# NATO Standardization Agreement:
# Profile for High Frequency (HF) Radio Data Communications
# STANAG 5066
# Version 1.2

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Radio Branch
Communications Systems Division

STANAG 5066

NATO STANDARDIZATION AGREEMENT
(STANAG)

PROFILE FOR HF RADIO DATA COMMUNICATIONS

RELATED DOCUMENTS:

| | |
|---|---|
| STANAG 4203 | TECHNICAL STANDARDS FOR SINGLE CHANNEL HF RADIO EQUIPMENT |
| STANAG 4285 | CHARACTERISTICS OF 1200/2400/3600 BITS PER SECOND SINGLE TONE MODULATORS/ DEMODULATORS FOR HF RADIO LINKS |
| STANAG 4529 | CHARACTERISTICS OF SINGLE TONE MODULATORS/ DEMODULATORS FOR HF RADIO LINKS WITH 1240 HZ BANDWIDTH |
| MIL-STD-188-110A | INTEROPERABILITY AND PERFORMANCE STANDARDS FOR DATA MODEMS |
| CCITT V.41 | CODE INDEPENDENT ERROR CONTROL SYSTEM |
| CCITT V.42 | ERROR-CORRECTING PROCEDURES FOR DCES USING ASYNCHRONOUS-TO-SYNCHRONOUS CONVERSION |

AIM

The aim of this agreement is to define the functions and interfaces required for networked, error-free communication over HF radio channels, nominally for beyond-line-of-sight communications.

AGREEMENT

The participating nations agree to implement the profile defined in this STANAG (including mandatory Annexes) to provide long-haul communications over HF radio circuits.

IMPLEMENTATION OF THE AGREEMENT

This STANAG is implemented by a nation when data communication on long-haul HF radio circuits complies with the characteristics detailed in this agreement.

DEFINITIONS

| | |
|---|---|
| node | An implementation of the profile described in the main body of and mandatory annexes to this STANAG. The node is generally assumed to include the HF (modem and radio) and cryptographic equipment required for communications. |
| profile | A document describing a set of functions (some or all of which may be defined in separate documents or standards), segregated logically into layers, together with the interfaces, data formats, and procedures required for interoperability. |
| subnetwork | A collection of nodes. As a whole, a subnetwork provides a reliable networked data-transport service for external users or clients. |

# 1 INTRODUCTION

This document describes a profile for data communication over HF radio, nominally for beyond-line-of-sight circuits. The technical characteristics that are required to ensure interoperability and reliable system operation are described in the main body of and mandatory annexes to the document. Information-only annexes provide information on possible implementation of interfaces and subnetwork clients, and implementation advice based on extensive experience during the development of the protocols.

This document is organised so that the main body gives an overview of the structure of the profile and the capabilities that should be realised when it is implemented. The details of the interfaces, data formats, and procedures are described in a number of mandatory annexes.

The HF profile provides interoperability at the two major interfaces: first, the “common air interface”, describing how information is exchanged between nodes by radio; and second, the non-HF interfaces which allow external users or clients to interact with the subnetwork and with each other over the subnetwork. While physical interfaces are left up to the system implementer (e.g., Ethernet, FDDI, internal bus, or shared memory), the data formats (primitives) and procedures that make up the interface are specified in detail so that client applications can make use of the subnet.

## 1.1 Common Air Interface: Reliable Data Communications over HF Radio

Reliable data communications over HF radio is provided by using an ARQ data link protocol supported by modern, equalized single-tone HF data modems[1] or other modems using modern modulation and coding techniques.

The data transfer sublayer defined in the profile supports automatic changes of the user data rate (that is, code rate) of the HF modem in response to changing channel conditions (adaptive data rate). This capability requires remote control of the HF modem. The profile is defined so nodes in which remote control of the modem, and hence adaptive data rate, is not available will interoperate with nodes which do have the capability. The profile includes adaptive data rate with STANAG 4285 and STANAG 4529 waveforms.

[1]Although this document may be used with other HF data modems such as parallel-tone or Orthogonal Frequency Division Multiplexed (OFDM) waveforms, it has been developed and tested for use with the MIL-STD-188-110A, STANAG 4285, and STANAG 4529 single-tone waveforms.

The HF radio associated with a node is assumed to be an HF SSB radio with specifications appropriate to the modems mentioned above and used within the node. The profile defined here does not assume that any remote control of the radio (specifically, frequency) is available.

## 1.2 Interoperability With the Subnetwork

The profile also defines the interface between a node and external users of the subnetwork. While physical interfaces are left up to the system implementer (e.g., Ethernet, FDDI, internal bus or shared memory), data formats (primitives) and procedures are defined so that external applications can make use of the subnet. There are two reasons for including these definitions as a mandatory part of the STANAG: first, with a standard interface definition, any vendor can develop an application which makes use of the subnetwork; and second, without such a definition, interoperability is only guaranteed between nodes implemented by the same vendor. Annex F to this STANAG defines the data formats and procedures that will allow interoperation for a limited subset of client applications. Other vendors may define client applications that make use of other procedures; while they should be able to make use of the subnet to communicate with another application of the same type, there is no guarantee of interoperability between vendors. The client application itself is not defined in this document.

For the purposes of clearer discussion, this document divides the functions of the HF profile into a number of sublayers as shown in Figure 1. These sublayers contain the functions which, in terms of the Open Systems Interconnection Reference Model, would be found in the Physical and Link Layers (with a few network layer functions). Figure 1 contains, for completeness, a number of sublayers (shaded) which are not addressed in this document.

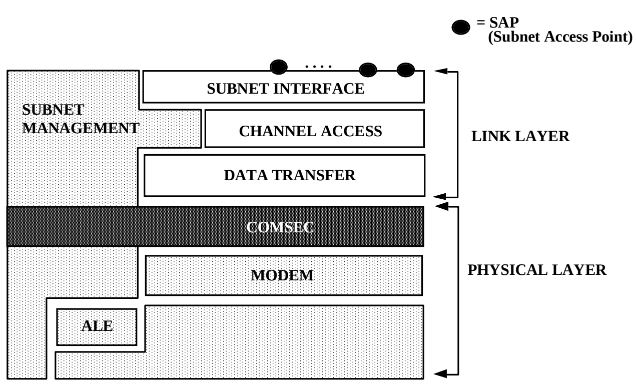


**Figure 1. Sublayers within the Profile for HF Data Communication**

## 1.3 Communications between adjacent sublayers and peer sublayers

Communications between adjacent sublayers within a node is done with “primitives”. Primitives at certain sublayer interfaces must be defined to achieve interoperability; the main example is primitives entering the system at the subnet interface. Other primitives that are not required for interoperability are defined here only minimally for information and as an aid to specifying or describing sublayer operation, but are discussed in detail in [1].

Communications between a sublayer and the corresponding sublayer in a different node is done with Protocol Data Units (PDUs) exchanged using the delivery services provided by lower (sub-) layers. For interoperability, PDUs at all sublayers must be defined, together with the protocols for their use. These definitions are given in the annexes to this document.

A brief description of the functions associated with each sublayer follows:

The **Subnetwork Interface Sublayer** provides a common, standard interface to all users. This is the interface between the subnet and the "rest of the world". Annex A contains a detailed specification of the primitives that are exchanged between this sublayer and external users (clients), and the PDUs that are exchanged (over HF radio) between peer subnetwork interface sublayers.

Annex F contains a definition of how the Subnetwork Interface Sublayer primitives can be used to support specific client applications. This is provided so that a subset of client applications will be interoperable across vendors.

The **Channel Access Sublayer** provides additional functionality as needed to allow different forms of channel access. For the purposes of this document, this sublayer supports communication over a "dedicated" HF radio channel, under the assumption that the processes required to place the two ends of the link on the proper channel are handled by procedures that are external to this system (mechanisms for handling unintentional interference are provided). The PDUs exchanged (over HF radio) between peer sublayers are defined in Annex B of this document. The primitives exchanged between this sublayer and the Subnetwork Interface sublayers within a node are defined minimally for information purposes and as an aid to specification of the sublayer functions and requirements.

The **Data Transfer Sublayer** provides the various data transfer protocols. These protocols provide a reliable (ARQ) data link service, as well as unreliable broadcast services, for regular data-delivery and expedited data-delivery. The PDUs exchanged (over HF radio) between peer sublayers are defined in Annex C of this document. The primitives exchanged between this sublayer and the Channel Access sublayer within a node are defined minimally for information and as an aid to specification of the sublayer requirements. Annex C also contains the protocol for adaptive control of the HF modem data rate and other parameters when using the STANAG 4285 or 4529 waveforms. The interface between this sublayer and the supporting sublayers below (either communications security sublayer or modem sublayer) is defined in Annex D to this document.

The **Communications Security Sublayer** provides communications security using hardware crypto equipment. A number of NATO approved cryptos, including BID-950 and KG-84C, have been shown to be suitable to provide this function; detailed information may be found in [2].

The **Modem Sublayer** provides a means for transmitting digital data over an analogue channel. This STANAG has been developed specifically for use with HF modems defined in STANAG 4285 and STANAG 4529 (as well as with MIL-STD-188-110A), though use of other modems that use other waveforms is not precluded. The interface between the modem sublayer and radio equipment is not specified in this document for two reasons: first, it is outside the scope of this document, and second, it is specified in other STANAGs. Current trends in system security indicate that encryption will, in the future, be implemented at or near the application layer. If this change occurs while this STANAG is still in service, the interface between the Data Transfer and modem sublayers shall be as defined in Annex D. This is provided to allow migration toward a more flexible system architecture, in which systems would not be specific to a single vendor's HF modem. Continued requirements for link-level communication security, outside of the scope of this STANAG, may still exist even with application-layer security services.

The **Automatic Link Establishment Sublayer** automates the process of establishing a radio path (link) with one or more remote nodes. This sublayer is not addressed in this document. The system as it is defined is fully compatible with the use of ALE. If in the future ALE is added, no changes to the other sublayers will be required and only minor changes to the implementation will be required (assuming that implementors follow a layered approach in implementing the profile).

The **Radio Equipment Sublayer** comprises the equipment required to establish a radio link between two or more nodes, i.e. transmitters, receivers, transceivers, antennas, etc. This sublayer is not defined in this document. A NATO STANAG (STANAG 4203) exists which specifies minimum standards for transmitters and receivers.

The **Subnet Management Sublayer** is shown in Figure 1 as a vertical column with interfaces to each sublayer. The main subnet management function, in the context of this STANAG, is automatic link maintenance (ALM) in the form of adaptive control of the HF modem. The management sublayer messages and associated procedures which are required for ALM are defined in Annex C of this document, in the context of the MANAGEMENT D_PDU. The other functions of the Subnet Management Sublayer, which may be critically important to a successful implementation, need not be standardized for interoperability and are not addressed further in this document.

**List of Annexes**

Annex A: Subnetwork Interface Sublayer (mandatory)
Annex B: Channel Access Sublayer (mandatory)
Annex C: Data Transfer Sublayer (mandatory)
Annex D: Interface between Data Transfer Sublayer and Communications Equipment (mandatory)
Annex E: HF Modem Remote Control Interface (information only)
Annex F: Subnetwork Client Definitions (information only)
Annex G: Use of Waveforms at Data Rates Above 2400 bps (information only)
Annex H: Implementation Guide and Notes (information only)
Annex I: Messages and Procedures for Frequency Change (information only)

**References**

1. Clark, D., and N. Karavassillis, "Open Systems for Radio Communications: A Subnet Architecture for Data Transmission over HF Radio", TM-937, May 1998

2. Miller, T., and P. Reynolds, "Experience with Approved Cryptographic Equipment in HF ARQ Systems", NC3A TN 638, NATO CONFIDENTIAL, November 1996