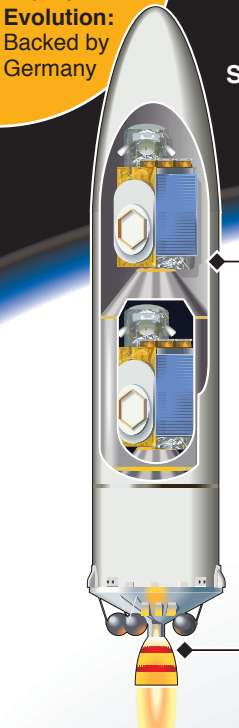


Ariane 5 ME – Midlife Evolution:
Backed by Germany

Next-generation heavy-lift rockets

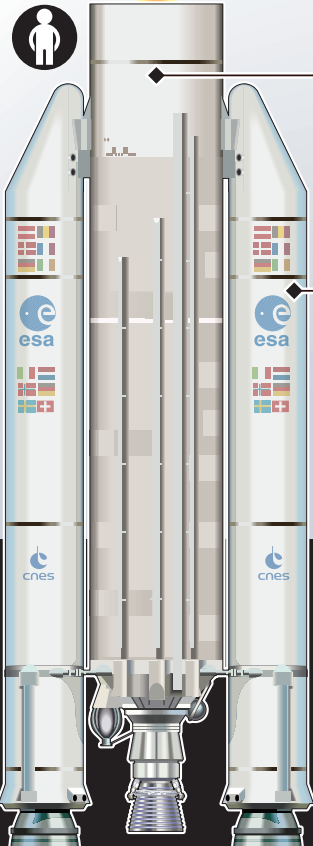
Europe faces a critical decision over its next-generation Ariane launch vehicle which will be in direct competition with SpaceX's Falcon 9 Heavy. Competing ideas to cut operating costs include a midlife upgrade of Ariane 5, or new cryogenic-liquid or solid-fuelled versions of Ariane 6

Falcon 9 Heavy
SpaceX, United States



Payload: 11 tonnes to geostationary transfer orbit (GTO). 20-metre-long satellite bay

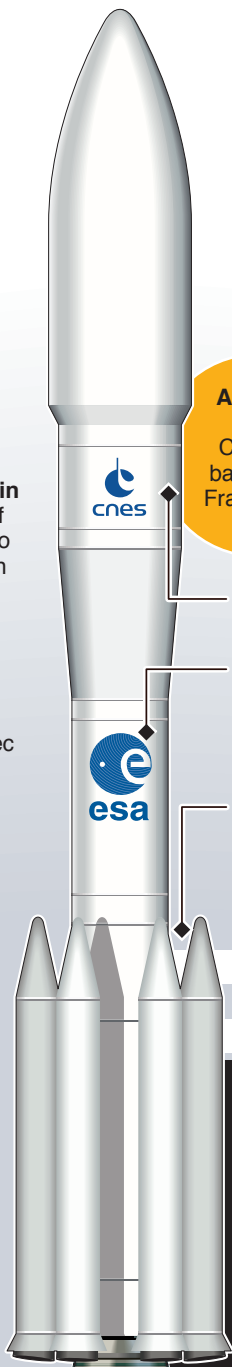
Vinci cryogenic upper stage: New restartable engine to deliver two satellites to GTO at 33,660km/h. Orbital insertion about 29 minutes from launch



Vulcain 2 cryogenic main stage: Ratio of liquid oxygen to liquid hydrogen raised to give 20% extra take-off thrust to increase payload. Engine burns for 8 min 59 sec

Solid-fuel boosters: Each burns more than 100 tonnes of propellant in first 134 seconds of flight

Current cost per launch: \$220 million
Subsidy from EU taxpayer: \$150m
Ariane 5 ME to enter service 2017



Ariane 6 P1B: Concept backed by France and Italy

Vinci upper stage (as Ariane 5 ME)

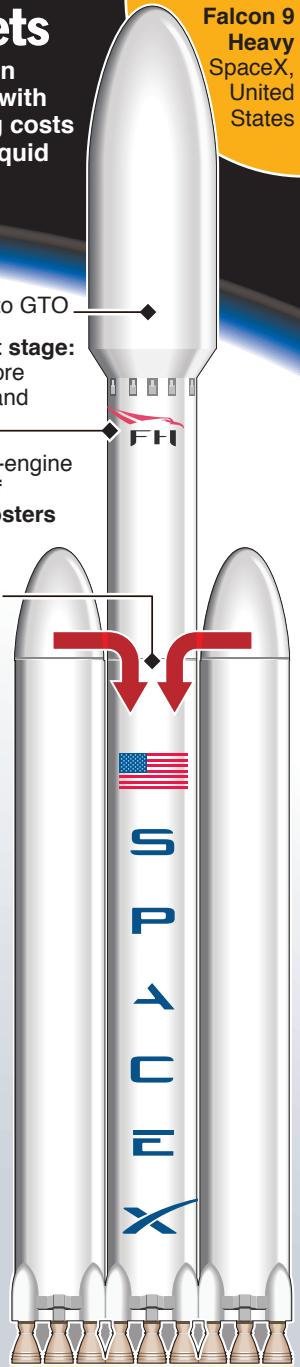
Vega P135 solid-fuel engines: Newly designed two-stage core rocket

Strap-on P39 boosters: Variable number of boosters increase payload range

| Payload | Boosters |
|------------|----------|
| 5 tonnes | 2 |
| 6.5 tonnes | 4 |
| 8.1 tonnes | 6 |

Cost per launch: From \$80 million
Any subsidy financed by builder-nations

To enter service 2020



Payload: 19 tonnes to GTO

Falcon Heavy's first stage: Merlin nine-engine core fuelled by kerosene and liquid oxygen

Boosters: Twin nine-engine cores. **Cross-feed of propellant from boosters leaves centre core almost full on booster separation**

| Payload | Boosters |
|------------|----------|
| 5 tonnes | 2 |
| 6.5 tonnes | 4 |
| 8.1 tonnes | 6 |

Cost per launch: Up to 6.4 tonnes to GTO – \$83 million

Above 6.4 tonnes – \$128 million

Enters service 2013-14

Sources: Aviation Week & Space Technology, FAA, SpaceX
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