

Semiconductors: Signal and Power Integrity

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Career

BS in Electrical Engineering
University of Utah

PhD in Electrical Engineering
Brigham Young University

*3 Internships (**Micron, Intel**)*

*Started with **Micron Technology, Inc.** in 2006*

*Transitioned to **Qualcomm, Inc** in 2012*

*Returned to **Micron** in 2014*

Micron Fellow - Signal and Power Integrity
R&D Lead

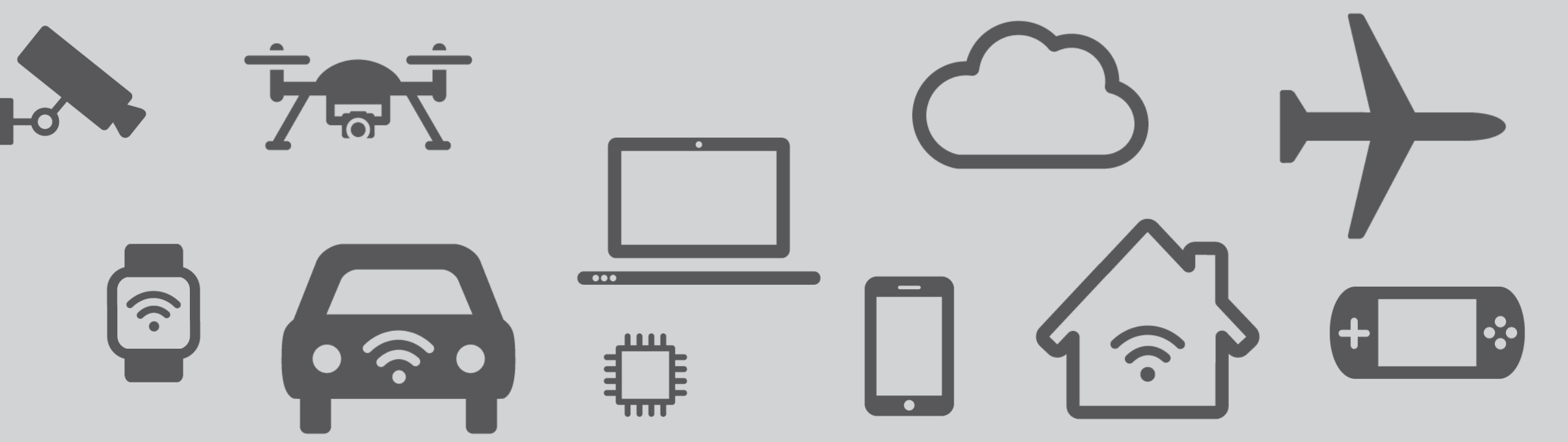


Micron by the Numbers

40 Years strong in
17 Countries with
12 Manufacturing sites,
34,000+ Team Members with over
40,000 Patents and
Net Sales in 2017 of
\$20,000,000,000
(Yes, that is \$20 **Billion!**)

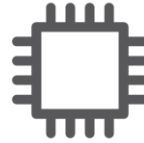
Headquarters & Global Technology Development Boise, Idaho





**Micron memory is in
the things you use
every day**

What does Micron make?



OEM* DRAM memory

**Dynamic
Random
Access
Memory**

- Volatile
- Short-term



OEM* Flash memory

**NAND Flash
NOR Flash
Managed Flash**

- Non-volatile
- Long-term



Memory solutions

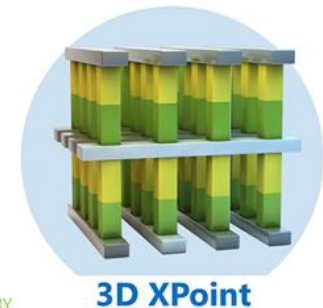
Solid State Drives

- No moving parts
- Mixture of products



3D Xpoint

**1000X
FASTER
THAN NAND**
**1000X
ENDURANCE
OF NAND**
**10X
DENSER
THAN CONVENTIONAL MEMORY**



3D XPoint

*OEM = Original Equipment Manufacturer

Micron's Global Expertise

Headquarters - Boise, Idaho

North America

Idaho Colorado
California Texas
Virginia Utah

Europe

Belgium Italy
Finland Netherlands
France Sweden
Germany United Kingdom

Asia

Australia Malaysia
China Singapore
India South Korea
Japan Taiwan

Areas Technical Majors are used at Micron

- Design
- Research & Development
- Product Engineering
- Fabrication
- Probe
- Test
- Assembly
- Facilities
- Information Systems
- Marketing
- Training
- Legal
- Purchasing
- Operations

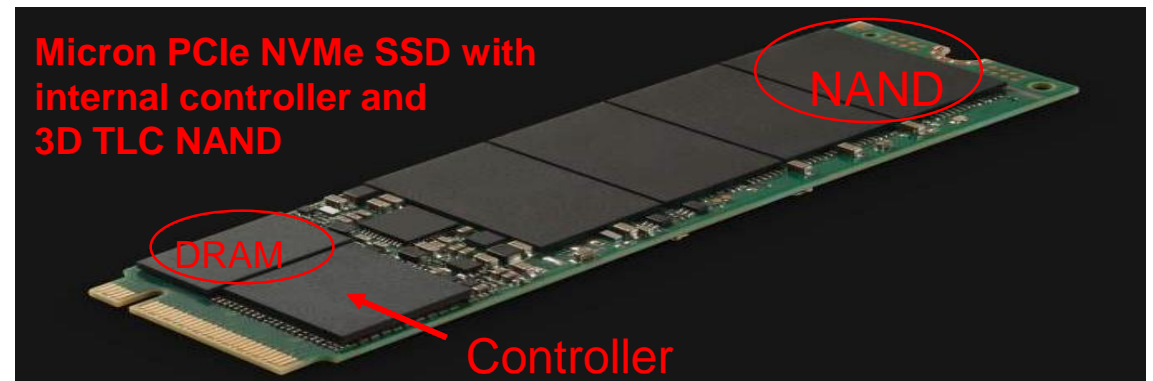
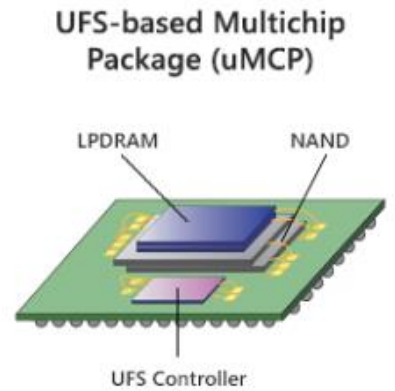
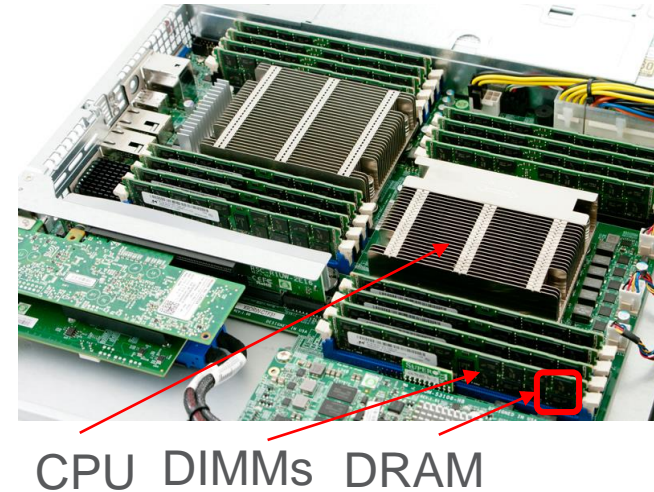
Top 10 Technical Majors at Micron

■ Electrical Engineering	44%
■ Chemical Engineering	11%
■ Mechanical Engineering	9%
■ Computer Engineering	7%
■ Computer Science	6%
■ Physics	5%
■ Chemistry	4%
■ Materials Science	4%
■ Engineering, General	4%
■ Industrial Engineering	1%
■ All other engineering degrees	5%

What are Signal Integrity (SI) and Power Integrity (PI) ?

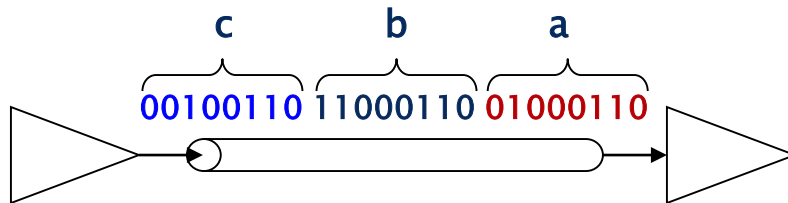
- Engineering Practices that ...
 - ensure proper transmission of electrical signals on a channel (SI)
 - ensure robust power delivery (PI)
 - ensure signals don't 'pollute' the electromagnetic spectrum (EMI)
 - study tradeoffs between signaling bandwidth and energy efficiency

Examples of Systems



Basic Signal Integrity

Serial Transmission

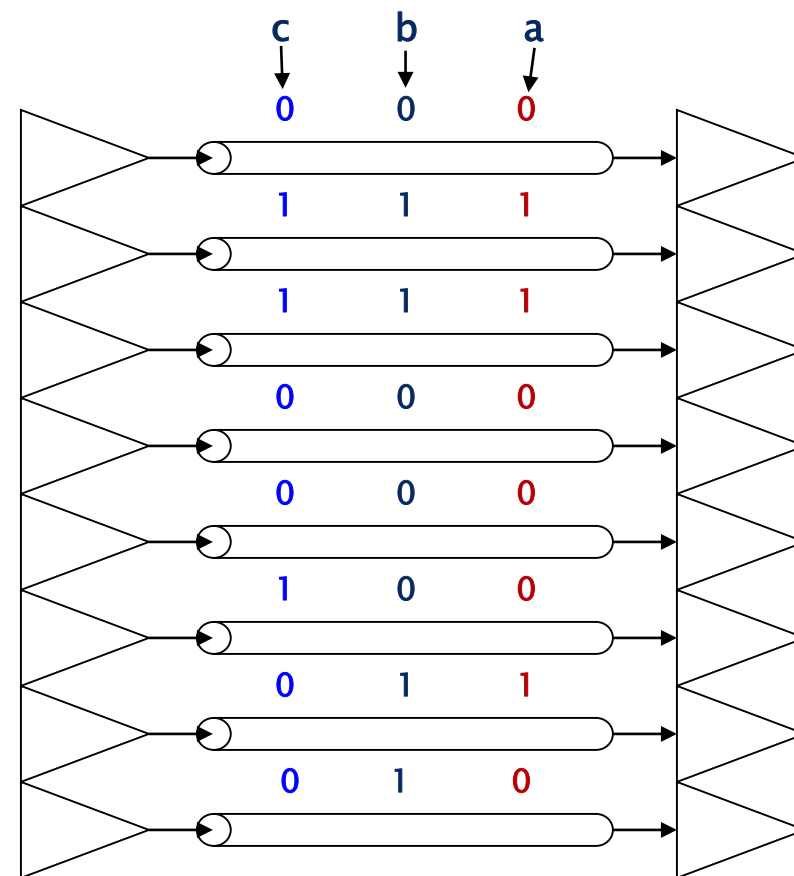


- Trade-off: speed-per-pin vs. number of pins.

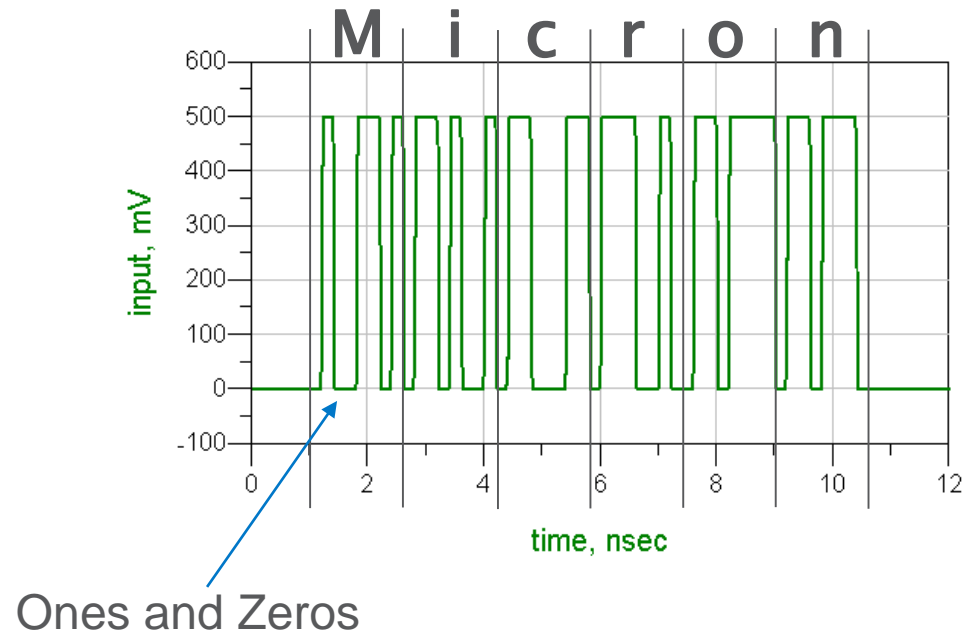
■ American Standard Code for Information Interchange (ASCII):
- Represents Alphanumeric Data and Common Symbols using 8bit Codes

■ A = 01000001
■ B = 01000010
...
■ a = 01100010
■ b = 01100011
...
■ : = 00111010
■ ; = 00111011

Parallel Transmission

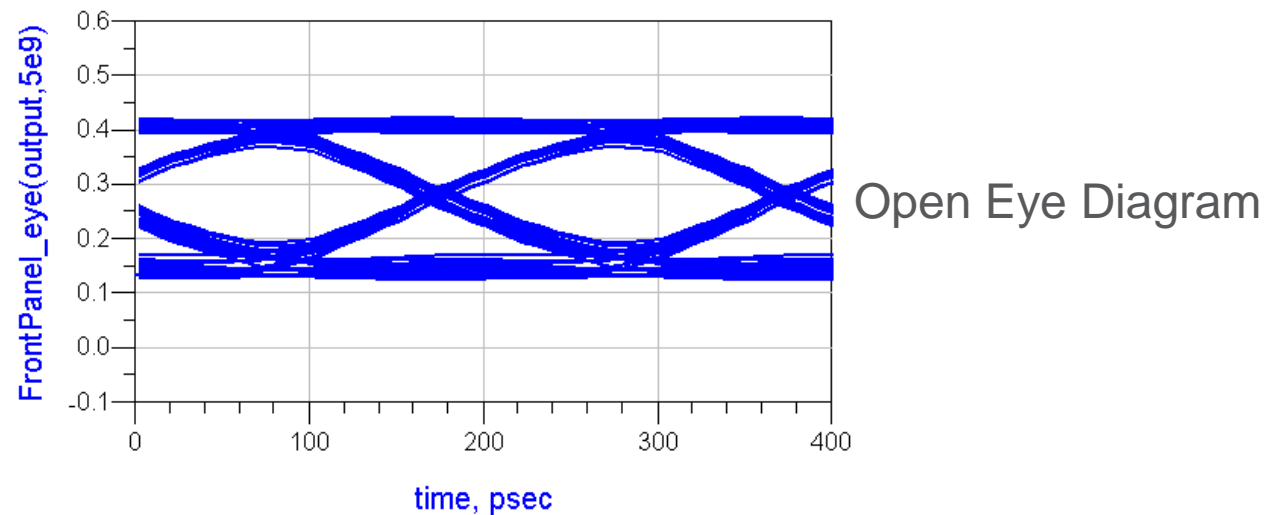
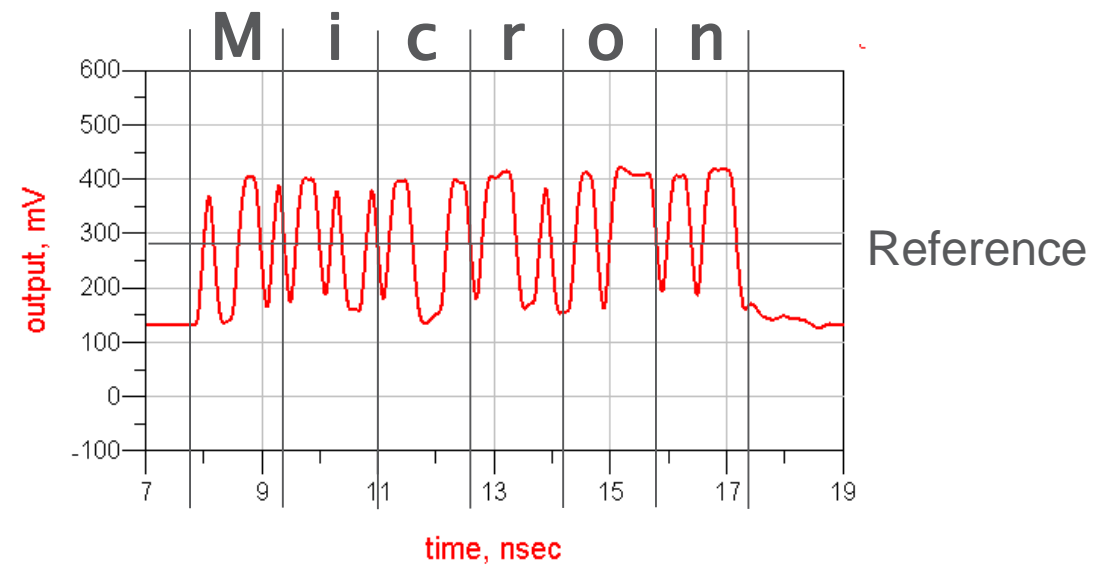
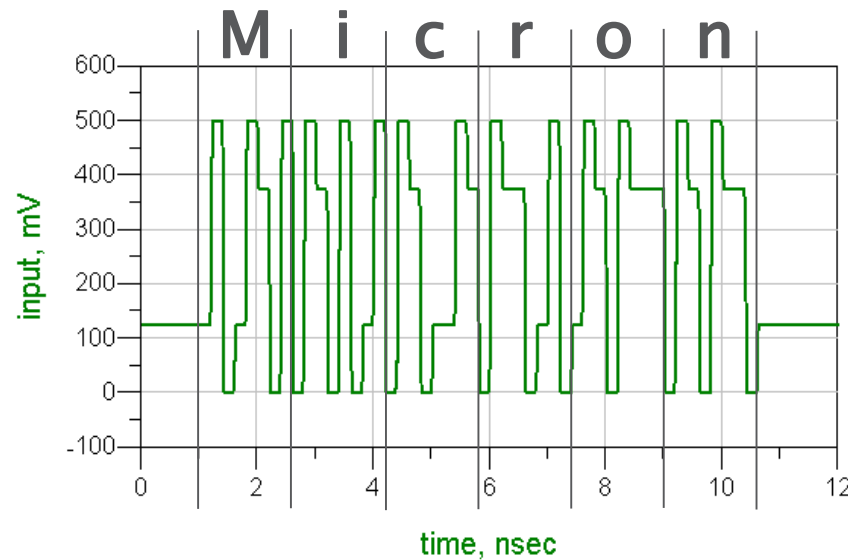


Basic Signal Integrity



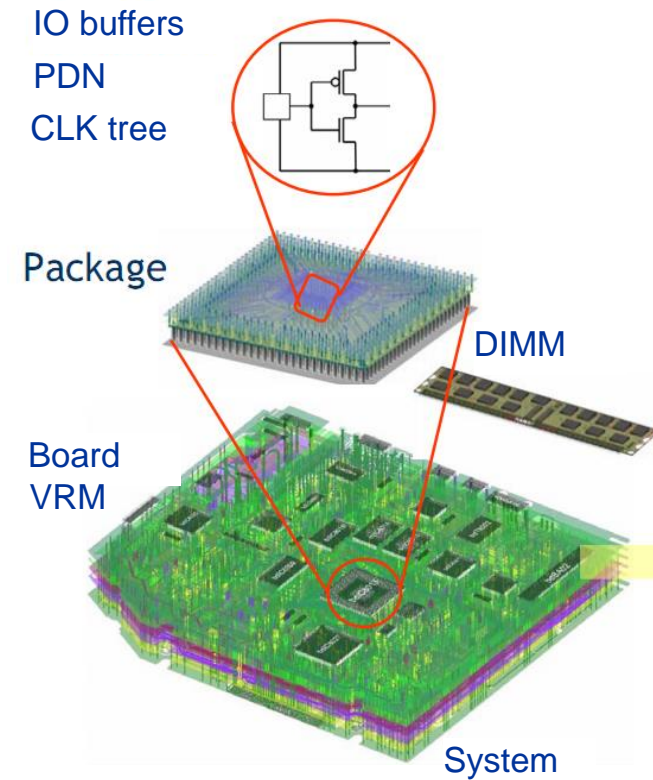
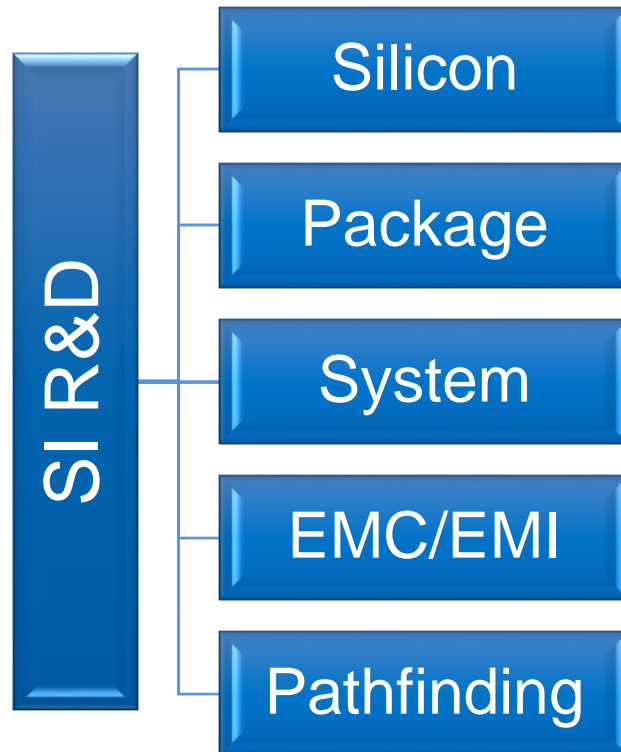
Corrupted data can be very dangerous in applications like automotive.

Basic Signal Integrity



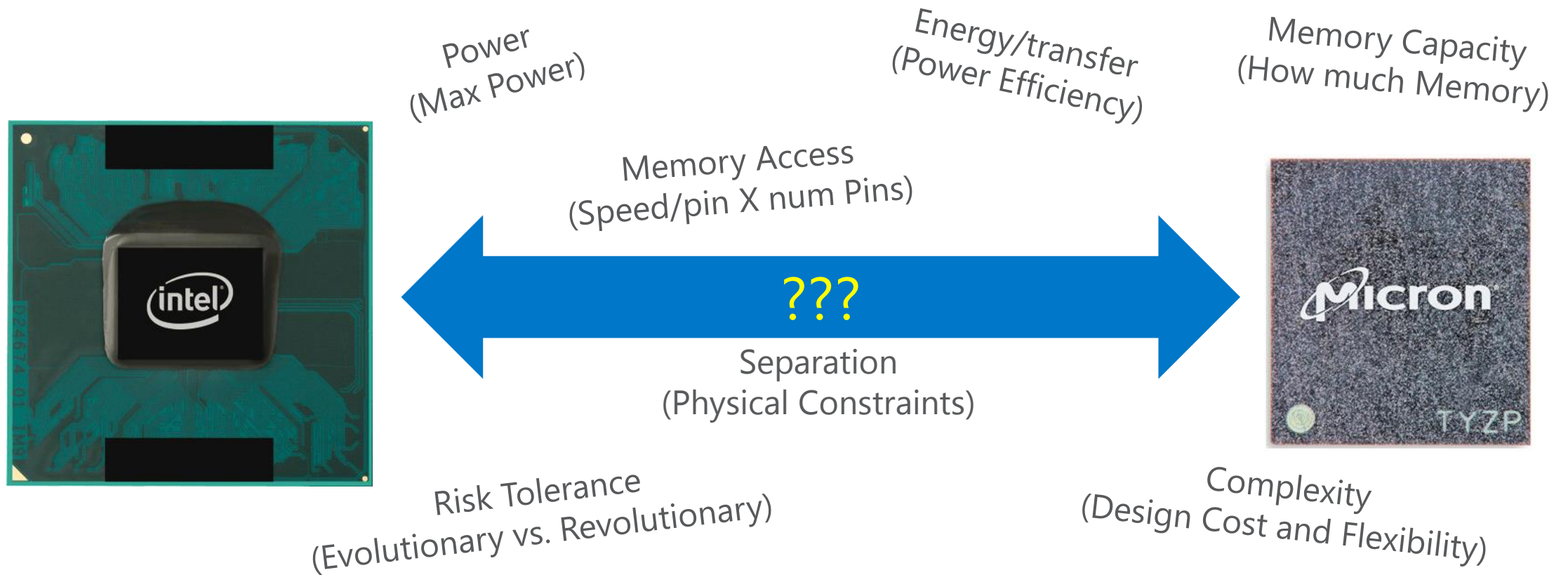
Pre-distorting the data can make it easier to receive correctly.

Signal and Power Integrity span all levels of Product Hierarchy



Memory Subsystem Architecture

HIGH-LEVEL CONSIDERATIONS

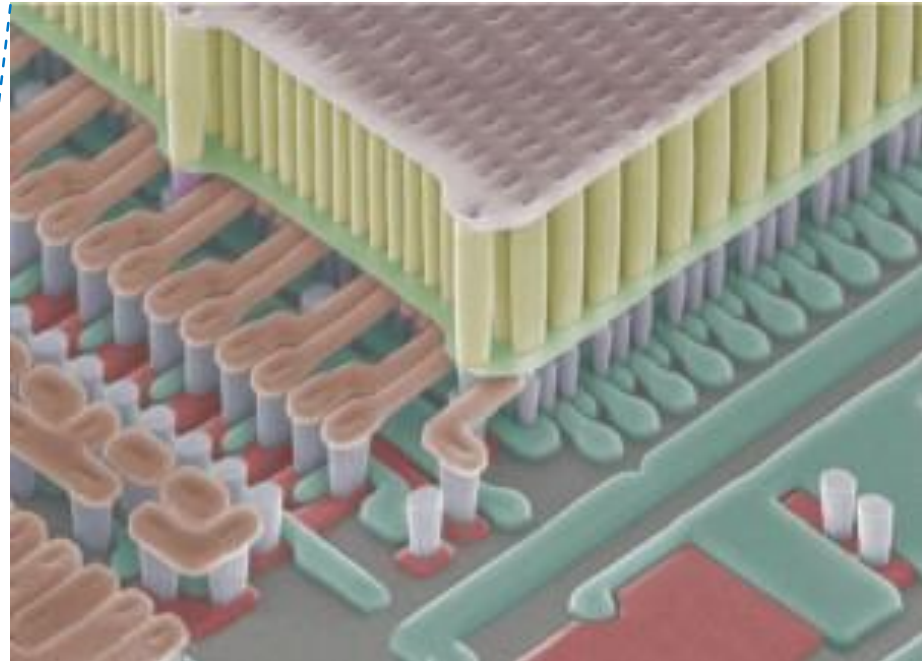
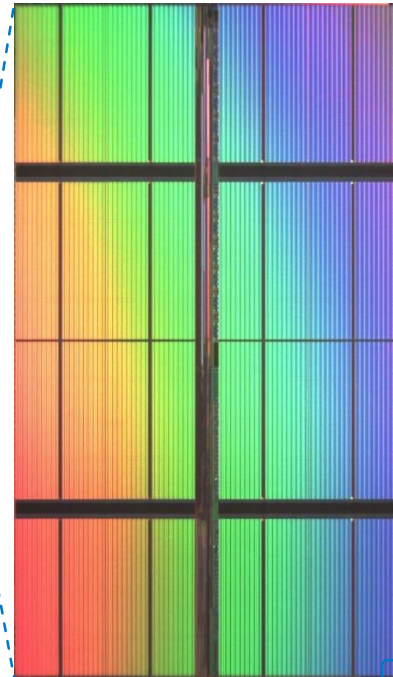
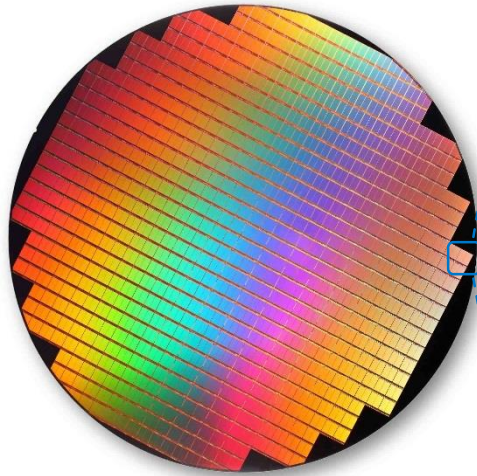


Memory – Scaling

2017 Numbers

~6434
DRAM
bits on
the tip of
a 50um
hair

~239,502
Flash
bits on
the tip of
a 50um
hair

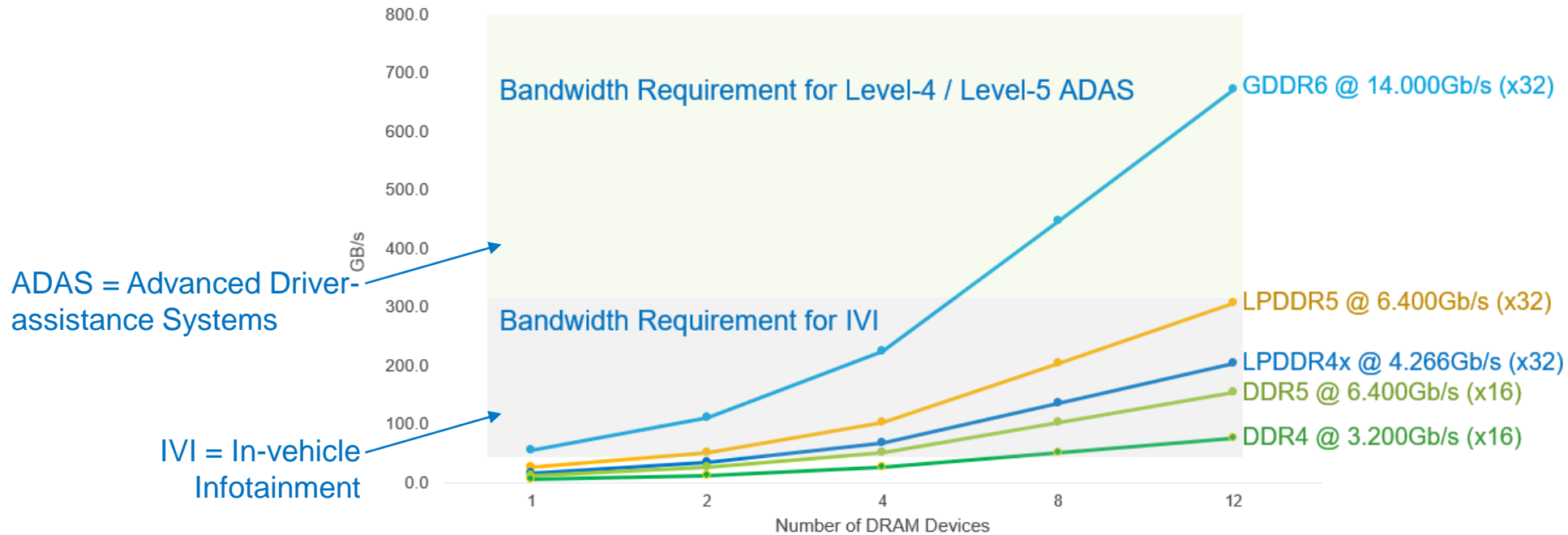


Memory – Scaling

Emerging applications and platforms must handle a lot of data.

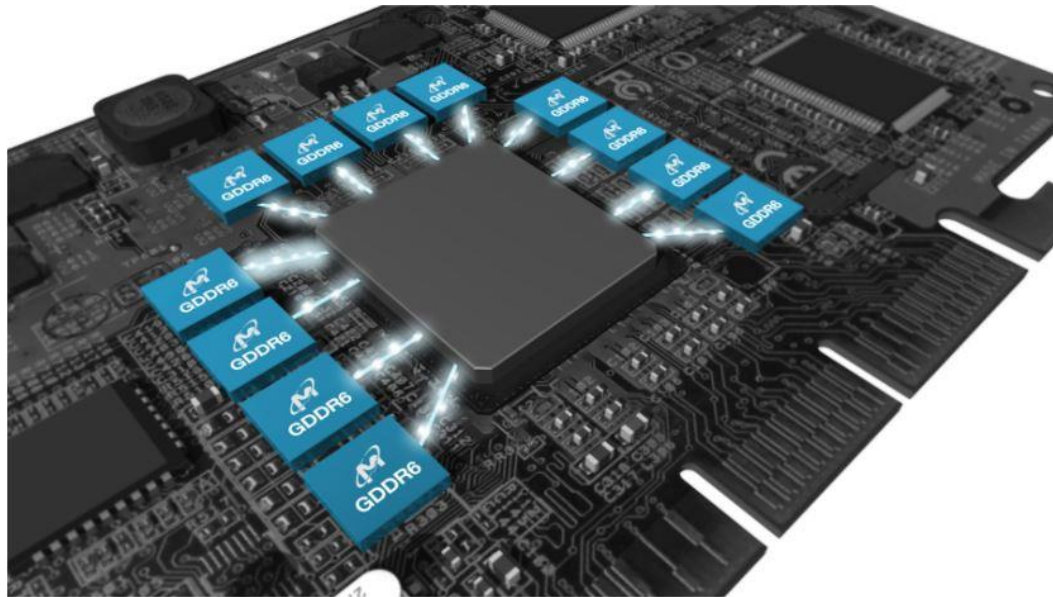


Bandwidth vs. Number of DRAM Devices



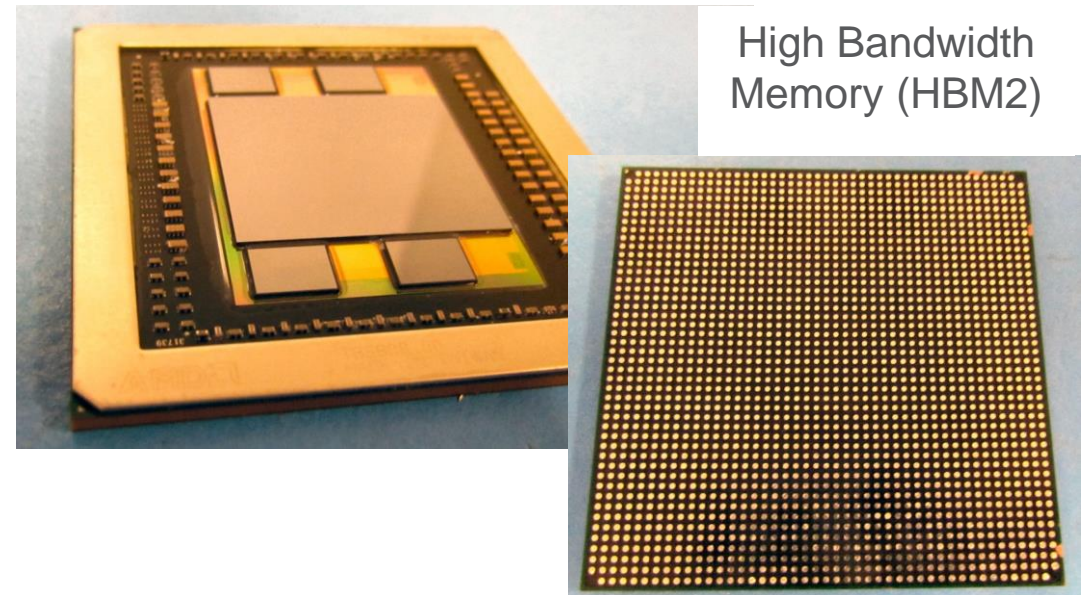
Multiple Solutions → Technical Trade-offs

More Data per Pin



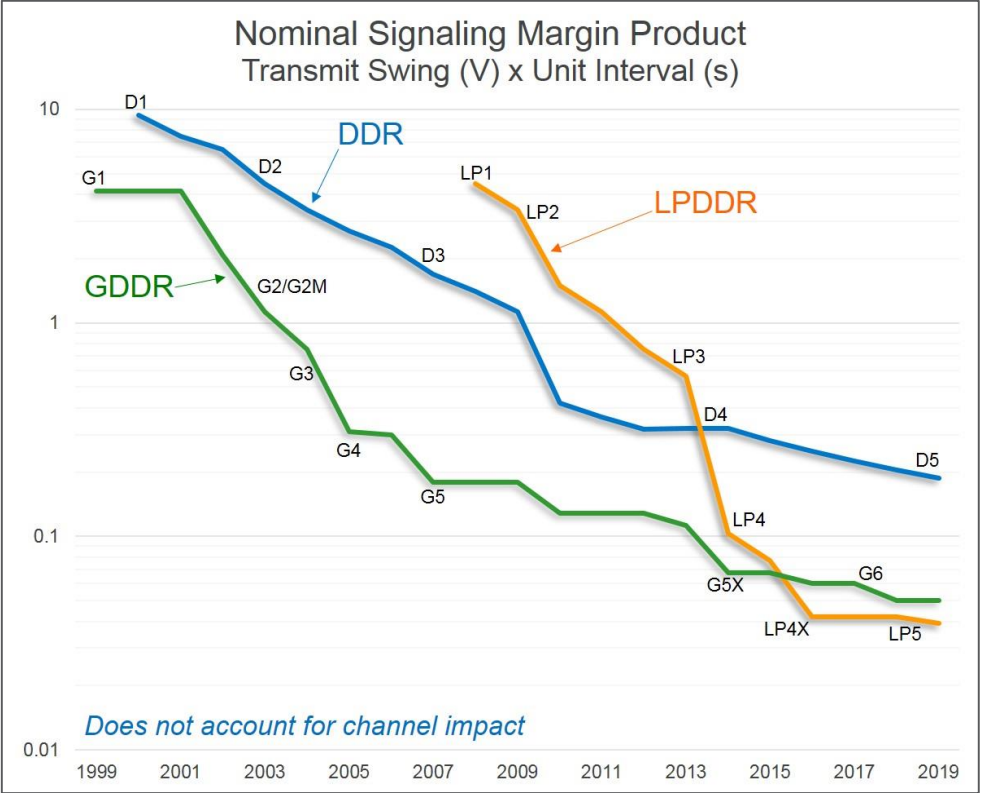
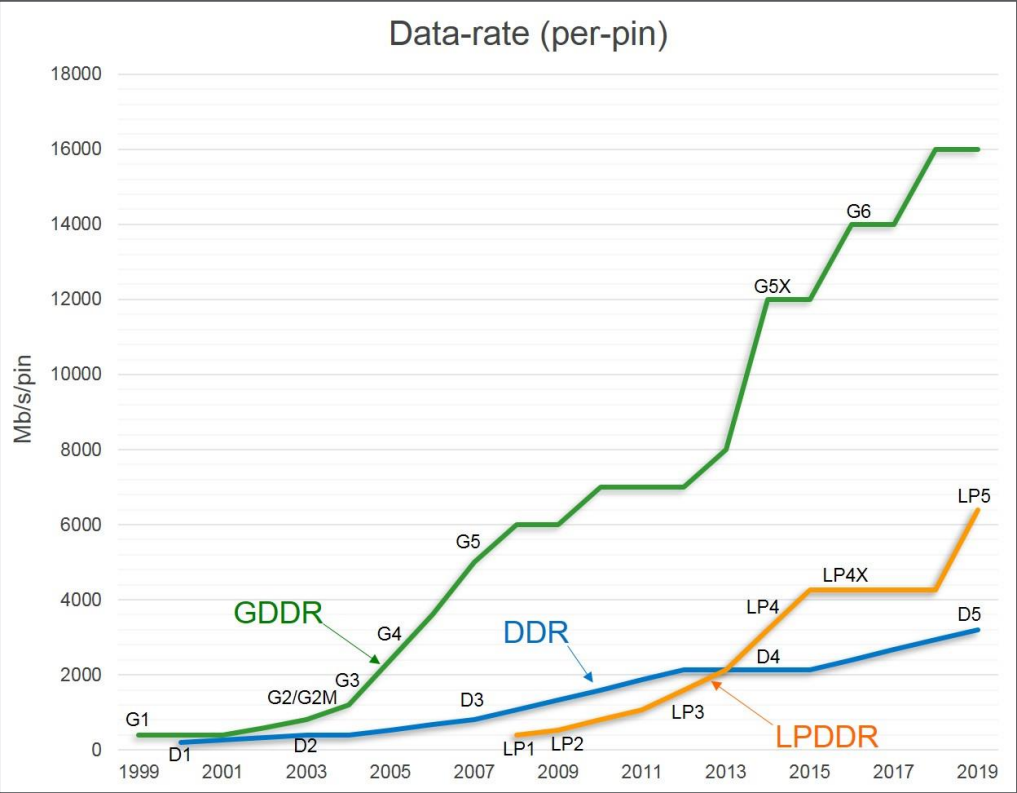
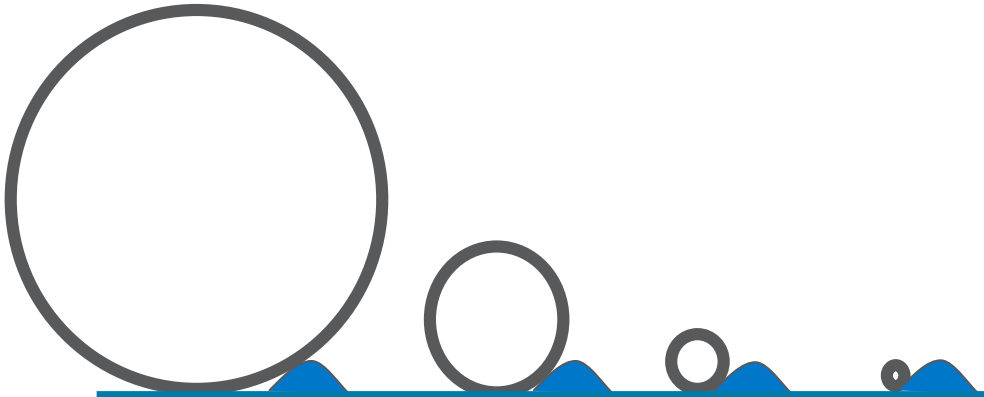
16 billion bits per second per pin
x 32 pins x 12 chips
= 6.15 trillion bits per second

More Pins



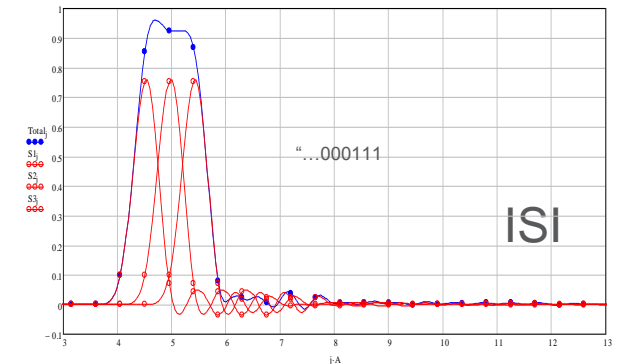
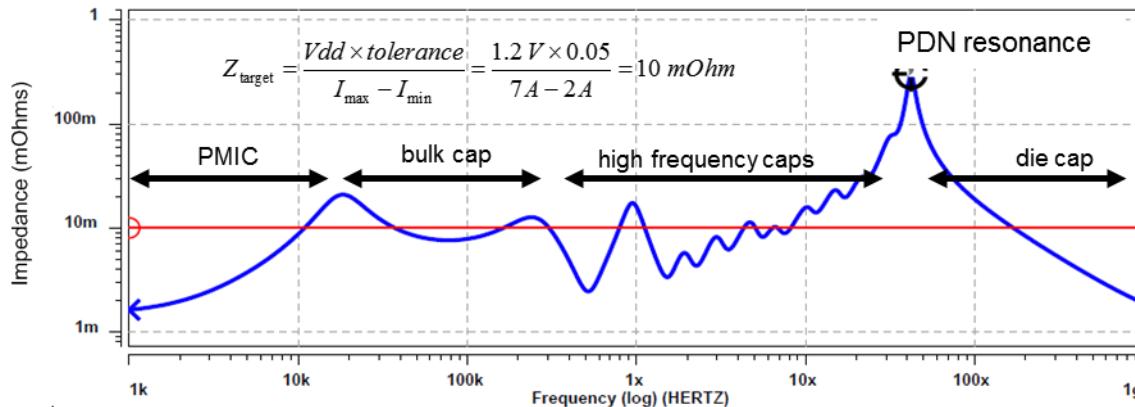
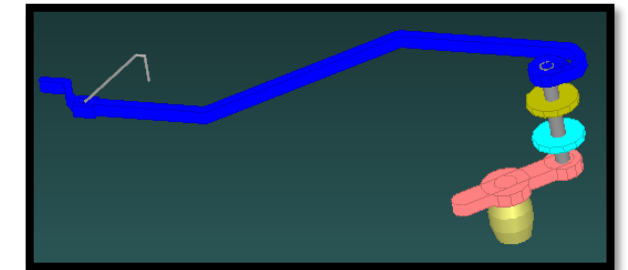
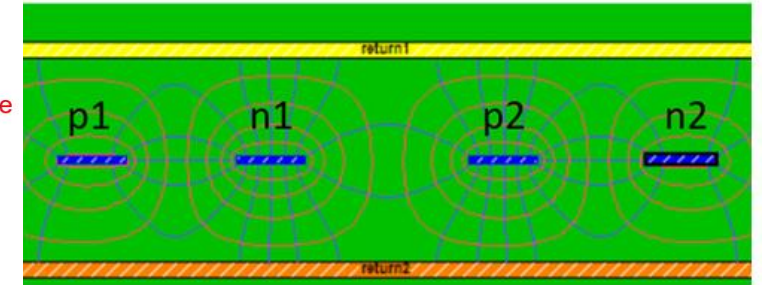
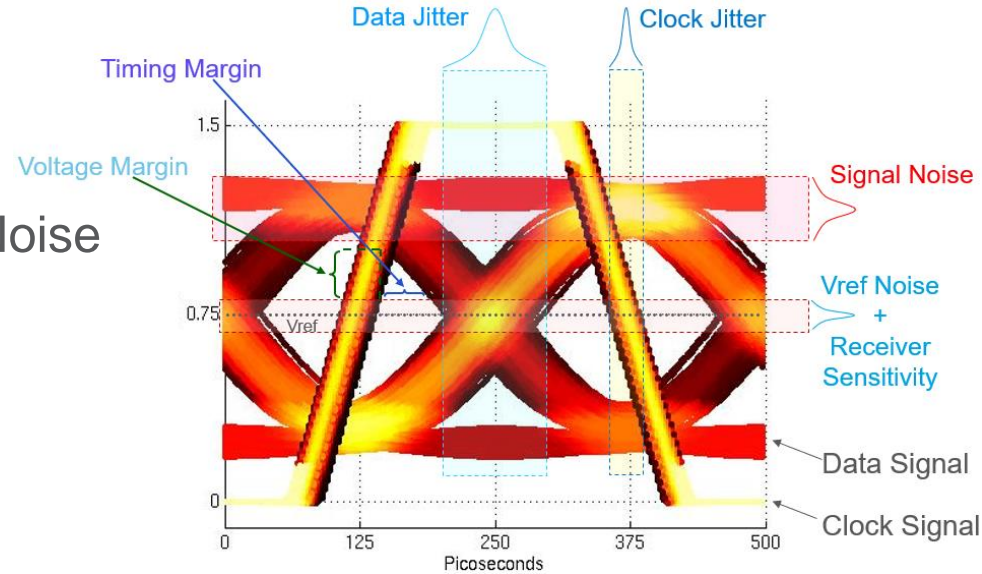
2 billion bits per second per pin
x 1024 pins x 4 chips
= 8.19 trillion bits per second

Growing demand for Signal and Power Integrity expertise



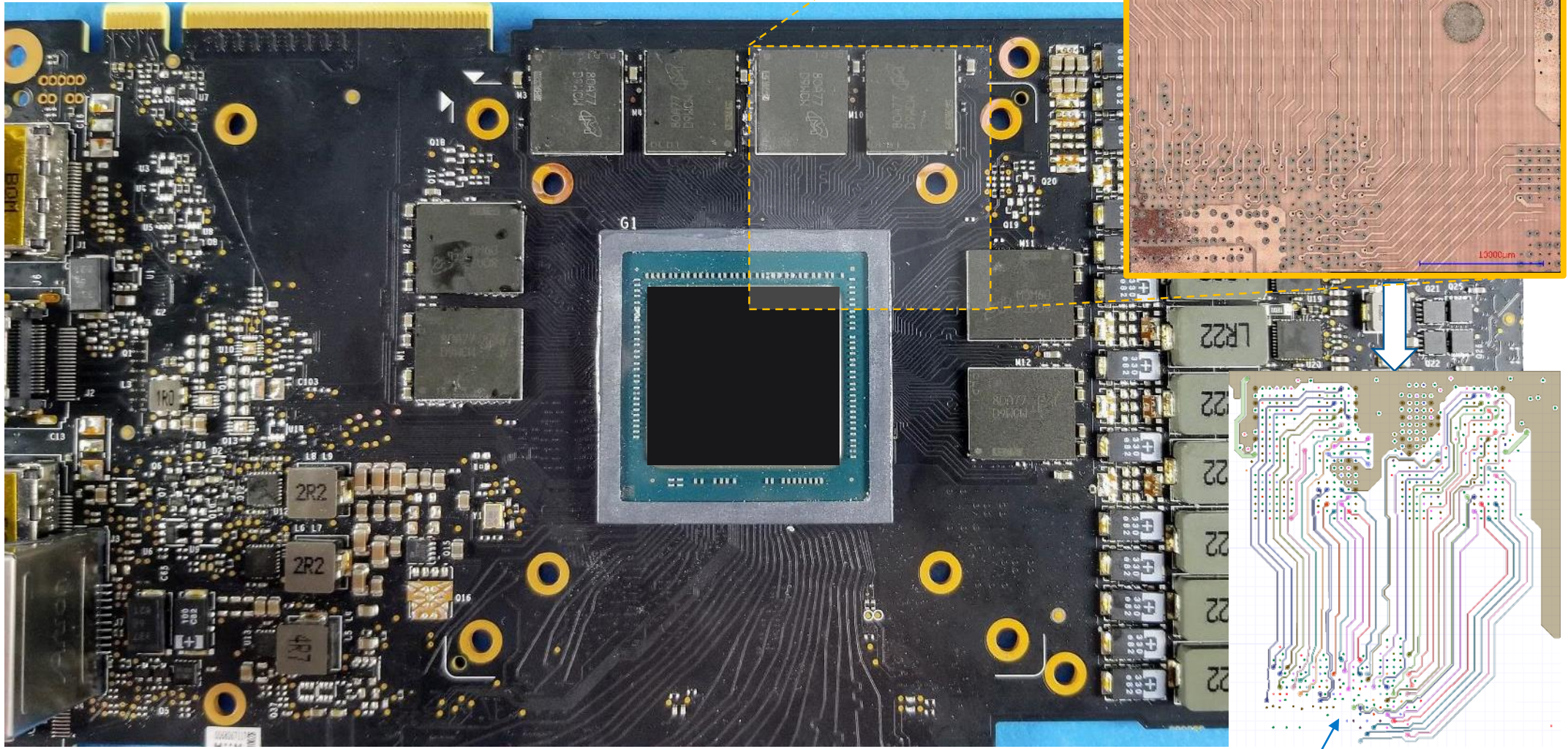
Signal and Power Integrity Issues and Analysis

- Crosstalk
- Simultaneous Switching Noise
- Inter Symbol Interference
- Power supply droop and resonances



Problem: How can Micron help customers design their systems, when Micron doesn't design systems?

Solution: Customer system forensics



Layout for 3D modeling 

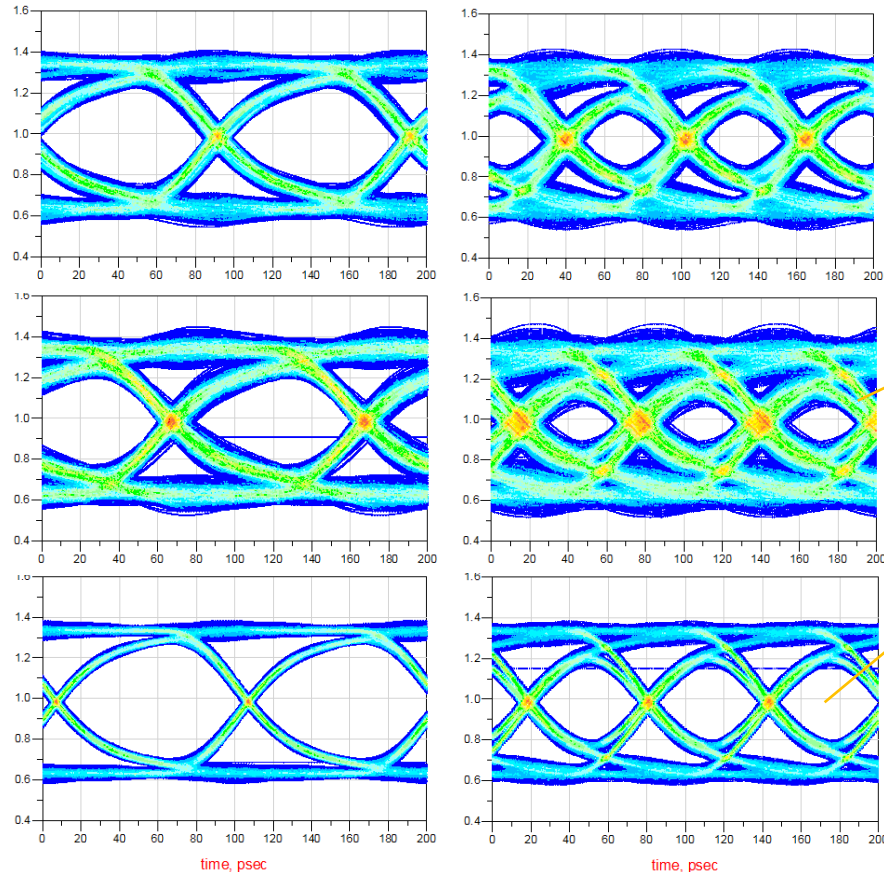
Sensitivity to channel features

Small changes - Big Impact

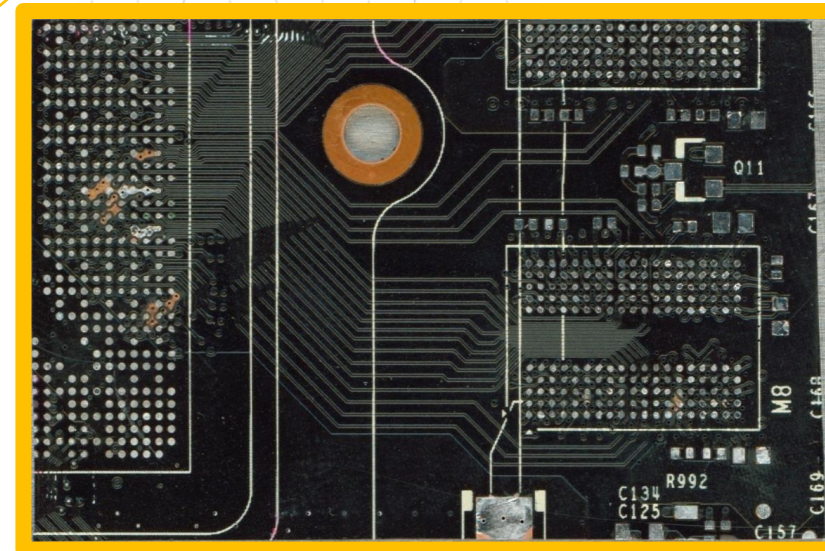
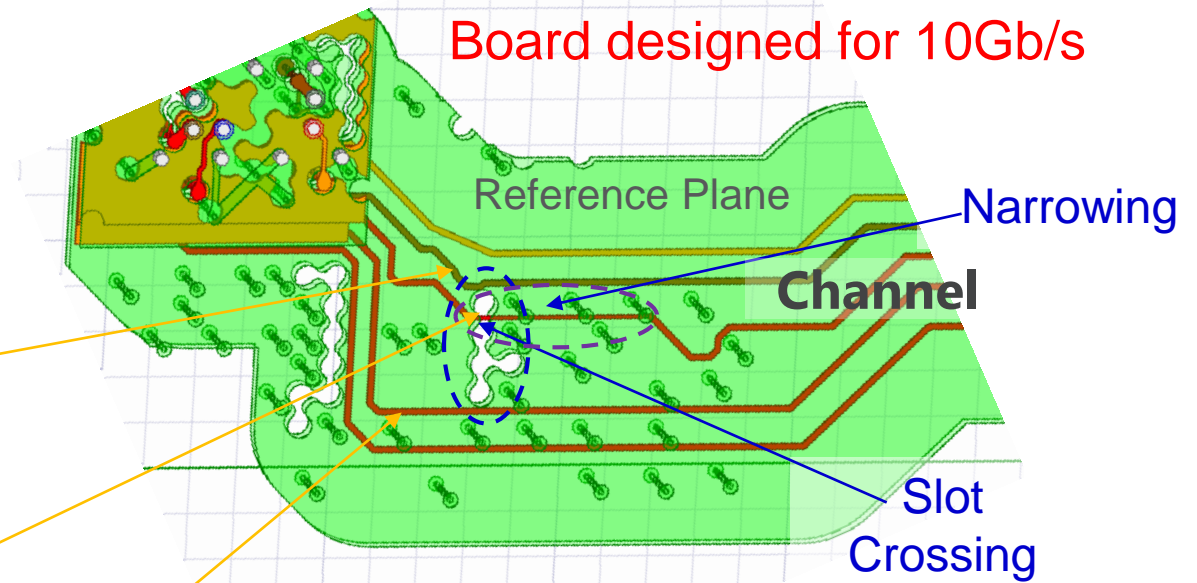
High-speed System

10Gb/s

16Gb/s

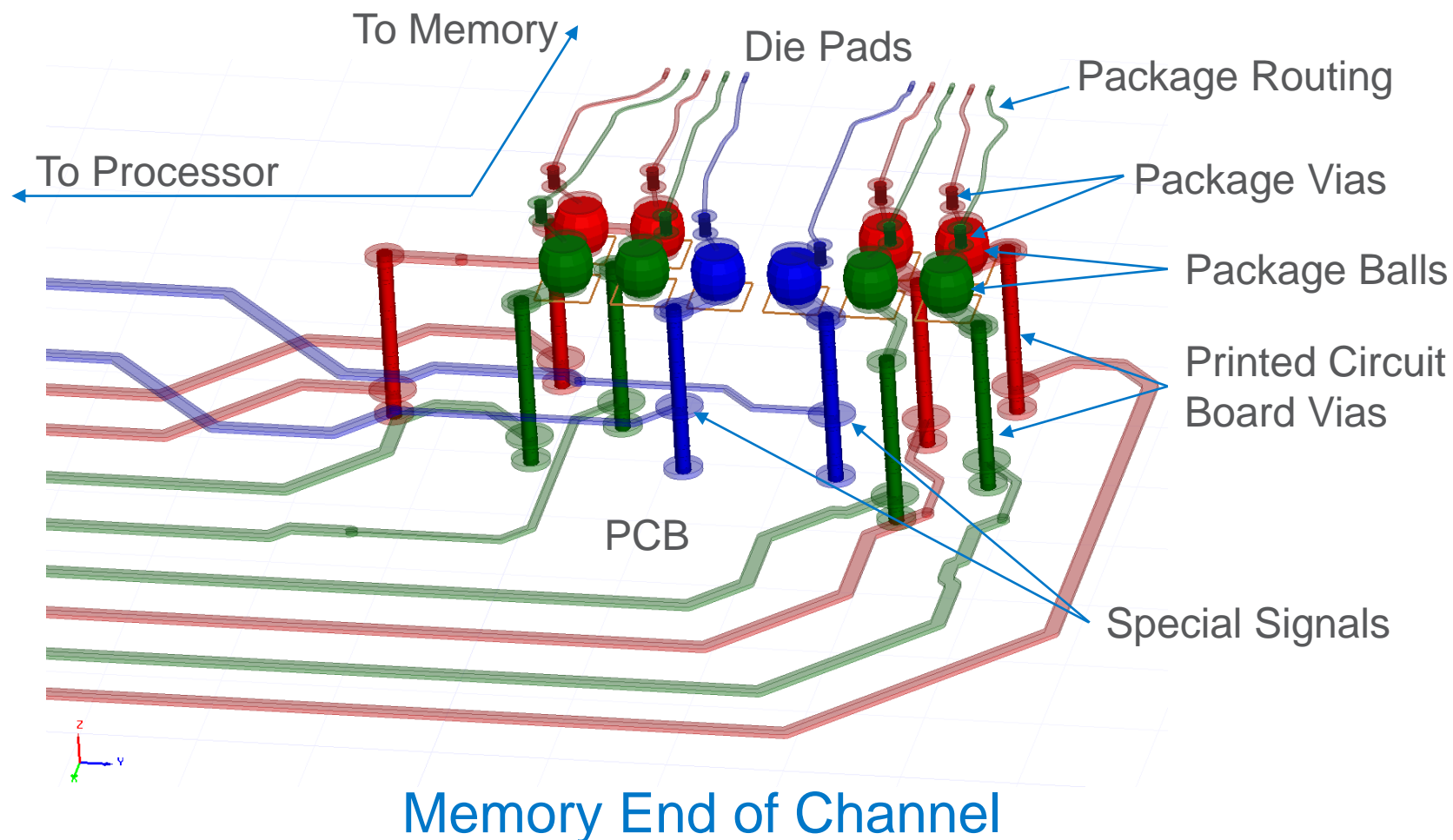


Less of an issue at 10Gb/s.



3D Model Creation to Simulate Electro-magnetics

- Allows us to simulate high-speed communication and learn from successes and mistakes.
- Provides insights into customer limitations and trade-offs.
- Provides a baseline for future exploration and improvement.
- ... all without designing and manufacturing the product ourselves.



Open positions in SI-PI team

- Summer internship 2020 – 2 positions
- New College Graduate
 - Signal Integrity IO Modeling Engineer – 1 position
 - EMI Engineer – 1 position
- Senior Engineer positions
 - Principal Engineer - 1 position
 - Principal Customer-engagement Engineer - 1 position
 - Senior Engineers – 2 positions

Landing the Job ... What Micron interviewers are looking for

- GPA ≥ 3.0
 - Well-rounded (not just book-smart)
- Problem Solving and Communication Skills
- Personality and Attitude
- Intern/Work Experience a Bonus
 - The Intern interview is much less technical than the post-grad interview.
- Time management
 - Work experience shows ability to multi-task
- The Signal and Power Integrity team is specifically looking for individuals with experience (or interest in learning) circuits, communication theory and/or electromagnetics.

Personal Observations on Career Satisfaction

- Many argue that leaving school with a Bachelor's degree gives them a head-start (seniority), and that by the time the MS or PhD students graduate, a BS+experience may already be at the same salary, however ...
 - **Education \propto Opportunity**
 - Education level not only impacts your starting salary ... it opens doors.
- Location also impacts your starting salary, but do your research.
 - **More \$\$\$ \neq Better quality of life**
- A lot more to compensation than just salary
 - Job Satisfaction ... Opportunity for Development/Promotion
 - Company Culture ... Work/Life Balance
 - Cost of Living
 - Health Insurance
 - Retirement
 - Bonuses

Success through Technical Contribution

Criteria for Technical Promotion



Management Path		Technical Path	
VP	Vice President	F5	Principal Fellow
		F4	Senior Fellow
M4	Sr. Director	F3	Fellow
M3	Director	F2	Distinguished Member Technical Staff (DMTS)
M2	Sr. Manager	F1	Senior Member Technical Staff (SMTS)
M1	Manager	E5	Principal Engineer
		E4	Senior Engineer
		E3	Engineer
		E2	Engineer
		E1	Engineer

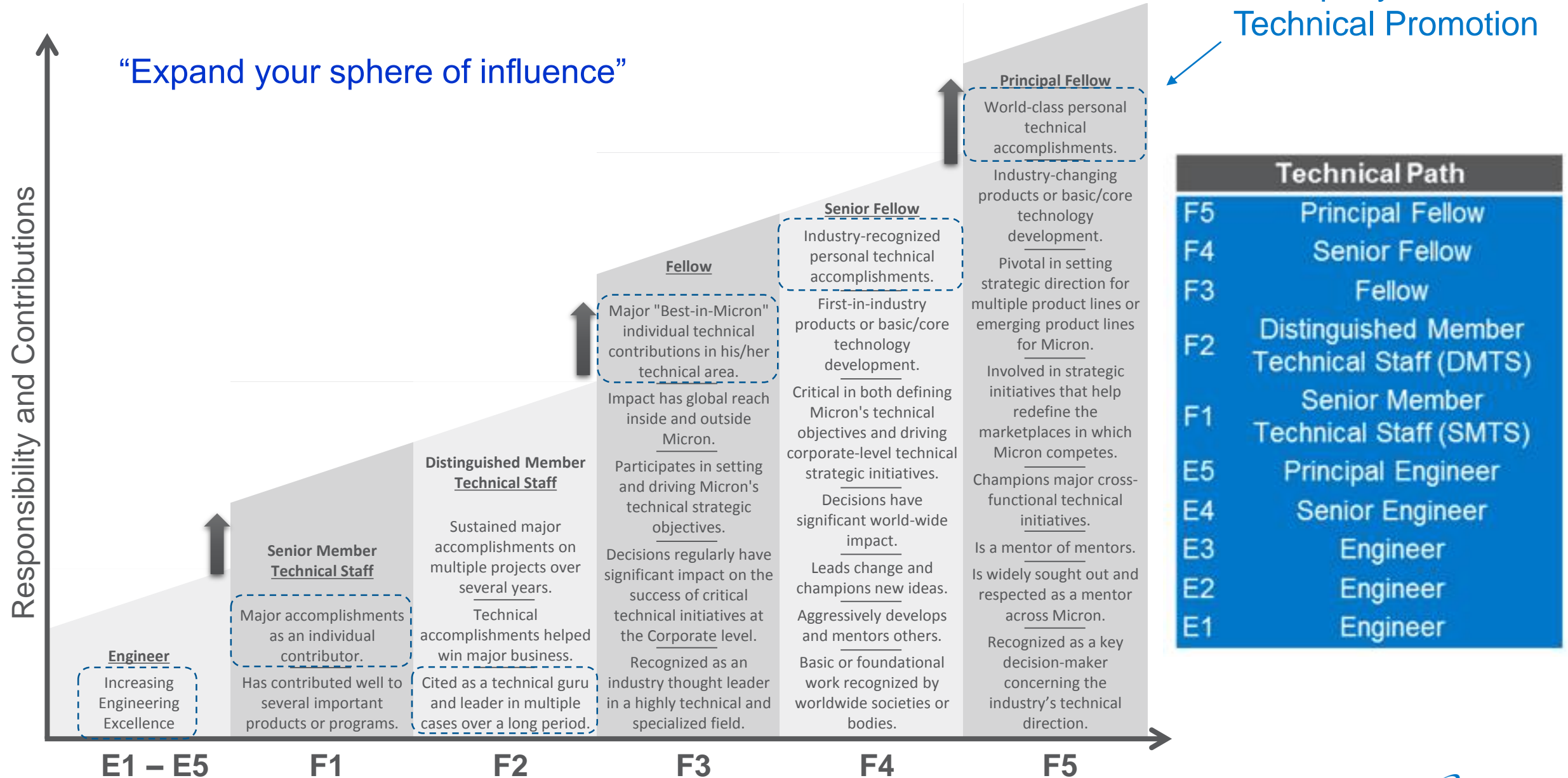
PhD

MS

BS

Collaborate	Technical	Technically Innovate	Demonstrates a track record of innovation delivering business value.
		Technically Focus	Recognized technical expert who focuses day-to-day on developing new technology and exhibits mastery of technical knowledge both within and external to the primary contribution area.
		Impact Results	Drives high-value, differentiated technology solutions that contribute to the company's success, measured through increased revenue, cost savings, customer wins, design wins, etc.
	Leadership	Influence	Reach spans across different technical disciplines, geographic areas, organizational boundaries, and the industry.
		Lead	Displays proactive leadership as defined by the Micron Leadership Framework and Mindset (Reality, Vision, People, Courage).
		Mentor	Directly inspires the technical growth of others, demonstrated in various ways such as organized teaching, individual influence, presentations, etc.

Success through Technical Growth



Success through Life-long Learning

- Technology continues to advance at an exponential rate, suggesting that a successful engineering career include/require life-long learning.
- Wherever you end up, look for mentors.



Mentoring through the Technical Leadership Program

One of the greatest values of mentors is the ability to see ahead what others cannot see and to help them navigate a course to their destination." — John C. Maxwell
"The delicate balance of mentoring someone is not creating them in your own image, but giving them the opportunity to create themselves." — Steven Spielberg

Mission:

Our mission is to provide an environment in which technical mentors offer guidance and career support to accelerate the growth of Micron's future technical leaders.

Vision:

The vision of the TLP mentoring program is an interactive venue where the sharing of senior technical leader's knowledge and experience with newer team members accelerates Micron's rate of technology development.

What is mentoring?	View Mentoring Playbook
What may I expect as a mentee?	What may I expect as a mentor?
Find a mentor	Serve as a mentor

Final Thoughts

You've made a great choice.

While in school:

- Grades are important, but so are a variety of other attributes.
- Internships can make all the difference.

On the job:

- Contribute and innovate (and document major contributions/innovations)
- Increase your sphere of influence.

