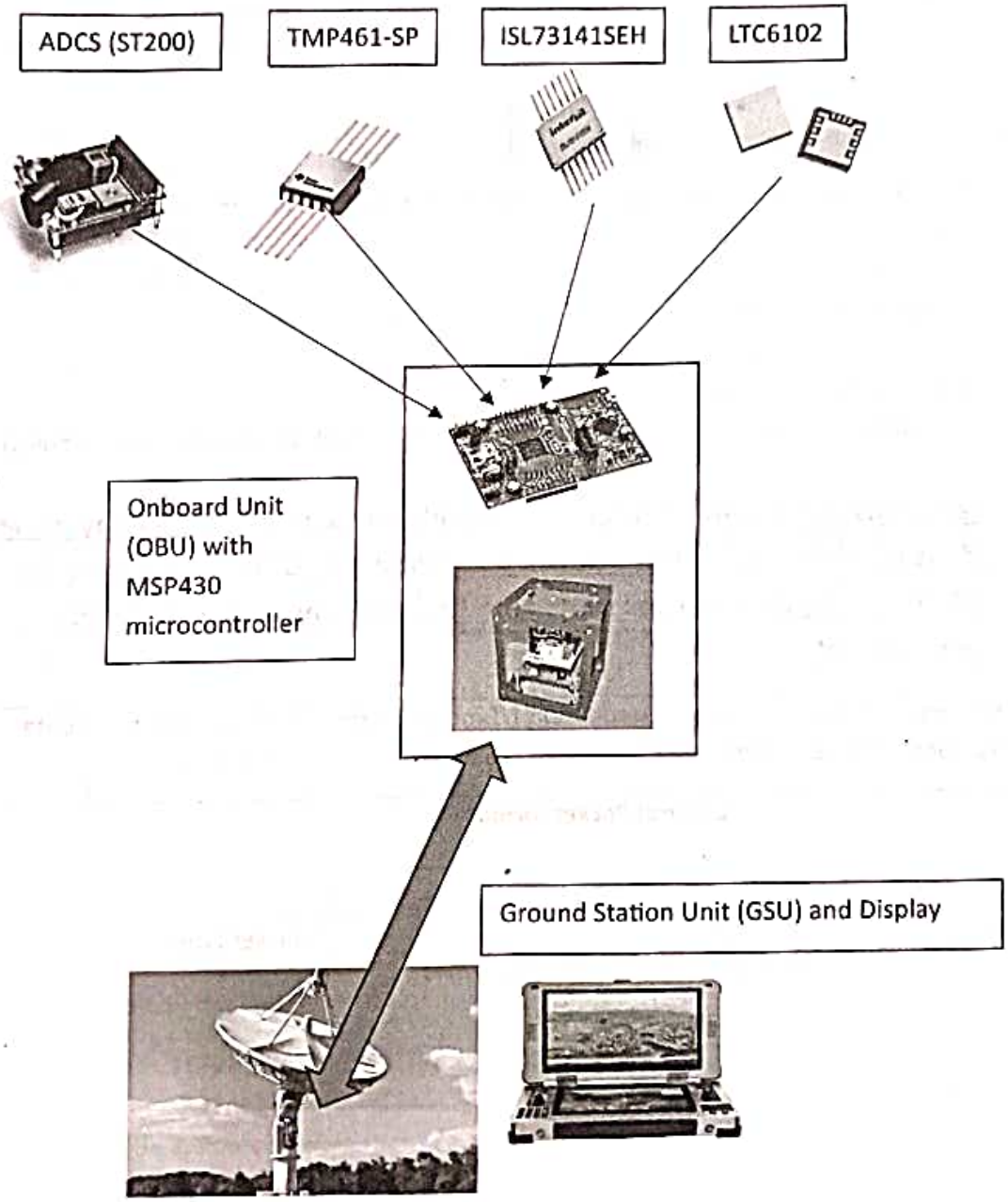
AV 341 CMPUTER NETWORKS LAB FINAL EXAM

SC CODE: Name: Date: 25/04/2025

QP Code: AV69 Time: 2.45-5.00 PM

System Diagram



Note-1: Question codes starting from 'D' need to do only Phase-1, Phase-2, and Phase-3.

Note-2: Question codes starting from 'A' need to do only Phase-1, Phase-2, and Phase-4.

Q: You are part of the POEM-5 mission designed by ISRO, where a low-power embedded system is developed using the MSP430 microcontroller to interface with multiple sensors. These sensors form part of a smart payload data acquisition system. The system is responsible for periodic data collection, processing, power-aware operation, and reliable communication with a ground station.

The sensors used in the system include:

1. ADCS (Attitude Determination and Control Sensors: star tracker, sun sensor, magnetometer) (ST200)
2. Temperature Sensor (TMP461-SP)
3. Voltage Sensor (ISL73141SEH)
4. Current Sensor (LTC6102)
5. Cell Gauge Sensor (BQ41Z50)
6. OBU (Onboard Unit – placeholder for other mission-critical sensors or status modules)

I. **Each sensor generates packets periodically and send to MSP430 by using ideas of lab-5 and lab-9 which will work similar to UART, SPI, and Serial I/O lines, i.e., data transmission, with the following constraints and requirements:**

ID	Sequence number	Packet Type	Source Port	Destination Port	Time of Packet Generation	Time of Packet Reception	Data

General Packet format

ID	Sequence number of Missing Packet	Packet type

Acknowledgement packet format

Where,

1. ID: Unique identifier of sensor (e.g., ST200)
2. Sequence number: Serial number of each sensor packet (starts from 0 for each sensor)
3. Packet Type value:
   - 0: ADCS
   - 1: Temperature
   - 2: Voltage
   - 3: Current
   - 4: Cell Gauge
   - 5: OBU
   - 6: Acknowledgment (ACK)
4. Source Port / Destination Port: Represent origin/destination modules
5. Time of Packet Generation: System time at the time of sending the packet
6. Time of Packet Reception: System time at the time of receive the packet
7. Data: Payload based on module type

II. Data Payload Format (Data) (data field need to change in the packet according to the source)

- ADCS: [Roll in °| Pitch in °| Yaw in °| Angular Velocity in °/s]
- Temperature: [Temp of payload in °C]
- Voltage: [Bus Voltage in Volts]
- Current: [Current in mA]

Note: Those values can be any integer values

III. Sensor Packet Generation Time

- ADCS: every 2 seconds
- Temperature: every 5 seconds
- Voltage & Current: every 3 seconds
- OBU: every 120 seconds

IV. Power Mode-Dependent Sensor Operation

The MSP430 supports three power management modes depending on battery percentage (determined by the Cell Gauge):

- **Mode 1: Fully Operational (Battery: 80–100%)**
  Active Sensors: All (ADCS, Temp, Voltage, Current, Cell Gauge, OBU)
- **Mode 2: Power Saving (Battery: 50–79%)**

Active Sensors: ADCS, Voltage, Current, Cell Gauge

- **Mode 3: Ultra Power Saving (Battery: 20–49%)**
  Active Sensors: ADCS and Cell Gauge only
- **Below 20%, the system again charges to 100%**

V. Power Consumption Accounting

Each packet received by the MSP430 consumes 0.25% of charge. The MSP430 dynamically updates the charge status based on the packet reception.

VI. Data Logging and Uplink

Collected packets are saved into a log file on the MSP430 every cycle. Every 2 minutes, the file is transmitted to the Ground Station Unit (GSU) via similar to a telemetry link (ideas from lab-6 and lab-9).

VII. Ground Station Operation

The GSU receives and displays sensor data grouped by sensor type, providing real-time diagnostics. Each sensor's data stream is parsed and displayed separately for monitoring.

VIII. Packet Loss and Acknowledgment Protocol

There is a 10% probability of packet loss during transmission from MSP430 to the ground station. The GSU sends ACK packets (type 6) indicating which packet IDs were not received. The MSP430 resends those packets until successfully acknowledged. Further, Packet-to-ACK loss ratio percentage can be show as a diagnostic parameter which follows below equation:

Packet-to-ACK loss ratio percentage = (Total packets received within two minutes / total acknowledgements lost) x 100

Note: The ideas from lab-9 can be considered to realize this problem.

Tasks to do:

Phase-1

1. Design all sensor codes (client) and microcontroller code (server) in C
2. Encodes sensor data using the defined packet format according to Sections I and II.
3. Complete the communication sessions of all sensors to microcontroller
4. Display each session information in terminal, i.e., packet received and sent.

Phase-2

1. Accommodate all points of phase-1

2. Encodes sensor data using the defined packet format and generation interval according to Section-III
3. Saves all sensor data to a text file (refer Section-III)
4. All information of the file transmits to the GSU in every 2-minute interval (refer Section-III)
5. GSU display all packet received

Phase-3

1. Accommodate all points of phase-1 and phase-2
2. Add the power consumption mode according to Sections VI and V
3. Switches between operational modes based on battery level.

Phase-4

1. Accommodate all points of phase-1 and phase-2
2. Perform Section-VII tasks
3. Simulate 10% packet loss with acknowledgement according to Section-VIII instructions
4. Calculate and display Packet-to-ACK loss ratio percentage according to Section-VIII