
INTEL®
EXPERIENCE
DAY

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Intel does not control or audit third-party benchmark data or the web sites referenced in this document. You should visit the referenced web site and confirm whether referenced data are accurate.

INTEL® FPGA PROGRAMMABLE ACCELERATION CARDS

Intel® Network and Custom Logic Group

Konstantin Dobrosolets (Field Application Engineer)

BY 2020...

AVG. INTERNET USER	1.5 GB OF TRAFFIC / DAY
AUTONOMOUS VEHICLES	4 TB OF DATA / DAY
CONNECTED AIRPLANE	5 TB OF DATA / DAY
SMART FACTORY	1 PB OF DATA / DAY

Source: Amalgamation of analyst data and Intel analysis.

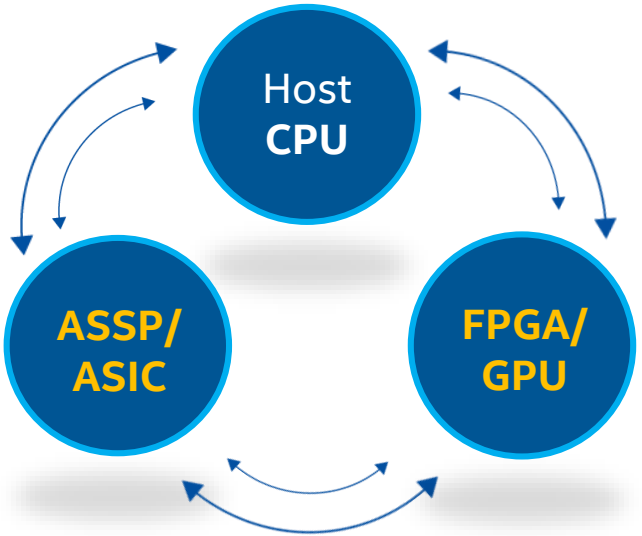
THE COMING FLOOD OF DATA

50 BILLION CONNECTED DEVICES!!

ACCELERATION CHOICES

Acceleration of compute means
HETEROGENEOUS COMPUTE

DEDICATED ACCELERATORS
for maximum compute efficiency of specific, stable functions

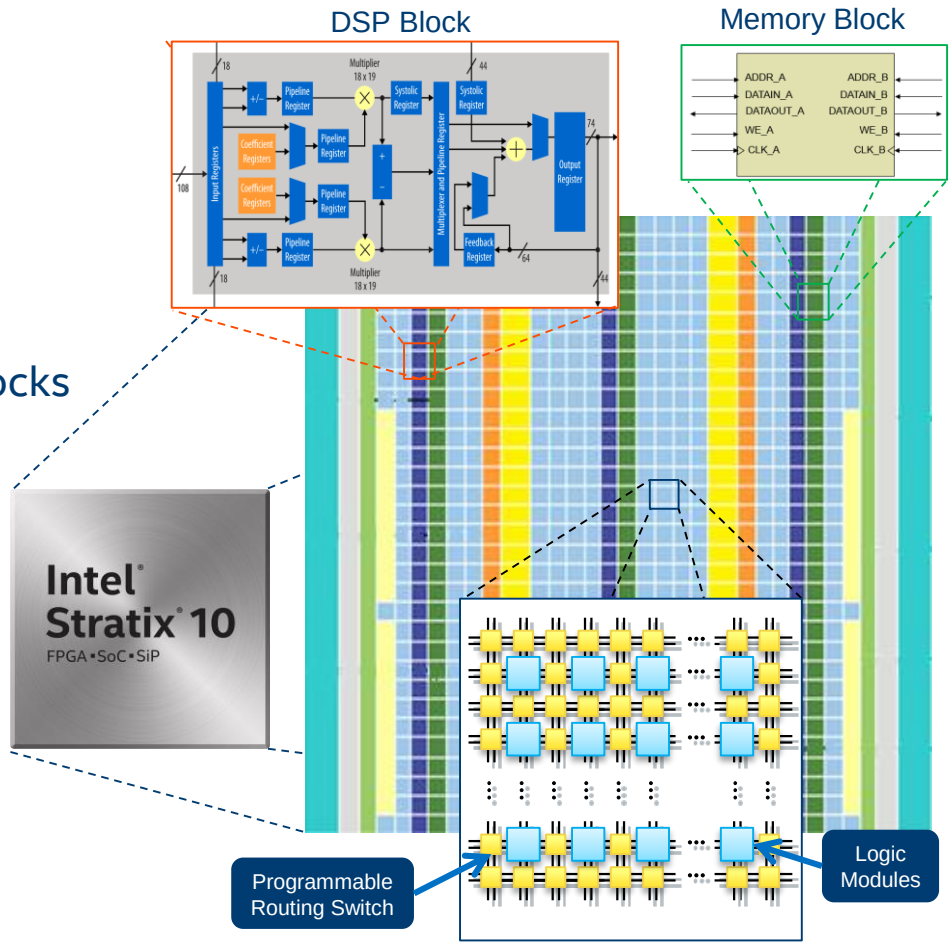


VERSATILE ACCELERATORS
for customized and changing workloads in networking, storage, and compute

WHAT IS A FPGA?

- Field Programmable Gate Array (FPGA)
  - Millions of logic elements
  - Thousands of embedded memory blocks
  - Thousands of DSP blocks
  - Programmable routing
  - High speed transceivers
  - Various built-in hardened IP

- Used to create **Custom Hardware!**



WHY INTEL® FPGAS ARE CRITICAL

Delivering the performance of hardware
with the programmability of software

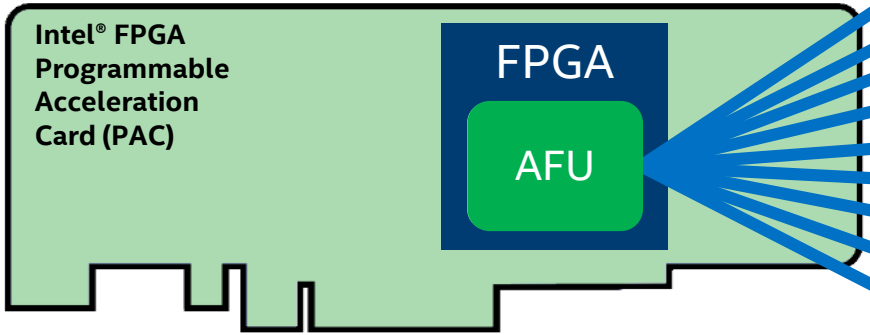
REPROGRAMMABLE	INHERENTLY PARALLEL	HIGH PERFORMANCE
FLEXIBLE	LOW LATENCY	ENERGY EFFICIENT

INTEL® FPGA – APPLICATION ACCELERATION FROM EDGE TO CLOUD

Combining Intel FPGA hardware and software
to efficiently accelerate workloads for processing-intense tasks

MULTI-FUNCTION HW ACCELERATION WITH INTEL® FPGA PROGRAMMABLE ACCELERATION CARDS

Any accelerator function Anytime!



- Data Analytics
- Edge Processing
- Security
- Scientific Computation
- Database Access
- A.I.
- Video Processing
- NFV/ Infrastructure
- Financial Computation

intel ARRIA 10 inside

intel STRATIX 10 inside

Accelerate the application you need, whenever you need it.

ACCELERATING DATA CENTER WORKLOADS


Data Analytics & Databases


Financial


HPC (e.g. Genomics)


Media Transcoding

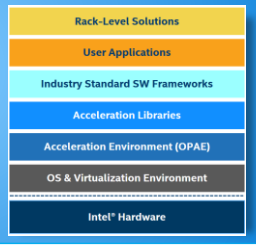

Cyber Security


Artificial Intelligence

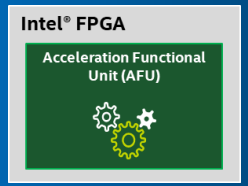
Supercharge Datacenter Performance & Reduce TCO with the Versatility of Intel® FPGAs

Intel® FPGA Programmable Acceleration Cards (PAC) Qualified on Industry-Leading Enterprise Servers

Acceleration Stack for Intel® Xeon® CPU with FPGAs



Acceleration IP From Application Experts



FPGA ACCELERATION CARDS FOR DATACENTERS

Intel® FPGA Programmable Acceleration Cards for Application Acceleration

Intel® FPGA PAC with Arria® 10 GX

Broad deployment at low power

½ H, ½ L, single slot PCIe card
60W-70W TDP

D5005 for Datacenter

Enabling high throughput

2x100GbE, PCIe Gen3x16, 32GB DDR4,
Stratix 10 architecture

WHAT SERVERS SUPPORT PAC?

Each qualified OEM offers acceleration card, appliance and rack scale solutions based on the below OEM qualified servers.

OEM	Dell	Fujitsu	HPE	Inspur	Quanta	Supermicro
Status	**Qualified**	**Qualified**	**Qualified**	**Qualified**	**Qualified**	**Qualified**
Servers Supported	R640 R740 R740xd R840 R940xa	RX2540 TX2550	ProLiant DL360 DL380	5280M5	QuantaGrid D52BQ-1U D52BQ-2U QuantaVault JG4080	Sys-1029U Sys-2029U Sys-6019U Sys-6029U






GROWING LIST OF ACCELERATOR SOLUTION PARTNERS

Easing Development and Data Center Deployment of Intel® FPGAs for Workload Optimization

- Data Analytics
- Finance
- AI
- Genomics
- Cyber Security
- Media Transcoding

Accelize
ALGO-LOGIC
ADAPTIVE MICRO-WARE
bcom
bigstream
ACCELERATING INTELLIGENCE
CAST
CTACCEL
Accelerated Computing
Falcon COMPUTING
iAbra
Levyx
MEGH COMPUTING
myrtle.ai
NAGASE
NAGASE & CO.,LTD.
napatech
rENIAC
SOC
System-On-Chip Technologies
enyx
swarm64

SOLVING REAL-WORLD PROBLEMS:
DATA WAREHOUSING ACCELERATION

swarm64

50%
TCO SAVING [4]

UP TO 55X
FASTER QUERY PERFORMANCE [1]

1.2GB/S
(25M ROWS/S)
DATA INSERTION RATE [2]

3-5X
DATABASE COMPRESSION [3]

See System Configurations slide for more details. With Intel® FPGA Programmable Acceleration Card with Intel® Arria® 10 FX FPGA compared to traditional CPU based implementation.
All testing performed by SWARM64. Intel does not control or audit third-party data. You should review this content, consult other sources, and confirm whether referenced data are accurate.

(1) Based on database queries run with SWARM64 acceleration vs. no acceleration.
(2) Data warehousing tested with queries and data taken from TPC-DS benchmark.
(3) Based on database size run with SWARM64 acceleration vs. no acceleration.
(4) Projected Total Cost of Ownership savings for SWARM64DB over PostgreSQL database over a 3 year period. SWARM64 estimate.

SOLVING REAL-WORLD PROBLEMS:
IMAGE PROCESSING

3-4x
FASTER
JPEG TO WEBP (1)

3x
LOWER
LATENCY (1)

20W
JPEG
TO WEBP

See System Configurations Slide for more details. All testing performed by CTAccel. Intel does not control or audit third-party data.
You should review this content, consult other sources, and confirm whether referenced data are accurate.
(1) With Intel® FPGA Programmable Acceleration Card with Intel® Arria® 10 FX FPGA compared to Intel® Xeon® E5-2630 v2 CPU, JPEG to WEBP.
(2) Projected Total Cost of Ownership savings for CTAccel based FPGA solution vs traditional implementation. CTAccel estimate

SOLVING REAL WORLD PROBLEMS:

GENE SEQUENCING

99.98%

GATK ACCURACY (1)

Falcon COMPUTING

UP TO 15X

DATA THROUGHPUT (1)

NON PROPRIETARY GATK PIPELINE

See System Configurations slide for further details. Testing performed by Falcon. Intel does not control or audit third-party data. You should review this content, consult other sources, and confirm whether referenced data are accurate.
(1) With Intel® FPGA Programmable Acceleration Card with Intel® Arria® 10 FX FPGA compared to traditional implementation.
(2) Projected Total Cost of Ownership savings for Falcon based FPGA solution. Falcon estimate.

SOLVING REAL WORLD PROBLEMS:
SECURITY & NETWORK MONITORING

napatech
Reconfigurable Computing

50%
INCREASE IN SURICATA PERFORMANCE (1)

0%
PACKET LOSS (1)

40G
LINE RATE

See System Configurations slide for further details. All testing performed by Napatech. Intel does not control or audit third-party data. You should review this content, consult other sources, and confirm whether referenced data are accurate.
(1) With Intel® FPGA Programmable Acceleration Card with Intel® Arria® 10 FX FPGA compared to traditional NIC based implementation.

SOLVING REAL WORLD PROBLEMS:
CASSANDRA DATABASE ACCELERATION

rENIAC

UP TO 6X
HIGHER THROUGHPUT (1)

50-80%
TCO SAVING (2)

UP TO 25X
LATENCY REDUCTION (1)

See System Configurations slide for further details. All testing performed by rENIAC. Intel does not control or audit third-party data.
You should review this content, consult other sources, and confirm whether referenced data are accurate.
(1) With Intel® FPGA Programmable Acceleration Card with Intel® Arria® 10 FX FPGA compared to traditional Cassandra based implementation.
(2) Projected Total Cost of Ownership savings for rENIAC based FPGA solution vs traditional implementation. rENIAC estimate

SUMMARY

- FPGA is a high efficient and flexible acceleration platform
- Many FPGA-based accelerators: 3rd party and Intel®-branded boards
- Acceleration stack (tools, drivers, utilities) to simplify deployment
- Ready-to-go acceleration solutions from Intel® and ecosystem partners (DB acceleration, BigData, AI, Financial, Media transcoding, HPC etc)
- Development flow for SW developers – OpenCL SDK and OneAPI

INTEL® FPGA

THE ACCELERATOR OF CHOICE

SYSTEM CONFIGURATIONS FOR PERFORMANCE TESTING

Swarm64 system configuration:
Supermicro* SuperServer 2028U-TR4+ with Super X10DRU-i+ Mainboard, 2X Intel® Xeon® E5-2695 v4 CPUs, 8X Samsung* 32GB DDR4-2400 ECC RAM.

HPE ProLiant DL360 Gen 10, 2x Intel Xeon Scalable Gold 6130, 12x 32 GB DDR4 ECC RAM, 4x 6 Gbps SATA SSDs.
Up to 55x performance =TPC-H 1000 top quartile of query execution time acceleration. DA v1.6 on PSQL 11 vs native PSQL 11
Note: This is SQL to relational database, not SQL to semi/unstructured data.
Data Warehousing tested with data taken from the TPC-DS benchmarking suite and tested against the 99 TPC-DS query templates.
Swarm64 projected Total Cost of Ownership (TCO) savings for Swarm64DB over PostgreSQL database over a 3- year period.
Price of leading data warehouse solutions is ~$35K for 1TB, For PAC with Swarm64 solution 2 additional servers required in addition to servers with PAC cards installed, List Price of Swarm64 = $12K per year per node

Levyx Financial Risk Analytics system configuration:
Dell R640 server with 2 x Intel® Xeon® Gold 5115 CPUs @ 2.40 GHz, 128GB DRAM, Intel® FPGA Programmable Acceleration Card with Intel® Arria® 10 GX FPGA, 1 x 120GB SSD, 2 x 800GB SSD, CentOS 7.4 operating system. Testing performed by Levyx.
Levyx projected Total Cost of Ownership (TCO) savings for Backtesting application with Black Scholes, comparing CPU and FPGA accelerated systems of similar performance using costs based on values from AWS (Oct 2017). Described in document :
https://stacresearch.com/system/files/asset/files/Unaudited%20Configuration%20Disclosure%20-%20LEVX171004.pdf
https://stacresearch.com/system/files/asset/files/Unaudited%20Configuration%20Disclosure%20-%20LEVX171002.pdf

Testing with Intel® FPGA Programmable Acceleration Card with Intel® Arria® 10 FX FPGA compared to traditional implementations.
Testing performed by third parties. Intel does not control or audit third-party data.
You should review this content, consult other sources, and confirm whether referenced data are accurate.

SYSTEM CONFIGURATIONS FOR PERFORMANCE TESTING

CTAccel system configuration:
2x Intel® Xeon® processor E5-2630 v2 @ 2.6GHz (12 physical cores, 24 threads), 15MB cache, 128GB DDR3 (16GB x 8) memory, 300GB HDD (SAS 10000rpm) + 4TB x 2 SATA (7200rpm) with Intel Arria 10GX FPGA, CentOS Linux release 7.2.1511 kernel version 3.10.0-327.36.2.el7x86_64.

Napatech system configuration:
Dell PowerEdge R740, 2x Intel® Xeon® Gold 6138 CPU @ 2.0 GHz, 20 Cores, 40 Threads, 128GB RAM (16 x 8GB RDIMM, 2666MT/s), Intel® Programmable Acceleration Card with Intel Arria® 10 GX FPGA (1x40 GE), NIC: Intel® Ethernet Network Adapter XL710-QDA2 (2x40 GE), Optical Transceiver: 40GBASE-SR4 QSFP+ 850nm 150m MTP/MPO Optical Transceiver Module, Napatech Link™ Capture software v11.1.4 Linux, CentOS Linux release 7.3 - Linux kernel version 3.10.0-957.1.3.el7.x86_64, Suricata version: 4.0.5
Suricata is used in intrusion detection mode; traffic is sent one-way and throughput is measured using statistics reported by the application.

rENIAC system configuration:
PAC Host server: Intel® Xeon® Silver 4109T @2.0GHz, 64GB DDR3 , 120GB SATA SSD ,187GB Optane™ SSD (running rENIAC FPGA data engine), CentOS 7.6 – kernel 3.1
Cassandra client: Intel® Xeon® E5-2650 @2.6GHz, 64-128GB RDIMM, 266MY/s dual rank, 500GB-1TB SATA/NVME SSD, 22GB SSD (DB server), CentOS 7.6 – kernel 3.1
Cassandra client/server: Intel® Xeon® E5-2650 @2.6GHz, 64-128GB RDIMM, 266MY/s dual rank, 500GB-1TB SATA/NVME SSD, 22GB SSD (DB server), CentOS 7.6 – kernel 3.1

Testing with Intel® FPGA Programmable Acceleration Card with Intel® Arria® 10 FX FPGA compared to traditional implementations.
Testing performed by third parties. Intel does not control or audit third-party data.
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SYSTEM CONFIGURATIONS FOR PERFORMANCE TESTING

Falcon system configuration:
2x Intel® Xeon® Gold 6148 processor, 512GB of RAM, Intel® FPGA Programmable Acceleration Card with Intel® Arria® 10 GX FPGA, CentOS 7.3 operating system, Intel® Acceleration Stack for Xeon® processor (OPAE) version 1.1

Megh system configuration:
Dell 740 servers: 2x Xeon Gold 6126, Ubuntu 16.04, 12 DIMMs, 4 SSDs of 512 GB each, TOR switch with 40G QSFP connection to FPGA cards, 2x Intel® FPGA PAC with Arria™ 10, Intel® for Xeon® processor (OPAE) version 1.1

Testing with Intel® FPGA Programmable Acceleration Card with Intel® Arria® 10 FX FPGA compared to traditional implementations.
Testing performed by third parties. Intel does not control or audit third-party data.
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