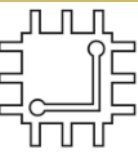


# Is there a paradigm shift for on-board computing and processing?

Anders Petersén, Thomas Lindgren, Patrik Sandin RUAG Space AB, Gothenburg, Sweden  
 anders.petersen@ruag.com, +46 31 735 43 54



# Lynx Single Board Computer

## Driving Requirements

Today we see the need for increased processing performance, driven by increased digitalization and new services such as Software Defined Radio, real-time Image Processing and enhanced Compression techniques, Artificial Intelligence and Machine Learning, Visual Navigation & Autonomous Control, Debris Removal etc. This, in combination with the bandwidth limitation in downlink channels present, the payload data needs to be processed and compressed on board before downlinked to the user on ground. Historically image processing in orbit has been performed using dedicated hardware and to certain extends software processing. These have been often, costly and in-flexible solutions, either using customized FPGAs or ASICs in order to achieve needed performance.

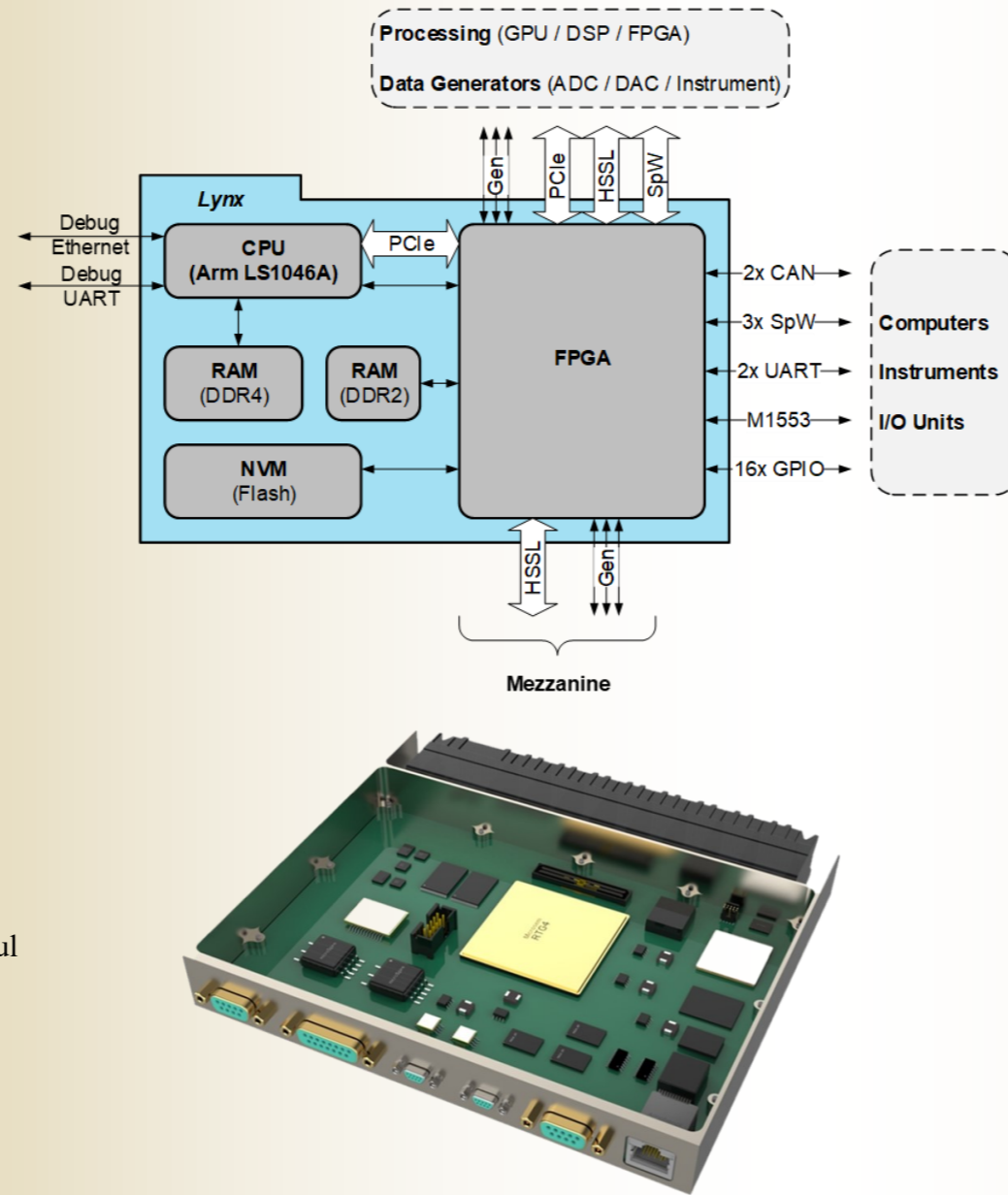
## Is there an answer to this demand allowing flexibility and cost-efficiency?

Yes, we believe there is!

RUAG Space have developed and designed a very powerful and flexible Single Board Computer processing board, called Lynx.

## Design Considerations

A thorough comparison between potential processor cores has been done, to find the most suitable CPU w.r.t. processing performance, power and radiation performance

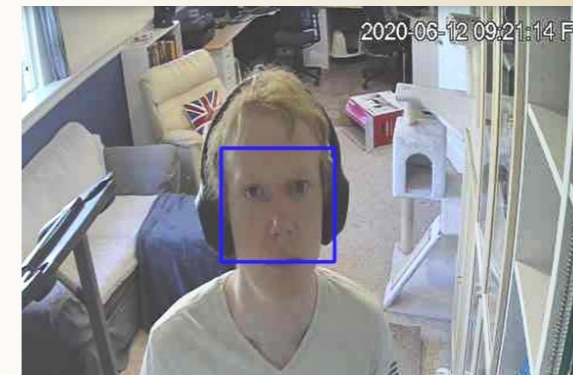


## What you get with Lynx

- Massive Performance
  - Quad-core ARM processor >30 000 DMIPS
  - Hardware acceleration state-of-the-art FPGA
- Flexibility
  - Late tailoring software defined interfaces
  - Easy function/interface extension mezzanine
- Software Support for
  - VxWorks, Linux, PikeOS, RTEMS
  - Extensive debug support over Gbit Ethernet

## Facial Detection Demo

A facial detection demo using machine learning algorithms have been successfully developed to demonstrate the performance of the Lynx board. The results show that the processing performance of Lynx is well suited for the intended real time image processing, Artificial Intelligence and machine learning applications.



## Budgets

- Form factor 6U-160, 234x160x25,4 mm
- Mass 1 kg incl. frame
- Power consumption 10-25 W

## Radiation Tolerance

- Latch Up free
- All memories with error correction
- Sustain total dose up to 15 years in GEO orbit

## Specification

- ARM processor with 4 x CPU cores
  - > 30 000 DMIPS
  - 32 KiB L1 cache, 2MiB L2 cache
- 4/8 GiByte DDR4 processing memory with ECC
- 4/8/16 GiByte Flash memory with ECC
- 512 MiByte DDR2 communication memory with ECC
- Gigabit Ethernet Debug Link
- Front panel: 3 x SpaceWire (optional), 2 x UART, 2 x MIL-STD-1553B (optional), 2 x CAN (optional), 16 x GPIO (configurable), Debug Ethernet
- Back-plane: 5 x HSSL (PCIe gen X) @ 3 Gbps, 10 x SpaceWire, 2 x I2C, 6 x SPI, 2 x UART, 32 x GPIO

## About

RUAG Space have 1300 employees across 12 sites with offices in Sweden, Switzerland, Austria, Finland, Germany and US (Denver, Huntsville/Decatur & Titusville)

USD 385 million net sales in 2018

Products on 1000 payloads delivered to space.

Extensive single-board computer heritage:

- > 2900 failure free equipment years in orbit
- > 300 Launcher On-Board Computers
- > 120 Satellite Data Handling Systems

Processor	Performance DMIPS
ARM LS1046A	33 840
PowerPC 2020	6 118
PowerPC RAD5545	5 600
PowerPC PC8548E	3 065
GR740	1 840
Intel Pentium III	1 595