Launch into Space

Prof. Richard Crowther
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There are many ways to get into space…

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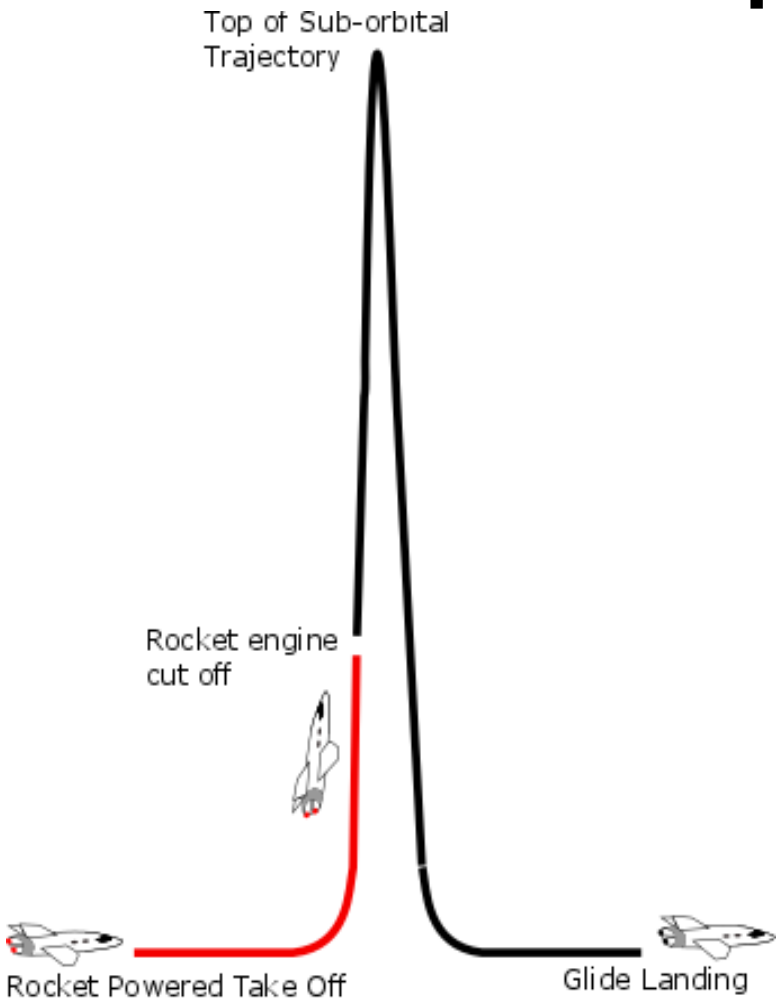

Single Stage Sub-orbital Spaceplane

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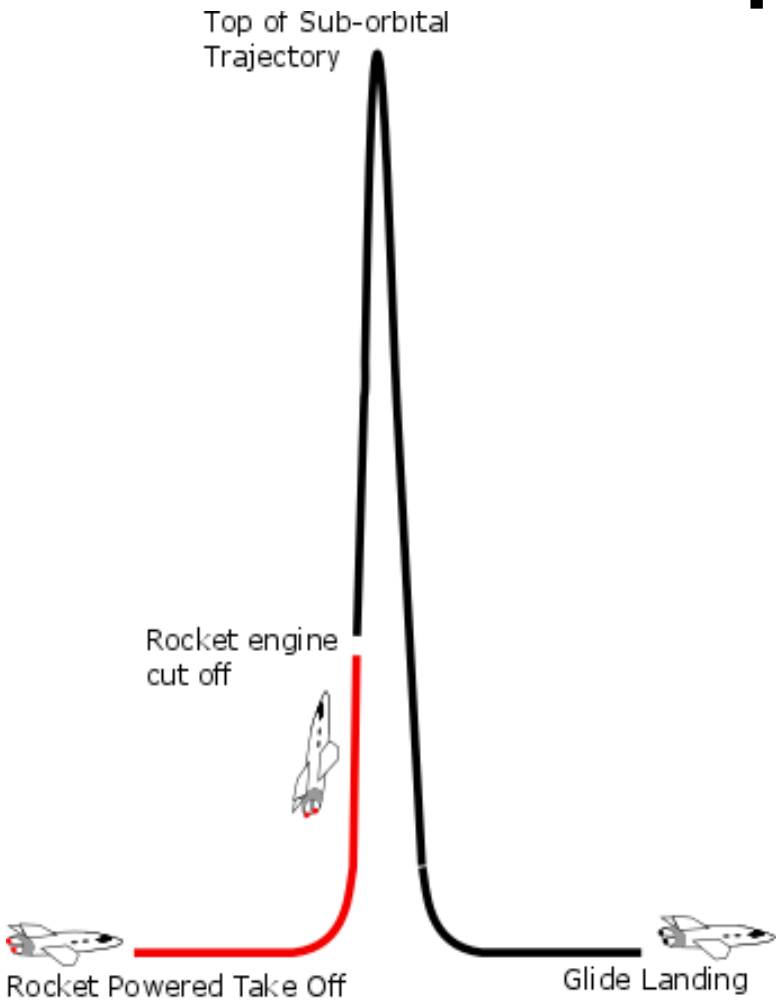
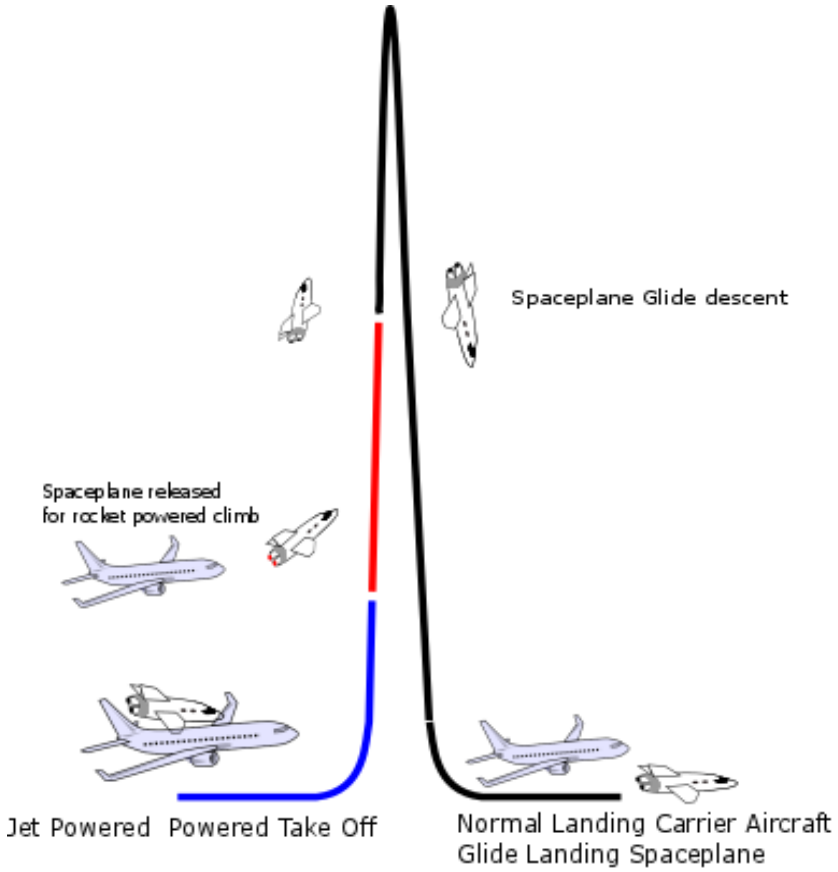


Single Stage Sub-orbital Spaceplane



Two Stage Stage Sub-orbital Spaceplane

And also stay there …

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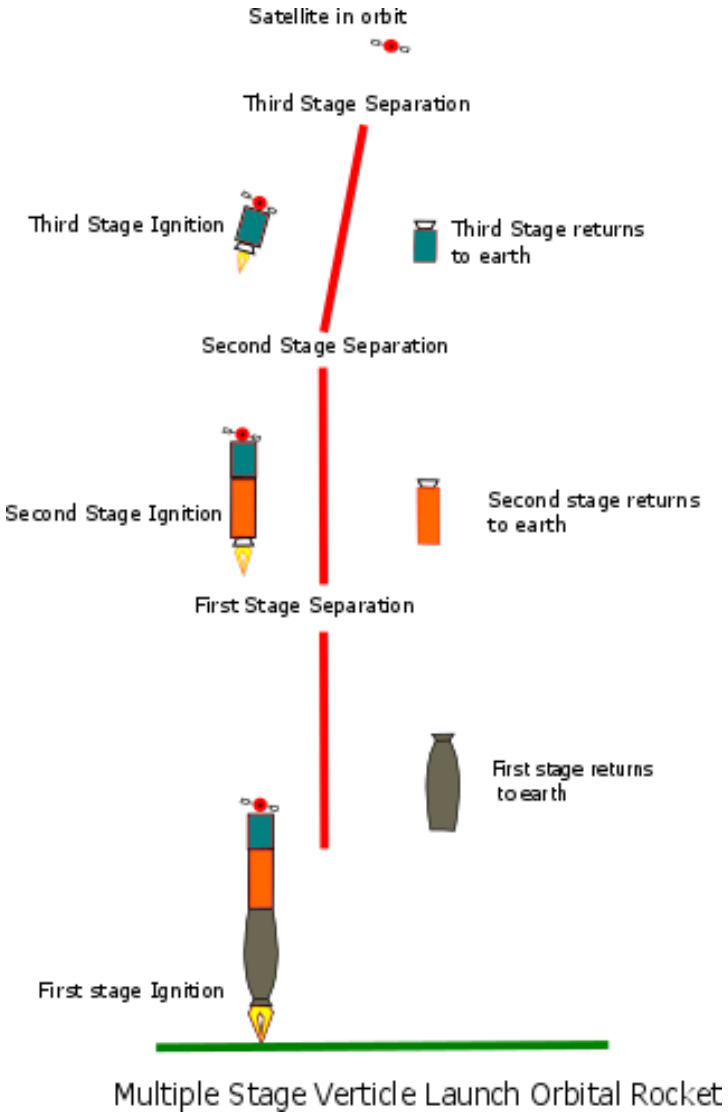
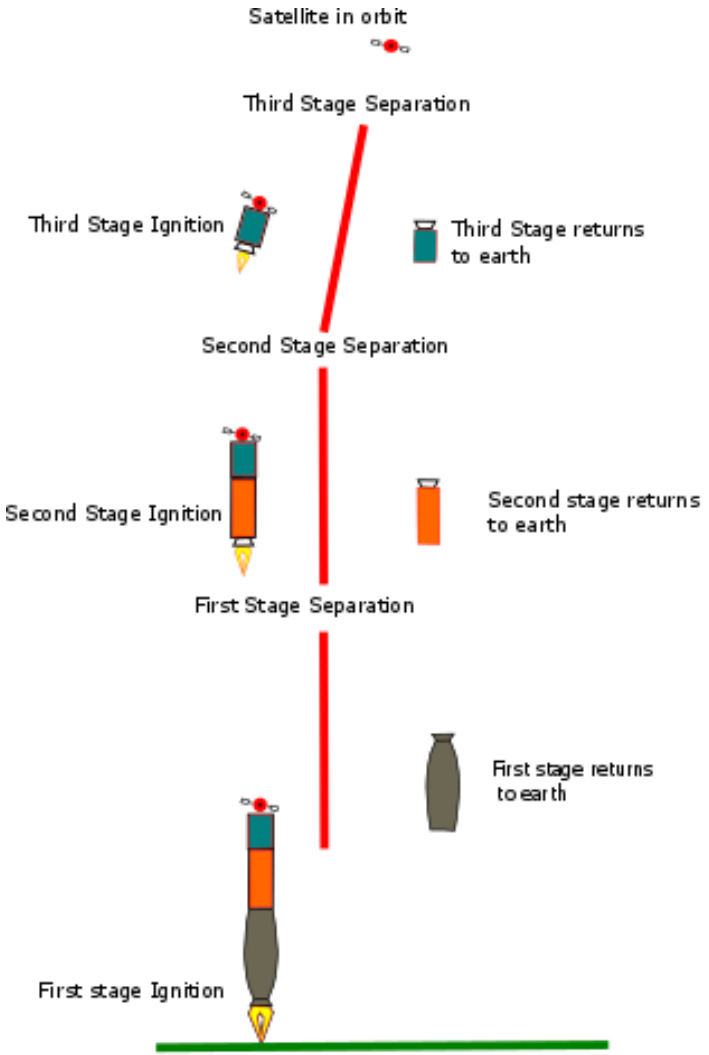
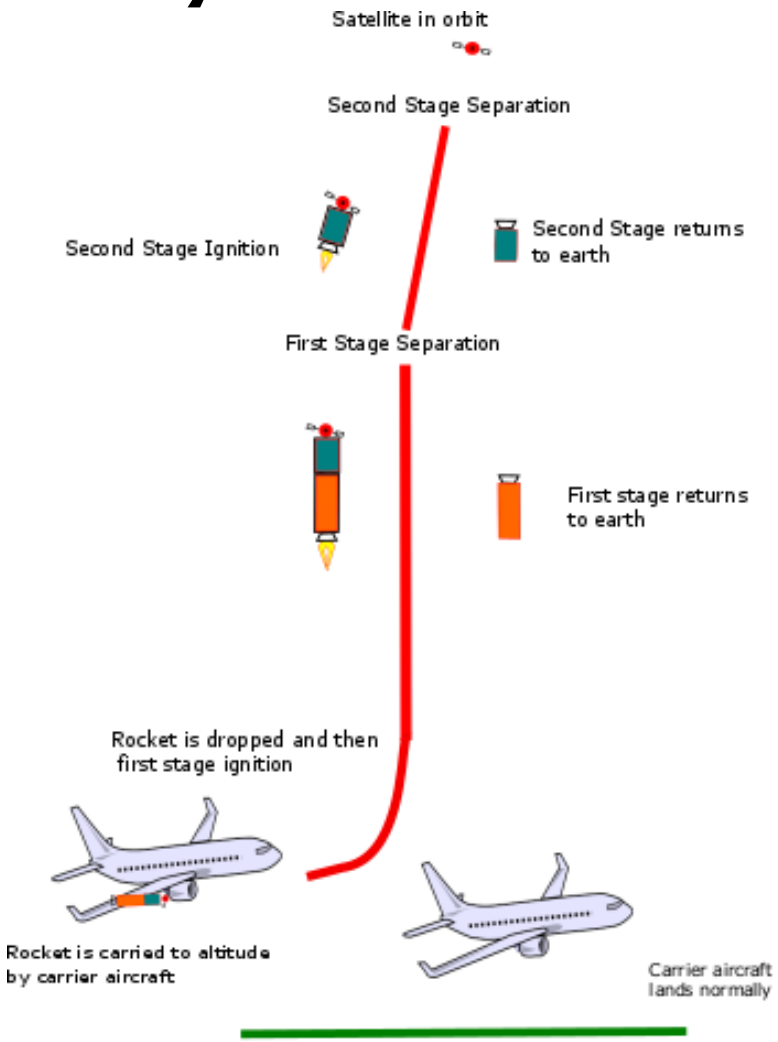


And also stay there …

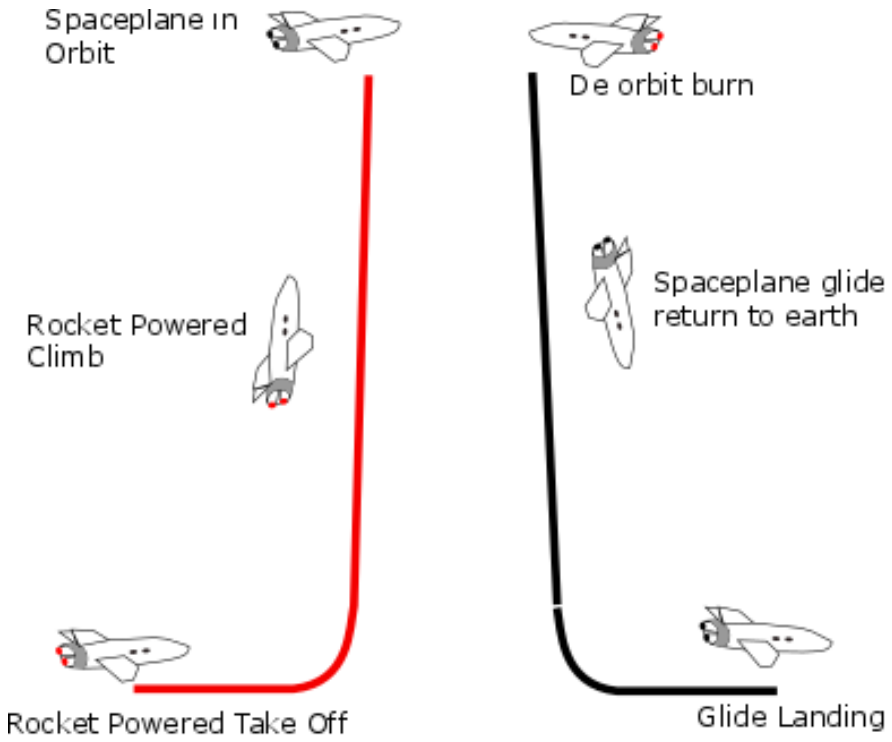


Multiple Stage Verticle Launch Orbital Rocket



Orbital Rocket launched from Conventional Aircraft

And go back again and again …



Single Stage Orbital Spaceplane

Delivering payloads to space

- A launch vehicle must:
  - Use **thrust** and/or lift to overcome the forces of gravity and drag
- A rocket produces **thrust** by expelling propellants
  - High mass at high speed (mass flow rate)
- Propellants can be liquid or solid and tend to comprise a fuel and an oxidiser
  - Solid rockets more reliable, liquid rockets flexible
- Staging used is shed redundant mass
  - Trade-off between altitude, fuel and payload mass

Launch site location can influence achievable orbit

- We can exploit Earth rotation to add 470 m/s at Equator
- Initial orbit inclination of launcher dictated by launch site latitude
- For an expendable launch vehicle, overflight and down-range impact of spent stages may dictate the need for dog-legs to avoid population centres

Launch Site Requirements

- Ground Facilities
  - Vehicle and payload integration and test
- Range with supporting flight infrastructure
  - Telemetry and tracking
  - Meteorological services
  - Flight termination system
- Airspace management to enable access to space
  - Must ensure that launch vehicle does not interfere with aircraft in flight
  - NOTAMs issued for launch and re-entry

Safety Management System

- Ground and flight safety informed by detailed risk analysis
- All potential hazards identified, evaluated and prevention/mitigation plans assessed
- Accident response plan developed
- Roles and responsibilities confirmed
- Criteria for evaluation and thresholds for action confirmed

Key Regulatory Issues

- Ground safety
- Environmental Impact
- Vehicle Performance and Reliability
- Hazard transmission and Mitigation
- Overflight and ground impact of spent stages


T+ 00:08:01
STAGE 2
TELEMETRY
SPEED
ALTITUDE
23128
km/h
178
km
FALCON HEAVY TEST FLIGHT