Viral Space Situational Awareness

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CONFERENCE PAPER

ABSTRACT

Viral SSA takes advantage of the amateur astronomy community to provide an extremely low-cost and geographically-diverse network of optical SSA sites. In the spirit of programs such as DARPA′s Grand Challenge and the National Weather Service′s program of providing amateur meteorologists with weather stations linked to a central professional meteorological facility, we form a cooperative bond with a willing community of technically-minded individuals. We term this program "viral" because we will qualify an initial set of astronomers for SSA operation and then use word of mouth in the astronomy community, as well as an outreach program, to pull in new observers. The use of modern remote controlled telescopes allows the incorporation of certified amateur, university, and commercial telescope systems. The availability of the local Viral SSA member for troubleshooting eliminates most significant costs of operating a large network. In this talk, we discuss the key concepts of Viral SSA and the route to a network of 100+ sites in a three year or less timeframe.

1. SPACE SITUATIONAL AWARENESS COST MODEL

Viral SSA (VSSA) takes advantage of the amateur astronomy community to provide an extremely low-cost and geographically-diverse network of optical SSA telescopes. Forty sites could be installed for less than $250k each (<$10M total; this includes all equipment, assembly and installation labor, and all facilities costs), with total yearly maintenance cost for the entire network between $1-2M.

For Viral SSA, we provide high-performance SSA telescope "kits" to qualified amateur astronomers and universities. By sharing observing time on the telescope in exchange for their labor and land use, we eliminate almost 90% of the on-going operational costs. Advances in remote observing allow one central coordination facility to provide observing control of the member's telescopes; therefore, the local astronomer will not be required to interact with the telescope when it is being used for satellite observations, thus minimizing the labor impact on the astronomer while simultaneously allowing, through remote control, all the correct data collection procedures to occur to provide traceable and certifiable satellite orbit observation data.

We term this program "viral" because we would qualify an initial set of astronomers for SSA operation and then use word of mouth in the astronomy community to pull in new observers. Qualification of a VSSA member would include not only their astronomy credentials, but also the quality of the site they would provide and the number of sites in the area that are already part of the network. We have developed a compensation plan for VSSA members that provides for time sharing on the telescope hardware as well as financial payment for SSA time provided beyond the minimum. Key parts of the plan include maintaining long-term motivation, as well as retrieving hardware from non-participating members. In addition to telescope time-sharing members, we will take advantage of the growing market for astronomical site rental space, in which domes and local operation/maintenance are provided for small telescopes at good astronomical sites. These sites require a modest rental fee per year, but we would control all observing time at those sites (i.e., 100% SSA versus time sharing).

In this seedling project, we develop the designs for the following: (1) the SSA kit, which contains the 0.5 m diameter telescope, mount, imagers, timing, and computers; (2) SSA prefab dome for those astronomers who need one; (3) maintenance and operations procedures for the SSA member. Additionally, we provide the concept design for the central control facility that commands the individual site observations and pulls in the data for processing. Subsequent phases will see the development of the VOC with initial operation of 12-20 sites. Once this is operational, expansion to 100-200 sites will allow collection of robust SSA data.

2. NATURE OF THE PROBLEM

Current SSA installations typically focus on extreme challenges when being designed (e.g., FOV, magnitude, GEO detection optimization, etc.), which tends to make them large, complex and expensive to both install and operate. These facilities typically require a significant number of highly technical people, which drives up the yearly operations costs. These cost considerations tend to limit the number and geographic diversity of sites.

Limited numbers of sites is an issue because robust optical SSA requires a large number of sites to account for the following issues: (1) limited observational capability from any one site; (2) weather and maintenance-related down time; (3) limited ability for parallax viewing; (4) limited observation time restricts the revisit rate.

The VSSA network is complimentary to the major U.S. Space Surveillance Network (SSN) systems (e.g., SST, Cobra Dane, Haystack, GEODSS, AMOS, etc.) in that it provides frequent updates to the orbits of objects visible to the telescopes employed within the network. This preserves the SSA time on the larger assets, which costs far more per observation, for the more difficult challenges.

The idea for using this class of telescope for SSA is in no way new (e.g., papers and data from half-meter telescopes for SSA have been around for decades), and in fact the telescope and the cameras are not the revolutionary part of this concept. It is the inclusion of the amateur astronomy community to provide an inexpensive, but very capable, network of geographically diverse SSA sites that is the revolutionary concept.

Without the VSSA concept, the cost of such a network would be as much as an order of magnitude higher than the VSSA concept. For example, to implement a network of forty SSA sites in the usual way of doing business would necessitate hundreds of site visits, negotiation of leases or purchases of property and overseeing construction in forty different locations. These sites would each require offices, and possibly even living quarters if the operators have to travel to a remote site to work. The cost of constructing each site would be at least $1M, and possibly more, depending the location and infrastructure needs, and this is before placing the SSA telescope and sensor inside it. After initial construction, site security would have to be arranged, and multiple operators, all trained in telescope operations, would have to be moved to each site to assure seven-days-per-week operation. Each site would require a minimum of two operators (12 hours a day, seven days a week operation) to man the system during operation time and one maintenance person, who would also cover for the operators when they were absent, resulting in yearly operational costs in the neighborhood of $250k-$500k/year. Forty SSA sites set up in the business-as-usual manner would therefore cost $40M to install the facilities and $10M-$20M per year to operate.

In contrast, the typical VSSA member site would have only a small prefab dome (available for $40k - $50k), rather than a full observing complex with offices, which will be installed on member property. We comfortably allocate another $50k for site preparation (e.g., electrical lines, a concrete pier and foundation, etc.), which brings the total site installation cost to only $100k, or 10% of a standard installation. In many cases, this cost will be completely eliminated as there is now a cottage industry in which astronomers are creating larger domes than they need and simply renting space to additional telescopes at very reasonable costs.

When the telescope is being used for SSA, we operate remotely from the VSSA Operations Center (VOC), so the VSSA member does not have to operate the hardware. If the system is not operating properly, we notify the local VSSA member, who would then perform troubleshooting and certain levels of maintenance. This eliminates all labor costs from the site, which, when combined with no facility cost, is why we can reduce yearly operating costs by 90%.

3. CONCLUSIONS

By providing shared telescope time and relatively minor financial compensation in exchange for the VSSA member astronomers providing the site, site security, and maintenance, Viral SSA eliminates 90% of the site development costs. Equally important, the use of remote observing and availability of the local VSSA member for troubleshooting eliminates the need for any paid employees at the site, thus eliminating 90% of the yearly operational costs and making VSSA the most cost-effective way to assure robust protection of our critical space assets.

The end result will be the following: (1) dramatically increased SSA observation capabilities; (2) an order of magnitude reduction in the cost of ground-based optical SSA operations; and (3) the inclusion of a community of motivated, highly-talented, small-telescope observers into SSA operations, which will create continuing opportunities for improvement and innovation.