Specification and Design of a Video Phone System

PROJECT REPORT

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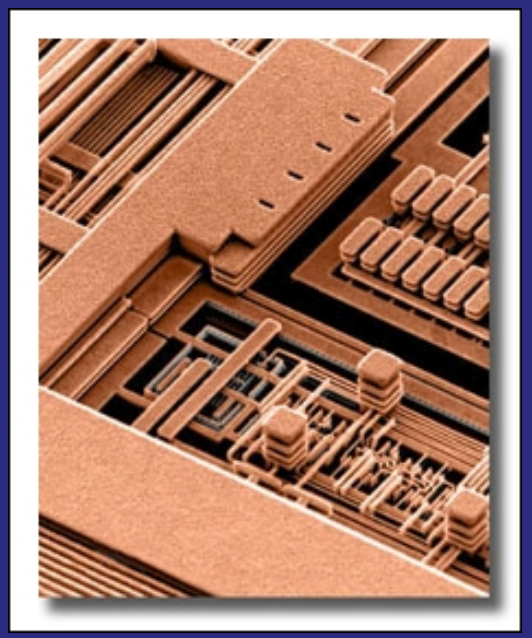


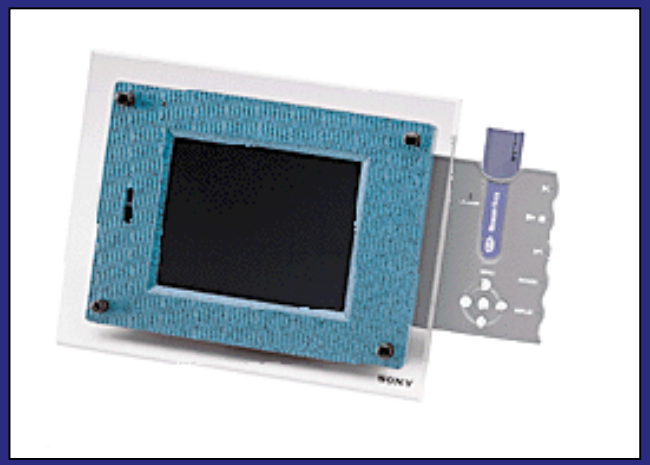
Introduction

Motivation:

Our main goal is to provide a solution beyond the basic functionality provided by a phone. In addition to implementing video and answering machine capabilities, other features are included by making use of basic hardware components already included in the system, therefore providing a competitive and feasible solution for the embedded system in the least amount of time.

Introduction

Description of the problem:



GOALS:

- Simplicity
- Portability / Design
- Power Consumption
- Versatility (extra func.)
- Design Time
- Easy of use
- Performance
- Expandability
- Cost

Introduction

Approach / Project Frame:

System Partitioning: Functional (controller oriented)

- Better size/performance tradeoffs, fewer objects, permits hardware/software solutions.

Phase I – Design / Implementation

- Behavior and State Machine Harware Design
- Component Selection/Specification
- Memory Management

Phase II – Simulation

- VHDL Software Development
- FPGA Hardware Testing

Specification

- The phone should use the POTS telephone system.
- Compatibility with other videophones that follow the H.324 standard.
- Handle analog to analog communication (for compatibility with regular phones) and digital to digital communication (with other videophones).
- The phone gives users a “video” option, which allows the users to send to each other images to be viewed on the videophone’s LCD screen every 12 seconds.
- The phone can be used as a digital picture frame by displaying stored images when idle.

Specification

- The videophone has an answering machine feature that can record both voice and images.
- The phone can store up to 30 one minute messages and 5 images per message. (1 image every 12 sec)
- The phone uses MPEG compression on the voice messages that it stores. It uses JPEG compression on any images that it stores.
- The phone has four modes. *Playback*, *Playback Voice Only*, *Playback Image Only*, *Call*.

Specification

- The phone contains the following buttons:

  Dialpad - **For dialing numbers**

  Mode - **Switching between the 4 modes**

  Play/Reverse - **Begin playing messages. If messages are already playing reverse the direction of play.**

  Delete/Undelete - **Delete the current message after messages are done playing/ cancel delete.**

  Skip - **Skip this message, play the next or previous message according to direction of play (Forward/Backward).**

  Stop - **Stop message playback.**

  Rec. Announcement - **Record the announcement.**

  Hear Announcement - **Hear the announcement**

  Memo - **Record a memo as a voice message**

  Video - **The phone signals another Videophone and then starts sending it images every 12 sec.**

Components

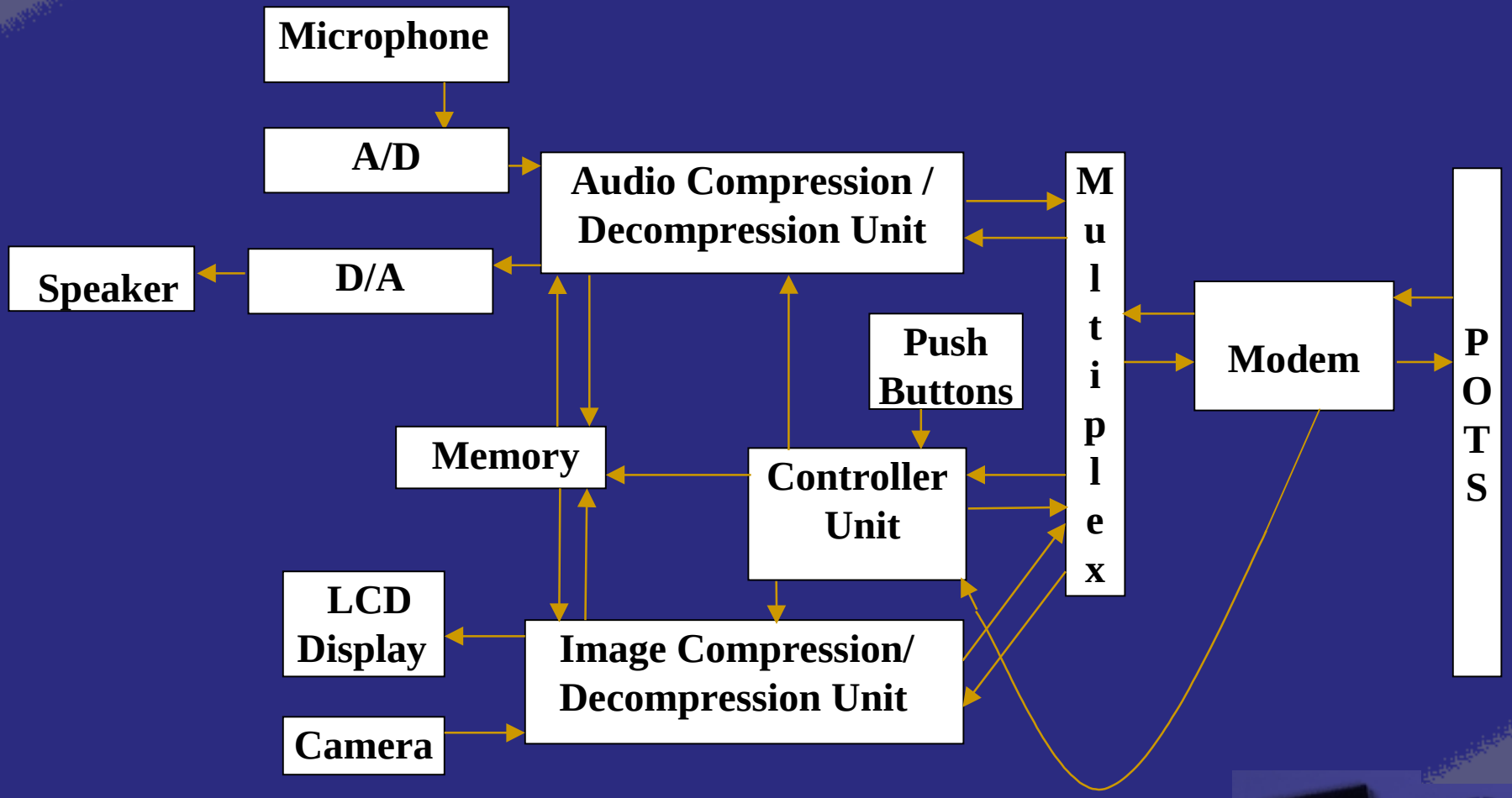


Figure 1 Block Diagram of the system components

Components

1- Memory: (removable)

Compact Flash Memory / and Slot: 8MB

Dimensions:	1.43" x 1.68" x .13”
Memory Capacity:	Up to 96MB (upgradable)
Endurance:	300,000 cycles per logical sector
Data Retention:	10 years
Media Transfer Rate:	Up to 3.5MB/sec.
Interface Transfer Rate:	Up to 8MB/sec.
Average Seek Time:	10.8 ms.
Sleep/Standby Current:	0.5 mA (typical) 2.0 mA (max.)
Read/Write Current	45 mA (typical) 75 mA (max.)

Components

2- Digital signal processor: (2)

Texas Instruments TMS320LC549-80

Frequency (MHz)	80	(MIPS 80)
Cycle Time (ns)	12.5	
Data / Program Memory (Words)	64K/8M	
RAM (Words)	32K	
ROM (Words)	16K	
Timers	1 (used for date and time)	
Total Serial Ports	3	
Boot Loader Available	YES	
Core Supply (Volts)	3.3	

The TMS320C54x DSP family consumes 0.54mW/MIPS; therefore, 80MIPS * .54mW/MIPS = 43.2 mW.

Components

3- Microphone

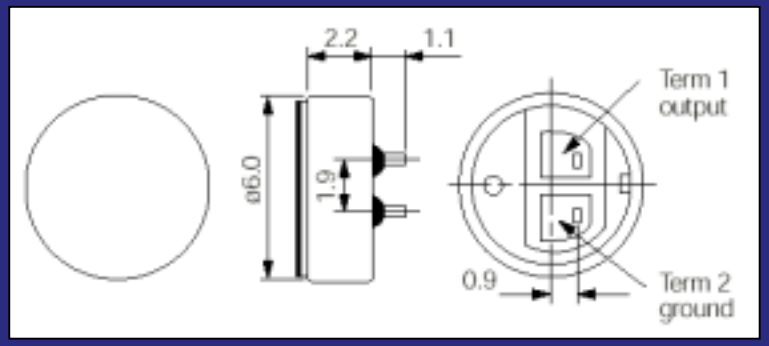
Panasonic Omnidirectial (directivity) Microphone:

- **-Sensitivity: -45 +/- 4dB**
- **-Frequency: 20-16,000 Hz**
- **-Power Consumption: 0.5mA**
- **-S/N ratio: more than 58dB**
- **-I/O: Terminal 1 Output, Ground, +Vs**

4- Speaker

Shihpei speaker

Model	Diameter	Impedance	Sensitivity	Frequency Range	Max Power
Ø	13.5mm	16~150	103~124dB	20~7kHz	30mW



Components

6- LCD Display

Sharp TFT LQ039Q2DS02

- Display size	14.5 [5.7] cm [‘’]
- Resolution (H x V)	320 x RGB x 240
- Power Consumption	3.9W
- Input	6-bit Analog
- Operating Temp.	-10 to +70 °C
- Wide viewing angle	(Horizontal: 130° Vertical: 105°)
- Backlight type	1CCFT
- Outline Dimensions (W x H x D)	44.0 x 104.6 x 13.0 mm
- Weight	220g

7- LCD Controller

Components

8- Modem

Conexant V.90/K56flex/V.34/V.32bis RC56LD

-56 kps data transfer
-Voice/Data Detection
-Full duplex speakerphone
-Power Consumption: 550mW max.
-MDP (modem data Pump) handles
Multiplexing functions
- ROM sector is upgradable

Components

9- Camera

Panasonic color board camera GP-CX161 Series

-NTSC
-Uses a built-in 10- bit DSP
-Horizontal Scanning Frequency = 15.734 khz
-Vertical Scanning Frequency = 59.94 khz
-30 frames per second
-Resolution: Horizontal Min: 330 lines, Vertical Min: 350 lines.

Pin1: +Vs Pin2: Gnd Pin3: Video Out
Pin4: Gnd Pin5: IC SCL Pin6: IC SDA

-Dimensions: 26mm(W) x 22 mm(H) x 13.3 mm (D)
-Power Consumption: 160mA (5V input logic)

Components

10- Controller

-The controller, the main focus of our project, will be implemented using state machines. VHDL is use for synthesis and simulation.

11- Alternative implementations considered:

a) processor

Motorola DragonBall

StrongARM 1110

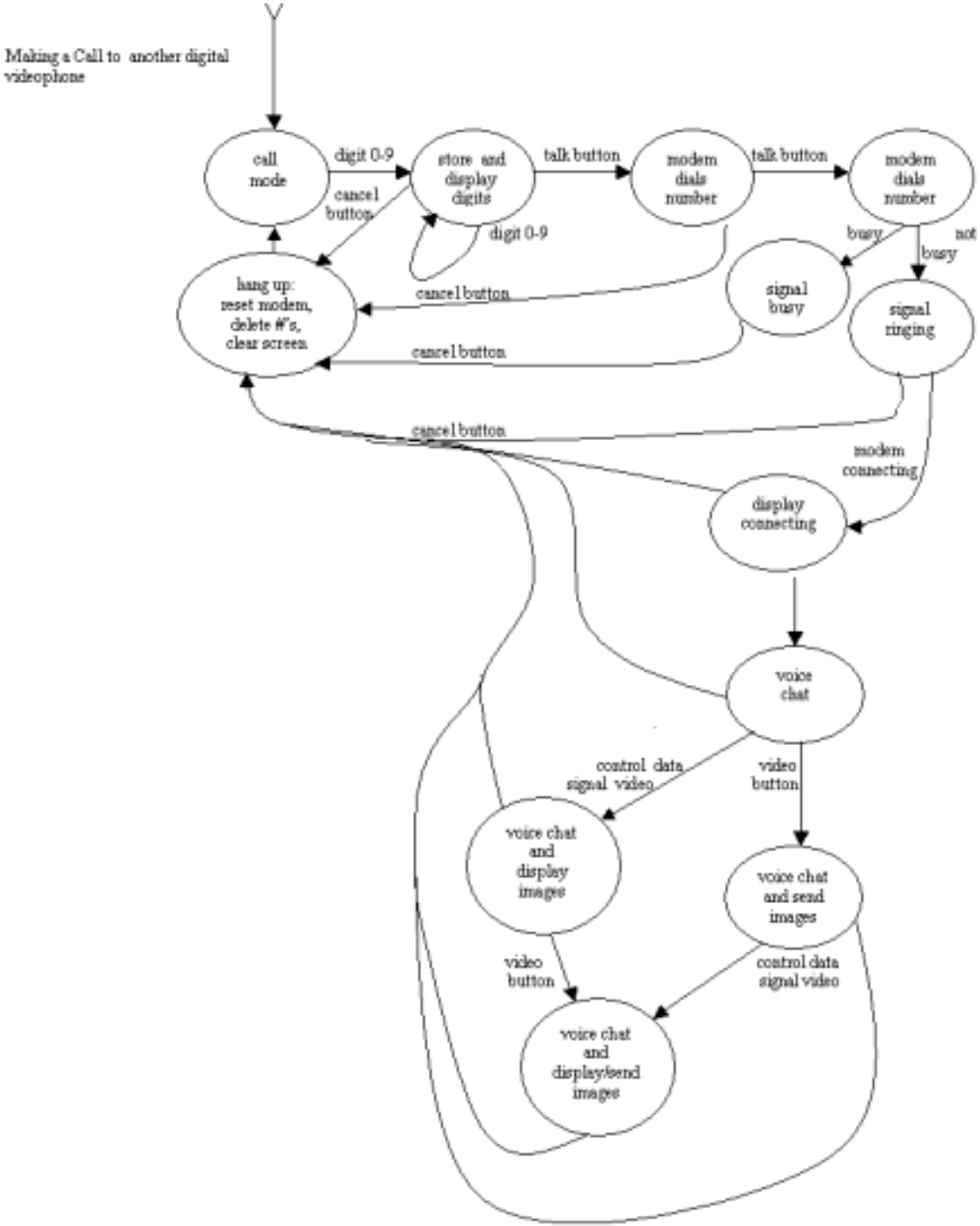
b) storage

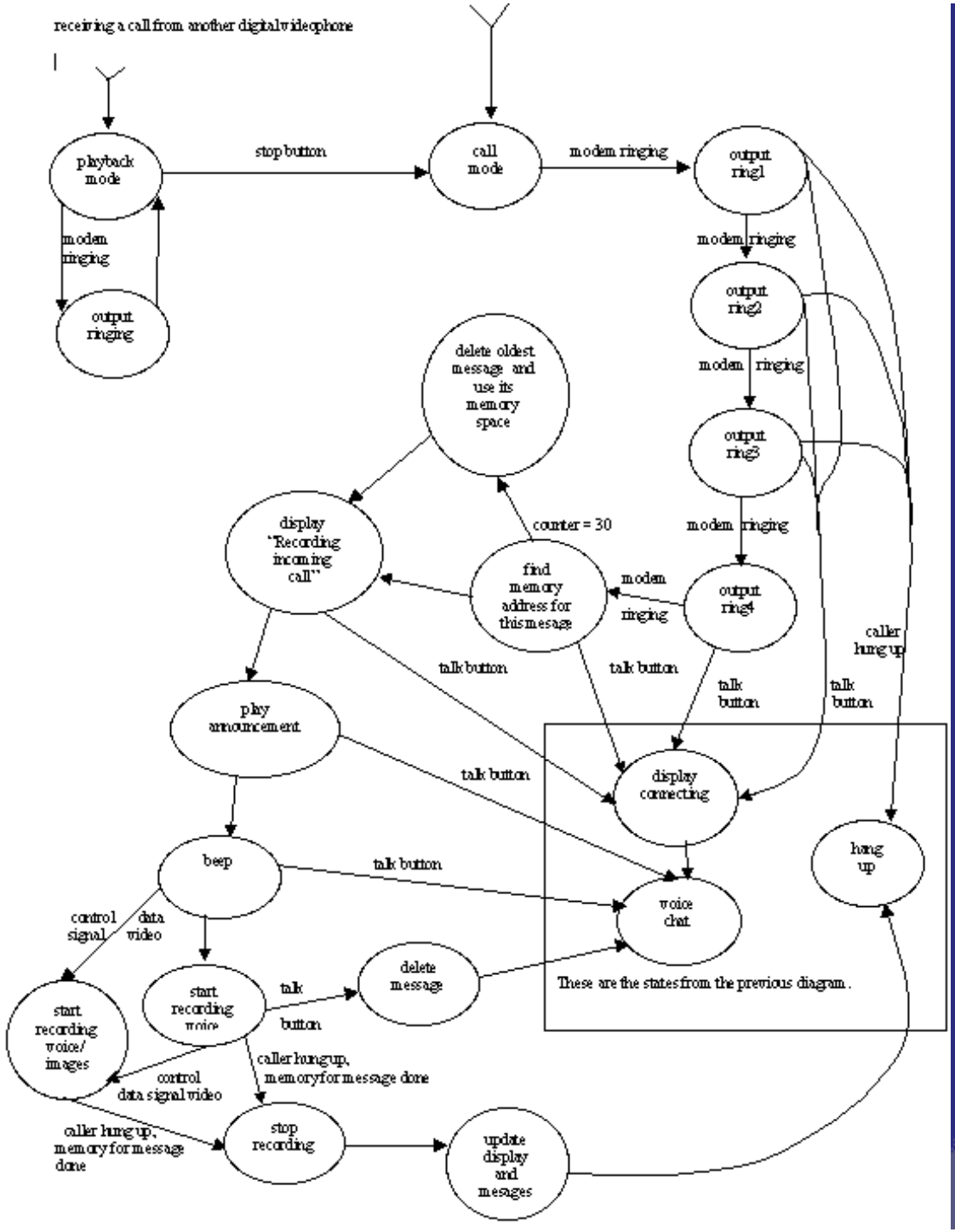
Controller

-Behavior of Machine

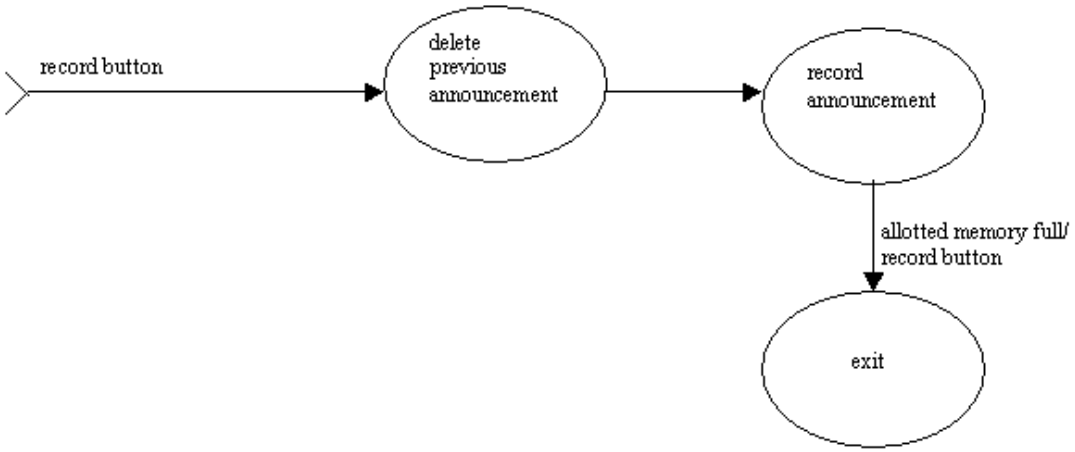
-State Diagrams
- Playback
- Other operations

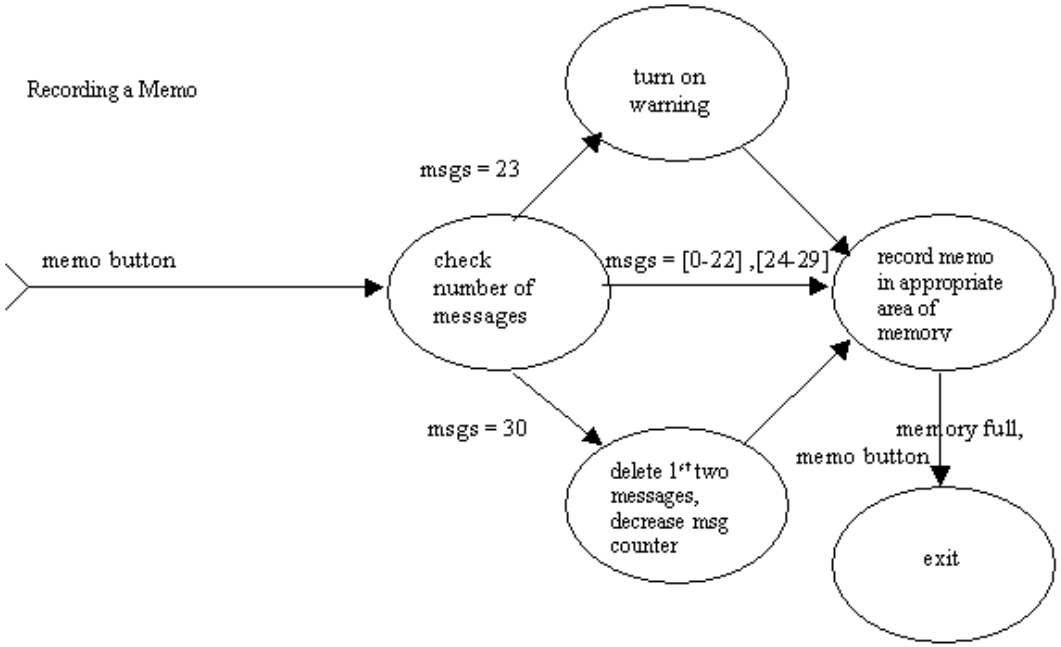
-Implementation and Simulation in VHDL
(in progress)


Making a Call to another digital videophone
call mode
digit 0-9
store and display digits
talk button
modem dials number
talk button
modem dials number
cancel button
digit 0-9
busy
not busy
hang up: reset modem, delete #'s, clear screen
cancel button
signal busy
signal ringing
cancel button
cancel button
modem connecting
display connecting
voice chat
control data signal video
video button
voice chat and display images
voice chat and send images
video button
control data signal video
voice chat and display/send images

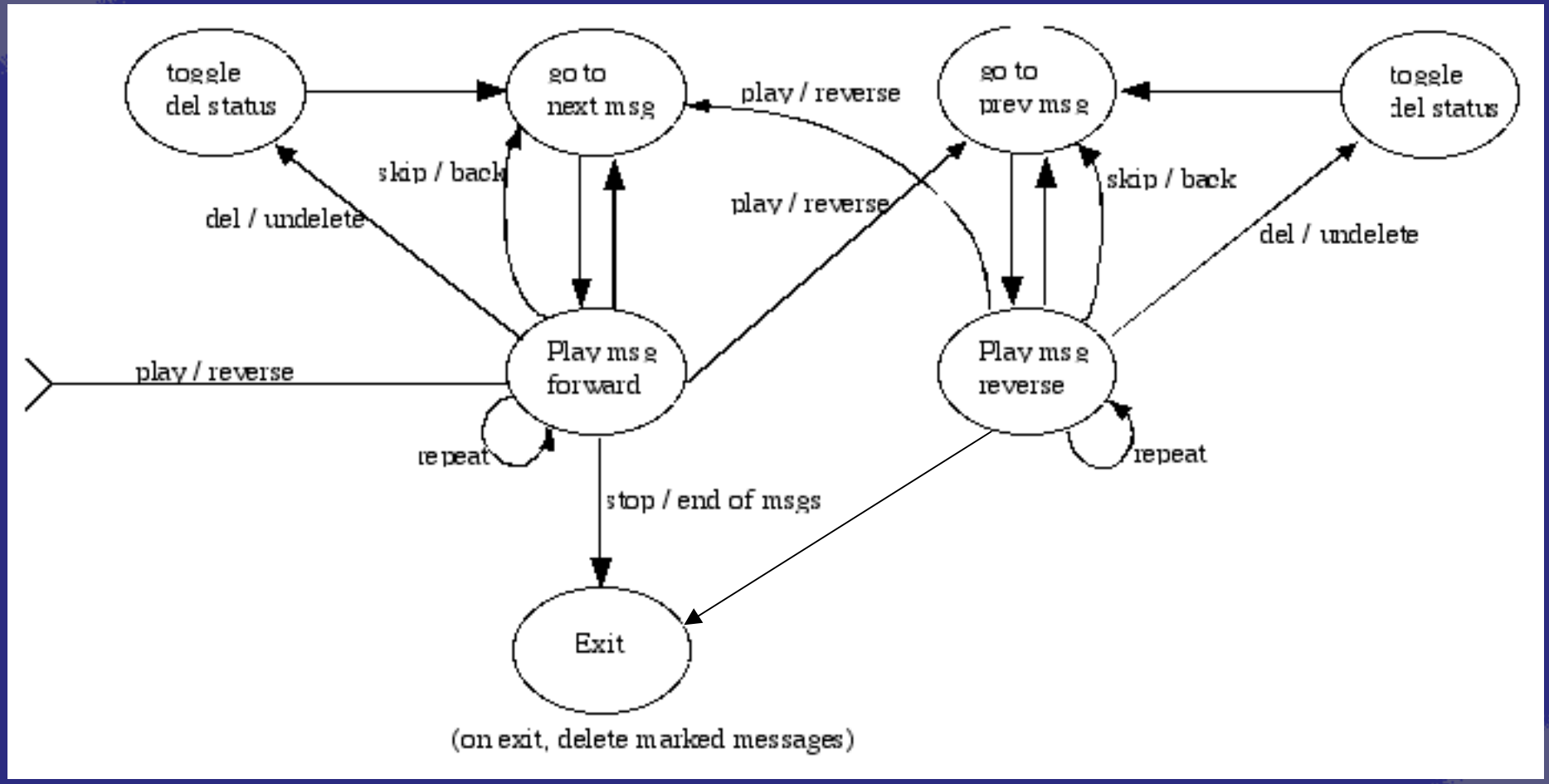

receiving a call from another digital videophone
playback mode
stop button
call mode
modem ringing
output ring1
modem ringing
output ringing
modem ringing
output ring2
modem ringing
output ring3
modem ringing
output ring4
delete oldest message and use its memory space
display "Recording incoming call"
counter = 30
find memory address for this message
modem ringing
caller hung up
talk button
talk button
talk button
talk button
play announcement
talk button
display connecting
hung up
beep
talk button
voice chat
control signal
data video
start recording voice/ images
start recording voice
talk button
delete message
These are the states from the previous diagram.
caller hung up, memory for message done
control data signal video
caller hung up, memory for message done
stop recording
update display and mesages

Recording announcements





Message Playback



Memory Management

a) Requirements:

-Images

(320x240 resolution)*(12bit/pixel)/(8bits/byte)

= 115.2 KB per image (uncompressed)

at 20:1 JPEG compression ratio

= 5.76 ~ 6 KB per image

5 images/message * 6 KB/image

= 30 KB max per message

-Audio

(8000 samples/sec * 16 bits/sample) *
(60sec)/(8bits/byte)

= 960 KB per 1 min message (uncompressed)

at 6:1 MPEG compression ratio

= 160 KB per 1 min

Memory Management

b) Partitioning:

- 160 KB voice + 30 KB images
  = 190 KB per message
- Each page = 192 KB = 30000h Bytes
- 30 pages or 5.625 MB of RAM are for storing messages.
- There are 2.375 MB left
  - User stored pictures 96 MB (5 pages)
    160 JPEG images can be stored
  - Index Table, Variables, Compression Algorithms booted into the DSPs
  - Status Messages

Memory Management

c) Message Index Table:

- A linked list of nodes used to keep track of messages
- Kept in video unit DSP
- Original copy in Flash RAM, so if there is ever a power out loaded into DSP's memory when DSP is booting.
- 30 nodes in the index table, one for each message page
- Node Structure

Audio Address	Image Address	Image Flag	Delete Flag	Addr next index	Addr prev index

Feasibility Study

	Cost(each)
-*Modem:*	**~$ 30.00**
-*Memory*: 1 Compact flash 8MB	**$ 41.00**
-*Memory drive:* (compact flash slot)	**~$ 20.00**
-*DSP:* (in qt. 5000+) 19.71600 each (x2)	**$ 39.43**
-*Analog to Digital / Digital to Analog Converter:* (in qt. 500+)	**$ 1.98**
-*Microphone:* (in qt. 100+) $3.03 each (in 100)	**$ 3.03**
-*Speaker:* (in qt. 100+) $3.16 each (in 100)	**$ 3.16**
-*Digital Camera:*	**$ 54.00**
-*Color LCD Screen:* (in qt. 100+)	**$ 91.73**
-*LCD Display Controller:* (in qt. 100+)	**$ 7.00**
-*Box:* (enclosure)	**~$ 5.00**
-*Engineering Design Costs:* $100,000 per worker	
- 5 employees for 1 year = $500,000 / 100K units	**$ 5.00**
-*Manufacturing Costs:* $1,000,000 / 100K units	**~$ 10.00**
-*Other Costs:* discrete, RC components, buttons, ports ($0.43 each)	

Total Estimated Cost per unit:	**$ 321.33**
Cost including $32 (10%) profit:	**$ 353.46**

Competition
(what is out there?)

- ViewStation MP-2200-08666-001

$8999.00

Used for video conferencing, probably by firms not individuals.

- Panasonic Victpro Video Phone System

$1194.99

- ECES 488 Class Projects

Competition
(what is out there?)

- VP-41

$698.95

- AIPTEK HyperVPhone 2000C Video Phone

$505.53

- HYPERVPHONE 2000S VID PHONE SET TOP BOX

$326.77

Most economic standalone found.

Conclusion