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(Common) Language-Independent Datatypes
Editor's Notes to Second Committee Draft

A. Overview

A.1. This draft is a revision of (C)LI Datatypes CD 11404.1, as balloted in SC22 (SC22 N970) in July 1991. All changes reflect committee decisions of WG11 at editing meetings in Vienna (September, 1991), Baltimore (April, 1992), and Tampere (August 1992), and an alignment meeting with the RPC Rapporteur's Group (from JTCL/SC21/WG8) in Paris (October, 1992).

This draft contains all changes required by resolution of the SC22 ballot comments (SC22 N1069). All national body comments are resolved in this draft. Document SC22/WG11 N346 describes the resolution of the individual comments.

All formerly Outstanding Issues are now resolved, but there are a few unresolved alignment issues with RPC (ISO CD 11578) remaining.

Section B below, Annotations to Changes, identifies individual changes clause-by-clause and the source of those changes.

A.2. The major changes from the First Committee Draft are:

1. The compliance rules have been significantly revised.
2. Value specification has been significantly revised and "dependent values" (dynamic datatype parameters) have been added.
3. Attributes have been replaced by freely occurring "annotations", and the "representation attributes" Annex significantly reworked.
4. The generated datatypes have been reorganized, the notion "aggregate datatype" has been added, and the semantics of primitive and generated has changed.
5. Defined datatypes are now "equal" in status to the types defined ab initio.
6. Type-declaration syntax and semantics significantly revised.
7. Character-type now permits a list of repertoires and is aligned with ISO 10646.
8. The Real and Complex datatypes have new descriptions.
9. Datatypes Null and Undefined have been replaced by Void.
10. Procedure-type syntax changed and termination-declarations added.
11. The Choice generator has been completely rewritten.
12. List datatypes renamed Sequence datatypes.
13. The Array generator has been completely rewritten.
14. The Table generator has been significantly revised.
15. Private has been redescribed as a defined-datatype.
16. Generator Tree (LiSP List) added to Defined-generators.
17. Physical appearance of the document changed in several ways.

A.3. Resolution of Outstanding Issues in CD 11404.1:

- Issue 1. How to classify datatypes. Resolved Issues 31 and 32. Extensive taxonomic changes have been made to resolve this Issue with respect to "aggregate" datatypes. See 6.4 and 6.8.
 - Issue 2. Required datatypes. Resolved Issue 27.
 - Issue 3. Is Character-string primitive? Resolved Issue 25.
 - Issue 4. Description of the Table type. Revision and Notes to 8.4.6. (but see Issue 1.)
 - Issue 5. User-defined datatypes and generators. Note to clause 9. (Whether the generator capability will be used by RPC or LIPC is a matter for those standards.)
 - Issue 6. Null and Undefined. Null is changed to "Void". Void has a "nominal" value and Equal is defined to be "true" (vacuously satisfied). Undefined has been removed. Resolved Issues 10 and 11 revised.
 - Issue 7. Is Direct compliance meaningful? Provide examples of direct and indirect compliance. Notes to 5.1 and 5.2.
 - Issue 8. Use of outward mappings. Revision of 5.2 and 12.1 Notes 4 and 5.
 - Issue 9. Radices of Scaled datatypes. Resolved Issue 28. A 3-element representation, in which each value is a decimal integer is now used for values of arbitrary radix.
 - Issue 10. Model of Real and Complex. Resolved Issue 29 and 8.1.11 Notes 1 and 2. LI Datatype Real is a conceptual type; LiA-1 is a specification for language implementations of Real.
 - Issue 11. Model of Pointer. Resolved Issue 13 revised and 8.3.2 Notes 3 and 5. The WG decided that these are LIPC Issues, not LID Issues.
(Omitted) Example Mapping (required by N906/FR59).
A draft mapping to Pascal is included in Annex E.
(Omitted) Alignment with RPC.
Resolved by numerous changes herein, except as noted in A.4.
- A.4. Outstanding Alignment Issues between CD 11404.2 and CD 11578-2.2:
1. Choice-type discriminant.
RPC replaces "tag-type" with "value-reference", requiring the discriminant source to be specified and limiting it to "dependent-values". In LID, the source of the discriminant is NOT a parameter of the datatype.
 2. Value-expression syntax.
RPC value-expressions are much more limited, and the RPC syntax is organized for parsing what little is permitted, not for supporting the LID semantics.

- A.5. Outstanding editorial changes (These were agreed to, but the timely distribution of the CD made it necessary to forgo them in this draft.)
1. Align wording of definitions with ISO 2382.
 2. Reorganize Annex F (Resolved Issues) to follow the format of the normative text, like LIA Annex A. Many notes from the text could also be moved into such an Annex, but the Editor requires direction.
- B. Annotations to Changes
- Because significant textual changes occurred throughout, even though the technical changes were limited, the committee felt that "change bars" would not be informative.
- B.1. Abbreviated references
- All comment documents are referenced by both WG11 and X3T2 document number wherever they are applied. Abbreviated references are used for the following documents, which recommend many individual changes:
- [US n] refers to SC22 N1069, comments on the CD ballot from USA.
 [FR n] refers to SC22/WG11 N271, comments on the CD from the French national body, not formally attached as a ballot comment (but treated as such by WG11). The n is the number of the French comment.
 [Aries] refers to the joint agreements reached at the Aries meeting (5/91) with SC21/WG6 RPC Rapporteurs Group.
 [SC2] refers to changes made to align with terminology and positions of SC2 (Character Sets) suggested by van Wingen, in Vienna, 9/91.
 [RPC] refers to changes made to align with terminology and positions as resolved in the joint meeting in Paris (10/92).
 [Tampere n] refers to agreements reached at the Tampere meeting to resolve issues that were not addressed by national body comments. n is the issue number from the minutes, - k identifies an issue from WD5.
 [Paris n] refers to agreements reached at the Paris meeting to resolve issues that were not addressed by national body comments. n is the issue number from the minutes which matches WD5 issue numbers.
 [N309] refers to comments from Roger Scowen, convener WG17 (Prolog), in document SC22/WG11 N309 and responses by BSI IST/5 in SC22/WG11 N324.
 [Directives] refers to editorial changes made to satisfy requirements of the ISO Directives.
- B.2. Global changes
1. The term "discrete" has been replaced by "exact" and the term "dense" by "approximate" in all appropriate cases. (In two cases, other changes were required.) [FR 8.9, 8.10]
 2. The notion "attribute" has been changed to "annotation", and attributes have been eliminated from all syntactic productions. [RPC]
 3. All text references to syntactic objects italicized, and all definiens changed to boldface. [Paris, RPC]
 4. All references to Common Language-Independent changed to Language-Independent and all occurrences of CLI changed to LI. [Title change agreed to by WG11 in Paris]

5. All references to "this (International) Standard" replaced by "this draft International Standard". [N309]
 6. Value-syntax is now a separate item in each type description and type-generator description, and is accompanied by identification of the value denoted. [N309]
 7. The syntactic objects "datatype-designator", "datatype" and "CLI-datatype" have been uniformly replaced by "type-specifier". [RPC]
 8. The delimiter for the definition of a characterizing operation uniformly changed to either "-" or "<bold>|a". [N309]
 9. All uses of the term "mapping" which did not refer to datatype mappings have been changed to "function" or "association" as needed. [Tampere 2 = 1d,e].
- B.3 Changes by clause
1. Scope
 - Discussion of primitive and non-primitive datatypes moved to Clause 6. [US 1]
 - 4.1 Formal Syntax
 - The rationale for the formal syntax was moved to new Clause 7. [Directives]
 - All occurrences of the word "glyph" changed to "mark". [SC2]
 - Erroneous space delimiter rules removed. [FR 8.3]
 - The alternative delimiter (') for terminal symbols is introduced. [N309]
 - Definition of repeated, optional and alternative sequences modified to parallel that of non-terminal symbol. [Ed.]
 - former 4.2
 - The Lexical objects subclasses of clause 4 were moved to a separate clause 7 and reorganized. [Directives]
 - 4.2 Text Conventions. new.
 - Added to clarify distinction between syntactic and semantic objects in the text. [Paris, RPC]
 - 5.1 Direct compliance
 - Revised to remove references to Annex A. [US 1]
 - Revised to remove total direct compliance and former requirement (11) requiring use of the declaration mechanisms for additional types removed. [US 1]
 - Requirement (11) split into two parts, and the new (11) reworded to make clearer the requirements relative to characterizing operations. [FR 2, N309]
 - Former Note 1 deleted. Lexical compliance is now defined. [Ed.]
 - Note 2 added to clarify the requirements for the use of the value syntax. [N309]
 - Note 3 added to clarify what is prohibited. [Meek, in committee, 8/92]
 - Note 4 revised to clarify the notion of "additional semantic interpretation" vis-a-vis characterizing operations. [US 1, FR 2, N309]
 - 5.2 Indirect compliance
 - Revised to remove references to Annex A. [US 1]
 - Revised to remove notion of total/partial compliance. [US 1]
 - Note added to indicate what may comply indirectly. [SC22 N906 FR14]

- 5.3 Compliance of a mapping.
Note 2. Syntax of example changed to conform to current IDN. [Ed.]
- 6.1 Datatype.
Note added. [US 7]
- 6.3 Properties
All specifications for support moved to a new clause 10. [US 8]
- 6.3.4 Cardinality
Statements about discrete and dense corrected to approximate/exact. [FR 8.9, 8.10]
- 6.3.5 Exact/Approximate replaces former 6.3.5 Dense/Discrete.
Most requirements for the discrete property unintentionally excluded rational. The former notions have been replaced by the proper notions. [FR 8.9, 8.10]
- 6.3.6 Numeric.
Redescribed. [resolution of FR 2.3]
- 6.4 Primitive and Non-primitive datatypes. new.
Revision of 3 paragraphs of Scope clause which were moved to Clause 6. [US 1, FR 8.2]
Text modified with respect to aggregate types. [Paris 1]
- 6.5 Datatype generator former 6.4
Reworded to avoid ambiguity. [Ed.]
- 6.7 Datatype families former 6.6
Parameter notion explained. [Aries]
- 6.8 Aggregate Types new.
Made from Heek's treatise on Aggregates, incorporating notes from Schaffert and Greengrass. [Paris 1]
7. Fundamental Objects of the DSL (IDN) new.
Made from the non-"convention" parts of the former clause 4. [Directives]
Rationale for syntax moved here [Ed.]
Relationship to IDN added. [RPC]
- 7.1 Character-set (formerly part of 4.2 Lexical Objects)
Quote and escape characters added to the character set to support character string literals. [US 13]
By-symbol bindings to ISO 10646 added to explain string semantics. [SC2]
- 7.3 formerly part of 4.2 Lexical Objects.
7.3.2 Digit-string
The lexical object "number" was renamed "digit-string" to avoid the semantic connotations of "number" which do not necessarily apply to the lexical object, as in time-literals. [Ed.]
- 7.4 Annotations. new.
Replaces former "attribute" notion and syntax. [Tampere 15]
- 7.5 Values. new, added to provide a home for the following. [Ed.]
- 7.5.1 Independent values. New clause added. [US 3, US 13].
Note explaining relationship of denotations to values added.
- [FR 4]
- 7.5.2 Dependent values. New clause added. [US 3, Aries, Paris]
Text and syntax aligned with RPC to the extent possible.
8. Datatypes former 7.
Syntactic objects datatype, CLI-datatype and datatype-designator replaced by type-specifier and corresponding text revisions. [RPC]
Type-attributes removed. [Tampere 15, resolution of US 9]
Heading reformatted. [Ed.]
- 8.1 Primitive types former 7.1
Notation "datatype.operation" defined. [N309]
- 8.1.1 Boolean former 7.1.1
Syntax corrected. [Ed.]
- 8.1.2 State (former 7.1.2)
State values can no longer be parametric, because of changes to type-declaration. [RPC]
- 8.1.3 Enumerated (former 7.1.3)
Enumerated values can no longer be parametric, because of changes to type-declaration. [RPC]
Specification of successor corrected. [Ed.]
- 8.1.4 Character (former 7.1.4)
Changed syntax and text to allow a repertoire list. [RPC]
Changed to allow a default to be otherwise specified. [RPC]
Many editorial changes to align wording with SC2 work. [SC2]
Positional value removed and Character-name extension added to agree with resolution of [US 13].
Type changed to "unordered". [Canada, N1069]
Example rewritten with new syntax. [Ed.]
- 8.1.5 Ordinal former 7.1.5
Specification of values corrected. [FR 8.5]
Specification of successor corrected. [Ed.]
- 8.1.6 Date-and-Time former 7.1.6
"unit-type" uniformly replaced by "time-unit" and related editorial changes, to avoid the word "type" which is otherwise used only for datatypes. [Ed.]
Reference to ISO 8801 corrected. [Ed.]
- 8.1.9 Rational former 7.1.9
Definition of rational-literal corrected. [FR 8.7]
Rational is "exact" (dense, but not approximate). [FR 8.9]
Note 3 modified to avoid implication that CLID describes arithmetic.
- 8.1.10 Scaled (former 7.1.10)
Syntax of values changed to accommodate radices other than 10. [Paris 9]
Note 3 modified to avoid implication that LID describes arithmetic. [Paris 10]
- 8.1.11 Real (former 7.1.11)
Syntax of values changed to accommodate radices other than 10. [Paris 9]
Real changed to "a computational approximation to" the mathematical reals. This change required numerous changes to the definitions of the value space and the operations. [FR 5]

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- Representation of "relative-error" changed to match Scaled. [US 10, Arles]
 Definition of InOrder changed to appeal to mathematical notion. [FR 1.1]
 Note 1 changed to match the computational notion.
 Note 2. Corrected references to DIS 10967 (LIA) and IEC 559. [Ed.]
- 8.1.12 Complex former 7.1.12
 Complex changed to "a computational approximation to" the mathematical complex type. This change required numerous changes to the definitions of the value space and the operations. [FR 5]
 Representation of "relative-error" changed to match Scaled. [US 10, Arles]
 Re-phrased to remove the term "algebraic closure". [FR 8.8]
 Note. Inserted reference to future parts of ISO 10967 (LIA). [Ed.]
- 8.1.13 Void (former 7.1.13 Null)
 Definition and description rewritten. [US 4]
 Changed Values clause to explain the pseudo-value nil and defined the characterizing operation Equal to match WDS.
 Note 1 changed to match procedure-type and add cross-references. [Ed.]
 Note 2 added per discussion in Paris. [Paris 6]
 Note 3 added to explain Equal. [Paris 6]
- Previous 7.1.14 Undefined. Deleted. [US 4, FR 7]
 Previous 7.1.15 Private.
 Moved to 10.1.9 and redescribed as array of bit. [US 11]
- 8.2.4 Extended, former 7.2.4
 Base type is not required to be either "discrete" or "exact". [FR 8]
- 8.2.5 Size, former 7.2.5
 Definition of values corrected. [FR 8.11]
 Separator changed from comma to "." to match Range. [Arles]
- 8.2.6 Explicit subtypes, former 7.2.6
 Syntax changed to avoid ambiguity for attributes and subtypes. [US 9, Arles]
 Keyword changed to avoid conflict with Restricted. [RPC]
- 8.3 Generated datatypes (former 7.3)
 All type descriptions modified to use the wording suggested by ? [Ed.]
 Redescribed to avoid the non-atomic implication. [Tampere 2]
- 8.3.1 Choice (former 7.3.1)
 Datatype was rewritten to distinguish alternatives by tag-values. [US 5, Arles] [Editor substituted "tag" for "selection" in the recommended text, to avoid confusion with "select-list" and "selecting-type".]
- 8.3.2 Pointer, former 7.3.3
 Redescribed to avoid use of the term "variable". [US 6] [This draft is not exactly the recommendation made by the U.S., but rather the editor's attempt to verbalize the compromise reached in committee (4/92), the substance of which was that the words "associates to" should replace "identifies" and the notions "instance" and "variable" should disappear altogether.]
 Syntax changed to avoid ambiguity for subtypes. [US 9, Arles]
- Description reworded to parallel others. [Ed.]
 Null-value is not required to be available. [X3J3 comment]
 Note 1. Extraneous mathematical wording deleted. [Ed, following Baltimore decision on similar French comments.]
 Note 5 added to explain RPC attributes. [Paris]
- 8.3.3 formerly 7.1.16 Procedure.
 Syntactic and text changes in the non-terminals: "exception" to "termination" and procedure-name to procedure-identifier. [RPC]
 Principal result added, permitting an optional argument-name in the return clause, with corresponding changes to the text. [US 20, RPC]
 Attributes removed. [RPC]
 Model of a value of procedure-type defined mathematically, note 3 revised to match. Note 7 modified to explain the reason for the difference between the syntax and the mathematical model. Note 8 added to relate the mathematical model of the input and result spaces to the computational model. [resolution of US 20]
 Definition of subtypes repaired to support the returns clause [Ed.]
 Apply changed to Invoke. [RPC]
- 8.4 Aggregate types. new.
 Result of the committee compromise on the handling of Pointer, Procedure, Choice versus the types which are not atomic. [Tampere 2]
 All type descriptions modified to use the Meek property list. [Paris 1]
 All type descriptions modified to use the wording suggested by ? [Ed.]
- 8.4.1 former 7.3.2 Record
 "field-attributes" corrected to "component-attributes". [Ed.]
 Characterizing operation Aggregate replaced by FieldReplace to match the Meek properties. Notes modified to match. [Paris 1]
 Note 4 added per Greengrass and Turba. [Tampere 2]
- 8.4.2 formerly 7.3.4 Set
 Set-value syntax changed to support empty value. [Arles]
 Syntax changed to avoid ambiguity for subtypes. [US 9, Arles]
 Description reworded, type defined with a mathematical model. [FR 1]
- 8.4.3 formerly 7.3.6 Bag
 Bag-value syntax changed to support empty value. [Arles]
 Syntax changed to avoid ambiguity for subtypes. [US 9, Arles]
 Type defined with a mathematical model. [FR 1.3]
- 8.4.4 Sequence, former 7.3.5 List
 Renamed to avoid confusion with LISP list datatype. [Paris 1]
 Value syntax changed to support empty value. [Arles]
 Syntax changed to avoid ambiguity for subtypes. [US 9, Arles]
- 8.4.5 formerly 7.3.7 Array
 Datatype redescribed as mappings, and the sequencing of the product space restricted to interpreting array-values. This required revision of much of the text including several Notes. [FR 6]
 Asterisk removed from upperbound, lowerbound syntax, replaced by data-dependent-value in value-expression. [US 3]
 Syntax changed to avoid ambiguity for subtypes. [US 9, Arles]
 Index-types must be finite and exact (the only case in which "discrete" was r). [FR 8.10]
 "Array-Index" changed (back) to Index-type and corresponding

- text changes, to match Meek model. (Paris 1)
Note 1 incorporates text from Meek.
Note 4 and 5 Change List to Sequence.
- 8.4.6 formerly 7.3.8 Table
Syntax changed to avoid ambiguity for subtypes. (US 9, Arles)
Table-value syntax changed to support empty value. (Arles)
Table redescribed to permit multiple keys and be analogous to Array. (Tampere 4 - 4)
Repaired definition of Equal and Empty. (Ed.)
Notes 1, 2, 3 reorganized per Meek and Greengrass. (Paris 1)
- 8.5 Defined Types (former 7.4)
Revised and combined with former 7.3.9 Declared Generators to match the changes to type declarations (RPC, Ed.)
9. Declarations former 8.
- 9.1 Type Declarations
Rewritten from 8.1 and 8.2 to require the formal parameters to specify the datatype of the actual value. The syntax departs from that of the RPC IDN to avoid ambiguous references in the text. (RPC)
The parallel construction to make the generator declarations similar was the Editor's invention.
- 9.2 Value declarations, former 8.3
value-expression changed to independent-value, and associated new syntax. (US 3)
- 9.3 Termination Declarations. new.
Added to accommodate RPC changes to procedure declarations. (RPC)
former 9. Attributes. deleted.
Notion is now supported by "annotations" (7.4) and recommendations in Annex B. (Tampere 15, Paris)
10. Derived types and generators, former Annexes B and C.
Moved into main text, editorial changes made to clause headings. (US 14)
Declaration syntax revised to correspond to the changes in type-declaration. (FR 8.13)
- 10.1 Defined datatypes, former Annex B.
Value specification for defined-datatypes added. (US 13)
- 10.1.1 Switch (former B.1)
Note: cannot be modified to comply with new type-declaration syntax. (Ed.)
- 10.1.3 Bit String, former B.3.
Value syntax added, editor's invention. (US 13)
Derived from Sequence instead of List. (Ed.)
- 10.1.4 Character String, former B.4.
Value syntax added, similar to previous RPC draft, with the character name extension. (resolution of US 13)
Minor changes to the notes to agree with SC2 comments. (SC2)
Derived from Sequence instead of List. (Ed.)
Note 3 (Concatenate) moved to 8.4.4 Sequence Note 2. (Ed.)
- 10.1.5 Modulo, former B.5 Integer-Modulo
Renamed and syntax slightly revised. (US 14.4, Tampere 12)
- Quotient and Remainder moved to Integer. (Ed.)
- 10.1.9 Private, former 7.1.15.
Moved from 7.1 and redescribed. (US 11)
- 10.1.10 Object-Identifier, former B.9
Renamed and redescribed. Note added to explain why it is not primitive. (resolution of US 19)
Reference to ISO 9836 was wrong. Changed to ISO 8824. (Ed.)
Value syntax corrected. (Ed.)
List changed to sequence.
- 10.1.11 Distinguished-name. new. (resolution of US 18)
- 10.2 Defined Generators. formerly Annex C.
- 10.2.1 Stack, former C.1
Derived from Sequence instead of List. (Ed.)
- 10.2.2 Tree. new
Added to resolve the "recursive" attribute of List. (Paris 1)
- 10.2.3 Cyclic. replaces former C.2 Modulo.
The generic Modulo operation was reduced to redefining Successor on Enumerated types. (US 14.4, Tampere 12)
11. Support of Datatypes. new
Made from excerpts of support requirements from 6.3 (US 8)
- 11.4 Approximate/Exact.
New. Replaces excerpts from 6.3.5. (FR 8.4, 8.9, 8.10)
- 11.5 Numeric.
New. Replaces excerpts from 6.3.6. (FR 2.3)
- 12.1 Outward Mappings, formerly 10.1.
Notes 4 and 5 added. (Tampere 7 - 8)
- 12.2 Inward Mappings, formerly 10.2
Note 4 added, to explain relation to "marshalling". (Tampere 7-8)
- 12.3 Reverse Inward Mappings
Replaces former 10.3 Consistency of Mappings. This concept is the one wanted by LIPC/RPC. (Tampere 7-8)
former Annex A. Datatypes required. Deleted. (US 1)
- Annex A, formerly Annex E. Character Set standards
Reworded per SC2 recommendations. (SC2)
ISO 2375 added. (US 16)
Reason for inclusion of ISO 6093 added. (Arles)
ISO 8824 added, to define VisibleString, etc. (Arles)
Notes to ISO 10646 added to explain references to the repertoires thereby defined. (RPC, Paris)
- Annex B. Recommended Placement of Attributes, former Clause 9.
Informative salvage from former clause 9 Attributes. It is not clear whether there is still consensus on this material. (Ed.)
- Annex C. Recommended Representation Attributes, formerly Annex D.
Reduced to a list of representation concerns. This is the attempt to resolve the U.S. comment requesting deletion of the "representation" annex outright. (US 15)
It is not clear whether there is still consensus on this

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material. Any national body is welcome to propose suggested syntax, but much of the former syntax is no longer appropriate.

Annex D. IDN. formerly Annex F.

Reconstructed from the text. [Ed.]

Annex E. Pascal Mapping. new.

Added to exemplify mappings. (FR registration comment 59)

Annex F. Resolved Issues, former Annex G.

All references to "the committee" replaced by "there was consensus". [N309]