WETIBO

uFind

Wireless Parked Car Finding System

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ENSC 440/305
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Agenda

- motivation and marketability
- team dynamics
- overall system functionality
- high level system design
- results and performance
- financials, scheduling
- what was learned
- future enhancements & conclusion

Motivation

- ever lost your car in a crowded parking area?
- cold and raining?
- exhausted and frustrated?
- embarrassed to press the panic button to find your car?
- short range keyless entry systems?

Source: www.nmsu.edu/~safety/images/signs/sign_caution_blk_lg.GIF

Motivation

Applications:

- **busy parking lots**
  - airports
  - stadiums
  - movie theatres
  - malls

Other Potential Applications:

- infants
- pets

Source: www.nmsu.edu/~safety/images/signs/sign_caution_blk_lg.GIF

Marketability

- a conventional keyless entry system
  - stand-alone
  - installable in an existing system
- cost effective
  - competitive selling price

- alternatives to uFind:
  - Keyless Entry Systems (disturbing, ineffective, short range)
  - GPS (non functional underground)

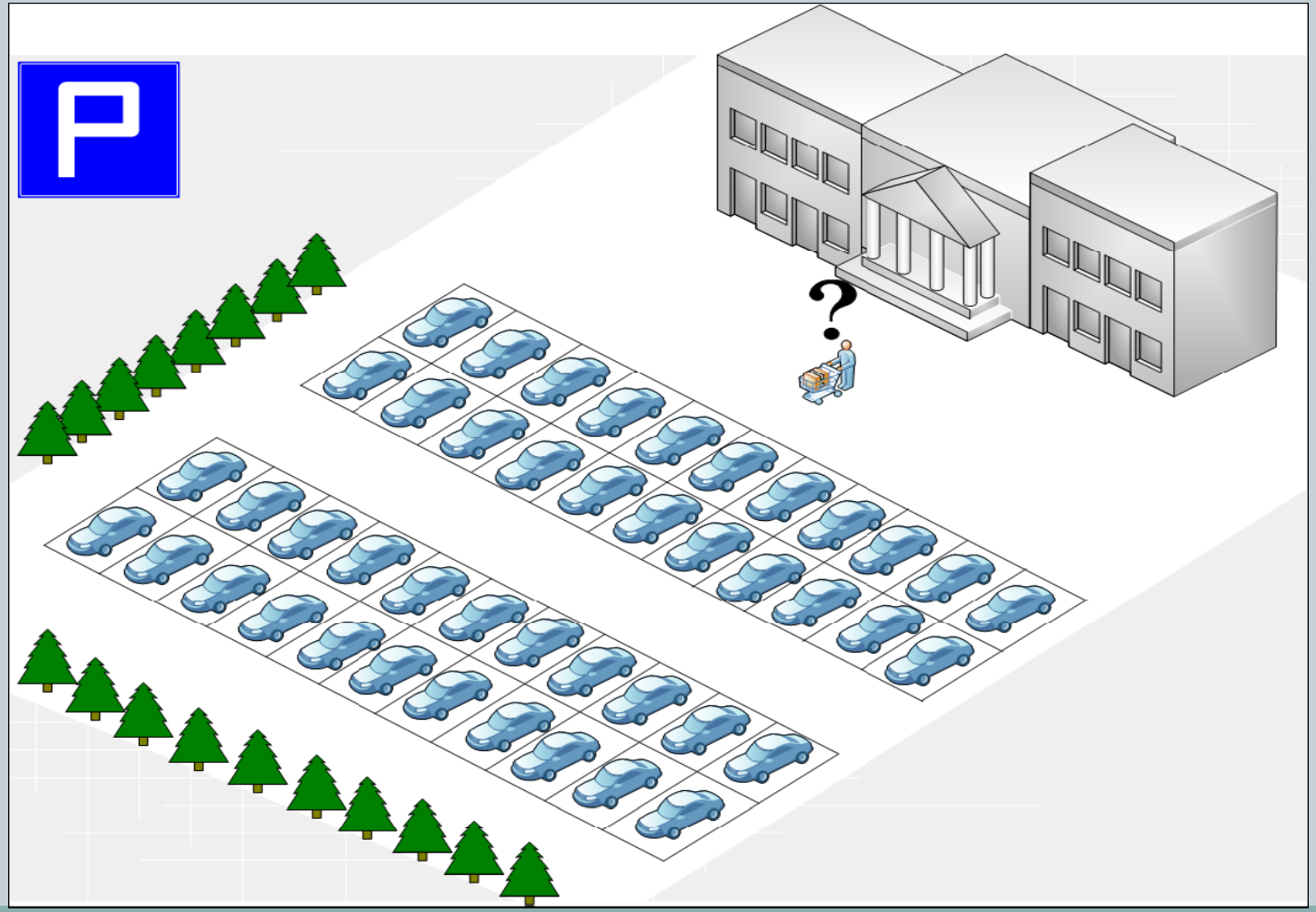
Marketability

Source: www.adpunch.org/images/viper-security_25.jpg

Keyless Entry Systems (Car Alarms)

- avoid disturbance
  panic button or lock/unlock buttons used to find a car is annoying
- cuts down on people ignoring car alarms
- longer range (1000m)

Application Example



Team Dynamics

- excellent team work
- formal weekly meetings
- roles:
  - **Hooman**: hardware/firmware design, R&D, documentation, mounting/assembly, Q/A
  - **Karl**: firmware/hardware design, Q/A
  - **Diwaker**: documentation, hardware assembly, quality assurance, R&D, firmware, Q/A, budgeting
  - **Dennis**: firmware design/implement/test, documentation, Q/A

Overall System Functionality

- display proximity between user and car
- assist user find direction towards the car
- display parking lot information (number)
- remotely turn on car light, beeper, car engine, etc for further help (<1 km) much longer range than what is in the market)

Proximity Detection Designs

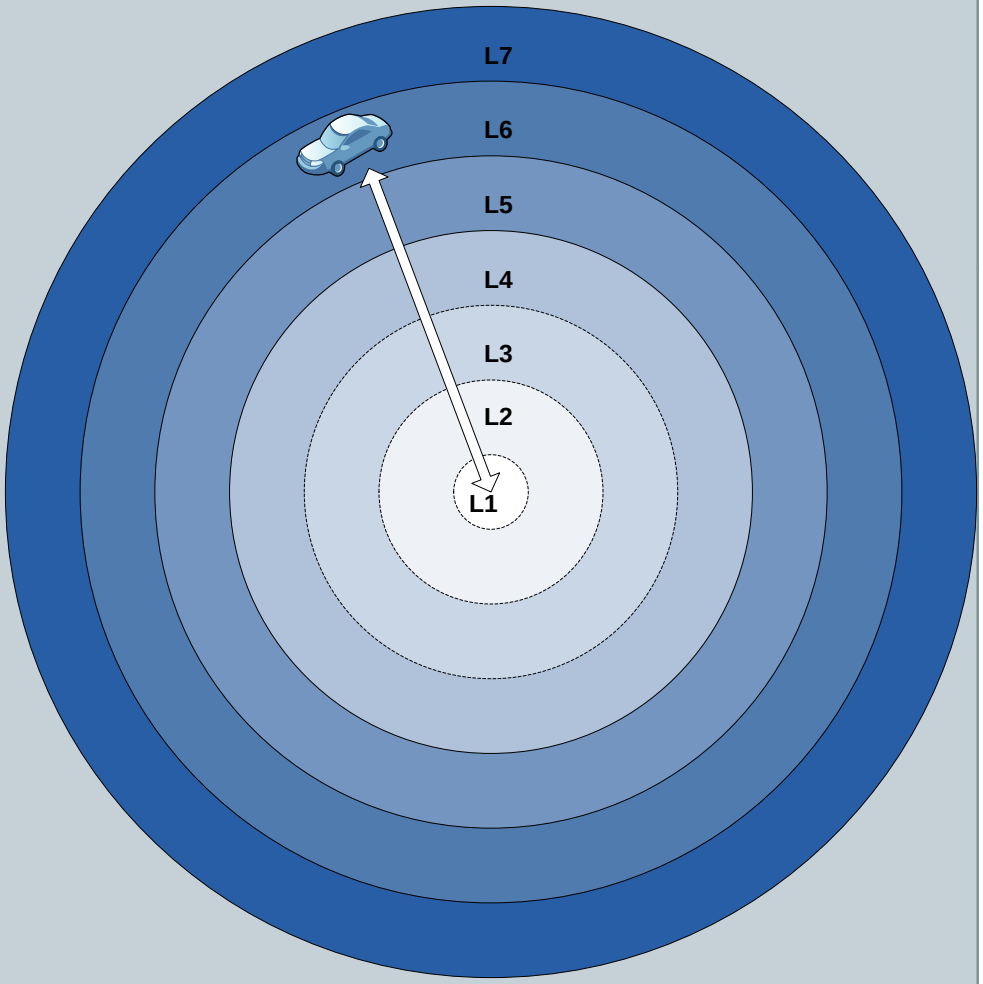
- Transmission Power Adjustment (TPA)

alternative design method:

- Time of Flight Loop Frequency (TFLF)

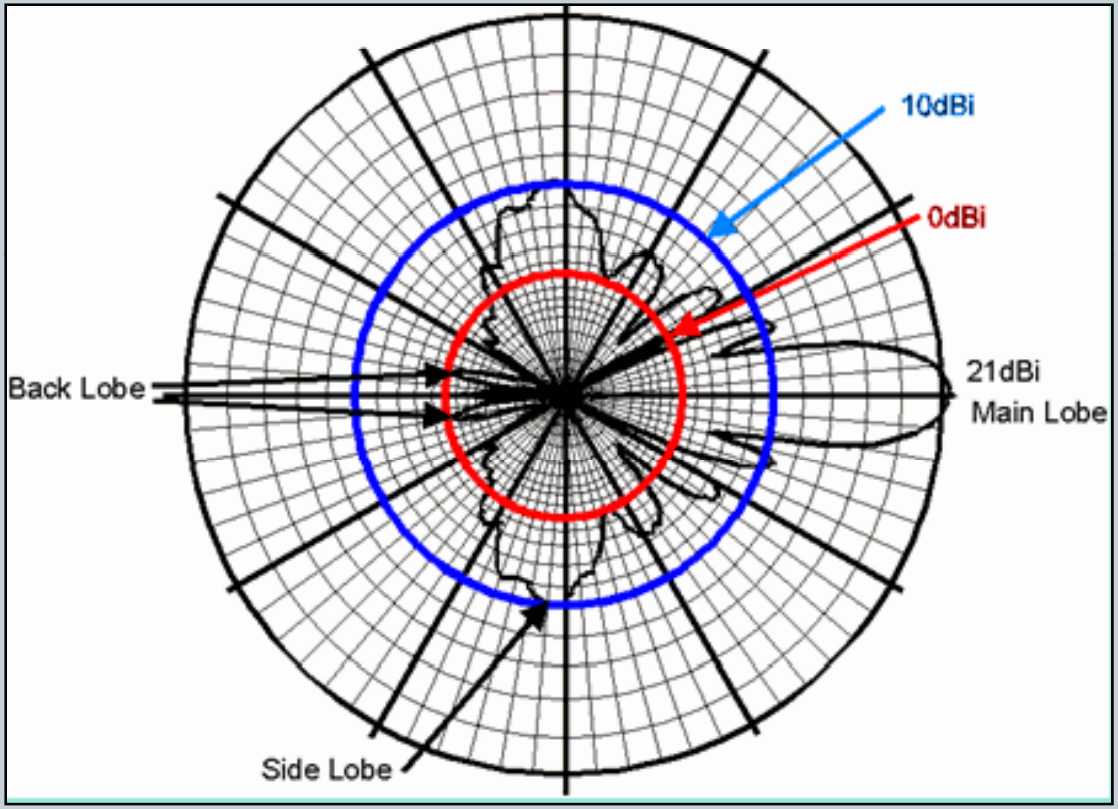
TPA Method

- reach different ranges by adjusting the transmission power
- search algorithms
- direction detection



Directional Antenna

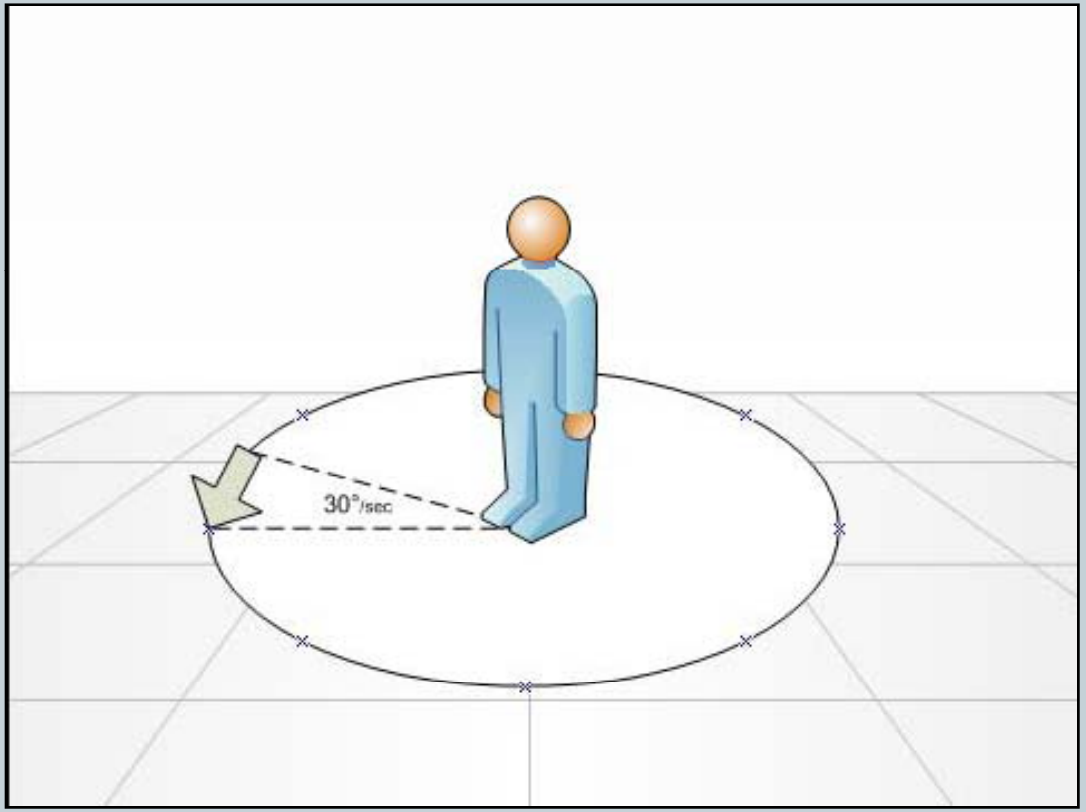
- receive/transmit signal stronger in a direction
- 2 directional antennas are ultimately needed on the hand-held



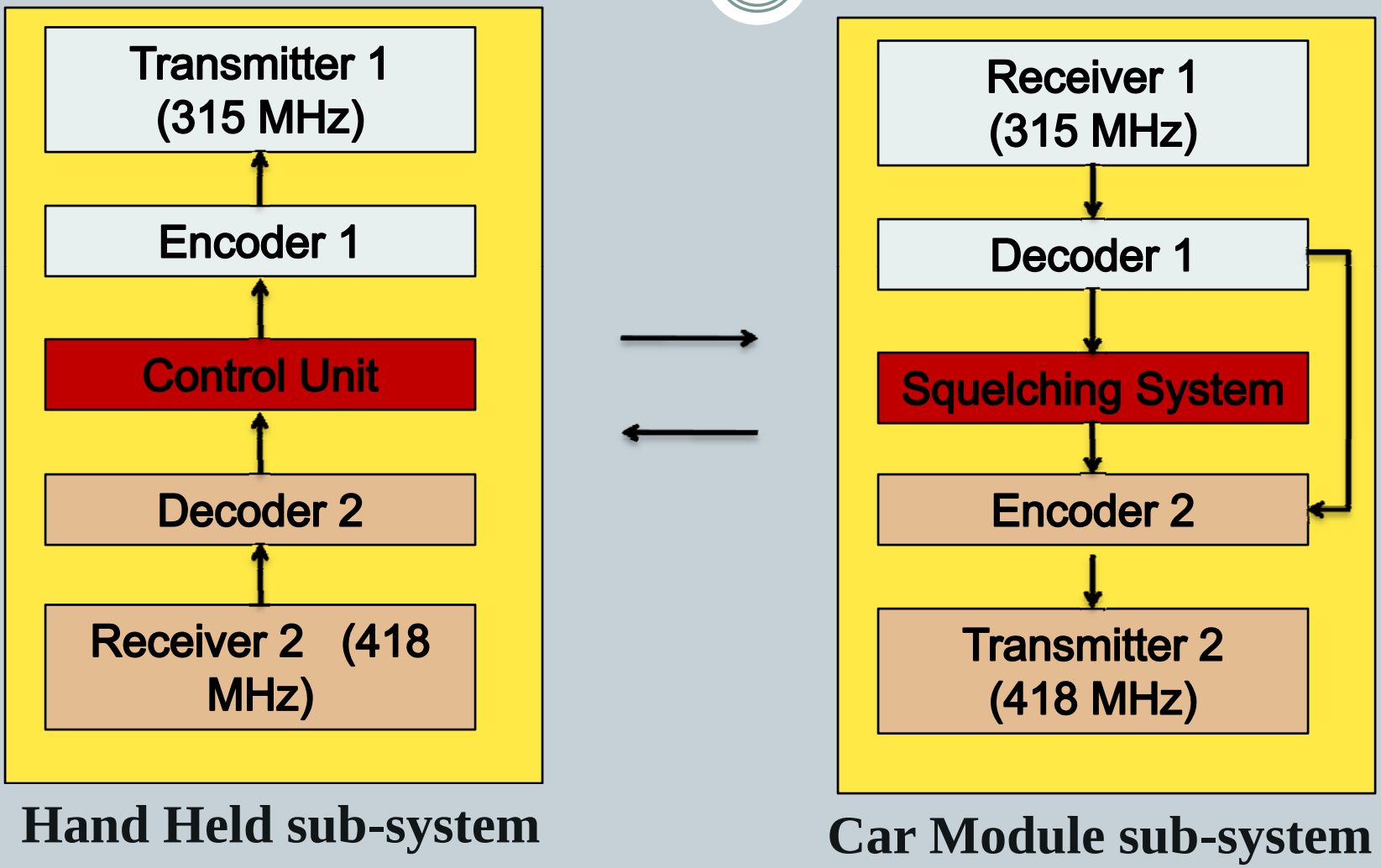
source: http://www.cisco.com/warp/public/102/omni-vs-direct6.gif

Directionality

- read filtered RSSI
- calculate/calibrate directionality indicator
- display



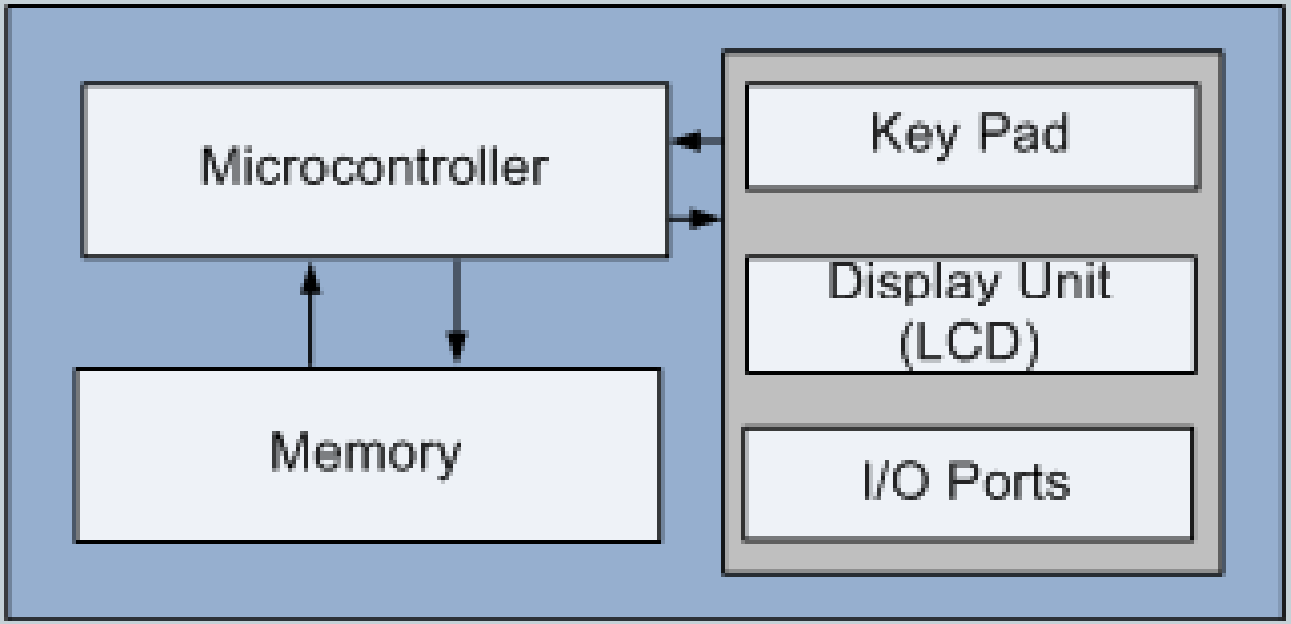
Communication System



Hand Held sub-system

Car Module sub-system

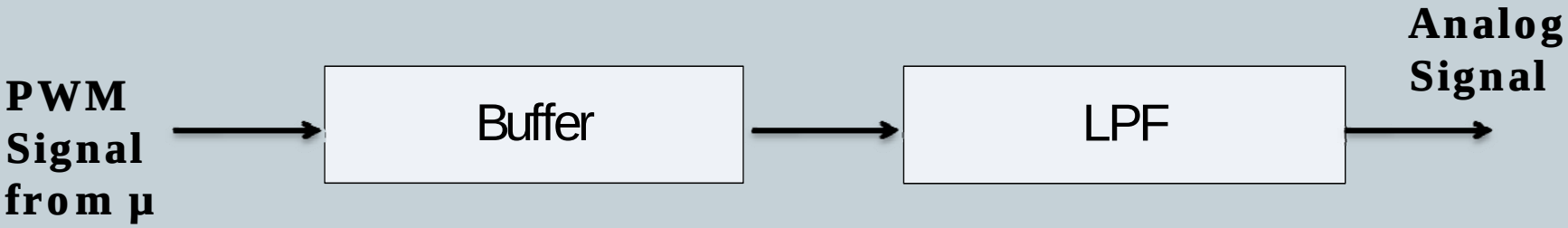
Control Unit and User Interface



Hand Held - subsystem

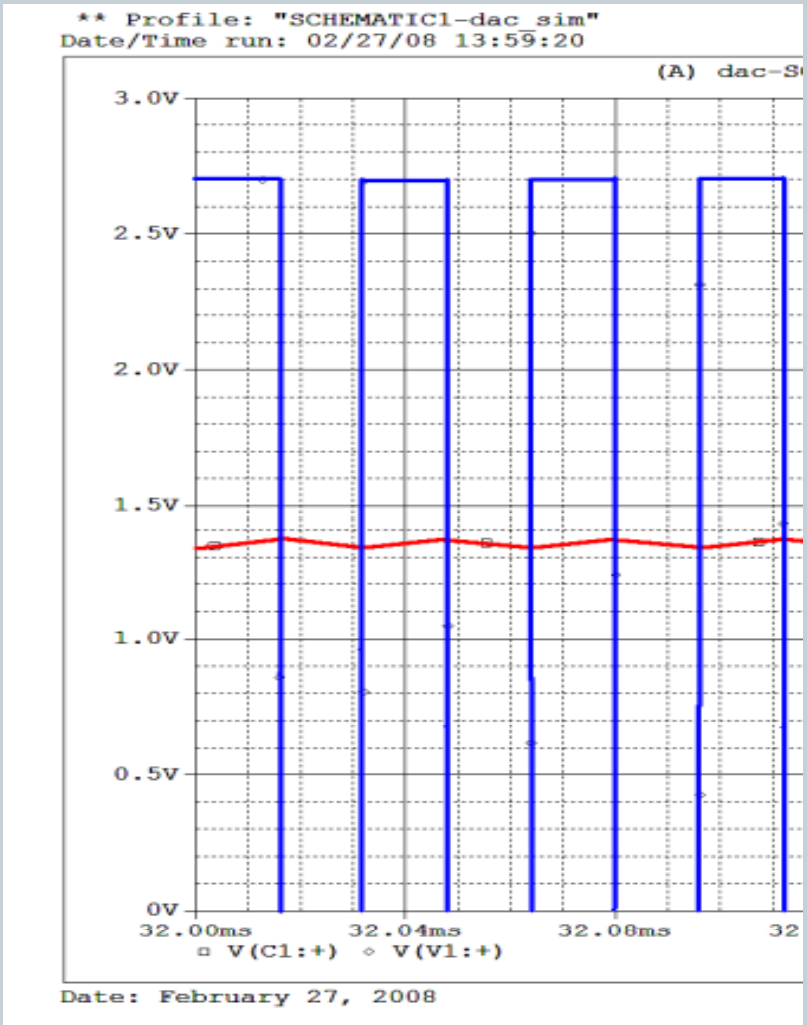
Digital Power Adjustment Circuit

$$V_C(t) = V_i(1 - e^{-t/RC})$$

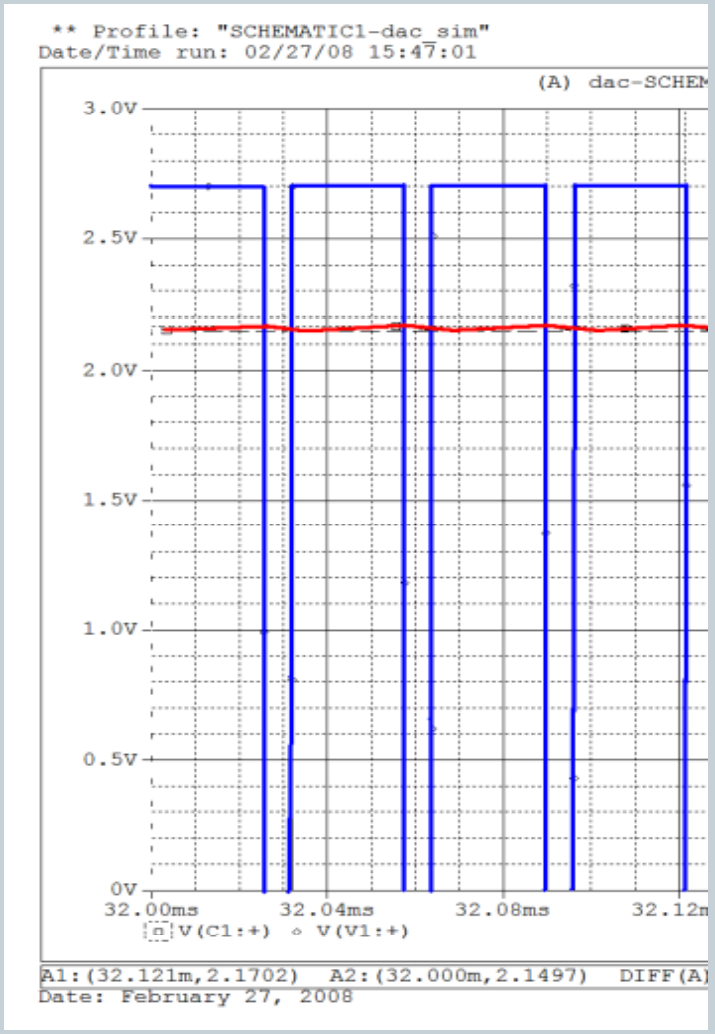


- 7 ms delay
- 14.5% ripple ratio
- causes little proximity detection error

DAC Simulation

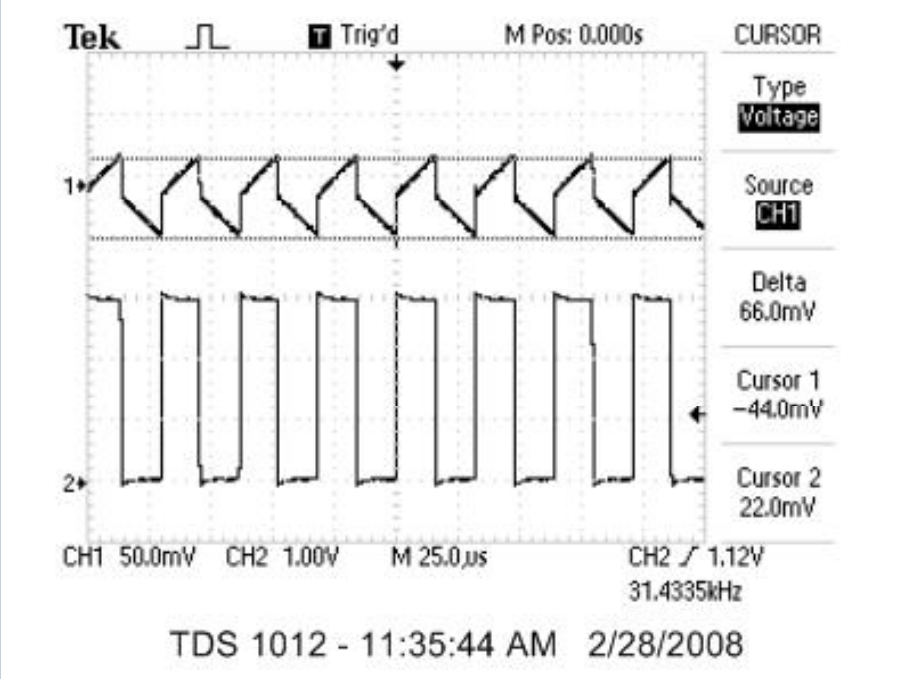


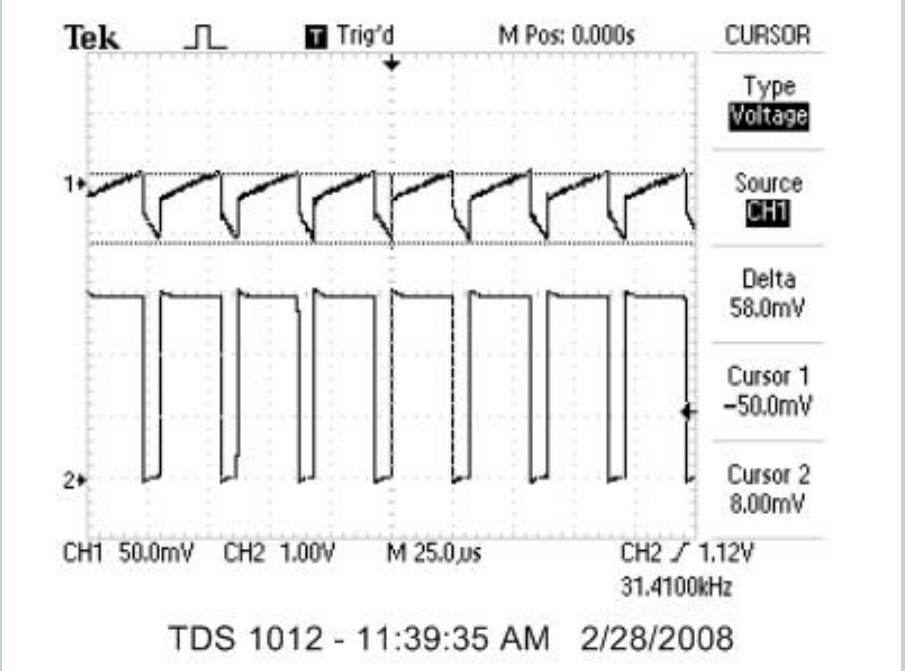
50% Duty Cycle



80% Duty Cycle

DAC Results

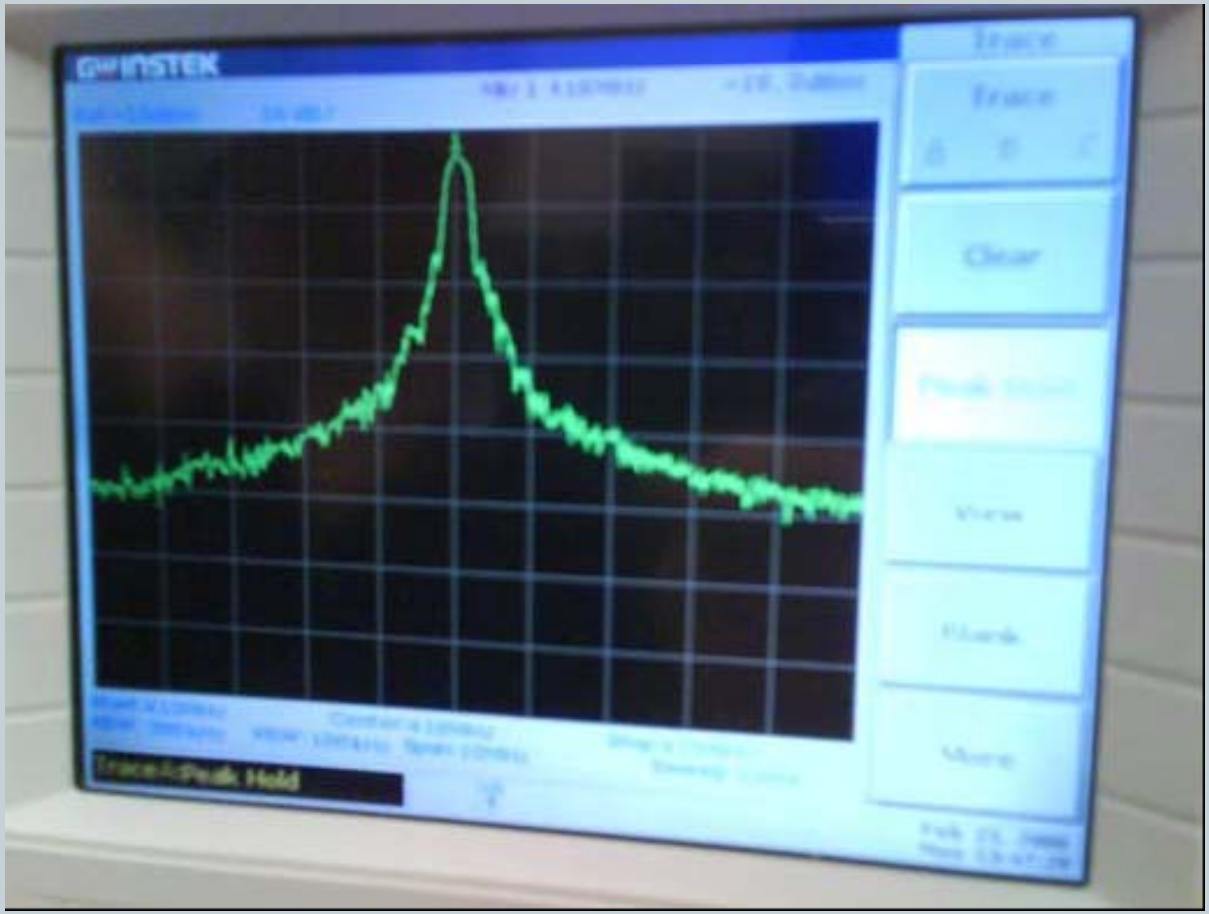




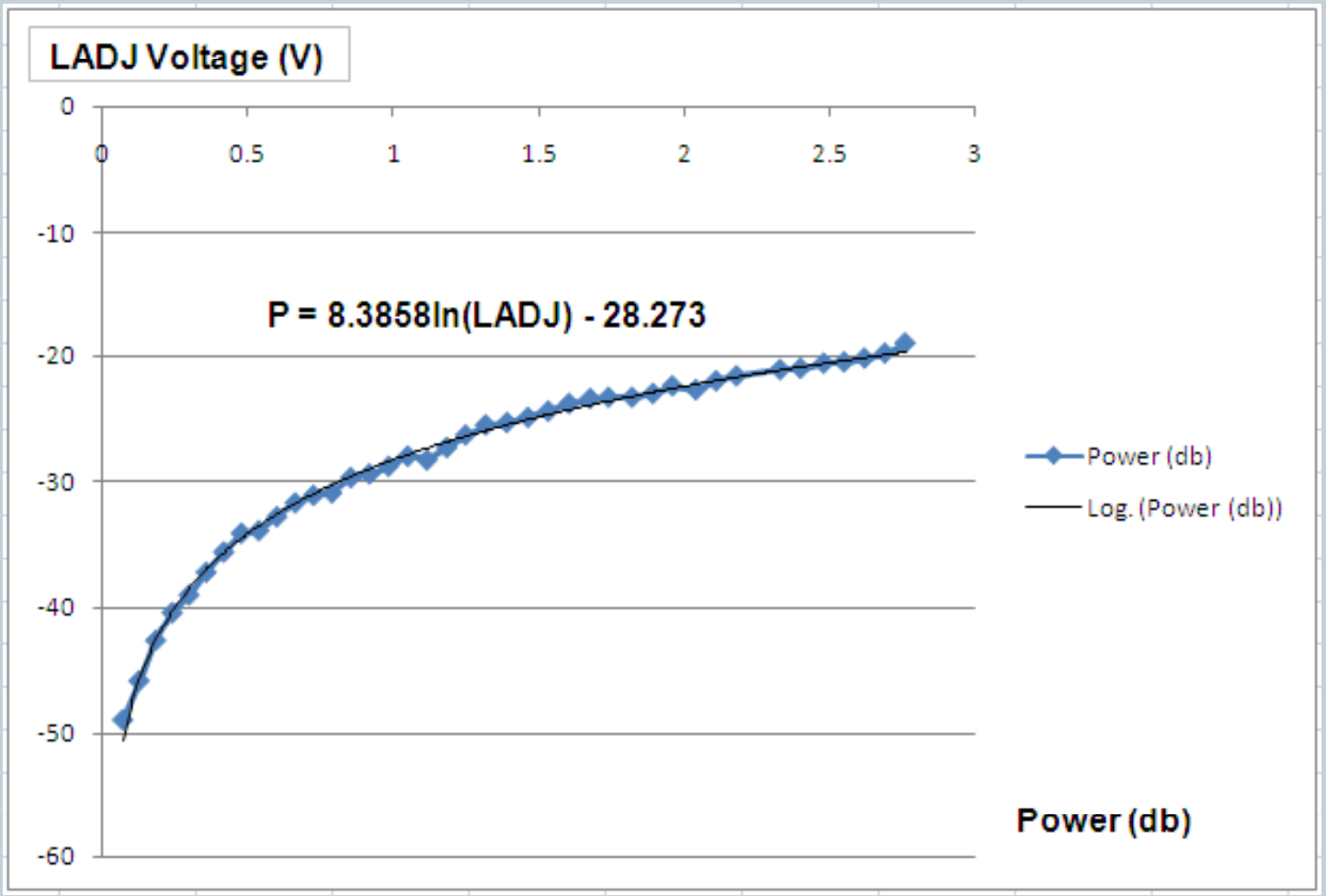
50% Duty Cycle

80% Duty Cycle

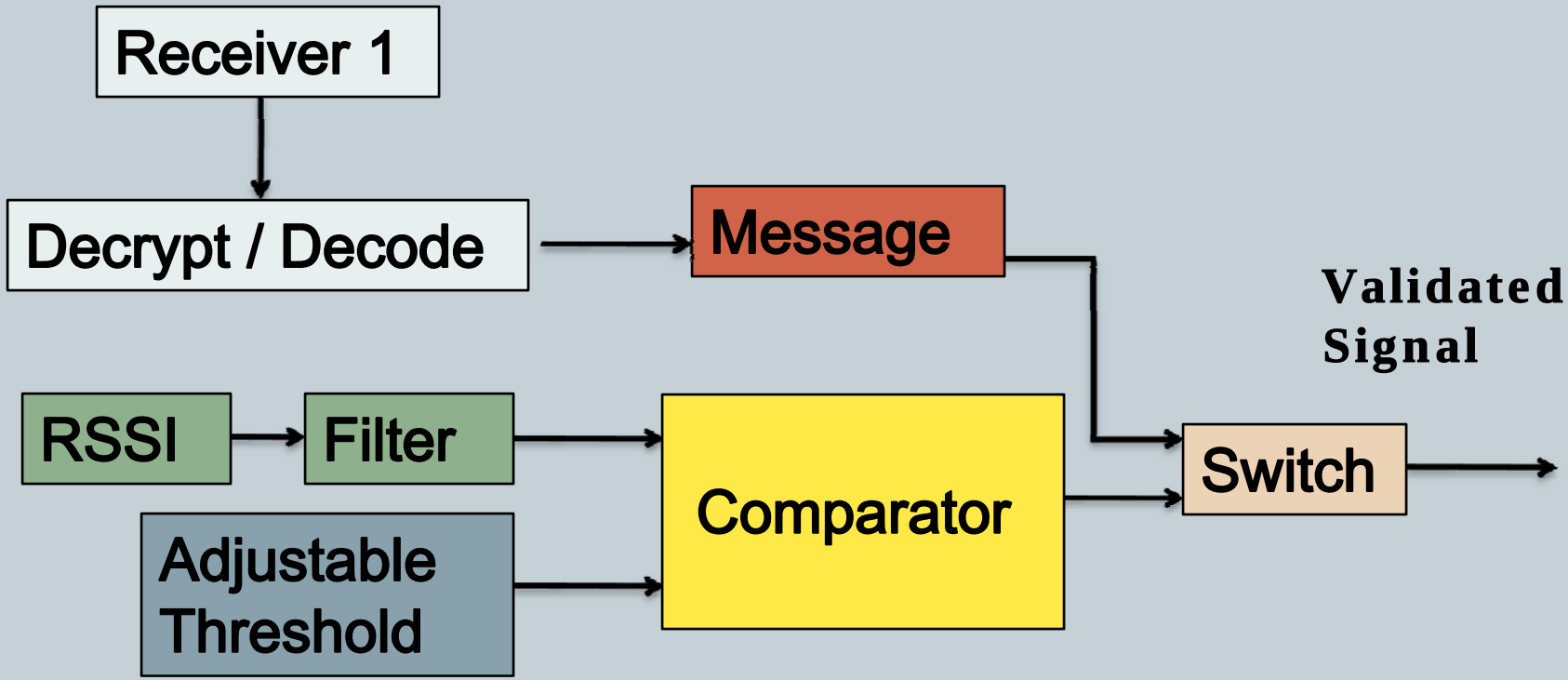
Power Measurement



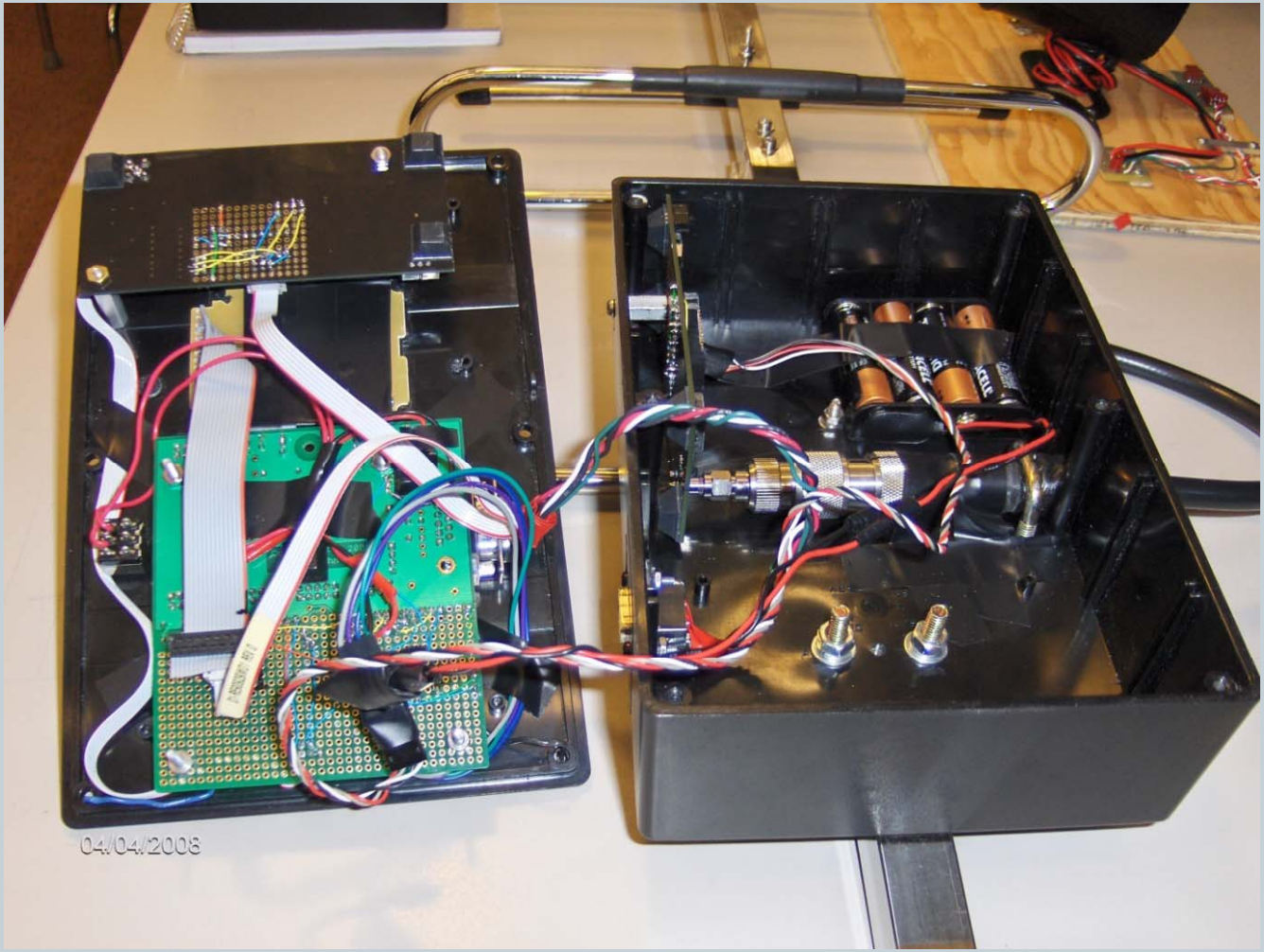
Transmission Power



Receiver Squelching System

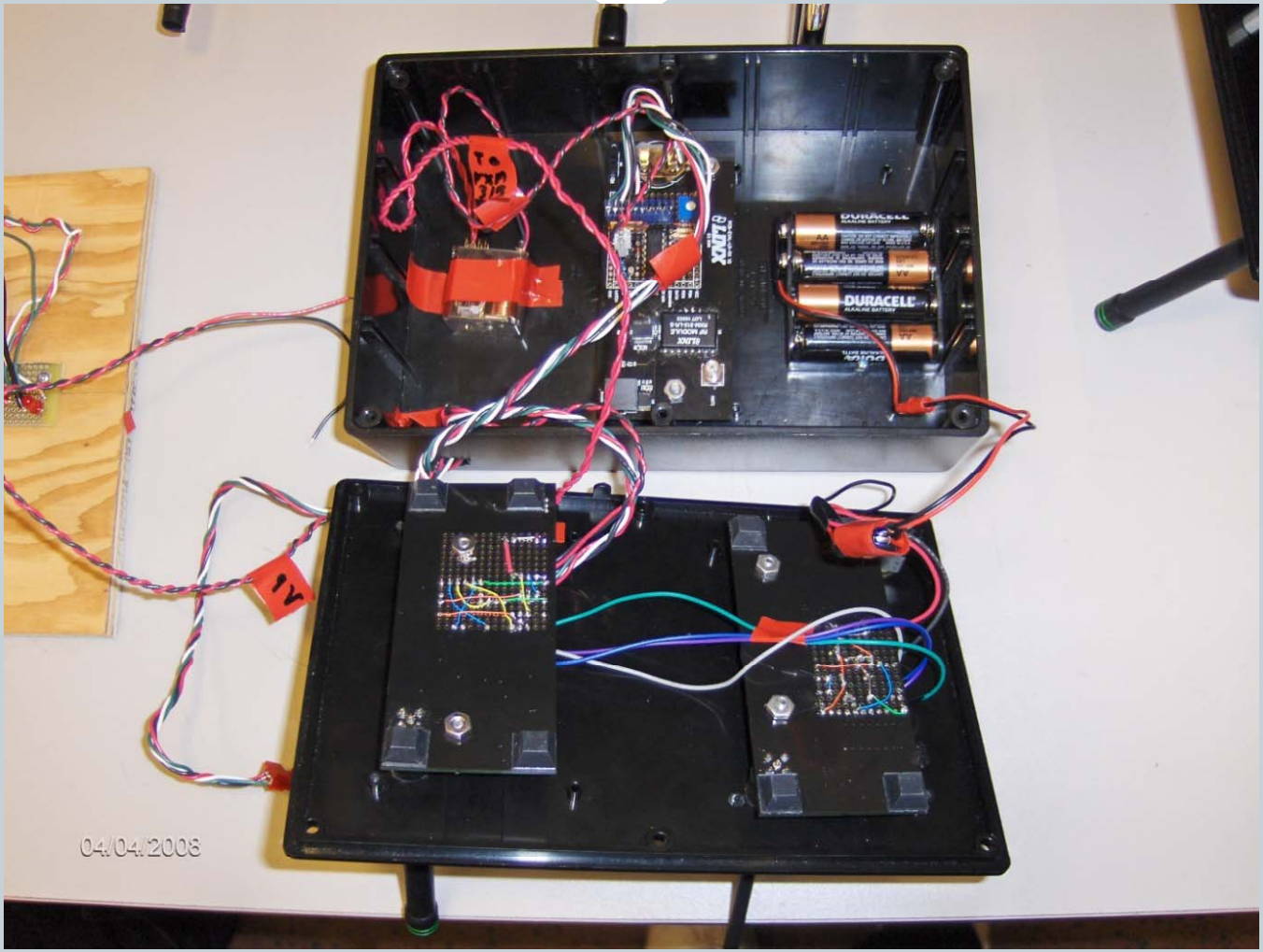


Hand-Held Module



Hand-Held Module User Interface

Car Module

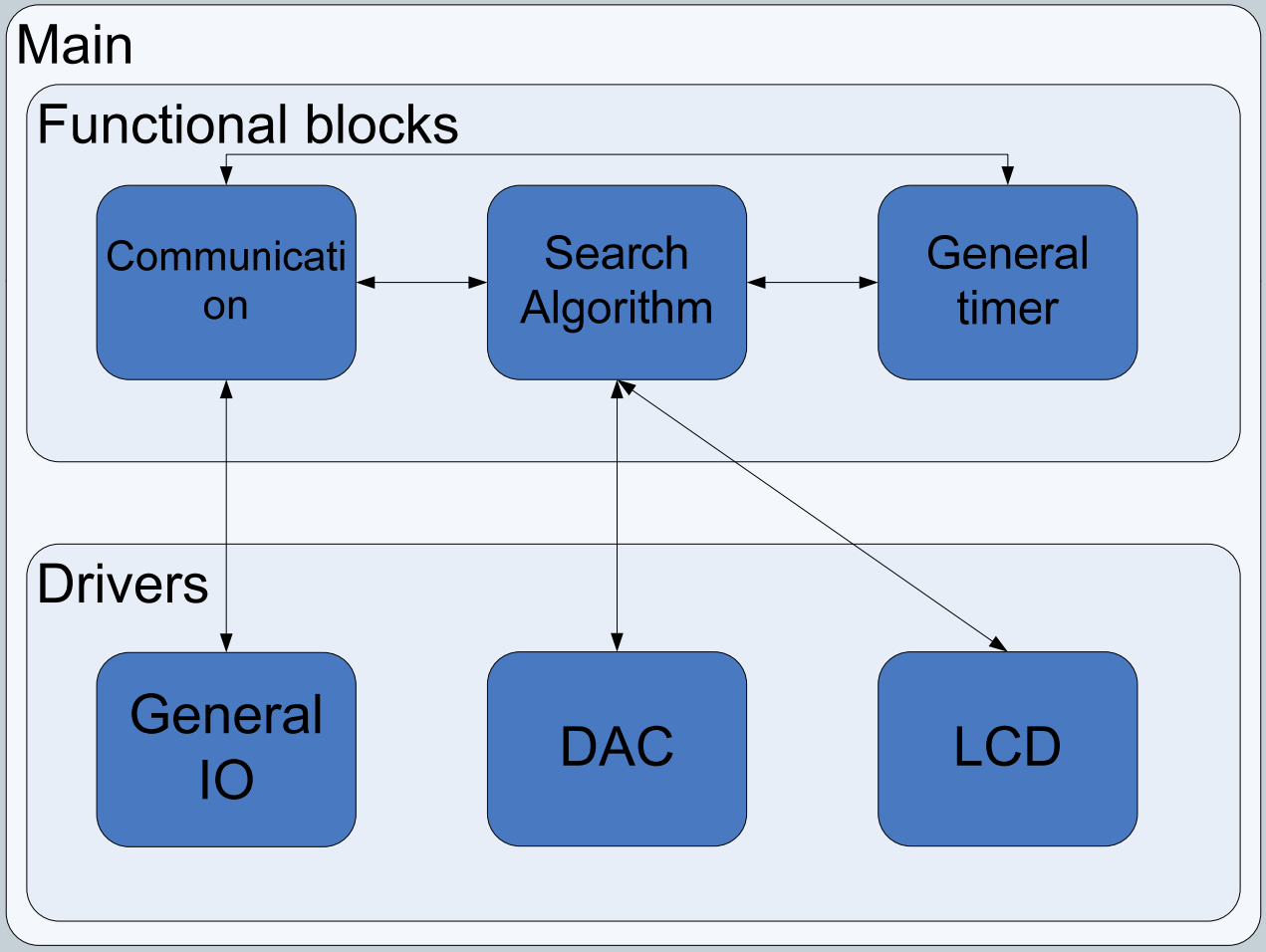


Entire System

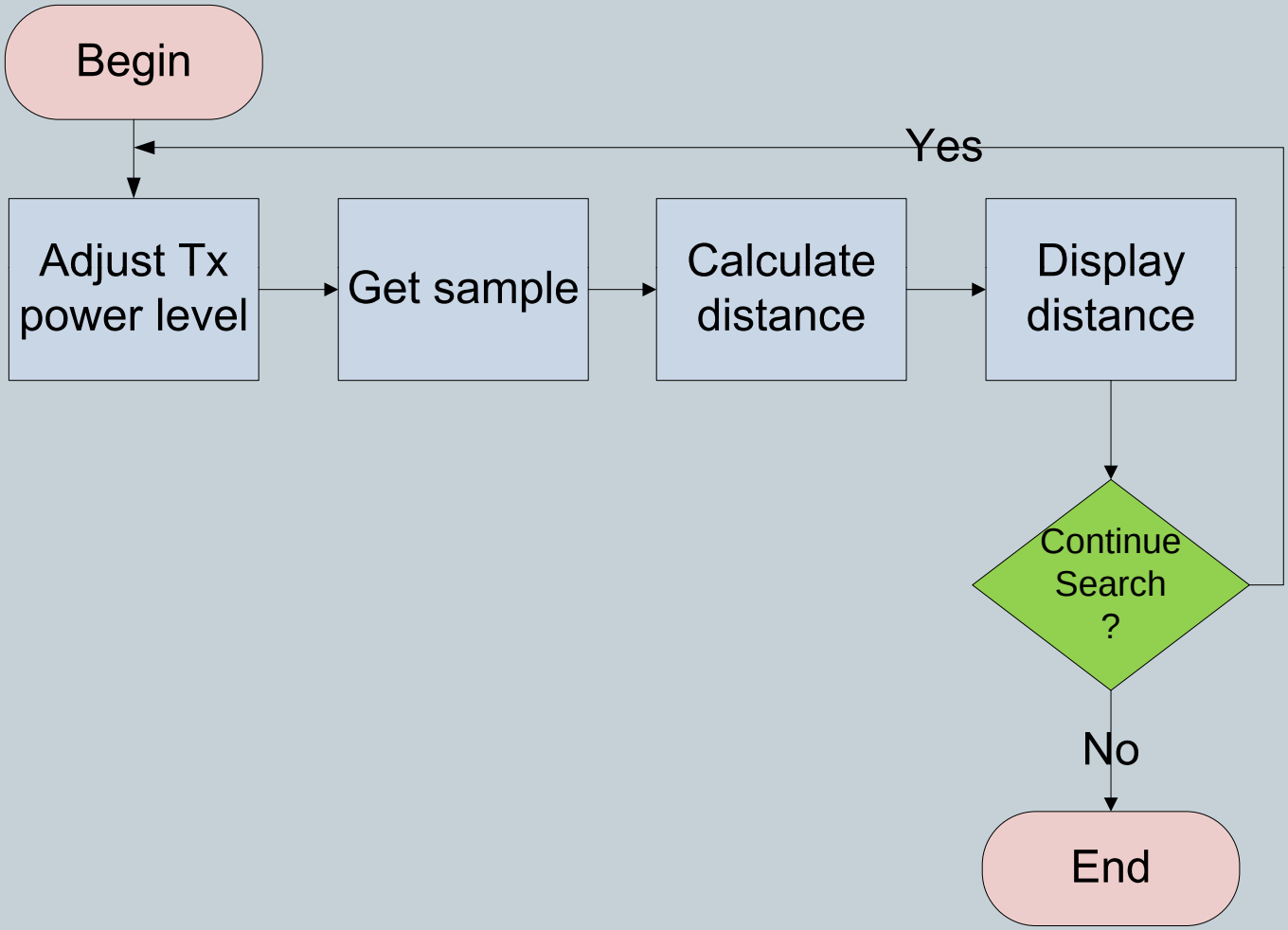
Firmware Design

- firmware
- different methods tested
- related issues

Firmware Organization

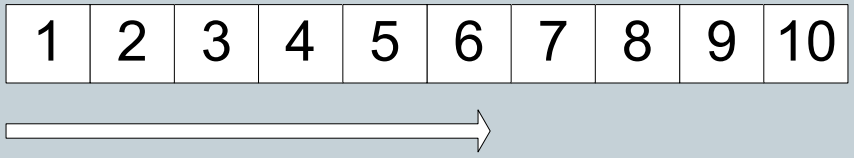


Search Algorithm

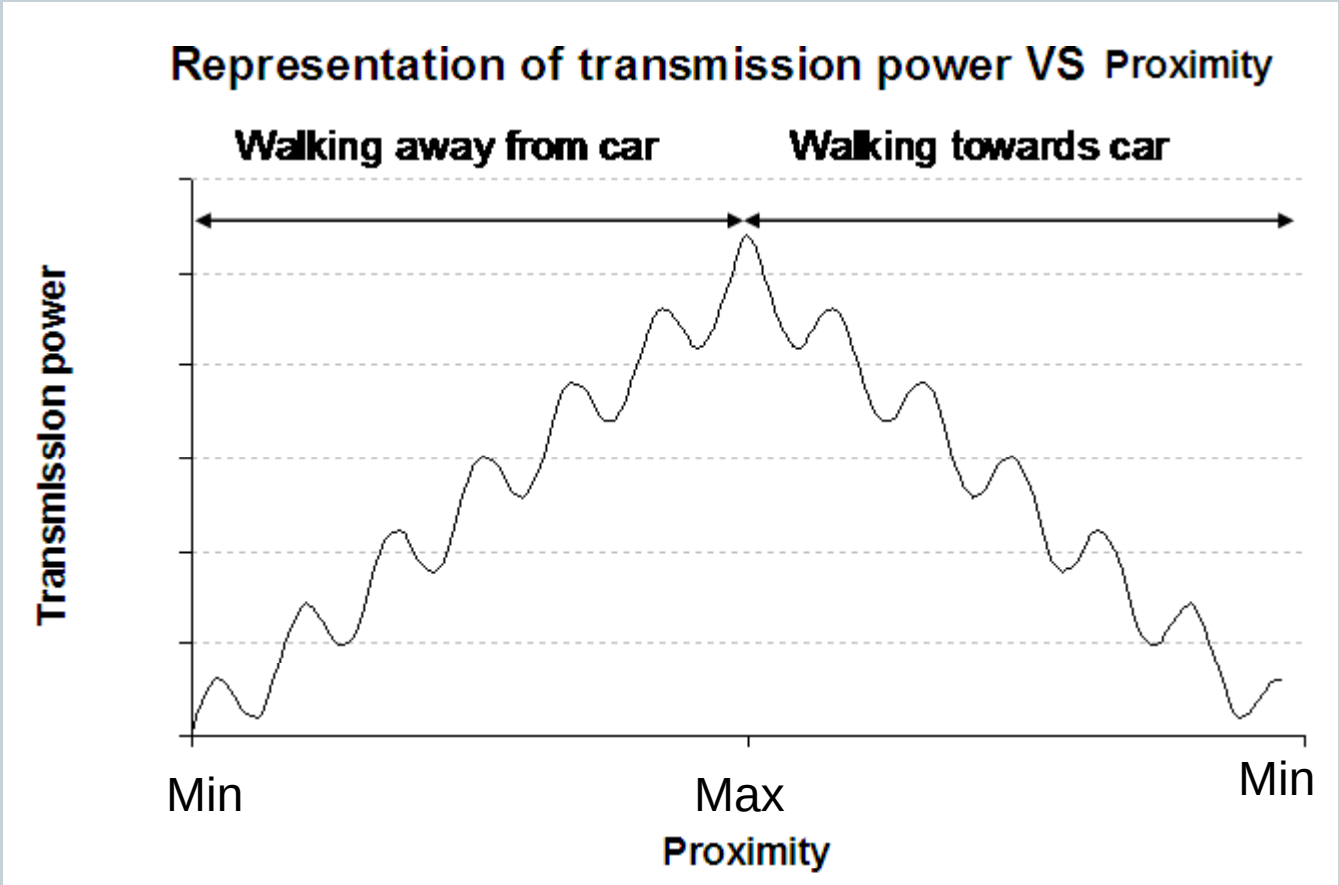


TPA Software

- linear search
  - k comparisons in worst case
  - increase transmission power linearly
  - each comparison is 140ms
  - worst case is 17.92 seconds to determine distance between user and car

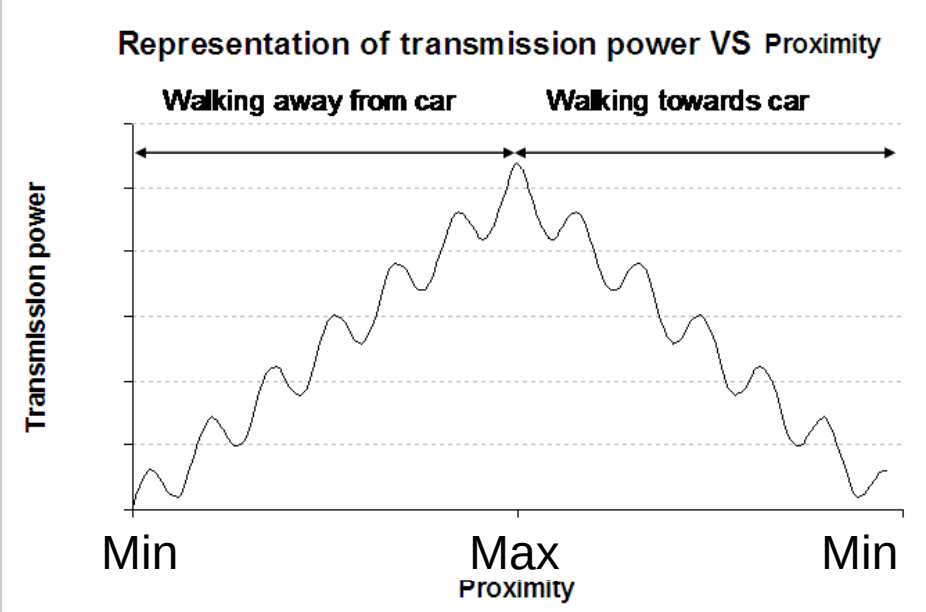


TPA Software

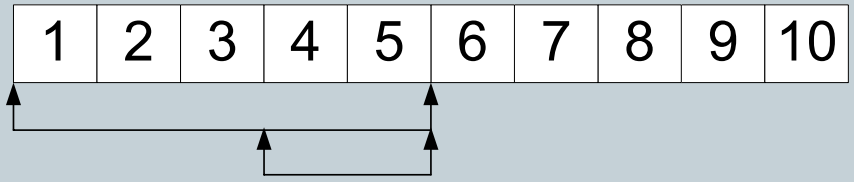


TPA Software

- distance calculation
  - peak average
  - crest average
  - peak & crest average
  - all point average

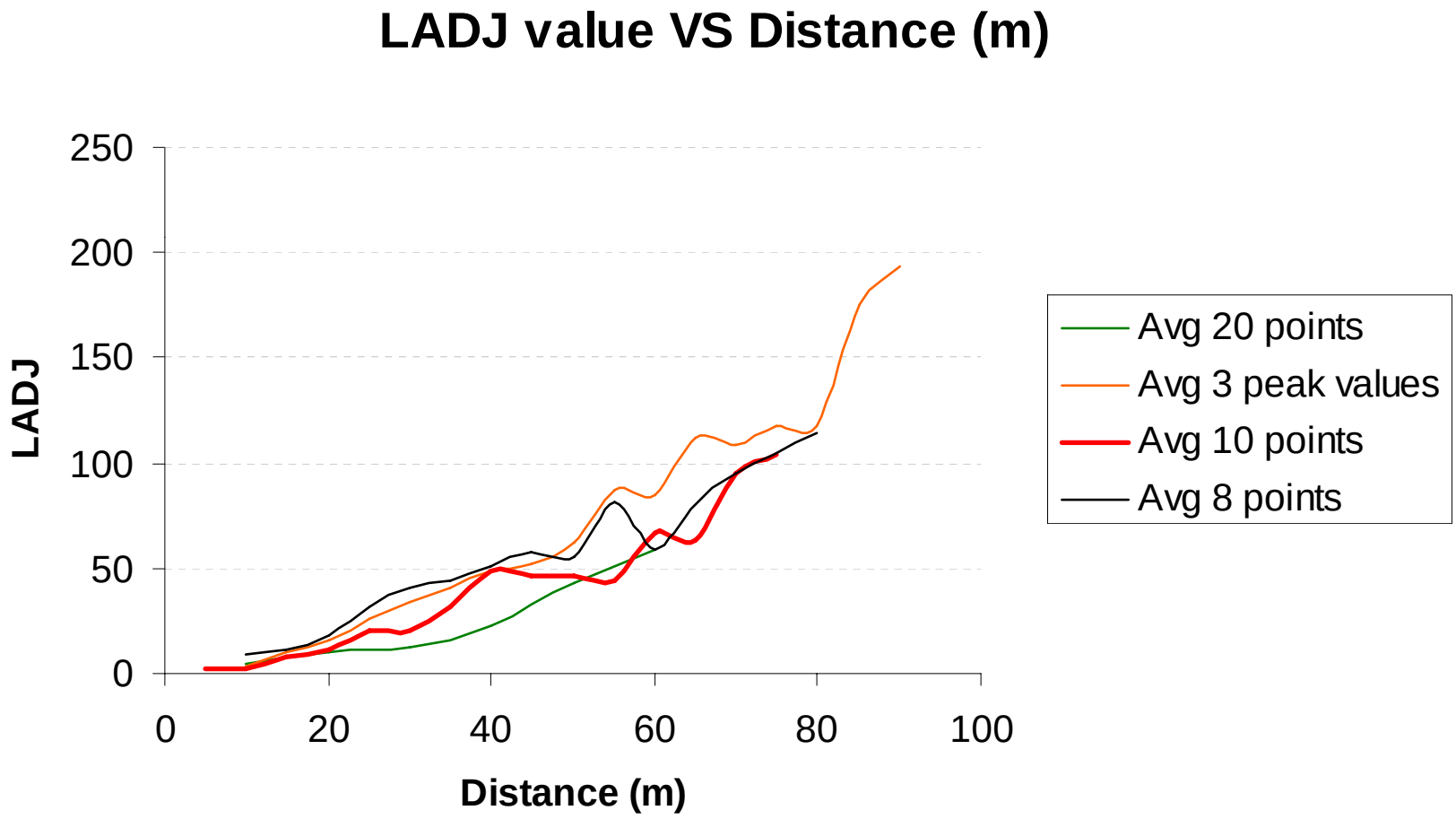


- binary search
  - $\log_2 k$ comparisons in worst case
  - each comparison is 140ms
  - worst case 980ms before distance is updated

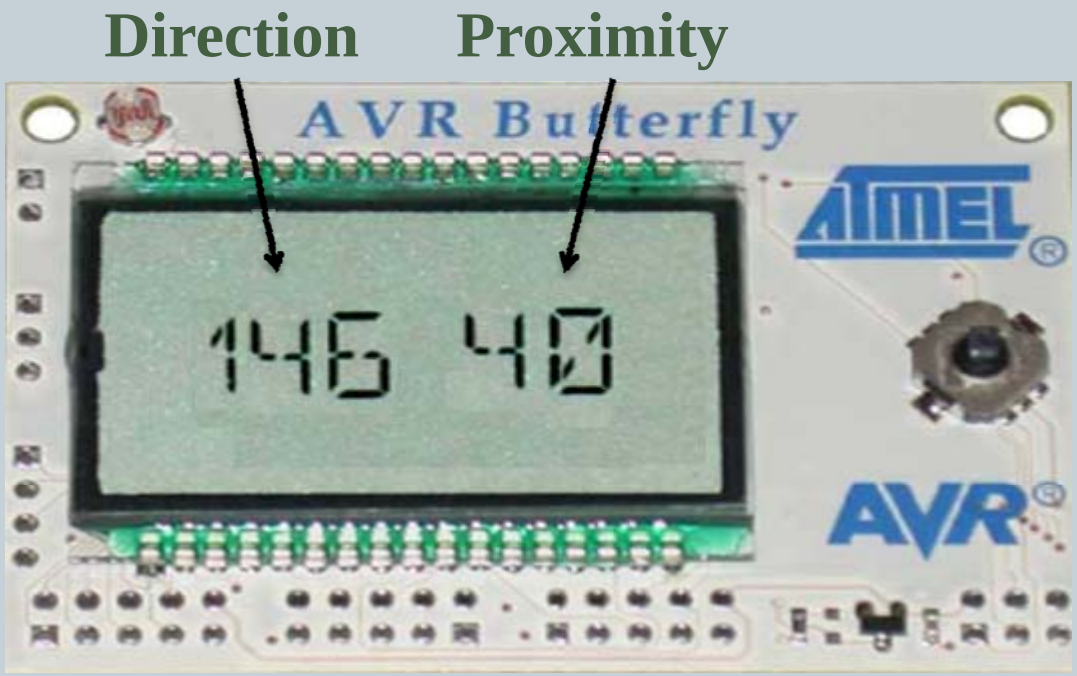


Binary search illustration

Power VS distance relation



Directionality / Proximity Indicators



User Interface - Menus

- Weiibo Inc. -> uFind 2008
- find car
- enter parking lot information
- show parking lot information
- date and time
- user name and phone number
- settings

Menu

- find car – password needed
  - fast search: display signal strength and related distance
  - advanced search: display signal strength and relative power level or proximity
- show parking lot information – password needed
  - parking lot level and number
  - time and date parked

Menu

- enter parking lot information
  - six letters
  - date and time
- date and time
  - real date and time
  - format can be changed
- user name and phone number
  - 26 letters
  - stored in EEPROM

Menu

- settings
  - password – enable, disable and modify
    - two digits (37x37 = 1369 possibilities)
    - stored in EEPROM
  - power save mode (default:30 minutes)

Environmental Limitations and Constraints

- reflections
- multipath
- absorptions
- effect of conducting planes nearby
- water in air

Finances

- Engineering Science Student Endowment Fund (ESSEF) Award

  $640

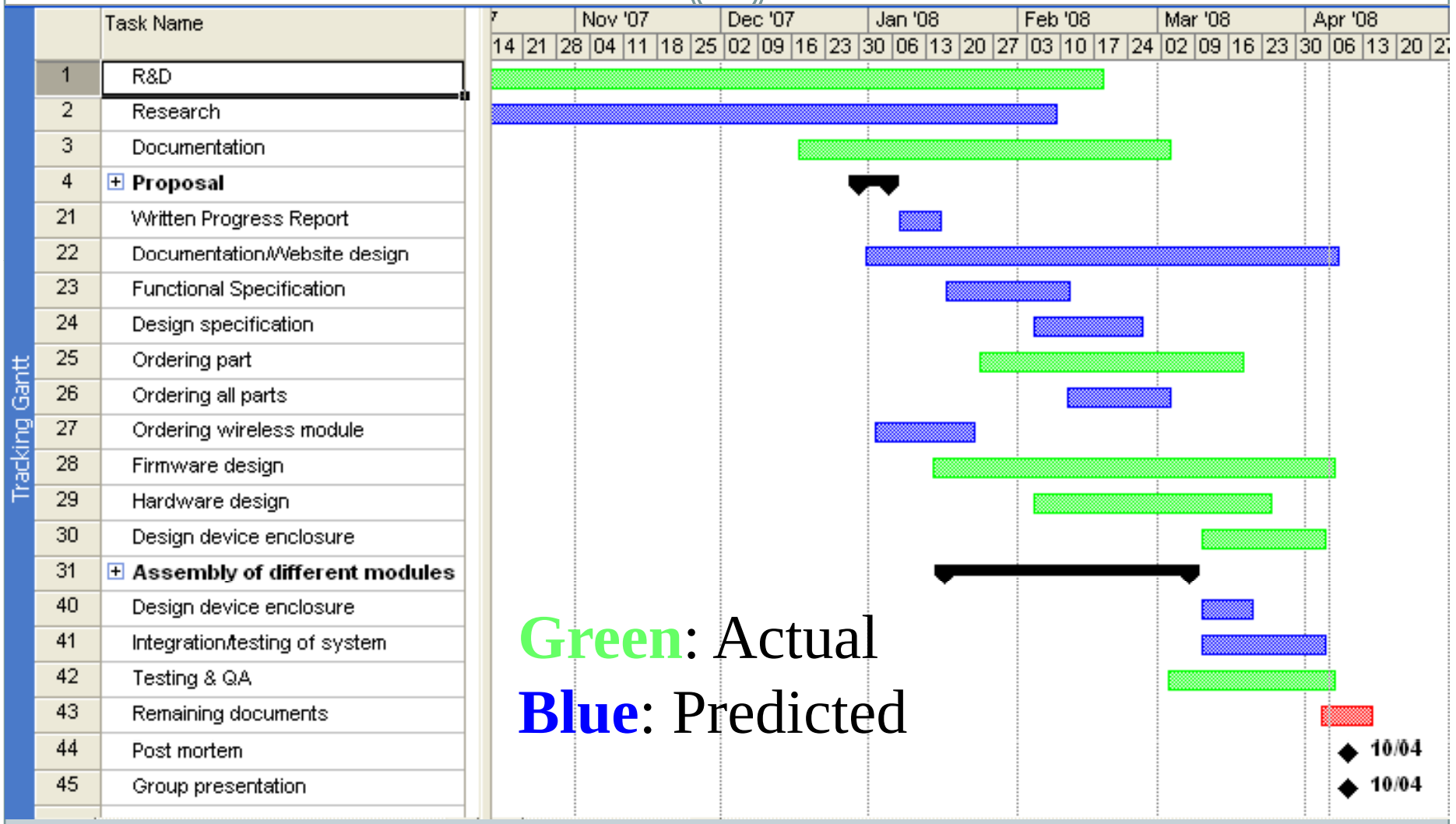
- School of Engineering Science

  $50 per group

Budget

Part Description	Estimated Cost ($)	Actual Cost ($)
Communication Module	380	489.96
Control Module	120	112.84
User Interface (W/ Enclosure)	120	76.00
Antenna (Instead Of Internet Domain)	30	126.87
Miscellaneous	140	90.06
Total	**790**	**895.73**

Timeline & Scheduling



What We Learned

- engineering product development cycle
- hands on experience with wireless communication design
- improved documentation skills
- hands on experience with firmware design
- practiced hardware (analog and digital) design
- improved soldering skills
- assembling, mounting, prototyping, enclosing skills
- testing, Q&A, apply design changes
- improved team work skills

Conclusion

- met design & functional requirements
- created functional prototype
- detected proximity up to ~80 meters
- implemented ~5 meters resolution
- achieved ~1 km range for other functions
- met predicted schedule & budget
- performed excellent team work

Future Improvements

- make the hand-held portable
  - use compact fractal antennas
  - PCB design integrating the system
- improve display unit
- multiple directional antennas
- implement different communication protocol
  - exclude decoder and encoder chips

Future Improvements – Fractal Antennas

Source:http://fractenna.com/

Acknowledgements

- We'd like to thank
  - Patrick Leung
  - Steve Whitmore
  - Bradley Oldham
  - Jason Lee
  - Dr. Rodney Vaughan
  - and all others who contributed towards our project success

Demo Video!

WEIIBO

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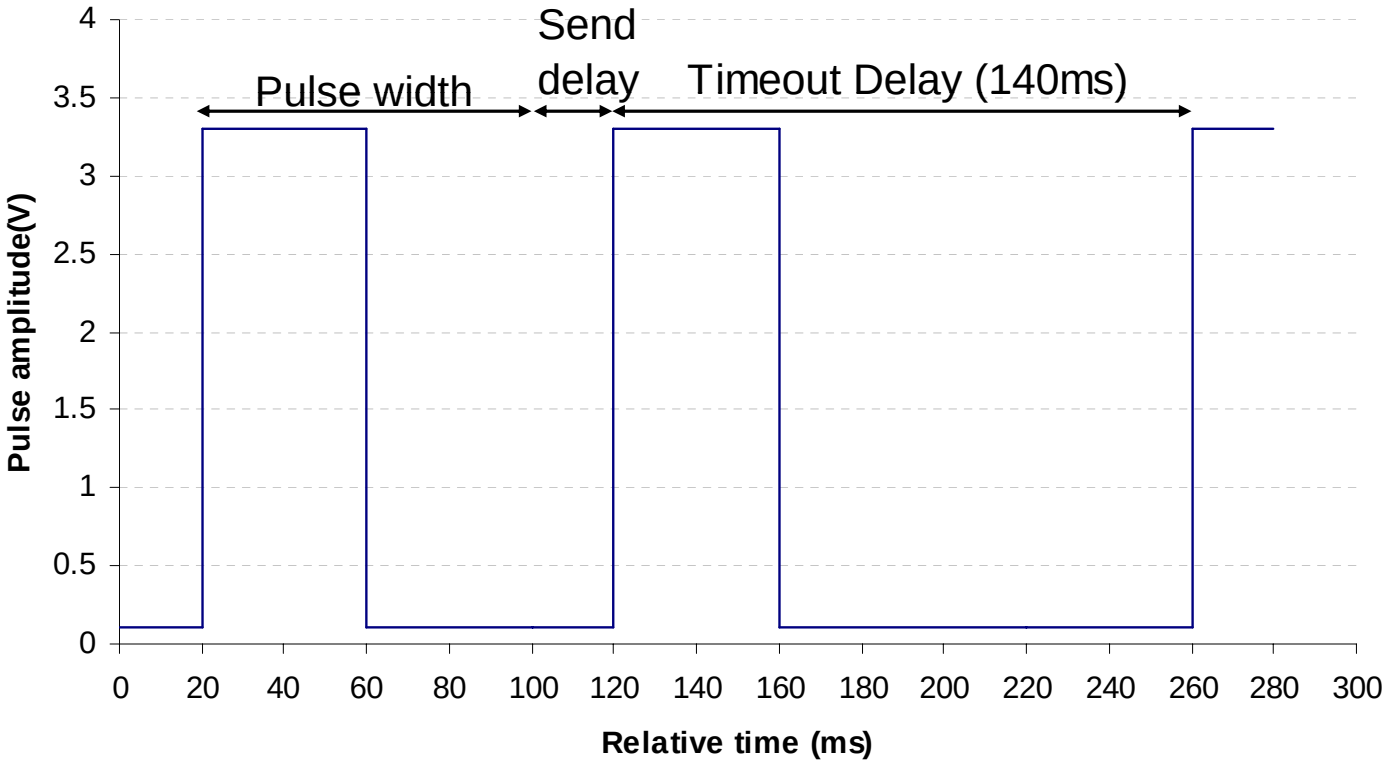
Q&A

For more information, visit http://www.sfu.ca/~dmalla

Communication pulse



1st Part of Budget Breakdown

Part Description	Actual Cost ($)
Communication Module	
Cprogramming Book (Smiley Micros)	15.82
Microcontroller with LCD (Smiley Micros)	55.85
Microcontroller with LCD (Digikey)	41.17
Control Module	
4 Communication Modules (Digikey)	317.06
2 Extra Communication Modules (Digikey)	172.90
Antenna (Antenna Factor)	126.87

2nd Part Budget Breakdown

Part Description	Actual Cost ($)
Antenna (Antenna Factor)	126.87
User Interface (W/ Enclosure)	
Buttons (Active Electronics)	4.01
Keypad (Active Electronics)	9.06
Enclosures (Active Electronics)	25.17
LED Array, Battery Connectors, LED Driver, Potentiometer (Main Electronics)	17.10
Connectors (Active Electronics)	20.66

3rd Part Budget Breakdown

Part Description	Actual Cost ($)
Miscellaneous	
Decoder and Receiver Chip (Digikey)	12.57
Labels for User Interface	5.00
Refreshments	20.00
Batteries (Costco)	20.70
Connectors (The Source)	6.12
Tool Box and Electrical Tape (Rona)	22.54
Soldering Tip (Active Tech Electronics)	11.19
Serial to USB Converter (A-Power)	16.94
Gas (Chevron)	11.25
Total	**931.98**