Moonlighting missions

The next big NASA flagship mission to the outer planets will go to one of the moons of Jupiter or Saturn. By 1 January, the agency plans to narrow down the four candidate missions to two or three. It wants to keep costs below US$3 billion, but is planning to partner with the European Space Agency, which could contribute almost $1 billion. The final decision should be made by the end of 2008. **Eric Hand** weighs up their chances.

	EUROPA EXPLORER (JUPITER)	JUPITER SYSTEMS ORBITER / GANYMEDE	ENCELADUS EXPLORER (SATURN)	TITAN EXPLORER WITH ORBITER (SATURN)
Cost	$3.3 billion	$3.1 billion	$2.1 billion–$2.4 billion	$4 billion
Orbiter destination	A year spent circling above Europa, which has a saltwater ocean underneath a thin cap of ice.	A three-year tour of the jovian system, with many fly-bys of Europa, Io and Callisto, before settling into orbit around Ganymede.	To Enceladus, a frozen ball of ice only 500 kilometres in diameter. The Cassini mission discovered a geyser there spewing a plume of water into space.	It would use Titan's thick atmosphere to slow the spacecraft into orbit. This 'aerocapture' process reduces the amount of fuel needed and would allow a hot-air balloon and a lander to be dropped.
The pay-off	Data obtained by ice-penetrating radar would end a debate about the thickness of the ice shell and how often the water reaches the surface. Spectroscopy could detect organic signatures in any recent watery outbursts on the surface.	Scientists want to understand why Ganymede is the only moon in the Solar System with its own magnetic field.	The orbiter would pass through the water plume a dozen times, offering a rare chance to evaluate the biological potential of sub-surface water without landing or complicated drilling.	Like Earth, Titan has a 'water' cycle including rain and lakes — but with methane rather than water. Water erupting from ice volcanoes may combine with organic compounds to make amino acids — but scientists need a lander to test for them.
The challenge	Protecting the orbiter from Jupiter's radiation is expensive. Another cost is assembling the probe in a sterile environment so that microbes from Earth don't mix with those from Europa when the probe crashes to the surface.	The planet's radiation. The orbiter would have to survive for five years in Jupiter's harsh environment.	Enceladus is tiny and sits close to Saturn, which means it takes a lot of fuel to brake into its orbit. The geyser might only be spewing sublimated ice, rather than water from a sub-surface ocean. And what if the geyser stops before the probe gets there?	The Huygens probe's batteries lasted for just 90 minutes. A year-long balloon and lander mission would require expensive radioisotope power. Aerocapture hasn't been tested outside Earth.
Planned launch	2015	2017	2018	2018
The tip-book	**The one to beat.** Europa has been a top priority in NASA road maps and surveys. But some wonder whether it is worth visiting without actually landing there and sampling the ice and ocean directly.	**Dark horse.** The Jupiter community got a major mission 20 years ago with Galileo. And Juno, a smaller Jupiter mission, is scheduled for a 2011 launch. But proponents say that the whole-system approach gets the most bang for the buck.	**Wait until next time.** Enceladus wouldn't have even been considered but for the discovery of the plume. There are too many risks for an uncertain gain.	**Up and coming.** A Titan mission probably offers the most opportunities for ground-breaking science — and the only chance for an affordable lander, not to mention a balloon. But it will be hard to justify going to the same place as Huygens.

*Moons not to scale

DLR; JPL; JPL; JPL; NASA; HURCHER (UNIV. BRITISH COLUMBIA)