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Review Article

Modern Cluster Integration of Advanced Weapon System and Wireless Sensor Based Combat System

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Abstract: Future combat system (FCS) is a network based soldier friendly system which connects eighteen individual weapon system connected with the soldier via network. The prime idea of FCS concept is to support the soldier with real time situational awareness and joint operability among forces to complete a mission successfully with low mortality rate. This system allows the soldier to see first, understand first and act decisively. Basic work done behind the screen is fusing data collected from different reconnaissance vehicle, unattended ground sensors, unmanned aerial vehicles and live assets. System of system common operating environment supports the system. SOSCOE provides reusable software architecture for platform and battle command application via low bandwidth Adhoc network. It uses TINEX workflow engine which minimizes traffic and allows different software to execute flexibly. Since, most of the system operates in remote environment with battery support, power consumption is a serious issue. System with many nodal points has to be encrypted strictly to prevent the network from attacks (simply hacking). Use of instruments with less power consumption, particularly custom design hardware and wireless sensors or sensors will help to tackle this problem.
Keywords: Battlefield, future combat system, system of systems, advanced trauma management, multifunctional aerial system, wireless sensor network, cluster integration, distributed clustering.

INTRODUCTION

FCS is a joint, networked system of systems, consisting of a network and 18 individual systems and using an advanced network architecture that will enable levels of joint connectivity, situational awareness and understanding. It is designed to interact with and to improve the ability of the Army's most valuable weapon—the Soldier. It can be adapted to traditional warfare as well as complex, irregular warfare in urban terrains, mixed terrains such as deserts and plains and restrictive terrains such as mountains and jungles. It can also be adaptable to civil support such as disaster relief.

The very structure of modern warfare is changing. Today's warfare is increasingly irregular, requiring us to find, engage and defeat the enemy on complex terrain. The opponents are adapting and improving their skills to defeat our current strengths and abilities using guerrilla and terror tactics to attack and defeat our forces. This is our time to change our basic strategy from the 20th century, world war II model which relied on massive logistics buildup, heavy brigades, sequential operations, linear warfare and intelligence gained by direct observation/contact. FCS supports us against the current irregular warfare by providing light, agile Brigade Combat Teams with a small logistics footprint that is networked and capable of conducting simultaneous operations to directly attack the enemy centers of control and exploits the intelligence gained via remote reconnaissance and surveillance systems.

At the heart of the FCS, BCT is the network which will allow every FCS system from unmanned vehicles to precision weapons to share the information and work together. The network will offer decision-making not just at the brigade level, but all the way down to the battalion and company levels. The FCS allows the army to achieve greater situational awareness, improved survivability, lethality, efficiency and joint operability. On today's battlefield, the availability of real-time information is vital for success. FCS technology will allow the soldiers to see first and understand first: from a position far away. Systems such as the Unattended Ground Sensor (UGS), Unmanned Ground Vehicles

(UGVs) and Unmanned Aerial Vehicles (UAVs) will provide information about the enemy's position in individual buildings and neighborhoods, as well as over the bunkers. Wireless sensors can be used in case of unattended war environments. This information will be fed into the network and immediately shared with brigade, battalion and company commanders, even to the platoon leaders. This networked surveillance increases the reliability of information and reduces tactical risk to the soldiers. In short, FCS provides enhanced situational awareness. On today's battlefield, precision weapons are necessary to defeat enemies who are often mixed with civilian populations or hidden in restrictive terrain such as mountainous regions. FCS systems such as the Mounted Combat System (MCS), Non-Line of Sight-Cannon (NLOS-C) and Non-Line of Sight-Mortar (NLOS-M) [2] combined with FCS's unmanned systems and the soldiers, provide the ability to destroy enemy and increases the ability to identify targets and to engage with precision munitions that reduce the risk of collateral damage. On today's battlefield, soldiers in complex environments are at risk within vehicles, due to the enemy's use of Improvised Explosive Devices (IEDs), Rocket-Propelled Grenades (RPGs) and Anti-Tank Missiles. As the soldiers move into complex terrain (urban areas) where the enemy is well hidden and traditional fighting vehicles are largely ineffective.

FCS reduces that risk by using unmanned vehicles such as the Armed Robotic Vehicle (ARV), Small Unmanned Ground Vehicle (SUGV) and Multifunctional Utility/Logistics and Equipment Vehicle (MULE) to locate and engage the enemy, identify toxic chemicals, destroy tanks and disable the land mines [4]. FCS manned vehicles are agile and carry an advanced hit avoidance technologies such as active protection systems (APS) which allow the soldiers to stay protected longer, which reduces their risks before delivering them close to the fight. In short, FCS increases survivability as well as lethality. On today's battlefield, it is more important to maximize the fighting capacity of the force. The FCS (BCT) features smaller, lighter vehicles which quickly transport more combat power to where it's needed. In addition, FCS vehicles will require much less fuel, reducing the number of refueling vehicles. By building many of its systems on a common chassis, the number of mechanics and spares will be reduced. In addition, reduced support requirements mean fewer convoys. Threats from IEDs will be minimized by FCS's sensors and robots. In summary, FCS increases efficiency and reduces the Army's logistics footprint, resulting in fewer support soldiers and vehicles, thus saving lives and money. Because FCS is a system of systems, the whole is more than the sum of its parts. By interconnecting the capabilities of 18 cutting-edge systems with a state-of-the-art network and the unmatched abilities of the soldier, FCS will allow the Army to find, fight and finish the enemy on the 21st century, irregular battlefield. These systems are basically classified in to the following on the basis of their operation and functionalities: Manned ground vehicles, unmanned ground vehicles, unmanned aerial vehicles and unattended systems. In recent unattended environments, Wireless Sensor Networks (WSN) with multifunctional sensing capabilities can be employed on both vehicles and the soldiers to offer better outcome. Distributed clustering can be employed to effectively cluster and optimize the battery life of the wireless sensors in unattended environments [7].

MANNED GROUND VEHICLE

The manned ground vehicle constellation consists of eight separate classes of vehicle systems which mostly shares the same chassis. It is classified as follows,

1. **Mounted combat system**
2. **Infantry carry vehicle**
3. **Non-line of sight cannon**
4. **Non-line of sight mortar**
5. **Reconnaissance and surveillance vehicle**
6. **Command and control vehicle**
7. **Medical vehicle treatment and evacuation**
8. **FCS recovery and maintenance vehicle.**

1. Mounted Combat System (MCS)

The Mounted Combat System (MCS) provides Line-of-Sight (LOS) and Beyond-Line-of-Sight (BLOS) offensive firepower capability allowing BCTs to engage close with and destroy enemy forces. The mounted combat system provides precision fires at a rapid rate to destroy multiple targets at standoff ranges quickly to complement the fires of other systems in the BCT. It is highly mobile and can easily maneuver over rough terrains. It is capable of providing direct support to the infantry in an assault by defeating bunkers, breaching walls and also by providing cover fire whenever necessary. The MCS also provides BLOS fires to destroy the point targets using the integrated sensor network. This capability enhances lethality and also increases the options available to the BCT commander for the destruction of point targets through the integrated fires network. MCS shares a common mobility platform with the other Manned Ground Vehicles of FCS [11].

2. Infantry Carrier Vehicle (ICV)

The Infantry Carrier Vehicle (ICV) consists of four platform versions: a Company Commander; a Platoon Leader; a Rifle Squad and a Weapons Squad. All infantry carry vehicles looks alike to prevent particular vehicle from targeting. The ICV effectively employs weapon systems, rapidly maneuver during fallback,

night operations, all weather and limited visibility periods. The ICV carries most of equipment freeing the individual soldier to focus on the mission. The ICV can shoot, communicate, detect threats and protect crew/critical components on the move and almost under all retains. Constant data transfer with other components of the BCT permits constant update of the common operational picture and rapid identification of targets with updated situational awareness.

3. Non-Line of Sight-Cannon (NLOS C)

The Non-Line of Sight-Cannon (NLOS-C) (figure 1) is an indirect fire support component of the System of Systems (SoS) of the FCS (BCT) [5]. NLOS-C is more significant to provide networked, extended-range, responsive and sustained precision attack of point and area targets in support of the FCS [6]. NLOS-C provides close support and destructive fires for tactical standoff engagement during both offensive and defensive operations in line-of-sight and beyond-line-of-sight. The NLOS-C is a self propelled howitzer with a two man crew. Advanced Crew Served Weapon (ACSW) as its secondary armament and incorporates a suite of protection measures to enhance crew and platform survivability. The NLOS-C will be deployable worldwide and can operate in a wide range of ordinary environmental conditions. The cannon can move rapidly, stop quickly and deliver lethal fire on target in a very short time. The NLOS Cannon has a multiple round simultaneous impact (MRSI) capability. The cannon, like all Manned Ground Vehicle (MGV) can rearm and refuel quickly. Its system weight makes it quickly deployable, fully automated handling, loading and firing is the state of the art modern engineering work piece. The NLOS-C adoptability and sustainability with fast response [1], lethality, survivability, agility and versatility are quite modern features.

4. Non-Line of Sight-Mortar (NLOS M)

The Non-Line of Sight-Mortar (NLOS-M) is the short-to-mid-range indirect fire support component of the System of Systems (SoS) of the FCS (BCT). It fires a suite of 120mm munitions that also include special purpose precision guided munitions such as Precision Guided Mortar Munitions. NLOS-M provides close support and destructive fires for tactical standoff engagement during both offensive and defensive operations.

Fig-1: Non-Line of Sight Cannon (NLOS-C)

5. Reconnaissance and Surveillance Vehicle (RSV)

The Reconnaissance and Surveillance Vehicle (RSV) consist of a set of advanced sensors technology which can able to detect, locate, track, classify and automatically identify targets from for-beyond ranges under all climatic conditions: day or night [14,15]. It includes a set of roof-mounted, long-range electro-optic infrared sensor, emitter mapping sensor for radio frequency intercept and direction finding, remote chemical detection and a multifunction RF sensor. RSV also conducts automatic target detection, target recognition and level one sensor fusion. To further increase troop capabilities, the RSV is equipped with Unattended Ground Sensors (UGS), a Small Unmanned Ground Vehicle (SUGV) with other payloads and two unmanned aerial vehicles (UAVs). WSNs recently started replacing these sensors, for their advanced and undetectable presence in unattended environments [3].

6. Command and Control Vehicle (C2V)

The Command and Control Vehicle (C2V) is part of manned ground vehicles and is the hub of battlefield command and control. The C2V platform provides the commander the necessary information to lead the team towards success. It is capable of joint command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR). The C2V provides commanders with the ability to command and control on the move. C2Vs contains the interfaces that allow commanders and superior staff to gain access to the Battle command mission applications including: mission planning and preparation, situation understanding, battle command and mission execution and war fighter-machine interface. These applications enable commanders and their staff to perform tasks such as fusing friendly, enemy, civilian, weather/terrain situations and distributing this information via a common operating picture. Commanders also utilize the C2V's integrated C4ISR suite to receive, analyze and transmit tactical information. The C2V can also deploy wireless sensor based unmanned and manned aerial vehicles to enhance situational awareness.

7. Medical Vehicle-Treatment (MV-T) & Evacuation (MV-E)

The Medical Vehicle is designed to provide advanced trauma life support within hour to critically injured soldiers. The Medical Vehicle serves as the primary emergency treatment system within the Brigade Combat Team and has two mission modules: Evacuation and Treatment. The Medical Vehicle-Evacuation (MV-E) vehicle allows trauma specialists, to be closer to the casualty's point-of-injury and is used for casualty evacuation. The Medical Vehicle -Treatment (MV-T) vehicle enhances the ability to provide Advanced Trauma Management (ATM)/Advanced Trauma Life Support (ATLS) treatments and procedures forward for more rapid casualty support and clearance of the battle space. Both modules will be capable of conducting medical procedures and treatments using installed networked telemedicine interfaces, Medical Communications for Combat Casualty Care (MC4) and the Theater Medical Information Program (TMIP).

8. FCS Recovery and Maintenance Vehicle (FRMV)

The FRMV is the recovery and maintenance system for employment within both the Brigade Combat Team (BCT)/ divisions and contributes to sustaining and generating combat power to the Future Force structure. Each BCT will have a small number of 2-3 man Combat Repair Teams within the Brigade Support Battalion (BSB) to perform field maintenance requirements. The capabilities of the FRMV include in-depth Battle Damage Assessment Repair (BDAR) and it limits the recovery operations.

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THE UNMANNED GROUND VEHICLES

1. Armed Robotic Vehicle (ARV)

The Armed Robotic Vehicle (ARV) (figure 2) is an unmanned 9.5 ton 6x6 Hybrid Electric Drive (HED) vehicle and comes in two variants: the Assault variant and the Reconnaissance, Surveillance and Target Acquisition (RSTA) variant. The two variants share a common chassis. The Assault variant will support the troop in the assault with direct fire of anti-tank weapons providing LOS/BLOS targeting. The RSTA version will remotely provide reconnaissance capability, deploy sensors, locate or by-pass threat acts as a communications relay and remotely assess/report battle damage assessment (BDA).

Fig- 2: Armed Robotic Vehicle (with communication relay and anti-tank weapon mounted)

2. Small Unmanned Ground Vehicle (SUGV)

The Small Unmanned Ground Vehicle (SUGV) (figure 3) is a small, lightweight man portable UGV capable of conducting military operations in urban terrain, tunnels, sewers and caves. The SUGV helps in enabling the performance of manpower intensive or high-risk functions (i.e., Urban Intelligence, Surveillance and Reconnaissance (ISR) missions, Chemical/Toxic Industrial Chemicals (TIC)/Toxic Industrial Materials (TIM), Reconnaissance, etc.) without exposing soldiers directly to the hazard. The SUGV mini design allows multiple payloads to be fused in and with a plug-and-play option. Weighs less than 13 kg, it is capable of carrying up to two kilo of payload weight. Intelligent wireless sensors can be employed in order to attain enhanced surveillance [16,17].

Fig-3: Small Unmanned Ground Vehicle (SUGV)

3. Multifunctional Utility/Logistics and Equipment (MULE) Vehicle

The Multifunctional Utility/Logistics and Equipment (MULE) Vehicle is a 2.5-ton Unmanned Ground Vehicle (UGV) that supports dismounted operations (figure 4). It consists of four major components: Common Mobility platform (CMP), Three Mission Equipment Packages: Mule-Transport, ARV-A-L and

Mule- Countermine, Centralized Controller (CC) for Dismounted operations and Autonomous Navigation System (ANS) mission payload package integrated on MULE platforms, Armed Robotic Vehicles and Manned Ground Vehicles (MGVs) to provide semiautonomous and leader-follower capability. This vehicle can be sling-loadable under military rotorcraft. The MULE Vehicle has three variants sharing a common chassis: transport, countermine and the Armed. Robotic Vehicle (ARV)-Assault-Light (ARV-A-L). The Countermine MULE Vehicle (MULE-CM) will provide the capability to detect, mark and neutralize anti-tank mines by connecting mine detection sensors. The ARV-Assault-Light (ARV-A-L) MULE Vehicle is a mobility platform with an integrated weapons and reconnaissance, surveillance and target acquisition (RSTA) system to support the infantry to locate and destroy enemy vehicles and bases. Wireless mine sensors can be employed for detection, marking and neutralizing anti-tank mines in unattended environments. As the MULE vehicle is mobile in nature, clustering can be employed in gathering information collected from different MULE vehicles [8,12,13].

Fig- 4: Multifunctional Utility and Logistic/Equipment support vehicle (MULE)

UNMANNED AERIAL VEHICLES

1. Class I Unmanned Aerial Vehicle (UAV)

The Class I Unmanned Aerial Vehicle (UAV) provides the infantry soldier with Reconnaissance, Surveillance and Target Acquisition (RSTA) (figure 5). Estimated to weigh less than 16 kg, the air vehicle operates in urban, forest and mountain terrains with a vertical take-off and landing potential. It can be easily controlled by an infantry soldier. The Class I UAV incorporates autonomous flight and navigation but it interacts with the network and the soldier to periodically update routes and target information which is defined by the soldier or by C2V. It provides real-time video streaming with improved reconnaissance support and early warning to Brigade Combat Team (BCT) in environments which is not suited to larger assets like B-52 and SU-30. It also acts as a communication relay in restricted terrain like mountains, bunkers and inside the buildings. The system (which includes air vehicles, a control device and ground support equipment) is back-packable. Wireless sensors can be incorporated with these vehicles in order to attain superior surveillance and target acquisition.

2. Class II Unmanned Aerial Vehicle (UAV)

The Class II Unmanned Aerial Vehicle (UAV) has twofold endurance and a wider range of capabilities than the Class I. It is a multifunctional aerial system possessing the Vertical Take-Off and Landing capability. It supports the infantry soldier with reconnaissance, early warning, target acquisition and locating. It differ from class I UAV in capabilities like target designation in day, night and adverse weather. This provides the infantry the ability to study the battle space from far away by using a combination of Line-of-Sight (LOS), Beyond-Line-of-Sight (BLOS) and Non-Line-of-Sight (NLOS) systems. The Class II Unmanned Aerial Vehicle (UAV) can be carried by two soldiers.

Fig-5: Class I UAV

3. Class III Unmanned Aerial Vehicle (UAV)

The Class III Unmanned Aerial Vehicle (UAV) is a multifunction system which has the range and endurance to support infantry with reconnaissance, surveillance and target acquisition. The Class III has to maximize endurance and payload while minimizing maintenance, fuel and transportation requirements. It can be used for communications relay, mine detection, Chemical, Biological, Radiological, Nuclear and High-yield Explosive (CBRNE) detection and meteorological survey. It allows the Non-Line-of-Sight (NLOS) precision fire for BCT in their area of interest. It operates at high altitudes during day, night and hares weather conditions. Wireless sensor network with weather, light and object sensors can be greatly employed

with these vehicles so as to monitor these parameters in a remote manner [9].

4. Class IV Unmanned Aerial Vehicle (UAV)

The Class IV Unmanned Aerial Vehicle (UAV) has a longer range and endurance (figure 6). It supports Brigade Combat Team (BCT) Commander with communications relay, long endurance and wide area surveillance.

Fig-6: Class IV UAV

Class IV can also be used for aerial support. It has the capabilities of Wide Band Communications Relay, long-range Chemical, Biological, Radiological, Nuclear and High-yield Explosive (CBRNE) detection. In addition, it has the payload to augment the RSTA capability by cross-cueing multiple sensors.

UNATTENDED SYSTEMS

1. Unattended Ground Sensors (UGS)

The FCS (BCT) Unattended Ground Sensors (UGS) (figure 7) is divided into two foremost subgroups. Tactical-UGS (T-UGS) comes with enhanced intelligence, surveillance and reconnaissance package. The ISR-UGS shoots out in compact and uses multiple ground-sensing technologies. An Unattended Ground Sensors (UGS) field includes multifunction sensors for target detection, location and classification. A sensor field also includes a gateway node to provide sensor fusion which provides common operating picture of the battle space. The UGS is used to perform mission tasks such as perimeter defense, surveillance, target acquisition and situational awareness (SA), including chemical, biological, radiological, nuclear and high-yield explosive (CBRNE) early warning.

Urban-Unattended Ground Sensors (U-UGS) is low cost, networked to report for situational awareness and force protection in an urban setting. They are easily employed by soldier himself or robotic vehicles either inside or outside the buildings. U-UGS will support the soldier by monitoring urban hit points such as corridors and stairwells as well as sewers and tunnels. Wireless sensors can be employed widely here in order to offer remote monitoring of target, location and providing awareness for the soldier. U-UGS gateways provide the urban situational awareness data to the network. Distributed clustering can be used in areas of higher mobility and aggregation of the collected data to be forwarded to the remote monitoring center.

Fig-7: Tactical Unattended Ground Sensor

2. Non-Line of Sight-Launch System (NLOS-LS)

The Non-Line of Sight-Launch System (NLOS-LS) consists of missiles and a highly mobile, independent Container Launch Unit (CLU) with self-contained fire control electronics and software for remote and unmanned operations (figure 8). Each Container Launch Unit (CLU) consists of a computer communications system and 15 missiles [Precision Attack Missiles (PAM)]. Precision Attack Missiles (PAM) is a modular, multi-mission and guided missile with two trajectories: a direct-fire and a boost-glide trajectory. The missile receives target information before being launched and changes the target details during flight. The PAM also supports laser-designated and automatic operation modes, being capable of transmitting real-time information in the form of target imagery before impact. PAM is designed to defeat heavy armored targets.

Fig-8: Non-Line of Sight Launch System

3. Intelligent Munitions System

The Intelligent Munitions System (IMS) is an unattended munitions system providing both offensive and defensive force protection (figure 9). The IMS is a system of mutually lethal and non-lethal munitions integrated with advanced command and control features, communications devices, sensors and seekers that make it an integral part of the network's core systems. IMS provides unmanned terrain dominance and tactical control over the area.

Fig-9: Intelligent Munitions System

Typical missions include: a) isolating enemy forces from friendly location, b) creating isolation and indirect fire on enemy forces, c) filling loop-holes in the battle space and d) controlling noncombatant movement with its non-lethal weapon capabilities. With its reduced footprint, IMS can deliver fire by various means. Once, on the ground, it can locate itself, organize all of its components and report its location to the battle command and control center. The munitions field can be armed, turned off to allow friendly passage and then rearmed to resume its mission. This on-off capability allows it to be recoverable and reusable, further reducing its logistics footprint. It does not become a hazard to friendly forces; it will self-destruct on command or at a preset time interval. It will also be tamper resistant.

The Intelligent Munitions System (IMS) consists of a hand-deployable module, an integrated sensor system, lethal and non-lethal munitions and a command and control gateway node. The IMS consist of both anti-vehicle and anti-personnel munitions. It works as a stand-alone device or along with other systems. It consists of a communication system which allows wireless inter-component communication. The IMS allows locating and destructing of enemy forces, enabling real time battle damage information and improves the ability of the commander to deploy forces more effectively. This is a weapons program that consist of Antipersonnel Landmine-Alternative (APL-A). The system consists of a number of explosive charges that is detonated by a commander who would be alerted by the presence of a person because of the body contact with a sensor. This system is described as "Man-in-the-Loop", which indicates that it is a commander and not the target that activates the explosive charge.

THE NETWORK

The Army's FCS (BCT) network allows the FCS Family-of-Systems to operate as a system-of-systems in which the capabilities of all the systems are greater than the sum of its parts. The network enables the infantry soldiers to better understand and dominate the future battlefield at greater level. The network consists of five layers, when combined provides very high speed data flow within the network. The FCS network possesses the adaptability and management functionality required to maintain standard services, while the FCS (BCT) fights on a rapidly shifting battle space giving them the advantage to see first, understand first, act first and finish decisively.

1. The Standards

The Standards Layer is the foundation of the network. It provides the governance for which the other layers are shaped and formed. The FCS (BCT) network conforms to the standards documentation to ensure that the net-centric attributes like flexibility and adaptability on distributed computing environment. Information needs, information timeliness, information source and networked capabilities provide enhanced guidance to ensure the technical exchange of information and end-to-end operational effectiveness. Uniform standard allows interoperability with other networks.

2. The Transport

The FCS (BCT) Family-of- Systems is connected to the command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) network by a multilayered transport layer with extreme range, capability and dependability. The primary function of the transport layer is to provide secure and reliable data transfer over complex terrain. The network supports advanced functions like integrated network management capability, information assurance and information dissemination management to ensure dissemination of critical information among sensors, processors and war fighters both within and external to the FCS (BCT)- equipped organization.

3. The Services

Heart of FCS (BCT) network is the Services Layer, commonly referred to as System-of-Systems Common Operating Environment (SOSCOE) which supports multi mission-critical applications both independently and simultaneously. It is designed so that, at any specific instant, one can incorporate only the

components that are needed for that particular instant. It enables advanced integration of separate software packages, independent of their location, connectivity mechanism and the technology used for developing them.

4. The Applications

The Applications Layer is responsible for providing the integrated ability to assess, plan and execute the network-centric mission operations by using a common interface and a set of non-overlapping functional services that provides the full range of FCS (BCT) war-fighter capabilities. This layer combines ten software packages to enable full interaction, integration and interoperability between the systems with no hardware, software or information bank. It also allows cross Battlefield Functional Area (BFA) problem-solving, decision aiding, adaptable doctrine, tactics, techniques and procedures, reconfiguration of roles and levels of automation during execution development, the basic efficiencies promotion, technology refresh and insertion.

5. The Platform and Sensors

The Sensors and Platforms Layer is comprised of a distributed and networked array of multi-spectral sensors that provides the FCS (BCT) with the ability to "see first." Intelligence, Surveillance and Reconnaissance (ISR) sensors are integrated onto all manned ground vehicles, all unmanned ground vehicles and all four classes of unmanned aerial vehicles within the FCS (BCT). To provide war fighters with current, accurate and actionable information, the data from the various distributed ISR and other external sensor assets are subjected to complex data processing, filtering, correlation, aided target recognition and fusion. The 18 networked systems consist of eight manned ground vehicles, three unmanned ground vehicles, four unmanned aerial vehicles and three specialized devices.

6. The Soldier—The Heart of FCS

All Soldiers in the Brigade Combat Team (BCT) are part of the Soldier as a System (SaaS) overarching requirement that encompasses everything the soldier wears, carries and consumes to include unit radios, crew served weapons and unit specific equipment in the execution of tasks and the duties. All soldiers systems will be treated as an integrated System of Systems (SoS). The soldier, as defined by Soldier as a System (SaaS) meets the need to perk up the current capability of all the soldiers, regardless of Military Occupational Specialty (MOS) to carry out army warrior tasks and functions more proficiently and effectively. Soldier as a System (SaaS) establishes a baseline for core soldier requirements and establishes the foundation for specific or mission unique soldier programs (Ground, Mounted and Air). It presents a fully integrated modular soldier that provides a balance of tasks and mission equipment in support of the soldier team: the current and the future force. FCS also enhances the SaaS with additional benefits like joint embedded training: allowing the soldier to train anywhere, at any time, including enroot to the battlefield

7. Major problems in FCS concept

A) One of the somber issues is the lifetime of the battery. Longer the lifetime of the battery, longer is the life of the soldier. Since the soldiers depend only on the system to identify and eliminate threads which affects his survivability, long lasting fast rechargeable batteries are required. One solution for this issue is to replace the sensors with wireless sensors with novel distributed clustering algorithms embedded in it. B) It is very tricky to establish communication relays near the battlefield, as it becomes a target to enemy forces. If reliable communication could not be established, soldier can't obtain real-time war picture. For real-time situational awareness, secure and reliable communication is the foremost criterion. More the number of node points, more is the possibility for hacking and as a result providing reliable communication link in non-line of sight is a severe issue. The problem could be overcome by clustering all the nodes in distributed manner. C) When the battle field has to cover wider area, signal strength becomes weaker and this paves a way for losing the collected information. This creates a SNR problem that has to be taken in to account. This can be eliminated completely by increasing the number of nodes in the network.

CONCLUSION

Future combat system (FCS) is a network, which connects eighteen individual weapon scheme connected with the soldier all the way through the network. Supporting the soldier with real time situational awareness and cooperative operability among forces to entire a mission successfully with low mortality rate is the fundamental thought, thereby enabling the soldier to see first, understand first and take action decisively. Fusing the data collected from dissimilar reconnaissance vehicle, unattended ground sensors, unmanned aerial vehicles and live assets has to be made successfully. System of system common operating environment (SOSCOE) supports the system, providing reusable software design for platform and battle command application via low bandwidth network. After the comprehensive study on the problems and issues concerning FCS, two foremost criterions have to be accounted principally: battery lifetime and reliable communication over disrupted terrains. These two issues could be greatly minimized by replacing the sensors with wireless sensors embedded with a

distributed clustering protocol like, Low Energy Adaptive Clustering Hierarchy (LEACH) [10].

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