Intelligent Computing, Hyperconnected Cloud*, and Fujitsu

Dr. Hideyuki Saso
CEO and Representative Director
Fujitsu Laboratories Ltd.
June 24, 2015

*Hyperconnected cloud: refers to one of Fujitsu Laboratories' visions related to ICT evolution
ICT is driving a New Industrial Revolution

- Hyperconnected World
- ICT advances are enabling diverse innovations
## Transformations in Artificial Intelligence (AI), Computing, and Data

<table>
<thead>
<tr>
<th>Year</th>
<th>Project</th>
<th>System</th>
<th>Turing Machine</th>
<th>Computing Power</th>
<th>Data</th>
<th>File System</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>1st Gen AI</td>
<td>1st Gen AI</td>
<td>1st Gen AI</td>
<td>1st Gen AI</td>
<td>1st Gen AI</td>
<td>1st Gen AI</td>
</tr>
<tr>
<td>1960</td>
<td>1st Gen AI</td>
<td>1st Gen AI</td>
<td>1st Gen AI</td>
<td>1st Gen AI</td>
<td>1st Gen AI</td>
<td>1st Gen AI</td>
</tr>
<tr>
<td>1970</td>
<td>1st Gen AI</td>
<td>1st Gen AI</td>
<td>1st Gen AI</td>
<td>1st Gen AI</td>
<td>1st Gen AI</td>
<td>1st Gen AI</td>
</tr>
<tr>
<td>1980</td>
<td>2nd Gen AI</td>
<td>2nd Gen AI</td>
<td>2nd Gen AI</td>
<td>2nd Gen AI</td>
<td>2nd Gen AI</td>
<td>2nd Gen AI</td>
</tr>
<tr>
<td>1990</td>
<td>2nd Gen AI</td>
<td>2nd Gen AI</td>
<td>2nd Gen AI</td>
<td>2nd Gen AI</td>
<td>2nd Gen AI</td>
<td>2nd Gen AI</td>
</tr>
<tr>
<td>2000</td>
<td>2nd Gen AI</td>
<td>2nd Gen AI</td>
<td>2nd Gen AI</td>
<td>2nd Gen AI</td>
<td>2nd Gen AI</td>
<td>2nd Gen AI</td>
</tr>
<tr>
<td>2010</td>
<td>3rd Gen AI</td>
<td>3rd Gen AI</td>
<td>3rd Gen AI</td>
<td>3rd Gen AI</td>
<td>3rd Gen AI</td>
<td>3rd Gen AI</td>
</tr>
<tr>
<td>2020</td>
<td>3rd Gen AI</td>
<td>3rd Gen AI</td>
<td>3rd Gen AI</td>
<td>3rd Gen AI</td>
<td>3rd Gen AI</td>
<td>3rd Gen AI</td>
</tr>
</tbody>
</table>

- **1st Generation AI**
  - Era of search and Deductive inference
- **2nd Generation AI**
  - Era of knowledge Acquisition
- **3rd Generation AI**
  - Era of Machine learning

### Project
- **AI term coined** (Dartmouth conference) ['56]
- **Massive AI Project established** (Japan ICOT ['82], U.S. MCC ['83], U.K. Alvey ['84])
- **AI's failures** (Lighthill report) ['73]
- **DEC R1** ['82]
- **ELIZA language processing program developed**
- **Mycin diagnostics program developed** ['73]
- **Deep Blue victory** ['97]
- **K computer** 1 PFlop
- **ASCI Red** 2.4 TFlops
- **CM-5/1024** 60 GFlops
- **Cray-1** 160 MFlops
- **VP-400** 1 GFlops
- **Integrated Data Base (GE社)【'64】**
- **Relational Database (Acceleration)**
- **Column-Oriented DB**
- **In-Memory DB**
- **Graph Database (Full-scale Utilization)**
- **Multimedia DB (IoT, Imagery, Video)**

### System
- **Turing test proposed**
- **Expert System Artificial Incompetence**
- **Agent System Cognitive Computing**

### Computing Power
- **Exascale ~1 EFlop**

### Data
- **Structured (SQL)**
- **Unstructured (NoSQL)**
- **Big Data (40 ZB)**
- **Transformations in Artificial Intelligence (AI), Computing, and Data**

---

Copyright 2015 FUJITSU LABORATORIES LTD.
Fujitsu Laboratories’ R&D Initiatives in Intelligent Computing
Intelligent Computing: Overview of R&D and Applications
Bringing AI to the cloud: Integration from front end to back end to create Collective Intelligence
Core ICT

- Human-Centric Era
  - Network Era
    - Computer Era

Information: Safe and Secure Intelligent Computing interlinked with Clouds

People: Hyperconnected Networking connecting People, Information, and Things

Infrastructure: Integrated Infrastructure supporting Hyperconnected Clouds

- Computer Era
- Network Era
- Human-Centric Era

- Page 6
Fujitsu Laboratories’ worldview of ICT evolution: Hyperconnected Cloud

- From Server Consolidation-based usage (Servers/Storage/Applications), to Clouds
- Further permeation of Cloud Architecture, to Front-End Networks and Devices
- Hyperconnected Cloud, comprised of amoeba-like interlinkages of Multiple Clouds
Big Intelligence

The Social Cortex

Source: THE SOCIAL BRAIN HYPOTHESES, DUNBAR 1998

Average social group size vs. Size of neocortex relative to rest of brain

Monkeys = Apes

Humans = 150

1× 2× 3× 4× 5× 6×

Intelligence

Connection & Traffic

Hyper-Connection

Big Intelligence

Multi-Agent System

Expert System

Internet

Telephone

Typography

Big Data

Data Volume

Source: THE SOCIAL BRAIN HYPOTHESES, DUNBAR 1998
Creating Intelligence from Data

- IT Infrastructures
  - Servers & Storage
  - Datacenters

- Knowledge Base
  - LOD, Ontology
  - Knowledge System

- Algorithms
  - Application
    - Q&A Sys.
    - Med. Diagnosis
    - Image Recognition
    - Education
  - Context Awareness
    - Situational understanding
  - Reasoning
    - Problem solving, Optimization
  - Machine Learning
    - Deep Learning, Online Learning

- Social Science
  - Social Mathematics
    - Policy design and evaluation
  - Simulation
    - Virtual verification, Virtual data generation
  - Neuroscience
    - Neuroscience insights
  - Data Analytics

Big Data High Speed Processing

Data Collection

Interfaces
- Graphics
- Audio
- Video
- Web/SNS
- Sensor
- GPS
- Timeline
Applicability and Social Acceptance

- Agriculture
- Education / Life
- Transportation / Logistics
- Social Infrastructure
- Energy
- Natural Disaster Countermeasures

- Increase income
- Improve learning
- Reduce congestion
- Improve safety
- Balance demand and supply
- Alleviation of natural disaster damage

Social Policy Design

Social System Modeling Technologies

Technologies for Leveraging Data

Policy Refinement

Social Policy Evaluation
Leveraging Intelligent Computing to enhance Solutions for Existing/New Domains

- Business Models
- Social Acceptance
- AI Core Technology
- Big Data
- Healthcare
- Automotive
- Energy
- Transportation
- Social Infrastructure
- Environmental
- Robotics
- Digital Content
- Sports

Interfaces/Algorithms/Knowledge Base/IT Infrastructure/Social Science
Innovation

= Invention × Business Models
Cautionary Statement

These presentation materials and other information on our meeting may contain forward-looking statements that are based on management’s current views and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in such statements. Words such as “anticipates,” “believes,” “expects,” “estimates,” “intends,” “plans,” “projects,” and similar expressions which indicate future events and trends identify forward-looking statements. Actual results may differ materially from those projected or implied in the forward-looking statements due to, without limitation, the following factors:

• general economic and market conditions in the major geographic markets for Fujitsu’s services and products, which are the United States, EU, Japan and elsewhere in Asia, particularly as such conditions may effect customer spending;
• rapid technological change, fluctuations in customer demand and intensifying price competition in the IT, telecommunications, and microelectronics markets in which Fujitsu competes;
• Fujitsu’s ability to dispose of non-core businesses and related assets through strategic alliances and sales on commercially reasonable terms, and the effect of realization of losses which may result from such transactions;
• uncertainty as to Fujitsu’s access to, or protection for, certain intellectual property rights;
• uncertainty as to the performance of Fujitsu’s strategic business partners;
• declines in the market prices of Japanese and foreign equity securities held by Fujitsu which could cause Fujitsu to recognize significant losses in the value of its holdings and require Fujitsu to make significant additional contributions to its pension funds in order to make up shortfalls in minimum reserve requirements resulting from such declines;
• poor operating results, inability to access financing on commercially reasonable terms, insolvency or bankruptcy of Fujitsu’s customers, any of which factors could adversely affect or preclude these customers’ ability to timely pay accounts receivables owed to Fujitsu; and
• fluctuations in rates of exchange for the yen and other currencies in which Fujitsu makes significant sales or in which Fujitsu’s assets and liabilities are denominated, particularly between the yen and the British pound and U.S. dollar, respectively.