An Integrated Homeland Security Surveillance System

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***Abstract* – We propose a novel module as the main building block of a wireless surveillance system for homeland security applications. The proposed module houses processors (DC, IF and Microwave), cameras and batteries rechargeable by solar energy. Conformal solar panel and antenna are mounted on at least two of its surfaces. At least one inclined surface for maximum sunlight exposure is required for the solar panel. Multi-beam property of the antenna together with the module side adjustment will cover a complete hemisphere which satisfies the line of sight communication at the desired microwave ISM band. A standard module has a fixed inside housing for processors and cameras and adjustable inclined surfaces for the solar panel and antenna mounting.**

***Keywords* – Security; wireless surveillance system; solar powered security system; homeland security**

I. INTRODUCTION

We propose a novel homeland security system based on an anatomical study approach of all the factors and building blocks. The system uses a modular design to form regional clusters; a regional headquarter (cluster head) collects ambient data from surveillance modules connected to the cluster. Regional landforms, nature of surveillance, required video resolution, assigned sensitivity level and "What if?" scenarios determine the number of surveillance modules that can be connected to a cluster head. The distance between the surveillance modules and the cluster head and the distances among the surveillance modules also depend on the stated factors which affect the number of modules that can be used in a cluster.

II. MODULE

The surveillance module is illustrated in Fig. 1. We propose a hexagonal pyramid structure for the module in order to satisfy several requirements at the same time: (i) The ***same module*** can be used between a wide range of latitudes, (ii) the same solar panel to satisfy (i), (iii) the same antenna to satisfy line of sight (LoS) communications and allowable maximum transmitted power, (iv) landscape formations and (v) easy and fast deployment.

Figs. 2 and 3 show module side adjustment and antenna and solar panel placement options, respectively. The panel size depends on the total power load and the PV-GIS data for the chosen location. The battery bank is designed to supply power to the processors for several months under worst-case conditions. Two of the hexagon's surfaces provide enough flexibility for a single or double (the same type) solar panel mounting for the desired power load at a specific location satisfying the dimensional coordinates and GMT-wise time limits stated in (i) above. Fig.2 shows the module side adjustment examples. One or more sides can be adjusted to satisfy LoS and solar panel angular requirements simultaneously at any location. Conformal antenna and solar panel placement options are given in Fig. 3. Fig. 4 is an illustration of the antenna beams of the novel array antenna. Five directional beams with the indicated angular coordinates combined with the module side adjustment can cover a complete hemisphere to satisfy LoS connection as illustrated in the figure. Any desired number of the standard module and this type of an antenna will allow immediate implementation of the system at any location. Fig. 5 illustrates a cluster implementation at 2.45 GHz ISM band. Any desired number of modules can be connected to the cluster head based on the format of the required surveillance data.

Suspect monitoring, camera zooming and autonomous communication among the modules are done by an intelligent decision making unit at the cluster head.

III. CONCLUSION

An autonomous novel solar-powered wireless system for homeland security is presented in this paper. The proposed integrated system is based on anatomical studies of all the components and factors associated with the system. A hexagonal unique module is used as the main building block for the proposed homeland security surveillance system. The proposed module houses the communication hardware and has inclined surfaces for optimum solar panel placement and antenna beam alignment for microwave LoS communications at the chosen ISM band(s).

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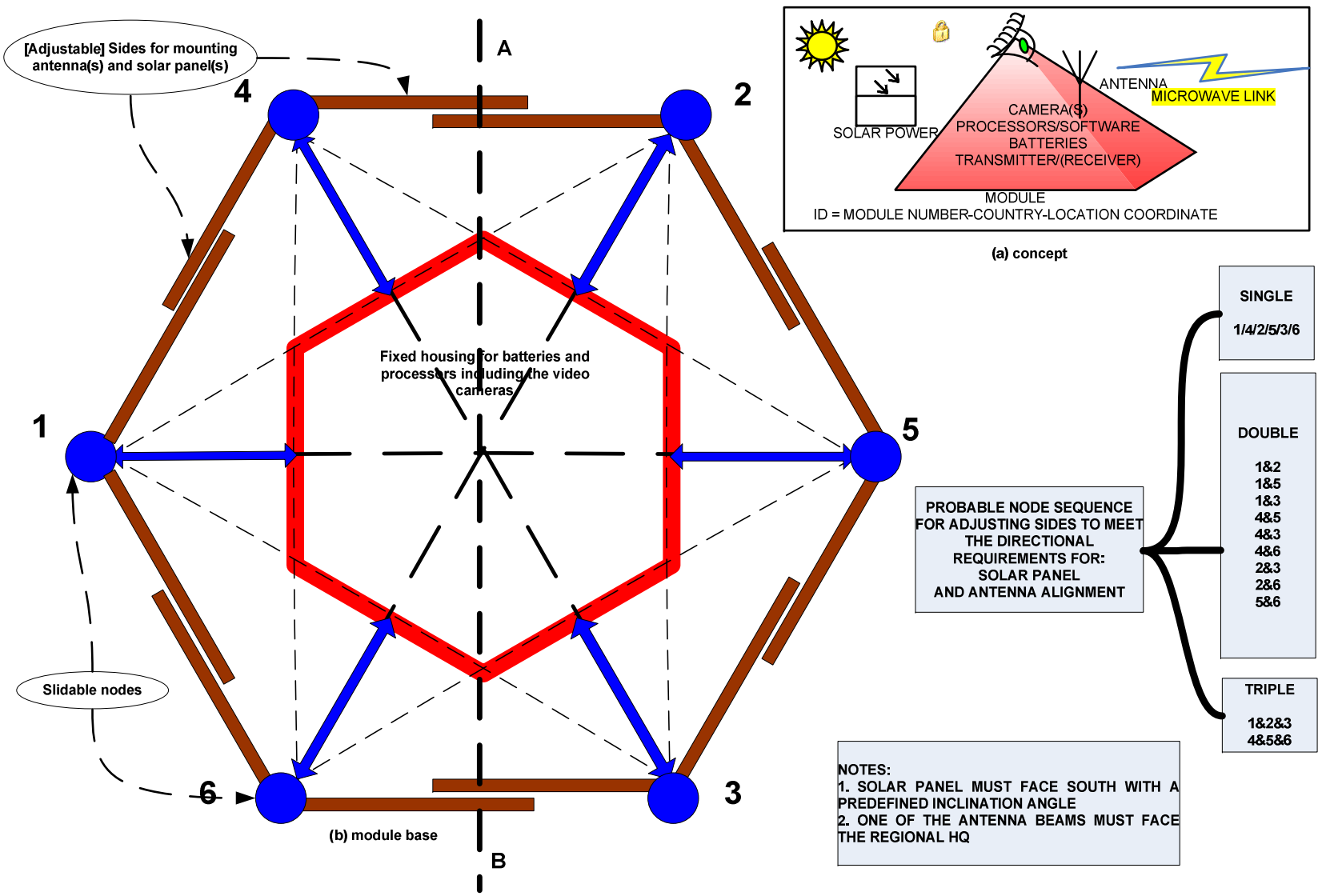


Fig. 1 Solar powered module: (a) Concept and (b) module base; nodes 1-6 are slidable as indicated by double arrows. The internal hexagon is the perimeter of the fixed housing.

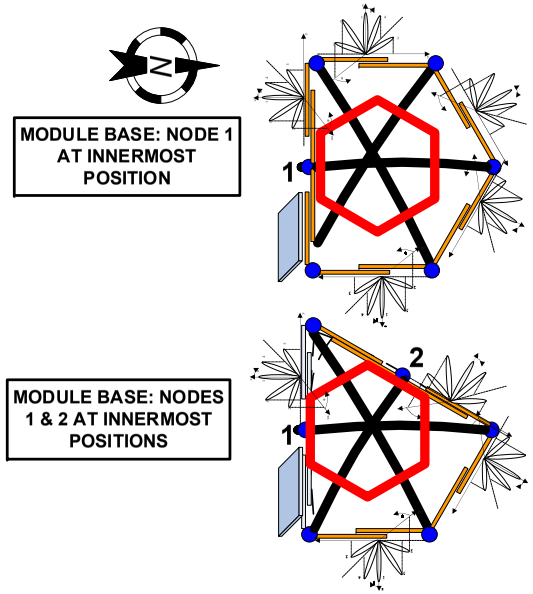


Fig. 2 Module side adjustment examples.

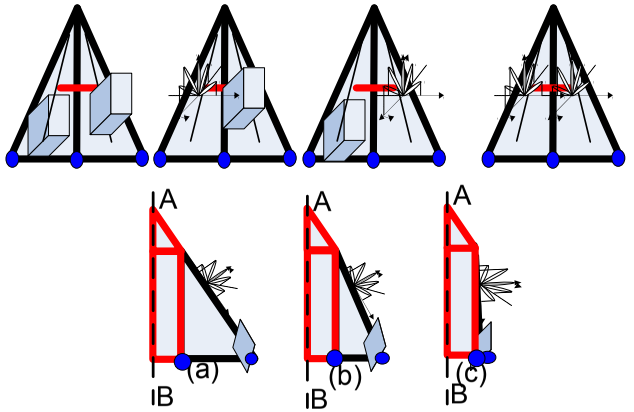
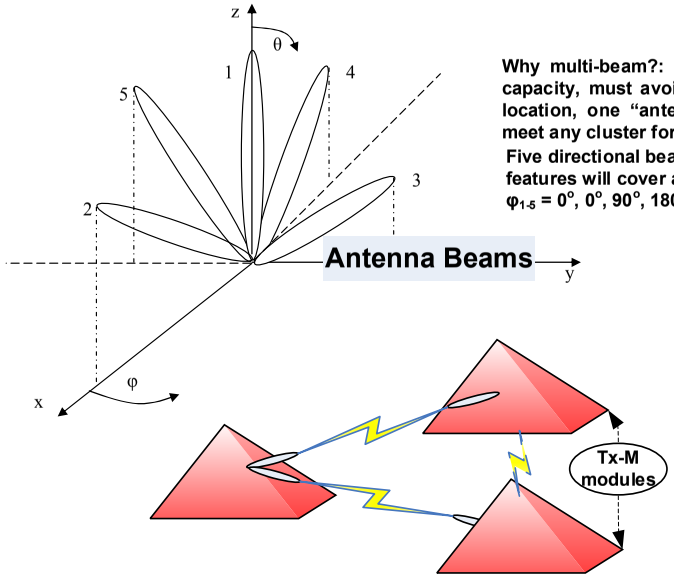


Fig. 3 Antenna and solar panel placement options and angular alignment examples.



Why multi-beam?: Landscape features, multi-signal, higher info capacity, must avoid different design requirement based on the location, one "antenna" together with module side adjustment meet any cluster formation needed for Line of Sight (LoS)

Five directional beams together with the module constructional features will cover a complete hemisphere. $\theta_{1\text{-}5}$ = 0°, 45°, 45°, 45°, 45° $\varphi_{1\text{-}5}$ = 0°, 0°, 90°, 180°, 270°

LoS illustrated with two transmitting (Tx-M) and a receiving (Rx-HQ-M) modules; modules may be placed at different altitudes. Distance between Tx-M and Rx-HQ-M depends on the regulations on the chosen frequency bands. Distance between Tx-M modules mainly depends on the desired video resolution and the sensitivity level. Multi-beam and multi-band properties of the antenna will also allow an option for establishing communication between modules which will result in multi-function and intelligent use of module clusters for intelligent surveillance and multi-purpose use of the system.

Fig. 4 Antenna Beams and LoS illustration.

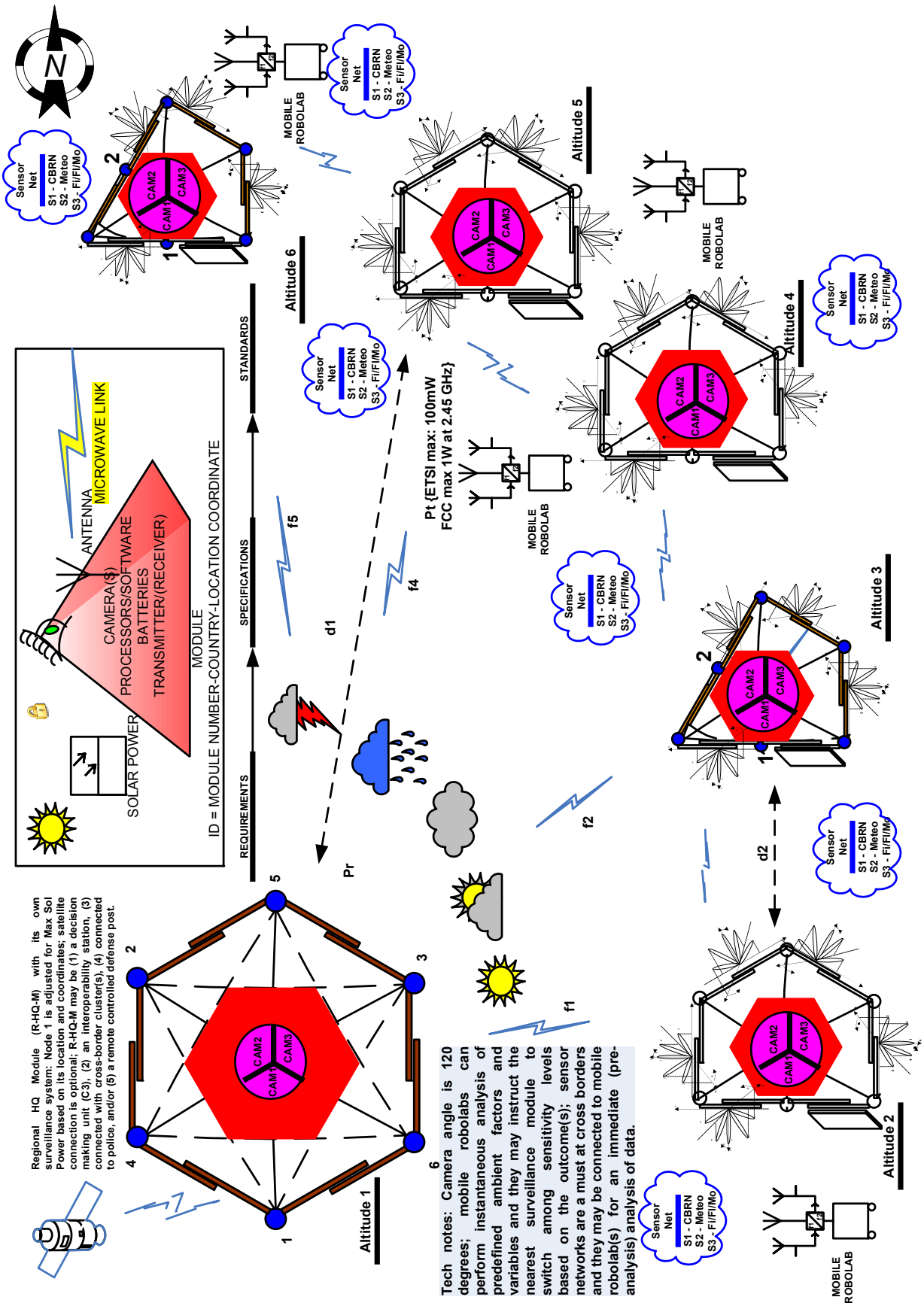


Fig. 5 Proposed multi-functional, multi-purpose surveillance system at a glance; an illustrated example.