GPS Gaucho

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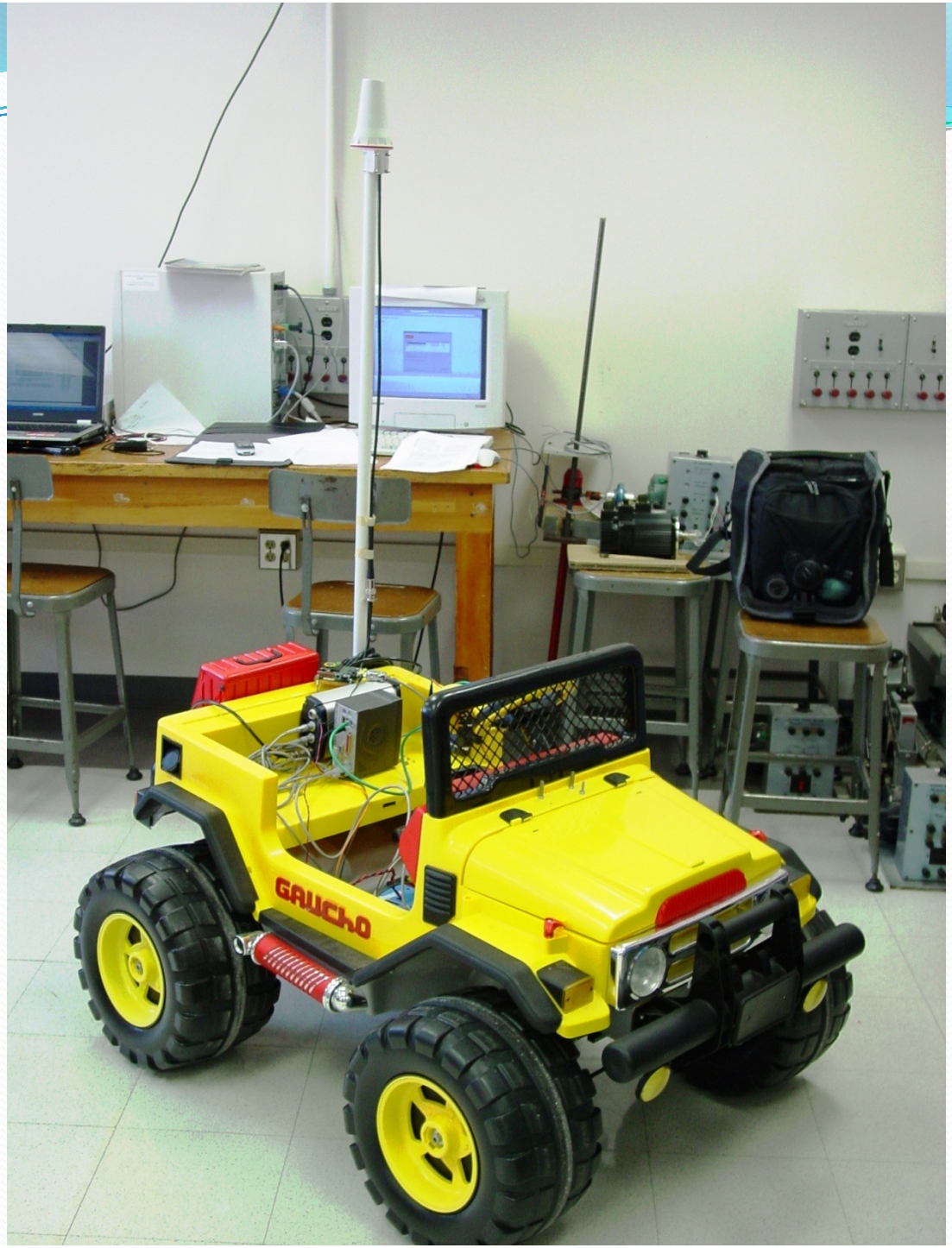
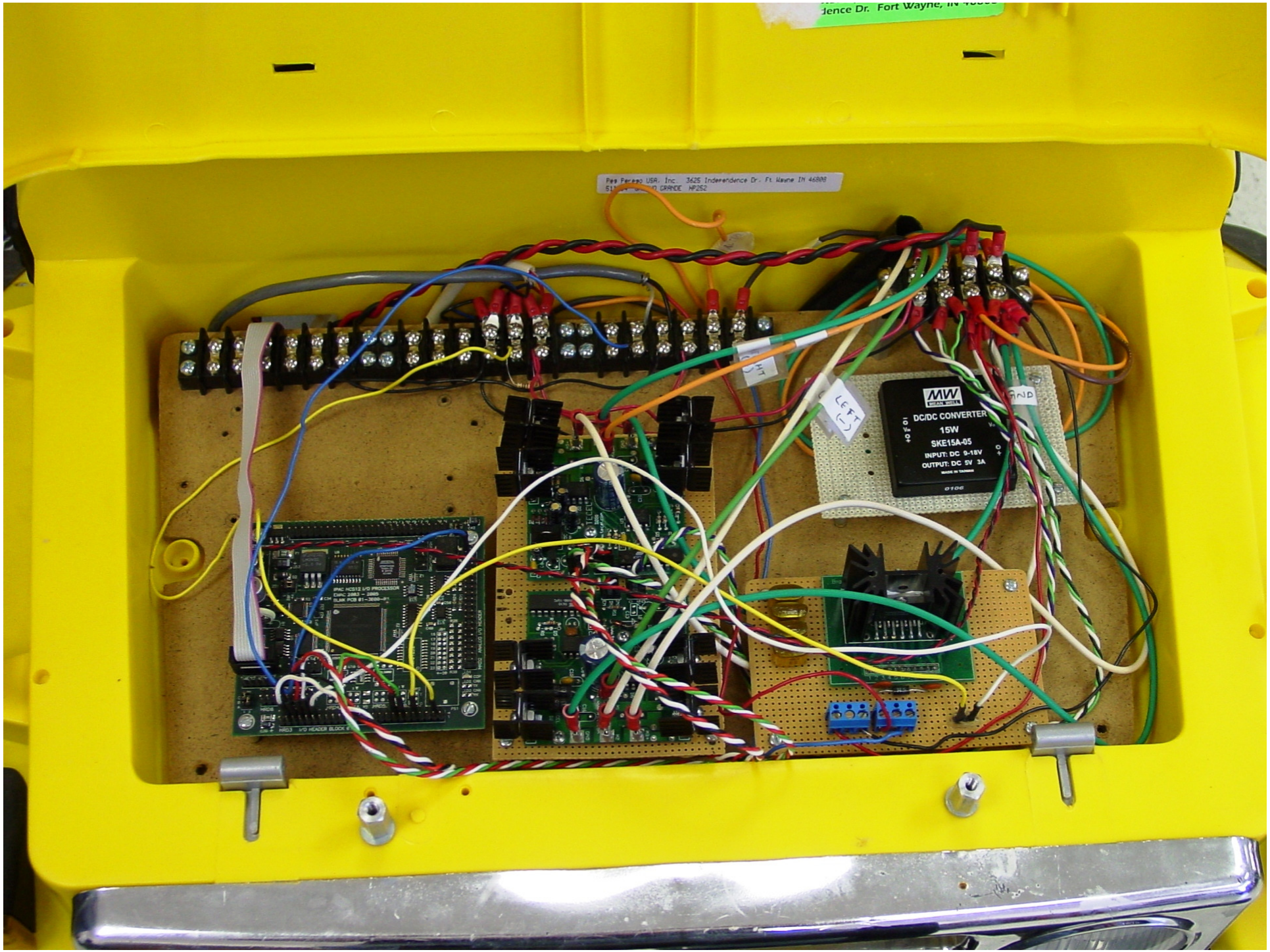
GPSGaucho Application

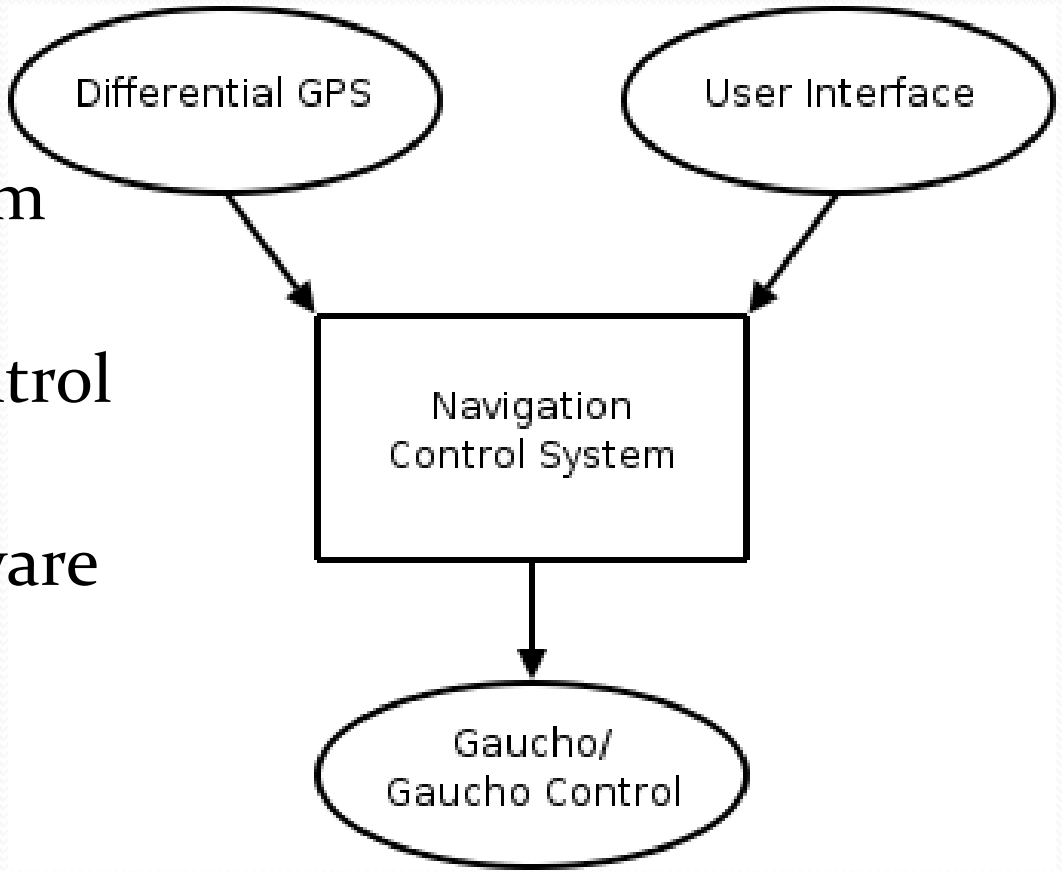
- GPS-based Self-navigating Autonomous Vehicle
- Vehicle that can drive from point A to point B with no outside intervention
- Many uses
  - Farm Machinery
  - City Bus Routes
  - Tour Busses
  - Nuclear warfare


GAUCHO

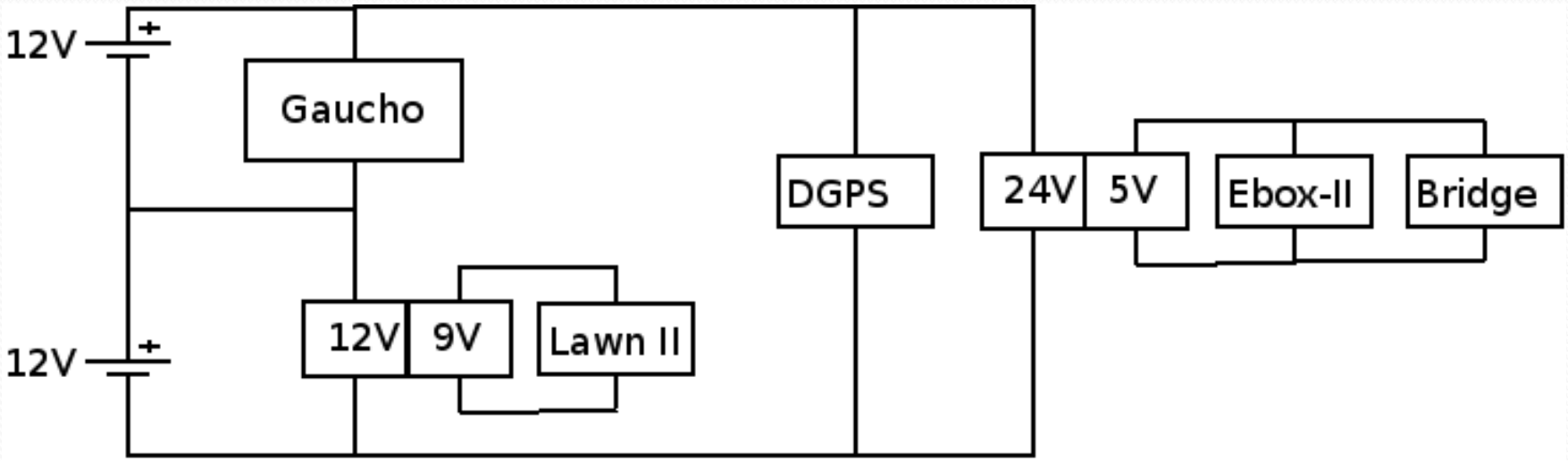

DC/DC CONVERTER
15W
SKE15A-05
INPUT: DC 9-18V
OUTPUT: DC 5V 3A
LEFT (-)
GND

System Overview

- Differential GPS
- Gaucho control system redesign
- Ebox-II/WinCE6 Control System Platform
- Control System Software

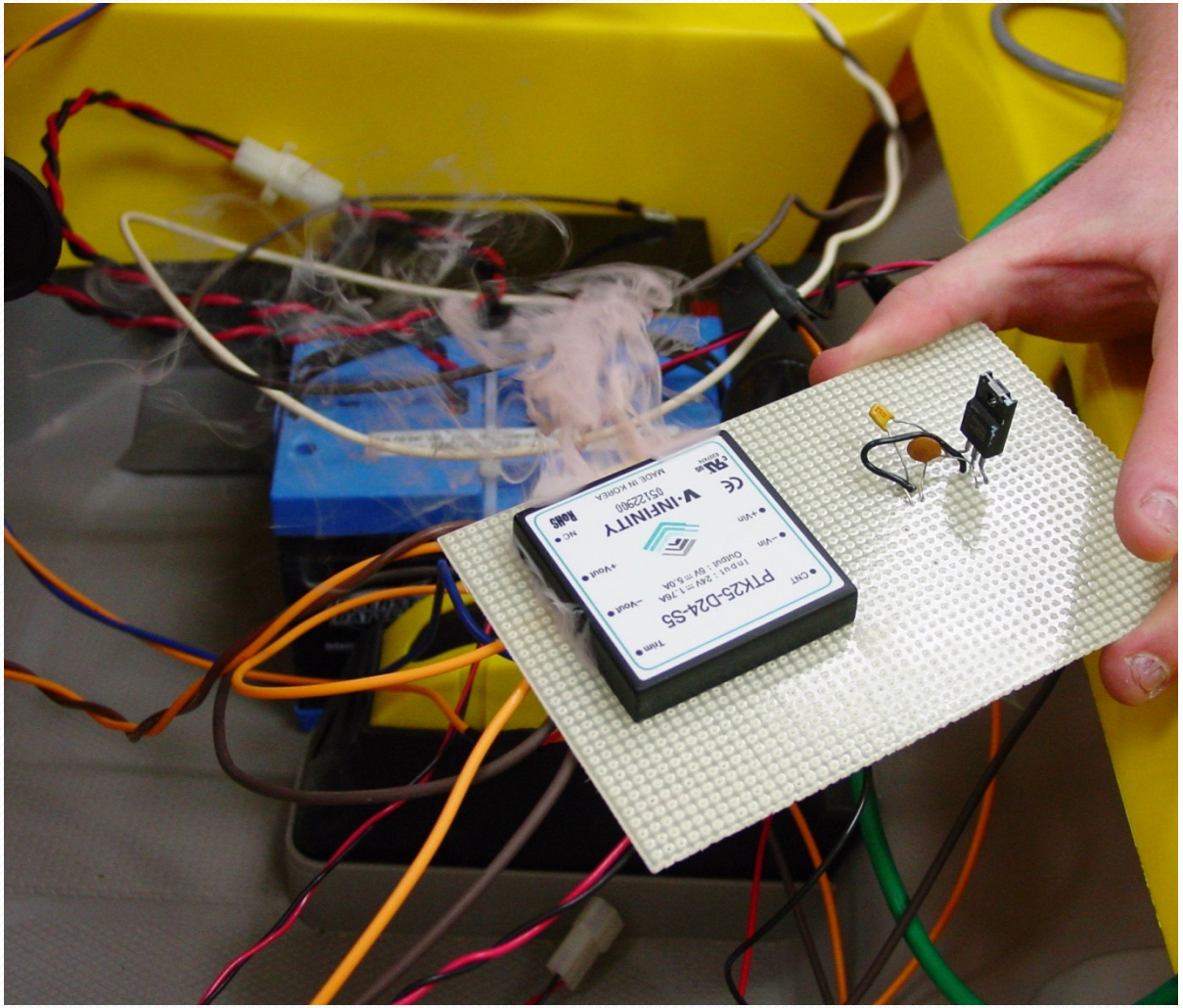


Power Sub-system

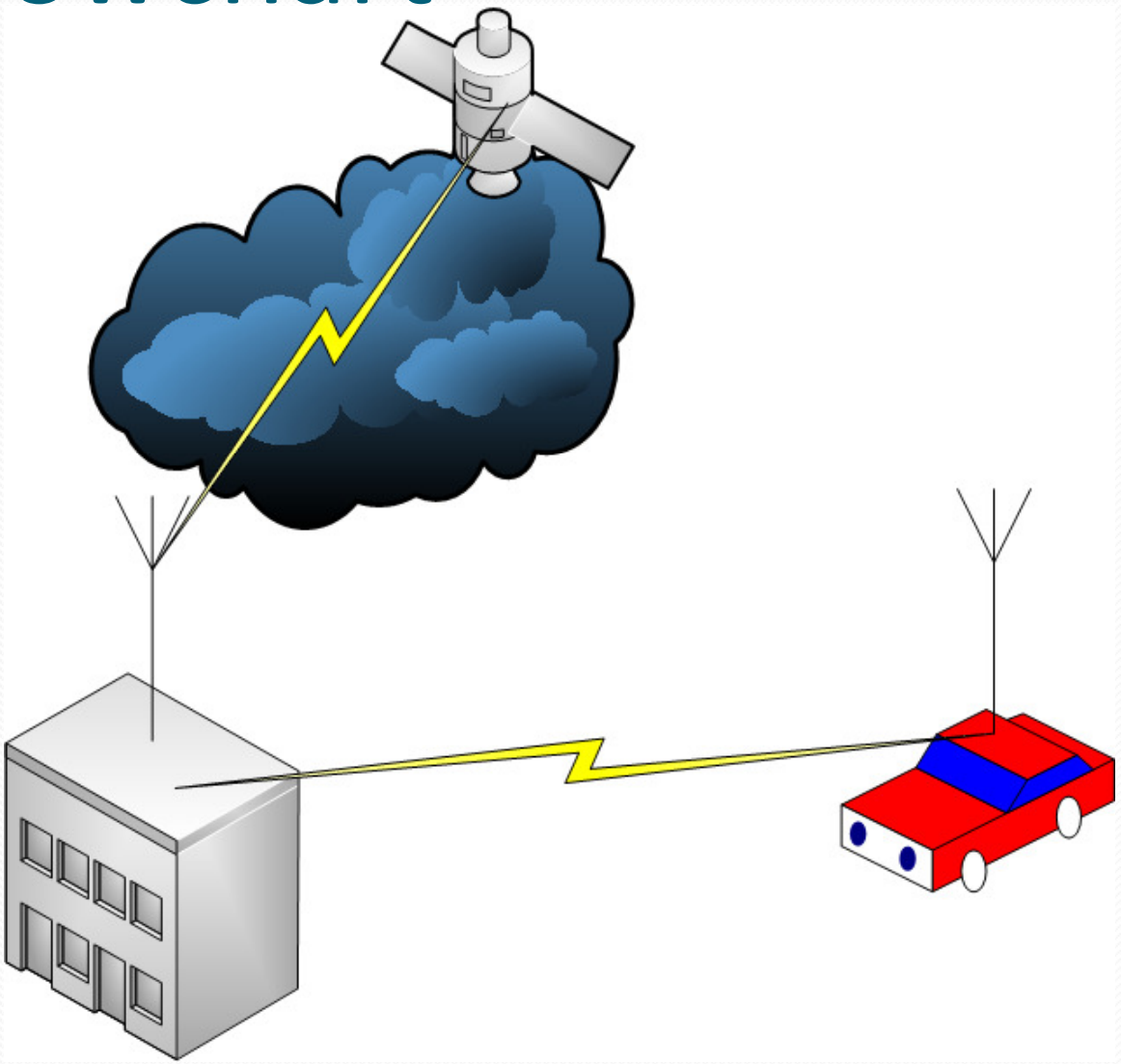


Power Sub-system

- 5v
  - E-Box II
  - Ethernet Bridge
  - Gaucho
- 24v
  - GPS Unit
- 9v
  - RF Serial transceiver
- Smells great!



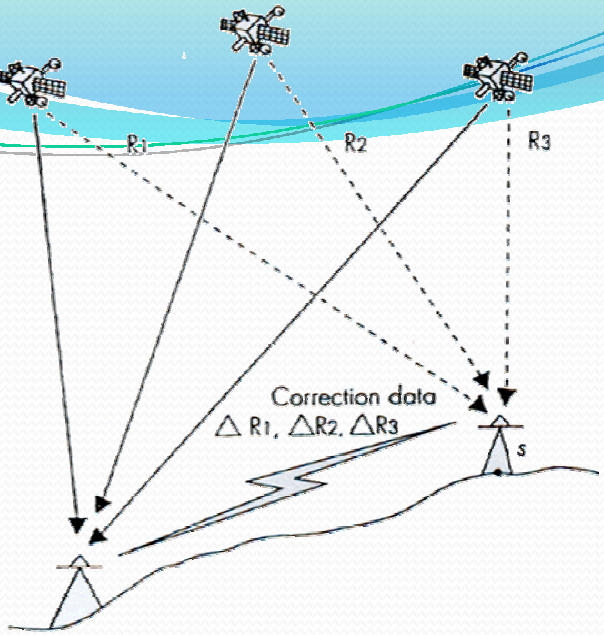
DGPS Flowchart



Differential GPS

- What does this do?
  - Normal GPS 20 ft accuracy
  - Differential GPS involves two units to improve accuracy to 1 ft (RT-20)
  - Stationary base station generates correction data
  - Mobile receiver uses correction data

Differential GPS



- Two main parts
  - Base Station
    - GPS receiver on top of Jobst Hall
    - GPS device parsing data and generates RT-20 data
    - Broadcasts correction data
    - Latitude 40.699629905355N
    - Longitude 89.61684333092W
    - Altitude 198.75
  - Remote Station
    - Receives RT-20 data via serial RF data
    - Parses RT-20 correction data with current raw coordinates and outputs corrected GPS data on secondary serial port

Differential GPS

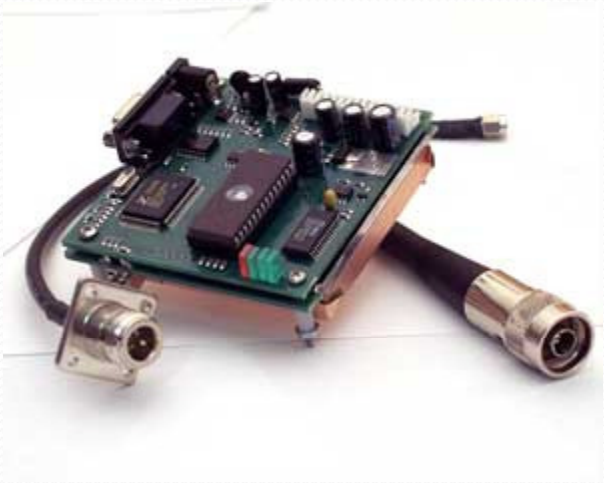
- RT-20 protocol
  - Includes worst case scenario to still help improve accuracy in poor conditions
  - Must maintain 4 satellites for decent performance
    - After 3 minutes of use – 20 cm accuracy
    - After 10-20 minutes of use – 3-4 cm accuracy
    - Keeping the unit still for any period of time helps improve accuracy
  - Transmitted logs
    - RTCM (10 seconds) – Reports fixed location that was entered into base station
    - RTCM49 (2 seconds) – Reports base station's satellite observation data <= 12 satellites
    - RTCM (5 seconds) – Reports RTCM type 1 data for quick 1 meter position (worst case scenario)

Differential GPS

- Easy to implement
  - Does not require any additional programming for Ebox or any future client to receive these improved coordinates
- Serial Communication
  - Each RT20 unit includes 2 serial ports
  - Typically one for programming and one for sending data
- Saving settings
  - Each unit has onboard flash memory to save configuration (saveconfig)
  - Allows proper operation immediately upon power up

Differential GPS

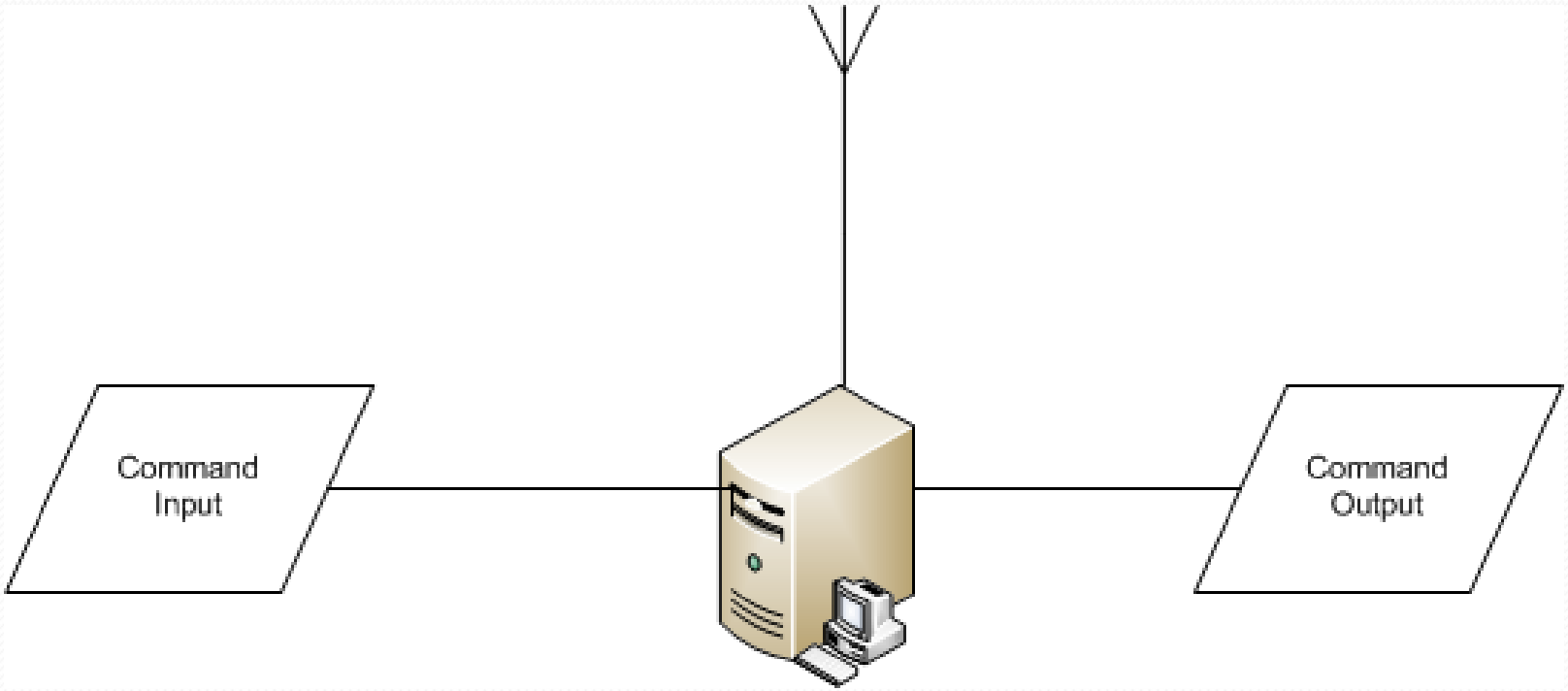
- Communication
  - Lawn-II RF transceiver
  - Broadcasts via 900 MHz
  - 9600 baud
  - No configuration



GPSGaucho Control System Redesign

- Multi-year project
  - Started with developing both software and h/w
  - Then was developed with hardware only
  - This year developed software for the Gaucho
- Gaucho Hardware
  - HCS12DG256B
  - H-Bridges
  - Two 12VDC motors
  - Linear Actuator

GPSGaucho Control System



GPSGaucho Control System Redesign

- Our onboard system redesign
  - Reprogramming two-way serial communications
  - Accepts F,B,L,C,R,H,X commands
  - Communication
    - 19200 Baud, 8 data bits, 1 stop bit, no parity, no flow control
- Code design allows for future extensions
  - Ultrasonic sensors
  - Distance sensor for wheels (detects slippage)
  - Variable turning radius

GPSGaucho Control System Redesign

- Programming was done in MetroWerks Codewarrior 3.1
- Uses embedded C code
- Used better serial communication (sends back ACK)
- Allows for specific motor speed
- Uses PWM to control speed and bits for direction
  - steering (linear actuator)
  - drive speed (two independent motors)

GPSGaucho Control System Redesign

- What this allows us to do
  - This is more than adequate to allow any type of navigation
  - Some driving tasks may be require redundant commands
- Current steering is full left/full right (drunk driving)
  - Makes fine control difficult

Ebox-II

- Encompasses all subsystems and manages vehicle controls
- Small form factor x86 computer
- Has low power requirements
- Supports .Net 2.0 Compact Framework
  - allows easy development

Ebox-II System Control

- Network connected - (802.11b bridge)
  - Able to coexist on Bradley's Wi-Fi network
  - Limited access on quad, but should be adequate for testing
  - Able to handle movement between access points
- Serial Connectivity – Only one at a time
  - USB Dongle not supported
  - GPS receiver
    - 9600 Baud
  - Gaucho
    - 19200 Baud

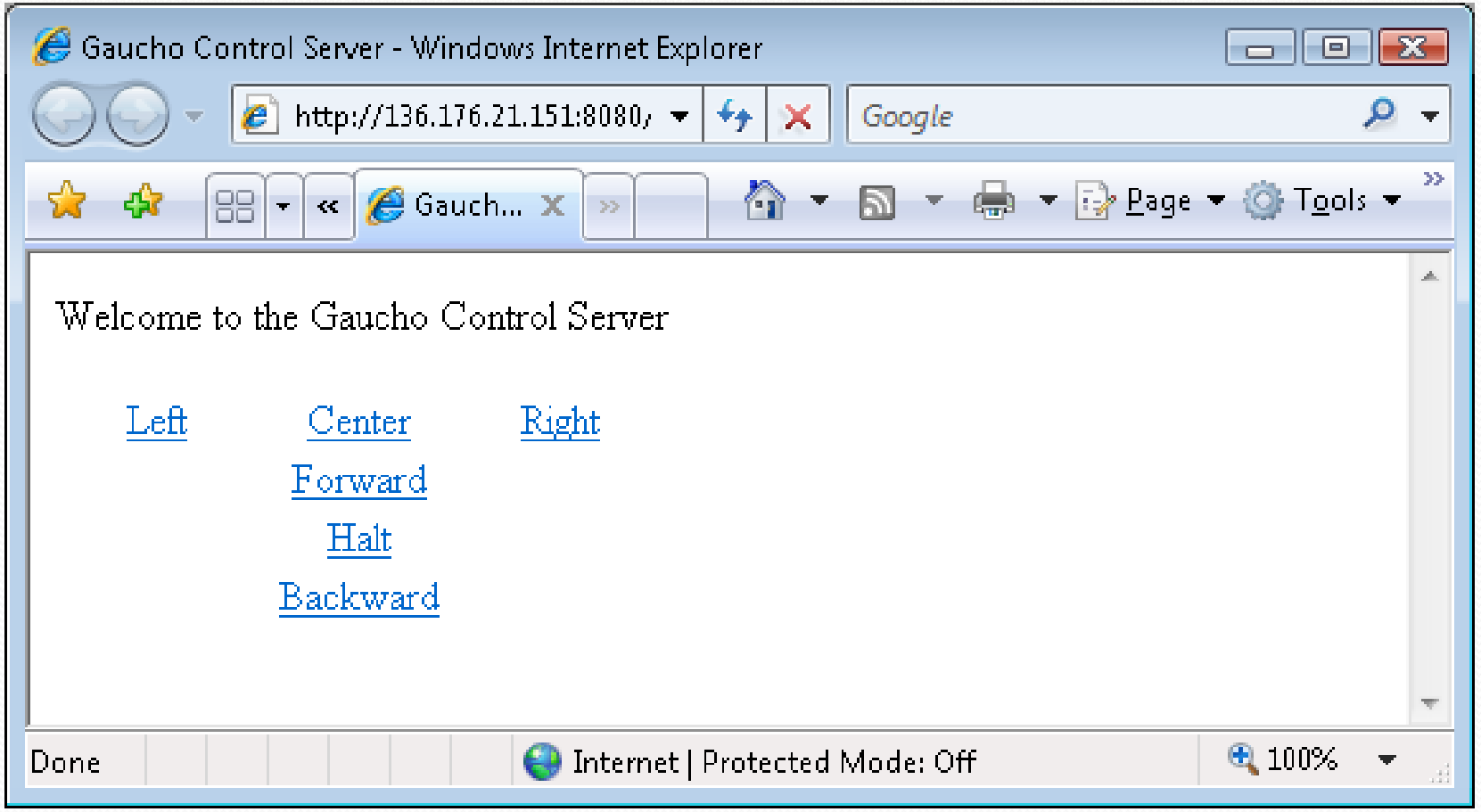
Windows CE 6

- New Baseline OS
- Used for embedded systems
  - Pocket PC's and Smartphones
  - Delivery and POS
- .Net 2.0 Compact Framework built in
- Includes helpful drivers for easier device integration

Control System Software

- Web server
  - Allows access on port 8080 from any computer
  - Commands are based on requested URL (/left.html)
  - Currently is a basic implementation
    - Needs to be improved to serve more dynamic data and include more capabilities
  - Responsive enough for navigation but not live driving
    - Current lag is due to web browsers and network

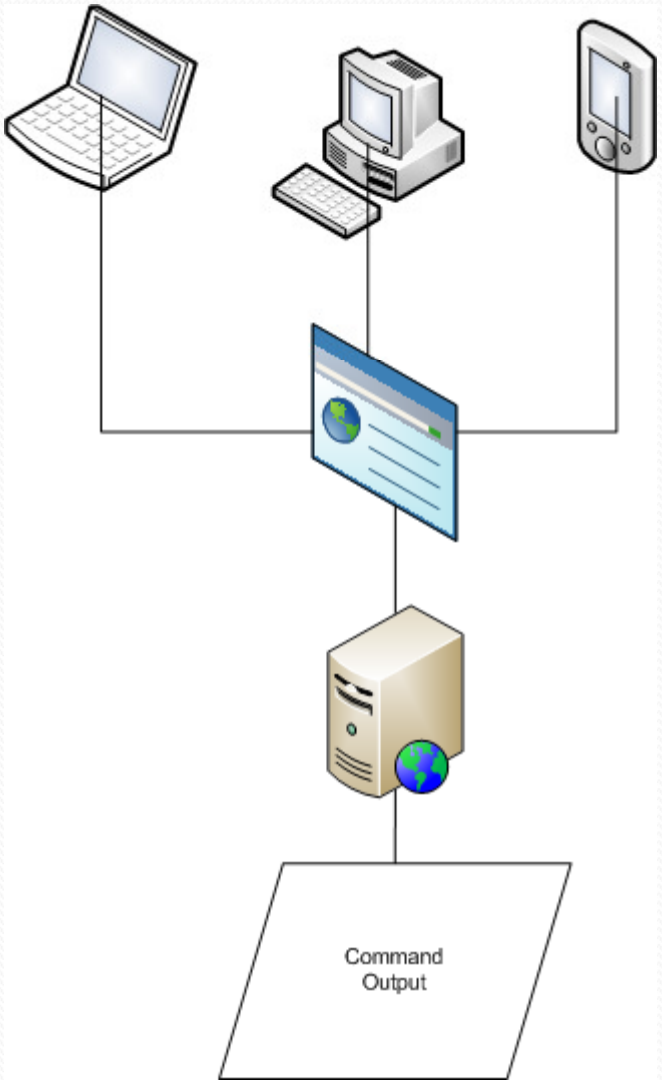
Web Interface



Web Server

- Receives http request
- Translates into command
  - /left.html
  - /sequence.html
  - /
- Handles exceptions with too many requests

Web Server Flowchart



Video Demonstration

- 100 Degree right turn
  - Preprogrammed sequence
  - Open loop
  - 5 seconds forward
  - 3 seconds turning right
  - 5 seconds forward

Video Demonstration

Summary

- RT 20 Differential GPS to provide accurate position data
- Gaucho with low-level control system for platform
- E-Box II provides high-level software to provide control
  - Web Server allows universal access
  - Receives data from DGPS
  - Sends commands to Gaucho

What can be improved/finished?

- Need E-Box 2300
  - Includes two serial ports (GPS and Gaucho control)
- Low-level control improvements
  - Ultrasonic Sensors
  - Variable radius turning
- More automatic navigation system – apply DGPS
- WebCam for remote video feed

Conclusion

- Gaucho as a whole is a stable system
- Overall goals of being closed loop were not completed
- This was due to having to rebuild low-level system
- Future projects involving the Gaucho will not need to rebuild any subsystems

Questions?