NASA Facts

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Mars Polar Lander/Deep Space 2 First Signal

What if we don't hear from Mars Polar Lander at 12:39 p.m. PST on Friday, December 3, when it is scheduled to radio Earth following its landing?

That window is only the first of several communications opportunities over the weekend when we might possibly hear from the lander for the first time. Any one of several factors could delay first contact without preventing the lander from establishing communication and carrying out a full mission. These factors generally fall into two categories: telecommunications issues, or a spacecraft "safing" event.

So if you don't hear from the lander right away, what happens next?

First, it should be kept in mind that the 12:39 p.m. PST time is an estimate of when the lander's signal would first reach Earth. Under the best of circumstances, it may take a few minutes to lock onto the signal and establish contact.

If we do not have the signal within a few minutes of the start time, teams will begin checking ground systems at Deep Space Network stations and elsewhere to make sure that the problem is not on the Earth end. We would then continue listening until the lander's first transmission would be scheduled to end, at approximately 1:25 p.m. PST.

What happens then?

The next time we would listen for the lander would be during a 40-minute window beginning at 2:04 p.m. PST landing day. Polar Lander would transmit at this time if it entered a safe mode immediately upon touchdown.

What is a "safing" event, and how could it happen?

All planetary spacecraft are loaded with "fault protection" software designed to safeguard the craft in the event of various kinds of unusual events. When certain events take place, this software puts the spacecraft into a so-called "safe" mode that protects it and places it in standby, awaiting intervention by ground controllers. Fault protection software is usually disabled during critical flight events such as landings, orbit insertions and some flybys in order to prevent a minor glitch from interfering the event.

In the case of Polar Lander, the fault protection software is disabled about 18 hours before landing so that it does not interfere with the critical events of entry, descent and landing. It is then reenabled about 10 minutes after landing during the period when the lander is unfolding its solar panels and preparing to transmit to Earth. If an event triggers the fault protection software immediately when it is reenabled after the lander touches down, the spacecraft will be put into a "safe" mode. In this mode, it shuts down activities and goes into its low-power "sleep" mode. It would then automatically start transmitting to Earth at about 2:04 p.m. PST.

What if a safing event took place as the lander was closing in on its approach to Mars? Would you have enough time to recover the spacecraft so that it could land properly?

The fault protection software is disabled 18 hours before landing to make sure that there is enough time to reconfigure the spacecraft. If a safing event took place at any time up to this disabling point, there should be ample time to reset the lander for entry, descent and landing.

So if you do not hear from the lander during this 2:04 p.m. window, what happens then?

Our next step would be to investigate the possibility that the lander's dish antenna is not pointed close enough to Earth to establish contact. To get a good communication session and hear telemetry, or data, from the lander, the antenna must be pointed within about 5 degrees of Earth. If the antenna is pointed more than about 15 degrees away from Earth, we would not hear a carrier signal at all.

At about 6:27 p.m. PST on landing day, we would send commands to the lander to carry out a procedure designed to help it find Earth. In this procedure, the lander transmits while it moves its dish antenna from one point to another, gradually covering the entire horizon. Sending these commands would be completed by 7:27 p.m. PST. The lander would then carry out the procedure attempting to transmit to Earth while it moves its antenna from 8:08 to 10:40 p.m. PST.

If this procedure doesn't result in a signal, what is your next step?

There is a window on Saturday evening, December 4, during which the lander would transmit if it experienced a slightly different safing event. You will recall from the above that the lander would transmit on Friday afternoon if it entered safe mode immediately upon touchdown. If it went into safe mode sometime after touchdown but before its first transmission session began, it would shut itself down and wait until Saturday evening to transmit to Earth. This signal would be expected during a window between 8:30 and 10:45 p.m. Saturday, December 4.

Another possibility is that, even though we haven't heard from it for some reason, the lander could be carrying out its normal post-landing activities. If this were the case, it would be scheduled to transmit data to Earth during a window from 8:50 to 10:50 p.m. Saturday, December 4. Although it is difficult to say why we would not have already heard from the lander if it were otherwise operating relatively normally, we would listen during this window just to make sure that we didn't miss a possible signal.

Would you send more commands to the lander?

Very probably so. Depending on exactly what we are seeing, we might send commands instructing the lander to switch between its main and backup radio or computer systems. There is a window during which we might send commands from 6:35 to 8:05 p.m. Saturday, December 4.

What about later opportunities?

One possible scenario is that the power amplifier on the transmitter that the lander uses to communicate

Lander Communication Windows

All times Pacific Standard Time

12:39 - 1:25 p.m. Friday 12/3	**Transmission if dish antenna is pointed at Earth**
2:04 - 2:44 p.m. Friday 12/3	**Transmission if lander entered safe mode at touchdown**
6:27 - 7:27 p.m. Friday 12/3	**Window to send commands to lander**
8:08 - 10:40 p.m. Friday 12/3	**Transmission if lander is executing normal activities, or using its dish antenna to find Earth**
6:35 - 8:05 p.m. Saturday 12/4	**Window to send commands to lander**
8:30 - 10:45 p.m. Saturday 12/4	**Transmission if lander entered safe mode just after touchdown**
8:50 - 10:50 p.m. Saturday 12/4	**Transmission if lander is executing normal activities**
10:50 - 11 a.m. Sunday 12/5	**Relay transmission through Mars Global Surveyor**

directly with Earth -- called its "X-band" transmitter -- could not be working right for some reason. This is one of few components on the spacecraft that do not have an identical backup. If the lander doesn't hear any commands from Earth telling it not to do so, it would automatically switch to another radio, called the UHF transmitter, and would send data to the orbiting Mars Global Surveyor spacecraft. Global Surveyor would relay these data in turn to Earth.

If this happened, the lander would transmit to Global Surveyor between 10:50 and 11 a.m. PST on Sunday, December 5. Global Surveyor would relay the data to Earth immediately.

If you haven't heard from the lander by the end of the weekend, what would you do next?

At this point it is likely that we would continue sending commands for several days instructing the lander to swap out various hardware systems.

There is also another milestone that we would investigate. The lander has what is called a "command loss timer" that counts how long it has been since the last time it received a command from Earth. If it does not hear from Earth for six days, this system "times out" and the spacecraft assumes it has a hardware failure somewhere. It then begins swapping between main and backup systems in its flight computer, radio, etc., and attempts to contact Earth. This would take place early morning Mars time on sol 6 (the evening of Thursday, December 9) if the lander has received no commands from Earth after landing. Since we would have been sending commands to the lander well before this, the likelihood of receiving a signal at this time would not be strong. However, for the sake of completeness we would listen for it.

How many systems on the spacecraft have identical backups?

Most systems such as the computer and radios are redundant. There is only one power amplifier for the X-band transmitter and only one dish antenna, but the lander can switch to the UHF transmitter if the X-band system isn't working. A few other parts of the lander such as the robot arm do not have backups.

The lander will be out of touch with Earth for half an hour during its entry, descent and landing. Even if the lander cannot send data to Earth during its descent to Mars, why can't it send a carrier signal or "beacon" signals like Mars Pathfinder did?

The reason that the lander cannot send a signal to Earth during descent is mostly dictated by the geometry of landing near Mars' south pole. As the spacecraft descends through the atmosphere, an ionization layer builds up around it that is very difficult to transmit through. In addition, there was concern that attempting to send a signal from the lander at this point might interfere with onboard electronic systems. We decided to take all steps to protect the lander as it descends, even though this means we will be out of touch with it as it descends.

What about the Deep Space 2 microprobes? What if we don't hear from them right away on Friday evening, December 3?

It is possible that communications with the microprobes could be delayed by factors such as the orientation of the probes following impact or the temperature at the impact sites. If communication is not established during the first relay pass by Mars Global Surveyor on Friday evening, December 3, we will continue listening for the probes every two hours as Global Surveyor passes over the impact site throughout the weekend.

The microprobes wait to hear a command from Mars Global Surveyor before they transmit. If the probes' radio receivers are compromised, it is possible that they may not receive this command correctly. Just like Polar Lander, each of the microprobes has a "command loss timer" that keeps track of the last time each probe received a command from Earth via Global Surveyor. If they do not hear from Global Surveyor within 29 and 32 hours of impact, respectively, they will automatically begin transmitting to Global Surveyor. If we do not hear from the probes on Friday evening, it is very possible that we might hear from them late afternoon or early evening Saturday, December 4.

12-2-99