The
Digital Geographic Information Exchange Standard
(DIGEST)

Part 1
GENERAL DESCRIPTION

Edition 2.1
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DIGEST Part 1

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NOTICE TO USERS

1. This international exchange standard has been designed to enable the transfer of Digital Geographic Information (DGI) between geographic information systems. This documentation forms a baseline from which both system developers and national survey organizations can plan their development and production activities.

2. Research into all aspects of DGI is continuing within the Digital Geographic Information Working Group (DGIWG) forum and any subsequent potential changes will be subject to formal change control procedures.

3. Any clarifications or corrections to the standard approved by the committee will be recorded as amendments to the document. These documents will be incorporated into a future version of DIGEST along with any upward compatible extensions approved at that time.

RECORD OF AMENDMENTS

NUMBER	DATE	ENTERED BY	REMARKS

FOREWORD

Authority. The **DI**gital **G**eographic Information **E**xchange **ST**andard (DIGEST) was prepared by and issued under the authority of the Digital Geographic Information Working Group (DGIWG).

Security Classification. All parts of DIGEST are unclassified but may be subject to the limitation of use that the copying of the documents is prohibited without the authority of the national representative (see Part 1 Clause 5.2).

Digital Geographic Information Working Group (DGIWG). DGIWG was formed to develop standards to support the exchange of Digital Geographic Information (DGI) among NATO nations. Interoperability and burden sharing continue to be the goals of the DGIWG since the group's establishment in 1983. Many of the DGIWG standardization achievements have been adopted directly by NATO. The current DGIWG membership and work program extends beyond NATO.

Implementation. Since the early 1990's, the DGIWG has maintained and extended DIGEST to satisfy the current and emerging needs of the DGIWG community. Over the years, DIGEST has become the basis for co-production opportunities between nations. DIGEST-compliant datasets are being produced and exchanged by numerous nations to support a variety of military and civilian applications. DIGEST is NATO Standardization Agreement (STANAG) 7074.

DIGEST Components and Document Structure. DIGEST is a comprehensive "family of standards" capable of supporting the exchange of raster, matrix, and vector data (and associated text) among producers and users. DIGEST can support the entire range of levels of topological structures.

DIGEST is divided in 4 parts:

- Part 1 consists of a brief general description of the standard.
- Part 2 consists of the Theoretical Model, Exchange Structure, Encapsulation specifications (Annexes A through D) and a Standard ASCII Table of Contents (Annex E).

  The Part 2 encapsulations include:

  - Annex A – based on ISO 8211 – Information Processing - Specification for a descriptive file for information interchange.
  - Annex B – based on ISO 8824 – Information Processing Systems – Open Systems Interconnection – Specifications of Abstract Syntax Notation One; and ISO 8825 – Information Processing Systems – Open Systems Interconnection – Specification of Basic Encoding Rules for Abstract Syntax Notation One.

- Annex C – Vector Relational Format (VRF) – "Table-based direct-use format" for vector data.

- Annex D – Image Interchange Format – based on the NATO Secondary Imagery Format (NSIF) profile of ISO 12087-5 - Basic Imagery Interchange Format (BIIF).

Part 3 consists of Codes and Parameters.

Part 4 is the Feature Attribute Coding Catalogue (FACC) Data Dictionary – FACC is a comprehensive coding scheme for features, feature attributes, and attribute values.

Changes from the Last Edition. DIGEST Edition 2.1 cancels and replaces DIGEST Edition 2.0 (June 1997). The major changes are documented below:

Changes:

- Incorporation of corrections and clarifications accumulated since version 2.0.

Part 1:

- Revision of the general description of DIGEST to reflect an emphasis on standardizing geographic information content that may be exchanged using different encapsulations or stored in data bases or data warehouses.
- An indication in the general description of DIGEST of the increased level of alignment between DIGEST and other external standards, in particular, the International Hydrographic Organization S-57 standard, the ISO / TC211 suite of Geographic Information / Geomatics standards and the ISO JTC1 SC24 Image Processing Standards.

Part 2:

- Addition of circular arcs as a geometric primitive. (Annex C, C.2.3.2.2)
- Addition of an optional z attribute parameter for geometric primitives, which provides a method of storing multiple z-values in select cases where disjoint z-values occur. (Annex C, C.2.3.2.6)
- The use of the z attribute parameter in coordinates for geometric primitives to represent the elevation (special cases) at the location in a 2.5-D context. That is two-dimensional planar graph topology applies on a manifold in three dimensions. (The special cases and limitations have been defined for Annex C.)
- Extension of feature relations (i.e., stack-on/stack-under), previously limited to the coverage level and the library level. (Annex C, C.2.3.3.1)
- Addition of optional columns in the feature join table to support the storage of source information down to the feature and attribute level. (Annex C, C.2.3.3.2)
- Defined standardized coded values commonly associated with attribute values (i.e., null, unknown). Provides encoding mechanism for non-coded attribute types. (Annex C, C.2.3.4.4)

- Revision of DIGEST Part 2 Annex D "Image Interchange Format (IIF) Encapsulation Specification", to bring it into full alignment with the current editions of the NATO Secondary Imagery Format STANAG 4545 Edition 1 Amendment 1, the ISO 12087-5 Basic Image Interchange Format (BIIF) and the US National Imagery Transmission Format (NITF), MIL-STD 2500B Change Notice 1 and 2.
- Replacement of Annex E with enhanced capabilities to support exchange of DIGEST information packages together with non-DIGEST set of files.
- Clarification of the use of Not A Number (NAN) and special case enumerated values.

Part 3:

- Revision of Clause 5 to more clearly define the basic numerical primitives used in Part 2 Annex E and to clearly specify the Not A Number (NAN) values.
- Revision of Clause 6 to update geodetic codes and parameters.

Part 4:

- Deletion of attribute and feature language translations from published version. (Translations on Internet page.)
- Harmonization of DIGEST FACC Data Dictionary with the IHO S-57 Object Catalogue.
- Enhanced explanations of concepts and implementation issues.
- Backward compatibility documentation.

Acknowledgement. The editor would like to acknowledge the efforts and contributions of all DGIWG members—past and present—in the creation and evolution of this standard.

1 SCOPE, PURPOSE, AND FIELD OF APPLICATION

1.1 Scope

Digital Geographic Information (DGI) has evolved into an essential element in the planning and conduct of civil and military operations. The required data volume, demands, and data complexity dictate that multi-national agreements for digital data standards be established to assure compatibility. In support of this aim, these standards define those aspects necessary to the exchange of DGI. They are as follows:

- the data structures to be supported (including spatial structure and metadata);
- feature and attribute coding scheme;
- format;
- exchange media; and
- administrative procedures.

The type of data to be exchanged using these standards includes the digital representation of the following:

- geographic feature geometry and feature attribute information;
- information concerning the appearance and status of the Earth's surface and its features in the electromagnetic spectrum, e.g. radar, infra-red; and
- other geographic information.

The data will all be available on a common worldwide reference datum of World Geodetic System 1984 (WGS 84).

1.2 Purpose

These standards will enable interoperability and compatibility among national and multi-national systems and users. They will also support the increasing use of joint development programs. In fact, it is essential that geographic staffs involved in the development of national Geographic Information Systems are advised of the advantages of making their data structures and feature and attribute coding schemes compatible with these standards.

1.3 Field of Application

The application of the agreed standards being dealt with hereafter has several aspects, including organizational; geo-scientific; and regional and thematic.

1.3.1 Organizational Applicability

This document applies to the topographic, hydrographic, and aeronautical institutions of the participating nations. The standards have been built to support exchange of DGI between the central agencies operating in this geo-scientific field. This does not preclude the use by other institutions; on the contrary, all users are requested to widen the field of applications even to their contractors on the commercial side by making these standards part of relevant contracts. This will help to avoid redundant developments and cut costs by using common approaches.

1.3.2 Geo-Scientific Applicability

These standards apply to geodetic, geographic, geological, and geophysical data of interest. Since the present, and more importantly, the future area of interest for research, development, planning, and execution of operations is hard to define; the term has to be interpreted in a wide sense. Positioning, navigation, simulation, targeting, map and chart automated production, display, and manipulation of data are some applications. All the data in this document is covered by the terms "geo-data" and DGI. Geo-data will be turned into applications-specific user-oriented "product data" out of the original "non-product-oriented data".

1.3.3 Regional and Thematic Applicability

The contents of databases are mainly a national responsibility, but authorities may wish to state points of interest referring to the regional extension and the thematic subjects held in these databases. An integrated multi-national database is not foreseen. Should it come into existence, the standards of this document can easily be applied, since international agreements (ISO standards and NATO STANAGs) have been considered as far as published and known to DGIWG. For bi- or multi-national system developments, this document should apply.

1.4 Compatibility with Other Geographic Information Standards

The DGIWG has been working for a number of years to align the DIGEST standard with other standards in the area of DGI that have been developed by other user communities, or have been developed in a generic manner in the International Organization for Standardization (ISO). In particular, DGIWG has worked extensively with the International Hydrographic Organization (IHO) to produce a close alignment between the DIGEST standard and the IHO standards for Electronic Charts. DGIWG has also participated actively in the work of ISO Technical Committee 211 on Geographic Information / Geomatics to ensure that the generic standards being developed in ISO / TC211 support the needs of DIGEST. DGIWG has supported NATO imagery standardization efforts that are aligned with the ISO Joint Technical Committee (JTC1) SC24 Image Processing standards.

1.4.1 International Hydrographic Organization (IHO)

The work with the International Hydrographic Organization (IHO) has addressed the alignment of the DIGEST standard and the IHO S-57 standard. This has included the alignment of the spatial schema (data-models), the geodetic codes and parameters, and the development of an equivalence between the S-57 Object Catalogue and DIGEST Part 4 FACC. The alignment of the catalogue supports the conversion of objects and attributes from the S-57 catalogue to equivalent combinations in FACC.

1.4.2 ISO / TC211

The ISO / TC211 is developing a generic suite of standards for geographic information. Many of these standards are abstract standards that address the entire field of geomatics. DGIWG holds a Class A liaison relationship with ISO / TC211 and has worked toward making the DIGEST standard compatible with the ISO standards. The intent is to restructure a future edition of DIGEST to be constructed out of ISO standardized components. This will make the implementation of the DIGEST standard easier since the ISO standards have wide commercial support through industrial consortia.

1.4.3 ISO JTC1 SC24

The ISO JTC1 SC24 committee on Computer Graphics and Image Processing has developed standards for the exchange of imagery. These standards are used as the base for the NATO Secondary Imagery Format STANAG 4545, which is aligned with DIGEST Part 2 Annex D. In addition the ISO JTC1 SC24 standard ISO / IEC 12087-5 makes reference to DIGEST for georeferencing.

1.4.4 US MIL-STD 2407 VPF

The United States of America Department of Defense (DOD) developed the Vector Product Format (VPF) Standard (MIL-STD-2407) as a compliant profile of the DIGEST VRF (Part 2 Annex C). This Military Standard includes all of the mandatory tables and columns that are described in DIGEST VRF. The difference between the two formats is that the US Military Standard does not implement all of the options in VRF. The differences between the VRF options NOT currently defined in MIL-STD-2407 are:

1) Select optional metadata fields in standardized tables

2) Single node table description (C.2.3.2.1.c)

3) Circular arc option for edge primitive (C.2.3.2.2)

4) Area to edge join table definition and relations (C.2.3.3.1)

2 CONFORMANCE

This standard is applicable to all member nations of DGIWG. Information processing systems that have the capability of exchanging DGI shall have the capability of reading and writing data in conformance with this standard. This standard shall be used for the exchange of DGI unless the interchanging parties have agreed on an alternative exchange format.

The conformance requirements for this edition of DIGEST Parts 1, 2, and 3 are general in nature. More detailed conformance requirements for FACC are contained in DIGEST Part 4 Clause 2.

3 REFERENCES

Following are the normative references used in the application of DIGEST. References which are informative, or merely assisted in the preparation of the standard are included in the bibliography (Part 1 Clause 8).

International/Multinational

- IHO Dictionary, International Hydrographic Bureau, Monaco (1997).
- IHO S-57 edition 3.0 - IHO Transfer Standard for Digital Hydrographic Data, (released 1996-11).
- ISO/IEC 646:1991 - Information Technology - ISO 7-bit coded character set for information interchange, (confirmed 1997-05-07).
- ISO 1000:1992/ Amd 1:1998 - SI units and recommendations for the use of their multiples and of certain other units, (published 1998-11-19).
- ISO 1001:1986 - Information Processing - File Structure and Labeling of Magnetic Tapes for Information Interchange, (published 1996-11-06).
- ISO/IEC 2022:1994/ Cor 1:1999 - Information Processing - Character Code Structure and Extension Techniques, (corrigendum 1999-04-08).
- ISO 2375:1985 - Data Processing - Procedure for registration of escape sequences, (revised 1995-09-13).
- ISO/IEC 3788:1990 - Information Processing - 9 Track 12.7 mm (0.5 in) wide magnetic tape for information interchange recorded using phase encoding at 126 ftpmm (3200 ftpi), 63 cpmm (1600 cpi), (confirmed 1995-09-13).
- ISO 5652 - Information Processing - 9 Track 12.7 mm (0.5 in) wide magnetic tape for information interchange - Format and recording, using group coding at 246 cpmm (6,250 cpi), (confirmed 1995-09-13).
- ISO/IEC 7498-1:1994 Information Technology; Open Systems Interconnection; Basic Reference Model, Part 1: The Basic Model; (reviewed 1999-10-30).
- ISO/IEC 8211:1994 - Information Technology - Specification for a data descriptive file for information interchange, (reviewed 1999-10-30). (Note: DIGEST does not make use of any capability of ISO/IEC 8211 beyond that defined in the 1985 edition).
- ISO 8601:1988/Cor 1:1991 - Data elements and interchange format; Information interchange - Representation of dates and time, (published 1991-05-09). (Replaces ISO 4031).

- ISO/IEC 8824-1:1998 - Information Technology - Abstract Syntax Notation One (ASN.1): Specification of basic notation, (published 1998-12-15).

- ISO/IEC 8824-2 - Information Technology - Abstract Syntax Notation One (ASN.1): Information Object Specification, (published 1998-12-15).

- ISO/IEC 8825-1:1998 - Information Technology - ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER), (published 1998-12-15).

- ISO/IEC 8825-2:1998 - Information Technology - ASN.1 encoding rules: Specification of Packed Encoding Rules (PER), (published 1998-12-15).

- ISO/IEC 8859-1:1998 - Information Technology - 8-bit single-byte coded graphic character sets - Part 1: Latin alphabet No. 1, (published 1998-04-16).

- ISO 9660:1988 - Information Processing - Volume and file structure of CD-ROM for information interchange, (confirmed 1999-11-02).

- ISO/IEC 10646-1:1993/Amd 23:1999 - Information Technology - Universal Multiple-Octet Coded Character Set (UCS), Part 1: Architecture and Basic Multilingual Plane, (published 1999-05-06).

- ISO/IEC 10918-1:1994 - Information Technology; Digital compression and coding of continuous-tone still images; Part 1: Requirements and guidelines, (confirmed 2000-01-21).

- ISO/IEC 10918-3:1997 - Information Technology; Digital compression and coding of continuous-tone still images; Part 3: Extensions, (published 1997-05-29).

- ISO/IEC 10918-4:1999 - Information Technology; Digital compression and coding of continuous-tone still images; Part 4: Registration of JPEG profiles, SPIFF profiles, SPIFF tags, SPIFF colour spaces, APPn markers, SPIFF compression types and Registration Authorities (REGAUT), (published 1999-08-12).

- ISO/IEC 12087-5:1998 - Information Technology; Computer graphics and image processing - Image Processing Interchange (IPI) - Functional Specification; Part 5: Basic Image Interchange Format (BIIF), (published 1998-12-01).

- ITU-T Recommendation T.4 - Standardization of Group 3 Facsimile Terminals for Document Transmission, (published 1999-04).

- ITU-T Recommendation T.50 - Information Technology - 7-bit coded character set for information interchange, (published 1992-09).

- ITU-T Recommendation X.208 - Specification of Abstract Syntax Notation One (ASN.1), (published 1988-11).

- ITU-T Recommendation X.209 - Specification basic encoding rules for of Abstract Syntax Notation One (ASN.1), (published 1988-11).

- NATO STANAG 2211 Geodetic Datums, Ellipsoids, Grids and Grid References, (Edition 6 promulgated 2000).

- NATO STANAG 2215 Evaluation of Land Maps, Aeronautical Charts and Digital Topographic Data, (Edition 5 Amendment 3 promulgated 1999-04-22).

- NATO STANAG 4545 NATO Secondary Imagery Format (NSIF) Edition 1 (promulgated 1998-11-27), Amendment 1 (2000-04-14).

- NATO STANAG 4654 Warship Electronic Chart Display Information System (WECDIS), (Study Draft, 1999-01).

- DLMS Accuracy Working Group. (Accuracy Determination Method.)

National

- ANSI X3.27: - 1997, File Structure and Labeling of Magnetic Tapes for Information, (reaffirmed 1999-01-04).

- ANSI X3.39 - 1986, Recorded Magnetic Tape for Information Interchange (1,600 cpi, PE), (reaffirmed 1998-01-30).

- ANSI X3.4 - 1977, Information Systems - Coded Character Sets - 7-bit American National Standard Code for Information Interchange (7-bit ASCII), (reaffirmed 1997-12-23).

- ANSI X3.54 - 1986, Recorded Magnetic Tape for Information Interchange (6,250 CPI, Group-Coded Recording), (reaffirmed 1998-01-30).

- ANSI X3.61 - 1986, Representation of Geographic Point Locations for Information Interchange, (ANSI approval 1998-04-01).

- IEEE - 754-1985, IEEE; Standard for Binary Floating Point Arithmetic, (ANSI approved 1985-02-21).

- DoD (US Department of Defense) Standard Printing Color Catalog.

- DoD (US Department of Defense) Operator’s Manual for the MC&G Standard Printing Color Identification System.

- NIMA TR 8350.2 World Geodetic System 1984 (WGS84), 1991-09.

- NIMA TR 8358.1 Datums, Ellipsoids, Grids, and Grid Reference System.
- MIL-STD 188-199(1) Vector Quantization Decompression for the National Imagery Transmission Format Standard, 1996.06.
- MIL-STD 2407-1996 Interface Standard for Vector Product Format, 1996.06.
- MIL-STD 2500B National Imagery Transmission Format Standard and Change Notices 1 and 2.
- NOAA Manual NOS NGS 5 – State plane coordinate system of 1983 (author James E. Stem), (1990).

Reference Dictionary

- The DIGEST standard makes primary use of the Concise Oxford Dictionary as the reference dictionary in alignment with the practice of the International Organization for Standardization. However, due to the international nature of the DIGEST standard, there may be occurrences of other valid English spelling based on other reference dictionaries.

4 TERMINOLOGY

4.1 Terms and Definitions

The following are definitions of various terms as used in DIGEST. For an explanation of what various acronyms and abbreviations stand for, refer to Clause 4.2.

Absolute accuracy - The evaluation of all errors encountered in defining the position of a single feature or point on a geodetic datum or system.

Accuracy - The degree of conformity with a standard, or the degree of perfection attained in a measurement. When linked to a measurement, it usually takes the form of an error estimate such as standard error (standard deviation of the errors). Accuracy relates to the quality of a result and is distinguished from precision, which relates to the quality of the operation by which the result is obtained. See also precision.

ARC (Equal Arc-Second) - System of representing geographic coordinates by 16 rectangular latitude bands and 2 circular polar zones. Each latitude zone has its own longitude scale to keep distortion to a minimum.

Area feature - A geographic entity that encloses a region; for example, a lake, administrative area, or state.

Area feature class - A collection of area features that maintains a homogeneous set of attributes. Implies the use of face primitives.

Area feature table - The implementation of an area feature class in a VRF attribute table.

Attribute - A property of an entity; for example, the colour of a building, the width of a road, or the accuracy level of a database. Attributes are either quantitative or qualitative.

Attribute accuracy - The accuracy or reliability of attribute data within the limits described by feature completeness. If attribute accuracy information is not available in the above form, a description of known attribute accuracy characteristics may be substituted.

Attribute completeness - The percentage of feature attribute fields not populated by null or default values.

Attribute identifier - A three alphanumeric character designator of an attribute.

Attribute table - A collection of identically formatted (defined) attribute rows.

Attribute value - A specific coded or actual value assigned to an attribute. For example, green for building colour, 48 feet for road width, level 2 for the accuracy of database.

Automated cartography - An approach to producing map/chart products using computer-assisted techniques.

Byte order - A hardware implementation of an encoding scheme. It determines the order in which bytes are stored in a long word. Two commonly used orders are little-endian, or least significant first (i.e., 1234); and big-endian, or most significant first (i.e., 4321).

Cartographic primitive - A primitive with no topological relationship to adjoining or surrounding primitives. The text primitive is a cartographic primitive.

Cartographic system - See Grid system.

Chain-node - See Level 1 Topology.

Character code table - A set of character specifications. A code table defines the alphanumeric and special characters that are used in a computer system to model written languages.

Colour bar - The bar normally printed on the side of each map copy, prior to trimming, that may be used to determine the individual colours used on the map. (For displaying colour used in printing.)

Colour coding - A nominal code assigned to a defined range of red, green, and blue intensities.

Colour patch - A standard colour reference of defined intensity and hue that is attached to each multi-colour graphic to be scanned. (Used for calibration.)

Column - The set of all instances of a particular field within a table; not to be confused with Raster or Matrix data.

Column type - The relational model uses column types to implement the data type of an attribute. For instance, the column ELEVATION could have an integer column type (VRF only).

Completeness - The extent of agreement between the features represented and those defined by a capture specification. Spatial completeness requires that the coverage of the plane be exhaustive. Attribute completeness requires that all attribute values use known meanings.

Complex feature - A single feature that relates directly to other features rather than to a primitive. A single feature composed of other features, either simple and/or complex.

Complex feature class - A feature class that includes one or more other feature classes (simple or complex).

Complex feature table - An implementation of a complex feature class in VRF.

Composed of - The relationship that means "includes the following among its constituent parts". So a feature can be "composed of" one or more primitives, and (in this generalized sense) more than one feature may be "composed of" a particular primitive.

Compound feature - A single simple feature composed of more than one primitive of the same type. A compound feature may cross tile boundaries.

Compound key - A group of columns used together to create a key in a relational table.

Conjunction - Relationship between an ordered pair of line features indicating a flow from the first feature to the second.

Connected node - A node at the end of an edge. A connected node is topologically linked to edges (VRF). See also Node.

Containing face - The face in which an entity (isolated) node lies.

Coordinate - One element of an ordered set of numbers, normally numbers specifying position.

Coordinate array - A fixed-length list of coordinate tuples.

Coordinate pair - An ordered pair of numbers, normally used to specify position in two dimensions or on a surface.

Coordinate string - A variable-length list of coordinate tuples.

Coordinate triplet - An ordered triplet of numbers, normally used to specify position in three dimensions.

Coordinate tuple - An ordered set of values, for example a coordinate pair or coordinate triplet.

Coverage - A set of feature classes that has a specified spatial extent and in which the primitives interconnect as described by the coverage's topology.

Coverage attribute - A property of a coverage. The coverage attribute table contains properties for all coverages in the library.

Cross-tile topology - The encoding of topological relationships in such a manner that those relations are maintained even when a coverage has been physically partitioned into multiple tiles.

Data - A representation of facts, concepts, or instructions in a formalized manner suitable for communication, interpretation, or processing by humans or by automated means (ISO). Geographic data can be in either neutral or product form. See also information.

Data bank - A collection of data relating to a specific subject; such as digital data pertaining to bridges, roads, or vegetation.

Data dictionary - A collection of tables with entries that define the meaning of attributes and the allowable values (or ranges of values).

Data format - A specification that defines the order in which data is stored, or a description of the way data is held in a file or record.

Data structure

(1) In the context of data model, the formal organization of data elements, their attributes and spatial position. For definitions of different types of data structures see Spaghetti, Chain-node, and Topological.

(2) The physical structure used to represent the data model.

Data syntax - A description of the computer-readable (bit-level) representation of data.

Database

(1) A collection of interrelated data stored to serve one or more applications. The data are stored so that they are independent of programs which use the data. A common and controlled approach is used in adding new data and in modifying and retrieving existing data within a database.

(2) A collection of related libraries (VRF).

Database attribute - A property of a database.

Database Management System (DBMS) - An organized collection of software required to use a database. There are three common ways of organizing the data within a specific DBMS:

(1) **Hierarchical or Tree** - All data element groups except the root are related to one and only one group at a parent level.

(2) **Network or Plex** - A relationship between records in which a child record can have a more than one parent record.

(3) **Relational** - A capability to recombine the data elements in a database to form new relations.

Dataset - An identifiable collection of data.

(1) A DIGEST dataset is a collection of data arranged in a DIGEST compliant format. It is normally used for the bulk exchange of data between producers.

(2) A standardized DIGEST dataset is a collection of data which has a specification which pre-defines the content and the DIGEST encapsulation.

Date status - The date at which the data was introduced or modified in the database. This date of entry is used as a proof of modification for a single data element and permits the statistical interpretation of groups of data elements.

Datum change constants - Constants used in formulae to transform geographic coordinates in one geodetic datum to geographic coordinates in another. For example, in the UTM/UPS system, where WGS 84 latitude and longitude are transformed to source datum latitude and longitude, they are normalization constants and area limits for multiple regression equations.

Density - The amount of detail within a given area. Density normally varies with scale and the nature of the area being compiled.

Diagnostic point - A point within a dataset with known and accurate geographic location, which is used to verify the adequacy or inadequacy of transformation result to the dataset (the diagnostic point is not part of the transformation solution).

Digital Geographic Information (DGI) - includes the digital representation of the following:

(1) Elevation and sounding information;
(2) Geographic feature geometry and feature attribute information;
(3) Information concerning the appearance and status of the Earth's surface and its features in the electromagnetic spectrum; e.g., radar, infrared, etc.;
(4) Military Geographic Information together with other ancillary information; and
(5) Other digital information.

DIGEST Information Package - The DIGEST interchange unit is called a "DIGEST Information Package". A "DIGEST Information Package" may contain different data types as described in the theoretical model and/or use different encapsulations as described in the Annexes A through D. A DIGEST Information Package is composed of one or more DIGEST Geo Datasets [Libraries]. Each DIGEST Geo Dataset [Library] is composed of one or more DIGEST layers [Coverages].

Digitized vector graphics - Digital representation of a map or chart which is captured by manual digitization, digitization by automated line following systems, or vectorizing of graphics, stored on digital media. This data may be accompanied by descriptive information (attributes of the individual map/chart features).

Direct access - Retrieval of data by reference to its location on a storage medium rather than relative to the previously retrieved data. The access mechanism goes directly to the data in question. This access method is normally required for on-line data usage.

Directory - A file that contains a list of the unique names, beginning addresses, and lengths of other files.

Disjunction - Relationship between an ordered pair of line features indicating the absence of flow from the first feature to the second.

Domain - The set of all permissible values for an attribute.

Easting - Eastward coordinate on a plane. This may be used for defining position on a map.

Easting coefficients - Coefficients used in the ARC-system map-projection formula to derive the normalized easting.

Easting false origin - Value assigned to the easting at the origin of the projection. Also known as a *false easting*.

Edge - A one-dimensional curve primitive joining two (possibly the same) nodes used to represent the location of a linear feature and/or the borders of faces. Depending upon the level of topology, edges may be topologically linked to nodes, edges, and faces. Edges are located by an ordered collection of two or more coordinate tuples (pairs or triplets). At least two of the coordinate tuples must be distinct. The orientation of an edge can be recognized by the ordering of the coordinate tuples.

Electronic map - Consists of the information of a map or chart, which is captured, stored, and displayed by electronic means.

Ellipsoid - A mathematical figure generated by the revolution of an ellipse about one of its axes. Every ellipsoid in DIGEST has the minor axis as the axis of rotation and representing the polar axis; the major axis represents the equatorial axis.

Encapsulation - The identification of fields, grouping of fields, and data syntax rules used.

Encoding - The assignment of bit-patterns to data types in a computer. For example, one given bit arrangement may define an integer data type (e.g., 2's complement, 1's complement, or biased), whereas another may describe a character data type (e.g., ASCII, EBCDIC).

End node - The terminating node of an edge.

Entity - A phenomenon that can not be subdivided into like units.

Entity node - See Isolated node.

Entity set - An attribute table.

Face - An undivided area defined by its bounding edges and nodes. More rigorously, a face is a maximal, connected area in the complement of the edge-node graph, representing all or part of the extent of a Feature or of the unattributed area.

Feature - A geographic entity related in some way to the Earth's surface. It may be either a Simple Feature or a Complex Feature. A Simple or Complex Feature has a specific set of Attribute values. A Complex Feature consists of a number of Features (Simple and/or Complex).

Feature attribute - A property of a feature. See Attribute.

Feature class - A set of features that shares a homogeneous set of attributes. A feature class consists of a set of tables that includes one or more primitive tables and one or more attribute tables. A feature class has the same columns of attribute information for each feature. Every feature class has one and only one feature table. The two types of feature classes are the simple feature class and complex feature class. The subtypes of the simple feature class are the point feature class, line feature class, area feature class, and text feature class.

Feature class attribute table - The feature class attribute table contains properties for all feature classes in a coverage. The feature class attribute table is required to support the feature index tables.

Feature class schema table - A table that stores the composition rules of each feature class. This table describes the definition for each feature class and the way in which each table in a feature class relates to other tables (in VRF).

Feature code - A unique identifier assigned to a feature. The code is composed of five characters. The first is a letter indicating the category, the second is a letter indicating the sub-category and the last three characters (numeric) indicate a serial number in the sub-category. DIGEST uses the FACC coding scheme for all feature codes (see DIGEST Part 4).

Feature completeness - The degree to which all features of a given type for the area of the data set have been included.

Feature index table - The feature index table is constructed specifically to provide for rapid retrieval of feature information when given a selected primitive. It provides a join index from primitive to feature.

Feature join table - A table that identifies 1:N or N:1 relationships between features and other features or primitives. Simple features may be composed of one or more primitive instances, and complex features may be composed of one or more simple features or other complex features. A primitive instance may belong to more than one feature (VRF).

Feature table - A table made up of rows of features in a feature class. These rows collectively form the feature table for that feature class.

Feature-oriented - A term used to describe the approach for encoding geographic entities in which a series of interrelated geographic/cartographic objects are organized into a network-like structure of data and predefined relationships.

Field - An individual data element. In a Part 2 Annex C- VRF, a field corresponds to a single column entry of an attribute table. A field contains a single attribute value. A table column identifies the data types for the fields within that column.

First edge - An edge arbitrarily selected as the first edge to enable traversing around a connected node.

Fixed (length) field - A field having a predefined number of bytes. Fixed fields are generally used for numeric data, or when blank entries are significant.

Flattening - The ratio of the difference between the equatorial and polar radii of an ellipsoid to its equatorial radius. It is usually denoted f and equals (a-b)/a. Inverse flattening is 1/f and equals a/(a-b).

Foreign key - One or more columns in one table that are used as a primary key in another table (VRF).

Geodetic datum - An ellipsoid fixed in relation to the earth so that the polar axis, the central point and the zero meridian plane are all fixed. There are two types.

(1) local geodetic datum: the ellipsoid has been chosen and fixed to fit a region.

(2) geocentric geodetic datum: the ellipsoid has been chosen to fit the earth as a whole and its central point is based on a definition of earth's centre of mass.

Geoid - Level surface that best fits mean sea level either locally or globally. Level surface in this context means an equipotential surface of the earth's gravity field which is everywhere perpendicular to the direction of gravity. A model geoid is a mathematically-defined surface which approximates the geoid (e.g., EGM 96 Geoid).

Geographic coordinates - Latitude and longitude (with height in the 3-dimensional case). In DIGEST, geographic coordinates are geodetic, so they are based on a geodetic datum.

Geographic data model - A formalized method for representing geographically referenced information.

Geographic (geo) data subset - one of two logical components of a dataset. This logical component consists of the actual, digital geographic information being transferred. These data are characterized by common properties such as geodetic datum and projection.

Geographic entity - A real-world feature that is of interest; something about which data is stored.

Geographic Information System (GIS) - An organized collection of computer hardware, software, geographic data, and standard operating procedures for efficiently capturing, storing, maintaining, retrieving, analyzing, displaying, and reporting spatially-referenced information.

Geographic non-linearity - The error introduced by digitization and subsequent processing to the total error of both absolute and relative positioning of any feature on the graphic.

Geographic primitive - See Geometric primitive.

Geographic Reference Point (GRP) - A point within the Feature that allows an easy geographic locating method.

Geographic reference table - A table that defines the coordinate system of a dataset or library.

Geometric non-linearity - Any distortion introduced by digitizing and subsequent processing of a mathematically correct reference system or grid, other than simple rotation, translation or scale change.

Geometric primitive - The basic geometric units of representation; specifically, nodes, edges, and faces.

Georelational data model - A generic conceptual model in which geographic information is represented by using a combination of vector geometry, planar, topology, and relational data models.

Graphic product - May be a paper copy of a map or chart, or the reproduction material (repromat) used to produce the map or chart. Repromat may be in layers (bands), each representing a single colour on the map, or all colours on the map may be reproduced using 3 to 4 layers (process printing repromat).

Greenwich meridian - Meridian plane passing through Greenwich, England. For datums in DIGEST, the zero meridian plane is almost always Greenwich. (Between different datums there are very slight variations in the definition of the Greenwich meridian.)

Grid rotation constants - Constants used in the UTM/UPS-system formula to derive source-datum grid coordinates from WGS 84 UTM grid coordinates.

Grid system - A precise one-to-one relationship between points on a specific geodetic datum and points on a plane, normally used for making maps of a region. Position on the plane is given by *grid coordinates* (easting and northing).

Header data subset - One of two logical components of a dataset. This logical component consists of descriptive information about the digital geographic information contained in the second logical component; the geo data subset.

Hierarchical DBMS - See Database Management System.

Horizontal datum - Geodetic datum used for horizontal positioning (latitude and longitude on the ellipsoid).

Image - A raster representation of a graphic product or remotely sensed surface that consists of one or more image bands.

Image band - A scan of an image recording intensities of a single colour, or sensor consisting of one or more subblocks.

Index - A mechanism used to quickly identify a particular record or group of records based on a table's primary key.

Index file - The implementation of an index stored in a file. There are variable-length indexes, spatial indexes, thematic indexes, and feature indexes.

Information - Items of knowledge. In DIGEST, use of the word reflects the entry in Chandor's Dictionary of Computers: "Sometimes the following distinction is made between 'information' and 'data': Information results from the processing of data; i.e., information is derived from the assembly, analysis, or summarizing of data into a meaningful form." See also Data.

Inner ring - The inner boundary of a face, composed of edges ordered in a sequence. A face may have none or any arbitrary number of inner rings.

Instance - A particular occurrence of an object.

Integrated data - A geographic data set in which all feature data are contained in a single coverage. Opposite of layered data.

Isolated node - A zero-dimensional primitive used only to represent a feature. An isolated node is never used as a start or end node. An isolated node is topologically linked to its containing face when faces are present and cannot occur on an edge. This is also known as an "Entity Node".

Key - In a relational data model, one or more columns (attributes) whose values uniquely identify or can be used to select a row.

Latitude - Angle from the equatorial plane to the upward direction at the given point, northward treated as positive, southward as negative. DIGEST only uses latitude in the sense of geodetic latitude, which means the upward direction is normal to the ellipsoid.

Latitude coefficients - Coefficients used in the datum-change formula to derive the source-datum latitude. There are 7 in the ARC system, but in the UTM/UPS system the number varies for different datum changes.

Layer - A layer consists of a consistent set of data of the same type (e.g., Raster, Vector, Matrix, Imagery, Text). For Vector data, a layer is a pre-defined collection of geographical features, grouped by theme, contained within a single specified level of topology (following the rules of that level of topology, e.g., if it is planar graph there are no crossing lines). Layers will be composed of one or more area, line, or point features as defined by a specification. A layer can also be referred to as a coverage.

Layered data - Feature data thematically separated into separate coverages. Opposite of integrated data.

Left edge - The left edge is the first neighbour of the current edge as one moves counterclockwise around the start node of the current edge.

Left face - The face to the left of an edge in a traverse from the start node to the end node.

Level 0 topology - A surface which contains a set of entity points and edges. Edges contain only coordinate and attribute information; no topological information is present for the entity nodes or edges (VRF). Also known as Spaghetti.

Level 1 topology - A non-planar surface that consists of a set of entity points and edges that may not meet at nodes. Edges contain start node, end node, right edge, and left edge information (VRF). Also known as Chain-node.

Level 2 topology - A planar surface which consists of a set of edges and entity points, where the edges meet only at connected nodes. Edges contain start node, end node, right edge, and left edge information (VRF).

Level 3 topology - A planar surface which is partitioned by a set of mutually exclusive and collectively exhaustive faces. Edges contain left face and right face, start and end node, and right and left edge information. Edges meet only at connected nodes (VRF).

Levels of topology - See Topology.

Library - A collection of one or more coverages contained within a specified spatial extent, all of which share a single coordinate system. Coverages may be tiled in a library. All tiled coverages in a library must share a common tiling scheme.

Library attribute - A property of a library. The library attribute table describes the properties of each library in a database.

Line feature - A geographic entity that defines a linear (one-dimensional) structure; for example, a river, road, or a state boundary.

Line feature class - A collection of line features that maintains a homogeneous set of attributes. Composed of edge primitives.

Line feature table - The implementation of a line feature class in a VRF attribute table.

Lineage information - Information that describes processing tolerances, interpretation rules applied to source materials, and basic production and quality assurance procedures. Lineage information should include all available information from the source.

Logical consistency - The fidelity (correctness) of the relationships encoded in a data set. In a VRF data set, logical consistency requires that all topological foreign keys match the appropriate primitive, that all attribute foreign keys match the appropriate primitive or features, and that all tables described in the feature class schema tables maintain the relationships described.

Logical set - A collective item of data that is a parent to other items of data. A logical set contains logical set(s) and/or simple data element(s).

Longitude - Angle from the zero meridian plane to the meridian plane of the given point, eastward treated as positive, westward as negative. DIGEST only uses longitude in the sense of geodetic longitude, which means the meridians contain the polar axis of the geodetic datum.

Longitude coefficients - Coefficients used in the datum-change formula to derive the source-datum longitude. There are 7 in the ARC system, but in the UTM/UPS system the number varies for different datum changes.

Magnification - The multiplication factor which causes apparent change in linear distance between two points in an image. Thus a magnification of 2 is a change which doubles the apparent distance between two points (multiplying the area by 4), while a magnification of 0.5 is a change which halves the apparent distance.

Matrix data - Data in an array with associated information about regularly spaced points.

Mean sea level - Average level of the surface of the sea for all stages of the tide. When mean sea level is linked to a place or region, it usually means mean sea level for the region as measured by tide gauge measurements at one or more points. A mathematical model of the geoid, such as EGM 96 Geoid, can be used as an approximate representation of mean sea level.

Media volumes - As used herein, the number of distinct media that comprise a VRF database. For instance, there may be four CD-ROM media volumes in one database.

Medium - A data storage device (e.g.,, a CD-ROM, hard disk drive, magnetic tape, or floppy disk).

Meridian - The intersection between a reference figure of the Earth and a plane containing the polar axis. It is often used for the pole-to-pole arc rather than the complete closed figure.

Metadata - Information about data; more specifically, information about the meaning of other data.

Minimum Bounding Rectangle (MBR) - A rectangle of coordinate pairs that defines the minimum and maximum coordinates of an entity.

Minimum Bounds (MB) - Two coordinate tuples that define the minimum and maximum extent of the spatial coordinates defining a Feature.

Multi-national database - A standardized database operated and maintained under the control of two or more participating member nations.

Multiple regression equation - A polynomial function of normalized latitude and normalized longitude. It is used in the UTM/UPS system to apply geographic-coordinate transformations between a source datum and the WGS 84 datum.

Note: around the limits of a region covered by a multiple regression equation, normalized latitude or normalized longitude may be slightly outside the range -1 to 1.

Names reference coverage - A coverage that contains (at a minimum) a point feature table with columns indicating a place name and its known coordinate. Used to help a user locate places by name. (Also known as *Names placement coverage)*

National database - A database designed, operated, and maintained by one nation for purposes specific to that nation.

Node - A zero-dimensional primitive. See also Isolated Node, Entity Node, Connected Node, Start Node, and End Node.

Normalization constants - The constants used in a linear formula to normalize a variable.

Normalize - To convert a real variable by a linear formula so that its value is constrained to a range such as -1 <= x <= 1 or 0 <= x < 1.

Northing - Northward coordinate on a plane. This may be used for defining position on a map.

Northing coefficients - Coefficients used in the ARC-system map-projection formula to derive the normalized northing.

Northing false origin - Value assigned to the northing at the origin of the projection. Also known as a *false northing*.

Object - The physical representation of a feature entity corresponding to a feature and associated attributes.

Outer ring - The outermost boundary of a face, composed of edges ordered in a sequence.

Pathname - A file name that uniquely identifies the location path to a file within a series of one or more directories.

Physical implementation - The specifications for physically encoding the data at the file/record/field level.

Pixel - (originated from "picture element") A single element of a raster image usually characterized by row, column and spectral value.

Pixel run - A set of consecutive pixels with the same value.

Planar model - A two-dimensional surface in which every point has a neighbourhood (a two-dimensional region) that is topologically equal to a flat disk. It is implemented as a planar graph {N, E, F} with a finite number of nodes N = {n1, n2,...}, edges E = {e1, e2,...}, and faces F = {f1, f2,...} bounded by edges and nodes. Each edge has an orientation from its first (starting) coordinate tuple to its last coordinate tuple. Also, each face of the graph has a certain orientation (cycle) around its edges and nodes. Each edge of a planar model is incident with exactly two faces.

Point feature - A geographic entity that defines a zero-dimensional location; for example, a sounding.

Point feature class - A collection of point features that maintains a homogeneous set of attributes. Composed of node primitives.

Point feature table - The implementation of a point feature class in a VRF attribute table.

Polygon - A closed line which consists of a finite number of straight lines (or a finite number of arcs on a surface that appear as straight lines in a 2-dimensional representation). A polygon is often specified by an ordered set of points represented by coordinate pairs: each point linked to the next, and the final point is linked to the first.

Pointer - A field within a record or within an index that contains the address of a record.

Positional accuracy -. Accuracy of a position in a coordinate representation. Absolute accuracy refers to absolute position. Relative accuracy or point-to-point accuracy refers to position relative to a particular location. An example is 90% confidence level (estimated from a multiple of the root mean square error RMSE). See also Accuracy.

Precision - A quality associated with the refinement of instruments and measurements, indicated by the degree of uniformity or identicalness of repeated measurements. See also accuracy.

Primary key - A key whose value uniquely identifies a row (VRF).

Primitive - The smallest spatial component, of which all features are composed. There are three geometric primitives (nodes, edges, faces) and one cartographic primitive (text).

Primitive table - A primitive table inherits the properties of a VRF table, but may also have an associated minimum bounding rectangle table and/or a spatial index file.

Product - A DIGEST-compliant product is a standardized dataset with a defined media and packaging, stated in a product specification. A product is usually delivered to an end user.

Product data - Data which is either collected in a specific product form or data which is derived from neutral data for a specific application.

Projection - Mathematical mapping of a geodetic ellipsoid, or part of a geodetic ellipsoid, to a plane. It is a *type* of function that does not become a grid system until projection parameters have been specified and a geodetic datum has been chosen.

Product specification - A document that defines the precise content and format of a specific product. It contains technical requirements and database design decisions such as coding, tiling, special relationships between entities, and so forth.

Radiometric linearity - Grey levels in linear proportion to the light intensities (in each colour band).

Radiometric non-linearity - The analogue-to-digital conversion system which provides signal-to-noise (S/N) ratios of the sensors, where the S/N is calculated by the difference of the sensor's average response to a white reference and the sensor's average dark signal value divided by the Root Mean Square dark noise value. Intermediate intensities will be linear representations from average white reference to the average dark reference. Intermediate intensities will be represented using a linear tonal transfer curve for each colour channel. Error introduced during the digitization process causes the grey scale values for a colour component (RGB) to NOT be in linear proportion to the source intensities for that component.

Raster data - Data arranged in a regular array, giving total area coverage, with information pertaining to each area element or group of area elements.

Registration point mensuration accuracy - Registration point identification will be accurate to plus or minus half the pixel interval. The absolute and relative accuracies of the registration points falling on Latitude/Longitude line intersections are the same as the accuracies given for the source graphic. This type of accuracy measure only applies to raster data.

Relation - A logical link between two elements (topological entities and/or features), such as "is on the left of"; "is on the right of"; "is composed of "; "is contained in"; etc.

Relational DBMS - See Database Management System.

Relational join - A logical operation that combines two tables which both contain a column or a set of columns possessing domains common to both tables. Rows from each table are combined with all rows in the other table that possess identical values in their join columns.

Relative accuracy - An evaluation of the random errors in determining the positional orientation (e.g., distance, azimuth) of one point or feature with respect to another point or feature, or with respect to a graticule or datum defined by that graticule.

Reliability - Percentage probability of correctness. It is used to indicate the probability of a qualitative attribute being correctly identified.

Resolution - The measure of the ability to distinguish detail or separation of objects under certain specific conditions. Alternatively, it is the minimum distance between two adjacent objects, or the minimum size of an object that can be distinguished under certain specific conditions.

RGB - The scanned response for any colour represented by red, green, and blue intensities.

Right edge - The first neighbour of the current edge as one moves counterclockwise around the end node of the current edge.

Right face - The face to the right of an edge in a traverse from the start node to the end node.

Ring - A connected set of edges that composes the face border. Any single ring is only referenced to and by a single face. If the same set of edges is shared by two different faces, two rings that correspond to the two faces are created from the single edge set. Rings only occur at level 3 topology (when faces are also present).

Root mean square - The square root of the mean of the squares of a set of quantities. It is often applied to errors or estimated errors.

Row - An ordered collection of fields pertaining to the entity (VRF). Not to be confused with Raster or Matrix data.

Row id - An integer that uniquely identifies each row in a table.

Schema - A description (or picture or diagram) of the structures of a database system.

Schema table - A schema table defines the tables and their relationships within a coverage.

Seamless database - Logically continuous topological and feature relationships across physical partitions (Tiles) of the data. This is also referred to as "Sheetless database" (VRF).

Semantics - The implied meaning of data. Used to define what entities mean with respect to their roles in a system.

Semimajor axis - Half of the longest diameter of an ellipsoid or ellipse. For an ellipsoid representing the Earth, it is the equatorial radius. It is usually denoted by the letter “a”.

Semiminor axis - Half of the shortest diameter of an ellipsoid or ellipse. For an ellipsoid representing the Earth, it is the polar radius. It is usually denoted by the letter “b”.

Shape line - An ordered set of one or more coordinate tuples that define the placement and shape of a text primitive.

Simple data element - An element of data at the most basic level of data hierarchy in the sense that it cannot be subdivided. Examples include: a code, an individual coordinate.

Simple feature class - Consists of a single type of primitive (face, edge, node, or text) and a feature table. There are four subtypes of simple feature classes: point, line, area, and text (VRF).

Sounding - Measured or charted dept of water, or the measurement of such a depth. Necessary because of a sounding datum.

Sounding datum - Horizontal plane or tidal datum to which soundings on a hydrographic survey are reduced. A sounding datum becomes a (hydrographic) chart datum if it is a permanently established surface from which soundings or tidal height are referenced (usually low water).

Source information - It describes the origin or derivation of a single feature, primitive, or attribute. It includes information about processing of the data as well as information about the data source.

Spaghetti - A digital storage format in which all lines and points are unrelated to each other.

Spatial index - A data structure file that allows for the rapid identification of a primitive by using the values of the primitive's coordinates.

Spatial Segment - A non-topological edge (a curve joining two, possibly the same, coordinate points).

Standard deviation - The square root of the quantity obtained by dividing the sum of the squared deviations by the number of deviations minus one. Typically, the deviations are the differences between measurements and a computed estimate. When standard deviation is used as a measure of accuracy, it is called *standard error* and implies a 68.27% probability that the magnitude of the error will not exceed that value. (The probability changes to 39.35% in two dimensions.) For a large set of deviations, standard deviation is approximately equal to Root Mean Square.

Standardized Raster Graphics (SRG) - A digital representation of a map or chart which is captured by automatic digitization (scanning), stored on digital storage media, and displayed on raster screens or raster plotters; obtained by a regular scan of a paper map or chart or repromat. It consists of a raster dataset of RGB intensities or colour codes.

Start edge - Referenced from the ring table, an edge arbitrarily selected as the start edge to enable traversing through the edge table to compose the ring(s) which define a face.

Start node - The first node of an edge. (An edge is traversed from start node to end node.)

Subblock - See Tile.

Syntax - The rules governing the construction of a machine language or machine representation of entities.

Table - An organizational structure for data content. In the relational model, a table is a group of repeating rows defined by columns. Equivalent to a relation.

Tag - Within an encapsulation, a tag uniquely identifies a field or subfield. In ISO 8211, a tag is a character string in a directory entry used to identify a data field or an associated data descriptive field. In ISO 8824, a tag is a numeric code used to identify a data field.

Text feature - A cartographic entity that relates a textual description to a zero- or one-dimensional location. A text feature usually contains information such as font, colour, and height.

Text feature class - A collection of text features that maintains a homogenous set of attributes. Composed of text primitives.

Text feature table - The implementation of a text feature class in a VRF attribute table.

Text primitive - Characters placed in specific locations in a coordinate system. Text is a cartographic object, rather than a geographic entity, since it does not participate in topology. A text array indicates a fixed-length string of characters. A text string indicates a variable-length collection of characters.

Thematic attribute - A column in a table that provides a thematic description of a feature. For example, a feature class that contains rivers may have attributes such as width, depth, and name.

Thematic index - A file that allows software to access the row ids of its associated table. In a VRF table, the index is created on a column. Thematic index may be created for any column in an attribute table.

Theme - An organizational concept used in the design of spatial databases. Common themes in spatial geographical databases are transportation, hydrology, and soil/land suitability.

Tile - A spatial partition of a dataset/coverage. In a vector data set, a tile shares the same set of feature classes as the dataset/coverage, and the topology of the tile is complete within itself; however, links to adjoining tiles may also be maintained. In a raster or matrix data set, a tile may be called a subblock.

Tiled coverage - A dataset/coverage that has been partitioned into tiles.

Tiling scheme - The scheme used to define tile shape and size, and to assign identification numbers.

Topographic data - Data about the features of the surface of the Earth. It will include its relief features, water and drainage features and man-made features.

Topological entities - A collection of objects (i.e., nodes, edges and faces) used to define the spatial relationships among the features of the earth's surface. See also Geometric Primitives.

Topology - A branch of mathematics that investigates the properties of a geometric configuration that are unaltered if the configuration is subjected to any one-to-one transformation continuous in both directions.

Transfer standard - A set of procedures used to export data information from one system to another system.

Traverse - An algorithm that uses winged-edge topology to retrieve a series of neighbouring edges to satisfy a query of a network.

Tree DBMS - See Database Management System.

Triplet id - A variable-length structure used to contain information for crossing tile boundaries. The first field contains the internal primitive id (referred to as ID). The second field contains the tile reference coverage id (TILE_ID), and the third field contains the primitive id in the associated tile (EXT_ID).

Tuple - An ordered set of elements.

Universe face - The unbounded region surrounding a level 3 topology coverage. The universe face always maintains the first record in a face table.

Variable-length field - A field whose length is determined by the amount of storage needed to store its contents. Useful for character strings and coordinate strings, both of which are highly variable in length.

Vector - Indicates a collection of coordinate tuples to define a geographic or geometric entity.

Vector data - Spatial information whose data model is based on graph theory.

Vector Relational Format (VRF) - A standard format, structure, and organization for large geographic databases based on a georelational data model and intended for direct access.

Vertical datum - The surface used as a reference for defining elevation. In the case of geodetic (ellipsoidal) height, the vertical datum is the ellipsoid of the geodetic datum. In the case of height above mean sea level, the vertical datum is the local determination or global model of mean sea level.

Volume - An exchangeable physical unit of storage media (e.g., a reel of magnetic tape). A volume may contain part of a file (e.g., a geographic header (sub) file, a complete file (e.g., geographic information file) or more than one file (ANSI)).

Volume set - A collection of one or more volumes on which one and only one file set is recorded (ANSI).

VRF table - Consists of a table header and rows of data sharing the same column definitions, each having a unique row id. Primitive tables, attribute tables and feature tables are all special purpose VRF tables.

Winged-edge topology - A topological construct that connects each edge to two of its neighbouring edges, allowing topologic traversal of an edge and/or face network. A neighbouring edge is any edge that shares a start or end node with the original edge. An edge has a start node, which is connected to the left edge, and an end node, which is connected to the right edge.

Z-values false origin - Height value assigned to the reference elevation surface. It is sometimes used to ensure positive height values in a country partly below sea level.

Zero meridian plane - The reference half-plane containing the polar axis and bounded by the polar axis. Also known as the *zero meridian, prime meridian plane,* and *prime meridian.*

2-dimensional manifold - A planar graph and its complementary areas. Each edge bounds two, and only two, not necessarily distinct, faces. The faces are mutually exclusive and collectively exhaustive (VRF).

4.2 Acronyms and Abbreviations

Although most acronyms and abbreviations are defined the first time they are used, the following list is provided as a quick reference for all the acronyms and abbreviations appearing throughout DIGEST.

AAH	Source Graphic's Horizontal Accuracy Value
AAV	Source Graphic's Vertical Accuracy Value
ABM	**A**beam
ALSF	**A**pproach **L**ighting **S**ystem with sequence **F**lashing
ANSI	**A**merican **N**ational **S**tandards **I**nstitute
ARC	Equal **A**rc-second **R**aster **C**hart/Map
ARSR	**A**ir **R**oute **S**urveillance **R**adar
ASCII	**A**merican **S**tandard **C**ode for **I**nformation **I**nterchange
ASN.1	**A**bstract **S**yntax **N**otation one

ASR	**A**irport **S**urveillance **R**adar
ASRP	**A**RC **S**tandard **R**aster **P**roduct
ASRG	**A**RC **S**tandard **R**aster **G**raphics
BNF	**B**ackus **N**aur **F**orm
BP	**B**yte **P**osition
BIIF	**B**asic **I**magery **I**nterchange **F**ormat
CCITT	**C**omité **C**onsultatif **I**nternational **T**élégraphique et **T**éléphonique (now ITU-T)
CD-ROM	**C**ompact **D**isk - **R**ead **O**nly **M**emory
CIE	**C**ommission **I**nternationale de l'**E**clairage (International Commission on Illumination)
CIPM	International Committee for Weights and Measures
col	**Col**umn
cpi	**c**haracters **p**er **i**nch
cpmm	**c**haracters **p**er **m**illi**m**etre
DBMS	**D**ata**b**ase **M**anagement **S**ystem
DCC	**D**ocument **C**hange **C**ontrol
DDR	**D**ata **D**escriptive **R**ecord
dept	**Dep**artmen**t**
DG	**D**irector **G**eneral
DGI	**D**igital **G**eographic **I**nformation
DGIS	**D**igital **G**eographic **I**nformation **S**ystem
DGIWG	**D**igital **G**eographic **I**nformation **W**orking **G**roup
DIA	U.S. **D**efense **I**ntelligence **A**gency
DIGEST	**Di**gital **G**eographic Information **E**xchange **St**andard
DLMS	**D**igital **L**and**m**ass **S**ystem
DoD	U.S. **D**epartment **o**f **D**efense
DTED	**D**igital **T**errain **E**levation **D**ata
ECMA	**E**uropean **C**omputer **M**anufacturer's **A**ssociates
E/W	**E**ast/**W**est
FACC	**F**eature and **A**ttribute **C**oding **C**atalogue
GCR	**G**roup **C**oded **R**ecording
GDS	**G**eo **D**ataset **S**ubset
geo	**Geo**graphic
GIS	**G**eographic **I**nformation **S**ystem
GRP	**G**eographic **R**eference **P**oint
HAV	Raster **H**orizontal **A**ccuracy **V**alue
HDS	**H**eader **D**atas**e**t
HQ	**H**ead**q**uarters
IA5	**I**nternational Reference **A**lphabet-**5**
ICAO	**I**nternational **C**ivil **A**viation **O**rganization
ID	**Id**entification
IEEE	**I**nstitute of **E**lectrical and **E**lectronic **E**ngineers
IFF	**I**mage **F**ile **F**ormat
IGMI	**I**stituto **G**eografico **M**ilitare **I**talia
IGN	**I**nstitut **G**éographique **N**ational

IHO	**I**nternational **H**ydrographic **O**rganization
IIF	**I**mage **I**nterchange **F**ormat
ILS	**I**nstrument **L**anding **S**ystem
IMO	**I**nternational **M**aritime **O**rganization
in	**In**ch
IRV	**I**nternational **R**eference **V**ersion
ISO	International Organization for Standardization ("iso" = Greek for "same")
ITU	**I**nternational **T**elegraphic **U**nion
ITU-T	**I**nternational **T**elegraphic **U**nion- **T**elecomunications
LDA	**L**ocalizer type **D**irection **A**id
Ln()	Natural Logarithm of...
LORAN	**Lo**ng **Ra**nge **N**avigation
LUT	**L**ook-**U**p **T**able
MALSF	**MALS** (**M**edium **I**ntensity **A**pproach **L**ight **S**ystem) with Sequenced **F**lashers
MALSR	**MALS (M**edium Intensity **A**pproach **L**ight **S**ystem) with **R**AIL (**R**unway Alignment Indicator Lights)
MIS	**M**anagement **I**nformation **S**ystem
MB	**M**inimum **B**ounds
MBR	**M**inimum **B**ounding **R**ectangle
MC&G	**M**apping **C**harting **& G**eodesy
MLSAZ	**M**icrowave **L**anding **S**ystem A**z**imuth Guidance
MLSEL	**M**icrowave **L**anding **S**ystem **El**evation Guidance
mm	**M**illi**m**etre
MRE	**M**ultiple **R**egression **E**quation
MSD	**M**etric **S**upport **D**ata
NaN	**N**ot **a N**umber (used as a floating-point null value in VRF)
NATO	**N**orth **A**tlantic **T**reaty **O**rganization
NE	**N**orth-**e**ast
NIMA	**N**ational **I**magery and **M**apping **A**gency
NOAA	**N**ational **O**ceanic and **A**tmospheric **A**dministration
NSIF	**N**ATO **S**econdary **I**magery **F**ormat
N/S	**N**orth/**S**outh
NITF	**N**ational **I**magery **T**ransmission **F**ormat
NW	**N**orth-**w**est
OSI	**O**pen **S**ystems **I**nterconnection
PAPI	**P**recision **A**pproach **P**ath **I**ndicator
PAR	**P**recision **A**pproach **R**adar
PCB	Size of **P**ixel/Element **C**ount element in **B**its
PE	**P**hase **E**ncoded
PVASI	**P**ulsating **V**isual **A**pproach **S**lope **I**ndicator
PVB	Size of **P**ixel/Element **V**alue element in **B**its
RG	**R**aster **G**raphic
RGB	**R**ed, **G**reen, **B**lue
RID	**R**ecord **ID**

RTY	**R**ecord **Ty**pe
SATOC	**S**tandard **A**SCII **T**able **o**f **C**ontents
SDF	**S**implified **D**irectional **F**acility
SE	**S**outh-**e**ast
SF	**S**imple **F**eature
SRG	**S**tandard **R**aster **G**raphics
S/N	**S**ignal to **N**oise ratio
SSALF	**S**implified **S**hort **AL**S (Approach Light System) with Sequenced **F**lashers
SSALR	**S**implified **S**hort **AL**S (Approach Light System) with **R**AIL (**R**unway Alignment Indicator Lights)
STANAG	**Stan**dardization **Ag**reement
SQL	**S**tructured **Q**uery **L**anguage
Sqrt()	Positive **Sq**uare **r**oo**t** of ...
SW	**S**outh-**w**est
TA	**T**otal **A**rea
TAD	**T**errain **A**nalysis **D**ataset
TBR	**T**o **B**e **R**esolved
THF	**T**ransmittal **H**eader **F**ile
TIN	**T**riangular **I**rregular **N**etwork
TRCV	**Tr**i-**c**olour **V**isual Approach Slope Indicator
TRE	**T**agged **R**ecord **E**xtension
TVAI	**"T" - V**isual **A**pproach **S**lope **I**ndicator
UCS-2	**U**niversal **C**haracter **S**et **2**
UN	**U**nited **N**ations
UPS	**U**niversal **P**olar **S**tereographic
US	**U**nited **S**tates
USRP	**U**TM/UPS **S**tandard **R**aster **P**roduct
UTF	**U**niversal **T**ransfer **F**orm
UTM	**U**niversal **T**ransverse **M**ercator
UVL	**U**ser **V**olume **L**abel
VA	**V**oid **A**rea
VA	**V**irgini**a**
VASI	**V**isual **A**pproach **S**lope **I**ndicator
VDT	**V**alue **D**escription **T**able
VHF	**V**ery **H**igh **F**requency
VOR	**V**HF **O**mni**r**ange
VORDME	**VOR** and **D**istance **M**easuring **E**quipment Collocated
VORTAC	**VOR** and **TAC**AN Navigational Facilities Collocated
VRF	**V**ector **R**elational **F**ormat
WGS	**W**orld **G**eodetic **S**ystem
WGS 84	**W**orld **G**eodetic **S**ystem 19**84**

4.3 Codes and Labels

Although most are defined the first time they appear, the following list is provided as a quick reference for all the codes, labels, etc. found in this part of DIGEST (excluding the annexes).

A	**A**lphanumeric (attribute value format)
A	M**a**trix datasets (use code)
AAH	Horizontal Accuracy (quality and control attribution code)
AAV	Vertical Accuracy (quality and control attribution code)
ALT	**Alt**ernative Representation (explicit relation code)
BFC	**B**uilding **F**unction **C**ategory (attribute code)
C	**C**oincident (spaghetti/chain-node code)
C	**C**ommon to all datasets (use code)
C	**C**onfidential (security classification code)
CCC	**C**olour **C**ode **C**ategory (attribute code)
CLI	**Cli**pping Indicator (quality and control attribution code)
COD	Column Sequence (Scan direction parameter)
CMO	**C**o**m**posed **O**f (explicit relation code)
CPO	**C**om**p**onent **O**f (explicit relation code)
D	**D**epending on a condition(requirement code)
D	**D**isjoint Forward (spaghetti/chain-node code)
DA	ATTRIBUTE/VALUE_ASSOCIATION_RECORD (Record Type)
DAT	**Dat**e (date code)
DD	Day (Up-to-**d**ateness **d**escriptor)
DD	FEATURE/ATTRIBUTE_ENTRY_RECORD (Record Type)
DF	FEATURE/ATTRIBUTE_ASSOCIATION_RECORD (Record Type)
DIG	Table (**dig**itized) data (geo parameter)
E	Disjoint Reverse (spaghetti/chain-node code)
ED	EDGE_RECORD (Record Type)
EXC	Number of Coordinate Sets (counter)
EXE	Number of Edges, Faces, or Nodes (counter)
EXR	Number of Explicit Relations (counter)
EXT	Number of Explicit Attributes (counter)
F	**F**orward (spaghetti/chain-node code)
FA	AREA_FEATURE_RECORD (Record Type)
FC	COMPLEX_FEATURE_RECORD (Record Type)
FE	FACE_RECORD (Record Type)
FL	LINE_FEATURE_RECORD (Record Type)
FP	POINT_FEATURE_RECORD (Record Type)
GEN	**Gen**eral Information File (file name extension)
GER	**Ge**ographic **R**eference File (file name extension)
GMA	**G**rid North - **M**agnetic North **A**ngle (source code)
HH	Hour (Up-to-dateness descriptor)

I	**I**nside Forward (spaghetti/chain-node code)
I	**I**nteger (attribute value format)
IMG	Main Raster **Im**a**g**e (file name extension)
J	Inside Reverse (spaghetti/chain-node code)
L	**L**eft (Chain-node orientation parameter)
M	**M**andatory (requirement code)
MAP	**Map** data (geo parameter)
MM	Month (Up-to-dateness descriptor)
N	**N**o (flag)
NFC	Number of Subblocks West/East or Left/Right (counter)
NFL	Number of Subblocks North/South or Top/Bottom (counter)
NLF	Number of Features (counter)
NO	NODE_RECORD (Record Type)
O	**O**ptional (requirement code)
ORC	**O**perating **R**ange **C**ategory (attribute code)
PAT	Buoy **Pat**tern Category (attribute code)
PNC	Number of pixels per subblock E/W (counter)
PNL	Number of pixels per subblock N/S (counter)
POR	Pixel Order (Scan direction parameter)
PRODSPEC	**Prod**uct-**spec**ific Directory (VRF)
QAL	**Q**u**al**ity File (file name extension)
QID	**Q**uality/Source Record **Id**entifiers (quality and control attribution code)
QLE	Releasability (quality and control attribution code)
QUL	Reliability of **Qu**a**l**itative Attribute (quality and control attribution code)
QUT	Standard Deviation of **Qu**an**t**itative Attribute (quality and control attribution code)
R	**R**aster datasets (use code)
R	**R**estricted/For Adminisrative Use Only (security classification code)
R	**R**everse (spaghetti/chain-node code)
R	**R**ight (Chain-node orientation parameter)
ROD	**Ro**w Sequence (Scan **d**irection parameter)
S	**S**ecret (security classification code)
SOU	**Sou**rce File (file name extension)
SP	**SP**ATIAL_DATA_RECORD (Record Type)
SPL	number of **sp**atia**l** data records (counter)
STK	**St**ac**k**ed On
STU	**St**acked **U**nder
T	**T**op Secret (security classification code)
THF	**T**ransmittal **H**eader **F**ile (file name extension)
TMC	**T**op **M**ark **C**haracteristic (attribute code)
TP	**T**EXT_**P**LACEMENT_RECORD (Record Type)
U	**U**nclassified (security classification code)
UNI	**Uni**ts (attribute code)
V	**V**ector datasets (use code)

VEC	Edges, Nodes, Faces, Features (file name extension)
WID	**Wid**th (attribute code)
Y	**Y**es (flag)
YYYY	**Y**ear (up-to-dateness descriptor)

5 MAINTENANCE OF DIGEST

5.1 Custodian

The United States National Imagery and Mapping Agency (NIMA) is the custodian of DIGEST.

NIMA
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Reston, VA 20191-3449, USA
Telephone: +1-703-262-4420
Fax: +1-703-262-4401

e-mail: custodian@digest.org

5.2 National Representatives

Any queries with regard to the content or application of DIGEST should be addressed to the national representative (point of contact). The DGIWG national representatives are:

- Australia:
  Defence Imagery & Geospatial Organization
  Department of Defence
  R7-5
  Russell Offices
  ACT 2600
  Australia

- Belgium:
  Institut Géographique National
  Abbaye de la Cambre 13
  B 1050 Brussels
  Belgium

- Canada:
  Director of J2 Geomatics
  National Defence Headquarters
  MGen G. Pearkes Building
  Ottawa, Canada K1A 0K2

- Czech Republic:
  Chief of Military Topographic Institute
  Military Topographic Institute
  51816 Dobruška
  Czech Republic

- Denmark:
  Chief of Defence Denmark
  Log Plans Branch
  PO Box 202
  DK-2950 Vedvæk
  Denmark

- France:
  Centre Géographique Interarmées
  F-00450 Armées
  France

- Germany:
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  Frauenberger Str 250
  Mercator Kaserne
  53879 Euskirchen
  Germany

- Greece:
  Hellenic Military Geographical Service
  Eyelpidon 4, 11362
  Athens – Greece

- Italy:
  Istituto Geografico Militare
  Via C. Battisti, 10
  50100, Firenze
  Italy

- The Netherlands:
  Operational Staff / RNLA
  Military Geographic Branch
  P.O. Box 90701
  2509 LS The Hague
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- New Zealand:
  AD Geographic Information, JCIS
  Operations Branch
  HQ New Zealand Defence Force
  Private Bag
  Wellington
  New Zealand

- Norway:
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  Oslo Mil/Akershus
  N-0015 Oslo
  Norway

- Spain:
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  Dario Gazapo Num 8
  28024 Madrid
  Spain

- Turkey:
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  06100 Cebeci - Ankara
  Turkey

- United Kingdom:
  Geo Standards Branch
  Defence Geographic & Imagery Intelligence Agency
  Defence Geographic Centre
  Elmwood Avenue
  Feltham
  TW13 7AH, UK

- United States:
  NIMA
  Data Content Standards and Interoperability Office
  Mail Stop P-24
  12310 Sunrise Valley Drive
  Reston, VA 20191-3449, USA

5.3 Proposed Changes and Amendments

Any proposed changes or comments should be keyed to the specific page, paragraph, and line of text. Rational reasons should be provided for each proposed change and or comment to ensure understanding and complete evaluation. Comments from member nations of DGIWG should be sent to your DGIWG National Representative (see clause 5.2). The national representative will then forward the details to the custodian nation. Comments from non-members should be forwarded directly to the DIGEST custodian nation (see clause 5.1). DGIWG will ensure that all such comments are processed through formal document change control (DCC) procedures.

Amendments to this specification will be the responsibility of the custodian nation on behalf of and in agreement with DGIWG, and will be issued as necessary through the national representatives. Amendments can also be viewed and downloaded via the DIGEST web page (www.digest.org).

5.4 Distribution

Distribution of DIGEST and DIGEST amendments is the responsibility of the DIGEST custodian and DGIWG national representatives. National representatives are responsible for distributing within their own country. The custodian and all national representatives can distribute DIGEST freely to non-member nations. The DIGEST can also be viewed and downloaded via the DIGEST Web Site (http://www.DIGEST.org).

6 GENERAL CONCEPT OF DIGEST

6.1 National Digital Geographic Information System

As a prerequisite to creating a multi-national system for the exchange of DGI, each nation wishing to participate will need to establish a national system having the following major elements:

a database of positionally-related digital information including:

- elevation and depth information;
- geographic feature geometry and feature attribute information;
- information concerning the appearance and status of the Earth's surface and its features in the electromagnetic spectrum; and
- other geographic information together with other associated data.

procedures for the:

- acquisition of data to populate the database;
- maintenance of the database;
- transmission of data to and from the database;
- management of data to ensure its integrity and quality; and
- provision of information about the data, including availability, accuracy, security classification, and release restrictions. This includes the capability to allow for the exchange of indexing or catalogue information.

Nations may differ in their concepts for digital production. In one case, a range of products may be produced by largely separate production processes. For each product, data is extracted from source material and that data is then formatted for the specific product in the input to a product database, from which the needs of users are constrained to use a limited range of standard products. The product data may be further transformed, by the user, to obtain data in the precise form needed.

In another production approach, a nation with a wide range of products will extract data on a multi-product basis from source material to form a multi-product database from which a range of products may be generated. In some cases this product generation may be simply the extraction of certain features from the database; other cases may involve a considerable amount of further processing.

The important data exchange issue is the creation of compatibly-structured database(s) for neutral data and products, so the exchange of data under the multi-national system is practical.

6.2 Operational Concept

International exchange standards for DGI are the principal concern of DGIWG. The development of a multi-national digital geographic information system is needed to facilitate the exchange. The system will consist of standards and procedures needed to permit data to be exchanged among nations. The following paragraphs describe the principles that will govern this exchange and therefore form the basis of the operational concept for DIGEST.

Data exchange will be governed by a series of agreements among nations. There will be no single master database; each nation will be responsible for providing data to meet its international commitments and for holding data, both nationally-produced and received from other nations.

Nations may agree to arrange for the procurement of common hardware and software. However, standards have been produced with the assumption that, in general, nations will be using different hardware and software.

Standards for data exchange have been agreed to on a multi-national basis. The standards must allow for the exchange of both digital geographic products and basic geographic data. This geographic data may consist of multi-product database information or other forms of intermediate digital data used in the production of maps, charts or digital products.

There are a number of types of exchange relationships (Figure 6-1).

- Internal Exchange - the exchange within national agencies. This is not of direct concern to other nations.

- Inter-Agency Exchange - the exchange of basic data and products between map production agencies. This is the principal concern of DGIWG.

- Provision of Products - the supply of products by production agencies to their users. This is a national responsibility; however, DGIWG is interested in product standards.

- User Exchange - the exchange of products and information between user systems. Such an exchange may take place if a system is developed as an international project; then there will be commonality of equipment between nations. Exchanges of this type are primarily the responsibility of those responsible for the system and are not the concern of DGIWG.

The exchange of DGI will be carried out initially by means of an accepted international standard for removable storage media. Emphasis will be placed initially on magnetic tape and optical disks. Interchange by means of communication links may be a further alternative.

The work of DGIWG is directed towards establishing a multi-national system to enable the exchange of DGI and products, and information about them between national systems.

This will require the development of standards for data and the definition for the exchange media and the procedures for exchange. Exchange of data will be by a series of agreements among nations.

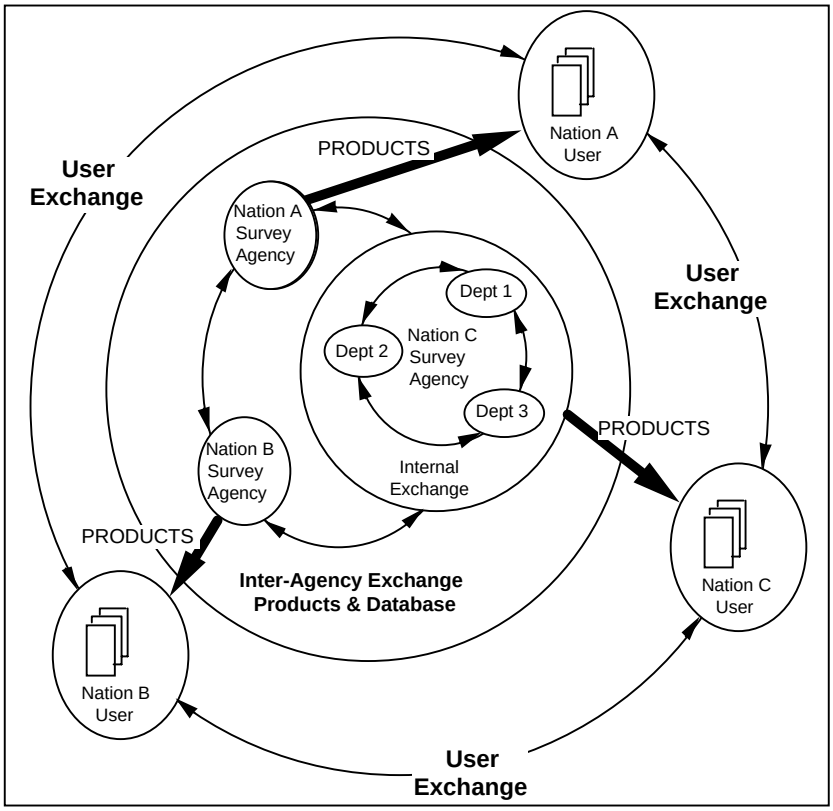

Figure 6-1 DGIWG Digital Data Exchange

6.3 Data Structures

DIGEST applies to:

- spaghetti vector data (Level 0 Topology);
- chain-node vector data (Level 1 Topology);
- planar graph vector data (Level 2 Topology);
- full topological vector data (Level 3 Topology);
- raster data (radiometric information pertaining to pixels); and
- matrix data (non-radiometric information pertaining to points at regularly identified intervals).

These structures may accommodate:

- neutral "geo data";
- processed "product data"; and
- information about data holdings, which will include (among other things):
  - -- data quality information (accuracy, consistency, completeness, currency, and security classification); and
  - -- availability (production status and releasability).

Since the architecture of national databases is not contained in the field of application of these standards, it is the main goal of this document to suggest common approaches to the definitions of features and attributes, values and units as well as to a coding catalogue and a logical structure of data elements and their relations. The exchange format will ensure that the receiver of such data can integrate them into his own database or at least will be able to understand the meaning of the DGI.

DIGEST does not apply to analog (video) data or to any additional data required by telecommunication techniques (protocols, modems, etc.).

6.4 Guiding Philosophy

DIGEST is designed to establish a uniform method for the exchange of DGI. This uniformity is based on a common logical organization of any geo dataset exchanged, whatever the data exchange structure used, on the fundamental principles agreed to within DGIWG as expressed throughout DIGEST; and on methods of representation of the data taken from the International Organization for Standardization (ISO).

For any exchange of DGI between national agencies to be carried out in a practical manner it is necessary that the following aspects be supported:

- a clear definition of the data model to be used for each type of data (see Part 2 Clause 5);
- a commonly-understood means of identifying features and their descriptive attributes (see Part 2 Clause 6 and Part 4);
- a clear statement on the quality and accuracy of the data (see Part 2 Clause 7);

- a clear definition of the logical organization and structure of the data (see Part 2 - Section Two), including:

    -- a clear definition of information for interpreting the overall content of a DIGEST Information Package (see Part 2 Clause 9), and

    -- a clear definition of information for supporting each specific dataset (see Part 2 Clauses 10 and 11);

- a clear definition of the organization and representation of the data (i.e. format) on the exchange media (see Part 2 Clause 12); and

- a clear statement of the recording standards used for the exchange media (see Part 2 Clause 13).

7 SUMMARY DESCRIPTION OF DIGEST

7.1 Theoretical Model

The theoretical model includes the data models, feature and attribute coding structure, and data quality.

7.1.1 Data Model

There are two basic types of spatial data supported by DIGEST. These are spatial data defined in terms of boundaries and spatial data defined in terms of sets of attribute values distributed over an area by a "coverage" function. Spatial data defined in terms of boundaries are commonly called "vector" data. Spatial data defined by the distribution of attributes over an area can be further subdivided primarily into "raster" data and "matrix" data, where raster data addresses the distribution of radiometric information over an area such as imagery, and matrix data addresses the distribution of non-radiometric information such as elevation values over an area. Other spatial data defined by special coverage functions such as Triangular Irregular Networks (TINs) are not presently addressed by DIGEST.

These types of data are illustrated in Figure 7-1 and are listed below:

- vector data (at various levels of topology);
- raster or image data; and
- matrix data.

These types of data are complementary in that they provide different methods of representing information about the same geographical area.

Vector data represents geographic information in terms of the boundaries and attributes of individual features. Features are real items that can be identified on the earth, such as a river or a tower, or they are abstract items such as political boundaries. Attributes may be ascribed to features, which describe what type of item that they are and also provide information with respect to the particular instance of the item. For example, a feature code might describe that a particular item is "bridge" and an attribute code may describe that the bridge is capable of supporting a specified load. Features may be either of Point, Line or Area type or be of Complex type composed of other Point, Line, Area, Text or other Complex features. The spatial extent of features is described in vector data in terms of Node, Edge and Face elements. These primitive elements carry positional attributes. The relationship between these primitive spatial elements is optionally described in terms of topology. For example, whether a point feature is contained in a particular area feature is described in terms of the containment of the corresponding entity point (node) element within a face element. DIGEST permits topological relationships to be described in a vector dataset to four different levels of sophistication. DIGEST provides a single vector data model, which can carry any of the four identified levels of topology.

The most basic vector dataset (level 0 topology) does not carry any topological relationship information. This is known as "Spaghetti" data.

The next level of data is "Chain-Node" (level 1 topology) where all edges terminate on nodes. This describes the connectivity of the dataset, but edges are permitted to cross without intersecting.

The next level of vector data is "Planar Graph" data (level 2 topology) where a node must exist at the intersection of each edge. Adjacency information is carried at this level of topology.

The highest level of topology, currently supported by DIGEST vector data, is termed "Full Topology" (level 3 topology) where the dataset forms a mathematical 2D manifold, complete with faces. Containment information is carried at this level of topology.

The DIGEST spatial schema for vector data is aligned with the ISO / TC211 Spatial-schema work (as represented in ISO FCD 19107). The DIGEST vector geometry and the four levels of topology correspond with equivalent structures within the ISO standardization work. In addition, the DIGEST Feature model for vector data corresponds to the General Feature Model defined in the ISO / TC211 work on Application Schema (as represented in ISO FCD 19109).

Raster or image data represents geographic information in terms of an array of picture elements, corresponding to the individual colours or greyscale for each small (raster) segment of a map or image or other geographic information. A raster file is defined as a distribution of picture elements together with a traversal order, which is normally a set of rows and columns of picture elements (pixels). Each pixel may take on a given colour (or greyscale). Colour may be described either as a set of Red, Green, or Blue values for the individual pixel, or as a reference to a colour lookup table which indirectly describes the Red, Green, or Blue colour values (or greyscale). A significant amount of support metadata is carried along with the set of pixels to put the raster data set in context. If the raster dataset was created by scanning a paper map or chart, the projection, map grid, reference points, and other information about the scanned source paper map is carried. If the data is from some other source, information about the source is carried.

Matrix data represents geographic information as a set of values measured on a grid of points. For example, a Digital Terrain Elevation Model consists of a set of elevations measured on a regular grid of points.

The DIGEST schema for raster and matrix data is aligned with the work in both ISO / TC 211 Geographic Information / Geomatics and ISO JTC1 SC24 Computer Graphics and Image Processing. ISO / TC211 is defining general Coverage Geometry and Functions (as represented in ISO WD 19123) and other aspects of Imagery and Gridded Data Components (as represented in ISO RS 19124). ISO JTC1 SC24 has developed the Basic Imagery Interchange Format (BIIF) in ISO 12087-5. DIGEST Part 2 Annex D is closely aligned with BIIF.

Theoretically, raster and/or matrix data can provide the geometry definition for attributed features, however, this is currently not addressed in DIGEST.

Note: The reference to ISO WD (Working Draft), FCD (Final Committee Draft), and RS (Review Summary) are valid as of the date of publication of DIGEST 2.1. These ISO documents are evolving and DGIWG will ensure that future versions of DIGEST reference (and are aligned where possible) the most current applicable ISO standards.

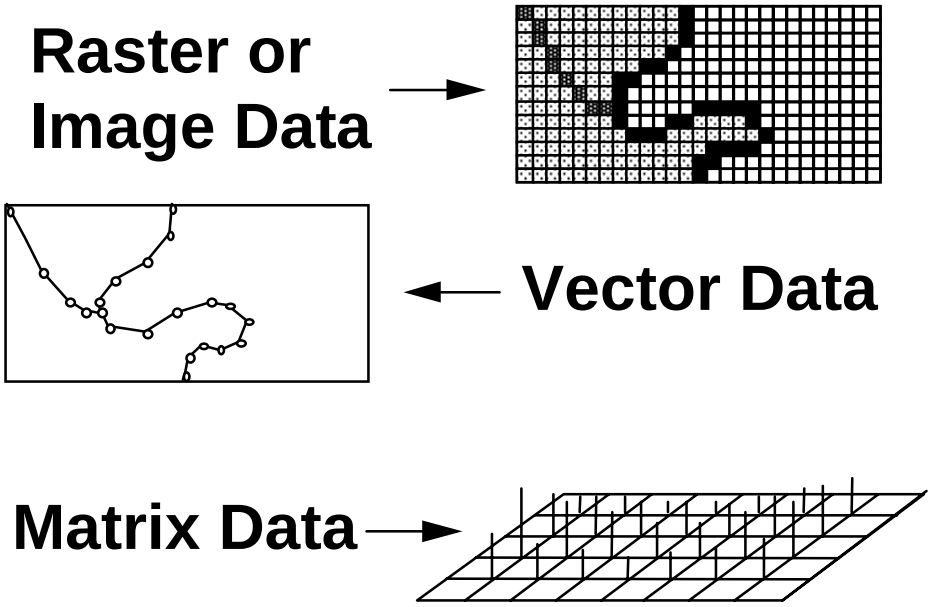

Figure 7-1 Spatial Data Types

7.1.1.1 Vector Data

Conceptually, the three possible topological data entities - node, edge and face - form the building blocks of a complete and consistent topological representation of the two-dimensional space covered by a given dataset. Well-defined topological relationships exist between the different topological entities. In addition, a succinct set of rules is defined to which each entity must conform. The geographic features - point, line, area and complex - in the dataset are then represented by one or more topological entities with a many-to-many mapping between features and entities.

In DIGEST, topological entities and features are linked by a mandatory one-way relation, and, optionally, some reverse relations (see Figure 7-2). The use of only the one-way relation reduces the data volume while preserving the structure of the full conceptual scheme. This is known as Minimum Redundant Topology. The use of the reverse relationship, available in Vector Relational Format (VRF) form, improves computational efficiency.

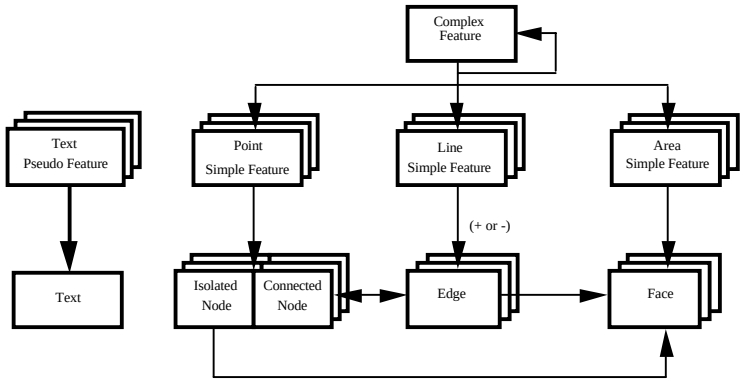

Figure 7-2 Mandatory Topology

Note: The arrow indicates, for example, that an isolated (entity) node refers to the face that contains it, but faces do not refer to nodes. Some reverse arrows are optional, for example, Edge-to-Line, Simple Feature-to-Complex Feature. The relationship between nodes, edges, and faces are described at different levels of topology.

There are four types of feature objects based on the type of spatial object that defines its geometric boundary. The four spatial object types are:

- simple point feature
- simple line feature
- simple area feature
- complex feature

In DIGEST both the geometry (coordinates, and the shape of lines) and topology (relationships) are defined in the same object classes. These combined geometry / topology objects are:

- node object
- edge object
- face object

A set of node, edge, and face objects form a geometric / topological complex, which has a consistent geometry and topology. (Note: A geometric / topological complex is different from a complex feature.)

Text is a cartographic feature and exists to provide an annotation capability. It is different than other spatial objects in that it does not correspond to a real physical geographic object.

Text feature objects are related to a separate geometric / topological complex from spatial objects. The text feature exists to provide an annotation capability, which can have complex attributes similar to the topological features.

Four levels of topology are provided in DIGEST for vector data. These are:

Level 0 Spaghetti

Level 1 Chain-Node

Level 2 Planar Graph

Level 3 Full Topology

These four levels of topology are based on the same data model with additional topological relationships described at higher levels.

Spaghetti data (level 0) does not describe any topological relationships between primitive entities. Spaghetti data, in the strictest interpretation, can be used to represent only line and point features. However, area information may be captured in spaghetti data by the use of "closed lines" which circumscribe an area.

Chain-Node data (level 1) describes edge-to-node topological relationships, where every edge must begin and end on a node; however, edges may cross without intersecting. This level of topology is sufficient to describe connectivity.

Planar Graph data (level 2) introduces the additional mathematical constraint that edges may not cross except at a node. This permits adjacency to be calculated although it is not directly stored in the structure.

Full Topology data (level 3) introduces the concept of a face and describes face-to-edge as well as node-to-face topological relationships. This carries adjacency, left face / right face topological relationships as well as node-in-face-containment.

The topology represented in the exchange dataset is logically consistent, and all related entities and features are exchanged. It represents a topology consistent with the coordinate plane.

7.1.1.2 Raster or Image Data

Raster or Image data consist of imagery and raster graphics to include:

- distributed attribute data in pixel form;
- geographic coordinates with which to register the digital data to the original graphic’s projection; and
- metadata information about the raster data.

Raster data are a collection of attributes usually corresponding to red, green, and blue (RGB), or colour-coded (including greyscale) digital images stored in (optionally compressed) binary form.

One type of raster data product is a scanned paper map or chart. The total extent of a map or chart may be scanned including margin, border, and legend areas. Each image, which normally consists of one scanned map or chart, is provided with geographic control on the original datum or projection so that transformation and seaming of the data can be performed at user discretion.

Another type of raster data is an image consisting of radiometric data elements. Such data may be collected from a satellite or other type of sensor. Registration information, colour map information, and other metadata information are included with the raster data.

7.1.1.3 Matrix Data

Matrix data are arrays of non-radiometric information pertaining to points at regularly identified intervals (e.g., grid, Cartesian, latitude/longitude) and characteristics which are present at that particular location. Such characteristics could be soil type or elevation. Each array of matrix information will consist of a uniform number of locations, the basic structure of which is identical to the raster structure.

7.1.2 Feature and Attribute Coding

The aim of the feature and attribute coding specification is to provide a standard scheme for documenting features and attributes necessary to distinguish those features commonly found in a Digital Geographic Information System and for the orderly exchange of such data.

The specification, which is Part 4 of DIGEST, provides a common menu of features and attributes along with a standardized coding system. They are known collectively as the Feature and Attribute Coding Catalogue (FACC) Data Dictionary. FACC provides Data Dictionary elements of a geographic nature to support the development of database schemas and product specifications. The FACC Data Dictionary allows for individual nations to define "national" features and attributes for cases where such features and attributes are not readily defined in the normative FACC Data Dictionary. National extensions are not specified within the normative FACC Data Dictionary, and may not support interoperability.

FACC can be modified and updated to keep pace with the dynamic technology improvements and changing requirements. National extensions may, if proposed and approved, be incorporated into future editions of the normative FACC Data Dictionary. Procedures for extending and modifying the FACC Data Dictionary are described in Part 4, Clause 5.3. In this way, the FACC Data Dictionary may be extended so as to satisfy application requirements.

Within FACC, each feature is identified by a unique five-character code. The first character corresponds to the feature category and can have an alphabetic value from A to Z. Currently there are ten major feature categories, including one category, S, which has been reserved for dataset-specific features. The categories are as follows:

Category Code	Category Name
A	Culture
B	Hydrography
C	Hypsography
D	Physiography
E	Vegetation
F	Demarcation
G	Aeronautical Information
I	Cadastral
S	Special Use (Dataset-specific)
Z	General

Each major category is further divided into subcategories identified by the second character of the five-character code containing an alphabetic value from A to Z. Finally, the third, fourth, and fifth characters of the five-character feature code are a numeric value from 000 to 999. This value provides unique feature type identification within categories. Thus, all features must be identified by all five alphanumeric characters (e.g., the feature "Building" is represented by AL015). Feature codes are listed in Annex A of the FACC Data Dictionary.

DIGEST provides an extensive list of explicit attributes, which are used to describe characteristics of a feature, e.g., vegetation characteristic of forested areas (deciduous or evergreen). Each attribute is associated with a textual description, which provides a human readable dictionary definition for the attribute. Attribute value format statements provide a computer interpretation for the attribute value data type (e.g., real, alphanumeric) and attribute values give quantitative/qualitative meaning to the attribute code. Each attribute is identified by a unique three-character alphanumeric code. For example, the attribute "Building Function Code" has the code BFC, and the attribute "Total Usable Width" has the code WD2. DIGEST also allows implicit attribution, which supports data encoding. (Implicit attribution is defined for Vector data in Part 2, Clause 12.2.3 and Annex C).

There are two types of attribute values: coded and actual. A given attribute has only one type of value, which is specified in Annex B of the FACC Data Dictionary. Coded values may range from 0 to 999 and each value is given meaning by descriptive text, which may, for example, be implemented by means of a look-up table. Real values are typically measurements like height, width, etc. The units of measurement associated with an attribute are abbreviated according to the units of measurement codes as detailed in DIGEST Part 3 - 7. An attribute value may be logically coded as shown below:

Attribute Code	Attribute Value Format	Attribute Value
BFC	I	6

where "BFC" represents a Building Function Category;
"I" represents the datatype of the coded value (e.g., a 4-byte integer); and
"6" represents the coded value of the BFC attribute (e.g., a hospital).

DIGEST is a "Data Dictionary" consisting of a list of feature types and attributes. When a particular set of features are chosen for a type of application, and a set of attributes are associated with those features, then the result is a "Feature Catalogue" for that application.

7.1.3 Data Quality

Data quality descriptors are necessary in order to express the quality of exchanged geographical data referring to features / attributes and geometry and to integrate them into a receiving database without ambiguity. Therefore quality statements are required for a single datum as well as for certain data levels or categories. Special statements are required for:

- source;
- accuracy (positional and attribute);
- up-to-dateness/currency;
- logical consistency;
- completeness (feature and attribute);
- clipping indicator;
- security classification; and
- releasability.

Note: The last three descriptors, although not relating to data quality, are included here because of their logical similarity to data quality descriptors.

Data is organized in structures that comprise several categories, e.g.:

- information package;
- dataset;
- layer;
- feature; and
- attribute.

Quality descriptors may be assigned to each of the above categories.

7.2 The Exchange Structure

DIGEST allows the definition of sets of geographic information to be exchanged. The interchange unit is called a “DIGEST Information Package”.

The guiding philosophy has been to organize the required information for the DIGEST Information Package of any geo data into the following logical sets of data (see Figure 7-3):

- the **DIGEST Information Package Metadata Subset,** which describes the contents of the DIGEST Information Package (which may comprise one or several Geo Datasets [Libraries]) and identifies its parent standard DIGEST database.

- the **Geo Datasets [Libraries]** included within this DIGEST Information Package, each of them organized into the following logical sets of data:

  - the **Dataset [Library] Metadata Subset** which provides the supporting information specific to each included Geo dataset [Library].

  - the **Geo Data Subset** composed of one or more layers [coverages], defined as a collection of digital information representing physical and cultural characteristics of the Earth's surface; the collection of information shall be geographically contiguous except for raster insets which may not be contiguous to the primary source; these items of data must utilize the same geographic reference system and projection.

  - optionally, the **Supporting Data Subset** composed of one or more layers [coverages] such as Legend graphics, Colour patch, and Location grids.

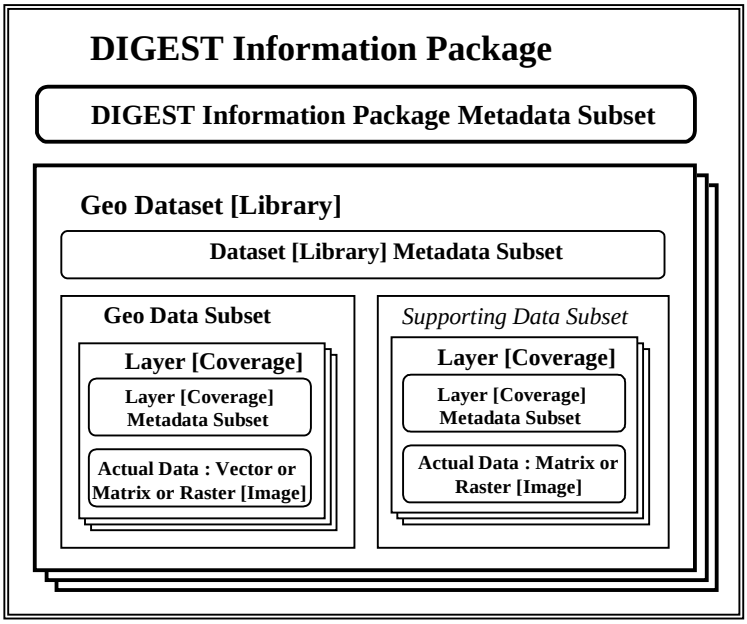

Figure 7-3 Logical Structure of a DIGEST Information Package

7.2.1 DIGEST Information Package Metadata Subset

The DIGEST information package metadata is contained in a specific set of information, which occurs only once for each DIGEST information package. The DIGEST information package metadata defines the contents of the DIGEST information package and identifies its parent database.

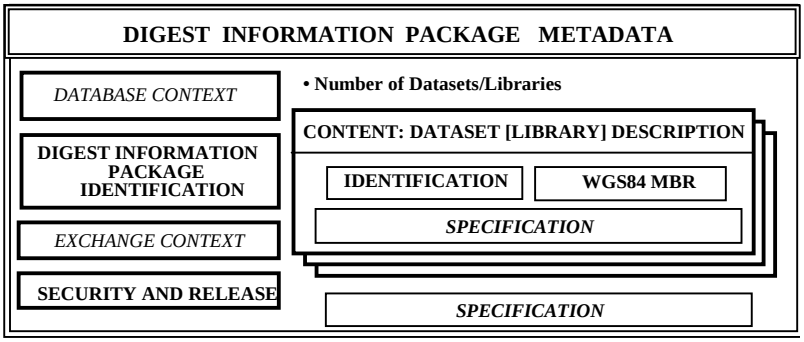

Figure 7-4 DIGEST Information Package Metadata Subset

The DIGEST Information Package Metadata Subset occurs once for each DIGEST Information Package and a DIGEST Information Package is composed of one or more Geo Datasets [Library]. Each Geo Dataset [Library] consists of two, possibly three, subsets of data: a Dataset [Library] Metadata Subset, a Geo Data Subset and, possibly, a Supporting Data Subset.

7.2.2 Dataset [Library] Metadata Subset

Supporting information relating to the Geo Data Subset is contained in Dataset [Library] Metadata Subset (see Figure 7-5). Such items as projection, quality, control parameters, and datums are included in this subset providing the information necessary to interpret all the Geo Data Layers(s) [Coverage(s)] composing the Geo Data Subset. Supporting information specific to each Layer [Coverage] is included in the Layer [Coverage] metadata subset within each Layer [Coverage].

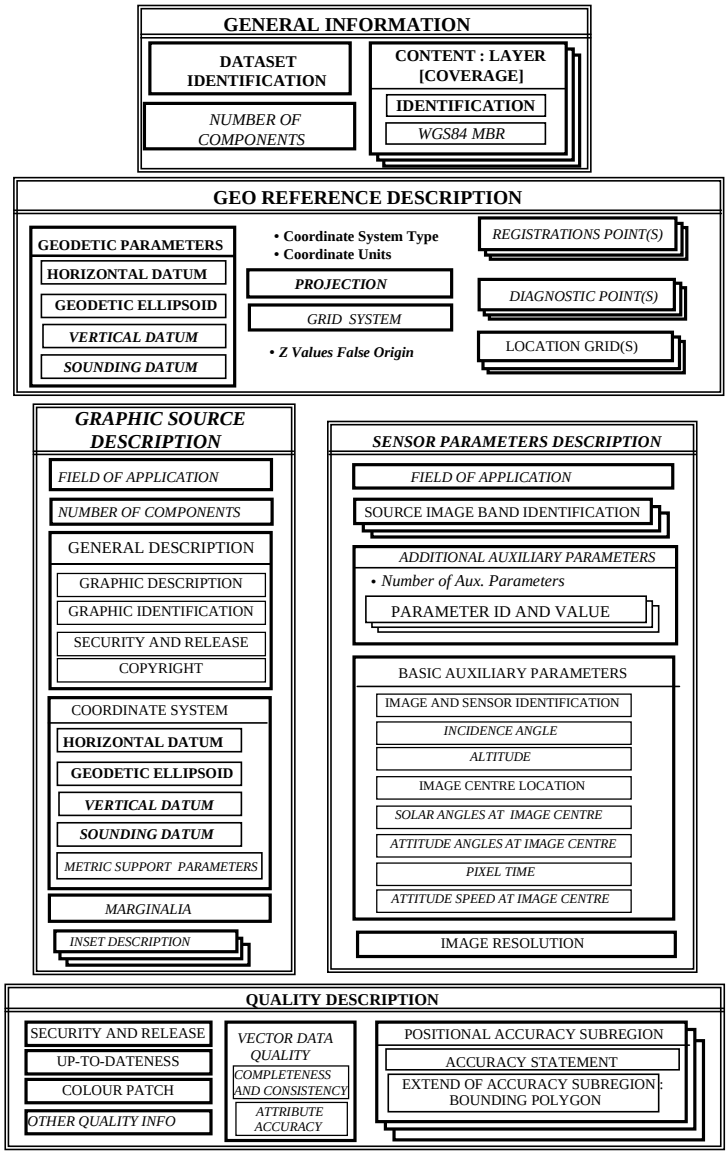

Figure 7-5 Dataset [Library] Metadata Subset

7.2.3 Geo Data Subset

The Geo Data Subset (GDS) contains the actual collection of digital information representing physical and cultural characteristics of the Earth's surface. Thus, the geographic information describing a map, chart, or other geographic information will be contained in the GDS. The collection of information shall be geographically contiguous except for raster insets, which may not be contiguous to the primary source. These data, however, must be represented in the same data structure and utilize the same geographic reference system and projection. The GDS can support several data structures; however, data structures may not be mixed within a layer. Also, within a single dataset only one geographic reference system and projection are allowed. Figure 7-6 illustrates the contents of the GDS.

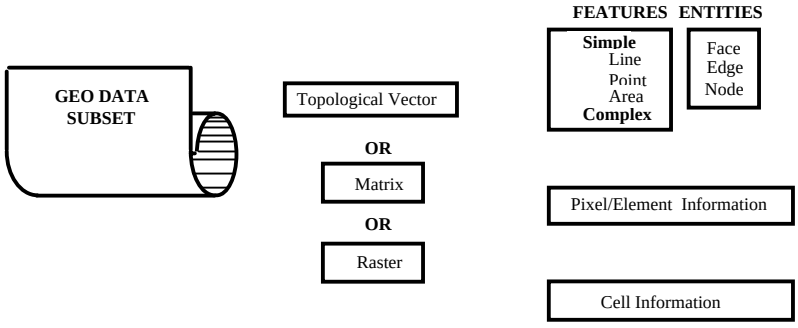

Figure 7-6 Geo Data Subset

Although the GDS is a single logical entity, it may be represented as a number of separate files for convenience in processing or transfer. For example, it may be beneficial to group all of the Edge, Node, and Face Records into their own separate files.

The vector data may be implemented by either a feature-oriented data structure or a relational data structure. In both approaches the topological relationships are accomplished by means of pointers, or keys, to the relevant features or entities. In the case of the feature-oriented approach, the link is defined by pointers to the record ID; for the relational approach, it is by keys to the row ID of a table.

All record structures necessary to capture the topological, spatial, descriptive feature / attribute, and data quality information are contained in the GDS. A GDS consists of one or more files.

7.3 Encapsulation Specifications

DIGEST provides a small number of ways to encode geographic data. This makes the task of decoding the data simpler for the recipient (as opposed to more generalized exchange structures, which require the recipient to interpret the source structure). The four encapsulation specifications provided are:

- ISO 8211 - generally for bulk transfer and for archival purposes;
- ISO 8824 (ASN.1) - for telecommunication;
- Vector Relational Format (VRF) - generally for database user applications; and
- Image Interchange File (IIF) - for image, raster, and matrix data.

7.3.1 ISO 8211 Encapsulation

This encapsulation is data descriptive, i.e., it carries a description of the meaning of each data element along with the data about the element. Although this is less efficient, it is easier to handle on a diverse array of machines and systems.

An ISO 8211 exchange set is usually a large data structure, which must be specified in great detail, usually for bulk transfer and for archival purposes. It is typified by a large amount of header data, which completely describes the format and structure of its encapsulation. It is thus self-descriptive. The specifications include the data structures and data descriptions for:

- the files of the transmittal file set;
- the records and fields of each file; and
- the subfields of each field.

The first two items are specified as ordered, rooted fields with an explicit statement of the required or permitted subtrees. The third item is specified as the field descriptions of the component files. The details of this specification format are given in Annex A to Part 2.

7.3.2 ISO 8824 (ASN.1) Encapsulation

An ISO 8824 (ASN.1) encapsulation is in alignment with the OSI standards for telecommunication systems, and it is normally used for telecommunications and thus consists of a sequential stream of information. The structure of this stream of information is defined by the identifier together with the length of the data elements embedded in the stream. The basic information elements are equivalent to the fields used in the ISO 8211 formulation of the same data format. The details of this specification format are given in Annex B to Part 2.

7.3.3 Vector Relational Format: Encapsulation

Vector Relational Format (VRF) is a direct-use data format for representing large spatially referenced databases. VRF is a standard format, structure, and organization for large geographic databases that are based on a geo-relational data model and are intended for direct use. VRF allows application software to read data directly from computer-readable media without prior conversion to an intermediate form. VRF uses tables and indexes which are sufficient to implement the entire VRF data model. VRF permits direct access by spatial location and thematic content. It is designed to be used for any DGI in vector format that can be represented using nodes, edges, and faces. VRF defines the format of the data objects, and the geo-relational data model provides a data organization within which software can manipulate the VRF data objects.

In VRF a field is an individual data element. VRF supports many different types of fields (fixed, variable, coordinate pairs, etc.). Text strings, for example, can be fixed or variable-length and are not viewed as collections of smaller fields, but rather they are viewed as single atomic data elements, which permits VRF tables to be viewed as a form of relation.

Features are defined from tables of primitives; attributes are defined by relational modeling. A feature is represented by a set of one or more primitives, a single primary row of attribute data, and zero or more other rows of attribute data. A simple feature with only one primitive and one primary row might consist of a single face and a single row of

attribute data. Features can be operated on as sets, which are grouped into feature classes. Feature classes may be identified by their feature tables, since every feature class has one and only one such table. There are two types of feature classes in VRF: simple and complex.

The VRF structural scheme (Figure 7-7) differs from that shown for mandatory topology (Figure 7-2) in that some reverse pointers are possible, and relationships between features and entities are accomplished by means of intermediate "join tables". They allow one-to-many, many-to-one, and many-to-many relationships.

The details of this specification format are given in Annex C of Part 2.

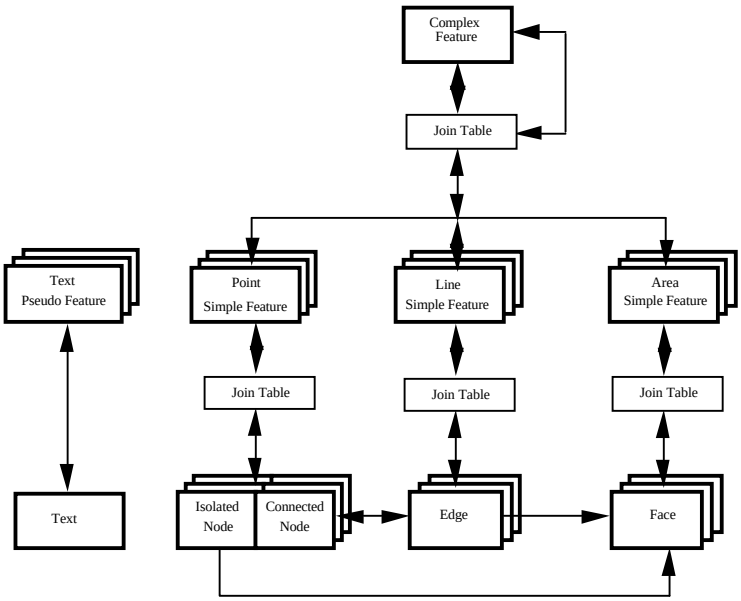

Figure 7-7 VRF Structural Schema

7.3.4 Image Interchange Format

The Image Interchange Format (IIF) is based on the NATO Secondary Imagery Format (NSIF). The IIF only implements the part of the NATO Secondary Imagery Format, which handles Raster (Image), or Matrix data structure. Other data structures such as graphic data or text data, which are not described within the DIGEST main body, may be implemented using the NSIF specification, but are not described in the IIF specification.

The details of this specification format are given in Annex D of Part 2.

7.4 Standard ASCII Table of Contents

The purpose of the standard ASCII Table of Contents (SATOC) is to provide a description of transmittal content in simple ASCII text that requires no software interpretation. This identifies the names of geo datasets [libraries], the layers [coverages] within each library, and the way each file is encapsulated. The details of this Table are given in Annex E to Part 2.

7.5 Media Standards

DIGEST defines media and labeling standards for magnetic tape, CD-ROM, and other exchange media. The data format is largely independent of the underlying exchange media used for transmission over which it is carried. In addition, file naming conventions and character representation are also specified.

The details of this specification format are given in Annex E to Part 2.

7.6 Codes and Parameters

Various technical codes and parameters to be used with DIGEST are provided in Part 3.

8 BIBLIOGRAPHY

The bibliography consists of informative references and supplementary material that assisted in the preparation of the standard. The normative references can be found in Part 1 Clause 3.

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- NATO STANAG 3985 (Edition 1) - Preferred Magnetic Tape Standards for the Exchange of Digital Geographic Information", 1987-06-04.

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