Test Platform for Intelligent Internet of Vehicles Video Exchange System

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Abstract. Intelligent Internet of Vehicles is the hot spot of current traffic industry. Video information as a very important part of multidimensional perception, is widely used in vehicle-vehicle interconnection, vehicle-road interconnection and vehicle-management platform interconnection. Because there are obvious differences in the efficiency level between different methods and devices in specific operation, relevant video exchange testing and verification become necessary. This paper presents a test platform and method for video information exchange in Intelligent Internet of Vehicles. Through this platform, a combination of subjective evaluation of video streams and objective testing of transmission network is used to test the availability of the test platform for video exchange on the Internet of Vehicles.

1. Introduction
Intelligent Internet of Vehicles is the hot spot of current traffic industry. On the basis of modern transmission network, multiple sensors with intelligent control system [1, 2] is used to form a multidimensional data perception and multiparty exchange cooperative control intelligent traffic system [3,4]. In multidimensional perception, Video information as the data of most direct and suitable for intuitive review, has attracted much attention[5,6,7]. Video information is one of the main body information in this exchange process[8,9], it referred to herein includes media stream, control stream, and the data flow for structured analysis of video content. From the analysis of the effect of video information exchange in Intelligent Internet of Vehicles, it mainly involves the performance of basic transmission network, the efficiency of video exchange method, the load of transmitting video information, and the performance of equipment to realize the exchange. Therefore, the effective evaluation of the overall video exchange effect is an indispensable link in the process of technological development.

In the early stage, Vercammen N[10] and others conducted research on the construction of test platform for IPTV, VOD and other video service. Subsequently, Dmitry O [11] Gorodnichy [12] and others research the video quality testing and platform deployment in the development stage of Video Surveillance business. However, there is a certain difference between the test platform for the internet of Vehicles video exchange system and the test platform mentioned above. It is characterized by the bidirectional transmission characteristics of the video stream in the bearer network. At the same time, due to the uncertainty of the participation in the video exchange object and the structural instability of the exchange path. Therefore, this paper establishes a test model based on the video exchange system of the Internet of Vehicles, builds a test platform, and conducts experiments on the platform through a combination of subjective evaluation of video and objective test of transmission network.
2. Test Model and Experimental Platform

The video exchange system of Network Connected Vehicles’ characteristics are: firstly, information transmission is bidirectional peer to peer or non-equivalent multiple forms; Secondly, the content transmitted in the transmission network is a kind of compound information flow, including media flow, signaling flow and formatted data flow; Finally, the multiple routing dynamic adjustment characteristics of the transmission network. Therefore, the constructed video exchange test model should be composed of three parts: the video exchange system under test, the transmission network and the test equipment. The minimum structure of the video exchange system is a bidirectional control device with both sending and receiving functions; the transmission network is a multistage multiple routing structure, and the test equipment consists of the transmitted video resources, the video browsing client, the network fault simulation equipment, the network performance test equipment and the video quality test equipment, as shown in Figure 1.

Minimum Structure of Video Exchange System for Test Model, that is to say, two nodes are exchanged equally, on the basis of this model, video exchange units that are relatively independent of A and B nodes can be added to the basic transmission network, thus extending the model structure of multiple node video exchange such as 3 nodes and 4 nodes. In view of node A and node B are equal and trust ends, the test process can be divided into two types:

a) One-way test, node A as the requester, calls video resources from node B, the process is B→A one-way signaling request, A→B one-way media stream and return of structured data stream, therefore, it is necessary to test the bandwidth asymmetry of the transmission network

b) Two-way test, node A and node B as both the requester and resource provider, the process is A←B and A→B two-way signaling, media flow and structured data flow, therefore, it is necessary to test the bandwidth symmetry of the transmission network.

The test platform is built according to the test model, the structure of the platform is shown in Figure 2. Firstly, three Ethernet switches are used to form three multistage multiple routing transmission links. The video exchange system under test uses video exchange units produced by two different companies as the A and B ends. Thirdly, the PC with GPU is set as the client to control and soft decode the video separately at A and B. Fourth, Set four IP network smart cameras as exchangeable real-time video resources on the A and B ends, and each set one video storage device and one intelligent analysis server as a historical video resource and as a structured source of video data, on the B and A ends. Fifth, a network tester is installed on the B end of the A end to test the network transmission performance.
3. Test content

3.1 Test Classification

Application Mode of Video Exchange for Network Connected Vehicles, through the establishment of the test platform, video exchange function verification test, performance test, compatibility protocol test of heterogeneous exchange equipment, video quality test, transmission performance and link selection adaptability test were completed, as shown in Table 1.

Table 1. Test Classification

| Sort                          | Objective description                                                                 | Operation equipment                                                                 |
|-------------------------------|----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Functional Test               | Operational test to verify the basic functions of video exchange system                 | Control terminal                                                                    |
| Protocol Test                 | Verify the normative and compatibility of interaction protocols between heterogeneous nodes | Protocol analysis function of network tester                                          |
| Video Quality Test            | Verify the final display effect of video exchange or the quality of a machine's identified interest area in a video | Reference video source, IP camera, video storage, intelligent analyzer and other access device Control terminal subjective evaluation Video analyzer |
| Performance Test              | Verify transcoding, distribution and other ability of video exchange system             | Reference video Source, camera, video storage, intelligent analyzer and other access device Control terminal subjective evaluation |
| Routing Selection Test        | Verify the autonomous routing setting capability of video exchange system              | Multiplexer network equipment Reference video source, camera, video storage, intelligent analyzer and other access devices Control terminal subjective evaluation Device that interferes with or regulates a network |

3.2 Functional Test

Functional Test of video exchange unit mainly includes authorization and authentication process of exchange parties, video resource information query, resource list acquisition, resource detailed information query, resource sharing push and cancel, call real-time video stream and call demolition,
historical video record query, historical video play link query, structured information subscription and cancellation, event subscription and cancellation, cradlehead control and so on. The function test of the exchange unit under test and resource center is based on the system software, compile test cases according to the implementation function, each test case should contain all the functional sets provided by the object under test. Related functional tests of the signalling flow, connect the Node A and the Node B directly in a point-to-point connection, and the network protocol analyzer is used to capture and analyze the transmission protocol between the A-B through the network mapping, and the request and response values of each functions is verified whether meet the requirements of the agreement, such as Restful interactive definition using the HTTP protocol. In the process of function test, the method of video image quality test is assisted to verify the realization degree of function and the basic performance of the equipment under test.

3.3 Video Quality Test

Video image quality testing is a direct effect reflection of video exchange end users. The main difference between them lies in the difference of the choice of interest area and analysis and discrimination ability. The content of video quality test includes objective test and subjective test. The objective test is to use the video analyzer as a measurement tool to obtain objective indicators such as resolution, colour saturation and gray level form the measurement of a single image. The subjective test evaluates the quality by the degree of image damage, generally divided into five levels. Video quality in video exchange system is mainly reflected in the loss difference of video accessed from one node to another node after transformation distribution and multistage routing transmission. The access video used in the test process must meet the following conditions:

a) The frame rate with colour characteristics is not less than 25 frames per second;
b) Various resolution and coding formats, such as 1080P, 720P, 4K, H. 264, H. 265, etc;
c) Subjective evaluation showed no damage;
d) Comprehensive scenarios such as fast moving vehicles mixed multiple targets of passengers and vehicles at stations, roads under low illumination, etc.

The method of subjective evaluation of video quality is testers evaluate the tested video according to whether there are colour blocks in the monochrome area picture, contrast difference and deformation of object boundary and linework, the degree of colour hierarchy of monochromatic area pictures in Images, at the same time, it needs to be evaluated according to the picture integrity and color difference of continuous video, the continuity of moving track of fast moving target and the image readability in low illumination environment and so on, according to the degree of defect loss observed in each index, the measurement was carried out according to the accuracy of 0.1 level. The final value of video stream damage value is the weighted sum of the loss values of each item.

In the case of point-to-point connection and ignoring the influence of network transmission, video image quality test aims to test the transcodin and distribution ability of VideoExchangeUnit (VEU), when using multilayer transmission network, video image quality test should test the performance impact of network interference and congestion packet loss. In the video resource node A of the test platform, input reference camera acquisition coding standard video test card video or the test sequence of the reference video that meets the requirements are inputs, decoded output on client B and get the video, check the subjective and objective test results of video quality, thus, the overall video quality from node A to node B should meet the requirements.

3.4 Performance Test

Transmission network performance test is conducted with network test equipment in the test network built as shown in figure 2. According to the test model, two test schemes, one-way test and two-way test, are constructed respectively. Initial test of no-load transmission performance, data flow constructed by transmitter of tester, simulation of user flow; the receiving port measures and get the indicators of network delay, delay jitter, packet loss rate, packet error rate and so on.
Normal fall, using functional test mode of point-to-point transmission, to ignore the impact of transmission network performance, the bandwidth of network ports should be 10 times larger than the transmission stream, the experimental use video stream and bandwidth settings are shown in Table 2. Observing the video stream of IP camera in real time, at the same time, call up four video streams in video storage, the video output format should be configured to the maximum resolution supported by the system and connected to the system under test through the video exchange unit. Subjective evaluation of 1-way real-time video and 4-way historical video obtained by calling node, and tested the real-time values of transmission performance parameters with video load by network tester. Until the subjective evaluation loss of video quality increases to more than 1, the maximum concurrent transmission ability is calculated. From the test results, the optimal transmission capability can be obtained, that is, when the subjective evaluation of the number of video paths transmitted by video exchange unit does not decrease significantly, and Network transmission metrics are also at the maximum acceptable number of ways.

Table 2. Test Video Stream and Transmission Bandwidth Configuration

| Test Video Stream   | 1xCIF | 1x4CIF | 1x1080P | 1x4K | 5x1080P | 1x1080P NxCIF |
|---------------------|-------|--------|---------|------|---------|----------------|
| H.264 Bit Stream    | ≈0.5  | ≈1     | ≈4      | ≈16 | ≈20     | ≈4+N×0.5       |
| Test the transmission bandwidth of network environment (Mbps) | >5   | >10    | >40     | >160 | >200    | >40+N×5        |
| Functional Test     | ✓     | ✓      | ✓       | ✓   | ✓       |                |
| Video Quality Test  | ✓     | ✓      |         | ✓   |         |                |
| Performance Test    |       |        |         |     | ✓       |                |
| Routing Optimization Test |     |        |         |     | ✓       |                |

3.5 Routing optimization test

In the practical application system of Internet of vehicles, there are often multiple routing connections between two points. Therefore, it is necessary to set up multiple layer simulation exchange device on the test platform to construct multiple routing transmission network between node A and node B, at the same time, need adjust the network state of different routing. When the state of setting the system under test between nodes A-B is the optimal transmission capacity, make differential adjustments to three transmission links which set up for the experiment platform, and tested the changes of collision, delay and other indicators by network tester. The main methods of adjusting link include:

a) Limiting the maximum transmission rate of links through bandwidth management functions, it can be either one-way or two-way speed limit;
b) Through electromagnetic interference equipment interfere switched transmission cable;
c) Increase the proportion of other bit stream or bit stream interference within the link.

Through differential Transmission Link Adjustment comparison, such as the system under test is limited or disturbed by links, transmission performance indicators and continued decline, video quality loss continues to increase, it means that the system does not have the function of autonomous routing, such as the transmission performance index and video quality loss show a fluctuating change, it means that the system has the function of autonomous routing. Based on the ability to choose independently, through comparing video quality loss with network delay, packet loss and other indicators can obtained the dynamic range of autonomous selection.

4. Expectation

Simulation test based on video exchange test platform, transfer from point to point to multiple points, this will be a gradual increase in the data load. Therefore, how to adopt appropriate bit stream or assign different quality image resolution to different regions of interest can be further verified on the
test platform. For possible information security problem, were not on platform constructed in this paper, the future can be expanded related safety equipment and testing equipment, to verify that the information attack and corresponding information security equipment brought about by the impact.

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References
[1] Zhang Dengyin, Zhang Min, Ding Fei. (2018) Survey of connectivity for 5G-Vechular Ad Hoc networks [J]. Journal of Nanjing University of Posts and Telecommunications(Natural Science Edition), 38(1):27-36.
[2] Li X, Yu Y, Sun G, et al. (2018) Connected Vehicles' Security from the Perspective of the In-Vehicle Network[J]. IEEE Network, 32(3):58-63.
[3] XIA Yuan-Qing, YAN Ce, WANG Xiao-Jing, et al. (2019) Intelligent Transportation Cyber-physical Cloud Control Systems [J]. ACTA AUTOMATIC SINICA, 45(01):134-144.
[4] Sjoberg K, Andres P, Buburuazn T, et al. (2017) Cooperative Intelligent Transport Systems in Europe: Current Deployment Status and Outlook [J]. IEEE Vehicular Technology Magazine, 1-1.
[5] Guo M, Ammar M H, Zegura E W. (2005) V3: A vehicle-to-vehicle live video streaming architecture [J]. Pervasive and Mobile Computing, 1(4):404-424.
[6] Xia J, Rao W, Huang W, et al. (2013) Automatic multi-vehicle tracking using video cameras: An improved CAMShift approach [J]. KSCE Journal of Civil Engineering, 17(6):1462-1470.
[7] Jian Q, He Y, Shen X S. (2018) Improving Video Streaming Quality in 5G Enabled Vehicular Networks [J]. IEEE Wireless Communications, 25(2):133-139.
[8] Zheng S K, Li M, Zhu Q, et al. (2013) Video-Based Traffic Flow Parameters Monitoring and Integrated Traffic Information System [J]. Applied Mechanics and Materials, 462-463:77-84.
[9] Zhen-Tao H, Wang Z, Shu P, et al. (2018) Learning an video-based message sharing system for large-scale smart vehicles [J]. Multimedia Tools and Applications.
[10] Vercammen N, Staelens N, Rombaut A, et al. (2008) Extensive video quality evaluation: A scalable video testing platform[C]/ International Conference on Computer & Information Technology. IEEE.
[11] Scarth L, Maclellan-Brown K, Grimshaw E, et al. (2015) A practical end-to-end test of image quality applied to digital CCTV systems with unknown compression engines [J]. The Imaging Science Journal, 63(3):137-144.
[12] Gorodnichy D O. (2010) VAP/VAT: video analytics platform and test bed for testing and deploying video analytics [J]. Proceedings of SPIE - The International Society for Optical Engineering, 7709(6):77090T-77090T-11.