TowerJazz: The Global Specialty Foundry Leader | Full Circle Value Creation

Proof of Value Creation

Necessary

Proven Analog Business Model
Fastest growing foundry in the world with proportional growth in all financial metrics.

Technology Leadership
Wide range of advanced and differentiated specialty analog offerings.

Strong Market Support

Customer Partner "Youthful Mind"

Market Leadership
Well positioned in the fastest growing markets with long term customer relationships and roadmap alignment.

Sufficient

Our focus:
Create value through customer partnership

1. Protecting and growing high-end share of presently served markets

2. Organically increase into growing new served markets

3. Acquire technologies with capacity or a large raw capacity, to enter new served markets where organic development and/ or CapEx investment would not create ROI.

TOWERJAZZ
The Global Specialty Foundry Leader

Annual Revenues $M - 5-year tracking till today

Year	Revenue ($M)
2005	102
2010	509
2015	961
2017	1387

TOWERJAZZ
The Global Specialty Foundry Leader

Protecting and growing high-end share of presently served markets

TOWERJAZZ
The Global Specialty Foundry Leader
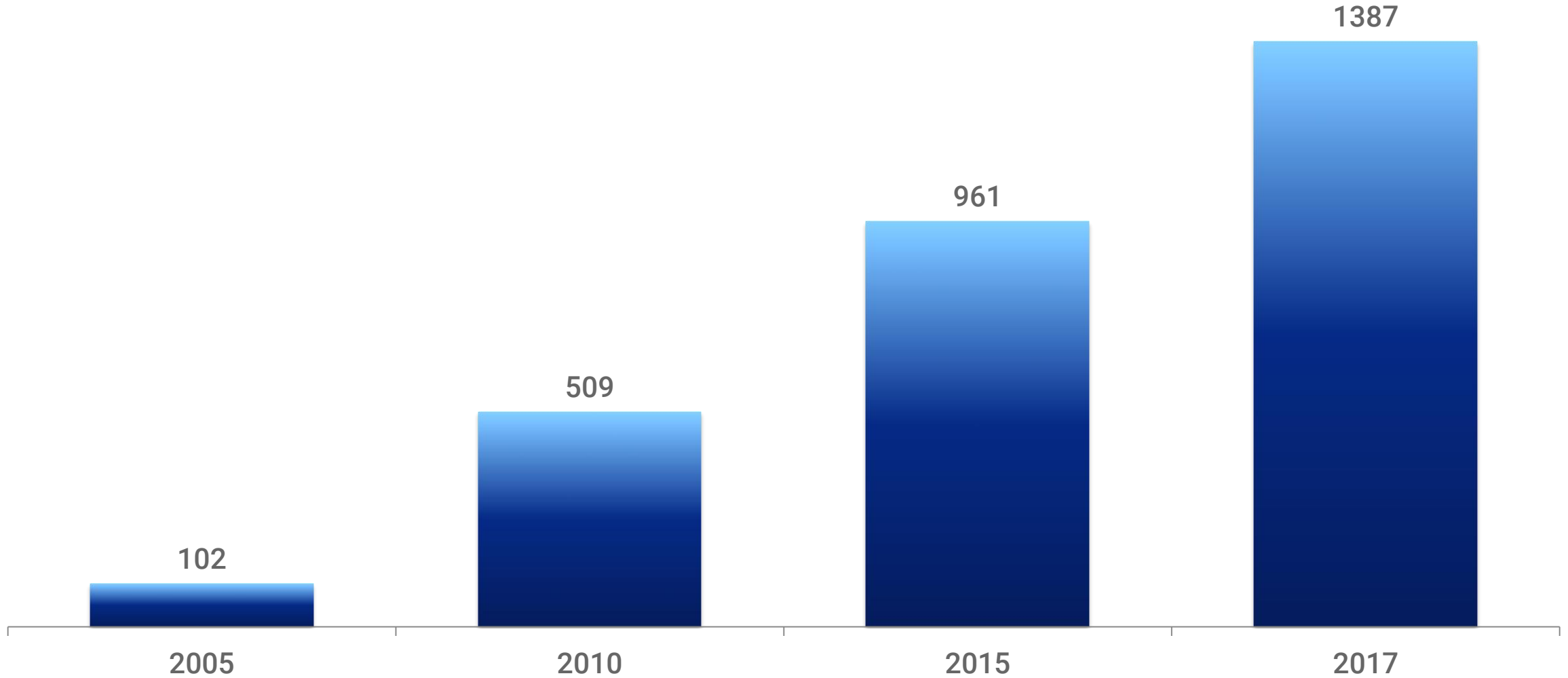
Market Mega Trends
Resulting in rapid growth in specialty analog applications

Wireless Everything	**Green Everything**	**Smart Everything**
Seamless Connectivity	Energy Efficiency	Interactive Smart Systems

Radio Frequency and **High Precision Analog**

~30%
of corporate revenues

Power

~30%
of corporate revenues

Sensors

~15%
of corporate revenues

TOWERJAZZ
The Global Specialty Foundry Leader

Protecting and growing high-end share of presently served markets

- **Intrinsic to our analog model is CapEx re-use for advanced technologies**

  - Power discrete:
    - Strong partnerships with Infineon, Vishay, Semtech, On Semi– where we run and/ or co-developed flows which are kept behind a firewall on long-term, captive agreements
    - CAGR 9,5,3 years: 17%, 19%, 21%

  - Image sensors:
    - 200mm smallest global shutter pixel in the world for high growth industrial sensors
    - 200mm BSI partnership in China as a bridge to next generation family of sensors
    - Continued growth in our 200mm major market share dental x-ray activities
    - Ramping 300mm single die per wafer medical sensors to augment already high market share 200mm larger area dental
    - Protecting high market share of studio cameras with transition to 300mm
    - DSLR and large sensor mirrorless: partnering with tier-1 for next generation camera (evolutionary) and a specific G+2 revolutionary performance
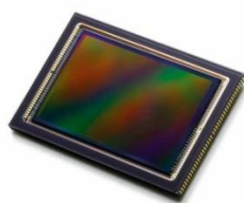   - CAGR 9,5,3 years: 19%, 19%, 23%

CIS Application Range
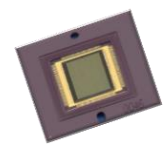
Small Medical

Consumer

Industrial, Machine Vision, Bar-Code

Professional Photography

Prosumer Photography

Medical (X-ray)

12" wafer size

8" wafer size

Medical (X-ray)

Studio & High End Photography
Large Industrial, Scientific, Space

6" Wafer Size

1/24" 1/3" 1/2"
1/4"
2/3"
1"
4/3"
APS (3:2)
35 mm
645
48x36

TOWERJAZZ
The Global Specialty Foundry Leader
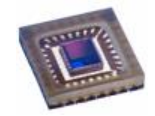
TowerJazz Addressed CIS Markets

Automotive

ADAS and
Autonomous
driving

**Industrial /
Machine Vision**

2D barcode reader
Traffic control
Industrial QA
Food automation

Medical

Intra-oral
Extra Oral
Mammography
Surgery
C-Arm and Flouro

High end
photography and
Cinematography

Cinematography
High end DSLR
Mirror less (ILC)

**3D, Gesture
control, AR/VR**

Gesture control
Augmented Reality
Virtual Reality

Security

City safety
Borders camera
House safety

TOWERJAZZ
The Global Specialty Foundry Leader

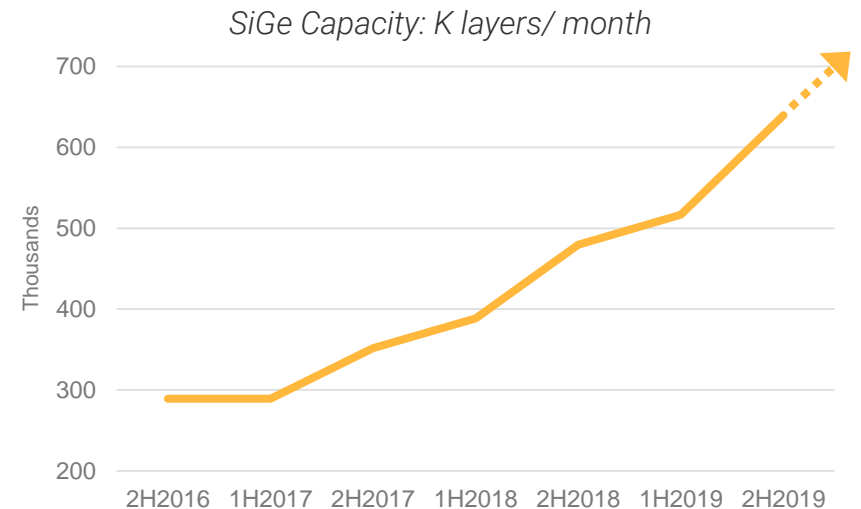# Protecting and growing high-end share of presently served markets

– RF mobile

- Continue high end RF SOI roadmap
  - 300mm 65nm sub 95fsec RonCoff with high digital capability (e.g. switch LNA combo): ramping presently
  - 200mm QT8 and QT9 high power: multiple tier-1 engagements
- Breakthrough RonCoff MEMS switch (partnering with Cavendish Kinetics)
- New materials with game changing RonCoff: tier-1 FEM provider partnership
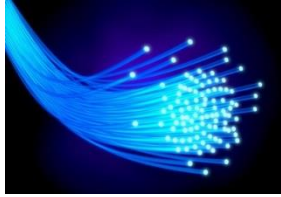- CAGR 9,5,3 years: 12%, 34%, 3%

– RF Infrastructure

- SiGe multi generations capacity increase
  - Press released supply relationships with Broadcom, Inphi, MACOM, Maxim, Maxlinear and Semtech, among others
- CAGR 9,5,3 years: 11%, 12%, 18%

SiGe Capacity: K layers/ month

Thousands

	2H2016	1H2017	2H2017	1H2018	2H2018	1H2019	2H2019

TOWERJAZZ
The Global Specialty Foundry Leader

RF HPA Applications and Technology

Wireline Front-Ends
High Performance SiGe

- Optical Fiber Networks
- TIA, LA, Laser Drivers, CDRs
- Photodetectors, Photonics

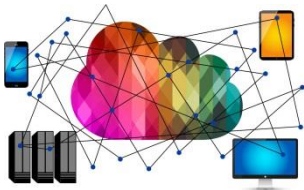**mmWave**
High Performance SiGe

- Automotive Radar
- 5G Wireless
- 60GHz WiFi and Backhaul

Wireless Front-Ends
RF SOI and SiGe

- Power Amplifiers
- Antenna Switch
- Low Noise Amplifiers

High Performance Analog
Complementary BiCMOS

- DSL Line Drivers
- HDD PreAmp for the Cloud
- OpAmps, DAC, ADC

TOWERJazz
The Global Specialty Foundry Leader

Protecting and growing high-end share of presently served markets

– Power Management
  - Best in world up to 16V 300mm 65nm BCD platform
  - Incorporating 1.2V to enable high gate count logic to the otherwise best in the world flow
  - Adding high voltage offering of up to 140V breakdown to the 0.18um BCD platform
  - Adding advanced reprogrammable NVM to our 0.18um BCD platform
  - CAGR 9,5,3 years: 29%, 16%, 8%
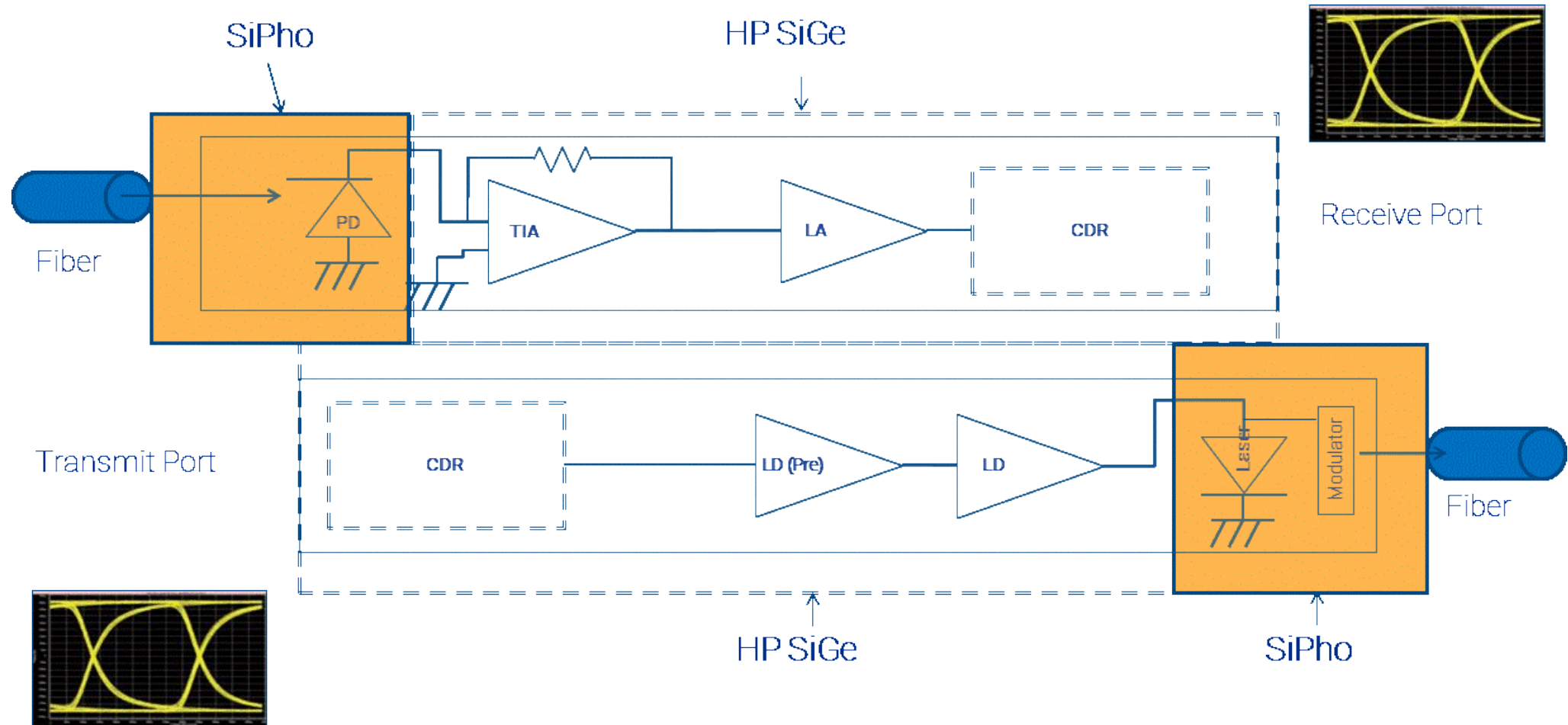
Computers & Servers

Consumer

Automotive

Industrial

Organically increase into growing new served markets

Organically increase into growing new adjacent served markets

- RF infrastructure: SiPho

Organically increase into growing new served markets

New Superordinate "Mega" Trends Requiring Enhanced Sensing

Artificial Intelligence
Experiencing the World Differently

Augmented Reality & Virtual Reality
Creating Alternative Reality

Automotive & Autonomous Driving
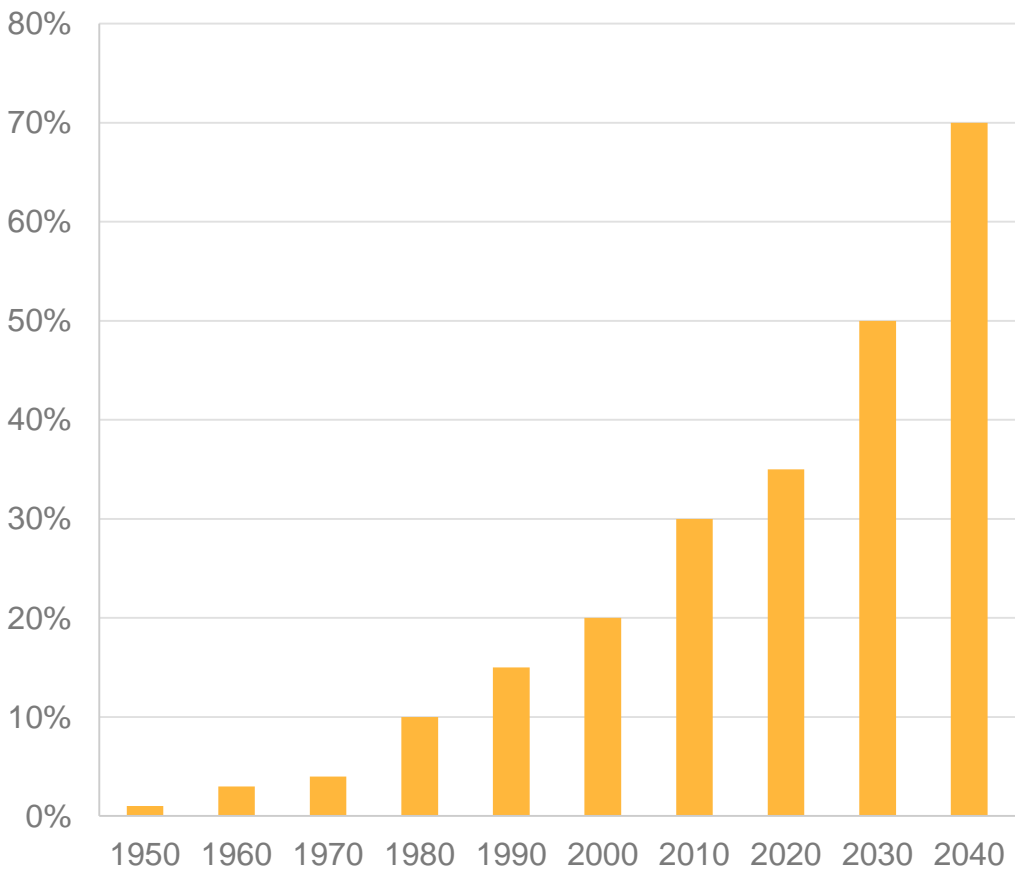The sensor fusion experience

TOWERJAZZ
The Global Specialty Foundry Leader

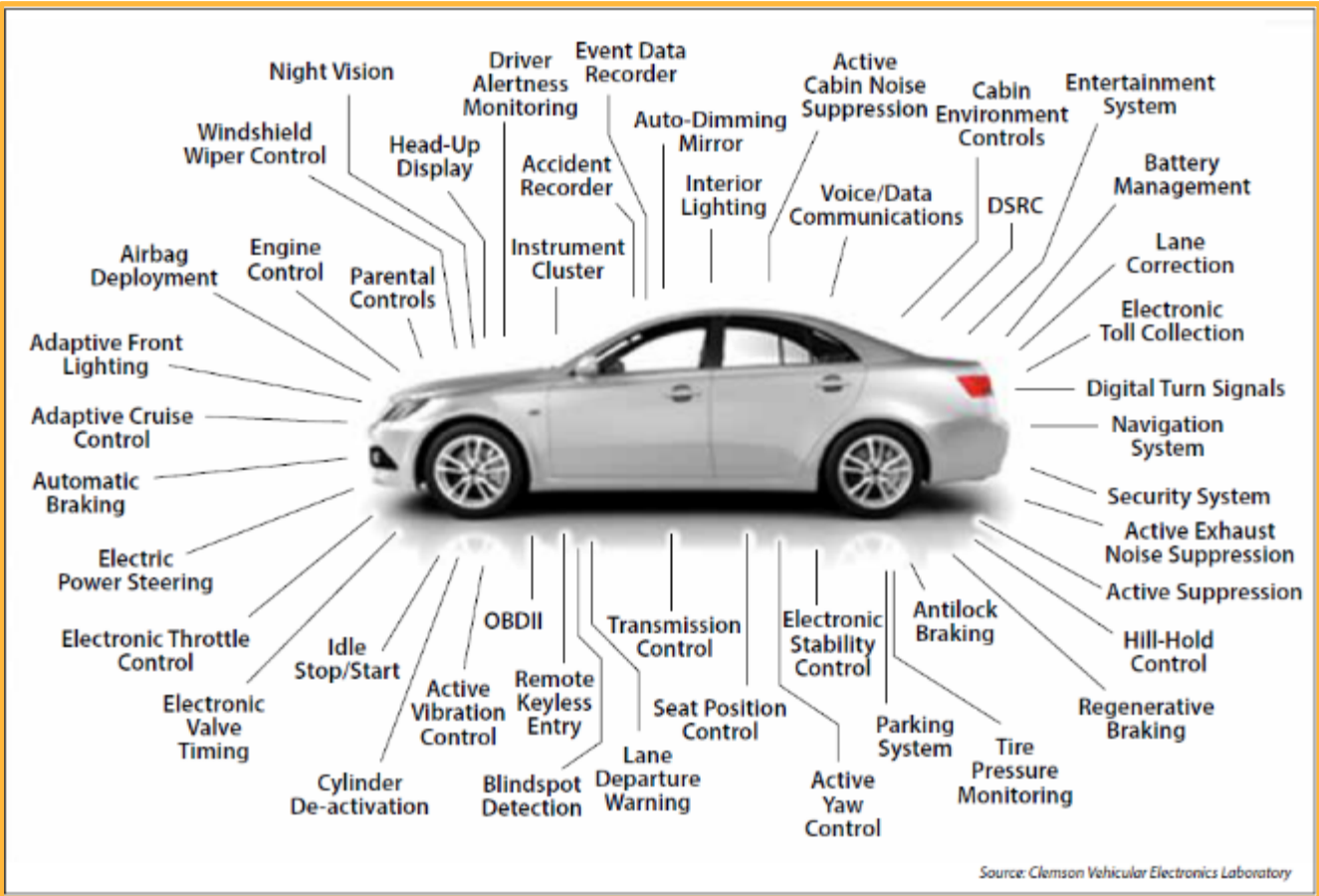# **Automotive & Autonomous Driving**

The Sensor Fusion Experience

Digitization of the automobile is driving rapid growth in electronic content

Electronics as % of Cost in an Automobile

Automotive Electronics Systems

Source: Clemson Vehicular Electronics Laboratory

Automotive Market Focus

- Automotive is the **fastest growing** and the **third largest** end-use IC market

- Nearly **70%** of Automotive IC content is **Analog*,** well **aligned to TowerJazz** Specialty Analog technologies

  - **Power** for EV/Hybrid battery management

  - **RF** for connectivity and Radar (Example: Denso/Toyota partnership announced)

  - **Sensors** for ADAS (Example: FLIR IR night vision partnership announced)

IC End-Use Markets ($B) and Growth Rates

*Covers only the Internet connection portion of systems.

Source: IC Insights
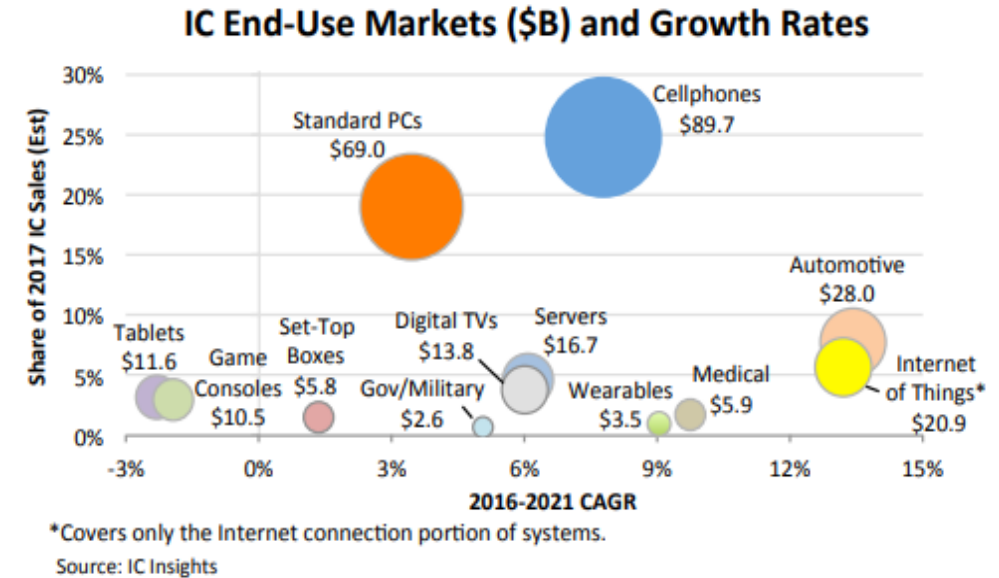
* MarketsandMarkets report 2017

Autonomous and Advanced Driver Assistance Systems (ADAS)

360° coverage required | 6-8 cameras per car | VGA moving to HD | High Dynamic Range | Near IR vision | LIDAR for accurate ranging

"TowerJazz's leading SiGe technology enabled us to create the collision avoidance system which is our flagship offering. TowerJazz's advanced process enabled the engineers to fully achieve the challenging specs required for next generation short range radar (SRR) for automotive applications. This solution allows DENSO to be a world leader in supplying collision avoidance systems for automotive safety." (Denso, Director, Advanced Safety Engineering)

Long-Range Radar
LIDAR
Camera
Short-/Medium Range Radar
Ultrasound
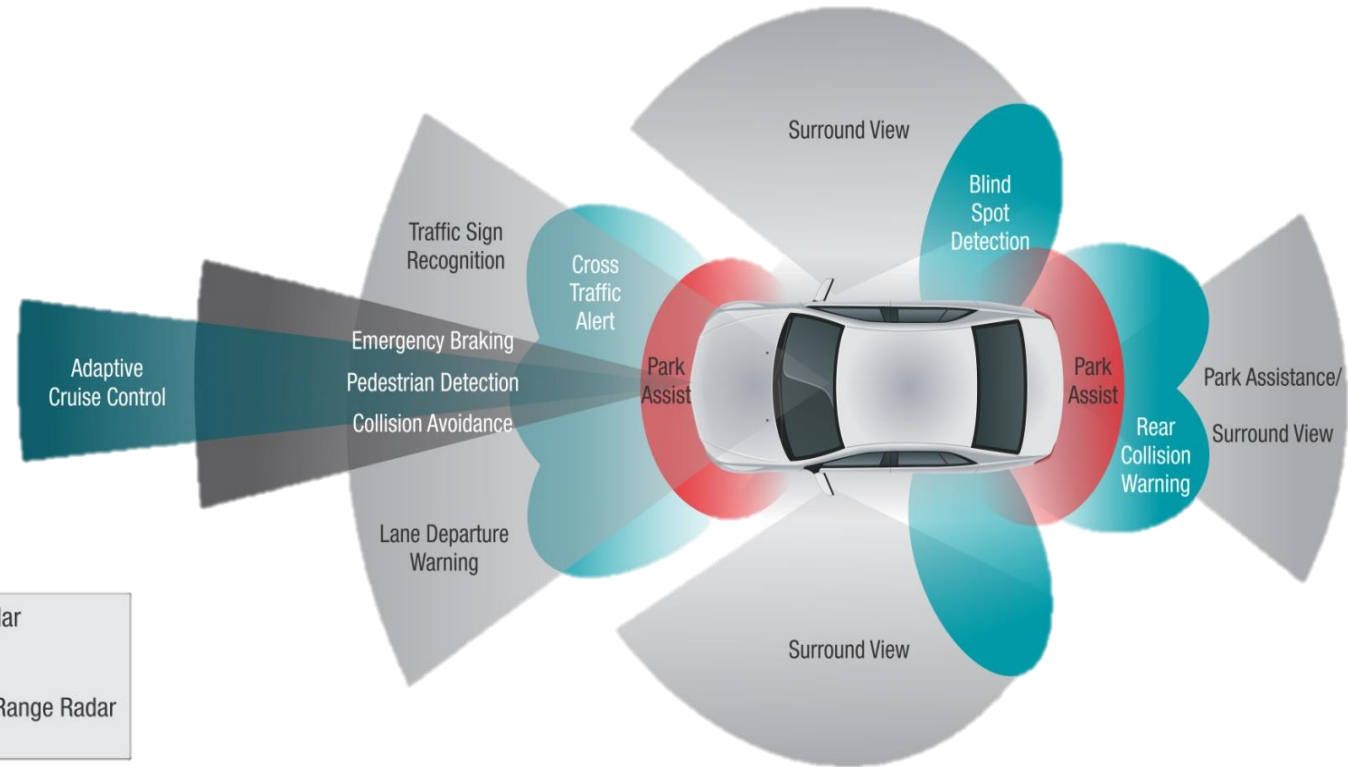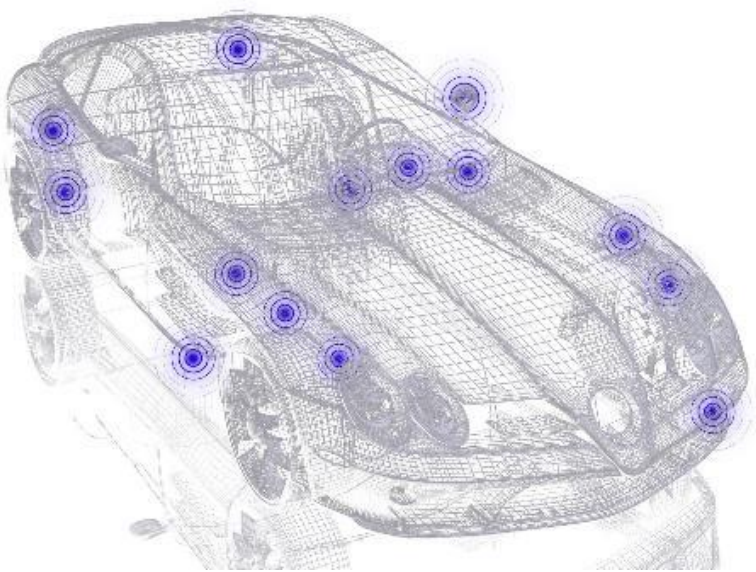
"We chose TowerJazz for its advanced pixel technology, specially customized for our CMOS image sensor chips addressing very high volume markets. Together with our technology, we were able to demonstrate a 4X better sensitivity to our customers. TowerJazz's CIS offering is proven in the industry and we are pleased to manufacture locally in Israel with a leader in the global analog foundry space." (Newsight Imaging, CEO).

Organically increase into growing new served markets

New Superordinate "Mega" Trends Requiring Enhanced Sensing

Artificial Intelligence
Experiencing the World Differently

Augmented Reality & Virtual Reality
Creating Alternative Reality

Automotive & Autonomous Driving
The sensor fusion experience

AR and VR Worldwide Market Size 2016-2021 ($B)

8X growth
in the next 2 years

Market size in billion U.S. dollars

- 2016: 6.1
- 2017*: 9.4
- 2018**: 17.8
- 2020**: 143.3
- 2021**: 215
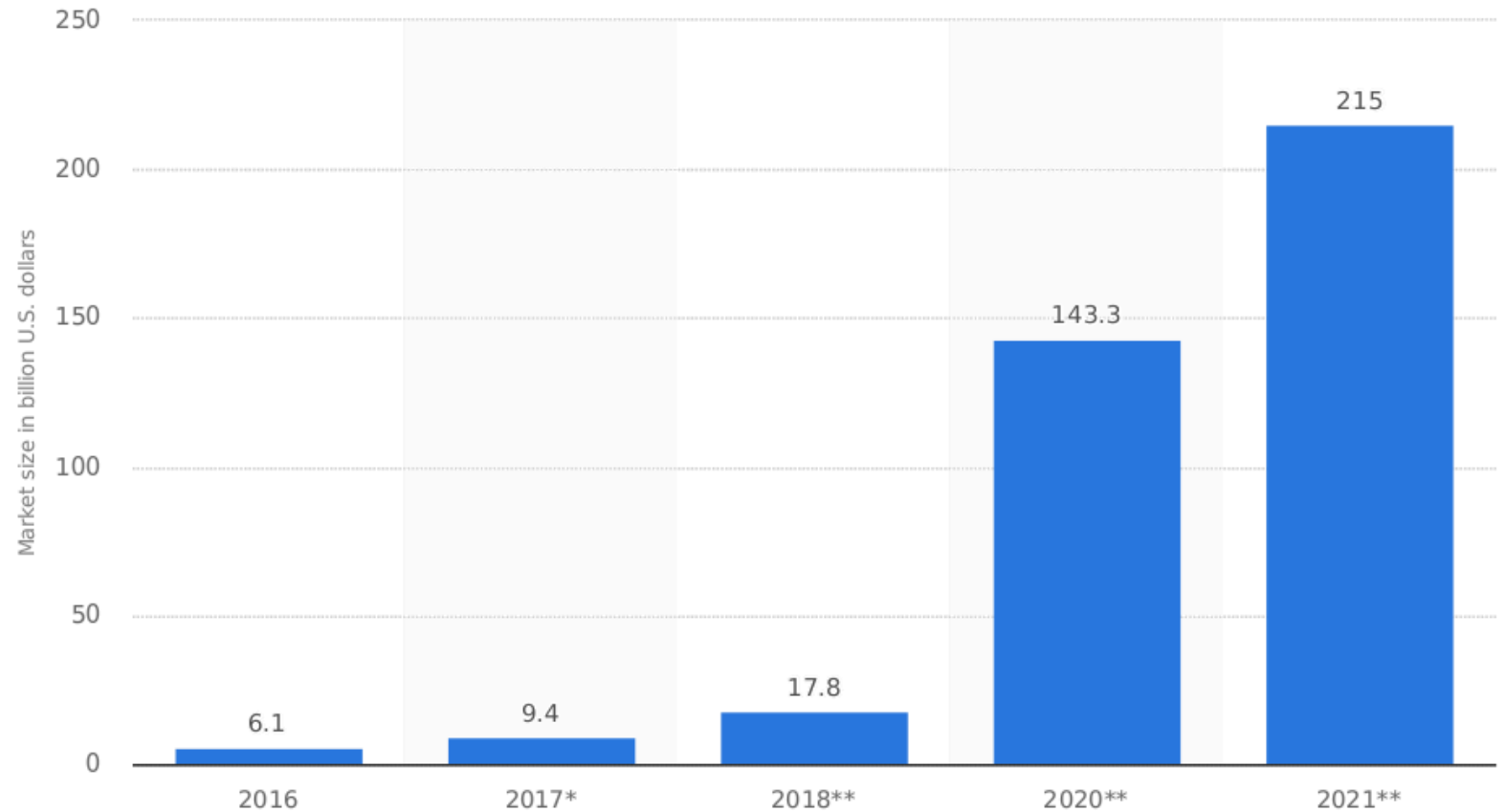
Source
IDC

Additional Information:
Worldwide; IDC; November 2017

TOWERJAZZ
The Global Specialty Foundry Leader

AR/VR – 3D ToF sensors and OLED on Silicon displays

Time of Flight Sensing

- Simple idea: measure the time it takes for light to return from the object
- Two detection mechanisms that trade off between speed and SNR
    - Active Gating: Ultrafast Global shutter technology for real-time imaging, but lower SNR
    - Single photon Avalanche diode (SPAD): Highest SNR but relatively slower due to "quenching" required
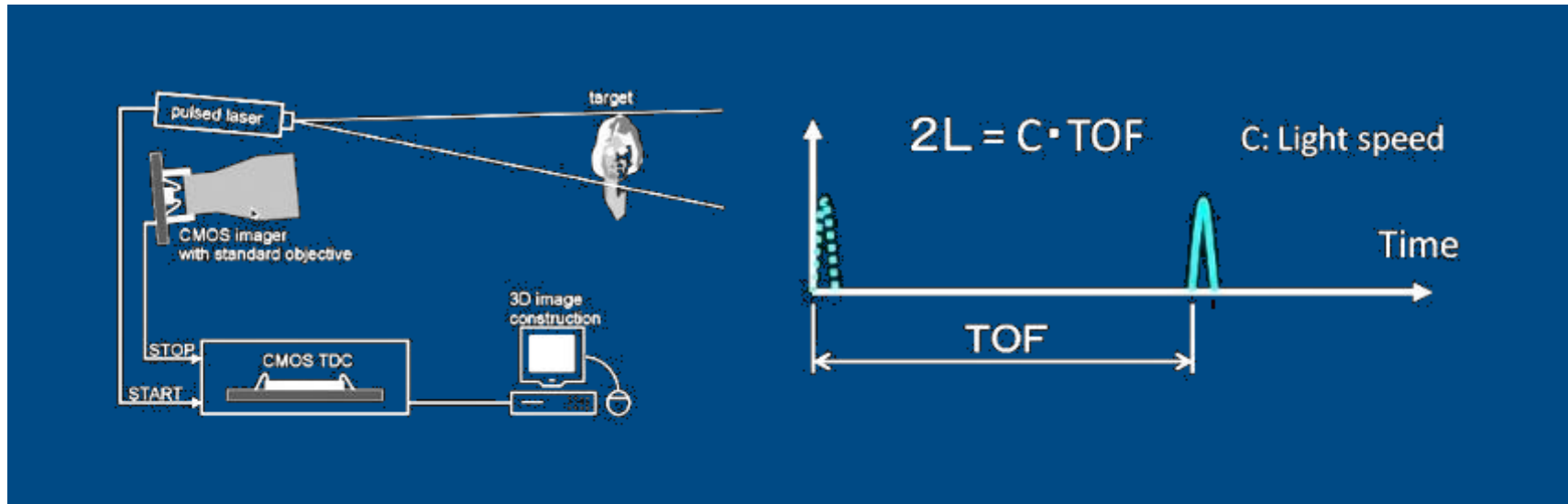
Organically increase into growing new served markets

New Superordinate "Mega" Trends Requiring Enhanced Sensing

Artificial Intelligence
Experiencing the World Differently

**Augmented Reality & Virtual Reality**
Creating Alternative Reality

Automotive & Autonomous Driving
The sensor fusion experience

TOWERJAZZ
The Global Specialty Foundry Leader

Analog Neural Network AI processor based on CIS pixels as Neurons
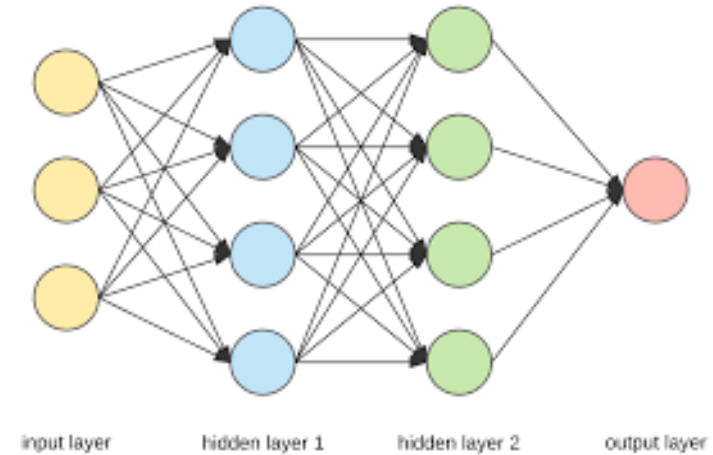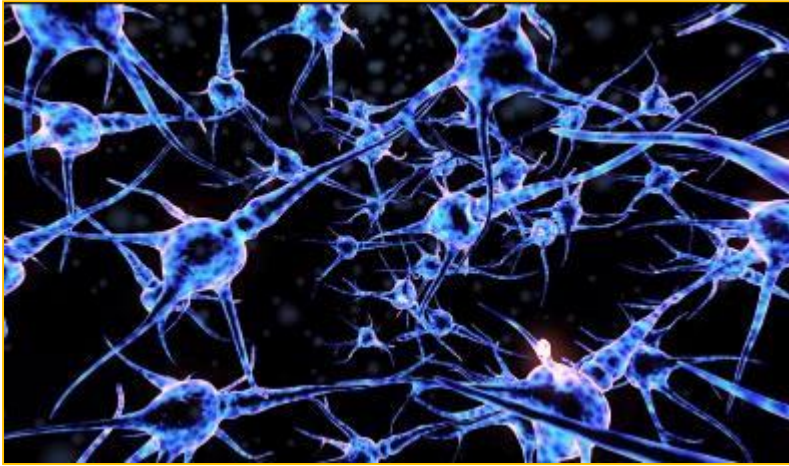
Neuron is a mixed-signal device
Axon is an analog device

input layer   hidden layer 1   hidden layer 2   output layer

x_0 w_0
axon from a neuron — synapse
$w_0 x_0$
dendrite
$w_1 x_1$
cell body
$\sum_i w_i x_i + b$ f $f\left(\sum_i w_i x_i + b\right)$
output axon
$w_2 x_2$
activation function

TOWERJAZZ
The Global Specialty Foundry Leader
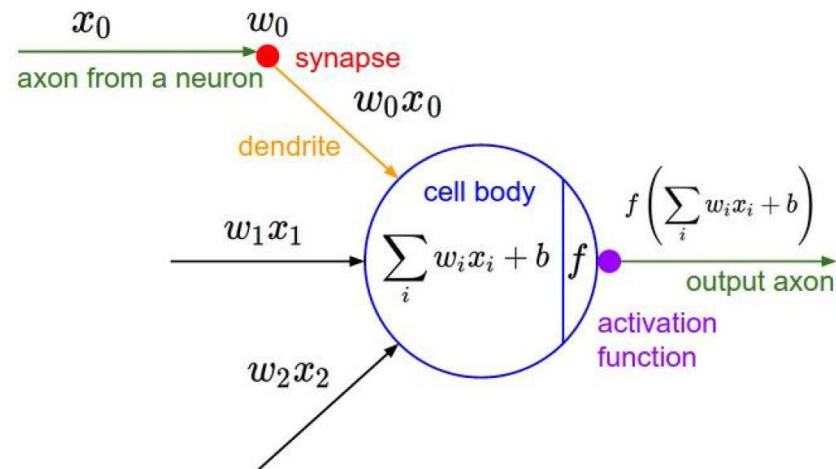
The Opportunity: Emerging Applications need low power analog AI
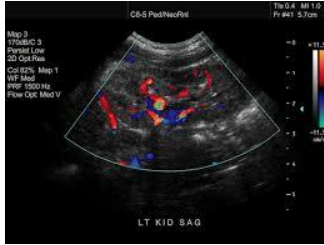
AI Medical

Personal Assistants

Virtual Reality

Portable Navigation

Radar & Optical Gesture Control

Augmented Transportation

Robotics

Drones

Wearables

Insurance

Smart City Sensors

AIaaS

Security/ Authentication

Acquire technologies with capacity or a large raw capacity, to enter new served markets where organic development and/ or CapEx investment would not create ROI

Partnerships and M&A Strategy

- **Increase Operational Capacity and Flexibility**
  - Acquiring capacity at substantial lower cost than organic growth, coupled with long-term supply agreement
  - Green field, predominantly funded by partners

- **Increase Served Market and Technology Offering**
  - Acquire new technologies w/ established customer base
  - Acquire new technologies which serves existing base
  - Acquire existing foundry (manufacturing and business)
  - Green field predominantly funded by partners

Target Acquisitions

High-end technology outside of present portfolio

Low cost, regional focused capacity expansion

Under-valued, high revenue asset acquisition

TOWERJAZZ
The Global Specialty Foundry Leader

A song that greatly impacted my life and relevance to TowerJazz

- Tapestry (1972, Carole King)
    - When I was 17 years old; The lyrics touched me deeply, "How do I create a tapestry of my life?"

"My life has been a tapestry of rich and royal hue,

An everlasting vision of the ever-changing view

A wondrous woven magic in bits of blue and gold

A tapestry to feel and see, impossible to hold."

	Fab1	Fab2	Fab3	Fab5	Fab6	Fab7	Fab9	China BSI	M&A
Disruptive magnetic sensor									
Automotive sensor fusion									
Novel integrated SiPho									
Adv. Material switch									
MEMS switch									
Haptic and Gas Sensor									
Sensors "Fusion"									
Analog AI									
AR/VR									
Best-in-world PM									
Best-in-world RF Switch/ LNA									
Advanced M/S									
Game changing X-Ray									
High end ind. vision									
Game changing high end DSLR									
CIS High End Studio									
Game Changing Broadcasting									
Advanced Discrete									
Embedded NVM									
CIS Security									
CIS Advanced Ind. Vision									
Embedded Memory									
CCD									
Automotive									
Discrete									
M/S									
Power									
IR Camera (A&D)									
RF SOI									
SiGe									
M/S									
Discrete									
PM									
CIS									
HSL									
CIS									
Discrete									

29

www.towerjazz.com