Working Together to Develop Key Technologies for the Internet of Things

Towards Data Centric Computing for the Future of Internet of Things

Satoshi Sekiguchi, Ph.D.

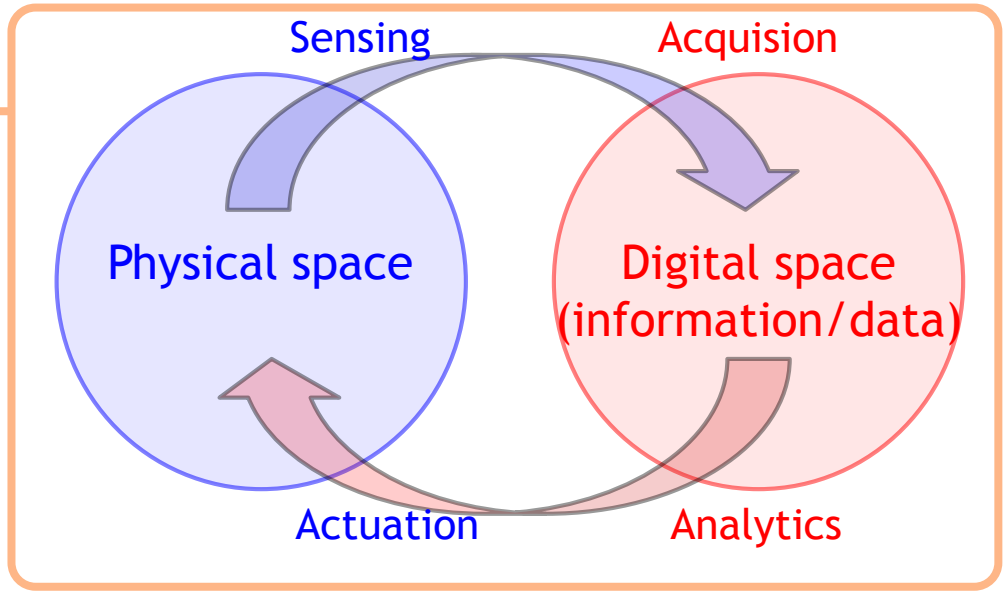
Director General,

Department of Information Technology and Human Factors,

National Institute of Advanced Industrial Science and Technology (AIST)

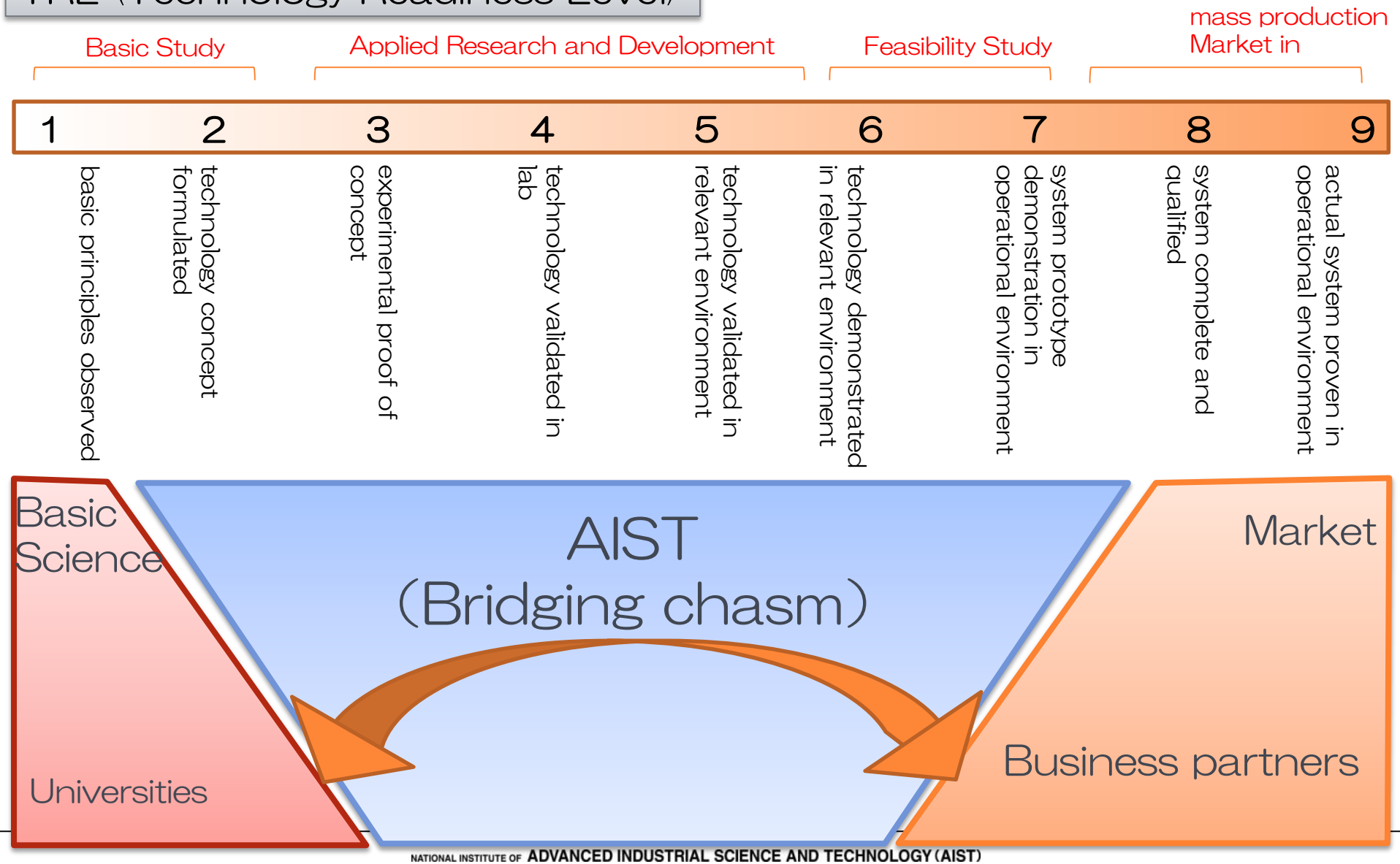
National Institute of Advanced Industrial Science and Technology, JAPAN

- AIST
  - Energy and Environment
  - Life Science
  - Information Technology and Human Factors（250FTE）
  - Material and Chemistry
  - Electronics and Manufacturing
  - Geological Survey
  - Metrology



AIST: Expected mission for innovation

TRL (Technology Readiness Level)

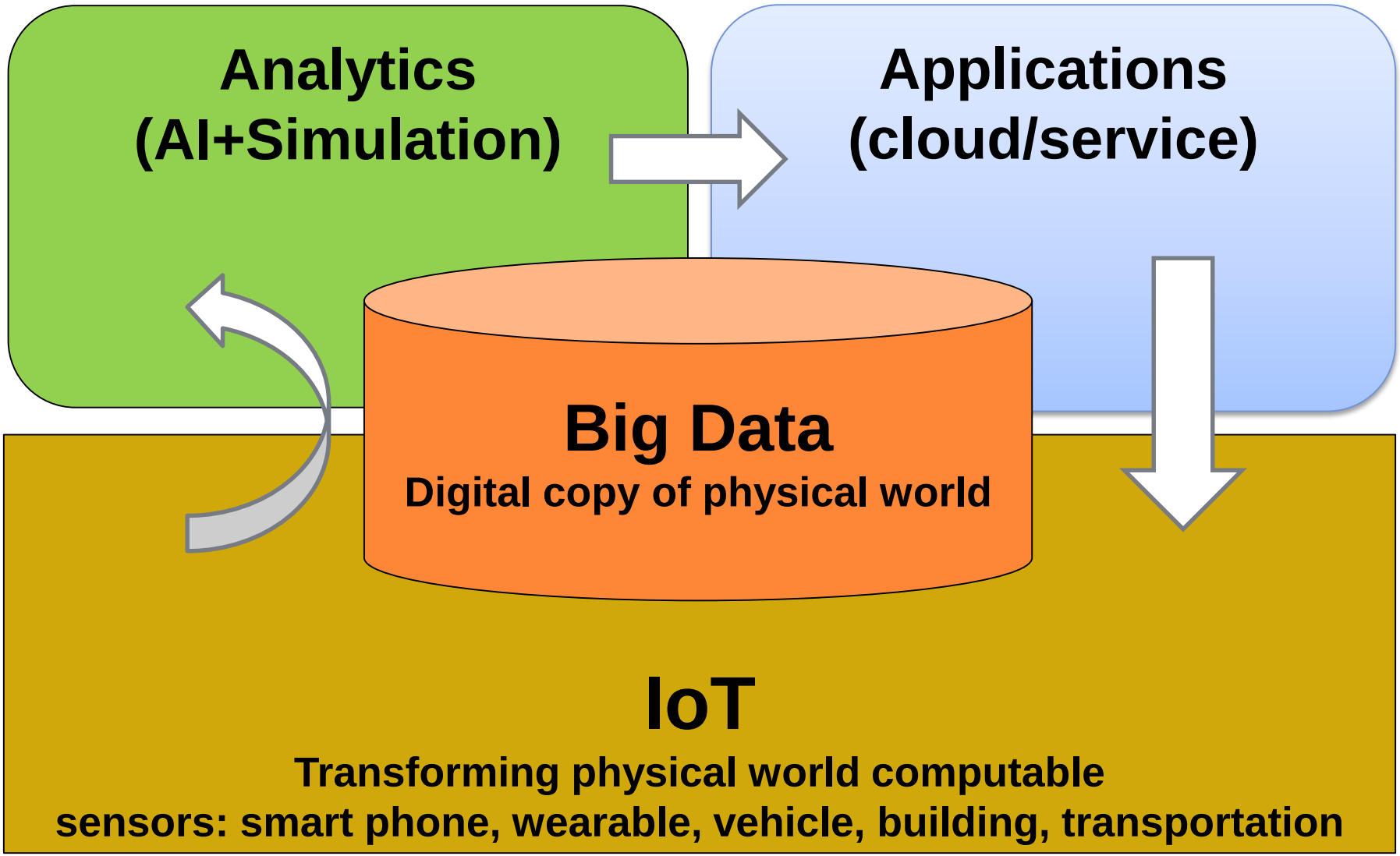


Key topic – "The Internet of Things" (IoT)

- IoT is the network of physical objects or "things"
  - embedded with electronics, software, sensors,
  - connectivity to enable objects to collect and exchange data.
- IoT allows objects to be sensed and controlled remotely across existing network infrastructure
  - creating opportunities for more direct integration between the physical world and computer-based systems,
  - resulting in improved efficiency, accuracy and economic benefit.

From Wikipedia, the free encyclopedia

The Trinity – IoT, Big Data, CPS changes the paradigm



Big DATA ANALYTICS

Gartner 2015 Hype Cycle: Big Data is Out, Machine Learning is in

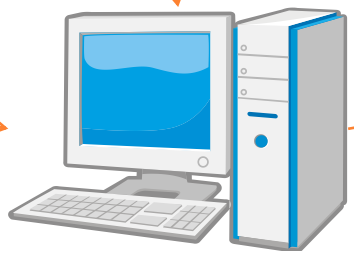
Anomaly detection for video surveillance

Learning samples

Usual motion

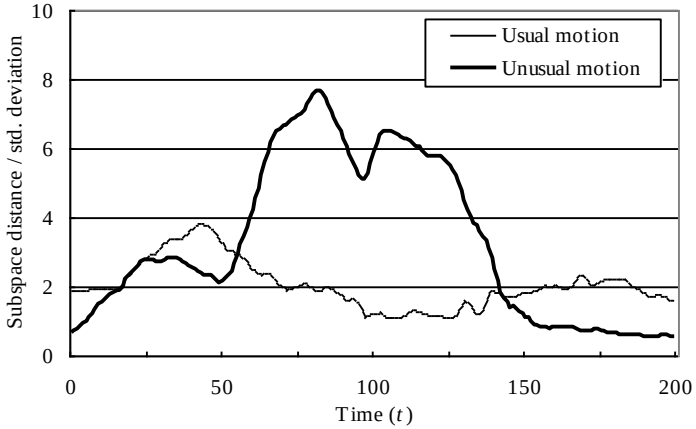
Input

Learning



Computer

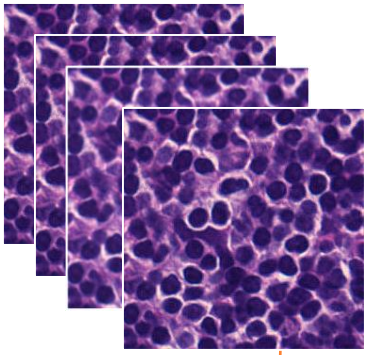
Detect anomaly



Unusual motion

slide by courtesy of Dr. K. Iwata

Anomaly detection for histological diagnosis

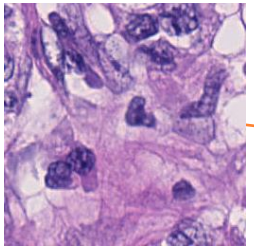


Learning sample

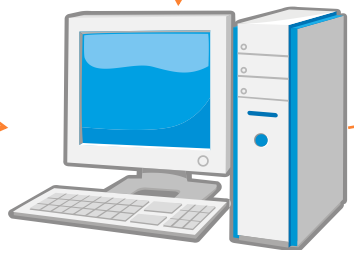
Normal tissue (non-cancer)

Learning

input



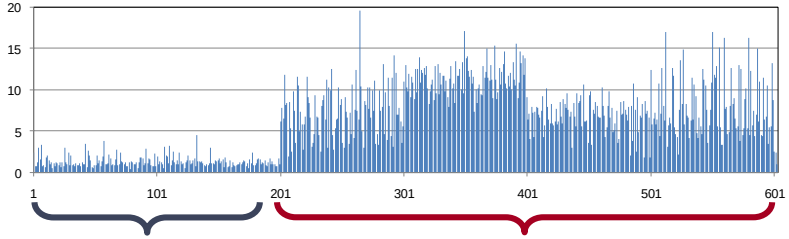
Cancer



computer

Detect anomaly (cancer)

The same method as the case of the video surveillance is applied.



non-cancer

cancer

slide by courtesy of Dr. K. Iwata

Anomaly detection

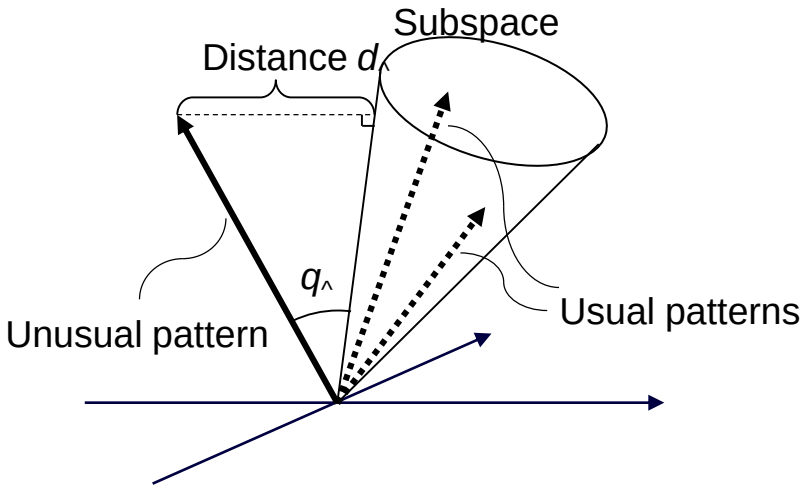
Subspace distance :

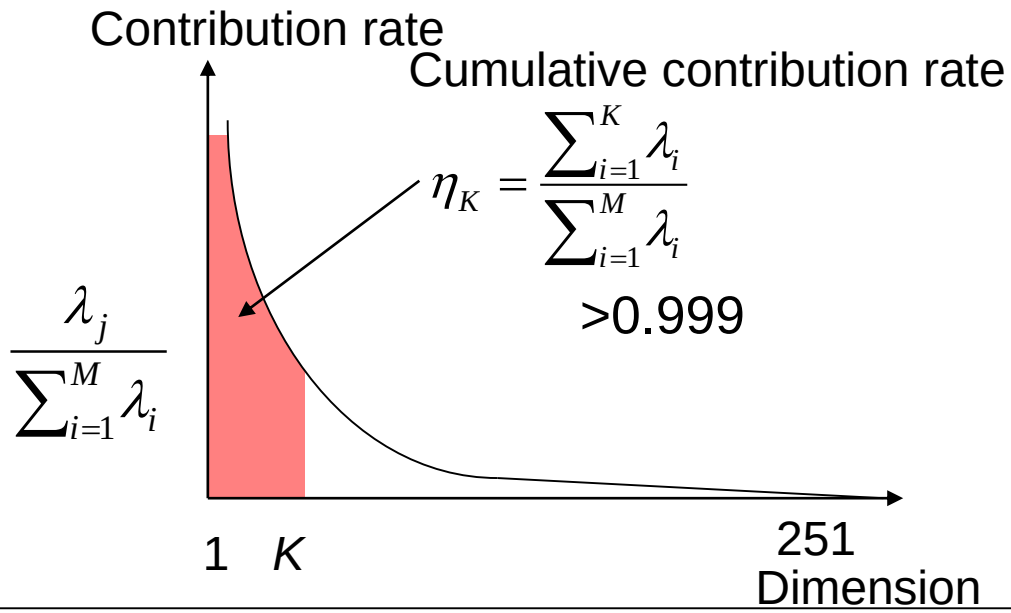
$$d_{\perp} = \left\| \boldsymbol{P}_{\perp} \boldsymbol{x} \right\|$$

$$\boldsymbol{P}_{\perp} = \left[\boldsymbol{u}_{K+1}, \cdots, \boldsymbol{u}_{251} \right]^{T}$$

$$\begin{cases} d_{\perp} \le n\sigma_K & \textbf{Usual} \\ d_{\perp} > n\sigma_K & \textbf{Unusual} \end{cases}$$

$$\sigma_K^2 = \sum_{i=K+1}^{M} \lambda_i$$





slide by courtesy of Dr. K. Iwata

Big Data: A key to success in Business

Big Data Everywhere

18B (2015) IC-tag ->in 2020 50B

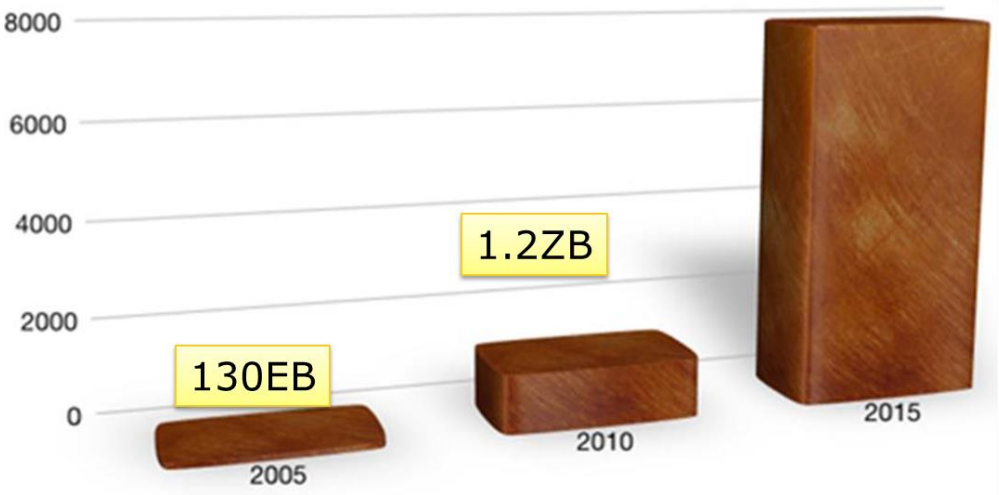
2.0B internet users (2011)
Traffic 667 Exabytes (2013)

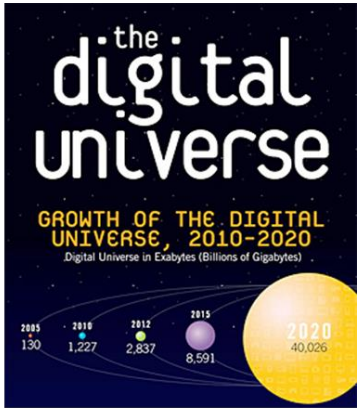
Facebook 10 Terabytes
Twitter 7 Terabytes
social data daily

4.6B Cell phones world wide

Google handles 24 Petabytes of data

NYC stock exchange handles
1 Terabyte of transactions





2020 40ZB
2012 EMC & IDC

CERN LHC generates 40 Terabytes/day

Big Data is/is not

Emerging story
- Small <10GB
- Medium 10GB-1TB
- Big > 1TB

September 4, 2008
(Volume 455 Number 7209)

- 'Big-data' is similar to 'Small-data', but bigger(*)
  - …but having data bigger consequently requires different approaches:
    - techniques, tools, architectures
  - …with an aim to solve new problems
    - …and old problems in a better way.

Big Data is multi-structured data

(*) Mark Globelnik "Big-Data tutorial" in 201

Big Data's 3Vs

Velocity（頻度）

Streaming Data

Batch

POS

Customer

Logs

Big Data

Structured

web

flickr

YouTube™

Terabytes

Structured & Unstructured

Zettabytes

movie files, images, documents, geo-location data, web logs, and text strings

Volume（量）

Variety（多様性）

Evidence based value creation

New value

Strengthening Management Capability
Business Advantages
Avoid risks

Knowledge

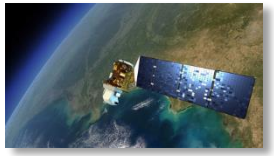
Analysis

Data

Cloud

Big Data

Wide variety of data



Big-data use-cases for industry segments

Finance & Insurance

- Detection of improper activities
- Transaction analysis
- Risk analysis
- Telematics Insurance

Communication & Broadcasting

- System log analysis
- Network analysis
- Audience rating
- Contents analysis

Commerce & Logistics

- Management of incentives and rewards
- Consumer sales marketing and promotion

Manufacturing

- Quality management
- Demand analysis
- Product traceability

Web and media

- Access log analysis
- Content analysis
- Analysis of social-media activities

Public sectors

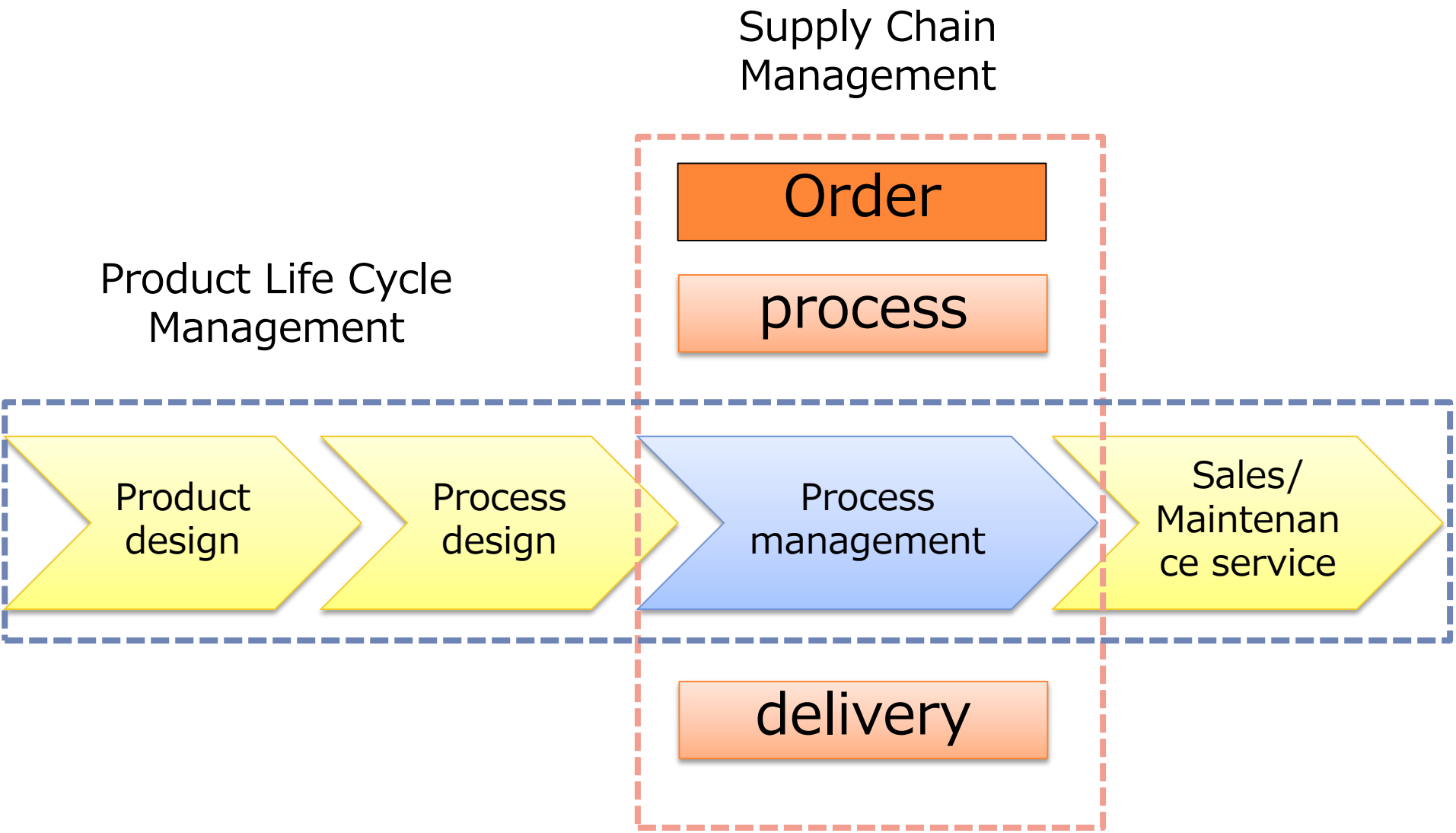
- Meteorology
- disaster mitigation
- Energy planning
- Risk mitigation

Based on
http://www.hitachi.co.jp/products/it/bigdata/column/column02.html

Big Data for Manufacturing

How many of you feel a reality of receiving benefit from IoT ?

Industry 4.0 production system

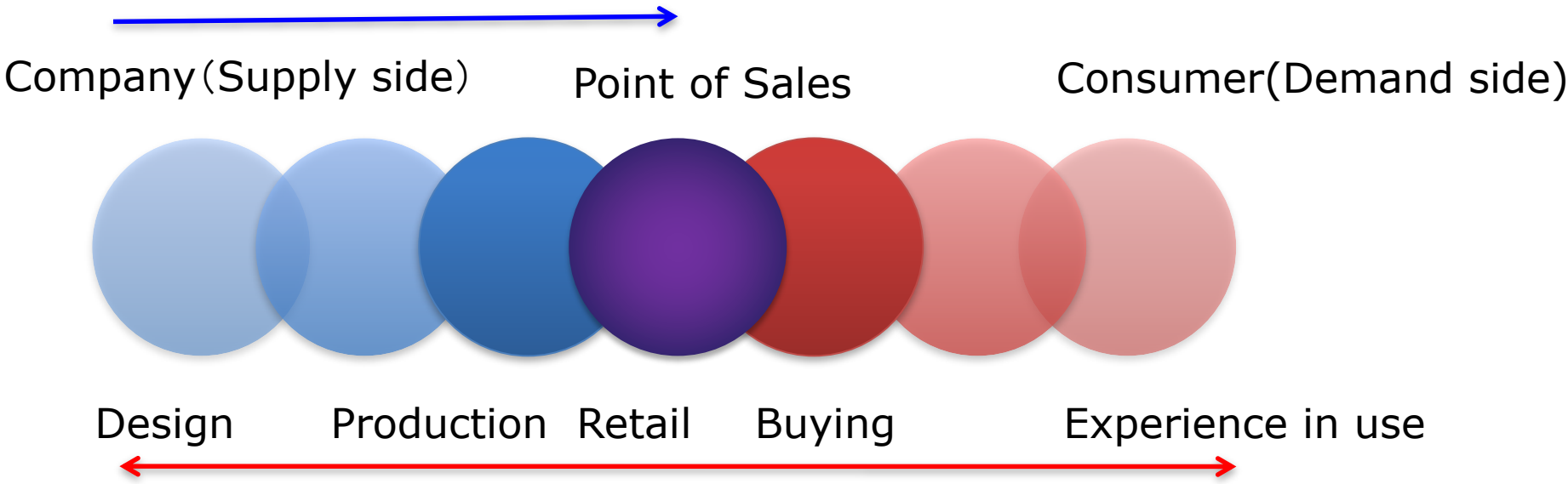


経済産業省作成図を元に作成

Paradigm shift in manufacturing industry

from manufacturing
(tangible object) to service (intangible value)

manufacturing: value chain of products (from supply side to consumers)



service: value chain of information between supply side and demand side
(Both of supply chain and demand chain)

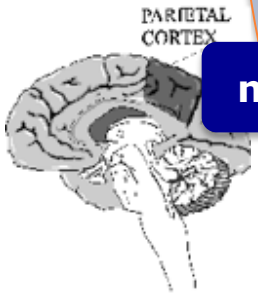
slide by courtesy of Dr. Y. Motomura

Big Data x Deep Data

Low accuracy, limited items, various context, large scale

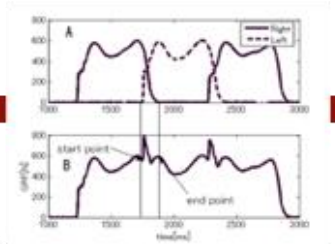
Big data accumulated through Services

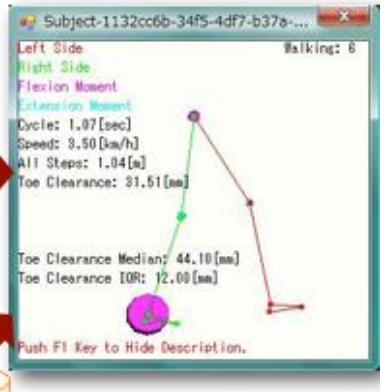
Deep data accumulated in labs



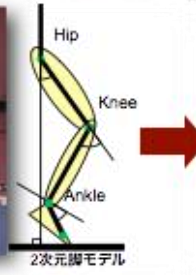
High accuracy, many items, small scale

サービス現場での計測





ラボでの詳細計測



詳細歩行データベース

slide by courtesy of Dr. M.Mochimaru

Insole Customization and Footwear Design

Measurement of customer's factors

Shape, Motion DB

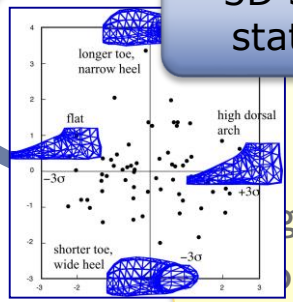
Human factors database

Development of shoes

Services

Products

3D Shape statistics



Modeling

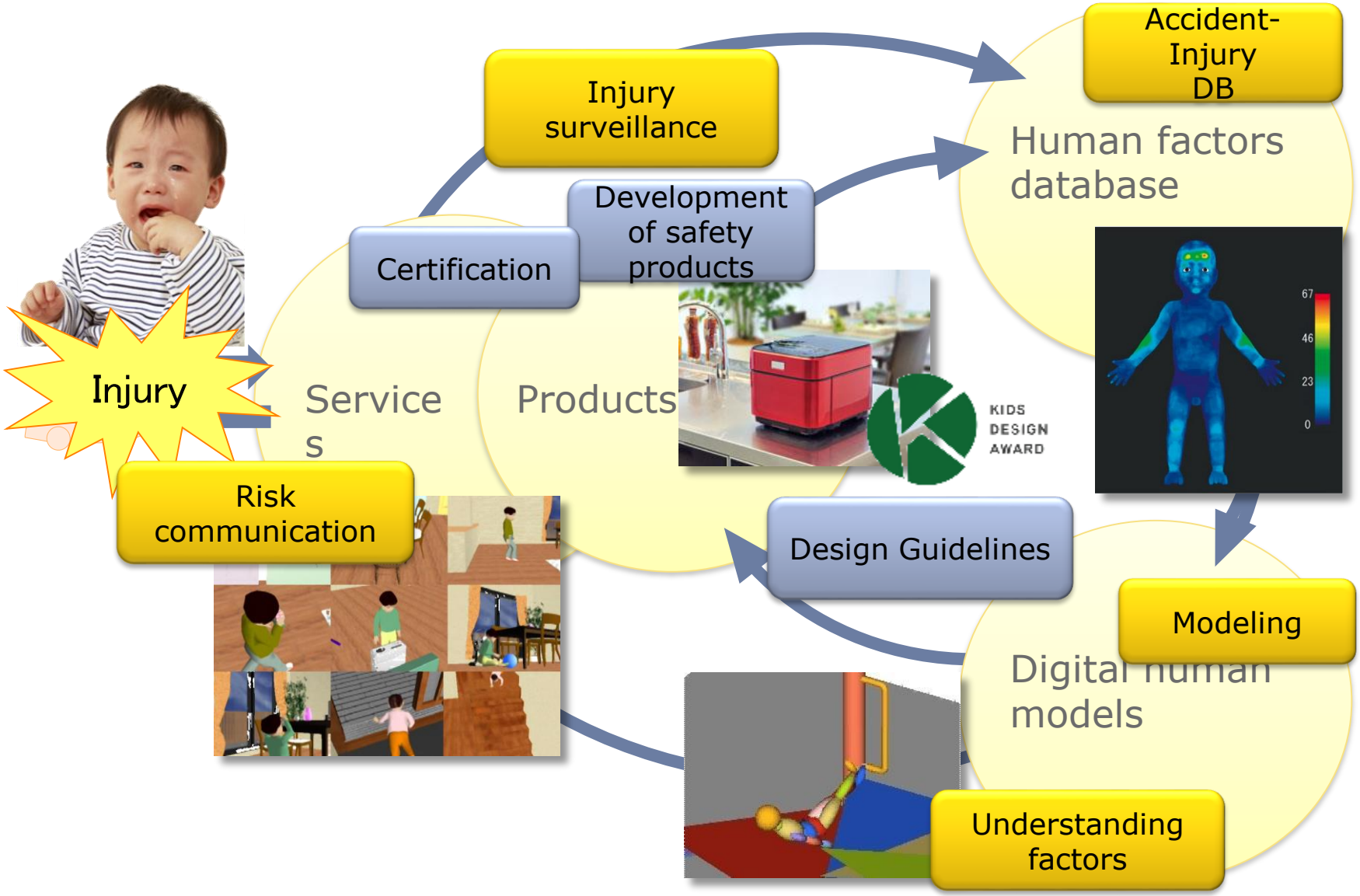
Recommendation of shoes

Customization of insoles

asics

slide by courtesy of Dr. M.Mochimaru

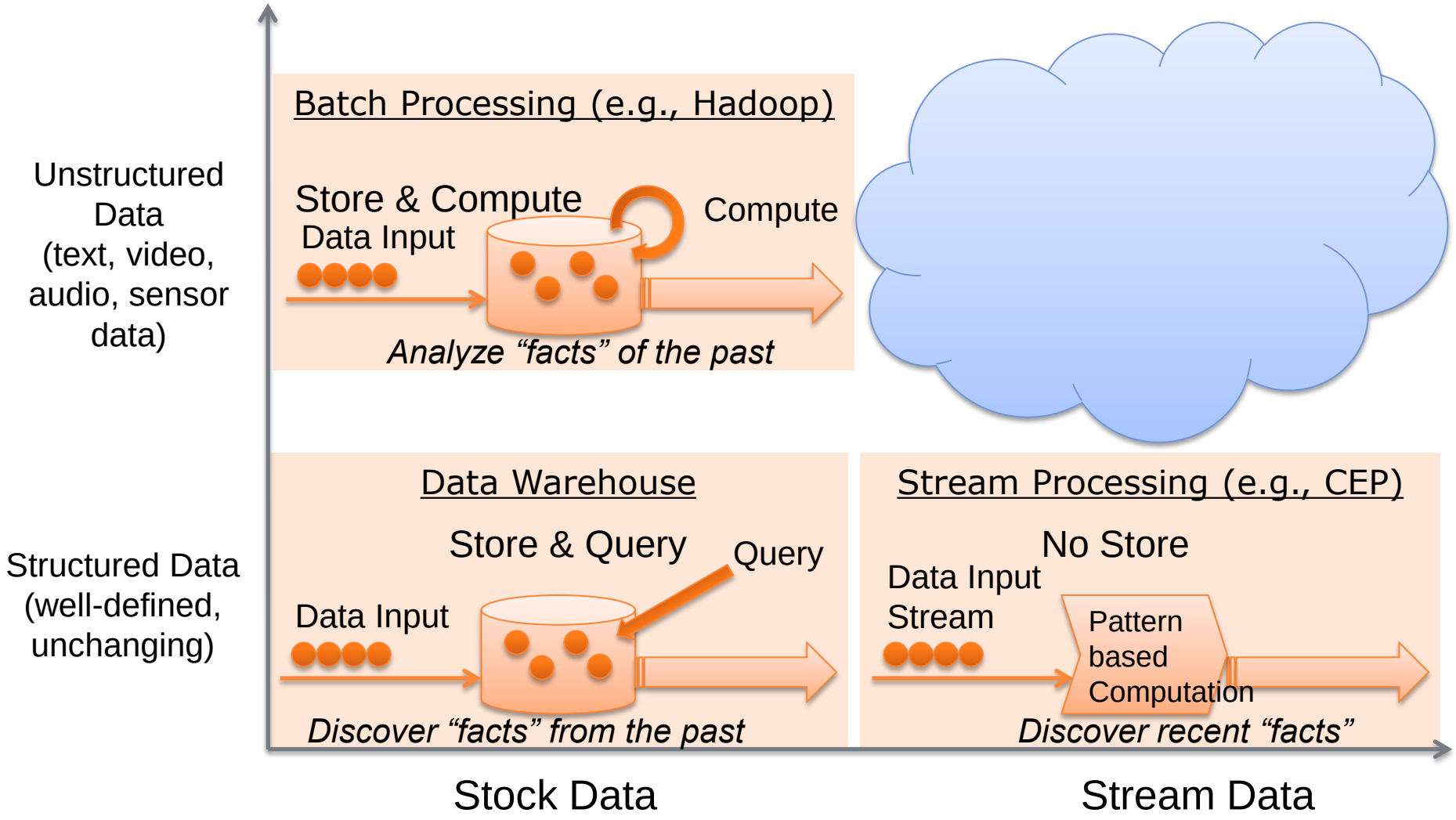
Child Safety through Design



slide by courtesy of Dr. M.Mochimaru

More Big Data Challenges

Big Data Challenges

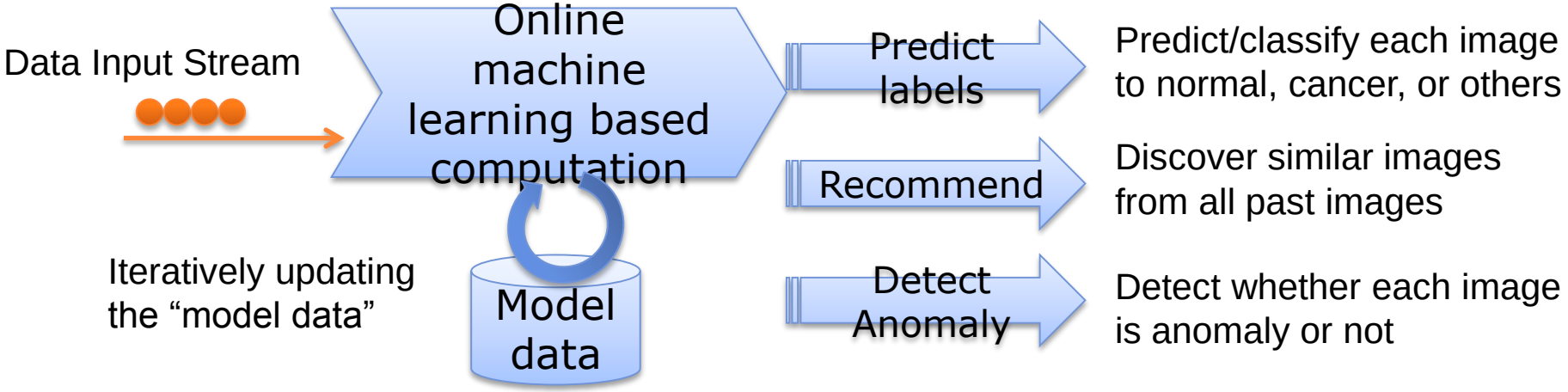


slide by courtesy of Dr. H. Ogawa

Real-time Analytics Platform for Big Data

- The platform must have a highly scalable online machine learning system
  - Continuously captures incoming streamed data
  - And performs deep analytics using machine learning algorithms, e.g., label prediction, recommendation, anomaly detection, etc.
  - Up to 10K real-time events can be processed in a second

Discover "facts" from the past on real-time +
Predict "future" using prior knowledge



slide by courtesy of Dr. H. Ogawa

IMPULSE: Initiative for Most Power-efficient Ultra-Large-Scale data Exploration

Non-Volatile Memory

- Voltage-controlled, magnetic RAM mainly for cache and work memories

Optical Network

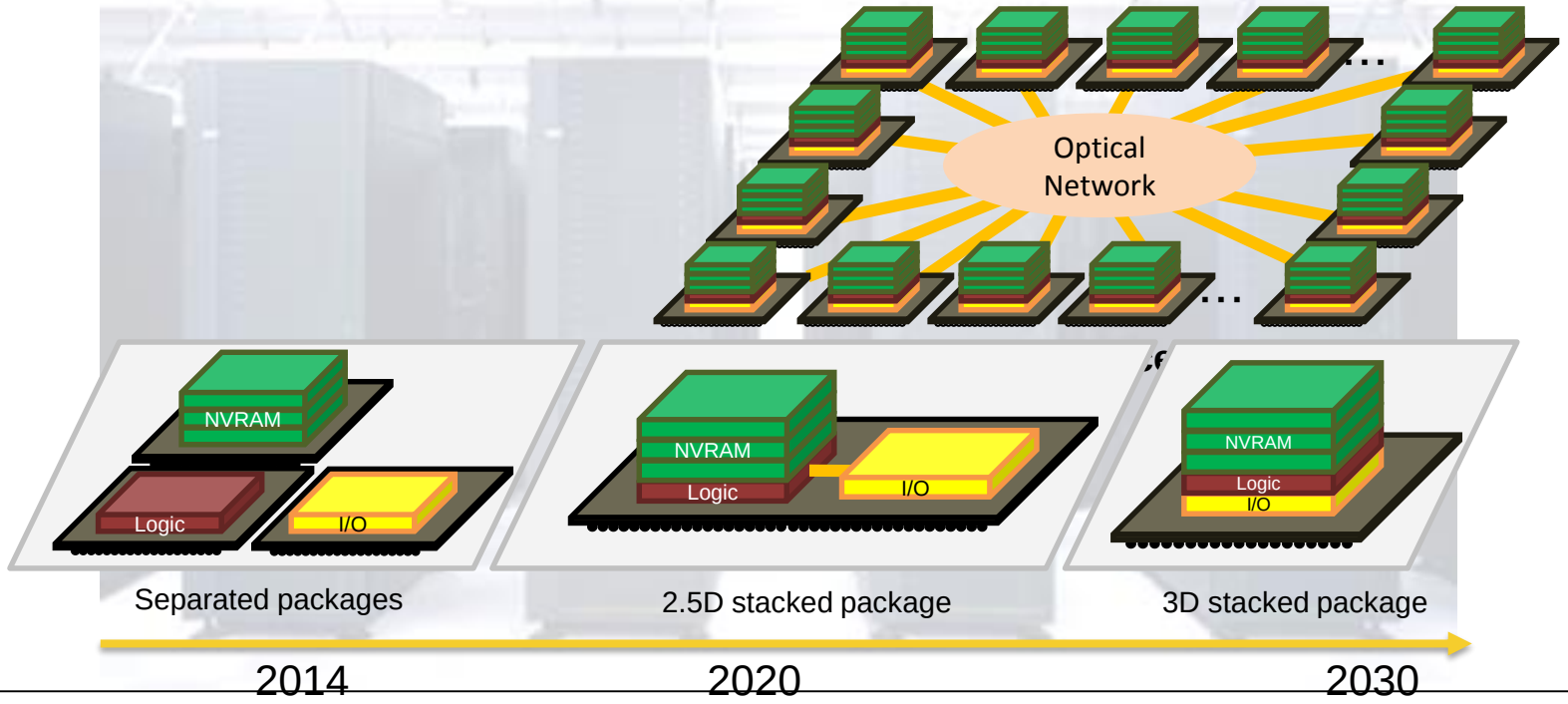
- Silicon photonics cluster SW
- Optical interconnect technologies

High-Performance Logic

- 3D build-up integration of the front-end circuits including high-mobility Ge-on-insulator FinFETs. / AIST-original TCAD

Architecture

- Future data center architecture design / Dataflow-centric warehouse-scale computing



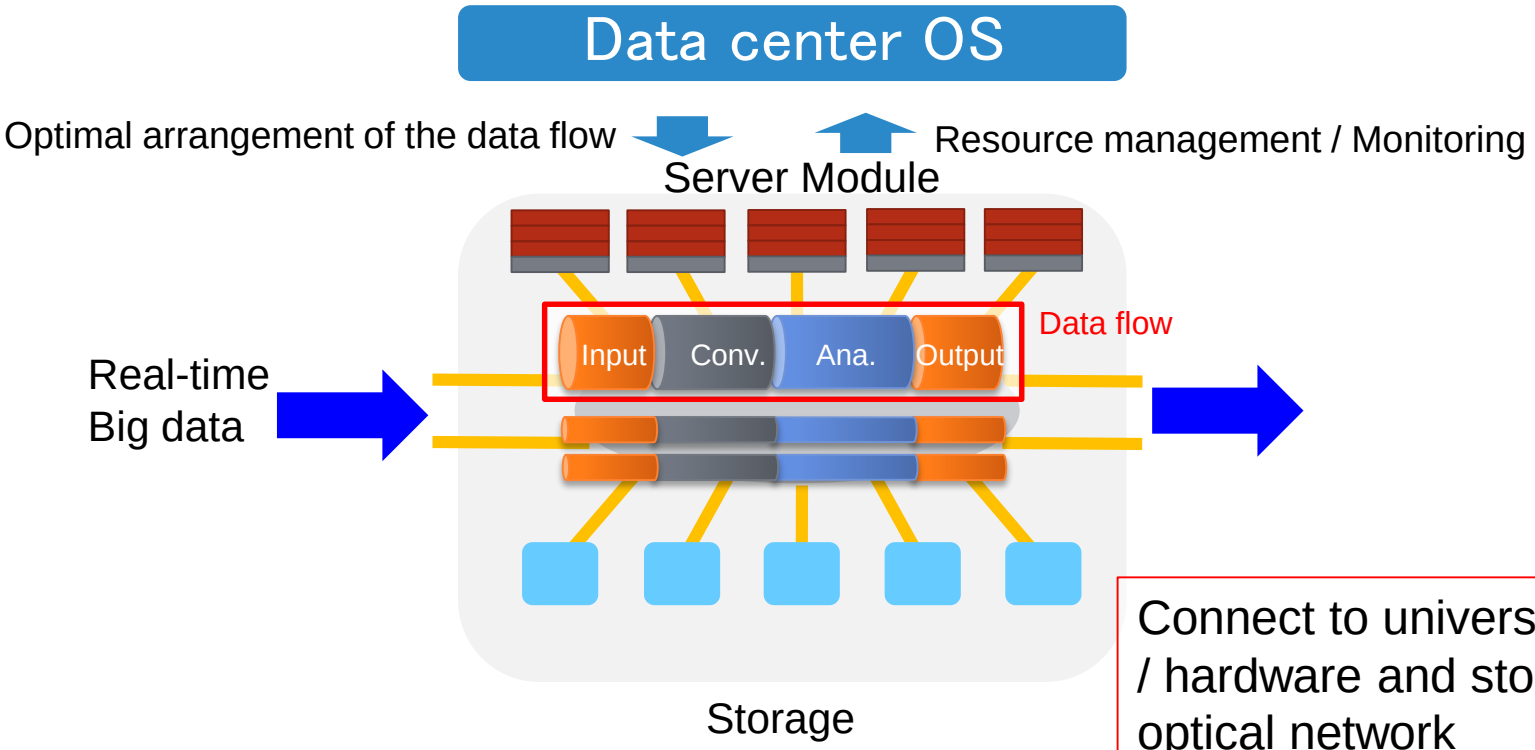
slide by courtesy of Dr. R. Takano

Architecture for Big Data and Extreme-scale Computing

Warehouse Scale and data flow centric computing

1 - Single OS controls entire data center

2 - Guarantee the real time data processing by the priority controlled architecture for data flow



Connect to universal processor / hardware and storage by using optical network

slide by courtesy of Dr. R. Takano

Final Remarks

- The Trinity – IoT/Big Data/CPS is the key to business success
- Your imagination will create value for new business and societal infrastructure.

- Another key area is Big Data X Manufacturing
  - beyond Industrie 4.0 and/or Industrial Internet

- Think about architectures for future data centers to deal your big data

- Many opportunities to work together in Business and Research.

Thank you !