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# Small Sats Getting Big Boost from Reliable, Cost-effective COTS



# Agenda

- Trends within the Small Satellite Industry
- Increased Reliance on COTS for These Programs
- New Series 300 Qualification & Mil-aero to Space Migration
- AI Reshaping the Space Industry: introducing the S-A1760
- Best practice: 3 NEO/LEO orbit programs examples
- Aitech Capabilities Overview

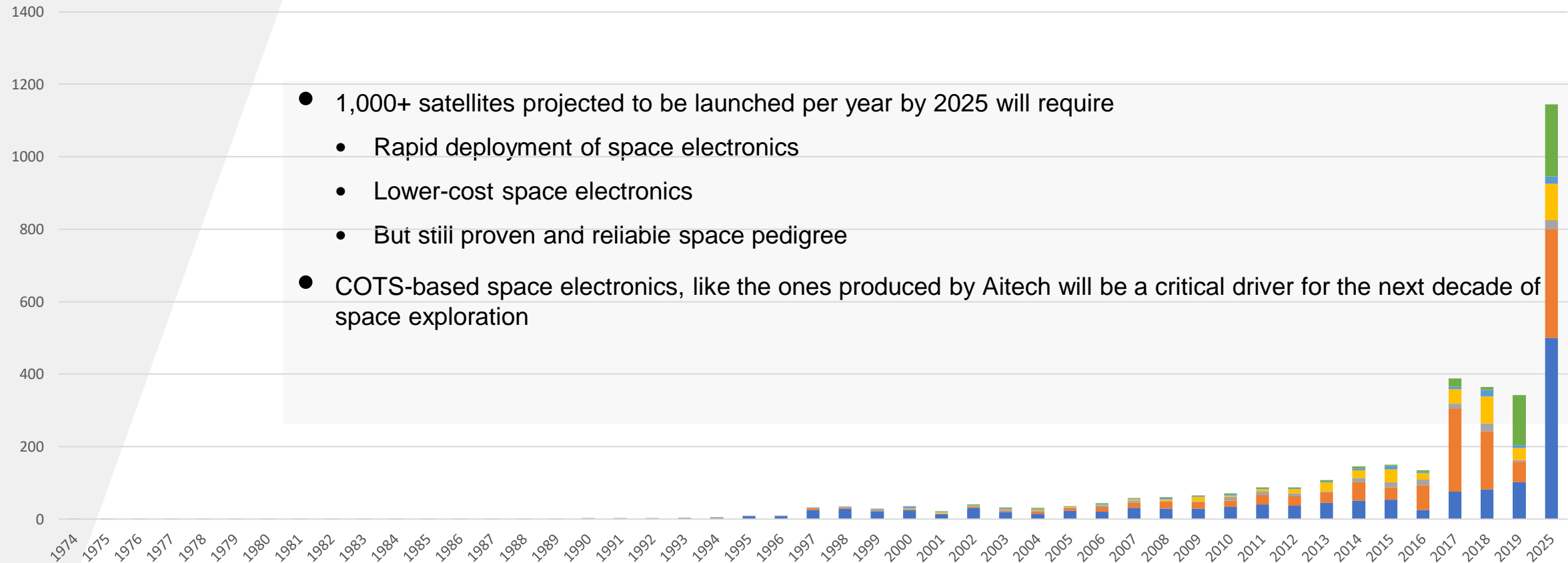
## Space Market Trends

# Entering the Small Sat Space Boom



- Companies are buying subsystems, not just modules or boards, to improve vertical satellite integration.
- Need for increased digital platforms in multiple satellite subsystems.
- Requests for faster processing, more I/O, better integration, early delivery, higher volumes, etc.
- Systems must still withstand the rigors of launch and the space environment:
  - Radiation effects
  - Fixed downlink throughput or bandwidth demands
- Cost-to-performance ratios are top priority

# The Next 10 Years Will not look like the last 10 years



- 1,000+ satellites projected to be launched per year by 2025 will require
  - Rapid deployment of space electronics
  - Lower-cost space electronics
  - But still proven and reliable space pedigree
- COTS-based space electronics, like the ones produced by Aitech will be a critical driver for the next decade of space exploration

Source: MIT Technology Review

# Why COTS in Space is a Growing Trend

Delivery timetables tightening: development hardware sometimes needed in as little as six months, and flight units within a year.

Building space electronics centers on mitigating risk:

Risks vary based on each mission unique:

- Reliability
- Mission duration
- Orbit location and inclination
- Type of orbit
- Manned or unmanned, etc.

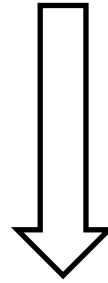


COTS are providing proven rugged, reliable electronics to help satellites last longer, to make space vehicles go farther.

# COTS for Digital Space Electronics

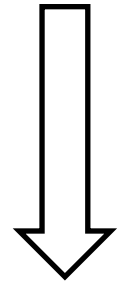
**Affordable**

Up to **90%** cheaper than  
Custom



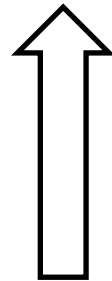
**Low Risk**

Immune to radiation greater than  
**65 MeV-cm<sup>2</sup>/mg**



**Reliable**

**Decades** of flight pedigree  
over Custom



**Rapid Deployment**

Flight ready systems in  
**months, not years**



# COTS Facilitates Digital Technology Adoption

## Faster Deployment

- Ready in months, not years
- Combine boards and components for custom solutions



## Proven Reliability

- Moving from military to space electronics
- Decades of demonstrated solutions



## Lower Risk

- Tested and qualified
- Different mission profiles

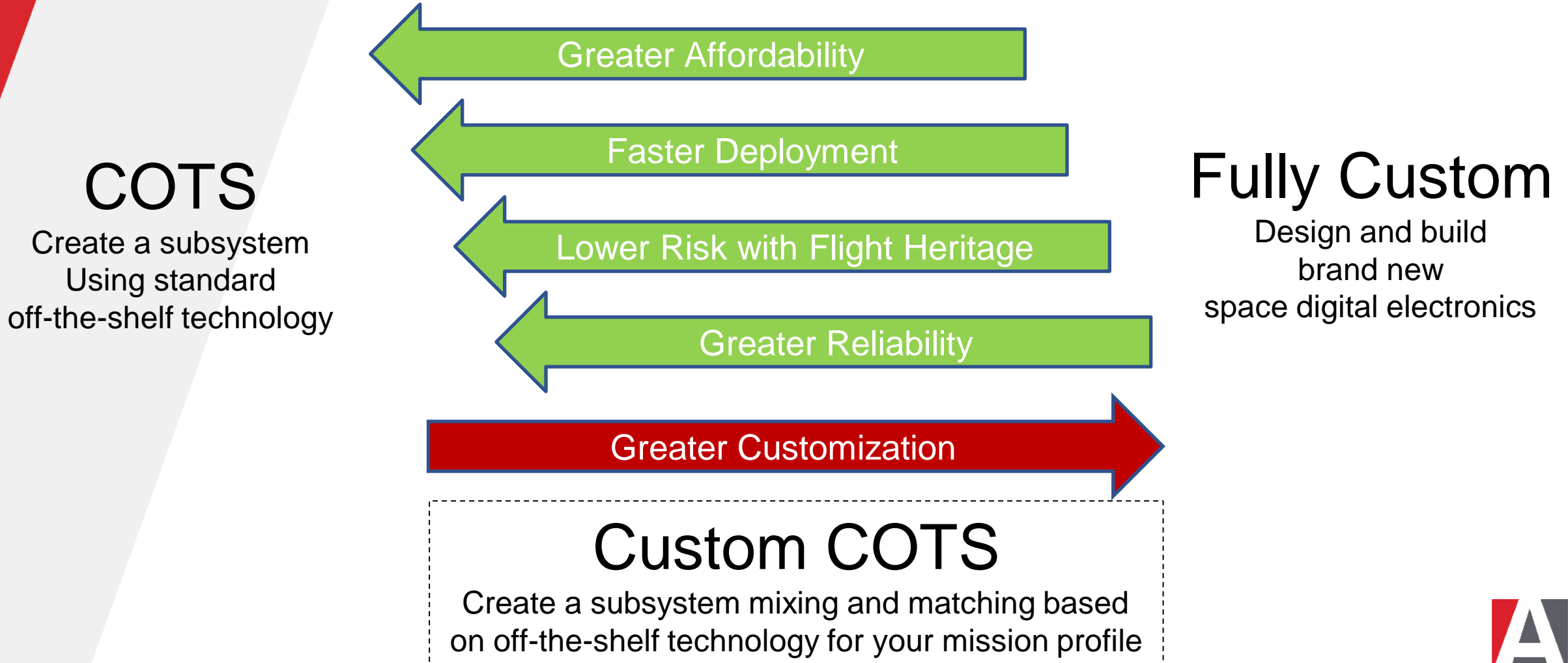


## Affordability

- Lower NRE
- Modular systems for easy scalability



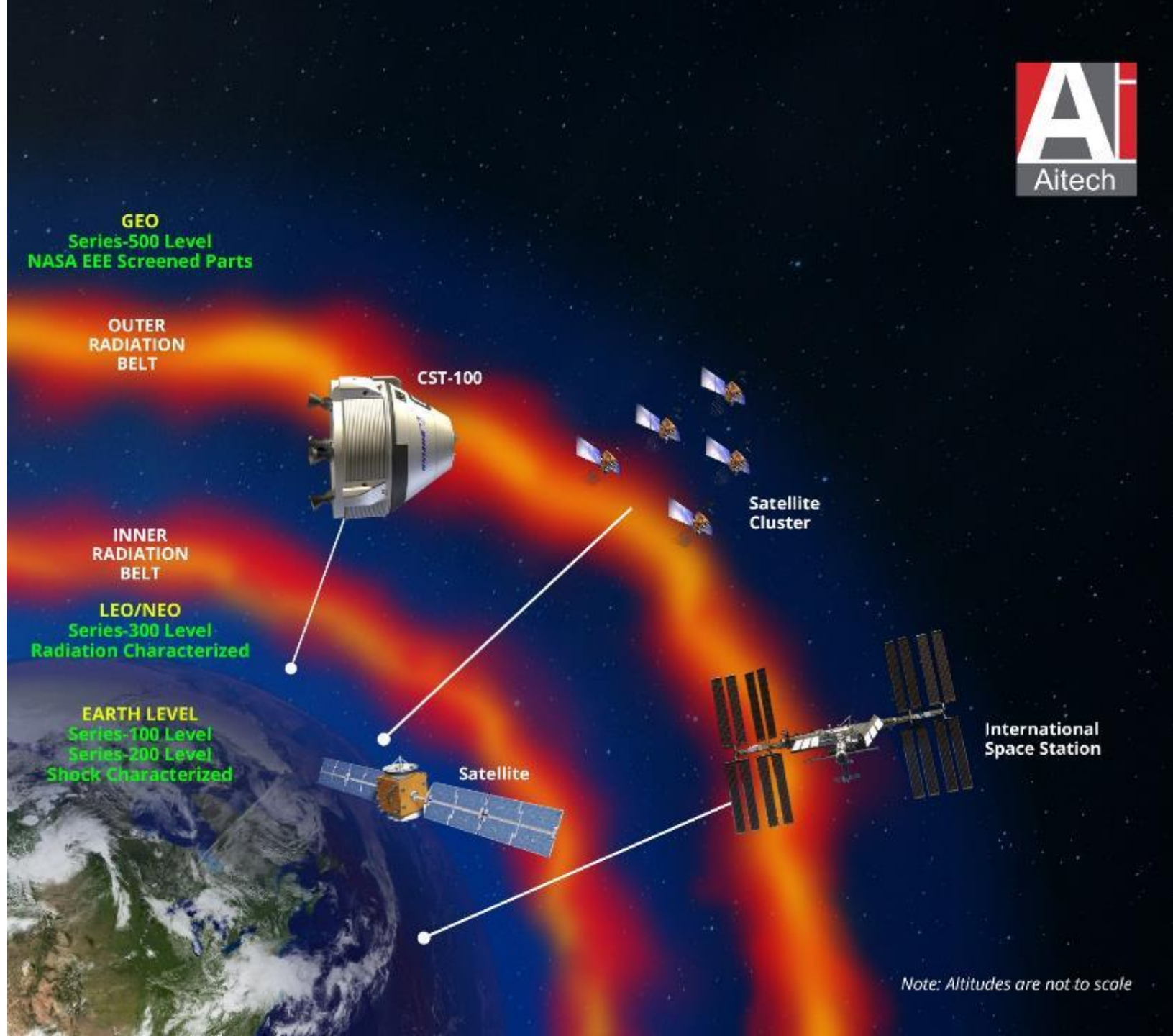
# Finding The Ideal Balance for Space Digital Electronics





# Aitech Space Products for All Missions

The use of COTS has become a necessity to meet the cost, time to market and integration requirements mandated in newer NEO/LEO space applications.



# New Qualification Level from Aitech

Bridges the gap between low level testing and expensive fully qualified components

Provides cost-effective COTS for today's lower orbit and short duration space missions

## Series-300 Level for NEO & LEO Space Applications

Table 1: Series-300 Level Parameters for LEO & NEO Space Application

Parameter	SERIES 100 Development/Lab	SERIES 200 Test Flight	SERIES 500 Flight: Beyond LEO	SERIES 300 (Flight: NEO & LEO)
<b>Cooling Method</b>	Convection	Conduction <sup>1</sup>	Conduction <sup>1</sup>	Conduction
<b>Temperature (°C)</b>		(In air)	(In vacuum)	(In vacuum)
Storage	-40°C to +85°C	-50°C to +100°C	-62°C to +125°C	-62°C to +125°C
Operating	0°C to + 55°C	-40°C to + 71°C	-40°C to + 65°C	-40°C to + 65°C
<b>Vibration (3 axes)</b>				
Random (Freq)	0.02g (20-2000Hz)	0.01g (0-2000Hz)	0.01g (0-2000Hz)	0.01g (0-2000Hz)
Sine (Freq)	2g (10-100Hz)	10g (0-500Hz)	10g (50-500Hz)	10g (50-500Hz)
<b>Shock (3 axes)</b>				
Half Sine G (duration)	20g (6ms)	40g (11ms)	40g (11ms)	40g (11ms)
Saw Tooth G (duration)	20g (6ms)	100g (6ms)	1000g (6ms)	1000g (6ms) [SRS]
<b>Altitude (ft)</b>				
Operating Max	15,000	70,000	10 <sup>-4</sup> Torr	10 <sup>-3</sup> Torr
<b>Relative Humidity</b>				
Operating	0-90%	0-100%	0-100%	0-100%
<b>Conformal Coating</b>	Optional	Acrylic Silicone	Urethane	Arathane 5750
<b>Part Selection</b>	Commercial	Unscreened	EEE-INST-002 Level 2 or higher by lot	COTS with no screening
<b>Radiation Tolerance</b>				
TID			> 25 krad (Si)	> 1.5 krad (Si) <sup>2</sup>
Latch up immunity	Not Applicable	Not Applicable	≥ 37 MeV·cm <sup>2</sup> /mg	Mitigated
SEU rate [ISS Orbit]			One Type-2 SEFI per 1,200 days at ISS orbit	One Type-2 SEFI per 14 days at ISS orbit

**NOTE:**

Conduction-cooled per ANSIVITA 30.1 - 2008 3U cPCI Mechanical Format Factor, Conduction-cooled PMCs: per ANSI/VITA 20-2001 (R2005)  
Aitech had characterized the TX2i module in proton irradiation with final characterization to be done for updates at the box-level characterization later in 2021

# Next Level of AI GPGPU in Space Applications

**Aitech's S-A1760 Venus™**: most **powerful and smallest** space AI GPGPU in small form factor (SFF). Suitable for the next gen of short duration spaceflight, NEO and LEO.



**Aitech S-A1760 Venus™ Radiation-characterized Space AI GPGPU**

Based on NVIDIA® Jetson™ TX2i SoM



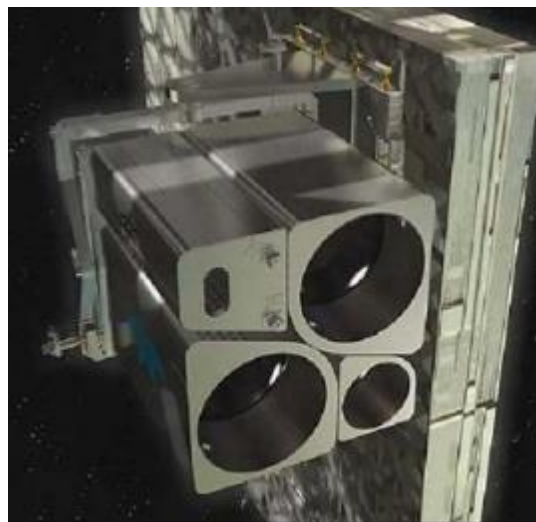
## KEY PRODUCT INSIGHTS

NVIDIA Jetson TX2i SoM, 1 TFLOPS, 60 GFLOP/W	Linux OS pre-installed
Pascal™ architecture, GPU with 256 CUDA® cores	Dimensions: TBD Weight: TBD
2 Dual-core ARM® CPU + Cortex®-A57 Quad-core ARM CPU	11-36 VDC input voltage range, 8-10W under typical CUDA load (20W fully utilized)
8 GB LPDDR4, 128-bit interface, TX2i @ 1,600 MHz w/ECC	EMI/RFI per MIL-STD-461, vibration and shock per VITA 47
I/O: Gigabit Ethernet, DVI/HDMI out, CANbus, USB 2.0, discretes, UART Serial, composite in, SDI In	TID >1.5 krad (Si), watchdog mitigated, no more than one Type-2 SEFI per 14 days at ISS orbit

**Note:** Aitech has characterized the TX2i module in proton irradiation with final characterization to be done for updates at the box-level characterization later in 2021.



# Multi-User System for Earth Sensing (MUSES) Earth Imaging at International Space Station (ISS)



## Mission Profile – ISS

### Aitech Products

- SBC
- Memory Board
- Firewire
- GbE Switch
- 1553 Interface
- CompactPCI Enclosure

Launch Date

June 2017

Current Status

Operational

## Building MUSES' COTS-based C&DH System



Aitech SBC



Aitech  
Memory Board



Aitech  
Firewire Board



Aitech GbE Switch



Aitech  
1553 Interface



Aitech Enclosure &  
Power Supply



MUSES'  
Semi-Custom  
C&DH  
System

# Rocket Motor Controller

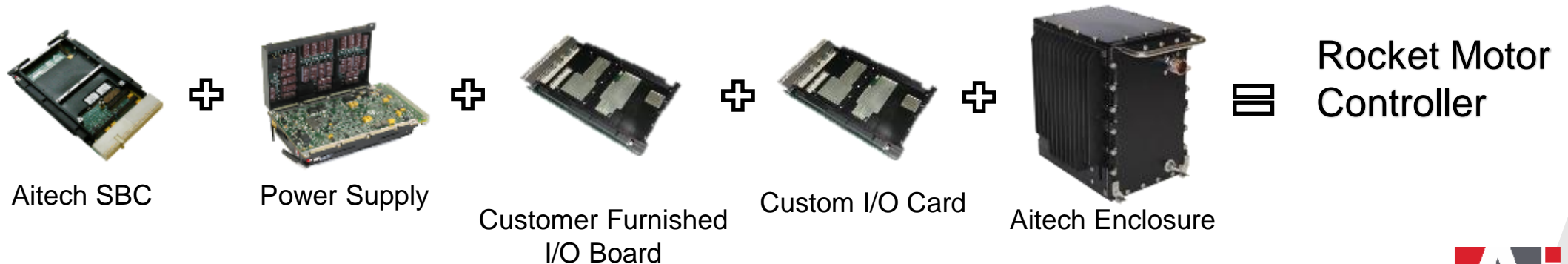
## Space Tourism with Virgin Galactic SpaceShipTwo



### Mission Profile – SpaceShipTwo Rocket Motor Controller

Aitech Products	<ul style="list-style-type: none"><li>• SBC</li><li>• I/O Boards</li><li>• One customer furnished board</li><li>• Power Supply</li><li>• CompactPCI Enclosure</li></ul>
Launch Date	Latest in 2021 with tourists
Current Status	Operational

COTS with Custom I/O Boards and a Customer-Furnished Board in a System for Mission Critical Applications



# Low-Earth Orbit Flight Test of an Inflatable Decelerator (LOFTID) Cross-Cutting Aeroshell for Atmospheric Reentry



## Mission Profile – ISS

### Aitech Products

- General Purpose GPU
- Integrated I/O and Power Carrier
- Small Form Factor Enclosure

### Launch Date

Q1 of 2022

### Current Status

Demonstration flight is scheduled

Next Generation High Performance Radiation Tolerant Computing for Space Systems



**Aitech S-A1760 Venus™ Radiation-characterized  
Space AI GPGPU**

Based on NVIDIA® Jetson™ TX2i SoM



## COTS Flight Pedigree

# COTS in Space Begins on April 5th, 1990

...Orbital Sciences Corporation (OSC) launches two satellites aboard Pegasus launch platform with Aitech's Flight Control and Navigation Computer based on COTS VME boards.

“Pegasus took an off-the-shelf computer with minimum modifications and applied it to a very demanding application, thereby obtaining a product very fast at very low costs”

– Pegasus Supplement in AW&ST September 3<sup>rd</sup>, 1990 issue





# 30 Years of COTS Flight Pedigree with Aitech

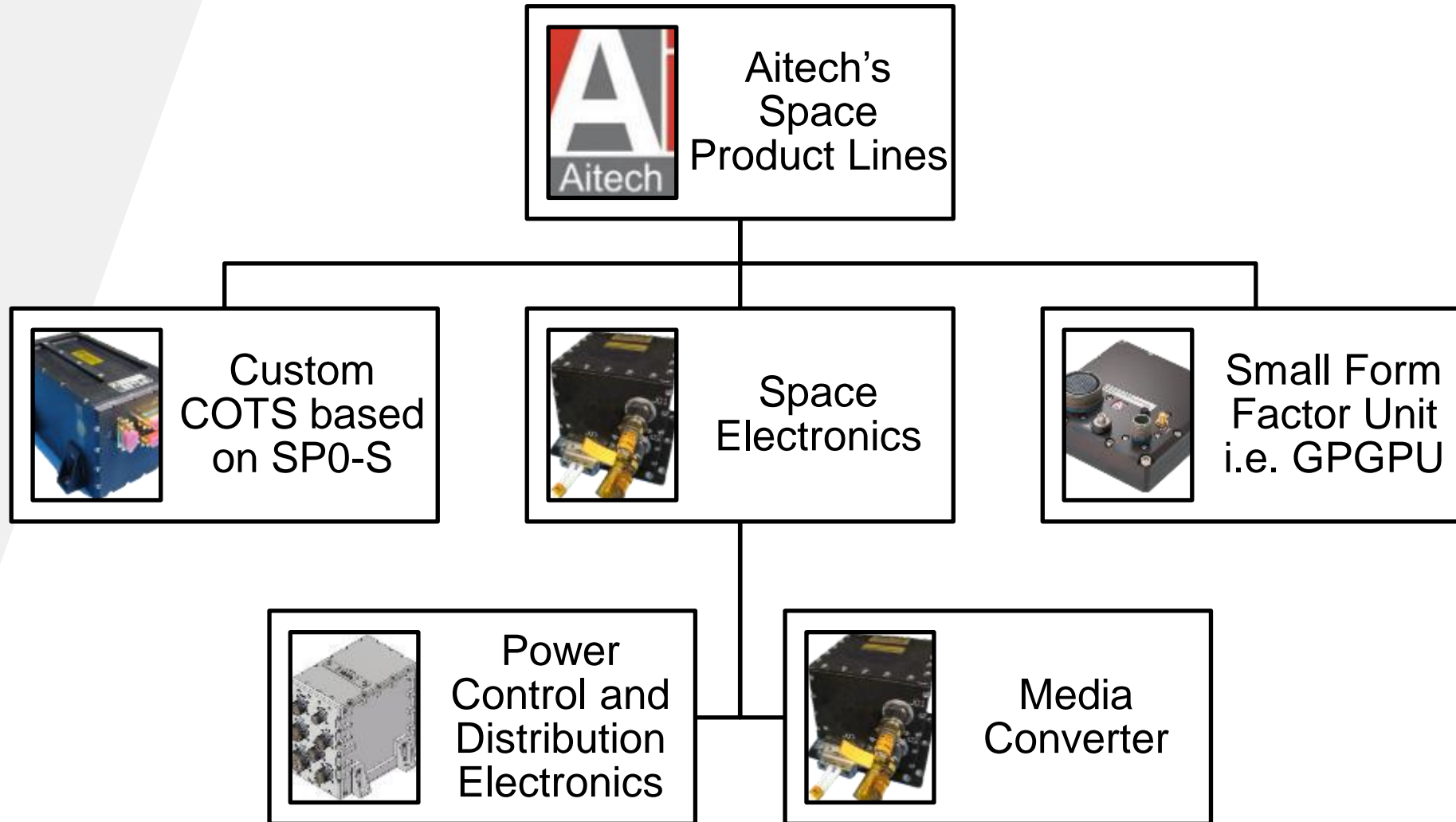
Program/Platform	Launch Date	Purpose
Express Rack/ISS	Jul-97	Express Rack Controller
Orbital Express	Mar-07	Avionics and Robotic Controls
TacSat III	May-09	C&DH
Falcon HTV-2 (Launch I)	Apr-10	Flight Recorder
FalconSat 5	Nov-10	C&DH Computer
ORS-1	Jun-11	C&DH Computer
SAC-D	Jun-11	C&DH Computer
Falcon HTV-2 (Launch II)	Aug-11	Flight Recorder
SCaN CoNNeCT / ISS	Jul-12	SDR C&DH Processor
NASA ODAR ICU / ISS	Jul-12	Network Ku band Comms system
Cassiope	Sep-13	C&DH Processor
Orbcomm OG2	Oct-12	SDR Processor

Program/Platform	Launch Date	Purpose
NEOSSat	Feb-13	3-axis platform telescope stab.
Orbcomm OG2 (6 Small Sat Const.)	Mar-14	SDR Processor
OSIRIS-REx	Sep-16	SBC for asteroid lander
ISS	Dec-16	GigE Edge Router
Earth Atmosphere Research	Feb-17	SBC
MUSES / ISS	Jun-17	C&DH
Hispasat 30W-6	Mar-18	Imaging / Video inspection
Microsatellite Payload	Nov-18	
USAFA SSA	Dec-18	Control
Starliner	Dec-18	Electro-optical sensor
Orion Crew Display System	Nov-19	
Fiber Media Converter	Nov-19	GbE to Fibre

**More Flight Experience Than Any Other  
COTS Space Digital Electronics**



# Overview of Aitech's Space Product Lines



# Aitech's Capabilities in Space

- Redundant on-board resources for mitigating Single Event Effects (including Single Event Upset – SEU)
- CPU clock rate dynamically adjustable to optimize power consumption and enhance SEU rate on-orbit
- Responsive delivery of standard OSA products
- Fast delivery of customized standard products
- Multiple radiation tolerant levels and component pedigrees with various price points
- Qualified to operate in and launch on most launch vehicles worldwide
- Qualified for most orbiting and inter-planetary platforms

# Benefits of Aitech's Custom COTS Based on SP0-S Single Board Computer

- Faster deployment
- Combine COTS boards to create your custom solution for your mission profile
- Instead of years, deploy in months
- Lower risk
- Build with space proven boards, tested and qualified for radiation tolerance qual or single event latchup LET of over 60 MeV
- From LEO to deep space
- Affordable
- Lower NRE costs; no custom design. Modular card-level solution to build any system.
- Take advantage of COTS pricing
- Proven & Reliable
- Trillions of Miles flown in Space without Failure

# Thank you for listening.

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