This presentation provides an overview of the Gen-Z scalable connector, its high-level features and application flexibility.
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Gen-Z Scalable Connector Requirements

• Goal: Develop a high-volume universal connector capable of spanning multiple market segments
• Requirements:
  • Support vertical, horizontal, right angle, and straddle mount connectivity
  • Universal connector for memory, I/O, storage, etc.
  • Support copper and optical cabled solutions
  • Eliminates customer and industry “hard choices”
    • Eliminate industry fragmentation and simplify supply chain—drive high volume adoption and lower cost
    • Support any component, any slot, any time
    • Support any mix of static and hot-plug modules
    • Support enclosure internal and external modules
    • Support multi-connector solutions to provide added scalability in terms of power, bandwidth, connectivity, etc.
    • Supports cable applications to enable modular system design, enable system disaggregation, and eliminate expensive board materials
    • Support multiple links per connector to increase aggregate bandwidth, enable resiliency, and eliminate stranded resources
    • Support multiple topologies—point-to-point, daisy-chain, mesh, switch-based, etc.
SFF-TA-1009 specifies the pinout and signal assignments for multiple new SFF-specified SSD form factors.

To maximize interoperability, representatives from Gen-Z Consortium member companies have worked with multiple industry bodies that reference SFF-TA-1002 to ensure pinouts and signal assignments build upon or are identical to the Gen-Z Scalable Connector pinout and signal assignment.
This slide illustrates the mechanical ecosystem based on the SFF-TA-1002 connector at the time of this presentation’s creation.

The SFF form factors (in bold) are primarily focused on flash-based SSDs.

• SFF-TA-1009 specifies the NVMe pinout and signal definition for the SFF-TA-1006, SFF-TA-1007, and SFF-TA 1008 mechanical form factors.
• SFF-TA-1006 is optimized for 1U server and storage applications up to 12W
• SFF-TA-1007 is optimized for 1U server and storage applications.
  • It supports two widths (9.5 mm up to 25W, and 18 mm up to 40W).
• SFF-TA-1008 is optimized for 2U server and storage applications (vertical and
horizontal insertion).

- It has two widths (7.5 mm up to 25W, and 16.8 mm up to 70W). Higher power enables SFF-TA-1008 to support data-centric accelerators and alternative high-capacity media (DRAM and Storage Class Media aka SCM). SFF-TA-1008 enables a solution to reduce dark flash impacts (flash that cannot be powered up due to power and thermal constraints).
- It supports two lengths to improve capacity and to support discrete data-centric accelerators.
- SFF-TA-1008 is also known as ZSFF 223 and ZSFF 224 (Gen-Z Scalable Form Factors) which were contributed to SFF.

The differential memory ecosystem is focused on DIMM-based DRAM and SCM solutions.

The OCP ecosystem is focused on mezzanine NIC applications which enable up to 4 servers to simultaneously share a NIC.

The Gen-Z ecosystem specifies a series of mechanical form factors that support memory, I/O, storage, accelerators, etc. solutions.

- Gen-Z Scalable Form Factor (ZSFF) supports DRAM / SCM / flash media and I/O solutions
- PECFF (PCI Enclosure Compatible Form Factor) supports I/O solutions that are mechanical compatible at the enclosure level with the PCIe® Card Electromechanical form factor.
- Gen-Z Scalable is the basis for SFF-TA-1002. Its innovations enable new solutions to be created.
The Gen-Z Scalable Connector supports the following connector sizes as illustrated in SFF-TA-1002 Connector Sizes for Reference and 4C-HP Connector:

- 1C connector supports up to 8 differential pairs of data signals as specified in SFF-TA-1002.
- 2C connector supports up to 16 differential pairs of data signals as specified in SFF-TA-1002.
- 4C connector supports up to 32 differential pairs of data signals as specified in SFF-TA-1002.
- 4C+ connector supports up to 32 differential pairs of data as specified in SFF-TA-1002 and additional sideband signals.
- 4C-HP connector supports up to 32 differential pairs of data signals as specified in SFF-TA-1002, and a high-power interface.

Any pin in the SFF-TA-1002 connector can be used for any purpose, thus enabling a variety of pinout options. Further, this capability enables the connector to be repurposed to support vendor-defined purposes, e.g., to support more high-speed signaling pins to enable wider links or multiple links.
- Connector organized into chiclets, i.e., building blocks
  - 1C indicates a single chiclet.
    - 1C contains power, management and sideband, and up to 8 differential pairs
  - 2C adds support for up to 16 differential pairs
  - 4C adds support for up to 32 differential pairs
- Gen-Z supports symmetric and asymmetric links, hence uses differential pairs to indicate number of lanes
  - PCIe supports symmetric links, hence a 1C is equivalent to a PCIe x4, 2C equivalent to a PCIe x8, 4C equivalent to a PCIe x16
Internal cables can be used to overcome distance without requiring high-cost board materials to connect components. For example, internal cables have been used to connect processors with media components within a media bay.

Internal cables support an active latching retention system to prevent accidental disconnection of the interface. The mating receptacle has mechanical support hardware providing strain relief and latching for the mating cable plug. The internal cable receptacles and plugs are specified in 1C, 2C and 4C configurations. All dimensions not specified in this document shall be as specified in SFF-TA-1002. The datum names are consistent for the receptacle connectors from SFF-TA-1002 with additional datum(s) added for the internal cable supporting structure.

- All internal cable plugs shall connect all PRSNT_nC# pins to GND. Refer to the Gen-Z PHY Specification for channel requirements.
- A 1C, 2C, or 4C internal cable may support power.
- An internal cable may support sideband signals, and if supported, then all applicable sideband signals shall be supported. Sideband signals that are not applicable, e.g., the 802.3 electrical does use a reference clock, should be terminated within the paddle card.
- An internal cable that does not support power and / or sideband signals shall implement the full AIC interface including board dimensions and plated pads to ensure proper mechanical alignment and to avoid damage to the AIC and host.
The Gen-Z Scalable Connector supports complete upward and downward mechanical and electrical interoperability as specified in SFF-TA-1002. Gen-Z modules shall operate as follows:

- A 1C mechanical form factor shall interoperate with a 1C, 2C, 4C, or 4C-HP connector.
- A 2C mechanical form factor shall interoperate with a 1C, 2C, 4C, or 4C-HP connector.
- A 4C mechanical form factor shall interoperate with a 1C, 2C, 4C, or 4C-HP connector.
- A 4C-HP mechanical form factor shall interoperate with a 1C, 2C, 4C, or 4C-HP connector.
  - A 4C-HP that supports 12V shall interoperate with a 4C-HP 12V keyed connector.
  - A 4C-HP that supports 48V shall interoperate with a 4C-HP 48V keyed connector.
- If a mechanical form factor supports multiple Gen-Z Scalable Connectors, then each 1C, 2C, 4C, or 4C-HP shall operate as described above. The Gen-Z cable plugs and receptacles are specified for 1C, 2C and 4C sizes, and shall support the interoperability specified in *Gen-Z Cable and AIC Interoperability Matrix*. 

**Gen-Z Cable and Add-in Card (AIC) Interoperability Matrix**

<table>
<thead>
<tr>
<th>Host Board</th>
<th>1C Card Edge Only</th>
<th>2C Card Edge Only</th>
<th>4C Card Edge Only</th>
<th>1C Cable</th>
<th>2C Cable</th>
<th>4C Cable</th>
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<tr>
<td>1C Card Edge Only</td>
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<td>4C Cable Recept</td>
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- Mechanical form factors and Gen-Z Scalable connector supports full interoperability
- Due to mechanical latching and stability requirements, a cable only interoperates with an equivalent-sized component
Though 48V solutions have been deployed for many years in telecom market, the Gen-Z 4C-HP connector is the first to enable 48V solutions to be deployed across multiple market segments. Due to the inherent power efficiency gains, 48V solutions can provide significant customer OPEX savings.

The 4C-HP enables high-power solutions without requiring a separate cable connection to the enclosure power supply. This simplifies manufacturing and customer service events.
The following describes implementation details of a Gen-Z connector used in a Media Bay application, where a Media Bay is a 3-D mechanical structure with a back panel PCB (BP) that accepts user pluggable Gen-Z media modules with the Gen-Z connector interface as illustrated. The BP illustrates a 4C vertical connector that accepts a media module on one side and a 4C vertical internal cable receptacle placed directly opposite on the other side. A Gen-Z internal cable plugs into the 4C internal cable receptacle connector and into internal host resources.

The front media SFF-TA-1002 connector and the back internal cable SFF-TA-1002 connector are mounted precisely opposite on the BP PCB. This configuration provides the following benefits:

- Maximizes through BP airflow for cooling media modules and downstream components.
- Enables tighter module pitch.
- Enables cooling solutions for high-power devices.
- Eliminates signal trace lengths, signal swapping, and cross-over cabling as the pinouts are maintained on both connectors.
- Minimizes VIAs and short traces on the BP to support higher signaling rates.
Connector Test and Validation

- Gen-Z Consortium is developing a test fixture (as illustrated above) to validate connector compliance
- Gen-Z Consortium is developing a test fixture to validate mechanical form factor compliance
- Please periodically visit http://genzconsortium.org/ to learn more about the Gen-Z compliance program and test fixture specifications
Gen-Z Scalable Connector Reduces CAPEX and OPEX

- Reduces CAPEX
  - Eliminates high-power cable and associated connector, simplifying cost and complexity
  - Internal cable reduces platform cable management cost and complexity
  - Full 1C, 2C, 4C, 4C+, 4C HP interoperability simplifies platform design and manufacturing
  - Signaling rates up to 112 GT/s PAM 4 enables high-volume adoption across multiple market segment
    - 112 GT/s signaling support provides customer investment protection for many years to come
  - Surface mount improves signal integrity (reduces NRE and validation costs) and reduces manufacturing costs
  - High density, small size improves PCA yields
  - Belly-to-belly cable-to-media module reduces platform design and material costs
- Reduces OPEX
  - Small size reduces air flow impedance
  - Reduces service times—hot-plug, no high-power cable, etc.
  - Optimized signal integrity reduces potential for customer field problems and associated warranties
As previously mentioned, the Gen-Z connector supports multiple applications, such as internal add-in cards, hot pluggable modules, and both electrical and active optical cables shown here. This enables system configuration flexibility, while leveraging connector volumes across these use cases for maximum cost savings and design simplicity.

In addition, the Gen-Z connector supports full forward and back interoperability between connectors and plugs. This allows systems to be configured for multiple use cases and freedom for end users to upgrade as bandwidth needs increase.

Finally, the Gen-Z connector is, at its core, a high performance and flexible connector that is protocol agnostic. This allows it to be leveraged into other application such as storage, both SAS and NVMe, PCIE, and memory. By establishing a common interconnect across the maximum number of use cases within the datacenter, the Gen-Z connector can take advantage of economies of scale to become a truly cost optimized high performance solution for cutting edge high speed data rates.
The Gen-Z connector’s full mechanical and electrical details were developed by the Gen-Z consortium, and contributed to SFF under SNIA, in the form of SFF-TA-1002. Please visit SNIA for the latest revision and more details. For additional specifications and news from the Gen-Z consortium, please visit the consortium website at genzconsortium.com. Thank you.
Thank You

This concludes this presentation. Thank you.