Video Phone System Design

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Mike Halfen

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Introduction

Unique Design Features

• Button Scheme
• “Streamed Video”
• Time Stamp From Caller ID
User Defined System Constraints

- Require external power supply
- Plug directly to Telco Jack
- Maximum message length of 60 seconds
- Maximum of 30 messages
  - When message memory is filled, the oldest message is erased.
- Standalone device
Technical System Constraints

- Audio Sample Rate = 8K samples/second
- Audio Memory Requirement
  384 Kbyte/message
- QCIF Standard Video Format (176 x 144)
  304 Kbit/ frame
  Compressed (20:1) = 15.2 Kbit/frame
  At 1 frame/sec = 114 Kbyte/message
- Total Message Storage - 14.9 MB
- Additional DSP Data/Table Memory = 64K
Design Options

- Available Hardware Options
  - Off the shelf IC
  - DSP/Microcontroller
  - FPGA
  - ASIC

- Determining Factors
  - Design Cost
  - Production Cost
  - Flexibility
## Component Comparison

<table>
<thead>
<tr>
<th>Hardware Type</th>
<th>Design Cost</th>
<th>Production Cost</th>
<th>Flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shelf IC</td>
<td>None</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>DSP/Micro Cont</td>
<td>Moderate</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>FPGA</td>
<td>High</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>ASIC</td>
<td>Very High</td>
<td>Moderate</td>
<td>Low</td>
</tr>
</tbody>
</table>
The Competition

- Market segmented
  - Video calls over IP
    - Dominant segment
    - Extremely cheap ($70 for camera/software)
      - Hardware often consists only of digital camera
      - Software driven design
    - Computer, network connection required
  - Video over telephone
    - TV / Monitor products
      - Still cheap (< $300)
    - Display Integrated devices
      - Most Expensive
Display Integrated Videophones

• Common features
  • H.324 compliant
  • Able to send minimum of 7 frames/sec (up to 15!)
    • Use of QCIF standard (176 x 144 pixel picture transmitted)
  • Camera electronically adjustable: zoom, pan, tilt
  • 4” LCD Display: adjustable picture quality and size
  • Average retail price: $600

• Manufacturers
  • Aiptek
    • Cheap!! ~$450 at Amazon.com
    • Basic features only
  • MCF Enterprises (~$600)
    • Picture in Picture
    • Advanced standard telephone features
      • Answering machine (voice only)
      • Redial & Number Memory
Display Integrated Videophones

- **Other Manufacturers**
  - **8x8**
    - Led market in this segment
    - Discontinued telephone products
      - Now manufactures H.323 products
        - Video conferencing over I.P.
      - Provides chip sets and development solutions for H.324
  - **Panasonic**
    - Only major electronics manufacturer in this market
    - Same features as Aiptek, 8x8
    - Priced 2 - 3 times higher ($1150!!)
Components

• LCD Display
• Digital Camera
• Analog to Digital Converter (ADC)
• Digital to Analog Converter (DAC)
• Modem DSP
• Video DSP
• Memory
LCD Display

Requirements

- 320 x 240 resolution 8 bit color
- DSP Controlled
- Low Cost

Market Analysis

<table>
<thead>
<tr>
<th>Vendor</th>
<th>PN</th>
<th>Price</th>
<th>Notes</th>
<th>Color/BW</th>
<th>Pixels/1000</th>
<th>Metric/Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hantronix</td>
<td>HDM3224-LC</td>
<td>$70.81</td>
<td>320x240 (Color)</td>
<td>30</td>
<td>77</td>
<td>$1.31</td>
</tr>
<tr>
<td>Epson</td>
<td>SED1335</td>
<td>$10.60</td>
<td>Controller for above LCD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Newark Electronics</td>
<td>AND32222MST</td>
<td>$273.00</td>
<td>B/W 320x240</td>
<td>5</td>
<td>77</td>
<td>$0.30</td>
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<tr>
<td>Newark Electronics</td>
<td>AND711AST-30</td>
<td>$115.00</td>
<td>B/W (240x64)</td>
<td>5</td>
<td>15</td>
<td>$0.18</td>
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<tr>
<td>Lumex</td>
<td>LCM5240x128GSF</td>
<td>$78.00</td>
<td>240x128 B/W</td>
<td>5</td>
<td>31</td>
<td>$0.46</td>
</tr>
<tr>
<td>NEC</td>
<td>NL3224</td>
<td>$297.00</td>
<td>320x240 Color</td>
<td>30</td>
<td>77</td>
<td>$0.36</td>
</tr>
<tr>
<td>Sharp</td>
<td>LO039Q2DS54</td>
<td>$250.00</td>
<td>320x240 Color</td>
<td>30</td>
<td>77</td>
<td>$0.43</td>
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<tr>
<td>Crystalloid</td>
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<td>320x240 (B/W)</td>
<td>5</td>
<td>77</td>
<td>$1.17</td>
</tr>
</tbody>
</table>
Digital Camera

Requirements

- 320 x 240 resolution 8 bit color
- DSP Controlled
- Low Cost

Market Analysis

<table>
<thead>
<tr>
<th>Vendor</th>
<th>PN</th>
<th>Price</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allied</td>
<td>CVC-50BC/PH</td>
<td>$89.00</td>
<td>Color Board</td>
</tr>
<tr>
<td>Stark Electronic</td>
<td>V-X0095-PCB-3.6</td>
<td>$79.00</td>
<td>Color Board - NTSC</td>
</tr>
</tbody>
</table>
ADC / DAC

Requirements
- 8,000 Samples per Second
- 8 bits per Sample
- Low Cost

Market Analysis

<table>
<thead>
<tr>
<th>Vendor</th>
<th>PN</th>
<th>Price</th>
<th>Bits</th>
<th>Speed MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fairchild</td>
<td>ADC0804</td>
<td>$2.00</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Phillips</td>
<td>TDA8792M/C2</td>
<td>$6.40</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>National Semiconductor</td>
<td>ADC0804</td>
<td>$2.00</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>FSC/Raymill</td>
<td>ADC0804</td>
<td>$2.00</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vendor</th>
<th>PN</th>
<th>Price</th>
<th>Bits</th>
<th>Speed MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fairchild</td>
<td>DAC0808LCMX</td>
<td>$1.37</td>
<td>8</td>
<td>6.67</td>
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<td>Phillips</td>
<td>TDA8702TD-T</td>
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<td>30</td>
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<tr>
<td>National Semiconductor</td>
<td>DAC0808LCM</td>
<td>$0.81</td>
<td>8</td>
<td>6.67</td>
</tr>
<tr>
<td>FSC/Raymill</td>
<td>DAC0808</td>
<td>$1.37</td>
<td>8</td>
<td>6.67</td>
</tr>
</tbody>
</table>
Memory

Requirements

• Maintain 30 Messages
  • 60 Seconds each
• Communicate with Video DSP
• Large Flash Memory for Message Storage
• Small Memory for Program and Data Space
• Low Cost

Market Analysis

<table>
<thead>
<tr>
<th>Vendor</th>
<th>PN</th>
<th>Price</th>
<th>Notes</th>
<th>Size Metric</th>
<th>Metric/Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bright (Winbond)</td>
<td>BM29F040</td>
<td>$6.50</td>
<td>4Mb Flash - 90ns sector erase</td>
<td>4.00</td>
<td>$0.62</td>
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<tr>
<td>Sharp</td>
<td>LH28F008SCTL85</td>
<td>$10.39</td>
<td>8 MB Flash - 64K block erase</td>
<td>8.00</td>
<td>$0.77</td>
</tr>
<tr>
<td>Sharp</td>
<td>LH28F004SCTL85</td>
<td>$8.78</td>
<td>4 MB Flash - 64K block erase</td>
<td>4.00</td>
<td>$0.46</td>
</tr>
<tr>
<td>Sharp</td>
<td>LH28F160SCBL95</td>
<td>$13.01</td>
<td>3V-FLASH 16 MEG - Block Erase</td>
<td>16.00</td>
<td>$1.23</td>
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<tr>
<td>Sharp</td>
<td>LH5164A</td>
<td>$2.07</td>
<td>64K SRAM - 8K*8 arrangement</td>
<td>0.06</td>
<td>$0.03</td>
</tr>
</tbody>
</table>
Audio DSP

Requirements

- Communicate with Video DSP
- Process Audio (ADC/DAC)
- Communicate with Modem
- H.324 Compliance
  - Mux/Demux modem data
    - H.223 Protocol
  - Process Inter-terminal communication
    - H.245 Protocol
- Low Cost
Video DSP

Requirements

• Communicate with Modem DSP
• Receive and Compress Camera Data
• Decompress and Send LCD Data
• Encode/Decode Video Data
  • H.263 Protocol for H.324 Compliance
• Store and Retrieve Messages
DSP Evaluation

- Speed
- # of Interfaces
  - Serial
  - Parallel
- Cost
- Bit capability
  - ALU
  - Bus width
  - Registers
DSP Market Analysis

Rating Per DSP

TI TMS320VC35402
Pricing Analysis Summary

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handtronix LCD Display</td>
<td>$70.81</td>
</tr>
<tr>
<td>Epson LCD Controller</td>
<td>$10.60</td>
</tr>
<tr>
<td>Philips Modem Interface</td>
<td>$8.00</td>
</tr>
<tr>
<td>Cermtek Modem DAA</td>
<td>$16.67</td>
</tr>
<tr>
<td>Stark Electronic Camera</td>
<td>$79.00</td>
</tr>
<tr>
<td>Sharp Flash Memory</td>
<td>$13.01</td>
</tr>
<tr>
<td>Sharp SRAM</td>
<td>$2.07</td>
</tr>
<tr>
<td>National Semiconductor ADC</td>
<td>$2.00</td>
</tr>
<tr>
<td>National Semiconductor DAC</td>
<td>$0.81</td>
</tr>
<tr>
<td>Texas Instruments Audio DSP</td>
<td>$6.94</td>
</tr>
<tr>
<td>Texas Instruments Video DSP</td>
<td>$6.94</td>
</tr>
<tr>
<td>Labor &amp; Engineering (per unit)</td>
<td>$18</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td><strong>$234.85</strong></td>
</tr>
</tbody>
</table>
Bus Interfaces

- Serial Interface
  - Digital Camera
  - AD/DA converters
- HPI Interface
  - DSP – DSP communication
- Parallel
  - Memory
  - LCD Controller
Clock 1: Data is loaded into output register
Clock 2, rising edge: Frame sync signal is generated
Clock 2, falling edge: Interrupt generated to indicate transmission has begun
Clock 3..10: One data bit is sent on each rising clock edge
Clock 9: New data may be loaded into output register
Clock 10: If output register was loaded, frame sync signal is generated
Serial Port Interface: Receiving

Clock 1: Frame sync is generated
Clock 2..9: One data bit is sampled on each falling clock edge
Clock 9, falling edge: Interrupt generated to indicate data is ready in receive register
Clock 10, rising edge: Frame sync may be generated for next transaction
Clock 10: If frame sync generated, MSB of next byte is received
Parallel Bus to HPI Interface Bus

Slave is mapped into master’s IO space
HPI Transaction Timing Diagrams:

### Read:
- /HCS
- HR-/W
- HA[15:0]: 15-bit address
- HD[15:0]: HPID contents
- HREADY

### Write:
- /HCS
- HR-/W
- HA[15:0]: 15-bit address
- HD[15:0]: HPID contents
- HREADY
Push-button Interface

- Implements user interface
- Software definable functions
  - Greatly reduces number of physical buttons needed
  - Menu of options displayed on-screen

Video Picture displayed in this box.

Menu options listed in boxes to the right and below.

<table>
<thead>
<tr>
<th>Hz. 1</th>
<th>Hz. 2</th>
<th>Hz. 3</th>
<th>Hz. 4</th>
<th>Hz. 5</th>
<th>Hz. 6</th>
<th>Hz. 7</th>
<th>Hz. 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vert. 1</td>
<td>Vert. 2</td>
<td>Vert. 3</td>
<td>Vert. 4</td>
<td>Vert. 5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Push Button Interface

- Physical buttons
  - 13 buttons used
    - Buttons needed for a single function placed together
      - Keeps the interface easy to use
    - Making a call requires 0-9, #, *, and “Cancel”
  - Placed around LCD screen
    - Adjacent to on-screen menu options
Interface Flow Example (1):

1: Initial Menu:

Place Call
Play Messages
Greeting Options
System Options
Cancel

2: “Place Call” is pressed

3: Numbers/Symbols pushed
(displayed on-screen as pushed)

1 216 368 200

4: a) Sequence completed-- dials
   b) “Cancel” pushed – returns (1)

1 216 368 2000
Dialing…
Interface Flow Example (2):

1: Initial Menu:

2: “Place Messages” is pressed

3: a) “Erase Message” pushed

Message Erased.

3: b) “Play Message”: Plays current message

c) “Cancel”: Returns to 1

d) “Greeting Options” displays Greeting menu
Flow Chart Level 1

- Idle
  - Time out/disconnect
  - 4 Rings
  - User Selects Play Messages
  - No messages/disconnect
  - User Presses Record Greeting
  - Time-out/button press
  - User Presses Call Button
  - User Presses Answer Phone

- Recording Messages
- Code Entered
- Playing Messages
- Record Outgoing Message
- Calling
- Phone Answers
- Communicating

- Hang up
Flow Chart Level 2: Recording Messages

1. Digital Connection?
   - Yes: Get Voice Out Message
   - No: Get Audio/Video Out Message

2. 4 Rings
   - Yes: Digital Connection?
     - Yes: Get Voice Out Message
     - No: Get Audio/Video Out Message
   - No: 4 Rings

3. Code Entered?
   - Yes: Play Out Message
   - No: Code Entered?

4. Receive Phone Data Packet
   - Extract Audio/Video Data
   - Store In Flash
     - Time Out?
       - Yes: Done?
       - No: Time Out?

5. Receive Voice Message
   - Code Entered?
     - Yes: Store In Flash
     - No: Code Entered?

6. Send
   - Done?
     - Yes: Done?
     - No: Send

7. Play Out Message
   - Done?
     - Yes: Done?
     - No: Code Entered?

8. Play Messages
   - Code Entered?
     - Yes: Play Messages
     - No: Code Entered?

9. Done?
   - Yes: Done?
   - No: Done?

10. Time Out?
    - Yes: Done?
    - No: Time Out?
Flow Chart Level 2: Calling

- Call Button Pressed
  - Dialtone? (No: Connected? (No: Communication) (Yes: Cancel Button Pressed)
  - Yes: User Presses 0-9, #, * (Send Tone)

Yes: Communication
Flow Chart Level 2: Record Outgoing Message

- Record Button Pressed
  - Get Audio
    - Compress Audio
  - Get Video
    - Compress Video

- Cancel Button Pressed?
  - Yes
  - Time Out?
    - No
    - Yes
      - No
Flow Chart 2: Communication

Answer Phone —> Other End Picks Up

Establish Digital Communication/Modem Training —> Initialization

Hangup? —> No

Is Sender? —> No

Get Audio —> Compress Audio —> Pack Audio into H.324/ Add Audio Delay —> Send Over Phone

Get Video —> Compress Video —> Pack Audio into H.324/ Add Audio Delay —> Send Over Phone

Get Phone Data —> Unpack Audio from H.324 —> Decompress Audio —> Insert Requested Delay —> Play Audio

Decompress Video —> Play Video
State Machine Diagram

Idle State 1.0

- Rings == 4
  - State = 2.0
- State = 1.0
- Record_Greeting == TRUE
  - State = 3.0
- Play_Msgs == TRUE
  - State = 4.0
- Answer == TRUE
  - State = 6.0
- Disconnect == TRUE
  - State = 1.0
- Make_Call == TRUE
  - State = 5.0
- User_Cancel == TRUE
  - State = 1.0
- No_Messages == TRUE || Disconnect == TRUE || Stop_Playback == TRUE
  - State = 1.0
- Disconnect == TRUE || Rec_Msg_Time_Out == TRUE
  - State = 1.0
- End_Recording == TRUE || Rec_Msg_Packets > OUT_MSG_MAX
  - State = 1.0
- Valid_Code_Entered == TRUE
  - State = 4.0
- User_Cancel == TRUE
  - State = 1.0
- Phone_Answer == TRUE
  - State = 6.0
- Record_Greeting == TRUE
  - State = 3.0
- Record_Call == TRUE
  - State = 2.0

Callin 5.0

Make_Call == TRUE
- State = 5.0

Communicating 6.0

Answer == TRUE
- State = 6.0

Playback Message 4.0

Play_Msgs == TRUE
- State = 4.0

Record Caller Msg 2.0

Valid_Code_Entered == TRUE
- State = 4.0

Record Outgoing Greeting 3.0

End_Recording == TRUE || Rec_Msg_Packets > OUT_MSG_MAX
- State = 1.0

Disconnect == TRUE || Rec_Msg_Time_Out == TRUE
- State = 1.0

Rings == 4
- State = 2.0
Idle State 1.0 Diagram

Count Rings 1.2

- Rings < 4
  - State = 1.2
  - Ring_Detect == TRUE
    - State = 1.2
- Rings == 4
  - State = 2.0
- Answer == TRUE
  - State = 6.0

Listen For First Ring 1.1

- Ring_Detect == TRUE
  - State = 1.2
- Ringer_Timeout == TRUE
  - State = 1.1
- Make_Call == TRUE
  - State = 5.0
- Record_Greeting == TRUE
  - State = 3.0
- Play_Msgs == TRUE
  - State = 4.0
Record Caller Msg State 2.0 Diagram

Retrieve Outgoing Greeting 2.1

- More_Data_Available == TRUE
  - State = 2.1
  - Packet Retrieved

Send Data 6.3

- More_Data_Available == FALSE \&\& Flash_Full == FALSE
  - State = 2.3
  - Done_Overwriting == TRUE

- More_Data_Available == FALSE \&\& Flash_Full == TRUE
  - State = 2.2

Get Next Available Msg Location 2.3

- Flash_Ready == TRUE
  - State = 6.4

Receive Data 6.4

- Packet_Stored == TRUE
  - State = 6.4

- Data_Received == TRUE
  - Packet_Type = MSG

Store Packet 2.4

- Disconnect == TRUE \| Rec_Msg_Time_Out == TRUE
  - State = 1.0

- Valid_Code_Entered == TRUE
  - State = 4.0
Record Outgoing Greeting State 3.0 Diagram

Get Audio / Video
7.0

Get Audio / Video
7.0

Read_Data_Buffer == FULL
State = 3.2

Compress Audio and Video
3.2

Compress Audio and Video
3.2

AV_Compression == COMPLETE
Packet_Type = OUTGOING
State = 2.4

End_Recording == TRUE ||
Rec_Msg_Packets >= OUT_MSG_MAX
State = 1.0

End_Recording == FALSE &&
Rec_Msg_Packets < OUT_MSG_MAX
Rec_Msg_Packets++
State = 7.0

Store Packet
2.4
Retrieve Message 4.1

Valid_Code_Entered == TRUE &&
Msg_Retrieved == TRUE
State = 4.2
Audio_Decompression == COMPLETE
State = 4.3

Decompress Audio And Video 4.4

Play_Msgs == TRUE &&
Msg_Retrieved == TRUE
State = 4.4

Decompression == COMPLETE
State = 4.5

Play Audio And Video 4.5

Msg_Palyed == TRUE
State = 4.6

No_Messages == TRUE ||
Disconnect == TRUE ||
Stop_Playback == TRUE
State = 1.0

Message Selection 4.6

Msg_Selection == NEXT
Message_To_Play++
State = 4.1

Msg_Selection == PREVIOUS
Message_To_Play--
State = 4.1

Msg_Selection == REPEAT
State = 4.1

Play Audio 4.3

Audio_Sent == TRUE
State = 4.6

Audio_Decompression == COMPLETE
State = 4.3

Decompress Audio 4.2

No_Messages == TRUE ||
Disconnect == TRUE ||
Stop_Playback == TRUE
State = 1.0
Calling State 5.0 Diagram

Waiting For User Input 5.1

- User_Cancel == TRUE
  - State = 1.0

Number_Entered == TRUE
  - State = 5.2

Send Tone 5.2

Ringing == FALSE
  - State = 5.1

Ringing == TRUE
  - State = 5.3

Wait For Pickup 5.3

Phone_Answer == TRUE
  - State = 6.0
Communicating State 6.0 Diagram

- **Negotiate Setup 6.1**
  - Parameters_Set == TRUE
    - State = 7.0

- **Wait For Data 6.2**
  - Data_Reception_Complete == TRUE
    - State = 6.2
  - Outgoing_Data_Present == TRUE
    - State = 6.3
  - Outlet_Down == TRUE
    - State = 1.0

- **Receive Data 6.4**
  - Decompression == COMPLETE
    - State = 4.4
  - Packet_Received == TRUE
    - State = 4.4
  - Parameters_Set == TRUE
    - State = 6.2
  - Outgoing_Data_Present == TRUE
    - State = 6.2

- **Get Audio / Video 7.0**
  - Data_Transmission == TRUE
    - State = 7.0

- **Compress Audio and Video 3.2**
  - Read_Data_Buffer == FULL
    - State = 3.2

- **Decompress Audio And Video 4.4**
  - Play Audio And Video 4.5

- **Send Data 6.3**
Caller ID – Physical Layer

Physical Layer
- 8 bit Characters Transmitted Asynchronously
- One Start Bit, Between One and Ten Stop Bits
- 1200 baud FSK Modulated Data

Format

S2 M B7 B6 B5 B4 B3 B2 L S1

S1 – Start Bit
S2 – Stop Bit
M – Most Significant Bit
L – Least Significant Bit
B* - Bit Numbers 2 to 7

Most Significant Octet is Transmitted First
## Caller ID – Datalink Layer

<table>
<thead>
<tr>
<th>Channel Seizure</th>
<th>Mark Signal</th>
<th>Message Type</th>
<th>Message Length</th>
<th>Message Presentation Layer</th>
<th>Checksum</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 – 262 ms</td>
<td>&gt; 45 ms</td>
<td>~ 9.8 ms</td>
<td>~ 9.8 ms</td>
<td>0 – 2488 ms</td>
<td>~ 9.8 ms</td>
</tr>
<tr>
<td>96 – 315 bits</td>
<td>&gt; 55 bits</td>
<td>8 bits</td>
<td>8 bits</td>
<td>0 – 2040 bits</td>
<td>8 bits</td>
</tr>
</tbody>
</table>

Channel Seizure – Phasing Pattern of Alternating 1’s and 0’s
Mark Signal – A Series of Mark Bits (1’s)
Message Type – Application Dependent
Checksum – 2’s Complement Sum of all Bytes From “Message Type” Word
### Caller ID – Presentation Layer

<table>
<thead>
<tr>
<th>Parameter Type</th>
<th>Parameter Length</th>
<th>Parameter Byte(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Time &amp; Date</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 – Calling Line Directory Number (DN)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 – Called Directory Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 – Reason for Absence of DN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 – Caller Name / Text</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 – Reason for Absence of Name</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 – Call Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19 – Network Message System Status</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
When a message is recorded, it is put on the bottom of the Next Available Msg buffer.

When a message is deleted, it is put on the top of the Next Available Msg buffer.
Interphone Communication

- Follow H.245 control protocols
  - Mandated by H.324
- Overview
  - Master/Slave relationship between terminals
    - Based on terminal type or random #
  - Machines exchange capabilities
    - Master transmits preferences
    - Slave accepts/rejects
      - Based on capabilities and settings
  - Master establishes channels for data transfer
  - Data transferred
Conclusions

- Potential per unit profit margin: $215
  - Low competitor’s retail: $450
  - Per unit expense: $235
- Competitively featured
  - H.324 compliant
  - Video messaging capabilities
  - Slick UI
- Solid Design Foundation
  - Ease Implementation Issues
  - Facilitate quick time to market