arrays used on Deep Space 1 used GaInP/GaAs high-efficiency dual-junction cells. A more advanced SCARLET-II array will build on the SCARLET technology with lower cost, easier fabrication, and simplified assembly and testing [14].

### 10.4.1 Thin-film Solar Cells

One of the first thin-film cells, $Cu_2S/CdS$, was developed for space applications. Reliability issues eliminated work on this particular cell type for both space and terrestrial considerations even though AM1.5 efficiencies in excess of 10% were achieved. Thin-film cells require substantially less material and thus lower mass and promise the advantage of large-area, low-cost manufacturing. Until recently, the focus in space cells has been on efficiency rather than cost. In a several billion dollar spacecraft the solar cell cost is relatively small at even a thousand dollars per watt, which is approximately the current array cost. This has primarily been true for spacecraft with power needs from a few hundred watts to tens of kilowatts. However, deployment of a large Earth-orbiting space power system or some of the proposed SEP missions will require major advances in the PV array weight, stability in the space environment, efficiency, and ultimately the cost of production and deployment of such arrays. The development of viable thin-film arrays has become a necessity for a host of space missions [37]. Mission examples include ultra-long duration balloons (e.g. Olympus), deep space SEP "tug" array, Mars surface power outpost, and Mars SEP Array (see Figure 10.9). Solar electric propulsion missions are those in which the solar array is used to provide power for an electric propulsion system such as a Hall thruster or an ion thruster. These missions require large, lightweight, low-cost power systems. Studies have shown that the specific power or power per mass that will be required (i.e. 1 kW/kg) cannot be achieved with single-crystal technology [30]. The specific power required is almost 40 times what is presently available in commercial arrays. While high-efficiency ultralightweight arrays are not likely to become commercially available anytime soon, advances in thin-film photovoltaics may still impact other space technologies (i.e. thin-film integrated power supplies) and thus support a broad range of future missions.

Lighter power generation will allow more mass to be allocated to the balance-of-spacecraft (i.e. more payload). In addition, less expensive power generation will allow

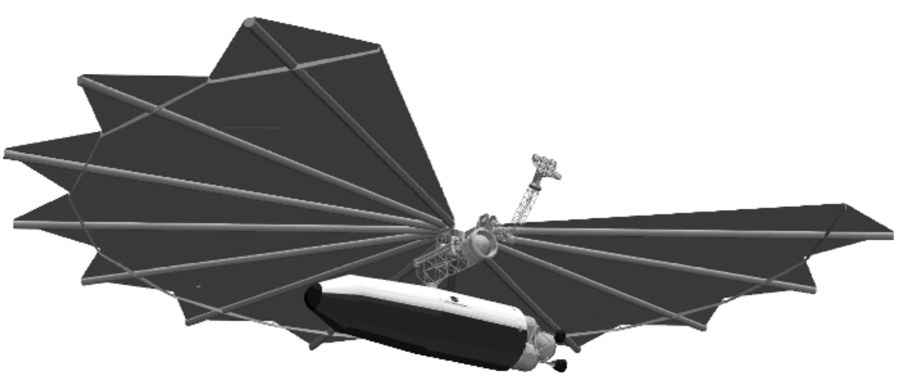

**Figure 10.9** Proposed Mars solar electric propulsion vehicle. (Picture courtesy of NASA)