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OVERVIEW OF MICROWAVE CONCEPTS

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LEO TO GEO AND RETURN TRANSPORT

POSSIBLE APPLICATION SCENARIOS FOR BEAMED POWER

SPACE BASED APPLICATIONS

- SPACE-TO-SPACE
- SPACE-TO-PLANETARY SURFACE

PLANETARY SURFACE BASED OPERATIONS

- SURFACE-TO-SURFACE
- SURFACE-TO-ORBIT

THE SCENARIOS PRESENTED HERE ARE NOT THE RESULT OF ANY "DETAILED" ANALYSIS. THEY REPRESENT "ZERO th ORDER" ESTIMATIONS AND ARE PRESENTED TO FOSTER DISCUSSION ON THE VIABILITY OF BEAMED POWER TRANSMITTION.

BEAM POWER TRANSMISSION

APPLICATIONS: SPACE BASED OPERATIONS - SPACE-TO-SPACE.

Concept	Ref. Technology	Pow. Level	Attributes	Benefits	Comments
Non-propulsive					
• Central sta. power for space complexes.		Multi-MW.	Isolation of nuclear power source from inhabited stations. Multiple users served from single source.	Reduced costs - Econ. of scale. - Reduced operat. costs. • Power costs in space reduced by one-half.	Space operations more complex; - Avoidance of beam paths. - May need relay stations. - Requires siting of facilities. Simplified station/satellite design; - Eliminates solar panels and storage for solar power systems.
• Power trans. to operational satellites.		100's to MW's.	Isolation of nuclear power source from user satellites. Higher payload mass fractions on satellites.	Reduced costs - Econ. of scale. - Reduced oper. costs. • Satellite payload increased by 20 percent.	Complex space operations; - Avoidance of beam paths. - Requires multiple power satellites for coverage. • Handover operations as satellites pass from one power source to another. Simplifies satellite design; - Same reason as above.
Propulsive					
• Orbit raising/ orbit operations.		Multi-MW.	Centralized power system/systems for LEO-GEO/orbital ops. electric propulsion vehicles. Increased payload mass fractions for transit vehicles.	Reduced costs - Econ. of scale. - Reduced oper. costs. • Vehicle payload increased by factor of 2.	Use of electrical propulsion for Earth-moon space orbit operations. - May extend trip time; questionable for manned operations. - May require multiple power sources for viable op's scenarios. • Roving power sources required? Simplified vehicle design; - Same reason as above.

KAF: BEAM POWER; JSF (166), 9/4/88.

BEAM POWER TRANSMISSION

APPLICATIONS: SPACE BASED OPERATIONS - SPACE-TO-PLANETARY SURFACE.

Concept	Ref. Technology	Pow./Level	Attributes	Benefits	Comments
Non-propulsive					
• Power for exploratory/ initial manned landing on Mars.		10's KWs.	No need to land power system for initial Mars landing team. • Uses excess power from Earth-Mars transit vehicle while in Mars "holding orbit".	Reduced mass of of Earth-Mars transit vehicle. - Separate power system not required for surface op's. • No estimate.	Requires electric propulsion Earth-Mars transit vehicle. - Multi-MW required for transit not needed at planet. Surface operations requires 10's KWs only. Cannot est. ben'fts at this time.
• Lunar/ planetary outpost power.		10's KWs.- 100's KWs.	Temporary/permanent power sources to support exploration activities. Power supply for a distributed surface infrastructure.	No need to land separate power system to support temporary outpost or exploration activities. • Reduce power costs by 1/2.	Requires "orbiting/stationary" power satellite. - Specialized orbit requirements. - May be attractive for low-power activities on surface. • Could use solar based power. - Could cover wide surface area.
• Space Power Satellite for terrestrial power.		GW's.	Solar power supply for terrestrial needs. Renewable energy resource its atmosph. intrusion.	Environmentally attractive system. • Protects the Earth's atmosphere	High inital cost. Transportation to orbit; - Launch system atmospheric effects. Environ. effects of power beam? Siting may be a problem.
Propulsive					
• Planetary rovers/ sample collectors.		KW's.	Reduced mass of rover system. Could service any number of rovers. - Rovers could be widely spread.	Higher rover pay-mass fraction - Greater mobility for rover. • Could increase rover P/L by 1/2.	Power to be supplied by orbiting satellite/station. - Specialized orbit requirements for orbiting station. - Rover must have provision for loss of beam (shadowing).
• Mars airplane.		10's KWs.	Could make Mars air-plane a viable con-cept for Mars exploration. - Extremely flexible exploration system.	Mars airplane does not need its own power source. - increase in range for plane. • No estimate of benefits.	Power to be supplied by orbiting satellite/station. - Specialized orbit requirements for orbiting station. - Could require a number of orbiting stations for vast surface coverage.

KAF: BEAM POWER: JSF (167) 9/4/88.

BEAM POWER TRANSMISSION

APPLICATIONS: PLANETARY SURFACE BASED OPERATIONS.

SURFACE-TO-SURFACE

Concept	Ref. Technology	Pow./Level	Attributes	Benefits	Comments
Non-propulsive					
• Central sta. power for surface complexes.		Multi-MW.	Isolation of nuclear power source from inhabited stations. Multiple users served from a single source.	Reduced costs - Econ. of scale. - Reduced operat. costs. - Eliminate land lines across hostile terr. • Reduce power costs by 2/3.	Requires some clustering of op's. - Could use fixed relay stations for widely spaced complexes. • Incurs additional transmission losses. - Eliminate maintenance of transmission/distribution system for "conventional" utility on planetary surface.
Propulsive					
• Planetary surface exploration vehicles. (Surface/ Air)		10-100 KW's.	Reduced mass of transportation systems. Could service any of trans. systems.	Higher transport system payload mass fractions. • Increase payload mass fraction by 50 percent	Power from fixed station may have to be augmented by relay stations. - Incurs additional transmission losses. Could result in a highly flexible transportation/exploration system with supporting infrastructure.

SURFACE-TO-ORBIT

Concept	Ref. Technology	Pow./Level	Attributes	Benefits	Comments
Non-propulsive					
• LEO-GEO orbit raising.		100's KW's. Multi-MW's.	Increased payload mass fraction of transport vehicle with electric propulsion.	Reduced cost of delivering mass to orbit. • Increase payload mass fraction by factor of 2.	Power system located on Earth surface. Operational complexity: - Requires LEO staging point. - Ascent in equatorial plane, • Plane change with electric propulsion impractical. - Power Station siting difficult. • Vehicle in-sight of station small portion of orbit. • Longer trip times. - Multiple stations may be needed to make this concept viable.

KAF: BEAM POWER: JSF (168), 9/5/88.