Transforming the Internet with 6G: Towards Architectural Extensibility

Aleksandr Zavodovski
University of Oulu
Oulu, Finland
aleksandr.zavodovski@oulu.fi

Nitinder Mohan
TU Delft
Delft, The Netherlands
n.mohan@tudelft.nl

Abhishek Kumar
University of Oulu
Oulu, Finland
abhishek.kumar@oulu.fi

Sasu Tarkoma
University of Helsinki
Helsinki, Finland
sasu.tarkoma@helsinki.fi

Jussi Kangasharju
University of Helsinki
Helsinki, Finland
jussi.kangasharju@helsinki.fi

Ari T. Pouttu
University of Oulu
Oulu, Finland
ari.pouttu@oulu.fi

***Abstract*—6G is envisioned to be substantially more than just a next-generation wireless communication technology. It is thought of as a universal intelligent fabric that will have a transformative effect on societal structure, empowering the emergence of smart societies. A massive deployment of the new technology at the very edge of the network provides a limited, yet unique opportunity for the evolution of the Internet itself. In this paper, we aim to identify how the impact of a wide-scale 6G deployment can affect the Internet's architecture, which has a long time been criticized for its ossified state. To take advantage of this chance, careful consideration must be taken at an early stage of the 6G infrastructure design. We investigate how to implement extensibility in 6G to enable deployment and proliferation of what essentially is layer 3.5, and, eventually, unbuckle the thin waist of the Internet. Also, we examine what clean-slate internet architectures appear to be the most promising in conjunction with the massive renewal of the Internet's edge. Our paper serves as a call to action for making the Internet future-ready as 6G reshapes its edge.**

***Keywords*—6G, Internet architecture, Internet evolution**

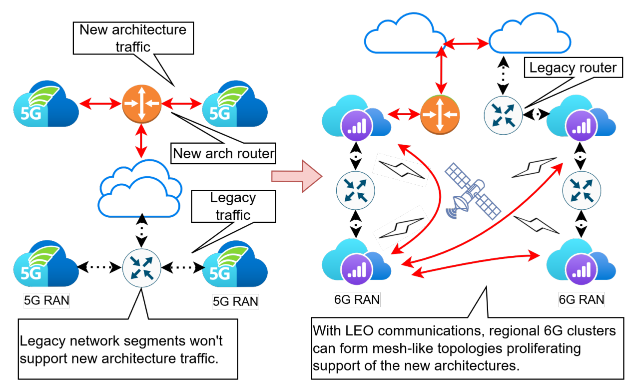

Fig. 1. The concentration of traffic in hub-and-spikes-like patterns around conventional cloud data centers can be complemented by point-to-point mesh-like topologies formed by 6G clusters connected by direct LEO satellite links. Therefore, layer 3.5 (new architecture) traffic can flow directly between them without being affected by the lack of upgrades in the core network.

I. Introduction

The edge of the Internet is on the verge of a prominent transformation due to the upcoming upgrade to the 6G wireless technology. The change is presumably to be significant because 6G is anticipated to be not just a quantitative improvement to the existing 5G [1], but rather a new technological paradigm to trigger a shift in societal structure towards what is envisioned as a smart society [2], [3]. Therefore, in addition to reducing the latency of the last mile to the sub-millisecond level, 6G is poised to cater to a variety of highly advanced services and technologies, such as artificial intelligence (AI), distributed ledgers (DLT), metaverse, etc., to establish a comprehensive fabric capable of empowering the smart society of the future. While the "network of networks" concept of 5G also matures in 6G by incorporating satellite and cloud-based core networks, it also embraces the vision of "service of services" [4]. This all means that not only will radio equipment be replaced, but also local and regional networks are likely to undergo a deep renovation to become the unifying medium of the edge-cloud continuum, since the provisioning of computing capacity for the services will be 6G's integral part.

In this context, the Internet will experience strong evolutionary pressure as it will have to cope with a bottom-up revolution on its periphery, which will be pulling increasing amounts of resources and services toward itself and demand ever-shortening paths to central hubs such as data centers. However, the Internet is notoriously known for its intrinsic capability to resist changes [5], and *revitalization* [6] is considered one of its main challenges nowadays since many innovative propositions with sound technology and socioeconomic value remain either research peculiarities or hobbies of enthusiastic but non-mainstream communities.

The current situation can be considered as a unique opportunity. Even if we assume that the core of the Internet will remain mostly rigid, the massive deployment of new technology on its periphery opens up the possibility of embedding long-anticipated architectural extensibility, at least, into the edge of the network. Despite its limited scope, such an opportunity should not be neglected, as if it is properly implemented, it can be a catalyst for broader changes in other core strata of the Internet, eventually leading to what McCauley et al. [7] see as the state of *permanent revolution*. Also, as we show next, the severity of limitations can be overcome to some extent.

The primary hindrance to the Internet's development has been the necessity of performing a massive upgrade involving numerous heterogeneous entities. A good example is the IPv6 upgrade, which has been ongoing for two decades but is still reaching around 50% of the connectivity.[1] The QUIC [8], which became an innovative success due to its initial developer's unique position – controlling both endpoints – was forming around 7.8% of the total traffic[2] in 2018 and 30% of EMEA (Europe, the Middle East and Africa) region traffic[3] in 2022. Logically, since 6G will be deployed at the periphery of the network, equipment upgrades will also be limited to the network's edge. Then, what can make 6G a game-changer so that the novel architectures won't be confined just to regional networks of mobile network operators (MNOs)? The opportunity can be in the emergent topology that regional MNO's 6G networks can form due to novel, long-range communication channels, such as those provided by low Earth orbit (LEO) satellites. Namely, installations of 6G networks can become interconnected via those links and provide direct communication channels for clients residing in geographically different installations, which previously could be connected only via core routers. In this setting, legacy core routers won't prohibit the utilization of novel architectures if 6G is architecturally extensible. We illustrate this development in Figure 1, suggesting that the evolution pathway of network topology may be expanded from a hub-and-spoke, cloud-centric model towards a point-to-point mesh-like structure, where "points" will be regional 6G installations. This trend is further amplified with computation becoming more decentralized with edge and various forms of in-network computing.

The importance of local computing facilities will grow as 6G aims to provide more secure and faster services, which may even lead to a decrease in the amount of direct client traffic towards hub-like data centers. Further, this may lead to a situation where shortages in computing and storage capacities will be compensated with resources from adjacent, LEO-connected 6G network clusters instead of conventional cloud data centers. Given this trend and that 6G will have built-in extensibility, adding the missing 3.5 layer, the new architectures can gain significant amounts of traffic, therefore bringing numerous benefits that they have promised.

This paper comes at the cusp of 6G developments before they get muddled with incremental discussions that satisfy low-hanging improvements that could not be satisfied in 5G, and the intention is to provoke discussion. Also, we attempt to encourage closer collaboration on 6G between the 3GPP, IRTF, and IETF. Since 6G is intended to be more than just a wireless link to fulfill its mission, the challenges of 6G require a holistic approach involving contributions from both the wireless and internet sides of the networking community. To summarize, we will investigate how revitalizing the Internet by rebuilding its periphery is possible and what limitations this approach will have.

[1] https://www.google.com/intl/en/ipv6/statistics.html
[2] https://blog.apnic.net/2018/05/15/how-much-of-the-internet-is-using-quic
[3] https://www.sandvine.com/blog/quic-is-quickly-taking-over

II. New Architectures at a Glance

As the Internet went public, it was soon realized that it would be beneficial to continue the evolution of its core architecture to accommodate society's needs better, improving security, performance, mechanisms of addressing and routing, etc., and incorporate opportunities for extensibility that will make this evolution smooth. The NewArch project was the first prominent undertaking to envision and prototype the future technical foundations of the Internet. Releasing its final report in 2004 [9], the project introduced many key elements and concepts (e.g., separation of location and identity, the knowledge plane, etc.), many of which have become mainstream topics of the networking research for the next decade, and many still remain relevant. Particularly, the New Inter-domain Routing Architecture (NIRA) [10] can be considered as a precursor of eXpressive Internet Architecture (XIA) and, consequently, SCION (standing for Scalability, Control, and Isolation On Next-Generation Networks), which is, to the best of our knowledge, probably the only one commercially deployed alternative architectural framework at the moment [11].

Next, we examine the potential of the four prospective candidates for future 6G-driven internet design: Trotsky Processor (TP), Information-Centric Networking (ICN), SCION, and XIA. Many more clean-slate designs have been proposed, but due to the limited scope of this work, we selected these four due to specific reasons. **TP** is not a new architecture but a universal extensibility layer that enables the deployment of many existing clean-slate designs and also future ones, providing the Internet with a long-anticipated layer 3.5. **ICN** is a good candidate for deployment in the 6G context since it effectively utilizes caches near end-users. **SCION** has strong security features, such as path selection, and it is the only practically used framework. **XIA** was the predecessor of SCION, which also implements key security features of SCION and, due to its expressiveness, can symbiotically support ICN and other novel architectures. XIA also has good intrinsic support for mobility, which is an essential need for 6G.

Trotsky Processor. Relatively recently proposed in 2019, TP [7] is a framework that is capable of hosting existing clean slate architectures, e.g., according to the authors, they tested TP with ICN implementation, Named Data Networking (NDN), and XIA [12], [13]. However, the main advantage of TP is that it is intended to be a universal extension point capable of hosting not only existing ones but also future architectures, thus enabling the state of the permanent revolution for the entire Internet.

The downside for TP in the 6G context is that the framework requires installations at the inter-domain boundaries, where a couple of BGP routers connecting two different domains should be replaced (or augmented) by two TPs. Another major drawback of TP is that the authors did not make their solution open-source or otherwise available for testing or production deployment, so there is no third-party practical experience or supporting ecosystem. If anyone becomes motivated to utilize the concept of TP, the entire framework must be implemented from scratch, which is both a challenge and an opportunity. Despite these shortcomings, we find the general idea of TP very attractive, as it serves as a universal extension point, a vital trait of any solid architectural design. As we show later, there are various ways to adapt this idea to a bottom-up scenario when the change will initially happen only at the edge of the network near end-users, excluding immediate changes at other inter-domain boundaries, which ISPs might be reluctant to do. If TPs were to firmly integrate into 6G, enabling TP connections for hosts and end-users, it would be a strong impetus for further propagation of this layer 3.5 technology in the Internet's topology.

ICN. ICN is an approach to network architecture that emphasizes data as a primary element, shifting the focus from host-based to content-based communication with semantic addressing. ICN has many variants and implementations, i.e., the very first one was Data-Oriented Network Architecture (DONA) [14] and later came Named Data Networking (NDN) [15], which is supported by TP. From a 6G perspective, ICN is particularly attractive since it is based on powerful caching mechanisms that perform best when deployed at the edge. ICN is not limited to content delivery. ICN concepts also facilitate distributed computing [16] and Compute First Networking (CFN) [17].

SCION. One of the major features of the SCION [11], [18] is to provide route control, i.e., the source and destination domains of the packet can specify the list of domains that should be avoided during packet delivery. SCION is also more efficient and scalable than BGP and provides numerous other security benefits, such as support for global and heterogeneous trust. Importantly, the framework is used by Swiss financial sector companies SNB and SIX.[4] It has also been successfully deployed by Swisscom[5] and SWITCH[6] ISPs, making it probably the most practically tested architectural candidate.

In [11], the team behind SCION provides an in-depth comparison of other clean-slate designs against SCION. According to them, SCION can be even more energy efficient than ICN technologies. However, this may depend on many parameters and settings, and more investigation is probably needed. They see TP to be complementary to SCION and see that SCION can benefit from deployments of the Trotsky framework. Additionally, in [19], the author addresses the "New IP" initiative by Huawei, saying "'New IP' has already arrived, and it is called SCION".

XIA. XIA [12], [13] is built on the concept of *architectural principals* that can mutually define the ways and conditions for communication. The principals are first-class citizens in XIA, and they can be such entities as users, content, or even services. Due to its expressiveness, XIA aims to support the continuous evolution of novel architectures, similar to TP. However, this is accomplished differently, not establishing layer 3.5 serving as a universal vehicle for clean-slate approaches but translating between architectures, thus losing end-to-end connectivity [7]. The design of XIA supports ICN and also service-centric networking well, e.g., there is a Serval [20] port to XIA [13]. XIA also has user path selection and other security features that are analogous to SCION. Relevant to 6G, XIA's architecture supports mobility well. XIA was also chosen to be tested as a TP layer 3.5 platform.

These architectures can be considered as a minimum of what 6G's extensibility should aim to support out-of-box. Each of these frameworks shares an emphasis on performance, security, and extensibility-critical characteristics for supporting the advanced applications and global scale of 6G. In short, while these designs differ in their implementation specifics, their underlying principles pave a path toward internet infrastructure capable of meeting future ambitious goals.

[4] https://www.six-group.com/en/newsroom/media-releases/2021/20210715-ssfn-snb-six.html

[5] https://www.swisscom.ch/en/business/enterprise/offer/wireline/scion.html

[6] https://www.switch.ch/en/network/scion-access

III. Making 6G Extensible

6G architecture is far from being fully defined, so here, we rely on existing 5G design and experts' opinions on how it is likely to evolve towards the next generation. One such vision is given in [21]–[23], and the main differences between 5G and 6G are the following: the Distributed Unit (DU) is seen to be located closer to the Radio Unit (RU); also, the User Plane Function (UPF), which is especially important for us because of its responsibility for forwarding data packets, will be closer to DU; the number of network functions is likely to be reduced, and their placement across the extreme edge and cloud will become more flexible. Envisioning UPF out of the core and placing it near the boundary of the network, or even on satellites [24] at the extreme, has a good reason behind it. This can enable the routing of the packets inside the extreme edge networks, avoiding the time-costly trips to the core, which is likely to be located further away in the cloud. Moreover, this can lead to a new topology where inter-domain connectivity will be established at the grassroots level using radio or, given 6G multi-connectivity, another kind of link, e.g., visible light communication (VLC) [25]. Utilizing satellite-terrestrial [26] communications, such horizontal inter-domain links will not be limited to locally adjacent operators but, at the extreme, can potentially span over continents.

With the above preliminary architectural sketch, we identify two main candidates for placing extensibility points in a 6G system, as shown in Figure 2. The first natural place to have extensions is near UPF at the MEC or extreme edge level, where networking packets are assembled. The second convenient place is located at the core, where, as in 5G, the packets leave the boundaries of the telecommunication system. We call them *edge extension point* (EEP) and *core extension point* (CEP), respectively. This division is arbitrary as the 6G is not yet defined and exists in the form of prototypes, but conceptually, it is interesting to examine the extreme cases.

Core Extension Points. Technically, the possibility of implementing the CEPs will not be much affected by the particular design of a 6G system, and it is expected to be cloud-native. Due to available computational resources in the cloud, there will be favorable conditions for deploying additional functionality at CEPs. This can be beneficial for deploying ICN, which requires a large cache space. Also, new arch technologies such as SCION or Trotsky require a deployment at a domain boundary, and in some cases, 6G core's deployment may offer an opportunity for inter-domain connectivity. If not, for the SCION, there is a so-called *router-on-a-stick* deployment model [11], where the SCION border router, which is not located at the inter-domain boundary, can be connected to a legacy BGP router to minimize the changes in the network. For TP, the authors do not directly describe a workaround like the above, but there also may be an opportunity to introduce a technique similar to SCION's

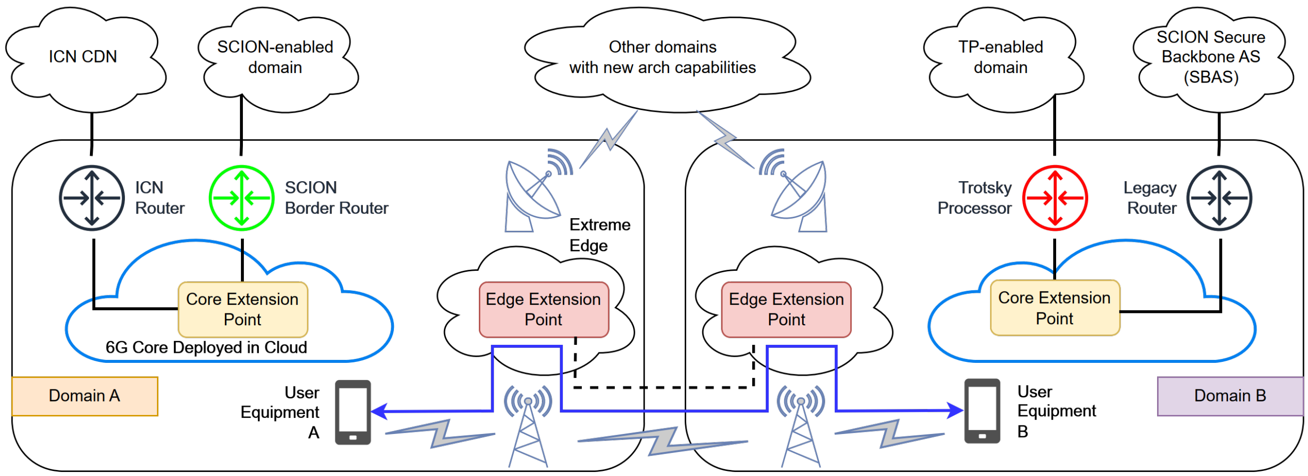

Fig. 2. Potential extension points of 6G architecture. Due to inter-domain communication at the level of EEPs, clients from A and B adjacent 6G installations can communicate directly, taking advantage of new architectures, avoiding the legacy backbone. Additionally, in the case that 6G installations will have access to long-range communication channels, native new arch connectivity will not be limited only to geographically proximate systems.

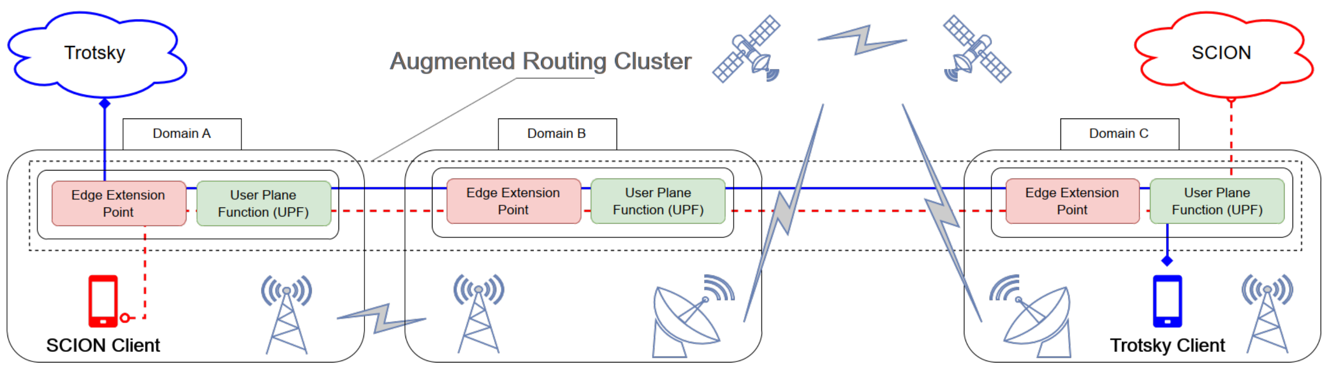

Fig. 3. Forming 6G Augmented Routing Cluster (ARC) utilizing EEPs with radio and satellite links. ARC can be seen as a sort of "subnet" or "autonomous system" whose purpose is to organize and route new architecture traffic across multiple 6G installations so that clients supporting novel technologies can either communicate directly or reach "clean slate" routers on the Internet, avoiding legacy networks.

approach as a temporary measure to facilitate incremental deployment. Alternatively, CEPs can be configured into an overlay, although it will provide more limited possibilities for deploying new architectures than border processors favored by TP and SCION.

Edge Extension Points. The design and very existence of EEPs depend heavily on how 6G architecture will be realized in practice. Despite this uncertainty, we prefer to explore the possibility of having extension points at the edge as it can provide interesting opportunities, especially when the 6G design will allow horizontal inter-domain links. In such a case, EEPs will be at the ends of these grassroots-level inter-domain connections, forming a topology with extension points at the boundaries of the domains – exactly what is desired by many clean-slate approaches. We depict a resulting structure in Figure 3 and call it an Augmented Routing Cluster (ARC). Within ARC boundaries, any domains that support the same new architecture (or universal TP-like functionality) can exchange traffic seamlessly. Moreover, ARC has the potential to form paths enabling connectivity toward the outer internet for domains that do not have direct connections with internet domains supporting the required technology. In Figure 3, we depict a situation where Domain A has no connectivity to SCION, but in ARC, there is a Domain C that is connected to SCION, so ARC can route all incoming SCION traffic there. Similarly, incoming TP traffic can be directed to Domain A, which connects to the boundary TP router. The challenge for EEPs is a scarcity of computational resources at the extreme edge. The inter-domain routing we suggested above can be computationally demanding. Also, the deployment of TP, which acts as a universal extension point supporting installations of many novel protocols, can be resource-hungry (this also depends on what technologies TP will host). The solution can be to have only the necessary components at the extreme edge and deploy less latency-sensitive components to the CEP. For example, SCION emphasized security more than speed, so its major components can reside in the cloud. In the case of ICN, EEP, together with CEP, can form a two-level cache structure.

IV. Emerging Challenges and Research Directions

Although the potential of 6G to revitalize Internet architecture is vast, a few critical challenges need systematic attention to ensure that these new infrastructures, frameworks, and protocols integrate harmoniously and securely. Below, we discuss several key areas where further research and collaboration are needed to realize the vision of a 6G-driven Internet transformation.

Standardization and Cross-Organizational Collaboration. A significant obstacle to deploying novel architectures in real-world networks is the fragmented landscape of standard-setting bodies. While 3GPP leads the charge in cellular network specifications, the IETF and IRTF spearhead Internet-related standards and long-term research. Achieving the necessary synergy between wireless technologies and Internet architectures will require closer cooperation among these organizations. Specifically, 3GPP's evolving 6G specifications need to incorporate new Internet-layer functionalities (e.g., SCION border gateways, Trotsky's extension points) in a way that can be embraced by IETF standards. Joint working groups or liaison efforts could harmonize terminology and protocol definitions, which may otherwise remain siloed.

Security and Trust Models. As network functionalities move closer to the edge, decentralized topologies become more prevalent, and new trust models will need to be established. Traditional perimeter-based security mechanisms, such as those assumed in many corporate networks, are less effective in a highly distributed, multi-tenant 6G environment. This is where frameworks like SCION can shine by enabling path selection and cryptographic validation across domains. However, even with these techniques, open questions remain regarding how to manage trust efficiently in inter-domain environments that include private networks, different nation-state policies, and potentially thousands of independently operated 6G installations. Further research on decentralized identity, zero-trust architectures, and privacy-preserving protocols at scale is critical.

Sustainability and Energy Efficiency. The growing density of edge computing resources and the proliferation of satellites for 6G (LEO constellations in particular) raise concerns about energy consumption and ecological impact. Large-scale networks that utilize distributed caching and in-network computing can reduce latency and backbone load but may increase local power demands in edge clusters. Research efforts should focus on designing protocols, routing decisions, and caching mechanisms that optimize performance without excessively raising power usage. Solutions may include AI-based network orchestration that can dynamically shift workloads to regions or times of lower energy cost or advanced battery and solar-powered edge deployments, especially in remote locations.

Integration with Emerging Technologies. Looking beyond direct communications, 6G will also intersect with trends like AI-driven service orchestration, distributed ledger technologies (DLT), and immersive metaverse applications. Each of these areas brings additional requirements.

AI-Oriented Networking: AI-based resource allocation schemes can adaptively manage network load, but they require high-quality data from diverse network points – raising privacy and data governance questions.

DLT: Smart contracts or blockchain-based identity and payment systems could facilitate dynamic, on-demand edge resource sharing among different 6G operators. However, the computational overhead of consensus algorithms demands lightweight or specialized approaches.

Metaverse and XR: Extended reality (XR) services place extremely tight latency and throughput requirements on the underlying network. ICN's caching abilities, coupled with XIA's mobility support, could be leveraged to deliver immersive experiences efficiently. Yet practical design patterns and standards for delivering XR over next-generation topologies remain underexplored.

Roadmap for Implementation. Finally, translating 6G's architectural possibilities into production environments requires an incremental roadmap. Early pilots may focus on intra-domain enhancements (e.g., deploying Edge Extension Points in testbeds), gradually moving toward inter-domain trials with partial SCION or Trotsky deployments. Industry consortia and public-private partnerships can facilitate these phased rollouts, ensuring that technical maturity aligns with market and regulatory considerations.

V. Conclusive Discussion

Ideally, the design of extension points should follow the vision of the permanent technical revolution presented along with the TP framework. This means that they must be capable of accomplishing the tasks that TP is capable of, i.e., providing a convenient platform for the deployment of clean-slate architectures, existing and future ones. Technically, extension points themselves should be designed as a well-defined abstraction layer for deploying upper-layer extensibility TP-like frameworks. Additionally, extension points can offer a set of basic services with standardized interfaces so that extensibility frameworks can interact with other components of the 6G installation and benefit from features like slicing and other techniques that are essential for next-generation networks. With edge computing being an integral part of 6G, it would be beneficial if extension points could also provide a set of services for allocating latency-stringent computational tasks and general support for edge and in-network computing in general. At present, novel architectural frameworks that would account for computing and the opportunities provided by next-generation networks are not mainstream, but the development of such architectures is a future opportunity that 6G can bolster, along with intrinsic support for extensibility. Access to edge computing may be offered via specialized interfaces as a set of services. Taking this further, extension points can offer a catalog of AI, DLT, and other services available at the particular 6G installation or in others belonging to the same cluster – ARC.

The main opportunity we see in 6G for technical renovation – the possibility of forming mesh-like topologies where different 6G installations can communicate with each other directly – is also a considerable challenge. To tackle this problem at its initial stage, we suggested forming clusters of 6G installations that can be directly connected so that novel traffic will avoid legacy routers of the backbone network. These clusters have a natural analogy in networking, namely, autonomous systems. The difference is that the entities forming ARCs can belong to different administrative domains, and the purpose of ARC is to forward new architecture traffic across its clients and also outside of the cluster, either to other ARCs or border routers of ASes that support the required novel architecture. When direct native connections are not possible, required paths can be established with overlaying and translation [27].

We aim to identify an opportunity, promote discussion, and optimistically trigger cooperative action in 3GPP, IEFT, and other remarkable internet/wireless communities. As of now, there is an obvious lack of a holistic approach, as wireless technologies form their own silo, and collaboration between the communities is limited. Our technical suggestions should be considered rough sketches that can be overturned as 6G evolves closer to its standardization and practical realization.

Hopefully, we have shown that the deployment of 6G has considerable potential to revitalize the Internet despite the fact that its scope will be limited to the edge of the network. For many clean-slate designs, a domain boundary is the right place for installation. Although 6G is not expected to trigger massive replacements or upgrades of BGP routers, it is possible that with 6G infrastructure, additional inter-domain links can be established to provide better access to edge computing resources, complex services, and other shared assets. Due to recently introduced technology, such as LEO satellites, these links can span over the continents, enabling direct connections between distant clients and avoiding legacy network segments that previously blocked the proliferation of architectural innovations.

Our vision is that once sufficiently widespread at the network edge and embraced by clients, the novel technologies can potentially trigger a bottom-up revolution for the rest of the Internet. Since the original NewArch project, the amount of innovation in computer networking has become critically massive. However, not only did the Internet but also work on novel architectural designs stagnate as there was little chance for practical adoption. The time is right for the community to consolidate its efforts again, as there is a tempting and concrete opportunity for innovation.

Acknowledgements

This work was supported by 6G Flagship (Grant Number 369116) funded by the Research Council of Finland, and Neural Publish-Subscribe for 6G (diary number 8754/31/2022) project funded by Business Finland, and partly supported by the National Growth Fund through the Dutch 6G flagship project "Future Network Services".

References

[1] P. Ahokangas and A. Aagaard, *The Changing World of Mobile Communications: 5G, 6G and the Future of Digital Services*. Springer Nature, 2024.

[2] C. Levy *et al.*, "Towards a Smart Society," *The Big Innovation Centre (The Work Foundation and Lancaster University), London.*, 2014.

[3] M. Katz *et al.*, "6Genesis flagship program: Building the bridges towards 6G-enabled wireless smart society and ecosystem," in *2018 IEEE 10th Latin-American Conference on Communications (LATINCOM)*. IEEE, 2018, pp. 1–9.

[4] T. Taleb *et al.*, "6G System Architecture: A Service of Services Vision," *ITU journal on future and evolving technologies*, vol. 3, no. 3, pp. 710–743, 2022.

[5] T. Liu *et al.*, "The barriers to overthrowing internet feudalism," in *Proceedings of 16th ACM Workshop on Hot Topics in Networks*, 2017.

[6] H. Balakrishnan *et al.*, "Revitalizing the public internet by making it extensible," *ACM SIGCOMM Computer Communication Review*, vol. 51, no. 2, pp. 18–24, 2021.

[7] J. McCauley *et al.*, "Enabling a permanent revolution in internet architecture," in *Proceedings of the ACM Special Interest Group on Data Communication*, 2019, pp. 1–14.

[8] A. Langley *et al.*, "The QUIC transport protocol: Design and internet-scale deployment," in *Proceedings of the conference of the ACM special interest group on data communication*, 2017, pp. 183–196.

[9] D. Clark *et al.*, "NewArch: Future Generation Internet Architecture," 2003. [Online]. Available: https://www.isi.edu/websites/newarch/iDOCS/final.finalreport.pdf

[10] X. Yang, D. Clark, and A. W. Berger, "NIRA: a new inter-domain routing architecture," *IEEE/ACM transactions on networking*, vol. 15, no. 4, pp. 775–788, 2007.

[11] L. Chuat *et al.*, "The Complete Guide to SCION," *Information Security and Cryptography*, 2022.

[12] A. Anand *et al.*, "XIA: An architecture for an evolvable and trustworthy Internet," in *Proceedings of the 10th ACM Workshop on Hot Topics in Networks*, 2011, pp. 1–6.

[13] D. Naylor *et al.*, "XIA: architecting a more trustworthy and evolvable internet," *ACM SIGCOMM Computer Communication Review*, vol. 44, no. 3, pp. 50–57, 2014.

[14] T. Koponen *et al.*, "A data-oriented (and beyond) network architecture," in *Proceedings of the 2007 conference on Applications, technologies, architectures, and protocols for computer communications*, 2007, pp. 181–192.

[15] L. Zhang *et al.*, "Named data networking," *ACM SIGCOMM Computer Communication Review*, vol. 44, no. 3, pp. 66–73, 2014.

[16] W. Geng *et al.*, "SoK: Distributed Computing in ICN," in *Proceedings of the 10th ACM Conference on Information-Centric Networking*, 2023, pp. 88–100.

[17] M. Król *et al.*, "Compute first networking: Distributed computing meets ICN," in *Proceedings of the 6th ACM Conference on Information-Centric Networking*, 2019, pp. 67–77.

[18] A. Perrig *et al.*, *SCION: a Secure Internet Architecture*. Springer, 2017.

[19] C. Gloor, "Huawei proposes a 'New IP', but it is already here!" [Online]. Available: https://scion-architecture.net/newsletter/huawei.pdf

[20] E. Nordström *et al.*, "Serval: An {End-Host} stack for {Service-Centric} networking," in *9th USENIX Symposium on Networked Systems Design and Implementation (NSDI 12)*, 2012, pp. 85–98.

[21] W. Qiao, "6G Network Architecture," Ofinno, 2021. [Online]. Available: https://ofinno.com/wp-content/uploads/2021/03/OFNO_White_Sheet_032421.pdf

[22] V. Ziegler *et al.*, "6G architecture to connect the worlds," *IEEE Access*, vol. 8, pp. 173 508–173 520, 2020.

[23] C. Sergiou *et al.*, "Complex systems: A communication networks perspective towards 6G," *IEEE Access*, vol. 8, pp. 89 007–89 030, 2020.

[24] Y. Li *et al.*, "A case for stateless mobile core network functions in space," in *Proceedings of the ACM SIGCOMM 2022 Conference*, 2022, pp. 298–313.

[25] S. Ariyanti and M. Suryanegara, "Visible light communication (VLC) for 6G technology: The potency and research challenges," in *2020 Fourth world conference on smart trends in systems, security and sustainability (WorldS4)*. IEEE, 2020, pp. 490–493.

[26] B. Evans, "6G Satellite Communications," in *2022 27th Asia Pacific Conference on Communications (APCC)*. IEEE, 2022, pp. 175–177.

[27] G. Ribeiro *et al.*, "Internet Architecture Evolution: Found in Translation," in *Proceedings of the Workshop on Hot Topics in Operating Systems*, 2024, pp. 300–307.