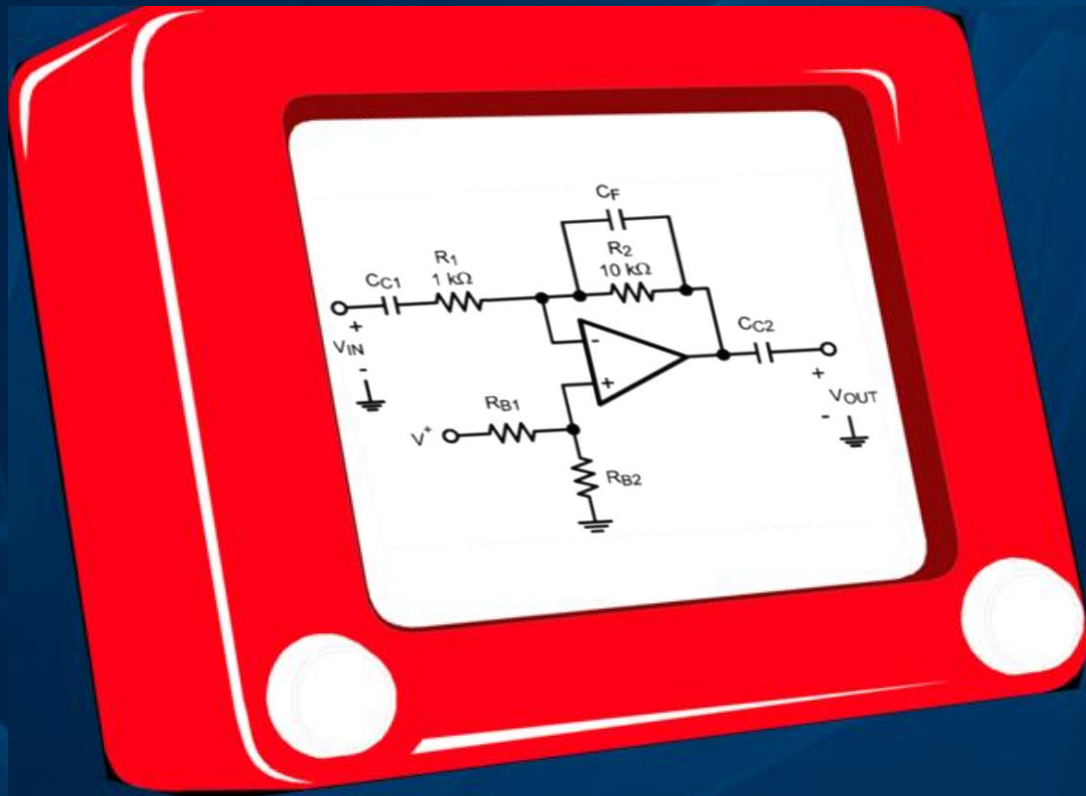


Drive on: Where are the flying automobiles?

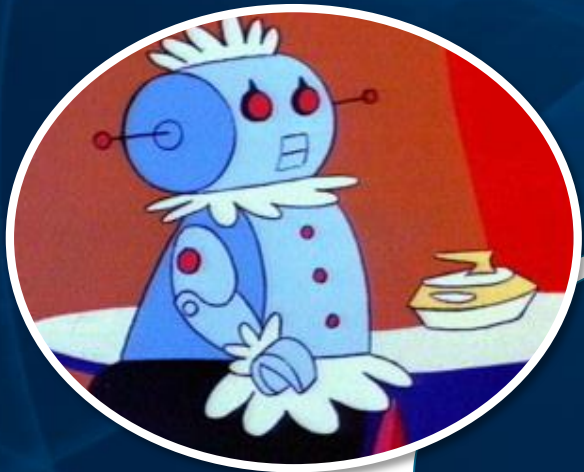
Tom Beckley – Senior VP & GM, Custom IC and PCB Group
MATLAB EXPO 2017; San Jose, CA
November 7, 2017

Early 1960s

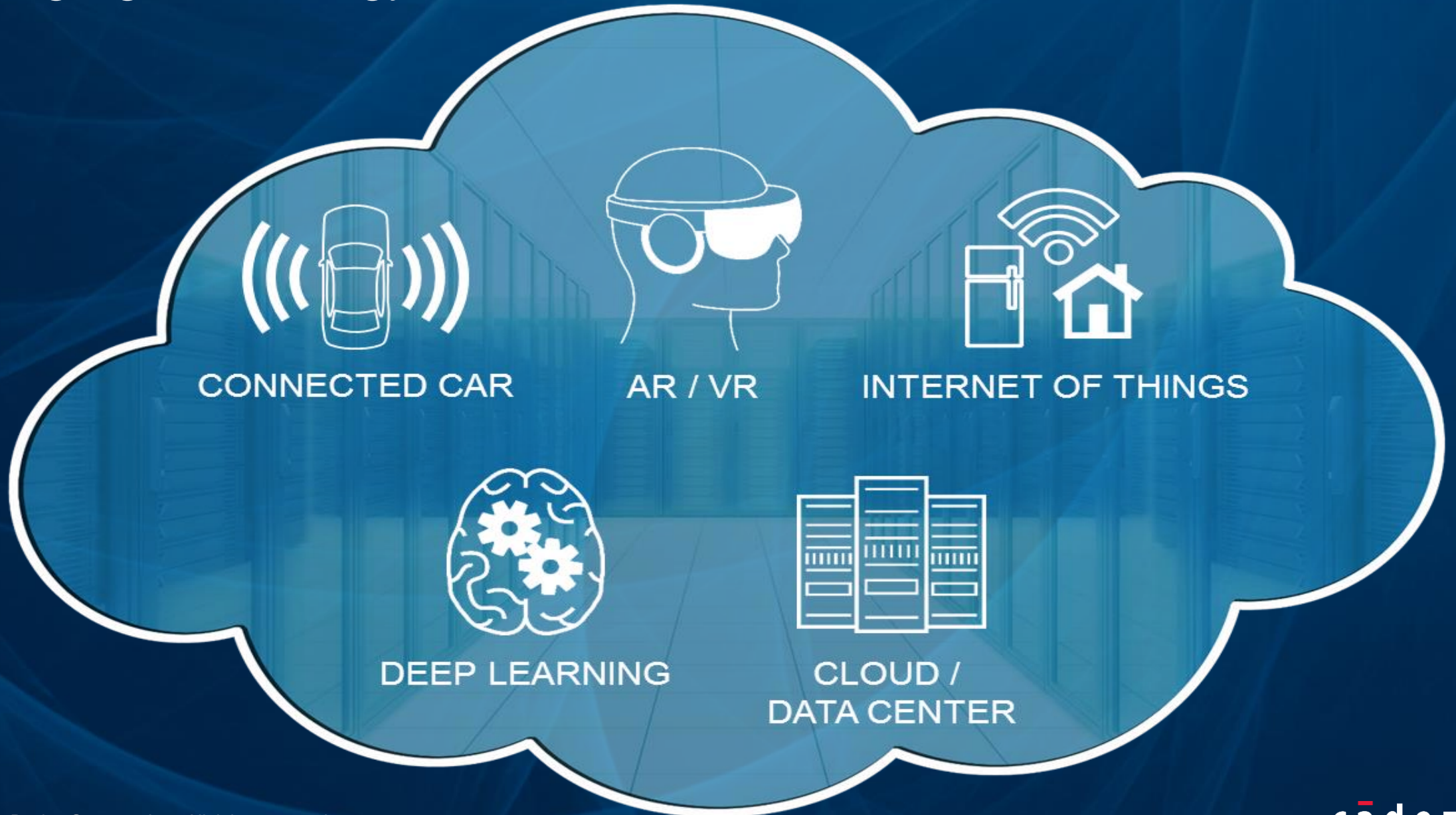


The Jetsons predicted the future

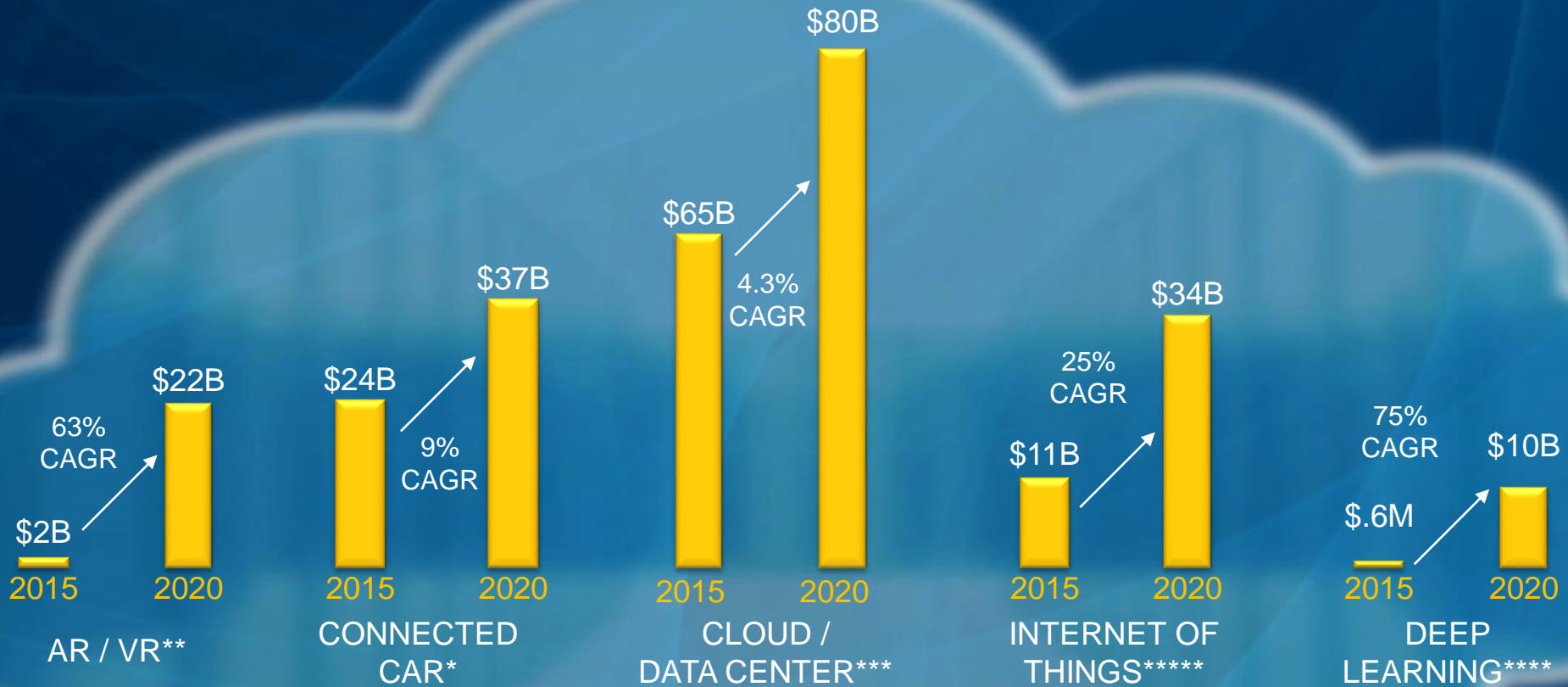
American television early 1960s



Emerging technology trends



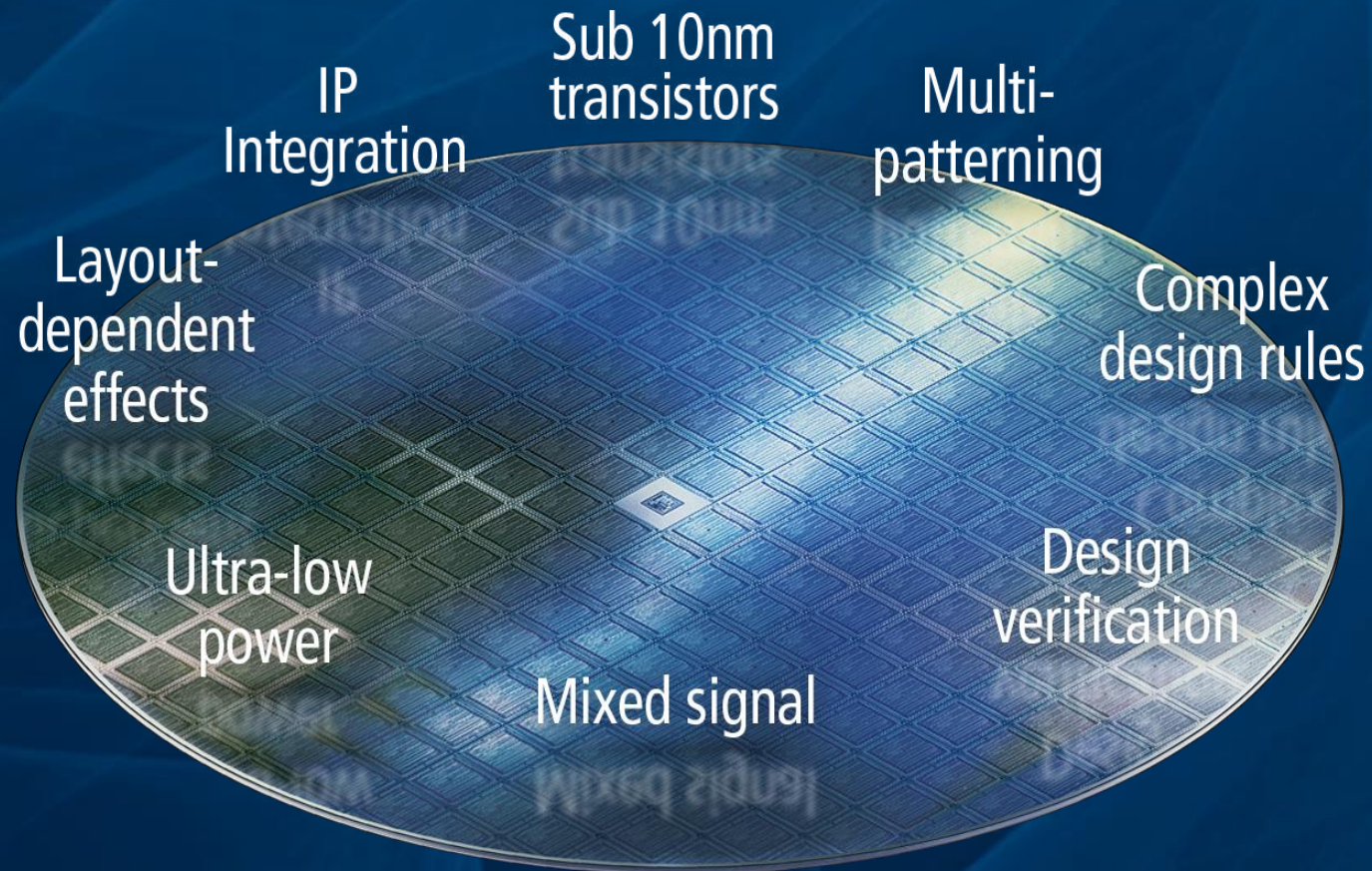
Emerging technology trends



The opportunities are massive

* IBS Global Service Industry Report, Nov 2016
** MarketAndMarkets, AR/VR Market Forecast 2016
*** Gartner Semiconductor Forecast Q3'16
**** BofAMerrill Lynch Global Research estimates October 2016
***** Gartner Forecast – IoT Endpoints, Nov 2016

Design challenges – Silicon



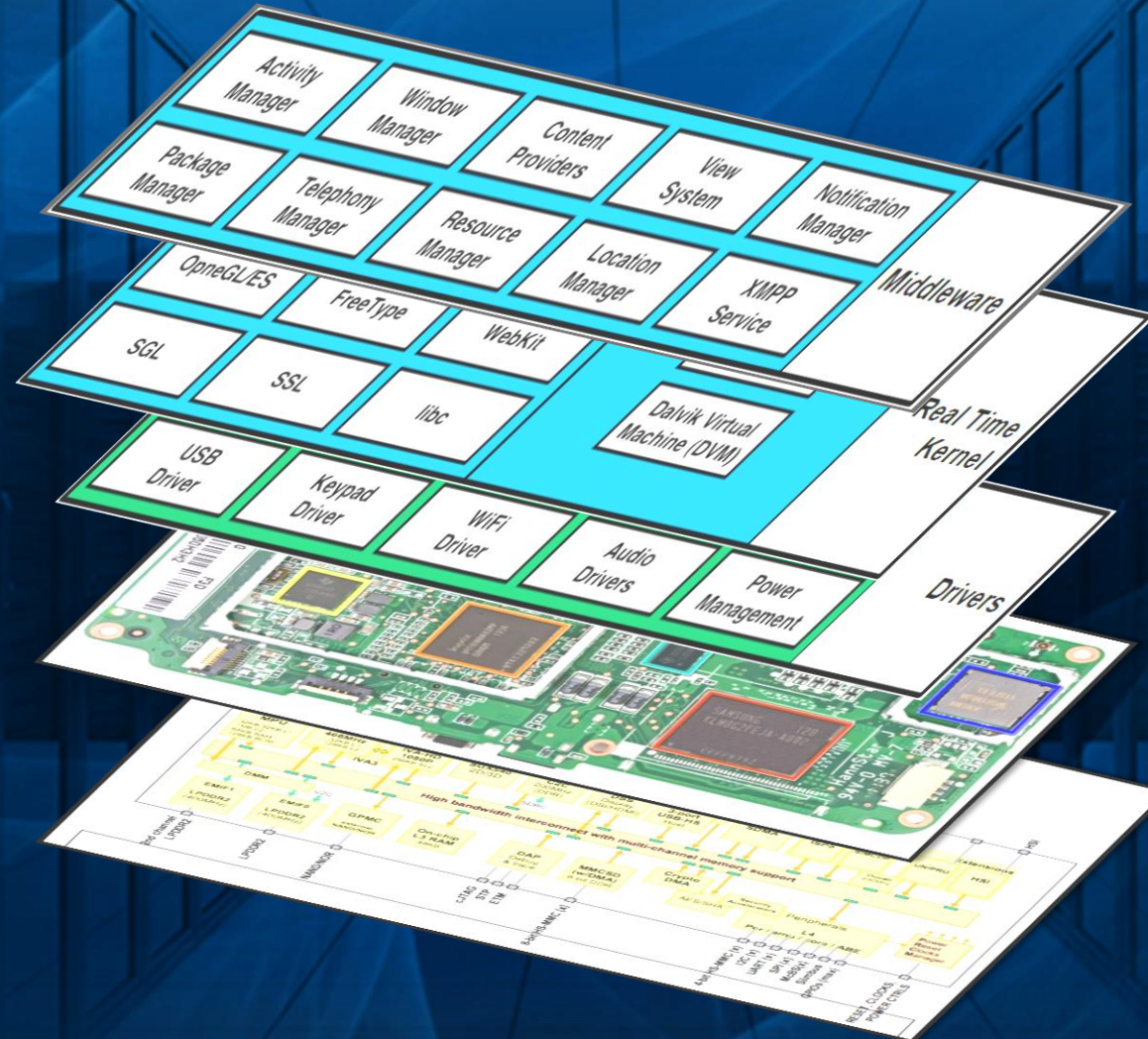
Design challenges – Silicon and system design

System Modeling and Analysis

RF/Photonics /Mixed Signal

Fault Sim & Thermal Analysis

System-Level SI and PI



Integrated Chip, Packaging, and Board

System Prototyping

Metric-Driven Design and Verification

Flow-to-Enterprise PLM

Cadence at a glance

Tools, IP, hardware, solutions and services for electronics design - from IC design to IC packaging to boards to systems



4,250+ R&D engineers
1,535 field engineers



7,200+ employees



1H FY17 revenue
\$956M



\$735M R&D investment
in 2016

Part of what we do is to work in “extremes”

Create, simulate and verify designs that use advanced nanometer transistors

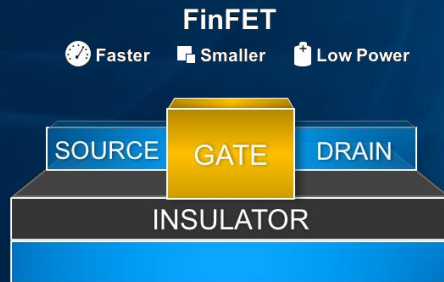


~512 Billion Transistors



x 68

Living on a Flat Planet
about 1 inch in diameter



10nm Gate Size



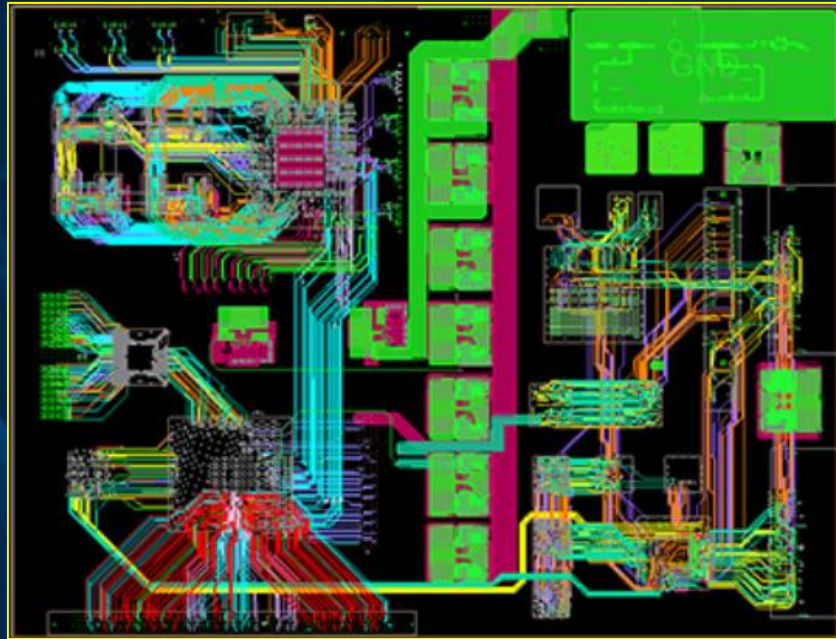
÷ 10,000

A cat whisker

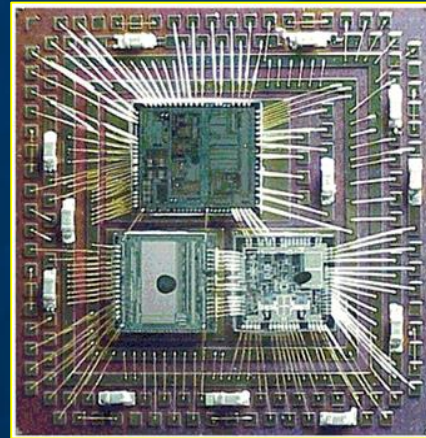
Cadence system design environment

Integrating IP, IC, package, PCB, and analysis

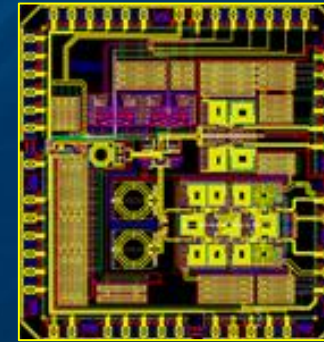
- Our software helps engineers move between various stages of electronic design so that your favorite electronic gadget is ready for the holiday rush!



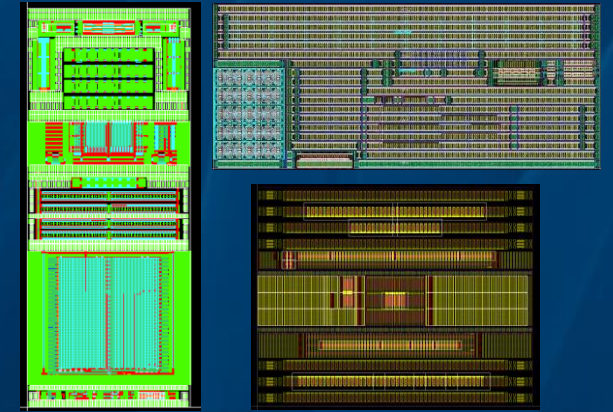
Printed Circuit Board (PCB)



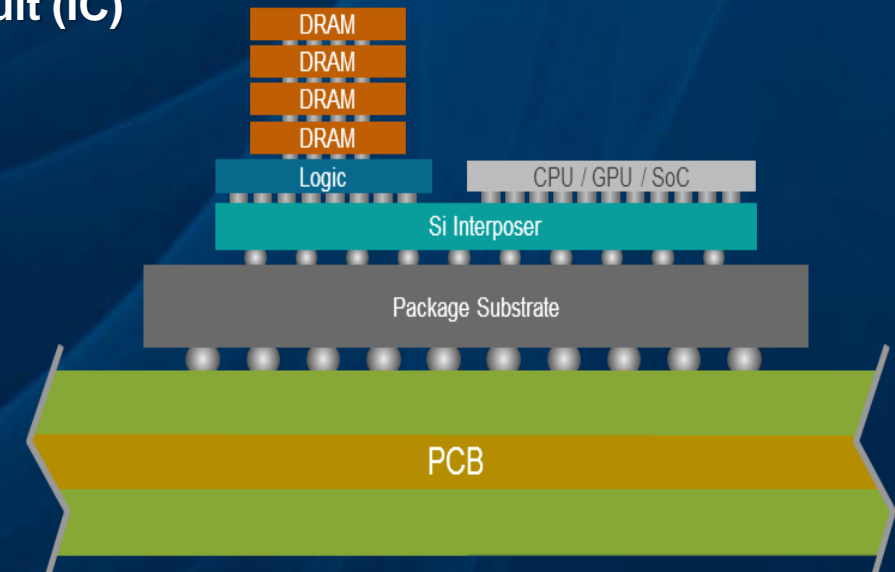
Package



Integrated Circuit (IC)



Intellectual Property (IP)



Bridging the divide between ICs and Systems

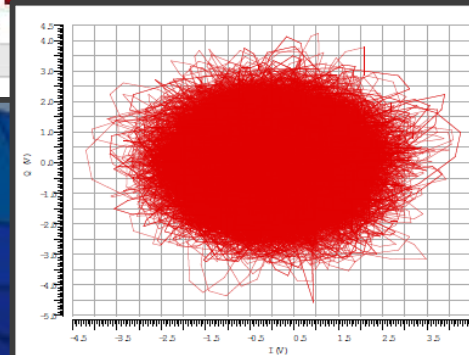
MathWorks system design capabilities integrated with Cadence solutions



+

cādence[®]

Test	Name	Type	Details	EvalType	Plot	Save
env	constplot	matlabexpr	constellation('vin')			
env		signal	/vin			



High-performance IC data exchange and analysis

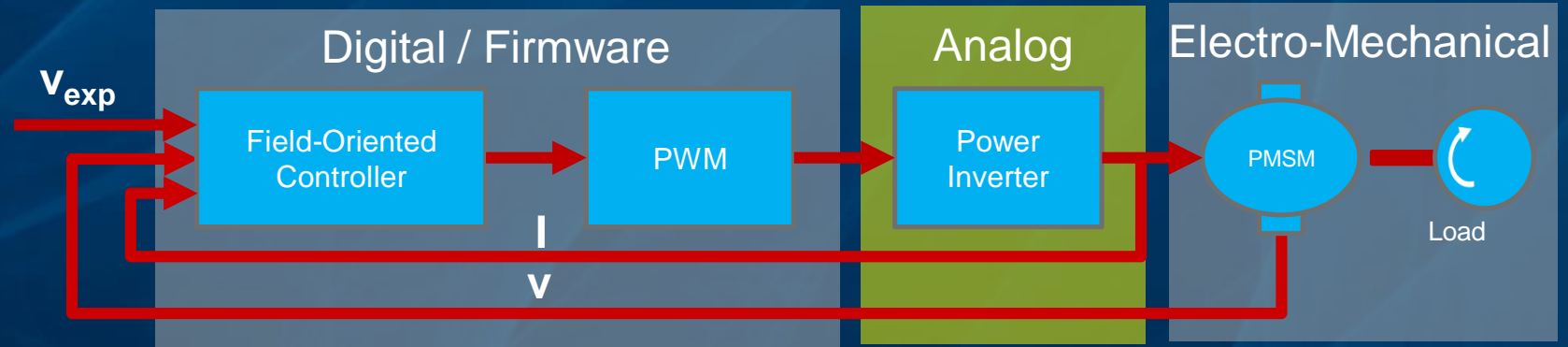


System-level simulation solutions for IoT and automotive applications

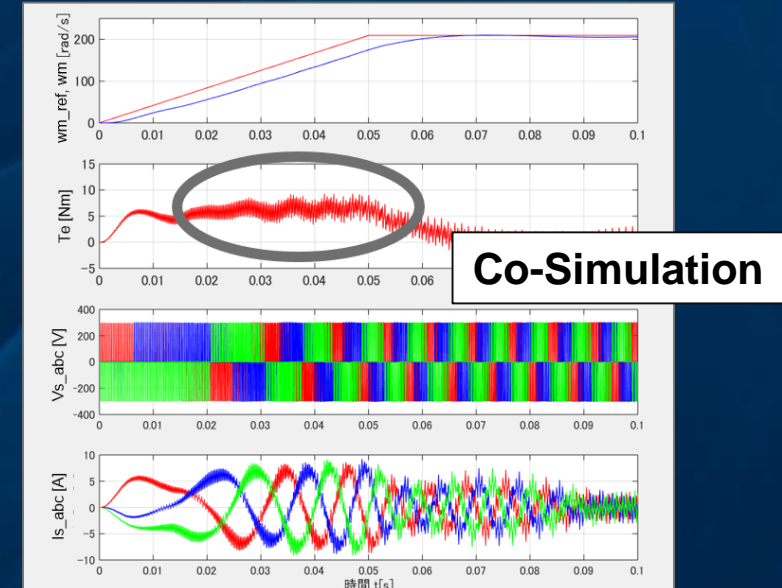
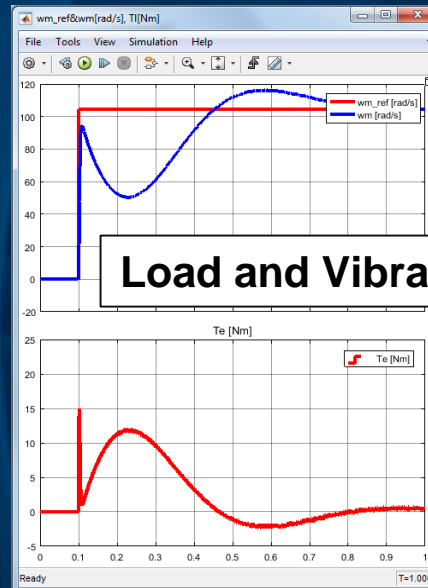
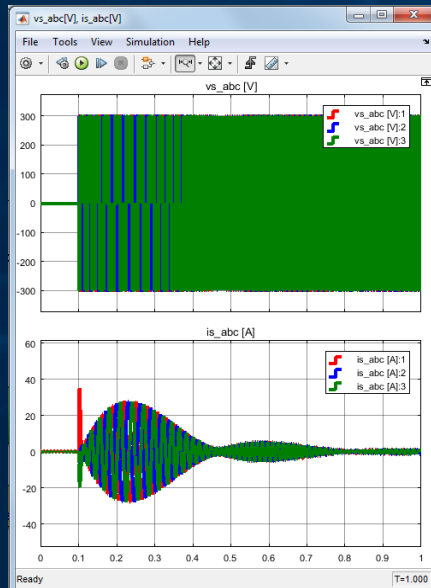
Automotive system design for electric vehicles

MATLAB / Simulink / PSpice integration

- From actuators to electric vehicle motors
- Acceleration of 0-60mph in 2.7 secs

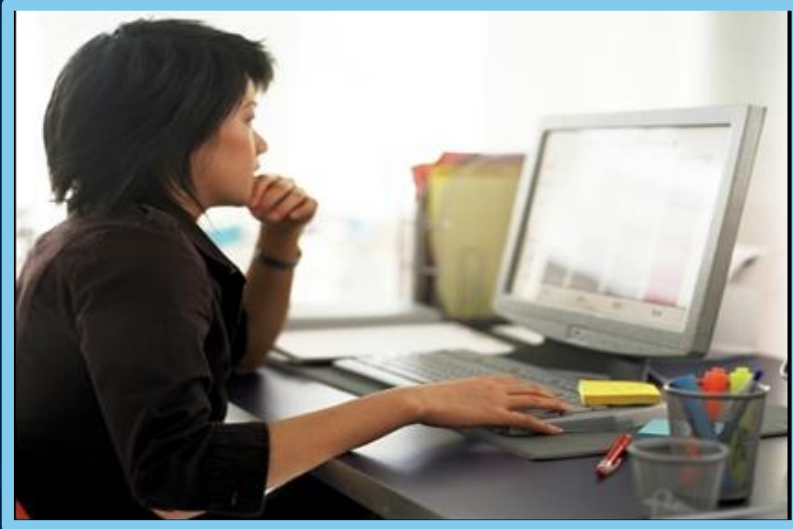


- Example control of a permanent-magnet-synchronous-machine for motor powertrains



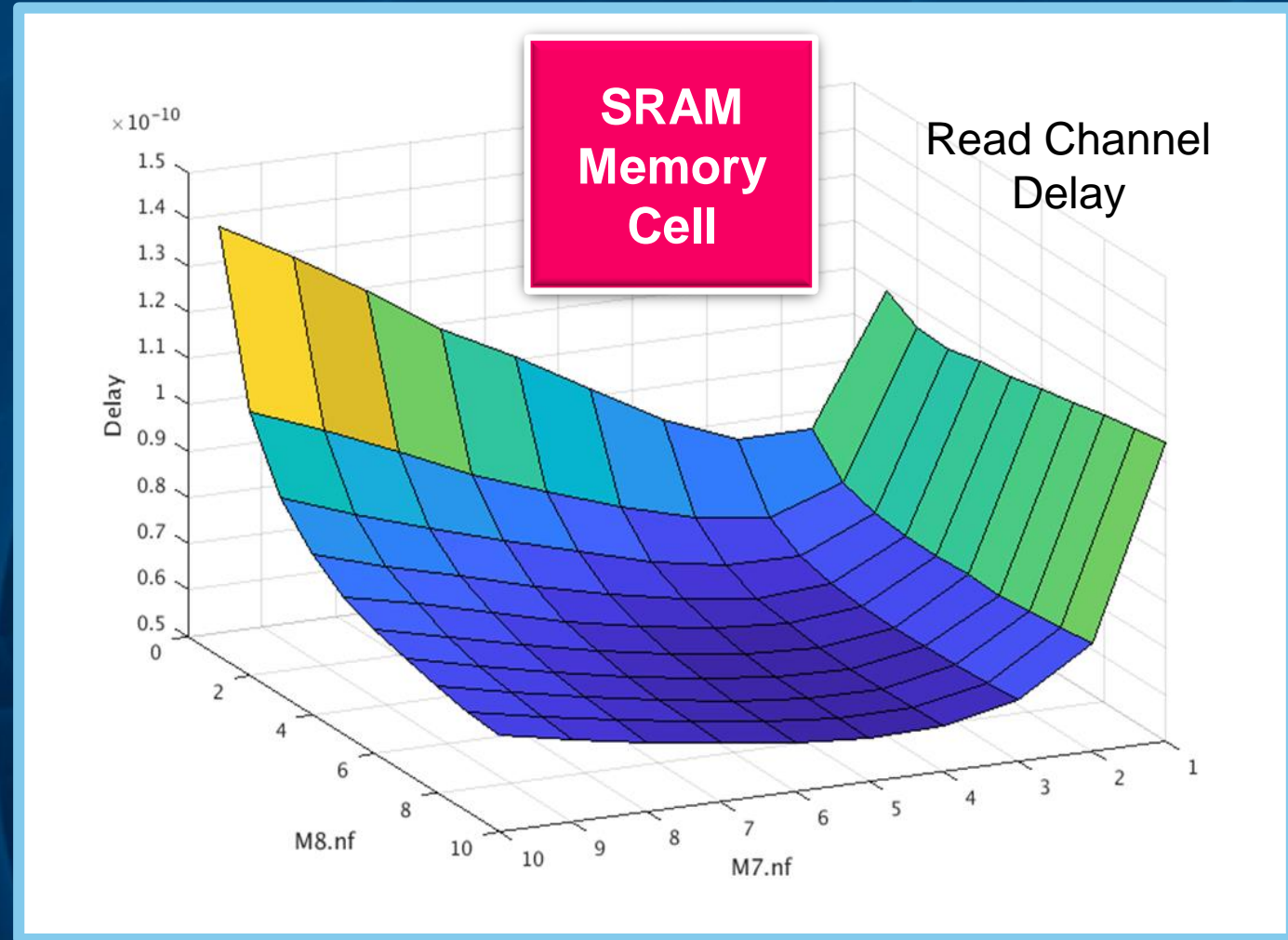
Quickly determine trade-offs even when using gigabytes of data

MATLAB / Virtuoso ADE Product Suite integration



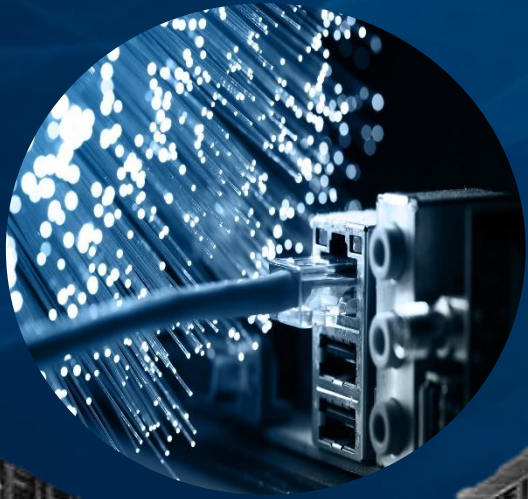
Q: What is the impact on the read channel delay if I change the size of my transistors?

A: Simulate the design in Virtuoso ADE and visualize the trade-off results in MathWork's Matlab



Moving data at the *speed of light(ning)* in the cloud

The science of *Photonics* and the impact on ICs and Boards



*Bringing modeling, design
and data analysis all
together to invent the future*

Intelligent design solutions = analytics + ML + optimization





Disruption and Opportunity

Agility, Change, and New Fabrics within the Automotive Ecosystem

Cars – we've come a long way in a short time



1968 Ford Falcon



The straight six Ford engine – a bear to keep running smoothly (carburetor adjustments, checking distributor/plugs, timing light, etc.)

Early 21st century automobiles

Electromechanical subsystems unfold

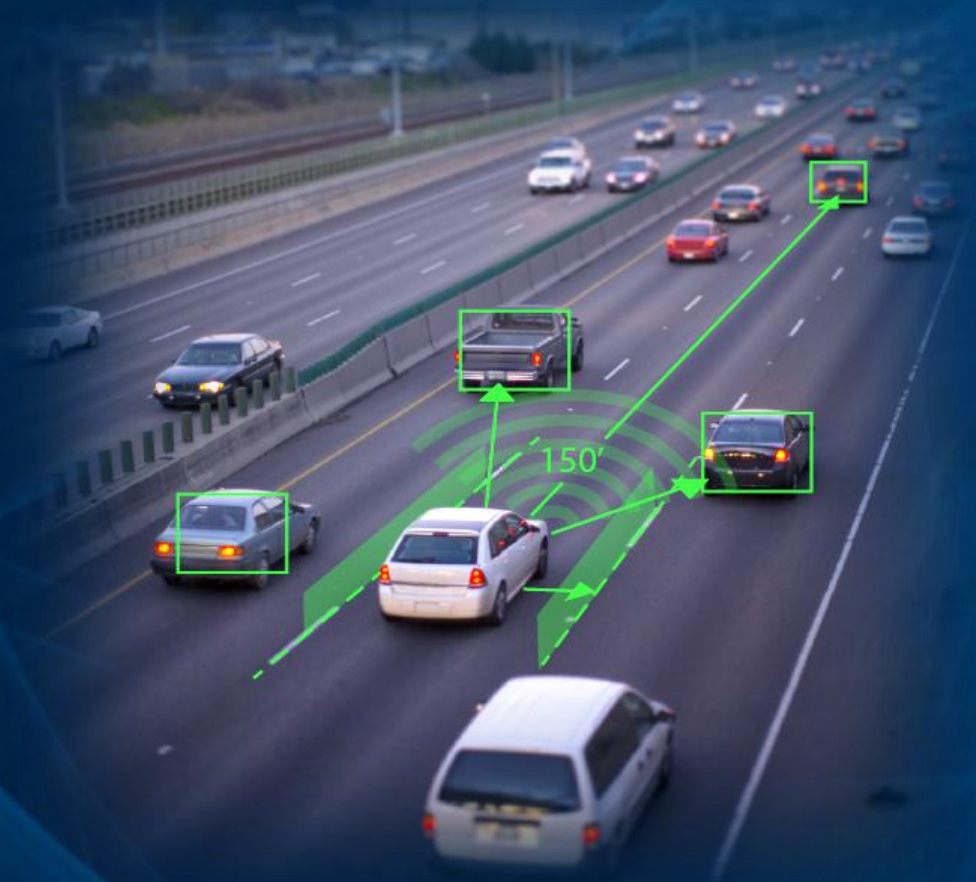
- A sophisticated platform of actuators
 - Anti-lock brakes
 - Traction control
 - Air suspension control
 - Electric power steering
 - Powertrain (air, fuel, exhaust, cooling, turbo, transmission)
- Dynamic stability control (DSC)
 - Driving automation for safety, synergistic control of actuators
 - Pedal-to-the-metal acceleration, foot-to-the-floor braking
 - Cornering, oversteer, understeer
- Engine management
 - ICE: Driving automation for efficiency, performance
 - EV: Inverter / converter for efficiency, performance

Dynamic stability control ECU

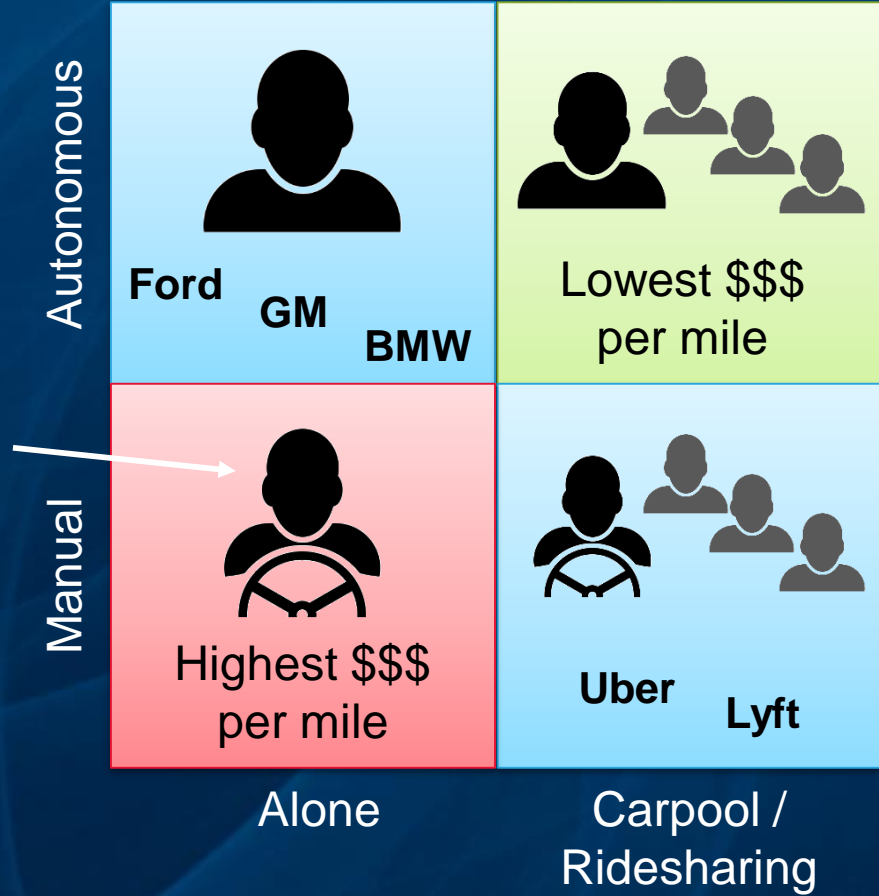


Courtesy of Bosch

Rapidly evolving driver mentality



Most cars today



Automotive ecosystem disruption enroute to autonomous vehicles

- What we see
 - OEMs frustrated by 7-year product development cycle
 - OEMs challenged by 2-year consumer product development of new entrants
 - AV demands higher data rates and higher performance density
 - ECUs must be smaller, lighter, lower power and cost, more integrated and reliable

New ICs and packages decrease:

- ECU/board size
- ECU/board power
- ECU/board BOM
- ECU/board weight

New ICs and packages increase:

- Performance
- Differentiation
- Reliability, security
- Security of supply

MEMS, silicon photonics, and wireless create opportunities

Cadence automotive IP

Digital radio and voice command

Multi-microphone voice command, and noise reduction



Multi-channel audio decode and advanced post processing

Acoustic noise cancellation

Digital Radio receiver:
HD Radio, DAB, DAB+,
DRM, T-DMB

Embedded signal processing

Battery management

Regenerative power management

Engine control

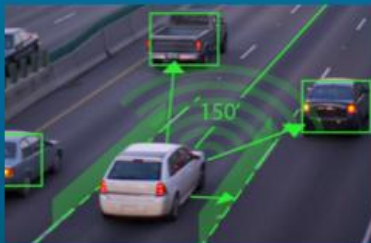
Cabin environmental control



ADAS Vision processing

Advanced Driver Assistance Systems

Traffic sign detection / recognition



Automatic high beam

Lane-departure warning

Front-collision warning

Telematics connectivity / Radar

Emergency Services

Peer-to-peer smart car networking for intelligent vehicle highway control

Built-in LTE Modem and WiFi Access Point



Cadence – industry's highest scoring German traffic sign recognition

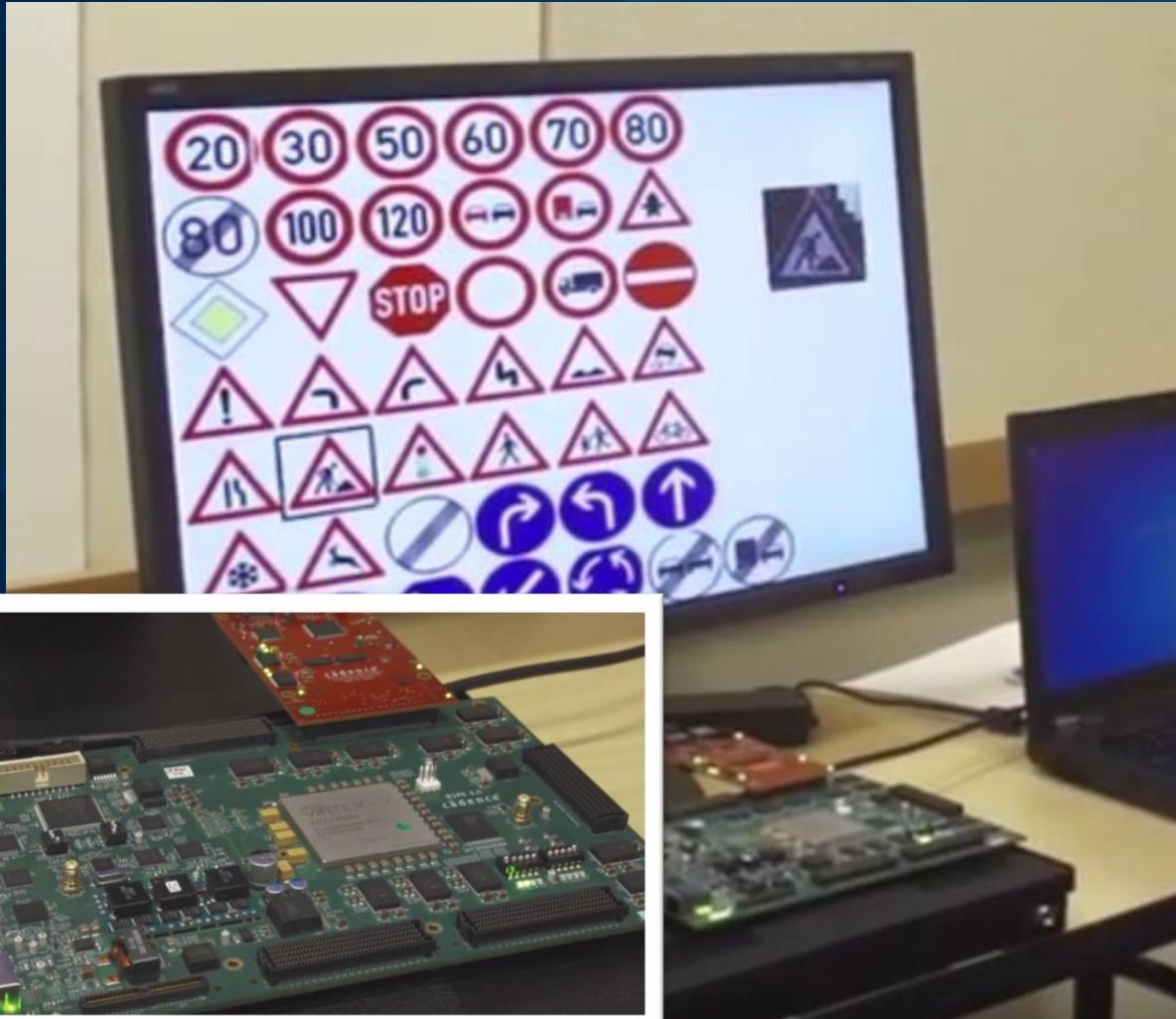
Artificial intelligence DSPs provided by Cadence Tensilica IP

- Machine learning
- Analyze big data
- High-performance computing
- Leverage statistical methods
- Pattern recognition
- Automated decision making

German Traffic Sign Recognition Benchmark (GTSRB)

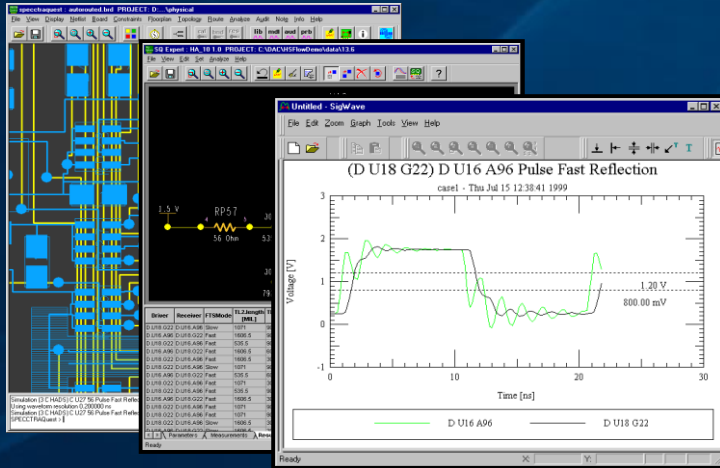
CNN - compares 51840 input signs with 43 trained signs
→ 99.82% detection rate (human 99.22%)!

CNN Convolutional
Neural
Networks

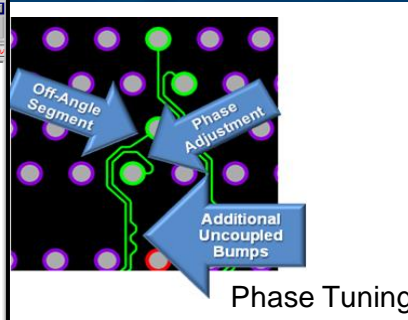


Automotive PCB design and analysis

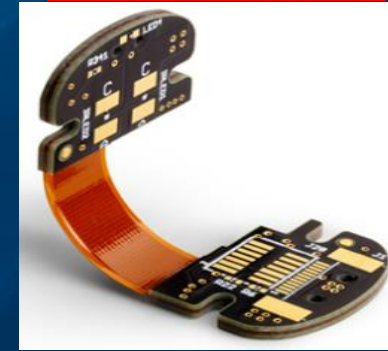
MathWorks



ARROW

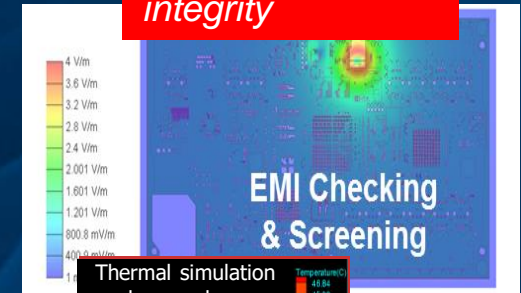


Flexible design

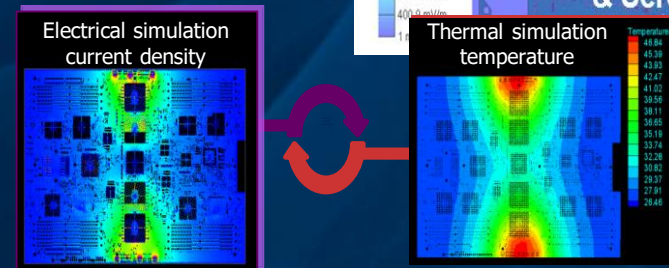


ptc
Dassault-Systemes
SIEMENS PLM

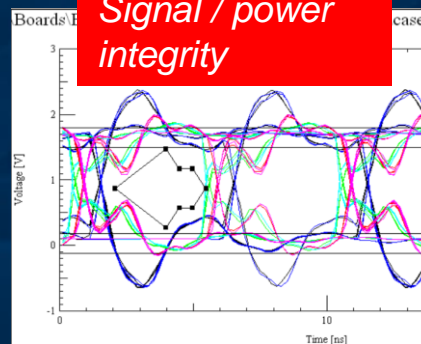
Electromagnetics
integrity



Thermal
integrity



Signal / power
integrity

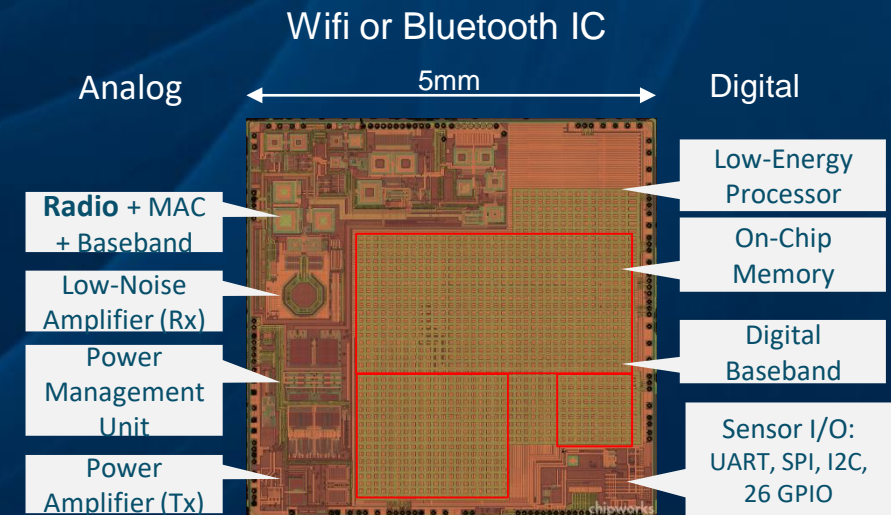
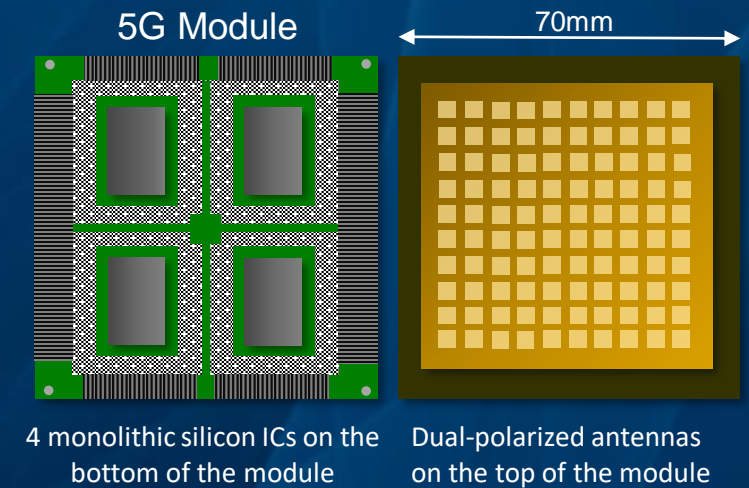


“Cadence Sigrity™ technology dramatically reduced EMI/EMC testing time. And our product went to market much faster.” Imran Shak - Hyundai

Automotive 5G / wireless design technologies

Wireless is a rapidly emerging opportunity for suppliers

- V2X: for 25Gb of data per car per hour
 - Neural net training coefficients (1M-1B weights) download from data center
 - Sensor data upload to data center
 - HD maps download from data center
- WiFi: for in-car passenger streaming
- Drive-by-wireless: for lower cable weight and cost
 - Eliminate failure points associated with wire and connectors
 - Remove wiring installation costs
 - Simplify design of vehicle variants

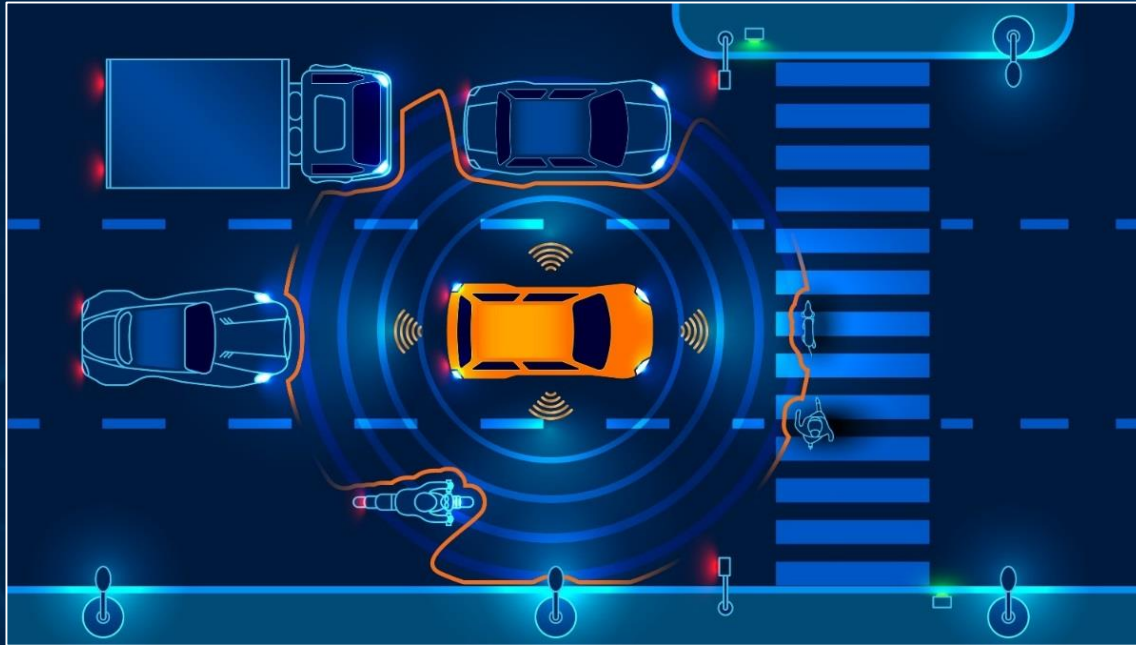


Picture ©Chipworks

Bringing it all together

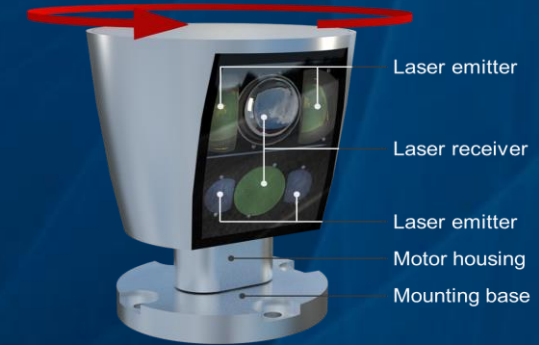
Example: Automotive ADAS/AV LiDAR

- Alternative / addition to cameras and radar

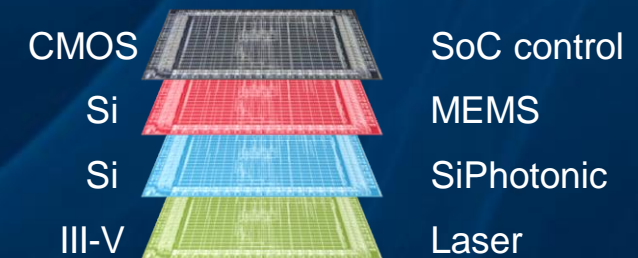


- Solution: Cadence integrated platform for multi-fabric design / DSP beamforming offload
 - MathWorks beamforming algorithm toolkit

Today: \$80K rotating roof-top box



Soon: <\$100 solid-state technology

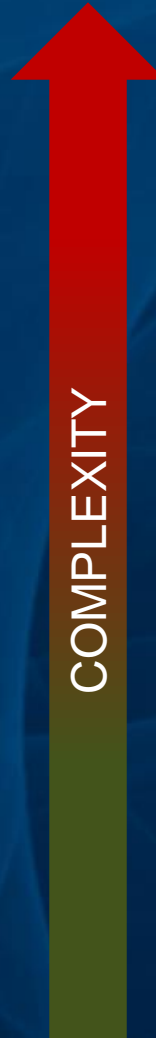


Example: 3/4-die SiP Lidar

Cadence System Design Enablement

“Chips to systems”

- System design authoring
- Rules-driven design, metric-driven verification
- Power-aware budgeting, electrical verification and signoff
- Co-design / analysis across silicon/package/board
- MCAD/ECAD board, system assembly, connectivity and reliability co-design
- Design / supply chain collaboration
- WIP product design data management with enterprise PLM



	Domain	Scope	Example	View
OEM	System		Connected Vehicles	
OEM Tier 1	Subsystem		 Delphi V2X	
Tier 1	Module		 http://bit.ly/1z6lb3r	
Tier 2	Chip		 NXP RoadLINK	
Tier 3	IP		 Tensilica IP	

*“I shall be telling this with a sigh
Somewhere ages and ages hence:
**Two roads diverged in a wood, and I —
I took the one less traveled by,
And that has made all the difference.”***

The Road Not Taken, 1916

Robert Frost, American Poet



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