High-Level Assessment of Statewide GNSS-RTN Business Models

Ahmed Al-Kaisy, PhD[1], Sajid Raza, MS[2]

[1]Professor of Transportation Engineering, Department of Civil Engineering, Montana State University
213 Cobleigh Hall, Bozeman, MT 59717, Phone: (406) 994-6116, Email: alkaisy@montana.edu
[2]Graduate Research Assistant, Western Transportation Institute, Bozeman
104 Cobleigh Hall, Bozeman, MT 59717 Phone: (217) 552-9125, Email: sraza@alaska.edu

Abstract

The applications of geospatial technologies and positioning data embrace every sphere of modern-day science and industry where geographical positioning matters. Among all other fields, geospatial technology plays a remarkable role in the transportation sector and has the potential to play an even more critical role in future autonomous transportation systems. In this regard, the GNSS-Real-Time Network (GNSS-RTN) technology is promising in meeting the needs of automation in most advanced transportation applications. The GNSS-RTN is a satellite-based positioning system that uses a network of reference stations to provide centimeter-level accuracy in positioning data in real-time. The technical aspect and working technology of GNSS-RTN are widely studied, however, only limited research has been conducted on the various GNSS-RTN business models currently in use nationally and internationally. Therefore, this study aims at assessing the various GNSS-RTN business models currently used in practice as well as those that are deemed potentially viable but have not yet moved to practice. Eight different business models were cataloged and used in the current assessment. All business models were assessed using three criteria: state control, sustainability, and state/agency costs. The findings of this research are important in helping state agencies make informed decisions as they build, expand or manage their own GNSS-RTN systems.

Keywords: GNSS-RTN, business model, geospatial data, highly accurate location services.

1 Introduction

In the past few decades, significant technological advances have been made in various spheres of the modern world. One good example is the global navigation satellite system (GNSS) which includes the GPS (U.S. global positioning system) and its counterparts: GLONASS (Russia), Galileo (Europe), and BeiDou (China). The GNSS has become one of the fastest-growing emerging technologies delivering location services to various industries. Geospatial data are not only used in measuring ground distances and mapping topography (R. L. Clark and R. Lee 1998), but it has found significant applications in various fields such as agriculture, construction, mining, safety and sustainability, structural health monitoring, natural disaster management (Nordin et al. 2009; Raza et al. 2022b), and precise localization and accurate navigation (Jo et al. 2013). Consequently, there is an ever-increasing demand for more ubiquitous, more accurate, and more reliable positioning and navigation solutions that partly led to the development of modernized location-based services (LBSs) known as GNSS Real-Time Network (GNSS-RTN). The GNSS-RTN is a satellite-based positioning system and works on the concept of GPS-Real-Time Kinematics (GPS-RTK), however, it uses a network of reference stations (known as continuously operating reference stations (CORSs)), instead of a single base station in case of GPS-RTK, as shown in **Figure 1**. The network of reference stations extenuates and alleviates the spatially correlated atmospheric and satellite orbit biases (Rizos & Satirapod 2011), and improves the precision of geospatial positioning through real-time corrections sent from a central processing center to a rover within the network. The utilization of ground CORSs enable systems to have a range of 1 to 5 centimeters in accuracy, compared to a range of 1 to 10 meters when CORSs are not utilized (Schrock 2006).

The advent of GNSS-RTN made it possible to achieve highly accurate positioning over a distance of 70-100 km (reference station spacing should generally not exceed 70-100 km) from the base station (Feng & Li 2008). Schrock acknowledged that, although the GNSS-RTN technology was reasonably new, it had already made a significant impact on many fields and showed a tremendous increase in popularity and national networks have been established in many countries around the world, especially in developed countries.

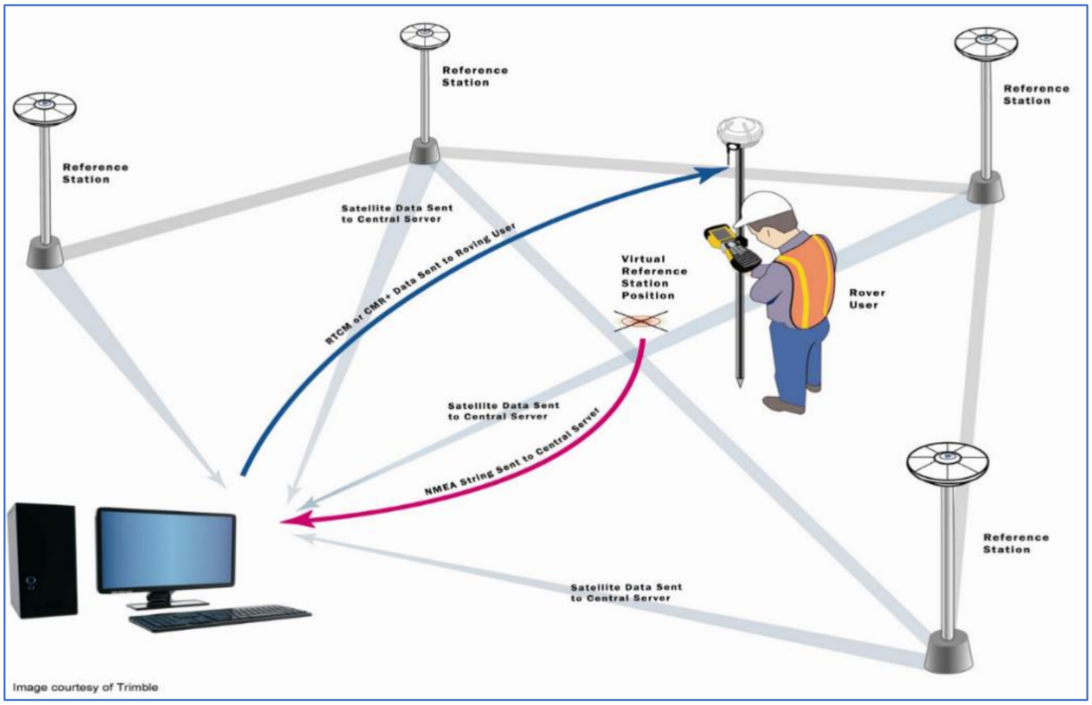

Figure 1. Data Flow in RTN and Configuration of a VRN (Courtesy of Trimble)

In the U.S., there were 18 systems at the beginning of 2005 and 40 in 2006 (Schrock 2006). Currently, statewide (or partial) networks have been established in more than half of the 50 states with the respective state Departments of Transportation (DOTs) being key players in developing and operating many of these networks (Raza and Al-Kaisy 2021). In addition, several private companies are offering GNSS-RTN products and location-based services (LBSs) with Leica Geosystems, Trimble, and Topcon being the three most pervasive providers of GNSS-based services and products around the globe (Lorimer and Eric 2008; Raza et al. 2022a). The GNSS-RTN system comes with many benefits but has certain limitations. Benefits include eliminating the need to establish a base station for each task, reduced labor cost, continual accuracy and integrity monitoring by GNSS-RTN, no distance correlated error, and a common reference coordinate system for geospatial data. Limitations included the high cost to establish and maintain such a system and accuracy being limited by the poor quality of the cellular phone connection (Henning 2007; Huff 2019).

2 Research Motivation

While significant research has been conducted on the components and working technology of the GNSS-RTN systems, only little attention has been given to aspects concerning the business models for planning, building, operating, and managing these systems. Therefore, while there is a lot of published information on the technical aspects of the GNSS-RTN technology including national guidelines, information on current and most viable business models for building and operating statewide GNSS-RTN systems is lacking in practice. This lack of information and guidance was the main impetus for the current study. The study aims to synthesize and report some of the potentially viable GNSS-RTN business models and to provide high-level assessment of these models using model main characteristics and attributes. The results from this assessment should be of interest to state agencies as it helps them in making informed decisions as they plan, build, expand or manage their own GNSS-RTN systems.

3 Background

It should be noted that while there is a considerable body of research on technology and working principles of the GNSS-RTN systems, there is only limited research on the various business models for implementing and operating the GNSS-RTN systems nationally and internationally. Most of the previous studies presented in this paper were conducted as part of a single specific GNSS-RTN system or a cost-benefit analysis of the GNSS-RTN system based on a specific application of the system.

The most recent study on current practices of GNSS-RTN was conducted by the California Department of Transportation (CalTrans) in 2015 (Martin 2015). The researchers conducted interviews with only six state DOTs regarding the GNSS-RTN system ownership, funding, system operations, and maintenance. In most cases, the GNSS-RTN was owned by the state department of transportation (DOT) with station ownership varying between the public and private owners. Software is typically owned by the state while hardware ownership varies between the DOTs and other state agencies. Most of the CORSs are located on public land. In a few cases, however, station owners did pay a small lease if they didn't own the site. Regarding funds, most of the funds for the system come from the state DOT budget, however, funding for Washington network operation comes from users' charges in terms of a subscription fee for network access. None of the six DOT-owned networks charge a subscription or other annual fees to end users except the Washington State Reference Network (Martin 2015). This study has reported on important aspects of a business model for a statewide GNSS-RTN system, however, the scope of collected information is very limited and the number of agencies interviewed was small. Similarly, Washington State Reference Network (WSRN) is a cooperative of about 80 different partners spanning the public and private sectors. The network is owned by the cooperative; joining the cooperative requires contributing one or more stations to the network. Access to static files is free, while access to real-time corrections is free for partners but requires annual subscription fees from other entities to help cover operations costs. Seattle Public Utilities hosts the central processing center for the network, provides stations to the network, and serves as a point of contact for WSRN matters(WSRN 2021).

To better understand the business models of the GNSS-RTN system, it is also important to discuss studies conducted internationally. Ojigi developed an implementation plan for a GNSS-RTN system in Nigeria to provide RTK corrections services. A central data processing facility is proposed in the capital with a total of 111 CORSs. Two possibilities for a business model were investigated: the state would build the system and either charge a fee for access to the system or treat the system as a utility and provide access for free to all users (Ojigi 2015). Jenssen et al. (2016) presented an overview of CORSnet-NSW, a GNSS-RTN owned by the Government of New South Wales in Australia. CORSnet-NSW also engages in data-sharing agreements with neighboring states to provide adequate coverage. The Government owns the equipment and conducts all the maintenance and operations. Raw data is sold to three companies, while CORSnet-NSW subscriptions are sold through 16 authorized providers. Raw data is also made available to various positioning efforts including the Asia-Pacific Reference Frame (Janssen, Haasdyk, and Mcelroy 2016).

In another study, the North Carolina Geodetic Survey (NCGS) department gave an overview of the economic benefits of the North Carolina Continuously Operating Reference Stations (NC CORS) network compared to its costs. NCGS estimated that the system provided $360 million in annual economic benefits to North Carolina. This is compared to the annual operating cost of $625,000 per year (North Carolina Geodetic Survey 2018).

4 Research Approach

To better understand the GNSS-RTN business models and gather information on the currently employed models as well as other potentially viable models, a thorough review of the literature was conducted to learn more about current practices in the U.S. and around the world. Subsequently, eight different business models were cataloged and used in the current assessment. These business models are briefly described in the following section.

4.1 Existing Business Models of GNSS-RTN System

This subsection catalogs the existing business models of statewide GNSS-RTN systems. The models are numbered in a sequence without necessarily following a specific order.

4.1.1 Business Model 1

In this model, the state agency owns the GNSS-RTN system and is responsible for all the costs associated with building and operating the system. In a survey conducted by the California Department of Transportation (Caltrans), it was reported that the Minnesota GNSS-RTN network follows this business model (Martin 2015). Specifically, the Minnesota-CORS (MnCORS) network is primarily composed of CORSs and a Central Processing Center (CPC) that are owned and operated by the state DOT. At the time of the study, the users of the network had free access to all products provided by the MnCORS network.

The main advantage of this business model is that the state has full control over the system. However, the state is responsible for all costs associated with building, operating, and maintaining the system. This model has the potential to improve user engagement by providing end users with free access to all data and system products.

4.1.2 Business Model 2

In this model, the state owns the CPC facility and part of the CORSs within the state while other CORSs are owned by other state partners including private entities. Operation and maintenance costs are borne by the owners of system components, i.e., the state is responsible for operating and maintaining the CPC and state-owned CORSs, while other partners are responsible for maintaining their CORSs. In a study conducted by Caltrans (Martin 2015), it was reported that the GNSS-RTN system in the state of Oregon follows this model. Specifically, the study reported that the Oregon Real-Time GPS Network (ORGN) is operated and controlled by the Oregon DOT’s Geometronics Unit. Around 30% of CORSs in this network are owned and maintained by the agency while the remaining 70% CORSs are owned and maintained by ORGN partners. At the time of the study, the users of the network had free access to all products provided by the system.

In this model, the state still owns the majority of the infrastructure of the network, i.e., the CPC and a part of the CORSs network, which allows the state to have good control over the network. The public-private partnership requires agreements in place between the state agency and all other system partners. Similar to the first model, this model provides access to all system users free of charge, which can potentially increase the number of end users.

4.1.3 Business Model 3

This business model shares a great deal of similarity with business model 2 except that the public agency which owns and operates the CPC does not necessarily own any notable portion of the CORSs network. In the same study conducted by Caltrans, it was found that the GNSS-RTN system in the state of Washington follows this model. The state CORS network, called the Washington State Reference Network (WSRN), is owned by a cooperative of more than 80 partners (cities, counties, utilities, state agencies, and private partners). An entity can be a partner by providing, operating and maintaining one or more CORSs. The Seattle Public Utilities (SPU), one of the partners in the cooperative, owns the CPC and is responsible for its operation and maintenance costs. Operation and Maintenance costs for each CORS are the responsibility of that station's owner. The WSRN provides free real-time services to partners in the cooperative, while other (non-cooperative) users have access to real-time services for a subscription fee to cover some of the operating costs of the network.

Similar to the previous two models, a state agency is responsible for addressing any technology-related cost of the network and to implement, operate, and maintain the CPC. This model also requires agreements between all partners of the network and the operating agency. The strategy used to deliver data in this model differs from the first two models by requiring an annual subscription fee for all non-partner end users. The level of control the state has over the system is still reasonable given that a state agency is operating and maintaining the CPC.

4.1.4 Business Model 4

In this business model, the state agency has full ownership of the system, i.e., the CORSs network and the CPC, however, the system is operated by a private company/corporate. All costs associated with operating and maintaining the system are the responsibility of the state agency. This was one of the business models proposed by GNSS-RTN manufacturers/vendors to the state of Iowa as part of planning the statewide GNSS-RTN system (Milligan and Jackson 2008). Specifically, Iowa DOT required that the CORSs and the CPC facility are owned by the state but managed by a private vendor. Operation and maintenance costs for CORSs and the CPC are paid by the state. The state DOT also requested that all users have access to the system services and products free of charge. This model is very similar to business model 1, except that the state would use a private vendor for operating and maintaining the system.

Similar to business model 1, this model involves considerable initial and annual costs borne by the state. As the system is completely owned by the state, the state maintains a high level of control over the system. Contracts and/or agreements between the vendor and the state agency are required. User engagement is estimated to be high with this model, as users have access to system products free of charge.

4.1.5 Business Model 5

The University of New South Wales, Australia, and Leica Geosystems worked together in the analysis of GNSS-RTK network business models. One of the models examined in the study recognized the existence of 90 CORSs that were owned by public entities and suggested that Leica would install 40 more CORSs (Rizos 2007a). In this business model, the CPC is owned and operated by the vendor. The study suggested a partnership between public and private entities to address the operation and maintenance costs of the CORSs. All costs related to the CPC are the responsibility of the vendor. This model also considers a subscription fee to help cover costs to operate and maintain the CORSs. Rizos (2007) reported that the model was adopted by the U.K.'s Ordnance Survey, which has licensed the CORS data to Leica Geosystems and Trimble. Leica has undertaken to install more than 40 additional GNSS CORS receivers.

This model suggests a strong public-private partnership with a vendor, in which the vendor installs all remaining CORSs needed to complete the network and utilizes its own CPC to process and deliver location data to end users. While this dynamic requires negligible initial investment and annual costs by the state, it also provides the state with lower control over the network.

4.1.6 Business Model 6

In this model, the state would establish the CORSs network (alone or with partners) while the private vendor would host and manage the network using their infrastructure. The state network in this model would contribute to the private vendor network, and in return, the vendor would provide the state agency with free access to the network data and services in the form of an agreed-upon number of network subscriptions. The agency in this model has the freedom to use those subscriptions in any way they see fit including selling some subscriptions to private users. One variation of this model is for the state to control access to the network by purchasing additional subscriptions at discounted prices and selling those to "other" users usually at a higher market price. This business model was discussed as part of a study which interviewed technology vendors (Raza and Al-Kaisy 2021).

The main advantage of this business model is the use of a CPC that is owned, operated, and maintained by a private vendor, to host the network. This will remove a significant proportion of the initial and running costs that would otherwise be borne by the state agency. However, this requires that the state enters into an agreement with owners of existing CORSs and may have to provide incentives in the process. While this model significantly reduces the amount of state investment in the GNSS-RTN system, it provides the state with a lower level of control over the system. Another advantage of this business model is that technology upgrades and changes can be incorporated on time by the vendor without any financial obligations on the state (Raza and Al-Kaisy 2023).

4.1.7 Business Model 7

In this model, the state would establish the CORSs network (alone or with partners) and will be responsible for the costs of operating and maintaining the network. The vendor would host and manage the network using their infrastructure but with full state control on operating the statewide network. The state network in this model will not be incorporated/added to the vendor's private network, and the vendor has no access to the state network. The state will pay the vendor annual fees for hosting and managing the network using a fixed-term agreement. The state is free to decide who can access the network and can impose fees for different products and user types within the state (Raza and Al-Kaisy 2021).

This business model shares many similarities with the previous model in regard to the ownership of the CORSs network and the network hosting infrastructure. The CORSs needed to complete the network are implemented, operated, and maintained by the state (alone or with partners), and the vendor uses its infrastructure to host the network. In this business model, the vendor has no authority over the network, it simply provides the CPC hosting and management services for an annual fee, allowing the state to hold full control over the network, its products, and users' fees. The operating costs of the system including network hosting costs, which are borne by the state, could be significant.

4.1.8 Business Model 8

In this business model, a technology vendor would establish, operate and maintain the CORSs network and provide hosting and management services through their own networks. The vendor would develop and use a business model for marketing the GNSS-RTN services to end users including public and private entities. In this model, the system is 100 percent owned by the vendor and the state plays no role in establishing, operating, and maintaining the system. A variation of this model is to have a consortium of private companies as the owners and operators of the GNSS-RTN system instead of a single technology owner such as the CORS-RTK network across the whole of France (Rizos 2007b).

The main advantage of this model is the lower financial responsibility for the state. Like other end users, state agencies would need to purchase subscriptions to satisfy their GNSS-RTN data needs. However, this model provides no control to the state over the system, which may not serve the best interests of the state (e.g., inconsistent or incomplete geographic coverage of the state).

4.2 Conceptual Elements of Business Model

Any business model for establishing and operating a GNSS-RTN system should address three major elements: infrastructure ownership, costs, and user access charges (revenue). This section discusses each of these conceptual elements in some detail.

4.2.1 *Infrastructure Ownership*

The ownership of the GNSS-RTN infrastructure largely determines the level of control a state agency has over the statewide GNSS-RTN system. The ownership combination of system components varies among states, partners, and vendors, and so does the level of control the state has in each of the models.

CORSs

A CORS primarily consists of hardware and the physical structure supporting the hardware. The hardware of each CORS is composed of a GNSS receiver along with an antenna to obtain high-precision coordinates. Each CORS needs a physical structure to ensure hardware support at a fixed location. This physical structure (a.k.a. monument) can generally be of two types, building mounts and ground mounts.

CPC

The central processing center is a major component of any GNSS-RTN system. The CPC hardware primarily consists of computers and data servers. Much like the CORSs, the CPC also needs a physical structure to host the hardware, more specifically a building. All data collected at the stations is sent to the CPC wirelessly, which allows the location of the CPC building to be anywhere. A mirror of the CPC is highly recommended by the NGS (optional) (National Geodetic Survey 2018). The other major component of a CPC is the software suite used for processing the data received from CORSs in real-time. The software suite offered by technology vendors notably varies in capabilities, functionalities, and costs.

Supporting Components

The CPC and CORSs do not compose a GNSS-RTN network on their own, other elements are needed for the network to function properly. Constant and reliable connectivity service between the CORSs and the CPC is needed for the network to ensure optimum functionality. A survey of GNSS-RTN operators/owners (mostly state DOTs) shows that the majority of GNSS networks across the country use the internet or mobile networks to provide communication between the CORSs and the CPC (Raza and Al-Kaisy 2023). A radio-based communication can be useful for stations located in areas with low internet and mobile coverage. Receivers should be supplied with continuous power via a reliable source. The national electric grid is the most common source of power for the CORS receiver. However, solar panels, regulators, and lead acid batteries are viable alternatives for uninterrupted power in remote locations (National Geodetic Survey 2018).

4.2.2 *Costs*

This section provides an overview of the cost-items associated with establishing and operating a GNSS-RTN system. Both initial and running costs will be discussed under each system's component.

CORSs

The initial costs involved in building a CORS include the cost of the hardware (receiver and antenna) and the cost of the physical structure and the mounting mechanism. The cost of a single CORS varies widely depending on hardware specifications and whether the hardware is building-mounted or ground-mounted. The running costs for operating a CORS include costs for communication services, power, and regular maintenance for the hardware and structure.

CPC

The initial costs of a CPC include the costs of the computers and servers, the cost of the software suite to process the GNSS-RTN network data, and the cost of the furnished physical building where the CPC is located (space owned or leased by the system operator). The running costs for the CPC primarily include the needed staff to manage/administer the network, regular software updates and license fees, upgrades and regular maintenance required for computers and servers. In the case of hosting all data on cloud servers, usage fees/charges will be part of the running costs of CPC.

Supporting Elements

The costs associated with supporting elements primarily involve the running costs associated with providing power to the CORSs and communication service between the CORSs and the CPC.

4.2.3 User Access Charges

The GNSS-RTN location data has applications in many fields, which explains the diversity of potential system users, i.e., public agencies, private entities, and individuals. From a previous study (Raza and Al-Kaisy 2021), it became clear that currently the system access privileges are handled in three different ways:

i. Systems that allow all end users, public and private, to access the system data and products free of charge.
ii. Systems that allow public agencies to access the system free of charge while requiring usage fees (often in the form of subscription fees) from all other users, namely; private entities and individuals.
iii. Systems that require all users, public and private, to pay usage fees to access the data and products of the system.

The scenario (iii) above exists when the technology vendor owns and operates the whole GNSS-RTN system.

4.3 GNSS-RTN System Conceptual Elements: Possible Business Models

This section attempts to analyze the information presented in the previous sections in order to clearly highlight the merits and demerits of the various business models analyzed.

As the use of the GNSS-RTN systems is relatively new in practice (most installations occurred within the past 15 years), and to be comprehensive in our approach, this section will consider all scenarios of business models using various combinations of the conceptual elements, i.e., ownership, costs, and user access charges. Two possible owners for the CPC exist: the state or the vendor. For the CORSs, owners may be the state, other partners, or the vendor.

The CPC costs including system management and administration are usually borne by the state or the vendor regardless of ownership. The costs of implementing CORSs are usually borne by the owners which could be the state, the vendor, or other partners. However, other CORSs running costs including power, communication, and maintenance are often borne by the owners or by the CPC owner or GNSS-RTN operator (as an incentive to incorporate existing stations in statewide networks).

For access privileges to system data and products, most of the existing systems either provide free access to all end users (public and private) or provide free access to public agencies but charge individuals and private entities for using the system (in the form of subscription or per-use fees) (Raza and Al-Kaisy 2023). Only in the instance when the vendor owns the whole system (CORSs and the CPC) then all users, private and public, have to pay for the services.

Considering the three elements above, possible business models for the prospective Montana GNSS-RTN system are presented in Table 1.

As shown in the Table 1, three different scenarios for CPC ownership and operation are provided; CPC owned and operated by the state, CPC owned and operated by the vendor for a fee, or CPC provided as part of the vendor network. The latter scenario requires the statewide network to be incorporated into the vendor's network.

Under each of the CPC scenarios, two different cost possibilities for CORSs are provided; all CORSs are operated and maintained by the state, or CORSs are operated and maintained by owners, i.e., the state and other partners. A third cost possibility was added to the option "CPC – Vendor Network" when the vendor is responsible for CORSs operations and maintenance (the vendor owns the whole GNSS-RTN system). The owners of CORSs always pay for building their CORSs, and therefore building costs are not part of the cost scenarios.

Regarding CORSs ownership, three different scenarios are provided to cover the different ownership possibilities: the state, the state and partners, and the technology vendor. All cost and ownership scenarios and their combinations in Table 1 may include user access charges or not, except for a system that is fully owned by the vendor where access charges always exist. User access charges are shown in the cells as either free access (FA) or user charges (UC).

4.4 High-Level Assessment of the GNSS-RTN Business Models

This section provides a preliminary assessment of the business models discussed in the previous section and outlined in **Table 1**. To remove some of the subjectivity in the process, a high-level quantitative analysis of the merits or demerits of all possible business models is needed.

To provide an objective assessment of the different business models included in **Table 1**, certain criteria must be considered. Three major criteria are used in this high-level assessment, i) state control, ii) sustainability, and iii) state/agency costs. State control refers to the level of control the state has on the prospective GNSS-RTN system being planned and built to align with the state's best interests (Al-Kaisy and Teixeira 2022). A sustainable business model refers to a model that would help the state maintain and provide the desired level of location data service over time within available resources. For sustainability, the lower the running costs the higher the sustainability of the system. Similarly, having user access charges would help the state recover all or some of the operating and maintenance costs, which should result in improved sustainability.

Table 1 - Possible GNSS-RTN Business Models

CPC Operations		CPC – State		CPC – Vendor for Fee		CPC – Vendor Network		
CORSs Operating & Maintenance Costs		State	State + Partners	State	State + Partners	State	State + Partners	Vendor
CORSs Ownership	State	FA*	---*	FA	---	FA	---	---
		UC*	---	UC	---	UC	---	---
	State + Partners	FA	FA	FA	FA	FA	FA	---
		UC	UC	UC	UC	UC	UC	---
	Vendor	---	---	---	---	---	---	UC

* *FA: Free Access; UC: User Charges; "---": Not Applicable*

For the assessment, the star scoring scheme will be used for each criterion as shown in **Figure 2**.

Summing the number of stars for the three criteria will provide a composite score (out of 17) which refers to the overall merit of a specific business model. Using the star scoring scheme for the criteria above, and considering all possible business model scenarios in **Table 1**, **Table 2** shows a high-level assessment of the different business models considering the three criteria: state control, sustainability, and state/agency costs in the given order.

In this high-level assessment, it should be kept in mind that while the scoring scheme described above attempts to provide a quantitative and systematic comparison among alternative business models, the process still has some subjectivity, i.e., two individuals using the same scoring scheme may end up having slightly different results. It should be noted that the star scoring shown in **Table 2** reflects the opinion of the researchers and is mainly intended to demonstrate the evaluation framework. For practical applications, a panel of experts assembled by the agency would ideally perform the evaluation.

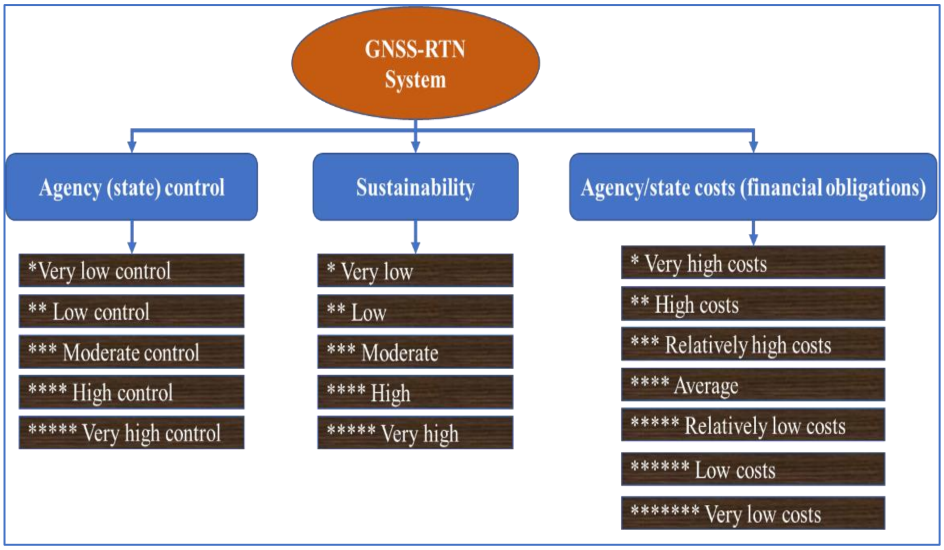

Figure 2. Star Scoring Scheme for High-Level Assessment

In general, the business models in **Table 2** show that the higher the level of agency (state) control over the GNSS-RTN system, the higher the financial obligations of the state. The two extremes shown here are: a system that is fully owned and operated by the state where the state has full control over the system and a system that is fully owned and operated by the technology vendor where the state has minimal control (if any) over the system. Further, it is evident that partners' contribution to the CORSs maintenance and operations costs as well as the user access charges both lead to improved sustainability. However, the partners' contribution to CORSs maintenance and operation costs may lead to lower state control over the GNSS-RTN system.

Table 2 - Assessment of Possible Business Models Using the Star Scoring Scheme

CPC Operations		CPC – State		CPC – Vendor for Fee		CPC – Vendor Network		
CORSs Operating & Maintenance Costs		State	State + Partners	State	State + Partners	State	State + Partners	Vendor
CORSs Ownership	State	***** * **	NA	***** * *	NA	**** *** ****	NA	NA
	State	***** ** ***	NA	***** ** **	NA	**** **** *****	NA	NA
	State + Partners	**** * ***	*** ** ****	**** * **	*** ** ***	*** ** *****	** ** ******	NA
	State + Partners	**** ** ****	*** *** *****	**** ** ***	*** *** ****	*** *** ******	** *** *******	NA
	Vendor	NA	NA	NA	NA	NA	NA	* *** ****

Note: Cells highlighted in grey are for business models with user access charges. Star ratings in cells from top down are given for level of state control, sustainability, and state/agency costs respectively.

5 Summary

The main objective of this study was to conduct a high-level assessment of the business models of statewide GNSS-RTN systems. This paper synthesized and evaluated those business models that have been proposed or used in practice, both nationally and internationally. Total of eight different business models (currently adopted and potential models) are identified and discussed in detail. Based on these models, three main conceptual elements of a business model for GNSS-RTN are ascertained and articulated. These elements include infrastructure ownership, costs, and user access charges (revenue). Afterwards, the business models were assessed based on three major criteria that include, i) state control, ii) sustainability, and iii) state/agency costs. Based on these criteria, a state agency can opt for any specific business model that suits best the agency's objectives and priorities.

Though this study offers high-level guidelines regarding business models for the statewide GNSS-RTN system, the authors recommend further research into the economic feasibility (e.g., benefit-cost analysis) of various business models which would help the states in making appropriate decisions in embracing the technology and in updating and expanding the existing networks.

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