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Research Paper

Intelligent protocol for uniform implementation of EU cohesion policy in the development of NGA infrastructure

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ABSTRACT: *For the development of rural areas, one must ensure internet access with necessary speed, needed for the new generation access (a speed of at least 30 Mbit/s, NGA). The matter which is also discussed in the Digital Agenda for Europe (DAE), one of the initiatives of the European cohesion policy. In order to meet the objectives of DAE, the European Commission (EC) has budgeted app. 50 mio EUR / 1 mio inhabitants to the EU member states in the 2014-2020 perspective. Due to the lack of standardization, incoherence and lack of interest of the public structures, these funds have been used contrary to the defined guidelines. This resulted in inefficiency of encouraging investment into NGA infrastructure, irrational and irregular use of EU taxpayers' funds, as well as ineffective implementation of the EU cohesion policy. For this reason, the rural areas don't develop within expectations of the EC. Intelligent protocol for harmonization of data was developed as part of this research. It was established that such protocol provides detailed and measurable information for a balanced development of the NGA infrastructure between urban and rural areas, ensuring a balanced deployment of private investments. If developed further and concretized, this protocol can become universally usable for the establishment of all kinds of infrastructure, thus enabling effective development of rural areas. In this way, the intelligent harmonization protocol can be focused on the rational use of taxpayers' money by encouraging private investment in rural areas, and effective implementation of the EU cohesion policy.*
Keywords: *big data, data management, NGA, infrastructure, cohesion policy*

I. INTRODUCTION

One of the main tasks of the European Union (EU) is implementation of the cohesion policy on the entire territory of the EU. Furthermore, the purpose of the European cohesion policy is a balanced development of all regions of the EU, which is clearly defined in the main strategic document of the European Commission, Europe 2020 [1].

The cohesion policy is implemented on the basis of several initiatives. One of the most important ones is the Digital Agenda for Europe (DAE), which defines that in order to ensure a balanced development of all EU regions, one must provide them with the new generation internet speeds of at least 30 Mbit/s (NGA) in areas where it is not yet available, which is mostly in the rural areas. [2]. Key tools for implementation of the cohesion policy are the Cohesion Fund and structural funds [1].

There are multiple benefits of the NGA approach: a digital standard of living becomes the same as in urban areas, creating potential for the development of independent economic activities and various aspects of working remotely or from home, the availability of educational services is increasing, so is the gross domestic product (GDP); improvements are noticeable in the usage of web services (e.g. Cloud services), productive growth of SMEs, new business opportunities open up and new jobs are created [3].

Areas without the NGA access will be given the opportunity to develop the NGA access in areas where the telecom operators don't want to develop it because it is not financially feasible [1]. The strategic document of the EU, that is the DAE, has the objective to ensure a 100% coverage within the EU households through NGA access, providing 50% usage of the speed >100 Mbit/s by households. The EU thus decided to fund such projects to meet these objectives in areas without NGA access [2]. Such projects are subject to rules which are unique in the whole EU. These rules regulate the eligibility of funding for those users and locations that don't have NGA access [4].

For an effective application of these rules, it is necessary to conduct large data processing in large-scale institutions. This processing is performed by the "big data management" tools [5]. One also needs good and qualitative communication among institutions in order to share "Big data" on a large-scale. Because of the

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absence of standards, and recording information in different ways, the processes of data sharing, managing and analyzing are inefficient. The same data are not recorded the same way in different institutions [6]. Results of their analysis and processing are of poor quality because low quality input gives poor results when these are combined [7]. The processing process thus runs according to the principle "garbage in - garbage out" irrespective of strength, quality or the speed of the system [8].

One cannot adequately apply the EU rules to this kind of output data [9], nor determine the adequate criteria for constructing a NGA network that would ensure a balanced coverage of rural areas [10]. This results in the fact that investors focus on narrow areas of project implementation, resulting in rural areas not being sufficiently represented in the investments (construction of NGA through EU funding). At the same time, it is not possible to fulfil the DAE objectives in such areas, which negatively influences the fulfilment of the DAE objectives at the EU level. Furthermore, at the same time the rural areas remain without any possibility of further development [11].

In areas with NGA access, effective development of other infrastructure, co-financed by the European funds, is not possible for the same reason. Taxpayers' money is not spent rationally because of inefficient development of rural areas [12].

II. HYPOTHESIS

Effective implementation of the EU cohesion policy through even distribution of investments within the construction of NGA infrastructure, financed by the European funds, is only possible by using appropriate protocols for harmonization of data from different institutions. Using data that are not harmonized with each other results in inefficient allocation of resources, intended for the construction of NGA infrastructure.

III. METHODS

For the purpose of this research financial data was explored, relating to the financial contribution of EU member states involved in the process of EU enlargement after 2004. This included data on the amounts of the value of private investments into NGA infrastructure in urban and rural areas in the respective countries. Respective countries show different levels of development and are on average less developed than those, who became members prior to 2004. For the purpose of this research, the latest available data was explored, as presented in Table 1.

Table 1. Contribution to the EU and private investments into NGA infrastructure in urban and rural areas of selected EU countries

Category	Amount in mio EUR	%
Contribution towards EU	9,682	100
Private investments into NGA infrastructure	4,602	100
Urban areas	3,820	83
Rural areas	782	17

During this analysis, a sample was created with input parameters that are necessary for planning development of NGA infrastructure. This sample includes the following input parameters: the number of users in urban and rural areas, location of users, geolocation of the object in the respective coordination system, population density, relief, distance between locations and NGA technologies. Data was consolidated and exploratory analysis used for its processing. The sample was analyzed with state-of-the-art method[1], and at the same time also parallel through intelligent harmonization protocol which represents the "beyond state of the art" method of data processing. The calculated values are amounts of private investments into NGA infrastructure in rural and urban areas, co-financed by the EU funds, with regard to the results of the state-of-the-art method and data processing through intelligent harmonization protocol.

IV. RESULTS

Processing the samples through **state of the art** method includes pairing non-harmonized data of natural locations of users and geolocation of objects in a set coordinate system, relief characteristics of the area and the average value of the investment at each location, based on the international experience.

Intelligent harmonization protocol (**beyond state of the art**) allows mutual harmonization of data prior to their mutual combinations. Harmonization includes mutual comparison of the same type of data, finding

[1] Data can be combined and processed without previous analysis on mutual compatibility and without implementation of the harmonization process.

differences, analysis of these differences and equalization of the same types of data that are written in a different way. This eliminates the possibility of exclusion of some locations due to unevenness of the input data. Data is thus paired and assessed with geolocation, coefficient of urbanity / rurality and population density, considering the relief characteristics of the analyzed area. The intelligent harmonization protocol includes modern NGA technologies in the way that each of them is assigned a weighted value of optimal use in respective areas, depending on the characteristics of the area, which also includes the possibility of mutual combining of different technologies. Data are imported for further processing with the aim to find the optimal value of investment depending on the location, involved in processing.

The protocol is applied considering the following mathematical relation:

$B_{U,R}$ (c,t,s,h)=$L_{U,R}$ (c,t,s,h) (1)
$GL_{U,R}$ = x,y,z ($L_{U,R}$) (2)
I_{NGA} = f (r,d_p,d_l,t) (3)

The following applies:

$B_{U,R}$ = beneficiaries in urban and rural areas,
$L_{U,R}$ = beneficiary locations in urban and rural areas,
$GL_{U,R}$ = geolocations of urban and rural beneficiaries,
I_{NGA} = investment in NGA infrastructure,
c = county,
t = town,
s = street,
h = house number,
x,y,z = actual physical location in a coordinate system,
r = relief,
d_p = population density,
d_l = distance between locations,
t = technology.

Results of data processing using the state-of-the-art method and intelligent harmonization protocol are shown in Figure 1 and Table 2.

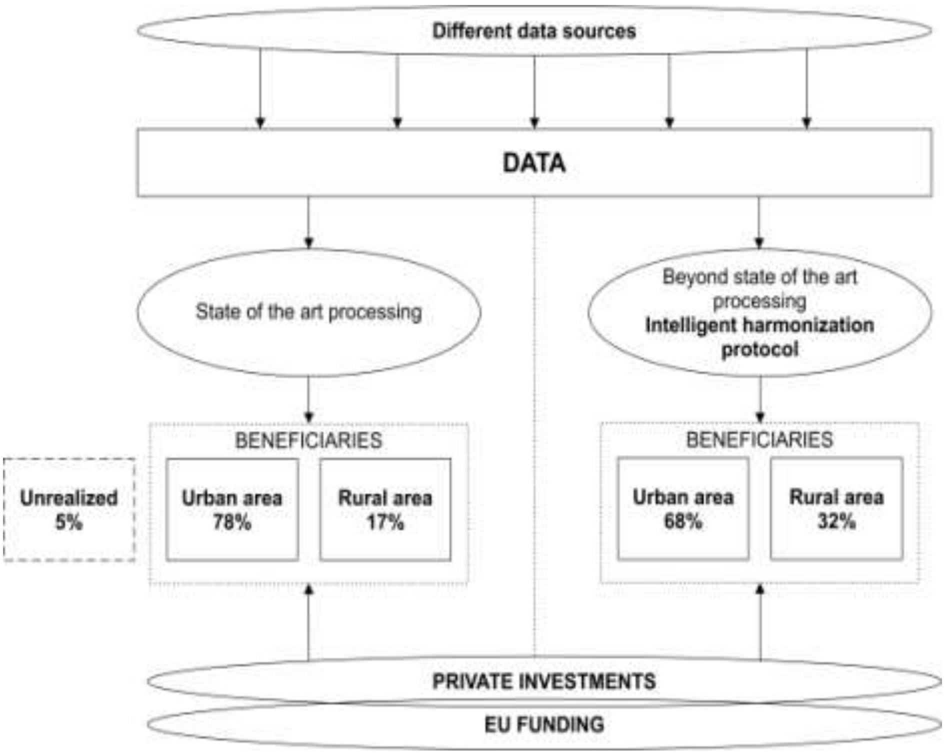

Figure 1. Results of the ratio of investment into NGA infrastructure in urban and rural areas through implementation of the harmonized protocol data.

Table 2. Comparison of private investments in NGA infrastructure in urban and rural areas according to state of the art model and intelligent harmonization protocol

Category	State of the art		Beyond state of the art – intelligent harmonization protocol	
	Amount in mio EUR	%	Amount in mio EUR	%
Private investments into NGA infrastructure	885	100	1,023	100
Urban areas	690	78	696	68
Rural areas	150	17	327	32
Unrealized amount of investment	45	5	0	0

Table 2 shows that the state of the art method of processing non-harmonized data results in the value of private investments in the amount of 690 mio EUR in urban areas, and 150 mio EUR in rural areas. This method of processing results in exclusion of a certain number of locations, which leads to 45 mio EUR of unrealized investments.

Processing data through the intelligent harmonization protocol results in harmonized data that include all locations. The amount of unrealized investments is 0. Because of parameterization of urbanity, weighted values of NGA technologies, relief and population density, the average value of investment at the level of location in urban areas is lower than the one, defined through the state-of-the-art method. By including a larger number of urban areas and lower amount of investments according to location, the investments in urban areas amount to 696 mio EUR. On the other hand, by reducing the amount of unrealized investments while at the same time increasing the number of locations, the investments in rural areas amount to 327 mio EUR.

V. DISCUSSION AND CONCLUSION

Results of performed research show a discrepancy of financial resources of telecommunication operators, invested in infrastructure in rural and urban areas. State-of-the-art data process showed that the private investments in construction of NGA infrastructure amount to 150 mio EUR, which represents only 17% of the total private investments.The hypothesis, set during this research, is thus proven. Data processing of various institutions through the intelligent harmonization protocol resulted in an increase of the share of private investments in construction of NGA infrastructure in rural areas. The amount of investments is also increasing in urban areas, but to a lesser extent as in case of rural areas. This ensures a better utilization of the EU funds which are at the same time also the means of taxpayers, paid directly into the EU budget through government taxes.Analysis, conducted during this research showed that the results, obtained through harmonized protocol data, evokes a higher interest of private operators for investments into NGA infrastructure in rural areas, all of course with help of co-financing by the EU funds. Data, harmonized through the intelligent harmonization protocol are of higher quality and as such also result in higher quality and more realistic projections of the cost development of NGA infrastructure in rural areas. Such results are a precondition for a greater focus of private investments into rural areas, which is the case at the moment.

It is thus important to stress that urban areas that are currently without NGA internet access, are partly found in areas where the telecommunication operators at present don’t show commercial interest for independent investments into NGA infrastructure. However, the interest will rise in the near future due to trends in urban development. Rural areas, on the other hand, are not interesting for operators and will because of the growing dispersal of the population in rural areas also become less and less interesting in the future.Users of the future NGA networks, co-financed by the EU funds, depend on the complex EU rules. Rules are defined in documents of the European Commission and by telecommunication standards [13]. Implementation of complex rules in the context of intelligent harmonization protocol enables a detailed and more uniform definition of eligible users.

Further research of harmonized protocol data makes sense in case of concretization of the intelligent harmonization protocol into a software application that would include all protocol parameters, defined in this research, and applicable in practice. Further development and concretization of the intelligent harmonization protocol may become applicable to all areas of building infrastructure, co-financed by the EU funds, without territorial restrictions and regardless of the type of technology, used in construction.

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