New Accelerated Applications in Space enabled by RISC-V and AI

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Imsys - AI and space

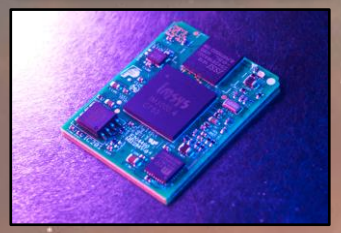
The Swedish National Space Board has decided to approve Imsys' application to the Space Application Program 2023-2 and grants funds to work with "New Accelerated Applications in Space" with support in Industrial Research.

The project is on track with our partners.

Rymdstyrelsen
Swedish National Space Agency

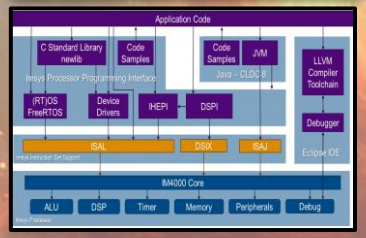
Tiny core

Alice AI Accelerator



IM-processor family

Software



SW Tools

FRONTGRADE
Technology Made to Perform
in the Harshest Conditions

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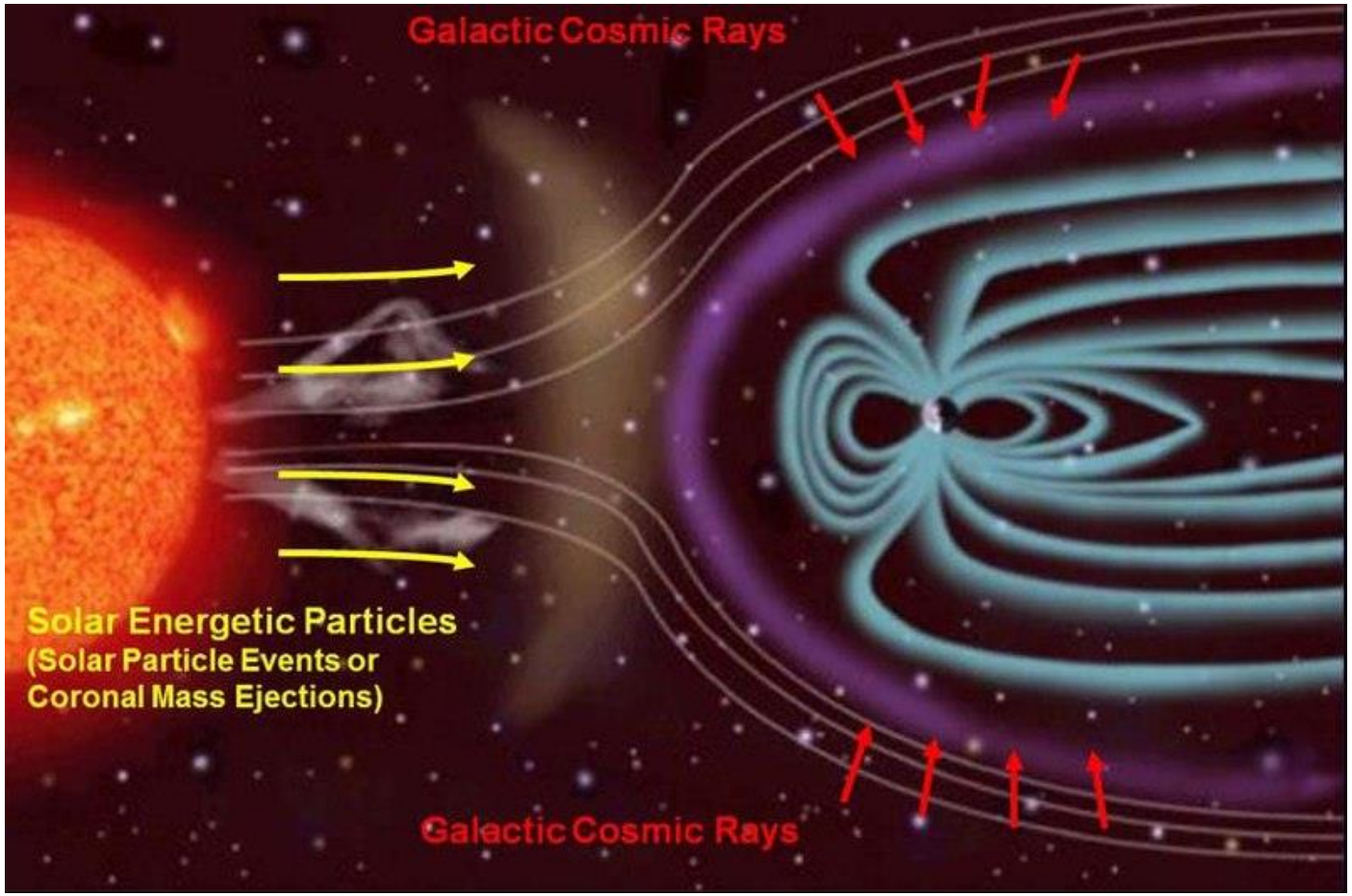
Radiation hardening process and/or design

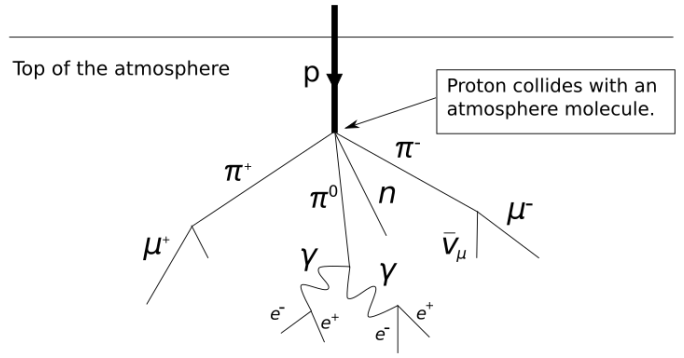


Wikipedia: Radiation hardening

Rays

alpha
beta
gamma

proton
ion



Radiation-hardened products are typically tested to one or more resultant-effects tests, including total ionizing dose (TID), enhanced low dose rate effects (ELDRS), neutron and proton displacement damage, and single event effects (SEEs).

Physical and/or logical protection.

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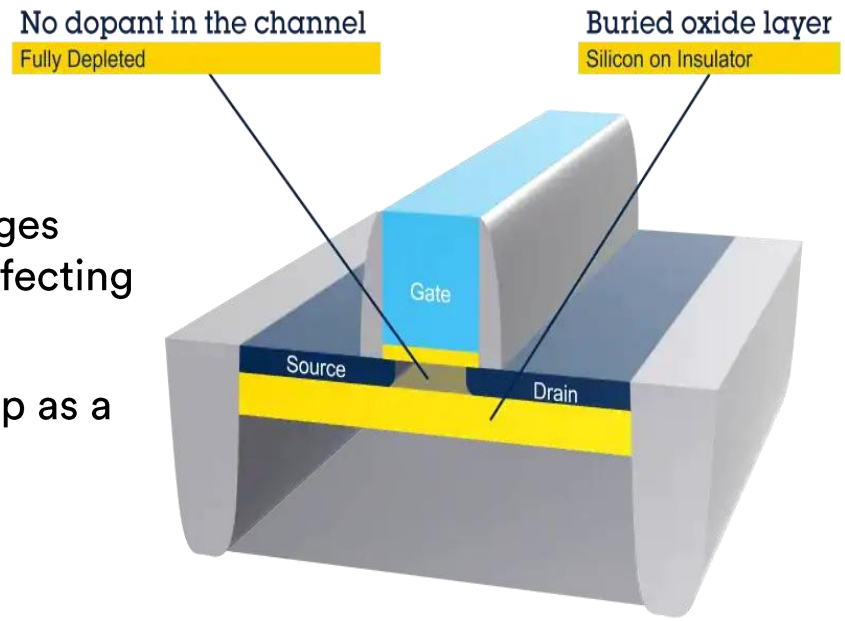
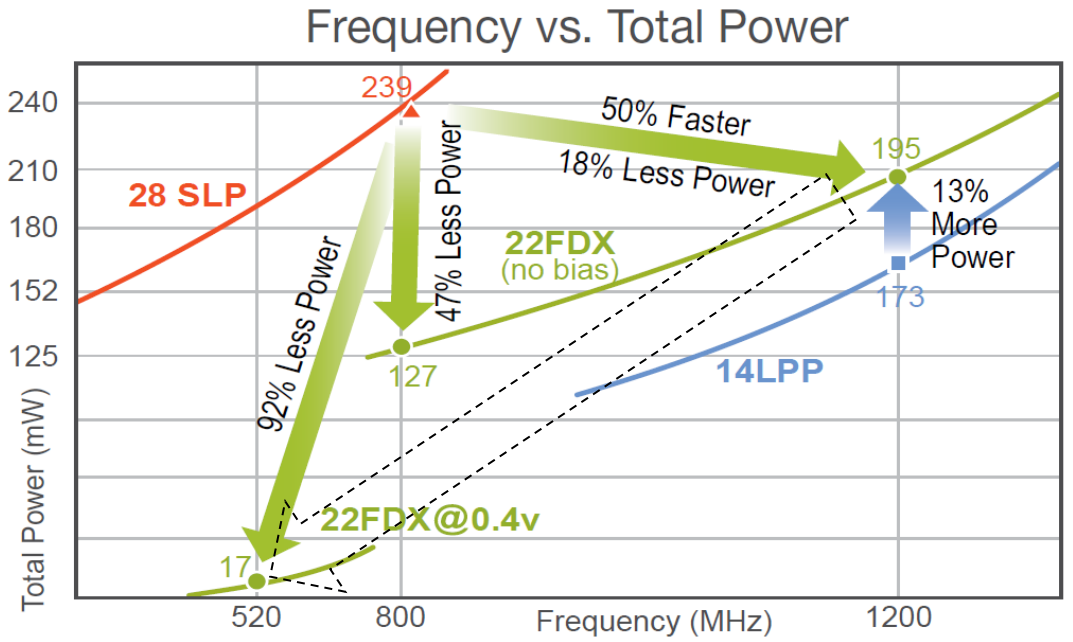
Curtesy of Frontgrade Gaisler

Radiation resilience from technology

Less likelihood of charges created by radiation affecting the channel in FD-SOI.

Less bit flips or latch-up as a result.





SOI with power scaling for high energy efficiency.
Also interesting for IoT, smart sensors …

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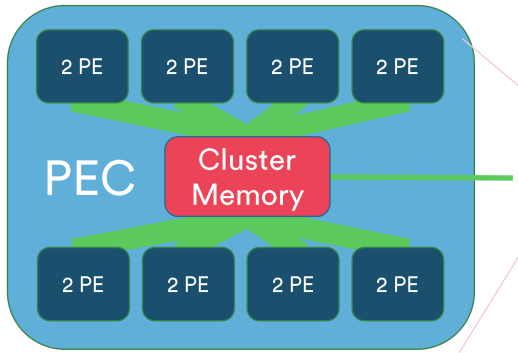
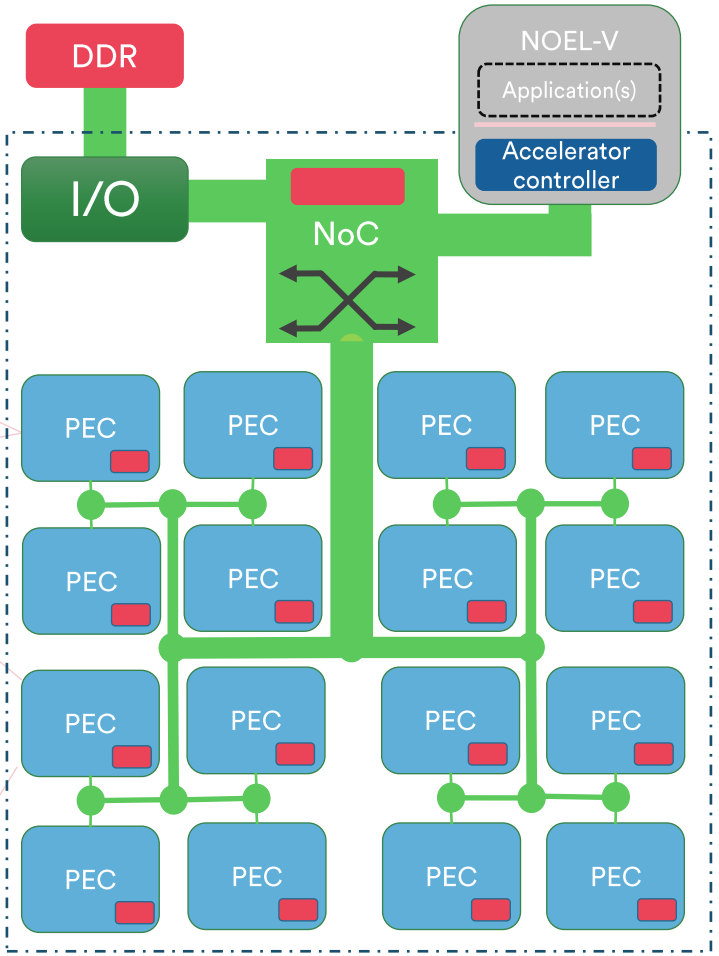
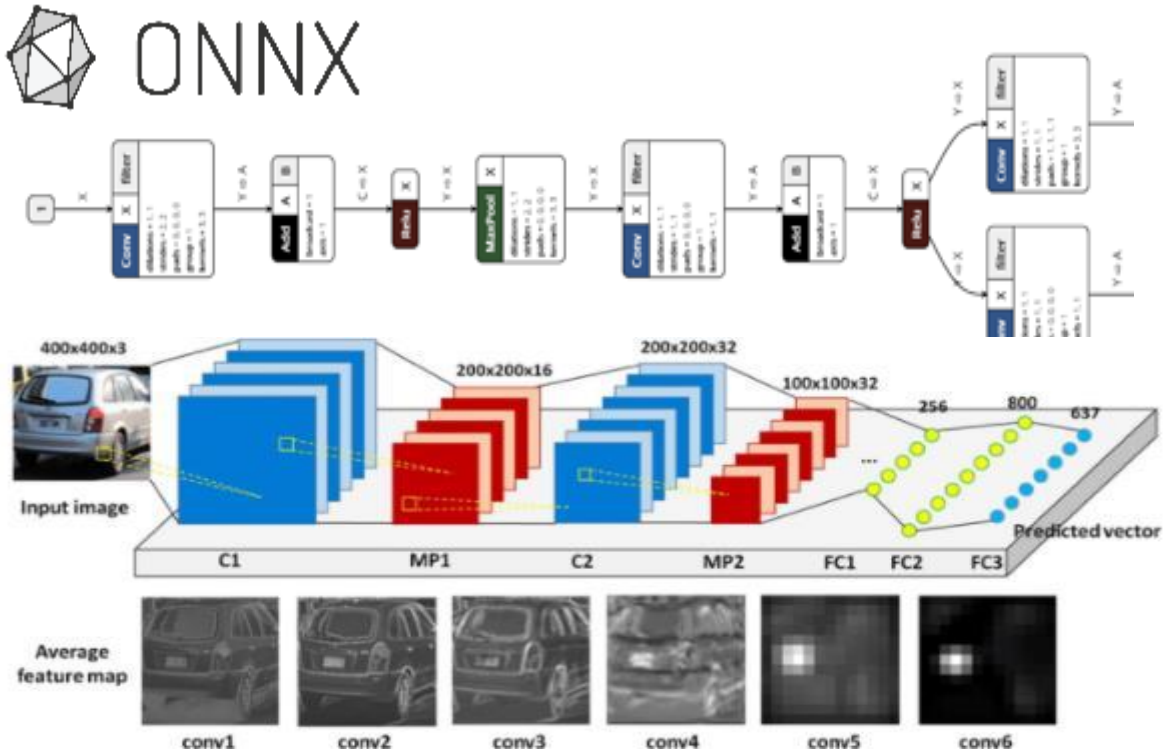
Imsys Accelerator – architecture

Flexible
Microprogrammed
Accelerator
Operations (FW)





- **Accelerator controller and application processor**
  NOEL-V (cluster)
- **SW: Accelerator controller**
  Software to sequence the accelerated functions
- **IP: Network on Chip (NoC)**
  High speed data and control
  Application controlled peer2peer
  Configurable for 1 to 16 PEC
- **IP: Processing Element Cluster (PEC)**
  Multiple Processing Elements with shared memory
  Processing near memory in each Processing Element (PE)
  These contain the vector engine (VE) (40 Gop/s per PE)
  Contained IP blocks: PE, VE, Cluster Controller, etc
- **IP: I/O**
  External memory, (AXI4 support)



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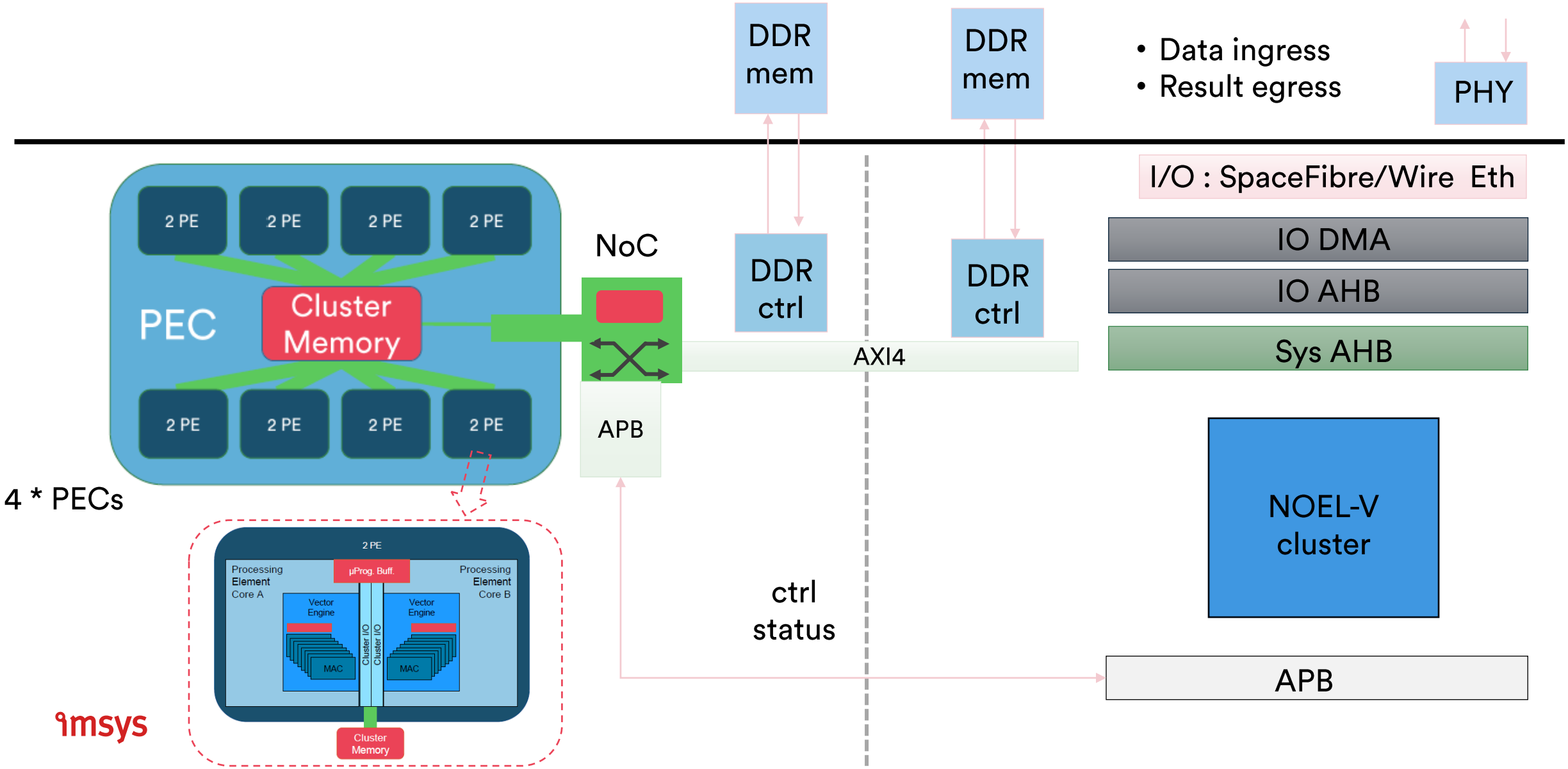
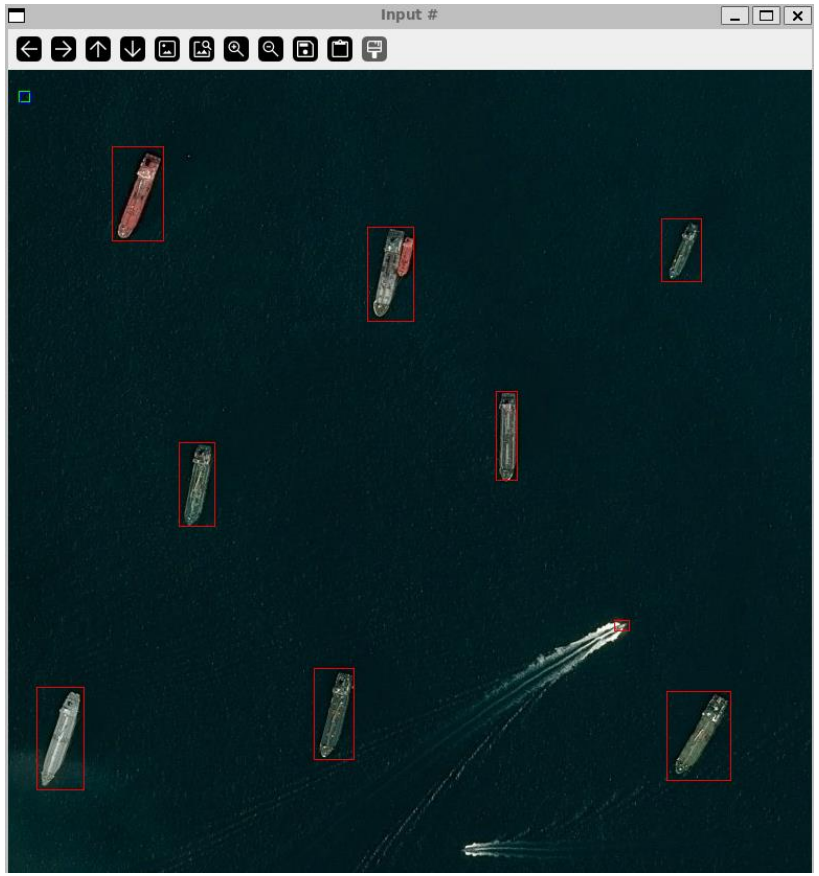
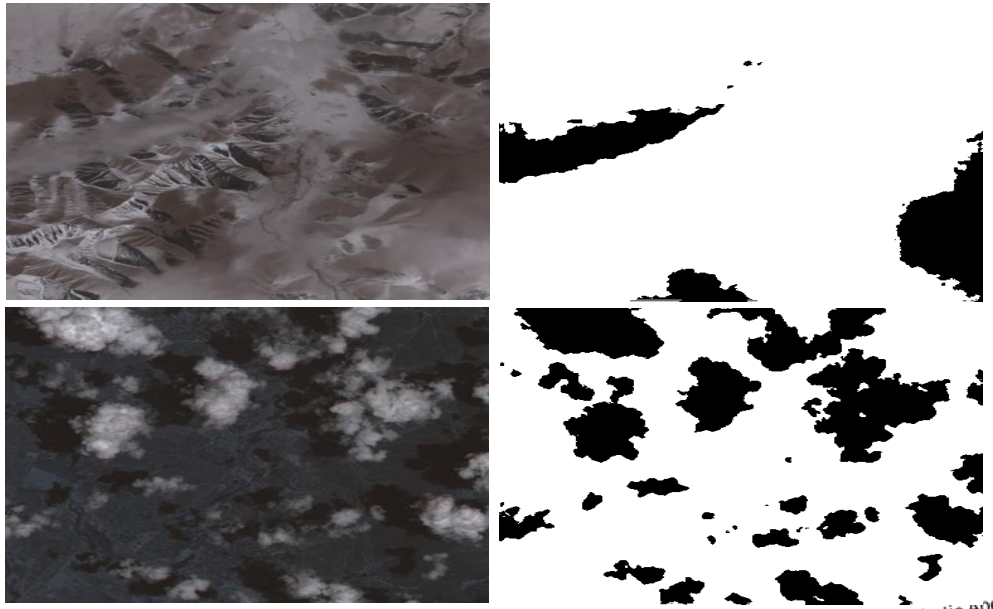
Integration – NAAS (New Accelerated Applications in Space)



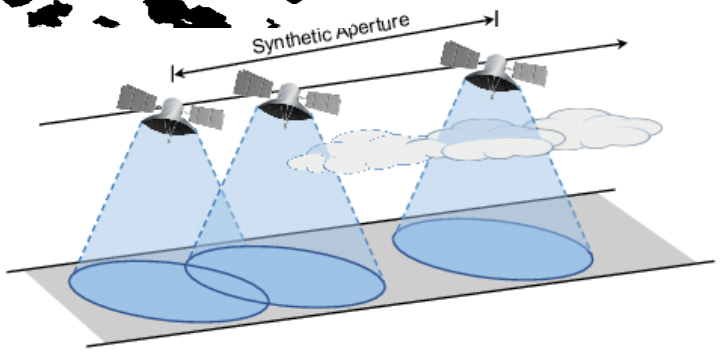
Satellite on board accelerated processing opportunities



Ship detection using Yolox and 8-bit quantization. Imsys run on “Airbus Ship Detection Challenge” (2018) dataset.



Real image & 8-bit quantization result for lightweight U-Net segmentation network for cloud screening. Imsys run on “38-Cloud: Cloud Segmentation in Satellite Images”



SAR – Benefits from acceleration of large DFT

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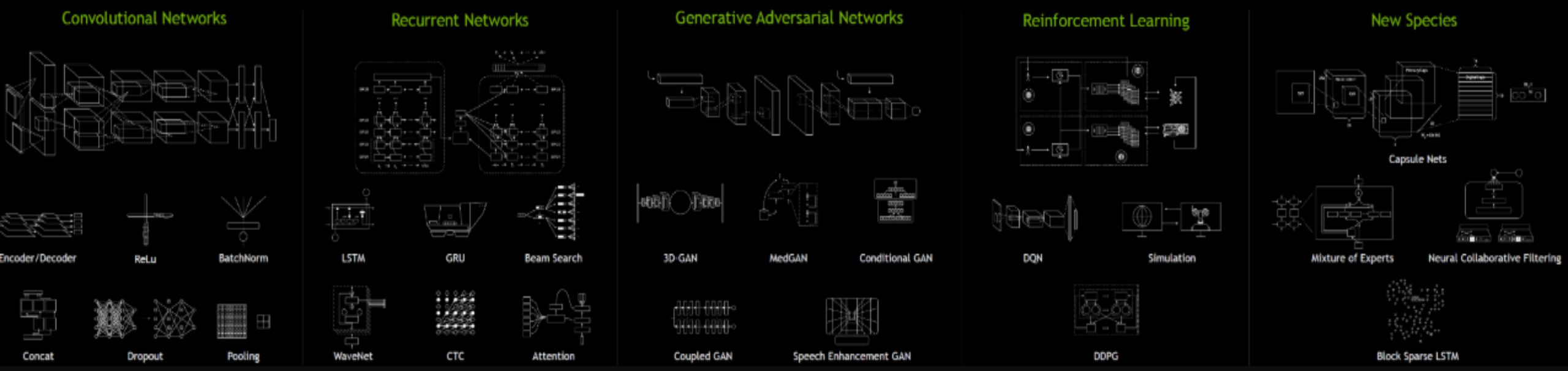
Low energy 8-bit AI inference

Flexibility to execute neural networks efficiently



Flexible Microprogrammed Accelerator Operations (FW)

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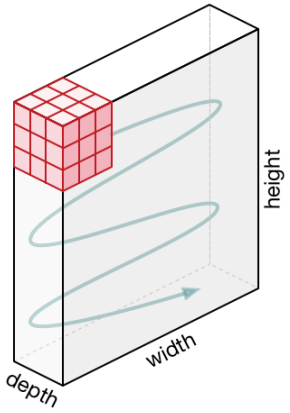
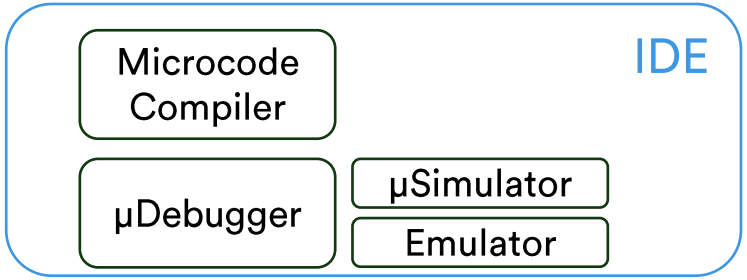


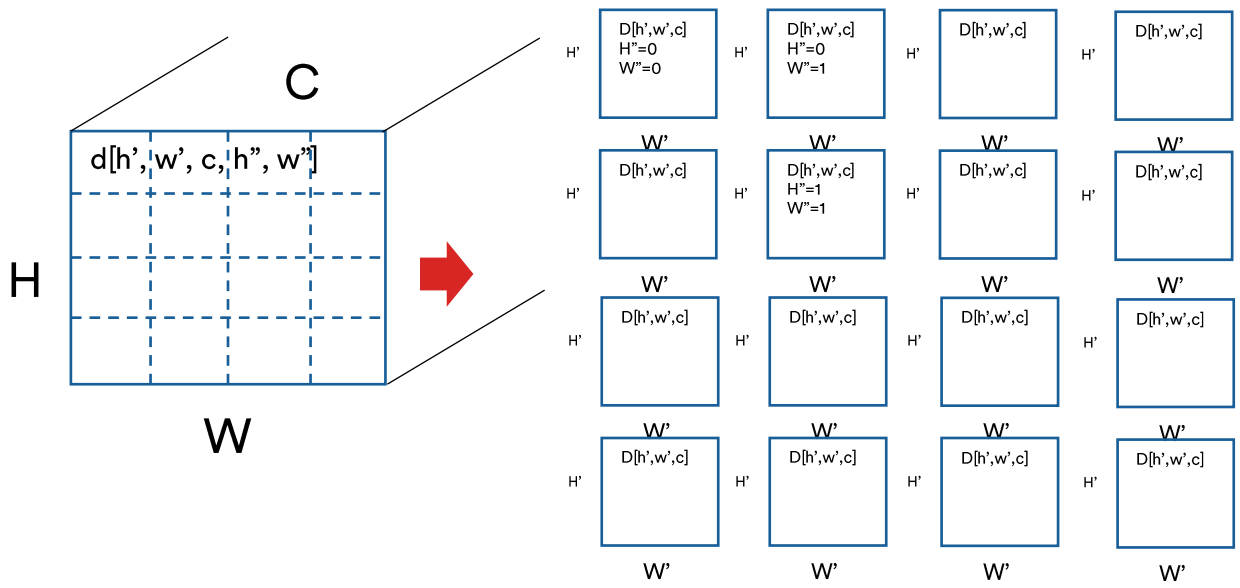
- Library of Accelerator Operations
  - Extensive instructions for quantized neural network operations and other kernel-based operations
- Programmable user operation creation and customization

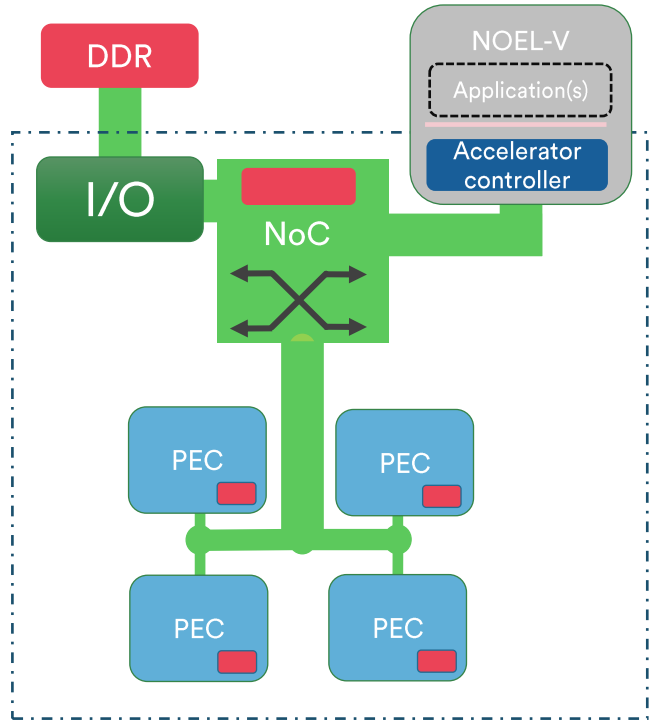
- Tools for custom kernel development



Robustness in NAAS

- NOEL-V is designed for rugged deployment
- Memories of the accelerator will be protected
- Watch-dog on accelerator FW (Static schedule enabled by tools and HW
- Lock-step PEC operation with majority decision in NoC
- Imsys future: FW based testing during operation (ISO 26262 enabler)





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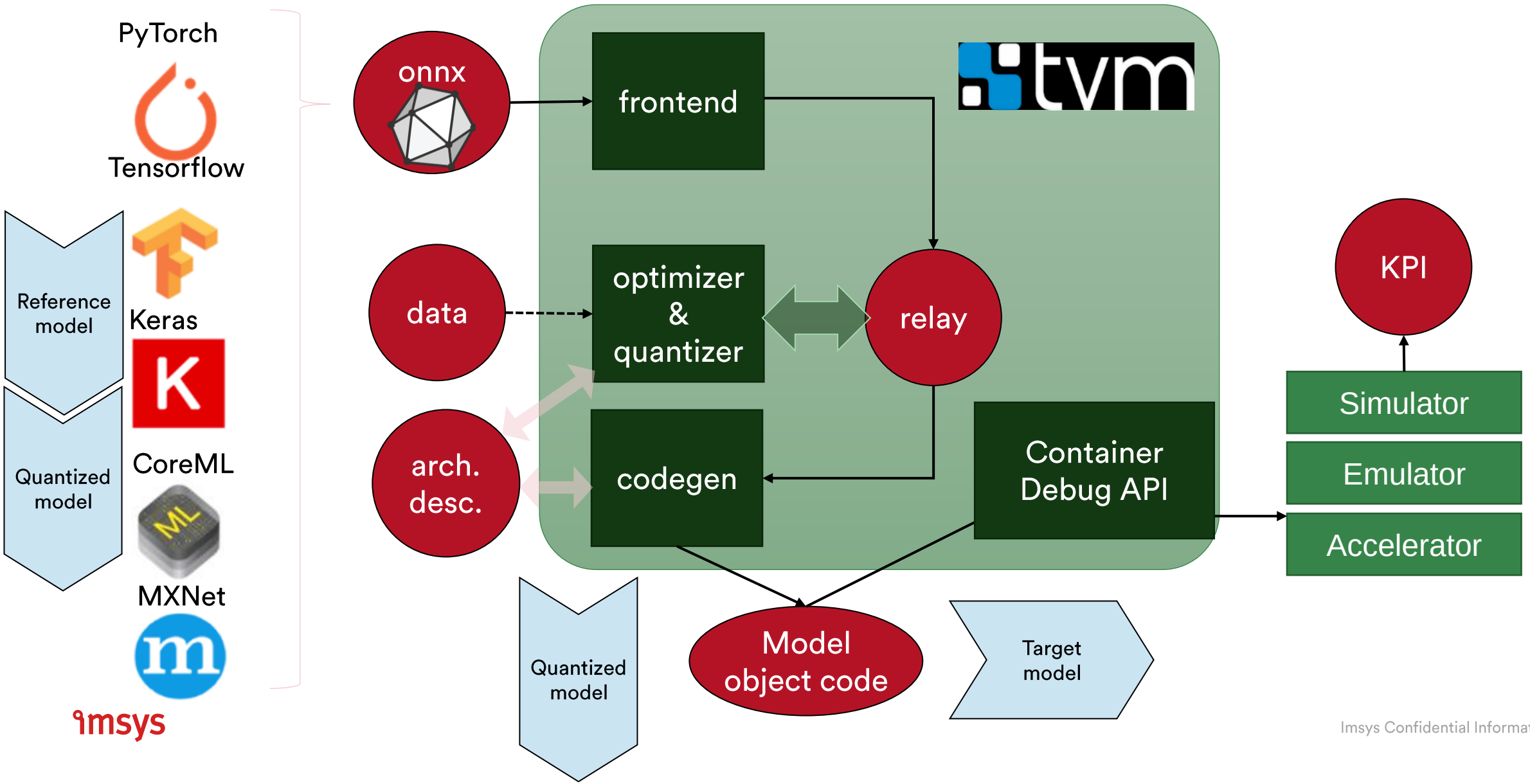
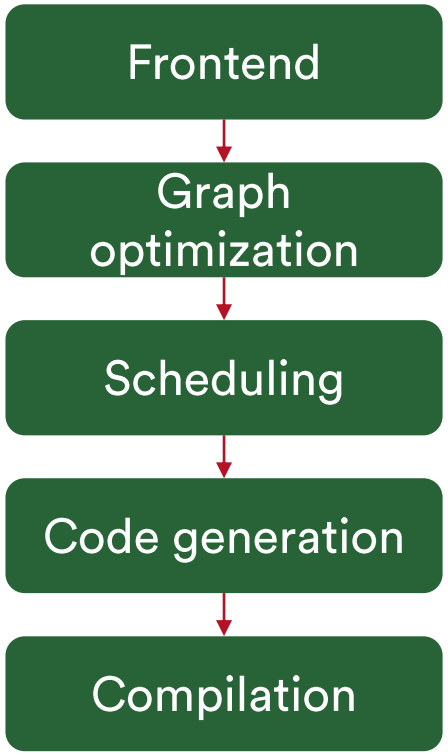
AI application development



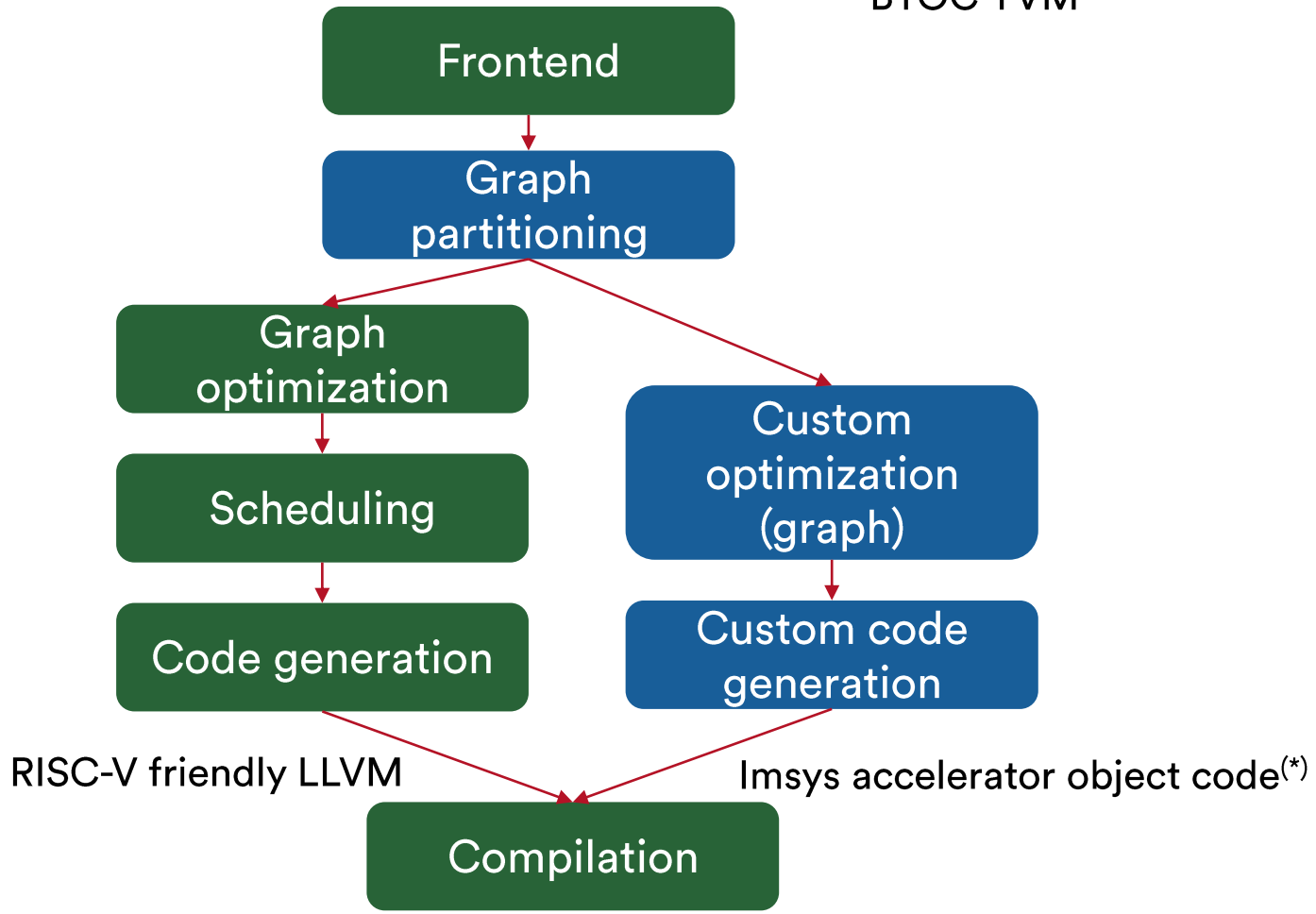
Bring Your Own Code generator in TVM

- Protect model investment
- Utilize HW optimally



Standard TVM compilation

BYOC TVM



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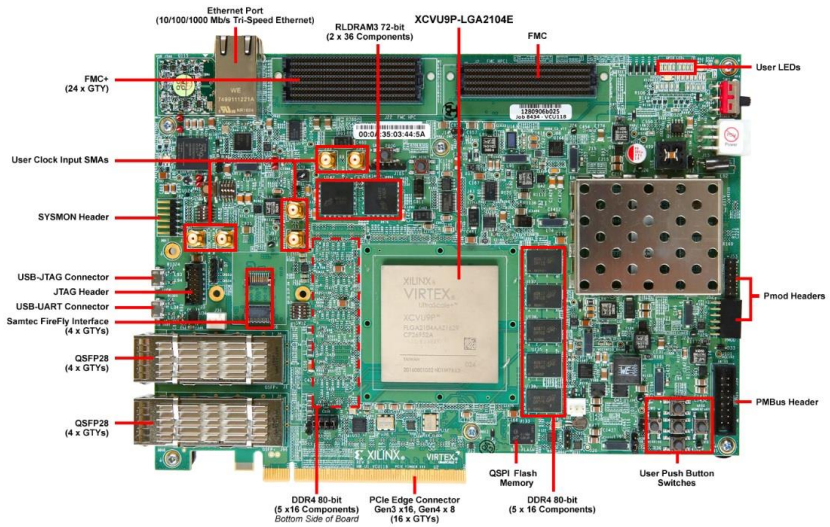
(*) or other accelerator

NAAS Evaluation Platform (and IoT)

The FPGA board
- ✓ VCU118 Virtex UltraScale+ Evaluation Kit
- ✓ FPGA: UltraScale+ XCVU9P

System Logic Cells (K)	2,586
DSP Slices	6,840
Memory (Mb)	345.9
GTY 32.75 Gb/s Transceivers	120
I/O	832



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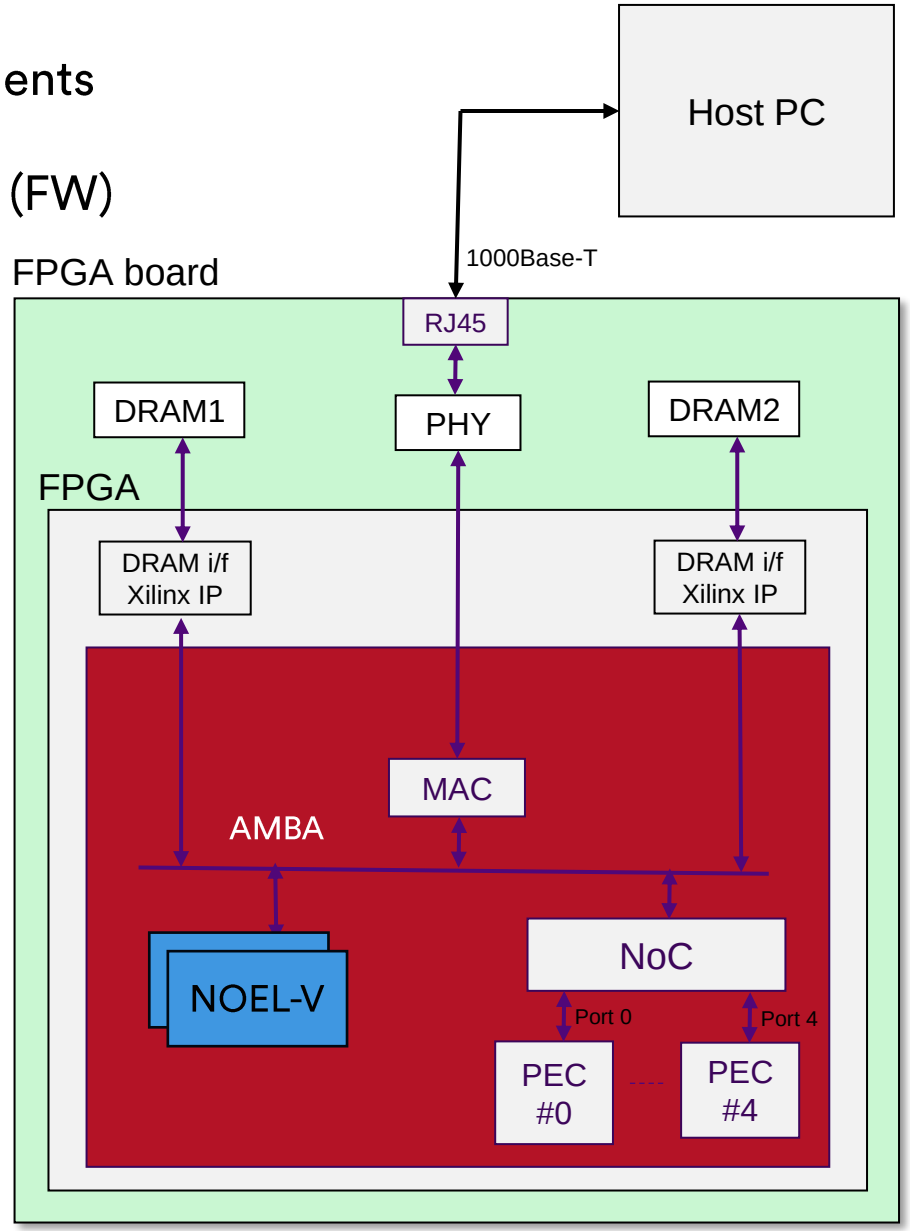
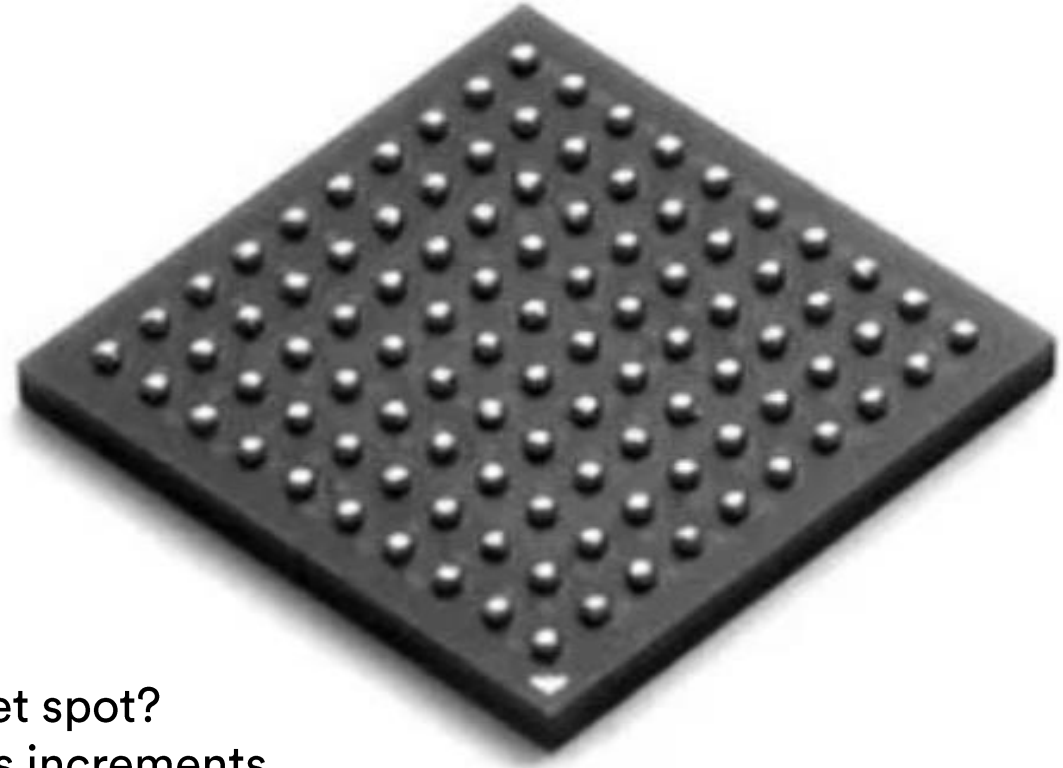
Acceleration on processing elements
- ✓ 64 PE = 4 PEC (~320 GOP/s)
- ✓ Micro coded DNN operations (FW)

High speed data
- ✓ DRAM1
- ✓ DRAM2
- ✓ Control & Data i/o: Ethernet

- ✓ NOEL-V
- ✓ Fault tolerant NOEL-V



Imsys Accelerator and NOEL-V for edge and IoT



- Capacity sweet spot?
  - 625 Gop/s increments
  - Matching NoC
- Shared fast bulk memory
- RISC-V based applications
- Security

Ongoing discussion

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Thank you

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