

# Trends in Consumer and Automotive MEMS Sensors

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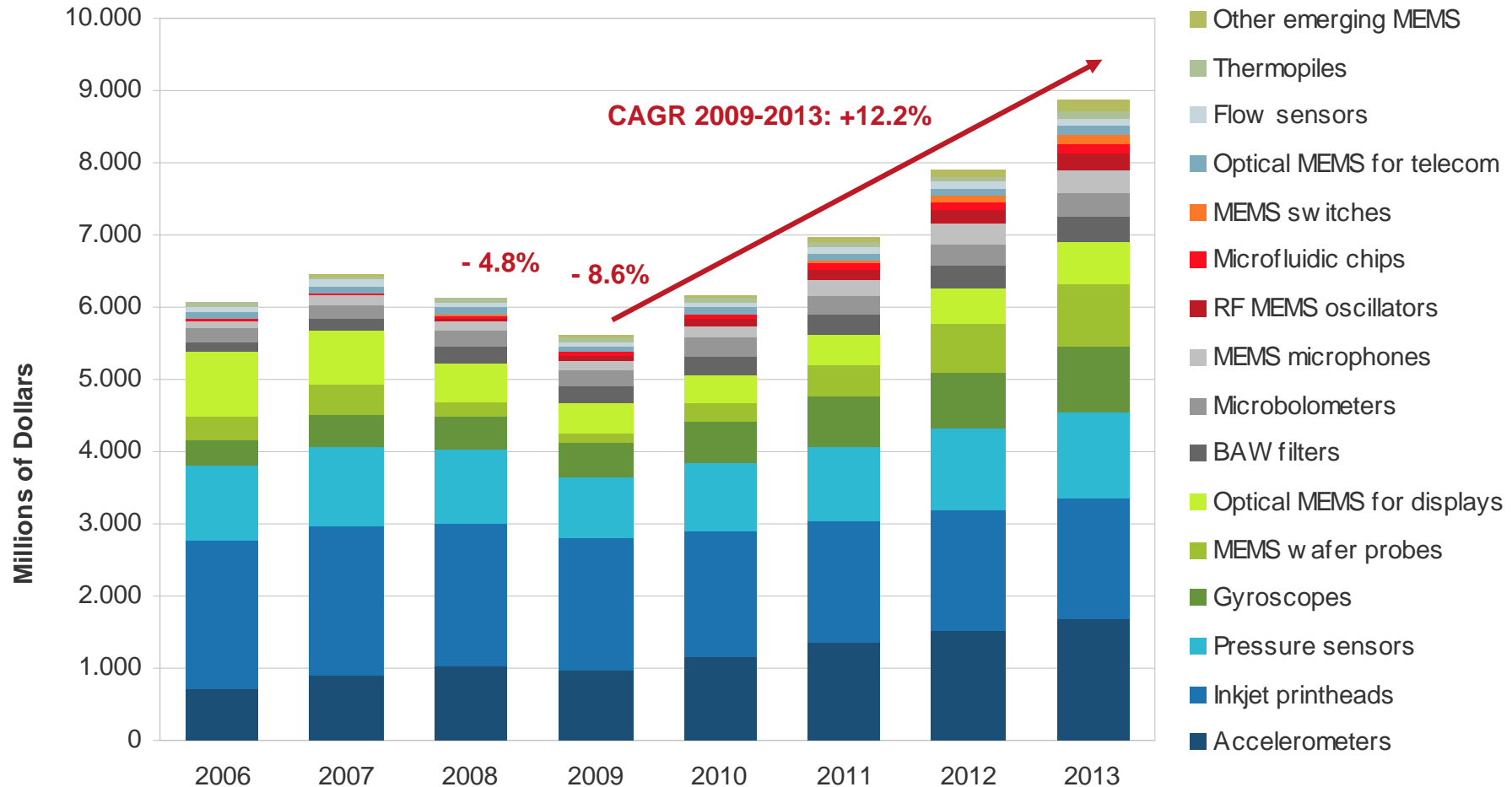
April 2010

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- ▶ Overview of MEMS market recovery
- ▶ New market driver: Consumer MEMS
- ▶ Automotive market recovers in 2010
- ▶ Impact of mandates in EU & US: ESC and TPMS

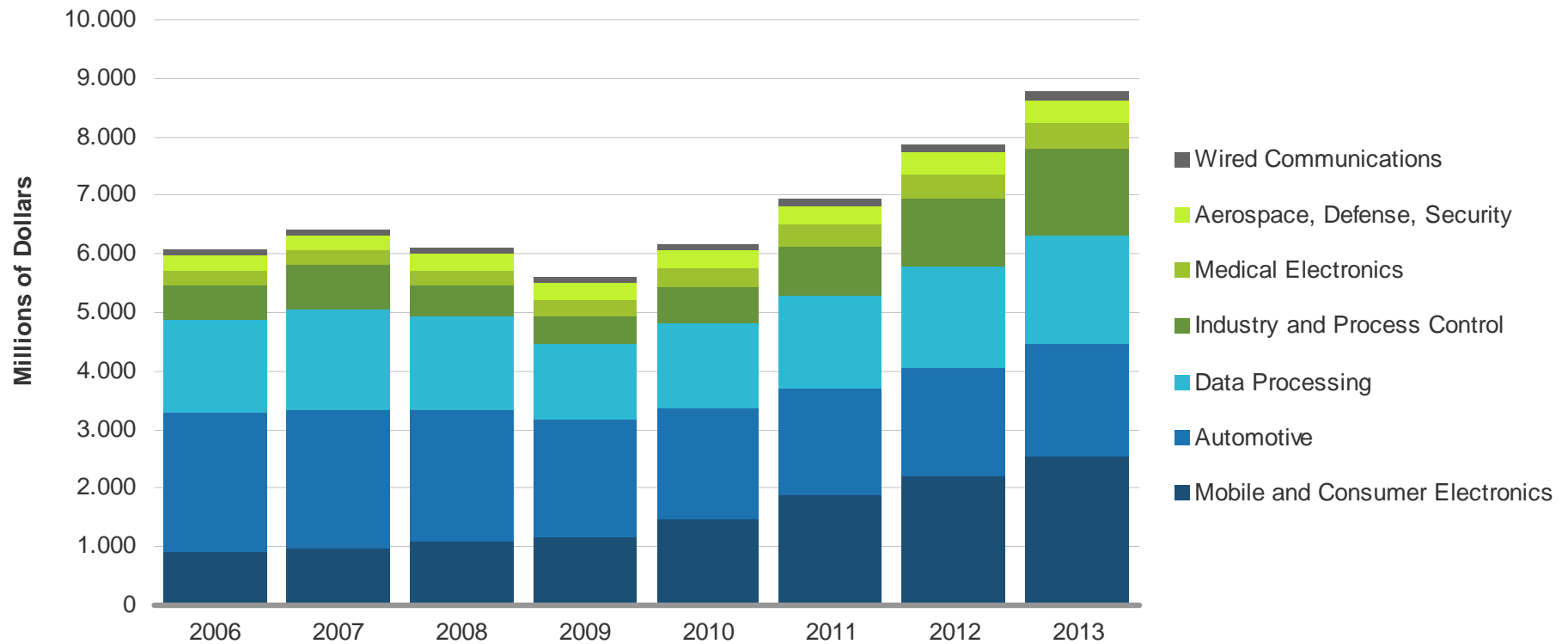
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# MEMS includes many sensors & actuators, applications



Source – iSuppli Corporation MEMS market tracker, H2 2009

## From 3 big segments in 2009 to 4 in 2013



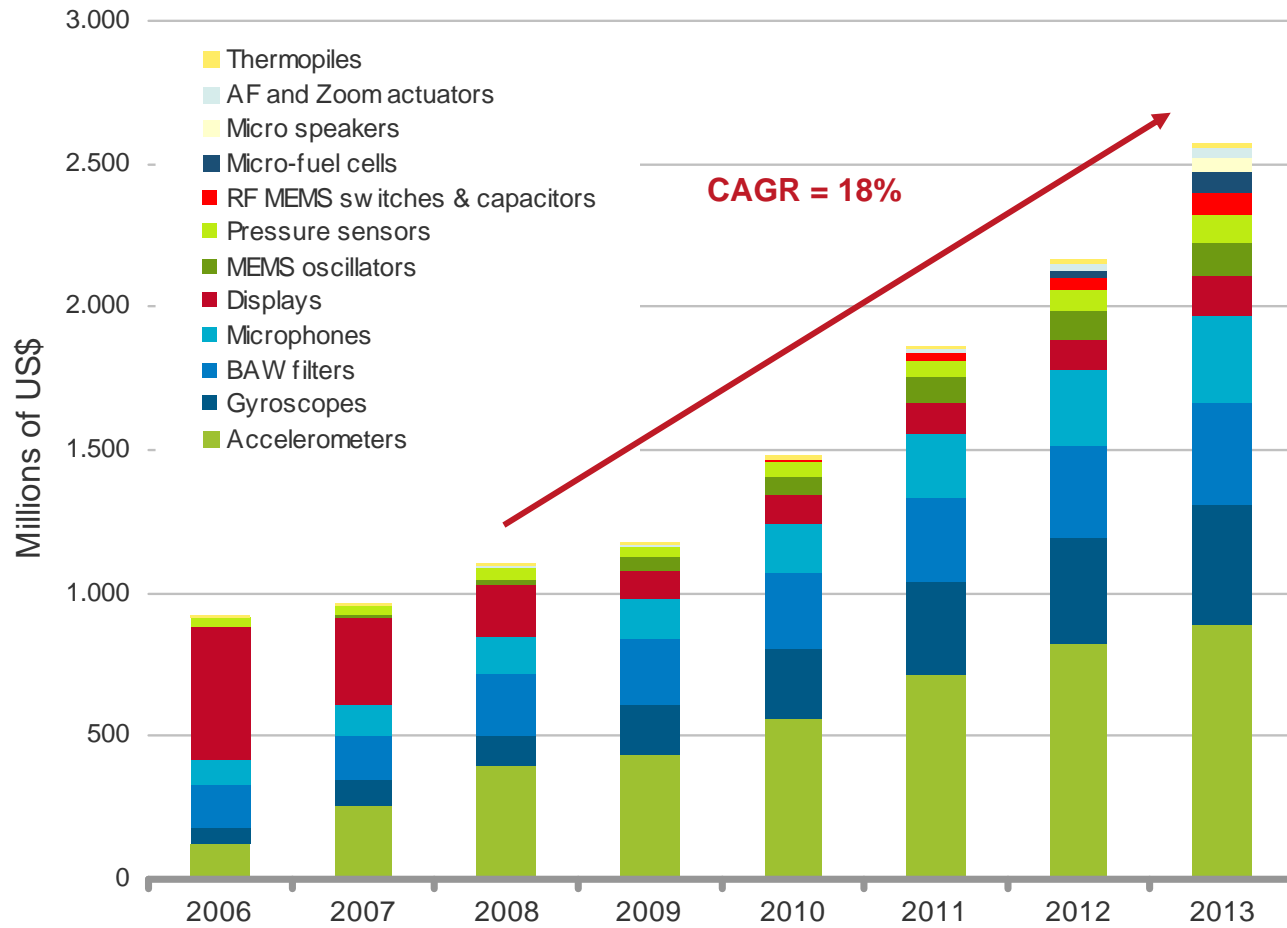
Note: emerging MEMS categories not counted in this breakout (\$163 M in 2013 up from \$19M in 2009)

Source – iSuppli Corporation *MEMS market tracker, H2 2009*

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**Consumer market confirm their status as  
the new locomotive of MEMS markets!!**

# CE and mobile MEMS bulldozed their way through the crisis



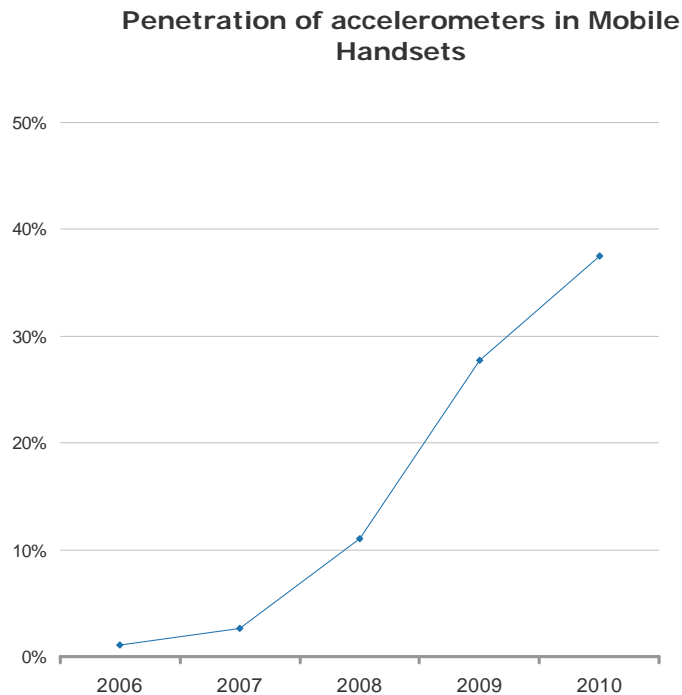
Source – iSuppli Corporation Television Systems Market Tracker

- ▶ Accelerometers for cell phones
- ▶ Multi-axis silicon gyroscopes for gaming and cell phones
- ▶ Pico-projectors
- ▶ BAW filters
- ▶ Microphones stagnate in 2009
- ▶ Accelerometer saturating in gaming
- ▶ No killer app for pressure sensors

Source – iSuppli Corporation Consumer and Mobile MEMS market tracker, H2 2009



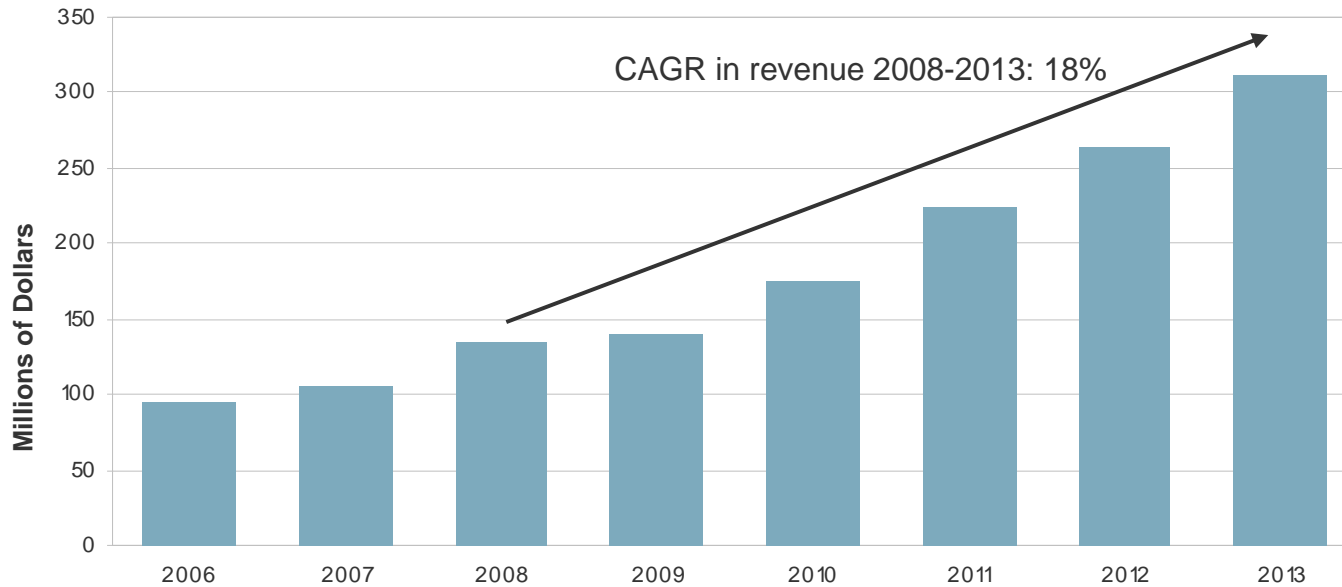
## Every 4th phone with an accelerometer in 2009



- ▶ Bottom-up: 354 million accelerometers shipped for cell phones in 2009
  - Up from 146 million in 2008
  - Reported shipment from ST, Bosch, Kionix, Freescale
  - Estimate shipment from ADI, Memsic and Hokuriku
- ▶ Top down
  - 46% of models introduced by Nokia with accelerometer in 2009
  - 76% at Sony Ericsson!
- ▶ Chinese market feeds growth
  - 80-90 million accelerometers shipped to China
  - Significant impact of the Gray Handset market in 2009
- ▶ Price erodes fast: -34% in 2009!

Source – iSuppli Corporation *Motion Sensors in Mobile Handset report, H2 2010*

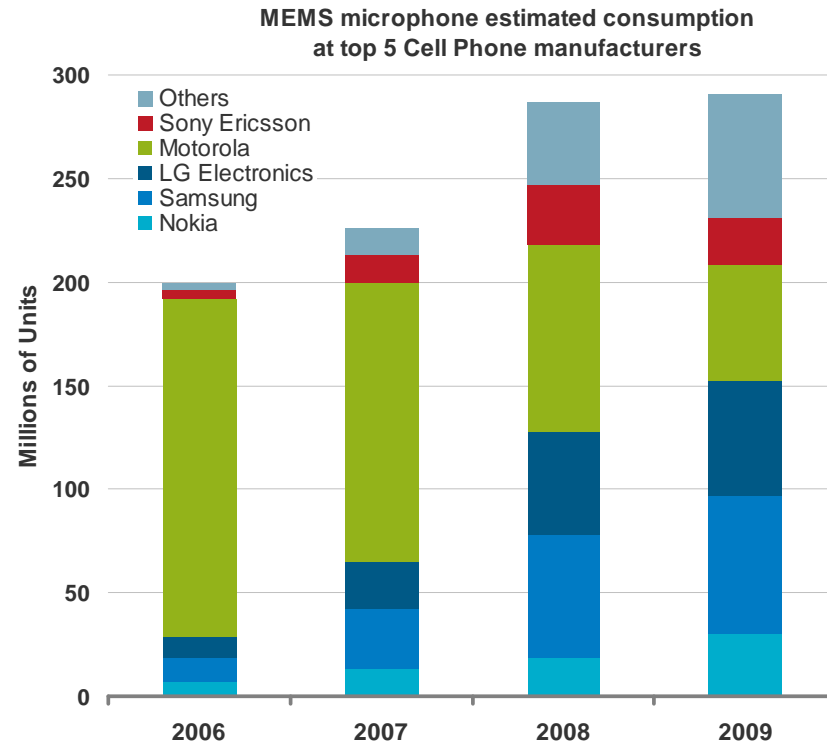
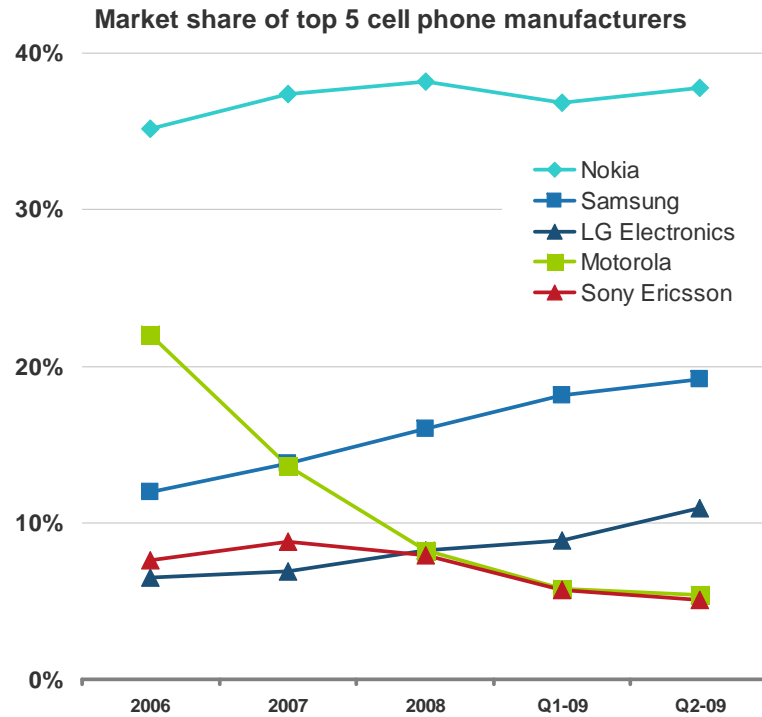
### MEMS microphone market 2006-2013



- ▶ Market up by modest 3% in revenue.
- ▶ Mobile phone market shrunk. This is caused by Motorola’s freefall in the mobile handset space, in addition to overall 12% lower shipments for cell phones this year.
- ▶ Back to significant growth in 2010. **Over a billion units in 2013!!**

Source – iSuppli Corporation *MEMS microphone market report, Dec. 2009*

# Motorola's freefall impacts MEMS microphone market

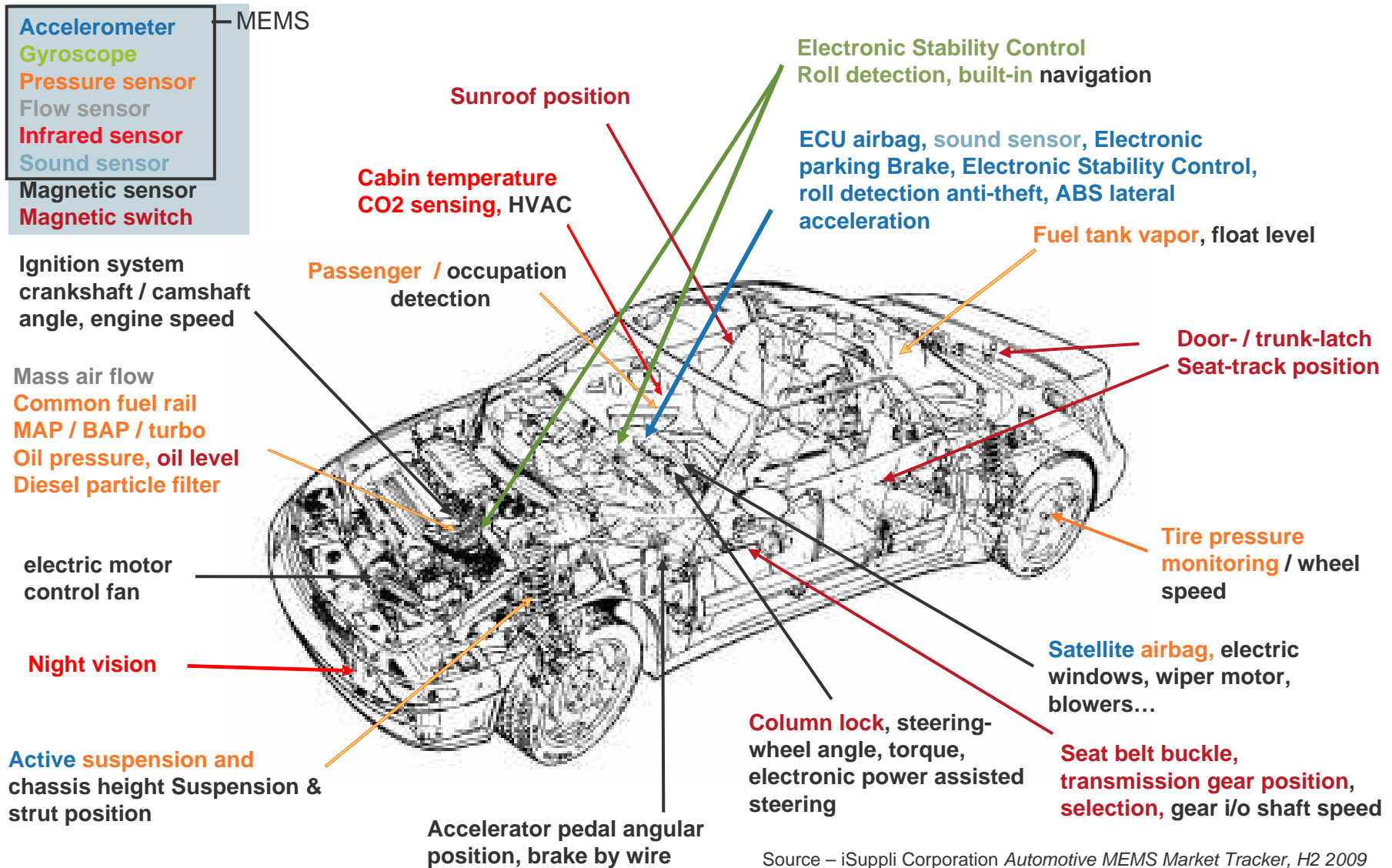


Source – iSuppli Corporation *Mobile Handset Market Shares*

Source – iSuppli Corporation *MEMS microphone market report, Sept. 2009*

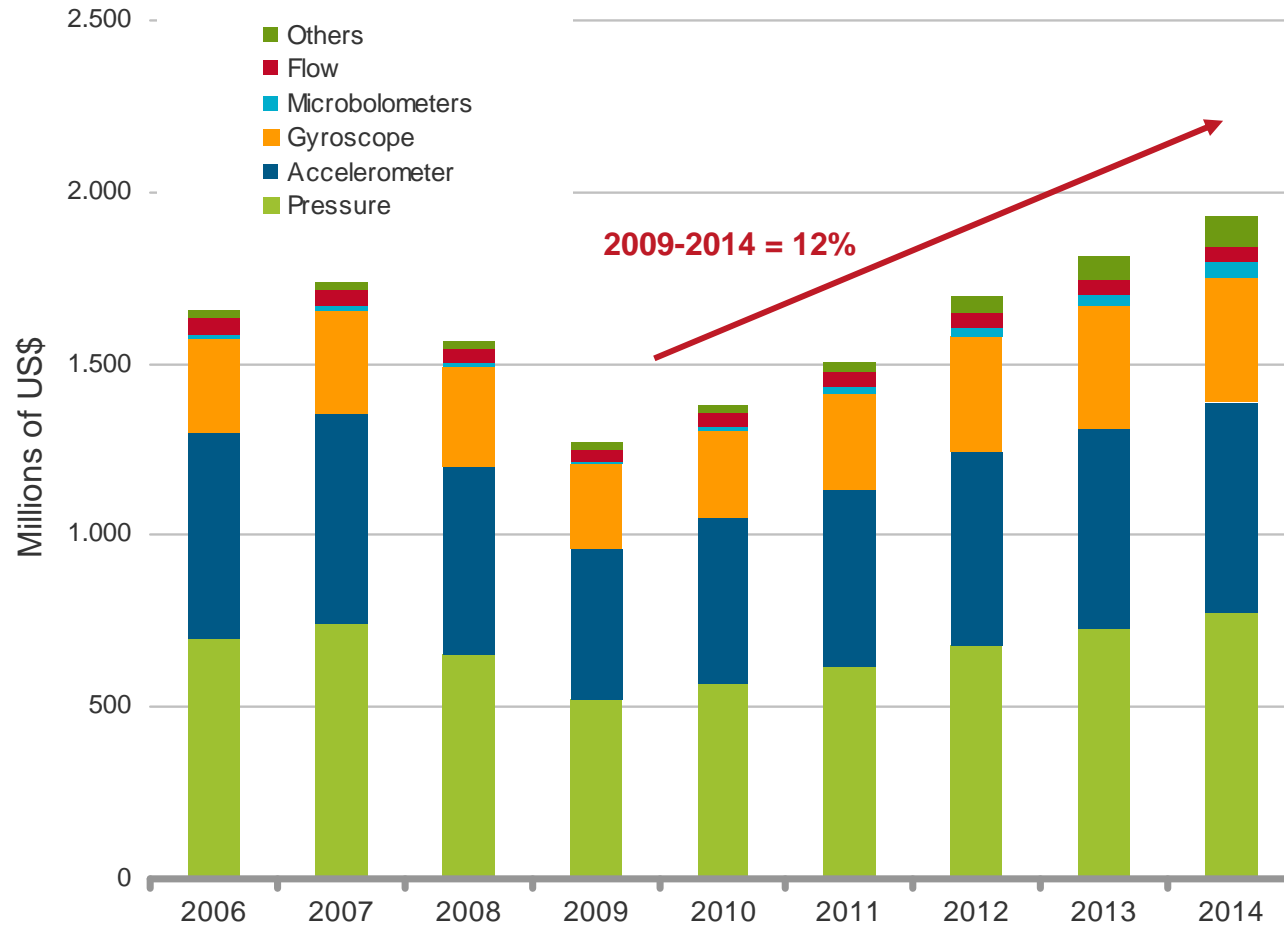
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# Over 30 MEMS sensors in high end cars today



Source – iSuppli Corporation Automotive MEMS Market Tracker, H2 2009

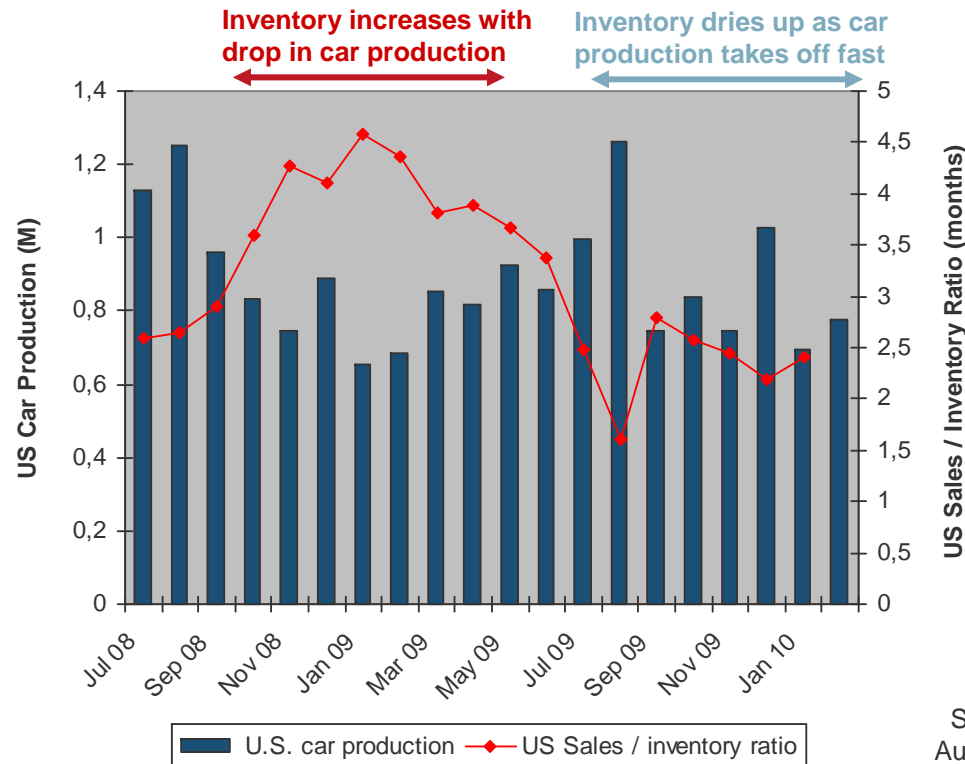
# Automotive MEMS back to double digit growth in 2010



Source – iSuppli Corporation Automotive MEMS Market Tracker, H2 2009

- ▶ -19% in 2009
- ▶ 12% growth 2009-14
  - Multiple sensors/car (8)
- ▶ Market driven by mandates
  - Price erosion
- ▶ Sensor fusion calls for multi-sensor solutions
  - Size issue
  - Cost reduction
- ▶ Supplier's landscape is being re-shaped
  - Mandates
  - Multi-sensor solutions
  - Low-cost from CE
  - Vacuum left by bankrupt companies
- ▶ Impact of electric cars?

# What happened to the supply chain in 2009?

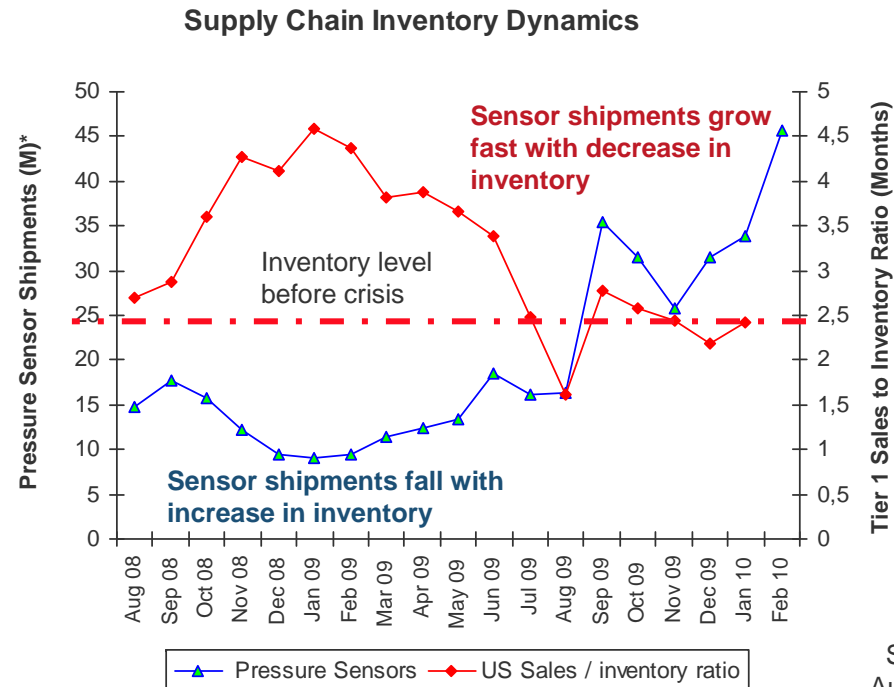


Data courtesy: US Department of Commerce

Source: iSuppli H1 2010 Automotive MEMS Tracker

- ▶ U.S. showed automotive sales-to-inventory level had swollen from historical run rate of 2,5 months to 4 months due to lack of car sales
  - OEMs stop buying sensor components and use what they had on shelves
  - Due to continued slow sales this inventory level bottomed at 1.5 months and required restocking quickly as vehicle demand resumed

## What was the implication, e.g. for pressure sensors?



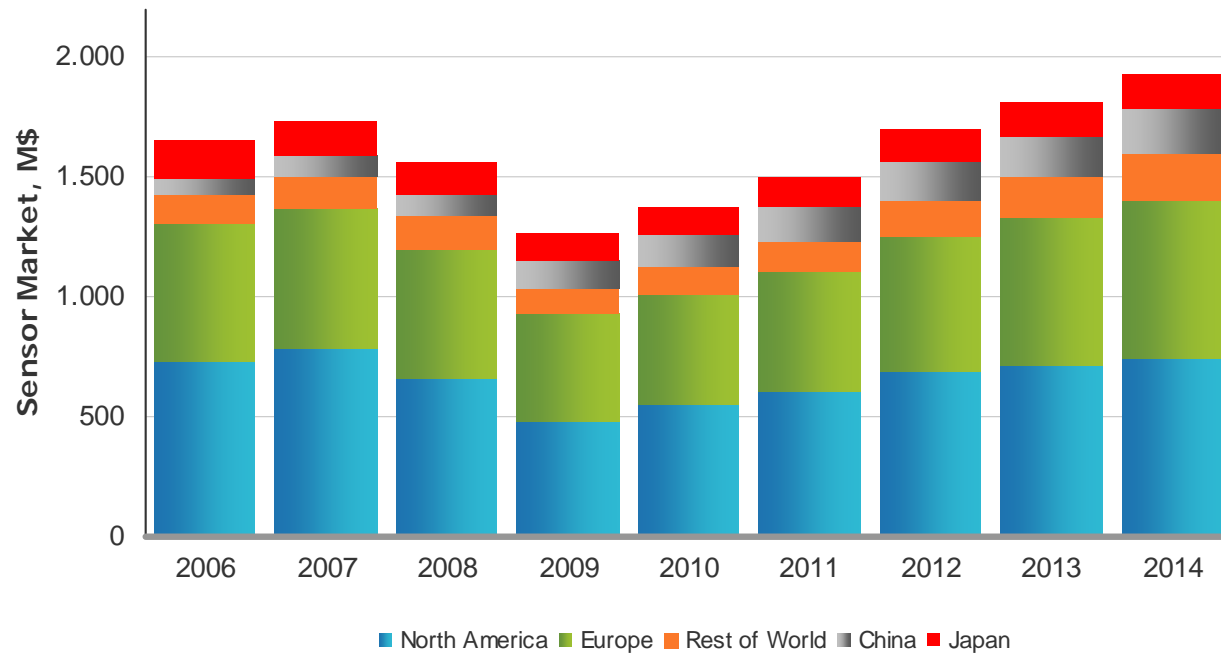
Data courtesy: WSTS Sensors and Actuators, US Department of Commerce

Source: iSuppli H1 2010 Automotive MEMS Tracker

- ▶ Sensor makers hit hard as the tier 1s burned inventory
  - Huge ordering spree to replenish stocks starting in mid-2009
  - Pressure sensor shipments triple, show no signs of slowing yet!
    - Multiple sensors per car (engine management, TPMS, side airbags, ESC.....)
  - Shipments should stabilize in first half of 2010 to avoid a “bubble” in H2

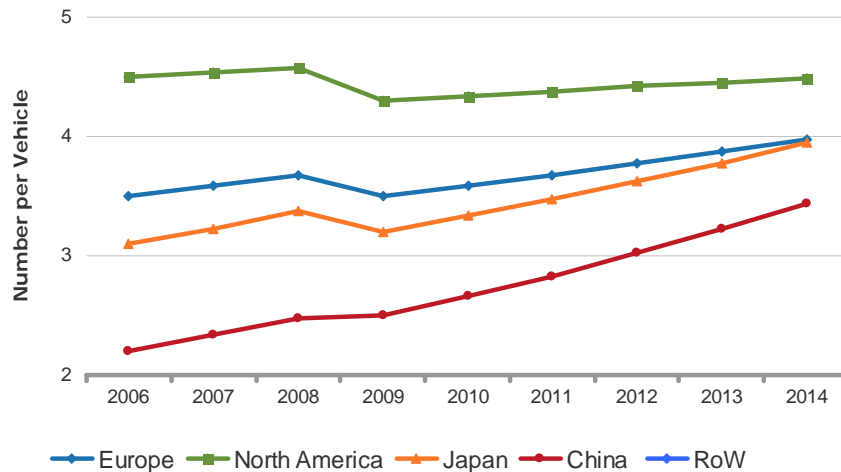
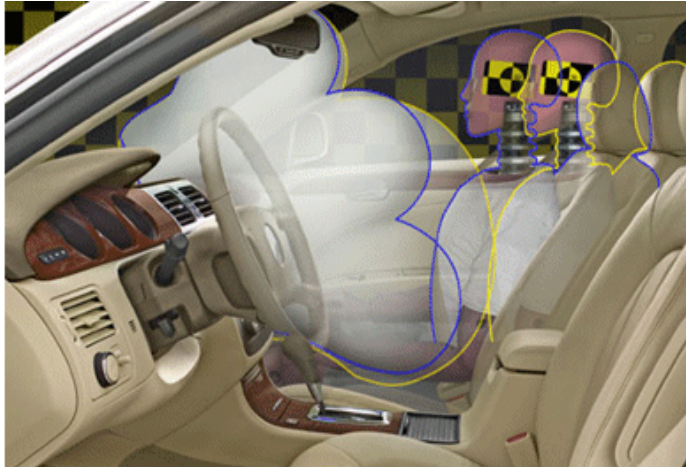


# Market by region



Source: iSuppli H1 2010  
Automotive MEMS Tracker

## The importance of China

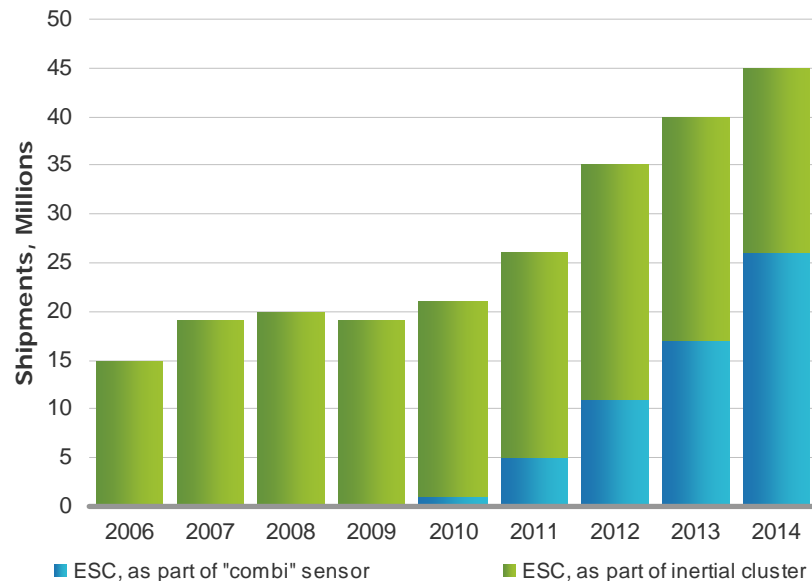


Source: iSuppli H1 2010 Automotive MEMS Tracker

- ▶ Fastest growing region for sensors: CAGR 19% from 2009 to 2014
  - Ahead of Japan in 2014
- ▶ Bright spot for suppliers, helped soften blow in 2009
- ▶ Mostly due to high car sales and reasonable equipment rates
  - Sales up 48% over 2008 (iSuppli China Research Group)
- ▶ Currently third behind North America and Europe, which are being driven by mandates
  - Chinese cars with several airbags
  - ESC in the luxury segment
- ▶ Bosch (and local JV United Automotive Electronic Systems) leading position in engine management sensors
  - China extending subsidies to encourage buying of cleaner cars in 2010
  - More sensors in powertrain, e.g. MAP, position sensors in crank...

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## Combination Package Sensors: Market and Supply Chain



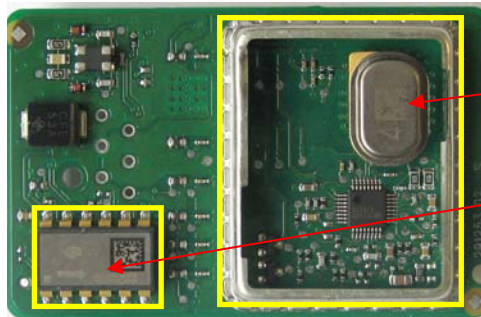
Source: iSuppli H1 2010  
Automotive MEMS Tracker

- ▶ Start in 2010 with low penetration, but grows to over 50% in 2014
  - ESC mandates (US/EU), are driving price of system components down
  - Obvious savings with packages, etc
  - Simple inertial clusters with a gyroscope and 2 axis accelerometer in separate packages will co-exist in market, for low cost platforms
- ▶ Supply chain
  - Continental with VTI sensors, Bosch with Bosch (> 70% market share)
  - Denso develops combo using its own accelerometers and gyroscope (due in 2010)
  - Freescale targets ESC combination sensors in 2012
  - Could relegate some suppliers to ESC systems without multi-sensor packages
    - Panasonic, ADI....
- ▶ Supply chain becomes more dynamic
  - Autoliv attacks market with ESC market with inertial sensors in airbags
    - Analog Devices (gyroscope) and MEMSIC (accelerometer)

## ESC “combination” sensors close up

Sensor cluster SC03, SOP Year: 2003

Board space for inertial sensors: 1308 mm<sup>2</sup>



Systron Donner  
(BEI) gyroscope

VTI  
accelerometer



VTI  
accelerometer  
+ gyro cluster

Sensor cluster SC06.2, SOP Year: 2009

Board space for inertial sensors: 234 mm<sup>2</sup>

Courtesy of Continental 2009

- ▶ Simple inertial cluster
  - 2 packages, 2 ASICs, 2 sensors = 6 components
- ▶ Combination sensor
  - From 6 down to 4 components
  - \$0.20 saved on package if plastic, more if ceramic
  - Shared ASIC, save on silicon area, and gyro ASIC is expensive
- ▶ Integration and space saving
  - Up to 5X less real estate
  - Yield issue offsets major cost savings = about 5-10% reduction
- ▶ Ultimate step monolithic integration
  - 1 package, 1 ASIC, 1 sensor
  - Yield issues, not before 2014

### Approach 1: inertial cluster



### Suppliers of sensors



### Approach 2: multi- sensor package ("combi" sensor)



Developing markets with domestic focus like China, India, Russia...buy inertial sensor clusters and integrate into cheap "box" with own electronics + algorithms

- Brake ECU
- Not for export
- simple, low cost, lower algorithm content

Mainstream developed markets, also with export focus (EU, US, Japan, Korea...) follow current integration route

- Brake ECU
- Body ECU / Airbag system ECU
- combined with ACC, etc (ADAS)
- complex, high algorithm content

iSuppli

- ▶ Since 1998 at Porsche
- ▶ Two-fold motivation:
  - Safety
  - Fuel savings
- ▶ Long presented as the new “El Dorado” of automotive MEMS
  - US mandate in 2007
  - EU mandate from 2012
- ▶ Direct system largely dominates
  - 100% of US in 2007
- ▶ Over 10 companies in R&D in 2006



TPMS system, Schrader

## Why is TPMS such a hot debate today?

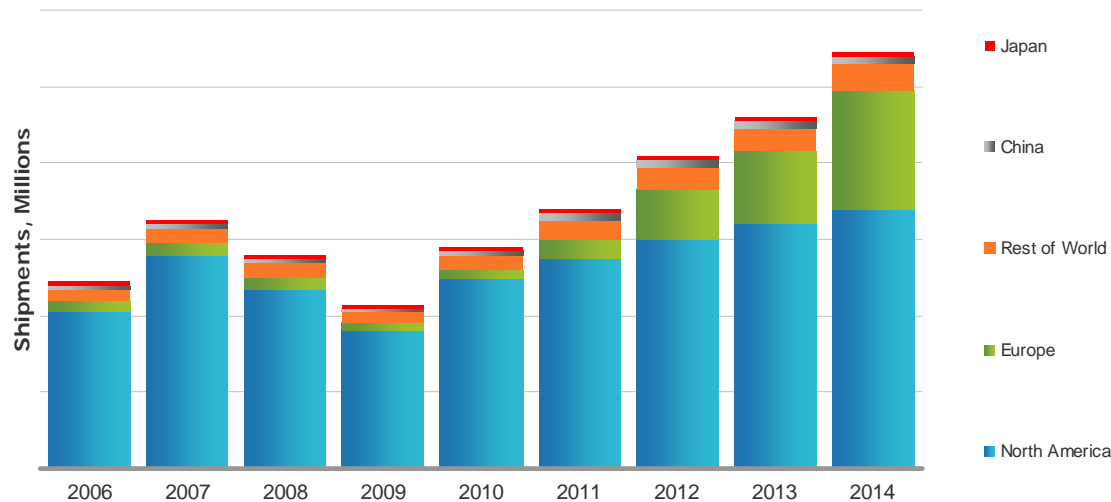
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- ▶ Direct systems
  - Direct systems bring best performance. Use MEMS pressure sensors
- ▶ Indirect systems
  - Indirect is potentially much cheaper. Use wheel speed sensors from ABS + algorithm
  - But cannot make instant measurements, driver is responsible for calibrating system
- ▶ March 2010 UN economic Commission on Europe (UNECE) specs indicate direct pressure TPMS will win
  - In European market, TPMS must detect 20% drop in pressure in any of 4 tires in maximum 60 minute interval, within tolerance of +7 kPa
  - In US, systems warn driver within 20 minutes of a drop of pressure of 20%.
- ▶ 7 kPa tolerance very tough for indirect systems as they stand today
  - Second set of more stringent criteria will be agreed and phased in for Europe market in 2015, making it tougher for indirect systems
- ▶ Wounded animal syndrome: indirect will probably come with better designs
  - Today only one company really pushing (Nira Dynamics/Audi)



## Market impact of European TPMS mandate

- ▶ Proportion of cars with TPMS grows from 17% in 2009 to 33% in 2014
  - Exception Audi A6 already in U.S. market, some high end models like BMW using Nira D. system
- ▶ Big market driver for sensors
- ▶ 4.2 MEMS pressure sensors per car on average
- ▶ US and EU drive market. low penetration elsewhere, even Japan
  - Low cost inaccurate indirect systems
  - Not all cars with ABS (15% without)



Source: iSuppli H1 2010  
Automotive MEMS Tracker

- ▶ MEMS sensors and actuators market experience first downturn in 2009
  - Market down 9% in 2009
- ▶ Growing at 12% starting 2010
- ▶ Consumer electronics and mobile devices new market locomotive
- ▶ Automotive disaster in 2009
  - Exception China
- ▶ Recovery in 2010
  - 12% from 2009 to 2014

**Thank you**

- ▶ 3 trackers, updated every 6 months
  - General MEMS
  - Automotive MEMS
  - Consumer & Mobile Phones
- ▶ Topical reports updated every year
  - MEMS for Automotive ESC
  - Inertial MEMS and magnetic sensors for mobile phones
  - Magnetic sensor market
  - MEMS microphone market
  - MEMS switches (2010)
  - MEMS oscillators (2010)
- ▶ MEMS Competitive Analysis (yearly)
- ▶ Monthly MEMS Market brief
- ▶ **Custom projects:** strategy, competitive analysis, tailored market research

The screenshot displays a Microsoft Excel spreadsheet titled "MEMS\_H1\_2009\_Market\_Tracker\_Database.xls". The spreadsheet contains a table with columns A through M and rows 1 through 11. The table header is "iSuppli". Below the table, there is a section titled "Economic Crisis Accelerates Transformation of the MEMS Industry" and "MEMS H1 2009 Market Tracker". This section includes several hyperlinks: "Review of 2008 Results, Top 50 MEMS Suppliers", "Review of 2008 Results, Top 20 MEMS Foundries", "Total Market by MEMS Device Groups", "Total Market by Application Field, Revenue", "Total Market by Application Field, Units", and "Wafer Starts for MEMS".

Below the spreadsheet, there is a green banner with the iSuppli logo. To the right of the banner is a "MEMS Market Brief" report. The report is titled "MEMS Market Brief" and is dated January 2009. It is written by Thomas Barwood, Principal Analyst & Robert Dixon, Senior Analyst, MEMS. The report includes a "Market Snapshot" section titled "2008: What a Year!" which discusses the year's performance for MEMS. It also includes a "Flashback to 2008" section titled "Consumer and Mobile: Exceeding Expectations" which discusses the impact of the iPhone and other mobile devices on the MEMS market. The report also includes a "Table of Contents" and a "Market Snapshot" section.

## Unique resources of iSuppli for MEMS and sensors coverage

iSuppli

- ▶ iSuppli MEMS & Sensors team
  - Four analysts and researchers
  - Leading expertise in automotive MEMS, CE and mobile handsets, RF MEMS, magnetic sensors...
- ▶ Unlimited access to iSuppli analyst teams specialized in
  - Mobile phones
  - Display
  - Consumer electronics
  - Laptops and storage
  - Automotive...
- ▶ iSuppli teardown team
- ▶ Worldwide coverage



**Teardown analysis of new Sony PS3 controller**

Source – iSuppli Corporation Teardown Analysis