A Low-Power Dual-Processor Computing System for Advanced Nanosatellite Missions

Nathaniel Colson
Purdue University
ncolson@purdue.edu

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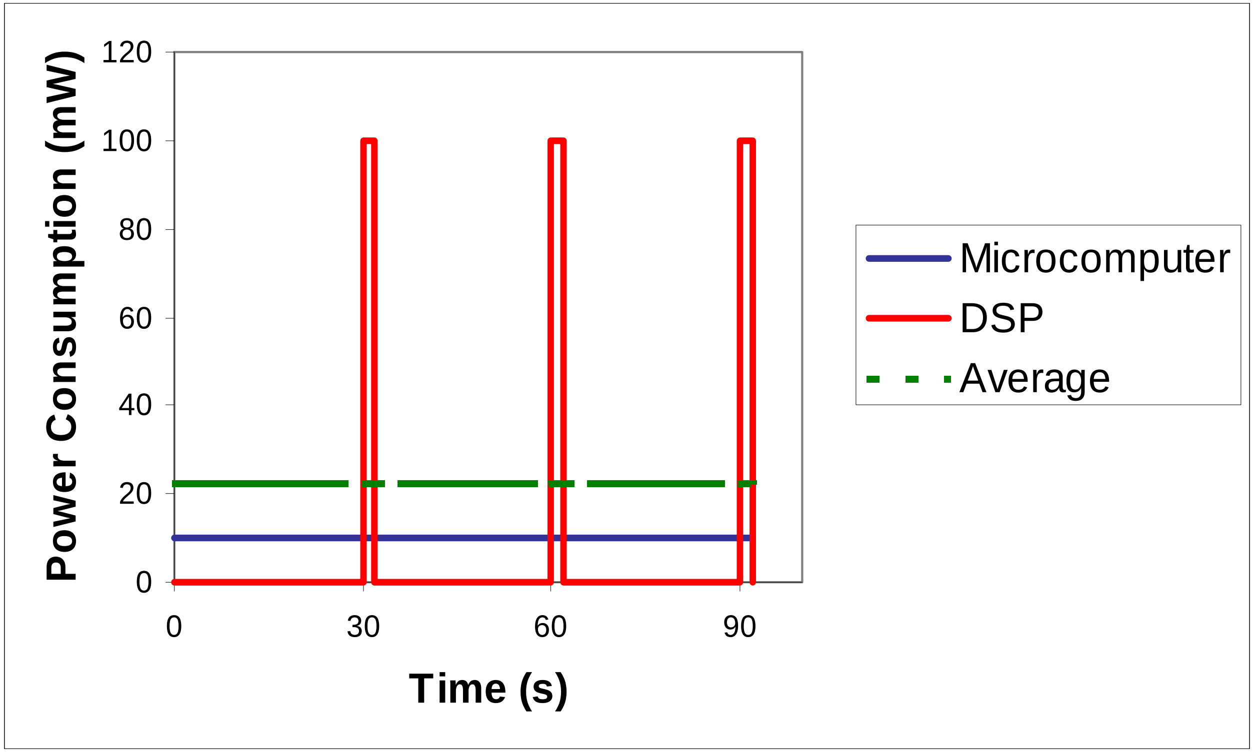
Two Processors:

- DSP
  - 500 MHz
  - 1 W
- Microcomputer
  - 8 MHz
  - <10 mW

Overview

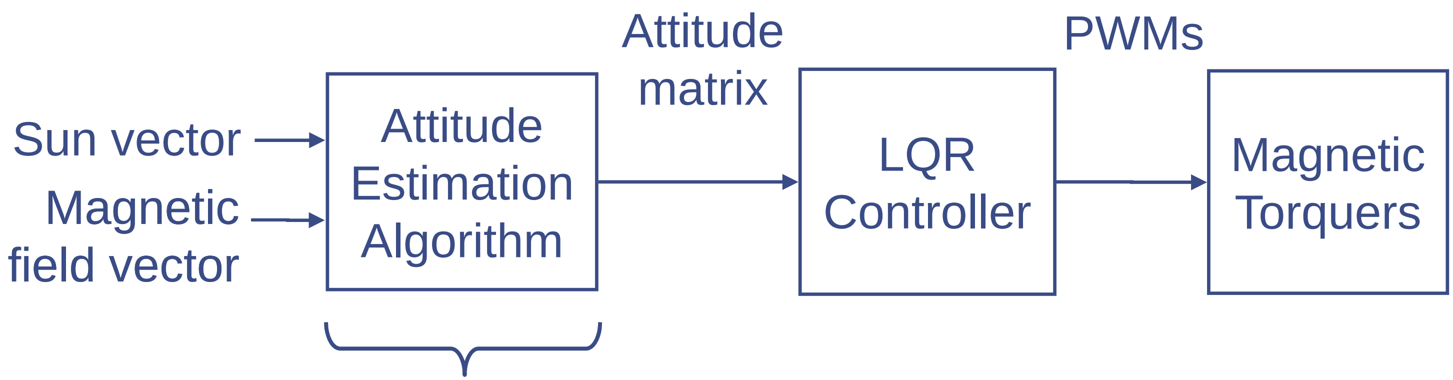
- Very large computational power available
- Low average power consumption



Attitude Determination and Control

- Primary engineering mission:
  - Attitude determination within 1 degree
  - Attitude control within 5 degrees

- Algorithm:



- Matrix / vector multiplications
- Matrix inversions
- Floating point variables

ZMobile DSP System

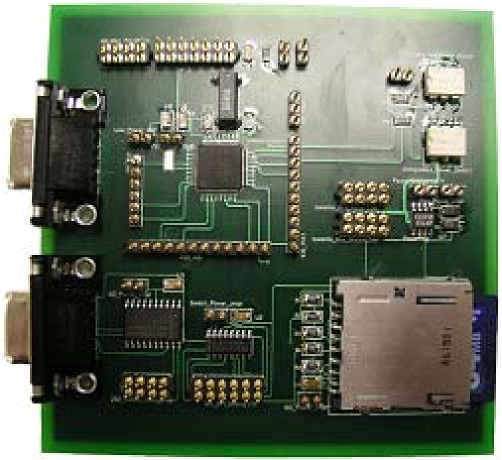
- Zmobile Mixed Signal board from Schmid Engineering:

  - Graphical DSP programming with Embedded LabVIEW
  - Four 14-bit A/D channels
  - Five UARTS
  - Programmable self-shutdown

Host Computer

- Tasks:
  - Generating wakeup signals for ZMobile DSP
  - Generating PWMs to drive torque coils
  - Performing all Command and Data Handling

- Communications On Board system



  - Generic C&DH system from Taylor University
  - Supports I2C, SPI, RS232
  - Based on ultra low-power MSP430

Host Computer

Microcomputer Upgrade:

- MSP430-**1611**
  - 10 KB RAM
  - 48 KB Flash Memory
  - 2.5 mA Supply Current
  - 2 Serial Interfaces

→

- MSP430-**5438**
  - 16 KB RAM
  - 256 KB Flash Memory
  - 1.55 mA Supply Current
  - 4 Serial Interfaces

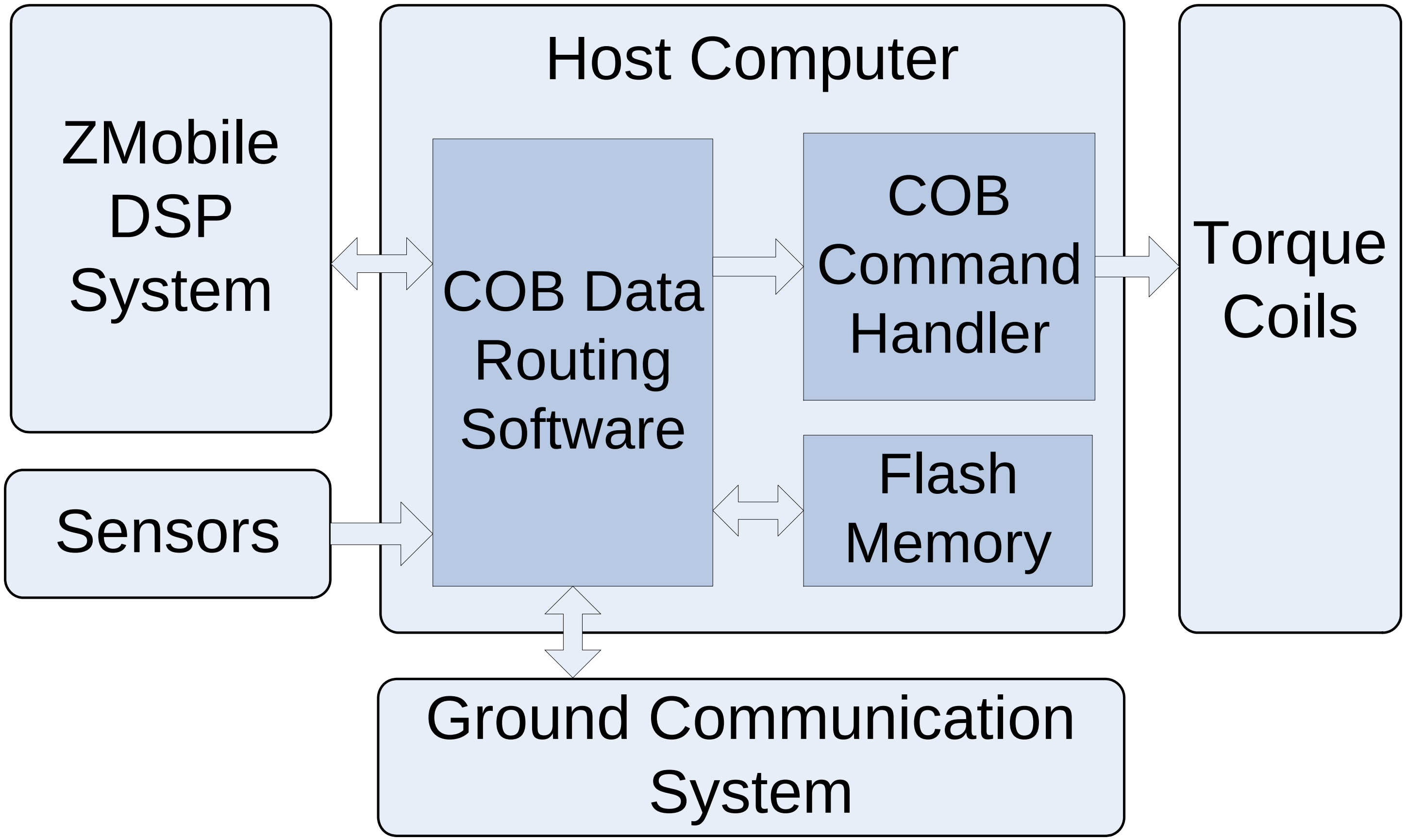
- 6-layer PCB
- 4"x4" board size

→

- 4-layer PCB
- 4"x2.4" board size

System Operation

- Overview
- Attitude D & C
- ZMobile DSP
- Host Computer
- **Operation**
- Results
- Conclusion



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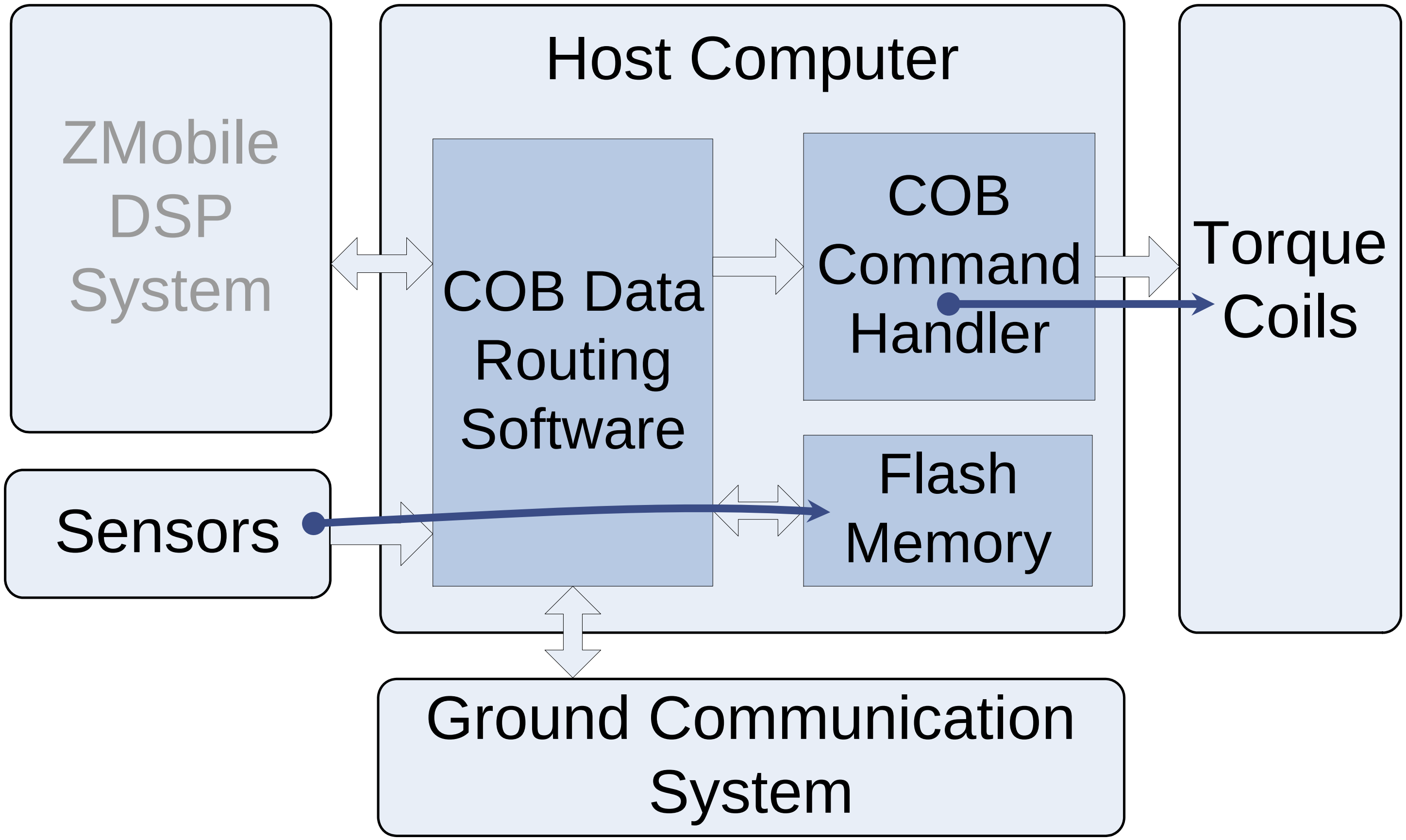

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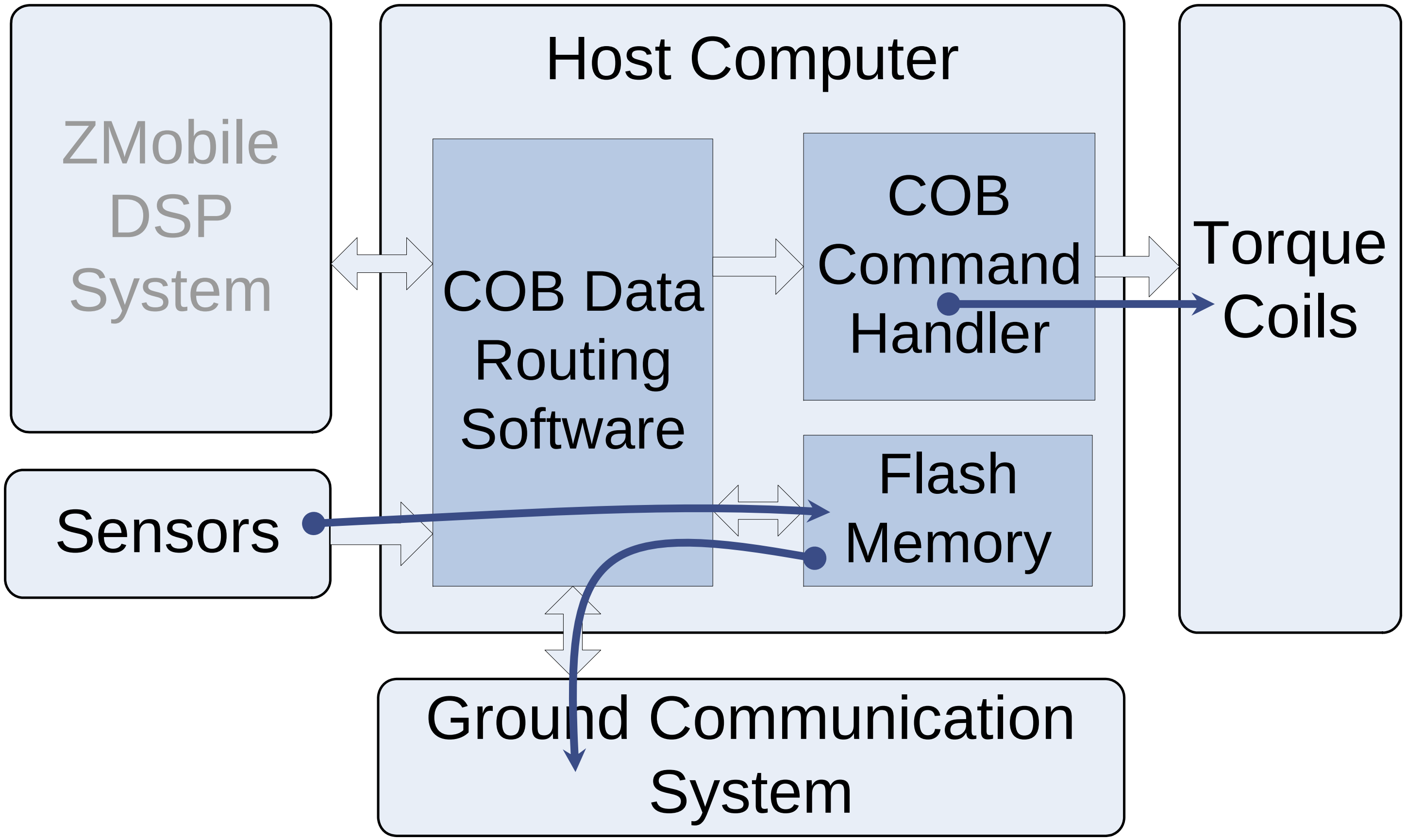

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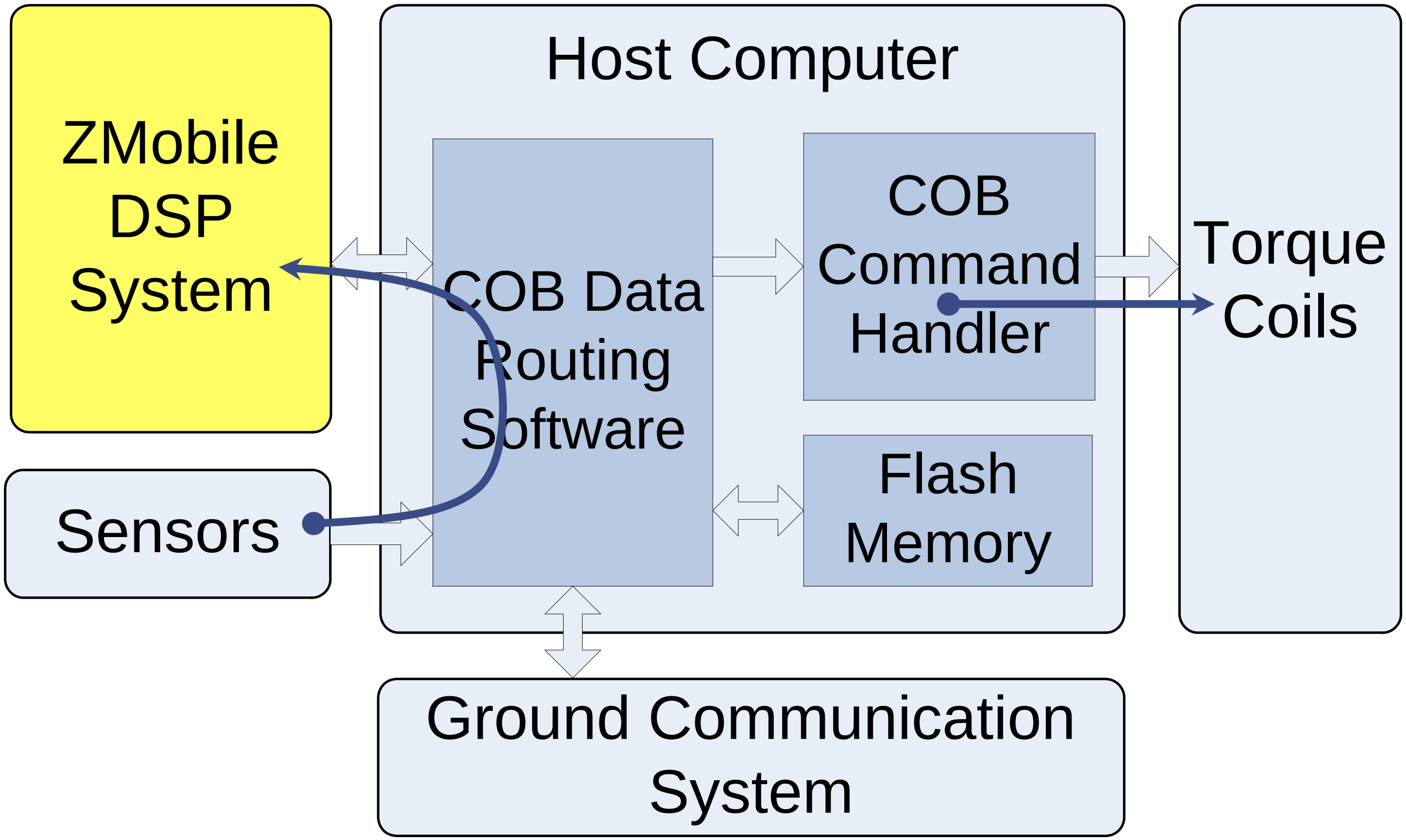

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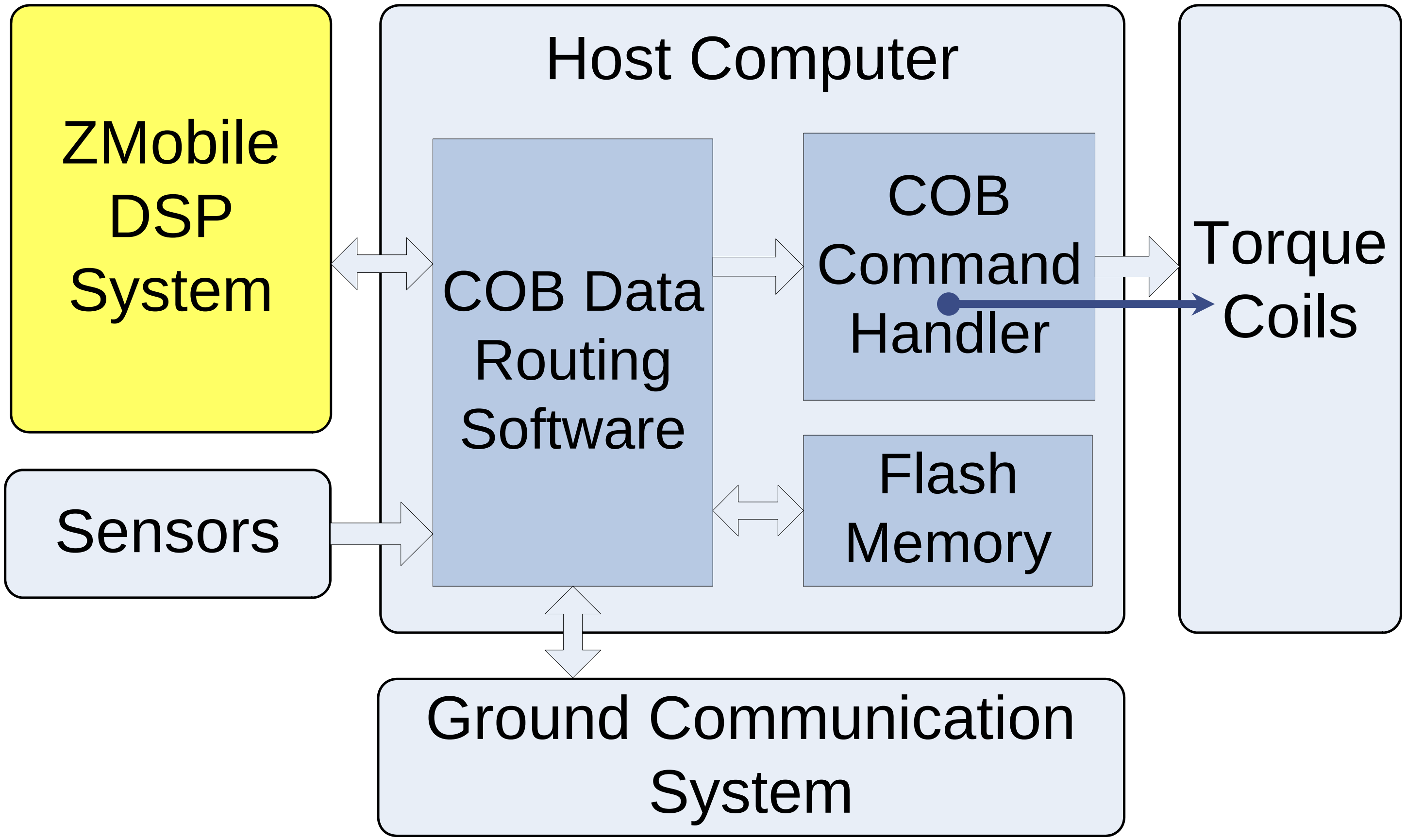

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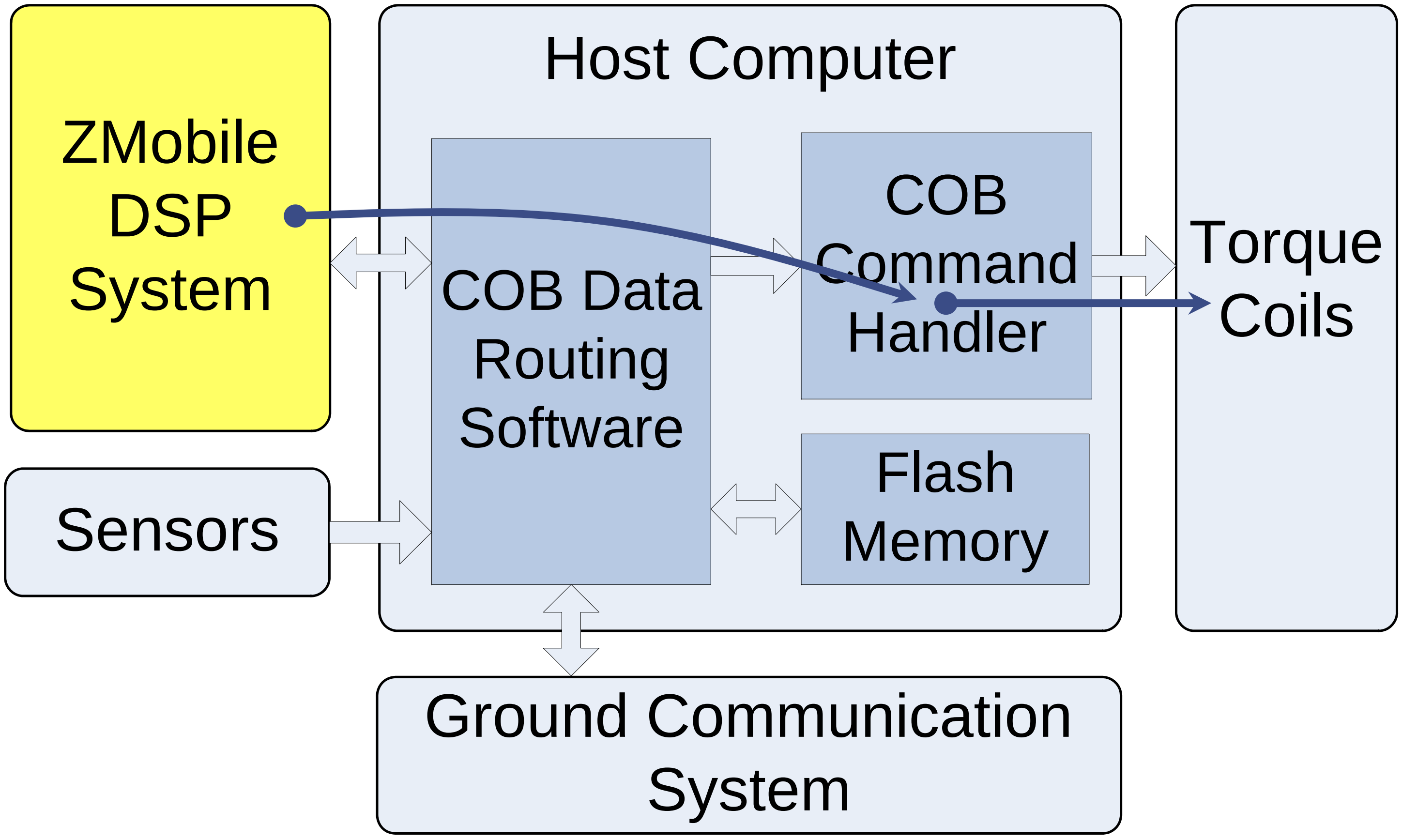

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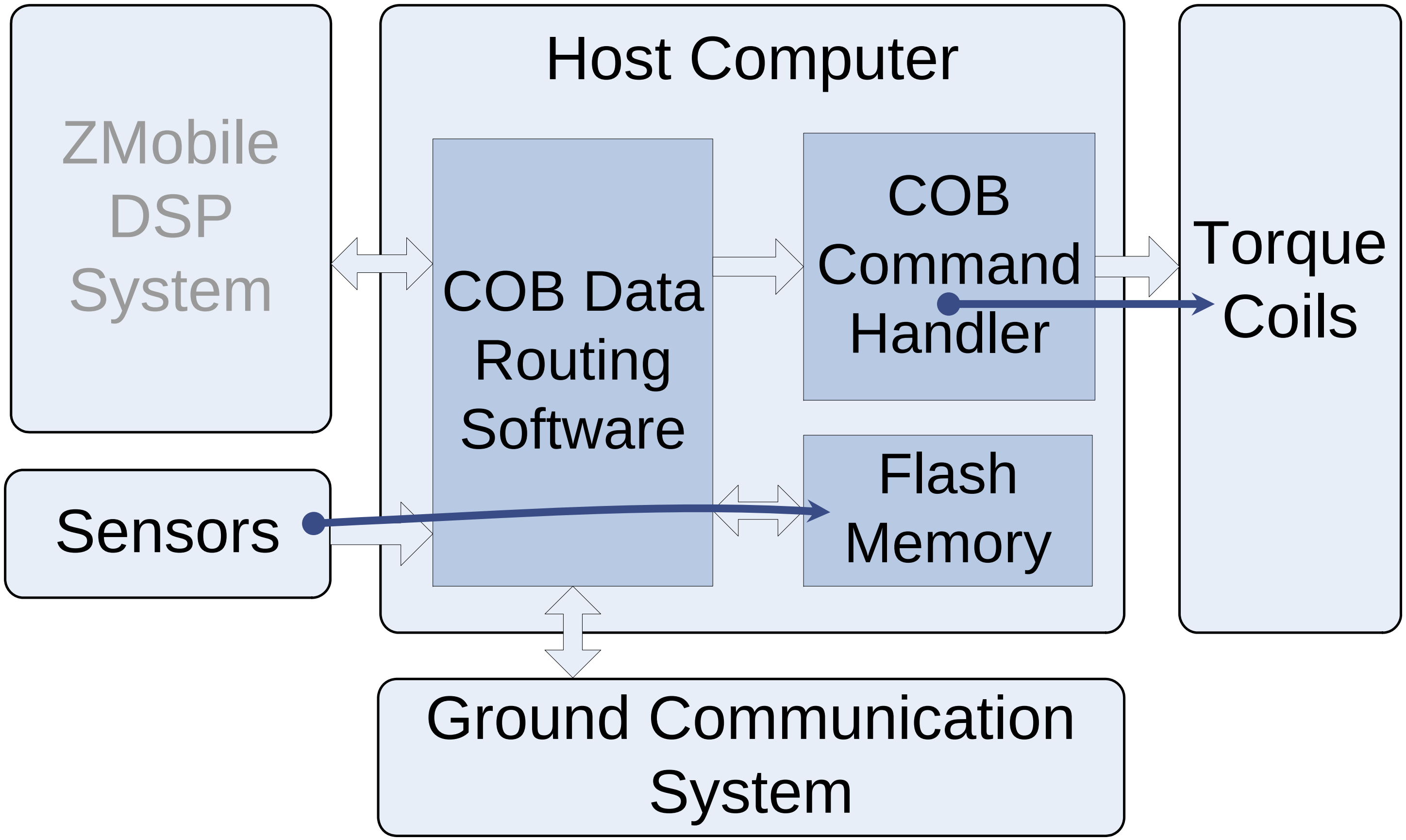

Average Power Consumption

1.0 W * 10% Duty cycle

+

10 mW * 100% Duty cycle

=

< **125 mW**

Design Verification

- ☑ Computational Performance
- ☑ Power Consumption
- ☑ Inter-processor Communication

Nathaniel Colson
ncolson@purdue.edu

Paul Moonjelly
pmoonjel@purdue.edu

Faculty advisor: Prof. David Filmer
filmer@purdue.edu

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