

The Application of Multiple System Integrated technology in Miro-nano Satellite

Lidong Lan

NUAA/MXT





Index

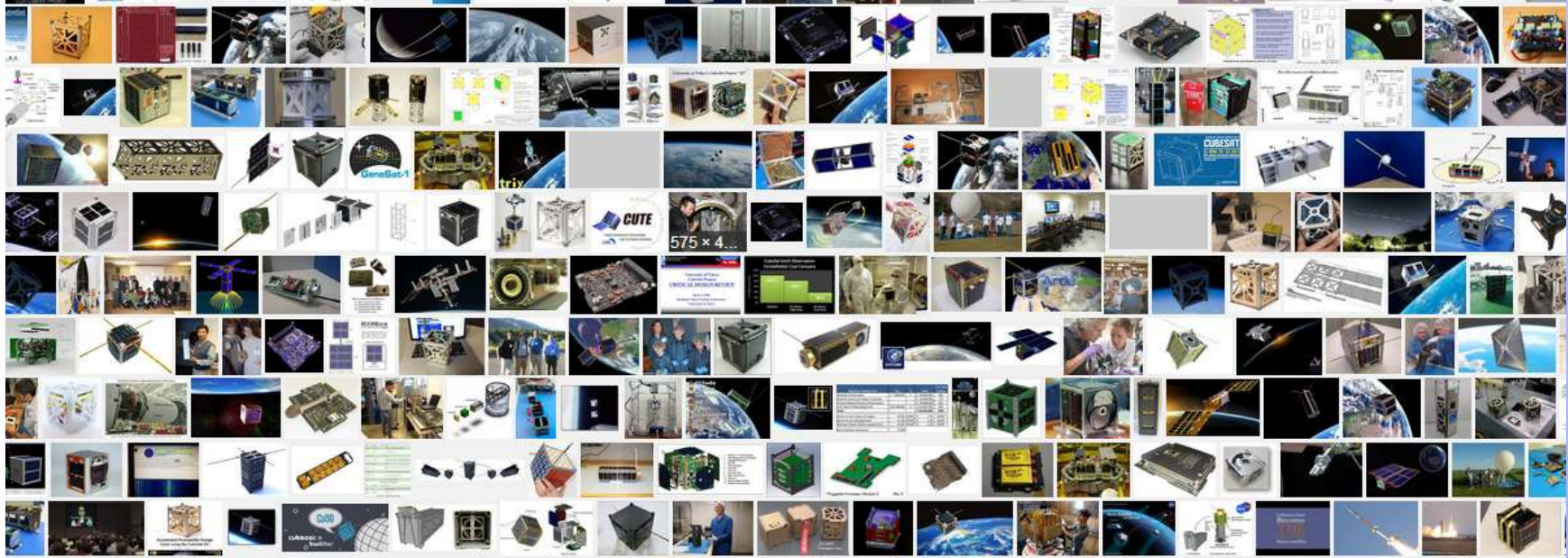
- Integrated technology
- Related work
- implementation
- Application and result
- Conclusion and future work



What is requirement of Cubesat?

- Miniaturization
- Low cost
- standard
- Flexibility

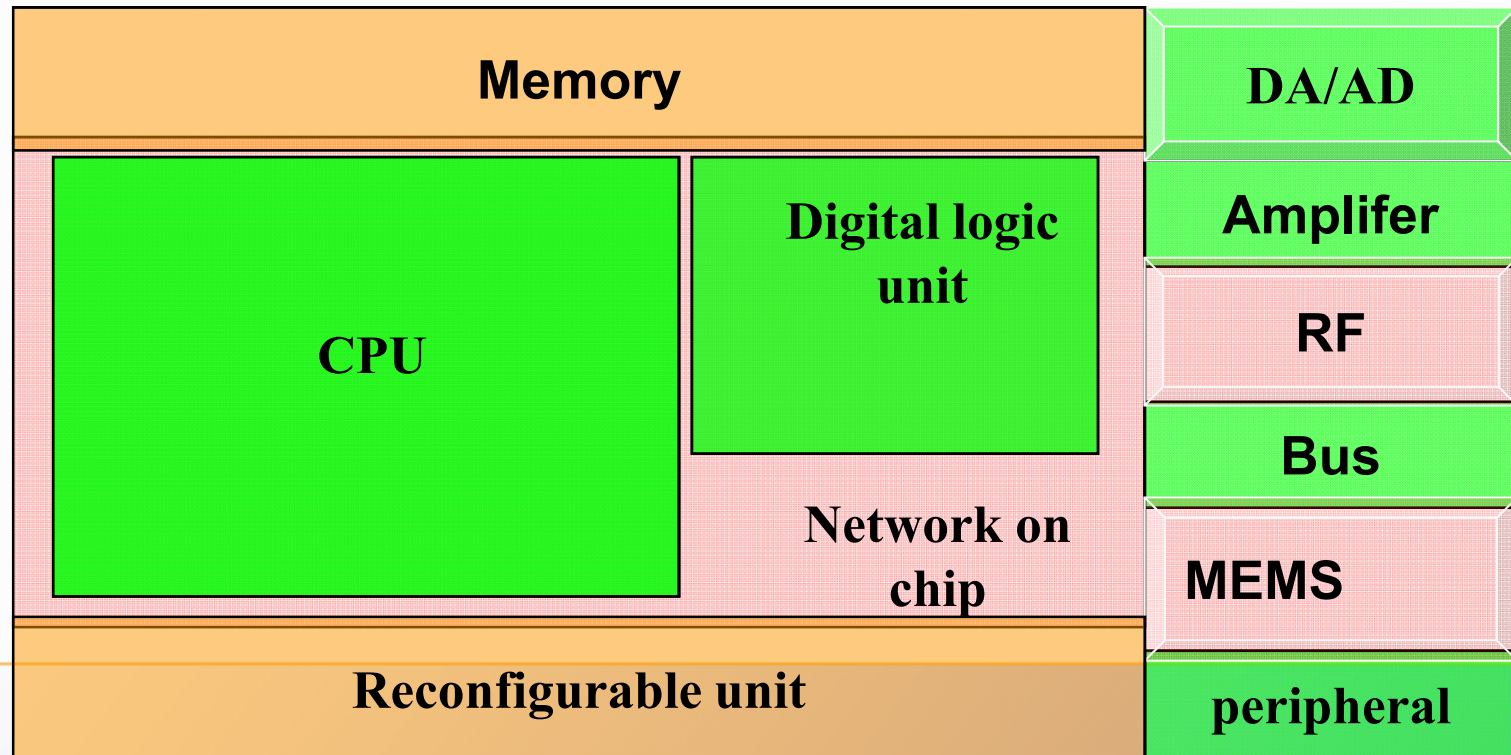
and governments pay loads.





Integrated technology

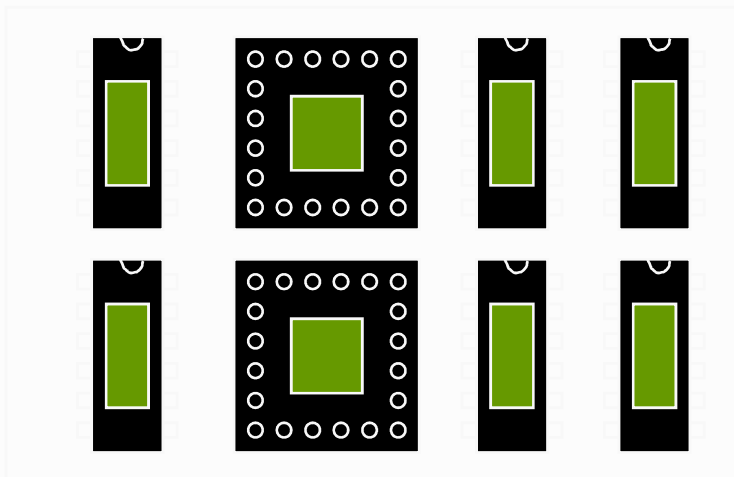
SoC (System on Chip) , high density system chip , which can integrated many homogeneous digital or analogy IP(Intelligent Property)





Integrated technology

MCM (multiple chip module) / SiP (System in Package), high density system chip, which can integrate many heterogeneous digital or analog chips



(a) PCB Implementation (silicon efficiency ~5%)



(b) MCM with bonding wire connection

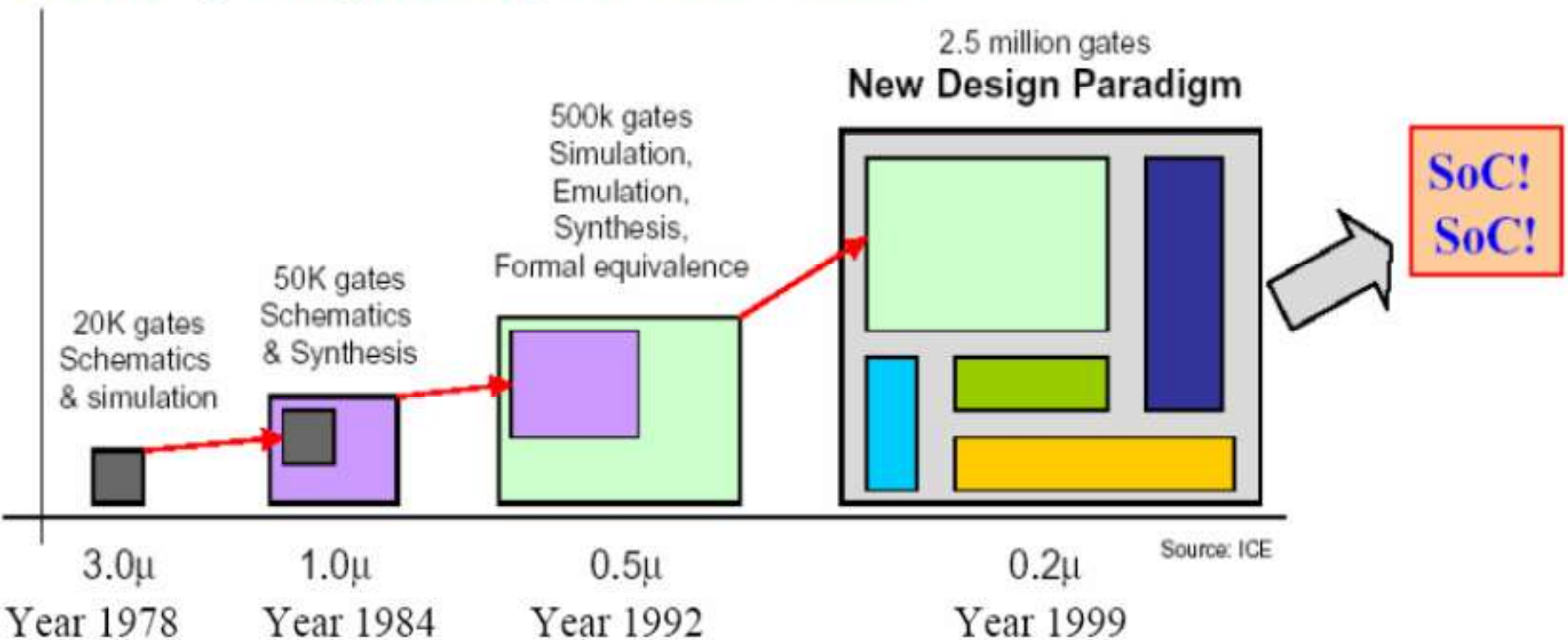
(silicon efficiency >25 %)



Integrated design method

Evolution of SoC

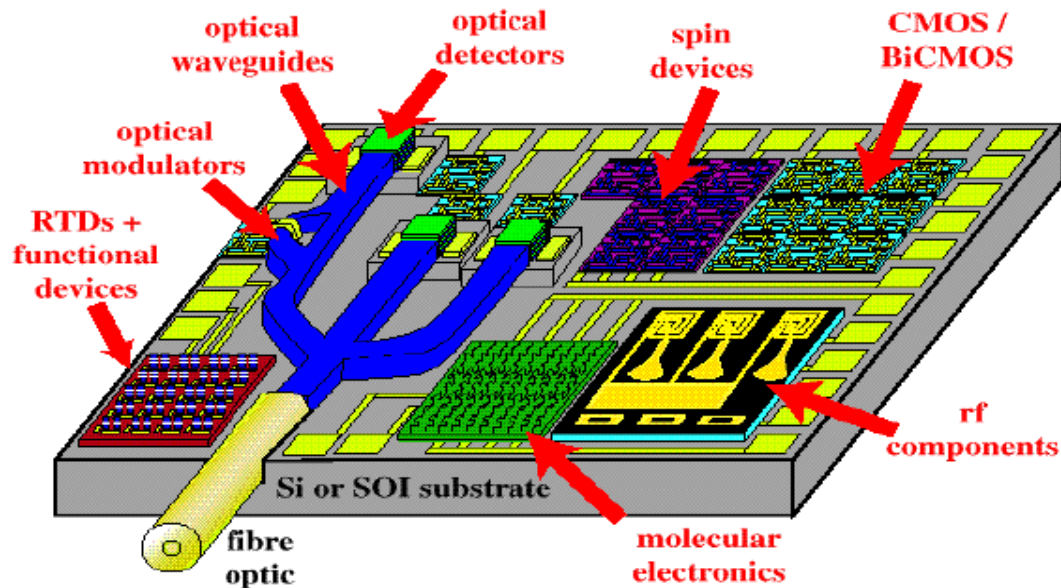
Yesterday's chip is today's function block!





Relative Work

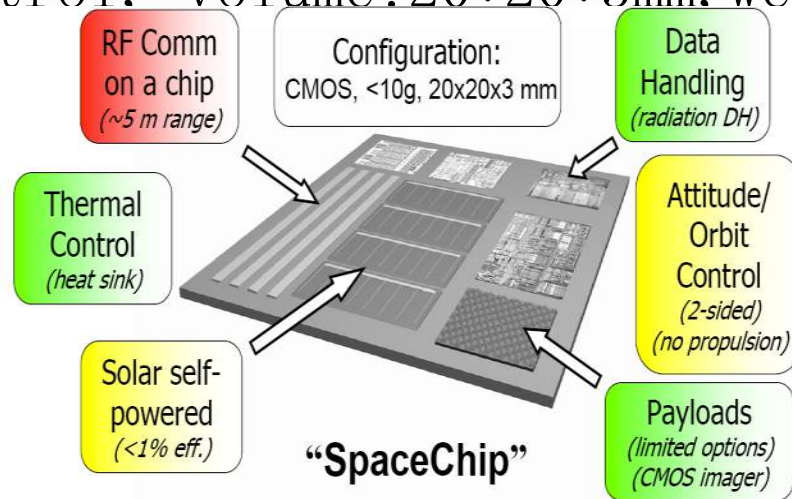
DoD , USA, Plan to integrate digital process, Cmos-sensor, optical waveguides and decoders , RF, and Active module into a one chip





Related Work

Satellite-On-a Chip (SoC) or silicon-Satellite) compose of RF, thermal management, payload, on-board computer and attitude and orbit control. volume: $20 \times 20 \times 3$ mm. weight: 10g

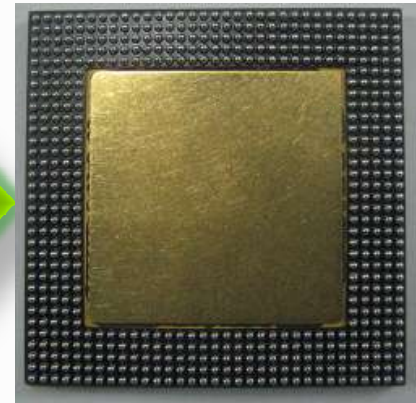
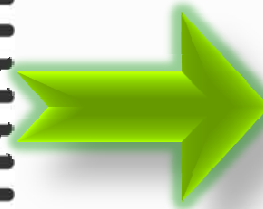
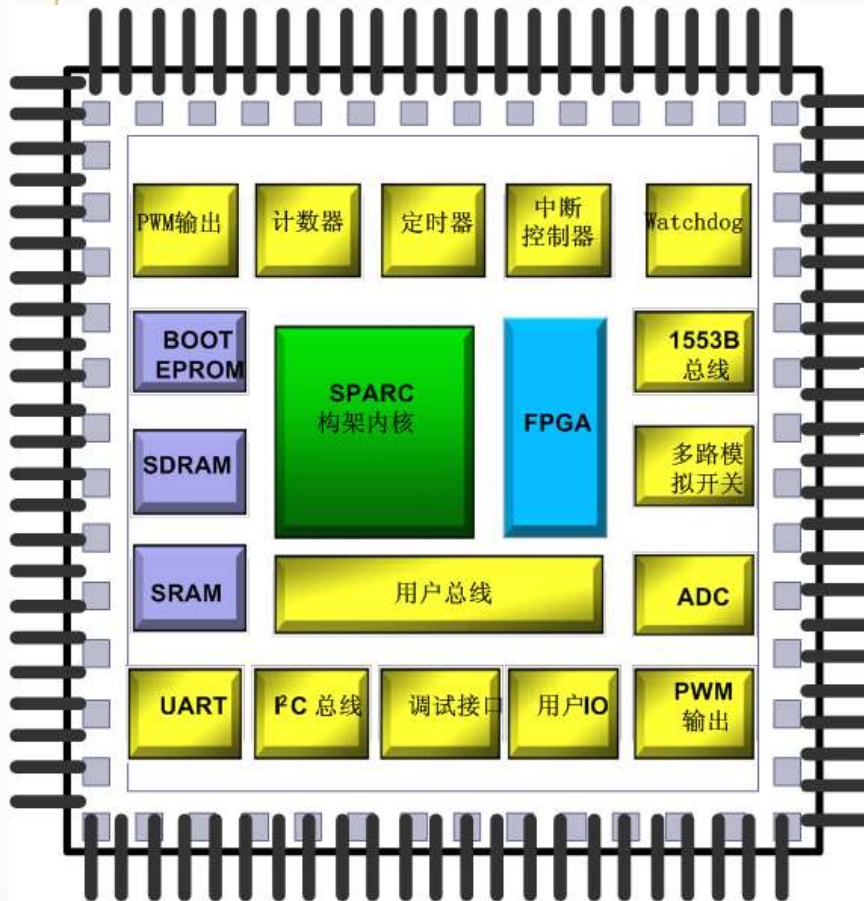


Space Mission Analysis and Design (SMAD)
process used for first-order design



Implementation

- Architecture

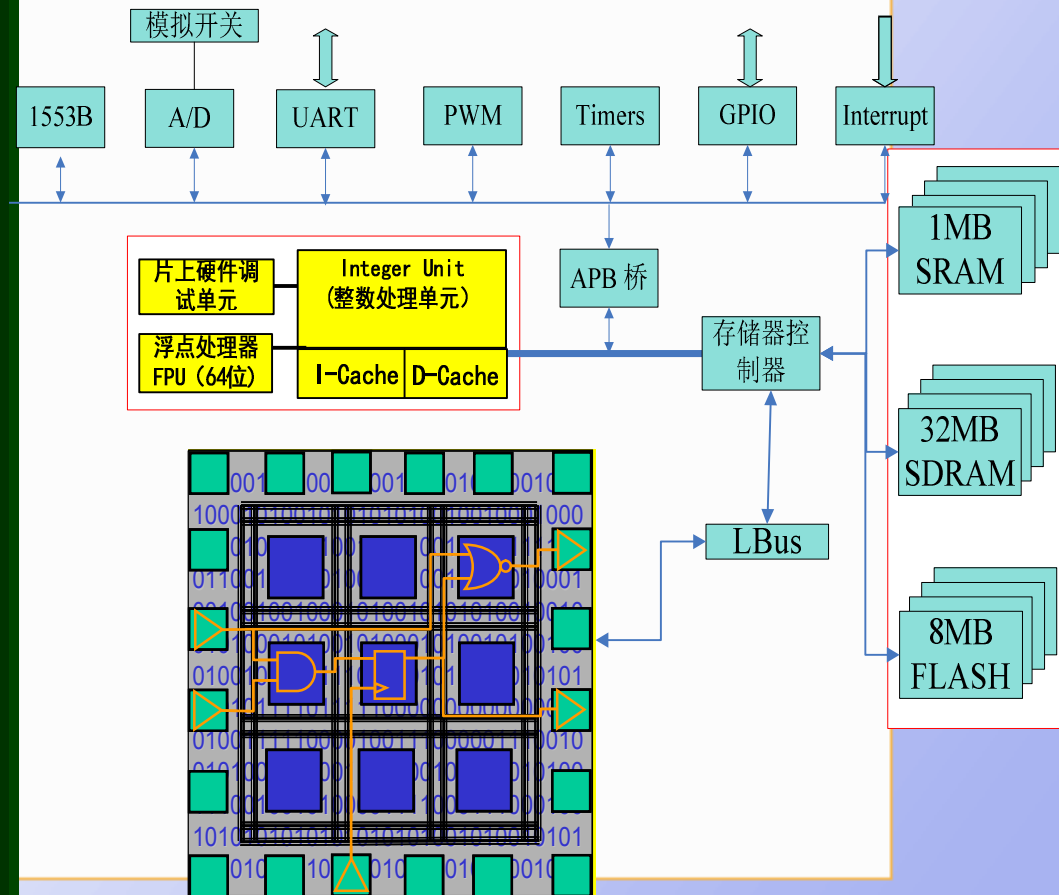




Implementation

Program logic

- 300,000 logic gates
- Frequency:200Mhz
- 16kinds of electric standard
- registers/latches
- Time/clock managerment
- Multi-level memory system
- Temperture monitor
- IEEE 1149.1 boundary scan





Features of SoPC

One chip solution

simplify complexity of PCB design, set program logic and boot processor from one boot-ROM,

High security

improve the security by cryptographic module, protect the software and configure file

Dynamic reconfigure

through bootstrap, permit to modify the configuration in running time and update on line

IDE

support to develop software and hardware in unique editor and co-simulate



Characteristic

voltage:

- I/O : 3.3V +/- 0.30V;
- Kernel:1.8V +/- 0.15V;

Temperature: -45~+85°C / -55~+125°C

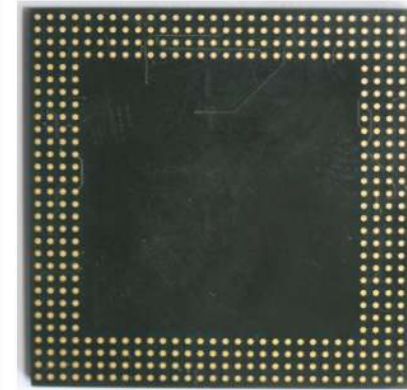
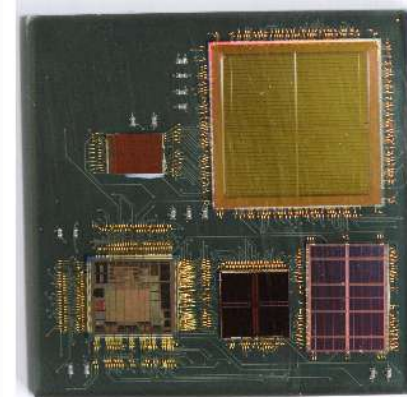
frequency: 1MHz~150MHz

power: 1W/100MHz

Application Set

- Hardware EVB
- Software IDE

Package: PBGA/CPGA, pins:416





Application CubeSat OBC

Computing Unit

133Mhz, 32-bit CPU

SRAM 1MB, SDRAM 16MB, FLASH 8MB,

Satellite Navigation

2-D positional accuracy $< 7\text{m}$

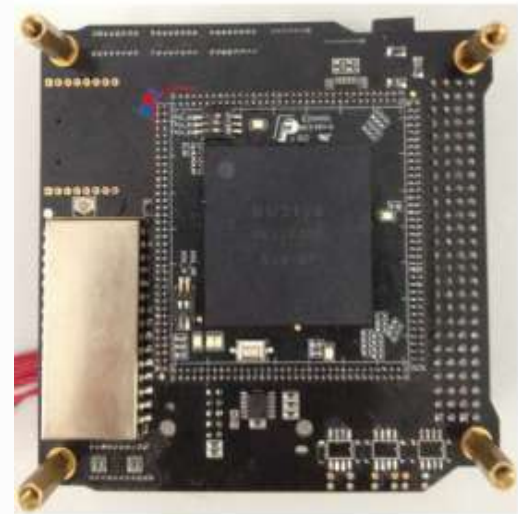
Height accuracy $< 10\text{m}$

Speed accuracy 0.01m/s

惯性导航 Inertial Navigation

Measurement range: $300^\circ / \text{s}$, 30g

Zero offset $13^\circ / \text{s}$, 1mg





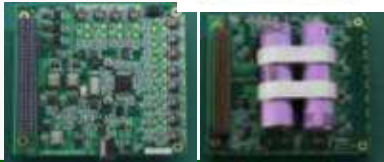
Electronic components for Cubesat

能源 (Power)

Mianline :5V; 3.3V

power: 5600ma.h

Solar plane ,battery and DC



测控 (TT&C)

UHF/VHF

efficiency: 20DBm

Receive sensitivy: -103DBm



结构&温控 (structure)

1U/2U/3U机箱结构

材料: A17075-T651

降服应力: $4.4e+0.08 \text{ N} \cdot \text{m}^2$



综合电子 (OBC&AOC)

high performace

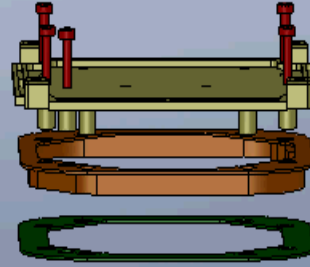
CPU:32bit 120Mhz

GPS L1 (high dynamic range)

position accuracy < 7m

speed accuracy 0.01m/s





Question?

