

Improved Method for Telemetry Data Processing in LEO Satellite

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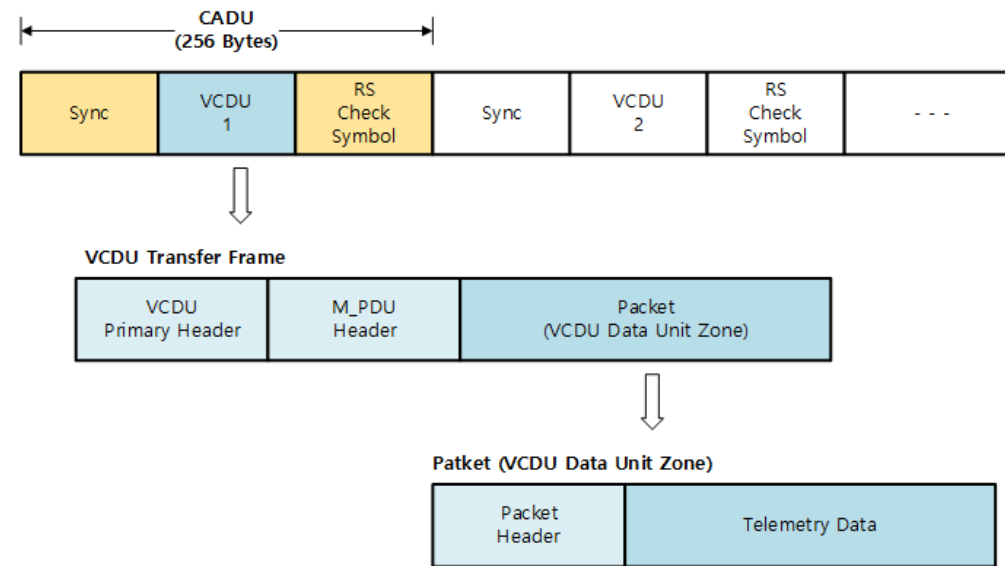
Introduction (1/3)

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- Satellite telemetry data is typically gathered using predefined telemetry data tables.
- In the event of specific errors during satellite operations or transitions to particular states, it becomes imperative to include specific data corresponding to the satellite's state or to modify the collection frequency of certain data sets.
- Given the constrained contact time and communication speed of low-Earth orbit satellites, a functionality is essential to selectively transmit only the indispensable data contingent upon the prevailing circumstances.
- This paper provides
 - an overview of the telemetry data processing methodology utilized for low-Earth orbit satellites developed in Korea
 - outlines mechanisms for automatic adjustment of telemetry data in alignment with the satellite's operational status.
 - Additionally, it presents various strategies for selectively transmitting essential data based on the prevailing conditions.

Introduction (2/3)

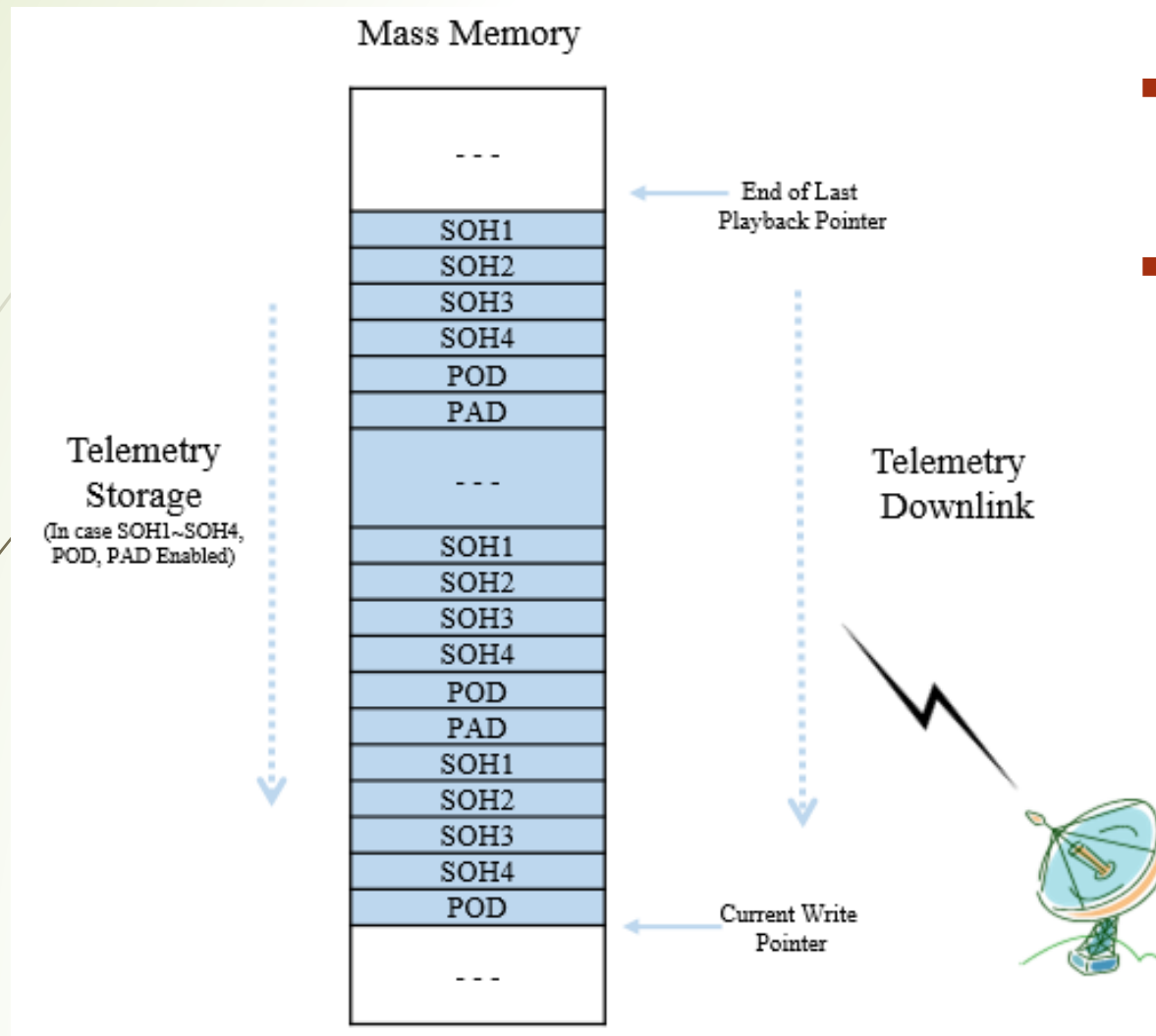
- The telemetry data is categorized into specific packet groups based on data type
- And the designated items for each packet are collected every second according to a predefined telemetry data table, then stored in mass memory.
- These stored data are transmitted to the ground in the form of playback data, along with real-time data, during ground communication



Telemetry Format

Introduction (3/3)

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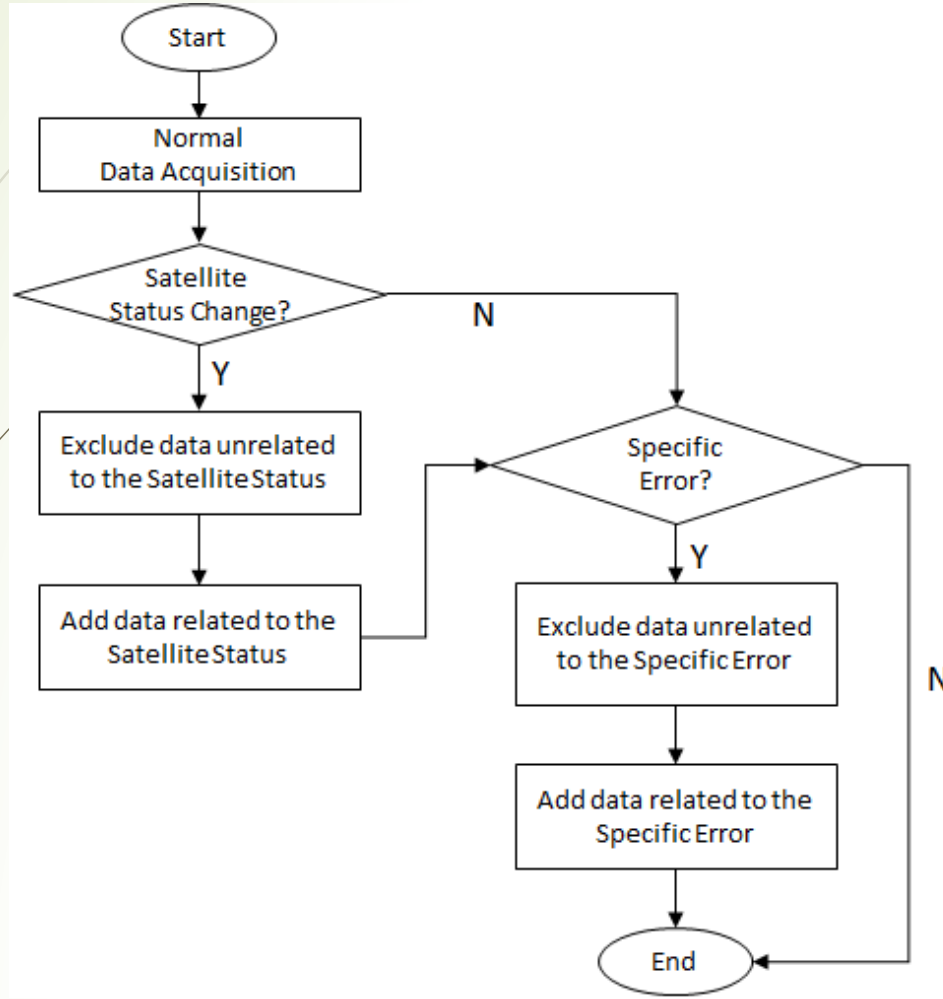


- LEO satellites store all telemetry data generated in a mass memory in the sequential order of generation.
- Subsequently, the accumulated telemetry data is transmitted collectively to the ground control system during communication with the ground.
 - It may not be feasible to transmit all data if the communication environment is unstable or the satellite is in safe mode.

Telemetry Data Storage and Downlink Example

Basic Concept of Telemetry Acquisition

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Telemetry Packet Seq. Example by Satellite Status

TM Group	Packet Sequence (by Satellite Status)			
	Normal	State #1	State #2	State #3
SOH1	PKT1, PKT3 PKT3, PKT4	PKT1, PKT2	- PKT3, PKT4	PKT1, PKT2
SOH2	PKT5, PKT6 PKT7	PKT5, PKT6 -	- PKT7	PKT5, PKT6 -
SOH3	PKT8 PKT9	- PKT9	- PKT9	- PKT9
SOH4	- -	PKT10, PKT11 -	- PKT12, PKT13	PKT10, PKT1 1 PKT12, PKT1 3
POD	POD	POD	-	POD
PAD	PAD	PAD	PAD	-
PLD	PLD	-	-	PLD

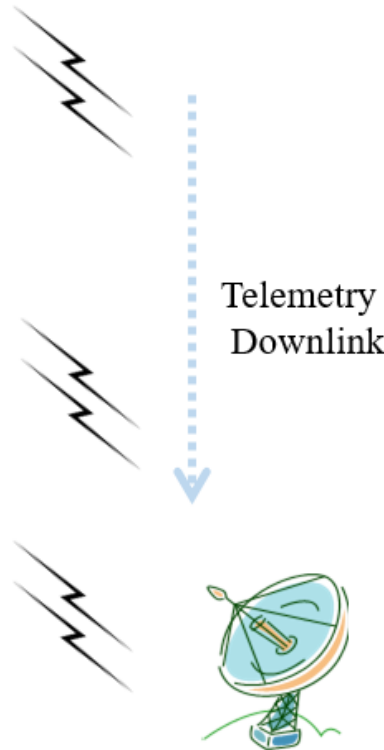
Telemetry Storage and Downlink – Method 1

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Mass Memory

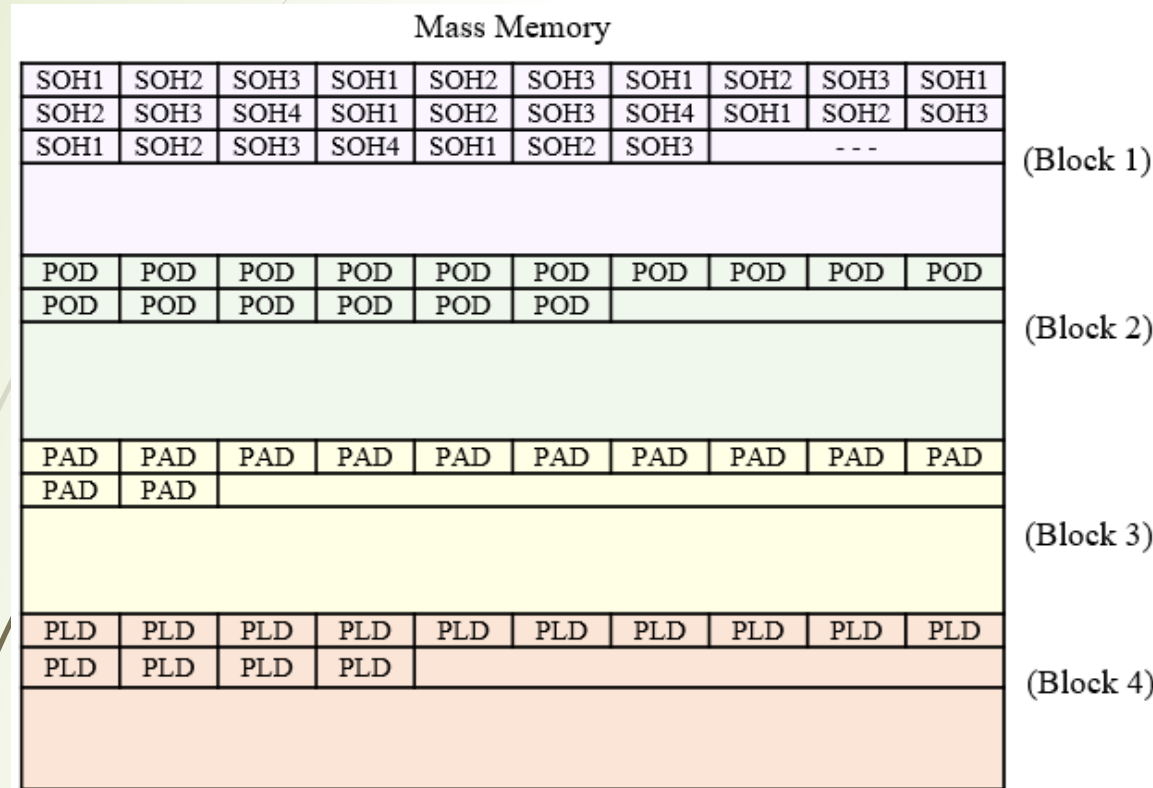
SOH1
SOH2
SOH3
SOH4
POD
PAD

SOH1
SOH2
SOH3
SOH4
POD
PAD
SOH1
SOH2
SOH3
SOH4
POD



- ▶ During transmission, each data type is discerned, and solely the pertinent data is transmitted.
- ▶ The data must be read and verified in frame units, and only the relevant data must be selected and transmitted
- ▶ While this approach maintains the existing system to a significant extent, it entails extensive processing time.

Telemetry Storage and Downlink – Method 2



- The utilization of separate memory areas for each data type
- This method enables the transmission of only specified necessary data to the ground, it necessitates the separate management of pointers for each block.
- The size of the memory block must be appropriately allocated in accordance with the data type

Telemetry Storage and Downlink – Method 3

Mass Memory

(Page #)	1	2	3	4	5	6	7	8	9	10
SOH1	SOH1	SOH1	POD	PAD	PLD	SOH1	POD	SOH1	PAD	
SOH2	SOH2	SOH2	POD	PAD	PLD	SOH2	POD	SOH2	PAD	
SOH3	SOH3	SOH3	POD	PAD	PLD	SOH3	POD	SOH3	PAD	
---	---	---	---	---	---	---	---	---	---	---
SOH1	SOH1	SOH1	POD	PAD	PLD	SOH1	POD	SOH1	PAD	
SOH2	SOH2	SOH2	POD	PAD	PLD	SOH2	POD	SOH2	PAD	
SOH3	SOH3	SOH3	POD	PAD	PLD	SOH3	POD	SOH3	PAD	

(Page #)	11	12	13	14	15	16	17	18	19	20
SOH1	PLD	SOH1	POD	SOH1	PAD	SOH1	POD			
SOH2	PLD	SOH2	POD	SOH2	PAD	SOH2				
SOH3		SOH3	POD	SOH3		SOH3				
---		---	---	---		---				
SOH1		SOH1	POD	SOH1		SOH1				
SOH2		SOH2	POD	SOH2						
SOH3		SOH3	POD	SOH3						

(Page Table)

SOH	SOH	SOH	POD	PAD	PLD	SOH	POD	SOH	PAD
SOH	PLD	SOH	POD	SOH	PAD	SOH	POD	-	-
-	-	-	-	-	-	-	-	-	-

- ▶ Storing data of the same type on each page and managing it with a data table stored in each page.
- ▶ By maintaining a record of the type of data within the page table, it becomes possible to classify and transmit
- ▶ While Method 3 is somewhat more intricate than Method 2, it eliminates the need to consider memory allocation size for each data type.

Conclusion and Future Work

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- ▶ Given the constraints of limited memory size and communication time inherent to low-orbit satellites, it becomes imperative to generate meaningful data aligned with the satellite's status, rather than redundantly transmitting data.
- ▶ Furthermore, the capability to swiftly transmit only essential data in response to the prevailing situation is indispensable.
- ▶ Several methods to address this challenge have been outlined.
- ▶ To implement this functionality effectively, a comprehensive assessment is required, taking into account the existing flight software's downlink driving method and its integration with hardware functions.
- ▶ In future efforts, detailed analyses of each method will be conducted to identify the most appropriate approach.
- ▶ Additionally, for transmitting stored data, consideration is being given to designating a memory area and implementing a method for transmitting data from the satellite corresponding to a specific time designation.

Reference

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