Websensors –
Sensors with an Internet Address

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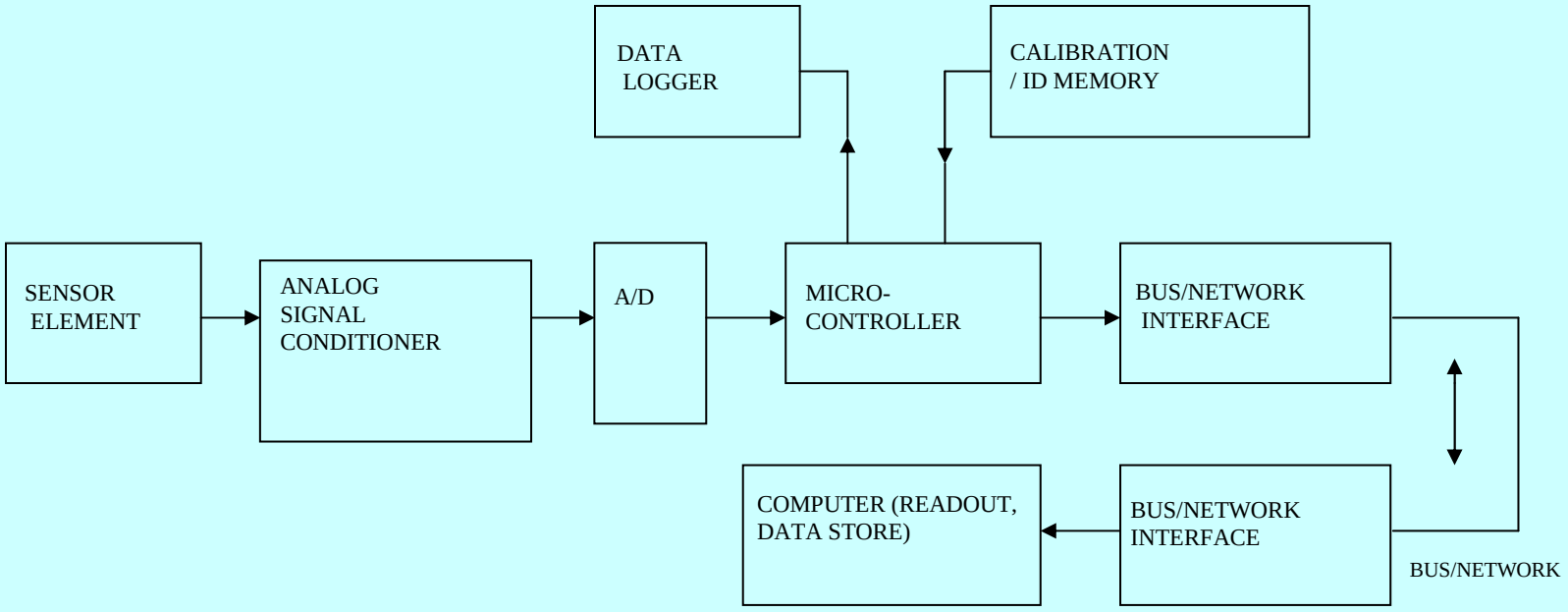
Scope of Presentation

- Outline sensor networking challenges
- Describe the websensor approach
- Focus on HVAC and power monitoring
- Discuss applications and benefit
- List websensors under development

Digital (Smart) Sensor Block Diagram



Digital Sensor Engineering Design
Choices and Compromises

- Location of ID/Calibration data
  (with sensor element, microcontroller, or readout computer)
- Off-the-shelf vs special purpose
- Should data logging included?
- Multi-purpose vs targeted signal conditioners
- Choice of network
- Plug & play vs. standard format
- Optimizing system costs
  (hardware, software, installation, maintenance, monitoring)
- Best Partitioning of functions

Sensor Networks and Busses

- Smart sensors without a network have limited applications (and not very smart)
- Multiple (50+) network standards available and widely used
  Examples: Fieldbus, CAN (Device-net & SDS), LonWorks, Modbus, ARCnet, HART, various wireless
- Lack of standards inhibit wider use of digital sensors
- The sensor industry is fragmented (by technology, parameters measured, application areas, price ranges)
- No universal standard in spite of efforts to establish one (multiple standards likely for many years)

IEEE 1451 Sensor Network Standard

- Newly established NIST/IEEE standard for sensor manufacturers (several versions: .2, .3, .4, .5)
- Hardware interface between smart sensors and network interface/driver
- Specifies Transducer Electronic Data Sheet (TEDS)
- Very limited adoption by sensor industry so far
- We (D. Wobschall) are on standards committee

Websensor Design Approach
--Hardware--

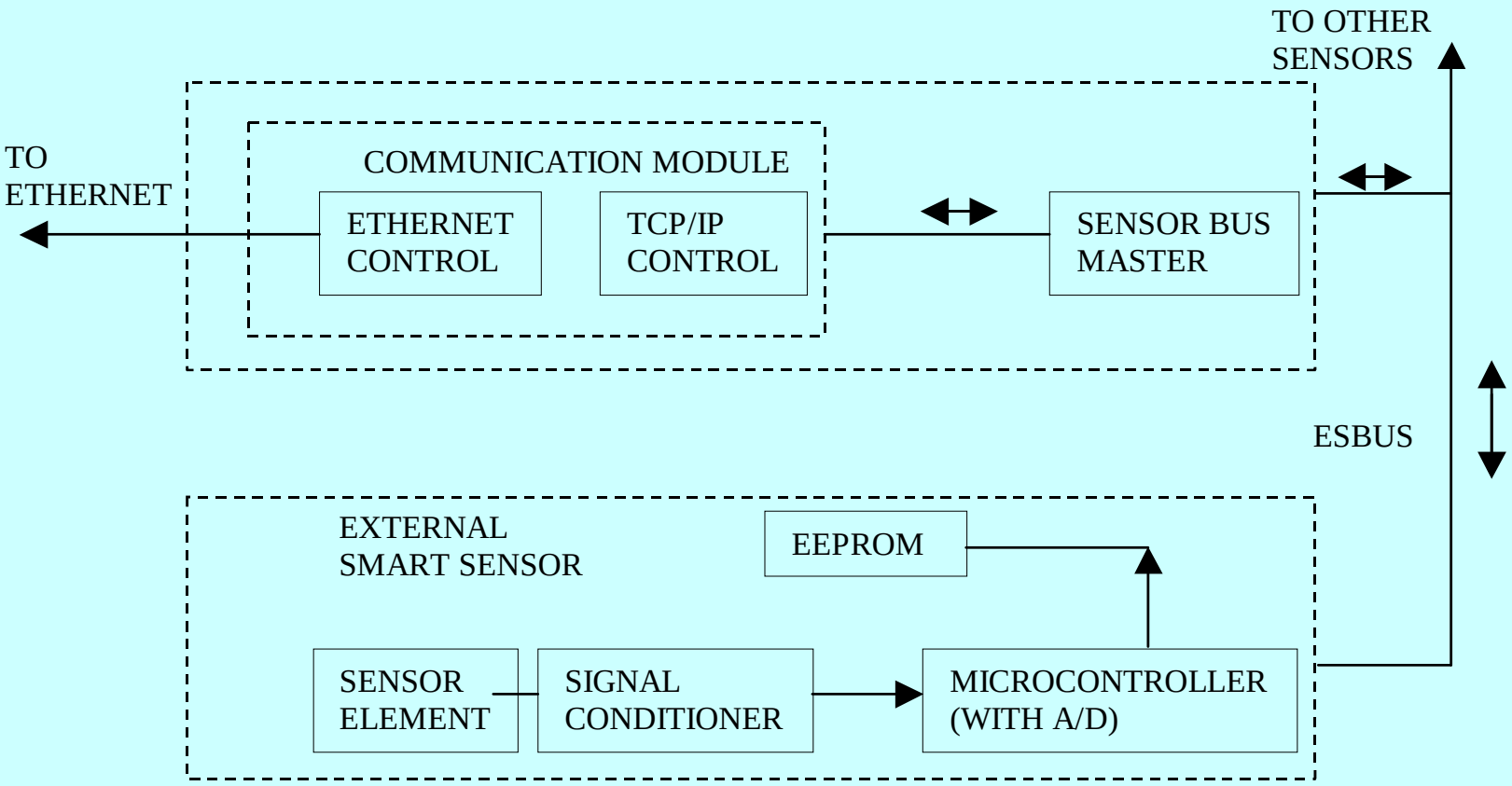
- Maximize use of off-the-shelf hardware and software
- Partition into modular sections for interchangeability
- Optimize system costs for small production runs
- No multi-functional signal conditioners

  (rather series of easily designed & produced related sensors)
- Incorporate IEEE 1451 concepts where possible
- Choose Internet via Ethernet as the network (industrial)
- Different microcontrollers for different functional modules
- Connect sensors locally via an isolated SPI bus (ESbus)
- Allow multiple local bus options (RS232, wireless)

Websensor Design Approach
--Software--

- Modularized software (Communication module, sensor data encoding, signal processing) to allow rapid new designs.
- Use available TCP/IP routines (modified for sensor use)
- Compatibility with standard Internet browsers and server software.
- Send data (especially sensor data) in ASCII (human readable form) where possible.
- Provide website (at Esensors) to (optionally) automatically poll and record sensor data (for later access by users).

Block Diagram of a Websensor
Local bus (ESbus) Version



Websensor Data Command Format

ecfybbbb (example: e4100000)

where "e" is a header character

c is the channel or sensor # (0 to 9)

f is the format code (1 for Esbus)

y is a command (optional)

bbbb is command data, if any

Sent by originating website via Internet browser

(example: **www.eesensors.com\e4100000**)

Websensor data format

sent by Websensor back to website

Header format

Eiiiicfw (example: EM02a410)

where iiii is a sensor ID or model #

c is the channel (sensor) #

f is the format (1 for Esbus)

w is a status/command code (optional)

Data format (follows header, format 1):

ssdddd.dd

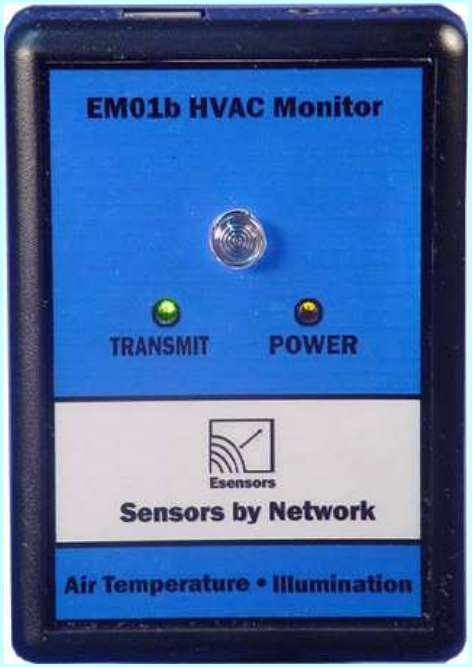
(example TC025.30 for 25.3 deg. C)

Sensor http format may by read by any standard browser

Heating, Ventilation and Air-conditioning (HVAC) Monitor (EM01 Websensor)

- Measures temperature, rel. humidity, and illumination
- Accuracies of 0.2 deg C and 3% RH
  (illumination is uncalibrated)
- Sensor (T and RH) on cable (tail) to allow positioning
  (inside mounting also available)
- Email sent if limits exceeded
- Polling website (eesensors.net) available

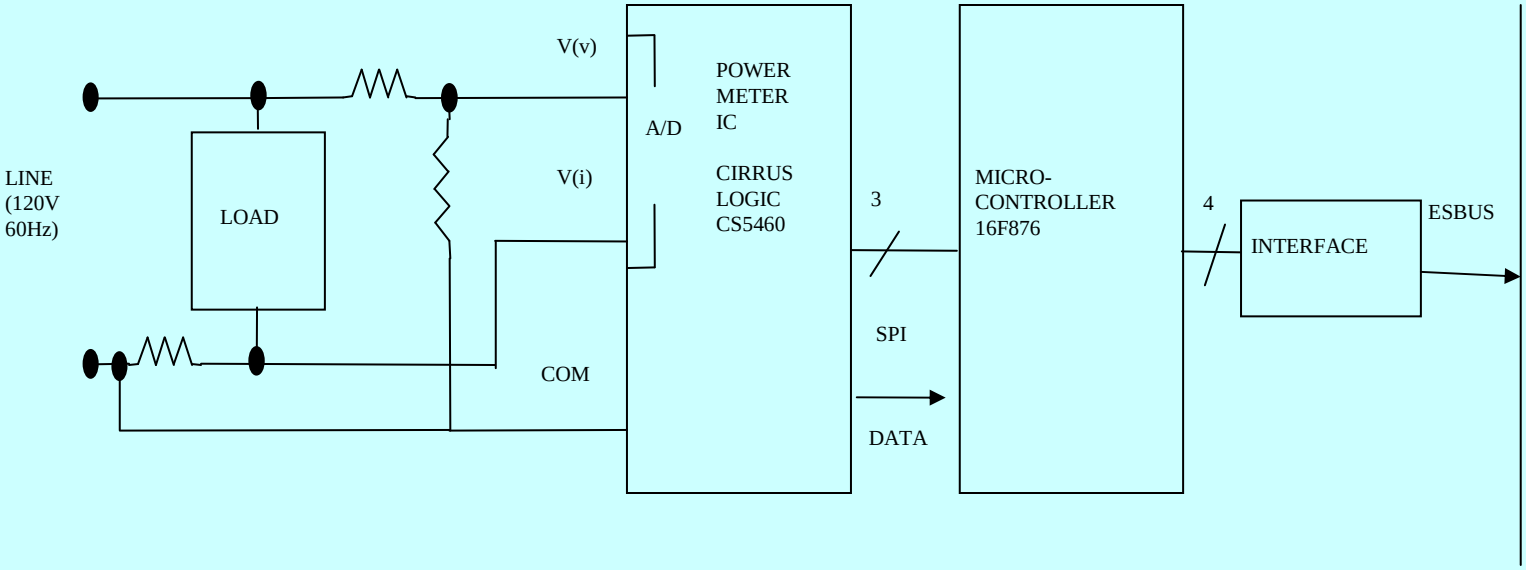
Photo of HVAC Monitor



Digital Power Meter (ES02a)

- Measures AC voltage, current and (true) power
- Wall-mounted plug (“a” version) – being tested 2ndQ, ‘03
- Nominal range: 120v @20 Amp
  (200 v and 80 amp short term max)
- Accuracy is 0.2% (suitable for metering)
- Connects to Esbus which requires the ES02 interface
  (up to 9 devices on bus)
- Power factor and energy (watt-hours) calculated
  (accumulated energy kept in local memory)
- Polled by ES02 several times a minute to check for limits
  (email send to website if over limits)
- Other ranges (including 3-phase) under development

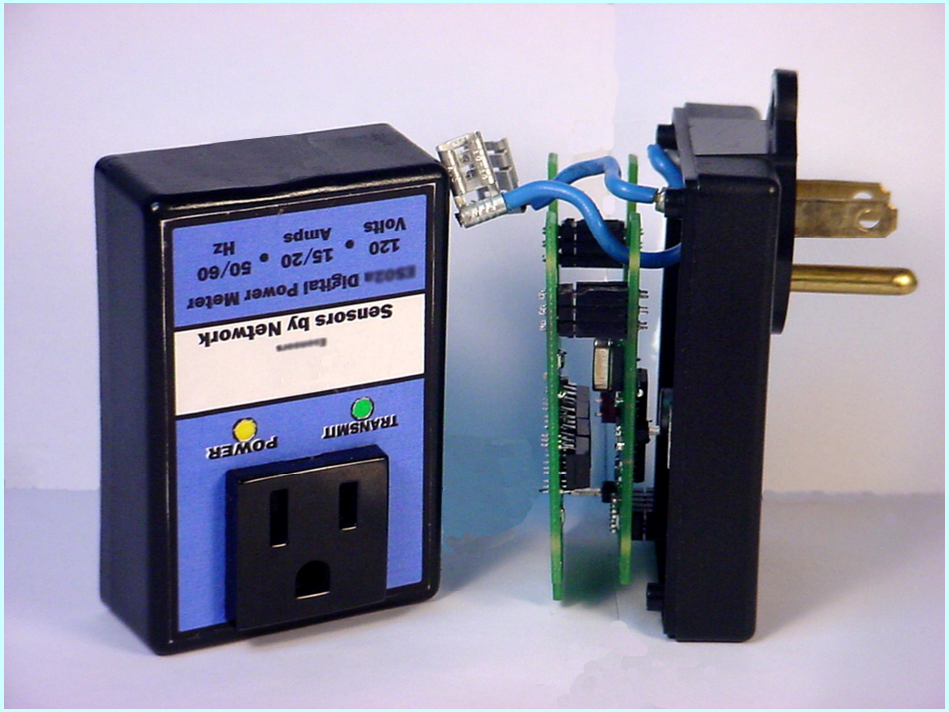
Block Diagram of Digital Power Meter
with Esbus Interface



DALI/Internet Interface

- Digital Addressable Lighting Interface (DALI) to Internet/Ethernet/Esbus under development
- Allows control of lighting via Internet
- Internet interface similar to EM02 websensor
- Prototype testing scheduled for summer

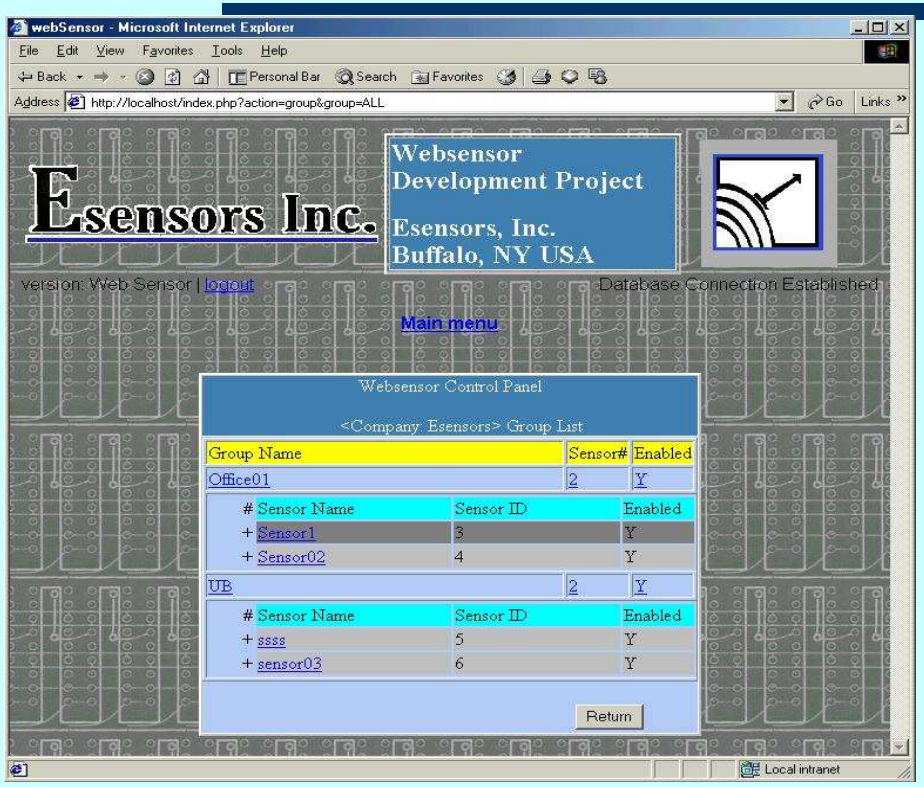
Photo of Digital Power Meter (ES02a)



Websensor Address Setup

- Required Addresses
  * Websensor (website) internet address (e.g.10.11.12.13)
  * Ethernet address
- Optional ID
  * Site name
  * Sensor name
- Configuration Method
  * Computer (PC) via RS232 (ES00r interface for Esbus)

Websensor Website Screens
Dot.net



Specialized webpages for digital camera, IEEE-1451, etc fix this

Cost Components of a Networked Sensor System

- Sensor with signal conditioner and conversion to digital format (often sensor and sig. cond. companies are separate)
- Network interfaces (local and Internet)
- Meeting standards, inter-changeability (plug and play)
- Software polling, data collection, storing in data base, and retrieval (display)
- Installation (hardware, cables, and software)
- Maintenance

Websensors, which combine many of these functions in one package, may have lower total costs

Websensors under development

- HVAC monitor (temp, rh, illum)
- Digital power meter (volts, power, pf, current)
- IEEE 1451 standard industrial sensor interfaces
- RS232/Internet interfaces (several versions)
- DALI/Internet interface
- Webcamera (1kx1k, segmented image transfer, Esbus)
- Various I/O (e.g. switches, relays) on Esbus
- Weather monitor (temp, press, wind-speed, rh)
- Environmental monitor (CO2, CO, VOC, + above)

Esensors Business Plan

- Develop a series of networked sensors
- Focus on sensors with an Internet address (via Ethernet)
- Initial sensor applications
  - *Environmental*
  - *Energy conservation*
  - *Industrial sensors (IEEE 1451 network standard)*
- Primarily serve OEM customers
- Market through Internet and trade shows

Summary

- A series of websensors (sensors with direct internet address) are being developed at Esensors
- Featured here are the HVAC and power monitor
- Access to the Internet is through Ethernet
- Several local network options are available [e.g. Esbus]
- Data can be read (in condensed form) by standard Internet browsers
- A website can provide users with automatic readings and graphical readouts, including archived data