Limited Range/Blue Water Capability

Problem Statement:

The as-is system uses Line Of Sight (LOS) UHF transmission using the Navy Common Datalink (NCDL) data format. This data transmission mode has a nominal maximum range of approximately 200 Nautical Mile (nmi). The 200 nmi range of the as-is C2 system is suboptimal for threat representative testing systems in the performance of modern tactics which require blue-water capability, resulting in constrained test operational area, long transit times, and restricted operational flexibility. The limited range of the as-is C2 system restricts the threat presentations of aerial targets resulting in incapability to facilitate representative blue-water emulations.

Key Solution Attribute:

Element	Threshold	Objective	Constraints
Range	200 nmi	Global Operations from CONUS	N/A

Possible Solutions:

Long range LOS C2

Implementation of a LOS network capable of extended range. Due to the physics of LOS, range performance cannot be significantly improved without the use of relays. However, the physical system could be improved in terms of data bit rate, signal path resiliency, and smaller physical antennas for shipboard use. Some candidate technologies are: L/S/C Band RF Spectrum, multi path, water-based relays.

Beyond Line of Sight (BLOS) C2

Implementation of a BLOS system using a satellite-based network. This would be a novel technology as used on an aerial target. It would also require re-work and policy changes in terms of control latency/lost-link, target antenna placement, and range safety. The physical system would interface with the GCS layer and some satellite communications layer which would interface with a node on each aerial target. Some satellite communications services, such as Starlink in the S/Ka/Ku band, or Amazon LEO in the Ka band, exist in varying maturity levels. However, satellite communications have successfully been integrated into many operational assets such as carriers, cruisers, destroyers, F/A-18, and E-2D. The commercial satellite services tap into internet access which enables future growth.

Insufficient Data Rate

Problem Statement:

The as-is system transmits control data as a LOS UHF transmission using the Navy Common Datalink (NCDL) data format. This data transmission mode has a nominal maximum bitrate in kbps. The programmed data stream is at its capacity and does not allow for growth. Targets have been lost in flight, not been recovered, and had too little data to perform an engineering investigation due to the insufficient data rate of the system. As a result, the targets were catastrophically lost without an identified root cause or follow-on correction. The insufficient data of the as-is C2 system restricts the telemetry data captured causing insufficient data collection in flight which may lead to catastrophic loss of aircraft.

Key Solution Attribute:

Element	Threshold	Objective	Constraints
Data Rate	1.0 Mbps	30 Mbps	• Transponder-FCS update rate at least 10 Hz • Transponder downlink update rate at least 10 Hz • Peak signal latency less than 1.0 sec

Possible Solutions:

Modernization Independent of Comms Solution

Whether implementing a modern LOS or BLOS system, the maximum data rate must reliably exceed the as-is system. A benchmark goal is to enable telemetry to backhaul from payloads carried by the aerial targets, up to and including high quality video (~20 Mbps). In the as-is system, the SD card fills significantly more data than is transmitted over the C2 net, in the future it is desired to be capable of sending either all of- or a much larger sample of the onboard data.

Low Signal Resiliency

Problem Statement:

The as-is system uses a LOS UHF transmission directly between the GRFU and aerial targets or airborne relay to aerial targets. The LOS transmission is sensitive to airframe masking which is largely mitigated by top and bottom mounted antennas with a signal strength seeking selecting RF switch antenna selector. Aerial targets themselves do not relay communications to other aerial targets by current operational procedure. It has happened that the RF switch has failed in flight leading the antenna selection to become locked and subsequently lost communications in a maneuver while within LOS to the GFRU antenna and other aerial targets. This event caused the aerial target to go into recovery, failing the presentation mission. The low signal resiliency of the as-is system will cause aerial targets to lose communications within LOS to nodes of the C2 network resulting in failed target presentation.

Key Solution Attribute: N/A

Possible Solutions:

Mesh Relay Network

The mesh relay network is a technology that enables nodes to move in and out of a network and allows for message relay between nodes of the network. This is a self-forming, self-healing network. Implementation of a mesh relay network would effectively make every aerial target also a relay, creating multiple redundant communication paths in the target formation. This mesh relay network does not extend LOS capability, though aerial targets could be flown in such a way to do so. Enabling this technology will feed into future growth in terms of autonomous flight / artificial intelligence development, target formation flight ranging, and the Closest Point of Approach minimization effort.

LOS RF multi path

Implementation of LOS RF multi path is a technology that enables a signal to bounce off of a surface and still be received by a system. Single LOS signals are fixed in time, based on the range to the receiver, where a multi path signal would accept signals both on LOS range and accounting for a bounce from the surface back up to the receiver, geometrically like complementary triangles. The difference in angle of arrival and time of arrival enables more opportunity for the C2 signal to be received by the aerial target, thus partially mitigating airframe masking. Due to the physical properties of RF multi path, this technology becomes less useful as range increases. Its maximum range is slightly less than LOS maximum range.

Multi-Band Transmission

Implementation of physical antennas that operate in multiple frequency bands. Multi-band transmission is naturally resistant to electromagnetic interference (EMI) due to the physics of radio frequency (RF) interaction. This sort of network would need dedicated coordination and control to enable the antenna to switch bands and not self-jam in signal generation.

Restricted Datalink Connectivity

Problem Statement:

The as-is system uses a LOS UHF transmission using the Navy Common Datalink (NCDL) data format. The NCDL data format is not compatible with any known operational platforms. The data incompatibility causes the aerial targets to be incapable of direct data exchange with operational platforms; precluding position reporting, collaborative control, and communications relay. Link-16 is an operational datalink and expected pathway for development of command and control of operational unmanned aircraft, especially Combat Collaborative Aircraft (CCA). The restricted datalink connectivity will hinder target threat representations resulting in sub-optimal enterprise test and training.

Key Solution Attributes:

Element	Threshold	Objective	Constraints
Datalink Connectivity	One-way push TSPI as J-Series messages	Two-way interaction with Link-16 network	System does not raise the security classification of the SNTC network

Possible Solutions:

Integration of Legacy Operational Datalinks

Operational datalinks may be achieved by using legacy COMSEC equipment such as a MIDS box for Link-16. This option involves acquiring the legacy hardware to access associated datalinks. The datalink outgoing signal would be received and transmitted either on the aerial target or from the GCS station. This path likely includes a COMSEC management system See Enclosure 1) for Operational Datalinks Applicability.

Integration of Crypto- Firmware IP Connection

Operational datalinks may be accessed via an IP based internet connection. This may be achieved via a virtual machine with cryptography permanently installed on the firmware of a system. This option would include an unclassified machine that increases the security level up to that of the accessed network and returns to unclassified after operation. In this fashion, a system is known to be capable of accessing internet, IP based datalinks (e.g Link 16). This technology may be used with LOS, landline, or BLOS systems.

Fixed Telemetry Data Stream

Problem Statement:

The as-is system uses a LOS UHF transmission using the Navy Common Datalink (NCDL) data format. The programmed data stream is fixed and difficult to modify. The data transmitted by the telemetry does not reflect the data needs of customers and cannot be modified based on the needs of each presentation. The user community has created a standalone telemetry system as a workaround. The fixed data stream of the as-is C2 system limits the telemetry data captured during presentations requiring an additional telemetry system to collect required mission data.

Key Solution Attributes: N/A

Configurable Data Backhaul

The configurable data backhaul will enable maintainers and/or operators to select the desired telemetry preflight, as suited to mission needs and carried payloads. This effort would include creating of a standardized payload interface such that payloads are capable of providing the telemetry to the system for transmission.

Data Pathway Parsing and Prioritization

Data pathway parsing and prioritization will enable the system on the aerial target to receive data from the FCS and payloads, sort the data into critical and non-critical data, and facilitate data transmission prioritized by criticality. This capability would send only critical data backhaul in the event data transmission quality and/or data bit rate fell below some threshold value. A data parsing and prioritization capability would require the system to have awareness to current transmission quality and bit rate, and some programmable data priority set.