

Black Coral LIVE Foreign Comparative Test – FINAL ENGINEERING REPORT

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Abstract:

A US Congressionally funded Foreign Comparative Test (FCT) was awarded to Black Coral in October 2006 to test the tactically fieldable Black Coral LIVE with the US Army Command Post of the Future (CPoF) system. CPoF is a fielded system used in multiple theatres of operations by the US Army and other services, primarily at the Brigade and higher echelons. Black Coral LIVE is a commercially available technology that allows in-field tactical collaboration for sharing information amongst dispersed team members over austere networks. Black Coral LIVE was evaluated in three areas: interoperability with CPoF, compatibility with the CJMTK, and its ability to operate on the Lower Tactical Internet.

During testing and evaluation by US Army CERDEC C2D personnel, Black Coral LIVE met or exceeded all of the named objectives. Additionally, Black Coral LIVE was fielded in the US ARMY C4ISR OTM (on-the-move) Exercise 2008 with great success. Black Coral LIVE passed all objectives in the FCT and was deemed to be a valuable tool, providing collaborative capabilities to mounted and dismounted warfighters operating on the Lower Tactical Internet.

Keywords:

Tactical, dismounted, C4ISR, collaboration, command and control, CPoF, netcentric, CJMTK, ArcGIS, ESRI, MIL-STD-2525B, 2525B

Introduction

In October 2006, Black Coral and CERDEC C2D were awarded a US Congressionally funded Foreign Comparative Test (FCT). The purpose of the test was to examine Black Coral's suitability in meeting multiple classified US Army requirements. To this date, Black Coral has no direct knowledge of the requirements, but can only assume that they are urgent and important.

Prior to the award of the FCT, Black Coral and CERDEC C2D sought an internal sponsor in the US Army, and the Command Post of the Future (CPoF) project (PM TBC – PEO C3T) stepped up and sponsored the project. As such, the project was focused on efforts that were immediately applicable to CPoF and its use in theatre.

Black Coral created its tactical field application, Black Coral LIVE, to address the lack of tools and capabilities that field teams have to share information, collaborate, and gain situational awareness while in the field. This combination of high-level requirements has made Black Coral LIVE a unique and best-in-class field collaboration tool that allows dispersed teams to share more information than they have ever been able to before.

Upon contract award in July 2007, Black Coral immediately teamed with Future Skies out of Tinton Falls, NJ. Future Skies was retained due to its extensive knowledge of the Lower Tactical Internet, CPoF (included having several formal field support reps on staff), and CPoF DataBridge capabilities - a perfect fit. Using Future Skies also allowed Black Coral to avoid issues with International Traffic in Arms Regulations (ITAR) restrictions on both of these key technologies. All work that was US restricted and subject to ITAR was performed by Future Skies in New Jersey.

There were three high-level objectives to the FCT:

- **CPoF Interoperability** - The overriding guidance that Black Coral insisted upon was that the successful collaborative experience

that the US Army has had with CPoF must be maintained.

- **CJMTK Compatibility** - Compatibility with the Commercial Joint Mapping ToolKit (CJMTK) was a key requirement. US DoD and NGA have standardized on CJMTK to ensure that they are best positioned to leverage the digital and human assets that are available to support the warfighter. The support for the geospatial data and the MIL-STD-2525B warfighter symbology was key to ensuring that the US Army is able to immediately leverage Black Coral LIVE in its field operations.
- **Lower Tactical Internet Integration** - As a tactical field tool, the ability for Black Coral LIVE to operate in the field over the Lower TI was critical.

All three high-level objectives were met successfully in this project. The interoperability with CPoF, and operating on the Lower TI were the two biggest successes. As registered CJMTK developers, Black Coral's experience with the CJMTK ArcGIS objects, data loading, and symbology was already known before entering the FCT.

The following sections provide more detail on the three high-level objectives.

Objective: CJMTK Compatibility

The key requirement to this objective was to test and validate the CJMTK compatibility of Black Coral LIVE. MIL-STD-2525B symbology support and ability to load NGA datasets using CJMTK methods were evaluated and Black Coral LIVE passed all tests successfully.

The key success of the CJMTK Compatibility objective was based on the ability to load CJMTK compatible data in a manner consistent with CJMTK systems and in support for the MIL-STD-2525B symbology set. Both of these requirements were met by Black Coral LIVE.

CJMTK is a US DoD and NGA major acquisition program that provides leverage of geospatial technology, digital data, and human assets (geospatial technicians) across the broad needs of US DoD, specifically in a C2 environment.

The CJMTK is based on a single scalable open architecture, with open development environments, incorporating industry standards, where significant research and development costs are borne mainly by vendors, offering regular software upgrades, extended functionality, and standard, regular training. The primary commercial component of the CJMTK is the ESRI Geographic Information System (GIS) software called ArcGIS. This award can be viewed simply as the adoption of the ArcGIS platform as the standard geospatial exploitation tool for the DoD C2I systems.¹

Black Coral is a registered CJMTK developer and has been developing on the essential components behind CJMTK since 2004. In 2004 it made its first sale of Black Coral LIVE to the US National Geospatial Agency (NGA), and was integrated at the time (JWID 2004) with Palanterra - a premier homeland security capability.

Testing of Black Coral's CJMTK compatibility was performed early in the FCT by CERDEC's Ron Kane. There were some minor MIL-STD-2525B symbology issues noted (some naval symbols were incorrect) but the pass rate was well in excess of 98%. Black Coral uses its own graphics engine to handle drawing of the MIL-STD-2525B as it has proved that the CJMTK symbology components (MOLE/Military Analyst) simply cannot provide the performance for systems that have a lot of graphics moving on the screen at one time. The performance of Black Coral's graphic engine handled the data loads that were provided across the DataBridge with no performance issues noted.

¹ Source: Official CJMTK public web site
<http://www.cjmtk.com/Overview.aspx>

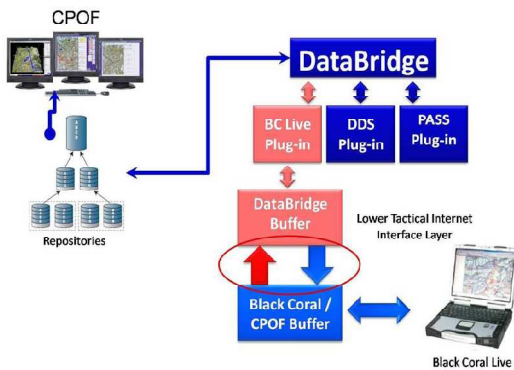
Data loading was performed in support of scientific tests, field examinations, and exercises. Data ranging from CADRG to CIB1/5 were successfully loaded into Black Coral LIVE for Ft Dix (NJ), Ft Hood (TX), and SWA (Iraq). All data were loaded and compatible with the CJMTK systems.

It is noteworthy that Black Coral's licensing with ESRI requires that US DoD does not receive any discount if software is purchased from a commercial vendor that embeds the same components in its system. There is potential that since the US Army has specific needs, Black Coral could create a US Army (or US DoD) version that allows the benefit of the CJMTK license, thus radically reducing costs for acquisition of Black Coral LIVE.

Objective: Lower Tactical Internet

Black Coral LIVE is designed to operate in austere communications environments, ranging from flaky communications to extremely limited bandwidth capabilities. In order to address the Lower Tactical Internet objective for the FCT, Black Coral engaged Future Skies to perform the network communications between the CPoF DataBridge and the in-field Black Coral LIVE devices.

The basic approach taken for the communication was for Future Skies to create a communications buffer application that used the Black Coral LIVE API to push data from CPoF and to receive events from Black Coral LIVE as the field operator made changes in the system. The software components that were developed to communicate via the Lower TI were developed and used solely in the United States, by Future Skies. The Future Skies team worked with Black Coral to ensure that no ITAR restrictions were imposed on Black Coral's commercial technology. The "double-buffer" approach is illustrated below (source C4ISR OTM 2008 report):



later time. This approach is basic and could be made more intelligent with access to network parameters that allow Black Coral LIVE to know when bandwidth is available to send lower-priority images.

- Thumbnail then Request - It is possible to augment CPOF so it can receive a thumbnail or reduced quality image and then allow it to request a higher-resolution picture as needed.

Communications Optimization

Communications over the Lower TI must consider the effective use of available bandwidth and be able to handle the unique characteristics of this network. Black Coral and Future Skies worked primarily on being able to handle the needs of software-defined-radio, due to the unique network needs of the US Army Lower Tactical Internet radio systems.

- **XML vs Binary** - There were some simple steps taken to attempt to compress the XML-data that was being exchanged but there was only a minor improvement in bandwidth usage. Potential future development can radically improve the bandwidth usage using approaches that Black Coral has used in other similar situations (e.g. Binary data, data deltas only). Future Skies also has some approaches that can be used, but those approaches may delve into ITAR-restricted areas, which would be beyond the scope and intent of this paper.
- **Images** - Black Coral LIVE allows operators to geo-reference images taken in the field with a digital camera and these images are then shared up to the CPOF system. There was no attempt during the FCT project to optimize the use of bandwidth, but several potential solutions exist for the future:
 - **Thumbnail/Reduced Image Quality First** - A more bandwidth friendly approach could be to send a thumbnail or reduced image first, followed up by the full image at a

WIN-T

Black Coral LIVE was successfully integrated into CPOF and utilized over the OTM E08 and over a WIN-T Increment 2 surrogate system at the AUSA annual conference in Washington D.C. The Future Skies team integrated CPOF and Black Coral LIVE across WIN-T with minimal effort and great success.

Objective: CPoF Interoperability

The requirements of this objective were to prove that Black Coral LIVE could exchange information with CPoF in a bidirectional manner, without requiring changes to the CPoF technology or changing the way that CPoF is used in operations.

The major capability that Black Coral LIVE brings to the US Army is the ability to extend the successful collaborative experience that CPoF enables to the mounted and dismounted warfighter. The major portion of the FCT was spent on evaluating how well Black Coral LIVE worked with CPoF, a test of its interoperability. There was one high-level constraint that Black Coral imposed on this test, that being that there could be no change to CPoF required to support Black Coral LIVE. Black Coral understands the investment that DoD and the US Army have made it deploying and operationalizing CPoF. In order to be as effective as possible as an augmentation of CPoF, Black Coral felt that it couldn't impose a change in the CPoF application, nor in the way that CPoF operators use CPoF.

In support of the current CPoF (Florida and Georgia releases), Black Coral worked with Future Skies to understand how CPoF was used in theatre. The former field support representatives (FSR) were invaluable in providing the experience and in determining how CPoF and Black Coral LIVE can work together without requiring changes to how CPoF is used.

One key concept from CPoF was used heavily – the Effort concept. Efforts in CPoF are an abstract concept that allows operators to group information together for similar purpose. Efforts are used for local “scratch pads”, sharing plans, sharing PLI (blue force positions), and many other things on a day-to-day basis in CPoF. Black Coral and Future Skies created a concept of operations together that allowed a CPoF operator to share information with a Black Coral LIVE operator using a Black Coral Effort in CPoF. This Effort allowed the operators to share detailed information that included advanced graphics from other efforts, PLI, and information gathered from the mounted/dismounted warfighters.

During testing and development at the DataBridge side, Future Skies created a “virtual operator” console that allowed automatic sharing of data from different Black Coral LIVE teams without requiring human input. This capability is very powerful, and should be examined further, but goes beyond the scope of the FCT and this document.

Details on Shared Items

In testing and analysis the following items were shared between Black Coral LIVE and CPoF:

Situational Awareness

- Send Platform Position Report Real-Time Updates
- Receive Current Platform Location Identifier (PLI) Data From CPOF PLI Effort

Command and Control (C2)

The following C2 elements were shared between Black Coral LIVE and CPoF with no loss of data

fidelity (i.e. no data elements were stripped out or lost in between systems):

- Receive Events Sent by Division Clients
 - Hostile Command Post Run
- Receive Battalion Mission Brief
 - Dispatch Platoon to reinforce Command Post Run
- Receive Battalion Graphical Boundaries
 - Exact location of Command Post
- Ability to Send and Update Events
 - Improvised Explosive Device (IED)
 - Vehicle Born IED (VBIED)
 - Mortar Attack
 - Sniper Attack
 - Suicide Bomber
 - Murder
 - Rocket Propelled Grenade (RPG)
 - Small Arms Fire (SAF)
 - Explosion
 - Anti Aircraft Artillery (AAA) Fired
 - Weapons Cache
 - CP Run
 - Surveillance
 - Drive By Shooting
 - Demonstration
 - Refugees
 - Safe House
 - Known Insurgent Vehicle
- LIMITED Ability to Send and Update Graphics – this capability was discussed in the CJMTK discussion area.
 - As Defined by TB 2525-B Military Graphics
 - Multiple Colors\Colours
 - Multiple Line Styles
 - Multiple Line Weights
 - Text
 - Non Military Graphics
 - Line
 - Ellipse\Circle
 - Rectangle\Square
 - All the above Non Military Graphics will have to be able to change Colors, Styles and Weights

- Ability to Send and Update Geo-Sticky
 - Name
 - Set Grid Coordinate
 - Text
 - Sub Elements
- Ability to Send and Update An Effort
 - Name
 - Text
 - Sub Elements

During testing of CPoF Interoperability in the lab and in the field it became evident that extending the concepts of digital collaboration from the CPoF operators (Brigade and above) to the Lower TI operators (Brigade and below) may pose some doctrinal and organization issues. Black Coral understands that these issues are significant, but they meet the future concepts that are envisioned for the US Army and other military services. The following observation was made during the C4ISR OTM E08 (see Exercise C4ISR OTM E08 for more detail).

... [A] human factor we had to overcome was to alleviate the Company Commander's apprehension about sharing ground truth data directly with the Command and Control Leadership up to Brigade. This requires a change in the military decision-making process and an unprecedented level of trust in automated systems. At the platoon level, this prototype adds another dimension to the task of knowledge management to military leadership but simultaneously fulfills the drive for greater commander SA demanded by Army Netcentric Warfare policies.²

Demonstration Scenarios

Two key scenarios were used during testing and demonstration:

- **Patrol on Mission** – simulating the information flow between a mounted/dismounted group of warfighters

on patrol, reporting back to a CPoF operator in a command center.

- **Fallen Angel** – simulating a Quick Reaction Force response to a downed helicopter.

Details on the key elements of these scenarios are provided below.

Patrol on Mission Scenario

In this scenario, a VBIED explodes and a quick reaction force (QRF1) is dispatched to examine the explosion site. En route, QRF1 is fired up and engages. A second QRF (QRF2) is dispatched to investigate both events. The key sequence of events is as follows:

- Car explodes
 - VBIED posted on CPoF
- QRF 1 dispatched
 - Simulator moves 4 platforms to VBIED location
- QRF 1 (Quick Reaction Force) is fired on
 - RPG is posted in Black Coral LIVE
 - Text posted to RPG incident
- QRF 2 dispatched to investigate both incidents
 - QRF 2 posts updates for both incidents using Black Coral LIVE

Fallen Angel Scenario

In the Fallen Angel scenario, two helicopters are on patrol when one is hit by a surface-to-air missile. The operational helicopter begins circling the area while a QRF is dispatched. INTEL is posted by the dismounted Black Coral LIVE operator and shared to CPoF from the crash location. Additionally route clearance graphics are created in field but the Black Coral LIVE operator and shared up to the CPoF command center operator. The key sequence of event is as follows:

- 2 helicopters fly patrol
 - Simulator moves 2 helos into zone X
- 1 helo hit by surface to Air missile
 - Post incident in CPoF
- 2nd helo flies cover for Fallen Angel
 - Simulator flies helo in circle
- QRF is dispatched

² C4ISR OTM E08 Report, RDECOM, US Army - p.403

- Simulator moves QRF to Fallen Angel
- INTEL Information is posted by Black Coral LIVE user
- QRF reports BDA of Fallen Angel location
- Send Route Clearance Graphic from Black Coral LIVE to CPOF

Exercise C4ISR OTM E08

Black Coral LIVE was fielded in the C4ISR OTM Exercise 2008 (E08) at Ft Dix. The results of the exercise proved that Black Coral LIVE provides a unique collaborative capability that can greatly improve the situational awareness level of warfighters.

During C4ISR OTM E08, it was demonstrated that the use of this technology will provide significant advantages. It provides leaders with a collaborative capability between CPOF and dismounted operations. On this system, information is automatically sent as it is entered, meaning that there is no need to perform addressing or to compose individual messages. Relevant data is fluidly exchanged, including handling of network disconnection using automated resynchronization. This technology allows soldiers to rapidly markup and share information between dismounts and headquarters. It also allows personnel to perform collaborative planning and provides the situational awareness for mounted and dismounted Lower Tactical Internet assets.³

Interoperability - Outstanding Items

There were several capabilities and doctrinal/CONOPS-level decisions that were not made though the technical impediments to these were handled during the FCT. The two key capabilities were the decision to not implement CPOF's "flashlighting" capability, and decisions were not made on what to do about deleted items that are exchanged between CPOF and Black Coral LIVE.

The rationale for both of these items is discussed below.

CPoF Flashlighting – CPOF's flashlighting capability is very powerful in that it allows operators to temporarily draw attention to things by drawing freehand on the screen. Other CPOF operators are able to see the highlight and it fades out over a period of time, nominally 8 seconds. There are two reasons that Black Coral did not implement this capability:

- Time Delay – The 8-second time delay that shows the flashlight is intended to draw attention to areas of the map that are significant to a person speaking during a battle update briefing or command update briefing. Since the remote users don't have realtime access to the data, by the time the data are received, the flashlighting is stale and effectively useless.
- DataBridge API Issue - The flashlighting data is considered transient and is not stored in the CPOF repositories. Therefore, it is not available via the DataBridge and could not be shared without structure modification to the deployed CPOF software.

Conclusion

It is clear that the Black Coral LIVE Foreign Comparative Test was a success. The three major objectives of sharing information between Black Coral LIVE and CPOF (CPOF Interoperability), CJMTK Compatibility, and the ability to operate on the Lower TI were proved in many areas.

The team that was assembled proved that the technology is, without a doubt, unique and valuable to the US Army and other services. As the project wrapped up, Black Coral looked back at the accomplishment of all of the stated goals of the FCT. There is a certain level of frustration amongst the team that though the test was a success there is a long road to successfully transitioning the technology to the warfighter.

³ C4ISR OTM E08 Report, RDECOM, US Army - p.403

The success of this project was largely due to existing technology at Black Coral (Black Coral LIVE) and DoD/Future Skies (CPoF DataBridge) but it was also partly due to the team that was assembled between Black Coral and Future Skies.

This success should be extended to ensure that the US Army and US Congress derive the maximum benefit from the dollars expended, and to improve the level of capability of deployed warfighters.

Black Coral LIVE successfully fulfilled all requirements of the FCT. The system successfully connected to the LTI, demonstrated the ability to transmit all required data, graphics and message types using a PASS interface to the CPoF DataBridge. It was also demonstrated that Black Coral is fully interoperable with CPoF CJMTK and 2525B symbology capabilities.⁴

⁴ C4ISR OTM E08 Report, RDECOM, US Army - p.403