Vision on Medical Device Plug-and-Play

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Vision and Roadmap
Why do we want Medical Device Plug-and-Play (MDPnP)? (and why wireless MDPnP?)

Flexibility and expanded medication capability

Safety

Convenience and Efficiency

Independence from device vendors
Hundreds of thousands of medical devices exist in nowadays hospitals, but are mostly designed for isolated use (proprietary).
Flexible composition of medical devices expands medication capability by enabling new methods/apps

Patient Controlled Anesthesia (PCA)
Flexible composition of medical devices expands medication capability by enabling new methods/apps

Patient Controlled Anesthesia (PCA)

Infusion Pump

Pain Button

Computer

Std. Vital Sign Monitor

Special Vital Sign Monitor

Patient
We need interconnected/interlocked medical devices to provide safety
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Blood Pressure Measuring

Proposal: MDPnP interlocked Bed and BP meter

Offset Corrected

49/59
47/74
We need interconnected/interlocked medical devices to provide safety.

Cardiopulmonary Bypass v.s. Ventilator Accident

Correct Procedure:

Heart Lung Machine

Ventilator
We need interconnected/interlocked medical devices to provide safety

Cardiopulmonary Bypass v.s. Ventilator Accident

Heart Lung Machine  Correct Procedure:

Ventilator
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Cardiopulmonary Bypass v.s. Ventilator Accident

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Absent Minded Procedure:
We need interconnected/interlocked medical devices to provide safety.

Cardiopulmonary Bypass v.s. Ventilator Accident

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Cardiopulmonary Bypass v.s. Ventilator Accident

Heart Lung Machine

Absent Minded Procedure:

“... In the second case, the anesthesiologist forgot to resume ventilation after separation from cardiopulmonary bypass. The delayed detection of apnea was attributed to the fact that the audible alarms for the pulse oximeter and capnograph had been disabled during bypass and had not been reactivated. Both patients sustained permanent brain damage.”

Anesthesiology. 87(4):741-748, October 1997
We need interconnected/interlocked medical devices to provide safety

Cardiopulmonary Bypass v.s. Ventilator Accident

Proposal: MDPnP Interlocked Architecture

Heart Lung Machine

Ventilator

MDPnP Control Computer

Capnograph

Oximeter

Qixin Wang, for non-profit academic use
We need interconnected/interlocked medical devices to provide safety

X-Ray v.s. Ventilator Accident
We need interconnected/interlocked medical devices to provide safety

X-Ray v.s. Ventilator Accident

Blurry Image

Picture provided by Mu Sun
We need interconnected/interlocked medical devices to provide safety

X-Ray v.s. Ventilator Accident

Picture provided by Mu Sun
We need interconnected/interlocked medical devices to provide safety

X-Ray v.s. Ventilator Accident
We need interconnected/interlocked medical devices to provide safety

X-Ray v.s. Ventilator Accident
We need interconnected/interlocked medical devices to provide safety

X-Ray v.s. Ventilator Accident

“A 32-year-old woman was having a laparoscopic cholecystectomy performed under general anesthesia. ... At some point, the anesthesiologist glanced at the EKG and noticed severe bradycardia. He realized he had never restarted the ventilator …

The patient ultimately died.”

We need interconnected/interlocked medical devices to provide safety.

X-Ray v.s. Ventilator Accident

Proposal:
MDPnP interlock of X-Ray and Ventilator

Picture provided by Mu Sun
We need interconnected/interlocked medical devices to provide safety.

Laser v.s. Oxigen Concentration Accident
We need interconnected/interlocked medical devices to provide safety

Laser v.s. Oxygen Concentration Accident

Proposal:

MDPnP interlock of Laser and O2 Monitor
No airway laser allowed when O2 > 30%
We need interconnected/interlocked medical devices to provide safety

Contagious patient calls nurse for help
We need interconnected/interlocked medical devices to provide safety

Contageous patient calls nurse for help

Contageous, must wear mask!
We need interconnected/interlocked medical devices to provide safety.

Contageous patient calls nurse for help

Contageous, must wear mask!

Proposal:

MDPnP connection of EMR DB, Nurse Station, and Vital Sign Monitors
MDPnP, particularly wireless MDPnP, improves convenience and efficiency

Messed Up Operation Room

High-acuity care today: How do we prevent errors? How do we keep track of all this?

Picture quoted from www.mdpnp.org
MDPnP, particularly wireless MDPnP, improves convenience and efficiency

Messed Up OR v.s. Vital Sign Bulletin Board
MDPnP, particularly wireless MDPnP, improves convenience and efficiency

Messed Up OR v.s. Vital Sign Bulletin Board
MDPnP, particularly wireless MDPnP, improves convenience and efficiency

The Operation Room Spider Web
MDPnP, particularly wireless MDPnP, improves convenience and efficiency

The Operation Room Spider Web, after MDPnP safety interlocks

Picture quoted from www.mdpnp.org
MDPnP, particularly wireless MDPnP, improves convenience and efficiency

Spider Web OR v.s. Wireless OR
Indepedence: hospitals need hundreds of thousands of types of medical devices; don't want to be controlled by one vendor.
Why do we want Medical Device Plug-and-Play (MDPnP)? (and why wireless MDPnP?)

- **Flexibility** and expanded medication capability
- **Safety**
- **Convenience and Efficiency**
- **Independence** from device vendors
MDPnP benefits whom?

Hospitals: independence, medication capability, safety

Doctors: medication capability, safety, convenience

Patient: medication capability, safety, cost

Government: tracktability, cost

Vendors: larger market

Academia: typical case of cyber-physical systems
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Existing Efforts

Vision and Roadmap
IEEE 1073 Committee

IEEE 1073 (5/1996): overall network/middleware architecture


ISO/IEEE 11073-20601 (9/2008): middleware group management and communication protocol guideline

ISO/IEEE 11073-30200 (1/2000): cable PHY ~ transportation layer

Draft ASTM TC F29.21 N21 (2008):

Medical Devices and Medical Systems – Essential safety requirements for equipment comprising the patient-centric integrated clinical environment (ICE) – Part 1: General requirements and conceptual architectural
US Government Efforts

FDA:

Draft Guidance for Industry and FDA Staff: Radio-Frequency Wireless Technology in Medical Devices, draft released for comment on Jan 3, 2007
US Government Efforts

President's Council of Advisors on Sci. & Tech. (PCAST):

2007 Report on Federal Networking and Information Technology R&D list Cyber-Physical Systems as the top of the eight priorities for federal research investments.
US Government Efforts

NSF:

Call for Proposals: Cyber-Physical Systems (CPS), solicitation 08-611, deadline: Feb., 2010.

“... Research advances in cyber-physical systems promise to ... enhance societal wellbeing (e.g., assistive technologies and ubiquitous healthcare monitoring and delivery) ... NSF ... are spear-heading the Cyber-Physical Systems (CPS) program because of its ... impact ... critical to U.S. Security and competitiveness, including ... healthcare ...”
US Government Efforts

National Coordination Office for Networking and Information Technology Research and Development Program (NCO/NIRTD):

High-Confidence Medical Devices: Cyber-Physical Systems for 21st Century Health Care, Feb., 2009
Industry and Academia Efforts

MDPnP: http://www.mdpnp.org, initiators:

- NIST (National Institute for Standards and Technology)
- NSF (National Science Foundation)
- Society for Technology in Anesthesia
- DocBox
- Philips Healthcare
- Etc.
Industry and Academia Efforts

MDPnP:  http://www.mdpnp.org, initiators:

Conference: June 2007

Source: www.mdpnp.org
Industry and Academia Efforts

CIMIT: http://www.cimit.org

Center for Integration of Medicine & Innovative Technology, a non-profit consortium initiated by 12 institutes, including Mass. Gen. Hospital, Harvard Medical School, MIT, VA Boston Healthcare System etc.

More than 40 industry partners.
Industry and Academia Efforts


**CPS Week**: since 2008 (NSF CPS Summit), involving RTAS, IPSN, HSCC

**CPS Track**: since 2007, IEEE RTSS
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Healthcare CPS can involve and stimulate the growth of nearly every CS area.