Part 1: "Elevator" Introduction

Combining EpiSci's artificial intelligence and communications technology expertise, *SwarmSense* is a group of intelligent drones working together to accomplish your high-risk missions for you to save time, money, and human lives. They are 1) Fully Autonomous with "Sense and Avoid" capability: Say goodbye to pre-flight planning, setting waypoints, or manual, line-of-sight flying. Simply upload the mission objective into the drone's command center, and supervise the drones "self-flying" while avoiding obstacles; 2) Cost Effective: Minimize the time taken to accomplish a single task with our swarm solution rather than running multiple flights with a single drone; 3) Safe and Secure: Feel protected from drone hackers with SwarmSense's multiple layers of protection and safety features. Intervene at any point during the mission. You will always be in control.

Part 2: Market and Industry Analysis

In 2015, the U.S. drone manufacturing market was valued at $3.3b (Ibis). The key eternal drivers for market growth is increased federal funding for defense and homeland security. Outside the defense market, firms are also developing drones for civil and commercial use such as border enforcement, search and rescue, agriculture, firefighting, and infrastructure inspection. The market segments we are targeting are defense (because it is the fastest growing sector and industry we have the most relationships in) and commercial for applications such as search and rescue, outdoor facility and security patrol, firefighting, infrastructure inspection, target detection or tracking (law enforcement), or disaster management. We chose these commercial sectors because the tasks required of a drone cover large areas, are time sensitive, and potentially dangerous for humans to execute.

According to Ibis, the drone manufacturing market is expected to have an annual growth rate of 5.% between 2015 and 2020. It is unclear how fast the drone-swarming sector is growing. However, defense has been increasing its spending on swarm R&D projects (e.g. Navy LOCUST) and more R&D firms are researching swarming capabilities. In addition, the increasing demand for commercial application and new FAA regulations regarding small commercial drone use is expected to drive the growth of the commercial drones market. The rising need for advanced, efficient, and reliable small drones, and the trend of military modernization across these nations are expected to drive the overall market growth.

The drone swarming market for defense and commercial customers is highly fragmented. There are several types of competitors: artificial intelligence startups such as Skydio (in stealth mode) who are developing navigation algorithms for drones, swarm intelligence startups such as Skydio (in R&D mode; the only direct competitor we found), small turnkey drone companies such as AirCover Integrated Solutions (who do not have any AI capabilities but create custom systems solutions for each specific customer), hobby drone market incumbents such as DJI (who are transitioning towards providing solutions for the drone commercial sector, unclear if they have swarming capabilities). Barriers to entry are high due to companies who already have IPs and high R&D costs.

Part 3: Go-to-Market Plan

Defense: We have paying R&D customers: DoD (DARPA, ONR, MDA, Boeing , AFRL, and Navy) and NASA. We are aggressively marketing *SwarmSense* technologies and capabilities to several large defense contractors such as Boeing, Raytheon, and Northrop Grumman. Founders and co-founders have various contacts with them. Because defense contracts and acquisition processes take substantially long lead time, it is imperative to advance the technology to stay ahead of the competition.

Non-Defense: Our first commercial *SwarmSense* sale was for infrastructure inspection application. Our most near term customers are non-defense vendors that sell single drone systems to government agencies such as fire departments and public works departments. We have begun preliminary discussions, and they are waiting for our demonstration videos and product specifications. We have had inbound inquires from research organizations such as NOAA, agricultural customers (e.g. vineyard owners), and public works departments (i.e. Los Angeles).

Customer Acquisition Strategy: We intend to win our customer through technology innovations (AI + Sense&Avoid + Swarm + Mesh Networking), cost saving (swarm) product quality (industry-grade ruggedization and robustness), cost (exclusive manufacturing partner for large-quantity production), and superior service, all in a single package of product/service combo. Our continuing success of winning defense and NASA R&D projects boost the credibility of our innovations. This will be leveraged wherever possible, including the sole-source contracting opportunities available to SBIR awardees like EpiSci.

Competitive Advantage: Currently, drones in service are controlled individually and independently, each by a single operator under the authority of a mission commander at present. Consequently, for N drones, we need N "separate" communication links and operators, requiring both substantial communication bandwidth and manpower (including training). This also makes it extremely difficult to rapidly respond to unexpected hostile attacks or degraded communications with correct actions, since the response must be coordinated among multiple operators first. Through innovative combination of artificial intelligence, distributed agents, and self-organizing networking technologies, *SwarmSense* addresses this problem by enabling a single operator to "monitor" a group of unmanned airborne assets/platforms with ease and little training.

Part 4: Technical Product Description and Plan

Product/Service Description: *SwarmSense* is a group of autonomous drones that collectively solve complex missions without manual piloting, while achieving significantly more robust, efficient, and scalable Command and Control (C2) solution for managing multiple heterogeneous airborne node. Our swarm intelligence enables multiple autonomous air platforms, or drones, to "self-fly" per mission objective and on-board sensor data while sensing and avoiding obstacles in real time. Neither pre-configured flight paths nor multiple pilots are necessary: our patented artificial intelligence equips *SwarmSense* with adaptive decision-making abilities while maintaining continuous communication between each node during a mission.

Technology Validation: We sold our first *SwarmSense* system to a non-defense customer in 2016, who can vouch that our product works as advertised. Our defense customers can be our references as well. Numerous over-the-air tests and demos over the last 2 years with multiple drones; search SwarmSense in Youtube for additional videos.

Competitive Advantage: 1. The area coverage of a mission is expanded in direct ratio to the number of added drones. SwarmSense gives operators unlimited choices for extension and extraction because it can coordinate an unlimited number of drones, launched from different locations, to stay airborne as long as needed. This relieves pressure and reduces costs for end users such as the military or commercial businesses by not having to hire multiple pilots to operate single drones, or run multiple flights with a single drone to finish one task. **2**. For tactical/military applications, Our *SwarmSense* UAV swarming technology solves a bounded-autonomous system to support collaborative engagement with multiple unmanned airborne vehicles in Anti-Access (A2), Area-Denied (AD) and bandwidth limited environments (BLEs) for robust, efficient, and effective command and control applications. Collaborative military engagements with integrated systems across multiple disparate airborne platforms require secure communications to achieve desired effects against enemy threats. Existing tactical communications are subjected to severe degradation in terms of available communication bandwidth within emerging A2/AD threat environments caused by hostile communication jamming, evasive maneuvering to avoid kinetic attacks, and new terrains creating major communication shadowing effects.

Issued patent: US Patent 9,537,954 . **Pending patent:** US App. No. 14/716841 (SwarmSense algorithm), along with PCT applications in EU, Japan, and Korea. **Patents being prepared**: Surprise-Based Deep Learning, Flexible, scalable Fast-Fourier Transform (FFT) High-speed, Versatile RF signal detection and classification.

Non-IP Barriers to Entry: Existing swarm solutions designed for military and industrial uses are highly expensive and not flexible. Partnership with credible drone vendors will further reduce the cost, making our solution extremely affordable.

Part 5: Risk vs. Talent Narrative

Risk Identification and Mitigation: Hardware manufacturing costs. We are currently partnered with a Korean drone manufacturing company to develop our own novel hardware system for our end users. However, we realize that we do not have the current capacity to develop military grade drones or bring our manufacturing in house. Therefore, we have plans to integrate our intelligent swarming software with target third party hardware platforms from a wide range of drone vendors, from commercial to military grade.

Team: Bo Ryu, Ph.D.: Founder and president of EpiSci. Holds 10 patents in tactical military networking and security. **Nadeesha Ranasinghe, Ph.D.:** Swarm system and HAI co-inventor and software engineering director. **Wei- Min Shen, Ph.D.:** Co-founder of EpiSci and co-inventor of our swarm system and HAI. **Tamal Bose, Ph.D.:** Co-founder of EpiSci and co- inventor of CR and emerging RF sensors. **Thomas Shucker, M.S.:** Research scientist and engineer. **Epiphany Ryu:** Business development and market analyst. Holds a B.S. In Business Administration from Berkeley Haas. The team needs at least one senior marketing strategist with strong credentials in defense market. Also, a seasoned CFO with successful private capital raising experience will be a huge plus.

Key Advisors: Executives and partners from IDG Partners, Draper Athena, TeK One (www.tekone.org), and mentors from University of Arizona Innovation Center have provide us with invaluable tips and advices on transitioning from an R&D organization to an industrial and military product/service provider.