Strawman VLBI Standard Software Interface Specification – VSI-S

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1. Introduction

The VSI-S specification is the software counterpart of the VSI-H specification [Reference 1], which specifies the standardized hardware interfaces of a VLBI Data Transmission System (DTS). Systems adhering to both the VSI-H and VSI-S specifications should be interchangeable with minimal effort at both data-acquisition and data-processing sites.

2. Intent of the VSI-S Specification

The goal of VSI-S is to minimize the software impact of interchanging various VSI-H compliant systems by providing a common structural, syntactical and logical framework for software control, as well as the specification of a set of basic VSI-S commands, queries and responses.. In this regard, VSI-S must address three issues:

1. Specify a generalized command and response syntax model to be used by the DTS.

2. Specify a basic set of commands to configure and operate a generic DTS adhering to VSI-H specification.

3. Specify, as necessary, client/server relationships to be defined between the VSI DTS and the controlling agent.

The basic set of VSI-S commands is intended only to address those functions of a DTS which are in common to all VSI-H DTS's. It is recognized that there may be some necessary modifications and/or additions to VSI-S commands and command sets to support specific DTS's of varying technologies.

3. Functional Description of Minimal VSI-S Command Set

Following is a simple list of the functional capabilities required to operate a VSI-H compliant system.

3.1 DIM Functions

Following is a descriptive list of the functions required to operate a DIM

    Select sync (1PPS or ALT1PPS)

    Specify CLOCK frequency and sample frequency

    Set DOT clock (or allow setting from PDATA)

    Set bit-stream mask

    Use/ignore PVALID

    Position media

    TVR configuration; report TVR statistics

    Start/stop receive (record)

3.2 DOM Functions

Following is a descriptive list of the functions required to operate a DOM

Specify RCLOCK frequency

Set ROT clock and speed-up factor

Specify crossbar setup

Set Delay

TVG on/off

Position media

Start/stop transmit (playback)

3.3 P/QDATA Functions

The VSI-H specification includes P/QDATA signals as a generalized method of quasi-realtime transmission of information into the DIM and from the DOM. Some uses of P/QDATA are suggested, but not mandated, by VSI-H. However, it is perhaps useful to specify P/QDATA formats for some of the commonly expected uses. In particular, the following:

Time transfer

One of the most useful applications of P/QDATA is to transfer data-time during a data-copy operation between heterogeneous DTS's. In particular, the source DOM may utilize its QDATA output to transmit high-level data-time information to set the DOT clock in the receiving DIM. In this way, any data-time discontinuities within a data volume may be automatically recognized and properly processed.

General information transfer

For DTS's which can pass PDATA information through to the DOM, general information such as recording mode, station, source, etc may be useful for bookkeeping or perhaps to automate processing.

4. Syntax

VSI-S specifies a general command syntax which is adhered to by generic VSI-S commands and which can be used as a framework for DTS control and command outside of the VSI-S specification.

4.1 Command Syntax

Commands are of the form:

<keyword> = <field> : <field> : ….;

where <keyword> is a specified VSI-S command keyword. The number of fields may either be fixed or indefinite; fields are separated by colons and terminated with a semi-colon. A field may be of type decimal integer, decimal real, integer hex, character, literal ASCII or a special 'time' code. White space between tokens in the command line is ignored. Each command will elicit an *immediate* response of one of the following four possible responses:

!<keyword> = <VSI-S return code> [: <DTS-specific return> :….] ;

where

<VSI-S return code> is a standardized numeric code with the following definitions:

    2 - action successfully completed

    1   - action successfully initiated, but not completed ('delayed completion')

    0 - command not implemented or not relevant to this DTS

  -1 - syntax or parameter error

  -2 - 'soft' (non-catastrophic) error encountered

  -3 - 'hard' (catastrophic) error encountered

<DTS-specific return> is a return of one or more fields specific to the particular DTS, which may be of any type, and should be more informative about the details of the action or error.

'Delayed completion' commands are defined as those commands requiring more than ~1 second to execute. For these commands, an immediate response with a VSI-S return code 1 will normally be followed by another response with VSI-S return code 2 when the action is complete.

In addition, some commands, such as the test-vector receiver (TVR) command, may request periodic informational/status responses, which will be of the form

    !!<keyword> = <field> : <field> : ….;

where <keyword> corresponds to the initiating command.

4.2 Query Syntax

Queries are of the form

    <keyword>?;

with a response of the form

    !<keyword> ? <field> : <field> : ….;

Notes:

1. The command/query structure is such that a simple chronological log of all communications, both to and from the DTS, is unambiguous as to receiver and sender. In addition, each response is unambiguous with respect to the command/query with which it is associated.

2. Though this syntax is not the most concise, the communications rate with a DTS will normally be quite low so that ultimate conciseness is not required.

4.3 Comment Syntax

Any character string beginning with an asterisk (*) and terminating with a semi-colon is considered to be a comment and is ignored by the DTS. For example,

    *This is a comment, which the DTS should ignore;

Comments may be useful to include, for example, in a pre-prepared ASCII command file for user information, but will be ignored if transmitted to the DTS.

4.4 Command/Query Execution Syntax

A command or query will not be executed until the DTS receives a terminating <CR> (carriage return). This allows a series of commands/queries to be queued for near-simultaneous execution, which may be useful in testing or in DTS operation from direct operator-entered commands. Each command/query in a multi-command sequence is delimited by it own terminating semi-colon. The DTS will execute the commands in the order specified, limited only by any special constraints of a specific DTS, of which the user must be aware. Any number of commands/queries may by concatenated in this manner:

> *<command/query> <command/query> <command/query> <CR>*

A <CR> with no preceding command/query will be ignored.

Notes:

1. For user convenience, each response from the DTS should also terminate with a <CR>, which will normally be ignored by controlling software.

2. Any embedded comments in a command/query stream will be ignored.

4.5 Unsolicited-Error Syntax

In some circumstances, a DTS may encounter an error that is not in specific response to a command. In such a case, the DTS may notify the user with an 'unsolicited error' message of the form

> !error = <VSI-S return code> [: <DTS-specific return> :….] ;

where the returned fields are the same as those in response to a command, though in this case the VSI-S return will presumably always be –2 or –3. The DTS-specific return fields should be more informative as to the details of the error.

4.6 P/QDATA Syntax and Usage

The format of P/QDATA data is identical to the command syntax, except that the content is strictly informational. Of course, there will be no responses since the P/QDATA is strictly a one-way transmission.

4.6 Keyword and Field Rules

Keywords

The following rules apply to keywords:

1. Length is limited to 16 characters.

2. Any standard printable ASCII character except white space and any of the 8 characters ''*=:;!? (including the single-quotes) may be used. Case is significant.

Fields

Each field in a command or return statement may be one of the following six types:

> Integer – a simple positive, negative or zero decimal integer (examples: '12', '-25'; of course, no quotes in actual usage).

> Real – number with a decimal point and/or possible exponent (examples: '1.12', '-2.23e-6')

Hex – in standard 'C' format (example: '0x4a32dc09')

Character – prescribed character string (examples: 'on', 'off')

Literal ASCII – arbitrary ASCII string enclosed with single quotes (example: 'This is a string'; in this case, the quotes would be included). Quote characters themselves are not allowed within a literal ASCII string. Similarly, non-printing characters are not allowed within a literal ASCII string.

Time – following the vex format, time will be specified as '..y..d..h..m..s', where the '..' fields represent year, day-of-year, hour, minute and second, respectively. Leading zeroes may be dropped. Examples: '2000y212d19h03m', '2003y91d9h23m13s'. *VSI-S time information never has a time resolution smaller than one second, so fractional seconds should never be specified in any VSI-S time field.*

The following rules apply to character fields (same as keywords):

3. Length is limited to 16 characters.

4. Any standard printable ASCII character except white space and any of the 8 characters ''*=:;!? (including the single-quotes) may be used. Case is significant

5. Client/Server Relationships

5.1 RS-232 Control

As stated in the VSI-H specification, the DTS is configured as a DCE device. The DTS controlling device will therefore act as a DTE device.

5.2 Ethernet Control

Under Ethernet control, the DTS will act as a server in the server/client relationship with the controlling device. The protocol used in the connection will normally be TCP/IP.

Question: Should a specific port number be assigned?

6. VSI-S Command/Response Format Tables

The following tables detail the VSI-S command set. Field numbers in square parenthesis ('[]') are optional. Field numbers in curly brackets ('{}') may be DTS specific; the recommended implementation is stated.

6.1 DIM Setup and Operation Commands

Keyword	Field #	Description	Type	Allowed values	Default	DTS-specific?	Comments
dimsync	1	Select second-tick sync source	char	1pps | alt1pps	1pps	No	
clockfrq	1	Clock frequency	int	2 | 4 | 8 | 16 | 32 [| 64 |128]	-	No	Units are MHz. 64 and 128 MHz may be supported by some units.
	[2]	Sample rate divider ratio	int	1,2,4,8,16	1	No	
dotset	1	Set DOT clock to specified time	time	Valid time	-	No	Sets specified time into DOT clock on *next* DOT second tick.
mask	1	Bit-stream receive mask	hex	32-bit hex	0xffffffff	No	Specifies bit-streams to be received (recorded) by DIM; VSI-H allows selection of any 1, 2, 4, 8, 16 or 32 bit streams
pvalid	1	PVALID line active/inactive	char	on | off	off	No	If 'on', PVALID signal indicates data validity. PVALID may be ignored by some systems.
tvr	1	Test-vector receiver reporting period	integer secs	>=0	0	No	Sets tvr analysis period to specified number of DOT seconds. Value of 0 stops tvr reporting immediately.
	[2]	Number of periodic tvr reports to be transmitted	int	>=1	1	No	Default = 1 report
	{[3]}	Bit-stream mask	hex	0x00000001 to 0xffffffff	0x00000001	Yes	Default is DTS dependent (some systems may only be able to analyze a single bit-stream at a time).
	{[4]}	Analysis mask	hex	0x1 to 0x7	0x3	Yes	LSB – error rate analysis MSB – DC-level analysis Default = 0x3 (full analysis)
	{[5]}	Bit-stream rotation	int	0-31	0	Yes	Rotate full set of 32 bit-streams to the left by specified number of positions before entering tvr. For example, '2' places BS0 in place of BS2 before entering tvr, BS1 in place of BS3, BS30 in place of BS1, etc. This capability is useful for unscrambling misdirected bit-streams, but may not exist in some systems or be implemented in a different fashion.
position	1	Position media	int		-	Maybe	Units are DTS-specific. Suggest >0 to position media, -1 to dismount media Probably not relevant for real-time or quasi-real-time DTS's.
receive	1	Start/stop data receive (recording)	char	on | off	off	No	

	[2]	Media speed	int	>0 forward <0 reverse	-	Yes	Probably relevant only for tape systems. Absolute value is speed in units appropriate for specific DTS.

Notes:

1. Additional fields may be added beyond those specified to meet need of specific DTS's.

6.2 DIM Query Responses

Keyword	Returned Field #	Description	Type	DTS-specific?	Comments
dimsync	1	Select second-tick sync source	char	No	Returns current value
clockfrq	1	Clock frequency	int	No	Returns current value
	2	Sample rate	int	No	Returns current value
dotset	1	Read current DOT clock time	time	No	Responds with DOT clock reading *immediately* after *next* DOT clock second tick. Response can be used as synchronizing agent for 'dotset' command.
mask	1	Bit-stream receive mask	hex	No	Returns current value
pvalid	1	PVALID line active/inactive	char	No	Returns current value
tvr	1	Test-vector receiver reporting period	integer secs	No	Returns current value
	2	Number of periodic tvr reports to be transmitted	int	No	Returns *remaining number* of tvr reports to be transmitted
	3	Bit-stream mask	hex	Yes	Returns current value
	4	Analysis mask	hex	Yes	Returns current value
	5	Bit-stream rotation	int	Yes	Returns current value
position	1	Position media	int	Maybe	Returns current media position in DTS-specfic units
	[2]	Media speed	int	=0 stopped >0 forward <0 reverse	Returns current media speed; units are appropriate to specific DTS
receive	1	Start/stop data receive (recording)	char	No	Returns current value
	[2]	Media speed	int		Returns current value
status	1	General status	hex	Yes	DTS-specific status word; meaning not defined here

Notes:

1. Note that the response to 'dotset?' status request is delayed until the occurrence of the *next* DOT second tick.

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6.3 DIM Periodic Responses

Currently only the 'tvr' command can elicit a periodic DIM response.

Keyword	Returned Field #	Description	Type	DTS-specific?	Comments
tvr	1	Bit-stream number	int	No	
	2	Analysis period in DOT seconds	int	No	
	2	Error rate	int	Yes	Interpretation is DTS-specific
	3	DC offset	int	Yes	Interpretation is DTS-specific

Notes:

1. A separate '!!tvr=…..;' string will be transmitted for each bit-stream under TVR scrutiny.

6.4 DOM Setup and Operation Commands

Keyword	Field #	Description	Type	Allowed values	Default	DTS-specific?	Comments
domclock	1	Select DOM clock source	char	dpsclock | dpsclockx | qctrl	dpsclock	No	'qctrl' puts clock source under control of QCTRL, as specified by VSI-H.
domsync	1	Select DOM second-tick sync source	char	dps1pps | dpsclockx | qctrl	dps1pps	No	'qctrl' puts sync source under control of QCTRL, as specified by VSI-H.
rclockfrq	1	DOM clock frequency	int	2 | 4 | 8 | 16 | 32 [| 64 |128]	-	No	Units are MHz. 64 and 128 MHz may be supported by some units.
	[2]	$\log_2$(DOM speedup factor)	int	-4 to +4	0	Yes	Default=0 (no speedup); capabilities are very DTS-specific. Speedup factor is necessary for ROT clock to increment properly.
rotset	1	Set ROT clock to specified time	time	Valid time	-	No	Sets specified time into ROT clock on *next* DPSCLOCK/DPSCLOCKX tick.
delay	1	Specified data delay wrt ROT clock	int	See comments	0	Perhaps	Units are sample bits; >0 indicates data delayed relative to ROT clock. Specified delay is set on *next* ROT1PPS tick. Implemented range should be sufficient to cover +/-0.5*ROT1PPS.
crossbar	1	Select bit-stream RBS0	int	0-31	0	No	Causes specified DIM input bit-stream to be directed to RBS0
	2	Select bit-stream RBS1	int	0-31	1	No	Causes specified DIM input bit-stream to be directed to RBS1
	…..						
	32	Select bit-stream RBS31	int	0-31	31	No	Causes specified DIM input bit-stream to be directed to RBS31

qvalid	1	QVALID line active/inactive	char	on | off	off	No	If 'on', QVALID signal indicates data validity. QVALID may be ignored by some systems.
tvg	1	Test-vector generator on/off	char	on | off	off	No	If 'on', replaces DOM output data with TVG data
position	1	Position media	int		-	Yes	Same as DIM 'position' command
transmit	1	Start/stop data transmit (playback)	char	on | off	off	No	

Notes:

1. Note that 'position' command is common for DIM and DOM.

6.5 DOM Query Responses

Keyword	Returned Field #	Description	Type	DTS-specific?	Comments
domclock	1	Select DOM clock source	char	No	Returns current value
domsync	1	Select DOM second-tick sync source	char		Returns current value
rclockfrq	1	DOM clock frequency	int		Returns current value
	2	$\log_2$(DOM speedup factor)	int		Returns current value
rotset	1	Set ROT clock to specified time	time		Responds with ROT clock reading *immediately* after *next* ROT clock second tick. Response can be used as synchronizing agent for 'rotset' command.
	2	Delay data wrt ROT clock	int		Responds with delay value in place at *next* ROT clock second tick.
crossbar	1	Select bit-stream RBS0	int		Returns current value
	2	Select bit-stream RBS1	int		Returns current value
	…..				
	31	Select bit-stream RBS31	int		Returns current value
qvalid	1	QVALID line active/inactive	char		Returns current value
tvg	1	Test-vector generator on/off	char		Returns current value
position	1	Position media			Returns current media position in DTS-specfic units
	[2]	Media speed	int	=0 stopped >0 forward <0 reverse	Returns current media speed; units are appropriate to specific DTS
transmit	1	Start/stop data transmit (playback)	char		Returns current value
status	1	General status	hex	Yes	DTS-specific status word; meaning not defined here

Notes:

1. Note that the response to 'rotset?' status request is delayed until the occurrence of the *next* ROT second tick.

6.6 Suggested P/QDATA formats

Keyword	Field #	Description	Type	Allowed values	DTS-specific?	Comments
time	1	Data time	time		No	Data time
	2	Relative epoch	int	0 | 1		0 (default) – time in field 1 refers to *previous* second tick 1 – time in field 1 refers to *next* second tick
mode	1	Data/recording mode	literal ASCII		Yes	DTS-specific
source	1	Celestial source name	literal ASCII		No	From schedule
	2	On/off source	char	on | off	No	Specifies whether time in field 3 is on-source or off-source time
	3	Time	time		No	On/off source time
cal	1	On/off	char	on | off	No	Specifies whether time in field 2 is cal-on or cal-off time
		Time				On/off cal time
station	[2]	Station ID	char			Standard 2-char station ID

Note:

1. When using the 'time' format, it is essential that the P/QDATA be passed as soon as possible after a second tick in order that the DTS has time to properly respond.

2. If P/QDATA are passed through the system, VSI-S setup information and comments in standard VSI-S format may also be usefully passed as a fully self-contained log.

References:

'VLBI Standard Hardware Interface Specification – VSI-H', Rev 1.0, 7 August 2000