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AltiumLive 2017:
Where Have We Been?
Where Are We Going?
The Paradigm Shift of PCB Design

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THIRTY YEARS AGO

- Thirty years ago, the IPC reported that there were more than 1200 printed circuit fabricators in the United States.
- The attendance at PCB West was nearly 5000 engineers and designers. There was enough demand for a PCB East and PCB Europe each year.
- Most integrated circuits were in 16 or 20 lead dual in line packages and had only one supply voltage, 5 volts.
- Most printed circuit boards had only two layers or four for complex designs.
- There were more than ten suppliers of laminate materials in the US.

WHERE ARE WE TODAY?

- The most recent IPC listing of fabrication shops in the United States was less than 200.
- PCB West struggles to reach an attendance of 1000 designers and engineers. There is no demand for a PCB East or Europe show.
- There are only three prominent laminate suppliers in the United States.
- What happened?
- Did everything go off shore as some have said?
- Will this trend continue to happen?

WHAT HAPPENED OVER THE LAST 30 YEARS?

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- Thirty years ago, integrated circuits were mostly TTL with rise times around 5 nanoseconds and transistor counts in the few thousands.
- A 3D work station consisted of six or more 14 layer PCBs and a backplane. These PCBs were densely packed with dual in line ICs and were often 14” (26 cm) by 22” (56 cm).
- Five years later, the same 3D work station was down to a single printed circuit board, also 14 layers, also about 26 cm by 56 cm.
- This was possible because integrated circuits became more complex with a few hundred thousand transistors made from CMOS with rise times as fast as one nanosecond. Supply voltages dropped to 3.3 Volts.

INOVATIONS IN IC TECHNOLOGY DRIVE IT ALL

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- Most of us are familiar with Moore's Law that says the transistor count in ICs would double every 2 years.
- This has made it possible to, first, make microprocessors that replaced dozens of ICs and reduced the number of PCBs required to design a computer to one or two.
- Products such as digital cameras have been made possible at very low cost.
- Cell phones and other products are possible that were previously impractical or prohibitively expensive.
- Flash memory ICs containing as many as 256 Gigabits are also common.

A LOOK AT HOW THE IC INDUSTRY STARTED

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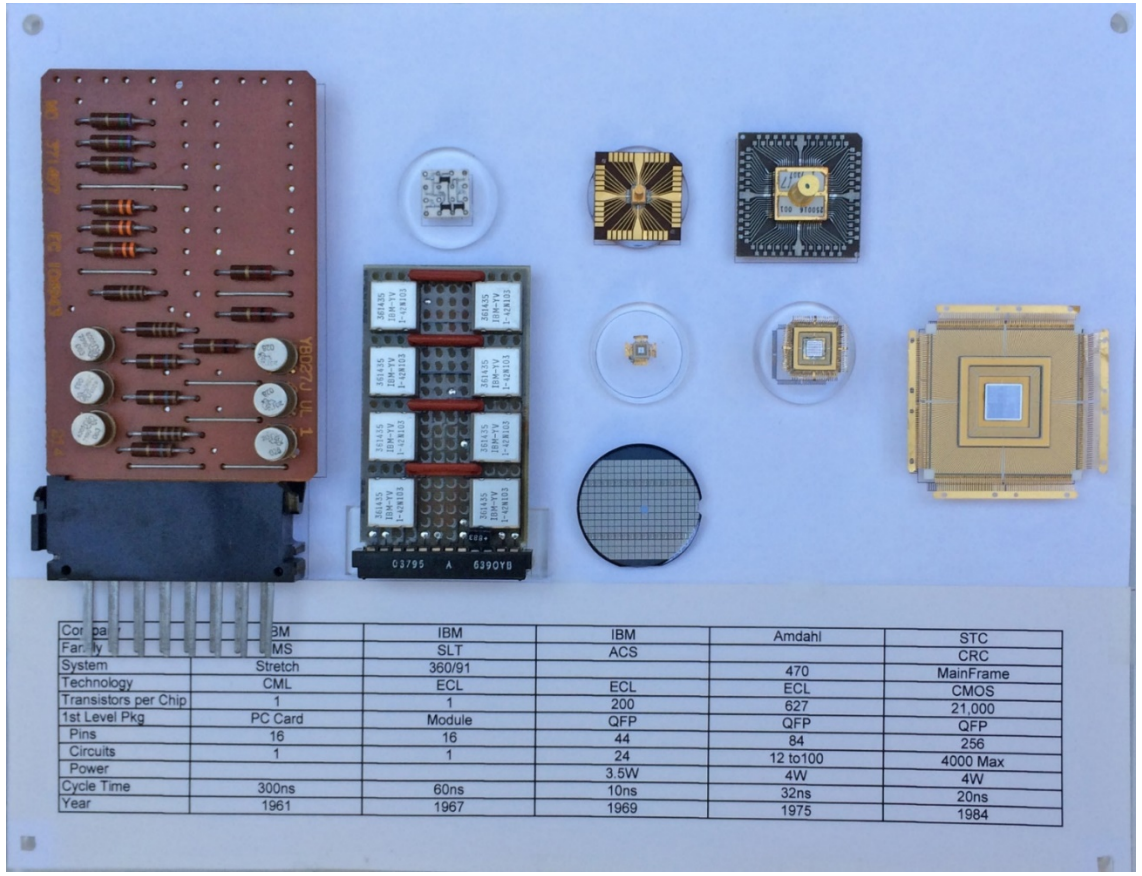
Early evolution of IBM computers.



Co pa	BM	IBM	IBM	Amdahl	STC
Fa ly	MS	SLT	ACS		CRC
System	Stretch	360/91		470	MainFrame
Technology	CML	ECL	ECL	ECL	CMOS
Transistors per Chip	1	1	200	627	21,000
1st Level Pkg	PC Card	Module	QFP	QFP	QFP
Pins	16	16	44	84	256
Circuits	1	1	24	12 to100	4000 Max
Power			3.5W	4W	4W
Cycle Time	300ns	60ns	10ns	32ns	20ns
Year	1961	1967	1969	1975	1984

	1961	**1967**	**1969**	**1975**	**1984**
Transistors	6	48	200	827	21,000

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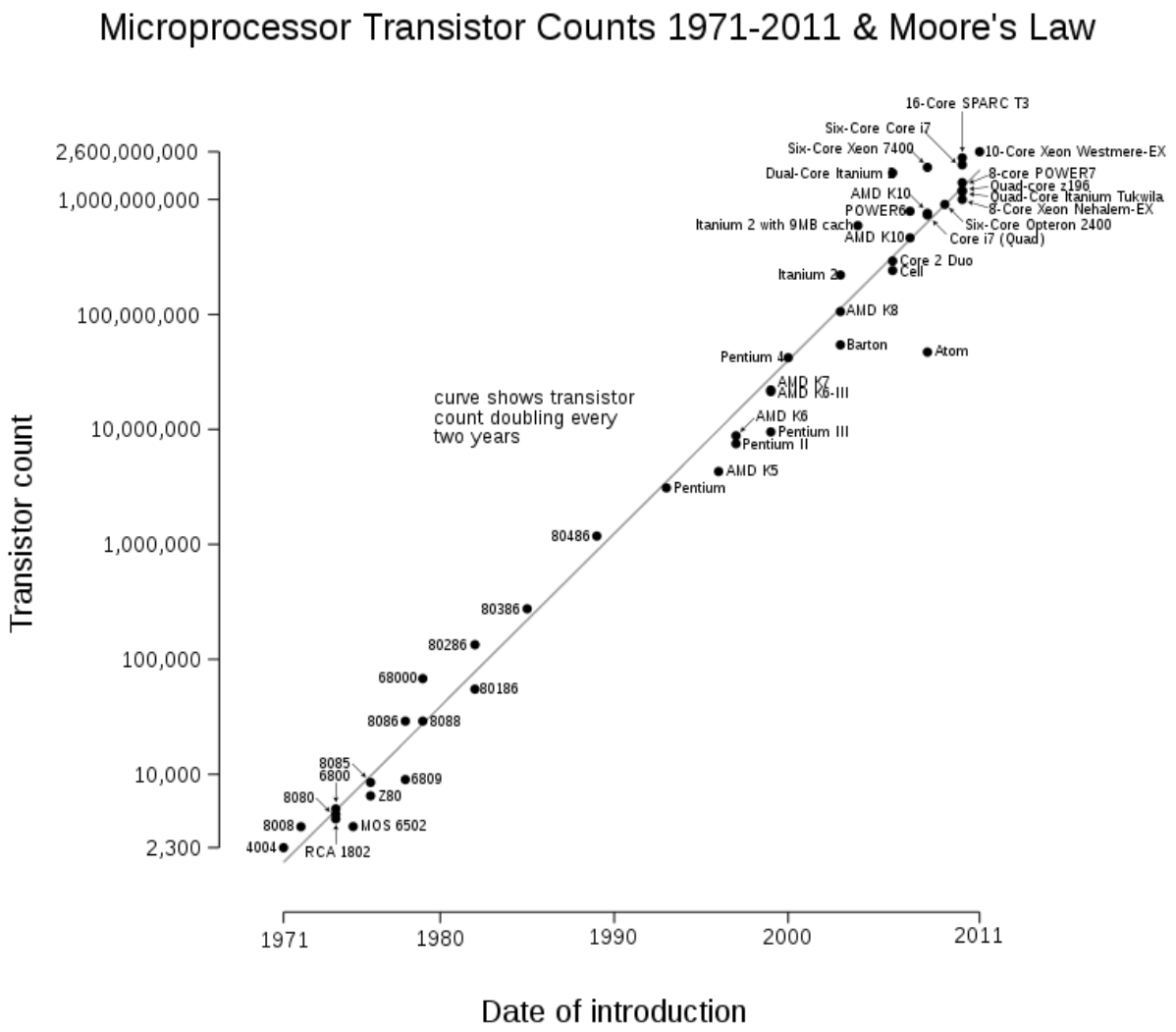
If it's current technology, it's high speed

HOW TRANSISTOR COUNT HAS RISEN



- 1970 2000 TRANSISTORS
- 1980 30 THOUSAND TRANSISTORS
- 2011 2.6 BILLION TRANSISTORS
- 2017 10+ BILLION TRANSISTORS

CHART COURTESY OF WIKIPEDIA

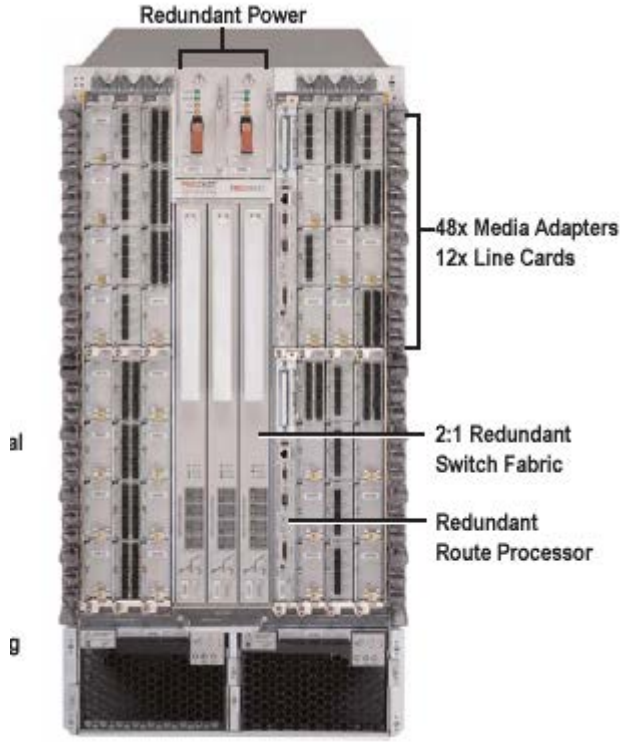
WHAT IS INSIDE A CELL PHONE

- Dozens of PCBs have been reduced to a single PCB as a result of very high levels of integration.
- This means less PCBs to design and less PCBs to fabricate.

EVOLUTION OF INTERNET ROUTERS

- Until 2002 an Internet router capable of routing a terabit of data per second was on the horizon, but not practical due to the very large number of PCBs that would be required.
- In 2002 the first terabit router was introduced by a company called Procket Networks. It required 51 PCBs, occupied half a rack and weighed 350 pounds (160 kilograms). It is shown on the next slide.
- In 2007 that same terabit router was reduced in a single PCB occupying one single slot in a rack and weighed 22 pounds (10 kilograms).
- How did this happen? Very high levels of integration in the ICs.

A TERABIT ROUTER IN 2002



Photos Courtesy Procket Networks

This design consume 7 KW. It contains no ferrite beads anywhere in it. There are in excess of 100K 2.4 Gb/S data paths in this design. There are a total of 11 different PCB designs and more than 60 individual PCBs. It has 48 10 Gb/S line cards.

A TERABIT ROUTER IN 2007

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Arista 7148S

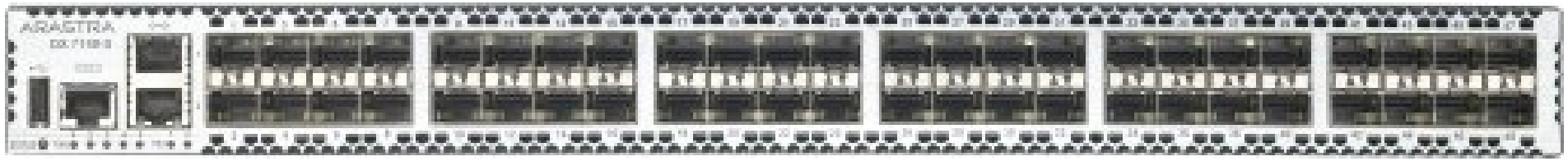

Photo Courtesy of Arista Networks

All I/O are 10 Gb/S. All internal signals are 3.125 Gb/S. It is in a 1U high “pizza box” package. 700 Watts, 22 pounds. All functions on a single PCB. 48 10 Gb/S ports. 96 10 Gb/s data paths up to 4” long built on FR408 laminate.

The contrast between the 2002 and 2007 router designs illustrates how rapidly technology is changing and the need for constant skill updates.

Even more it is a good reason why last year’s design practices may not work this year.

It also illustrates why there are less fabricators and a need for far less PCB designers.

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2.5 TERA BIT ROUTER IN 2013

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ARISTA 7050QX- 32 40 Gb/S PORTS

Photo Courtesy of Arista Networks

Same 1U high box, single PCB and 2.5 times the performance of the box on the last slide.

Technology is changing so rapidly that it is not safe to carry old design rules to new designs.

The latest version of this has all 32 ports operating at 100 Gb/S.

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WHERE ARE WE NOW?

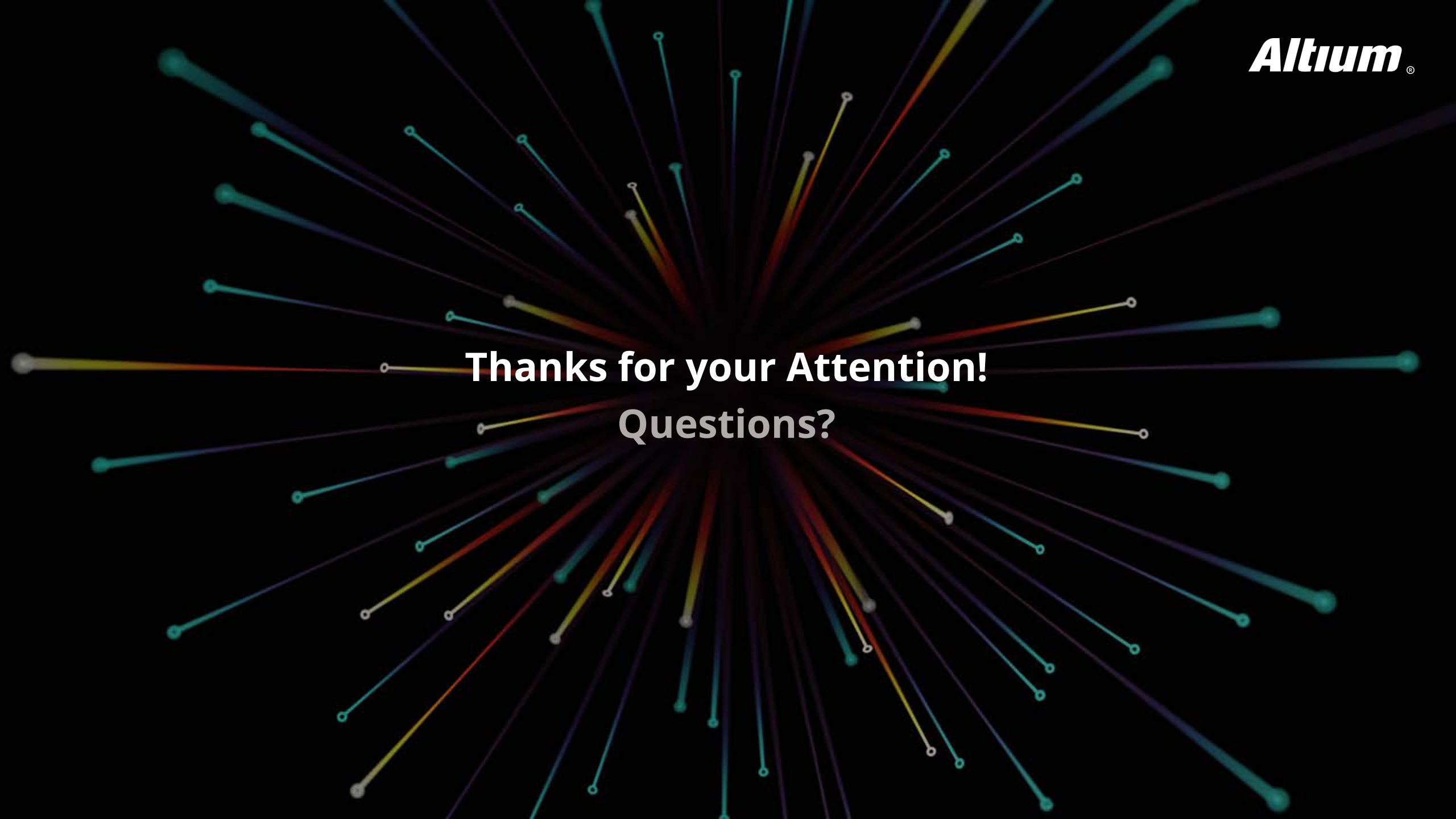
- The last few slides seem to show that the need for PCB designers and fabricators is diminishing every year.
- Is this trend going to continue? Will that mean that more designers will lose their jobs? Will the fabricator base continue to shrink?
- No, we have reached an era where almost all products can be designed using a single PCB.
- However, each PCB does more and at much higher data rates.
- PCBs often have more than a dozen different power supply voltages.
- Supply voltages have dropped to below 1 volt with currents exceeding 100 amperes requiring great care engineering the PCB to insure proper operation.

MORE WHERE ARE WE NOW

- Most wide, parallel buses such as the PCI bus have been replaced by very high data rate differential pair based data paths such as PCIe. (137 lines have been replaced with 8 differential pairs using only 16 lines.)
- These changes have made the routing of data signals easier while making power deliver system design much more demanding and difficult.
- In the past, PCB stackups were focused on maximizing the number of routing layers and minimizing the number of power and grounds.
- The skill levels are shifting away from routing the wires to designing a system on a PCB that has adequately designed power delivery systems.
- However, routing skills still need to improve in order to make sure that signal paths operating at speeds as high as 32 Gb/S function correctly and that is not an easy task.

SUMMATION

- No, the design jobs did not go off shore.
- No, fabrication did not go off shore eliminating fabrication in the US and Europe.
- Very high levels of integration have made it possible to design very complex systems on a single PCB eliminating many designer jobs and reducing the demand for fabrication capacity.
- The technical demands placed on engineers and designers to make sure these single board systems perform properly have increased dramatically.
- The need for advanced training seminars to enable designers to upgrade their skills is greater than it has ever been.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Thanks for your Attention!
Questions?