

The logo is a circular emblem with a red outer ring containing the text "EMERGENCY COMMUNICATIONS" at the top and "RADIO AMATEUR OPERATIONS" at the bottom, separated by a star on the left. The inner blue circle features a satellite, a laptop, a radio tower, and a lightning bolt. The acronym "A.C.S." is written in large yellow letters at the bottom of the inner circle.

Pinellas ACS Training

Introduction to Automatic Link Establishment

7/20/2023

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Pinellas ACS Training Officer



Agenda



- ALE Overview
- ALE System Configuration
- ALE Operations
- ALE System Implementation
- Conclusion



ALE Overview

Description



Automatic Link Establishment

- The capability of an HF radio station to make contact, or initiate a circuit, between itself and another specified radio station, without operator assistance and usually under processor control.



ALE Overview

Description



ALE automates HF frequency selection and linking

- Allows inexperienced **HF operators** to use radio effectively, similar to using a cell phone.
- Skilled **HF Network Manager** needed to create and distribute system configuration settings (Code Plug)
 - Time of Operation
 - Communication link distances
 - Transmitter power levels
 - Types of antenna available for use
 - Transmission types, voice, data, voice and data

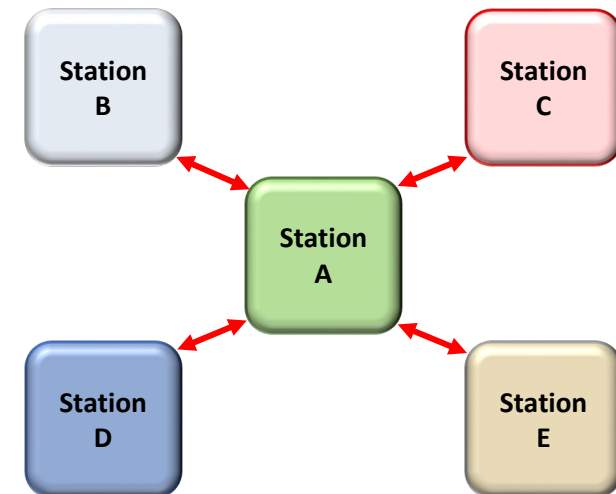
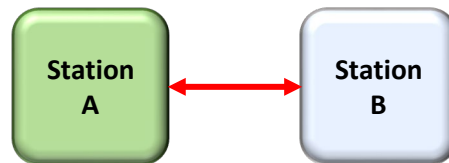


ALE Overview

Description

ALE only selects best channel and establishes link

- Once link is established operators can use an external system to send digital traffic (Winlink, FLDIGI, VarAC, etc.) or
- Communicate with linked station used PTT Voice
- Links can be established between individual or multiple stations





ALE Overview

Description



ALE system can send short overwire digital messages

- Displayed on front of radios or on ALE Controller
 - Automatic message display (AMD)



ALE Overview

Description



Error Detection and Correction

- Forward Error Correction (FEC)
 - One 24-bit word encoded into two 24-bit codewords (48-bits)
 - Detect and correct bit errors
- Interleaving
 - Rearrange order of bits to reduce impact of burst errors
- Redundancy
 - All words repeated three times

24 Data bits In – 144 bits transmitted

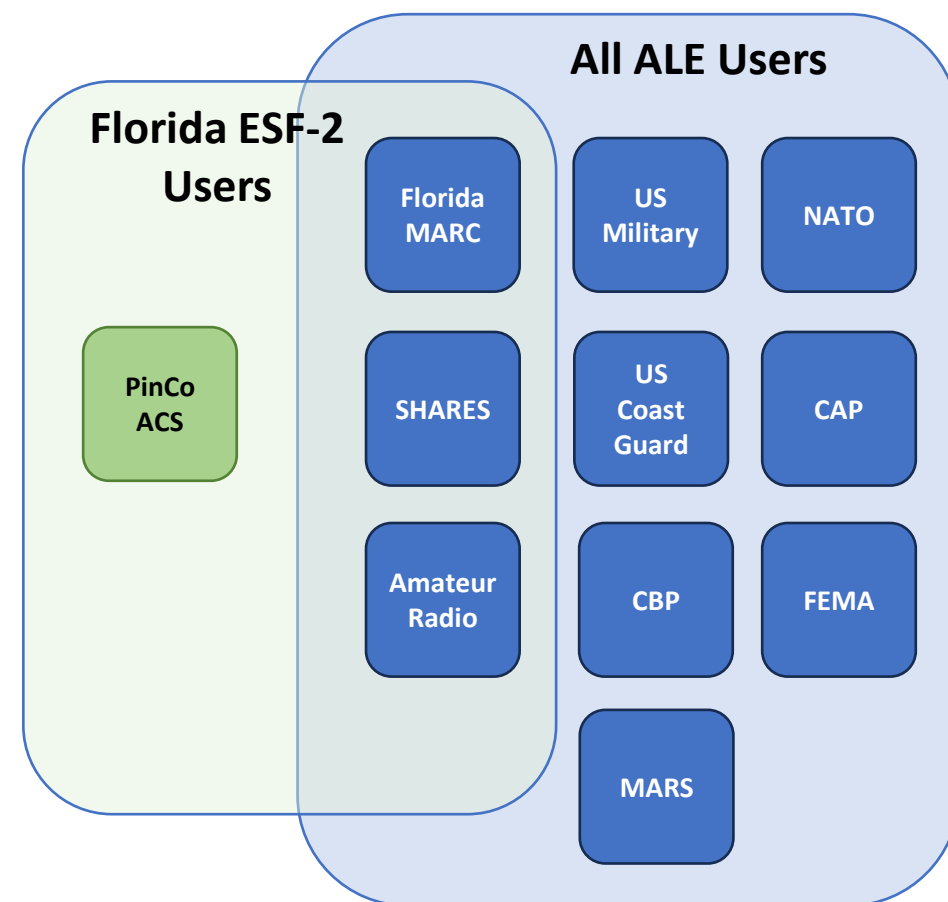


ALE Overview

Description



- World-wide Standard for HF Communications
 - US Military
 - USAF High Frequency Global Communications System
 - North Atlantic Treaty Organization (NATO)
 - US Coast Guard
 - Civil Air Patrol (CAP)
 - Customs and Boarder Control
 - Cellular Over the Horizon Enforcement Network (COTHEN)
 - Federal Emergency Management Agency (FEMA)
 - **Florida Mutual Aid Radio Communication Units (MARC)**
 - SHARED RESources (SHARES) High Frequency program
 - Military Auxiliary Radio System (MARS)
 - Amateur Radio





ALE Overview

Description



Two Generations of ALE

- Second Generation (2G)
 - Widely accepted and used
 - This presentation only covers ALE 2G
- Third Generation (3G)
 - Higher degree of complexity
 - Requires time synchronization
 - Synchronous scanning
 - Faster link setup time, improved performance, higher throughput



Agenda



- ALE Overview
- ALE System Configuration
 - Channels
 - Networks
 - Addresses
 - Network Parameters
- ALE Operations
- ALE System Implementation
- Conclusion



ALE System Configuration

Channel Definition

- Master list of frequencies (Channels) defined for ***potential*** use during a training event, activation, deployment, or blue-sky operation.
 - Operational parameters for each channel defined

Name	Freq	Mode	TX Enable	Sounding	Pwr Level	Antenna	Use
01BALE	1843.0	USB	Yes	Yes	High	1	Data
01FALE	1996.0	USB	Yes	No	High	1	Voice
03DALE	3596.0	USB	Yes	Yes	High	1	Data
03LALE	3996.0	USB	Yes	No	High	1	Voice
05EALE	5357.0	USB	Yes	No	Med	2	Voice
05GALE	5371.5	USB	Yes	No	Med	2	Voice
07DALE	7102.0	USB	Yes	Yes	High	2	Data



ALE System Configuration

Network Definition

- Channels from master list **selected** for use during a training event, activation, deployment, or blue-sky operation.
- Each User (SHARES, MARS, DoD) creates its own set of networks
- Two Amateur Radio ALE network defined

Netcall: HFL	
1996.0	10131.0
3996.0	14346.0
5357.0	18117.5
5371.5	21432.5
7296.0	28312.5

Voice Channels - USB

Netcall: HFN	
1843.0	18106.0
3596.0	21096.0
7102.0	24926.0
10145.5	28146.0
14109.0	

Text Message Channels - USB



ALE System Configuration

Address Assignment

SELF ADDRESS

- Identifies a unique ALE station
 - Amateur
 - FCC Call sign
 - Non-Amateur (SHARES, MARS, etc.)
 - Up to 15 characters in length
 - Basic 38-ASCII subset of characters
 - 0-9; A-Z; @;?

Up to 100 addresses can be defined

NET ADDRESS

- Identifies a predefined set of ALE stations
 - Used to link multiple stations into a single active net
 - Each station can be a member of multiple nets.

PINCOACS

Net Address: PACS

Network: HFL

Net Membership

WA1RYQ	W7WMS	KJ4RUS
KA4EBX	W4PXE	



ALE System Configuration

Additional Network Parameters

- **Channel Dwell Time** (T_d) – How long system listens on a frequency before tuning to the next frequency in the network.
 - Total network scan time (T_s) = T_d times (Number of network channels (C))
 - Example: $T_d = 200$ ms
 - $C = 10$ (Number of channels in HFL Net)
 - $T_s = 200\text{ms} \times 10 = 2$ Seconds
- **Calling Cycle Time** – How long a transmitting station will continue call a receiving station to ensure that the receiving station hears the call.
- **Sounding Interval** – Time between soundings
 - Example: 60 minutes

CODE PLUG

Channels, Networks, Addresses, Net Parameters



Agenda



- ALE Overview
- ALE System Configuration
- ALE Operations
 - Scanning
 - Sounding
 - Link Quality Analysis and Channel Selection
 - Selective calling
- ALE System Implementation
- Conclusion



ALE Operations

Multichannel Frequency Scanning

CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	
01BALE	03DALE	07DALE	10DALE	14BALE	18AALE	21BALE	24BALE	28BALE	
1843.0	3596.0	7102.0	10145.5	14109.0	18106.0	21096.0	24926.0	28146.0	Not Used



HFN

Sounding and Texting

Channel Dwell Time (Td) – 200ms
Total network scan time (Ts) – 1.8 Seconds

- Command Network to Scan
- System will continue to scan until:
 - Manual input to stop from operator
 - System hears a *sounding, individual call, or net call* transmission



ALE Operations

Multichannel Frequency Scanning

CH 1 01BALE	CH 2 03DALE	CH 3 07DALE	CH 4 10DALE	CH 5 14BALE	CH 6 18AALE	CH 7 21BALE	CH 8 24BALE	CH 9 28BALE	
1843.0	3596.0	7102.0	10145.5	14109.0	18106.0	21096.0	24926.0	28146.0	Not Used



HFN

Sounding and Texting

Channel Dwell Time (Td) – 200ms
Total network scan time (Ts) – 3.8 Seconds

CH 1 01FALE	CH 2 03LALE	CH 3 05EALE	CH 4 05GALE	CH 5 07HALE	CH 6 10BALE	CH 7 14EALE	CH 8 18DALE	CH 9 21EALE	CH 10 28DALE
1996.0	3996.0	5357.0	5371.5	7296.0	10131.0	14346.0	18117.5	21432.5	28312.5

HFL

Voice Channels



ALE Operations Sounding

- A brief beacon-like transmission
- Performed at periodic intervals (Sounding Interval)
- Used by receiving stations to evaluate connectivity and propagation
 - Link Quality (LQ) Data for each received *sounding* (beacon) stored in database

CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	
01BALE	03DALE	07DALE	10DALE	14BALE	18AALE	21BALE	24BALE	28BALE	
1843.0	3596.0	7102.0	10145.5	14109.0	18106.0	21096.0	24926.0	28146.0	Not Used



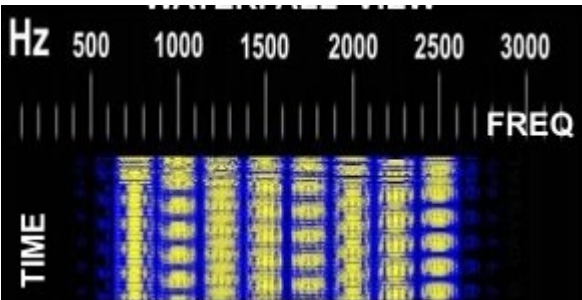
HFN

Sounding and Texting



ALE Operations

Sounding – Receiving Station



DATABASE

Address: WA1RYQ
Time: 2301
Frequency: 10145.5
LQ Data: (BER, MP, SINAD)

CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	
01BALE	03DALE	07DALE	10DALE	14BALE	18AALE	21BALE	24BALE	28BALE	
1843.0	3596.0	7102.0	10145.5	14109.0	18106.0	21096.0	24926.0	28146.0	Not Used



HFN

Sounding and Texting

BER - Bit Error Rate
LQ - Link Quality
MF - Multipath
SINAD - Signal-plus-noise-plus distortion to noise-plus distortion



ALE Operations

Sounding – Receiving Station

- Once sounding is complete, receive station resumes scanning

CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	
01BALE	03DALE	07DALE	10DALE	14BALE	18AALE	21BALE	24BALE	28BALE	
1843.0	3596.0	7102.0	10145.5	14109.0	18106.0	21096.0	24926.0	28146.0	Not Used



HFN



ALE Operations

Link Quality Analysis and Channel Selection

Link Quality Analysis (LQA)

- The evaluation of signal quality measurements to determine the best channel to place a call.
- This signal quality is characterized by up to three parameters
 - Bit error ratio (BER)
 - Ratio of signal-plus-noise-plus-distortion to noise-plus-distortion (SINAD)
 - Multipath (MP).
- Quality scores are stored in a database and may be exchanged between stations.



ALE Operations

Link Quality Analysis and Channel Selection

Link Quality Analysis Database for WA1RYQ – Current Time										
Address	Channels (Red Channels for data only)									
	01BALE	01FALE	03DALE	03LALE	05EALE	05GALE	07DALE	07HALE	10BALE	10DALE
W7WMS	31	33	12	14	81	76	42	45	-	-
KJ4RUS	40	48	-	-	86	87	60	51	18	23
KA4EBX	-	-		22	52	63		55	65	
W4PXE	-	-	67	55	75	72	61	68	59	71

- Individual voice call from WA1RYQ to KA4EBX
 - What channel is selected?
 - If call fails on first choice, what happens?

Channel Selection	
1 st	10BALE
2 nd	05GALE
3 rd	07HALE
4 th	05EALE



ALE Operations

Link Quality Analysis and Channel Selection

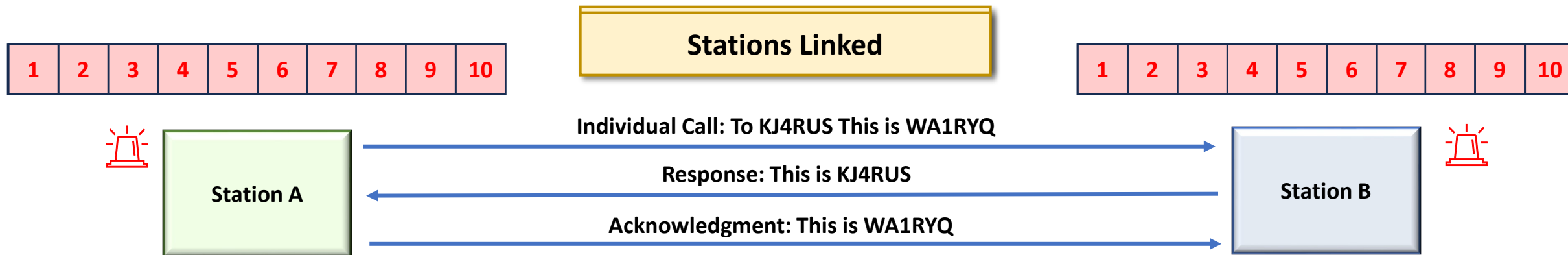
Link Quality Analysis Database for WA1RYQ – Current Time										
Address	Channels (Red Channels for data only)									
	01BALE	01FALE	03DALE	03LALE	05EALE	05GALE	07DALE	07HALE	10BALE	10DALE
W7WMS		33		14	81	76		45	-	-
KJ4RUS		48	-	-	86	87		51	18	
KA4EBX	-	-		22	52	63		55	65	
W4PXE	-	-		55	75	72		68	59	
Average Value:		20.25		22.75	73.5	74.5		54.75	35.5	

- Voice Net call from WA1RYQ to PACS
 - What channel is selected?



ALE Operations

Link Establishment – Individual Station



1. **Operator** at Station A initiates call to station B
2. Channel 5 Selected based on LQA
3. Transmit Individual Call to Station B
4. Receives Response Message from Station B
5. Sends Acknowledgement to Station B
6. Unmutes Radio and alerts operator
7. **Operator** begins voice or data exchange



1. Receives Individual Call on Channel 5
2. Stops Scanning
3. Transmit Response message to Station A
4. Receives Acknowledgement Fm Station A
5. Unmutes Radio and alerts operator
6. **Operator** begins voice or data exchange



Agenda

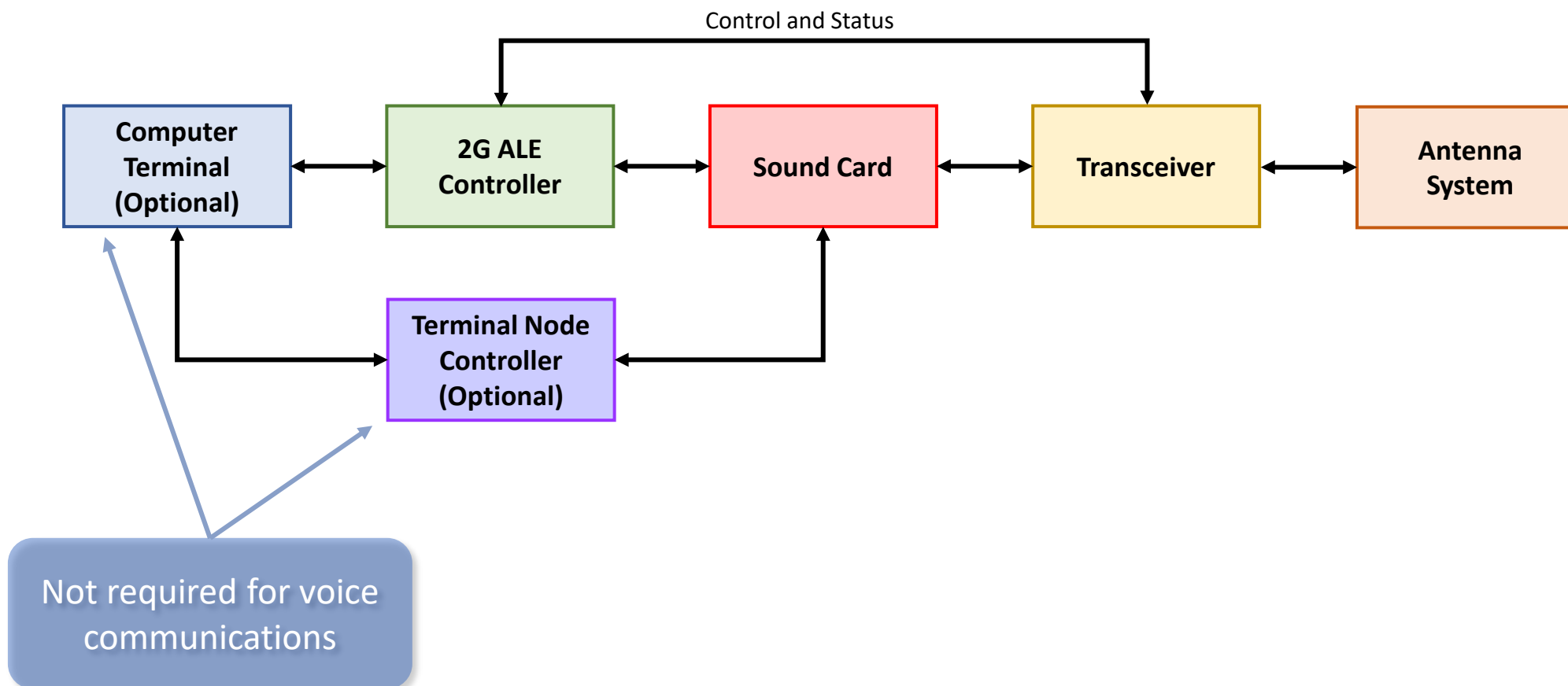


- ALE Overview
- ALE System Configuration
- ALE Operations
- ALE System Implementation
- Conclusion



ALE Implementation

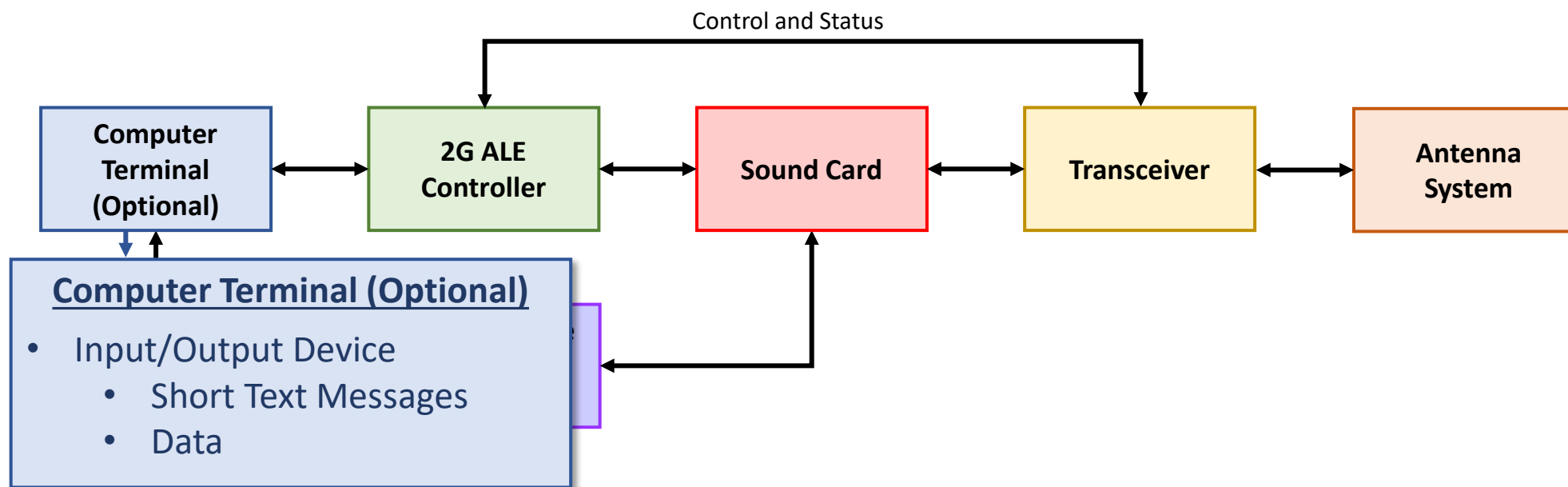
Functional Description





ALE Implementation

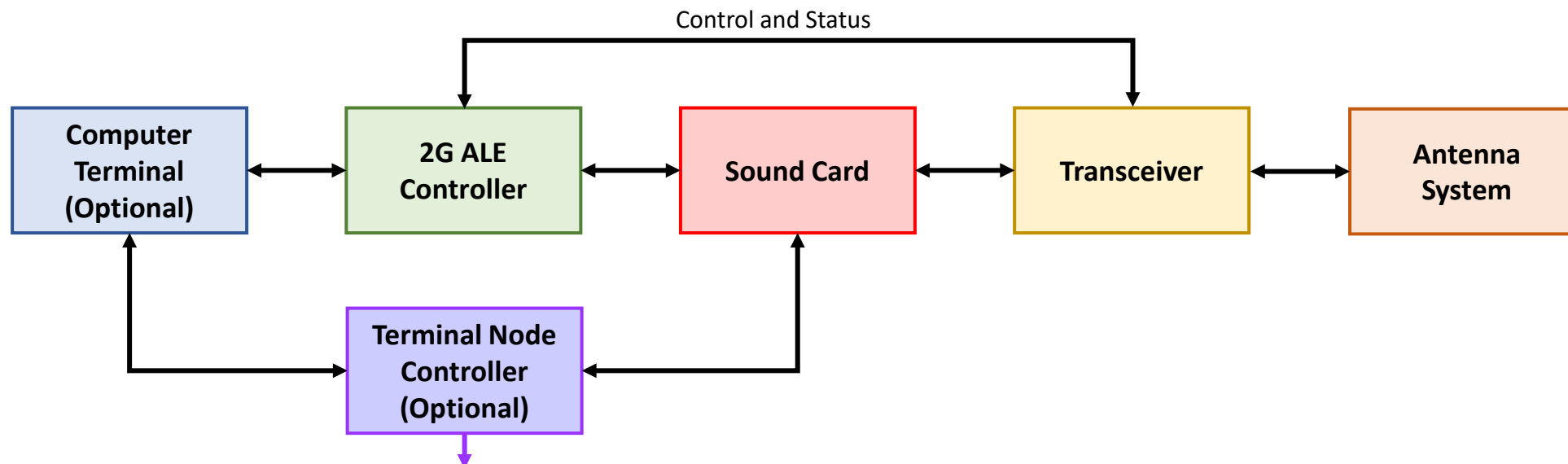
Functional Description





ALE Implementation

Functional Description



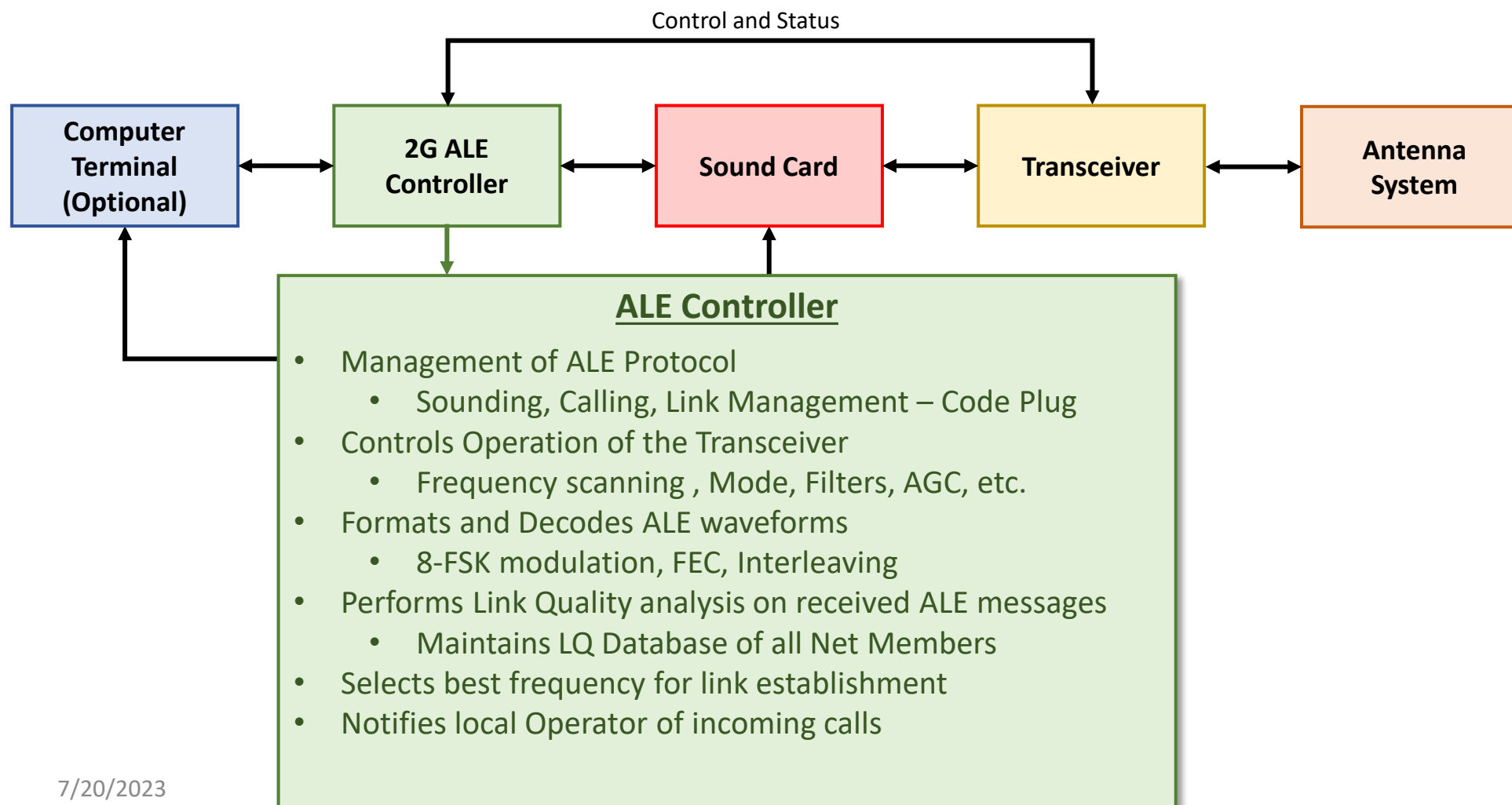
Terminal Node Controller (Optional)

- Implements Communications Protocol
 - Packet (AX.25), Pactor, ARDOP, VARA
- Formats data for transmission
 - Headers, Compression, Encoding, etc.
- Decodes receive data
- Used **only** after link has been established



ALE Implementation

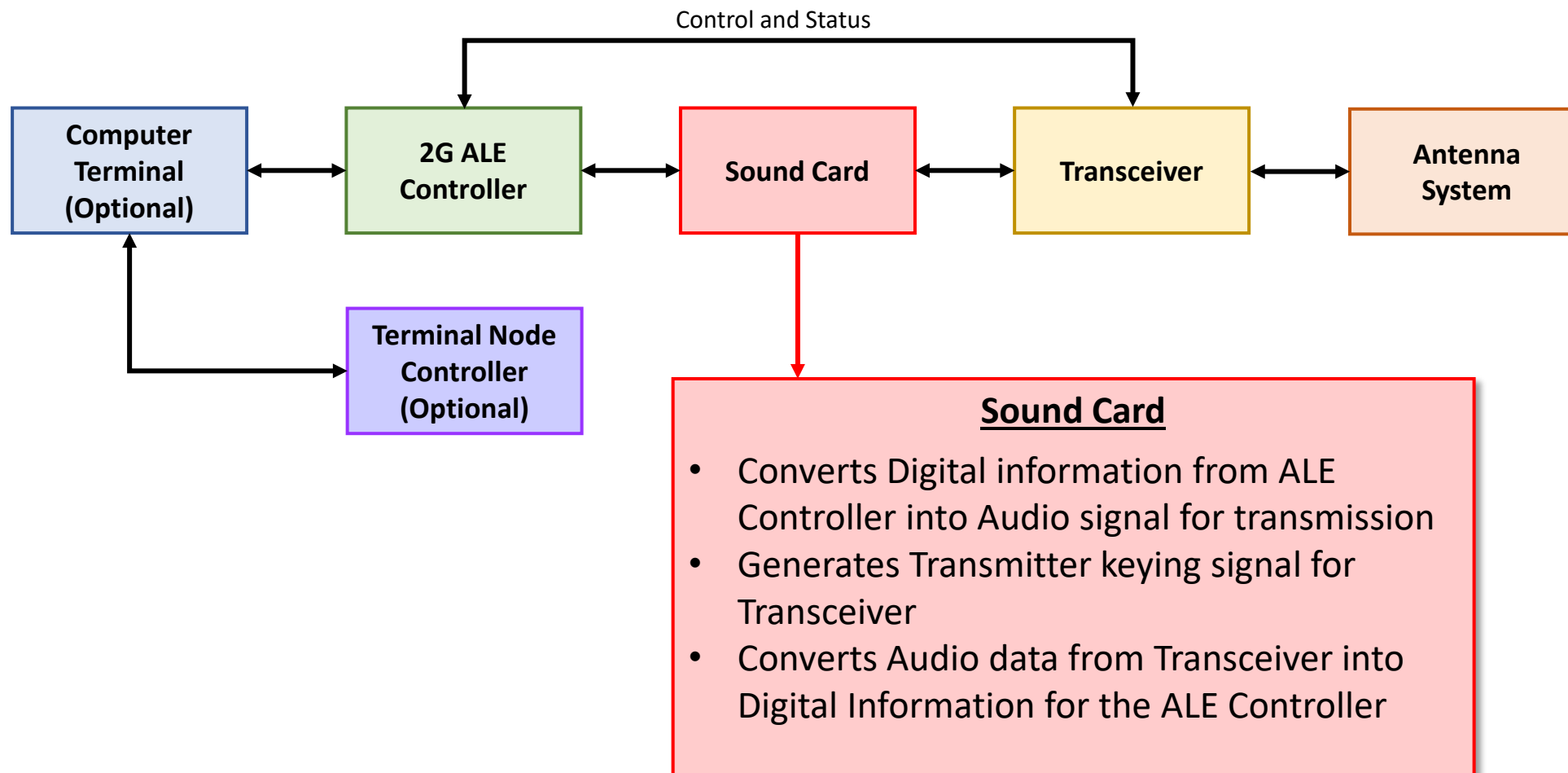
Functional Description





ALE Implementation

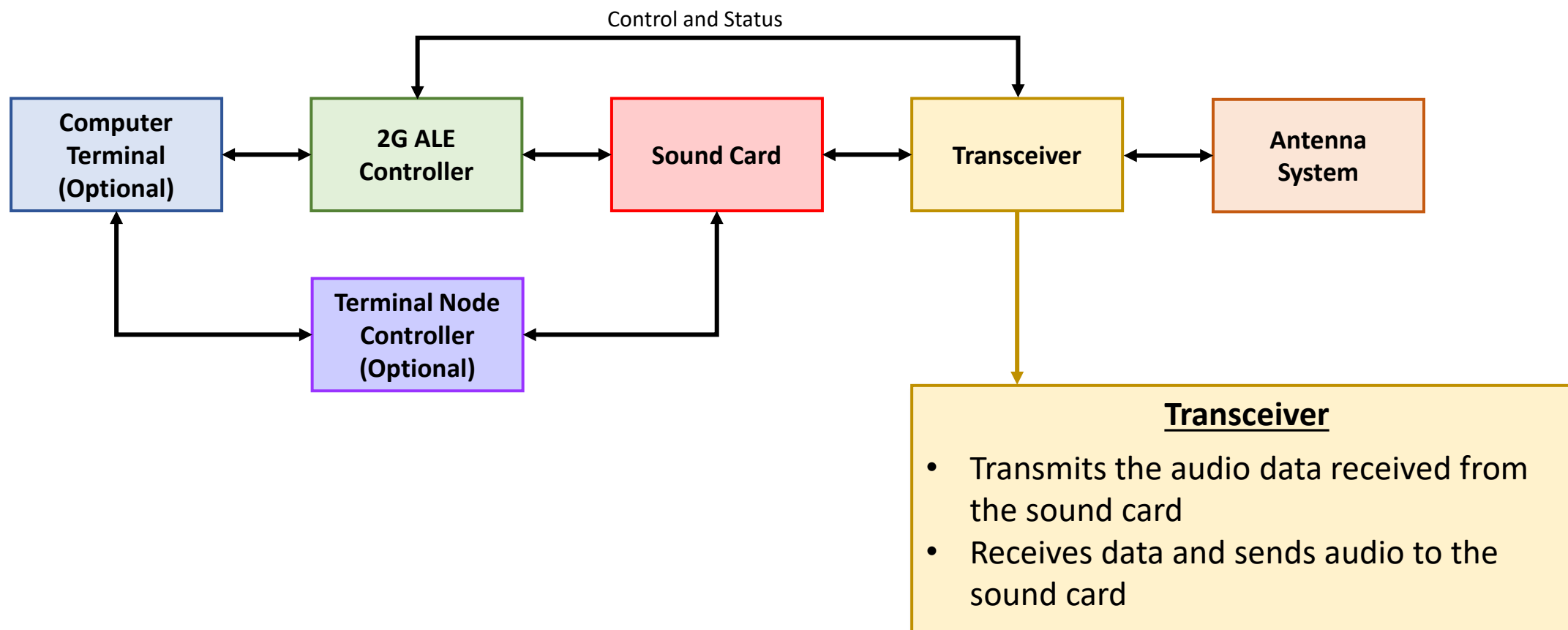
Functional Description





ALE Implementation

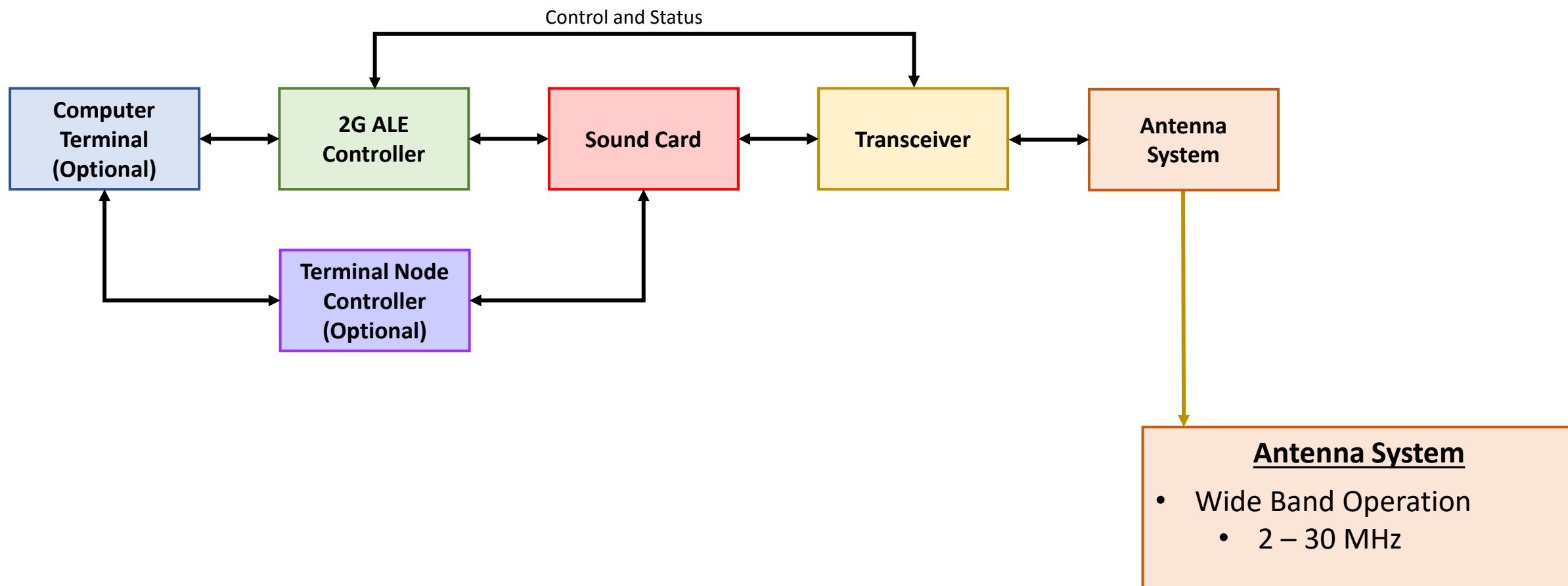
Functional Description





ALE Implementation

Functional Description





ALE Implementation

Embedded ALE Controller

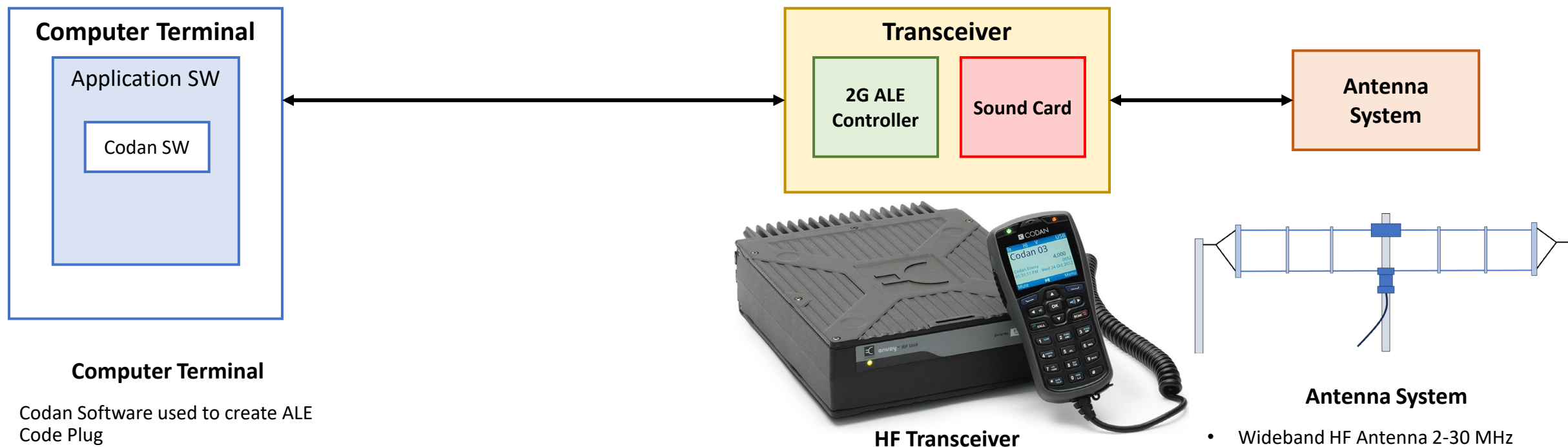


Simplest Configuration to Implement – PinCo ACS Radio Room



ALE Implementation

Embedded ALE Controller



HF Transceiver

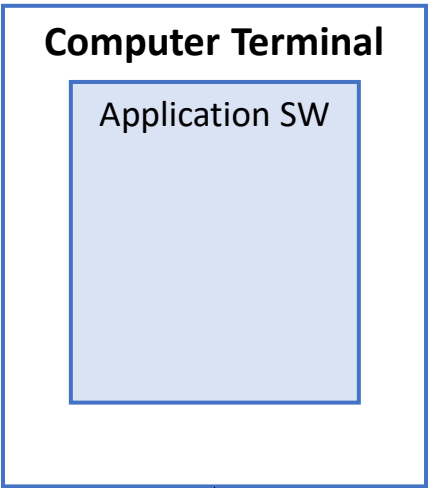
- Embedded 2G/3G ALE Controller
- Analog / Digital Voice
- PTT once Link established
- *Very Expensive*

Florida MARC Units



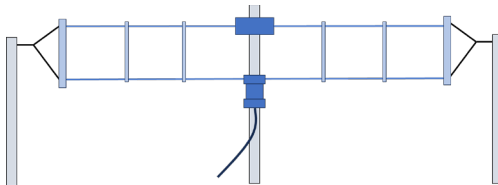
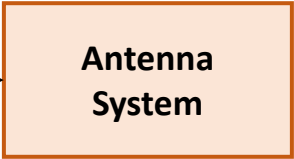
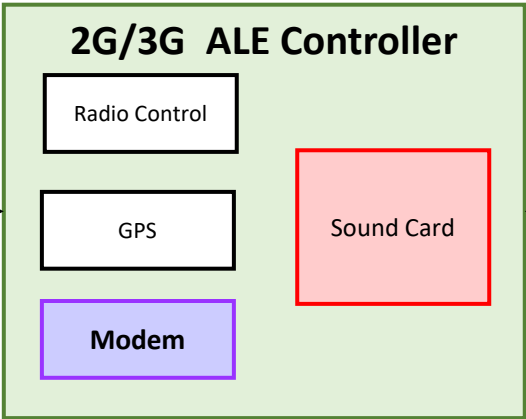
ALE Implementation

External ALE Controller



Stand-Alone ALE Controller

- 2G/3G ALE Controller
- STANAG 5065 compliant modem
- *Very Expensive*



Antenna System

- Wideband HF Antenna 2-30 MHz

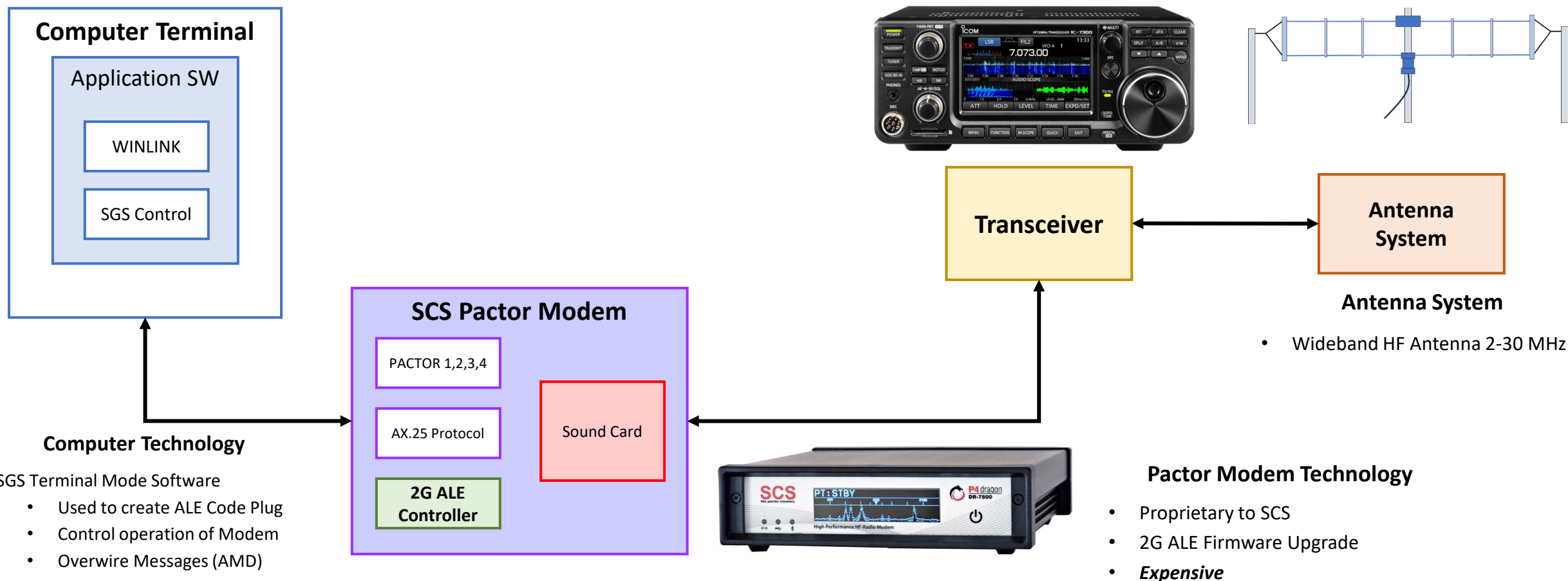
Computer Technology

- Remote Control
- Data Source



ALE Implementation

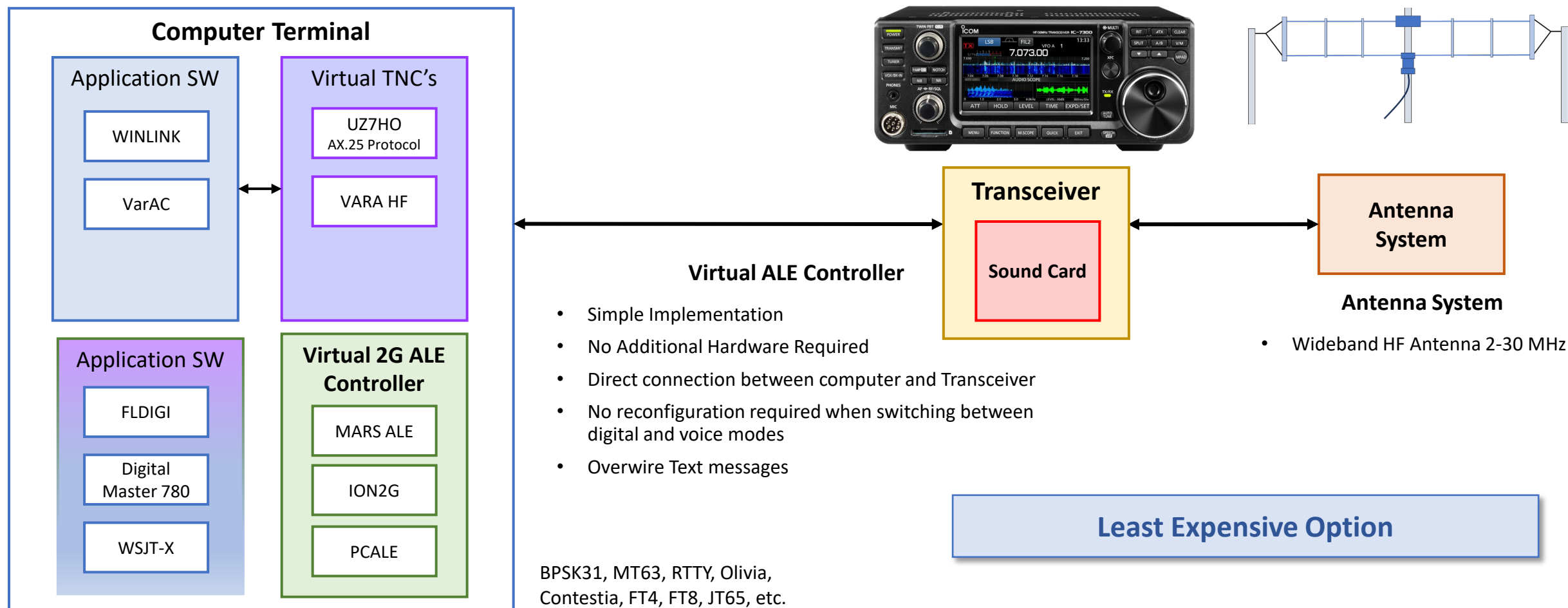
External ALE Controller





ALE Implementation

Virtual ALE Controller





Agenda

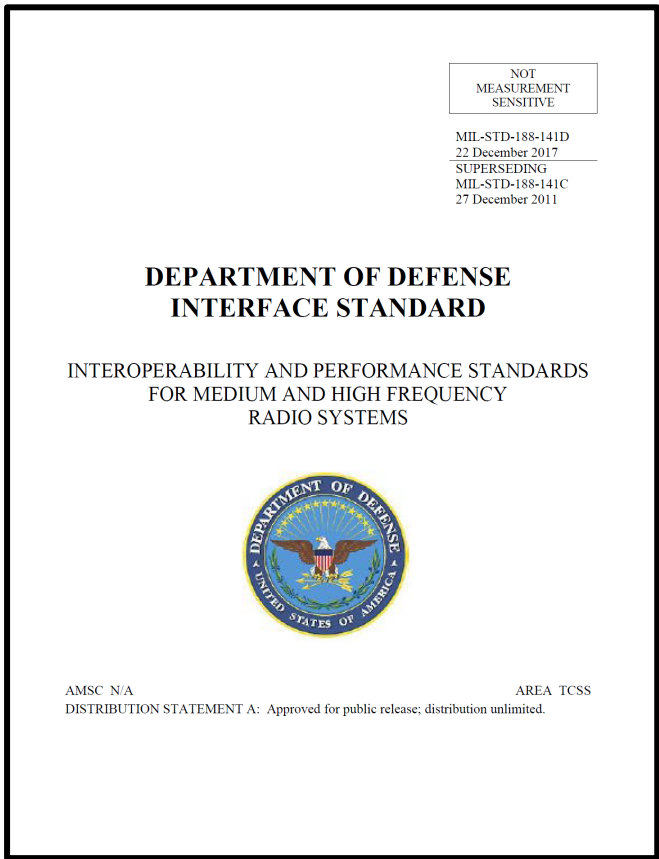


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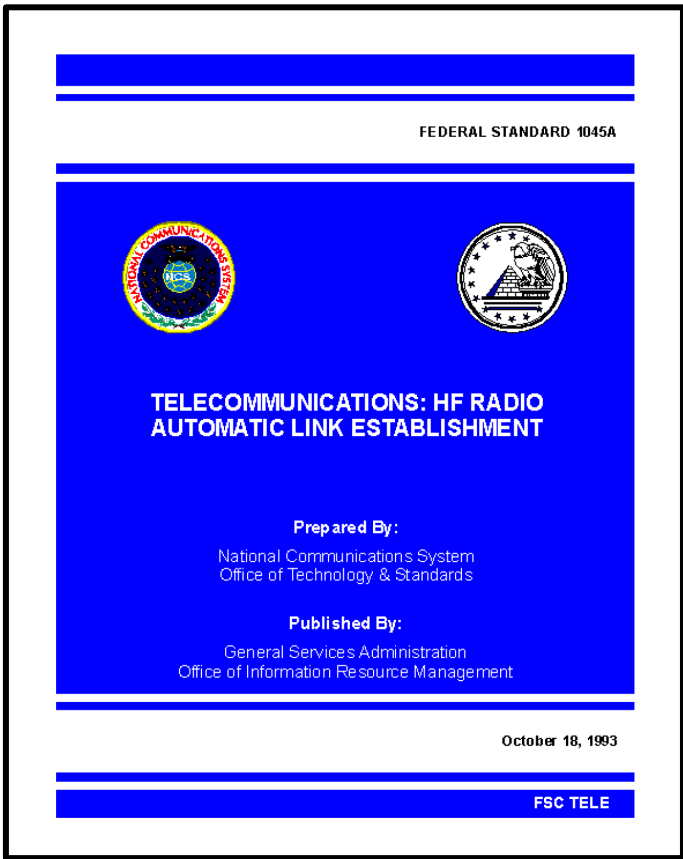


Conclusion

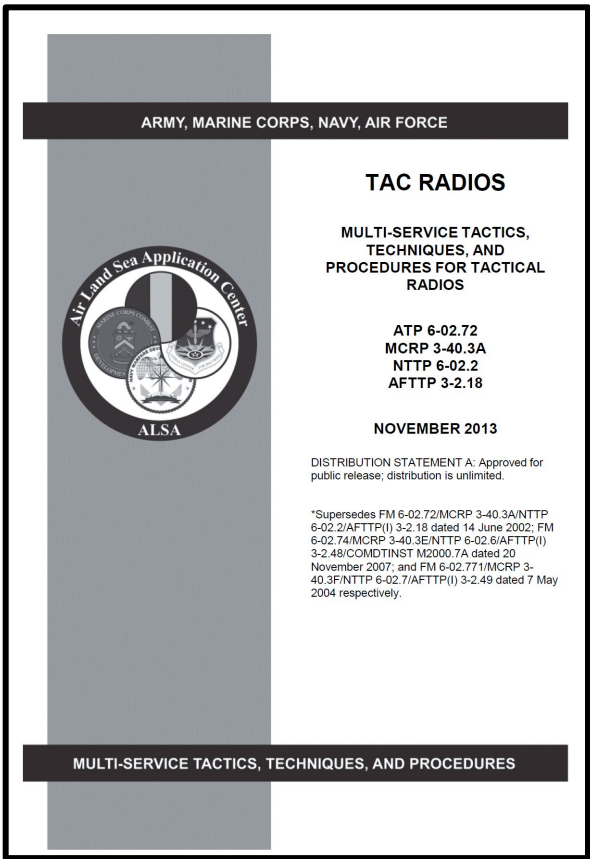
Reference Documents



MIL-STD-141



FED-STD-1045A



ATP-6-02.72

