

Big Data Approaches To Real-time Sensor Information Overload, and Macro Vs. Micro Process Improvement

2013 Big Data Conference

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Scope

1. Sensor Data Integration challenges.
2. Micro is BIGGER than Macro
3. A Semantic Approach
4. Sensor data Optimisation and Integration
5. Benefits to Health in new approaches

31 billion devices
& 4 billion people connected to the internet
by 2020

2020

2019

Exponential growth

15 Billion
connected devices

2015

2014

2013

2012

2011

2010

2009

2008

2007

2006

2005

2004

2003

2002

2001

2000

1999

1990

1980

There is an exponential explosion in the number of devices giving us data, from the personal level to the global level.

The limiting factor here is tools for making this data useful!

93,047,
connected devices

313,000
connected devices

188
connected devices



First laptop, the Osborne[®] is built

World Wide Web is born



Tablets take off with the launch of Apple iPad[®]



Launch of Google TV[™] and best-seller Freebox Revolution

Facebook[®] is founded

First connected smart energy meters are available

Sony LIBRIe[®] arguably the first e-book reader, launched

Source: Intel

Trends: Quantified Self and Consumer Health Sensors - making Health data available from Mobile devices

- “The “Quantified Self” uses personal tracking devices to begin to address the big challenge [of] expanding the scope of big data in healthcare to encompass an individual’s environment outside the walls of the clinic or hospital” - Joel Dudley, director of biomedical informatics at Mount Sinai School of Medicine in New York, in an email to *Wired*.



- Yahoo chief Marissa Mayer described Big Data as “watching the planet develop a nervous system.”

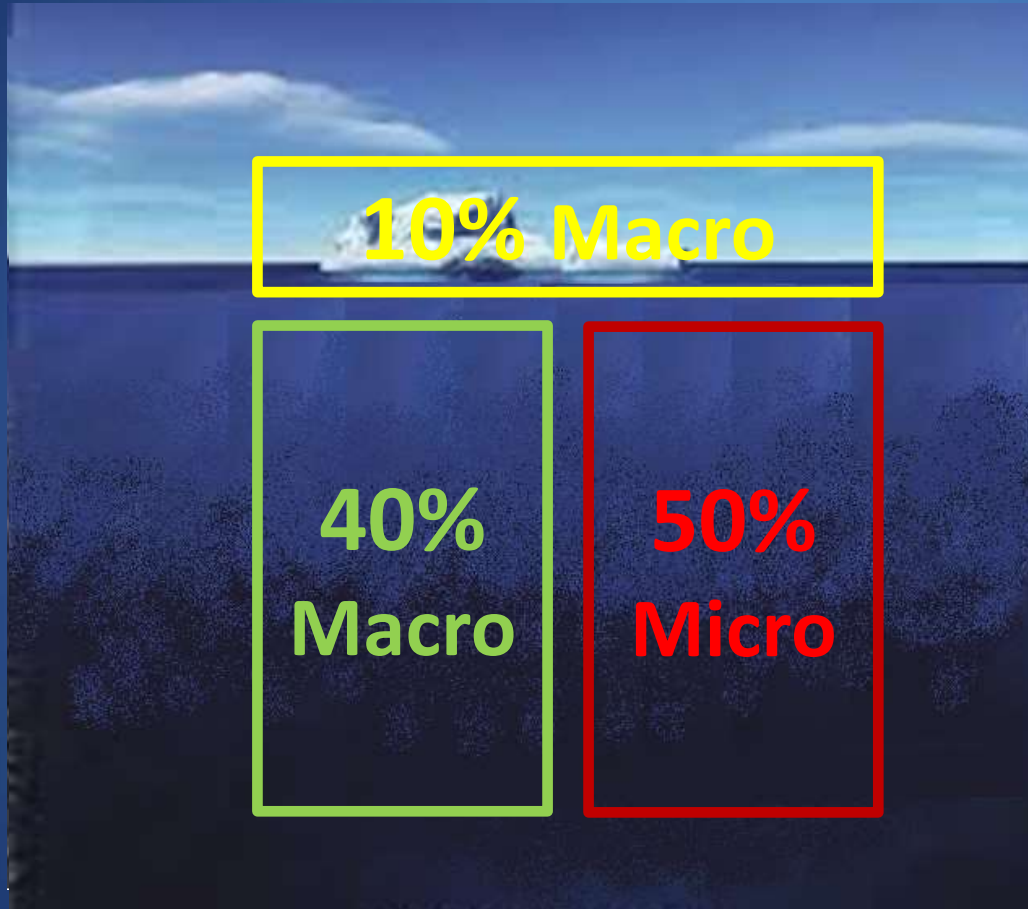
1. Rethink the Problem

- Big “Sensor” Data is not just Data at all!
It is people, places and things and their relationships.
- The challenges are:
 - how to dynamically collect and manage data from multiple sources, thousands of sensors, and diagnostic text analysis in real time running 24x7
 - -how to intelligently respond to changing circumstances such as interactions between multiple entities -- in this case hospital patients, sensors, and staff.
- This approach to designing health care systems mirrors that used in the defence industry to deliver enhanced situational awareness.

In a hospital case - real-time sensor data needs to be contextualised and enhanced - to drive real-time decision support and appropriate responses.

2. BPM-Workflow & Macro vs. Micro Processes

Note: Yet Another Iceberg Analogy: 10% Visible but... 90% Hidden!



- BPM captures Top 10% of the key Macro-processes
- BPM service calls embed another 40% of Macro-processes in “code”
- Micro-Processes not captured represent 50% of daily activities
- [checklists, learnt on job, word of mouth ,or just obvious!]
- Harvard Business Review suggests these frequent daily processes can be major improvement options!
- **Why? How to address?**

- G.E study - 21 mins/nurse shift wasted searching
- 54% Asset overspend – unable to locate reliably

2. Micro is BIGGER than Macro

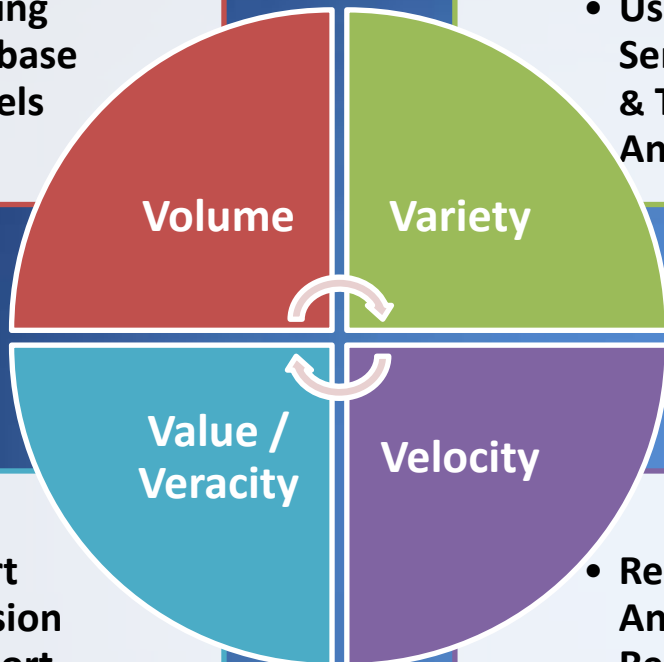
- **Micro-process knowledge is often not formalised**, explicit or tacit
- **you can't easily reach out and "grab it"**
- Business Process Modelling (BPM) captures about the top 10% (in an inflexible model) with BPM Services capturing another 40% in apps/code
- So "Business transformation" projects really only address 50% of total activities - but not the micro-processes
- **In reality, informal micro-processes are the bulk of daily activities**, are learned by rote, or "word of mouth", and regularly "assume" a knowledge of location and proximity. **People do it well, machines not so well**
- Social Network Analysis, movement patterns, etc are a more successful method of understanding and capturing these activities
- Realtime Location and Proximity are therefore the most useful attributes to support these decisions and activities

Converting Big Data Into Actionable Information

Gartner Big Data 3V's + 1

- Existing Database Models

- Use Semantics & Text Analytics



- Smart Decision Support

- Real-time Analysis & Response

New

Value Enhancement (Semantic)

- **Semantic Data Enhancement** – easily adds context and cross-connections using semantic / data silos
- Integrate additional info to **enhance info value**
- **Establish Veracity** against other sources
- Must **provide Real-time Staff Decision Support**

Historic Data

- **Statistical Analysis/Prediction**
- Population trends
- Largely Structured
- Database/Data Warehouse enhancements

Unstructured Data/Semantics

- Simple Structured Text Conversion
- **Need Text Analytics** to extract “meaning” and **create real Structure**
- **Need Semantics** and **External “Linked-Data”** to establish domain context

Real-time Data

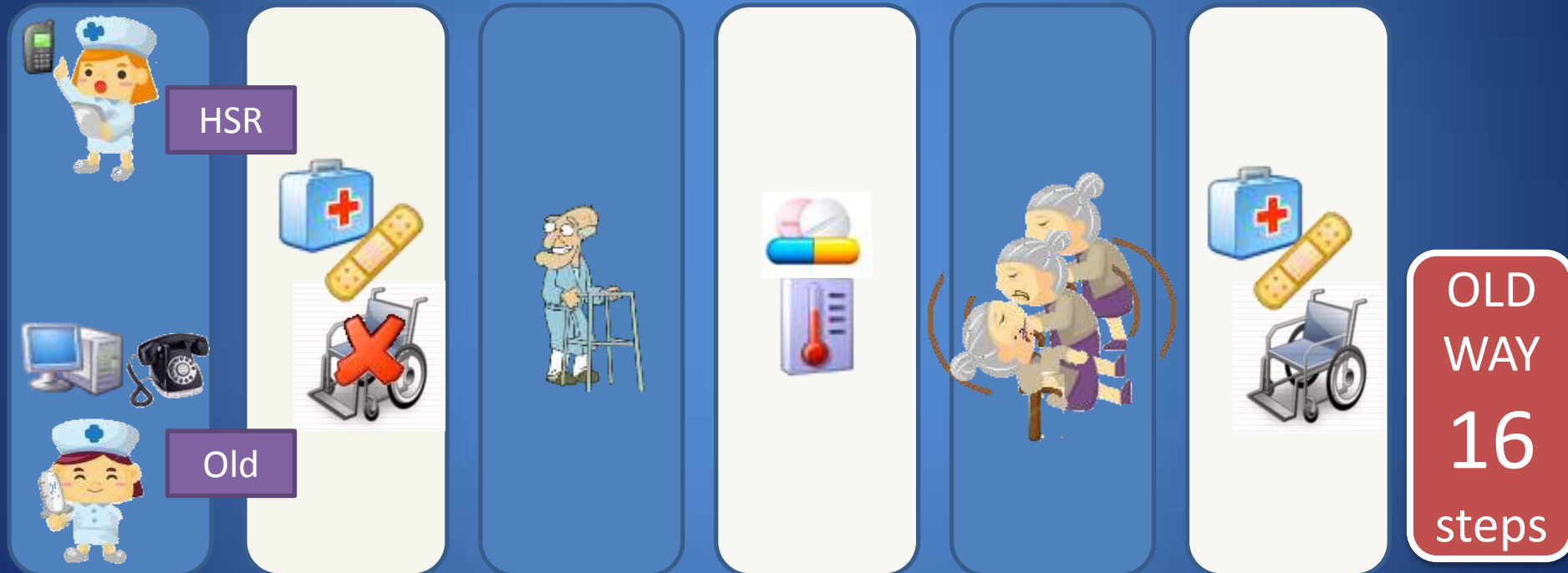
- **Real-time Sense & Respond**
- Move to Patient, RTLS, other Sensors
- **Real-time text analysis** as well
- **Needs knowledge source integration**
- **High Performance Architecture, Infrastructure & Networks** to support

So we need a new focus for Real-time Staff Support

3. Micro-processes and “Coincidental Optimisation”

Patient Management the old way

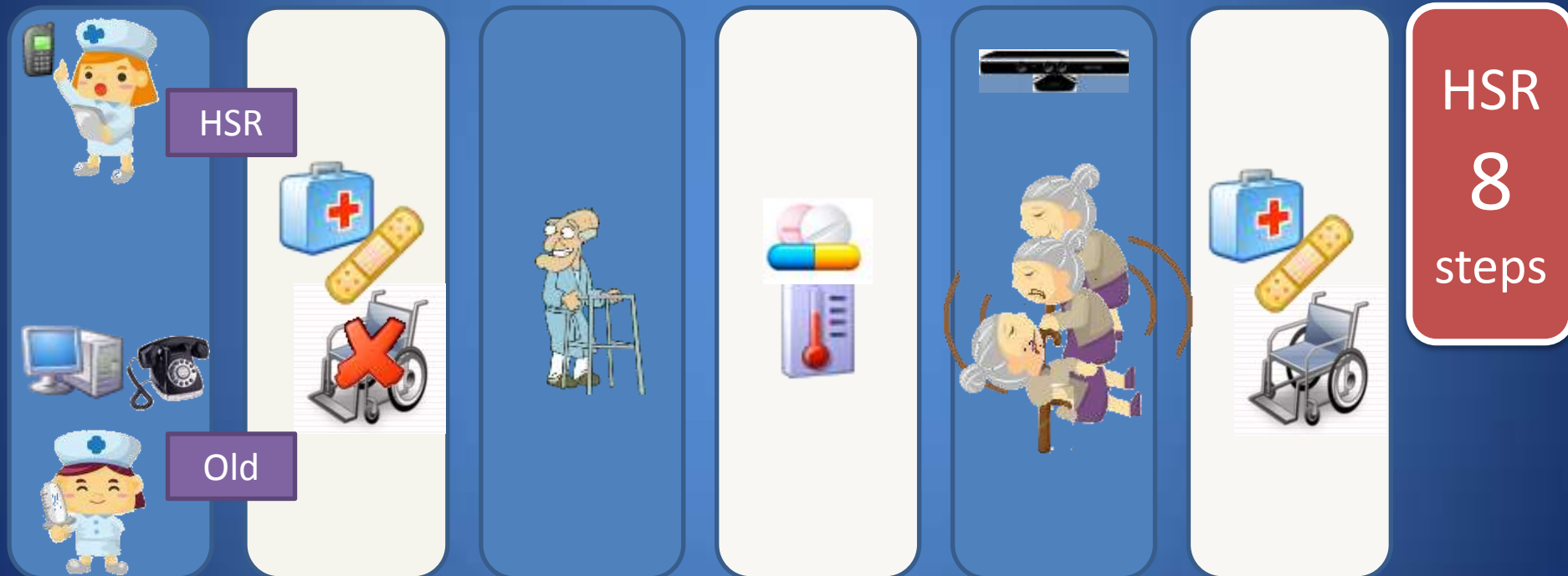
- 1. Time for Harrys Pain Medication – Check chart – Get & Dispense
- 2. Return to desk
- 3. Margret falls – someone eventually finds her on floor and calls!



- 4. Check Desk Asset Register for Wheelchair and Med Kit
- 5. Wheelchair Missing – so search (carrying med kit!)
- 6. Attend Margret - “Patched up” – Back to desk

3. Micro-processes and “Coincidental Optimisation” Patient Management the HSR way

- 1. Time for Harrys Medication – Verify by Mobile
- 2. Margret falls – Smart 3D Sensor notifies **nearest** Nurse
- 3. Check **nearest** Wheelchair and Med Kit - Margret “patched up”



**HSR “Coincidental Optimisation” of micro-processes
meant staff movements went from 16 down to 8 steps
- A significant saving of time and effort!**

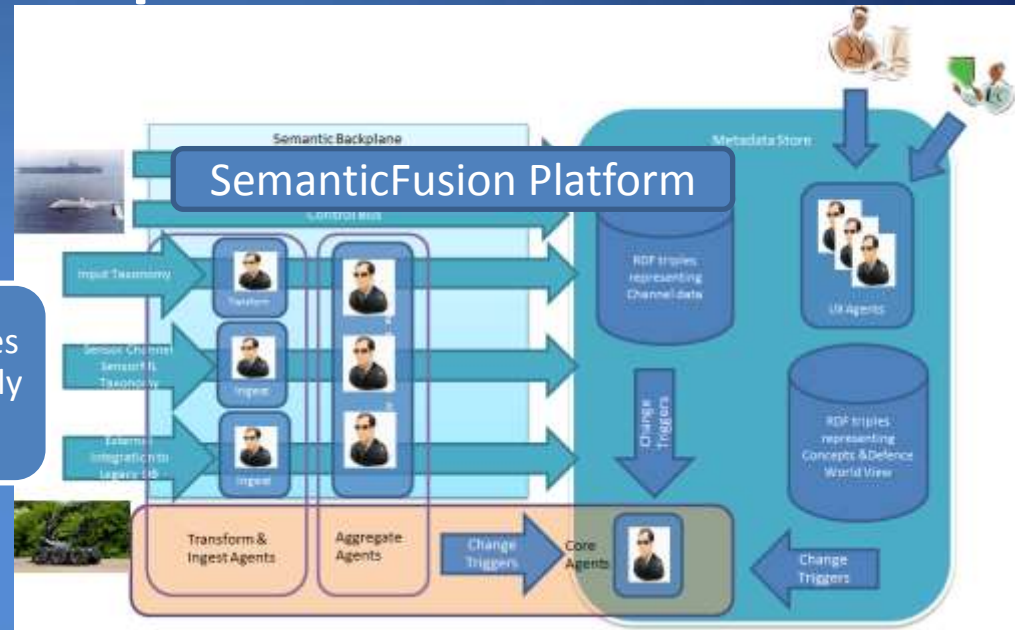
3. HSR: Sensor Big Data Platform Attributes

- **Integrates instrumentation and data/text analytic sensors**
- **Delivers a Scalable platform, Non-Contact 3D Sensor based behavioural monitoring and falls detection**
- **Represent and reason about concepts** (things we both understand)
- **Concepts** represent both **records** and also **patient movement and stability** – “stable patient / unstable patient”, sitting, standing, lying on bed / on floor”
- **Mobile delivery** next to patient bedside
- **Integrates Text analytics** to analyse reports & diagnostics
- **Distributed/real time**

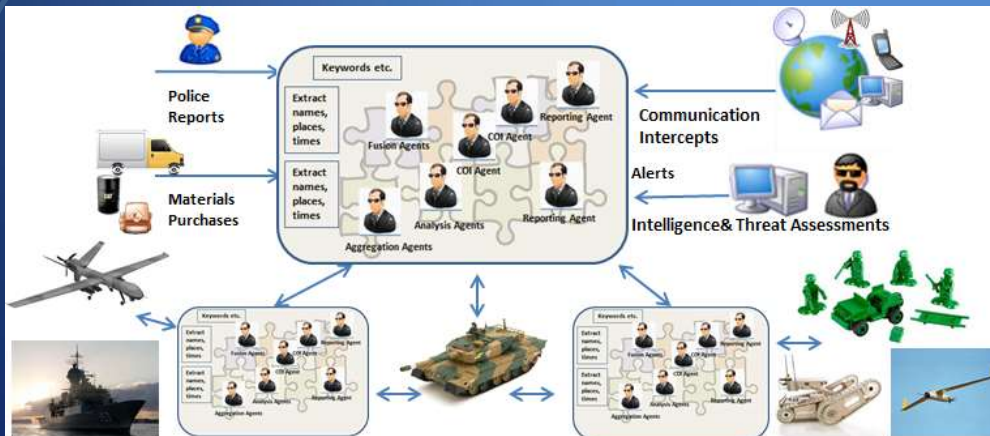
Health Sense Respond Platform

So we designed a flexible, scalable, distributed, platform that incorporates proprietary, agent, semantic, concept extraction, & text analysis technology to do just that!

Plus it does significantly more!



Real-Time & Distributed



- Initially targeted at Defence
- Huge Numbers of sensors, staff, assets, networks, systems
- The platform was also intended to support Emergency Services, Police, Manufacturing, Autonomous Systems and of course **Health!**

So what does a Hospital Real-time Sensor Big Data and Staff Decision Support System look like?



Hospitals actively monitor patients, their location and behaviour using NFC/RFID & Smart 3D sensors



Handheld devices provide staff with patients status, scheduled treatments, activities, and sensor diagnostics



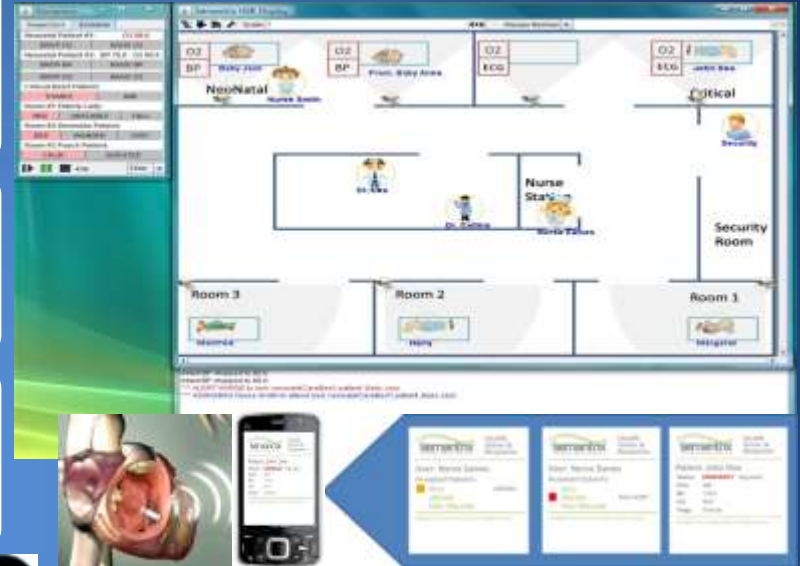
Staff receive high quality, relevant information next to the patient – translating to more informed decisions - delivering better patient outcomes

Patient Behavioural Monitoring

Falls detection & prevention

Track & Monitor Patient Sensors, Activities & Status

Enhanced Patient Security



Automated Patient Information Publishing



“Treatment Timeline” captures everything related to Patient



HSR logs all patient activities & Sensor Data, & status info



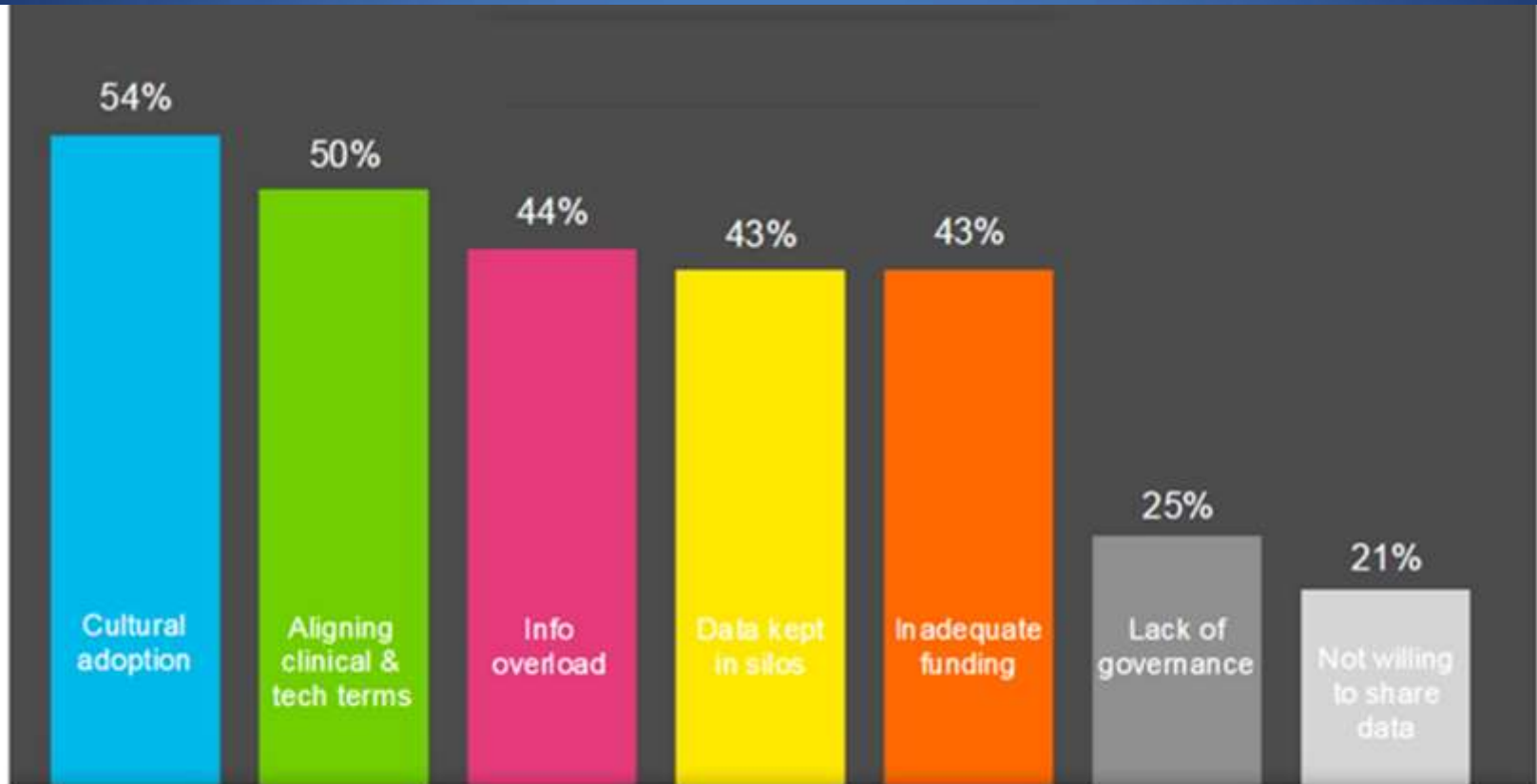
Analyses Sensors, Diagnostics, Results against SNOWMED CT, etc.

3. HSR solution approach

- Original platform targeted at defence, Semantrix developed HSR - a version targeted at health
- HSR has the ability to rapidly and easily integrate third-party information sets from sensors, health information coming from patient records, test results and reports
- The ability to also integrate information from your doctor, your gym, or your personal sensor systems in real time
- Semantic integration technologies are orders of magnitude faster to implement and adapt compared to traditional ICT approaches
- HSR also has the text analytics and NLP capabilities to access to SNOWMED CT and (19) other life sciences databases
- It is capable of providing one of the richest semantic knowledge repositories (Ontotext) available in the Medical world today

4. Implementation Hurdles

Some Key challenges you may face



Challenges: Technology integration

Source: PwC Health Research Institute Clinical Informatics Survey, 2011

HSR and Semantic technology approaches will help

4. Typical Time wasters / HSR Enabled Solutions.

Some Common Time WASTERS	HSR: Real-Time Big Data & Sensor Solutions
Time spent finding equipment	RTLS monitoring of equipment tags allows equipment to be found quickly, saving time and reducing the need for excess inventory
Time spent locating patients	RTLS monitoring of patient tags shows the patient's location saves staff time
Late attendance or forgotten appointments, wastes staff time reduces and facility throughput	Integrating patient's schedule with location allows staff to ensure that the patient is at the appointment on time. RTLS tracking allows the closest staff member to be sent to collect a wandering patient (co-incidental optimisation). Saves staff time and improves usage of facilities
Lack of real-time staff decision support & updates as Individual Hospital/scheduling systems are not well integrated or able to	Intelligent scheduling uses "Coincidental Optimisation" to match Patient Tasks and events with staff locations/skills based on Proximity, rosters, and Staff profiles, plus "smart sensors" to detect patient issues early
Delays in detecting patient condition	Real-time 24x7 monitoring of "smart" sensors triggers alerting, saving staff time and improving patient outcomes
Patient handover and information access	All relevant information for the patient, from all sources, immediately available in your hand, saves staff time, improves consistency and patient outcomes
Reliable Information distribution- access & sharing difficult	Integrates all Patient info and provides staff contextual access – via mobile devices in you hand (dynamic publishing): - Condition changes, Medication changes, New diagnostic reports, emergencies, etc.

A Big Data Enhanced HSR platform, RTLS & Smart Sensors delivers major benefits

Clinical IT Systems

- Operating Room
- Emergency Dept
- Other Departmental
- Electronic Medical Record
- Positive Patient ID
- Optimise O.R. utilisation using intelligent scheduling
- Smart Decision support applied to medications, diagnostics, treatment options
- Treatment Timeline integrates and publishes all patient related information, sensor readings, results, etc

Asset Management

- Tracking, Locating & Status
- Automated Work Orders
- Theft / Loss Prevention
- Inventory Tracking
- Room Management
- Optimal Theatre Management (staff, + skills = next patient)
- Minimise staff movements
- Co-incidental optimisation

Building Systems

- Temperature Monitoring
- Door Locks / Access Control
- Audible & Visual Alarms
- Telemetry
- Fire Alarms
- Hygiene Monitoring
- Alert staff on patient moves outside zones / Emergencies / nearest patients & exits

Patient & Staff Safety

- Staff Panic / Duress
- Emergency Response and automated Security calls
- Wireless Nurse Call
- Patient / Staff Locating
- Infection Control
- Stranger detection using Facial recognition 3D Vision & RFID
- Automated Behavioural monitoring & Falls detection
- Automated detection of wandering patients

Operational workflow

- Integrated Staff & Patient Intelligent pre-emptive scheduling
- Co-incidental optimisation
- Bed Management Transport
- Transport Management
- Unified Messaging / Alerts
- Reporting & Analytics
- Automated Task Routing
- Match staff skills, tasks, proximity and locations
- Dynamic Semantic Publishing updates all views of info automatically

5. . Benefits to Health using this new approach

- The Technology is Available
- Primarily only non-technical barriers need to be overcome
- We can start now and scale up
- There are Commercial returns
- There are Patient benefits
- Can be ubiquitous across the Health sector





**HSR can help you ride the Real-time Big Data “Health wave”
with a seamless integration of Sensors, RTLS Location,
Semantic Data Integration, and Intelligent Staff Support**