ASU COMPLEX ADAPTIVE SYSTEMS INITIATIVE
ARIZONA STATE UNIVERSITY

m.Health: The Emergence of a New Ecosystem for Healthcare Delivery, Global Public Health and National Security

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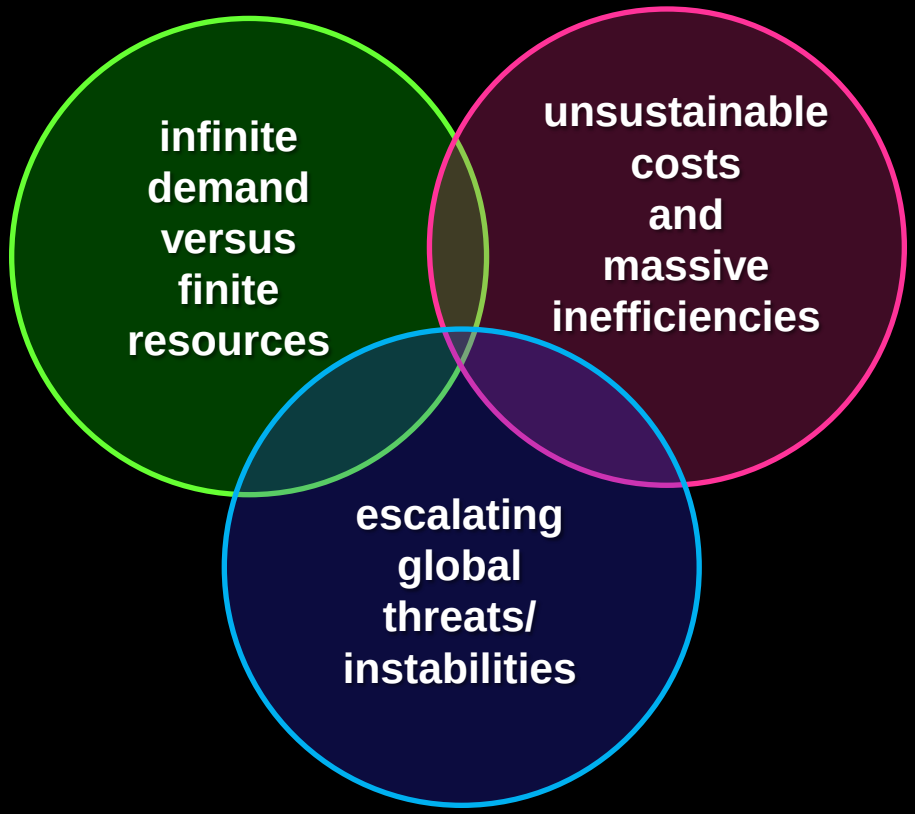
WORLD ECONOMIC FORUM

World Economic Forum Event on Mobile Health (m.Health)

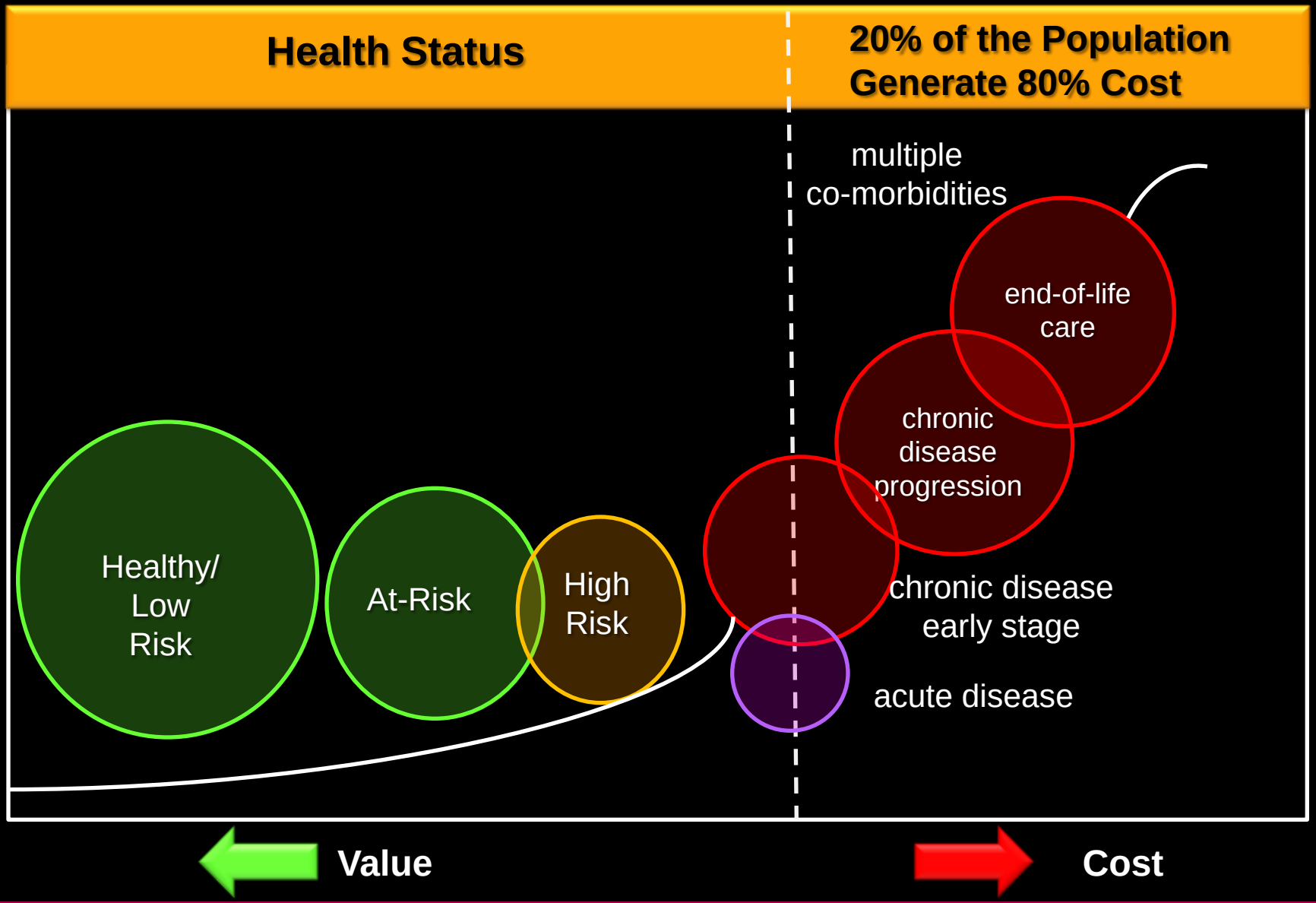
La Jolla, California June 28, 2010

Healthcare:
Major Unmet Needs and Unsustainable Systems

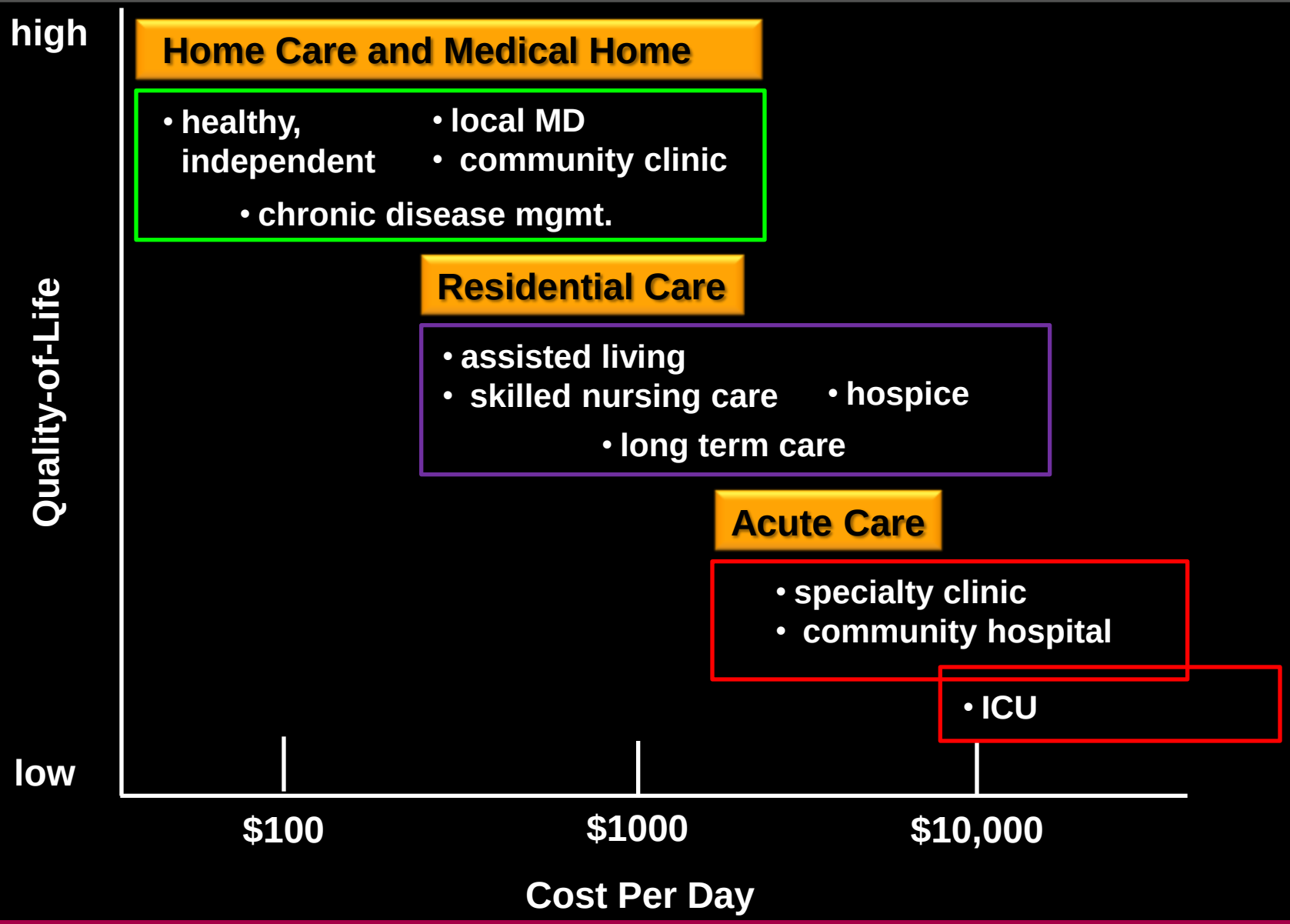


- prospering in an era of escalating economic constraints
- managing the limit(s) of society's willingness and ability to pay for innovation
- global health: risk mitigation, economic productivity, equity

The Economic, Social and Clinical Benefits of Proactive Mitigation of Disease Risk and Chronic Disease Co-Morbidities (G8:OECD)

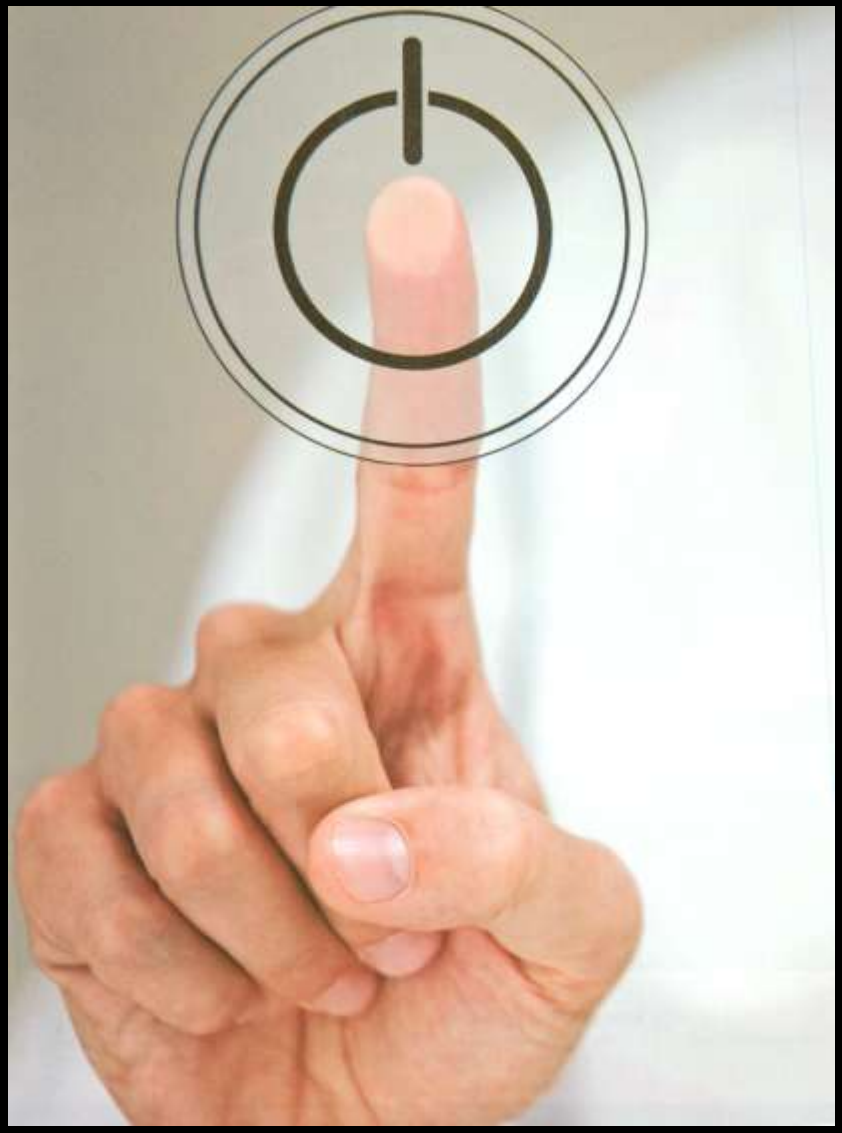


The Challenge of Cost Reduction and Improved Quality-of-Life



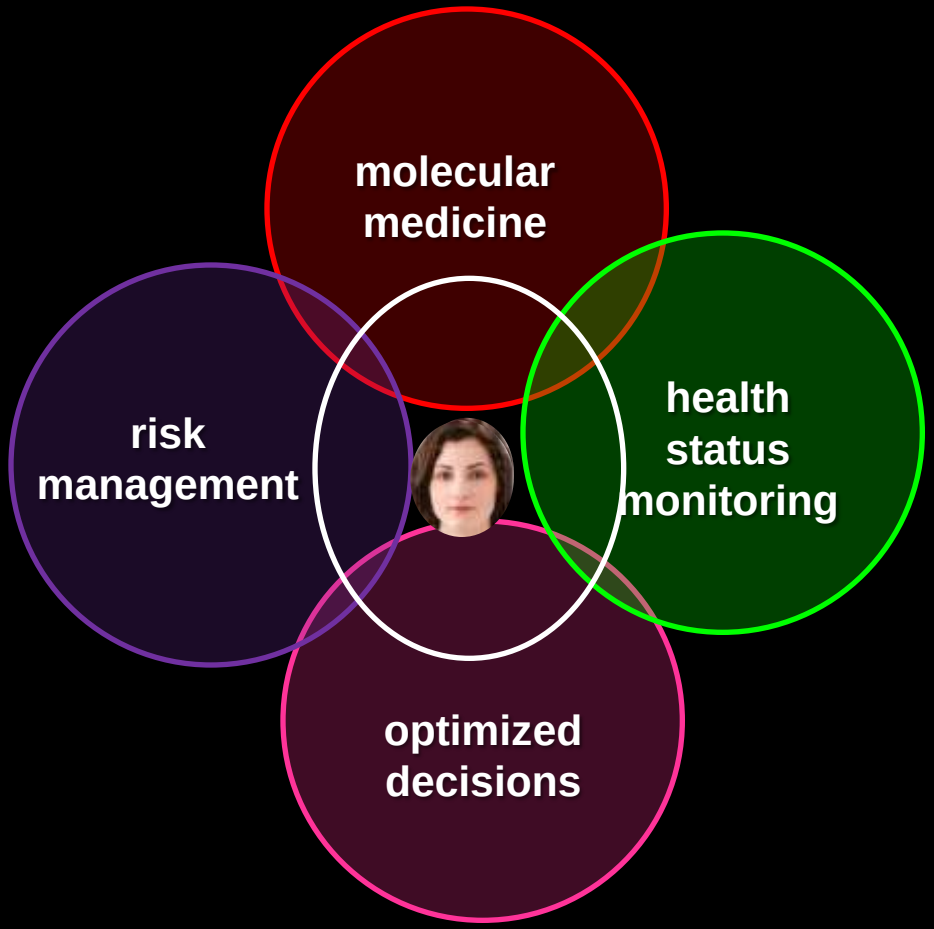
From
Healthcare Delivery
to
Health (Wellness) Systems and Services

Reframing the Healthcare Debate: Reimaging Healthcare as a Designed Service

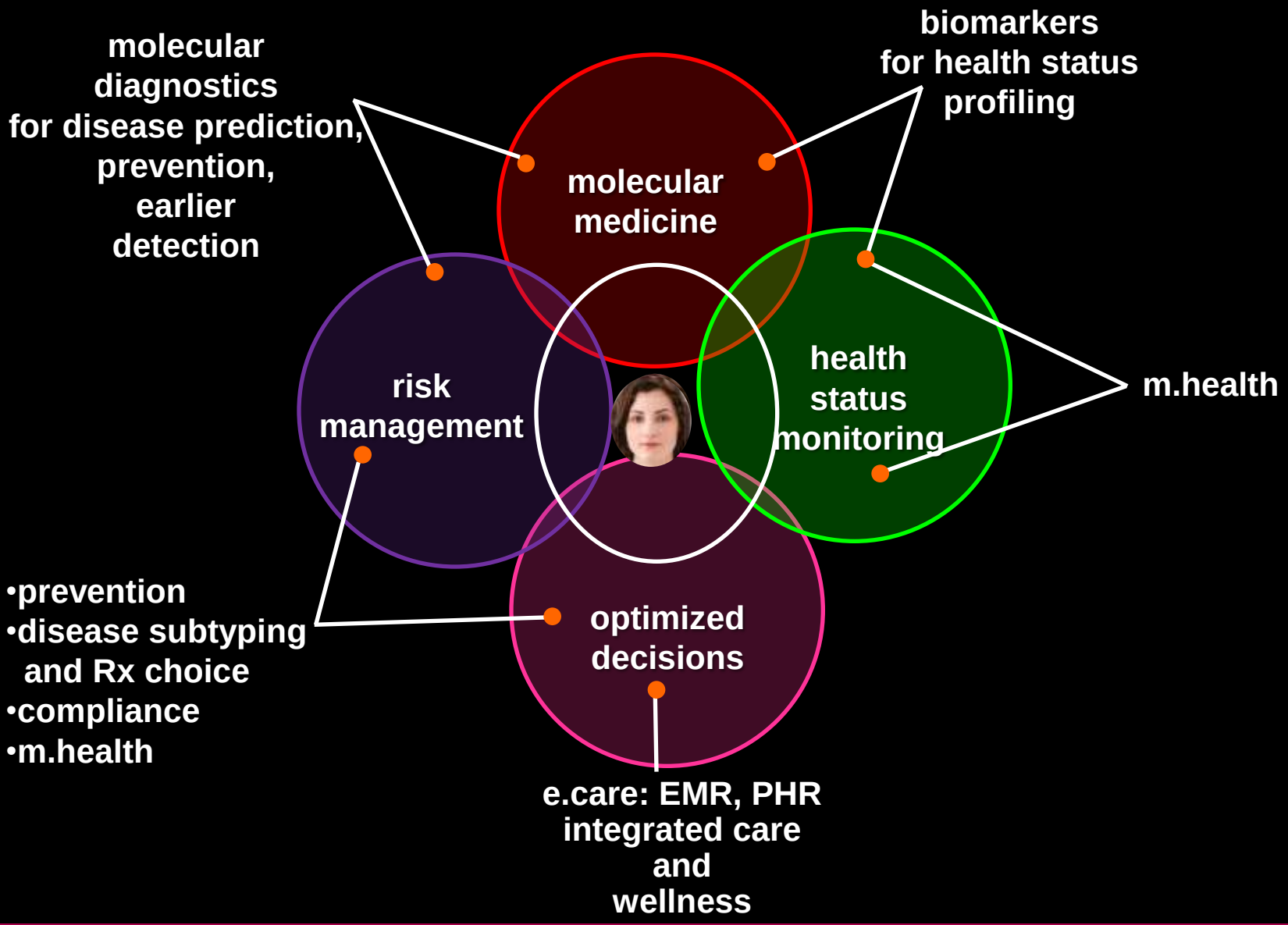


- high quality and affordable care
- the wellness imperative
- major redesign of the way:
  - healthcare services are organized and delivered
  - medical knowledge is disseminated and measured to ensure best practices
  - accountability of consumers/patients for self-management
- commitment to improved global public health

The Key Strategic Elements in the Evolution of Healthcare



The Key Strategic Elements in the Evolution of Healthcare



The Future of Mobile Communications: A Global Cooperation for the Advancement of Mobile Health and Wellness

- empower individuals to manage their health
- extend health services to people at all economic levels
- evidence collection for best practices and promote ROI
- integrate m.health into payment programs
- incentivize government investment in long term programs
- facilitate connectivity between critical infrastructure and health delivery networks
- open ecosystem: interoperability, innovation, competition and consumer choice

The Evolving m.Health Ecosystem

The Evolving m.Health Ecosystem

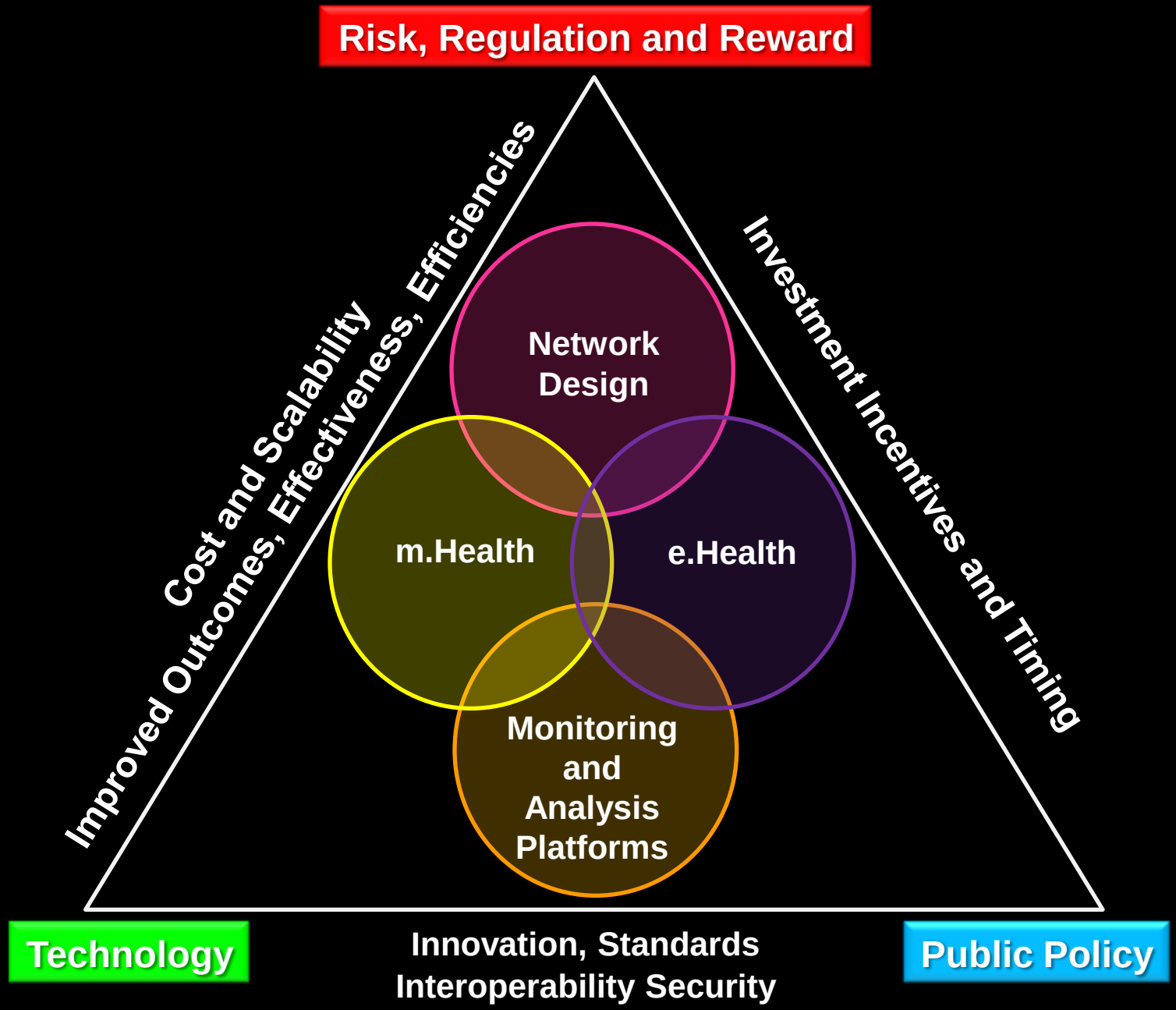
- technology
- regulation
- legal
- financial

- incentives
- behavior change
- metrics

- new services
- new business models
- new organizational relationships

DEMONSTRATING VALUE

The Digital Health Ecosystem



You, Me and Health in a Networked World

- mobile
- multimedia
- monitored
- measured
- me, and those like me
- multiple markets of one, but primarily ME!







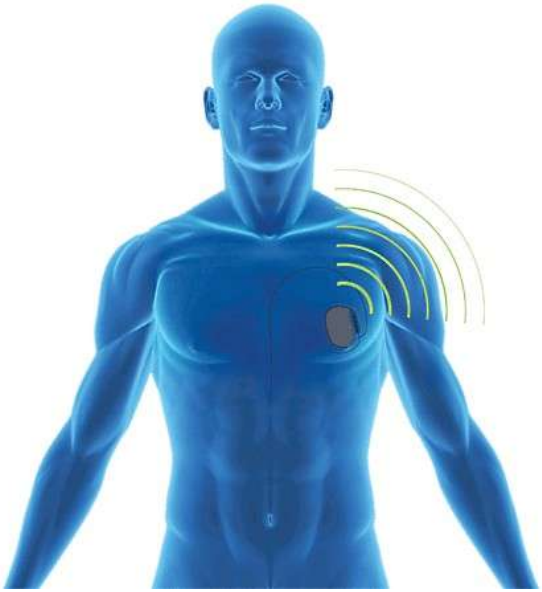







Mobile Services: Universal, Personalized and Indispensable

- 5 billion plus mobile phones, 6 billion projected by 2013
- 3 billion more than any other consumer electronic devices
- 750 + million 3G mobile users, 1.6B projected by 2012
- 7 trillion wireless devices serving 7 billion by 2017
- projected 1000 wireless devices per person by 2017 (source WWRF)
  - devices, smart homes, intelligent cars, consumer goods and healthcare



Remote Health Monitoring and Chronic Disease Management

Lifestyle and Fitness

Information for Proactive Health Awareness (Wellness)

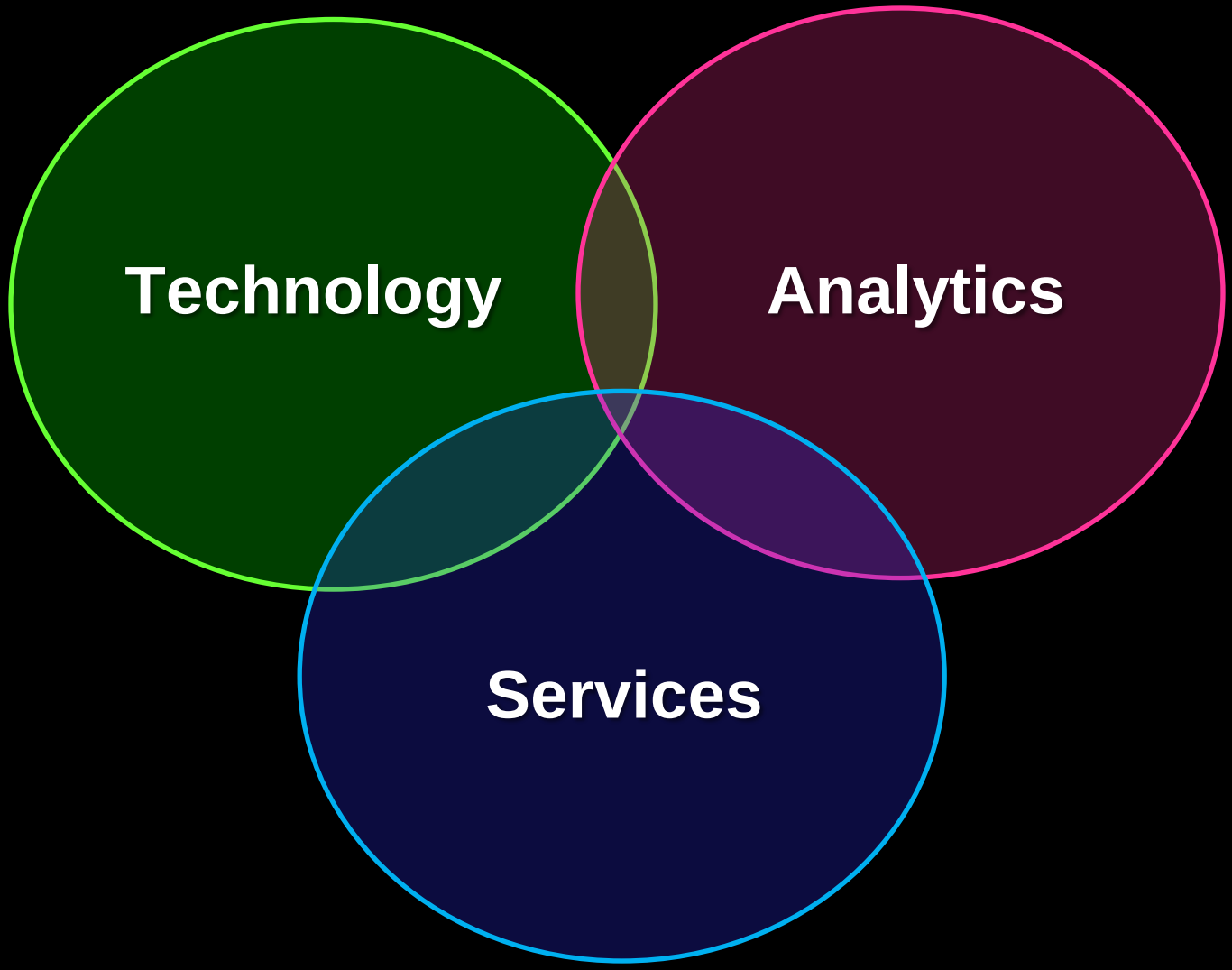
Mobile Services and Web 2.0
AORTA: Always On, Real Time Access

- collapsing time and space
  - access, analysis and action
- everybody on the net: one world
  - services, surveillance and security
- every body on the net (Qualcomm)

Wireless Integrated Data Systems

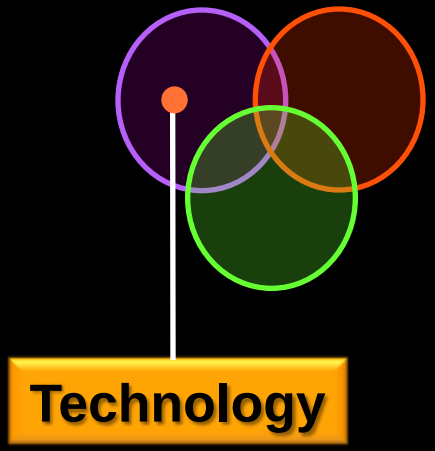
- geolocation data (where)
- temporal information (when)
- contextual information (what)

m.Health



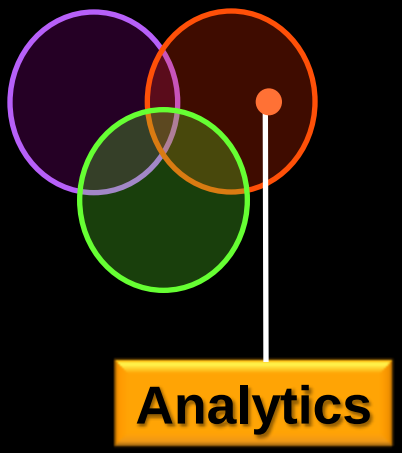
Major Drivers of m.Health

- networked sensor systems
- device miniaturization
- diverse signal capture
- complex signal deconvolution
- broadband wireless
- blended physical and virtual environments
- integrated personal technologies
- embedded intelligence
- intelligent environments



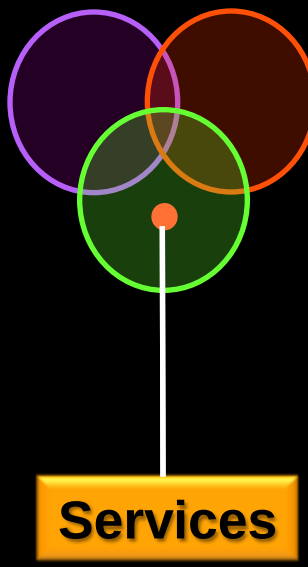
Major Drivers of m.Health

- remote health status monitoring
- real time monitoring of networked sensors
- deconvolution of complex, diverse signals
- mobility and behavior patterns
- social networks
- epidemiological and outcomes data
- continuous, integrated analytics
- large scale dbase federation
- EHR/PHR uploading
- privacy and security
- health performance metrics (systems and individuals)



Major Drivers of m.Health

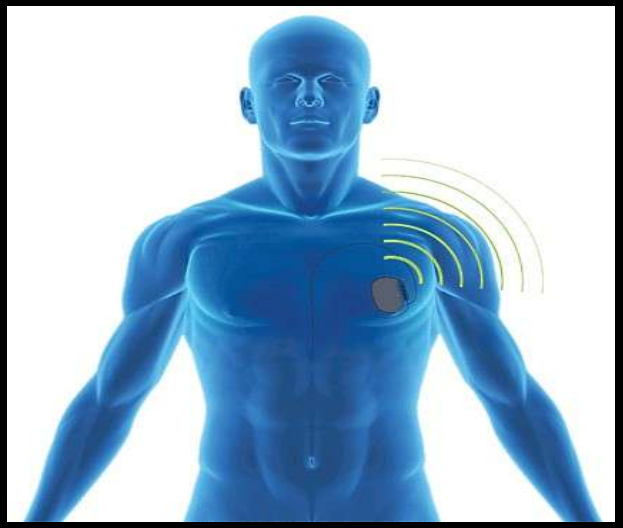
- distributed networks and POC monitoring/decisions
- remote health status monitoring
  - patient self-management/ accountability
  - Rx compliance
- improved supply chain/care delivery process/resources allocation
- performance and outcomes metrics
- trusted health information services
- increased knowledge symmetry between providers/patients/payors
- social networks and empowerment
- evidence-based decisions and decision-support tools

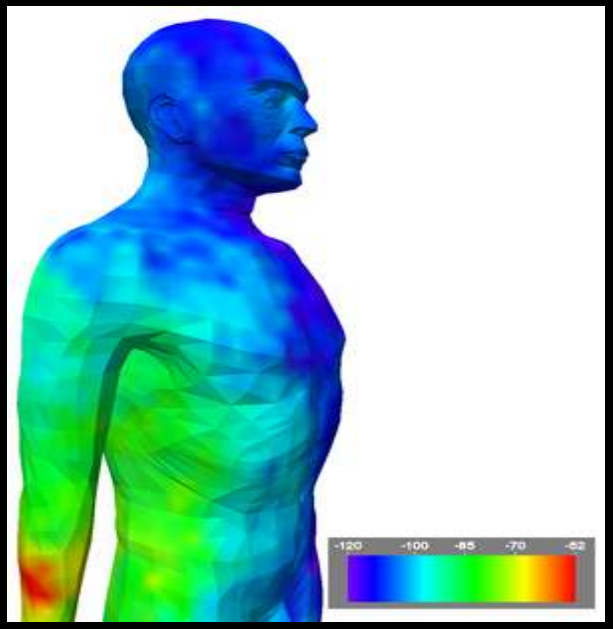


On-Body:In-Body Sensors (OBIBs) for Health Status Monitoring

- minimally intrusive/invasive
- portable/mobile
- point-of-care (POC)
- multi-parametric
- real-time monitoring and actionable feedback for decisions/recommendations
- extended lifetime and reliability
- accuracy, safety and security

On-Body:In-Body Sensors





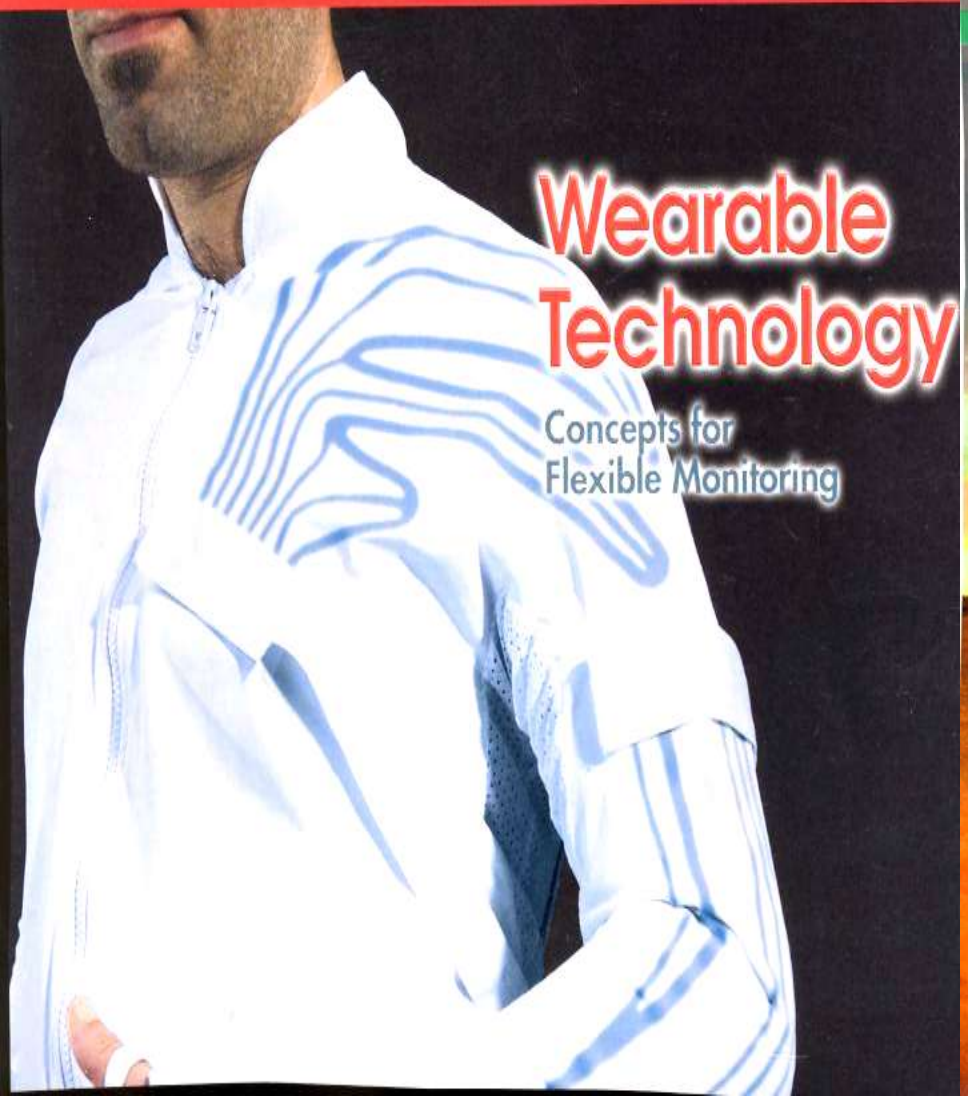
- extended lifetime: ultra-low power sources
- sensor processing and transmission cycles
- sensor networks: data aggregation and integration from multiple sensors
- complex signal deconvolution
- data volume and storage
- security and privacy
- passive and active feedback loops
- regulation

“This isn’t a device it’s a service.”

Jeff Bezos
CEO, Amazon

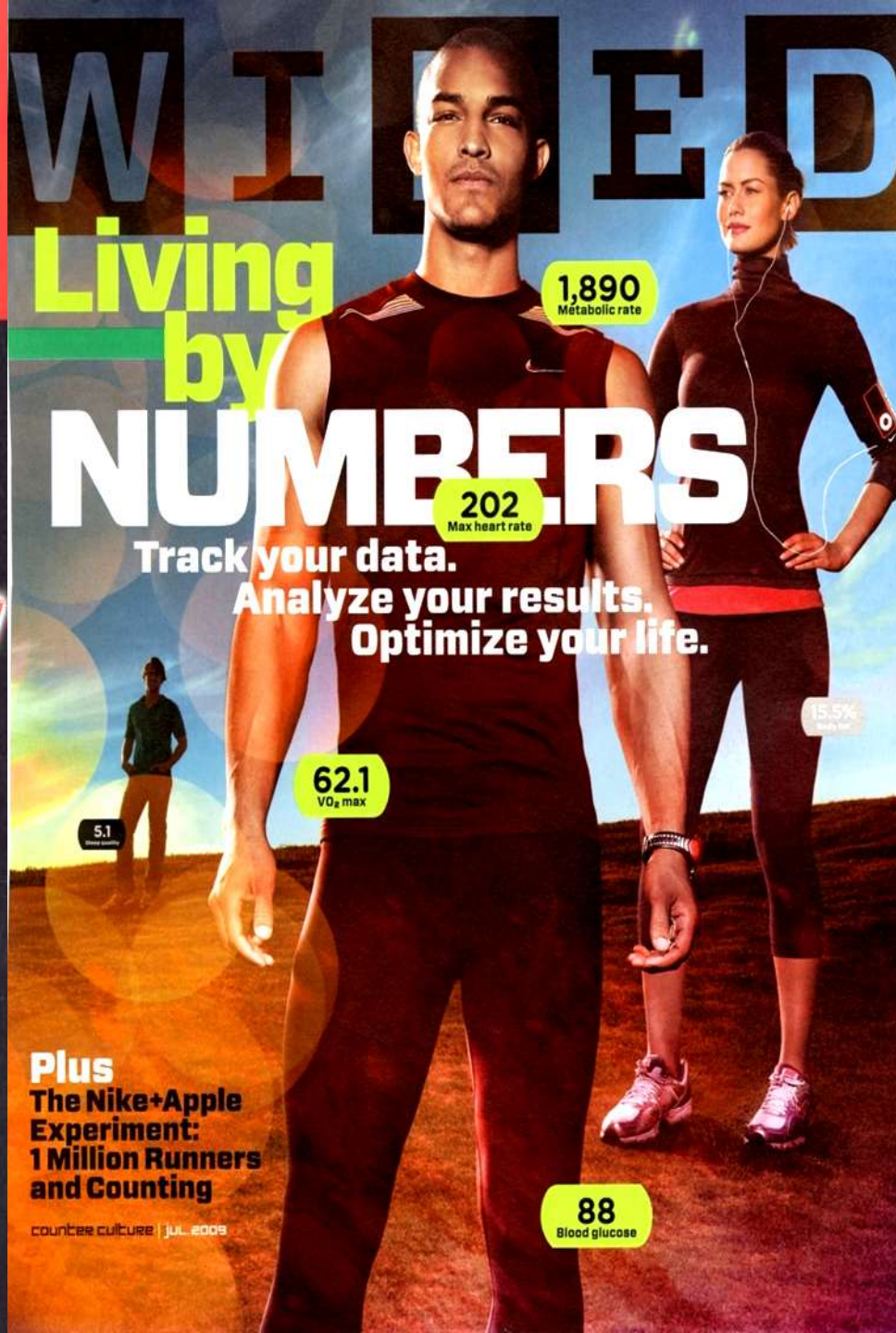
IEEE ENGINEERING IN
MEDICINE AND BIOLOGY
Magazine

VOLUME 29 • NUMBER 3 ■ http://magazine.embs.org ■ MAY/JUNE 2010

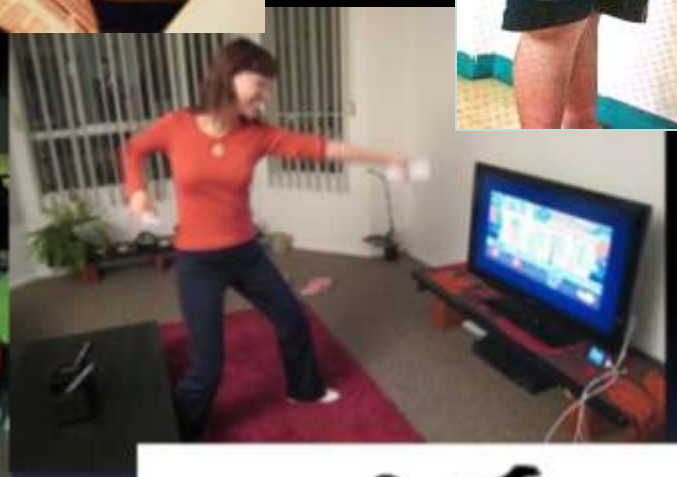


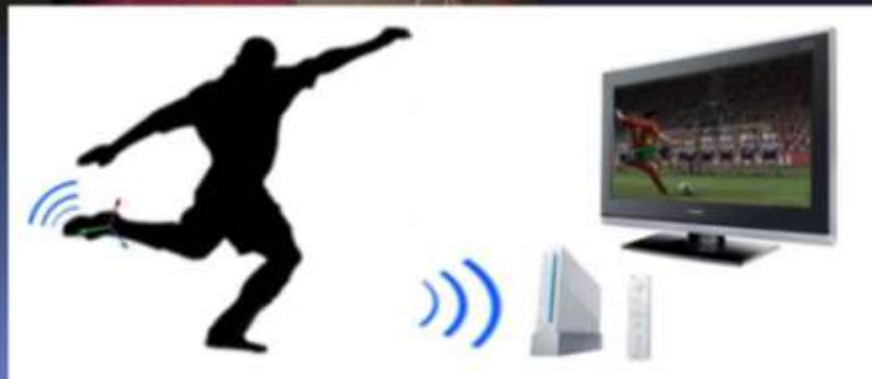
Wearable Technology

Concepts for Flexible Monitoring



Gaming for Health:





Wii Fit Plus

myFoodPhone

‘Take a photo and get advice’

As seen on:

abc CNN WSJ.com

The Washington Post

Consumer Behavior and Healthcare Costs

“diabesity” $200 billion

smoking $190 billion
alcohol $20 billion

PressureAlert™ Orthotic System

A pressure sensing Orthotic to alert patients and/or their caregivers when blood flow may have been compromised to the point where serious injury may occur

Major Target Markets for Wireless Medicine

Disease	*Patients	Parameter
Alzheimer's	5 million	vital signs, location, activity, balance
Asthma	20 million	respiratory rate, FEV, air quality, oximetry, pollen count
Breast CA	3 million	ultrasound self-exam
COPD	10 million	respiratory rate, FEV, air quality, oximetry
Depression	19 million	medication compliance, communication
Diabetes	21 million	glucose, hemoglobin ATC
Heart Failure	5 million	cardiac pressures, weight, blood pressure fluid status
Hypertension	74 million	continuous blood pressure monitoring, medication compliance
Obesity	80 million	smart scales, caloric in/out, activity
Sleep Disorders	15 million	sleep phases, quality, apnea, vital signs

From: West Wireless Health Institute, Medtech Insight, August 2009

The Costs of Non-Compliance with Rx Regimens

- $177 billion projected cost
- 20 million workdays/year lost (IHPM)
- 40% of nursing home admissions
- projected 45-75% non-compliance (WHO)
- 50-60% depressed patients (IHPM)
- 50% chronic care Rx (WHO)

Intelligent Medicine Dispensers for Enhanced Rx Compliance

http://hypedesire.blogtv.com.pt/img/image/HypeDesire/2009/abril/glowcap3.jpg

mHealth: CTIA-The Wireless Association and Harris Interactive Survey (Dec. 2009)

Patients

- allow for more home-based care (68%)
- perceived reassurance by patients and family (57%)
- more freedom of choice (51%)

Physicians

- estimated 25-40% patients would benefit

The Patient Experience

- most appropriate care and best outcome
  - access to clinical expertise
- much more than the clinical encounter
- “touch points” in a period of vulnerability
  - first and last impressions of myriad non-clinical events
  - efficiency, compassion
  - support for family members
  - transparency

Personalized (“Me”)

‘The Medical Home’: Integrated Care Services for Independent Living

Deloitte.

Connected Care

Technology-enabled Care at Home

Produced by the
Deloitte Center
for Health Solutions

Audit . Tax . Consulting . Financial Advisory.

State of Technology in Aging Services According to Field Experts and Thought Leaders

By:
Majd Alwan, Ph.D.,
Center for Aging Services Technologies (CAST)
American Association of Homes and Services for the Aging (AAHSA)

and

Jeremy Nobel, M.D., M.P.H.,
Harvard School of Public Health

Report Submitted to: Blue Shield of California Foundation

February 2008

cast™
Center for Aging Services Technologies

Key Determinants in Adoption of m.Health

technical

- standards, inter-operability, scaleability
- integrated multi-sensor feeds
- validation analytics for multiplex biomarker profiles
- dynamic monitoring, dbase integration and facile real-time analytics

regulatory

- certification and safety standards for multi-vendor solutions

financial

- value-based versus cost-based reimbursement
- new co-pay solutions
- risk of ‘vendor lock-in’ for high CapEx in immature technology domains

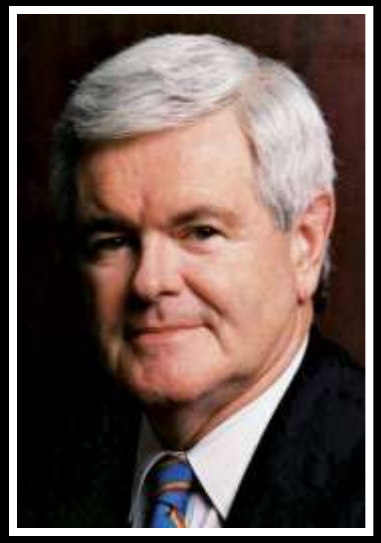
legal

- error liability, DOS
- security and privacy

If You Build It Will They Pay?
Adoption of Disruptive Innovation

- new technology/service that simplifies a complex/costly problem
- business model that allows market adoption of the simplified solution at low(er) cost
- incentivized supply and demand to networks to reinforce the disruption

Misaligned Reimbursement Incentives: Rewarding Process Versus Results



"You have a (healthcare) system that traps us
into bad performance
because it's the only way you can bill"

Hon. Newt Gingrich
Medical Device Daily (2009) 27 Jan. p8

"If it isn't billable – it isn't going to happen!"

In-Home Health Connections: Engaging the Elderly

In-Home Health Connections: Engaging the Elderly

- 30 reporting countries
- continued low percentage of use in older age groups
- only USA (42%) and Sweden (41%) exceed 40% use by 65yr or older cohort

m.Health: Changing Minds and Changing Behaviors

- technology is only the enabler
- emergence of new organizational structures, alliances and business models
- engage and educate multiple constituencies with long entrenched behaviors
- ‘care’ space will be increasingly decentralized
  - from hospital/clinic to ‘personal health space’
- from episodic encounters to continuous interactions
- new business opportunities in customized health services and health broker/concierge services

Digital Health and New Delivery Pathways

- new organizational/business models
- rapid expansion of e.health/m.health
- social media and promotion/adoption of OTC/wellness/lifestyle products/services
- integration of consumer health product categories with remote health monitoring services
- new ‘infomediaries’ will change balance of power between healthcare professionals and consumer
  - transparency, positive outcomes and performance
  - consumer choice

The Fundamental Drivers of Healthcare Delivery: Implications for Training Physicians and Healthcare Professionals

- molecular medicine
- engineering-based medicine
- information-based medicine
- consumer-centric medicine
- recalibration of the roles/expectations and status of healthcare professionals

Social Networks and Consumer: Patient Empowerment

Source: R&D Directions May 2010

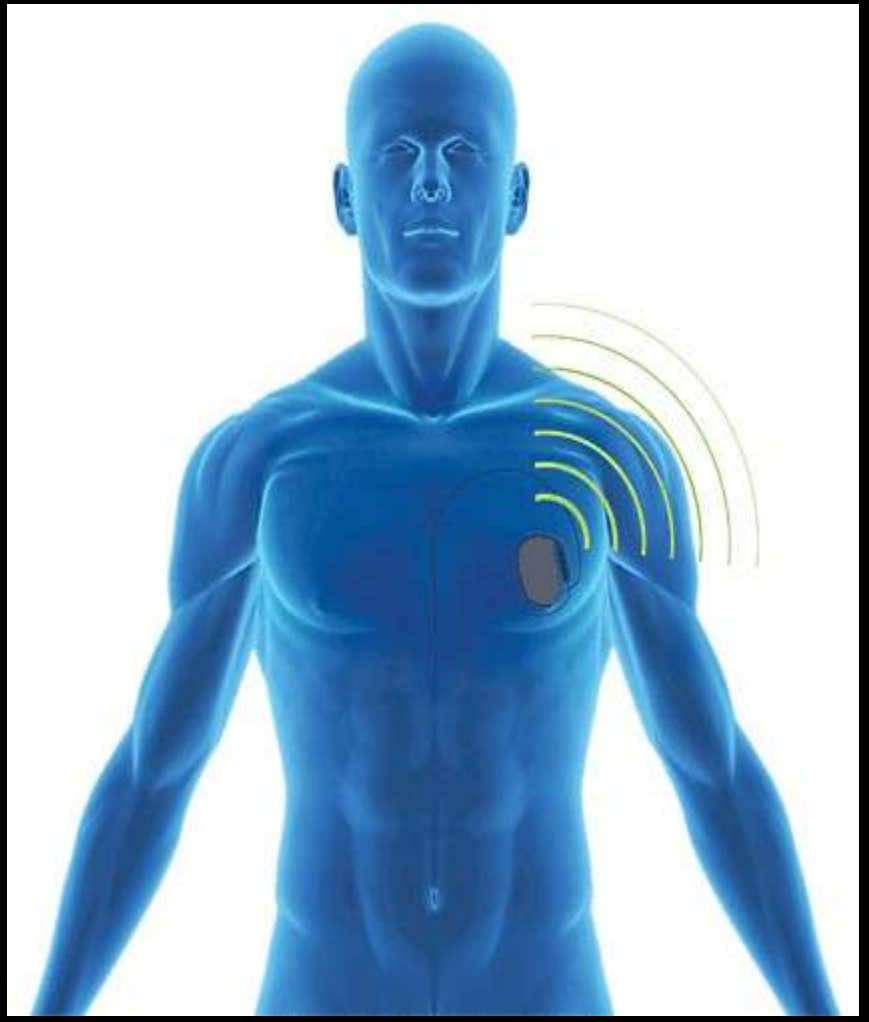
Pharma and Healthcare Social Media Brand Sponsored Patient Communities

Regulation of Drugs, Diagnostics and Devices: Marketing and New Media

- FDA guidelines to be issued
- need for clear rules of engagement
- content (passive), conversation (active)
- covert eavesdropping on patient sites
- sponsor transparency
- how to adapt presentation of benefits:risks required by DDMAC in new media formats
- level of sponsor responsibilities to monitor and correct misinformation and report claimed AEs
- surveillance against black campaigns to discredit products

Safety

Interference in High Density Medical Device Areas



The Security of Medical Devices is Not a Luxury

Applications of RFID Technology in Healthcare

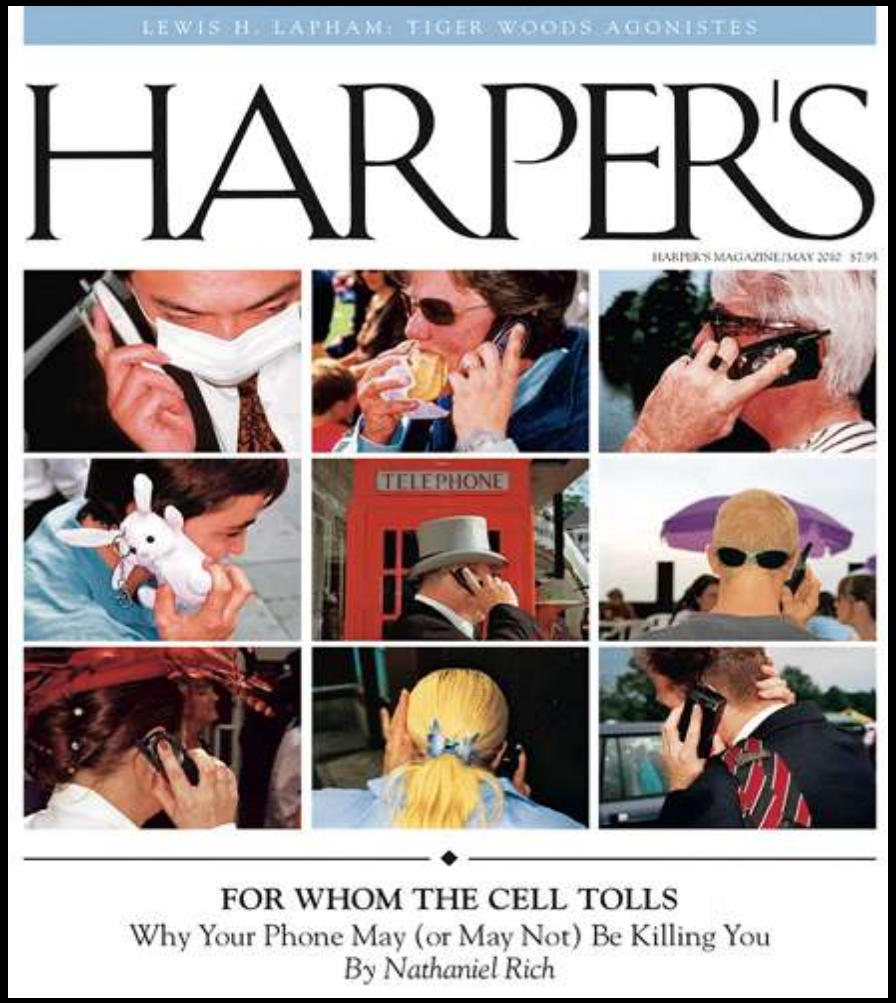
- patient ID, tracking and status monitoring
- location of equipment and assets
- supply chain management
- surgical QC inventory of instruments/materials
- directed endoscopy and placement of microdevices
- patient support device alarms
- product authentication
- capture of device-generated data and uploading to EHR

Bad Habits

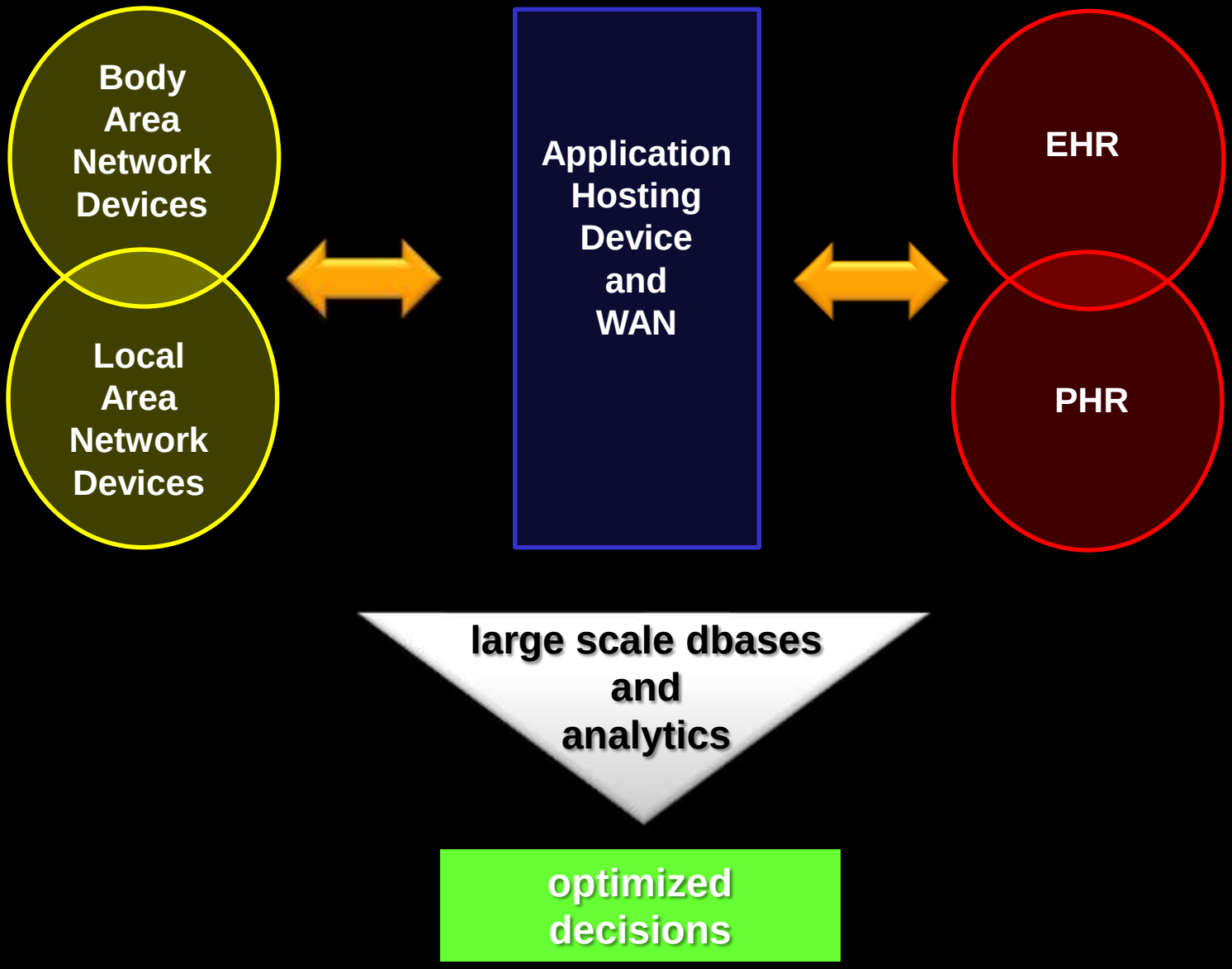
non-sterilizable m.devices

non-consented ID

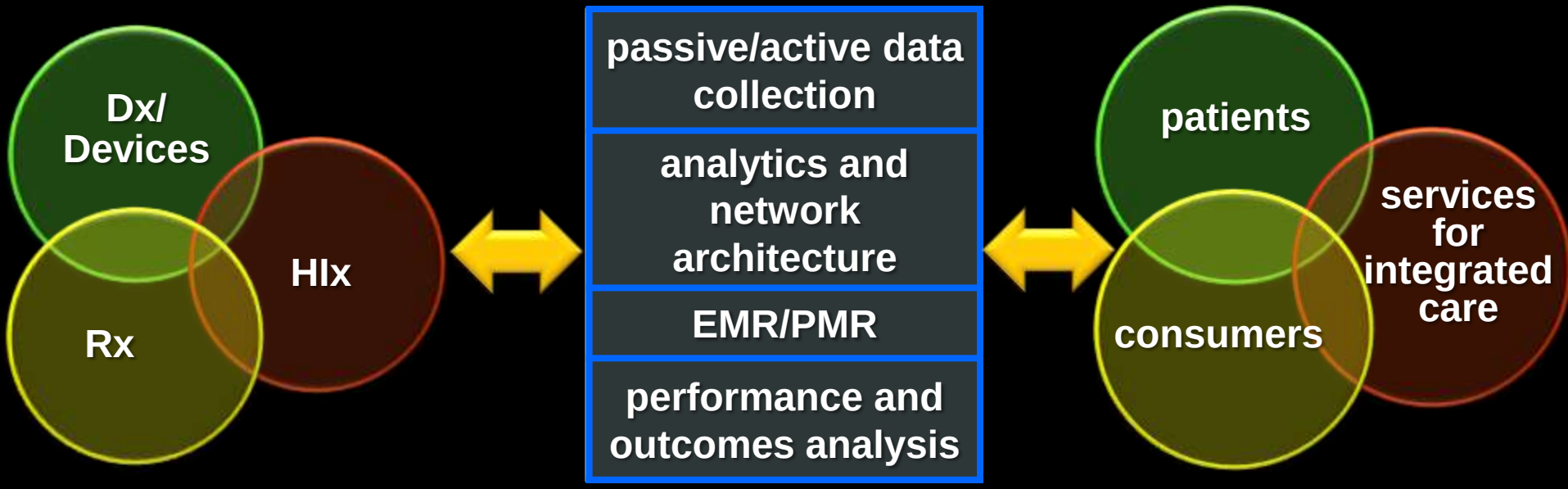
The Continued Debate Over Cell Phone Safety



Systems Architecture and Design Guidelines for Inter-Operability in Remote Health and m.Health Applications



A New Healthcare Ecosystem Arising From Technology and Market Convergence



Integrated Technology Platforms

Data Mining and Integration Services

Increasingly Targeted Care and Efficient Use of Finite Resources

Getting Ready For The PEZ Transition

- Petabyte
- Exabyte
- Zettabyte

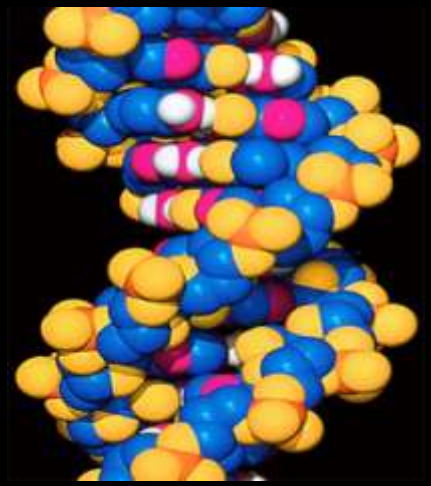
- massive datasets
- mining tools
- minds: customized context and formating for optimum cognitive processing and improved decisions

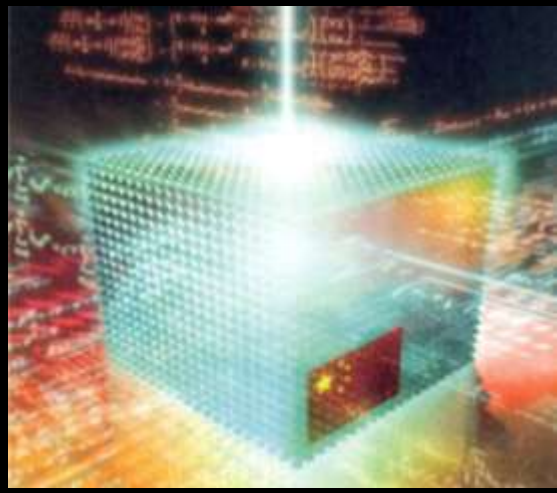
Managing “Mega-Data”

volume

Infrastructure

global networks

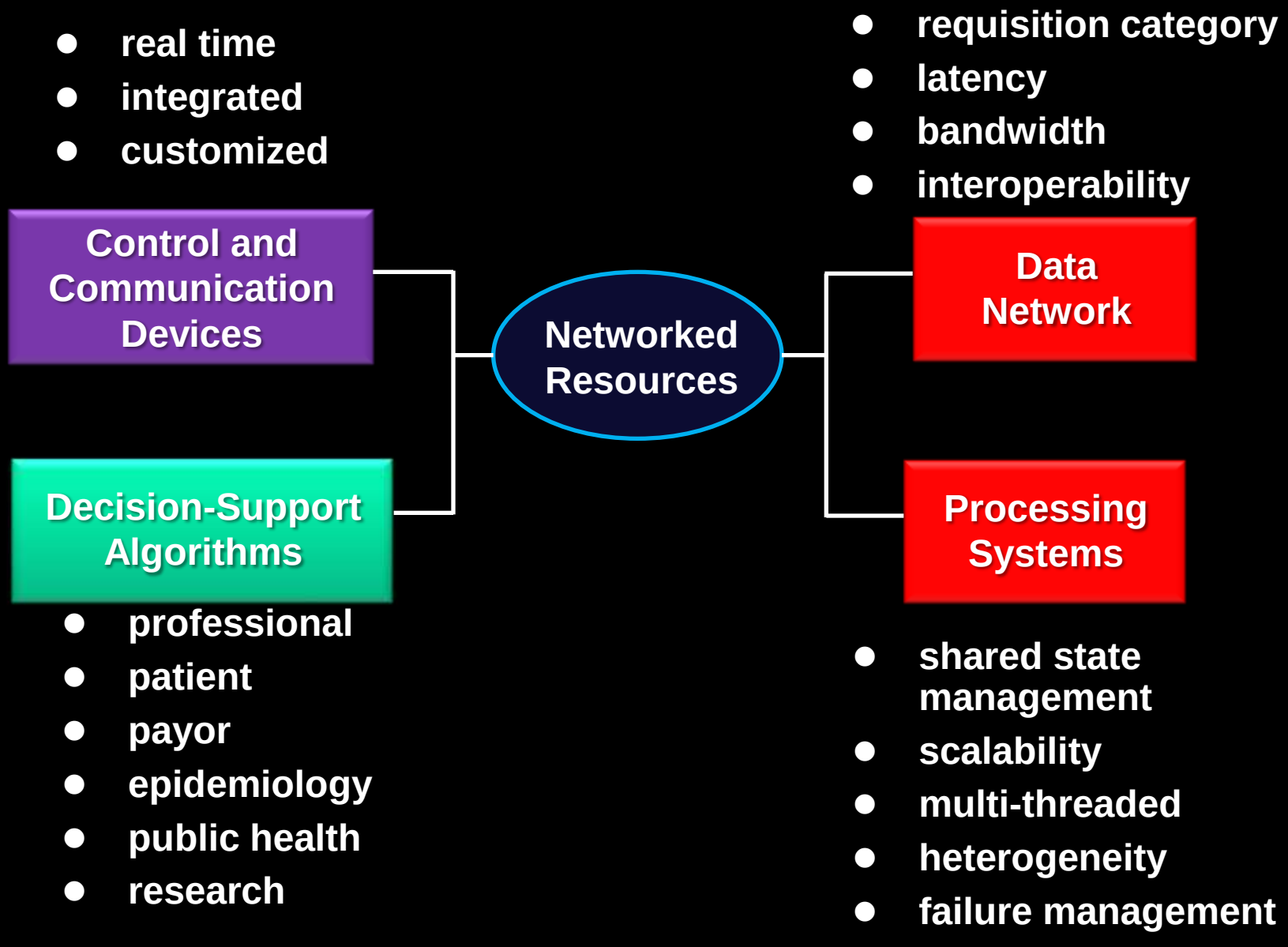




data heterogeneity/ spatio-temporal scale

integration

Key Elements of Healthcare Data Mining and Decision-Support Networks



Analytics for m.Health and HIT

spectrum

- mobility and ubiquitous sensor nets demand dynamic reconfiguration
- device heterogeneity and diverse connectivity strategies
- unreliable wireless
  - interference, blocking, fading
- 7 trillion connected devices will rapidly exhaust available spectrum
- current spectrum policy has full allocation but poor utilization
- cognitive device platforms and dynamic shifting to unallocated spectra

Integration of Advances in Customized Data Formating and Visualization Tools for Different User Constituencies

- escalating quantities and diversity of information
- real time decision support systems under conditions of uncertainty
- new multi-modal, multi-sensory high performance human: information interfaces
- representation and comprehensibility of information flows
  - optimize representation (perception and recognition)
  - integrated multi-user interfaces (customized and actionable)
- adoption of advances in cognitive neurobiology in customizing data formats (kinds of minds)

Analytics for m.Health and HIT

New Services and Business Models

- increasingly customized services for risk mitigation
- automated decision-support
- large scale dbase curation and mining
  - resources demand modeling and supply chains
  - proficiency metrics
  - CER, guidelines, best practice
  - global surveillance and epidemiology
  - new research platforms

Global Biosecurity:
The Broadest Definition of Health

Global Health:
Understanding the Implications of Major Economic and Environmental Dislocations

http://mobileactive.org/files/Picture%201_46.png

mHealth Alliance

Digital Health Services for the Global South

doi: 10.1377/hlthaff.2010.0006

E-Health's Promise For The Developing World

BY SUSAN DENTZER

Imagine a health worker in a remote clinic in mountainous Rwanda, who must ensure that HIV/AIDS patients take their daily medication. Whipping out her cell phone, she sends a text message to a national health registry in Rwanda's capital, Kigali, noting that PatientX, who just came in for a clinical consultation, has been taking his meds and that a new round of antiretrovirals has been dispensed on his behalf.

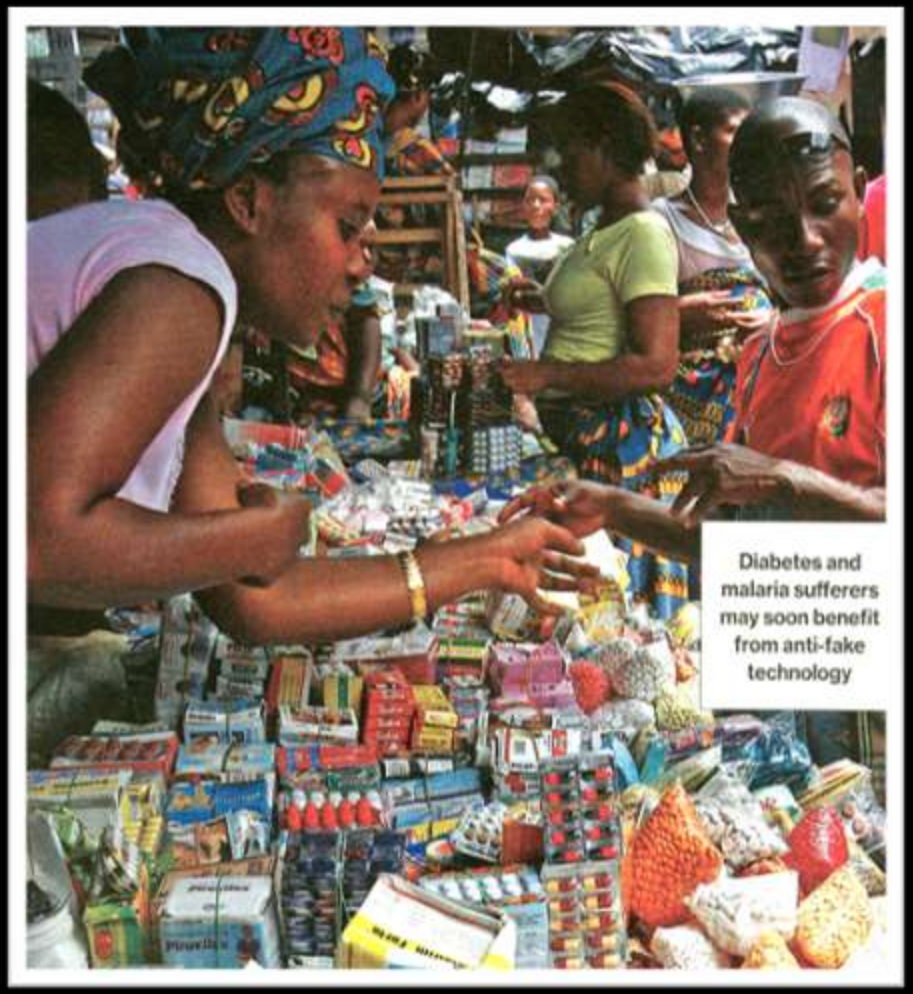
Minutes later, other workers at the national health ministry take this information and add it into their records of

(Health Affairs February 2010)

m.Health Services for the Global South

- adapt global materials
- content tailored to local settings
- translation into local languages
- content repackaged for specific health needs
- create local content

m.Health Services for the Global South: Verification of Product Authenticty



Bloomberg Businessweek May 17-23, 2010

- malaria medication
- acetaminophen syrup

Pedigree

hp

- glucophage

SPROXIL

Geo-demographic Information Systems (GIS): Real-Time, Front Line, Ground Zero Data from Field Sampling and Sentinels

Global Disease Surveillance

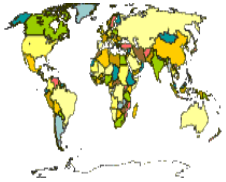
EMERGEncy ID NET

Public Health Department's Surveillance

U.S. Influenza Sentinel Provider Surveillance Network

GIDEON

Quarantine Activity Reporting System (QARS).



GeoSentinel

The Global Surveillance Network of the ISTM and CDC

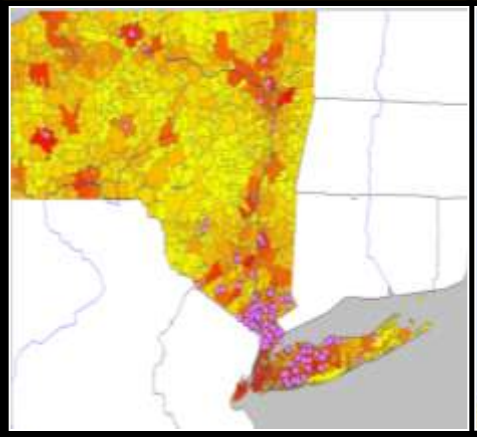
a worldwide communications & data collection network of travel/tropical medicine clinics

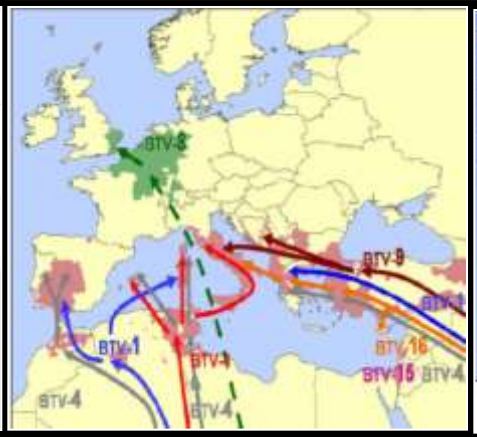
google.org

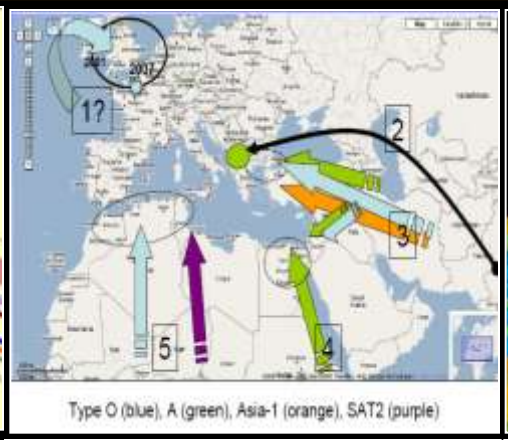
Geo-demographic Information Systems: Mapping Disease Patterns and Modeling Trends

Anomaly Detection and Early Alert

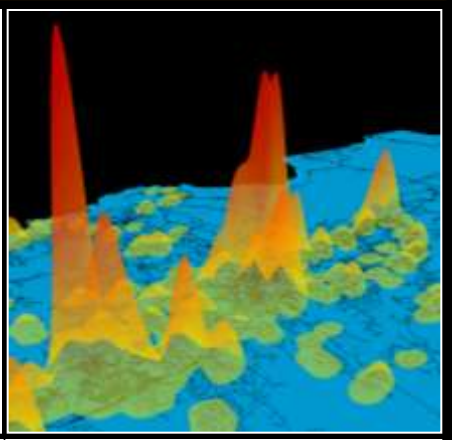
Disease Progression

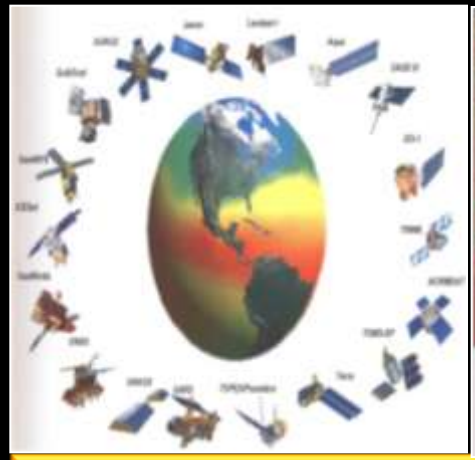


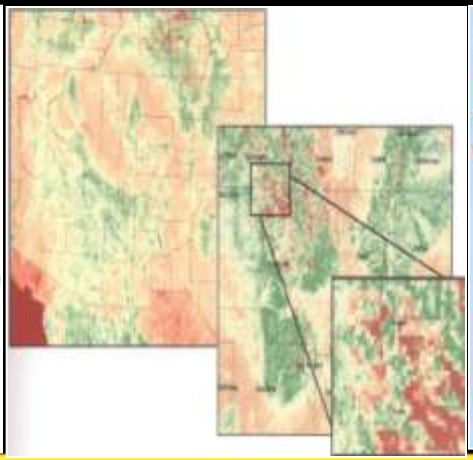


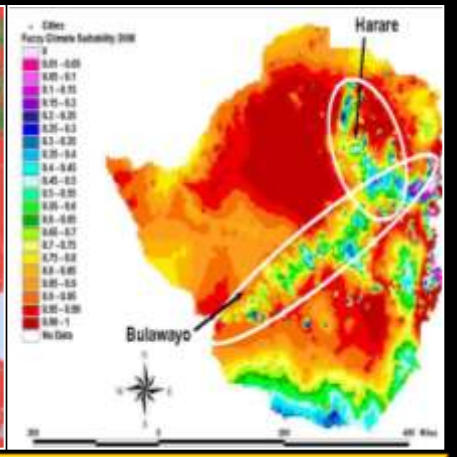


Type O (blue), A (green), Asia-1 (orange), SAT2 (purple)



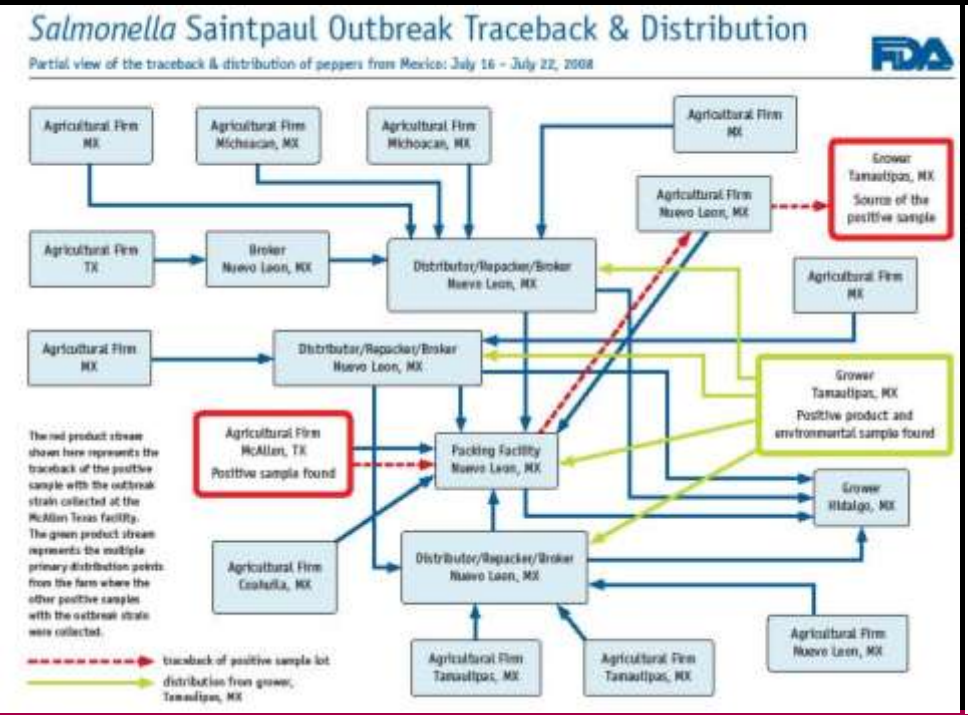


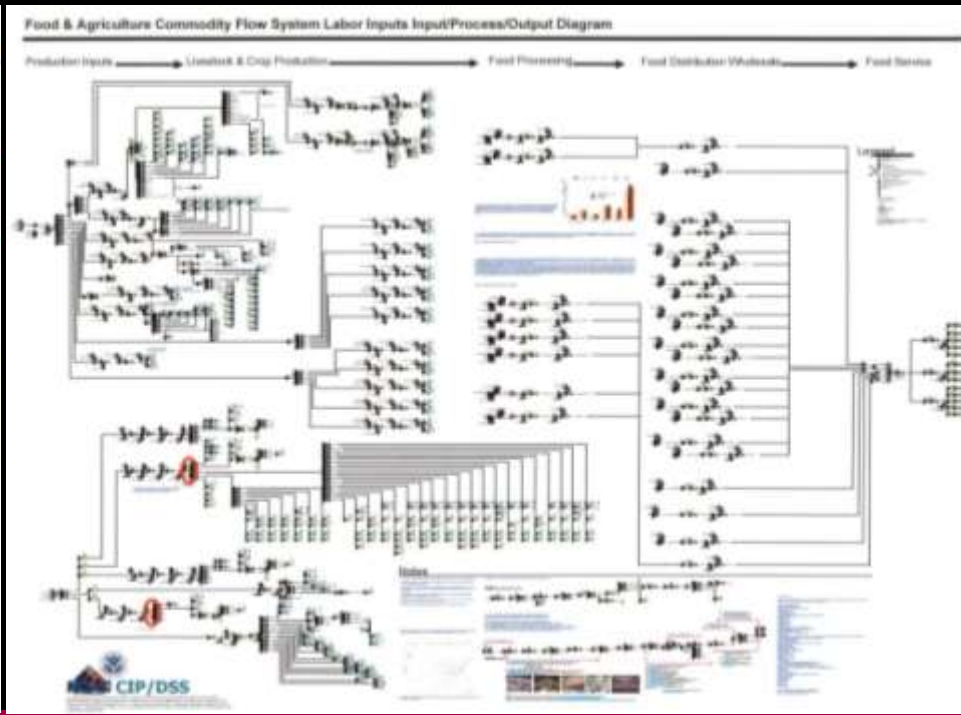




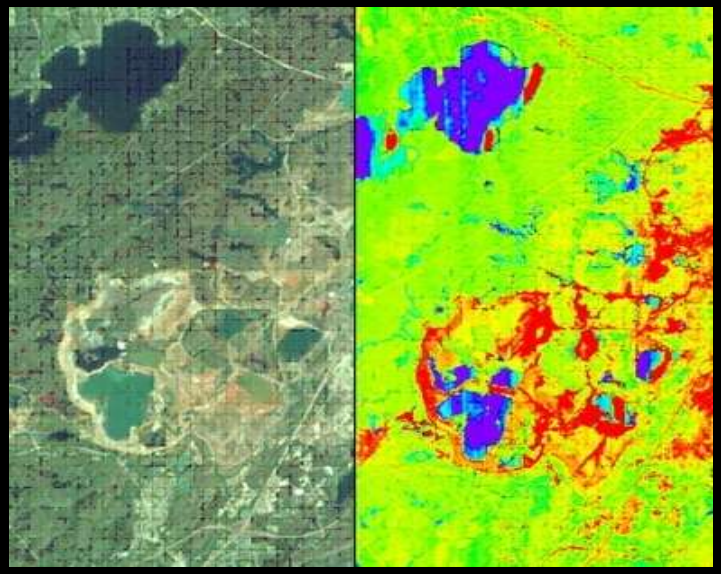
Satellite Surveillance and Predictive Modeling of Disease Trends

Traceability



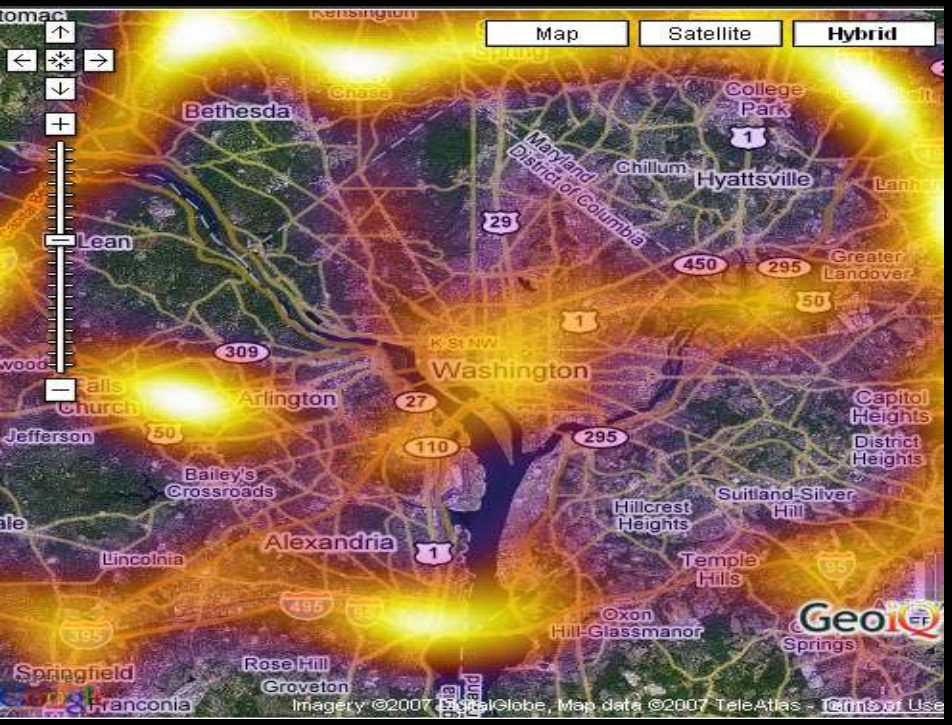


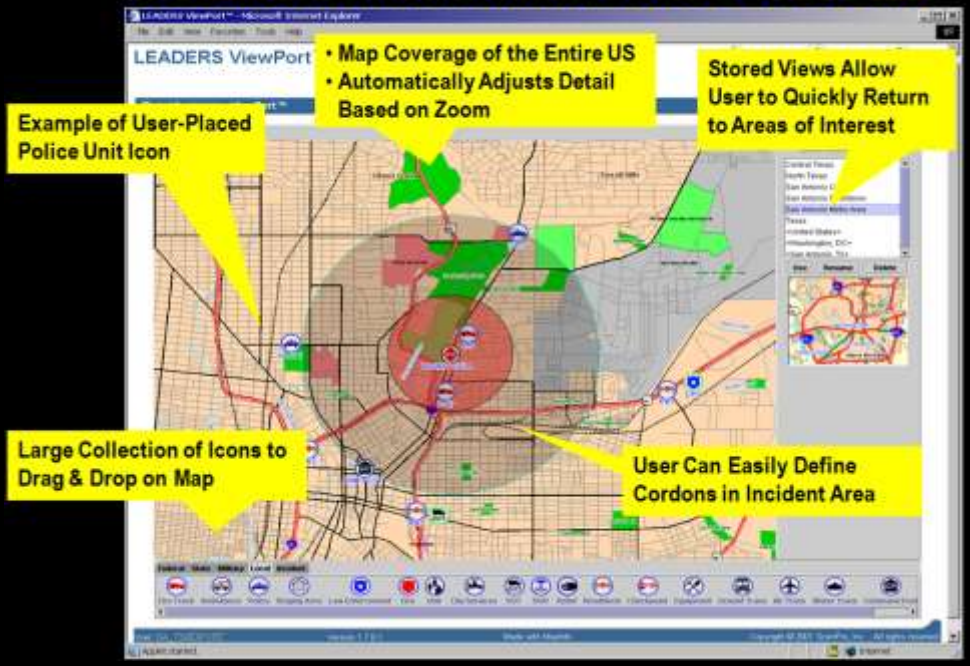
Wireless Sensors and Systems for Improved Agricultural Productivity



“For most of us design is invisible until it fails”
Bruce Mau

Use of GIS and Wireless Devices for Tracking Population Movement, Healthcare Resources and Supply Chains in Large Scale Disasters





m.Health as a Disruptive Change

- multidimensional impact on broad range of healthcare technologies/delivery processes
  - individual wellness to global public health
- information is power
  - redress medical paternalism and information asymmetry in healthcare decisions
  - consumer : patient empowerment
  - increased consumer:patient accountability for mitigation compliance risk
- key element in evolution of decentralized healthcare services
  - point-of-care diagnostics
  - treatment compliance
  - remote health status monitoring
  - emergency response

Healthcare Delivery

- MD/payor-centric
- controlled information
- medical paternalism
- patient:consumer dependency
- reactive, episodic interaction/intervention
- fragmented care and information silos
- system-constraints on PC-centric services
- system-shielded from economic competitiveness and outcomes metrics

Health Systems and Services

- patient:consumer (PC)-centric
- transparency
- active PC participation in care decisions
- health literacy and accountability
- proactive, integrated care continuum
- PHR + ERH + mobility and ambient intelligence
- options + choice
- performance metrics/ emergence of a real market

Major Challenges in m.Health and the Redesign of Health Systems and Services

- governmental commitments and resolve
  - sustainable, long-term investments
- infrastructure, investment and ROI
- policies for cross-domain integration
  - education
  - control of communicable diseases
  - safe water and food security
  - environmental sustainability
  - trade
  - national security

Healthcare:
The Long Overdue Need for Radical Redesign

- demand and debt (unsustainable)
- demographics (aging societies)
- divisiveness (public expectancy and political populism)
- digital (connectivity networks)
- data (lottabyte world)
- decision support (precision and improved outcomes)
- decentralization (point-of-care)
- distance disappears (remote monitoring)
- devolution (MD-centric to patient centric care)
- disparities (equity in global health)

DEMONSTRATING VALUE:

DISRUPTIVE TECHNOLOGIES AND NEW BUSINESS MODELS

Health Matters!