

Track G: IoT and other Power Sensitive Solutions

IoT Applications Based on AI

13th May, 2019

NEC Space Technologies, Ltd.
a subsidiary of NEC Corporation





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NEC brings together and integrates technology and expertise to create the ICT-enabled society of tomorrow.

We collaborate closely with partners and customers around the world, orchestrating each project to ensure all its parts are fine-tuned to local needs.

Every day, our innovative solutions for society contribute to greater safety, security, efficiency and equality, and enable people to live brighter lives.

Contents

What is space systems business?

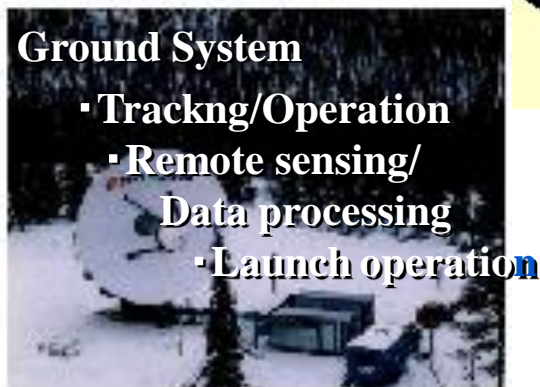
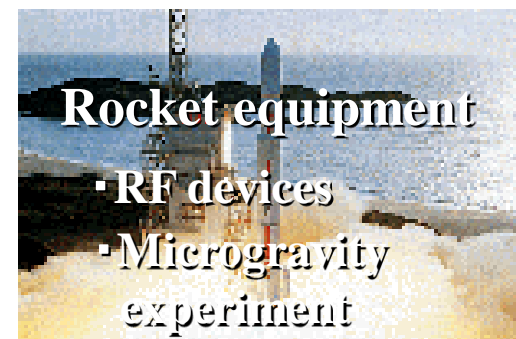
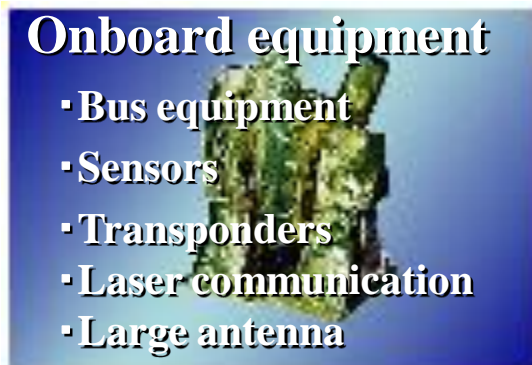
Satellites as sensors in IoT

AI in Edge Nodes

IoT Edge node Processor Architecture

The scope of space system business in NEC/NECSpace

ChipEx2019



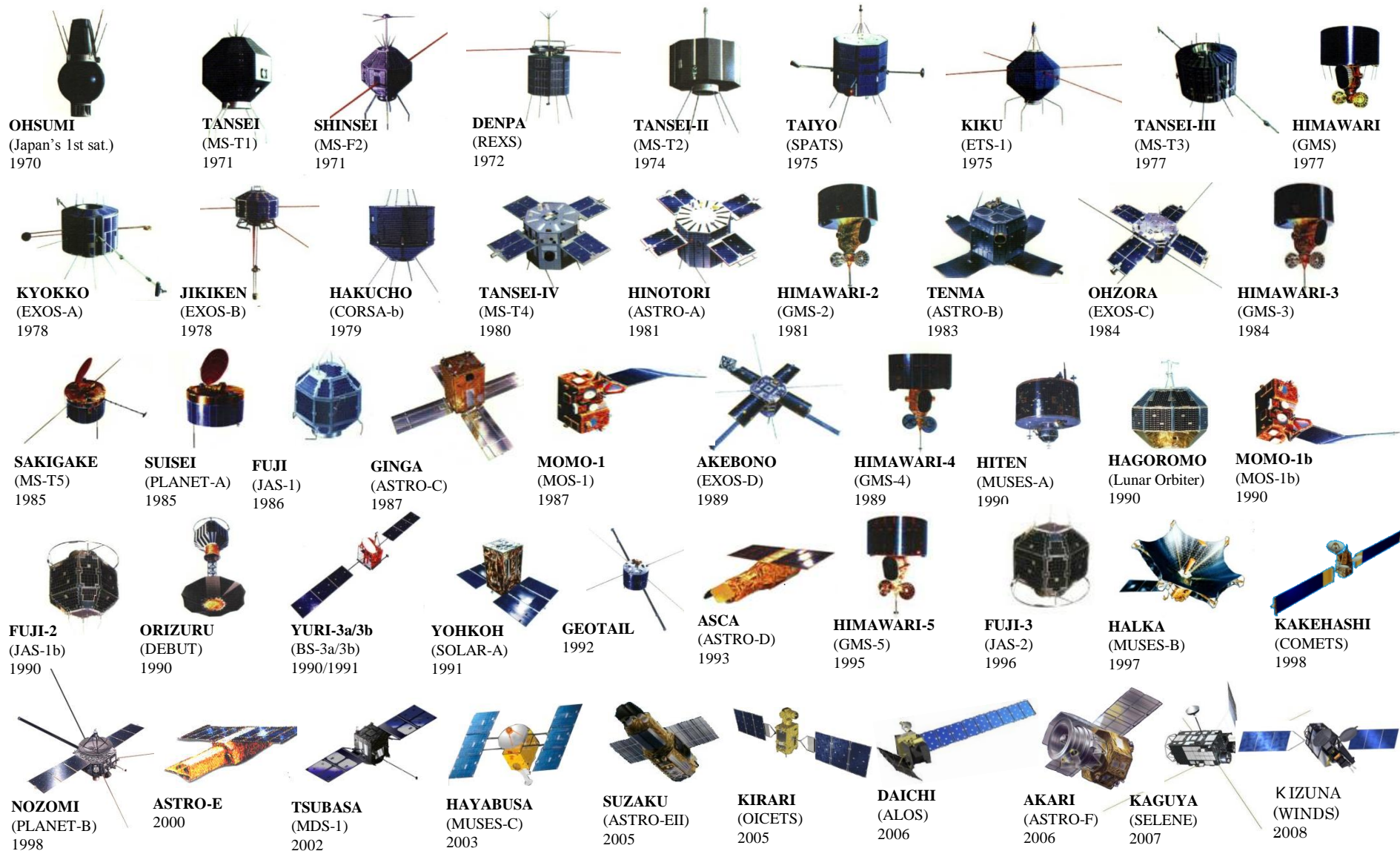
More than 8000 components have been supplied to the customers around the world for more than **280** satellites



As of Nov. 21, 2018
(Including under manufacturing)

Major Japanese Satellites integrated by NEC/NECSpace

ChipEx2019



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Satellites as sensors and communication nodes in IoT (Internet of Things) business



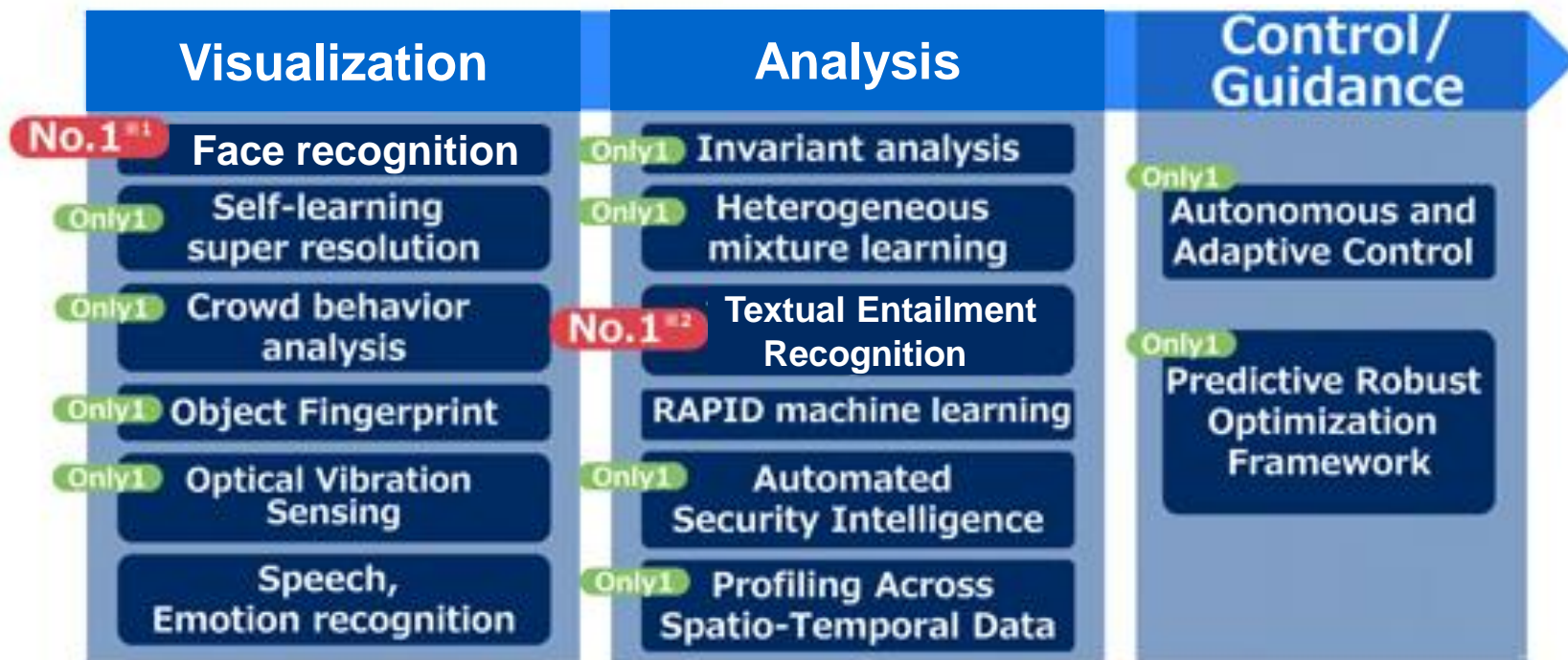
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https://www.nec.com/en/global/solutions/space/remote_sensing/



NEC the WISE

AI technologies from NEC
for enriching human intellect and creativity



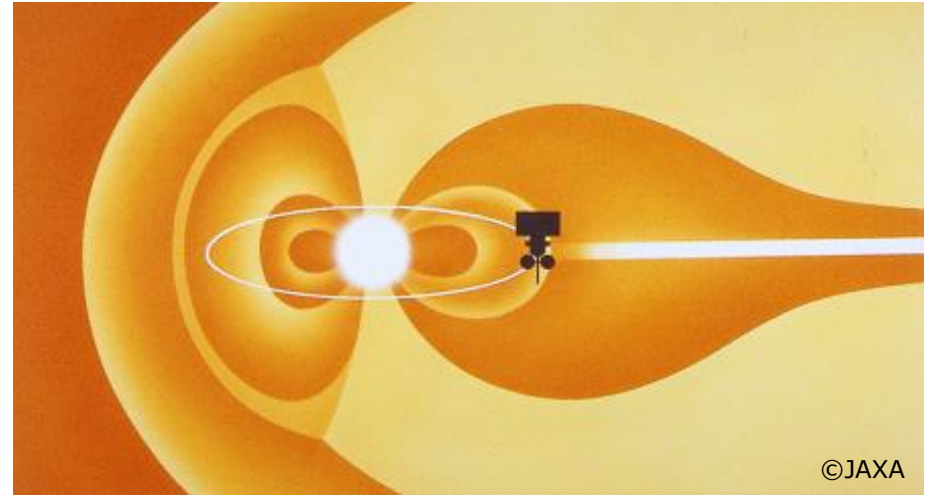
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※1 : Ranked 1st three consecutive times in task assessment as sponsored by National Institute of Standards and Technology (NIST) of the US
※2 : Ranked 1st in task assessment as sponsored by National Institute of Standards and Technology (NIST) of the US (2012)

https://www.nec.com/en/press/201607/global_20160719_01.html

Cosmic radiation in space

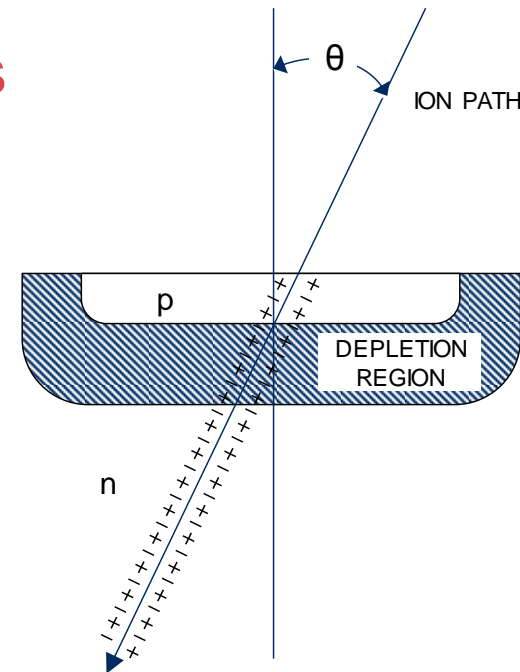
- High energy particles from the Sun and Galaxy cause soft errors



Soft-errors in semiconductor memories

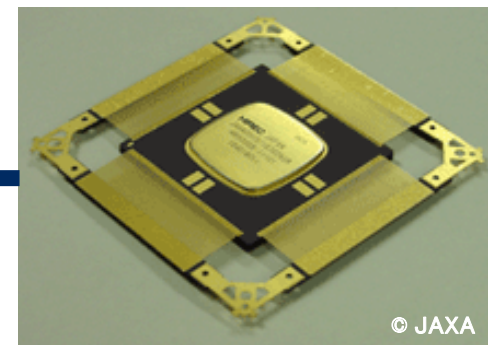
- Ion path through p-n junction
- Bit errors occur in memory cells.

AI implementation techniques against harsh environment are required.





Field
Programmable
Gate Array
(FPGA)



Micro Controller
@ 33 MHz



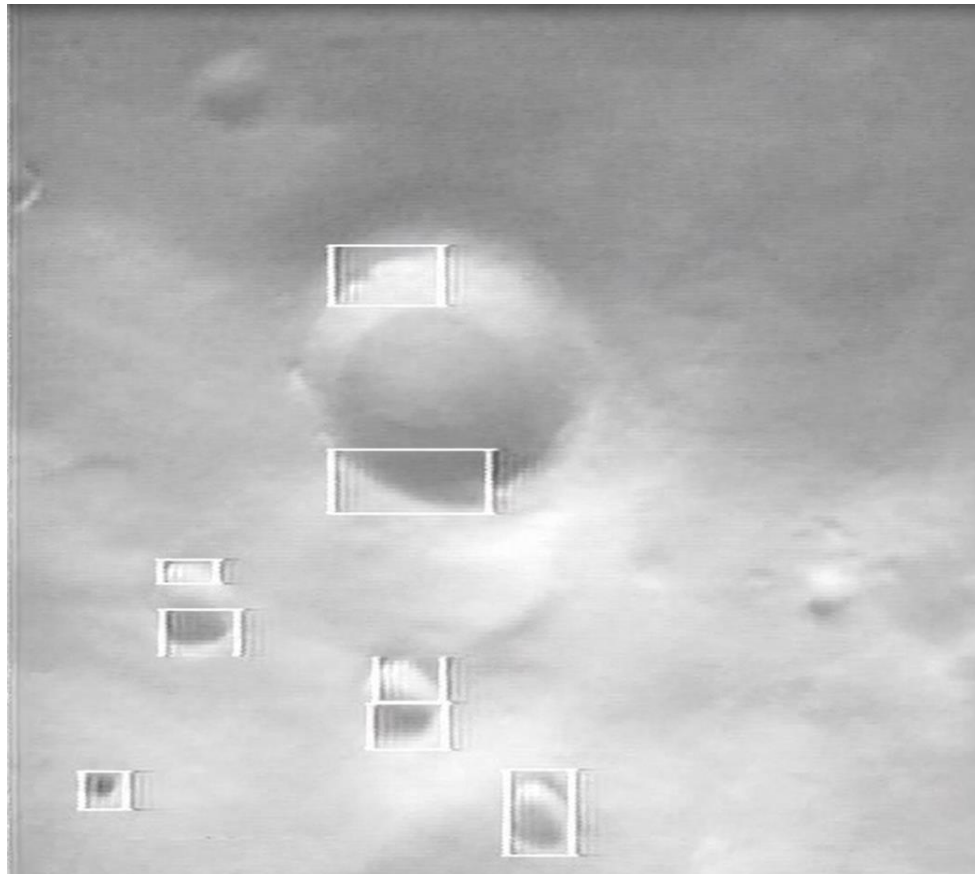
**Performance
Compensation**

Sensor Electronics & Optical Navigation Computer of HAYABUSA-2

AI implementation techniques for
resource limitation are required.



- The first image recognition implementation for HAYABUSA asteroid probe in 2000
 - Modification for craters



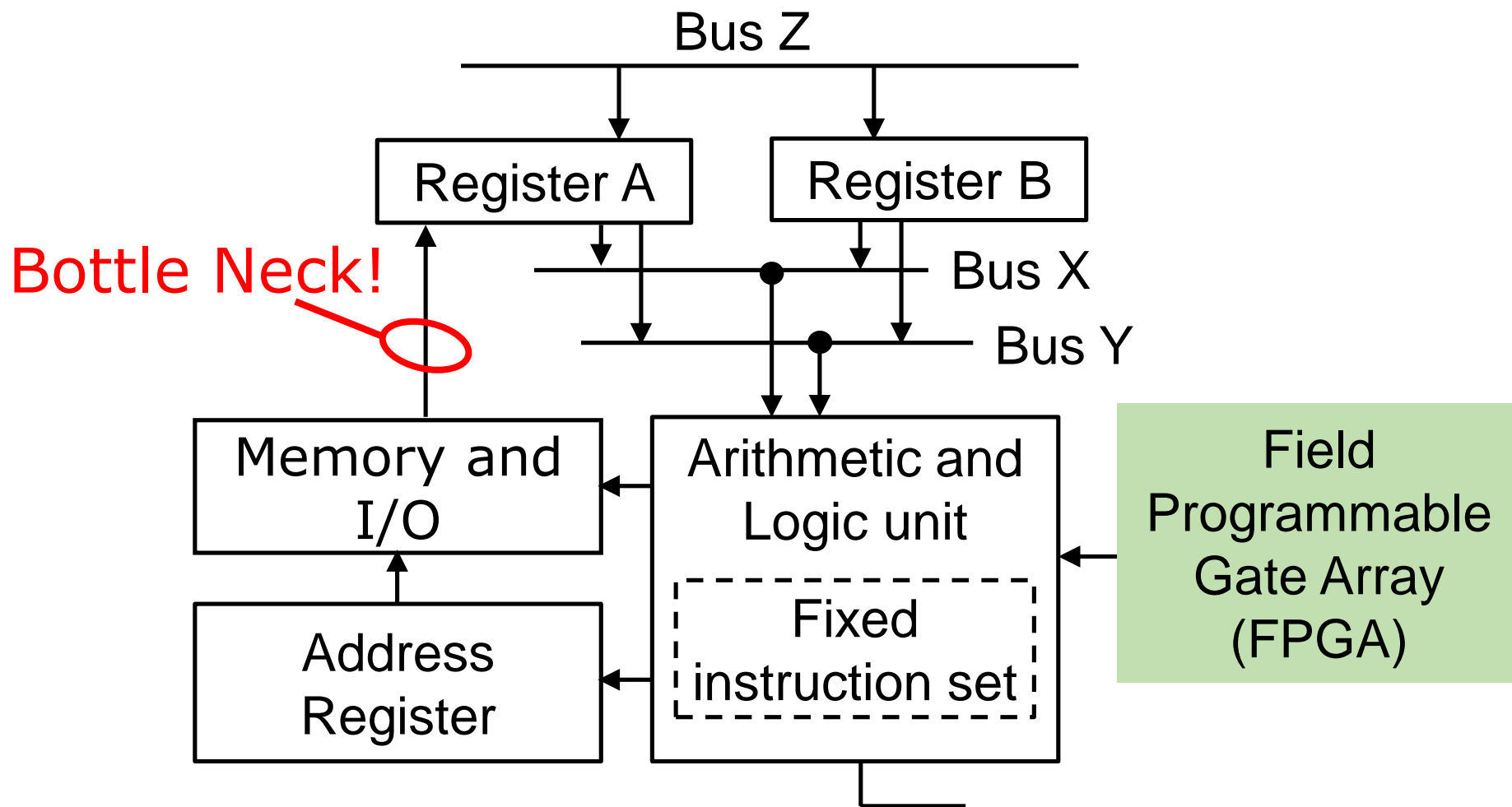
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Lessons Learned from the first HAYABUSA asteroid probe

- We learned that even in the internet age, there are things that you don't know until you go to the site.
- **Programmability for “Unknown in the field”** is required at the site.

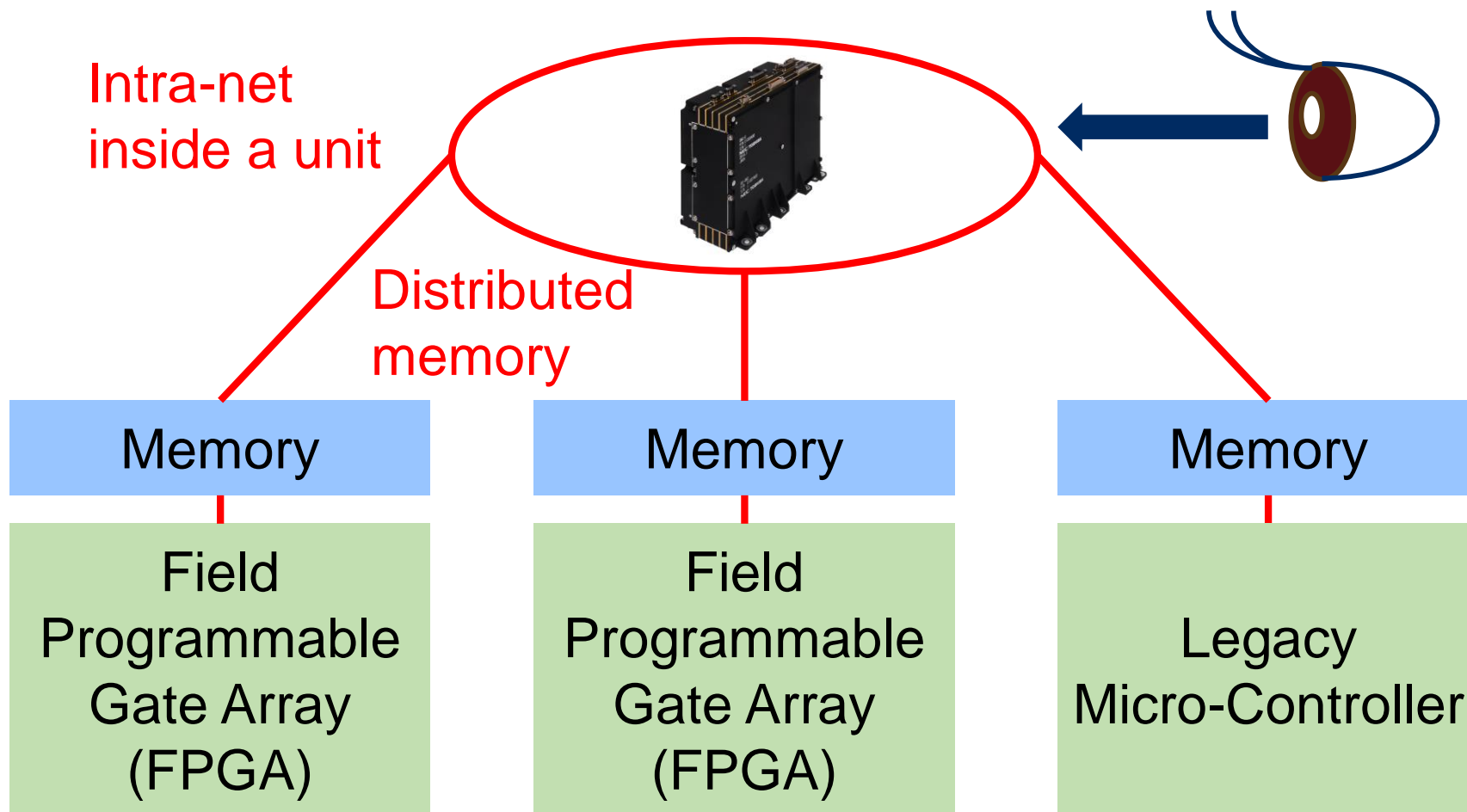


■ FPGA = Co-processor?



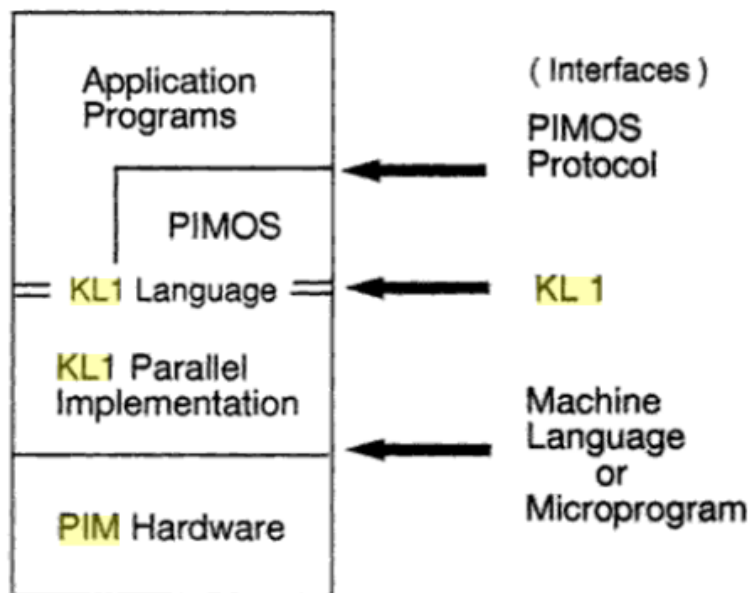
- Distributed Memory architecture to keep latency

One integrated programming language



Heritage from the Second Generation AI Computer - The Fifth Generation Computer Systems (FGCS) Project in Japan

- T. Chikayama, “KLIC: A KL1 implementation for Unix systems,” New Generation Computing, vol. 12, no. 2, pp. 123-124 (1993).
- K. Rokusawa, A. Nakase, T. Chikayama, “Distributed memory implementation of KLIC,” New Generation Computing, vol. 14, no. 3, pp. 261-280 (1996).



K. Taki, “Parallel Inference Machine PIM”, Proc. of Intl. Conf. on FIFTH GENERATION COMPUTER SYSTEMS 1992.

<http://www.jaist.ac.jp/iscenter-/mpc/old-machines/pim/>



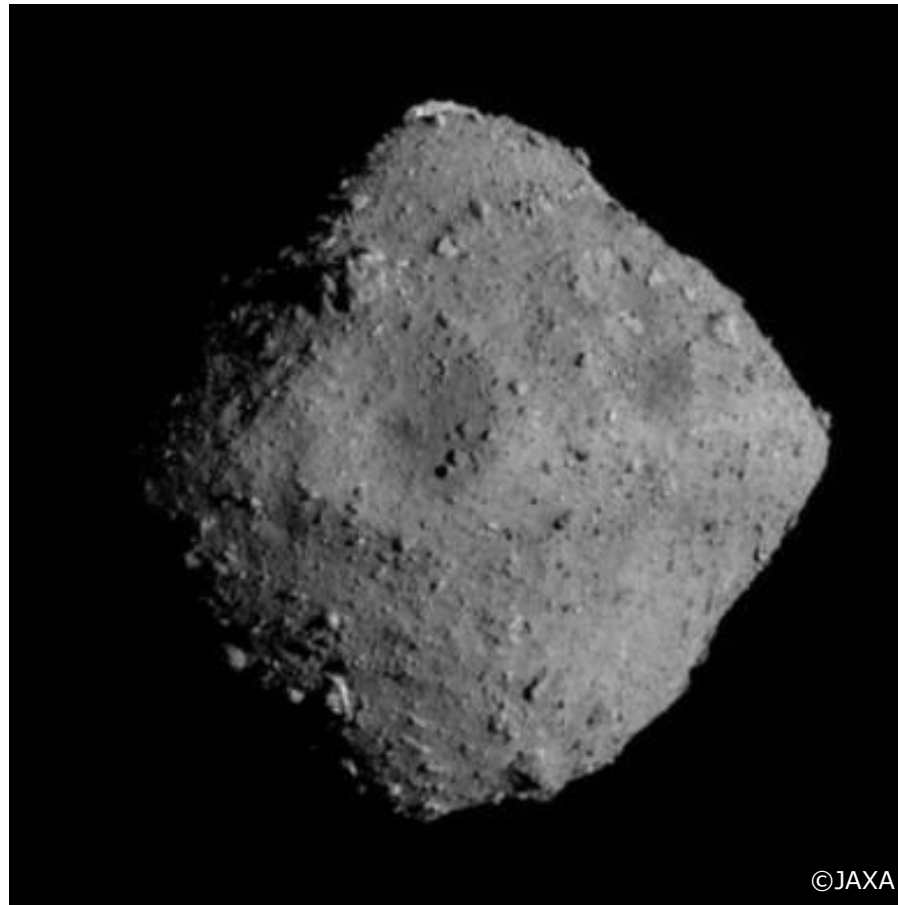
pim/p



pim/m

Another unknown world “Ryugu” – the target of HAYABUSA-2

- “Unexpected surface” is “as expected”, because we have designed a fully programmable IoT edge node for “Unknown in the field”.
- HAYABUSA-2 asteroid probe has been optimized at the site.



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Mar 5, 2019

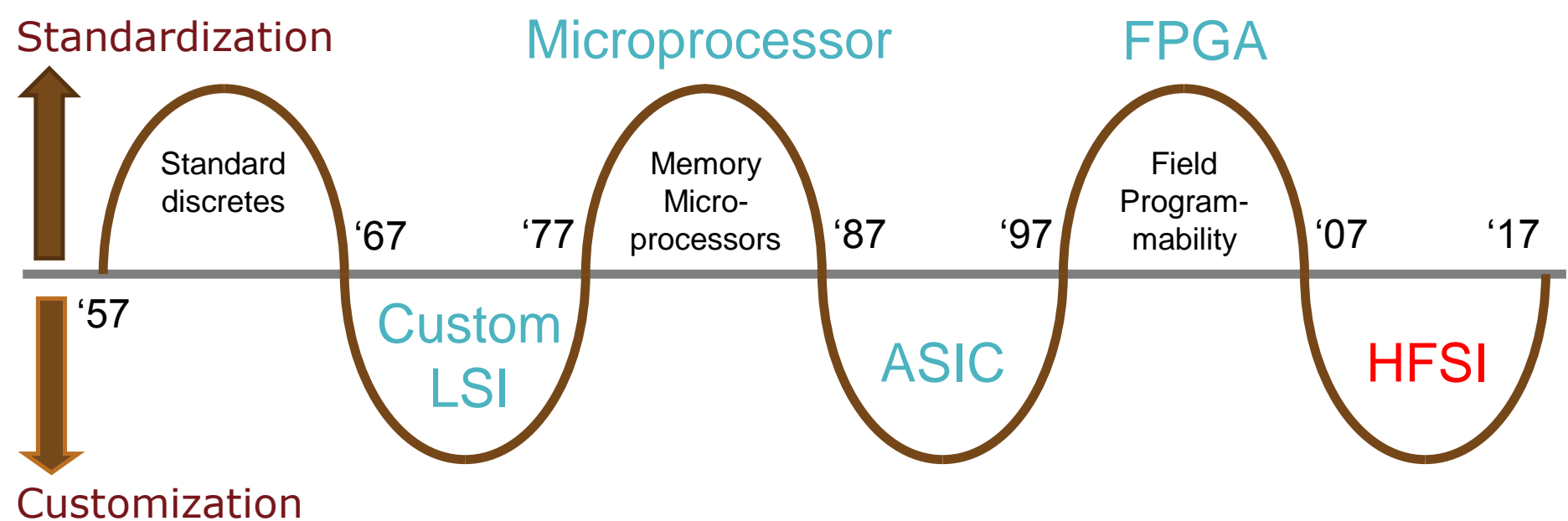
Hayabusa2 CAM-H has successfully imaged Ryugu during the touchdown



<http://www.isas.jaxa.jp/en/topics/002076.html>

Yet another technology trend : **Makimoto's Wave**

- Cf. IEEE Computer, Dec. 2013 (Vol. 46 no. 12), ISSN: 0018-9162

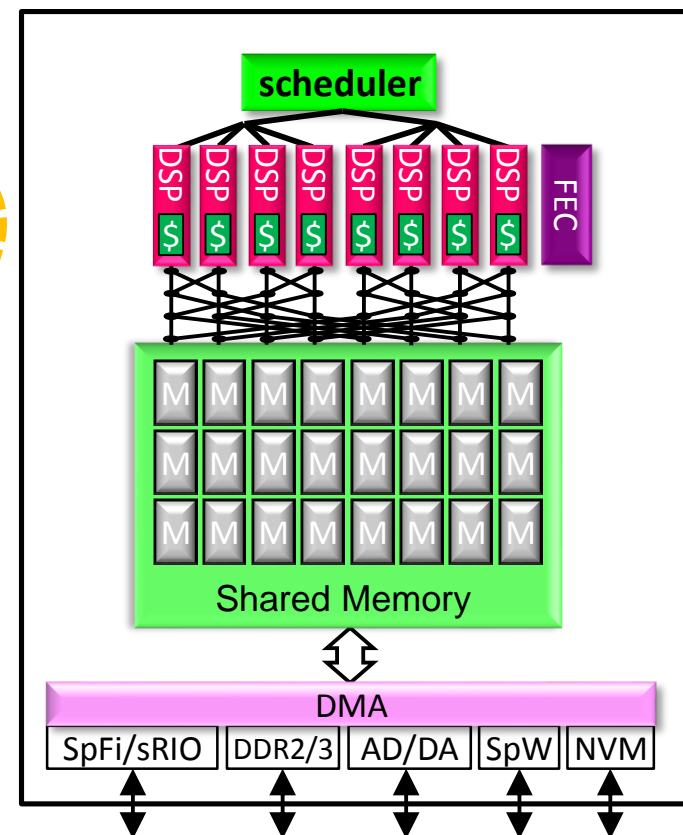
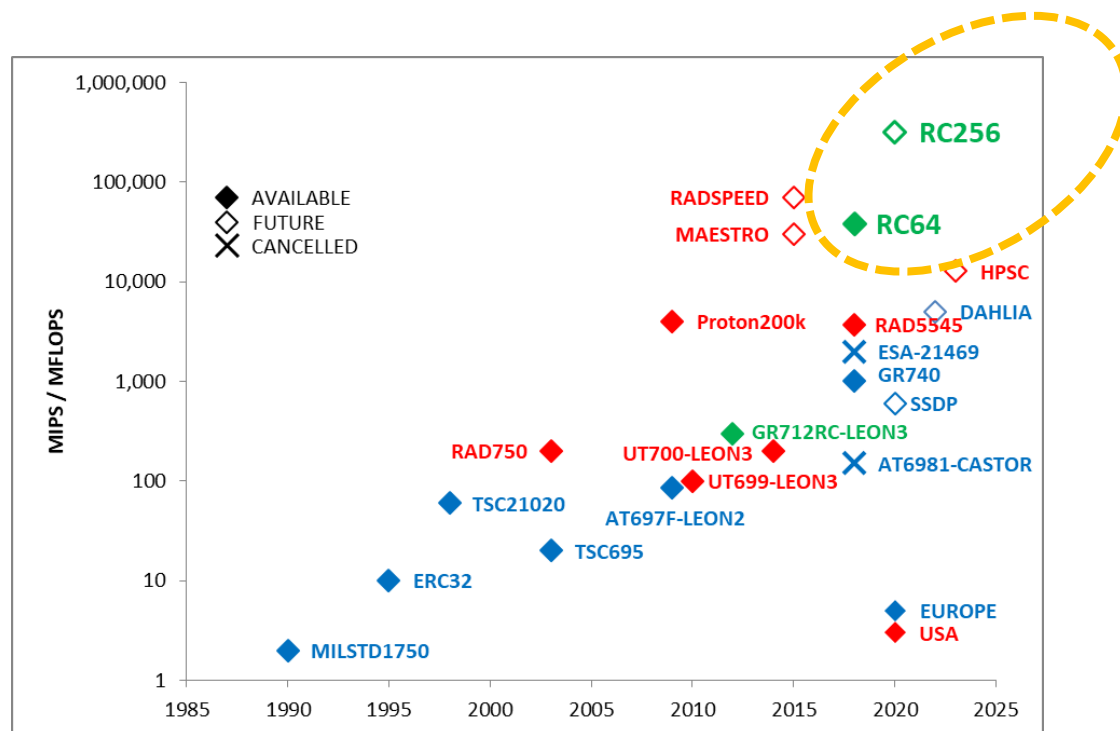


Just after the decade of “Highly Functional Super Integration: HFSI”.

Unique processing elements are integrated into one chip.

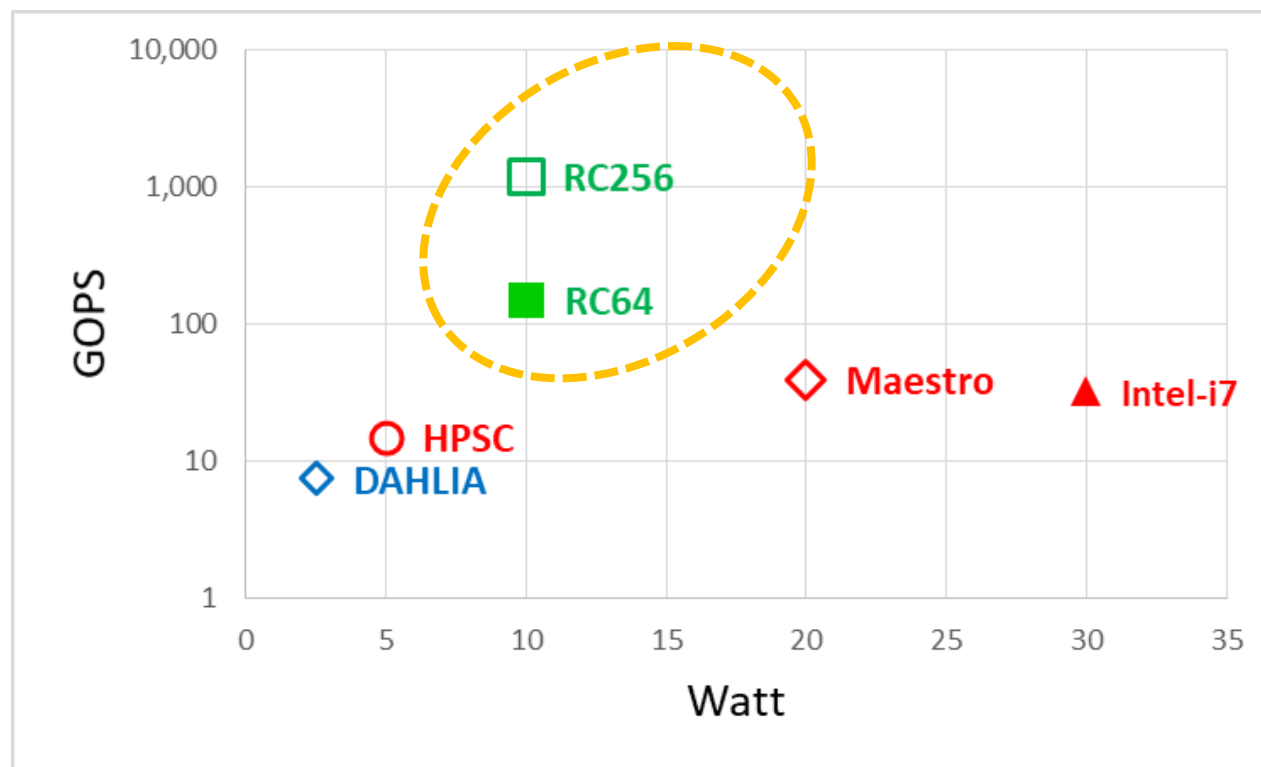
Many core with fully connected shared memory

- RC64 by Ramon Chips, Ltd.
- Israeli Company



Low power consumption with high performance

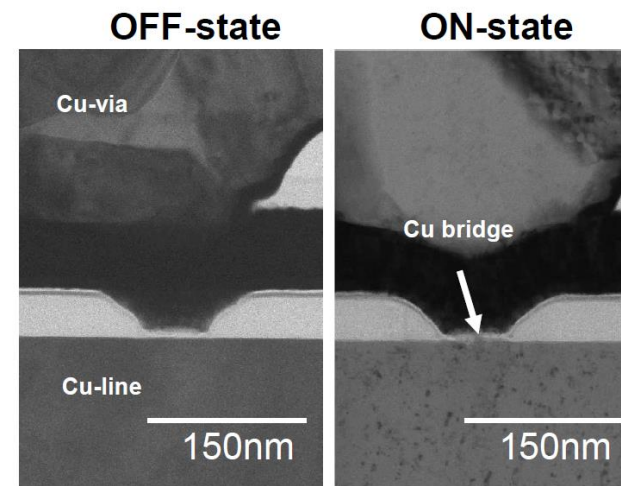
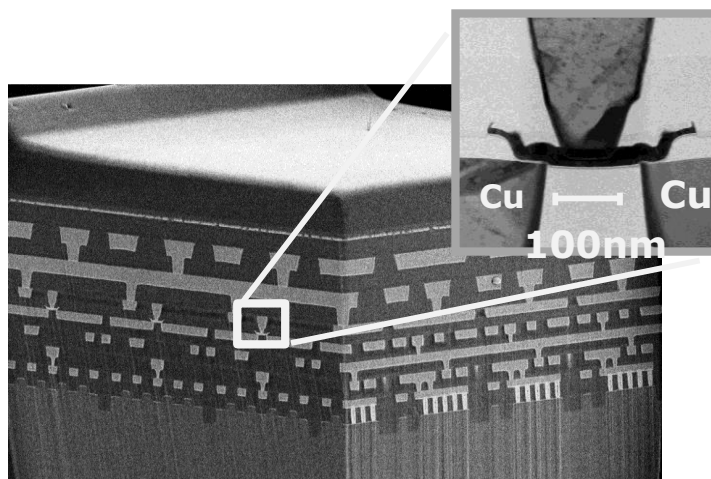
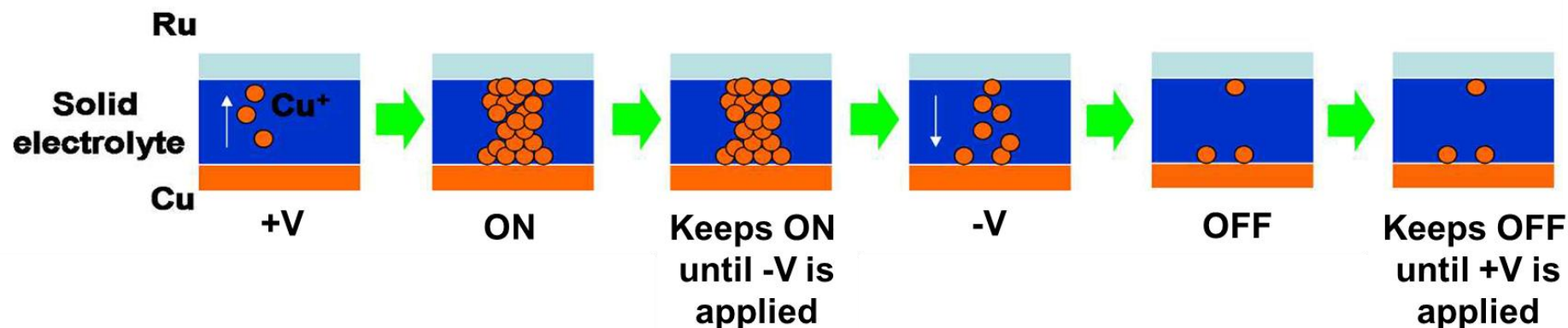
- Indispensable characteristics for IoT applications



RC64 by Ramon Chips, Ltd.

NanoBridge[®] Programmable Metal Wire

- Atomic switch for IoT applications of AI



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https://www.nec.com/en/press/201703/global_20170307_03.html

How to implement AI applications in IoT edge nodes

- **Programmability for “Unknown in the field”**

Architecture of IoT edge nodes against harsh environment

- **Distributed memory implementation**
- **Integrated programming language interface**

The age of Highly Functional Super Integration (HFSI)

- **Makimoto's Wave**
- **Unique processors / Atomic Switch (NanoBridge[®])**

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