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TACKLING DESIGN HURDLES OF THE IOT

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ABSTRACT

Internet of things (IOT) is attracting many industries to make huge investment and profit. Industrial manufacturers are incorporating sensors with its physical devices and connecting them to internet, also collecting huge and minute information from them. All those huge data collected them are stored in database for further analysis and to improve lifestyle. Industries are very much eager to incorporate machine learning and an artificial intelligent into its physical devices which acts on its own decisions. This leads to data-driven business models.

Keywords–IoT, Design Hurdles, IoT Sensors, Integrated data.

I. INTRODUCTION

Internet of things designs engaged many industries to work on their own domain and products to build products of their future. These physical products ready for real-time activities [3]. Internet of Things inviting designers and engineers to explore more complex and futuristic design that satisfies all the needs of users in real- time. This is a big change in recent era [1][2]. Figure 1 shows basic blocks of typical IoT device.

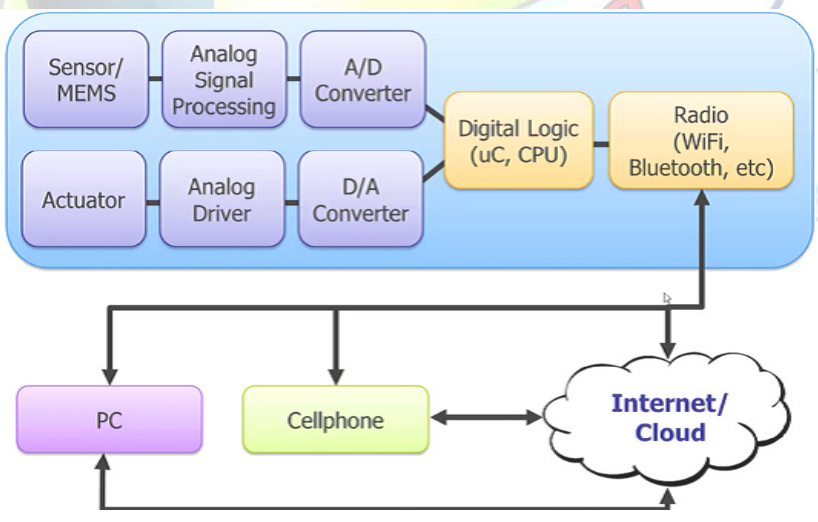

Figure 1: Basic blocks of typical IoT device

The above device contains a sensor that interface to the internet. The sensed signals received at analog signal processing device through low-pass filter and processed signal is sent to digital conversion [4]. The digital signal is sent to logic unit. This proper logic signals are passed or broadcast to the cloud or smart-phone or servers [12]. [5] discussed about Intelligent Sensor Network for Vehicle Maintenance System. Modern automobiles are no longer mere mechanical devices; they are pervasively monitored through various sensor networks & using integrated circuits and microprocessor based design and control techniques while this transformation has driven major advancements in efficiency and safety. In the existing system the stress was given on the safety of the vehicle, modification in the physical structure of the vehicle but the proposed system introduces essential concept in the field of automobile industry. It is an interfacing of the advanced technologies

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like Embedded Systems and the Automobile world. This "Intelligent Sensor Network for Vehicle Maintenance System" is best suitable for vehicle security as well as for vehicle's maintenance. Further it also supports advanced feature of GSM module interfacing. Through this concept in case of any emergency or accident the system will automatically sense and records the different parameters like LPG gas level, Engine Temperature, present speed and etc. so that at the time of investigation this parameters may play important role to find out the possible reasons of the accident. Further, in case of accident & in case of stealing of vehicle GSM module will send SMS to the Police, insurance company as well as to the family members.

II. DESIGN CONVERGENCE

Each of these IoT basic blocks can be assembled from ready-to-wear, discerning components. However, there is a huge requirement to split the components from Figure 1 into a small individual packaged device [6].

Spitting into small components improves the cost, size, performance, and power consumption of the IoT device. By designing a multifunctionalchip, design integration can be improved and the component count can be reduced. Figure 2 shows twoexamples of spitting. A radio chip industry adds a microcontroller and the A/D and D/A converter. A sensorindustry adds the analog signal processing and A/D converter [9][11].

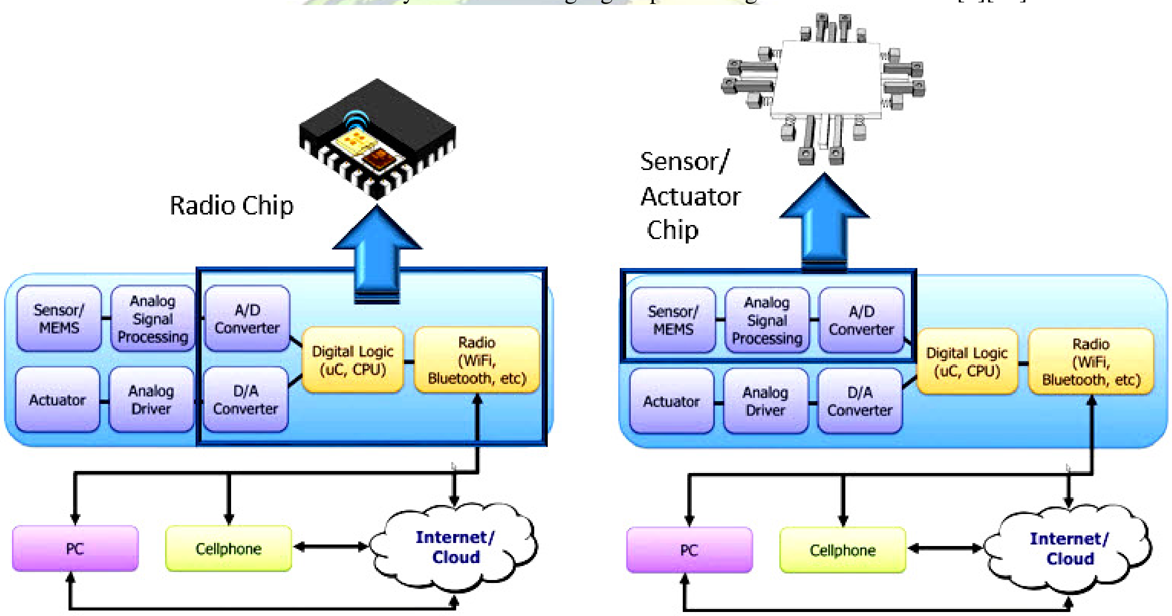

Figure 2: Splittingbasic blocks to create a multi-functional chip.

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III. THE IOT DESIGN CHALLENGE

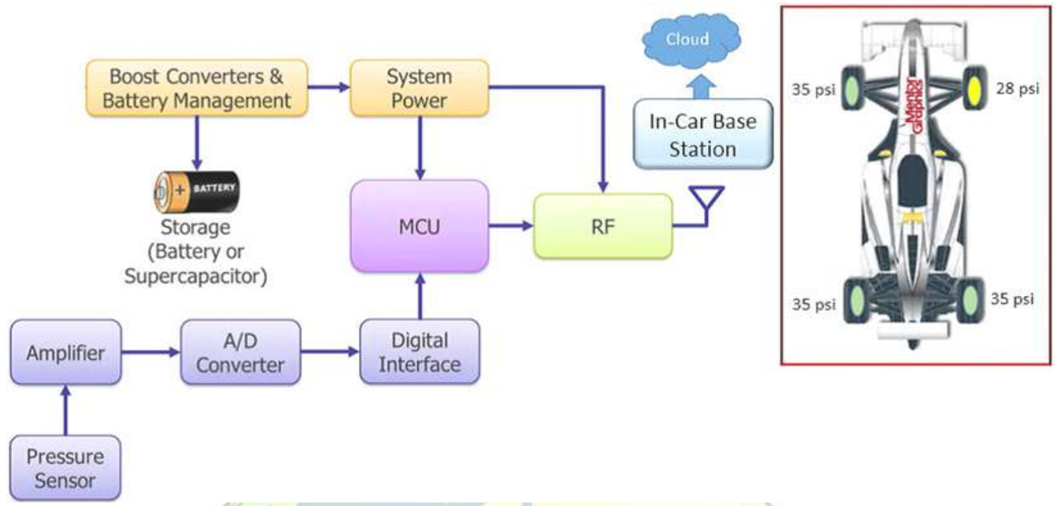

Figure 3: A racing team tyre pressure monitoring system.

A tyre pressure sensing device is embedded in each of the tyres of a race car. The tyre pressure data is sent to an in-car base station in turn to the cloud [13][16]. This data is available for the racing team to monitor.

If the tyre pressure is low, the monitoring team is alerted and instruct the driver to make a pit stop[17][19]. A MEMS pressure sensor frequently checks air pressure for the tyre. The analog signal from the sensor isamplified and digitalized. A digital signals are fed through digital interface to the microcontroller for processing, which in turn to the radio. The in-car base station uploads data to the Cloud received from radio [10]. The racing team's software translates the data stream and presents readout of the tyre pressure. A battery charges a super-capacitor that energizes the microcontroller and radio [8].

The tyre pressure design identifies the fundamental hurdle to IoT design: the four design domains that Figure 4 shows all live together in the IoT device[15].

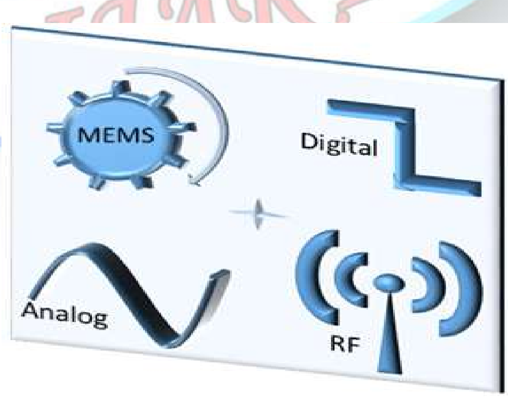

Figure 4: The four IoT design domains.

IV. The Tanner Solution

Tanner gives a single, top-down design flow for IoT design, unifying the four design domains. Whether you are designing a single or multiple die IoT device, for creating and simulating this device:

- Capturing and simulating the design. S-Edit catches (capture) the design at multiple levels of abstraction for any givencell and represent a cell as schematic, RTL or SPICE and then interchange

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those descriptions in and out forsimulation. T-Spice simulates Verilog-A and SPICE representations of the design which is fully integrated withS-Edit. ModelSim simulates the digital, Verilog-D portions.

- Simulating the mixed-signal design. S-Edit creates the Verilog-AMS netlist and passes it to T-Spice. T-Spicesplits the netlist automatically to partition the design for analog and digital simulation inModelSim, as shown in Figure 5.

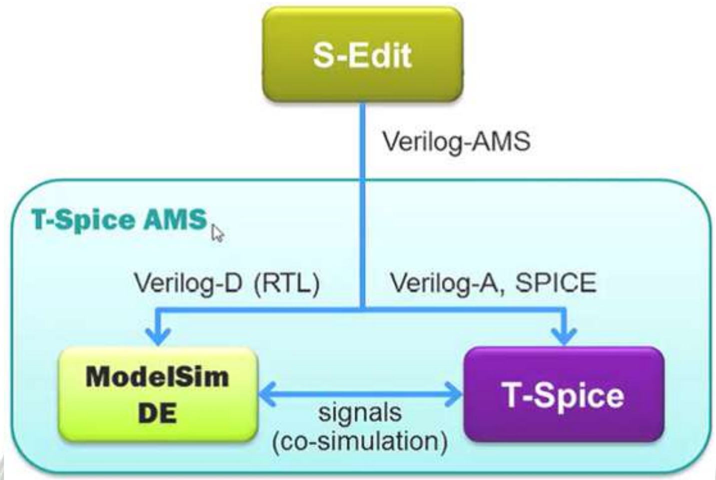

Figure 5: Analog and digital partitions for simulation.

Both simulators are triggered automatically and during simulation the signal values are exchanged between the simulators. This means, that regardless of the design implementation language, you just run thesimulation from S-Edit and the design is automatically partitioned across the simulators and results can be viewed using the ModelSim or T-Spice waveform viewers.

- Laying out the design. Create the physical design using L-Edit which creates a custom layout of the IoT design. The parameterized layout library of common MEMS elements and true curve supportfacilitate MEMS design.

V. IMPLEMENTING THE MEMS DEVICE

The MEMS component pays an important role in determining device performance since associated packaging andfabrication process. In the pressure sensor, pressure is exerted on a diaphragm above an etched cavity[20]. The package must be deep enough to accommodate the cavity that Figure 6 shows. To characterize the sensor, simulate the device with pressure exerted.

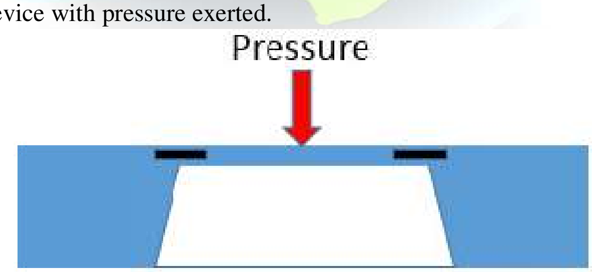

Figure 6: MEMS pressure sensor.

Create a 3D model of the pressure sensor and then analyze the physical characteristics. But, need a 2D mask in order to fabricate the MEMS device[8]. Figure 7 shows, deriving the 2D mask from the 3D model successfully in a fabricated sensor.

To create the device, start with 2D mask layout in L-Edit. Then, instruct L-Edit to automatically generate the 3Dmodel from those masks in order to provide a simulation of the fabrication steps that occur at the Fab. Perform 3D analysis using finite element software and then iterate if any issues. Make the proper changes to the 2D mask layout and then repeat the flow. Using this mask-forward design flow, you can converge on a working fabricated MEMS device because you are directly creating masks that will eventually be used for fabrication, rather than trying to work backwards from the 3D model.

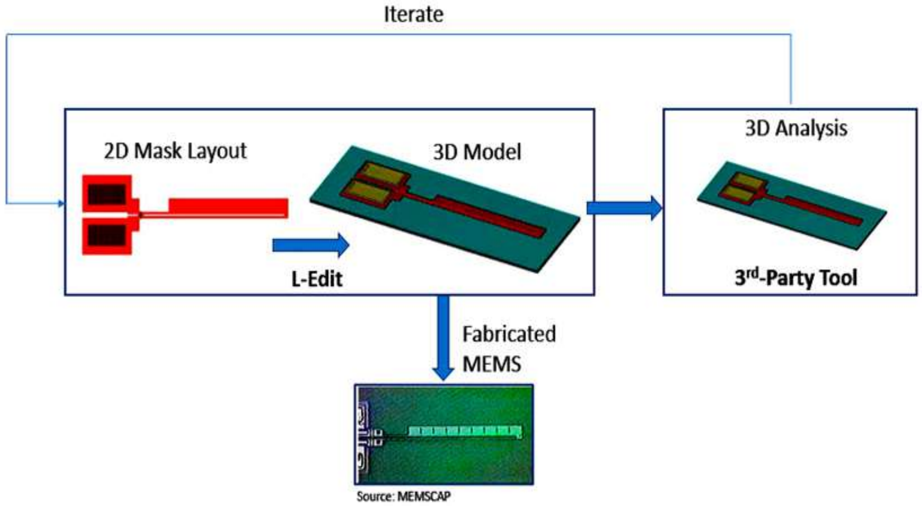

Figure 7: The mask-forward MEMS design flow.

VI. CONCLUSION

The fundamental hurdes of IoT design is working in four design domains; analog, digital, RF, and MEMS. The Tanner design flow is architected to seamlessly work in any of the design domains by employing an integrated design flow for design, simulation, layout, and verification.

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