Choosing Appropriate Rack Size of a System

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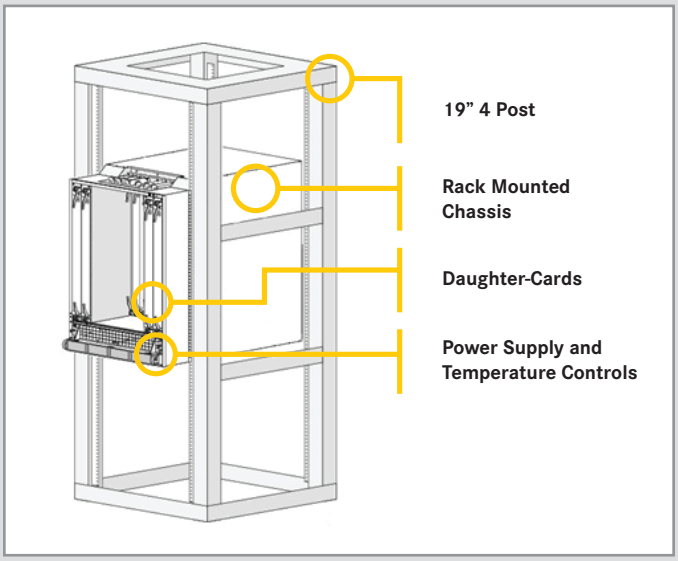
When you are purchasing a new rack mounted system how do you balance future proofing with current project allocations? A rack mounted chassis with additional slots provides future expansion at a cost substantially lower than expanding an installed system through other means.

Introduction

Rack mounted chassis systems are used in a variety of applications including, Aerospace, Broadcast, Datacom, Industrial, Telecom, Transportation and others. These systems involve a rack mounted chassis that has slots for managing daughter-cards which link to each other electrically through a backplane. The most common process for specifying a chassis is to determine the communication protocol, the card size and the number of slots required. The communication protocol is determined by the applications' industry standards and the communication speed required and is not included as a variable in this investigation. The card size is dependent on the available daughter-cards for the application and typically is dividable by 3. The number of slots allows the most variability of the three choices and there can be several choices for the number of slots. The number of slots is also related to designing in slots for future expansion of a system, however, the specifics of the future needs are unknown at the time of the purchase. This white paper explains the advantages of the varying number of slots available for an embedded chassis.

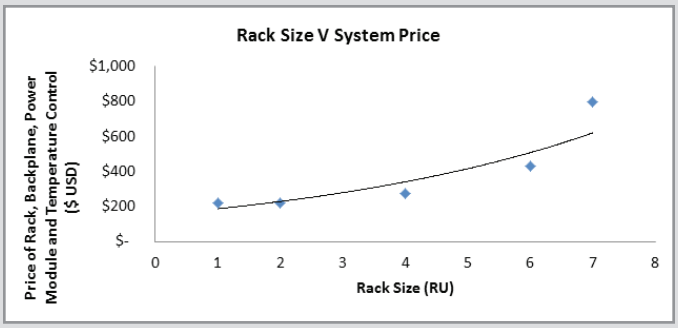
This investigation focuses on families of generic rack mounted chassis. For each, a choice in the size was dependent on the number of slots to provide a comparison focused on the overall size of the system, rather than architecture or other variable. In addition to comparisons within the product families, this investigation also considers expanding a system by adding a secondary chassis or single board and the related cabling required.



Sketch of Typical Rack Mounted Chassis

Rack Mounted Chassis Considerations

The comparison looks at several aspects of each chassis or system that are important to an overall project. The first aspect considered is of course, retail price, which instinctively increases as the size of the system increases. But is this relationship linear to the number of slots? No, the relationship is non-linear and larger sizes grow exponentially in price.



Trend between Size of Rack Mounted Chassis and Price

The next aspect reviewed is the number of slots available to the size in a 19" rack. This relationship is not exactly linear and fluctuates because of ancillary equipment such as temperature control systems and redundant power supplies that accompany larger systems. Often the number of slots is pre-determined for the current needs of the platform, but in many cases the platforms lifespan will exceed the near term technology and the number of electrical connections required is nearly guaranteed to expand far surpass expectations at the inception of a system design.

The next two aspects are currently huge optimization factors for military embedded, size and weight. The military uses the acronym SWaP to align suppliers to focus on shrinking size and weight while increasing the computing power available in the smaller form factor. Volume is especially linearly related to the rack size and weight is fairly linearly correlated to the rack size of a chassis.

For application specific systems, two systems were investigated to understand the constraints from the size of the system. In both systems multiple rack sizes are available. The rack sizes are directly attributed to the number of available slots and the number of slots is linearly related to the amount of I/O to and from the system. Therefore, the amount of I/O connectivity is linearly related to the rack size.

For both applications, if the max I/O is reached there are two possible ways to increase I/O:

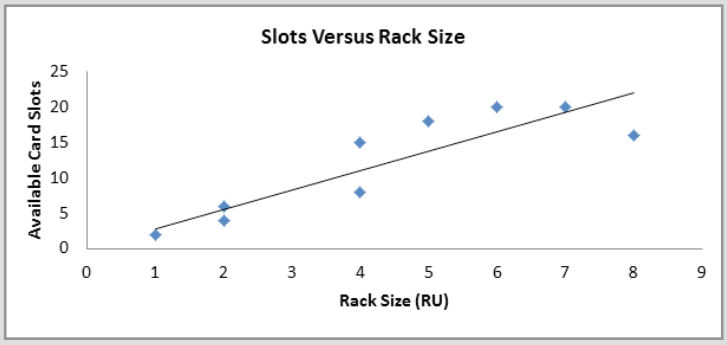
1. Replace the system with a larger available size
2. Add a twin system and link them with cabling

Taking a detailed look at option 2 is valuable since no system provides and infinitely increasing rack size. The benefits of routing with a backplane become obvious when the aspects of daisy chaining systems are reviewed. I/O connectors to the field have a larger physical footprint than I/O between PCBs. The footprint of a shielded binary pair using 2 mm hard metric connectors is much less than the footprint of the same shielded binary pair using a BNC connector, 9mm2 to 252mm2.

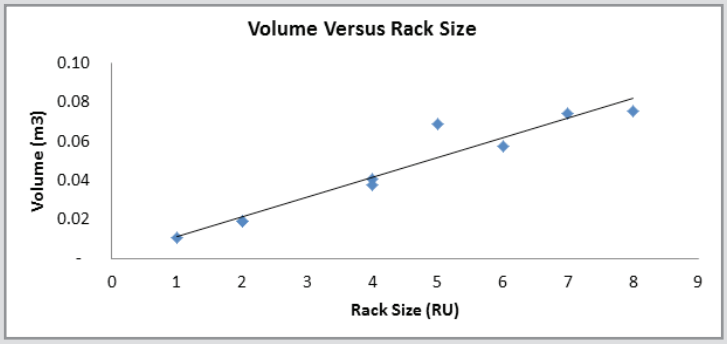
Additionally, daisy chaining systems requires interlocking cabling to take up a portion of the systems I/O. Therefore, adding systems is not a summation formula as shown below. Daisy chaining is accomplished by changing standard cards to accept high density I/O between systems. These cards can be costly as well as the cables used. An example of a high density cable is the DensiShield cable, which provides 8 pairs at >2.5 Gb/s. Therefore, the cost of daisy chaining systems exceeds the cost of the larger system without every providing a linear growth in I/O. Another factor to consider is cabling is more prone to quality and reliability problems especially when using cable kits versus factory made cables.

Conclusion

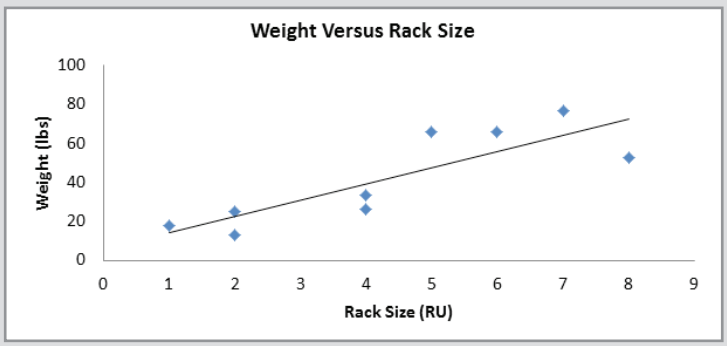
- If future expansions are a possibility than a system design should consider implementing a larger system than currently required
- Expansion by adding systems is much less than linear, because much of the I/O is used to communicate with the twin system.
- Connectors between boards are much denser than connectors on an enclosure linking to field cabling.



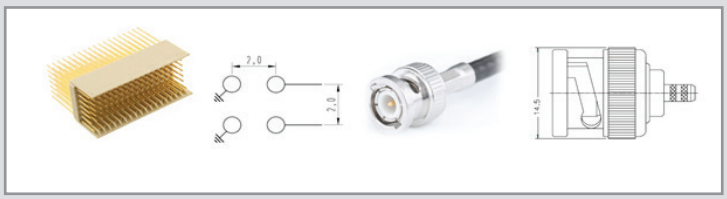
Trend between Number of Card Slots and Size of a Rack Mounted Chassis



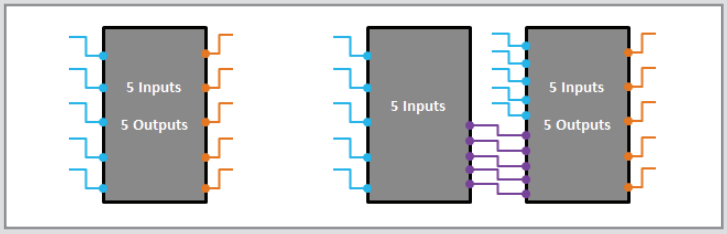
Trend between Volume of Rack Mounted Chassis and Size in RU



Trend between Weight of Rack Mounted Chassis and Size in RU



Comparison of Shielded Binary Pair Connectors on a Board and on an Enclosure



Sketch Displaying How I/O Is Structured in Daisy Chaining Chassis Systems