

TOSHIBA

Leading Innovation >>>



Storage & Electronic Devices Solutions Company Business Strategy

Dr. Yasuo Naruke

Company President and CEO

Storage & Electronic Devices Solutions Company

Representative Executive Officer

Corporate Senior Executive Vice President

Toshiba Corporation

July 6, 2016

➤ I . Introduction

II . SDS Company Overview

III . Memory and Storage

IV . Discrete and System LSI

V . Closing

Completion of Business Structural Reforms

Redefine focus businesses, withdrawal from non-focus areas

Discrete: Termination of white LED business
System LSI: Withdrawal from CMOS image sensor business
HDD: Acceleration of enterprise development,
Shift of resources to SSD

Establishment of “Japan Semiconductor”, a new wafer fab company

Reduction in headcount (4,590 in total) in non-memory

Early retirement, 2,058; moved to Sony Group, 1,100;
re-allocation to other divisions, 1,112; reduction overseas, 320

**Committed to return to the black in all of
Discrete, System LSI and HDD in FY16**

I . Introduction

➤ II . SDS Company Overview

III . Memory and HDD

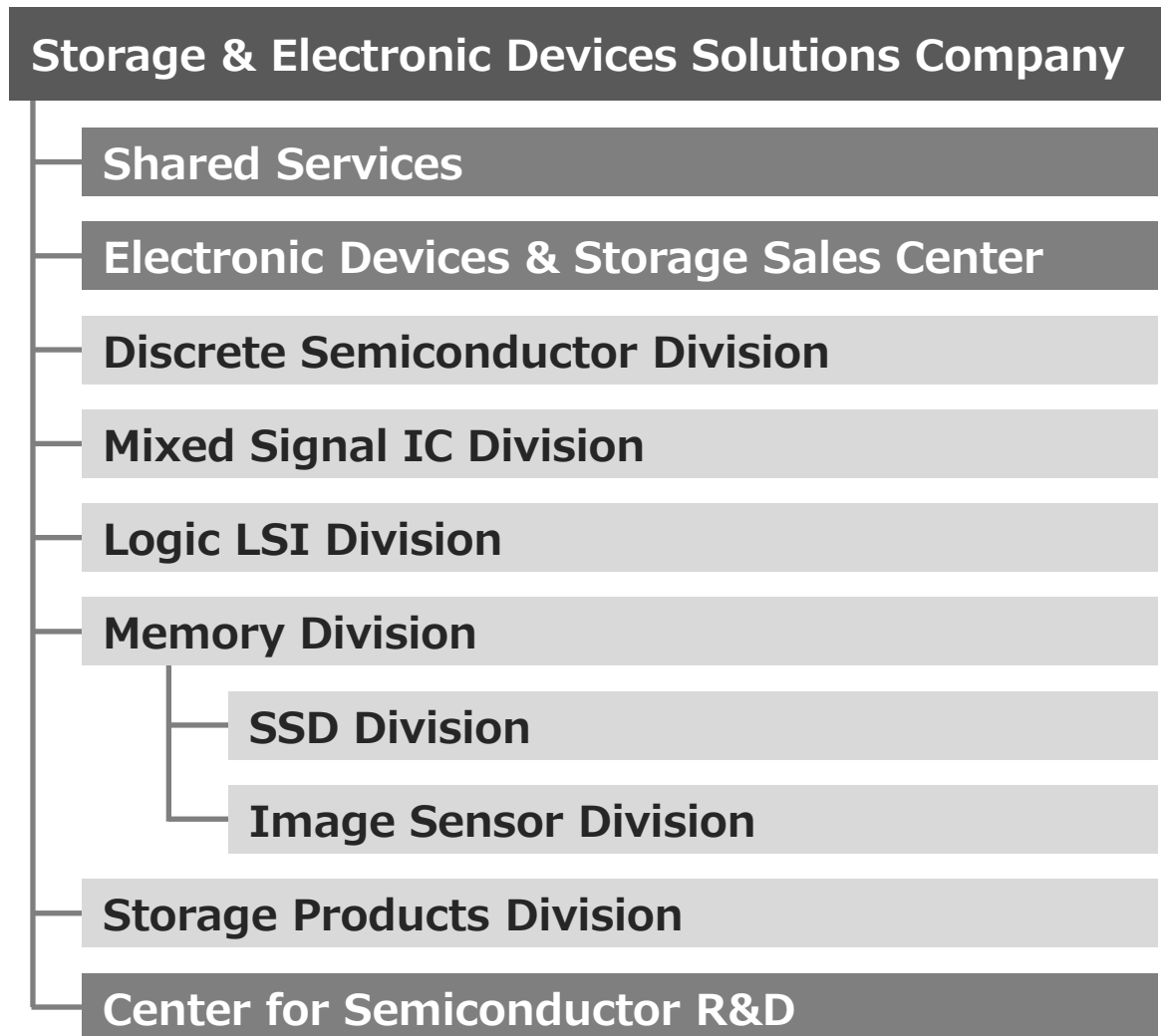
IV . Discrete and System LSI

V . Closing

SDS Company Organization

Storage & Electronic Devices Solutions (SDS) Company

July, 2016



Production Sites

Himeji Operations - Semiconductor

Wafer Fab 6"
Assembly
■ Discrete



Buzen Toshiba Electronics Corp.

Assembly
■ Discrete



Kaga Toshiba Electronics Corp.

Wafer Fab 6", 8"
Assembly
■ Discrete



Japan Semiconductor Corp. (established in April, 2016)

HQ and Iwate Operations

Wafer Fab 8"
■ System LSI



Japan Semiconductor Corp. Oita Operations

Wafer Fab 6", 8"
■ System LSI
■ Discrete



Yokkaichi Operations

Wafer Fab 12"
■ Memory

Toshiba Memory Advanced Package Corp.

Assembly
■ Memory



Toshiba Semiconductor (Thailand) Corp. (TST)

Assembly
■ Discrete



Toshiba Information Equipment (Philippines) Inc. (TIP)

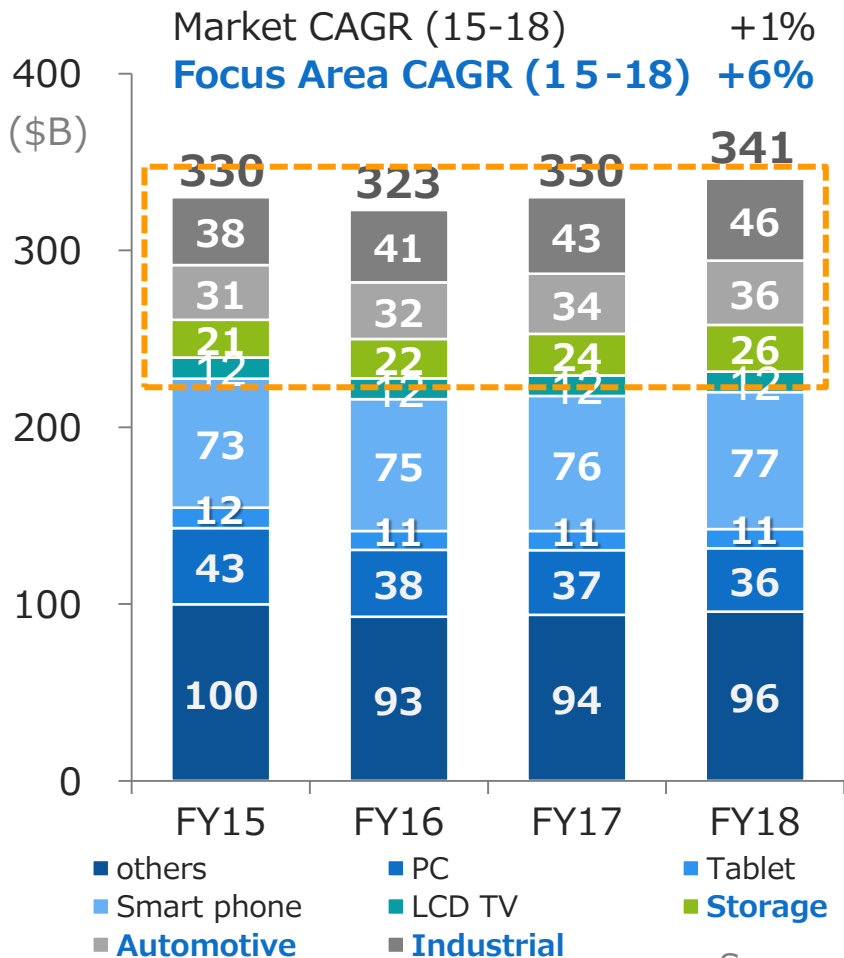
■ HDD, SSD



Market Projection: Focus Areas

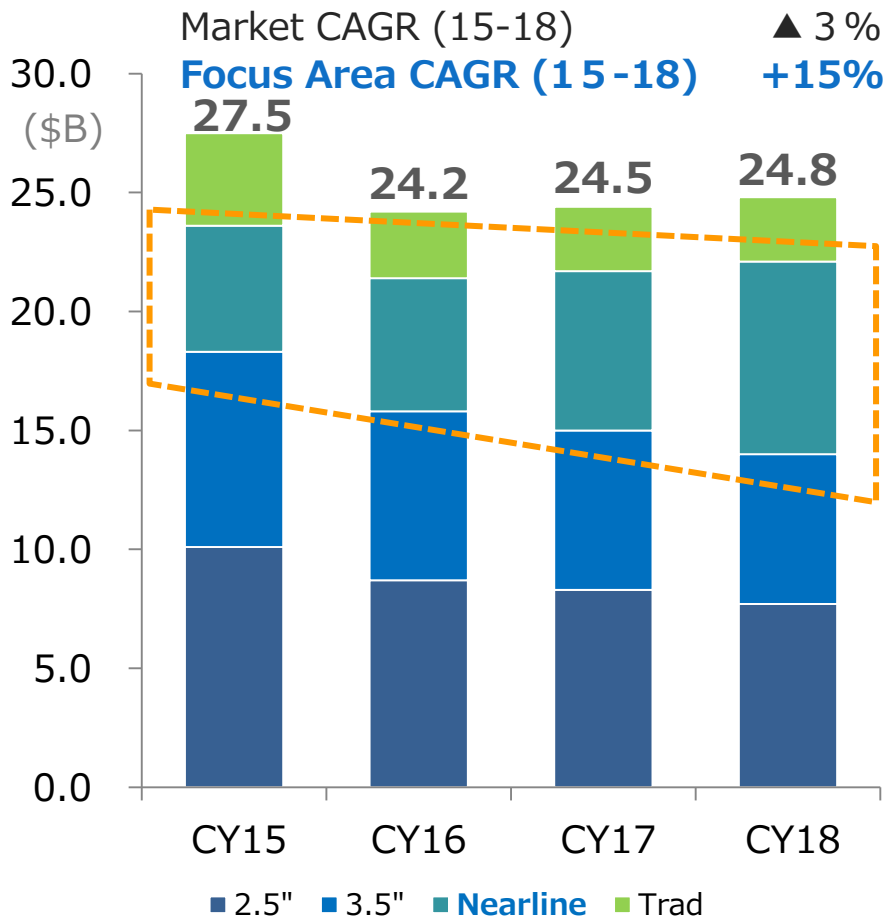
Enterprise storage, automotive and industrial should lead the mid-term markets

Semiconductor



Source: Toshiba

HDD



Source: IDC Worldwide Hard Disk Drive Forecast, 2016-2020 (Doc #US41223716, May 2016)

FY16 Market Outlook

Semiconductors

- Possible slowdown in 2nd half, -0.4% YoY
- Healthy automotive market, industrial demand expected to recover gradually
- NAND demand has been tight, thanks to larger memory density of Chinese smart phones
- Price decrease rate slowing, especially in retail market, thanks to strong NAND demand
- SSD demand grow both in PC and Enterprise

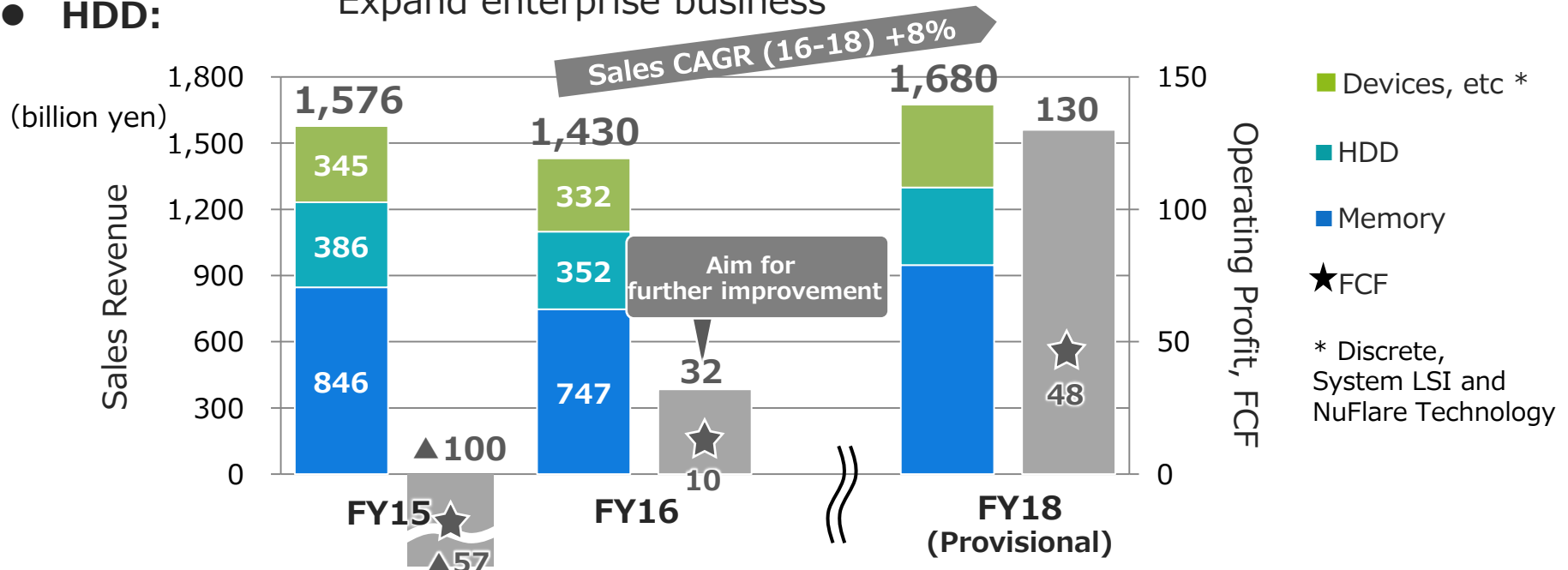
HDD

- Sluggish PC market, but supply requests to Toshiba have been increasing lately
- Nearline HDD demand continues to grow

FY16 Sales and Profit Plan

Return to black in all businesses, V-shaped recovery, back on the right track for growth

- **Memory:** Enhance BiCS (3D flash memory) and SSD business
- **Discrete:** Grow three focus areas: RF switches, power devices, couplers
- **System LSI:** Promote ASIC for industrial markets, etc., fully utilizing image recognition and motor control technologies
Engage with major industrial and infrastructure-related customers based on system design technology
- **HDD:** Expand enterprise business

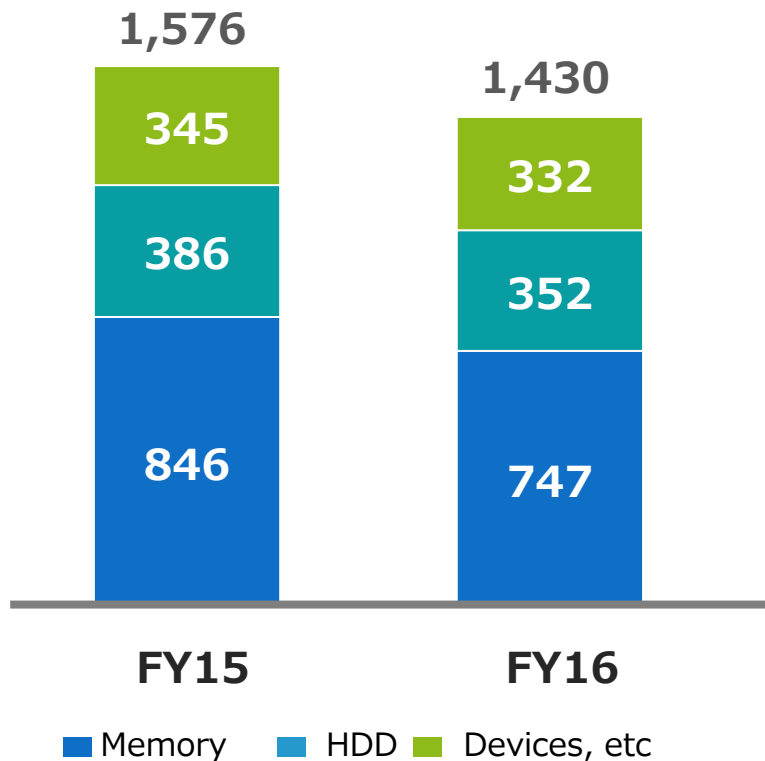


FY16 Sales and Profit Plan

Committed to return to the black
in profit and free cash flow in all businesses

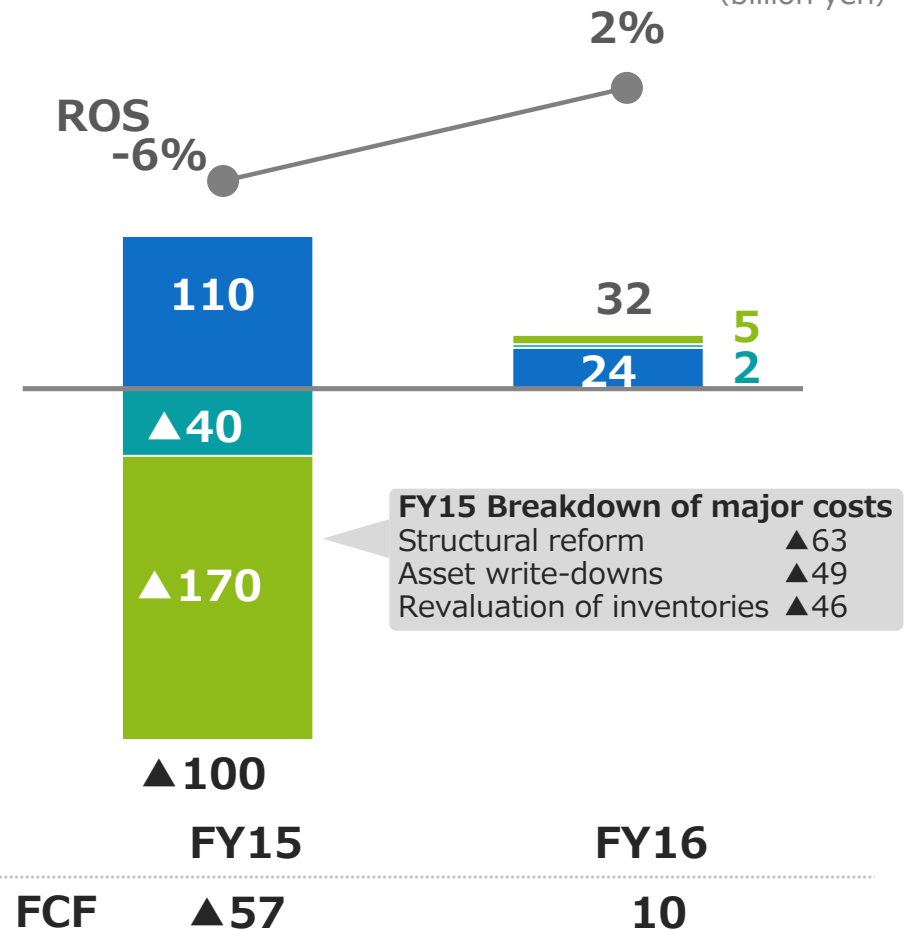
Sales revenue

(billion yen)



OP / OP margin % / FCF

(billion yen)



I . Introduction

II . SDS Company Overview

➤ III . Memory and HDD

IV . Discrete and System LSI

V . Closing

Toshiba Everywhere: Broadest Storage Portfolio

Smart phones

Tablet PCs

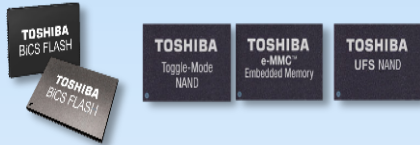
Automotive

Note PCs

Desktop PCs

Servers/
Storage

Data Centers



- Raw NAND
- eMMC™
- UFS
- MCP Memory

- eMMC™

- Client SATA SSD (2.5-inch & M.2)
- Client NVMe/PCIe SSD (2.5inch & M.2)

- High Performance NVMe/PCIe SSD
- Enterprise SAS SSD
- Enterprise SATA SSD



- BGA SSD (PCIe)

- 2.5-inch
- Automotive HDD

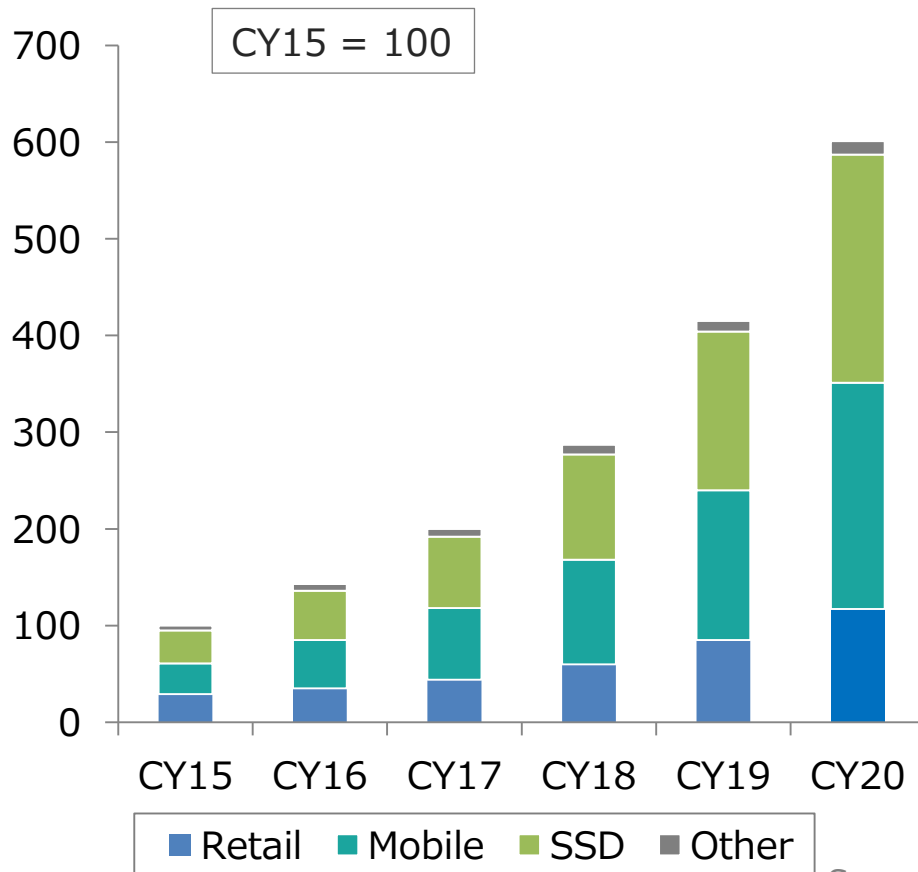
- 2.5-inch Mobile SSHD SATA
- 2.5-inch Mobile HDD SATA
- 3.5-inch Desktop HDD SATA

- Enterprise HDD
 - Performance (15K/10Krpm) SAS
 - Capacity (7.2Krpm) SAS/SATA

NAND Market Overview

Smart phones and data centers lead market growth:
about 40% bit growth (CAGR) expected

NAND Market Projection (GB base)



Source: Toshiba

Market Trends

- High single digit growth in amount
- Expect replacement demand from HDD

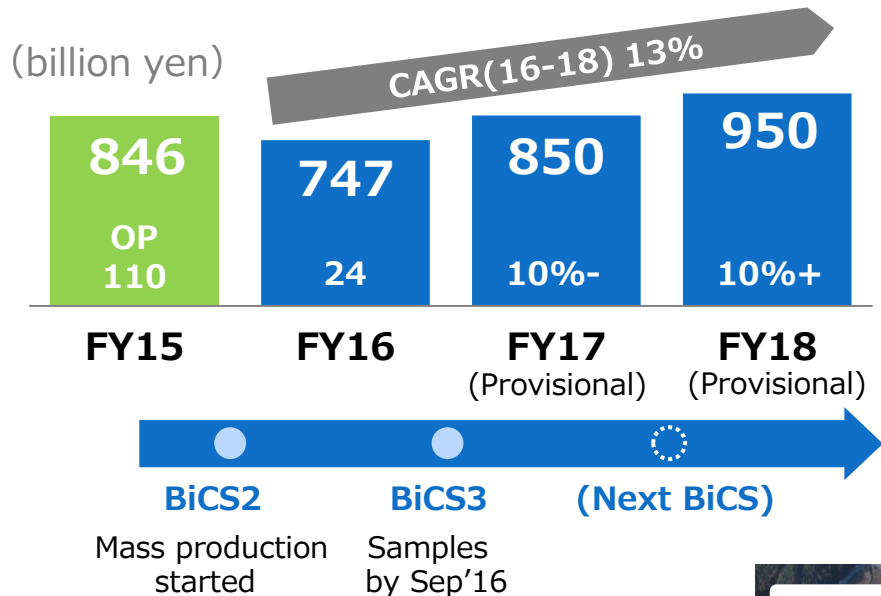
Key Market Drivers

- Higher memory density in smart phones
- Data center demand increases
- Market expansion on price erosion

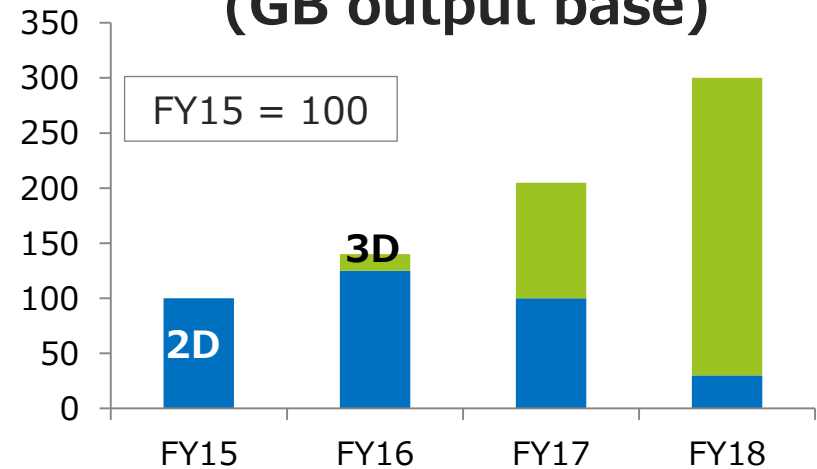
Memory Business Strategy

Accelerate BiCS development and production to meet expanding storage demand and stay price-competitive

Sales Revenue



NAND production plan (GB output base)



OP margin rates in Memory have been fluctuating but always between 10–30% in FY03-15 (except for FY08, on impact of Lehman collapse)



Capex (Commitment basis)

**Total 860 billion yen capex (FY16-18),
utilizing operating CF, internal resources and leasing**

Major investments

Yokkaichi

Y5-Ph2

N-Y2

New clean room

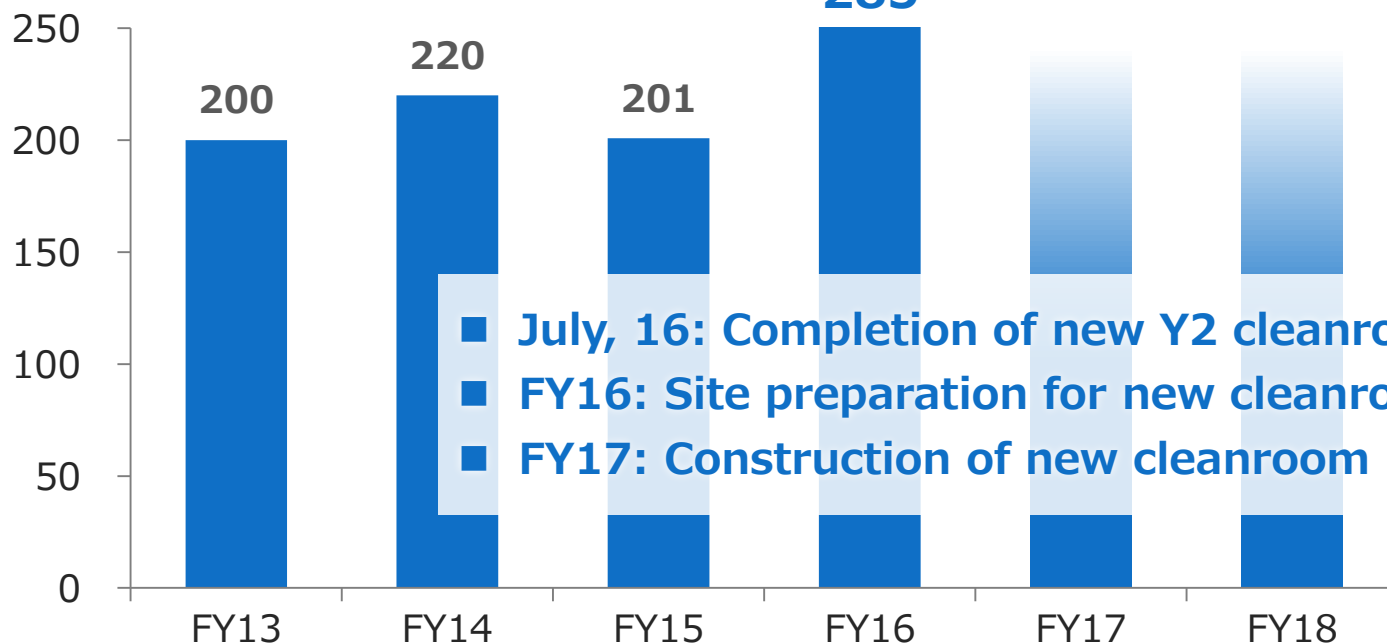
Process

A19nm

15nm

BiCS FLASH™

(billion yen)



- July, 16: Completion of new Y2 cleanroom
- FY16: Site preparation for new cleanroom
- FY17: Construction of new cleanroom

Price-competitiveness of Memory

Further integration and cost competitiveness through deepening 3D technologies

Deepening 3D Technology

- Super-stacking technology (technology needed for more than 100 layers)
- Vertical shrinkage technology
- Die shrinkage technology (effective layout of peripheral circuits and memory arrays)



ReRAM

*ReRAM:
Resistive Random Access Memory

Further integration and cost reductions over the long term

3D Manufacturing Innovation

- Die shrink and cost reduction through Nano-ImPrint Lithography (NIL)
- High productivity production technology (deposition and etching processing)
- High efficiency production (multi-clean room production)

Yokkaichi's Utilization of Big Data

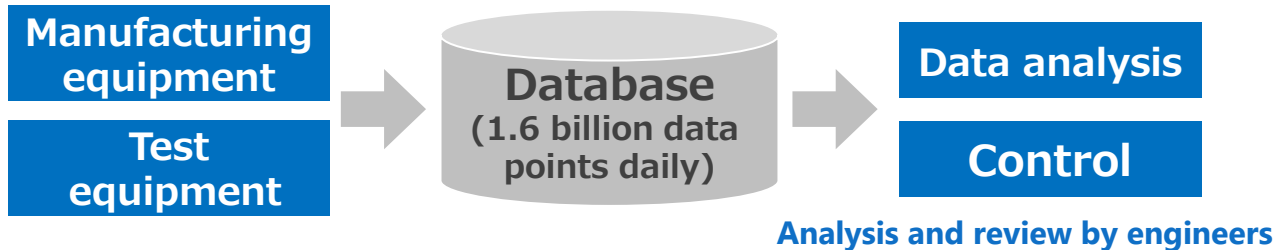
Improving productivity through highly automated clean room operations



Automated Transportation System
Equipment that requires advanced control



- Process and analyze a flood of data to improve productivity, production yields and reliability
- Timely visualization of analysis results

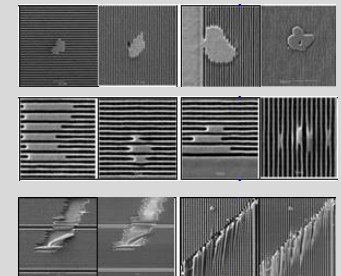


Introduced AI-based analytical tool this year

- Apply machine learning technology to analyze big data that people cannot process
- Closely work with Corporate R&D Center and INS Company

Example of visual inspection analysis

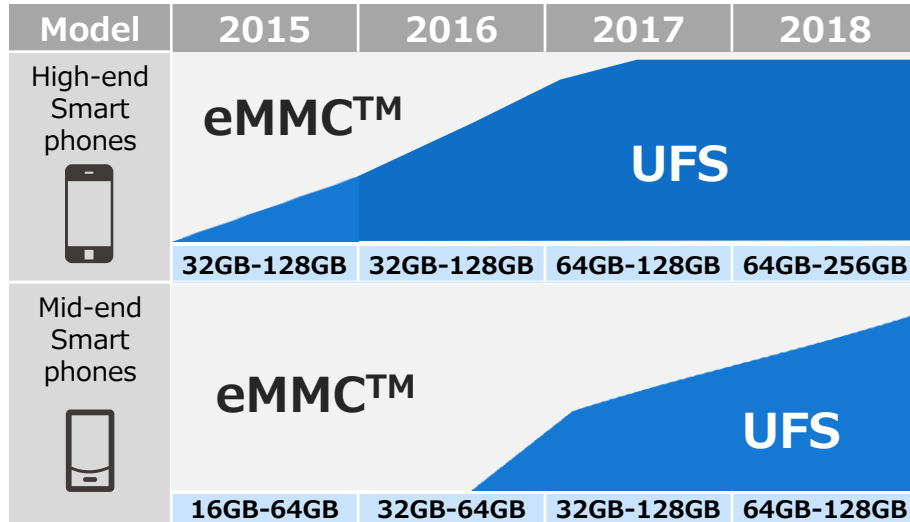
Analyzing several hundreds of thousand images daily
Automatically sort failure modes



Expansion of UFS Market

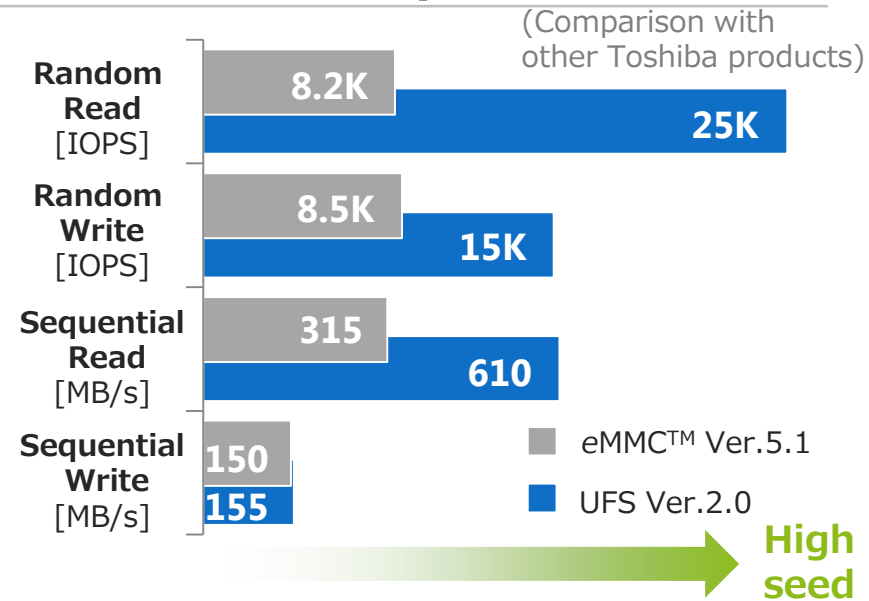
Higher memory density and better performance in smart phones

Smart phone storage trend

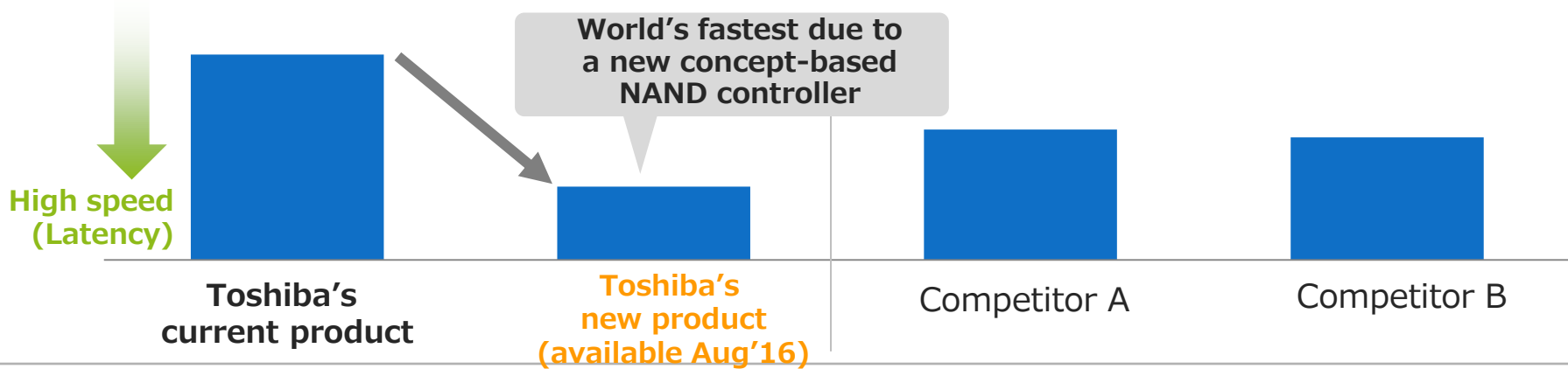


eMMC™: embedded MultiMedia Card
UFS: Universal Flash Storage

eMMC™/UFS performance



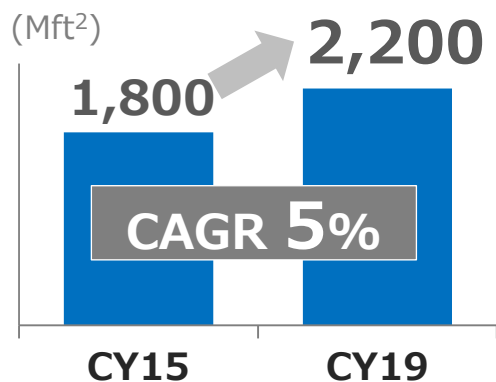
Comparison of 64GB UFS 1-day access pattern performance



Storage Strategy (SSD/HDD)

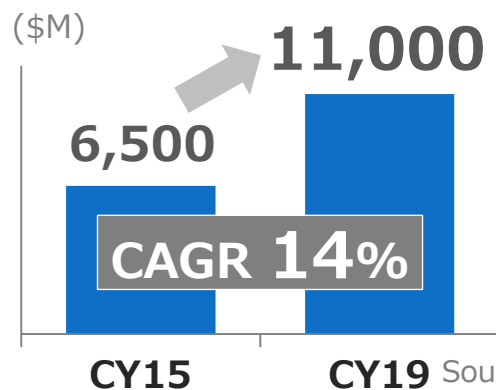
Data Center SSD market to grow to over ¥1 trillion thanks to expanding cloud services; growing sales as a total storage solutions supplier

Data center floor space



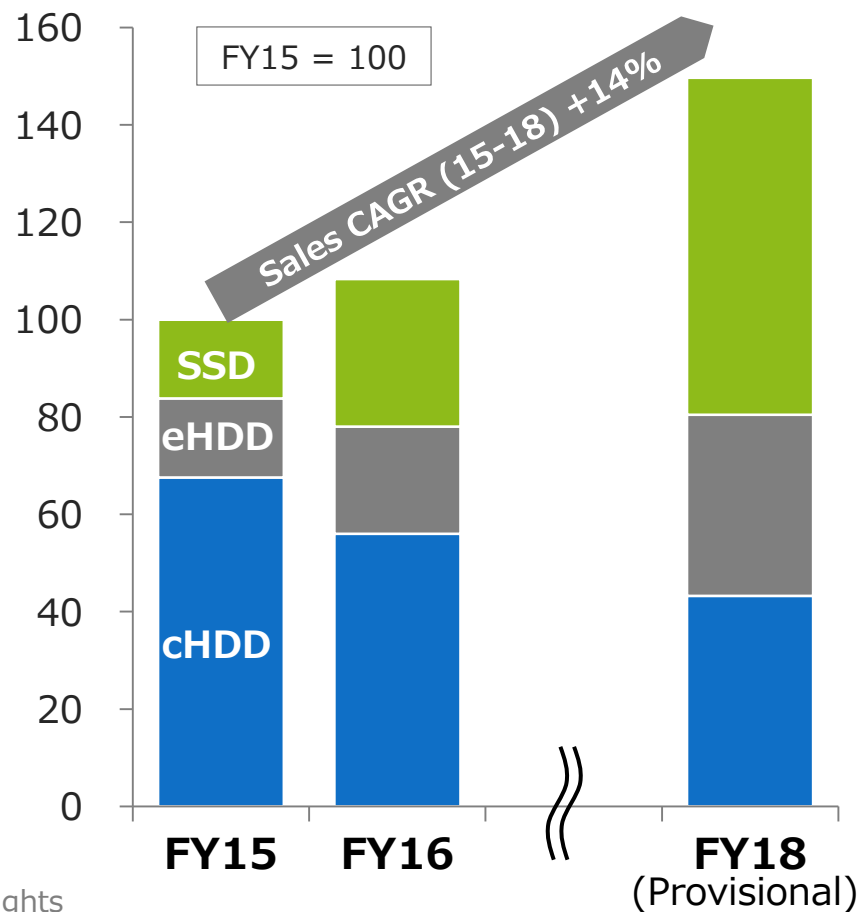
Source: Forward Insights

SSD demand for data centers



Source: Forward Insights

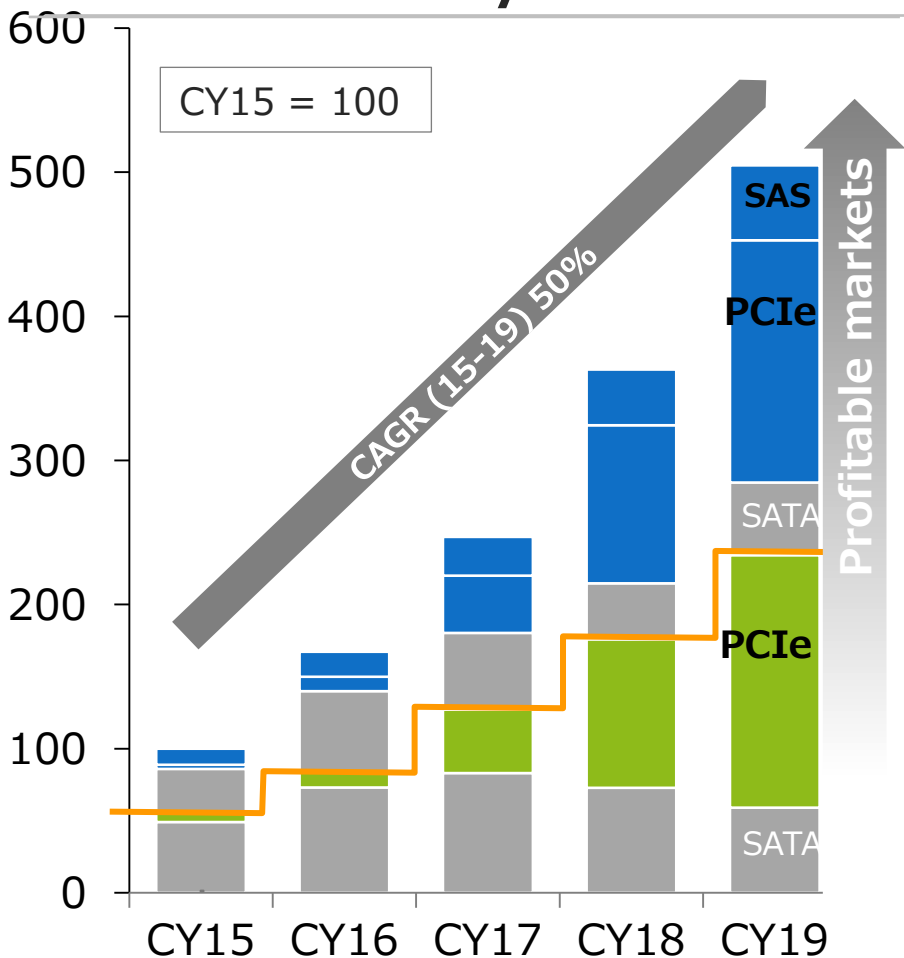
SSD/HDD Sales Plan



SSD Market Projection

Promising market to lead NAND demand

Market by GB



Source: Toshiba

Enterprise

Performance & operability

SAS	For high end servers	Fully utilizing relations with HDD customers; continue to offer No.1 performance products
PCIe	For high end data centers, replacing SATA	Launch products with new features, North America development center
SATA		Customer support in North America

PC, Tablet, Retail

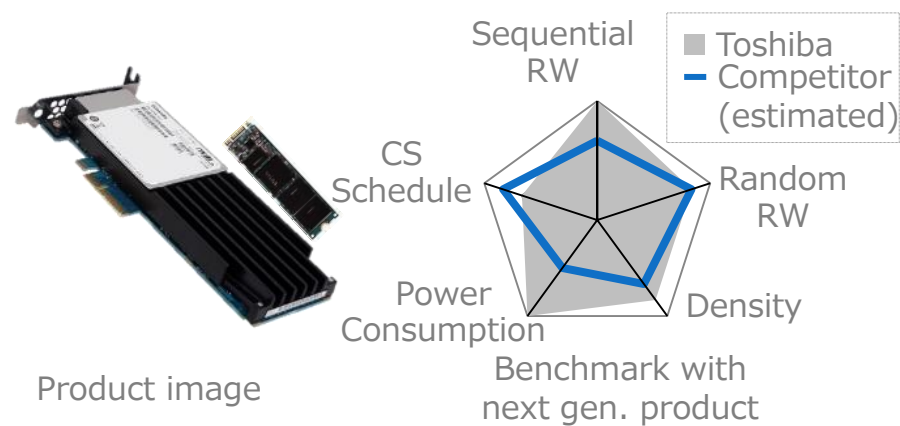
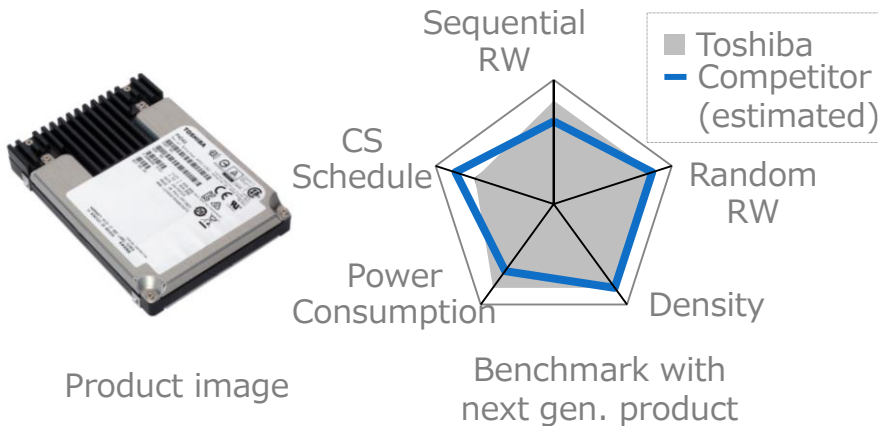
Cost-effectiveness

PCIe	PCIe increasing even in price-competitive market	Grow market share with optimized in-house controllers
SATA		Existing controller, from 3rd party

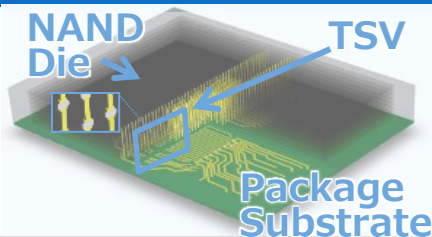
Strengths of SSD for Enterprise & Data Centers

Apply cutting-edge technologies to retain performance competitiveness against competitors

Next gen. SAS-SSD: available in Q1'17 Next gen. PCIe-SSD: available in Q1'17



TSV* Technology



- Low power consumption
- High-speed data transfer

*Through Silicon Via

NAND Cell Technology



- pMLC*, TLC
- Larger density
higher speed

*Pseudo MLC

New feature proposals

- Early compliance with next-gen. high speed interface spec (**SAS 24G/Multi Link, PCIe Gen4**)
- Host control of SSD operation, better performance management and reliability (**Host Managed I/F, Multi Stream, etc**)

America's Storage Development Center



Accelerate qualification, feedback key data center customers' requirements to product development (Folsom, California)

Nearline HDD Market and Strategy

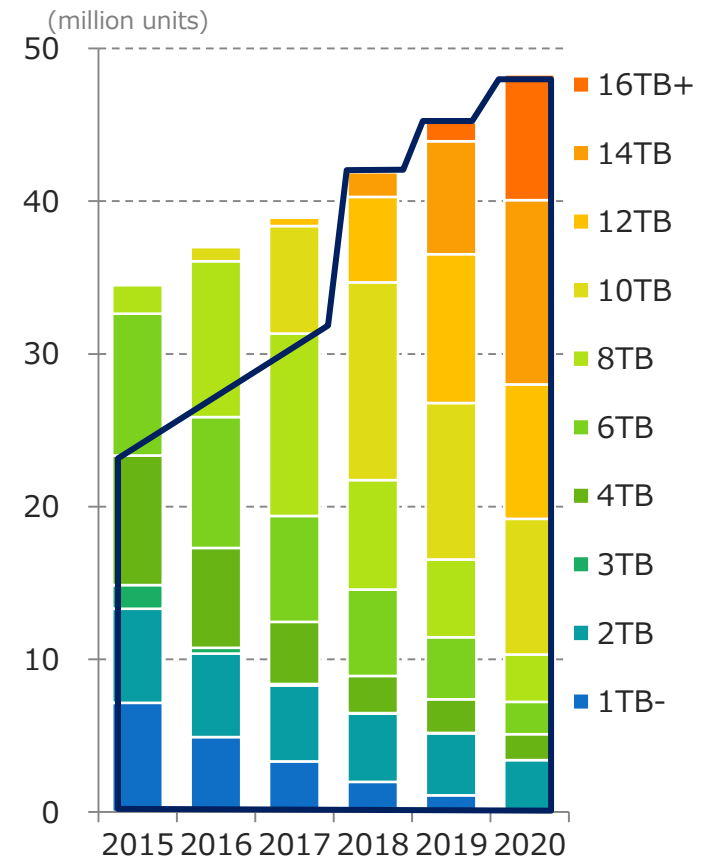
Nearline HDD market to continue to grow,
Long relations with major enterprise customers

- Qualified by 11 of 16 major enterprise customers; highly praised for performance and reliability
- Continue to launch high quality, large density products for major data center customers
- Maintain a long-term partnership with key components suppliers from the early stage of development

New product launch plan

2015	2016	2017	2018	2019	2020
● 2/4TB ● 6TB	● 8TB	● 10TB			
			★ He 14TB	★ He 16TB	

Nearline HDD Market in Units

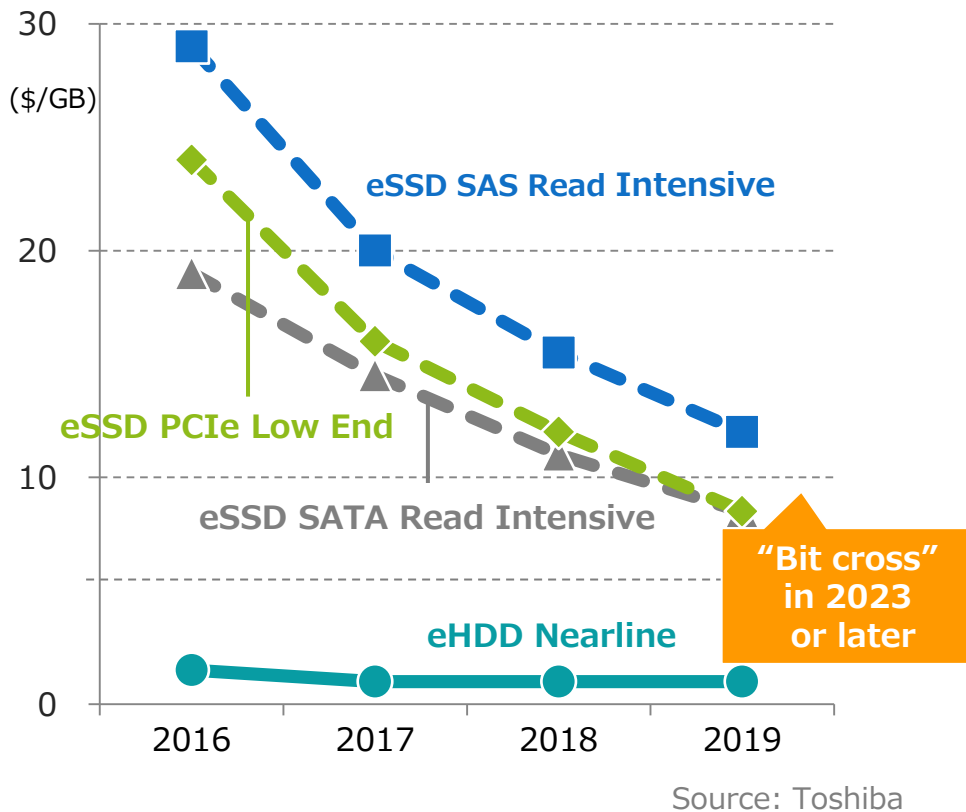


Source: Toshiba

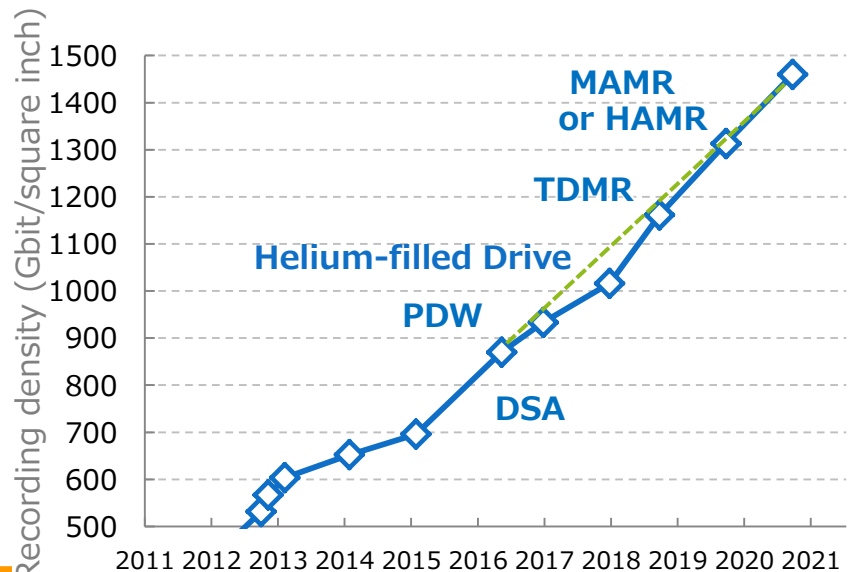
Future of Nearline HDD

Recording density improving >15%/Y,
Realizing better bit cost over SSD

Bit cost comparison (vs SSD)



Recording density >15%/Y



Source: Toshiba

MAMR: Microwave Assisted Magnetic Recording
HAMR: Heat Assisted Magnetic Recording
TDMR: Two-Dimensional Magnetic Recording
PDW: Pattern Dependent Write Control
DSA: Dual Stage Actuator

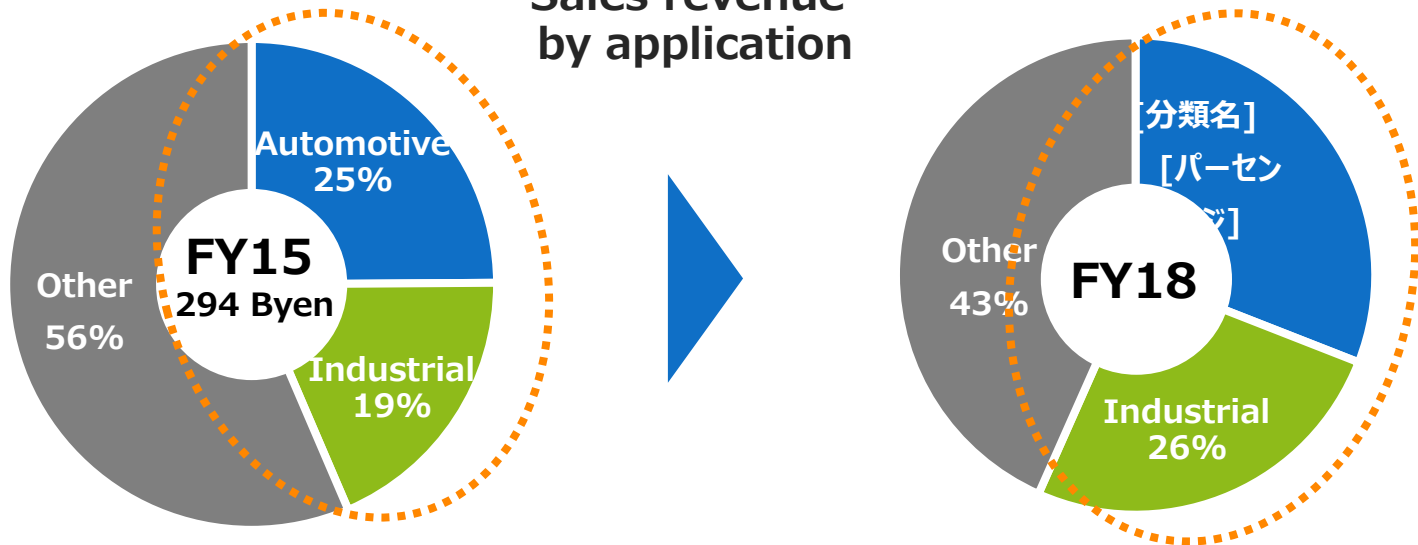
Cope with shrinking HDD market by shifting resources to SSD business

- I . Introduction
- II . SDS Company Overview
- III . Memory and HDD
- IV . Discrete and System LSI**
- V . Closing

Discrete and System LSI: Sales by Application

Focus on automotive and industrial
Grow business through solutions for major markets

Sales revenue by application



Automotive

Sales CAGR (15-18) +10%

Products

- Image recognition LSI for automotive camera
- FRD for inverter
- Power IC for EPS
- MCU for ECU etc.



Image recognition LSI



•FRD: Fast Recovery Diode

Industrial & Energy

Sales CAGR (15-18) +13%

Train



Smart meter



Server



PV inverter



UPS



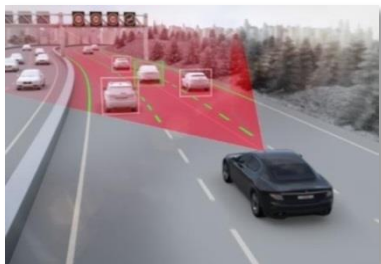
PLC



Solutions for Automotive Markets

Focus on automotive, fully utilizing Toshiba's unique technologies

Safety...video and image

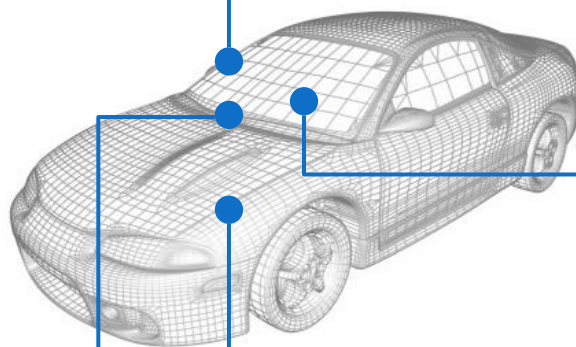


Application ADAS, Driver's info, etc.
Product Imaging IC, Comms IC, Power, Small signal

Information...storage



Application GPS, HUD, etc.
Product eMMC™, SD card, HDD, Power, Small signal



Driving



Motor Control

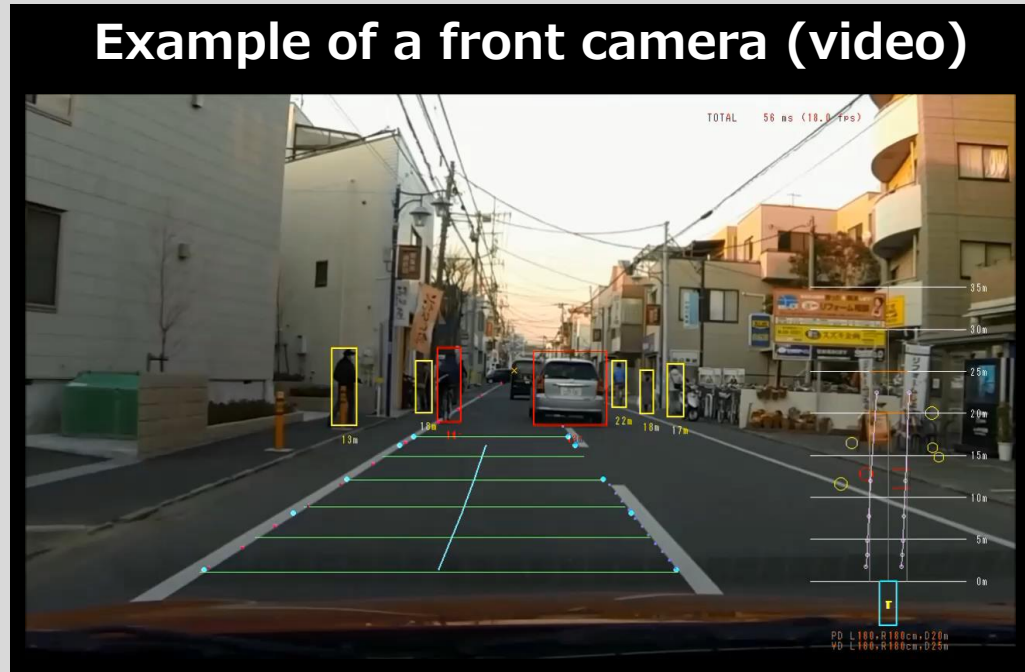
Application Inverter, Pump, etc.
Product Analog IC, MCU, Coupler, Power, Small Signal

Engine Control Unit

Application Engine, EPS, etc.
Product Analog IC, MCU, Power, Small Signal

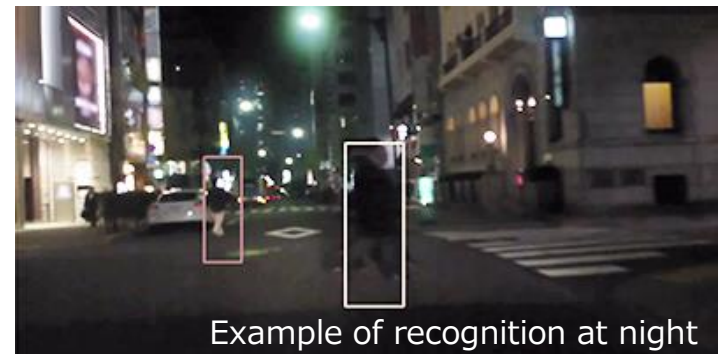
Image Recognition LSI for Automotive

Example of a front camera (video)



Oct'15 **Denso Corp.** deployed our image recognition LSI in its front-camera-based active safety system

May'16 Recognized by **The Institute of Image Info. and Television Engineers** in Japan (subject: Co-occurrence Histograms of Oriented Gradients)



Solutions for Industrial Markets

A range of unique products for various industrial applications

FA and Robotics



ASIC/FFSA:

Custom LSI to offer highly efficient production system

ApP Lite™/MCU:

Products suitable for industrial IoT and motor control

Wireless



BLE Smart Mesh:

Low power consumption wireless communications connected to Mesh network for mail security system, FA, building energy management system

Power Supply



MOSFET:

Broad lineup with many voltage specifications, used in various applications (especially power supply)

Smart Grid



MCU + Analog IC:

ASSP/solution tailored for smart meter (electric power meter, etc.), micro inverter (photovoltaic)

Transportation / Power Systems



IGBT:

Available for trains, construction machinery, power converters, industrial inverters and specialized power supply

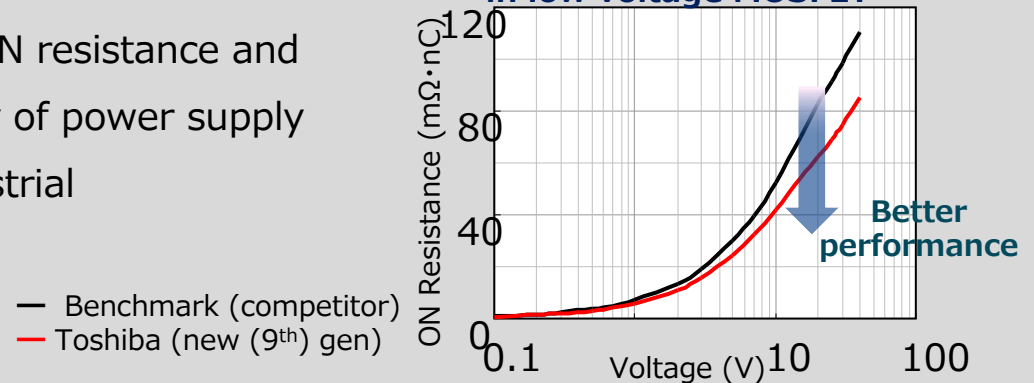
- ASIC : Application Specific IC
- FFSA™ : Fit Fast Structured Array
- ApP Lite™ : Application Processor Lite
- ASSP : Application Specific Standard Product
- BLE : Bluetooth® Low Energy
- IGBT : Insulated Gate Bipolar Transistor

Strengths in Discrete

Power Device

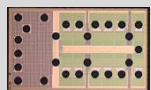
- Broad product offering
- **High performance MOSFET** (low ON resistance and low switching loss) enables efficiency of power supply
- **IGBT and SiC** for railways and industrial

Better ON Resistance performance in low voltage MOSFET



RF Switch

- Original process realized the **industry's best reduction in insertion loss**
- Aiming to expand share in the smart phone market where the number of switches is rapidly increasing



CY15 3.1 switches/phone

CY18: 7.0 switches/phone

Source:
Toshiba

Photo Coupler

- **Major player in the market** (24% share/15)
- Focus on **high performance IC couplers** for industrial and automotive markets
- World's smallest MOSFET coupler for tester application (for surface mounting at high density)



Strengths in System LSI

Focus on advanced technology to boost IoT

- Cutting-edge wireless LSI
Bluetooth[®], BLE, WLAN, etc.
Recognized by the New Technology Development Foundation in Japan (subject: high-speed and safe wireless technology)

Chip set for Google Ara modular system

Design capability to materialize its concept as real chips incorporating advanced technology



Focus on steadily growing industrial & automotive markets

- Image recognition LSI



- **Power supply and motor control LSI**
- **FFSA[™]**: Enter the market with products with FPGA's and ASIC's advantages

TAT from specification determination to mass production (40 nm's case)

ASIC	12 months
FFSA [™]	8 months

→ New ASIC methodology reduces customers' development steps

Japan Semiconductor

Oita Operations and Iwate Toshiba Electronics: Merged in Japan Semiconductor on April 1



Company name	Japan Semiconductor Corp.
Business facilities	HQ/Iwate Operations, Oita Operations, Kawasaki Branch Office (Foundry Business Dept) Taiwan and US offices (planning)
Date of Establishment	April 1, 2016
Capital	15 billion yen
Representative	Kazuya Mori, President & CEO
Employee	2,030



Strengths

- Automotive-grade quality based on IDM's experience
- Cost-competitiveness and short development turn around time
- World leading analog technology (unlike digital, tuning is critical in analog)

Products

Mixed Signal IC, MCU, ASIC, Linear sensor and Discrete

Aiming to win foundry business equal to 30% of production in FY18

I . Introduction

II . SDS Company Overview

III . Memory and Storage

IV . Discrete and System LSI

> V . Closing

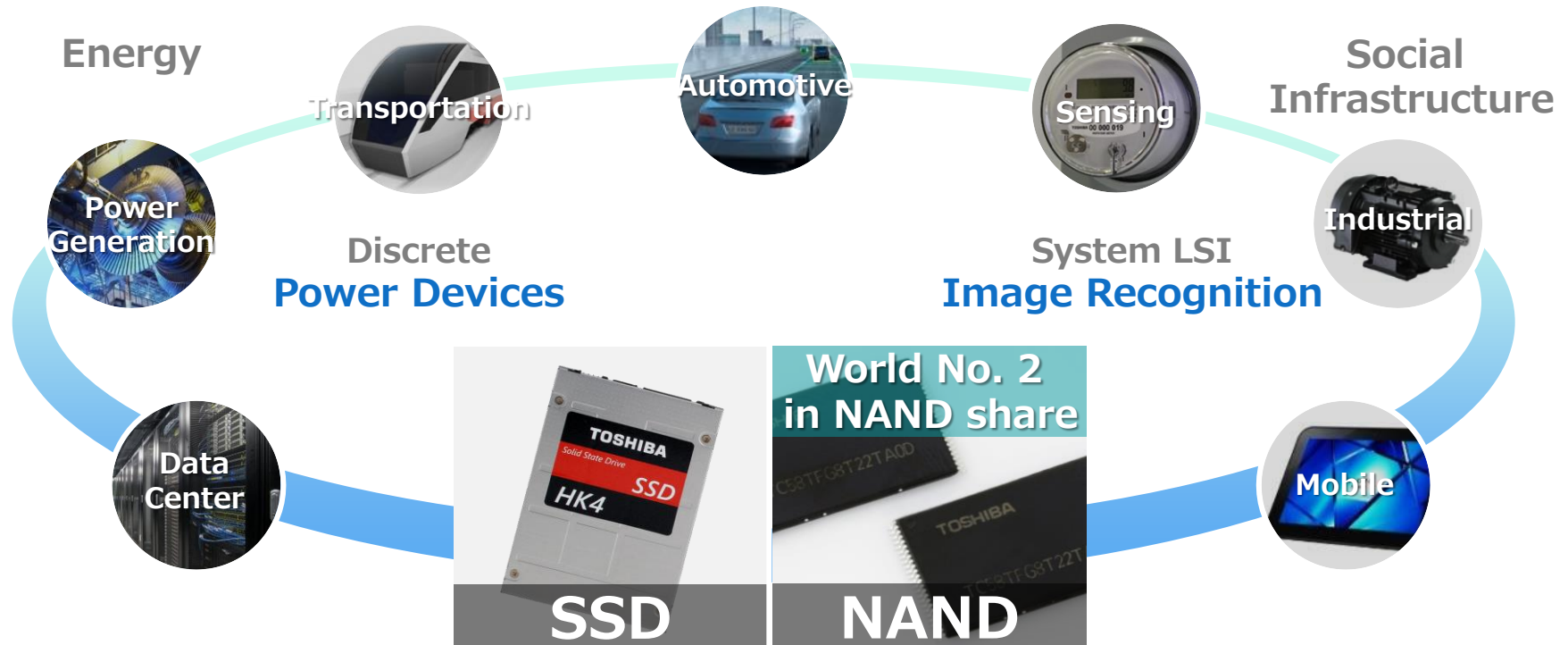
Closing

FY16

Return to the black in operating profit
and cash flow in all businesses
Early launch of BiCS FLASH™

FY17 onwards

Return to profitable growth businesses



Use advanced manufacturing technology to bring cutting-edge products to innovative markets

**Contribute to creating the infrastructure of
the Information (Big data) Society and Eco-Friendly Society**

Forward-looking Statements

- This presentation contains forward-looking statements concerning future plans, strategies and performance of Toshiba Group.
- These forward-looking statements are not historical facts, rather they are based on management's assumptions and beliefs in light of the economic, financial and other data currently available.
- Since Toshiba Group promotes business in various market environments in many countries and regions, its activities are subject to a number of 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. Toshiba there wishes to caution readers that actual results might differ materially from our expectations.
- Toshiba's fiscal year (FY) runs from April 1 to March 31. All figures are consolidated totals for the 12 months, unless otherwise indicated.

TOSHIBA

Leading Innovation >>>