



Synopsis of IEEE 1451

IEEE 1451: Empowering the Smart Sensor Revolution

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Outline

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- IEEE 1451 Smart Transducer Interface Standards
- Status of the Family of IEEE 1451 Standards
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National Institute of Standards and Technology (NIST)

Mission: Develop and promote measurement, standards, and technology to enhance productivity, facilitate trade, and improve the quality of life.



Gaithersburg, Maryland

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Manufacturing Engineering Laboratory Programs

- Dimensional Metrology
- Homeland and Industrial Control Security
- Intelligent Control of Mobility Systems
- Manufacturing Interoperability
- Manufacturing Metrology and Standards for the Health Care Enterprise
- Mechanical Metrology
- Nanomanufacturing
- Smart Machining Systems



IEEE 1451 Smart Transducer Interface Standards

- IEEE 1451 is set of open, network-independent communication interfaces for connecting transducers to computers, instrumentation systems, and networks.
- Using IEEE 1451, sensor manufacturers and users eliminate the need to custom make specific protocols to support multiple networks.
- IEEE 1451 accommodates transducers connection to networks by wired or wireless means.
- Over the years, IEEE 1451 has expanded to include a family of seven standards to support a number of sensor connection configurations to meet industry needs.
- IEEE 1451 is being developed in the IEEE I&MS Sensors Technology Technical Committee TC-9.



Concept Behind IEEE 1451

- IEEE 1451 establishes "plug and play" standards for "Smart Transducers".
- A "smart" transducer includes enough descriptive information so that control software can automatically determine the transducer's operating parameters based on the decoded (electronic) data sheet and issue commands to read or actuate the transducer.
- Thus, IEEE 1451 defines
 - standardized communication interfaces for transducer connection to network with for support multiple sensor connection configurations including wired and wireless
 - standardized electronic data sheet encoding scheme called Transducer Electronic Data Sheets (TEDS) and standardized data formats for the TEDS. The TEDS contains manufacture-related data such as manufacturer ID, sensor type, measurement range, physical unit, calibration information, and more...

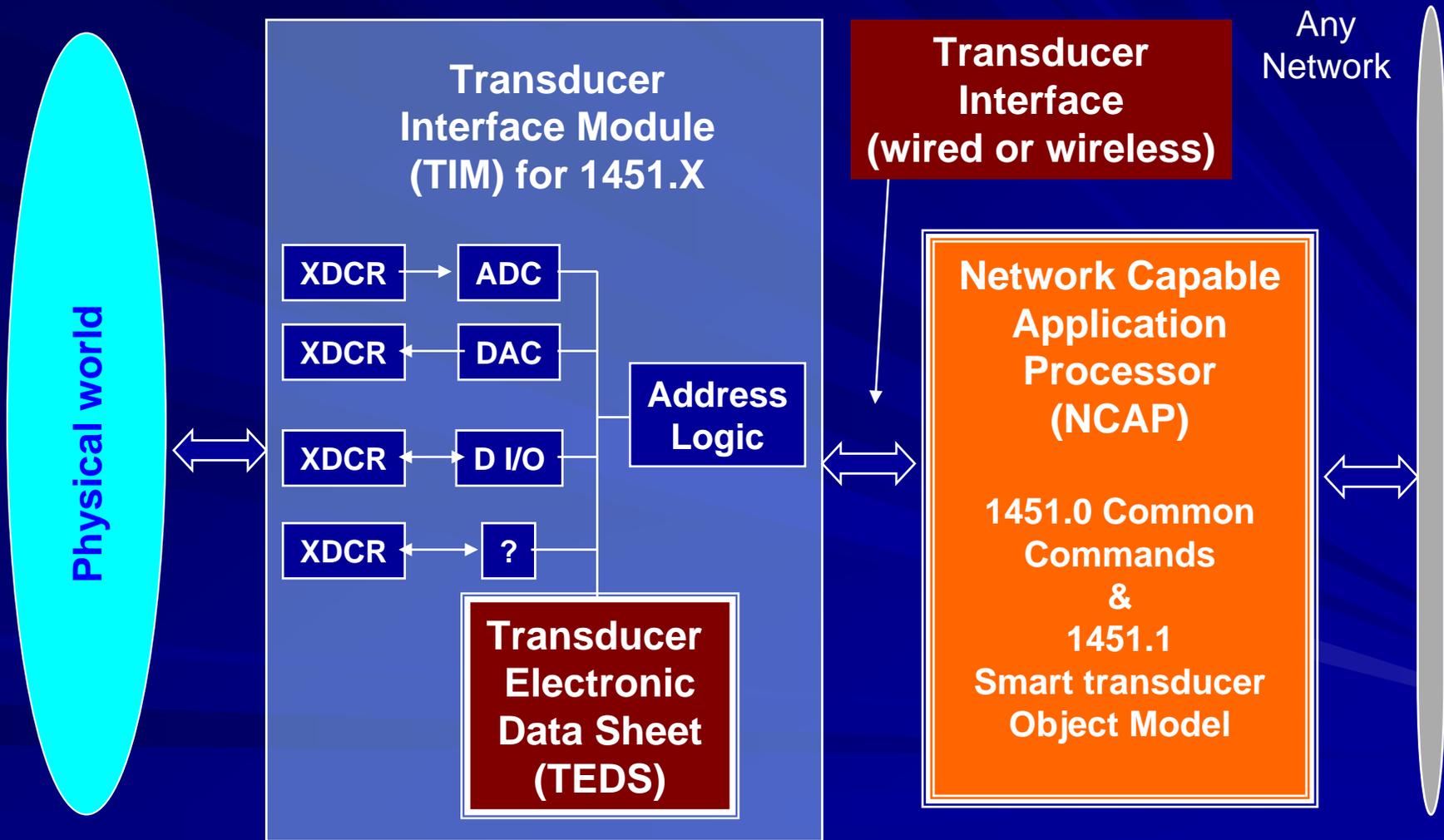


Concept Behind IEEE 1451 - cont'd

- IEEE 1451 defines a Transducer Interface Module (TIM) and Network Capable Application Process (NCAP)
- A TIM contains (see next slide)
 - from 1 to 255 transducers (can be a mix of sensors and actuators)
 - signal conditioning and processing electronics
 - address logic (or microprocessor) to implement a standardized **Transducer Interface** (a wired or wireless interface) defined by IEEE 1451.X (.2, .3, .5, .6, ...) between the TIM and NCAP
 - a TEDS
- A NCAP contains (see next slide)
 - a neutral smart transducer object and data models that allow
 - NCAP to communicate sensor data and information to any network
 - NCAP to NCAP communications (defined by IEEE 1451.1)
 - application programming interfaces (API) and a common command set to access transducers from a network (defined by IEEE 1451.0)



IEEE 1451 Smart Transducer Interface System Diagram



XDCR = sensor or actuator



Status of the Suite of IEEE 1451 Standards

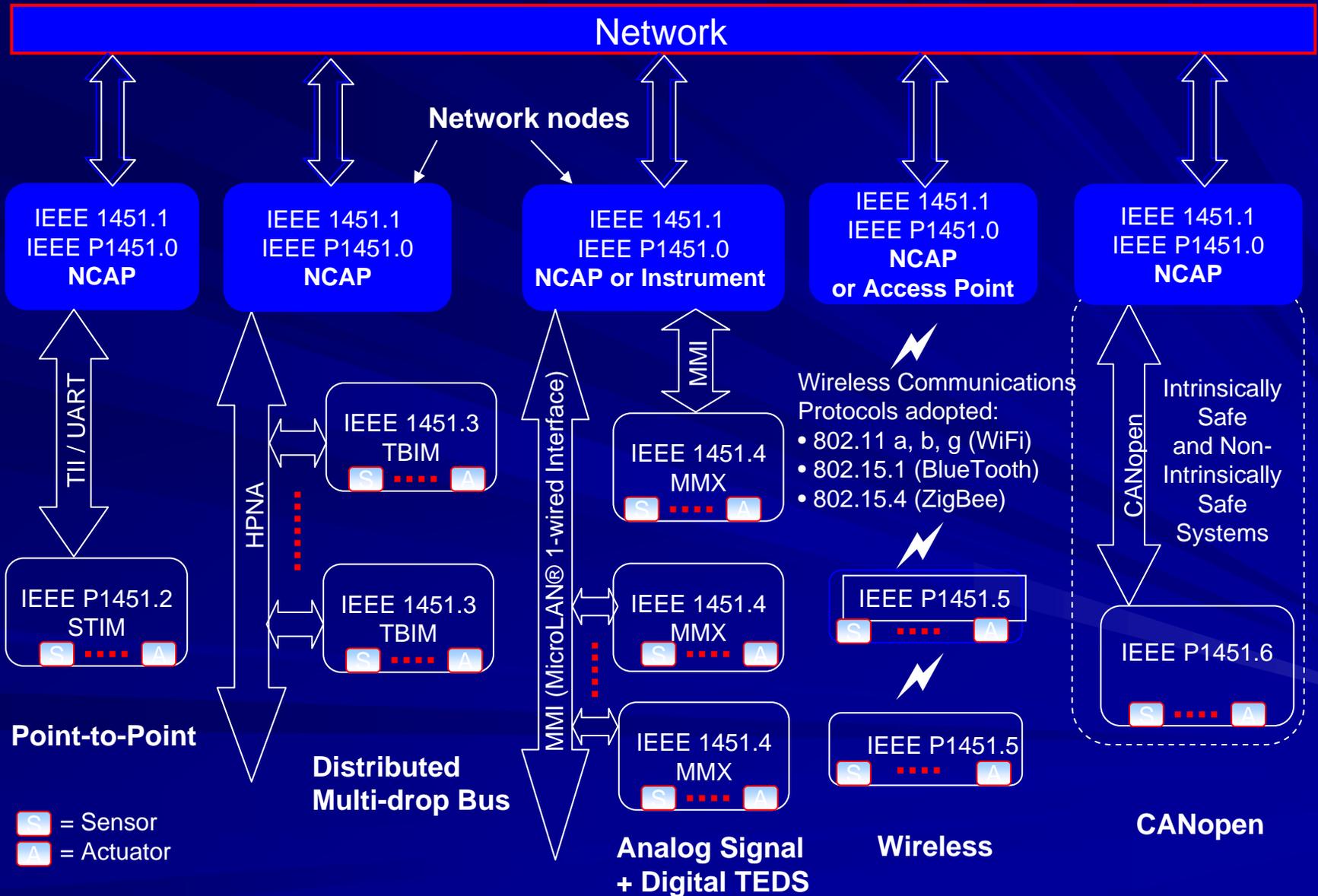
- IEEE P1451.0 defines a set of common functions, communication protocols, and transducer electronic data sheet (TEDS) formats for the family of IEEE 1451 standards -- *In progress*
- IEEE Std 1451.1-1999 defines a Network Capable Application Processor (NCAP) Information Model for smart transducers -- *Published standard, being revised*

Physical Layers

- IEEE Std 1451.2-1997 defines a point-to-point digital transducer interface between a TIM and NCAP -- *Published standard, being revised*
- IEEE Std 1451.3-2003 defines a digital transducer interface for distributed multi-drop systems -- *Published standard*
- IEEE Std 1451.4-2004 defines a mixed-mode transducer interface (digital interface for TEDS access and analog interface for sensor signal) – *Published standard*
- IEEE P1451.5 defines a wireless communication interface for sensors adapting existing wireless communication protocols such as Bluetooth, WiFi, and ZigBee – *In progress*
- IEEE P1451.6 defines a high-speed CANopen-based transducer network interface – *In progress*



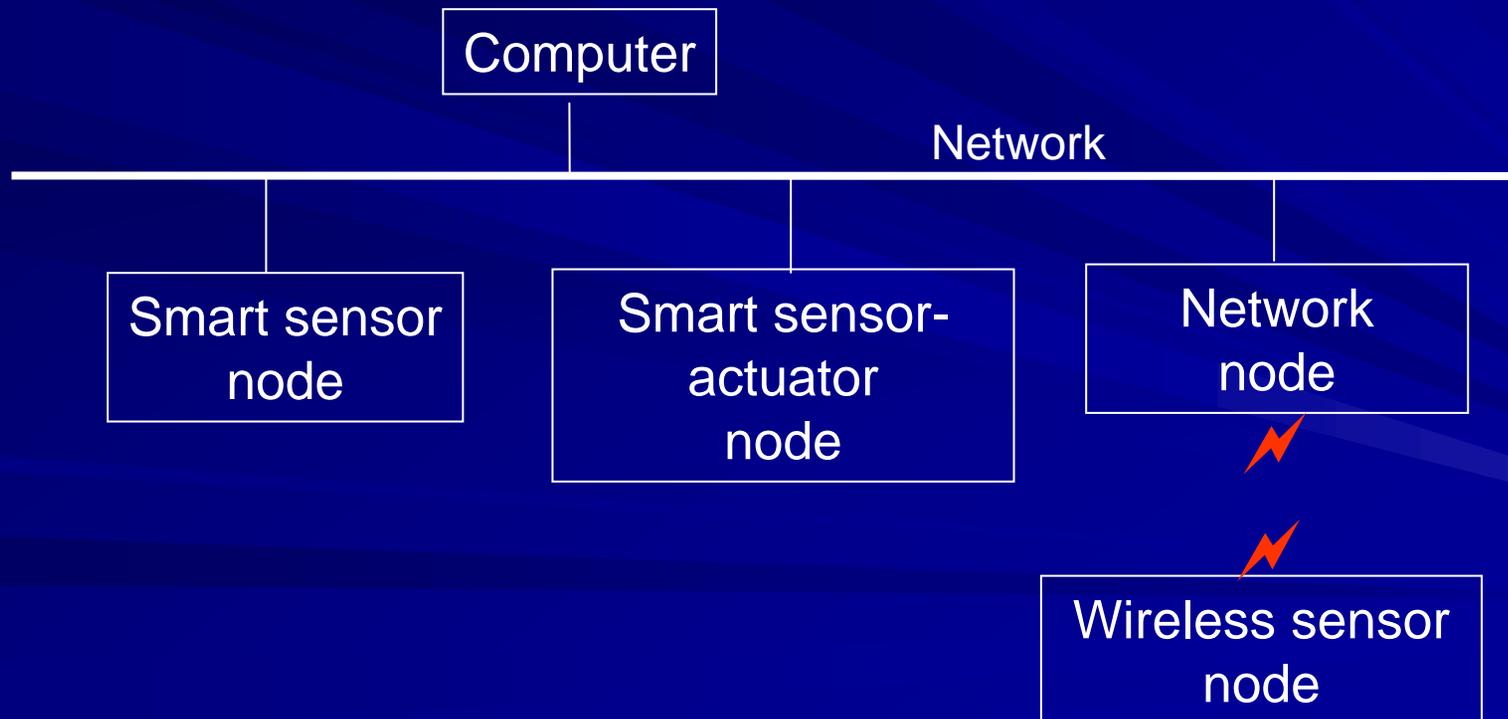
IEEE 1451 Family of Standards





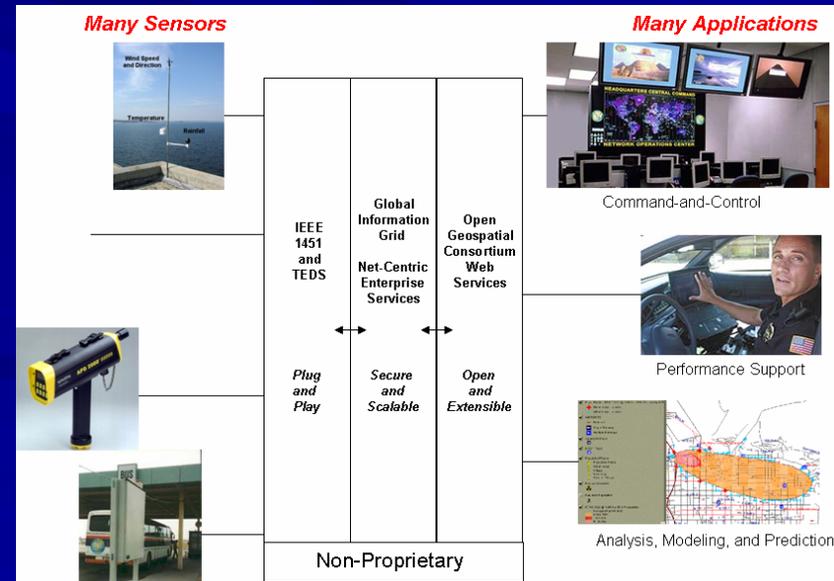
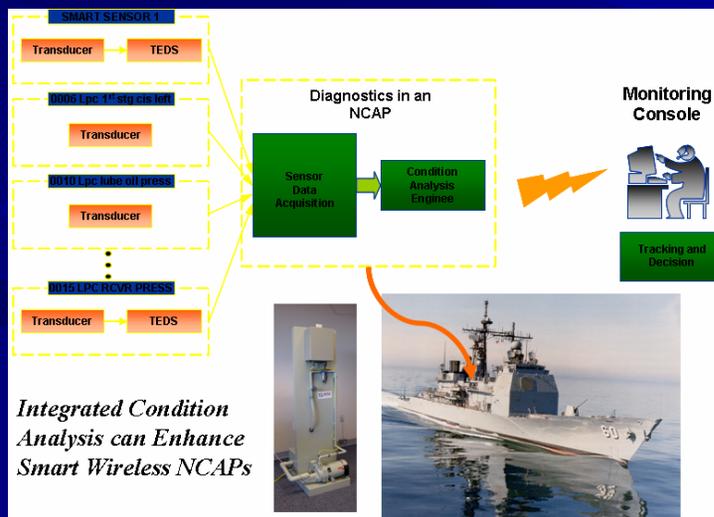
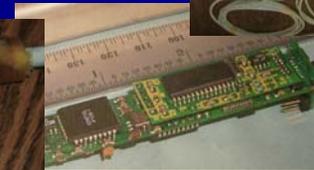
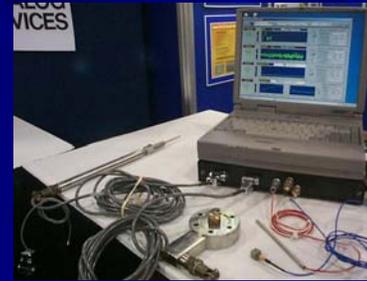
IEEE 1451 Enables

- -- users to build “Distributed Smart Sensor/Actuator Systems”.
- -- users to access all kinds of sensors in wired and wireless networks using a common command set.

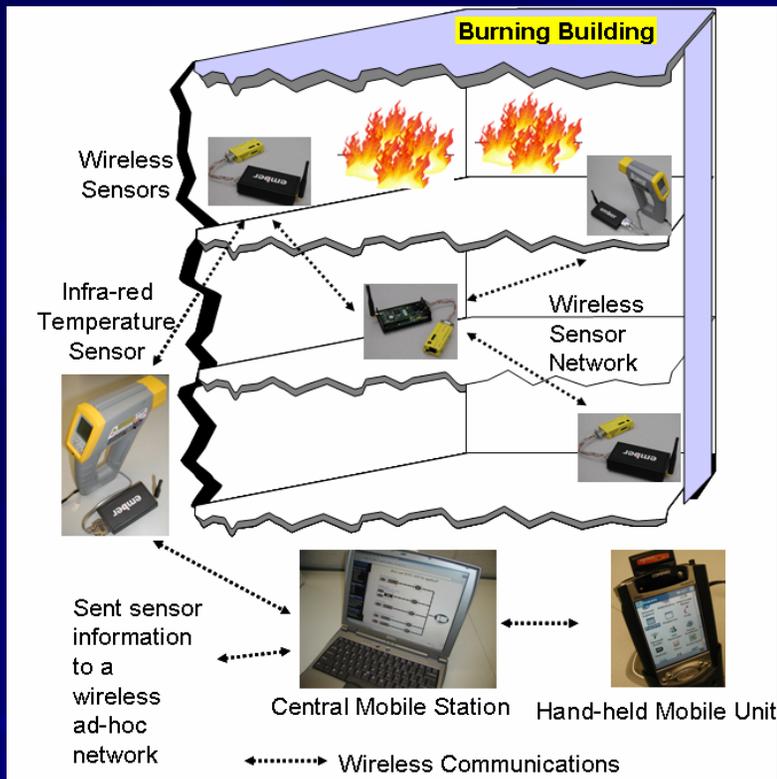


Examples of IEEE 1451 Applications

- NI LabVIEW integrated with IEEE 1451.4 interfaces.
- EDC applies IEEE 1451.2 in the monitoring of casing for oil drilling.
- ORNL applies IEEE 1451 in SensorNet.
- 3eti applies IEEE 1451 in naval vessels for CBM.



Other Potential IEEE 1451 Applications



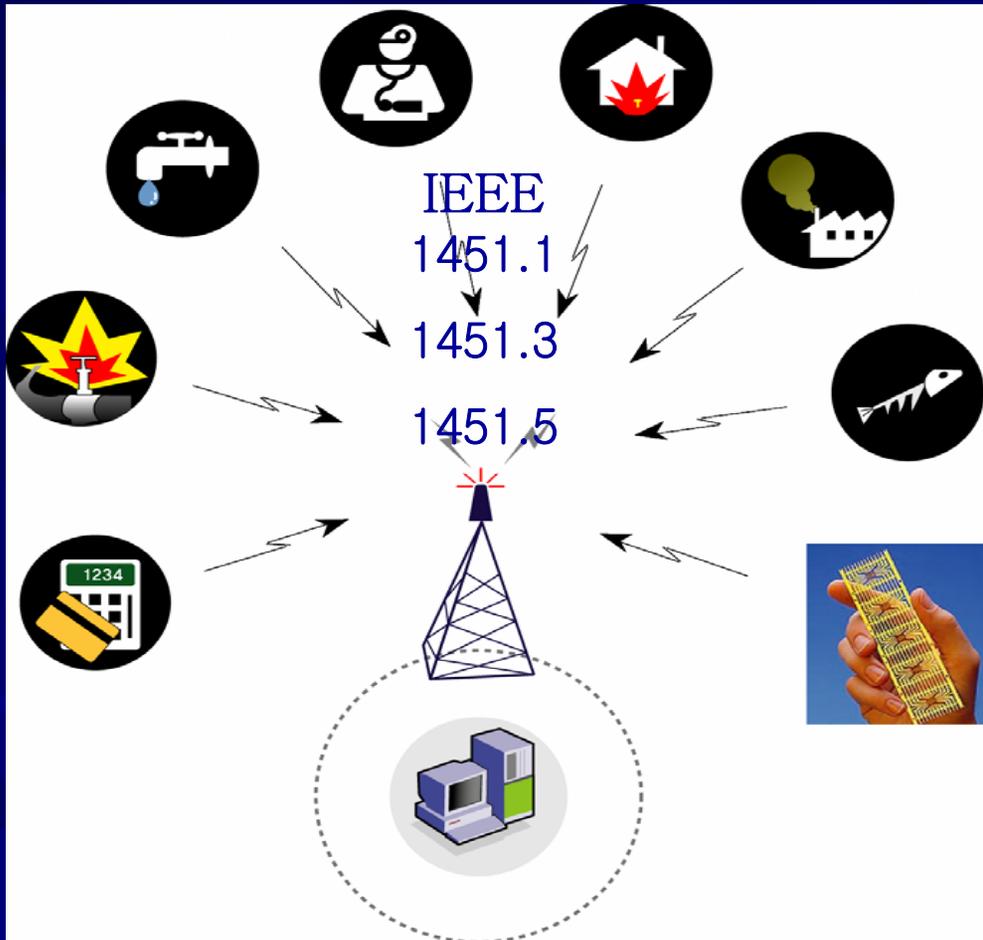
Port authority can monitor the condition of the shipping containers (or **smart containers**) based on IEEE 1451 smart sensor standards and technologies.

A fire chief can use handheld PDA or remote mobile station based on IEEE 1451 wired and wireless sensor networks to monitor the condition of the **first responders** and their operating environment to help make decision to ensure the safety of the fire fighters.



Example: Telemetrics applications supported by MOCIE – applying IEEE 1451 Standard in Korea

Remotely monitoring and controlling of Korea national facilities and personal communication systems



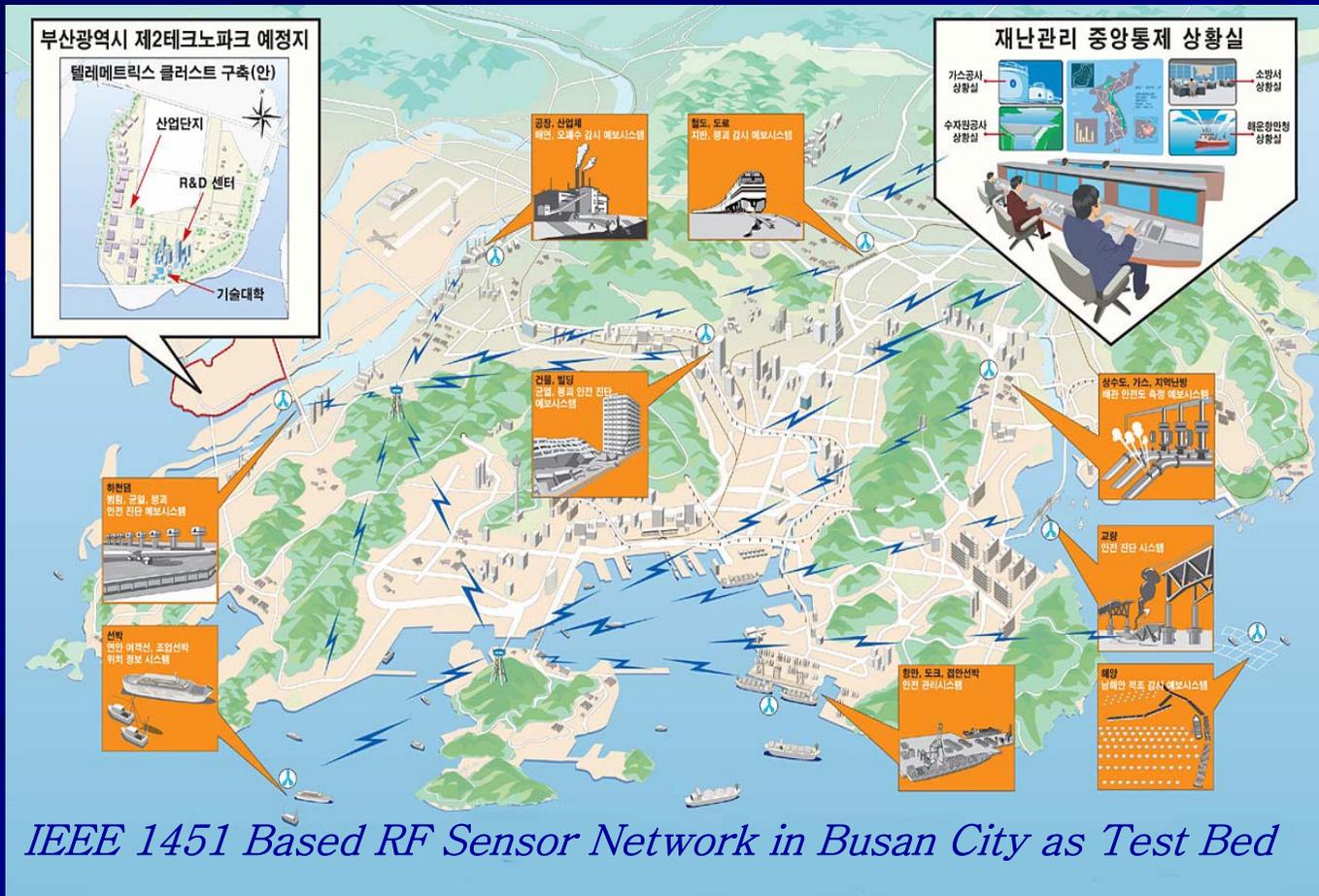
A highlight of Telemetrics technology, sensors, and systems is the prevention of national accidents through the real-time examination of pipeline erosion, environmental pollution, structural deterioration, and other potentially hazardous inaccessible places.



DOC

Central Command Center

Telemetry Test Bed applies IEEE 1451 standards and technologies in South Korea for infrastructure monitoring and surveillance in a major city. It is supported by the Ministry of Commerce, Industry, and Energy (MOCIE)





Summary: Essence of IEEE 1451

IEEE 1451 Standards

- define **network-neutral** and **vendor-independent** transducer interfaces
- define standardized Transducer Electronic Data Sheets (**TEDS**) that contain manufacture-related sensor data
- support a **general model** for transducer data, control, timing, configuration, and calibration
- eliminate error prone, manual entering of data and system configuration steps, ultimately achieving **Plug and Play**
- allow transducers (sensors or actuators) to be installed, upgraded, replaced or moved with **minimum effort**
- enable users to access **wired or wireless** sensor data and information seamlessly from a host system or network anywhere



For More Information About TC-9 Sponsored IEEE Standards

- Contact: Kang Lee at kang.lee@nist.gov

- IEEE 1451 websites:
 - 1451: <http://ieee1451.nist.gov>
 - 1451.4: <http://grouper.ieee.org/groups/1451/0>
 - 1451.4: <http://grouper.ieee.org/groups/1451/4>
 - 1451.5: <http://grouper.ieee.org/groups/1451/5>
 - 1451.6: <http://grouper.ieee.org/groups/1451/6>

- **ANSI/IEEE 1588 (ISO/IEC 61588), Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems.** website: <http://ieee1588.nist.gov>,

- Published IEEE standards can be purchased at <http://standards.ieee.org/reading/ieee/std/numerical.html>