Enabling the Real-Time Enterprise

www.sensinode.com

SENSINODE

Zach Shelby, CTO

EWSN 2008

I have a dream

The *Internet*

+

The *physical* world

=

The Internet of things

How we get to the Internet of Things

Arpanet,
Usenet,
BBSs

Internet

Web 2.0

Web Services

Sensor Networks

Ubicomm

802.15.4 + 6LoWPAN + Web Services

Ethernet

Proprietary
ISM Radios

Modems
Leased Lines
RS232

Wi Fi

Bluetooth

**IEEE
802.15.4**

6LoWPAN

ULP BT

ISA100

80s 90s 2000 2003 2006 2008

Benefits of IP-based Sensor Networks

- IEEE 802.1
  - 802.15.4
    standard
  - The new
    every wi
- The benefit
  - Open, long-l liable **st**
  - Easy learni
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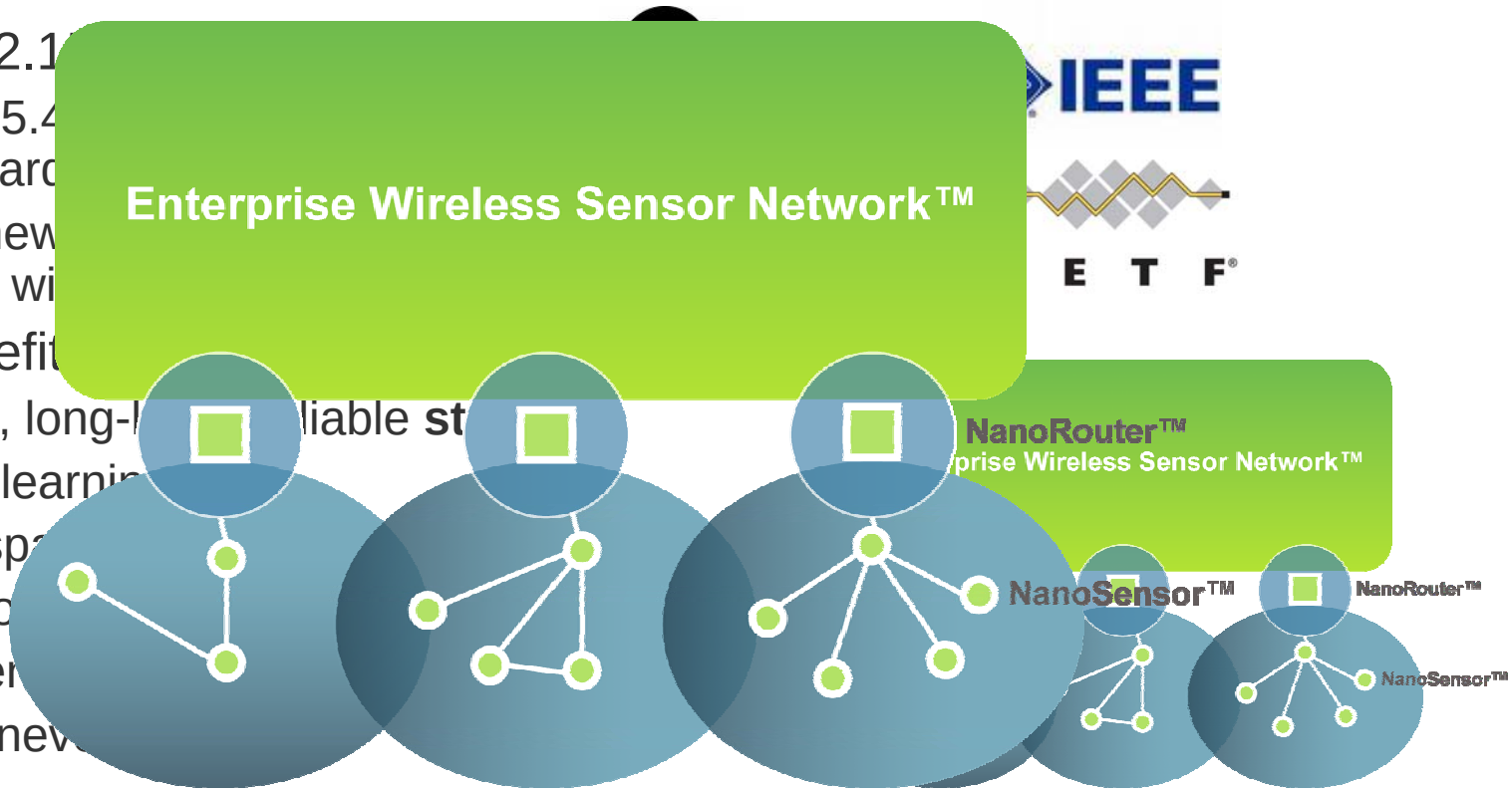


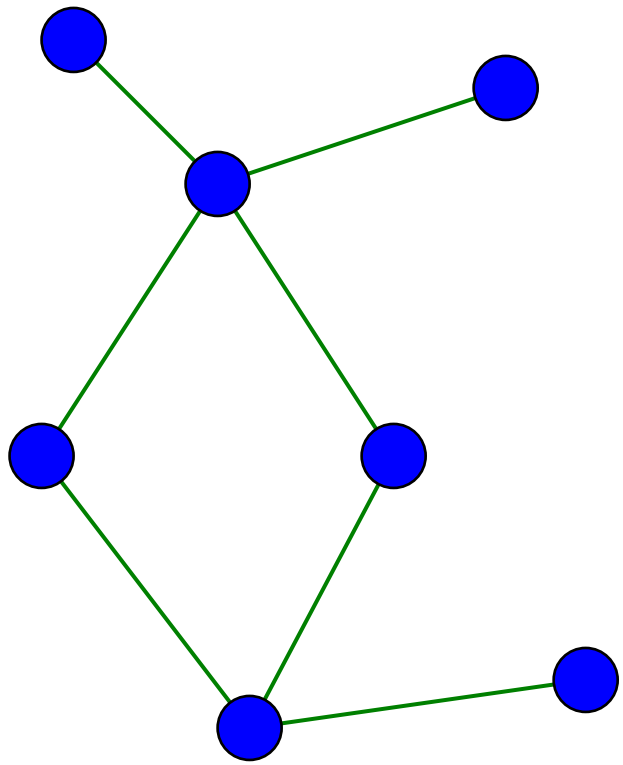
Applications for IP-based WSNs

There are commercial, industrial, health and consumer markets for IP-based WSNs

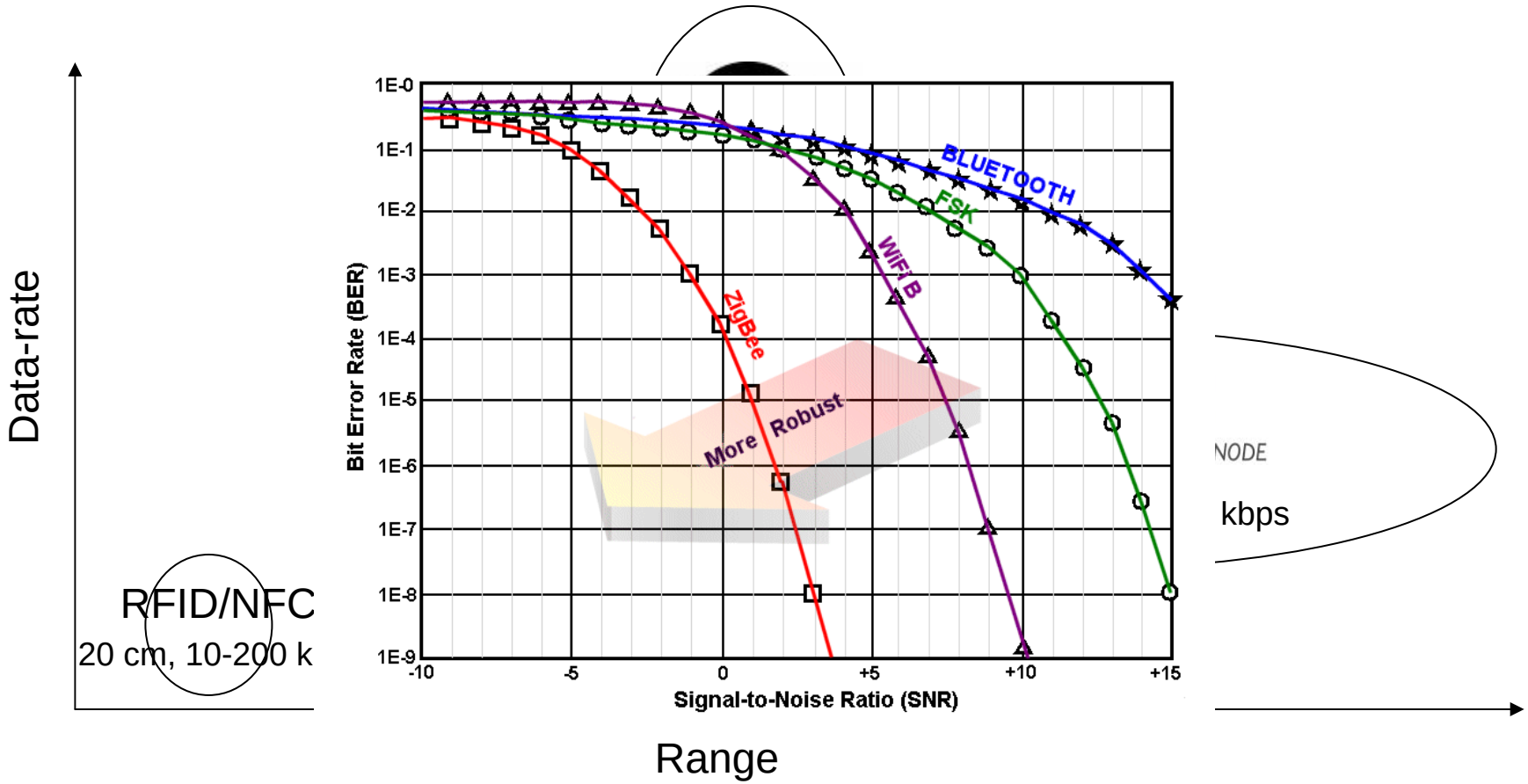
1. **Logistics**, manufacturing and automation
2. **Smart buildings, environments** and **security**
3. **Healthcare** and well-being
4. Consumer applications e.g. **home automation** and health

IEEE 802.15.4 - **The** global standard

- Important standard for home networking, industrial control and building automation
- 802.15.4 Original
  - 250 kbps at 2.4 GHz (DSSS)
- 802.15.4a CSS and UWB
  - Up to 2 Mbps typical, accurate positioning
- Robust radio with flexible topology
  - Slotted CSMA algorithm
  - Beacon and beaconless modes
  - Reduced and full function nodes
- The next WiFi



Technology Comparison



The 802.15.4 Market

- 802.15.4 chip shipments are growing fast:
  - Up to 10 million units in 2006
  - Over 100 million units estimated for 2009
  - 200% growth per year
- OnWorld's industry expert survey showed that by 2009
  - 55% will support ISA100 (based on 6LoWPAN)
  - 40% will support WirelessHART
  - ZigBee will hold onto about 30%
  - Although not noted, most proprietary applications move to 6lowpan

Source: OnWorld

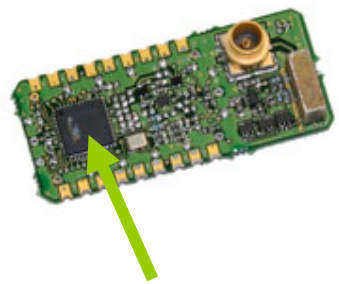
Growth for Industrial WSN Applications

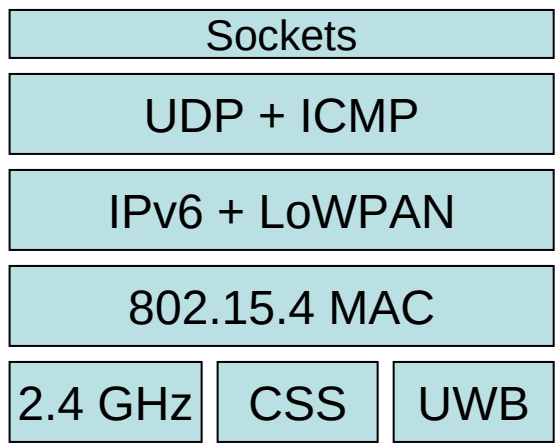
- **Asset monitoring 300%**
- **Machine health 122%**
- **Safety & security 86%**
- Tank level monitoring 75%
- Process monitoring 32%
- Facility environmental 14%
- Relief valves/steam traps 14%

Source: OnWorld

6LoWPAN - IP for Low-power Devices

- IETF Standard for IPv6 over IEEE 802.15.4
- 80% compression of headers
- Rich and flexible features
  - Auto-configuration
  - IPv6 fragmentation
  - UDP + ICMP
  - Mesh forwarding
- Common Socket API
- Super compact implementation
- Direct end-to-end Internet integration
- Extremely scalable

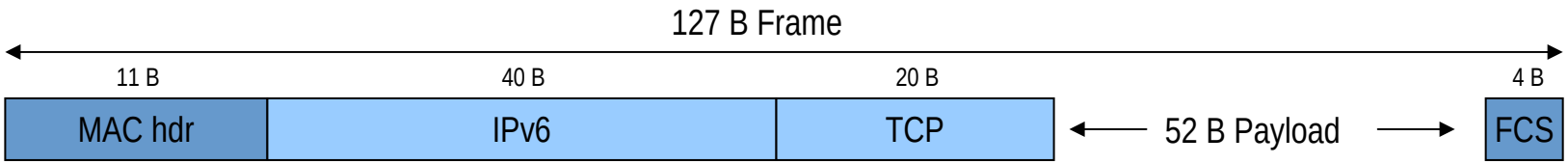




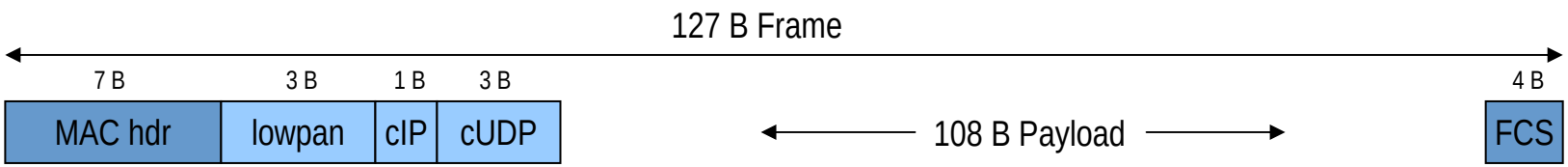
6LoWPAN Headers

- Orthogonal header format for efficiency
- Stateless header compression

Impossible case: Full TCP/IPv6



Best case: 6LoWPAN UDP/IPv6



ISA SP100

- The Instrumentation, Systems, and Automation Society (ISA)
- Society for promoting and standardizing automation
- Standardization activities accredited by ANSI

- ISA100 group standardizes wireless systems for automation
- ISA100.11a standardization is in progress
  - IEEE 802.15.4 2006 Radio Standard
  - 6LoWPAN Networking (6lowpan, IPv6, UDP)
  - Network gateways, monitoring, deployment, interoperability
  - Defining reliability classes 0 to 5
  - Draft available 4Q-2007, finished end of 1Q-2008

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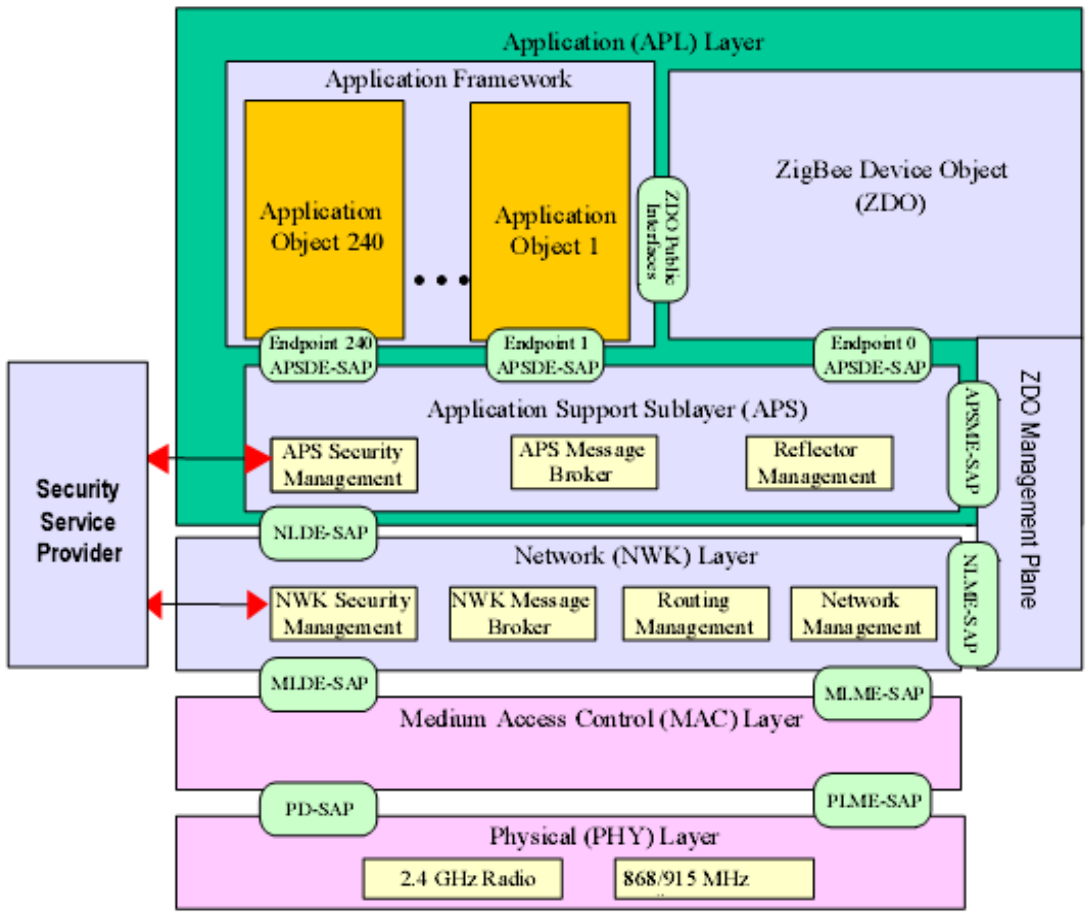
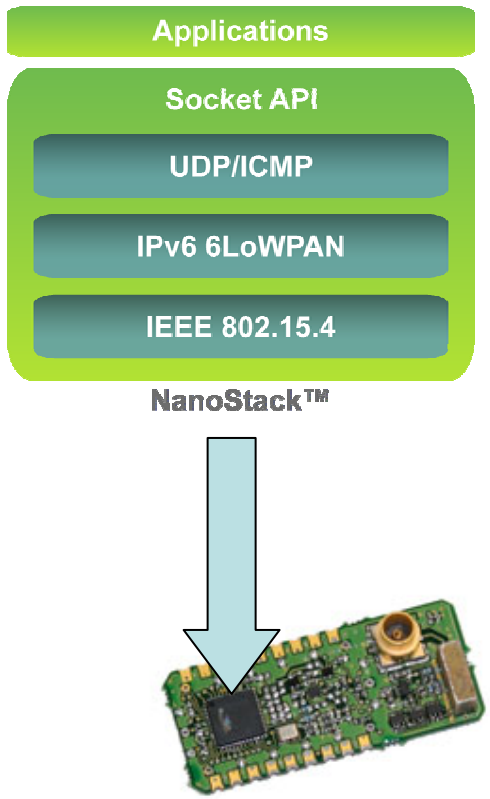

Application (APL) Layer
Application Framework
Application Object 240
Application Object 1
ZigBee Device Object (ZDO)
ZDO Public Interfaces
Endpoint 240 APSDE-SAP
Endpoint 1 APSDE-SAP
Endpoint 0 APSDE-SAP
Application Support Sublayer (APS)
APS Security Management
APS Message Broker
Reflector Management
APSME-SAP
ZDO Management Plane
Security Service Provider
NLDE-SAP
Network (NWK) Layer
NWK Security Management
NWK Message Broker
Routing Management
Network Management
NLME-SAP
MLDE-SAP
MLME-SAP
Medium Access Control (MAC) Layer
PD-SAP
PLME-SAP
Physical (PHY) Layer
2.4 GHz Radio
868/915 MHz
IEEE 802.15.4 defined
ZigBee™ Alliance defined
End manufacturer defined
Layer function
Layer interface

NanoStack™

- Sensinode's 6LoWPAN implementation
  - IEEE 802.15.4, IPv6, UDP, ICMP
- Simple, modular stack with a Socket API
- NanoMesh™ multihop forwarding
- Portable C implementation
- MSP430, AVR, CC2420, CC2430 support
- Support for the FreeRTOS microkernel
- PC tools included
- Dual-license open-source
- Sourceforge open-source project
- Download at www.sensinode.com



Thank You!

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