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

- Connected Car
- AR / VR
- Internet of Things
- Deep Learning
- Cloud / Data Center
Emerging technology trends

The opportunities are massive

- **AR / VR**: 2015: $2B, 2020: $22B, 63% CAGR
- **CONNECTED CAR**: 2015: $24B, 2020: $37B, 9% CAGR
- **CLOUD / DATA CENTER**: 2015: $65B, 2020: $80B, 4.3% CAGR
- **INTERNET OF THINGS**: 2015: $11B, 2020: $34B, 25% CAGR
- **DEEP LEARNING**: 2015: $65B, 2020: $80B, 4.3% CAGR

* 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

©2017 Cadence Design Systems, Inc. All rights reserved.
Design challenges – Silicon

- IP Integration
- Sub 10nm transistors
- Multi-patterning
- Complex design rules
- Design verification
- Mixed signal
- Ultra-low power
- Layout-dependent effects
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

FY12 – 16
Revenue ($B)

1.3 1.5 1.6 1.7 1.8

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

7,200+ employees

1H FY17 revenue
$956M

$735M R&D investment in 2016

©2017 Cadence Design Systems, Inc. All rights reserved.
Part of what we do is to work in “extremes”
Create, simulate and verify designs that use advanced nanometer transistors

~512 Billion Transistors

10nm Gate Size

Living on a Flat Planet about 1 inch in diameter

A cat whisker

= 10,000
Our software helps engineers move between various stages of electronic design so that your favorite electronic gadget is ready for the holiday rush!
Bridging the divide between ICs and Systems
MathWorks system design capabilities integrated with Cadence solutions

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-synchroner 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

©2017 Cadence Design Systems, Inc. All rights reserved.
Rapidly evolving driver mentality

- Manual
  - Ford
  - GM
  - BMW

- Autonomous
  - Uber
  - Lyft
  - Lowest $$$ per mile

- Highest $$$ per mile

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
  – ECU s 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
  - Lane-departure warning
  - Front-collision warning
  - Automatic high beam

Telematics connectivity / Radar
- Emergency Services
- Peer-to-peer smart car networking for intelligent vehicle highway control
- Built-in LTE Modem and WiFi Access Point
- GPS
- Radar/Lidar

©2017 Cadence Design Systems, Inc. All rights reserved.
Cadence and the Cadence logo are trademarks of Cadence Design Systems, Inc. in the United States and other countries. All other trademarks are the property of their respective owners and are not affiliated with Cadence.
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%)!
Automotive PCB design and analysis

“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
Bringing it all together
Example: Automotive ADAS/AV LiDAR

• Alternative / addition to cameras and radar

Today: $80K rotating roof-top box

Soon: <$100 solid-state technology

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

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

<table>
<thead>
<tr>
<th>Domain</th>
<th>Scope</th>
<th>Example</th>
<th>View</th>
</tr>
</thead>
<tbody>
<tr>
<td>OEM</td>
<td>System</td>
<td>Connected Vehicles</td>
<td>OEM</td>
</tr>
<tr>
<td>OEM Tier 1</td>
<td>Subsystem</td>
<td>Delphi V2X</td>
<td></td>
</tr>
<tr>
<td>Tier 1</td>
<td>Module</td>
<td>NXP RoadLINK</td>
<td></td>
</tr>
<tr>
<td>Tier 2</td>
<td>Chip</td>
<td>Tensilica IP</td>
<td></td>
</tr>
<tr>
<td>Tier 3</td>
<td>IP</td>
<td>Suppliers</td>
<td></td>
</tr>
</tbody>
</table>
“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