Implementation of Bluetooth Video Distribution Profile Tester based on TTCN

Jaeyoun Kim, Kanghae Lee, Yongbum Park, and Keunku Lee

Network Testing Center, IT Testing & Certification Laboratory
Telecommunications Technology Association (TTA)
Seongnam, Republic of Korea
E-mail: {jykims, kanghae, ybpark, and kklee}@tta.or.kr

ABSTRACT

Bluetooth Video Distribution Profile (VDP) defines the protocol and procedures that realize the distribution of video content compressed in a specific format for the efficient use of the limited bandwidth. In this paper, we describe the design of VDP tester based on TTCN-2 (Tree and Tabular Combined Notation), a language standardized by ISO for the specification of tests for real-time and communicating systems. Our work was carried out as a part of supporting a new profile testing module for VDP in PTS (Profile Tuning Suite), a reference test system for Bluetooth interoperability testing. Test demonstration for the interoperability with various VDP solutions at the PTS session in UPF30 (Unplug Fest) showed the validity of the developed tester. Eventually, we introduce the PTS architecture, and show the design and implementation of VDP tester included in the released PTS 3.0 in this paper.

Keywords: Interoperability testing, Bluetooth, Video Distribution Profile, TTCN

1. Introduction

With increasing spread of multimedia mobile devices using wireless communications technology, WPAN (Wireless Personal Area Network) is rapidly matured to provide multimedia service which has tremendous effects on everyday life. Specially, key technologies for this service such as enhanced data throughput, low-energy consumption, and security functionality are starting in mobile devices.

Bluetooth, the most widely used WPAN technology in the mobile phones, also has been evolving as adoption emerging new technologies in Bluetooth core specification such as Bluetooth 2.1+EDR (Enhanced Data Rate) for stronger security aspects, Bluetooth Low Energy for less power consumption, and alternative MAC/PHY of 802.11/UWB for high speed transmission [1]. New profiles have been developed to offer exceptional quality in various services with these technologies.

One of the new profiles, VDP (Video Distribution Profile) using AVDTP (Audio/Video Distribution Transport Protocol) defines protocol and procedures to realize distribution of video content compressed in a specific format, such as H.263 and MPEG-4 Visual Simple Profile, for efficient use of the limited bandwidth [2]. Although VDP was adopted as a version 1.0 Specification in 2004, it has been not utilized in Bluetooth end-product due to the limited bandwidth for video transmission. Some VDP mobile phones based on Bluetooth 2.0/2.1+EDR Specification for delivering the data rate up to 3Mbps have already been rolled into the market.

In order to sell a Bluetooth product on the market, it should go through Bluetooth Qualification Program including interoperability and conformance testing. Bluetooth SIG has released PTS as a reference test system to ensure consistent interoperability [4].

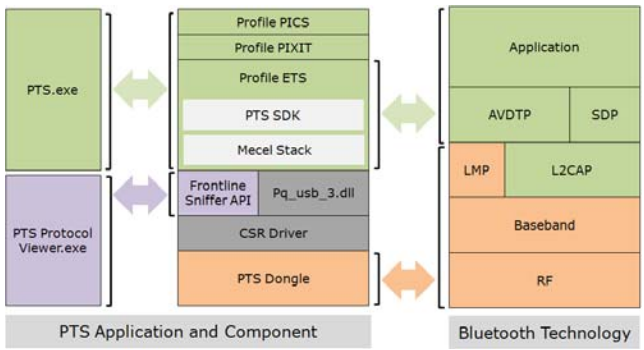

Fig. 1: PTS Architecture.

PTS is a piece of software, compliant with the Bluetooth Core and Profile Specification, which controls a Bluetooth endpoint connected over USB and runs controlled implementations of Bluetooth Profile Test Purposes. It aims to improve product interoperability within the Bluetooth industry. The PTS is capable of acting as both an initiator and acceptor in a test scenario. As shown in Fig.1, PTS is composed of three parts: (1) PTS execution file presenting user interface, (2) Profile ETS (Executable Test Suite) defining test cases and procedure, (3) PICS/PIXIT specifying IUT(Implementation Under Test)'s features. Thus, the implementation of a profile tester based on PTS is meaning as same as the development of the Profile ETS in the parts of PTS. Currently, many of profiles including VDP are supported in the PTS 3.0 and VDP is developed by TTA collaborating with Bluetooth SIG.

In this paper, we describe the design of VDP ETS based on TTCN-2(Tree and Tabular Combined Notation), which is a language standardized by ISO for the specification of tests for real-time and communicating systems [5]. Our work was carried out as a part of supporting a new profile ETS for VDP in PTS, and then the developed VDP ETS is installed in released PTS 3.0.

Demonstration at the PTS session in UPF30 (Unplug Fest) held in Bangkok, Thailand are performed to verify the interoperability of the developed VDP tester with various VDP solutions. The remaining outline of the paper is as follows. In Section 2, we describe the details of the developed VDP ETS at the point of the development of tester based on TTCN-2. The demonstration and evaluation are explained in Section 3. Finally, conclusion is discussed in Section 4.

2. Modeling the VDP ETS

We will first give an overview of VDP Specification. Then we discuss how we formally modeled VDP ETS.

2.1 Overview of VDP Specification

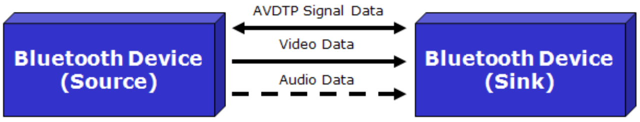

Fig. 2: VDP Configuration.

VDP Specification defines two types of device entities, *source* and *sink* [2]. Source transmits video streams to the sink in the same piconet. As shown in Fig. 2, there are two kinds of AVDTP channel for signaling and streaming media between two devices participating in a streaming connection. Essentially, VDP is an architecture based on AVDTP for discovery, configuration, establishment, and transfer control. Additionally, VDP Specification describes the use case of video and audio streaming by applying two profiles, A2DP and VDP. However, this application using multi-profile is not covered in current VDP Test Specification.

2.2 Structure of General ETS

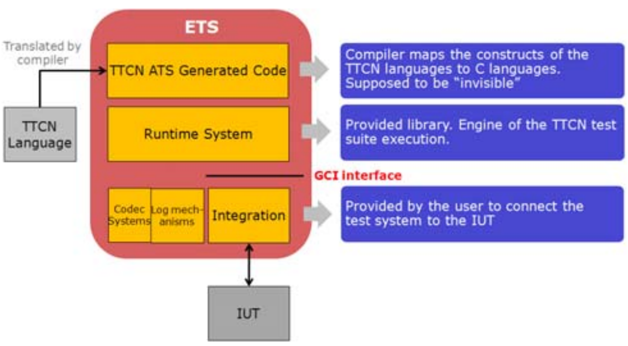

Fig. 3: The Structure of ETS.

The typical structure of ETS based on TTCN is shown in Fig. 3. The ETS consists of five parts: TTCN generated code, Runtime System, Codec System, Log mechanism, and Integration part. TTCN generated code is compiled from ATS (Abstract Test Suite) in TTCN where tests are specified at an abstract level. Runtime System is the engine to execute TTCN test suite. Codec System is an entity that administrators the value and type handling include encoding and decoding between the TTCN generated code and a native language. Log mechanism provides the means to write a character string to the logging interface of a test system. Finally, integration part includes the adapter implementing timer and the external functions on a specific platform and operating system.

2.3 Selection of Test Method

In ISO/IEC 9646, Remote Test Method has been defined in Test Methods Classification [6]. This method is too simple to be used in practice, because there is no assumption on feasibility or realization of TCP (Test Coordination Procedures), and no limitation of upper test boundary. In VDP ETS, since MMI (Man Machine Interface) is configured as upper tester, IUT is not required to load additional upper test modules. Therefore, IUT can be an end-product.

2.4 Test Configuration for VDP

The test configuration in VDP ETS is based on concurrent TTCN, composed of a Main Test Component (MTC) and one more Parallel Test Components (PTCs) [5]. As shown in Fig. 3, there are five PCOs (Points of Control and Observation) and four PTCs (Parallel Test Components) in VDP ETS.

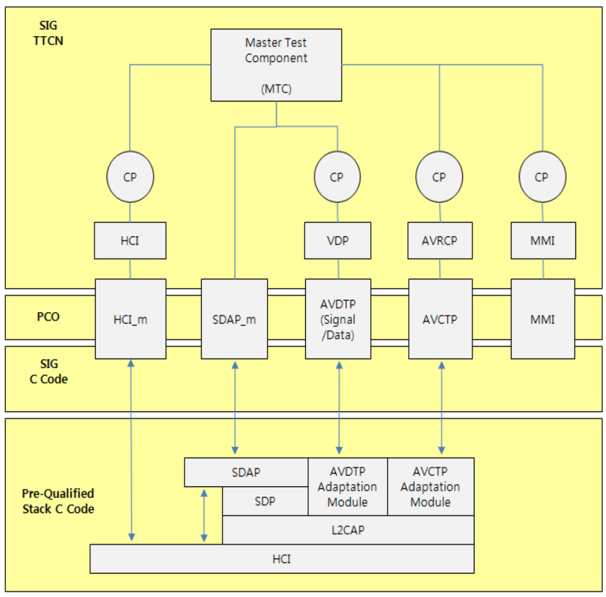

Fig. 4: VDP Test Configuration.

When VDP tester sends AVDTP PDU (Protocol Data Unit) for signaling or streaming media data to IUT, the PDU is forwarded from the TTCN generated code to the pre-qualified stack, Mecel stack is covering Bluetooth layers over Host Controller Interface (HCI) [7]. Because there are two L2CAP (Logical Links Control and Adaptation Protocol) channels for each signaling and streaming media, and a single AVDTP PCO, test event for sending AVDTP is distinguished by AVDTP PDU identifier and to be sent to corresponding to the L2CAP channel.

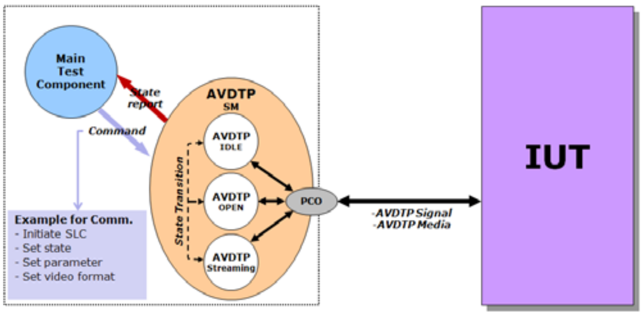

Fig. 5: Test Components of AVDTP in VDP ETS.

As shown in Fig. 5, MTC control PTCs by means of Coordination Message (CM) for actions such as the initialization of service level connection, the change of AVDTP state, and the setting of video format. Received PDU from IUT via the PCO can be caused to the change of AVDTP state. Whenever AVDTP state is changed, AVDTP PTC reports the updated state to MTC. Then MTC performs the test step according to the updated state.

2.5 Example of Test Case for Video Streaming

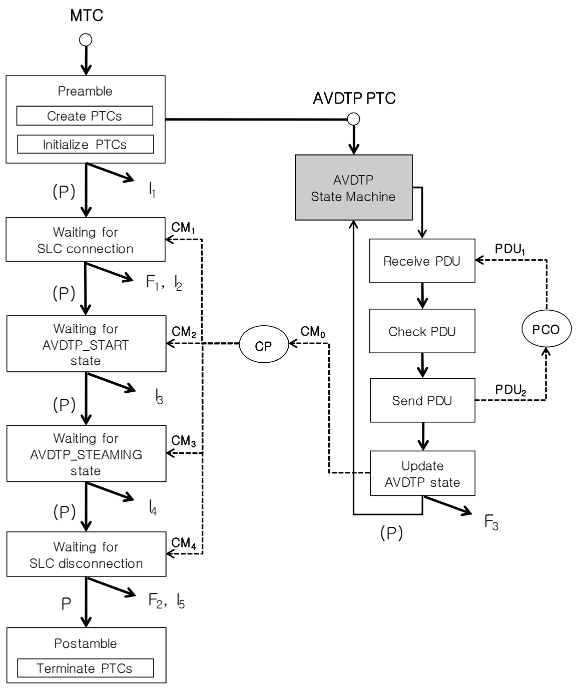

Fig. 6: Test Procedure between MTC and AVDTP PTC.

Fig. 6 shows the procedure of an example test case for streaming the video data. The purpose of this test case is to verity that VDP source can stream video data encoded in H.263 baseline and VDP sink as tester can receive encoded video data properly. In this case, streaming connection and configuration are initiated by source. Tester checks the format and parameter values in the received PDU for signaling, and the video output after decoding H.263 baseline packets in the received PDUs for streaming.

When the test case is executed, it creates and initializes PTCs at the first tester. This step includes the configuration for discoverable mode in Bluetooth dongle. If the initial configuration state is not correct, inconclusive verdict (I_1) can be given. After the first procedure for PTCs initialization, MTC waits for the AVDTP connection from IUT, VDP source. CM_1 indicates the event related to the connection and MTC determines the verdict according to the indication. If IUT fails to establish the service level connection, tester gives F_1 verdict. If the connection is established correctly, MTC checks the state of AVDTP by means of CM_2 when signaling procedures are finished.

AVDTP state machine changes the its state and reports the result to MTC as CM_0. The state can be updated in AVDTP PTC whenever it receives PDU from IUT via PCO. If the received PDU_1 is AVDTP signaling command to negotiate stream connection, such as the configuration of video codec or discovery of media capability, tester responds to it with PDU_2. If the parameter in PDU_1 has incorrect values according to the state, then the result code in PDU_2 can be error code and the verdict of test case can be fail as F_3. IUT should try to do proper action in the limited time, because timeout can be placed by the reason of inconclusive verdict, I_2, I_3, I_4, and I_5.

After signaling is completed, PTC receives and stores AVDTP media packets. When sufficient H.263 baseline packets to playback are streamed to the tester, PTC informs MTC that streaming is completed by the change of AVDTP. Finally, MTC disconnects the service level connection and closes the test case.

3. Demonstration and Evaluation

In anticipation of accelerated growth for video streaming service, VDP Tester in PTS is developed for end products to reduce testing time and costs as well as to increase testing consistency and confidence for qualification. Figure 7 shows VDP testing process in PTS with three phase; test preparation, testing operation and report generation.

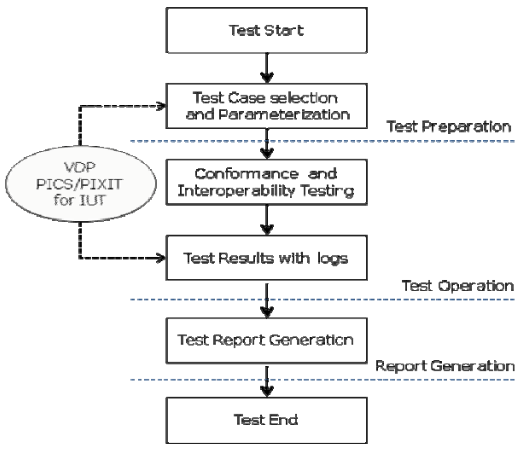

Fig. 7: VDP Testing Process in PTS

VDP tester is validated by the Bluetooth SIG in the UPF30, non-profit interoperability testing events, meeting the requirements of VDP Test Specification which is categorized 4 items; Setup, release, suspend and video streaming.
Related test cases are performed with 4 IUTs as VDP Source or Sink role evaluating all steps referred in Fig 6., table1 shows test results.

Table 1. VDP test result for validation

	Device A (SRC)	Device B (SRC)	Device C (SRC)	Device D (SNK)
Application	Cinema Transmission	Cam video file Transmission	Image file Transmission	Cinema Transmission
Setup Video Streaming	FAIL	PASS	PASS	PASS
Release Video Streaming	PASS	PASS	PASS	PASS
Suspend Video Streaming	PASS	PASS	PASS	PASS
Video Streaming	PASS	PASS	PASS	PASS

VDP tester is designed to qualify video streaming only, but some end products such as device A listed in Table1 is required both audio and video connection at the application level, this is caused to generate fail verdict when connection setup. To make up for this problem, the latest A/V Sync CR (Change Request) is handing Audio/Video Synchronization for VDP source to manipulate delay timing and frame rate.

Though current qualified end products installed VDP are very few, VDP is obviously available in a wider range of devices in the near future and VDP technology is evolving very fast to satisfy end user's requirements. For this reason, VDP tester in PTS will play a significant role to popularize Bluetooth VDP devices by improving interoperability and reducing testing time.

4. Conclusion

In this paper, we described the design of VDP tester based on TTCN-2 which is included in the released PTS. This is very efficient to perform the VDP interoperability testing of end-products in current market with the lack of VDP devices as counterpart role. It not only ensures systematic testing and increases the reusability of test implementations, but it also improves test consistency and reduces test complexity. Besides, it is worthwhile to discuss how to extend a single profile tester to multi-profile tester in order to verify the interoperability with the existence of multi-SLC (Service Level Connection) for of two or more profiles between multimedia devices. In the future, it may consider developing new ETSs in PTS to cover up multi-profile interoperability testing for meeting the consumer's needs.

5. REFERENCES

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