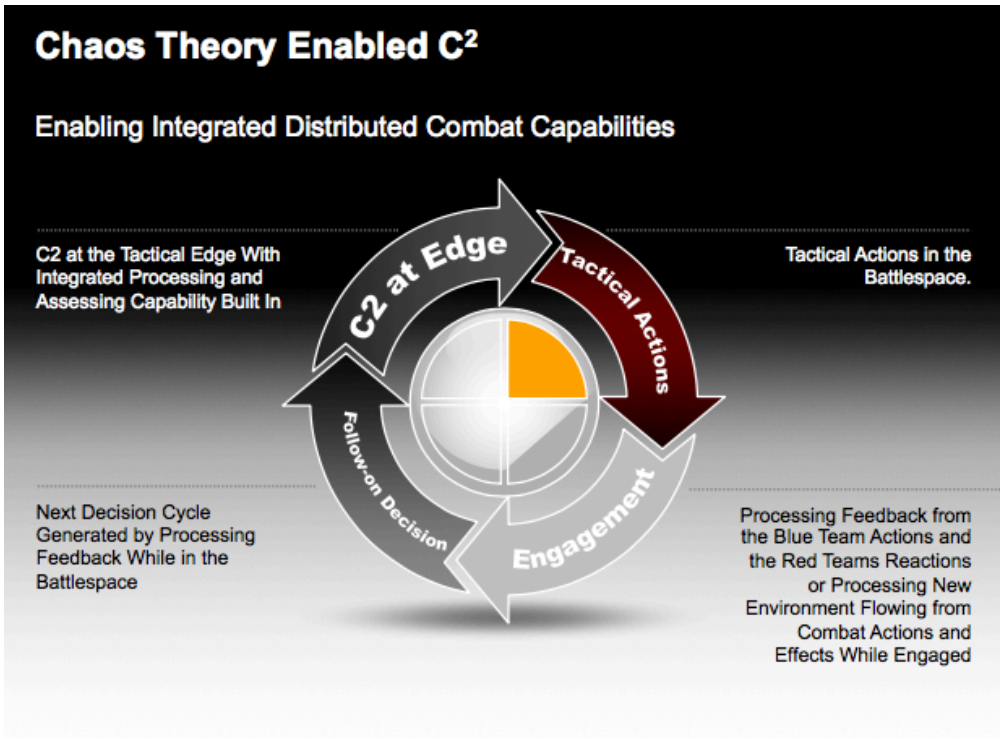
DEFENSE.info

C2 Innovations and Transformation: January 2020



January 6, 2020

Shaping a 21st Century C2/ISR Infrastructure: The Emergence of C3

12/22/2019
By Robbin Laird

At the recent International Fighter Conference 2019, there was much discussion of the growing salience of the combat cloud to the "next" generation of air combat power.

This discussion was subsumed within a growing emphasis on multi-domain operations, and the need for the kind of C2 which can leverage the right information at the right time to make the right decisions within a multi-domain environment with the right package of combat force.

In effect, this capability is what precedes any discussion of what a 6th generation fighter aircraft might be.

What clearly the F-35 has generated is the "renorming of airpower" which we predicted some years ago.

But what it is also generating is a significant rethink of how to fight at the speed of light in terms of high confidence data to deliver capabilities to for decisive decision making at the tactical edge.

In effect, C3 is emerging as a key driver of change Command, Control and Confidence in the most relevant ISR data is required at the tactical edge to make the decisions necessary to prevail in the evolving battlespace.

At the International Fighter Conference 2019, Lt. General David Nahom, Director of Strategic Plans and Programs, for the USAF, underscored that a core focus in shaping the evolution of USAF airpower was upon joint all-domain command and control.

He argued that "we are building the high-speed highway on which to put the trucks."

The focus in his perspective needs to be upon building the C2/ISR infrastructure where "we can all work together."

The approach to shaping an advanced battle "manger" is no longer focused on a specific air platform, AWACS, Joint Starts or the like.

It is now focused on crafting, leveraging and evolving a distributed system which draw upon the "high-speed data highway."

Obviously, in such an approach, machine-to-machine interactions and artificial intelligence enabled decision making are foundational elements. And with a "high speed data highway" focus enabled by

the fifth-generation transition; the next generation fighter is not likely to be a single "truck" but a family of systems.

Clearly, a key component of the new high build out is already here and key element of the F-35 global fleet, namely, the CNI.

The significant impact of an INTEGRATED CNI solution simply is not part of the strategic discourse about the evolution of the U.S. and allied combat forces in a way that gets out of a fifth-generation marketing pitch, qua fifth gen.

It is not about fifth generation, it is about shaping the "high speed data highway" which the F-35 global enterprise can provide support to task forces engaged in an area of interest and enabling a key aspect of a targeted "combat cloud."

By DoD putting in motion the effort to build the F-35, the program has forced DoD to integrate its core combat fighter in ways that would not otherwise have occurred.

The CNI is to combat air as the smartphone is to the original Nokia mobile phone.

And it would NOT have happened without the F-35 program driving the need and the requirement.

Sensor fusion enabled by machine to machine operations and expanded by integratability across an F-35 fleet is a significant driver of air superiority now and lays down the way to the future being hypothesized at conferences like IFC 2019.

As the cards within the CNI are updated, modernized or transformed, along with the capabilities contained on those cards, and any accompanying hardware changes made, not only can an F-35 as a combat asset itself improve.

But the technology upgraded on that aircraft can reshape the combat elements on the air, sea or land which can benefit directly to F-35 connectivity and those demonstrated capabilities can inform decisions with regard to modernization or transformation of other combat assets which can employ similar variants of the new systems contained within the CNI.

Put in blunt terms, the integrated capability delivered by the CNI within the F-35 fleet is a key driver of change for the C2/ISR "highway" able to empower the integrated distributed force and deliver C3.

After the IFC 2019, I had a chance to discuss with Scott Rosebush of Cubic Mission Solutions, a company focused on enhancing capabilities for C2 and ISR at the tactical edge, including with regard to the F-35 and CNI.

We discussed how such a highway might be built out leveraging where we are today, and how emergent capabilities today can provide a way ahead with regard to this C2/ISR "highway" building effort.

Rosebush started the discussion by describing the vision of a High Capacity Backbone or HCB.

“The idea is to equip a select set of nodes with high throughput data links that could encapsulate data and pass it amongst themselves in a reliable way.

“Any node on the network to which the HCB nodes subscribes would then be able to access the date on the HCB.”

He argued that this would bring the power of the cloud into multi-domain operations.

We discussed the combat cloud at length comparing the viability of network architectures that feature an enterprise network like a commercial WAN as compared a numerous set of smaller networks optimized for a particular task force that could potential be connected by a backbone.

The HCB could be built to facilitate this approach.

According to Rosebush: “By connecting multiple combat clouds, fusion applications could be generated to empower the combat force.”

Rather than simply networking data, information and domain knowledge would be available to the tailored combat force through fusion applications including those empowered by artificial intelligence.

He underscored that the underlying HCB technology needed to realize the 21st century vision is ready for fielding now.

Advancements in phased array antennas paired with sophisticated digital beam forming technology enables the ability to produce and maintain numerous simultaneous high bandwidth directional communications links.

These solutions facilitate opportunities for data relays, networking bridging, and data format conversions leading to resilient and robust multi-domain networks.

The HCB highway can also be used to pass data that would traditionally be sent over congested time division multiple access networks like Link 16 freeing up capacity on those legacy networks.

Cybersecurity is a necessary focus area for the future of networked C2 and ISR objectives as well.

“The flip side to connectivity and interoperability is vulnerability to cyber-attack” said Rosebush.

He believes there isn’t a silver bullet to ensure cybersecurity for the combat cloud, but instead thinks that “a mindful application of defense-in-depth principles and solutions while taking advantage of factors like the use of cryptography and directionality of the links can lead to an ultimately agreeable resultant security posture for the warfighter.”

Rosebush argued that HCB technology is ready to field – with mass adoption feasible in the one to three year timeframe.

He then focused on the next round of capability – the three to six-year time horizon — which he argued was in the domain of free space optical communications (aka laser-comm).

"Historically, the challenges associated with the precise pointing and tracking required to acquire and maintain FSOC links between dynamic platforms have been too problematic to overcome for mature solutions.

But with recent technology advances in these fields as well, the ability to point, acquire, and hold FSOC links on moving platforms is increasingly feasible.

A realistic long-term goal is to combine the laser communication options with a smart RF node to provide for hybrid data links."

In short, creating and enabling a cluster of data transportation solution sets or the data highway system is the "next" platform.

And in the course of doing so the redesign of platforms and what is expected from new platforms will be a work in progress.

Rear Admiral Peter Garvin on the Way Ahead for the US Navy's Patrol Reconnaissance Group

12/18/2019
By Robbin Laird

Recently, I had the opportunity to visit with Rear Admiral Pete Garvin in his office in Norfolk Virginia to discuss the way ahead with the US Navy's Patrol and Reconnaissance Force (MPRF).

Commander Patrol and Reconnaissance Group / Commander Patrol and Reconnaissance Group Pacific (CPRG/CPRG-PAC) provides oversight to more than 7,000 men and women on both coasts operating the U.S. Navy's maritime patrol aircraft including the P-8A "Poseidon", P-3C "Orion", EP-3 "Aries II" and MQ-4C "Triton" unmanned aircraft system.

The MPRF is organized into two Patrol and Reconnaissance Wings at NAS Jacksonville, Florida, and NAS Whidbey Island, Washington including 14 Patrol and Reconnaissance squadrons, one Fleet Replacement Squadron (FRS) and over 45 subordinate commands. The MPRF is the Navy's premier provider for airborne Anti-Submarine Warfare (ASW), Anti-Surface Warfare (ASuW), and maritime Intelligence, Surveillance, and Reconnaissance (ISR) operations.

We discussed the force transformation currently underway as the foundation for further innovation moving into the future for the maritime force in its global operations. The P-8A and MQ-4C are not simply replacement platforms for the P-3 and EP-3. The change is as dramatic as the Marines going from the CH-46 to an Osprey which could only be described as a process of transformation rather than a transition from older to newer platforms.

It is not simply that these are different platforms, but the question of how to title the article suggests the dynamics of change. These are not merely maritime patrol aircraft but rather a synergistic 'Family of Systems' empowering global maritime domain awareness and the joint strike enterprise.

Most importantly, while the P-8A is a capable engagement platform in its own right, the information generated by the P-8A/MQ-4C dyad empowers and enhances the organic ASW strike capability on the P-8.

Moreover, the entirety of Department of Defenses' strike capability is enhanced against adversarial multi-domain forces.

We hear a lot about the coming of Artificial Intelligence and new sensors to the combat force, but the P-8A and MQ-4C are bringing these capabilities to the force today. With pre-mission planning and post-mission product dissemination supported by a dedicated "TacMobile" ground element, these platforms comprise a solid foundation for the new MDA enterprise. Working together, the weapon systems will deliver decisive information to the right place at the right time to empower the multi-domain combat force. These systems are designed to be quickly software upgradeable and evolve over time as combat performance, and contact with the adversary, provide significant real-world feedback.

Although these are US Naval platforms, they are designed to connect with the larger C2/ISR infrastructure, changing the capabilities and operations of the entire U.S. and allied combat forces.

With core allies buying P-8 and MQ-4C, this force is truly global.

My visits to Norway, the United Kingdom, and Australia have provided significant opportunities to discuss with those nations, how they are engaged with the United States in recrafting the MDA and strike enterprise.

These platforms provide significant situational awareness for a task force, and can operate in effect as combat clouds for a tailored task force operating across the spectrum of conflict.

At the recent International Fighter Conference 2019, there was significant discussion of the coming of manned and unmanned teaming. There were no naval aviators at the conference but if they had been present, they would have told the conference that the U.S. Navy is already working and improving manned/unmanned teaming concepts and doctrine.

With the coming of Triton, a completely new approach is being shaped on how to operate, and leverage the data and systems onboard the manned and unmanned air systems joined at the hip, namely, the P-8 and the Triton.

There is an obvious return to the anti-submarine mission by the U.S. and allied navies with the growing capabilities of the 21st century authoritarian powers.

However, as adversary submarines evolve, and their impact on warfare becomes even more pronounced, ASW can no longer be considered as a narrow warfighting specialty.

This is reflected in Rear Admiral Garvin's virtuous circle with regard to what he expects from his command, namely, professionalism, agility and lethality.

The professionalism which defines and underpins the force is, in part, about driving the force in new innovative directions. To think and operate differently in the face of an evolving threat. Operational and tactical agility is critical to ensure that the force can deliver the significant combat effect expected from a 21st century maritime reconnaissance and strike force. Finally, it is necessary but insufficient to be able to find and fix an adversary.

The ability to finish must be realized lest we resign ourselves to be mere observers of a problem.

The Australians consider the P-8/Triton force to be part of their fifth-generation transition in that the information being processed and worked by the machines in the dyad and the analysts onboard or ashore is informing assets across the enterprise with regard to threats and resolutions required by the entire combat force.

It is not simply about organic capabilities.

The P-3 flew alone and unafraid; the dyad is flying as part of a wider networked enterprise, and one which can be tailored to a threat, or an area of interest, and can operate as a combat cloud empowering a tailored force designed to achieve the desired combat effects.

The information generated by the 'Family of Systems' can be used with the gray zone forces such as the USCG cutters or the new Australian Offshore Patrol Vessels. The P-8/Triton dyad is a key enabler of full spectrum crisis management operations, which require the kind of force transformation which the P-8/Triton is a key part of delivering the U.S. and core allies.

A key consideration is the growing importance of what one might call "proactive ISR."

It is crucial to study the operational environment and to map anomalies; this provides a powerful baseline from which to prepare future operations, which require force packages that can deliver the desired kinetic or non-kinetic effect.

Moreover, an unambiguous understanding of the environment, including pattern of life and timely recognition of changes in those patterns, serves to inform decision makers earlier and perhaps seek solutions short of kinetic.

This is not about collecting more data for the intelligence community back in the United States; it is about generating operational domain knowledge that can be leveraged rapidly in a crisis and to shape the kind of C2 capabilities which are required in combat at the speed of light.

Historically, a presence force is about what is organically included within that presence force; today we are looking at combat reach or scalability of force.

Faced with limited resources, it is necessary for planners to exercise economy of force by tailoring distributed forces to a specific area of interest for as long as required.

The presence force however small needs to be integrated not just in terms of itself but also in its ability to operate via common C2 or ISR connectors with both allied and U.S. forces. This enhanced capability needs to be forward deployed in order to provide enhanced MDA, lethality and effectiveness appropriate to achieve the desired political/military outcome.

Success rests on a significant rework of C2 networks to allow a distributed force the flexibility to operate not just within a limited geographical area, but reach beyond the geographical boundaries of what the organic presence force is capable of doing by itself.

This is about shaping force domain knowledge well in advance of and in anticipation of events.

This is not classic deterrence – it is pre-crisis and crisis engagement.

This new approach can be expressed in terms of a kill web, that is a U.S. and allied force so scalable and responsive that if an ally executes a presence mission and is threatened by a ramp up of force from a Russia or China, that that presence force can reach back to relevant allies as well as their own force structure in a timely and effective manner.

For this approach to work, there is a clear need for a different kind of C2 and ISR infrastructure to enable the shift in concepts of operations. Indeed, when describing C2 and ISR or various mutations like C4ISR, the early notions of C2 and ISR seen in both air-land battle and in joint support to the land wars, tend to be extended into the discussions of the C2 and ISR infrastructure for the kill web or for force building of the integrated distributed force.

The P-8/Triton dyad lays a solid foundation for the wide range of innovations we can expect as the integrated distributed force evolves: expanded use of artificial intelligence, acceleration of the speed for software upgradeability, achieving transient combat advantage from more rapid rewriting of software code, an enhanced ability to leverage the weapons enterprise operating from a wide variety of air, ground, and naval platforms (off-boarding), and an ability to expand the capabilities of manned-unmanned teaming as autonomous maritime systems become key elements of the maritime force in the years to come.

In short, the Maritime Patrol and Reconnaissance Force is not simply transitioning, it is transforming.

C2 and ISR Paradigm Shifts Enabling 5th Generation Maneouver: Force Integration and Augmenting Regional and Global Influence

11/05/2019
By Robbin Laird

To achieve the kind of agility and decisive effect which 5th generation maneouver can achieve requires a significant re-focus on the nature of the C2 and ISR infrastructure.

Such an evolved infrastructure enables the legacy and new platforms which are re-shaping capabilities for the combat force to be much more capable of operating across the full spectrum of crisis management.

In today's world, full spectrum crisis management is not simply about escalation ladders; it is about the capability to operate tailored task forces within a crisis setting to dominate and prevail within that crisis.

If that stops the level of escalation that is one way of looking at it.

But in today's world, it is not just about that but it is about the ability to operate and prevail within a diversity of crises which might not be located on what one might consider an escalation ladder.

They are very likely to be diffuse within which the authoritarian powers are using surrogates and we and our allies are trying to prevail in a more open setting which we are required to do as liberal democracies.

This means that a core legacy from the land wars and COIN efforts needs to be jettisoned if we are to succeed – namely, the OODLA loop.

This is how the OODA loop has worked in the land wars, with the lawyers in the loop, and hence the OODLA loop.

The OODA loop is changing with the new technologies which allow distributed operators to become empowered to decide in the tactical decision-making situation.

But the legalistic approach to hierarchical approval to distributed decisions simply will take away the advantages of the new distributed approach and give the advantage to our authoritarian adversaries.

But what changes with the integrated distribute ops approach is what a presence force can now mean.

Historically, what a presence force is about what organically included within that presence force; now we are looking at reach or scalability of force.

We are looking at economy of force whereby what is operating directly in the area of interest is part of distributed force.

The presence force however small needs to be well integrated but not just in terms of itself but its ability to operate via C2 or ISR connectors to an enhanced capability.

But that enhanced capability needs to be deployed in order to be tailorable to the presence force and to provide enhanced lethality and effectiveness appropriate to the political action needed to be taken.

This rests really on a significant rework of C2 in order for a distributed force to have the flexibility to operate not just within a limited geographical area but to expand its ability to operate by reaching beyond the geographical boundaries of what the organic presence force is capable of doing by itself.

This requires multi-domain SA – this is not about the intelligence community running its precious space- based assets and hoarding material.

This is about looking for the coming confrontation which could trigger a crisis and the SA capabilities airborne, at sea and on the ground would provide the most usable SA monitoring.

This is not "actionable intelligence."

This is about shaping force domain knowledge about anticipation of events.

This requires tailored force packaging and takes advantage of what the new military technologies and platforms can provide in terms of multi-domain delivery by a small force rather than a large air-sea-ground enterprise which can only fully function if unleashed in sequential waves.

The focus on the requirements for fifth generation maneouver at the Williams Foundation seminar underscored several key aspects of how to achieve the outcome of a tailored force which could achieve sufficient effects to operate and determine outcomes across the spectrum of crisis management.

Getting the Right Piece of Information to the Right Shooter, the Right Effector, the Right Sensor, at the Right Point in Time

Air Vice Marshal Chris Deeble, now retired and now head of Northrup Grumman in Australia, provided a perspective based on his unique experience working the fifth generation transition in the RAAF. He has worked on the Wedgetail, the tanker, and the F-35 programs, and based on a decade of extensive experience bringing new capabilities to the RAAF and the ADF, he is well positioned to suggest ways ahead with regard to the build out of a fifth generation maneouver force.

The core target which needs to be achieved in order to enable, empower and further develop the fifth generation force was identified by Deeble as follows: “Getting the right piece of information to the right shooter, the right effector, the right sensor, at the right point in time.”

He argued that such an outcome cannot occur by happenstance but must be the focus of attention from the outset. “It must be architected.”

Deeble underscored that “we need to focus on information management as a maneuver force capability. It is not just about the platforms, but the information enabling the joint force to operate as a fifth generation maneouver force.”

He further argued that for such a capability to become a dominant reality will require “future proofing the force” by having an evolving but guiding architecture which is based on operational experience and open ended to innovations.

But it is crucial that such innovation is done through evolving adaptations from operational experience, rather than long lists of requirements keeping industry outside of the ongoing conceptual rethinking.

“We have not yet achieved critical mass for the kind of collaborative efforts which can achieve this outcome.”

But clearly this is the means through which the ongoing future proofed architecture can be shaped and implemented by the innovations being delivered by the combat force operating throughout the spectrum of conflict management.

Rethinking the Nature of Networks

When describing C2 and ISR or various mutations like C4ISR, the early notions of C2 and ISR seen in both air-land battle and in joint support to the land wars, tend to be extended into the discussions of the C2 and ISR infrastructure for the kill web or for force building of the integrated distributed force.

But the technology associated with C2 and ISR has changed significantly throughout this thirty year period, and the technology to shape a very different kind of C2 and ISR infrastructure is at hand to build enablement for distributed operations.

As Marja Phipps of Cubic Mission Solutions highlighted with regard to the evolving approach to building out C2 and ISR networks:

“Earlier we built a dedicated single network connection for a specific task, such as providing targeting information to the platforms involved in a specific operation.”

The “networked” force was built around platforms that would use networked information to create desired and often scripted events.

But the C2 and ISR revolution we are now facing is reversing the logic of platforms to infrastructure; it is now about how flexible C2 and ISR interactive systems can inform the force elements to shape interactive combat operations on the fly.

That is, the new capabilities are enabling tactical decision making at the edge and posing real challenges to traditional understandings of how information interacts with decision making.

It is about learning how to fight effectively at the speed of light in order to achieve combat dominance.

And these new capabilities are providing a real impact on force development, concepts of operations and force training as well.

"With the new technologies and capabilities, we are now reusing networks for multiple purposes and making sure that they can adapt to the changing con-ops as well."

"We are seeing integration of the networks and the integration of the information management services and then the dual nature of the applications on top of those integrations.

"Rather than building a single purpose intel common operating picture, we are now capable of building an integrated intelligence and battlespace management common operating picture for the use of the combat forces engaged in operations."

In other words, "we are building an adaptable network of networks. In traditional networks, when data is brought in from a dedicated system, it needs to be repurposed for other tasks as needed."

At the seminar, AIRCDRE Leon Phillips, OAM Chief Information Officer Group, provided a very comprehensive overview to the kind of changes, both evolutionary and revolutionary, which networking was undergoing as the infrastructure of the ADF as a fifth generation force.

According to AIRCDRE Phillips:

Modern, 5th generation defence forces, will need to be competent across the continuum of conflict, supporting times of political tension through to high-end peer to peer warfighting.

This left and right of arc has the potential to leave us conflicted with choice over exactly what our data and network needs are. Notwithstanding, technology growth is leading to a greater array of more complex sensors and shooters, dispersed across the battlefield.

We face the threat of faster, more agile hypersonic threats and the proliferation of disruptive technology offered by cheaper drones as well as attacks on our networks.

For us to be effective we need to ensure our systems are well connected, through robust, multi-pathed networks and that we are capable of operations despite degraded networks.

Data exchange between tactical and strategic networks offers us competitive advantage and we need to recognise the merging and synergistic nature of both. We are benefiting through our investment in high-end warfighting technology however need to think more deeply about the information exchange between these and our CONOPS so we make the best investments and tradeoffs in a fiscally constrained environment.

Finally, we must invest more heavily, both intellectually and financially in the development of weapon systems and C2 systems that we develop as they give us control in how we bind and glue our tactical systems together, ensuring our ecosystem is optimised.

He argued that the investment piece clearly needs to be aligned with what Deeble was calling for in terms of architectures which can deliver the kind of sovereign capability which Australia needs for its fifth- generation force but capable of being interoperable with allies and partners as well.

This is not Costco buying where we leverage US economies of scale by buying in packs of 6. Like all good investment portfolios, there should be some money slated for high risk, high return ventures. The real Jericho challenge is to convince the Investment Committee and Government of this.

Noting the volume of data we capture and the likelihood of constrained data paths, I suggest this data analytics needs to be at both the tactical and strategic level to ensure only data of value is kept and shared.

For instance, you can collect a lot of imagery on a maritime patrol flight but how much is useful?

Processing at the tactical edge to extract more immediate value and sharing only what is of value is paramount. Opportunities exist to use our developed and controlled technologies such as our converged deployable and embedded networks to be the hub of this effort. It's the applications that are hosted here that we need to invest in with a tighter coupling of strategist, warfighter, delivery agency and industry.

At the strategic level there will be an abundance of data. Data from allied sources and data collected over days, months and years. Combing through the data, perhaps more slowly than at the tactical edge, can offer us early queues on our adversary's intent.

Earlier on I mentioned the geopolitical landscape and the murky nature of modern conflict. Data analytics at this level may need to expand beyond traditional military sources, depending on the circumstances.

How much social media and public information would we also be interested in?

Having an agility to respond and evolve our analytics given the strategic circumstance we find ourselves in is important.

Again, investment in Australian owned and developed data systems allows us this flexibility.

Enhancing the Capability of the ADF to Contribute to Full Spectrum Crisis Management

The COS of the RAAF, Air Marshal Mel Hupfeld, provided the final presentation at the Williams Foundation Seminar. In his presentation, he embraced the earlier discussions on the C2, ISR, network development assessments, but underscored how he saw such efforts reshaping the capabilities of the ADF and its role for the nation.

Clearly, a fifth-generation force "Will necessarily require robust redundant ITC systems capable of handling an exponential growth in data generation accompanied by exponential increases in processing power and speed."

Certainly, as the ADF enhances its network capabilities to deliver a more integrated force, it will be more capable of multi-domain integrated operations.

But for the Air Marshal, we needed to think beyond narrowly considered kinetic or warfighting impacts of such a capability.

"The multi-domain approach should not be limited to thinking about combat scenarios. We should use a multi-domain approach across the spectrum of operations to shape our thinking about how to generate access, presence, influence, deterrence, denial…."

In effect, he argued that force integration was not an end in of itself but a means of expanding Australian influence in the region and its ability to more effectively defend Australia's interests.

Enabling fifth generation maneouver means that the ADF can expand its role and utility for the Australian government to expand its impact and influence throughout the region and globally.

In short, although the discussion of C2, ISR and networking can get terribly technical, the ground truth is that these are means to enhance an operational force's capabilities which, in turn, enhance its utility to the nation and to the ability of the national leadership to achieve the effects, politically and diplomatically they seek.

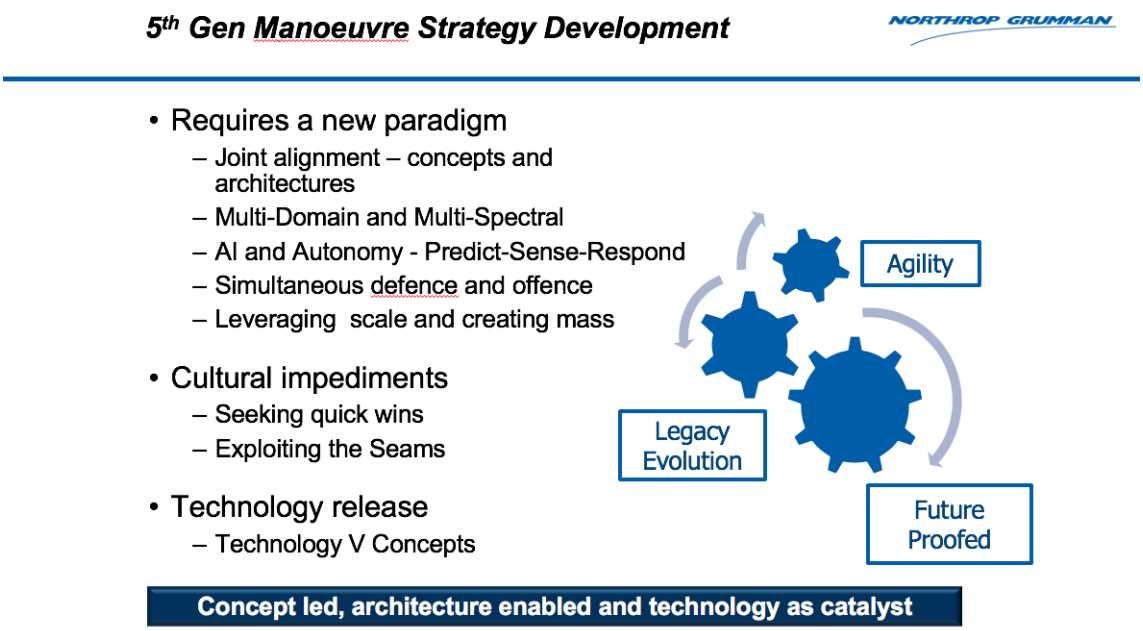


Figure 1 The graphic was taken from Air Vice Marshal (Retired) Deeble's Presentation.

Shaping the C2/ISR Infrastructure for an Integrated Distributed Force

10/19/2019
By Robbin Laird

Over the past thirty years, the United States and its core allies have gone through three phases of innovation with regard to conventional forces.

The first was air-land battle designed for the European theater and executed in the 1991 Iraqi War.

The second was the innovations associated with the land wars and the joint force support for COIN operations.

The third which is unfolding now is designed to deal with 21st century high intensity operations which can be conducted by peer competitors.

This new phase might be called shaping, exercising and building an integrated distributed force.

This entails interactive technological, force structure and geographical deployment dynamics. We have argued that a new basing structure combined with a capability to deploy and operate an integrated distributed force is at the heart of the strategic shift, and not only in the Pacific.

This is a key part of the effort to shape a full spectrum crisis management capability whose con-ops is shaped to deal with adversary operations within what some call the "gray zone" or within the "hybrid warfare" area.

The nature of the threat facing the liberal democracies was well put by a senior Finnish official: "The timeline for early warning is shorter; the threshold for the use of force is lower."

What is unfolding is that capabilities traditionally associated with high end warfare are being drawn upon for lower threshold conflicts, designed to achieve political effect without firing a shot.

Higher end capabilities being developed by China and Russia are becoming tools to achieve political-military objectives throughout the diplomatic engagement spectrum.

This means that not only do the liberal democracies need to shape more effective higher end capabilities but they need to learn how to use force packages which are making up a higher end, higher tempo or higher intensity capability as part of a range of both military operations but proactive engagement to shape peer adversary behavior.

In today's world, this is what full spectrum crisis management is all about. It is not simply about escalation ladders; it is about the capability to operate tailored task forces within a crisis setting – to dominate and prevail within a diversity of crises which might not be located on what one might consider an escalation ladder.

This means that a core legacy from the land wars and COIN efforts needs to be jettisoned if we are to succeed – namely, the OODLA loop. The OODA loop is changing with the new technologies which allow distributed operators to become empowered to decide in the tactical decision-making situation.

But the legacy approach to hierarchical approval to distributed decisions simply will take away the advantages of the new distributed approach and give the advantage to our authoritarian adversaries.

What is changing is that the force we are shaping to operate in the littorals has expansive reach beyond the presence force in the littorals themselves. If you are not present; you are not present. We have to start by having enough platforms to be able to operate in areas of interest.

But what changes with the integrated distributed ops approach is what a presence force can now mean.

Historically, a presence force is about what is organically included within that presence force; now we are looking at reach or scalability of force. We are looking at economy of force whereby what is operating directly in the area of interest is part of distributed force.

The presence force however small needs to be well integrated but not just in terms of itself but its ability to operate via C2 or ISR connectors to an enhanced capability. But that enhanced capability needs to be deployed in order to be tailorable to the presence force and to provide enhanced lethality and effectiveness appropriate to the political action needed to be taken.

This rests really on a significant rework of C2 in order for a distributed force to have the flexibility to operate not just within a limited geographical area but to expand its ability to operate by reaching beyond the geographical boundaries of what the organic presence force is capable of doing by itself.

This requires multi-domain SA. This is not about the intelligence community running its space- based assets and developing reports. This is about looking for the coming confrontation which could trigger a crisis and the SA capabilities airborne, at sea and on the ground that would provide the most usable SA monitoring. This is not "actionable intelligence."

This is about shaping force domain knowledge in anticipation of events.

This also requires tailored force packaging to take advantage of what the new military technologies and platforms can provide in terms of multi-domain delivery by a small force rather than a large air-sea enterprise which can only fully function if unleashed in sequential waves.

This is not classic deterrence – it is about pre-crisis and crisis engagement.

The force we are building will have five key capabilities:

- Enough platforms with allied and US forces in mind to provide significant presence;
- A capability to maximize economy of force with that presence;
- Scalability whereby the presence force can reach back if necessary at the speed of light and receive combat reinforcements;
- Be able to tap into variable lethality capabilities appropriate to the mission or the threat in order to exercise dominance.
- And to have the situational awareness relevant to proactive crisis management at the point of interest and an ability to link the fluidity of local knowledge to appropriate tactical and strategic decisions.

The new approach is one which can be expressed in terms of a kill web, that is a US and allied force so scalable that if an ally goes on a presence mission and is threatened by a ramp up of force from a Russia or China, that that presence force can reach back to relevant allies as well as their own force structure.

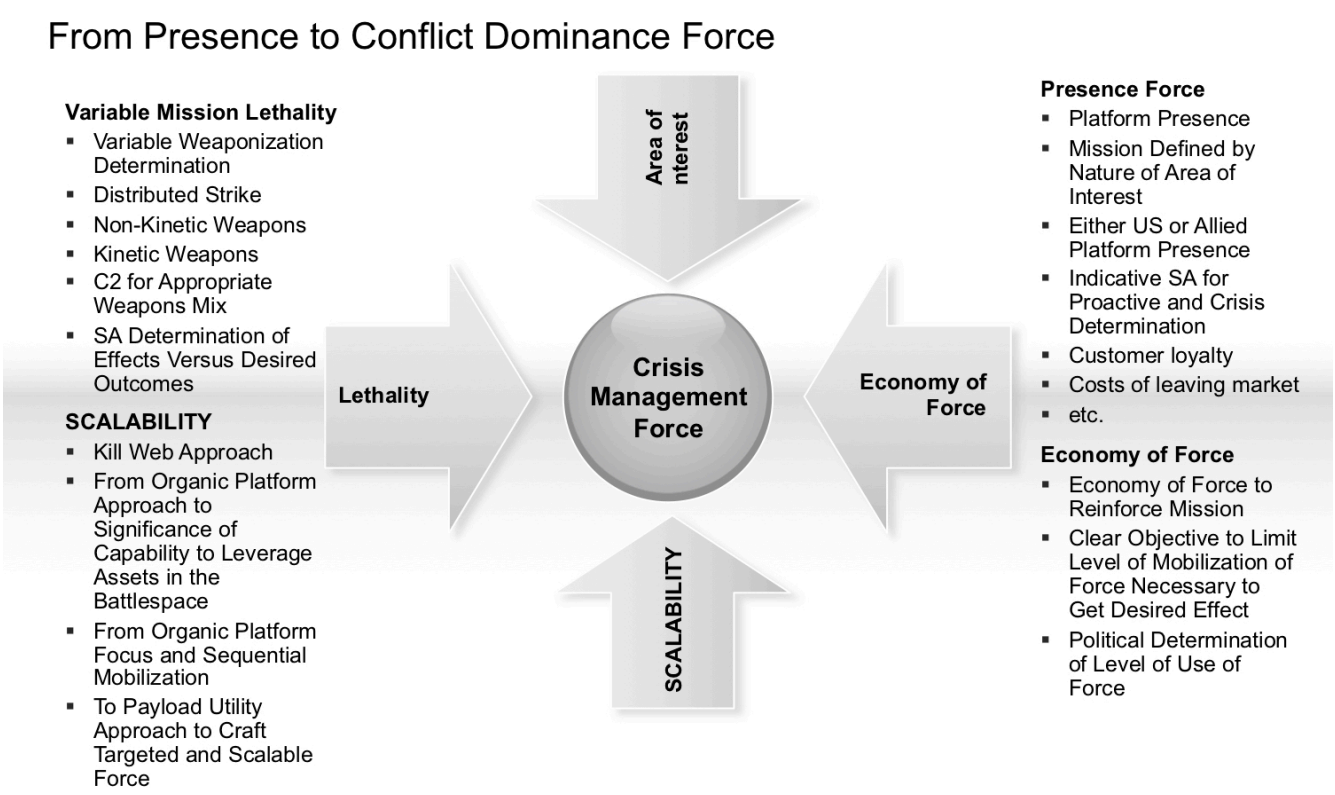


Figure 2 Conceptualizing a Full Spectrum Crisis Management Integrated Distributed Force. Credit Graphic: Second Line of Defense

A shift to a kill web approach to force building, training and operations is a foundation from which the US and its allies can best leverage the force we have and the upgrade paths to follow.

For this approach to work, there is a clear need for a different kind of C2 and ISR infrastructure to enable the shift in concepts of operations.

Indeed, when describing C2 and ISR or various mutations like C4ISR, the early notions of C2 and ISR seen in both air-land battle and in joint support to the land wars, tend to be extended into the discussions of the C2 and ISR infrastructure for the kill web or for force building of the integrated distributed force.

But the technology associated with C2 and ISR has changed significantly throughout this thirty year period, and the technology to shape a very different kind of C2 and ISR infrastructure is at hand to build enablement for distributed operations.

Recently, I had a chance to talk with an industry leader with regard to the evolution of C2 and ISR infrastructure.

Marja Phipps currently is business development director for Cubic Mission Solutions (CMS), a business division of Cubic Corporation.

She has more than thirty year's experience in the C2 and ISR areas and has lived through the thirty-year development of C2 and ISR with the cycles of innovation changing dramatically to create the new technological situation in which we find ourselves.

She has focused on providing C4ISR system offerings to military services, defense agencies, intelligence community and multinational partners. Her domain expertise includes communications and networking, knowledge-based systems, multi-INT Processing Exploitation and Dissemination tradecraft, and enterprise interoperability.

What she explained is that the earlier concepts of networking relied on hardwired networks, and single point networking solutions. This meant that the network required careful planning and coordination with the particular platforms which were using the networks to get the combat or joint effect from a networked capability.

"Earlier we built a dedicated single network connection for a specific task, such as providing targeting information to the platforms involved in a specific operation."

The "networked" force was built around platforms that would use networked information to create desired and often scripted events.

But the C2 and ISR revolution we are now facing is reversing the logic of platforms to infrastructure; it is now about how flexible C2 and ISR interactive systems can inform the force elements to shape interactive combat operations on the fly.

That is, the new capabilities are enabling tactical decision making at the edge and posing real challenges to traditional understandings of how information interacts with decision making.

It is about learning how to fight effectively at the speed of light in order to achieve combat dominance.

And these new capabilities are providing a real impact on force development, concepts of operations and force training as well.

"With the new technologies and capabilities, we are now reusing networks for multiple purposes and making sure that they can adapt to the changing con-ops as well."

"We are seeing integration of the networks and the integration of the information management services and then the dual nature of the applications on top of those integrations.

"Rather than building a single purpose intel common operating picture, we are now capable of building an integrated intelligence and battlespace management common operating picture for the use of the combat forces engaged in operations."

She argued that there are significant changes at each layer of the C2 and ISR systems becoming increasingly integrated for a distributed force.

"At each layer, we are making the technology more robust. For example, at the communications layer, the connections are more redundant and protected and are data agnostic.

"You don't have a dedicated network for one piece of data or between specific platforms, you've got the ability to network anything essentially."

In other words, "we are building an adaptable network of networks. In traditional networks, when data is brought in from a dedicated system, it needs to be repurposed for other tasks as needed."

What the technology is allowing us to do, is to think about C2 and ISR in a very different fashion, and to think in terms of enabling a small force operations or Lego block approach to the buildup of forces.

The new C2 and ISR infrastructure allows one to think about force development differently.

Phipps noted: "Access data points are becoming ubiquitous and operating in conjunction with processing data services which are scalable across a highly redundant protected communications network."

"We are putting communications capabilities understood in terms of being able to operate with scalable processing and data services at the tactical edge.

"The edge players are becoming key players in the decision making involving the distributed force.

"They are not just sending data back but they are making decisions at the tactical edge.

"The network gives you the access to not only the ISR data, but the C2 processes as well. The targeting data can be repurposed as well for additional decision-making, not just at the edge but back into the larger combat enterprise."

This obviously requires rethinking considerably the nature of decision making and the viability of the classic notion of the OODA loop.

If the machines are fusing data or doing the OO function, then the DA part of the equation becomes transformed, notably if done in terms of decision making at the tactical edge.

The decisions at the edge will drive a reshaping of the information about the battlespace because actors at the tactical edge are recreating the information environment itself.

In effect, chaos theory becomes a key element of understanding of what C2 at the tactical edge means in terms of the nature of the fleeting information in a distributed combat space itself.

"With the new technologies, what you are calling the new C2 and ISR infrastructure enables new warfighting approaches which need to be shaped, exercised and executed, and in turn affect how our forces train for the high-end fight."

She underscored a key difference from the earlier phase of network centric warfare.

"I think of net-centric as a hardwired con-ops. I think it's preplanned. You can do it, but there's no adaptability, there's no protection, there's no scalability as far as those architectures were concerned.

"Now we're going to the next step where we're making networks adaptable and scalable so that you can essentially re-plan on the fly and make decisions differently, in a distributed manner.

"It's not a preplanned or scripted way of operating anymore."

She went on to argue that the focus needed to be going forward on what she called "smart network management."

What she highlighted is the importance of what might call information parsimony, or getting the right information, to the right person, at the right time.

One of the challenges facing analysts discussing networks is that assumption that too much information is being collected and data is overwhelming the human decision maker. If that is the case, then we are talking about bad network architecture and information management.

She focused on how the key layers in the modern approach to networking interact with one another.

"In an adaptive network of networks, there are several layers interacting dynamically with one another, from a comms layer, to a data processing layer, to a data distribution layer with a network management layer able to dynamically provide for information parsimony."

On the technology side, it is about both hardware and software solutions which are allowing new capabilities to emerge which allow for a smart networking capability to emerge.

"We're talking about adaptability and upgradeability here. It's not just about software upgradeability, it's about hardware changes that allow for more flexible software solutions and more flexible cross-engagement solutions."

With the new C2 and ISR infrastructure the opportunity to enhance the capabilities of the legacy force are significant.

"One can add information management and decision processes on an airborne platform with a small processing footprintt.

"You could make good decisions on what you do as far as control on that platform versus what you're doing as far as control on another platform.

"And it's across domains as well. We should not think of just a certain processing or information management activity taking place on the ground or in the air.

"We're also talking space as well and figuring out how to basically connect across all those layers and the assets across those layers as well."

And going forward we will look at new platforms quite differently.

Rather than discussing generations of platforms, with the information and decision-making infrastructure building out an integrated distributed force, we will look at platforms in terms of what they contribute to the overall capability to such a force, rather than simply becoming autistic injections into the force.

The F-35, CNI Evolution, and Evolving the Combat Force

12/04/2019

By Robbin Laird

The F-35 is termed a fifth-generation platform, but is better understood as a first generation flying combat system.

Or a next generation capability or foundation for building a C2/ISR infrastructure for the integrated distributed force.

Because the F-35 is being stood up worldwide with both the U.S. Services and multiple core allies, how the F-35 global enterprise is being shaped has significant consequences for interactive transformation of those forces.

A key aspect of the F-35 comprises the onboard combat systems and data fusion inside the aircraft.

Because the software is upgradable and concomitant hardware changes have been made to facilitate major software upgrades, separate combat systems are affected by innovation driven within each combat system, and separate innovations and upgrades are driven by the core companies and the partners responsible for each combat system.

The companies driving change in each combat system, along with their partners, can reach a global user community and use these innovations while considering how such innovations could proliferate into their wider force structure development.

A key example is the CNI system.

I remember that one of the early criticisms by some F-35 analysts was that it did not have a radio. But that was good news, not an oversight.

According to Lockheed Martin:

"The Communications, Navigation and Identification (CNI) system is the most advanced integrated avionics system ever engineered. The integrated CNI has been developed by Northrop Grumman and affords F-35 pilots capabilities derived from more than 27 avionics functions. Through software-defined radio technology, the CNI allows for simultaneous operation of multiple critical functions, such as identification of friend or foe, precision navigation, and various voice and data communications, while greatly reducing size, weight, and power demands.

"When we visited the then-head of the USAF Warfare Center, we asked what he found most interesting about the F-35 as a new combat capability and he instantly latched on to a discussion of the CNI."

Major General Silveria, then head of the USAF Warfare Center and now Lt. General Silveria, Commandant of the USAF Academy, explained:

"Clearly, a key aspect of the F-35 is software upgradability. [It] provides for growth potential but requires a significantly different way to operate.

"This is difficult for people to grasp who do not fly the aircraft. One aspect associated with both fusion and software upgradability is that the F-35 is an integrated weapons system.

"Many articles have criticized this or that particular system on the aircraft; but [the F-35] aircraft is not really about this or that system; it is about the capability of a set of diverse systems to work together to deliver an effect and overall capabilities.

"Another key aspect is what software eliminates from the aircraft yet allows for enhanced combat effectiveness. A chief example is the CNI system. The plane has *none* of the items traditionally on airplanes that transmit and receive. It does not have any of those.

"Instead, it has two CNI com and navigation racks. It has two racks and you instruct the airplane: I would like to transmit in the UHF waveform; it generates that waveform and transmits in the UHF waveform, which is a difficult concept to think about, because there is no UHF radio on the airplane. There is no ILS on the airplane.

"If I want an ILS, I have to go in, tap on my glass and say, 'hey, good morning jet, I'm going to need an ILS today, so I need you to generate the ILS waveform when I need it.'

"What does this mean in terms of performance and maintainability? I do not have to maintain what is not there; I do not need to be affected by failure rates of systems that are no longer there.

"Let me use the example of the IFF transponder, which I do not have on the plane as a separate system. On an F-15 E, you can walk to the ramp and open a panel where you'll find a little box that has all sorts of cannon plugs on it labeled 'IFF transponder.'

"If it failed during the operation, when you came back you told maintenance it did not work. They'd undo the cannon plugs, they'd pull out this IFF and send it to the back shop; they'd go through all the testing, they'd figure out, they'd fix it, and it would come back. They would put in another one. Well, the F-35 doesn't have that either to fail or to fix."

As the infrastructure for Command and Control (C2) and Intelligence, Surveillance, and Reconnaissance (ISR) evolves and transforms, the upgrades on the F-35 can benefit from those changes as well as generate them.

The CNI is a core case in point.

As the cards are transformed, along with the capabilities they enable, and any accompanying hardware changes occur, not only can an F-35 improve as a combat asset but the upgraded onboard technology can reshape the combat elements in the air, on sea, or land.

These can benefit F-35 connectivity directly and those demonstrated capabilities can inform decisions about modernization or transformation of other combat assets which can employ similar variants of the new systems contained in the CNI.

Cubic Mission Solutions' (CMS) involvement on the CNI system and its recent contract with Lockheed Martin exemplifies this dynamic.

The contract is designed to provide Full Motion Video (FMV) capabilities for the integrated battlespace.

Cubic Mission Systems expertise focuses in part on the innovations that FMV can deliver as part of the C2 and ISR infrastructure modernization for an integrated distributed force.

CMS' new contract with Lockheed Martin will provide new capabilities in the CNI, and they will bring that experience to bear for the benefit of the F-35 global enterprise.

They will also be able to work through the ways that communicating through FMV from the aircraft can impact related efforts for other key combat assets in the future.

A press release published by Cubic Corporation on June 11, 2019, highlighted the new contract:

Cubic Corporation today announced that its Cubic Mission Solutions business division was selected by Lockheed Martin as the Video Data Link (VDL) provider for the F-35 Lightning II Program. Cubic's VDL capability for the F-35 will significantly increase the aircraft's combat capability and is an essential capability to the overall F-35 follow-on modernization program.

"We are very pleased to partner with Lockheed Martin to provide a secure video data link capability for the F-35," said Mike Twyman, president, Cubic Mission Solutions. "Our team of protected communications experts has decades of experience supplying common data link systems and we look forward to partnering on this critical program."

"With our proven track record of managing a program from development through fielding, along with the proven performance of our software-defined radio products including the nano Multiband Miniature Transceiver, we are confident in our ability to deliver a low-risk, cost-effective Video Data Link solution with built-in life cycle enhancements," said James Parys, program director, Cubic Mission Solutions.

Cubic's offering is a secure and mission-enhancing system that easily fits within the allocated CNI subsystem volume. The software-defined, radio-based VDL solution features high-performance processing that can support future live video enhancements, while minimizing Size, Weight, Power and Cooling (SWaP-C). Cubic's solution enables the F-35 to transmit and receive sensor and metadata to and from multiple ground or airborne units.

The significance of this way forward rests in part on the changing C2 and ISR infrastructure and the evolving role of full motion video as integral to transforming the infrastructure itself.

In a recent interview with Vice President and General Manager Bradford Powell, Cubic Corporation's C2ISR Solutions business, he discussed FMV's enhanced role within the evolving C2 and ISR infrastructure for the integrated distributed force.

According to Powell, the clear trend line is toward significantly expanding access to imagery and FMV while improving integration between the two:

"We are working to provide context within the full motion video feeds, which will enable the operational user to make tactical decisions more effectively."

Powell described C2 as moving from a focus on maps to command and control operating from within full motion video. Such focus will require tools that provide context easily used by the tactical decision maker.

As a relatively simple example, Powell referred to how television networks superimpose yellow first-down markers over the video of a football game. Imagine, then, the various data clusters which could be laid down over the full motion video available to the tactical decision maker in his area of interest or the area where he is operating, and one can envision the coming future of video-driven context for C2 at the tactical edge.

The task is to insert relevant tactical data into the full motion video.

"The full motion video–focused C2 environment would thereby evolve to make a broader set of intelligence products discoverable in the video."

The overall focus is to give the local decision maker much greater context for what he is looking at in the full motion video.

Cubic's input into the CNI system will allow the F-35 to evolve along the lines suggested by Powell.

To expand my understanding of how this process was going to work, I had a chance to talk with James Parys at CMS, the man responsible for the teams working the new CNI capability into the F-35.

James Parys is the Director of Platform Communications Programs for Cubic Mission Solutions, a business division of Cubic Corporation. Mr. Parys has more than 25 years of experience in program management and business development in the defense, information technology, and computer science industries.

Parys began his career in the U.S. Navy and, after leaving the service, has worked in industry on a variety of C2 and ISR programs.

In his current role, he manages Cubic's platform-focused communication system program organization, which includes the F-35 Joint Strike Fighter and MQ-25 Unmanned Carrier-Launched UAS Video Data Link (VDL) programs for CMS.

As a combat system, the F-35 allows for significant upgrades over time, which is why some commentators' notion about the F-35's obsolescence makes little sense when one considers the aircraft's built-in software and related hardware upgradability.

According to Parys, "We're providing a set of cards that will integrate into our own segregated element of the CNI rack. It's basically going to be, for lack of a better term, a rack inside a rack.

"We will take video feeds from other very complex sophisticated sensors onboard the aircraft and communicate informationto other users, whether they're on other aircraft or on the ground, which they can leverage. Our data link's primary CONOPSis to support close air support."

Cubic has developed the ability to put into cards what once took up a lot of real estate and power generation to process the data and then communicate. Cubic is putting technology inside the F-35 that is battle-tested and matured within other systems operating in the battlespace.

The data fusion on the aircraft is unique and also leverages proven technologies in step with modernization of the CNI function on the aircraft.

In other words, Cubic is harvesting their experience elsewhere and putting it on the F-35 as the aircraft matures and evolves.

They will be able to harvest some of those solutions to benefit universal enhanced capability for an ISR C2 integrated infrastructure, which is evolving for the overall force development of the integrated distributed force.

A key element of the new capabilities Cubic is providing for the F-35 is an ability to pass over the middleman, or to reduce the need to send the data to a processing center which, in turn, sorts through the data and then sends it out to the user.

Cubic is significantly reducing what one might call the tooth-to-tail relationship in the C2 and ISR infrastructure.

Parys said, “We are supplying data directly from the F-35 to the ground combat elements that have not had access to before.

“We will provide very-high-resolution information coming off the F-35sensors directlyto the ground forces.

“With our solution, we’re leveraging other capabilities, such as ISR Processing, Exploitation, and Dissemination (PED)–type capabilities to be able to clean up the video, and enable higher levels of resolution and higher contrast.

“By that I mean, being able to clear fog or see through smoke and share that view to the troops down on the ground, rather than the data having to be back-hauled to a PED station somewhere.

“The troops on the ground receive that data directly, which helps them make better, time-urgentdecisions.”

Effectively, this capability contributes to building an infrastructure that connects the ground combat element to the aircraft’s systems.

The modernized CNI takes abundant visual data and transforms it to shape a more usable data stream that supports combat operations.

Parys added, “We aregoing to reduce the whole timeline of the mission and what they need to do.

“This information can be sent to other aircraft; it can also be sent to other ground units.

“It means taking this advanced sensor in the sky and making its information available for whoever needs to leverage it and use it, whatever their mission is.

“The information will be available at an enterprise level rather than be limited to the traditional single stakeholder to single stakeholder process.”

I have argued elsewhere that one advantage of the F-35 global enterprise for defense companies, and not just the prime contractor, is to provide global users with the experience of working with a variety of companies they might not have experienced before.

This certainly is the case with Kongsberg and its F-35 Joint Strike Missile (JSM), which additionally has led to broader understanding of what their technology can provide to other combat elements.

This was demonstrated when the U.S. Navy adopted a Kongsberg strike missile being coproduced with Raytheon.

A similar positive outcome is predictable for Cubic and its engagement on the F-35.

As users become familiar with innovative processes of incorporating full motion video into a decision-making flow, we will see a demand to replicate such experiences elsewhere for other combat forces.

Parys highlighted: “We’re taking what we’re putting on the F-35 and we’re making it even smaller; fully packaged, but even smaller, and we’re putting it in the hands of users on the ground as well.”

Fighting at The Speed of Light: Making it All Work

05/20/2019

By Ed Timperlake

Honoring, and empowering humans engaged in the deadly serious occupation of defending their fellow citizens as combat warriors in putting their life on the line is everything in a military analysis before any future technology discussions can begin.

It is no good to talk about future technologies without starting from the nature of warfare and of human engagement in that warfare.

Often looking at ground battles from the earliest recorded days, the forces engaged had a simple guiding rule — kill the enemy in greater numbers.

There is no hard and fast rule from history of what tips a battle one way or another except one core principle: with the will and means to continue to degrade ones opponent winning is enhanced. The great quip often credited to Grantland Rice who gives full credit to a fellow sports writer comes to mind;

As Hugh Keough used to say: "The race is not always to the swift, nor the battle to the strong; but that is the way to bet.

Such insights actually are biblical from The King James Bible (such poetic writing):

"I returned, and saw under the sun, that the race is not to the swift, nor the battle to the strong, neither yet bread to the wise, nor yet riches to men of understanding, nor yet favour to men of skill; but time and chance happened to them all."

At the most basic Payload Utility function, the key to combat success since the dawn of warfare is captured in a ery simple example — the great command of learning the very basic art of accurate marksmanship.

"Ready on the Left Ready on The Right-Already on the firing line" and with that every Marine is trained in the use of their rifle.

Once trained and retrained and retrained until actual combat because their skills are never allowed to atrophy the individual Marine has a direct engagement using a very simple payload utility function in shooting the weapon.

The combat utility of the basic rifle is acquiring the target and then accurately engage to kill the enemy.

That type of engagement at the basic infantry level is no different than the senior Generals and Admirals having their fighting forces acquire and engage targets using many different mixed and matched payloads.

This universal way of war is often correctly referred to as combined arms, as layer after layer of direct and indirect fires, kinetic and non-kinetic, weapons are engaged to defeat the enemy.

I created a short hand phrase "Tron" war for that spectrum of non-kinetic offensive and defense weapons integrated together.

In fighting against a reactive enemy in a larger battle, the aggregation and disaggregation of sensor and shooter platforms with no platform fighting alone is the commander's goal.

Making it all come together effectively is the challenge.

The infantry squad leader directs his combat force by pre-briefing, briefing and then direct voice commands to maneuver his fire team elements during the very confusing heat of combat, often accurately called the fog of war.

Using voice commands since biblical days is fighting at the speed of sound it is up close and personal.

However, with early electronic devices, for example the Civil War telegraph, the platoon leader concurrently reached electronically up and down the chain-of-command to be part of a greater focused unity of purpose combat force.

Commanders at the highest level have to keep both cohesion of the combat engagement mission by effective communications, while concurrently relying on all to engage intelligently relying on their individual initiative to fight to the best of their ability.

Communicated information is essential.

But central as well is empowerment of the force.

The key is to ensure a maximum of capability for combat operations to be able to operate independently with accurate real time dynamic intelligence at the right level at the right time to make their combat function superior to the enemy.

Very little is different from the deck of Navy Strike force or Air Battle or Ground Commander from a Marine Platoon commander except the complexity of all the "moving parts" to be managed and employed to fight that are also spread out over very great distance.

Fighting at the Speed of Light

But after two decades of the land wars, we need to learn to fight again in higher intensity operations.

We need to Fight at the Speed of Light.

This requires that a fighting force at all levels must take advantages of ever increasing technological advances to make decisions using the speed of light.

In other words, symbolically as the laws of theoretical physics are evolving, the test is the application phase or the success of the applied physics phase, so to speak. Nothing illustrates this more than E-MC squared to the atomic bombs that ended WWII.

With advances in all forms of "tron" war from Directed Energy, to Cloud Computing to Artificial Intelligence to robust encryption, many building block mathematical algorithms are now assisting the process of generating accurate and timely information in making the step from being theoretical to applied.

At the moment battle begins, command and control is essential and has to have several attributes.

First and foremost, accurate information has to flow through robust redundant systems at the speed of light in making everything come together to fight and win.

The infantry platoon commander trusts the training and combat effectiveness of each Marine to do the right thing using initiative in following orders in the heat of battle while also trusting higher commands to provide supporting arms, including air, to get it right and at the right time.

The communication and intelligence capability in this 21st Century evolution/revolution of global coms is the connective tissue for human decisions with how to conduct successful operations and to use payloads effectively at the speed of light.

This where the capabilities begin to come together.

The future is now because from today "zero day" to five years out, there is sufficient insight to merge the human combat brain functioning with existing and near term technology to fight and win in any combat theater.

We have highlighted the importance of the 0-5 military and the central significance of how technology is integrated into evolving concepts of operations rather than focusing on an abstract long term future.

Recently, a senior British commander when discussing our approach referred to this as the rolling FYDP which in his view is crucial to engaging in combat operations successfully going forward, rather than abstracting waiting for the best hi tech solution some think tank could come up with.

America is blessed that many in the defense industrial base in responding to combat requirements have answered the challenge to build systems of systems inside the emerging Kill Web way of fighting, vice obsolete Hub Spoke and linear Kill Chain thinking.

First existing command and control is always against a reactive enemy a time dependent factor that is critical to force level combat.

If a commander can count having the initiative combat ops tempo over the enemy then his forces can be dynamically optimized as a coherent combat directed fighting force.

This is the challenge of effective command and control, of course ultimately the commander has to always have the wisdom and judgment to fight to win effectively.

If victory in battle could have been simple engineered it would have already been done so.

The Challenge

Given competent and skilled commanders there are two qualities of a fighting force that are needed for the force to derive the full capabilities of its weapons systems.

The first is motivation or dedication, or call it; will, heart, ambition or competitiveness. It is the quality that makes fighting personnel appear enthusiastic rather than lackadaisical or dispirited.

The second is a forces technological capability which is the ability at the appropriate level to have the capacity to understand and operate the rather sophisticated equipment associated with modern war.

Marrying force motivation with technological capability allows a superior force to achieve combat performance over the enemy. It is a combination of appropriate combat equipment at all levels of any engagement operated by trained individuals .\ Inventory of weapons systems and platforms, including sufficient munitions at the start of a war can make all the difference.

The time factor of both battle damage repair with any possible industrial surge and sufficient logistical supply/resupply while ensuring a pipeline of well-trained individuals from E-1, basic initial enlisted rank to 0-10, Admiral or General is simple to identify but a huge challenge to get it so right at the time of initial conflict. Trained humans matched up to technology is an obvious statement and makes all the difference as a combat campaign progresses.

The biggest challenge in the rapidly exploding human/information dynamic in this 21st Century challenge of modern war is the ability to have all make accurate decisions using light speed technology.

The Big Three

The emerging "Big Three" of 21st Century Tron war are: Cloud Computing, Artificial Intelligence and ever advancing encryption technology.

There are many appropriate technological stovepiped research applications which can be drawn upon to shape a dynamic integrated capability.

Cloud computing, Artificial Intelligence and secure encryption are very appropriate research areas unto themselves. There is also the need to be ever technology and con-op vigilant for a counterpunch combat challenge of a reactive enemy always working to deny their enemy's (US) successful employment of our Big Three while protecting the development and employment of their own.

Remember it is not just about the money but it always about the money.

CLOUD COMPUTING

Cloud Computing R&E with the recent sole source DOD contract of Ten Billion awarded to Amazon comes at just the right time. Such a massive influx of R&D money if managed smartly will make a significant difference to advance US military cloud computing capabilities.

American military test and exercise planners can easily horizontally intellectually work inside emerging Cloud, Kill Webs, with the template of the payload utility function of multi-domain, multi platforms sensors and shooters with no platform fighting alone.

Combat Cloud research and engineering can be tied together as a global enabler to fight at the speed of light.

Success in building testing and using cloud computing emerging capabilities can become a significant component of a combat force engaged in stopping a strategic nuclear attack delivered by hypersonic weapons at all levels of threat-from space and atmospheric maneuvering glide to sub launched HSCM.

The potential of ready secure data being interactive at all levels of command is an intriguing concept. The theory and execution of "Kill Webs" by the U.S. Sea Services shows great promise.

The US Navy has pioneered the Kill Web concept versus the kill chain, with the latter reflecting linear thinking.

A global Combat Cloud built as a secure, robust, and redundant go to source of data based decision making at light speed can provide useful warfighing networking and intelligence sharing concurrently in and out of each combat theater.

This potential real time combat dynamic learning at all levels of command and when needed capability is central to the way ahead.

This will allow directed combat action sensor/shooters delegated down to all and will be very significant at all levels of force engagements.

In other words, successful cloud research is tailor made to have scalable forces operating around the globe using the same data base.

ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) is rapidly approaching fleet wide empowerment to make truly actual speed of light decisions. It is not necessary to try and integrate AI into diverse military utility functions because it will most definitely find it's own way in.

The Defense Advanced Research Agency (DARPA) is championing AI research.

For more than five decades, DARPA has been a leader in generating groundbreaking research and development (R&D) that facilitated the advancement and application of rule-based and statistical-learning based AI technologies.

Today, DARPA continues to lead innovation in AI research as it funds a broad portfolio of R&D programs, ranging from basic research to advanced technology development.

DARPA announced in September 2018 a multi-year investment of more than $2 billion in new and existing programs called the "AI Next" campaign.

What should not be overlooked by DOD and, specifically DARPA, is the fact that Medicine has been pioneering many dimensions of AI, with significant research investments. Although HIPAA privacy rules and DOD Classification protocols are different, they both have a very similar issue to deal with: to guard the sanctity of data and there are significant penalties in each system. Violate HIPAA and there can be significant private sector law suits. Violate the sacred trust of one's security clearance and it can be a career ending mistake at a minimum.

So far the differential in research money between Military AI research and medical AI research greatly favors medicine

"Healthcare Artificial Intelligence Market to Top $34B by 2025"

This would suggest that learning from what currently exists in medical AI should most definitely be part of any important DARPA research way ahead.

The global market will rise to the challenge of synthesizing massive volumes of big data though machine learning techniques, including deep learning, semantic computing, and neural networks, according to the report.

Key clinical and operational areas will include medical imaging analytics, drug discovery and clinical trials, clinical decision support, natural language processing, biomarker discovery, and patient management.

Software developers seeking to address these use cases are likely to see $8.6 billion in annual revenue by 2025, contributing to the $34 billion total in software sales, hardware installations, and consulting opportunities within the AI market.

(Note Medicine is already integrating AI and Cloud Computing)

Cloud-based solutions accounted for the largest segment of the software and service market in 2017, and are likely to continue to grow in popularity as organizations seek speedy, low-cost options for deploying and maintaining health IT systems.

Two examples of AI in a health care applications touch on just two of countless lessons from a community spending billions of dollars already.

First, a paper on deep learning and a computer vision in which deep learning can outperform humans highlights research in the health field of relevance to defense.

Examining the use of AI for Imaging in Clinical Care

Aalpen A. Patel, MD, Chair, Department of Radiology, Geisinger Health

In recent years, deep learning has revolutionized the field of computer vision. In ImageNet competition, deep learning models are now outperforming humans in object detection and classification. In medical imaging, deep learning has been used in variety of image processing tasks such as segmentation and in recent years, for diagnostic purposes such as diabetic retinopathy and skin cancer detection using large medical datasets.

More recently, we have published a paper describing DL based identification of intracranial hemorrhage on CT scans of the head and using it to prioritize the list for interpretation.

We believe that using large clinical grade, heterogenous data set is extremely valuable in generalizing and translating to clinical tools. This is just the beginning – combining all the -ologies, -omics with imaging will lead to insights we have not had before.

AND this is a universal dynamic as DOD research moves forward:

Avoiding Hype and False Conclusions About AI in Medicine: Key Concepts and Examples

Mike Zalis, MD, Associate Professor of Radiology, Harvard Medical School

With advances of machine intelligence in healthcare, key stakeholders risk suffering from an inflation of expectations and misunderstanding of capabilities. This talk will summarize key conceptual underpinnings of machine learning methods and discuss academic and industry implementation examples of AI in healthcare. The goal of this talk is support participants in adroit critical thinking as they face potential applications, initiatives, and products involving AI in healthcare.

ENCRYPTION

Ever improving encryption technology can take many different research paths and often can create as much confusion as enlightenment.

Just one example of interesting research paths this is building a "Security Token"-

One example of dynamic possibilities in this field can be ways t leverage encryption technologies from the Bitcoin world.

This is but one example of many was to encrypt data based information. I am not engaging in the Bitcoin money fight-just the proof of concept of using block chain math potential for national security information secure transmittal research.

One should always be mindful of a word of warning from a man owning 10% of all bitcoins in the world of the damage of a very early bad start; never make a Security Token-as brutally said by the owner of 10% of all bitcoins isn the world a "Shit token" inside a corrupted ecosystem. The key is always "trust of information" in any ecosystem.

A "value" of bitcoins is obvious, when thought about, is that in the actual creation process it is not just "value" but it is also a standalone unique "nugget" of information.

The mathematical protected uniqueness of each bitcoin now may highlight a way of transferring classified information flow in 21st Century war fighting enterprise.

Instead of focusing on "bitcoin" as a unit of value which is a very real attribute, think of creating mathematically unique "nuggets" that when 'spent" are used to "buy" or actually access classified information.

Thanks to a Cornell Professor's research using a unit of Block-chain math in perhaps securely fighting at the speed of light has had a brilliant proof of concept.

Intel's core idea allows users to run their code unmolested in a secure enclave. That means both ends of a transaction have the same constraints.

"Normally you don't know what the computer on the other end of the relationship is going to do," Sirer says.

"You have no idea what code they're running or what kind of adversarial behavior they could engage in, so you have to write your protocols in the most conservative manner possible.

"But with this technology, you know exactly what code the other side has, and you're assured the person cannot change or violate the integrity of that code.

"This allows us to build mechanisms on top that are much more efficient."

In a test, Sirer and his colleagues set up a Teechan channel between Imperial College in London and Cornell University and sent transactions across the Atlantic at the blistering fast speed of one-one-hundred-thousandth of a second

Shaping a Way Ahead

The senior leadership challenge in defense is to foster and accept innovations generated within "stovepipe" fielding processes from vertical IR&D to R&D to requirements and to engage in cross-learning, It is not enough to introduce innovation in the individual sectors,

The challenge and the opportunity to empower decision making at the speed of light by shaping integrated C2 drawing upon these technologies in the big three areas of innovation,

Rather than chase individual emerging technologies such as the Cloud, AI or encryption it is much more productive to immediately begin the "applied physics" phase of crafting experiments for dynamic iterative solutions that allow all to constantly learn how to fight at the speed of light.

Each of the "Big Three" has it's own R&D dynamic so having an open dynamic testing process can accommodate each technology's current practical demonstrated capability — all constantly integrated together in an open loop learning but operational cycle.

Accurate, timely, target acquisition and target engagement leading to payload utility success from the heavens to under water is the goal.

Shaping success is ongoing con-ops learning process success is found in the Nike saying of just do it.

It is not about simply discussing technology in isolation.

As the cloud comes on line, we can embrace it as a dynamic way to share information.

As AI improves in many situations, the human factor can be successfully taken out of the loop. One huge caution in that there is both promise and danger in getting AI correct to consider never having a totally closed loop AI engagement process.

Encryption is a wondrous field of research and mathematical advance are being made every day.

For the most advanced military forces in the world, the most practical way to learn to fight at the speed of light begins just like the first command a private hears "Ready on the Right Ready on the Left, with the boundaries of being ready on right and left incorporate global engagements with all weapons.

The command "Ready" can begin on instrumented training ranges. Not only is training for training sake essential, but just like the individual Marine sees exactly where his rounds have hit the target.

The real time data collected on instrumented ranges is everything for enragement improvements at all levels.

Feeding back the captured range data results in trying to make accurate payload decisions at light speed can accelerate all aspects of future combat success.

Hard data from instrumented ranges is the most essential building block of marrying human capacity with their ever improving force technological adeptness.

For all who want to successfully fight at the speed of light, they are only limited by their imagination on how to mix and match offensive and defense engagement exercises on instrumented ranges.

One simple example, one could deploy staggered F-35s on station hundreds miles apart integrated with advanced Hawkeyes, UAVs and active AEGIS ships and then run very fast low level bogies with a minimum RCR signature at them from hundreds of miles away.

Then clock the ability to safely pass target acquisition and then weapon engagement data against such a threat.

Finally, begin to include Space Assets after testing integrated "air-breathing" systems. I suspect Space is nice but might not be the panacea all believe it can be in the year 2030.

After such a series of engagements break the problem down to simple questions with the focus being only technology available specifically in a 0-to 5 years out year time horizon with a rolling FYDP being created.

Conclusion

The future of combat is very high right now and it is essential to deal interactively with these various dynamics:

Will Combat Cloud research help?

Will AI make a difference?

Is encryption of data essential?

How can various platforms mix and match weapon payloads?

What is the current and five year out use of space based systems.

Do all types of UAVs help?

What difference does ever improving Directed Energy make?

If the threat comes from below the surface, on the sea or land or screaming from space, where does existing technology come together and where are deadly seams for an adversary to exploit?

If a very fast set of bogies, one R&D team suggests several F-104s as adversary, what is similar with low flying Mach 1+ targets to being different from hypersonic incoming warheads going a mile a second .

With that initial lower Mach data collected than asked the above questions again and again and again, so successful ways ahead will be discovered by integrating in considerations of HSCM and advanced BMD (including hypersonic maneuvering glide warheads) .

Eventually the research and testing is for both Live Virtual Ranges and computer simulations.

But nothing should take the place of first learning by doing in building from limited in geography operations to the very large global combat.

With respect to U.S. test ranges, the East Coast military Warning Areas are perfect, eventually Allies can be part of learning by doing.

Four distinct possible combat global areas could be considered to eventually test proof of concepts between US and Allies while building stronger integrated combat Kill Webs;

The round two of suggested research, after limited test range experiments is to acknowledge the global geography of threats being both similar and different all with the common threat of escalation into a potential nuclear weapon exchange.

Looking at potential flash points of global threat areas that the American Military has can be seen in four "wicked" combat theaters anyone of which can escalate to major tactical and strategic use of of Nuclear Weapons.

1. South China Sea
2. North Pacific
3. Nordics
4. Battle of the Atlantic.

My personal opinion is research will demand better quicker longer reach payloads as the most pressing challenge.

America might have to go back to the future in looking a very low yield Nuc warheads.

But that is a national debate, including all Allies, fraught with much political danger but it still may be considered as the most productive way ahead to save a Navy Carrier strike force.

A Nuc is one heck of a Payload Utility function.

Strategy, Concepts of Operations and Technology: The Challenge and Opportunity of Shaping a Distributed C2 Enabled Force

05/20/2019

By Robbin Laird

I would argue that the US and its allies are not so much facing a great power competition. I would refer to it as a global contest between 21st century authoritarian powers and the liberal democracies.

And on each side of the competition there is significant cross learning going on. With regard to the authoritarian powers, Russia, China, Iran, Turkey, just to mention the most prominent they are clearly playing off of each other's policies challenging the democracies and, in some cases, actively collaborating,

With regard to challenging the democracies, these authoritarian states are using what some in the West refer to a "whole of government policies" or in other words, using a very wide range of tool sets to try to disrupt an dominate
It is clear that the democratic powers need to find ways to expand their own tool sets to respond, including capabilities such as offensive cyber operations.

One clear line of difference is the reliance of the authoritarian militaries on hierarchical decision making versus the potential for Western militaries to shape a much more flexible, distributed force.

But for the Western forces to do so will requires a significant change beyond the legacies of the land wars.

In the land wars, which have been intensive from time to time but are largely slow mo war from a strategic point of view. The West has shaped rules of engagement which create a very hierarchical C2 system.

The new video technologies and new communications systems have been shackled by a centralized command structure.

And if this template continues, the West will lose a significant advantage which new technologies will allow.

This is why analysis of military technologies can never stop with an analysis of technologies, but must look to concepts of operations, training and the system of authority which militaries are built around.

An interview which I did some time ago with Robert Evans, formerly of Northrop Grumman and now with Cubic Corporation highlighted what the technology built into the F-35 could unleash in terms of C2.

Formations of F-35s can work and share together so that they can "audible" the play.

They can work togethe, sensing all that they can sense, fusing information, and overwhelming whatever defense is presented to them in a way that the legacy command and control simply cannot keep up with, nor should keep up with.

That's what F-35 brings.

If warfighters were to apply the same C2 approach used for traditional airpower to the F-35 they would really be missing the point of what the F-35 fleet can bring to the future fight.

In the future, they might task the F-35 fleet to operate in the battlespace and affect targets that they believe are important to support the commander's strategy, but while those advanced fighters are out there, they can collaborate with other forces in the battlespace to support broader objectives.

The F-35 pilot could be given much broader authorities and wields much greater capabilities, so the tasks could be less specific and more broadly defined by mission type orders, based on the commander's intent.

He will have the ability to influence the battlespace not just within his specific package, but working with others in the battlespace against broader objectives.

Collaboration is greatly enhanced, and mutual support is driven to entirely new heights.

The F-35 pilot in the future becomes in some ways, an air battle manager who is really participating in a much more advanced offense, if you will, than did the aircrews of the legacy generation.

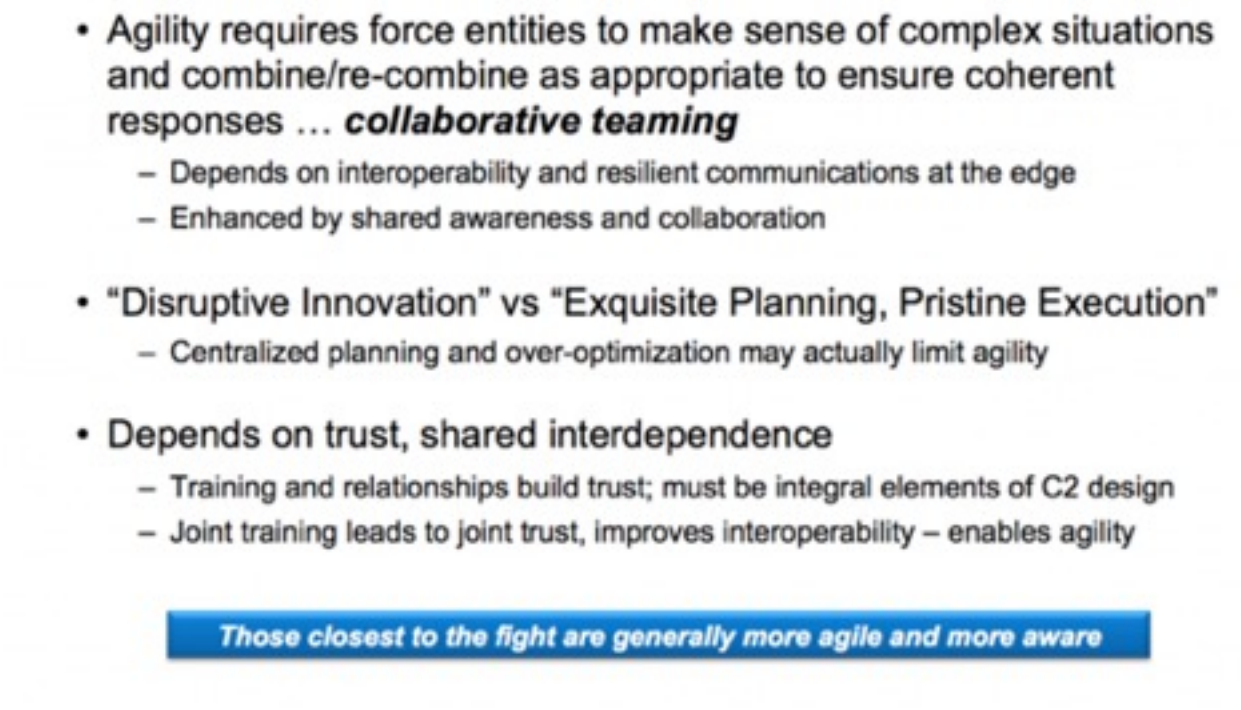


Figure 3 Slide from Briefing by Robert Evans, Cubic Corporation.

What Evans identified was a potential inherent within the F-35 which can be delivered by the integrated combat systems on the aircraft which can not only create data fusion but a very different decision-making system, one able to operate very effectively and comprehensively at the tactical edge.

But this advantage built into the aircraft will simply not be realized if the older templates of decision making are pursued; and this will be doubly a challenge if this happens as the authoritarian states are building strike in mass directed by hierarchical decision making as a key way ahead.

This will not happen by itself and requires a very different approach to C2 and building out from this approach to capturing the technologies which will accelerate this potential strategic advantage as well.

The F-35 with its DAS systems and its integrated approach for a man-machine system to managing data and to establish a very different approach to reversing the relationship between C2 and SA, whereby decision making at the speed of light gets enhanced by man-machine capabilities on board the aircraft informed by data coming into the network is laying the foundation for a broader revolution.

But this revolution can be enabled by the technology but will not happen unless the services and the allies embrace it and shape new distributed decision-making templates.

The global fleet of F-35s lays a solid foundation for engaging a broad coalition of liberal democratic military powers to contribute to shaping s new template of decision making and distributed concepts of operations.

Re-shaping C-2: Decision Making at the Tactical Edge

05/22/2019

By Robbin Laird

With the introduction of new communications and video technologies, military decision making has changed over the past twenty years.
A significant point of change was the introduction of Rover which created what Secretary Wynne, under whose mandate Rover was introduced, referred to as the democratization of the battlefield.

In a 2012 interview with one of the key shapers of the Rover technology, the impact of Rover on C2 was highlighted.

Rover has been a key element of democratizing the battlefield.

The General has the generally same picture as the guy in the field does.

And this rover essentially creates a horizontal command structure where any Special Forces Team or Captain or a Lieutenant on the ground or a Battalion Commander or a theater committee can call in the air strike commensurate with the Rules of Engagement (ROE).

It's really the story about the JTACS and how they into very effective fighting tools that we have used in

This democratization of the battlefield has unfolded in the context of the land wars in the Middle East and has been an essential part of a significant reshaping of what air support means to the ground forces.

With the strategic shift from the land wars to higher intensity operations, how then to replicate the Rover experience but to do so for the distributed force operating in much higher tempo operations?

As noted in the last piece in this series on distributed C2, the coming of the F-35 and its sensor fusion provides a significant foundation for rethinking how C2 at the tactical edge could occur.

In some ways this is just the beginning of a significant shift in the capability which can be unleashed by new technologies and new approaches to command and control.

A key technology which could drive such change is the delivery of ubiquitous full motion video, embedded with overlays which can provide dynamical contextual awareness to the warfighter at the tactical edge.

With a proliferation of decision-making technology, risk can be reduced and decisions made more rapidly and with better outcomes.

But for a full motion video enabled force with embedded overlays to lead to the kind of change, which inherently it could, two related capabilities need to occur.

First, senior commanders have to avoid detail management through C2 intrusiveness and to focus on appropriate mission command.

The practices of the past twenty years where video technologies have often been used for intrusive controls at the tactical edge by senior commanders simply will not work in a high tempo operational environment and will take away the advantages which could accrue to a distributed force.

And, secondly, operators at the tactical edge need to learn how to make decisions using the context provided via overlays to the full motion video.

They need to understand how to implement mission command in a high tempo environment with enhanced decision-making tools made available to them.

In effect, the challenge facing today's F-35 pilots to shift from performing as an AWACs-like commander, to becoming a decision maker at the point of interest with the full motion video and overlays available to them, is a harbinger of a broader transformation of the C2 environment.

But this will not happen unless both aspects of change interactively occurs – namely, Generals lead but do not provide detailed intrusion; and distributed force commanders, operate on the SA which can be constructed with the tools available at the tactical edge.

And another challenge involves how the US has operated its intelligence processes.

In high tempo operations, it is not about collecting data, and culling it at some command post in the rear. It is about the intelligence function being embedded into a tactical edge rapid decision-making process.

Much of this information is fleeting, and it is a question of making better rather than worse decisions more rapidly; it is not about slowing down decision-making to the speed which hierarchical review requires.

Recently, I had a chance to talk with Bradford Powell, Vice President and General Manager of Cubic Corporation's C2ISR Solutions business, about the nature of change in the C2 sector.

We discussed both the general dynamics of change as well as some solutions being worked by Cubic as well.

In this piece, I am focusing our discussion of the dynamics of change and in the next one I will address some specific Cubic solutions.

According to Powell, the clear trend line is to expand significantly access to imagery and to full motion video (FMV), while improving integration between the two.

While today, access to FMV within the military is targeted and to some extent limited, a decade out, full motion video will be ubiquitous.

He noted that his group at Cubic has primarily focused on handling the movement of video from Airborne ISR platforms.

For example, they have provided means for getting MQ-9 video from point A to point B.

With the growing flood of video, the challenge will be not simply to manage it, but to turn the video stream into an effective decision-making tool at the tactical edge.

"We are working to provide context within the full motion video feeds, which will enable the operational user to make tactical decisions more effectively."

He described C2 as moving from a focus on maps, to command and control operating from within full motion video.

And to do so will require tools that provide context easily used by the tactical decision maker.

As a relatively simple example he referred to the television networks placing yellow first down markers over the video of a football game. If one then imagines the various data clusters which could be laid down over the full motion video available to the tactical decision maker, in his area of interest or the area where he is operating, then the coming future of video driven context for C2 at the tactical edge can be envisaged.

The task is to insert relevant tactical data into the full motion video.

"The full motion video focused C2 environment would then evolve to make a broader set of intelligence products discoverable in the video."

The overall focus is to provide the local decision maker with much greater context for what he is looking at in the full motion video.

Obviously, as this capability is introduced, refined and developed, artificial intelligence can be shaped to provide effective tools to help shape the data coming into the contextual shaping function for the full motion video.

In short, "what is the impact of full motion video in terms of making faster decisions and communicating those decisions in a more effective way and enabling decision making at the lower level?"

In other words, the template for decision making is changing.

A shift to a distributed force will be effective only if a new template for decision making is put in place, one that allows for 21st century mission command and decision making at the tactical edge operating in high tempo operations.

Shaping C2 for a Degraded Operational Environment: The Role of GATR

05/30/2019

By Robbin Laird

With the central role which crisis management will play for the US and its allies, a key area of change is in the area of C2. Distributed operations which will be an essential part of the strategic shift will require distributed C2.

And C2 will have to operate in degraded operations environments.

A tested technology which can provided capabilities to support flexible insertion forces in the higher end and support for HADR operations on the lower end is the GATR system.

The GATR system provides a very flexible, mobile, deployable solution to ensure for reliable communications on the fly which can be used to support military insertion forces or to provide for connectivity when natural disasters have brought down normal operating systems.

I recently had a chance to talk with Cubic's Victor Vega, Director of Emerging Solutions, about the GATR system.

I first became aware of both Mr. Vega and GATR from the role of the system in dealing with the HADR situation in Puerto Rico in 2017.

In an article by Debra Werner of Space News published on December 5, 2017, the role of GATR was highlighted.

Cubic Corporation's GATR satellite antennas continue to provide communications links for residents and community leaders in Puerto Rico more than two months after Hurricane Maria devastated the U.S. territory and nearby Caribbean islands.

Employees of GATR Technologies, part of Cubic Corporation's Mission Solutions Division, were in the U.S. Virgin Islands working to reestablish communications in the wake of Hurricane Irma, when Help.NGO's Disaster Immediate Response Team and Cisco Systems' Tactical Operations Team called for assistance in Puerto Rico.

Victor Vega, GATR Technologies director of emerging solutions, and his colleagues packed inflatable satellite antennas in suitcases and brought them to areas of Puerto Rico where hurricane-force winds and fallen trees had dismantled the terrestrial communications infrastructure. They installed inflatable GATR 2.4 meter antennas on rooftops, including two U.S. Army National Guard buildings that served as a distribution point for food and water.

Vega noted that he has been with the GATR program from the early days when it was produced by a small startup company (GATR Technologies) which was acquired by Cubic Corporation in 2015.

He argued that the acquisition has been good for the GATR effort as "We have been able to move from being an antenna provider to being part of a broader effort to become a satcom provider and to provide systems to DoD as a program of record."

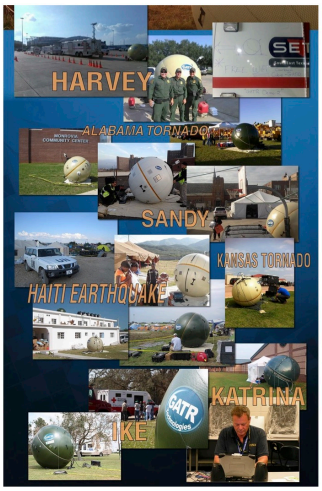
But he underscored that the core GATR capability is really about rapid response. He pointed out that when they began, the already contributed capability to the Hurricane Katrina disaster. The factory is located in Huntsville, Alabama and they put GATR into a truck and drove to the disaster area and provided sat com capabilities for the first responders.

"The prototype already allowed FEMA to get Internet access so people could come in and fill out the FEMA request forms and to communicate with their familes to let them know they were alright."

He underscored that since that time, the GATR system has been a frequent contributor to HADR C2. The graphic below shows the HADR events at which GATR has provided C2 in a degraded operational environment.

Our Disaster Response

- Hurricanes
  - Katrina - 2005
  - Ike - 2008
  - Typhoon Hiyan (Philippines) – 2013
  - Sandy - 2012
  - Harvey, Maria, Irma – 2017
  - Michael – 2018
  - Idai (Mozambique) - 2019
- Tornados
  - North Alabama - 2011
  - Kansas - 2013
- Earthquakes
  - Haiti - 2010
  - Nepal - 2015



CUBIC | GATR

Figure 4 Working in a Degraded Enironment with Effective C2

Vega argued that given the centrality of communications to modern society, re-establishing C2 has become a central focus for relief agencies which providing HADR rebuild efforts. “The faster C2 can be restored, the more rapidly can order be re-established and chaos mitigated.”

GATR has virtually no logistics footprint so to speak. It can be packed along with suitcases for transport with other cargo; it does not need specialized vans or specialized lift helos or aircraft to bring to the area of interest. The small logistical footprint means it can be brought to the area of interest by a wide range of ground or air or sea transport systems.

This also means for insertion forces in higher end contingencies, a distributed C2 capability can be laid down rapidly and with minimal lift required. The system can be and has been carried with airborne troops and precision air dropped to the area of interest as well.

Because the focus is shifting from the big established bases of the Middle East land wars, to an ability to operate across the combat spectrum in a crisis situation with distributed forces, such a flexible coms capability is an essential part of the mobility and flexibility which the evolving force structure needs to prioritize.

With regard to HADR operations, FEMA has become a customer of GATR as well as several NGOs which operate in the HADR environment.

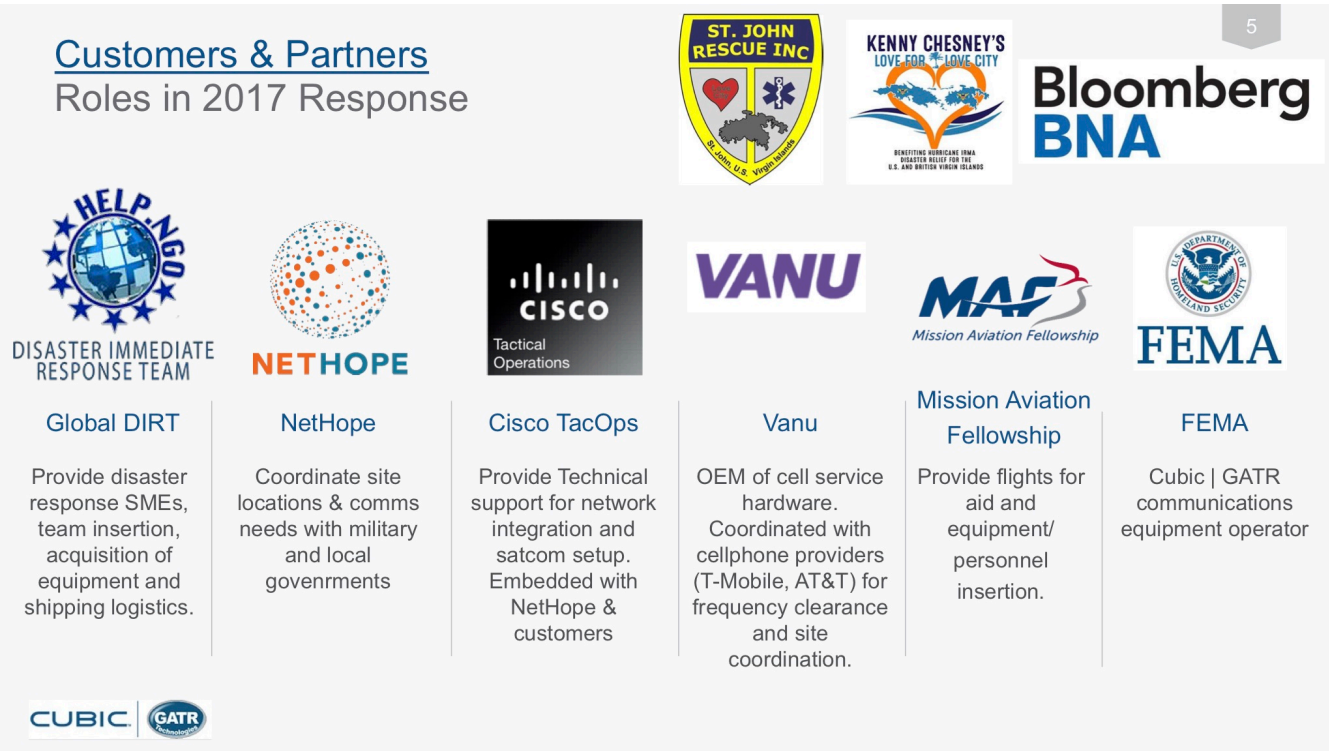


Figure 5 Partners in the 2017 Operation. Credit: Cubic Corporation

In other words, GATR can support a wide range of missions operating in a disrupted or degraded environment.

I noted that the US military is clearly reworking island hopping as part of the US-allied strategy in the Pacific.

Vega commented that GATR clearly has a role in such a strategy and provided this example.

A US Army Unit based in Hawaii has been using GATR for some time to support exercises across the Hawaiian Island chain.

One of the officers of this particular unit told Vega that "we cannot do our mission operating out of ice cream truck satcom. We cannot move all that equipment and get our job done."

To do their mission, this US Army unit transitioned from the legacy system of trucks and antennas to GATR, a clear harbinger for a more flexible approach, one needed for HADR or other mission sets.