

# MEMS Engineer Forum

## April 25, 2014

### Tokyo, Japan

## MEMS Industry Group Introduction

### MEMS and Sensor Trends

Karen Lightman, Executive Director  
MEMS Industry Group



# Today's Presentation

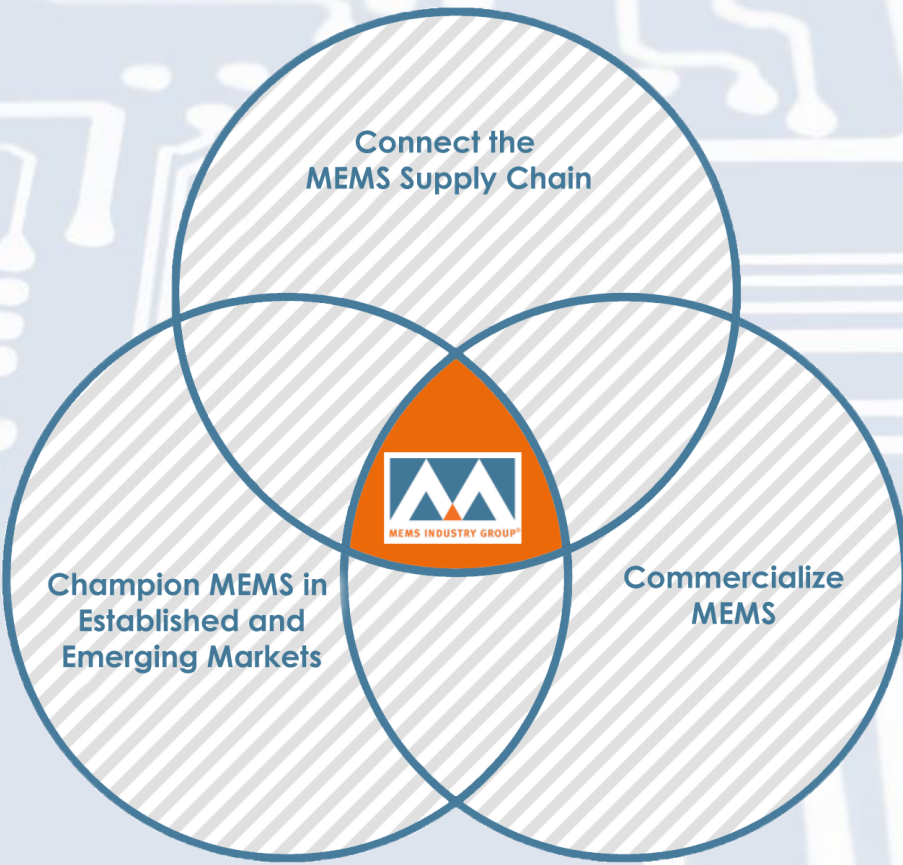


- Introduction to MEMS Industry Group
- MEMS and Sensors Market Trends
- MEMS and Sensors Technology Trends
- Challenges and Opportunities

# About MEMS Industry Group® (MIG)



MIG is the trade association advancing MEMS across global markets.



# About MEMS Industry Group® (MIG)



- **Formed in in the US in 2001 with five companies** - outgrowth of MEMS industry executive meetings at Defense Advanced Research Projects Agency (DARPA)
- MIG is an industry trade association incorporated as a not-for-profit organization, based in Pittsburgh, Pennsylvania, USA
- MIG is international, with over 160 member companies and partners worldwide
- MIG managed by Executive Director Karen Lightman, with Governing Council composed of representatives from member companies





# MEMS Supply Chain = MIG Members



MEMBERS



Acuity

AnaCatum

DiPaola Consulting

GLOBAL FOUNDRIES

Kilbrydon

MERIT SENSOR Performance Under Pressure

OMRON

MEMS INDUSTRY GROUP

ACUTRONIC

bluechip

DYNALOY A subsidiary of Eastman Chemical Company

HARTING

Kionix

micralyne

sand

AKUSTIKA Bosch Group

BOSCH Invented for life

EMPOWER MATERIALS

hp

KNOWLES

MICREL

OAI

sensoror

SPTS life.augmented

a:etris

BROADCOM

Energizer Personal Care

hp

kb SO

microGen Energizing the Wireless World

OXFORD INSTRUMENTS

siconnex customized solutions

AEP

brueck integrated circuits

EPSON EXCEED YOUR VISION

hp

kb SO

microGen

plan op tik

SUSS MicroTec

TELEDYNE DALSA Everywhere you look

AKrion systems

brueck integrated circuits

EPSON EXCEED YOUR VISION

hp

kb SO

microGen

plan op tik

SUSS MicroTec

SSEC tsmc

AMFITZGERALD

BULLEN ULTRASONICS, INC.

EPSON EXCEED YOUR VISION

hillcrestlabs

Lam RESEARCH

MicroVision

UBOTIC Your eHEALTH Partner

TEXAS INSTRUMENTS

tronics ENVISION MEMS | DELIVER MEMS

Amkor Technology

csem

ESS european sensor systems

Honeywell

Lam RESEARCH

Plasma-Therm A leading supplier of plasma process equipment

tektion Consulting

Trusted Positioning Positioning Everywhere

ANALOG DEVICES

C2MI MiQro Innovation Collaborative Centre

Expertech

imt

Maradin PROJECTING THE FUTURE

Picosun PANORAMA SYNERGY The ALD Powerhouse

silex MICROSYSTEMS

ULVAC Veeco

APPLIED MATERIALS

Fraunhofer ENAS

IntelliSense

intel

maxim integrated

Midwest MicroDevices

Polytec

siWARE SYSTEMS

VECTORNNAV Embedded Navigation Solutions

VIT

APPLIED M S T

Fraunhofer IPMS

IntelliSense

intel

maxim integrated

Midwest MicroDevices

Polytec

siWARE SYSTEMS

VECTORNNAV Embedded Navigation Solutions

VIT

ASE GROUP [CINDER]

infineon

LG Life's Good

MEGGITT

micronit MICROFLUIDICS

Siargo Ltd.

SmallTech Consulting

wiSpry

DRAPER LABORATORY

freescale

MEMSIC

QuickLogic

muRata

camLine agile • efficient • reliable

SONY

ST

apm Asia Pacific Microsystems, Inc.

ClassOne EQUIPMENT

FRT the art of metrology

INTERLINK ELECTRONICS Sensor Technologies

memsstar

NEUTRONIX-QUINTEL

SunEdison

SilverBlip Ltd IP and Technology Consulting

Wisdom IC 硅智

ARM COVENTOR

GE

brewer science

MEMSTAFF

Qualtré

SITRI

SolMateS Solutions in Material Science

unisem

VALUTEK

COTO TECHNOLOGY

DeIFMEMS

JAWBONE

OKMETIC

OEN GROUP

SO-CUBED Solid • Smart • Stable

SPT SPP Technologies Co., Ltd.

ksens

FAB MEMS FOUNDRY EXPERTS

ZMDI The Analog Mixed Signal Company

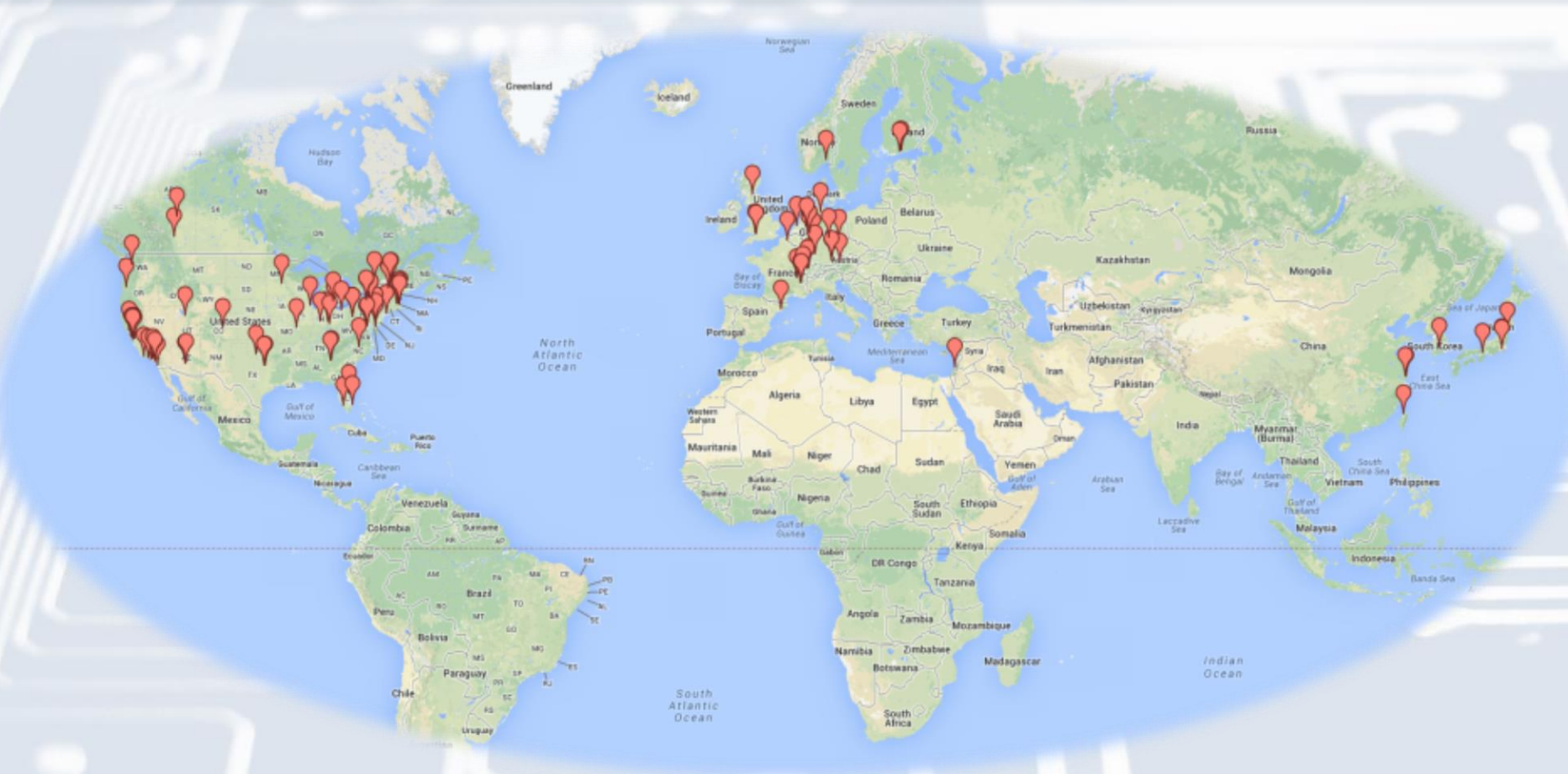
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For a complete list of members and partners, please visit [www.memsindustrygroup.org](http://www.memsindustrygroup.org).



# MIG's Global Presence





# Join MEMS Industry Group



- Access the entire MEMS supply chain throughout the year



**YOUR  
LOGO  
HERE**

# MIG Champions MEMS in Established and Emerging Markets



MEMS EXECUTIVE CONGRESS®

MEMS Industry Group® Conference • Japan  
THE GLOBAL MEMS SUPPLY CHAIN - APRIL 24, 2014 - TOKYO, JAPAN



MEMS Industry Group® Conference Shanghai  
The Global MEMS Supply Chain & The Internet of Things  
September 10-12, 2014 Shanghai, China



**SEMICON®**  
West2014  
July 8-10, 2014 | Moscone Center | San Francisco, CA

**nanomicro biz**  
**ROBOTECH**

**sensors**  
expo & conference  
Sensing Technologies Driving Tomorrow's Solutions



# M2M Forum- Members Only Conference



## The MEMS Supply Chain - It Takes a Village

May 20-21, 2014 | Berkeley, CA

Organized and presented by MEMS Industry Group®



- Requirements driving MEMS technology
- Successful Tech Transfer examples
- Learning from MEMS: What's the cycle time around learning and how do we improve this?
- Technical barriers/advances that MEMS needs to advance
- Includes tour of UC Berkeley Marvell Nanofabrication Laboratory



# Where else will MIG be in 2014?



**sensors expo  
& conference**

**Sensors Expo & Pre-Conference  
Symposium**  
June 24-26, 2014 | Rosemont, IL

**SEMICON<sup>®</sup>**  
West2014

**SEMICON WEST**  
**MIG Member Cocktail Party**  
July 9, 2014 | San Francisco, CA

# MIG Conference Shanghai



**September 10-12, 2014**  
**Shanghai, China**

*In Partnership with SIMT (Shanghai Institute of  
Microsystem and Information Technology)*



## **Theme: Global MEMS Supply Chain & The Internet of Things**

- Site Visit to Jiading – Shanghai Center for Internet of Things
- Chinese and Multi-national Speakers
- Topics include:
  - Global trends, collaboration, tech transfer/innovation, competitive advantage of foundry models

# MEMS Executive Congress US 2014



MEMS EXECUTIVE CONGRESS®

November 5-7, 2014, Scottsdale Arizona





# MIG Enables MEMS Commercialization



MIG is THE neutral forum for discussion of issues affecting the commercialization of MEMS.



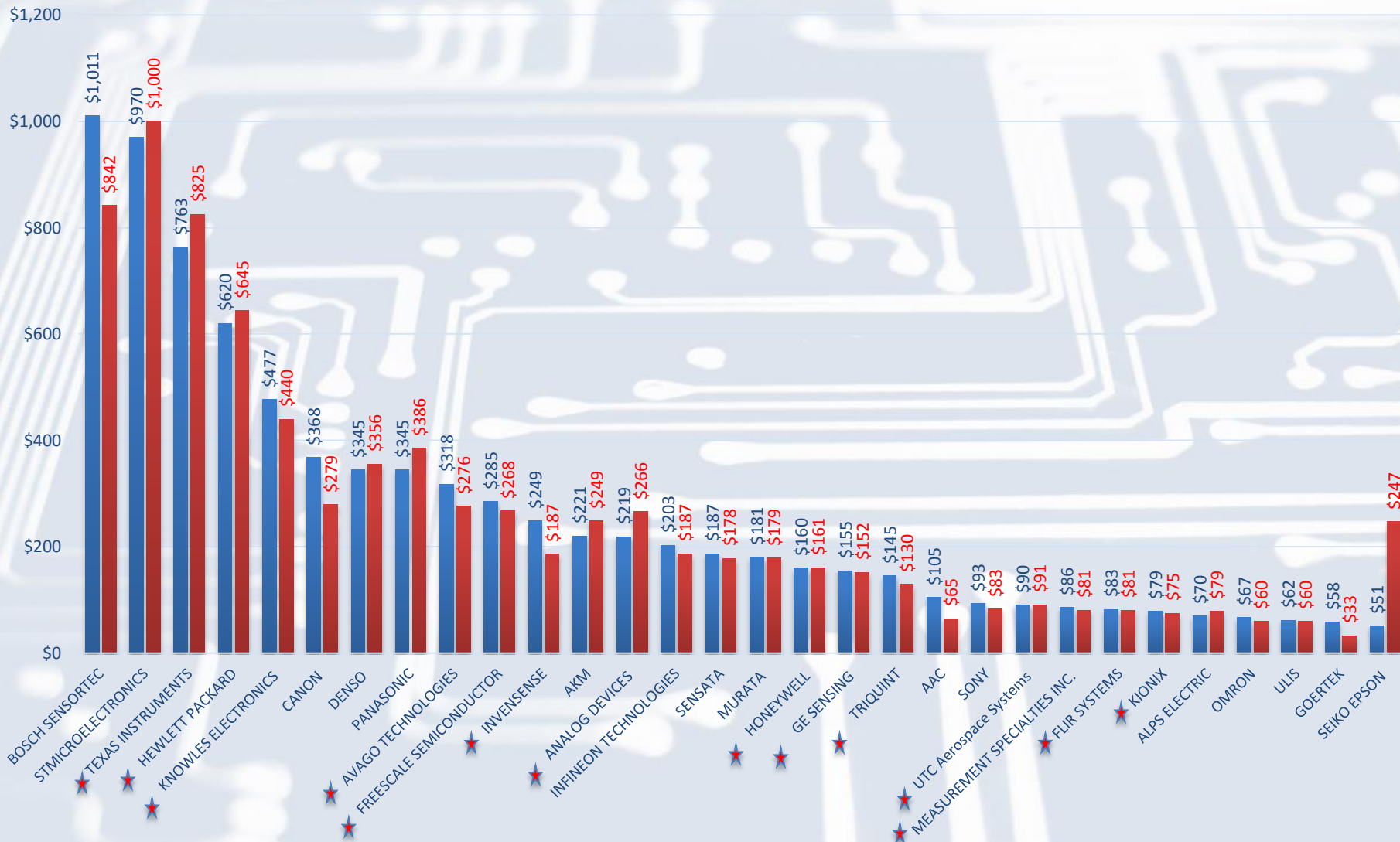
# The “So What?” Factor



- What’s our vision?
  - MEMS and Sensors EVERYWHERE
- Where does MIG add value?
  - By acting as a partner and facilitator to bring the diverse MEMS supply chain together to tackle the tough issues like standardization and new MEMS product development
- Why is this important?
  - To speed MEMS commercialization and reduce ¥costs¥
- What’s Next?
  - Global MEMS Supply Chain Challenges

# TOP MEMS Ranking

2013 MEMS Ranking  
April 2014





# MEMS Market Adding \$1B/Year



**US\$11.4 B**

**US\$9B**

**MEMS market, 2006–2017**

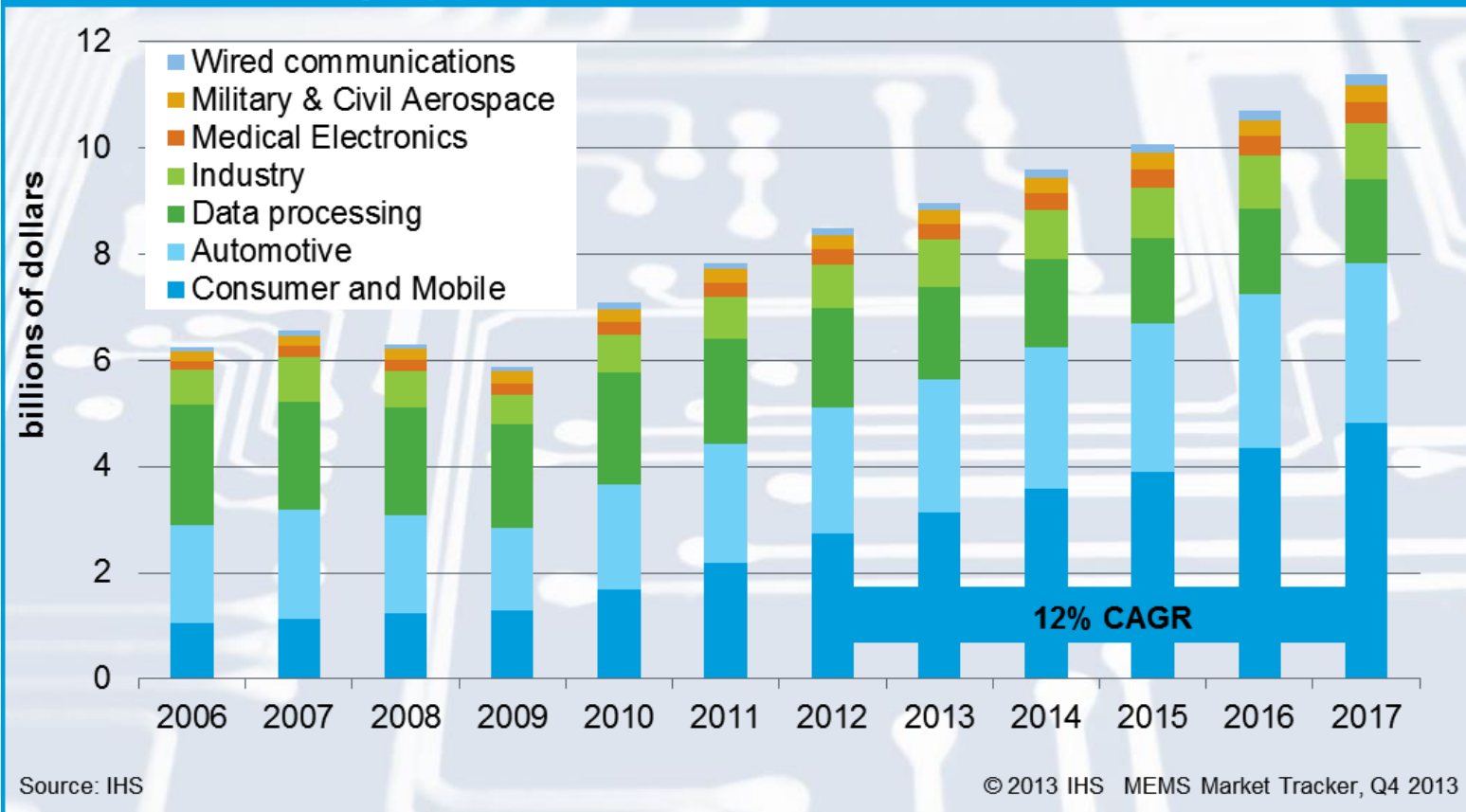


- 2013 another record year
- MEMS growth 2x as fast as semiconductors in next 5 years
- Consumer market reigns supreme. After smartphones and tablets, wearables are third wave in CE

# Consumer & Mobile = Today's Powerhouse MEMS Markets

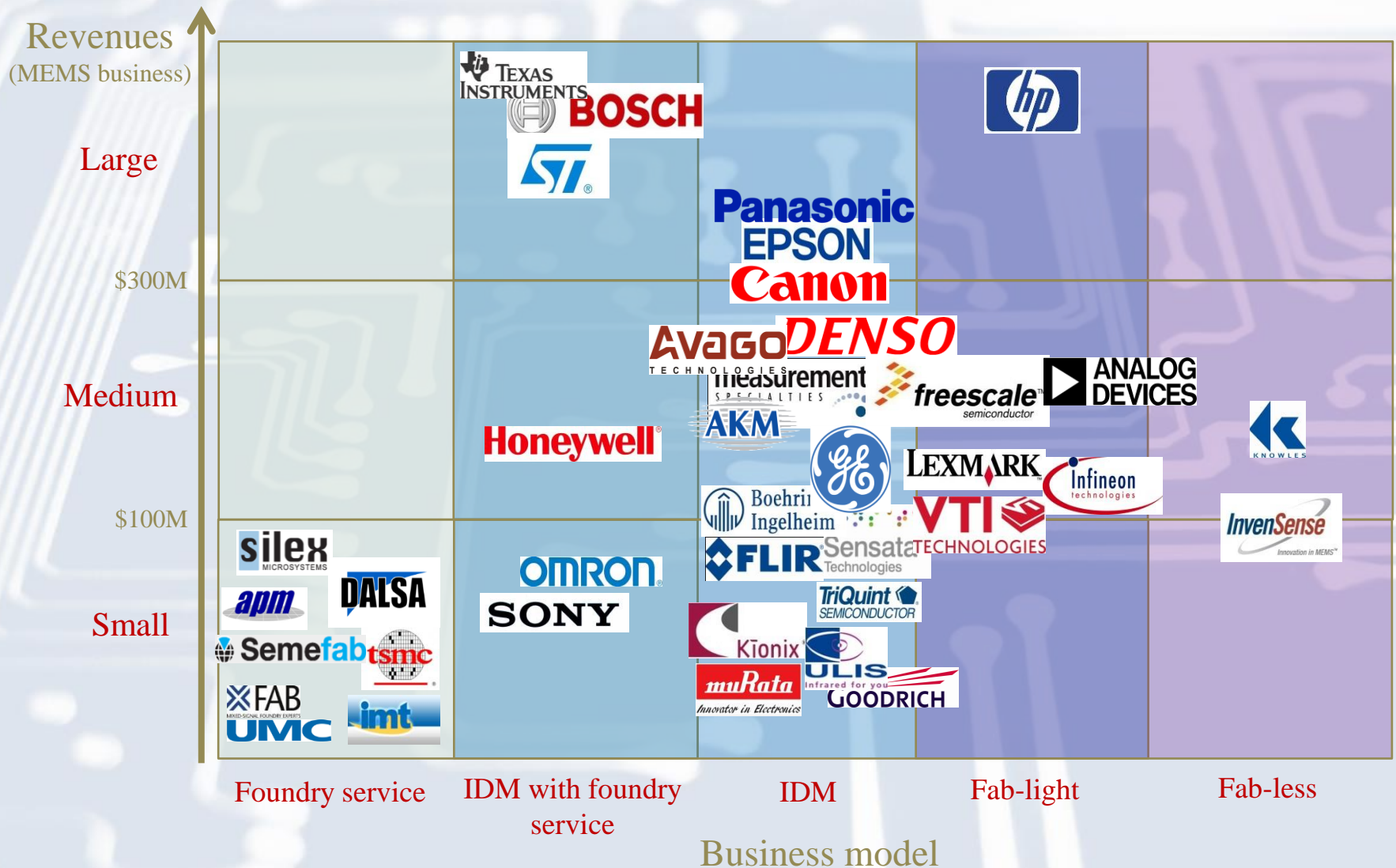


## MEMS market by application, 2006–2017



# Typology of MEMS Companies

## Business model for MEMS manufacturers



# MEMS and Sensor Technology Trends



Biggest technology trends are with:

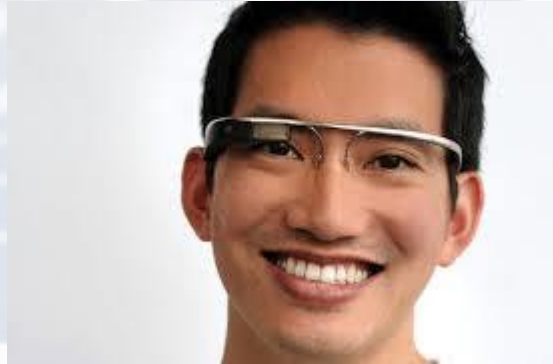
- Sensor Fusion
- Integration
- Energy and Wireless Sensor Networks



# MEMS Is Everywhere



Sony Smartwatch



Google Glasses



Samsung Galaxy S4



Wii U Gaming Device

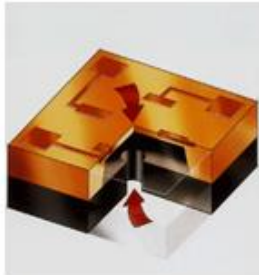


Ipad Air Tablet

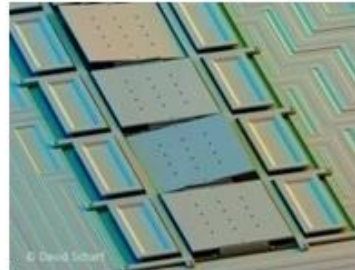


Jawbone Up  
Fitness Band

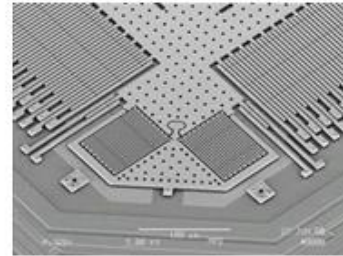
# MEMS /S Inside



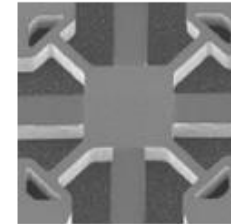
Pressure sensor



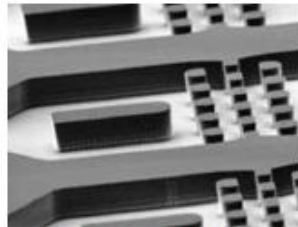
Micro-mirrors  
Optical MEMS



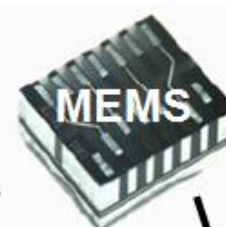
Inertial MEMS  
Gyroscopes & accelerometers



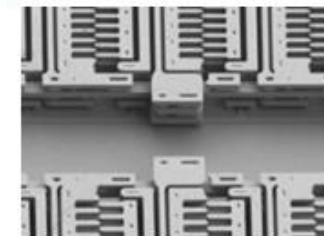
RF-Resonators



Ink-jet & Micro-fluidic  
Print Heads



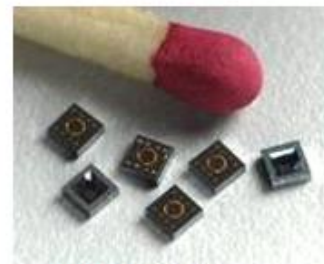
MEMS



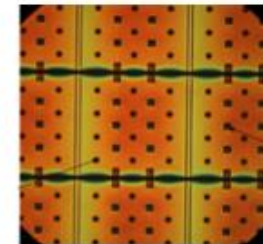
Micro-actuators



RF-MEMS  
switches, Filters...



Si Microphones



Micro-Displays

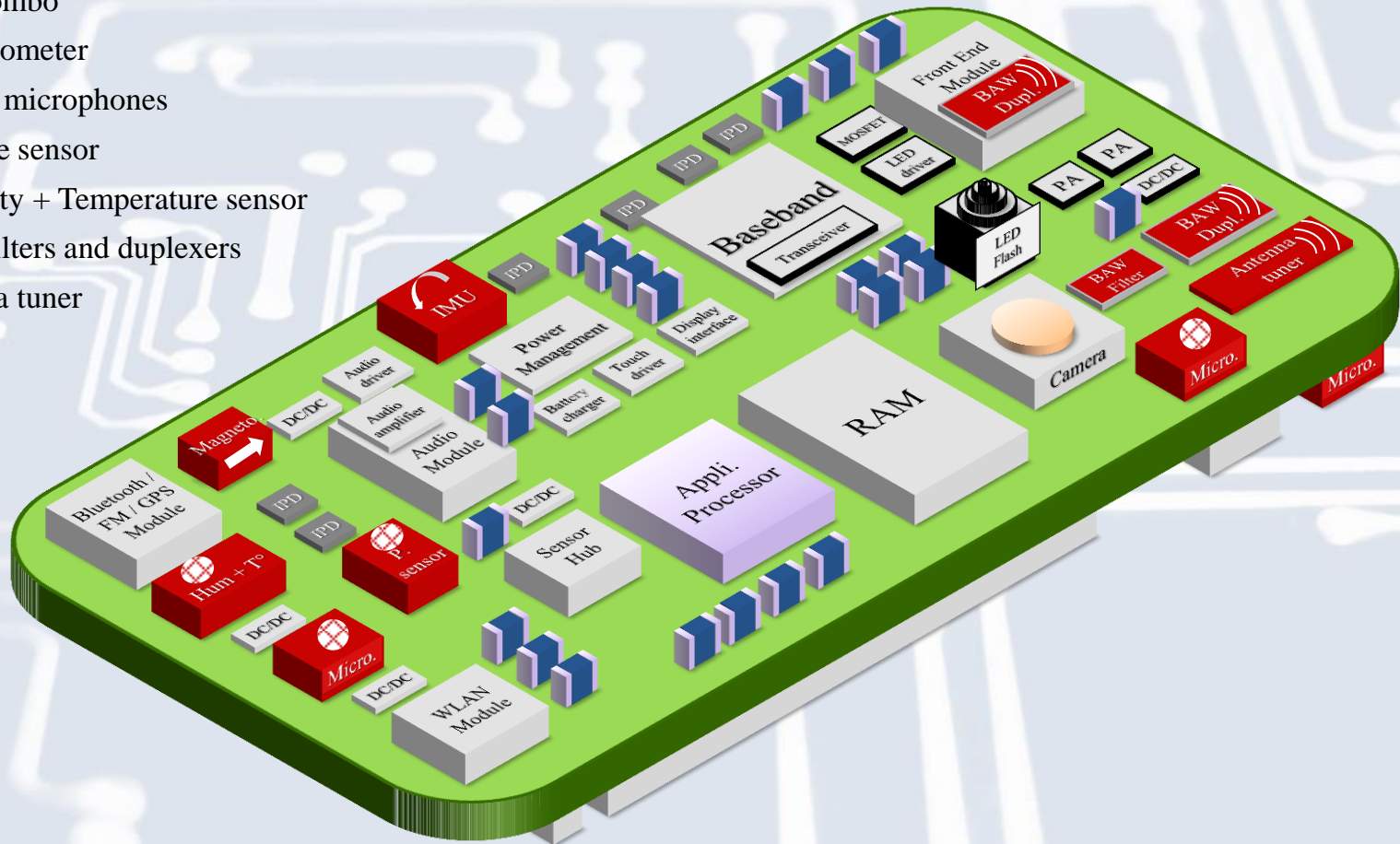
Images courtesy of

# Simplified View of TODAY (2013's) Smart-Phone Board MEMS in red



## MEMS devices in volume in 2013:

- IMU combo
- Magnetometer
- MEMS microphones
- Pressure sensor
- Humidity + Temperature sensor
- BAW filters and duplexers
- Antenna tuner



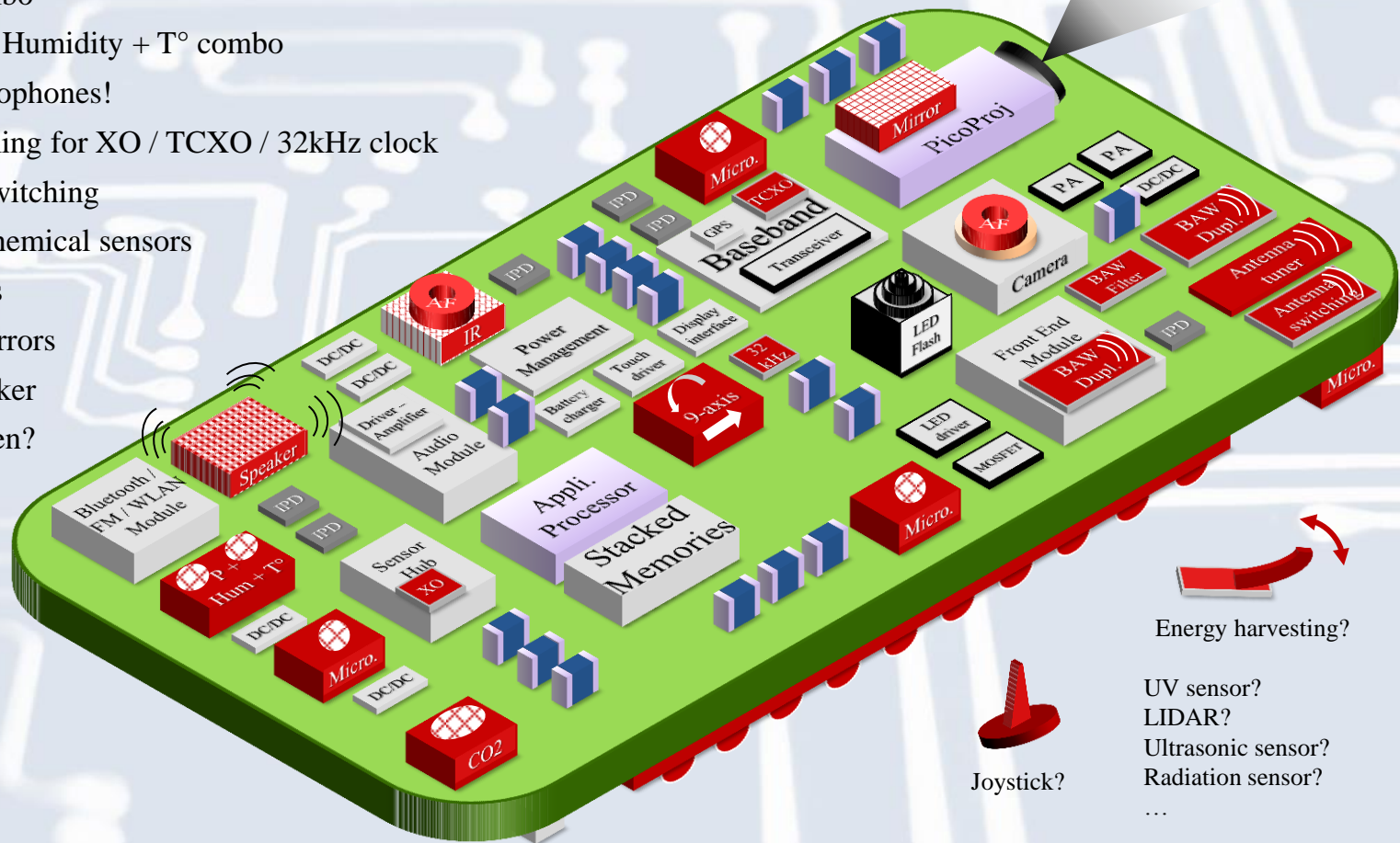


# Simplified View of TOMORROW (2018's) Smart-Phone Board MEMS in red



## New MEMS devices in volume in 2018?

- 9-axis combo
- Pressure + Humidity + T° combo
- More microphones!
- Silicon timing for XO / TCXO / 32kHz clock
- Antenna switching
- Gas / biochemical sensors
- Auto-focus
- MEMS mirrors
- Microspeaker
- Touchscreen?
- IR sensor?





# MEMS Sensor Fusion



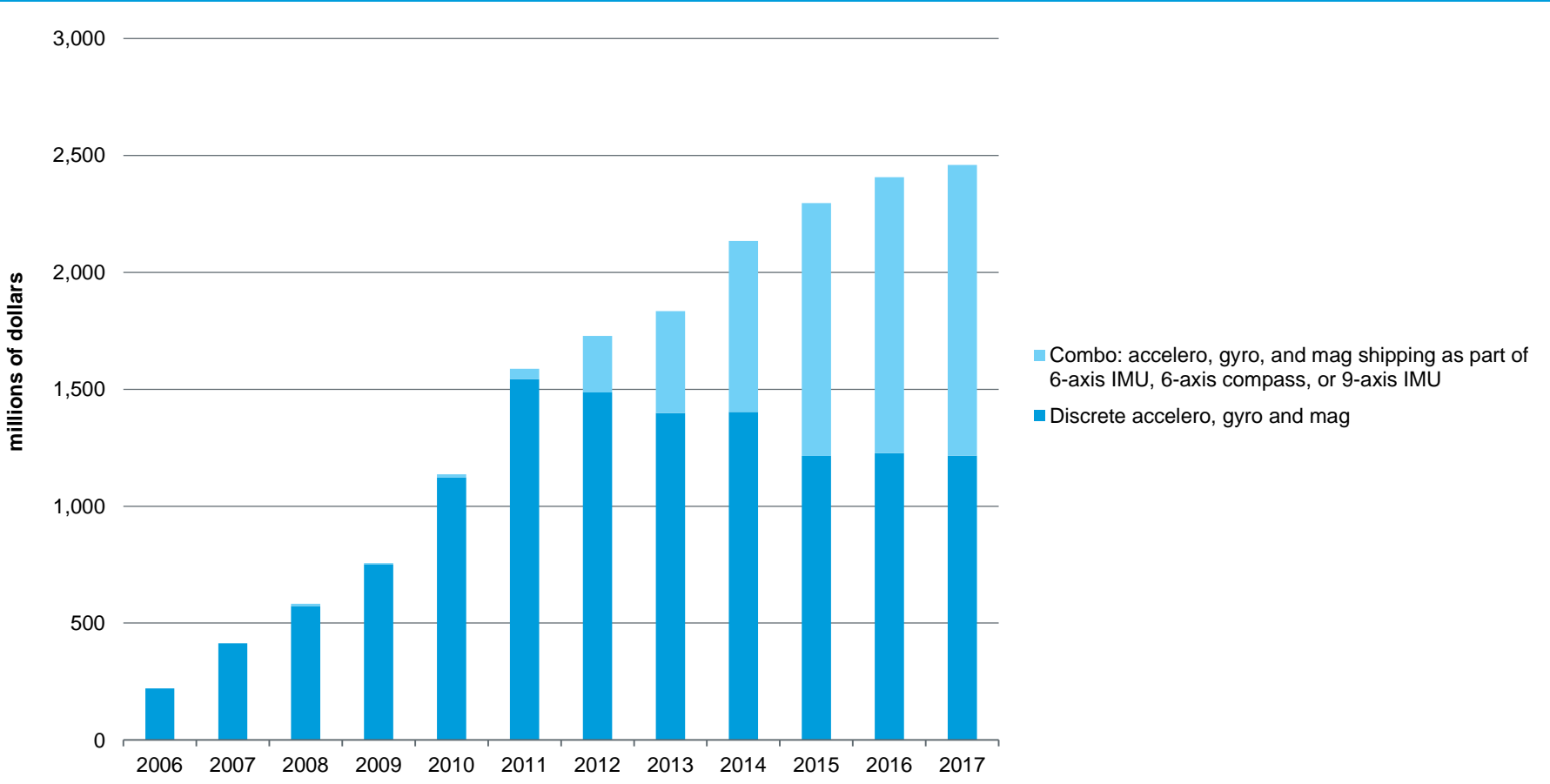
- Combination of software and hardware
- Intelligent, complex and integrated
- Promises increased power and performance while reducing cost
- Often sensor-agnostic



# MEMS Integration - Winning Combination



Combo vs. discrete motion sensor market in value, 2006–2017



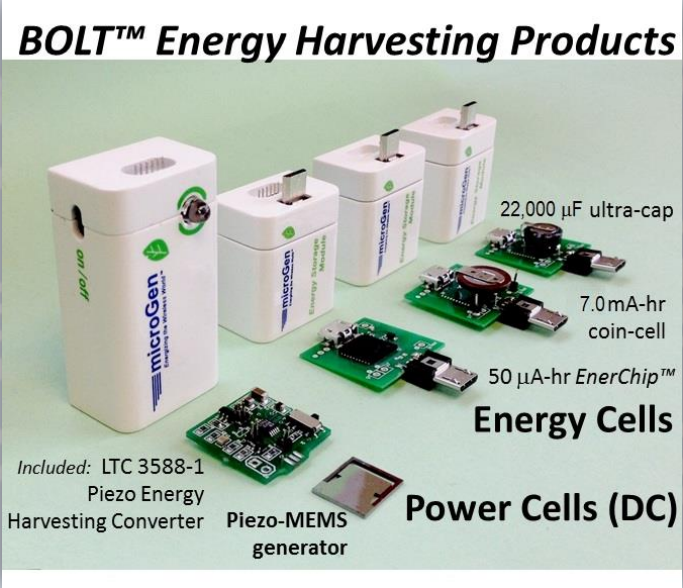
Source: IHS

© 2013 IHS Consumer & Mobile MEMS market Tracker, H1 2013

## Conserving and Harvesting all in One!



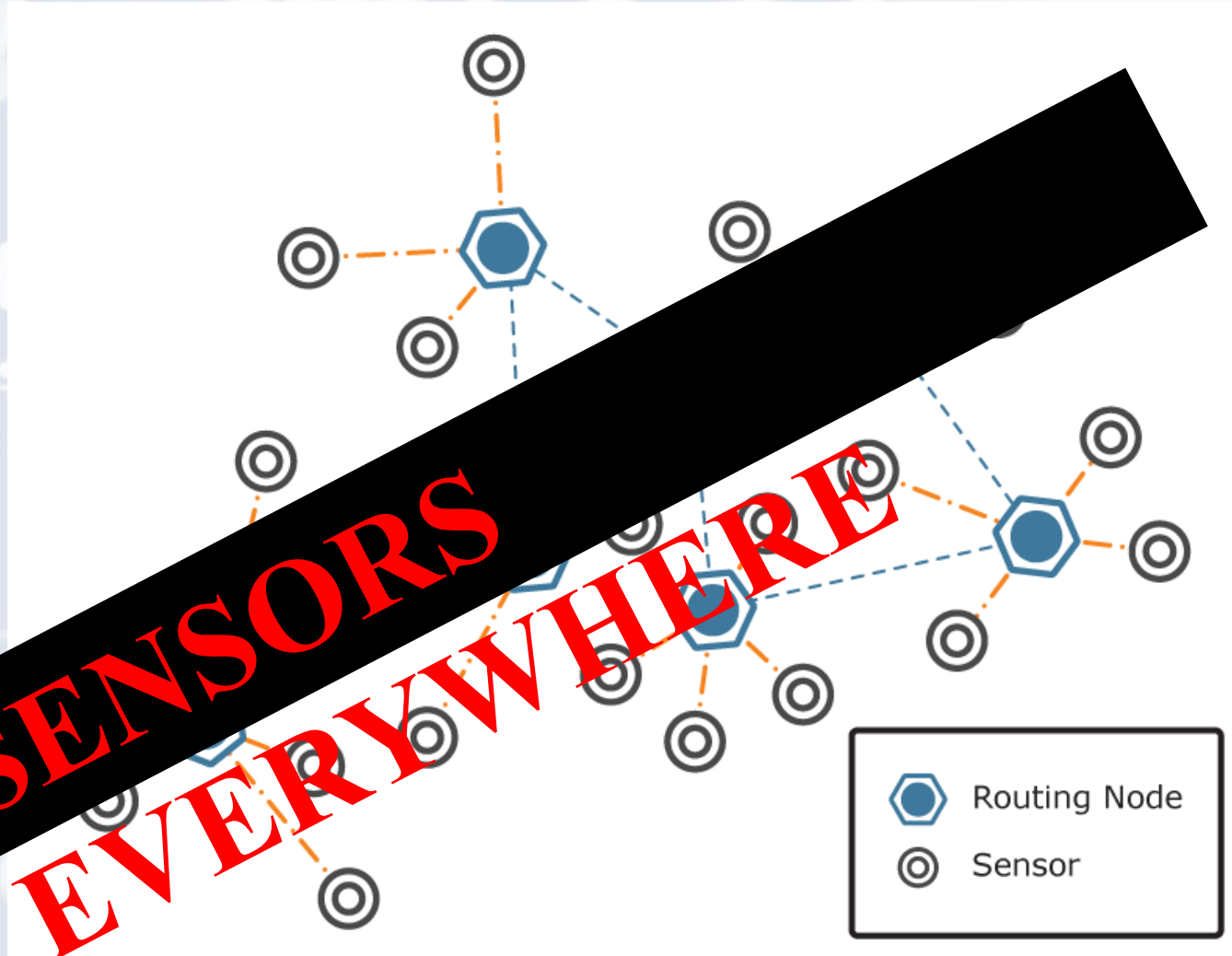
Imec's Autonomous TPMS System ('unity') with Integrated Piezo-electric Energy Harvester



MicroGen Systems' Micro-Power Product Line for Wireless Sensor Applications

# Wireless Sensor Networks (WSN)

**SENSORS  
EVERYWHERE**





# Biggest Trend = “Smart Everything”



By 2020, the IoT is estimated to help drive 22 times as much data traffic as exists today

An illustration showing a wireless tower on the left and three server racks on the right, both connected to a central cloud labeled "IoT". The background is a stylized cityscape.

**freescale** Connected Intelligence

## MEMS/Sensor Market Trends:

- Wireless everywhere
- Smart MEMS and sensors everywhere
- Quantified Self phenomenon
- Multifunction devices – always on and “at the ready”
- Cloud Computing and “Fog Computing”

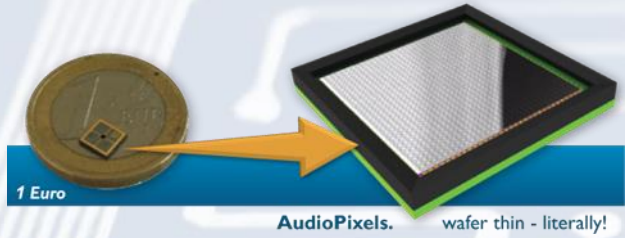
*All enabling a **smart** Internet of Things and Services (IoT<sup>S</sup>)*

# What Does the Future Hold?



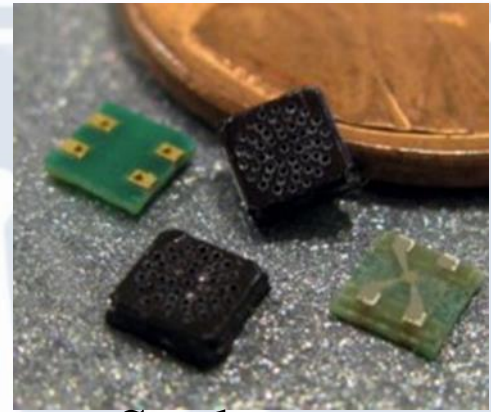
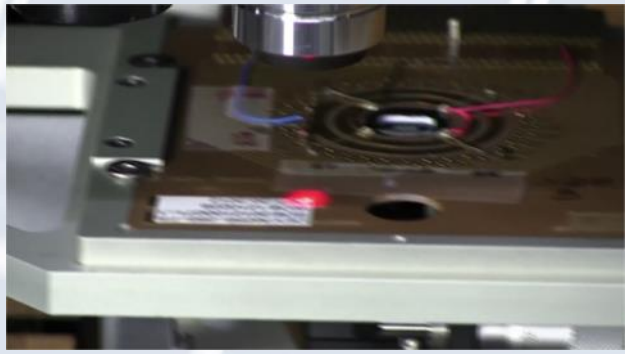
MEMS Speakers?

Thermal camera in handsets?



Audiopixels?

Gas Sensors in Handsets?



# Remaining Challenges



## Standardization (and lack thereof )

Commonly Requested Sensor Vendors

Vendor	Accel	Gyro	Mag	ALS/Prox	Baro-Meter
Aichi Steel			•		
AKM			•		
Alps			•		
ADI	•				
Avago					
Bosch	•	•	•		•
Freescall	•				
Intersil					
Kionix	•				
Honeywell					
InvenSense	•	•			
Maxim				•	
MEMSIC	•		•		
OKI	•				
Rohm				•	
ST	•	•	•		•
Taos				•	
Yamaha			•		
<b>18</b>	<b>8</b>	<b>3</b>	<b>8</b>	<b>5</b>	<b>2</b>

**18+ Vendors**  
**26+ Sensor Product Lines**

MEMS/Sensor Industry response:

- MIG-led creation of historic Standardized Performance Definitions (SPD)

Up next: API Standardization

Courtesy of Qualcomm, used with permission

Courtesy of Qualcomm, used with permission

# MEMS + Innovation = Opportunity



- Wearables!!
  - Smart mobile anything
  - Smart Homes, Smart Farms!
  - Smart Health and Medical Care
- Smart Everything creating a truly intelligent Internet of Things



**Where will MEMS take you?**



# Thank you



**Contact MIG**

**[www.memsindustrygroup.org](http://www.memsindustrygroup.org)**

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