Motion Interface
A Transformational Technology

InvenSense
Innovation in MEMS

Motion Interface
The Next Large Market Opportunity

Rapid Adoption by Leading Consumer Electronics

Accelerometer · Gyro · Compass[1] · Pressure[2]

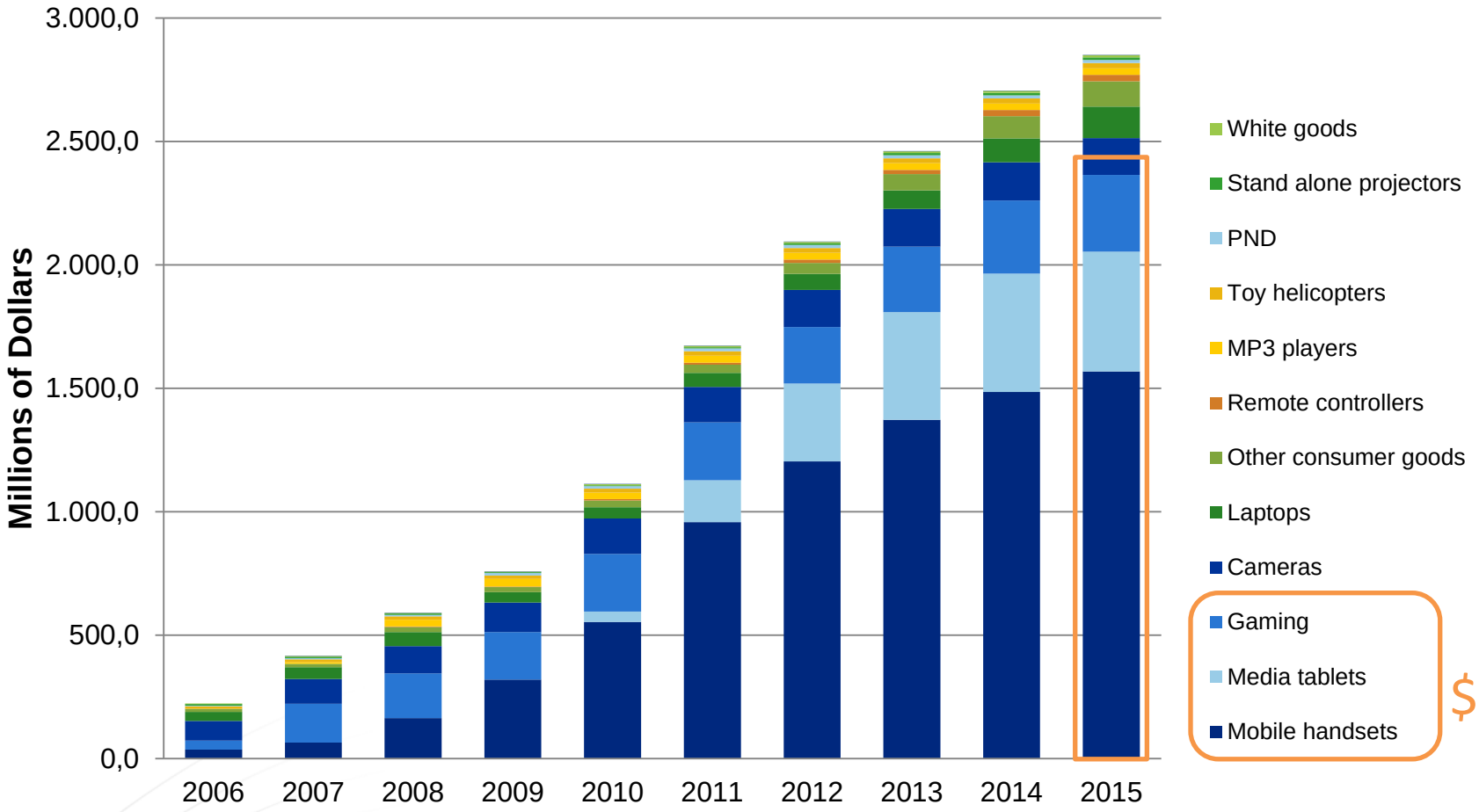
Motion Interface: Key Enabling Functions

Motion Interface Use Cases

Motion Interface: A Transformational Technology

Bluetooth®	Wi Fi™	*Touch Screen*	MotionInterface™
2.5BU/yr	**1.9BU/yr**	**1.4BU/yr**	**~2BU/yr**

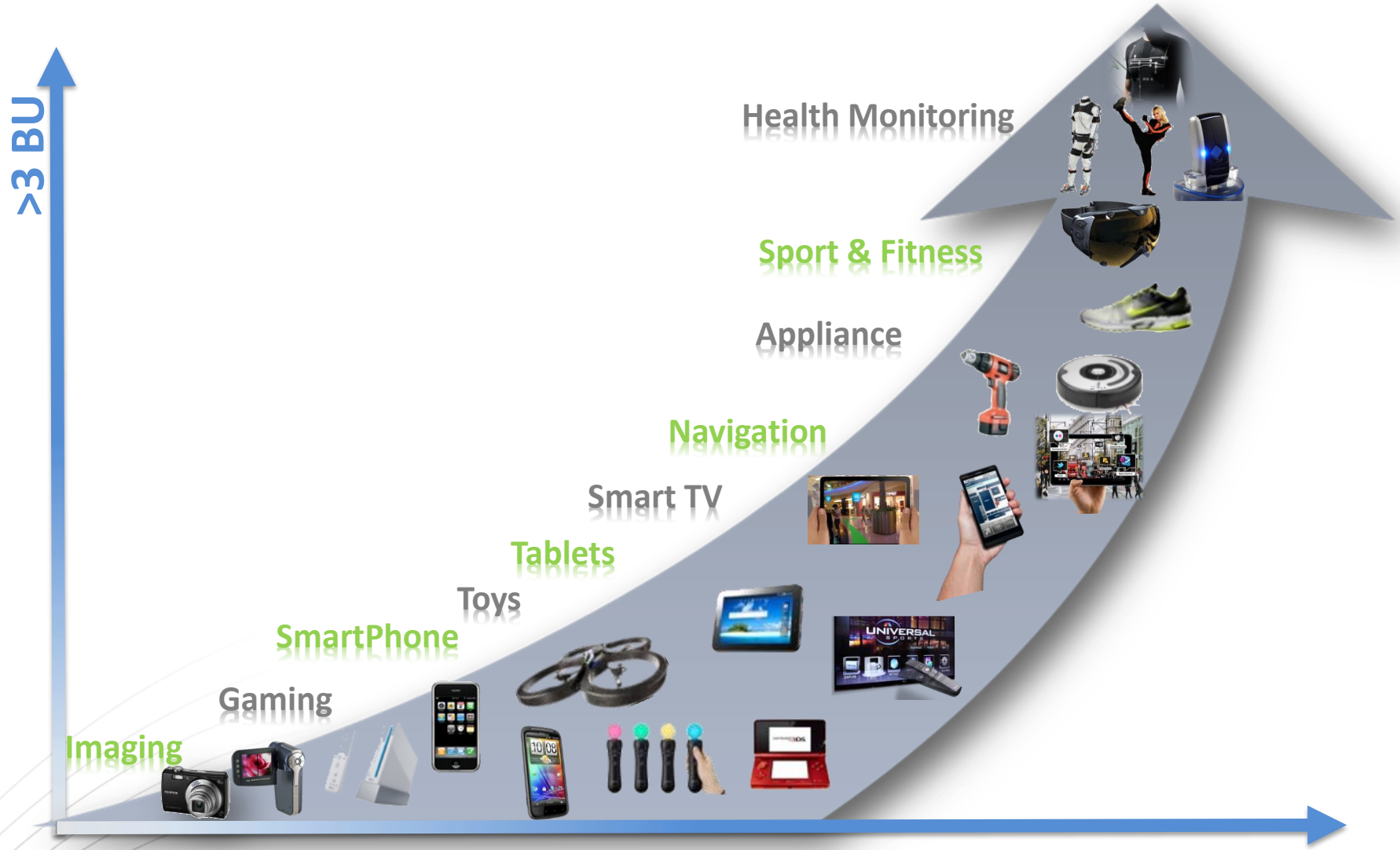
Market for Motion Interface (accelero, gyro, compass) Consumer and Mobile Applications, 2006-2015



Source: IHS iSuppli „Consumer & Mobile MEMS Market Tracker“ and Special report „Magnetic Sensors“

Opportunity for Many More High Volume Applications

Fast Adoption and High Market Growth



Gaming
1:1 Motion for More Immersive Experience

Motion Sensors for Gaming
Inertial sensor use pushed by game-station manufacturers

Example of game station manufacturer push for inertial sensors: Wii Motion plus

1st Game Controller With 6-axis 2009

Motion Sensors for Gaming
Portable game stations

- Portable game station now also integrate motion sensors!

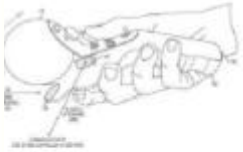
Nintendo 3DS

nasonic has announced a portable game station to be released in 2011: "The Jungle"

Motion Sensors for Gaming
Microsoft and Sony follow Nintendo in motion sensing

- After numerous rumors, Sony announced a new motion-sensing

Sony Move Controller



Concept of new controller (Sony patent)

Motion Sensors for Gaming
Microsoft and Sony follow Nintendo in motion sensing

- Kinect project is supposed to remove controllers
  - Developed by the Israeli company 3DV Systems, acquired by Microsoft in June 2009
    - Technology was originally developed for the defense industry!
    - Rumors say that Nintendo declined the technology. 3DV Systems then contacted Microsoft
  - Kinect technology also uses optical recognition technology licensed from GestureTek
  - This system is able to recognize motion of several players
    - Time-of-flight camera technology was considered but it was too costly
    - The choice was thus to use a IR LED and the standard VGA CIS → special NIR camera which capture projected IR patterns by pulses + classic video camera
  - Released in Nov. 2010, it has been a media success, but will it be a market success?
  - Casual gaming and party games are targeted

Microsoft Kinect, using NIR camera (developed by PrimeSense)

Smart Phones: Intuitive User Interface

1st SM-Phone With 9-axis 2010

~60% Attach Rate for High End SM-Phones

Tablets: Intuitive User Interface

Apple iPad

Blackberry Playbook

1st Tablet With 9-axis 2011

~80% Adoption By all Makers

Key Drivers for Motion Interface Expected to Become Standard Function

Gaming

Panorama Viewer

Gesture UI

Health & Fitness

LBS

LBS Driving Motion Interface and Performance

Strategy Analytics predicts consumer and advertiser expenditure on LBS to approach $10 Billion by 2016

Location based service (excluding business market) revenues are forecast to increase from $2.9bn to $10.4bn between 2010 and 2015

Alternative Location Market to Reach $8 Billion, Indoor to Follow

- Published on: 17th May 2012

- Precision indoor location is stealing the headlines
  - **Wide-area alternative/hybrid location is where the money is today**.
- GPS, Bluetooth, Wi-Fi, and cellular location technologies will be installed on over 1B devices in 2017
  - **Direct revenues forecast to break the $8 billion mark.**
- "Increasingly, tablet, camera, and portable gaming vendors are using location to differentiate and support additional services and revenue models. Others, like the femtocell market, are driven by mandates. ….."
  - Patrick Connolly ABI Research

Motion Interface Is Now A Requirement

- Android v4.0 Ice Cream Sandwich
  - "4.0 Compatibility Definition" spec from Google

- Windows 8
  - "Integrating Motion and Orientation Sensors with Windows 8 PC Hardware" spec from Microsoft

Smart TV Remote Market

Air Mouse

SmartTV Remote

Motion Software - SmartTV

Motion Remote Benefits

- Intuitive
- Gesture shortcuts
- Fewer buttons

Set-Top Box Remote

SmartTV Remote

Personal Navigation Market

GPS Sports Watch

Sensor aided Navigation Benefits

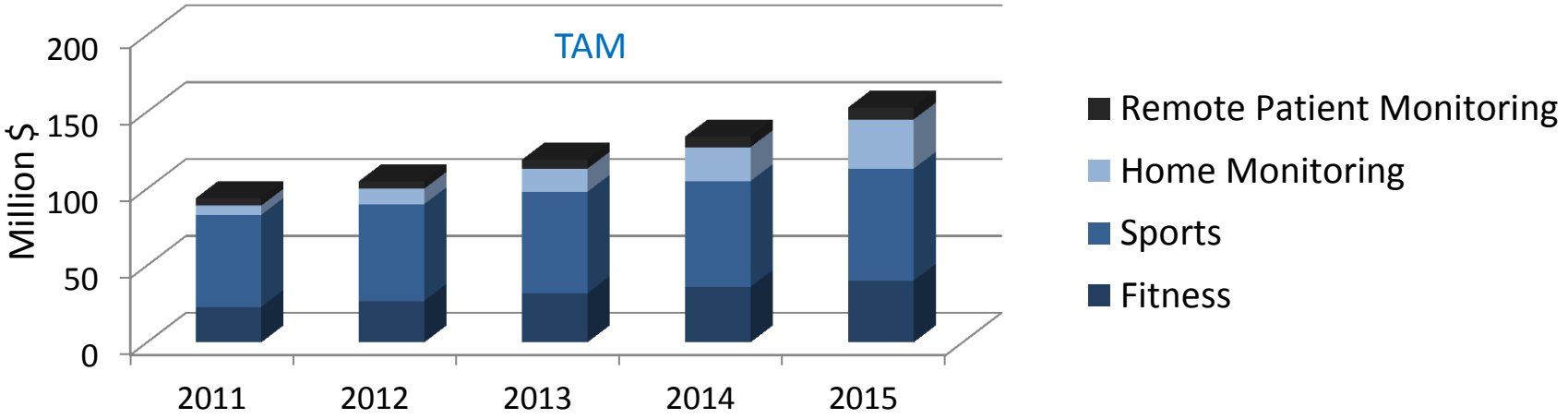
- 1m Accuracy for Indoor Nav
- Aid GPS in urban canyons & tunnels
- Lower system power

GPS AutoNav

Handheld GPS

GPS enabled Ski Goggles

Wearable Sensor Large Market Opportunity



Basis

BodyBugg

Fitbit

Oregon Scientific

Adidas

Nike

Polar

Garmin

MotoActiv

Motion Interface: Enabler for Sports

Activity Monitor

Robust activity detection over a wide range of human body motion

Golf Putter

Swing Analysis – Range, Plane of swing, club speed

Power Meter

Accurate measurement of power output by a bicyclist

Sports Kinetics

Range and Speed of motion for athletes

Ball Tracking

Tracking ball for performance

Motion Interface: Enabler for Health Monitoring

Fall Detection

Patient Tracking

Indoor location tracking
for Alzheimer's patients

Activity Monitor

Prosthetics

Prosthetic support enhanced by
Detected activity by 9-axis motion
tracking device

Motion Interface: Enabler for Medical Applications

Orthotics

Orthotic support aided by by 9-axis motion tracking device

Posture Aid

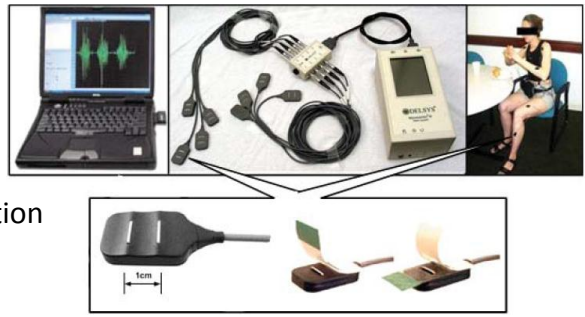
Posture Detection for Disease Prevention

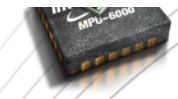
Sleep Care

Higher quality sleep aided sleep sensor

Parkinson's Treatment

Motion Tracking for tremor detection and titration of medicines





Motion Interface: Enabler for Other Consumer Applications

Augmented Reality Goggles

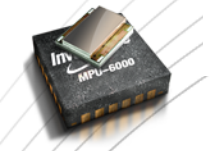
- 9-axis Motion Tracking for LBS
- Gesture based input control for navigating screen

Microphone

Tracking performance artist on stage for spotlight

Gesture-base headset

Headset control with tapping. shaking…



Motion Interface for Industrial Applications

Robotics

Agriculture/
Heavy Equipment

UAV Navigation

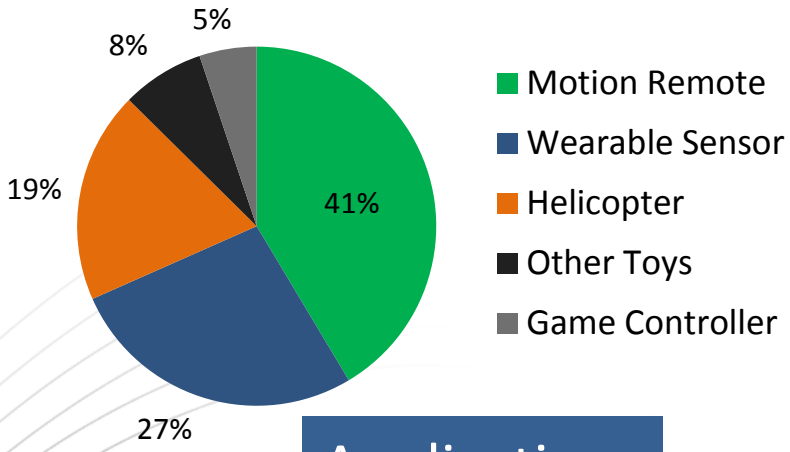
Fleet Tracking

Antenna Stabilization

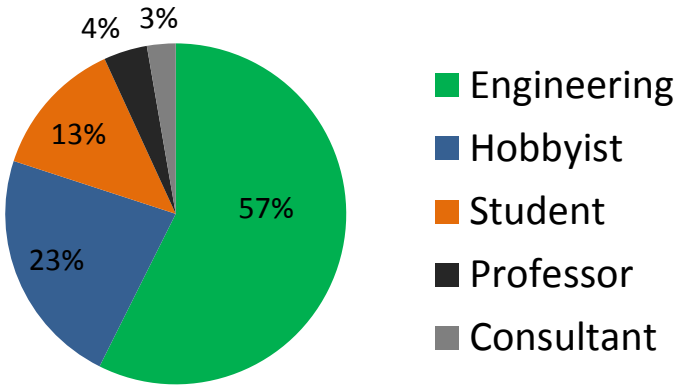
Motion Interface Developer Community

InvenSense MotionFit SDK

Over 3300 Application developers registered



Applications



Professions

First Motion Interface Developer's Conference

Motion Interface

Motion Interface
developers conference

Sponsored By InvenSense
Innovation in MEMS

June 14, 2012
W Hotel, San Francisco

Bringing the Industry and Developers Together

Evolution of Motion Sensors to MotionTracking

Motion Sensors

MotionTracking

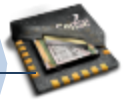
Gyroscope

1-axis
7x12x2.6 mm

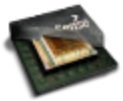
2-axis gyro
6x6x1.4mm

2-axis Gyro
4x5x1.2mm

3-axis Gyro
4x4x0.9mm



MPU-6050
6-axis
4x4x0.9mm



MPU-9150
9-axis
4x4x1mm

Accelerometer

3-axis Accel
5x5x1.8mm

3-axis Accel
4x4x1.45 mm

3-axis Accel
3x3x1 mm

Compass

3-axis compass:
X/Y: 3x3x1mm
Z: 10x1.4x3.9

3-axis compass
3x3x1.4 mm

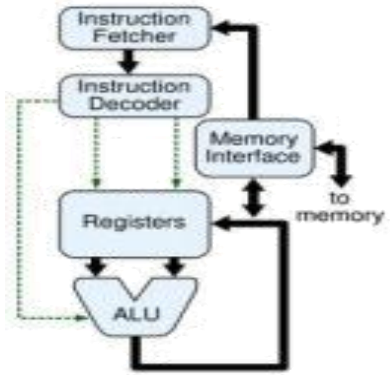
3-axis compass
4x4x0.7 mm

~2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012

Tracking Motion is a Complex Science

Motion Sensors Selection

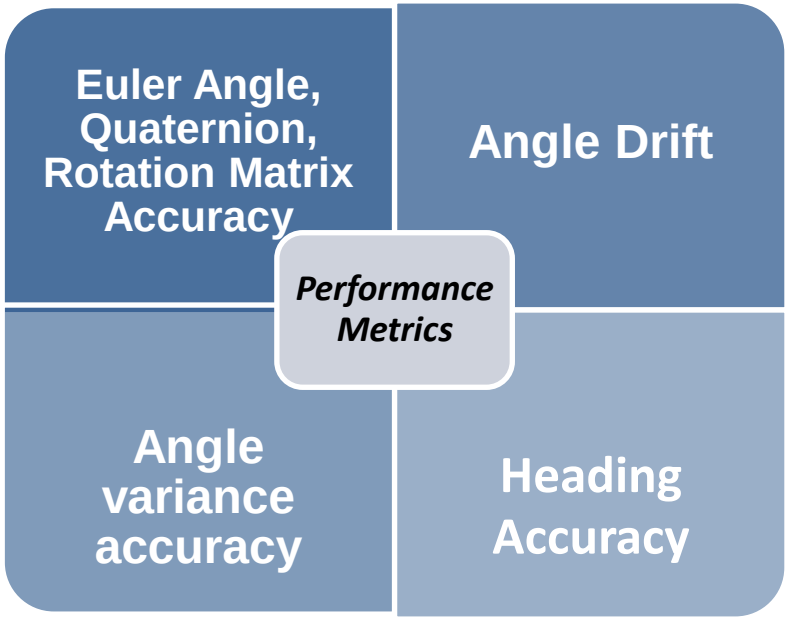
Sensor Computations



Sensor Fusion

$$\begin{pmatrix} r_{11} & r_{12} & r_{13} \\ r_{21} & r_{22} & r_{23} \\ r_{31} & r_{32} & r_{33} \end{pmatrix} \begin{pmatrix} v_x \\ v_y \\ v_z \end{pmatrix} = \begin{pmatrix} v'_x \\ v'_y \\ v'_z \end{pmatrix}$$

MotionTracking Solution



Performance is dependent on combination of sensors, calibration, and fusion algorithms

[1] Integrated solution with third party e-compass available for sampling to selected customers.

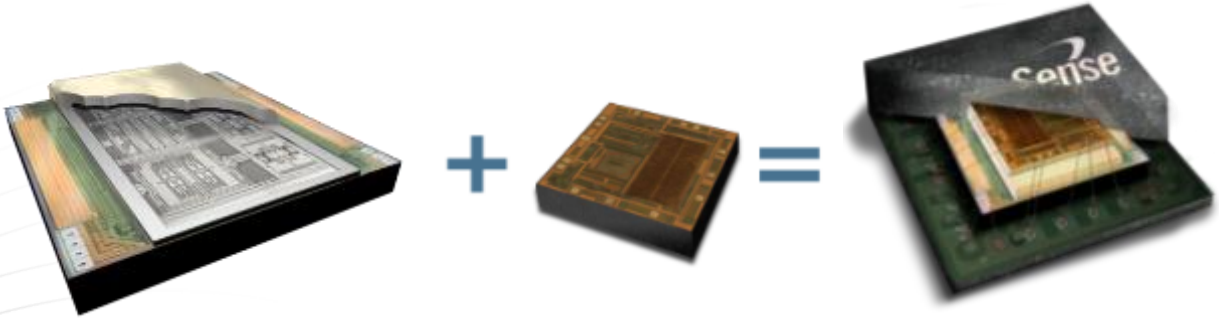
[2] Currently under development.

“Integrated MEMS” MotionTracking Devices

InvenSense MotionTracking Devices
In 4x4x0.9 mm QFN Package

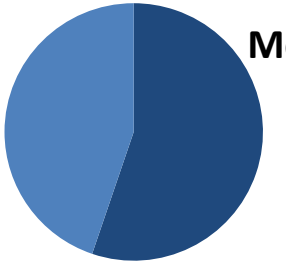
6-axis

9-axis



Company Overview

Multiple High Growth End Markets



FY12 Revenue

Tier One Customers

Nintendo, SAMSUNG, Sony Ericsson, htc smart mobility, LG, ASUS, RIM, ZTE中兴, PANTECH, acer, SHARP, Roku

High Volume Fabless Supply Chain

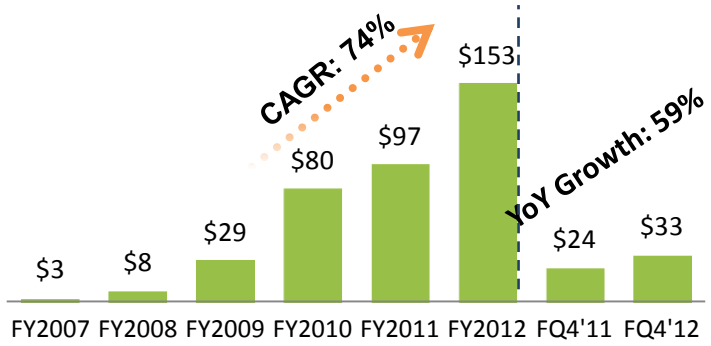
tsmc, GLOBAL FOUNDRIES, LINGSEN, SPIL

Manufacturing & Packaging

In-House Test & Calibration Facilities

Strong Growth and Profitability

($ in Millions)



12 Consecutive Quarters of Profitability[3]

Summary

- Motion interface is a transformational technology
- Rapid adoption in many CE products
- Large market opportunity in nearly $3B by 2015
- Smart Phones, tablets, and gaming represent $2.4B
- Many other innovative products are emerging
- Advances in MEMS are driving the market adoptions
- Integrated MotionTracking solutions expected to dominate
- InvenSense is continuing to drive innovations in this segment

InvenSense®
Innovation in MEMS