Draft for Reaffirmation Review

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EPI 33. ACN Root Layer Protocol Operation on TCP

(E1.17 Profile for Interoperability)

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Contents

ACN EPIs

E1.17 is the “ESTA Architecture for Control Networks” standard [ACN]. It specifies an architecture – including a suite of protocols and languages that may be configured and combined with other standard protocols in a number of ways to form flexible networked control systems.

E1.17 Profiles for Interoperability (EPIs) are standards documents that specify how conforming implementations are to operate in a particular environment or situation in order to guarantee interoperability. They may specify a single technique, set of parameters or requirement for the various ACN components. They may also specify how other standards (including other EPIs) either defined within ACN or externally are to be used to ensure interoperability.

1. Applicability

This interoperability profile specifies the operation and formats for the ACN Root Layer Protocol [Arch] operating on [TCP].

2. Introduction

The nature of TCP as a stream and connection oriented protocol and the fact that it provides reliability lacking in [UDP] means that the root layer requirements are different from UDP or other datagram oriented transports.

2.1 Streams

TCP data is essentially a stream of octets and the fact that the underlying transport (IP) is packet based is not relevant. The reliability mechanisms of TCP operate at the single octet level and TCP stacks may divide the stream into packets at any boundaries they choose. In the case of retransmission of missing or corrupted segments of the stream, the division into packets may also differ from the original. At the receiving end, TCP guarantees reconstruction of the original stream but makes no guarantee about which sized chunks the stream arrives in.

A primary purpose of the ACN root layer on TCP is therefore to divide the stream up into identifiable blocks. In this document these blocks are called *frames*.

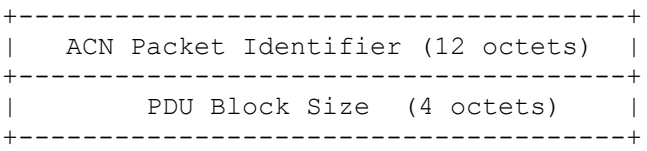
2.2 Synchronization

One relevant guarantee that TCP does make is that the start of a newly connected stream is clearly defined. This combined with the reliable delivery means that there is no need for a rigorous synchronization method to identify the start of a frame as there might be for an unreliable protocol or one where the stream was joined in mid flow. Assuming each message is correctly constructed before transmission and correctly parsed on reception, the two will remain in lock-step indefinitely.

However, the assumption of correct construction and parsing may not always be met, so there is benefit in some data predictability at the start of each frame to ensure a good probability that a loss of synchronization due to implementation bugs is detected quickly. This is a much looser requirement than for guaranteed synchronization.

2.3 Connections
Each TCP stream forms a connection that is uniquely identified by both the IP address and port at each end. All four values must match for the stack to associate an IP packet with a stream. This is how many hosts can each establish multiple connections (using ephemeral ports) with the same server without interfering with each other. Once a TCP connection is established, the identity of the endpoint cannot change (excepting elaborate spoofing). The maintenance of this connection is a fundamental job of any TCP stack and typical APIs provide means to maintain multiple simultaneous connections (up to tens of thousands if resources permit) efficiently.

3. Frame Preamble Format
Each block of Root Layer PDUs shall use the following preamble:



3.1 Packet Identifier
The ACN Packet Identifier shall be the text string “ASC-E1.17\0\0\0” encoded in [ASCII]. In hexadecimal this is the octet sequence:

41 53 43 2d 45 31 2e 31 37 00 00 00

3.2 PDU Block Size
PDU block size shall be the size of the entire block of Root Layer PDUs and shall be transmitted in network byte order.

A Block Size of 4 octets allows a PDU Block up to 4 GBytes. This standard does not require that the entire block must be received before commencing processing, however see the note below. A block size of 4 294 967 295 (0xffffffff) shall be treated as a block of indefinite length and must be processed PDU by PDU until the connection is closed.

Note: Individual client protocols (as specified in the Vector field of the PDUs within the block) may place additional restrictions on their use of this format including on the maximum permissible length of the PDU Block, on the number of PDUs within the block or on the mixing of PDUs of differing protocols within the block.

4. Root Layer Protocol Operation

4.1. Transmission
Implementations shall send the correct preamble sequence before each block of Root PDUs according to the rules of [Arch]. No postamble shall be added. This standard places no restriction on the number of Root PDUs that may be sent in a block.

4.2. Reception
Upon accepting a connection and receiving data, implementations shall check the ACN Packet Identifier. If the ACN Packet Identifier is not correct the receiver shall close the connection.

Having received a preamble, implementations shall compute the size of the Root Layer PDU block from the size provided. Implementations shall then proceed to process the PDU block as specified in [Arch].

It is an error for any other octets other than the ACN packet identifier to be present in the data stream immediately following a PDU Block. If a PDU Block is not followed by another TCP Root Layer Protocol preamble with a matching ACN Packet Identifier, the receiver shall close the connection.

Normative References

[ACN] ESTA [http://tsp.esta.org]. ANSI E1.17 - 2010. *Entertainment Technology - Architecture for Control Networks.*

[ASCII] International Electrotechnical Commission (IEC) [http://www.iec.ch/]. ISO/IEC 646 Ed.3. *Information technology - ISO 7-bit coded character set for information interchange.* 1991.

[Arch] ESTA [http://tsp.esta.org]. ANSI E1.17 – 2010. *Entertainment Technology – Architecture for Control Networks.* E1.17 “ACN” Architecture.

[TCP] Internet Engineering Task Force (IETF) [http://ietf.org/]. RFC 793 [http://www.ietf.org/rfc/rfc793.txt]. *Transmission Control Protocol.* 1981.

[UDP] Internet Engineering Task Force (IETF) [http://ietf.org/]. RFC 768 [http://www.ietf.org/rfc/rfc768.txt]. *User Datagram Protocol.* 1980.