The 21st Century MAGTF C² Environment

Consolidating wideband BLOS capabilities

by Maj Kelly Haycock

Once again, we are confronted with a forked road in the fielding of the right systems to the Operating Forces. On the left lies another decade of systems mired in insufficient operator and maintainer training, frustratingly low stocks of spare parts, and understaffed project office teams having difficulty providing the wide spectrum of system support to the Operating Forces. On the right, we find a synchronized C^2 environment where, in addition to being highly capable and inexorably expeditionary, commonality is the predominate feature. This commonality yields a categorically smaller number of types of spare parts required to be stocked, a major reduction in specialized operator and maintainer training, and a project office focused on a single cohesive family of systems and using added personnel depth to bolster that system's cyber network defense planning, supply chain management, and life cycle sustainment. If the Marine Corps goes down the road of integrating the U.S. Army SIPR/NIPR Access Point (SNAP™) Tactical Transportable TROPO (3T) into our MAGTF C^2 environment, we will be stepping off down the wrong road. An opportunity for the largest, most impactful consolidation of redundant C^2 capabilities ever seen will be missed.

An alternative exists with the potential to lighten the BLOS (beyond line-of-sight) wideband capability of the MAGTF by roughly 85 percent in volume, 75 percent in weight, and it

>Maj Haycock is the CO, Headquarters Company, Marine Corps Communication-Electronics School, Twentynine Palms, CA.

takes roughly less than 12 percent of the C-130 sorties to lift (i.e., over 850 percent increase in transportability). After a targeted population of systems is phased out in this scenario, the cost of the fleet would be reduced to roughly 45 percent of what it is today. Combine these unprecedented gains in lightening the innumerable cost, training, and logistics advantages made possible by fleet-wide ubiquity, and we will unlock the path to a new era in MAGTF C^2. (See Figure 1 and 2 on following page.)

Wideband Fundamentals

Wideband communications systems require three fundamental components.

1. Parabolic antenna: Where radio signals are reflected and focused.
2. Feed assembly: Consists of a band-specific radio amplifier (a.k.a. transmitter), receiver, and waveguides. This assembly must transmit from the geometric focus of the parabolic antenna.
3. Modem: Transcribes the information to be communicated into a radio signal that is encoded for proper transmission and decoded at the distant end.

As long as these three fundamental components are correctly integrated, it doesn't matter much which antenna is used. It is possible to marry up a very small aperture terminal (VSAT)-medium antenna with a network-on-the-move (NOTM) modem and a TRC-170 C-Band feed assembly and, with a certain amount of professional integration, make a useful wideband communications system. The Marine Corps doesn't involve itself too much with how that integration happens; the contracted systems manufacturer is solely responsible for that. The Marine Corps concerns itself more with meeting performance, cost, and risk reduction requirements. However, armed with the understanding of wideband communications' fundamental simplicity, the program offices can broaden their expectations for what industry can quickly and easily produce.

Getting the Wrong Systems

The SNAP™ terminal is a U.S. Army program of record wideband SATCOM terminal roughly equivalent to the Marine Corps' VSAT-M and is similarly used at middle echelon command posts and communications nodes. The SNAP™ 3T is a variant of the SNAP™ terminal that has an integrated C-Band feed assembly and a Tropo-Modem add-on kit. The Army program office is leveraging their ubiquitous SNAP™ terminal platform to achieve the desired troposcatter radio capability while maximizing commonality with the rest of their wideband BLOS fleet. There is no doubt that the Army seeks maximum logistics, maintenance, training simplicity, and, ultimately, cost reduction through the bulk procurement of complete systems and spare or upgraded parts.

Original Platform	Antenna Size (m²)	Volume (cu ft)	Weight (lbs)	Fielded Qty	Fleet Volume (k cu ft)	Fleet Weight (k lbs)	Cost Each ($K)	Fleet Cost ($M)
TRC-170	5.0	1,620	14,610	151	245	2,200	1,500	226.5
VSAT-Large	4.5	1,160	5,279	126	145	642	450	56.5
VSAT-Small	1.1	47	523	165	7.8	86	148	24.4
VSAT-Med	2.5	116	975	62	7.2	61	203	12.6
GATR ISA	4.5	25	487	87	0.9	17.5	154	13.4
VSAT-E/ECCS	1.1	38	315	66	2.5	20.8	308	20.3
GBS	1.1	26	271	81	2.2	22	58	4.7
SMART-T	1.5	781	8,270	42	33	347	1,300	54.6
Fleet Totals	C-130 Sorties: 214			780 systems	444.2 k cu ft	3,427 k lbs		$413M

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Figure 1.

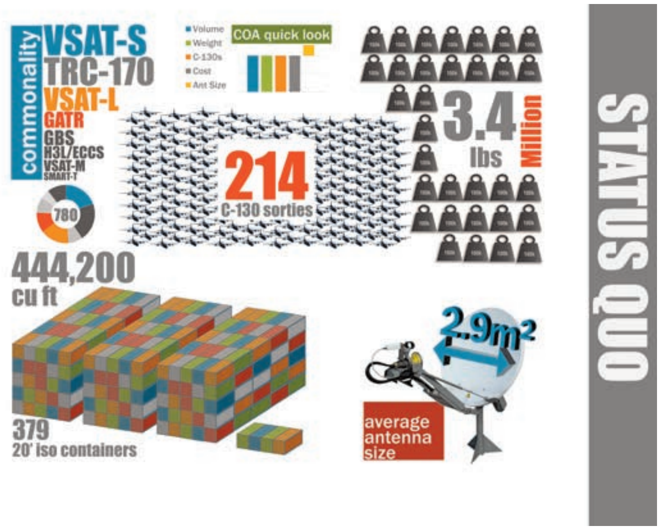

Figure 2.

The Marine Corps does *not* have any SNAP™ terminals; the Marine Corps *does* have many other systems that are similar or more capable.

Commonality for Sustainability

The Marine Corps' fleet of wideband BLOS communications systems includes approximately 780 terminals consisting of ten program-of-record systems including VSATs, TRC-170s, rapid response kits, special intelligence systems, anti-jam SMART-Ts, military broadcast receivers, and highly transportable inflatable SATCOM antennas. This is not the progeny of a well-crafted, net-centric C^2 environment. This is a mess of hasty patchwork acquisitions in response to myriad combat-related urgent-need statements.

Systems were (and often still are) bought in stovepiped acquisitions approval chains, where a user community worked with a particular combat developer who assigned requirement sets to a particular project team for a closed-loop system development process. There may very well be another user community that desires similar capabilities. However, this user community, associated combat developer, and associated system acquirer don't have an obligation to reduce redundant capabilities. There is no precedent for concerted coordination and de-confliction with adjacent user communities, combat developers, or project teams that may be better suited to provide certain elements of the required capability. For example, the project team buying voiceover Internet protocol (VOIP) phone systems for combat operations centers (COCs) had no obligation to collaborate with the Tactical Voice Switching System acquirers to ensure interoperability is built into these two tactical telephone systems from program inception. This resulted in two materiel solutions bought to meet the exact same requirement. Because both programs of record generally support COC operations, there is a high potential that in a deployed COC, two Defense Switch Network phones could sit on the same desk and not be interchangeable if one were to break. More so, the Marine Corps has to stock two different sets of spare parts and train a Marine in operating and maintaining two redundant systems. Worse yet, it may be necessary to deploy two Marines to do the job of one. We now have to live with this fleet of multiple disparate and non-interchangeable phone systems.

We cannot correct the problem until we achieve a reasonable amount of return on investment in the wrong systems (five to ten years for information technology systems), we pour more money into integration efforts to make the best out of the wrong systems, or we take the loss of hundreds of thousands of dollars of unrealized investment and buy the right systems. It is this fundamental principle of systems acquisitions that necessitates making the right investment decision at every turn. Failure to buy the right systems has significant long-term negative effects.

This tactical VOIP situation is a small oversight compared to the tragic, systemic reality of our fleet of disparate wideband BLOS systems. Among these ten program-of-record systems, there are roughly six funding lines; six acquisition strategies; six systems engineering plans; six test and evaluation strategies; six cyber security strategies; six contracts each in the test and evaluation, procurement, sustainment, and upgrade varieties; and eight sets of expensive, disparate components that must be stocked in repair issue points but cannot be bought in bulk. This disarrayed fleet of systems also requires significant specialized on-the-job training for operators and maintainers. The schoolhouse can't produce independent operators with much depth on any one system during the students' limited number of training days. The real training occurs after being introduced to the exact mix of equipment at a particular unit.

We can forgive the lack of unified vision in response to urgent combat requirements that led us to the mess in which we are currently mired. During a time of wartime funding, leaning on expensive field service representatives and global overnight in-warranty part replacement for operations and maintenance of our systems was acceptable. Out of necessity, we rapidly fielded systems that were not based on de-conflicted sets of requirements and were only loosely holistically integrated. However, now we have two harsh realities that are exacerbating the friction inherent in this hodgepodge, rapidly assembled fleet of systems.

1. Wartime funding is long gone, and future funding is uncertain. We may have funded extended warranties and 24-hour per day worldwide field service representative support in the past. Those days are over. We must now be proficient in the operation and maintenance of our own equipment. The spare parts must be bought up front and stocked in accordance with the most pessimistic expected failure rates. Anyone who has stood in a nine-month line to get a high-failure replacement part for a low-density mission critical system knows the pain that this lack of funding is causing.

2. The Marine Corps has fewer Marines now at the end of the drawdown than it did when the systems were bought and fielded. With the availability of field service representatives diminishing, operations and maintenance of our systems are becoming more and more dependent upon the depth of knowledge of the individual Marine. With the frustrating complexity of our wide spectrum of systems, no Marine comes from the schoolhouse ready to be an independent operator, and one can hardly get there during a two-year overseas tour.

Getting the Right Systems

It is clear that as the only BLOS terrestrial wideband system in our inventory, the TRC-170 is long overdue for a replacement. This system is not the result of a secret government technology but is a simple and proven commercial technology that can be integrated into any wideband SATCOM terminal with a few considerations. Generally, with any wideband transmissions system, the larger the antenna, the better. The larger surface area on a reflector catches more receive signal and focuses it into the receiver while catching more of the transmit signal and focusing it toward the distant end. This means that the Marine Corps system with the largest antenna would be best for troposcatter capability integration. Currently, the Marine Corps has several 2.4m (4.5 square meter) antenna systems. Also, a troposcatter radio requires far more power than a wideband SATCOM terminal. The power required of the amplifier can be lessened with a larger antenna, and a lower-power amplifier is generally less expensive and less prone to failure. Finally, in order to transmit on occasion in a line-of-sight mode, the system must be able to point and transmit at a zero-degree elevation, essentially level to the ground.

The Army SNAP™ 3T does, vaguely, meet these requirements. The Army has done the hardest portions of the acquisition process in preparing the SNAP™ 3T for fielding. It has mitigated performance risk by conducting a wide spectrum of tests and evaluations, and it has done the hardest, most time-consuming part of the process by establishing a contract vehicle for the procurement of systems and parts. The Marine Corps has only to fund the Army's contract, mitigate some program risk through proper ordinary bureaucratic paperwork, field, and buy replenishment spares. This is by far the easier path for a program office to tread. The path looks well paved by Army engineers and their respective project teams; however, once we pass the first bend, we see another decade of complex and insufficient logistics, long wait times for unfunded spare parts, and a reliance on operators and maintainers to support too many different systems.

There is another way. Imagine a USMC-fielded system adapted to meet troposcatter requirements. Imagine a system that meets or exceeds the capability potential (or antenna size) of the SNAP™ 3T, that lightens the MAGTF in accordance with *Expeditionary Force 21*, (Washington, DC: HQMC, 2014), and provides us with the ubiquity of spare parts and training simplicity associated with a common system. This may require a significant amount of time and effort associated with test and evaluation, contract development, and other bureaucratic risk mitigation tasks required to bring a system into service as a program of record; and the path may look rocky and risky from this vantage. However, around the first bend, we find the skies open and the path an easy downhill pitch. The Army found it worth traversing with its fielded SNAP™ terminal in buying the SNAP™ 3T. We must do the same with one of our own systems.

In designing the concept for a TRC-170 replacement system, we must first consider what salient characteristics define the *right* troposcatter solution. In order to achieve the 100-mile range requirement, the TRC-170 can operate in the 80 mph winds expected at the tops of mountains, and its 2x1.8m antenna (with 5 square meters of surface area) is paired with a power amplifier (transmitter) capable of 1,250 watts or greater. In selecting a replacement system, physics would dictate that a smaller surface area would normally require a higher-power transmitter in order to match the 100-mile range capability.

Because the Marine Corps is considering a 2.0 meter SNAP™ terminal, all of our terminals with 2.0m (3.14 square meters of surface area) or larger antennas should be candidates. Because the SNAP™ terminal has maximum wind speed of 30 mph, any of our 2.4m (4.5 square meters of surface area) antennas capable of operating in 30 mph wind should continue on as candidates. Upon review of the fleet of wideband BLOS systems, there are two strong candidates that are both larger (higher potential capability) and have better wind ratings than the SNAP™: the VSAT-L at 45 mph and the GATR™ Inflatable SATCOM Antenna (ISA), which has demonstrated solid performance in 80 mph winds.

Finally, central to the argument of the SNAP™ terminal's inclusion into the Marine Corps fleet, is the impact to the fleet's expeditionary character. There must be positive gains in lightening the MAGTF. The Marine Corps operates in austere environments where the capacity to lift and self-sustain determines the relevance of each warfighting organization. The cost of lift in terms of aviation sorties and pallet spaces is high. Often, if you can't fit on the plane, you can't get into tonight's fight, and you'll wait until the slower surface vessels can get you there next week. By then, you are far less operationally relevant. It is a paramount desire of commanders to have the maximum C^2 capability with the minimum lift required in order to become and remain operationally relevant.

Evaluating the Legacy Fleet

Let's evaluate the current status quo fleet of wideband BLOS systems and determine the possible candidates for a USMC-integrated SATCOM/troposcatter platform like the SNAP™ 3T.

Based on actual measured or advertised size and weight dimensions of each system listed, an assessment was made on the current fleet's transportability. Based on real considerations applied to the embarkation of systems, while holding constant the flight distance and associated fuel weight variables, it was calculated that the fleet could be transported by 214 KC-130 sorties, or flights.[1] Because commanders need their combat equipment in the immediate fight, large rolling stock communications systems are not likely going to get priority on the aircraft. The chances of getting on the first flight dramatically increase for palletized systems, especially considering that these rolling stock systems are not transportable by any of our rotary-wing or tilt-rotor lift assets.

Finally, based on actual cost data and some parametric cost estimation where actual cost data was not available, a fleet-wide replacement cost figure was calculated. This is not an acquisitions term. This is not a life cycle cost estimate, and the figures are not average procurement unit costs. These are based on figures that appeared on contracts for systems bought by the Marine Corps or Army program offices or, in some cases, are based on parametric estimates. In order to make assertions about the true cost to own these systems, professional cost estimators must be brought in to support. Until then, a replacement cost term is used to illustrate a financial value of the systems among the following courses of action. We also make an assumption that in 2026, every system currently fielded will reach its ten-year mark and become a good candidate for fleet-wide replacement, especially the more frustrating ones. From the replacement cost figures, we can assume that the Marine Corps would have to invest $214 million to do a fleet-wide replacement of all systems in their current configuration. As long as we strive to invest less than $214 million in the next generation of BLOS wideband systems, we will achieve gains in fiscal due diligence. The more we can reduce our fleet-replacement cost, the better.

COA 1: SNAP™ 3T Replaces TRC-170

The first course of action (COA) in the replacement of the TRC-170s is to go along with the Army's SNAP™ 3T. (See Figures 3 and 4.) In order to maximize commonality, any terminal that is heavier and less capable should also be evaluated for replacement by the SNAP™ 3T. If we are going to invest in a new system to replace our TRC-170s, at minimum, it must be a SATCOM capable terminal with which we can achieve maximum fleet-wide ubiquity, leverage bulk purchasing advantages, and reduce operator and maintainer training.

The following pairwise comparison between the SNAP™ terminal and the other wideband BLOS systems in the USMC fleet will illustrate which systems may be good candidates for replacement.

Based mostly on antenna size, the 1.2 meter VSAT-S and 1.8 meter VSAT-M are good candidates for replacement by the 2.0 meter SNAP™. Though less transportable, the VSAT-L and SMART-T are more capable, so they would not be replaced by the SNAP™. The GATR™ ISA is more capable and more transportable, so it would not be replaced by the SNAP™. Though less capable, the VSAT-E, Expeditionary Command and Control Suite-Rapid Response Kit, High Bandwidth Special Intelligence Team Terminal, and Global Broadcast Service (GBS) System are more transportable, so these would not be replaced by the SNAP™. As a result of the pairwise comparison, the TRC-170, VSAT-S, and VSAT-M would be good candidates for replace-

COA 1 Platform	Antenna Size (m²)	Volume (cu ft)	Weight (lbs)	Fielded Qty	Fleet Volume (k cu ft)	Fleet Weight (k lbs)	Cost Each ($K)	Fleet Cost ($M)
SNAP-3T	3.1	91	1,120	151	13.7	169	151	228.3
VSAT-Large	4.5	1,160	5,279	126	145	642	450	56.5
SNAP-3T	3.1	74	985	165	12.2	163	164	27.1
SNAP-3T	3.1	74	985	62	4.6	61	164	10.2
GATR ISA	4.5	25	487	87	0.9	17.5	154	13.4
VSAT-E/ECCS	1.1	38	315	66	2.5	20.8	308	20.3
GBS	1.1	26	271	81	2.2	22	58	4.7
SMART-T	1.5	781	8,270	42	33	347	1,300	54.6
Fleet Totals	C-130 Sorties: 69			780 systems	215 k cu ft	1476 k lbs		$210M

COA 1

Figure 3.

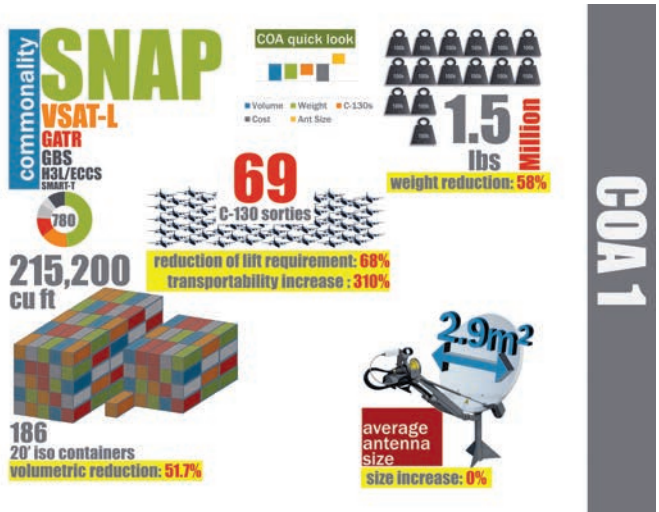

Figure 4.

ment. Upon the phase out of these systems for replacement by the SNAP™, the impact to fleet transportability and replacement cost should be evaluated.

In this COA 1 analysis, we see that there is a significant increase in transportability for this new fleet of systems. This COA lightens the BLOS wideband capability roughly by half in terms of size and weight and takes roughly one-third of the C-130 sorties to lift (i.e. 310 percent increase in transportability). The new investment cost is roughly $61 million, and the replacement cost is reduced roughly by half. This is a major improvement, and if the Marine Corps continues down this path, it will have done its due diligence in lightening the MAGTF, reducing costs, and achieving an important level of commonality in the wideband BLOS fleet. However, we have added one system to take three away. Would it be more responsible to never introduce a new system into our inventory and leverage our own system? It is critical to retain maximum value in our financial, logistic, and training investments.

COA 2: GATR™ ISA Replaces TRC-170

In COA 2, we evaluate the use of the GATR™ ISA and the remainder of the USMC wideband BLOS fleet. (See Figures 5 and 6.) The ISA has been employed by the Special Operations Command since at least 2010 and has been adopted by most or all of the MEUs. The program office for high bandwidth special intelligence bought 51 of these systems as their palletized terminal to replace the AN/TSQ-90 Trojan SPIRIT. Because 87 of our wideband BLOS systems in the fleet use this in the base configuration, for the purpose of this analysis, its standard 2.4 meter ISA is used. With the endorsement of the MEUs, the intelligence community, and the special operations community, this system should certainly be considered for the MAGTF C^2 community.

There are likely questions about an inflatable SATCOM system's utility and durability in combat. This can be alleviated by understanding that a GATR™ ISA can be repaired much more easily than its rigid counterparts. Repairing shrapnel damage to the inflatable skin is operator-level maintenance with inexpensive patch kits similar to tent-patching kits. Videos can be found online to show the low impact that small arms ammunition has on the ability for this system to operate in a combat environment. This has not been similarly validated on our rigid antenna systems. Because the system is manually pointed, there are also fewer complex single-point-of-failure components. These two areas represent some of the more serious maintenance risks found among our current systems. A lack of heavy auto-acquiring, satellite-pointing equipment also allows this highly capable 2.4m system to fit in a few airline-checkable cases, depending on the mission. Its large size and extremely high level of transportability allows this one single terminal to be relevant in all echelons of the MAGTF, from first-in through sustained operations. Finally, its ease of use has been proven with the speed by which minimally trained incidental operators bring the GATR™ ISA into operation. That can't be said of many of our systems, with or without auto-acquiring capability.

Finally, the most daunting portions of the acquisition process include the test and evaluation of the systems to mitigate performance risk and the time-consuming contract development and award phases. The GATR™ ISA COA has mitigated both. These systems have been fielded to expeditionary organizations for many years. This platform has already achieved one of the highest technology readiness ratings by being proven in deployed environments. Performance risk is therefore significantly lower than most other new platforms. Also, because of the disruptive nature of GATR™'s ISA technology, the Army awarded the company a fast-track contract vehicle called a Small Business Innovative Research contract. This contract is in place and alleviates the concern over otherwise glacial contract timelines.

The following COA 2 pairwise comparison identifies the best candidates among our legacy wideband BLOS fleet for eventual replacement by the GATR™ ISA:

COA 2 Platform	Antenna Size (m²)	Volume (cu ft)	Weight (lbs)	Fielded Qty	Fleet Volume (k cu ft)	Fleet Weight (k lbs)	Cost Each ($K)	Fleet Cost ($M)
GATR ISA+ T	4.5	20	609	151	3	92	151	27.7
GATR ISA	4.5	63	1,047	126	7.1	132	188	23.8
GATR ISA	4.5	25	487	165	4.2	80.4	188	29.5
GATR ISA	4.5	25	487	62	1.6	30.2	154	11.1
GATR ISA	4.5	25	487	87	0.9	17.5	154	13.4
VSAT-E/ECCS	1.1	38	315	66	2.5	20.8	308	20.3
GBS	1.1	26	271	81	2.2	22	58	4.7
SMART-T	1.5	781	8,270	42	33	347	1,300	54.6
Fleet Totals	C-130 Sorties: 25			780 systems	55 k cu ft	767 k lbs		$185M

COA 2

Figure 5.

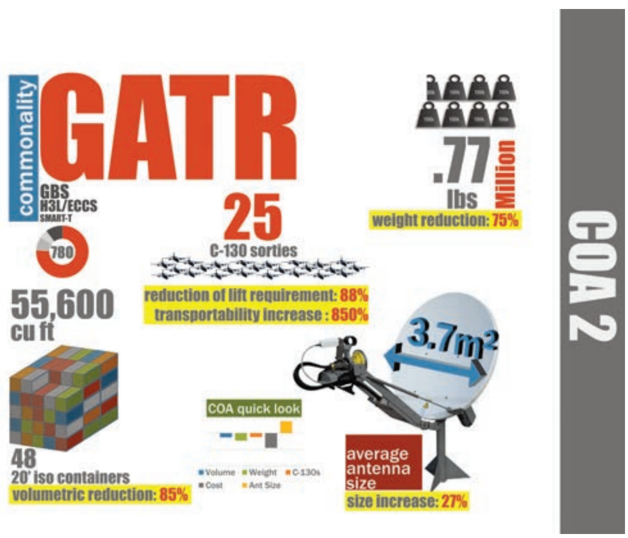

Figure 6.

Because the GATR™ ISA exceeds the VSAT-L, VSAT-M, and VSAT-S in terms of transportability and is at least equivalent in its capability potential, each are good candidates for replacement by the GATR™ ISA. Because the GATR™ ISA is negligibly less transportable than the VSAT-E, it is arguable whether the ISA should replace it. Both systems work well as first-in systems, and their sizes scale with their additional modular capabilities. As of this writing, it is also not practical to replace the SMART-T or GBS.

In COA 2, we evaluate the fleet systems with the ISA as the common base system. From the legacy fleet, COA 2 lightens the BLOS wideband capability of the MAGTF by roughly 85 percent in volume, 75 percent in weight, and it takes roughly less than 12 percent of the C-130 sorties to lift (i.e., over 850 percent increase in transportability). The new investment cost of roughly $92 million alleviates the already-likely replacement costs by 2026, and the new fleet's replacement cost is roughly 45 percent of the legacy fleet.

COA Comparison

From the following comparison of these three COAs, it is clear that COA 2 stands out. (See Figures 7 and 8.)

While all COAs guarantee an equal or greater capability than the legacy systems, COA 2 is the clear winner in terms of lightening the MAGTF while categorically reducing the cost of the fleet, logistics complexity, and cyber defense, maintenance, and training burdens. In the eyes of the operator, maintainer, logistician, supplier, operations planner, trainer, cyber network defense planner, program engineer, and contract officer, COA 2 is the most desirable and achievable end state. This is an end state worth fighting for.

Other Considerations

In evaluating the most reasonable COAs, it became obvious that a few variables could be added to the analysis to provide additional options to the combat developer in determining a long-term, strategic approach to replacing the TRC-170 and modernizing the wideband BLOS fleet. (See Figure 9.)

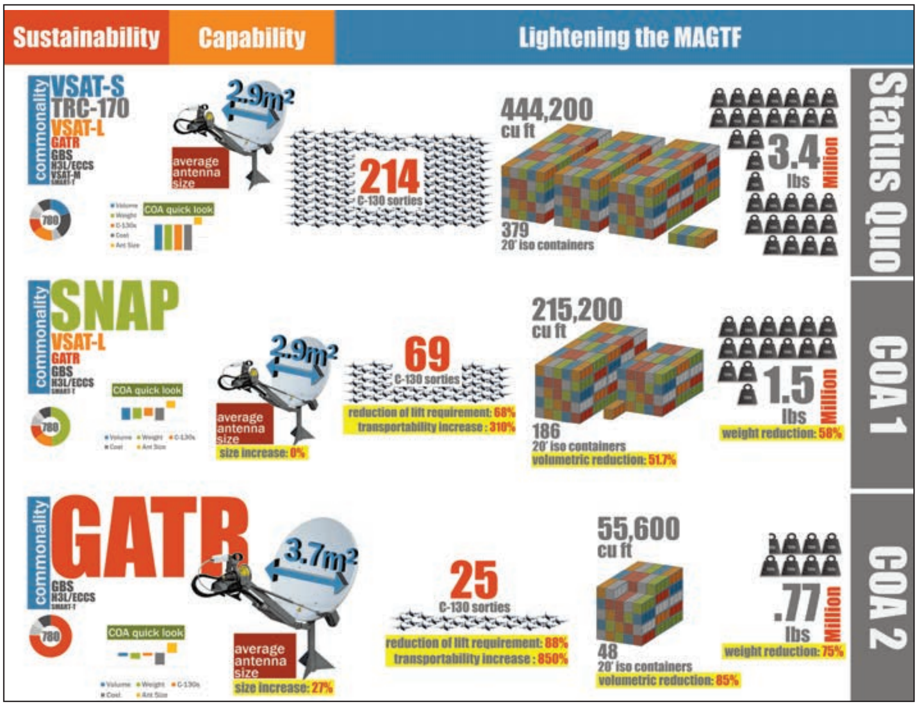

Figure 7.

COA Comparison

Status Quo		COA 1		COA 2	
TRC-170 (151)		SNAP 3T (151)		GATR ISA + Tropo (151)	
VSAT-Large (126)		VSAT-Large (126)		GATR ISA + HMP + MRT (126)	
VSAT-Small (165)		SNAP (165)		GATR + ISA (165)	
VSAT-Medium (62)		SNAP (62)		GATR ISA (62)	
GATR ISA (87)		GATR ISA (87)		GATR ISA (87)	
VSAT-E (ECCS-RRK) (66)		VSAT-E (ECCS-RRK) (66)		VSAT-E (ECCS-RRK) (66)	
GBS (81)		GBS (81)		GBS (81)	
SMART-T (42)		SMART-T (42)		SMART-T (42)	
Fleet Vol (cu ft)	444.2K	Fleet Vol (cu ft)	215K	Fleet Vol (cu ft) ★	55.5K
Fleet Weight (lbs)	3,427K	Fleet Weight (lbs)	1,467K	Fleet Weight (lbs) ★	767K
C-130 Sorties to Lift to Theater	214	C-130 Sorties to Lift to Theater	69	C-130 Sorties to Lift to Theater ★	25
New Investment Cost	0	New Investment Cost	$61M	New Investment Cost	$92M
Replacement Cost	$413M	Replacement Cost	$210M	Replacement Cost ★	$185M
		COA Rank	2	COA Rank ★	1

While both COAs guarantee equal or greater capability than the legacy systems, **COA 2 is the clear winner in terms of lightening the MAGTF while categorically reducing the cost of the fleet, logistics complexity, and cyber defense, maintenance, and training burdens**

Figure 8.

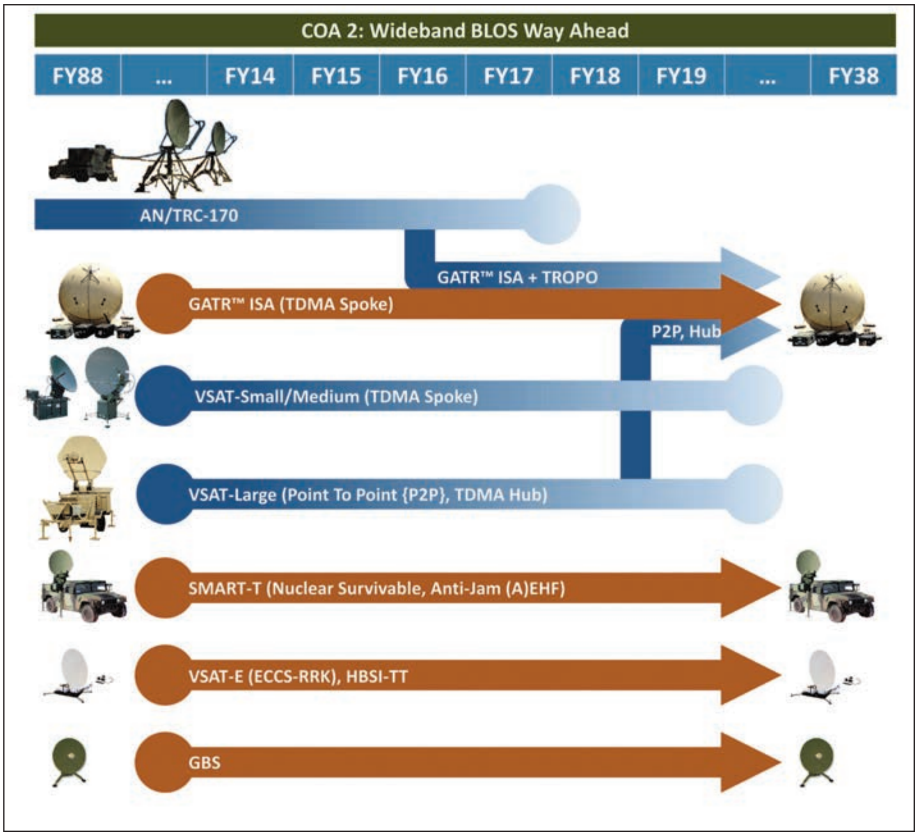

Figure 9.

First, with any COA, it should be considered that a system replacement ratio less than 1:1 may be appropriate. Where the TRC-170 replacement system and wideband SATCOM system share major commonality, there may be a reduction in the total systems required to meet all warfighter needs. For example, a unit that has five VSAT-Ls, three VSAT-Ms, six VSAT-Ss, and fourteen TRC-170s may be able to accomplish its doctrinal mission with 25 wideband BLOS systems instead of 28. Whatever the right mix of troposcatter-capable and wideband SATCOM-capable replacement systems is, that ratio would be applied similarly across all of the COAs evaluated in this analysis. It may be suggested that, with more commonality, more systems become candidates for quantity reduction due to efficiency. In other words, our fleet of 780 systems may be marginally reduced perhaps to 720, thus reducing our fleet's total ownership costs.

Second, the VSAT-L was not able to fully replace the lightweight multiband satellite terminal's ability to do multiple point-to-point missions on X-band. Because of a self-interference reduction requirement (called the low Phase Inter Modulation or low-PIM requirement) levied by the Army Strategic Command in accessing wideband global satellites or Defense satellite communications satellites, and because of a lack of space and power margin on the terminal to mitigate this with a second level multiplexor, it was found to be cost prohibitive to include multi-point X-band capability on the VSAT-L. The GATR™ ISA has a natural buffer to the self-interference risk and has demonstrated better PIM metrics than the VSAT-L. Achievement of low-PIM and subsequent multi-point X-band on the GATR™ ISA, therefore, becomes more achievable.

Third, the GBS is a capability that could be integrated into any terminal that operates on military Ka-band. It does not need an entire dedicated GBS system packed out to the field to meet its requirements. The GBS capability requires only a Ka-band capable system, a modem with SIM card, and connection to the local area network. In the case where a site's major SATCOM missions use Ku-band or X-band only, an additional terminal would have to be set up to terminate the GBS feed on Ka-band. Aside from this stipulation, significant efficiency could be found by reducing the number of systems in the fleet according to the number of times a GBS requirement would exist in the absence of a Ka-band C^2 SATCOM mission.

Fourth, the SMART-T's access to the advanced, extremely high-frequency satellite constellation has been commercialized and can be found in other, smaller terminals including the Single Channel Anti-Jam Man Portable terminal. It can be assumed that with the correct professional integration, the SNAP™, GATR™ ISA, or VSAT-L could also be adapted to meet this requirement. However, with such a small quantity requirement for this capability (42 SMART-Ts), it may be assumed that the efficiencies gained through commonality would be cost prohibitive. However, given the technological threat our future adversaries pose to wideband communications, this capability probably rates a significant quantity increase among the Operating Forces. This study welcomes the detailed business case analysis associated with the migration of the nuclear survivable anti-jam capability to the common wideband BLOS platform.

Next, the VSAT-E (or Expeditionary Command and Control Suite-Rapid Response Kit) is nominally more transportable than the GATR™ ISA. It may be practical to further develop a COA in which the GATR™ ISA replaces the VSAT-E because the GATR™ ISA's antenna size yields roughly double the data rate of the VSAT-E, and the vast efficiency gained in ubiquitous commonality outweighs the negligible transportability shortfall.

Finally, there is an Army troposcatter prototype that provides much better tropo capability than the SNAP™ 3T. If the Marine Corps is going to introduce a system not already found in our inventory, at least choose the most capable system on the modern tactical troposcatter market. This may be the Army's Ultra Tropo system, and this would be a preferable capability over the SNAP™ 3T. It does meet the 80 mph wind requirement and uses 2.4m antennas (4.5 square meter of surface area), while having a similar level of transportability to the VSAT-M or SNAP™ 3T. It could replace the TRC-170 at a 1:1 ratio and can be purchased at approximately $231,000 each. While it would constitute a reduction in size, weight, and cost of the fleet, it would not satisfy our paramount desire for commonality, high economy of scale purchasing power, or enterprise logistics and training simplicity. It is unknown whether this system could one day supercede any of our wideband SATCOM systems.

Conclusion

In summary, now is the only time it is possible to achieve the maximum gain in MAGTF expeditionary capability. Every disparate, stovepiped system we field is a failure to progress toward a unified, holistically integrated, net-centric C^2 environment. Conversely, a common wideband BLOS system requires far less engineering burden in enabling digital interoperability across the MAGTF. There are few greater opportunities to maximize our ability to provide worldwide Marine Corps Enterprise Network access from every base, post, or station to every tactical C^2 node in the field or in combat. When the technical complexity of our fleet of systems is reduced (from ten program-of-record systems down to four or fewer), then we can expect the ability of our communications Marines to operate to increase proportionally. With funding for spare parts held constant, it may be suggested that when there are fewer different repair parts to stock, the quantity of each stocked part should increase. Every effort should be made to increase the stock of critical spare parts, and maximum commonality is the only alternative to maximum funding that achieves this increase.

As the organization solely responsible for the design of the wideband systems, the contractors are there to maximize profits. They propose material solutions with which they can maintain customer satisfaction, minimize company expenses, and maximize long-term company value. The contractors do this by best fulfilling the written contract requirements. They are not even minimally concerned with how efficiently the Marine Corps can maintain its fleet of systems unless it also involves more sales or service contracts and profits. The contractors' proposed material solution is not, by default, the only or best material solution they can produce; it's the solution that they could produce in the most economic manner for themselves. It is our duty to ensure that the needs of the Marine Corps, especially transportability and commonality, are clearly communicated in the terms of the contract.

... let's demand that interoperability be built in ...

Additionally, when the Marine Corps writes the requirements for wideband BLOS systems, naval integration has a seat at the table. Our systems are much more likely to be compatible with the Navy's shipboard systems when Marines are writing the requirements instead of Army combat developers. A wise USMC combat developer will carefully coordinate with both Services in order to maximize simplicity in achieving true, seamless digital interoperability.

In conclusion, let's demand that interoperability be built in from the very beginning of system development. When interoperability and commonality become the dominant features of our network, then the innumerable benefits become clear. With commonality comes a more defensible cyber domain, operations and maintenance simplicity, and an uncomplicated and affordable supply chain. Interoperability also promotes plug and play operations, flexibility, and scalability, which is exactly how the 21st century MAGTF fights—with the responsive and scalable integration of plug and play, task-organized enablers. We must recognize that this is the most important gift we can give to the warfighter as the primary beneficiary of tomorrow's MAGTF C^2 environment.

As an example, the H-1 Program upgrade effort for the Cobra and Huey helicopters has resulted in the AH-1Z "Viper" and UH-1Y "Venom" variants of these platforms central to our aviation combat power. For years, these platforms shared minimum commonality despite their major overlap in capabilities. Both platforms must be controlled by pilots and transportable by fixed-wing aircraft, provide lift through rotors, combust fuel, navigate, counter missile threats, etc. Being built by the same manufacturer, it would seem that they would be designed with maximum commonality in order to maximize efficiency and, ultimately, profits. It wasn't until the H-1 Program initiation in 1996 that the commonality deficiency was corrected to the maximum extent. As a result of this effort, the two helicopters have achieved 85 percent commonality of maintenance-significant components, including tail fuselage, main and tail rotors, transmission, engine, power supply, software, countermeasures, helmet-mounted display, fire extinguishing systems, etc. The benefits are obvious and include maintenance simplicity, lower cost parts, training, and overall sustainment costs. *The Marine Corps found it financially and operationally responsible to take advantage of the benefits this upgrade investment would provide. It would have been far less wasteful to require commonality at program inception.*

Note

1. This accounts for the ability to embark one TRC-170 on a KC-130 on pallet positions 1 through 4, and pallet positions 5 and 6 would remain available for additional palletized systems. This also accounts for loading three VSAT-Ls on a KC-130, leaving no remaining pallet positions. Finally, this accounts for two SMART-T systems per KC-130, leaving pallet positions 5 and 6 available for additional systems. This exercise in embarkation planning revealed that all of our palletized systems could fit in pallet positions 5 and 6 of the (214) KC-130 sorties required to lift our rolling stock transmissions systems.