The Case of Cloud Designing and Development

P. Fedchenkov(*), O. Lazo(*), A.Shevel(*,), S. Khoruzhnikov(*), A. Shvetsov(**), O. Sadov(*), N. Samokhin(*), A. Oreshkin(**)**

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* ITMO University

** PNPI of NRC «Kurchatov Institute»

Outline

- IT challenges & geographically distributed computing systems
- Project
- Results

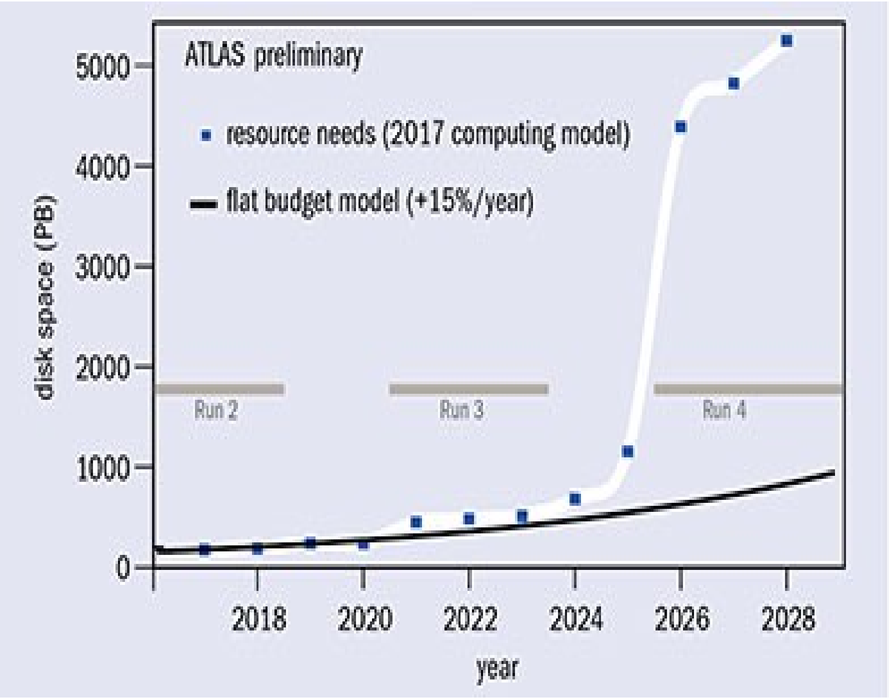
Contemporary IT challenges in the World

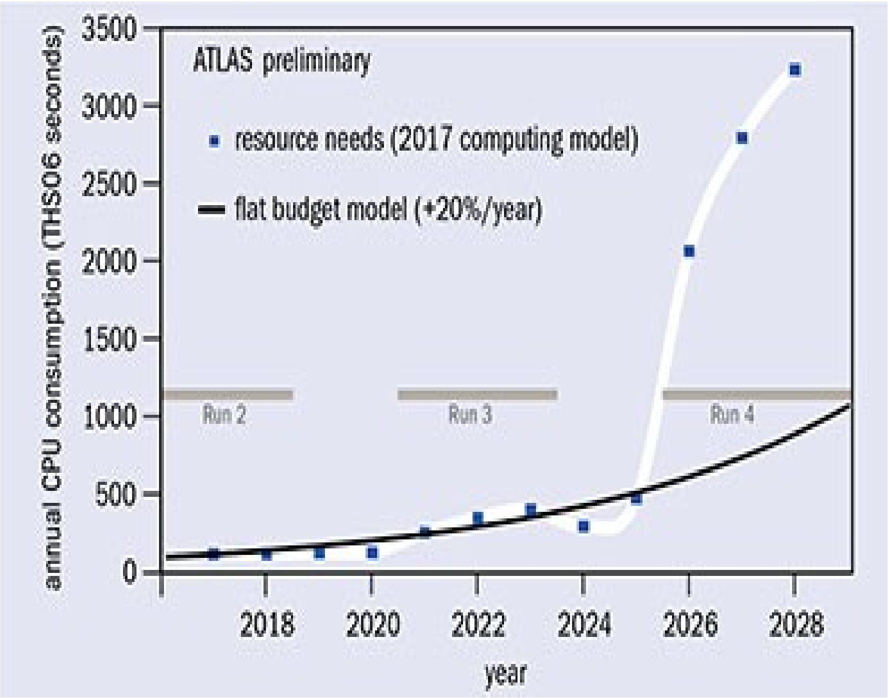
- Geographically Distributed computing infrastructure
- Growing demands on data volume & computing in all areas of human activities
- Network security
- Reliable distributed storage
- Service reliability (fault tolerance)
- Scalability

Geographically distributed DC

- The number of DCs is growing each year thanks to growing of data volume.
- The specific demands for computing power is often exceeds abilities of one DC. It leads to various types of DC clustering.
- Make computing power more flexible: aggregation and share of geographically distributed computing resources.

Atlas flat badget vs Requirements





'THS06' stands for 'Terra HEP SPEC 06'

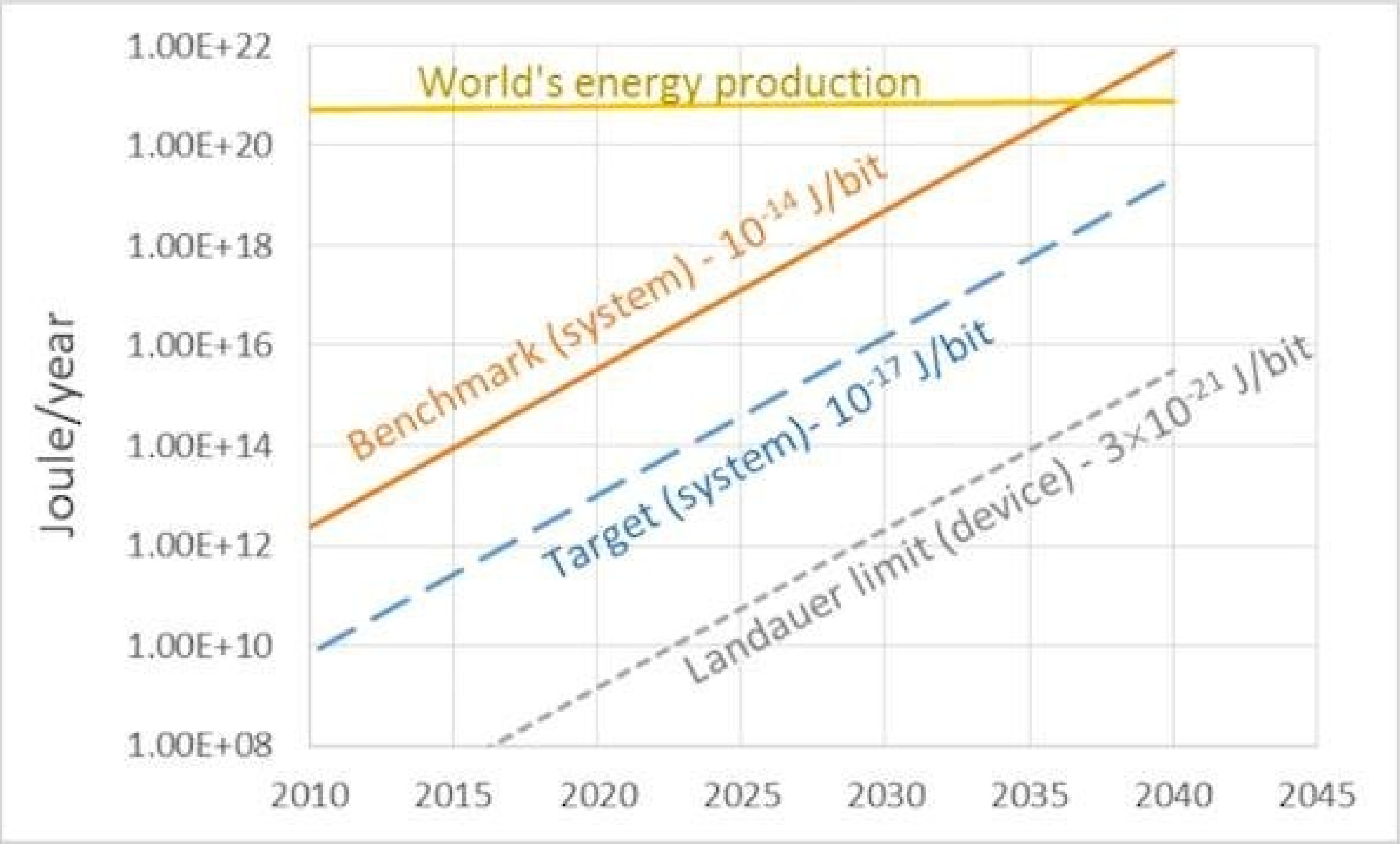


Fig. A8. Total energy of computing.

From https://www.theregister.co.uk/2016/07/25/semiconductor_industry_association_international_technology_roadmap_for_semiconductors/

Examples of aggregation of distributed computing power

- Computing Grid – World LHC Computing Grid – biggest Grid in the World.
- Computing Clouds
  - Amazon.com/ec2
  - Cloud.google.com
  - Azure.microsoft.com (number of users ~5*10**8)
- Cloud computing offers tremendous potential benefits in *agility*, *resiliency*, and *economy*.

Computing Clouds

- Computing Clouds
  - Total number of different cloud systems in the World ~ 10**3 and more (why so many?)
  - "The old idea that everything would move to the public cloud never happened. Instead, the cloud market evolved to meet the needs of clients who want to maintain on-premises systems while tapping a multitude of cloud platforms and vendors. "
  - — Stephen Elliot, Program Vice President, IDC.

The problems

- How to avoid clients locked in specific cloud ?
- How to make data in data storage safe for many years?
- How to guarantee security for data transfer between geographically distributed DCs?

Goals of this project

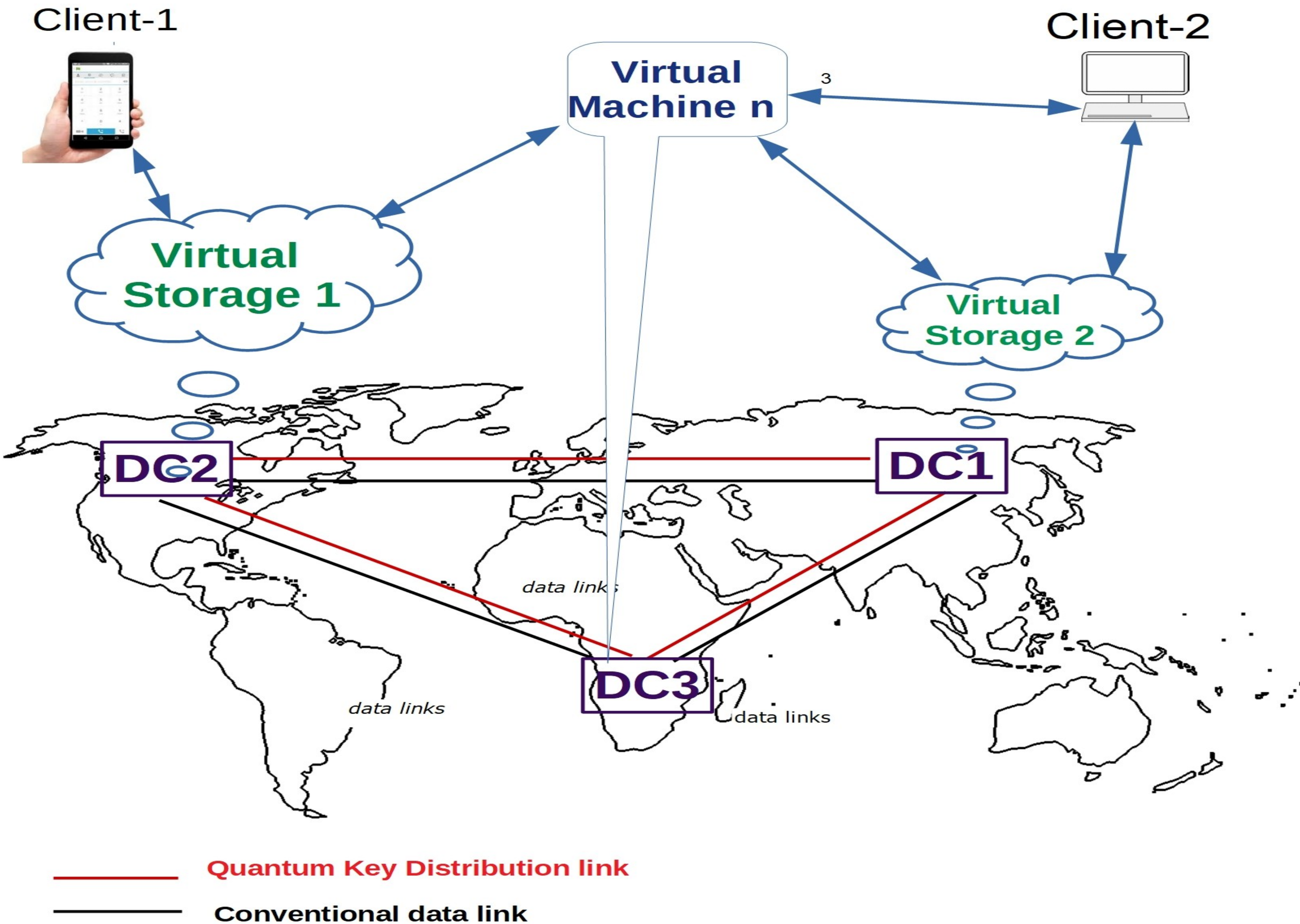
- The designing and development computing infrastructure, which permits to integrate the resources of Geographically Distributed DCs to form cloud Infrastructure as a Service (IaaS) and attempt to answer on questions from previous slide.
- Initial assumptions
  - DCs (groups of servers) are distributed on the planet or solar system.
  - DCs might be a group of bare metal servers or virtual servers in existing cloud systems.

The constituent elements of the solution

- Security
  - ‘zero trust’ approach (*beginning from hardware level*);
- Connectivity
  - SDN + NFV
- Flexibility
  - Program agents (microservices) architecture approach
- Scalability
  - horizontal scalability to meet changing demands
- Openness
  - FOSS components

Aims and Solutions

- Security of data transfer between DCs
  - Quantum Key Distribution (QKD) for data coding keys
- Data storage reliability
  - Stored Data is replicated on independent storage units (or DCs).
- Slow degradation with malfunction of hardware or software components.
  - Independent Program Agents in isolated operating environment.

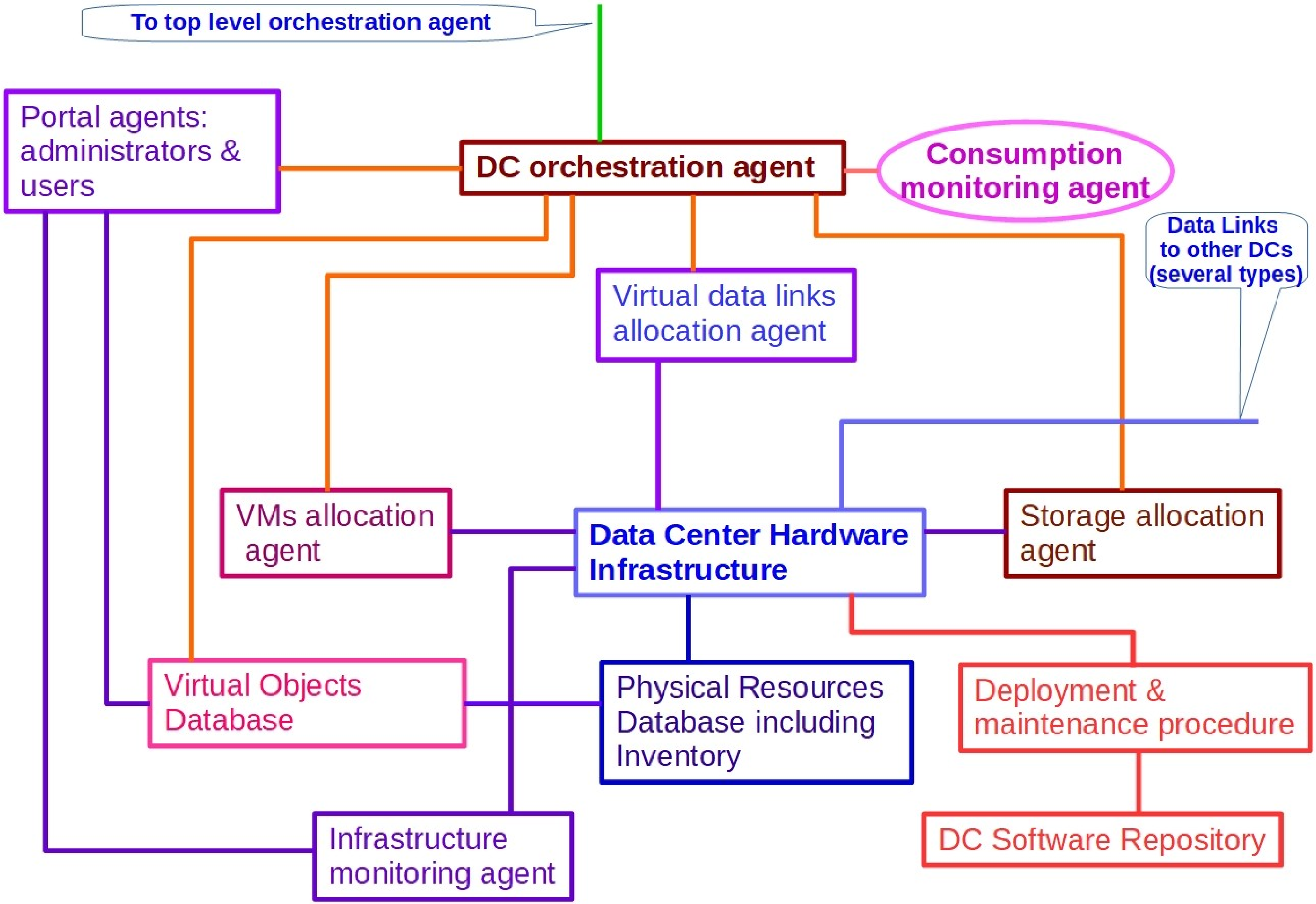

Client-1
Client-2
Virtual Machine n
3
Virtual Storage 1
Virtual Storage 2
DC2
DC1
DC3
data links
data links
data links
Quantum Key Distribution link
Conventional data link

Architectures for Integrated Management System (IMS)

- Infrastructure as Code (IaC)
- Semi-automatic deployment of IMS
- Monitoring of Engineering Infrastructure
- No lock to specific components like CEPH, Openstack, etc. It might be used another components.

Architecture technical solutions

- Data Storage: CEPH.com.
- VM management: Openstack.org.
- Monitoring of virtual and physical components: Zabbix.
- Visualization: Grafana/Kibana.
- Other components: Postgres, Rabbitmq, Nextcloud, Saltstack, GLPI, Ryu, ...
- Operating system (OS): NauLinux (clon RedHat).
- Own repository for all program components.
- Own semi-automatic procedure for system deployment.



To top level orchestration agent
Portal agents: administrators & users
DC orchestration agent
Consumption monitoring agent
Data Links to other DCs (several types)
Virtual data links allocation agent
VMs allocation agent
Data Center Hardware Infrastructure
Storage allocation agent
Virtual Objects Database
Physical Resources Database including Inventory
Deployment & maintenance procedure
DC Software Repository
Infrastructure monitoring agent

Advantages

- IMS permits to build up hybrid clouds and to avoid cloud lock in.
- Data transfer between DCs with QKD.
- IMS is built upon operating isolated program agents in form of VM and/or containers.
  - Program Agents are implemented with 'added reliability' approach, i.e. HA or/and automatic restart in unexpected Agent abort.
- IMS horizontal scalability.

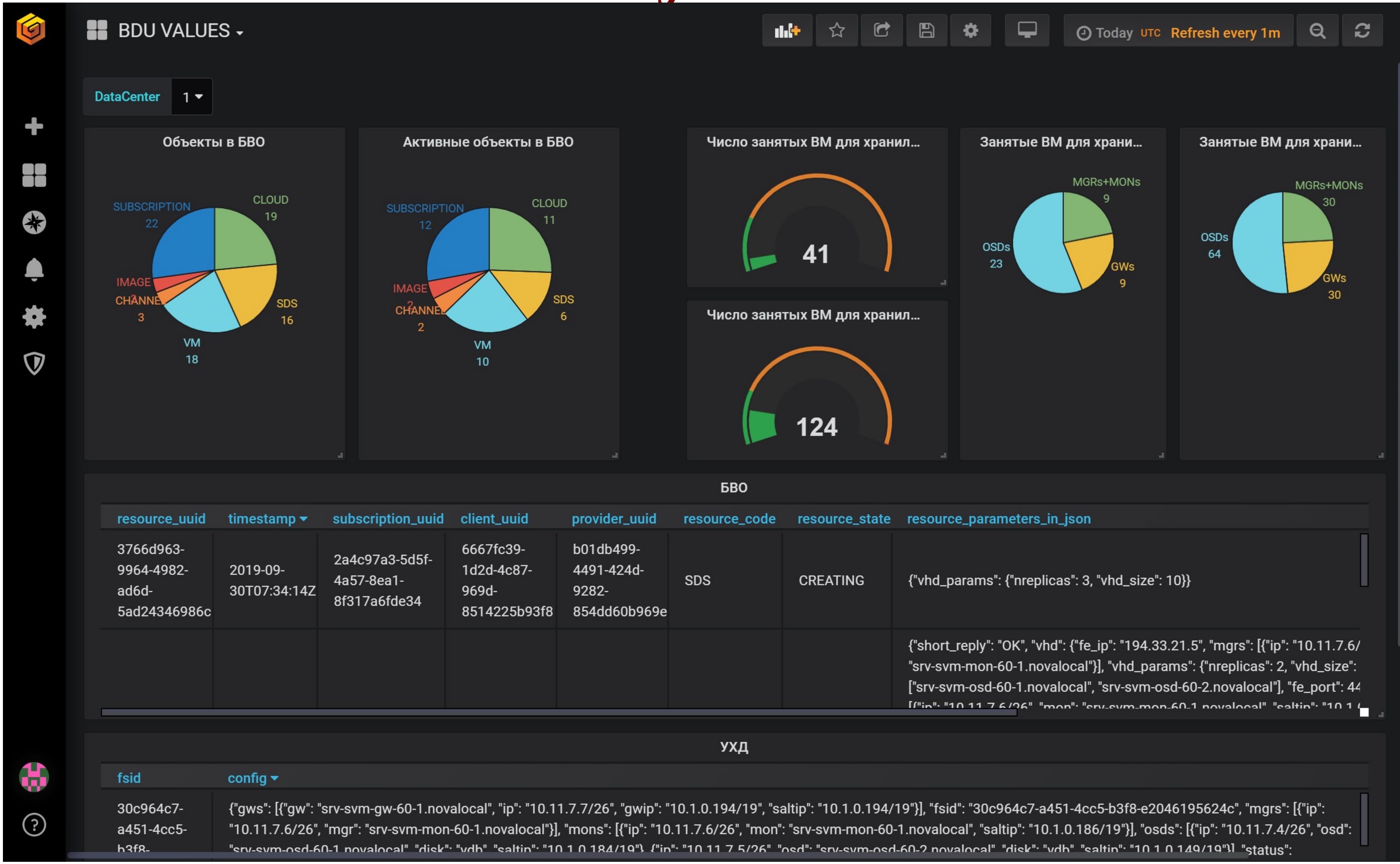
Status

- Testbed consisting of 3-x microDCs [10 servers (6-2-2) HPE DL380 Gen10 8LFF CTO
  - **CPU : 2 x Intel Zeon Gold 6130 ;**
  - **Main memory: 128 GB**
  - **Disk storage 32 TB**
  - **4 switches: HP FF 5700-32XGT-8XG-2QSFP+**]
- The distance between DCs are around 100 Km and more.
- The testbed is in use from March of 2019.

Experience

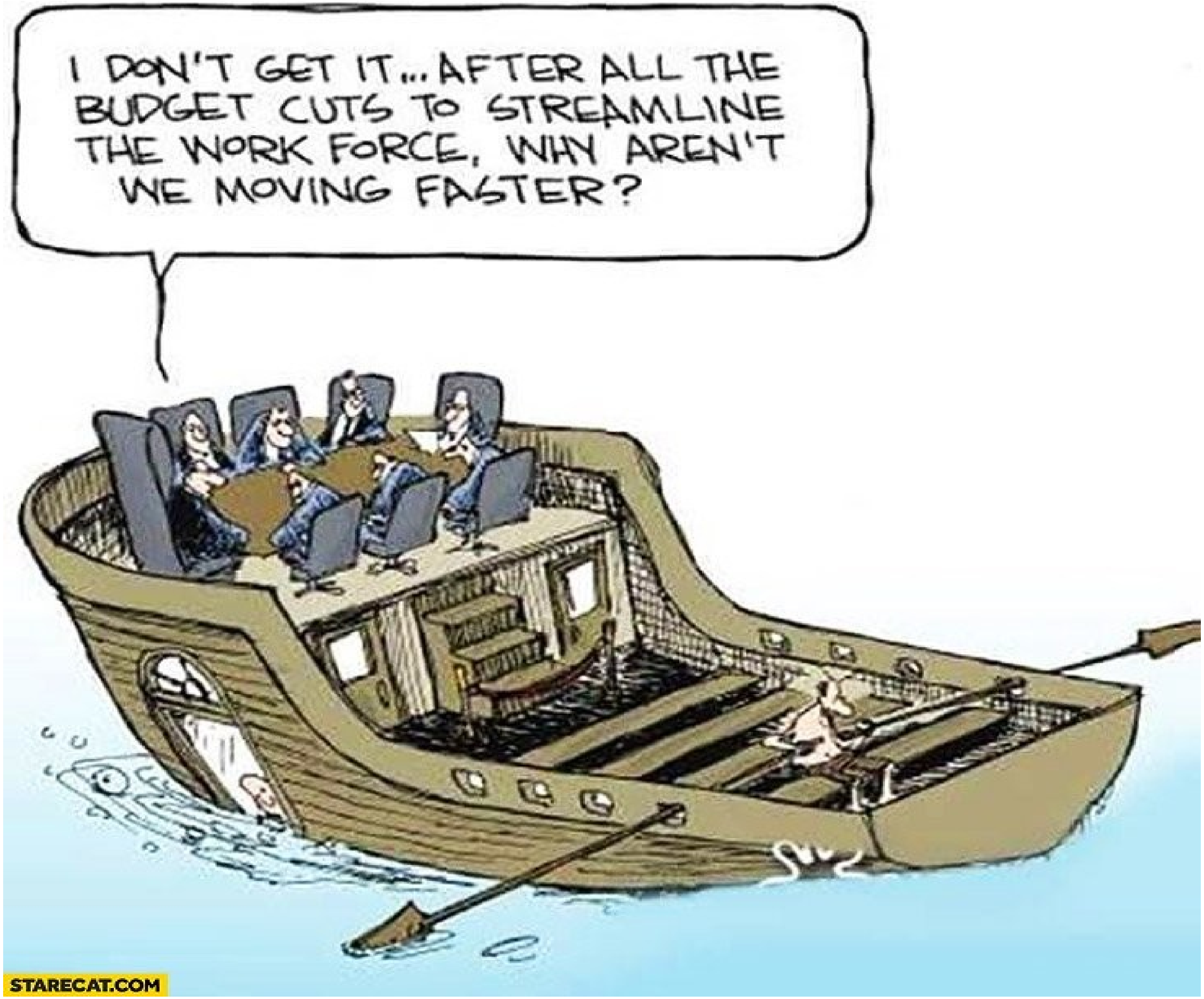
- IMS implementation suggests just base services: *Virtual Machines*, *Virtual Storage*, *Virtual Data Transfer Links* give freedom to use commercial public clouds, server co-location or own bare metal servers.
- Each program agent might be (and was) developed with different program language, libraries, by different developers with different development styles, etc.
- IMS permits to control ‘dark’ data centers.
- The project commissioning is running well.

Virtaul Objects of IMS



Experience-2

- Important component of project experience is creation of development team:
  - ~ ½ students of ITMO University;
  - Developers from different organizations and cities;
  - Team meeting ***each week***: ‘face to face’ or/and skype;
  - DevOp + gitlab sites + other collaborative tools;
  - ~ ½ of our efforts was QKD procedure;
  - The development process took 2+ years.


I DON'T GET IT... AFTER ALL THE BUDGET CUTS TO STREAMLINE THE WORK FORCE, WHY AREN'T WE MOVING FASTER?
STARECAT.COM

Now is time for questions and comments

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