

# Server Sky – Computation and Power in Orbit

Keith Lofstrom   <http://server-sky.com>   keithl@server-sky.com

*“Space Solar Power is a great dream, achievement of which is a great necessity for the 21<sup>st</sup> century world.”*

*- Dr. APJ Abdul Kalam*

**The problem:** Data centers consume almost 3% of US electrical power, and this fraction doubles every 5 years. The demand grows faster than efficiency improvements. Power generation is not growing to meet this increase in demand. Energy production scales with mechanical structure and land/habitat, which suffer from dis-economies of scale. Expensive first world data center strategies are not affordable or maintainable in the developing world.

**New possibilities:** The sun produces **380 trillion terawatts** which nature cannot use. Solar cells in space can be very thin, need no mechanical structure, and do not rob the biosphere of energy. Recent advances in solar cell materials and VLSI radiation hardness permit ultralight gram-scale satellites.

**Server Sky** converts space solar power into computation with arrays of thousands of tiny solid-state satellites. Each server sky **thinsat** is 20 cm across, 75 microns thick, and weighs **5 grams**. Aluminum foil substrates are covered with integrated circuits, radios, solar cells and slot antennas, propelled and steered by light pressure, networked and located by microwaves, and cooled by black body radiation.

Thinsats are stacked by the thousands in solid cylinders, and launched into **6400 km altitude** equatorial orbits, passing overhead 5 times a day. Thinsats are deployed into precisely located and actively-stabilized three-dimensional geodesic ellipsoidal arrays 80 meters across, with spacings of about a meter. An array weighing **40 kg** contains **8,000 thinsats**, producing **32 kilowatts** of power for computation and radios. Arrays act as phased array transmitters at **70 GHz**, producing ultra-narrow beams to many **sub-kilometer ground footprints** simultaneously. Phased array ground antennas may be attached to existing cell towers.

Thinsat arrays can also be used for radar location of space debris. The tanks of derelict rocket bodies may be captured and cut into gram-weight ballasts for ultralight thinsats, permitting lower launch mass. Failed thinsats converted to ballast prevent space debris, and escaped thinsats falling to LEO will deorbit in hours.

Server sky will launch in three phases, and: (1) Experimental co-payload launch of 100 thinsats, with a cold gas thruster to bring perigee above 1000 km for a 3 month mission, (2) 24 arrays launched with one PSLV class vehicle, (3) Exponential increase towards hundreds of launches per year, with 100% in-orbit recycling as ballast.

**The market:** New technologies emerging from development will be licensed to existing industry. First server sky deployments will be used for space debris tracking and satellite protection, with potential billion dollar revenues. Computation and internet markets will include global high bandwidth connections in the **rural developing world**, cell phone system augmentation ( education, speech recognition, translation, “sound web”), data centers for power-starved or insecure regions of the world. Very large arrays will someday beam power directly to local electrical grids, providing terawatt-level peak power worldwide with zero environmental impact. Solar system resources permit continued rapid growth and new market development for centuries.

**Server Sky for India:** India's rural cell network has 400,000 diesel powered cell towers, mostly interconnected by microwave repeaters. Gigabit internet service requires far more bandwidth and fuel consumption. Optical fiber reduces power needs, but requires powered repeaters is very expensive per kilometer of interconnect, especially in remote regions, and is easily disrupted by power failures, construction and landslide damage, and civil unrest. Prime Minister Narendra Modi envisions nationwide internet connections. Provision from space avoids terrestrial problems and exports growing Indian information technology expertise to the world from anywhere in the country.

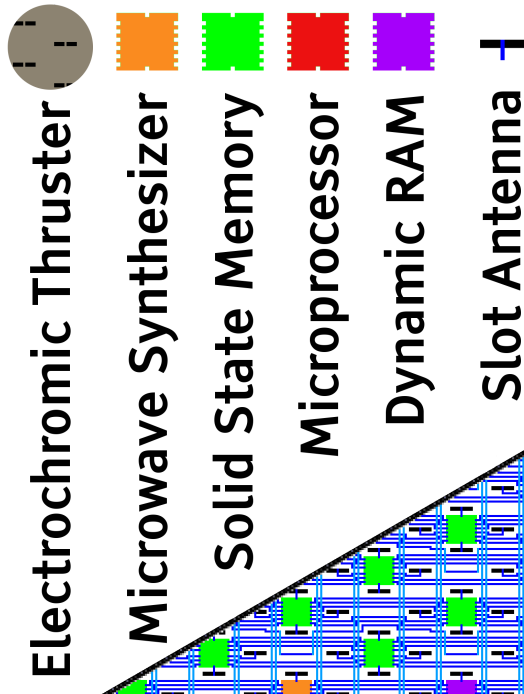
# Server Sky Thinsat

<http://server-sky.com>  
Version 5, 2014-08-20

80 micron thick  
aluminum foil  
substrate

20.5 cm wide  
18.4 cm tall  
240 cm<sup>2</sup>

5 grams  
4 watts



All chips drive 4  
slot antennas

## Back Side

Drawing is to  
page scale -  
chips are  
smaller  
than  
drawn

