OpenTSN3.2 Networking Demonstration

System User Manual

(version 1.1)

OpenTSN Open Source Project Team

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Version history

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1 Overview

OpenTSN3.0 is divided into TSN switch (switching logic) and TSN network card (end logic)
Two independent hardware logic, on this basis, add self-learning function in hardware, software
In addition, the indicator light verification function is added, which is the OpenTSN3.2 version. This article builds a group by
A network case is used to demonstrate and verify the functional accuracy of the TSN network card and TSN switch logic.

2. The composition of the networking environment

2.1 TSN networking environment topology

Use 2 TSN switches, 2 TSN NICs, 1 TSN tester, a
Network cameras and 4 PCs build the demo environment topology shown in Figure 2-1, the solid line in the figure
All are connected by network cables, and the arrow points are the data flow direction. The figure contains three traffic test paths,
They are vlc traffic channel, camera real-time monitoring video traffic channel and mixed traffic channel.
road.

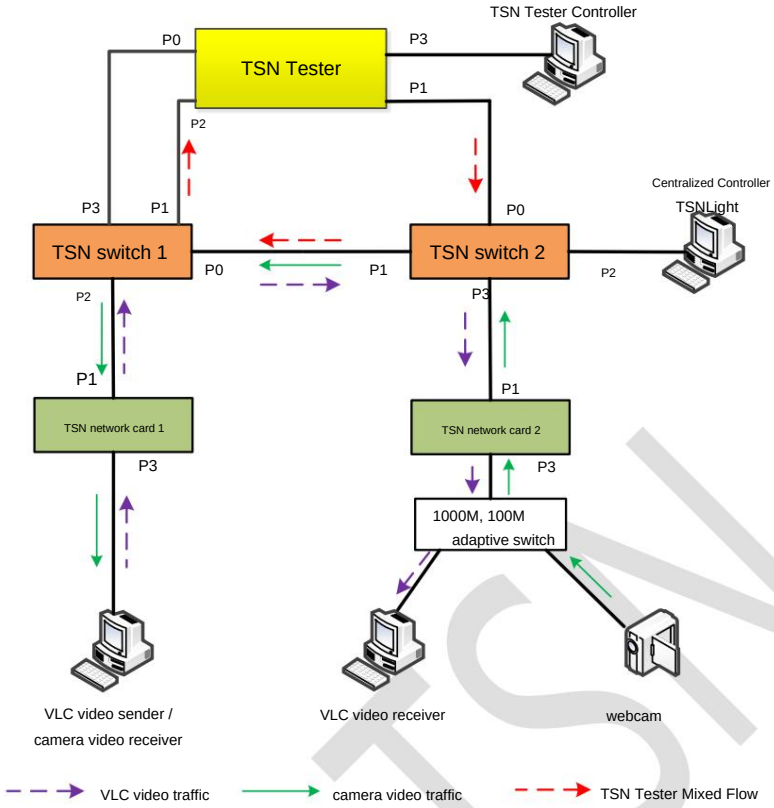

Figure 2-1 Demonstration environment topology

2.2 Network device configuration

The information of each device in the networking is shown in Table 2-1 below.

Table 2-1 Device configuration

serial number	device name	configuration information	Remark
1	TSN switch	2, equipped with OpenTSN3.2 switch logic	For the exchange of traffic in the TSN network
2	TSN network card	2, equipped with OpenTSN3.2 network card logic	It is used for mapping, remapping, submitting, and injecting traffic in the TSN
3	VLC traffic sender/ camera video receiver	Windows computer: 1) Connect to TSN via network card 1 P2 port of switch 1;	network. It is used for testing VLC traffic and camera video traffic. The firewall needs to be turned off when network testing is used.

serial number	device name	configuration information	Remark
		2) Install VLC playback software and camera video traffic receive client;	
4	Webcams	1) Since the TSN network card is currently Only supports gigabit, so 100M network Webcam with TSN card 2 Gigabit connection is required between adapt to the switch; 2) Connect to TSN via network card 2 P3 port of switch 2;	It is used for sending camera video traffic. The IP addresses and MAC addresses of different cameras may be different from those mentioned in this article, and the corresponding entries need to be modified.
5	VLC traffic receiver	Windows computer: 1) Connect to TSN via network card 2 P3 port of switch 2; 2) Install VLC playback software piece;	It is used to receive VLC traffic, and the firewall needs to be turned off when network testing is used.
6	Centralized controller TSNLight3.0	Linux devices (virtual machines are also available, Please refer to the appendix for specific requirements) 1) Directly connected to TSN switch 2 the P2 port; 2) Need to run centralized control	Used for network configuration, network-wide time synchronization, etc.

serial number	device name	configuration information	Remark
		Controller software TSNLight;	
7	TSN Tester Controller	Linux devices (virtual machines are also available, Please refer to the appendix for specific requirements) 1) Need to run TSN tester Controller software TSNNic	Used to control the content, rate, etc. of traffic sent by the TSN tester
8	TSN Tester	1) Transmission of ST/RC/BE stream and receive;	Used for ST, RC, BE, traffic transmission and reception, and statistics delay jitter and other information

2.3 Hardware board description

The actual board is shown in Figure 2-2 and Figure 2-3 below. The size of the board is: 100mm*80mm.

The internal functions of the board are different according to the solidified logic code. Board can be cured

Tester, network card, switch hardware logic.

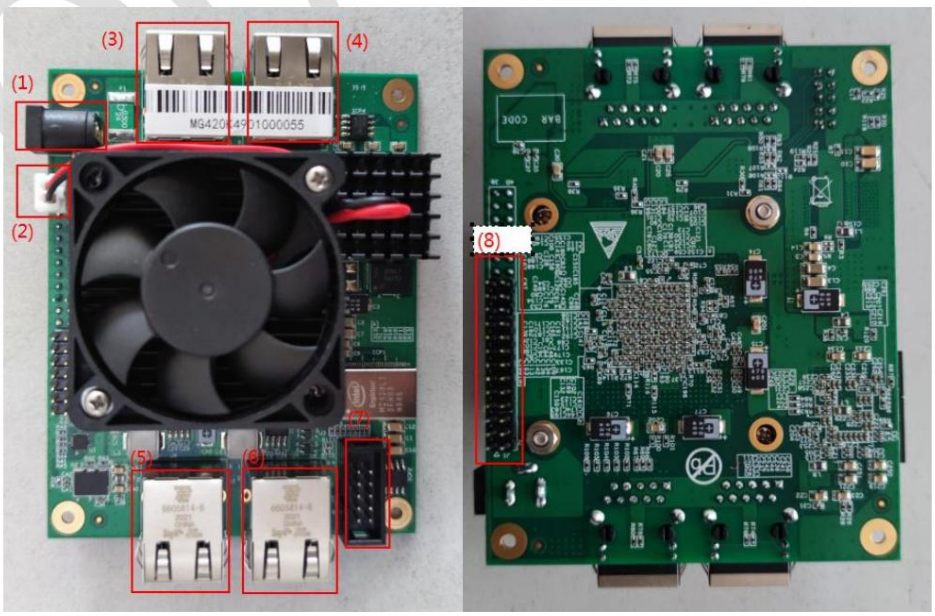

Figure 2-2 Boards - Front and Back

Figure 2-3 Board-side

The interfaces marked (1)-(8) in Figure 2-2 and Figure 2-3 are described in Table 2-2. Table 2-2

Interface description Interface description 12V power

Numbering	socket. Note that this socket cannot be
1	plugged into the 12V socket on the bottom panel at the same time.
2 12V fan sockets with foolproof design. 3 Gigabit ports 3 4	
Gigabit ports 2 5 Gigabit ports 0 6 Gigabit ports 1 JTAG socket,	
foolproof design. It can be used for JTAG side scan debugging	
and AS Flash programming. 8 2.54mm grid pins	
7	

2.4 Instructions for use of the centralized controller software TSNLight3.0

The source files included in the centralized controller are shown in Figure 2-4, which are stored in the arp_proxy directory

arp proxy application files, basic configuration application files stored in the basic_cfg directory,

Common library files are stored in the cnc_api directory, and local files are stored in the local_cfg directory.

The configuration file, the net_init directory stores the network initialization file, and the ptp directory stores it

It is the time synchronization application file, the remote configuration file stored in the remote_cfg directory,

The state_monitor directory stores the files of the applications implemented by the network in the running state.

main.c file is the main function of the program, makefile is the file required for compilation, tsnlight

The executable file generated after compilation.

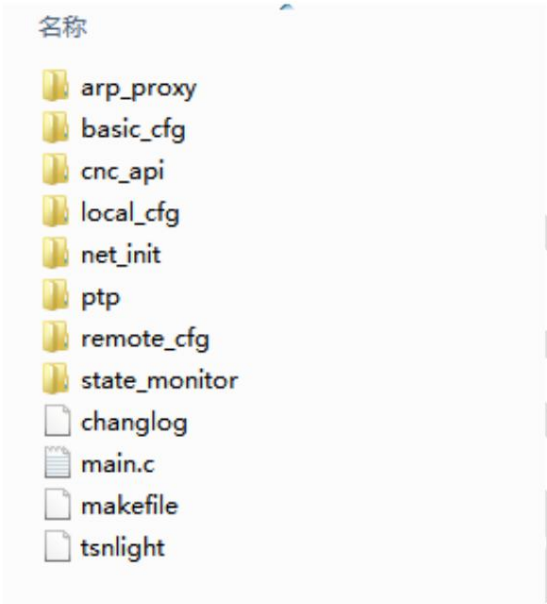

Figure 2-4 Centralized control software directory

Three steps are required before running the centralized controller TSNLight3.2:

Step 1: Compile the library file, execute make in the cnc_api directory, and compile the library file;

Step 2: Compile the application, execute make in the TSNLight3.2 directory, compile

TSNLight Controller.

Step 3: Execute ./tsnlight net_interface, where net_interface is the name of the network interface

It can be viewed through ifconfig.

Refer to Appendix A for the specific environment in which the controller operates.

2.5 TSN Tester Controller Software Description

The TSN tester controller software currently only provides compiled executables and

Required text file, where the executable is tester_ui. execute at runtime

"./tester_ui" to display the configuration interface.

3. Hardware logic code solidification

The specific operation steps of TSN project curing logic code are as follows:

1) After the project is built and compiled, a solidified file is produced, such as Figure 3-1.

2) Click tools->programmer->add files to add the compiled .jic file

file (to solidify the TSN network card logic nic_output_file.jic file, and to solidify the TSN switch logic

select the TSSwitch_output_file.jic file).

3) Select the USB serial port of the programming cable, select the JTAG mode for programming, and click start

Start burning the TSN project. As shown in 3-2 below.

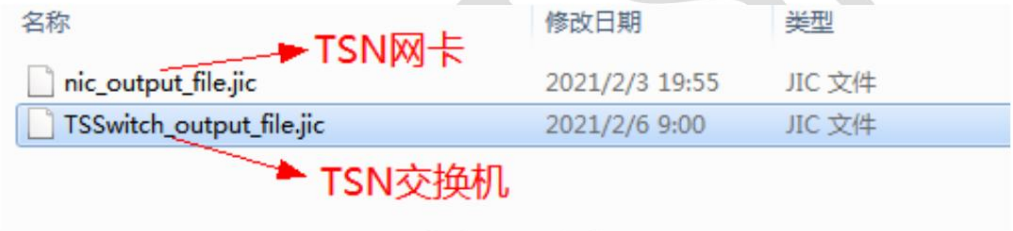

Figure 3-1 jic file

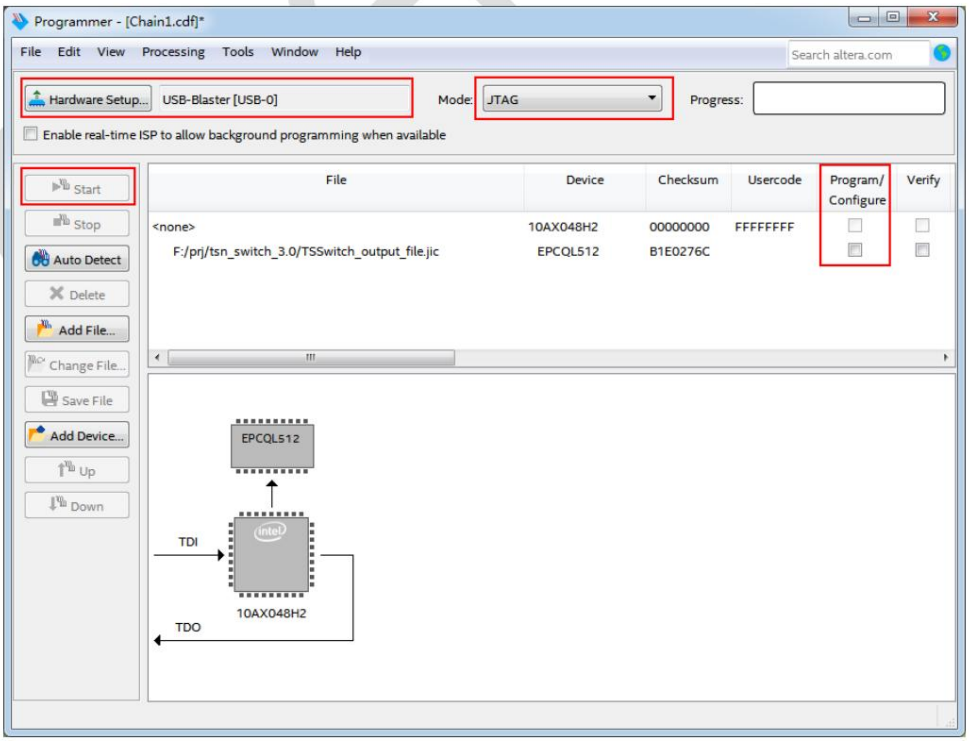

Figure 3-2 Solidified logic code

4. Demonstration case

Set up the TSN networking topology environment according to the test scenario in Figure 2-1, and configure the configuration according to Figure 4-1.

Configure the initial configuration of the switch and network card. where TSN switch 1's

"imac=2", "imac=3" for TSN switch 2, "imac=4" for TSN NIC 1, TSN

"imac=5" for network card 2, "imac=100" for TSN tester. Part of the initial configuration

The information is shown below:

```
<network_init_cfg>
<!-- 控制器的IMAC地址默认为0-->
<tsnlight_info>
    <master_imac>3</master_imac>    <!-- master_imac表示主时钟的imac地址为1-->
    <sync_period>200</sync_period>    <!-- sync_period表示时间同步的周期为200ms-->
    <sync_flowID>4096</sync_flowID>    <!--sync_flowID表示sync组播的flowID为4096-->
    <report_period>200</report_period>  <!-- report_period表示上报周期为200ms-->
</tsnlight_info>

<switch>
    <register> <!-- TSN交换机的属性信息-->
        <IMAC>3</IMAC>    <!-- 交换机的IMAC地址-->
        <port_type>0</port_type>    <!-- 示例port_type=253（二进制8b'1111 1101）表示设备的7、6、5、4、3、2、0号端口为非协作模式，1号端口为协作模式-->
        <time_slot>32</time_slot>    <!--时间槽的长度为32us-->
        <inject_slot_period>4</inject_slot_period>  <!-- 注入周期为4-->
        <submit_slot_period>4</submit_slot_period>  <!-- 提交周期为4-->
        <qbv_or_qch>0</qbv_or_qch>                  <!-- 调度模型为qbv-->
        <ST_buf_threshold>200</ST_buf_threshold>   <!-- ST帧的缓冲区块阈值-->
        <port_num>4</port_num>  <!-- port_num表示当前端口的数量，支持网卡1个端口，交换机8端口和4端口-->
    </register> <!-- 交换机的属性信息-->
    <forward_table>  <!-- 交换机的初始转发表-->
        <entry>
            <flowid>0</flowid>
            <outport>4</outport>
        </entry>
        <entry> <!-- 交换机0 -->
            <flowid>2</flowid>
            <outport>2</outport>
        </entry>
        <entry> <!-- 交换机1 -->
            <flowid>3</flowid>
            <outport>256</outport>
        </entry>
        <entry> <!-- 交换机2 -->
            <flowid>4</flowid>
            <outport>2</outport>
        </entry>
        <entry>
            <flowid>5</flowid>
            <outport>8</outport>
        </entry>
```

Figure 4-1 Initial configuration of some networking

4.1 Self-learning test

4.1.1 Expected results

The camera receiver and the VLC video transmitter are connected through the self-learning function of the switch.

If you can ping, the self-learning function is running normally.

4.1.2 Operation steps

The specific operation steps of the self-learning test are as follows:

1) Set up the network topology environment, and configure the terminal equipment environment according to Table 2-1;

2) Communicate the camera video receiver with the VLC video sender

3) Observe whether the camera video receiving end and the VLC video sending end can be pinged.

4.1.3 Test Results

Observe that the camera video receiving end and the VLC video sending end can ping through, self-learning Function is functioning normally.

4.2 Time synchronization accuracy test

4.2.1 Expected results

TSN switch 2 is the master clock node, TSN switch 1, TSN network card 1, Network topology of TSN network card 2 and TSN tester as slave clock nodes, time Synchronization accuracy test, record and print the offset values of 4 slave nodes during the test. on the net When the network is running normally, on the terminal interface of the centralized controller, the synchronization node will report the real-time The synchronization information parameter offset value is printed, and the offset parameter value should be kept at 12 (100ns) Within.

4.2.2 Parameter configuration

The key entry configuration for the time synchronization accuracy test is the forwarding configuration of time synchronization packets. set, the sync message flowid sent by the centralized controller periodically is 4096, and the sync message

It needs to be forwarded to each slave clock through the master clock. Pass 1 is required in TSN switch 2 No. and No. 3 network ports are forwarded to each slave node; in TSN switch 1, it needs to pass the host port forwarded to the local and forwarded to the TSN tester via port 3.

The IMAC of the centralized controller is 0, and each TSN switch needs to communicate with the centralized controller. Therefore, it is necessary to configure the forwarding direction of IMAC=0.

For other configurations of switches and network cards, see Table 4-1.

Table 4-1 Time synchronization accuracy test configuration items

TSN switch 1 configuration (IMAC=2)		
Forward table forward_table		
	Flow_id	Outport
Time synchronization message	4096	264
Time synchronization response message arts	0	1
register register		
	name	Numerical value
port type port_mode time slot time_slot		0
inject_slot_perio		32
injection cycle	d	4
Commit cycle	submit_slot_peri od	4
scheduling mechanism qbv_or_qch 0 (0 means qbv)		
Reserved ST buf	ST_buf_threshol d	300
TSN switch 2 configuration		
Forward table forward_table		
	Flow_id	Outport
Time synchronization message	4096	10
time synchronization response message	0	4
register		
	name	Numerical value

Port type port_mode Time slot time_slot Injection		0
period inject_slot_period Submission period	submit_slot_period	32
Scheduling mechanism qbv_or_qch Reserved ST buf		4
ST_buf_threshold		4
		0
		300
TSN network card (2) configuration		
register register		
	name	Numerical value
port type port_mode time slot time_slot injection	period	0
inject_slot_period submission period	submit_slot_period	32
reserved ST buf ST_buf_threshold		4
		4
		300

4.2.3 Operation steps

The specific operation steps of the time synchronization accuracy test are as follows:

1) Set up the network topology environment, and configure the terminal equipment environment according to Table 2-1;

2) Configure the entries according to Figure 4-1 and Table 4-1;

3) On the centralized controller terminal, run the centralized controller software TSNLight3.2, execute

Line "./tsnlight net_interface". (Refer to chapter 2.4 for the specific operation method)

4) On the terminal of the centralized controller, the offset of each node can be observed.

According to the offset information, the time synchronization status of each node can be observed.

4.2.4 Test results

After a fixed time period, the clocks of each node of the network are aligned, and the

The offset value of each slave clock can be stable at 0--12 (this value represents the number of beats, and each beat is 8ns)

, ie within 100ns accuracy, as expected.

4.3 End-to-end latency testing for time-sensitive traffic

4.3.1 Expected results

Under the scheduling mechanism of qbv, the TSN tester is used to construct 3 bytes of length 124B,

The traffic with a bandwidth of 8Mbps is sent from the transmitter of the tester and forwarded through the TSN network.

In the mixed traffic received at the receiving end of the TSN tester, the delay fluctuation of ST traffic is small, and the delay

The delay is within a certain expected range, and there is no packet loss in the traffic.

4.3.2 Parameter configuration

The key entry configuration for end-to-end delay testing of time-sensitive traffic lies in the

Path planning, that is, the configuration of the forwarding table and gating table, the detailed configuration of the switch is shown in the table

4-2ÿ

Table 4-2 Mixed traffic test configuration items

TSN switch 1 configuration		
Forward table forward_table		
	Flow_id	Outport
100M ST stream quantity	11	2
100M of RC streams quantity	12	2
100M BE stream quantity	13	2
TSN switch 2 configuration		
Forward table forward_table		
	Flow_id 11	Outport
100M ST traffic		2
100M RC traffic	12	2
100M BE traffic	13	2

```
<switch>
    <IMAC>2</IMAC><!-- TSN交换机1交换机的imac为2 -->
    <forwarding_table>   <!-- 转发表 -->
        <entry>
        <entry>
        <entry>
            <flowid>11</flowid>
            <outport>2</outport>
        </entry>
        <entry>
            <flowid>12</flowid>
            <outport>2</outport>
        </entry>
        <entry>
            <flowid>13</flowid>
            <outport>2</outport>
        </entry>
        <entry>
```

Figure 4-2 TSN switch 1 forwarding table configuration

```
<gate_control_list_table>
    <port_id>2</port_id><!-- 1号节点中0号端口门控表 -->
    <!-- 其中id表示端口号，id=2表示2号端口，每个交换机有8个网络口，分别为0，1,2,3,4，5,6,7 -->
    <entry>
        <time_slot>0</time_slot>
        <gate_state>255</gate_state>
        <!-- gate-state表示门控状态，使用bitmap形式，共8位，
        从低到高依次代表TS0、TS1、TS2、RC、PTP、BE、NMAC、重组队列。
        每一位代表一个队列的门控状态，1表示门控打开，0表示关闭。
        示例gate_state=254（二进制8b'11111110）表示7、6、5、4、3、2、1号队列为打开状态，
        0号队列为关闭状态。-->
    </entry>
    <entry>
        <time_slot>1</time_slot>
        <gate_state>255</gate_state>
    </entry>
    <entry>
        <time_slot>2</time_slot>
        <gate_state>255</gate_state>
    </entry>
    <entry>
        <time_slot>3</time_slot>
        <gate_state>255</gate_state>
    </entry>
</gate_control_list_table>
```

Figure 4-3 TSN switch 1 gating table configuration

```
<switch>
<IMAC>3</IMAC><!--TSN交换机2的imac为3 -->
<forwarding_table>   <!-- 转发表 -->
    <entry>
    <entry>
    <entry>
        <flowid>11</flowid>
        <outport>2</outport>
    </entry>
    <entry>
        <flowid>12</flowid>
        <outport>2</outport>
    </entry>
    <entry>
        <flowid>13</flowid>
        <outport>2</outport>
    </entry>
    <entry>
```

Figure 4-4 TSN switch 2 forwarding table configuration

```
<gate_control_list_table>
    <port_id>0</port_id><!-- 1号节点0端口门控表 -->
    <!-- 其中id表示端口号，id=2表示2号端口，每个交换机有8个网络口，分别为0，1,2,3,4，5,6,7 -->
    <entry>
        <time_slot>0</time_slot>
        <gate_state>255</gate_state>
        <!-- gate-state表示门控状态，使用bitmap形式，共8位，
        从低到高依次代表TS0、TS1、TS2、RC、PTP、BE、NMAC、重组队列。
        每一位代表一个队列的门控状态，1表示门控打开，0表示关闭。
        示例gate_state=254（二进制8b'11111110）表示7、6、5、4、3、2、1号队列为打开状态，
        0号队列为关闭状态。-->
    </entry>
    <entry>
        <time_slot>1</time_slot>
        <gate_state>255</gate_state>
    </entry>
    <entry>
        <time_slot>2</time_slot>
        <gate_state>255</gate_state>
    </entry>
    <entry>
        <time_slot>3</time_slot>
        <gate_state>255</gate_state>
    </entry>
```

Figure 4-5 TSN switch 2 gating table configuration

4.3.3 Operation steps

The specific operation steps of the deterministic transmission test of time-sensitive traffic are as follows:

1) On the basis of Section 4.1;

2) Configure the entries according to Figure 4-2, Figure 4-3, Figure 4-4, Figure 4-5 and Table 4-2;

3) Run the TSN tester controller, execute "./tester_ui", in the TSN tester

Controller interface, configure and send mapped 3 mixed streams of 100M each

The configuration test example is shown in Figure 4-6 and Figure 4-7, click to start the test;

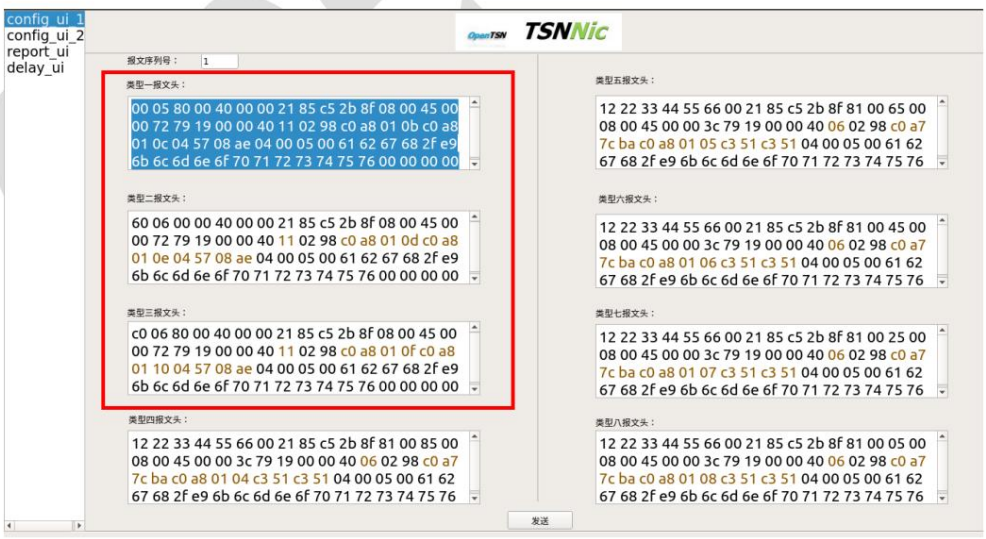

Figure 4-6 TSN tester configuration interface 1

Figure 4-7 TSN tester configuration interface 2

4) After the TSN tester test process, you can

View the delay jitter of the traffic on the interface, click Stop Test to view the traffic

of packet loss.

4.3.4 Test Results

Mixed traffic is transmitted through the network, and the end-to-end delay of time-sensitive traffic is small.

The jitter is also small, and the number of packets lost in traffic is 0. The test results are in line with expectations.

4.4 Gated test

4.4.1 Expected results

According to the XML text, set the time slot size to 32us, and set the time slot gate to full

Open is set to close the time slot when traffic enters, for example, the original gate is 255, that is, 1111 1111

The gate control is fully open. When testing the gate control switch, set the corresponding time slot gate control to 191 or 1011.

1111, the expected result delay is about 32us.

4.4.2 Parameter configuration

Modify the gate control table of port 1 of switch 1, and modify the XML configuration text as follows:

```
<gate_control_list_table>
    <port_id>1</port_id><!-- 1号端口门控表 -->
    <entry>
        <time_slot>0</time_slot>
        <gate_state>255</gate_state>
    </entry>
    <entry>
        <time_slot>1</time_slot>
        <gate_state>255</gate_state>
    </entry>
    <entry>
        <time_slot>2</time_slot>
        <gate_state>255</gate_state>
    </entry>
    <entry>
        <time_slot>3</time_slot>
        <gate_state>191</gate_state>
    </entry>
</gate_control_list_table>
<gate_control_list_table>
    <port_id>2</port_id><!-- 2号端口门控表 -->
    <entry>
        <time_slot>0</time_slot>
        <gate_state>255</gate_state>
    </entry>
    <entry>
        <time_slot>1</time_slot>
        <gate_state>255</gate_state>
    </entry>
    <entry>
        <time_slot>2</time_slot>
        <gate_state>255</gate_state>
```

Figure 4-8 local_cfg_xml modification part

4.4.3 Operation steps

On the basis of 4.2 and 4.3, watch the transmission delay of the tester's message by modifying the XML text.

4.4.4 Test Results

After testing, when a time slot is closed, the transmission delay is about 32us. In line with expectations.

4.5 Traffic Priority Test

4.5.1 Expected results

Camera video traffic is mapped to BE traffic, VLC video traffic is mapped to RC traffic,

When there is no congestion in the TSN network, the video traffic of the camera and VLC can be transmitted normally

Playback; when the TSN network is congested, the camera video traffic is sluggish, and VLC

When the video traffic is played smoothly and the network is not congested, the camera video traffic will also resume.

Repeat smooth playback.

4.5.2 Parameter configuration

The entry configuration of the camera real-time monitoring video traffic test lies in the mapping of video traffic

and remapping, see Table 4-3 for detailed switch configuration, and see Figure 4-9 and Figure 4-10 for NIC entries.

Table 4-3 Camera real-time monitoring video traffic test configuration items

TSN switch 1 configuration		
Forward table forward_table		
serial number	Flow_id 8	Outport
1		1
2	9	4
3	22	1
TSN switch 2 configuration		
Forward table forward_table		
	Flow_id 8	Outport
1		8
2	9	2
3	22	8

```
<RX_FL-tag_remapping_table>   <!-- TSN网卡2的逆映射表 -->
<entry> <!-- 重映射表 -->
    <remap_id>0</remap_id>      <!-- 重映射表的id号，表示第0个重映射表 -->
    <flow_id>8</flow_id>
    <dmac>BC:BA:C2:F3:F0:D0</dmac>  <!-- 摄像头MAC -->
    <outport>3</outport>
</entry>
<entry>
    <remap_id>1</remap_id>      <!-- 重映射表的id号，表示第1个重映射表 -->
    <flow_id>22</flow_id>
    <dmac>E8:6A:64:C4:96:FF</dmac>  <!-- vlc接收端的MAC-->
    <outport>8</outport>
</entry>
<entry>
    <remap_id>2</remap_id>      <!-- 重映射表的id号，表示第2个重映射表 -->
    <flow_id>4308</flow_id>
    <dmac>E8:6A:64:C4:96:FF</dmac>
    <outport>8</outport>
</entry>
<entry>
    <remap_id>3</remap_id>      <!-- 重映射表的id号，表示第3个重映射表 -->
    <flow_id>14709</flow_id>
    <dmac>BC:BA:C2:F3:F0:D0</dmac>
    <outport>8</outport>
</entry>
</RX_FL-tag_remapping_table>
```

Figure 4-9 TSN network card 2 configuration

```
<RX_FL-tag_remapping_table>   <!-- TSN网卡1的逆映射表 -->
<entry> <!-- 重映射表 -->
    <remap_id>0</remap_id>      <!-- 重映射表的id号，表示第0个重映射表 -->
    <flow_id>9</flow_id>
    <dmac>C0:04:80:00:00:00</dmac>
    <outport>8</outport>
</entry>
</RX_FL-tag_remapping_table>
```

Figure 4-10 TSN network card 1 configuration

4.5.3 Operation steps

The specific operation steps of the camera video traffic test are as follows: 1) Set up the network topology environment, and configure the terminal equipment according to Table 2-1;

2) According to Figure 4-9 (in the XML text "local_cfg_xml", according to the actual access network The MAC of the network camera is modified), Figure 4-9 and Table 4-3 Configure the table item;

3) On the centralized controller terminal, run the centralized controller software TSNLight3.2, execute Line "./tsnlight net_interface". (Refer to chapter 2.4 for the specific operation method)

4) Start the camera, run the "ivms-4200 client" on the camera receiver, and set the Add the camera device to the client, click to play the monitoring screen, if not Real-time screen, please refresh the device;

5) Open the VLC playback software on the VLC video sender, select the

For streaming video, select UDP format for push streaming, and then video in VLC

The receiving end receives VLC video;

6) At this time, observe the real-time monitoring screen of the camera and the VLC video should be played normally;

7) Run the TSN tester controller, execute "./tester_ui", in the TSN tester

Controller interface, configure and send mapped 3 mixed traffic, among which ST

The flow rate is 8M, the RC flow rate is 8M, and the BE flow rate is 8M. The configuration test example is shown in Figure 4-11.

Figure 4-12;

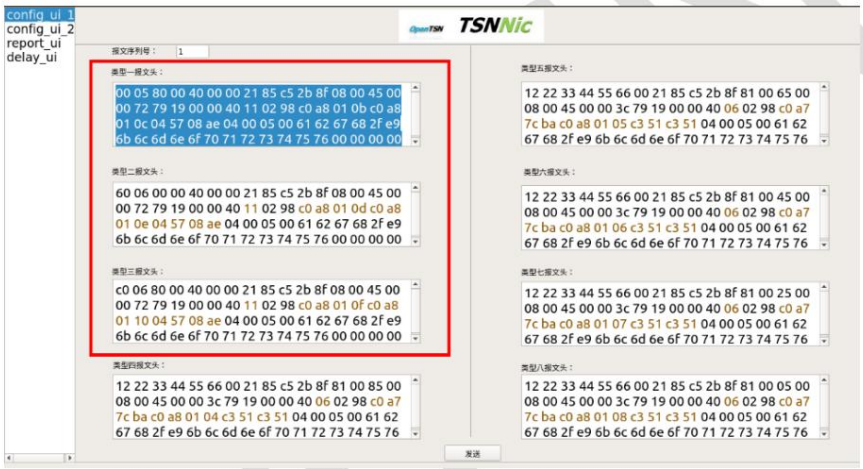

Figure 4-11 TSN tester configuration interface 3

Figure 4-12 TSN tester configuration interface 4

8) Click to start the test, you should see that the camera video is obviously lag and stuck,

VLC video plays smoothly, click to stop the test, you should be able to see VLC

The video plays smoothly, and the camera traffic resumes to play smoothly.

4.5.4 Test Results

Camera video traffic is mapped to BE traffic, VLC video traffic is mapped to RC traffic,

When there is no congestion in the TSN network, the video traffic of the camera and VLC can be transmitted normally

Playback; when the TSN network is congested, the camera video traffic is sluggish, and VLC

When the video traffic is played smoothly and the network is not congested, the camera video traffic will also resume.

Repeat smooth playback.

Appendix **1:** Construction of Software Operating Environment

The software needs to be run on a Linux device (Ubuntu16.04LTS is recommended), and

And need to install libnet, libpcap and libxml libraries.

This article provides two ways for users to choose

Method 1: Use the virtual machine provided by OpenTSN to run the centralized controller.

In order to facilitate users to build the operating environment as soon as possible, reduce the cost of building the environment

Time, provide the configured virtual machine in Baidu network disk, the following describes the construction of virtual machine in detail

A step of.

(1) Download the files in the Baidu network disk

Download all files from Baidu network disk, network disk link:

https://pan.baidu.com/s/10TFms21z_-En0esnTxhhvg, extraction code: mx3q.

(2) Install VirtualBox-5.2.14-123301-Win

It is preferred to install the VirtualBox software. After installation, you can import the required software under the software.

Installed virtual machine.

(3) Import the virtual machine

Import the downloaded virtual machine in VirtualBox, first click "Manage" in the interface,

In the management, select "Import virtual computer", and then select the file to be imported (from Baidu.com

file downloaded on your disk), and then select Import. The import takes about 5 minutes.

Figure A-1 Management Options

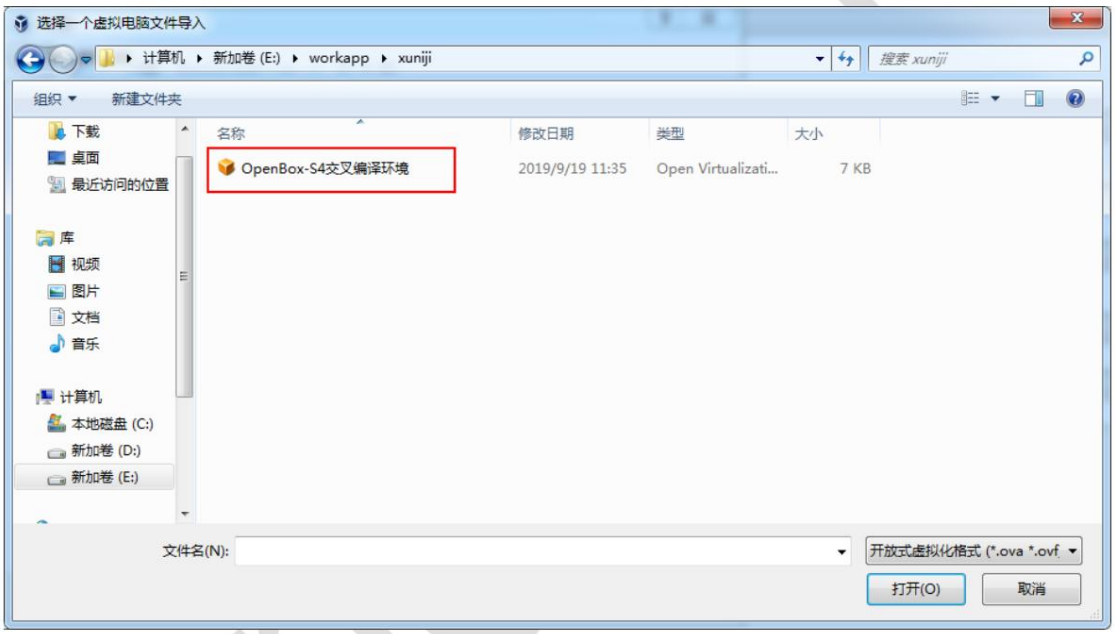

Figure A-2 Files to be imported

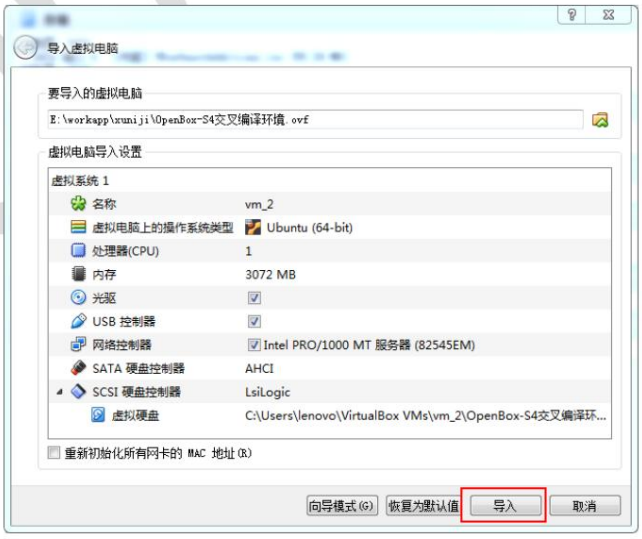

Figure A-3 Confirm Import

(4) Virtual machine settings

After the import is successful, you need to configure the virtual machine. On the vbox interface, click "Settings",

Set up storage, network, and shared folders in turn.

Figure A-4 Virtual Machine Settings

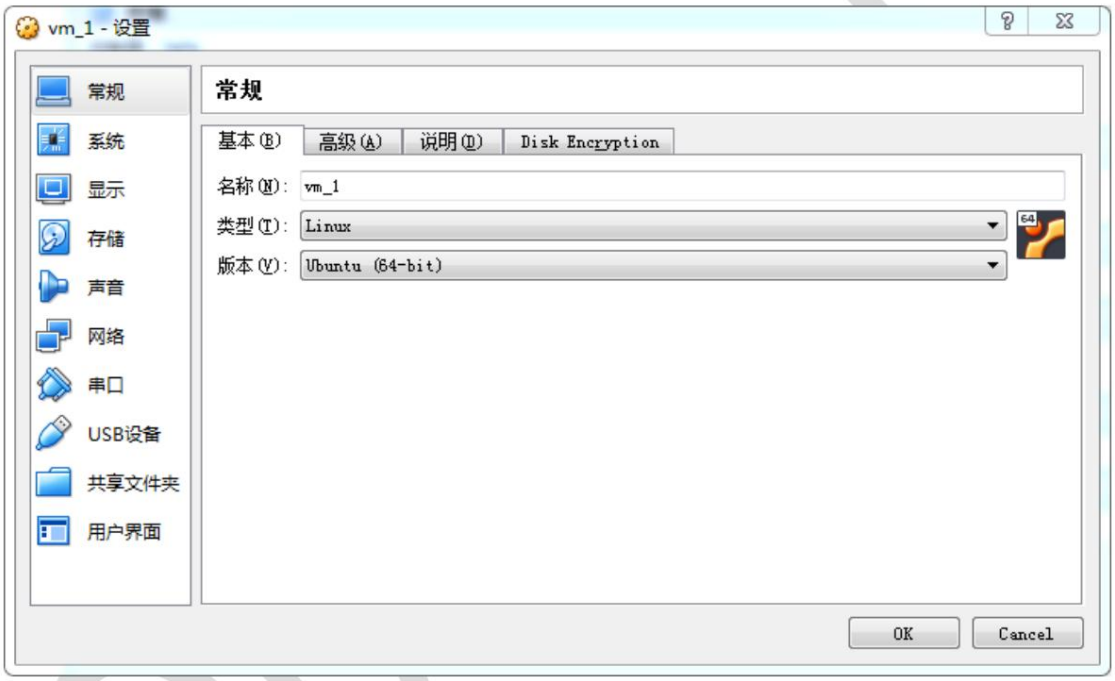

Figure A-5 Setting Contents

Set up storage, add a virtual hard disk, and select according to the red boxes.

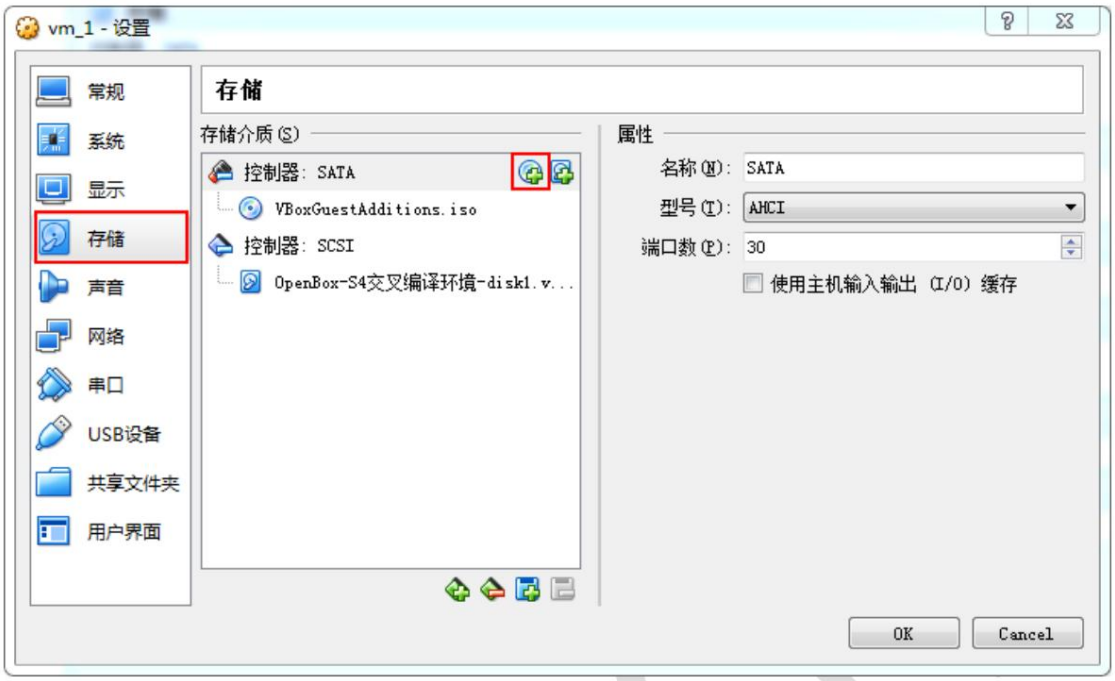

Figure A-6 Storage Settings

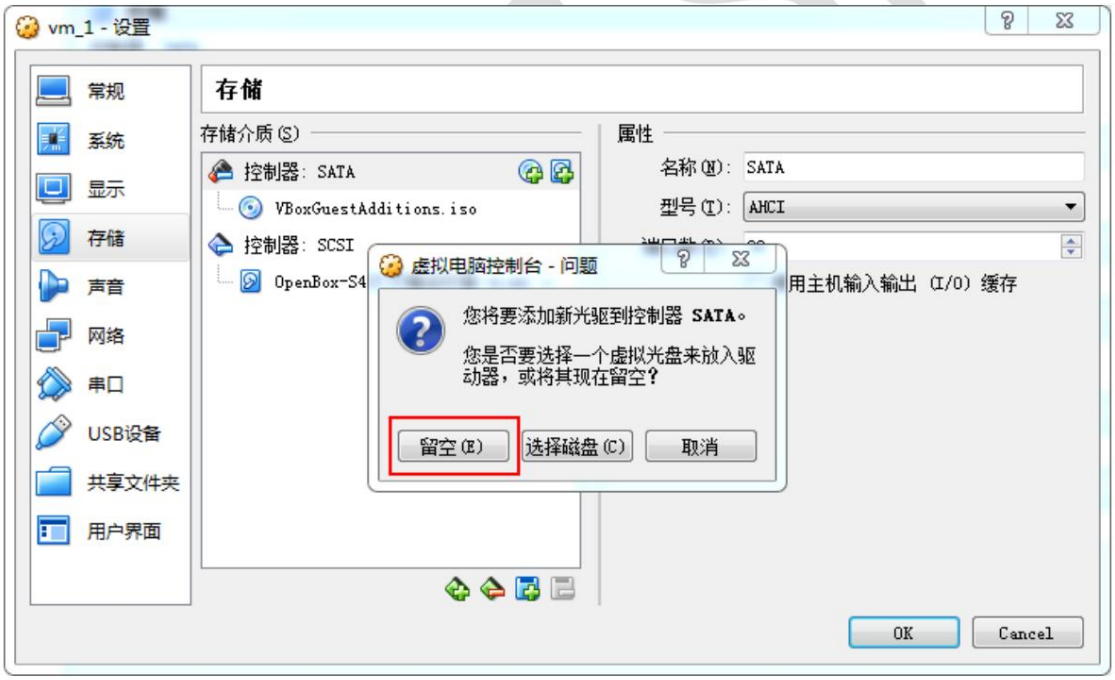

Figure A-7 Select leave blank

To set up the network, you need to set the promiscuous mode so that all packets can be captured.

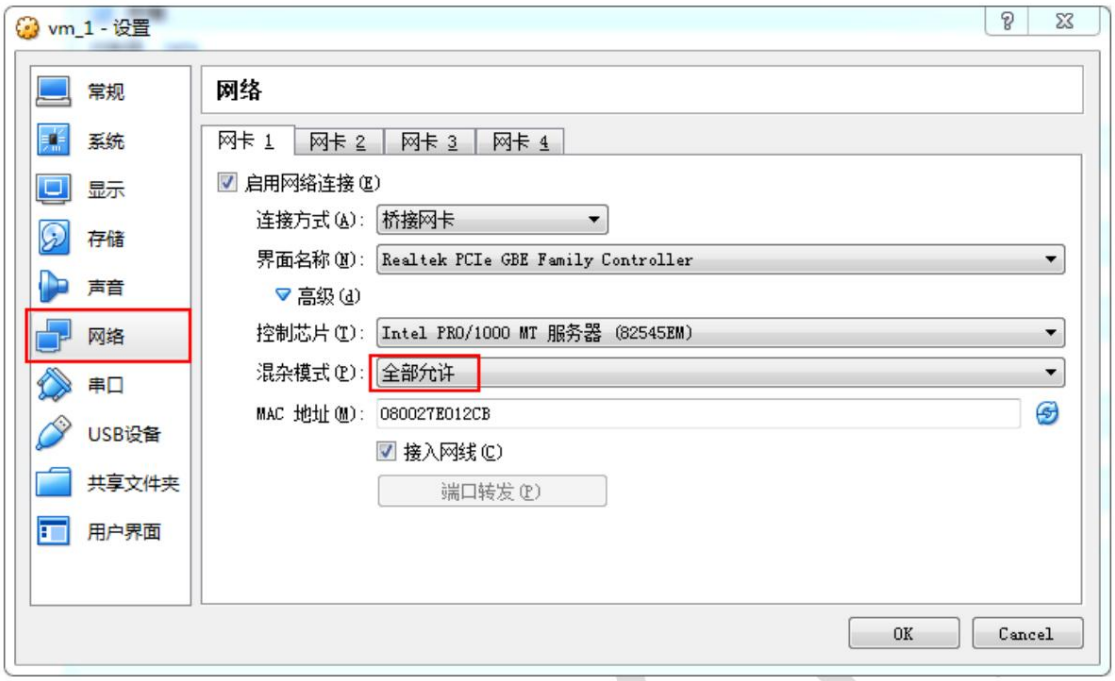

Figure A-8 NIC Settings

Set up a shared folder for sharing files between the Windows host and the virtual machine.

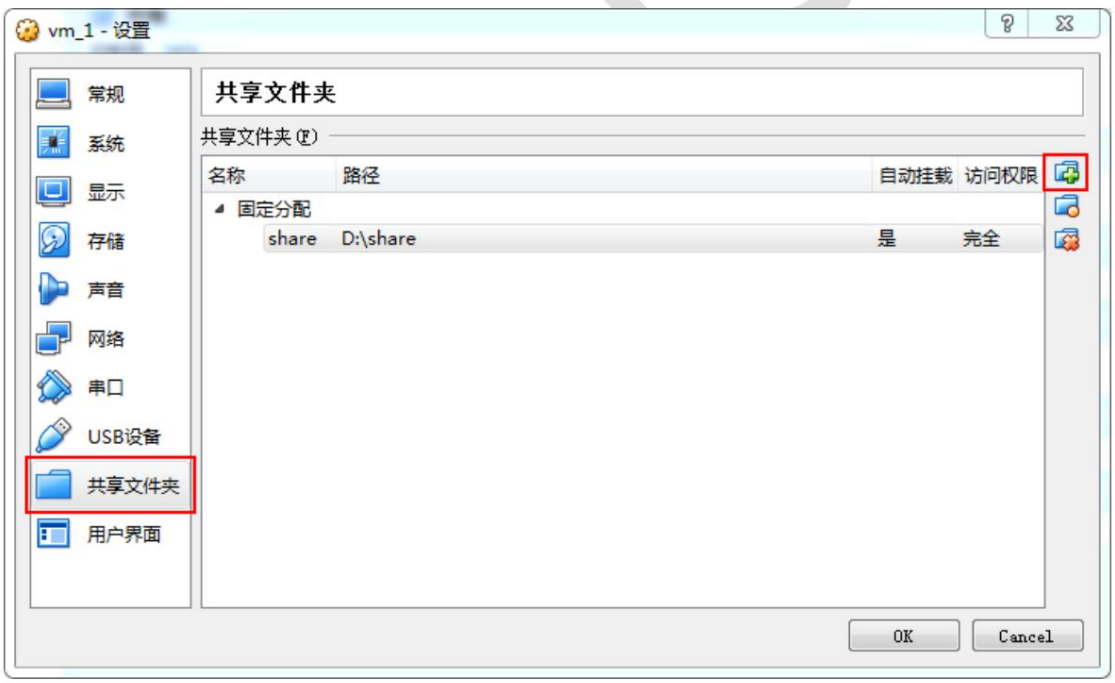

Figure A-9 Shared Folder Settings

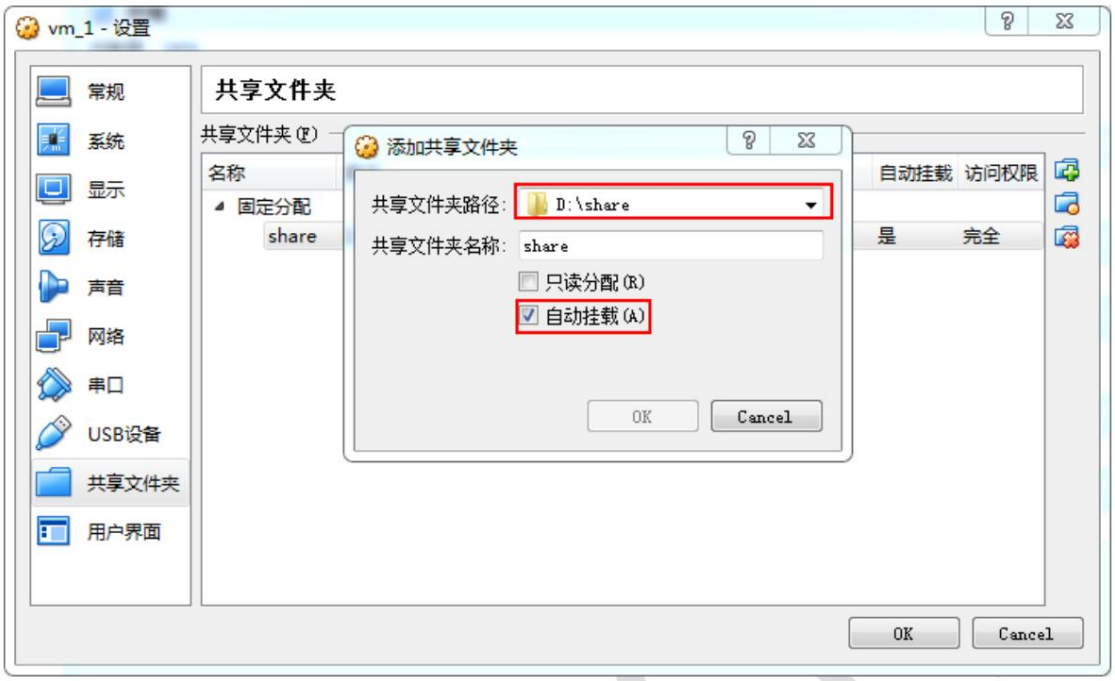

Figure A-10 Shared Folder Options

(5) Enter the virtual machine

Then open the virtual machine, and select "Start without interface" when opening, such as starting the computer normally

In the same way, you need to enter the password to enter the system after startup, the password is "970904"

Figure A-11 Boot without interface

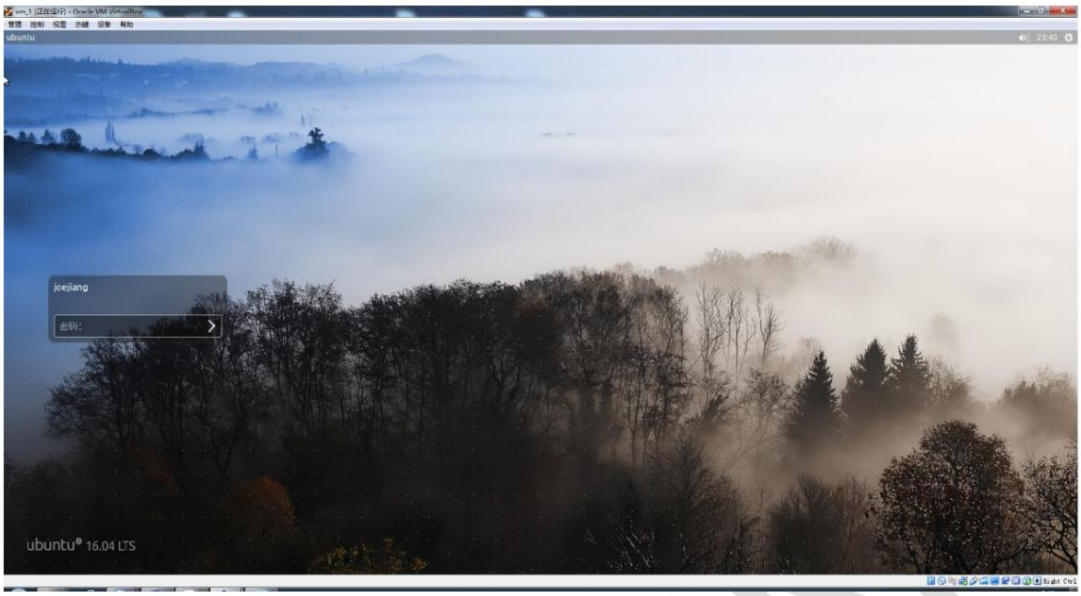

Figure A-12 Virtual machine startup screen

After entering the system to install the enhanced features, after selecting the device, click "Install Enhanced Features"

can", and then keep pressing the "enter" key to proceed to the next step until the installation is successful.

Figure A-13 Installing Enhancements

(6) Set up shared folders

Enter "sudo su" to enter root privileges, enter the password "970904"

Enter "mount -t vboxsf share /mnt/hgfs" where share is the shared folder

name, then the Windows host shares the share folder with the virtual machine

Enter "cd /mnt/hgfs" to enter the shared folder.

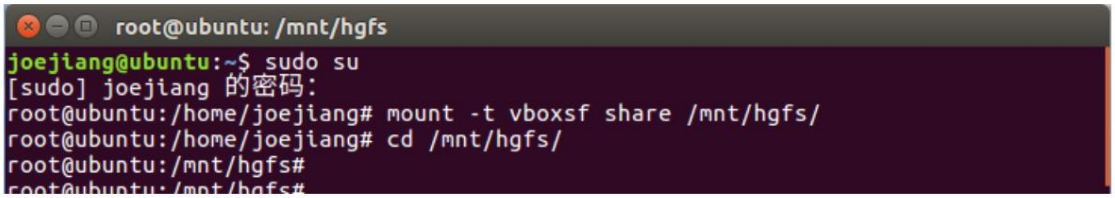

Figure A-14 Virtual Machine Shared Folder Settings

(7) Run the application

Copy the application that needs to be run in the virtual machine to the share file in the Windows host

Under the folder, run the corresponding application in the virtual machine. Take running TSNLight3.0 as an example to introduce

run order.

First enter "cd /mnt/hgfs/TSNLight3.2" to enter the centralized controller

Under TSNLight3.2 application;

Then enter "ifconfig" to view the network card name, the network card name is enp0s17;

Finally, enter "./tsnlight enp0s17" to execute the centralized controller program.

Method 2: Run the centralized controller in a local virtual machine or Linux device.

This method does not need to reinstall the virtual machine, but it needs to install the existing virtual machine or

Libraries required for Linux device installation software to run, namely libpcap, libnet and

libxml2. After installation, you need to set the network card to promiscuous mode so that libpcap can capture

All messages.

Precautions:

(1) Root privileges are required to run the software;

(2) If there is no executable file and no permission, take tsnlight as an example, you need to give

tsnlight executable permission, enter "chmod 777 tsnlight".