# PAM-2 Broad Market Potential

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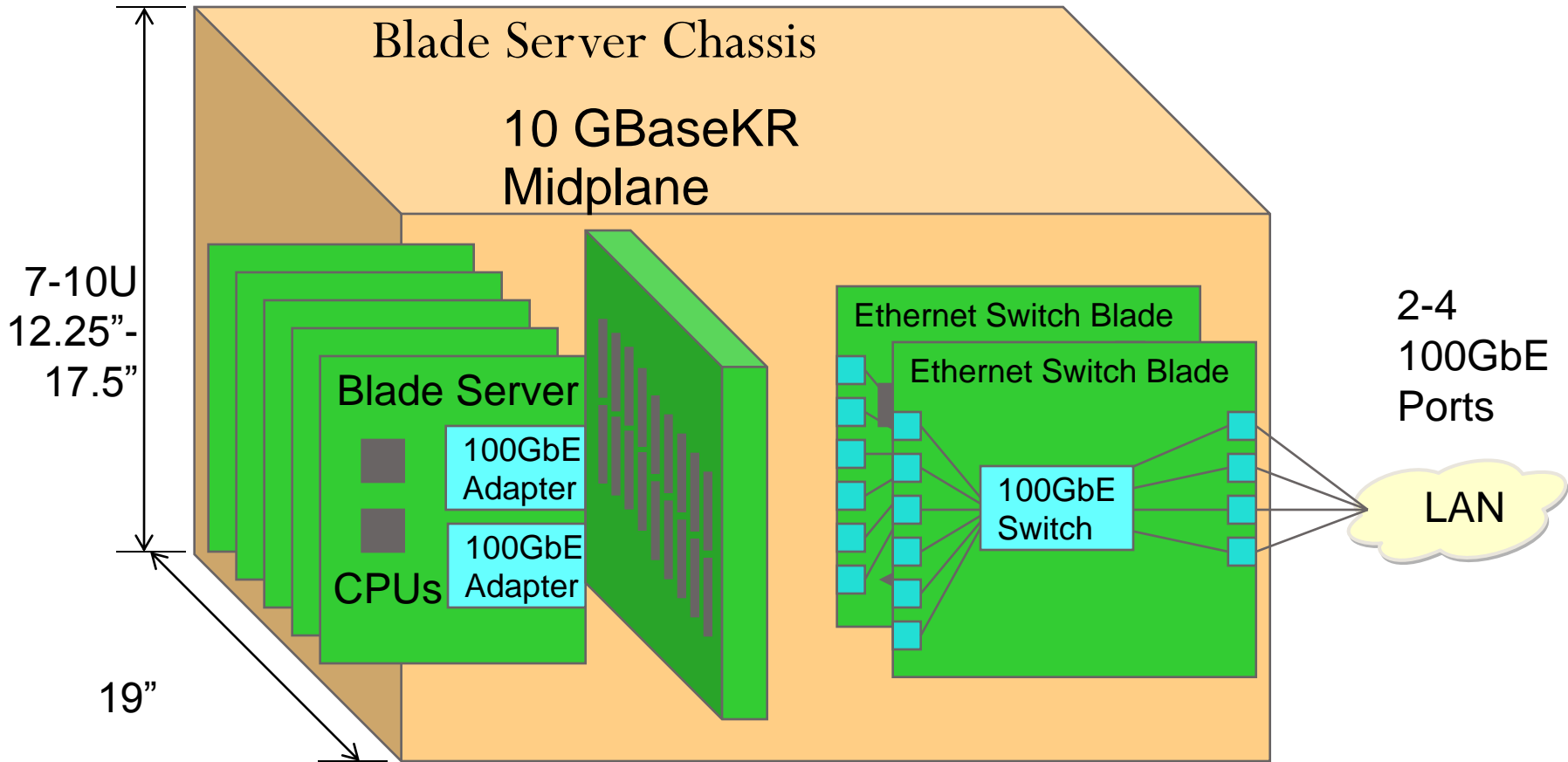
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# Meeting Broad Market Potential

- This presentation shows how PAM-2 (NRZ) has broad market potential for 100GbE Backplane applications

- Simulations from several companies (patel_01_0911) have shown PAM-2 supports 30dB of loss which correlates to:
    - 1 meter (39.2") on Megtron6 with 0.68dB/inch material loss
    - 0.67 meter (26") on Improved FR4 with 1.04dB/inch material loss

- With FEC and no overclocking(Beukema_01_1111), the insertion loss can be increased to 35dB and support:
    - 1.2 meter (48") on Megtron6 with 0.68dB/inch material loss
    - 0.79 meter (31.3") on Improved FR4 with 1.04dB/inch material loss

- With FEC and Serial PHY, the PAM-2 solution supports Improved FR-4 channels over 1 meter

# Blade Server Architecture

Blade Server Chassis
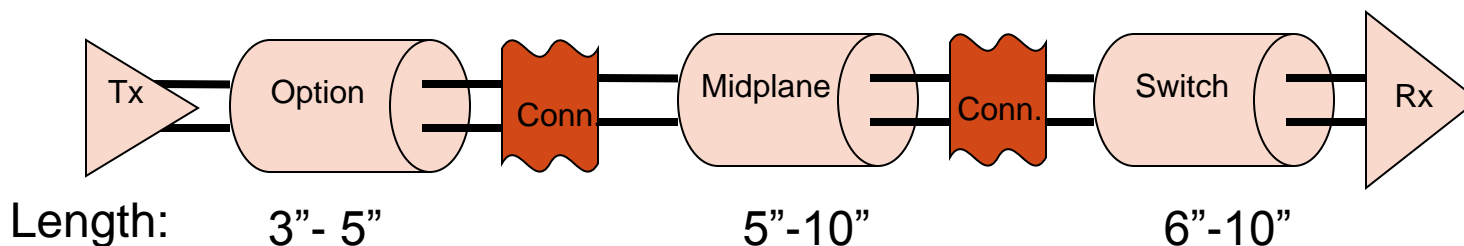
10 GBaseKR
Midplane

7-10U
12.25"-
17.5"

19"

Blade Server

100GbE
Adapter

100GbE
Adapter

CPUs

Ethernet Switch Blade

Ethernet Switch Blade

100GbE
Switch

2-4
100GbE
Ports

LAN

3

# Blade Server Market

- Blade Servers are typically less than 10U high and can be supported by less than 1 meter

### Front View    Back View
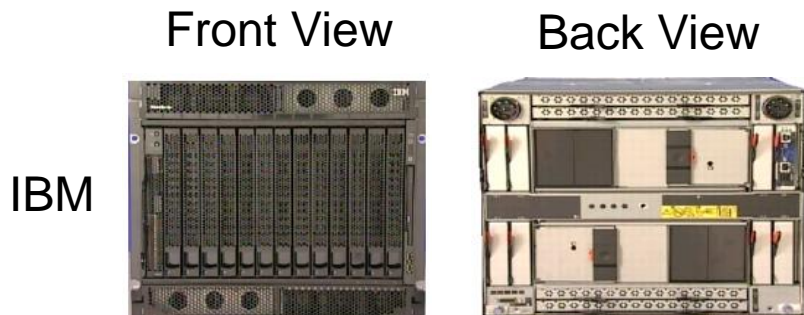
IBM

| Server Supplier | Rack Units | Longest Channel Length |
|---|---|---|
| IBM BladeCenter H Chassis | 9U / 14 Bays | <25" |

## IBM Maximum Distance of 25"

Tx — Option — Conn. — Midplane — Conn. — Switch — Rx

Length:   3"- 5"        5"-10"        6"-10"

http://www-03.ibm.com/systems/bladecenter/hardware/chassis/

# Blade Server Midplane Architecture

- Typical Midplane distance of 15" = 10" + 5"
- Maximum midplane distance of 22" = 17" + 5"

18" Maximum

Midplane

10" Typical

5" Maximum

17" Maximum

5
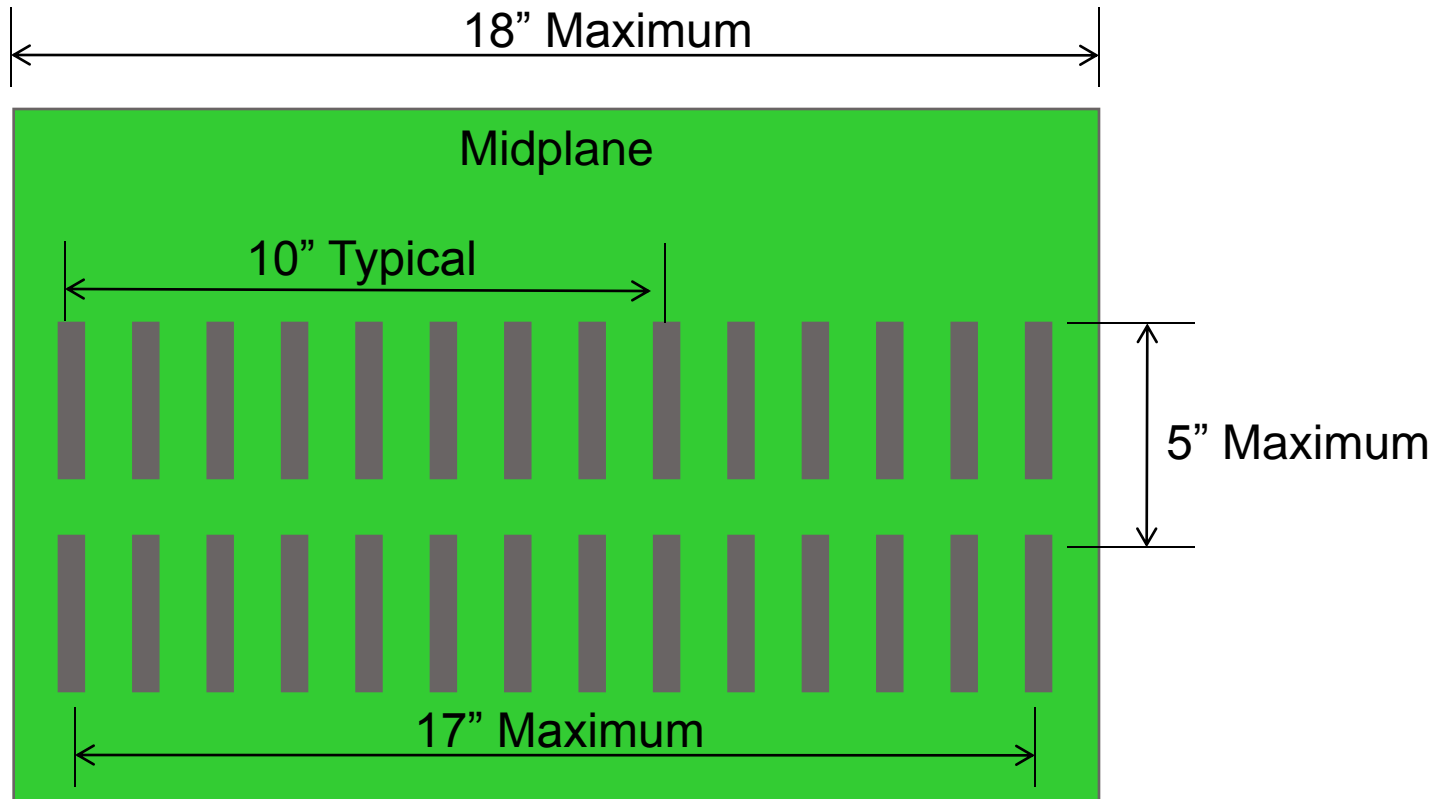
# Blade Server Summary

- Many blade servers have switch blades in the middle of the midplane and do not go card edge to card edge

- For worst case blade servers, the full channel distance would be <34"

- This correlates with Chalupsky_02_0311

PHY ASIC    ←——— Total Distance ———→    PHY ASIC

Card 1         Card 2

Connectors
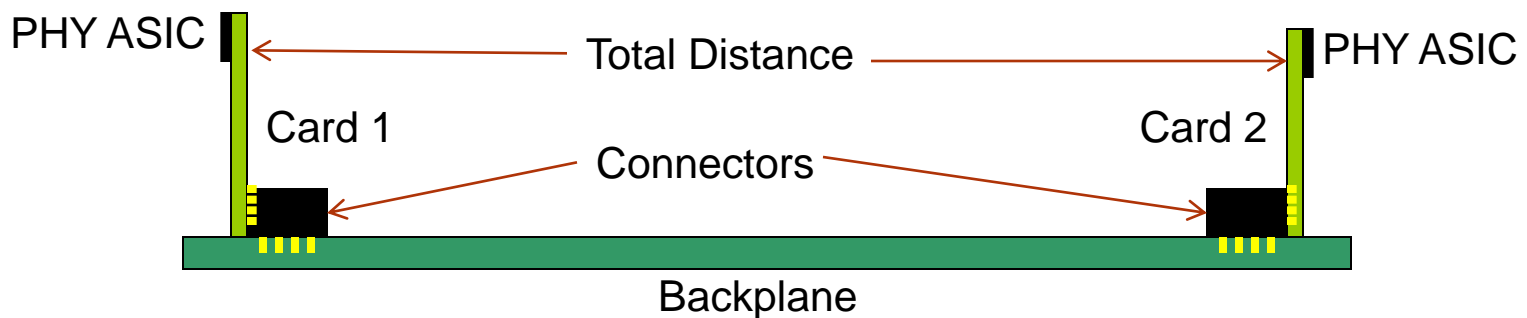
Backplane

|  | Card 1 | Backplane or Midplane | Card 2 | Total |
|---|---|---|---|---|
| Max Blade Switch Distanct | 6" | 22" | 6" | 34" |

# Modular Switches

- The most challenging backplanes are the large modular switches/routers that can exceed 30RU or half a rack
    - These are out of scope for 802.3bj because they need more than 1 meter long backplanes
- Most half-rack switches/routers are appropriate and they usually come in at ~14RU
    - The PCB usually comprises 3-7% of the cost of the modular switch depending on other component costs
- Quarter-rack switches are easier to support

33RU = 57.75"

14RU = 24.5"

7RU = 12.25"

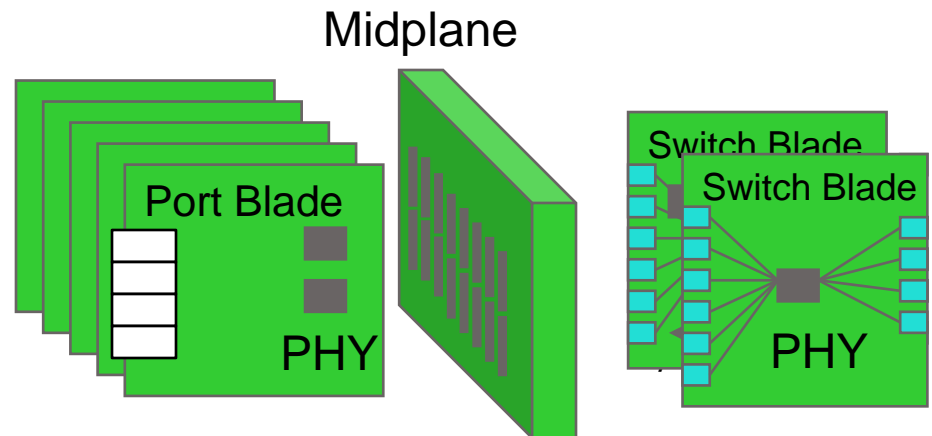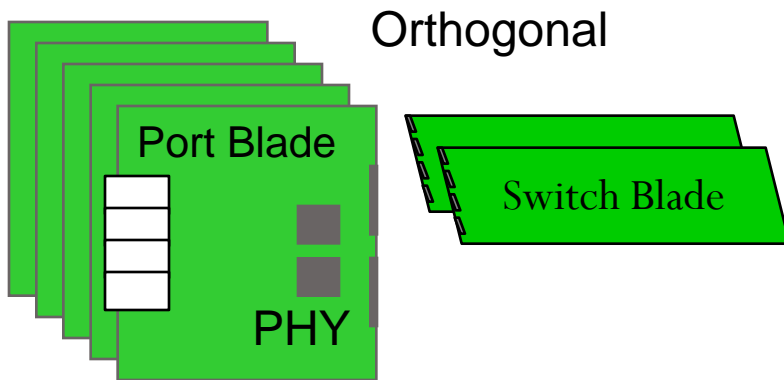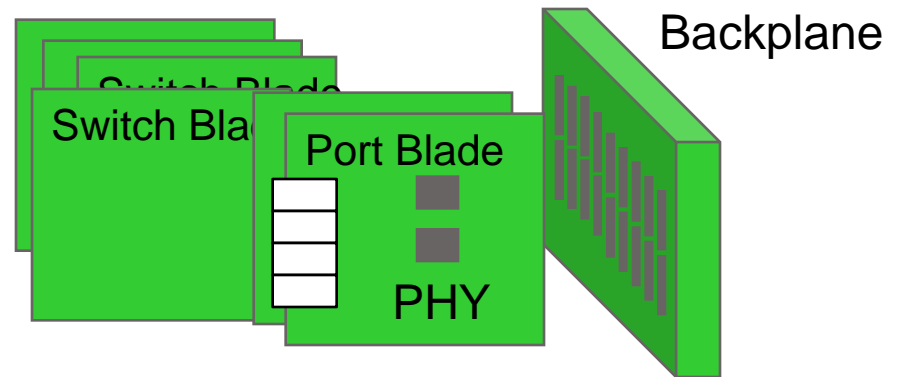4RU = 7.0"

# Modular Switch Architectures

- Three main types of modular switch designs
1. Backplane
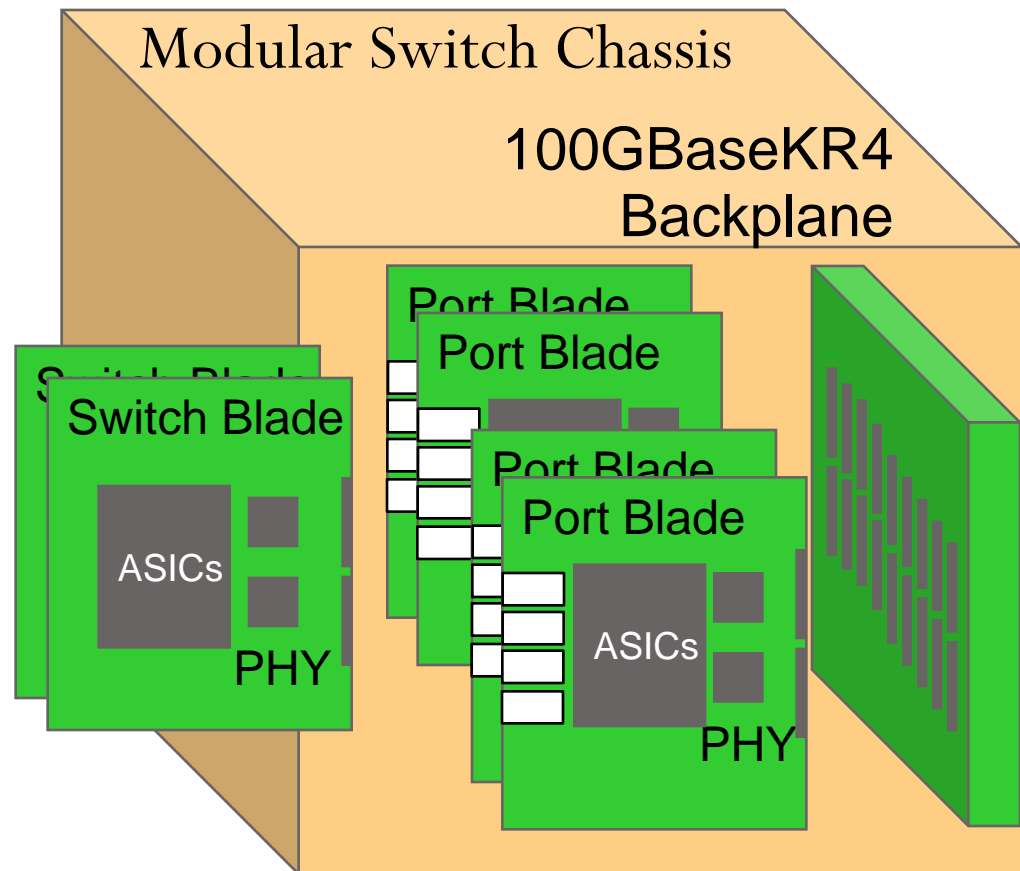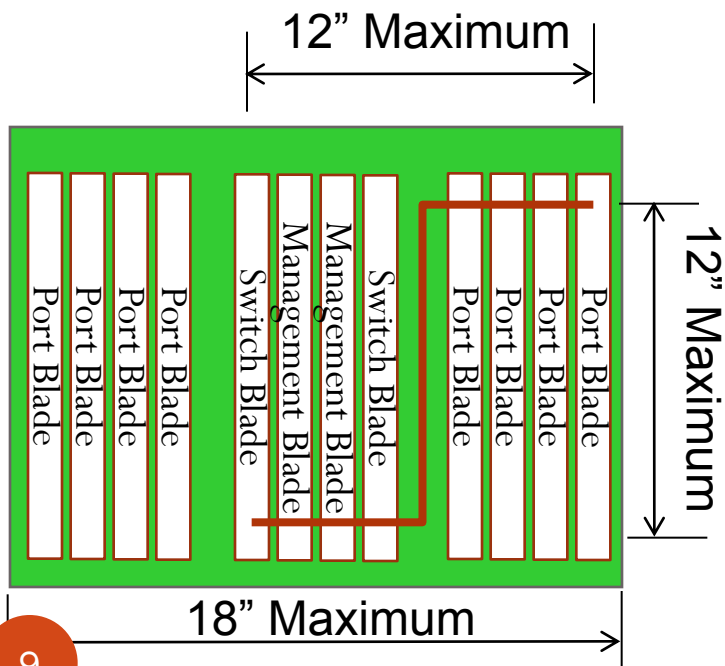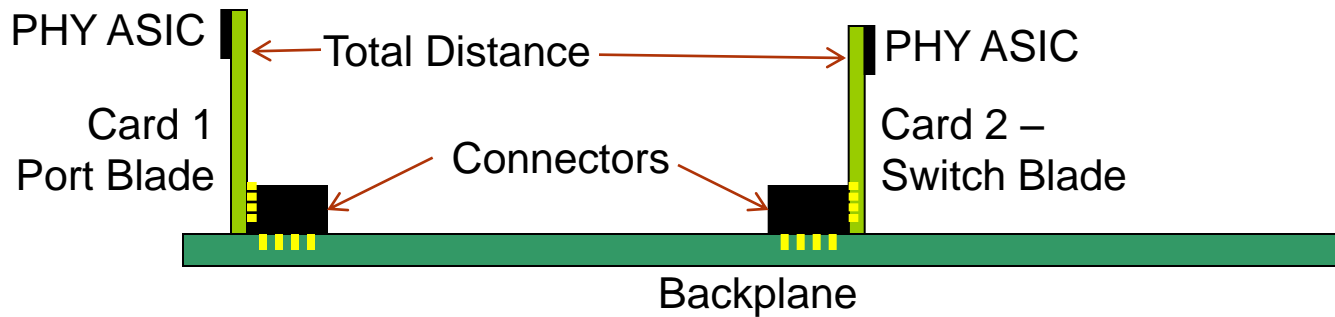2. Midplane
3. Orthogonal

# Backplane Architecture

- If one backplane is used, the switch blades are usually the center blades

### Distance from Port Blade to Switch Blade about 24"

# Backplane Architecture Summary

- Most backplane architectures have the switch blades in the middle of the backplane

- For most backplanes, the full channel distance would be <34"

PHY ASIC

Total Distance → PHY ASIC

Card 1
Port Blade

Connectors

Card 2 –
Switch Blade

Backplane

| | Card 1 | Backplane or Midplane | Card 2 | Total |
|---|---|---|---|---|
| Max Blade Switch Distanct | 5" | 24" | 5" | 34" |

# Midplane Architecture

- Similar to Backplane Architecture but the switch cards are on the backside of the midplane
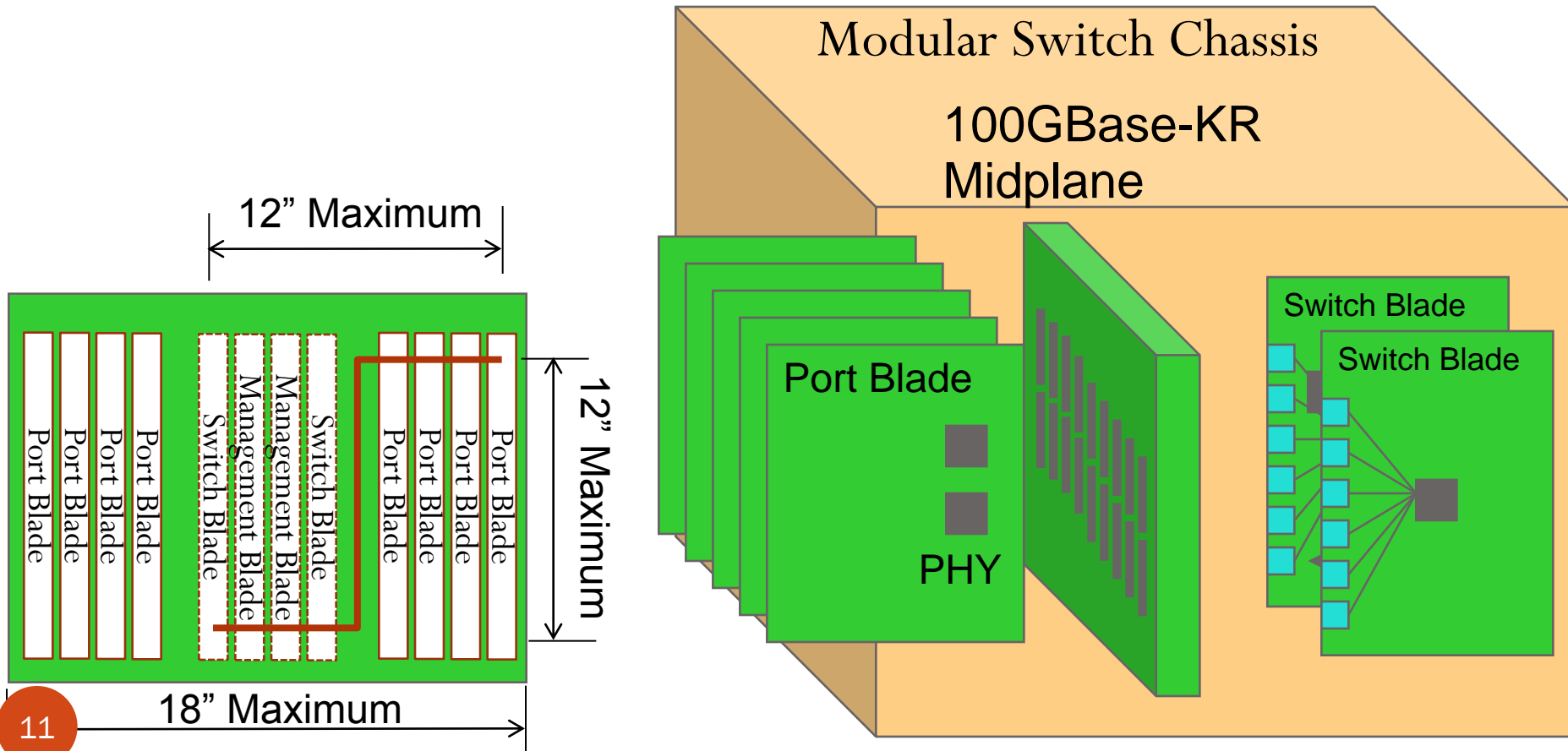


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# Midplane Architecture Summary

- Most backplane architectures have the switch blades in the middle of the backplane

- For most midplanes, the full channel distance would be <34"

PHY ASIC

Total Distance

Card 1
Port Blade

Midplane

Card 2 –
Switch Blade

PHY ASIC
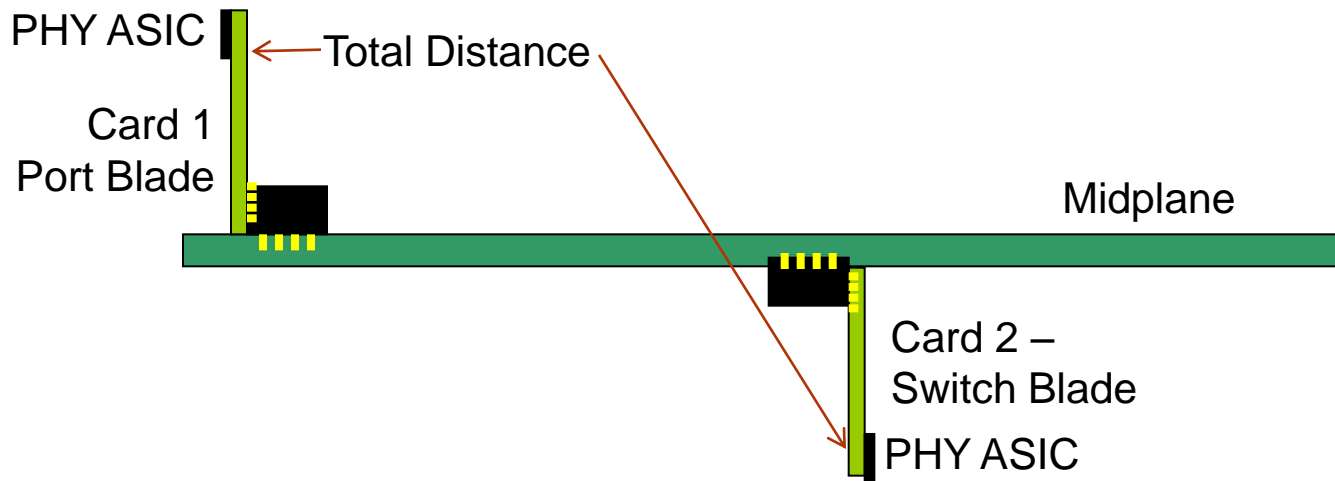
| | Card 1 | Backplane or Midplane | Card 2 | Total |
|---|---|---|---|---|
| Max Blade Switch Distanct | 5" | 24" | 5" | 34" |

# Orthogonal Architecture

- Orthogonal has no backplane and is shorter

Modular Switch Chassis

100GBaseKR4
Backplane

Port Blade

Port Blade

Switch Blade

ASICs

Port Blade

Port Blade

ASICs

PHY
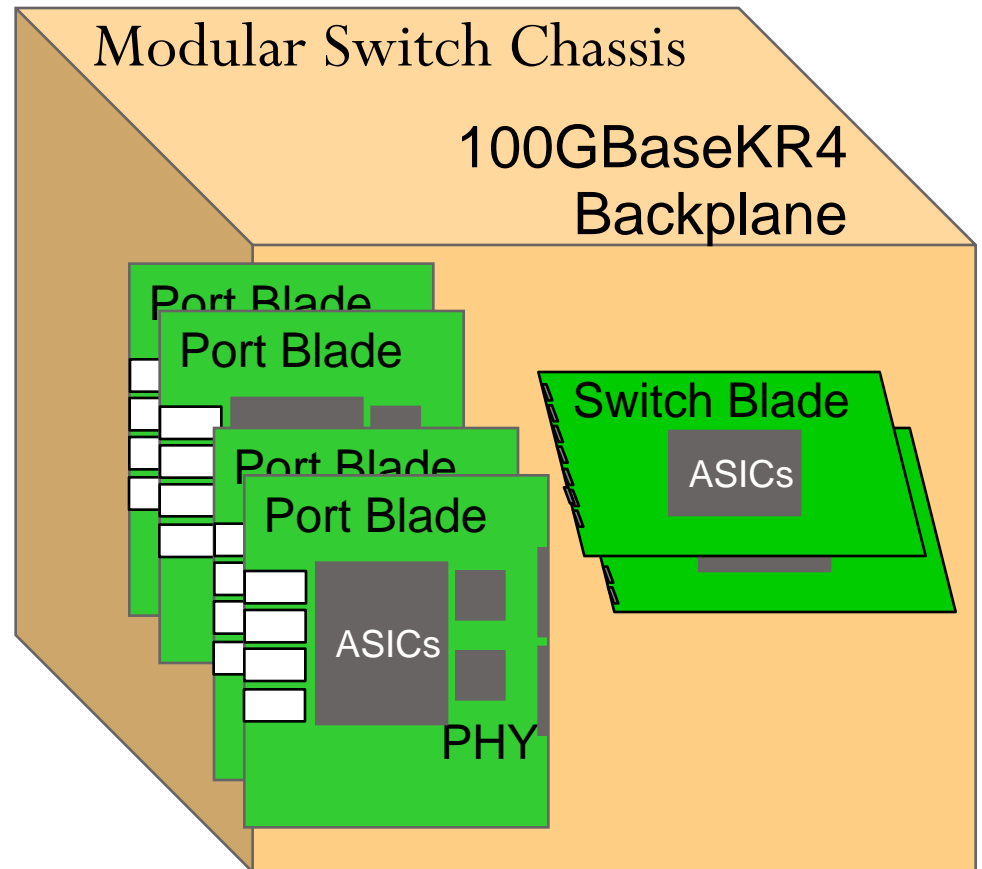
# Orthogonal Architecture Summary

- Orthogonal architectures are the simplest case
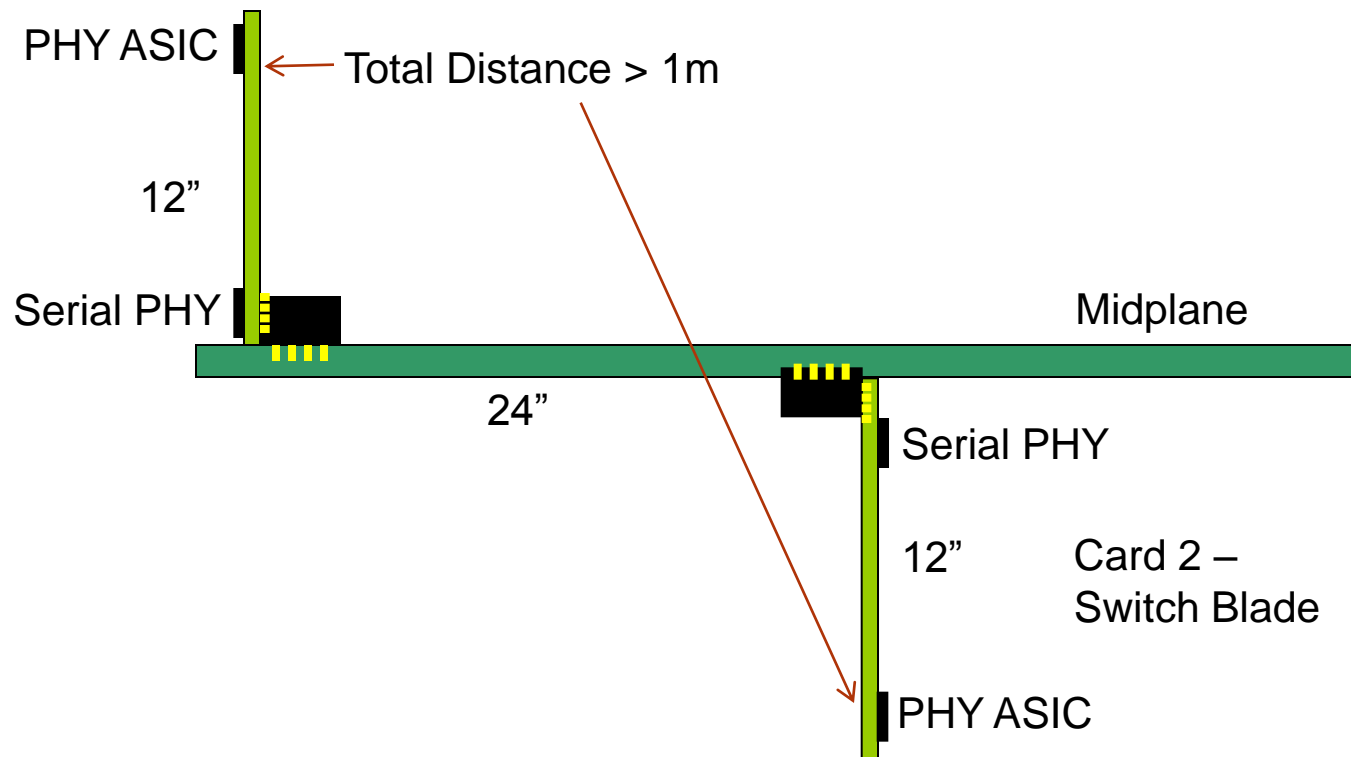- For most orthogonal architectures, the full channel distance would be <24"

PHY ASIC

← Total Distance

Card 1
Port Blade

Card 2 –
Switch Blade

PHY ASIC
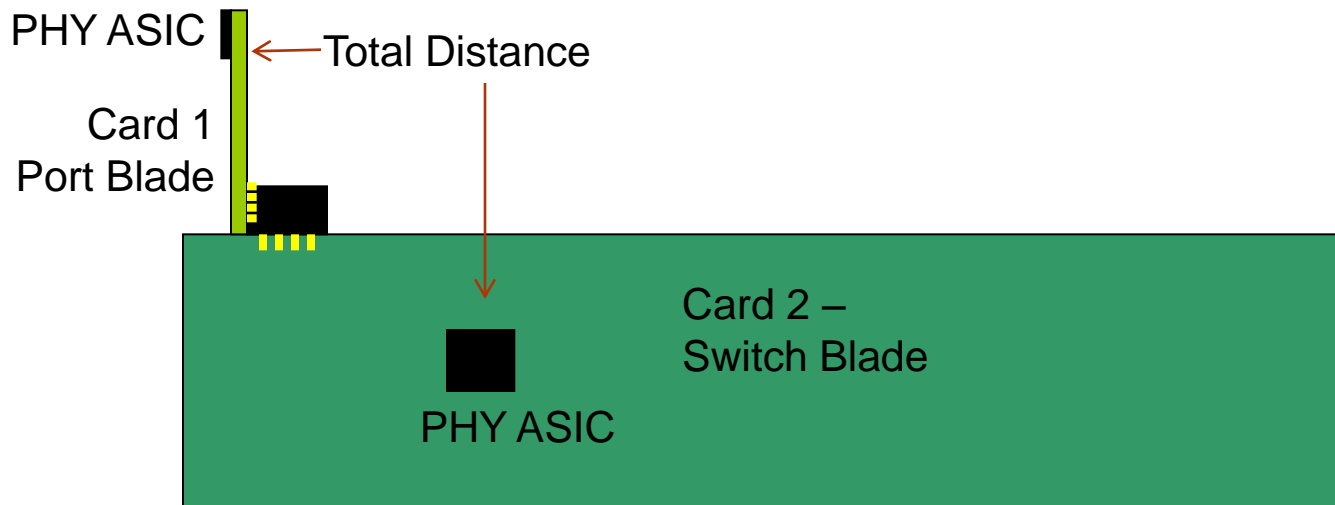
|  | Card 1 | Backplane or Midplane | Card 2 | Total |
|---|---|---|---|---|
| Max Blade Switch Distanct | 12" | 0" | 12" | 24" |

# What about Greater than 1 meter?

- If the channel distance on each port card is extended to 12" instead of 5", then the channel distance goes to over 1 meter.

- In these scenarios, a Serial PHY could be used to extend the distance on each card

PHY ASIC

← Total Distance > 1m

12"

Serial PHY

Midplane

24"

Serial PHY

12"    Card 2 –
Switch Blade

PHY ASIC

# Backplane Summary
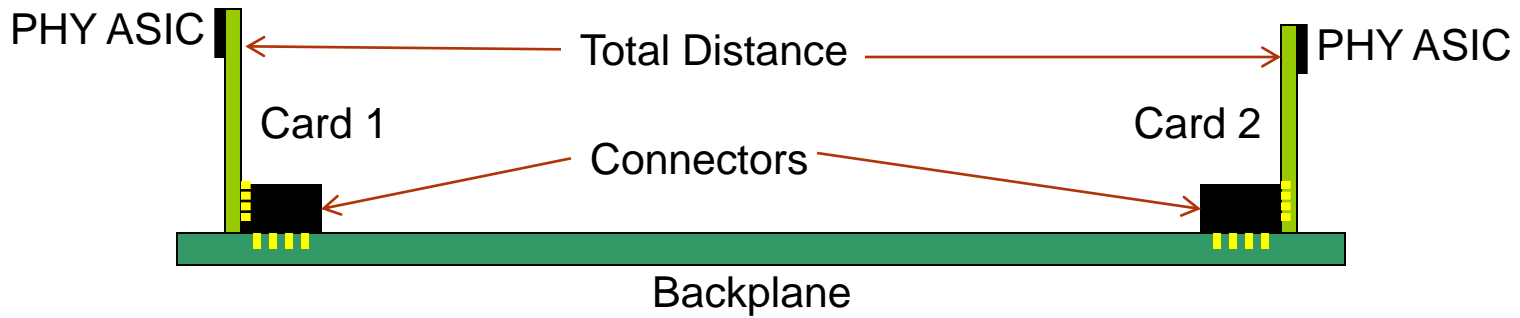


| Channel Type | Card 1 | Backplane or Midplane | Card 2 | Total |
|---|---|---|---|---|
| Patel_1a_0911 measured test channel | 5.1" | 29" | 5.1" | 39.2" |
| Max Blade Switch Distance | 6" | 22" | 6" | 34" |
| Max Backplane Distance | 5" | 24" | 5" | 34" |
| Max Midplane Distance | 5" | 24" | 5" | 34" |
| Max Orthogonal Distance | 12" | 0" | 12" | 24" |
| Max Retimed Distance | 12" | 24" | 12" | 48" |

# Calculated Trace Lengths

- Assume 2 connectors with 0.65dB/connector and 6 Vias with 0.2dB/via loss
- With the 35dB loss budget, the "Better Material" loss is calculated over 34" since this meets the broad market potential

| | Measured Megtron6 Channel (Patel_01_0911) | Improved FR4 | "Better Material" | Measured Metron6 Channel with FEC | Improved FR4 with FEC | "Better Material" with FEC | |
|---|---|---|---|---|---|---|---|
| Loss Budget (dB) | 29.2 | 30 | 30 | 35 | 35 | 35 | |
| Loss of 2 Connectors (dB) | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | |
| Loss from 6 Vias (dB) | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | |
| Loss Budget for Traces (dB) | 26.7 | 27.5 | 27.5 | 32.5 | 32.5 | 32.5 | |
| Material Loss (dB/inch) | 0.68 | 1.04 | 0.95 | 0.68 | 1.04 | 0.95 | Calculated Values |
| Trace Distance (in) | 39.3 | 26.4 | 28.9 | 47.8 | 31.3 | 34.2 | |
| Trace Distance (m) | 1.0 | 0.7 | 0.9 | 1.2 | 0.8 | 1.0 | |

# Conclusion and Summary

- Without FEC and 30dB of loss, the PAM-2 solution can support 1 meter channels with Megtron6

  - If Megtron6 cost is 50% more than FR4, it should add 25% to the cost of the PCB and less than 1.75% to the cost of the switch in 2015

    - Since the 100G IC cost will increase, the PCB % of the cost will probably be less

- With FEC, 35dB and "Better Material", the 34" broad market is met when the loss of the material is 0.95dB/in

- With serial PHY, the PAM-2 solution can support implementations with more than 1 meter of FR4

- With full support of blade servers and most modular switches, the PAM-2 solution reaches a broad market potential as defined in the 802.3bj 5 criteria