

# Sensors System Integration Challenges

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# Qualcomm & Qualcomm CDMA Technologies

OUR CHIPSETS CONNECT AND POWER LEADING DEVICES WITH INTEGRATED AND DISCRETE 3G, 4G, LTE AND MULTI-MODE

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RFIC COMPANY

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SEMICONDUCTOR COMPANY



# System Integration Challenges - Overview

- **Sensor Trends**
- **System Integration**
  - Sensor types
  - Sensor characteristics
  - HLOS requirements
  - Third-party software libraries
  - Algorithm tuning for each sensor's characteristics
  - Sensor calibration requirements
  - Sensor mechanical design and placement effects
- **Workable?**
- **A way forward ...**

# Sensors Trends for Handsets



# Sensors System Integration Trends

Trend	Direction
Time to market	Ever shortening product cycles
Lower power	Always-on monitoring with sub-milliamp battery currents
Device proliferation	Hundreds of new handset and tablet models each year
Sensor fusion	Combining multiple sensors, from different vendors, for contextual awareness
High performance	Navigation and augmented reality applications demand better sensor calibration and lower noise
Multiple sensors in one package	6-axis and 9-axis combo inertial/magnetic sensors

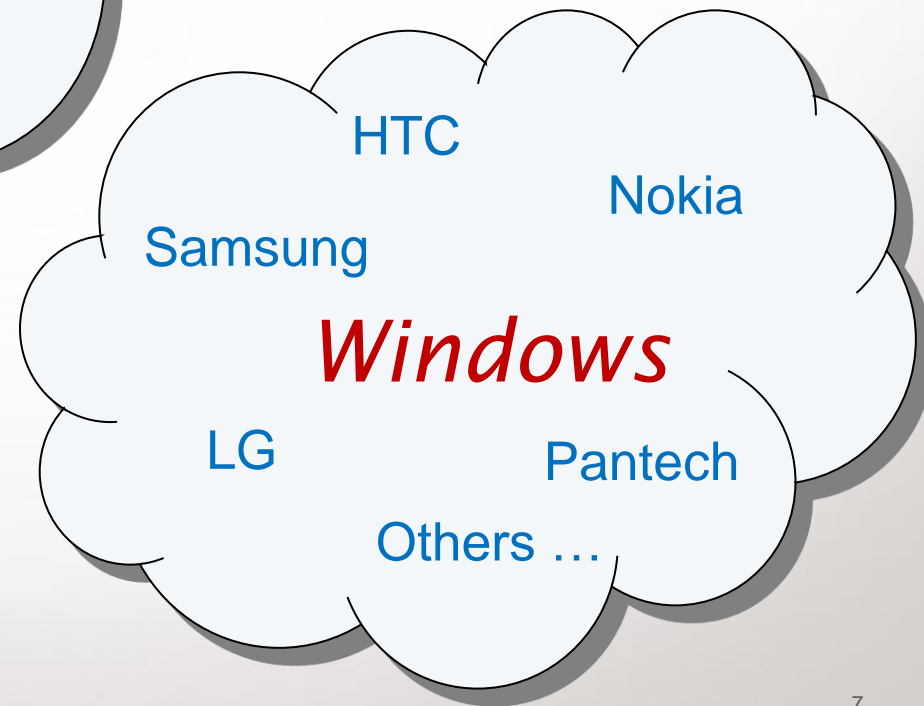
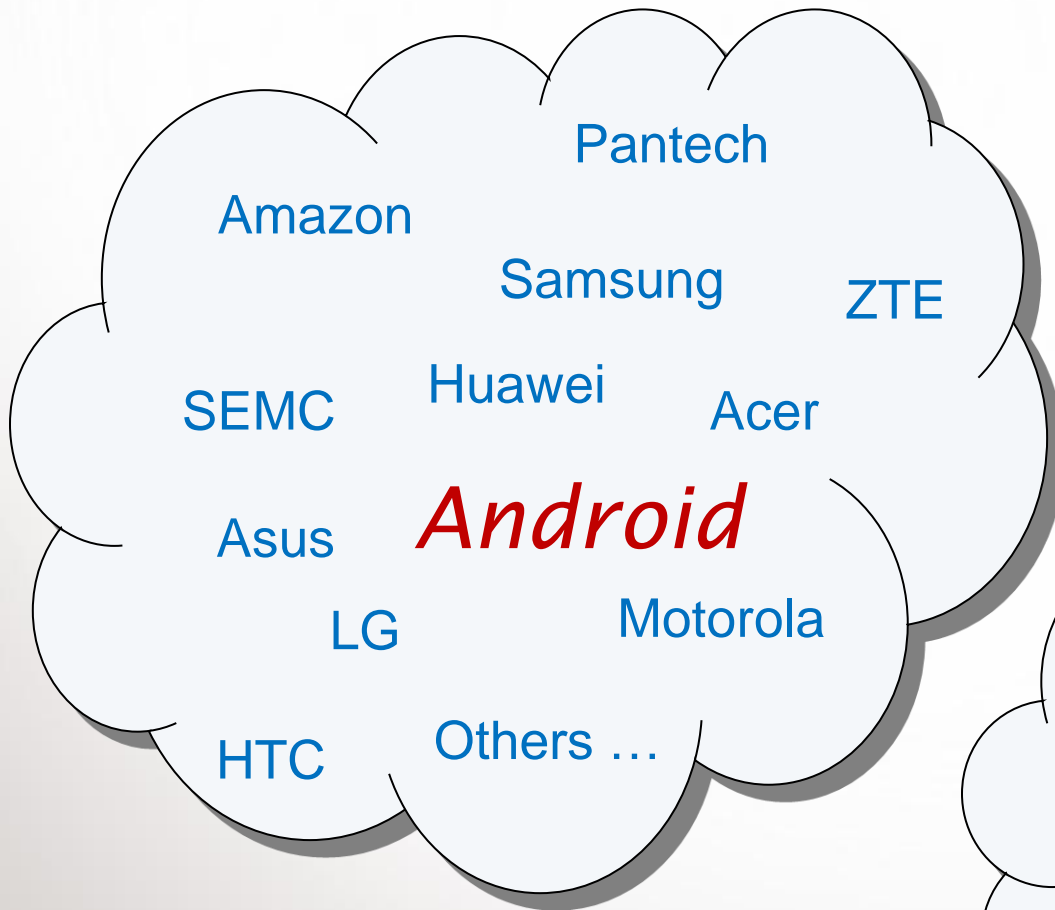
# Commonly Requested Sensors Vendors

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

18+  
Vendors

26+  
Sensor  
Product  
Lines

# Handset and Tablet OEMs



# HLOS Sensors Requirements

- **Frequent HLOS releases**
  - Android and IOS: twice a year
  - Windows: once a year
- **Each HLOS release brings ...**
  - New sensor types
  - New “virtual” sensors
  - New and modified sensor APIs
  - New features (e.g., auto-rotation, free fall detection, etc.)
- **HLOS sensors requirements**
  - Unspecified or vague performance targets
  - Sometimes overly restrictive
  - Lacking support for proprietary extensions



# Software and Algorithm Integration

- **Software Integration**

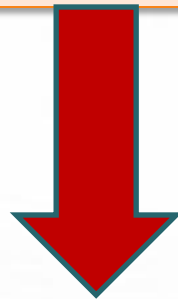
- Sensor drivers
- Factory calibration tools
- Sensor calibration libraries
- Sensor fusion libraries
- Sensor features (gestures, fall detection, etc.)

- **Algorithm Tuning** - compensates for

- Variations in sensor characteristics
- Calibration quality
- Device mechanical design (e.g., glass transparency)
- Sensor location (e.g., magnetometer placement)

# System Integration Challenges

- **14+** Sensor types
- **18+** Sensor vendors
- **26+** Sensor product lines
- **16+** HLOS/OEM combinations
- **5+** Third-party software libraries
- **2** HLOS requirements sets
- Algorithm tuning for each sensor model
- Sensor mechanical design and placement considerations
- Sensor calibration requirements



*Scalable*

# Taming the Sensor System Integration Problem



# A Way Forward: Standardization

## ■ Opportunities for standardization

- Data sheet contents
- Calibration and motion library APIs
- Sensor self-test and reporting
- Sensor configuration (e.g., axis conventions)

## ■ Recommendations

- Standardize basic functions to enable rapid bringup and test
- Provide extensible common APIs supporting a basic set of functions
- Allow proprietary enhancements in addition to standard features
  - Encourage innovation
  - Support sensor product differentiation

# Thank You

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