

# A Survey in Adaptive Hybrid Wireless Sensor Network for Military Operations

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**Abstract**—A Sensor Network is the primary source for acquiring information in today’s military operations that require situation awareness (SA) of a battlefield. There are several types of sensor nodes, and each type of sensors has limited capability. The requirement for gathering and analyzing information about the field cannot be fulfilled by one type of sensor. Several sensors are needed to be networked and provide distributed sensing in such the way that the complete information about the field can be achieved. With current sensor and wireless technologies, a large number of heterogeneous sensor nodes can be rapidly deployed and wirelessly networked in a battlefield. These sensor nodes can perform distributed sensing tasks in collaborative and cooperative manner in order to extract features of the event in the field. Unlike any typical network, military wireless sensor network is operating under the harsh condition of a battlefield. Hence, the resources are constrained in terms of energy, bandwidth, and computing power, which limit the sensing capability of the wireless sensor network. In addition, a network is prone to attack by enemies. Such a network requires the self-adaptability that can cope with intermittent changes in a harsh environment. This paper presents a survey for adaptive hybrid wireless sensor networks in the military operations, which reviews their technologies, applications, constraints, architectures, and challenges.

**Index Terms**—Wireless Sensor Network, Distributed Sensing, Military Sensor Network.

## I. INTRODUCTION

The requirement for Situation Awareness (SA) is proved to be mission critical to wide range of military operations [1]. According to [1], SA has evolved from knowing what are the threats to knowing what is the situation (who, where, why, and how) in the battlefield theatre. SA is the military doctrine of perceiving the elements in the environment [2]. Fig. 1 illustrates the information sources for acquiring SA. Perceiving the situation of the battlefield would require internal knowledge of the military commander and external knowledge collected from regulated and un-regulated information. Un-regulated information is the information that can be obtained from media, internet, or community. Regulated information can be acquired through Intelligence, Surveillance and Reconnaissance (ISR) missions as well as status reports from allied units. ISR is the military practice for acquiring such critical information in order to support military’s commander in decision-makings [3]. ISR contains three principles; Intelligence, Surveillance, and Reconnaissance. According to [4], Intelligence is a continuous process that involves analyzing of collected information, which is conducted through surveillance and reconnaissance.

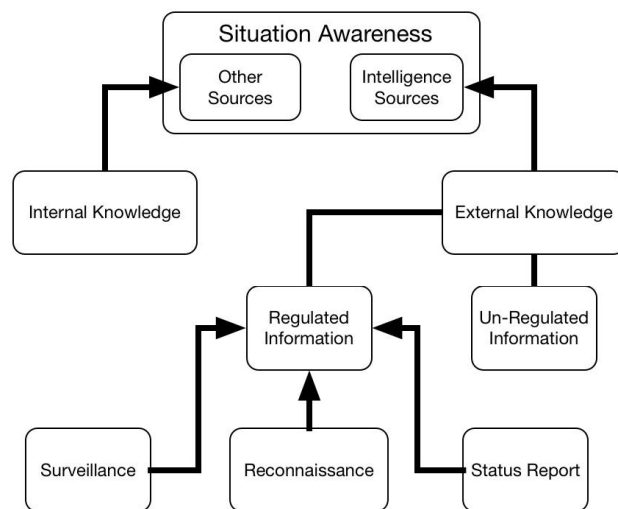


Fig. 1: Sources of Situation Awareness adapted from [1]

While surveillance is a systematic observation of the area, reconnaissance is a mission undertaken to observe the area [4]. The main difference between surveillance and reconnaissance is that surveillance is passive and conducted continuously, but reconnaissance is active and conducted in shorter period. All three principles integrate the operation of sensors for answering commander’s information requirement. Sensor devices are capable of capturing events or changes in a battlefield, in which the environment is very hostile and hardly accessed by human. In addition to acquire information about an enemy, perceiving information about allied forces is also needed to fill the gap in situation awareness. Knowing the situation of allied forces will definitely support military commander’s decision for launching any actions in a battlefield. The situation of allied forces can be location or weapon status, in which they can be captured by sensor devices.

Sensor technology for ISR includes passive and active electro-optical, radar, radio-frequency (RF) geolocation, magnetic, seismic and acoustic sensors. The position of allied forces can be captured by position sensors i.e. Global Navigation Satellite System (GNSS) or land-based positioning system, while the status of allied forces can be captured by sensors equipped on platforms or carried by troops. The advent