Augmented Reality Universal Controller and Identifier (ARUCI)

Group 40

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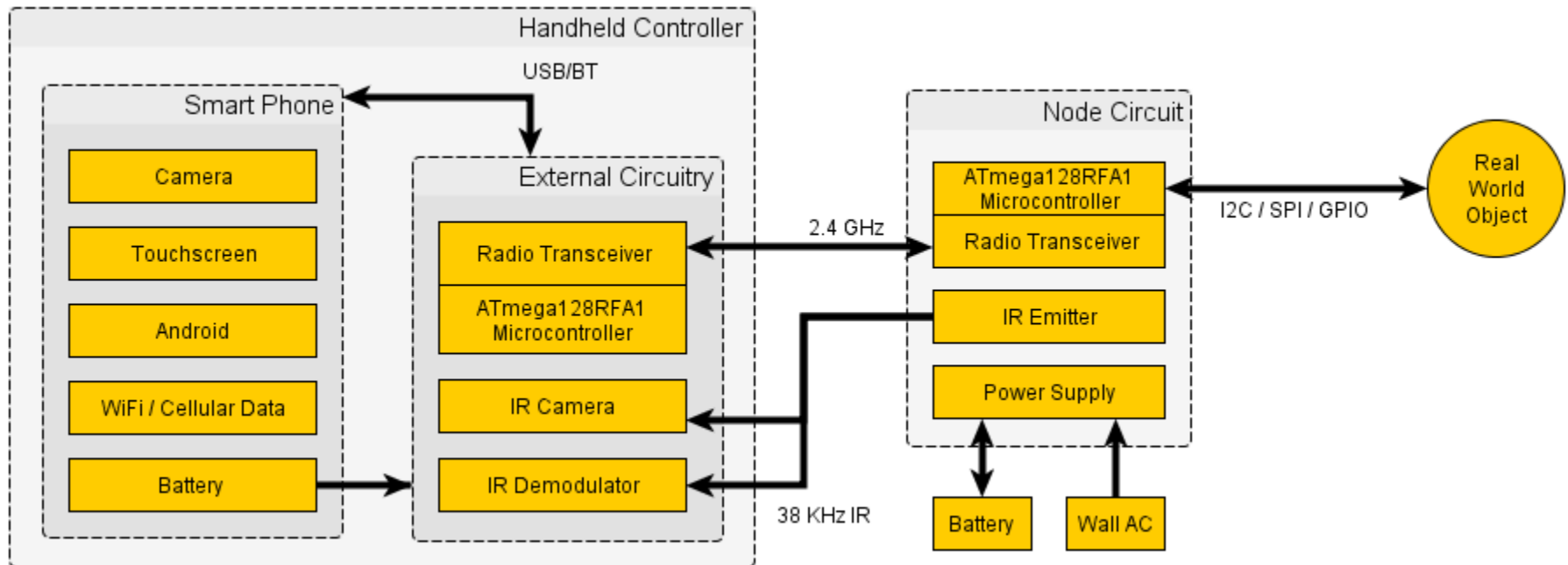Luke Shum
Frank Zhao
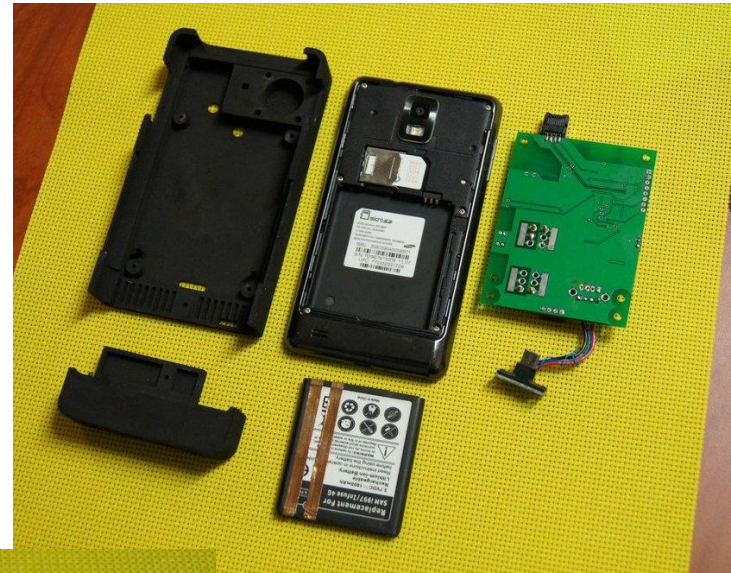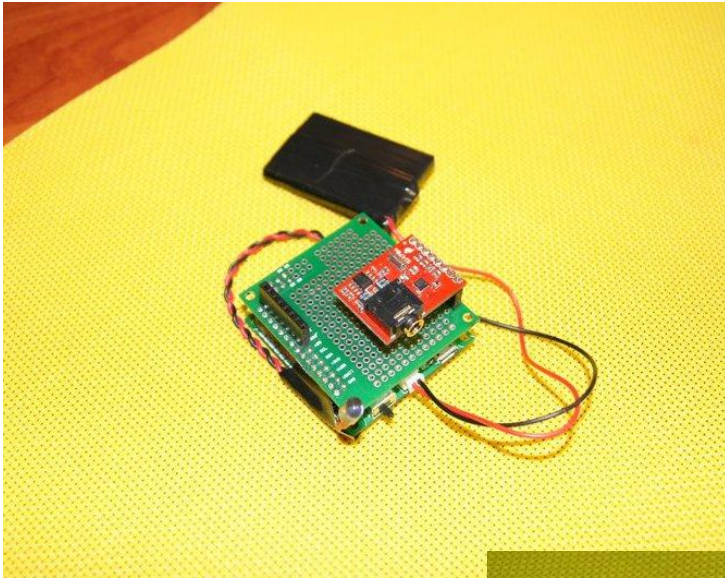Consultant: Patrick Mitran

The Problem of Remote Control

- Remote control hasn't changed in years
- Technology changes quickly
- Need a way to update remote control
- Align control with modern technology

What is ARUCI?

- Augmented Reality Universal Controller and Identifier
- Utilizes smartphone and custom hardware to control devices
- Commands are sent wirelessly to device nodes
  - Line-of-sight not required
- Nodes are identified and located visually in real time
  - Multiple nodes can be shown simultaneously
- Integrates control with augmented reality
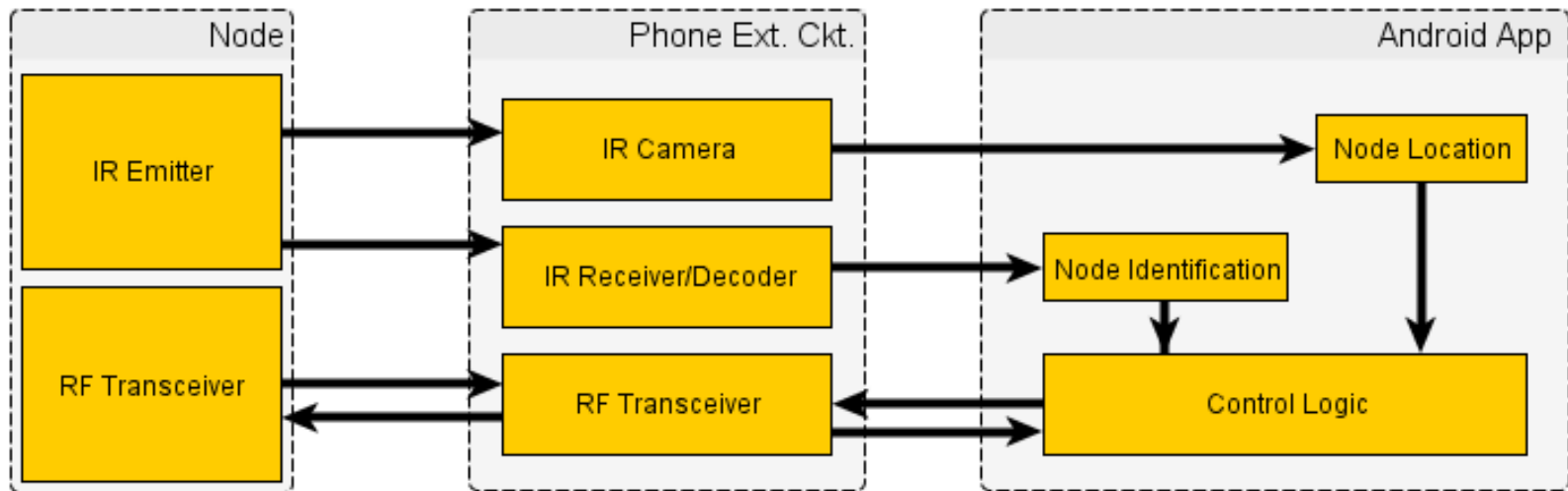- Updates remote control far beyond simple 1950s IR control
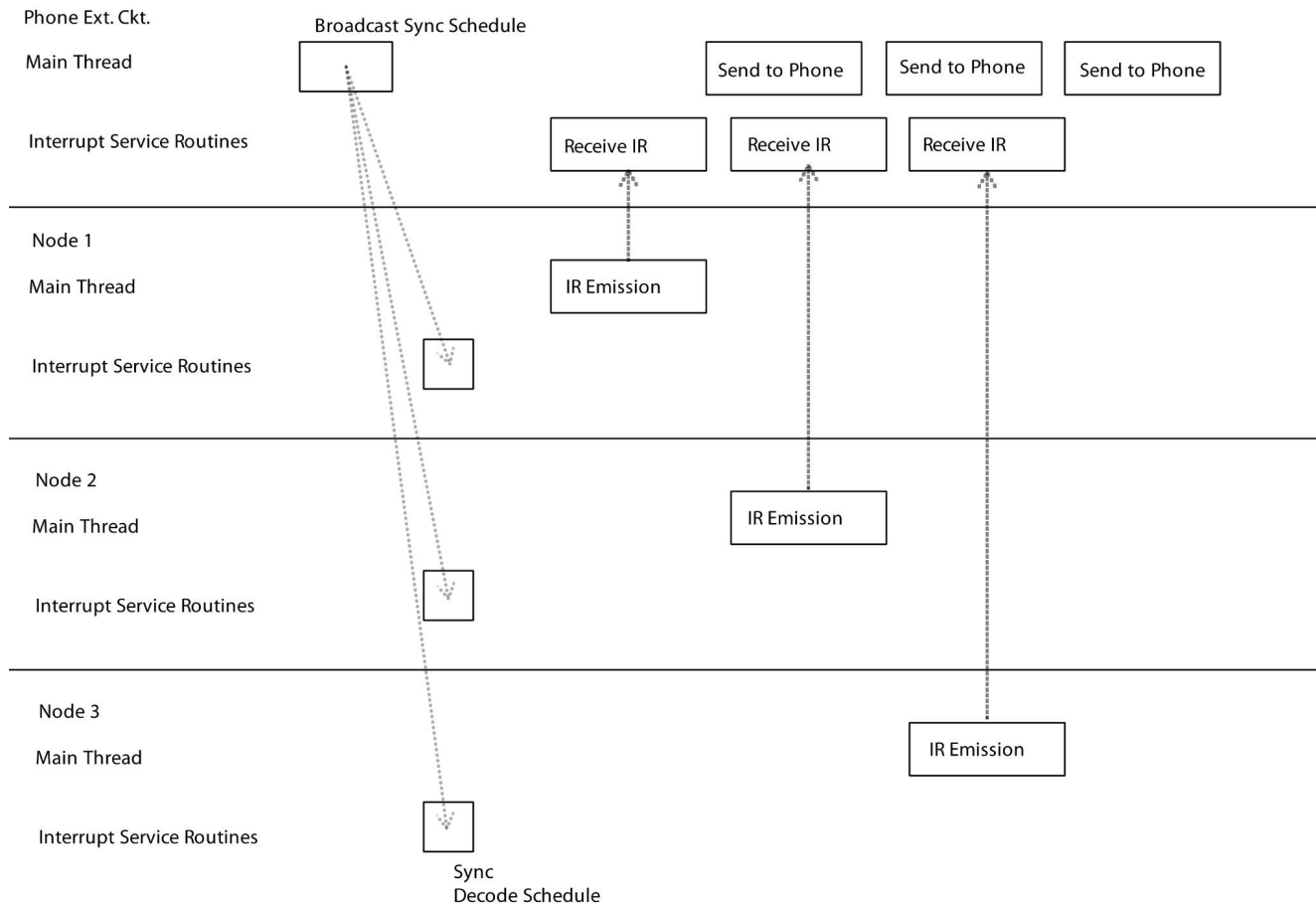
ARUCI System

The ARUCI System in Three Parts

ARUCI Communication

IR Scheduling

Phone Ext. Ckt.

Broadcast Sync Schedule

Main Thread

| Send to Phone | Send to Phone | Send to Phone |

Interrupt Service Routines

| Receive IR | Receive IR | Receive IR |

Node 1

Main Thread

IR Emission

Interrupt Service Routines

Node 2

Main Thread

IR Emission

Interrupt Service Routines

Node 3

Main Thread

IR Emission

Interrupt Service Routines

Sync
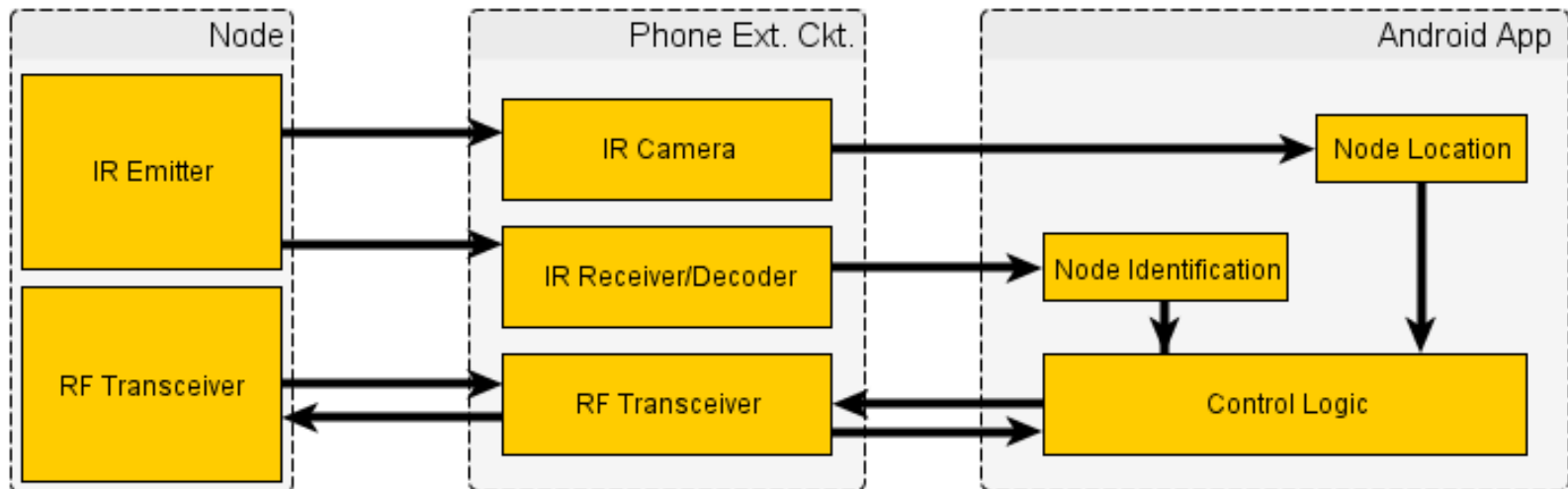Decode Schedule

ARUCI Communication

Risks

- IR camera response time
  - Could be out-of-sync with IR decoder
  - Could be compensated if lag is deterministic
  - Tested with logic analyzer, results acceptable
- Microbridge protocol overhead
  - Since it emulated TCP, it had significant overhead, on top of the overhead for the MAX3421 chip itself
  - Testing showed the performance was acceptable
  - The requirement of a boost converter killed the battery life
- Circuit / PCB flaw
  - Application circuit board allows for changes
  - We had to do one PCB re-spin
    - Timeline did take this possibility into consideration
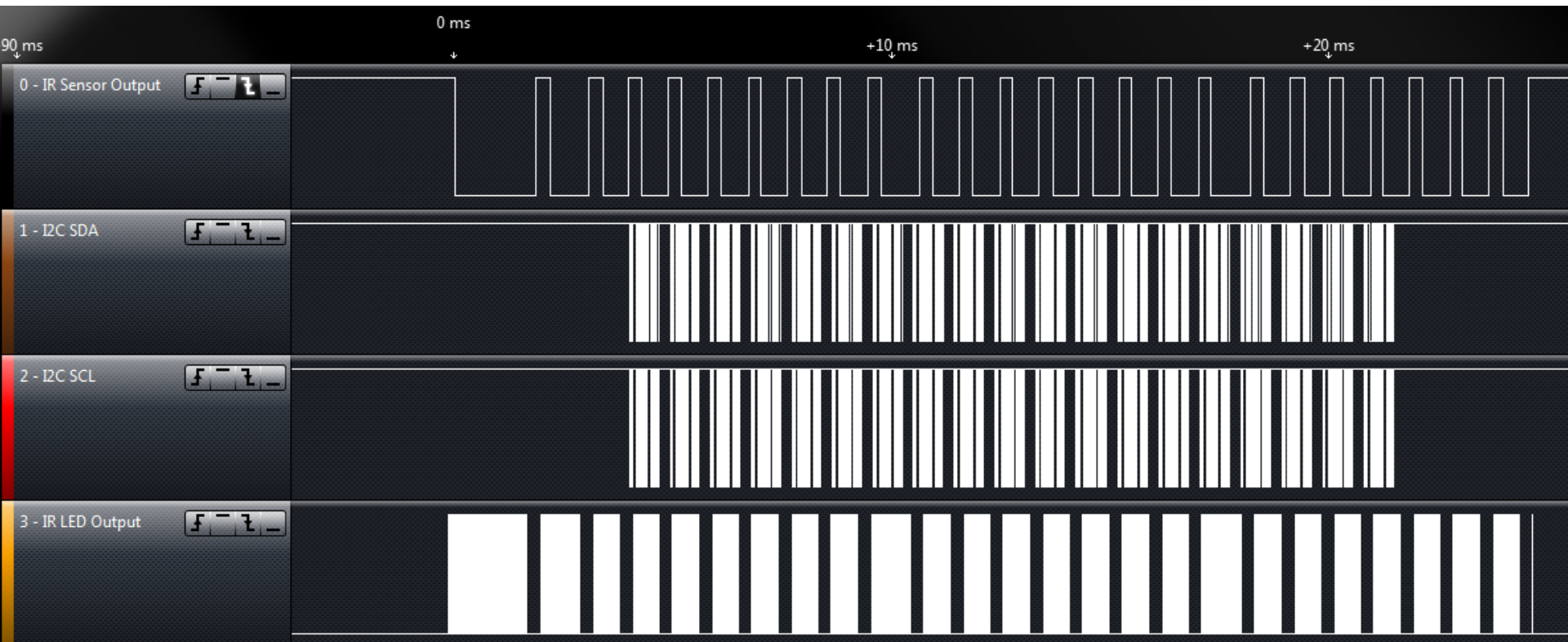
Alternatives

- Bluetooth
  - Limited connections
- Other IEEE 802.15.4 standards (or other ISM bands)
  - ZigBee, BitCloud, etc.
    - Bloated
  - CC2000, STM32W, etc.
    - Unavailable tools and software
- Wi-Fi or XBee
  - Power hungry
  - More hardware
- Premade AR APIs (Vuforia, etc.)
  - Not flexible enough

ARUCI Advantages

- Small form fitting
  - No ground base station required
- Low energy wireless protocol
  - Speak only when spoken to
  - Low overhead and best effort
- Intuitive augmented reality interface
- Customizable and flexible
  - Many more applications are possible
- Many other neat features

Testing ARUCI

- Prototype almost fully functional last July
- Prioritized core functionality
  - Some optional features were dropped
  - More nodes created and tested after
- Sandwich testing model was used
  - Emulation tools were developed and used

ARUCI

- Brings remote control to today's standards
- Utilizes better technology to make lives easier
- Easy to setup
- Wireless, Small, Efficient
- Has potential for growth and expansion
  - More applications
  - Multiple IR emitters for object size and orientation estimation
  - Integrate into smartphone hardware

Questions?

FAQ:

- ATmega128RFA1 microcontroller for all circuits
  - 128KB flash, 4KB SRAM, 16MHz, AVR core (Harvard architecture)
  - Integrates an IEEE 802.15.4 transceiver
- Cadsoft EAGLE for PCB and schematic
  - PCB fabricated by SeeedStudio
  - Soldered by us, even the QFN footprint
- SolidWorks for 3D printed case
  - Printed by Shapeways, using SLS
- All firmware written in C
  - compiled using GNU AVR-GCC
  - Atmel Studio 6 as IDE
  - USBasp for flash programming, serial port for debugging
- Phone: Samsung Infuse 4G
  - Android OS 2.3.7, SDK version 10
- One nodes costs roughly $25, excluding the cost of the application circuit