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Preparing principles of technical network for spacecraft development

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Preparing principles of technical network for spacecraft development

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FOREWORD

The standard is translated from the Chinese version of Standard on GB/T 29072-2012 released by Standardization Administration of China (SAC) under the management of State General Administration of Quality Supervision and Inspection and Quarantine. TC 425 is responsible for the translation. In case of any doubt about the contents of English version, the Chinese original shall be considered authoritative.

This standard is drafted in accordance with rules given in GB/T 1.1-2009.

This standard is proposed by China Aerospace Science and Technology Corporation.

This standard is under the jurisdiction of National Technical Committee on Space Technology and Operation of Standardization Administration of China (SAC/TC 425).

INTRODUCTION

This standard belongs to the National Standard System of China Space. The National Standard System of China Space is applicable to the formulation, revision, and management of national standards in the field of space, covering three sectors of space management, space technology, and space application and services and serving as the basis for guiding spacecraft and launch vehicle project management, engineering, space launch services, and in-orbit satellite applications.

Spacecraft project development is a complicated system engineering, involving a long development cycle, multiple critical work items and task nodes. Therefore, a technical network is required to guide the whole process of spacecraft development. An ill-prepared technical network of spacecraft development may result in work items missing, eventually which will affect the quality of a spacecraft. This standard is formulated hereby to specify the preparation of technical network of domestic spacecraft project development, and to actively promote the completion of spacecraft project development tasks.

Preparing principles of technical network for spacecraft development

1 Scope

This standard specifies related terms, preparation principles, basis, classification, requirements and contents, steps and methods for spacecraft development technical networks (hereinafter referred to as technical network).

This standard is applicable to the preparation of technical network on the work items of spacecraft systems and subsystems. Technical network for the equipment development may be prepared by reference to it.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1

technical network

process of all technical activities arranged in sequence during the spacecraft development.

2.2

technical network diagram

technical network expressed in diagram.

2.3

work item

work at a certain phase classified based on time and contents.

3 Preparation principles

Preparation principles are as follows:

a) Technical network shall be prepared to fully ensure the quality of spacecraft design, manufacture and test;

b) Preparing technical network shall embody the scientificity, rationality and economy of development work comprehensively;

c) Under the premise of quality assurance, preparing technical network shall meet the requirements of the overall schedule;

d) Technical network shall be consistent with contents of spacecraft development at different phases.

4 Preparation basis

Preparation basis is as follows:

a) Spacecraft system scheme;
b) Spacecraft system-level ground test items;
c) System-level engineering models (electrical model, thermal model and structural model) at detailed design phase;
d) Work breakdown structure;
e) Contract and its additional clauses.

5 Classification of technical network

5.1 Classification by spacecraft breakdown structure

Classified by spacecraft breakdown structure, technical network includes:

a) System-level technical network (system-level technical network at different development phases);
b) Subsystem-level technical network (subsystem-level technical network at different development phases);
c) Equipment-level technical network.

5.2 Classification by spacecraft development process

Classified by spacecraft development process, technical network includes:

a) Technical network of the whole process (technical network prepared for the whole process ranging from concept design to in-orbit delivery);
b) Technical network of different development phases (system, subsystem and equipment levels);
c) Technical network of work items (system-level or subsystem-level technical networks prepared based on the work items determined by project breakdown structure).

6 Preparation requirements and contents

Preparation requirements and contents are as follows:

a) Technical network shall be prepared for each level and each phase. Technical network at the top level is the one relating to the whole process of system development and technical networks at different levels are derived from it. Technical network system for the spacecraft development comprises all technical networks;
b) Technical network system starts from concept design phase to in-orbit delivery for use;
c) The nodes of development phases shall be defined in technical network and critical nodes shall be taken as its milestones; logistics for reaching each work node shall be formulated;
d) Technical contents of technical network shall be complete and without missing. Any change to the sequence of items shall be put under configuration control;
e) Technical network consists of diagrams and statements. Statements contain the description of technical network diagram and work items. Terms used shall be specified and unified.

7 Preparation steps

Preparation steps are as follows:

a) Determine work items at different development phases according to the spacecraft development contents;

b) Reasonably and scientifically arrange the work items according to the development sequence;

c) Specify work contents, required conditions and purposes to be realized for each work item.

8 Preparation methods

8.1 Drawing of technical network diagram

Drawing method is as follows:

a) Technical network diagram consists of boxes representing work items, arrows indicating the flow of technical work and nodes between boxes.

b) Technical network diagram is divided into two forms of lines: main line and auxiliary line. Figure 1 is the schematic diagram showing the composition of technical network diagram (Name of work item shall be written inside each box, but not given here).

c) Main line of technical network diagram is represented by “M”. All boxes shall be drawn by continuous heavy line and code of each box is expressed in “M” and “number”. If a certain node on the main line behind Mi box is divided into several branches of parallel work, parallel branches can be distinguished by a, b and c. Box code on each branch may be composed in accordance with the following provisions:

   Mi+1 plus a (or b, c) and plus number (1, 2, 3… etc.). Figure 2 is the schematic diagram on the main line composition of technical network diagram. Figure A.1 in Annex A is a detailed example of the main line composition of technical network diagram.

   Example:

   In Figure A.1, the main line is divided into three branches after M4:

   Codes of boxes at the first branch are M5a1 and M5a2 in sequence;

   Codes of boxes at the second branch are M5b1, M5b2 and M5b3 in sequence;

   Codes of boxes at the third branch are M5c1, M5c2 and M5c3 in sequence.

   After these branches are converged to some node again, codes of the next box will be numbered from Mi+2. In Figure A.1, it is M6.

d) Auxiliary line of technical network diagram is represented by Ai (i means the number of Auxiliary line) and box of each work item is drawn by continuous thin line. Box code on the Auxiliary line is represented by Ai + serial number of box. See A1.1, A1.2, A2.1, A2.2 in Figure 1 for details.

e) In the two boxes of technical network diagram, continuous thin line with arrows is used to indicate the flowing direction directly.

f) Nodes which have two more arrows are expressed in hollow circle while critical nodes between two boxes are shown in filled circle. Nodes between other boxes don’t need to be expressed.

Critical nodes are shown in Ci (i is the number of critical node).

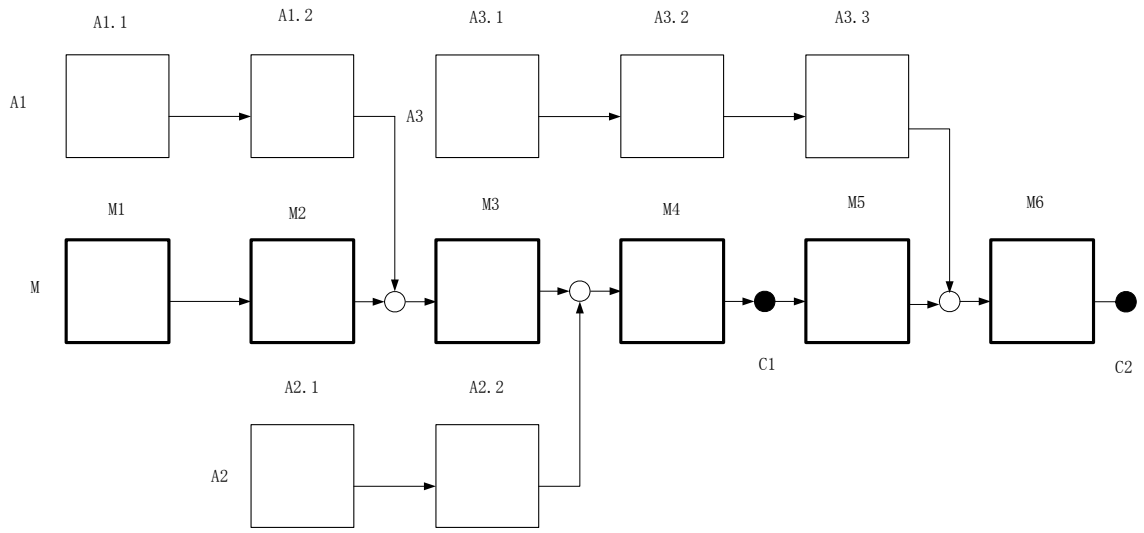

Figure 1 Schematic diagram on the composition of technical network diagram

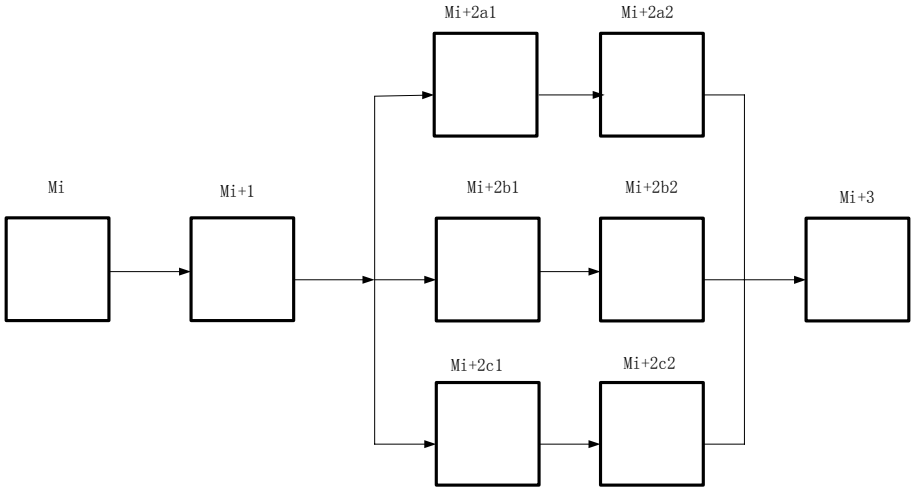

Figure 2 Schematic diagram on the main line composition of technical network diagram

8.2 Statements of technical network

8.2.1 Statement of technical network is as follows:

a) Specify this technical network goal for phase or life cycle, and define specific requirements for realizing the goals;

b) Identify critical nodes in technical network diagram;

c) Define control points in technical network diagram and important reviews of phases;

d) Other contents necessary.

8.2.2 Statements of work items are as follows:

a) Each box of technical network diagram shall have corresponding statements of the work item.

They may be preparation of technical documents, preparation of drawings, development of hardware equipment and software, engineering calculation and analysis and test operations;

b) The statement includes title and contents;

c) Define the input conditions of this work content, that is, what items shall be completed before the work item starts;

d) For statement order, main line shall take precedence over the auxiliary line and statement is provided based on the sequence of M1, M2 … and A1.1, A1.2 …A2.1 and A2.2…;

e) Contents of technical network for concept design phase or whole process may be described in the form of outline; contents of technical network for detailed design or manufacture phase shall be described in detail;

f) Operation items may be described specifically, such as “what, why, how, who or what purpose”;

g) Illustrate the conditions required for completing work items, such as work-sharing organization, workplace, required equipment and fund;

h) Provide estimated working days (hours);

i) Explain possible relationship between boxes without arrow links and coordinate relevant work items during the implementation;

j) Some work items may be described based on the technical documents, or refer to technical network of next lower level;

k) List documents used in completing this work item;

l) Specify quality and safety matters for completing this work item.

8.3 Example of technical network

8.3.1 Example of technical network diagram

According to the levels and phases of technical network, examples of two technical network diagrams are as follows:

a) Technical network diagram of the whole process of system reflects the overall view of spacecraft development process. See Figure A.1 in Annex A;

b) Technical network diagram of the whole process of subsystem reflects the overall view of subsystem development process. See Figure A.2 in Annex A.

8.3.2 Example of statement

See Table A.1 in Annex A for an example of statement (The example is the statement of work items).

Annex A

(Informative)

Example of technical network for spacecraft development

A. 1 Example of simplified technical network diagram of the whole process of system

Simplified technical network diagram of the whole process of a spacecraft system is shown in Figure A.1.

A.2 Example of simplified technical network diagram of the whole process of subsystem

Simplified technical network diagram of the whole process of a spacecraft system circuitry subsystem is shown in Figure A.2.

A. 3 Example of Statement

Statement of the work item of M13 spacecraft launching in Figure A.1 is provided in Table A.1.

Table A.1 Statement of the work item of M13 spacecraft launching

SN	Item Contents
1	Logistics a) Spacecraft has already completed the electrical test at launch site; b) Spacecraft propulsion subsystem has completed the propellant filling; c) Spacecraft and launch vehicle have completed overall inspection; d) Launch vehicle has completed the pre-launching preparations; e) Launch site has finished the pre-launching preparations. Spacecraft Tracking, Telemetry and Command (TT&C) Center is ready.
2	Work contents Based on the implementation program of spacecraft launch site, electric test procedures and failure respond scheme, the following work shall be carried out: a) Conduct the pre-launching thermal control for the spacecraft; b) Carry out pre-launching power-on test for the spacecraft; c) Set up the pre-launching status for spacecraft and report relevant data before launch to TT&C Center; d) Conduct the telemetry and monitoring over the spacecraft status before launch; e) Carry out relevant work based on the pre-launching failure respond scheme. Complete withdrawal after launching.
3	Precautions a) Equipment and circuits on the spacecraft have been set up based on the flight status. Pre-launching operation shall be implemented in strict accordance with the operating procedures; b) Pay high attention to pre-launching safety precautions. Monitor the satellite status closely after the powering on of spacecraft. Report timely when problems occur.
4	Participants Participants involved in the spacecraft development.
5	Duration for work item 1 day.

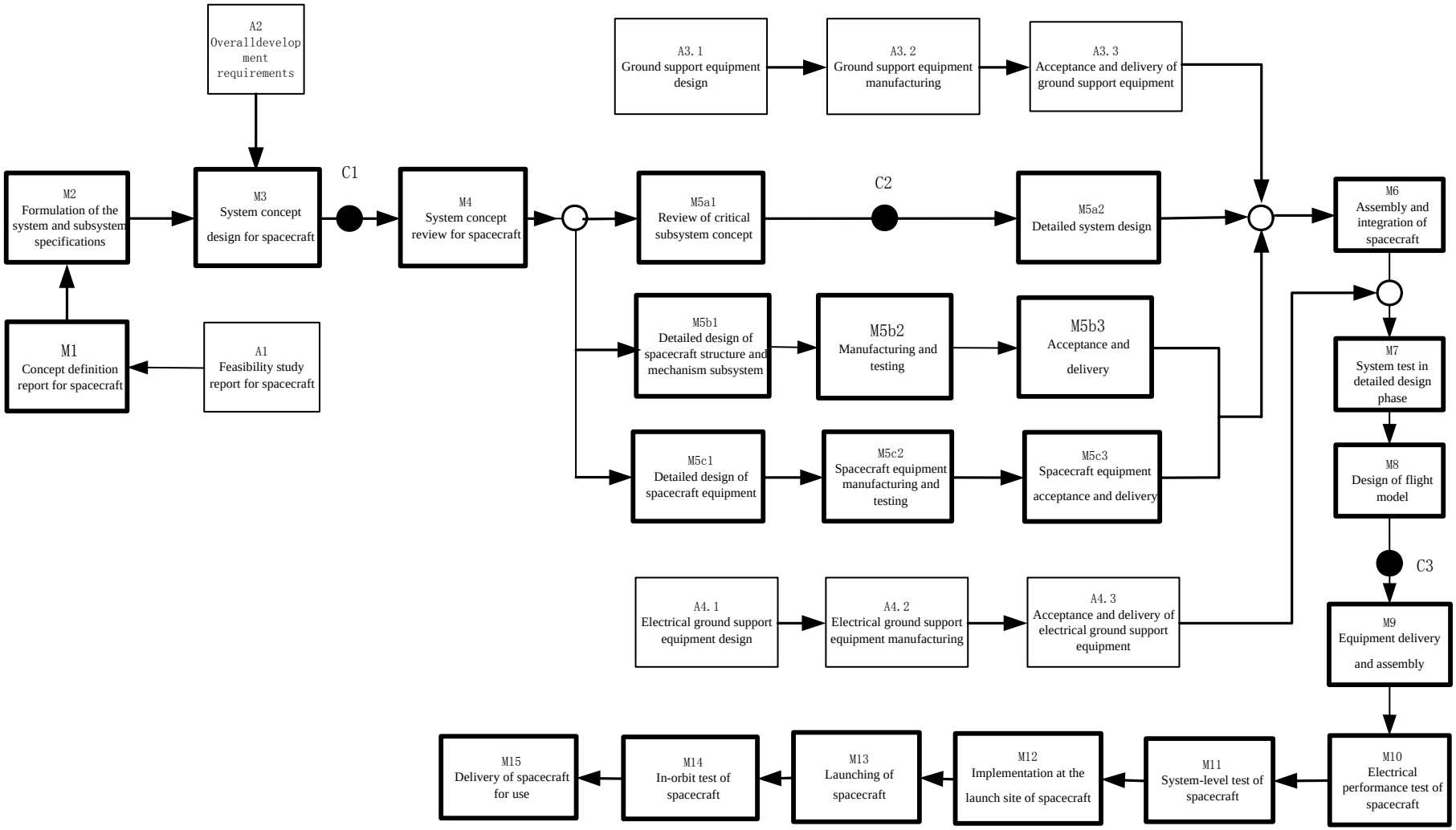

Figure A.1 Simplified technical network diagram of the whole process of a spacecraft system

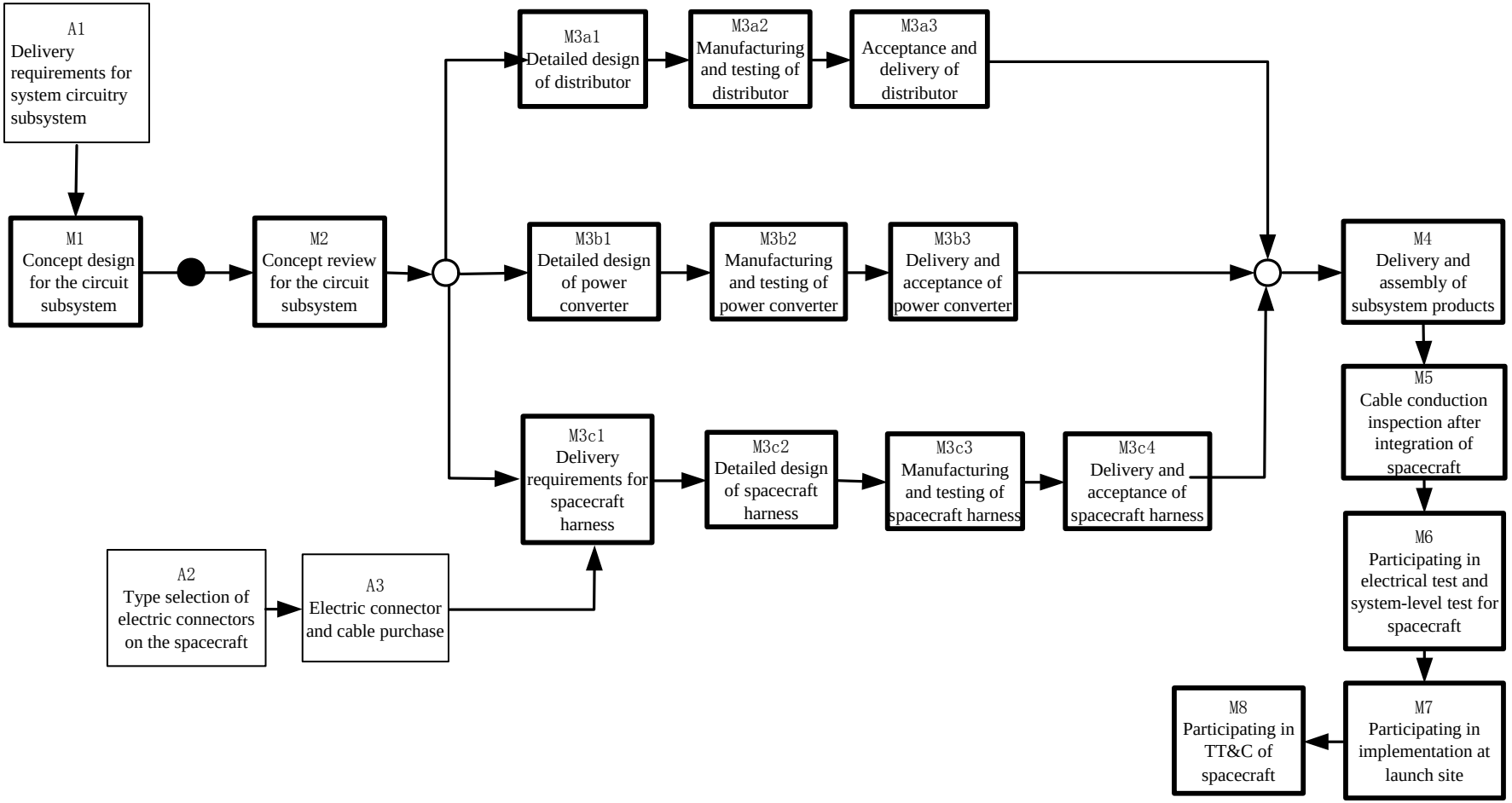

Figure A. 2 Simplified technical network diagram of the whole process of a spacecraft system circuitry subsystem