What Sensys Networks Does

- Sensys Networks make wireless sensors and associated networking components to detect vehicles and monitor traffic.
- Sensys Networks has designed its own wireless sensor protocol to meet the demanding system level requirements of our applications. The protocol and underlying implementation have proven to be robust and very effective.
Three Pieces of a Wireless Sensor Network

- Application
- System Design
- Circuit Design
Our Application: Replacing Inductive Loops
Issues with Inductive Loops

Inductive Loops

- Pavement Damage
- High installation cost
- Break all the time
- Up to 40% of loops in the Bay Area are out of order at any given time

Everybody hates them – but there are no alternatives, until now!
VDS240: Wireless Sensor-Based Vehicle Detection

- **VSN240 sensors** are flush mounted in 2” cored hole or glued to the surface.
- Magnetometers in the sensor nodes detect the presence and passage of vehicles.
- Sensor node radio transmits sensor data to the AP240 access point.
- AP240 collects data from sensor nodes and relays it back to the controller or TMC.
VDS240 For Traffic Signal Control

- No Trenching
- No Power
- No Calibration
- 2-hour Total Installation Time
VDS240 Permanent Count Station

AP240-EG
ACCESS POINT

GPRS

170/2070

ETHERNET
POWER-OVER ETHERNET
Sensys Application

Replace inductive loops in as many applications as possible

- Detection performance
- Event reporting latency
- Event reporting accuracy/resolution
- System capacity
Sensys Application (cont.)

Provide additional features over inductive loops

- Easier to install
- Detect and report sensor failure
- Provide additional information (magnetic signatures, classification, etc.)

Interface to existing equipment

- GPRS for count stations
- 170/2070 controllers for control applications
- Web server to show statistical and per vehicle information
System Design

Identify critical parameters

- Event synchronization
  - TDMA based, star architecture w/repeaters
  - Sync beacon w/special packet structure
- Predictable/low latency
  - nominal 150ms second latency requirement
  - latency requirement can be as low as 50ms
- Low power consumption
  - Minimize RF receive time in all contexts
  - Don’t waste transmit energy (no collisions)
  - Non-layered retransmission scheme
System Design (cont.)

Support secondary features

- watchdog transmissions for detecting "down" sensors
- software download over the air
- commands can be sent to device to set channel, timeslot, operational mode, detection parameters
- operational modes include events, continuous 3D magnetic data, gated 3D magnetic data and idle
RF Considerations

Move power consuming functions to line-powered units

- Downlink at higher RF power than uplink
- Use high performance LNA on uplink
- Use uplink diversity
- Support battery powered repeaters with replaceable batteries
Some Circuit Design Issues

- Use off the shelf radios, more choices and leverage industry investments.
- Leakage current of all components is a critical design parameter.
- Sensor circuit must be designed with low power specifically in mind.
- In physics they taught you that capacitors do not consume energy. Don’t believe it!
Assorted Specifications

- Air Interface based on 802.15.4 (2.4GHz, 250kbps, DSSS)
- Sensor sampling rate: 128Hz
- Nominal sensor current (total): <60uA
- RF Range: 150 feet with access point at 16’
- Sensor size: 2.5” x 2.5” x 2”
- Operating temperature: -40C to +85C
- Repeater types: uplink, diversity, and channel
VSN240 In-Pavement Sensors

VSN240-f: Flush-Mount

- Mounted in a 2” cored hole
- 10-year battery life

VSN240-s: Surface mount

- Glued to the pavement like pavement markers
- 7-year battery life
The End for Loop Detectors

- Side-by-Side Installation with Loops in Scottsdale, AZ on Hwy 101
- VDS240 sensors installed in 1/10th the time with 1/10th the crew
- We have significantly improved our installation procedure which takes about 20 minutes
AP240 Access Point

- Communicates with large number of sensors within its range
- No Calibration
- No Adjustment
- Installs in minutes
In Summary

- We have developed an ultra-low power, time-synchronous wireless sensor networking platform that meets the stringent requirements of vehicle detection for traffic signal control.
- We have achieved a remarkable 10-year battery life for sensors that constantly measure the earth-magnetic field and report every vehicle event – which at peak hour is close to 1 event per second.
- Our wireless sensor networking based vehicle detection products are in production and are being used in many traffic applications.