Common Data Link (CDL) Overview

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"This document does not contain technical data as defined by 22 CFR (ITAR) 120.10"
Purpose and Objectives

- Provide an Introduction to the Common Data Link (CDL)
- Discuss CDL Systems and Their Evolution
- Introduce Net-Centric CDL Systems
- Offer a Top Level Description of How CDL Works
- Present Examples of the L-3 CDL Products
- Provide Points of Contact for Additional Information
Agenda

• Definition of CDL

• Common Data Link Basics and Missions

• Interoperability

• Common Data Links - The Community and the Environment

• Samples of the CDL Family of Products

• Summary and Questions
What is CDL?

1. A Set of Common and Interoperable Waveform Characteristics and Interfaces

2. A Communications Architecture, Providing Interoperability and Connectivity From Sensors to Shooters

3. Full Duplex, Jam Resistant, Digital Wireless, Point to Point Communications
The Common Data Link (CDL) Program Goals:

- Achieve Data Link Interoperability
- Provide Seamless Communications Between
  - Multiple Intelligence, Surveillance, and Reconnaissance (ISR) Assets
  - Collection Systems Operated by Armed Services and Government Agencies.

The CDL Program Establishes:

- Data Link Standards and Specifications Identifying
  - Compatibility
  - Interoperability
  - Operational Requirements Between Collection Platforms and Surface Terminals Across User Organizations
What is CDL? (Part Trois)

Related Programs:

- Tactical Common Data Link (TCDL)
- Modular Interoperable Surface Terminal (MIST)
- Sea-based Common Data Link-Navy (CDL-N)
- Common High Bandwidth Data Link Surface Terminal (CHBDL-ST)
- ARL
- ASTOR [UK]
- GLOBAL HAWK/PREDATOR/UCAV/VTUAV
- GUARDRAIL COMMON SENSOR
- RIVET JOINT (RC-135V/W)
- TARS
- TIGDL
- U-2
CDL Functions

- Multiplexer / Demultiplexing
- Randomization / Derandomization
- Differential Encoding / Decoding
- Encryption / Decryption
- Forward Error Correction Coding / Decoding
- Interleaving / Deinterleaving
- Spread / Despread
- Modulation / Demodulation
Data Link Model

Generic Data Link Functions

Source: General Technical Analysis / Theoretical References
CDL Functions - Duplex

Transmit Terminal:
- MUX
- Encrypt
- Differential Encoder
- Interleaver
- Spread & Modulator
- Up Converter
- TWTA
- Diplexer

Receive Terminal:
- DEMUX
- Decrypt
- Differential Decoder
- Deinterleaver
- Despread & Demodulator
- Down Converter
- LNA
- Diplexer

User Channels
Overhead Channels

Data Rate Expansion
Data Rate Reduction
Baseband
IF
RF

Transmit
Receive
Waveform Definition

• Does Not Define
  – Hardware
  – Implementation
  – SWAP
  – Environmental Requirements

• Defines Functions Required
  – The TV Concept
    • Many Sizes
    • Many Shapes and Costs
    • Operate on the Same Waveform
Mission Examples
Wide Band LOS Data Links

Broadcast to Receive-Only Users

Tethered Line of Sight
Air Force Surveillance Systems

Source: Part of Diagram with DFOISR Public Release Approval 99-S-1657
Army Surveillance Systems

Source: Part of Diagram with DFOISR Public Release Approval 99-S-1657
Navy/Marines Surveillance Systems

Source: Part of Diagram with DFOISR Public Release Approval 99-S-1657
Interoperable systems **must possess the interoperability necessary to ensure success** in joint and combined operations. Interoperability is the condition achieved among C4 systems or items of C4 equipment when information or services can be exchanged directly and satisfactorily between them and their users. To ensure C4 systems’ **interoperability** all aspects of achieving it **must be addressed throughout the life cycle of a system**.

- Additional principles furthering interoperability include:
  - Commonality
  - Compatibility
  - Standardization

Source: http://www.dtic.mil/doctrine/jel/new_pubs/jp6_0.pdf
Concept of Interoperability

Source: ISR Interoperability and NATO STANAGs; DFOISR reference number 00S-3281; September 2000
“Interoperability is achieved when any platform can connect through a family of data link communication systems to provide both data and C2 transport for all authorized users.”

Source: ISR Interoperability and NATO STANAGs; DFOISR reference number 00S-3281; September 2000
The Community and the Environment
Vice Adm (Ret) Cebrowski: “The Source of Power in OIF was Information Sensors, Not Shooters.”
CDL Links and History

• In the Late 1970s, CDL Was a Point to Point Link for Transmitting ISR Data

• In the Mid-1990 Time Frame, CDL Started Evolving to an IP Enabled Net-Centric Architecture

• The CDL Specification is IP Enabled and Supports Interoperability of Networked Data Links

• Common Waveforms Provide Product Interoperability Both Forward and Backward
CDL as a Communications Infrastructure

CDL Standard Established

CDL Fielded Units

Year

Rev A Spec
Rev C Spec
Rev D Spec
Rev E Spec
Rev F Spec
DARPA TCDL PRG

“The Common Data Link (CDL) System is a Family of Full Duplex, Jam-Resistant, Point-to-Point Microwave Communication Links Developed by the United States Government and Used in Imagery and Signals Intelligence Collection Systems.”*

CDL Is ... A U.S. Mandate

Mandated by DoD as the Wideband Communications Standard for Transferring ISR Sensor Data

“CDL remains the Department standard for ISR wideband links for manned and unmanned platforms to promote Service interoperability. As such, all ISR wideband terminal variants, including tactical CDLs (TCDLs), shall comply with the “Waveform Specification for the Standard Common Data Link (Rev F),” and its appendices, which address the Physical and Data Link OSI layers”*

* This policy was last reinforced by ASD C3I Dec 30, 2005

* ASD (C3I) Memorandum, Common Data Link (CDL) Policy, 18 October 1994.
CDL Is ... A Family of RF Waveforms

A US and NATO Waveform Standard

- US: CDL Waveform Specification #7681990
- NATO: STANAG 7085 Implementation #1

<table>
<thead>
<tr>
<th>Standard CDL (Includes TCDL)</th>
<th>CDL Specification Rev F</th>
<th>NATO STANAG 7085 Implementation #1</th>
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<td>BR-274</td>
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Hundreds of CDL Terminals

– Have Been Developed
– Have Been Deployed
– Are Currently Being Employed Effectively to Transport ISR Information

• *Implementation #1* of STANAG 7085

• *Related documents and technical information*
  – *CDL System Description Document (SDD)*
  – *CDL Studies*
  – *Link Budget Software Tool*
  – *Mission Deployment Software Tool*
CDL Is ... A Body of Knowledge

- **Military Service and Agency Users (Operators)**
  - Mission Specifics
  - Operational Requirements (Thresholds and Objectives)
  - Operational Experience (Lessons Learned)
- **Service and Agency Program Managers**
  - Platform, Sensor, and Application Specifics
  - Desired “to-be’ State and Acquisition Strategies
- **CDL Contractors**
  - Specific Hardware and Software Implementations
  - Design, Testing, and Manufacturing Expertise
- **Support Contractors**
  - Support Services and Corporate Knowledge
CDL Is ... A Vision of The Future

• A Secure Wireless Networking Architecture to Support the Warfighter
  – Designed and Managed in Compliance With Open-Standard Waveform and Networking Specifications
  – Based on secure and interoperable wideband data communications waveforms

• Migrating to Support Current and Future DoD Mandates

• Meeting Military Operational Requirements with Flexible and Scalable Systems

• Focusing on Meeting the Needs of the Individual Warfighter

• Software Configurable to Support Multiple Roles, Waveforms, Data Transfer Rates, and Interfaces

• Configured and Managed within Rigorously Applied Processes
• **TADIL (Tactical Data Link) Family**
  – *E.g., Link 16 is Established as the Primary Tactical Data Link for the Dissemination of Processed Information Directly to Operators in the Battlespace*
  – *Inherently Not Interoperable with CDL*

• **SCDL (Surveillance and Control Data Link)**
  – *Used to Transfer MTI data to Surface Terminals*
  – *Not Interoperable with CDL*

• **C-band, analog, and other ISR data links**

• **Other Tactical Data Links**
CDL Flexibility

• **Flexibility and Capability**
  – Varies Based on Product Implementation and Operational Use
  – **Typical Configurable Parameters Include**
    • Data Rate and Multiplexing / Demultiplexing Format
    • Spread Spectrum
    • Operational Frequency

• **BUT: This Complicates Configuration Control and Interoperability**
The CDL Product Family
Communication Systems West Products

- Intelligence Surveillance & Reconnaissance (ISR) Manned and Unmanned Communication Systems
- High-Capacity Communication Products & Systems
- Network-Centric Migration Programs
- Surface SATCOM Terminals
- Key Technologies for High-Capacity Mobile Networks
• **Full duplex and receive only continuous waveform**

• **Airborne terminals can be single band**

• **Surface terminals typically dual band**

• **Traditional Forward link is 200 Kbps**

• **Traditional Return link is**
  - 10.71 Mbps
  - 44.7 Mb/s
  - 137 Mbps
  - 274 Mbps

Common Data Link

- Full duplex, continuous waveform
- Airborne terminals can be single band
- Surface terminals typically dual band
- Traditional Forward link is 200 Kbps
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  - 10.71 Mbps
  - 137 Mbps
  - 274 Mbps

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Tactical Airborne Reconnaissance System (TARS) Collector Data Link

- Ruggedized Construction - SEM-E Modules
- Software Configurable
- Modulation Type
  - BPSK - QPSK
  - Bi-BPSK - O-QPSK
- Frequency (combined or selected)
  - CDL Ku-Band
  - TARS X-/Ku-band
- Dual-band Antenna
- Power/Data Rates automatically adjusted for environment
- Autonomous Spatial and RF Channel acquisition
- Data Rates
  - CDL Mode
    - Return Link 274, 137, 45, 10.71 Mb/s
    - Command Link 10.71, 2, 0.20 Mb/s
- TARS Full Duplex Mode
  - Return Link
    - Wideband Data 274 ÷ 2^n Mb/s n = 0 to 11
    - Protected Data 306 ÷ 2^n kb/s n = 0 to 4
    - Command Link 250 ÷ 2^n kb/s n = 0 to 4
- TARS Queuing Mode
  - Return Link 19.125 kb/s (TDMA)
  - Command Link 15.625 kb/s
Tactical Interoperable Ground Data Link (TIGDL II)

Command Link
- Data Rates 200 kb/s, 2Mb/s, 10.71Mb/s
- Modulation SS’BPSK SS’BPSK OQPSK
- Power Amp 5 Watt SSPA

Return Link
- Data Rates 10.71, 137, 274 Mb/s
- Modulation Offset QPSK (OQPSK)

Antenna
- Size 6 foot parabolic reflector
- Frequency X-band and Ku-band
- Azimuth capability Continuous, 360° azimuth
- Slew rate 20°/sec (30°/sec optional)
- Synchro Accuracy 16 bit (24 bit optional)
- Operational wind 40 mph (70 mph optional)
- Remoting 300 meters with standard cable (Up to 10Km with optional cable)

Other
- Encryption Optional (Bypass or Embedded)
- Dual Band Operation Yes
- Frequency Tuning CDL 5 MHz steps
- BIT To module level
- Link Audio Yes
- Maintenance Audio Yes
- Remote Spectrum Analyzer Yes
- ATM User I/F Yes
- CDL User I/F Yes
- AN/AIC-26 (Airborne Intercommunication System) Optional
Mini TCDL Transceiver

- Symmetric & Asymmetric Data Rates up to 45 Mbps with Ranges Up to 150 Nautical Miles
- Supports Both Omni and Directional Antenna Systems
- CDL Specification Annex A & B Compliant Interface
  - Dual Ethernet 10/100 Base-T
  - Serial RS-232
  - NTSC/RS-170, PAL
  - Wideband Network Router
- Integrated COMSEC
  - Easy Access for Multiple Platforms
- Software
  - Control GUI Including Router Configuration
  - Pre-mission Configuration
  - Video Display
  - MPEG-2
  - H.261
- Power
  - 28VDC

**ROVER 4 Receiver**

**Multi-band reception**
- Ku-band Digital
- C-band Digital
- C-band Analog
- S-band Analog
- L-band Analog

**Included antennas**
- Ku-band omni
  - Integral LNA with DC power via RF cable
- C/L/S-band omni
  - Integral LNA with DC power via RF cable

**Triple DES Decryption**

**Software**
- Control GUI
- Pre-mission configuration
- Automatic frequency acquisition

**Software Configurable**
- Waveform
- Band and Frequency
- Video Protocol
- Video display software

**MPEG-2**
**MPEG-4**
**H.261**
**Analog**

Integrated MPEG-4/MPEG-2/H.261 decoder
Digital Video Recorder with standard .wmv file format
KLV Metadata mapped to FalconView

**Video display**
- Ruggedized Laptop via Ethernet
- NTSC/RS-170 Video Port

**Power**
- BA-5590 form factor batteries (Battery not included)
- Battery eliminator that allows AC or DC input
- DC NATO plug cable
- DC vehicle accessory power plug cable
- AC plug cable
- Alternate laptop power supply
- Allows laptop to be powered from any
- BA-5590 form factor battery
  - Extends laptop battery operation by 8-10 hours

**Options**
- Directional C-band antenna for increased range
Network Centric Communications Systems
Network Model

• **All Network Interfaces Follow a Common Scheme**
  – *Network Layer with Routing*
  – *Segmentation and Reassembly of Transmitted Packets*
  – *Framing Packet Segments for Transmission*
  – *Physical Layer with Low Level Error Correction*

• **Designed to Provide Standardized COTS Networking Interfaces**

Source: General Technical Analysis / Theoretical References
CDL Is ... A Wireless Network Backbone

Network Applications

IP

CDL Network Interface

- BR-0.2
- BR-0.4
- BR-2.0
- BR-10.71
- BR-21.42
- BR-44.73
- BR-137
- BR-274

Application Layer
Presentation Layer
Session Layer
Transport Layer

Network Layer

Data Link Layer

Physical Layer
(CDL RF Waveforms)
Wireless Networking
What is Common Data Link?

- A Transmission Architecture for ISR* Sensor Data
- A Mandate From the United States DoD
- A Family of RF Waveform Standards
- A Large Deployed Infrastructure
- A Wireless Network Backbone
- A Library of Technical Specifications
- A Body of Knowledge
- A Vision of the Future

* ISR: Intelligence, Surveillance, and Reconnaissance
Summary

• **CDL is the Standard Used by the US ISR Community**

• **CDL Provides Common Communication Services for Platforms and Sensor Payloads**

• **CDL Provides Growth for “Signals in Space”**
  
  Supporting:
  
  – **LOS (Symmetric / Asymmetric Operations)**
  
  – **BLOS**
  
  – **Air-Air Relay**
  
  – **Networked User Interfaces**
  
  – **Networked Waveforms**
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Your Questions