CoSort Version 9.5

Big Data Manipulation

Software Overview, Interface Samples, Technical Specifications

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AN INTRODUCTION TO COSORT

Since 1978, CoSort has been meeting the growing data manipulation needs of companies with high-volume flat-file, database and data warehouse installations. CoSort is also a favored solution for legacy sort and data migrations to Unix and Windows. IRI has worked to make CoSort the most widely licensed commercial sort product on open systems, and is heavily focused on the development of related data manipulation technologies. CoSort is now a performance-enhancing solution for many applications, and a single-pass platform for large-scale:

- **Data Processing**
- **Data Presentation**
- **Data Protection**
- **Data Prototyping**

Data Processing

CoSort's Sort Control Language (SortCL) program can execute parallel data transformations to integrate, stage, and convert large data volumes. In just one I/O pass and job script, SortCL can:

select, sort/merge, join, lookup, convert data types and file formats, re-map/reformat, sequence, calculate, aggregate, manage sub-strings, scrub, encrypt, de-identify, and perform complex transforms

Sources and targets include compressed, flat and index files, pipes, tables via Open Database Connectivity (ODBC), and custom procedures.

Data Presentation

SortCL users can output the results of the above processes into one or more detail and summary reports. Users can combine joins, cross-calculations, hash lookups, and conditional selection to generate formatted reports and subsets for: billing operations, customer segmentation, change data capture, forensic data analysis, and business intelligence tools. Formatting may include special field and file layouts, headers and footers, page numbers, environment values, embedded HTML tags (for web posting), and the conversion of data into CSV or XML for dashboard use.

Data Protection

SortCL, and the spin-off data masking product (FieldShield), can secure sensitive data at the field level, based on business rules. Functions include 256-bit AES format-processing encryption and de-identification, and data masking techniques to anonymize, obfuscate, pseudonymize, or redact fields. Additional encryption or security functions are also available through custom field transforms. Securing data at the field level (during or after processing and presentation) is faster, and leaves non-sensitive file, disk and database data available.

Data Prototyping

SortCL, and the spin-off test data product (RowGen), can randomly create or select test field data and display it in real (production) file and report formats. You can create any number, type, and size of files, records and value ranges necessary to safely simulate reality and stress-test applications. Uses include database and ETL tool population, benchmarking, application development, and outsourcing.

COSORT APPLICATIONS

CoSort is a general-purpose, high-performance processor of sequential data in a variety of formats. It also serves as a migration platform for legacy sorts, files, and data types, and supports business intelligence, ETL, and data governance operations. CoSort reduces runtimes, risks, and complexity for a variety of IT stakeholders.

Job Function	CoSort Deliverables and Benefits
IT Manager	• Legacy sort software migration and modernization tools • Universal flat-file format, and data type, conversion capabilities • Detail and summary batch reporting with optional dashboard • Codes and runs faster than Perl, shell, SQL, ETL and COBOL jobs • Affordable price points and flexible licensing policies
DBA	• Parallel pre-sorts improve load, reorg and query performance • Combined sort, join, and aggregate transformations off-line • External batch and delta reports that are faster/easier than SQL • Flat-file lookups offer discrete, off-line, one-to-many solutions • Shared metadata with Fast Extract, FieldShield and RowGen
Data Warehouse (ETL) Designer	• Plug-in sort accelerators for DataStage and Informatica • Multi-threaded transformations in the file system for data staging • Complex selection and expression logic for data integration • Easy, open metadata and converters interface with existing tools • Integrated protection, custom transforms, and in/out procedures
BI Architect	• Large file aggregation and filtering franchises data for BI tools • Batch reporting with many formatting functions, including PCRE • Join, select, encrypt, and report for safe customer segmentation • Web log and IPA data handling facilitate click-stream analyses • Change data capture (delta) reporting using joins and selection
CISO, Data Governance, or Compliance Officer	• Field-level anonymization, de-id, encryption, pseudonymization • Protection functions can run within transform and reporting jobs • Query-ready XML audit log of job details help verify compliance • Quality and safety improvements for Master Data held in flat files • Support for 24 of 34 COBIT 4.0 control objectives
Application Developer (ISV)	• Thread-safe API libraries for embedded parallel sorts, transforms • Serial and parallel system calls to the SortCL program • Access to included encryption libraries protect real-time data flows • Built-in test data generation capabilities (“RowGen” functionality) • Affordable licensing, customized to individual business models

Figure 1 on the following page depicts the CoSort product flow diagram for fast, single-pass data manipulation.

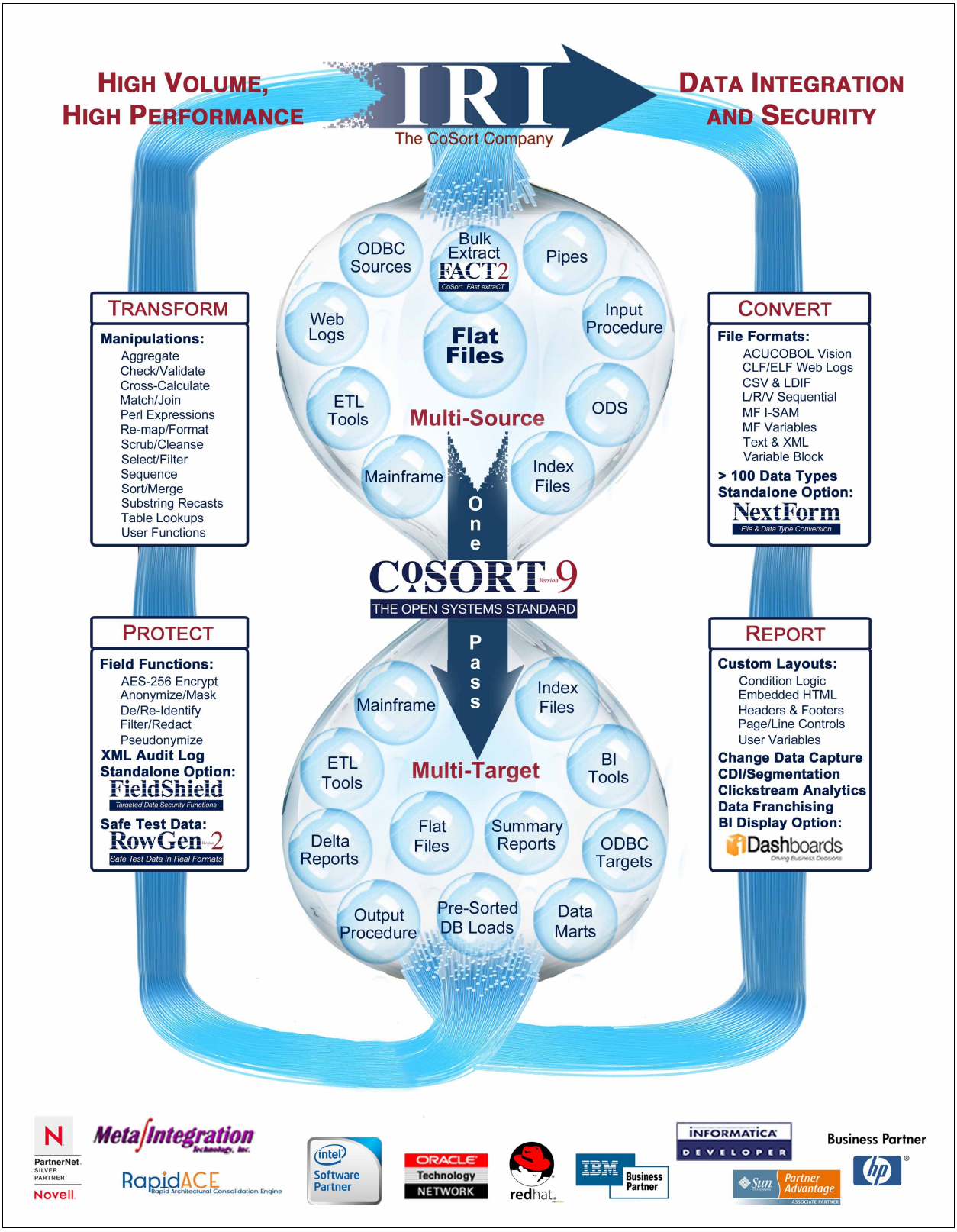


Figure 1 *Fast Single-Pass Data Manipulation*

COMPATIBLE APPLICATIONS

These other IRI tools create or leverage the metadata of CoSort's SortCL program:

Fast Extract (**FACT**)	Unloads large database tables to flat files in parallel for off-line archival, data transformation, reporting, migration, and reloads. FACT can work through metadata and pipes with CoSort's SortCL tool to perform fast reorg, replication, encryption, ETL, and BI operations, all in one I/O pass.
Data masking (**FieldShield**)	Protects personally identifying information and other sensitive data residing in ODBC-connected database tables or popular file formats using various techniques such as encryption, obfuscation of data, and pseudonymization.
Test Data (**RowGen**)	Creates safe test data in real file, report, and table formats for DB population, application development, benchmarking, etc. The same SortCL scripts used to process real data can be used to generate test data in the same formats.
Data Migration (**NextForm**)	Converts file formats and field data types for data, application, and platform migration projects.

The following are examples of third-party products with which IRI maintains various levels of compatibility to enhance their operational performance or personal data privacy:

Oracle	CoSort can source and target Oracle tables via ODBC or the file system (using FACT and SQL*Loader). On this data, CoSort can: • transform (sort, join, aggregate, reformat, etc.) • capture changed data (generate delta reports) • protect (column-level encryption, masking, etc.) • perform index pre-sorts (on the longest table key) By pre-sorting, CoSort can improves the speed and efficiency of SQL Loader operations, and thus reorgs and queries. Oracle index creation and queries work faster on large pre-CoSorted tables. With the space and time saved by offloading transforms and accelerating SQL Loader, DBAs can also create and maintain more tables -- in multiple query orders.
IBM DB2 UDB	CoSort can source and target Oracle tables via ODBC or the file system (using FACT and DB2 Load), to do the jobs above. The CoSort Load Accelerator for DB2 (CLA4DB2) speeds bulk loads.
IBM InfoSphere DataStage	CoSort's unique sort Stage plug-in for DataStage Server Edition can improve sort performance up to 10 times with no interface changes. Subsequent join, aggregation and load stages benefit. Alternatively, running CoSort's SortCL program in the sequential file stage can enhance DataStage sort, join, and aggregation goals by running large transforms in fewer, faster, external passes. In SortCL, these transforms can also be combined with conversion, reporting, field protection, and load functions at the same time.
Informatica PowerCenter	CoSort's unique custom transform (CT) for PowerCenter's sort seamlessly replaces the native SorterTx component to improve its performance. Subsequent join, aggregation and loads benefit. IRI recommends, however, performing "push out" optimization of large transformation jobs by allowing CoSort's SortCL program to perform them in the file system. This approach is more efficient than "push-down optimization" into Oracle (DB layer transforms) and far less expensive than Teradata, AbInitio, or DMExpress.

BI Dashboard

While CoSort's SortCL tool can simultaneously filter, transform, protect, and convert massive files, its reporting capabilities are two-dimensional. The next level of activity and sophistication in business intelligence is often the creation and customization of interactive dashboards.

Dashboards help you derive insight and knowledge from raw data, but they first require relevant data subsets in compatible formats like CSV and XML, since they are not designed to handle large, raw data volumes effectively. IRI has partnered with a leader in digital dashboard technology to feed data from CoSort's Sort Control Language (SortCL) program into state-of-the-art visual presentations.[1]

By combining high-volume data staging jobs with the iDashboard application, you can:

1) translate raw data into graphical business intelligence
2) integrate SortCL and other application outputs with ODBC sources
3) help unify and direct diverse departments to business goals and action
4) import and export Excel spreadsheet data and display preferences

iDashboard is very user friendly and uses patented "Visual Intelligence" technology. It allows you to customize your views using a library of chart types, including: tables, 3-D views, geographic maps, metric tickers, animated speedometers, and ad hoc data displays:

Figure 2 *iDashboard Interface*

Given iDashboard's ability to create insight and knowledge from raw data, the applications are as diverse as an organization's needs, for example:

- Balanced Scorecard
- Supply Chain Management
- Process and Quality Control
- Sales & Marketing Intelligence
- Facility Performance
- Project Management
- Market Research & Analysis
- Enterprise Resource Planning
- Financial Intelligence
- Executive Reporting
- IT Systems Monitoring
- Service Level Agreement

[1] IRI is a registered reseller of iDashboards™ technology, and as such, can offer a discounted bundle of this software along with, or separately from, CoSort licenses.

COSORT CONTENTS

The **CoSort** package contains standalone utilities, file layout metadata and sort parameter converters, third-party sort replacements, API libraries, and documentation.

The core **utility programs** in CoSort are:

- **SortCL –** a fourth-generation *sort control language* program for defining data and manipulations with syntax and semantics familiar to both mainframe sort and SQL users. The most comprehensive interface in the CoSort package, SortCL combines multi-file, multi-format data transformation functions (such as sorting, joining, aggregation and re-mapping) with reporting and field-level protections for: file compares and changed data capture, data type and file format conversions, data warehouse integration and staging (flat file ETL), business intelligence, delta and summary reporting, and compliance with data privacy regulations.
- **Sort –** a drop-in replacement for the Unix *sort* command that runs faster and scales linearly. It runs on all Unix and Windows (unixsort.exe) platforms.
- **SortI –** a user-friendly *sort interactive* session for simple sort/merge jobs. SortI offers context-sensitive help during the specification of ad hoc and batch jobs.

SortI and SortCL recognize environment variables and support pipes to allow data to flow between processes without additional I/O. SortI and SortCL may also be customized with user exits; such as procedures for special input, output, or comparison criteria. Usage instructions for each utility are in the user manual and man pages.

These **metadata converters** leverage your existing input and output layouts:

- **cob2ddf** translates COBOL copybook layouts to SortCL data definitions
- **csv2ddf** translates Microsoft **.csv** file headers to SortCL data definitions
- **ctl2ddf** translates Oracle SQL*Loader control file layouts to SortCL data definitions
- **elf2ddf** translates web logs in W3C "Extended Log Format" to SortCL data definitions
- **ldif2ddf** translates LDIF layouts to SortCL data definitions
- **xml2ddf** translates XML formats to SortCL data definitions
- **MIMB** (from MITI) translates many application file layouts to SortCL data definitions
- **odbc2ddf** converts database table layouts into a SortCL data definition file (.ddf).

These sort parameter conversion utilities facilitate legacy sort migrations:

- **mvs2scl** translates MVS JCL sort cards to SortCL job specifications
- **sorti2scl** translates SortI parameters to SortCL job specifications
- **vse2scl** translates VSE JCL sort cards to SortCL job specifications

CoSort Workbench, a graphical user interface (GUI) built on Eclipse, facilitates the specification, execution, tuning and maintenance of SortCL job scripts through job creation and metadata definition wizards, a dynamic job outline, and a syntax-aware editor for manual SortCL specification.

The CoSort Workbench also provides database data access, viewing, and integration into SortCL jobs, and includes extensions for team contributions, job version control, and remote system data sourcing.

The following third-party **sort replacements** are available with the CoSort package:

- **acu-cosort –** a drop-in replacement for the sort verbs supplied with ACUCOBOL-GT
- **cla4db2 –** the "CoSort Load Accelerator for DB2" replaces IBM's sort routine within the UDB 5-8 loader, as much as doubling throughput on Unix
- **mf-cosort –** a drop-in replacement for the sort verbs supplied with Micro Focus Net Express, Server Express, and Workbench on Unix and Windows. COBOL users can link statically or dynamically to mfcosort and the CoSort engine to accelerate sort speed and reduce temporary sort space in new executables or a full RTS
- **nat-sort –** a drop-in replacement for the sort verb in Software AG Natural
- **proc-sort –** SAS System 7-9 users can link dynamically to shared cosort() libraries to replace the sort function in SAS on Unix systems
- **Sorter Tx CT –** a drop-in custom transform for the sort in Informatica PowerCenter
- **Sort PlugIn–** a drop-in replacement for the IBM Infosphere DataStage SE sort.

CoSort provides similar drop-in sort replacement facilities for Tetrad OPX, and the UniKix Mainframe Batch Manager. CoSort hooks are also available for The ETI Solution, Kalido's Dynamic Information Warehouse, and IDS Korea's TeraStream ETL suite.

For developer and Independent Software Vendor (ISV) use, CoSort also includes two Application Programming Interface (API) libraries.

- **cosort_r() –** A thread-safe version of the original cosort() API that allows multiple coroutine sort/merge operations to occur in the same pass through the data. The coroutine engine allows in-memory record transfers between programs and the sort.
- **sortcl_routine() –** The thread-safe SortCL library that allows programmers to exploit the full range of CoSort Sort Control Language commands within their own programs.

CoSort APIs let you define any input (selection), compare (order sequence), or output (reporting) criteria, enabling applications to accomplish complex jobs in one I/O pass. You can write calls to either library in any language that can link to a C library, such as C++, COBOL, VB, Java, etc.

Finally, the CoSort package also includes the following **documentation**:

- **Installation Guide –** platform-specific loading, licensing, and tuning advice
- **Manual –** full user and programmer documentation for all the above interfaces
- **man pages –** in original .man format, as well as .cat and .help versions for Unix and Windows systems, respectively
- **Job Examples** – sample SortCL job scripts, metadata conversions, and API calls

SORT CONTROL LANGUAGE PROGRAM (SORTCL)

Well beyond traditional sort/merge operations, **CoSort** provides a broad range of flat-file manipulation and management functions for data warehousing, legacy migration, and business intelligence projects through its fourth-generation Sort Control Language (SortCL) program. SortCL is a language, program, tool and library that allows end-users and developers alike to:

Filter	At the byte, field and record level
Segment	Conditional (include/omit) selection
Sort	Multiple keys, directions, sequences
Merge	Pre-sorted files
Join	Un/sorted files over many conditions
Re-map	Resize, reposition, and realign fields
Convert	Change data types (for example, EBCDIC↔ASCII, Packed↔Numeric)
Re-format / Interchange	Convert between file formats (for example, Text↔XML, VS↔RS, Micro Focus ISAM↔Acucobol Vision, LDIF↔CSV, MFVL↔Text)
Aggregate	Parallel roll-up and drill-down sum, min, max, average, and count values. Accumulation. Ranking.
Calculate	Expressions and functions across detail and summary rows
Sub-string	Perl-compatible regular expression (PCRE) logic for pattern matching and other intra-field manipulations
Validate	Check and realign characters to specifications (for example, "isdigit")
Sequence	For indexing and loading operations
Lookup	Discrete field substitutions, pseudonymization, etc. using "SET" file field dimensions
Protect	Encrypt data at the field level and audit data security measures, plus anonymization, de-identification, filtering, pseudonymization
Report	Custom-formatted, segmented detail, delta, and summary targets
Transform	Custom field-level user functions (for example, data quality libraries)
Log	XML audit trail records job specs for compliance verification, etc.

SortCL also provides for *all in one job script and I/O pass* through multiple data sources and targets.[2]

By running multiple data manipulations at once, you can use SortCL to:

- Replace slower 3GL, shell, Perl and SQL procedures
- Transform high volumes outside BI, DB and ETL tools
- Relieve application and system overhead
- Filter, integrate, and stage large data volumes
- Generate custom reports and hand-offs
- Accelerate bulk database reorgs and loads
- Detect, capture, and audit changed data
- Combine data privacy with transformation and reporting

[2] With IRI's Fast Extract (FACT) unload tool, bulk input can also come directly from RDBMS tables.

SortCL uses a self-documenting Data Definition Language (DDL) and Data Manipulation Language (DML) syntax that is familiar to both mainframe sort and SQL users. By supporting the separation of data definition and manipulation statements, SortCL supports the use of shared metadata, and the independence of data from applications.

SortCL job scripts can be invoked from: the command line, the CoSort Workbench, a batch processing stream, or the thread-safe SortCL API (sortcl_routine).

Application-level statistics can be output with each job, either to the screen or a file. In addition, the CoSort job log runs in a self-appending file, and debugging information in a self-replacing file. On-screen monitoring optio
ns are available at various verbosity levels for runtime progress assessment. You can also enable and secure an XML audit trail for validating compliance and performing forensic application and data analyses.

Users converting from legacy sort products can leverage CoSort's metadata conversion tools and services to ease job script migrations to SortCL. See METADATA CONVERSION TOOLS.

SortCL Operations

One of the most basic SortCL scripts that you can write contains only an infile and an outfile, as in the following:

```
/infile=accts695
/outfile=accts695.new
```

This re-orders the accounts695 file from left to right without reformatting.

SortCL processes data in three phases -- input, action (processing), and output. In the input phase, source records are processed with selection. Actions are sort, merge, join, report, or check. In the output phase, selected records are remapped to one or more targets simultaneously. Derived fields and multiple formats can be defined in the same file. A special "inrec" section is defined when a virtual record layout is needed for processing input sources that are formatted differently.

However, SortCL also has the ability perform and combine many more data transformations, as well as protect data at risk, and produce formatted reports, all at the same time. Through the use of metadata repositories -- SortCL data definition files – you can define and share any structured data subset, or relational view, in SortCL job specification files. Those file layouts can be re-used in many applications.

SortCL Application Sample #1 – Sort and Reformat, Metadata Repository

This SortCL job is a simple two-key sort job. A single, flat input file is specified directly in the script. In addition to re-ordering the data, this script will convert the file layout from a pipe-delimited format to fixed position fields. Notice, however, that the fixed output field definitions are stored in this reusable SortCL "data definition file" metadata repository:

Data Definition file "chiefs.ddf"

```
/FIELD=(president,POS=1,SIZE=22)
/FIELD=(service,POS=25,SIZE=9)
/FIELD=(state,POS=40,SIZE=2)
/FIELD=(party,POS=45,SIZE=3)
```

Input file 1, "chiefs_10_sep"

```
Eisenhower, Dwight D.|134|1953-1961|REP|
TX
Kennedy, John F.|135|1961-1963|DEM|MA
Johnson, Lyndon B.|136|1963-1969|DEM|TX
Nixon, Richard M.|137|1969-1973|REP|CA
Ford, Gerald R.|138|1973-1977|REP|NE
Carter, James E.|139|1977-1981|DEM|GA
Reagan, Ronald W.|140|1981-1989|REP|IL
Bush, George H.W.|141|1989-1993|REP|TX
Clinton, William J.|142|1993-2001|DEM|AR
Bush, George W.|123|2001-2009|REP|TX
```

```
### CoSort SortCL Job Specification ###
### example1.scl Copyright 2011 IRI ###

### Input Phase ###
/INFILE=chiefs_10_sep
      /FIELD=(president,POS=1,SEP='|')
      /FIELD=(votes,POS=2,SEP='|')
      /FIELD=(service,POS=3,SEP='|')
      /FIELD=(party,POS=4,SEP='|')
      /FIELD=(state,POS=5,SEP='|')

### Action Phase ###
/SORT
      /KEY=party
      /KEY=president

### Output Phase ###
/OUTFILE=chiefs.out
        /SPEC=chiefs.ddf      # metadata
```

*As shown above, the job script on the right uses explicit layouts for the input, but relies on the metadata file, **chiefs.ddf**, for the output layout. By centralizing the metadata, it can be used in other SortCL job scripts.*

SortCL job scripts are typically run from a batch script, with a command entry similar to:

```
$COSORT_HOME/bin/sortcl /spec=/path2/example1.scl
```

Output file 1, "chiefs.out"

```
Carter, James E.        1977-1981      GA   DEM
Clinton, William J.     1993-2001      AR   DEM
Johnson, Lyndon B.      1963-1969      TX   DEM
Kennedy, John F.        1961-1963      MA   DEM
Bush, George H.W.       1989-1993      TX   REP
Bush, George W.         2001-2009      TX   REP
Eisenhower, Dwight D.   1953-1961      TX   REP
Ford, Gerald R.         1973-1977      NE   REP
Nixon, Richard M.       1969-1973      CA   REP
Reagan, Ronald W.       1981-1989      IL   REP
```

The input file, **chiefs_10_sep** is now in order by party and president, and displayed according to the fixed position layout specified in **chiefs.ddf**. Notice that the second input field, *votes*, was not in the output file specification, and that the state and party field were transposed. By mapping using symbolic field name references, SortCL gives you field level control of all of your output targets, as the following examples will further demonstrate.

SortCL Application Sample #2 – Data Transformation and Protection

This SortCL job is an example of a single-key sort. The fields are defined in the input phase, the sort key in the action phase, and then, in the output phase a series of target files are defined in different formats for different departmental purposes. Notice how individual fields are protected according to different business rules, or role based access controls (RBAC).

The input file below was generated with IRI's RowGen tool to create realistic transaction data. Note that any number of sources can be input and that these input sources can have any number of formats. The input sources can be files, pipes, and/or procedures. Data integration of this kind was not demonstrated for the sake of simplicity.

Input file, "seqdata"

```
01 330170363 Stuart Clay           0056681.42 6 cT 101 B St              B
02 421901269 Taylor Guerrero       0015019.10 9 MD 1031 Park Ln Apt D    A
03 529433545 Charles Caldwell      0041116.71 3 NY 14 Main St            A
04 129737773 Robyn Puckett         0044558.62 3 ny 822 Hwy 76            B
05 594521240 Santiago Lindsey      0055836.11 0 TX Star Rt Box 822       A
06 796569799 Charles Lindsey       0098525.58 2 TX 12746 Wolf Circle     A
07 384127387 Santiago Puckett      0059036.80 4 NY 321 Baltic Ct         B
08 711604065 Charles Williams      0018645.95 1 Tx 1103 Fresh Creek Ln   A
09 343054521 Jack Velazquez        0029205.44 2 NY 6780 Sand Dr Apt 3A   B
10 148354977 Donald Cooke          0044121.44 4 MA 35 La Palma Dr        A
```

The job script below produces several output files in the same job script and I/O pass, which includes all 10 records from the above input files (though filters could have been applied).

```
### CoSort v9.5.1  Copyright 2011 IRI, Inc.###
### Sort Control Language (SortCL) Program ###


### Job Controls Phase ###
# Load encryption library for integrated protection
/LIBRARY="C:\IRI\CoSort95\lib\libcscrypt.dll"


### Input Phase ###
/INFILE=(seqdata)                    # Reads 1 input file
   /FIELD=(idnum,POS=1,SIZE=2)       # Unique record identifier tag
   /FIELD=(ssno,POS=4,SIZE=9)
# Overdefines the social security number into parts for obfuscation
    /FIELD=(ssno_part1,POS=4,SIZE=1)
    /FIELD=(ssno_part2,POS=5,SIZE=4,NUMERIC)
    /FIELD=(ssno_part3,POS=9,SIZE=4,NUMERIC)
    /FIELD=(name,POS=14,SIZE=20)
# Defines the last name letter field for conditional selection
    /FIELD=(last_name_letter,SEP=' ',POS=4,SIZE=1)
    /FIELD=(salary,POS=36,SIZE=10,NUMERIC)
    /FIELD=(salary2,POS=36,SIZE=10) # Redefined as ASCII for encryption
    /FIELD=(deduction_no,POS=47,SIZE=1)
    /FIELD=(state,POS=49,SIZE=2)
    /FIELD=(address,POS=52,SIZE=20)
    /FIELD=(group_code,POS=75,SIZE=1)
    /FIELD=(wholerec,POS=1,SIZE=71) # Define a field to be the entire record


### Action Phase ###
/SORT
    /KEY=(group_code)                # Sort on code field for aggregation
    /KEY=(salary)                   # Sort on salary field
```

```
### Output Phase ###
/OUTFILE=testdata       # First Output File. Obfuscates data, preserves format
    /FIELD=(idnum,POS=1,SIZE=2.0,FILL='0',NUMERIC)
    /FIELD=(ssno_part1,POS=4,SIZE=1)
# Obfuscate the next 4 digits through conditional cross-calculation
    /FIELD=(ssno_part2_new,POS=5,SIZE=4.0,FILL='0',NUMERIC,\
            IF ssno_part2 GT 4500 THEN ssno_part2 / 2 ELSE 2 * ssno_part2 - 55)
# Obfuscate the final 4 digits
    /FIELD=(ssno_part3_new,POS=9,SIZE=4.0,FILL='0',NUMERIC,\
            IF ssno_part3 GT 4500 THEN ssno_part3 / 2 ELSE 2 * ssno_part3 - 54)
# Create pseudonym of the real name using the lookup table pseudo.set
    /FIELD=(name_fake,POS=14,SIZE=20,SET=pseudo.set[name])
# Make the salaries anonymous using conditional cross-calculation
    /FIELD=(salary_new,POS=35,SIZE=10.2,NUMERIC, \
            IF salary GT 50000.00 THEN 0.85 * salary ELSE 1.15 * salary)
    /FIELD=(deduction_no,POS=46,SIZE=1)
    /FIELD=(state,POS=48,SIZE=2)
    /DATA=" "
    /DATA={20}"*"                       # Masks address data with asterisks

/OUTFILE=aggregate_salaries_by_group    # Summary record format
    /FIELD=(total_salary,POS=51,SIZE=12,CURRENCY)
    /SUM total_salary FROM salary BREAK group_code
/OUTFILE=aggregate_salaries_by_group    # Detail record format
    /FIELD=(group_code,POS=1,SIZE=1)
    /FIELD=(name,POS=3,SIZE=20)
    /FIELD=(address,POS=25,SIZE=20)
    /FIELD=(TOUPPER(state),POS=47,SIZE=2) # Capitalization function
    /FIELD=(salary,POS=51,SIZE=12,CURRENCY)

/OUTFILE=salaries_de_id
# De-identify fields using bit manipulation function (to preserve field size)
    /FIELD=(idnum,POS=1,SIZE=2.0,FILL='0',NUMERIC)
    /FIELD=(de_identify(salary,"abc"),POS=6,SIZE=10,NUMERIC)
    /FIELD=(TOUPPER(state),POS=20,SIZE=2)

/OUTFILE=encrypt_all
    /FIELD=(encryptAES256(wholerec),POS=1) # Default key phrase used

/OUTFILE=encrypt_2fields
                # Encrypt 2 fields, each with a different key phrase
                # To determine the size of the encrypted output field:
                # Increase field size to next multiple of 16 and divide by 3
                # Round up to the next whole number and multiply by 4
    /FIELD=(encryptAES256(ssno,"passphr1"),POS=1,SIZE=24)
    /FIELD=(name,POS=26,SIZE=20)
    /FIELD=(encryptAES256(salary2,"passphr2"),POS=47,SIZE=24)
    /FIELD=(TOUPPER(state),POS=73,SIZE=2)

/OUTFILE=report.csv
    /PROCESS=CSV                        # Creates header from fieldnames
    /FIELD=(idnum,POS=1,SEP=',',FRAME='"')
    /FIELD=(ssno,POS=2,SEP=',',FRAME='"')
    /FIELD=(name,POS=3,SEP=',',FRAME='"')
    /FIELD=(salary,POS=4,SEP=',',FRAME='"')
    /FIELD=(deduction_no,POS=5,SEP=',',FRAME='"')
    /FIELD=(state,POS=6,SEP=',',FRAME='"')
    /FIELD=(address,POS=7,SEP=',',FRAME='"')
    /FIELD=(group_code,POS=8,SEP=',',FRAME='"')
```

This job script turns the two input files into six output files, all in one I/O pass. Many more inputs or outputs, of any size and format, could have been specified, and conditional selection criteria could have be applied against any source or target. A number of additional field level transformation functions could also have been specified. For a more complete list of available data manipulation functions that can be performed in SortCL, see the TECHNICAL SPECIFICATIONS chapter.

Outputs from the sample above follow, along with explanations of each.

Output file 1, "testdata"

```
02 443252484 Clifton Jimenez        17271.97 9 MD ********************
08 722658076 Jeffery Gomez          21442.84 1 Tx ********************
03 558317036 Teddy Black            47284.22 3 NY ********************
10 124182488 Julio Koch             50739.66 4 MA ********************
05 547262426 Spencer Craig          47460.69 0 TX ********************
06 748284900 Landen Sullivan        83746.74 2 TX ********************
09 385552260 Francisco Duffy        33586.26 2 NY ********************
04 158913886 Salvador Jacobson      51242.41 3 ny ********************
01 359790672 Ramsey Flynn           48179.21 6 cT ********************
07 342063694 Alvaro Mcleod          50181.28 4 NY ********************
```

This file shows safe, protected results in the form of similarly formatted test data. The data are sorted on group_code and then salary prior to the salary being protected; therefore, the salary order will not appear to be ordered. Note that the social security numbers were obfuscated with expression logic defined in 2 lines of the SortCL script Part 2 is shown below:

```
/FIELD=(ssno_part2_new,POS=5,SIZE=4.0,FILL='0',NUMERIC,     \
        IF ssno_part2 GT 4500 THEN ssno_part2 / 2           \
        ELSE 2 * ssno_part2 - 55)
```

and that names were de-identified with pseudonyms in a look-up table called pseudo.set:

```
/FIELD=(name_fake,POS=14,SIZE=20,SET=pseudo.set[name])
```

SET file, "pseudo.set"

```
Charles Caldwell    Teddy Black
Charles Lindsey     Landen Sullivan
Charles Williams    Jeffery Gomez
Donald Cooke Julio Koch
Jack Velazquez      Francisco Duffy
Robyn PuckettSalvador Jacobson
Santiago Lindsey    Spencer Craig
Santiago Puckett    Alvaro Mcleod
Stuart Clay         Ramsey Flynn
Taylor Guerrero     Clifton Jimenez
/default/
```

In the above set file, the 'real name' Charles Caldwell is identified with the 'fake name' Teddy Black, and so on. A tab character separates the two names in the lookup table.

Output salaries were anonymized with math functions (which caused the appearance of disorder in that field). The TOUPPER syntax applied in the state field converted the input values to all upper case letters on output; this is one of several built-in data quality functions. Finally, the last three input fields were redacted and masked with asterisks.

At the same time, this output file (with protected real data) was also produced:

Output file 2, "aggregate_salaries_by_group"

```
A Taylor Guerrero       1031 Park Ln Apt D    MD    $15,019.10
A Charles Williams      1103 Fresh Creek Ln   TX    $18,645.95
A Charles Caldwell      14 Main St            NY    $41,116.71
A Donald Cooke          35 La Palma Dr        MA    $44,121.44
A Santiago Lindsey      Star Rt Box 822       TX    $55,836.11
A Charles Lindsey       12746 Wolf Circle     TX    $98,525.58
                                                  $273,264.89
B Jack Velazquez        6780 Sand Dr Apt 3A   NY    $29,205.44
B Robyn Puckett         822 Hwy 76            NY    $44,558.62
B Stuart Clay           101 B St              CT    $56,681.42
B Santiago Puckett      321 Baltic Ct         NY    $59,036.80
                                                  $189,482.28
```

This is a detail and summary report, grouping records by their group code (A or B). Two same-named /OUTFILE sections were used: one to define the format of the detail records, and the other for the summary information. The group totals were derived with this syntax:

```
/SUM total_salary FROM salary BREAK group_code
```

Output file 3, "salaries_de_id"

```
02   335735<253    MD
08   335:9872<7    TX
03   33855592;5    NY
10   3388545288    MA
05   3377:69255    TX
06   33<:74727:    TX
09   334<437288    NY
04   338877:294    NY
01   33799:5284    CT
07   337<3692:3    NY
```

This third output file contains the same information, but without the header record. Salaries have been de-identified with an internal bit manipulation function using the pass code 'abc' (which creates the bit manipulation parameters). This method is akin to, but less secure than, encryption, but preserves the field size.

Output file 4, "encrypt_all"

```
lS7t5h+/s3sUbOs+42pYtkTau2K4kzZMOB4CrvE5QSJes2kvxrYIiWtg3y4VWYT7qIoc/rYwELAux4Gh3Cg9EoWf68OdPh+ATqOJ4xE6/T4=
Xh2nImJY4hBLfwWIDGeR1d0hNCC4Fbtz1UICR31wgr7rQo7byO1fVFGw5mwh+GSbh5OM7icopQ84lNVnODVuw6QpqLJCIpwkrYyjO0wvDFg=
twoxGCkGxWn76wrnHlBMX7V1AdRAqXne1123i30ljkMhbWkf+K9E6JZ/iJtHElPi90bgeqGJyaXcMRMRHlcQkdV/wLAXJJ2b1N16Sz/A8uQ=
O1v4mpIxb+D+egm3MbovHPi1hnlMI67Kmdza38JvfIjEw5/tXLbFC4GllUK1eaaNDYdRuJw8CcV1wf05nJ1wQU5UmXmP8uIqeHW41tFK2Xo=
b7B4w8SWnGaM7gXFC6pGAu1qOwp3aX8vFTkRSmUF57hFLQ9IxmLjd7nqDQKMgPg9SVBvlcB4Jsk13TIL6NKM5J0TCKYIH38aVfcw6cG+LuA=
usnCrehsH109zkzDdCYJnfkTp35IjdgA+p4JXZAF3W4uPlqhieH4fKg5zLxYZPtfA1ThT4oWxNCV9Yb/Ey4m/oTM8CaqFderHAqRQJiqj5c=
e0DUXvL1/axHuLzgxPaCG0w/IT1QKcypks3al9hXCCHGh29yegi3Tp+9/nVGaWxVn/UFBYvuiVOJB1hw9RQuzmJMDsuEnr6zGbpl4gvzrCA=
ysO8dAWoGb2soHkp+W1pML7B2MXR8i5kKjzcHjCnxEqoU5Dtd/GXToy1fuM0CrJfmz3F/oRnlw6YhVlvAc46X+Cr033y0y5eCIrATGFqGkI=
Pe8gYs51/3z9eQrxobmMo/FHI0c1QboyNylmtWdWBa4/UekwCssPRnvYh8J17y4PrmE9V94WPTZ3RrL7rijQdz8WzS8ES1taZ/MpVaUJ0Gk=
LR5H66hXx7YtaaNSJRCiwmC2Hssc6YA3VAhSRtUQDWTkF/+vxonCrpR6tP87LphMB/k3hKUD5rxuaJkCLrugfZhD3XiLGDxnuryfOXhPeJo=
```

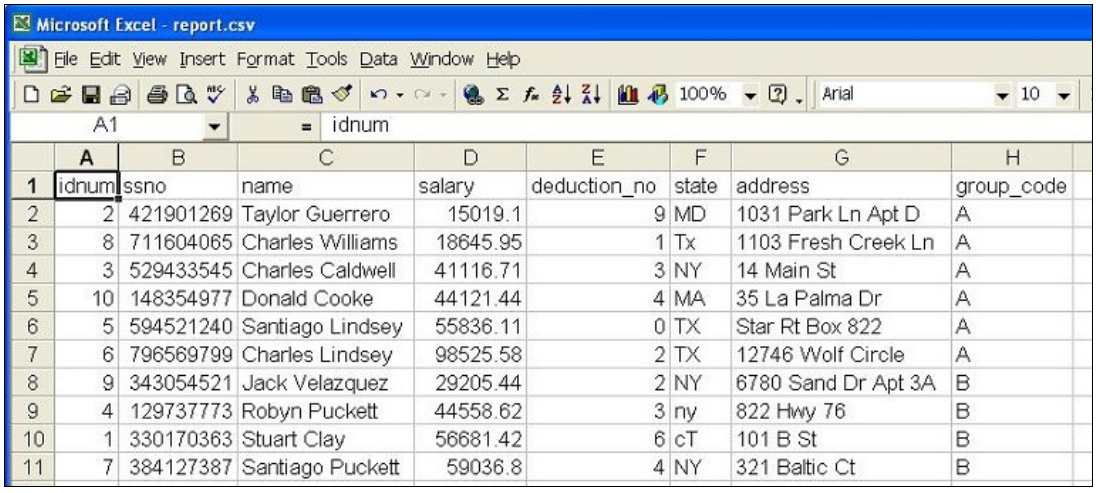
Here, the entire record was declared as a field and encrypted. You may have noticed that the encrypted "ciphertext" results contain only printable ASCII characters for printing and inclusion in text files.

Output file 5, "encrypt_two_fields"

```
bUWn/CrhAql4MXNxoy7OkA== Taylor Guerrero      2iyseYtWEd3ESFwE91433Q==  MD
8XvhrNe7ecF2DKFZyP4cNw== Charles Williams     SK8auRS56YxRWMtLTXEGtg==  TX
pHxUwHhkcXW06JEhoDIlJg== Charles Caldwell     bCz/W5bEpDpA2KJYDi3xvQ==  NY
sAol8DlsqS2viXEMPHullQ== Donald Cooke         kpCZLODnoWFht50aH7u2LQ==  MA
eGoUczVoZEm95/9eBD8iOQ== Santiago Lindsey     8inKXdYDU4AH9tJx8xlPAg==  TX
AJJEKjJuJQErVR726ytkZg== Charles Lindsey      Vzm4/kcz/ypUNfWJjBBrcA==  TX
2KcftKVKDv+OCaG/FFdJ6w== Jack Velazquez       m8MIpOmfPqxtNsO69cV0Mg==  NY
QMCKCxi32a9ZL3cYuBwHew== Robyn Puckett        qwn2T7pUF/Hu+YPQBThcwg==  NY
CcxB9LuMkdAJ0E3rhwDIuA== Stuart Clay          Q/bc3I756EPqn3TAYcqOUA==  CT
RQVeipLI4xlzvwzskHTE0Q== Santiago Puckett     9i1fjr3CQs0yjuKV/tVCEw==  NY
```

The fifth output file, shown above, encrypts the social security number (SSN) and salary fields, but with two different pass phrases so the data is protected for different disclosures.

Output file 6, "report.csv"



	A	B	C	D	E	F	G	H
1	idnum	ssno	name	salary	deduction_no	state	address	group_code
2	2	421901269	Taylor Guerrero	15019.1	9	MD	1031 Park Ln Apt D	A
3	8	711604065	Charles Williams	18645.95	1	Tx	1103 Fresh Creek Ln	A
4	3	529433545	Charles Caldwell	41116.71	3	NY	14 Main St	A
5	10	148354977	Donald Cooke	44121.44	4	MA	35 La Palma Dr	A
6	5	594521240	Santiago Lindsey	55836.11	0	TX	Star Rt Box 822	A
7	6	796569799	Charles Lindsey	98525.58	2	TX	12746 Wolf Circle	A
8	9	343054521	Jack Velazquez	29205.44	2	NY	6780 Sand Dr Apt 3A	B
9	4	129737773	Robyn Puckett	44558.62	3	ny	822 Hwy 76	B
10	1	330170363	Stuart Clay	56681.42	6	cT	101 B St	B
11	7	384127387	Santiago Puckett	59036.8	4	NY	321 Baltic Ct	B

The last output file above, viewed in a spreadsheet, shows how specifying /PROCESS=CSV on output automatically adds a header record with the output field names. The conversion of the source records to a comma-separated framework (including the addition of the header record) allowed the output target to be read by Excel without additional processing.

SortCL Application Sample #3 – Alpha-Numeric Format-Preserving Encryption

This example uses personal information data, **personal_info**, including credit card numbers, driver's license numbers, and names.

```
9654-4338-8732-8128     W389-324-33-473-Q     Jessica Steffani
2312-7218-4829-0111     H583-832-87-178-P     Cody Blagg
8940-8391-9147-8291     E372-273-92-893-G     Jacob Blagg
6438-8932-2284-6262     L556-731-91-842-J     Just Rushlo
8291-7381-8291-7489     G803-389-53-934-J     Maria Sheldon
7828-8391-7737-0822     K991-892-02-578-O     Keenan Ross
7834-5445-7823-7843     F894-895-10-215-N     Francesca Leonie
8383-9745-1230-4820     M352-811-49-765-N     Nadia Elyse
3129-3648-3589-0848     S891-915-48-653-E     Gordon Cade
0583-7290-7492-8375     Z538-482-61-543-M     Hanna Fay
```

The following SortCL script encrypts the credit card and driver's license number fields, while preserving the field formats.

```
### CoSort v9.5  Copyright 2011 IRI, Inc.###
### Sort Control Language (SortCL) Program ###


### Job Controls Phase ###
# Load encryption library for integrated protection
/LIBRARY="C:\IRI\CoSort95\lib\libcscrypt.dll"


### Input Phase ###
/INFILE=personal_info     # Reads 1 input file
   /FIELD=(credit_card,POS=1,SEP='\t')
   /FIELD=(driv_lic,POS=2,SEP='\t')
   /FIELD=(name,POS=3,SEP='\t')

### Action Phase ###
/REPORT

### Output Phase ###
/OUTFILE=personal_info_encrypted
      /FIELD=(credit_card1=FPE_ALPHANUM(credit_card,"pass"),POS=1,SEP='\t')
      /FIELD=(driv_lic1=FPE_ALPHANUM(driv_lic,"pass"),POS=2,SEP='\t')
      /FIELD=(name,POS=3,SEP='\t')
```

This produces **personal_info_encrypted**:

```
0832-9678-1911-0645     R784-107-86-619-Q     Jessica Steffani
0835-7171-0577-5699     G156-454-45-303-O     Cody Blagg
0789-2128-0461-5374     Q305-118-71-384-Q     Jacob Blagg
1591-0561-0417-5772     D344-156-20-555-G     Just Rushlo
9296-9613-4710-5436     U751-860-67-075-Y     Maria Sheldon
9881-4436-0773-0973     X878-716-85-252-C     Keenan Ross
4594-9802-2566-4840     T273-579-67-063-M     Francesca Leonie
6514-3079-6147-6828     A617-849-83-864-X     Nadia Elyse
9221-6125-6496-9606     S039-406-12-369-U     Gordon Cade
1404-8512-8389-2619     K379-587-05-591-C     Hanna Fay
```

SortCL Application Sample #4 – Data Transformation and Reporting

This example uses stock trading data. It performs a full outer join of two differently formatted input files to produce three differently formatted targets. The script includes cross-calculation, aggregation, selection, and markup tags for BI, data interchange, and web posting purposes.

It is important to remember that the input and output files samples shown are small so they can easily illustrate combinable functionality, not performance. The major benefit of SortCL, in addition to task consolidation, is the ability to churn through many, *massive* input files together.

In this example, the input files to be joined are unsorted. The first, **nyse-a**, is in tab-delimited format and could have been exported from a Sybase table. The second input file, **buys.csv**, is in CSV format, typical of a spreadsheet application.

Input file 1, "nyse-a"

```
A. O. Smith Corporation AOS     42.40   142900  0.04    0.09
A.G. Edwards Inc.       AGE     52.81   251800  0.48    0.91
A.O. Tatn EFT First     TNT     103.01  136000  1.01    0.99
AAG Holding Company1    GFZ     24.71   1900    0.06    0.24
AAG Holding Company2    GFW     25.05   4200    0.05    0.20
Aames Investment Corp.  AIC     4.84    145500  0.04    0.82
Aaron Rents, Inc.       RNT     24.05   1706300 2.53    9.51
ABB LTD.                ABB     12.55   2456100 0.13    1.04
Abbey National plc      SXA     25.00   24700   0.15    0.60
Abbott Laboratories     ABT     47.25   4210700 0.15    0.31
Abercrombie & Fitch     ANF     50.86   1973000 1.32    2.53
Abitibi-Consolidated    ABY     2.61    240600  0.00    0.00
ABM Industries Inc.     ABM     16.44   102600  0.36    2.14
ABN AMRO Holding N.V.   ABN     27.47   195900  0.31    1.14
```

Input file 2, "buys.csv"

```
Shares,Symbol,Client
"1000","DIS","Bill Gates"
"950","EDS","Ben Graham"
"25000","WMT","Warren Buffet"
"3250","AMR","Jeff Bezos"
"775","TSG","Wendi Deng"
"400","HBC","Stephen Covey"
"2100","HIG","Richard Branson"
"950","TEM","Sergey Brin"
"1500","AGE","Michael Bloomberg
"5000","BAC","Donald Trump"
"3333","PRU","Steve Wynn"
"2000","ABN","Jack Welch"
"8500","RNT","George Soros"
"1000","MCK","Kerry Packer"
"4300","UNH","Rupert Murdoch"
"9000","SDS","Jesse Livermore"
"3500","SNE","Alan Greenspan"
"825","ABT","Lakshmi Mittal"
"9000","ABY","Robert Kiyosaki"
"855","ADS","Lisa Mangino"
"50","IBM","Rick Haines"
"90","SUN","Amrita Thakur"
```

The goal of the following SortCL job script is to order and match these files by the ticker symbol in their second columns so that a meaningful set of output reports can be created. Field-level protections could certainly have been applied if desired.

```
### Job Controls Phase ###
/WARNINGSON
/MONITOR=4

### Input Phase ###
/INFILE=nyse-a                                    # 1st Input, tab-delimited
    /FIELD=(Issue,POS=1,SEP='\t')
    /FIELD=(Symbol,POS=2,SIZE=3,SEP='\t')
    /FIELD=(LastTrade,POS=3,SIZE=5.2,SEP='\t',NUMERIC)
    /FIELD=(Volume,POS=4,SEP='\t',NUMERIC)
    /FIELD=(Change,POS=5,SIZE=4.2,SEP='\t', NUMERIC)
    /FIELD=(Percent,POS=6,SIZE=4.2,SEP='\t', NUMERIC)

/INFILE=buys.csv                                  # 2nd Input, CSV format
/ALIAS=buys
/INSKIP=1          # skip header record
    /FIELD=(Shares,POS=1,SEP=',',FRAME='"')
    /FIELD=(Symbol,POS=2,SEP=',',FRAME='"')
    /FIELD=(Client,POS=3,SEP=',',FRAME='"')


### Action Phase ###
/JOIN FULL_OUTER NOT_SORTED nyse-a NOT_SORTED buys \
      WHERE nyse-a.Symbol EQ buys.Symbol


#### Output File 1 - 2D BI Report with Selection ####
/OUTFILE=TradingA                                 # Summary record format
    /HEADREC="                                              -----------\n"
    /FIELD=(New_balance,POS=50,SIZE=14.2,currency)
    /SUM New_balance from (nyse-a.LastTrade * buys.Shares)  # Expression logic

/OUTFILE=TradingA                                 # Detail record format
    /HEADREC="Client    Symbol      Shares  LastTrade  Shares*LT    Ln.\n\n"
    /FIELD=(buys.Client,POS=1,SIZE=17)
    /FIELD=(buys.Symbol,POS=20,SIZE=5)
    /FIELD=(nyse-a.Symbol,POS=28,SIZE=5)
    /FIELD=(buys.Shares,POS=35,SIZE=5)
    /FIELD=(nyse-a.LastTrade,POS=45,SIZE=5.2,NUMERIC)
    /FIELD=(product,POS=54,NUMERIC, IF nyse-a.Symbol NE buys.Symbol        \
            THEN "" ELSE nyse-a.LastTrade * buys.Shares)
    /FIELD=(Sequencer,POS=66,SIZE=4)              # Creates sliding index column


#### Output File 2 - Data Interchange Format ####
/OUTFILE=TradingA.xml
    /PROCESS=XML
    /FIELD=(Client,POS=1,SEP='|',XDEF="/Trades/Buy@Client")
    /FIELD=(Symbol,POS=2,SEP='|',XDEF="/Trades/Buy/Symbol")
    /FIELD=(Shares,POS=3,SEP='|',XDEF="/Trades/Buy/Shares")
    /INCLUDE WHERE nyse-a.LastTrade GT 10 AND buys.Shares GT 0
```

```
#### Output File 3 - Web-ready Summary Report ####
/OUTFILE=TradingA.htm                              # Summary record format
    /DATA="</FONT><B></TD>\n<TD align=right><B><U><FONT SIZE=+2>            \
           <FONT COLOR='GREEN'>"
    /FIELD=(New_balance,SIZE=15,CURRENCY)       # Derived in prior output spec!
    /DATA="</FONT></U></B></TD>\n</TR>\n"
    /SUM New_balance from (nyse-a.LastTrade * buys.Shares) WHERE symbol NE "RNT"
    /FOOTREC="</TABLE><BR>\nCreated on </B>%s.\
             <HR></BODY>\n</HTML>",AMERICAN_DATE

/OUTFILE=TradingA.htm                              # Detail record format
    /HEADREC="<HTML><HEAD>\n<TITLE>HTML produced by SORTCL \
             </TITLE>\n</HEAD>\n<BODY><H2><FONT COLOR='RED'>Trading Summary \
             </H2>\n<TABLE CELLPADDING=4 CELLSPACING=1 BORDER COLS=5>\n"
    /OMIT WHERE Symbol EQ "RNT" OR SYMBOL EQ "" # Selection applied in display
    /DATA="<TR>\n<TD><I>"
    /FIELD=(buys.Client)
    /DATA="</B></TD>\n<TD align=right><FONT COLOR='BLUE'>"
    /FIELD=(buys.Symbol)
    /DATA="</TD>\n</TR>\n"
```

The following command ran the job above, producing all targets and job statistics at once:

```
sortcl /spec=stockjoin.scl
```

And as the outputs were created, requested warning and monitor messages were displayed:

```
  +16 stockjoin.scl: warning (101): "PRECISION" ambiguous reference
  +18 stockjoin.scl: warning (101): "PRECISION" ambiguous reference
  +19 stockjoin.scl: warning (101): "PRECISION" ambiguous reference
  +38 stockjoin.scl: warning (101): "PRECISION" ambiguous reference
  +47 stockjoin.scl: warning (101): "PRECISION" ambiguous reference
     warning TradingA
   gap [1 -> 49]
     warning TradingA
   gap [18 -> 19]
   gap [25 -> 27]
   gap [33 -> 34]
   gap [40 -> 44]
     warning TradingA.htm
         overlap [1 -> 14]
     warning TradingA.xml
         missing field before field 175
         missing field before field 177


CoSort Version 9.5 D90070608-1306 Copyright 1978-2011 IRI, Inc. www.iri.com
EDT 05:25:53 PM Monday, April 18 2011.  #11162.9543 2 CPUs
Expires Dec 31, 2011     Monitor Level 4
   <00:00:00.00> event (57): /spec=stockjoin.scl initiated
   <00:00:00.00> event (57): /infile=nyse-a initiated
   <00:00:00.03> 2 CPUs
   <00:00:00.14> event (59): P5a5b88 infile opened
   <00:00:00.14> event (59): P5a5c08 infile opened
   <00:00:00.00> event (57): /infile=buys.csv initiated
   <00:00:00.06> event (66): cosort() process begins
   <00:00:00.14> event (59): d:\CS_JOIN_7d8.6fc infile opened
   <00:00:00.14> event (66): cosort() process begins
   <00:00:00.22> event (67): cosort() process ends
   <00:00:00.22> event (58): /infile=buys.csv completed
   <00:00:00.33> event (61): TradingA outfile opened
   <00:00:00.33> event (61): TradingA.xml outfile opened
   <00:00:00.33> event (61): TradingA.htm outfile opened
   <00:00:00.30> event (67): cosort() process ends
   <00:00:00.30> event (58): /infile=nyse-a completed
   <00:00:00.34> event (60): P5a5b88 infile closed0
   <00:00:00.34> event (60): P5a5c08 infile closed0
   <00:00:00.34> event (68): left 0  right 0
   <00:00:00.34> event (62): TradingA outfile closed
   <00:00:00.34> event (62): TradingA outfile closed
   <00:00:00.34> event (62): TradingA.xml outfile closed
   <00:00:00.34> event (62): TradingA.htm outfile closed
   <00:00:00.34> event (62): TradingA.htm outfile closed
   <00:00:00.39> event (58): /spec=stockjoin.scl completed
EDT 05:25:53     CoSort Serial # 11162.TEST  2 CPUs  Expires Dec 31, 2011
```

In **TradingA**, both matches and non-matches are shown in order by ticker symbol. The cross and down-row calculations across support business intelligence and billing operations.

Output file 1, "TradingA"

Client	Symbol		Shares	LastTrade	Shares*LT	Ln.
		ABB		12.55		1
		ABM		16.44		2
		ABN		27.47		3
Lakshmi Mittal	ABT	ABT	825	47.25	38981.25	4
Robert Kiyosaki	ABY	ABY	9000	2.61	23490.00	5
Lisa Mangino	ADS		855			6
Michael Bloomberg	AGE	AGE	1500	52.81	79215.00	7
		AIC		4.84		8
Jeff Bezos	AMR		3250			9
		ANF		50.86		10
		AOS		42.40		11
Donald Trump	BAC		5000			12
Bill Gates	DIS		1000			13
Ben Graham	EDS		950			14
		GFW		25.05		15
		GFZ		24.71		16
Stephen Covey	HBC		400			17
Richard Branson	HIG		2100			18
Rick Haines	IBM		50			19
Kerry Packer	MCK		1000			20
Steve Wynn	PRU		3333			21
George Soros	RNT	RNT	8500	24.05	204425.00	22
Jesse Livermore	SDS		9000			23
Alan Greenspan	SNE		3500			24
Amrita Thakur	SUN		90			25
		SXA		25.00		26
Sergey Brin	TEM		950			27
		TNT		103.0		28
Wendi Deng	TSG		775			29
Rupert Murdoch	UNH		4300			30
Warren Buffet	WMT		25000			31

					$346,111.25	

The next target, in valid XML format, contains only the selected fields and condition results:

Output file 2, "TradingA.xml"

```
<?xml version="1.0" encoding="UTF-8" standalone="yes" ?>
- <Trades>
  - <Buy Client="Lakshmi Mittal">
      <Symbol>ABT</Symbol>
      <Shares>825</Shares>
    </Buy>
  - <Buy Client="Michael Bloomberg">
      <Symbol>AGE</Symbol>
      <Shares>1500</Shares>
    </Buy>
  - <Buy Client="George Soros">
      <Symbol>RNT</Symbol>
      <Shares>8500</Shares>
    </Buy>
  </Trades>
```

The last output target is formatted with HTML and thus ready for web posting. Notice how the omission of the RNT transaction changes the grand total from the first output file, and how SortCL supports the use of 'conversion specifiers' to include system information (in this case, the date below) in is reports:

Output file 3, "TradingA.htm"

Trading Summary

Lakshmi Mittal	ABT
Robert Kiyosaki	ABY
Lisa Mangino	ADS
Michael Bloomberg	AGE
Jeff Bezos	AMR
Donald Trump	BAC
Bill Gates	DIS
Ben Graham	EDS
Stephen Covey	HBC
Richard Branson	HIG
Rick Haines	IBM
Kerry Packer	MCK
Steve Wynn	PRU
Jesse Livermore	SDS
Alan Greenspan	SNE
Amrita Thakur	SUN
Sergey Brin	TEM
Wendi Deng	TSG
Rupert Murdoch	UNH
Warren Buffet	WMT
$141,686.25	

Created on April 18, 2011.

COSORT WORKBENCH

CoSort 9.5 includes a new Graphical User Interface (GUI) for the Sort Control Language (SortCL) program. The new CoSort Workbench is a plug-in to the Eclipse Integrated Development Environment (IDE) that helps users create, maintain, and execute SortCL jobs. The Workbench provides new functional and ergonomic enhancements, including:

New job wizards, form dialogs and syntax-aware script editing

CoSort's new Workbench utilizes several different job presentation facilities within Eclipse to improve the SortCL job design experience. The wizards take you from source and metadata specification through the action phase of a job, and finally to the specification of one or more targets and formats. Wizard and form dialog results help populate and modify SortCL job scripts. A syntax-aware editor also facilitates valid script creation and change.

The top window in the figure below shows the editor view of a join job script. You can invoke the join wizard (shown in the bottom left) from the main menu and within the script editor view. The join wizard allows you to specify all details of a multi-table join action. The bottom right window shows the target field layout of this job script. Note that multiple input sources (shown in upper tabs) and output targets (shown in lower tabs) are presented in this view to enable you to specify file and table target layouts quickly and efficiently.

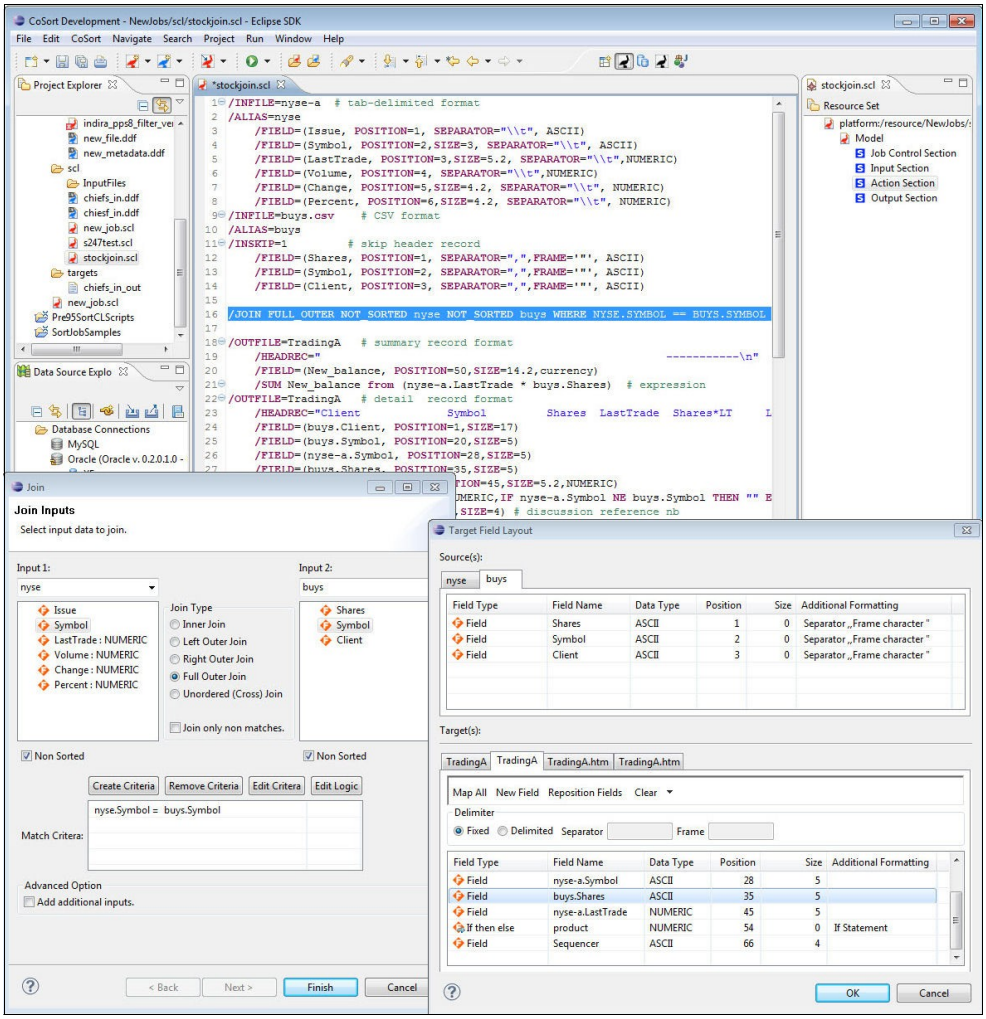


Figure 3 *CoSort Workbench Overview*

ODBC-connected (DB table) data sources and targets

The introduction of ODBC source and target handling in CoSort 9.5 means that SortCL users can integrate, stage, transform, protect, and report against relational data stored in Oracle, DB2, SQL Server, SAP, MySQL, Sybase, and other tables. The Workbench uses the JDBC-ODBC bridge in the Eclipse Data Tools Platform (DTP) for viewing and selecting table data.

In the graphic below, the left panel shows the DTP view of the database. The middle panel displays the contents of the selected table, and the right panel is the Data Definition File (DDF) form editor that is used to modify the table metadata specifications for a CoSort job.

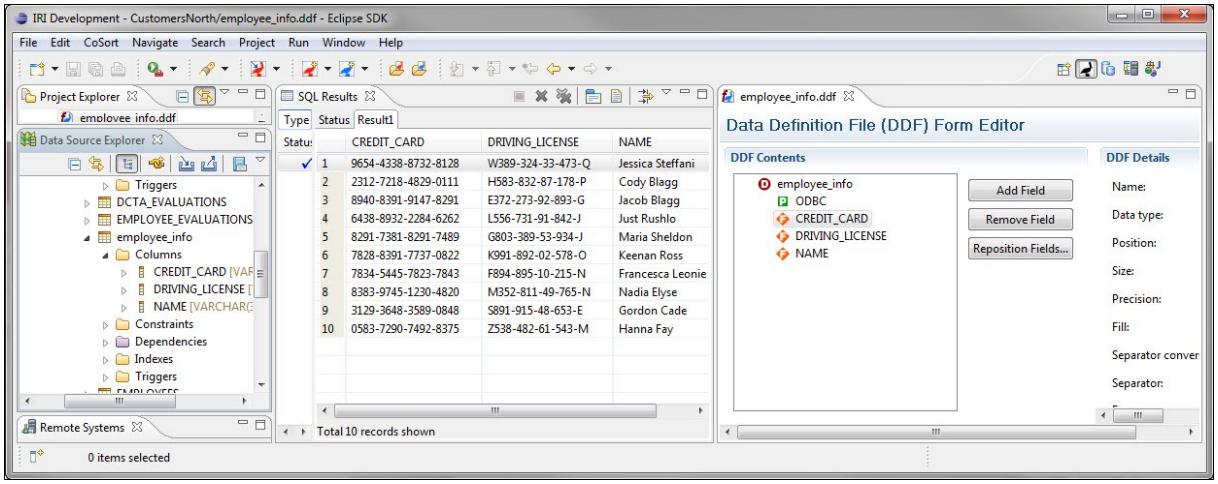


Figure 4 *DTP and DDF Editor*

Metadata discovery

Those familiar with CoSort know that you must define the structure of all input and output files in SortCL DDF syntax. This has traditionally been a manual field-by-field editing process, or the result of a command line conversion program like cob2ddf (for COBOL copybooks). For situations in which pre-existing metadata is not available, the new CoSort workbench helps users to visually define their field layouts and populate file and table metadata for use in SortCL jobs.

The following screenshot shows how users can define fixed-position fields by moving sliders to the start and end of each field in a source data preview window. Once you add a field, the bottom spreadsheet view reflects the DDF specifications which you can then modify. For records with delimited fields, a column-based editor is provided instead, as sliders are unnecessary. A HEX view option facilitates the definition of binary data.

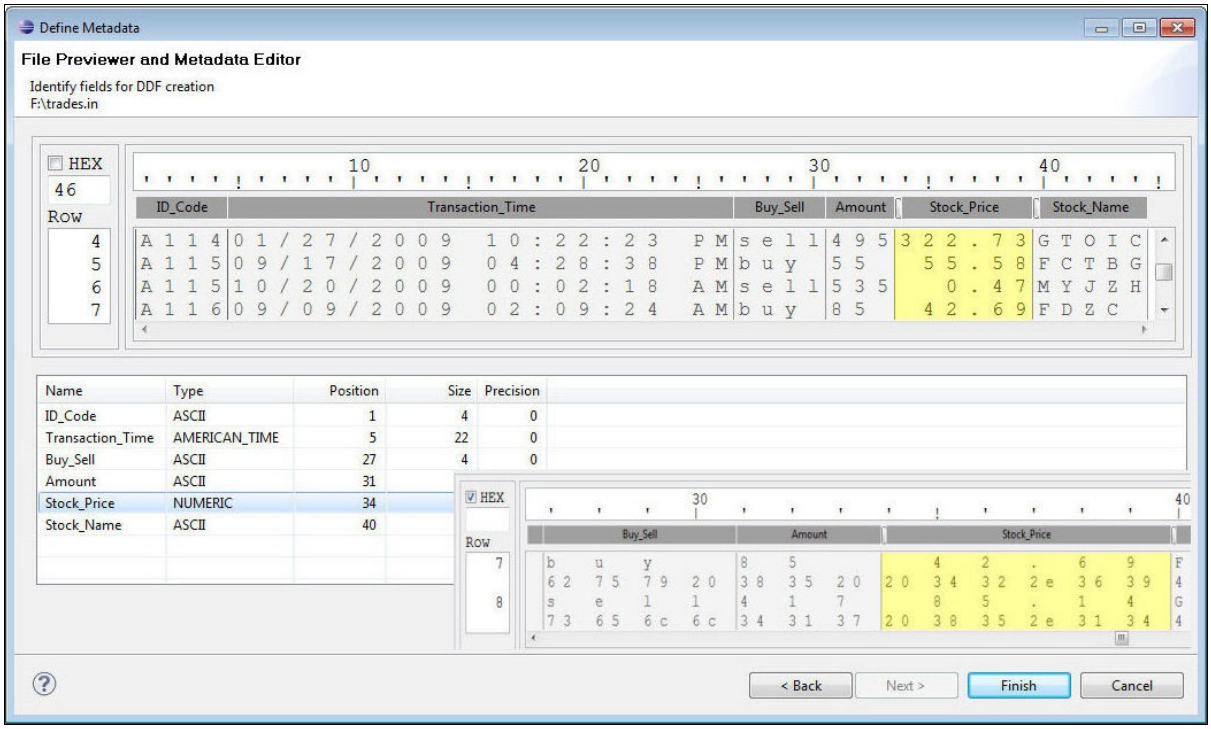


Figure 5 *Define Metadata Wizard*

Metadata conversion

The process of bulk metadata and third-party sort script migration to CoSort's SortCL syntax has been modernized and automated in the Workbench. Wizards exist to translate third-party data layouts into SortCL DDFs and SortCL job scripts. An example of the former would be bulk COBOL copybook conversions to SortCL .ddf targets. There is a wizard to convert one or more metadata repositories or file headers into DDF. There is also a wizard to convert and import third-party sort specifications into SortCL job scripts.

The conversion wizard shown below demonstrates the conversion of one or more JCL sort decks to SortCL job scripts. You can browse to identify the location of the parms, and then automatically convert them for use in SortCL. The middle window shows advanced options available for these conversions. The bottom window shows from left to right: project explorer files (including the source and target job scripts), an editor displaying the source job script, a display of the target job script, and a tree view of the components of the target job script.

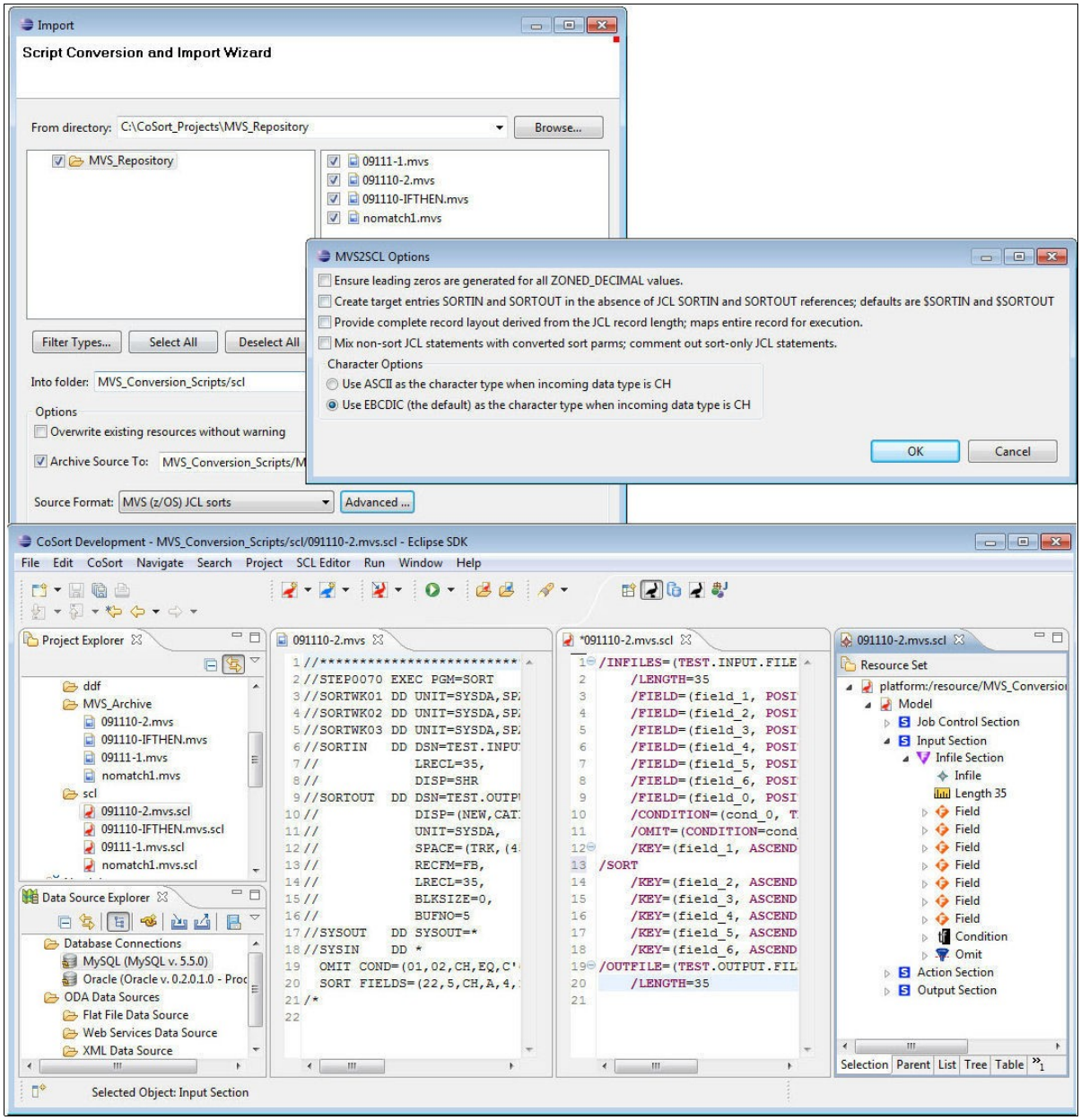


Figure 6 *Import Wizard and Imported Script*

SORTCL COMMAND SET

The following is a list of the core commands available in SortCL as of CoSort Version 9.5:

/ALIAS
/APPEND
/ALTSEQ
/AVERAGE
/CHARSET
/CHECK
/CONDITION
/COUNT
/CREATE
/DATA
/DEBUG
/DUPLICATESONLY
/ENDIAN
/EXECUTE
/FIELD
/FILE
/FOOTREC
/HEADREAD
/HEADREC
/HEADSKIP
/HEADWRITE
/INCLUDE
/INCOLLECT
/INFILE
/INFILES
/INPROCEDURE
/INREC
/INSKIP
/JOBCOLLECT
/JOBSKIP
/JOIN
/KEY
/KEYPROCEDURE
/LENGTH
/LIBRARY
/LOCALE
/MAXIMUM
/MINIMUM
/MEMORY-WORK
/MERGE
/MONITOR
/NODUPLICATES
/OMIT
/OUTCOLLECT
/OUTFILE
/OUTPROCEDURE
/OUTSKIP
/PROCESS
/RC
/RECSPERPAGE
/REPORT
/ROUNDING
/SORT
/SPECIFICATION
/STABLE
/STATISTICS
/SUM
/TAILREAD
/TAILSKIP
/TAILWRITE
/WARNINGSOFF
/WARNINGSON

Note that each command may contain additional parameters that expand its functionality. For example, the /JOIN ONLY command will eliminate the inner join results of a full outer join. Note also that many external functions can be invoked beyond the command set. For example, 256 AES encryption and de-identification functions, as well as set file lookups, are specified as functions within /FIELD statements.

METADATA CONVERSION TOOLS

CoSort Version 9.5 includes several tools to translate existing flat file layout (and sort job) metadata for use in CoSort's Sort Control Language (SortCL) program. IRI has also partnered with a leading metadata conversion company, Meta Integration Technology, Inc. (MITI) to automatically create SortCL-ready file layouts from BI, ETL and relational metadata.

About SortCL Metadata

SortCL's explicit text-based metadata is straightforward and self-documenting -- making it easy to learn, use, and audit. You can store your files' field (column) layouts in reusable Data Definition File (.ddf) repositories. You can paste or reference these definitions in your SortCL job script. SortCL uses /FIELD= statements to identify column:

- Names or Aliases
- Sizes or Ranges
- Positions or Delimiters
- Data Types
- Conditions and Expressions
- Security and Other Functions

Third-Party Metadata

File layout translators included in the CoSort package can migrate your existing field/column descriptions into SortCL (and RowGen) .ddf repositories. These tools can reduce or eliminate the overhead associated with migrating metadata to a .ddf from:

- COBOL copybooks (cob2ddf)
- comma-separated values (csv2ddf)
- LDIF (ldif2ddf)
- XML (xml2ddf)
- W3C extended log format (elf2ddf)
- Oracle SQL*Loader control files (ctl2ddf)
- ODBC table data

Therefore, if you already have file layouts defined in the above applications, you can automatically reproduce that metadata for use in any SortCL manipulations. If your file layouts exist in *other* formats (including CWM, DSX, UML, XMI and XML), the Meta Integration Model Bridge (MIMB) will convert these repositories into SortCL .ddf syntax. This precludes the need for manually re-defining flat file field layouts for reference in SortCL applications.

Sort Program Conversions

The included mvs2scl, and vse2scl utilities convert legacy MVS JCL, and VSE JCL, respectively, to functionally-equivalent SortCL job specifications. Conversion tools cannot translate every script. However, field re-casting usually works, and manual translation of source scripts to SortCL equivalents is usually not difficult. For more information on, and examples of, these tools, see IRI’s Legacy Sort Migration white paper.

Another CoSort tool -- called sorti2scl -- translates CoSort's sort interactive (SortI) program job specifications into their SortCL job equivalents. See the SORTI PROGRAM chapter.

UNIX SORT REPLACEMENT (BIN/SORT)

The /bin/sort utility provided with the Unix operating system is designed for ordering small collections of alphanumeric data. It does not work well when the size of the data increases beyond available memory. For those with an investment in, or familiarity with, existing system sort commands, IRI provides a drop-in /bin/sort replacement tool that improves high-volume sort performance through the CoSort engine.

Unix users are provided with a new /bin/sort, and Windows users get a unixsort.exe program. Upon installation, the object file can be moved into a system directory to provide sort services with the same syntax as the original sort verb, but at much higher performance levels.

An example of CoSort's Unix sort replacement follows, using the following data sample:

Input File 1, "chicago"

```
5180 On Top 15.95 Harper-Row
3391 Married Young 24.95 Prentice-Hall
8835 Beginnings 8.50 Prentice-Hall
2272 Still There 13.05 Dell
1139 Greater Than 34.75 Valley Kill
3928 Not On Call 9.99 Harper-Row
4877 Going Nowhere 17.95 Valley Kill
```

We first define the way to specify fields for the sort key. White space denotes the end of a field unless a field separator character is defined.

To sort **chicago** starting with the second field, use the command:

```
/path2/cosort95/bin/sort -k 2 chicago –o out1
```

Output File, "out1"

```
8835 Beginnings 8.50 Prentice-Hall
4877 Going Nowhere 17.95 Valley Kill
1139 Greater Than 34.75 Valley Kill
3391 Married Young 24.95 Prentice-Hall
3928 Not On Call 9.99 Harper-Row
5180 On Top 15.95 Harper-Row
2272 Still There 13.05 Dell
```

To sort starting at the second character of the first field, use the following command:

```
sort -k 1.2 chicago –o out2
```

Output File, "out2"

```
1139 Greater Than 34.75 Valley Kill
5180 On Top 15.95 Harper-Row
2272 Still There 13.05 Dell
3391 Married Young 24.95 Prentice-Hall
8835 Beginnings 8.50 Prentice-Hall
4877 Going Nowhere 17.95 Valley Kill
3928 Not On Call 9.99 Harper-Row
```

The CoSort /bin/sort replacement also supports legacy Unix sort options. For example:

```
sort -t, +3 +2nr -3 chicago –o out3
```

Output File, "out3"

```
2272 Still There 13.05 Dell
5180 On Top 15.95 Harper-Row
3928 Not On Call 9.99 Harper-Row
3391 Married Young 24.95 Prentice-Hall
8835 Beginnings 8.50 Prentice-Hall
1139 Greater Than 34.75 Valley Kill
4877 Going Nowhere 17.95 Valley Kill
```

CoSort's Unix sort replacement supports these command-line flags:

```
[-c][-d][-m][-f][-u][-i][-o][-M][-T][-b][-n][-t][-r][-z]
```

`[-y]` and `[-Kmem]` flags are supported indirectly via values defined in your cosortrc file. For more information, see the SYSTEM TUNING chapter.

SORT INTERACTIVE PROGRAM (SORTI)

One of the unique components of the CoSort package is a menu-driven prompting program for users who may not have prior experience with data sorting software, or with prior metadata. The purpose of CoSort's "Sort Interactive" or SortI program is to allow users to easily create and run sort/merge specifications from any Unix, Linux or Windows command line.

CoSort's interactive and batch **SortI** program is invoked with the command:

```
sorti
```

A banner appears similar to the one below:

```
C:\iri\CoSort95\bin>sorti

        CoSort Sort Interactive Version 9.5  D90110608-1306
        Copyright 2011 Innovative Routines International, Inc.
        S/N 11162.9543  2 CPUs
        Eastern Daylight Time 04:15:51 PM Monday, April 18 2011

        Directory: C:\iri\CoSort95\bin
        # Threads: 2
        BlockSize: 2097152  bytes
        MaxMemory: 268435456 bytes
        WorkAreas: d:\temp\sortwork, e:\temp2

        Responses: <cr> takes offered default
                   'stop' restarts the Action
                   'help' explains each query
                   $variable defined in shell
                   # starts comment for batch
                   !command for shell command


_____________________________________________________
Action:   SORT   MERGE   DISPLAY   GUIDE (default)  END:
```

The SortI user is then prompted for responses. For example:

```
Action:   SORT   MERGE   DISPLAY   GUIDE (default)  END: SORT

INPUT   Record length  0 (variable (default)) / fixed #: 0
        Number of files: 0 (proc) / +- numb (1 default): 1
            Input file 1:  sales2.dat

KEYS [number] [stable] [unique / dus_only] (1 default): 1
  Key  1   Direction: ASCENDING (default) or DESCENDING: ASC
           Location: FIXED (default) / <separator char>: FIXED
                    Starting byte position: 1 (default): 22
                Field Size: 32767 (maximum) 50 (default): 10
          Form: ALPHA (def), NUM, DATE, TIME, TIMESTAMP: DATE
        Type AMERICAN (default) or LIST to show options: LIST

                 TYPE                 DATE        TIME
                ------------------------------------------
                AMERICAN             (MM/DD/YYYY Hr:Mn:Ss AM)
                EUROPEAN             (DD.MM.YYYY Hr.Mn.SS)
                JAPANESE             (YYYY-MM-DD Hr:Mn:Ss)
                ISO                  (YYYY-MM-DD Hr.Mn.Ss)
                CS_Y2K_ASCII_JULIAN (YYDDD)
                CS_Y2K_ASCII_YR    (YY)
```

Users are also prompted to save their job specifications to a parameter file that can be run in batch mode. In this case, specifications were saved to *sales2_sort.spc*. To run the same job in a batch stream, the shell command would be:

```
sorti sales2_sort.spc
```

To expand beyond sorting the input file, and to leverage the extensive data transformation, reformatting, and reporting capabilities available through CoSort's SortCL program, a "SortI – to – SortCL" parameter translation tool is also provided in the CoSort package. Running the tool **sorti2scl** against the original SortI parameters will create the equivalent file layout and manipulation metadata for SortCL. For example, this command:

```
sorti2scl sales2_sort.spc sales2_sort.scl
```

will automatically build this SortCL job script equivalent:

```
# sortcl specs created by sorti2scl on Mon April 18 10:15:45
# sorti specifications by cosort_user (user)
# Tue April 19 09:31:12 2011
/INFILE=sales2.dat
/SORT
      /KEY=(pos=22,size=10,ASCENDING,ISO_DATE)
/OUTFILE=sales2_sorted
```

COBOL MIGRATION TOOLS

CoSort Version 9 ships with the tools, libraries, and documented examples you need to achieve a wide range of COBOL data migration and processing goals on open systems:

Sorting and Migrating COBOL Data

All CoSort interfaces support MF and RM COBOL data type collation while SortCL also handles conversion. CoSort includes a COBOL copybook metadata translation tool to leverage your file layouts in SortCL applications, and JCL sort parm conversion tools to leverage your MVS and VSE cards. CoSort can also sort EBCDIC data and can sort ASCII data in EBCDIC order. Multiple conversions can be done while simultaneously sorting.

Accelerating Native Sort Calls

CoSort is faster than your compiler's built-in sort function, and CoSort packages include several tools and methods to improve COBOL sort performance:

- Sort replacement for ACUCOBOL-GT
- Sort replacement for Micro Focus COBOL
- Serial and concurrent system calls to SortCL
- Static and dynamic API calls to CoSort libraries

Sorting and Converting Index, Variable Length & Blocked Files

CoSort's SortCL tool can perform multiple manipulations and conversions on ACUCOBOL-GT Vision files, Micro Focus variable length records, and I-SAM files. In the SortCL (4GL) job script, you define your input and output file formats and record layouts, along with your data filtering and transformation (sort, join, aggregate, etc.). You can integrate these formats with files in other formats all at the same time, and write output files in the same or different file format.

Generating Reports

CoSort's SortCL program includes a wide range of reporting features you can exploit to customize detail and summary targets for presentation and hand-offs to other tools.

Protecting Sensitive Data

Either as a separate process, or in combination with the above SortCL activities, you can also engage field-level protection functions like encryption and de-identification.

Creating Safe COBOL Test Data

CoSort's Test Data (RowGen) product uses the same syntax as SortCL to define the layout of COBOL index and sequential files containing randomly-generated or individually-selected test data.

Auditing Data and Applications

For data governance and other tracking purposes, SortCL also offers several logging options, including a query-ready XML file with complete scripts (containing field privacy protection specifications).

APPLICATION PROGRAMMING INTERFACES (APIs)

In addition to the many standalone utilities and third-party sort replacements in each CoSort package, there are two high-performance, thread-safe sorting libraries you can call into your software. Each API satisfies a different class of requirements.

You can link these C routines statically or dynamically, and the same calling code runs across all Unix, Linux and Windows platforms. Both libraries leverage the same multi-threaded CoSort sorting routine against any volume of input. Inputs and outputs can be in the form of files, pipes, records and record buffers (blocks) streaming to and from multiple calls simultaneously from your applications.

Integrating Sort/Merge Operations Only

The traditional CoSort API is now thread-safe, and is documented as cosort_r(). You can call cosort_r() to speed operations that sort or merge high volumes of data. Because your programs configure the input, compare, and output processes into the CoSort engine, you also can apply your own selection and comparison criteria.

The 'r' in cosort_r() refers to the reentrant nature of the call; you can call the function recursively from multiple processes. This means you can specify multiple sort orderings on the same input, and in the same pass. Flexible architecture also allows you to manage several sort jobs from within a single process, and from within as many processes as you like.

Integrating Multiple Transformation Functions

CoSort's multi-purpose SortCL tool is also available for thread-safe application calls and can enable the simpler execution of scripts. Embed CoSort's sortcl_routine() library to speed and combine many functions, including:

- Sort/Merge
- Match/Join
- Aggregate/Calculate
- Filter/Scrub
- Type-Conversions
- Encrypt/De-ID
- Reporting
- Random Data Generation

This API gives you access to all the data transformation, business intelligence, protection, and prototyping functions available in SortCL's data definition and manipulation syntax. Integrating sortcl_routine() into an ETL environment allows you to source and target database tables, as well as files, pipes, and custom input/output procedures.

The following C program demonstrates the simplicity of calling SortCL scripts via the sortcl_routine(api):

```
/* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* Copyright 1978-2011 CoSort / Innovative Routines International (IRI), Inc.
* All Rights Reserved.
*
* SortCL API example to run a script file
* ScriptFile: keyproc.scl
* Input File: chiefs
* Output File: chiefs.out
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * */
/* cosort header file */

#if defined (_WIN32)
#define __DLL_IMPORT__ /* IMPORTANT: needed to work with Windows DLL */
#pragma pack(1) /* or compile with /Zp1 option */
#endif /* (_WIN32) */
#include "cosort.h"
#include "sortcl_routine.h"

int main()
{
int iRetVal; /* return value */
cs_sortcl_t* sortcl; /* main sortcl context variable */
/* allocate the main sortcl context variable */
sortcl = sortcl_alloc();
if (sortcl) {
/* call sortcl_routine api */
iRetVal = sortcl_routine(sortcl, "/spec=keyproc.scl");
/* free the sortcl variable */
sortcl_free(sortcl);
}
/* if return value != 0 it is an error */
return (iRetVal);
```

You can make calls to the sortcl_routine library from any language that links to C. For more information about the content of SortCL job specification (.scl) files, see the functional description and scripting samples in the SORTCL PROGRAM chapter.

COBOL programmers may also wish to consider the ability to call SortCL scripts as system calls; for example:

```
CALL "system" USING "sortcl /spec=keyproc.scl &"
```

where **keyproc.scl** starts in the background while other COBOL program functions run.

SYSTEM TUNING

High-volume sorting and related data manipulations can be very resource-intensive. CoSort can achieve scalability that is nearly linear through its proprietary processing techniques and the proper application of system tuning. At the same time, however, CoSort is designed to be a good neighbor in a multi-user computing mix.

System administrators can combine kernel and CoSort tuning to optimize the performance of large data transformations without unduly impacting concurrent jobs. To prioritize CoSort operations at the system (global), user, or job level, simply adjust the values associated with the parameters shown below in your resource control file(s) (on Unix) or Windows registry:

Threads

On SMP platforms, CoSort users can manually set the number of sub-processes that sorts and related transformations will create. In most cases, the closer this value is set to the number of actual processors and disk drives on the system, the better the performance.

Memory Allocation

By assigning, or limiting the amount of random access memory available for sorting, system administrators can maximize the efficiency of jobs according to their desired system priority. Like CoSort's other system tuning controls, this variable allows users to determine how much impact CoSort will have on concurrently running applications.

Block Size

Blocks of memory are used as buffers to hold data temporarily. The data move through input, sort and output phases of the CoSort utilities (or a customized front-end), and between an application (calling) program and the cosort() engine. The size of these blocks determines how often disk I/O will be performed, and is a function of how much memory is available.

Overflow Storage

Overflow occurs in sorting when there are more input records than can be held in memory. When all the overflow data are distributed to temporary files, these files and the internal data are merged to produce output. Users can control the location of these temporary files and distribute them across multiple file systems. Where multiple drives and threads are specified, speed can increase in the later stages of the sort as the data is read back (into the output file/s) in parallel. You can also use input selection to reduce processing volume and temporary space requirements at runtime.

CoSort resource controls also include these application-specific values:

Record Terminator
Where variable length output is specified, any record terminating character can be specified. The default option is to use the same terminator present in the input data source, if applicable (which is typically a linefeed on Unix and carriage-return/linefeed on Windows). Alternatively, you can choose either of these styles, regardless of the terminator type used on input -- or you can select your own special terminator character(s), including a NULL character ("").

Century Window
Users with non-Y2K-compliant (2-digit date) data can specify the minimum year for CoSort to sort after 1999. This "sliding" feature allows custom collation for any century-bordering dates.

Pause / Resume
During large sort operations that require the creation of temporary work files, CoSort can warn users when temporary disk space is exhausted, and allow for ad hoc re-allocation so that the job can continue without having to be re-started.

Runtime Monitoring
By specifying various levels of verbosity, CoSort users can view on-screen job progress reports with timestamps and event messaging. Events include the opening and closing of input, work, and output files and the number of records accepted, rejected or processed. Displays range from off (level 0) to showing every single record (number) being processed (level 9).

Execution Log
Basic runtime information can be directed to one or more files to archive CoSort jobs and their performance. This log file is a self-appending text file. A self-replacing text file called *.cserrlog* is created during each run to record tuning and version information, and any error messages, in the event of an abnormal termination (for debugging purposes).

Audit Log
Detailed runtime information can be optionally directed to a self-appending, query-ready XML log file that contains environmental and performance details, and the entire SortCL job script, to record every aspect of the application (data definitions, manipulations and protections) in order to verify compliance with procedures and data privacy regulations.

A complete description of all parameters, and how to tune them, can be found in Appendix D of the **CoSort User Manual**.

TECHNICAL SPECIFICATIONS

CoSort is a general-purpose data manipulation package for large file transformation, reporting, protection and conversion. All of its native utilities, third-party sort replacements, and API calls link to the same coroutine sort engine which processes all file formats and record types, and provides in-memory, record-level processing for file and data manipulation. CoSort uses these techniques, along with granular tuning parameters, to both optimize application throughput and prioritize resources in the multi-user mix. CoSort's unique approach cuts production times without compromising performance of concurrent jobs.

Installation

- Distributed via internet or user-specified media
- Loads in under two minutes
- Menu-driven setup and configuration utility

Invocation

- Command line (including pipe sequences), shell commands and batch scripts
- CoSort Workbench – installed on your local system
- Application calling programs as a standalone executable, subroutine or coroutine call, with or without additional exit routines.

Ease of Use

- Processes using record layouts and SQL-like field definitions from central data dictionaries
- Converts and processes native COBOL copybook, Oracle SQL*Loader control file, CSV, and W3C extended log format (ELF) file layouts
- SortCL is a supported MIMB metadata format
- Provides on-line help, pre-runtime application validation, and runtime errors
- Leverages centralized application and file layout definitions (metadata repositories)
- Reports problems to standard error when invoked from a program, or to an error log
- Runs silently or with verbose messaging without user intervention
- Allows user control over the amount of informational output produced
- Generates a query-ready XML audit log for data forensics and privacy compliance
- Describes commands and options through man pages and on-line documentation
- Easy-to-use interfaces and seamless third-party sort replacements preclude the need for training classes; however, advanced training is available in Florida or at user sites
- Phone, fax and Email support available directly from the product developers
- Local language support is available from 30 international offices.

Resource Control

- Sets and allows user modification of the maximum and minimum number of concurrent sort threads for sorting on multi-CPU and multi-core systems
- Uses a specified directory or a combination of directories for temporary work files
- Limits the amount of main and virtual memory used during sort operations
- Sets the size of the memory blocks used as physical I/O buffers

Input and Output

- Processes any number of files, of any size, and any number of records, fixed or variable length (to 65,535 bytes) passed from flat files, an input procedure, from **stdin**, a named pipe, a table in memory, or from an application program
- Supports the use of environment variables and wildcards in the specification of input and output files, as well as absolute path names and aliases
- Accepts and outputs fixed- or variable-length records with delimited fields
- Generates one or more output targets, and/or summary information, including formatted and dashboard-ready reports
- Returns sorted, merged, or joined records one (or more) at a time to an output procedure, to **stdout**, a named pipe, a table in memory, one or more new or existing flat files, or to an application program
- Outputs optional sequence numbers with each record, at any starting value, for indexed loads and/or reports
- Synthesizes randomly generated or randomly hand-selected field test data values.

Record Selection and Grouping

- Includes or omits input or output records using field-to-field or field-to-constant comparisons
- Compares on any number of data fields, using standard and alternate collating sequences
- Sorts and/or reformats groups of selected records
- Matches two or more sorted or unsorted files on inner and outer join criteria using SQL-based condition syntax
- Skips a specified number of records, bytes, or a record header
- Processes a specified number of records or bytes, including a saved header
- Eliminates or saves records with duplicate keys.

Sort Key Processing

- Allows any number of key fields to be specified in ascending or descending order
- Supports any number of fields from 10 to 65,535 bytes in length
- Orders fields in fixed position or floating (on one or more delimiters)
- Supports numeric keys, including all C, FORTRAN, and COBOL data types
- Supports single and multi-byte character keys, including ASCII, EBCDIC, ASCII in EBCDIC sequence, American, European, ISO and Japanese timestamps, and natural (locale-dependent) values, as well as Unicode and double-byte characters such as Big5, EUC-TW, UTF32, and S-JIS
- Allows left or right alignment and case shifting of character keys
- Accepts user compare procedures for multi-byte, encrypted and other special data
- Performs record sequence checking
- Maintains input record order (stability) on duplicate keys
- Controls treatment of null fields when specifying floating (character separated) keys
- Collates (and converts between many of) the following data types (formats):

Form Group	Form Type
0	Alphabetic
1	Numeric
2	Date
3	Time
4	Timestamp

Single Byte Types of Form 0	Reference Standard
ASCII [LATIN1]	ISO 8859-1
EBCDIC	IBM Standard
LATIN2	ISO 8859-2
LATIN3	ISO 8859-3
BALTIC	ISO 8859-4
CYRILLIC	ISO 8859-5
ARABIC	ISO 8859-6
GREEK	ISO 8859-7
HEBREW	ISO 8859-8
TURKISH [LATIN5]	ISO 8859-9
LATIN6	ISO 8859-10
ASC_IN_EBC	e.g. "123">"ABC"
ASC_IN_NATURAL	e.g. "ABC">"A-D"
Multi-Byte Types of Form 0	**Reference Standard**
JOHAB	KS X 1001:1992
KEF	Korean EBCDIC
EHANGUL	IBM DBCS-HOST
HHANGUL	Hitachi Hangul
UTF8/UNICODE	ISO 10646:1993-1
UTF16/UCS2/UNICODE	ISO10646
UTF32/UCS4/UNICODE	ISO10646
GBK/EUC_CN	ISO10646 (China)
BIG5	BIG5 (Hong Kong)
EUC_TW	CNS 11643-1992 (Planes 1 - 3)
EUC_KR	KS X 1001:1992
EUC_JP	JIS X 0201-1976 JIS X 0208-1990 H/W Katakana JIS X 0212-1990
SJIS (Shift_JIS)	JIS X 0208-1990
IBM_DBCS_HOST (Mainframe Encoding) and IBM_DBCS_PC (PC Encoding)	IBM Japanese, IBM Korean, IBM Simplified Chinese, and, IBM Traditional Chinese
Form 1- Numeric Types	**Alphanumeric**
ASCNUM, NUMERIC	Integers, real numbers, and floating points

Form 1 - Numeric Types	C Types
CHAR	Character, Natural (ASCII)
SCHAR	Character, Signed
UCHAR	Character, Unsigned (EBCDIC)
SHORT	Integer, Short Signed
USHORT	Integer, Short Unsigned
INT	Integer, Natural Signed
UINT	Integer, Natural Unsigned
LONG	Integer, Long Signed
ULONG	Integer, Long Unsigned
FLOAT	Single Precision Float
DOUBLE	Float, Double Precision
Form 1 - Numeric Types	**Ryan-McFarland (Liant) COBOL Types**
RM_COMP	COMP, Signed
URM_COMP	COMP, Unsigned
RM_CMP1	COMP-1
RM_CMP3	COMP-3, Signed
URM_CMP3	COMP-3, Unsigned
RM_CMP6	COMP-6
RM_DISP	DISP, Signed
URM_DISP	DISP, Unsigned
RM_DISPSL	DISP, Sign Leading
RM_DISPSLS	DISP, Sign Leading Separate
RM_DISPST	DISP, Sign Trailing
RM_DISPSTS	DISP, Sign Trailing Separate
Form 1 - Numeric Types	**Micro Focus COBOL Types (Meaning)**
MF_COMP	COMP, Signed
UMF_COMP	COMP, Unsigned
MF_CMP3	COMP-3, Packed Decimal
UMF_CMP3	COMP-3, Unsigned
MF_CMP4	COMP-4, Signed
UMF_CMP4	COMP-4, Unsigned
MF_CMP5	COMP-5, Signed
UMF_CMP5	COMP-5, Unsigned
MF_CMPX	COMP-X
MF_DISP	DISP, Signed
UMF_DISP	DISP, Unsigned
MF_DISPSL	DISP, Sign Leading
MF_DISPSLS	DISP, Sign Leading Separate
MF_DISPST	DISP, Sign Trailing
MF_DISPSTS	DISP, Sign Trailing Separate

Form 1 - Numeric Types	Miscellaneous
ZONED_DECIMAL	Zoned Decimals
ZONED_EBCDIC	Zoned Decimals in EBCDIC
PSIGNF	Packed Decimals
Form 1 - Numeric Types	**EBCDIC Native RM COBOL Types**
ERM_COMP	COMP, Signed
ERM_UCOMP	COMP, Unsigned
ERM_CMP1	COMP-1
ERM_CMP3	COMP-3, Signed
ERM_UCMP3	COMP-3, Unsigned
ERM_CMP6	COMP-6
ERM_DISP	DISP, Signed
ERM_UDISP	DISP, Unsigned
ERM_DISPSL	DISP, Sign Leading
ERM_DISPSLS	DISP, Sign Leading Separate
ERM_DISPST	DISP, Sign Trailing
ERM_DISPSTS	DISP, Sign Trailing Separate
Form 1 - Numeric Types	**EBCDIC Native Micro Focus COBOL Types**
EMF_COMP	COMP, Signed
EMF_UCOMP	COMP, Unsigned
EMF_CMP3	COMP-3, Packed Decimal
EMF_UCMP3	COMP-3, Unsigned
EMF_CMP4	COMP-4, Signed
EMF_UCMP4	COMP-4, Unsigned
EMF_CMP5	COMP-5, Signed
EMF_UCMP5	COMP-5, Unsigned
EMF_COMPX	COMP-X
EMF_DISP	DISP, Signed
EMF_UDISP	DISP, Unsigned
EMF_DISPSL	DISP, Sign Leading
EMF_DISPSLS	DISP, Sign Leading Separate
EMF_DISPST	DISP, Sign Trailing
EMF_DISPSTS	DISP, Sign Trailing Separate

Forms 2-4 Date, Time and Timestamp	Syntax
AMERICAN_DATE	*month*(name or integer)*/day/year*
AMERICAN_TIME	*hour[:minute][:second]* xM
AMERICAN_TIMESTAMP	*month/day/year hour[:minute][:second]* xM
EUROPEAN_DATE	*day.month*(name or integer).*year*
EUROPEAN_TIME	*hour[.minute][.second]*
EUROPEAN_TIMESTAMP	*day.month.year hour[.minute][.second]*
JAPANESE_DATE	*year-month*(name or integer)-*day*
JAPANESE_TIME	*hour[:minute][:second]*
JAPANESE_TIMESTAMP	*Year-month-day hour[:minute][:second]*
ISO_DATE	*year-month*(name or integer)-*day*
ISO_TIME	*hour[.minute][.second]*
ISO_TIMESTAMP	*Year-month-day hour[:minute][:second]*
MONTH_DAY	Jan"<"Feb" and "Wed"<"Thu"
Year 2000 Types	**Syntax**
Y2K_ASCII_YR	*2-digit year*
Y2K_ASCII_JULIAN	*5-digit Julian date*
ASCII Supplement	**Data Example**
ALIGNMENT NONE	" Chars "
ALIGNMENT LEFT	"Chars "
ALIGNMENT RIGHT	" Chars"
CASEFOLD YES	" Chars "
CASEFOLD NO	" CHARS "

Chinese Big5 Multi-Byte Types of Form 6	Collation Order/ Encoding Standard
CHINESE_UNICODE_STROKE	Unicode 5.2.0: http://www.unicode.org/versions/Unicode5.2.0/
CHINESE_BIG5,HK,MO,ROC,TW	Bihua (Stroke) Windows Codepage 950: http://msdn.microsoft.com/en-us/goglobal/cc305155.aspx
CHINESE_BIG5_RARE,HK_RARE, MO_RARE,ROC_RARE,TW_RARE	
CHINESE_BIG5_DIGITS	Encoding order
Chinese GBK Multi-Byte Types of Form 6	**Collation Order/ Encoding Standard**
CHINESE_UNICODE_PINYIN	Unicode 5.2.0: http://www.unicode.org/versions/Unicode5.2.0/
CHINESE_GBK_SIMPLIFIED, PRC_SIMPLIFIED,SG_SIMPLIFIED	Pinyin Windows Codepage 936: http://msdn.microsoft.com/en-us/goglobal/cc305153.aspx
CHINESE_GBK_TRADITIONAL, PRC_ TRADITIONAL, SG_TRADITIONAL	
CHINESE_GBK_TRADITIONAL_RARE, PRC_ TRADITIONAL_RARE, SG_ TRADITIONAL_RARE	
CHINESE_GBK_DIGITS	Encoding order
Japanese Shift_JIS Multi-Byte Types of Form 6	**Collation Order/ Encoding Standard**
JAPANESE_ALPHABET,JP_ALPHABET	Dictionary order Windows Codepage 932: http://msdn.microsoft.com/en-us/goglobal/cc305152.aspx
JAPANESE_HIRAGANA_BIG, JP_HIRAGANA_BIG	
JAPANESE_HIRAGANA_SMALL, JP_HIRAGANA_SMALL	
JAPANESE_HIRAGANA, JP_HIGRAGANA	
JAPANESE_KATAKANA_FULL_BIG, JP_KATAKANA_FULL_BIG	
JAPANESE_KATAKANA_FULL_SMALL, JP_KATAKANA_FULL_SMALL	
JAPANESE_KATAKANA_FULL, JP_KATAKANA_FULL	
JAPANESE_KATAKANA_HALF, JP_KATAKANA_HALF	
JAPANESE_DIGITS,JP_DIGITS	
JAPANESE_UNICODE_ALPHABETIC, JP_UNICODE_ALPHABETIC	Dictionary order Unicode 5.2.0: http://www.unicode.org/versions/Unicode5.2.0/
JAPANESE_UNICODE_HIRAGANA_BIG, JP_UNICODE_HIRAGANA_BIG	
JAPANESE_UNICODE_HIRAGANA_ SMALL,JP_UNICODE_HIRAGANA_ SMALL	
JAPANESE_UNICODE_HIRAGANA, JP_UNICODE_HIRAGANA	
JAPANESE_UNICODE_KATAKANA _FULL_BIG, JP_UNICODE_KATAKANA _FULL_BIG	
JAPANESE_UNICODE_KATAKANA _FULL_SMALL,JP_UNICODE_ KATAKANA _FULL_SMALL	
JAPANESE_UNICODE_KATAKANA _FULL,JP_UNICODE_KATAKANA _FULL	
JAPANESE_UNICODE_KATAKANA_ HALF,JP_UNICODE_KATAKANA_HALF	

Korean KSC5601 Multi-Byte Types of Form 6	Collation Order/ Encoding Standard
KOREAN_HANGUL,KR_HANGUL	Dictionary order Windows Codepage 949: http://msdn.microsoft.com/en-us/goglobal/cc305154.aspx
KOREAN_HANGUL_RARE,KR_ HANGUL_RARE	
KOREAN _DIGITS,KR_DIGITS	
KOREAN_UNICODE_HANGUL, KR_UNICODE_HANGUL	Dictionary order
Standard Unicode Data Types	**Collation Order/ Encoding Standard**
UTF16_UNICODE	Dictionary order
UTF16_DIGITS	Encoding order

Record Reformatting

- Inserts, removes, resizes, and reorders fields within records
- Defines new fields through the use of various field-level functions
- Converts data in fields from one format to another either using internal conversion
- Maps common fields from differently formatted input files to a uniform sort record
- Joins any fields from several files into an output record, usually based on a condition
- Changes record layouts from one file type to another, including: Line Sequential, Record Sequential, Variable Sequential, Blocked, Microsoft Comma Separated Values (CSV), ACUCOBOL Vision, MF I-SAM, MFVL, Unisys VBF, VSAM (within UniKix MBM), Extended Log Format (W3C), LDIF and XML
- Maps processed records to many differently formatted output files
- Writes multiple record formats to the same file for complex report requirements
- Performs mathematical operations and other mathematical functions, such as trigonometric functions, on field data (including aggregate data) to generate new output fields
- Calculates the difference in days, hours, minutes and seconds between two timestamps

Field Reformatting/Validation

- Aligns desired field contents to either the left or right of the target inrec or output field, where any leading or trailing fill characters from the source are moved to the opposite side of the string
- Retrieves and re-maps values from multi-dimensional, tab-delimited lookup files
- Creates and processes sub-strings of original field contents, where you can specify a positive or negative offset (from the left or right, respectively, of the source field) and a number of bytes to be contained in the sub-string
- Finds a user-specified text string in a given field, and replaces all occurrences of it with a different user-specified text string on output
- Supports Perl Compatible Regular Expressions (PCRE), including pattern matching
- Uses C-style "iscompare" functions to validate contents at the field level (for example, to determine if all field characters are printable), which can also be used for record-filtering via /INCLUDE and /OMIT statements
- Protects sensitive field data with field-level de-identification and AES-256 encryption routines, along with anonymization, pseudonymization, filtering and other column-level data masking (obfuscation) techniques
- Supports custom, user-written field-level transformation libraries, and documents an example of a field-level data cleansing routine from Melissa Data (AddressObject)

Record Summarization

- Consolidates records with equal keys into unique records, while totaling, averaging, or counting values in specified fields, including derived (cross-calculated) fields
- Produces maximum, minimum, average, sum, and count fields
- Displays running summary value(s) up to a break (accumulating aggregates)
- Breaks on compound conditions
- Allows multiple levels of summary fields in the same report
- Re-maps summary fields into a new format, allowing relational tables
- Ranks data through a running count of descending numeric values
- Write detail and summary records to the same output file for structured reports

LICENSING INFORMATION

IRI and its expert agents around the world license **CoSort** for perpetual use on individual computer systems. Maintenance (technical support and site-specific software updates) services are provided free of charge during the first year after installation. Subsequent annual maintenance is usually offered at 15% and 20% of the base license fee, and 24/7 technical support is available as an upgrade.

CoSort license fees for Unix systems are based on specific machine make and model numbers. CoSort license fees for x86 Linux and Windows are based on RAM. In either case, additional charges for multiple CPUs and cores are assessed to reflect the performance gains from parallel-processing operations.

License fee discounts apply for multiple copies of CoSort at the same installation, and for runtime integration and redistribution (for ISVs only). IRI is generous with credit for hardware upgrades and migrations, and provides for no- or low-cost fail-over (disaster recovery) licenses.

U.S. educational and 501c(3) non-profit institutions qualify for a 10% license fee discount and government agencies will find CoSort on the GSA schedule.

A confidential license fee quotation and a free 30-day trial are available from your IRI agent, pursuant to a non-disclosure agreement.

A free, 30-day trial period is offered prior to licensing. A non-disclosure agreement must be completed, executed and returned by fax or mail to an IRI agent.

COMPANY BACKGROUND

IRI is an Independent Software Vendor (ISV) specializing in high-performance data sorting and manipulation software. The company was founded as Information Resources, Inc. of New York in May 1978. Its high-performance sort specialists were the first to apply coroutine sort (CoSort) technology off the mainframe and onto personal computers -- CP/M 80 and 86 in 1980 and MS-DOS in 1982. CoSort was then the first commercial Unix sort package, developed in C on an AT&T 3B2 in 1985.

IRI began to grow more rapidly in the early 1990s amid a sort platform downsizing trend that continues to this day. Business improved further from CoSort's adoption in the world's largest Unix data warehouses, and from its unparalleled flexibility in Windows environments. Since the advent of commercial Unix, all major hardware manufacturers, including: HP, IBM, Intel, Siemens, Sun, and Unisys, have continued to seek CoSort benchmarks and cross-certifications while recommending CoSort to their customers. In addition, many leading DBMS, data warehousing, and vertical-industry ISVs -- as well as consultants in these spaces -- embed or recommend the use of CoSort technology within applications to improve performance in high-data volume environments.

During a key expansion in 1995, IRI moved to Melbourne, on Florida's high-technology "Space Coast," and changed its name to Innovative Routines International, Inc. The Company moved to larger space again in 1996, and announced the release of CoSort for Windows NT, Windows 95 and OS/2 Warp. In 1997, CoSort became the first Unix sort package to run across SMP CPUs and set industry performance standards. CoSort version 6.2 sorted a gigabyte in under a minute. Later that year, PC Week declared CoSort the fastest sort for Windows. In 1999, CoSort 7 was introduced, and featured the only single-pass join technology in the sort market, in addition to extensive drill-down aggregation and cross-calculation functionality. Multi-threaded for SMP servers, CoSort 7 also introduced a unique Java GUI to allow users to read and write SortCL specifications and then execute them locally or any networked Windows or Unix platform.

In succeeding years, CoSort saw increased integration into third-party database, data warehouse extract-transform-load (ETL), automation, and e-commerce analytic software. Version 7.5 was an interim release in 2001 that enhanced Internet and international data type support, made the original CoSort API thread-safe, and improved aggregation and reporting features in SortCL. In 2002, IRI also lead the sort world by porting CoSort to Intel's 64-bit Itanium platform and IBM eServer iSeries (AS/400) for Linux and OS/400 PASE. 2003 marked IRI's 25th year and a new "V8 Engine" in CoSort. Using just 6 Sun 12K CPUs, CoSort sorted 2.4GB in 39 seconds, and with just 4 CPUs on an IBM p690, CoSort sorted 1GB in 12 seconds. To serve its rapidly growing base of data warehouse architects, CoSort 8 introduced a new API call for the "sortcl_routine", support for click-stream data types and web log metadata, plus markup language formatting in SortCL for web reporting. Support was announced for Linux and HP-UX on Itanium, and for Linux on IBM zSeries mainframes.

In 2004, IRI enhanced both CoSort's transformation performance and its "point solutions" for its cross-platform users. The Fast Extract (FACT) product was introduced to rapidly unload Oracle tables and build metadata for instant ETL flows through CoSort's SortCL (transformation and reporting engine) and SQL*Loader. That year IRI also "YES!"-certified CoSort for SUSE Linux (SLES) 9 through Novell, and for use on IBM's 64-bit Power5 processor running AIX 5.3. In 2005, IRI released CoSort v8.2, and a robust test data generator and custom file synthesizer based on SortCL called RowGen. That year IRI made CoSort "Red Hat Ready" for Enterprise Linux, and released versions for Solaris 10 on x86, FreeBSD 5.3, and the then latest Unix, Linux and Windows platforms. In 2006, IRI updated its exclusive sort plug-ins for IBM's DataStage and Informatica's PowerCenter ETL suites,

and partnered with Meta Integration Technology to automatically convert file layouts in ETL and BI tool repositories to SortCL and RowGen data definition files. IRI continued to expand its base of resellers and expert consultants around the world, and worked hard to enhance the CoSort, FACT, and RowGen tool sets.

The year 2007 marked the start of the CoSort Version 9 era and a major expansion of functionality and services for solution architects, IT managers, compliance officers, and application developers. In addition to its already combined file processing and presentation (manipulation and reporting) functionality, CoSort's SortCL tool uniquely integrated field-level protections for sensitive files, plus safe test data generation and custom transformations -- all into that same job script and I/O pass. Also introduced as unique features were: built-in processing and cross-conversion support for multi-byte data and file types, including Shift-JIS, Big 5, Unicode, ISAM, LDIF, and XML; multi-file joins and dimensional lookups; and, integrated Perl Compatible Regular Expression (PCRE) logic. In 2008, RowGen v2 went into general release for the creation of massive, safe, and intelligent table and flat-file test sets. IRI also introduced more spin-offs from SortCL, including a unique data encryption and masking tool called FieldShield, and a file-format and data-type conversion tool called NextForm.

In 2009, IRI released improvements to FieldShield and NextForm, and began work on another significant upgrade in CoSort functionality and ergonomics. Released in 2011, CoSort v9.5 can source and target data in relational databases, convert between Unicode and native multi-byte Asian character sets, recognize endianness at the field level, and handle more date and mainframe numeric data types. The new "CoSort Workbench" is an Eclipse plug-in with wizards for job creation, metadata discovery and conversion, and job tuning. The IDE also features a syntax-aware editor for SortCL scripting, and components for database views, version control, and remote execution.

With CoSort 9 and its adjunct tools and connectors, IRI has delivered both standalone solutions and seamless accelerators for high-volume data warehousing, business intelligence, and data security. Please subscribe to our newsletter for more details on the "innovative routines" available today, and those you can expect next.

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