FileFormat

Contents

Description

Action **FileFormat** can be used on file locations (including HDFS and S3) and on Kafka locations.

For file location, it controls how HVR's read and write files. The default format for file locations is HVR's own XML format.

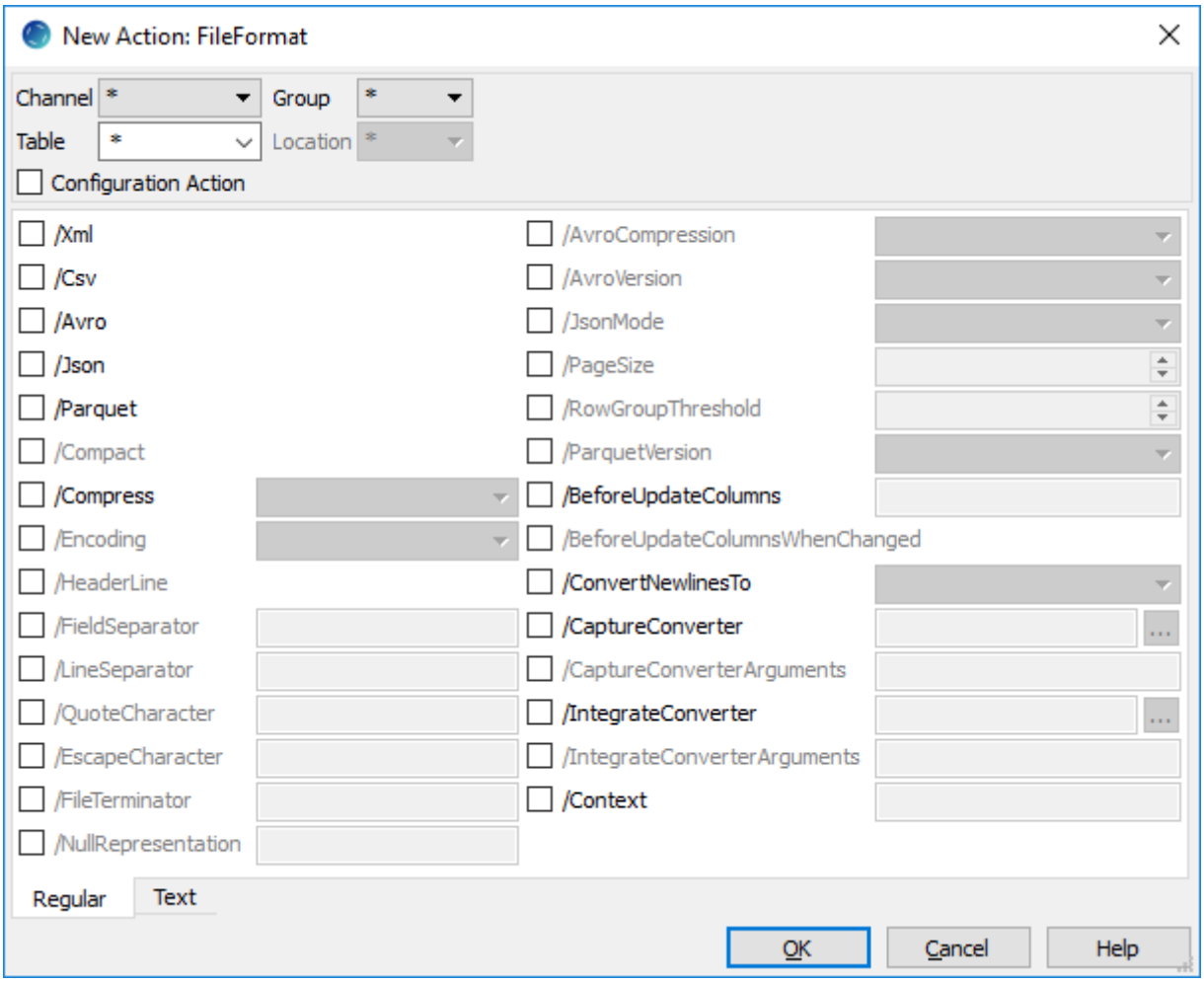
For Kafka, this action controls the format of each message. HVR's Kafka location sends messages in JSON format by default, unless the option **Schema Registry (Avro)** in Kafka location connection is used, in which case each message uses Kafka Connect's compact Avro-based format. Note that this is not a true Avro because each message would not be a valid Avro file (e.g. no file header). Rather, each message is a 'micro Avro', containing fragments of data encoded using Avro's data type serialization format. Both JSON (using mode **SCHEMA_PAYLOAD**, see parameter **/JsonMode** below) and the 'micro AVRO' format conform to Confluent's 'Kafka Connect' message format standard. The default Kafka message format can be overridden by parameter such as **/Xml**, **/Csv**, **/Avro**, **/Json** or **/Parquet**.

A custom format can be used using **/CaptureConverter** or **/IntegrateConverter**. Many parameters only have effect if the channel contains table information; for a 'blob file channel' the jobs do not need to understand the file format.

- If this action is defined on a specific table, then it affects all tables in the same location.
- Defining more than one file format (**Xml**, **Csv**, **Avro**, **Json** or **Parquet**) for the same file location usin g this action is not supported, i.e., defining different file formats for each table in the same location is not possible. For example, if one table has the file format defined as **/XML** then another table in the same location cannot have **/CSV** file format defined.

Parameters

This section describes the parameters available for action **FileFormat**.



Parameter	Argument	Description
/Xml		Read and write files as HVR's XML format. Default. This parameter is only for the channels with table information; not a 'blob file'.
/Csv		Read and write files as Comma Separated Values (CSV) format. This parameter is only for the channels with table information; not a'blob file'.
/Avro		Transforms the captured rows into Avro format during **Integrate**. An Avro file contains the schema defining data types in JSON and a compact binary representation of the data. See Apache Avro documentation for the detailed description of schema definition and data representation. Avro supports primitive and logical data types. The normal way to represent Avro file in human-readable format is converting it to JSON via Apache Avro tools. However, there is a drawback in representing decimal values using standard Avro-tools utilities. The **decimal** type in Avro is supported as a logical type and is defined in the Avro schema file as follows:

		`` { "type": "bytes", "logicalType": "decimal", "precision": precision, "scale": scale } ``` - **Precision** is the total number of digits in the number. - **Scale** is the number of digits after the decimal point. The **decimal** logical type represents an arbitrary-precision signed decimal number of the form **unscaled × 10^{-scale}**. For example, value 1.01 with a precision of 3 and scale of 2, is represented as 101. **Decimal** values are encoded as a sequence of bytes in Avro. In their JSON representation, decimal values are displayed as an unreadable string instead of human-readable values. For example: A source table is defined as follows: ``` create table Dec (c1 number(10,2) , c2 number (10,4)); ``` wherein column c1 stores a decimal value with precision 10 and scale 2, and column c2 stores a decimal value with precision 10 and scale 4. If we insert values (1, 1) into **Dec** table and select them from the table, we expect to see (1, 1) as an output. But Avro format uses the specified scales and represents them in binary format as 100 (1.00) in column c1 and 10000 (1.0000) in column c2. According to the JSON specification, a binary array is encoded as a string. JSON will display these values as "d" (wherein "d" is 100 according to ASCII) and "'\x10" (wherein 10000 is 0x2710, and 0x27 is **'** according to the ASCII encoding). Formats like **/Parquet /ParquetVersion=v2** or **v3**, **/Json /JsonMode=SCHEMA_PAYLOAD** uses the same rules to encode decimal data types. When using Hive (Hive external table) to read Avro files, the **decimal** data type is displayed properly.
/Json		Transforms the captured rows into JSON format during **Integrate**. The content of the file depends on the value for parameter **/JsonMode**.
/Parquet		Transforms the captured rows into Parquet format during **Integrate**.
/Compact		Write compact XML tags like **<r>** & **<c>** instead of **<row>** and **<column>**. This parameter is enabled only if the parameter **/Xml** is selected.

/Compress	*algorithm*	HVR will compress files while writing them, and uncompress them while reading. Available options for *algorithm* are: • **GZIP** • **LZ4** The file suffix is ignored but when integrated, a suffix can be added to the files with action like **Integrate** **/RenameExpression="{hvr_cap_filename}.gz"**.
/Encoding	*encoding*	Encoding for reading or writing files. Available options for *encoding* are: • **US-ASCII** • **ISO-8859-1** • **ISO-8859-9** • **WINDOWS-1251** • **WINDOWS-1252** • **UTF-8** • **UTF-16LE** • **UTF-16BE**
/HeaderLine		First line of CSV file contains column names.
/FieldSeparator	*str_esc*	Field separator for CSV files. The **default** value for this parameter is comma (**,**). Note that only a single Unicode glyph is supported as a separator for this parameter. Examples: **, \x1f** or **\t**. This parameter is enabled only if the parameter **/Csv** is selected.
/LineSeparator	*str_esc*	Line separator for CSV files. The **default** value for this parameter is newline (**\n**). Examples: **;\n** or **\r\n** This parameter is enabled only if the parameter **/Csv** is selected.
/QuoteCharacter	*str_esc*	Character to quote a field with, if the fields contains separators. The **default** value for this parameter is double quotes (**"**). This parameter is enabled only if the parameter **/Csv** is selected.
/EscapeCharacter	*str_esc*	Character to escape the quote character with. The **default** value for this parameter is double quotes (**"**). This parameter is enabled only if the parameter **/Csv** is selected.

/FileTerminator	*str_esc*	File termination at end-of-file. Example: **EOF** or **\xff**. This parameter is enabled only if the parameter **/Csv** is selected.
/NullRepresentation	*str_esc*	String representation for column with NULL value. Note that Hive 'deserializers' recognize **\N** as NULL when reading a CSV file back as an SQL row, this can be configured by setting this parameter to **\\N**". Example: **\\N** This parameter is enabled only if the parameter **/Csv** is selected.
/AvroCompression	*codec*	Codec for Avro compression. Available option for *codec* is: • **Deflate**. This parameter is enabled only if the parameter **/Avro** is selected.
/AvroVersion	*version*	Version of Avro format. Available options for *version* are: • **v1_6**: supports only the following basic types: **Boolean**, **int** (32-bit size), **long** (64-bit size), **float**, **double**, **bytes**, and **string**. • **v1_7**: supports only the following basic types: **Boolean**, **int** (32-bit size), **long** (64-bit size), **float**, **double**, **bytes**, and **string**. • **v1_8** (**default**): supports the above mentioned basic types and the following logical types: **decimal**, **date**, **time** and **timestamp** (with micro and millisecond resolutions), and **duration**. This parameter is enabled only if the parameter **/Avro** is selected.
/JsonMode	*mode*	Style used to write row into JSON format. This parameter is enabled only if the parameter **/Json** is selected. Available options for *mode* are:

- **ROW_FRAGMENTS**: This format is compatible with Hive and BigQuery deserializers. Note that this option produces an illegal JSON file as soon as there is more than one row in the file.
  Example:

```
{ "c1":44, "c2":55 }
{ "c1":66, "c2":77 }
```

- **ROW_ARRAY**:
  Example:

```
[
{ "c1":44, "c2":55 },
{ "c1":66, "c2":77 }
]
```

- **TABLE_OBJECT** (**default** JSON mode for all location classes except for Kafka):
  Example:

```
{ "tab1" : [ { "c1":44, "c2":55 },
{ "c1":66, "c2":77 } ] }
```

- **TABLE_OBJECT_BSON**: This format is the same as **TABLE_OBJECT**, but in BSON format (binary). Note that a BSON file cannot be bigger than 2GB. This makes this format inapplicable for some tables (e.g. when LOB values are present).
- **TABLE_ARRAY**: This mode is useful if **/RenameExpression** does not contain a substitution which depends on the table name and when the location class is not Kafka.
  Example:

```
[
{ "tab1" : [{ "c1":44, "c2":55 },
{ "c1":66, "c2":77 }] },
{ "tab2" : [{ "c1":88, "c2":99 }] }
]
```

- **SCHEMA_PAYLOAD** (**default** JSON mode for location class Kafka): This format is compatible with Apache Kafka Connect deserializers. Note that this option produces an illegal JSON file as soon as there is more than one row in the file.

```
{ "schema": {"type":"struct", "name":"tab1",
"fields": [{"name":"c1", "type":"int"},
{"name":"c2", "type":"int"}]}, "payload": {
"c1": 44, "c2":55 }}
{ "schema": {"type":"struct", "name":"tab1",
"fields": [{"name":"c1", "type":"int"},
{"name":"c2", "type":"int"}]}, "payload": {
"c1": 66, "c2":77 }}
```

/PageSize		Parquet page size in bytes. **Default** value is 1MB. This parameter is enabled only if the parameter **/Parquet** is selected.
/RowGroupThreshold		Maximum row group size in bytes for Parquet. This parameter is enabled only if the parameter **/Parquet** is selected.
/ParquetVersion **Since** v5.3.1/4	*version*	Category of data types to represent complex data into Parquet format. • **v1** : Supports only the basic data types - **boolean**, **int32**, **int64**, **int96**, **float**, **double**, **byte_array** to represent any data. The logical data types **decimal** and **date/time** types are not supported. However, **decimal** is encoded as **double**, and **date/time** types are encoded as **int96**. • **v2** (**default**): Supports all basic data types and one logical data type (**decimal**). The **date/time** types are encoded as **int96**. This is compatible with Hive, Impala, Spark, and Vertica. • **v3** : Supports basic data types and logical data types - **decimal**, **date**, **time_millis**, **time_micros**, **timestamp_millis**, **timestamp_micros**. For more information about parquet data types, refer to Parquet Documentation. This parameter is enabled only if the parameter **/Parquet** is selected.
/BeforeUpdateColumns **Kafka**	*prefix*	By default, the update operation is captured as 2 rows: 'before' and 'after' versions of a row. During the update operation, this option merges these two rows into one and adds user-defined *prefix* to all the columns of the 'before' version. For example: `insert into t values (1, 1, 1)` `update t set c2=2 where c1=1` The output will be as follows: `{"c1": 1, "c2": 2, "c3": 1, "old&c1": 1, "old&c2": 1, "old&c3": 1}` where 'old&' is a user-defined *prefix*

/BeforeUpdateColumnsWhenChanged Kafka		Adds the user-defined *prefix* (**/BeforeUpdateColumns**) only to columns, in which values were updated. This is supported only for JSON and XML formats. This option can be applied only when **/BeforeUpdateColumns** is selected. For example: `insert into t values (1, 1, 1)` `update t set c2 =2 where c1=1` The output will be as follows: `{"c1": 1, "c2": 2, "c3": 1, "old&c2": 1}` where 'old&' is a *prefix* defined for the **/BeforeUpdateColumns** option.
/ConvertNewlinesTo	*style*	Write files with **UNIX** or **DOS** style newlines.
/CaptureConverter	*path*	Run files through converter before reading. Value *path* can be a script or an executable. Scripts can be shell scripts on Unix and batch scripts on Windows or can be files beginning with a 'magic line' containing the interpreter for the script e.g. **#!perl**. A converter command should read from its **stdin** and write to **stdout**. Argument *path* can be an absolute or a relative pathname. If a relative pathname is supplied the command should be located in **$HVR_HOME/lib/transform**.
/CaptureConverterArguments	*userarg*	Arguments to the capture converter.
/IntegrateConverter	*path*	Run files through converter before writing. Value *path* can be a script or an executable. Scripts can be shell scripts on Unix and batch scripts on Windows or can be files beginning with a 'magic line' containing the interpreter for the script e.g. **#!perl**. A converter command should read from its **stdin** and write to **stdout**. Argument *path* can be an absolute or a relative pathname. If a relative pathname is supplied the command should be located in **$HVR_HOME/lib/transform**.
/IntegrateConverterArguments	*userarg*	Arguments to the integrate converter program.
/Context	*context*	Action only applies if **Refresh** or **Compare** context matches.

HVR's XML Format

The XML schema used by HVR can be found in **$HVR_HOME/lib/hvr.dtd**.

Simple Example

Following is a simple example of an XML file containing changes which were replicated from a database location.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<hvr version="1.0">
<table name="dm01_product">
<row>
<column name="prod_id">1</column>
<column name="prod_price">30</column>
<column name="prod_descrip">DVD</column>
</row>
<row>
<column name="prod_id">2</column>
<column name="prod_price">300</column>
<column name="prod_descrip" is_null="true"/>
</row>
</table>
</hvr>
```

Extended Example

Following is an extended example of HVR's XML.

1. Create tables in Oracle:

   ```
   create table mytab (aa number not null, bb date, constraint mytab_pk
   primary key (aa));
   create table tabx (a number not null, b varchar2(10) not null, c blob,
   constraint tabx_pk primary key (a, b));
   ```

2. Switch to a different user to create new table with same name.

   ```
   create table tabx (c1 number, c2 char(5), constraint tabx_pk primary
   key (c1));
   ```

3. Defined an HVR channel with the following actions:

Group	Table	Action	Remarks
SOURCE	*	**Capture**	
TARGET	*	**Integrate**	
TARGET	*	**ColumnProperties /Name=hvr_op_val /Extra /IntegrateExpression={hvr_op}**	Causes an extra column named **hvr_op_val** to be shown, which indicates the operation type (**0**=delete, **1**=insert, **2**=update, **3**=before key update, **4**=before non-key update).
TARGET	*	**ColumnProperties /Name=hvr_timekey /Extra /IntegrateExpression={hvr_integ_key} /TimeKey**	This is needed if the target location is a file or Kafka location to replicate delete operations.

4. Apply changes to the source database using the following SQL statements:

```
insert into tabx (a,b,c)                        -- Note: column c
contains binary/hex data
    values (1, 'hello',
'746f206265206f72206e6f7420746f2062652c007468617420697320746865');
insert into tabx (a,b,c)
    values (2, '<world>', '7175657374696f6e');
insert into mytab (aa, bb) values (33, sysdate);
update tabx set c=null where a=1;
commit;
update mytab set aa=5555 where aa=33;  -- Note: key update
delete from tabx;                                  -- Note: deletes
two rows
insert into user2.tabx (c1, c2)            -- Note: different tables
share same name
    values (77, 'seven');
commit;
```

The above SQL statements would be represented by the following XML output.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<hvr version="1.0">
        <table name="tabx">
                <row>
                        <column name="hvr_op_val">1</column>
            <column name="hvr_timekey">5FFEF1E300000001</column>
                        <column name="a">1<
/column>                                <-- Note: Hvr_op=1 means insert -->
                        <column name="b">hello</column>
                        <column name="c" format="hex">                  <--
Note: Binary shown in hex       -->

<-- Note: Text after hash (#) is comment -->
                                746f 2062 6520 6f72 206e 6f74 2074
6f20               # to be or not to
                                6265 2c00 7468 6174 2069 7320 7468
65                # be,.that is the
                        </column>
                </row>
                <row>
                        <column name="hvr_op_val">1</column>
             <column name="hvr_timekey">5FFEF1E300000002</column>
                        <column name="a">2</column>
                        <column name="b"><world></column>               <--
Note: Standard XML escapes used -->
                        <column name="c" format="hex">
                                7175 6573 7469
6f6e                                    # question
                        </column>
                </row>
        <
/table>
<-- Note: Table tag switches current table -->

        <table name="mytab">
                <row>
```

```
                        <column name="hvr_op_val">1</column>
             <column name="hvr_timekey">5FFEF1E300000003</column>
                        <column name="aa">33</column>
                        <column name="bb">2012-09-17 17:32:27<
/column>        <-- Note: HVRs own date format -->
                </row>
        </table>

        <table name="tabx">
                <row>
                        <column name="hvr_op_val">4</column>        <--
Note: Hvr_op=4 means non-key update before -->
            <column name="hvr_timekey">5FFEF1E300000004</column>
                        <column name="a">1</column>
                        <column name="b">hello</column>
                </row>

<row>
  <-- Note: No table tag because no table switch -->
                        <column name="hvr_op_val">2</column>        <--
Note: Hvr_op=2 means update-after -->
            <column name="hvr_timekey">5FFEF1E300000005</column>
                        <column name="a">1</column>
                        <column name="b">hello</column>
                        <column name="c" is_null="true"
/>                  <-- Note: Nulls shown in this way -->
                </row>
        </table>

        <table name="mytab">
                <row>
                        <column name="hvr_op_val">3</column>        <--
Note: Hvr_op=4 means key update-before -->
            <column name="hvr_timekey">5FFEF1E300000006</column>
                        <column name="aa">33</column>
                </row>
                <row>
                        <column name="hvr_op_val">2</column>
            <column name="hvr_timekey">5FFEF1E300000007</column>
                        <column name="aa">5555</column>
                </row>
        </table>

        <table name="tabx">
                <row>
                        <column name="hvr_op_val">0</column>        <--
Note: Hvr_op=0 means delete -->
            <column name="hvr_timekey">5FFEF1E300000008</column>
                        <column name="a">1</column>
                        <column name="b">hello</column>
                        <column name="c" is_null="true"/>
                </row>
                <row>
                        <column name="hvr_op_val">0</column>        <--
Note: One SQL statement generated 2 rows -->
            <column name="hvr_timekey">5FFEF1E300000009</column>
                        <column name="a">2</column>
```

```
                        <column name="b"><world></column>
                        <column name="c" format="hex">
                                7175 6573 7469
6f6e                                    # question
                        </column>
                </row>
        </table>

        <table name="tabx1">        <-- Note: Name used here is channels
name for table.   -->
                                                    <-- Note: This may differ
from actual table 'base name' -->
                <row>
                        <column name="hvr_op">1</column>
            <column name="hvr_timekey">5FFEF1E300000010</column>
                        <column name="c1">77</column>
                        <column name="c2">seven</column>
                </row>
        </table>
</hvr>                          <-- Note: No more changes in replication cycle
-->
```

Capture and Integrate Converters

Environment

A command specified with **/CaptureConverter** or **/IntegrateConverter** should read from its **stdin** and write the converted bytes to **stdout**. If the command encounters a problem, it should write an error to **stderr** and return with exit code **1**, which will cause the replication jobs to fail. The transform command is called with multiple arguments, which should be defined with **/CaptureConverterArguments** or **/IntegrateConverterArguments**.

A converter command inherits the environment from its parent process. On the hub, the parent of the parent process is the HVR Scheduler. On a remote Unix machine, it is the **inetd** daemon. On a remote Windows machine it is the HVR Remote Listener service. Differences with the environment process are as follows:

- Environment variables **$HVR_CHN_NAME** and **$HVR_LOC_NAME** are set.
- Environment variable **$HVR_TRANSFORM_MODE** is set to either value **cap**, **integ**, **cmp**, **refr_read** or **refr_write**.
- Environment variable **$HVR_CONTEXTS** is defined with a comma–separated list of contexts defined with HVR Refresh or Compare (option **–C***ctx*).
- Environment variables **$HVR_VAR_***XXX* are defined for each context variable supplied to HVR Refresh or Compare (option **–V***xxx*=*val*).
- For file locations variables **$HVR_FILE_LOC** and **$HVR_LOC_STATEDIR** are set to the file location's top and state directory respectively.
- For an integrate converter for 'blob' file channel without table information and for all capture converters, environment variables **$HVR_CAP_LOC**, **$HVR_CAP_TSTAMP**, **$HVR_CAP_FILENAME** and **$HVR_CAP_SUBDIRS** are set with details about the current file.
- Environment variable **$HVR_FILE_PROPERTIES** contains a colon–separated *name=value* list of other file properties. This includes values set by 'named patterns' (see **Capture /Pattern**).
  If a channel contains tables: Environment variable **$HVR_TBL_NAMES** is set to a colon–separated list of tables for which the job is replicating or refreshing (for example **HVR_TBL_NAMES=tbl1:tbl2:tbl3**). Also variable **$HVR_BASE_NAMES** is set to a colon–separated list of table 'base names', which are prefixed by a schema name if **TableProperties /Schema** is defined (for example **HVR_BASE_NAMES=base1:sch2.base2:base3**). For modes **cap_end** and **integ_end** these variables are restricted to only the tables actually processed. Environment variables **$HVR_TBL_KEYS** and **$HVR_TBL_KEYS_BASE** are colon–separated lists of keys for each table specified in **$HVR_TBL_NAMES**

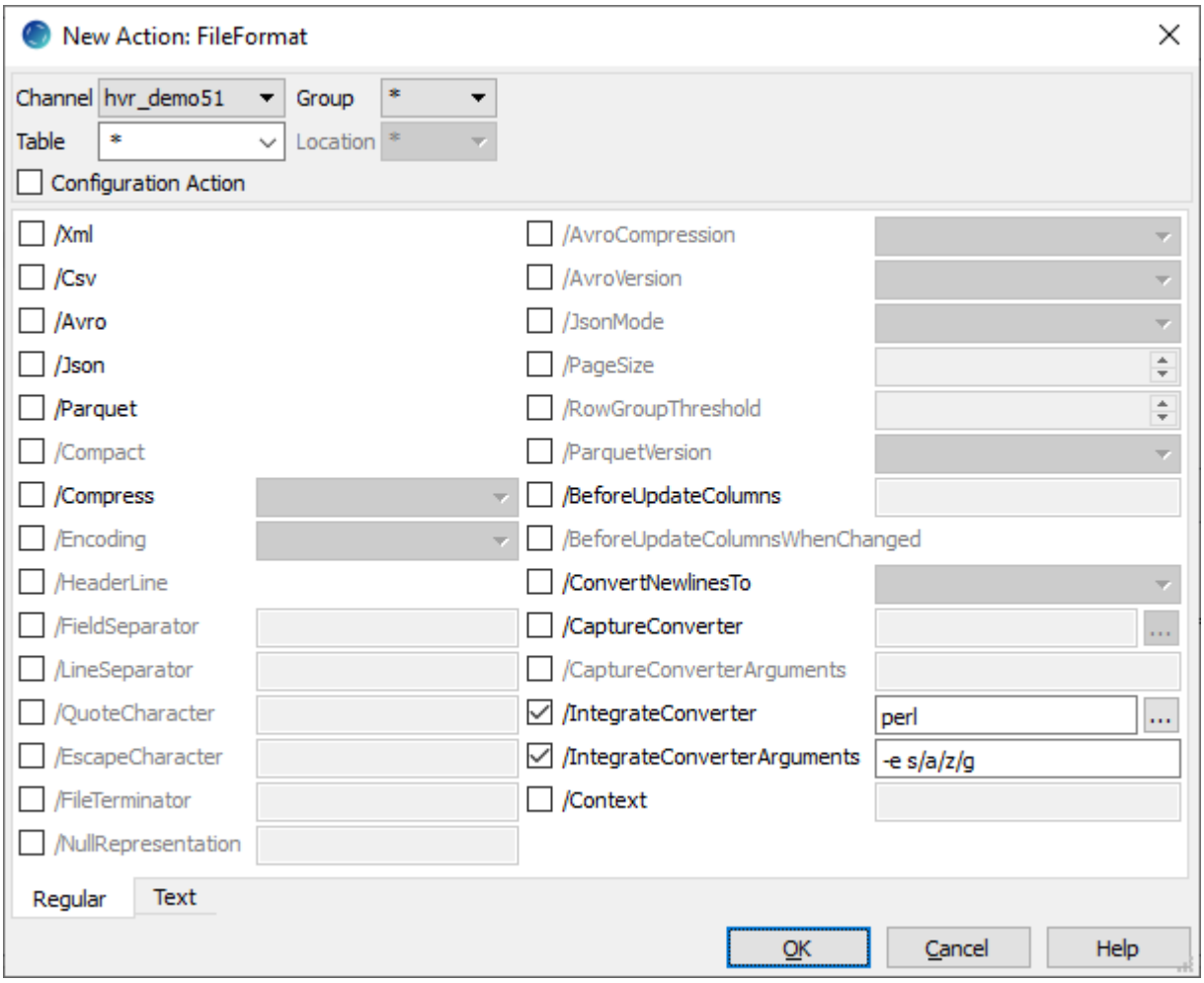
(e.g. **k1**,**k2:k:k3**,**k4**). The column list is specified in **$HVR_COL_NAMES** and **$HVR_COL_NAMES_BASE**. Any variable defined by action **Environment** is also set in the converter's environment.

- The current working directory is **$HVR_TMP**, or **$HVR_CONFIG/tmp** if this is not defined.
- **stdin** is redirected to a socket (HVR writes the original file contents into this), whereas **stdout** and **stderr** are redirected to separate temporary files. HVR replaces the contents of the original file with the bytes that the converter writes to its **stdout**. Anything that the transform writes to its **stderr** is printed in the job's log file on the hub machine.

The output of a capture converter must conform the format implied by other parameters of this **FileFormat** action. Therefore if **/Csv** is not defined then the command should be XML.

Examples

A simple example is **FileFormat /IntegrateConverter=perl /IntegrateConverterArguments="-e s/a/z/g"**. This will replace all occurrences of letter **a** with **z**.



Directory **$HVR_HOME/lib/transform** contains other examples of command transforms written in Perl. Converter **hvrcsv2xml.pl** maps CSV files (Comma Separated Values) to HVR's XML.

Converter **hvrxml2csv.pl** maps HVR's XML back to CSV format. And **hvrfile2column.pl** maps the contents of a file into a HVR compatible XML file; the output is a single record/row.