e) If the Object-ID is to be tracked across multiple Database-IDs and Owner-IDs, then the Object-ID must be in the range of “Common Object IDs” which is [32768 – 65535]. If the Object-ID exists in the SANA RFID-Tag Object-ID Registry then the

existing registered Object-ID must be utilized. If a "Common Object ID" for a class of objects does not exist, then a request to add a new common Object-ID per the specified Registration Rule must be completed.

f) If the Object-ID does not require common-object cross-referencing then the Object-ID must be in the range [0 – 32767] to indicate a unique agency test activity.

Table A-1: RFID Tag-Encoding Properties

Item	Field Description	Reference	Status	Values Allowed	Item Support or Values Supported
1	Database-ID	3.2	M	(20_h .. $7E_h$) && ($A0_h$ .. FF_h)	
2	Owner-ID Byte 0	3.2	M	(20_h .. $7E_h$) && ($A0_h$ .. FF_h)	
3	Program-ID Byte 0	3.2	M	(20_h .. $7E_h$) && ($A0_h$ .. FF_h)	
4	Program-ID Byte 1	3.2	M	(20_h .. $7E_h$) && ($A0_h$ .. FF_h)	
5	Serial-ID Byte 0	3.2	M	(20_h .. $7E_h$) && ($A0_h$ .. FF_h)	
6	Serial-ID Byte 1	3.2	M	(20_h .. $7E_h$) && ($A0_h$ .. FF_h)	
7	Serial-ID Byte 2	3.2	M	(20_h .. $7E_h$) && ($A0_h$ .. FF_h)	
8	Serial-ID Byte 3	3.2	M	(20_h .. $7E_h$) && ($A0_h$ .. FF_h)	
9	Serial-ID Byte 4	3.2	M	(20_h .. $7E_h$) && ($A0_h$ .. FF_h)	
10	Owner-ID Byte 1	3.2	M	(20_h .. $7E_h$) && ($A0_h$ .. FF_h)	
11	Object-ID	3.2	M	0 .. 65535	

ANNEX B

SECURITY, SANA, AND PATENT CONSIDERATIONS

(INFORMATIVE)

B1 SECURITY CONSIDERATIONS

B1.1 GENERAL

Security considerations discussed in annex A of reference [D2] apply to this specification.

B1.2 SECURITY BACKGROUND

It is assumed that security concerns is provided by encryption, authentication methods, and access control to be performed at the application and/or transport layers. Mission and service providers are expected to select from recommended security methods suitable to the specific application profile. Specification of these security methods and other security provisions is outside the scope of this Recommended Standard.

B1.3 SECURITY CONCERNS

Security concerns in the areas of data privacy, integrity, authentication, access control, availability of resources, and auditing are to be addressed in the appropriate layers and are not related to this Recommended Standard. The use of the specified RFID Tag-Encoding schema described in this document does not affect the proper functioning of methods used to achieve such protection.

B1.4 POTENTIAL THREATS AND ATTACK SCENARIOS

Security considerations discussed in annex A of reference [D2] apply to this specification.

B1.5 CONSEQUENCES OF NOT APPLYING SECURITY

Security considerations discussed in annex A of reference [D2] apply to this specification.

B2 SANA CONSIDERATIONS

SANA is requested to create and maintain two formal registries:

a) A registry to allocate unique Database-IDs.

b) A registry to allocate unique Object-IDs that can be utilized by multiple Databases, Owners, and Programs for common item tracking.

When creating or processing 'ADD' or 'MODIFY' registry operations SANA is requested to enforce the field typing, field length, and field restrictions as specified in table 3-1.

B2.1 SANA RFID PROVIDER REGISTRATION

B2.1.1 The RFID Provider Organization shall be one of the organizations registered in the CCSDS Organizations registry: (http://sanaregistry.org/r/organizations/organizations.html).

B2.1.2 If an Organization does not exist in the Organizations registry the identified Agency Head of Delegation or Organization official Point of Contact may request of the SANA that it be added, using the existing SANA procedures for that registry.

B2.1.3 The CCSDS Organizations registry shall be modified to add a Boolean attribute indicating that the Organization may be of type 'RFIDProvider'.

B2.1.4 For all Organizations that indicate that they offer RFID services this attribute shall be set 'TRUE', otherwise it shall be set 'FALSE'.

B2.1.5 Addition of any new organization shall require sponsorship by the CCSDS Member Agency for its country of origin or by the Secretariat if there is no CCSDS Member agency for its country of origin.

B2.1.6 The Agency Head of Delegation or Organization official Point of Contact shall be added to the CCSDS Contacts registry (http://sanaregistry.org/r/contacts/contacts.html).

B2.1.7 The Agency Head of Delegation or Organization official Point of Contact may appoint an Agency Representative (AR) as the point of contact for RFIDProvider requests.

B2.1.8 The RFIDProvider AR shall be added to the CCSDS Contacts registry (http://sanaregistry.org/r/contacts/contacts.html).

B2.1.9 The CCSDS Contacts registry shall be modified to add a Boolean attribute indicating that the person may be of type 'RFIDProviderContact'.

B2.1.10 For all Contacts that are identified as a RFIDProviderContact this attribute shall be set 'TRUE', otherwise it shall be set 'FALSE'.

B2.1.11 The RFIDProvider 'user' shall be the Spacecraft Name of one of the spacecraft registered in the CCSDS SCID registry (http://sanaregistry.org/r/spacecraftid/spacecraftid.html, or the field 'UNALLOCATED' or the field 'PROVIDER-RFID'.

B2.1.12 If the user spacecraft does not exist in the Spacecraft registry the identified SCID Agency Representative shall request of the SANA that one be assigned, following the SCID request procedures.

B2.1.13 If there is not a current SCID Agency Representative, or if the user agency is not yet registered, the SCID registration procedures must be followed to create these entries.

B2.1.14 The RFIDProvider 'Database-ID' shall use the Database-ID of one of the RFID-Tag Database-ID identifiers registered in the CCSDS RFID Database-ID registry http://sanaregistry.org/cgi/registry-auth?id=rfid_database_ids.

B2.1.15 The RFIDProvider 'Object-ID' shall use the Object-ID of one of the RFID-Tag Object-ID identifiers registered in the CCSDS RFID-Tag Object-ID registry http://sanaregistry.org/cgi/registry-auth?id=rfid_object_ids.

B2.1.16 If the Database-ID does not exist in the RFID-Tag Database-ID registry the identified RFIDProvider Agency Representative shall request of the SANA that one be assigned, following the RFID-Tag Database-ID registry request procedures.

B2.1.17 If the Object-ID does not exist in the RFID-Tag Object-ID registry the identified RFIDProvider Agency Representative shall request of the SANA that one be assigned, following the RFID-Tag Object-ID registry request procedures.

B2.1.18 If there is not a current RFIDProvider Agency Representative, or if the user agency is not yet registered, the Agency (SCID) registration procedures must be followed to create these entries.

B2.2 SANA REGISTRY: RFID TAG-ENCODING DATABASE-ID

It is the recommendation of this document that SANA create the following 2-field (RFID-Tag Database-ID, Database-ID Description) registry:

Table B-1: SANA Registry—RFID Tag-Encoding Database-ID

Registry Name:	RFID-Tag Database-ID
Column 1 Name:	RFID-Tag Database-ID
Column 1 Data Type:	8-bit ECMA-113(see reference [2]) character encoding; SANA field size 8-bit character
Column 1 Initial Value(s):	Row 1: 'I' Row 2: 'M'
Column 2 Data Type:	80-character ASCII string description
Column 2 Initial Value(s):	Row 1: "Inventory Management System" Row 2: "Medical"

Registration Rule:	Requests to add assignments to the registry or registries identified in this recommendation shall be submitted to SANA and shall come from a CCSDS Member Agency. The request shall be related to a RFID Tag-Encoding activity. After evaluation of the request and approval by the SOIS Area Director (AD) or SOIS Deputy Area Directory (DAD) or a person duly authorized by the AD or DAD, the new entity will be allocated and added to the appropriate registry. The contents of the new entity to be added to the indicated registry must be complete and compliant with the definitions of the applicable entity type.

B2.3 SANA REGISTRY: RFID TAG-ENCODING OBJECT-ID

It is the recommendation of this document that SANA create the following 2-field (RFID-Tag Object-ID, Object-ID Description) registry:

Table B-2: SANA Registry—RFID Tag-Encoding Object-ID

Registry Name:	RFID-Tag Object-ID
Column 1 Name:	RFID-Tag Object-ID
Column 1 Data Type:	SANA field size 16-bit integer [32768 : 65535]; [0 : 32767] are NOT SANA-administered and are available for the database owner to utilize in any self-defined schema
Column 1 Initial Values	Row 1: 64000
Column 2 Data Type:	80-character ASCII string description
Column 2 Initial Values	Row 1: “Reserved for CCSDS Wireless Working Group”
Registration Rule:	Requests to add assignments to the registry or registries identified in this recommendation shall be submitted to SANA and shall come from a CCSDS Member Agency. The request shall be related to a RFID Tag-Encoding activity. After evaluation of the request and approval by the SOIS Area Director (AD) or SOIS Deputy Area Directory (DAD) or a person duly authorized by the AD or DAD, the new entity will be allocated and added to the appropriate registry. The contents of the new entity to be added to the indicated registry must be complete and compliant with the definitions of the applicable entity type.

NOTE – For candidate Object-ID organizational schemas see references [D3] and [D4].

Value	Description	Status	Reference
0 – 32767	Permanently unassigned for individual agency testing	Unassigned	
32768 – 65535	Will be specified and allocated per registry update rule	Reserved	CCSDS 88X-R-0

B3 PATENT CONSIDERATIONS

The recommendation of this document is simply a namespace definition schema and thus has no patent issues.

ANNEX C

ENCODING EXAMPLE

(INFORMATIVE)

Figure C-1 shows the current (as of November 2014) legacy IMS RFID tag encoding schema. This standard expands the available namespace and defines the rules for the addition of new encoding options as per table 3-1. The example will encode a 96-bit RFID tag for the Owner IMS; a serial number of '12345' and an Object-ID = 45678 are assumed.

Owner / Program name	Database-ID	Owner-ID	Program-ID		Unique-ID (Serial Number ID)					Owner-ID	Object-ID	
	byte 0	*byte 1*	*byte 2*	*byte 3*	*byte 4*	*byte 5*	*byte 6*	*byte 7*	*byte 8*	*byte 9*	*byte 10*	*byte 11*
IMS	I	X	C	P						J		
IMS Russian	I	X	0	0						R		
coffee	I	X	F	2								
coffee	I	X	F	3								
food BOB	I	X	F	E								
SF Tucker/Kimmel	I	H	R	F						J		
CHeCS BPECG hardware	I	X	C	B						J		
SF Water Kits	I	X	W	M	S					J		
SD4 Bara medical	M	H	M	S								
MCT Sam Hussey/GRC	M	M	C	T								
EV4 testing	I	E	V	J								
R2 testing	I	R	2	T	E	S	T					
		<---	B	A	R	C	O	D	E	--->		

Figure C-1: Legacy IMS RFID Tag Encoding Schema

Tag Memory Background: The 'Tag ID', which identifies an RFID tag, resides in Memory Bank 01_2 of a tag as shown in figure C-2. By convention each memory bank starts at address 00_h and extends to the end address of the memory bank. Bit 00_h is the Most Significant Bit (MSB) of the memory bank. For binary fields (including the 96-bit tag ID) that are encoded into the memory bank, the MSB of the binary field occupies the lowest-numbered memory bit address. As shown in figure 1-1, the Least Significant Bit (LSB) is numbered 'bit 0'. For a 96-bit tag ID consisting of $b_{95}b_{94}b_{93}...b_0$, b_{95} is the MSB and b_0 is the LSB. When the 96-bit tag ID is encoded onto Bank 01_2 starting at memory bit address 20_h–$7F_h$ the MSB b_{95} is stored at address 20_h and the LSB b_0 is stored at address $7F_h$.

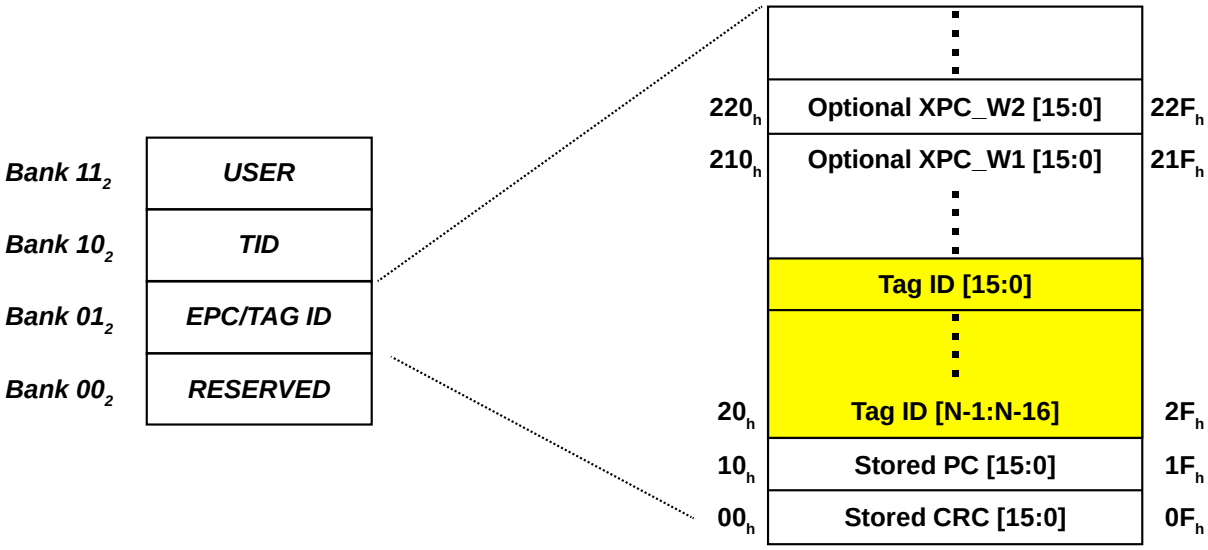

Figure C-2: RFID Tag Bank 01_2 Memory Layout

Example Basis: A 96-bit RFID tag is encoded for the Owner IMS; a serial number of '12345' and an Object-ID = 45678 are assumed (see figure C-1 for byte positions).

The tag Database-ID (Byte 0 of figure C-1) is comprised of the character 'I'.

The tag Owner-ID (Byte 1 and Byte 9 of figure C-1) is comprised of the characters 'X' and 'J'.

The tag Program-ID (Byte 2 and Byte 3 of figure C-1) is comprised of the characters 'C' and 'P'.

The tag Serial-ID (Byte 4–Byte 8 of figure C-1) is given as '1', '2', '3', '4', '5'.

The tag Object-ID (Byte 10 and Byte 11 of figure C-1) is given as the integer 45678.

The resulting encoding represented in binary and hexadecimal is given in table C-1.

Table C-1: Example Tag ID Field Encoding

Tag ID Field Address	Field Type	Field	Value	Value (binary)	Value (hexadecimal)
00_h – 07_h	8-bit ECMA-113 character	Database-ID	'I'	01001001	49_h
08_h – $0F_h$	8-bit ECMA-113 character	Owner-ID Byte 0	'X'	01011000	58_h
10_h – 17_h	8-bit ECMA-113 character	Program-ID Byte 0	'C'	01000011	43_h
18_h – $1F_h$	8-bit ECMA-113 character	Program-ID Byte 1	'P'	01010000	50_h
20_h – 27_h	8-bit ECMA-113 character	Serial-ID Byte 0	'1'	00110001	31_h
28_h – $2F_h$	8-bit ECMA-113 character	Serial-ID Byte 1	'2'	00110010	32_h
30_h – 37_h	8-bit ECMA-113 character	Serial-ID Byte 2	'3'	00110011	33_h
38_h – $3F_h$	8-bit ECMA-113 character	Serial-ID Byte 3	'4'	00110100	44_h
40_h – 47_h	8-bit ECMA-113 character	Serial-ID Byte 4	'5'	00110101	35_h
48_h – $4F_h$	8-bit ECMA-113 character	Owner-ID Byte 1	'J'	01001010	$4A_h$
50_h – $5F_h$	16-bit integer	Object-ID	45678	Byte 0: 01101110 Byte 1: 10110010	$B26E_h$

ANNEX D

INFORMATIVE REFERENCES

[D1] *Wireless Network Communications Overview for Space Mission Operations*. Issue 3. Report Concerning Space Data System Standards (Green Book), CCSDS 880.0-G-3. Washington, D.C.: CCSDS, May 2017.

[D2] *Spacecraft Onboard Interface Services—RFID-Based Inventory Management Systems*. Issue 1. Recommendation for Space Data System Practices (Magenta Book), CCSDS 881.0-M-1. Washington, D.C.: CCSDS, May 2012.

[D3] Kevin Gifford, et al. "Unified Communications for Space Inventory Management." In *Proceedings of AIAA Space 2009 Conference and Exposition (14–17 September 2009, Pasadena, California)*. AIAA 2009-6550. Reston, Virginia: AIAA, 2009.

[D4] "MIT Space Logistics: Interplanetary Supply Chain Management and Logistics Architecture." MIT - Massachusetts Institute of Technology. http://strategic.mit.edu/spacelogistics/. (5/4/2015)

ANNEX E

ABBREVIATIONS

(INFORMATIVE)

AD	Area Director
ALM	Automated Logistics Management
CCSDS	Consultative Committee for Space Data Systems
CRC	cyclic redundancy code
DAD	Deputy Area Director
EPC	electronic product code
ICS	Implementation Conformance Statement
ITF	Interrogator-Talk-First
IUT	Implementation Under Test
ID	Identification
IMS	inventory management system
ISS	International Space Station
LSB	Least Significant Bit
MSB	most significant bit
PICS	Protocol Implementation Conformance Statement
RFID	radio frequency identification
RL	Requirements List
SANA	Space Assigned Numbers Authority
SCID	Spacecraft Identification
SOIS	Spacecraft Onboard Interface Services
TID	tag ID (manufacturer)

ANNEX F
ECMA-113 LATIN/CYRILLIC ENCODING TABLE

(INFORMATIVE)

Table F-1: Code Table of Latin/Cyrillic Alphabet[2]

b_4	b_3	b_2	b_1		b_8 0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	
					b_7 0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	
					b_6 0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	
					b_5 0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
					00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	
0	0	0	0	00			SP	0	@	P	`	p			NBSP	А	Р	а	р	№	0
0	0	0	1	01			!	1	A	Q	a	q			Ё	Б	С	б	с	ё	1
0	0	1	0	02			"	2	B	R	b	r			Ђ	В	Т	в	т	ђ	2
0	0	1	1	03			#	3	C	S	c	s			Ѓ	Г	У	г	у	ѓ	3
0	1	0	0	04			$	4	D	T	d	t			Є	Д	Ф	д	ф	є	4
0	1	0	1	05			%	5	E	U	e	u			S	Е	Х	е	х	s	5
0	1	1	0	06			&	6	F	V	f	v			I	Ж	Ц	ж	ц	i	6
0	1	1	1	07			'	7	G	W	g	w			Ї	З	Ч	з	ч	ї	7
1	0	0	0	08			(	8	H	X	h	x			J	И	Ш	и	ш	j	8
1	0	0	1	09			)	9	I	Y	i	y			Љ	Й	Щ	й	щ	љ	9
1	0	1	0	10			*	:	J	Z	j	z			Њ	К	Ъ	к	ъ	њ	A
1	0	1	1	11			+	;	K	[	k	{			Ћ	Л	Ы	л	ы	ћ	B
1	1	0	0	12			,	<	L	\	l	|			Ќ	М	Ь	м	ь	ќ	C
1	1	0	1	13			-	=	M	]	m	}			SHY	Н	Э	н	э	§	D
1	1	1	0	14			.	>	N	^	n	~			Ў	О	Ю	о	ю	ў	E
1	1	1	1	15			/	?	O	_	o				Џ	П	Я	п	я	џ	F
					0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	hex

[2] Based on table 2 of reference [2].