



Research opportunities in Singapore

Presented by
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Data Storage Institute
Agency for Science, Technology and Research (A*STAR), Singapore

about **A*STAR**

A*STAR

Chairman : Mr Lim Chuan Poh

Managing Director : Prof. Low Teck Seng

SERC

Science and
Engineering
Research Council

DSI, I2R, ICES,
IHPC, IME,
IMRE, SIMTECH

JCO

Joint Council
Office

BMRC

Biomedical
Research Council

BII, BTI, GIS,
IBN, IMB, IMCB,
SICS

AGA

A*STAR
Graduate
Academy

ETPL

Exploit
Technologies
Pte Ltd

Research Institutes

**14 Research
Institutes
~2900 researchers
from >50 countries**

about **DSI** vision



Strong research programs and funding with a diverse full-time Researcher of 280, with approximately 100 undergraduates and post graduate students.

Founded in 1992, DSI's vision is to be a vital node in a global community of knowledge generation and innovation, nurturing research talents and capabilities for world class R&D in next generation technologies.

mission

To establish Singapore as an R&D center of excellence in data storage technologies.

Core competencies

HARD DISK DRIVE TECHNOLOGIES



- 10Tb/in² areal density technologies
- Thin Hybrid HDD (0.5TB 2.5", 5mm, hybrid HDD)

NON-VOLATILE MEMORIES



- STT-MRAM
- PCRAM
- RRAM

DATA CENTER TECHNOLOGIES



- Green Data Center technologies, and NVM Integration
- Petabyte Genome Data Center Platform
- Large scale data management

ADVANCED CONCEPTS & NANOTECHNOLOGY



- Nanofabrication
- Spintronics
- Plasmonics
- Photo-Electronics
- Metamaterials and Small Particle Physics Research

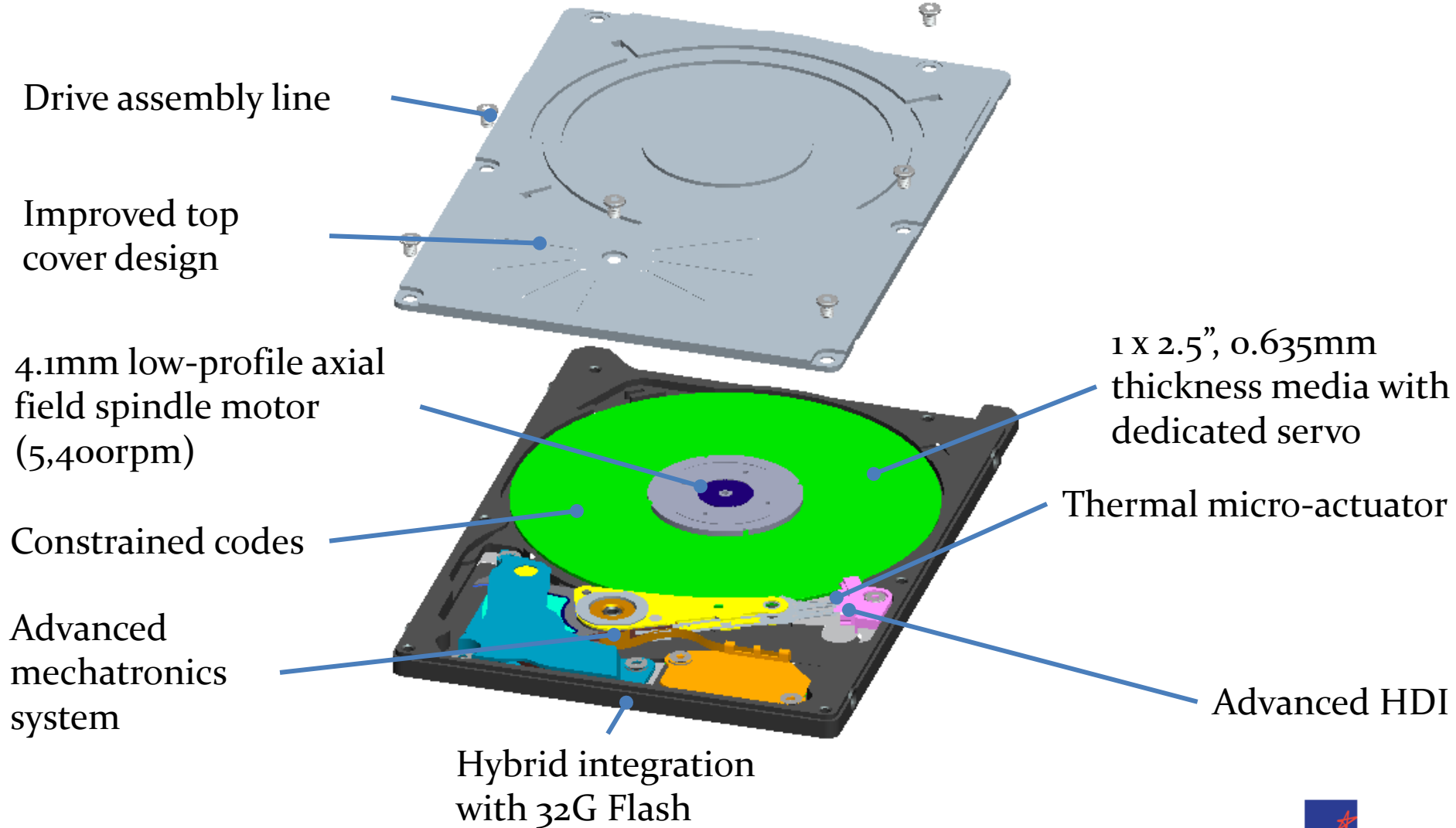
amplifying imagination...

DSI thin hybrid HDD project



2.5", 5mm thickness

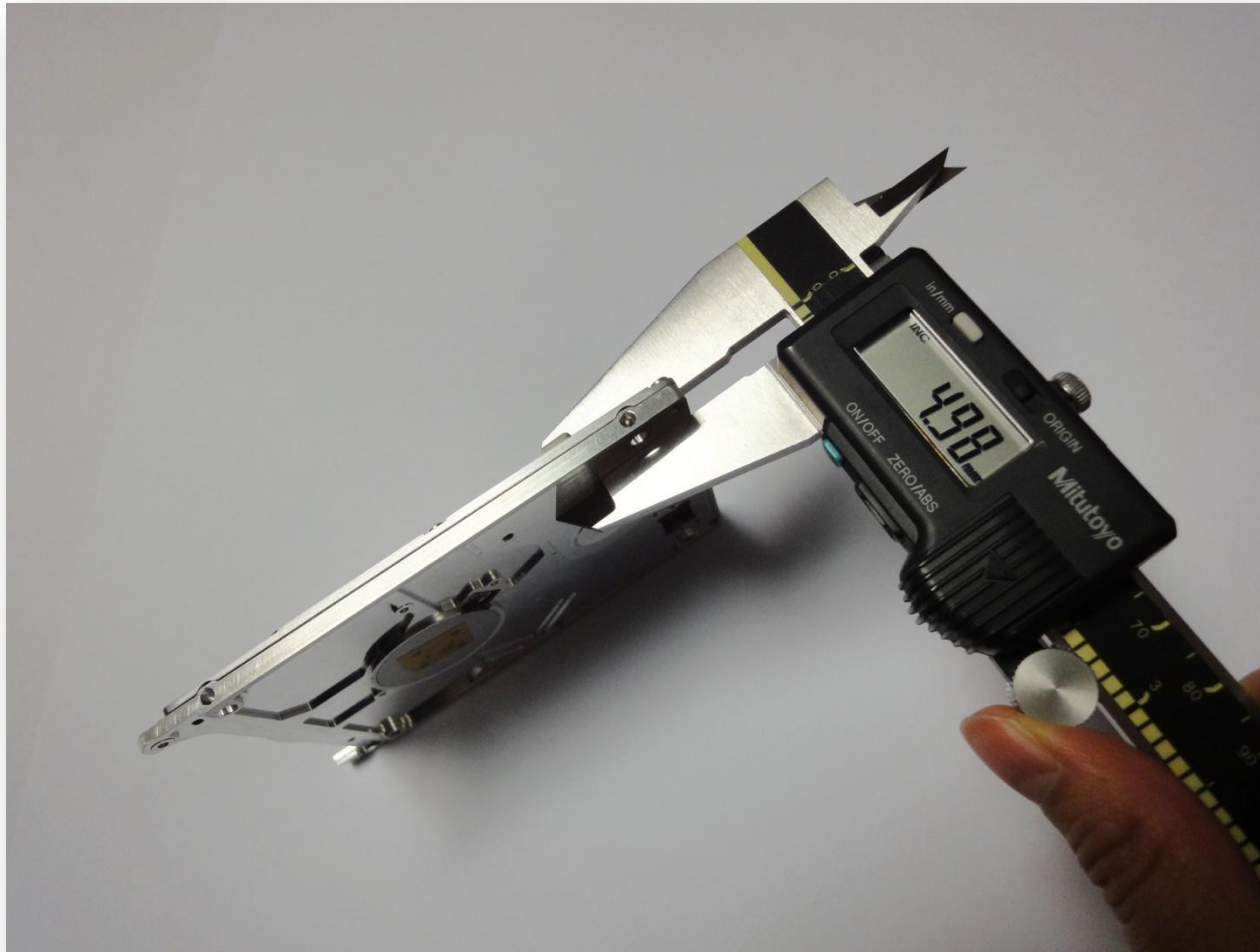
0.5TB Hybrid HDD



First Prototype of **DSI 5mm HDD**



First Prototype of **DSI 5mm HDD**

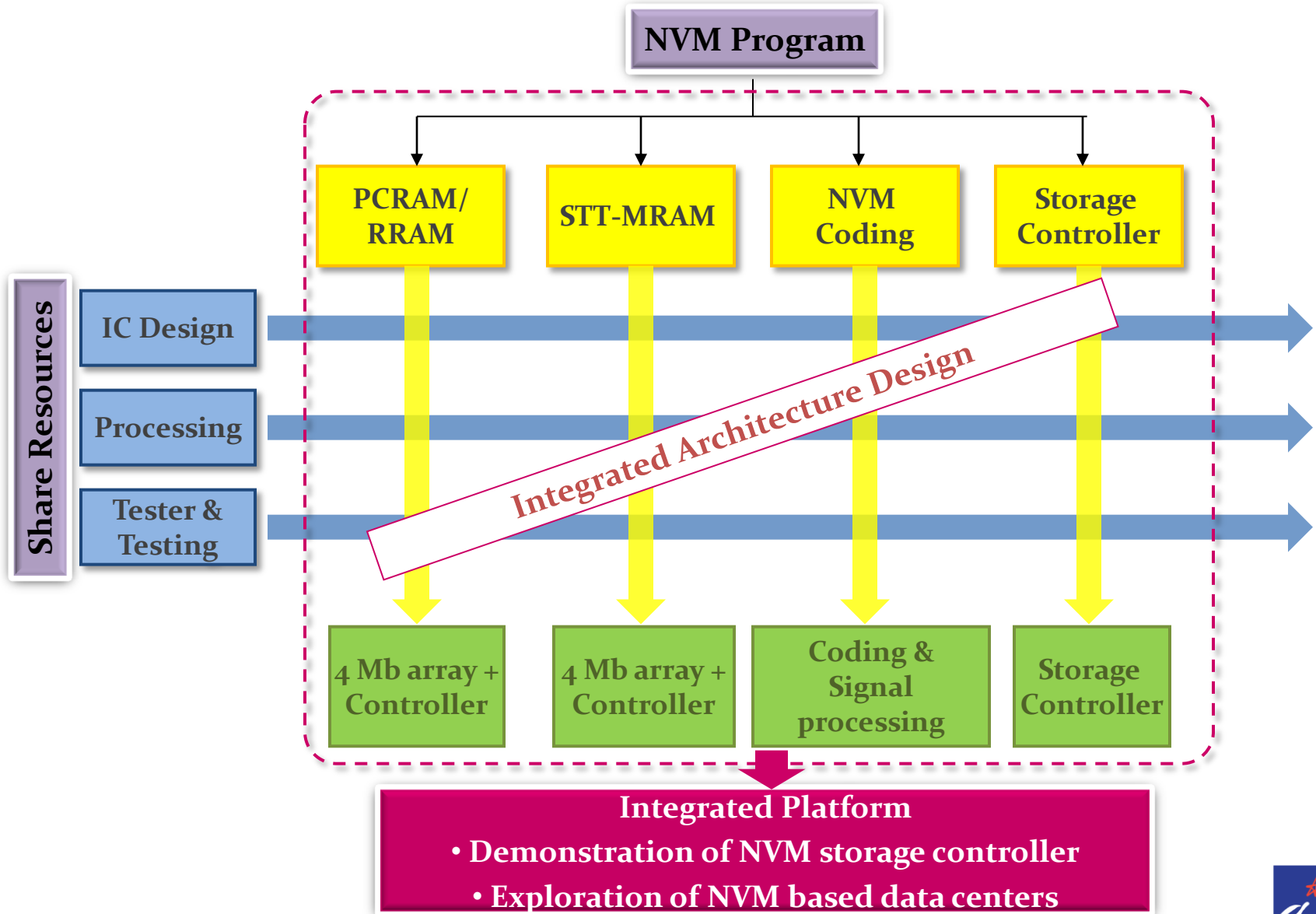


The image features three 3D models of memory modules, each with a blue top, a green base, and a red side. They are arranged on a background of a dense, repeating circuit board pattern. The modules have a central square window showing internal components and a row of pins along the bottom edge. The text 'next generation' is overlaid in white, and 'Non-volatile Memories' is overlaid in large yellow letters.

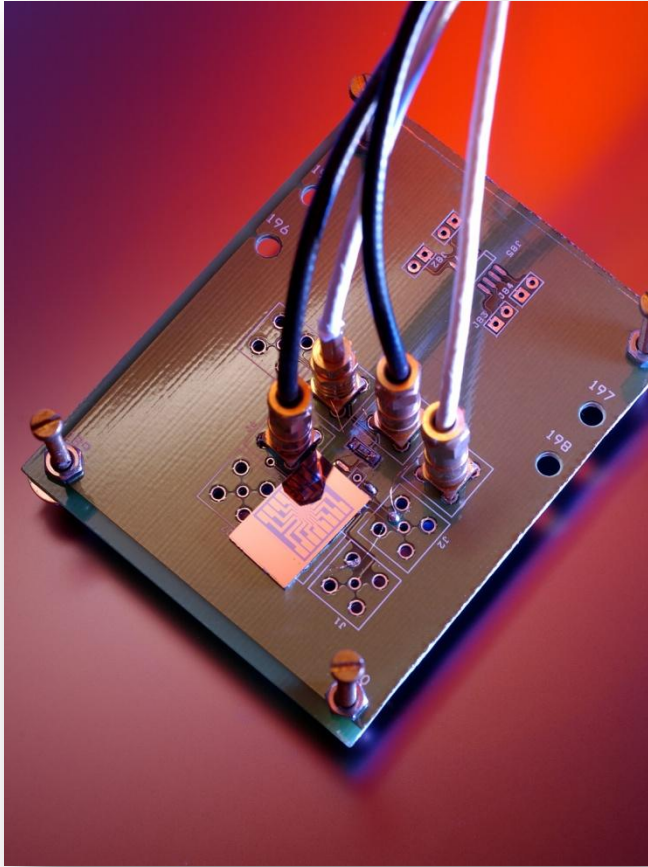
next generation

Non-volatile Memories

NVM integration program



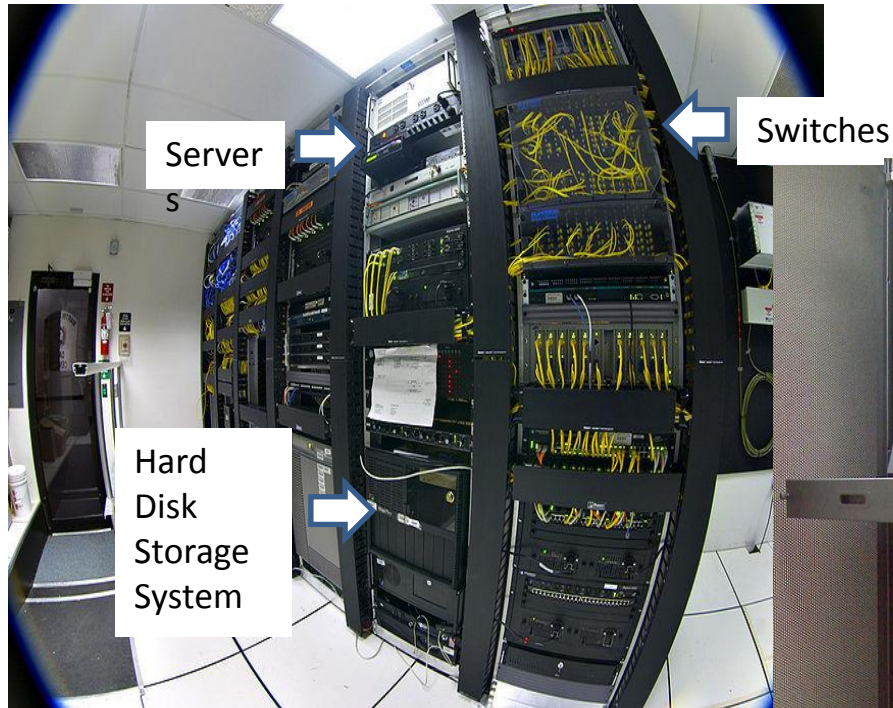
NVM research areas



1. Material design and synthesis
2. Device physics, modeling/simulation and structure design
3. Array design
 - Architecture design
 - SPICE modeling
 - IC design
 - Device/process integration
4. Fabrication process development and packaging
5. Tester development and testing technologies
6. NVM coding and signal processing
7. Failure analysis and reliability
8. Memory controller
9. Storage controller

Data Centers

They house IT equipments with the associated infrastructure to run software applications to process, store and deliver digital information.



Picture inside is a Data Centre

Data Centers are
information
factories !

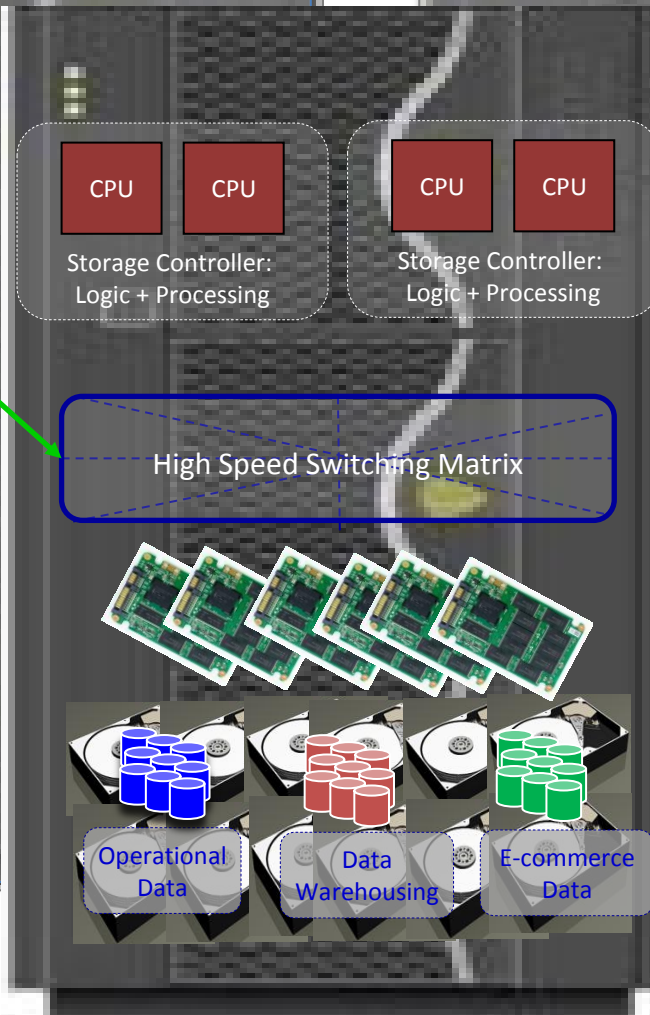


Rack used in Data Centre to
house equipment (server,
switch, storage)

Enterprise Storage Systems in Data Centers

Very high speed interconnecting switching matrix delivering millions of IOPS and tens GB/s throughput

Storage resources with hundreds of Hard Disk Drives or Solid State Disks for up to petabytes of storage

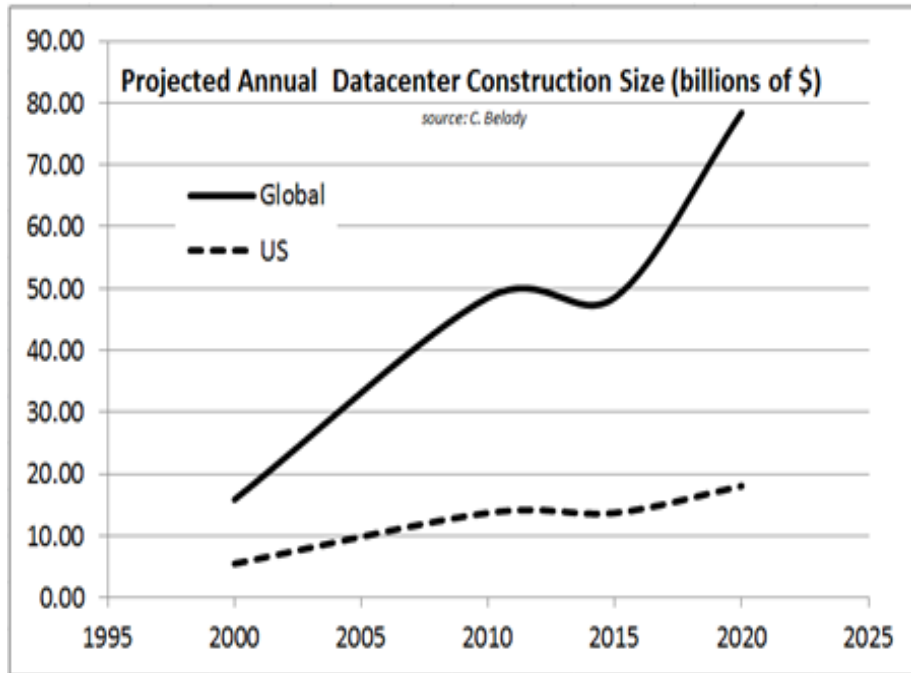


Very high performance intelligent computing system with failover protection

- Logical abstraction of storage resources
- High speed data delivery
- Data management & processing services: automated tiering, data redundancy/recovery, data reduction, backup/snapshots, load balancing, caching, etc

Data Centers

- Market report by TechNavio projected that the global **data centre outsourcing market** is expected to grow at CAGR of 11.6% to hit US\$163.0 billion by 2014.



- Microsoft projects that annual global spending on **new data centres construction** will reach \$78 billion by 2020 from about \$50 billion today.

Exponential Data Growth is Driving Demand for Data Centers

Data Centers industry identified as growth industry with Singapore continue to position itself as data hub for the region

Mar 10, 2011

Govt to set up data centre park by 2013

By Daryl Chin



Minister for Information, Communications and the Arts (MICA) Lui Tuck Yew acknowledged the difficulty businesses face in finding sites for their own data centres. -- ST PHOTO: CAROLINE CHIA

PLANS to develop a data centre park comprising up to six such centres were outlined yesterday.

These centres, to house computer systems and telecommunications equipment, among other things, will collectively take up 12ha of land and create some 1.3 million sq ft of space for the hardware.

Minister for Information, Communications and the Arts (MICA) Lui Tuck Yew acknowledged the

ZDNet / News / Internet

Google begins construction on Singapore data center

By Jamie Yap, ZDNet Asia on December 15, 2011

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Summary

Web giant commences construction work on Singapore data center which will cost US\$120 million and expected to be completed by early 2013.

SINGAPORE--Web titan Google has officially started construction of its Singapore data center, which will cost US\$120 million. Expected to be complete by early-2013, the 2.45-hectare facility is located in Jurong West.

Staffing requirements are still being finalized but recruitment for the leadership team that will helm the data center has begun and will continue as construction progresses, Google said Thursday when it officially broke ground on the site of the facility.

Salesforce.com Announces First International Data Center to be Located in Singapore

New data center to host the world's most popular Software-as-a-Service applications and Force.com, the world's first multi-tenant Platform-as-a-Service

Global leader in SaaS and PaaS anticipates new data center to further accelerate international expansion

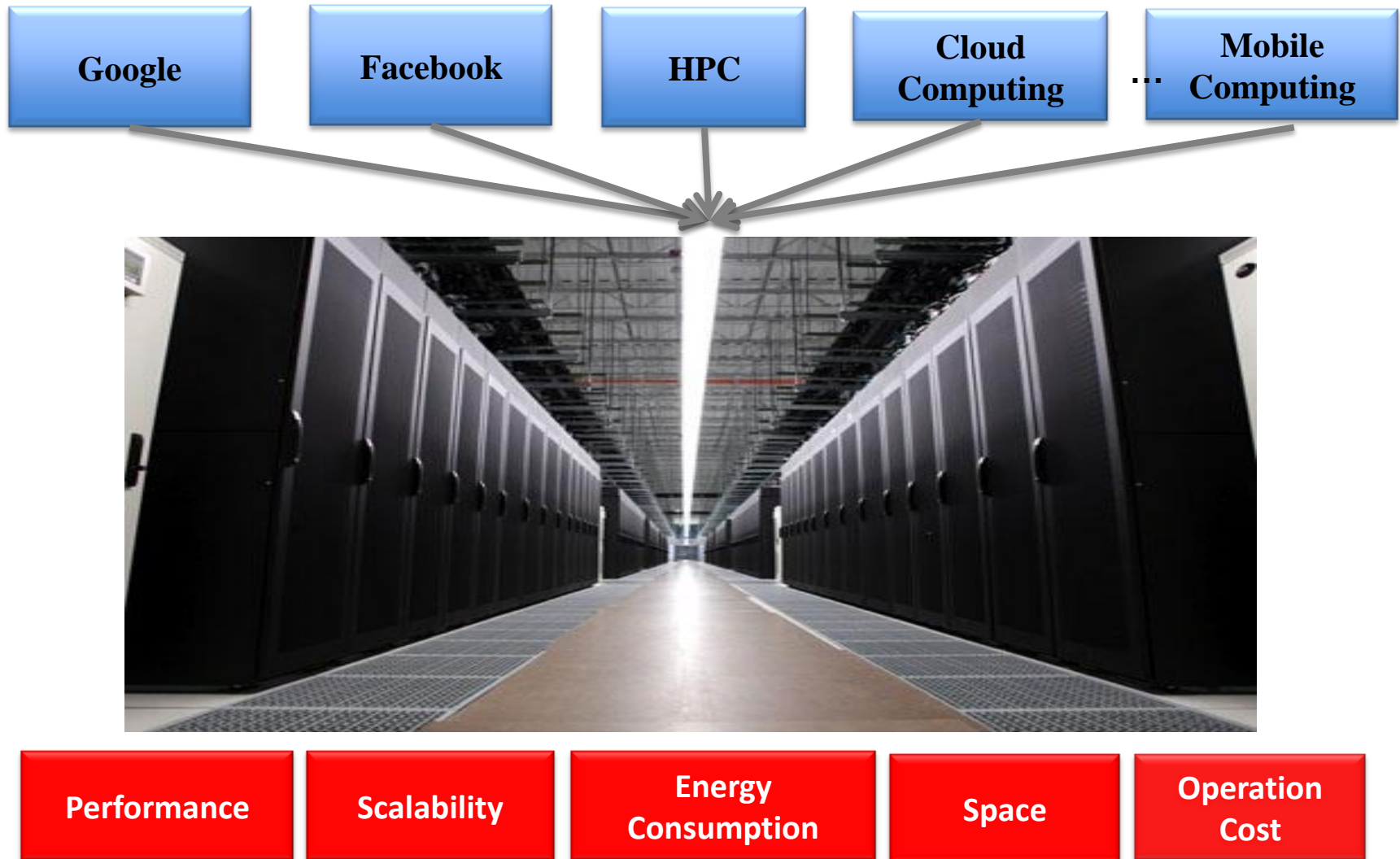
SAN FRANCISCO, Calif. - May 21, 2008 - Salesforce.com [NYSE: CRM], the market and technology leader in Software-as-a-Service (SaaS) and Platform-as-a-Service (PaaS), today announced that it is building its first international data center in Singapore. The data center, which is expected to go live before the end of year, will

Amazon Web Services opens first Asian data center in Singapore

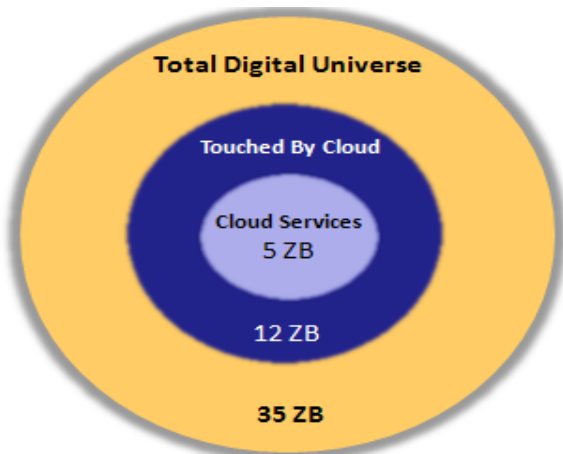
By Asia Cloud Forum staff 28-Apr-2010

Amazon Web Services LLC, subsidiary of Amazon.com, Inc., today announced the launch of its first Asia-Pacific (APAC) data center in Singapore, enabling its customers to run their infrastructure and applications over the side of APAC.

Data Center Challenges

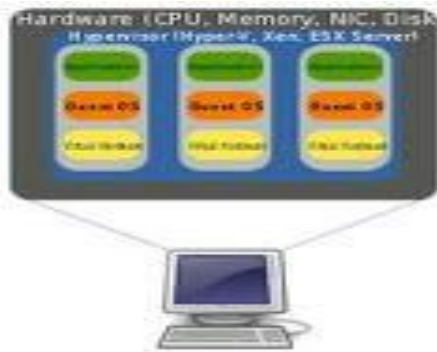


Data Centers Meltdown!

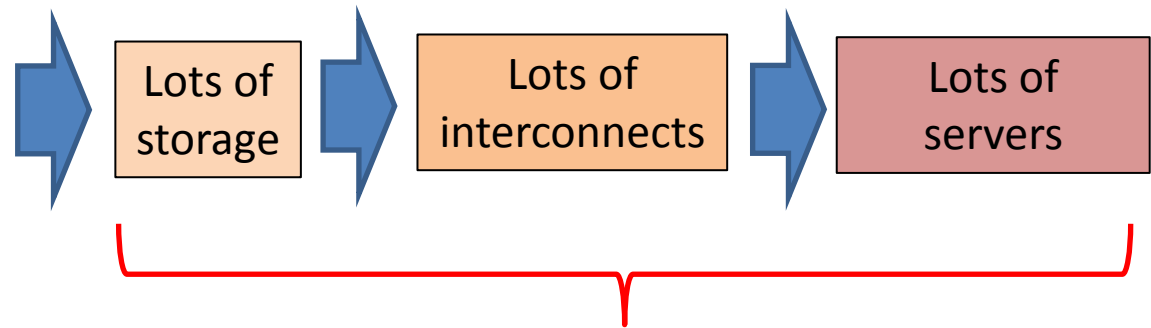


Source: IDC Digital Universe Study, sponsored by EMC, May 2010

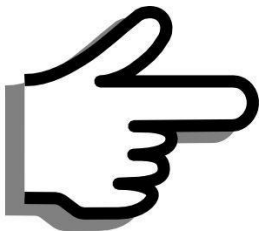
+



IDC estimate that by 2020, 35 ZB of digital data created.
 $1 \text{ ZB} = 10^{21} \text{ bytes} = 1,000,000,000,000,000,000,000 \text{ bytes}$

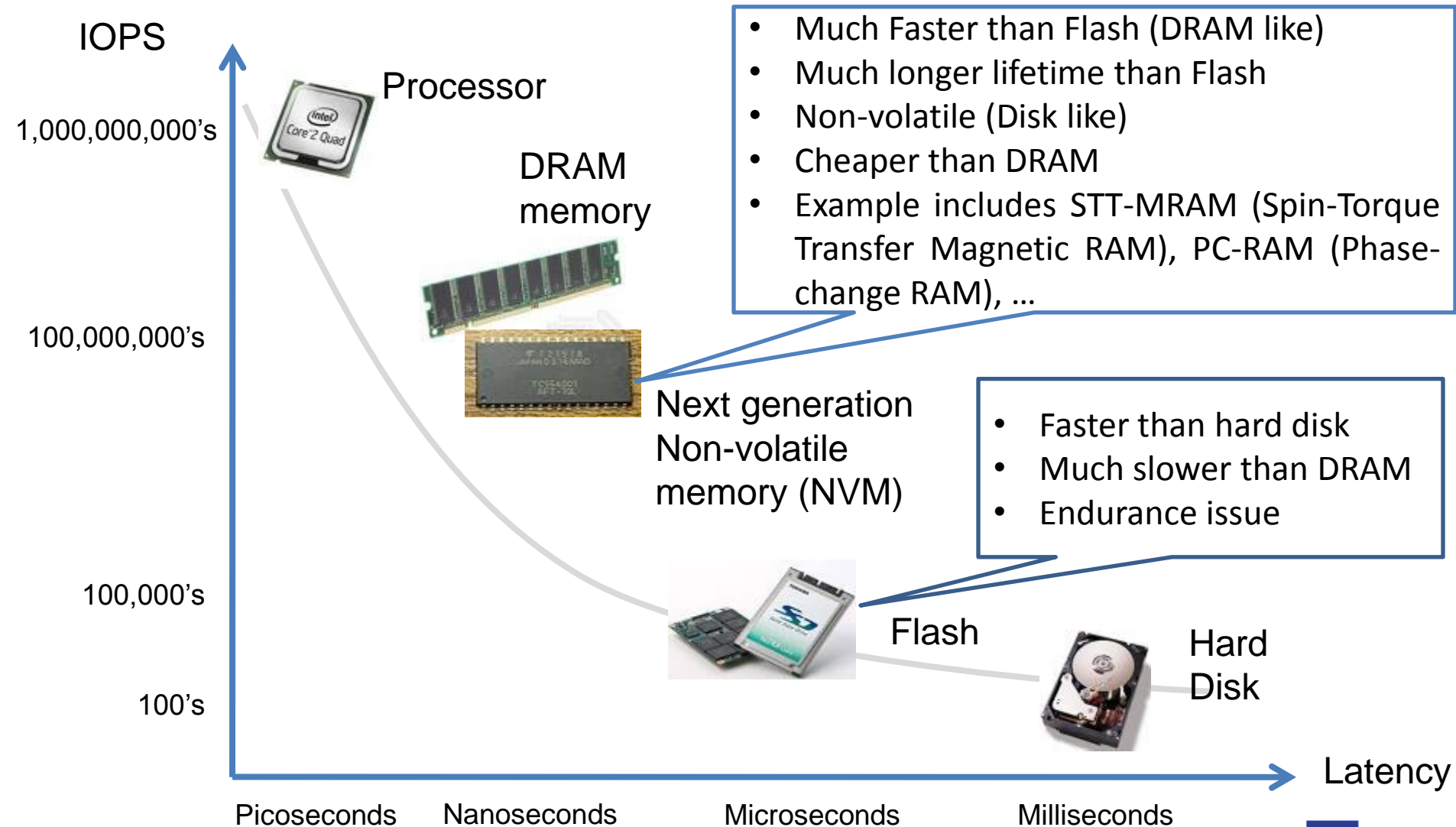


**Pressing issues in scalability,
performance, energy and
space/footprint in Data Centres!**



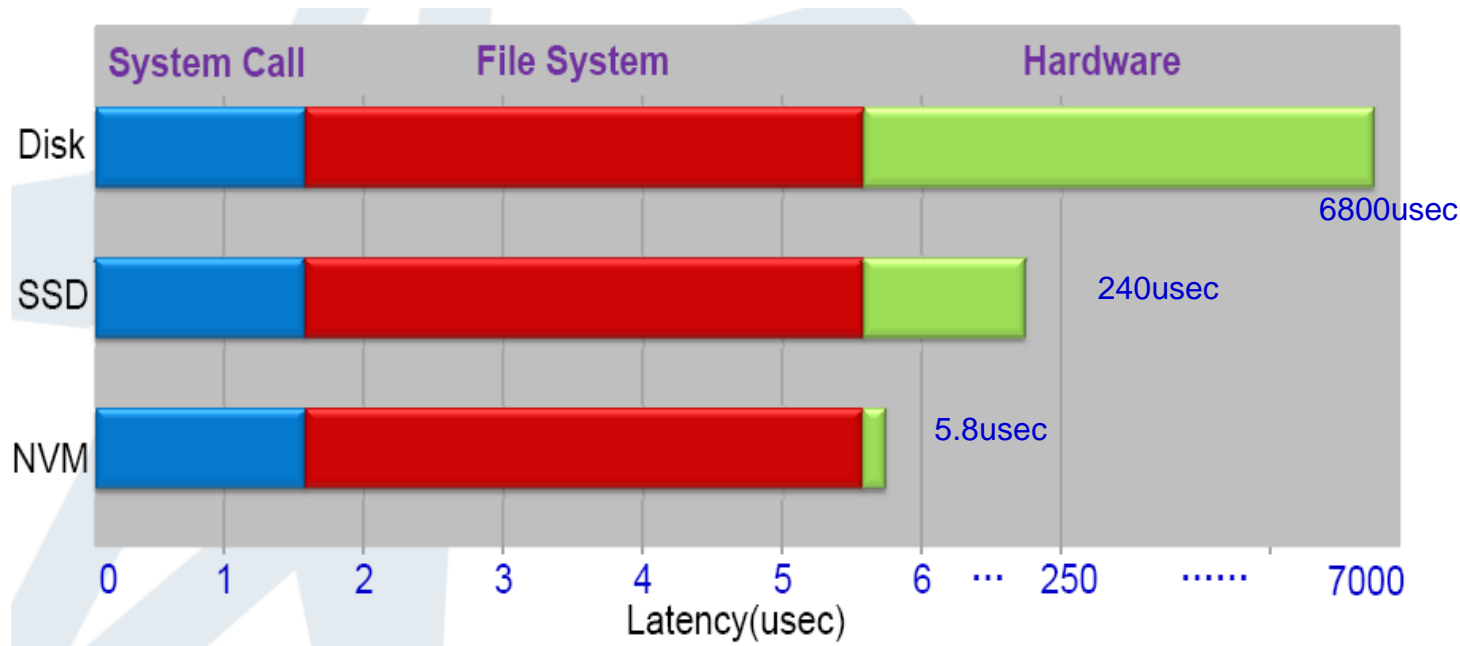
**High performance system for data processing, formatting,
reduction/compression, optimization techniques to deal
with this huge amount of digital data !**

Next Generation Non-Volatile Memory



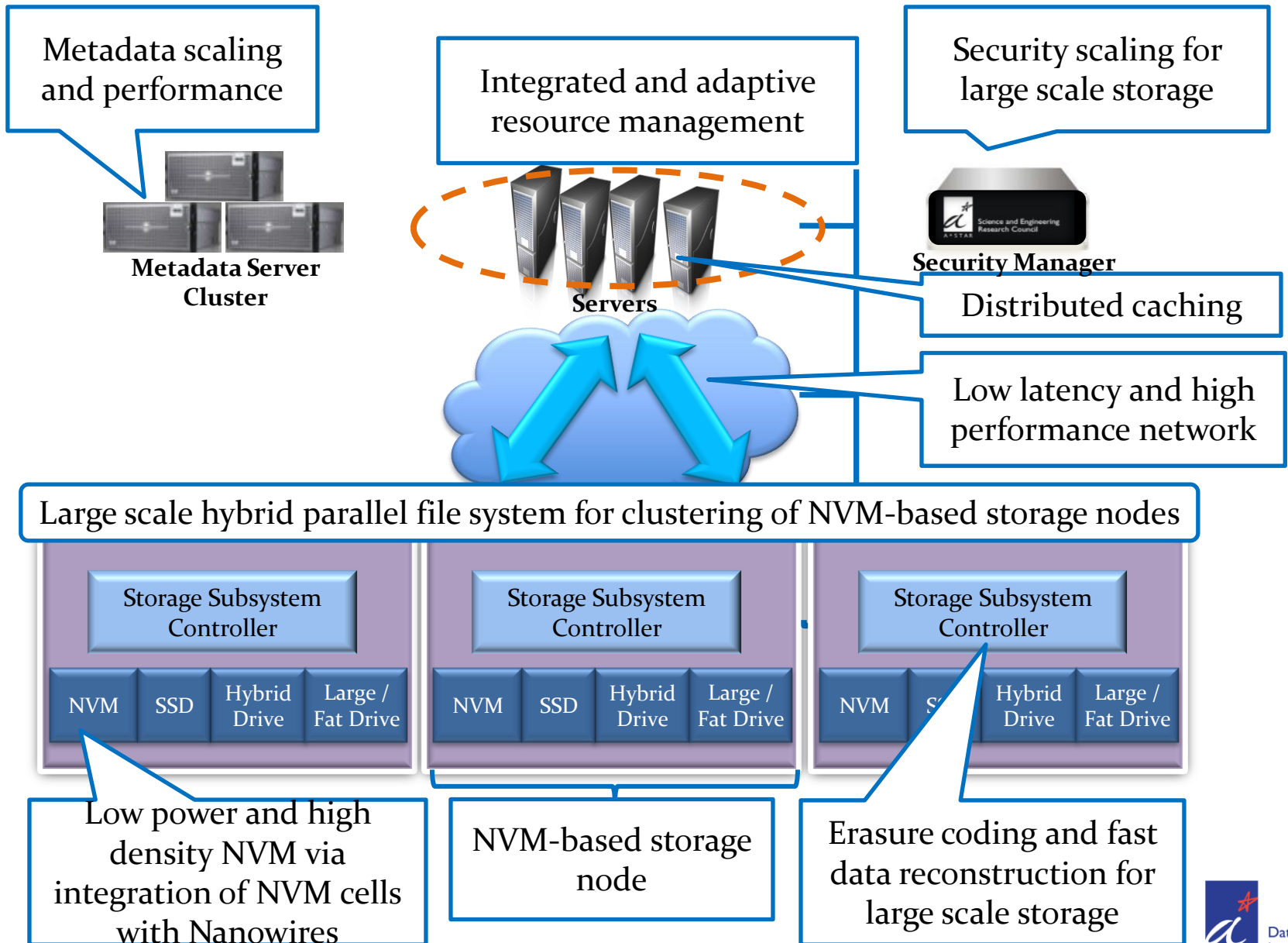
Next Generation Non-Volatile Memory

- ❑ Current storage stack including file system and memory management limits performance of next generation NVM.



- ❑ The integration of next generation into storage stack require optimization of hardware and software stack to storage system architecture

Storage Network Architecture for Data Center of the Future



job **Openings**

1. Research Scientists

**2. Post Doctoral
Fellowships**

3. Research Engineers

Nurturing Research
Talents and Capabilities
For World Class
Research &
Development

*Research and development of next generation
information storage system technologies for Data
Centers of the future*

job **Openings**

Research Scientists

**Post Doctoral
Fellowships**

A. Operating Systems and Computer Architecture:

- Research into highly scalable and robust computer architecture and operating system with next generation NVM technologies.

B. System Security

- Large scale storage security solutions including access control policies, privacy preserving security controls, file system security and in-memory security.

C. Large Scale Storage System

- Large scale and distributed architectures, parallel file system design, metadata management, workloads analysis, system modelling and simulation.

job **Openings**

Research Scientists

**Post Doctoral
Fellowships**

General Requirements:

- Exemplary attitude towards research.
- Outstanding research track record especially in the field of computer sciences or information system
- Hands-on experience in research environment is a big plus
- PhD in Computer Science/Computer Engineering

job **Openings**

Research Engineers

Requirements:

- Passionate about developing advanced technologies
- At least 3 years of strong experience in Linux kernel or device driver design and programming
- Knowledge of OS internals or storage technologies, such as RAID, Clustered File Systems, Snapshot, SAS, SATA will be a plus point
- At least a 2nd upper honors in Computer Science, Computer Engineering or Electronics/Electrical Engineering

- **Information Storage System Software Development**

- Design and development of software prototypes or packages for next generation information storage systems
- Developing advanced and innovative solutions for high performance and scalable information storage systems.

Please collect a brochure for details

PhD scholarships

for embedded systems and data center technology research



- A*STAR Graduate Academy in conjunction with National University of Singapore, Electrical & Computer Engineering Department.
- Equip candidates with knowledge and skills needed to architect and design multi-tenanted large data centers:
 - Architect and design high performance distributed software and hardware systems with high density I/Os capability
 - Ability to architect solutions that are inherently complex with intricate interdependencies between hardware and software in a multi-core or multi-processor computing platform.
 - Next generation non-volatile memory device technologies and system level integration.

PhD scholarships

for embedded systems and data center technology research



Samples of Research topics:

- *Performance optimization techniques for large scale and distributed I/O systems*
- *Content analytics, visualization and complex event processing for large scale data*
- *Scalable and reconfigurable architectures for multi-core and multi-processor systems*
- *Very high speed data processing and information retrieval system using multi-core and multi-processor architectures*
- *Dynamic programming, data wrapping, scheduling and concurrent execution strategies for multi-core system*
- *High fault tolerant erasure code and fast data reconstruction for large scale data systems*
- *Advanced non-volatile memory devices and integration with computer architecture.*

PhD scholarships

for embedded systems and data center technology research



- The award provides financial support for up to 4 years of PhD studies:
 - Full support of tuition fees
 - Monthly stipends of S\$2,500
 - One-time airfare grant of S\$1,500
- General Requirements:
 - Min Bachelor's Degree with 2nd Class Upper
- Detail information on PhD program:
 - http://www.ece.nus.edu.sg/academic/graduate/theme_data.html
- Application for Aug 2013 intake will closed by Dec 2012

Thank You

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SSD



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SAS



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Encryption Engine



10G



RAM



IBM
Power 3



8G



4G



Intel



SUN
SPARC



FCoE



AMD

