3GPP TSG-CT WG1 Meeting #119
Wroclaw (Poland), 26-30 August 2019

C1-194239

Possible Optimizations for CIoT Control Plane Data Transfer in 5GS

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Benefits of Solution 2

- Overall **benefits** for generic payload container based approach (See C1-193170):
  - **Facilitate reuse**:
    - for 5GS, Generic NAS transport mechanism has already been specified in 24.501 for UEs in connected mode to transport different types of payloads between the UE and the AMF based on payload type.
    - SMS payload container type is already supported and related handling already specified.
  - **Flexibility & modular design**: all information are optional. Any combination of scenarios can be supported.
  - **Ease of Implementation**: both data and SMS are transported via same existing payload container mechanism and same interface. This would simplify both network and UE implementation.
  - **Extensibility**: the mechanism is extensible and future proof. Generic NAS transport mechanism can be easily extended to accommodate more types, additional information can be transported as needed as optional IEs.
  - **Efficiency**: For IoT device in PSM/eDRX mode, once the UE wakes up for service, there could be multiple data packets to be transported UL or DL. With payload container based approach, these packets can be sent bundled via the existing payload container via “multiple payload”, therefore reducing the number of messages needed for transport the data packets. Furthermore, besides data packets, SM information and SMS can also be bundled in the same message, making the overall transport very efficient.

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Solution 2 + Potential Optimizations

- For infrequent small data transmission, it is generally not expected that 4 octets message header size difference would result in any significant battery usage change
- It is proposed to standardize Solution 2 for supporting 5G CIoT control plane infrequent small data transfer via existing generic payload container mechanism
- Using Solution 2 as baseline, optimizations to reduce message header overhead for IoT data could potentially be considered if the optimization would not bring too much complexity nor sacrifice too much handling efficiency or good design principles.

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Overview of Solution 2 (C1-193795/C1-193796)

- Idle mode and Connected Mode data transfer:
  - Both based on reusing the same generic payload container mechanism
  - Existing SMS transfer mechanism reused

Table 8.2.10.1.1: UL NAS TRANSPORT message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	…				
	UL NAS TRANSPORT message identity	Message type 9.7	M	V	1
	Payload container type	Payload container type 9.11.3.40	M	V	1/2
	…				
	Payload container	Payload container 9.11.3.39	M	LV-E	3-65537
12	PDU session ID	PDU session identity 2 9.11.3.41	C	TV	2
59	Old PDU session ID	PDU session identity 2 9.11.3.41	O	TV	2
	…				

Table 8.2.11.1.1: DL NAS TRANSPORT message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	…				
	DL NAS TRANSPORT message identity	Message type 9.7	M	V	1
	Payload container type	Payload container type 9.11.3.40	M	V	1/2
	…				
	Payload container	Payload container 9.11.3.39	M	LV-E	3-65537
12	PDU session ID	PDU session identity 2 9.11.3.41	C	TV	2
58	5GMM cause	5GMM cause 9.11.3.2	O	TV	2
	…				

8	7	6	5	4	3	2	1	
Payload container IEI								octet 1
Length of payload container contents								octet 2
								octet 3
Payload container contents								octet 4
								octet n

Figure 9.11.3.39.1: Payload container information element

Payload container type value (octet 1) bits				
4	3	2	1	
0	0	0	1	N1 SM information
0	0	1	0	SMS
0	0	1	1	LTE Positioning Protocol (LPP) message container
0	1	0	0	SOR transparent container
0	1	0	1	UE policy container
0	1	1	0	UE parameters update transparent container
0	1	1	1	~~xxxx~~ User data container
1	1	1	1	Multiple payloads
All other values are reserved.				
NOTE: The value "Multiple payloads" is only used when the Payload container contents in figure 9.11.3.39.1 contains multiple payloads as shown in figure 9.11.3.39.2.				

Table 8.2.x.1.1: CONTROL PLANE SERVICE REQUEST message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	Extended protocol discriminator	Extended protocol discriminator 9.2	M	V	1
	Security header type	Security header type 9.3	M	V	1/2
	Spare half octet	Spare half octet 9.5	M	V	1/2
	Control plane service request message identity	Message type 9.7	M	V	1
	Control plane service type	Control plane service type 9.9.3.47	M	V	1/2
	ngKSI	NAS key set identifier 9.11.3.32	M	V	1/2
8-	Payload container type	Payload container type 9.11.3.40	O	TV	1
7B	Payload container	Payload container 9.11.3.39	O	TLV-E	4-65538
12	PDU session ID	PDU session identity 3 9.11.3.41A	C	TV	2
50	PDU session status	PDU session status 9.11.3.44	O	TLV	4-34
F-	Release assistance indication	Release assistance indication 9.11.3.y	O	TV	1
40	Uplink data status	Uplink data status 9.11.3.57	O	TLV	4-34
71	NAS message container	NAS message container 9.11.3.33	O	TLV-E	4-n

Possible Optimizations

Message header size reduction

- Possible optimization to reduce message header size:
  1) Use a small data container for transfer of small data (data size less than 254 octets).
  2) Optimize the case when the device only has 1 PDU session. In this case the PDU session ID does not need to be transported. This is based on the fact that for simple monitoring/metering devices, the typical PDU sessions for these devices would not exceed 2 PDU sessions (in fact, one PDU session would be sufficient in most cases). If SMS is used, then no PDU session is needed. Potential saving is 2 octets.
  3) Reduce the size of PDU session ID IE by defining a smaller 1 octet PDU session ID IE of TV IE type (can reduce 1 octet)
  4) Encode PDU session ID and Release assistance indication information directly in the payload container data buffer. For simple device, these 2 pieces of information are more than sufficient. This would enable 2 octets header reduction.

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Message header size reduction

Optimization 1) + 4)

- Optimization 4) can be viewed as a compromised solution that can reduce message overhead for small data transfer while maintaining the 5G generic payload transport mechanism:
  - It would require additional processing on the network side to extract PDU session Id and Release Assistance information from user data container;
  - On the other hand, only first octet of the container needs to be checked, also only one message container format is needed (same for all messages), and SMS is still transported using existing mechanism. So complexity is much reduced comparing to solution 1.
- By combining optimizations 1) and 4), header size is reduced and not too much complexity is introduced. In addition, benefits for using existing 5G payload transport mechanism are still preserved.
  - Note that one benefit for using 5G generic payload transport mechanism is multiple small data/SMS can be bundled in one message when the UE wakes up with multiple uplink small data or SMS, which further reduce the total overhead and energy consumption.
  - Overall good combination of functionality and efficiency without sacrificing too much good design principles.

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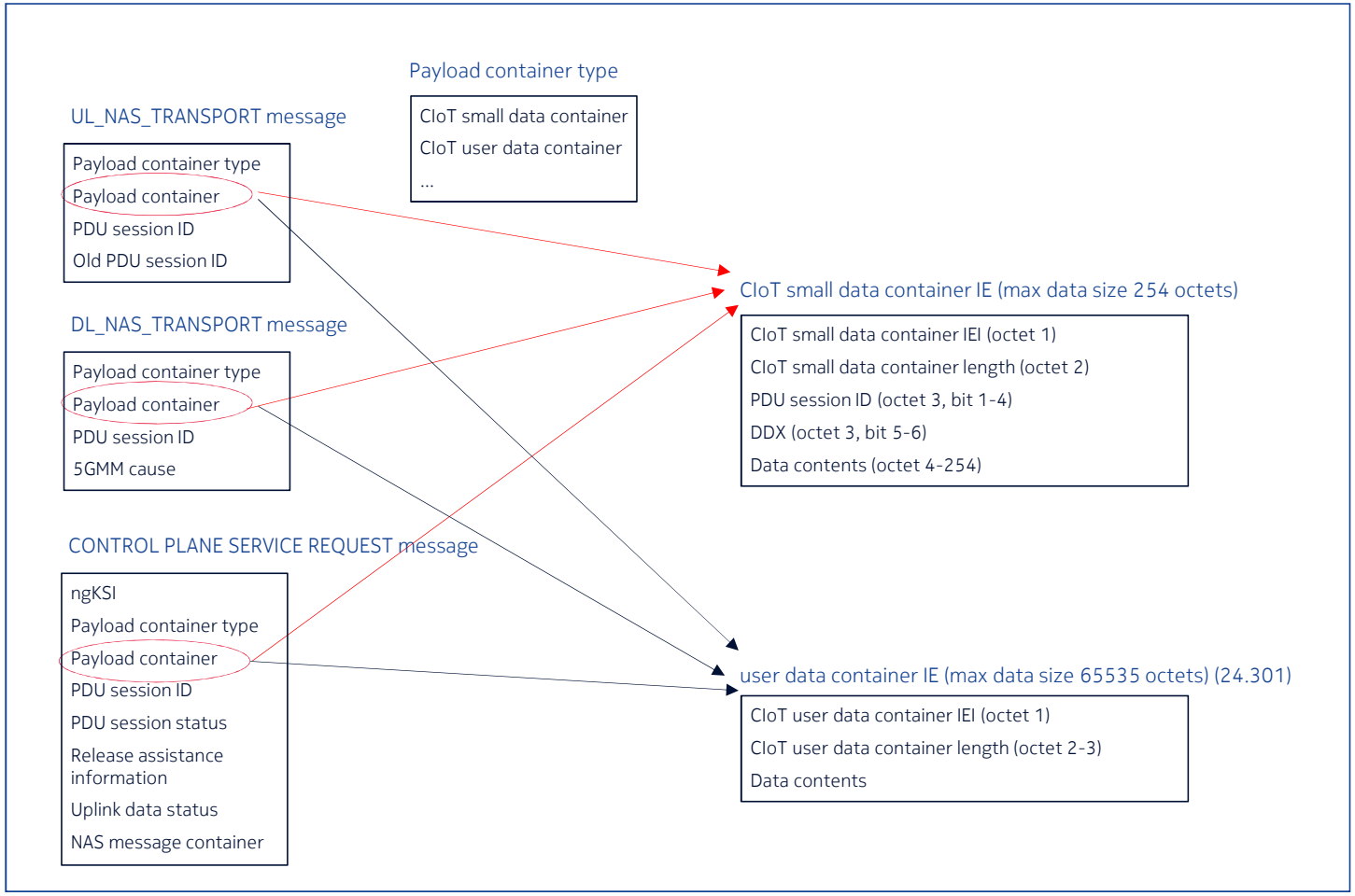
Message header size reduction

Optimization 1) + 4)



Optimization Variations – Sol2a and Sol2b

Sol2a (based on optimization #1 and #4):

- Use a small data container for small data (data size less than 254 octets).
- Encode PDU session ID and Release assistance indication information directly in the small data container for transfer of small data that is less than 254 octets
- Optimization applied to UE in both idle mode and connected mode
- Ciphering done via NAS message container
- **Expected message header size for typical scenario (data only): 12**

Sol2b (based on optimization #1 and #4):

- Use a small data container for small data (data size less than 254 octets).
- Encode PDU session ID and Release assistance indication information directly in the small data container for transfer of small data that is less than 254 octets.
- Optimization applied to UE in idle mode only
- Ciphering done via CIoT small data container
- **Expected message header size for typical scenario (data only): 7**

- Besides the message header size advantage**, the benefit for original solution 2 are also retained in the optimizations.**
- Good combination of functionality and efficiency without sacrificing too much good design principles
- overall the Sol2b offers smallest message header size among all solutions.

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Conclusion

- Solution 2 can support smaller message header size with optimizations, yet still maintain same benefits and principles without bringing too much complexity.
- Any combination of scenarios can be handled efficiently (data only, data+NAS, multiple data/SMS/NAS).
- Same EPC CIoT PDU session status synchronization logic can be maintained.

➢ Conclusion: **With Solution 2 as a base solution**, further optimizations can be additionally/optionally included if there is need to reduce message header size.

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References

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[2] 3GPP TS 23.502, Procedures for the 5G System; Stage 2

[3] 3GPP TS 24.501, Non-Access-Stratum (NAS) protocol for 5G System (5GS); Stage 3

[4] 3GPP TS 36.213, LTE Evolved Universal Terrestrial Radio Access Physical layer procedures;

[5] 3GPP TS 45.820 v13.1.0, “Cellular system support for ultra low complexity and low throughput internet of things,” Nov. 2015.

[6] C1-192277/C1-192768: Support for transmission of small data over NAS

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[9] C1-193795: Control2plane CIoT data transfer in 5GS for UE in connected mode, Nokia, Nokia Shanghai Bell, Huawei, HiSilicon, Verizon, Ericsson, Intel, AT&T, China Mobile, Orange, MediaTek Inc., Sharp, CATT, InterDigital, Gemalto, NEC

[10] C1-193796: Control plane CIoT data and SMS transfer in 5GS for UE in idle mode, Nokia, Nokia Shanghai Bell, Huawei, HiSilicon, Verizon, Ericsson, Intel, AT&T, China Mobile, Orange, MediaTek Inc., Sharp, CATT, InterDigital, Gemalto, NEC

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[12] C1-193190: Support for transmission of small data over NAS, Qualcomm Incorporated, Vodafone, Samsung R&D Institute UK, BlackBerry UK Ltd.