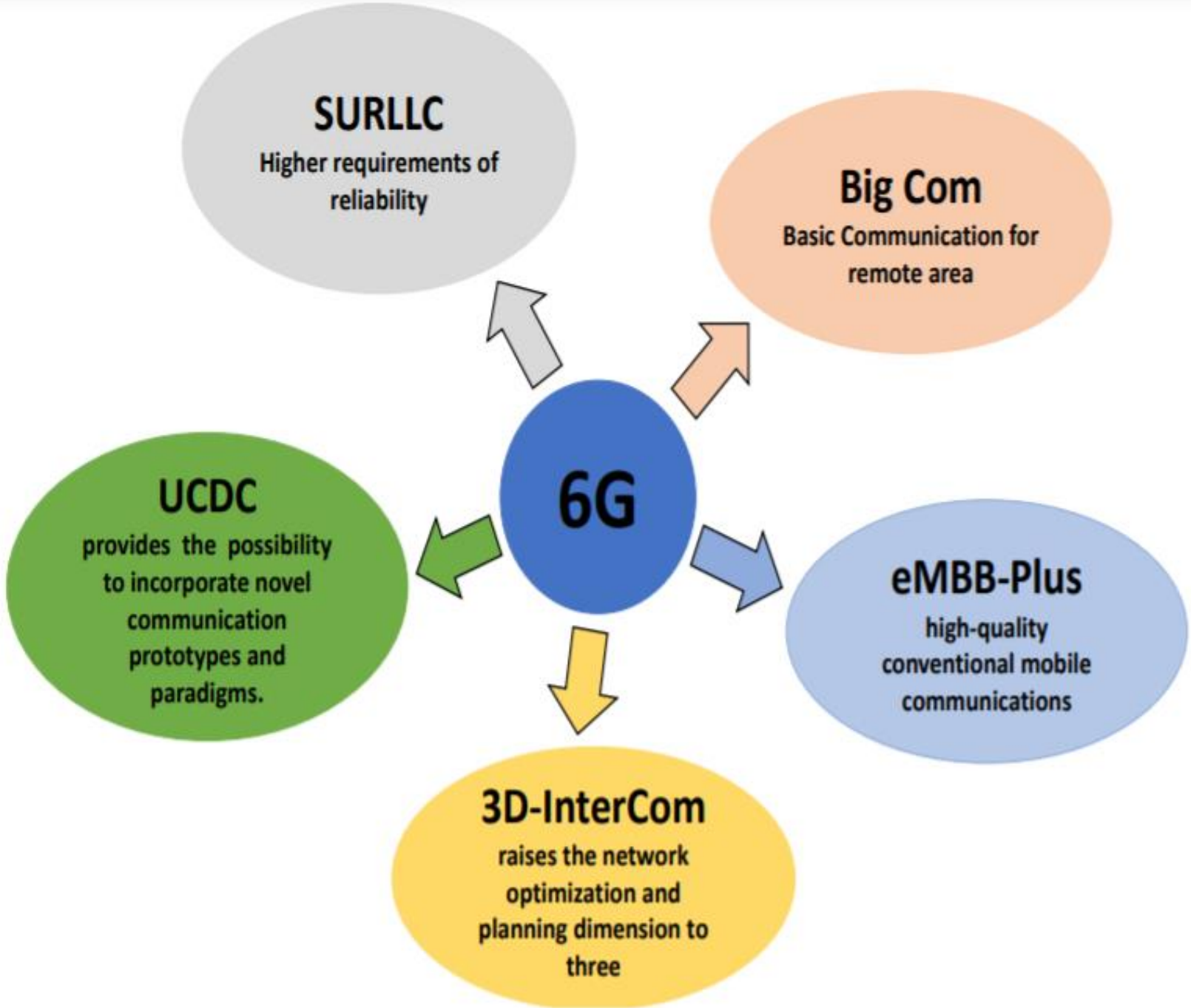
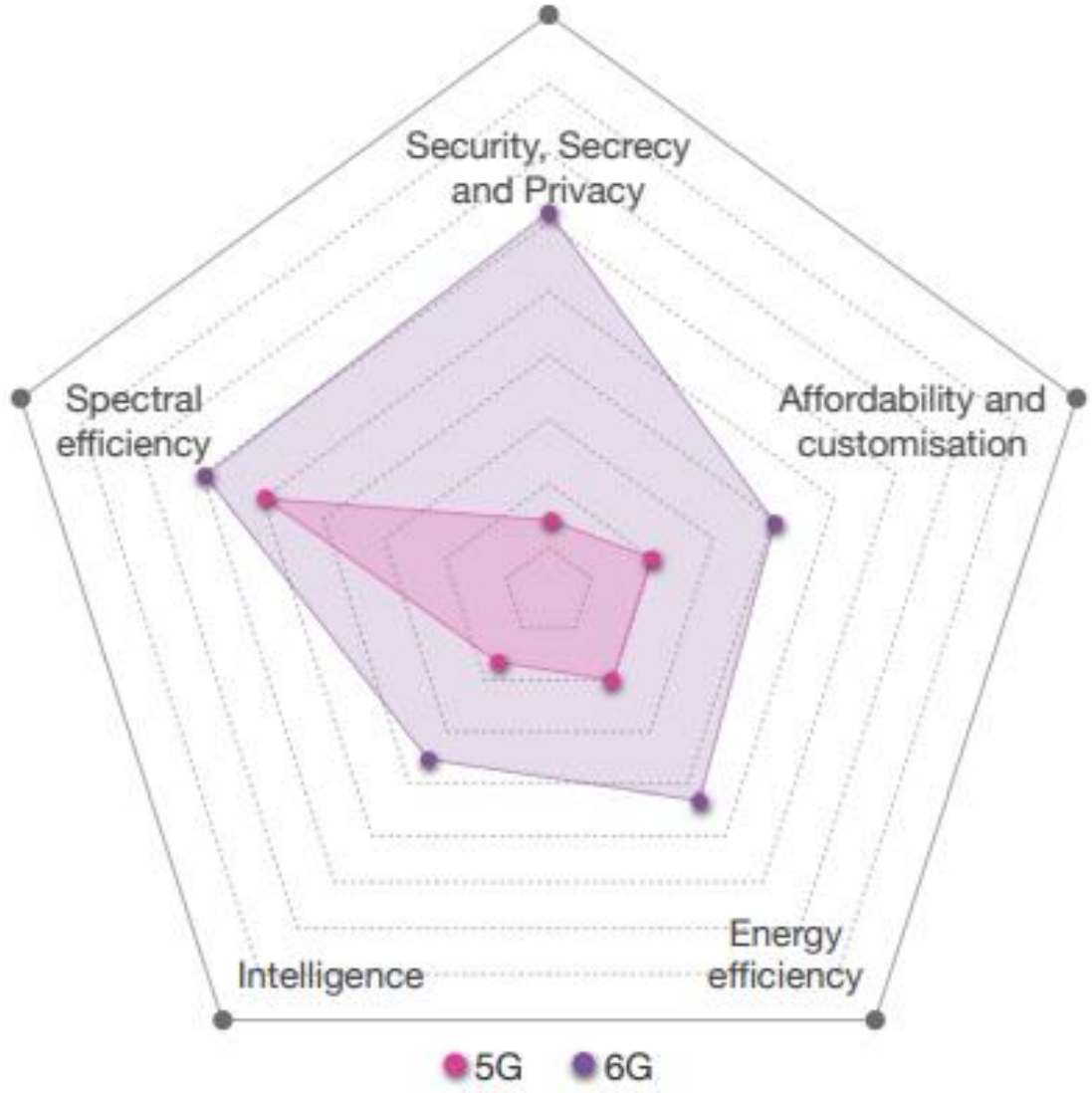
ITU Events

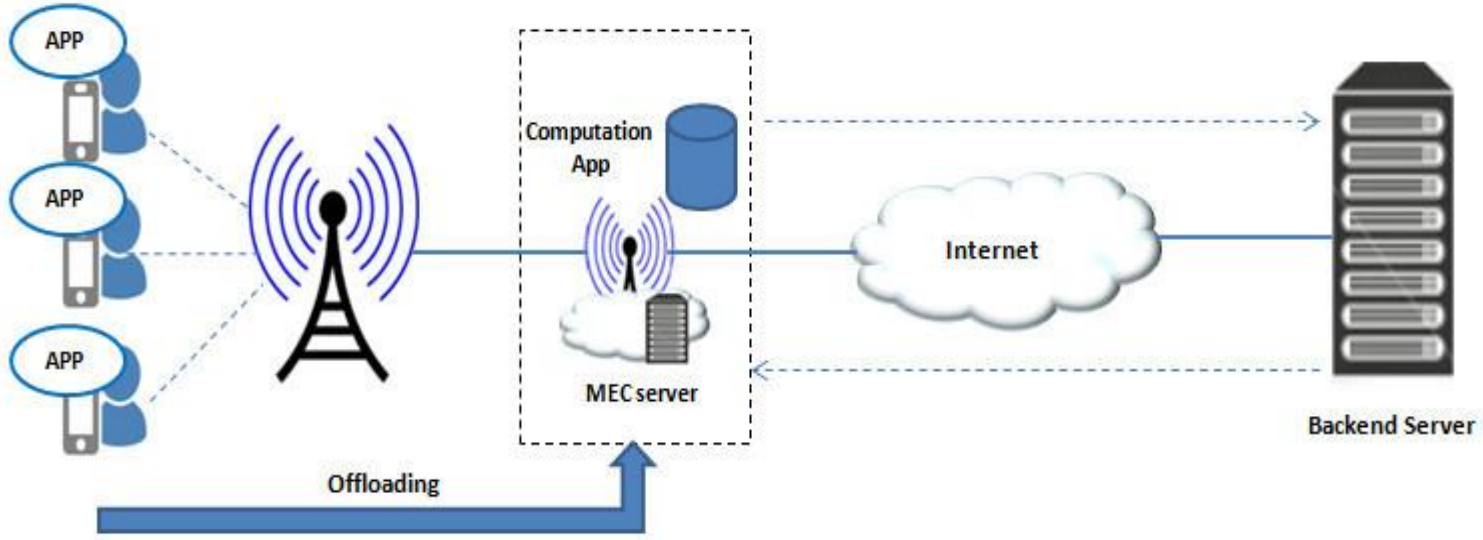
AI for Good
Machine Learning in 5G Challenge

Applying machine learning in communication networks

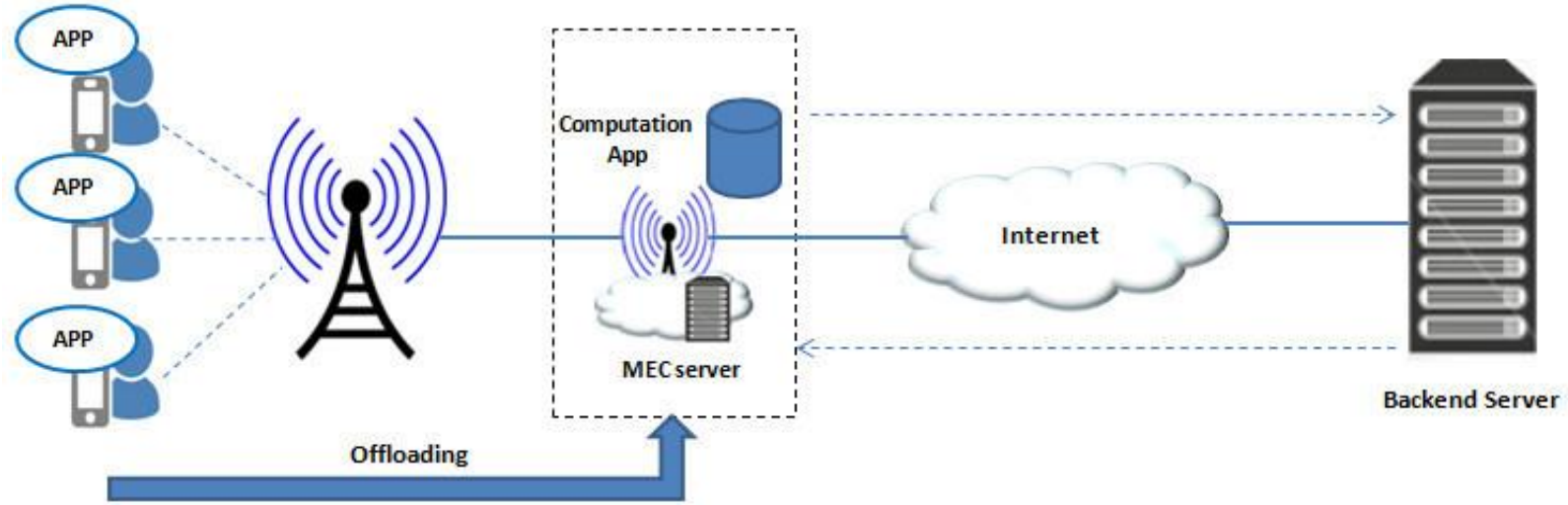
aiforgood.itu.int


SURLLC
Higher requirements of reliability
Big Com
Basic Communication for remote area
6G
UCDC
provides the possibility to incorporate novel communication prototypes and paradigms.
eMBB-Plus
high-quality conventional mobile communications
3D-InterCom
raises the network optimization and planning dimension to three


Security, Secrecy and Privacy
Affordability and customisation
Energy efficiency
Intelligence
Spectral efficiency
5G
6G



Cloud Computing



Mobile Edge Computing

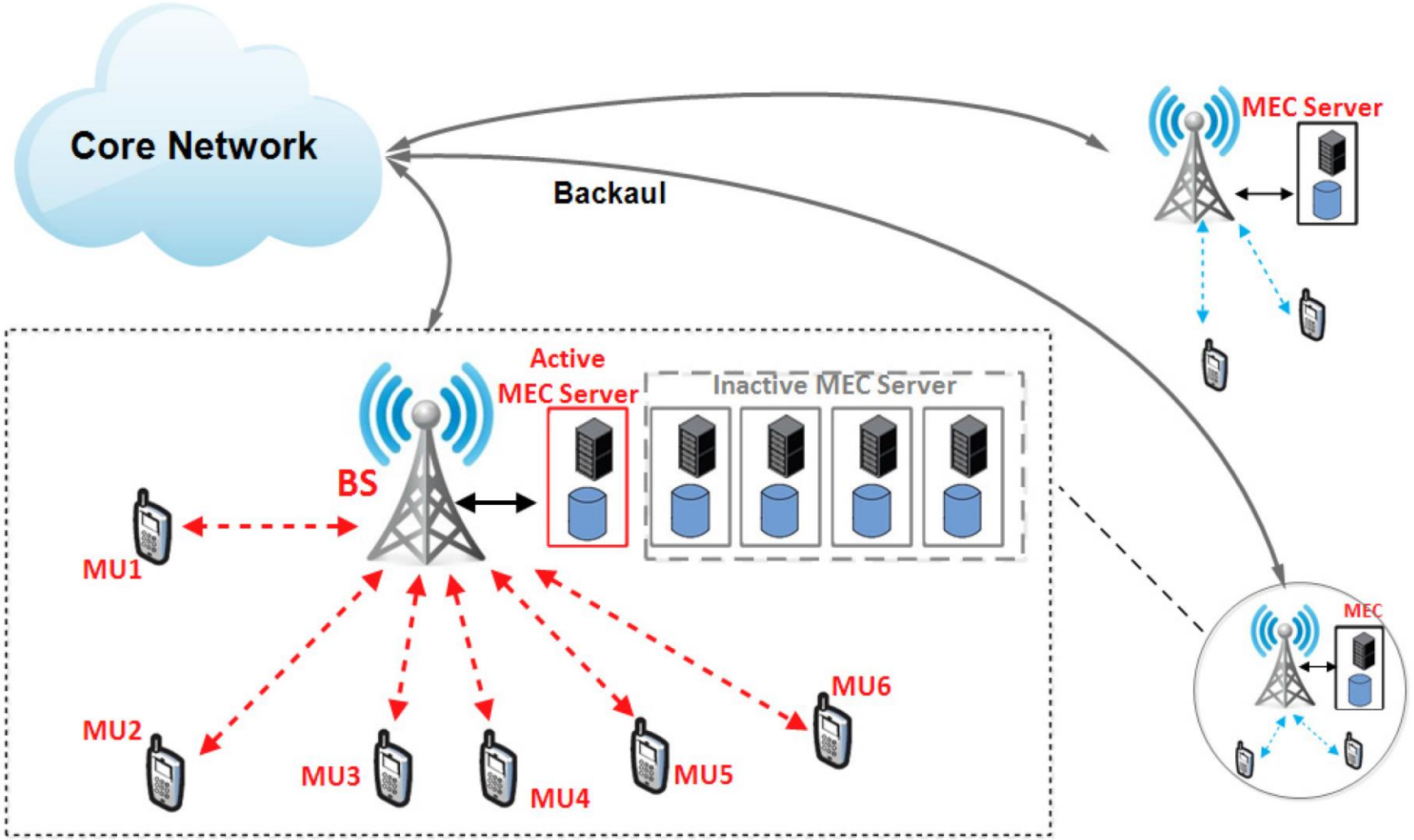
Mobile edge computing (MEC)

❑Simply MEC can be defined as the way of moving cloud computing capabilities to the edge of the mobile networks.

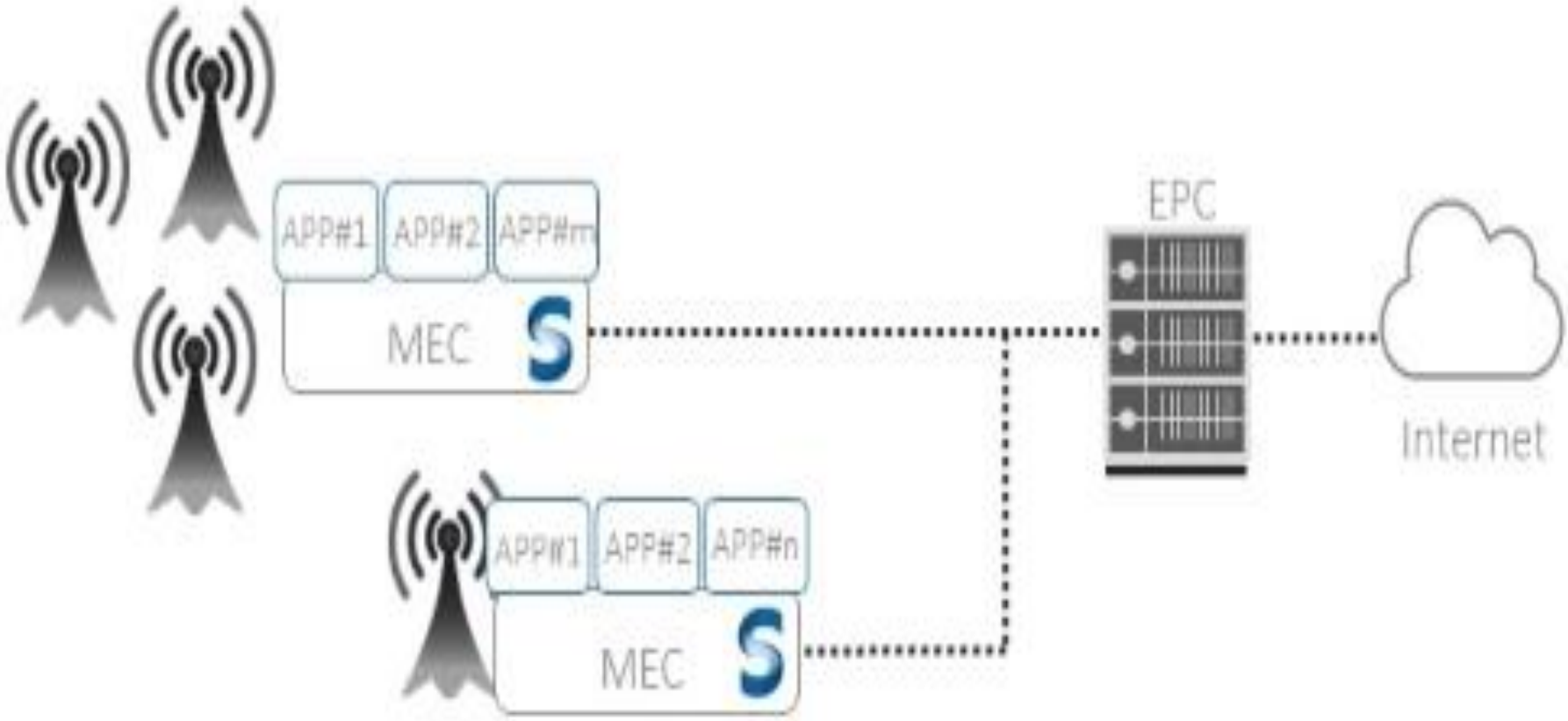
❑Moving cloud computing to the edge of the mobile produces a lot of benefits that can be summarized in the following points :

1. Reduces the round trip latency of communicated data,
2. Provides an efficient way for offloading data delivered to the core network,
3. Provides high bandwidth, and
4. Introduces new services and applications by accessing the network context information.

MEC


Core Network
Backaul
MEC Server
Active
MEC Server
Inactive MEC Server
BS
MU1
MU2
MU3
MU4
MU5
MU6
MEC

MEC



Mobile edge computing (MEC)

- Moving from the great, massive and expensive data centers into small distributed cloud units based on a small hardware platform will open the way for achieving the required latency constraint for tactile realization.

- There are multiple locations for the MEC servers such as :

1. Cloud servers are connected to the LTE macro base-station (eNB).
2. Cloud unit may be placed in the 3G/4G radio network controller (RNC).
3. Cloud unit may be connected to multiple sites (multiple eNB).
4. Cloud unit may be at the edge of the core network.

DD-FoG : Intelligent Distributed Dynamic FoG Computing Framework

Terms

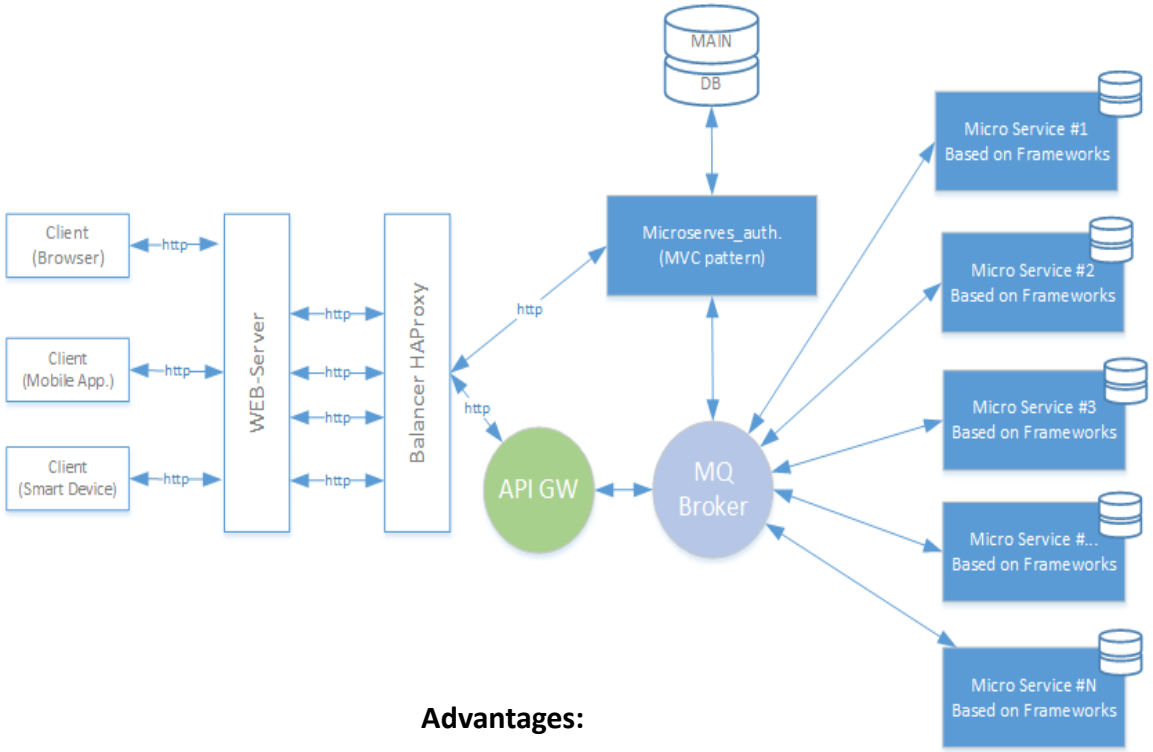
Fog computing - the distributed computing system based on the user and IoT-devices and their interconnection

Microservice pattern - an approach of software architecture design based on the software separation to logical part (e.g. sub-product based on the MVC-solution, function of the main service such as Neural network, etc.).

Microservice - a logical part of service software, which interconnecting with other microservice in order to provide the service life cycle. Can be presented by Virtual machine, Docker-container.

Microservice live migration - process, which include following steps: copy of microservice with current status, Fog-node defining for migration, allocation of network resources, transfer the microservice copy to Fog-node, microservice deploying, microservice connection to service architecture (for establish interconnection with other microservices)

Introduction. Typical software architecture based on microservices



Key features:

- **Microservice** is the logical **PART** of the Service software
- The **level of service decomposition** defining on the software architecture design layer
  - Microservice can represent **one of the service's products** (high level of decomposition)
  - Microservice can represent **only one function** of the service: e.g. Neural Network, Data preparing, e.t.c. (deep level of decomposition)

Advantages:

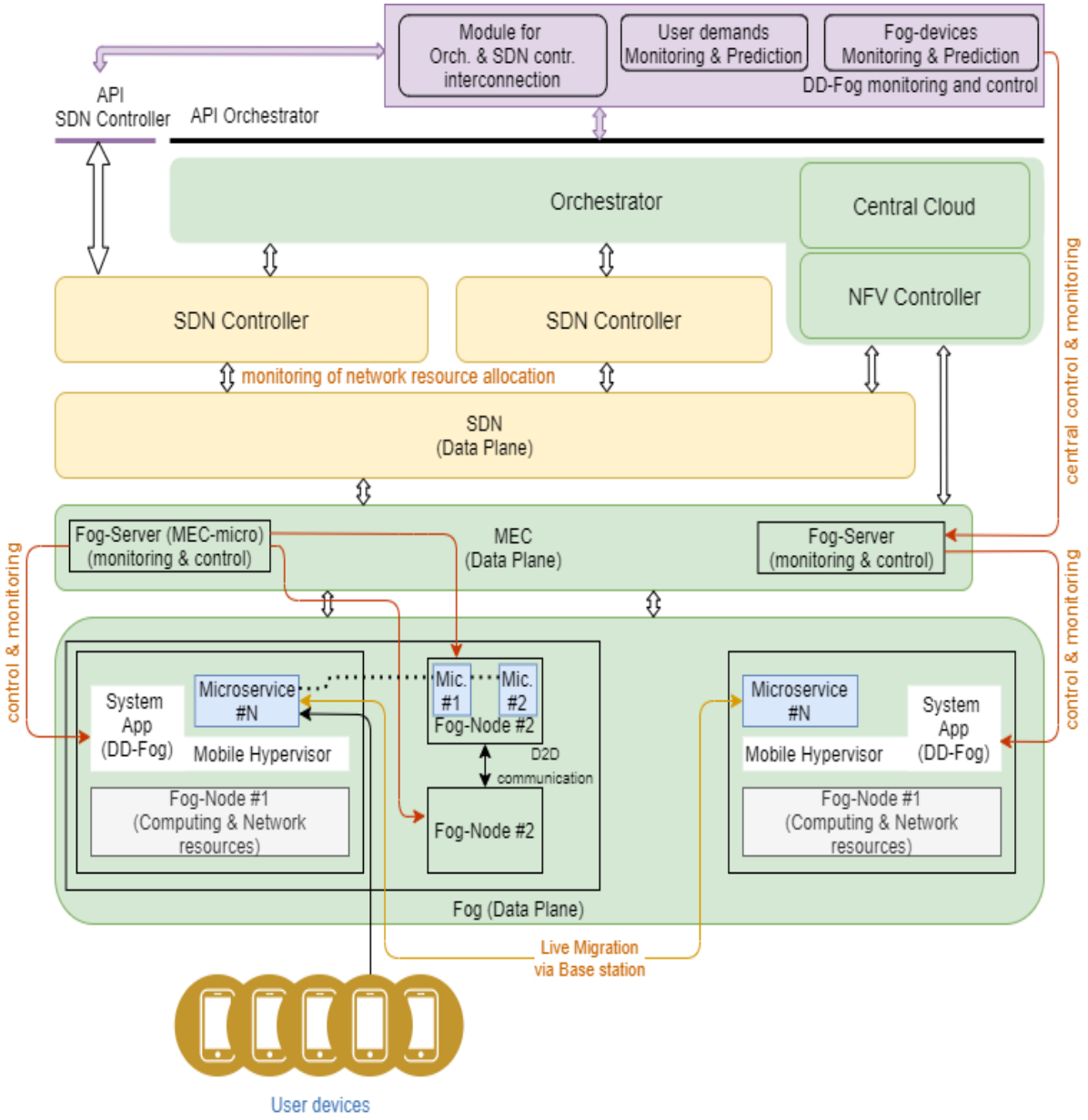
Advantages of Microservice architecture:

- Service decomposition on the "atomic-layer"
- **Fast Scalability**
- Software tools independence (1'st microservice on the PHP, 2nd on the Python, 3rd on the Java, etc.)
- Functions distribution in the Network

Advantages of Microservice migration:

- Fast scalability without stopping the main service
- The necessary microservices migration based on the **users demands**
- The group of devices with **few resources** using for the service deploying

Contribution (Framework)

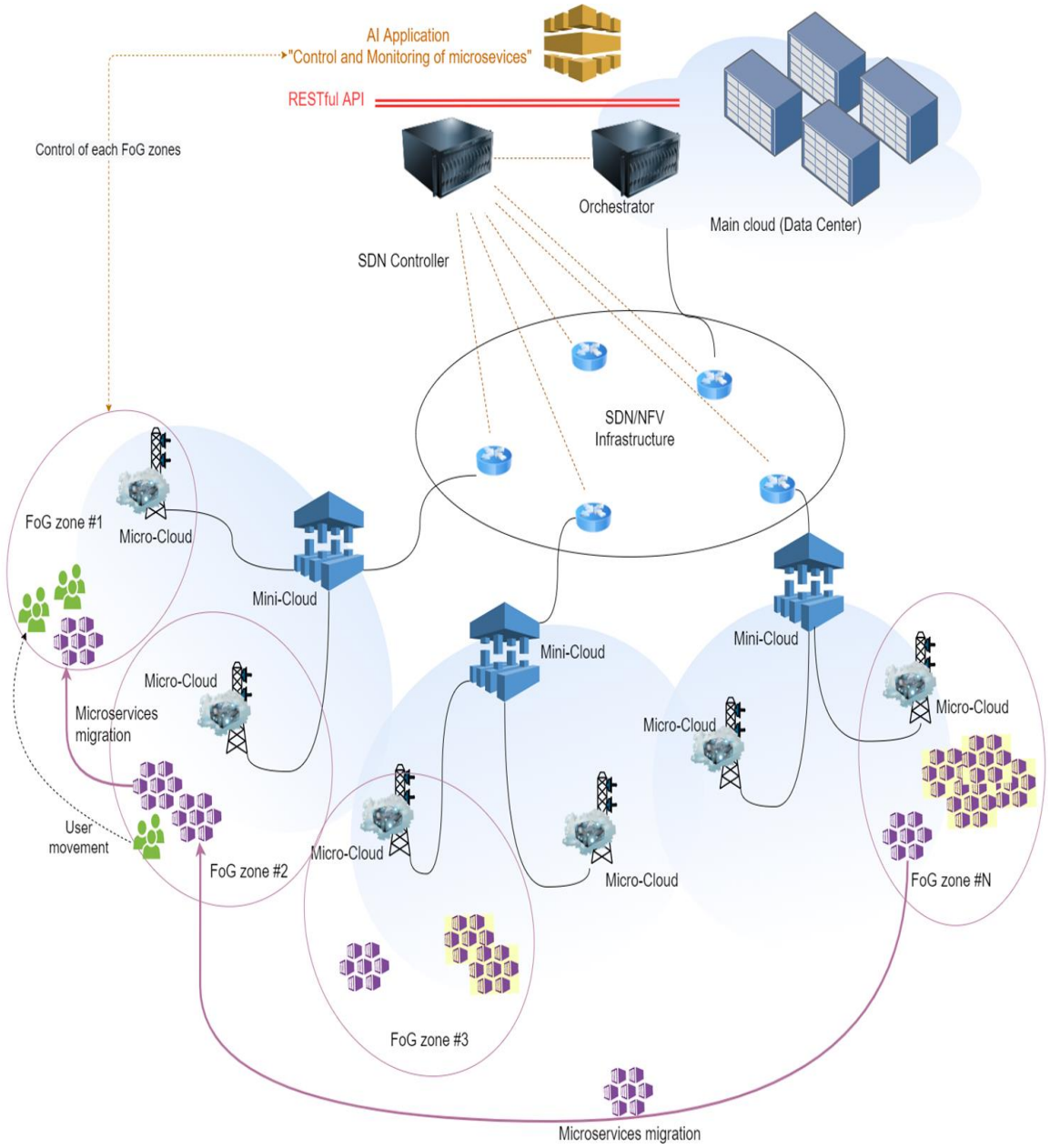


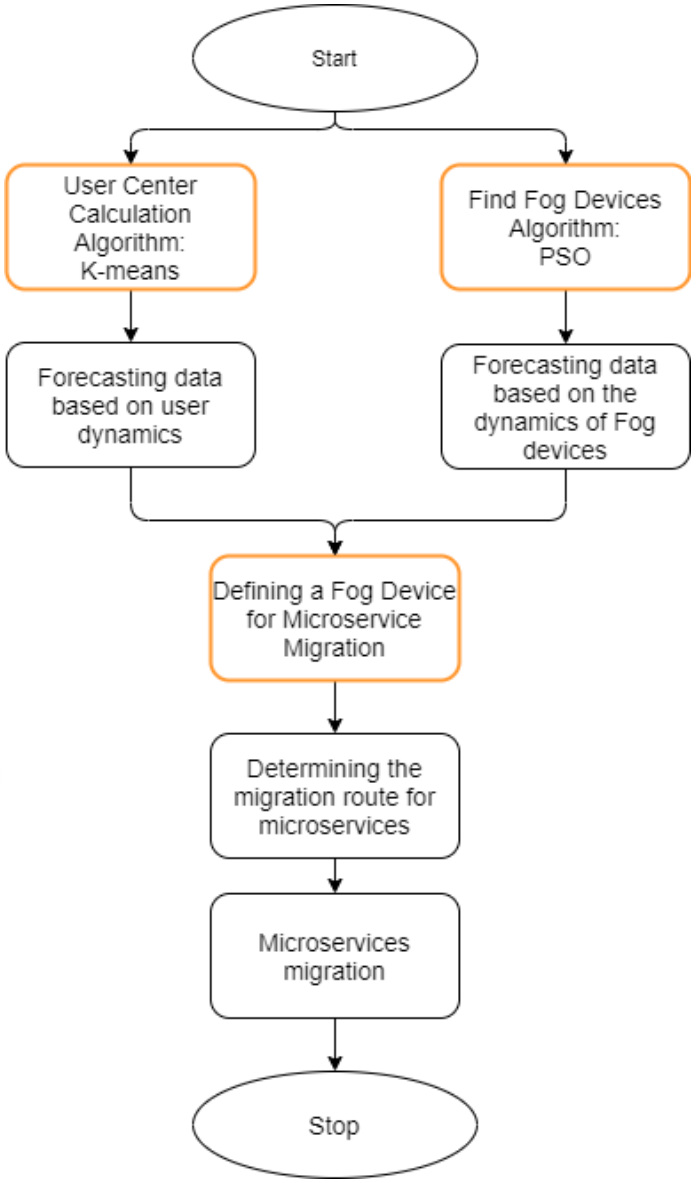
Functional Architecture of the Framework

is

- To use deep integrated “Fog” and “MEC” technologies
- The Software of each service have to be based on the “Microservices architecture”
- Monitoring of the Consumer demand (AI)
- Monitoring of the load on the Services and their components (microservices)
- Based on the monitoring making the prediction of user routes and their demand (AI)
- Based on the monitoring making the prediction of routes for microservices migration (via edge network and D2D) (AI)

Contribution(Use Case & Algorithm)





Future plans

The DD-FoG include the more than presented here research challenges, as well as directions.

On the next step of this project, expected to build the predictive model of user moving and service dynamics, taking into account presented results in the current paper.

For example, the following tasks:

- Monitoring of the Consumer demand (AI), taking into account their movement
- Monitoring of the load on the Services and their components (microservices)
- Based on the monitoring making the prediction of user routes and their demand (AI)
- Based on the monitoring making the prediction of routes for microservices migration (via edge network and D2D) (AI)

Intelligent platform for Deployment of Edge Computing Applications

Problem

- Addressing the placement problem between edge servers to optimize the mobile edge computing network performance for each service

Solution

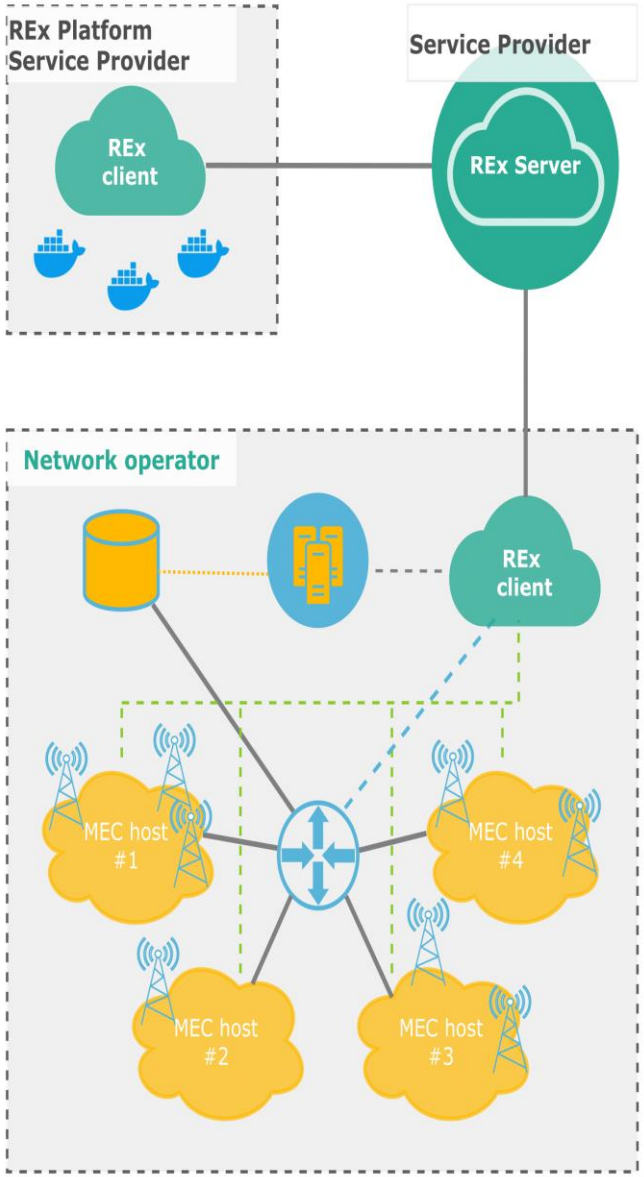
- a dynamic network topology and service placement using the Genetic Algorithm to analyze and predict services.

- an efficient forecasting and live migration methods of service as an application to edge computing systems.

- This approach can be utilized in the systems with an intelligent allocation of operator equipment resources for providing flexibility and high-quality topological organization.
- simulation results proved that the network equipment efficiency can significantly be increased by more than 30\%.

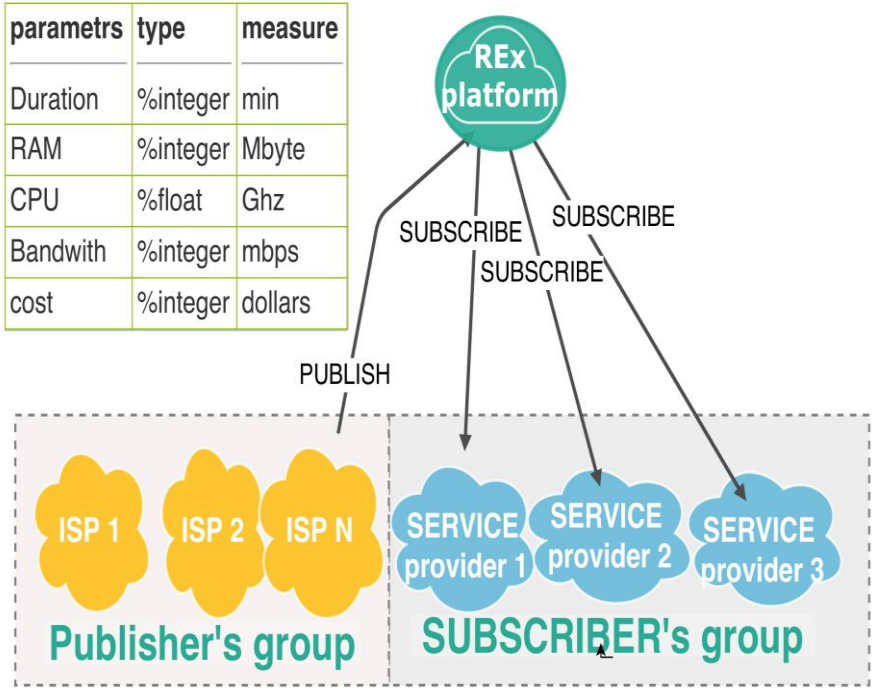
Network Architecture of Platform

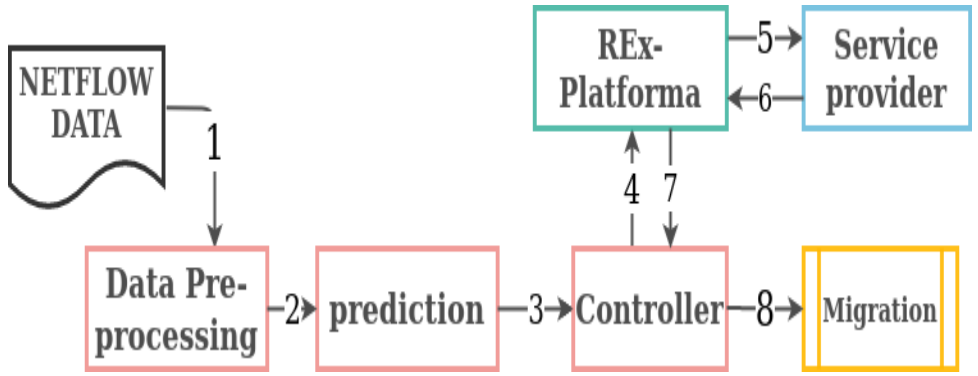
1. The service provider registers on the REx platform.
2. Receive a unique API with a key.
3. Register each MEC on the platform of its OSS/BSS.
4. Publishe its MEC status information to the platform.
5. Service provider subscribed to this carrier receives information about available MECs.



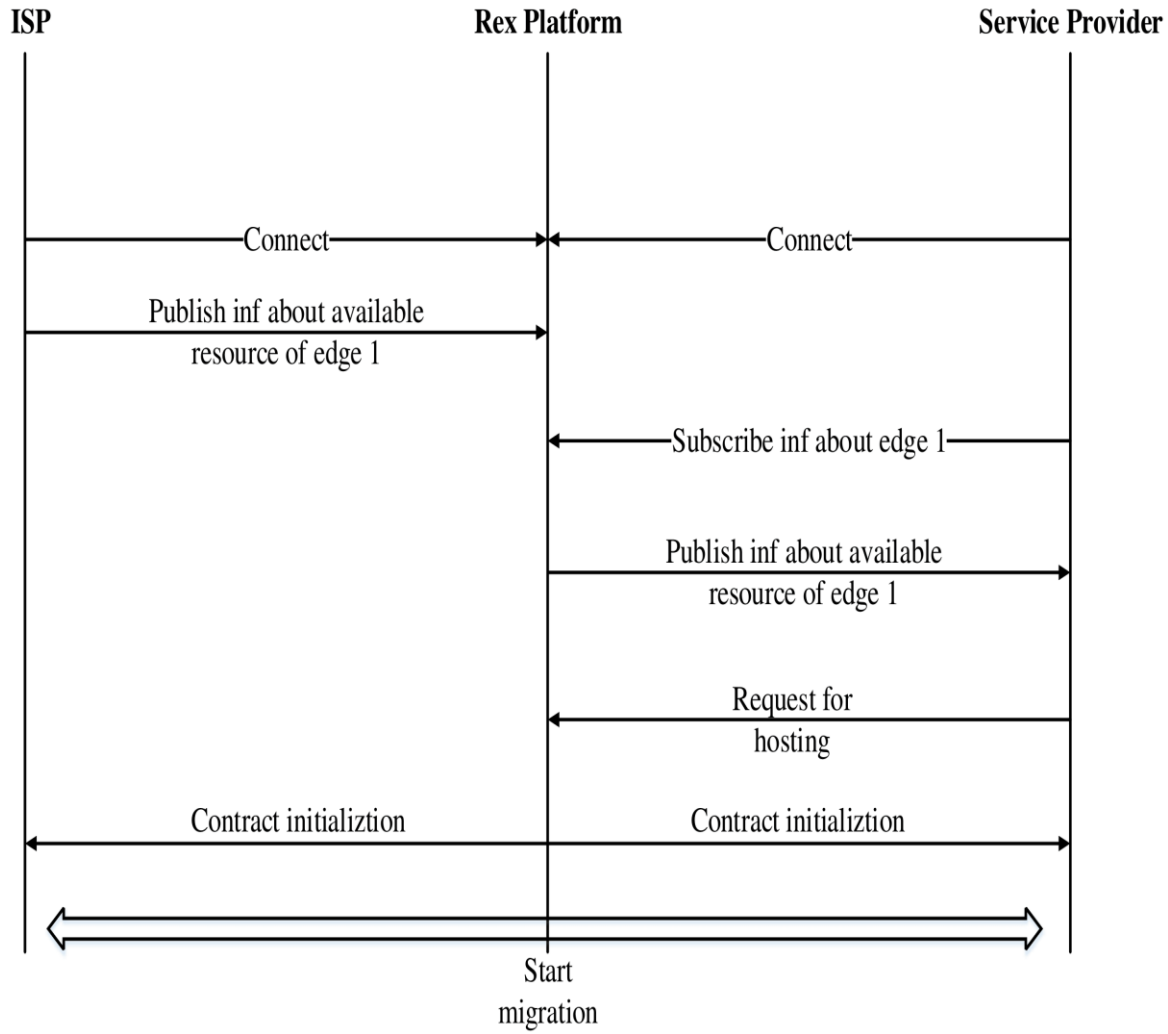
PUBLISH INFORMATION

parametrs	type	measure
Duration	%integer	min
RAM	%integer	Mbyte
CPU	%float	Ghz
Bandwith	%integer	mbps
cost	%integer	dollars





1: **Procedure:** OSS/BSS informs floating form REx about free computing resources on all MECs of the network operator.
2: **while** true **do**
3: REx: publishes information on MEC resources for subscribers to hosting services (service providers)
4: **if** REx: received a request from a service provider to host a service **then**
5: OSS / BSS: concludes a digital SLA between the operator and the service provider
6: **else**
7: OSS / BSS: updates information about the available resources of the MEC
8: **end if**
9: REx: transfers the authorization key to the service provider for the right to use the MEC resource.
10: **end while**

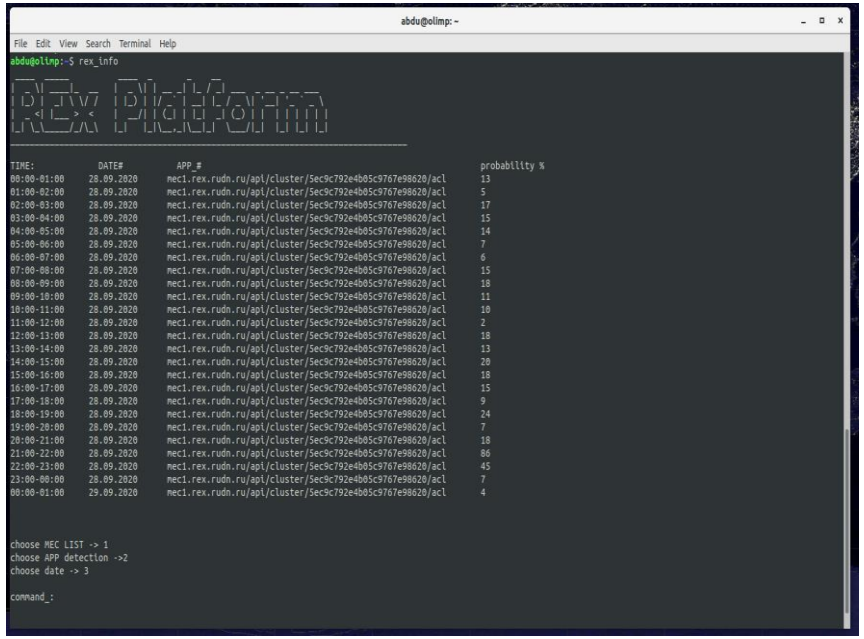

ISP
Rex Platform
Service Provider
Connect
Connect
Publish inf about available resource of edge 1
Subscribe inf about edge 1
Publish inf about available resource of edge 1
Request for hosting
Contract initializtion
Contract initializtion
Start migration

- We propose a platform that could guide research in the post-5G era and looks at potential 6G application scenarios. In addition, it allows you to place an application of service providers for a short time on the infrastructure of a network operator, to improve the quality of the service provided by bringing it closer to end-users
- Subsequently, key potential features of 6G are identified and the necessary communication technologies discussed.
- Furthermore, it explores issues beyond communications technology that could hinder 6G research and deployment.
- Finally, simulation results proved that the proposed platform can significantly increase the network equipment efficiency by more than 30%.

Challenge: Forecasting Model for Service Allocation Network Using Traffic Recognition

2020-01-21 00:00:35.503	INVALID	Ignore	TCP	82.204.246.18:54972	->	185.124.189.228:21	0.0.0.0:0	->	0.0.0.0:0	1300	0
2020-01-21 00:00:35.503	INVALID	Ignore	TCP	195.91.224.216:18217	->	91.108.43.232:50758	0.0.0.0:0	->	0.0.0.0:0	62347	0
2020-01-21 00:00:41.839	INVALID	Ignore	TCP	195.91.224.216:18287	->	185.7.145.22:49440	0.0.0.0:0	->	0.0.0.0:0	138	0
2020-01-21 00:00:41.839	INVALID	Ignore	TCP	195.91.224.216:18287	->	185.7.145.22:49442	0.0.0.0:0	->	0.0.0.0:0	138	0
2020-01-21 00:00:41.903	INVALID	Ignore	TCP	195.91.224.216:18287	->	91.108.43.233:61449	0.0.0.0:0	->	0.0.0.0:0	138	0
2020-01-21 00:00:35.631	INVALID	Ignore	TCP	195.91.224.211:30329	->	91.108.43.230:57170	0.0.0.0:0	->	0.0.0.0:0	286	0
2020-01-21 00:00:41.903	INVALID	Ignore	TCP	195.91.224.216:18214	->	91.108.43.232:50994	0.0.0.0:0	->	0.0.0.0:0	1164	0
2020-01-21 00:00:35.631	INVALID	Ignore	TCP	195.91.224.216:18214	->	91.108.43.232:50776	0.0.0.0:0	->	0.0.0.0:0	7464	0
2020-01-21 00:00:35.631	INVALID	Ignore	TCP	195.91.224.211:30329	->	91.108.43.230:57172	0.0.0.0:0	->	0.0.0.0:0	286	0
2020-01-21 00:00:35.631	INVALID	Ignore	TCP	195.91.224.211:30320	->	91.108.43.230:57173	0.0.0.0:0	->	0.0.0.0:0	344	0
2020-01-21 00:00:35.631	INVALID	Ignore	TCP	195.91.224.216:18211	->	91.108.43.233:61251	0.0.0.0:0	->	0.0.0.0:0	953	0
2020-01-21 00:00:41.967	INVALID	Ignore	TCP	195.91.224.216:18217	->	91.108.43.230:56991	0.0.0.0:0	->	0.0.0.0:0	384	0
2020-01-21 00:00:41.647	INVALID	Ignore	TCP	212.92.122.196:57584	->	91.108.43.230:3389	0.0.0.0:0	->	0.0.0.0:0	1512	0
2020-01-21 00:00:35.695	INVALID	Ignore	TCP	195.91.224.211:30320	->	91.108.43.230:57181	0.0.0.0:0	->	0.0.0.0:0	1692	0
2020-01-21 00:00:42.095	INVALID	Ignore	TCP	195.91.224.211:30320	->	91.108.43.230:57409	0.0.0.0:0	->	0.0.0.0:0	1159	0

Traffic prediction (NETFLOW collection)



Challenge: Forecasting Model for Service Allocation Network Using Traffic Recognition

Focusing on the intelligent application demand of networking management and computing resource management, the artificial intelligence technologies such as machine learning and big data include the possibilities of the softwarized approach in IMT-2020 (SDN/NFV) are applied to digital upgrade of the internet infrastructure. The one of the main issues in this area - is the services traffic allocation, taking into account the users dynamics. Here we propose the problem statement with the services traffic forecasting based on the changing user needs for services.
The suggestion of problem statement:

- Proposal with ML model for recognizing the user demands based on the traffic services allocation;
- Proposal with ML model for traffic forecasting, taking into account traffic types and user demands (in order to future service migration).

Links

- **Link to challeng**
  https://challenge.aiforgood.itu.int/match/matchitem/42

- **Link to dataset**
  http://khakimov.tech/ITU_dataset.zip