New PCIe/NVMe Memory Cards Open up New High-Speed Applications

Consumer/Mobile Applications Track
CMOB-201B-1 Ballroom A
Wednesday, August 8, 2018; 9:45 – 10:50am

Chairperson: Yosi Pinto

Mobile Apps Track Organizer: John Geldman

Flash Memory Summit

New PCIe/NVMe Memory Cards Open up New High-Speed Applications - Agenda

- SD Express: Combining the Reliability of SD Cards with PCIe/NVMe – Yosi Pinto (SDA)
- Adaptable/Expandable External SSD-like Storage for Endpoint Products Using SD Express Cards – Lee Prewitt (Microsoft)
- Industrial IoT: Using SD Express Cards as Edge Storage device – Crystal Chang (ATP)
- Exploring New Opportunities in Client Devices Using SD Express Cards as Expandable Storage - Jacek Wysoczynski (intel)
- Q&A session

Flash Memory Summit

Yosi Pinto - SD Association

- Yosi Pinto is Chairman of the Board and the Technical Committee Co-Chair for the SD Association. He is also Director of Standards at Western Digital. A 30-year industry veteran, he was a major contributor to the first SD Card standard, developed the first SD card controllers, led the Memory Stick project, and was responsible for other SD/eMMC products and standards initiatives. He holds over 30 patents related to memory cards, and has organized sessions and spoken for the SD Association at previous Flash Memory Summits. He earned an MSEE from Stevens Institute of Technology (NJ) and an MBA from Tel Aviv University (Israel).

SD Express
Combining the Reliability of SD Cards with PCIe & NVMe

Yosi Pinto

Chairman of the Board & Technical Committee Chair in SD Association
Director of Standards at Western Digital

SDA Confidential Information and Disclaimers

Forward-Looking Statements

During our meeting today we will be making forward-looking statements.

Any statement that refers to expectations, projections or other characterizations of future events or circumstances is a forward-looking statement, including those relating to industry trends, standardization plans and any SD Association's related plans. Actual results may differ materially from those expressed in these forward-looking statements due to various factors. We undertake no obligation to realize these forward-looking statements, which speak only as of the date hereof.

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Higher Quality Mobile Content Creates Demand for More Capacity and Greater Performance

1.2 trillion photos were taken on smartphones in 2017

Continued move from Full HD > 4K+ video.
A 2-hour 4K UHD movie requires 32GB storage

By 2020, over 50% of all video viewing will be on smartphones

Top 5 online streaming services Offer content download to cards for off line viewing

VR & AR video increasing in quality

RAW video recording

1.2 T source: https://mylio.com/media/press-release/mylio-announces-2017-world-digital-photo-forecast/
Video Viewing source: www.ericsson.com/en/press-releases/2017/10/tv-in-2020-50-percent-of-viewing-will-be-mobile
Online Streamlining services : by Tidal

More Apps + Larger Apps = More Capacity and Greater Performance

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197 Billion Apps Downloaded in 2017

The average size of Android™ apps is increasing: 15MB

49% of smartphone users have received a "memory full" notification

Apps can be stored on adopted SD card storage in the latest Android™ devices

The total number of mobile app downloads in 2017 – 197 billion (a forecast) -http://www.businessofapps.com/data/app-statistics/
memory full: (source: SanDisk survey)
size of apps: (source: https://sweetpricing.com/blog/2017/02/average-app-file-size

Client Computing, Imaging, Automotive – Transition to Higher Speed Interfaces

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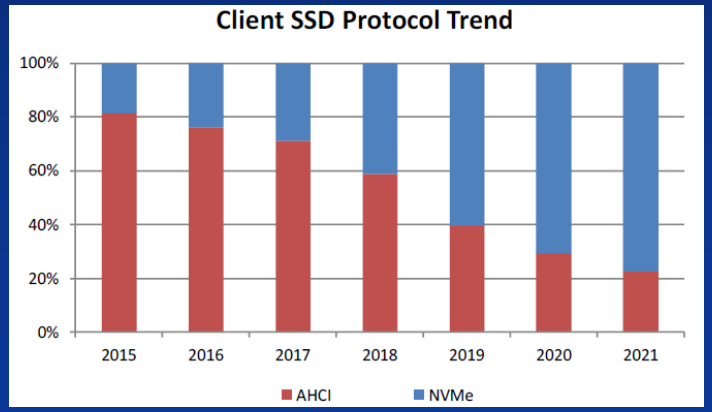
Client SSD

- PCIe and NVMe interfaces are rapidly gaining popularity - expected to become most dominant in 2018
- PCIe Gen 4 is expected to gain traction by 2019/20



Source: Forward Insights, May 2017

New Markets Demand More Memory with Higher Speed

- Autonomous vehicles and connected cars with multi-sensor data collection & processing

- Multi-channel video capture

- Gaming with 3D high resolution graphics

- New evolving imaging market (360o, VR, AR etc…)

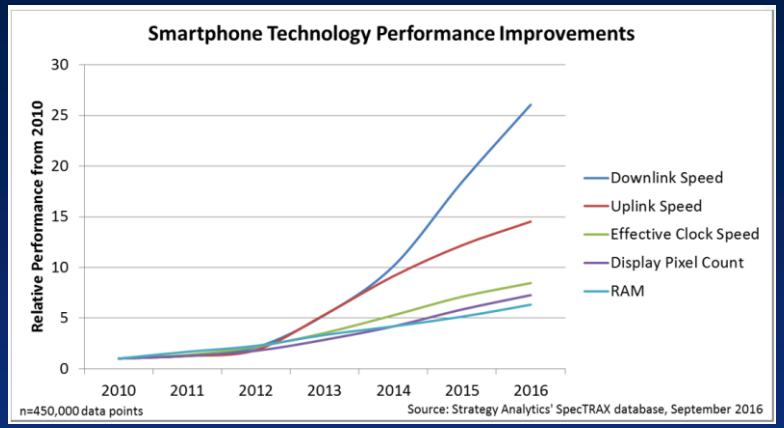
- Imaging market is already heading to PCIe

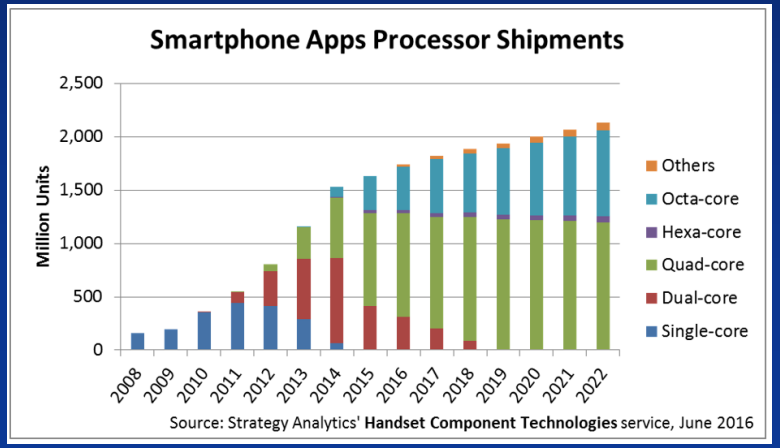
Evolving technology trends push memory interface requirements to higher sequential and random performance levels

Mobile Technology is Developing Rapidly

- Growing performance levels of IOs wireless (WiFi/WiGig…) and wired (USB3...)
- Rapid developments in APs technology (Multi cores, Speed, RAM increase etc..)
- Embedded storage is transitioning to more advanced protocols opening new opportunities (UFS, PCIe and NVMe interfaces)

Evolving technology trends push memory interface requirements to higher sequential and random performance levels





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SD Express: Running Towards New Horizons

PCIe® and NVMe™ Memory Card Interfaces

- Delivers performance and advanced protocol required for the next generation of memory-intensive mobile computing applications

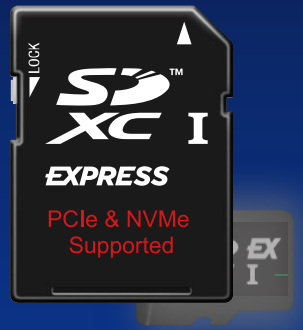
PCIe and NVMe Interfaces - the Future of High Performance

SD Express is the SD Card Association's Answer

Delivers sequential and random performance for next gen application platforms

Computing

8K
RAW Video and slow motion Recording



Automotive
Multi Channel
Data Collection

360º
Virtual and
Augmented
Reality

IoT
Multi
Channel
Processing

High Resolution
3D Gaming

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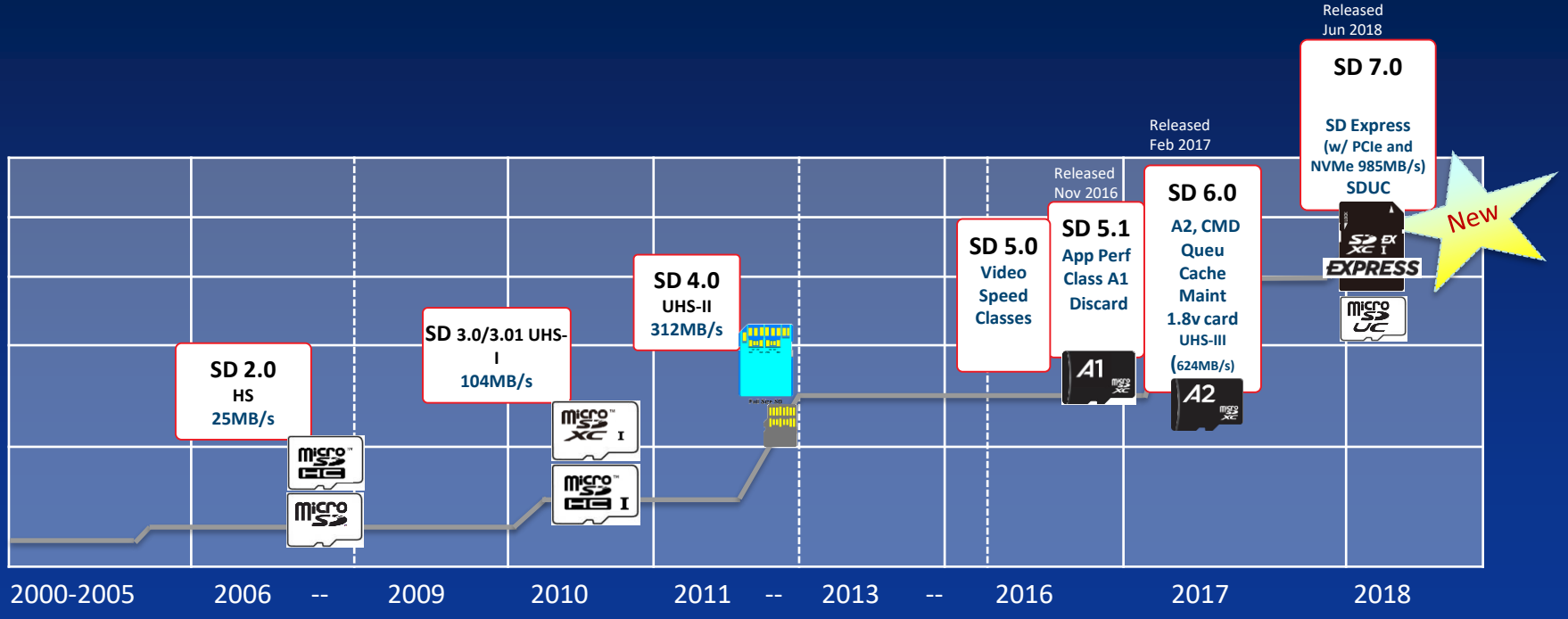
SD Memory Card Standard Evolution

SD's New Era…



SD Express card

- Released in June 2018 as part of SD7.0
  - PCIe Gen3 and NVMe v1.3 interface added
  - Existing SD form factor
  - Legacy UHS-I interface supported allowing backward compatibility with billions of host devices

- microSD Express will hopefully follow (not announced, yet, by SDA)

	UHS-I	UHS-II	UHS-III	PCIe
Bus Speed	104MB/s	312MB/s	624MB/s	985MB/s

Why were PCIe and NVMe interfaces chosen?

PCIe and NVMe are widely adopted…

- PCIe standard developed by PCI SIG
  - Gen 3 with up to 8Gbps is a proven, reliable and mature differential interface
  - PCIe already released also Gen4 with up to 16Gbps …and Gen 5 is underway
  - Proven environments were defined
- NVMe standard developed by NVM Express
  - The command layer protocol for Non Volatile Memories that teamed up with PCIe…
  - A scalable and sophisticated protocol – ready to handle future system needs
  - Become more and more popular as the de-facto standard for SSDs and other…
  - Supported by all major OSs
  - Proven test environments were defined

Both are world wide recognized as the preferable protocols for future needs ➔
Easy to adopt !

PCIe and NVMe Interfaces – Test Advantages

Many Bus Analyzers, Protocol Analyzers, Test Suites are in the market…

SerialTek

TELEDYNE TECHNOLOGIES INCORPORATED

OakGate Technology

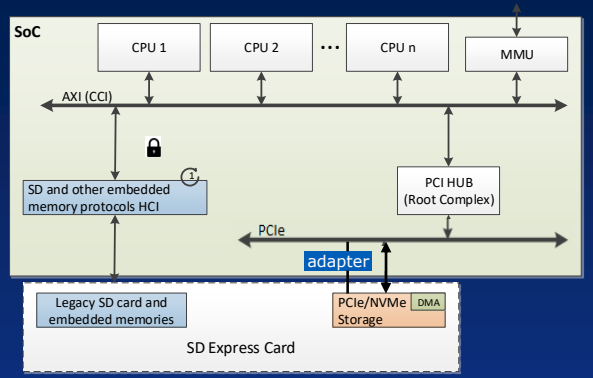
JDSU

KEYSIGHT TECHNOLOGIES

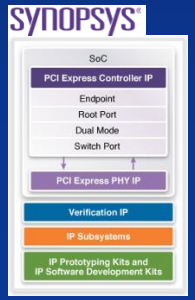
PCIe and NVMe Interfaces – Product Vendor Advantages

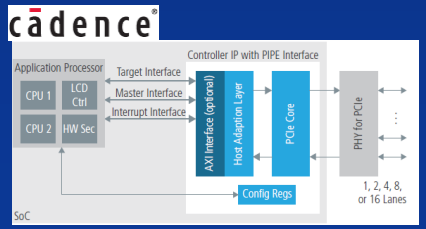
The building blocks are available in the market

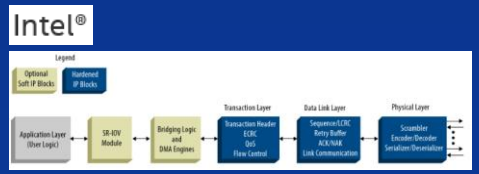
- Many SoC already implemented PCIe interfaces (for Modems, WiFi, Memory etc...) . Such PCIe interfaces exist either as:
  - Extra I/O that may be utilized for SD Express with adapter
  - Re-use of available PCIe IP building block in new SoC design

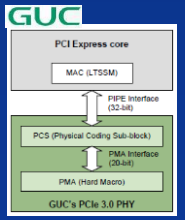


- Many standard PCIe IP modules exist in the market – supplied by the leading IP vendors









In Summary…

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SD Express – The best of all worlds…

PCIe/NVMe like in SSD

- SSD grade performances and features
- PCIe/NVMe – a continuously innovated market-wide platform
- Scalable SW stack widely supported
- Bus mastering and reduction ram and cost
- Low power options for mobile implementations
- Leveraging existing investments for card and products manufacturers

SD EXPRESS

SD Memory Card

- Most popular removable card in consumer market
- Enhanced features added: Command Queue, Cache
- SD UHS-I operation mode supported

Mobile Phones | ***Mobile Computing*** | ***Gaming*** | ***Imaging*** | ***Automotive*** | ***IoT*** | ***….***

A small SSD-Like card in reliable small SD form factor including backward compatibility with existing SD products

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Thank You

Yosi Pinto
yosi.pinto@wdc.com

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- Q&A session

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Lee Prewitt - Microsoft

- Lee Prewitt is a Principal Hardware Program Manager with 25 years of storage industry experience ranging from Magneto-Optical to spinning rust to Flash. Until recently, he worked in the Windows and Devices Group at Microsoft where he was responsible for many of the components in the storage stack including File Systems, Spaces, Storport and Microsoft's inbox miniport drivers. His responsibilities included storage devices ranging from SD and UFS in mobile to NVMe in Enterprise and Data Centers. He has recently moved to the Azure CSI team where he is responsible for Data Center storage initiatives.

Adaptable/Expandable External SSD-like Storage for Endpoint Products Using SD Express Cards

Lee Prewitt

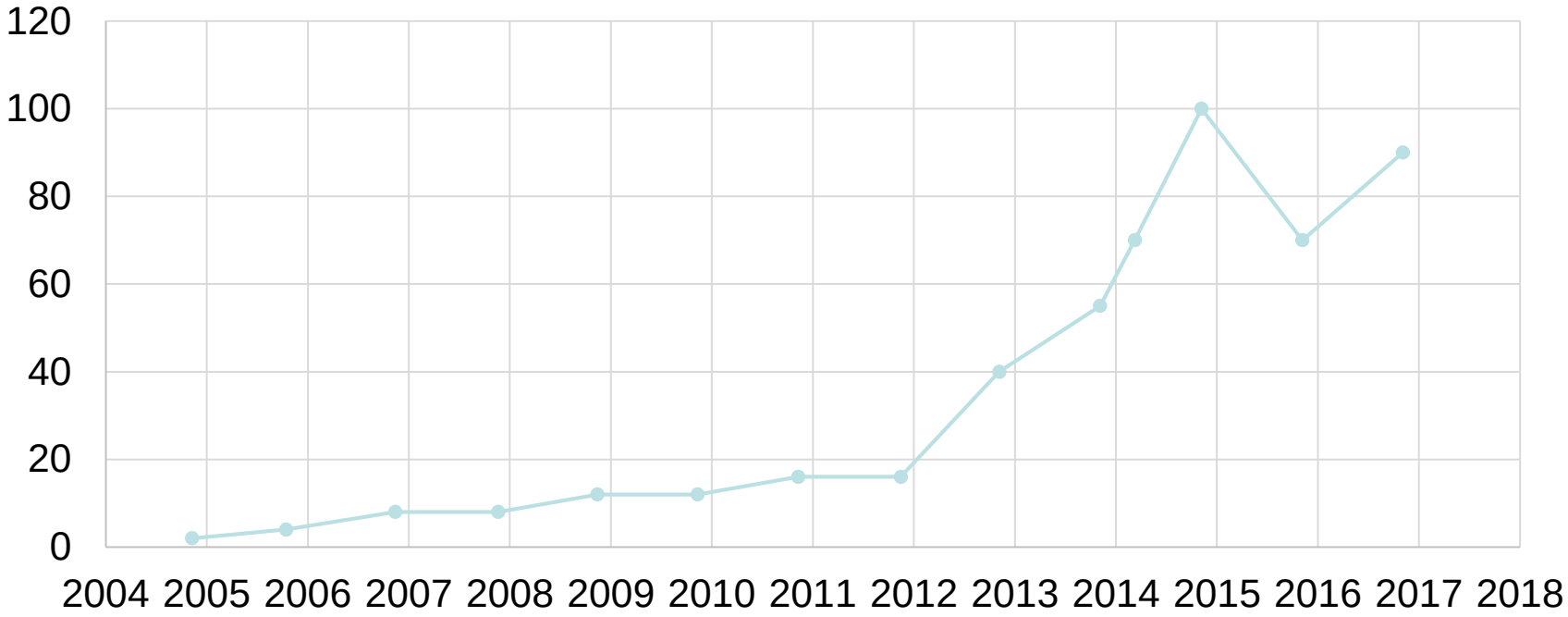
Principal Hardware Program Manager

Microsoft

AAA Game Development Cost

- Development Budget: $100M
- Marketing Budget: $100M
- 3000-4000 people on a single title at peak
  - 80% artists, 15% managers, 5% programmers
- Artists create textures, meshes, animation data, and audio

Game Storage Requirements



Gaming PC Market

- Gaming PCs are a growing business
- Desktop/Tower configs are high-margin but slow growth
- Gaming laptops are the top growth sector
- Most devices at gamer price points do have SSDs of some kind
- But their capacity is limited: 240GB is current sweet spot
  - But his is only sufficient to hold 2 or 3 AAA games

Key Take-Aways

- Monitors are increasing in resolution and quality (HDR)
- Game sizes are increasing too
- PC Game devices face challenges supporting this
- Dynamic loading can help significantly
- SD Cards as expandable storage can help
- SD 7.0 speeds allow game loads/game play to be done directly from the SD card

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Crystal Chang - ATP

- Crystal Chang, Senior Manager of Product Management at ATP Electronics, Inc.
- Crystal is in charge of the Memory card BU for ATP Electronics. During her 8 years tenure at ATP, Crystal dedicates to promoting memory cards in various industrial applications and contributing her business insight and front-end experiences to continuous product enhancement.

Industrial IoT era
Memory cards in Edge computing

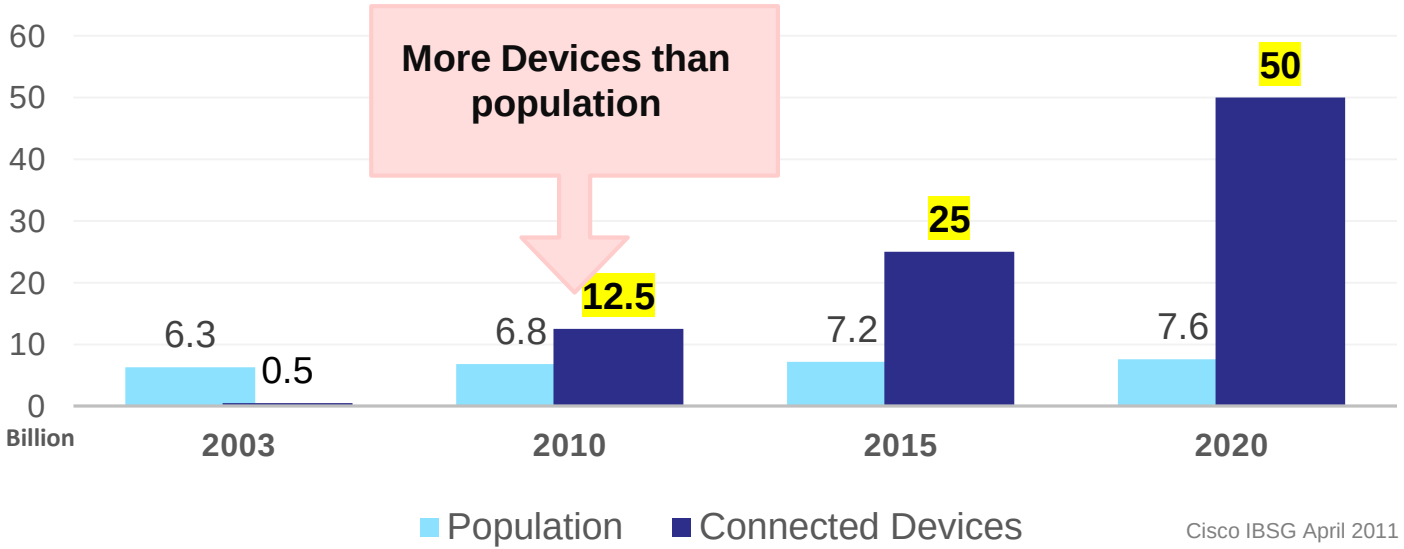
ATP Electronics, Inc.
Crystal Chang

Agenda

- Data Booming
- Why Edge Computing?
- When IoT go into Enterprise
- IIoT Edge Gateway Example, Function v.s. Form Factor
- SD Express: One Size Fits All?
- Take away

Data Booming

- 2021, 50 billion connected devices
- Person will use connected device 4800 times a day

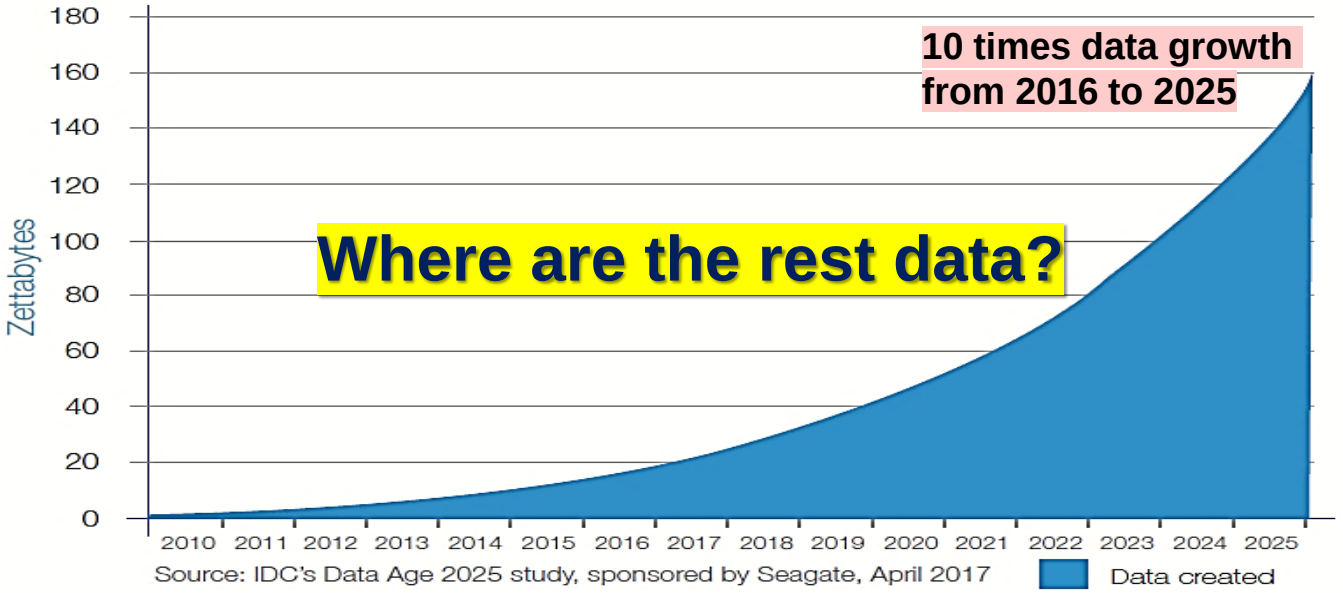


Cisco IBSG April 2011

As data sharply increasing

By 2025, world data sphere expect to grow to 163 zettabytes

Massive data creation, but very little will be transmitted to Cloud.

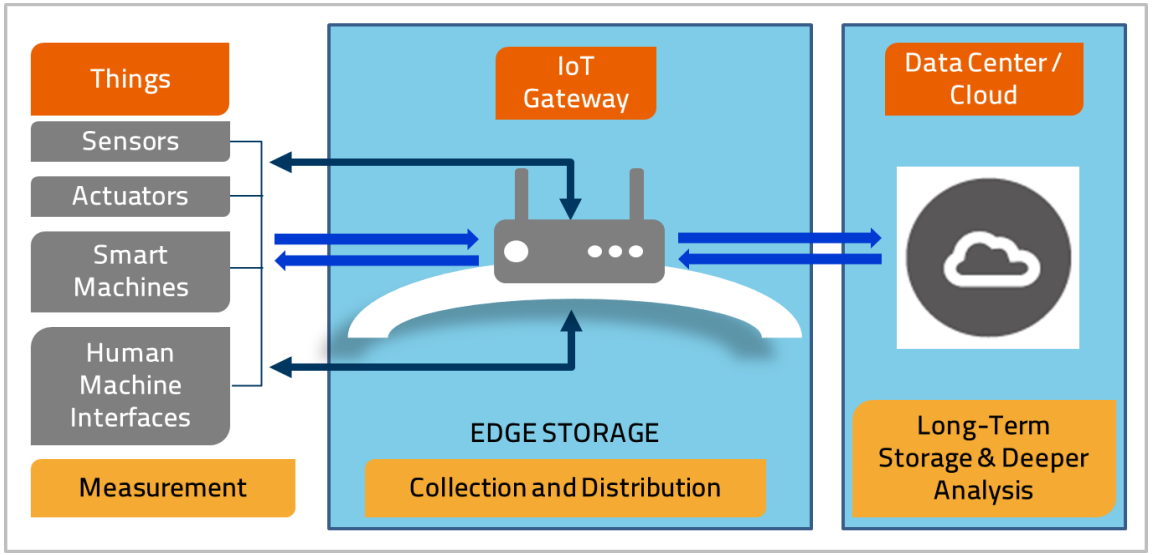


Data resource: ABI's report

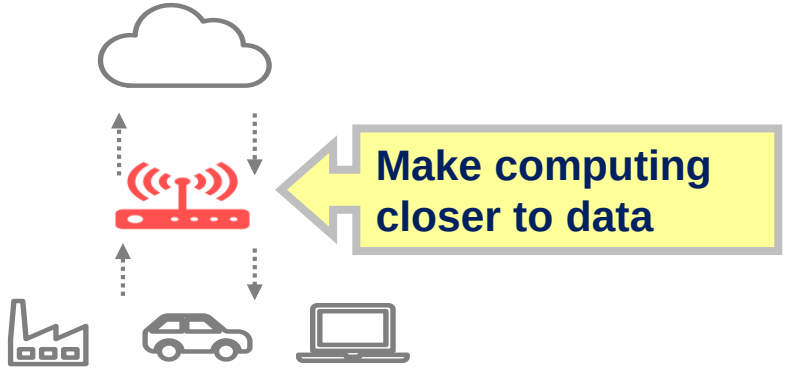
Edge Computing

Edge computing was designed to fulfill the demand of latency solution

By 2020, 10% of the world's data will be **processed on the Edge (IDC)**



Why Edge Computing?



Cloud Storage	Edge Storage
• **Analyze historical data** for forecasting • **Big data** processing • Data **warehousing**	• **Real time Response** • **At-source visualization** • **Temporary cache** for data waiting to be transmitted to the cloud • **Reduce network traffic** in the centralized data center

When IoT go into Enterprise

Industrial (Manuf.)
- Optimized Automation
- Manufacturing Process Control

Retail
- Digital Signage & Advertising
- Retail/Hospitality Kiosk & POS

Transportation
- Vehicles Communication
- Fleet / Traffic Control
- Logistics

Safety & Security
- Surveillance
- Disaster Management
- Emergency Service

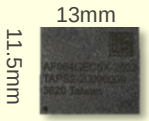
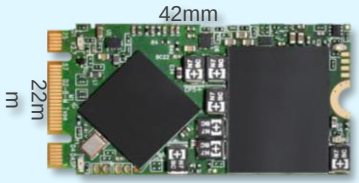
Healthcare
- Remote Health Monitoring
- Geriatrics Care
- Tele Health

Utilities
- Smart Grid
- Water , Energy
- Waste

IIoT Edge Gateway Example

Dell Gateway	3000 series(2017)	5000 series(2015)
Application	• Automation • Cargo Tracking/Truck/ Bus/ Train/ Marine Transportation Retail Kiosks • Managing Green Energy Assets (IP50 Dustproof, IEC 60068-Extreme Temp.) $399 up 	• Commercial and Industrial Environments • Boiler rooms or inside rooftop HVAC units. (Operating temperatures from -30C to 70C, IP50, IEC 60529) $1,260 up 

Edge Gateway: Function V.S Storage

Type	3000 series 	5000 series 
Dimensions	125mm wide x125mm high x51mm deep	229mm wide x216mm high x75mm deep
Storage/ Drives	**microSD: 8GB~64GB** **eMMc: 8 GB / 32 GB**  	**SSD M.2: 32GB~512GB.** 
Features	• **Limited space, Mobile, Localized** • **Robustness** • **Basic** edge analytics	• **Fixed** use cases for modular expansion • **Large sensor network** • **Advanced** edge analytics

1/2 Size

1/3 Size

SD Express: One Size Fits All?

- **Small Form Factor**
- Popular extension form factor in many IoT devices
- **Removable**
- **Low power consumption**
- Robust (IP57/67) waterproof, dustproof

- **Low Latency**
- **Faster performance**
  PCIe-G3
- As host memory buffer
- Bus mastering
- Multi Queue support in DRAM

SD Express for various gateway needs
Powerful, small form factor, flexible for storage "expansion" (removable)

Take Away

SD Express – Powerful, Bite size, Removable SSD

- ***SD Express*** with ***PCIe/NVMe*** interface
- Integrate all the benefits of PCIe/NVMe with existing SD form factor
- Suitable for ***Multi-Channel Edge Computing*** – collect massive data from sensors, process & analyze data for ***Real Time Response*** requiring ***High Bandwidth, Low Latency***
- Powerful yet ***Low Power Consumption***
- ***Removable, Bite Size and Robust*** – fit into limited edge device space running at harsh environment
- Backward compatible: select legacy SD or SD express [1]

Note 1: For more information, please refer to SDA white paper: SD Express Cards with PCIe and NVMe Interfaces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2018 Flash Memory Summit
August 7th ~9th
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Jacek Wysoczynski - Intel

- Jacek Wysoczynski is holding Strategic Planner position in Non-volatile Memory Solutions Group at Intel Corporation. He is responsible for defining the storage software strategy and long-range roadmap for Client platforms, including Intel® Rapid Storage Technology and Intel® Optane™ Memory solutions. During his 20+ years of working for Intel he contributed into numerous products from multiple domains including storage, embedded, networking, telecommunication, operating systems, and distributed services. Now he focuses on innovation and usages related to PCIe/NVMe storage and memory with strong emphasis on the system/software aspect of it. Jacek holds patents and publications in wireless technology field. Mr. Wysoczynski received his MSc degree from Technical University of Gdansk

Client Platform Evolution Using Expandable Storage

Jacek Wysoczynski

Non-Volatile Memory Solutions Group, Intel Corporation

Today's Problems with Removable Cards

Slow and Inefficient

Multiple Protocols with Different Drivers

Extra Cost to Use in PC

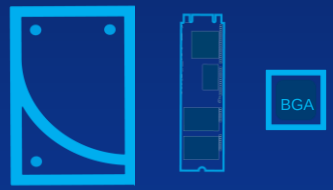
Usages Limited to Removable Storage

Solving Issues with SD Express

Performance

SD Express Cards with PCIe* NVMe Interface

Direct Connect to Lower BOM



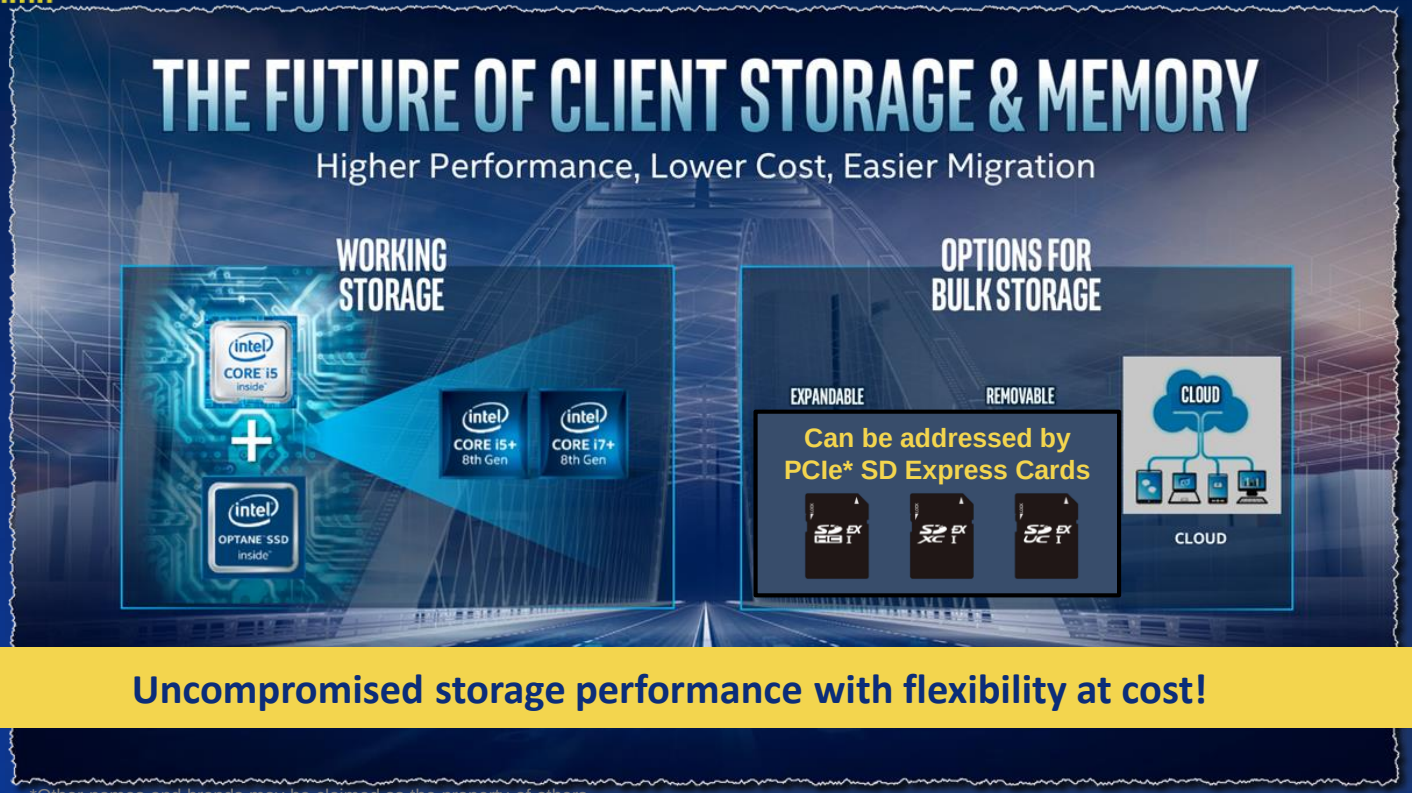
Leveraging the NVMe* SSD Ecosystem

Scalable PCIe* Interface

Solving these problems creates new usage possibilities!

*Other names and brands may be claimed as the property of others

Expandable Storage: The Future?



Uncompromised storage performance with flexibility at cost!

SD Express Expands Possibilities

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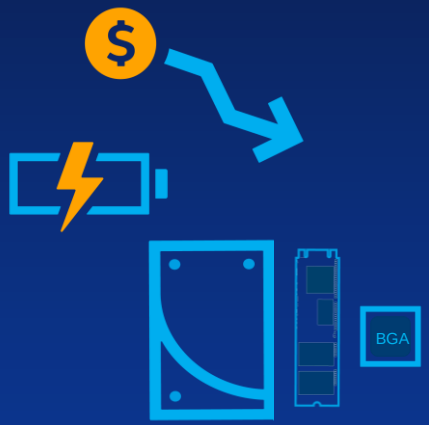
SD Express Propels SD Cards Forward Without Losing What Makes It Great



PCI EXPRESS® nvm EXPRESS

Consider new possibilities for using SD Express!

Thank You!

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