
Modular Platform Architecture for Small Satellites

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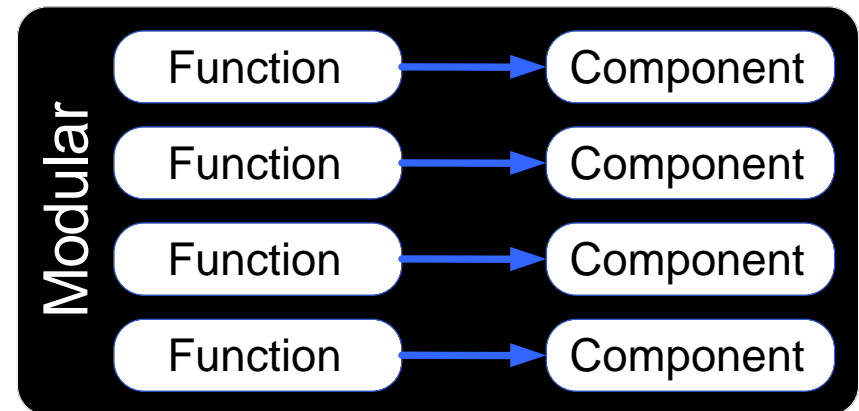
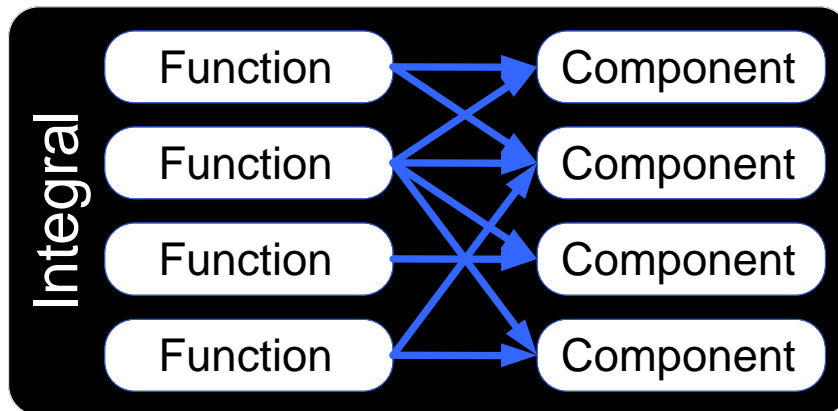


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Architecture Theory

- Product Architecture defines the way product functions are divided into physical components
 - Integral – complex relationship
 - Optimize single point design (performance, cost, etc.)
 - Modular – one-to-one relationship
 - Divide components by function
 - Optimize for family of products

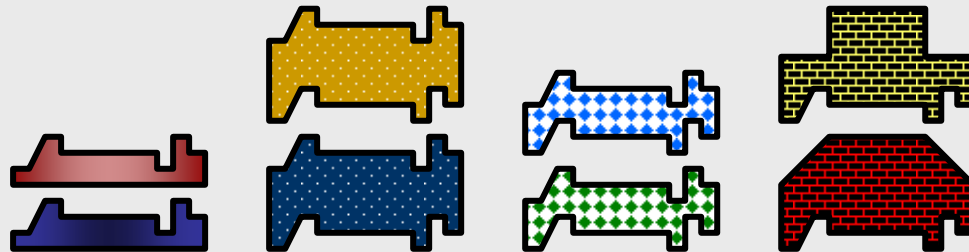


Modular Platform Architecture

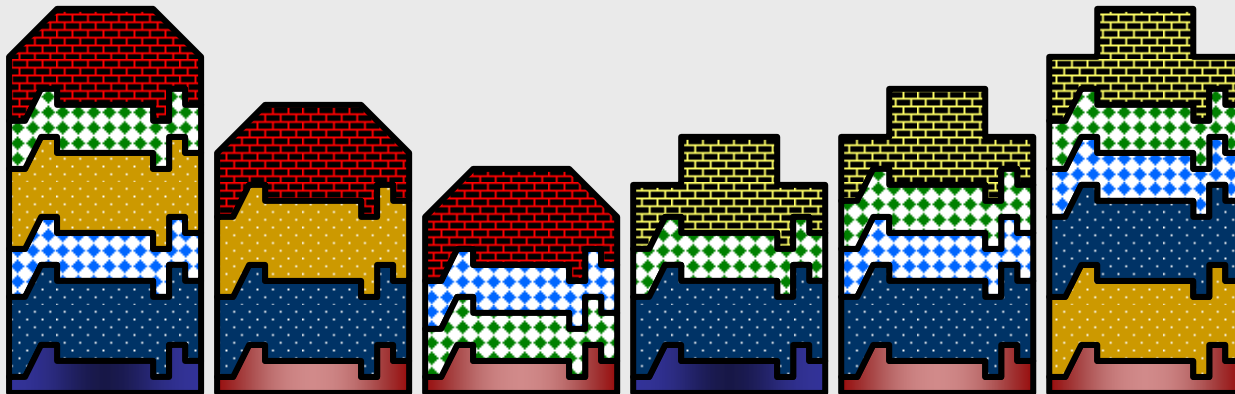
- *Platform* provides framework and modules for core functions
- Changing *modules* provides variation
- Maintains large degree of commonality within a product family or across product generations while allowing variation
 - Distinctiveness customers desire
 - Commonality for cost savings supplier desires

Symbolic Representation

Components / Functional Elements



Module Configurations



Satellite Architecture Selection

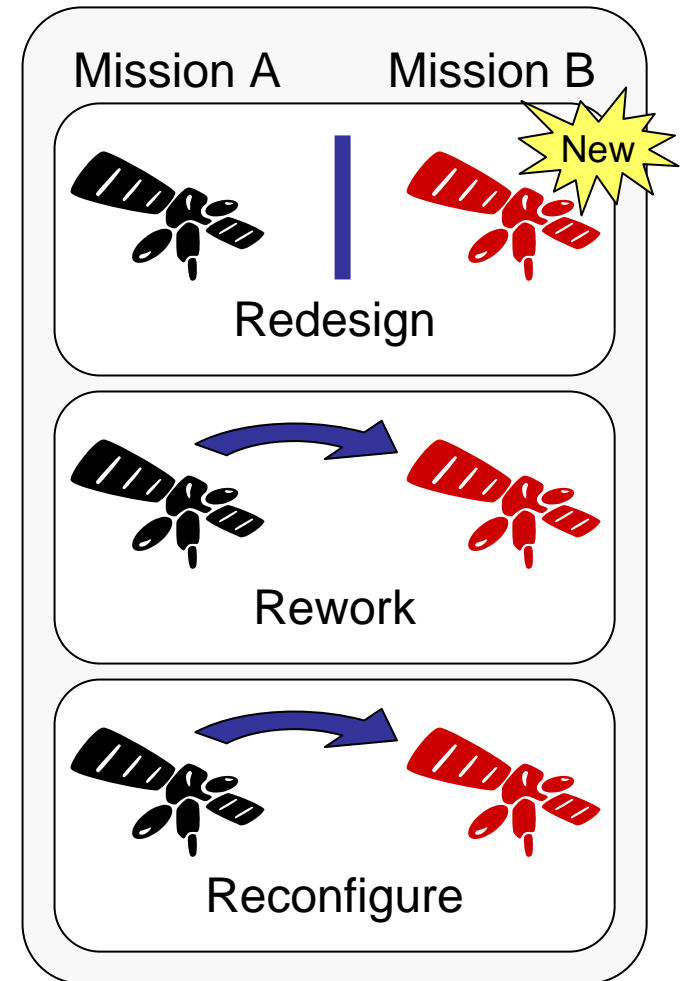
- Balancing goals between supplier, mission, market:

Supplier Goal	Recommendation
Push the technological envelope – develop new capabilities	Integral
Develop single low cost, high performance, custom system	Integral
Develop low cost, configurable system for family of missions	Modular
Increase profitability, reduce lead time and customer cost	Modular

Mission Objectives	Recommendation
Maximize performance	Integral
Minimize size	Integral
Minimize cost for unique, custom mission, or for short term	Integral
Minimize long term cost for family of missions	Modular

Architecture Options

- Traditional Bus
 - Customized mission
 - Customized design
 - Blend COTS and custom components
- “Common” Bus
 - Reuse of existing traditional design
 - Often requires rework for new mission
 - Limited Flexibility
 - Low cost for follow-on units
- Modular Platform
 - Higher initial cost
 - Highly flexible, adaptable, and scalable
 - Lowest follow-on cost for dissimilar missions
 - Few space implementations
 - Eases technology insertion

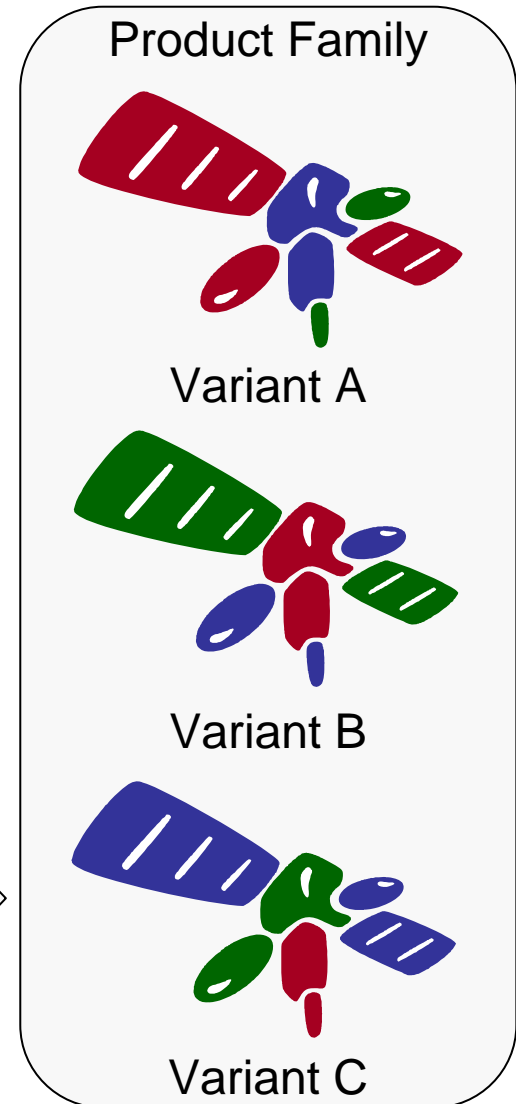
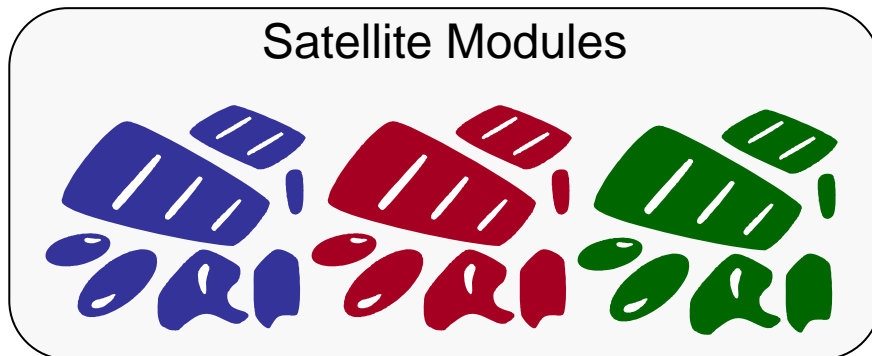


Satellite Platform Implementation

- More than a set of modules
- Requires top-down design for full implementation and benefits
- Key design characteristics
 - Division of functions
 - Minimize interdependencies and coupling
 - Ability to vary modules without affecting system
 - Interfaces
 - Mechanical – physical attachment, transfer of loads, envelope, center of gravity
 - Electrical – distribution of power (unregulated and regulated buses), magnitude of power required (power generation and power storage)
 - Data – data transfer, formats, and interdependencies (software)
 - Thermal – temperature limits, transfer energy (heat), disposal of energy

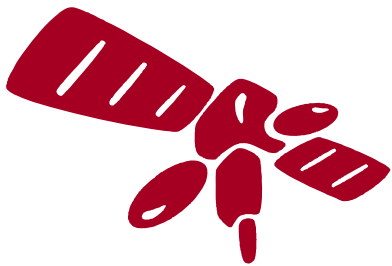
Benefit of Product Family

- A modular platform architecture allows creation of a product family with distinctive variation among concurrent products while sharing many common parts

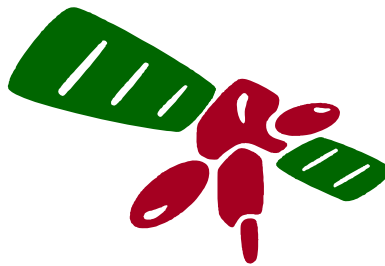


Benefit of Product Generations

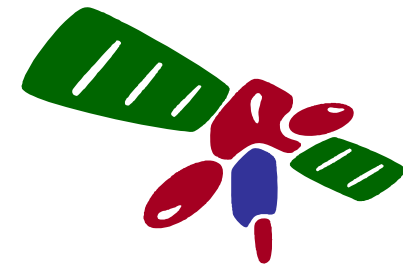
- Successive generations of the product only required incremental changes
 - Reduces time to market
 - Reduces cost (lower NRE for successive generation, fewer new components and procedures)
 - Increases reliability (fewer new components and procedures)



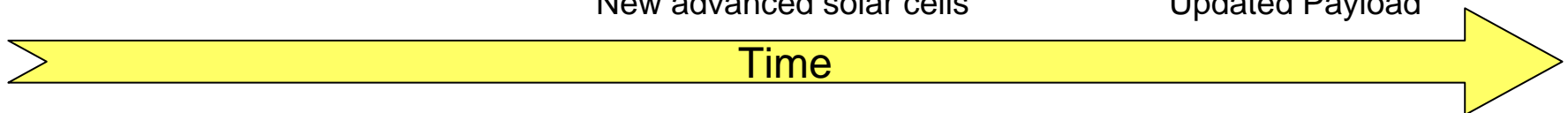
Generation 1



Generation 2
New advanced solar cells



Generation 3
Updated Payload



Cost of Modularity

- General rules of modular vs. integral:
 - More mass
 - More volume
 - More capable components than required
- Why?
 - Designing to standard interfaces (can't achieve last bit of performance optimization)
 - Designing to multiple missions

Applicability

- There are missions that:
 - Focus on lower cost (cheap access to space) more than optimized performance (pushing the envelope)
 - Require shorter development schedules
- This type of mission is a principle focus of small satellites

USU/SDL Modular Platform

- Developed Design Reference Missions (DRMs):
 - Communications (store and forward)
 - Remote sensing (imaging of earth)
 - Science (atmospheric science)
 - Technology demonstration
 - Rendezvous
 - Responsive Space (quick configuration, launch, activation)
- Developed Platform design applicable to all 6 DRMs
 - LEO
 - ESPA-class micro-satellite
 - 62 to 132 kg, depending on mission configuration



Questions?