Extremely Large Swarm Array of Picosats fro Microwave/RF Earth Sensing, Radiometry and Mapping

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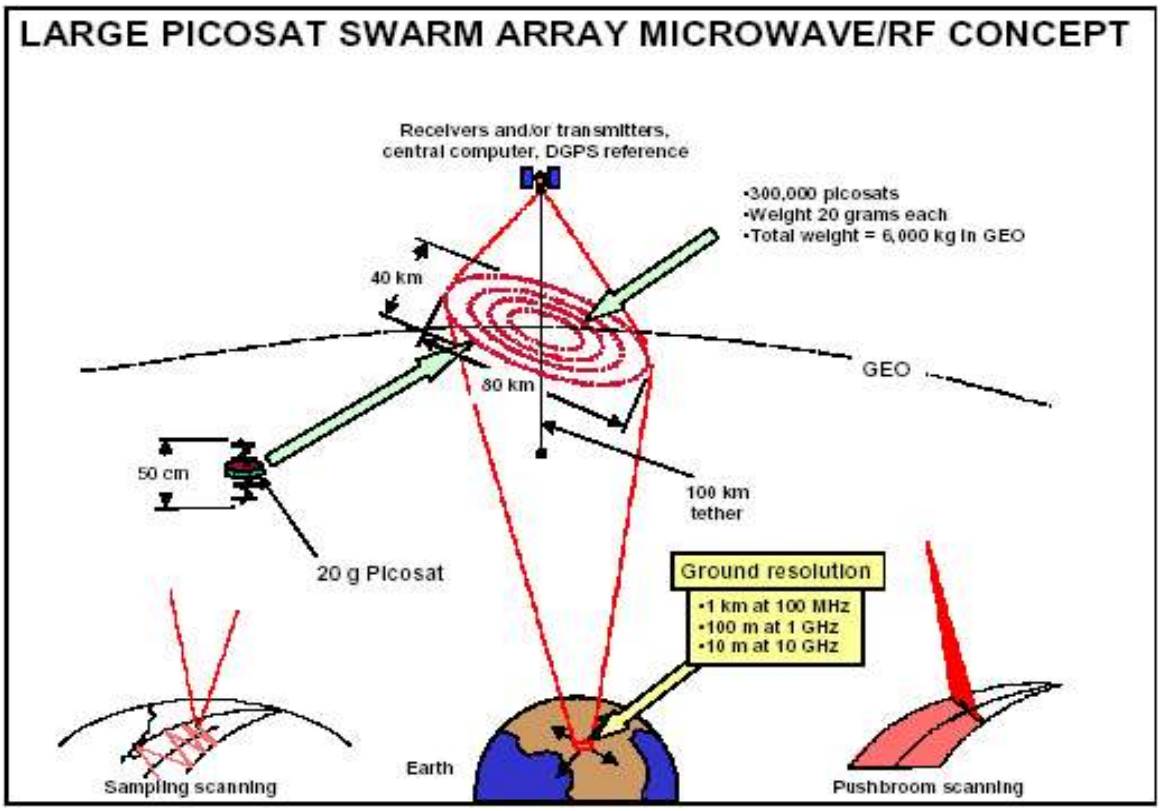
This proposal is principally intended to further the goals of NASA's Earth Science Enterprise. An extremely large yet very lightweight RF/microwave array in space is proposed to attain the small ground resolutions necessary to observe and characterize soil moisture content, atmospheric water content, snow accumulation levels, flooding, emergency management after hurricanes, weather and climate prediction, geological feature identification, and others.

Sensing of these features requires resolutions on the order of 100 meters at 1 GHz, so that from GEO an antenna size on the order of 100 kilometers is needed. In order to implement such enormous antennas at reasonable weight a highly sparse space-fed array antenna architecture is used for the concept, composed of a very large number of picosats that revolve in a large plane about their center in relative coordinates even though they are in Keplerian orbits. Station keeping propulsive requirements are reduced by over an order of magnitude and lack of antenna structure makes for a very low weight yet large effective aperture system. The position of the picosats is controlled only very loosely, each adjusting its own phase or time delay of signals received from the ground to compensate for its positional inaccuracies, so that the retransmitted signals from all arrive and add coherently at the receiver. The picosats determine their own position autonomously by using a local navigational environment established by a DGPS reference in the receiver spacecraft, held passively by a tether above the picosat swarm.

A typical system might have 300,000 picosats, each being a self-contained one-chip spacecraft weighing 20 grams. The complete space system thus might weigh no more than a practical 6,000 kg. The mass production of 600,000 identical spacecraft would bring about 2 orders of magnitude reduction in costs from current models, allow incremental emplacement, replacement, and upgrading. Though there is little question that this concept can work in principle, the proposed task structure will allow an assessment of the ability of the key technologies to function, both independently and as a system, and assess a system conceptual-level design's likely characteristics and performance. The likely system architecture of the concept will be explored, and its utility to NASA assessed via one or more Design Reference Missions, chosen by consultation with personnel from NASA's Earth Science Enterprise. Lastly the technologies and risks will be assessed, and the steps required to reduce the technology risks and develop the critical technologies identified; and overall feasibility of the concept assessed.


LARGE PICOSAT SWARM ARRAY MICROWAVE/RF CONCEPT
Receivers and/or transmitters,
central computer, DGPS reference
•300,000 picosats
•Weight 20 grams each
•Total weight = 6,000 kg in GEO
40 km
80 km
GEO
50 cm
100 km
tether
20 g Picosat
Ground resolution
•1 km at 100 MHz
•100 m at 1 GHz
•10 m at 10 GHz
Earth
Sampling scanning
Pushbroom scanning