HTX™ - PCI Express Compared

How and Why HyperTransport HTX Proves Best Choice for Compute-Intensive Applications
HTX™ Delivers the Extra Performance that PCI-Class Interconnects Cannot Deliver

Compute-Intensive Applications Expect Best Architectural and Transactional Efficiency from Interconnect Technologies

HTX™

Best-in-Class Slot Connector Interfaces such as HTX and HTX3 are Designed for Lowest Latency, Highest Bandwidth. They are Best Choice for Compute-Intensive Processing and Coprocessing Applications

General Purpose Slot Connector Interfaces such as PCI Express are Designed for Wide End-User Configurability and are Best Choice for Latency-Insensitive Peripheral and I/O Applications
Latency is **The HPC Market Driver**

Peak computing power is no longer the metric to consider

Feeding processing units with data is the real concern, and flow control dependencies in applications make latency the key performance metric

Prof. Jose Duato
Polytechnic Univ. of Valencia, Spain (*)

“1 mS of Latency Worth $100M in Stock Trading Business Value”
NYSE Executive
AMD Analysts Day, July 26, 2007

HTX Has Been and Continues to Be
**The Lowest Latency Slot Interface in Industry**

(*) Jose Duato is Professor of Computer Science at the Polytechnic University of Valencia, Spain and a world authority in high performance computing (HPC). Prof. Duato has directly contributed to some of the computer industry’s most advanced HPC product developments by companies like Compaq, Cray, IBM and Sun Microsystems. In 2006 Prof. Duato received Spain’s most prestigious technology achievement award from Queen Sophia of Spain. Dr. Duato is an active contributor to Hypertransport technology and the HyperTransport Consortium.
Multiple Latency Advantages

Advantage 1: Physical Layer Efficiency

- 1 Clock Lane per x8 Link
- 3 Sideband Lanes (x2 through x32)
- No 8B/10B Conversion Overhead (No SerDes)
- Lower Power Consumption (No SerDes)

- 1 Reference Clock Lane
- 4 Sideband Lanes (x1 through x32)
- 8B/10B Conversion Overhead (SerDes)
- Higher Power Consumption (SerDes)

HTX Offers 20% Better Physical Layer Bandwidth and Latency
Multiple Latency Advantages
Advantage 2: Leaner Protocol

**HTX™**

High-Performance Protocol
- **Minimized Packet Overhead**
  - 8/12 bytes (Min/Max)
- **Ideal for HPC Applications**

General Purpose Protocol
- **Considerable Packet Overhead**
  - 20/24 bytes (Min/Max)
- **Non-Optimal for HPC Applications**

HTX’s Vastly Leaner Packet Payload Yields Latency Advantage that Scales Linearly with Applications and Job Transactions
Multiple Latency Advantages

Advantage 3: No Intermediate Logic Overhead

- Direct CPU-to-Subsystem Connection
- No Latency Penalty from Intermediate Control Logic

HTX Delivers 55% Lower Latency per Transaction
Due to Absence of Intermediate Control Logic and Multiplexing

(*) PCIe Gen2
HyperTransport is the Only Interconnect that Can Dynamically Insert Peripheral Read Requests in the Middle of Data Packets (Priority Request Interleaving™)

Multiple Latency Advantages
Advantage 4: Peripheral Processing Efficiency

- PRI’s Delivers an Average of 20nS Less Per-Transaction Latency in Heavily Loaded Environments
- High Priority Packets Not Penalized by Low Priority Packets
- Lowest Peripheral Processing Latency
**HTX™ & PCI Express Bandwidth Comparison**

<table>
<thead>
<tr>
<th>Feature</th>
<th>PCIe Gen1</th>
<th>PCIe Gen2</th>
<th>HTX</th>
<th>HTX3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Clock Rate</td>
<td>2.5 GHz</td>
<td>5.0 GHz</td>
<td>800 MHz</td>
<td>2.6 GHz</td>
</tr>
<tr>
<td>Double Data Rate</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Max Bandwidth x Lane</td>
<td>2.5 Gbps</td>
<td>5.0 Gbps</td>
<td>1.6 GT/s (*)</td>
<td>5.2 GT/s (*)</td>
</tr>
<tr>
<td>8B/10B Penalty</td>
<td>-20%</td>
<td>-20%</td>
<td>No Penalty</td>
<td>No Penalty</td>
</tr>
<tr>
<td>Net Bandwidth x Lane</td>
<td>2.0 Gbps</td>
<td>4.0 Gbps</td>
<td>1.6 GT/s (*)</td>
<td>5.2 GT/s (*)</td>
</tr>
<tr>
<td>Net Bandwidth 16-Bit - Aggregate</td>
<td>8 Gbytes/s</td>
<td>16 Gbytes/s</td>
<td>6.4 GBytes/s</td>
<td>20.8 GBytes/s</td>
</tr>
</tbody>
</table>

(*) HyperTransport supports Double Data Rate (DDR), transferring data on both the leading and trailing edge of the clock. Therefore HyperTransport’s bandwidth is more appropriately represented by the term “Transfers/second” than the term “Bits/second”
HTX™ Packet Efficiency in Figures

HTX™ Packet Overhead Efficiency Margins over PCIe

Efficiency

Min Overhead
Max Overhead

Usual Processor-to-Processor Traffic

Data Bytes per Packet

HTX Delivers up to Twice the Packet Efficiency of PCIe with Proportional Latency Advantages
**HTX™ Per-Packet Latency Advantage**

The results take into account PCIe’s 20% clock recovery, packet payload and 55% chipset overhead penalties. HTX’s Priority Request Interleaving, if applicable, will add to HTX’s total latency advantage.
HTX™ Real World Time-to-Result Savings
Combined Bandwidth, Physical Layer and Protocol Latency Advantages

Compute-Intensive Tasks Require Hundreds of Thousands to Billions of Packet Transactions

HTX³™ Time-to-Result Saving vs. PCIe Gen2

<table>
<thead>
<tr>
<th>Number of Packets Transferred</th>
<th>100,000 Per Task</th>
<th>1 Million Per Task</th>
<th>1 Billion Per Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bytes per Packet Transferred</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.78 mS</td>
<td>7.8 mS</td>
<td>7.8 Sec</td>
</tr>
<tr>
<td>16</td>
<td>4 mS</td>
<td>40 mS</td>
<td>40 Sec</td>
</tr>
<tr>
<td>256</td>
<td>0.32 Sec</td>
<td>3.20 Sec</td>
<td>53 Min</td>
</tr>
<tr>
<td>512</td>
<td>1.16 Sec</td>
<td>11.62 Sec</td>
<td>3.23 Hrs</td>
</tr>
</tbody>
</table>

The results take into account PCIe’s 20% clock recovery, packet payload and 55% chipset overhead penalties. HTX’s Priority Request Interleaving™, if applicable, will add to HTX’s total time-to-result latency advantage.


**HTX3™ Link Splitting Capability**

The 16-Bit HyperTransport Link in an HTX3 Connector Can Split into Two Independent 8-Bit Links

Allows HTX Subsystem to Connect Directly to 2 CPUs Supports New-Generation System Functionality
HTX™ in Summary
Unique Technical Values

**HTX™** Provides Superior Performance and Architectural Capabilities In Line with HPC Market Expectations
HTX™ Complements PCI Express

With its Unique Architectural and Performance Edge over General Purpose Interconnects, HTX is an Ideal Complement to PCI-Class Slot Connector Interfaces
**HTX™ Business Values**

**HTX™** is a Competitive Differentiator for High-Performance Total Solution Vendors

- **Negligible BOM Cost**
  - Leverages PCIe Economy of Scale

- **System Flexibility**
  - Single MB Serves Multiple Markets

- **Growing HTX Subsystem Portfolio**
  - Coprocessors, Accelerated 10GE, ccNUMA Cluster Controllers, Content Processors, Others Released Soon

- **Up-Selling Enabler**
  - Delivers Greater End-User Value
The HPC Interconnector™