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Trillion-Node Engine: Open-Innovation IoT/CPS Platform
- Pioneering Future of IoT/CPS for Everyone, by Everyone -

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Abstract

Trillion-node engine is a small and battery-operatable hardware/software open platform which enables everyone to try out a proof of concept especially for novel and diverse IoT/CPS applications.

Summary

As the CMOS scaling is not forever, new values of semiconductor technologies are to be sought by exploring new applications and services, added to just striving for solving scaling issues (Fig.1). This presentation describes an open-innovation platform, namely trillion-node engine, to facilitate the system development and thus makes this journey to search for the new values of nanotechnology easier by bridging a valley between a technology and applications.

In order to make IoT/CPS market taking off, more than millions of new applications should be introduced, which is only possible by involving many people including non-engineering people to try out various service concepts (Figs. 2-4). The trillion-node engine provides this open-innovation platform. It is based on an open-source hardware/software concept, where associated technical information can be used for free by everyone. Since it is open, users of the platform can mix and match the best technologies to build the most suitable system.

Technical details of the trillion-node engine are shown in Figs. 5-11. By establishing open-innovation platform, the integrated electronics may enjoy the continuous growth for the generations to come after the CMOS scaling slows down and even stops (Figs. 12).

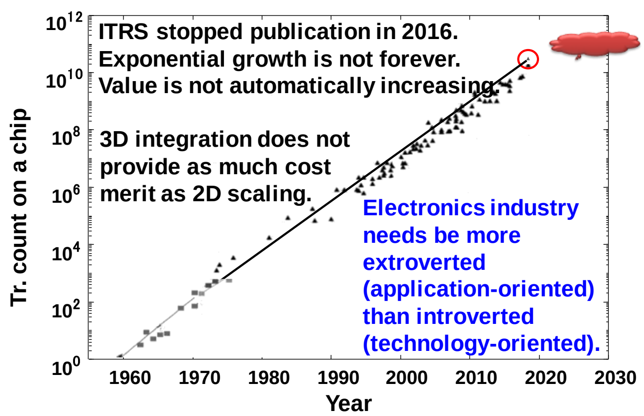


Fig. 1 CMOS scaling is not forever and a search for new values of semiconductor technology is on-going.

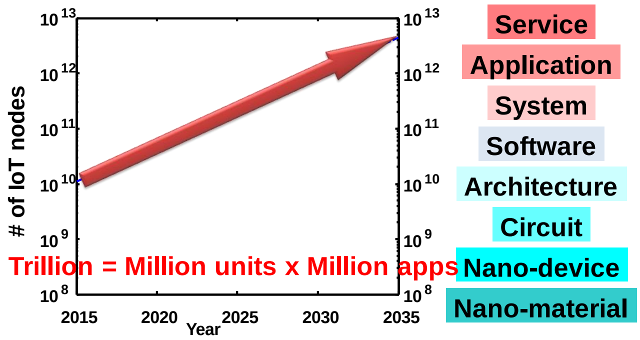


Fig. 2 In 2030, trillions of CPS nodes are expected to serve for people's life, which leads to more than 3 trillion of dollars market. Diverse applications will be needed for the number of CPS nodes to reach trillions.

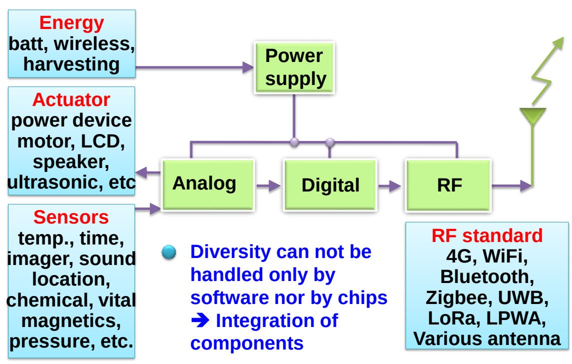


Fig. 3 IoT/CPS systems cannot be implemented with just IC components and software. Thus, board level integration platform is necessary. Trillion-node engine accommodates diverse system implementations with small-volume production capability.

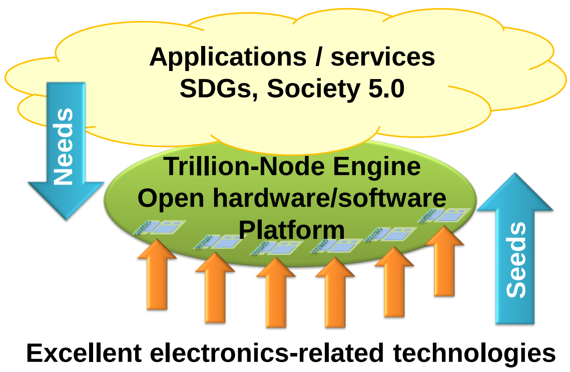


Fig. 4 With an open-innovation platform, application/service providers can meet with technology providers to initiate a new system construction.

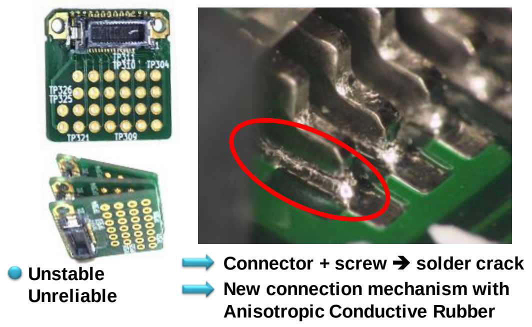


Fig. 5 If a micro-connector is used to stack Leafs (modules), screwing up is also required to reduce instability. Then, fixing modules by two ways, cracks develop in soldering. Thus, connection based on anisotropic conductive robber (ACR) is adopted.

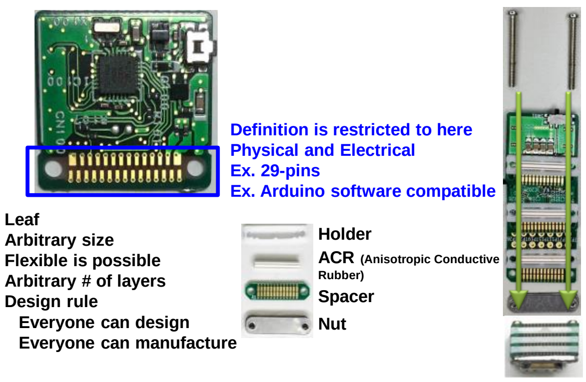


Fig. 6 The size of Leaf (module) is typically 2cm x 2cm and the definition is limited only to the 29-pin bus. Software-wise, it could be used with tens of thousands of Arduino downloadable codes.

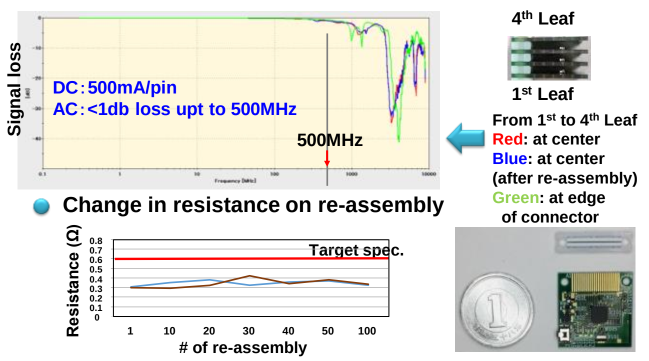


Fig. 7 Leafs are easily assembled like block toys with an ACR-based. Electrical characteristics and resistance stability over re-assembly are both satisfactory.

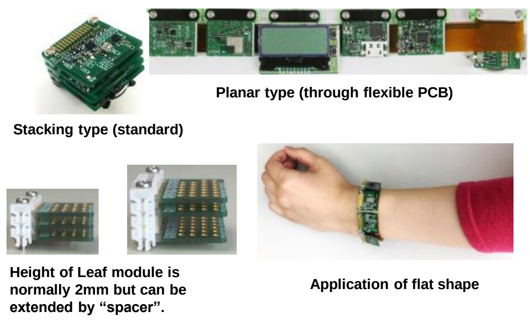
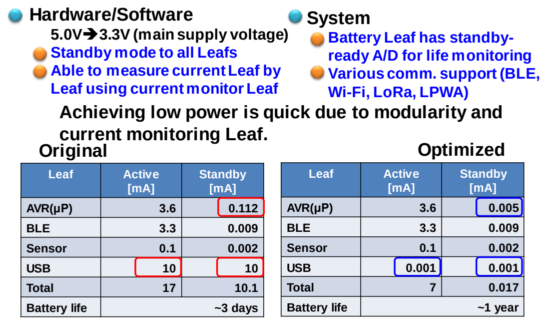


Fig. 8 Not only stacked assembly but also planar assembly style is possible with trillion-node engine, covering R&D of various systems.



Leaf	Active [mA]	Standby [mA]
AVR(μP)	3.6	0.112
BLE	3.3	0.009
Sensor	0.1	0.002
USB	10	10
Total	17	10.1
Battery life		~3 days

Leaf	Active [mA]	Standby [mA]
AVR(μP)	3.6	0.005
BLE	3.3	0.009
Sensor	0.1	0.002
USB	0.001	0.001
Total	7	0.017
Battery life		~1 year

Fig. 9 Considerations for low power. Low-power implementation is possible because each Leaf (module) implements standby mode by using software-controlled load-switch for example.

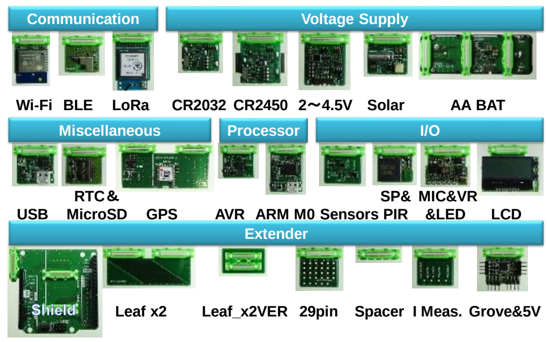


Fig. 10 Various Leafs (modules) are available including new wireless standards.

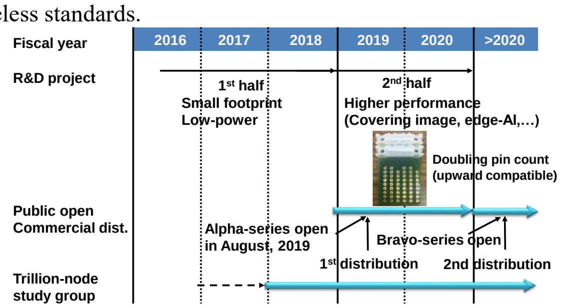


Fig. 11 Trillion-node engine will pursue higher performance to cover image and AI applications for the future.

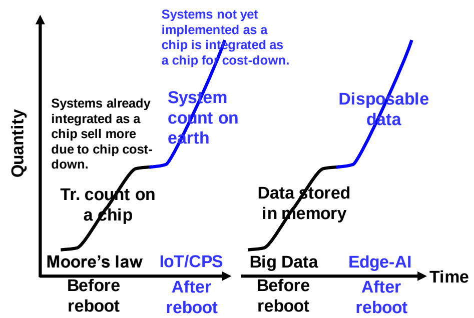


Fig. 12 Rebooting integrated electronics for another exponential growth

Acknowledgements

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References

[1] https://www.hpcwire.jp/archives/11238