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Discretion and electronic communications markets: O-RAN perspective

Barikova Anna*
PhD in Law
National Academy of Internal Affairs
03035, 1 Solomianska Sq., Kyiv, Ukraine
https://orcid.org/0000-0002-9707-0106

■ **Abstract.** In the period of post-war reconstruction, an urgent issue for Ukraine will be the issue of integration into the supranational infrastructure of the European Union, including the electronic communications industry. Given the above, the research aims to reveal the impact of discretion on a digital single market in the electronic communications area. Using the dialectical general philosophical method, a current era of discretion in a post-industrial society, which is closely associated with a large-scale digitalization of all processes of building new models of technical solutions in the context of revolutionary standalone, evolutionary non-standalone, compromise approaches, is presented. Using the specific scientific system-structural method, the structure of the Open Radio Access Network framework for the convergence of the electronic communications market, such as open internal RAN stack interfaces (HTTP Live Streaming; Lan-Like Switching), open Northbound interfaces (management, optimization, orchestration), open interfaces for hardware and software disaggregation (vRAN functions running on Network Functions Virtualization Infrastructure), was demonstrated. The evolution of RAN has gained special attention in the context of openness and virtualization, using the general scientific formal empirical method of comparison, based on a combination of Open Radio Access Network and Cloud Radio Access Network regarding vRAN as a key enabling technology. The practical value of the results is that key issues of legal policy and the prospects of its coordination with revolutionary transborder processes of building a coherent GAIA-X network ecosystem based on a new generation communication technology have been revealed, including privacy, justice and non-discrimination, responsibility, consistency with human rights

■ **Keywords**: connectivity; digitalization; network ecosystem; tracking; legal policy

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■ *Corresponding author

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Introduction

The current era of post-industrial society is closely related to the large-scale digitalization of all processes of building a new cross-border model of the electronic state. In the period of post-war reconstruction, an urgent issue for Ukraine is, in particular, the issue of integration into the supranational infrastructure of the European Union, including the electronic communications industry. For the effective implementation of this process, it is important to use relevant discretionary tools for ensuring the formation and development of the electronic state, which, of course, are electronic communications. During such activities in the electronic communications market, a set of processes begins regarding the establishment, implementation, and development of electronic communications to meet the needs and interests of the state and society, specific users of the electronic communications networks and consumers of the electronic communications services.

The establishment and implementation of the economic process management policy, in particular, in the industrial dimension, as well as the organizational and legal mechanisms for regulating the functioning of the electronic communications market, remains an unresolved issue. The main part of activities in the electronic communications market has a discretionary nature, as it provides free discretion of operators or providers on the appropriate exercise of their powers. Therefore, disputes regarding the implementation of the competence of authorized entities, as well as regarding the guarantees of technical security, protection of personal data and the interoperability of systems might arise.

At the national level of research activities regarding the use of electronic communications, the latest approaches have the following directions: digital transformation; operation of the "rule of law" principle; specifics of management; and procedural issues. For example, L. Shymchenko (2022) studied the indicators of communications effectiveness in the context of digitalization. At the same time, the approach is not fully covered, considering how exactly electronic communications contribute to the digital transformation of Ukraine and how to ensure the implementation of the national European integration policy. O.P. Metelev (2022) outlined the possibilities of using electronic communications during the administration of justice.

The Ukrainian doctrine is quite detailed regarding the application of the "rule of law" principle, in particular, in the context of implementing legislation on electronic communications. A. Donchenko & O. Petryshyn (2023) interpret this principle as the basis of democracy, including the use of electronic communications during the functioning of the media, as described by S. Burlakov (2020). V.M. Lazebnyi (2021) highlighted the regulations for the use of electronic communications during information removal. V.B. Marchenko (2023) detailed implementation features of electronic commerce under the provisions of the Law of Ukraine "On electronic communications"[1]. However, the issue of harmonizing Ukrainian legislation on electronic communications with the latest European regulatory practices, as well as the legal approaches of supranational judicial authorities, requires additional attention. The managerial dimension of the administrative telecommunications law functioning has been clarified by O.S. Fedorenko (2021) and R. Shchupakivskyi (2019). The issue of cross-border cooperation within the framework of the interaction of electronic communications markets needs further clarification.

The research aims to reveal technological and legal aspects of the O-RAN functioning in the context of defining clear limits for exercising discretionary powers by the participating subjects of the electronic communications market.

Materials and Methods

General philosophical, scientific, and specific methods were used to describe theoretical and practical issues of digitization as a strategic factor in the unity of the content component and external form of reflection related to increasing efficiency and productivity from using digital technologies and social transformation.

A formal-legal method as the specific research method was used to outline the gradual integration of all spheres of state and public life in the digital universe in terms of globalization, harmonization, decentralization, and empowerment. The dialectical general philosophical method was used to highlight the digitalization in the electronic communications area as the mechanism (platform) of the information society, the internal market of information and communication technologies via the build-up of efficiency and productivity from the use of digital technologies, ensuring equal opportunities for everyone to access information, knowledge and services, increasing confidence and security in using information and communication technologies. This legal category was studied based on the general research method of formalization as discretionary, characterized by such features as reliability, appropriate quality, and quantity, as well as ease of use and universal access to digital services. The axiomatic general research method was used to describe the

[1] Law of Ukraine No. 1089-IX "On Electronic Communications" (2020, December). Retrieved from https://zakon.rada.gov.ua/laws/show/1089-20.

adequacy of pricing policy, considering the interests of the maximum number of consumers (users).

A deductive method as the general research method of theoretical research was used to outline a large-scale expansion of the digital technologies scope among the subjects of private law; the service orientation, speed of response to the needs of the consumer (user), including the update of digital services and their use in real-time; the adaptability of digital services to the needs of local technological ecosystems.

Accordingly, the general research method of unity of historical and logical was used to clarify the features of national and transboundary legal policies regarding the discretion on a digital single market consistent with the revolutionary cross-border processes of institutionalizing a coherent network ecosystem based on 5G and 6G. In this regard, the comparative legal and system-structural methods were used to prioritise technological convergence, economies of scale, convergence of access and formation of metro-networks through the architecture of a switched packet via Voice over IP technology, synchronization of time-division multiplexing transmission systems, a set of consolidated broadband services such as "triple" and "quadrilateral" service (considering the addition of mobile communication). Empirical general methods of observation, description and comparison were used to outline the normative provision of spatial integration of the electronic communications markets, based on updating the corresponding legal framework in terms of the use of electronic communications through infrastructure shifts, i.e. the introduction of machine communication through the prism of creating conditions for advanced high-speed mobile broadband communications, universal availability of the latter, public anonymity and high reliability.

A hypothetical method has provided an opportunity to formulate recommendations regarding a GAIA-X network ecosystem functioning, considering the necessity to secure the tracking processes and guarantee personal status.

■ Results and Discussion

In 2018, 5 mobile carriers collaborated to launch the O-RAN Alliance (O-RAN Alliance Continues…, 2020), which has already united operators and providers worldwide, e.g., from China, Taiwan, Japan, United Kingdom, India, Germany, etc (44 Chinese companies have…, 2020). Major European Operators (Deutsche Telekom AG, Orange S.A., Telefonica S.A., and Vodafone Group Plc) are supporting the rollout of Open RAN (Major European operators accelerate…, 2023). Italian operator TIM (Telecom Italia Mobile) has also joined this initiative (Tomas, 2021) of collaboration to transform the Radio Access Network. As of September 2023, 13 countries have signed a Memorandum of Understanding, 11 have implemented a commercial launch of such an initiative, 10 are at the pre-commercial stage, 7 are in deployment, and 11 are in testing. Open Test and Integration Centres are located in the countries of America and Asia.

O-RAN structuring framework has instrumental and procedural characteristics. It could be considered as a dynamic category in the electronic communication market's convergence. In its technical dimension, it deals with openness and virtualization based on a combination of ORAN and Cloud RAN regarding vRAN as a key enabling technology. From its legal perspective, international legal sources for the regulation of relations in the area of electronic communications (international conventions, international treaties and agreements, directives) are to be primarily taken into account regarding the legal status of public administration, operators and providers (electronic communications operators and providers of electronic communications services), entities receiving services in the area of electronic communications (consumers and/or users), as well as the protection of individual rights and freedoms.

Software implementations of functionality might be considered one of the key factors of change during the implementation of the O-RAN framework (Hanselman, 2019), considering the technological base, software, communication speed, and data protection capabilities (Parallel Wireless, 2020). An Open vRAN is built to accelerate 5G Open RAN deployments. The xRan was designed for this task, which is now incorporated into O-RAN. ORAN defines the interfaces at the level, that which 3rd Generation Partnership Project does not (Third Generation Partnership Project Agreement, 2007). O-RAN does define interoperable profiles for F1 that have been defined for the 5G HTTP Live Streaming.

Technical solutions could have the following areas of discretionary implementation (Fig. 1): revolutionary standalone approach, based on the packet core, providing the latest services with ultr a-minimal delay, in particular, network segmentation, a new set of services with minimal delay for restructuring of technological solutions; evolutionary non-standalone approach with the development of existing technologies and products, possible simulation in combination with the "shake" approach, but with deteriorating quality or bandwidth service capabilities; compromise approach. It is important to consider the gold and millimetre frequency bands within the global map and synchronization, as well as the real effects and implementation problems. Radio network design involves stopping innovation from suppliers, and telecom industry leaders, and using open-source developments to collaborate.

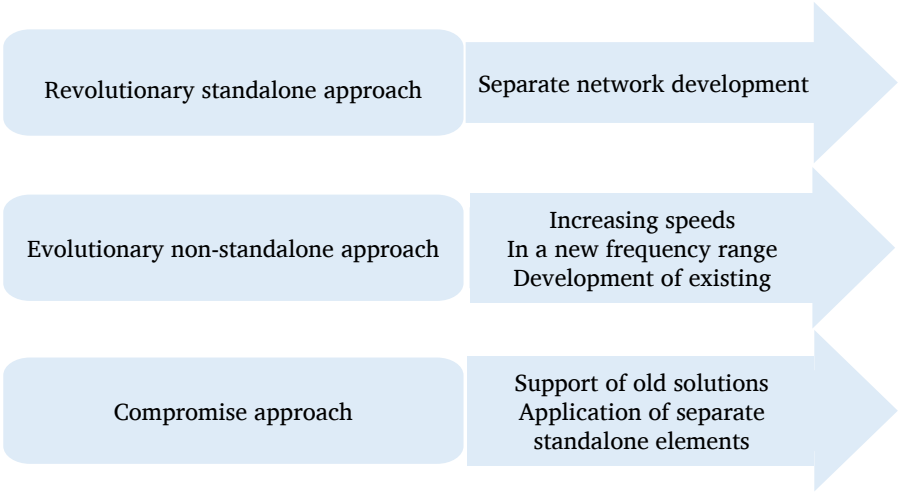

Figure 1. Discretionary implementation of technical solutions
Source: compiled by the author based on current technical solutions

O-RAN concerns the flexible architecture, being interoperable, with split and deployed layers with open communication (Kazemifard & Shah-Mansouri, 2021). O-RAN allows multiple architectural options. ORAN defines interfaces between various modules. These interfaces are fairly generic and could be used internally within a "box" if required. A primary advantage of ORAN is the possibility of innovation within the module. For a transboundary dimension, virtualized central unit server requirements are essential, regarding high central processing unit intensive, medium intensive, low storage intensive, high (SRIOV) input/output intensive, possible crypto hardware acceleration, no timing support, virtual machine, hardware-based container for virtualization, law environment constraints (standard indoor form factor compute, cases, temp hardening, Network Equipment-Building System compliance).

It is possible to form an intermediate conclusion that within the O-RAN common transport infrastructure. There are no solutions for hybrid automatic repeat request timing limit in 5G New Radio. Fronthaul is to have a minimum bandwidth usage even with no user equipment traffic. The constraint is to be on the operation of the random-access channel window, which could be set to 10ms. Fronthaul requires strict synchronization phase accuracy, but cluster relative sync could be used.

5G applications might be based on the cloud virtual reality regarding the appropriate quality of experience in "vertical" services, including the use of the Non-Real-Time RAN intelligent controllers and Near-Real-Time RAN intelligent controllers. As such, the O1 interface collects data for training in Non-Real-Time RAN intelligent controllers. The central unit software module helps support data provisioning to Near-Real-Time RAN intelligent controllers and Non-Real-Time RAN intelligent controllers and executes quality of service enforcement decisions from Near-Real-Time RAN intelligent controllers. The machine learning models about the multidimensional data could be trained offline in a Non-Real-Time RAN Intelligent Controller. The model inference is to be executed in a Near-Real-Time RAN Intelligent Controller. The Non-Real-Time RAN intelligent controllers could apply the A1 quality of service policies to re-allocate RAN resources via the same service and Near-Real-Time RAN intelligent controllers could implement these policies on central units / distributed units through the E2 interface (Li & Akman, 2020). Frontal security is a discussed issue. Some operators deploy IPSec on backhaul, as well as for Midhaul. The deployment strategy of IPSec on xHaul varies a lot from one part of the world to another. IPSec could be a useful tool for control and management messaging. The use of security encapsulation will vary on the level of trust the operator has in its infrastructure.

Convergence processes eliminate differences between the Anglo-Saxon and continental systems of law (Mykhailina & Hotsulyak, 2021). A legal framework is to be formed for adopting architectural decisions, using the resources and the latest technologies based on dynamic topology through the prism of consumer-oriented activities of government structures within the electronic communications industry (smart terminals, cloud technologies, personalized media centres, etc.). Accordingly, supranational law, as part of the regulation of activities of the subjects of the electronic communications market, objectively appears as the universal pluralistic regulatory order for their behaviour. The described model allows for establishing formalized criteria at the normative level for the effective use of electronic communications in the conditions of public and private life digitalization. There are rules of law on electronic communications relating

to the recognition of legal facts (validation rules) and those that establish conduct standards in the light of law-making facts, including conflict of laws, interpretations, and rules of logic operations (the rules of legal facts exegesis).

Within the GAIA-X initiative (an initiative that develops, based on European values, digital governance that can be applied to any existing cloud/edge technology stack to obtain transparency, controllability, portability and interoperability across data and services), it is crucial to adhere to the provisions of completion and antitrust law. The European Union Digital Markets Act is a legislative proposal that covers gatekeeper platforms and their obligations, data sharing between gatekeepers and business users (avoiding discrimination within the gatekeeper platform; data sharing obligations with business users inside the platform; data sharing with business users outside the platform); anti-competitive behaviour (tying and bundling, self-preferencing); advertising; app stores; mergers and merger policy (effects of mergers and acquisitions in the digital world, pre-emption, synergies, innovation); enforcement and the information gap between platforms and regulators; fair platform behaviour[1]. For the GAIA-X network ecosystem, regulations on anticompetitive behaviour and self-preferencing are exceptionally important.

The risks for GAIA-X and O-RAN ALLIANCE members of non-conforming with Regulation 2016/679[2] (General Data Protection Regulation) and the CLOUD Act[3] also remain. One such risk, concerning global processing services under supra-regional agreements, is data controllers' functioning, etc (Rojszczak, 2020). This issue is particularly relevant, as tracking is often about the status of persons or their geolocation, as well as data from digital certificates often used in mobile applications. This is a restriction on the fundamental conventional rights and could lead to the disclosure of pseudonymised data, especially if the information systems are centralized and/or if the information is released publicly.

It is advisable to preserve the essence of the rights and freedoms of individuals using this traditional three-part test, with an emphasis on the proportionality of such intervention. According to the ECtHR's settled case law, to determine the compliance of a measure with the principle of legality, it is necessary to analyse three criteria (Fig. 2): 1) whether such a measure is lawful (provided by national law); 2) whether the purpose of such a restriction is legitimate; 3) whether such a measure is proportional to the goal (ensures a fair balance between the interests of society and the need to respect the fundamental rights of the individual). If at least one of these criteria is not met, the ECtHR finds that the state has violated Article 1 of Protocol No. 1 to the Convention for the Protection of Human Rights and Fundamental Freedoms[4]. The aforementioned case does not adhere to such criteria. The following principles are breached: privacy; justice and non-discrimination; responsibility; and consistency with human rights.

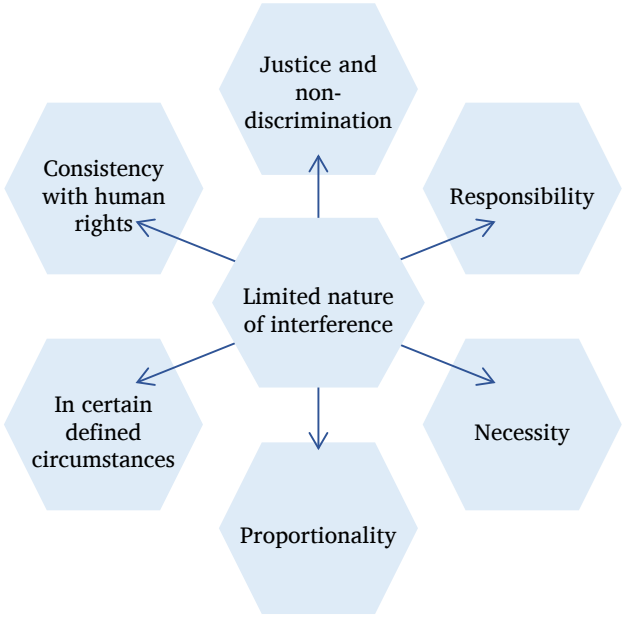

Figure 2. Guaranteeing the personal status within the tracking processes
Source: compiled by the author based on case law (Breyer v. Germany, 2020)[5].

However, requiring personal data from mobile operators does not always violate the right to privacy. The European Court of Human Rights has stated in the case "Breyer v Germany" that the interference

[1] Proposal for a regulation of the European Parliament and of the Council on contestable and fair markets in the digital sector (Digital Markets Act). (2020, December). Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020PC0842.
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[4] European Convention on Human Rights. (1952, March). Retrieved from https://www.echr.coe.int/documents/d/echr/convention_ENG.
[5] Case of Breyer v. Germany App No. 50001/12. (2020, January). Retrieved from http://hudoc.echr.coe.int/eng?i=001-200442.

might be of a limited nature regarding certain defined circumstances (paras 61, 95, 100, 103)[1]. The state is to take care of a certain balance between the means of influence, an adequate assessment of illegal actions and the goal to be achieved. The principle of proportionality must ensure that an appropriate balance is struck between any adverse effects that might be caused by the rights, freedoms, or interests of the parties to the legal relationship, as well as the objectives of the actions. The principle of proportionality provides for the use of means proportionate to the objectives pursued, ensuring, through measures taken, a clear balance between the public interest and the interests of individuals. Disclosing personal data and its use for any kind of research is unlawful.

Consequently, the relevant conditions for the digitalization of the electronic communications market and protection of the rights, freedoms, and legitimate interests of consumers of the electronic communications services (users), the rights and legitimate interests of operators and providers of electronic communications are to be institutionalized. From the organizational and legal perspective, this point of view means that the conditions for the entry of the national market segment to the cross-border electronic communications space are formed by streamlining the procedures for the cooperation of subjects of the electronic communications law.

Prospects for implementing artificial intelligence in the context of electronic communications functioning are related to the possibility of digitizing the identity of the law enforcement officer. It is about creating the "core" of a single ecosystem of artificial intelligence at the national and supranational levels for decision-making based on the best personal and professional qualities of a person from the gene pool of nations and a computer as a system of interconnected information. Such models and algorithms will allow, through prognostic and evaluative cognitive activity, to simulate the processes of conscious human activity while working with various objects of the subject area and other individuals. The final decision is to be made in the symbiosis of human and artificial intelligence. The representation of the pairing of the interaction of people and technology is considered optimal at the current stage of the global development of mankind. Such a possibility of introducing artificial intelligence during the exercise of discretionary powers is a constructively solvable uncertainty and a completely solvable variation (Fig. 3).

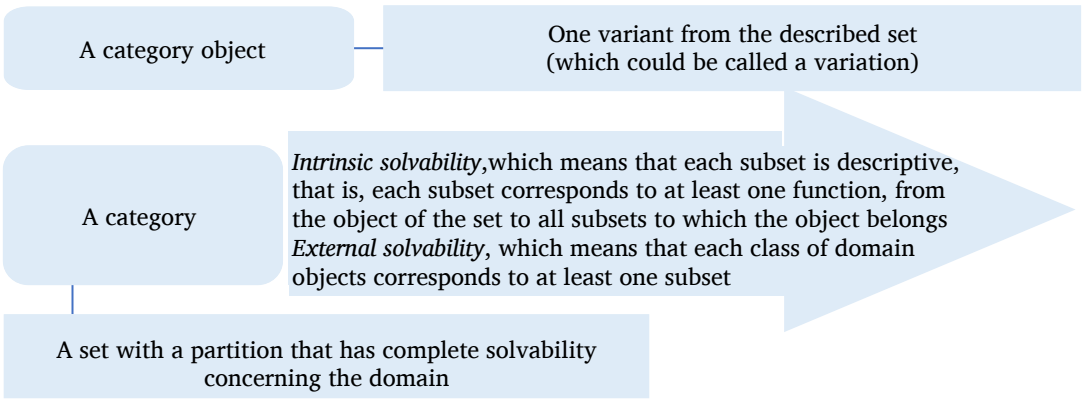

Figure 3. Introducing artificial intelligence during the exercise of discretionary powers
Source: developed by the author

On 9 June 2020, the Council of the European Union presented its Conclusions on shaping Europe's digital future[2]. Considering the provisions of this regulatory act, an urgent issue in the context of using the latest technologies of electronic communications is the creation of such an infrastructural environment where digital sovereignty and security are guaranteed, risks are minimized, conditions for connectivity are created, and post-crisis issues, which stand before humanity, will be resolved. It is about the formation of strategic international digital value chains and the provision of common European Union values that contribute to sustainable development, the institutionalization of fair competition on a global scale, autonomy, and transparency in the behaviour of subjects of the electronic communications market, as well as promoting human rights and fundamental freedoms, considering the position of the state, civil society, and scientific community.

[1] Case of Breyer v. Germany App No. 50001/12. (2020, January). Retrieved from http://hudoc.echr.coe.int/eng?i=001-200442.
[2] Council conclusions on Shaping Europe's Digital Future. (2020, June). Retrieved from https://www.consilium.europa.eu/media/44389/st08711-en20.pdf.

Thus, a challenge, which needs an urgent solution to achieve a substantial boost, is the attraction of investments, recovery planning, and the development of high-impact infrastructure projects, in particular, in the cross-border format, which will create conditions for the leadership of the European electronic communications market in the global dimension based on innovation and creativity. Considering the deployment of European Union-wide Gigabit networks, it is also important for Ukraine to reformat electronic communications markets appropriately, focusing on both global scale standards and national digital capacity to guarantee all-inclusive access to high-capacity digital infrastructures based on value chains. An important aspect of both legal policy and research activities is the formulation of a coordinated approach for members of the European and Ukrainian communities, both regarding the common framework for the functioning of electronic communications markets and ensuring cybersecurity during 5G and 6G deployment.

At the current stage of developing the electronic communications market in national and supranational dimensions, a scientific and practical discussion aims to evaluate the impact of the legal provisions on the electronic communication markets convergence, in particular, using empirical general methods of observation, description and comparison regarding the inextricable connection of such convergence with the transitional digitalization process. The main goal of scientific guidance is to advocate for public policies that support the development and implementation of open and interoperable technological solutions in the electronic communications market that are not only innovative but also secure, including wartime calls, in particular for the use of radio frequencies. The discussion on relevant practical technical solutions deals with ensuring convenience, universality, distribution, as well as observability and rationality of behaviour, transformation via virtualization through platforms in real-time, with dynamic updates from agency programs based on a combination of documentary and technical parts. It is about standard interfaces and network architecture for a decomposed, virtualized, open, and intelligent system.

The contemporary doctrine on digitization, including the electronic communications area, outlines the use of the legal and algorithmic normative systems, researched by P. Friedl (2022) in the Anthropocene, described by A. Camacho (2023) when controlling market power in the digital economy, which has been outlined within the digital services act. A characteristic feature of the European doctrine is the support of a practically established position regarding the adoption of a comprehensive regulatory act on electronic communications. The systematized normative act on electronic communications is to cover the scope of application, objectives, and principles; the institutional framework; the rules on market entry; the end-users rights; the obligations aimed to stimulate competition; the rules on universal service and must-carry (de Streel & Hocepied, 2021). It is worth agreeing with F. Liberator & J. Konidaris (2021) who single out such sources of law as treaties and conventions, regulations, directives, decisions, recommendations, communications, and notices, considering the proper cases. In the latest studies, special attention is paid to the "soft law" in the regulatory process to comply with European expectations (Sulev, 2020).

The positions, proposed in this study regarding the technical characteristics of ORAN are supported by doctrinal approaches considering the minimum delay function placement and resource allocation in mobile networks (Kazemifard & Shah-Mansouri, 2021). S.F. Schwemer *et al.* (2021) noted that the current liability exemption regime is to focus on transmission in, or access to, a communication network, as well as storage. In the context of the provisions of the ORAN Alliance outlined in the article, could partially support the outlined approaches, but consider the risks of excessive freedom in the electronic communications market. In the conditions of the digital economy, A. Camacho's (2023) conclusion is to be considered relevant regarding the essential requirement to pay attention to ethical and service circumstances for the use of mobile networks concerning adaptive law, in terms of the latest technological revolution and the aggravation of armed aggression.

One can agree with P.I. Colomo (2022), considering the market analysis procedure as the ideal of future-proof regulation with the ability to adapt to the economic and technological evolution of the industry. The approach of the integral "social" policy in establishing the digital society and economy deserves special approval regarding the balance between the "access rights and protection" and the "industrial policy" for the producers (Ruck, 2020). The author's development of this approach relates to the formulation of the comprehensive practice of the electronic communications market participants' behaviour, in particular, in the context of interpersonal relations, the introduction of artificial intelligence into the information and technical systems of operators and providers, as well as for security solutions. It is necessary to consider such privacy issues when using mobile applications as contact tracing, and use of personal data, on the one hand, as well as restrictions that violate interoperability on the other.

Particularly, O. Kokoulina (2023) deals with digital contact tracing regarding key subjects, technical processes, and data protection. The balance between privacy and transparency is a top issue against data exploitations by online platforms with a zero-price business model, which A. Toth (2023) has proven.

It is worth considering the opinion of researchers about the feasibility of reconciling transparency and privacy, particularly, in CLOUD Act agreements (Rojszczak, 2020) and tracing apps (Kokoulina, 2023). For Ukraine, the outlined approaches are extremely relevant, since the post-war reconstruction concerns, in particular, cross-border integration of electronic communications markets. This process requires coordinated regulatory regulation, management practices, and interoperability of networks and services.

Conclusions

The legal policy related to digitalization concerns the introduction of 5G and 6G in the transition to a discretionary technological mode. It is a whole ecosystem that can ensure the development not only of the communications industry but of the country's welfare as a whole, in particular, through revolutionary change. Key issues of coordinating the legal policy with revolutionary transborder processes of building a coherent GAIA-X network ecosystem refer to applying a new generation of communication technologies in the context of guaranteeing security and trust, system federalism, transparency and openness, digital sovereignty, opportunities for development and introduction of innovations to achieve a balance between the harmonization of the regulatory array in the area of electronic communications, the performance of rights and legitimate interests of the subjects of the electronic communications market and ensuring the synchronism of this process.

O-RAN architecture is truly open, covering accessible internal RAN stack interfaces (HTTP Live Streaming, Lan-Like Switching), open Northbound interfaces (management, optimization, orchestration), open interfaces for hardware and software disaggregation (vRAN functions running on Network Functions Virtualization Infrastructure). The baseline interoperability is guaranteed, but vendors can differentiate on top of that baseline. The O-RAN licence conditions enable such augmentation to their YANG models. O-RAN has a common transport infrastructure for all traffic types, allows any-to-any connectivity for evolved 5G architecture requirements and defines distributed unit (including radio) categories that determine transport latency.

The prospects for conducting additional research are intricately linked to the multifaceted technical and legal aspects surrounding the operational dynamics of a GAIA-X network ecosystem, which is founded upon cutting-edge next-generation communication technologies. Moreover, there is a compelling need to address and ensure the robustness of tracking processes and safeguard the personal status of individuals, particularly in the context of acquiring data sourced from digital certificates.

Acknowledgements

None.

Conflict of Interest

None.

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Дискреція та ринки електронних комунікацій: перспектива O-RAN

Анна Барікова
Кандидат юридичних наук
Національна академія внутрішніх справ
03035, пл. Солом'янська, 1, м. Київ, Україна
https://orcid.org/0000-0002-9707-0106

■ **Анотація.** У період післявоєнної відбудови актуальним питанням для України буде, поміж інших, питання інтеграції в наднаціональну інфраструктуру Європейського Союзу, зокрема в галузь електронних комунікацій. З огляду на зазначене, метою статті було виявлення впливу дискреції на єдиний цифровий ринок у сфері електронних комунікацій. З використанням діалектичного загальнофілософського методу представлено сучасну еру дискретності в постіндустріальному суспільстві, яка тісно пов'язана із широкомасштабною цифровізацією всіх процесів побудови нових моделей технічних рішень у контексті революційного автономного, еволюційного неавтономного, компромісного підходів. Із застосуванням конкретно-наукового системно-структурного методу продемонстровано структуру O-RAN (відкритої мережі радіодоступу) для конвергенції ринків електронних комунікацій: відкриті внутрішні інтерфейси стека RAN (комунікаційний протокол для потокової передачі медіа на основі HTTP; комутація, схожа на локальну мережу), відкриті північні інтерфейси (керування, оптимізація, оркестровка), відкриті інтерфейси для дезагрегації апаратного та програмного забезпечення (функції vRAN, що працюють на інфраструктурі віртуалізації мережевих функцій). Розвиток RAN привернув увагу в контексті відкритості та віртуалізації з використанням загальнонаукового формального емпіричного методу порівняння на основі поєднання ORAN і Cloud RAN, причому vRAN розглянуто як ключову технологічну технологію. Висвітлено головні питання правової політики та перспективи її узгодження з революційними транскордонними процесами побудови цілісної мережевої екосистеми GAIA-X на основі комунікаційних технологій нового покоління, з огляду на приватність, справедливість і недискримінацію, відповідальність, узгодженість з правами людини. Практична цінність дослідження полягає в можливості використання запропонованих автором рекомендацій у сфері державного регулювання електронних комунікацій

■ **Ключові слова:** зв'язність; цифровізація; мережева екосистема; відстеження; правова політика