EPIC Members Event Report

T(TRILLION) SENSORS SUMMIT

FOR TRILLION SENSOR ROADMAP IN MUNICH

Munich, Germany
15-17 September 2014

www.tsensorssummit-munich.org

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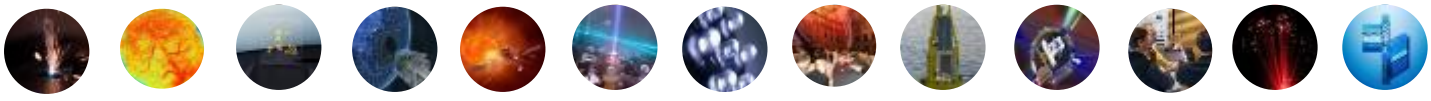
About the EPIC Members Event Reports

Initiated by the founder of EPIC Dr. Thomas Pearsall in 2003, these reports are prepared by members of EPIC to the benefit of the wider community. If you did not have a chance to attend the event but would like to know some key highlight, this report is for you. Emphasis is placed on exploring technical and business opportunities for the members of EPIC.



The T Sensors Summit was held from September 15th to September 17th 2014 in Munich (Germany). It was co-chaired by Prof. Dr. Christoph Kutter, director of the Fraunhofer Research Institution for Modular Solid State Technologies EMFT, and Dr. Janusz Bryzek, originator and Chair of TSensors initiative. The whole event was excellently organized by Prof. Kutter and his team at Fraunhofer Institut EMFT.

It was the 4th summit after it was formed in the Silicon Valley in 2013 and followed the successful summits at the Universities of California (Berkley) and Stanford in 2013 and the summit in Tokyo in 2014. There are two additional summits scheduled for 2014 in San Diego and Tokyo and plans for Abu Dhabi , China and the US for 2015. Over the three days the T Sensor Summit had 38 excellent presentations by high ranking people of leading companies in the world of sensor, sharing with us their latest progress made on the way to achieve a trillion sensors. The summit had 136 attendees from companies all over the world. Big interest was expressed in the opening words by State Secretary of the Bavarian Ministry of Economic Affairs and Media, Energy and Technology, Franz Josef Pschierer, and the Dinner Speech by Prof. Dr. Dr. h.c. Ernst Ulrich von Weizsaecker, Co-Chair, International Resource Panel (UNEP) and Co-President, The Club of Rome.

“The theme of the T Sensors Summit was inspired by “abundance” defined as a world without hunger, a clean environment and energy and medical care to all, to be enabled in one generation through technological innovations by so called exponential technologies producing goods and services faster than global demand” as Dr. Bryzek said in his introduction to the summit. The three day meeting was divided into 9 sessions covering most of the markets and technologies necessary to build a process to generate an industrial roadmap to achieve the TSensors: 1. Roadmap 2. Market forecast 3. Portable consumer devices 4. Automotive and driving sensors 5. Data & security 6. Everyday Life 7. Wearables & Health 8. Flexible Electronics Manufacturing 9. Technologies.

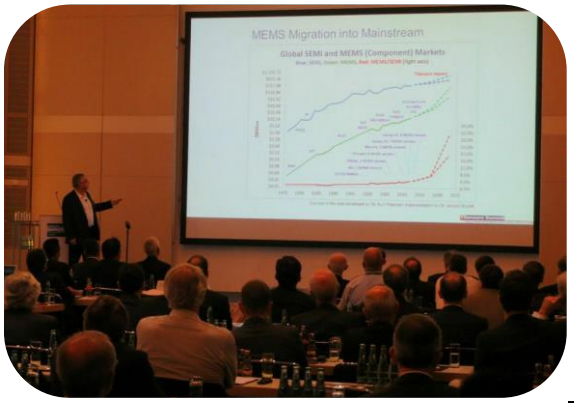
The talks in the Roadmap session dealt with aspects of building an industrial roadmap, highlighting several visions but also challenges ranking from basic technologies, over different business related issues to educational questions. “The end markets are clear: medicine, food production, energy, and water. Therefore, what is needed is to define the *specific* applications in order to focus companies on building the necessary software and hardware. Yes, there will be software only solutions that will make a difference but the biggest impact will come from hardware-centric or hardware-enabled (combined with software) systems” said Ira Feldman, a member of the TSensors organizing committee. As driving force behind TSensors Dr. Bryzek sees the achievement of large volumes to come to an “abundance”. Abundance is projecting a demand of 45 trillion sensors in two decades, many of them new, with its development accelerated by the TSensors initiative. Any particular sensing application must by deployed in extremely high volumes to have a global impact.

Over 300 potential sensing applications have been identify by TSensors Roadmap , called also TApps, i.e. application areas which have the potential to reach trillions of units like: Noninvasive / minimally invasive health monitoring, Personal Medical Imaging, Computer senses, Environmental sensing, Infrastructure Sensors, Smart Home, Smart Cities, Smart Food Production, Smart Energy generation and Control, Automotive Sensors

Dr. Marinakis from the University of New Mexico showed in his talk that the following drivers for TSensor systems have been defined:

- the T Sensor itself
- the Internet of Thing (IoT) comprising IP-enabled (Internet protocol) devices, RFID tags, wireless sensor networks, machine-to-machine (M2M) communications, mobile devices and apps, white space TV spectrum and cloud computing. It connects these devices and entities through new network architectures to enable low latency control
- 3D printing for manufacturing sensors and sensor components
- Energy harvesting for operating sensors
- Energy storage for operating sensors

- Ultralow power wireless communication for sensor communication (MEMS).
- Network protocols and standards
- Operating Systems
- Analytics



The following sessions were covering the already mentioned market segments able to drive the deployment of the Tsensors.

Dr. Julia from Samsung electronics showed in a very appealing talk the big importance of having tools to collect and process the "big data" collected by the multitude of different sensors on the example of Samsung's Architecture for Multimodal Interactions (SAMI).

A similar approach was shown by Dr. Janssen of Sense Observation Systems. Estimated 30 billion sensors in smartphones tracking their owners at a total rate of 6 petabyte /minute. Already existing standard sensors like a microphone can be used to collect data which is later on processed, showing information about the owner like loneliness, empathy, sleeping behavior and others. New sensors are on their way into phones. The challenge is to process all the collected data which is proposed to do with such platforms like the proposed and f.e. SAMI.

The next comprehensive session was dedicated to automotive and driving sensors. Cars are one of the best examples for the usage of lots of different sensors linked together and interconnected to other cars. A big topic in this session was the application of sensors in autonomous driven cars. Different aspects were discussed by high ranking specialist from Volkswagen, Infineon and Bosch reaching from tire pressure sensing to optimize and improve the driving performance like fuel consumption, tire wear out, etc... to the different driver assistant systems like lane assistants, Radar and Lidar based collision avoidance, road sign recognition systems and many others.

In the session about Data and Security were highlighted and discussed topics like "Security requirements and Solutions", "Data privacy in IoT and connected cars", "Security Vulnerabilities in IoT End to End" as well as philosophical and social aspects of the Tsensor roadmap.

The last day was dedicated to Tsensors in Everyday Life, including the wearables and health monitoring sensors and technology related questions and flexible electronics manufacturing. The integration of sensors in daily life in smart homes has been addressed in talks from Bosch and EnOcean. Already today are there many solutions on the market which are based on sensor networks, steering a lot of different application in the household from the kitchen to the garden.

Applying more and more sensors triggers the question of the power supply. High efficient batteries as well as energy harvesting solutions for self powered sensors have been discussed. A simple calculation showed that solving the problem of supplying power to the sensors is essential: "…CR2032 with 300mAh should contain around 0.1 grams of Lithium. This is based on the rule of

thumb that 1Ah of capacity requires about 0.3 grams of Lithium. So 10 Trillion (10^13) batteries would require 10^12 grams = 1 million tons of Lithium , – this is the combined worldwide Lithium production of 10 years… "(presentation of Mr. Kassner of EnOcean). This highlights only the hardware part of the problem because, maintenance, life time of batteries, etc.. will make the issue even worse. Energy harvesting solutions are under development helping to solve this issue.

Wearable sensor systems for health monitoring have set the focus of the next session. Using wearable sensor can drop the Health care costs dramatically. Progress was reported in several talks. Besides the medical aspect the consumer applications especially the fitness status and activity monitors are emerging, creating a driving force in the development.

All the above mentioned sessions were focused on general aspects of Tsensors and their applications, the last session of the event were dedicated to the technology and ways to manufacturer the big quantities of sensor effectively. Printing techniques for low cost sensor fabrication, scaling with printed electronics as well as new concepts for thin film batteries were discussed in several talks. MEMS CMOS technology as platform to manufacture large quantities played a big role in many of the talks as one of the key technologies to achieve the goal of Tsensors initiative.

The technology session ended with two talks about a hyperspectral imaging sensor, opening a new era of imaging. The essence of this technology is a special sensor which will add a spectral information to each pixel of a 2D image, allowing not only to "see" the sample but also to get information about the chemical surface composition, based on its spectral signature. This technology opens a wide field of possible applications from remote sensing in smart agriculture over machine vision and medical imaging up to security and surveillance. The next step towards a mass application of spectral sensing was shown in the last talk about the Spectrometer- on a- chip concept by nano Lambda. The technology is based on plasmonic nano-optic filter arrays, manufactured with standard semiconductor technologies on wafer scale. This allows to manufacture such spectrometer –on a-chip to a comparable low price allowing to use the huge abilities of spectral analysis in a much broader scale as yet.

The summit in Munich gave a real good overview about many facets of the future of Sensors, its interconnection , the Internet of things and gave an idea about the ways to reach the goal of the Tsensor initiative - "abundance".

Next Trillion Sensor summits will take place 12-13 November 2014 in la Jolla, CA,USA and 8-9 December in Tokyo, Japan.

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