Can Big data ?

Open New Era of Personalized Healthcare

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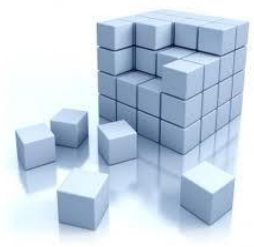
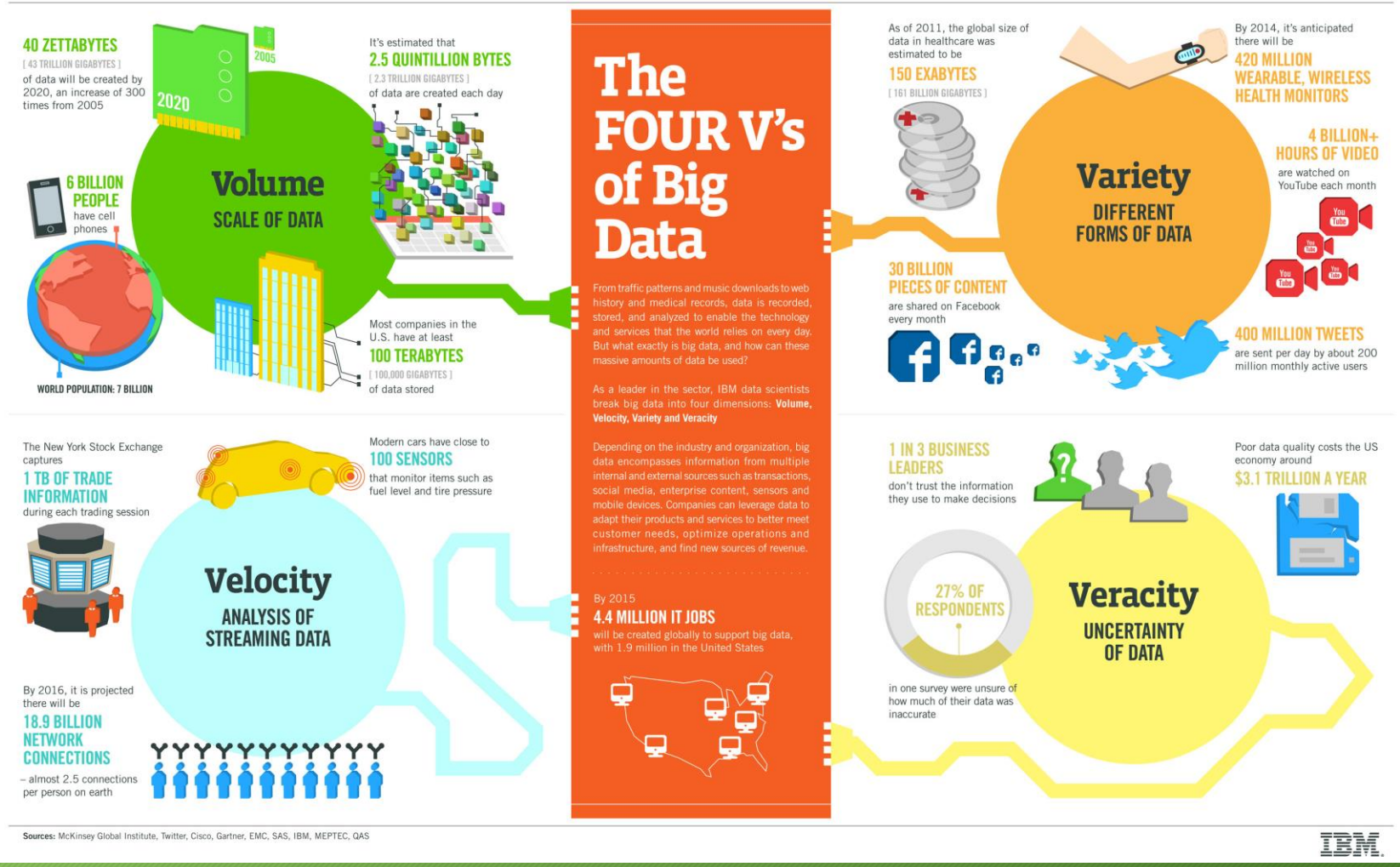


is changing the World !!!

Big Data at A Glance

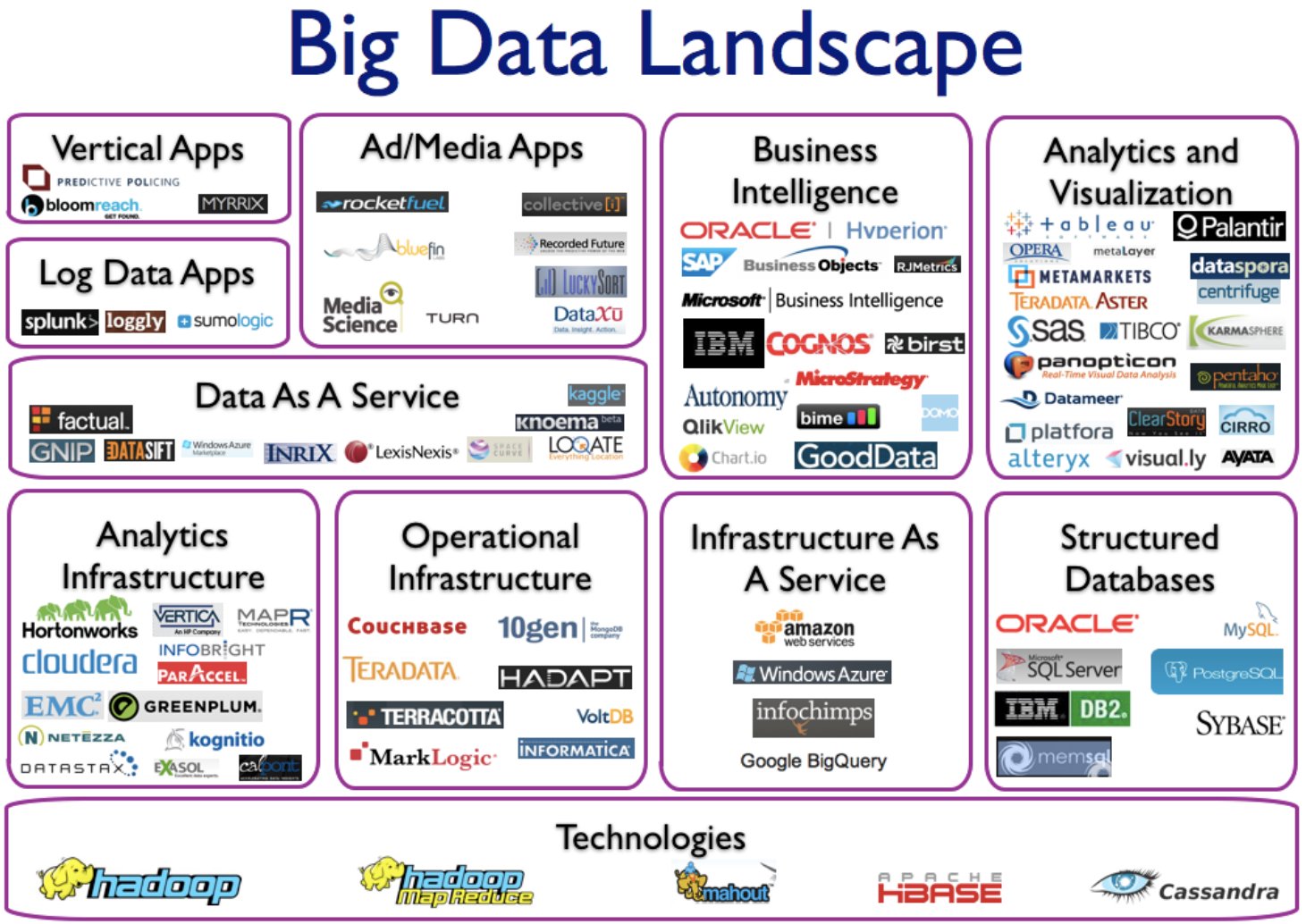
- **Definition of Big Data:**
  A collection of large and complex data sets which are difficult to process using common database management tools or traditional data processing applications.

- **The four dimensions (V's) of Big Data**
  - Volume
  - Velocity
  - Variety
  - Veracity



Big Data Landscape

- Technologies
- Infrastructure As A Service
- Operational Infrastructure
- Analytics Infrastructure
- Structured Databases
- Data As A service
- Business Intelligence
- Analytics and Visualization
- Log Data Apps
- Ad/Media Apps
- Vertical Apps



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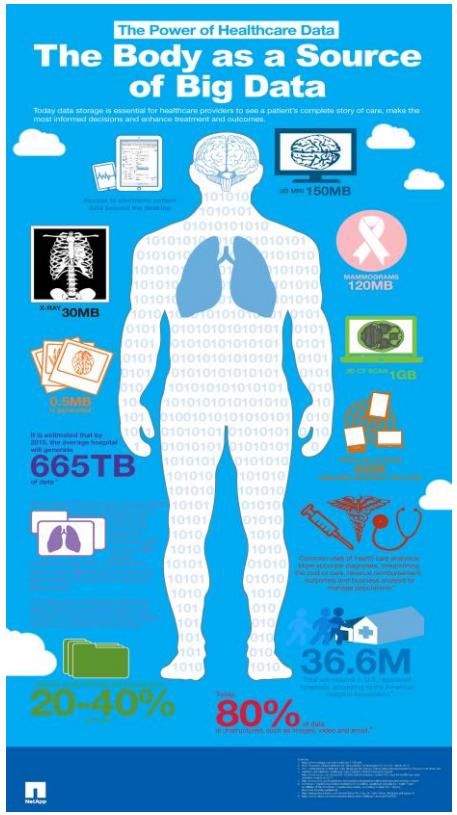
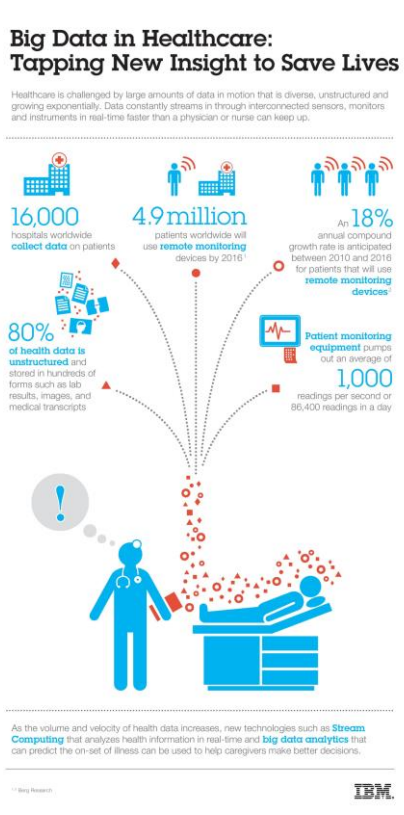
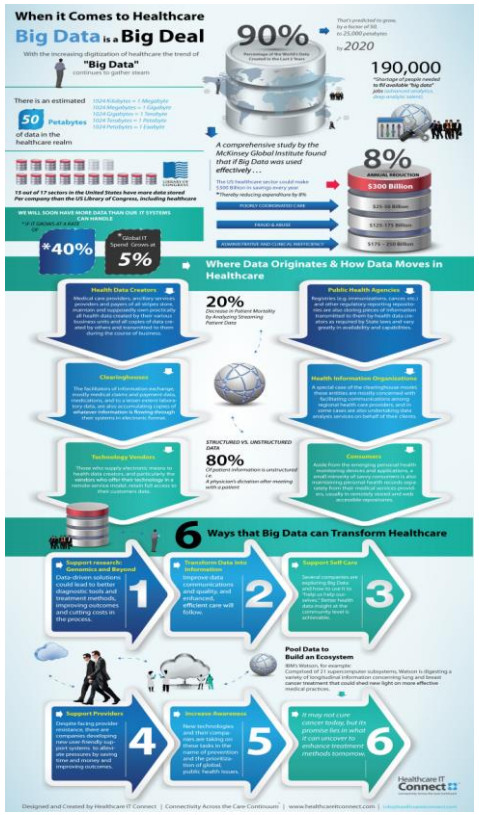
Big Data in Healthcare

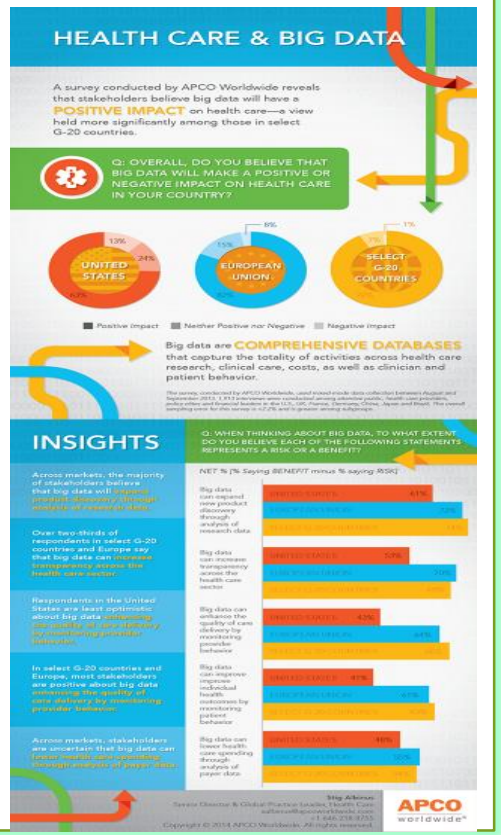
Big Data in *Healthcare* is revolutionizing the Healthcare Paradigm

Realization of Big data in Healthcare









Implication

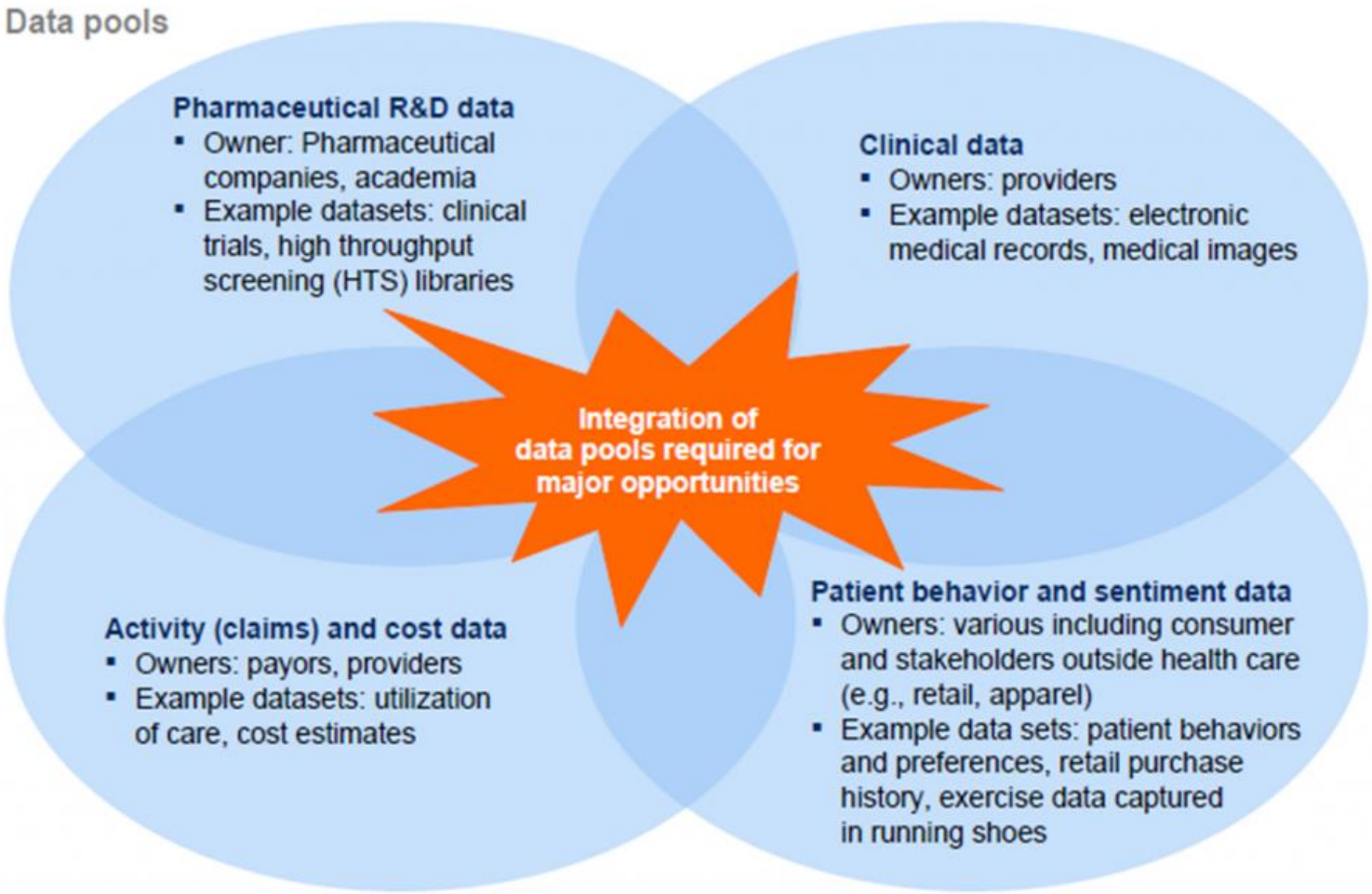
- **The Body as a source of Big Data -> Big data usage in healthcare is exponentially growing**
- **It is estimated that by 2015 average hospital will generate about 665TB of data**
- **Big data processing technique will be essential in Healthcare**

Source

1. http://www.dr4ward.com/dr4ward/2013/04/what-is-the-power-of-the-big-data-in-healthcare-infographic.html
2. http://www.flickr.com/photos/ibm_media/8591808129/
3. http://www.govtech.com/infographics/Infographic-Big-Data-and-Your-Health.html
4. http://www.apcoforum.com/health-care-and-big-data/

Big Data Pools in Healthcare

- **Data Sources**
  - Pharmaceutical R&D Data
  - Clinical Data
  - Activity (Claims) and Cost Data
  - Patient Behavior and Sentiment Data



Source: McKinsey Global Institute Analysis

Goals of Big Data Analytics in Healthcare

- Take advantage of the massive amounts of data and provide right intervention to the right patient at the right time.
- Personalized care to the patient.
- Potentially benefit all the stakeholders (provider, payer, patient, and management) of a healthcare system

Source: Jimeng Sun and Chandan Reddy, Tutorial Presented at the ACM SIGKDD 2013 Conference

Big Data Challenges in Healthcare

- Inferring knowledge from complex heterogeneous patient sources.
- Understanding unstructured clinical notes in the right context.
- Efficiently handling large volumes of healthcare data and extracting potentially useful information.
- Analyzing healthcare big data is a computationally intensive task and combining with standard clinical data adds additional layers of complexity.
- Capturing the patient's behavioral data through several sensors; their various social interactions and communications.

Source: Jimeng Sun and Chandan Reddy, Tutorial Presented at the ACM SIGKDD 2013 Conference

Personalized Healthcare (pHealthcare)

Big Data

in *Healthcare*

enables

personalized

Healthcare

Definition of pHealthcare

- **What is Personalized Healthcare?**

Personalized Health Care is the **tailoring of health care to the individual characteristics of the patient**. These characteristics can include environment, social history, health history, family history, genetics, proteomics, and more.

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Source: UNIVERSITY OF UTAH HEALTH SCIENCES

Why pHealthcare?

- **Why Personalized Healthcare?**

Preventive and predictive for disease, consequently Improve patient's safety, quality and effectiveness of healthcare

P4 Medicine

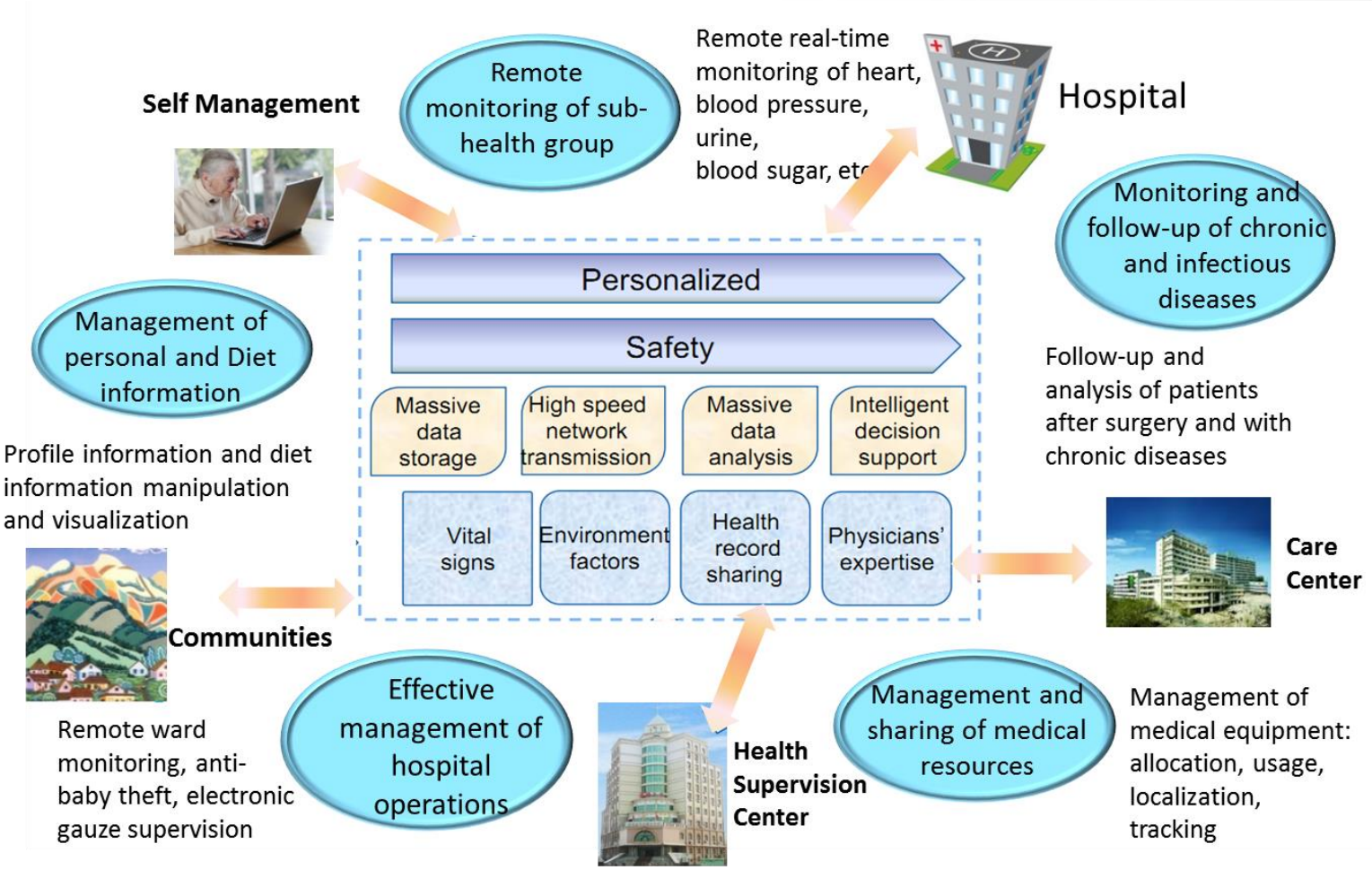
PREDICT PREVENT PERSONALIZE PARTICIPATE

- **What Benefits?**

Through improved science, *personalized healthcare* has great potential to improve quality and reduce overall costs of health promotion and care delivery.

Source: IBM, T-enabled personalized healthcare *Improving the science of health promotion and care delivery*

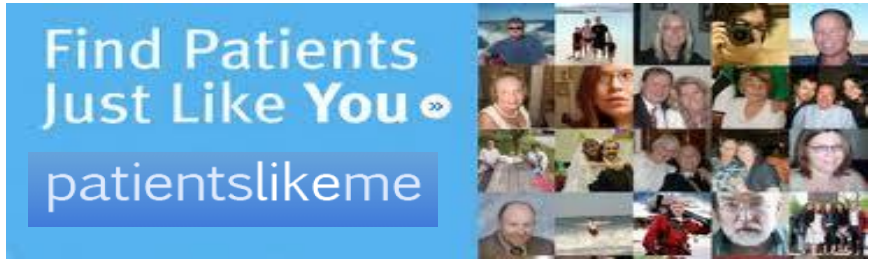
pHealthcare System in General



Source: Lionel Ni, "Internet of Healthcare Things" Proceedings of the 2nd SMCEW international workshop, Korea, October, 2011

Current pHealthcare Systems

IBM WATSON



NEXTBIO

PROPELLER HEALTH

CureMD
Practice without boundaries
AllinOne
SMART Cloud
EMR + PM + Portal + Hosting
Security + Backup + Upgrades +
Maintenance + Support more

Intivia
Taking the Hassle out of Healthcare

INTERSYSTEMS

practice fusion™
Free, web-based Electronic Health Records

Binary Spectrum
World-Class Software Solutions

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Empowering Individuals to Improve Health and Healthcare

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Limitations of Existing pHealthcare Systems

- Lack of an interoperable Healthcare Information Technology (HIT) environment for care delivery and research
- Prevalence of tightly coupled applications and data
- Inadequate data and knowledge standards
- Insufficient analytics capabilities due to lack of infrastructure support
- Absence of a clinical decision-making foundation

Source: IBM, IT-enabled personalized healthcare *Improving the science of health promotion and care delivery*

Proposed pHealthcare – Mining Minds (MM) Platform

Proposed Solutions	Approach
Interoperable HIT environment with **data acquisition service**	Data conformance and uniform representation
Layered infrastructure for providing loosely coupled applications	Data, Information, and Service Curation layers on the Cloud
Use of **healthcare standards** for data and knowledge creation and processing	Healthcare data (e.g., CDA, FHIR) and knowledge (e.g., MLM, SNOMED) standards
Utilizing **Personalized Big Data** in healthcare for **analytics**	Real-time data, information and knowledge management of heterogeneous resources
Clinical decision making by **maintaining high quality service**	Data driven and Expert driven knowledge creation and maintenance

Additional Considerations in MM Platform

- Prevention is better than treatment to reduce the healthcare cost efficiently
- Bad habits in our daily life cause the chronic diseases which are dominant factors to increase healthcare cost
- Provide monitoring and recommendation services by means of MM Platform to **promote healthy habits**

Focuses on MM Platform

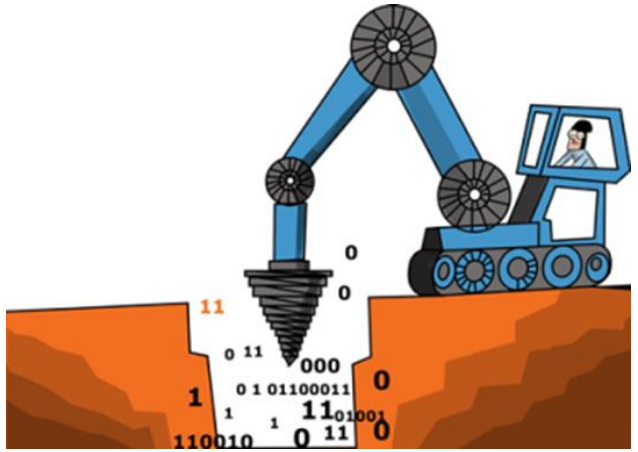
- ***How to support pHealthcare?***
- ***How to improve QoH?***
- ***How to induce habituation service?***

Keyword of Mining Minds Platform

- **Mining Minds:**
  Read Mind & Change Habits

Keyword of Mining Minds Platform

- **Big Data Analytics**



Keyword of Mining Minds Platform

- **Knowledge Creation & Maintenance**

Maintenance

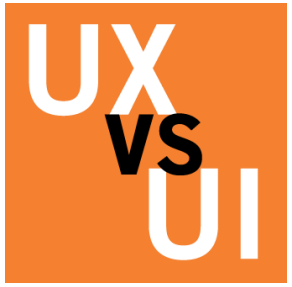
Keyword of Mining Minds Platform

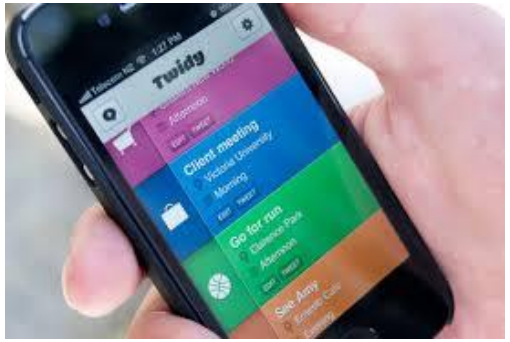
- **Curation:**

Time, location and Situation

curator

Keyword of Mining Minds Platform

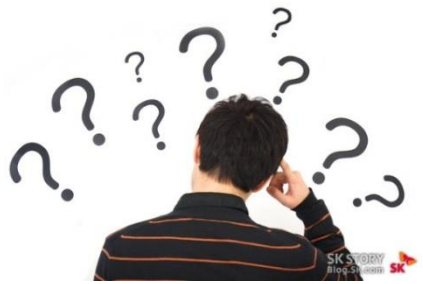




- **UI/UX:**

Habituation

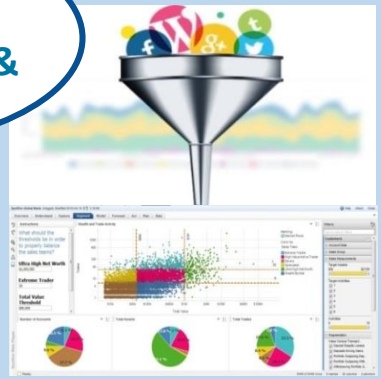
Concpt of Mining Minds Platform



Mining Minds Platform

1: Big data
Volume, Variety & Velocity

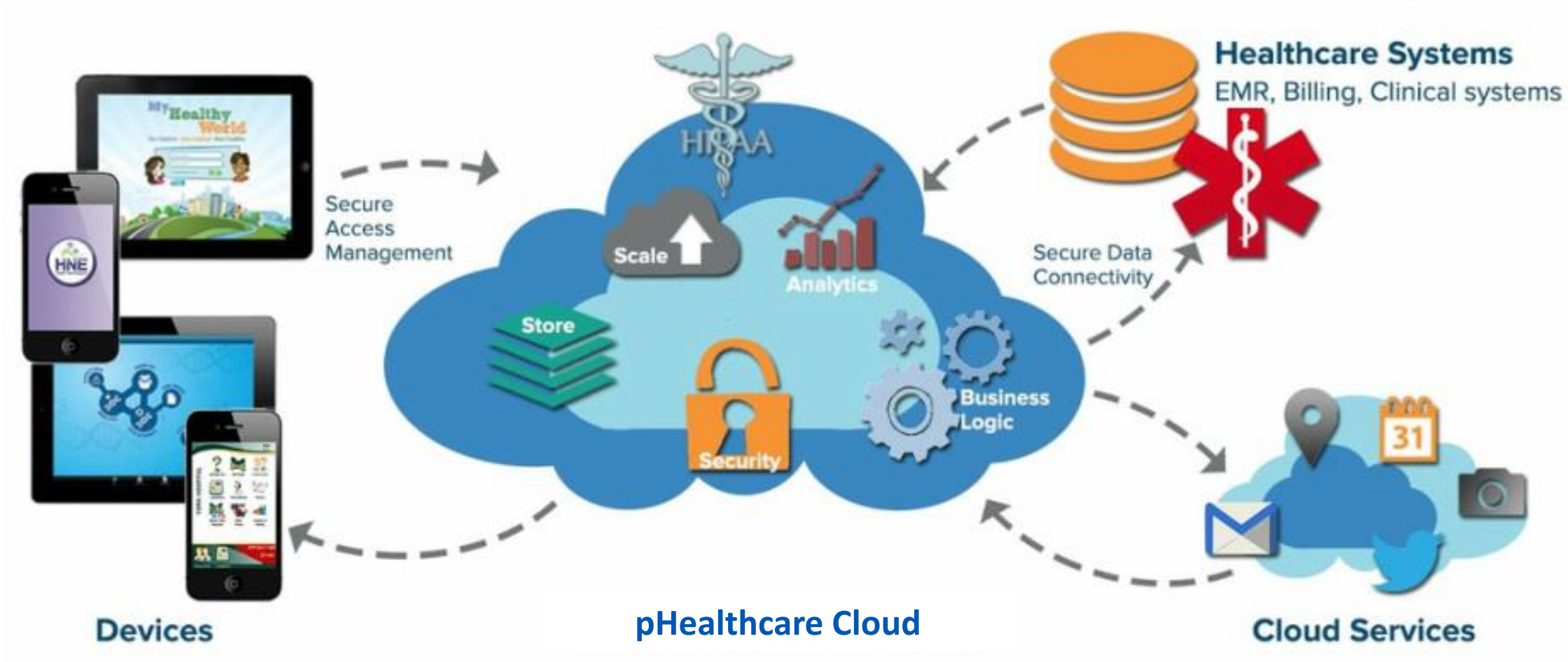
Sensing



2: Mining
Personalized minds model & knowledge management

3: UI/UX
Induce Healthy Habits

Reference of Mining Minds Platform



Source: http://www.efficaceconsultinggroup.com/healthcare-and-preventive-health-care.html

Considering Factors in pHealthcare

Credible

Secure

Personalized

Reliable

Accurate

Transparent

Context Aware

Easy to use

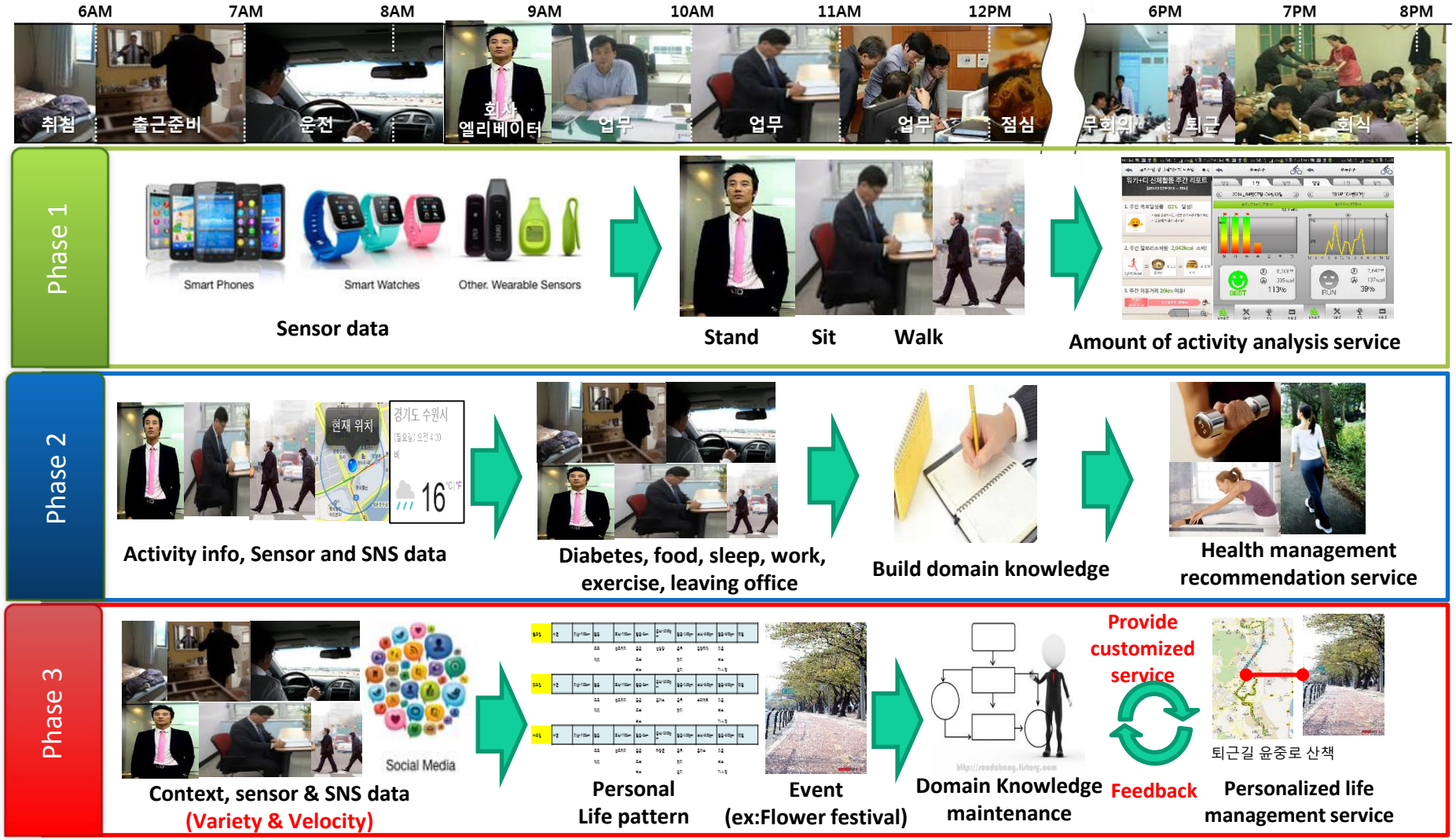
Source: Little, L. and Briggs, P., "Ubiquitous Healthcare: Do we want it?" Proceedings of the 22nd British HCI Group Annual Conference on People and Computers: Culture, Creativity, Interaction-Volume 2, 2008

PERSONALIZED HEALTHCARE PLATFORM

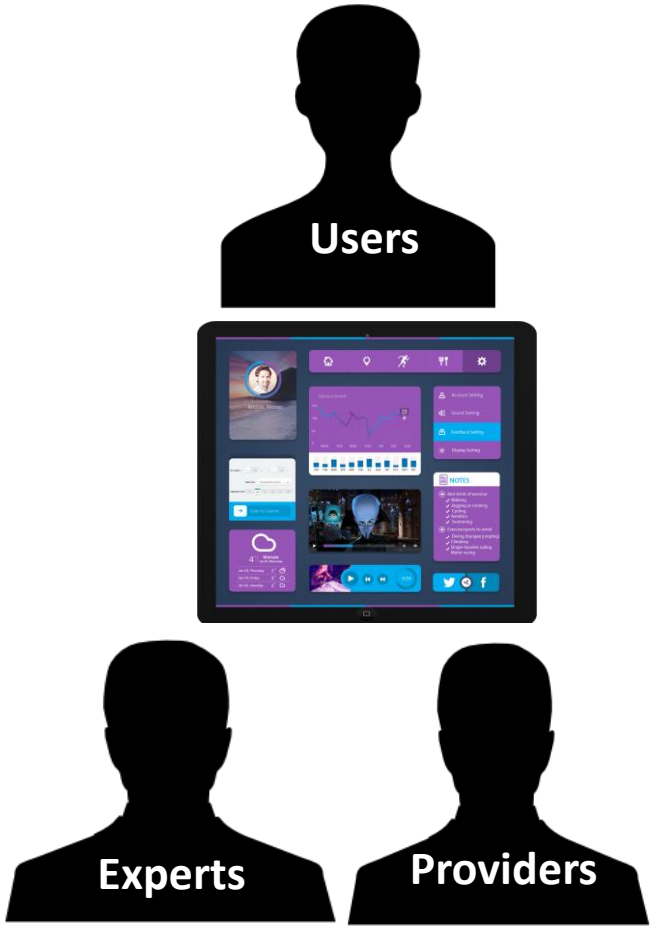
pHealthcare (Mining Minds) Platform in a Nutshell

"Collection of innovative services, tools, and techniques, working collaboratively to investigate on human's daily-life routines data generated from heterogeneous resources, for personalized wellbeing and healthcare support"

Target Services



User Centric Approach for Personalized Service



Interactive User Environment

Supporting Layer

User Privacy Control

Personalized Healthcare Services

Service Curation

User Involvement

Behavior Information

Information Curation

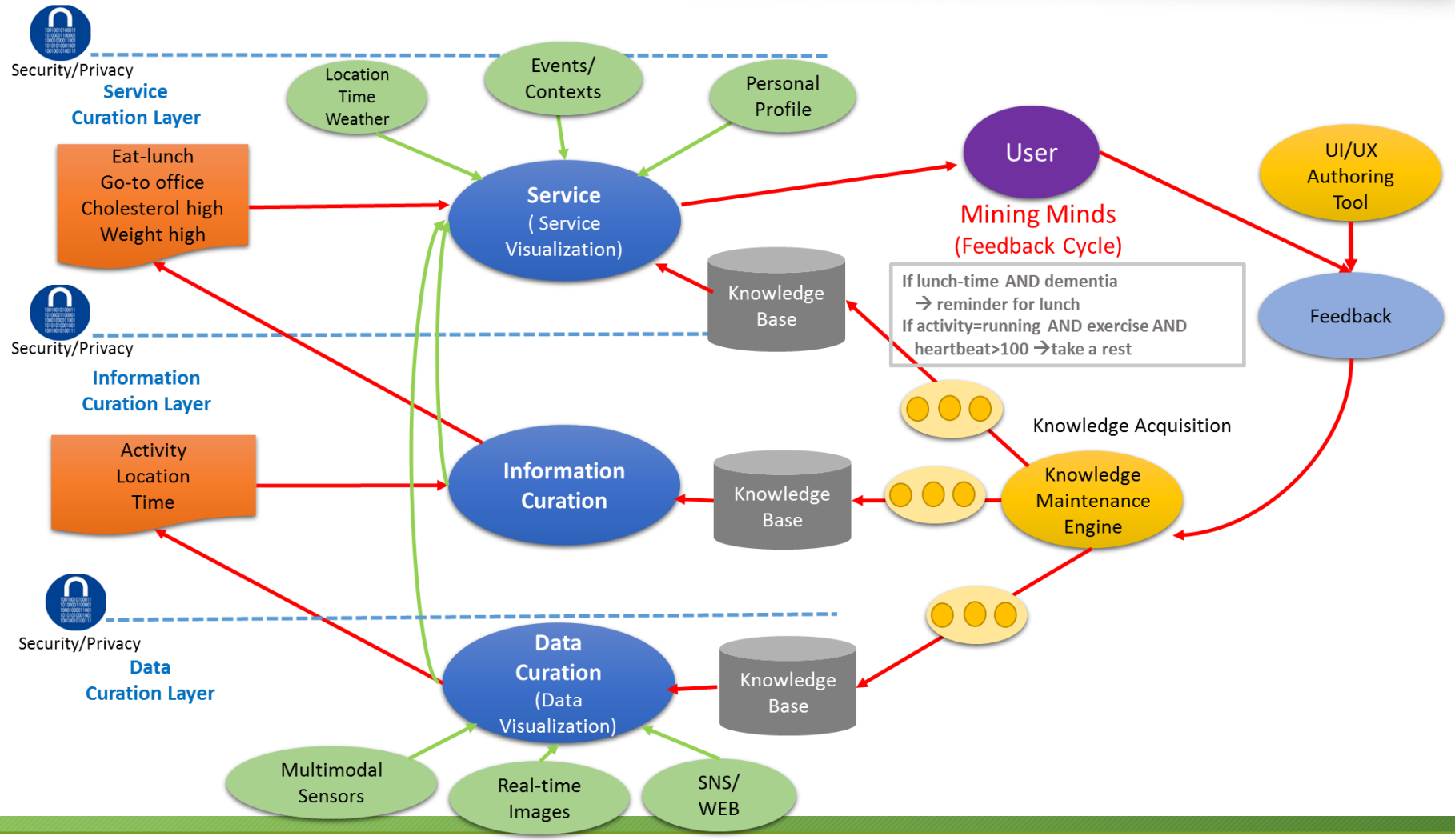
Context Information

Data Analytics

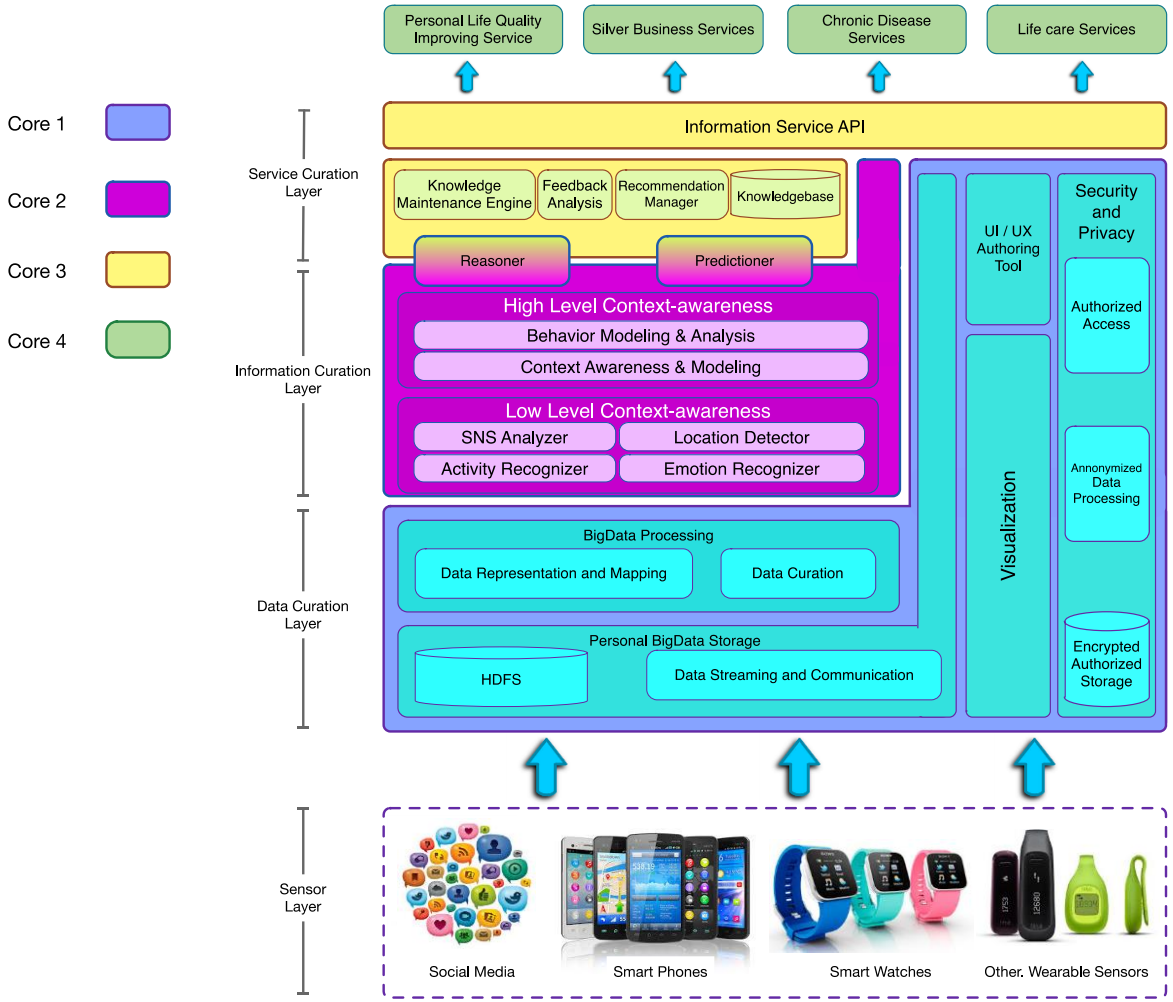
Data Curation

Infrastructure Information

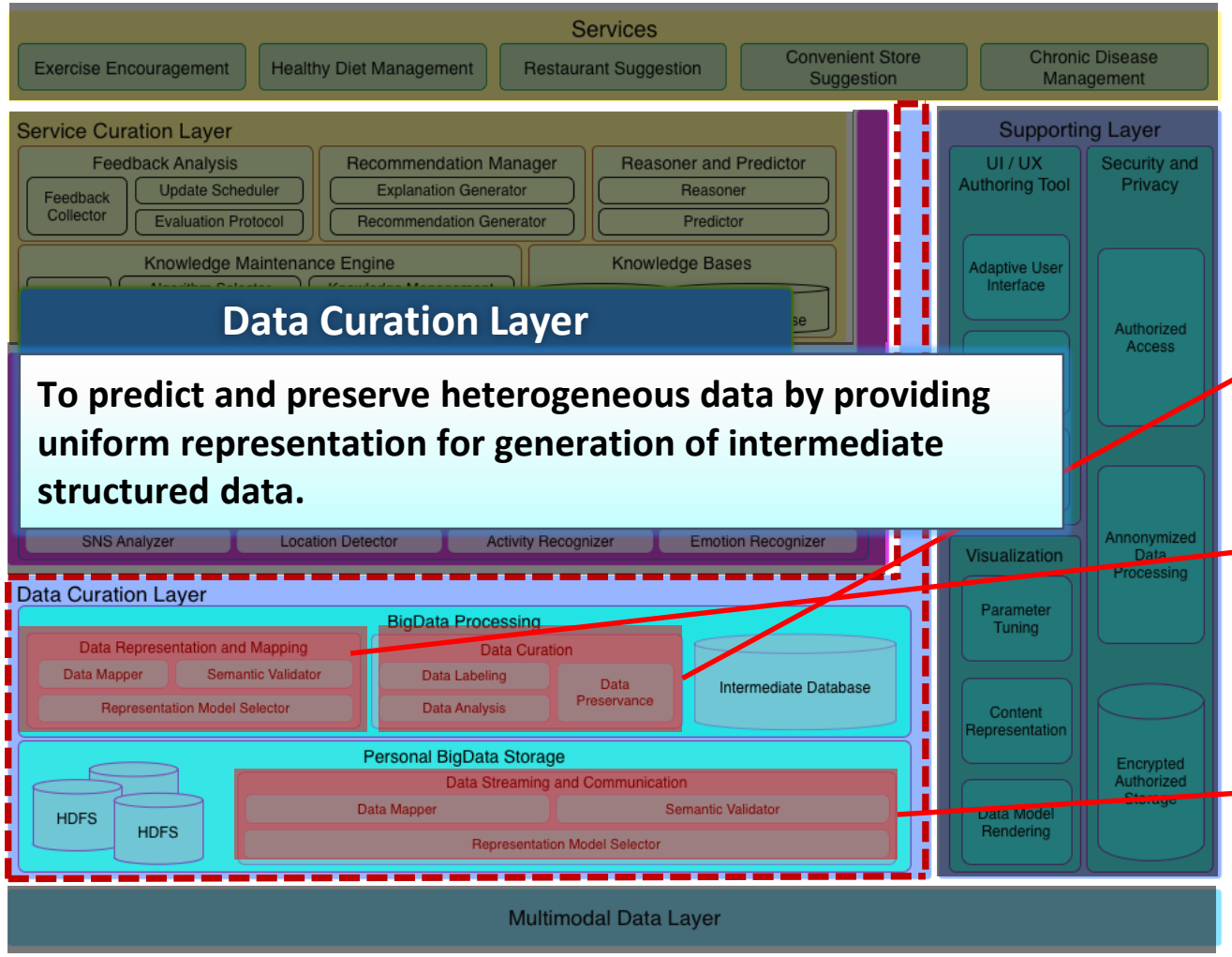
Abstract View of Ming Minds Platform - Curation



Architecture of Mining Minds Platform



Data Curation Layer



Data Curation Component

- To predict the data stream on real-time
- To remove the noise from the large volume of data
- To preserve the heterogeneous data of diverse format

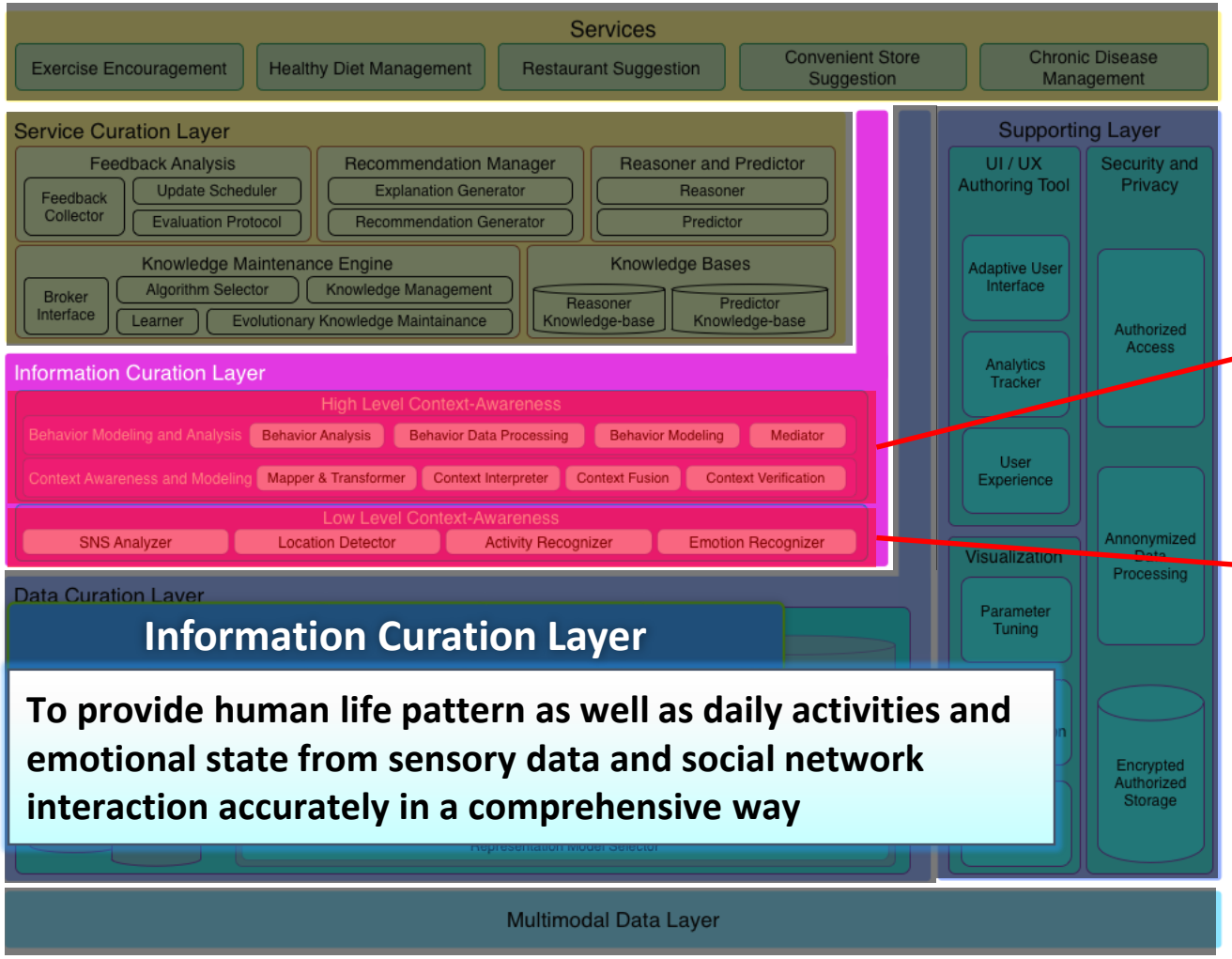
Data Representation and mapping

- Conformance of diverse unstructured data formats to ontological format
- Uniform ontological representation of data that is acquired from heterogeneous data sources
- Provide scalable data model and dynamic model selection based on input sources

Data Streaming and Communication

- To support streaming data retrieval on ontological data using improved caching mechanism
- To generate intermediate structured data
- To predict future requests based on itemset techniques

Information Curation Layer



Information Curation Layer

To provide human life pattern as well as daily activities and emotional state from sensory data and social network interaction accurately in a comprehensive way

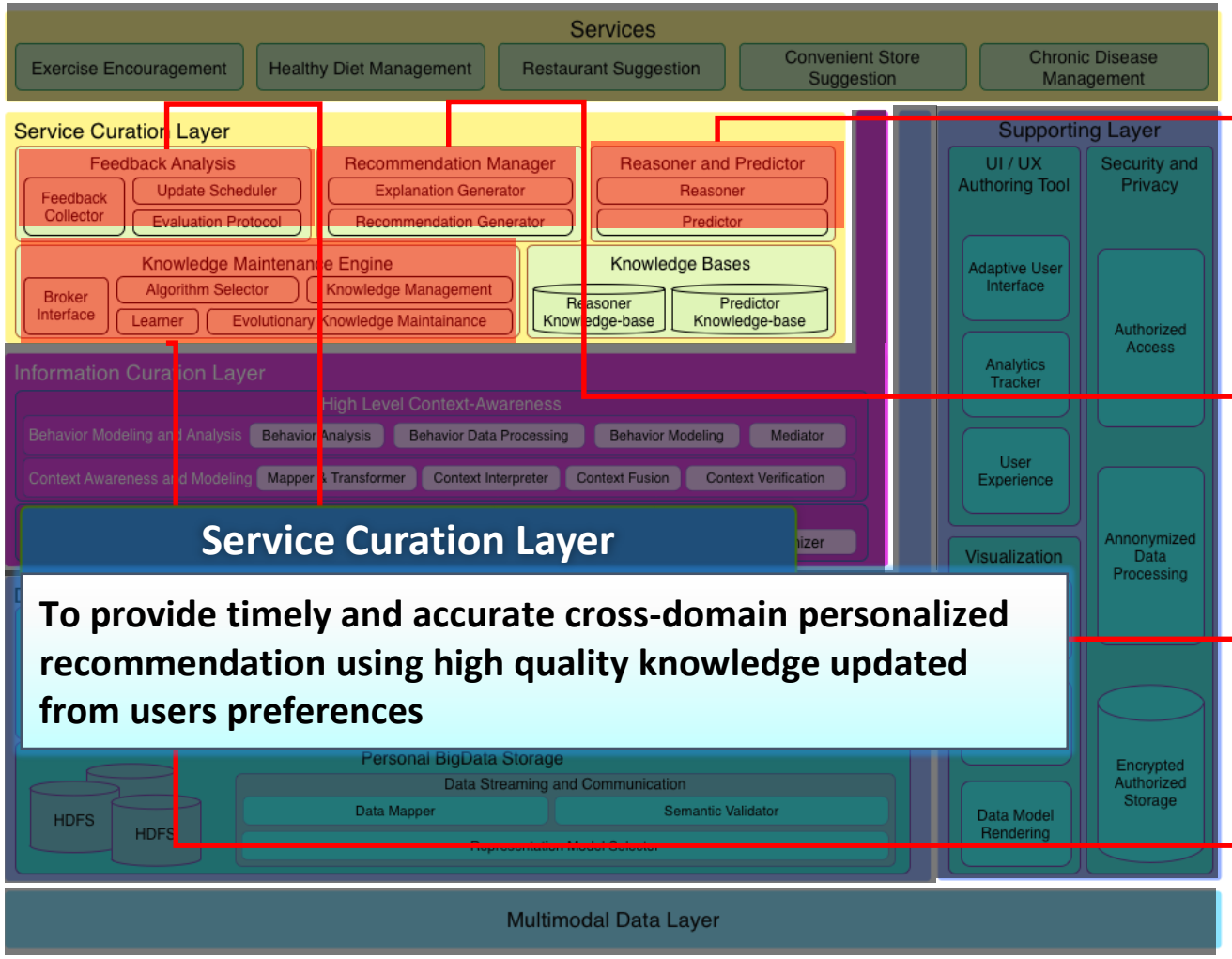
High Level Context Awareness

- **Context Modeling** – find the abstract context from low-level activities and information
- **Behavior Modeling** – model the user's behaviors in different contexts and scenarios

Low Level Context Awareness

- **Acquisition** – collect, process sensory, social data
- **Recognition** – Recognize different physical activities, location and emotional states of user
- **Fusion** – Fuse decisions from different classifiers in the same category

Service Curation Layer



Service Curation Layer

To provide timely and accurate cross-domain personalized recommendation using high quality knowledge updated from users preferences

Reasoning and Prediction

- **Reasoning**– finding the best ever timely recommendation for the requested service
- **Predictions**– supporting the recommendations by behavior patterns

Recommendation Manager

- **Personalized Recommendations**– finding contextualized recommendations
- **Cross-domain Recommendations**– finding unified recommendations using diverse domains

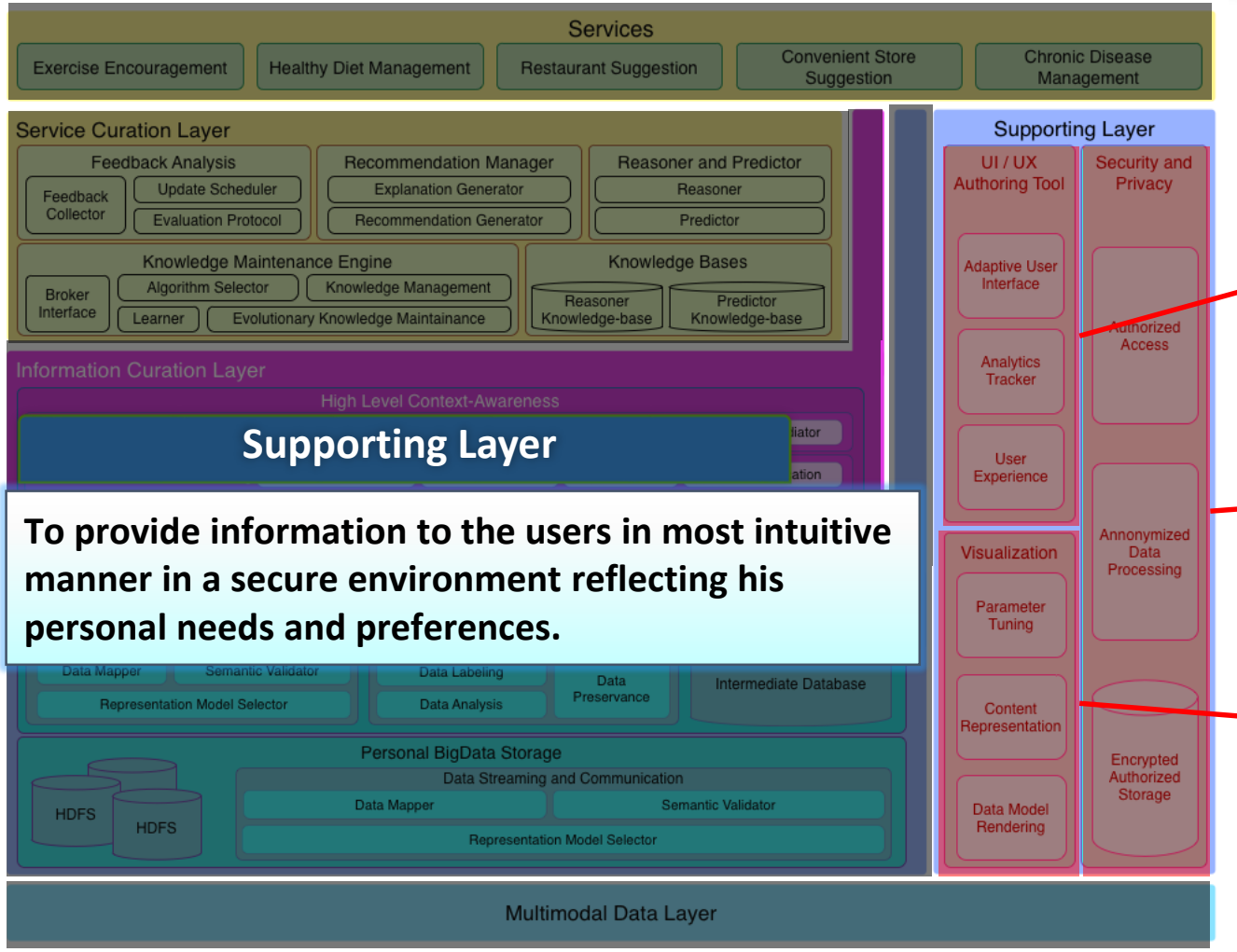
Feedback Analysis

- **Feedback Collection**- users satisfaction is collected
- **Knowledge Updation**- feedback is analyzed for knowledge updation

Knowledge Maintenance Engine

- **Knowledge creation**– knowledge extracted from curated information and guidelines
- **Maintenance**– keep the knowledge up to date and valid

Supporting Layer



UI/UX Authoring Tool

- To cater user personalized preferences in the user interfaces
- To utilize user experience in adaptation of UI with change in user preferences

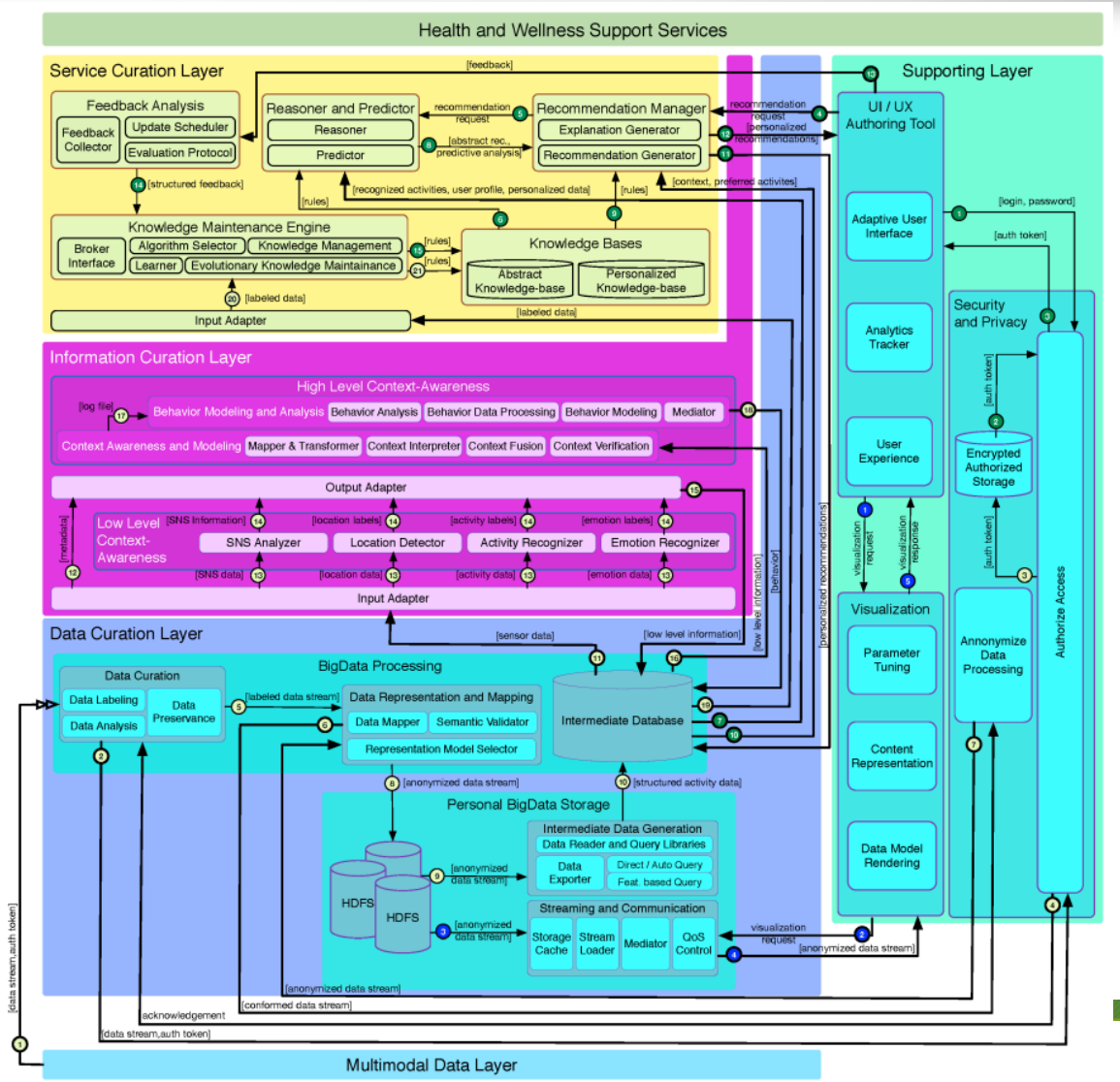
Privacy & Security

- To achieve security over personal data
  - Encryption, Hashing etc.
- To achieve privacy
  - Partial sharing, anonymization, limited authorization

Visualization

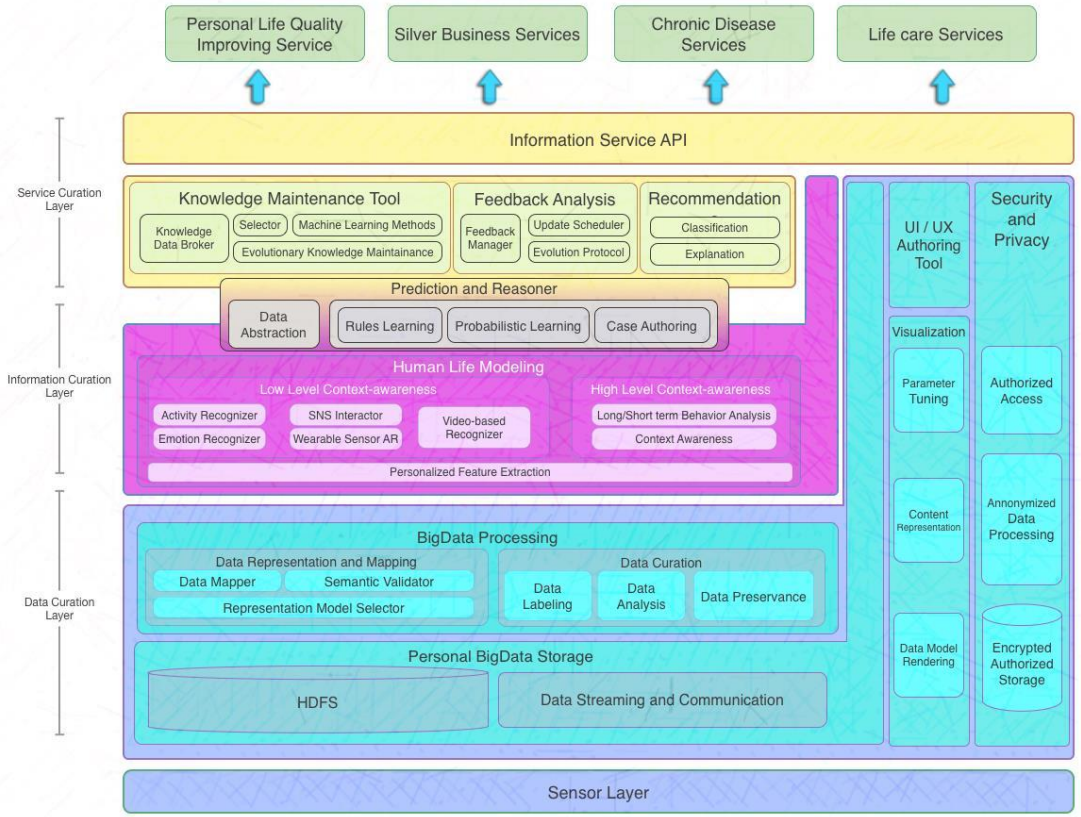
- To achieve deeper and faster insights into the data
- To enhance the decision making capability

Platform Workflow

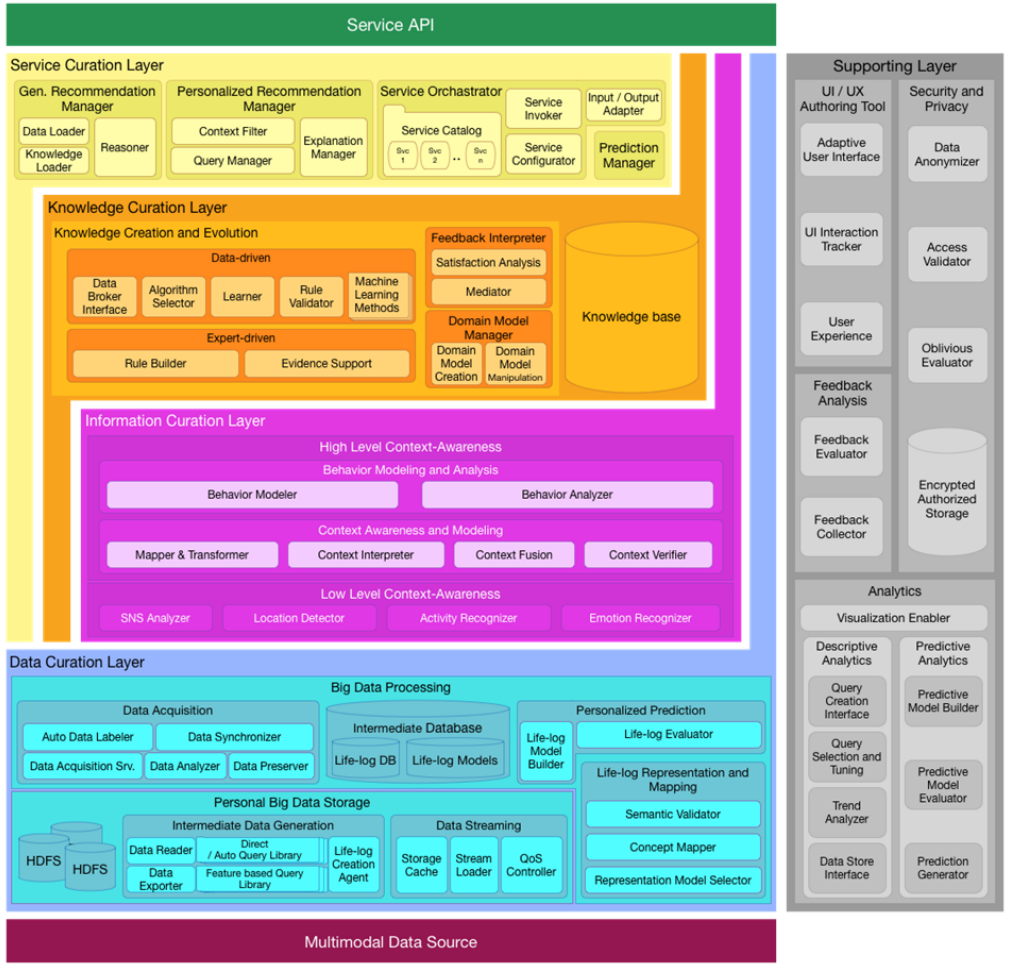


마이닝 마인즈 플랫폼 개선

Original Architecture



Updated Architecture

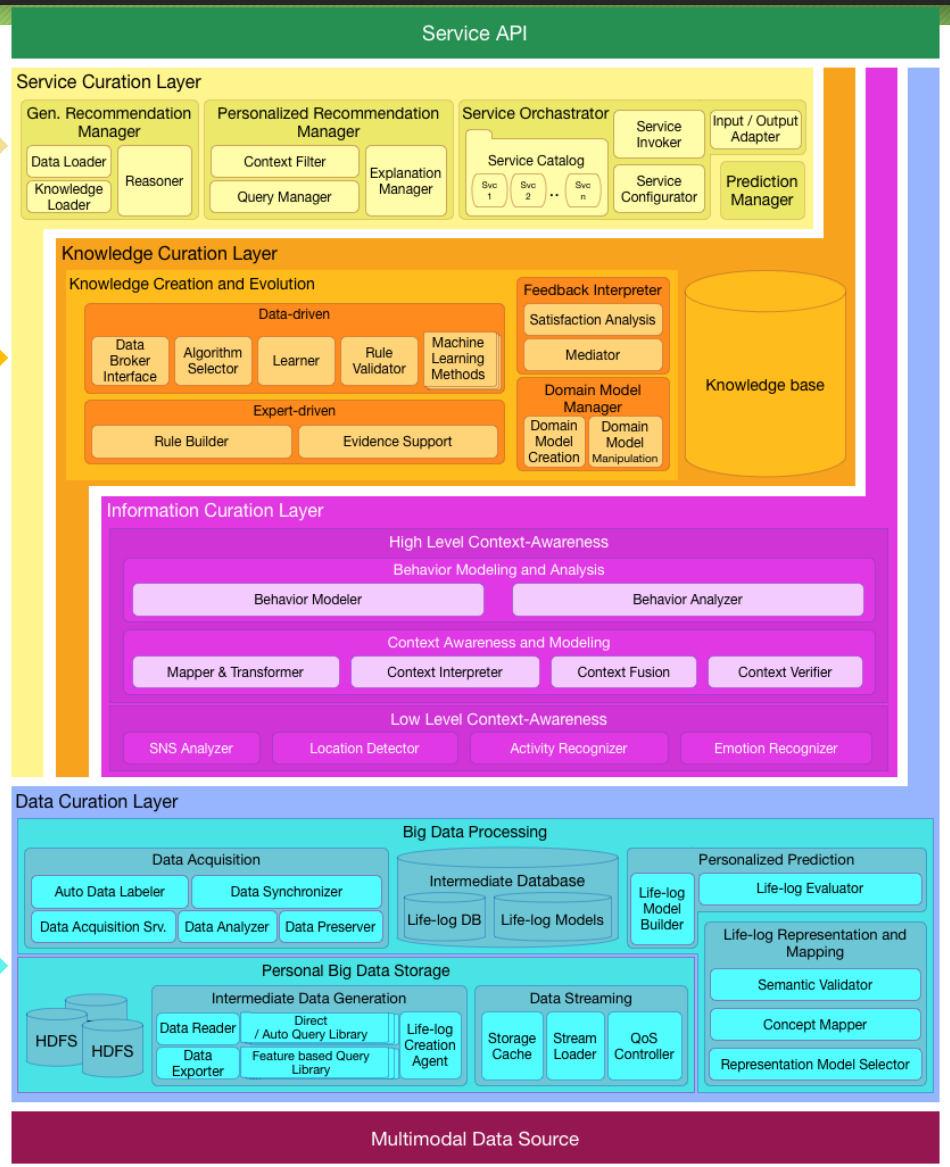


개선된 플랫폼 구조

Gen./Pers. Recommendations
Service Orchestrator
Prediction Manager

Knowledge Curation Layer

Lifelog Ontology
Personalized Prediction



Feedback Analysis

Analytics