The Case for Robots in the SBCTs (NOW)

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Figure 1 is more in line with the Future Combat System Organizational and Operational (FCS O&O) concepts than current force brigade combat teams (BCTs) or Stryker brigade combat teams (SBCTs). However, it does speak to the potential of unmanned systems (UMS) for our Army. Upfront it's worthy to note two things: first, that robots are not intended to replace Soldiers, but to enable them. Second, we are not talking C3PO or R2D2, rather a technological extension to bring down to the lower tactical echelons what we are doing with unmanned aerial vehicles (UAVs) today at mostly brigade-level echelons and higher. This will occur as platforms, and C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance) becomes more compatible with constraints and limitations at those lower levels.

The purpose of this article is to discuss how integration of robotic platforms (with an emphasis on capabilities) that are either available for fielding, or could be available within one to four years, could increase SBCT mission accomplishment for an overall benefit to the Army's short and long range future for a reasonable investment in training, manning, and support requirements. This article will cover:

- The reasons for selecting the SBCT as the vehicle for integration;
- A platform and payload overview of what is out there that could match desired capabilities;
- A discussion of MUM (Manned Unmanned Teaming) tactics, techniques and procedures (TTPs); and
- Thoughts on what a distribution of robotics might look like in a SBCT infantry battalion and why spiraling as a package is desirable.

The purpose of this article is not to nail down material solutions (although it will use specific platforms and payloads to discuss capabilities), nor does it cover a cost analysis in its discussion as to if the benefit is worth the cost. For the purpose of this article cost will be addressed in terms of: training, manning, support requirements, impacts on deployability, impacts on unit and platform mobility, and C4ISR implications. The cost analysis exceeds the scope of the article and at best would be subjective when trying to consider how much time and money will be saved of technical lessons learned, tactical experience gained, and increased effectiveness of tactical units.

As a captain assigned as an operations officer to the FCS Unit of Action Experimental Element (UAEE) at Fort Knox, Kentucky, one of my additional duties is to be a platform proponent for some of the UMS. This has allowed me the opportunity to work "hands on" with some of the platforms mentioned in this article and talk with some very learned engineers from different agencies and the defense industry. As a former SBCT infantry company commander, I have developed some thoughts on how robotics in the near term could have aided me and the rest of the SBCT echelons. Since I'm an operations guy and hope to stay one, the article is from a "user's" vantage, not a "seller's." If the article's language has me sounding like I need to add a pocket protector to my PCI list, it is because there is just no way around it, this is part of our future.

Figure 1 - *An FCS image used to illustrate MUM (Manned Un-Manned Teaming). In this illustration, a company ducted fan UAV hovers and stares to provide surveillance forward of the dismounted infantry platoon's position while an armed robotic vehicle provides overwatch.*

Why the SBCTs?

Why were SBCTs selected versus any of the reorganized BCTs under the new UA design? The SBCT was selected as the unit type for the purpose of this article for several reasons. It already has a good mobility platform with growth potential in the Stryker. Its force structure fits incorporation of robotic assets. The Stryker is already being used as a host for a potential candidate for a FCS robotic control station. Its doctrine is more mature then the reorganized BCTs. Its leaders and Soldiers possess an agile and adaptive mindset with Soldiers used to incorporating new technologies quickly into TTPs to make them more effective. SBCT digital systems could be expanded and adapted for robotic operations.

Recently in a map exercise, we compared a FCS combined arms battalion with a Stryker infantry battalion task force. The tactical scenario used both units to provide an outer cordon while special operations forces (SOF) units conducted a search for Theatre Ballistic Missiles (TBMs) as part of a larger UEx/UEy shaping operation. Both units had some implied tasks that involved neutralizing some border forces and blocking a potential short range (48-72 hour) attack by conventional forces, and if possible

aid the SOF units in their search for TBMs. Both types of units met their primary tasks, but the FCS unit through its density of UMS was able to extend its ISR coverage outside its cordon for early warning and inside its cordon to aid the TBM search.

This is one example of the utility of UMS and how tactical units can utilize UMS influence more of its battlespace to complete the mission faster and more effectively. With the SBCT's platform mobility in Stryker, battalions and companies can rapidly move to dominant points within their battlespace and mass combat power and effects ... if we know where that point is. Through the COP (Common Operational Picture) and enabled by FBCB2 (Force XXI Battle Command Brigade and Below), friendly SA (situational awareness) is known to the platform level while enemy SA must be imputed manually. At the brigade level, the tactical unmanned aerial vehicle (TUAV) platoon organic to the RSTA Squadron operates the Shadow TUAV. This capability, while incredible by today's standards, really supports the brigade commander's ISR plan, although one of its two RVTs (Remote Viewing Terminals) may be allocated to the brigade decisive effort and complement lower echelon ISR collection. Information collected by the RSTA and its TUAV platoon is added to the COP and the entire SBCT's SA is increased indirectly. Currently, it does not get much better for lower tactical echelons.

If we could provide lower tactical echelon leaders the capability to improve their own ISR collection through robotic assets (with some limited multi-spectrum sensor capabilities), the information flow (and COP) would improve bottom to top as well as top to bottom. If we could weaponize (lethals and non-lethals) some of the larger UGVs (we're already doing it in SWORDS, see page 36), we could also increase lethality, options to lethal force (consider not just the ROE, but the time, energy and resources required to use lethal force) and force protection by reducing the risks to mounted and dismounted Soldiers. In sum, robotic assets fielded in a manner that is complementary at team through battalion tactical echelons will allow leaders to focus combat power faster and more effectively resulting in increased mission accomplishment.

Robotics 101 (a brief overview)

Currently in OIF and OEF, robots are being used on a limited basis. Most of us have seen UAVs or UAV footage; we are also aware of the various payloads that larger UAVs such as the Predator have integrated and the successes they have generated. A great many have seen the small rubber tracked robots (TALON) that are helping with explosive ordnance disposal (EOD) procedures or exploration of tunnels and caves. From a joint perspective, there are a number of programs that are near to fruition that are aimed at enhancing force protection for forward operating bases (FOBs) and lines of communication such as smaller UAVs like Raven and Pointer. Within the next year, the Research and Development Engineering Command's (RDECOM's) TALON will be outfitted with SWORDS (Special Weapons Observation Reconnaissance Detection System) and integrated with a SBCT in OIF.

There are also foreign material solutions that would meet the desired capabilities. While purchasing foreign equipment has associated risk, the risk could be mitigated when viewed as an interim solution until some of the FCS UAV platforms are ready for fielding. For the purposes of this article, several Israeli UAVs are cited.

There are also a number of robotic platforms that we are referring to as technology demonstrators for FCS. While not capable of meeting FCS requirements, these platforms:

- ☐ Offer insights into how we will integrate these new technologies on a FCS scale;
- ☐ Serve as platforms for examining payloads; and
- ☐ Help look at DOTLMPF (doctrine, organization, training, leadership and education, material and facilities) issues such as additional skill identifier (ASI) versus MOS requirements for the operators.

They provide reality to what is otherwise conceptual. Some of these platforms are more mature then others and are moving in a direction that could prove useful for both today's units, and by extension of early integration/spiral – more useful for FCS units of tomorrow.

Robotics 102 (Platforms and Capabilities)

This portion of the article will cover descriptions (technical and functional) of the platform types and capabilities that I think would best complement the SBCT structure. It will do so using some of the existing technology demonstrators and some of the more mature hardware already earmarked for force integration. It will also cover the C4ISR hardware types that would be needed to employ these platforms.

Currently robots are limited to LOS (line of sight) operations or tele-operation by a remote operator. LOS is where the operator can physically see the robot and thereby control its actions in accordance with METT-TC (mission, enemy, terrain, troops - time civilians). Tele-operation is where the operator operates the robot through sensors such as cameras and instrumentation to accomplish the mission. Of the two, LOS is currently easier for most (certainly with UGVs because of terrain) because operators perspective is more in tune with that of the robot. UAV operations are an example of tele-operation. Ground based tele-operation is more difficult then aerial tele-operation. This is not based on mission tasks, but on having to deal with the three dimensional obstacles found on the ground versus having to maintain a minimum AGL (above ground limit) to avoid obstacles.

Much scientific effort is going into robotic perception. Perception can be thought of as tactical behaviors that occur through recognition of an event or a piece of terrain that allows for judgment and reasoning. Mobility is a key issue for perception since it reduces the operator burden of tele-operation. Initially, perception may take the form of aiding the operator with decisions such as route planning, aided target recognition, or terrain avoidance. Optimally, perception will allow for the operator to give the robot a route, then tele-operate when an event requires it such as payload employment or chance contact. This is also important because it reduces bandwidth requirements which will be covered later in support requirements.

SPINNER — A SPINNER is a Defense Advanced Research Projects Agency (DARPA) Unmanned Ground Combat Vehicle (UGCV) that was originally designed around a payload bay that could spin if the vehicle became inverted. The vehicle's articulated suspension could then pivot downward raising the robot's body

Figure 2

	Stryker	Spinner
Dimensions	6.9m L x 2.7m W x 2.6m H	4.9m L x 2.6m W x 1.4m H
Weight	17,240 kg	8,600 kg
Payload Fraction	17%	17.5%
Drivetrain Config.	8x8 - Mechanical	6x6 - Hybrid Electric
Steering	Ackerman - Front 2 pairs	Skid Steer - each wheel station independent
Max. Speed	27 m/s (97 kph)	12 m/s (42 kph)
Ground Clearance	0.46m	0.56m
Step Climb	0.58m	1.1m
Gap Crossing	1.98	1.75m
Slope Front	60%	60%
Ground Pressure	50 psi	27 psi

allowing it to continue mission. By virtue of its intended design, SPINNER had so low of a center of gravity that it was almost impossible to flip. The weight savings for dropping the spinning payload will allow it to integrate a sensor and weapons payload and still come in at around nine tons. The fact that SPINNER is big is a plus since the tele-operating is a dislocated experience, the operator has only the instrumentation and what video feed he receives and not the physical sense or equilibrium an operator has when driving his own vehicle.

This is a mature platform that has undergone multiple mobility tests. After observing tests at Fort Knox, I believe this platform has superior mobility to a Stryker. This is important since tele-operation is more difficult the driving; in this case its size aids in its survivability and mission accomplishment. Its size also allows multiple sensors and payloads to be mounted in order to execute a variety of tasks. Currently SPINNER has combined with another DARPA program to aid in robotic perception technology. Over the next year they are integrating sensor and weapons payloads, and continuing to do field testing with Soldiers wherever possible.

SPINNER is an example of a platform that could operate at the company level to perform the following tasks:

- ☐ Support by fire/attack by fire during assault,
- ☐ Recon: would probably be used to weight the decisive effort for assault;
- ☐ Could be used as part of an economy of force to isolate or contain; and
- ☐ Could help with SOSE missions — TCPs, etc.

SPINNER would require a dedicated operator such as a 11B30 working from the company commander's ICV's robotics control station, or attached to the company decisive effort with a dismounted controller. The table and images (Figure 2) give technical specifications and a sense of size. A final note: the original SPINNER used a very quiet hybrid electric turbine, but the next two produced will use a diesel-electric.

Golden Eye — The DARPA Golden Eye is used as an example because of the capabilities associated with ducted fan technology. Fixed-wing UAVs either have their sensors in a fixed position on the body which makes it more difficult to fix the sensor on a target or an area, or have the sensor mounted in a gimble. A gimble with a tactical behavior such as target lock could allow the operator to maintain better surveillance or lasing on a target while the UAV continues to orbit.

Ducted Fan UAVs such as Golden Eye will allow an operator to put a UAV in a "hover and stare" mode. This capability will enable the company commander to visually confirm his plan when limited planning to execution time does not allow for a detailed leader's recon, insertion of the SBCT infantry company's sniper team, or other METT-TC conditions do not favor it. Even with a good leader's recon it is often a limited perspective focused on a ground perspective of terrain supporting those tasks or events critical to the attack. While I think the leader's ground recon is indispensable, I also acknowledge that I've cut out options in order to focus what time I've had available. Since one of the SBCT's strengths is its operational mobility that could put it in unfamiliar terrain based on information that is LTIOV (Limited Time Information of Value), it would improve the chances of mission accomplishment.

Hover and stare also requires less orientation and allows for quicker recognition and interpretation. Hover and stare will be an important characteristic in an urban environment where orbiting a target or point of interest will degrade situational understanding because of terrain masking. During the fight the company commander can get a better feel for his battle space and aid in his decisions. The idea is not to have the CO CDR glued to the

Figure 3

Golden Eye 50

- ***Ducted Fan Air Vehicle (UAV)***
- ***Can hover and stare***
  - ***Height: 28 inches***
  - ***Weight: 18 lbs***
  - ***Payload Capacity: 2 lbs***
- ***Communications:***
  - ***Line of sight required between ground station and and UAV***
  - ***Range: 1.5 miles***
  - ***Video downlink range: 1.5 miles***
  - ***Camera range: 1.5 miles***
  - ***Video Resolution: Approximately 200 lines height and 300 lines width***

Dragon Eye
Wing Span - 45 inches
Length - 35.75 inches
Weight - 5 lbs
Cruising Speed - 35 knots (40 mph)
Range - 5 km (3.11 miles)
Service Ceiling - 300-500 feet AGL
Flight Time - 30-60 minutes

Raven
Wing Span - 53 inches
Length - 36 inches
Weight - 3.8 lbs
Cruising Speed - 96 km/h (60 mph)
Range - 9 miles
Flight Time - 90 minutes
Propulsion - Electric motor

Figure 4

Courtesy photo

Marines used the Dragon Eye UAV during operations in Iraq including those in Fallujah.

operator's station to interpret what is going on in his battle space, but to give him an ISR operator (recommended 35D 20/30) in his vehicle who is tuned into his CCIR and scheme of maneuver and can interact with the CDR, XO, FSO, and PLs on the FM or FBCB2, provide feedback to the BN TOC to help them focus higher echelon resources where the CO CDR needs them. Golden Eye specifications are listed in Figure 3.

Raven/Dragon Eye — Raven and Dragon Eye (Figure 4) are both successful, man portable, fixed-wing UAVs capable of being integrated at platoon, company and battalion levels to fulfill an interim UAV need. Raven is the successor to Pointer, and Dragon Eye has been in the use by the Marine Corps prior to and during OIF. Both have about a 60 to 80 minute flight duration as noted in the images and specifications in Figure 4. Both systems are "back-packable" so they could be used by dismounted Infantry.

Both Raven and Dragon Eye can be given a GPS waypoint route and controlled from a dismounted controller. These systems would conduct local RSTA functions for the infantry platoon similar to those of a ducted fan UAV for the company commander, aid in fires, effects, battle damage assessment (BDA) confirmation and registration for the company fire support officer, and aid the company executive officer in his battlefield reporting to higher. The BN FSNCO and S3 would be provided one each to launch from the TAC. The FSE in the TAC could use it to employ battalion and brigade effects. The S3 could use it to aid in bringing battalion and brigade assets to the decisive point in the fight. The battalion recon platoon would use it to refine NAIs (named areas of interest) for further exploitation by manned assets versus using it as a solitary asset to cover an NAI. The TOC would continue to draw on brigade assets such as shadow and do the analysis on the increased information. These UAVs,

Courtesy photos

Above, images from the Dragon Eye in Iraq show areas of Fallujah. At right, a Marine views images from the Dragon Eye during operations in Iraq.

PackBot

TALON with SWORDS

Figure 5

which are fairly easy to train and employ, would be employed as an additional duty, not as an additional Soldier, ASI or MOS. The Soldiers tasked with operating these would be able to perform their assigned duties from the robotics' crew station inside of the Stryker. The crew station could dedicate one of its six panels (see the description of the crew station in this section) to FBCB2, ASAS, or AFATADs; that way the operator could accomplish both tasks.

PackBot/TALON with SWORDS — PackBot is a "back packable," rubber, band-tracked robot (Figure 5). It is suitable for employment at the squad level, and well suited to built up areas such as tunnels, fortifications or urban areas. Control is either from a fiber optic tether or LOS controller. The idea is to allow the rifle squad to use the robot to investigate areas that are high risk to Soldiers to either determine if it's worth investigating, determine if it might be booby trapped, look around a corner, or with the aid of new sensor technologies such as STTW (See Through The Walls) to help determine threat composition and disposition in a building or room prior to clearing it.

For the recon platoon it would allow manned elements to stay concealed longer while the Pack-Bot is moved forward to pinpoint key positions or target buildings. TALON equipped with SWORDS could be integrated into the weapons squad. Equipped with a key system such as a M240 and UBL of CLV, it could aid in establishing the SBF by being moved in first as a stable platform to cover the rest of the squad's movement in and set up. These robots would not require an additional Soldier, MOS, or ASI. They would be assigned as an additional duty, perhaps to an ammunition bearer or assistant gunner in one of the machine gun teams. They would be employed using the arms room concept that other SBCT systems utilize; if directed or if the squad leader thought he needed it, he'd take it.

Figure 6

Mosquito

Mosquito1

Mosquito — A Mosquito is an Israeli Micro-UAV. It can be thought of as a saucer with a small propeller and a micro camera (Figure 6). It weighs about 250 grams, and has a wingspan of about 30cm. This robot would complement the PackBot for the squad leader. Its one piece assembly and small size would allow it to be put into operation quickly. I see this as a one or the other choice since every Soldier operating a robot is a Soldier not pulling security with his rifle or performing some other task; however, it would be the squad leader's discretion. Since the size of UAVs dictates performance capabilities, this UAV would allow quick looks at shorter ranges from operations, traffic control points, down a street before that leg of the patrol, etc. It would be controlled from a dismounted controller and assigned as an additional duty.

Throw-Bots — Throw-Bots are among the easiest and fastest to use (Figure 7). They will be introduced to the force probably by the time this writing is published. Throw-Bots can be thought of as a class of robots in which their intended use is in their name. Basically, the user is able to throw or drop this durable robot through windows, doors, down hallways or alleys, etc., and the robot will either land upright or be able to right itself with aid from the user. An onboard sensor such as a camera is then used to provide local SA. The robot has built in mobility either through wheels, spines or some movement mechanism that allow it to be moved by the operator over fairly rough terrain.

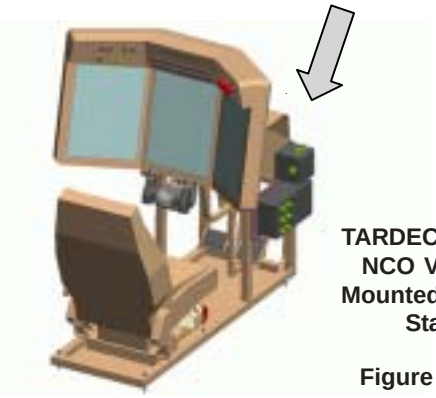
Figure 7

This type of robot would work great for fire team leaders or dismounted recon Soldiers since they could take it out of a pouch on their vest and put into action for a quick look before entering or clearing a room. This robot would take the least amount of training and support.

Robotics NCO Crew Station — TARDEC has built an outstanding vehicle mounted robotics control station (Figure 8) that is multi-functional (can be used to tele-operate the robot, input routes and commands to it and interface with other digital C4ISR systems), user friendly and has growth potential. As a participant in a week-long experiment, I had the opportunity to fly the Pointer UAV from it, remote drive (using only cameras) the Stryker I was in, and employ a UGV. The station also has an embedded trainer which will make concurrent training on Sergeant's Time much less resource intensive. There are a suite of additional capabilities such as an after action review (AAR) capability, etc. Since it has already been successfully integrated into a Stryker, it is easy to examine the space considerations and how that affects crew manning. If need be, an RTO could be replaced by the operator to

Robotics Control Station

- ☐ 3 panels allow for up to 6 screens
- ☐ Functional M1/M2 style "cadillacs"
- ☐ Button-style inputs across top
- ☐ Touch pad buttons on screen
- ☐ Brake & gas pedals on floor



TARDEC Robotics NCO Vehicular Mounted Countrol Station

Figure 8

Two control stations are mounted in the back of the vehicle. Battalion C2Vs, company FSV and Recon platoon RSVs would only be fitted with one station. Company commander's ICV and company XO's C2V would have two stations.

conserve space; it's a capability trade.

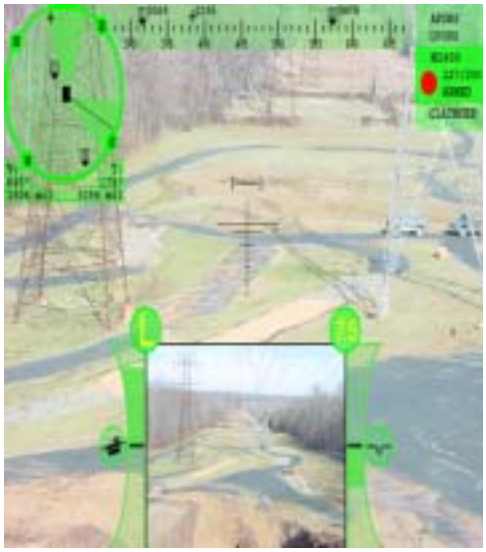
Robotics Dismounted Controller Device — There are multiple variants of dismounted control devices. All are striving to reduce the burden on the operator by: reducing size and weight; providing the operator with displays and controls that are ergonomic, being easily interactive, taking into consideration multiple platform types and their current and future capabilities; being interactive and intuitive, and requiring the least amount of formal training; are rugged, survivable, and logistically supportable; reduce the amount of impairment to the Soldier's primary job and survivability. The variant pictured is the MMI (Marine Machine Interface). One of the most notable things about it is the "game system" look to it. One of the things I considered was that a controller like this would take less time for Soldiers to train since it has many of the characteristics they are familiar with. This system (and likely all such systems in the future) will have an embedded trainer as well. (See Figure 9)

Robotics 201 (Payload Integration)

Integration of payloads with platforms is what provides the usefulness to the user. It also provides most of the challenges for making platforms useful to the lower

Operationally Suitable SDD Marine-Machine Interface

Figure 9



Drive Screen

Status

The Marine Machine Interface shown would be suitable for a dismounted robotics controls station. Note the video game style look to the graphic interface -- this approach should take advantage of younger generations experience and reduce the level of training and disorientation with tele-operation of a robot by a dislocated operator.

tactical echelons. The reasons are pretty straight forward: a payload (sensors or weapons) requires power, so adding a payload requires a larger power source; more powerful payloads are larger and increase weight, and that impacts mobility and flight characteristics. In the case of weapons, the ammunition basic load must be factored in. Larger platforms make payload integration easier (but not simple), smaller platforms must trade capabilities such as range or flight time for more powerful payloads and vice versa. Figure 10 is a Texas chart which shows UAV sensor payloads in gimbles. Gimbles are the mounts for sensor payloads which allow the sensors to be reoriented to a target while the fixed wing UAVs fly routes or orbit.

The challenge is how to get more capability into smaller platforms that would require: a single operator to launch, operate, and recover; less maintenance and other support requirements, be more survivable and stealthy, etc. Most UAVs suitable for fielding to company and below echelons are limited to sensors integrated into the UAV body (no gimble), and require the operator to maintain either an orbit at a particular slant range, or in some cases a "head on" look if the sensor is oriented forward. Also reduced is choice as to which sensor to employ.

From a TTP standpoint this means the UAVs available to lower tactical echelons are more limited then those such as Hunter, Shadow or Predator available to higher echelons. The payoff comes from providing the lower echelon leaders with what they need versus having it all at an unfeasible cost. The ability to get a quick look to confirm the situation and make any last minute changes or the ability to synchronize or provide higher with better information so they can reallocate assets is what we need at those levels. As technology miniaturizes optics and capabilities we'll continue to upgrade the small unit capabilities.

UGVs such as SPINNER have fewer constraints when incorporating payloads then UAVs since getting airborne is not a consideration. A platform the size of SPINNER can integrate weapons and sensors that provide the leader with complementing capabilities. The Marines are experimenting with their own version of a RSTA/ Assault UGV called GLADIATOR (not shown). DARPA and its partners are experimenting to find the right payloads which offer leaders the most flexibility, ease of integration, at an acceptable cost. Figure 11 shows SPINNER integrated with sensors that facilitate operation and RSTA tasks plus the same RWS found on Stryker.

MUM (Manned Unmanned Teaming)

MUM can be thought of as the TTP for robotic integration into manned formations. It is thought of as the linkages between the payload, the platform, the operator and the operator's unit that enhance mission accomplishment. Figure 1, on the first page of this article, shows a concept drawing from a FCS presentation on MUM shows several types of robots performing distinct tasks. Squad resupply is occurring by use of a vehicle that follows the squad and requires minimal operator input. A platoon CL I UAV is echeloned forward to enhance local SA and prevent surprise. A RSTA type platform is paired with it and the point man to provide enhanced sensors that could confirm information obtained by the CL I UAV, this requires a Soldier to check information obtained between the two robots. Finally, an armed UGV follows in support, but may be sent forward of the lead Soldier to suppress and enable movement. The armed UGV will require the most operator involvement since loss of fire control could result in fratricide or collateral damage.

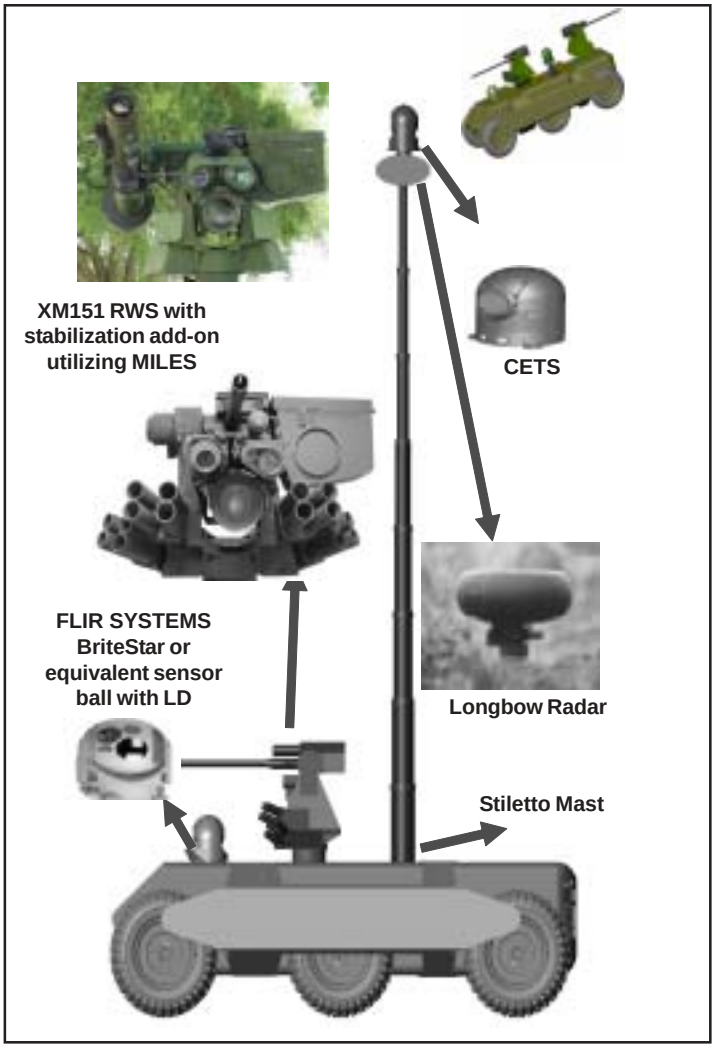


Figure 11

Figure 10 - Texas chart (bigger is better)

The scenario done at Fort Knox in the fall of 2004 used GPS way points and an LOS operator to examine mobility during a tactical task. A MUM TTP might call for the platform to confirm a route one terrain feature in front of a Stryker RSV. As I watched SPINNER move across the route, I considered how I had to train my own driver and VC that it was OK to move off the road in a Stryker. I considered how using a robot (which requires no convincing) and using its operator (pluses and minuses since he doesn't feel the terrain the robot is on) to confirm a route might enhance mobility and speed for follow-on forces. After a driver knows a similar vehicle has negotiated an obstacle, his confidence is heightened. The alternative is to put a dismounted Infantryman out front to examine compressible vegetation and other terrain variations. SPINNER with its low profile, good cross country speed, and mobility provide options to dismounting and walking a Soldier in front. Smaller platforms such as PackBot and Throw-Bot might improve speed and mobility to dismounted Soldiers by confirming or denying options (Ex: a dead end sewer infiltration route or confirming if tunnels are connected).

To speed movement further a unit might use employ a UAV in front or above the UGV to further confirm or deny options, or in targeting or BDA. This requires cooperation between operators, but they do not necessarily need to be collocated in order to do so. It would require a separate FM frequency to do so, or use of an existing frequency such as the CO A&L (Company Admin & Logistics) during periods of less activity.

One of the drawbacks to tele-operation is latency in terms of video. Latency can be described as a limitation due to dedicated bandwidth to transmit streaming video exactly how the human eye sees it. Human eyes operate off of about 35 frames per second (FPS), tele-operation is in the range of 25-30 FPS. With smaller (platoon) UAVs this is not as important since they generally fly in 2-D. LOS movement of UGVs is compensated for by giving the UGVs better mobility and by making them bigger and heavier. Perception will eventually help overcome some of these constraints, but until then the expression about being "smart or strong, so give me my rucksack" applies to UGVs. This really comes into play though with employment of weapons payloads. Latency has fratricide and collateral damage issues. Targeting chips (basically a near real time .jpg or .mpg file) and AiTR (Aided Target Recognition) transmitted from the platform to the operator will become the method for fire control and distribution when fratricide and collateral damage are not factors in the use of lethal force, such as an ABF task. The operator is still using judgment based off guidance and ROE, but it is near real time, not real time. The operator could pull in (or request) a targeting chip from the platform then assign it stationary targets in priority. The alternative using tele-operation is to accept that there is a one or two second delay between what the sensors see you shooting and where your rounds are going. If it's terrain or a stationary enemy that you are suppressing or destroying, this is not much of a factor. If trying to employ it against a moving enemy, Soldiers will have to compensate (Since this is the video game generation, it shouldn't be too difficult for them).

Another MUM TTP would be for an operator in a vehicle to turn over a payload function to an operator on the ground. An example of this would be for an operator employing the weapons payload to suppress an enemy occupied building. The situation changes now as the lead squad enters the building and needs support from the outside to enable its movement. The operator in the vehicle is still in FM contact with the squad and can see the squad leader's icon (a near term capability) on the FBCB2, but is hesitant to employ a tele-operative SBF due to latency in tele-operation (discussed later). He transfers control of the payload over to the squad through the dismounted controller. The squad is keenly aware of where it is at, where the robot is at and where the enemy is at; the squad leader can effectively and safely use the payload to suppress the enemy. This is kind of a hybrid between tele-operations and LOS operations.

What it Will Cost Us (Constraints, Limitations & Requirements)

Training — There are collective, leader and operator/Soldier training issues. At the operator Soldier level, the operator must be technically and tactically versed in robotics in order to maintain the robot, operate the robot, and employ its payloads IAW with the needs of the unit. The operator is essentially the crew. At the leader level, the training requires him to know capabilities and

Figure 12 — Proposed Distribution of Robotic Assets in a SBCT Infantry Battalion

	SPINNER	GOLDENEYE or a ducted fan UAV that can hover and stare	RAVEN OR DRAGON-EYE	TALON W/SWORDS for weapon's squads or PACKBOT for rifle and recon squads	MOSQUITO	THROWBOT
BN S3 in HQ 63 IN TAC		1 total				
BN FSOin HQ 66 IN TAC			1 total			
BN RECON PL HQs V			1 total			
BN RECON SQUAD RSV			4 total	4 total		
Dismounted BN RECON Soldiers and Snipers					5 (1 per team)	25 total
CO CDR 66V	3 total	3 total				
CO XO 65V			3 total			
CO FSO FSV			3 total			
RIFLE PLATOON LDR			9 total			
SQUAD LDR				27 total	27 total	
RIFLE TEAM LDR						54 total
Overall total - 170	3 total	4 total	21 total	31 total	32 total	79 total

limitations of the platform, its payload and the operator in order to best complement the tasks or scheme of maneuver. At the collective level the issue is integration, collective tasks, rehearsals and TTP need to account for robotics on the battlefield.

Creating a centralized point for training robotics at the company and battalion level would help train, maintain and cross train robotics' operators to fulfill a number of tasks. At the battalion level it might be a week of quarterly recertification or training during the battalion's other low density training events led by the S2 and a platoon sergeant from a rifle platoon.

At the company level, I'd recommend that those dedicated operators be grouped together as a robotics team with the FiST, mortars and snipers in what 1-24 Infantry called the Fire Support Platoon to take advantage of the synergy of grouping combat multipliers under the CO FSO who can provide leadership and guidance during periods of non-operational deployments. This would facilitate taking advantage of resourced events and SGT's Time. Non-dedicated operators could fall under a SGT's Time training plan once or twice a month with the most senior operator as the primary trainer.

Manning — Manning walks hand in hand with training, while the goal in a robotics platform is to not require additional personnel, MOSs or ASIs in order to reduce the manning burden on the unit, the reality is that there is still no substitute for experience. Some robots addressed in the MTO&E possibilities chart in Figure 12 recommend a specific MOS or pay grade not currently organic to the SBCT MTO&E.

Support Requirements — Support requirements come from adding additional systems, which means special training for 20 level maintenance and above. This could be mitigated by handing the tasks of the UGVs to the wheeled mechanics and the SBCT already has to address UAVs since it has a TUAV platoon. C4ISR is another consideration, paragraph 5 just got bigger as well as bandwidth needs. Fiber Optic cables and LOS reduce bandwidth requirements, but tele-operation even at 25 FPS still consumes about 500KBs worth of bandwidth (at 30-35); it's close to 1MB! Bandwidth compression efforts are ongoing, but until that is solved tele-operation C4ISR infrastructure will be a consideration if not a constraint. One of the work arounds might involve the small unit deployable, high altitude retrans blimps from the BN Retrans unit with a fiber optic tether or tail to extend LOS comms and the digital backbone.

Unit deployability and mobility will both be changed. While the smaller UAVs and UGVs don't amount to much at the mounted levels, they do add up to a dismounted Soldier, but what they add to the fight may reduce other burdens. Big platforms such as SPINNER will change deployability. At 9 tons such a platform would probably take one C130 per two robots. Long road marches to training areas such as Fort Lewis or Yakima, Washington. Would either require a PLS or be towed by a manned platform. Again it's a trade off about what this platform would bring to the fight.

MTO&E Possibilities

Figure 12 lists platforms that are meant to represent both platform selection options and platform capabilities that are available now or in the 1-2 year mark for maturation for the purpose of fulfilling a tactical/operational need. An applicable distribution could be done across the SBCT to include the RSTA BN, the FZ BN and the separate ENG CO and the separate AT CO. At the corresponding echelons the distribution would be similar. The focus of this proposal has been narrowed to the IN BN to scope it down.

Delivering the Spiral to the SBCT as a PKG vs. Piecemeal

Referencing Figure 12, you'll note the density of robotics in the infantry battalion. 170 systems looks like a high number, especially in light of the support requirements. It is probably safe to take out the last three classes (those systems at squad level and below) since they will be controlled LOS and by fiber optic tether. That leaves a total of 28 systems which will be the primary bandwidth consumers. The numbers are highlighted is to point out the primary detractor from the feasibility of fielding (or spiraling) these capabilities as a package, other then the monetary cost.

The benefits associated with fielding robotic capabilities to all the echelons in an SBCT IN BN only begin there, the ultimately extend to the rest of the Army, just as any other part of Transformation. The capabilities outlined in this article lend themselves to being fielded at the levels outlined in Figure 12 because together they offer complementing characteristics that would provide the same type of synergy as the positions in a fire team, the strength of the fist over four individual fingers. Whereas one platform or capability provides a limited increase in capability multiple platforms with complementing capabilities provide an exponential increase, an appropriate analogy would be digitizing a TOC versus digitizing squad, platoons, companies and the battalion C2 nodes. This aspect provides an exponential increase in capabilities.

Qualitative results from fielding as a package also extend to long term unit capabilities. Low level introduction breeds early familiarity at incremental levels of sophistication, or another way to say it would be that when the company commander's primary robotics' NCO PCS's or gets pulled up to the BN S3 shop, the company commander will not have to start from scratch, instead he can pull one up from a platoon. This aspect provides a cumulative increase in capabilities.

Robotics capabilities at the lower tactical levels are much closer then most of the Army suspects. While not quite those capabilities the Army hopes to acquire with FCS, they are significant and they can substantially increase combat power and capabilities in a unit. SBCT units are unique in the Army because of their structure and design, they have the one vehicle in the active Army that provides a platform with enough room for a two man crew and a nine man squad that is outfitted with FBCB2 and can accommodate the arms room concept. Integrating robotics on a large enough scale to make a significant impact to the team leader, squad leader, platoon leader and company commander is a course of action that empowers lower tactical echelons with technology that will enable them.

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