MEMS and Sensor Integration TWG

Mary Ann Maher, PhD., Co-Chair

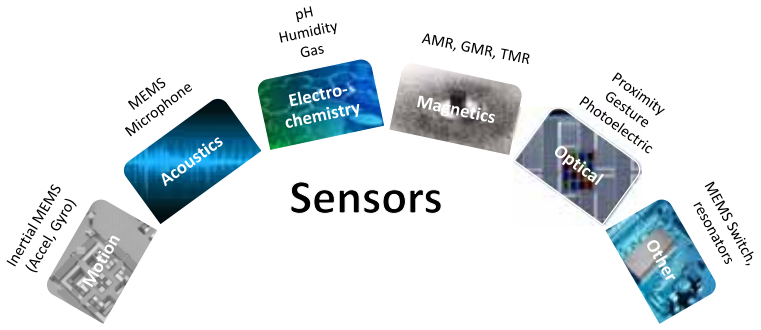
- Mary Ann currently serves as CEO of SoftMEMS
- She received her PhD from Caltech in 1989.
- She has over 30 years of experience in the area of electronic design automation (EDA) for MEMS, sensors, and analog circuits

Shafi Saiyed, PhD., Co-Chair

- Shafi leads package development team at Analog Devices
- Shafi received his PhD in Systems Science from SUNY Binghamton in 2005.

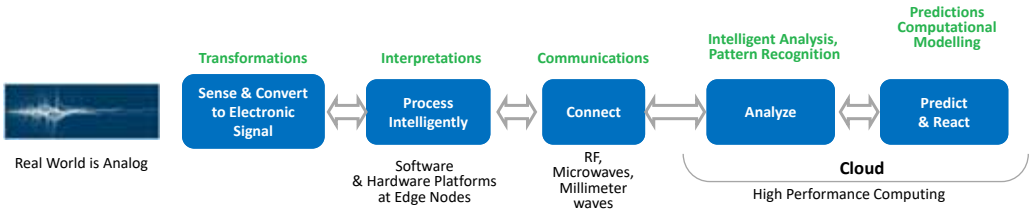
Defining Scope for MEMS & Sensor Integration

- **Sensors interact with the outside world**
- Real (analog) world requires different sensing modes
- Each sensing mode has different set of requirements and manufacturing approaches
- **Working principle (physics) drives packaging**
- No Moore's law or lithography-based roadmap



Integration Upward on Signal Chain

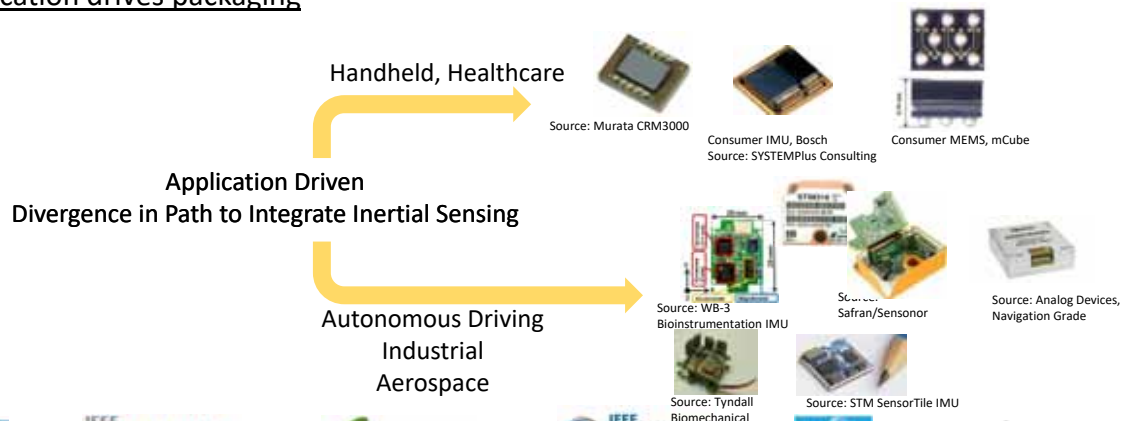
- **Across any application domain, the basic signal chain from real world-to-cloud remains common**



- **Challenge: How to Integrate components that require different fabrication processes, materials, designs**
  - with other sensors, ASICs, passives, antenna, power sources, etc, in the same advanced integrated packages
- **Challenge:** How to integrate diverse components up the signal chain (keeping sensor performance and signal integrity)?

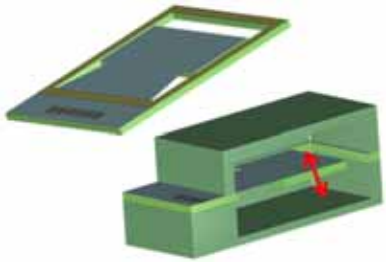
End Applications Drive Different Integration Path

- Diverging path to integrate Inertial MEMS sensors with <u>other components of the signal chain</u>
- <u>Application drives packaging</u>



Current Status of Chapter

- **What you will find:**
  - MEMS specific integration requirements
  - MEMS specific integration methods- overview
  - MEMS Application specific requirements and roadmaps for integration for
    - Automotive, Health/Wearables, Consumer
    - Materials
    - MEMS specific CAD
- **What we need to do :**
  - Address reviewer's comments on references etc
  - Make 5, 10, 15 year predictions more explicit

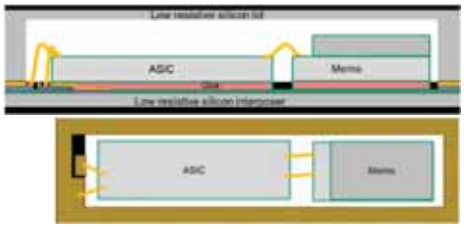


Applications & Packaging

	Current State-of-Art		5, 10 years & beyond	
	Application Areas	**Packaging**	**Emerging Application Areas**	**Packaging**
Mobile / Consumer	• Tilt • Navigation • Gaming	• Traditional low density LGA • Thick sensors	• Tilt • Navigation • Gaming	• Size reduction, **WLP** • **Thin sensors** • Integration with µProcessor • **EMI shielding**
Medical & Health	Not pervasive	Traditional plastic on rigid organic substrates	• Implantable • Concussion monitoring • Vital Signs monitoring • Telemetry	• **Flexible substrates** • Thin profiles, **WLP** • **Biocompatibility**
Automotive	• Air bag crash sensors • Rollover • Stability control	• Traditional large body SOIC / QFN	• Navigation grade IMUs • ADAS • Acoustic noise cancellation • Adaptive headlights • Vision correction • Condition monitoring	• **SiP based modules** • Substrate technology • Integration of µProcessor for intelligent processing • **Integration of RF for communication**
Aerospace & Defense	Not pervasive	• FOG and/or RLG • Traditional ceramic substrate based modules	• Machine Health • Attitude & Heading • Navigation • Stability	• **SiP based modules** • Substrate technology • Integration of µProcessor for intelligent processing • **Integration of RF for communication**

Important Collaborations with other chapters

- **MEMS interacts with almost all other chapters**
- **Discuss requirements and remove overlaps with:**
  - Automotive, IoT, Medical Health and Wearables
  - To be done in future: Mobile, Aerospace and Defense
- **Key linkages for this year:**
  - Review: Simulation and modeling, co-design, thermal and materials
  - New: security, reliability and test



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2023 and beyond, TWG continuing to work on …

- **Additional Foundational Technologies to be considered**
  - AI + MEMS- TInyML
  - MEMS on Flexible substrates
- **Important topic areas:**
  - Manufacturing and supply chain issues for regional manufacturing
  - Chips Act impact
- **Expand applications areas:**
  - Integration of chemical/environmental sensors
  - MEMS + Photonics

American Semi

MEMS and Sensor Integration TWG

- Team Members
  - Mary Ann Maher, PhD (SoftMEMS), Co-Chair
  - Shafi Saiyed, PhD (Analog Devices), Co-Chair
  - Jean-Charles Souriau (CEA LETI)
  - Benson Chan (IEEC, Binghamton University)
  - Allyson Hartzell (Philips)
  - Philippe Robert (CEA LETI)
  - Andrew Fung, PhD (AM Fitzgerald)
  - William Chen, PhD (ASE and HIR Chair)
  - Looking for industry volunteers to helps us with gas sensing, optical sensing
  - Looking for academics to join us……