



# ***Impact of Nanotechnology on Mobile Health Systems***

**Dr. Papu Maniar**

**MOTOROLA**



Mobility Mega-Trends (Consumer's Perspective)

Health Ecosystem Trends

Technology trends

Communications

Miniaturization

Nanotechnology

Nano-health application example

Nano Driven Health Scenarios

# Mobility Mega-Trend

## Consumer's Perspective



*Entertainment*



*Safety*



*Information*



*Finance*

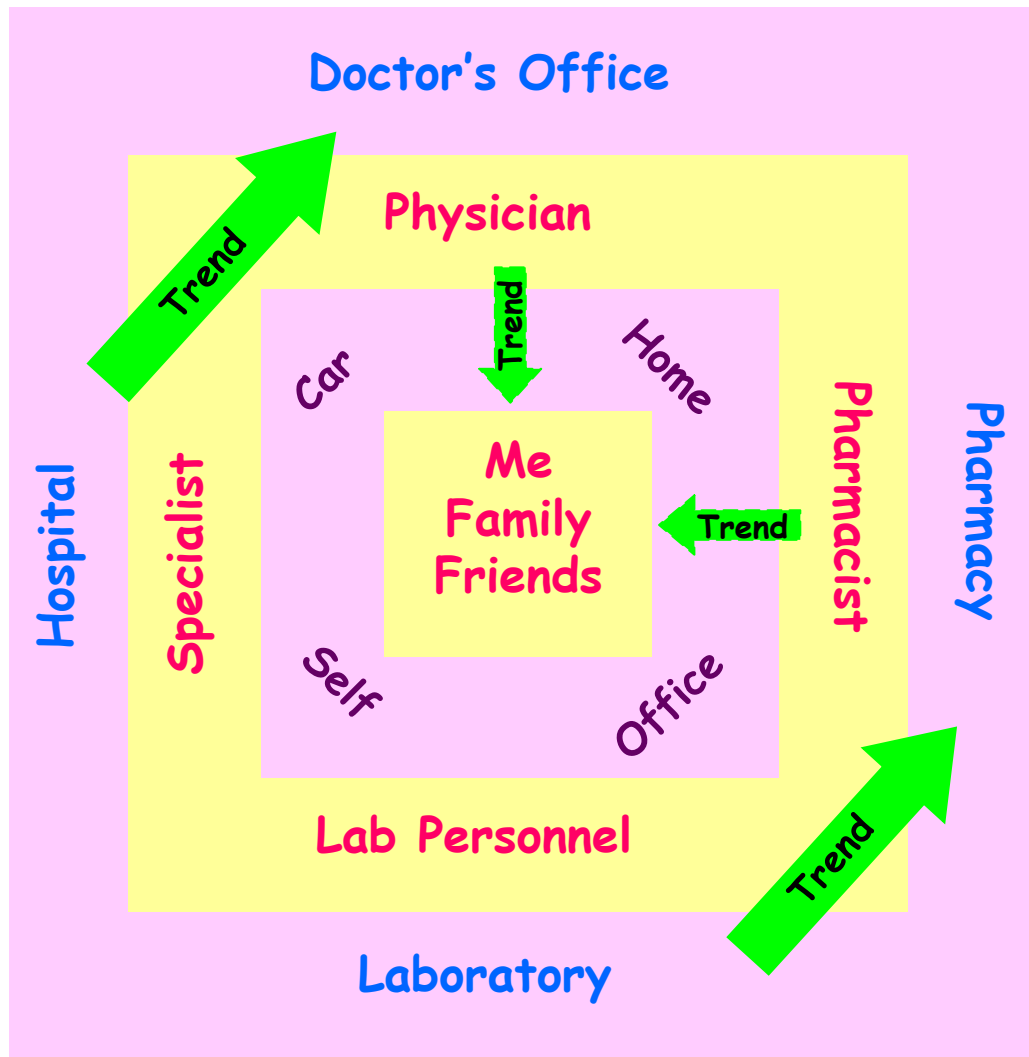


*Health*

At Location → At Home → In Car → On Person

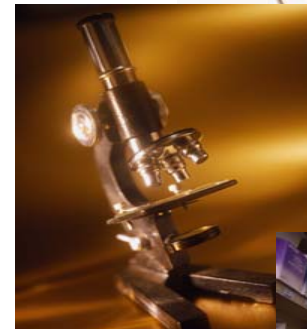
# Impact to Health Ecosystem

## Consumer's Viewpoint



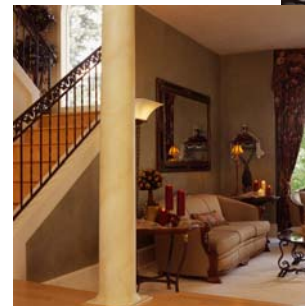
Hospital

Doctor's  
Office



Laboratory

Pharmacy

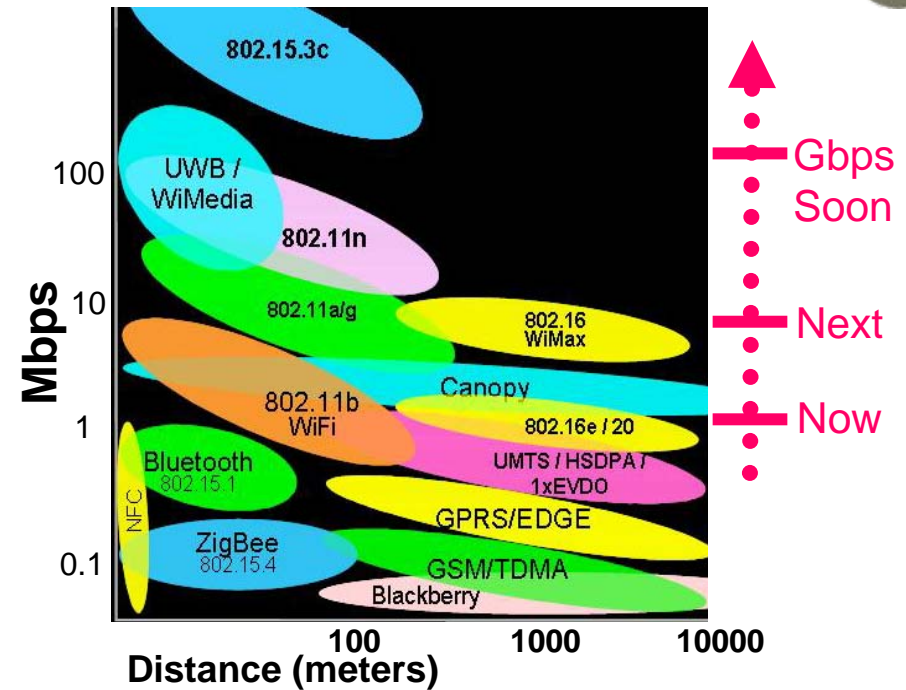


Home

Lower Cost, Less Time, Less Stress

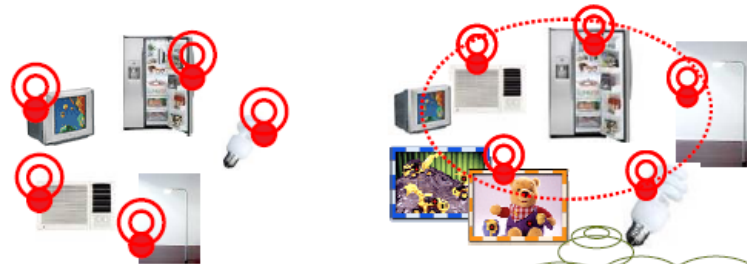
# Technology Trends

## Mobile Communications



.. digital  
.. handheld  
.. RF broadband  
.. networked  
.. intelligence

Radio in everything → Networked everything



# Technology Trends

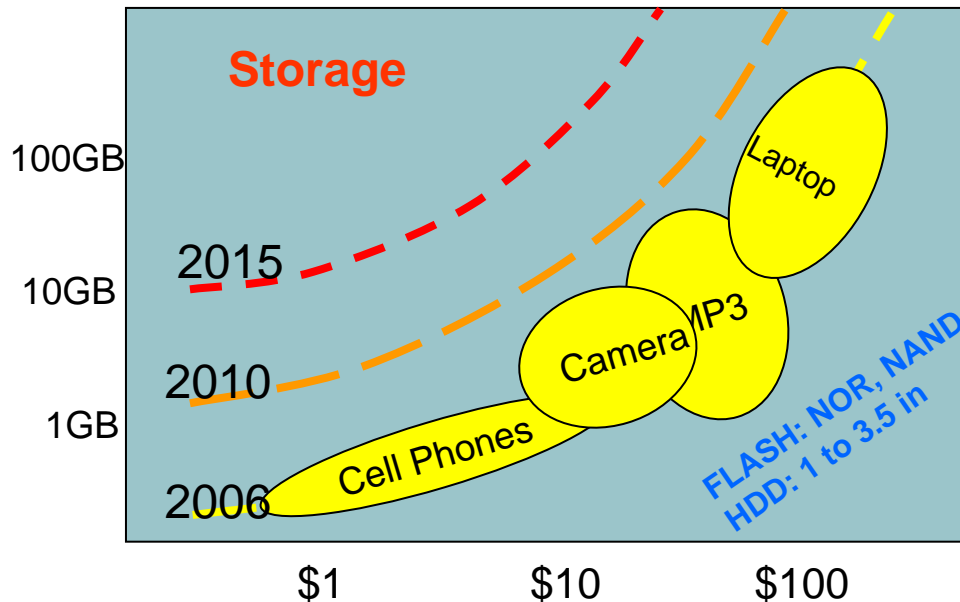
## Miniaturization



Microprocessor Logic Circuit Region



Dr. Theis, IBM-2007



.. MIPS  
.. storage  
.. smart  
.. ease of use

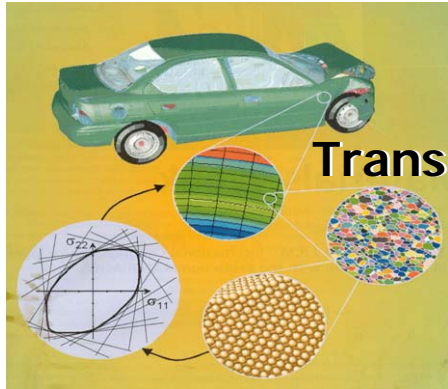


.. flexible  
.. wearables



# Technology Trends

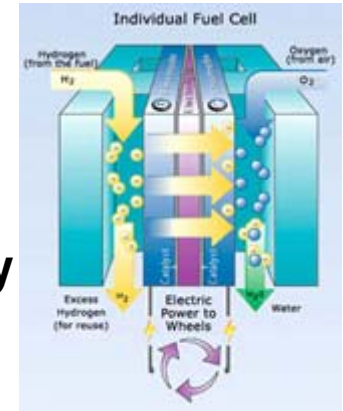
## Nanotechnology



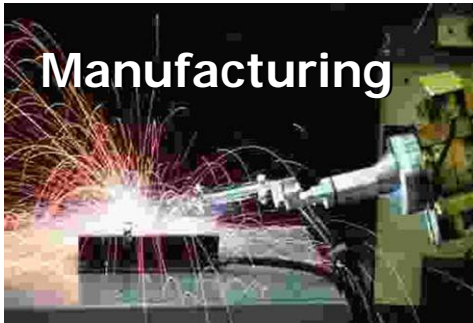
Transportation



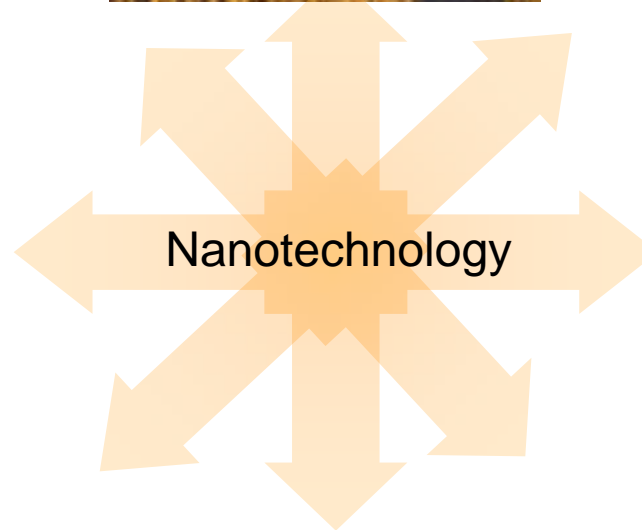
Environment



Energy



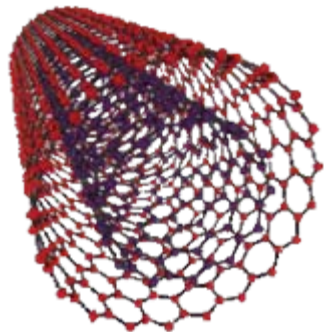
Manufacturing



Nanotechnology



Health



Materials



Electronics



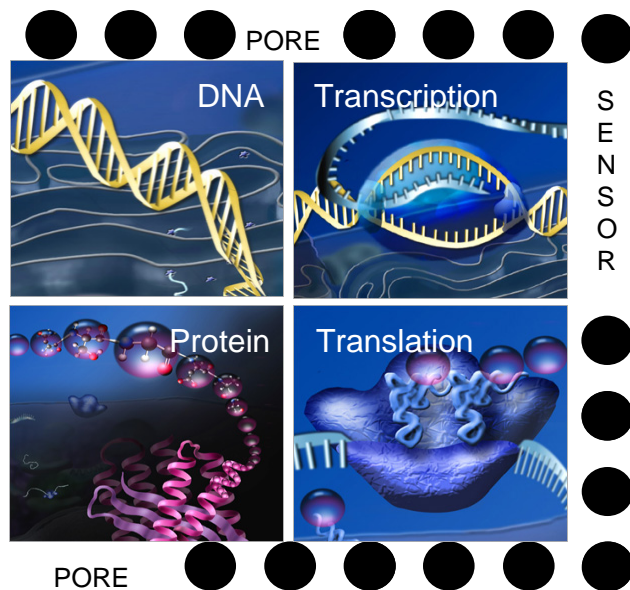
Agriculture

# Nanotechnology for Health



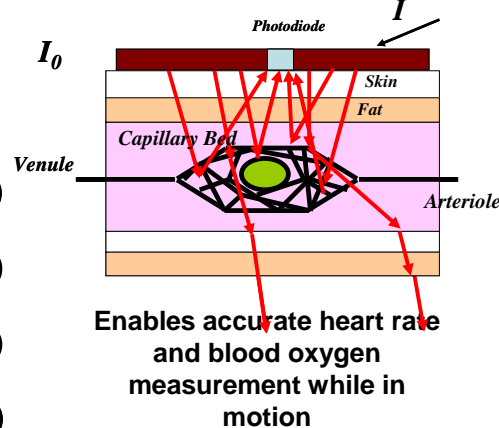
## Nano-chem/bio sensors & Bio-mimics

From Doktycz, Oak Ridge NL



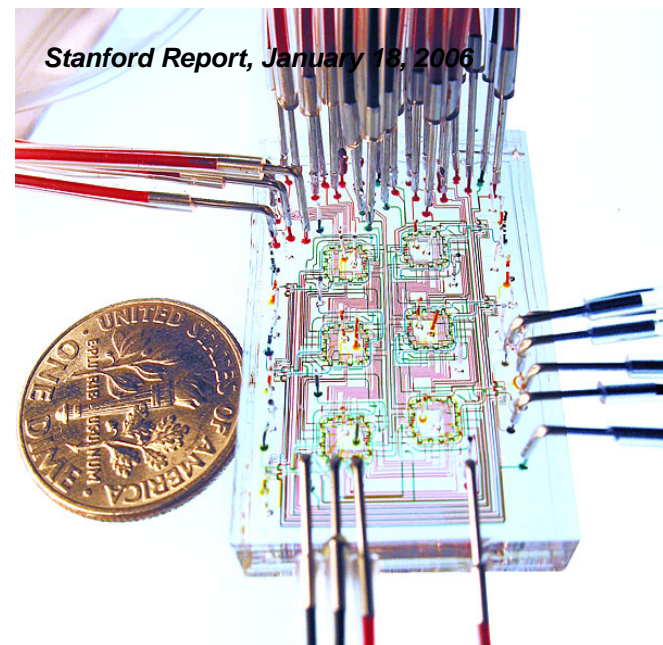
Images from www.nsf.gov

Quantum dot Light  
Source for  
PPG HR monitoring



## Nano-fluidics

Stanford Report, January 18, 2006



This microfluidic chip houses bioreactors, where bacteria can be cultured and observed. Stanford researchers make the chips using optical lithography to etch the circuit pattern into silicon. The etched silicon acts as a mold. Silicone is poured into the mold and then removed. By stacking several layers of molded silicone and then encasing them in glass, researchers can create an integrated circuit of channels, valves and chambers for chemicals and cells—like a rubbery labyrinth

### Scale in biology:

Cell content: 50 M molecules

Molecular components: ~1-5 nm

Cell dimensions: ~2 microns

Cell volume: ~10 femtoliters

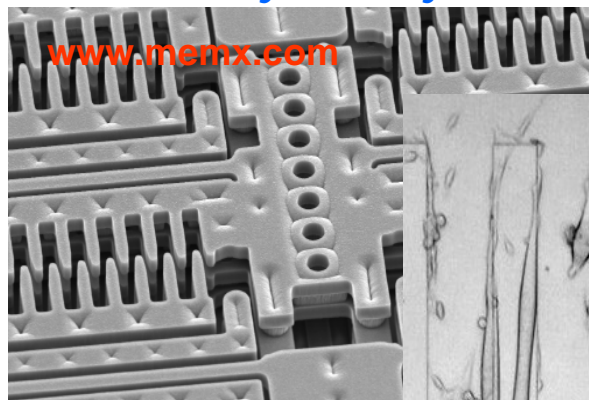
Any two molecules **diffuse** to meet each other every second in a micrometer-sized volume



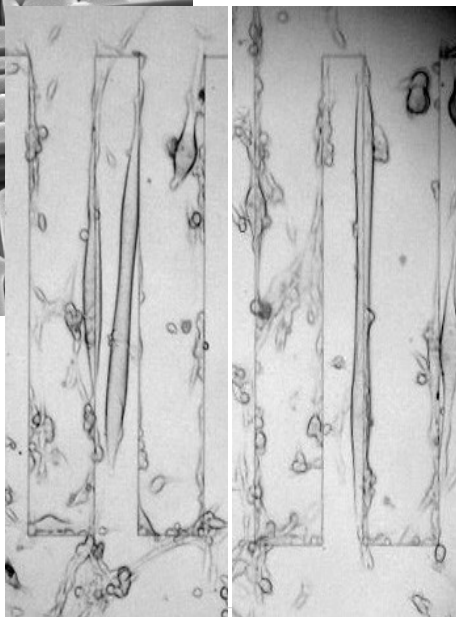
# Nanotechnology for Health



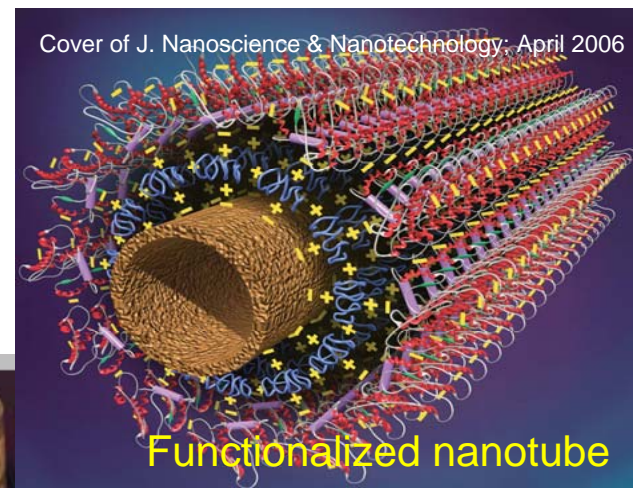
## Nano-electromechanical Systems (NEMS) & Bio-hybrid Systems



Myptubes on MEMS  
Hickman, Univ. C.  
Florida



## Nano-actives



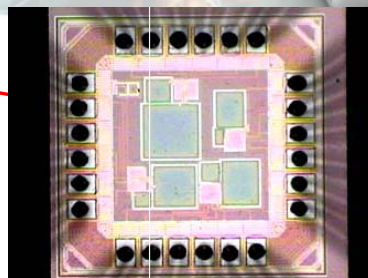
# Device & Application...



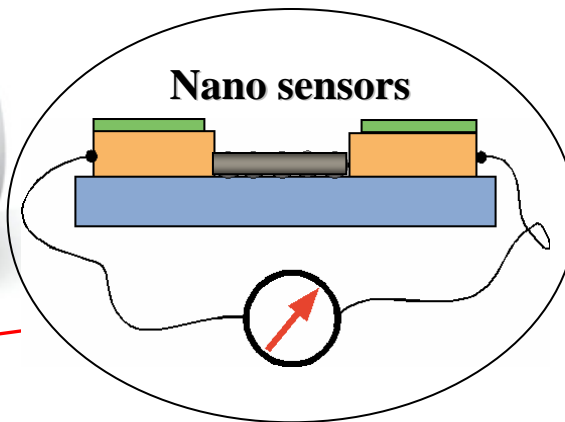
- High Sensitivity
- Rapid Response
- Small Form Factor
- Low Power Consumption
- Multi-analyte Detection



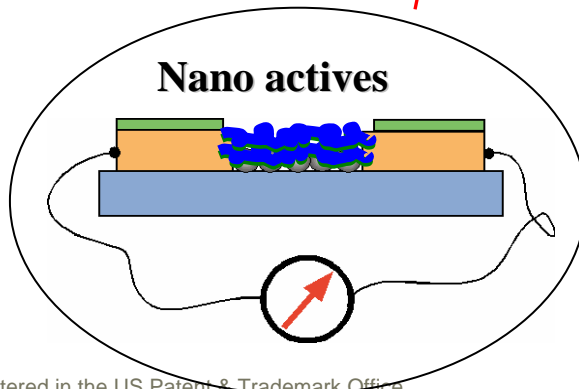
## Nano fluidics



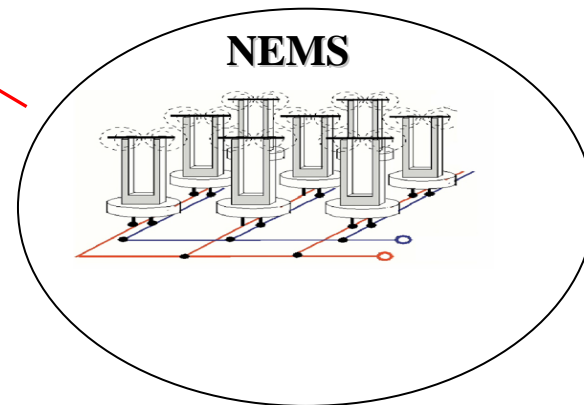
## Nano sensors



## Nano actives



## NEMS

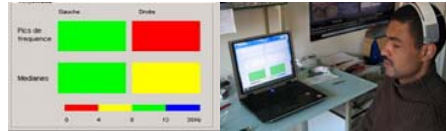




# System & Intelligence...

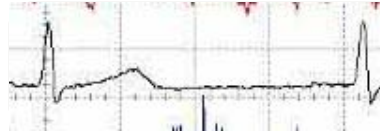
Approach taken at HOLST CENTER, IMEC-NL, Sywert H. Brongersma

Application layer



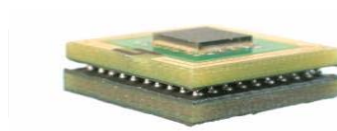
Data interpretation  
Application software, diagnosis, ...

Algorithmic layer



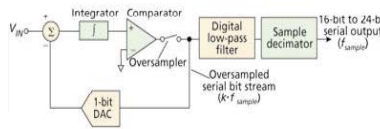
Algorithms for data interpretation  
Pattern matching, sensor data fusion, classification

Processing layer



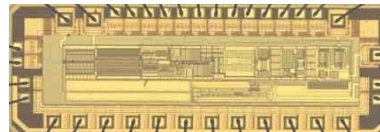
Low-level signal processing  
Sensor data calibration, data correction, compression  
Transducer feedback and control loop

Interfacing layer



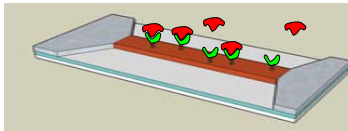
Interface between sensor and signal processing unit  
Typically ADC, DAC, or counter, pulse generator

Signal conditioning  
layer



Signal preconditioning:  
Amplification, buffering, actuator driving, ...  
Typically analog electronics

Physical layer



Physical sensing or actuating mechanism  
Transducer design & physics  
Device physics inside nanowire, MEMS, ...

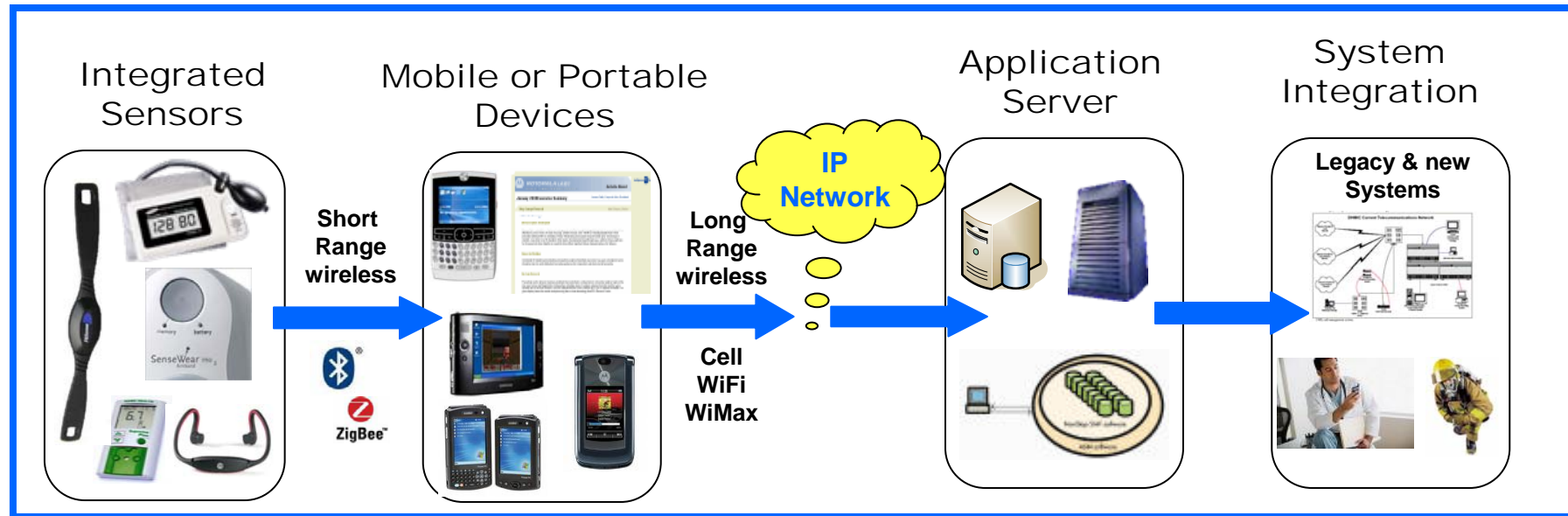
Technology layer



Underlying technology to fabricate transducers  
MEMS, nanowire deposition, micro-optics, ...



# Connectivity & Service...



- **Wearable Wireless Sensors**
- **On-board data processing**
- **Seamlessly integrated into peripherals, garments, etc.**
- **BAN & PAN wireless links to local device**

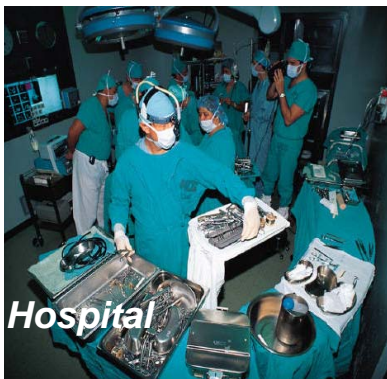
- **Data to local device; differentiation through seamless integration of software**
- **Data fusion from multiple sensor**
- **Security and encryption**
- **Data Visualization software and media – printed displays**

- **Context Aware Software**
- **Inference engines**
- **Database management**
- **Some functions can be moved to mobile device based on device features and application needs**
- **Web server for thin client architecture**

- **Integrated to systems based on application;**
- **In Telehealth scenario, linking with medical records, prescription monitoring and legacy hospital systems**



# Nano Driven Health Ecosystem



Portable  
Hospital



Remote  
Doctor



Portable  
Lab



Remote  
Pharmacy

