Extending PCIe® NVMe™ Storage to Client

John Carroll
Intel Corporation
No license (express or implied, by estoppel or otherwise) to any intellectual property rights is granted by this document. This document contains information on products, services and/or processes in development. All information provided here is subject to change without notice. Contact your Intel representative to obtain the latest forecast, schedule, specifications and roadmaps. The products and services described may contain defects or errors known as errata which may cause deviations from published specifications. Current characterized errata are available on request. You may not use or facilitate the use of this document in connection with any infringement or other legal analysis concerning Intel products described herein. You agree to grant Intel a non-exclusive, royalty-free license to any patent claim thereafter drafted which includes subject matter disclosed herein.

Forecasts: Any forecasts of requirements for goods and services are provided for discussion purposes only. Intel will have no liability to make any purchase pursuant to forecasts. Any cost or expense you incur to respond to requests for information or in reliance on any forecast will be at your own risk and expense.

Business Forecast: Statements in this document that refer to Intel's plans and expectations for the quarter, the year, and the future, are forward-looking statements that involve a number of risks and uncertainties. A detailed discussion of the factors that could affect Intel's results and plans is included in Intel's SEC filings, including the annual report on Form 10-K.

Tests document performance of components on a particular test, in specific systems. Differences in hardware, software, or configuration will affect actual performance. Consult other sources of information to evaluate performance as you consider your purchase. For more complete information about performance and benchmark results, visit http://www.intel.com/performance.

Copies of documents which have an order number and are referenced in this document may be obtained by calling 1-800-548-4725 or by visiting www.intel.com/design/literature.htm.

Intel, the Intel logo are trademarks of Intel Corporation in the U.S. and/or other countries.

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

© 2015 Intel Corporation.
Agenda

- Background on Storage Form Factors
- Using the same U.2 drives in Data Center and Client
- Power usage and time to throttle
Storage Form Factor Overview

Small form factor

2.5” and 3.5”

SATA* (2.5”/3.5”)

Add in Card

PCIe® add-in card (CEM)

SATA Express Device

U.2 SSD

BGA SSD

mSATA

M.2

SATA Express Device

mSATA

BGA SSD

M.2
Client Storage Background

Devices are getting smaller, thinner, and lighter

Client storage continues to get smaller…

High performance and capacity still expected in small form factors
**PCIe® Client Storage Form Factors**

### Add-in-card
- Higher performance (up to 16 lanes)
- Legacy form factor
- Higher thermal capabilities
- Disadvantage: size

### 2.5” drives
- Flexibility for SSDs, SSHDs, and HDDs
- High performance (U.2 up to PCIe x4, Sata Express PCIe x2)
- Cabled solution for larger platforms

### M.2
- Smallest PCIe SSD with a connector
- SATA* or up to PCIe x4
- Prefer 30mm and 80mm length

### BGA
- Ideal for small and thin platforms
- Up to PCIe x4
- Prefer 11.5x13mm and 16x20mm
Agenda

- Background on Storage Form Factors
- Using the same U.2 drives in Data Center and Client
- Power usage and time to throttle
Objective: The same U.2 drives in Data Center and Client

Source: http://hyvesolutions.com/solutions/ambient/
U.2 Host (SFF-8643) Pinout Vendor Specific in Data Center

- Data center uses additional pins on the host connector in a proprietary way
- The pinout for the U.2 Host Connector used in data center varies per platform
- The U.2 connector and pinout on the backplane is standard
A Consistent U.2 Host Pinout and Cable is Required for Client

- The same U.2 Host connector is used in client, but a different pinout

- Motherboard, cable and SSDs each come from different vendors
  - The host connector and cable need to be standard

- The connector and pinout for the drive remains the same for both client and data center
More on the Client U.2 Host Connector Pinout

- 7 pins per row used for PCIe lanes (pins 3-9)
- 2 pins per row used for sideband signals (A1, A2, ..., D1, D2)
- Intel releasing a whitepaper with more info
Agenda

- Background on Storage Form Factors
- Using the same U.2 drives in Data Center and Client
- Power usage and time to throttle
Importance of Power usage on Client Storage

- With smaller form factors, thermals can be more challenging

- High activity and power usage could lead to SSDs throttling sooner

- Max power and idle power are two levers to adjust time to throttle
  - Max power determines worst case time to throttle
  - Low idle power reduces temperature in typical client workloads

- Consider “data to throttle” instead of “time to throttle”
  - Time to throttle * performance

Example based on Intel internal model for a BGA SSD

August Ridge: Estimated Thermal-Time Profile
Max Workload (4.5W), Passive cooling only, 35°C ambient, No system-level cooling provisions
M.2 Provides Flexibility for M.2 or U.2

- M.2 to U.2 adapters enable flexibility for M.2 SSDs or U.2 cabled solutions
  - Enables flexibility to support SSD/SSHD/HDDs in the same M.2 connector
  - Allows for larger form factor drives which may use more power without a motherboard change

M.2 to U.2 Host Adapter
Summary

- Client platforms and storage form factors continue to get smaller
  - Going forward, innovation on physical size as important as performance for client

- Add-in-cards, 2.5” drives, M.2, and BGA are leadership PCIe® solutions