

EMBEDDED VOIP PHONE

Embedded System Design
(CSEE 4840)

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Overview

- Project Overview
- System Architecture
- VOIP Protocols
- Issues and Lessons Learned
- Future Work and References

Project Overview

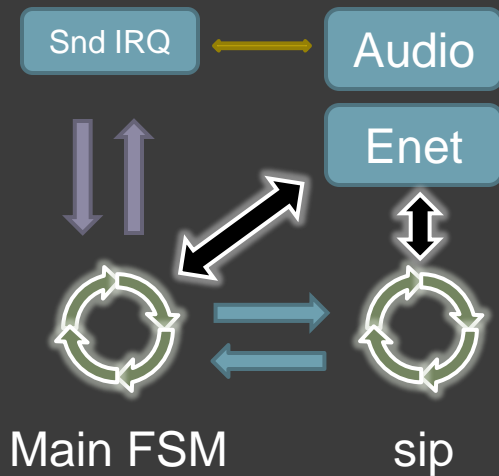
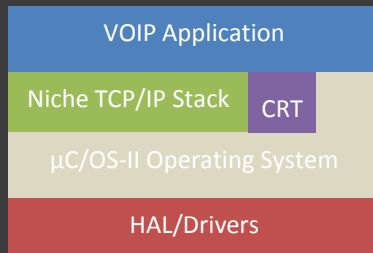
- SIP/RTP based VOIP phone with an Asterisk Registrar
- Very small memory footprint – 512KB SRAM
- PS/2 keyboard for input and 2-line LCD display
- Embedded Operating System (uCos/II) for multi-threading
- Iniche TCP/IP stack for socket communications
- Altera NIOS 2 processor (50 MHz)
- DE2: Wolfram Audio chip, Davicom DM9000A Emac

System Architecture

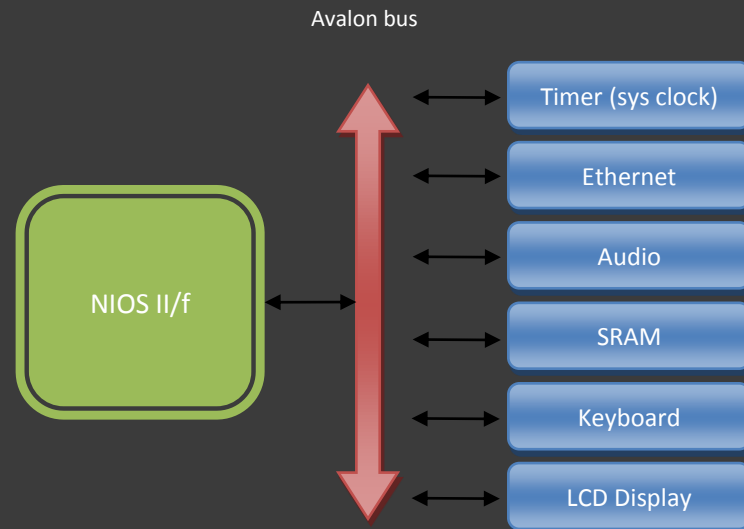
- Modularized into Application logic, System Software and Hardware Design layers with OOP design
- SIP/SDP and RTP on UDP for session initiation and media respectively

Architecture Diagram

Software Stack



Hardware Overview



System Software

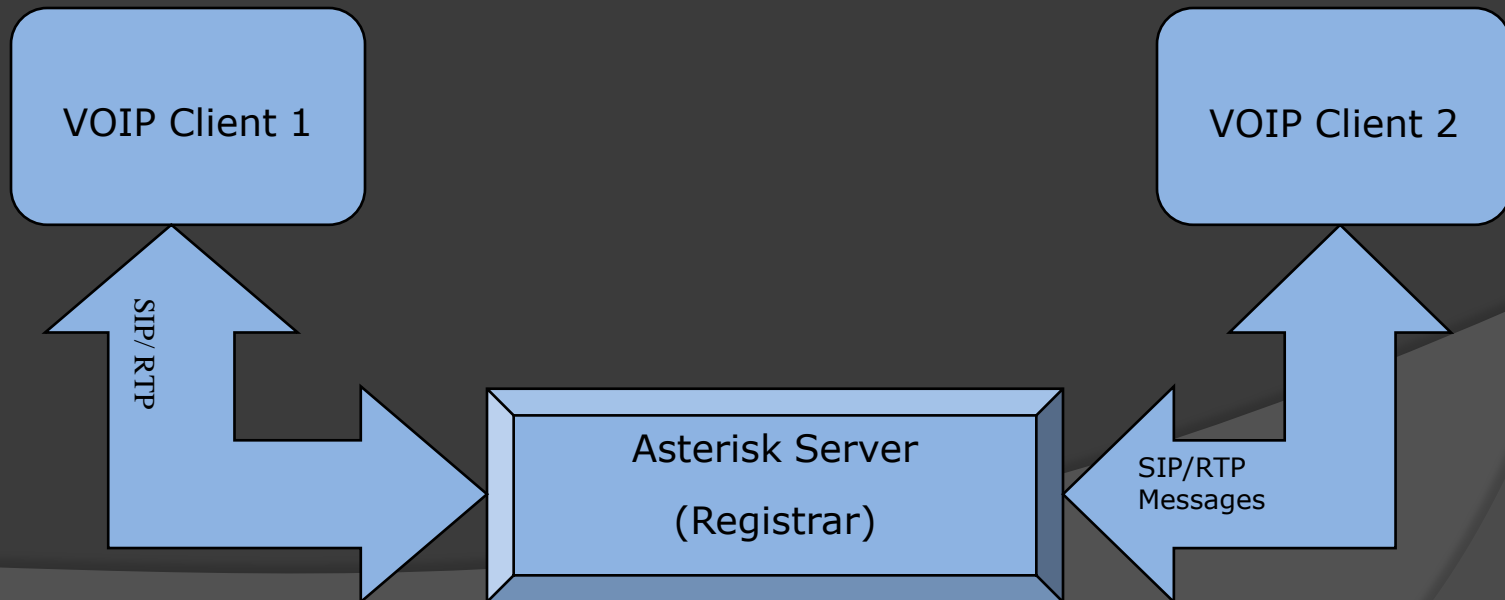
- uCos/II os, iniche TCP/IP stack
- NIOS 2 command line tools (bsp generate, make, download, terminal)
- Multi-threaded design
- No call-time heap allocation (pools, queues pre-generated)
- Drivers (DM9000A, sound, lcd, keybd)
- State machine app implementation

SIP and RTP Protocols

- ① Constructed SIP protocol for Unicast communication
- ① SDP used for Media Session Management
- ① Integrated the RTP lib API to create the RTP clients

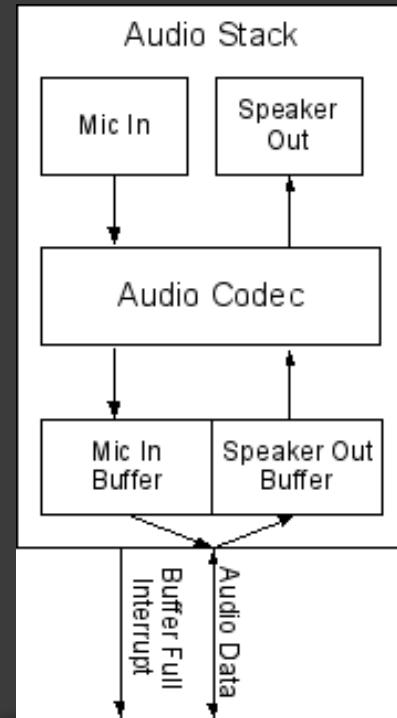
Asterisk Server

- Asterisk 1.6 configured in **canreinvite=no** mode
- All extensions support UDP traffic
- SIP Messages and RTP Media Sessions via Asterisk
- The message flow diagram:



Hardware Design

- Interrupts used as an interface to the processor
- 256 sample buffers in/out
- 8Khz sample rate
- Interrupts every 30msec



Issues and Lessons Learned

- Avoid use of 3rd party software libraries in embedded systems
- SIP implementation and use of SDP more (RTP) Media Session management
- TCP/IP can be done very nicely on a small embedded system
- Test audio with more than just a single tone

Future Work

- Video calls like Skype
- Contact lists for easy calling
- Audio conferencing (multi-way calls)
- World peace
- Cure hunger, cancer, etc.`

References

- RFC 3261 (SIP: Session Initiation Protocol) (<http://www.ietf.org/html/rfc3261>)
- RFC 1889 (RTP) (<http://tools.ietf.org/html/rfc1889>)
- RTP Library API (http://www.cs.columbia.edu/irt/software/rtp/lib/rtp/lib-1.0a1/rtp_api.html)
- Asterisk Server (<http://www.asterisk.org/>) and PJSIP (<http://www.pjsip.org/>)
- Nios II Software Developer's Handbook (http://www.altera.com/literature/hb/nios2/n2sw_nii5v2.pdf)
- NicheStack IPv4 Datasheet (http://www.iniche.com/pdf/nichestackipv4_ds.pdf)
- μ C/OS-II (<http://www.micrium.com/products/rtos/kernel/benefits.html>)
- HD44780U LCD Display Datasheet (<http://www.sparkfun.com/datasheets/LCD/HD44780.pdf>)
- LCD interface timing diagram (http://home.iae.nl/users/pouwaha/lcd/lcd0.shtml#_8bit-transfer)
- LCD interface commands (<http://www.geocities.com/dinceraydin/lcd/commands.htm>)