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Information technology — Representation for human communication of state transition of software

Technologies de l'information — Représentation pour un utilisateur final des états de transition des logiciels



Reference number
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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 11411 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 7, *Software engineering*.

Annexes A to D of this International Standard are for information only.

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Introduction

Software in some fields can be represented by state transition diagrams and tables. The software changes its states through transitions. When a certain condition arises, the corresponding transition from state to state is performed. Conditions are brought about by input of data. The data may take various forms, e.g.:

- signals,
- commands,
- messages,
- tokens, flags,
- characters, words,
- records, etc.

This International Standard describes minimum set of concepts and symbols for human communication of state transition of software.

This International Standard

a) defines the nature of state transitions of software;

b) defines the notation of state transition elements;

c) specifies a set of state transition elements.

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Information technology - Representation for human communication of state transition of software

1 Scope

The underlying concept of this International Standard is that diagrams and symbols defined herein can be helpful in representing software functions and transitions and in improving human communication. The areas covered by this International Standard are development, communication and review of software requirement analysis and design.

This International Standard is effective in the following fields of software.

Interactive software
----To describe the representation of functions and transitions on screens.

Data communication software
----To describe communication protocols and corresponding actions.

Language/command
----To describe the syntax.

2 Definitions

For the purposes of this International Standard, the following definitions apply.

2.1 state : A state is the unique value that represents the stage of progress of software in its execution. The state shall have a unique name as its identifier which is called state name.

2.2 transition : A transition is a change from one state to another state or the same state. A transition takes place when a condition is satisfied. An action may take place along with the transition. Formally, a transition consists of three parts:

- direction part;
- condition part;
- action part.

The direction part in turn consists of two state identifiers:

- previous state identifier, pointing to the previous state;
- next state identifier, pointing to the next state.

The condition part expresses the condition that must be satisfied for the action to take place and the change from one state to another. If more transitions are defined to change from one state to another state or the same state, they shall be mutually exclusive.

The action part represents the action which is performed by the software according to the condition. The action may be any processing or may be nil.

3 Specification

3.1 Specification of state

States are

a) Initial state
One and only one state is initial. In the initial state, the software starts its activity. The initial state must be the previous state of at least one transition.

b) Final state
One or more states can be the final state. In final states the software terminates its activity. Each final state must be the next state of at least one transition.

c) Initial/final state
The initial state can be the final state. In this case, the software terminates its activity and the activity may or may not be immediately restarted. The initial/final state must be the previous state of at least one transition and the next state of at least one transition.

d) Intermediate state
A state that is not initial, not final, and not initial/final is called an intermediate state. It must be the next state of at least one transition from another state and the previous state of at least one transition to another state.

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3.2 Specification of transition

Transitions are

a) Transition to another state
This transition indicates the change from one state to another state. The previous state and the next state identifiers in the direction part of such a transition designate different states.

b) Transition to the same state
This transition indicates the change from one state back to the same state. The previous state and the next state identifiers in the direction part of such a transition designate the same state.

3.3 Usage of state and transition

Description of the state transition of software shall obey the following conditions at the same time.

a) One and only one initial state exists.
b) Zero or more final state(s) exist(s).
c) One or more transition(s) exist(s).
d) A previous state and a next state in each transition exists.

4 State diagram

4.1 Concept

4.1.1 Diagram

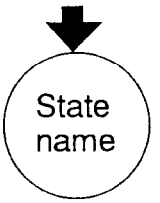
In the state diagram, state and transition are presented by symbols and texts. The state diagram represents permissible or defined changes of state.

4.1.2 Symbols

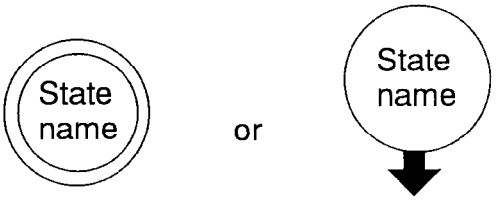
4.1.2.1 State

A state is presented by a circle and text.

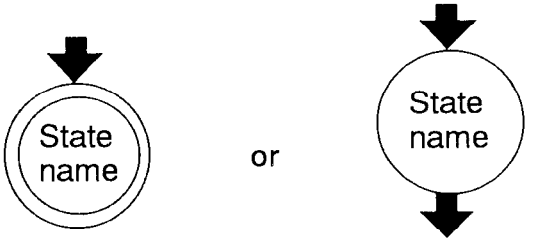
a) Initial state
The charting notation of the initial state is as follows.



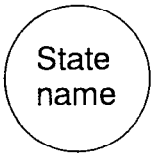
b) Final state
The charting notation of the final state is as follows.



c) Initial/final state
The initial state can be the final state at the same time. In this case, the charting notation of the state is as follows.



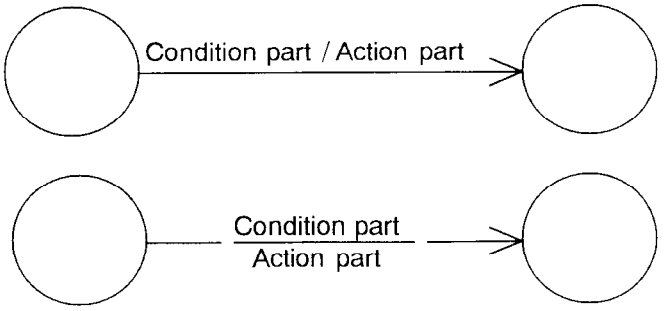
d) Intermediate state
The charting notation of an intermediate state is as follows.



4.1.2.2 Transition

Transition is presented by an arrow and text. The text includes condition part and action part. There should be a clear delimiter between condition part and action part, e.g. slash or horizontal line.

a) Transition to another state
The charting notation for a transition from one state to another is as follows.



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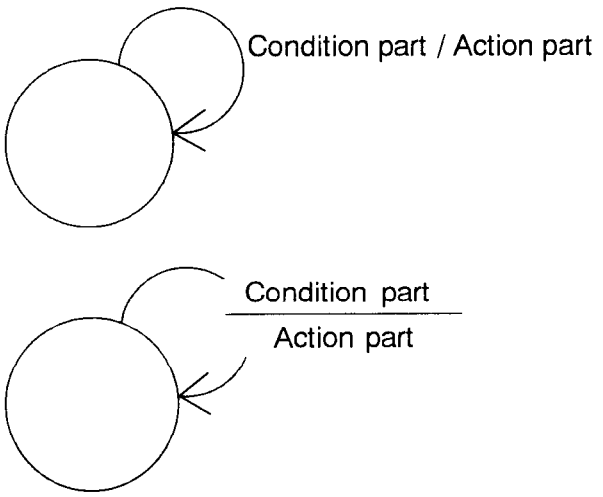
The condition part and action part should be described near the transition arrow. The description of the transition may interrupt the arc.

b) Transition to the same state
The charting notation for a transition from a state to the same state is as follows.

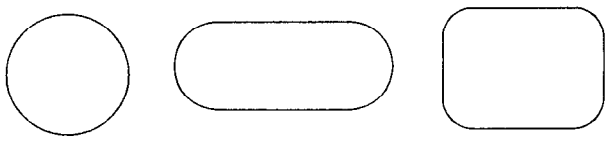


The condition part and action part should be described near the transition arrow. The description of the transition may interrupt the arc.

4.2 Conventions

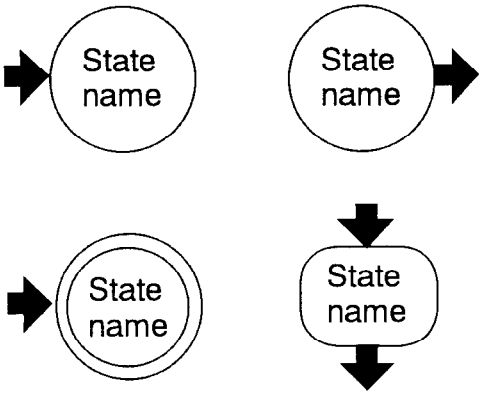
Diagraming conventions : The following are examples of allowed variations of charting notations.

a) Various shaped state symbols
Various state symbols whose basic shapes are shown as follows may be used.



In the case of the rectangle, the ratio of length and breadth is not defined. The way to represent initial, final and initial/final states in any basic shape is the same as shown in 4.1.2.

b) A filled or outlined arrow pointing to or from symbols may be used as the symbol of the initial, final, initial/final state, as follows.



c) Omission of an action part in a transition
The action part in the transition may be omitted when there is no action executing with the transition or there is no necessity to show the action. In this case, the delimiter is omitted, too.

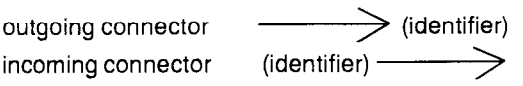
4.3 Usage and restrictions

4.3.1 Drawing

Both hand-drawn symbols and machine-drawn symbols are the same as 4.1.2.

A transition arc may be broken by an outgoing and incoming connector. A connector contains a unique identifier which is the same for corresponding outgoing and incoming connectors

Drawing is as follows.



4.3.2 Forms

This International Standard does not require a specific form sheet or template.

It is possible to describe a state diagram defined in this International Standard using only the usual straight and circle ruler.

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5 State table

5.1 Concept

5.1.1 Diagram

State transition may be also represented by a table. States and conditions will be represented in rows and columns. Transitions are at the corresponding intersections.

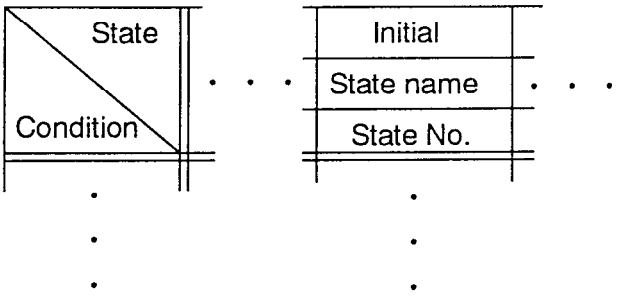
In state table, a state has a state No. as an additional identifier of state. The state No. is a unique number such as serial number of state.

5.1.2 Symbols

5.1.2.1 State

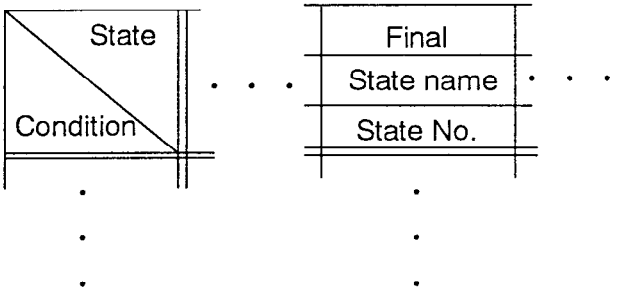
a) Initial state

The charting notation of an initial state is as follows.



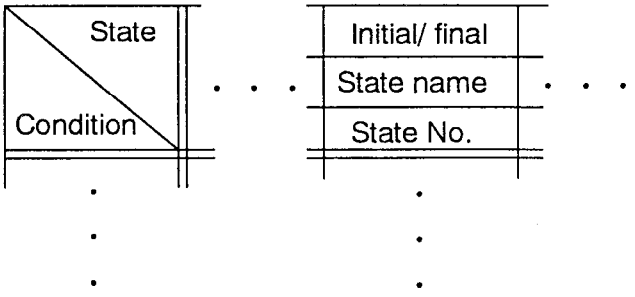
b) Final state

The charting notation of a final state is as follows.



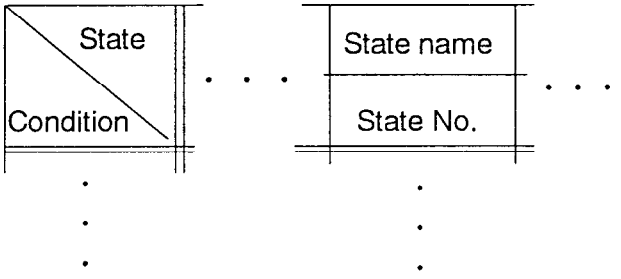
c) Initial/final state

The initial state can be the final state at the same time. In this case, the charting notation of the state is as follows.

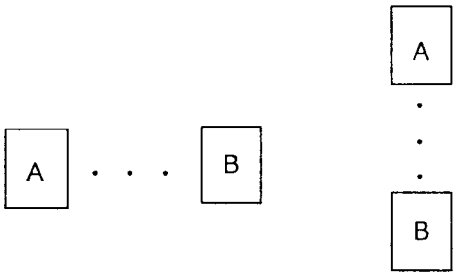


d) Intermediate state

The charting notation of this state is as follows.



NOTE - In clause 5, the ellipsis (three dots) is used to show general solutions with an open number of repetition of symbols or a set of symbols as follows.



5.1.2.2 Transition

Transition is presented by an intersection. Action part and next state number are described in the intersection.

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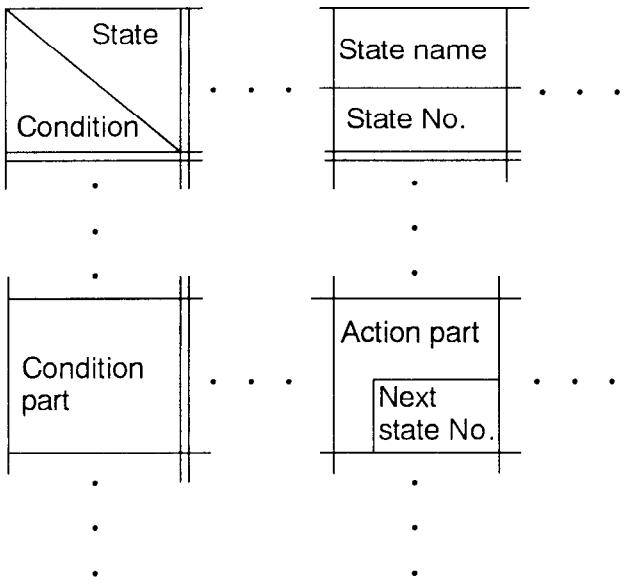
a) Transition to another state

The charting notation for a transition from one state to another is as follows.



The state No. and the next state No. designate different states.

b) Transition to the same state

In case of transition to the same state, the next state No. is the same as the original state No.

5.2 Conventions

Diagraming conventions : The following are examples of permitted variations of charting notations.

a) Use of the state name as the next state identifier

When it is easy to find a state in a state table using state name, state name may be used instead of state No. as the next state identifier in the intersection. In this case, the state No. part defined in 5.1.2.1 can be omitted.

b) Omission of an action part in a transition

The action part in the transition may be left blank when there is no action executing with the transition or it is not necessary to show the action.

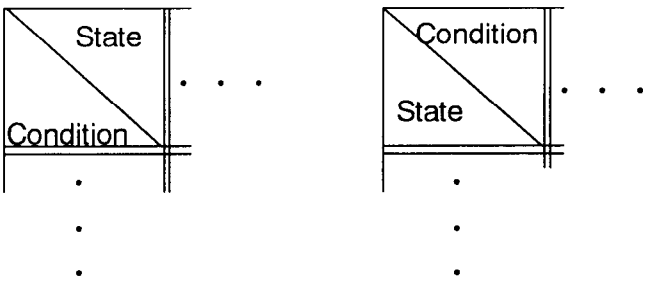
5.3 Usage and restrictions

5.3.1 Drawing

Both hand-drawn symbols and machine-drawn symbols are the same as those specified in 5.1.2.

5.3.2 Forms

Positions of state and condition are interchangeable, and this International Standard does not require a specific form sheet.



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Annex A
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Example of a state diagram

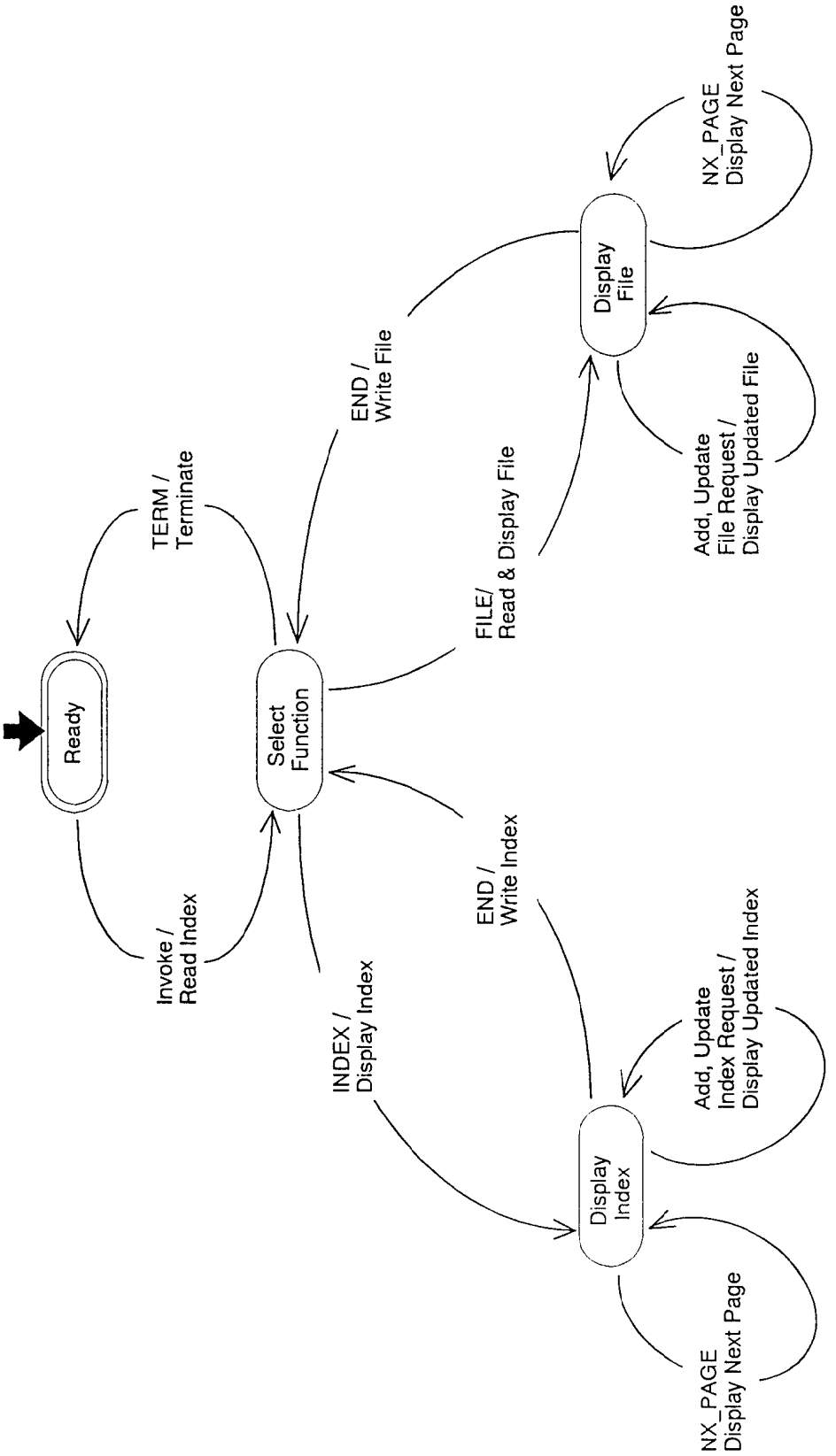

Figure A.1 - Interactive process in state diagram

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Annex B
(informative)
Example of a state table

State / Condition	Initial/ final Ready	Select Function	Display Index	Display File
	1	2	3	4
Invoke	Read Index → 2			
TERM		Teminate → 1		
INDEX		Display Index → 3		
FILE		Read & Display File → 4		
NX_PAGE			Display Next Page → 3	Display Next Page → 4
Add, Update Index Request			Display Updated Index → 3	
Add, Update File Request				Display Updated File → 4
END			Write Index → 2	Write File → 2

Figure B.1- Interactive process in state table

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Annex C
(informative)
Bibliography

1. Zohar Manna, *Mathematical theory of computation*, 1974, McGraw-Hill Inc.
2. Paul T Ward, Stephen J Mellor, *Structured development for real-time systems*, 1985, Prentice Hall.
3. Edward Yourdon, *Modern structured analysis*, 1989, Yourdon Press.
4. Wilfried Brauer, *Net theory and application*, Proceedings of the advanced course on general net theory of processes and systems, Hamburg, October 1979, Springer.

Users of this International Standard can refer to two other standards concerning state transition based techniques:

1. CCITT Rec. Z.100 and Z.120 *CCITT Specification and Description Language (SDL)*. (contains a graphical representation called SDL-GR)
2. ISO 9074 : 1989 *Information processing systems- Open Systems Interconnection- Estelle : A formal description technique based on extended state transition model.* (commonly referred to as ESTELLE)

NOTE- SDL-GR is mainly used in the telecommunications field and includes rich facilities specific to that field. This standard is more general and may become the base of SDL-GR.

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Descriptors: data processing, computer software, communication procedure, symbols, charts, diagrams.

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