Data & Command Handling Team

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DCH Team Members

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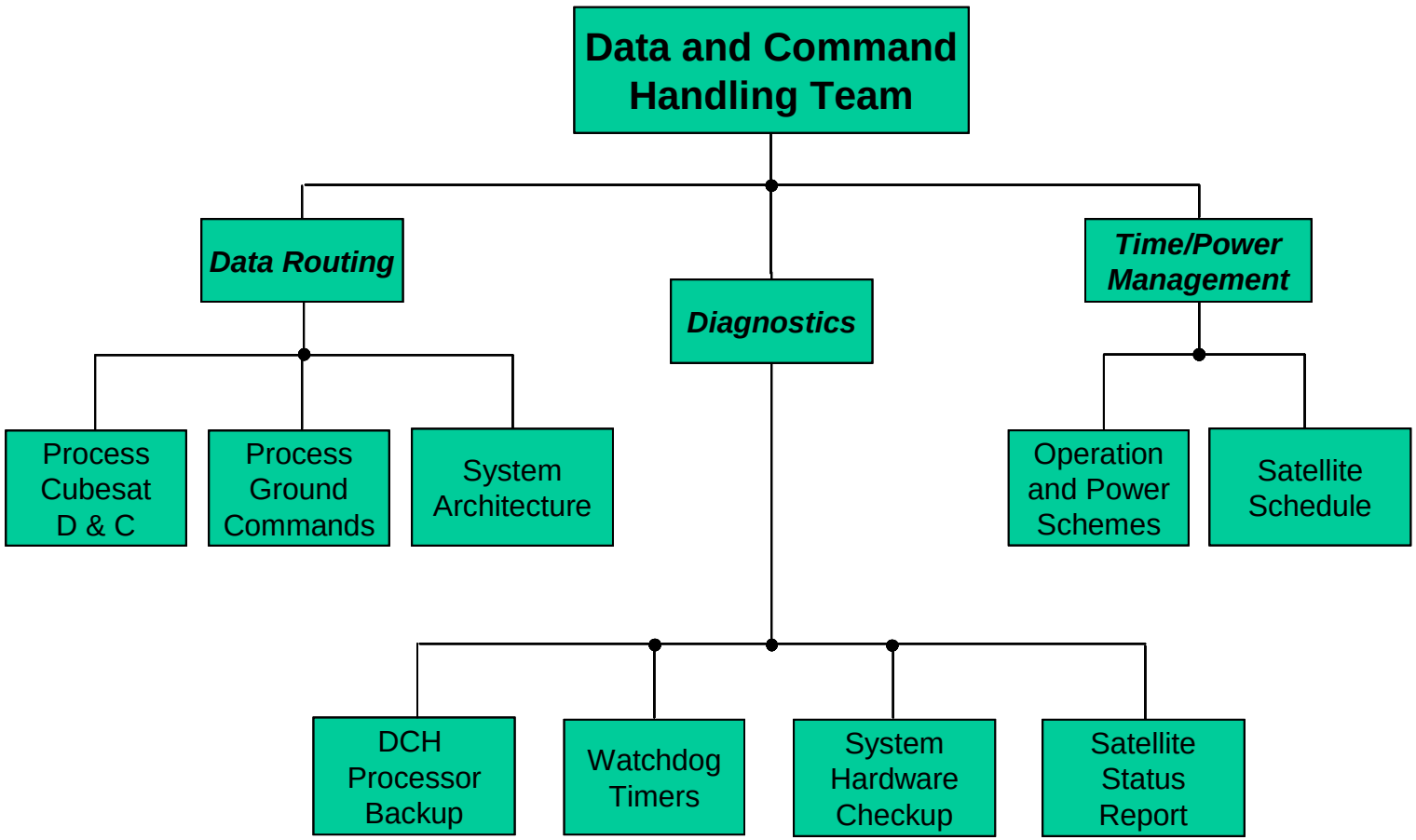
Overview

- Introduction
  - Team organization and responsibilities
- DCH Design
  - Hardware (Microprocessor, EEPROM)
  - Power, weight, size budget
  - Diagnostics and maintenance
  - I2C, standard interface
  - System architecture for data routing
- Discussion…

The Role of DCH

- Data/command routing and storage
- Diagnostics and housekeeping
- Managing time and power

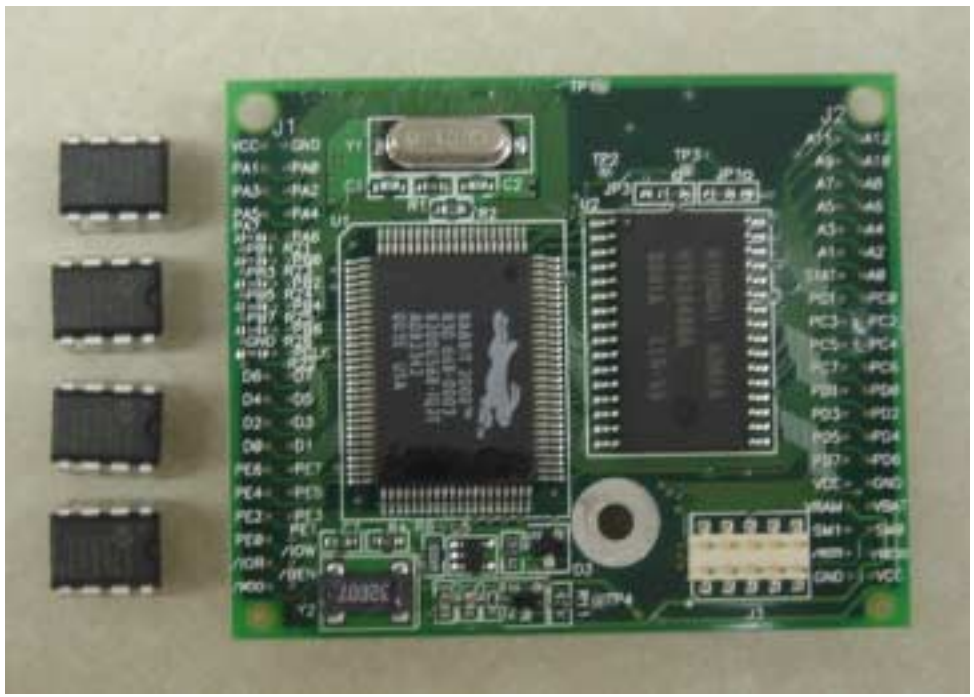
DCH Organization



DCH Hardware

Microprocessor

- Z-World: Rabbit Core Module 2000



Size (cm)
4.83 x 5.84 x 1.2

Weight
16.1 g

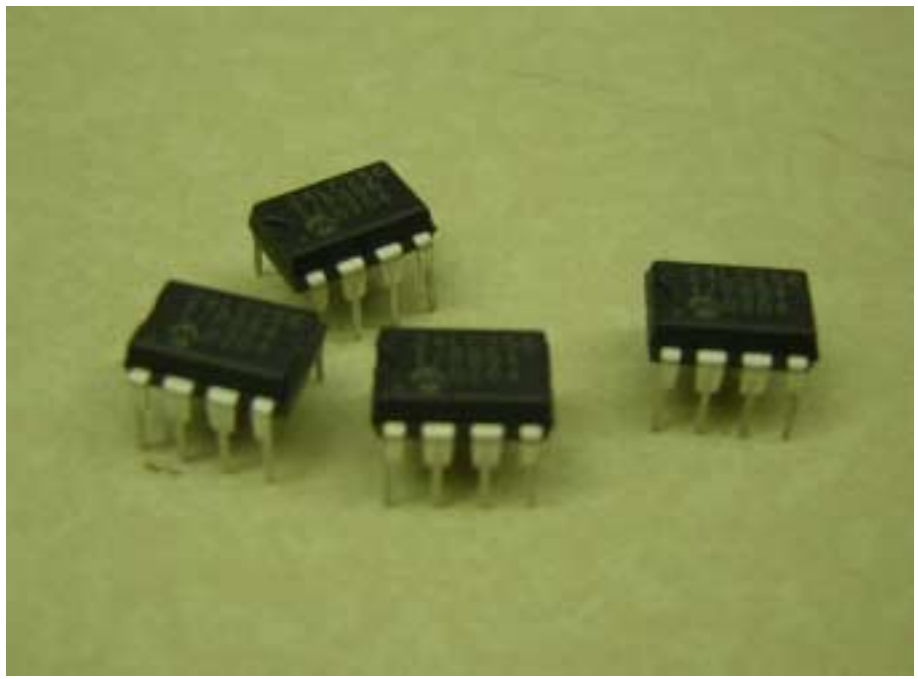
Microprocessor

- Why we chose this processor
  - It will operate in space
  - Low power consumption
  - Many power modes
  - Good processor speed
  - Serial interface (even documentation for I2C)
  - Sufficient number of I/O ports
  - Easy to use
  - Adequate amount of flash and SRAM

  - I’ve used it before
  - Programmed in C!

EEPROM

- Microchip: 24LC515 EEPROM



Size (cm)
8 pin DIP,
Unsure of board size

Weight
EEPROM: 0.5 g
PC board: 16 – 30 g

Weight Budget

2 Rabbit microprocessors

6 EEPROM

Full size PC board

3 PIC microcontrollers

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60 - 75 grams

Size Budget

2 Rabbit microprocessors

6 EEPROM

Full size PC board

3 PIC microcontrollers

One full rack.

Power Budget

- Microchip EEPROM (24LC256,24LC515)
  - 5.5 V @ 3 mA (max)
  - (16.5 mW/chip) x (10 chips) = 0.165 W [5 Mb memory]
  - **(16.5 mW/chip) x (6 chips) = 0.1 W [3 Mb memory]**

- Rabbit Core 2000
  - High: 5.0 V @ 130 mA → 0.65 W [30 MHz]
  - **Med: 5.0V @ 60 mA → 0.3W [15MHz]**
  - **Sleep: 1400μW [32kHz]**

- Total Power Needed:
- 0.1W + 0.3W + 1400μW = 0.4014W + buffer

- **Power Budget is: 0.5 W**

Diagnostics

Diagnostics

Importance

- Recognize failure of systems
  - It is unnecessary to power a broken system
  - System will be removed from Time/Power schedule

Diagnostics (cont'd)

How often should diagnostics be run?

- Internal DCH Processor Diagnostics
  - Done continuously
  - If Rabbit1 dies, Rabbit2 takes over
- May run daily, weekly…
- Diagnostics will vary for each subsystem

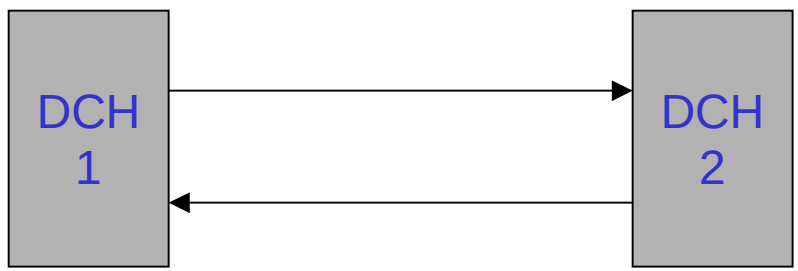
Diagnostics (cont'd)

What are we checking?

- Internal DCH Processor Diagnostics
  - Failure of main Rabbit Processor (DCH 1)

Diagnostics (cont'd)

How are we going to do this?



Diagnostics (cont'd)

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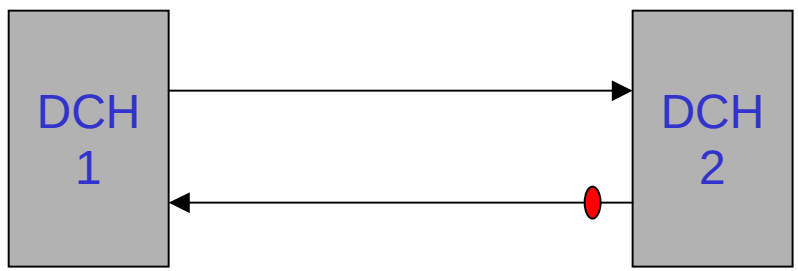

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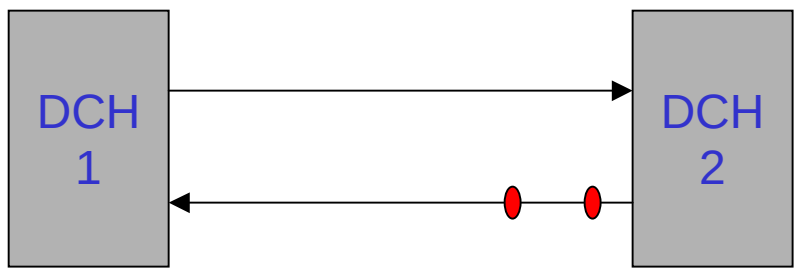

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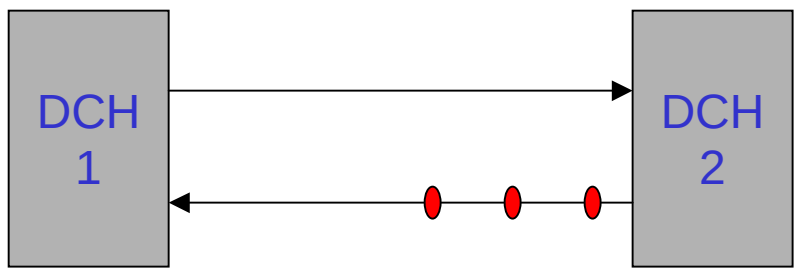

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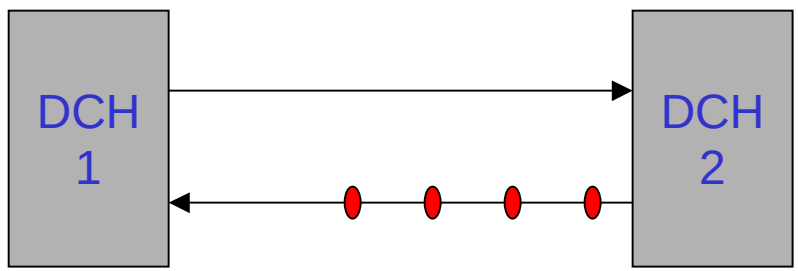

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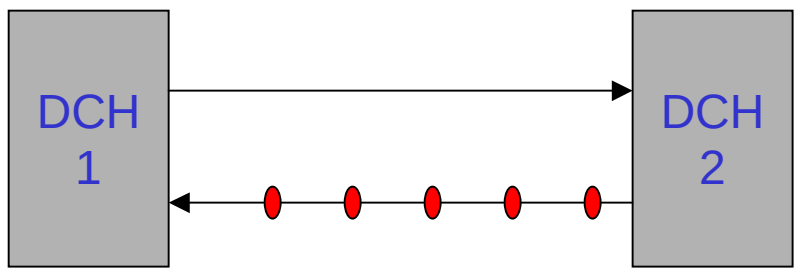

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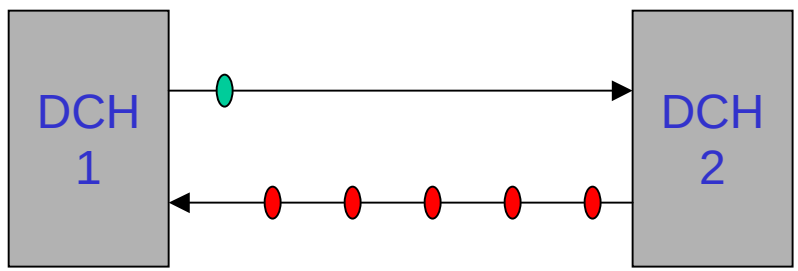

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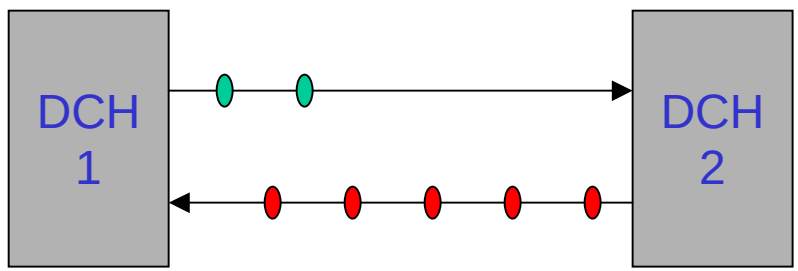

Diagnostics (cont'd)

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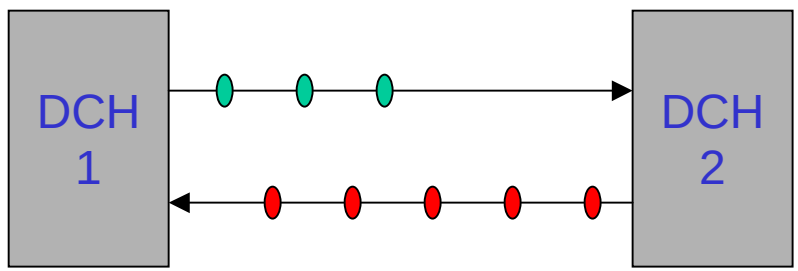

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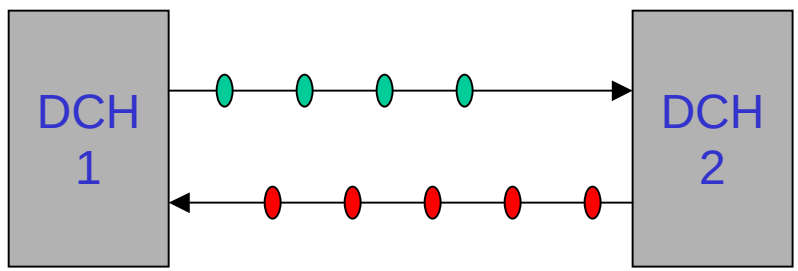

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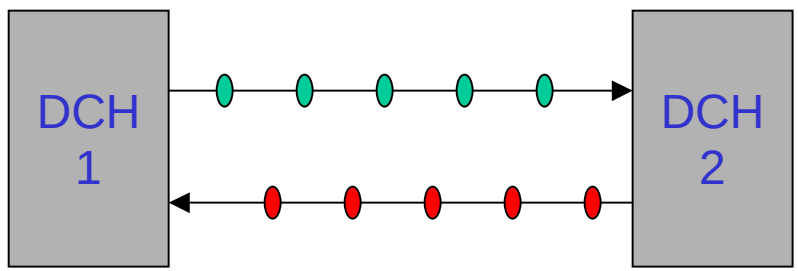


Diagnostics (cont'd)

- Cubesat Subsystems
  - TTC
    - Standalone node
    - Check to see if TTC node is working as a relay
  - PGD
    - It can act as a standalone node if DCH fails
    - Done by sending a command requesting battery power status
      - Rabbit processor determines which subsystems to run depending on battery power level

Diagnostics (cont'd)

- SCI and ADS
  - Done by sending a command requesting data
  - Rabbit processor to system microcontroller
  - Rabbit processor determines system not operation and taken out of daily operation schemes if no data received

If both Rabbit processors fail, satellite shall operate in basic configuration. Satellite operates as a beacon.

Operation Schemes

What systems will be on at the same time?

- DCH, TTC, and Power
- DCH, Imaging, TTC and Power
- DCH, Sensors, TTC and Power

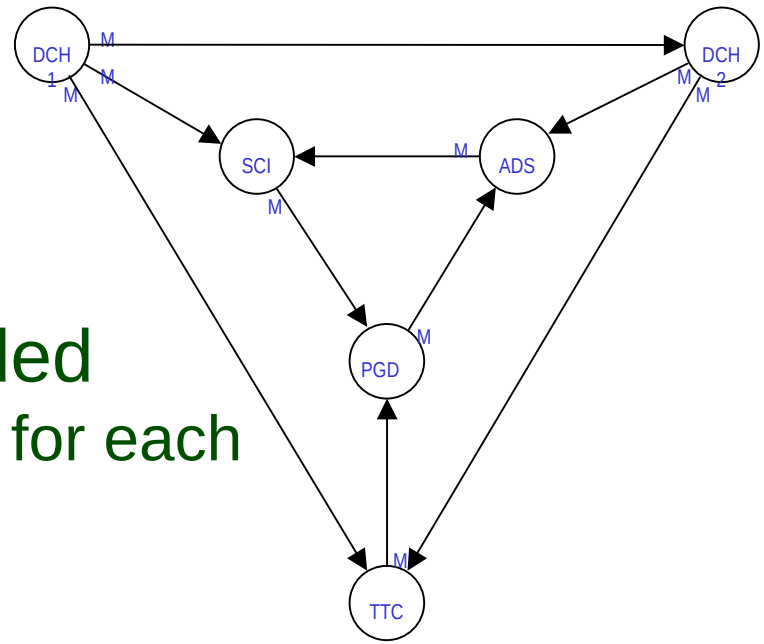
System Architecture

Data Routing Architectures

- Two choices
  - Hybrid Model
  - I2C bus

Hybrid Specifications

- PIC needed for each node
  - 6 nodes
- 6 ports per node
  - 3 serial clocks
  - 3 serial data
- I2C serial interface needed
  - Master/slave designation for each



Hybrid

- Pros
  - Reliable
  - Alternative Data routes
  - 4 point failure
- Cons
  - Messy Wiring
  - More I/O pin usage

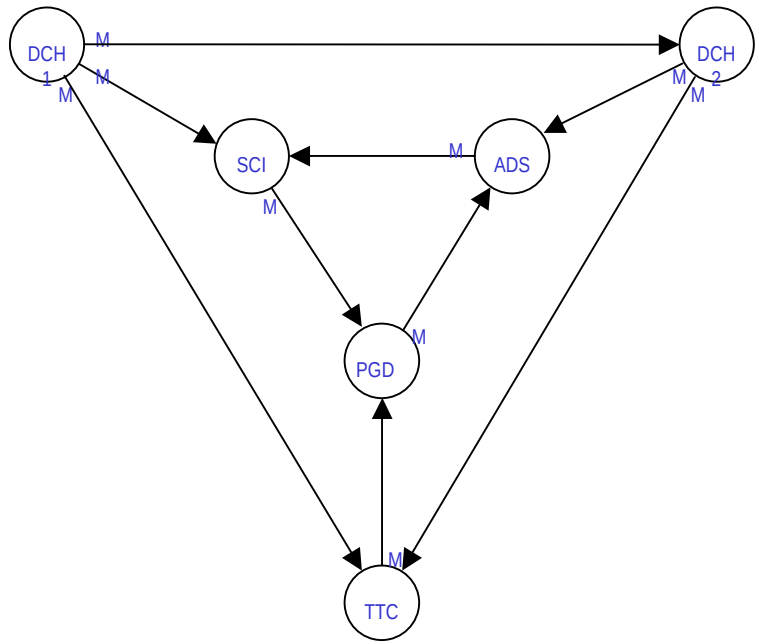
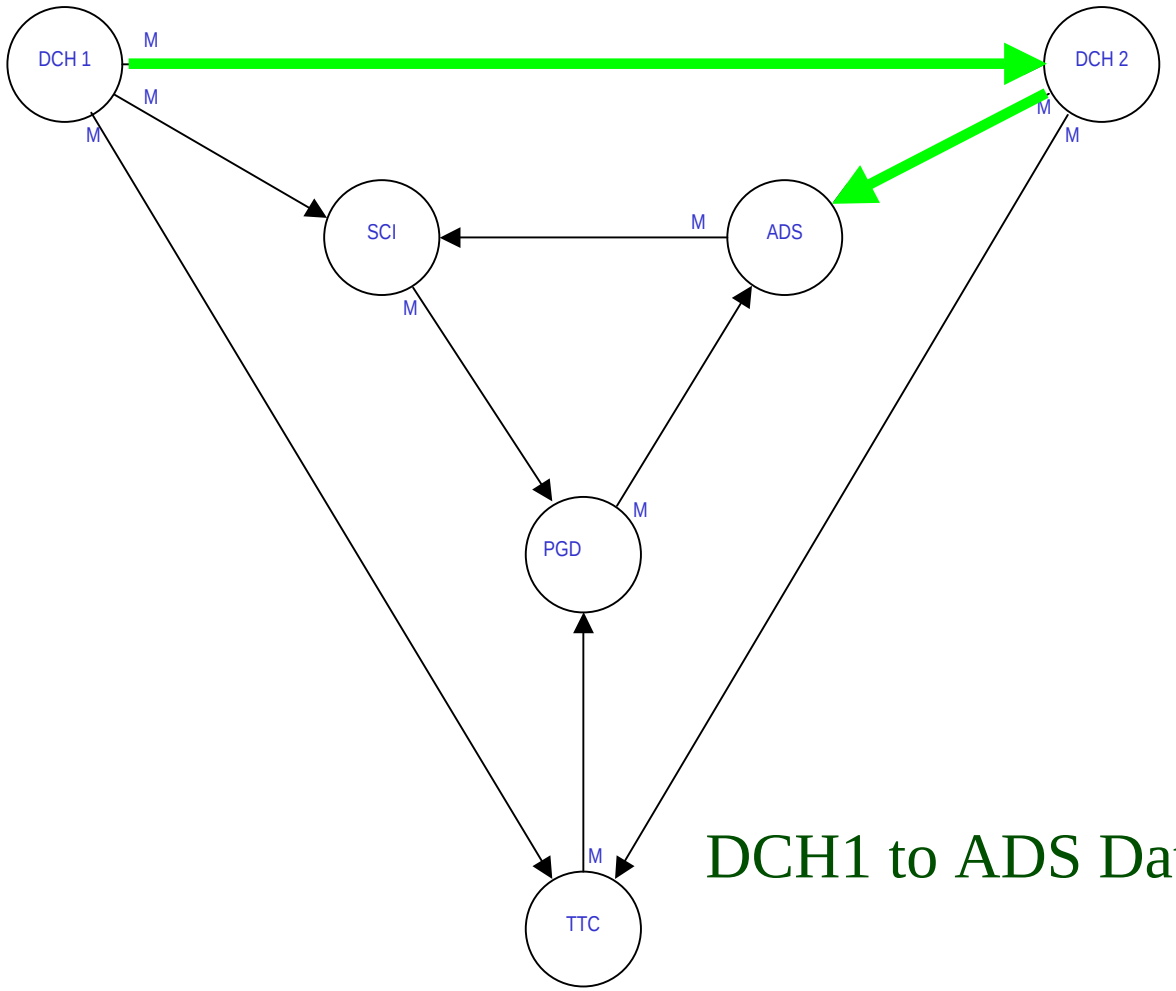


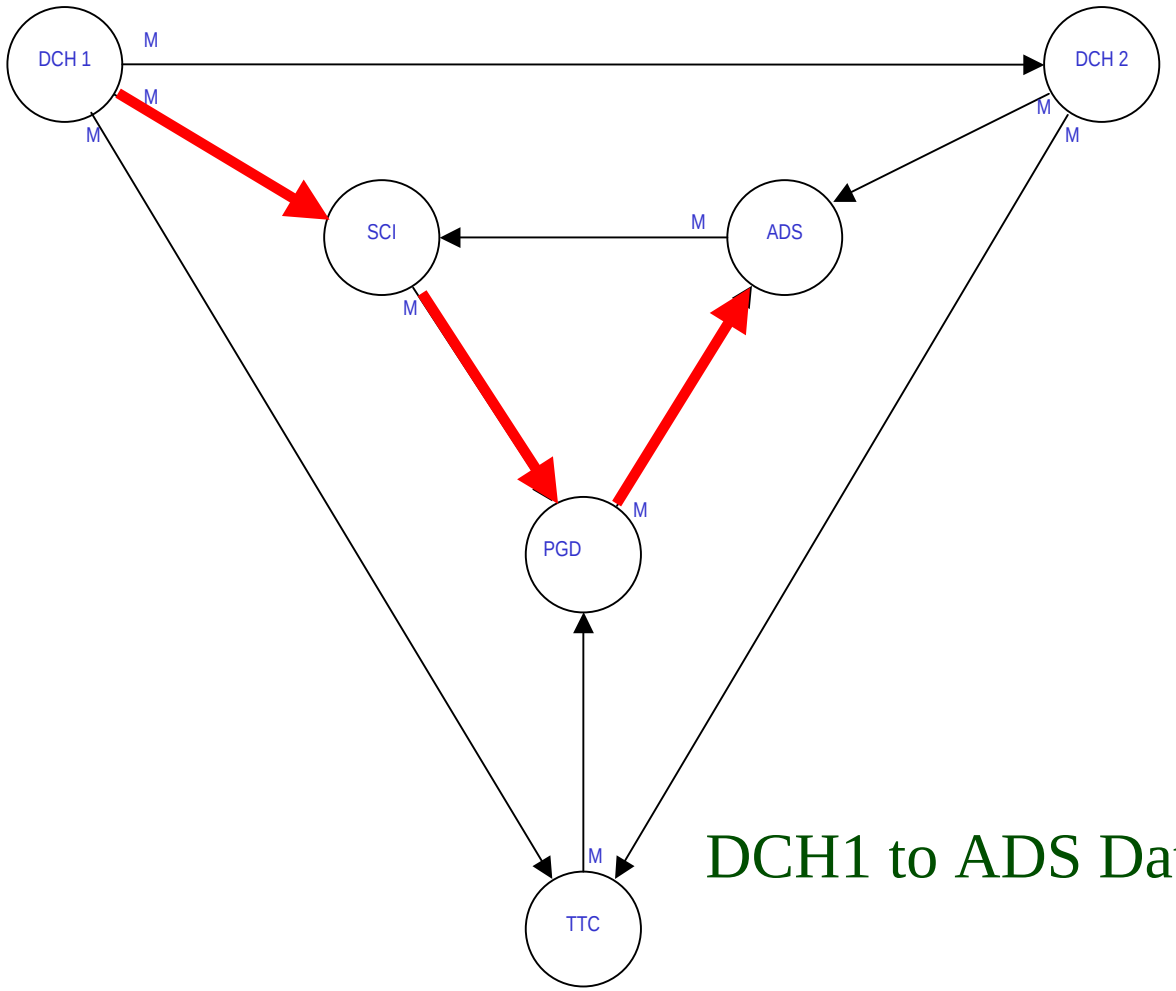
Fig. 1: Block diagram of Hybrid model

Hybrid



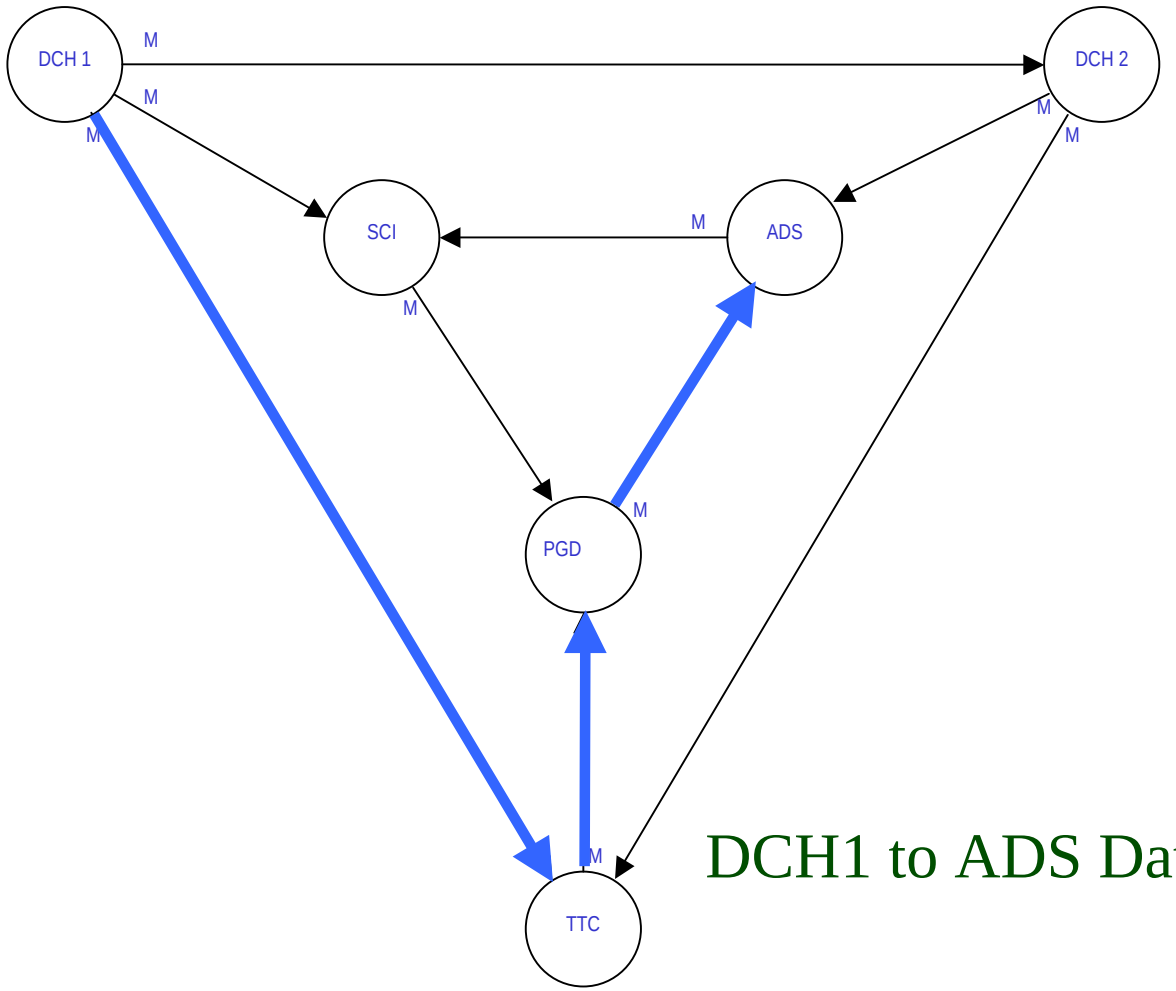
DCH1 to ADS Data Routing

Hybrid



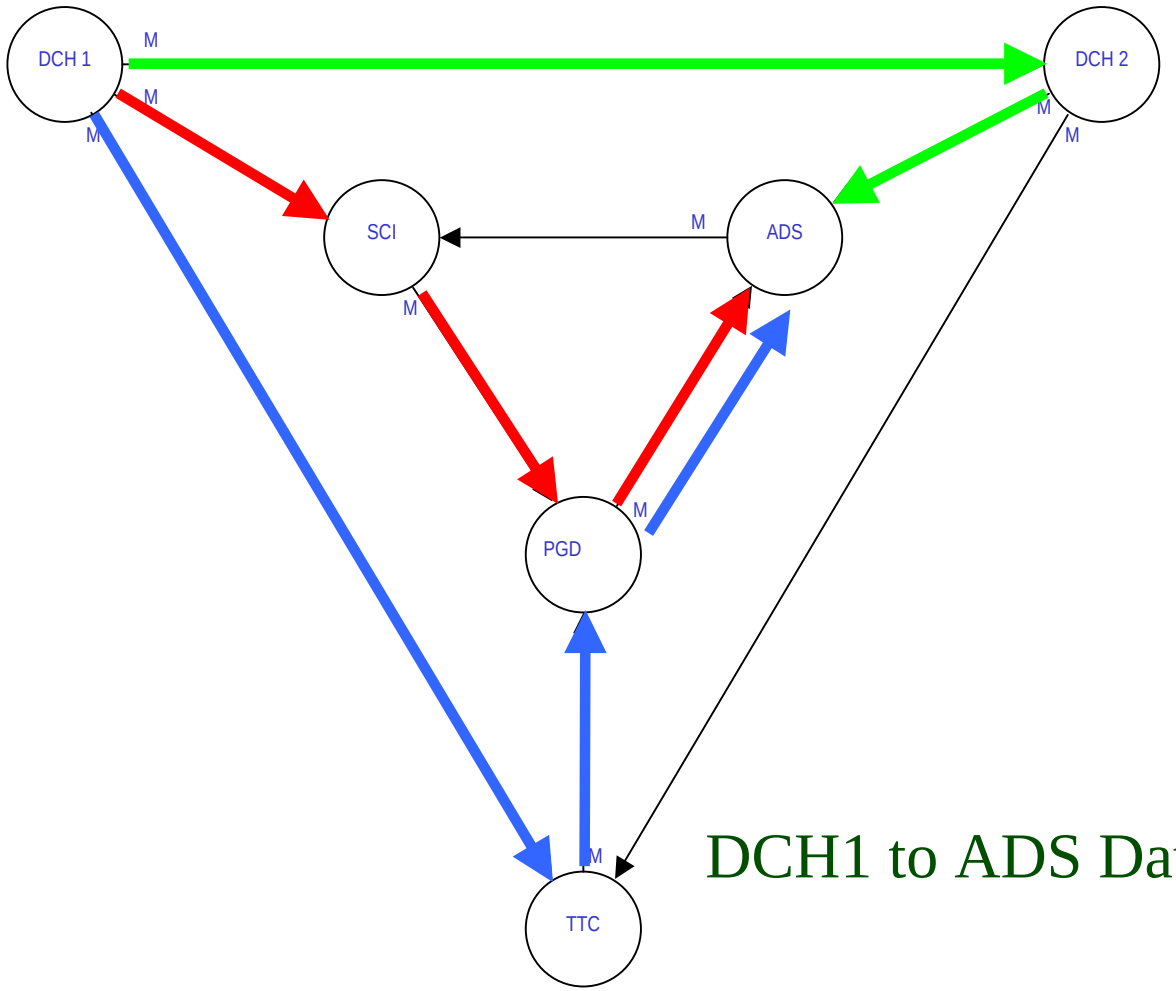
DCH1 to ADS Data Routing

Hybrid



DCH1 to ADS Data Routing

Hybrid

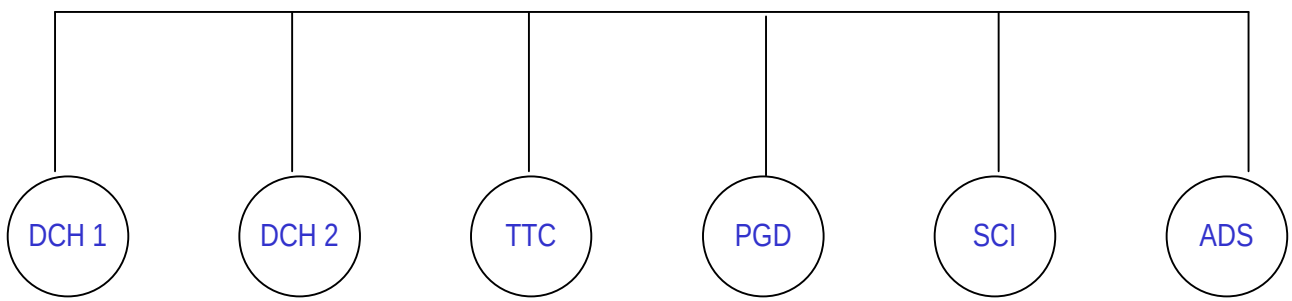


DCH1 to ADS Data Routing

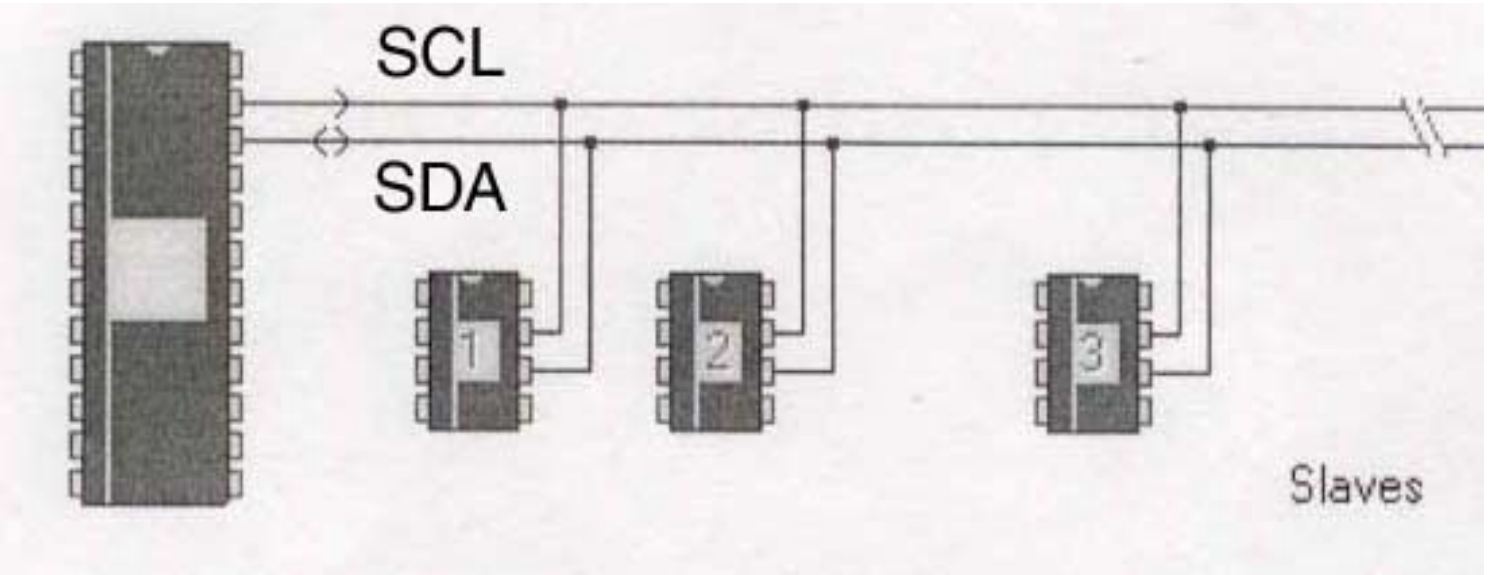
I2C Bus Specifications

- PIC needed to integrate systems
- Two ports per node
  - Serial clock
  - Serial data

  (Lines are Bidirectional)
- I2C serial interface needed
  - Master/slave designation built into interface



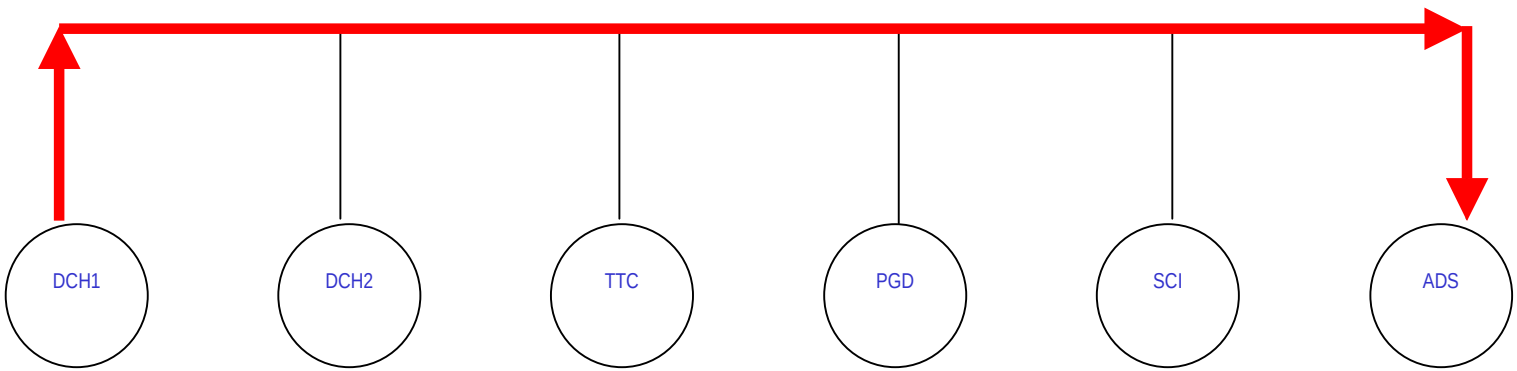
I2C Serial Interface



I2C bus figure: SCL = clock

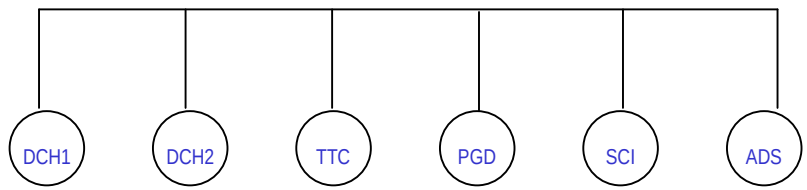
SDA = data

I2C bus



I2C bus

- Pros
  - Usually reliable
  - Easy to expand design for more nodes
  - Less wiring mess
  - 4 point failure
  - Low power
- Cons
  - Interface has to be the same
  - Programming is more difficult
  - No alternate data routes
  - Only one node can talk at a time
  - Regulated by a bus driver
  - Master is the system that's talking… Infinite loop could be devastating.



Integration Concerns

Outline of Concerns

- I2C interface — SCI, TTC, ADS
- Ground Control — TTC
- Communication — Everyone
- Power/Time — Everyone

Questions later…

Concerns

- I2C interface
  - Workshop for teams using interface
  - Teams share knowledge: code and test circuits

Concerns

- Ground Station System
  - Possible collaboration with TTC
  - Software?
    - Satellite tracking software
    - Manual control of satellite
    - Processing DCH status reports from CubeSat

We need to know what is requested of DCH for the Ground Station system

Concerns

- Communication / Data Handling
  - brief explanation in PDR
  - We will deal with diagnostics
  - What do other teams need to do?
    - Reserve 6 data pins for DCH on your PIC
    - **Each group is responsible for interfacing with their own hardware.**

Concerns

- Power and Time Management
  - Cannot be addressed now

Discussion

Question:

- Why not use a star configuration?
  - Single point of failure
    - All systems becomes isolated
    - No redundancy whatsoever
  - Adding another processor would be like using a bus architecture

One point failure