5 29267
N91-14361 pgs 28

A POLAR ORBIT FOR THE MARS GLOBAL NETWORK MISSION

Philip Knocke
Jet Propulsion Laboratory

Presented to the Mars Global Network Mission Workshop
Jet Propulsion Laboratory, Pasadena Ca.
February 6-7, 1990

INTRODUCTION

The purpose of the Global Network Mission (GNM) is to deploy simple landers on the Martian surface in late 1998. The objective is to create a globally distributed network of ground stations which will collect environmental data, perhaps for as long as several years. The GNM presents unique mission design challenges, which are addressed by the following essay.

The GNM mission concept calls for two carrier spacecraft, each equipped with a number of simple landers. Some of the landers may be deployed from approach, either to reduce carrier mass prior to orbit insertion, or to reach latitudes not available from the carrier orbit. The remaining landers are deployed from orbit.

One configuration for the Global Network Mission was proposed in a report from the Exploration Precursors Task Team to the Office of Space Science and Applications.[1] This formed the basis of a previous orbit design for the GNM.[2] The following analysis uses this mission scenario as a point of reference, but results from the current study are generally applicable to a wide range of GNM mission variants.

FACTORS INFLUENCING MISSION DESIGN

The need to minimize the orbit insertion ΔV of the carrier implies that the carrier orbit be as elliptical as possible, and have a low periapse altitude. Elliptical orbits also lead to lower de-orbit ΔV's than circular orbits.

A number of other requirements act in concert to lay severe constraints on the orbit design for this mission. Among them is the need to distribute the landing sites globally. The overall goals of the mission, as well as guidance from the Mars Science Working Group, indicate a need to emplace landers near the Martian poles. This calls for an orbit capable of reaching latitudes of at least ±80°. Coupled with this requirement is the need for good lighting angles at impact, to support descent imaging. Ideally, the sun elevations at impact would never exceed 30° or fall below 15°. An acceptable range of solar elevations is 10° to 45°.[1] The lighting conditions, coupled with the requirement for extensive latitudinal dispersal, constitute the major orbit design drivers.

In most cases, the lander is restricted to a given range of entry flight path angles. This has particular significance in the case of landers deployed from approach. The circumstances of the interplanetary trajectory, in particular the declination of the arrival asymptote, produce a minor circle of impact points which satisfy the desired entry angle. This leads to severe restrictions on the maximum north and south latitudes available to an approach lander. For example, a high negative approach declination produces rather low maximum northern latitudes at the desired entry angle. The only way to achieve impact at the North Pole in this case is to enter at prohibitively steep entry angles.[2] In addition, approach-deployed landers must accept whatever lighting conditions are available at their impact latitude.

ASSUMPTIONS

The current analysis uses the nominal GNM mission plan described in Reference 2. This specifies a launch period from December 6, 1998 to December 26, 1998, and an arrival period from September 22, 1999 to October 9, 1999. Entry interface was defined at an altitude of 125 km, and the nominal entry flight path angle at this point was taken to be -20°. The impact point was determined by propagating the free space trajectory from entry interface to an altitude of 10 km. Impact was assumed to occur directly beneath this point. (Atmospheric deceleration was not specifically addressed. The effects of drag would change the impact point by only a very few degrees along-track.) As mentioned earlier, this was only a reference scenario. The results are applicable to a range of entry angles and mission options.

The nominal deployment scenario described in Reference 2 was retained for this study. Figure 1 illustrates the deployment technique, in which the lander's de-orbit ΔV is applied tangential to the carrier's motion, and parallel to the entry velocity vector. This assures zero angle of attack at entry. The advantage of this mode of deployment is that no attitude sensors or attitude adjustments are required after deployment. All orbit-deployed landers are deployed from a fixed point in the carrier's orbit, and always impact at a fixed true anomaly with respect to the carrier's periapse location. As the carrier periapse moves due to nodal and apsidal rotation, the impact point moves along the surface of the target planet. The orbit must be chosen such that the nodal and apsidal motions place the impact points at favorable lighting conditions. Note that the maximum latitude available from orbit is equal to the orbital inclination. Longitudinal placement is achieved by making very small changes in the orbital period, causing the ground track to "walk" in longitude.

PREVIOUS ORBIT DESIGN

The nominal orbit design described in Reference 2 involves one carrier in a 45° inclined orbit, and a second carrier in a complementary, 135° retrograde orbit. Both carriers are in 1/5 sol site-synchronous orbits with periapse altitudes of 200 km. Figure 2 shows a plot of sun elevation at impact vs. latitude of impact for the 45° orbit. As shown, immediately after insertion, the carrier can deploy landers at favorable sun elevation angles. In this orbit, there is a single sweep of deployment opportunities from 45°N to 45°S. The retrograde, 135° orbiter must wait between 70 and 150 days after arrival before deploying its landers. The retrograde orbiter sweeps once from 45°S to 45°N.

The advantage of the nominal orbit design is that some landers may be deployed immediately after arrival. This orbit does not allow easy attainment of high latitudes, however. In order to reach the North Pole, a lander would have to be deployed on approach, and enter the atmosphere at very steep entry angles (-43.9° to -49.8°).[2] A lander placed at the North Pole would also enter in darkness. Another factor to consider is the lack of deployment redundancy; there is only one deployment sweep from 45°N to 45°S. Favorable lighting angles do not occur again for several hundred days, and only for a narrow range of latitudes.

POLAR ORBIT

Figure 3 shows a plot of solar elevation at impact vs. latitude of impact for a carrier in a 1/5 sol orbit, with an inclination of exactly 90° and a periapse altitude of 275 km. The graph applies to a direct, periapse insertion from a northern approach at the start of the arrival period. Initially, the impact point is at the North Pole, which is in darkness. After waiting approximately 160 days, however, the impact point has moved to the Southern Hemisphere, and the lighting angles have moved into the acceptable range. Shortly thereafter, the impact point sweeps from the South Pole to the North Pole, remaining at good lighting angles. After the North Pole is reached, the impact points move south again, staying at reasonable lighting conditions until a latitude of 55°S is attained.

This situation occurs, in part, because the impact point moves from the South Pole to the North Pole as the Sun is moving from the Southern Hemisphere to the Northern Hemisphere. Figures 4 and 5 illustrate how the impact point follows the Sun. In addition, it is necessary that the orbit plane be placed properly with respect to the Sun, and that the rate of periapse advance be chosen to complement both the nodal movement with respect to the Sun, and the rate of change in solar declination. The 1/5 sol orbit is the most elliptical site-synchronous orbit with the required characteristics, and the 275 km periapse altitude provides the best lighting conditions for both the south-north sweep and the sweep from the North Pole to 55°S. The situation is similar at the end of the arrival period, although a small periapse rotation at insertion is required.

The advantages of such an orbit are evident. It allows landers to be placed anywhere on the Martian surface at reasonable lighting conditions and at the desired entry angle. A measure of redundancy is afforded by the second sweep from 90°N to 55°S. (This sweep could be used as backup in the event of failed landings on the first sweep.) The polar landers would be deployed from orbit instead of approach, and would enter at the nominal entry angle. The option exists to deploy all the landers from orbit, thereby eliminating the need for two deployment techniques, and avoiding the larger landing dispersion of approach-deployed landers.

The major disadvantage of this orbit design is the 160 day wait time required before lander deployment. This interval is largely unavoidable, as the orbit only slowly drifts into the required solar geometry. It should be noted, however, that for the 1998 opportunity, the wait interval allows the dust storm season to pass before first deployment. The time could be used for other purposes as well, such as aeronomy measurements. The carrier could be placed in an orbit with a lower periapse, and then elevated to the 275 km altitude for a small investment in ΔV.

CONCLUSIONS

A 1/5 sol, polar orbit with a periapse altitude of 275 km offers the best circumstances for orbital deployment of the Global Network Mission landers. It allows easy polar access at nominal entry angles, and global dispersal of landing sites at lighting angles suitable for descent imaging. The polar orbit allows the option of deploying all the landers from orbit. A wait interval of 160 days after arrival is required before deployment can commence.

REFERENCES

1. Atkins, K., and Muirhead, B., "Mission Concept and Development for Mars Global Network Mission", Sept. 15, 1989, report from the Exploration Precursors Task Team (JPL) to the Office of Space Science and Applications.

2. Knocke, P., "Global Network Mission Analysis", NASA Jet Propulsion Laboratory Interoffice Memorandum 312/89.2-1581, December 15, 1989.

LANDER DEPLOYMENT FROM ORBIT

De-orbit ΔV applied tangentially and parallel to entry velocity vector.

Entry Interface: 125 km altitude, -20° entry flight path angle

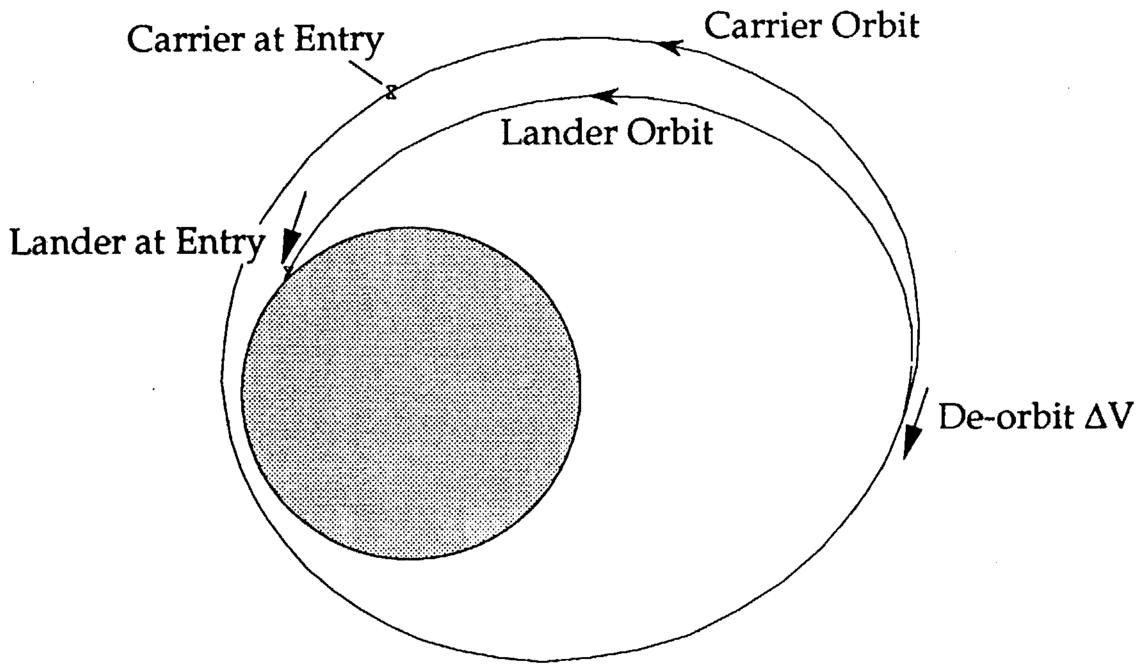

Figure 1

45° ORBIT: SUN ELEVATION VS. IMPACT LATITUDE

i=45°, 1/5 sol, 200 km periapse altitude

North Approach, Start of Arrival Period

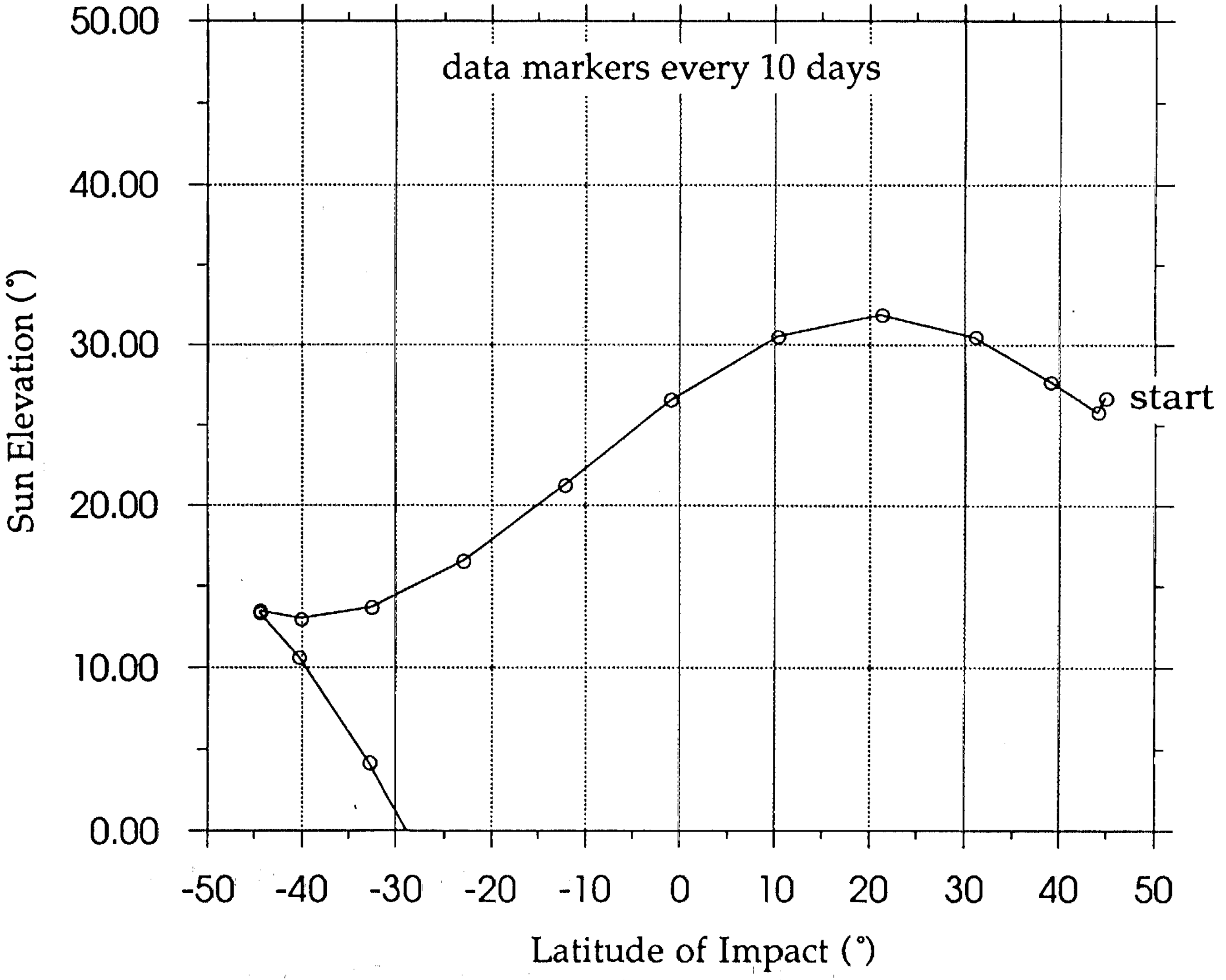

Figure 2

POLAR ORBIT: SUN ELEVATION VS. IMPACT LATITUDE

i=90°, 1/5 sol, 275 km periapse altitude

North Approach, Start of Arrival Period

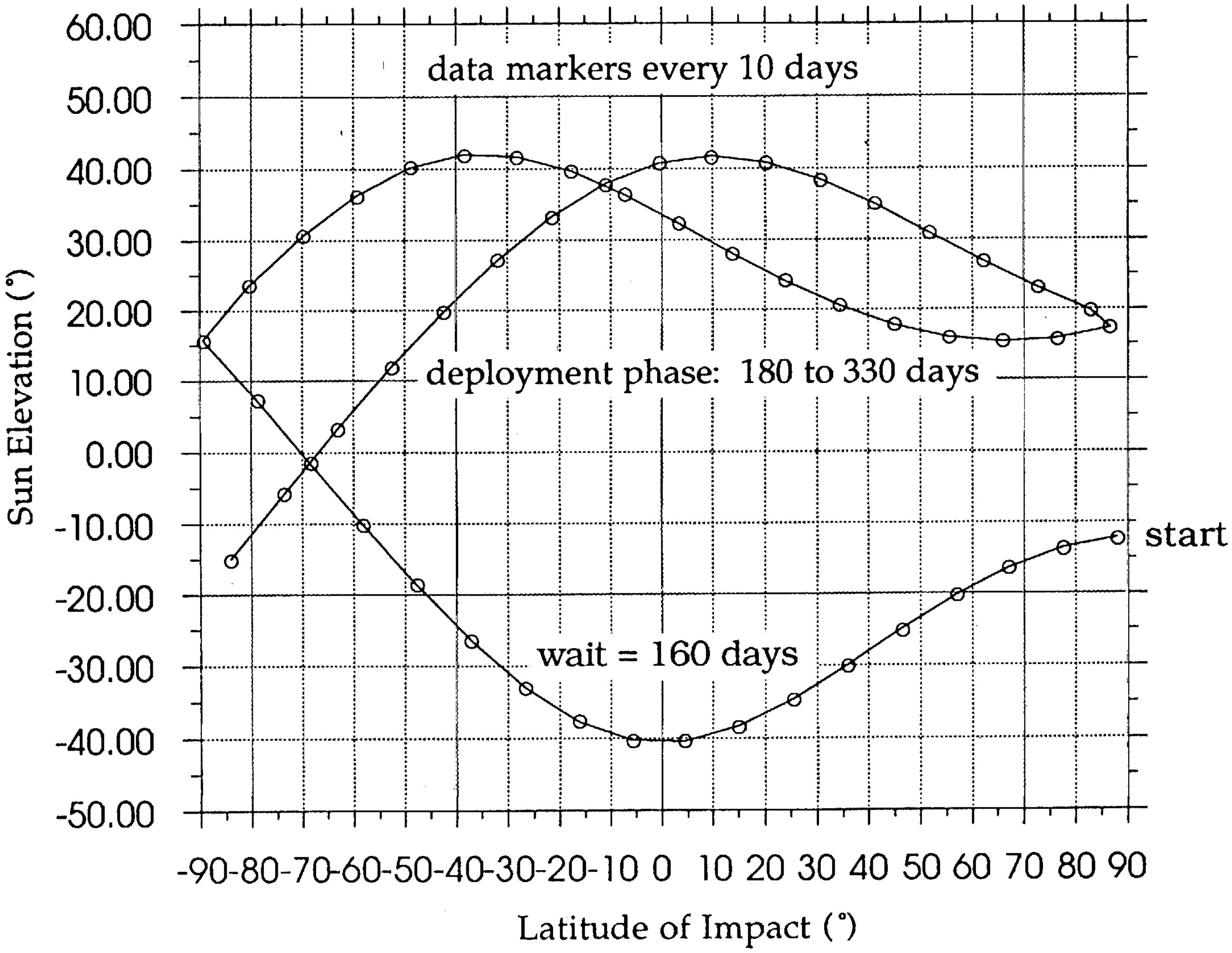

Figure 3

POLAR ORBIT: 200 DAYS AFTER ARRIVAL
(2000/04/14)

ENTRY: 125 km ,- 20° , 4.2 km/s

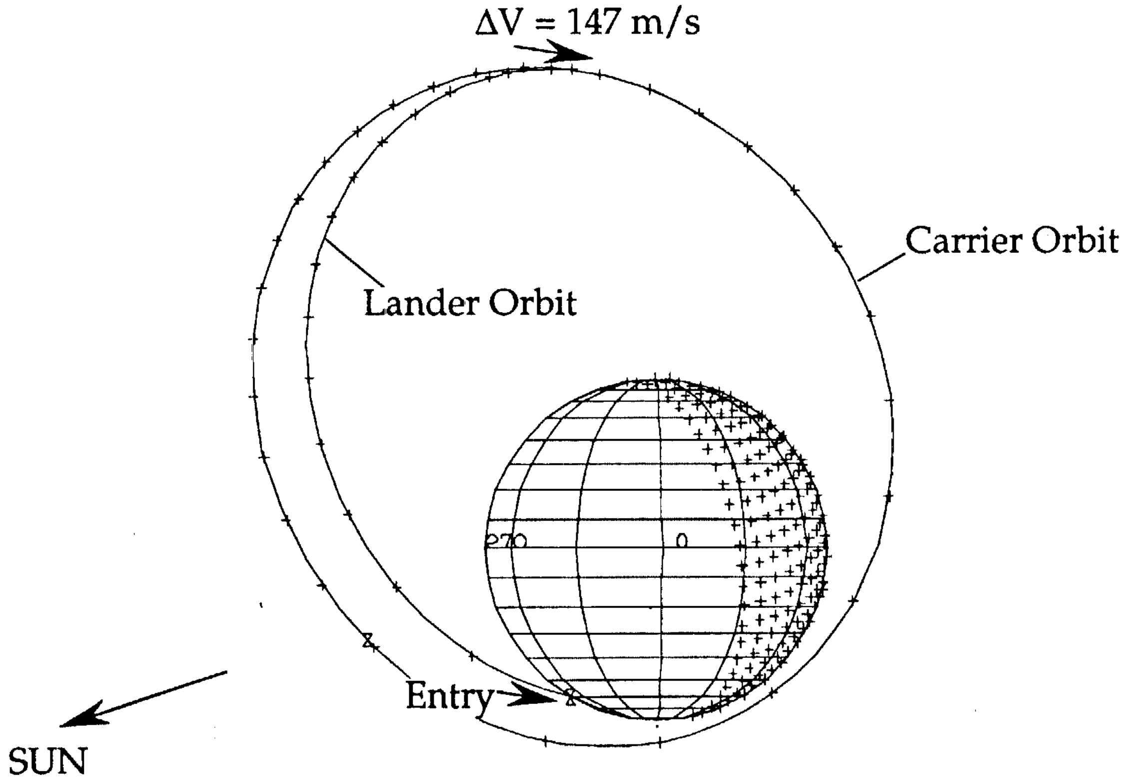

Figure 4

POLAR ORBIT: 300 DAYS AFTER ARRIVAL
(2000/07/25)

ENTRY: 125 km ,- 20° , 4.2 km/s

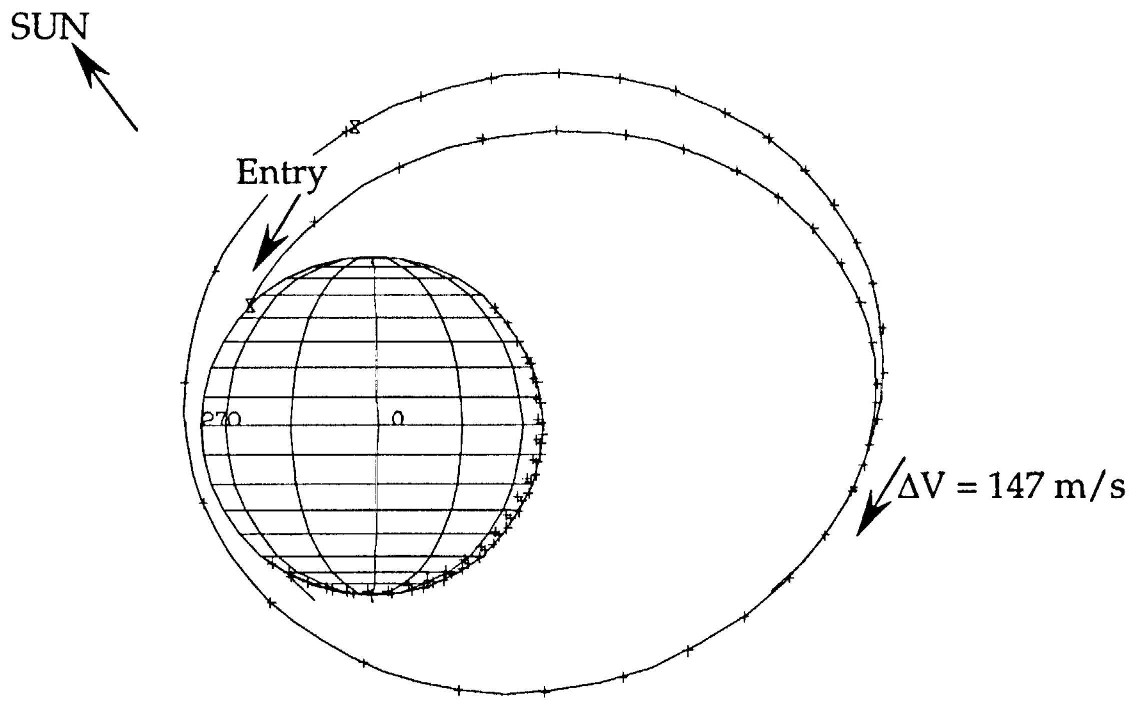

Figure 5

Session B, Submittal No. 2

Arden Albee
California Institute of Technology

Jim Burke and Robert Mostert
Jet Propulsion Laboratory/California Institute of Technology

MARS GLOBAL NETWORK SURFACE LANDERS

SYSTEMS DESIGN OPTIONS

ARDEN ALBEE

CALTECH

JIM BURKE
ROBERT MOSTERT

JPL

SYSTEM CONSIDERATIONS FOR MARS NETWORK SURFACE LANDERS

OBJECTIVES:

- PRIORITIZE MISSION GOALS RELATIVE TO 90 DAY STUDY (REF: 12/15/89)

- IDENTIFY MISSION CONSTRAINT(S)

  (a) Mission requires multiple landers for several sites ((O) = 20)
  (b) Mission requires long lifetime for successful data acquisition

- NEED TO CONSIDER MEANS TO:

  (a) Increase number of lander sites (90 day study = 12)
  (b) Reach higher latitudes (90 day study constrained by α = 15-20 deg)
  (c) Take advantage of prioritized goals to assess system designs

APPROACH:

- ASSESS IMPACT OF EACH POSSIBLE GOAL ON SYSTEM DESIGN

- SKETCH SYSTEM CONCEPTS COMPATIBLE WITH DIFFERENT SETS OF GOALS: ALTERNATIVE OR DUAL DESIGNS

  (a) Raises question of doing everything with one design
  (b) Two simple designs vs. one complex design

- DEFINE DEVELOPMENTS NEEDED FOR SYSTEM OPTIONS CONSIDERED PROMISING

DESIRED RESULT:

- BETTER KNOWLEDGE OF GOALS ⟷ DESIGN POSSIBILITIES;

  ∴ BETTER KNOWLEDGE OF DEVELOPMENT PRIORITIES

RNM
2/6/90

GOAL OBJECTIVES, SETS AND CONSTRAINTS

OBJECTIVES GROUP INTO THREE SETS:

	CONSTRAINT(S)
A) SIMPLEST SURFACE LANDER:	
LONG-LIFE METEOROLOGY LONG-LIFE SEISMOLOGY	RTGs vs. solar panels; small data rate, large quantity; power and thermal considerations
SURFACE CHEMISTRY	Additional feature to simplest lander
B) ADDITION TO SIMPLE LANDER (SUBSET OF (A)):	
DESCENT IMAGING POST-LANDING IMAGING	Lighting conditions; high data rate or store/readout; modest total quantity; relies on impact survival
C) OTHER ADDITIONS TO SIMPLE LANDER (W/WO IMAGING):	
SUBSURFACE SEISMOLOGY SUBSURFACE CHEMISTRY SUBSURFACE VOLATILES	Small data rate and quantity; long-life goal; power and thermal considerations; requires sample or instrument to be subsurface; favors penetrators

SOME GOAL IMPLICATIONS

A) POLAR LANDINGS	High entry angles; more TPS and aerodeceleration demand.
B) MAXIMUM DISPERSAL AND NUMBER OF SITES	Favors singly launched landers from S/C; favors smaller, simpler landers.
C) CONSTRAINTS ON EXPERIMENT DESIGN	Size, mass, volume, power, thermal, lifetime, data compression.

RNM
2/6/90

GOALS GROUP INTO THREE CLASSES

(1) WANT TO BE BELOW SURFACE (M's), CAN BE SHORT-LIVED, SMALL DATA RATE AND QUANTITY

(EXAMPLES: CHEMISTRY, VOLATILES DETECTION)

(2) MUST BE LONG-LIVED (~YRS), CAN BE AT SURFACE, SMALL DATA RATE, LARGE TOTAL QUANTITY

(EXAMPLES: SEISMOLOGY, METEOROLOGY)

(3) MORE COMPLEX, CAN BE SHORT-LIVED, EITHER HIGH DATA RATE OR STORE/READOUT, MODEST TOTAL QUANTITY

(EXAMPLES: DESCENT IMAGING, POST-LANDING IMAGES)

RNM
2/6/90

SYSTEM OPTIONS

- o VIKING/SURVEYOR-TYPE LARGE SOFT LANDERS - RULED OUT BASED ON SIZE AND BY NUMBER DESIRED FOR MISSION (NETWORK DESIGN)
- o SOVIET-TYPE "ROUGH" LANDERS - TOUCHDOWN PROXIMITY RETRO
- o CSAD-TYPE "SLOW IMPACTERS" (E.G. RANGER 3-5)
- o DESCENT IMAGERS THAT CRASH (E.G. RANGER 6-9)
- o DESCENT IMAGERS DESIGNED TO SURVIVE AND SEND IMAGE(S) AFTER LANDING
- o RUGGED LANDERS (HIGH "G") = PENETRATORS

⇒ NETWORK MISSION CONCEPT REQUIRES MANY SITES

POST-LANDING SURVIVAL (IT CAN BE BRIEF)
DESIRABLE AT THE NETWORK SITES

∴ CHOICE IS NARROWED TO "HIGH G (PENETRATOR AFTERBODY)" VS "MODERATE G" LANDERS WHERE "HI" $>10^3$; "MODERATE" 10's OF G's

RNM
2/6/90

PROS AND CONS OF ALTERNATIVE LANDER TECHNIQUES

	PROS	*CONS*
o BUS DEFLECTION	GOOD TARGETING; SIMPLIFIES LANDERS; USES EXISTING BUS SUBSYSTEMS	QUARANTINE
o LANDER DEFLECTION	QUARANTINE; SIMPLIFIES SEQ.	LANDERS MAY NOT ALL BE THE SAME
o NARROW ENTRY ANGLE TOLERANCE	SIMPLIFIES TPS DESIGN	MAY NOT REACH POLES
o WIDE ANGLE TOLERANCE	EXPANDS REACHABLE LATITUDES	MORE TPS, AERODECEL.
o STACKED ON AEROSHELL	SIMPLIFIES LANDERS	DISPERSAL IN PAIRS, SETS
o TPS FOR EACH LANDER	MORE SITES REACHABLE	COMPLICATES LANDERS
o LIFTING ENTRY	MORE DISPERSION	LARGER ERR. ELLIPSES
o PARACHUTES	SIMPLE	MAY LIMIT ANGLE TOL.
o BALLUTES	MORE ANGLE TOLERANCE	DIFFICULT
o AUTOGYROS	MAY ALLOW GOOD IMAGING	NEEDS R & D
o AEROSHELL/(L/D) SHAPES	COMBINES FUNCTIONS	MAY AFFECT PACKING
o IMPACT LIMITER	WELL TESTED	WITHSTANDS 100'S G's
o ROUGH OR HARD LANDERS	SIMPLEST	SOME MAY FAIL
o PENETRATORS	PACKING	LONG-LIFE POWER, THERMAL
o TERMINAL ROCKETS	WELL USED	ADDS MASS TO SYSTEM

RNM
2/6/90

A SUMMARY OF GOAL IMPLICATIONS

o DESCENT IMAGING	HIGH-RATE TELEMETRY AND/OR STORAGE, BUT STORAGE RELIES ON IMPACT SURVIVAL
o POST-LANDING IMAGING	RELIES ON IMPACT SURVIVAL
o LONG LIFE	PRIMARY IMPLICATION IS ON LANDER POWER/THERMAL SYSTEMS
o POLAR LANDINGS	HIGH ENTRY ANGLES; THUS MORE TPS AND AERODECELERATION DEMAND (NOTE: ENTRY "G's" MAY STILL BE LESS THAN TERMINAL DECELERATION "G's")
o MAXIMUM DISPERSAL	FAVORS NOT ENTERING IN PAIRS OR SETS AS A RESULT OF BEING STACKED ON AEROSHELLS
o MAXIMUM NUMBER OF TOTAL SITES DESIRABLE	FAVORS SMALLER, SIMPLER LANDERS
o SUBSURFACE MEASUREMENTS	FAVORS PENETRATORS, EITHER DROPPING IN OR DRIVEN IN
o CONSTRAINTS ON EXPERIMENTS	SIZE, MASS, VOLUME, POWER, THERMAL, LIFETIME, DATA COMPRESSION

RNM
2/6/90

SYSTEMS DESIGN TREE

1) S/C ORBIT TRAJECTORY FOR RELEASING LANDERS	ON APPROACH	FROM ORBIT			
2) INITIAL LANDER TRAJECTORY CONTROL	BUS DEFLECTED	LANDER DEFLECTED	LANDER RETRO		
3) AIM POINT AT ENTRY	CONSTRAINED	UNCONSTRAINED			
4) HIGH/HOT DECELERATION HYPERSONIC to TRANSONIC	STACKED BEHIND AEROSHELLS	OWN TPS	GUIDED ENTRY		
5) LOW ATMOSPHERE DECELERATION (SUPERSONIC TO SUBSONIC)	BALLUTE	PARACHUTES	SHAPES DRAG PLATE	WINGS/AUTOGYRO (MAPLE LEAF)	SHUTTLECOCKS
6) TERMINAL DECELERATION	DESCENT ROCKETS	PROXIMITY ROCKET	IMPACT LIMITER		
7) LANDERS	SOFT LANDER	ROUGH LANDER	HARD LANDER	PENETRATORS	
8) TELEMETRY	DIRECT XMIT TO EARTH	RELAY TO ORBITER	RECEIVER		

MISSION GOALS:

SURFACE OBSERVATIONS	SUBSURFACE OBSERVATIONS
1) LONG LIFE SEISMOLOGY	1) SHORT LIFE SEISMOLOGY
2) LONG LIFE METEOROLOGY	2) SHORT LIFE METEOROLOGY
3) POST-LANDING IMAGING	3) SUBSURFACE CHEMISTRY
4) SURFACE CHEMISTRY	4) SUBSURFACE VOLATILES

RNM
2/6/90

90 DAY STUDY RESULTS

1)	S/C ORBIT TRAJECTORY FOR RELEASING LANDERS	***ON APPROACH***	***FROM ORBIT***			
2)	INITIAL LANDER TRAJECTORY CONTROL	***BUS DEFLECTED***	***LANDER DEFLECTED***	LANDER RETRO		
3)	AIM POINT AT ENTRY	***CONSTRAINED***	UNCONSTRAINED			
4)	HIGH/HOT DECELERATION HYPERSONIC to TRANSONIC	***STACKED BEHIND AEROSHELLS***	OWN TPS	GUIDED ENTRY		
5)	LOW ATMOSPHERE DECELERATION (SUPERSONIC TO SUBSONIC)	BALLUTE	***PARACHUTES***	SHAPES	WINGS/AUTOGYRO (MAPLE LEAF)	SHUTTLECOCKS
			DRAG PLATE			
6)	TERMINAL DECELERATION	DESCENT ROCKETS	PROXIMITY ROCKET	IMPACT LIMITER		
7)	LANDERS	SOFT LANDERS	ROUGH LANDERS	HARD LANDERS	***PENETRATORS***	
8)	TELEMETRY	DIRECT XMIT TO EARTH	***RELAY TO ORBITER***	RECEIVER		

ISSUE	PRO VS.	CON
BUS DEFLECTION	GOOD TARGETING, SIMPLIFIES DESIGNS, USE OF EXISTING BUS SYSTEM	QUARANTINE
LANDER DEFLECTION	QUARANTINE, SIMPLIFIES SEQUENCE	REQUIRES DELTA V AND SPIN CAPABILITY
NARROW ENTRY ANGLE	SIMPLIFIES AEROSHELL TPS DESIGN	DIFFICULT TO REACH POLES
STACKED ON AEROSHELLS	SIMPLIFIES LANDER	DISPERSAL IN PAIRS OR SETS
PARACHUTES	SIMPLE	LIMITS ANGLE TOLERANCE
PENETRATOR	SIMPLIFIES SUBSURFACE OBSERVATIONS	DIFFICULT; POWER AND THERMAL CONSIDERATIONS

RNM
2/6/90

OVERALL DISADVANTAGE: MISSION HAS ONLY 6 PAIRS OF LANDERS; EACH PAIR TO BE DELIVERED TO THE SAME REGION

SAIC 1970'S RESULTS

1)	S/C ORBIT TRAJECTORY FOR RELEASING LANDERS	ON APPROACH	***FROM ORBIT***		
2)	INITIAL LANDER TRAJECTORY CONTROL	BUS DEFLECTED	***LANDER DEFLECTED***	***LANDER RETRO***	
3)	AIM POINT AT ENTRY	***CONSTRAINED***	UNCONSTRAINED		
4)	HIGH/HOT DECELERATION HYPERSONIC to TRANSONIC	STACKED BEHIND AEROSHELLS	***OWN TPS***	GUIDED ENTRY	
5)	LOW ATMOSPHERE DECELERATION (SUPERSONIC TO SUBSONIC)	PARACHUTES	***BALLUTE***	SHAPES DRAG PLATE	WINGS/AUTOGYRO (MAPLE LEAF)	SHUTTLECOCKS
6)	TERMINAL DECELERATION	DESCENT ROCKETS	PROXIMITY ROCKET	IMPACT LIMITER	
7)	LANDERS	SOFT LANDERS	ROUGH LANDERS	HARD LANDERS	***PENETRATORS***
8)	TELEMETRY	DIRECT XMIT TO EARTH	***RELAY TO ORBITER***	RECEIVER	

ISSUE	PRO VS.	CON
LANDER DEFLECTION	QUARANTINE, SIMPLIFIES SEQUENCE	REQUIRES DELTA V
NARROW ENTRY ANGLE	SIMPLIFIES TPS DESIGN	DIFFICULT TO REACH POLES
TPS FOR EACH LANDER	RANGE OF SITES REACHABLE AVAILABLE	COMPLICATES LANDERS
BALLUTES	MORE ANGLE TOLERANCE	DIFFICULT
PENETRATORS	SIMPLIFIES SUBSURFACE OBSERVATIONS	DIFFICULT; SHORT-LIVED

OVERALL DISADVANTAGE: MISSION DESIGNED TO HAVE ONLY 4-6 LANDERS; SHORT LIFETIME

RNM
2/6/90

AMES 1977 RESULTS

1) S/C ORBIT TRAJECTORY FOR RELEASING LANDERS — ***ON APPROACH*** | FROM ORBIT

2) INITIAL LANDER TRAJECTORY CONTROL — ***BUS DEFLECTED*** | LANDER DEFLECTED | LANDER RETRO

3) AIM POINT AT ENTRY — ***CONSTRAINED*** | UNCONSTRAINED

4) HIGH/HOT DECELERATION HYPERSONIC to TRANSONIC — STACKED BEHIND AEROSHELLS | ***OWN TPS*** | GUIDED ENTRY

5) LOW ATMOSPHERE DECELERATION (SUPERSONIC TO SUBSONIC) — BALLUTE | PARACHUTES | SHAPES | ***DRAG PLATE*** | WINGS/AUTOGYRO (MAPLE LEAF) | SHUTTLECOCKS

6) TERMINAL DECELERATION — DESCENT ROCKETS | PROXIMITY ROCKET | IMPACT LIMITER

7) LANDERS — SOFT LANDERS | ROUGH LANDERS | HARD LANDERS | ***PENETRATORS***

8) TELEMETRY — DIRECT XMIT TO EARTH | ***RELAY TO ORBITER*** | RECEIVER

ISSUE	PRO VS.	CON
LANDER DEFLECTION	QUARANTINE, SIMPLIFIES SEQUENCE	RETRO FROM SPACECRAFT; REQUIRES OWN TPS
NARROW ENTRY ANGLE	SIMPLIFIES TPS DESIGN	DIFFICULT TO REACH POLES
DRAG PLATE	ALLOWS ONE LANDER PER PLATE	DIFFICULT
PENETRATORS	SIMPLIFIES SUBSURFACE OBSERVATIONS	DIFFICULT; POWER AND THERMAL CONSIDERATIONS

OVERALL DISADVANTAGE: MISSION DESIGNED TO HAVE ONLY 3 LANDERS; DIFFICULT TO ESTABLISH A TRUE GLOBAL NETWORK

RNM
2/6/90

VIKING RESULTS

1) S/C ORBIT TRAJECTORY FOR RELEASING LANDERS — ON APPROACH | ***FROM ORBIT***

2) INITIAL LANDER TRAJECTORY CONTROL — ***BUS DEFLECTED*** | LANDER DEFLECTED | LANDER RETRO

3) AIM POINT AT ENTRY — ***CONSTRAINED*** | UNCONSTRAINED

4) HIGH/HOT DECELERATION HYPERSONIC to TRANSONIC — STACKED BEHIND AEROSHELLS | ***OWN TPS*** | GUIDED ENTRY

5) LOW ATMOSPHERE DECELERATION (SUPERSONIC TO SUBSONIC) — BALLUTE | ***PARACHUTES*** | SHAPES | DRAG PLATE | WINGS/AUTOGYRO (MAPLE LEAF) | SHUTTLECOCKS

6) TERMINAL DECELERATION — ***DESCENT ROCKETS*** | PROXIMITY ROCKETS

7) LANDERS — ***SOFT LANDERS*** | ROUGH LANDERS | HARD LANDERS | PENETRATORS

8) TELEMETRY — ***DIRECT XMIT TO EARTH*** | ***RELAY TO ORBITER*** | ***RECEIVER***

ISSUE	PRO	VS.	CON
BUS DEFLECTION	GOOD TARGETING, SIMPLIFIES LANDER		QUARANTINE
WIDE ANGLE TOLERANCE	EXPANDS REACHABLE LATITUDES		MORE TPS NECESSARY
AEROSHELL	ONE LANDER PER AEROSHELL, SIMPLIFIES ATMOSPHERIC TPS		AFFECTS PACKAGING
SOFT LANDER	HAS BEEN ACCOMPLISHED; LONG-LIVED; SIMPLIFIES POWER CONSIDERATIONS		LARGE; DIFFICULT TO GET DESIRED NUMBER

OVERALL DISADVANTAGE: MISSION AS DESIGNED HAD ONLY 1 LANDER PER S/C; DOES NOT CONSTITUE A GLOBAL NETWORK W/O SEVERAL SPACECRAFT

RNM
2/6/90

MARS 3 RESULTS

1) S/C ORBIT TRAJECTORY FOR RELEASING LANDERS — ***ON APPROACH*** | FROM ORBIT

2) INITIAL LANDER TRAJECTORY CONTROL — BUS DEFLECTED | ***LANDER DEFLECTED*** | ***LANDER RETRO***

3) AIM POINT AT ENTRY — ***CONSTRAINED*** | UNCONSTRAINED

4) HIGH/HOT DECELERATION HYPERSONIC to TRANSONIC — STACKED BEHIND AEROSHELLS | ***OWN TPS*** | GUIDED ENTRY

5) LOW ATMOSPHERE DECELERATION (SUPERSONIC TO SUBSONIC) — ***BALLUTE*** | ***PARACHUTES*** | SHAPES | WINGS/AUTOGYRO (MAPLE LEAF) | SHUTTLECOCKS | DRAG PLATE

6) TERMINAL DECELERATION — DESCENT ROCKETS | ***PROXIMITY ROCKET*** | IMPACT LIMITER

7) LANDERS — SOFT LANDERS | ***ROUGH LANDERS*** | HARD LANDERS | PENETRATORS

8) TELEMETRY — DIRECT XMIT TO EARTH | ***RELAY TO ORBITER*** | RECEIVER

ISSUE	PRO	VS.	CON
LANDER DEFLECTION	QUARANTINE, SIMPLIFIES SEQUENCE		REQUIRES DELTA V AND SPIN CAPABILITY
NARROW ENTRY ANGLE	SIMPLIFIES TPS DESIGN		MAY BE DIFFICULT TO REACH POLES
BALLUTE	MORE ANGLE TOLERANCE		DIFFICULT
PARACHUTES	SIMPLE		LIMITS ANGLE TOLERANCE
TPS FOR EACH LANDER	RANGE OF SITES REACHABLE		COMPLICATES LANDERS

RNM
2/6/90

Session B, Submittal No. 3

Alan L. Friedlander
Science Applications International Corporation

A GLOBAL VIEW OF LANDER-TO-ORBITER COMMUNICATIONS ACCESSIBILITY FOR A MARS GLOBAL NETWORK MISSION

ALAN FRIEDLANDER
SAIC