RUNNet: infrastructural and service basis of the national research and education network of the Russian Federation

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8th International Conference "Distributed Computing and Grid-technologies in Science and Education" (GRID 2018)
Dubna, Moscow region, Joint Institute for Nuclear Research, 10-14 September 2018

RUNNet

GLOBAL CHALLENGES IN ICT FOR R&E COMMUNITY

Cost accounting

Increased demands on network infrastructure

Technological limitations of traditional ISPs

Virtualization of R&E collaborations and operative approbation

Mobility and scalability of resources, including for short-term projects

Authentication and access protection

Efficiency in decision-making

Specialized software

Mobility of project participants

NATIONAL RESEARCH AND EDUCATION NETWORKS AS AN INFRASTRUCTURE BASIS FOR PROVIDING THE FUNCTIONING OF SUSTAINABLE R&E COLLABORATIONS

National Research and Education Network (NREN) is an information and telecommunication network, a nationwide high-performance telecommunication infrastructure that corresponds to the advanced technological achievements of the industry and is used exclusively in the interests of R&E community of the country, providing target users with the access to the global ICT space, the connectivity with world's NRENs and network consortia, and it is the core of the development and implementation of in-demand services

KEY CHARASTERISTICS OF NRENS

- **R&E target audience** (universities, scientific organizations, research centers, scientific and educational campuses)
- **increased demands on network quality** (high throughput of the backbone infrastructure, low latency, etc.)
- **fault-tolerant topologies** (ring topology, presence of duplicate paths between the backbone hubs)
- **developed fiber-optic infrastructure** (availability of own or leased fiber-optic lines between cities)
- **control and optimization of costs** for ICT infrastructure and commercial services
- usage of up-to-date **network technologies and protocols**
- development and provision to users of perspective **network services and services of shared use**

Telecommunications infrastructure for the delivery and processing of "scientific data"

Interaction with foreign NRENs and international network consortia

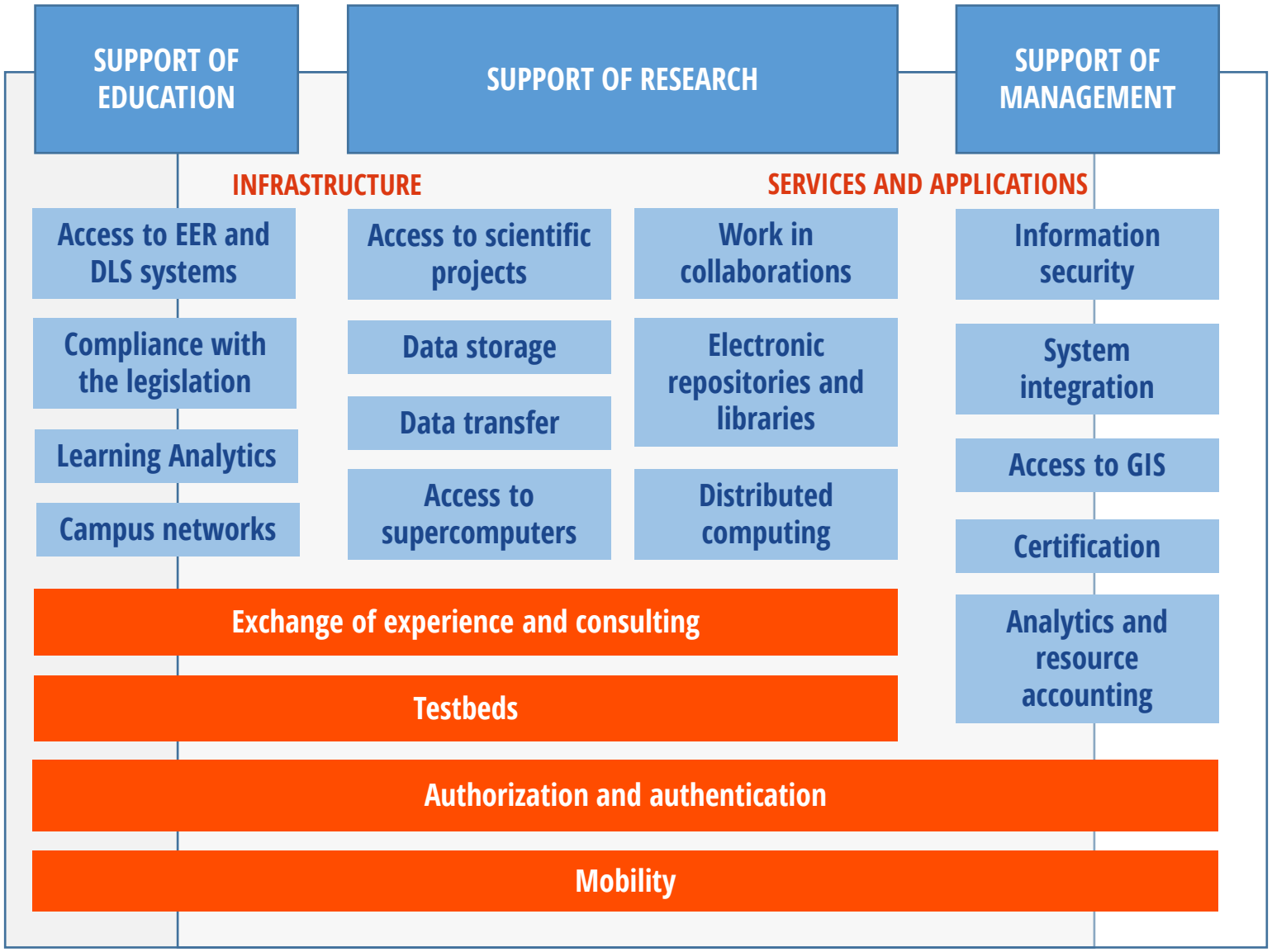
Ensuring access to the results of projects in priority scientific areas

PRIORITY SCIENTIFIC AREAS

- **nuclear physics, high energy physics** (the mega-science class facilities, particle accelerators, electronic synchrotrons, X-ray lasers)
- **astrophysics, satellite observations** (radio telescopes, space telescopes, laser-interferometric devices)
- **geophysics, meteorology, climatology**
- **biological sciences** (electron microscopes)
- **medical sciences, neurophysics, telemedicine**
- **ICT** (supercomputers and distributed computing, Grid-technologies, transfer, storage and processing of Big Data, blockchain)

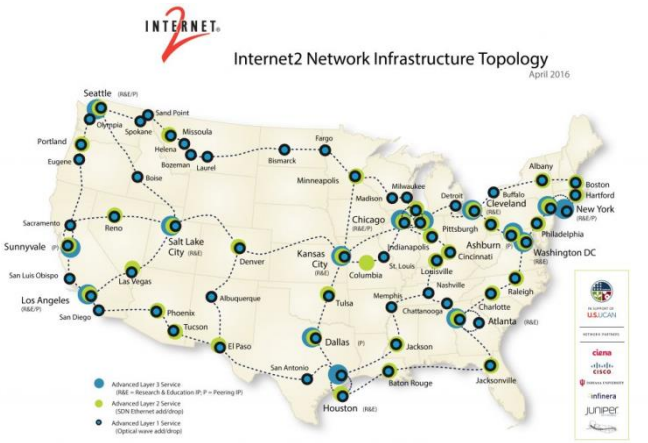
CERN DESY European XFEL ESRF elixir Super KEKB LSC esa WCRP World Climate Research Programme NICA

MAIN TASKS SOLVED BY NRENS TODAY

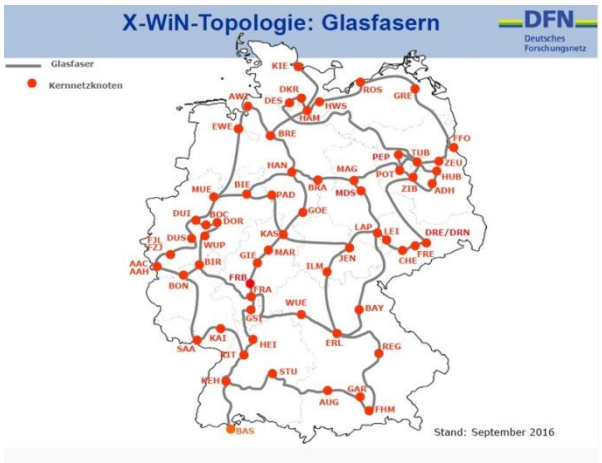


LEADING NATIONAL RESEARCH AND EDUCATION NETWORKS: EXAMPLES AND TOPOLOGIES

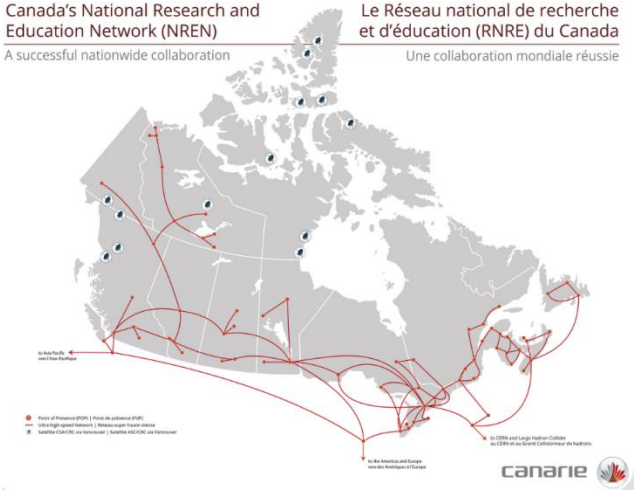
Internet2 (USA)



DFN (Germany)



CANARIE (Canada)



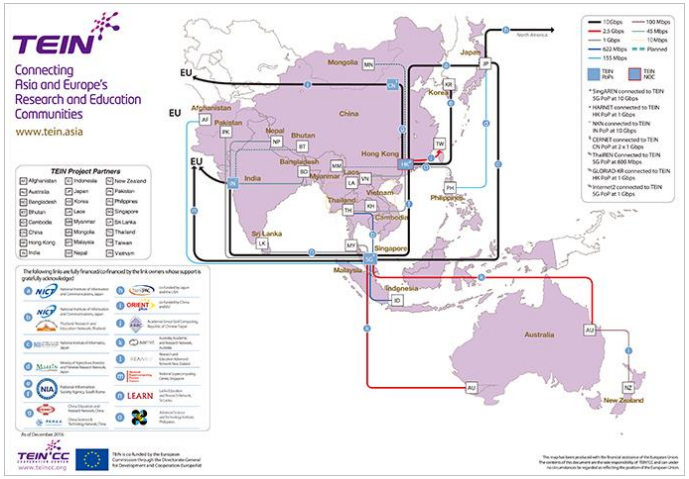
CERNET (China)

SURFnet (Netherlands)

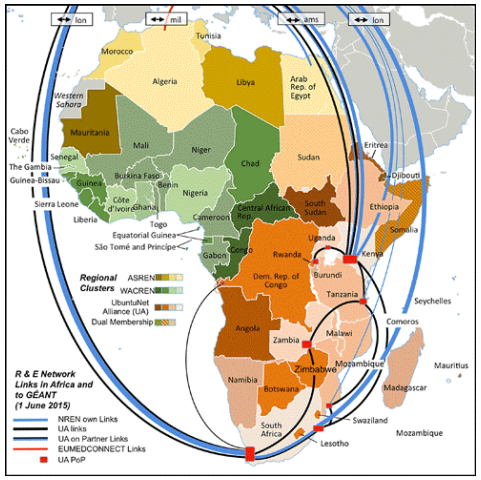
AARNet (Australia)

INTERNATIONAL NETWORK CONSORTIUM: EXAMPLES AND TOPOLOGIES

Asi@Connect / TEIN (Trans-Eurasia Information Network)

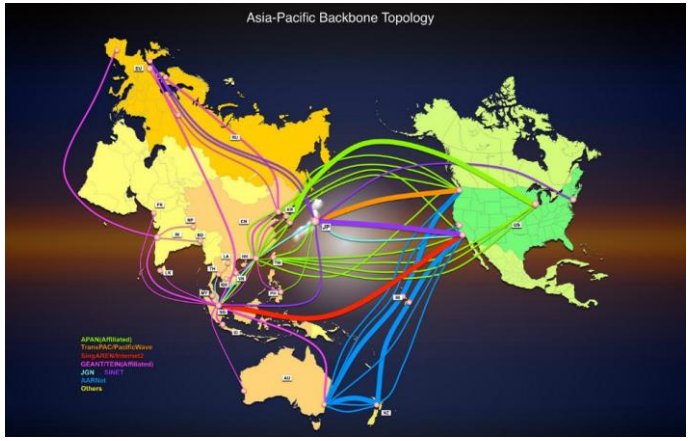


AfricaConnect

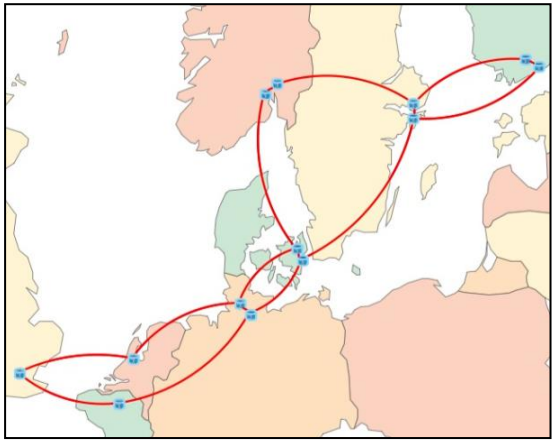


AMPATH (AMerica's PATH)

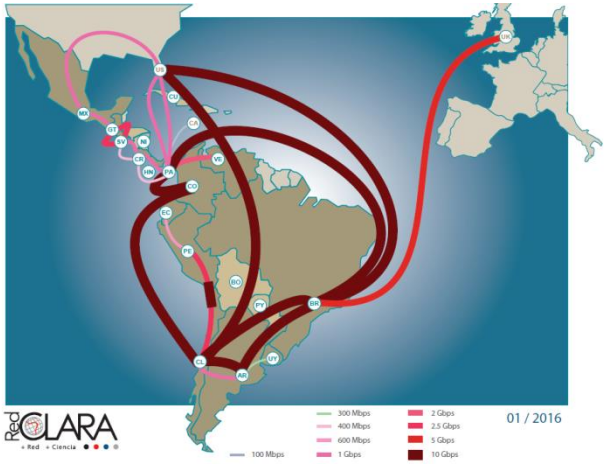
APAN (Asia-Pacific Advanced Network)



NORDUnet



RedCLARA

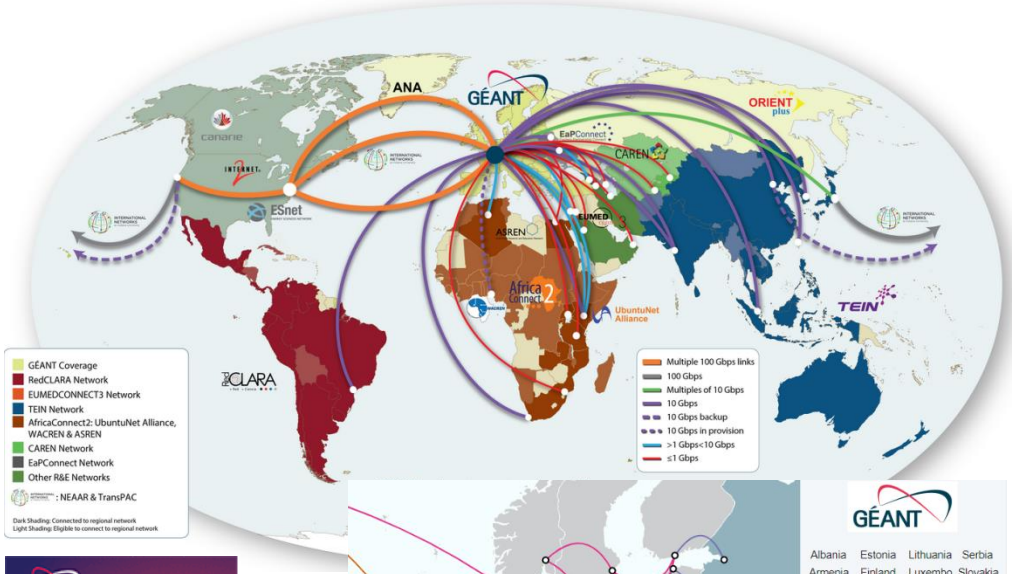


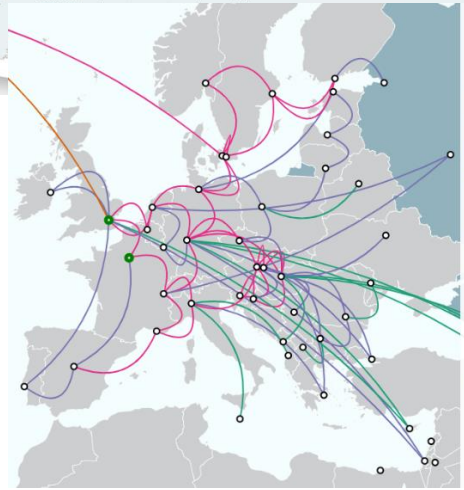
GÉANT: PAN-EUROPEAN R&E NETWORK CONSORTIA

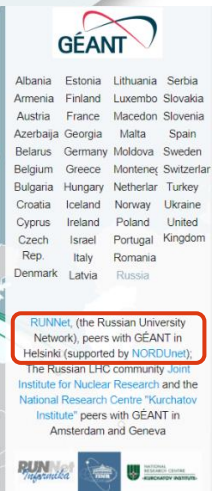
GÉANT is aimed at implementing the paradigm of "open science" through the integrated support of European and world research communities, stimulation and provision of network services and technologies in order to enhance cooperation opportunities in R&E, R&D and other fields

GÉANT: SHORTLY ABOUT THE SIGNIFICANT

- network connectivity of **> 10 thousand** educational and scientific organizations from 40 countries of Europe
- **> 50 mln.** of network end-users
- capacity of the backbone infrastructure - **100 Gbps**
- **100%** average monthly access availability of the backbone infrastructure
- **> 2 Exabytes** of data are transferred per year (global traffic growth - **> 50%** annually)
- high-speed connectivity with NRENs and network consortia по всему миру (Internet2, ESnet, CANARIE, RedCLARA, CERNET...)
- support of regional telecommunications projects (Asi@Connect, AfricaConnect, ASREN, APAN, EaPConnect, CAREN, RedCLARA)
- usage of up-to-date **network technologies and protocols** (DWDM, OTN, GMPLS,...)
- developing and support of perspective **services for R&E community**
- massive **investments in R&D** of new network architectures, technologies and paradigms

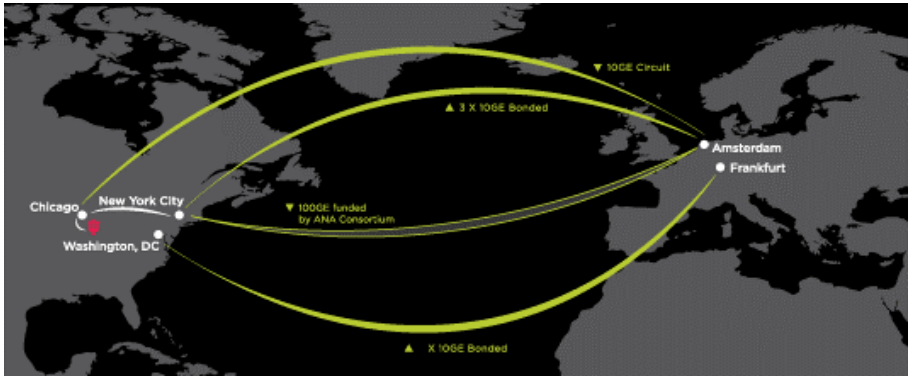




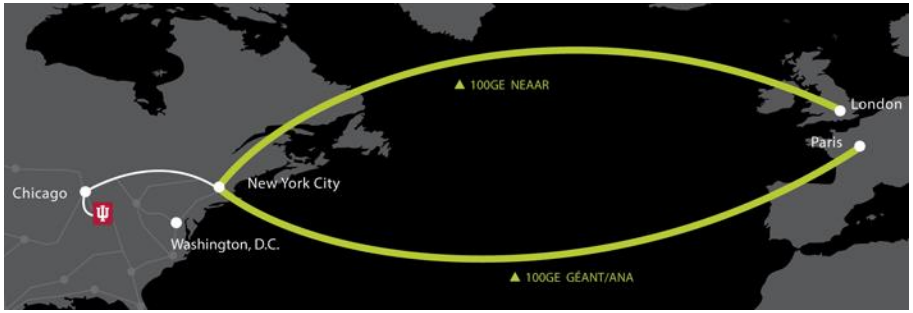


TRANSCONTINENTAL TELECOMMUNICATION CONNECTIVITY FOR THE NEEDS OF GLOBAL R&E COMMUNITY

ACE (America Connects to Europe)

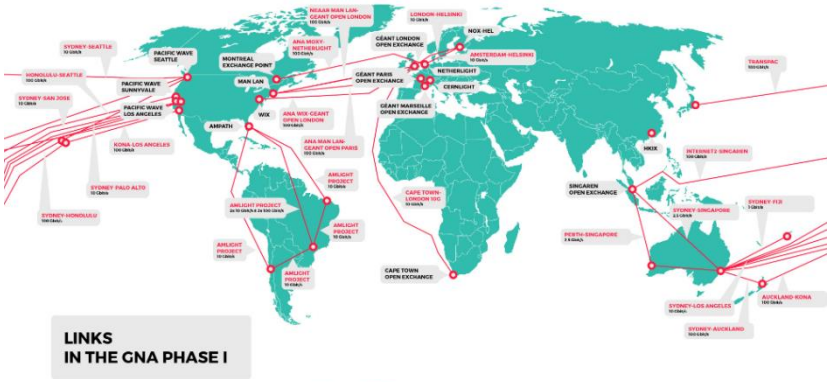


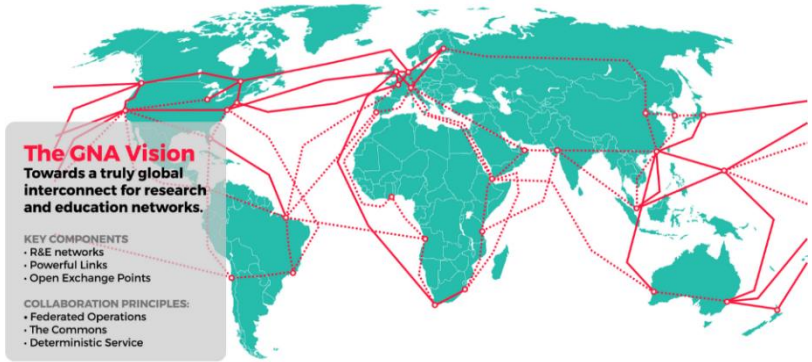
NEAAR (Networks for European, American, and African Research)



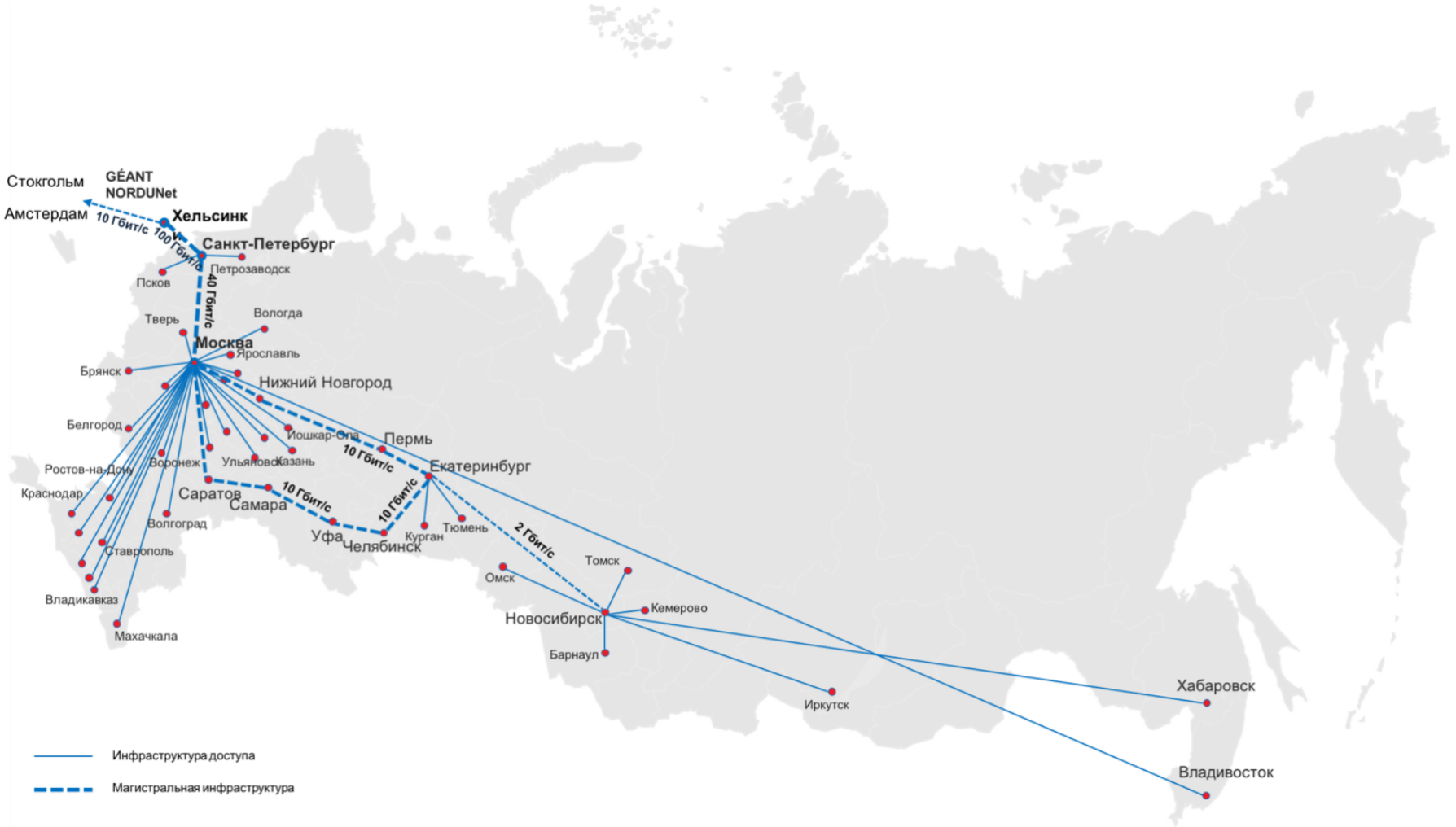
TransPAC

GNA (Global Network Architecture)

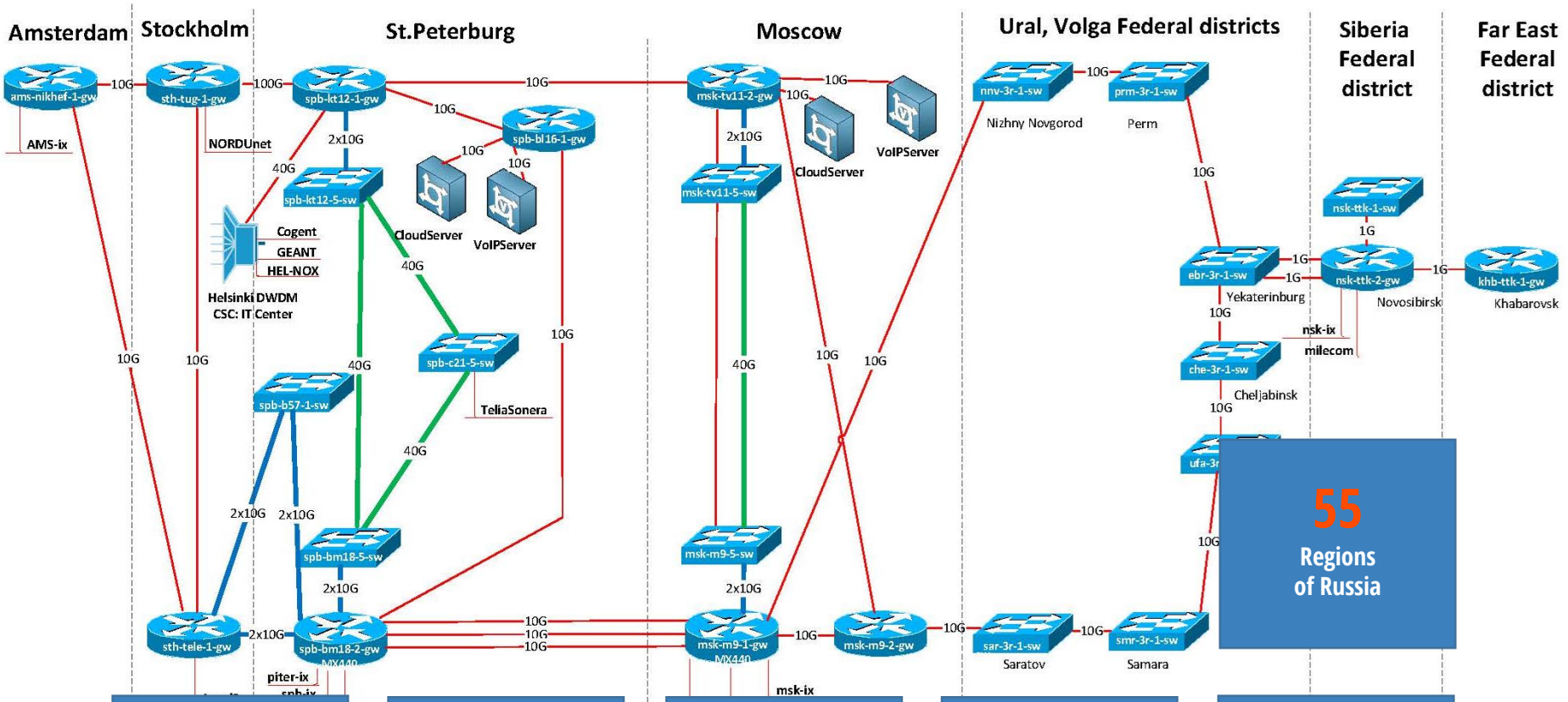




RUNNet (Russian UNiversity Network): SCHEME OF THE BACKBONE NETWORK INFRASTRUCTURE



RUNNet: HIGH-LEVEL DESIGN NETWORK ARCHITECTURE AND KEY CHARACTERISTICS



55
Regions of Russia

3
Higher-level Tier1 operators (30 Gbps in total)

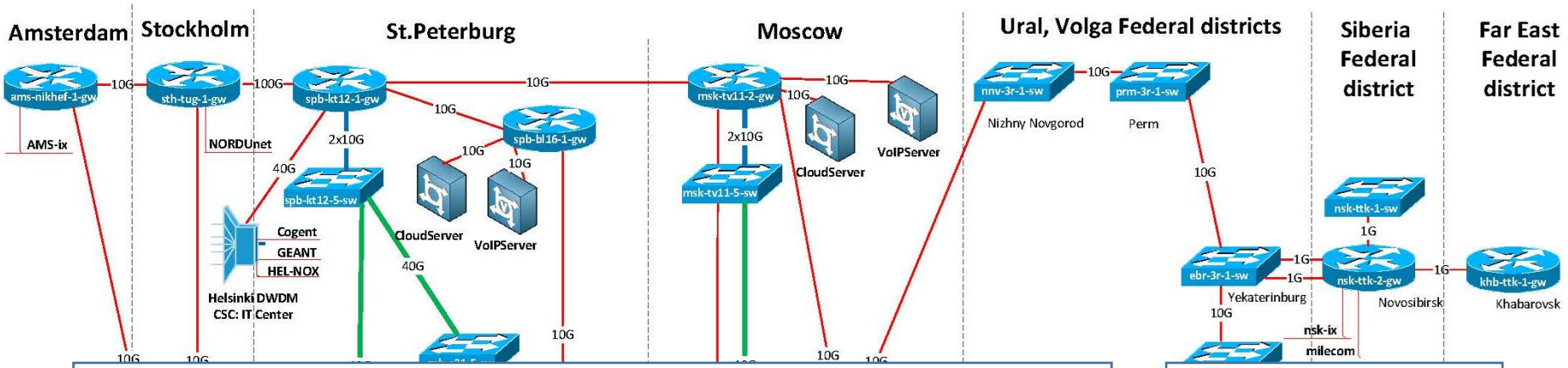
28
Direct peering connections (175 Gbps in total)

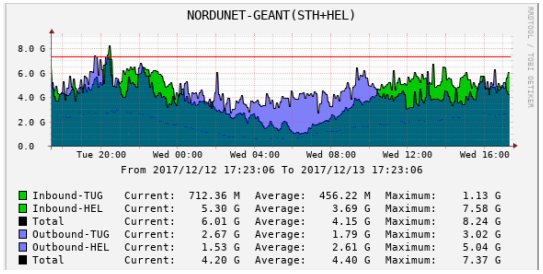
6
IX nodes (41 Gbps in total)

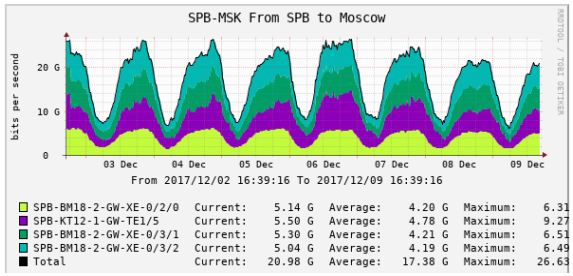
228
Petabytes of data are processed annually

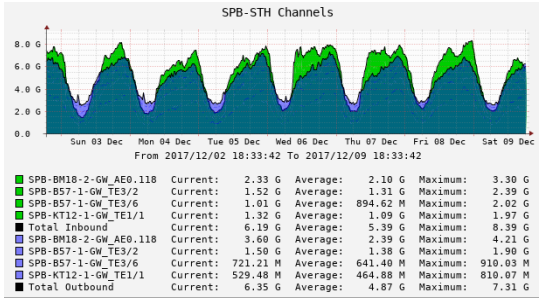
93
Telecommunications nodes in Russia and in Europe

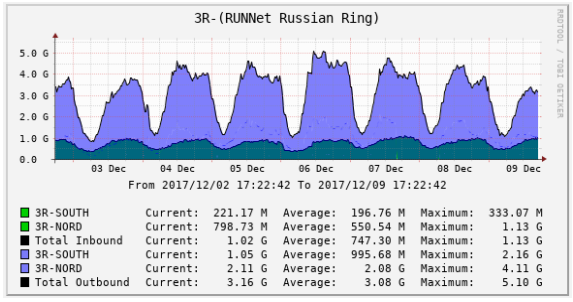
RUNNet: HIGH-LEVEL DESIGN NETWORK ARCHITECTURE AND KEY CHARACTERISTICS











BGP

IPv4 IPv6

3100

ANNOUNCED NETWORK PREFIXES

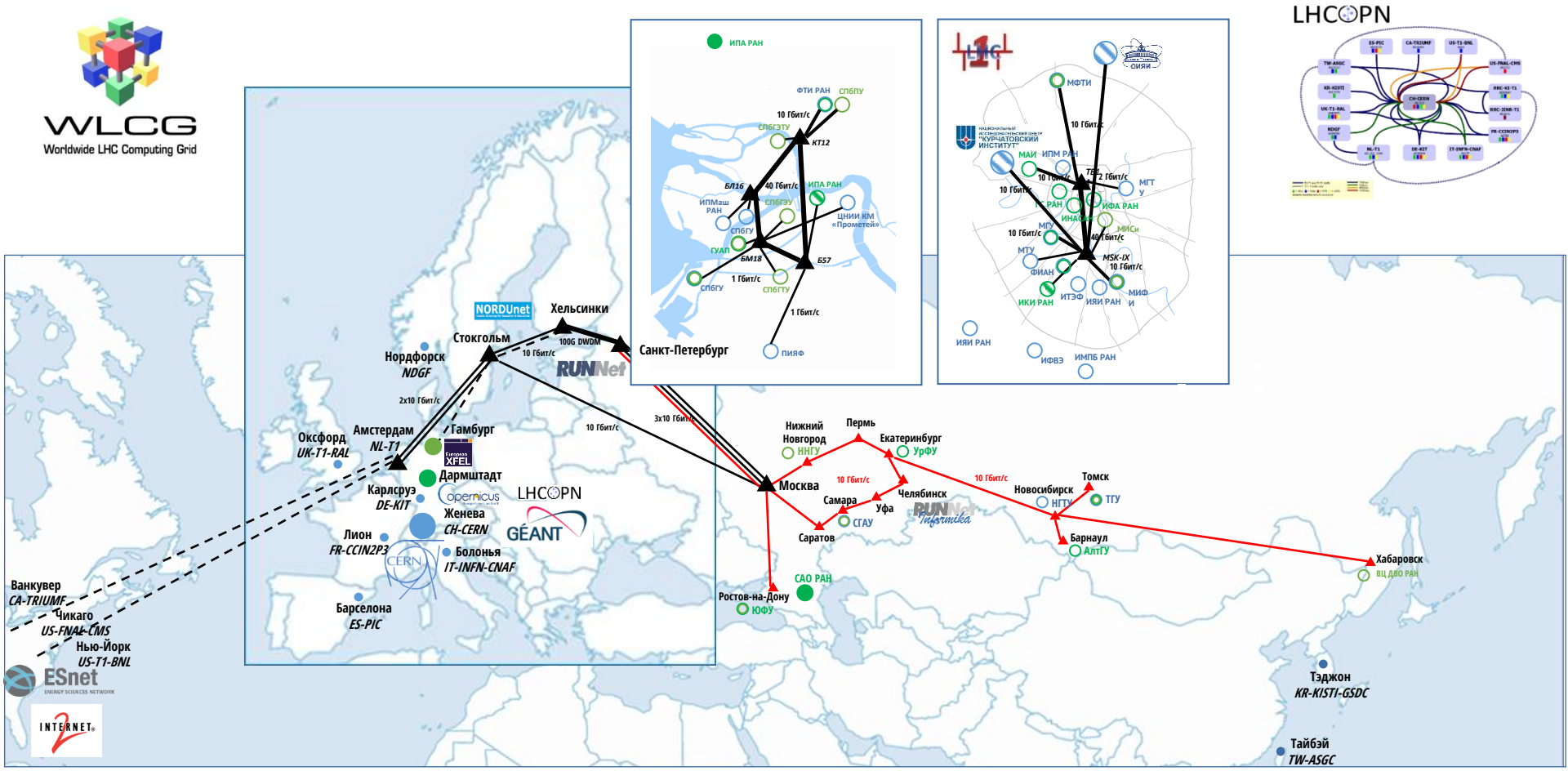
#10

RUSSIA AS RANKING

#68

WORLD AS RANKING

INTERNATIONAL RESEARCH COLLABORATIONS IN THE FIELDS OF HIGH ENERGY PHYSICS AND ASTROPHYSICS

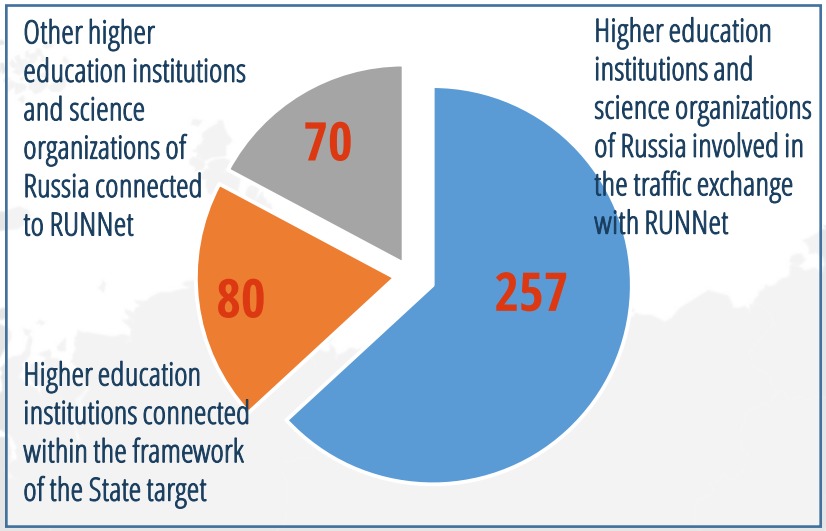


УСЛОВНЫЕ ОБОЗНАЧЕНИЯ

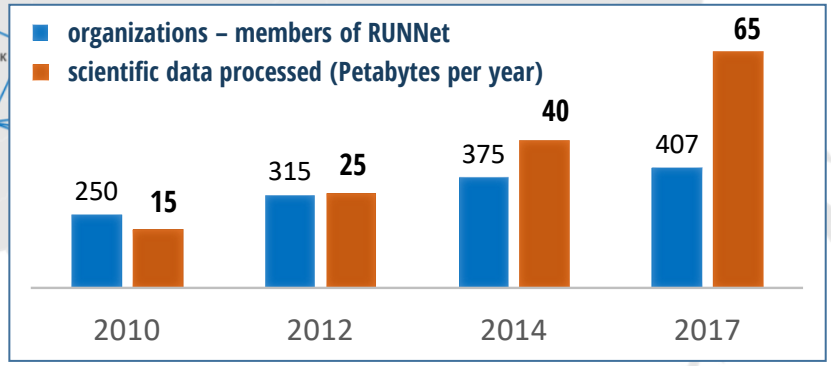
- проекты на базе Большого адронного коллайдера (LHC)
- проект «EUROPIAN XFEL»
- проекты в области астрофизики

- сетевая инфраструктура в рамках согласованного финансирования
- сетевая инфраструктура в рамках запрошенного финансирования
- сетевая инфраструктура в рамках плановых мероприятий развития

RUNNet: TARGET USERS AND DATA PROCESSING

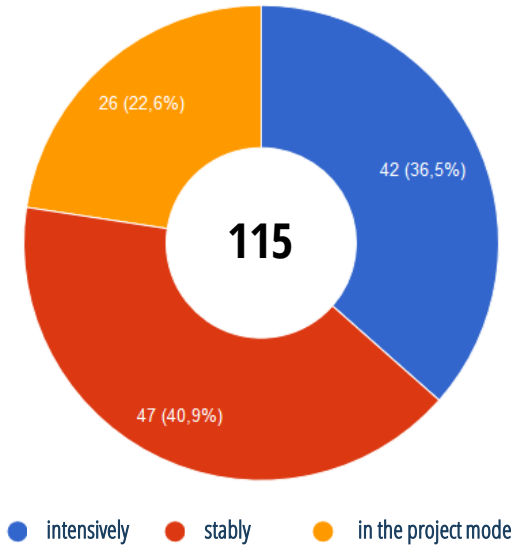


>3 mln. of end-users:
students, teachers, scientists, researchers

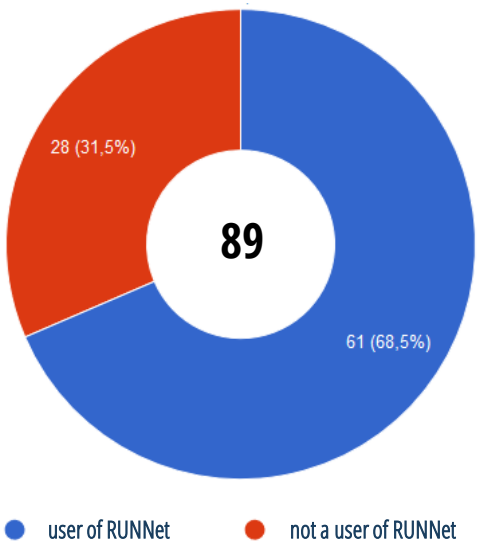


RUNNet: THE ANALYSIS OF THE RELEVANCE OF TELECOMMUNICATION INFRASTRUCTURE AND SERVICES

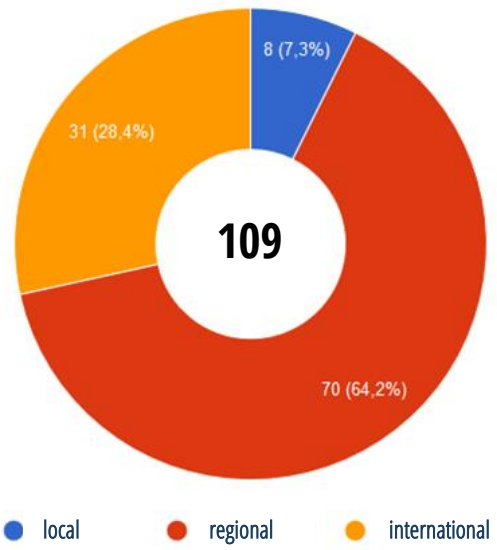
Usage of telecommunication means



Participants of scientific projects: status of connectivity with RUNNet



Classification of scientific projects



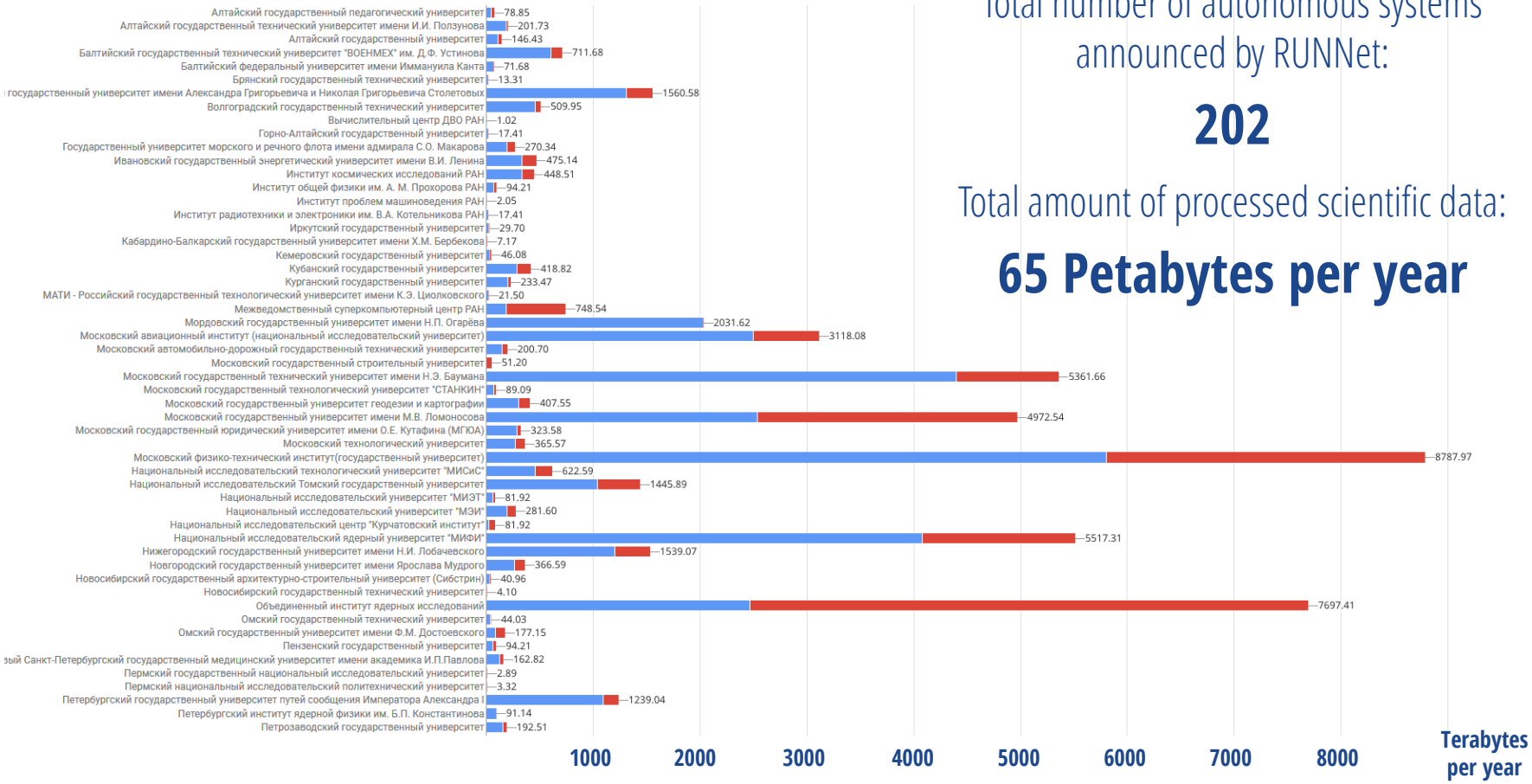
THE FOLLOWING FACTORS WERE TAKEN INTO ACCOUNT IN THE ANALYSIS:

- traffic volume of transmitted and received data with the separation of traffic of public IP-network
- statistics on the utilization of data transmission channels based on regular monitoring of the backbone routers using the special software
- data exchange with substantive autonomous systems (AS), determined on the basis of BGP-connectivity

RUNNet: AMOUNTS OF SCIENTIFIC DATA PROCESSED ON THE BACKBONE

inbound traffic
outbound traffic

Data on the diagram are given for the target users of RUNNet (educational and scientific organizations)



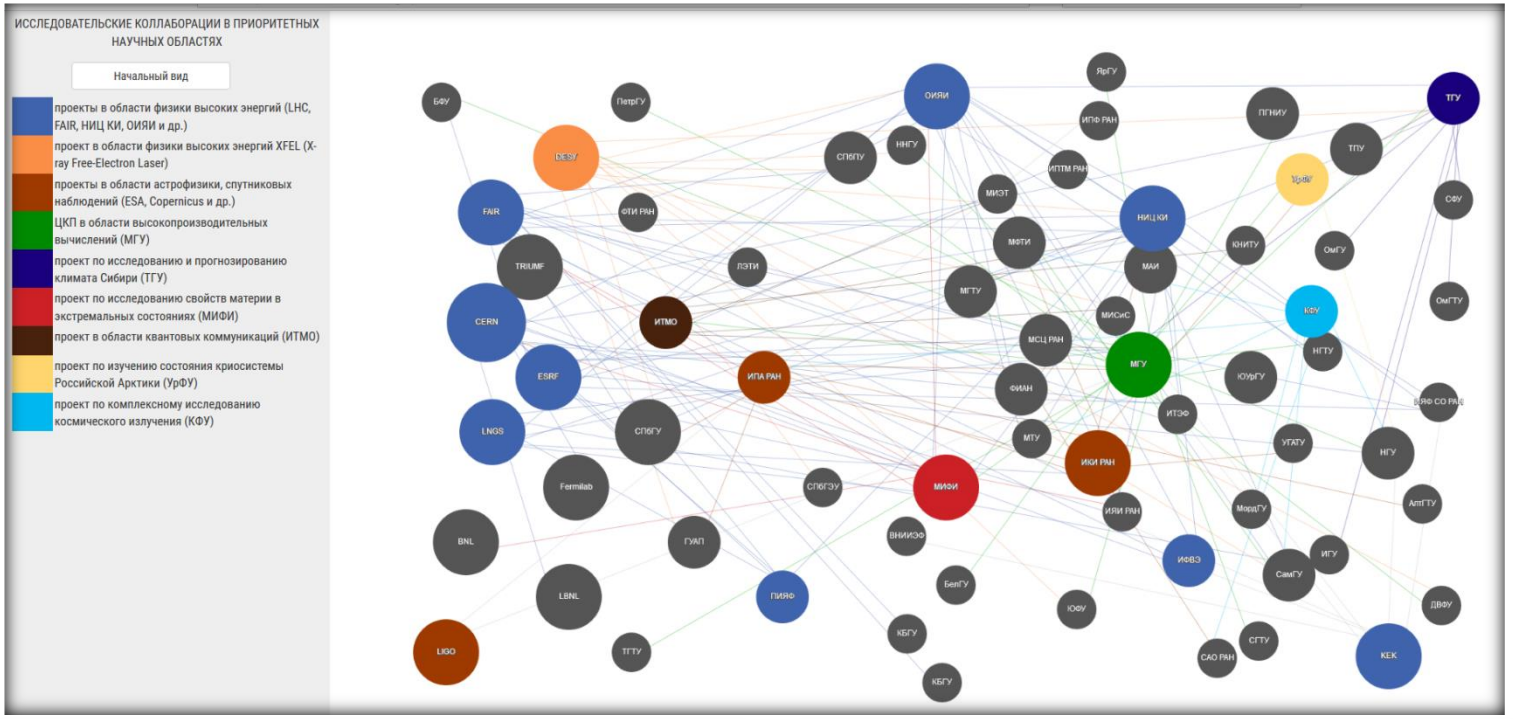
Total number of autonomous systems announced by RUNNet:

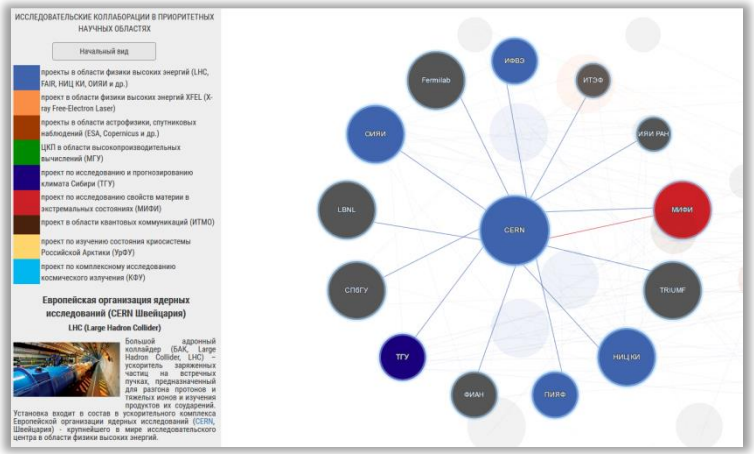
202

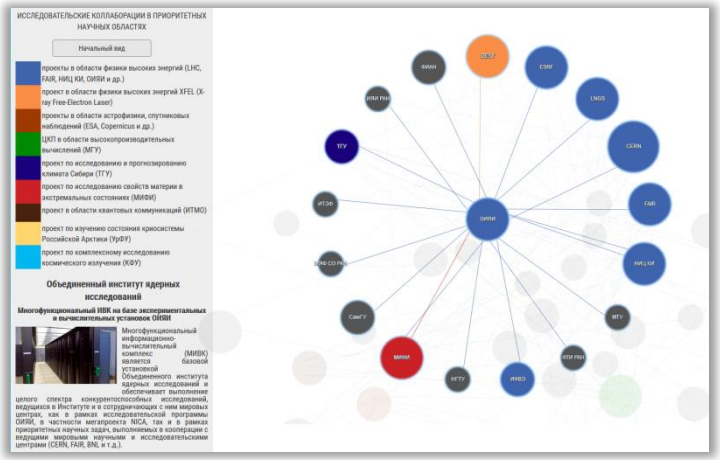
Total amount of processed scientific data:

65 Petabytes per year

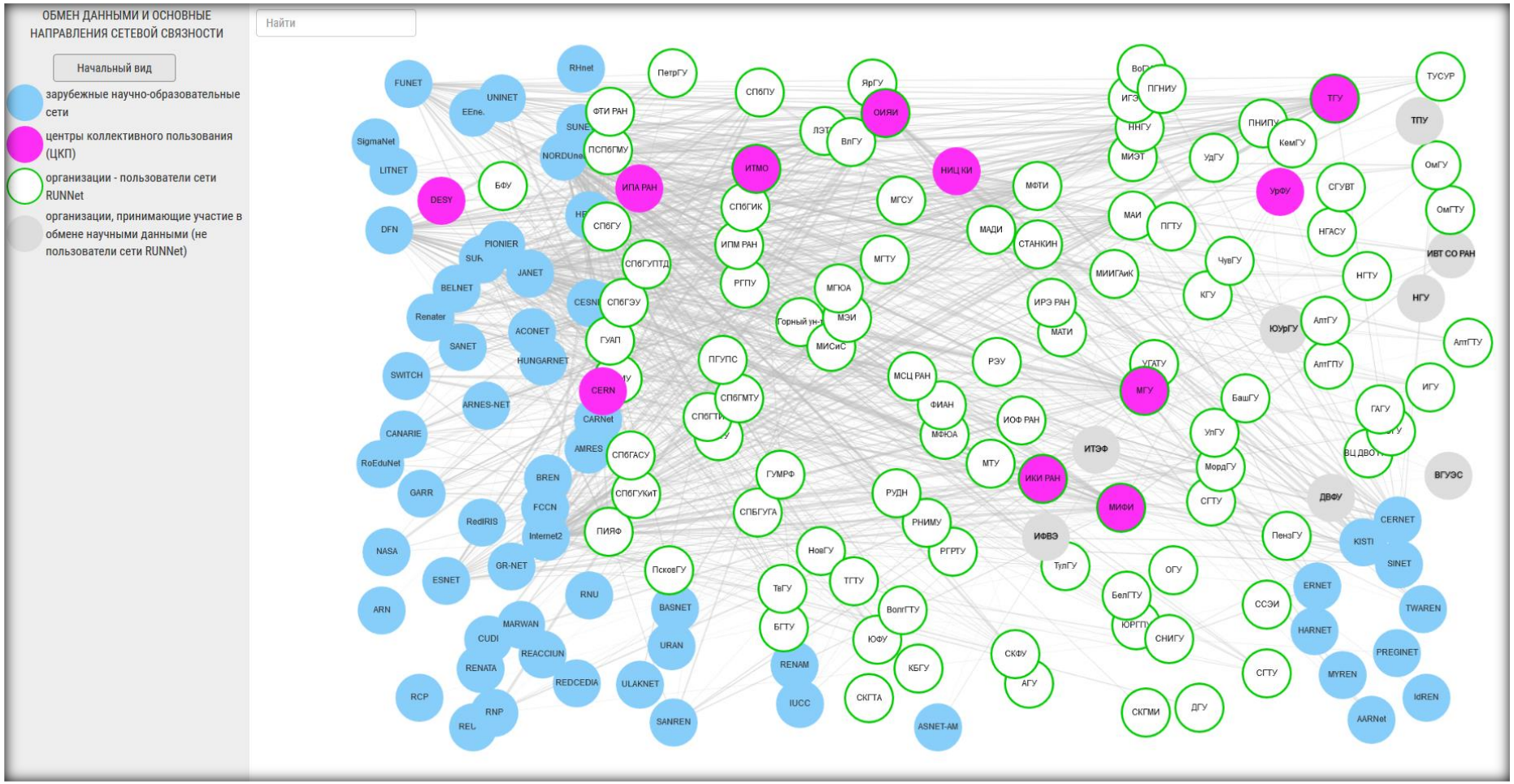
INTERACTIVE MAP OF SUSTAINABLE RESEARCH COLLABORATIONS IN PRIORITY SCIENTIFIC AREAS WITH THE PARTICIPATION OF ORGANIZATIONS FROM RUSSIA





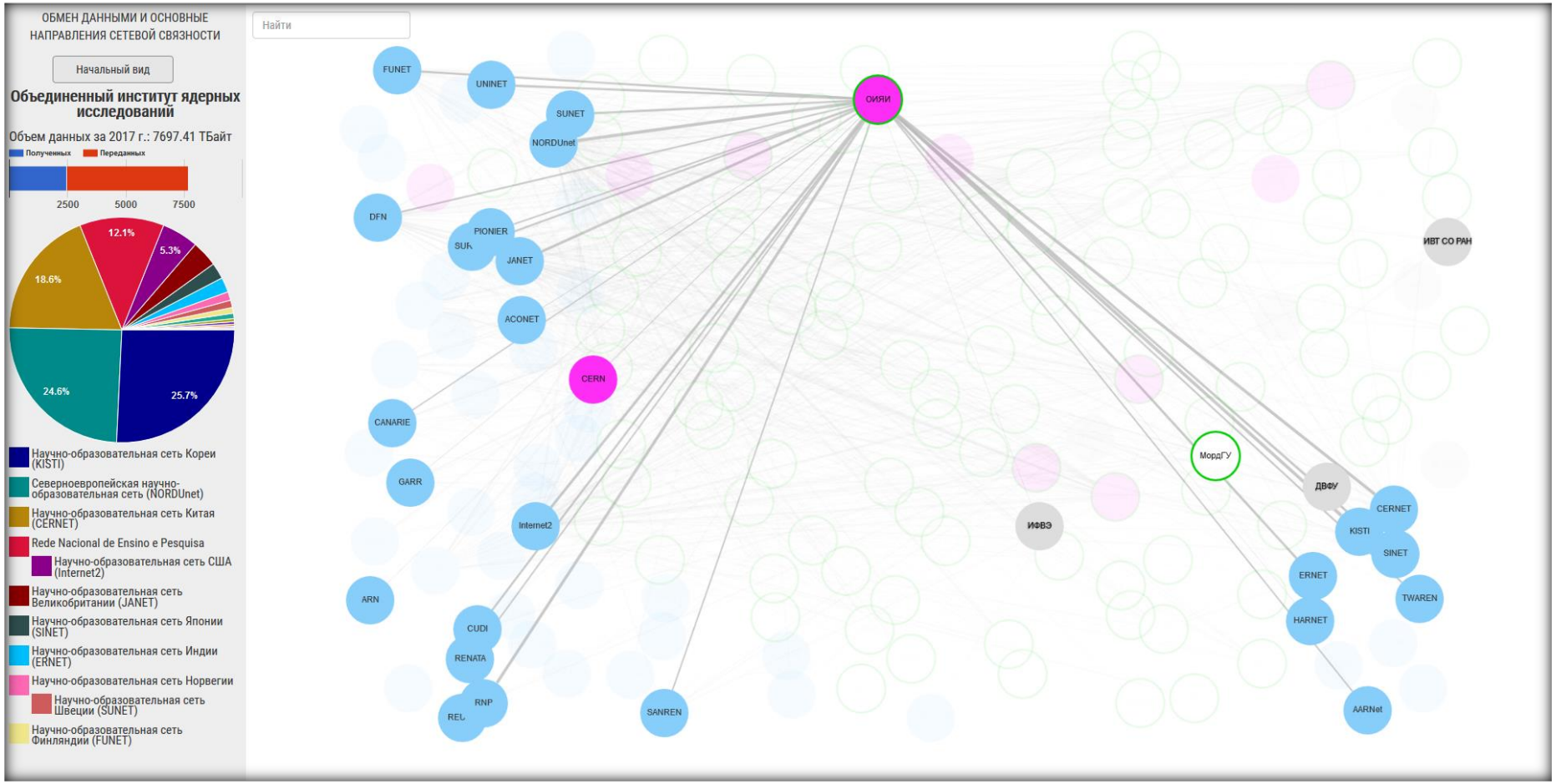


VISUALIZATION OF THE DATA EXCHANGE AND MAIN DIRECTIONS OF NETWORK CONNECTIVITY OF RUNNET USERS (GENERAL VIEW)

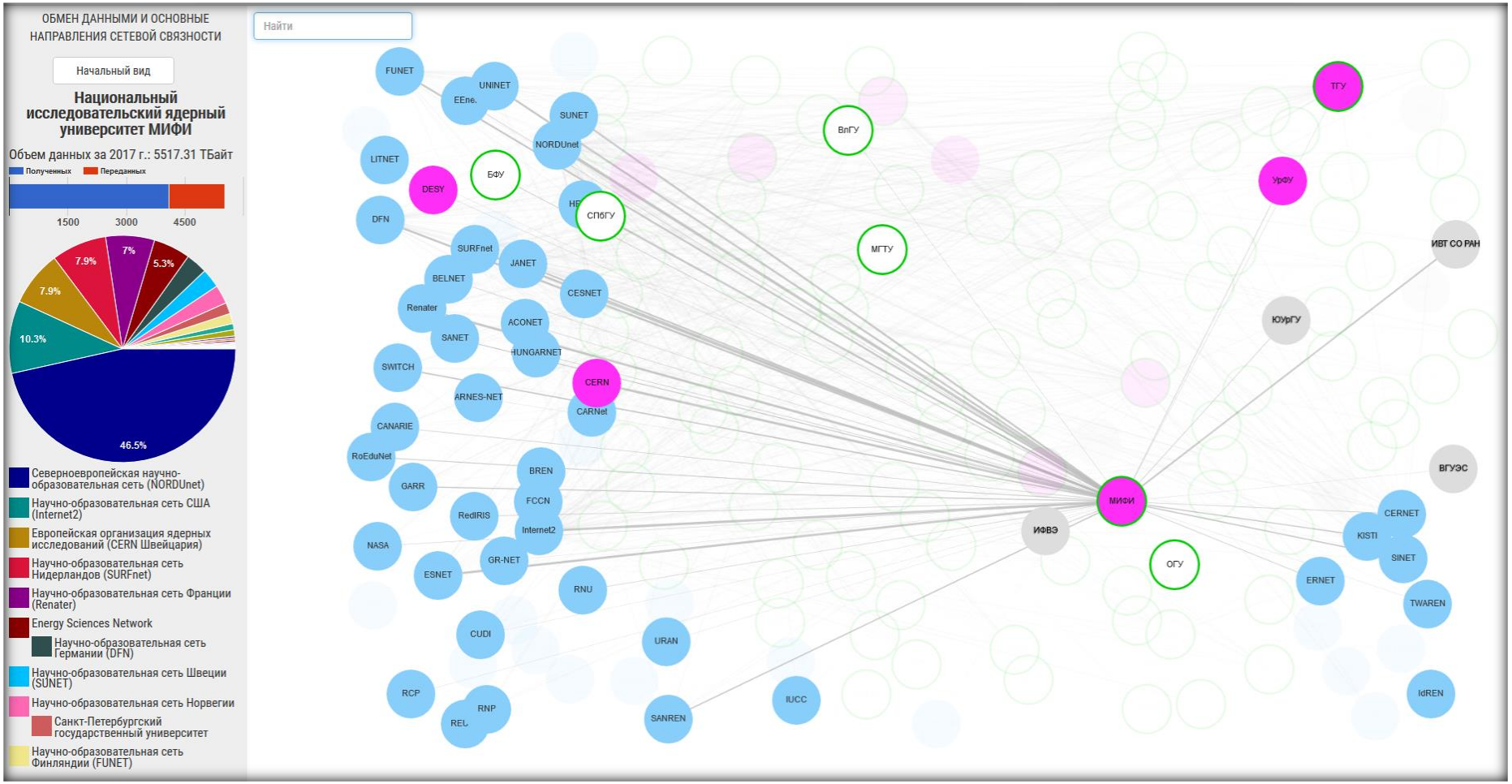


https://www.runnet.ru/science-traffic/

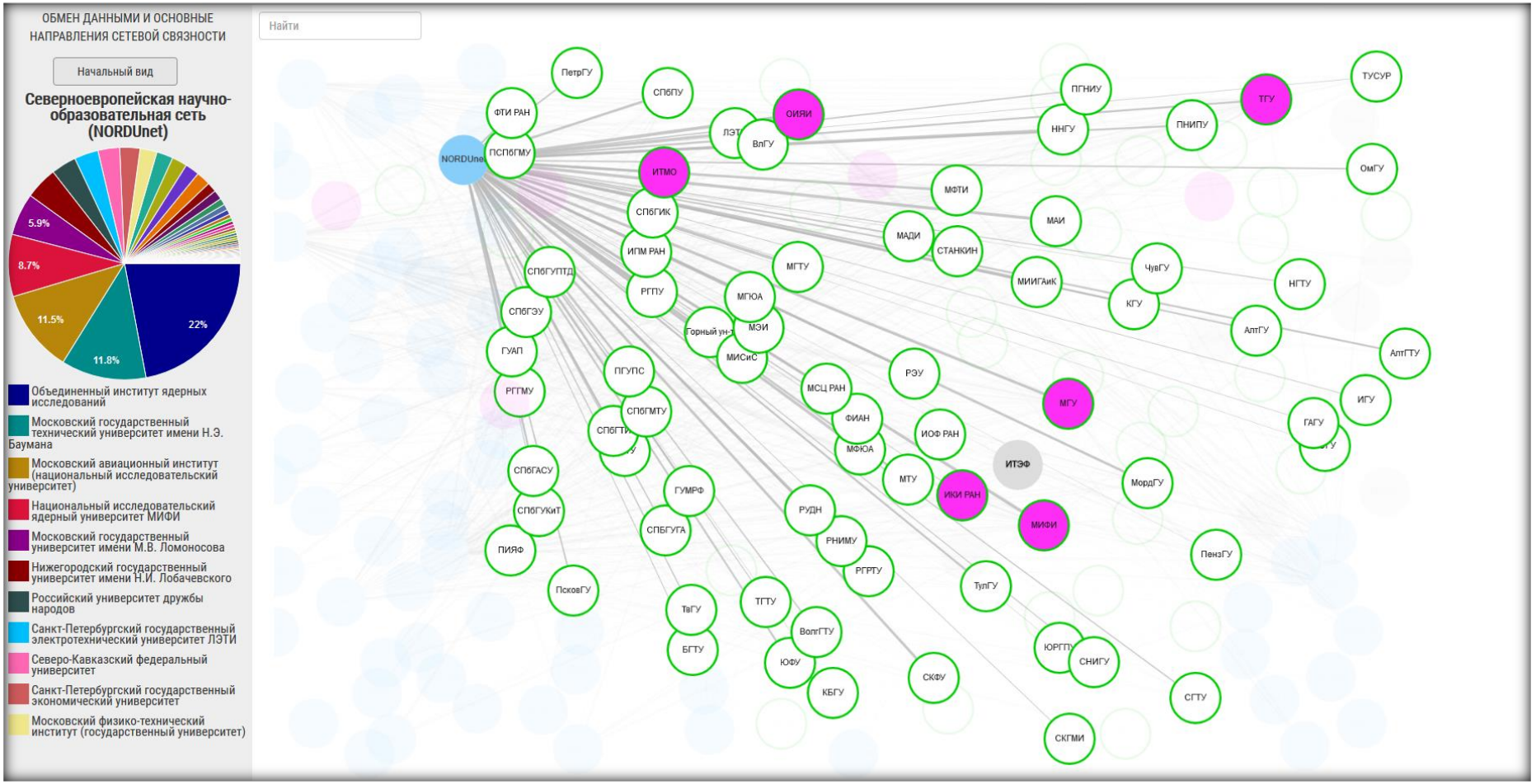
VISUALIZATION OF THE DATA EXCHANGE AND MAIN DIRECTIONS OF NETWORK CONNECTIVITY OF RUNNET USERS: JINR



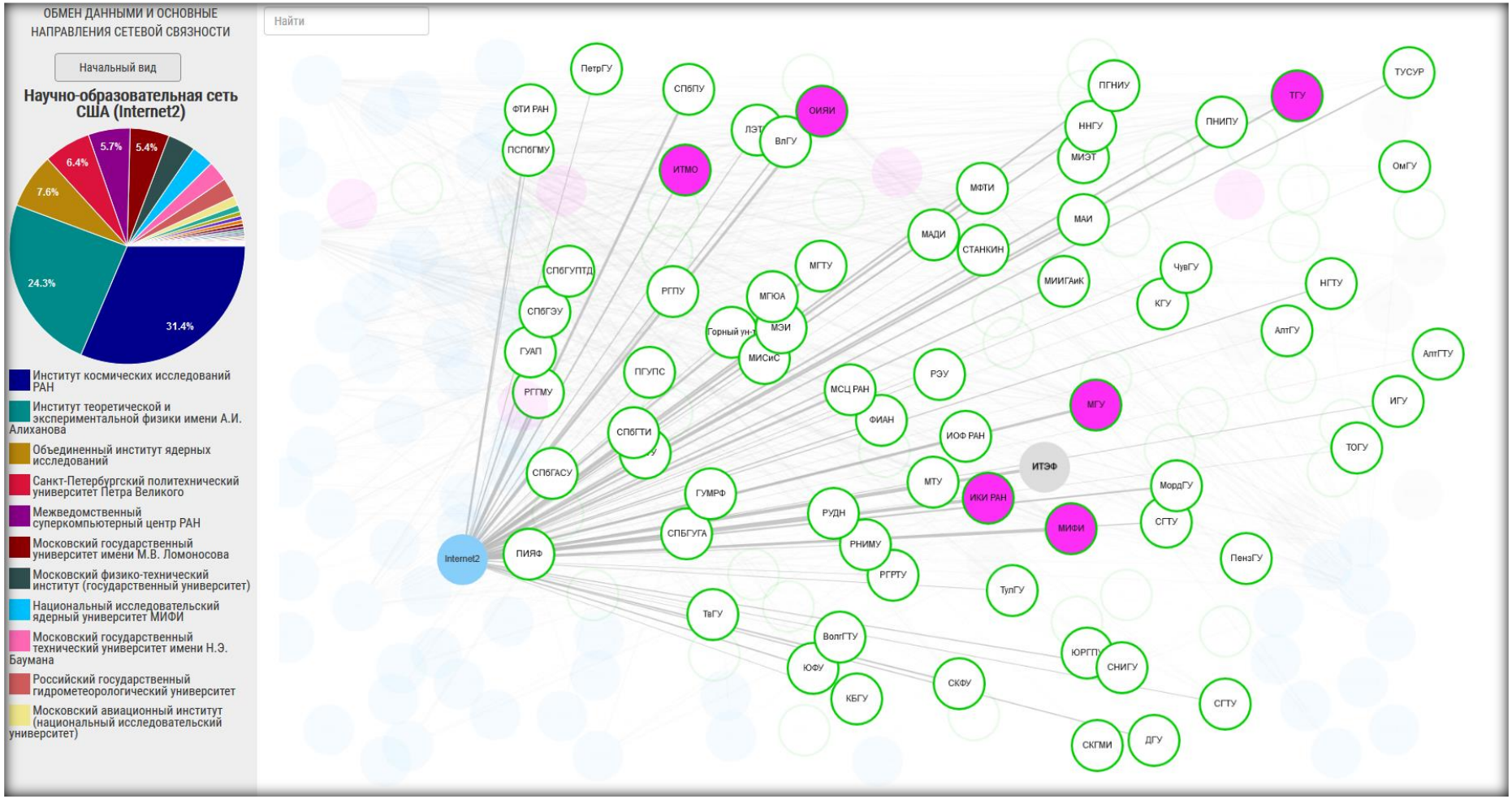
VISUALIZATION OF THE DATA EXCHANGE AND MAIN DIRECTIONS OF NETWORK CONNECTIVITY OF RUNNET USERS: MEPhI



VISUALIZATION OF THE DATA EXCHANGE AND MAIN DIRECTIONS OF NETWORK CONNECTIVITY OF RUNNET USERS: NORDUnet



VISUALIZATION OF THE DATA EXCHANGE AND MAIN DIRECTIONS OF NETWORK CONNECTIVITY OF RUNNET USERS: Internet2



DEVELOPMENT OF THE SERVICE PLATFORM ON THE BASE OF THE RUNNet NETWORK

Connectivity & network management services	Cloud services	Trust, identity & security services	Real-time communications services
IP Transit	Storage	Network roaming	Videoconferencing
Band weight on-demand	Virtualization	Federated Authentication	Streaming broadcasts
SDN	Data exchange	Certification	Webinars
VPN	Work in collaboration	DDoS protection	CDN
Testbeds		Traffic filtration	VoIP
eduIX			

Professional services

Consulting, user support, project management

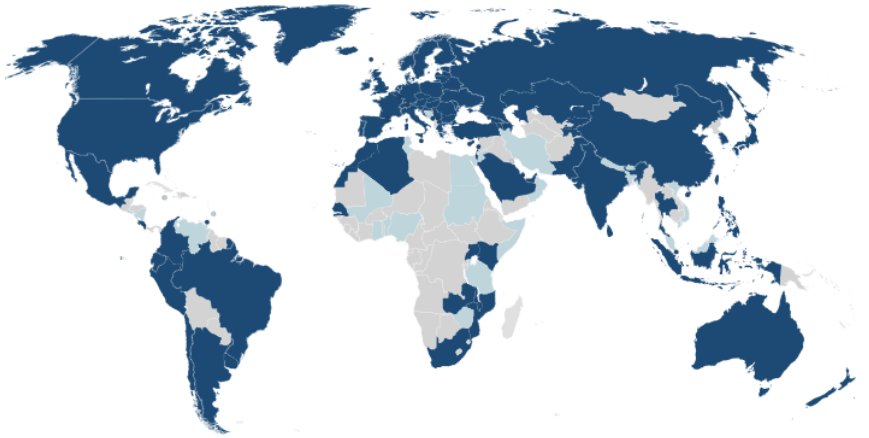
ownCloud INOVENTICA SERVICES openstack BigBlueButton AARC ONLYOFFICE FILESENDER eduCONF PART OF THE GÉANT SERVICES PORTFOLIO eduVPN

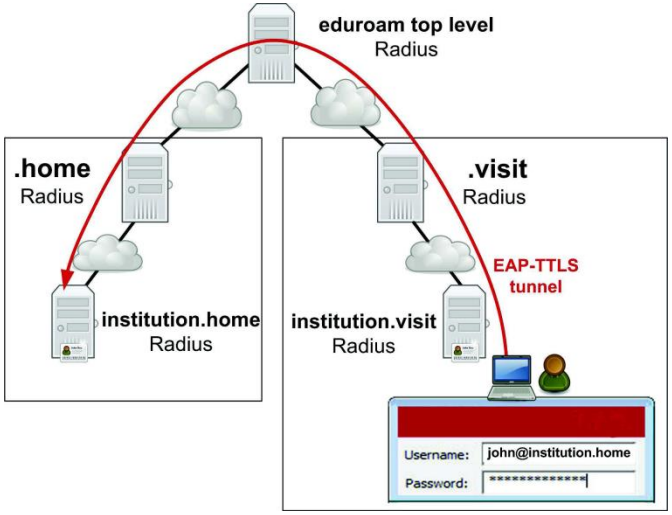
eduroam: SEAMLESS WI-FI ACCESS FOR R&E COMMUNITY AROUND THE WORLD

eduroam (EDUcation ROAMing) - secure, world-wide roaming access service developed for the international R&E community; the service allows students, researchers and staff to seamlessly access Internet connectivity when within range of a hotspot, whether they're moving across campus or visiting other participating institutions

KEY FACTS ABOUT THE SERVICE

- roaming broadband in **89 countries** around the world
- **> 15 000 R&E organizations** only in Europe
- free access at **thousands of locations**, with **one login and password** given to the user by his "home" organization
- secure and privacy-preserving technology
- service is based on 802.1X* and a linked hierarchy of **RADIUS servers** containing users' data (logins and passwords)





CURRENT STATUS OF THE PROJECT IN RUNNET

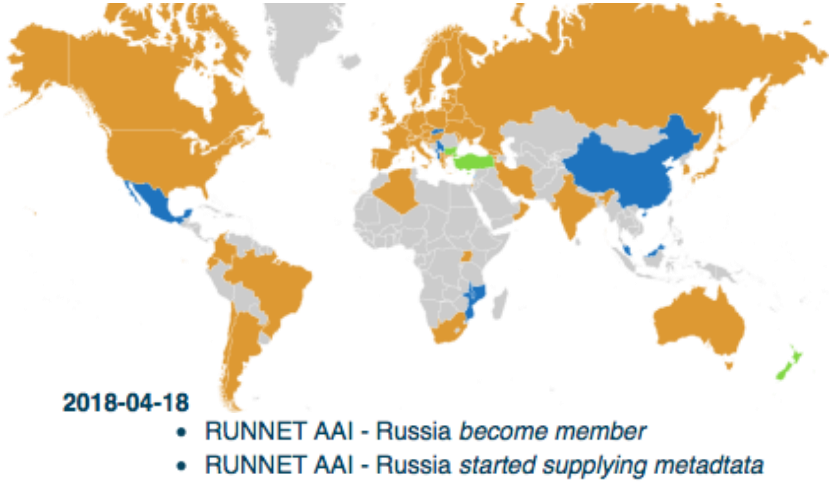
- realization and support the functioning of the integrated AAI infrastructure on the basis of RUNNet and RASNet networks with the organization of reservation of key infrastructure elements
- connection of the first higher education institutions of Russia to the project
- deployment of pilot roaming zones in scientific and educational organizations of the country
- approbation of solutions for the collection and visualization of service statistics

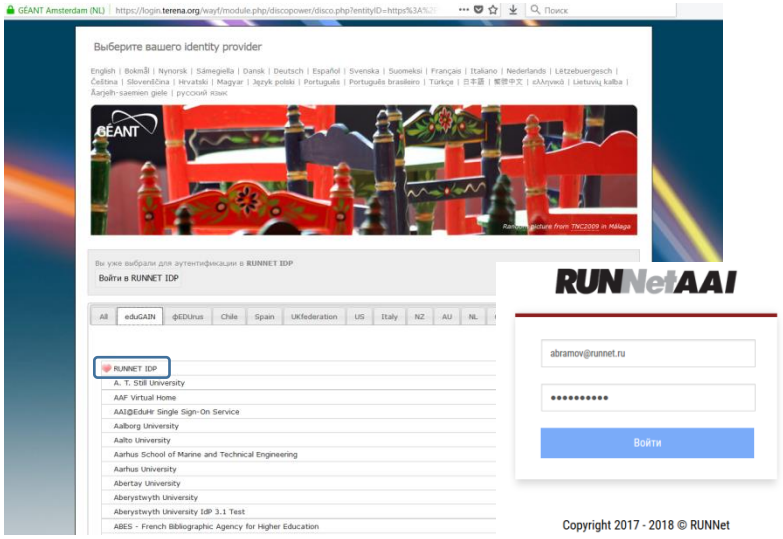
eduGAIN: INTERCONNECTION OF R&E IDENTITY FEDERATIONS AROUND THE WORLD

eduGAIN (EDUcation Global Authentication Infrastructure) – interconnection of R&E identity federations around the world, the project enables the trustworthy exchange of information between service providers and R&E institutions or other identity providers; this means simpler access to a wider range of online content, services and other resources that benefit collaboration in the R&E community

KEY FACTS ABOUT THE PROJECT

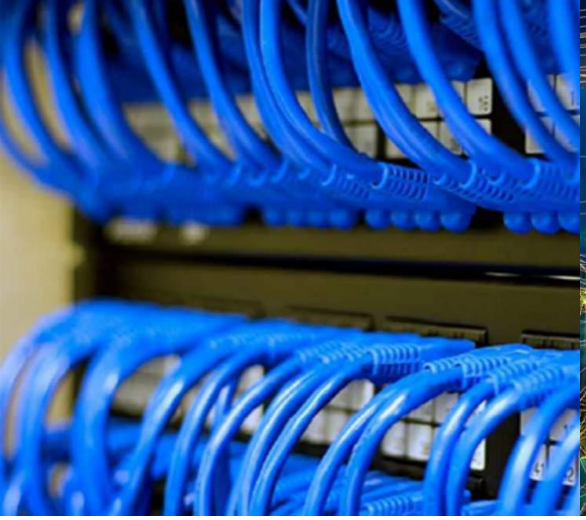
- > 55 participant federations around the world
- > 2 150 service provider nodes (SP), > 2 800 nodes of identity provider (IdP)
- provides access to all the online services that students, researchers and educators need while minimising the number of accounts
- gives SP access to a larger pool of users internationally
- allows users to access resources of peer institutions or commercial services using their one trusted identity





CURRENT STATUS OF THE PROJECT IN RUNNET

- creation of a federation management infrastructure on the base of the RUNNet network
- development and approval of organizational-legal and technical regulations of the identity federation of Russia RUNNetAAI
- development detailed instructions on the deployment of AAI services in organizations
- deployment of a demonstration polygon of federated access to corporate cloud services including ownCloud, FileSender, Redmine, et al.



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8th International Conference "Distributed Computing and Grid-technologies in Science and Education" (GRID 2018)
Dubna, Moscow region, Joint Institute for Nuclear Research, 10-14 September 2018

RUNNet