

TOSHIBA

Leading Innovation >>>

Toshiba Group R&D Strategies

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TOSHIBA CORPORATION

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Forward-looking Statements

- **This presentation contains forward-looking statements concerning Toshiba Group's future plans, strategies and performance.**
- **These forward-looking statements are not historical facts, rather they represent assumptions and beliefs based on economic, financial and industry data currently available.**
- **As a global entity, operating a wide range of businesses in countries and regions with different market environments, Toshiba wishes to caution that actual results may differ from our expectations due to risks and uncertainties that, without limitation, relate to economic conditions, worldwide mega-competition in the electronics business, customer demand, foreign currency exchange rates, tax rules, regulations and other factors.**
- **The company changed the structure of its internal organization in fiscal year 2011. Prior period data relating to the consolidated segment information has been reclassified to conform with the current classification.**

> I. Solutions for Total Innovations

- **Total Storage Innovations**
- **Total Energy Innovations**
- **Further Speed Up the Pace of Innovation
/ World's First and World's No. 1**
- **Intellectual Property Strategies**

II. Global R&D Management

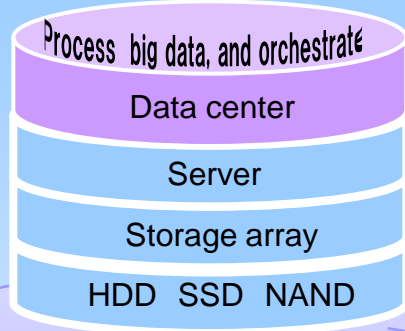
- **Global R&D Structure**
- **Intellectual Property Strategies**
- **R&D Investment**

Toshiba's Smart Community Business

**Big Data, Cloud,
Ensuring security**

**Secure highly-efficient,
stable power source**

Total Storage Innovation



Digital products solutions

Retail solutions

Smart Community

Healthcare solutions

Home solutions

Total Energy Innovation

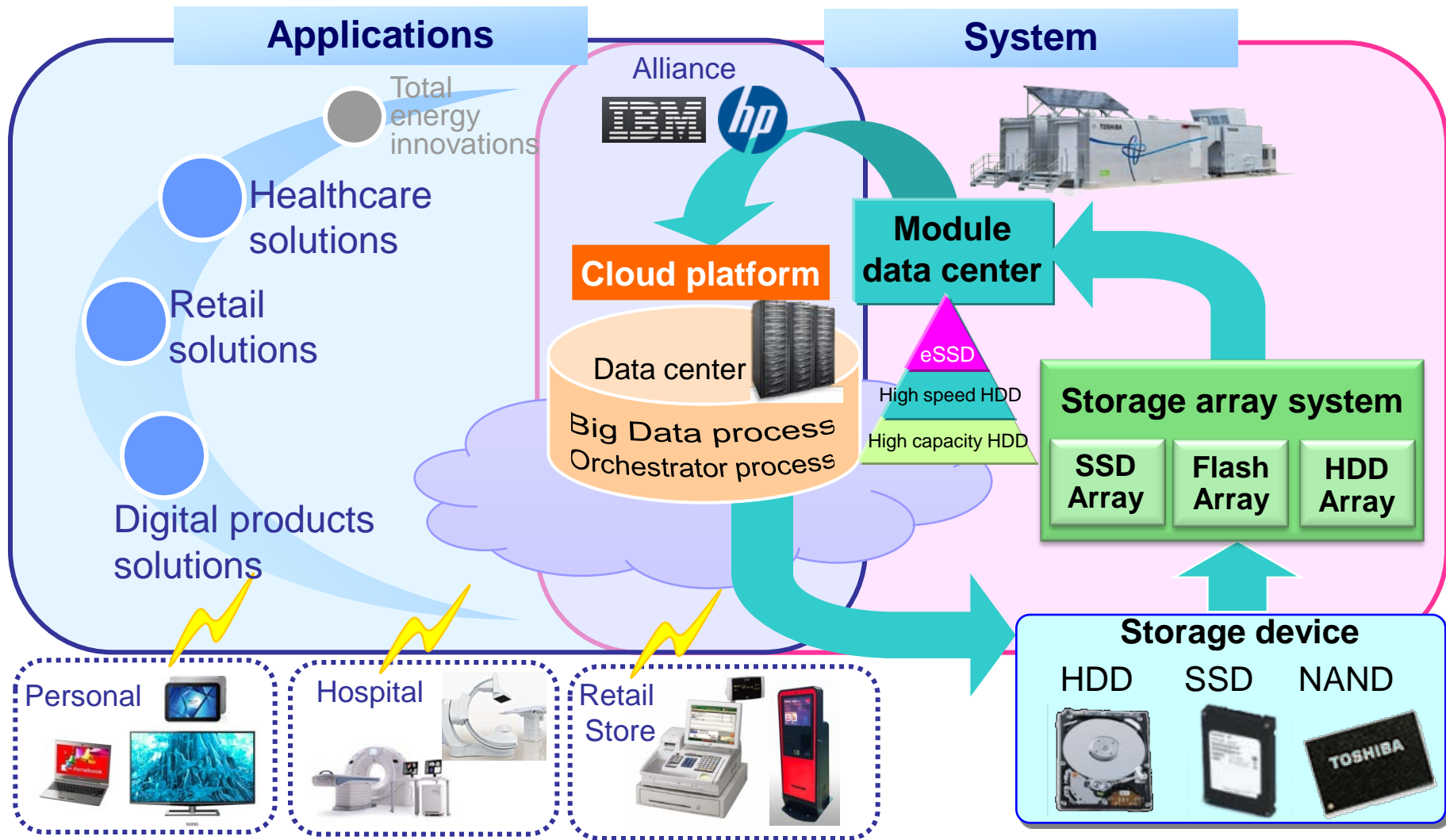
Base power

Renewable energy

Power electronics, EV

Factory, building solutions

Total Storage Innovations



Provide applications/system to meet Big Data requirements

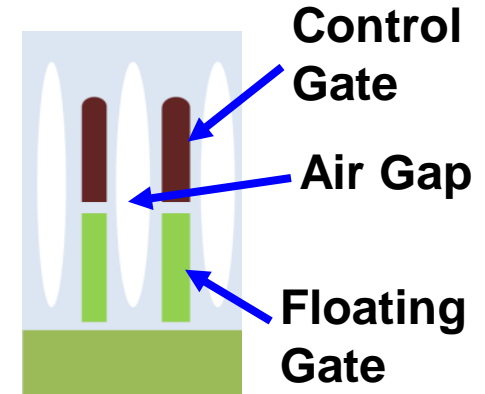
NAND Flash Memories

Maintain competitive edge in chip size.

- World's most advanced 19nm process
 - New structure with air gaps that suppress interferences between memory cells
- Chip-shrinking technology
 - Shrink peripheral circuit size by altering the architecture
- * 14.5% smaller than competitor's chip (21nm 64Gb)

Collaboration
SanDisk

Patent Application
over 100

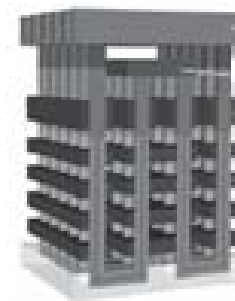


New Structure Example

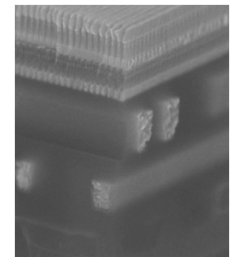
3D memories going beyond geometry shrinking

- High-capacity and low-bit cost solutions
 - BiCS: Memory cell stacking (≥ 16 layers)
 - ReRAM: Utilizes resistance changes (Development of thin-film materials)

Patent Application
over 700



BiCS



ReRAM

Data Centers

- Cloud infrastructure development and Providing application solutions

Storage array systems

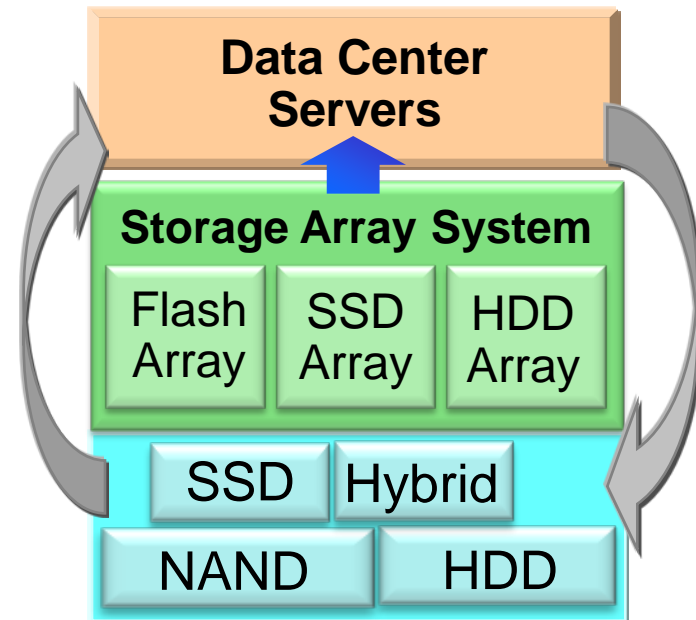
- Storage Layering Technology
 - Optimization takes advantage of the SSD and HDD
 - Proper system configuration for speed (27 times) and power saving (reduced by 40%) (compared to HDD system)

Storage devices

- Large capacity HDD solutions
 - 25% increase disk capacity by using SMR*1
- High-performance & high-reliability SSD solutions
 - Development of controllers (Proprietary ECC suitable for NAND and 3D memories)

Patent Application
over 3000

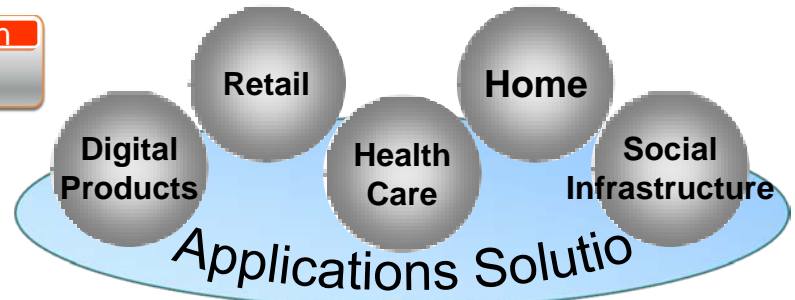
Patent Application
over 300



*1 Shingled Magnetic Recording: Method of overlapping the written data tracks

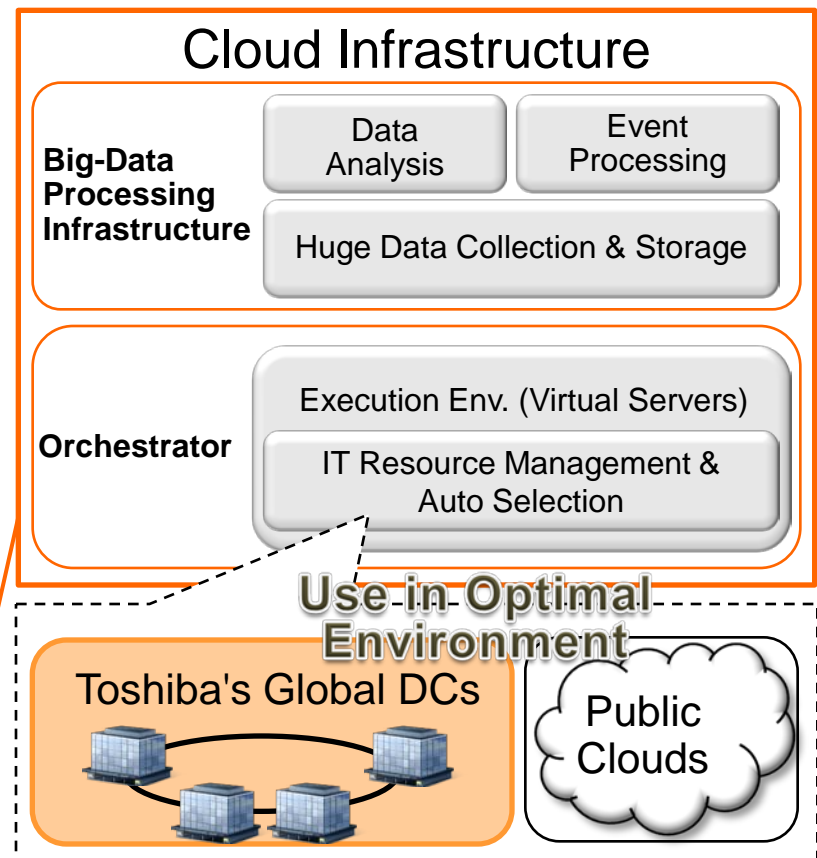
Big-data usage infrastructure.

Collaboration
IBM, hp



- Big-data processing
 - Petabyte performance
 - Real-time event processing to accommodate sensor data of over 10 millions of households

- Orchestration
 - Dynamic resource allocation of Toshiba Data Center and public cloud resources



From social infra. to BtoB and BtoC

BtoC solutions

Patent Application
over 100

● Lifestyle analysis

- Analyze user actions and preferences, based on data from in-home appliances.
- Present recommendations appropriate to situations.

● Image recognition & retrieval

- Efficient big-data search thru. video analysis (face recognition, scene classification)

Patent Application
over 100

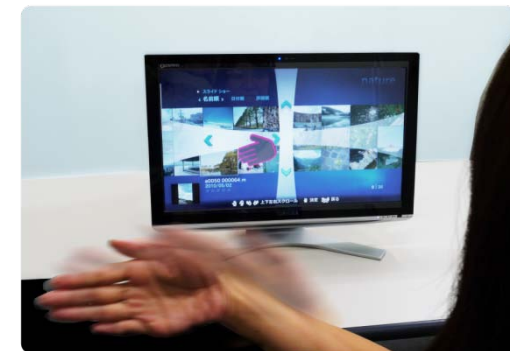
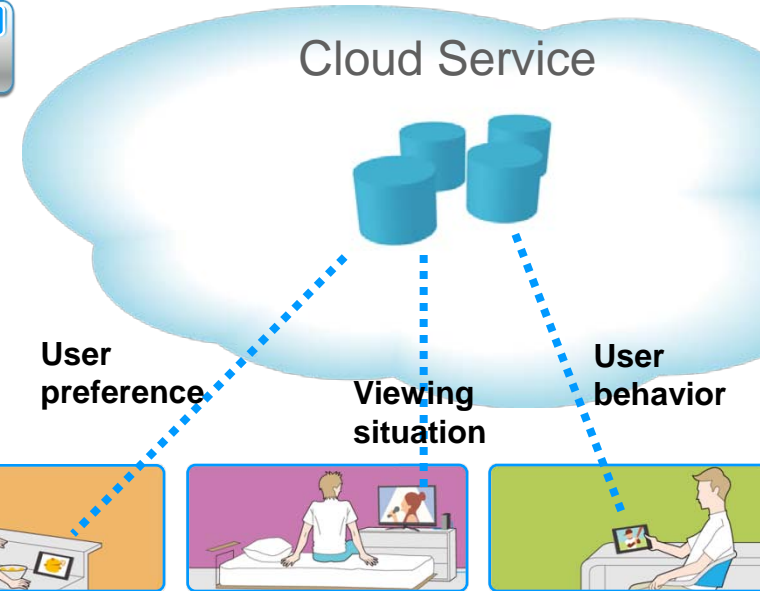
● UI ideal for cloud services

Patent Application
over 100

- Consistent and easy-to-use gesture/voice UI

● Interactions among appliances

- Seamless access to services and content thru. interactions among TVs, PCs and tablets



Solutions for retail stores

- POS big-data clouding
 - Demand predictions based on POS data and market trends
 - Online supermarket clouding: Web shopping
- Smart settlement technology
 - Merchandise object recognition and sensing

Solutions for shoppers

- Content distribution
 - High-speed close proximity wireless transfer (TransferJet™)
- Real-virtual fusion technology
 - AR technology, digital signage
 - Secure comm. for remote shopping

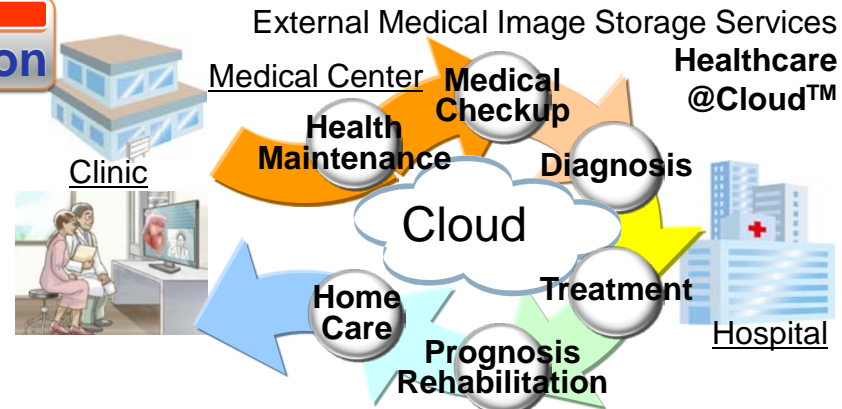
Collaboration
IBM
Patent Application
over 100



Healthcare IT

Collaboration
Vital, Amazon

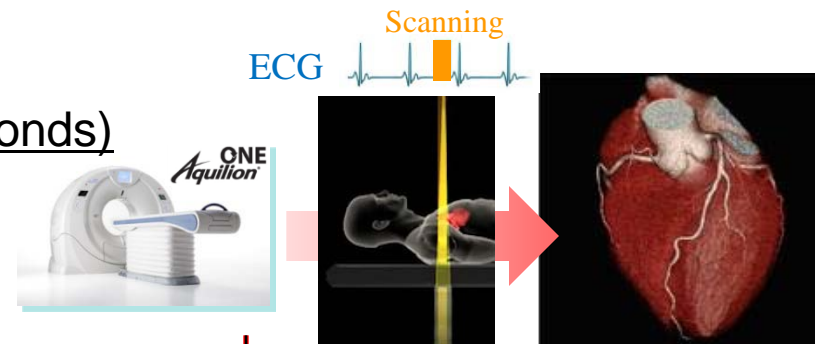
- Storage, distribution and analysis of huge clinical data
 - Expansion of healthcare cloud services and clinical applications



Diagnostic imaging

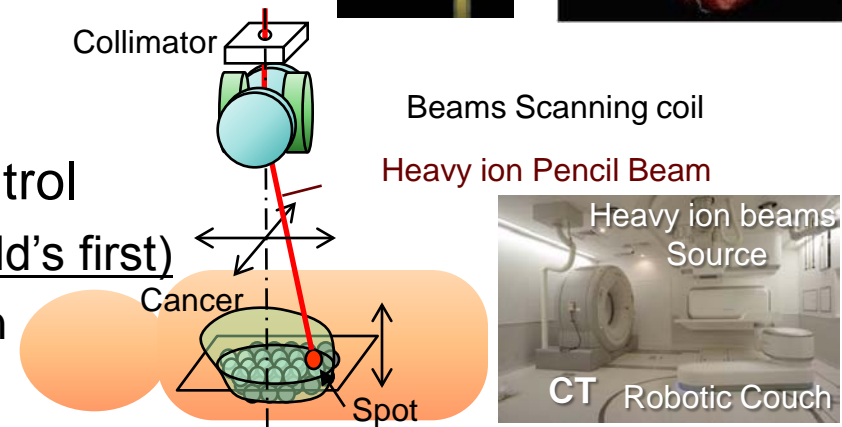
- High-safety medical sensing
 - Single-heartbeat CT heart scan (0.275 seconds)
 - Low-dose image reconstruction (75% less radiation dose)

Patent Application
over 100

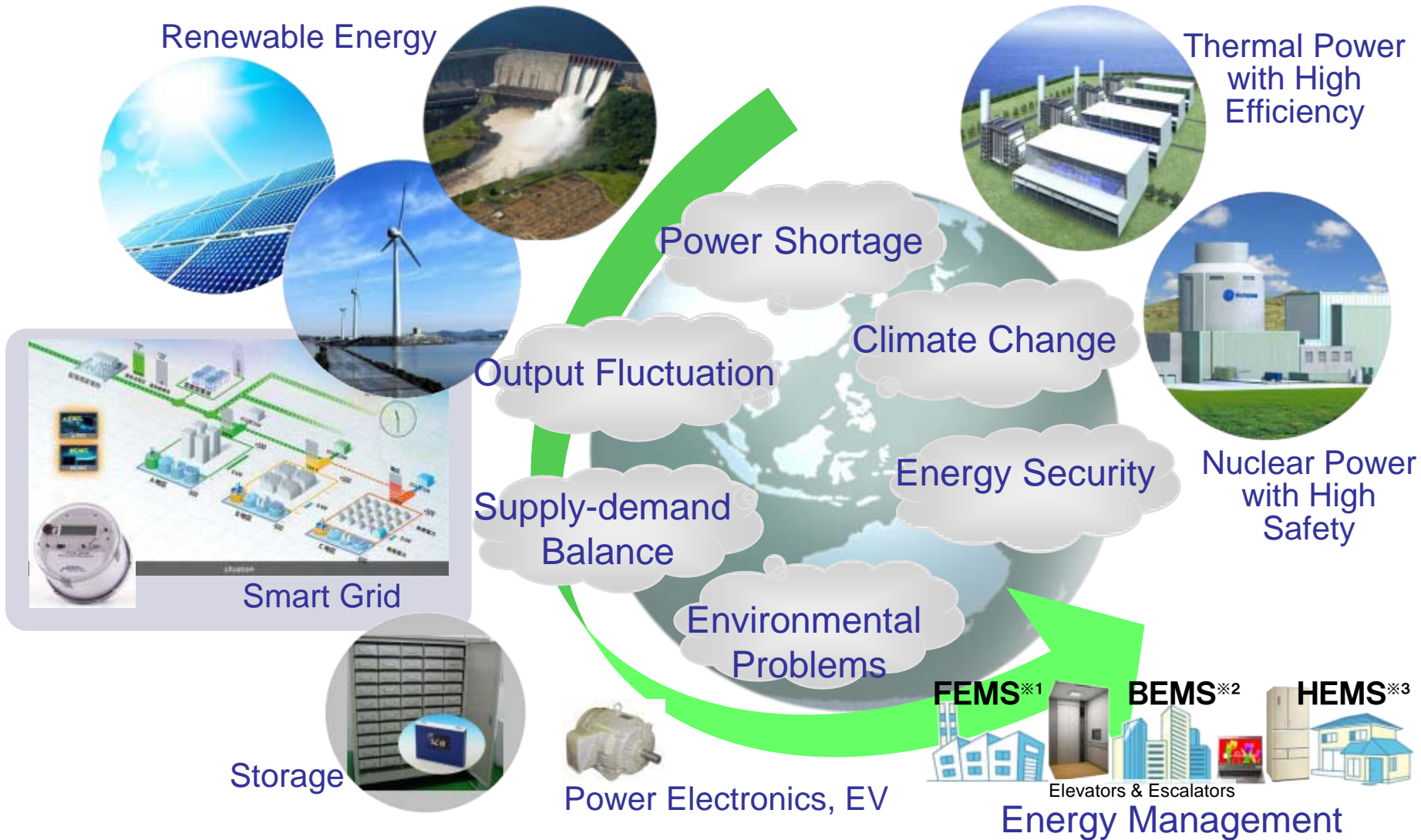


Treatment & treatment assistance

- Heavy ion beam transportation and control
 - 3D spot scanning ($\Phi 1\text{cm}$) irradiation (World's first)
 - 3D image diagnosis of cancer & irradiation control



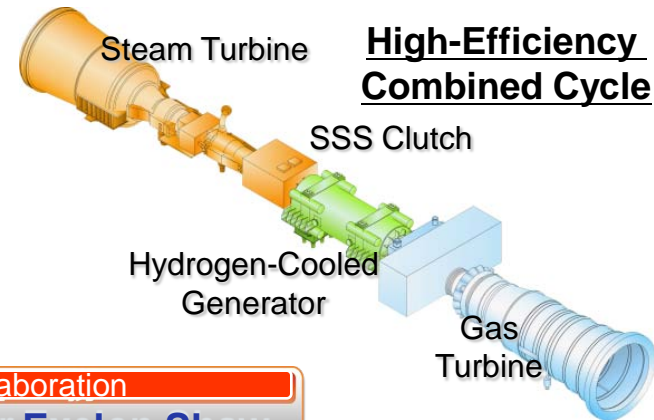
Total Energy Innovations



Optimal use of energy by No.1 technology and solutions

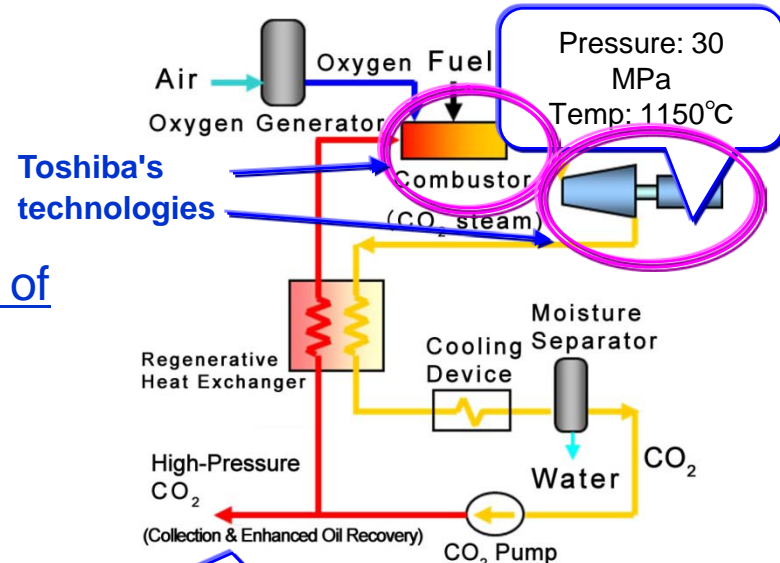
Thermal: High efficiency & low emission

- High-efficiency combined cycle
(Efficiency 59% → 62% *1)
 - Minimal steam loss by 3D design
- Supercritical CO₂ thermal power gen.
 - Supercritical CO₂ turbine, high-temp, high-pressure combustor
 - 100% CO₂ collection + Combined power generation class efficiency
- CCS(Carbon Capture and Storage)
Demonstrated recovered energy consumption of 2.6 GJ/t-CO₂ (world's highest)



Patent Application
over 400

Collaboration
NET Power, Exelon, Shaw



Simplifies collection and reuse of CO₂ due to high purity.

Supercritical-Pressure CO₂ Thermal Power Generation

Nuclear: Improved safety

- SMR (Small Module Reactor), 4S*2
 - Passive safety features, modular design

Geothermal

- Flash/binary combined plants
30% improvement in power output
- High efficient and environmentally friendly heating medium
- Heat balance design

Wind

Collaboration
UNISON

- Lightweight and high-efficiency power generation system
- Introduction of Direct drive type power generator
- Optimized blade shape (Annual generated electricity+10%)

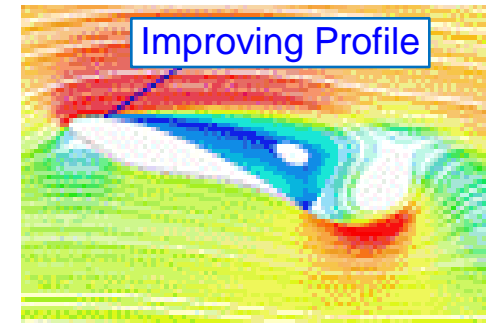
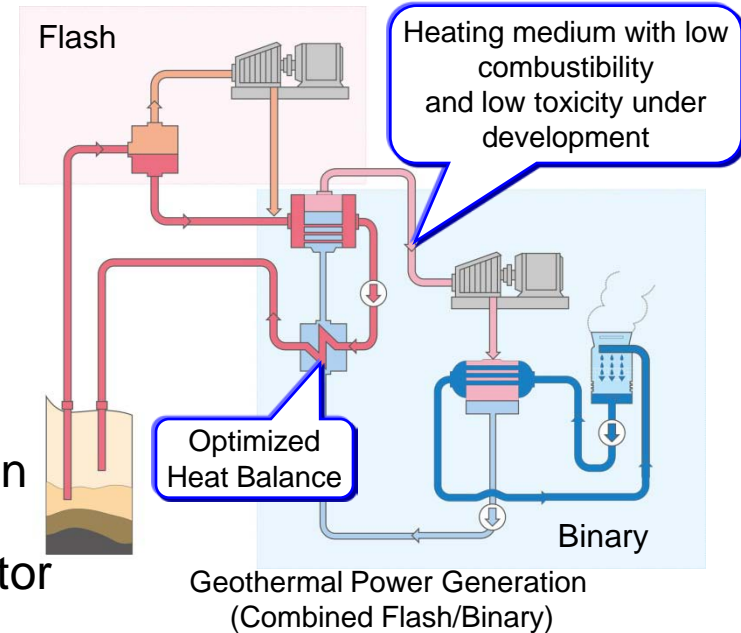
Photovoltaic

Patent Application
over 100

- High-performance PCS + Grid stabilization technology
PCS conversion efficiency: 97.7%

Fuel Cell

- Self-sustaining operation during blackout + HEMS linkage
World's highest efficiency: 94% *1



Wind Power Generation: Improving Blade Profile

Energy-efficient and low-emission transportation

- Inverter and motor
 - High-voltage purely SiC devices
 - 60% Smaller inverter
 - 20% more energy-efficient and lower life cycle cost (SiC-PMSM combinations)

Patent Application
over 200



1.7kV-1.2kA
2-in-1 Module

Adopted



SiC-based
Railcar
Inverter*1

- Storage cell technology
 - Quick Charging, Life Cycle=6,000charges (maintaining over 80% capacity),
 - Visualization of remaining value of SCiB™

Patent Application
over 500

Highest electric mileage*2 in U.S.
(29 kWh/100 miles)



SCiB™

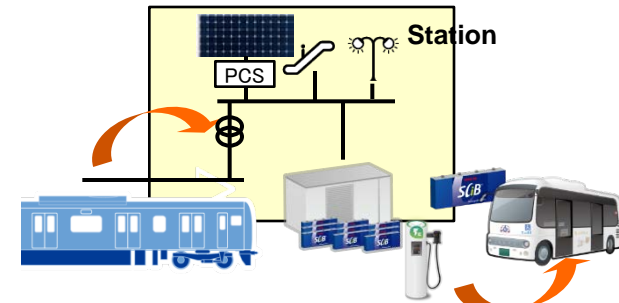
Adopted



Honda FIT EV (US Model)
Launch for Japan and US in 2012 summer

- Station energy solutions
 - Storage of regenerated and improve 5 to 15% in regenerated ratio*3
 - Optimal energy use at or by station buildings, trains and EV buses
 - Environmental consciousness (60% reduction in CO₂emission*4)

Energy storage of regenerated power

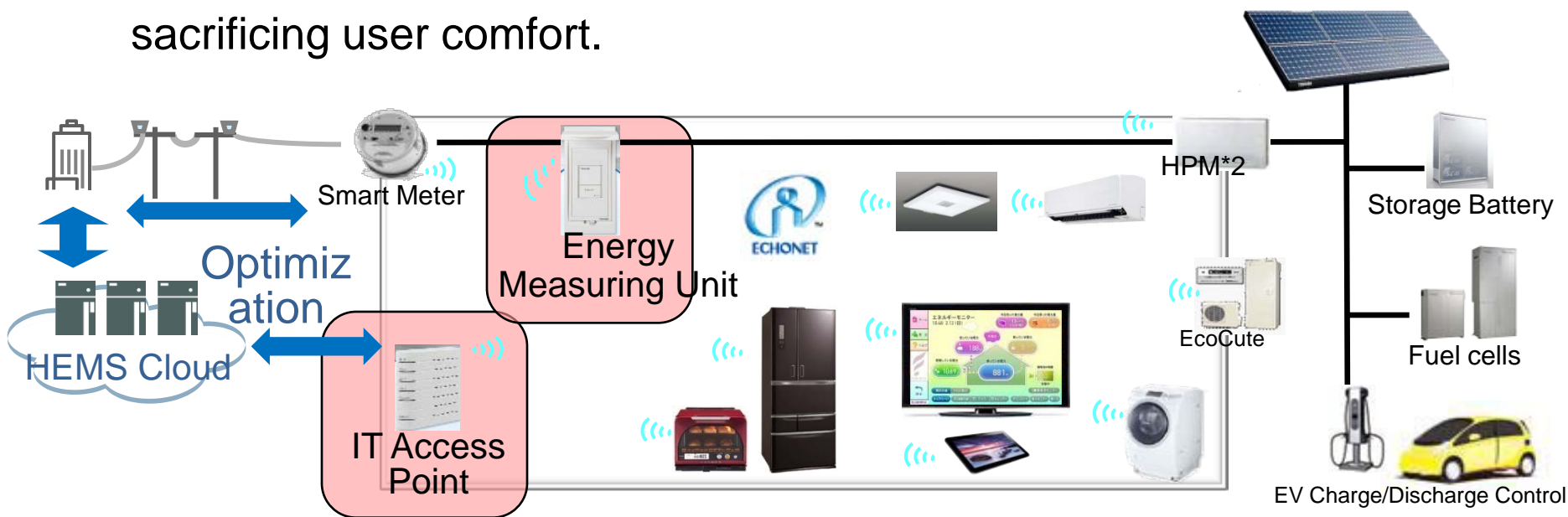


Ultra-Fast Charging: 5 min.

Visualization 10% energy-savings / DR *1 5 to 10% peak shift

Collaboration
Landis+Gyr

- ECHONET Lite-compliant HEMS platform
 - Launch energy measuring unit & IT access point ahead of competitors
 - Control of smart home appliances and alternative-energy appliances and its visualization.
- HEMS cloud engine
 - Demand response for peak power suppression without sacrificing user comfort.



Toshiba's Technology Network for Smart Community

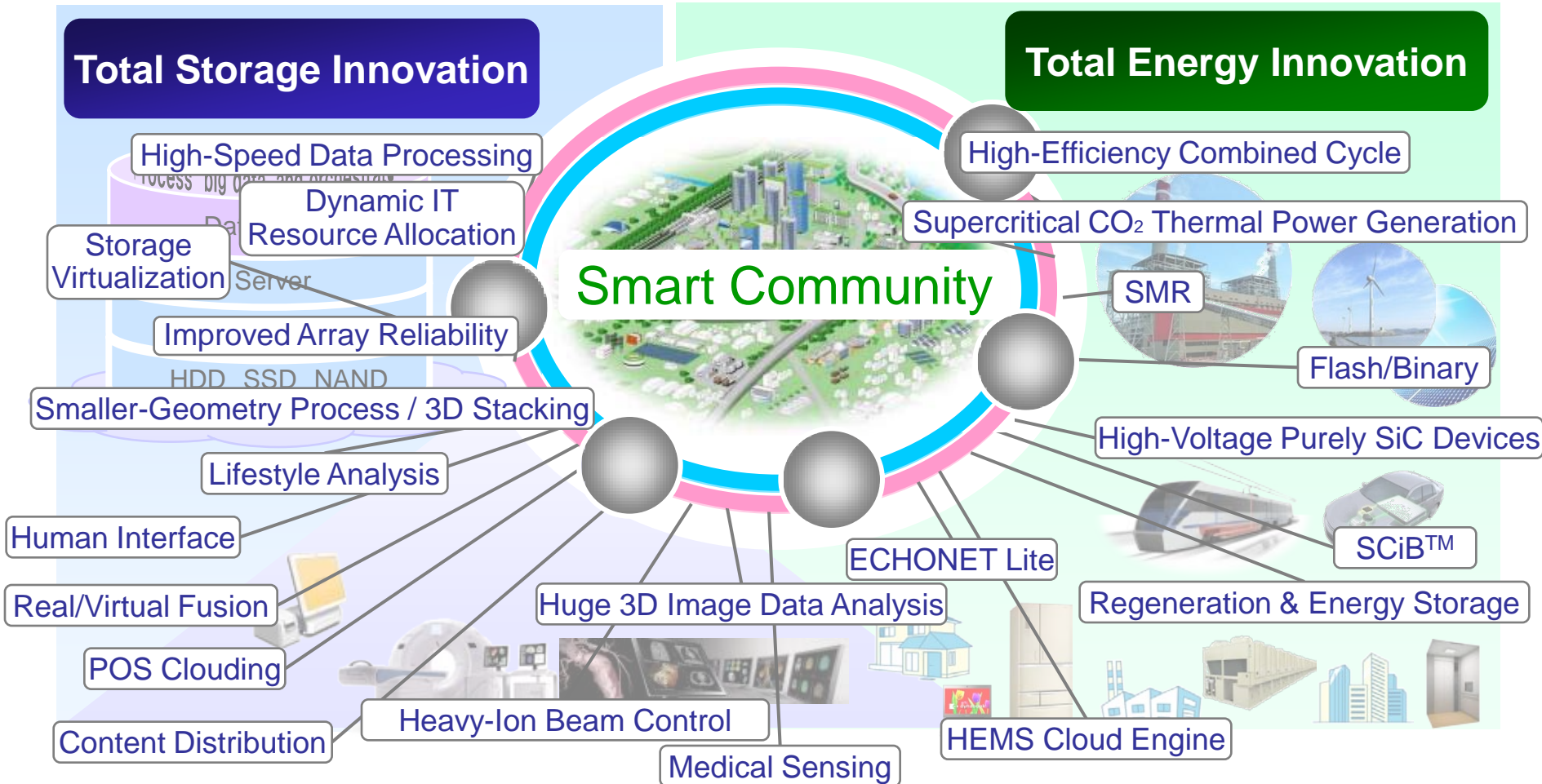
**Big Data, Cloud,
Ensuring security**

**Secure highly-efficient,
stable power source**

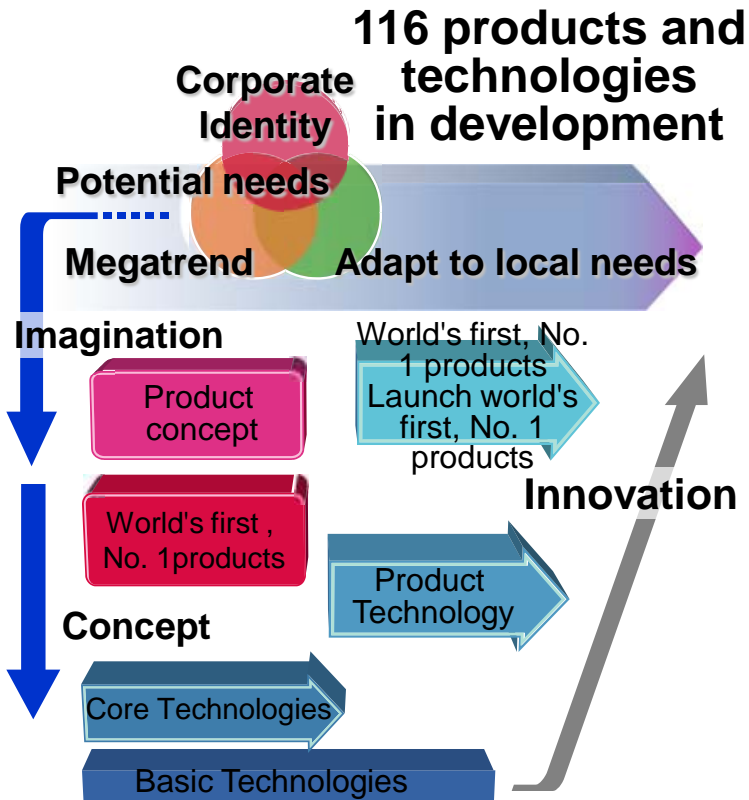
Total Storage Innovation

Total Energy Innovation

Smart Community



Further Speed Up the Pace of Innovation / World's First and World's No. 1 Products and Services



Creative Lighting

Human Sensitivity

- Lighting that satisfies both sensitivity and energy-saving needs

Quantum Cryptographic Communications

Society Security

- Ultimate security based on quantum mechanics

High-Temp. Superconductivity

Earth Sustainability

- 3D superconducting coil*

Yttrium

Contributed to the large accelerator for European Organization for Nuclear Research (CERN)

Superconductivity
4 polar electric magnet

Cultivate new technologies in three areas.

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- **Intellectual Property Strategies**

> II. Global R&D Management

- **Global R&D Structure**
- **Intellectual Property Strategies**
- **R&D Investment**

Major Laboratories Around the World

Corporate



- Corporate Research & Development Center
- Corporate Software Engineering Center



- Corporate Manufacturing Engineering Center

Business Divisions

- Platform & Solution Development Center (Digital Products)
- Center For Semiconductor Research & Development
- Power and Industrial Systems Research and Development Center

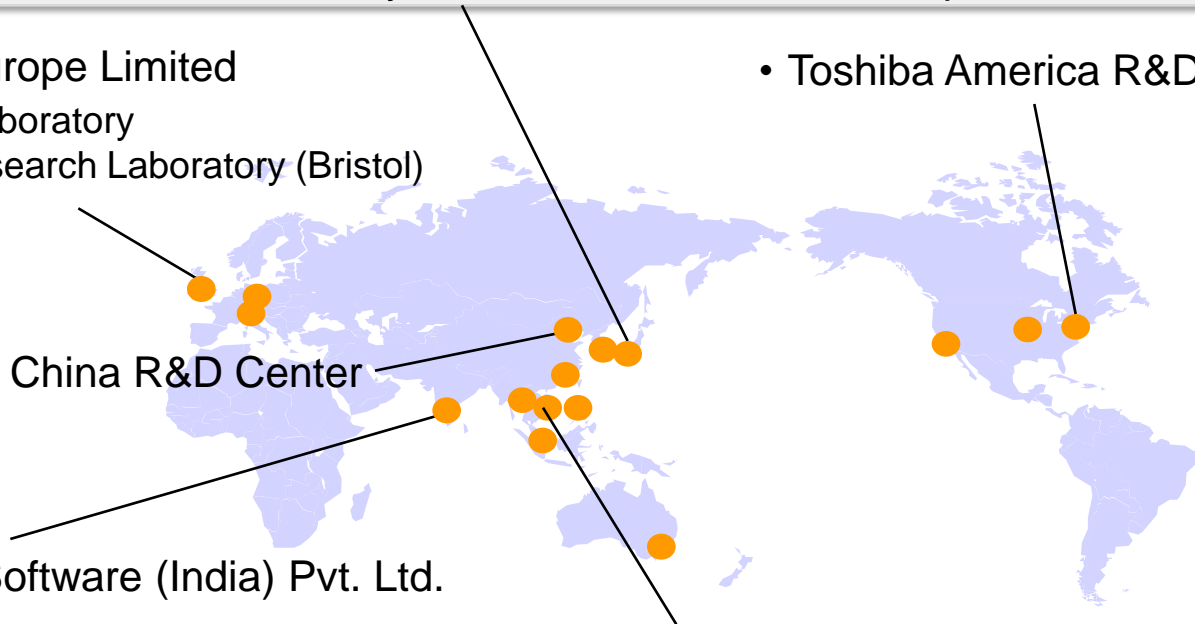
- Toshiba Research Europe Limited
Cambridge Research Laboratory
Telecommunications Research Laboratory (Bristol)

- Toshiba America R&D Center

- Toshiba China R&D Center

- Toshiba Embedded Software (India) Pvt. Ltd.

- Toshiba Software Development (Vietnam) Co., Ltd.



Strengthen Global R&D Activities (2011 to 2014)

- Promote international collaboration among facilities to ensure optimum R&D for products tailored to local needs.
- Acquire and utilize world-class R&D personnels.

Europe

R&D personnel: 1,100⇒1,110

- Smart community technology/ demonstration
- Imaging • Voice • Quantum cryptographic communications

U.S.

R&D personnel: 1,380⇒1,390

- Sensors • Networking
- Healthcare • Storage

China

R&D personnel: 720⇒980

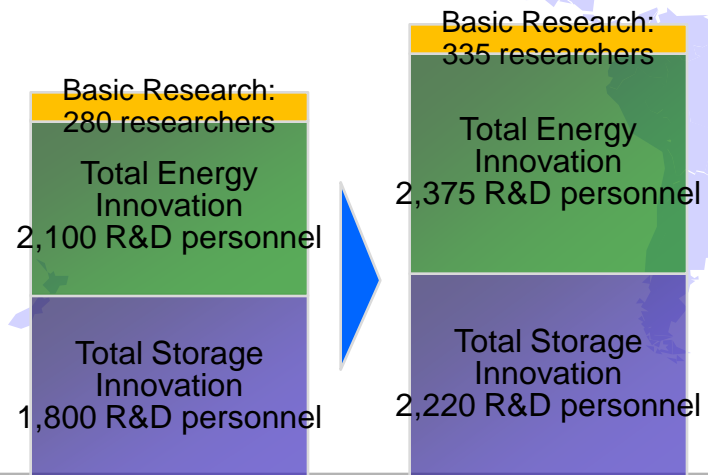
- Smart community technology for China
- Technology and product development for the Chinese market

India, Vietnam, etc.

R&D personnel: 980⇒1,450

- Cloud software for social infrastructure
- Technology and product development for emerging markets

- Increase the number of basic research personnel in cooperation with major foreign universities.
 Researchers: 280⇒335
 (Included in the numbers in each region)



Intellectual Property Strategy

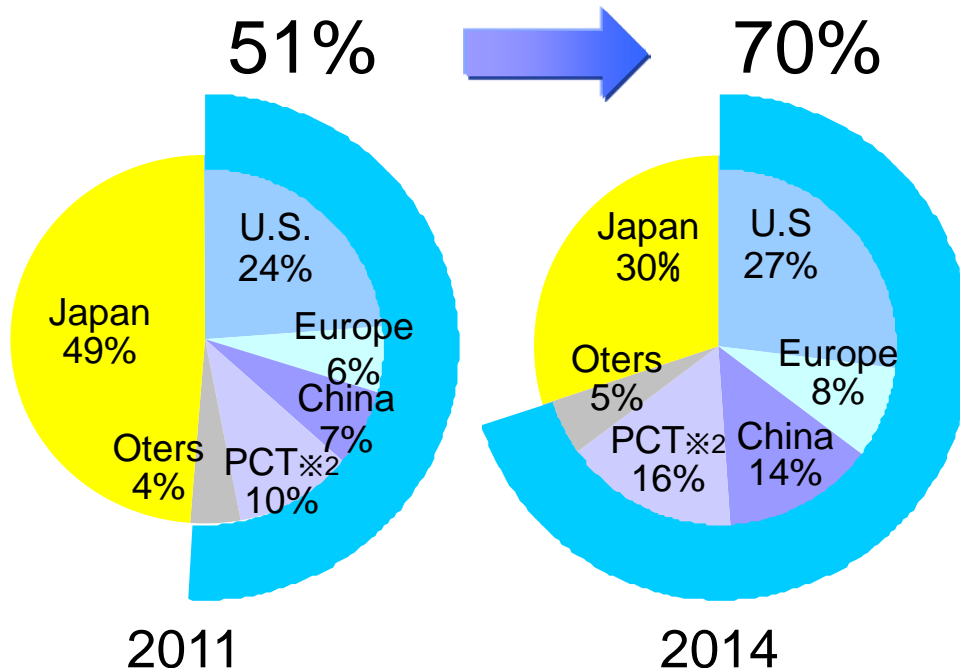
IP Portfolio Enhancement

- Enhance Global IP Portfolio
- Retain in position of yearly Top 10 US Patent Assignees
⇒2010: 6th, 2011: 5th

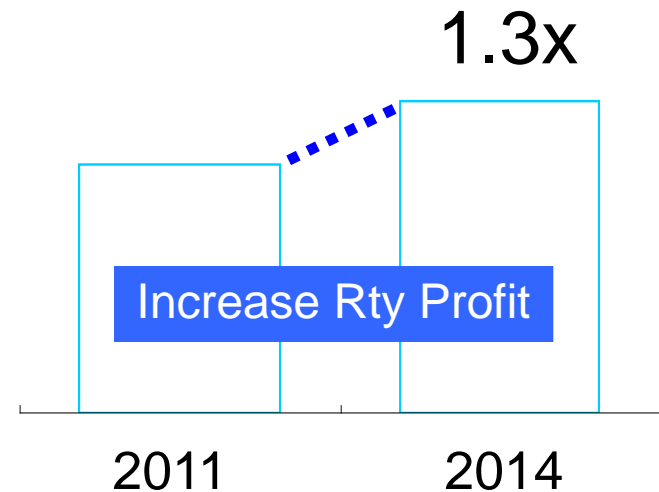
IP Portfolio Utilization

- Secure Business Advantage
- Proper Evaluation and License Revenue Expansion

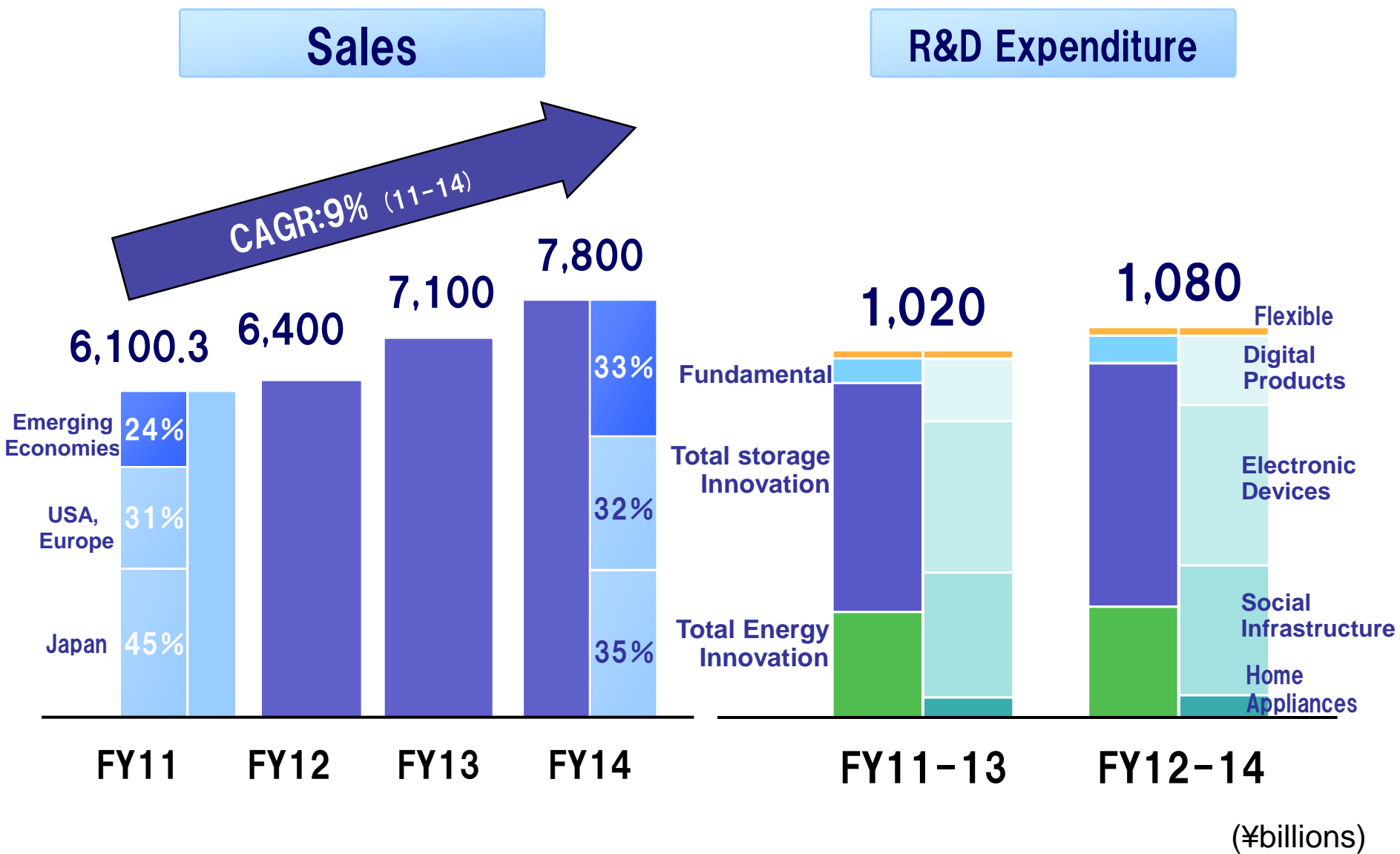
Global PAT Application Ratio*1



License Revenue



Consistent investment in R&D to sustain future business



(¥billions)

**Committed to People,
Committed to the Future. TOSHIBA**

**We will become an even stronger
global contender**

**by unleashing our powers of imagination
to anticipate, ahead of others, and
capitalize on the coming trends in the
world business environment**

TOSHIBA

Leading Innovation >>>