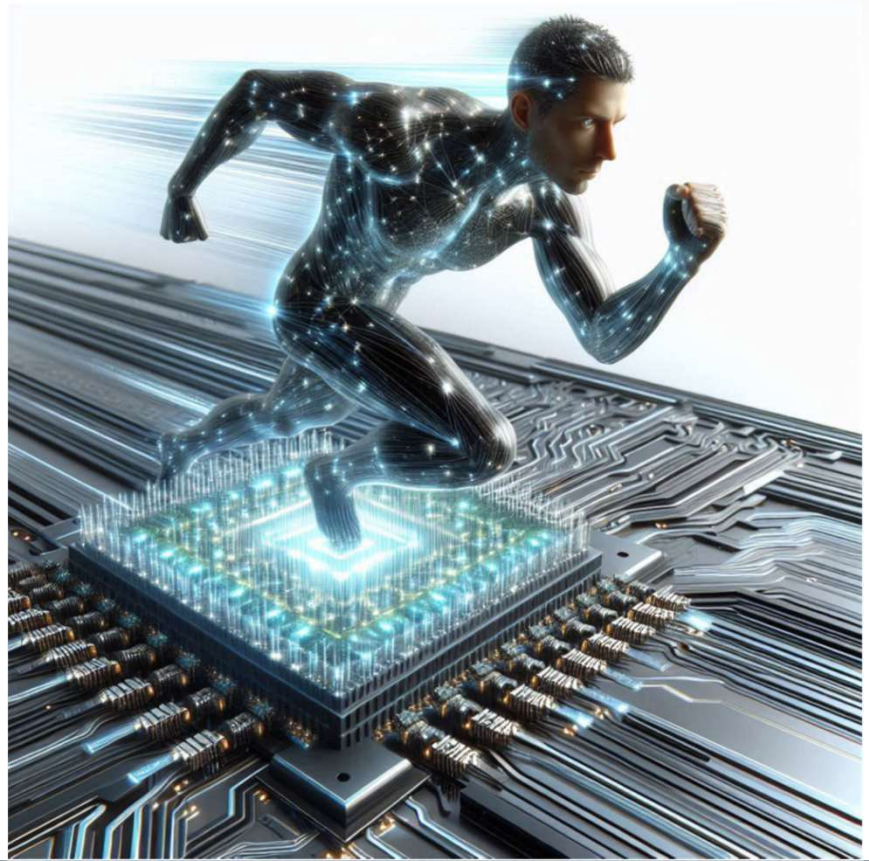
FPGA Conference
Europe

Fast data transmission with Artix UltraScale+ via various interfaces



Dr. Jörg Pospiech
CEO AVT GmbH

02.07. – 04.07.2024
München

Content

1 Brief description of company AVT

2 Applications and objective

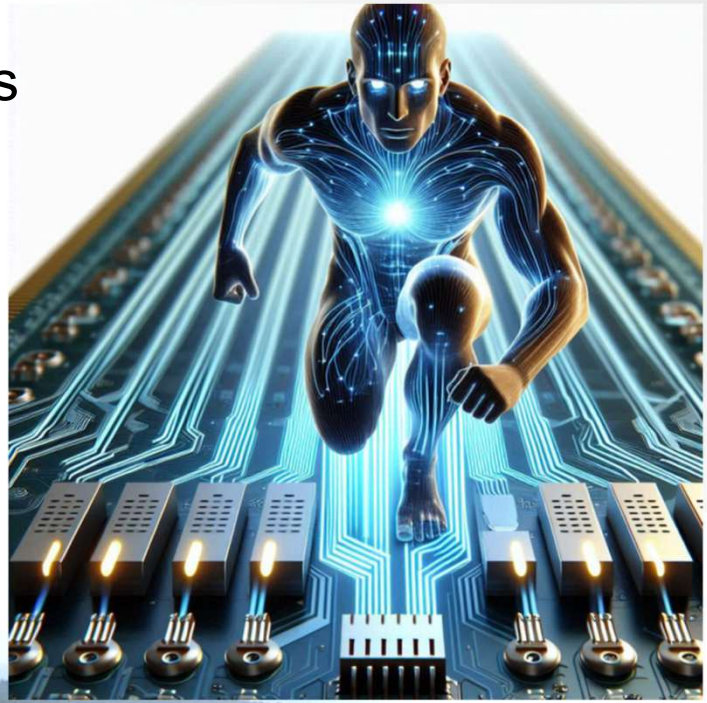
3 Comparison of the properties of cost-effective AMD FPGAs

4 What looks like the best price-optimized solution?

5 What need your special attention on Artix Ultrascale+?

6 Example designs with Artix UltraScale+

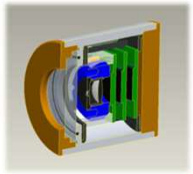
7 Summary



Brief description of company AVT GmbH

Range of services:

- FPGA and CAD design
- IP-Core development
- Image processing
- Seminar and consulting services
- EMC Testlab



Idea

Concept/
Feasibility

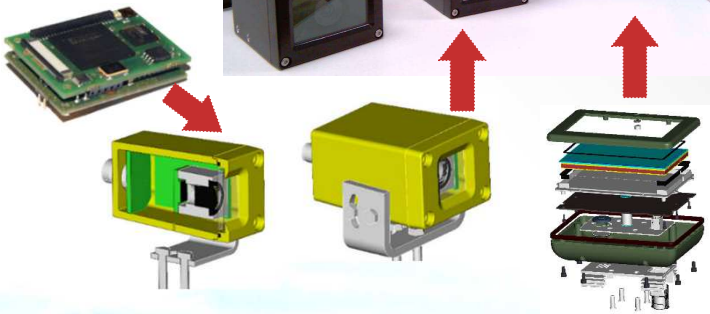
Development

Demonstrator/
Prototype

Small series

Series

Development for customers



Solving the impossible ...
... in the heart of Thuringia

since 1990

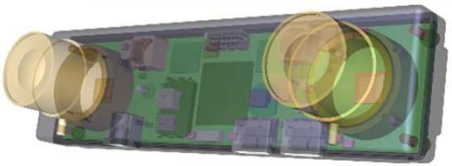
MathWorks®
Partner Programm

Local mountain: Kickelhahn (861 m)

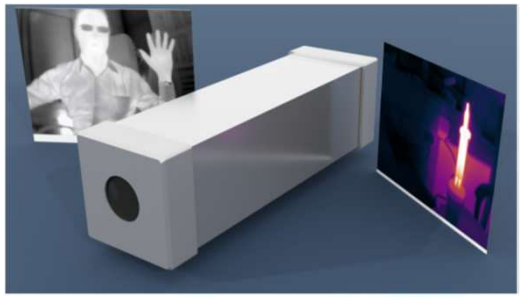
Brief description of company AVT GmbH

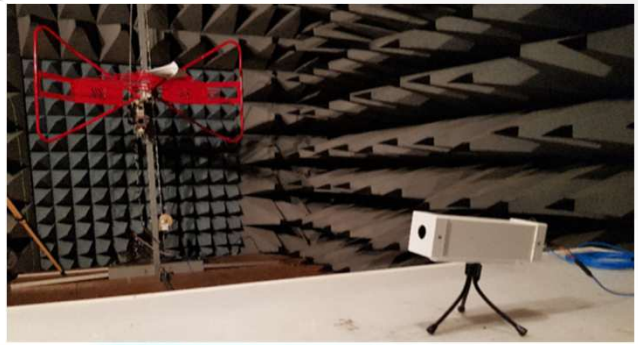
Range of products:

- ‚Smart' Cameras and Development Kits



- Development and production of EMC Lab equipment (emc hardened cameras, LED-lightings and devices)



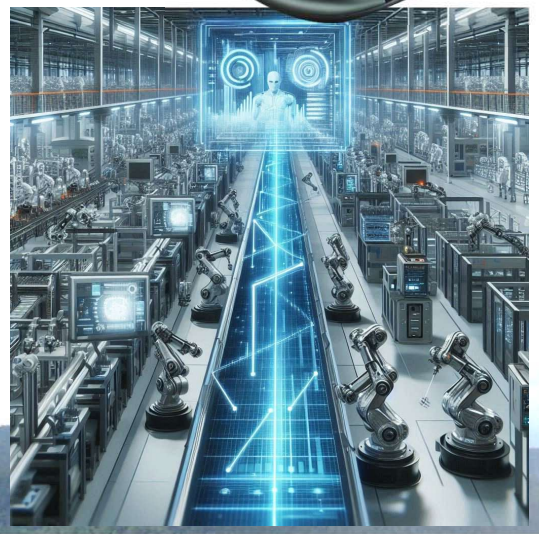


- IP-Cores (MJPEG + Image processing)
- Lighting controls for museums and castles
- and much more

Applications and objective

Cost-effective applications

- Machine vision
- Image processing
- Broadcast
- Robotics
- Industrial Automation
- IOT
- AI on the edge
- Medical
- Communication
- Machine control
- Measuring devices
- AR/VR systems

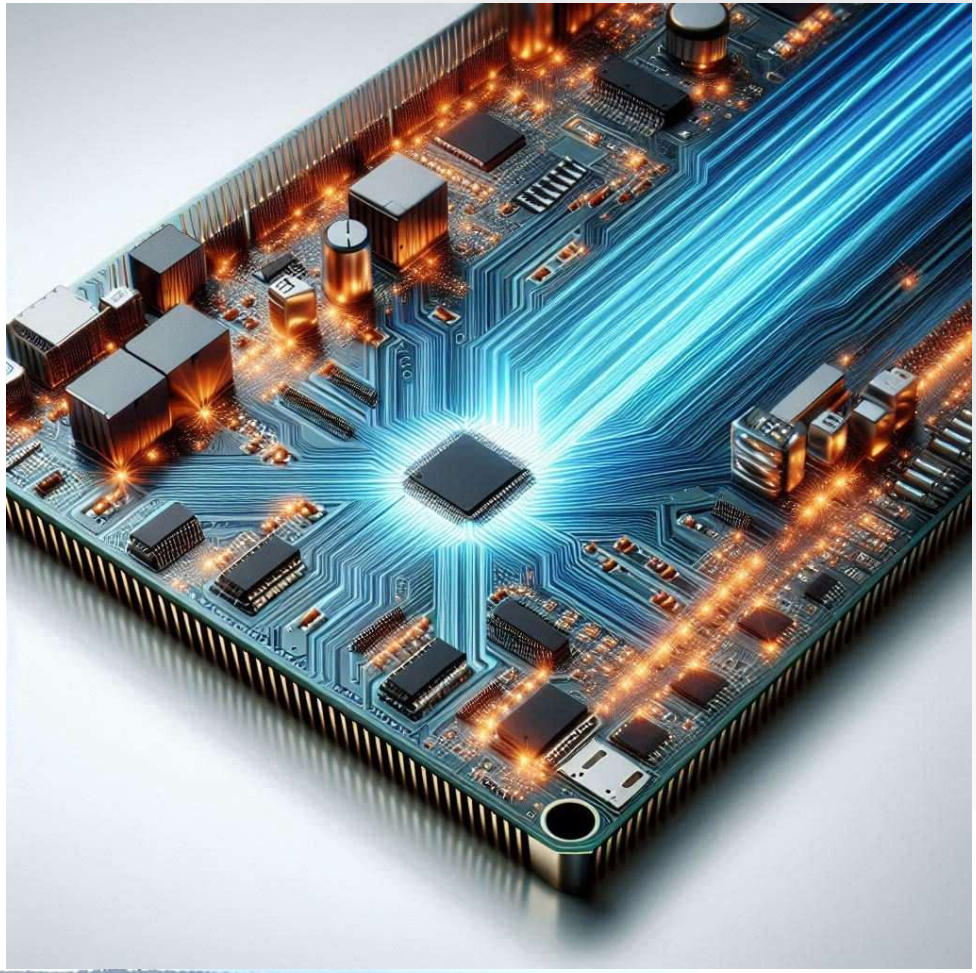


Applications and objective

1
2
3
4
5
6
7

Necessary features of used FPGAs

- Favorable ratio of price to required performance
- Fast enough for the task and necessary interfaces
- Low latency
- Sufficient IOs and their standards for the specific task
- Sufficient logic and DSP to solve the task
- Scalability
  - when retrofitting functions or
  - for different application variants
- High energy efficiency
- Future-ready design
- Long lifecycle



Applications and objective

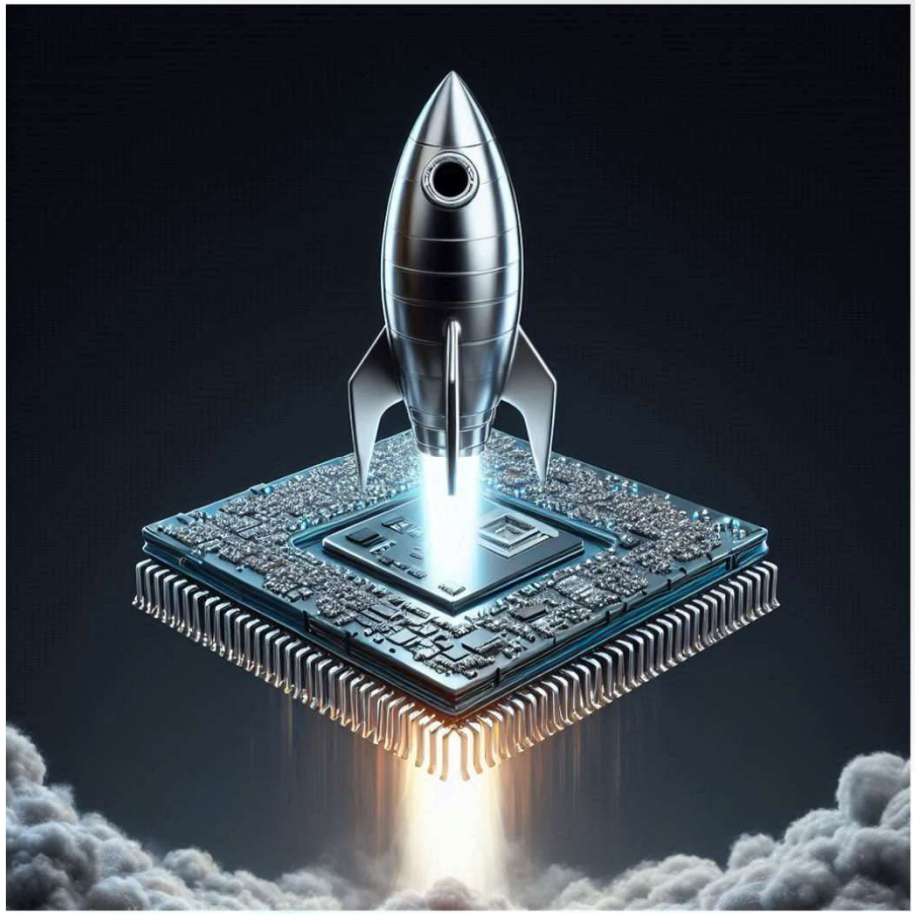
Speed conditions of current cost-effective applications

- DDR 4 RAM: min. 2 400 Mbps (1 200 MHz/IO)
  - Bsp: 16 bit → 38,4 Gbps / 4,8 GBps
- MIPI-CSI 2: 2 500 Mbps (1 250 MHz/IO)
  - Bsp: 4 Lanes → 10 Gbps / 1,25 GBps

HP-IOs

- DisplayPort
  - DP 1.4: 8,1 Gbps x 4 Lanes → 32,4 Gbps (25,9 Gbps netto)
  - DP 2.0: UHBR 10 x 4 Lanes → 40 Gbps (38,7 Gbps netto)
  - DP 2.0: UHBR 13.5 x 4 Lanes → 54 Gbps (52,2 Gbps netto)
- HD-SDI: 1,485 Gbps, 3G-SDI: 2,97 Gbps
- 6G UHD-SDI: 6 Gbps, 12G UHD-SDI: 12 Gbps
- PCIe Gen 3: 8 Gbps/Lane, Gen 4: 16 Gbps/Lane
  - Gen 3 x4: 32 Gbps / 4 GBps (< 3,9 GBps netto)
  - Gen 4 x4: 64 Gbps / 8 GBps (< 7,8 GBps netto)
- many more…

GTP/ GTH/ GTX/ GTY

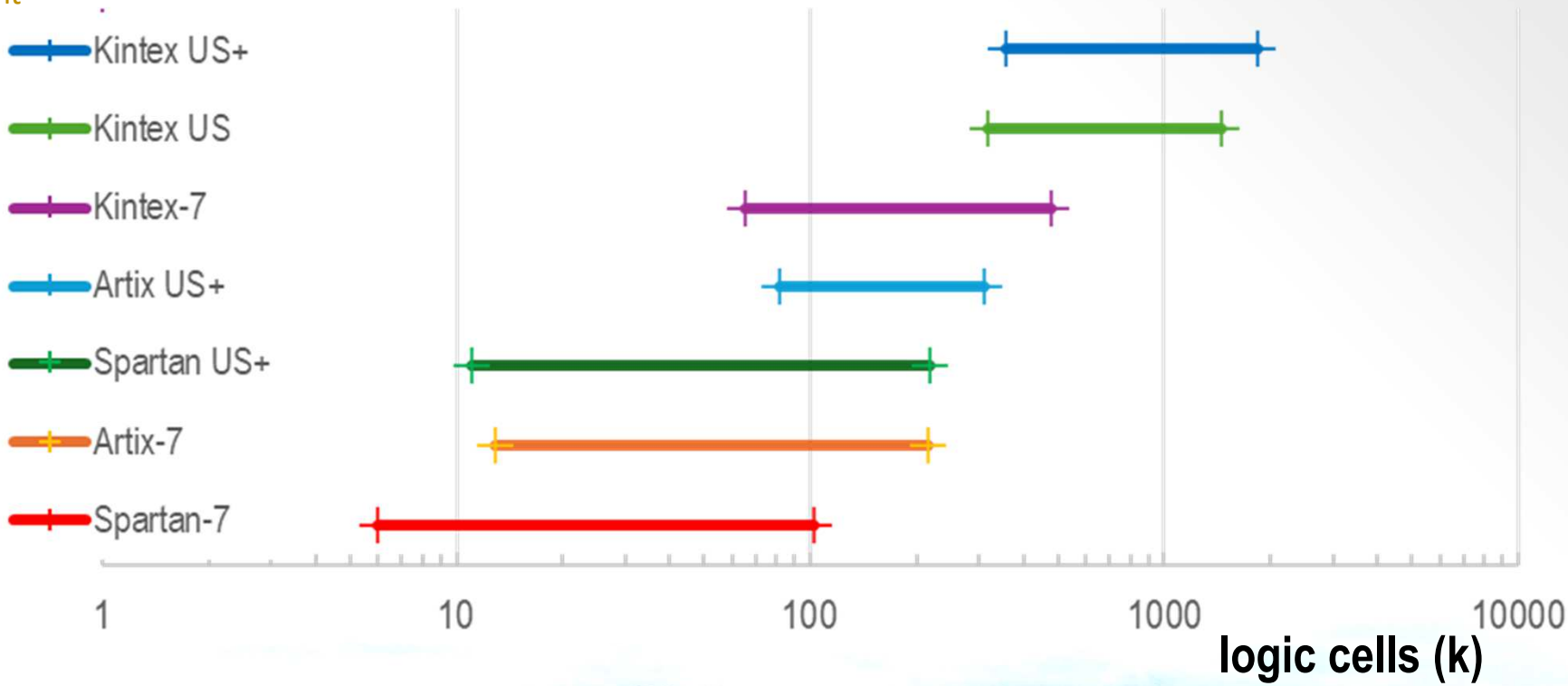


Comparison of the properties of cost-effective AMD FPGAs

Features

Spartan 7 | Artix 7 | Spartan UltraScale+ | Artix UltraScale+ | Kintex 7 | Kintex UltraScale | Kintex UltraScale+

cost-efficient — powerful



This presentation is only about FPGAs (Zynq and Versal are not considered).

Comparison of the properties of cost-effective AMD FPGAs

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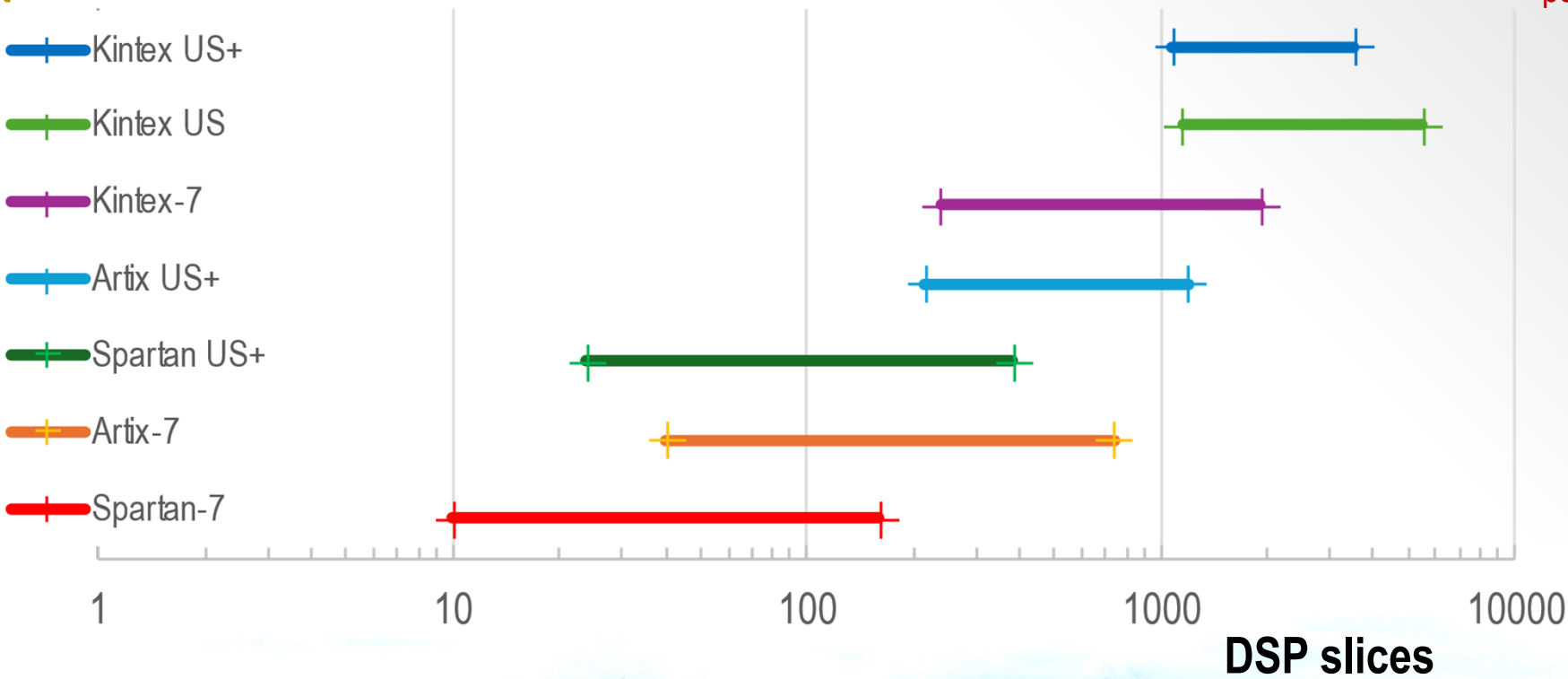

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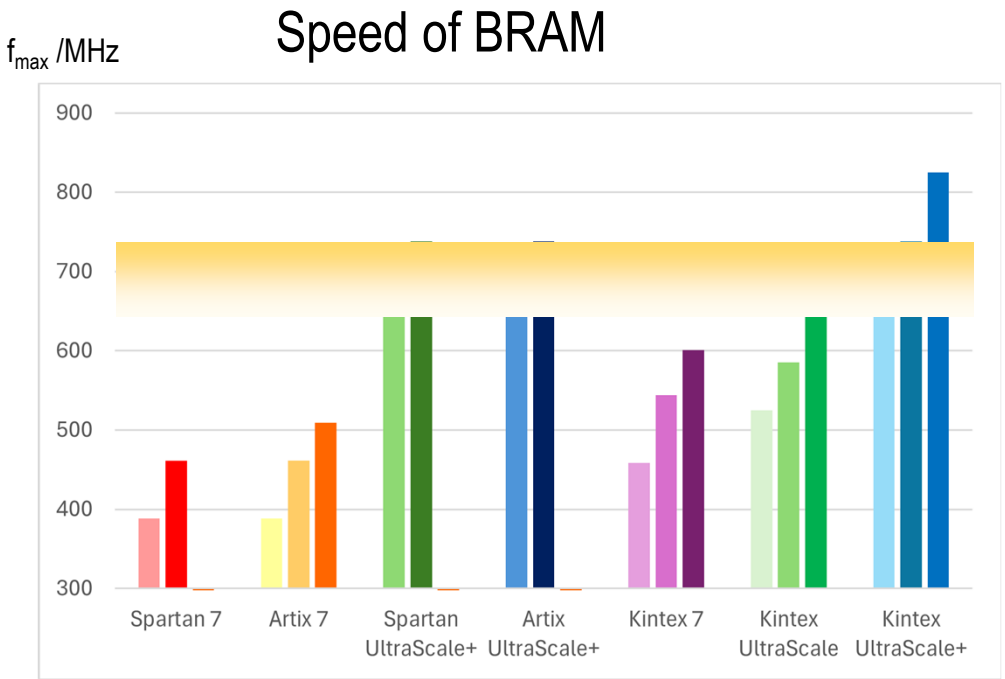
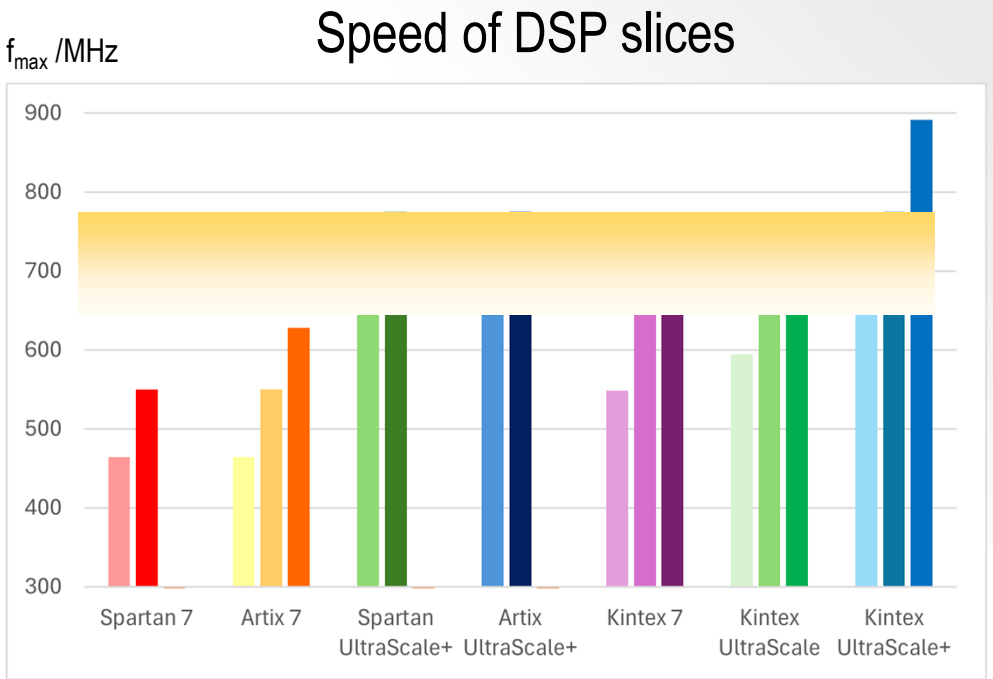
Comparison of the properties of cost-effective AMD FPGAs

Speed

Spartan 7 | Artix 7 | Spartan UltraScale+ | Artix UltraScale+ | Kintex 7 | Kintex UltraScale | Kintex UltraScale+

cost-efficient — powerful





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Comparison of the properties of cost-effective AMD FPGAs

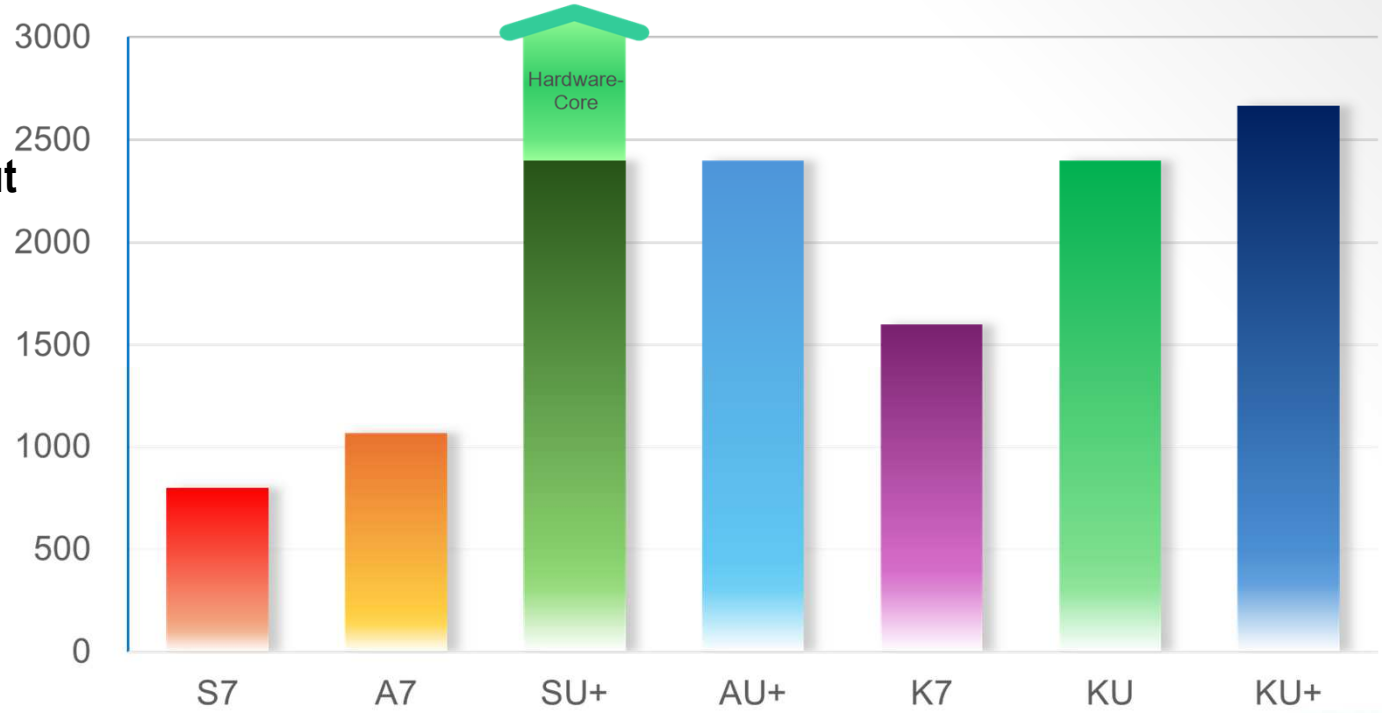
Speed

Spartan 7 | Artix 7 | Spartan UltraScale+ | Artix UltraScale+ | Kintex 7 | Kintex UltraScale | Kintex UltraScale+

cost-efficient — powerful

DDR-RAM data throughput each lane /Mbps

(depending on package and speed grade)



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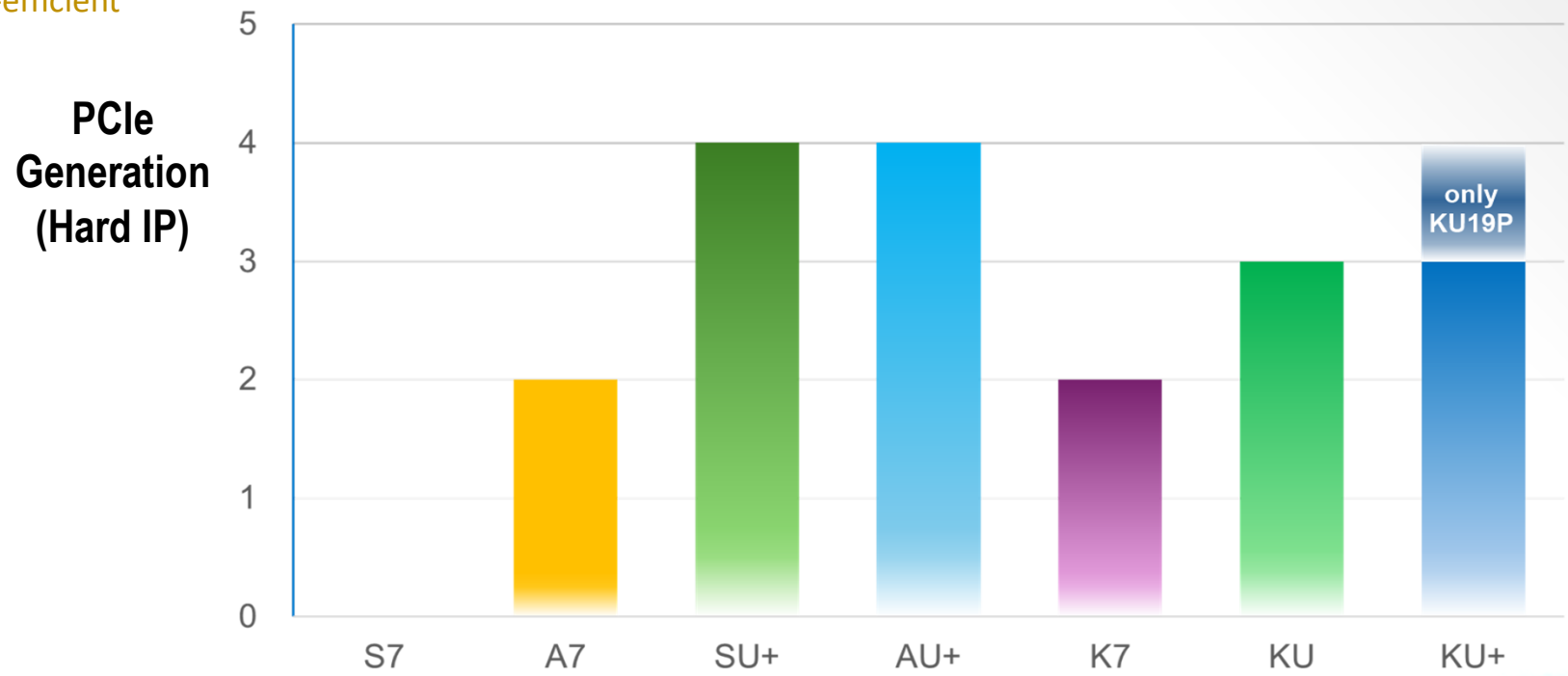
Comparison of the properties of cost-effective AMD FPGAs

Speed

Spartan 7 | Artix 7 | Spartan UltraScale+ | Artix UltraScale+ | Kintex 7 | Kintex UltraScale | Kintex UltraScale+

cost-efficient — powerful



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Comparison of the properties of cost-effective AMD FPGAs

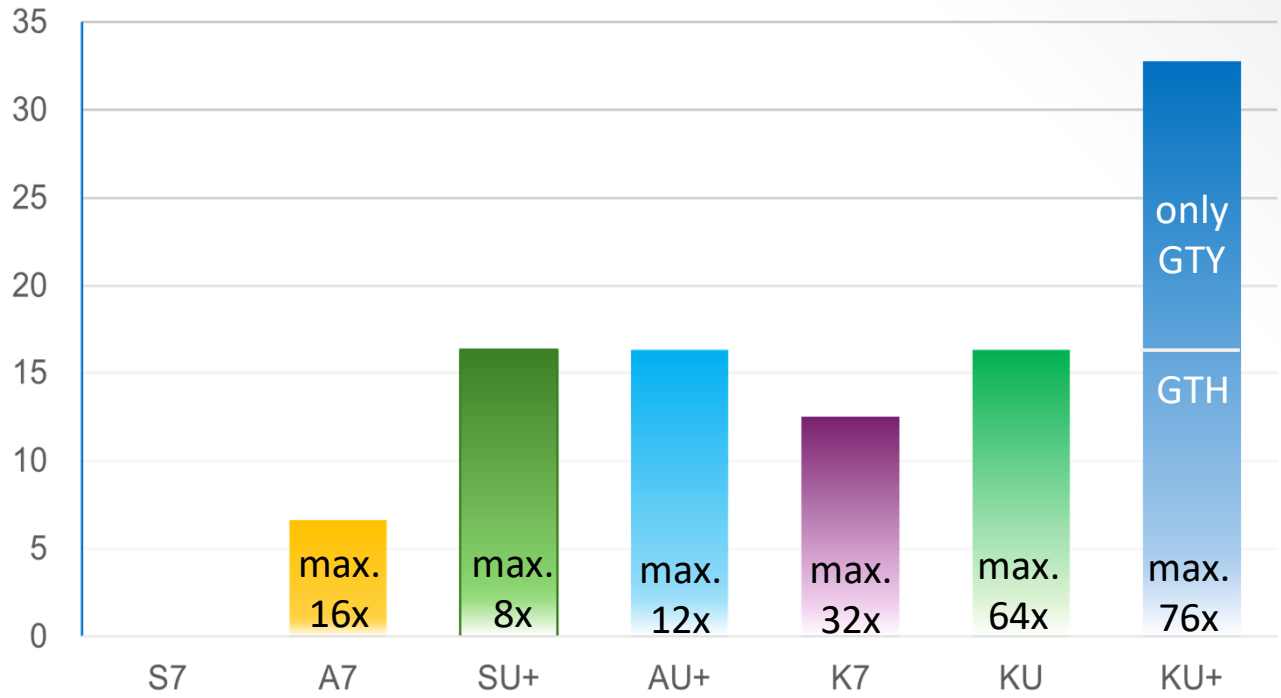
Speed

Spartan 7 | Artix 7 | Spartan UltraScale+ | Artix UltraScale+ | Kintex 7 | Kintex UltraScale | Kintex UltraScale+

cost-efficient — powerful

MGT data throughput each transceiver /Gbps

(depending on package and speed grade)



This presentation is only about FPGAs (Zynq and Versal are not considered).

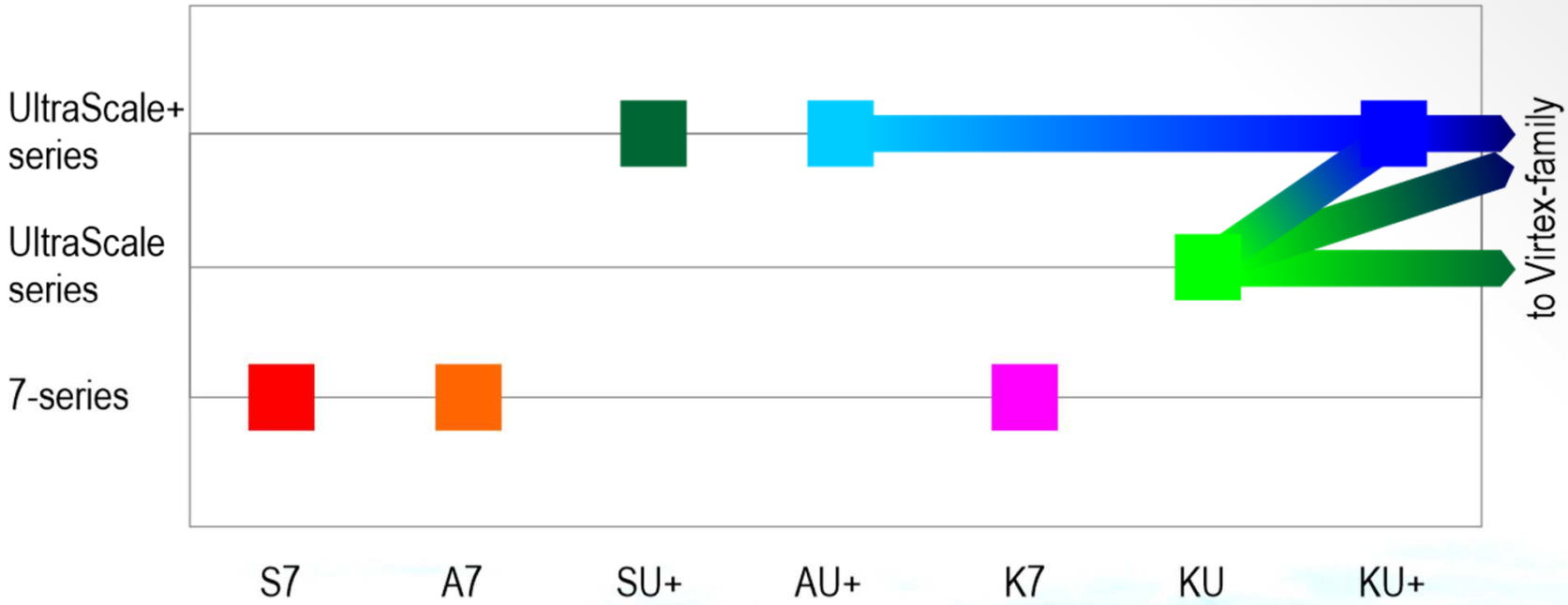
Comparison of the properties of cost-effective AMD FPGAs

Scalability

Spartan 7 | Artix 7 | Spartan UltraScale+ | Artix UltraScale+ | Kintex 7 | Kintex UltraScale | Kintex UltraScale+

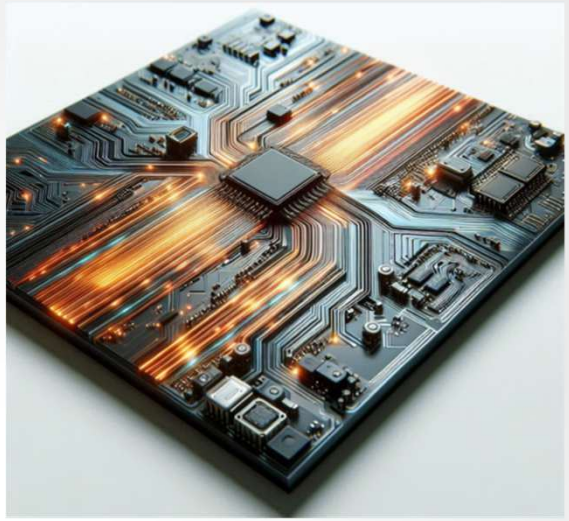
cost-efficient — powerful

Scalability is necessary if speed or logic hardware is not sufficient



This presentation is only about FPGAs (Zynq and Versal are not considered).

What looks like the best price-optimized solution?



What we know at this point:

- Kintex family is bigger and faster (but only Speedgrade 3 and GTYs)
- Artix UltraScale+ is also fast, partly more, partly less
- for fast (midrange) applications 7 series is outdated
- Artix UltraScale+ have enough logic for the most cost-effective applications
- Spartan UltraScale+ is also a good alternative, but needs a long time to market
- Artix UltraScale+ have the most DSP performance in cost-effective area
- Artix UltraScale+ is the only cost-efficient FPGA for higher scalability

What we need:

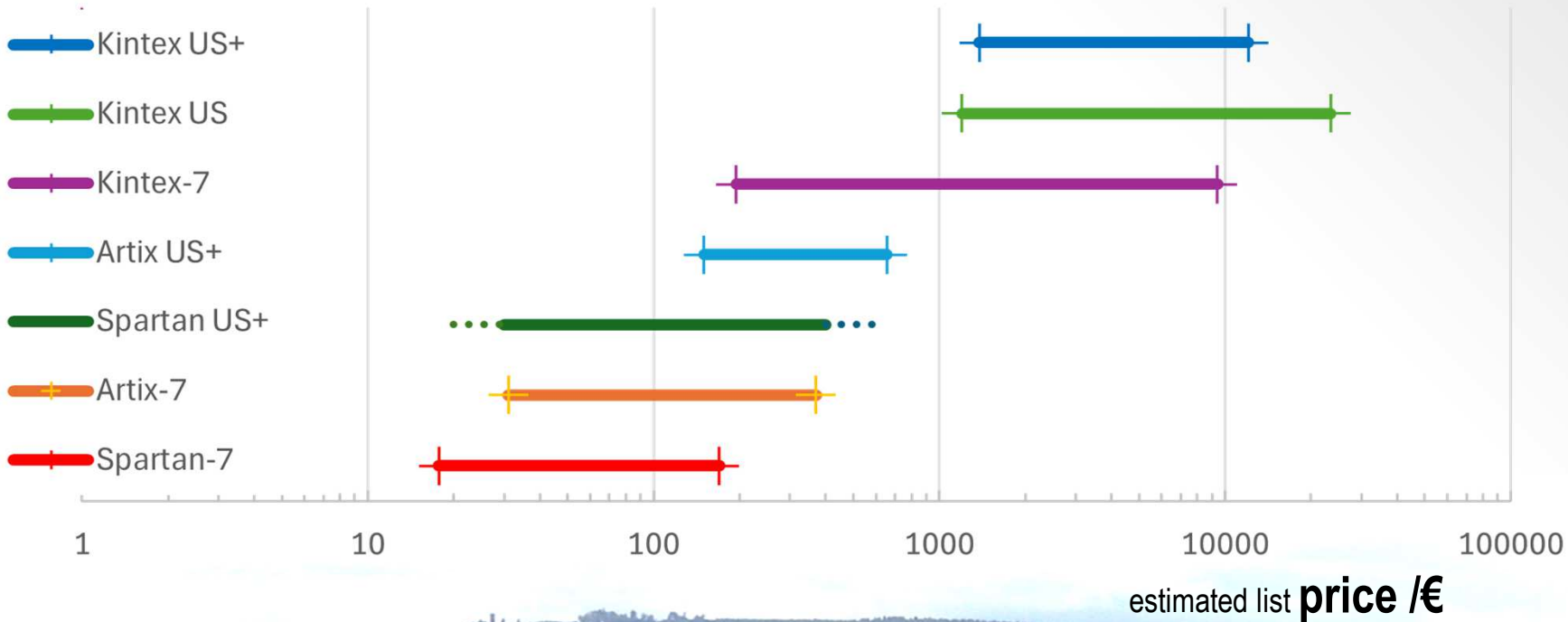
- a good solution for our fast applications, but not too expensive (real price-optimized)
- a price related comparison (not only technical as before)

What looks like the best price-optimized solution?

Price

Spartan 7 | Artix 7 | Spartan UltraScale+ | Artix UltraScale+ | Kintex 7 | Kintex UltraScale | Kintex UltraScale+

cost-efficient — powerful



What looks like the best price-optimized solution?

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Spartan 7 | Artix 7 | Spartan UltraScale+ | Artix UltraScale+ | Kintex 7 | Kintex UltraScale | Kintex UltraScale+

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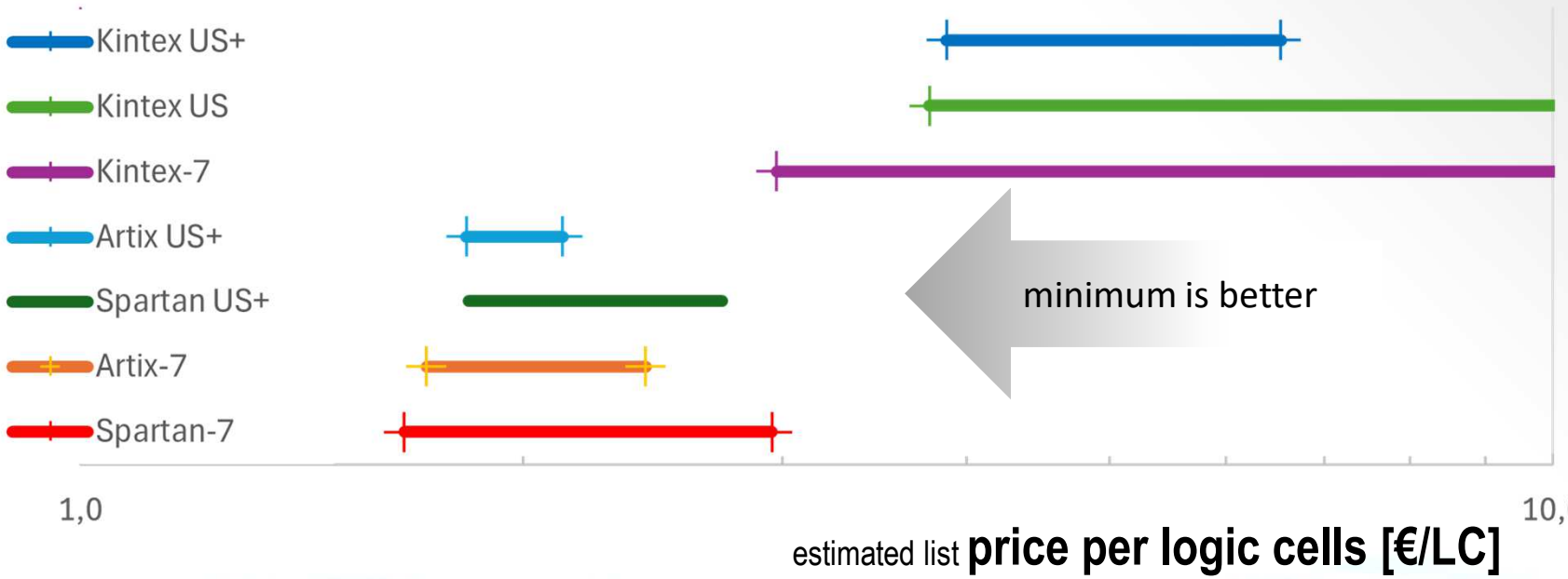
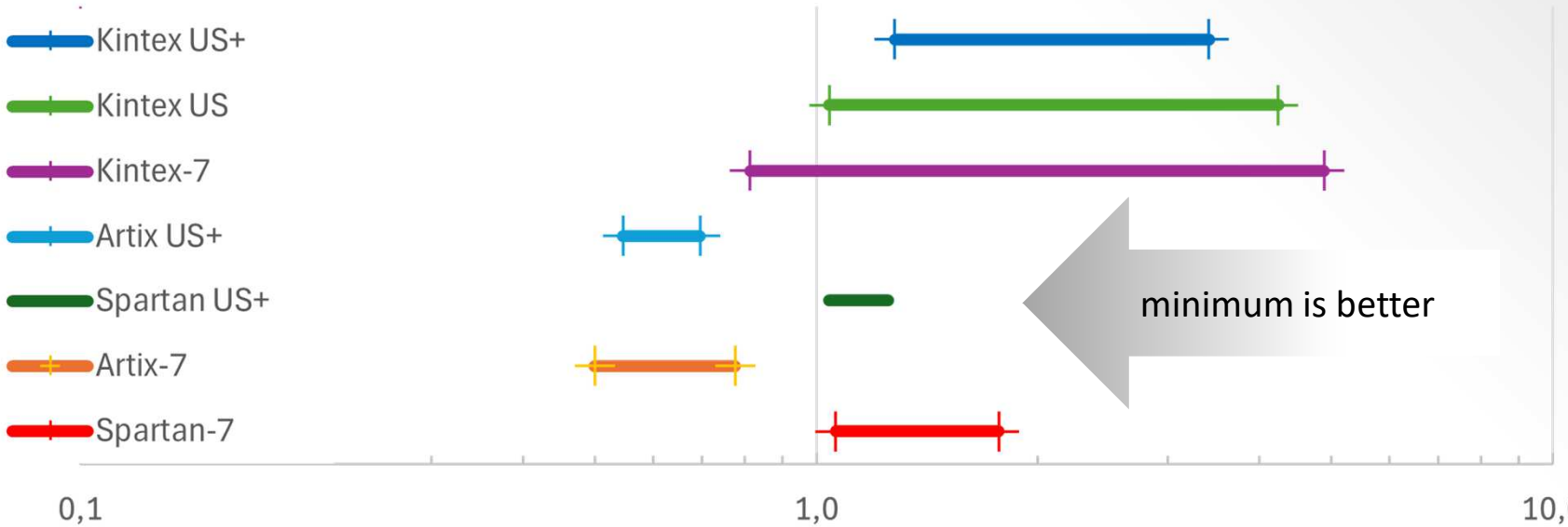


What looks like the best price-optimized solution?

Price

Spartan 7	Artix 7	Spartan UltraScale+	Artix UltraScale+	Kintex 7	Kintex UltraScale	Kintex UltraScale+

cost-efficient — powerful



estimated list **price per DSP slice [€/DSP]**

What need your special attention on Artix Ultrascale+?

Differences in speedgrades and MGTs

	Speedgrade 2	Speedgrade 1
MIPI	2500 Mbps	2500 Mbps
DDR4	2400 Mbps	2133 Mbps
DDR3	1866 Mbps	1866 Mbps
GTH (Artix UltraScale+ 7, 10, 15)		
QPLL0 frequency max	16,375 GHz	16,375 GHz
QPLL0 line rate max	16,375 GHz	12,500 GHz
QPLL1 frequency max	13,000 GHz	13,000 GHz
QPLL1 line rate max	13,000 GHz	12,500 GHz
GTY (Artix UltraScale+ 20, 25)		
QPLL0 frequency max	16,375 GHz	16,375 GHz
QPLL0 line rate max	16,375 GHz	16,375 GHz
QPLL1 frequency max	16,375 GHz	16,375 GHz
QPLL1 line rate max	16,375 GHz	16,375 GHz

High speed is always

speedgrade

and package dependent!

The only package for highest MGT data throughput is FFVB676,

but it also have the highest scalability

What need your special attention on Artix Ultrascale+?

AMD Artix™ UltraScale+™ FPGAs – Resources & Packaging

Device Name	AU7P	AU10P	AU15P	AU20P	AU25P
System Logic Cells (K)	82	96	170	238	308
CLB Flip-Flops (K)	75	88	156	218	282
CLB LUTs (K)	37	44	78	109	141
Dist. RAM (Mb)	1.1	1.0	2.5	3.2	4.7
Total Block RAM (Mb)	3.8	3.5	5.1	7.0	10.5
36K Block RAM Blocks	108	100	144	200	300
UltraRAM (Mb)	–	–	–	–	–
Clock Management Tiles (CMTs)	2	3	3	3	4
DSP Slices	216	400	576	900	1,200
PCI Express®	1x Gen3x4	1x Gen4x4(1)	1x Gen4x4(1)	1x Gen3x8	1x Gen3x8
AMS - System Monitor	1	1	1	1	1
Max. Single-Ended HD I/Os	144	72	72	72	96
Max. Single-Ended HP I/Os	104	156	156	156	208
GTH Transceivers(2)	4	12	12	–	–
GTY Transceivers(2)	–	–	–	12	12
Extended	-1 -2				
Industrial	-1 -2 -1L				

Package	Dim. (mm)	Ball Pitch (mm)	HDIO, HPIO, GTH, GTY				
FCVA289	9x9	0.5	72, 58, 4, 0				
UBVA368	11.5x9.5	0.5		24, 104, 8, 0	24, 104, 8, 0		
SBVB484	19x19	0.8		48, 156, 12, 0	48, 156, 12, 0		
SBVC484	19x19	0.8	144, 104, 4, 0				
SFVB784	23x23	0.8				72, 156, 0, 12	96, 208, 0, 12
FFVB676	27x27	1.0		72, 156, 12, 0	72, 156, 12, 0	72, 156, 0, 12	72, 208, 0, 12

1. PCIe Gen4 is available in AU10P and AU15P in the FFVB676 package. AU10P and AU15P in other packages support Gen3x8.

2. GTH and GTY data rates are package dependent:
- Maximum 12.5 Gb/s in FCVA289, UBVA368, SBVB484, SBVC484, SFVB784
- Maximum 16.3 Gb/s in FFVB676.

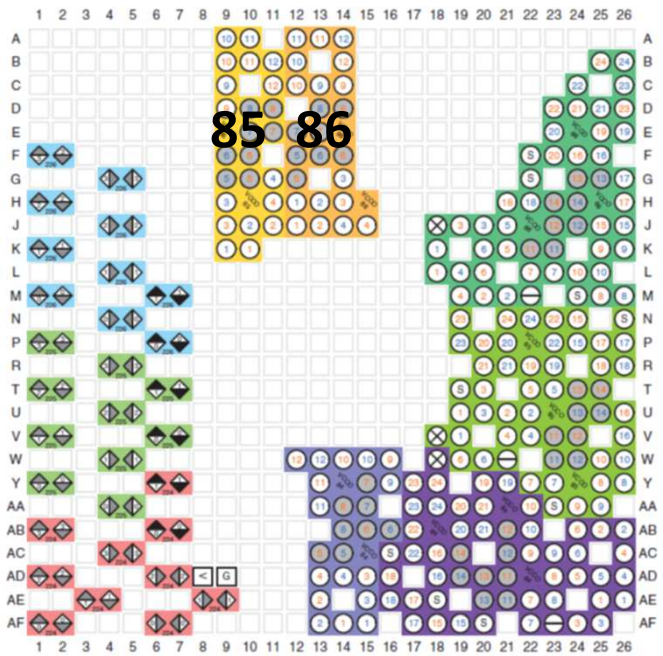
Important: Verify all data in this document with the device data sheets.

sheet from ultrascale-plus-fpga-product-selection-guide.pdf

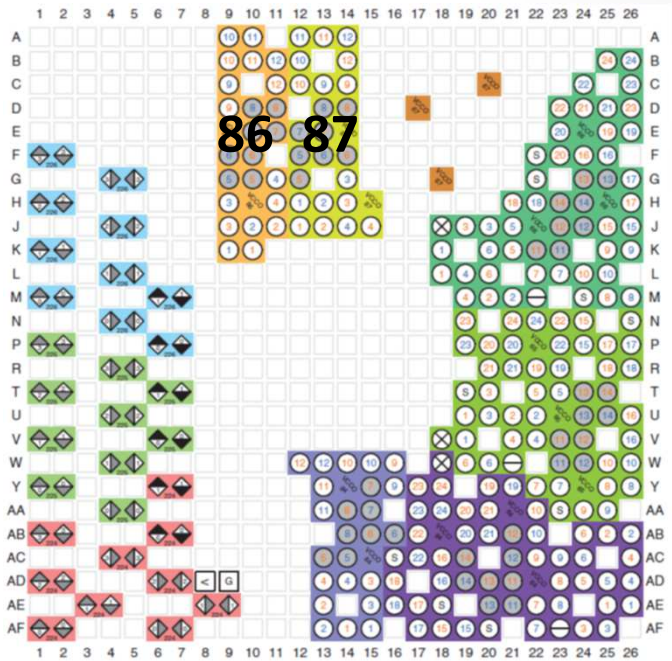
What need your special attention on Artix Ultrascale+?

AVT ILMENAU

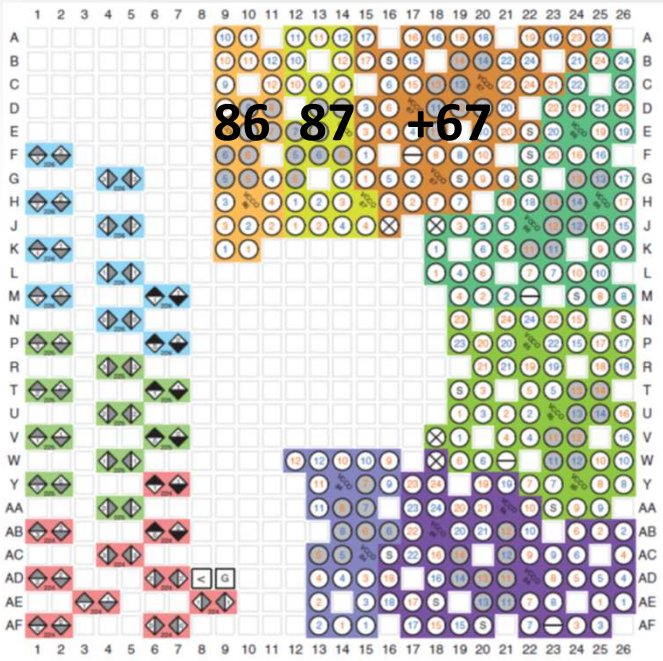
AU10P, AU15P



AU20P



AU25P



Differences in banks

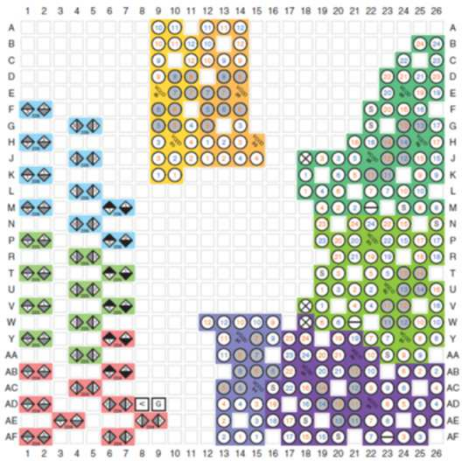
Bank 85 for AU10 and AU15 is → bank 86 for AU20 and AU25

Bank 86 for AU10 and AU15 is → bank 87 for AU20 and AU25

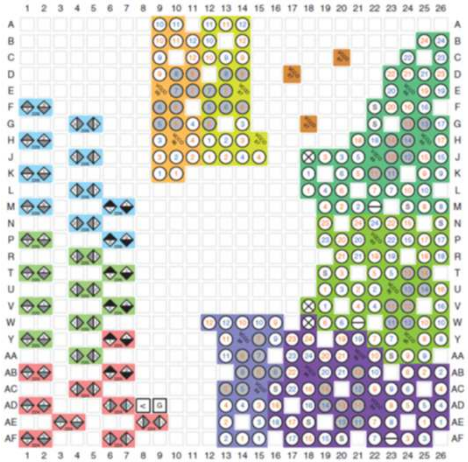
Bank 67 is only in AU25P available

What need your special attention on Artix Ultrascale+?

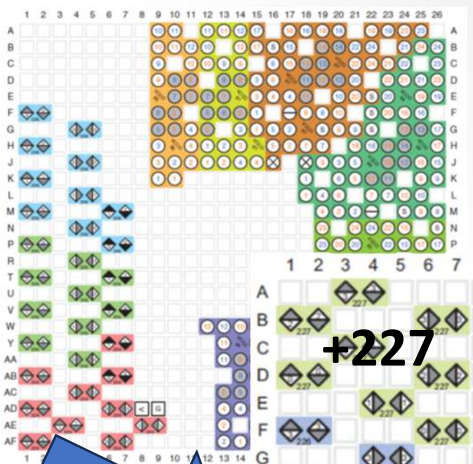
AU10P, AU15P



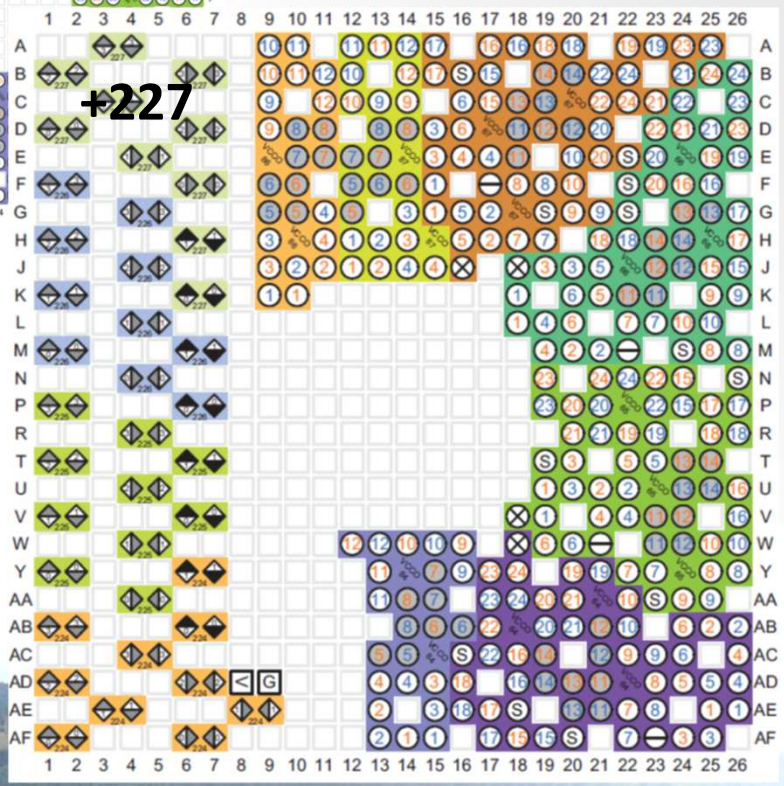
AU20P



AU25P



KU3P, KU5P

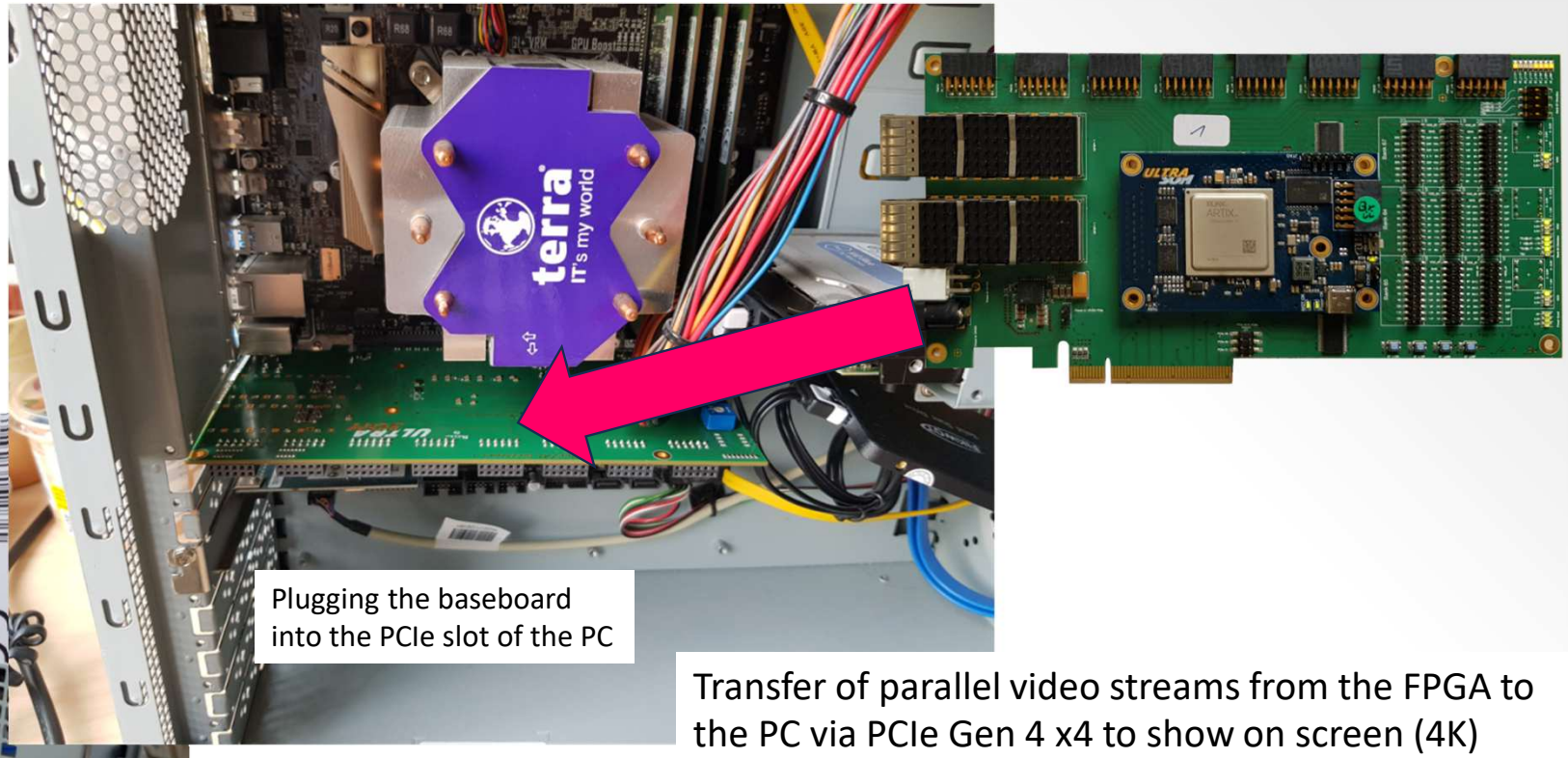


Scalability with Kintex KU3P + KU5P

MGT Bank 227 is only in KU3P and KU5P available

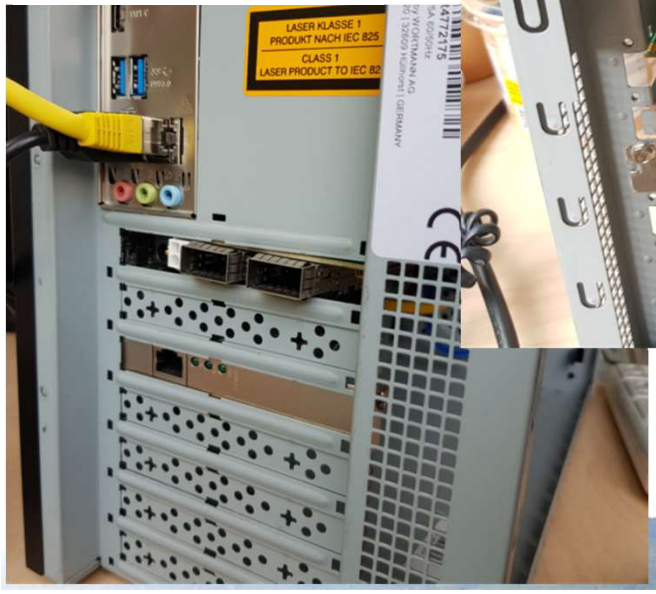
Example designs with Artix UltraScale+

PCIe Gen 4 x4 example with UltraSOM-Board and Baseboard 1



Plugging the baseboard into the PCIe slot of the PC

PC rear side with QSFP connectors of the baseboard

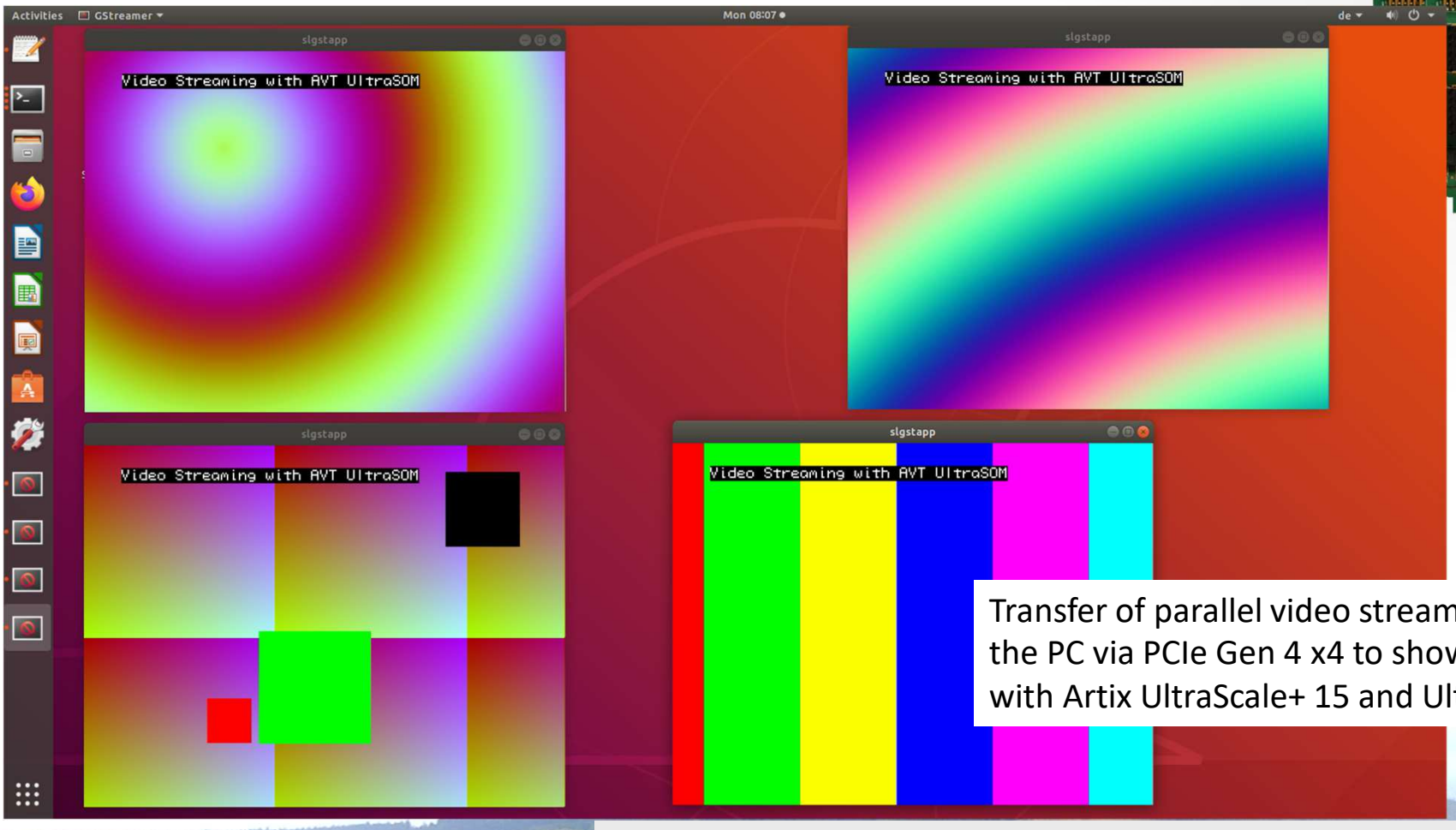


Transfer of parallel video streams from the FPGA to the PC via PCIe Gen 4 x4 to show on screen (4K) with Artix UltraScale+ 15 and UltraSOM Baseboard 1

UltraSOM-Board and Baseboard 1 available on **www.ultrasom.eu**

Example designs with Artix UltraScale+

PCIe Gen 4 x4 example with UltraSOM-Board and Baseboard 1



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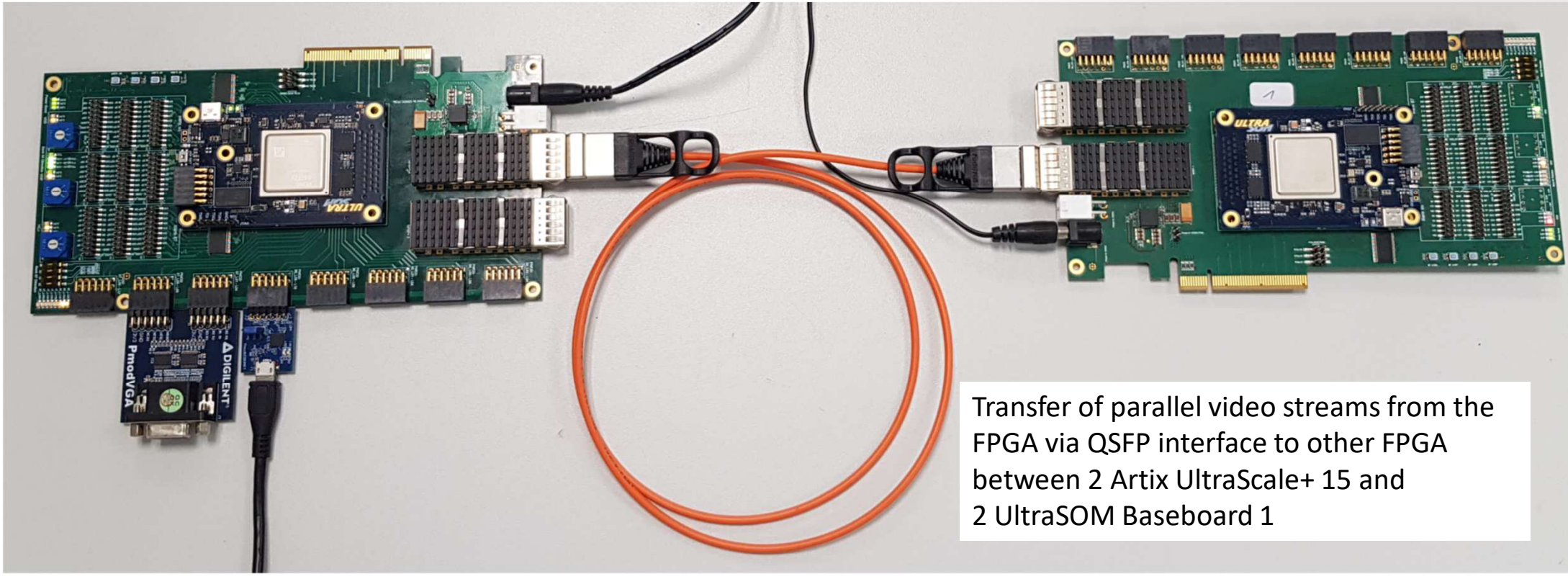
UltraSOM-Board and Baseboard 1 available on www.ultrasom.eu

Example designs with Artix UltraScale+

QSFP example with 2 UltraSOM-Boards and 2 Baseboards 1

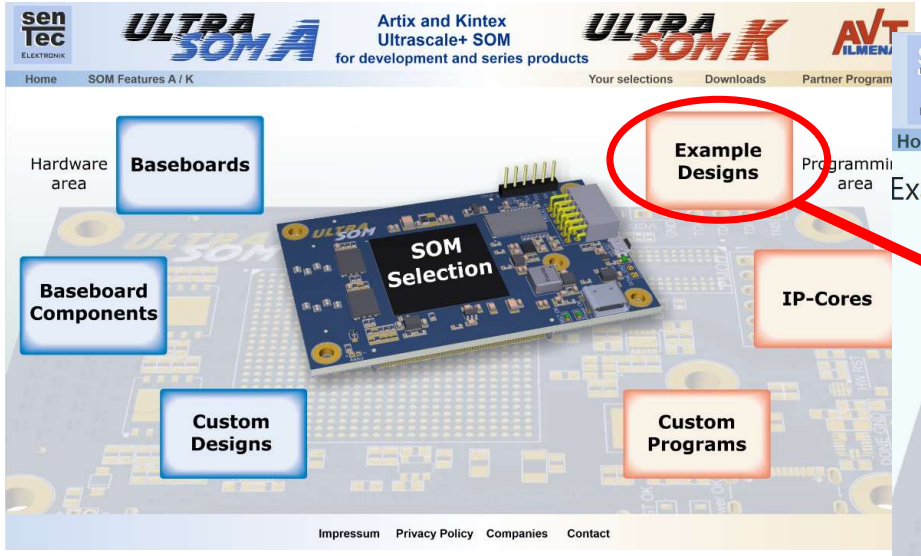


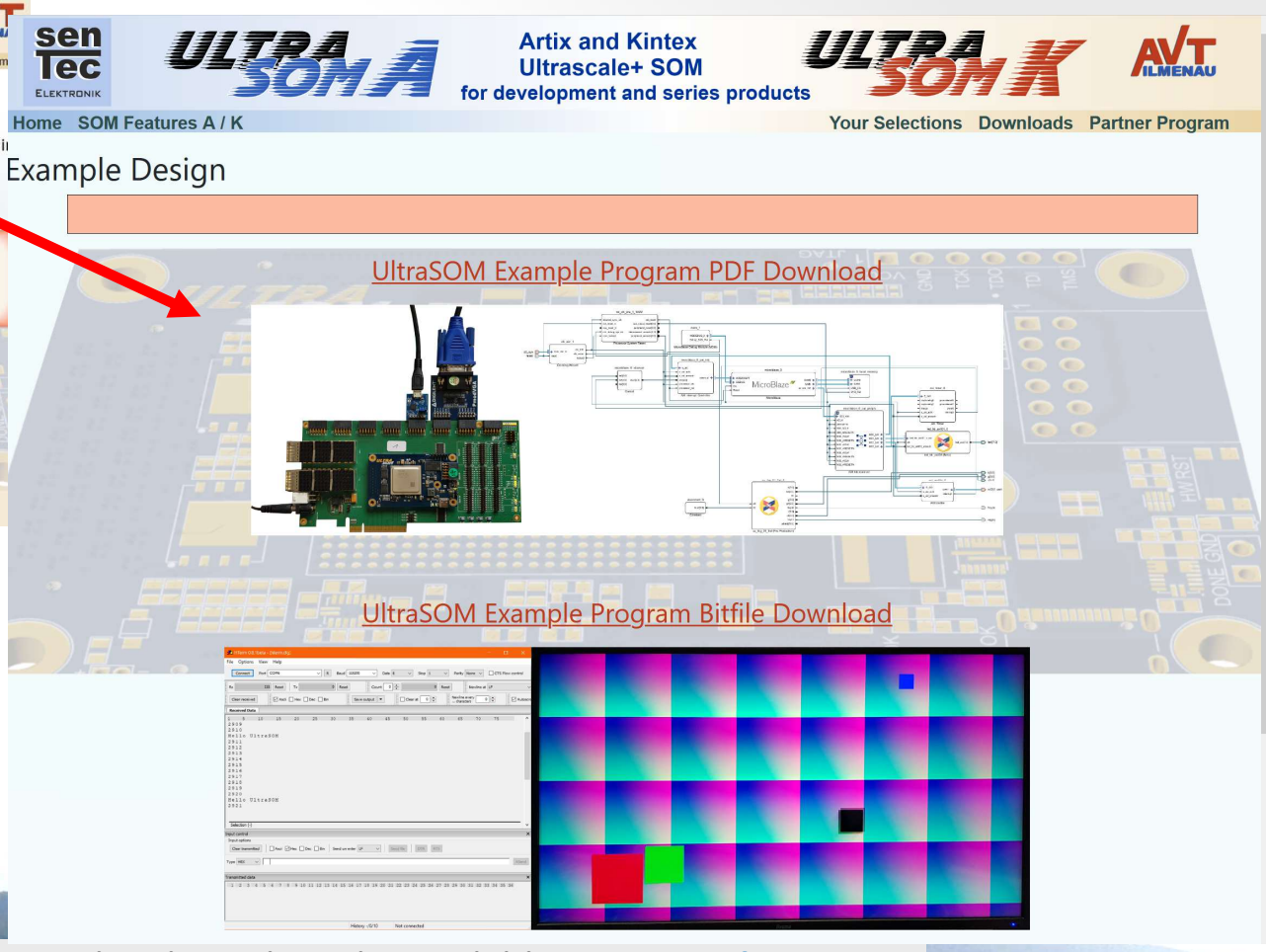
Transfer of parallel video streams from the FPGA via QSFP interface to other FPGA between 2 Artix UltraScale+ 15 and 2 UltraSOM Baseboard 1

UltraSOM-Board and Baseboard 1 available on **www.ultrasom.eu**

Example designs with Artix UltraScale+

All example will be described and available UltraSOM-website





UltraSOM-Board and Baseboard 1 available on **www.ultrasom.eu**

Summary

- **Artix UltraScale+ FPGAs have fast interfaces:**
  - DDR-RAM 2,5x faster than Artix 7 = same speed like Kintex UltraScale
  - GTH speed 2,5x faster than Artix 7 = same speed like Kintex UltraScale
  - PCIe data speed per lane 4x faster than Artix 7 and Kintex 7 as well as 2x faster than Kintex UltraScale and UltraScale+ (exept KU19P)
- **Artix UltraScale+ FPGAs are more cost-effective than all Kintex family**
  - Price/Logic cells >3,5x better than Kintex as well as 3x better than Kintex UltraScale and UltraScale+
  - Price/DSP > 5x better than Kintex as well as 3x better than Kintex UltraScale and UltraScale+
- **Spartan UltraScale+** is smaller in maximum size but comparable in performance

  → but unfortunately, series production will still take some time

  → packages not scalable with other UltraScale+ FPGAs

UltraSOM-Board and Baseboard 1 available on www.ultrasom.eu

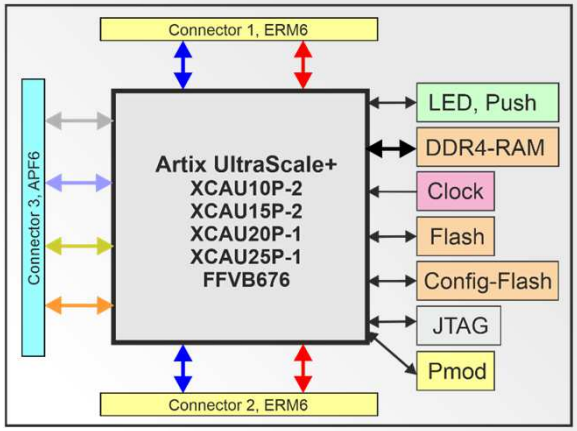
Summary

- **Artix UltraScale+ looks like the best solution for fast cost-effective designs**

- **Artix UltraScale+ is a modern solution for durable designs available on UltraSOM and its baseboards**

- **with UltraSOM-board and its baseboards a scalable solution from Artix UltraScale+ to Kintex UltraScale+ exist**

  (www.ultrasom.eu)



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Thanks for your attention

AVT GmbH
Automatisierungs- und Verfahrenstechnik
Am Hammergrund 1
D-98693 Ilmenau
Germany

Contact:
Tel: +49 (0) 36 77 / 64 79 56
Fax: +49 (0) 36 77 / 64 79 69
Email: info@avt-ilmenau.de
Web: www.avt-ilmenau.de

Contact persons:
Dr.-Ing. Jörg Pospiech CEO