DATA MANAGEMENT STANDARDS IN COMPUTER-AIDED ACQUISITION AND LOGISTIC SUPPORT (CALS)

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Basic Thrusts of CALS

CALS is intended to reduce cost, increase quality, and improve timeliness of weapon system acquisition and support by greatly improving the flow of technical information. This improvement will be realized by substituting an integrated digital environment, encompassing the total weapon system life cycle, for the current islands of automation linked by paper. The current prime targets for CALS are CAD/CAM data, such as engineering drawings; technical manuals, including text and illustrations; and logistic support data, such as tabular data about failure rates.

BASIC THRUSTS OF CALS

Reduce cost, increase quality, and improve timeliness of weapon system acquisition and support through standards for information technology

The current targets are

- -- design and manufacturing
- -- technical manuals
- -- logistic support

CALS Phased Development

CALS is concerned with two phases of development: the current Phase I, which provides standards for data interchange; and the future Phase II, which will provide standards for a shared Integrated Weapon System Database (IWSDB). Phase I standards are based on national and international standards; CALS has developed specific subsets or other guidance for the following:

- the Initial Graphics Exchange Specification (IGES) for product data,
- the Standard Generalized Markup Language (SGML) for documents,
- CCITT Group 4 for compressed raster graphics,
- Computer Graphics Metafile (CGM) for vector graphics, and
- the Government Open Systems Interconnection Profile (GOSIP) for data communications.

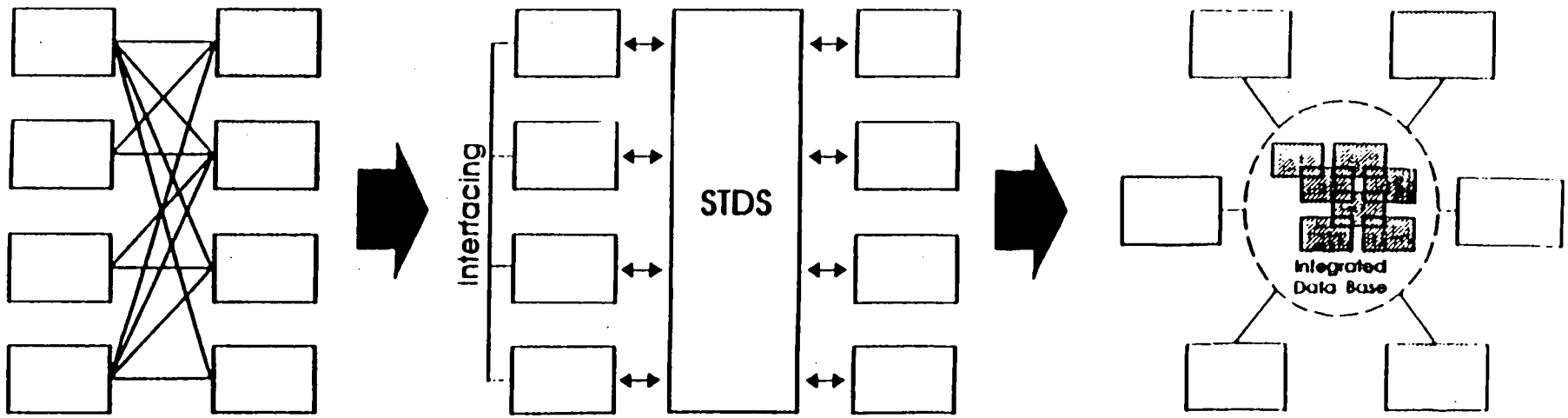
This presentation will be primarily concerned with the Phase II standards which are now being developed.

CALS Phased Development

(Today)
Islands of Automation
Paper Flow

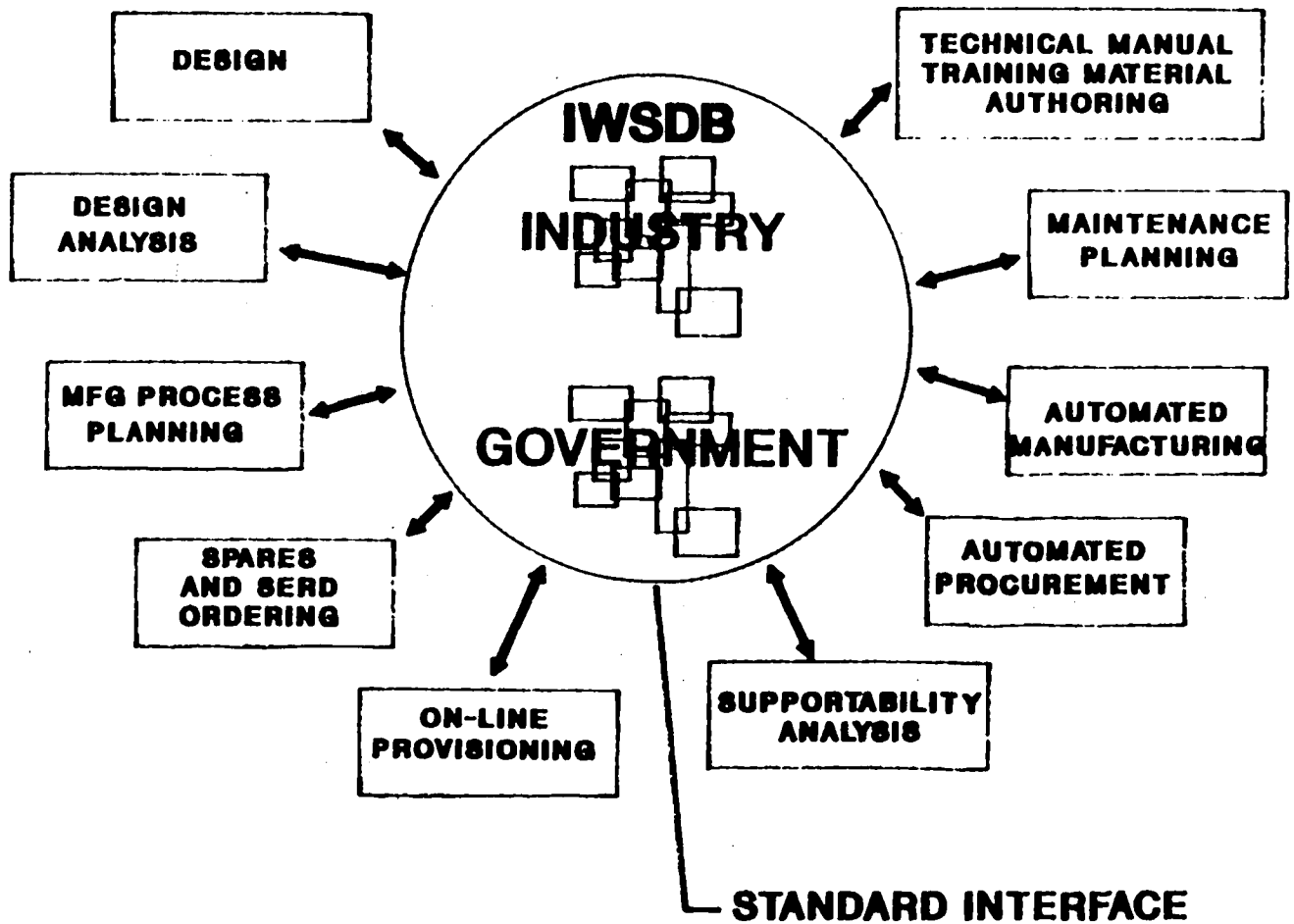
Phase I
(1988 – 92)
Interfaced Systems
Digital Flow

Phase II
(1991 95)
Integrated Systems
Shared Data Base



The IWSDB will provide a means for efficient, accurate, and timely sharing of technical information among the government, the prime contractor, and subcontractors. The primary means of information delivery to the government will be a contractor-supplied information service, rather than millions of pages of paper. This will save money and time in information development, review, and maintenance. Clearly data integrity and security are critical to the operation of the IWSDB.

INDUSTRIAL ENVIRONMENT-Phase II
INTEGRATED WEAPON SYSTEM DATABASE (IWSDB)



Standards

CALS is concerned with three types of standards: functional standards, such as those in military standards that describe DoD business processes; data content standards, which describe the structure and integrity rules of the data that supports those business processes; and technical standards, based on national and international standards for information technology. Technical standards provide the basis for open, non-proprietary systems only if:

- standards are developed through consensus and supported by products from a large number of vendors, and
- products are tested and certified by a standard procedure which provides evidence of reasonable quality.

Standards are frequently quite complex and may therefore require tailoring to a particular set of users. Very complex sets of standards, such as those of Open Systems Interconnection (OSI) may require the development of integrated profiles, or compatible tailored subsets, as in GOSIP and the Applications Portability Profile (APP).

STANDARDS

Three types:

- **Functional (shared business rules)**

  example: high-cost items must be reviewed manually

- **Data content (shared vocabulary)**

  example: high-cost is greater than $100,000

- **Technical (shared processing)**

  example: the Structured Query Language is used for table manipulation

Requirements for effectiveness

- **Development through consensus**
- **Testing and certification**
- **Tailoring to users**
- **Integration of compatible standards**

SQL

SQL became the international and national standard for relational database management systems in October, 1986. That standard specifies a standard cursor-based interface for calling to SQL modules from a number of standard programming languages. A 1989 extension specifies a standard means of embedding SQL statements within a program for a number of standard programming languages. Application system portability is therefore possible. SQL does not yet specify an interactive interface, so ad hoc queries may or may not be portable. SQL has been widely implemented and is being significantly enhanced, as will be described later. NIST has developed an SQL test suite, which has been widely used by SQL vendors; a NIST test service will begin in April, 1990.

SQL

ISO/ANSI STANDARD: OCTOBER 1986

FEDERAL INFORMATION PROCESSING STANDARD: AUGUST 1987

PROVIDES PORTABILITY OF DATABASE DATA DEFINITION AND DATABASE APPLICATION PROGRAMS VIA STANDARDIZED DATA DEFINITION LANGUAGE (DDL), DATA MANIPULATION LANGUAGE (DML), AND BINDINGS TO STANDARD PROGRAMMING LANGUAGES COBOL, FORTRAN, AND PASCAL.

EXTENSIONS

- ADDENDUM1 FOR ENHANCED INTEGRITY CONSTRAINTS: 1989
- EMBEDDED SQL FOR ADA, COBOL, FORTRAN, PASCAL: 1989

SQL2

Two major enhancements to SQL are under development: SQL2 and SQL3. Both include the current SQL. SQL2 is currently expected to become an international and national standard in 1992. SQL2 is quite stable and has achieved very strong vendor support. It provides a standard language for dynamic creation and modification of schema elements as well as an "information schema" which could be used to obtain information about the structure of a database.

SQL2

ISO/ANSI STANDARD: FALL 1992

FEDERAL INFORMATION PROCESSING STANDARD: 1993

PROVIDE UPWARD COMPATIBLE ENHANCEMENTS TO SQL.

SCHEMA MANIPULATION LANGUAGE FOR DYNAMIC CREATION AND MODIFICATION OF SCHEMA ELEMENTS.

"INFORMATION SCHEMA" FOR RUN-TIME ACCESS TO SCHEMA INFORMATION

SQL2 (continued)

SQL2 also provides dynamic SQL, which could be used to formulate ad hoc queries. Functional enhancements include:

- outer join to specify how null fields should be interpreted when joining tables,
- integrity enhancement through the automatic propagation (i.e., cascade) of the results of updates and deletes,
- standard types for date and time,
- data type casting (i.e., type conversion), and
- the ability to construct and use temporary tables.

SQL2 (continued)

DYNAMIC SQL FOR RUN-TIME CREATION OF SQL STATEMENTS. VERY IMPORTANT FOR THIRD-PARTY SOFTWARE DEVELOPERS BUILDING FOURTH GENERATION TOOLS OVER AN SQL DATABASE.

FUNCTIONAL ENHANCEMENTS SUCH AS: OUTER JOIN, UPDATE AND DELETE CASCADE, DOMAINS, DATE AND TIME, CASE EXPRESSION, DATA TYPE CASTING, STRING OPERATIONS, TEMPORARY TABLES, AND GENERAL RELAXATION OF PREVIOUS LANGUAGE RESTRICTIONS.

NATIONAL CHARACTER STRINGS FOR THE INTERNATIONAL MARKET.

SQL3

SQL3 is much less well-defined than SQL2. It is likely to provide support for object-oriented databases, and could therefore support applications such as CAD/CAM. External procedure calls and user-defined data types would provide the basic capabilities for extending the relational model.

SQL3

ISO/ANSI STANDARD: 1995

FEDERAL INFORMATION PROCESSING STANDARD: 1996

WILL PROVIDE UPWARD COMPATIBLE ENHANCEMENTS TO THE SQL STANDARDS TO SUPPORT DATA ADMINISTRATION, KNOWLEDGE-BASE SYSTEMS, AND OBJECT-ORIENTED DATABASE, AS WELL AS INTEGRATION WITH GRAPHICS STANDARDS AND EXPERT SYSTEMS.

EXTERNAL PROCEDURE CALLS FOR INTEGRATION WITH EXTERNAL SYSTEMS.

USER-DEFINED DATA TYPES, INCLUDING OPERATIONS, TO SUPPORT OBJECT-ORIENTED DATABASES.

SQL3 (continued)

Generalization and specialization hierarchies would help support object-oriented databases. SQL3 may also provide support for data administration, including integration with the Information Resource Dictionary System (IRDS) standard to be described later. Asynchronous processing would enable a user to initiate and monitor a number of parallel operations, which would be extremely valuable in dealing with lengthy queries to many different remote databases.

SQL3 (continued)

GENERALIZATION AND SPECIALIZATION HIERARCHIES TO SUPPORT EXPANDED SCHEMA DEFINITION.

DATA ADMINISTRATION TOOLS AND BETTER INTEGRATION WITH IRDS STANDARDS.

ASYNCHRONOUS PROCESSING.

RECURSIVE QUERY EXPRESSIONS TO BETTER SUPPORT BILL-OF-MATERIALS APPLICATIONS.

Information Resource Dictionary System (IRDS)

The IRDS can be considered to be a value-added database of metadata; access control and such configuration management features as version control and the use of variations provide the added value. The IRDS may be used to manage metadata describing such information resources such as programs and hardware, as well as data structures. The IRDS national standard currently specifies two interfaces: a "panel interface" that specifies functionality, and a "command language" that also specifies a concrete syntax.

INFORMATION RESOURCE DICTIONARY SYSTEM (IRDS)

ANSI STANDARD: 1988

FEDERAL INFORMATION PROCESSING STANDARD: 1989

MANAGES A POTENTIALLY LARGE VOLUME OF COMPLEX METADATA TO FACILITATE PLANNING, DESIGN, AND DOCUMENTATION FOR IRM.

ACCESS CONTROL OF METADATA.

CONFIGURATION MANAGEMENT OF METADATA.

Information Resource Dictionary System (IRDS) (continued)

The IRDS is based on entities (i.e., nouns representing objects or concepts), relationships (i.e., verbs representing associations among entities), and attributes (i.e., adjectives representing properties of entities or adverbs representing properties of relationships). A key feature of the IRDS is extensibility, i.e., the ability to define new types of metadata. For example, a new entity type called "screen" could be defined; it could "display" certain data elements and "receive" other input data elements. Communication between an IRDS and other IRDSs, database management systems, Computer-Aided Systems Engineering (CASE) tools, and other software will be enhanced by the addition of the Services Interface, for transferring small chunks of metadata, such as the attributes of a data element; and the Export/Import File Format, for transferring large chunks, such as complete schemas. In particular, the Export/Import File Format could be used to ensure the consistency of definition among a set of IRDSs.

INFORMATION RESOURCE DICTIONARY SYSTEM (IRDS) (continued)

STANDARD SET OF ENTITIES, ATTRIBUTES, AND RELATIONSHIPS (SUCH AS PROGRAM, RECORD, AND ELEMENT) FOR IRM MODELING.

EXTENSIBILITY TO SUPPLEMENT OR MODIFY THAT STANDARD SET TO ACCOMMODATE ORGANIZATIONAL TERMINOLOGY OR SPECIAL REQUIREMENTS.

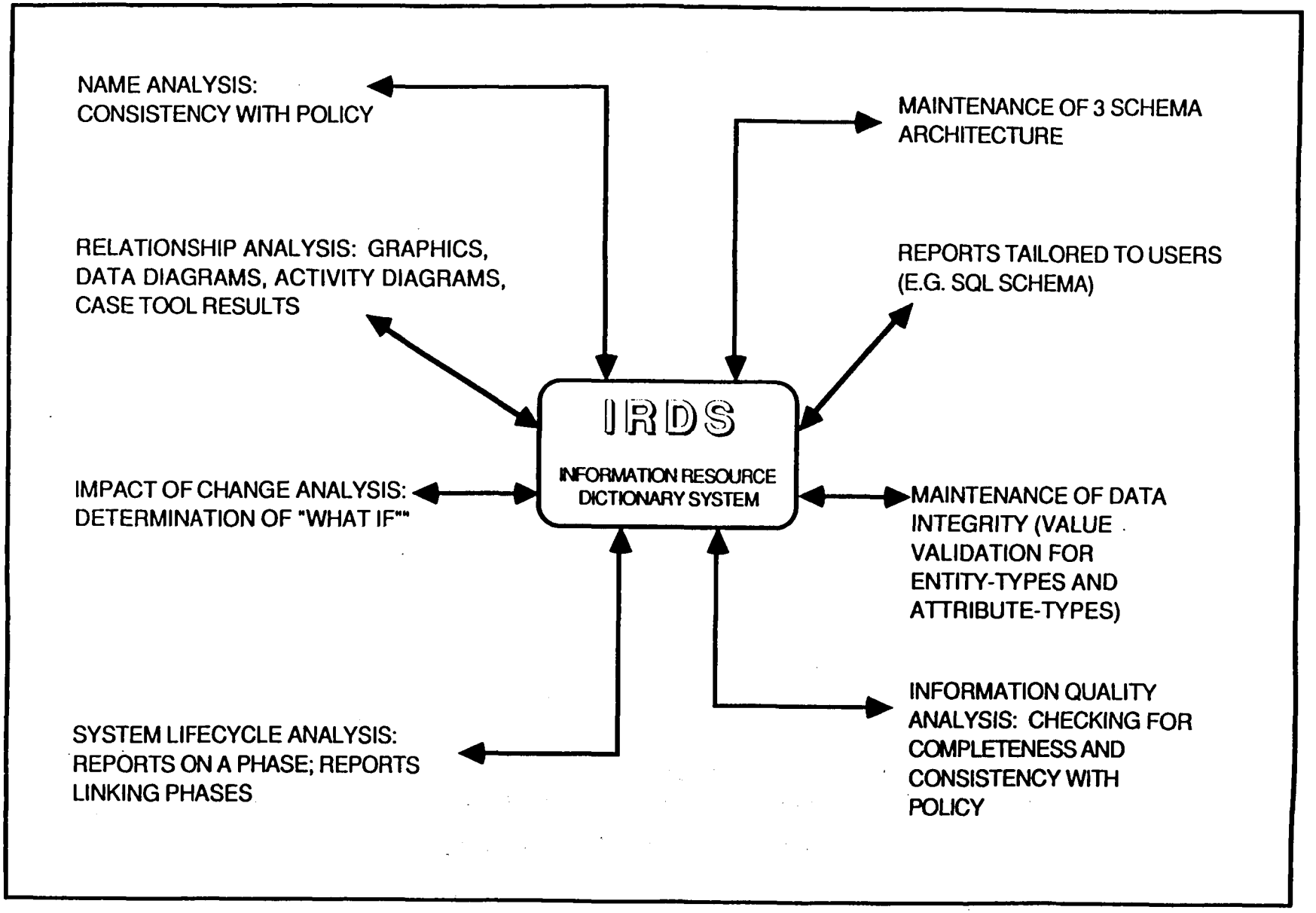
DICTIONARY WILL BE ACTIVE WITH ADDITION OF IRDS SERVICES INTERFACE: 1990

DICTIONARIES WILL COMMUNICATE VIA EXPORT/IMPORT FILE FORMAT: 1990

IRDS Functionality

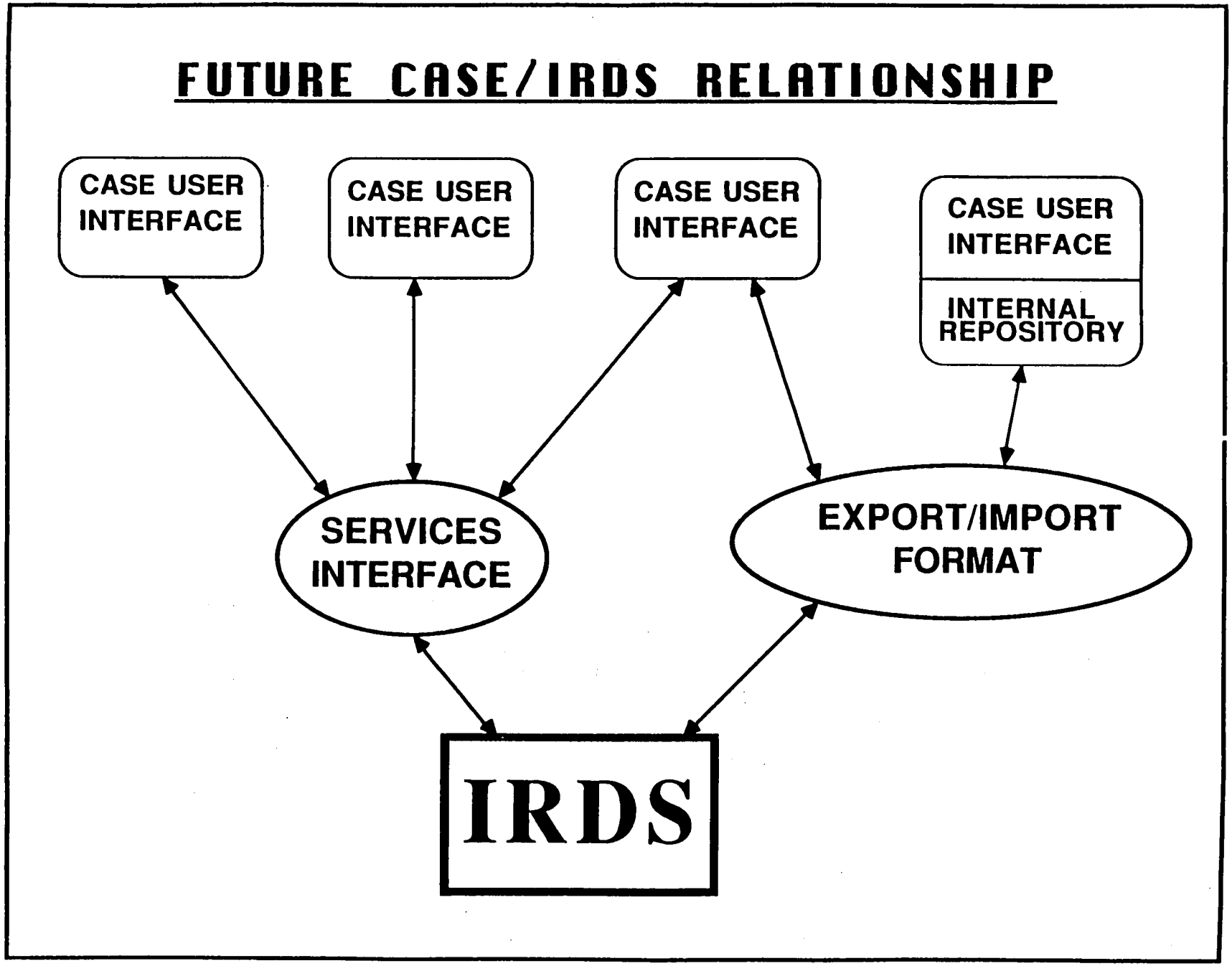
Examples of IRDS functionality include:

- a planned module to enforce data element naming conventions,
- metadata needed to drive a variety of graphically oriented CASE tools,
- a report on the effects of change, as, for example, what records, programs, etc. could be affected by a change in the size of the ZIP code,
- maintenance of a database architecture providing separate but interrelated definitions of the users' logical views of data, the physical representations of that data, and the consolidated enterprise view of that data, and
- maintenance of the data content rules that provide data integrity and conformance to the business rules.


NAME ANALYSIS:
CONSISTENCY WITH POLICY
MAINTENANCE OF 3 SCHEMA ARCHITECTURE
RELATIONSHIP ANALYSIS: GRAPHICS, DATA DIAGRAMS, ACTIVITY DIAGRAMS, CASE TOOL RESULTS
REPORTS TAILORED TO USERS (E.G. SQL SCHEMA)
IRDS
INFORMATION RESOURCE DICTIONARY SYSTEM
IMPACT OF CHANGE ANALYSIS: DETERMINATION OF "WHAT IF""
MAINTENANCE OF DATA INTEGRITY (VALUE VALIDATION FOR ENTITY-TYPES AND ATTRIBUTE-TYPES)
INFORMATION QUALITY ANALYSIS: CHECKING FOR COMPLETENESS AND CONSISTENCY WITH POLICY
SYSTEM LIFECYCLE ANALYSIS: REPORTS ON A PHASE; REPORTS LINKING PHASES

Future CASE/IRDS Relationship

In the future, the IRDS will provide a common source of metadata that can be used to link various CASE tools together.


FUTURE CASE/IRDS RELATIONSHIP
CASE USER INTERFACE
CASE USER INTERFACE
CASE USER INTERFACE
CASE USER INTERFACE
INTERNAL REPOSITORY
SERVICES INTERFACE
EXPORT/IMPORT FORMAT
IRDS

Remote Database Access (RDA)

The final database standard is Remote Database Access (RDA), which is expected to be an international and national standard in 1992. RDA will provide a standard means for sending an SQL statement to a specific remote site and receiving results and status. RDA provides only a basic capability for distributed database. It does not provide for transparent access to a data directory, nor for the decomposition of complex queries and updates, nor for the control of concurrent updates at multiple sites, nor for the recomposition of results of complex queries.

REMOTE DATABASE ACCESS (RDA)

ISO/ANSI STANDARD: 1992

FEDERAL INFORMATION PROCESSING STANDARD: 1992

WILL PROVIDE PROTOCOLS FOR REMOTE ACCESS TO DATABASES DISTRIBUTED OVER A COMMUNICATIONS NETWORK.

ASSOCIATION PROTOCOLS USING OPEN SYSTEMS INTERCONNECTION (OSI) STANDARDS.

REMOTE ACCESS ONLY - DOES NOT PROVIDE DISTRIBUTED ACCESS OR CONCURRENCY CONTROL. ONLY A FIRST STEP TOWARD TRUE DISTRIBUTED DATABASE.