

Vision SDK

Network Tools

User Guide

Document Revision v1.07

IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgment, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

Customers are responsible for their applications using TI components.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards ought to be provided by the customer so as to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, license, warranty or endorsement thereof.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations and notices. Representation or reproduction of this information with alteration voids all warranties provided for an associated TI product or service, is an unfair and deceptive business practice, and TI is neither responsible nor liable for any such use.

Resale of TI's products or services with *statements different from or beyond the parameters* stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service, is an unfair and deceptive business practice, and TI is not responsible nor liable for any such use.

Also see: [Standard Terms and Conditions of Sale for Semiconductor Products.](http://www.ti.com/sc/docs/stdterms.htm)
www.ti.com/sc/docs/stdterms.htm

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265

Copyright © 2014, Texas Instruments Incorporated

TABLE OF CONTENTS

1	Introduction	4
1.1	Building the PC side tools	4
1.2	Finding IP address of the target EVM	4
2	Network Control Tool	7
2.1	Tool Summary	7
2.2	Tool Usage	7
2.3	Extending the tool	11
2.4	Communication Protocol.....	13
3	Network TX Tool	15
3.1	Tool Summary	15
3.2	Tool Usage	15
4	Network RX Tool	17
4.1	Tool Summary	17
4.2	Tool Usage	17
5	Network CONS Tool	19
5.1	Tool Summary	19
5.2	Tool Usage	19
5.3	Tool Internal Implementation Details	19
6	Networking with TI Fast Data Transfer Protocol (TFDTP)	21
6.1	TFDTP/TCP tradeoffs.....	22
6.2	Enabling TFDTP.....	22
6.3	Tools Summary for TFDTP	23
6.4	Tools Usage.....	23
6.5	TFDTP/TCP Performance.....	26
6.6	TFDTP FAQs.....	26

1 Introduction

This document describes the various networking tools that are available on PC side to interface with Vision SDK network use-cases running on target (TDA2x or TDA3x or TDA2px EVM).

Following tools are available

- Network Control tool to send user defined commands and parameters to the target. Target will do a user defined action on receiving the command and can optionally return results to the PC.
- Network TX tool to send MJPEG compressed frames and RAW/YUV frames from PC to EVM. This tool can be used to feed pre-recorded test data to algorithms on target side
- Network RX tool to receive MJPEG compressed frames, RAW/YUV frames, meta-data buffers from EVM to PC. This tool can be used to send algorithm results to PC
- Network CONS (Console) tool to redirect Vps_printf() string from EVM over network to the tool and to redirect "getchar" from network CONS tool to the EVM

NOTE: These tools can be used for both BIOS and Linux usecases. For BIOS usecases, make sure that the NDK/NSP is enabled and runs on the target. For Linux usecases, make sure that Ethernet is enabled and correct ip address is provided in u-boot boot arguments.

1.1 Building the PC side tools

- Windows
 - Install GCC compiler for Windows (ex, <http://www.codeblocks.org/>)
 - Install GNU Make for Windows (ex, "gmake" is available as part XDC install at \$(xdc_PATH)/gmake)
 - Install bash shell in Windows via tool like <https://msysgit.github.io/> or Cygwin
 - Edit RULES.MK and change BUILD_OS to "Windows_NT"
- Linux
 - Make sure build tools like GCC and make are part of installation.
 - Edit RULES.MK and change BUILD_OS to "Linux"
- Edit RULES.MK at vision_sdk\apps\tools\network_tools\build to point to installed path of GCC compiler (CGTOOLS_PATH=xxx) and installed path of GNU make (MAKE=xxx)
- Edit RULES.MK to add path of NSP directory.
- Open bash shell prompt and goto vision_sdk\apps\tools\network_tools\build
- Invoke GNU make to build the tools ("gmake" if XDC path is in your system path)
- Binaries are generated at vision_sdk\apps\tools\network_tools\bin

1.2 Finding IP address of the target EVM

- All the networking tools uses TCP/IP to exchange data with EVM.

- For Linux, use `'ifconfig'` Linux command to know the IP address of the target.
- For Bios,
 - NDK needs to be enabled on EVM to support TCP/IP & TFDTP communication.
 - All the networking tools need to know the IP address of the EVM in order to exchange information with it.
 - By default NDK is enabled in Vision SDK
 - To make sure NDK is enabled, open command prompt at path `"$(VISION_SDK_INSTALL)\vision_sdk"` and type `"gmake showconfig"`
 - Make sure `"NDK_PROC_TO_USE"` is NOT `"none"`
 - By default for TDA2x or TDA2px, `NDK_PROC_TO_USE=a15_0`
 - By default for TDA3x, `NDK_PROC_TO_USE=ipu1_1`
 - You can edit `"cfg.mk"` (in `"vision_sdk\links_fw\src\rtos\bios_app_common /<configname>"`) to change the CPU on which NDK runs. NDK can run on `a15_0` or `ipu1_0` or `ipu1_1`
 - When transferring large data it is recommended to run networking on `a15_0` (TDA2x or TDA2px) to get better network throughput. Also TFDTP can be used for better throughput on M4 using optimized patch.

IMPORTANT NOTE: When FATFS (`FATFS_PROC_TO_USE != none`) is enabled in TDA3x, networking is DISABLED by the build system.

- By default IP address is set to DHCP mode
- This can be changed to static IP by editing below file `vision_sdk\links_fw\src\rtos\bios_app_common\<soc>\cfg\NDK_config.cfg`
- Change at lines


```
var enableStaticIP      = 1;
if (enableStaticIP)
{
    /* Settings for static IP configuration */
    Ip.address = "192.168.1.200";
    Ip.mask = "255.255.255.0";
    Ip.gatewayIpAddr = "192.168.1.1";
    Ip.ifIdx = 1;
}
```
- Build and boot the Vision SDK on EVM as mentioned in Vision SDK user guide. Make sure network cable is connected. If DHCP mode is selected make sure the network can give a IP address to the EVM via DHCP.
- After boot note the IP address as mentioned in the main menu


```
[IPU1-0] 23.294372 s: Current System Settings,
[IPU1-0] 23.294403 s: =====
[IPU1-0] 23.294464 s: Display Type   : HDMI 1920x1080 @ 60fps
[IPU1-0] 23.294494 s: Capture Source : Sensor OV10635 1280x720 @30fps - VIP,
YUV422
[IPU1-0] 23.294555 s: My IP address  : 172.24.190.226
```

- The IP address is also printed on the CCS console window.
- This IP address will be used as input when running the PC side tools
- Ping the EVM from PC side to make sure its accessible on the network
 - Ex, \$ ping 172.24.190.226
 - Make sure you see reply from EVM
 - If ping is not able to succeed then there is some issue in your network connectivity
- **IMPORTANT NOTE: Make sure “ping” is successful before trying any of the network tools**

2 Network Control Tool

This tool can be used to send user defined commands with parameters from PC side to the target. The target will respond with appropriate results. Users can extend this tool define their own set of commands, parameters and responses.

2.1 Tool Summary

Tool name	network_ctrl.exe
Tool source code (PC side)	vision_sdk\apps\tools\network_tools\network_ctrl
Tool source code (target side)	vision_sdk\apps\src\rtos\modules\network_ctrl

2.2 Tool Usage

- Make sure you know the IP address of the EVM
- Invoke the tool as shown below, it will print the supported options
 - \$ network_ctrl.exe

```
#
# network_ctrl --ipaddr <ipaddr> [--port <server port>] --cmd <command string>
# <command parameters>
#
# (c) Texas Instruments 2014
#
# Supported commands,
# -----
# echo <string to echo>
# mem_rd <memory address in hex> <size of memory to read in units of 32-bit
# words>
# mem_wr <memory address in hex> <value to be written in units of 32-bit words>
# mem_save <memory address in hex> <size of memory to read in bytes>
# <filename in which data is saved>
# iss_raw_save <filename in which data is saved>
# iss_yuv_save <filename in which data is saved>
# iss_send_dcc_file <dcc file name to be sent>
# iss_save_dcc_file <Sensor ID> <dcc file name to be sent>
# Supported sensors IDs are 140, 10640, 132 and 224
# iss_clear_dcc_qspi_mem <Sensor ID>
# Supported sensors IDs are 140, 10640, 132 and 224
# iss_write_sensor_reg <chan num> <RegAddr> <RegVal>
# iss_read_sensor_reg <chan num> <RegAddr>
# iss_read_2a_params
# iss_write_2a_params <AE Mode> {Digital Gain} {Analog Gain} {Exposure Time}
# <AWB Mode> {Red Gain} {Green Gain} {Blue Gain} {Color Temperature}
# stereo_calib_image_save <filename prefix in which data is saved>
```

```
# stereo_set_params <numDisparities> <disparityStepSize> <disparitySearchDir>
<disparitySupportWinWidth> <disparitySupportWinHeight> <leftRightCheckEna>
<censusWinWidth> <censusWinHeight> <censusWinHorzStep>
<censusWinVertStep> <pp_colormap_index>
```

```
[EXAMPLE] stereo_set_params 128 4 0 11 11 0 9 9 2 2 0
```

```
#stereo_set_dynamic_params <pp_cost_max_thresh> <pp_conf_min_thresh>
<pp_texture_lumalothresh> <pp_texture_lumahithresh> <pp_texture_thresh>
<pp_leftright_thresh> <pp_maxdisp_dissimilarity> <pp_minconf_nseg_thresh>
```

```
#stereo_set_dynamic_params <pp_cost_max_thresh> <pp_conf_min_thresh>
<pp_texture_lumalothresh> <pp_texture_lumahithresh> <pp_texture_thresh>
<pp_leftright_thresh> <pp_maxdisp_dissimilarity> <pp_minconf_nseg_thresh>
```

```
[EXAMPLE] stereo_set_dynamic_params 95 98 0 100 85 255 2 2
```

- The “port” option need not be specified
- By default when NDK is enabled on target, a task is started on target side to listen to commands from this tool

```
#stereo_calib_lut_to_qspi <rectMapRight_int_converted.bin>
<rectMapLeft_int_converted.bin>
```

2.2.1 Supported commands

Current commands mentioned below are supported

Command	Description
echo	Takes a string as input and on successful execution, this string is printed on target side console
mem_rd	Reads specified memory contents from target and prints its value on PC side. Useful for dumping HW registers when JTAG is not connected
mem_wr	Writes a value to user defined memory location on target. Useful for writing a HW register when JTAG is not connected
mem_save	Reads specified memory contents from target and write to a file on PC. Useful to dump a chunk of memory like buffer data to a file on PC
mem_load	Reads data from a file on PC side and writes to specified memory location on target.
qspi_wr	Writes SBL/TESOC/AppImage into QSPI memory. It accepts Image name and address where image to be written. SBL need to flash at 0x0 and AppImage_BE at 0x80000. For TDA3xx TESOC image need to be written at 0x60000
mmc_wr_appimage	Writes AppImage into MMC SD card.
mmc_wr_sbl	Writes MLO into MMC SD card.
sys_reset	EVM will receive command for COLD RESET

iss_raw_save	Dumps a frame of ISS raw data to a file on PC. Applicable only when ISS use-case with ISS capture link is running on target. Applicable to TDA3x ONLY.
iss_yuv_save	Dumps ISS simcop output frame in yuv format to a file on PC. Applicable only when ISS use-case with ISS simcop link is running on target. Applicable to TDA3x ONLY.
iss_send_dcc_file	Send DCC tuning file from PC to target and apply the settings to ISS HW. It applies the settings to the ISS HW immediately, so old settings will get overwritten with the new settings. But this will not save the new settings, so when the use case is rerun, it will rerun with the old settings. To save the new settings, use iss_save_dcc_file command which will save the settings in the QSPI or save the settings in the sensor specific driver (refer to the BSP driver user guide to get more information). Applicable only when ISS use-case with ISS capture link and ISS ISP link are running on target. Applicable to TDA3x ONLY.
iss_save_dcc_file	Send DCC tuning file from PC to target and target saves DCC tuning file to QSPI. Currently it is supported only for AR0140, OV10640 and AR0132 sensors. The QSPI offset for each sensor is fixed. If this is changed in network tool, it requires change in the target application also. Applicable only when ISS use-case with ISS capture link and ISS ISP link are running on target. Applicable to TDA3x ONLY.
Iss_clear_dcc_qspi_mem	Erases contents of the QSPI for the given sensor id. DCC profile is stored in the QSPI at a fixed location for the sensors AR0140, OV10640, AR0132 and IMX224. This API is used to erase this memory. Applicable only when ISS use-case with ISS capture link and ISS ISP link are running on target. Applicable to TDA3x ONLY.
Iss_write_sensor_reg	Writes the 16bit value to the given sensor registers. Channel id is used to select the sensor. For single sensor usecase, channel id must be set to 0. For multiple sensor usecase, appropriate channel id should be used. Used by the DCC (Dynamic Camera Configuration Tool) to write to sensor registers. Applicable only when ISS use-case with ISS capture link is running on target. Applicable to TDA3x ONLY.
Iss_read_sensor_reg	Reads a value of the given sensor register and prints it on PC side. Channel id is used to select the sensor. For single sensor usecase, channel id must be set to 0. For multiple sensor usecase, appropriate channel id should be used. Used by the DCC (Dynamic Camera Configuration Tool) to read sensor registers. Applicable only when ISS use-case with ISS capture link is running on target. Applicable to TDA3x ONLY.
iss_read_2a_param	Used to read AEWB algorithms current output parameters.

s	<p>This includes AEWB algorithm mode, analog/digital gains, exposure time and color temperature.</p> <p>Applicable only when ISS use-case with ISS capture link is running on target. Applicable to TDA3x ONLY.</p>
iss_write_2a_params	<p>Used to set the AEWB mode to manual and set the output parameters to fixed value. This includes AEWB algorithm mode, analog/digital gains, exposure time and color temperature.</p> <p>Applicable only when ISS use-case with ISS capture link is running on target. Applicable to TDA3x ONLY.</p>
stereo_calib_image_save	<p>This command saves a frame each from left and right sensor into pgm files. The final filename for the left image will be composed by the strings 'left_+' <filename_prefix> + '.pgm'. Similarly, the filename for the right image will be composed by the strings 'right_+' <filename_prefix> + '.pgm' It is used during stereo calibration process.</p>
stereo_set_params	<p>This command sets stereo parameters. It should be sent before any stereo usecase is started. All the parameters are configured together and there is no means of changing specific items.</p> <p>It takes following parameters : <numDisparities> <disparityStepSize> <disparitySearchDir> <disparitySupportWinWidth> <disparitySupportWinHeight> <leftRightCheckEna> <censusWinWidth> <censusWinHeight> <censusWinHorzStep> <censusWinVertStep> <pp_colormap_index> whose default values are 128 4 0 11 11 0 9 9 2 2 0 respectively.</p> <p>Please refer to the StereoVision_DSP_UserGuide.pdf inside the ti_components\algorithms_codecs\REL.200.V.ST.C66X.00.XX.XX.XX\modules\ti_stereovision\docs directory, for details on each parameter.</p>
stereo_set_dynamic_params	<p>This command sets stereo parameters on the fly. It can be sent after any stereo use-case is started. All the parameters are configured together and there is no means of changing specific items.</p> <p>It takes following parameters : <pp_cost_max_thresh> <pp_conf_min_thresh> <pp_texture_lumalothresh> <pp_texture_lumahithresh> <pp_texture_thresh> <pp_leftright_thresh> <pp_maxdisp_dissimilarity> <pp_minconf_nseg_thresh> whose default values are 95 98 0 100 85 255 2 2 respectively.</p> <p>Please refer to the StereoVision_DSP_UserGuide.pdf inside the ti_components\algorithms_codecs\REL.200.V.ST.C66X.00.XX.XX.XX\modules\ti_stereovision\docs directory, for details on each parameter.</p>
stereo_calib_lut_to	<p>This commands writes into NAND flash memory the lookup</p>

_qspi	<p>tables generated by the camera automatic calibration tool for use by the remap algorithm running on EVE.</p> <p>It takes following parameters:</p> <pre><rectMapRight_int_converted.bin> <rectMapLeft_int_converted.bin></pre> <p>These are files generated by the camera automatic calibration tool. Please see the <i>VisionSDK_MultiSensorFusionStereoCalibrationGuide.pdf</i> for further details.</p> <p>On the PC side, the following output should be displayed:</p> <pre># NETWORK: Connected to Server (172.24.190.212:5000)!!! # FILE: Reading file [rectMapRight_int_converted.bin] ... Done. [1136472 bytes] # FILE: Reading file [rectMapLeft_int_converted.bin] ... Done. [1136472 bytes] # Writing the QSPI tags # Command stereo_calib_lut_to_qspi: Sent 2272960 bytes # Command stereo_calib_lut_to_qspi: Received reponse (status = 0, prmSize = 0)</pre> <p>Whereas on the target's side, the console window should show something similar to:</p> <pre>[HOST] 119.827209 s: NETWORK_CTRL: Received command [stereo_calib_lut_to_qspi], with 2100032 bytes of parameters [HOST] 119.903656 s: NETWORK_CTRL: qSpiOffset = 30408704, size = 2100032 [HOST] 119.903686 s: QSPI Init Started [HOST] 119.903808 s: MID - 1 [HOST] 119.903808 s: DID - 18 [HOST] 119.903808 s: QSPI Init Completed Sucessfully [HOST] 119.903839 s: QSPI write Started, please wait! [HOST] 120.003295 s: QSPI Erase Block Started, please wait! [HOST] 123.427154 s: QSPI Erase Block Completed Sucessfully [HOST] 126.839233 s: QSPI write Completed Sucessfully [HOST] 126.840728 s: NETWORK_CTRL: Sent response for command [stereo_calib_lut_to_qspi], with 0 bytes of parameters</pre> <p>Note that due to the size of the tables, it will take a long time before seeing the text output 'QSPI write Completed'.</p>
-------	--

2.3 Extending the tool

NOTE: Users needs to read this section only if they plan to extend the tool by adding their own commands and command handlers, others can ignore this section.

This tool can be extended by users to add more commands from PC side and "plugin" different actions on target side when the command is received.

TIP: The easiest way to extend the tool is see an existing command implementation and customize it

- On PC side do the below
 - Create your own file for the command, ex, network_ctrl_handle_echo.c (vision_sdk\apps\tools\network_tools\network_ctrl\src)
 - Write a function that will send the command and receive the results, ex, handleEcho
 - A command is string of characters
 - Use below API to send the command, "params" point to the user specific parameters of "size" bytes
 - SendCommand(char *command, void *params, int size);
 - Command line parameters are available inside the user handler in the below structure fields
 - gNetworkCtrl_obj.params[x]
 - Use below API to receive results, "prmSize" is size of result parameters
 - RecvResponse(char *command, UInt32 *prmSize);
 - If "prmSize" is not zero then read the parameters using below API into user pointer
 - RecvResponseParams(char *command, UInt8 *pPrm, UInt32 prmSize);
 - Register this handler using below API in function Init()
 - void RegisterHandler(char *command, void (*handler)(), int numParams)
 - Now build and run the tool with the new command and command specific parameters
- On target side do the below
 - Create your own file for handling the command, ex, network_ctrl_handle_echo.c (vision_sdk\apps\src\rtos\modules\network_ctrl)
 - Void NetworkCtrl_cmdHandlerEcho(char *cmd, UInt32 prmSize)
 - This handler is called, when the "cmd" is received, "prmSize" is size of parameters that accompany this command
 - Use below API to read the received parameters
 - Int32 NetworkCtrl_readParams(UInt8 *pPrm, UInt32 prmSize)
 - Based on the parameters handle the command
 - Use below API to send reply for the command
 - Int32 NetworkCtrl_writeParams(UInt8 *pPrm, UInt32 prmSize, UInt32 returnStatus)
 - Register the handler in NetworkCtrl_init() (vision_sdk\apps\src\rtos\modules\network_ctrl\network_ctrl_tsk.c) using below API

- `Int32 NetworkCtrl_registerHandler(char *cmd, NetworkCtrl_Handler handler)`
- Ex, `NetworkCtrl_registerHandler("echo", NetworkCtrl_cmdHandlerEcho);`
- Once handler are registered on PC side and target side, recompile and run the binaries
- On PC side call the tool with the new command and parameters as input
 - Ex, **`network_ctrl --ipaddr 192.168.1.200 --cmd echo "hello, world !"`**

2.4 Communication Protocol

NOTE: Users needs to read this section only if they plan to implement their own tool on PC side to interface with the target side, others can ignore this section.

The tool uses TCP/IP as underlying communication protocol. On top of this a thin application layer protocol is added as described below.

This protocol needs to be used in case other tools are made on PC which need to interface to the target side.

See also `vision_sdk\apps\tools\network_tools\common\inc\networkCtrl_if.h`

NOTE: All fields are specified in little-endian order

2.4.1 Command protocol

Fields	Bytes	Description
Header TAG (0x1234ABCD)	4	HEADER TAG to make sure this is not a spurious data on the network port
Command	64	Command to be sent. Represented as a string of NULL terminated characters
returnValue	4	Set to 0 when sending command, filled by response
Flags	4	Flags for specific status control
prmSize	4	Size of parameters that follow. Can be set to 0 when no parameters are present
Params	"prmSize"	Stream of bytes representing parameters, MUST be equal to "prmSize" that is specified earlier

2.4.2 Response protocol

The response protocol format is exactly same as command protocol with the following differences

- "Command" is set to same value as the command that was received
- "returnValue" is set based result of command execution. Value itself depends on command. Typically value of 0 indicates successful command execution
- "Flags" is set with value of 0x00000001 to indicate that this response is ACK to earlier command
- "prmSize" is set to parameter of results, i.e parameter sent as response are different from parameters sent as command
- "Params" is the response / result parameters

3 Network TX Tool

Network TX tool is used to send MJPEG compressed frames and RAW/YUV frames from PC to EVM. This tool can be used to feed pre-recorded test data to algorithms on target side.

IMPORTANT NOTE:

- On TDA3x, though MPJEG frames can be sent to TDA3x, there is no MJPEG decode on TDA3x to decode the frames. Hence on TDA3x, typically one would use RAW/YUV frame for network TX
- When sending RAW/YUV frames
 - When NDK runs on M4 CPU, one can achieve a data rate of about 2 MB/s (16Mbps)
 - When NDK runs on A15 CPU (TDA2x or TDA2px), one can achieve a data rate of about 60 MB/s (480Mbps)
 - Make sure to select the appropriate CPU to run the NDK depending on the SoC that is used.
 - For higher throughput on M4, TFDTP can be enabled. Please refer to benchmarking numbers for each core in section 6.5.

3.1 Tool Summary

Tool name	network_tx.exe
Tool source code (PC side)	vision_sdk\apps\tools\network_tools\network_tx
Tool source code (target side)	vision_sdk\links_fw\src\rtos\links_common\network_rx
Example usage (target side)	vision_sdk\apps\src\rtos\usecases\network_rx_tx chains_networkRxDecDisplay*.* chains_networkRxDisplay*.*

3.2 Tool Usage

Make sure you know the IP address of the EVM (see 1.2 Finding IP address of the target EVM)

Target side: Create a Vision SDK use-case on target side

- Specify the source of data as "Network_rx" link.
 - **IMPORANT:** Make sure "Network_rx" is on the same CPU that NDK is enabled
- Set NetworkRxLink_CreateParams.dataRxMode as NETWORK_RX_LINK_DATA_RX_MODE_NETWORK
- Set NetworkRxLink_CreateParams.networkServerPort, if specified default value is not used.
 - This value needs to match the "--port" value specified in PC tool
 - Typically when only single "Network_rx" link exists in use-case no need to specify this value
 - When more than one "Network_rx" link is present in use-case then each "Network_rx" link MUST have unique networkServerPort. In this case, "network_tx.exe" is invoked multiple times on PC with matching "--port" value
 - Set other "Network_rx" create parameters like data type, MJPEG or RAW/YUV and frame resolution, like width, height

- Set NetworkRxLink_CreateParams.timerPeriodMilliSecs to specify the rate as which data should be sent, ex, set to 33 for approx. 30fps receive frame-rate
- Some examples which use the "Network_rx" link to receive data over network can be found at below path
 - vision_sdk\apps\src\rtos\usecases\network_rx_tx
 - chains_networkRxDecDisplay*.*
 - chains_networkRxDisplay*.*
- Compile and run the use-case as usual. Once the use-case is running on the target side ...

PC Side: Invoke the tool as shown below, it will print the supported options

Network PC tools are supported on both Windows and Linux PCs. Pre-built binaries are located in /bin/ folder for both platforms.

```
$ network_tx.exe or network_tx.out
#
# .\network_tx --host_ip <ipaddr> --target_ip <ipaddr> [--port <server
port>] --usetfdtp --verbose --no_loop --delay <delay in secs>] --files <CH0
file> <CH1 file> ...
#
# (c) Texas Instruments 2014
#
```

- The "port" option when not specified default port is used.
- Multiple "channels" of data can be sent by specifying multiple files.
- No need to specify the data type, frame resolution etc on the PC side, this is specified on the target side
- When use-case runs on the target, target will request frames from PC side, PC side will read from the input files and send the data over network
- "network_tx.exe" can be invoked multiple times, each invocation feeding different "Network_rx" links in the use-case on target
- Once the input file reaches "end of file", input is read again from start of the file, i.e it will continuously stream the data until either the use-case stops or tool exit by doing "Ctrl-C"
- For 'Network + stereo + Display' use-case, <Ch0 file> corresponds to the left camera and <Ch1 file> corresponds to the right camera.

IMP Note: Make sure to close PC tools first before stopping VSDK use-case from console. On Windows PC it is observed that if network tool from PC is not closed VSDK use-case doesn't stop.

4 Network RX Tool

Network RX tool is used to receive MJPEG compressed frames and RAW/YUV/Meta data frames from EVM to PC. This tool can be used to save data from algorithms on PC side.

IMPORTANT NOTE:

- On TDA3x, MJPEG frames can not sent to PC, since there is no MJPEG encoder on TDA3x

IMPORTANT NOTE:

- When sending RAW/YUV frames
 - When NDK runs on M4 CPU, one can achieve a data rate of about 2 MB/s (16Mbps)
 - When NDK runs on A15 CPU (TDA2x or TDA2px), one can achieve a data rate of about 60 MB/s (480Mbps)
 - Make sure to select the appropriate CPU to run the NDK depending on the SoC that is used
 - For higher throughput on M4, TFDTP can be enabled. Please refer to benchmarking numbers for each core in section 6.5.

4.1 Tool Summary

Tool name	network_rx.exe
Tool source code (PC side)	vision_sdk\apps\tools\network_tools\network_rx
Tool source code (target side)	vision_sdk\links_fw\src\rtos\links_common\network_tx
Example usage (target side)	vision_sdk\apps\src\rtos\usecases\network_rx_tx chains_networkTxEncDisplay*.* chains_networkTxDisplay*.*

4.2 Tool Usage

Make sure you know the IP address of the EVM (see 1.2 Finding IP address of the target EVM)

Target side: Create a Vision SDK use-case on target side

- Connect the output of the algorithm or link for which data needs to be saved to PC to a "Network_Tx" link
 - **IMPORANT:** Make sure "Network_rx" is on the same CPU that NDK is enabled
- Set NetworkTxLink_CreateParams.dumpDataType as NETWORK_TX_LINK_TRANSMIT_TYPE_TCPIP
- Set NetworkTxLink_CreateParams.networkServerPort, if not specified default value is used.
 - This value needs to match the "--port" value specified in PC tool
 - Typically when only single Network_Tx link exists in use-case no need to specify this value
 - When more than one "Network_Tx" link is present in use-case then each "Network_Tx" link MUST have unique networkServerPort. In this case, "network_rx.exe" is invoked multiple times on PC with matching "--port" value
- Set other "Network_Tx" create parameters as usual

- Some examples which use the “Network_Tx” link to receive data over network can be found at below path
- vision_sdk\apps\src\rtos\usecases\network_rx_tx
 - chains_networkTxEncDisplay*.*
 - chains_networkTxDisplay*.*
- Compile and run the use-case as usual. Once the use-case is running on the target side ...

PC side: Invoke the tool as shown below, it will print the supported options

```
#  
# network_rx --ipaddr --target_ip <ipaddr> --host_ip <ipaddr> [--port <server port>] --usefdtp --files <CH0  
file> <CH1 file>  
#  
# (c) Texas Instruments 2014  
#The “port” option when not specified default port is used.
```

- Multiple “channels” of data can be saved by specifying multiple files.
- No need to specify the data type, frame resolution etc on the PC side, PC side will just save whatever is sent by target side
- When use-case runs on the target, target will send frames to PC side via the “Network_Tx” link, PC side will write the received frames to files specified by the user
- “network_rx.exe” can be invoked multiple time, each invocation receiving data from different “Network_Tx” links in the use-case on target
- Once the use-case on target is stopped, the tool on PC exits and saved file can be viewed/analysed as required. Alternatively “Ctrl-C” can be used to stop the tool and close the file which is being written

IMP Note: Make sure to close PC tools first before stopping VSDK use-case from console. On Windows PC it is observed that if network tool from PC is not closed VSDK use-case doesn't stop.

5 Network CONS Tool

Network CONS (Console) tool is used to,

1. Redirect Vps_printf() formatted strings from EVM over network to the tool
2. And to redirect "getchar" from network CONS tool on PC to the EVM

This can be used to replace the UART console in cases when UART is not available on the EVM or HW board.

5.1 Tool Summary

Tool name	network_cons.exe
Tool source code (PC side)	vision_sdk\apps\tools\network_tools\network_cons
Tool source code (target side)	vision_sdk\apps\src\rtos\modules\network_cons
Example usage (target side)	Chains_readChar() in file chains_main_bios.c (vision_sdk\apps\src\rtos\common) RemoteLog_clientRun() in file utils_remote_log_client.c (vision_sdk\links_fw\src\rtos\utils_common\src)

5.2 Tool Usage

- Make sure you know the IP address of the EVM (see 1.2 Finding IP address of the target EVM)
- Set ENABLE_NETWORK_LOG=yes in your cfg.mk file (vision_sdk/apps/configs/<configname>)
- Confirm that networking is enabled and ENABLE_NETWORK_LOG is "yes" by doing "gmake -s -j showconfig"
- Build and run Vision SDK application by following steps as mentioned in the user guide
- On the PC invoke the network console tool as shown below from PC command prompt
network_cons.exe -ipaddr <ipaddr>
- The Vps_printf's from EVM will now be visible in PC command prompt windows
- Any key input to this window will result in the key value being sent to the EVM

5.3 Tool Internal Implementation Details

This section is meant for developers who want to understand and expand the tool. Simple users of the tool can skip this section.

5.3.1 Print Redirection

The flow of formatted string data when a Vps_printf is called with network log enabled is as mentioned below

1. Vps_printf takes a formatted string as input, similar to "printf" in stdio.h
2. Vps_printf can be called by any CPU in the system (A15, DSP, EVE, M4)
3. Vps_printf copies this string to a shared memory area called "RemoteLog". Each CPU has its own area within the "RemoteLog" shared memory.
 - a. This allows multiple CPUs to output formatted strings to the shared memory

- b. See `utils_remote_log_server.c` (`vision_sdk\links_fw\src\rtos\utils_common\src`) for implementation of `Vps_printf`
4. Remote Log Client (a low priority thread) running on IPU1-0 then reads the string from the shared memory and then outputs them over one of below interfaces
 - a. UART interface (via UART driver)
 - b. Network interface (via Network CONS)
 - c. CCS JTAG interface (via `System_printf`)
5. See `utils_remote_log_client.c` (`vision_sdk\links_fw\src\rtos\utils_common\src`) for implementation of this read logic
6. When the string needs to be output over network, `NetworkCons_txWriteString()` is called from within `RemoteLog_clientRun()` (Thread main for Remote Client)
7. The networking itself can be enabled on a different core on which the Remote Client runs, ex, IPU1-1 by default in TDA3x. Due to this one cannot make direct networking socket API calls from within Remote Client thread
8. Hence `NetworkCons_txWriteString()` copies the string to another shared memory area "NetworkCons_TxShm networkConsTxShm" defined in `system_ipc_if.h` (`vision_sdk\links_fw\include\link_api`)
9. A network console reader thread running on the core on which networking is enabled reads from this shared region and then outputs over the network using TCP/IP sockets.
10. See `NetworkConsTx_tskMain ()` in `network_cons_tsk.c` (`vision_sdk\apps\src\rtos\modules\network_cons`)
11. See `network_cons_ipc.c` (`vision_sdk\apps\src\rtos\modules\network_cons`) for implementation of `NetworkCons_txWriteString()` and `NetworkCons_txReadString`
12. On PC side within `network_cons.exe` a thread is created which reads from the network socket and writes to stdout

5.3.2 GetChar Redirection

The flow of character input from `getchar()` on PC via network CONS tool to EVM with network log enabled is as mentioned below

1. When `network_cons.exe` runs on PC a thread is created which calls `getchar()` in a loop. When user types a character in the console, the character is sent via TCP/IP to the connected EVM
2. On the EVM side, a network RX thread receives this char and puts the char into a shared memory.
 - a. See `NetworkConsRx_tskMain ()` in `network_cons_tsk.c` (`vision_sdk\apps\src\rtos\modules\network_cons`) for implementation of the RX thread.
 - b. "NetworkCons_RxShm networkConsRxShm" in `system_ipc_if.h` (`vision_sdk\links_fw\include\link_api`) defines the shared memory
3. This character copy to shared memory is done since the CPU on which networking runs and CPU on which UI "getchar" is called can be different. Ex, networking is enabled on IPU1-1, and `Chains_getChar()` is called from IPU1-0
4. When `Chains_getChar()` is called it can read input from one of below interfaces
 - a. UART interface (via UART driver)
 - b. Network interface (via Network CONS)
 - c. CCS JTAG interface (via `fscanf`)
5. When reading input via network CONS, `NetworkCons_rxReadChar()` API is called which reads from the shared memory and gives the character to the UI.
6. See `network_cons_ipc.c` (`vision_sdk\apps\src\rtos\modules\network_cons`) for implementation of `NetworkCons_rxWriteChar()` and `NetworkCons_rxReadChar()`

6 Networking with TI Fast Data Transfer Protocol (TFDTP)

TI Fast Data Transfer Protocol (TFDTP) is a light weight application layer protocol which implements standard UDP/IP based packet RX/TX using direct NSP APIs bypassing NDK. TFDTP sits on the top of NSP to aggregate UDP packets into larger logical frames for taking advantages of SoC resources like EDMA, Caching etc. For more details about TFDTP and its implementation refer to TFDTP user/design guide in NSP package.

The VSDK 2.12 and later support TFDTP in Network_Tx and Network_rx links with new data transmit/receive mode. For Network_rx, NETWORK_RX_LINK_DATA_RX_MODE_NETWORK is used as data receive mode whereas for Network_tx link NETWORK_TX_LINK_TRANSMIT_TYPE_TFDTP is added as data dump type.

The Network_tx and Network_rx links are modified to support TFDTP based receive and transmit with existing PC tools. The underlying framework has not changed and earlier data flow is kept same. The existing TCP/IP server is used as command server for TFDTP to synchronize data transfer between client and EVM.

Figure below shows data flow for Network_rx link with TFDTP enabled. As shown the for data synchronization, existing reliable TCP/IP channel is used as sync channel to send/receive ACKs, command headers etc. and TFDTP is only used for data transfer. Only difference between existing TCP/IP based Network use-case and TFDTP is that in TFDTP data is transferred using TFDTP instead of TCP/IP. Similarly data flow is shown in Figure 6-2 for Network_tx link.

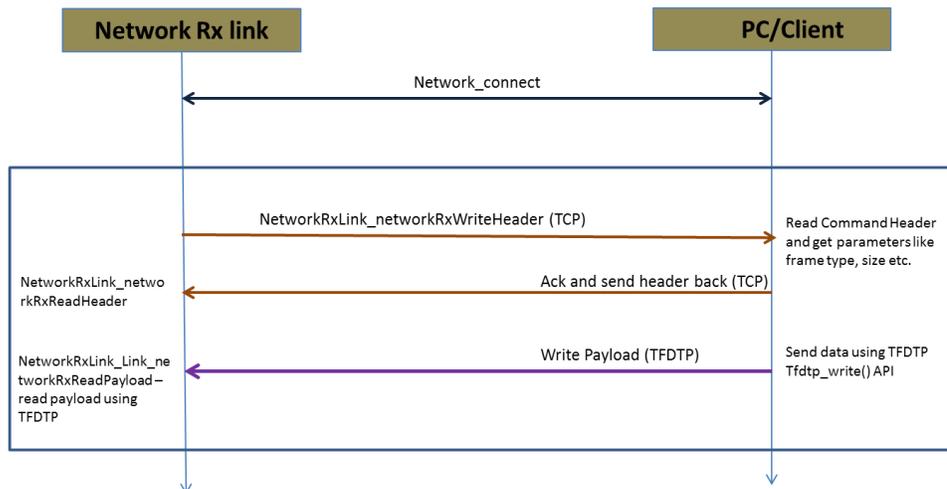


Figure 6-1 Network Source Network Receive using TFDTP

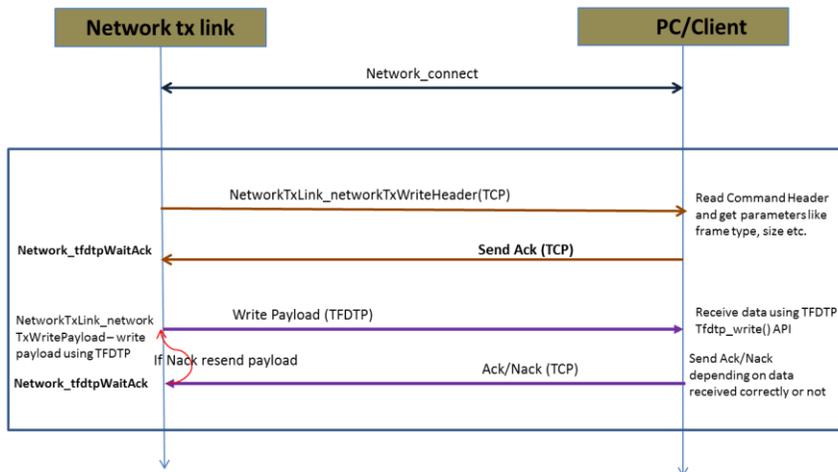


Figure 6-2 Network_tx Network Transmit using TFDTP

6.1 TFDTP/TCP tradeoffs

When running any of Network_tx and Network_rx based use-cases, menu option is given to select Network Rx and Tx mode resp. This selects dataRxMode for Network_rx & dumpDataType for Network tx link. Depending on mode selected make sure you use correct command line argument in Network PC tools.

Below are TCP/IP and TFDTP network mode comparison to choose between these two.

Network_rx/Network_tx mode		TCP/IP	TFDTP
Underlying Protocol		TCP	UDP
Protocol stack used		TCP/IP (NDK)	TFDTP (NSP)
Throughput/CPU Load On Cortex M4 running @212MHz	RX	10Mbps@50%	320Mbps@80%
	TX	40Mbps@80%	320Mbps@42%
Packet drop/Out of order support		Yes	No for RX Yes for TX

Note:

- When networking is enabled on IPU1-1, TFDTP is recommended to be used for high throughput with Network_tx, Network_rx links.
- When networking is enabled on A15, NDK with TCP/IP is recommended to be used for high throughput with Network_tx, Network_rx links.

6.2 Enabling TFDTP

To enable TFDTP stack in VSDK build, set NSP_TFDTP_INCLUDE=yes in the vision_sdk\apps\configs\configfile. Make sure NDK is enabled via

NDK_PROC_TO_USE in the same file. Also as TFDTP is not supported on cores other than ipu1_1, to use TFDTP build, NDK_PROC_TO_USE should be set to ipu1_1.

6.3 Tools Summary for TFDTP

For using TFDTP, the existing PC tools are used with added option to choose between TFDTP or TCP/IP based receive/transmit. To use TFDTP both address of server and host needed to be given through command line arguments. You should use --usetfdtp option to use network tools with TFDTP enabled on Network_tx source and Network_tx links. The other options like file path, verbose mode etc. are unchanged for using network tools.

Tool name	network_tx.exe --tfdtp argument
Tool source code (PC side)	vision_sdk\apps\tools\network_tools\network_tx
Tool source code (target side)	vision_sdk\links_fw\src\rtos\links_common\network_rx vision_sdk\links_fw\src\rtos\links_common\tfdtp_rx
Example usage (target side)	vision_sdk\apps\src\rtos\usecases\network_rx_tx chains_networkRxDecDisplay*.* chains_networkRxDisplay*.*

Tool name	network_rx.exe
Tool source code (PC side)	vision_sdk\apps\tools\network_tools\network_rx
Tool source code (target side)	vision_sdk\links_fw\src\rtos\links_common\Network_tx
Example usage (target side)	vision_sdk\apps\src\rtos\usecases\network_rx_tx chains_networkTxEncDisplay*.* chains_networkTxDisplay*.*

6.4 Tools Usage

Follow section 3.2 for using TFDTP with Network_rx link and section 4.2 for using TFDTP with Network_tx link. All other configuration like server port, data format etc. remains same with TFDTP except mentioned in below sections.

IMP Note: It is recommended to use Linux machine when using PC tools with TFDTP use-cases. We have observed issues when running on windows.

- Make sure you are using PC with good configuration (Ex - 8GB RAM, i5@3.40GHz)
- Make sure system is not fully loaded. Restart PC to have clean slate.
- Make sure ports used by networks tools are not used by other application. You can use tools like port scanner to identify all used ports.
- For receive, network rx tool writes received data to file which may cause slowdown of use-case and receive. Also as file size grows the file write may slowdown.

6.4.1 TFDTP Receive with Network_rx and tfdtp_rx

- **Target side: Create a Vision SDK use-case on target side - Network Rx using TFDTP with Network_rx**

- Specify the source of data as "Network_rx" link.
- Set NetworkRxLink_CreateParams.dataRxMode as NETWORK_RX_LINK_DATA_RX_MODE_NETWORK_TFDTP
- TFDTP Rx supports only single channel receive so it can't be used when multiple Network_rx link are used in parallel. Also parameters like TFDTP receive/transmit port no., data rate etc. are not user configurable and set in networkCtrlIntf.h

- **PC tool: Invoke the tool as shown below, it will print the supported options**

```
$ network_tx.exe or network_tx.out
```

```
# network_tx --host_ip <ipaddr> --target_ip <ipaddr> [--port <server port> --usetfdtp --verbose --no_loop --delay <delay in secs>] --files <CHO file>
```

```
#
```

```
# (c) Texas Instruments 2014
```

```
#
```

- The "port" option when not specified default port is used.
- **IMP:** Multiple "channels" of data is **not supported** for TFDTP for sending multiple files
- **IMP:** --usetfdtp option should be given when invoking network_tx.exe utility for using TFDTP receive on PC.

6.4.2 TFDTP Transmit with Network_tx link

- **Target side: Create a Vision SDK use-case on target side**

- Connect the output of the algorithm or link for which data needs to be saved to PC to a "Network_Tx" link
- Set NetworkTxLink_CreateParams.dumpDataType as NETWORK_TX_LINK_TRANSMIT_TYPE_TFDTP
- Set NetworkTxLink_CreateParams.networkServerPort, if not specified default value is used. Port values in needed when more than one Network_tx links are used in application.

- **PC tool: Invoke the tool as shown below, it will print the supported options**

```
#
```

```
# network_rx --ipaddr --target_ip <ipaddr> --host_ip <ipaddr> [--port <server port>] --usetfdtp --files <CHO file> <CH1 file>
```

```
#
```

```
# (c) Texas Instruments 2014
```

```
#
```

- The "port" option when not specified default port is used.
- **IMP:** Multiple "channels" of data is **supported but not tested** for TFDTP for sending multiple files.

- Multiple “channels” of data can be saved by specifying multiple files.
- “network_rx.exe” can be invoked multiple time, each invocation receiving data from different “Network_Tx” links in the use-case on target
- **IMP:** --usetfdtp option should be given when invoking network_rx.exe utility for using TFDTP receive on PC.
- **IMP:** For TFDTP TX it is recommended to have both receiver (EVM) and transmitter (PC app) on the same network switch. As UDP, by design, doesn’t employ flow control packet drop/miss can be seen if both operate in different speeds, configuration.

6.5 TFDTP/TCP Performance

Core	Config No	Config	TCP/IP	TFDTP	Null Src			Null			NDK Send	NDK Recv
					Mb/S	FPS	CPU Load	Mb/S	FPS	CPU Load		
A15	1	TCP/IP = En, TFDTP = En	Select					140	12	23.80%		160 (34%)
	2	TCP/IP = En, TFDTP = En		Select	112	10	5.50%	368	30	23.80%		160 (34%)
	3	TCP/IP = En, TFDTP = Dis	Select		115	10	17.20%	140	12	26.60%	125 (20%)	150 (30%)
IPU1	4	TCP/IP = En, TFDTP = En	Select		40	3.65	96%	50	4.3	100%	65 (100%)	15 (45%)
	5	TCP/IP = En, TFDTP = En		Select	112	10	30.4%*	368	30	46.50%	65 (100%)	15 (45%)
	6	TCP/IP = En, TFDTP = Dis	Select		40	3.65	96%	48	4.1	100%	60 (100%)	15 (45%)

* Run from Linux machine

6.6 TFDTP FAQs

Q. I see lot of drops when running network tx tool on Windows for Network_rx use-case
The flow control is not supported on Windows so when using network tx on Windows it sends data at maximum possible rate and causes packet drop at receive target. Please use Linux machine for flow control support in tool.
Q. I don't see any data traffic when running my PC tools application
Make sure to network mode selected on EVM and PC tool matches. Use option --usetfdtp only when TFDTP mode is enabled in use-case.
Q. Why TFDTP build is supported only on IPU1_1? Can I use it on A15 or IPU1_0?
This is because of EDMA PaRAMs requirements for the TFDTP. By default TFDTP needs 256 EDMA PaRAMs which in VSDK2.12 are allocated statically only for IPU1_1. To enable TFDTP on other cores, change EDMA PaRAMs allocation in src\utils_common\src\dma_cfg\utils_dma_cfg_sys_edma_tdaxx.c and add PaRAMs for A15 or IPU1_0.
Q. My use-case doesn't stop even issues stop command through console when running Network_rx TFDTP receive use-case
You need to stop PC/Client transmitter application for stopping use-case. When transmitter app is not stopped it will keep sending data at faster rate and overload IPU.
Q. I see packet drops and/or data corruption when running Network_rx TFDTP Rx
This issue can be due to Network_rx data (TFDTP) sent at maximum possible wire rate to EVM. Currently max. rate supported for TFDTP Rx is 350Mbps. If data-rate crosses this, packet drop can be seen.
On Linux Network_tx tool implements flow control to send data at rate which TDA can handle. This is not implemented on Windows. Please see TFDTP user guide in

NSP package for more details about this issue.

Q. I see data-rate drop in debug build

~30Mbps difference is seen with debug and release build. For debugging purpose, reduce input fps in debug build when packet drop is seen.

Q. My network throughput doesn't exceed 100Mbps

This can be due to either server or client on 100Mbps network.

Also some of Windows™ PC it is seen that it is not crossing 100Mbps throughput. It is possibly Winsock or PCAP issue. It is advised to use Linux PC.

Q. How to Enable/Disable TFDTP functionality. How is it advantages using TFDTP over TCP/IP.

To enable TFDTP set NSP_TFDTP_BUILD=yes in the config file. Please see TCP, TFDTP comparison table for TCP/TFDTP tradeoffs.