3GPP TSG-RAN Meeting #77
Sapporo, Japan, 11th –14th September 2017

RP-171819

Motivation for WI on UL data compression in LTE

- Concluding the study item on LTE Uplink Data Compression -

Qualcomm Inc., KDDI, Softbank, Reliance Jio, Kyocera, Sharp

- As per RAN #76, the UDC SI should conclude in RAN2#99 (21 - 25 Aug 2017) with the selection of a compression algorithm, but RAN2 did not conclude.

- Two candidate solutions are concluded by RAN2 at this point in TR 36.754
  1. APDC: defined in 3GPP TR 36.754 with example open source code for compressor and decompressor.
  2. Deflate: defined in IETF RFC 1951, need to be updated to meet RAN2 requirements of byte alignment and reliability

- **Observation 1**: The APDC solution outperforms Deflate in compression efficiency in 6 out of 11 cases by margin of up to **14%** in large files with traffic and multiple IP flow, for 8KB buffer setting. Deflate outperforms APDC by up to **3.17%** in 5 cases.

Compression Efficiency: APDC vs Deflate

(Numbers from TR 36.754 for 8KB buffer)

PCAP File #	PCAP File	APDC Compression Efficiency (8KB) Simulation results with disclosed example source code from 6 companies	Deflate Compression Efficiency (8KB) Static Huffman and 1 byte UDC header	Difference: APDC - Deflate
1	FTP- Client (CMCC)	54.34%	49.96%	**4.38%**
2	FTP- Server (CMCC)	50.34%	44.61%	**5.73%**
3	Online video (CMCC)	61.00%	62.98%	-1.98%
4	Long period video (CMCC)	76.67%	71.26%	**5.41%**
5	SIP UE1(CMCC)	83.91%	86.50%	-2.59%
6	SIP UE2 (CMCC)	80.62%	83.79%	-3.17%
7	SIP UE3 (CMCC)	84.20%	86.85%	-2.65%
8	Web surfing (CMCC)	64.24%	65.20%	-0.96%
9	Video data (MediaTek)	73.47%	59.08%	**14.39%**
10	Long duration FTP (MediaTek)	75.34%	62.01%	**13.33%**
11	Multiple IP flows (Qualcomm)	73.35%	71.63%	**1.72%**

- **Observation 2**: The APDC solution shows superior performance from reliability point of view.

	APDC	Deflate
Were results with **checksum** cross checked in RAN2?	Yes. By 6 companies.	No. UDC session chairman notes says "Indicate the results without cross check".
Is the behavior for checksum calculation and handling specified?	Yes. Defined in TR 36.754.	No. Not documented by 3GPP, IETF or other international standard bodies.
Is UDC reset flag behavior specified? The flag is used by compressor to tell decompressor if a packet is "first packet" compressed after UDC reset.	Yes. Defined in TR 36.754.	No. Not documented by 3GPP, IETF or other international standard bodies.

Observation 3: APDC has lower Computation complexity than Deflate compressor.

- Some internet traffic are encrypted: APDC "header-only" mode skips compressing the encrypted/uncompressible payload, whereas Deflate cannot.
- From TR 36.754 Table 7.3.1.1 below: Deflate requires additional Huffman encoding but APDC does not.

	Step 1	Step 2	Step 3
Deflate (RFC 1951)	Search for repeated strings from compression memory (e.g., LZ77).	**Huffman encoding.**	CATT proposes to add checksum calculation (not part of RFC 1951)
APDC		Write the matching and mismatching information (like pointers) into APDC headers and copy mismatched bytes to the compressed packet.	Compute checksum for decompressor to verify decompression result.

- **Observation 4: APDC compressor uses less memory than Deflate.**
  - Deflate additionally consumes 7KB compression memory at both compressor and decompressor
  - Additional memory for Deflate is required to store dynamic Huffman codes/Tree, fixed Huffman codes, length codes and code table discussed in detail in R2-1708979.

Proposal: APDC is selected as the UDC solution and moves to the normative phase