Realization of LEO-Systems with Architecture of Distributed Satellites for 5G/IoT

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Abstract. Proposed technical solution deals with the sphere of mobile communications, namely systems of satellite connection and can be used to proceed connection of orbit space crafts with land stations and users of satellite for 5G/IOT. The main point of proposed working out in system low orbit satellite connection with FC-architecture is to reduce the delay while transmitting signals to users and probability to overstrain nets in the system of low orbit satellite that connects housing part of satellites of the Earth. Each of them functions in the Earth orbit and communicate with board retransmitters, inter satellite connection, nets of loud station connection and control of part satellite of the Earth, grouping low orbit spacecrafts (LEO-system) including grouping the leading key satellite and satellite-retransmitters. Micro grouping satellite-retransmitters are formed near each key satellite and functions of key satellite in a certain phase spot of orbit area of work orbit are made by mini or micro satellites linked circular nets with lines of connection between satellites, but functions of satellite-retransmitters are reduced. The new thing is introduction of multi-level system of border clouds representing heterogeneous distributed cloud structure. Border clouds of multi-level system are united with help of hyped-speed wireless radio lines of THz diapason wireless optical connection systems. The method of evaluation of time access to proposed structure of "foggy calculation" based on the model access to "foggy calculation" with permission of collision of rousers realizing the regime of server.

Keywords: Radio Lines, Distributed Satellite, Low Orbit Satellite Systems, Internet of Things, Cloud Technology, Foggy Calculation, Border Calculation.

1 Introduction

The rapid development and standardization of land part of nets 5G/IMT – 2020 and reduction for global cover of wireless stylish nets while using millimeter waves make inventors of nets of satellite telecommunication pay much attention to this segment market of mobile satellite connection [1-2].

Conception of using satellite segment 5G, being considered nowadays, in based on the following things [3]:

- Satellite segment will be integrated with other nets of mobile and fixed connection, but it will not autonomic net and integration of satellite and terrestrial segment 5G is a core of this idea.
- Systems of space connection are fundamental components to provide reliable 5G connections not only in the territory of all Europe but also all over the world all time and at reasonable prices;
- Satellite segment will encourage global characteristics, an increase of opportunities for 5G services and problem – solving connected will a support of grows of multi-media traffic, cover of all over the world between machine connection and extremely important telecommunication mission while optimizing prices for eventual users;
- Space segment can become part of hybrid configuration of net consisted of cosmopolitan infrastructures managed so that they provide regular and urgent convergence of 5G services for all eventual users.

Requirements for satellite segment the nets of the 5^{th} generation will be identified by a range of services given for 5G nets united by there basic model: Enhance mobile broadband – MTC Massive Machine – Type Communication – MTC , uRLLC – ultra – Reliable low Latency Communications [4,5] satellite connection systems are famous for their reliability and opportunity to provide service on low latency signals in the Net. Low latency signals using geostationary KA will be acceptable for plenty of additional 5G nets. More sensitive for latency programmers can be maintained by new law – orbit satellite nets developed in the future. Analysis of proposition and technological projects of outstanding inventors on using satellite nets to expand 5G nets opportunities shows [5-6] that a lot of telecommunications companies have already given presentations of their projects to enlarge satellite segment. But there are some technic drawbacks such as:

- Difficult realizing recourse of different satellite systems;
- Essential increase prices of using quantities of satellite;
- Constant increase prices of using identifying mutual dislocation of satellite of low orbit spacecrafts.

As a result, the expansion of the area of service with accepted probability of necessary quality in the channel of transmissions they use satellites constantly moving accepting to stationary satellite at a considerable speed and in essential part of the area. So there are a lot of projects, ideas, plans on realizing and introduction new

systems, but nowadays they are ineffective because there is doubt of practical realizations and long – lived systems, i.e. LEO – HTS has serious problem in mutual use of spectrum with existed nets.

2 Problem statement

In this respect home-made technical decisions are very important to realize new service in which system of law - orbit satellite connection represents grouping of law – orbit spacecrafts (LEO systems) with architecture of distributed satellite – transmitters, around each of key satellite there are micro – grouping of satellite transmitters called distributed satellite. Function of key satellite in a chosen phase spot of area work orbit are made by mini or micro satellite and functions of satellite transmitters. The key satellites are connected with each other in a circular net of high-speed connection lines between satellites. Geometric series distributed satellites is an area around key satellites with radius not more 1km. It means satellites make grouping flight in a distance not more than 1km from key satellites. Space segments of LEO systems consist of some orbit area distributed satellites are eventually placed with relative some true anomaly but each distributed satellites is linked with two neighbors of distributed satellites in their own orbit area and with two nearest distributed satellites in two neighbors orbit area – one in each orbit area.
Con the base of measurement of their mutual locations. As a result it is possible to increase efficiency of use of kubsats by turning off part of equipment necessary to measure parameters. Useful load of satellite – transmitters involves SDR – modules for functioning and processing transport flow to transmit and receive importation. In order to have connection inside “distribute satellites” wireless net is used.

The drawback of the well known decision is that it is not identified architecture of intersatellite channel connection and it does not allow to evaluate its technical characteristics and its technical opportunities of low - orbit satellites radio – connection system to provide proper services in integrated 5G and Iot connections. Besides that, in order to realize FC – architecture in space segment of LEO system in distributed satellites there must be a separate satellites calculation whole task is to make necessary calculation to provide function to maintain IoT facilities within distributed satellites zone. This decision does not provide flexibility and high reliability of system in case of overload of the net and when a separate satellites calculator dos not work. The task of a new decision is to improve law - orbit satellites connection system:

1. Realizing intersatellites radio channel connection made in THz diapason.
2. Reducing latency while transmitting signals to uses.

3 Architecture of distributed satellites for 5G/IOT

The set up task can be solved because in low orbit satellites connection system there is additional multi - level system of order clouds. It represents heterogeneous

distributed calculation cloud structure. The inventors consider this system to be there sphere system based on 5G/ITM2020 from NGMN [8]. In this structure hardware and software are separated and in order to give service properly applied programming interface are used.

The idea of new approach to build up multi – level cloud system for low – orbit satellites connection shows that zones of service of separate satellite transmitters are united with pico clouds with little calculation possibilities to do border calculation.

This pico clouds are united with micro clouds united with separate satellite – transmitters and have huge calculation possibilities. Beside that each satellite transmitters is united due to radio lines of teracycle per second range with micro cloud with limit possibilities. The core of distributed satellite (key satellite) provides interaction of micro clouds in the system of the whole. This system reduced latency while transmitting signal to users and probability of overload of the net and increase flexibility and accessibility the idea of this decision is explained in the scheme (Fig. 1), of realization of low – orbit satellite connection system 5G/IoT.

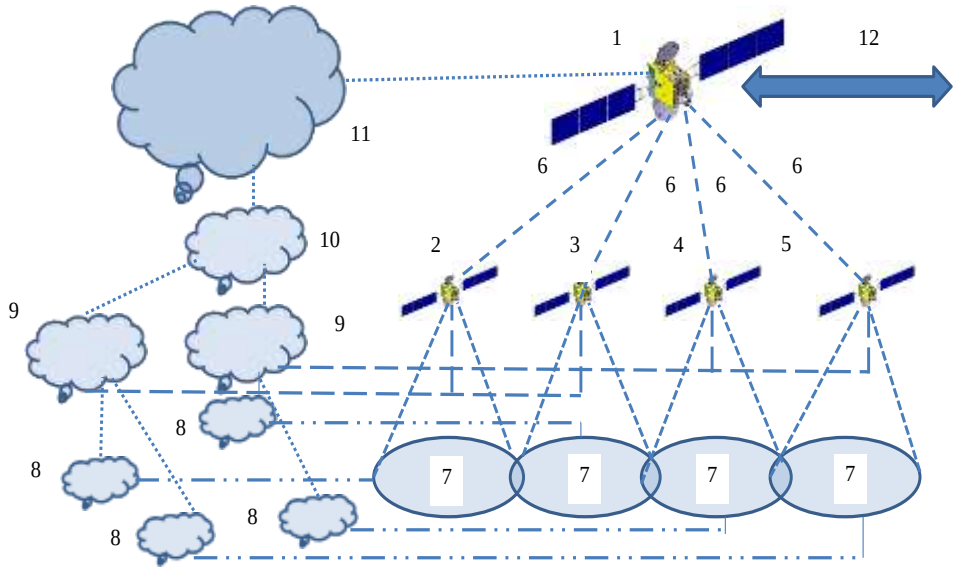

Fig. 1. Satellite communication scheme

On Fig. 1:

1 - Key satellite;
2,3,4,5 – satellites-transmitters;
6 – feeder lines;
7 – zone of the service of satellite connection system;
8 – pico cloud structure;
9 – micro cloud structure;
10 – macro cloud structure;
11 – main clod structure;

12 – intersatellite transmission line.

The scheme of functioning “distributed satellite” in low orbit satellite connection system 5G/IoT works out in the following way.

Information and intellectual core of “distributed satellite” is key satellite 1 (fig. 1). Satellites – retransmitters 2.3.4.5 of distributed satellite form ray/rays of users with limit service zone. A totality of rays formed by satellites-transmitters makes service zone LEO – systems (7). Requirements on integral service zone. Totality of rays formed by satellites – transmitters make service zone of Leo system (geographic service zone) identify requirement to some distributed satellites in the system of the whole. Feeder lines 6 provide connection of key satellite with satellite – transmitters and used to transmit transport digital blow according to the format to eventual users. The Feeder line 6 between key satellite and satellite- retransmitters is an inner connection line between satellites in distributed satellite. This line is a combined radioline providing duplex transmission information, measurement of distance and mutual angle location between key satellite 1 and satellites – transmittters 2,3,4,5.

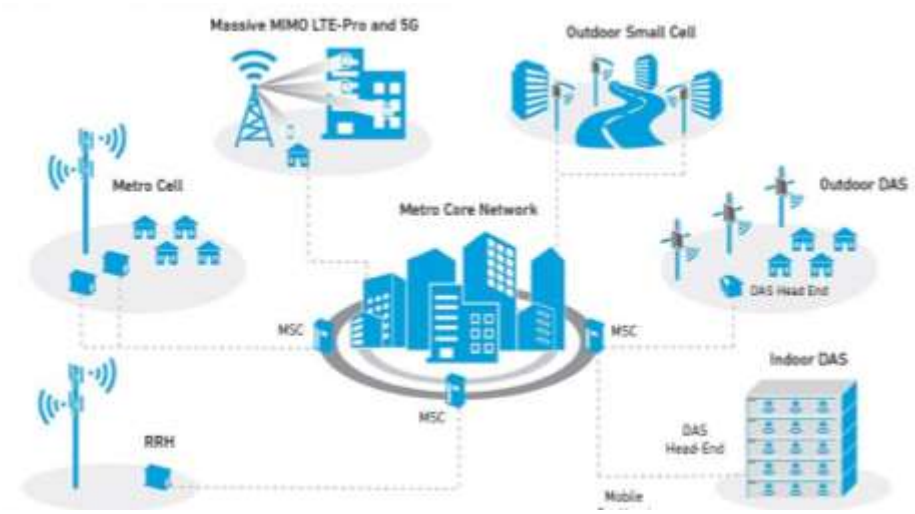

Fig. 2. 5G Infrastructure

Distributed satellite in Leo – system are linked between each other by intersatellite lines 12 of teracycle per second connection forming highway the net LEO – system. Each distributed satellite is linked with two neighbor orbit area on in each orbit area. In distributed satellite function of maintenance of connection line between satellites are fulfilled by key satellite 1 furnished with feeder line modules 6 and high frequency receiver transmitter satellite – transmitters. Multi-level system for low orbit satellite radio connection system 5G/IoT is development of cloud calculation system from centralized system to heterogeneous distributed system. Particularity of this system housing four level of cloud 8-11 is that clouds are linked due to high speed wireless radio lines of teracycle per second diapason. It allows to use wireless optic connection system (FiWi). They are one of the most important future net 5G. The

distance between equipment for user and the nearest cloud is one wireless transition. It allows low latency to transmit information and reduces probability overload in the net, increases an access to the net, improve safety because additional service is given to users in the middle of the net.

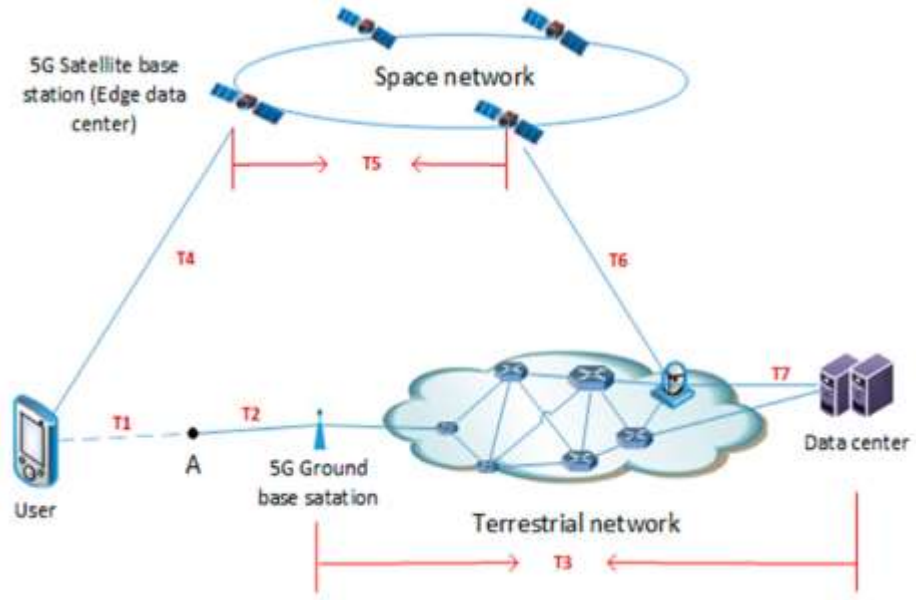

Fig. 3. 5G Infrastructure with satellites

Uploading data from users at the level of cloud includes three types of latencies: latency of uplink and downlink lines, latency of broading and latency of processing information.

For elevation time access to “foggy information” it is suggested access module in “foggy calculation” with percussion access module in “foggy calculation” with percussion of collision of data recourse, realizing the regime of server.

In the system of server regime there is central cnot (server) and some data resource. Data resource start transmitting data after addressing. Central knot. It data recourse does not have prepared data packet, special logic mechanism of data resource forms identification number of data recourse. As slot is most time interval its size is determined by transmission speed from data resource to central knot. It is determined by equipment used in the system.

Latency of transmission through up and down lines (iv in) can be calculation on the base of the following levels [9-13].

$$T_v = (1 + V_{bo})(D_b / V_b), \quad (1)$$

$$T_n = (1 + V_{no})(D_n / V_n), \quad (2)$$

V_{bo} and V_{no} – transmission speed for up and down lines allowing to refuse service, D_b and D_n – general number of bits through up and down lines and V_b and V_n – transmission speed of data for up – and – down lines.
Latency of broadening T_r is a function of distance and can be calculated in the following way:

$$T_r=R_{ob}/V_r\,, \tag{3}$$

R_{ob} – distance between mobile user and cloud
V_r – speed of broading
Latency of processing information Tobr can be calculated in the following way

$$T_{obr} = N/V_{proc}, \tag{4}$$

N – general number of necessary operations, V_{proc} - speed of cloud processor.
Mention above, general latency can be calculated as sum of three latencies. General latency of uploading data in cloud Tzag can be calculated in the following way:

$$T_{zag}= T_v+T_n +T_r +T_{obc}\,, \tag{5}$$

Full of interaction cycle M of data recourse and central knot is $T=MT_{zag}$.
It each data resource of average λ packets per second, in M data resource system general intensity of data flow comes to λM packets per second and middle interval $1/\lambda M$.. In order to avoid growing guence time service T_{zag} must be the following:

$$T_{zag} \leq 1/\lambda M, \tag{6}$$

According to (6) with $V_b=V_n$ necessity of data transmission speed for up and down radio lines $V=V_b=V_n$, there is a guarantee of absence of queue for each data resource.
Mentioned above, general latency, on the whole depends on distance. Introducing macro clouds there is less latency than latency while using recourse of core net.

Introducing level of macro cloud on satellite – retransmitter and providing interaction of macro cloud due to wireless high speed radio system of transmission teracycle per second diapason allow to use a new way of uploading traffic with interaction technology d2d and in improve quality service characteristic 5G/IoT.

The result of the previous modeling shows that comparing traditional decision with Evolved Packed Core founded on the vision 153Gpp new decision reduces cycle latency by 50-60% [14-17].

The result of achievement can be used realization conception of the internet – resource in system of Earth research from space for scientific and economic tasks to explore the surface of the Earth for providing force structure with information etc. In home scientific research works in contrast to worldwide there is a complex of models and methods for low – orbit satellite nets built up on the base of architecture of “distributed satellite”.

It allows to public a number of scientific technical tasks to create new low – orbit satellite nets that are part of a complex of interaction electro – connection systems to give new services to users and to M2M (Machine to Machine) [18-21].

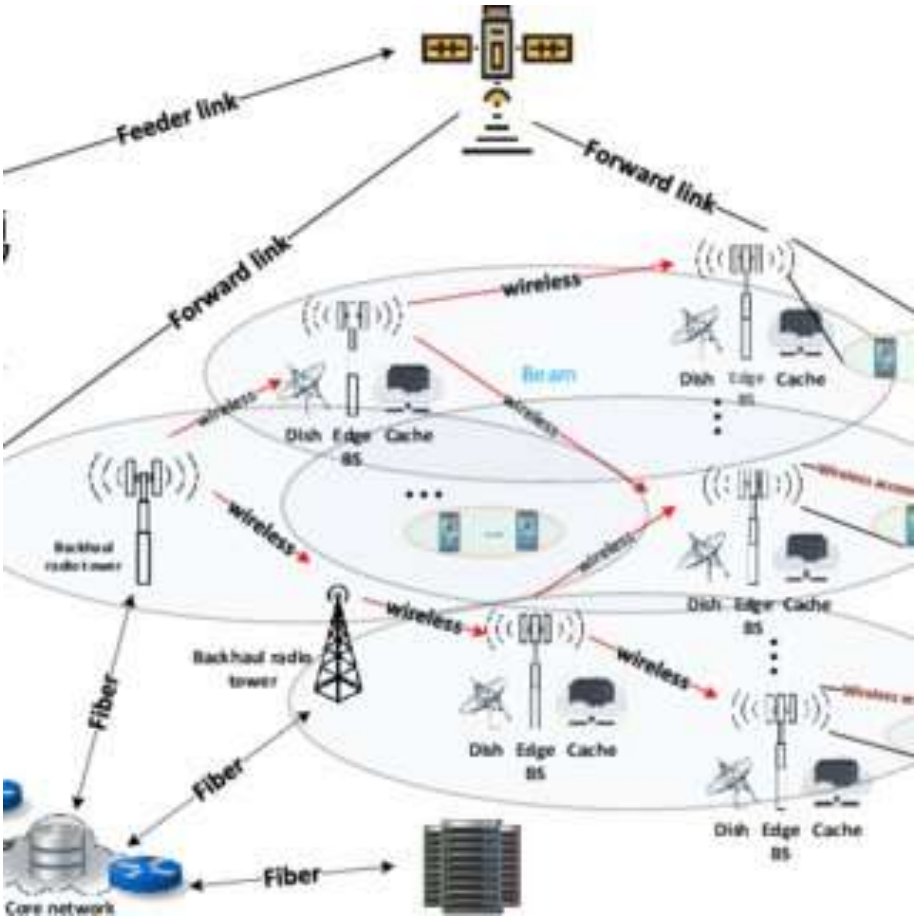

Fig. 4. 5G Hybrid scheme with satellites

Among scientific – practical task to public such as:

– Analysis of conception of the internet recourse and modern telecommunication technologies and grounding of necessary to create new low – orbit satellite nets based an architecture of "distributed satellite"

– Determination of theoretical and practical research in the sphere of low – orbit satellite nets based on architecture of "distributed satellite"

– Work out of methods of using low – orbit satellite connection system with architecture of "distributed satellite" for wireless sensor nets with a purpose of broadening of their connection.

– To sum up it is suggested the following things:

– Multi – level foggy calculation systems to improve effective function of low – orbit satellite connection systems to provide requirement of nets and system of fifth generation 5G dealing with the development of cloud calculation systems for radio connection nets from centralized system to heterogeneous distributed system [22-24].

– Methods of elevation of time access in foggy calculation on the base the model of access to “foggy calculations” taking into account collision of data recourse realizing the server regime [25].

4 Conclusion

A multi-level fogging system is proposed to improve the performance of low-orbit satellite communications systems while meeting the requirements of 5G generation networks and systems, which is the development of cloud computing systems for radio networks from a centralized system to a heterogeneous distributed system. The technique of estimation of access time in the proposed structure of "fog computing" on the basis of the model of access in "fog computing" with the resolution of collisions of data sources implementing the survey mode is presented.

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