[Public]

Reference Network Design Architecture MI3XX series

6K GPU

Version 4.1 – November 2025

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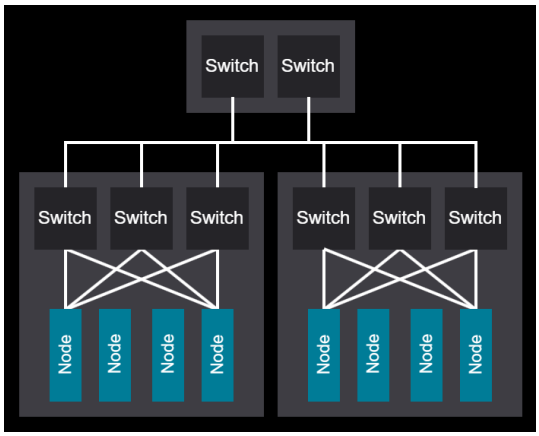
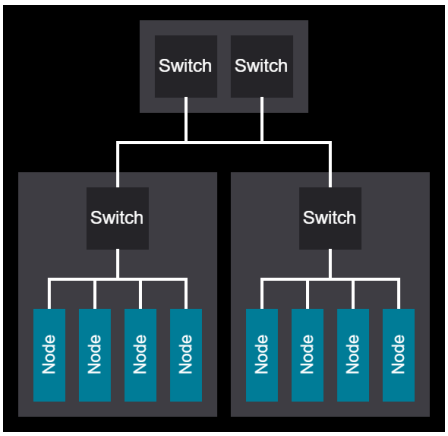
Basic network topologies

2-Tier rail network



- Enables large scalable unit sizes for large jobs or replica sizes.
- Efficient for workloads favoring ring-based collectives.
- Higher infrastructure costs.

2-Tier tree network



- Efficient for small workloads or replicas.
- Easy to add capacity with proper planning.
- Potentially allows for lower infrastructure costs.
- Limited blast radius compared to rail networks.

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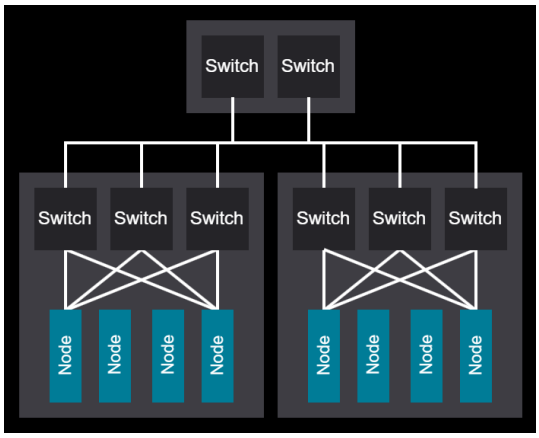
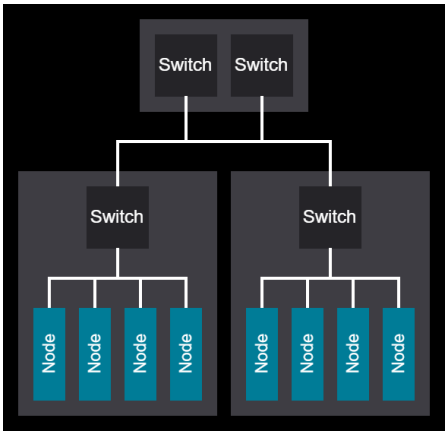
3-Tier rail TH5/J3 network



- Spine switches replaced with a 2-tier Jericho3-AI/Ramon3 fabric for increased maximum cluster size.
- Deep buffers and scheduled fabric aid greatly with congestion issues in large clusters at a small latency penalty.

3-Tier tree TH5/J3 network



- Same benefits from switch to scheduled spine fabric as with rail, but retains the primary characteristics of tree networks.

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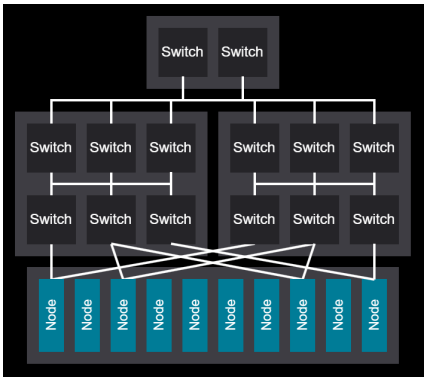
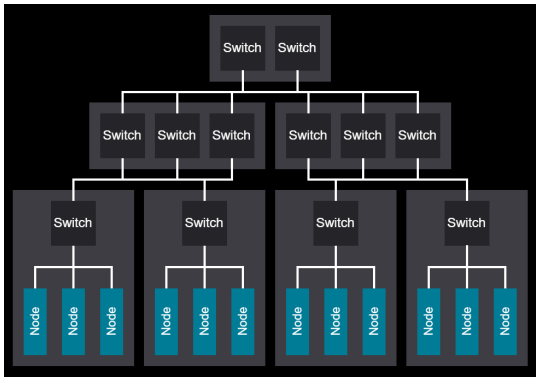
3-Tier rail optimized network



- Allows for massive scalable unit sizes.
- Best ring-based collective performance at scale; at the cost of poor any-any performance.

3-Tier tree network



- Allows for massive cluster sizes.
- Best any-any performance at scale.
- Suitable for a “campus style” deployment.

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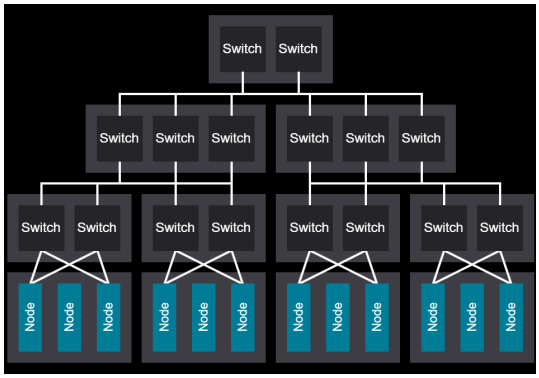
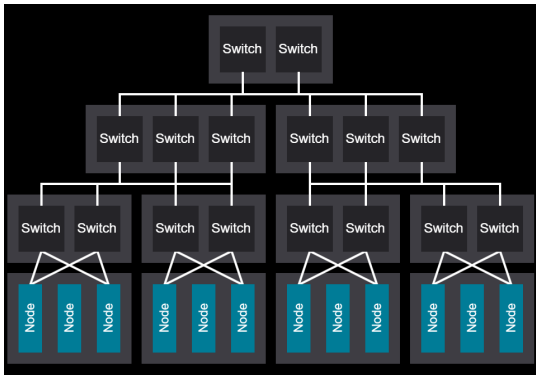
3-Tier hybrid rail network



- Allows for massive cluster sizes with large scalable units.
- Favors ring-based collectives, but does not sacrifice significant any-any performance on large jobs.
- Suitable for a “campus-style” deployment.

3-Tier fully scheduled rail network



- Medium sized scalable units.
- Excellent congestion performance due to deep buffers and scheduled fabric.
- Technical limitations limit cluster size to ~32K GPUs in recommended configuration.

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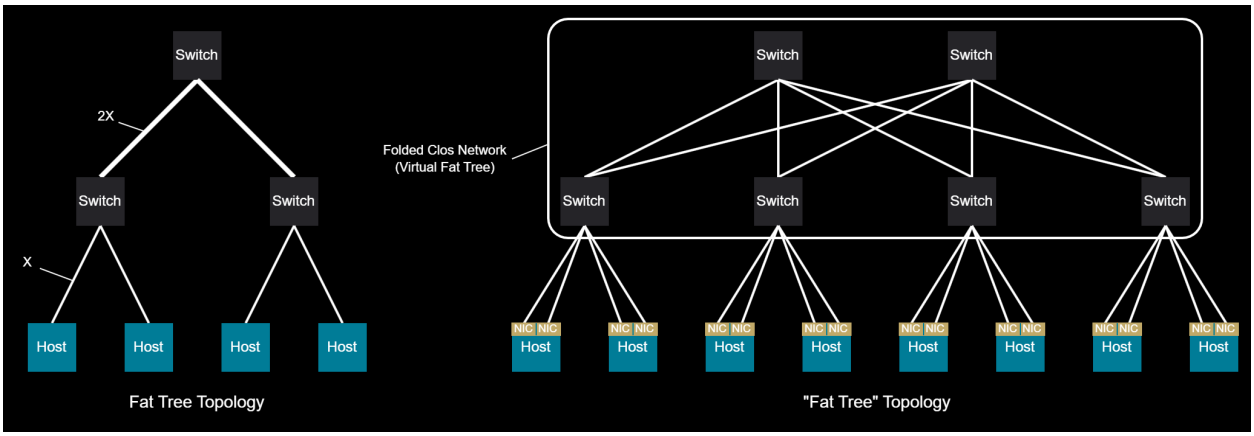
Tree and rail designs

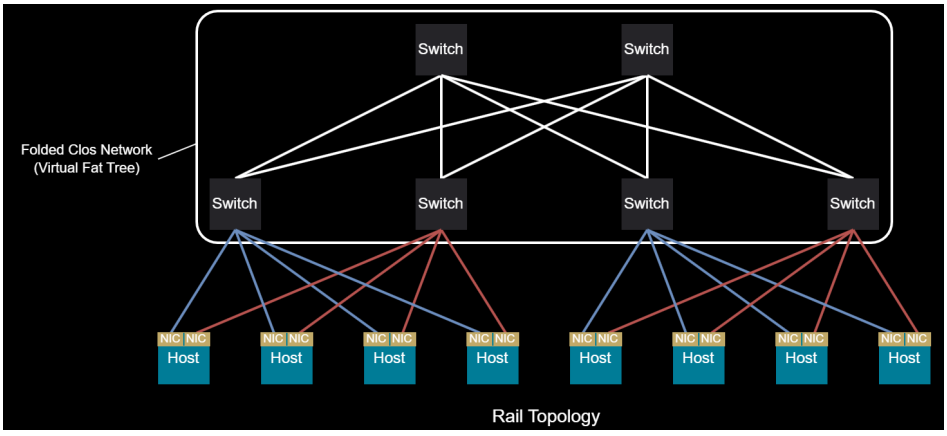
Fat tree networks



The canonical fat tree topology is a network concept where a switch's connection to upstream peers has at least parity bandwidth with the total aggregate bandwidth of its downstream connections. This causes links between switches to become "fatter" as they get closer to the core.

The "fat tree" topology for AI/ML clusters instead refers to how a host is connected to its upstream switches; in this case all host NICs terminate on the same switch. It can also be considered 1-rail network. The network itself is generally a 3-stage or 5-stage folded Clos network due the fixed radix of network switches.

Rail networks



Rail networks leverage the same folded Clos network as tree networks, but host connections are instead aggregated onto switches based on NIC rank. These shared ranks are referred to as rails and allow the network to provide preferential latency for connections which share the same rail. The downside to this design is any traffic which

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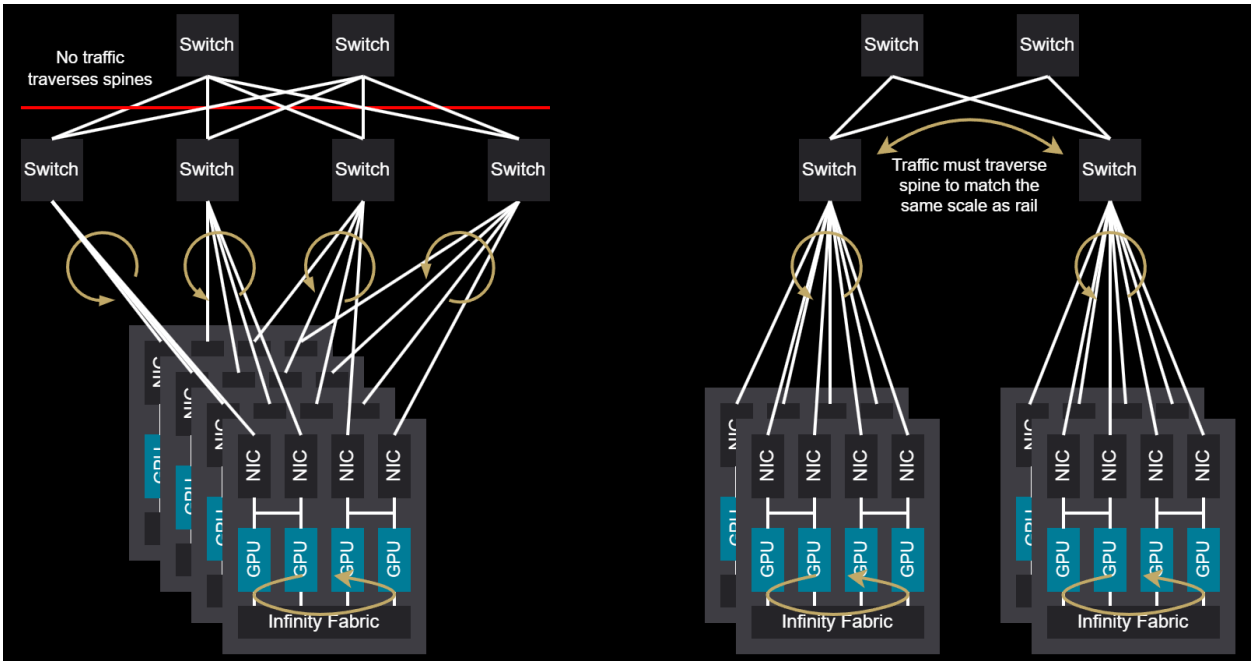
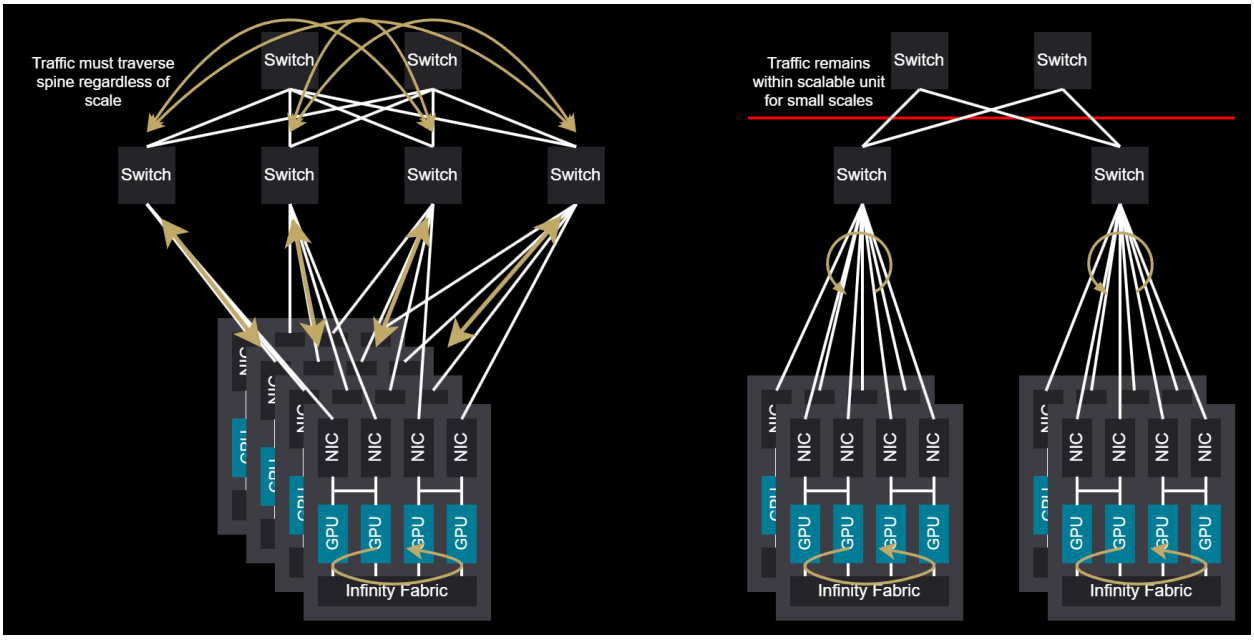
needs to cross rails/ranks must traverse either the network spine layer, or Infinity Fabric (PXN).

The above example shows an example 2-rail network, with the rails colored blue and red to differentiate them.

Rail enables larger single hop ring domains:



While tree handles cross-rank traffic better:



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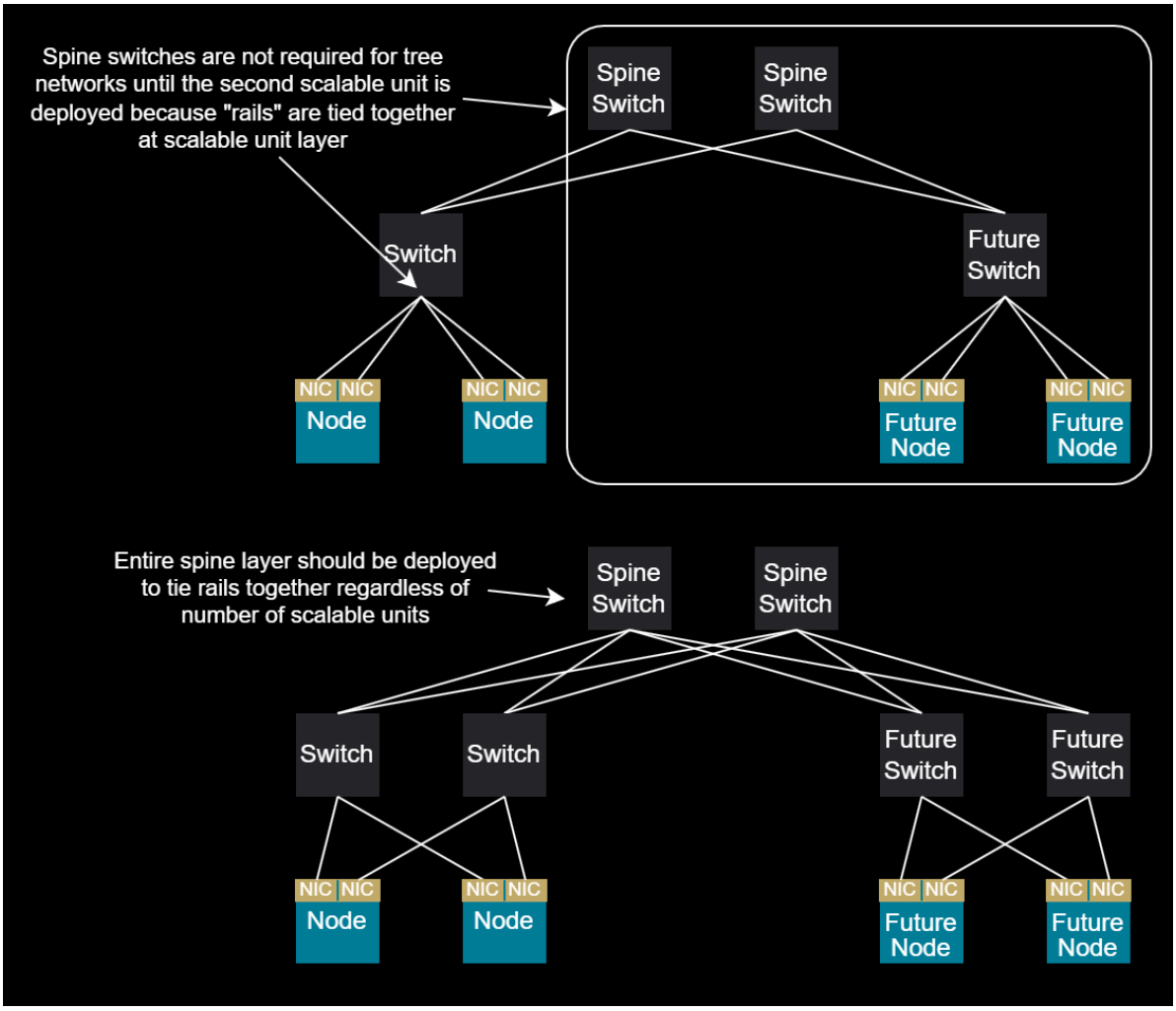
Scaling networks

Cluster backend deployment strategies

2-Tier networks



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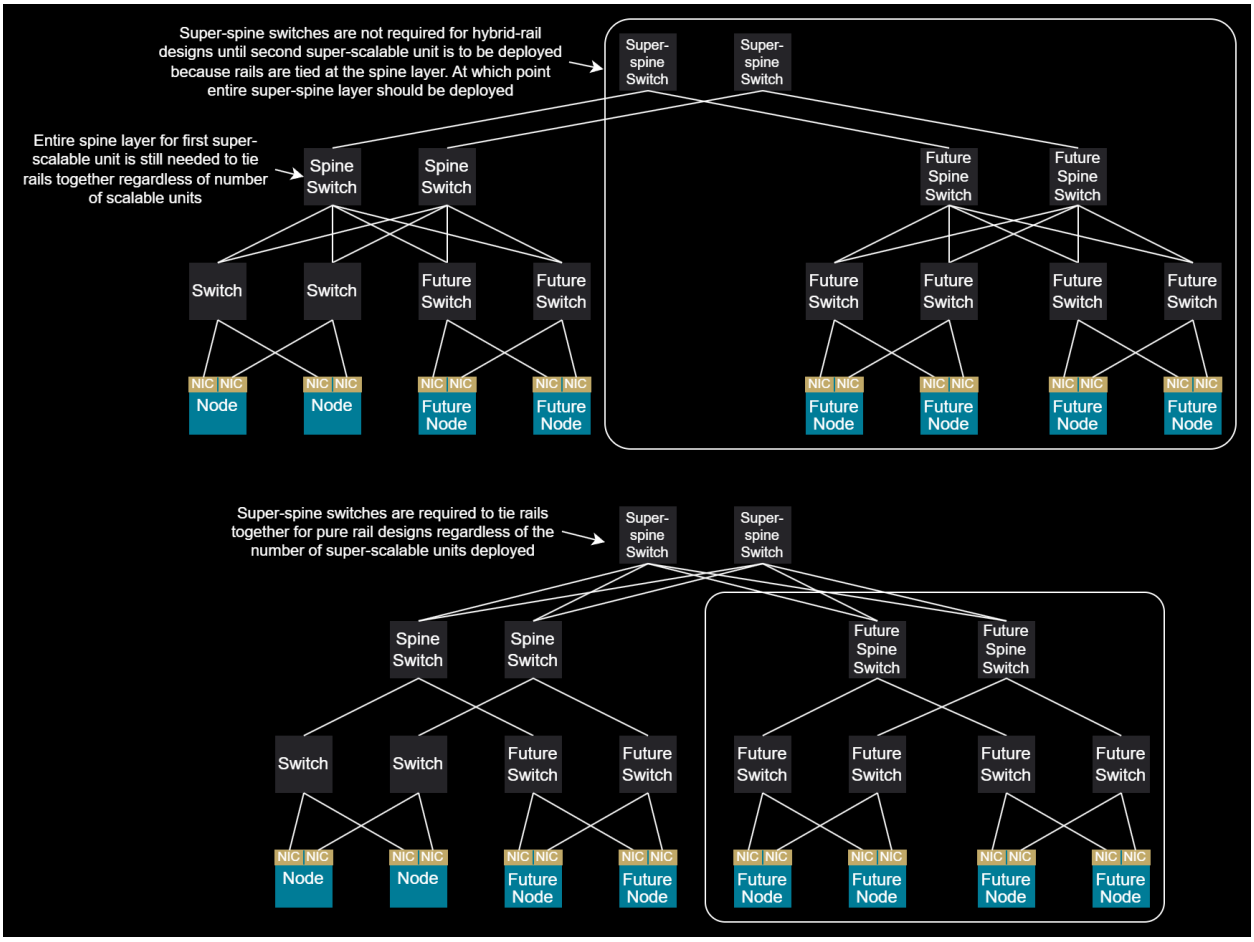
3-Tier tree networks



Network subscription

Subscription is the relationship between what is provided by the upstream network and what is required by the downstream network in demand side.

It is typically represented as a ratio:

$$Downstream\ Demand : Upstream\ Capacity$$

1:1 subscribed network would be equal downstream capacity to upstream capacity.

Example: 1:1.16 = (1 downstream demand : 1.16 upstream capacity. In this example there is .16 more upstream capacity)

Or as a percentage:

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$$Subscription\ Rate = \frac{Downstream\ Demand}{Upstream\ Capacity}$$

80% subscription ratio could be referred to as “20% undersubscribed”, or a 120% subscription ratio could be referred to as “20% oversubscribed”.

Network design topologies

Topologies listed are based on either Jericho / Ramon switch type (Accton, Arista, Ciena, Nokia) or 51.2T switch type (Arista, Cisco, Dell, Juniper). Vendors/switch models vary for port count and features – please consult desired vendor port count directly to confirm.

Some of the diagrams presented are designed around a Scalable Unit or POD – which can determine overall network end to end latency and AI use cases. Certain ML/AI workloads may require change of scalable unit size. Please consult with AMD Architecture as required.

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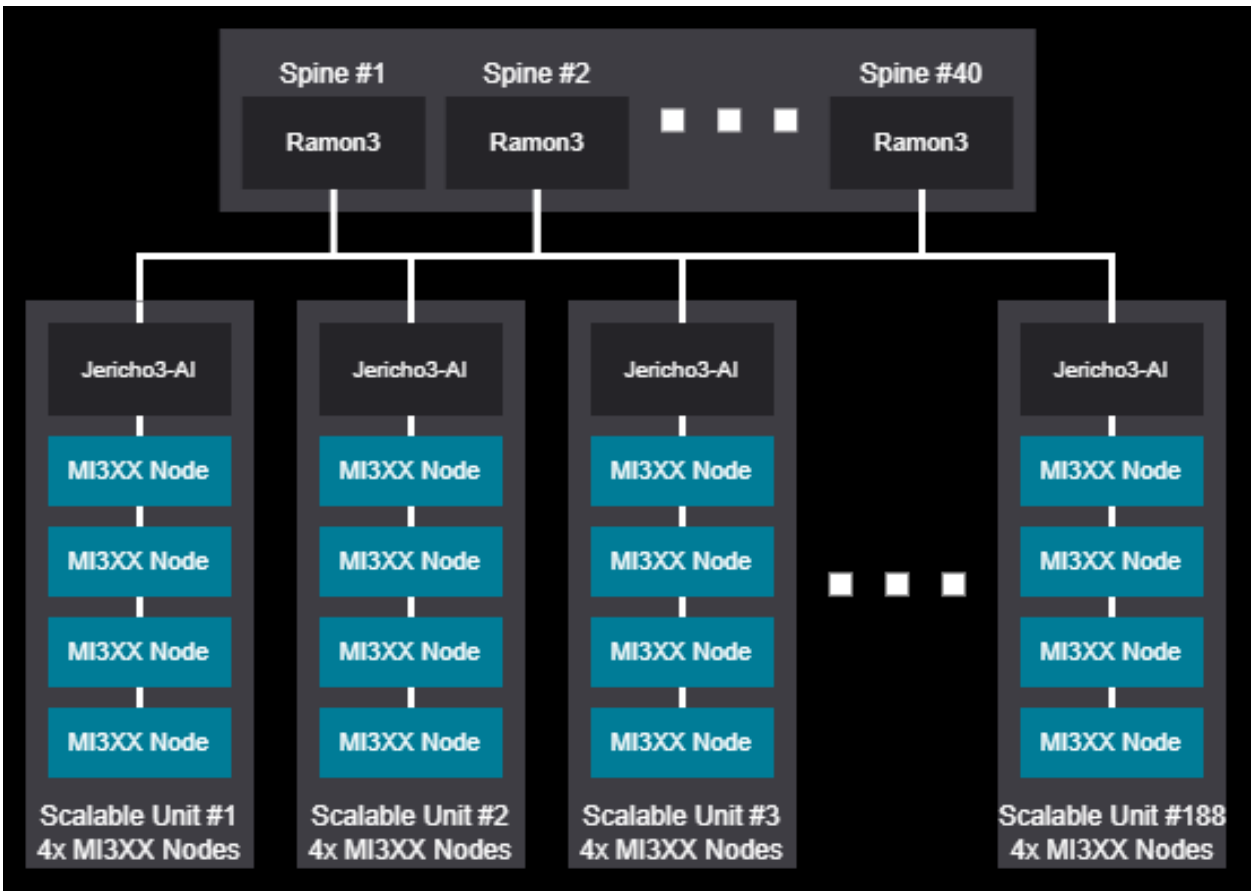
6K GPU topology design examples

Jericho/Ramon network diagrams

6016 GPU (752 nodes) tree design



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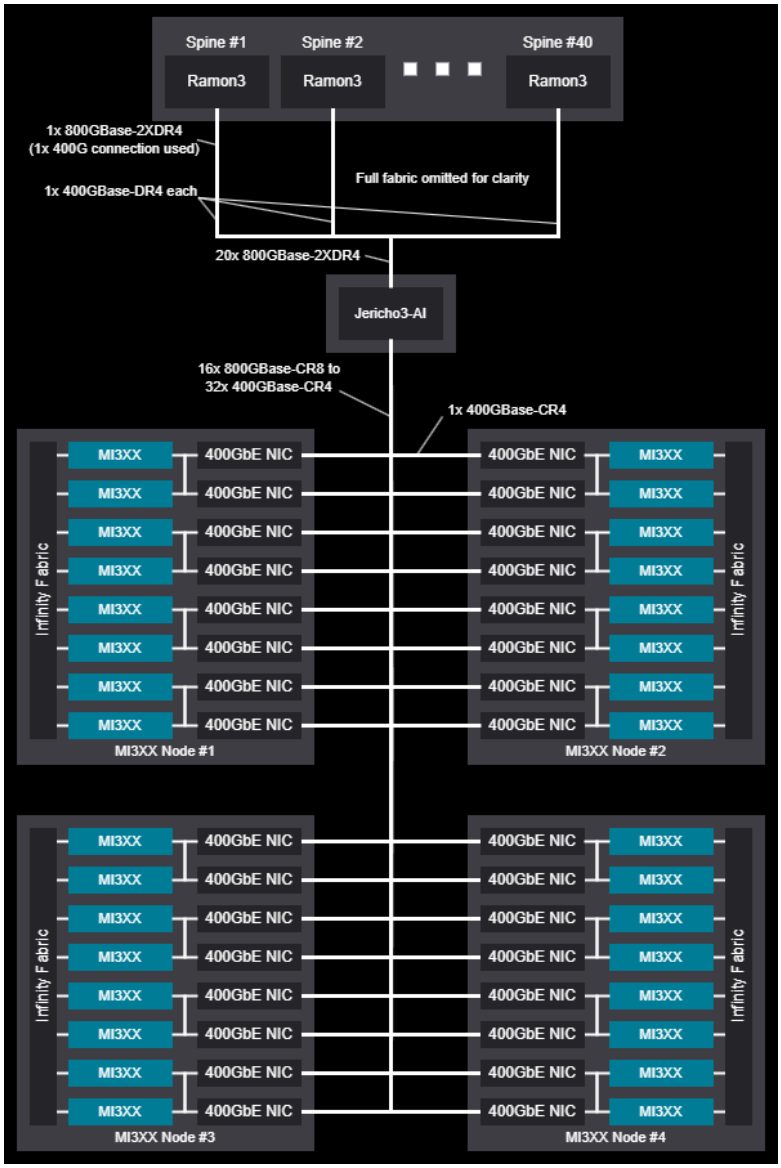
6016 GPU (752 nodes) tree scalable unit



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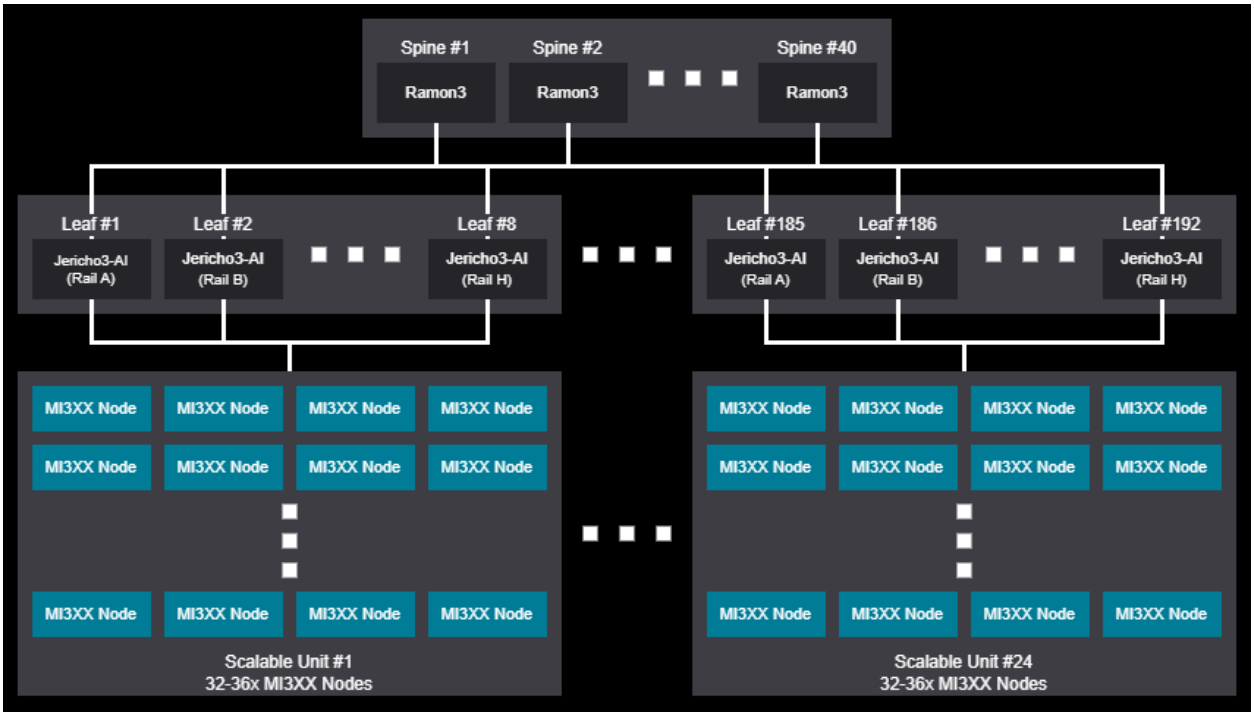
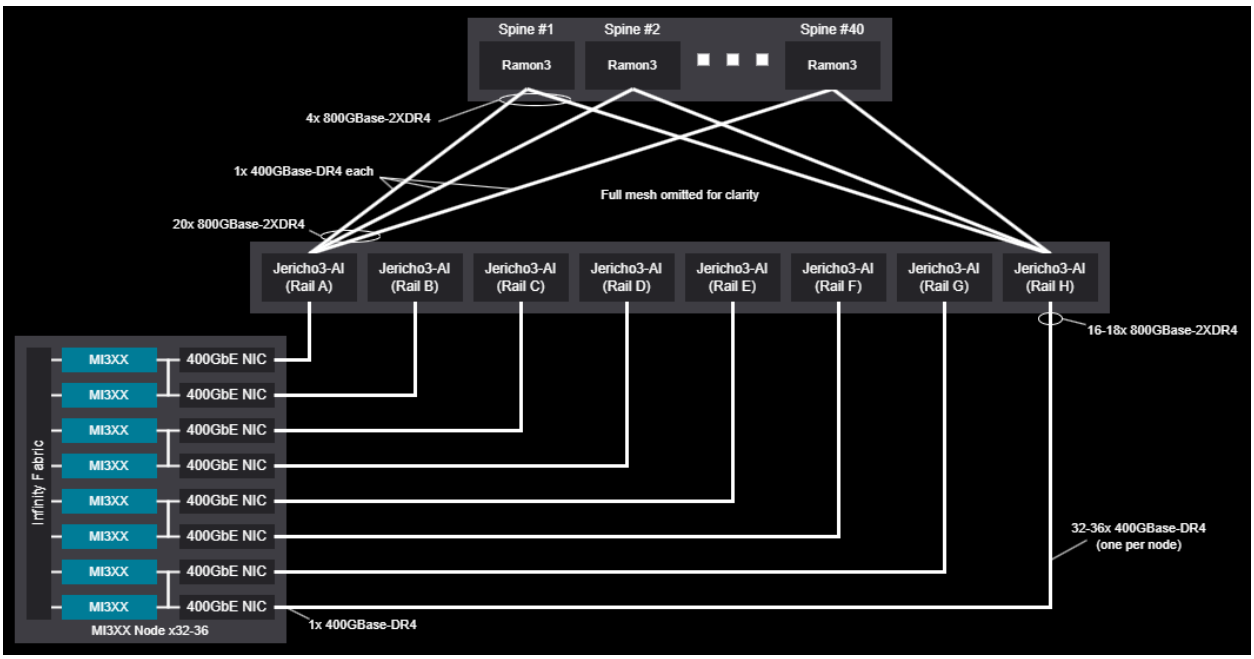
6144-6912 GPU (768-864 nodes) rail design



6144-6912 GPU (768-864 nodes) rail scalable unit



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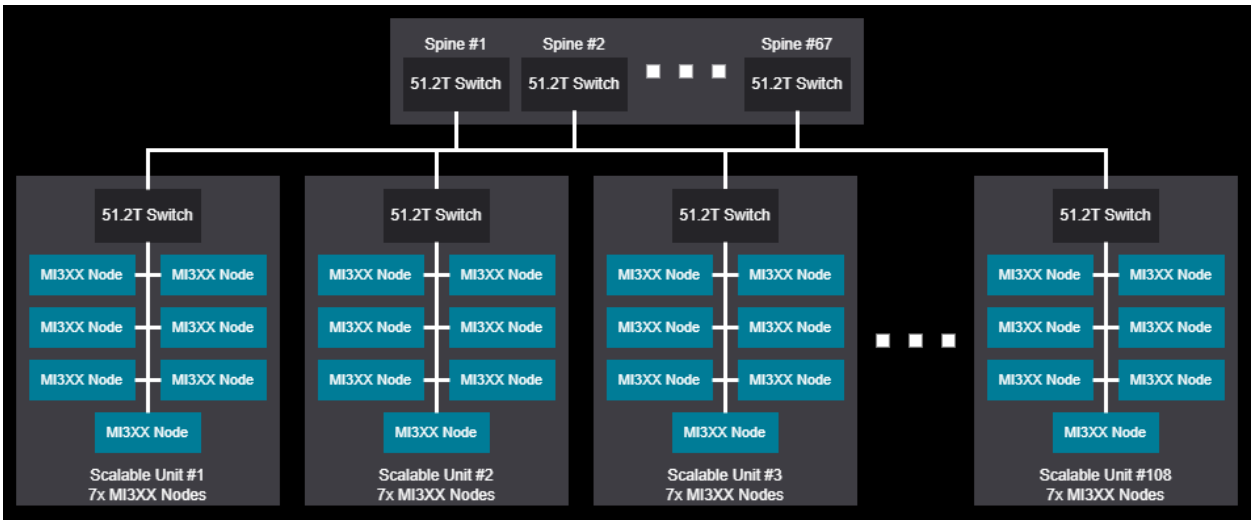
51.2T network diagrams

6048 GPU (756 nodes) tree design



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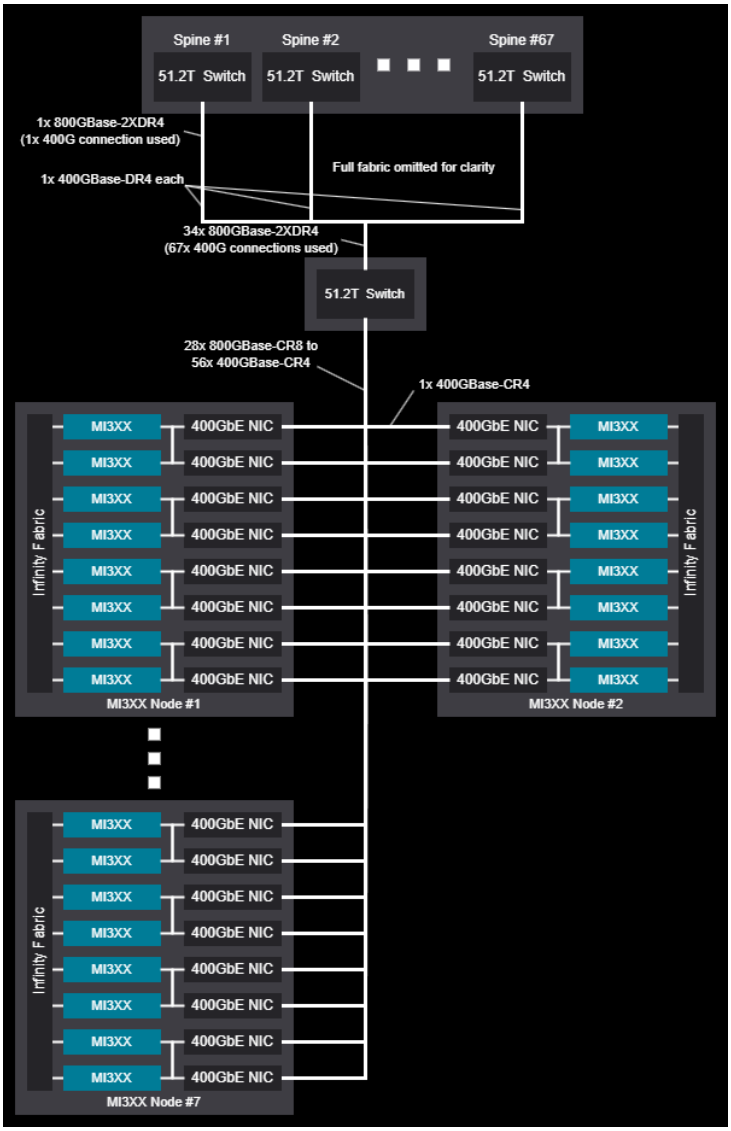
6048 GPU (755 nodes) tree scalable unit



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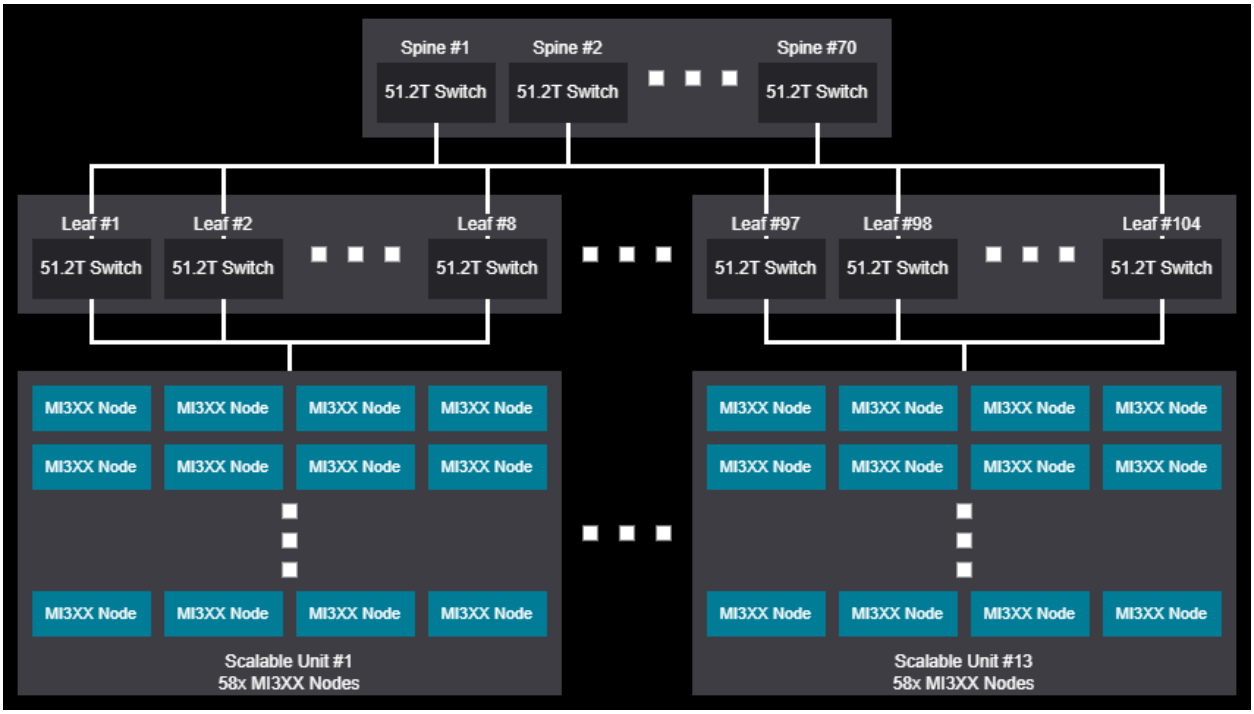
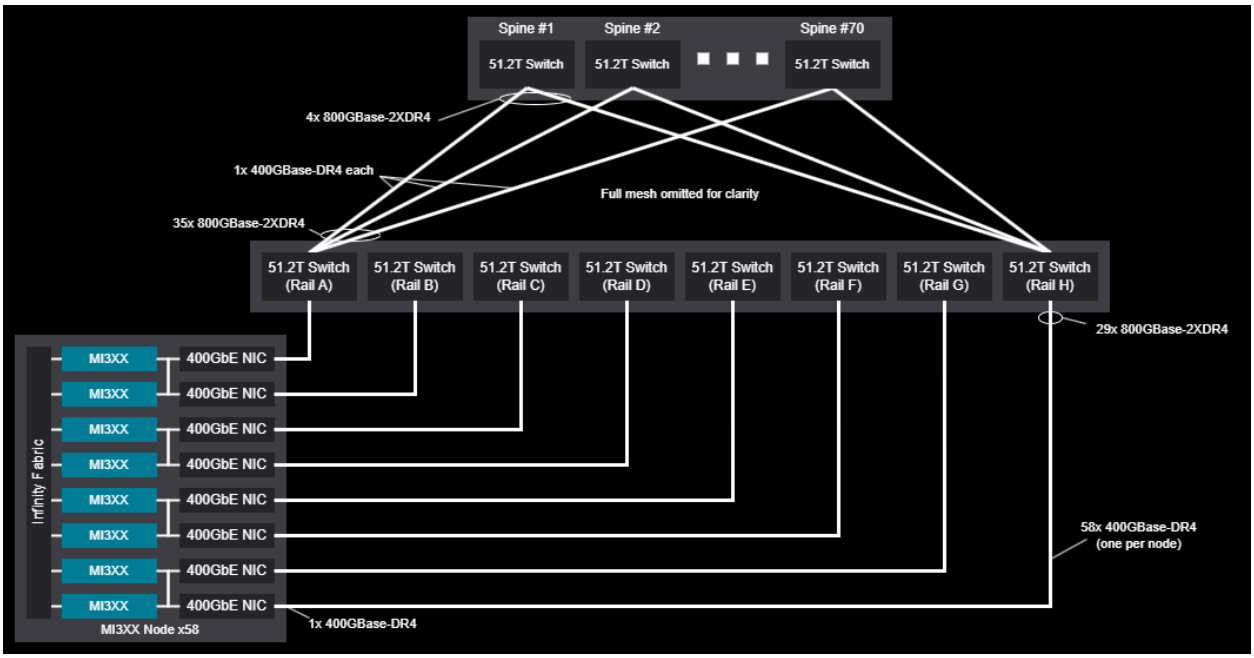
6032 GPU (754 nodes) rail design



6032 GPU (754 nodes) rail scalable unit



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