MANCEF
www.mancef.org

Micro and Nanotechnology
Commercialization
Education Foundation ®

Toward $1T: MANCEF's 3 Roadmap Approach

MEPTEC

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About MANCEF

Mission Statement: "MANCEF connects a global community focused on commercializing micro and nanotechnology through conferences and educational efforts."

- Founded in 2001
- Annual COMS conference: this year in Norway
- More details at MANCEF.org

MANCEF will coordinate the roadmapping effort

About Insight interAsia

- Founded in 2006
- Pan-Asia = full coverage of all tech centers
- Focus on small, high-tech clients in US & Europe

Corp HQ in Honolulu

Asia HQ in Singapore 

- Representative offices:
  - Japan: Tokyo 
  - Korea: Suwon 
  - Taiwan: Hsinchu 
  - Regular contractors:
    - Australia China India Indonesia Malaysia Thailand Vietnam

Our job for this roadmapping effort: interfacing with Asian participants and marketing the plan globally

What’s Needed for $1T Market?

Key MEMS devices toward $1T

- **RF Technology** - RF switches, antennas, tunable filters, phase shifters, passive components
- **Chemical Measurements** - Microfluidics: Lab-On-Chip devices, DNA test structures, micro-dispensing pumps, hazardous chemical, radiation, biological agent detectors
- **Energy Technology** - PowerMEMS, energy harvesting
- **Inertial Measurements** - accelerometers, gyroscopes, inclinometers, rate sensors, vibration sensors, seismic
- **Pressure Measurements** - pressure sensors, altimeters, ocean depth
- **Display Technology** - Optical MEMS in projectors and displays
- **Acoustic Sensors** - MEMS microphone for acoustic input devices

Needed: MEMS Processes & Tools

- Photolithography
- Silicon Wet & Dry Etch, DRIE
- Oxidation
- Diffusion
- LPCVD
- Sputter Deposition
- Others?

Needed: Process Modeling Tools

- Geometry and Material predictions
- 3D Solid Modeling
- SOC friendly
- Transferable from designer to fab
- Likely: *de facto* standard will arise from a dominant foundry-preferred model during the life of the roadmaps

Packaging Families

Robust, Rugged, and Long-life packaging required for future MEMS

- Package-on-Package
- System-in-Package
- Flip Chip CSP
- Multi-Chip Modules w/ Ball Grid Arrays
- TSV
- Wafer level packaging (turnkey solutions)

Test Systems

- Wafer-level testing
- Post-packaging testing
  - Media compatibility, thermal stress, mechanical stress, ESD, and EMI
  - Combinations of the above conditions
  - Cycling and lifetime
    - Particularly infrastructure MEMS

Industrial Consortia

MANCEF is asking to participate:

- iNEMI
- JMMC
- MIG
- MNTNetwork
- SIA ITRS
- SRC
- SEMI

Government sponsors?

- NIST
- DARPA
- MEXT/METI Japan
- LETI France
- A*STAR Singapore

Roadmapping

Premise

1. MEMS market is growing very rapidly and will accelerate
2. If we are going to achieve $1T MEMS market, *we are going to need some significant roadmapping efforts*
3. We can learn from past roadmapping efforts
4. Our roadmaps are *market goal* driven ($1T)

3 Generations of Roadmaps

- 1st Gen roadmaps aim for products and look for solutions to get those products to market
- 2nd Gen roadmaps use disruptive and emergent technologies which do not as yet have a foundation process, unit cell, or architecturally stable focus products
- **3rd Gen roadmaps** are those that focus on products which are generated at the interface of more than one technology

Some examples to learn from

- ITRS
  - Adaptability over time
- SETIS
  - Synergies, crosscuts
- JEITA
  - Systems approach
- Malaria vaccine
  - Global cooperation, common goal
- Quantum computing
  - Complex, esoteric, secretive
- Several others

Market Generated Roadmap

- Cooper (1994) was one of the first roadmapping professionals to focus on the market generated roadmaps initiated in the late 1990's.
- We will look at all of these roadmaps for techniques.

Market *Goal* Roadmap

- Use when there is a desired market size to be achieved - **$1T per year**

Our Rationale

- We suggest a bold initiative to break from current MEMS sales growth patterns and jump to a new **factor improvement** in MEMS sales
- This would move the industry from the current environment of *hyper competition* to one of **coopetition**
- Some lessons can be learned from other industries where **shared pre-competitive** research significantly expedited technology development at reduced costs

3 Roadmaps required

Our plan requires the interface of at least 3 elements of the system:

1. sensor technology itself
2. technology of data transfer from the sensor
3. technology behind the equipment used to process the data

First steps

New market goal roadmap efforts look toward market drivers that could generate need for their products as the top strata

- The base proposition of this roadmap is the need for ***ubiquitous sensing***
- We will use social media to develop drivers
  - Some initial candidates
    1. Highway infrastructure
    2. Preventative medicine sensing
- We next need to validate sensor candidates
    - For example: highway infrastructure

Key: Ubiquitous Sensing

Ubiquitous sensing that is the foundation of this roadmapping effort will require new means of transferring data.

- Thus, our roadmaps will require a *systems approach*.
- Some estimates are that with conventional (Internet) solutions we will need as much as 4 times the current bandwidth capacity
- New technologies
- Validate new technologies; think in terms of *technology readiness assessment* rather than Moore's law curves
- Some potentials for partial solutions include
  - High frequency RF MEMS

Data Analysis Explosion

Ubiquitous Sensing = enormous data

- Do we have the equipment to accommodate this? What do we need?
- Need for monitored social media
- Again look to the robustness of a solution; more like Technology readiness assessment.

Our roadmaps must have timelines

- The usual roadmap timeline starts at present and has a review at t+5 years, then finalizes at t+15
  - We do not see a reason to change this
- We must sequence 3 roadmaps to meet the requirements of a system that would enable the growth of sensor sales that we aim for
  - The approved candidate sensors will be used as the product platforms in the roadmap for sensors

Roadmap data gathering process

- Tools
  - Market drivers
  - Social media
  - Delphi studies
  - Curves
  - TRA

- Essential Personnel
  - Stakeholder corporations
  - Professional and student support

Roadmap data gathering process

- Essential interactions
  - Web-based meeting
  - Meetings at selected events

- What are some critical dimensions?
  - For sensors
    - Cost
    - Standard elements for each application area
  - For data transference
    - Effective data density management / cost
  - For analytical information
    - Capacity / cost

Conclusions

We propose a set of 3 roadmaps are needed to realize $1T in MEMS sales:

(1) Sensor (2) Data Transfer (3) Data Proc Equip

- Market *Goal* Roadmaps
  - Ubiquitous sensing is the foundation
  - The 3 roadmaps must be synchronized
- 15-year duration with 5-year review
- Will require coopetition to reach goals

Response to our idea

- Identification of candidate student at UNM / UNC / U Twente / KIT and others underway
- Some funding identified
- Corporate interest in Asia, USA, and Europe
- Consulting interest
- Industry group interest

Funding

- We are actively looking for $100K to move our roadmapping effort forward
  - Companies
  - Universities
  - Government organizations
  - Consortia

Roadshow our plan

- COMS 2102 – Norway
- Sensors Expo – Chicago
- TechConnect - Santa Clara
- Semicon West - SF
- Micromachine/MEMS – Tokyo
- IEEE MEMS 2013 – Taipei
- Nano Tech 2013 - Tokyo

Call To Action

What we need:

- Your hard work…get involved!
- Feedback: Ideas, Comments, Questions
- $ ¥ € ₩ £
- Other Resources
- Spread The Word & Evangelize

Thank you

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