The New INTERNET OF THINGS
Telemetry / Telematics / M2M

TCF 2011

Joe Jesson
CTO, XACT Technology

The New INTERNET OF THINGS
Telemetry / Telematics / M2M

Abstract: As the cellphone industry is becoming saturated with just personal calls, an entirely new business of assets communicating is heating-up.... billions of assets communicating wirelessly. This is known as Machine-to-Machine communication and expectations of billions of assets communicating wirelessly.

Today, we are seeing ocean-going ships communicating wirelessly to each other (AIS), Airplanes (ACARS), Trains (RFID), Trailers, Autos, and soon containers and every type of assets. . The first open, flexible wireless & GPS M2M Xact Technology platform will also be demonstrated. This highly-integrated platform is limited only by your imagination and will save you a year in getting your new product to market!

GSM/GPRS/GPS OPEN M2M Development KIT

- **Complete M2M Solutions Architecture**
  - **Cocoon Kit Includes**
    - **Tested Trax Board**
      - Quad-Mode GSM/GPRS (Sierra)
      - GPS (u-Blox AMY)
      - Accelerometer (Freescale 3D)
      - Magnetic Switch (Murata)
      - Temperature Sensor
      - Battery & Integrated Charger
      - USB Slave Port

Development Software
- Ellipse Integrated Development Environment
- Source Code
- Portal Access

Software Utilities
- Firmware Loader
- Configuration Editor
- GPS Analyzer (u-Center)
- GSM Analyzer

• **Software Tools**

– **Kit Includes**

- • **Development & Production Portal**
  - – Defined Packet Types
    - » Status, Log, Config Packets
    - » GPS Location (x3)
    - » GPS Quality
    - » Speed
    - » Battery State
    - » Onboard Geofencing

- • **GIS Portal Access**
  - – XML Gateway
  - – API's Documented
  - – Multiple Portal Options
  - – Customization Available

GSM/GPRS/GPS M2M Development KIT - Portal

GPS Analytic Tool, u-Center
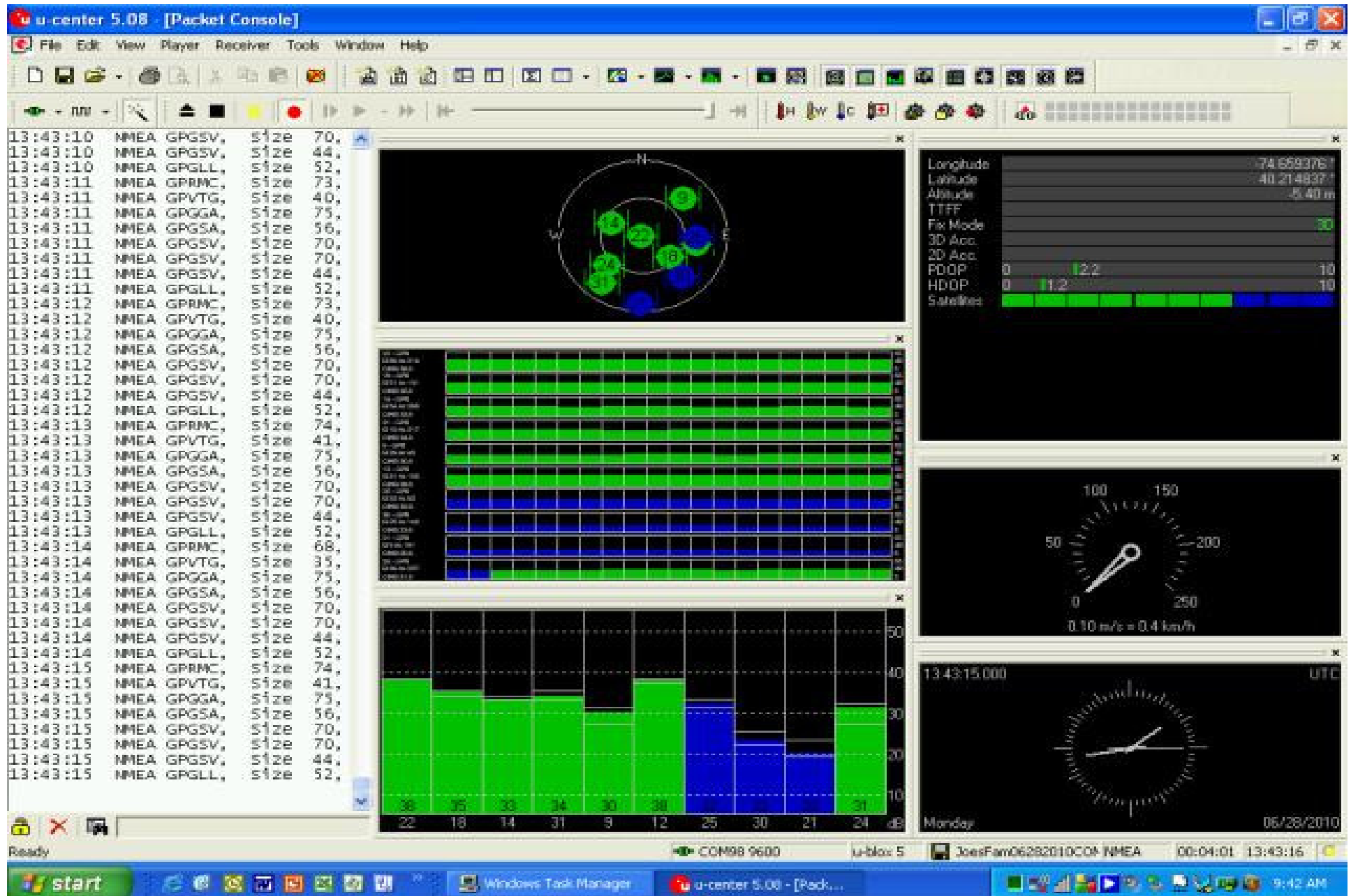
GIS Telematics Portal
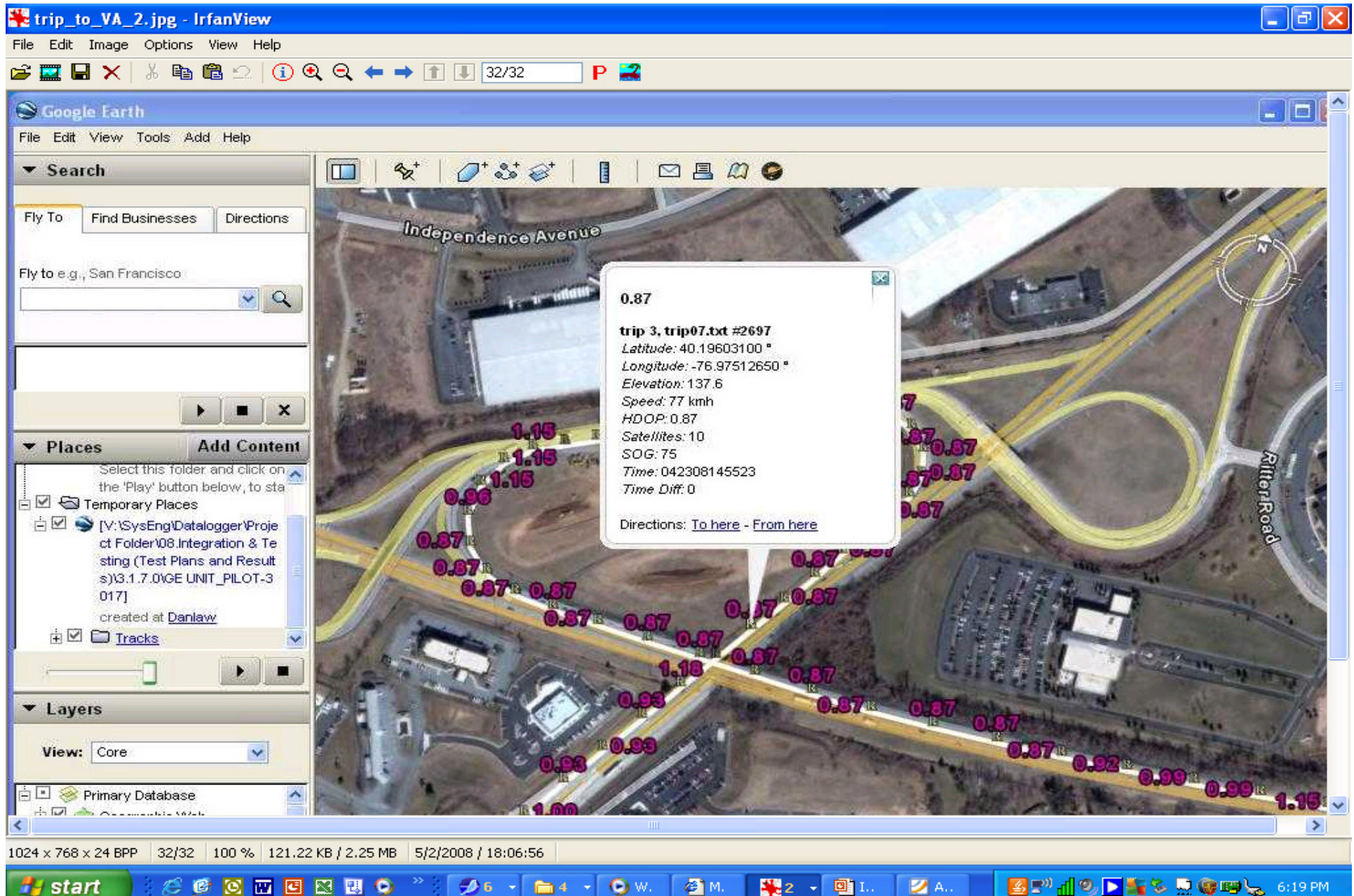
Open Architecture of an M2M Building Block

1 **u-blox GPS with AGPS**
50-channel engine with over 1 million correlators.
Sensitivity; -160dBm, TTFF of <1 Second
Speed threshold notification

2 **WMP100 Quad band GSM Module (WMP150 is a direct replacement)**
ARM9 Processor
Real-Time Clock/Timer
Over the Air software updating & diagnostics
Enhanced Power management features

3 **Magnetic Contact switch**
CONTAINER DOOR SENSOR
Detects device removal
Provides quick trigger methodology
Protect items not directly monitored by device
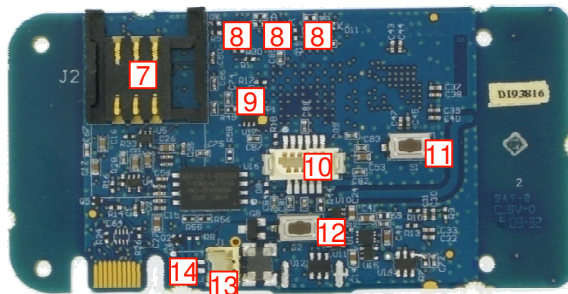
4 **On Board 2Mb x 16 Flash Memory**
Multiple geo-fences stored on device
Automatic logging of location data

5 **3D Multi Axis Accelerometer**
CONTAINER SHOCK SENSOR
CONTAINER PATTERN SENSOR
Can be used to trigger device alerts
Used for Enhanced Power management
Used for logging of waypoints

6 **High Performance Quad-Band GSM Antenna**

7 **SIM Card holder or**
CONTAINER SIM CHIP
Supports Chip SIM placement

8 **Status LED's**
Power, GPS signal, GSM signal

9 **Temp Sensor**
CONTAINER TEMP SENSOR
Inputs directly to WMP100 GPIO input

10 **Auxiliary interface port**
Multiple voltages to drive sensors
Multiple General Purpose Input/Outputs
Analog/Digital input
High Speed Serial
Audio output

*NOTE: PCB ACTUAL SIZE
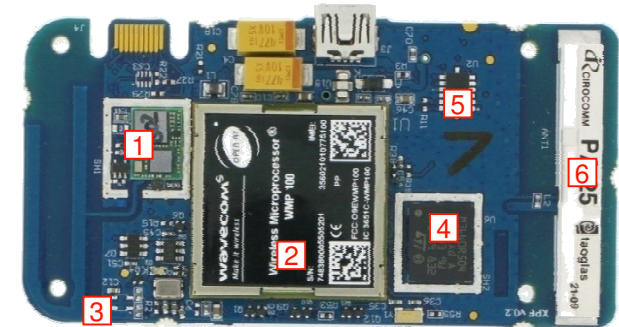
11 **Instant Alert button**
Confirmation of Alert via device feedback

12 **Mode Set button**
Can act as defeatable Power Switch

13 **Internal power connection**
CONTAINER PRIMARY POWER SUPPLY
Extended use Li-On Batteries Available
Automotive spec Power Supply Available

14 **Piezo or Vibration motor**
Audible or Vibrating notice of tracking request
Audible or Vibrating alert of geo-fence violation

TRAX ARCHITECTURE

GSM Quadmode Antenna

JTAG

USB Port

WMP100 GSM/GPRS

ARM 9 Processor

MEMORY

LEDS

I/O Connector

VIBRATION MOTOR

PB1

PB2

Li-PO Battery

Magnetic Switch

GPS – uBlox AMY5

Accelerometer

SIM
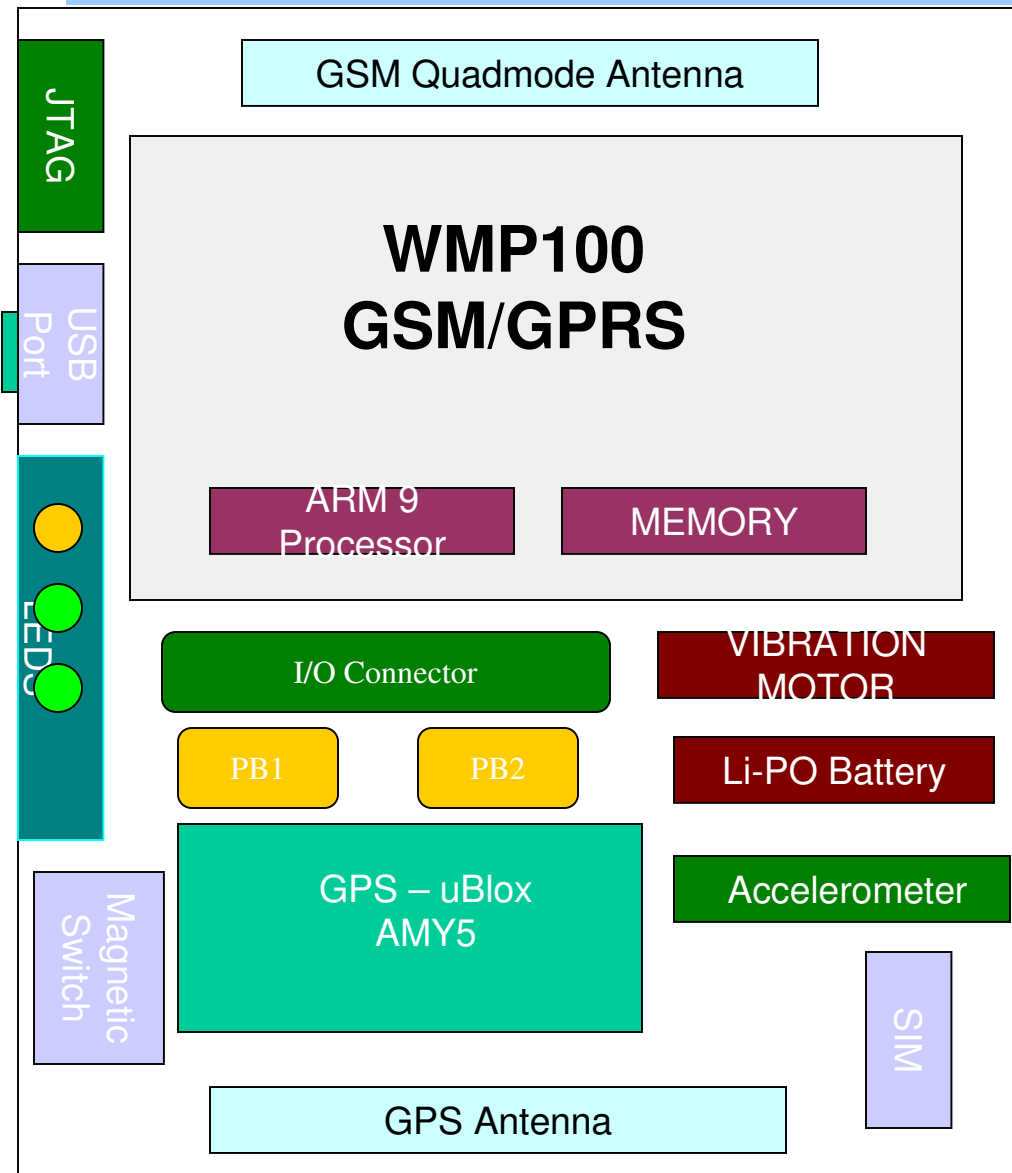
GPS Antenna

Existing Architecture

Architecture Elements

- ✓ GSM/GPRS Module
- ✓ GPS Module
- ✓ GSM/GPS Antennas
- ✓ Battery Power Supply
- ✓ Accelerometer
- ✓ Vibration Motor
- ✓ Magnetic Switch
- ✓ Two Push Buttons
- ✓ SIM Card and SIMLESS Option
- ✓ Expandable through I/O Port
- ✓ Optimized for Always "On"
- ✓ Integrated Antennas
- ✓ BGA Minimal Connections

TELEMATICS/M2M SYSTEM

GPS Satellites

Two-way Satellite e.g. ORBCOMM

End User

Customer System

Assets

GIS layer XML Data Feed FLEET Prop System

PORTAL - Parsing & DB Server

Cellular BSC

Gateway Earth Station

Network Control Center

e.g. ONSTAR
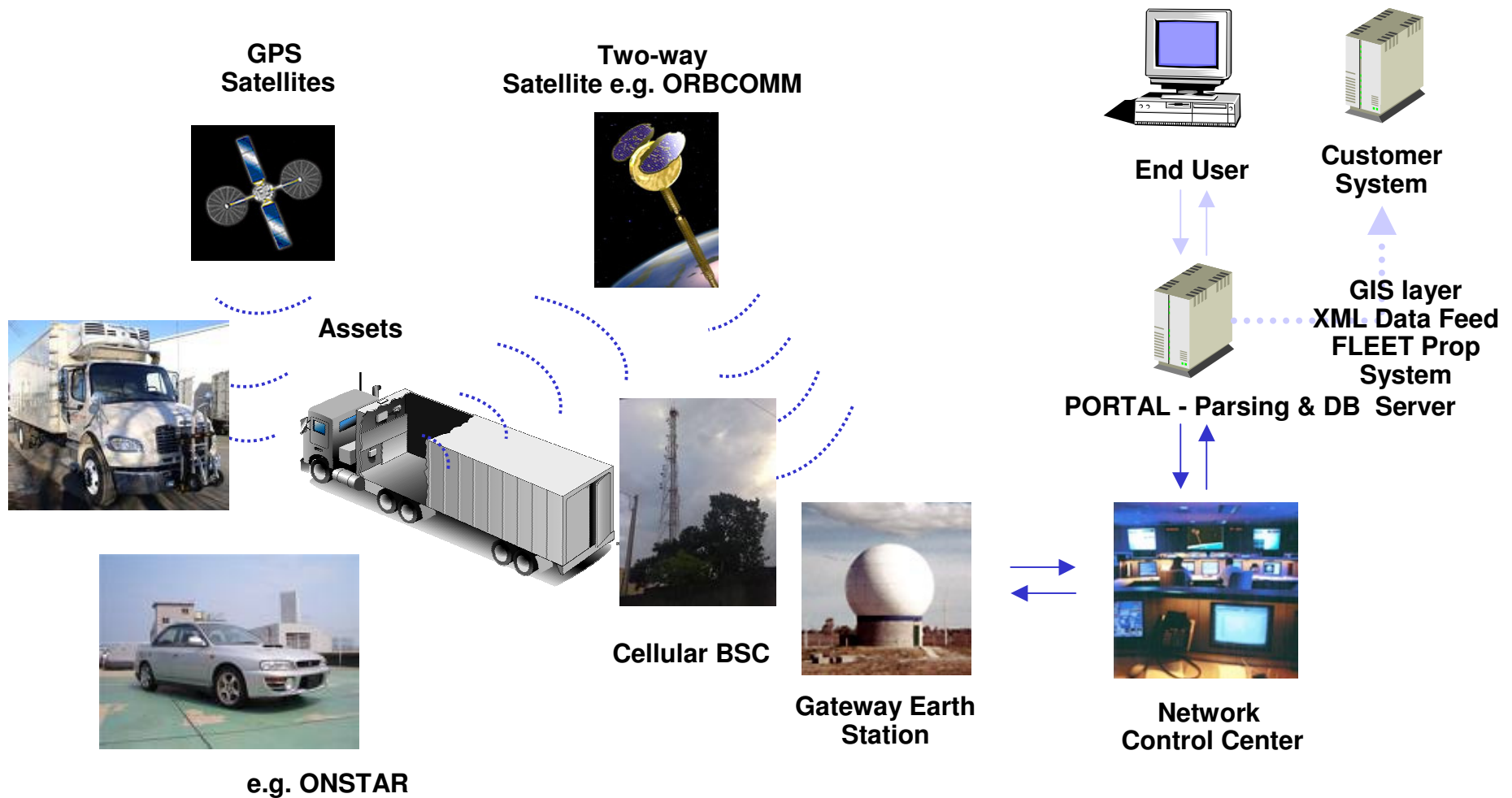
Standard Telematics Architecture installed on Powered and Unpowered Assets

LARGE-ASSET TELEMATICS SYSTEM
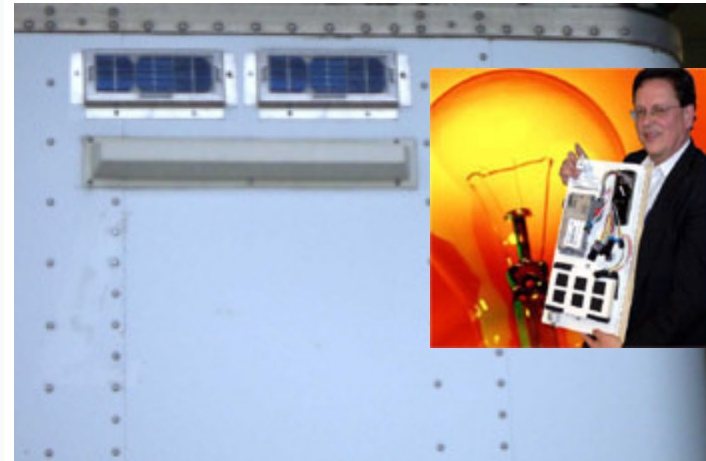
•**TRAILERS, >60,000 in Production**
1 x PVs, Solar Augmented
2 x PVs, 100% Solar w/o Sensors

• **RAIL**

4 x PVs, 100% Solar

Solar PV Specifications

Weight (typical)	9 oz.
Size	8.2" x 3.4" x 47"
Rated Current	120 ma (9V OC)
Service Life	>10 years
Panel Impact	1" hailstones @ b50 mph
Rated Power	1.25 Watts
Rated Temperature	-40C to +85C

* SLA Battery Pack Life Extended with Solar Trickle Charging

ISO MARINE CONTAINER SATELLITE LINK

SECURITY LOCATION AND DOOR STATUS

ORBCOMM & GLOBALSTAR & IRIDIUM SATELLITES

ISO MARINE CONTAINER SATELLITE LINK

Opportunity	**Smart Container Sensor Platform**
Solution	**Massive Number of Containers** to carry Satellite-based location and selective Nuclear-Biological-Chemical (NBC) Sensors
Customer Benefit	• **Leverage Commercial-Off-the-Shelf Trax solution** • **Potential of 5MM mobile sensor platforms throughout the United States** • **Lowest-Cost Sensor Communications Platform** • **Seamless and Complete U.S. Wireless Coverage, No Gaps** • **Leverage Low-Cost Sensors** • **Embedded GPS location sensor**

Dual Cellular / Satellite-based Transceiver

Existing Sensors
• Magnetic
• Accelerometer
• GPS Receiver

Optional Sensors
• Nuclear
• Biological
• Chemical
• Image / Video

Amateur Radio Location & Telemetry - APRS

Amateur Packet Reporting System (APRS) as designed by Robert Bruninga, WB4APR

Aircraft Telemetry - ACARS

Aircraft Telemetry - ACARS

Ship Telemetry - AIS

TRAIN Telemetry

TrainPlotter from COAA - processing live signals

File   View   Process   Options   Help

```
Train ID: D00000   Code: 55 Idle message        11:22:07 UTC
Train ID: 042988   Code: 08 Voice call grant     11:21:33 UTC
Train ID: 042988   Code: 80                       11:21:30 UTC
Train ID: 042988   Code: 80                       11:21:30 UTC
Train ID: D00408   Code: 55 Idle message        11:21:26 UTC
Train ID: D00308   Code: 55 Idle message        11:21:10 UTC
Train ID: D00208   Code: 55 Idle message        11:20:54 UTC
Train ID: D00108   Code: 55 Idle message        11:20:37 UTC
Train ID: D00080   Code: 55 Idle message        11:20:21 UTC
Train ID: D00000   Code: 55 Idle message        11:20:04 UTC
Train ID: D00408   Code: 55 Idle message        11:19:48 UTC
Train ID: 042980   Code: 80                       11:19:31 UTC
Train ID: 042980   Code: 80                       11:19:31 UTC
Train ID: D00308   Code: 55 Idle message        11:19:22 UTC
Train ID: D00208   Code: 55 Idle message        11:19:06 UTC
Train ID: D00108   Code: 55 Idle message        11:18:50 UTC
Train ID: 042980   Code: 08 Voice call grant     11:18:18 UTC
Train ID: 042980   Code: 80                       11:18:14 UTC
Train ID: 042980   Code: 80                       11:18:14 UTC
```

● Warning
● Listening
● Channel free
● Pilot

For Help, press F1

The messages are sent on channels around 460 MHz with 25kHz channel spacing, in FM mode, using FSK signaling at 600 bps. TrainPlotter decodes and displays these messages using the PC soundcard. You can use a simple UHF radio receiver (scanner) tuned to the appropriate band to pick up these messages. With TrainPlotter you can see the message data and find out the train's identity as well as such things as commands to increase or decrease speed, to set up a voice call or even to address the passengers.

RADIOSONDE Telemetry
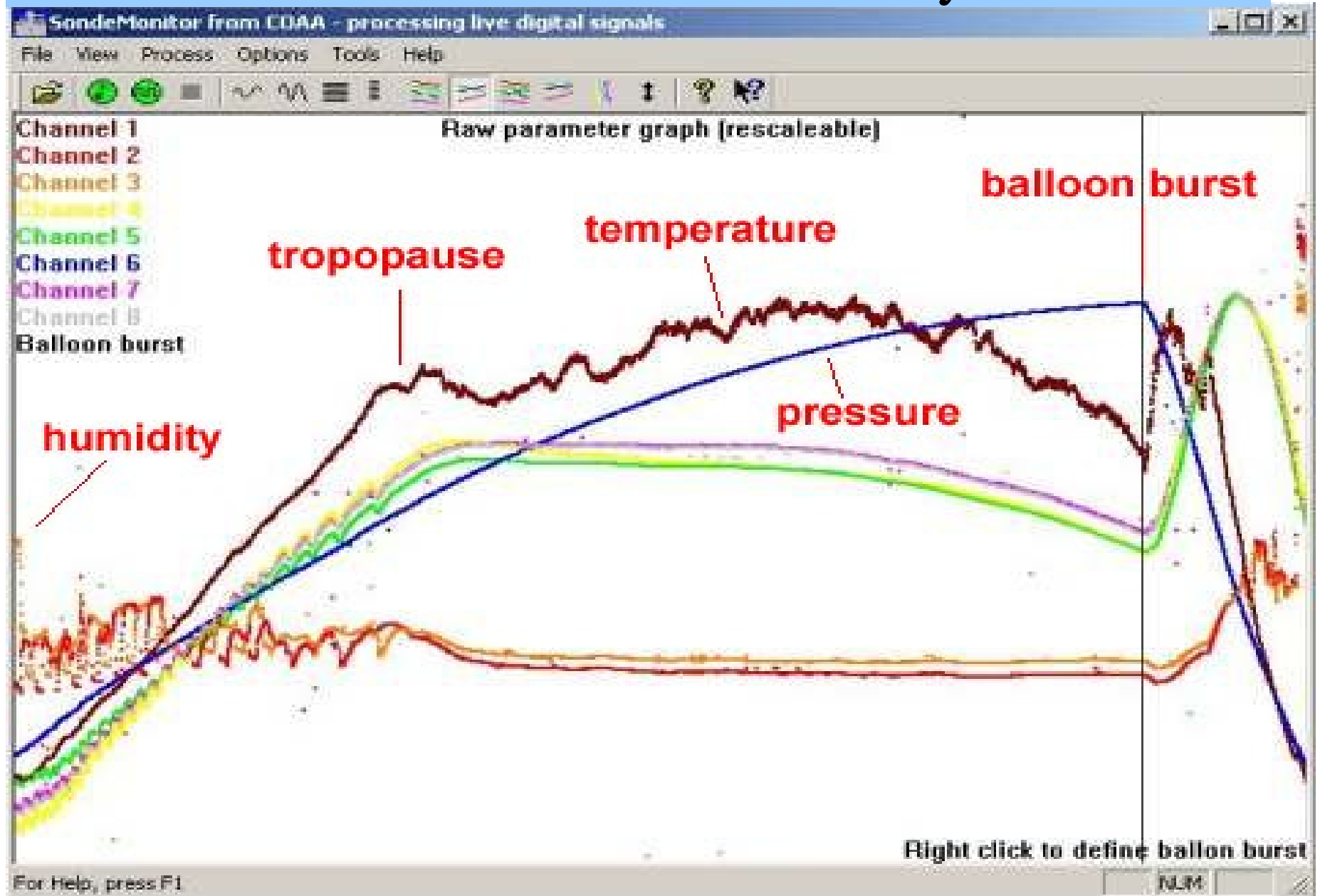
Oceanographic Buoys and Wildlife Tracking – Argos-3
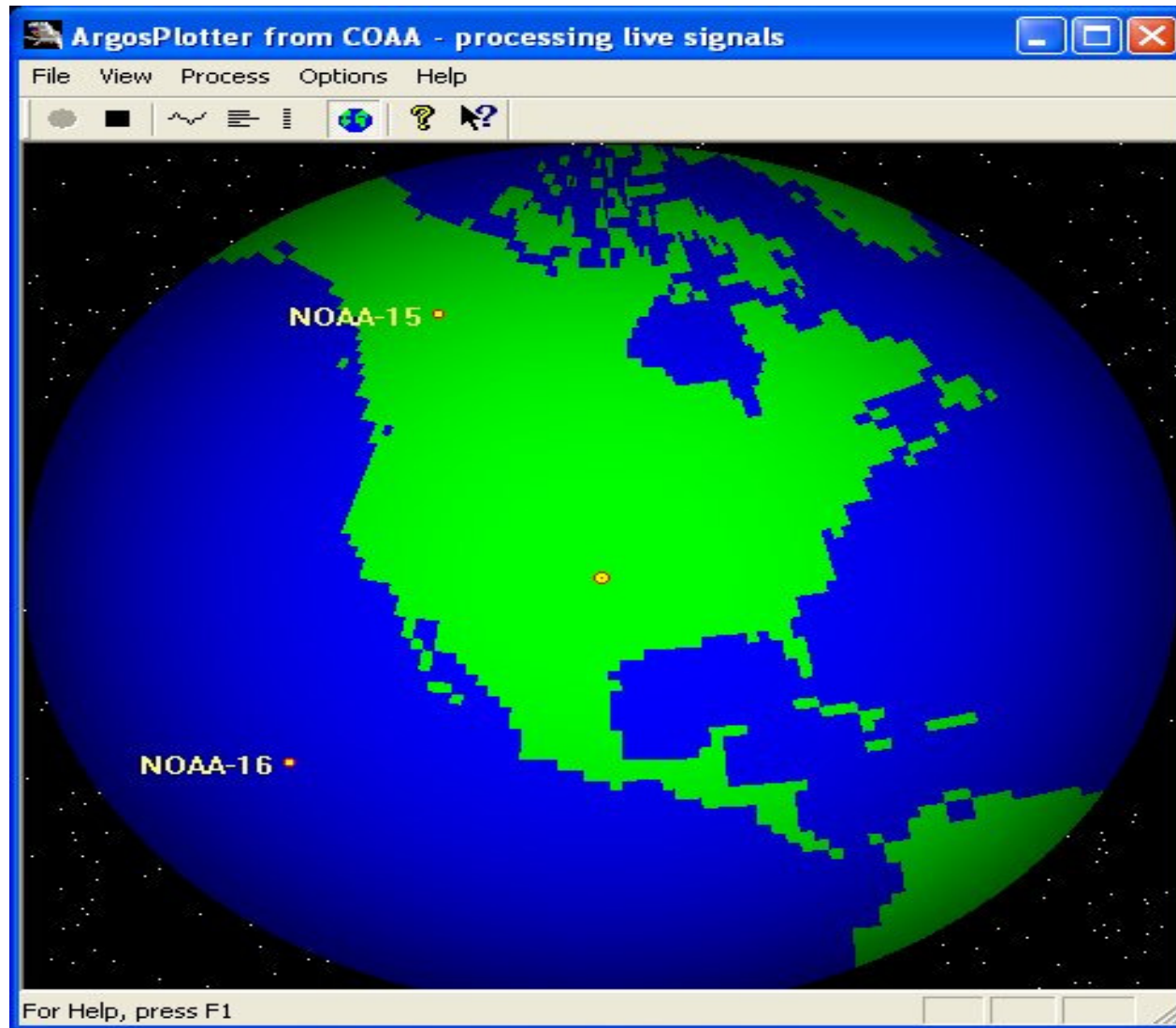
You can use a simple UHF radio receiver (scanner) tuned to the 465.9875MHz downlink frequency to pick up the strong signals from these satellites. With Argos3Plotter you can decode the telemetry and find out the positions of the satellites, their operational status and monitor the command messages sent to the remote data collection platforms.

Intel WISP, Wireless identification and Sensing Platform:
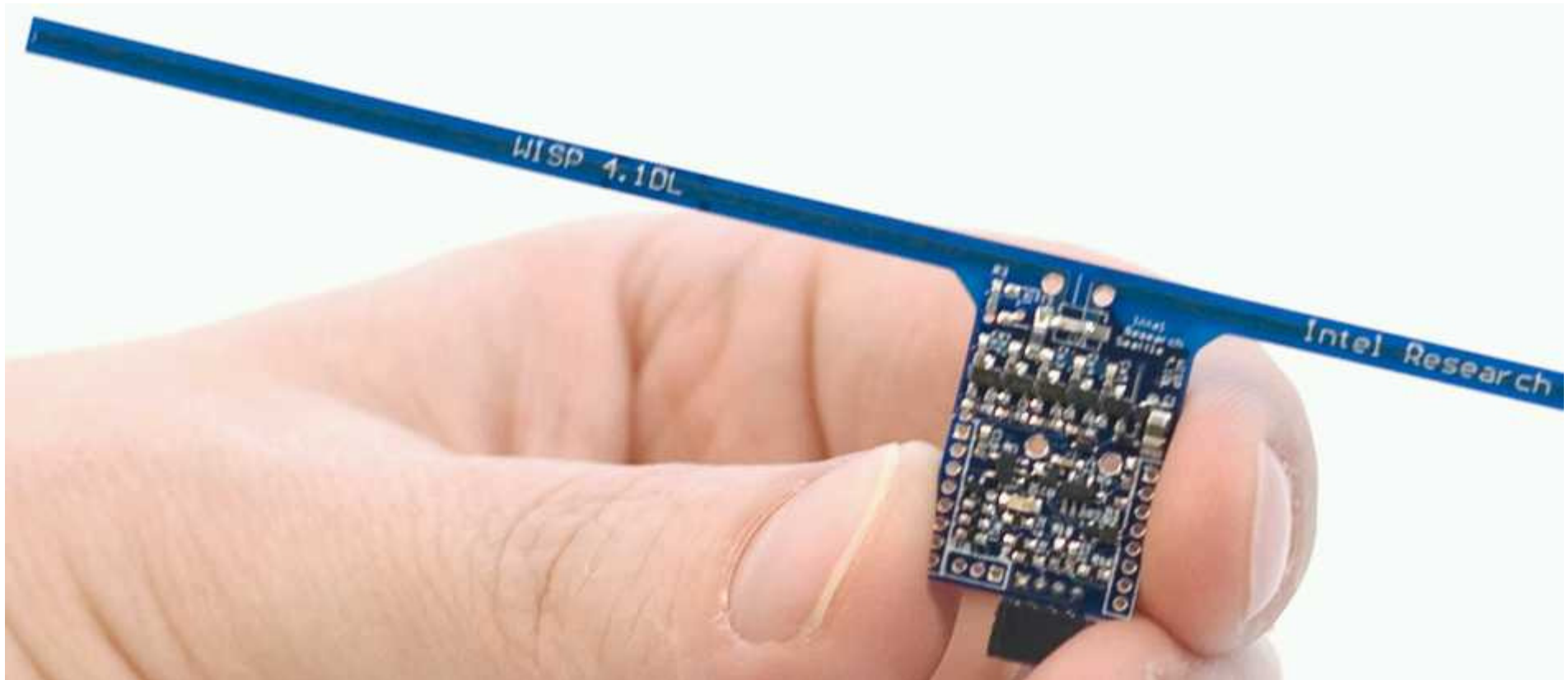
Imagine Powering your Smart Wireless Sensors by Stealing Power from your Local TV Station? Shades of Nicolai Tesla!!

TI & Chipcon Radio & Cymbet Evaluation Board:

EnerChip Solar Energy Harvesting Module

Wireless End Device

Wireless Access Point

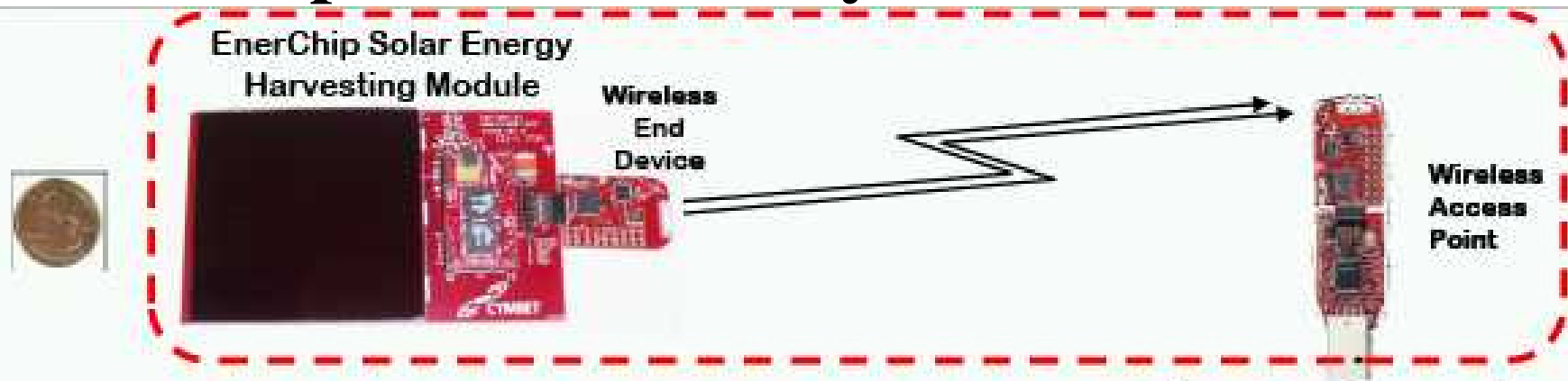- Available as the TI eZ430-RF2500-SEH Evaluation Kit in January 2009
- Compact module with integrated solar cell
- Works in low light – down to 150Lux
- Low self-discharge enables high-efficiency
- No battery replacement or disposal; 10-year life
- Uses the EnerChip EH CBC5300 – Energy Harvesting Module
- CBC-EVAL-08 is Cymbet's version of Solar EH Board for generic Energy Harvesting designs
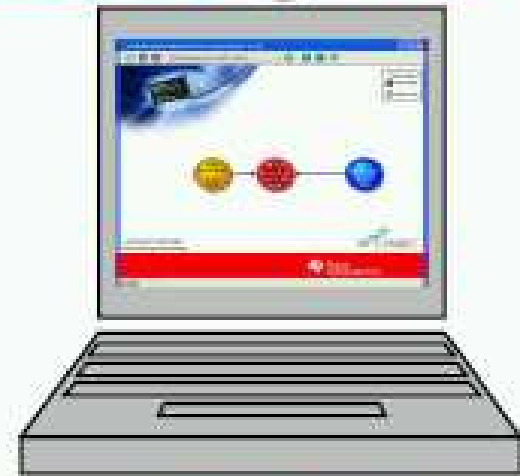
TI's eZ430-RF2500-SEH Evaluation Kit Contents

TI & Chipcon Radio & Cymbet Evaluation Board:

- EnerChip EH Module – CBC5300:
  - Capacity = 100uAh, uses 2 CBC050s
  - Compatible with solar, inductive, piezo & thermoelectric transducers
  - No battery replacement or disposal; 10-year life
  - Provides control signals to enable "Energy Aware" sensor nodes
  - Low self-discharge enables high-efficiency
  - Order P/N: CBC5300-24C
- Solar Evaluation Board – EVAL-08:
  - Solar Energy Harvesting Demo Kit
  - Compact module with integrated solar cell array
  - Works in low ambient light:
    - Down to 100Lux
  - Uses the EnerChip CBC5300
  - Adaptable to many sensors and wireless networks via Interface Header
  - Order P/N: CBC-EVAL-08
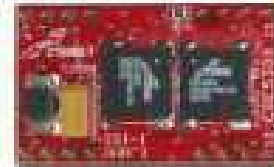
CBC5300 Module

Interface Header

Relative Power Availability by Parasitic Source:

| Energy Source	Challenge	Estimated Power (in 1 cm^3 or 1 cm^2)
Light	Conform to small surface area Wide input voltage range	10µW-15mW (Outdoors: 0.15mW-15mW) (Indoors: <10µW)
Vibrations	Variability of vibration	1µW-200µW (Electrostatic: 50µW-100µW) (Electromagnetic: <1µW)
Thermal	Small thermal gradients	15µW (10°C gradient)
Piezoelectric	Capturing pressure or motion	~ 200µW
RF & Inductive	Coupling & rectification	Various

Source: EE Times

AdaptivEnergy – JouleThief™

Solar - Various

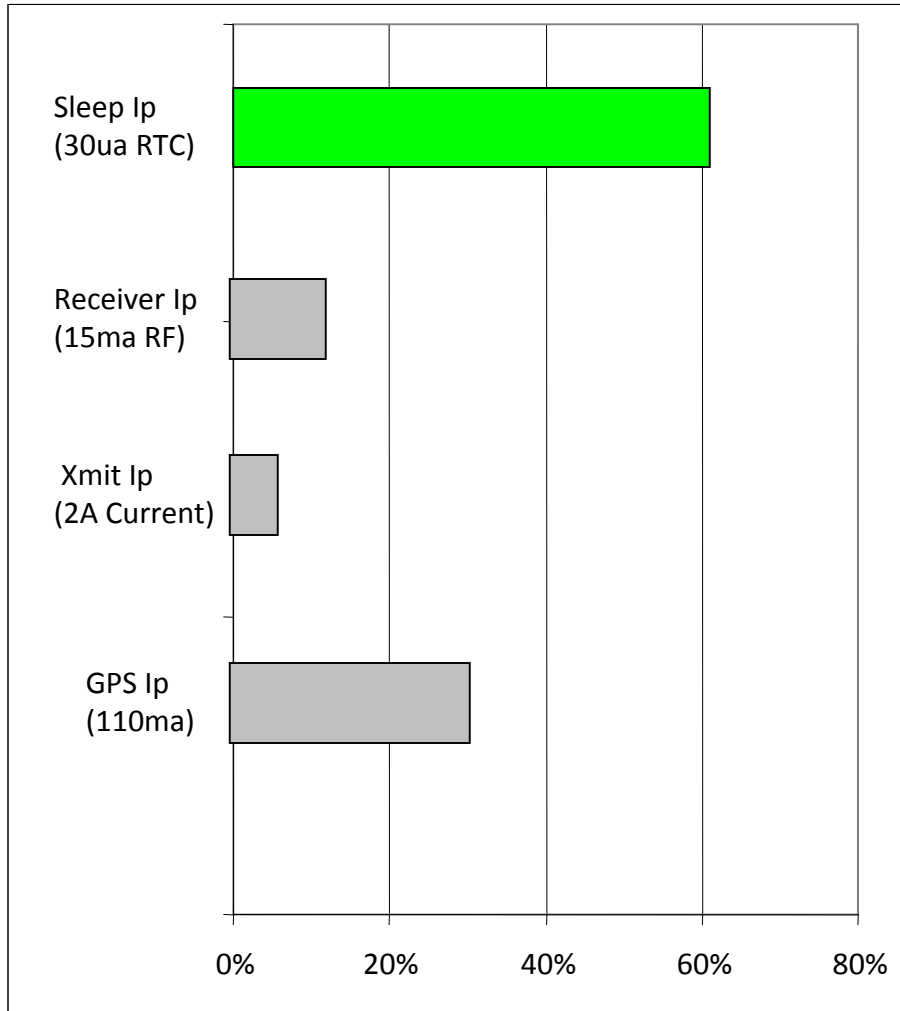Peltier - Thermo Life
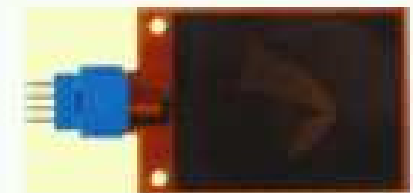
MIDE – Volture™ Piezo

Evaluation Board Power for 802.15.4 Protocol:

Parameter	Min	Typical	Units
Min input Lux	200		Lux
Full charge Lux	700		Lux
Load current (charging		20	uA
Load Current (not charging)		800	nA
Battery Charge Voltage		4.06	Volts
Battery Cutoff Voltage	3.0	3.3	Volts
UVLO Trip Select Voltage		0.7	Volts

Key Take-away is the 802.15.4 short-range wireless protocol can be powered through most of the Energy Harvesting Technologies which Enable self-powered sensors TODAY!

Percent Power by Architecture Element

Infrequent Location Reports (2x Day):

Sleep Ip (30ua RTC)	~61%
Receiver Ip (15ma RF)	~12%
Xmit Ip (2A Current)	~5%
GPS Ip (110ma)	~30%

Axis: 0% 20% 40% 60% 80%

Frequent Location Reports (12x Day):

Sleep Ip (30ua RTC)	~18%
Receiver Ip (15ma RF)	~34%
Xmit Ip (2A Current)	~15%
GPS Ip (110ma)	~48%

Axis: 0% 20% 40% 60% 80%