Fastwel

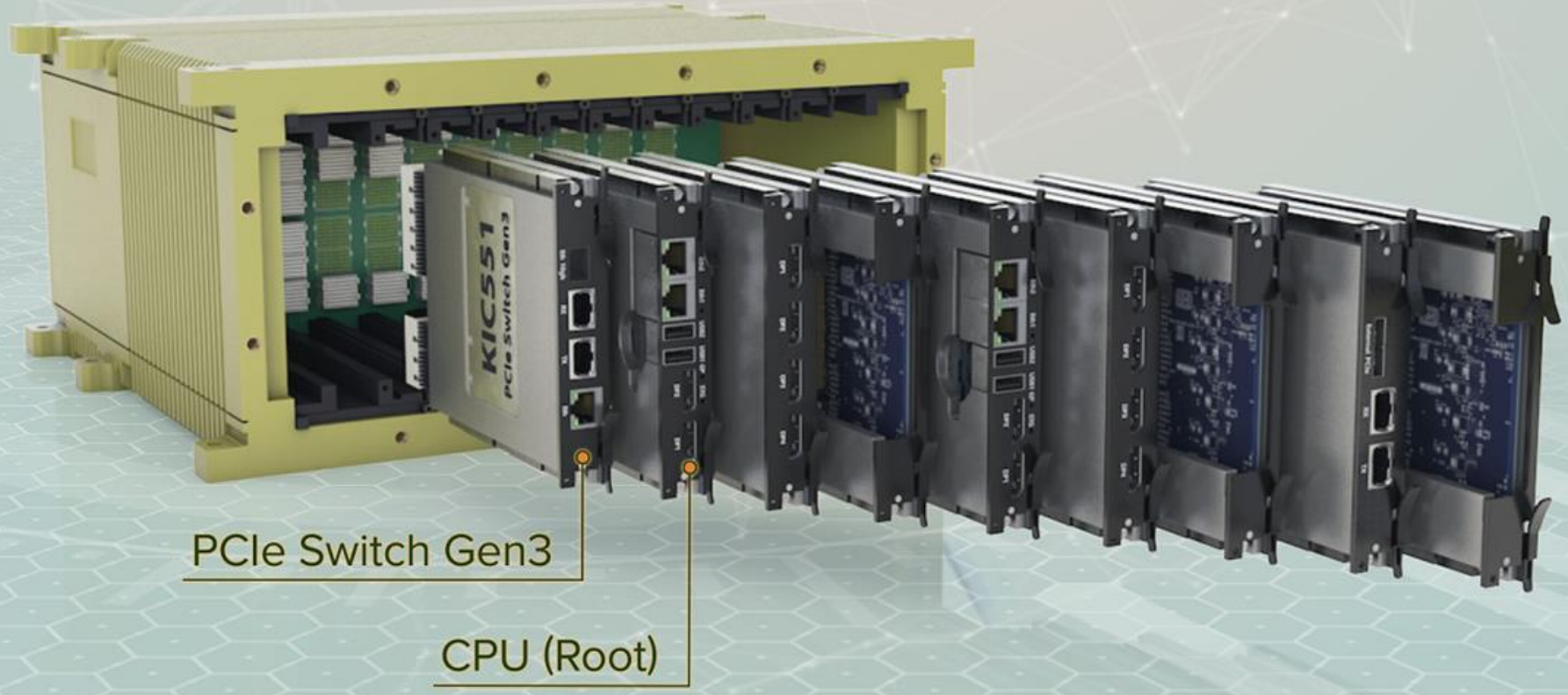
High-Performance Heterogeneous Computing Platform “GRIFON”

Purpose

- Input, processing and analysis of large volumes of radar and visual data.
- High resolution imaging and creation of virtual reality systems.
- Ensuring efficient operation of distributed real-time databases and data storage systems.
- Application for parts of the combat information and control system.

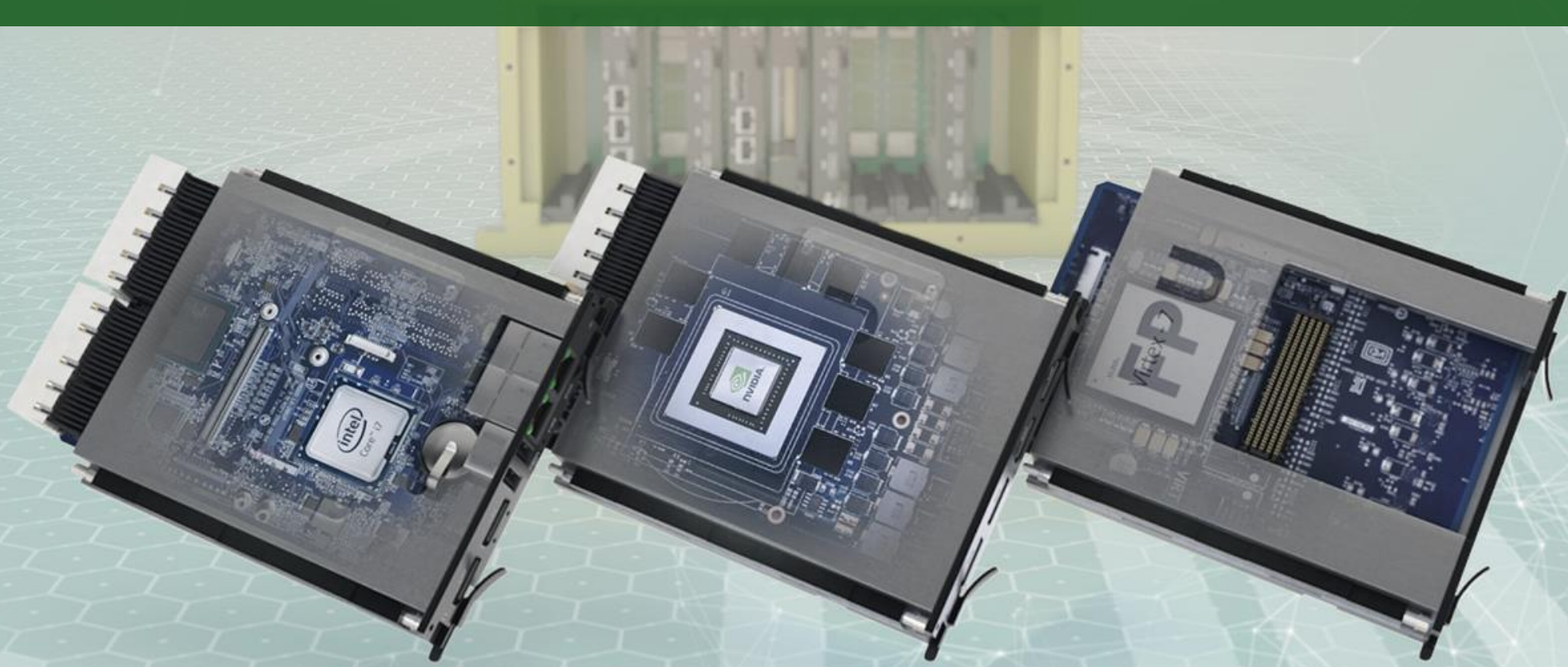
COMPUTING PLATFORM ARCHITECTURE

Bus-structured modular system based on Compact PCI Serial specification with 3U modules in size

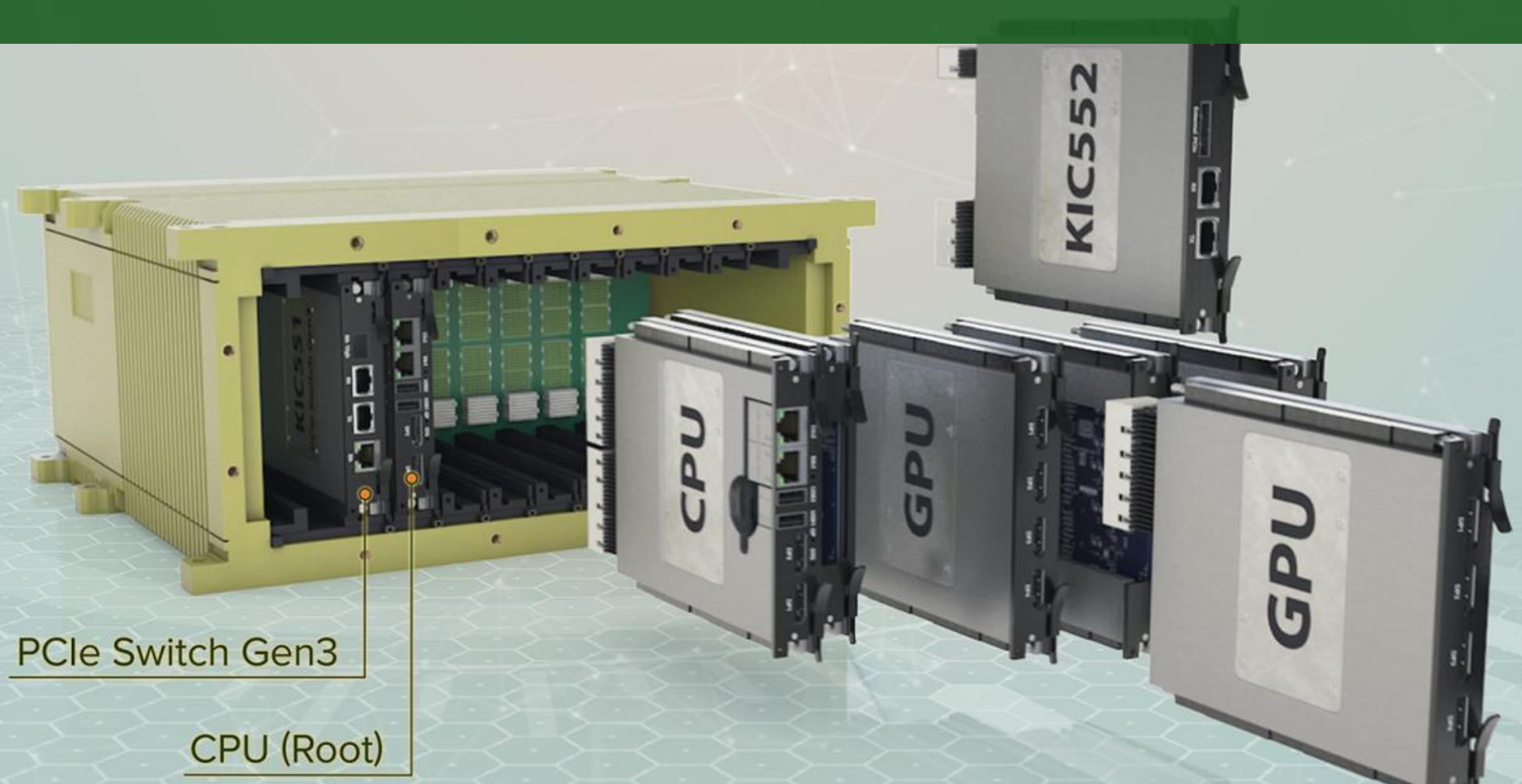


Heterogeneous: use of computers with various architectures:

1). CPU modules with x86;
2). Computers based on graphics processors (Nvidia, AMD);
3). Computers based on FPGA (Virtex,Kintex).



Parallel-pipeline computational process and scalability at the level of modules and units



Computing platform contains:

X86 architecture

Model	Description
CPC512	3U Intel Core I7 3rd, 2/4 **cores**, DDR3 8GB

FPGA-based computers

Model	Description
FPU500	3U VIRTEX-6, RAM 4 GB DDR3, FMC HPC, PCIe x8 Gen3

Computers based on graphics processors

Model	Description
VIM556	3U GPU Nvidia Quadro K2100M 2GB, 576 Cores TDP 55W,PCIe x8, 750Gflops SP
VIM556-03	3U GPU AMD Radeon E8860 2GB, 640 Cores TDP 55W,PCIe x8, 768Gflops SP

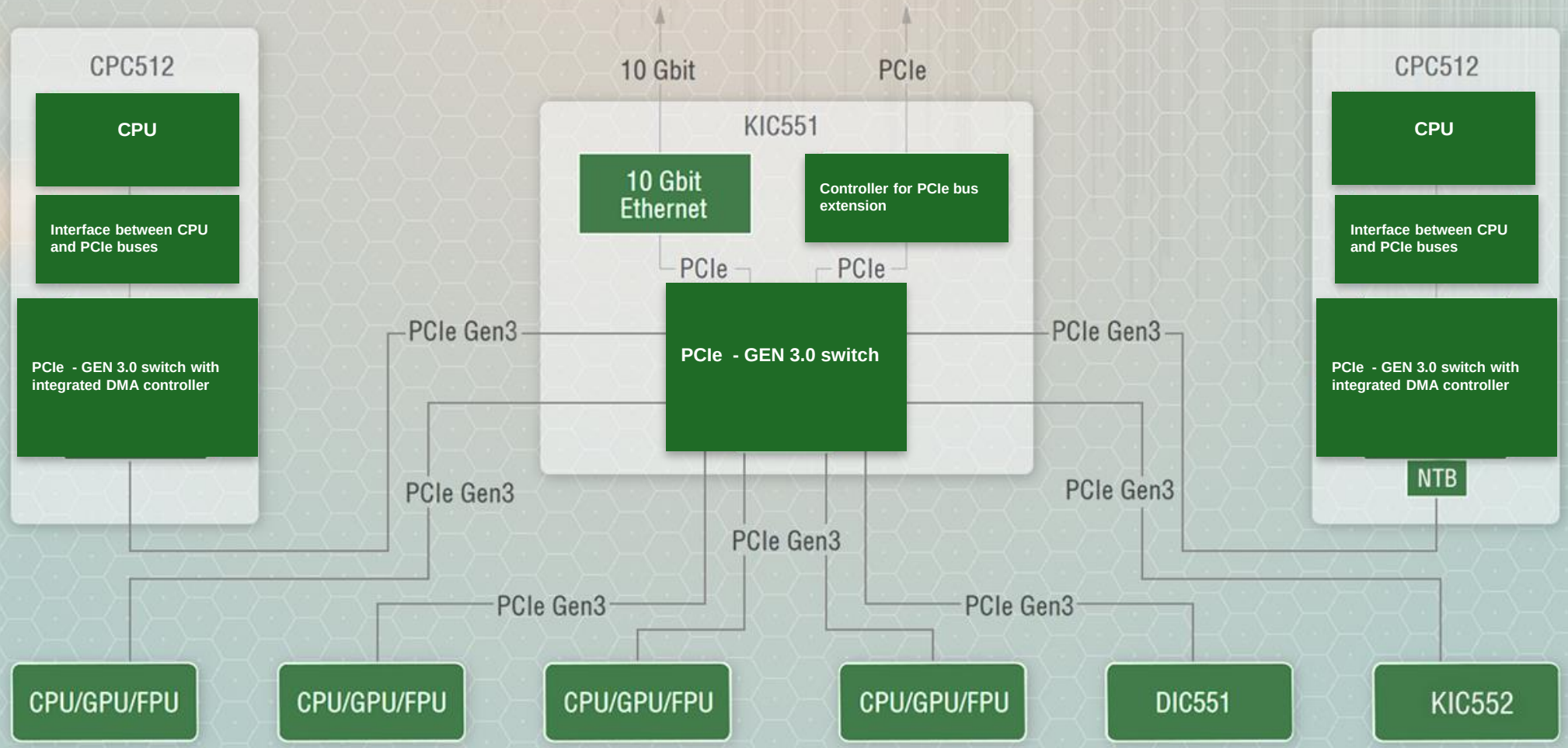
Switches and extenders

Model	Description
KIC551	3U Switch PCIe/10 Gbit Ethernet, PCIe Gen3, Fiber Optic
KIC552	3U Extension Module PCIe Gen 3.0 x8 Fiber Optic 50 m

I/O Modules

Model	Description
DIC551	3U PCI-E x1, 2x mezzanines with I/O (RS485/422/232, digital I/O, analog i/o, current loop,CAN, MIL STD1553)

Interaction Structure for Units of GRIFON High-Performance Heterogeneous Computing Platform



Inter-Modular Interaction Mechanisms

CPU-CPU

- Network driver with the transferring over PCIe.
- Library that displays memory parts of one module to the other.

CPU-FPGA

- Set of cores and their drivers, organizing interactions.

CPU-GPU

- CUDA SDK operation.

Support of peer-to-peer interaction between computing modules

Structural Variations

GRIFON-K

GRIFON-S

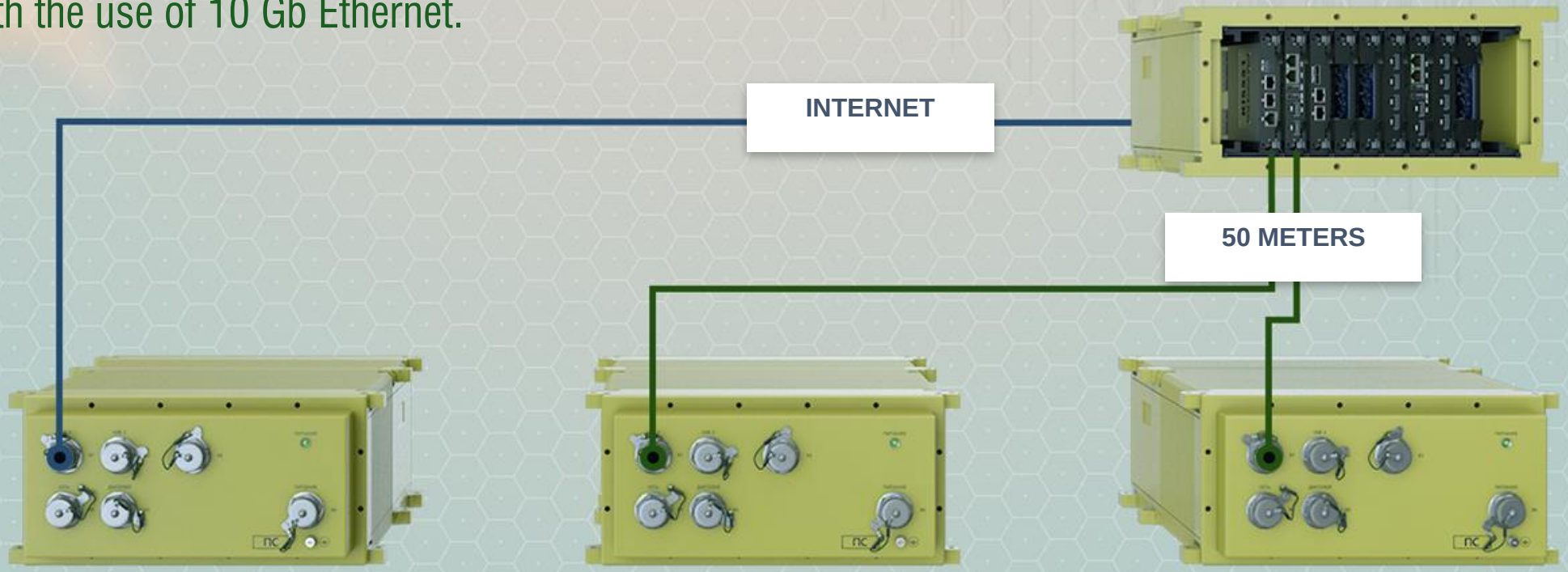
Implementation as per requirements for resistance to external influencing factors in accordance with the GOST RV 20.39.304-98

Unit Scalability

- Set of modules depends on a particular task
- Bandwidth between any pair of modules is up to 32Gb/sec.

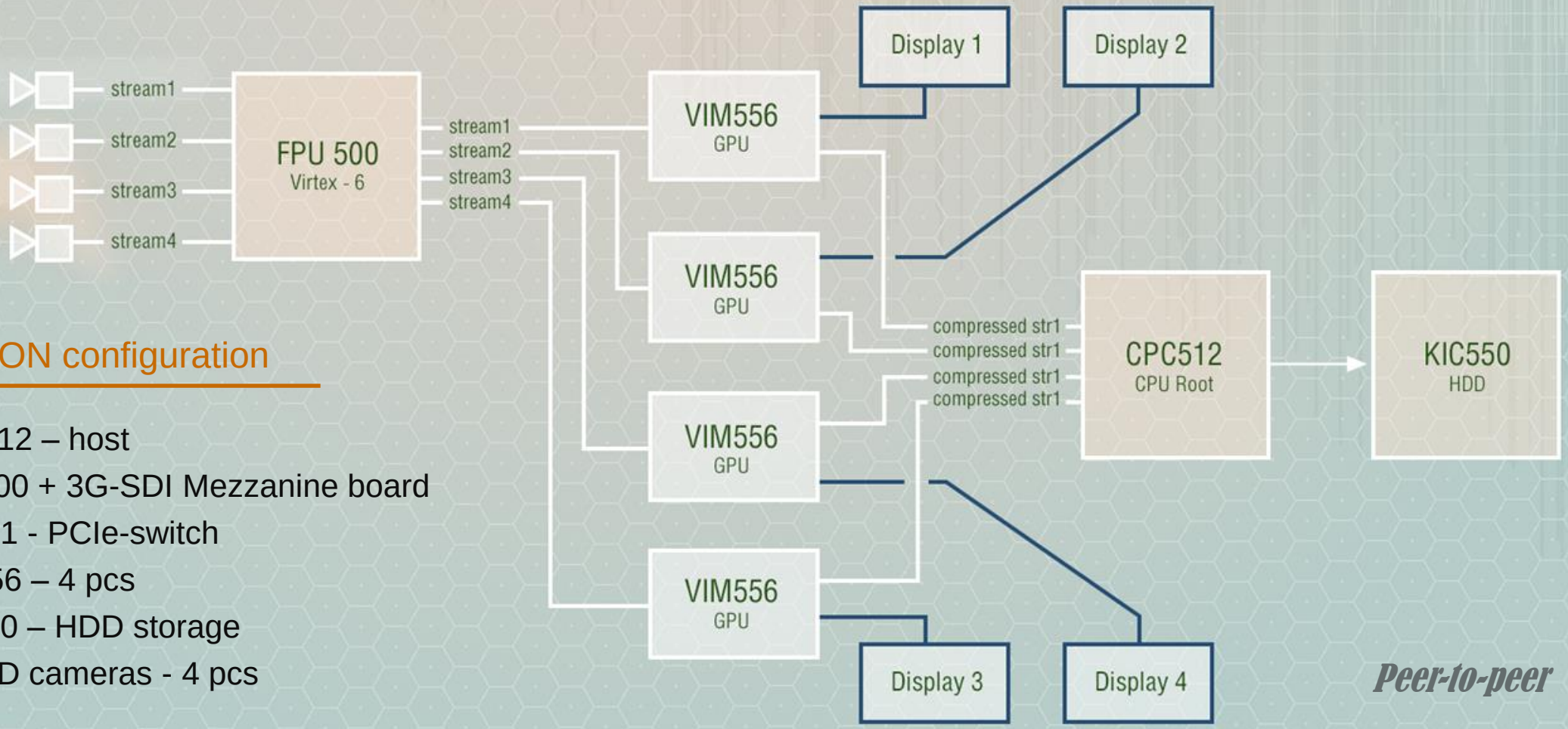
System Scalability

- Various topologies of inter-unit connections with the use of PCIe.
- Bandwidth up to 32Gb/sec.
- With the use of 10 Gb Ethernet.



Parallel-Pipeline Data Processing

As exemplified by the system of high-definition video processing in real-time



GRIFON configuration

CPC512 – host

FPU500 + 3G-SDI Mezzanine board

KIC551 - PCIe-switch

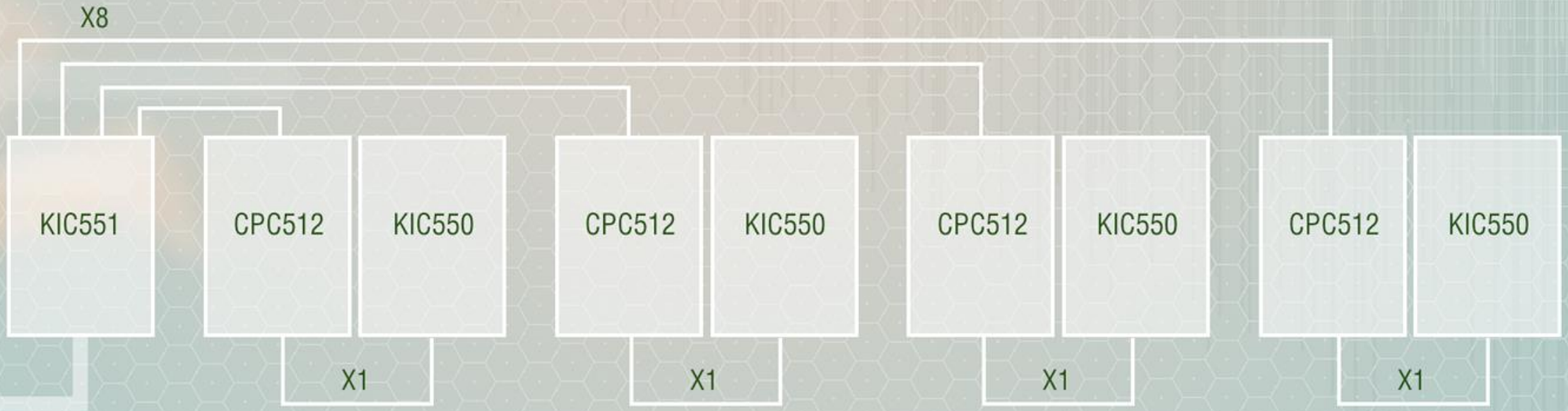
VIM556 – 4 pcs

KIC550 – HDD storage

Full-HD cameras - 4 pcs

Peer-to-peer

Example of the Autonomous Distributed Database

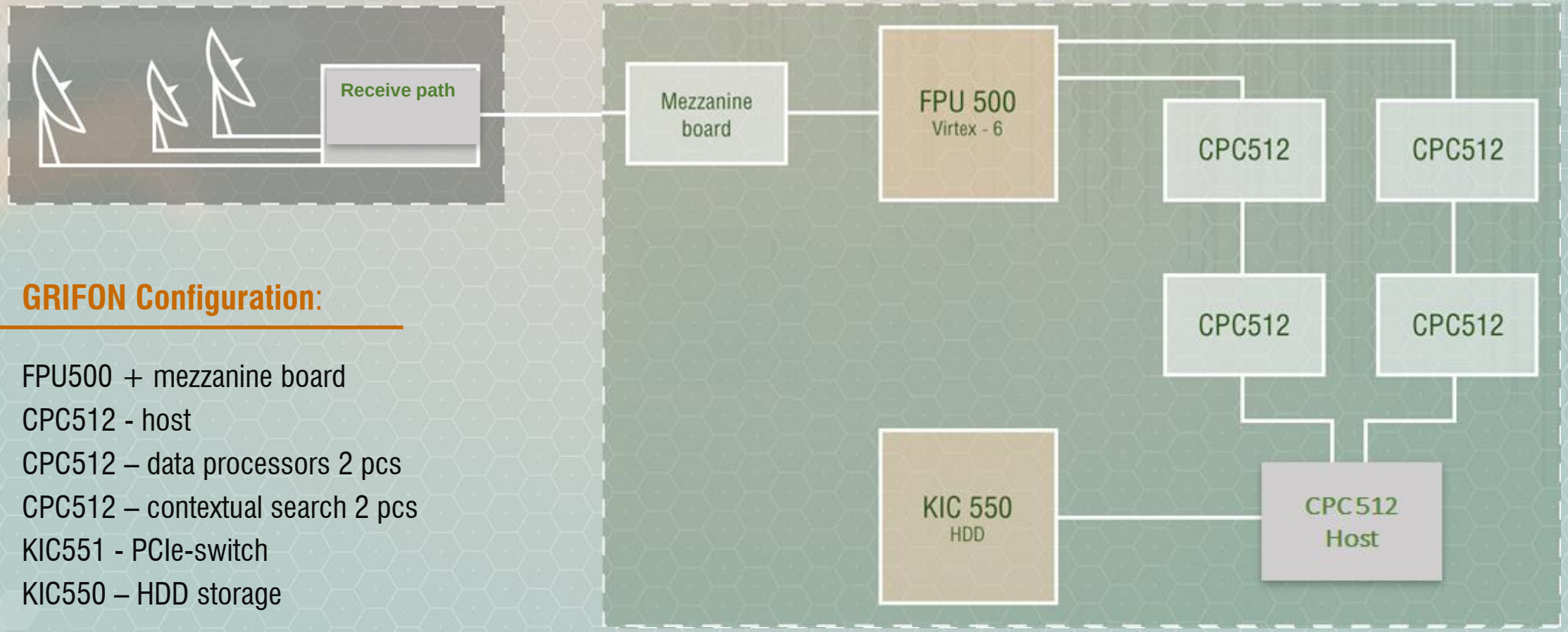


GRIFON configuration:

KIC551 – 1 pcs.
CPC512 – 4 pcs.
KIC550 – 4 pcs.

Parallel-Pipeline Data-Processing

as exemplified by mobile system of data acquisition and processing for wireless communication channels



GRIFON Configuration:

FPU500 + mezzanine board
CPC512 - host
CPC512 – data processors 2 pcs
CPC512 – contextual search 2 pcs
KIC551 - PCIe-switch
KIC550 – HDD storage

Activated / Deactivated Functions

- 1 – Detection of faces
- 2 – Recognition of faces
- 3 – Determination of distances to objects
- 4 – Detection of movements
- 5 – Keeping track of the object highlighted by mouse
- 6 – Detection of people
- 7 – Detecting any objects (interacting with user via appropriate algorithm)

Continuously Repeatable Data Processing Cycle

Receiving frames from 8 video cameras

Linking panoramic sight for the left and right eye from the frames of 8 video cameras

Drawing up a map of distances for any frame point

Face detection HaarCascades (if LBP face detection is activated)

Searching for moving objects

People recognition (HOG method)

Detecting movements of mouse-highlighted objects

Detecting any objects (interacting with user via appropriate algorithm)

Displaying new frames on the screen of 3D-monitor

Displaying frames in 3D Virtual-Reality Headset Oculus Rift Dk2

Compression of the current video-frame in H264-mpeg format using the hardware ASIC-codec nVidia

Performance Characteristics

- Speed of linking frames from 8 video cameras to the Full-HD 1920x1080 stereo-panorama without blurring, at 1 GPU – 12 FPS, response 100 ms.
- Displaying speed in the Oculus Rift Full-HD headset – 65 FPS, response15 ms.
- Speed of face recognition on panorama – 4 FPS, response 250 ms.
- Speed of recognition of 10 faces from the data base of 100 faces – 4 FPS, response 250 ms.
- Speed of keeping track over the highlighted object at GPU (PyrLK Optical Flow 150-200 FPS), but it is limited by the panorama linking speed - 12 FPS, response 100 ms.
- Speed of generation of distance map using GPU and defining distances to the objects – 3 FPS, response 300 ms.
- Speed of building 3D model in the territory in sight – 1 FPS, response 1 second.
- Speed of movement by the 3D model, using integrated graphics CPU – 20 FPS, response 50 ms.

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