Pricing Models for 5G Multi-Tenancy using Game Theory Framework

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***Abstract*—Regions with little or no access to modern information and communication technologies (ICT) experience the digital divide, and this is typically more prominent in rural areas. 5G network slicing with multi-tenancy, known as neutral host networks (NHN), is being investigated to reduce the digital divide in regions with and without existing infrastructure. Therefore, the key questions that need to be addressed include: What are the potential pricing strategies for 5G that support multi-operator network sharing? Which pricing strategy is most profitable in areas with a digital divide for the infrastructure provider (InP) and the national 5G mobile operator? This paper evaluates the pricing strategies for 5G NHN in rural areas to attract investment from stakeholders and maximize their return on investment. The study uses the game theory framework to understand the suitability of three pricing strategies: Shapley value, bargaining game, and dynamic pricing, to help minimize the digital divide. We also apply the Nash equilibrium concept to find the most suitable pricing strategy for various input scenarios for the players. The results of the case study for rural areas show that dynamic pricing produces the highest payoff compared to the other two strategies for the InP and the operators in a scenario with a combined total subscriber number of $\geq$ 200. In contrast, the Shapley value is a more suitable strategy for InP for a combined total subscriber $\leq$ 200, and for MNOs with a combined total subscriber $\geq$ 280. Applying the Nash equilibrium concept to the players in this game suggests that dynamic pricing produces a mutually beneficial strategy.**

***Index Terms*—5G, network slicing, game theory, NHN, pricing models**

I. Introduction

The digital divide refers to the disparity between regions with access to information and communication technology (ICT) and those with no or limited access. One of the potential reasons for the digital divide is the high cost of network deployment and the poor return on investment. Researchers are exploring multiple cost-efficient solutions to encourage wide-scale deployment to address the digital divide using different telecommunication technologies such as WiFi, 4G, 5G, fixed wireless access (FWA), and satellite communication [1]. One of the technologies with the potential to address the digital divide challenge is 5G network slicing that supports neutral host networks (NHN) [2]. 5G NHN can support the multi-tenancy of mobile network operators (MNOs) and other potential tenants on the same physical network. NHN involves two or more operators co-existing on the same physical network, who are willing to share all passive and active components, along with core and spectrum resources.

Typically, a 5G NHN would be deployed and operated by an infrastructure provider (InP), who could be a trusted third-party company, a community-run company, or a private network service provider. Operators such as MNOs and Internet service providers (ISPs), and other potential tenants such as factories, farming applications, industries, healthcare, education, local government, etc., would lease slices from the InP network. Operators play an essential role in leasing slices, providing access to the global network, facilitating user mobility, and assisting InP network installations [3]. End users typically pay subscription fees to MNOs and other service providers for using their products and services. The InP generates revenue from the leased slice resources by renting out those slices to tenants. The relationship between InP and MNO is like the airport and the airlines [4]. Studies have shown that NHNs have the potential to drive 5G deployments for various applications, such as factories, hospitals, and seaports [5]. This study also presents a survey of the state-of-the-art of 5G NHN technology and the optimal slice selection strategy.

Each slice tenant and the InP must assess the potential of entering the market while considering the possibility of negotiating cost and key performance indicators (KPIs). A negotiation process allows them to reach an agreement on their pricing model [6]. Typically, the service level agreement (SLA) of 5G KPIs and the cost associated with end-user applications are crucial decision elements in the selection of the strategy by the InP and the slice tenants, who negotiate the different cost-sharing models to minimize costs and increase revenues. As a result, there is a need to study the interactions between players to comprehend pricing strategies that are mutually beneficial to all stakeholders.

Game theory is a study that involves mathematical modeling of the interaction between two or more rational parties, called players; each player must consider the potential strategies of the other players when calculating their payoff. A game solution called utility or payoff outlines the optimal strategy for the players in the game who may have comparable, opposing, or mixed interests. The Nash equilibrium is a set of strategies for each player such that no player receives a higher payoff by deviating from their initial strategy [6]. The game theory framework is widely used in the telecommunication industry to better understand strategies among stakeholders and maximize their payoffs. The most famous example is the wireless spectrum auction model, which uses the game theory framework [7]. Telecommunication service provision-

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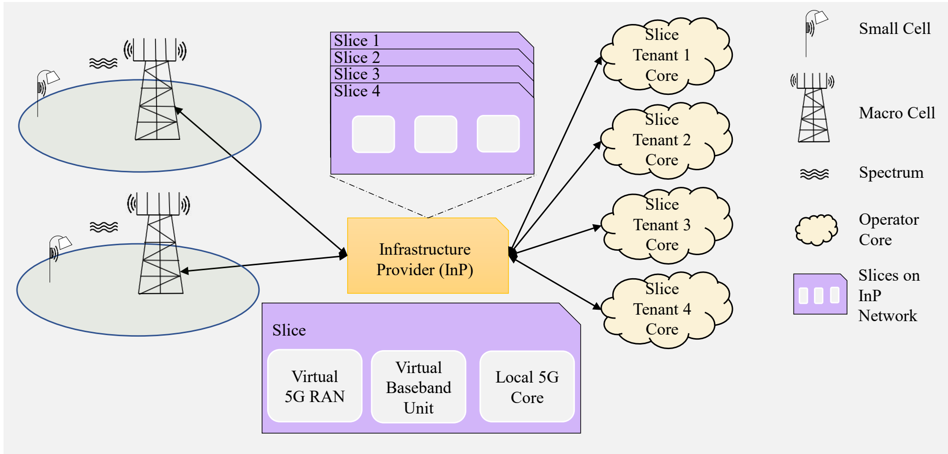

Fig. 1: NHN architecture - Relationship between InP and MNOs

ing involves interactions among the stakeholders, either a cooperative game (aims to maximize the output or payoff of the coalition of players) or a non-cooperative game (targets the maximization of an individual player's payoff). These pricing models were used to understand the cost-sharing models for 5G cloud resources in NHN and 5G Internet of Things (IoT) cloud data storage resources, respectively [4], [8]. The results show that the cost per player is lower when they share the infrastructure and fair sharing drives more deployments.

One of the main factors contributing to NHN deployment in urban areas as a solution to the digital divide is the difficulty in deploying network infrastructure due to the limited amount of space available in cable ducts and cell sites, as well as the extremely high subscriber density [5]. Meanwhile, the digital divide is more pronounced in rural areas than in urban areas due to the lower subscriber density in rural areas and the return on investment (ROI), promoting NHN to make the wireless broadband affordable in rural areas [9]. However, the existing pricing strategies and business models are not suitable for the rural scenario [10].

Therefore, the key contribution of the paper explores the suitability and limitations of different pricing strategies to minimize the digital divide using the NHN infrastructure sharing strategy in rural areas. In this paper, we present a general outlook for the three key pricing strategies involved in the decision-making process for the 5G NHN deployment in rural areas and calculate the Nash equilibrium to find the mutually beneficial pricing strategy for the InP and the MNO.

II. Technology aspects

The three main use cases of 5G are enhanced mobile broadband (eMBB), ultra-reliable and low latency communication (uRLLC), and massive machine-type communication (mMTC). The general architecture of 5G NHN for rural deployment is shown in Fig. 1. Network slicing allows dedicated end-to-end virtualization and support for multiple virtual networks on the same physical components. This implies that the deployment strategy involves the sharing of spectrum, radio access network (RAN), baseband unit (BBU), backhaul, core, power supply, tower, cabinets, sites, and technology. Despite this, independent resource allocation for end users served via leased slices still remains an independent decision made by the service provider. Network slicing allows each slice tenant to virtually own a network with guaranteed parameters such as a minimum data rate, latency, etc., and interference protection from other users even though they are all operating on the same network [5].

Telecommunications as a service (TaaS) is a new concept that is gaining interest around the world [5], [9]. A key challenge in the telecommunication industry is that technology is highly dependent on the equipment vendors supplying equipment. Therefore, the concept of network slicing is being integrated along with Open radio access network (RAN) to encourage vendor-independent hardware and software in the telecommunication industry. The key technological challenge with NHN is the use of slicing and efficient resource allocation while maintaining agreed-upon performance [5]. Therefore, this concept is being further extended to 6G, where network slicing is one of the key enablers of 6G [11]. The key benefits offered by NHN using network slicing, especially in rural areas, are maximization of resource utilization, efficient resource management, and reduction in terms of interference, cost, and power consumption [3].

The cost of deploying MNOs' independent (or *No Sharing*) 5G networks in rural areas generally increases because of technical, regulatory, and policy requirements that networks must achieve in terms of civil works, security, connection, availability, reliability, and other legal certification. In contrast, by selecting a rural 5G NHN level of sharing, the InP could receive support from government-funded rural community initiatives, MNOs, and other slice tenants while working together with local landowners and the community to provide 5G services, and this would help to lower the total cost of ownership (TCO) of 5G NHN deployments [9]. Additionally, the InP is legally bound to maintain 5G network performance and security standards as per the agreed standards with the slice tenants and industry-set standards.

The potential slice tenants need to pay proportionally for their network performance requirements, while still benefiting each stakeholder in the NHN business model. Each MNO

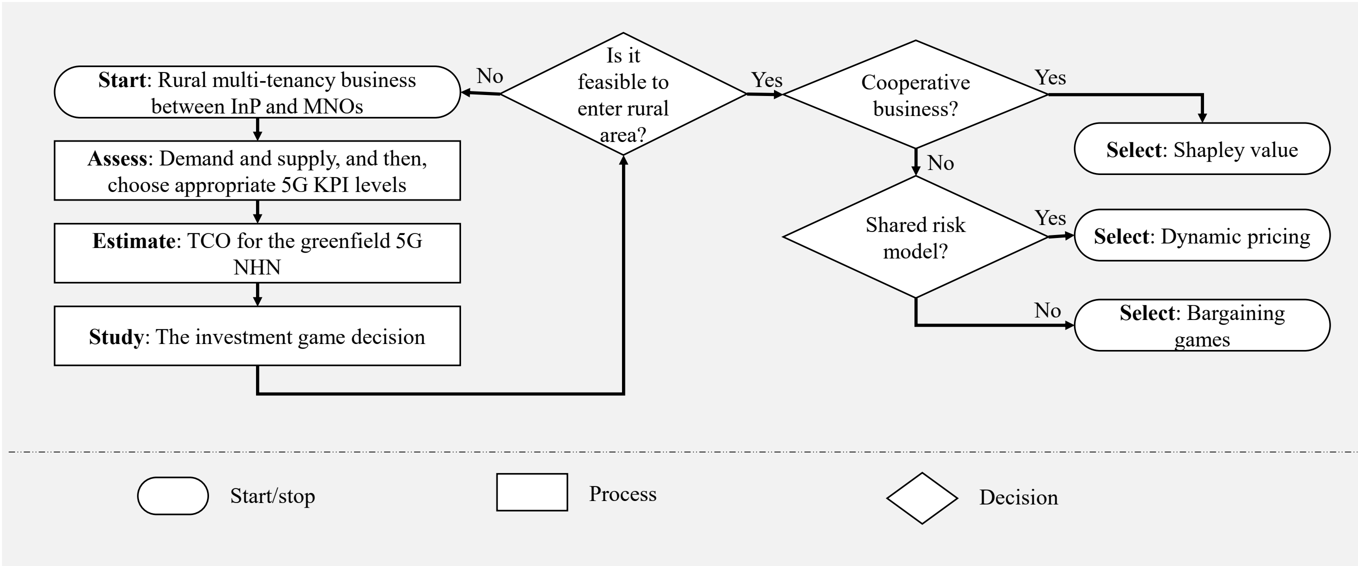

Fig. 2: Decision-making model using Game theory framework

could have different use cases to serve and different 5G SLA requirements to cater to those applications. Therefore, when MNOs lease slices from the InP's network, there is a need to explore the different pricing strategies to understand the interactions between the InP and the MNOs.

III. Pricing strategies for the InP and the MNO

For this study, we consider that 5G NHN in rural areas is built by the InP primarily to support the eMBB application and could potentially support uRLLC and mMTC [1], and MNOs are the only slice tenants. Typically, MNOs and InP negotiate on the possible investment model until an agreement or disagreement is reached regarding the cost and technical specifications of the network. The possible outcome of this scenario is whether or not the negotiation is achieved in a given period. The pricing strategies proposed for the rural NHN scenario are applicable to the urban NHN scenario as well, however, the latter scenario would also include additional revenue sources from use cases such as uRLLC and mMTC, leading to a higher ROI.

The cost of providing 5G NHN is highly dependent on technical factors such as the greenfield (no existing network) or brownfield (infrastructure upgrade) deployment, and the deployment factors such as the number of operators sharing the network, latency requirements, minimum throughput, network congestion, backhaul requirements, spectrum, and operational requirements; the mathematical equations and the corresponding costs are used from [9], [10]. Revenue for the InP network depends on the rent paid by the slice tenants for using the slices. Meanwhile, slice tenants earn revenue by offering services to end-users for various use cases [12]. The slice tenant's revenue for a greenfield deployment is estimated as the sum of revenues over the period of investment for each use case, which is the sum of the product of a number of subscribers each year considering the growth rate and the average revenue per user (ARPU) [9]. Similarly, the slice tenant's revenue for a brownfield deployment depends on the number of subscribers who would be upgrading as well as joining the network for 5G services [10].

Next, the question arises regarding the cost allocation and pricing strategies for each MNO (the slice tenant) on the InP network. The pricing strategy should reflect their network performance requirement to encourage investment by the MNO and other slice tenants, which would encourage improved end-user quality of service (QoS) and quality of experience (QoE). Based on this idea, the game theory framework provides different pricing strategies depending on the feasibility and risk appetite of various stakeholders. The objective of rational players is to maximize their payoffs while augmenting their probabilistic beliefs in the other players based on their own actions. In general, we assume that all players are rational and want to maximize their payoffs [6].

Figure 2 shows the decision-making model using the game theory framework for cost-sharing among the rural 5G NHN slice tenants. This model is suitable for studying the impact of cost and pricing models on the sustainability of the 5G NHN business models in each area. The first step involves evaluating the demand-supply assessment using parameters such as location, network traffic, latency, number of end-users, and subscriber growth rate [9], [10]. The next step involves the estimation of the TCO for the NHN based on the agreed 5G KPIs. Potential stakeholders would assess the potential returns of the network considering the growth of the network and study its feasibility. The InP and MNOs would contemplate bargaining over the pricing strategy if the network is feasible. If not, it is necessary to evaluate the network requirements in order to reduce costs while still achieving the goal of minimizing the digital divide. To decide whether or not to enter the rural connection market using 5G NHN and its potential rewards, the next step requires studying investment games for InP and MNOs [6].

For an economically feasible rural 5G NHN, the InP and the

MNOs need to decide their business approaches; cooperation or non-cooperation game with a positive approach, and their risk degree. The three cost-sharing models for the pricing strategies are the Shapley value, the bargaining game, and the dynamic pricing model are suitable for different scenarios based on the payoff of each player, and are shown in Figure 2, and the players would select a cost-revenue model depending on their risk-taking natures. The grand coalition of MNOs and InP can decide on the cost-revenue model to adapt. The payoff for the players is determined by factors such as ARPU, the number of subscribers, investment duration, subscriber growth rate, TCO, and expected rate of returns from the investment. Table I presents the different pricing strategies and their differences.

TABLE I: Pricing strategies

Factor	**Shapley value**	**Bargaining game**	**Dynamic pricing**
Type	Cooperative	Non-cooperative	Mixed
Focus of payoff maximization	Overall payoff	Individual payoff	Both
Example	Airport runway	Wholesale-to-retail	Shopping mall
Suitability	Minimize cost, maximize reach	Maximize individual profits	A combination of the two
Example studies	[4], [7]	[7], [8]	[6], [7], [13]

A. Shapley value

Players cooperate when there is value for them in terms of profits, knowledge, reputation, and trust. The players in a cooperative game should not have any incentive to earn a higher payoff independently, and one of the main types of cooperative games is the Shapley value. The Shapley value is a game theory concept that entails fairly allocating both gains and costs among several actors in a coalition strategy to achieve the desired payoff where each actor's contributions are asymmetrical [6].

In the Shapley value approach for a 5G NHN, the total revenue expected by InP is equal to the sum of the rent levied to all MNOs. The rent is fairly divided among the MNOs based on the requirements of each player in terms of 5G KPI using the Shapley value algorithm and could be estimated by the InP [4], [6]. The algorithm of the Shapley value would include the following logic: Initially, sort the MNOs based on ascending order of their slice requirements. The first step would be to divide the cost of catering to the slice with the lowest KPI and the slice priority requirements equally among the number of MNOs. Next, divide the additional cost of provisioning for the second-lowest KPI and slice priority equally between the MNOs but not the MNO with the lowest SLA and slice priority. Furthermore, continue this process until the incremental cost accounts for the MNO with the highest SLA and slice priority. Each MNO could have more than one slice to meet user demands. The algorithm of the Shapley value is given in [4], [6].

In this strategy, the InP receives a lump-sum payment for the service provided to cover the InP's expenses along with risk and returns. If the subscribers to the services are fewer than expected, the MNOs will be at greater risk and the InP's risk is minimal in this model.

B. Bargaining games

Generally, not all scenarios fit cooperative game theory as there will be situations where the players focus on obtaining the Nash equilibrium for their individual payoff rather than for the grand coalition's output. It is a non-cooperative game in which each player's goal is to maximize their own benefits, for example, wholesale-to-retail business model [6]. The non-cooperative game theory involves games such as bargaining games, zero-sum games, rock-paper-scissors, and the prisoner's dilemma. When there is no standard pricing for the services or items supplied in the market, the bargaining dilemma develops and helps to allocate profits from a deal between two or more players.

In bargaining games, the InP and MNOs strive to maximize their own revenues by dividing the 'per user' payment among them based on an agreed-upon rate. InP should provide 5G services to agreed KPI levels and user-data protection standards. The InP and MNOs pre-negotiate the revenue split ratio, which assists in determining the ROI. In real-life situations, tenants may lease slices for varying periods from the InP. For example, an MNO would be a long-term tenant, while a broadcasting agency leasing a slice for a live event would be a short-term tenant. In this scenario, both the MNOs and the InP assess their satisfaction in terms of monetary revenue gains from investments. All players must collaborate to provide service to common end-user requirements. As a result, all parties should receive payment for the services offered and will benefit from collaborating as they could generate higher mutual gains.

Typically, in this cost-sharing arrangement, the InP assesses demand and deploys a rural 5G NHN in a non-cooperative game. If the InP needs to expand the network to meet the increased demand from the slice tenants, then the InP will invest and charge the tenants who require higher capacity and performance correspondingly. This model has a higher risk for InP and a lower risk for MNO, as the bargaining game involves a 'per user' payment model [14].

C. Dynamic pricing - mixed game

Dynamic pricing is a means of revising a product's or service's price in response to changing market conditions [13]. This strategy aids in increasing revenue from the sale of a product or service. For this study, to simplify the model, we consider that the price variation 'per user' happens over a long period of time rather than instantaneously, that is follow, cost-plus pricing. This model is used to estimate, for example, the rental prices of stores in a shopping mall, e-commerce shopping, and electricity grid distribution [6]. This game is a hybrid of Shapley value and bargaining games, in which InP and MNO share the cost, revenue, and risk. In this type of revenue sharing, MNOs pay a fixed and variable component to the InP. The InP will generate more revenue as the number of users grows and will have a guaranteed fixed return even if network take-up falls short of expectations. Similarly, the MNOs will pay the InP a fixed fee as well as a 'per user' payment for accessing the InP's services and infrastructure. In this way, the MNOs reduce costs towards the network during poor take-up of the network.

In this case, the cost allocation is slightly complicated, as the risk needs to be shared between the InP and the MNOs to attract investments for providing digital services in rural areas. The fixed part is calculated using the Shapley value and distributed among the MNOs proportional to their demand requirements, while the variable cost component is computed using the bargaining game model. The cost for each slice tenant depends on the sum of the Shapley value component and the number of users multiplied by the 'per user' payment to the InP. The Shapley value component includes static pricing elements such as the base price, QoS fees, the NHN convenience fee, and the spectrum fee. The variable component would account for dynamic pricing elements such as demand over a period of time, the price for per-customer usage time, the cost for per-customer data usage, surge policy fees, and other miscellaneous fees.

IV. Game theory analysis of the pricing strategies

Consider a generic rural village with no connectivity and is located 10 km from the nearest internet point of presence. This would typically be a greenfield deployment, as there is no coverage and no existing asset in the study location. The InP would need to consider laying fiber or using wireless backhaul to support the required 5G KPIs. To understand the suitability of different pricing strategies, assume that the InP initially decides to deploy only a single macro cell, with a 3-sector antenna and MU-MIMO, for a study area of 100 km^2 with up to 1,500 subscribers per MNO (assuming that each MNO has a 25% market share). In the given deployment with 10 Gbps backhaul capability, up to 3,000 active subscribers could be served at 10 Mbps (ITU minimum data rate) and thousands of devices with low data rates could be served [1], [13]. The average TCO of the 5G NHN for a 10-year investment duration in rural areas is estimated using data from research papers such as [1], [9], [10]. For the study area, these studies show that for a generic greenfield 5G NHN deployment, considering the cost of fiber deployment, RAN, spectrum, local core, NHN technology, tower, site, etc., would cost \$415,456 [9]. For a detailed mathematical analysis of the cost estimate and feasibility study for greenfield deployments, refer [9], [10]. As the traffic generated increases and the macro cell gets congested, the InP would consider deploying small cells to increase the network capacity. After estimating the feasibility of the network, the InP and the MNOs would negotiate the pricing strategies. To understand the payoff for each InP and MNO combination in this proposed scenario, we estimate the players' profits (revenue minus cost) for different earnings scenarios by varying the ARPU from \$10 to \$40 and the number of subscribers to be served mainly using the eMBB use case, from 10 to 1500 per MNO and with a subscriber growth rate of 4% per year [10].

For this study, the percentage of revenue generated by end users of eMBB is shared between the InP and the MNO. The split ratio would depend on the pricing strategy chosen jointly by the InP and the MNOs. For example, using the Shapley value approach, the InP estimates the cost of building a network with the agreed-upon KPI requirements, and the MNOs fairly share the cost based on their individual requirements from the network. Considering the slight difference in terms of performance for each MNO, their Shapley value using its algorithm would be \$93,366, \$102,200, \$111,700, and \$108,366 [4], [6].

Assuming that the players are truthful in disclosing their overall costs in providing rural 5G NHN and that all MNOs' network requirements are similar, the revenue sharing percentages at Nash equilibrium are estimated for the players using the mathematical model in [8]. The different MNOs exhibit competitive behaviors between them, for example, they are collaborating to reduce cost via infrastructure sharing but they remain competitive in other aspects such as QoE. As with many businesses, the InP and the MNO would probably not disclose detailed costs but disclose only high-level costs. While using the bargaining game for a scenario of subscribers $\leq$ 1,500 for each MNO, we consider that 70% of the revenue generated by eMBB end-users is retained by the MNO while the remaining 30% of the revenue is shared with the InP. For a similar scenario with dynamic pricing, 55% of the revenue earned from the end-users of eMBB is kept with the MNO, while the remaining 45% of the revenue earned from the end-users is shared with the InP (Shapley + per-user variable). For a detailed calculation of these values, refer [6], [8], [13].

A. Pricing strategy evaluation and Nash equilibrium

The profits of the InP and MNOs using the 5G NHN depend on the pricing strategy and the demand-supply parameters, as shown in Figure 3. For some input parameters, certain strategies are non-profitable for the InP and/or MNOs, which have been omitted from Fig. 3. The revenue for the InP is estimated as the sum of revenues from all the MNOs, while the profits for the MNO are gained from the revenue generated by the end users. The results show that the Shapley value is suitable for a small number of subscribers and ARPU. In this scenario, both players would be willing to cooperate and share the cost of the 5G NHN deployment fairly when the total number of subscribers is $\leq$ 200. Dynamic pricing is appropriate when there is a moderate combined subscriber base $\geq$ 280 and a decent ARPU. Finally, the bargaining game is suitable when demand factors, such as the number of subscribers and the ARPU, are very high, that is, a guaranteed high ROI in the area of interest.

Figures 3 show that the profits increase exponentially for the MNOs when the InP selects the Shapley value, as the risk is higher for the MNOs. Meanwhile, the bargaining game is risky for the InP in the case of low subscriber take-up, as they would invest a considerable amount upfront in the network. The dynamic pricing range falls between the overlap region, as shown in Figure 3. Dynamic pricing is suitable for both the InP and the MNOs because it helps share the risks and profits of telecommunication deployments.

Some examples of the results of the pricing strategy study result from Figure 3 are tabulated in Table II. The results show that the most appropriate pricing strategy depends on the ARPU, the number of subscribers, and the profits earned. The suitability of the pricing model for the players varies according

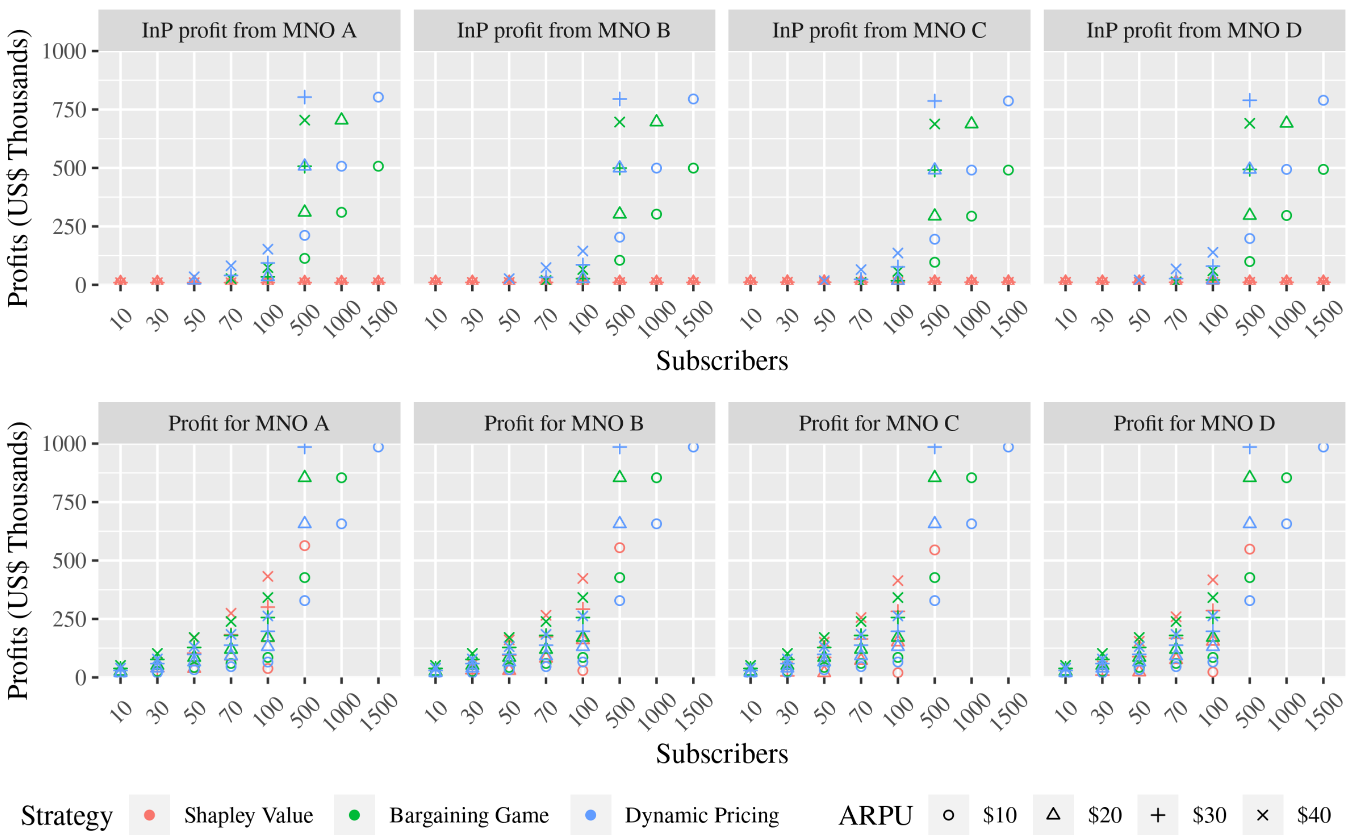

Fig. 3: Profits using different strategies for InP and MNO

TABLE II: Pricing evaluation - Average profits for each InP and MNO pair, at different ARPU and number of subscribers

Pricing model	**(InP, MNO)**	**(InP, MNO)**	**(InP, MNO)**
Subscribers, ARPU	**30, $40**	**500, $30**	**1500, $20**
Shapley value	($10,390, $53,768)	($10,391, $1,867,042)	($10,390, $3,837,992)
Dynamic Pricing	(-$22,563, $78,838)	($793,410, $985,475)	($1,680,338, $1,970,950)
Bargaining game	(-$46,214, $102,489)	($497,768, $1,281,117)	($1,089,0533, $2,562,235)

to the demand of the rural area. These scenarios show that cooperation between the InP and the MNOs plays a crucial role in improving rural connectivity. These players should negotiate to develop the best possible pricing strategy and minimize the digital divide.

To study the Nash equilibrium for the game payoffs presented in Table II, we use the online solver provided by [15]. The Shapley value is the most appropriate pricing approach for low ARPU and a small subscriber base, according to the Nash equilibrium study. For the remaining settings, dynamic pricing is the overall most appropriate pricing strategy. The difference between the profits for the MNO while using dynamic pricing and bargaining games is minimal; However, 5G *NHN* level of sharing earns higher profits compared to the *No Sharing* scenario. The results from Fig. 3 show that the InP and MNOs can benefit the most financially by selecting dynamic pricing for rural 5G NHN. Therefore, dynamic pricing is the Nash equilibrium optimal strategy for both players.

B. Discussion on the suitability of pricing strategies

It is well established that the supply and demand dynamics involved in reducing the digital divide and deploying new technology (e.g., 5G) can be challenging in both urban and rural areas. Therefore, the following evaluation explores different aspects of the results shown in Table II and the suitability of the three main pricing strategies for the deployment of 5G NHN.

Shapley value: Typically, the suitability conditions of this pricing strategy are in areas where 5G NHN economic profitability is very low for all players. Players share the cost as per their KPI requirements from the 5G NHN network. For example, the suitability of the Shapley value is highest in remote rural areas, when demand factors, such as the number of subscribers and the ARPU, are low. Here, each operator would ideally prefer to lower their cost and minimize the losses, to achieve the common goal of improved wireless broadband.

Bargaining game: Such a pricing model is more suitable in areas where the economic profitability of 5G NHN is very high and guaranteed. All players are motivated to maximize their profits by providing 5G services. For example, this pricing strategy is applicable in areas such as in-building connectivity, where demand factors are higher and operators are competing to provide service in the region.

Dynamic pricing: This pricing model is more suitable in areas with moderate profitability for the 5G NHN deployment. Dynamic pricing is also the most rational strategy for all players when there is uncertainty in demand factors. For example, this pricing model is the most appropriate if there is any ambiguity regarding the take-up rate of the service provided in locations such as retail malls and rural hamlets with a moderate or higher number of end-users.

V. Conclusion

A neutral host network (NHN), a type of 5G infrastructure sharing that facilitates slicing and multi-tenancy, would foster investment in the telecommunications industry and aid in narrowing the digital divide. Without a solid profit-generating business model, digital connectivity would not be an attractive investment choice for stakeholders. This paper has investigated three pricing models: Shapley value, the bargaining game, and dynamic pricing which have the potential to assist stakeholders in determining the viability, feasibility, and profitability, of rural 5G NHN businesses. The results help in selecting the appropriate pricing strategy that maximizes their payoffs. The pricing models developed in this study are location agnostic and the findings show that as the input parameters change, the profits earned by stakeholders in each pricing approach alter considerably. The 5G NHN pricing model could help to reduce the digital divide and make rural connectivity affordable. Improving ICT services would create new revenue streams in untapped rural areas, helping to achieve the UN's sustainable goal of Target 9.1. This model will also promote the rural 5G network to become self-sustainable. Further research is needed to determine whether the three pricing strategies will help narrow the digital divide for brownfield deployment using different infrastructure sharing approaches around the world in the long term. In addition, there is a need to explore the impact of industry verticals on pricing strategies.

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