SmartAmerica Closed Loop Healthcare Team
Development & Demo at the MGH/MD PnP Lab, Cambridge, MA March 2014

Closed Loop HealthCare Team: Home to Hospital to Home

Expo Participants

MD PnP
Getting Connected for Patient Safety
MGH · Harvard · Partners HealthCare

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PRISMTECH talend
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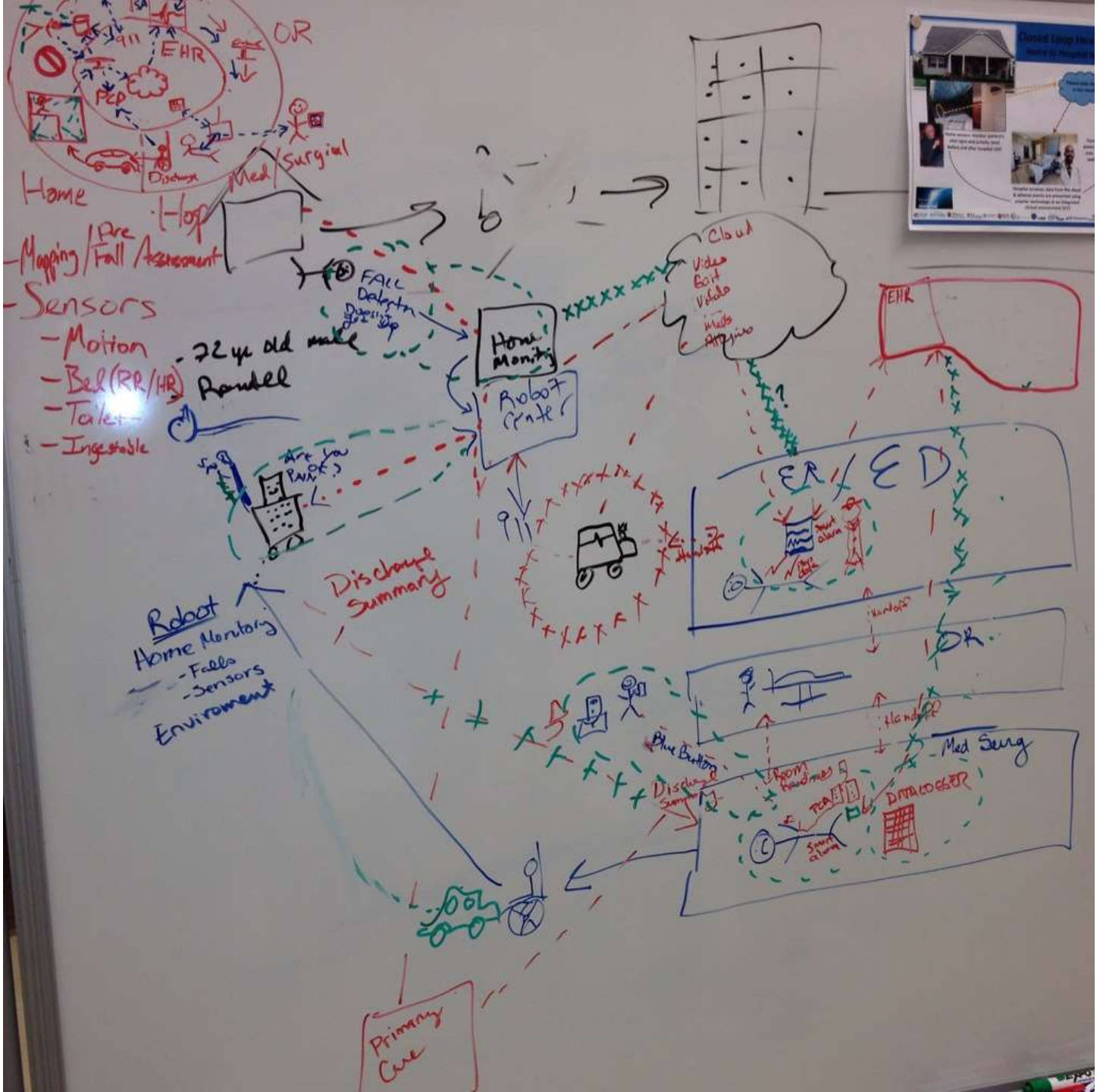
SMART AMERICA
PRESIDENTIAL INNOVATION FELLOWS

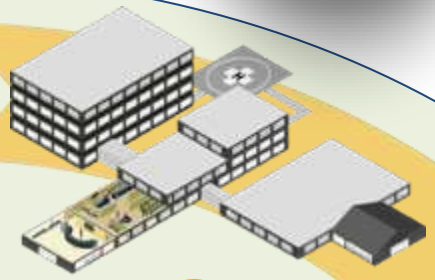
*Co-leads

Closed Loop HealthCare Team
Geographic Distribution



OR
EHR
PCP
Discharge
Home
Hosp
Med/Surgical
-Mapping/Pre Fall Assessment
-Sensors
-Motion
-Bed (RR/HR)
-Toilet
-Ingestable
-72 yr old male
Randell
FALL Detection
Home Monitoring
Robot Center
Cloud
Video
Gait
Vitals
Meds
Allergies
EHR
ER/ED
Discharge Summary
Robot
Home Monitoring
-Falls
-Sensors
Enviroment
Blue Button
Discharge Summary
Room Readiness
Handoff
Med Surg
DATALOGGER
Primary Care

CLOUD



2 Robot: Randall needs Medical help alerts 911

3 ER - Smart alarms utilize cloud data and EHR

4 Surgery – all data available

Robot dispatch And 911

EHR

Home Monitor

Data logger

PCP

Cloud

1 Fall Detected at home Randall doesn't get up

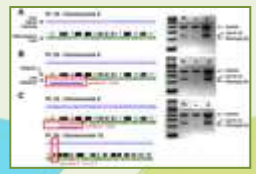
HOME

6 Safety Certification of interoperability

7 Real-time blue button

5 Pain meds: Reduce risk of injury and false alarms

9 Discharge



Device/Genomic Prescription CDS 8

NOTE:

this graphic depicts a mix of current and planned capabilities.

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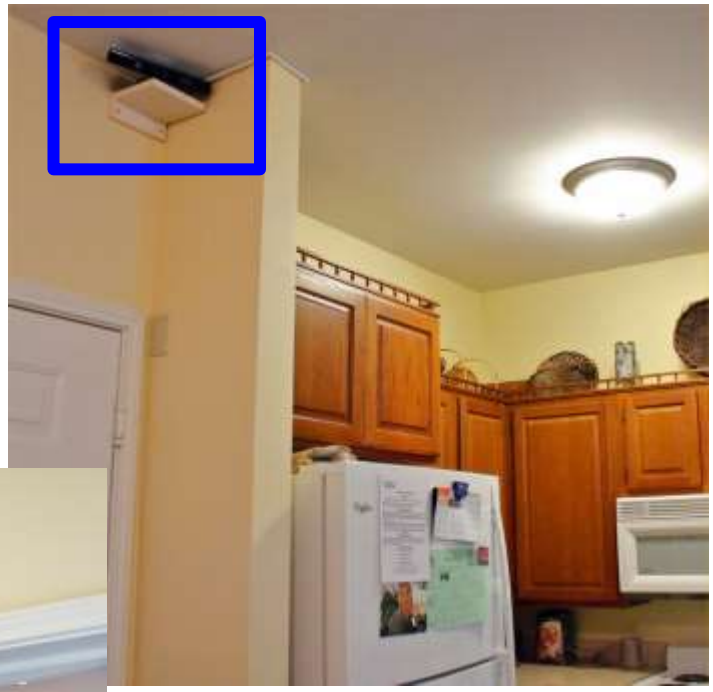
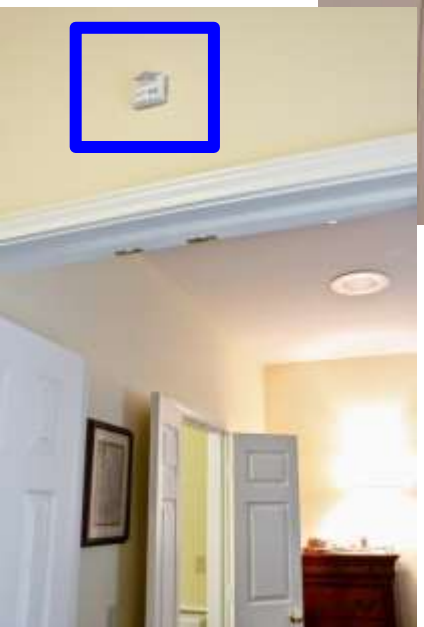
PRESIDENTIAL INNOVATION FELLOWS

Randall at Home

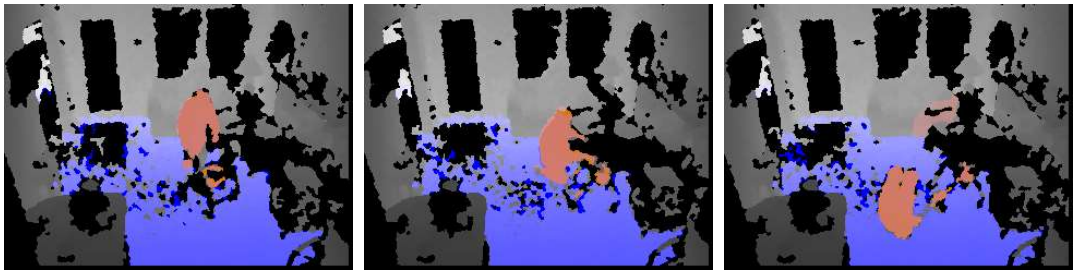
Depth camera for in-home fall detection
so Randall gets help fast





Bed sensor logs sleep patterns.

Motion sensors log activity.

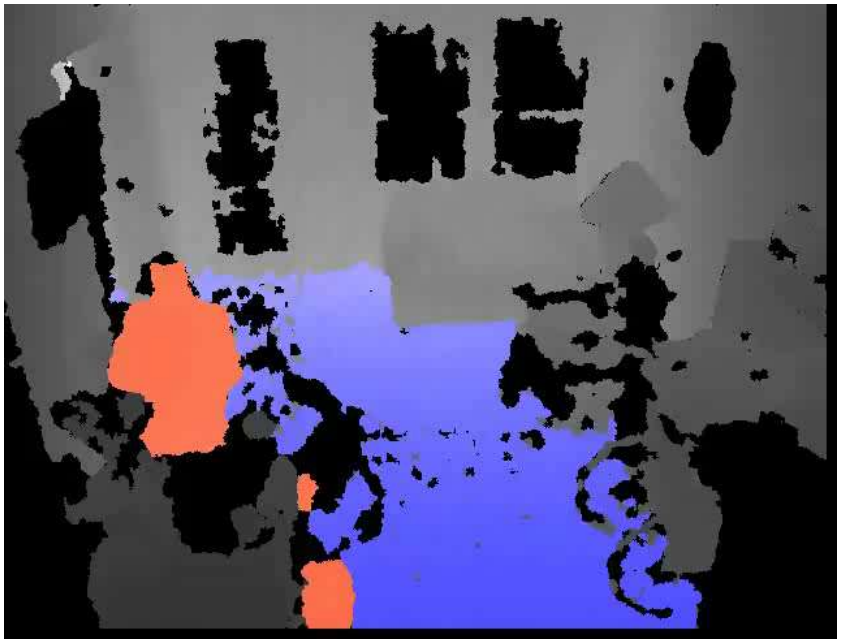


Real-Time Fall Detection

- Alert sent to caregivers with embedded link to depth video clip

Possible fall detected!

Fall confidence: 0.86
ID: 3012
IP: 10.0.1.200
Date: 12_04_2013
Time: 16_08_45_531
Another person was not detected walking in the room.
Video:



CENTER FOR ELDERcare & Rehabilitation TECHNOLOGY

Fall Detection and analysis …
Can change the course and outcome of the event

CLOUD

More information about the fall can influence medical intervention
Randall's data from home helps avoid un-necessary head CT scan
Nationally - $30B in wasted MRI/CT imaging
$2,000 each head scan. Radiation equivalent to 30 chest x-rays

Motion Sensors

Bed Sensor

Fall Detection – Kinect

1 **Fall Detected at home Randall doesn't get up**

2 **Robot dispatch performs triage alerts 911**

3 **911 dispatch**

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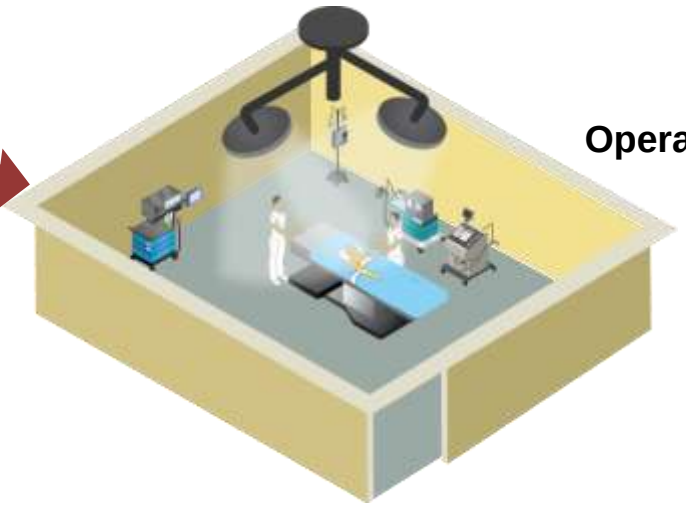
Hospital will have standards-based “Integrated Clinical Environments”, for full data interchange, device coordination, closed-loop control, “black box recorder”, “IoT for Health Care”

Emergency Department

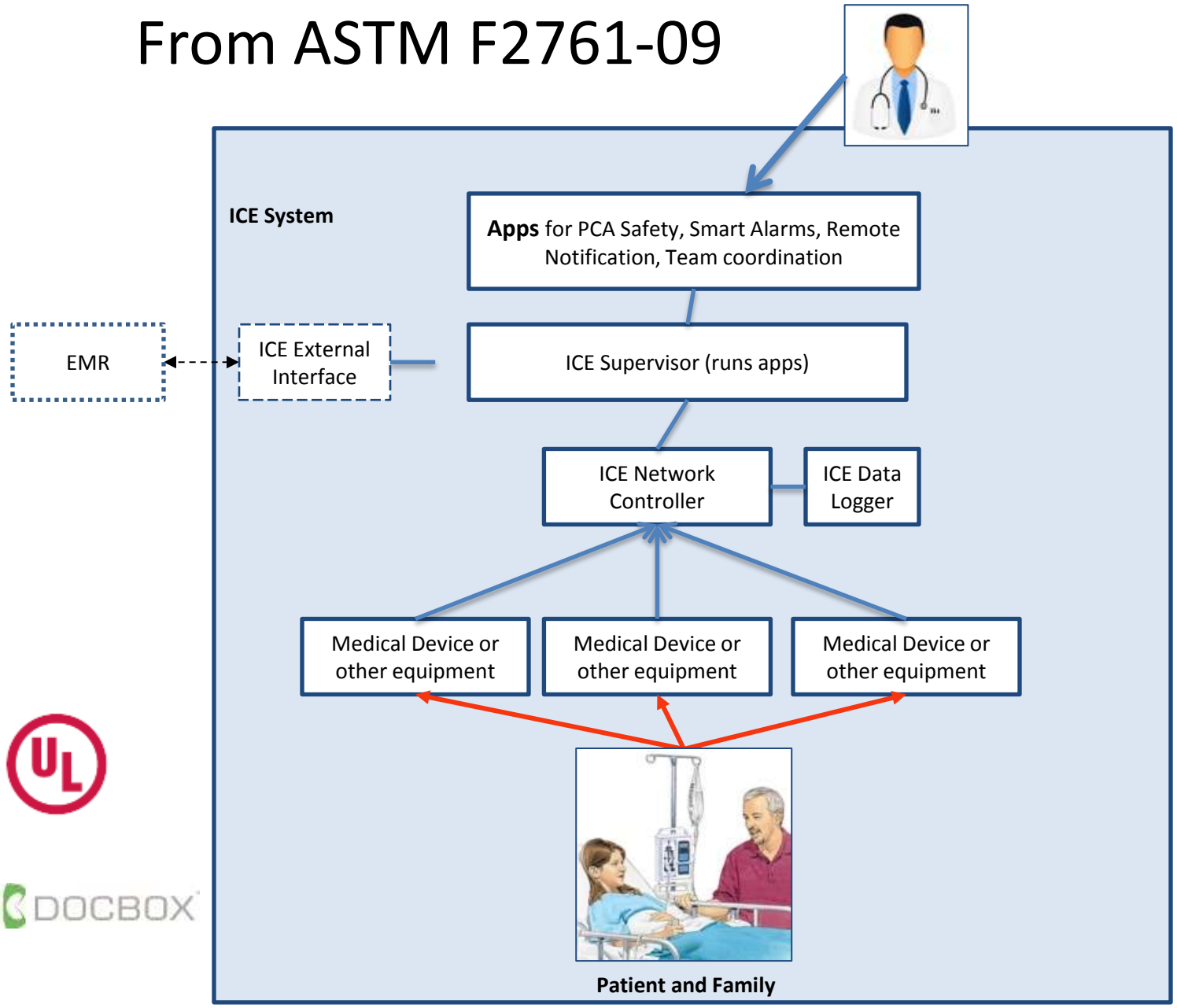


Operating Room

In ED: Retrieving data from remote EHR
Then: Transfer all data and device settings from ED->OR

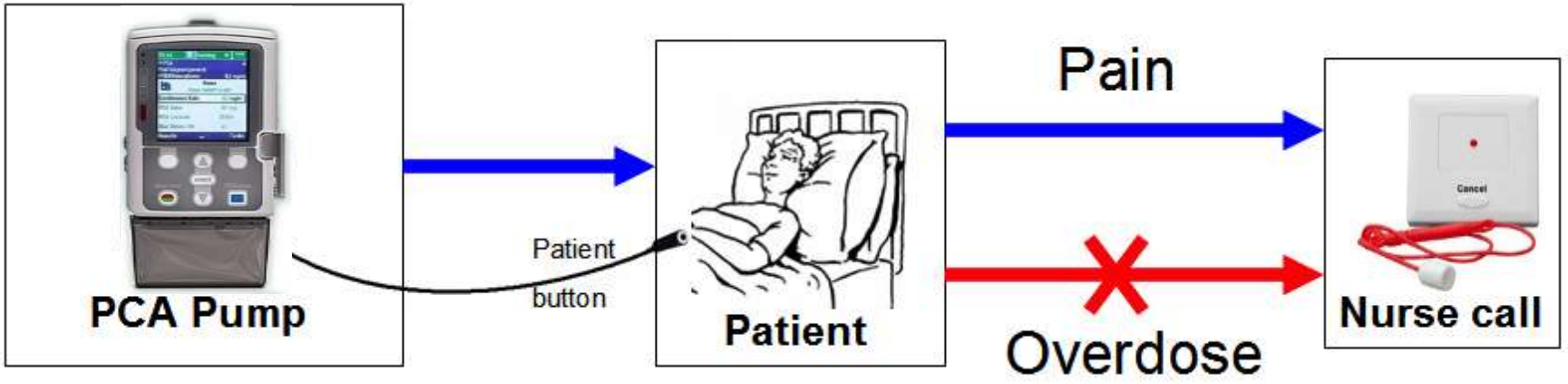
Integrated Clinical Environment - Simplified Architecture

From ASTM F2761-09



Standard recognized by FDA in August 2013

Patient-Controlled Analgesia (PCA)
system safety concerns



- *Patients can call to request more analgesia, but, cannot call for help when over-medicated.*
- *Over-medication can cause respiratory and cardiac arrest*
- *Comprehensive monitoring is not typically used due to high false and nuisance alarm rate*

MD PnP

PCA Safety Issues continue …

http://ppahs.wordpress.com/2012/02/01/guest-post-yes-real-time-monitoring-would-have-saved-leah-2/
This is the story of an 11 year old who died from narcotic-induced respiratory depression.
"Ten years after my daughter's death, nothing has changed in the codes of monitoring post-op patients continuously, until they leave the hospital. Alive."

http://www.apsf.org/newsletters/html/2010/spring/12_coalition.htm
This is a statement from a multi-hospital coalition frustrated by ongoing adverse patient events:
"A closed-loop system, which stops or pauses opioid dosing if respiratory depression is detected, is desirable. Systems are most ideally centrally monitored. In any case, alarms should be audible or otherwise available to the primary caregiver, and a mechanism for prompt response should be in place."

http://ppahs.wordpress.com/about/
"Carly Ann Pritchard ... suffered an ankle injury and then underwent surgery to reduce lingering pain from her ankle injury. Unfortunately, although she survived surgery, she suffered brain damage because of an accidental overdose from a morphine-filled pain pump - after surgery. A California appeals court recently upheld a jury's award of about $9.9 million in damages."

ICE = Integrated Clinical Environment

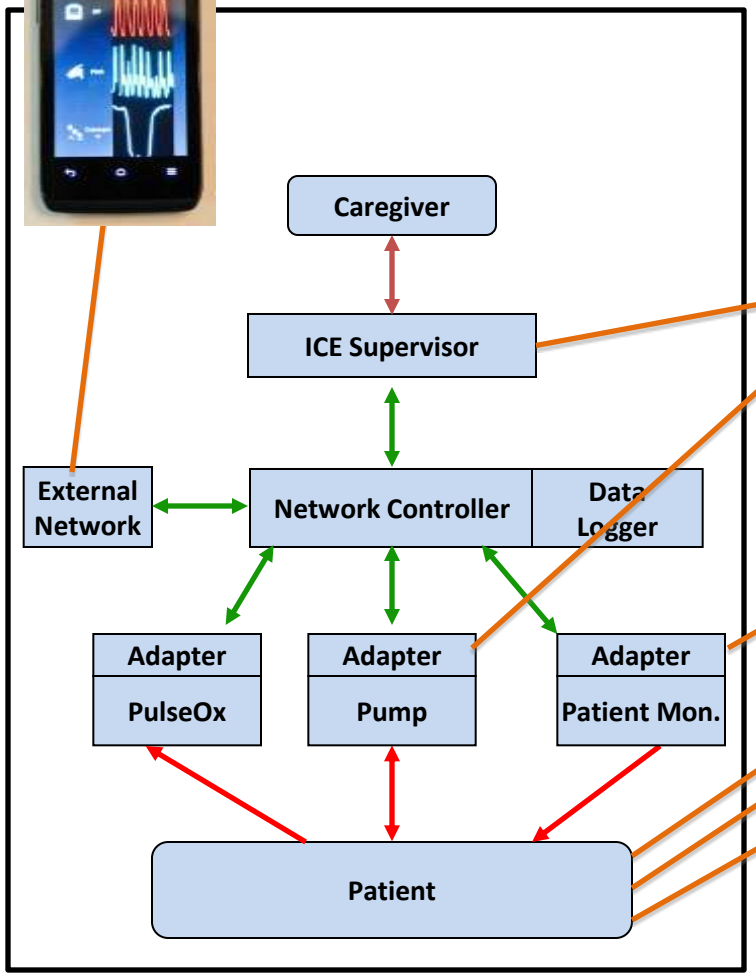
MD PnP™
Getting connected for patient safety

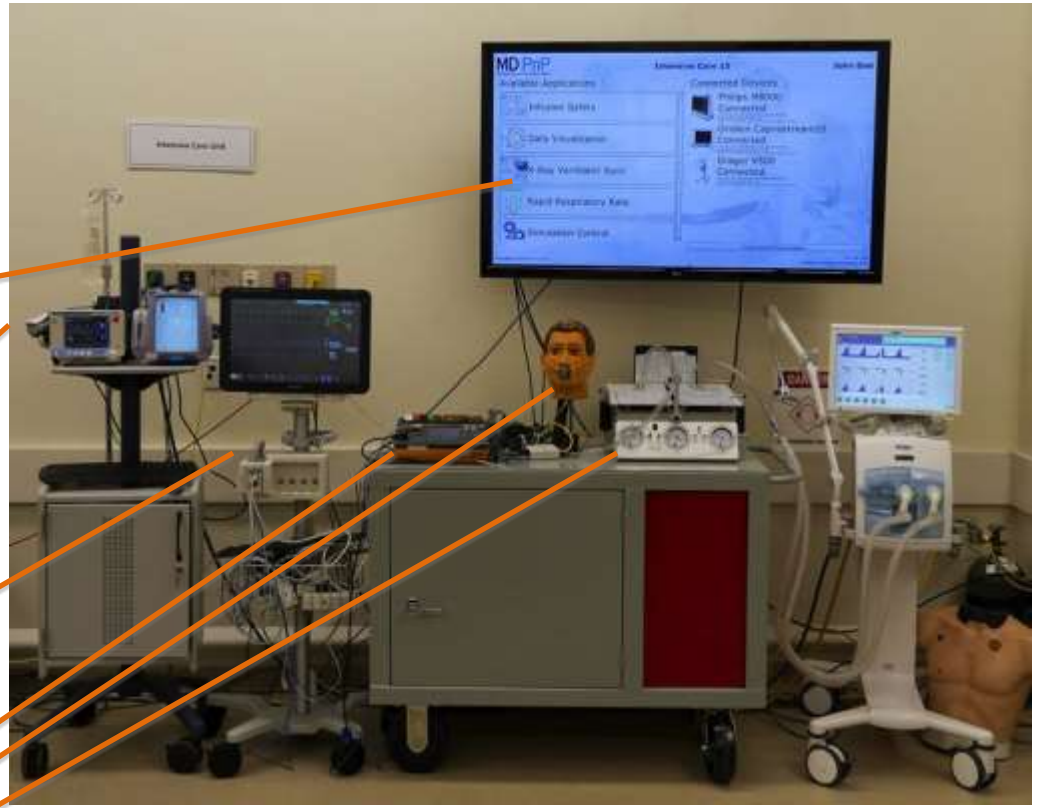
OpenICE

Bitly.com/open_ice

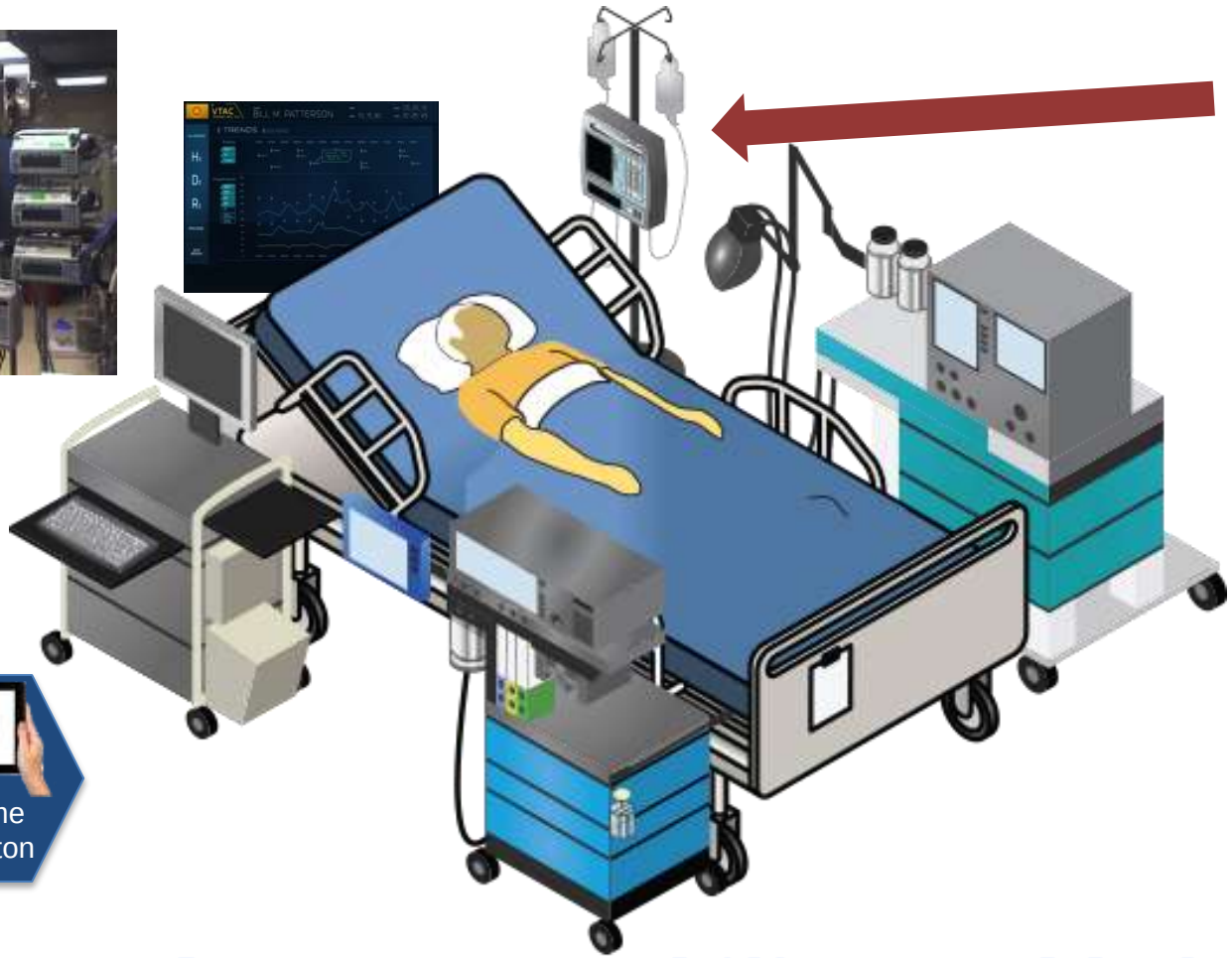
- OpenICE encompasses
  - Medical Device Interfaces
  - Patient Simulation
  - HIS Connectivity
  - Safety Assurance
  - Validation and testing
  - Regulatory Pathway
  - ICE Application eXchange (ICE AX)
    - Med apps, device management
- Everything is open source
- OpenICE™ is a work in progress
  - Currently useful for clinical and CS research, prototyping, standards development/ref implementation, starting point for med device deployment, etc.

Implementing ASTM ICE Standard





Reducing false alarms will reduce alarm fatigue
Safer, more effective pain control
Real-time blue button data available to family and staff



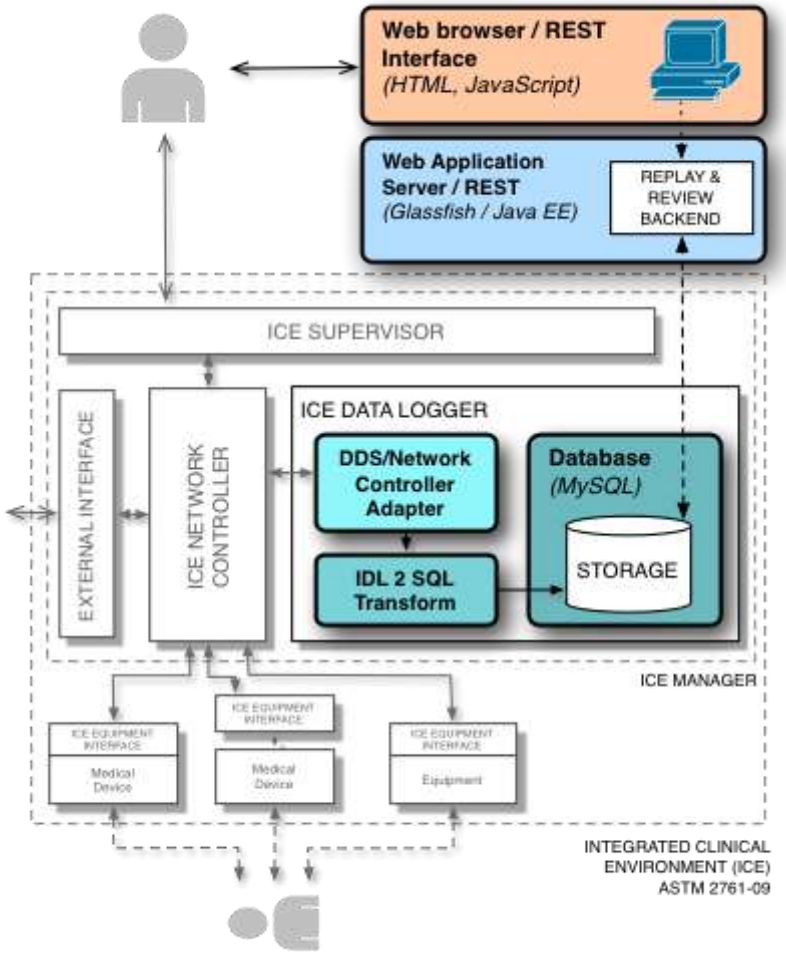
Pain Medication-related Injuries could be prevented with Medical CPS:

- Over 6000 patients severely injured/killed each year
- Up to $145M impact
- Untreated pain
- PREVENTABLE!

Safe Interoperability enabled by MCPS

Data Logger "Black Box Recorder" for the Integrated Clinical Environment (ICE)

- A Data Logger is a foundational component of MCPS clinical network. Required to to improve forensic analysis of clinical adverse events and near misses
- Required to address safety (Regulatory Science) and liability concerns of network medical systems
- NIST Prototype Features:
  - Platform Independent, Plug-n-play & DDS compliant VM based Data Logger
  - Browser based Playback: Intuitive Data Visualization with Annotation and Search capabilities (Mobile Compatible)
  - Modular Architecture (Loose Coupling)



NIST MD PnP Getting Connected for Patient Safety™

Personalized Medicine:
EMR data & Blood Pressure after Lopressor Administered

Acme Medical Center | Patient Search | Provider, X | Settings | Help | Logout

Doe, Randall | Docs

Inbox (1)

Date	Title	From
6/6/2014	CDS Medication Warning	CDS

More

Medication Administration Records (4)

Medication	6/5 08:10	6/5 12:15	6/5 14:00	6/5 16:03	6/5 18:05	6/5 20:00	6/5 23:23
Lopressor Tab 50mg po q6h		RN Jane Doe			RN Jane Doe		RN Jane Doe
Percocet Tab 5mg po q6h			HELD - RN Jeff Smith				RN Jeff Smith
Zocor Tab 20mg po qd						RN Jeff Smith	
Zoloft Tab 50mg po qd	RN Jane Doe						

Add Remove

Acme A | Acme B

DOE, RANDALL

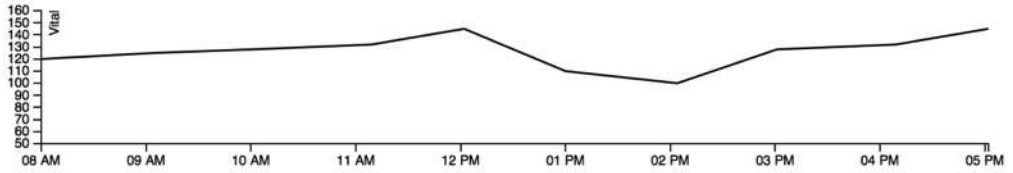
8989 BROOKLYN BRIDGE LANE
TAMPA, FL

SSN: 100550087
DOB: 27 Mar 1935

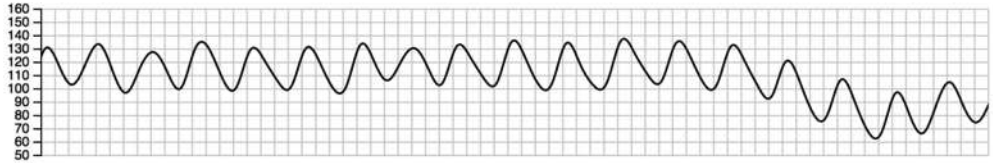
Vital Signs

Vital Sign	6/5 08:00	6/5 09:04	6/5 10:01	6/5 11:09	6/5 12:02	6/5 13:00	6/5 14:04	6/5 15:01	6/5 16:09	6/5 17:02
Heart Rate	80	78	70	82	74	80	78	70	82	74
Respirations	18	20	16	18	18	18	20	16	18	18
Temperature	98	98.2	99	97.9	98.4	98	98.2	99	97.9	98.4
SAT	94	98	96	96	97	94	98	96	96	97
sBP	120	125	128	132	145	110	100	128	132	145
mBP	88	90	96	100	120	78	72	96	100	120
dBP	80	82	86	90	100	70	65	86	90	100

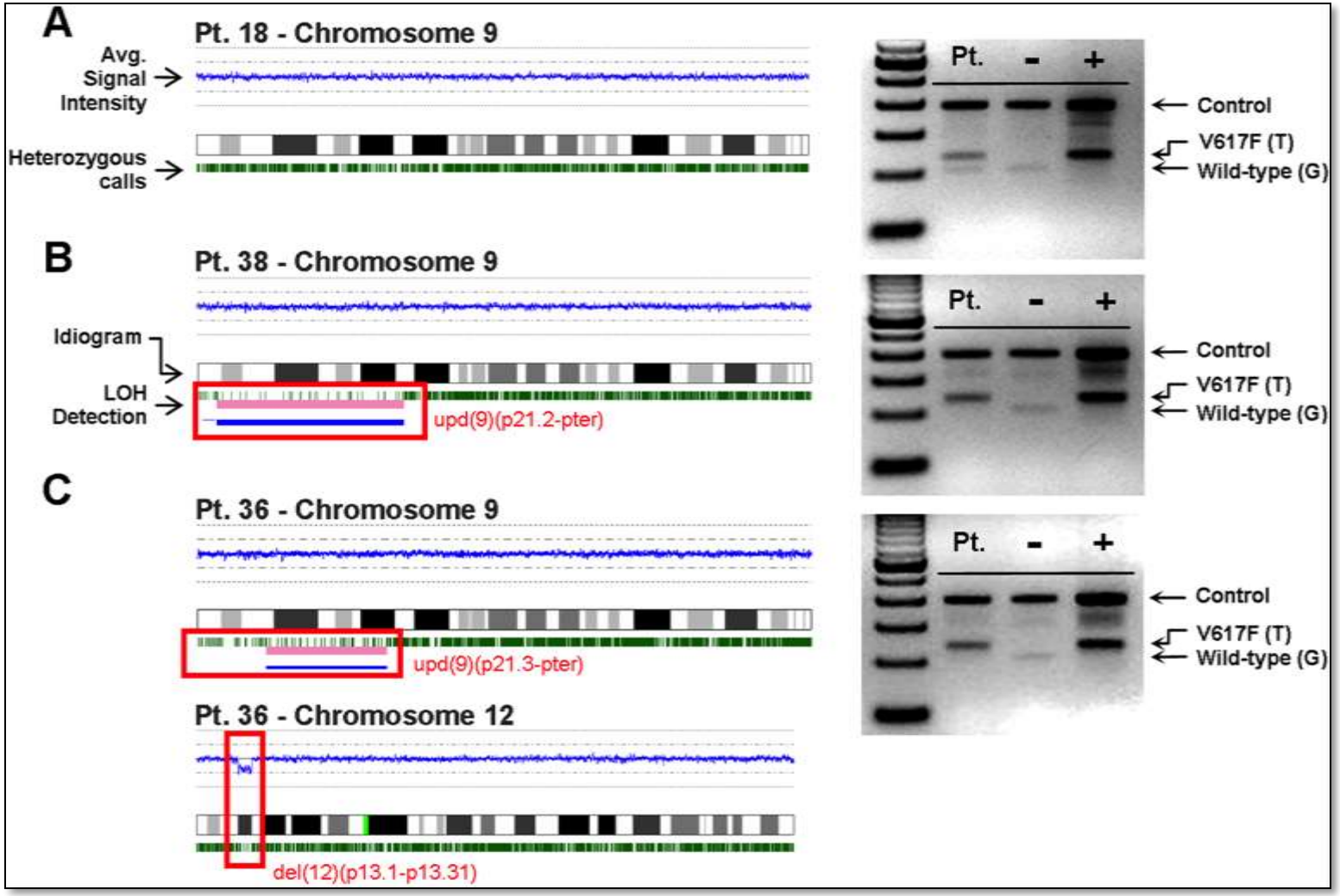
Trend



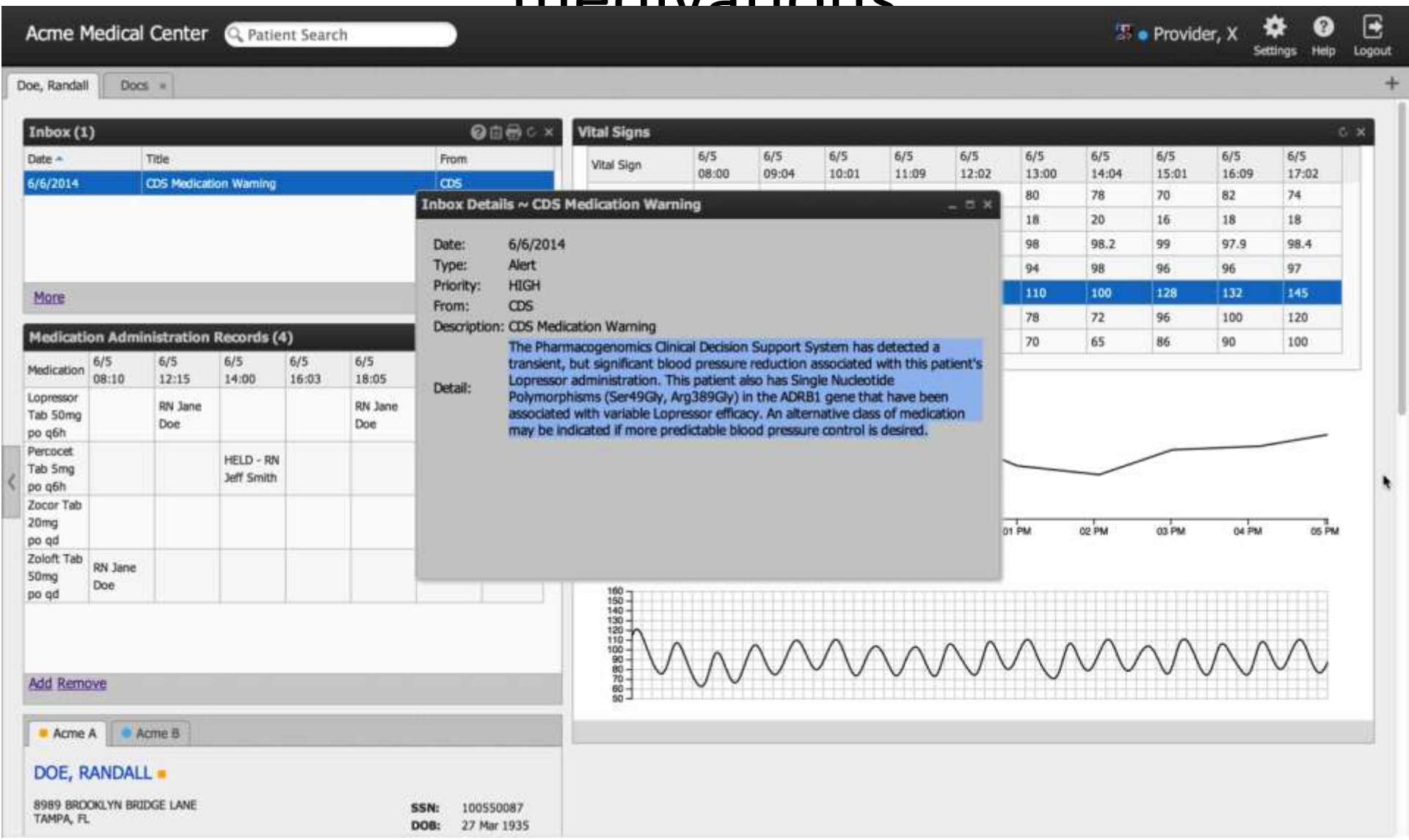
Live Waveform (Systolic Blood Pressure)



Randall's Genomic Profile



EMR Alert: Don’t use beta blcocker medivations



Open Healthcare

OSEHRA
Open Source Electronic Health Record Agent

MD PnP
Getting Connected for Patient Safety

Healthcare Technology

Reference Implementation

Standards

WorldVistA
www.worldvista.org

DOCBOX

Enterprise

Apache Camel

Reference Architecture

rti

Real-time

Standardization and Safety Certification

Devices

Apache Camel

OMG DDS

Information Technology

OpenICE + Analytics

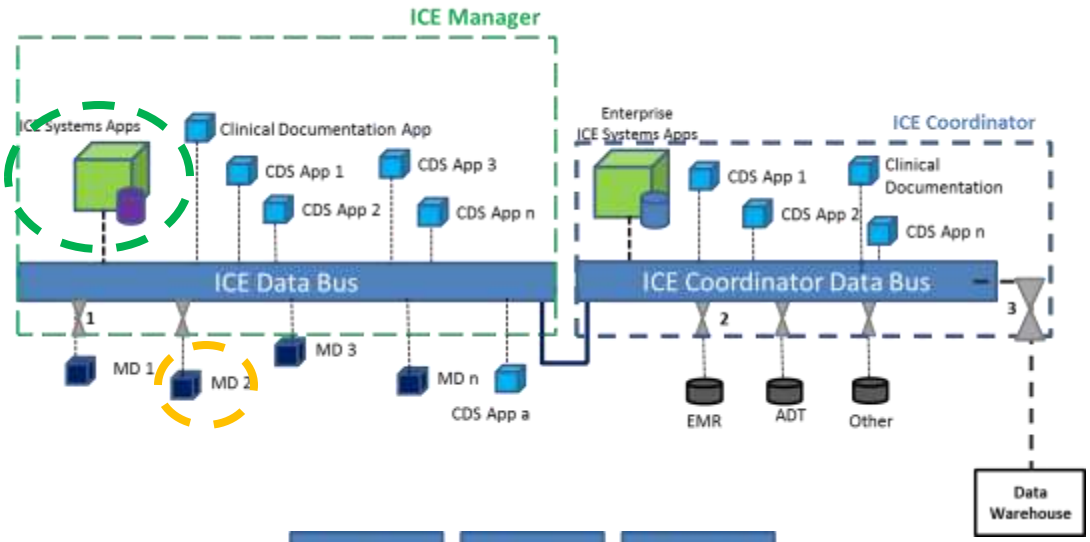
IoT for Health Care benefits from information about users of each specific device

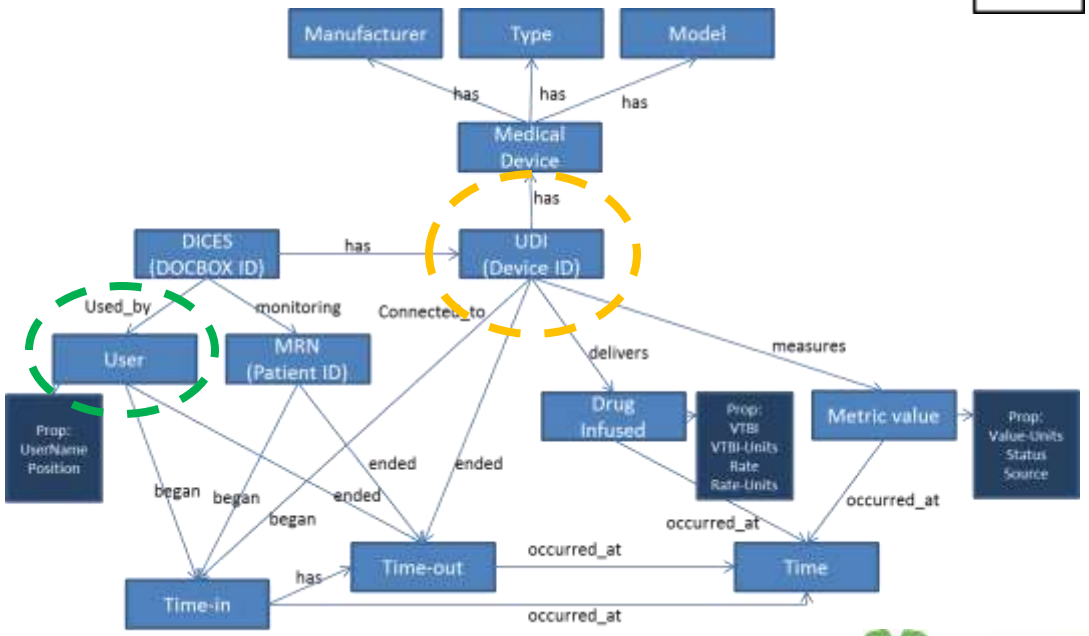
SEMOSS is an <u>open</u> analytics technology that can find connections between data stored in multiple repositories.

DOCBOX's ICE Manager integrates medical device data, clinical context, and IT data to enable real time decision support and analytics to occur for an individual patient, the point of care, or across the entire system.

Questions that could be answered:

a. How many times did this patient utilize this device ?
b. Who are the various users working with this device?
c. How much time Nurse ABC spend providing direct patient care across the continuum of care (all patients all units)





DOCBOX

Patient is discharged … to a smarter home

CLOUD

Bathroom/ Toilet Floor Sensor

Motion Sensors

Bed Sensor

Fall Detection – Kinect

Auto Light Control

Capsule Robots

Real-time blue button

Wearable sensors

home Gait Analysis – Kinect

SMART AMERICA

SmartAmerica EXPO – June 11, 2014 Washington DC Convention Center

Home Again

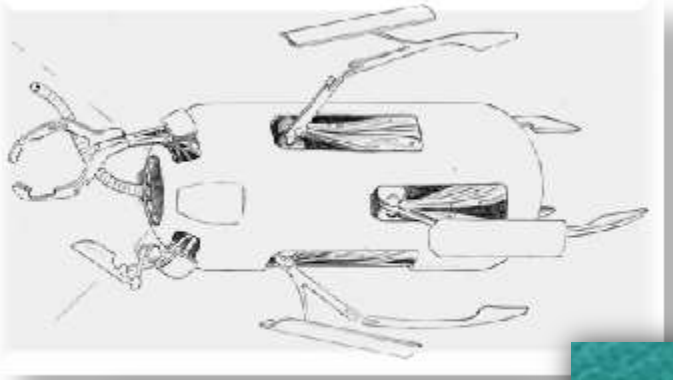
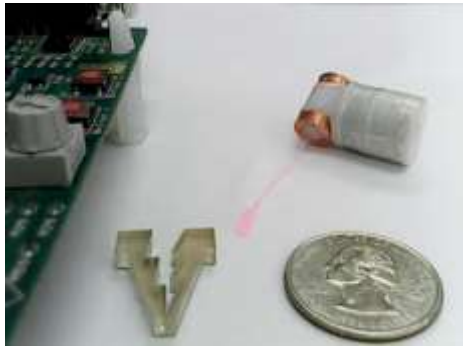
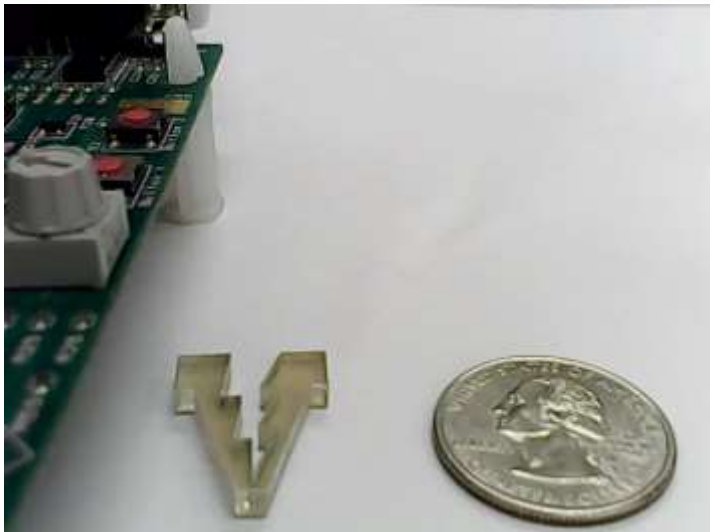
Sensors & Health Alerts Prevent Re-Hospitalization

in-home fall detection
and gait analysis

Bed sensor under the mattress logs
pulse, respiration & restlessness

Capsule Robots for Non Invasive Healthcare Monitoring and Localized Drug Delivery

Painless Diagnosis & Automated Therapy



Controllable Capsule for Localized Drug Delivery
On Display at the *Closed Loop Healthcare* Booth