ICT for Healthcare Services for the Elderly

16 Jan. 2014

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香港應用科技研究院有限公司
Hong Kong Applied Science and Technology Research Institute Company Limited
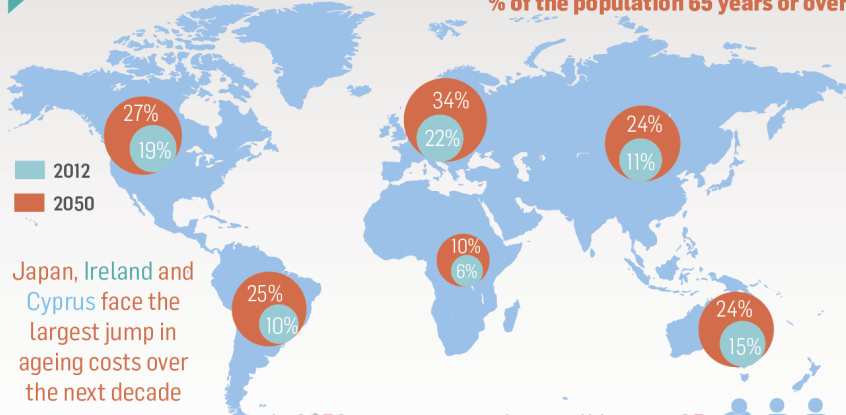
Outline of Today's Talk

- Ageing population and its impact on society

- ASTRI ICT for healthcare services related projects

- Key technologies

- Lessons learned & conclusion remarks
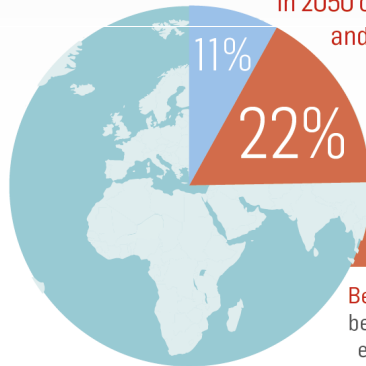
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The World's Ageing Population

THE WORLD'S AGEING POPULATION

% of the population 65 years or over

27% 19%

34% 22%

24% 11%

25% 10%

10% 6%

24% 15%

■ 2012
■ 2050

Japan, Ireland and Cyprus face the largest jump in ageing costs over the next decade

11%
22%

In 2050 one person in three will be over 65 and one person in ten will be over 80
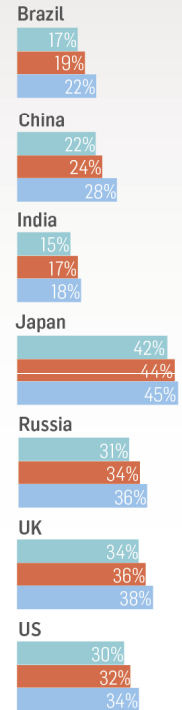
2012 - 11% of the world's 6.9bn people are over 60

2050 - 22% of the world's 9bn people will be over 60

Between now and 2050 the fiscal burden of the crisis will be 10% of the ageing-related costs. The other 90% will be extra spending on pensions, health and long-term care
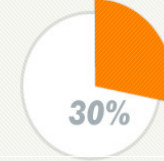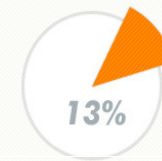
% of over 50's in overall population

	2006	2011	2016
Brazil	17%	19%	22%
China	22%	24%	28%
India	15%	17%	18%
Japan	42%	44%	45%
Russia	31%	34%	36%
UK	34%	36%	38%
US	30%	32%	34%

Hong Kong's Ageing Population

Year 2011

Year 2041

Percentage of the population over the age of 65

13%

30%

Proportion of working population to retirees

Retiree

Supporter

Each Retiree is supported by **6** working age adults

Each Retiree is supported by **2** working age adults

Life Expectancy of Hong Kong People

Men Age **80.5**   Women Age **86.7**

Men Age **84.4**   Women Age **90.8**
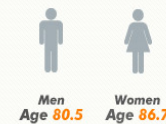
Source: MPF Authority

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HK - Towards an Aged/Super Aged Society

- **2011 HK Population Census**

  Age 65 and up – 13.4% (closing to an Aged Society – 14%)
  Age 60 and up – 19.3%

  http://www.census2011.gov.hk/en/index.html

- **#1 Life Expectancy for HK Mean & Women in 2012**

  Men : 80; Women: 86.7

Trends of HK Aging Population

- Increased percentage of elderly population

- Increased life expectancy

- Increased number of chronic diseases

- Increased (and) higher institutionalization rate

- Increased elderly dependency ratio (1:2 in 2033)

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HK Healthcare Challenge: Sustainability, Accessibility & Quality

- **Rising Health Care Cost Subsidized**
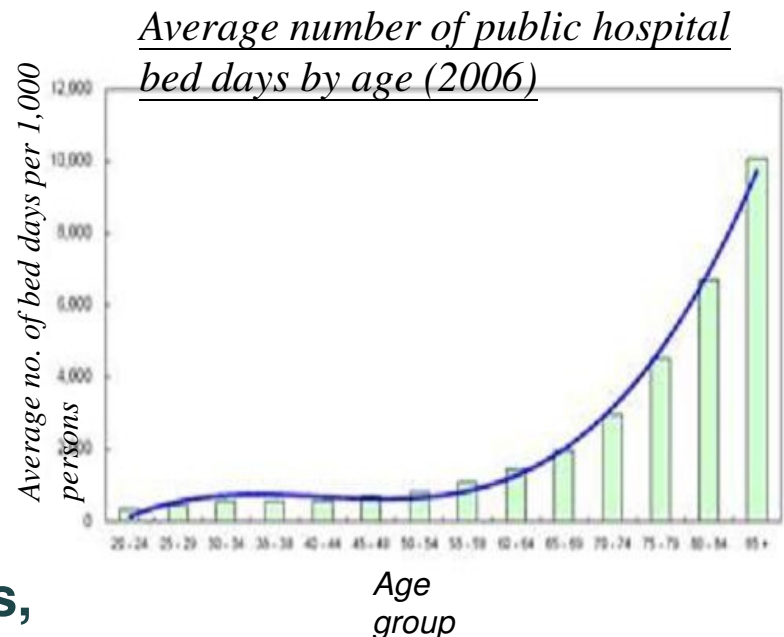 - ❖ CN visit: HK$220 per visit
  - ❖ Hospital stay: HK$3200 per day
  - ❖ Pay only 20% for subsidized Residential Care Services
  - ❖ Expenditure: 9.2% of GDP by 2033

- **Wait Time**
  - ❖ Care & Attention places: 22 months
  - ❖ Nursing Home places: 40 months
  - ❖ Day care service: 7 months
  - ❖ Home based services: 2 months

- **Acute shortage of registered nurses, enrolled nurses and health care workers**

It becomes an increasingly challenging problem to provide sustainable, accessible and good quality of health care to the elderly citizens!
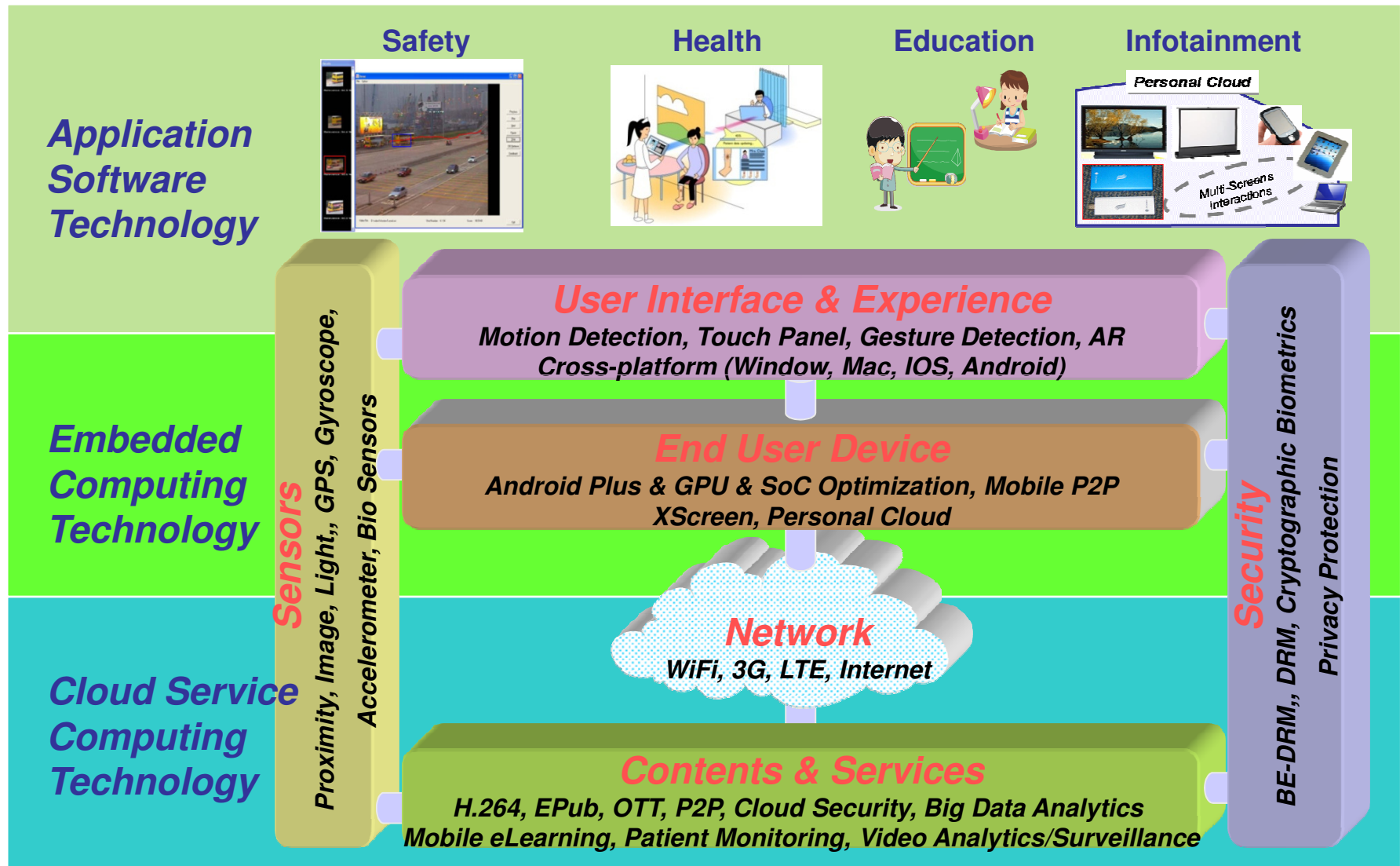
Average number of public hospital bed days by age (2006)

Average no. of bed days per 1,000 persons

Age group

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ASTRI/ECE Core Competence & Technologies
System & Software + Application Domain + Experience Design

Safety

Health

Education

Infotainment

Application Software Technology

Embedded Computing Technology

Cloud Service Computing Technology

Sensors
Proximity, Image, Light,, GPS, Gyroscope, Accelerometer, Bio Sensors

User Interface & Experience
Motion Detection, Touch Panel, Gesture Detection, AR
Cross-platform (Window, Mac, IOS, Android)

End User Device
Android Plus & GPU & SoC Optimization, Mobile P2P
XScreen, Personal Cloud

Network
WiFi, 3G, LTE, Internet

Contents & Services
H.264, EPub, OTT, P2P, Cloud Security, Big Data Analytics
Mobile eLearning, Patient Monitoring, Video Analytics/Surveillance

Security
BE-DRM,, DRM, Cryptographic Biometrics
Privacy Protection

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Health Related Applications

iHome Showcase at Housing Society Elderly Resources Centre

記憶退化會帶來甚麼影響?

Survey Questionnaires Collection System at Hong Kong Housing Society Elderly Resources Centre for Advocate of Ageing-in-Place

Audible Alert | Audible Alert
RFID Reader
位置
狀態
行動
RFID Garment
Alert Notification Interface
Control Centre | **Care Centre Entrance/EXIT**

東華三院社區照顧識別系統
TWGHs Community Care Identification System
東華三院
社區照顧識別系統
Initializing

Community Care Identification System for TWGHs Elderly Daycare Centers

And Others ...

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iHome Project at
Housing Society's Elderly Resources Centre

- Elderly friendly interface design
- Instant health condition indication

iHome - User Interface for Elderly

Housing Society's Survey Questionnaire Collection System

TWGHs Community Care Identification System

Audible Alert

Audible Alert

警告系統 Alert System — Admin

目前狀態 Current Status

記錄 History Log

用家註冊 Registration

系統設置 System Setting

位置　2 樓正門

狀態　注意

行動　停止廣播

　　　前往支援

RFID Reader

RFID Garment

Alert Notification Interface

Control Centre

Care Centre Entrance/EXIT

Push bar to open
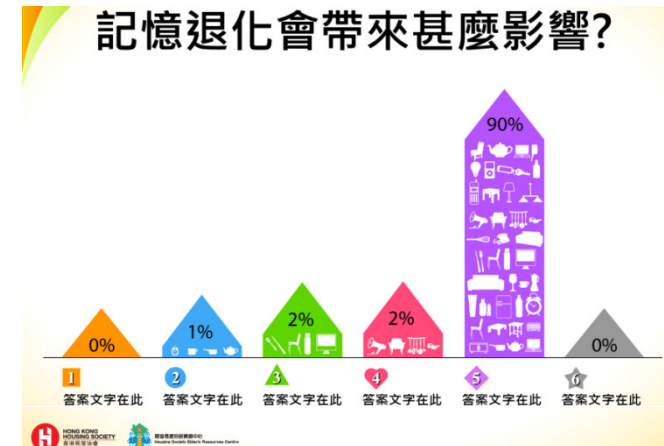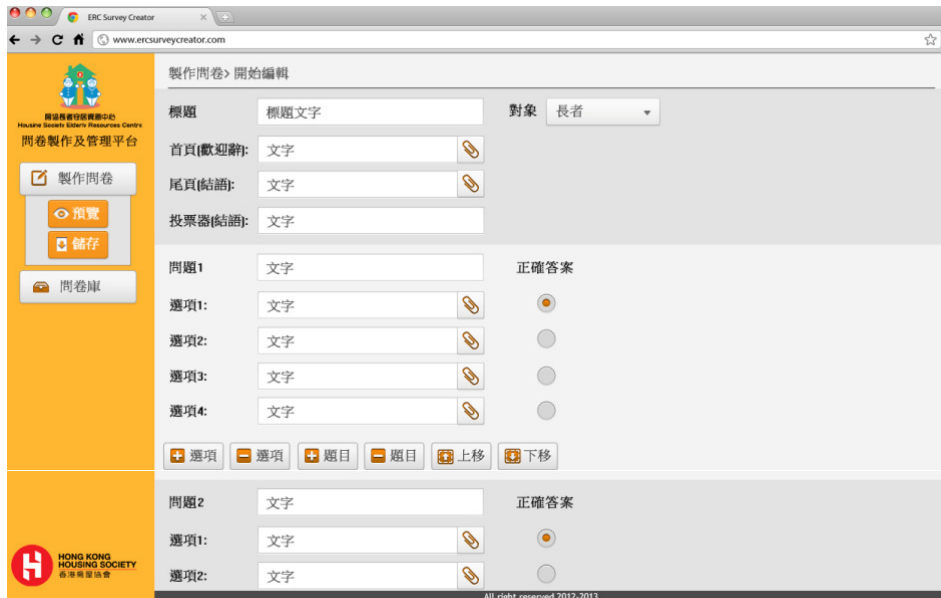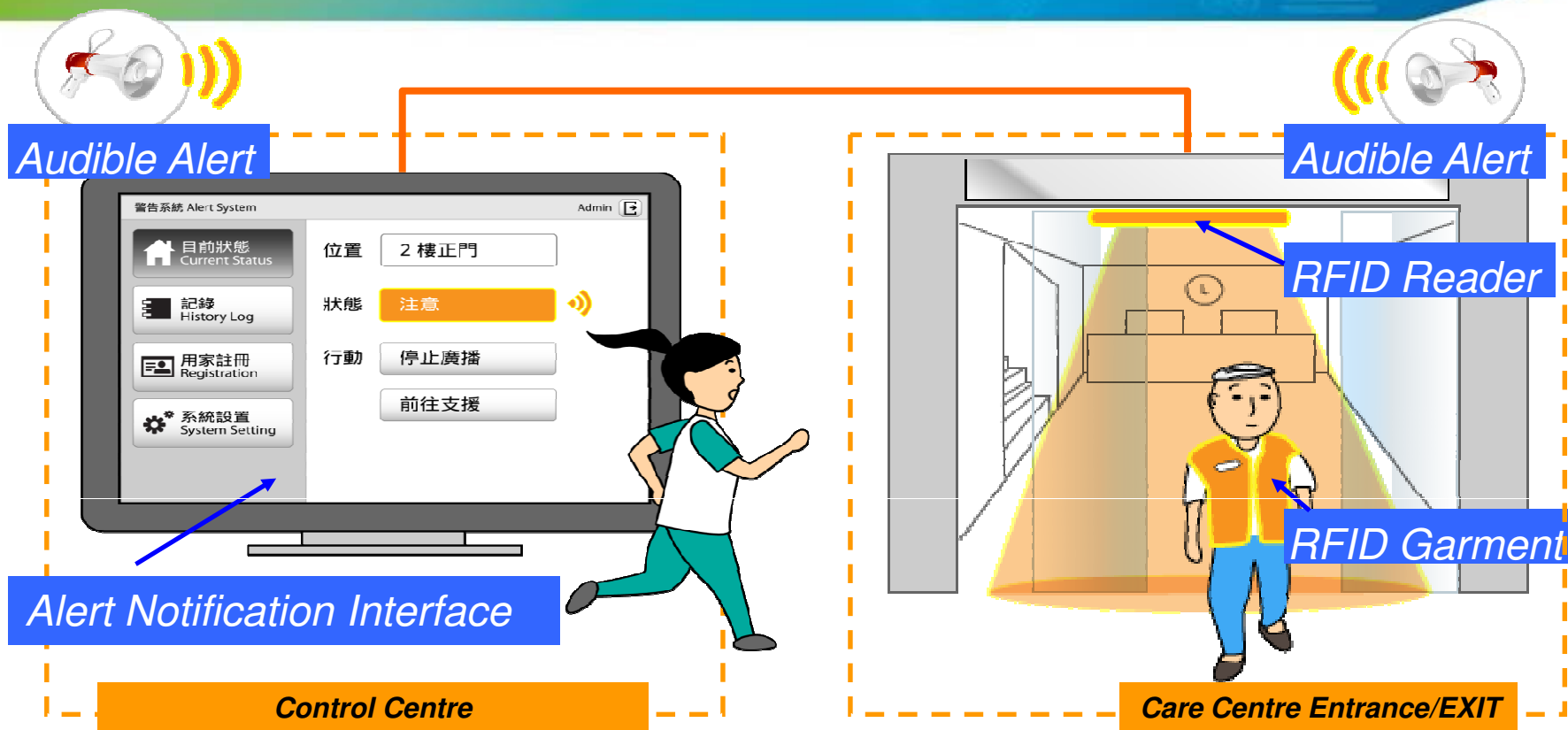
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TWGHs Video clip

ASTRI, HKRITA and LSCM collaboration

ASTRI Reflective Pulse Oximeter

Pulse Oximetry Module
(15x15x1.7mm)
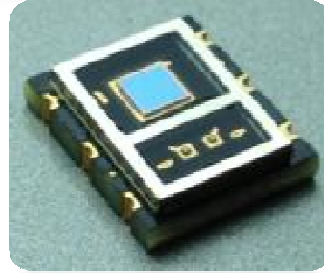
IP-protected Sensor Module (9x11x1.6mm)
Patent No.: US 2012/0176599
CN 102727220A

Pulse Oximetry Done
(57x27x14.5mm, 15g)

- **Reflective** pulse oximetry module
- **Continual measurement of** blood oxygen saturation, pulse rate, breathing rate **and heart rate variability**
- Key features:
  - Unaffected by nail polish or onychomycosis
  - Wireless connectivity
  - Easy integration with consumer electronics
- 1 US & China patent under application

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Abnormalities

Multi-parameter Sleeping Test in Clinic

- Measure **oxygen saturation** and **heart rate variability**

- Record the **seriousness**, **duration** and **frequency** of low oxygen saturation

Patent #：US 2012/0176599;
CN 102727220A

ASTRI's Reflective Pulse Oximeter

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Relieve Mental Stress

- **Measure Breathing Rate and HRV**

- **Monitor your Breathing Rate and HRV to let you easier to improve your HRV, relieve your stress, and improve your sleeping quality by controlling your breathing**

呼吸: 17 BPM   血氧: 98%   脉搏: 57 BPM

停止
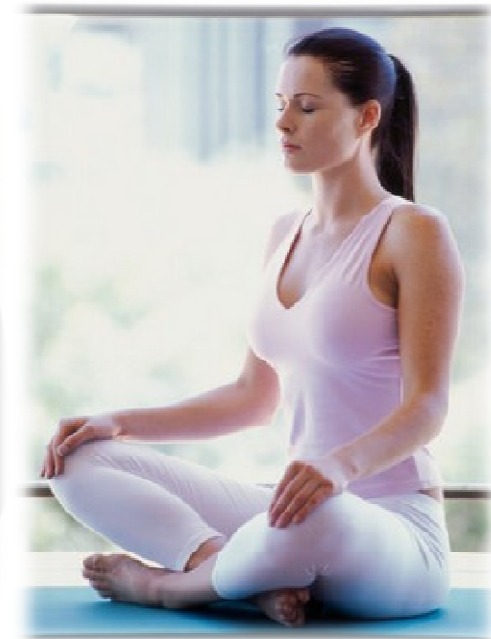
Physical Fitness and High Altitude Training

- **Continual** measurement of **blood oxygen saturation** and **pulse rate** variation
- **Data will be transmitted wirelessly** for trainer to monitor the **performance** and adjust **training intensity**
- **Allow sports lovers to monitor their health status anywhere anytime**

High-altitude Sports
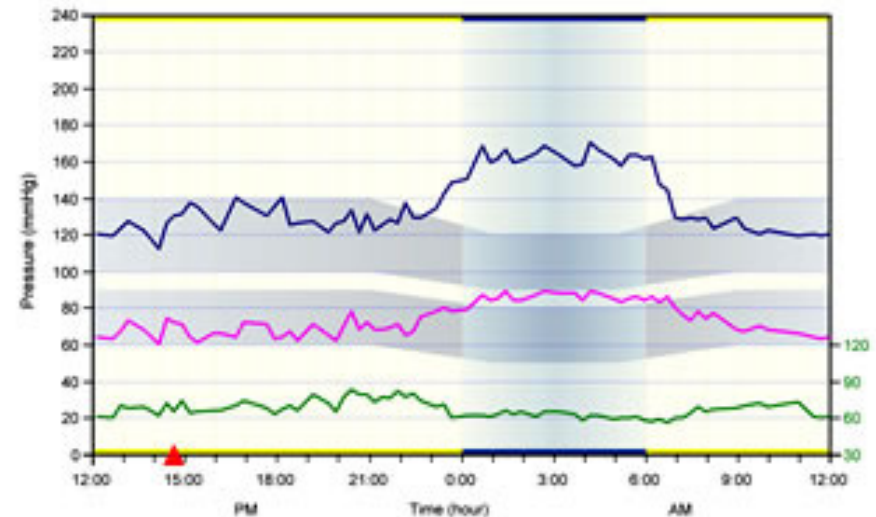
Training under hypoxia

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Cardio-Vascular Monitoring Device

Systolic BP (SBP)

Diastolic BP (DBP)

Arterial Stiffness Index (ASI)

應科院研發技術示範
智能反射式脈搏血氧儀及心血管監測儀

性別/Gender: 男

上壓/SBP: 120 mmHg
下壓/DBP: 80 mmHg
脈壓/PP: 40 mmHg
平均/MBP: 93 mmHg
心跳/HR: 70 BPM

以上資料只供參考 2013-10-29 18:05
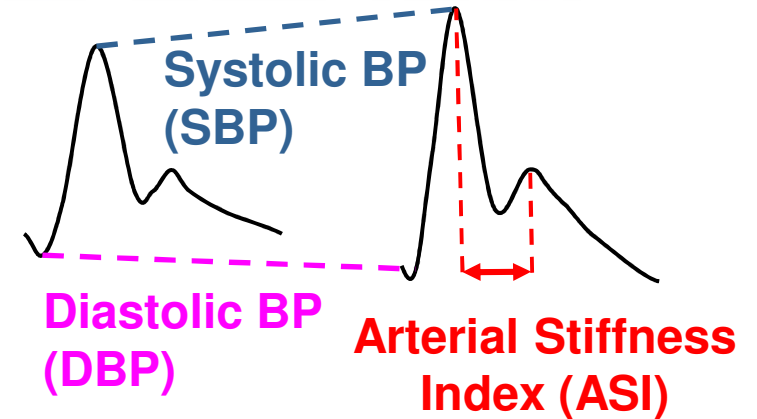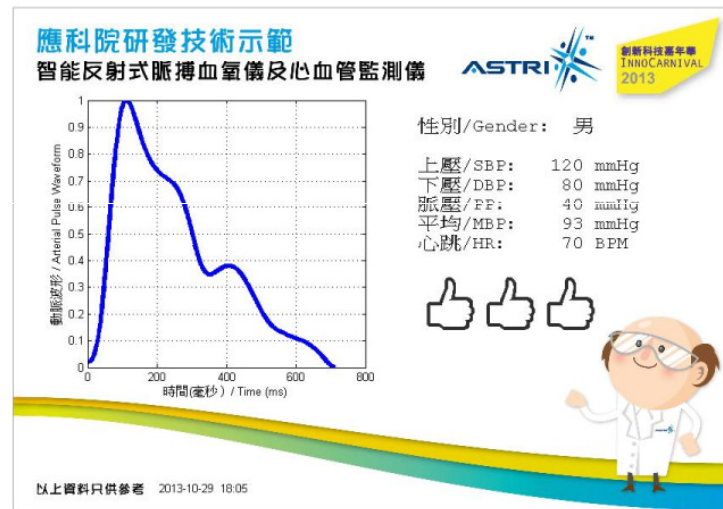
Identify Abnormalities at Night

- **Non-invasive Continuous Measurement of Blood Pressure, Arterial Stiffness Index and Pulse Rate at Wrist**
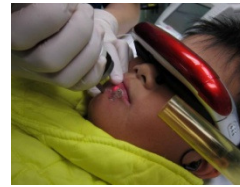- **Measurement without disturbing the Patients**

——— Systolic	——— Pulse rate (PR)
——— Diastolic	▓▓▓ Normal range

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ASTRI BME's Technology Focuses
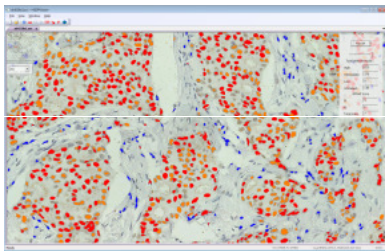
High Speed Digital Pathology System (Digitization and Diagnosis)

Multiple technologies:
- microscope automation
- image processing
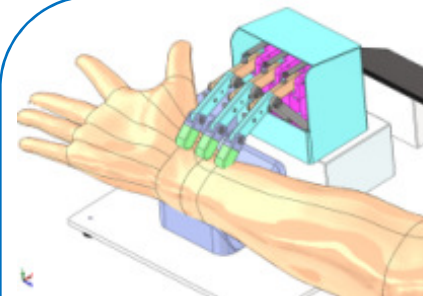- machine interfacing
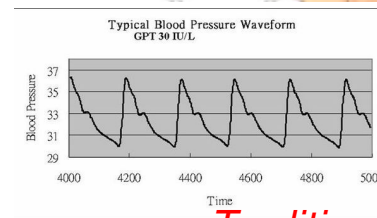- data management

Pain Distraction

Lazy Eye -- BTD

Minimal Invasive Surgery

Mobile Medicine -- Goggle base

Pulse Sensing

Typical Blood Pressure Waveform
GPT 30 IU/L

Diagnostic Instrumentation --Traditional Chinese Medicine

Healthy Ageing (WIP)

| 2014 | 2015 | 2016 | 2017 |

Goals:

Enabling Technologies for Healthy Ageing

Devices

Gateway & Backend Server

☐ Smart sensors, algorithms, SiP, SoC, and integrated health & wellness monitoring devices , image recognition
☐ User-friendly gateway
☐ Cloud-based healthcare & wellness solution platform

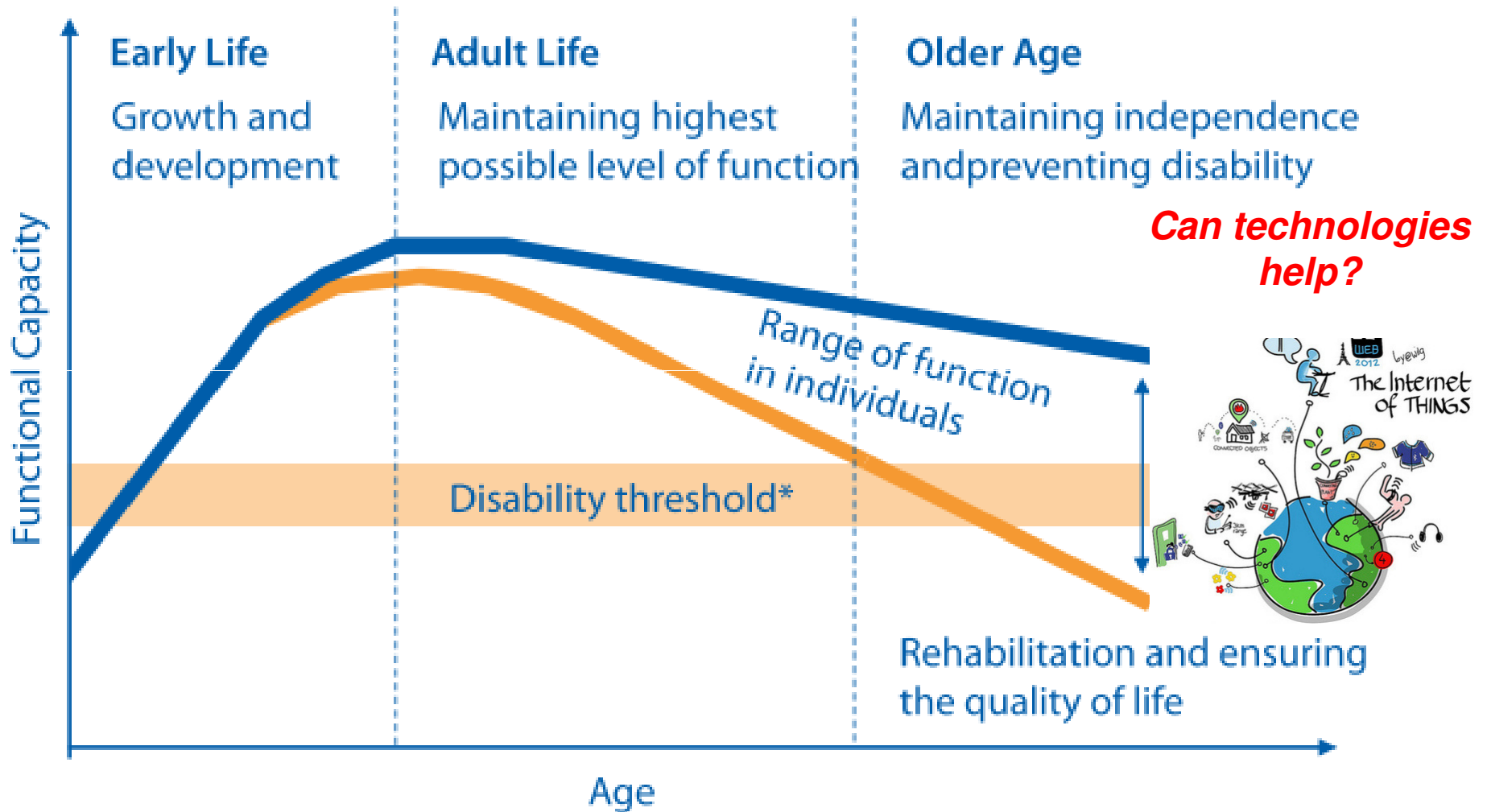*ASTRI's Core Technology*

Devices/Technology from partners*

Technologies/Devices from industry partners/universities/research institutes

Customers/Users

Clinics

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* For devices that are not yet developed by ASTRI, we leverage the technologies from partners, e.g., wheelchair, invasive blood glucose device, etc.

How Does Technologies Improve Life?

Source: "Global Age-friendly Cities: A Guide" by WHO
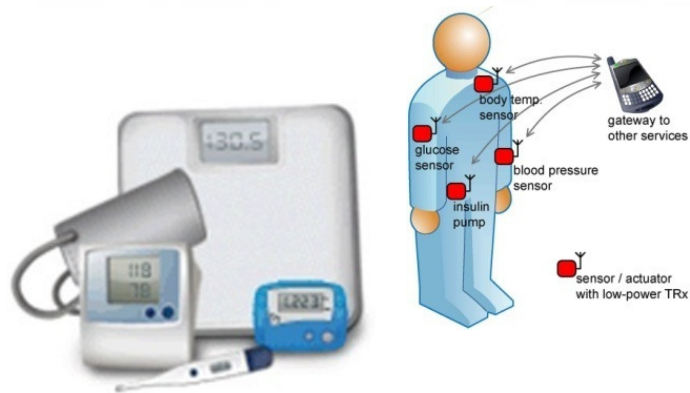
Preventive Healthcare

Preventive → Diagnosis → Treatment

- **Reduce public medical expenditure/burden**
- **Huge demand in aging population**
- **Lower risk and less regulation**

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What Are Needed in Preventive Healthcare – Devices & Sensors?

Daily life tracking	• Activity/exercise tracker • Health sensor: continual heart rate, electrocardiogram (ECG), stress/tiredness, blood pressure, arterial stiffness, blood glucose
Community Centers	• Integrated health sensors: heart rate, electrocardiogram (ECG), pulse oximetry, blood pressure, arterial stiffness, blood glucose
Housing Estate/Health Club	• Integrated health sensors: heart rate, electrocardiogram (ECG), pulse oximetry, blood pressure, arterial stiffness, blood glucose

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What Are Needed in Preventive Healthcare – Gateway & Big Data?

Daily life tracking	• Cloud-based Personal Wellness Solution Platform
Community Centers	• Elderly Healthcare Solution Platform • Real-time health big data
Housing Estate/Health Club	• Elderly Healthcare Solution Platform • Cloud-based Personal Wellness Solution Platform • Real-time health big data

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ICT for Healthy Ageing Consortium (DRAFT)

Vision
- Act as a central hub of technologies for elderly and to facilitate healthy ageing in Hong Kong

Mission
- To promote healthy and active ageing in Hong Kong so as to enhance well-being and quality of life of elderly through the use of homegrown technologies

Objectives
- To serve as a platform for the promotion and sharing of healthy ageing technologies
- To create an innovative and market-driven care delivery solution
- To generate sustainable business model through open collaboration

Targeted Members/Stakeholders
- Industry partners: device manufacturers, ISP/Network providers, IT vendors
- Customers/users: NGOs, elderly homes
- Other stakeholders: universities, research institutes, pressure groups

Contact
- Vicky Lai (tel: 3406 2616, email: **vickylai@astri.org**)

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Key Technologies

Two major areas

- **User experience**
    - User interface
    - Operation & System

- **Security**
    - Data transmission
    - Device Security
        - ❖Closed system approach
        - ❖Secured Android

Target audience

- Who will use? patient, nurse etc.
- Education? elderly, professional etc.
- Auto or Manual entry**?**

Dedicated UI design

- PC, tablet, phone?
- Portrait or landscape?
- Online or offline?
- Normal or big fonts or even graphic?
- Manual or auto input?

Conduct target user survey

Scenario/view graph to customer before actual development (programming)

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It's hard to imagine how unfamiliar, alien and complicated the technologies are to elderly users

The Cambridge Lab Where They Test How Elderly People Use Technology

http://www.youtube.com/watch?v=kS1Pz7-ACis

Button was supposed to be pushed, not to be slid

Slide buttons and slide-out hidden menus on touch screen are not intuitive for elderly

The elderly all ask for a bigger font

Smartphone with elderly mode

http://geek.miui.com/content-14-202-1.html

The elderly are not able to decipher the meaning of icons

Teaching once is not enough
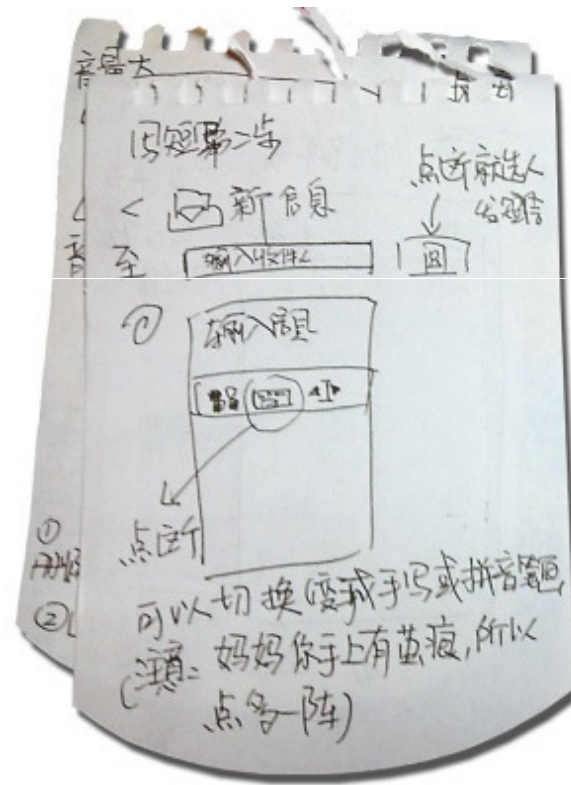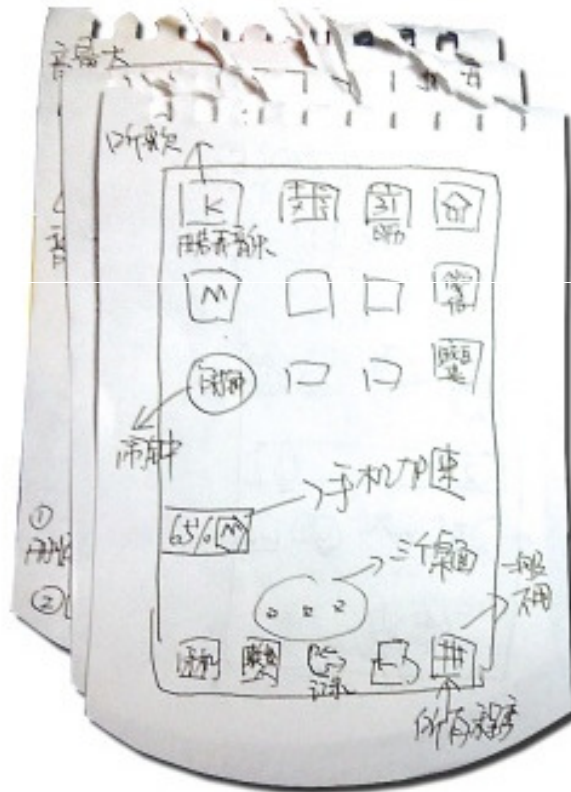
- simple function, clear guidance, big font, easy to understand illustration.
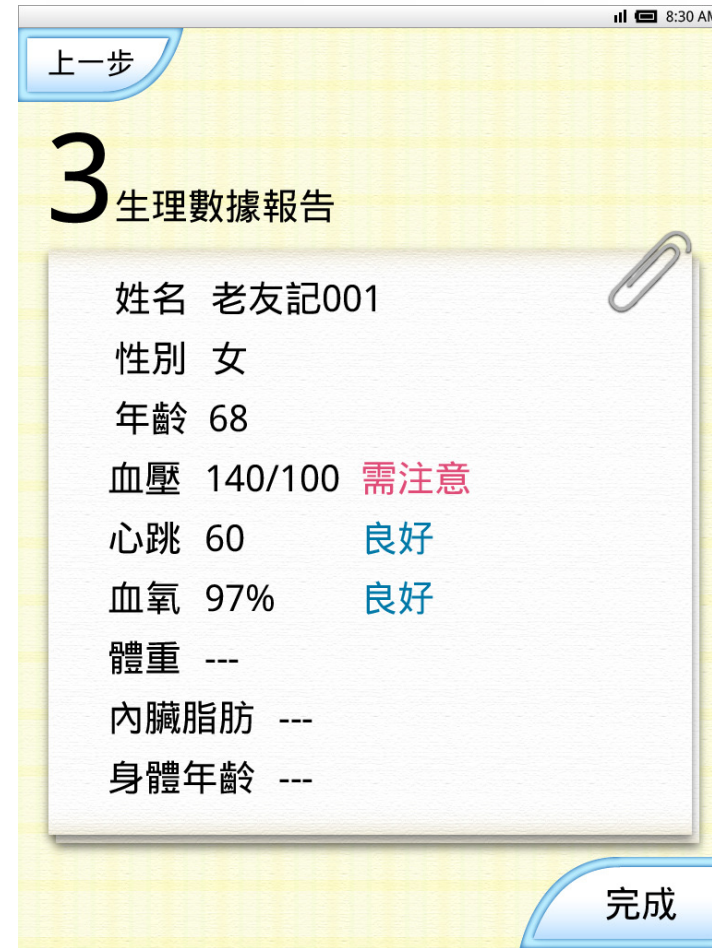
- instant feedback with plain language and easy to understand illustration.

Only way to an elderly friendly design – User Research

Operation & system deployment is vital

- Mostly tight with security and organization guideline & workflow
- Network infrastructure
  - ❖ wire or wireless
  - ❖ firewall
- Device consideration
  - brand, battery, interface, support, etc.

Testing is vital

- Zero-fault tolerance (healthcare industry)
- Sophisticated test plan
- Auto and random test
- Risk management design (e.g. how to handle server or device error)

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Security – Data Transmission

• **Medical Device -> gateway**

- Wire/Wireless (e.g. USB vs BT)
- Encrypt transmission (need vendor support)

• **Gateway -> Server**

- Encrypt transmission (e.g. HTTPS)
- Device registration (block unauthorized device)
- Extreme case:
  - Medical Device direct transmit to server (through SMS/IP) (rare device support)

Security – closed system device

Secure system and app log-on
- Secured fingerprint device unlocking
- Application authorization via NFC
- Power-on or Time-out password

Data protection
- Patient data encryption, including text, drawing, and images
- Auto factory reset after pre-defined failed device or application access
- Device encryption

Admin control and application security
- Controlled Android application access and setting for security measure
- Admin control to restrict the access of external SD card and USB
- No user application installation and debug (prevent 3rd application, malware, intrude from day one)

- Open system with closed system advantage (third party application coexist with enterprise one without sacrifice security)

- Increasing desire to use commodity mobile devices throughout enterprise (e.g., hospitals, elderly healthcare centers, government, etc.)

- What is Secured Android?

•Enhance policy for attribute permission (fine-grain control)
•Confines privileged daemons with damage limitation
•Prevent privilege escalation
•Strong separation among apps
•Prevent general "Root" exploit
•Multi-profile (personal/enterprise)
•Private key protection

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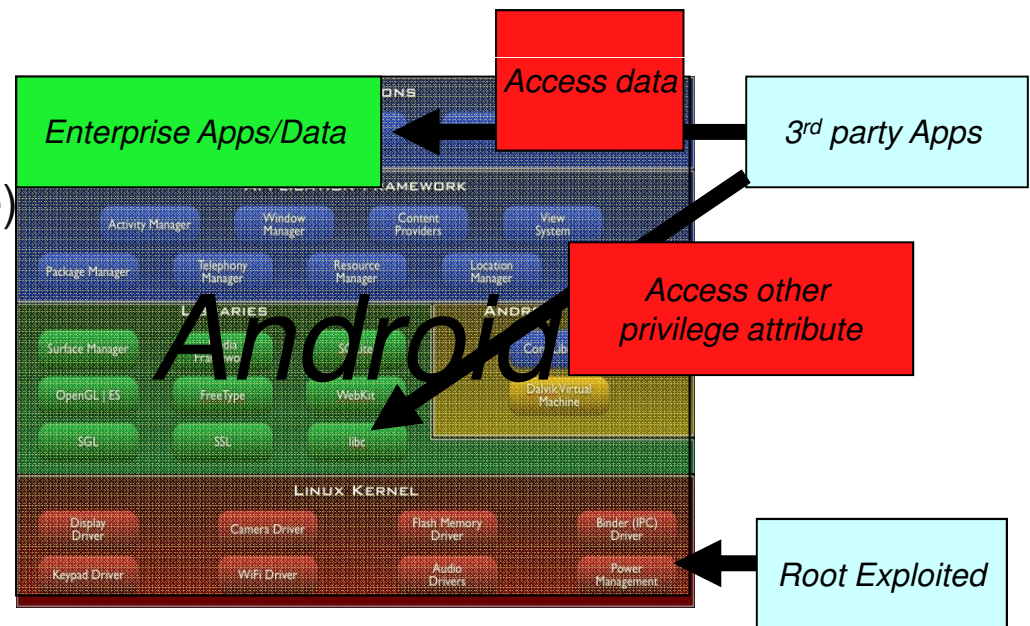
Secured Android Architecture

System & Telehealth Applications with Security Enhanced Policy

Central Policy Manager**

Policy and Labeling library

Mandatory Access Control (MAC)*
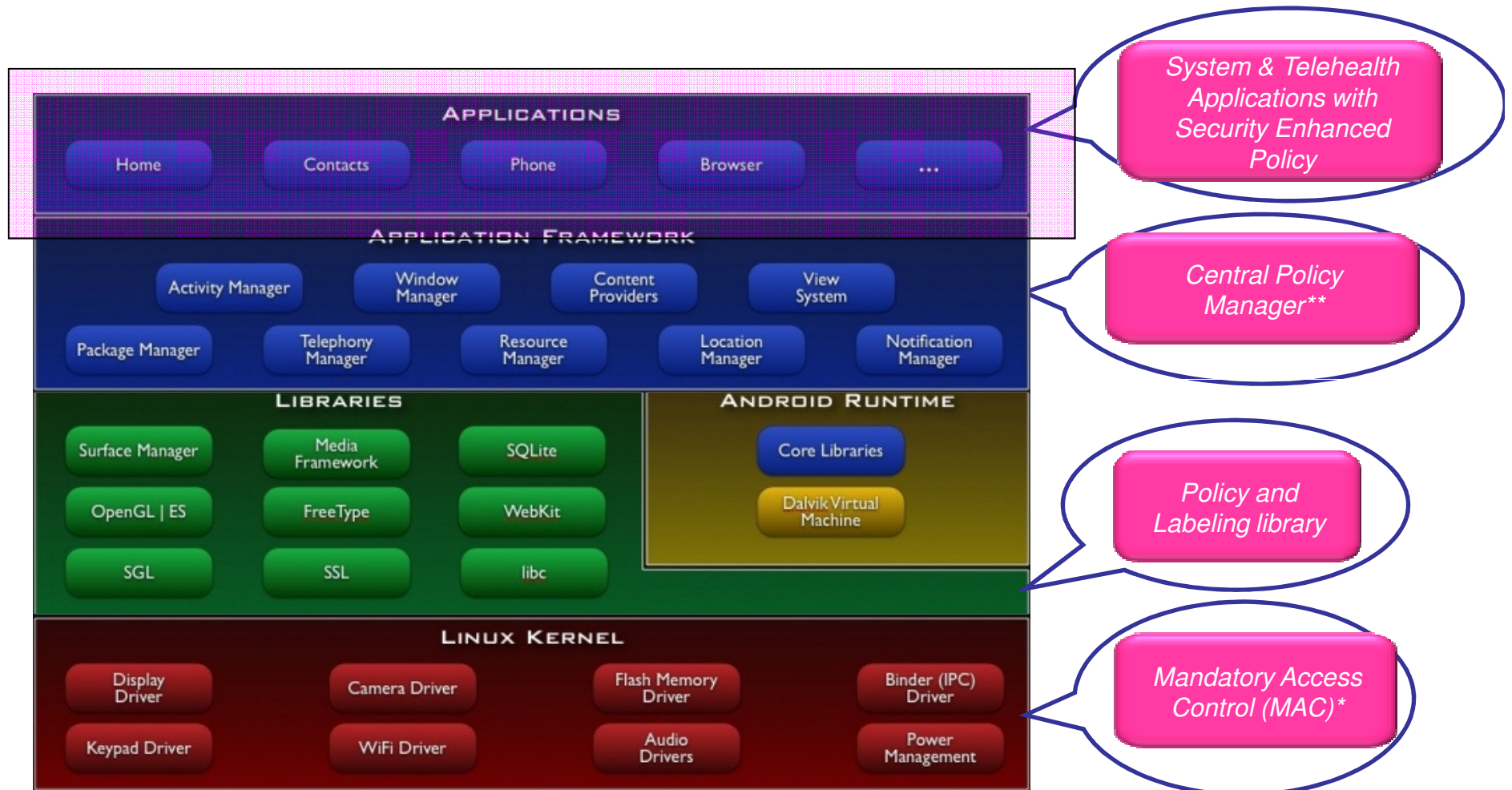
*   File system enhancement, extend attribute, Linux security module and audit
** Policy Management, modified package, activity, content and resource managers

Typical System Architecture

Server

Database

Web Pages

Data/Web Server

Medical Data Interface (Collect Data)	Web Interface

Medical Device

Medical Device

Gateway
(Tablet/Phone/PC)

Browser
Client

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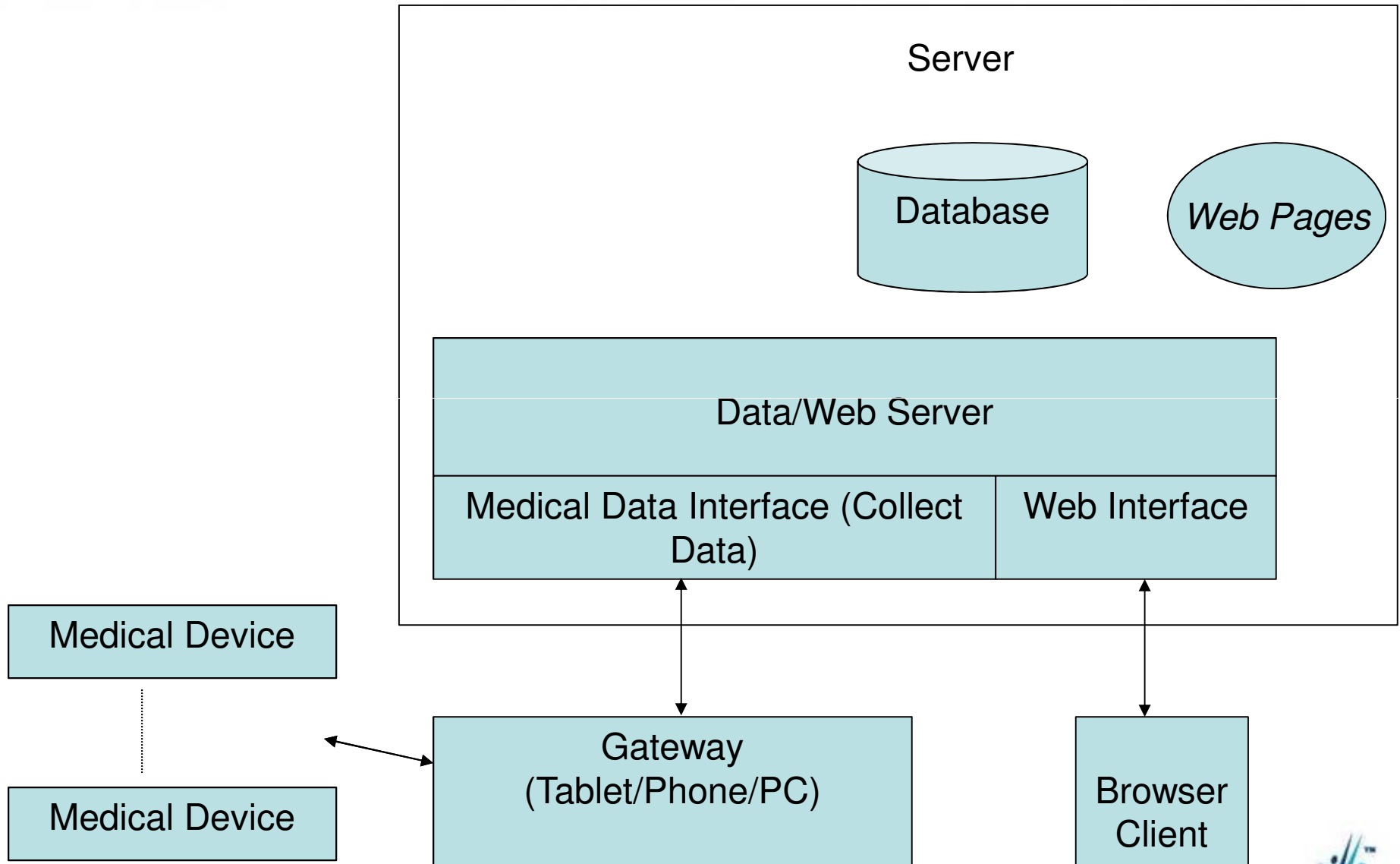
Flow of Healthcare Service (Simplified)

Data Collection

Data Analysis

Sharing & Notification
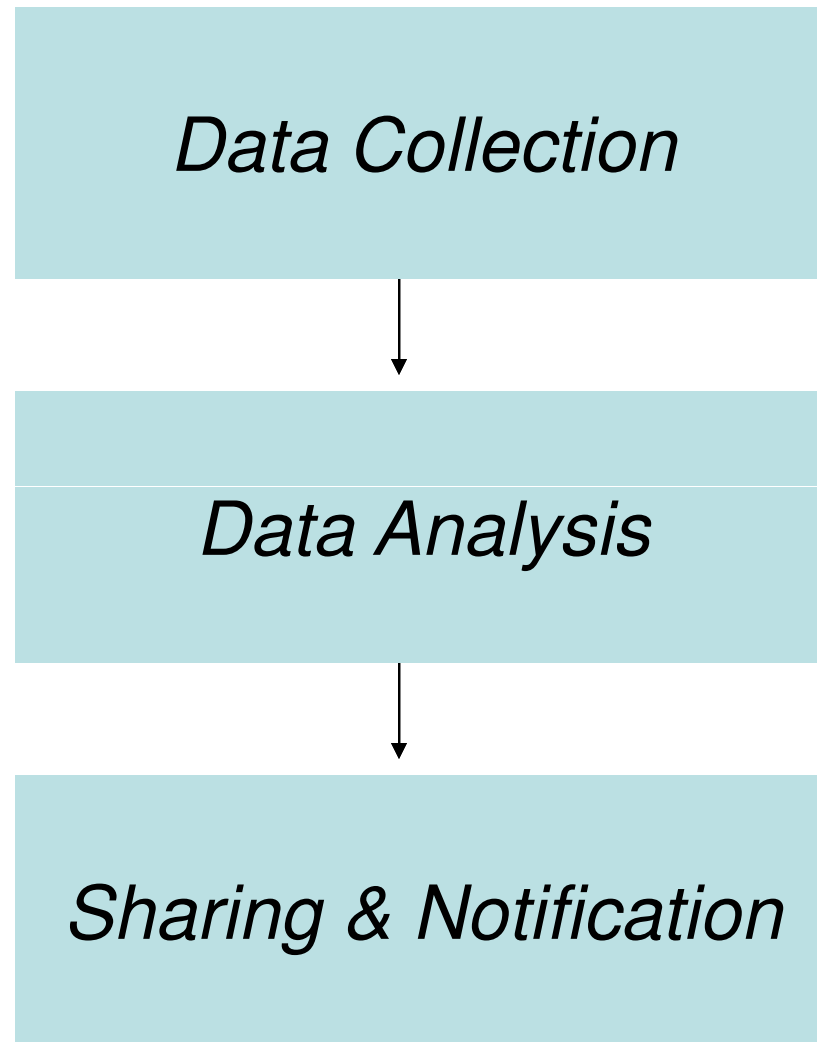
Data Collection (Multi-wireless Interfaces & Presentation)

- **Various interfaces of medical devices, how to manage?**
- **A cast of thousands (from BT, ANT+, USB/serial etc.)**

  BLE vital sign measurement devices are coming!

Vendor	Device Type	Model Number	Interface Type	Interface Protocol
Nonin	Oximeter	9560	BT	Proprietary/Continua
Omron	Blood Pressure Monitor	HEM-7081-IT	BT	Proprietary/Continua
Omron	Precision Health Scale	HBF-206IT	BT	Proprietary
A&D	Blood Pressure Monitor	UA-767PBT	BT	Proprietary
A&D	Precision Health Scale	UC-321PBT	BT	Proprietary
A&D	Precision Health Scale	UC-321PBT-C	BT	Continua
FORA	Blood Clucose Plus Blood Pressure Monitoring System	D40b	BT	Continua
CLEVER	Ear Thermometer	TD-1261	BT	Proprietary
iHealth	Blood Pressure Monitor	BP7	BLE	BLE HDP standard
A&D	Blood Pressure Monitor	UA-851ANT	ANT+	Standard
Oregon Scientific	Pedometer	PE912	ANT+	Standard
Oregon Scientific	Blood Pressure Monitor	BPW800	ANT+	Standard
Oregon Scientific	Hart Rate Monitor	SE836	ANT+	Standard

- **Management & presentation to support various healthcare services**

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Dynamic Device Management from ASTRI

Server

D   P

Besides
measurement
data,
Download
Medical
Device profile
from server

Gateway
(e.g. tablet)

only
measurement
data

D

Medical
Device #1 .... Medical
Device #n

46
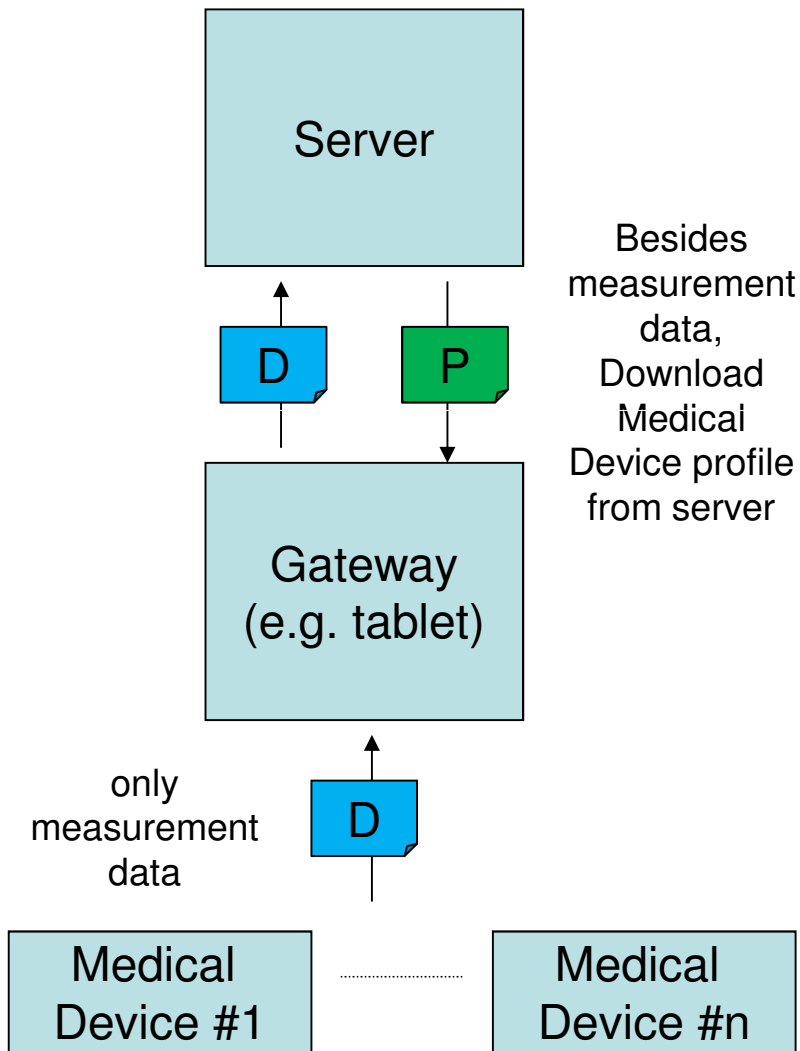
- Medical Device Profile could include devices related GUI display template, protocol, etc.
- The measurement data will not be parsed with semantic meanings in the client. Only the medical device profile can tell what it is.
- Adv: server can dynamically update client to handle as many devices as possible without predefined
- Adv: server can update GUI template to dynamically support new application feature with the device. Also, using template mechanism in local client can enhance user experience vs. web browsing mechanism
- Adv: minimize the effort to development / deployment of client

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Data Analysis

Clinical Data
(e.g. eHR)

Behavioral Data
(e.g. Mobility sensor data,
Social network data, etc.)

Analyzer
(e.g. Big Data analytic,
Knowledge based analytic)

Point of care

Statistic

Research

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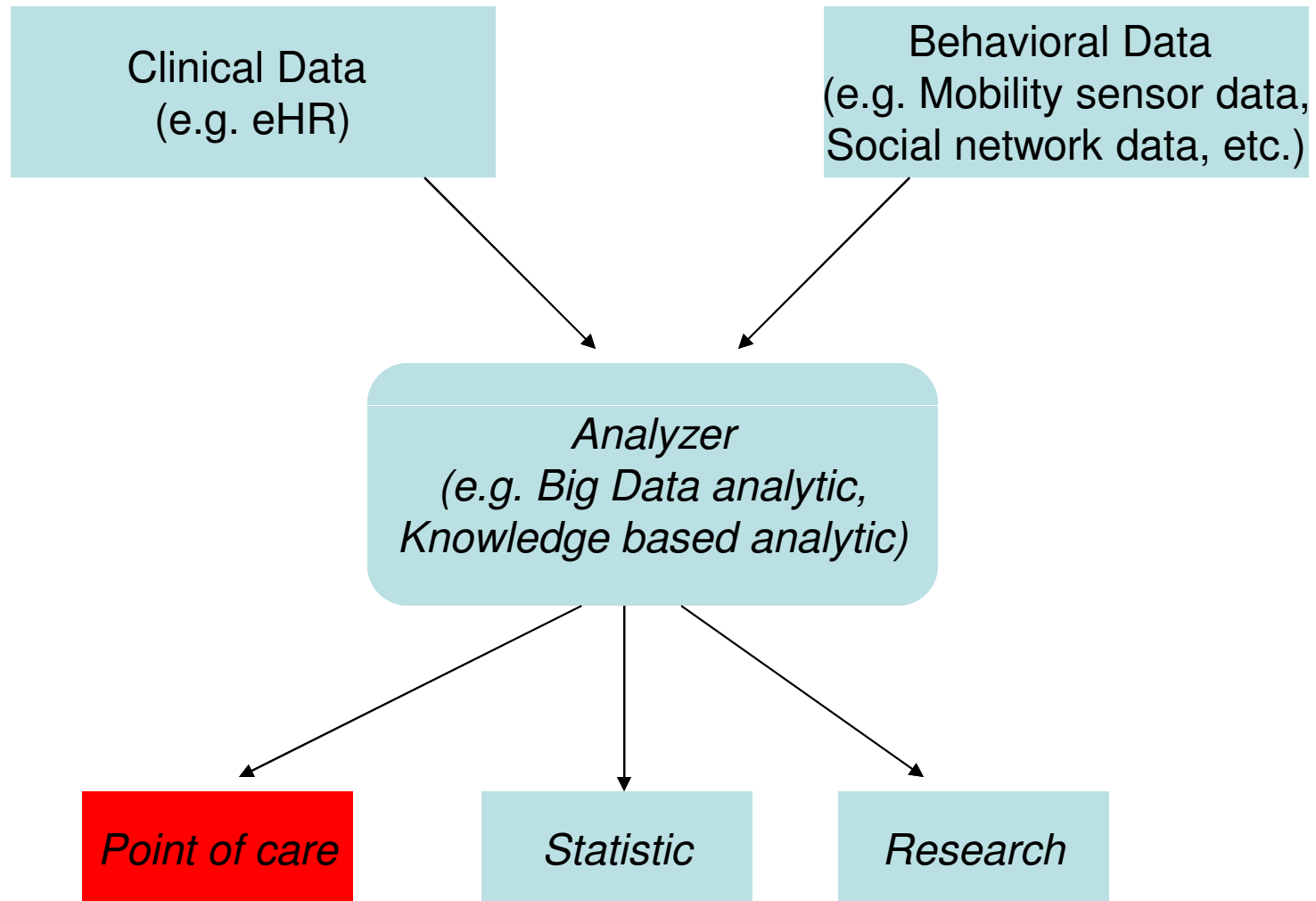
Data Analysis (Knowledge based)

Score-based Risk Assessment (e.g., diabetic awareness)

Sharing & Notification

3. Health data Sharing/Notification

Telehealth Server

Public notification servers
e.g. Telco SMS server, Google/IOS push server

1. Schedules Alerts

2. Health data upload

• Share/Notify with families members or
• Share/Notify with authorized parties like doctor/nurse

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- **Focusing on solution**
  - Workflow/Operations
  - User experience

- **Focusing on data protection**
  - Closed system approach
  - Secured Android

Conclusion Remarks

- **Growth of ageing population is an inevitable trend**

- **ICT can play an important role, in particular of increasing smartphone/table penetration**

- **Mobile operator is an obvious important player**

- **Insurance company is a neglected important player**

- **Focus on Solutions, not Technology**

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End of Presentation

Thank you. Questions are welcome.

Our corporate website: www.astri.org