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A company of the ATLAS ELEKTRONIK Group

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ATLAS Sounding Data (ASD) Format
for ATLAS PARASOUND and ATLAS HYDROSWEEP

Part 1 of 1

Bremen, 2012-02-06

Revision History

Issue	Date	Description
2.0	20-02-2004	Document replaces the PARASOUND DS-2 Sounding Data Format specification (latest issue 1.1) and extends this document for ATLAS PARASOUND and ATLAS HYDROSWEEP systems
2.1	25-11-2004	Removed term “ID” from ASD file name syntax
3.0	11-10-2005	Added details relevant for side scan data sets
3.1	03-04-2007	Remark concerning Schema documentation with version 2.x
3.2	26-02-2010	Changed PLS to SLS
3.3	17-11-2010	Added specification for reduced ASD files without binary part
3.5	06-02-2012	Added specification for interferometric phase data (IPH)

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1 Scope

This document specifies the format of the raw data files provided by the ATLAS Hydrographic systems

ATLAS PARASOUND DS-2

ATLAS PARASOUND

ATLAS HYDROSWEEP

2 Introduction

The ATLAS Sounding Data (ASD) format is a file oriented data format. It is designed for the purpose of formatting sounding profiles, i.e. series of measured amplitudes over time.

Each single ASD file contains the complete information about it's contents, i.e. there is no requirement for references within an ASD file. This allows simple archiving and data distribution processes.

The ASD format serves as container for different types of data. The section *3 File Naming* describes how the data type of an ASD file can be easily determined by evaluating the file name only. The naming of ASD files is essential and must be seen as inherent with the ASD format specification.

Note: A change of the name of an ASD file makes this file incompatible with the ASD format specification.

ASD files consist out of an ASCII part followed by a binary coded part. For this reason ASD files are characterized as *hybrid* data files. Refer to section *4 File Content Structure* for a description of the contents.

Note: This document uses a common approach for the notation of hexadecimal figures. A prefix '0x' defines that the following figure has the base 16, e.g. 0xFF equals to the decimal figure 255.

3 File Naming

The file name of an ASD file is an essential component of the ASD format specification. It allows for a quick access to the information about the type of system that provided this ASD file and the type of data that the file contains.

The ASD file name syntax is defined as follows:

`<system><type>_<date>T<time>Z_<identNo>.asd`

The terms in the angle brackets '<>' have to be replaced as follows:

`<system>` "PS2" – ATLAS PARASOUND DS-2
"PS3" – ATLAS PARASOUND
"HS3" – ATLAS HYDROSWEEP

`<type>` specifies the type of data. It can be distinguished between beam amplitude and side scan amplitude series. The type specifier can be:

for system "PS2":
"NBS" – high frequency channel beam amplitudes
"PAR" – low frequency parametric beam amplitudes

for system "PS3" or "HS3":
"PLF" – primary low frequency beam amplitudes
"PHF" – primary high frequency beam amplitudes
"SLF" – secondary low frequency beam amplitudes
"SHF" – secondary high frequency beam amplitudes
"PHS" – primary high frequency channel side scan amplitudes
"SLS" – secondary low frequency channel side scan amplitudes
"SHS" – secondary high frequency channel side scan amplitudes

`<date>` CCYY-MM-DD (e.g. 2003-01-31 for the 31.Jan.2003)
is the date when the file had been created

`<time>` HHMMSS (e.g. 235500, if it is 5 minutes to midnight)
is the time the file had been created. Time base is UTC.

`<identNo>` is a unique[1] number in order to identify a certain file. The `identNo` is unique with respect to a dedicated system/data type combination. E.g., a PS3PHF result file can have the same `identNo` as a PS3SLF result file. The `identNo` is padded with zeros to a length of 8 digits.

[1] The term 'unique' is restricted in that sense that it jumps to one in case of the overflow after 100,000,000 soundings of the same type.

Examples:

```
PS3SLF_2004-01-31T235500Z_00004711.asd
PS2NBS_2003-05-12T000130Z_00001958.asd
```

The date and time notation is in accordance with the ISO 8601 standard (with a separating capital 'T' and the 'Z' for 'Zulu', i.e. UTC time).

4 File Content Structure

ATLAS sounding data files are hybrid files. They consist out of an ASCII coded part which has a well-formed XML structure and of a binary part containing the sounding beam amplitudes or side scan amplitudes in a compact (binary) format.

Note: A special case is the reduced sounding data file. This kind of ASD file does not contain a binary part. Refer to the next chapter for more details about this.

The diagram below shows the general structure. A sounding file contains *n* soundings. Each sounding has *m* beams.

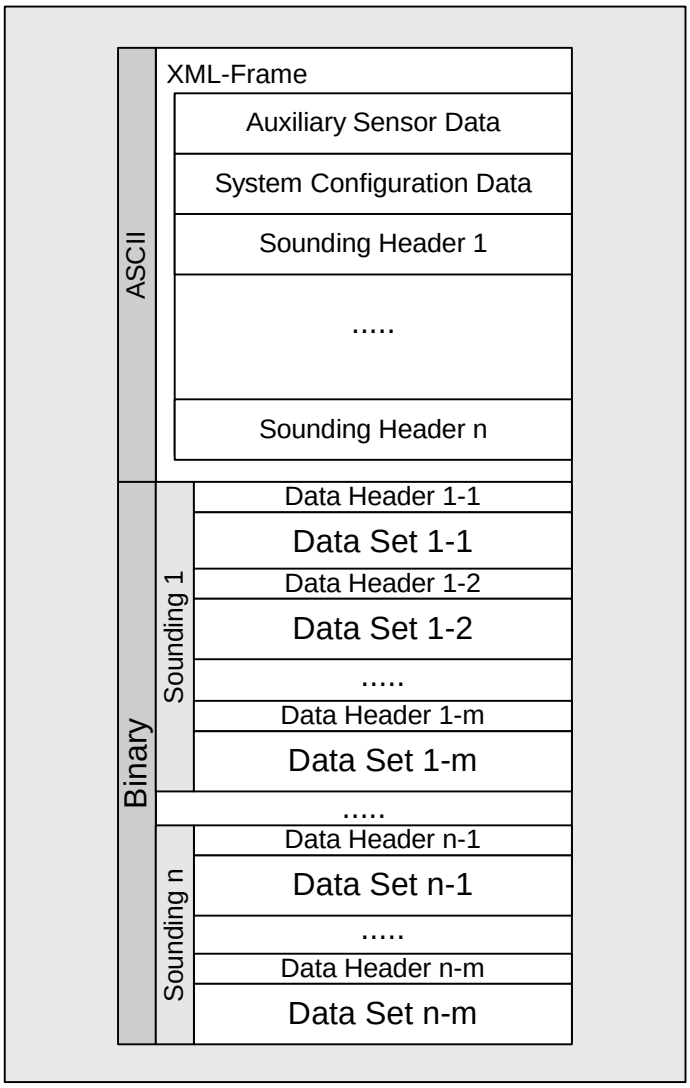

Figure 4-1: Hybrid Sounding Data File Structure

4.1 XML Part

The XML format specification is a standard of the World Wide Web Consortium (W3C). Refer to [1] for detailed information.

XML documents are based on Unicode. The XML part of the ATLAS Hydrographic sounding data files are ASCII coded, which is a subset of Unicode and allows reading this part with simple tools. Furthermore an internet browser can be used to visualize XML data in a structured and colored view.

The structure of an XML file can be described by a *schema*. A schema is a separate file of type XSD. An XML file which fulfils all constraints that the according schema requires is called a 'valid' XML file. A valid XML file is an instance of the schema (XSD file) it is referred to.

For this reason the documentation of an XML file is the documentation of the according XSD file. ATLAS Hydrographic provides this documentation as described in section *5 Schema Documentation Release History*.

All separate ASD format documents underlie an individual version control. In fact this means that the complete ASD format specification consists of **three** separate versions:

1. Version of the binary part of an ASD file. This document contains the relevant information for that. See the notes below.
2. Version of the XML part for ATLAS PARASOUND DS-2 systems. Refer to *5 Schema Documentation Release History* and see the notes below.
3. Version of the XML part for ATLAS PARASOUND and ATLAS HYDROSWEEP systems. Refer to *5 Schema Documentation Release History* and see the notes below.

Notes: *a) Binary part version number:*
The binary part specification versions are described in this document. This description refers to all released versions. The binary part version number of an ASD file shall be determined by evaluation of the binary header which contains the version number.

b) XML part version number:
The XML part version number is per definition the version number of the schema. Each ASD file contains the version label within the comment field at line 2 (see Figure 4-2) .
Within the schema documentation HTML file the namespace is nominated in the third line of the documentation as 'targetNamespace'. E.g. for version 1.0 the targetNamespace equals to "ps2_xml_schema_vers1_0" for ATLAS PARASOUND DS-2 systems and "asd_xml_schema_vers1_0" for ATLAS PARASOUND or ATLAS HYDROSWEEP systems. See Figure 4-3.

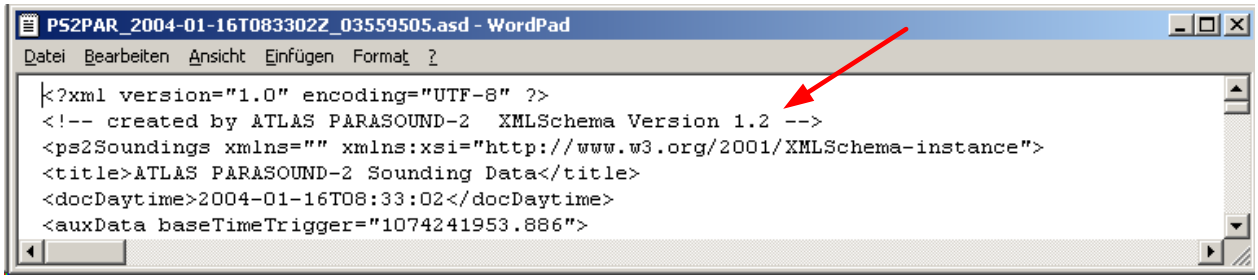

Figure 4-2: Begin of an ASD file example (PARASOUND DS-2)

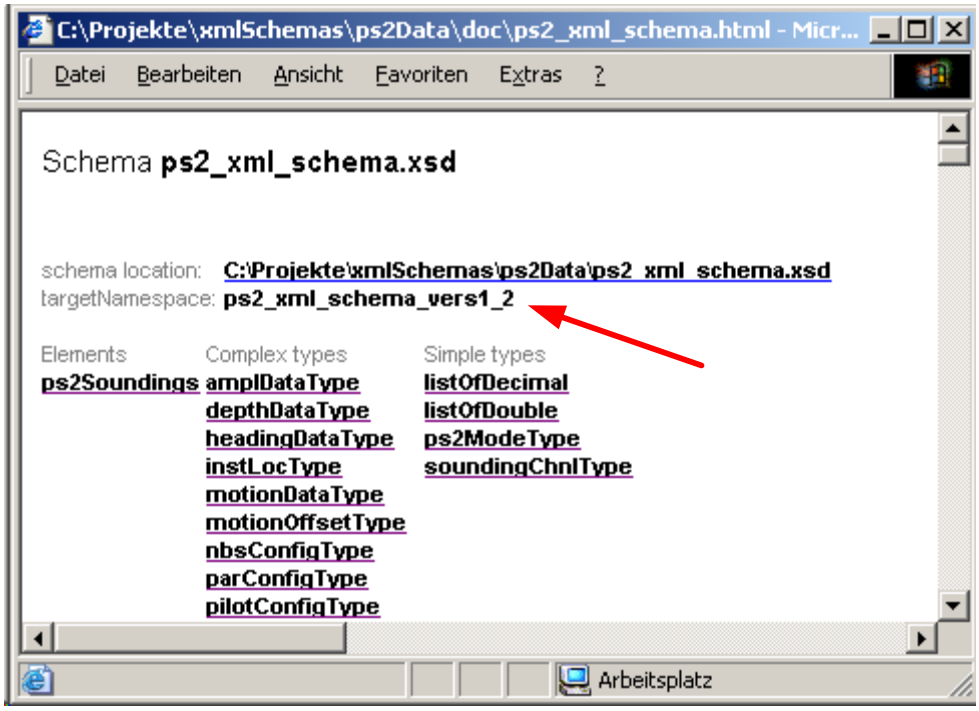

Figure 4-3: Begin of ASD Schema Documentation

4.1.1 Reduced ASD File

Reduced ASD files do not contain profile data sets. This means that they consist out of the XML part only. The XML part contains the full information as already implemented, but the attribute *noScans* at the "amplitudes" element is always set to zero.

```
<soundings xmlns="asd_xml_schema_vers2_0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="asd_xml_schema_vers2_0 asd_xml_schema.xsd" title="ATLAS Sounding Data" system="ATLAS
HYDROSWEEP DS" docDaytime="2006-02-14T14:41:30Z" noOfSoundings="1" reducedASD="true">
      <installation…..

…..
         <profiles subIdentNo="2" shading="1" pulseNoRef="1">
            <direction abs="true" N="0.000000" E="0.017499" D="0.999847"/>
         <amplitudes noScans="0" startTimeRel2TRG="0.275677" scanInterval="1.310723e-003"/>
         </profiles>
    </sounding>
</soundings>
```

Notes:

1. *The ASD file does not contain a binary part. No "Binary Header Separator" can be found.*
2. *A mix of soundings with and without a profile data set is not allowed. I.e., either the complete set of binary profile data sets or no binary profile data is possible.*
3. *Reduced ASD files contain an additional attribute named "reducedASD" of type boolean. This is set to true for reduced ASD files.*

4.2 Binary Part

The binary part of the sounding data file contains the beam amplitude time series or the side scan amplitude time series of soundings. It consists out of *Binary Data Header* and *Binary Data Set* pairs (see sections *4.2.1 Binary Data* Header and *4.2.2 Binary Data Set*).

A sounding data file can contain the amplitudes of a single sounding as well as the data of several soundings. Furthermore, a sounding may consist out of several binary data sets. The number of binary data sets is the number of beams respectively the number of side scan directions within one sounding. E.g., a single-beam sounding has only one related binary data set. Binary data sets of a certain sounding do all have the same "`Ident Number`", but are marked with individual "`Subident Number`"s. For single-beam soundings (e.g. ATLAS PARASOUND DS-2), there is only one "`Subident Number`", which is always zero.

There are two ways to determine the number of soundings that are in a single sounding data file. The easiest way is to look at the XML part of the sounding data file. It contains an element (ATLAS PARASOUND DS-2) respectively an attribute (ATLAS PARASOUND and ATLAS HYDROSWEEP) named "`noOfSoundings`" which holds the information.

Note: The number of soundings must be multiplied with the content of the '`noOfAmplDataSets`' attribute in order to obtain the total number of binary data sets in a sounding data file. For ATLAS PARASOUND DS-2 data files, there is always only one binary data set per sounding, i.e. '`noOfAmplDataSets`' is always 1 and for this reason <u>not</u> contained in ASD files of PS2 systems.

The second way to determine the number of soundings is to parse the binary part of the sounding data file and proceed from data set to data set until the end is reached.

4.2.1 Binary Data Header

The binary header is 32 bytes long (counting from byte 0 to byte 31). The latest version of the binary header is version 1.1.

A certain ASD file always contains only one type of binary data header version.

Version 1.0:

Binary Data Header (*Version 1.0*)		
Byte #	Content	Name
0...3	0xFFFFFFFF	Binary Header Separator
4...5	0x0020	Header Length (32 Byte)
6...7	0x0002	Bytes Per Sample
8..11	0xhhhhhhhh	Number of Samples (h = 0..F)
12..15	0x30313030	Header Version ("0100" for Version 1.0)
16..19	0x20TTTTTT	Data Type, e.g. "_PAR" (resp. T see below) ('_' is a space; 0x20)
20..27	0x######## 0x########	Ident Number (resp. # see below)
28..31	0x00000000	Reserve (don't care)

Version 1.1:

The binary header version 1.1 introduces the field '`Subident Number`'. Therefore the reserve field has been shortened to two bytes.

Binary Data Header (*Version 1.1*)		
Byte #	Content	Name
`0...3`	`0xFFFFFFFF`	Binary Header Separator
`4...5`	`0x0020`	Header Length (32 Byte)
`6...7`	`0xhhhh`	Bytes Per Sample
`8..11`	`0xhhhhhhhh`	Number of Samples (h = 0..F)
`12..15`	`0x30313031`	Header Version ("0101" for Version 1.1)
`16..19`	`0x20TTTTTT`	Data Type, e.g. "_PLF (resp. T see below) ('_' is a space; 0x20)
`20..27`	`0x########` `0x########`	Ident Number (resp. # see below)
`28..29`	`0xhhhh`	Subident Number
`30..31`	`0xhhhh`	Flags 0..15 0 – Complex sample 1 – Polar Coordinates 2..15 - Reserve (don't care)

The items of the binary header are defined as follows:

Binary Header Separator — Four bytes with all bits set. It is allowed to search the first binary header in a sounding data file by searching this pattern, because the XML part does not contain such a pattern. Within the binary part of a sounding data file it is not guaranteed that this pattern will not appear in the amplitude time series. It is strongly recommended to evaluate the binary part of a sounding data file by stepping from binary header to binary header by using the *Number of Samples* field information.

Header Length — Contains the length of this header which is 32 Bytes for all versions.

Bytes Per Sample — Indicates the length of one sample in the binary data set. A sample might be a complex figure which is a combination of two numbers, e.g. two 32 bit numbers. In this case, a sample is represented by 8 bytes. Refer to the *Flags* specification for more details about the definitions of a sample.

Number of Samples — This value specifies the number of samples in the binary data set which follows this header. An amplitude sample requires '*Bytes Per Sample*' bytes each which means that multiplying this value with the '*Bytes Per Sample*' item results in the number of bytes in the binary data set. This is an unsigned binary variable, e.g. 0x00010000 defines 65.536 samples or 131.072 bytes, if '*Bytes Per Sample*' is 2.

Header Version — The version number of this binary header, which is "0100" resp. "0101" (always in ASCII format!) for version 1.0 resp. 1.1.

Data Type

This field contains the type of data which follows this header. In accordance with the ASD file naming convention, the possible data types are:

for PS2 systems:
"_NBS" – high frequency channel beam amplitudes
"_PAR" – low frequency parametric beam amplitudes

for PS3 or HS3 systems:
"_PLF" – primary low frequency beam amplitudes
"_PHF" – primary high frequency beam amplitudes
"_SLF" – secondary low frequency beam amplitudes
"_SHF" – secondary high frequency beam amplitudes
"_PHS" – primary high frequency channel side scan amplitudes
"_SLS" – primary low frequency channel side scan amplitudes
"_SHS" – secondary high frequency channel side scan amplitudes

additionally for HS3 multibeam data
"_IPH" – interferometric phase data (alternating with "PHF" data)

additionally for side scan data files:
"_IDX" – index list as beam/target reference (refer to 4.2.2.1)

Rem.: the underline '_' character stands for a space character, 0x20 hex).
Note: With PS3 the type will be usually the same for all headers in one sounding data file. However with HS3 interferometric phase data can be included, where typically the "IPH" type data follows the "PHF" data of the same beam.
An other exception is the "IDX" type which appears in conjunction with side scan data sets (see 4.2.2.1).

Ident Number

The unique identification number of the sounding. This field comprises eight bytes for eight ASCII coded decimal digits. Ident numbers with less than eight digits are padded with ASCII zero characters. For example the ident number 4711 leads to
`4711 == 0x30 0x30 0x30 0x30 0x34 0x37 0x31 0x31`
Note: The ident number of the first binary header in a sounding data file is identical with the ident number part of the sounding data file name.

Subident Number

Version 1.1 only!
If a sounding consists out of more than one amplitude profile (multibeam), this number differs between the different beam directions of the sounding. The subident number is a reference to the XML part of the sounding data file. Each 'amplData' structure element of the sounding has an attribute named 'subIdentNo'. This section in the XML part then contains, among others, the beam direction.
The subident numbers are unsigned binary values. A value like 0x0010 specifies a sounding profile number 16. The first subident number of a sounding begins with zero (0x0000). The number of available profiles within one sounding, i.e. the range of the subident number, must be taken from the appropriate 'noOfAmplDataSets' element in the XML part of the sounding data file.

Flags

Version 1.1 only!
This field defines a set of up two 16 bits that serve to signal special conditions upon the binary data sets. Currently, the following bits are defined:

0 -	if set, the samples are complex numbers, i.e. one sample consists out of two components (refer to bit 1 for more information).
1 -	valid only, if bit 0 is set: if this bit is set, the samples are in polar coordinates else in Cartesian coordinates
2..15	not used

Examples: 0x0000 = real numbers
0x0001 = complex numbers with real and imaginary part
0x0003 = complex numbers in polar coordinates

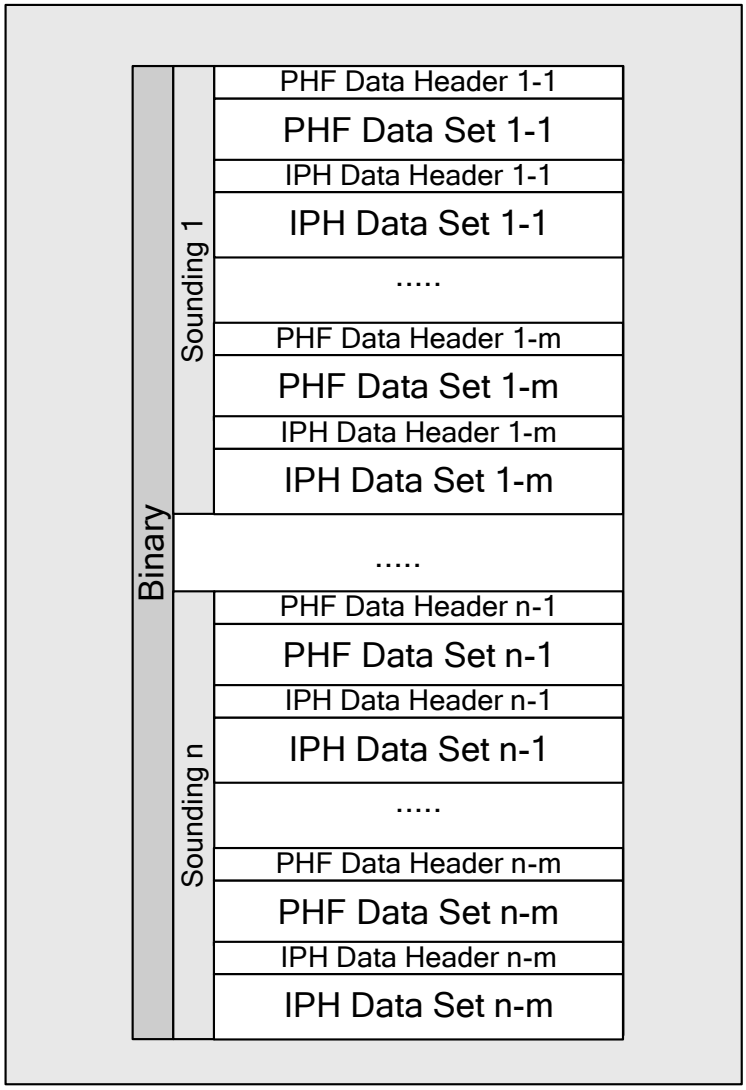

Figure 4-4: Binary Data with "IPH"-Data

4.2.2 Binary Data Set

The binary data set of the sounding data set contains the acquired amplitudes. Each amplitude sample takes "`Bytes Per Sample`" bytes (see header) and is stored as **big-endian** value respectively **big-endian** values in case of complex numbers. Regarding big-endian notification see the note below.

In case of complex amplitude values, the real part is the first part (lower storage address) followed by the imaginary part. If the representation is in polar coordinates, the modulus comes first, followed by the phase angle ranging from –pi to pi.

Note:

The internal representation of data in the memory of a computer differs. This difference can be caused by the used operating system, the development environment (compiler, programming language) or the CPU of a certain platform.

The CPU of a computer determines the sequence, in which a data value (a sequence of bytes) is stored. Machines, which store the most significant value first (at the lowest storage address) are named 'big-endian' systems. Most RISC-based and the Motorola CPU based systems are 'big-endian's'. 'Little-endian' machines are working with the reverse order, i.e. the least significant value is stored first. Intel CPU's and the DEC Alpha CPU are examples for this architecture.

The bit order within a byte is not affected by this. The bit order is the same for all CPU's.

In order to interpret an amplitude sample, further information from the XML part of the sounding data file is required.

There the analogue-digital converter (ADC) configuration is stored with the gain, the scale factor and the range.

The absolute time of the first amplitude sample is contained in the XML part as a relative offset to the trigger instance of the sounding. All following amplitude samples within a time series are equidistant. The interval shall be taken from the XML part, too.

Refer to the XML documentation as mentioned in section *5 Schema Documentation Release History* for further details.

4.2.2.1 Side Scan Data Sets

Like beam data profiles, side scan data sets are stored as amplitude over time profiles. The direction of a side scan profile shall be taken from the '`direction`' element of the appropriate '`profiles`' branch at the XML part of the ASD file. The attribute "`subIdentNo`" of the '`profiles`' element must match with the *Subident Number* of the binary data header.

Side scan samples are obtained from beam data profiles. With the means of an index list, each side scan sample can be referenced with a certain beam direction or even with the beam data set itself. The index list is an additional binary data set that usually follows each side scan data set. It contains indices that refer to "`index`" attribute of targets in the XML part of the same ASD file. The number of indices is identical with the number of side scan samples within the preceeding binary side scan data set. The length of an index entry is given by the *Bytes Per Sample* parameter in the according binary header. It is urgently recommended to evaluate this parameter in order to avoid data mismatches in case of changes of this length.

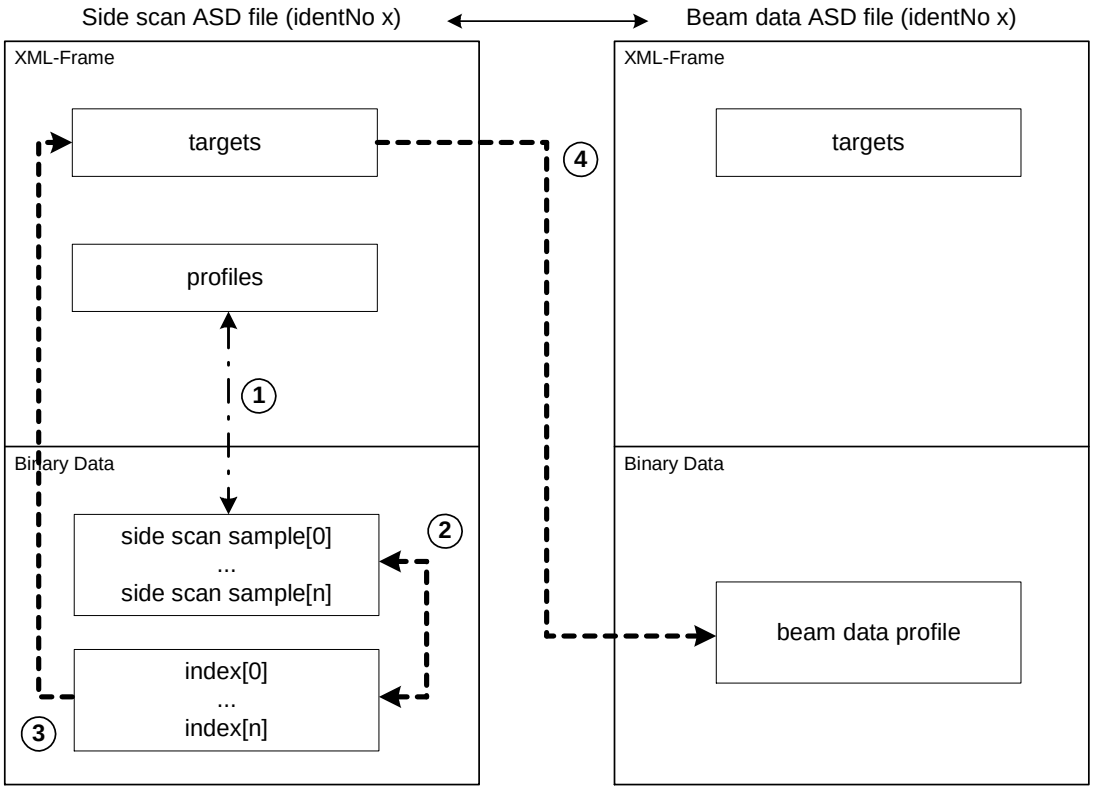

Figure 4-5: Side Scan Sample References

The above Figure 4-5 illustrates, how a single side scan sample could be referenced to other items within the ASD file structure. Refer to the numbers in the circles:

(1) Each side scan data profile is identified by the *Ident Number* and the *Subident Number* within it's binary header. To obtain the direction (and some other information), refer to the '`profiles`' element of the XML part with the same "`subIdentNo`" attribute. [1]

(2) A side scan sample and the appropriate index have the same place (index) in the according data array. I.e., the number of available side scan samples is identical with the number of indices.

(3) Each index entry of a side scan sample references to a certain target "`index`" within the list of targets. This allows to obtain more information about the direction, depth and others of the beam that contributed this single side scan sample.

(4) The "`index`" attribute of a certain target can be interpreted as the "`subIdentNo`" of the beam profile data set within the separate ASD file with the beam data measurements. [2]

[1] In case of several soundings in one ASD file, identify the correct ‚`profile`' element under the ‚`sounding`' element that has the same "`identNo`" attribute as in the binary header.
[2] The sounding „`identNo`" must be identical and the type must be suitable, e.g. type "PHS" side scan data sets must be referenced with type "PHF" beam data sets.

5 Schema Documentation Release History

This is a list of all released schema documentation sets only. Refer to 4.1 XML Part for more information about the XML formatted part of an ASD file and how to determine the version of the XML formatted part.

ATLAS PARASOUND DS-2 systems		
The schema file is named:	**`ps2_xml_schema.xsd`**	
Version	*Date*	*Comment*
1.0	10-09-2002	pre-release version (**obsolete**)
1.1	12-02-2003	1st release
1.2	05-12-2003	New optional section “auxData” that may contain position, heading and depth data sets from different sensors

ATLAS PARASOUND / ATLAS HYDROSWEEP systems		
The schema file is named:	**`asd_xml_schema.xsd`**	
Version	*Date*	*Comment*
1.0	14-06-2005	1st release (for PARASOUND only)
2.0	26-05-2006	pre-release version containing HYDROSWEEP configuration
2.x	03-04-2007	release versions for PARASOUND and HYDROSWEEP (x is greater 0; refer to the according zip file – see below)

The documentation for the above versions is provided as zip archive files. The naming convention is

`ps2_xml_schema_<version>.zip`

or `asd_xml_schema_<version>.zip`

where `<version>` must be replaced by the version identifier, e.g. “vers1_2” for version 1.2.

Example: `ps2_xml_schema_vers1_2.zip`

6 Referenced Documents

Ref.	Document Title	Author(s)	Version / Date
[1]	XML, XML Schema and others: http://www.w3.org	World Wide Web Consortium (W3C)	n.a.

7 Abbreviations

ADC	Analog-to-Digital Converter
AH	ATLAS Hydrographic
ASCII	American Standard Code for Information Interchange
ASD	ATLAS Sounding Data
ISO	Short name for the International Organization for Standardization
IPH	Interferometric Phase Data
NBS	Narrow Beam Sounder (primary high frequency of the PARASOUND DS-2)
PAR	Parametric (secondary low frequency) channel of the PARASOUND DS-2
PHF	Primary High Frequency
PLF	Primary Low Frequency
SHF	Secondary High Frequency
SLF	Secondary Low Frequency
UTC	Coordinated Universal Time (zulu or Greenwich Mean Time, GMT)
W3C	Short name for the Word Wide Web Consortium
XML	Extensible Markup Language
XSD	XML Schema Definition