

Implementation of
ISO/IEC 9804:1994

**Information
technology —
Open Systems
Interconnection —
Service definition for
the commitment,
concurrency and
recovery service
element**

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee IST/21, OSI, data management and open distributed processing, upon which the following bodies were represented:

- British Computer Society
- British Telecommunications plc
- CCTA (the Government Centre for Information Systems)
- Department of Trade and Industry [IT Standards Unit (ITD6A)]
- Digital Equipment Co Ltd.
- IBM United Kingdom Ltd.
- International Computers Limited
- Joint Information Systems Committee
- Level 7 Ltd.
- Logica UK Ltd.
- National Computing Centre Ltd.
- National Health Services
- Nine Tiles Computer Systems Ltd.
- PSC International Ltd.
- Rank Xerox Ltd.
- SEMA Group Systems Ltd.
- Salford Software Services (3-5)
- X Open Company Ltd.

This British Standard, having been prepared under the direction of the Information Systems Technology Assembly, was published under the authority of the Standards Board and comes into effect on 15 May 1995

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The following BSI references relate to the work on this standard:
Committee reference IST/21
Draft announced in *BSI News*, February 1995

ISBN 0 580 24079 7

Amendments issued since publication

Amd. No.	Date	Comments

Contents

	Page
Committees responsible	Inside front cover
National foreword	ii
Foreword	iv
Text of ISO/IEC 9804	1

National foreword

This British Standard reproduces verbatim ISO/IEC 9804:1994 and implements it as the UK national standard.

This British Standard supersedes BS ISO/IEC 9804:1990 which is withdrawn.

This British Standard is published under the direction of the Information Systems Technology Assembly (IST/-) whose Technical Committee IST/21 has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international committee any enquiries on interpretation, or proposals for change, and keep UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the ISO/IEC title page, pages ii to iv, pages 1 to 43 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

**Information technology — Open Systems
Interconnection — Service definition for
the commitment, concurrency and
recovery service element**

*Technologies de l'information — Interconnexion de systèmes ouverts
(OSI) — Définition du service pour l'élément de service d'engagement,
concurrence et reprise*



Reference number
ISO/IEC 9804:1994(E)

Contents

	Page
Foreword	iv
Introduction	1
1 Scope	1
2 Normative references	2
2.1 Identical Recommendations International Standards	2
2.2 Paired Recommendations International Standards equivalent in technical content	2
3 Definitions	2
3.1 Reference model definitions	2
3.2 Service conventions definitions	2
3.3 Presentation service definitions	3
3.4 ACSE service definitions	3
3.5 Application Layer Structure definitions	3
3.6 CCR service definitions	3
4 Abbreviations	6
5 Conventions	6
6 Concepts	6
6.1 Use of CCR in a distributed application environment	6
6.2 CCR facilities	9
6.3 Heuristic decisions	10
7 Service definition	11
7.1 C-BEGIN service	11
7.2 C-PREPARE service	12
7.3 C-READY service	12
7.4 C-COMMIT service	13
7.5 C-ROLLBACK service	13
7.6 C-RECOVER service	14
8 Sequencing information	15
8.1 General	18
8.2 Events	18
8.3 States	18
8.4 Interpretation of the state table	18
8.5 Completing the branch	18
8.6 Collisions and disruptive services	19
9 Using CCR	19
9.1 General	19
9.2 Use of CCR by a cooperating main service	19
9.3 Use of resynchronization services with CCR Protocol Version 1	19
9.4 Use of session synchronization and resynchronization services with CCR Protocol Version 2	19
9.5 Use of CCR with session activities	19
9.6 Use of transport expedited service with CCR Protocol Version 1	19
9.7 Use of presentation services with CCR Protocol Version 2	20
9.8 Starting a branch in CCR Protocol Version 1	20
Annex A CCR service-user rules	21
A.1 Introduction	21
A.2 Compliance	21
A.3 CCR service primitive usage rules	21
A.4 Atomic action data manipulation rules	23
A.5 Bound data manipulation rules	24

	Page
A.6 CCR service-user data transfer rules	24
Annex B Relationship of CCR to the Application Layer Structure	25
B.1 CCR service-provider	25
B.2 CCR service-user	25
B.3 Atomic action tree	25
Annex C CCR tutorial	27
C.1 Introduction	27
C.2 Structure of an atomic action tree	28
C.3 CCR service-user information resources	30
C.4 Concurrency	31
C.5 Recovery	32
C.6 Time relations and sequence of service primitives	35
C.7 Comments on implementation complexity	40
C.8 Using the User Data parameter on CCR services	41
C.9 Optional use of C-PREPARE	42
C.10 Use of session synchronize and resynchronize services with CCR Protocol Version 1	43
Figure 1 — Atomic action tree	7
Figure B.1 — Atomic action tree architecture	26
Figure C.1 — Atomic action tree	28
Figure C.2	29
Figure C.3 — Time relations for two-branch atomic action tree	36
Figure C.4 — Sequence of primitives — Atomic action is committed — Explicit C-PREPARE	37
Figure C.5 — Sequence of primitives — Atomic action is rolled back	38
Figure C.6 — Sequence of primitives — Atomic action is committed — Implicit prepare — C-BEGIN is not confirmed	39
Figure C.7 — Collision between application data and C-READY	42
Table 1 — CCR services	11
Table 2 — C-BEGIN parameters	11
Table 3 — C-PREPARE parameter	12
Table 4 — C-READY parameter	13
Table 5 — C-COMMIT parameter	13
Table 6 — C-ROLLBACK parameter	14
Table 7 — C-RECOVER parameter	14
Table 8 — Recover State parameter values	14
Table 9 — States	15
Table 10 — Events	16
Table 11 — State table for superior — Normal operation	17
Table 12 — State table for subordinate — Normal operation	17
Table 13 — State table for superior — Recovery	18
Table 14 — State table for subordinate — Recovery	18
Table C.1 — Example of atomic action data	33

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 9804 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 21, *Open systems interconnection, data management and open distributed processing*, in collaboration with ITU-T. The identical text is published as ITU-T Recommendation X.851.

This second edition cancels and replaces the first edition (ISO 9804:1990) and is a consolidation of Technical Corrigenda 1:1990. Amendment 2:1992 as well as ISO 9804:1990.

Annex A and Annex B form an integral part of this International Standard. Annex C is for information only.

Introduction

This Recommendation | International Standard is one of a set of Recommendations | International Standards produced to facilitate the interconnection of information processing systems. It relates to other ITU-T Recommendations | International Standards in the set defined by the Reference Model for Open Systems Interconnection (see ITU-T Rec. X.200 | ISO/IEC 7498). The reference model subdivides the area of standardization for interconnection into a series of layers of specification, each of manageable size.

The goal of Open Systems Interconnection is to allow, with a minimum of technical agreement outside the interconnection recommendations and standards, the interconnection of information processing systems:

- from different manufacturers;
- under different managements;
- of different levels of complexity; and
- of different technologies.

This Recommendation | International Standard recognizes that application-processes may wish to communicate with each other for a wide variety of reasons. However, any communication requires certain services independent of the reasons for communication. The application-service-element defined in this Recommendation | International Standard provides such services.

This Recommendation | International Standard defines the facilities of the application-service-element for commitment, concurrency and recovery (CCR). CCR provides services for a single association. A referencing specification uses these services for starting and ending a specific sequence of distributed application operations despite application or communication failure.

This Recommendation | International Standard is referenced by a specification to apply CCR to its operation. CCR services may be used with presentation services (see ITU-T Rec. X.216 | ISO/IEC 8822), or with other Application Layer services. However, the use of CCR services is subject to the restrictions specified in clause 9. The use of CCR services allows a referencing specification to define its activity as an atomic action. An atomic action may use many associations, possibly with different protocols on each association.

Annex A describes the rules that shall be followed by a specification that references this Recommendation | International Standard.

Annex B presents the relationship of the CCR model and concepts to the Application Layer Structure (see ITU-T Rec. X.207 | ISO/IEC 9545).

Annex C is a tutorial to aid the understanding of the concepts and facilities of CCR.

1 Scope

This Recommendation | International Standard is intended for reference by other specifications when the functionality of commitment, concurrency and recovery is required. It can be referenced whenever the processing of two or more application-entity invocations in a distributed application needs to be organized into an atomic action.

This Recommendation | International Standard defines services that are used on a single association to coordinate two application-entity invocations involved in an atomic action. The determination of which application-entity invocations are involved in an atomic action is not within the scope of this Recommendation | International Standard.

This Recommendation | International Standard establishes the general principles for the coordinated use of the CCR services when more than two application-entity invocations are involved in a single atomic action, or when recovery is required after failure. The coordination of multiple associations and the related application-entity invocations that constitute an atomic action is achieved by a referencing specification in conjunction with this Recommendation | International Standard.

This Recommendation | International Standard is only applicable to a distributed application whose specification references this Recommendation | International Standard.

This Recommendation | International Standard does not specify individual implementations or products. It does not constrain the implementation of entities and interfaces within a computer system.

No requirement is made for conformance to this Recommendation | International Standard.

This Recommendation | International Standard includes requirements for compliance that apply to a referencing specification.

The CCR service defined in this Recommendation | International Standard requires that either CCR Protocol Version 1 or CCR Protocol Version 2 is being used. Variations which are specific to each version are indicated in the text.

2 Normative references

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendation | International Standard. At the time of publication, the editions indicated were valid. All Recommendation and Standards are subject to revision, and parties to agreements based on this Recommendation | International Standard are encouraged to investigate the possibility of applying the most recent editions of the Recommendations and Standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunication Standardization Bureau of the ITU maintains a list of the currently valid ITU-T Recommendations.

2.1 Identical Recommendations | International Standards

— ITU-T Recommendation X.200 (1993) | ISO/IEC 7498-1:1994, *Information technology — Open Systems Interconnection — Basic Reference Model*.

— CCITT Recommendation X.650 (1992) | ISO 7498-3:1989, *Information technology — Open Systems Interconnection — Basic Reference Model: Naming and addressing*.

— ITU-T Recommendation X.207 (1993) | ISO/IEC 9545:1993, *Information technology — Open Systems Interconnection — Application layer structure*.

— ITU-T Recommendation X.215 (1993) | ISO/IEC 8326:1994, *Information technology — Open Systems Interconnection — Connection oriented session service definition*.

— ITU-T Recommendation X.216 (1994) | ISO/IEC 8822:1994, *Information technology — Open Systems Interconnection — Connection oriented presentation service definition*.

— ITU-T Recommendation X.217 (1994) | ISO/IEC 8649:1994, *Information technology — Open Systems Interconnection — Service definition for the Association Control Service Element*.

— ITU-T Recommendation X.852 (1993) | ISO/IEC 9805:1994, *Information technology — Open Systems Interconnection — Protocol Specification for the Commitment, Concurrency and Recovery Service Element*.

2.2 Paired Recommendations | International Standards equivalent in technical content

— ITU-T Recommendation X.210 (1993), *Open system interconnection layer service definition conventions*.

ISO/IEC 10731: ...¹⁾, *Information technology — Open Systems Interconnection — Basic Reference Model — Conventions for the definition of ISO services*.

3 Definitions

3.1 Reference model definitions

3.1.1 Basic Reference Model definitions

This Service Definition is based on the concepts developed in ITU-T Rec. X.200 | ISO/IEC 7498-1. It makes use of the following terms defined in them:

- a) application-entity;
- b) Application Layer;
- c) application-process;
- d) application-service-element;
- e) presentation-connection;
- f) presentation-service;
- g) session-connection;
- h) session-service.

3.1.2 Naming and addressing definitions

This Service Definition makes use of the following terms defined in CCITT Rec. X.650 | ISO/IEC 7498-3:

application-entity title.²⁾

3.2 Service conventions definitions

This Service Definition makes use of the following terms defined in ITU-T Rec. X.210 | ISO/TR 8509:

- a) service-provider;
- b) service-user;
- c) confirmed service;
- d) non-confirmed service;
- e) provider-initiated service;
- f) primitive;
- g) request (primitive);
- h) indication (primitive);
- i) response (primitive); and
- j) confirm (primitive).

¹⁾ Presently at the stage of draft.

²⁾ As defined in CCITT Rec. X.650 | ISO 7498-3, an application-entity title is composed of an application-process title and an application-entity qualifier.

3.3 Presentation service definitions

This Service Definition makes use of the following terms defined in ITU-T Rec. X.216 | ISO/IEC 8822:

- a) abstract syntax;
- b) abstract syntax name;
- c) defined context set;
- d) functional unit [presentation];
- e) presentation context; and
- f) presentation data value.

3.4 ACSE service definitions

This Service Definition makes use of the following terms defined in ITU-T Rec. X.217 | ISO/IEC 8649:

- a) association-initiator;
- b) association-responder; and
- c) disrupt.

3.5 Application Layer Structure definitions

This Service Definition makes use of the following terms defined in ITU-T Rec. X.207 | ISO/IEC 9545:

- a) application-context;
- b) application-entity invocation;
- c) multiple association control function;
- d) single association control function;
- e) single association object.

3.6 CCR service definitions

3.6.1 acceptor

the CCR service-user that receives the indication primitive for a particular CCR service. For a confirmed service, it also issues the response primitive

3.6.2 application failure

the failure of an application-entity invocation to meet its normal specification

3.6.3 atomic action

a specific set of operations of a distributed application that may be characterized by the properties of atomicity, consistency, isolation, and durability

3.6.4 atomic action branch; branch

a relationship between two CCR service-users representing an integral part of an atomic action. The relationship may survive both communication or application failure. It is begun by the use of CCR services and later completed by either the use of CCR services or by an application or communication failure

3.6.5 atomic action branch identifier; branch identifier

a value assigned by the superior that uniquely identifies a branch within the scope of the atomic action

3.6.6 atomic action data

state and control information about an atomic action and its branches. Atomic action data required for recovery persists if an application or communication failure occurs

3.6.7 atomic action identifier

a value assigned by the master that uniquely identifies an atomic action within the OSI environment

3.6.8 atomic action tree

a hierarchical relationship between CCR service-users involved in the operations of an atomic action

3.6.9 atomicity

a property of a set of related operations such that the operations are either all performed, or none of them are performed

3.6.10 bound data

data that are accessed and manipulated by a CCR service-user as part of an atomic action. Its state is bound by the rules of CCR. Bound data survives application and communication failures and exists beyond the atomic action branch

3.6.11 CCR service-provider

two peer CCR application-service-elements involved in the same atomic action branch

3.6.12 CCR service-user

that part of an application-entity invocation that makes use of CCR services to coordinate one or more branches of an atomic action tree

3.6.13 commitment of an atomic action branch; commitment

completion of an atomic action branch with the release of bound data in the final state

3.6.14 communication failure

the unexpected release of the supporting association

3.6.15

compensating action

operations used to re-establish either the initial or the final state from a mixed situation that was brought about by a conflict between heuristic decision(s) and the decision of the master

3.6.16

concurrency control

a real open system mechanism that coordinates modifications to bound data used by concurrent atomic actions so the isolation property of the atomic action is guaranteed

3.6.17

confirmation of commitment

a statement from a subordinate to the superior that the subordinate has completed local commitment procedures

3.6.18

consistency

a property of a set of related operations such that the effects of the operations are performed accurately, correctly, and with validity, with respect to application semantics

3.6.19

cooperating main service

a referencing specification that incorporates the CCR semantics within its own service primitives and carries CCR transfer syntax within its own protocol-data-units

3.6.20

distributed application

an information processing endeavor that is accomplished using two or more application-entity invocations interconnected within the OSI environment

NOTE This term will be removed from this subclause when its definition becomes available in another referenced Recommendation | International Standard.

3.6.21

doubt period

for a CCR service-user (that is not the master), the period during an atomic action that begins when it decides to offer commitment to its superior and ends when it receives either the order to commit or to rollback. The master CCR service-user does not have a doubt period

3.6.22

durability

a property of a completed set of related operations such that all the effects of the operations are not altered by any sort of failure

3.6.23

final state

the state of bound data produced as a result of the completed application operations of the atomic action

3.6.24

heuristic decision

a decision of a CCR service-user that has offered commitment to the superior and then releases all or part of its bound data before it is ordered to commit or to roll back by the superior

3.6.25

initial state

the state of bound data at the time of first use by an atomic action

3.6.26

intermediate CCR service-user; intermediate

a CCR service-user that has the role of both subordinate and superior. It is a subordinate of the master CCR service-user or another intermediate CCR service-user. It is the superior of one or more other intermediate and/or leaf CCR service-users

3.6.27

intermediate state

one of the states of bound data produced during the manipulation of bound data that is neither the initial nor the final state

3.6.28

interrupted branch

an atomic action branch whose supporting association was released because of an application or communication failure

3.6.29

isolation

a property of a set of related operations such that partial results of the set of operations are not accessible, except by operations of the set. This definition implies that different sets of related operations that have this property and that share bound data are serializable

3.6.30

leaf CCR service-user; leaf

a CCR service-user that only has the role of subordinate. It is the subordinate of the master CCR service-user or an intermediate CCR service-user. It has no subordinates of its own

3.6.31

local commitment procedures

establishing the final state of all bound data, removal of concurrency controls, and release of all resources used in performing the atomic action

3.6.32**local rollback procedures**

re-establishing the initial state of all bound data, removal of concurrency controls, and release of all resources used in performing the atomic action

3.6.33**master CCR service-user; master**

a CCR service-user that has the role of superior. As the creator of the atomic action tree, it has no superior, but it is the superior of one or more intermediate and/or leaf CCR service-users

3.6.34**mixed heuristic situation; mixed situation**

the state of bound data produced as the result of heuristic decision(s) when a CCR service-user releases bound data in a state different from the master

3.6.35**offer of commitment of an atomic action branch; offer of commitment**

a statement from the subordinate to the superior that the subordinate is ready for either commitment or rollback

3.6.36**order of commitment of an atomic action branch; order of commitment**

a statement by the superior to the subordinate to initiate commitment of the atomic action branch

3.6.37**phase I**

for a CCR service-user that is not the master, the period during an atomic action that ends when it decides to offer commitment to its superior. For the master CCR service-user, phase I ends when it decides to commit the atomic action. This Recommendation | International Standard does not specify when phase I starts

3.6.38**phase II**

for a CCR service-user that is not the master, the period during an atomic action that begins when it is ordered to commit by its superior. For the master CCR service-user, phase II begins when it decides to commit the atomic action. Phase II ends for any CCR service-user when it completes all of its branches and its involvement with the atomic action ends

3.6.39**presumed rollback**

the recovery mechanism used by CCR. It conditionally allows a CCR service-user to treat an application or communication failure as a rollback. This occurs if it has not recorded atomic action data for the branch. In addition, a CCR service-user acting as a subordinate may presume rollback under the following condition. It has recorded atomic action data for the branch but, during recovery, it discovers that the superior does not

3.6.40**recovery of an atomic action branch; recovery**

procedures used by a CCR service-user to complete an interrupted atomic action branch for which it has recovery responsibility

3.6.41**recovery responsibility for an atomic action branch; recovery responsibility**

a property of a CCR service-user that determines whether it attempts recovery. The CCR service-user acquires this property as a result of using certain CCR services. It retains the property until the completion of the atomic action branch

3.6.42**referencing specification**

an Application Layer

Recommendation | International Standard or other specification that specifies the use of CCR services. CCR services are always used in conjunction with a referencing specification

3.6.43**requestor**

the CCR service-user that issues the request primitive for a particular CCR service. For a confirmed service, it also receives the confirm primitive

3.6.44**rollback of an atomic action branch; rollback**

completion of an atomic action branch with the release of bound data in the initial state

3.6.45**subordinate of an atomic action branch; subordinate**

the CCR service-user that receives the request to begin the branch, offers commitment and receives the order to commit

3.6.46**superior of an atomic action branch; superior**

the CCR service-user that requests the beginning of the branch, receives the offer of commitment and orders commitment

4 Abbreviations

This Recommendation | International Standard uses the following abbreviations.

ACSE	Association control service element
AE	Application-entity
AEI	Application-entity invocation
Amd	Amendment to an ISO/IEC International Standard
ASE	Application-service-element
CCR	Commitment, concurrency, and recovery application-service-element
CCR-sp	Commitment, concurrency, and recovery service-provider
cnf	Confirm primitive
ind	Indication primitive
MACF	Multiple association control function
OSI	Open systems interconnection
OSIE	Open systems interconnection environment
req	Request primitive
rsp	Response primitive
SACF	Single association control function
SAO	Single association object
U-ASE	User application-service-element

5 Conventions

This Recommendation | International Standard defines services for CCR following the descriptive conventions defined in ITU-T Rec. X.210 | ISO/IEC 10731.

In clause 7, the definition of each CCR service includes a table that lists the parameters of its primitives. For a given primitive, the presence of each parameter is described by one of the following values:

Blank	Not applicable
C	Conditional
M	Mandatory
U	User option

In these tables, the notation (=) indicates that a parameter value is semantically equal to the value to its left in the table.

6 Concepts**6.1 Use of CCR in a distributed application environment**

CCR services are defined for a single association. They are not concerned with and do not address the organization and topology of a distributed application. A referencing specification is always required to coordinate the use of CCR services. However, the use of CCR services requires an understanding of the distributed application environment.

6.1.1 Atomic action environment**6.1.1.1 Atomic action properties**

An atomic action is a specific set of related distributed application operations that may be characterized by the following properties:

- a) *Atomicity* — A property of a set of related operations such that the operations are either all performed or none of them are performed.
- b) *Consistency* — A property of a related set of operations such that the effect of the operations are performed accurately, correctly and with validity, with respect to application semantics.
- c) *Isolation* — A property of a set of related operations such that partial results are not accessible, except by operations of the set. This definition implies that different sets of related operations that have this property and that share bound data are serializable.
- d) *Durability* — A property of a set of related operations such that all the effects of the operations are not altered by any sort of failure.

In the ideal case, all these atomic action properties are maintained by the CCR service-user. However, the degree of achievement of these properties depends on the level of compliance to the CCR service-user rules (see Annex A) and the local strategies of the CCR service-users.

Taking heuristic decisions is an example of a local strategy that might violate the atomic action properties (see 6.3). Heuristic decisions do not guarantee atomicity of the atomic action. Another example is the use of a concurrency mechanism that allows intermediate states of bound data to be visible outside the atomic action.

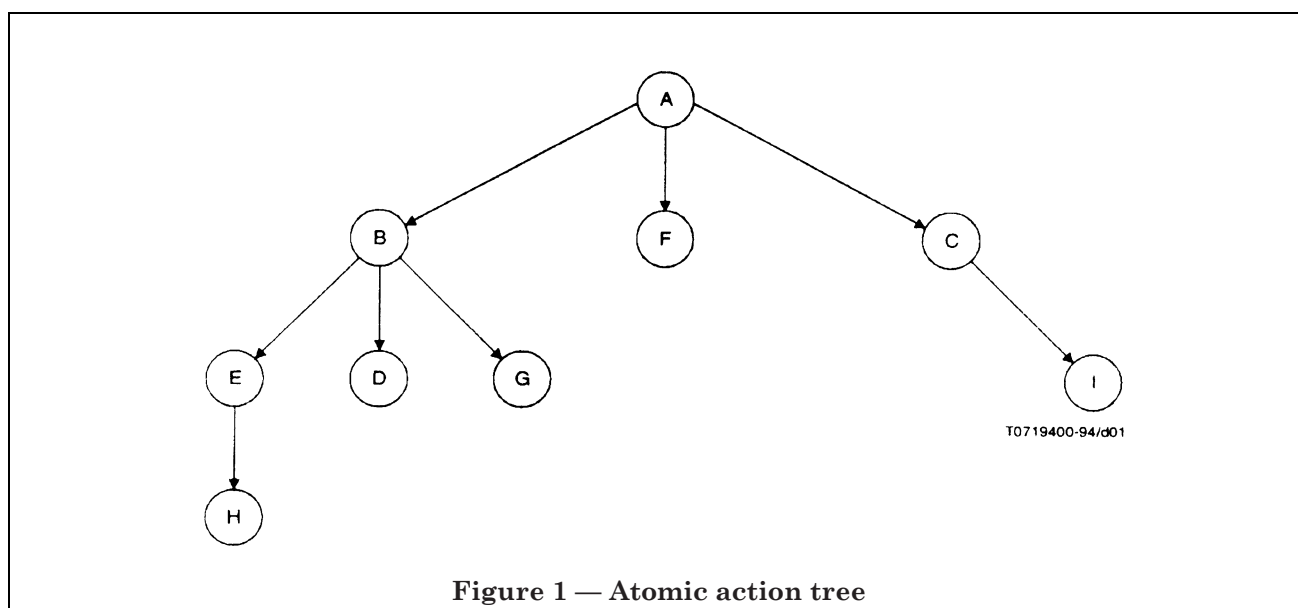


Figure 1 — Atomic action tree

6.1.1.2 The atomic action tree

The CCR service-users that participate in an atomic action form a relationship that has a tree structure. For this Recommendation | International Standard, such a relationship is modelled as an atomic action tree, as shown in Figure 1. An atomic action tree consists of CCR service-users and atomic action branches.

A given AEI can represent one or more CCR service-users of the same or different atomic action trees.

NOTE Atomic action branches between CCR service-users in the same AEI are outside of the scope of this Recommendation | International Standard.

A **branch** of the atomic action is the relationship between two logically adjacent CCR service-users.

An atomic action tree is dynamically constructed by the formation of its branches. The atomic action tree and its branches only exist for the lifetime of the atomic action.

An atomic action tree starts when a CCR service-user begins the first branch. This CCR service-user assigns this atomic action an atomic action identifier whose value uniquely identifies it within the OSIE. This value is propagated throughout the atomic action. A CCR service-user uses it to maintain concurrency controls. Following an application or communication failure, it is used to correlate recovery for interrupted branches of the atomic action.

Based on the requirements of the referencing specification, a CCR service-user can introduce another CCR service-user into the atomic action tree. This adds a new branch to the atomic action tree.

Beginning from any CCR service-user, an atomic action tree can be ordered hierarchically. Such an ordering that begins with the CCR service-user that started the atomic action defines the atomic action begin-tree. Figure 1 shows an atomic action tree in this ordering started by CCR service-user A. The arrow on each branch shows the direction in which it was started.

Following failure, the recovery facilities of CCR are used to ensure that branch completion procedures are correctly applied throughout the atomic action. An atomic action tree ends with the completion of all the individual branches.

6.1.2 Atomic action branch

An atomic action branch is a relationship between two logically adjacent CCR service-users. This relationship performs a portion of the work of an atomic action. The branch is requested by one of the CCR service-users and the other receives the request. Within the atomic action tree hierarchy, the CCR service-user that receives the request is one level lower than the CCR service-user that begins the branch.

The CCR service-user that begins a branch uses the appropriate atomic action identifier. It assigns a **branch identifier** whose value is unique within the scope of the atomic action. This branch identifier is used to identify a particular branch of the atomic action tree during recovery following an application or communication failure.

A branch is supported by an association. If an application or communication failure occurs, the branch may endure and continue with another association (see 6.2.2.2).

6.1.3 Bound data

The operations of an atomic action involve specific CCR service-user data as determined by the requirements of the referencing specification. For this Service Specification, such data under the control of an atomic action are called bound data.

Modifications made by the operations of the atomic action change the bound data from an initial state to a final state. The modifications are indivisible and either all are applied (placing the bound data in the final state) or none are applied (placing the bound data in the initial state).

During an atomic action, an intermediate state of the bound data is invisible outside of the atomic action. Any modifications are isolated from concurrent operations that take place outside of the atomic action.

6.1.4 Atomic action data

For this Service Specification, the term atomic action data refers to state and control information about an atomic action and its branches. Atomic action data needed for recovery is required to persist if an application or communication failure occurs.

6.1.5 Operation of an atomic action

The overall goal of an atomic action is to exchange application semantics to coordinate the setting of the final state of all bound data. To achieve this, CCR supports a two-phase commitment mechanism. During phase I offers of commitment are collected. During phase II commitment is ordered and confirmed.

Within the atomic action, each CCR service-user may offer commitment on one branch or it may make no offer of commitment. The atomic action may therefore be represented as a hierarchical tree ordered on the basis of offers of commitment — this is the atomic action commit-tree.

6.1.6 Roles in an atomic action

Offers of commitment on a branch are only made from the CCR service-user that received the C-BEGIN indication primitive for the branch.

The following roles for a branch can therefore be distinguished:

- a) *Superior* (of the branch) — The CCR service-user that requests the beginning of the branch, receives the offer of commitment and orders commitment.
- b) *Subordinate* (of the branch) — The CCR service-user that receives the request to begin the branch, offers commitment and receives the order to commit.

Three types of CCR service-users exist within an atomic action:

- a) *Master* — The role of superior. As the creator of the atomic action tree, it has no superior, but it is the superior of one or more intermediate and/or leaf CCR service-users.
- b) *Intermediate* — Has the role of both subordinate and superior. It is a subordinate of the master CCR service-user or of another intermediate CCR service-user. It is the superior of one or more other intermediate and/or leaf CCR service-users.
- c) *Leaf* — Only has the role of subordinate. It is the subordinate of the master CCR service-user or an intermediate CCR service-user. It has no subordinates of its own.

6.1.7 Two-phase commitment

CCR supports a two-phase commitment mechanism. During phase I offers of commitment are collected. This Recommendation | International Standard does not specify when phase I starts.

A CCR service-user offers commitment to its superior when it has received offers of commitment from all its subordinates and has completed all operations. At this point, it is capable of placing its bound data in either the initial or final state.

The master leaves phase I and enters phase II when it decides to commit the atomic action. To do this, it has received offers of commitment from all its subordinates. It also is capable of placing its bound data in the final state. The master then orders its subordinates to commit. The master leaves phase II after receiving commitment confirmation from all its subordinates to which it has ordered commitment.

A CCR service-user, that is not the master, leaves phase I and enters the doubt period when it decides to offer commitment to its superior. It leaves the doubt period and enters phase II when it receives the order to commit from its superior. An intermediate then orders its subordinates to commit. Finally, it leaves phase II when it sends commitment confirmation to its superior.

6.1.8 Commitment procedure

Commitment is the procedure whereby the CCR service-users participating in an atomic action release their bound data in the final state.

Commitment only occurs after all participating CCR service-users (other than the master) have offered commitment. The master initiates commitment. When the master decides to commit, it enters phase II. As each CCR service-user commits, it releases its bound data in the final state and orders all of its subordinates to commit.