

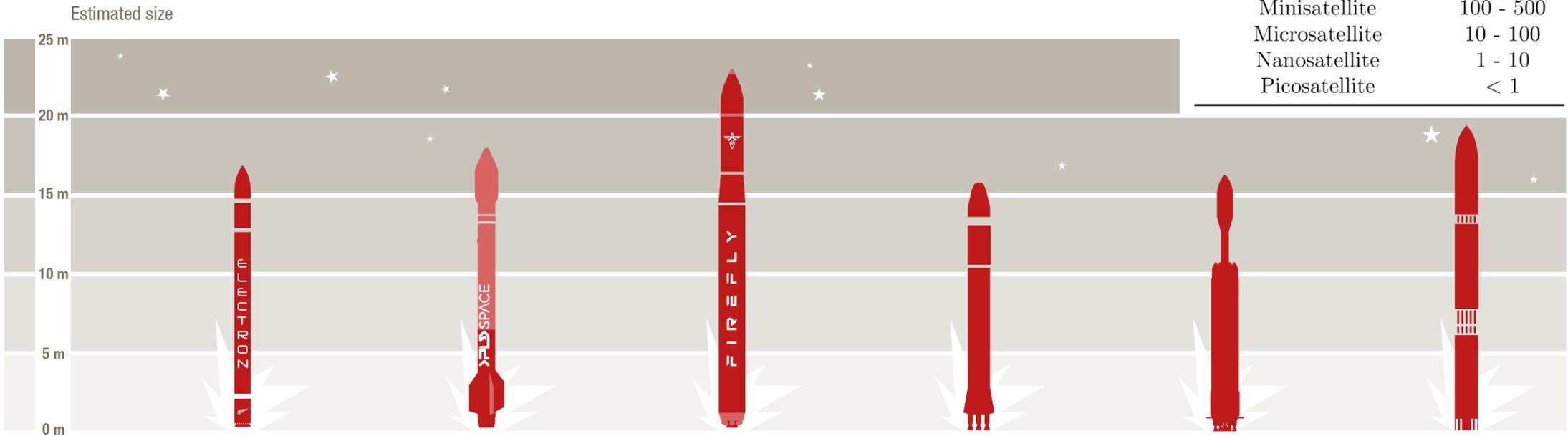
Summary

- **General Overview of Microlaunchers**
- **Development**
- **Testing**

General overview

Micro-launchers: what is the market?

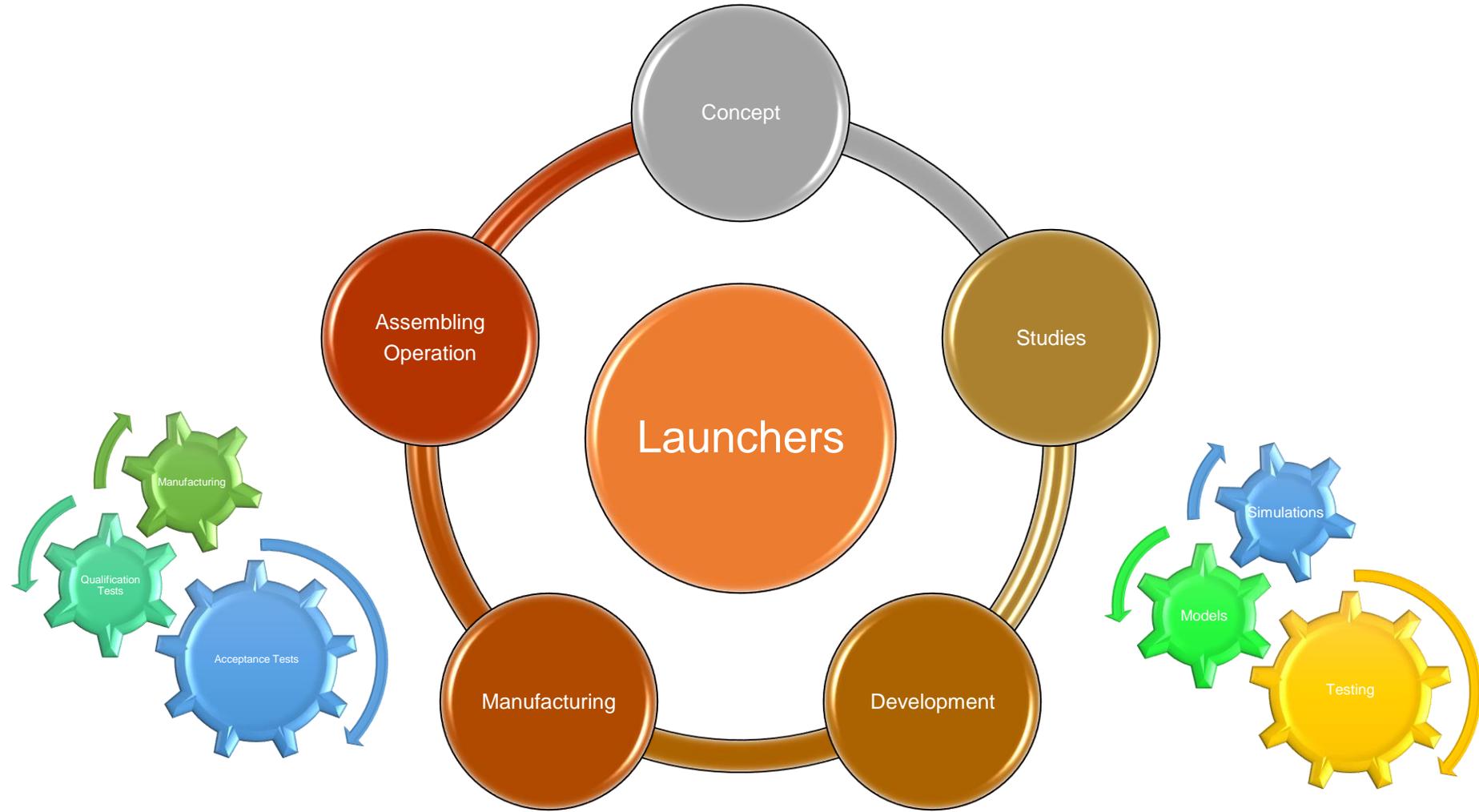
(February, 2017)



Satellite Class	Size [kg]
Large satellites	> 1,000
Medium-sized satellites	500 - 1000
Minisatellite	100 - 500
Microsatellite	10 - 100
Nanosatellite	1 - 10
Picosatellite	< 1

System	Electron	Arion 2	Alpha	Vector H	Taymyr 7	VLM 1
Manufacturer	Rocket Lab	PLD Space	Firefly Space Systems	Vector Space Systems	Lin Industrial	CTA
Country of Origin	USA / New Zealand	Spain	USA	USA	Russia	Brazil
Max payload	225 kg LEO	150 kg LEO	200 kg LEO	120 kg LEO	180 kg LEO	200 kg LEO

General overview



General overview

New concepts from European industry on microlaunch services (October, 2018)



General overview



• Electron – Rocket Lab

- ✓ Liquid propulsion (RP-1 and LOX)
- ✓ 1st stage: 9 x 22 kN engines
- ✓ carbon composite structure of 1.2 m diameter and 20 m length
- ✓ 225 kg payloads to low earth orbit. The payload for a 500 km sun-synchronous orbit is 100 kg.
- ✓ After more than **two years** of rigorous testing, more than **200 engine hot fires** as part of the qualification program, and many more engine test fires before the program began, the 5,000 lbf (22.24 kN) Rutherford engine is now qualified for flight on the company's currently-in-progress Electron launch vehicle.
- ✓ It's the **first oxygen/hydrocarbon engine to have all of its major components made using additive manufacturing** – that is, 3-D printing – “including the regeneratively cooled thrust chamber, injector, pumps, and main propellant valves,”

General overview



• VLM – DCTA / DLR

- ✓ 3 stages SRM (2 x S-50 + 1 x S-44)
- ✓ S-50: 12,000 kg of solid propellant
- ✓ S-44: 1,000 kg of solid propellant
- ✓ TVC - servo-hydraulic system
- ✓ Motor case - composite

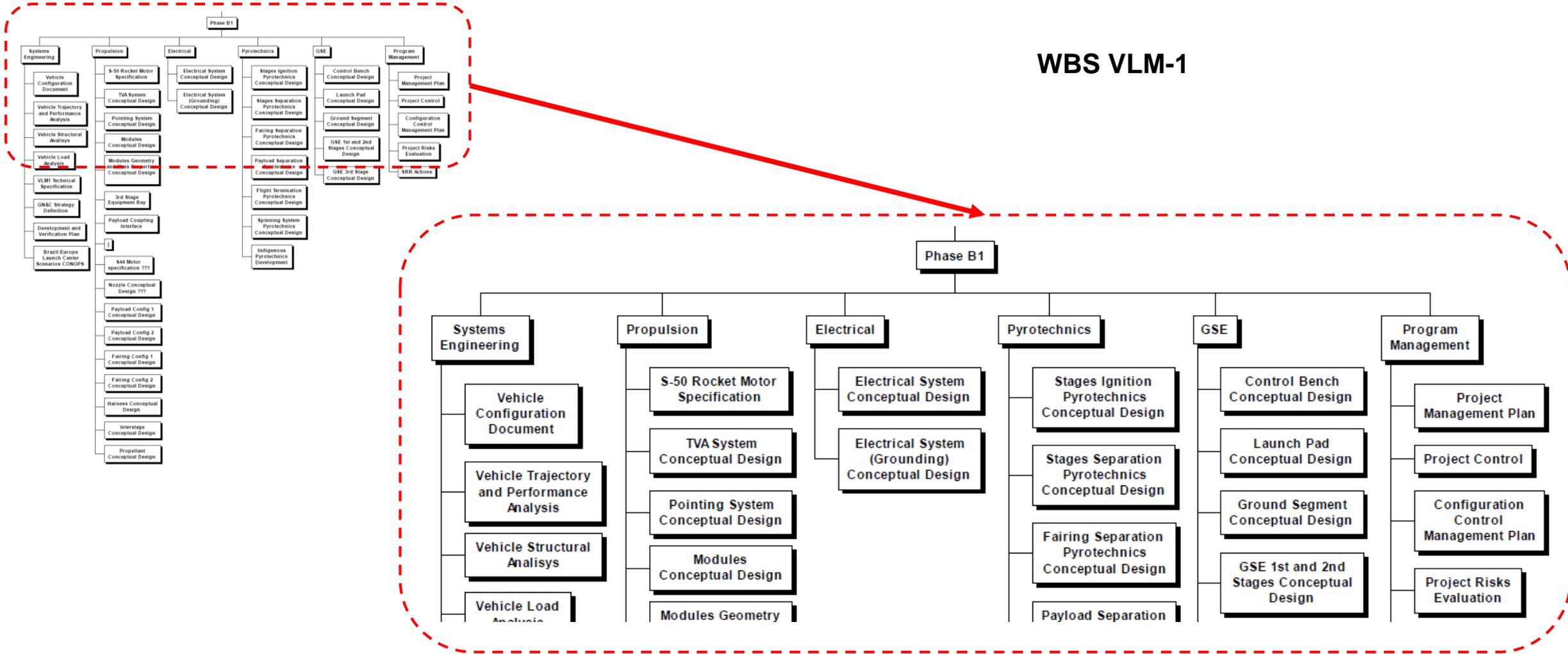


Development

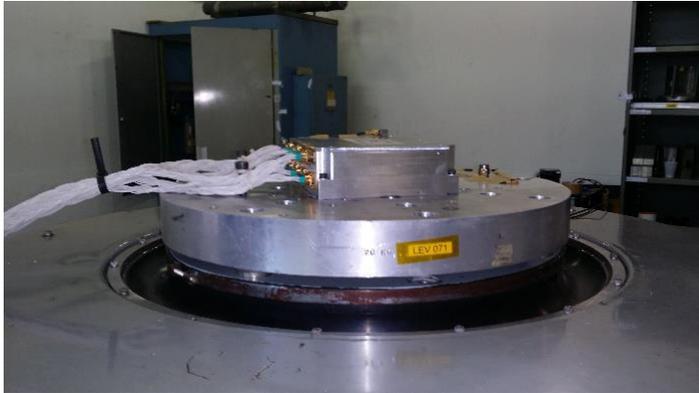


WBS VLM-1

Development

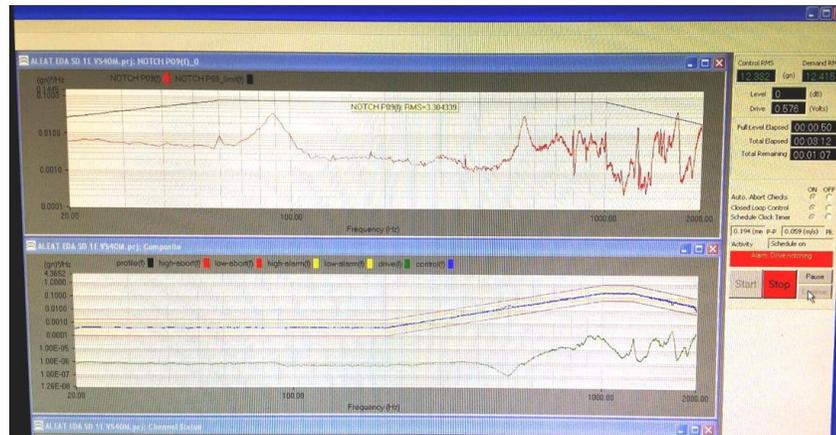
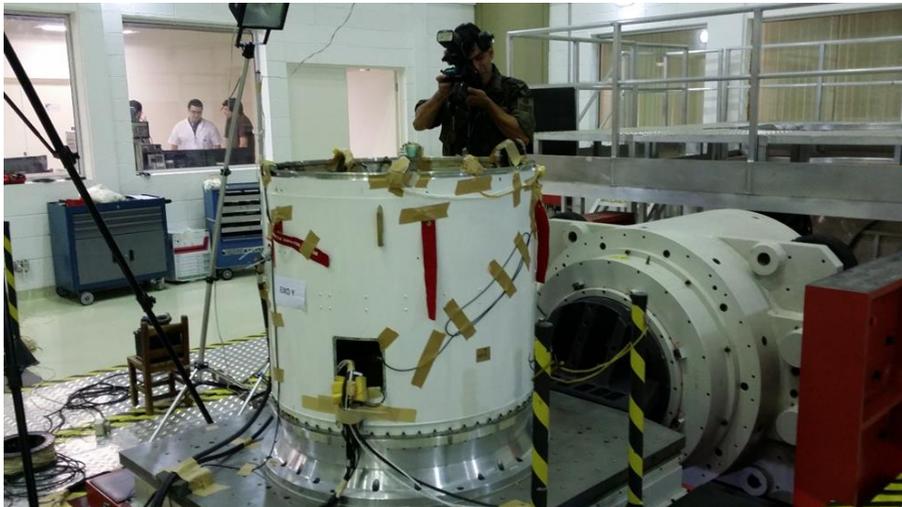


Testing



- Development, manufacturing, testing and operation

- ✓ Single component
- ✓ Integrated system
- ✓ Subsystem



Testing



Testbed for liquid propulsion

Testbed for solid propulsion



Testing

**GN&C Testbed: Hardware in the Loop testing & simulations
and
IMU & sensors calibration.**



