Termination & Recovery Systems

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Topics

- Overview - approach
- Guided payload return
- Impact protection
- Secure destruction systems
- Recovery beacons

Overview - approach

- GSFC developed set of technology requirements for ULDB
- JPL asked to provide
  - relationship to requirements in solar system exploration program
  - information on any applicable existing technology
  - guidance on potential industry contributions
- Hope to stimulate discussion not provide definitive guidance

Termination & Recovery Systems

What is needed

- GPS guided payload parasail
- Secure destruction systems to prevent inadvertent technology transfer
- Ground penetration shock absorbers
- Recovery beacons that can survive and operate for a long duration in extreme environments

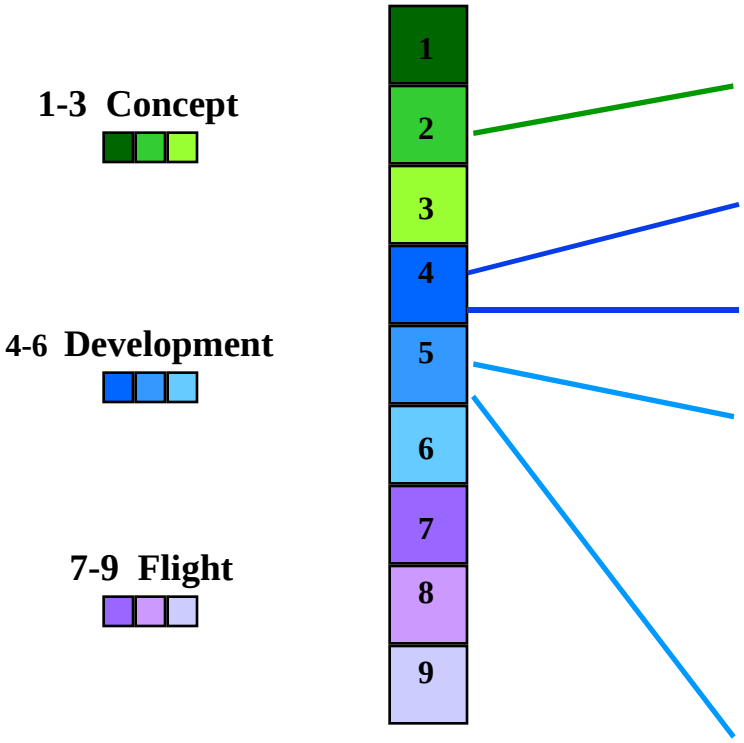
Today's State of the Art

- Cut and drop gondola
- Use a parachute
- Currently developing a parasail system

Technology Goals

- Land payload in targeted area
  - 1 mile target area - within 20 mile radius from drop point
  - 500 ft. - 30 mile radius
  - 10 ft. - 50 mile radius
- Extreme environment beacon
- GPS location phone home system
  - Above system with 1 year life

Termination & Recovery Systems



Current Technology Readiness Levels

Technology Required	*"Needed By"*
– Ground penetration shock absorbers	– 2003
– Extreme environment beacon	– 2003
– GPS phone home system • With 1 year life	– 2003 • 2005
– Parasail to land payload in • 1 mile target area w/in 20 mile radius from drop point • 500ft - 30 mile radius • 10 ft - 50 mile radius	• 2001 • 2004 • 2007
– Secure destruction systems to prevent inadvertent technology transfer	– 2000

Parasail Guided Payload

- ULDB Requirements are:
  - 1 mile target in 20 miles radius from drop point - by 2001
  - 500 ft at 30 mile radius - by 2004
  - 10 ft at 50 mile radius - by 2007
- Most important requirement in long term is range which drives glide angle of the recovery systems
- Accurate payload deployments is also needed for solar system exploration.
  - From space to the Earth's surface (solar system sample return)
  - From space to a planetary surface (Mars exploration)
  - From planetary atmosphere to planetary surface (balloon deployment of surface packages)
- Commercial systems may already meet some of the ULDB needs

Solar System Exploration

Payload Deployment - Space to Earth's Surface

Mission	Star Dust	Genesis	Mars Sample Return
Launch	1999?	2000?	2003,2005,2007
Objectives	Comet dust sample return	Solar Wind Sample Return	Mars rock and soil samples
Special Landing Issues	None	Fragile payload	Back contamination
Landing Site	UTTR	UTTR	UTTR and Eyre Lake
Landing Error (km x km	20 X 40	20 X 40	20 X 40
Terminal descent	Parachute	Parachute	Free fall
Control	None	None	None
Beacon	RF	RF	RF
Aerial Capture	None	Helicopter	None

Solar System Exploration

Payload Deployment - Space to Planetary Surface

	DS-2 penetrator mission	Mars Sample Acquisition Missions	Advanced M Sampling V
Objectives		Acquire and retrieve samples from martian surface	
Launch	1998	2003, 2005	Undefined
Positional uncertainty before entry (km x km)	50 x 50	50 x 50	50 x 50
Hypersonic Aeromaneuvering	No	Yes	Yes
Positional uncertainty after entry (km x km)	50 x 50	5 x 5	5 x 5
Terminal Descent	Ballistic	Parachute/Propulsive	Parachute/P
Lateral Control	None	Not required	
Terminal Navigation	No required	Not required	Imaging/sur beacon
Landing Accuracy	50 x 50	5 x 5	100 meters

Solar System Exploration
Payload Deployment - Planetary Atmosphere to Planetary Surface

Mission	Mars Balloon Lander	Venus Multisonde Mission	Venus Sample Return
Objectives	Deploy payload to Mars surface with a solar Montgolfiere balloon	Deployment probes from a balloon to surface of Venus	Acquire and return sample from surface of Venus to altitude
Launch	2003	2003	2005 to 2007
Approved Mission	No	No	No
Balloon Altitude (km)	9 (deployment	55	55
Positional Knowledge (km)	20 x 20	20 x 20	20 x 20
Parachute Deployment Altitude (km)	Not applicable	3	3
Range after parachute deployments (km)	Not applicable	10	30
Mission		Inertial RF DF with balloon	Inertial RFDF with balloon Surface imaging
Surface accuraacy	20 km	30 km	<1 km

Impact Protection

- Current technology is cardboard crash pads
  - Require 5 to 10% of payload mass
  - Reduce g loading to 10 g for descent speed of 10m/sec (comparable to chute shock)
- Solar System Exploration has developed airbag approach
  - Mars Pathfinder mission -1997 Mars landing
  - Future Mars Micromission landings post 2003 25 g goal
- ULDB operational payloads may have more stringent requirements
  - Desire to reduce impact protection below 5%
  - Handle higher surface winds - requires shear resistance and side protection
  - Possible additional stresses of parachute deployment at lower altitudes may require mitigation of chute deployment shock

Secure Destruction Systems

- Future payloads may contain “sensitive” technologies
- Secure destruction systems are needed that can
  - destroy the sensitive technology reliably
  - involve minimal risk of inadvertent damaged and hazard
- Distributed localized systems might be considered for this application
  - Explosive
  - Thermal
  - Chemical (corrosive)
- No comparable solar system exploration application

Recovery Beacons

- Recovery beacons must accommodate
  - Nominal recovery strategy
  - Recovery in event of system malfunction
- Baseline approach
  - GPS systems - communicate with Orbcom or Iridium
  - RDF for terminal location
- Major problem is not technology but a strategy to handle emergency recovery.