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Install a WISP at Any Location by Using STARLINK to Backhaul a WISP Network to the Internet

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There is a huge demand for Internet access in industrialized and developing countries, however a part of the Earth's population has no access to the Internet. There are reasons listed below why a significant proportion of the world population cannot get Internet access.

- There are large areas that have no communications services; there is no Internet service, no mobile phone service, no fiber, no DSL and there is no WISP service as a WISP requires a copper or fiber Internet connection.
- There are geo-stationary satellite services available for some areas of the earth however many people in the areas without terrestrial service cannot afford the cost of the geo-stationary satellite service; furthermore they have no bank accounts or credit cards so would not have a method of payment.
- Low earth orbit (LEO) Internet satellites are being launched and already provide a service in some parts of the world. LEO satellites have the same problem as geo-stationary satellites; their cost is too high for many people who live in the large areas that have no Internet service of any type.

There are a few WISP’s located in areas where there is no Internet backhaul connection who use geo-stationary satellites to provide Internet service for their customers, however the bandwidth of the satellite antenna is limited, which limits the number of customers that the WISP can serve. When LEO services become available the available bandwidth will be higher than geo-stationary satellites for a similar cost.

It is likely that some WISP customers in the USA will switch to LEO satellites, as the service will offer faster Internet for a slightly higher cost. In the parts of the world that have no Internet access most potential customers cannot afford the satellite services. WISP’s can use LEO satellites to provide the Internet connection and then share the service between many users. A WISP in a region without Internet and with potential customers who are economically limited in what they can pay, is able to provide a 2Mb/s Internet service for $2 per month. Such a WISP can provide a service for 300 people connected to one LEO antenna with a low contention ratio, more with a higher contention ratio.

The next figure shows areas of the earth where rural communities have no or limited access to the Internet. Fire4 Systems Inc. provided the regional information from sales data of WISP products that control network access with on-demand voucher Internet sales for cash payments, a product line that is popular in these areas. This method of selling Internet using on-demand vouchers is popular because customers can purchase vouchers with cash payments. The majority of the population in these areas cannot afford the cost of a satellite service and don't have bank accounts or credit cards to pay for the service. Some urban areas that are within the circles do have DSL and 3G/4G Internet access however the current cost is high for the people who live in these areas. In order to provide a lower cost Internet service in these urban areas WISP's share a DSL circuit between many users for a low monthly cost per user. There are no opportunities for WISP's in large areas like Russia and China and several smaller countries like Cuba as the governments only permit state provided and censored Internet access.

When the LEO constellations are completed then LEO wireless Internet will be available at any point of the earth. In the parts of the world where customers can easily afford the service, like North America, then LEO services like Starlink will be competing with other services of similar performance and cost. In the USA there are still rural areas without any type of Internet service however the people in those areas can afford the cost of Starlink if they wish to have Internet access.

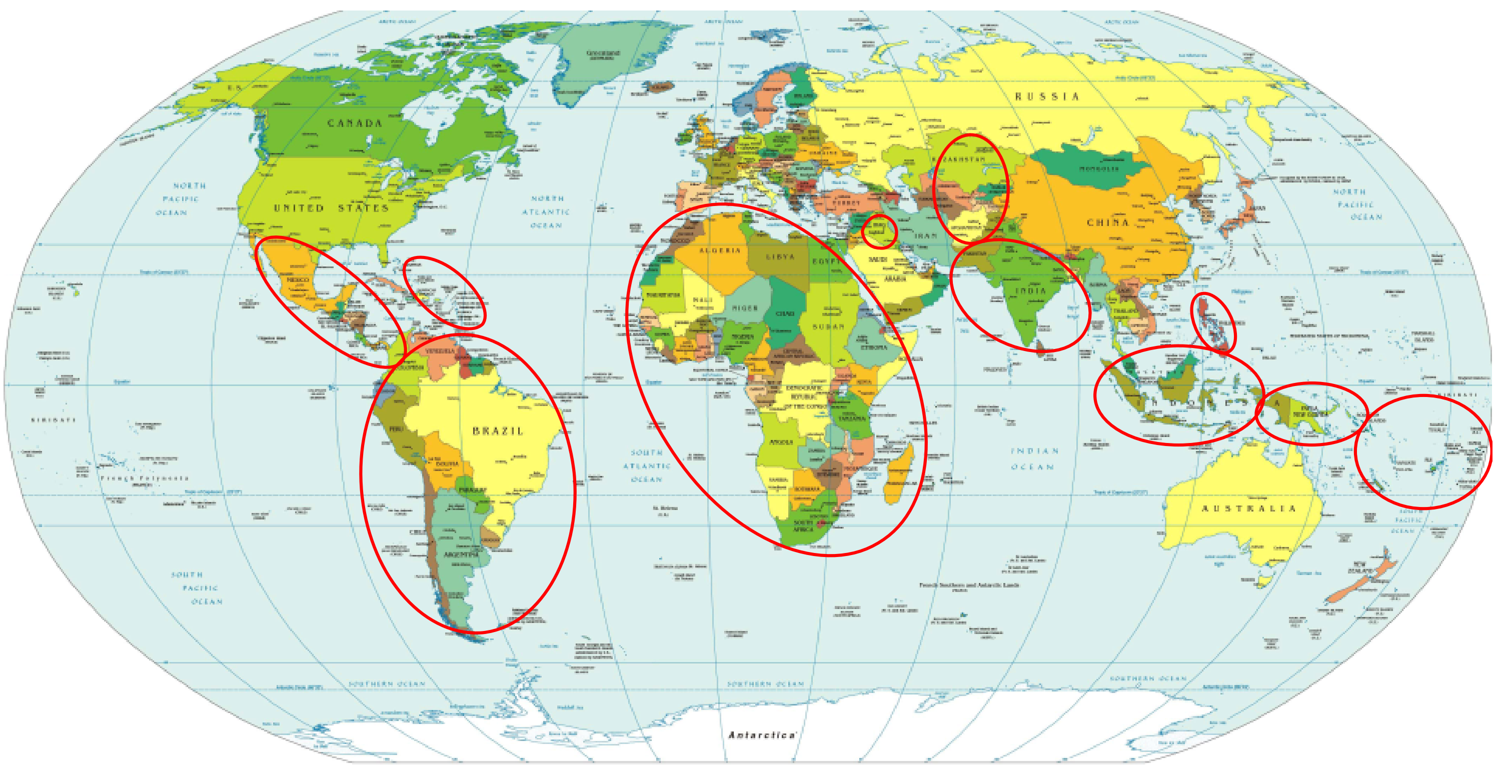

Figure 1. Approximate areas of the earth are circled where there is no or limited Internet access for rural customers. (Data compiled from Fire4 Systems Inc. sales records 2010 to 2021).

In many parts of the world that are indicated on the map there are no Internet services in rural areas and limited Internet in urban areas. The cost of LEO satellite services is too expensive for most people who want Internet access in these areas. A LEO satellite service however does provide an opportunity for a WISP to provide Internet access for many people, and for a low monthly cost that is affordable for the rural demographic who have no alternative means to access the Internet.

In the parts of the world that are indicated on the map, a LEO satellite service is the only possible Internet backhaul for WISP's who want to provide a service for customers. The introduction of LEO satellite Internet services will create many thousands of new WISP's who will have chance to provide a low-cost service for customers and make money. WISP's that are already established in the areas indicated in the figure operate with a different business model to WISP's in the USA.

- The Internet backhaul is divided between many more customers than a WISP would do in the USA, offering a lower performance service for a lower cost.
- A few customers with a higher income are monthly subscribers.
- The majority of customers choose the on-demand mobile broadband service rather than a fixed broadband subscription for reason of cost.
- Commercialization of the service is predominantly through cash payments.

The availability of LEO satellite services for enterprises to resell access will open low-cost Internet access for millions of people around the world and the majority of Internet users will be customers of new WISP's that were started to take advantage of the LEO satellite Internet services.

Comparing geo-stationary and LEO satellite technologies

Geo-stationary satellite Internet has been available for many years. Initially the service was very expensive and the customers were businesses that could afford the cost of the service. The marine industry has relied on VSAT and Intelsat to maintain data communications with merchant shipping around the globe. Several services are available for residences and businesses and the most popular is the HughesNet service.

LEO satellite networks have been available for phone services but the ventures were limited in success, in part due to the high prices charged. LEO satellites providing low cost Internet services are a recent development and appear to provide a very popular service. However the LEO satellite business must make the huge investments to ensure that the service is successful.

The characteristics of geo-stationary satellite services are listed next.

- A satellite in a geo-stationary orbit rotates at the same speed as the surface of the earth above the equator and so remains at a fixed point in the sky, a ground parabolic antenna can therefore remain fixed to the location of the satellite.
- One satellite communicates with ground antennas over an arc of the earth's surface.
- As the satellite is stationary above the equator then it can cover the northern and southern hemispheres however the satellite antenna beams are focused on the areas of land mass with denser populations to maximize the number of customers.
- As the satellite is above the equator antennas in the extreme northern and southern hemispheres of the planet see the satellite very low on the horizon, and as the radio signal passes a greater distance through the atmosphere the quality of the signal is reduced.
- All customers connect through one large satellite and so the bandwidth available per customer is small. There will be a maximum number of customer antennas that each satellite can support due to the limited data throughput capacity of the satellite.
- The satellite geo-stationary orbit is 22,000 miles above the equator, the time taken for the transmission to the satellite and back to earth is 236ms, and the total latency of Internet access is approximately 300ms to 600ms.
- The geo-stationary satellite operators put a data cap on monthly use due to the limited bandwidth and impose additional charges when data use exceeds the cap.

Geo-stationary satellite firms are listed below. Note that these firms do not offer complete global coverage.

- HughesNet.
- Viasat.
- Skycasters.
- VSAT.
- Intelsat.

Several firms have planned LEO satellite constellations to provide Internet services but at the present time Starlink is currently the only LEO satellite business that is operational, and is available only over part of the northern hemisphere. Starlink has published technical information about the satellite service and network operation but very little information is available about other LEO satellite systems. Characteristics of the Starlink low earth orbit (LEO) satellites are listed below.

- At any one time a point on the earths surface has visibility of one to several satellites.

- Starlink planed to have a total of 12,000 satellites in orbit initially however now that number has been increased to over 30,000 satellites when the constellation is complete.
- Starlink is launching satellites every month, with 60 satellites per rocket launch.
- At the present time Starlink has satellites located in a number of orbital shells around the earth.
    - First shell: 1,440 satellites in a 550 km (340 mi) altitude shell at 53.0° inclination.
    - Second shell: 1,440 satellites in a 540 km (340 mi) shell at 53.2° inclination.
    - Third shell: 720 satellites in a 570 km (350 mi) shell at 70° inclination.
    - Fourth shell: 508 satellites in a 560 km (350 mi) shell at 97.6°.
- As Starlink satellites are close to the earth they require less transmission power than a geo-stationary satellite and are therefore much smaller.
- Starlink customers report data download speeds exceeding 150Mb/s with a latency of less then 30mS.
- Starlink has no monthly data cap so no additional charges are imposed.
- Each customer’s antenna will be programmed to operate at a specific longitude and latitude coordinate.
- There is a maximum density of customer antennas per square Km due to the limited number of satellites overhead at any one time. Customer antennas that are close together will share data through the same satellite. As more satellites are launched the number of customer antennas that can be installed per square Km will increase.
- Starlink antennas are not directional as they communicate with satellites over a 180 degree arc of sky; the antenna used is a beam-forming phase array that can be directed electronically to any point in the sky to track the satellites.
- As LEO satellites have a low orbit then the orbital speed of a satellite is much faster than the rotation of the earth so a satellite will traverse the sky from horizon to horizon in a few minutes, the customer antenna will select a satellite that is close and switch between satellites as each moves overhead.
- Current Starlink customers are beta testing the service and Starlink restricts how the service can be used.
- The Starlink service is currently only available in the northern part of the USA, Canada and northern Europe and there is only a small fraction of the total number of satellites in orbit at the present time.

- The Starlink service requires approval for use of the communications frequencies in each country where the service will be provided, and it is approved in only a handful of countries at present.
- At present Starlink is limited to residential and small business use and cannot be used by WISP’s as an Internet backhaul to sell Internet services. However the company stated that an enterprise service will become at a higher price.

LEO satellite competitors are listed below. Some LEO firms have gone through bankruptcy and then continued with new investors.

- SpaceX Starlink.
- Amazon Kuiper satellites.
- Kepler Communications.
- Northrop Grumman.
- Boeing.
- Lockheed Martin.
- Thales Alenia Space.
- Airbus Defense and Space.
- SSL.
- Globalstar.
- BAE Systems.
- Oneweb.

WISP’s may have to wait until 2024 or later before a LEO satellite service is available for use as a tower backhaul, however WISP's should begin thinking about using a LEO satellite service now so that current infrastructure investments will support future LEO satellite expansion.

Starlink technology

The Starlink satellite constellation will have more than 30,000 satellites when completed. The satellites will orbit in several orbital shells, each shell at a different altitude and with a specific inclination to the orbit of the earth. Each customer will have an antenna that can communicate with a satellite over approximately 180 degrees of the sky, and can swap the connection between satellites as each move across the sky. Each satellite will relay the customer connection to one of the many ground stations around the globe. Each ground station will have a high-speed connection to the Internet. Eventually there will be a laser connection between satellites so that a circuit is made through a mesh of satellites to minimize the terrestrial connection between the customer’s antenna and the ground station server location to reduce latency between points on the earth.

Although the number of satellites may appear to be large, there are few satellites for each arc of the earth's surface. The density of satellites over the earth's surface can be calculated as follows.

Calculate the area of the earth's surface covered by each satellite.

- Total approximate area of the earth's surface;
    - = 196.9 million sq miles.
    - = 510 million sq Km.

- Area per satellite;
    - = 196.9 million mi² / 30,000 satellites = 1 satellite per 6,562 sq ml.
    - = 510 million sq Km / 30,000 satellites = 1 satellite per 17,000 sq Km.

- Calculate the circle diameter of the earth's area covered by each satellite;
    - D = 2 x root (6562 / pi) = 91 miles diameter.
    - D = 2 x root (17000 / pi) = 147 Km diameter.

Calculate the number of satellites over land at one time.

- Approximate area of the surface of the earths land mass;
    - = 57.5 million sq miles.
    - = 149 million sq Km.

- Ratio of land mass area to total area;
    - = 57.5 miles / 196.9 miles = 0.29.

- Number of satellites over land = 30,000 x 0.29 = 8700 satellites.

This number of satellites over land may be higher due to the selection of satellite orbits to increase the number of orbits over land areas. There will be a maximum data throughput for each satellite, which will limit the number of customer antennas within the area covered by a satellite. In practice the number of customer antennas can be higher as satellite orbits in different shells overlap to increase the density of satellites for an area of the surface. SpaceX has not released information about specific satellite orbits and customer antenna density limitations.

The next figure illustrates the orbits of satellites at different inclinations and in different shells.

Figure 3. Starlink satellite orbital inclinations, within shells at different altitudes. (Image copyright © SpaceX 2021).

Each satellite has a fixed orbit in space however the earth is rotating and so each satellite will be over a different landmass with each orbit of the earth. It is possible that any point on the earth might have two satellites overhead at any time due to orbital shells with different inclinations. The customer ground antennas will have a 180-degree visibility of the sky and so several satellites might be visible to the antenna. The satellites will move across the sky from horizon to horizon in several minutes as a low earth orbit requires a much faster orbital velocity that the speed of the earths rotation. The figure shown below illustrates the constellation of Starlink LEO satellites in orbit around the earth, within several shells, each shell at a different altitude.

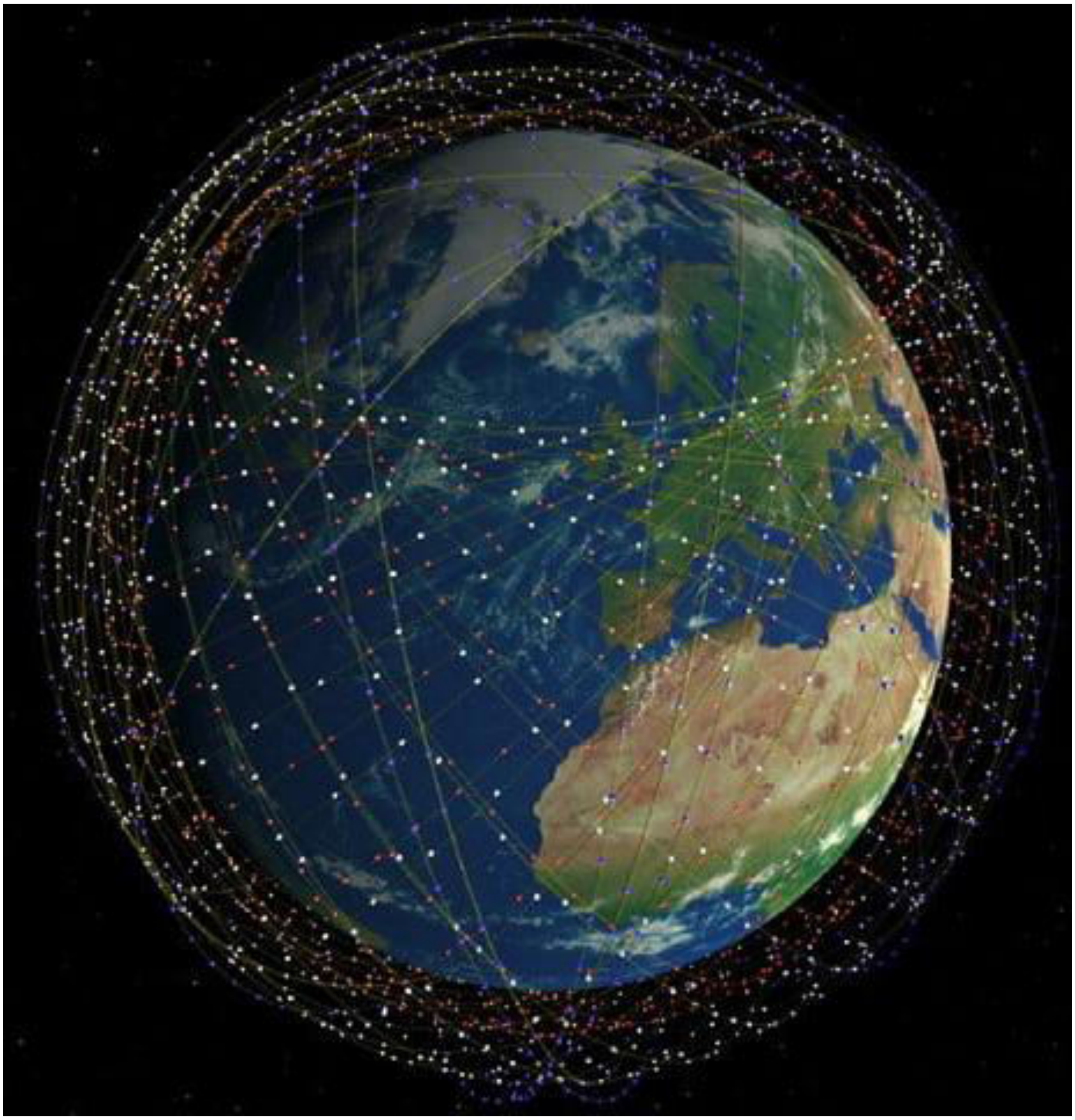

Figure 4. An illustration of Starlink satellites in orbit around the earth within several shells. (Image copyright © SpaceX 2021).

Starlink satellites are launched in batches of 60 satellites per launch. After the batch of satellites is in orbit each satellite is maneuvered into the correct orbital position. Satellites require positional corrections periodically to maintain the orbital position. Each Starlink satellite also has a positional booster to de-orbit the satellite if some technical failure occurs and the satellite will then burn up in the atmosphere. Starlink can replace satellites that have been de-orbited.

The following illustrations show Starlink satellites in orbit.

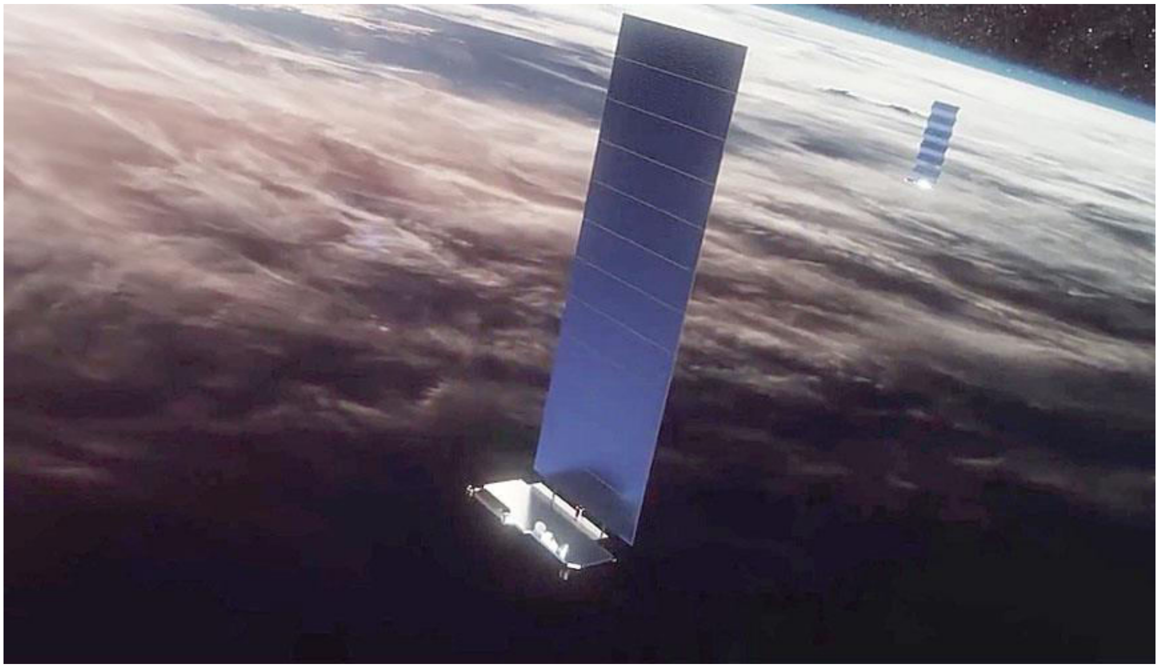

Figure 5. Starlink satellites in orbit. (Image copyright © SpaceX 2021).

Each satellite has a solar array to capture sunlight during the part of the orbit where the sun is visible. The electrical energy that is generated is stored in batteries to power the satellite during the part of each orbit where the earth blocks the sunlight. The expected lifespan of each satellite is in the range of 5 to 7 years. The space environment is harsh and dangers include electromagnetic radiation across all frequencies that may damage electronic circuits, and collision with micro-particles that may damage external components.

The next illustration shows the earth-facing antennas of a Starlink satellite.

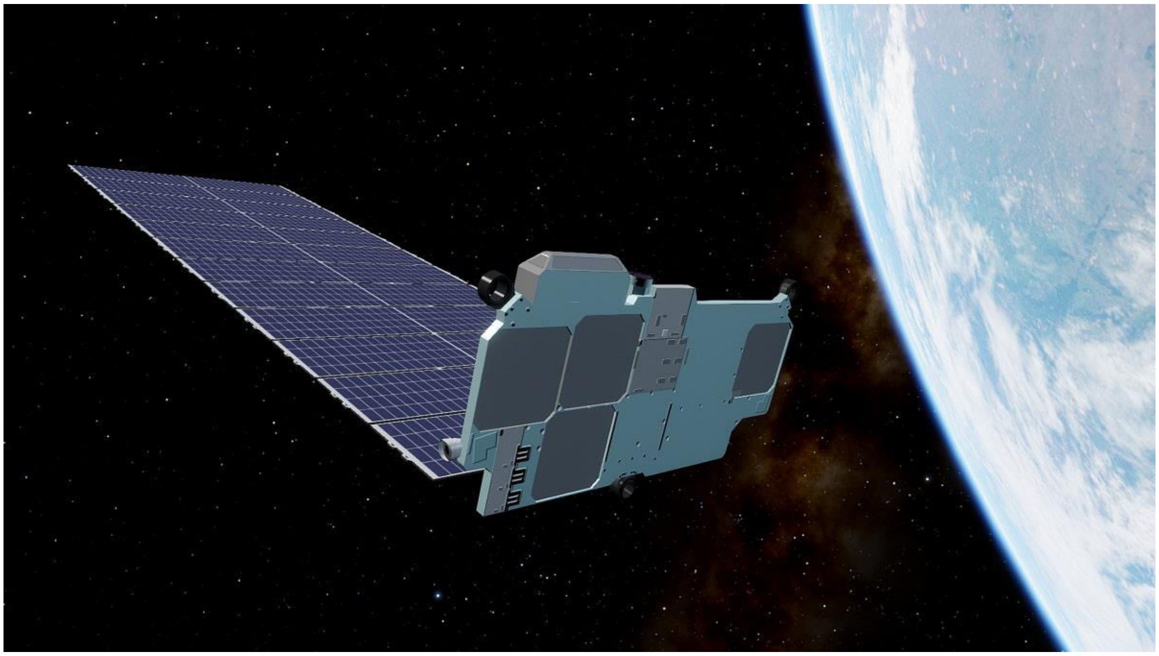

Figure 6. Starlink satellite antennas for transmitting and receiving from the customer antenna and to the ground station. (Image copyright © SpaceX 2021).

A customer Starlink antenna is shown in the next illustration. Each antenna includes a wireless router for installation inside the premises and a power over Ethernet (PoE) supply to power both the antenna and the wireless router. Starlink have stated that the cost of manufacturing this antenna exceeds the sale price of the antenna.

The antenna design shown is being replaced by a square antenna, which has a lower manufacturing cost.

Figure 7. Starlink customer antenna with wireless router and PoE injector (Image copyright © SpaceX 2021).

The Starlink customer antenna has a motor, which adjusts the attitude of the antenna. The antenna is a phase array beam forming design, which means that the antenna can be directed electronically over approximately 180 degrees of the sky. The beam-forming antenna was described in an earlier section of this book.

The antenna must have approximately 180-degree visibility of the sky to ensure that it can connect with at least one satellite. If the antenna is installed in a location surrounded by buildings or trees then the antenna must be mounted on a roof or antenna tower to provide 180-degree visibility of the sky. The following photo shows a Starlink antenna mounted on a Rohm antenna tower to support the antenna above surrounding trees.

Figure 8. Starlink customer antenna mounted on a mast for a clear view of the sky (Image copyright © SpaceX 2021).

Starlink has ground stations located around the earth and each one has a high speed Internet connection. SpaceX has an agreement with Google to install Starlink ground stations at Google data centers. Each ground-station includes a cluster of several antennas like the one shown in the next photograph. As satellites pass over the ground-station a link is established to permit the satellite to relay data packets between the customer antennas within the range of the satellite and the ground-station antenna.

Figure 9. Starlink ground stations are installed around the earth; no information is available about the number of ground stations currently installed (Image copyright © SpaceX 2021).

A future feature of the Starlink constellation is the ability to relay data communications between satellites using a laser data link so that the greater part of the data path between two points on earth is between satellites in orbit rather then through terrestrial data connections. This feature will speed data communications between two points by reducing the latency time or delays of the transmission.

The next illustration indicates a laser data connection between satellites for a data circuit from London to New York. Instead of the data connection passing through undersea fiber optic cables, which have a high latency due to the large number of repeaters, the data connection is relayed through several satellites in different orbits.

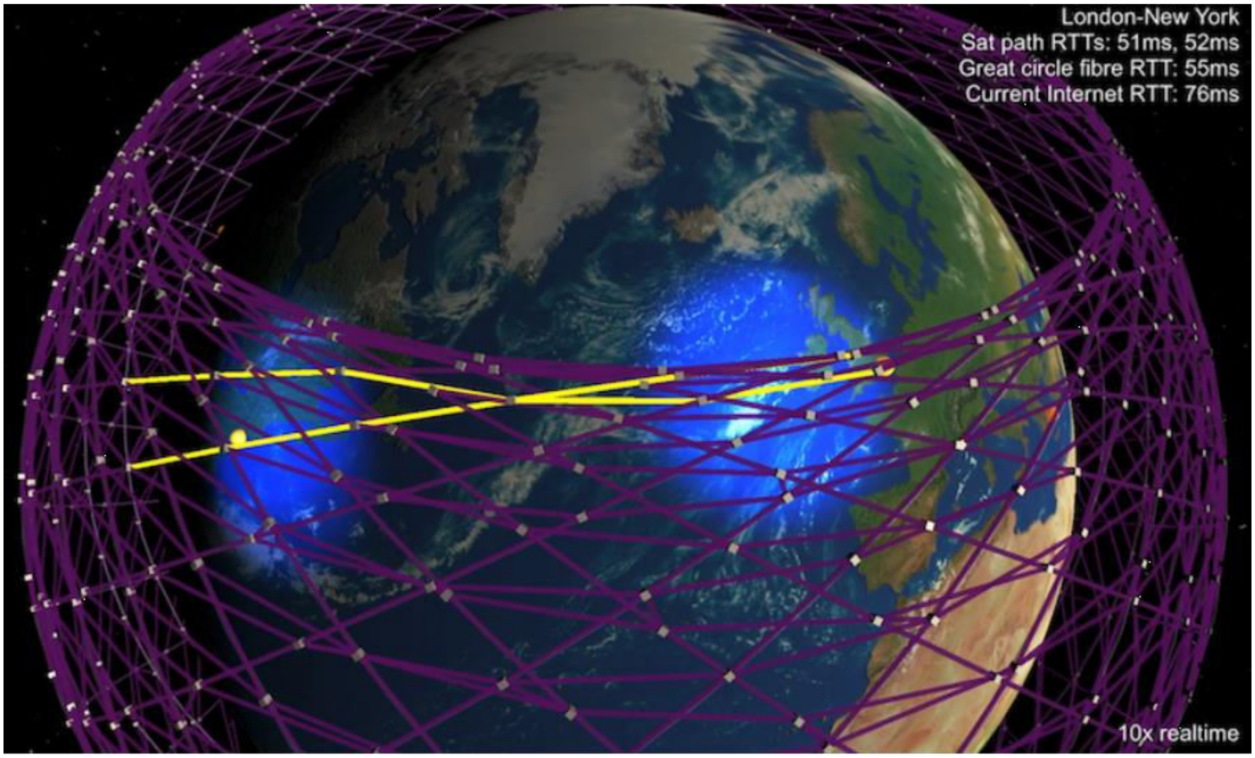

Figure 10. London to New York data connection; Starlink communication between satellites via laser to minimize high-latency terrestrial paths for each data link. (Image copyright © SpaceX 2021).

The operation of Starlink has to be approved in each country where it will provide service, as the frequencies used by Starlink require a license to authorize their use. At the time of writing Starlink has been approved by 14 countries and has pending license applications in many more countries.

Adding a LEO satellite backhaul to an operational WISP network

A WISP that has built a network with several PtMP towers, with each tower connected back to a NOC through a wireless distribution network has three methods to upgrade to a LEO satellite Internet backhaul.

The first method is to install the LEO satellite antenna at the NOC. There is little benefit installing two or more LEO antennas at the same location as multiple antennas will communicate through the same satellite, giving only a small throughput benefit compared with having only one antenna. A single LEO antenna installed at the NOC can augment the data backhaul capacity allowing more customers to be added to the network, and also provides redundancy in the case that a problem occurs with the principle fiber backhaul connection. The next diagram illustrates the installation of a Starlink antenna at the NOC.

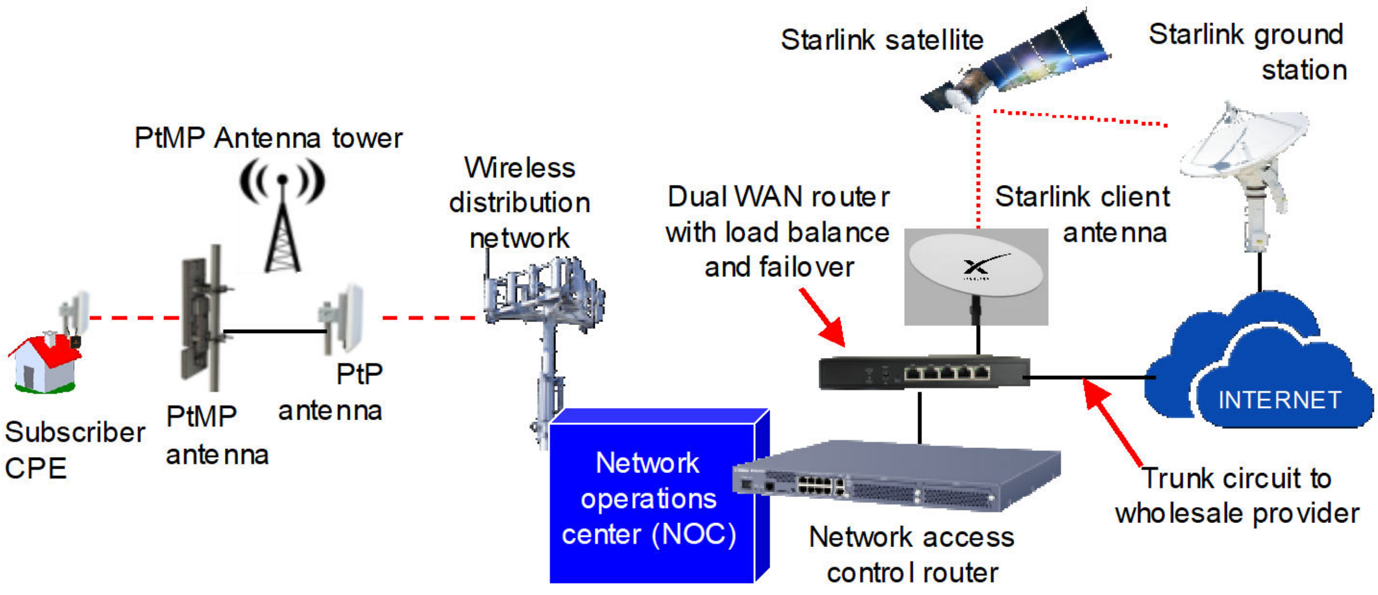

Figure 11. LEO satellite antenna installed at the NOC of an established WISP.

The WISP can obtain improved performance by installing a LEO antenna at each PtMP tower. Towers are spaced several Km apart and so each LEO antenna may communicate with a different satellite permitting each tower site to have the full backhaul bandwidth of 100+ Mb/s. The existing wireless distribution network to the tower can be maintained to increase tower capacity permitting the connection of more customers to that tower, and also add redundancy to the tower site.

There are two methods to implement and upgrade the WISP network when installing a Starlink antenna at each tower.

The first method requires the connection of the PtMP wireless access point to a load balancing router that routes the user traffic to both the wireless distribution network and to a VPN gateway to tunnel through the Starlink network via VPN back to the NOC to implement access control. This method has the disadvantage that a part of the customer traffic is routed to the NOC via the Internet for access control and therefore the NOC trunk circuit capacity has to be increased to correspond to the additional traffic carried over the Starlink network back to the NOC. The next figure illustrates the tower installation, where data is partly routed over the wireless distribution network to the NOC, and partly routed through a tunnel over the Starlink network to the NOC for access control. Maintaining access control at the NOC is not a satisfactory solution when the WISP adds Starlink antennas to increase the capacity of the network.

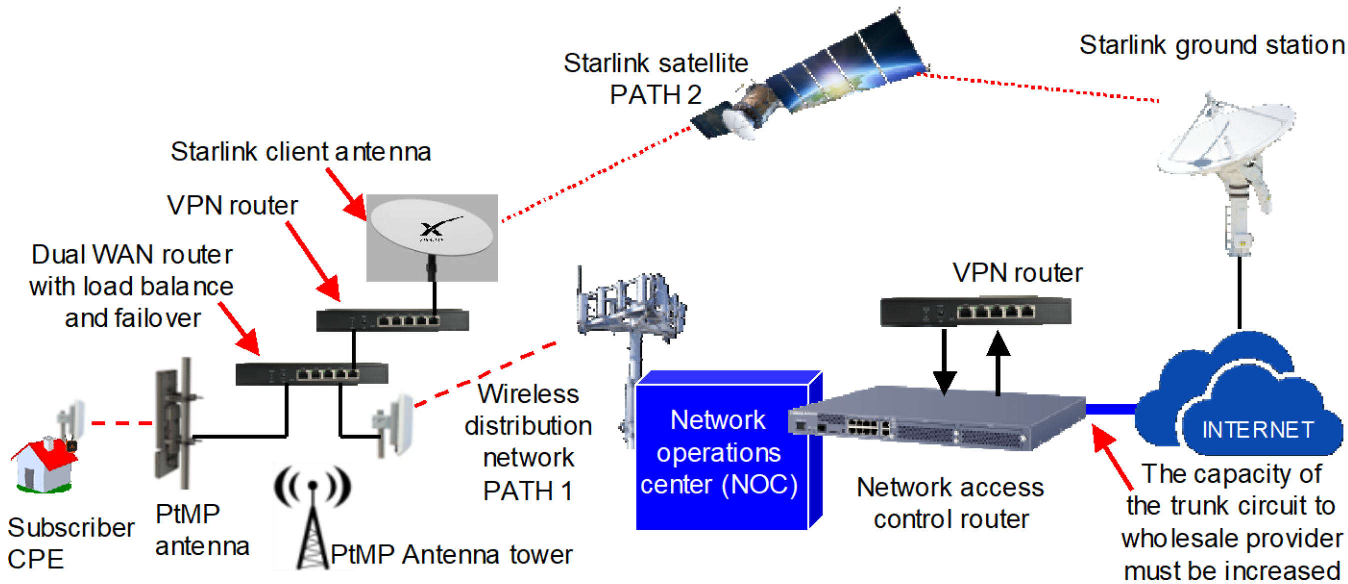

Figure 12. LEO satellite antenna installed at the PtMP tower with access control at the NOC.

The second method requires the installation an access control router at each tower. The access control router connects to a load balance router that routes customer data over both the Starlink network and the wireless distribution network back to the NOC, and from the NOC to the wholesale Internet connection. The load balance router shares the traffic load over the two circuits in function of the capacity of each circuit. The load balance router also has a failover function so that in the case that one-circuit fails; all traffic is routed over the remaining circuit. This network design requires no access control at the NOC.

Having access control at the tower simplifies the network implementation and also uses the available circuits efficiently. The network administrator has an additional workload due to programming several different routers, one at each tower. If the WISP chooses software that automates the programming of routers then the management of the network becomes very simple. The next figure illustrates the network design when a LEO antenna and access control router is installed at each tower.

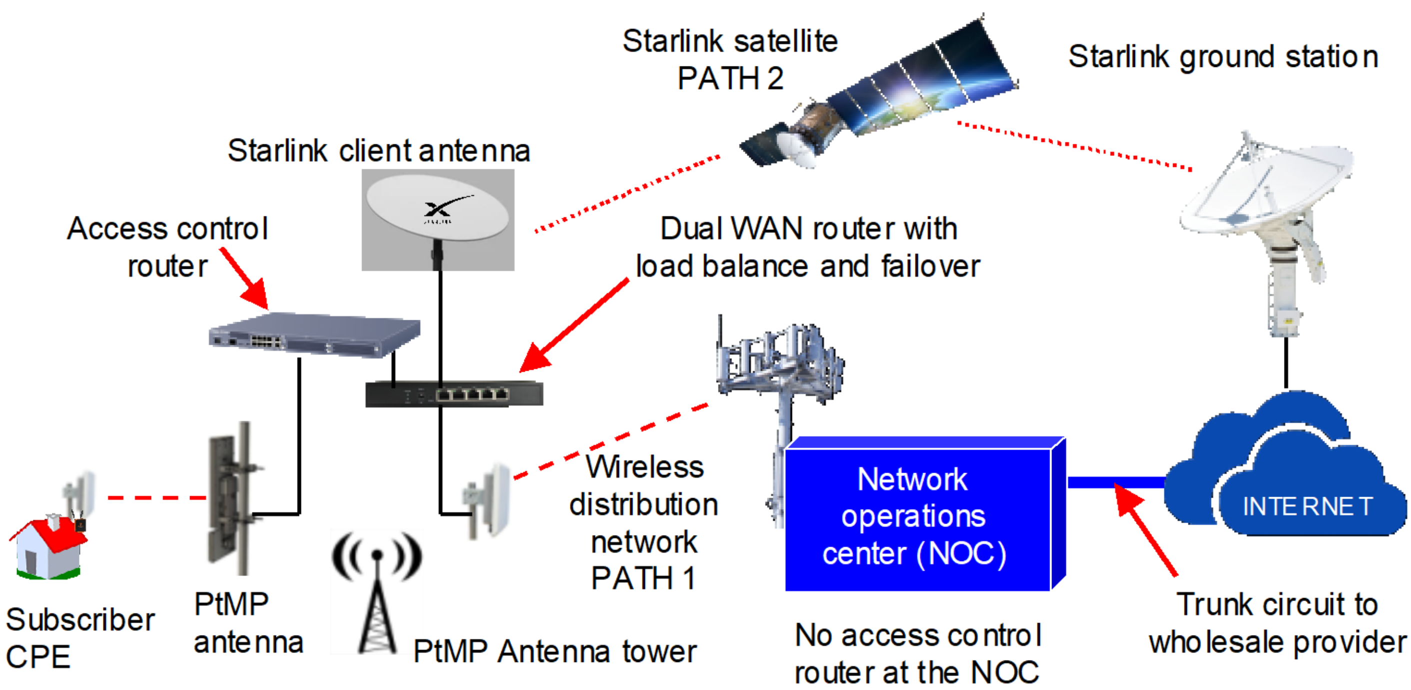

Figure 13. LEO satellite antenna installed at the PtMP tower with access control at the tower with dual WAN load balance and fail-over.

A network design for the start-up WISP using Starlink

An entrepreneur who starts a WISP business today has a limited radius of operation around the location where the WISP can contract a wholesale or even retail data connection to the Internet. The radius of operation can be up to 50Km depending on the facility to build multiple-hop wireless point-to-point links. If there is no Internet data connection then a WISP cannot be established. When LEO satellite services become available globally then entrepreneurs will have the opportunity to build a WISP anywhere in the world. A terrestrial Internet service connection is not required. The use of LEO services does place some restrictions on the network design, as listed below.

- LEO satellite antennas cannot be grouped together, they must have a minimum distance separating them; installing the LEO antennas at each PtMP tower site is a good solution as towers are spaced a few Km apart.
- The access control router is installed at each tower between the PtMP wireless antenna and the LEO antenna as part of the equipment configuration; therefore the technical person responsible for network configuration must manually configure multiple small routers, each router is configured for the customers served by that PtMP tower. Alternatively the WISP can install management software that automates the configuration of multiple routers.

The next diagram illustrates the network design with a LEO satellite antenna installed at each PtMP tower.

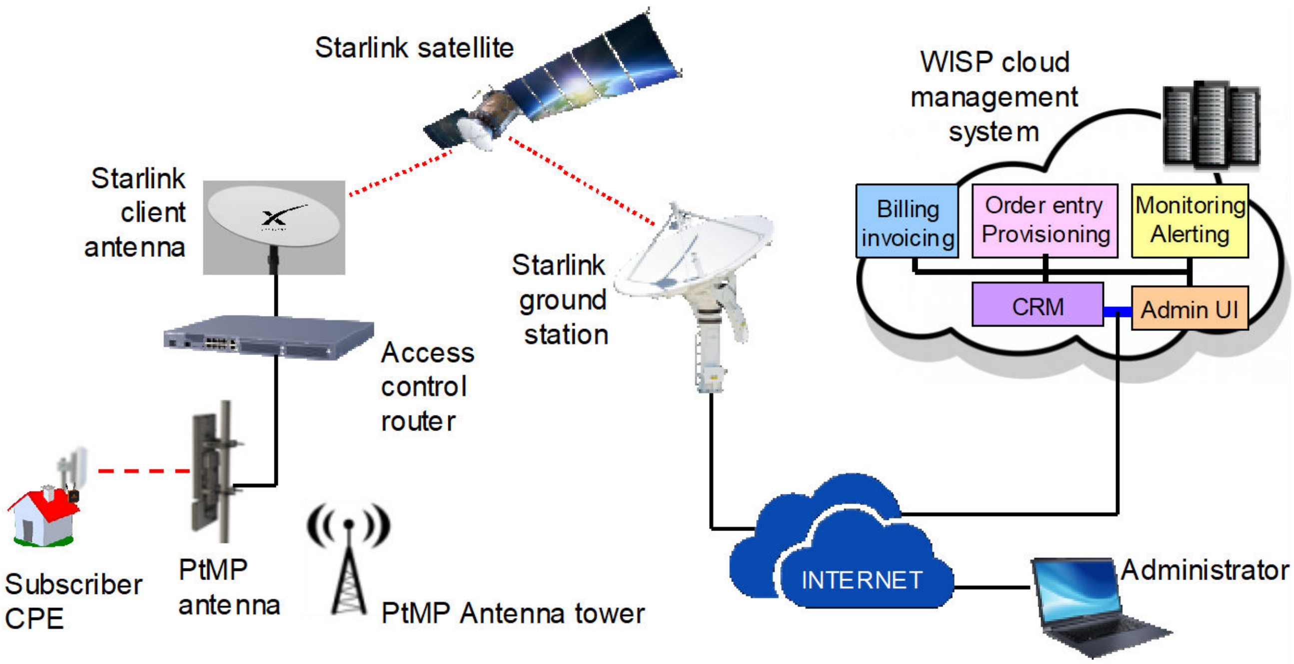

Figure 14. LEO satellite antenna installed at the PtMP tower with access control at the tower.

When an entrepreneur plans to start a WISP business in future then installing a LEO satellite antenna on each PtMP tower together with the access control router in a distributed network design has a series of business benefits when compared to the centralized NOC network management. The benefits are listed below.

- When LEO satellite services are available around the globe then a WISP company can be established anywhere.
- Building a NOC is not necessary, which eliminates a large initial investment.
- There is no wireless distribution network between each PtMP tower and the NOC, eliminating a considerable investment.
- As the only infrastructure build-out is the PtMP tower then the WISP can start in business much faster, speeding return on investment.
- The WISP can install business management software on a cloud service such as AWS, or else contract with one of the cloud management services.
- The reliability of the Internet service provided for the customer is improved, less equipment to fail and backup systems are required only at the tower.
- The WISP carries fewer inventory parts, which reduces investment; the only inventory items required are customer CPE kits and equipment to build and repair towers. Equipment for servicing the wireless distribution network and NOC is eliminated.
- Fewer technical staffs are required and some operating costs can be eliminated due to the simplified network design, installation, support and maintenance requirements.
- The WISP administrator uses an Internet connected laptop to manage the business from anywhere that has an Internet connection.

The next figure illustrates the tower installation with a LEO satellite backhaul. It may be necessary to install multiple PtMP wireless access point in order to cover the area desired.

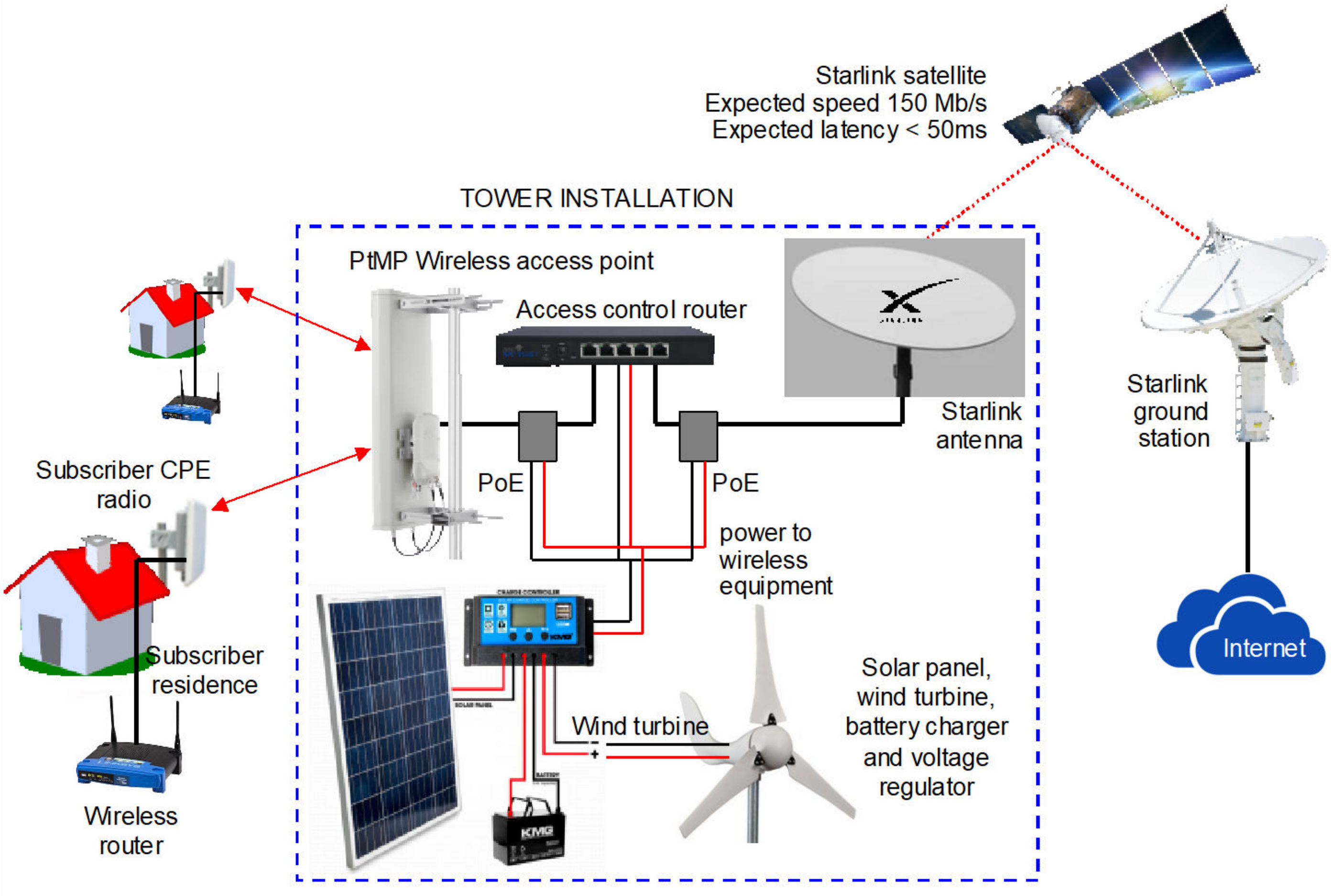

Figure 15. LEO satellite antenna installed at the PtMP tower with power generation for the equipment.

Network administration requires additional effort programming multiple access control routers. The WISP must maintain a list of subscribers at each tower and program the access control router for authentication and rate-plans of those subscribers. If the WISP chooses to implement a WISP management system that automates the programming of access control routers then distributed access control has no additional overhead for the WISP. Although few WISP administration software products support distributed access control management currently there are cloud products that were designed for a distributed management environment. It might be possible for a WISP who has programming skills to modify open-source management software for automation of distributed access control routers.

PtMP towers that are built in remote locations will not have electrical power and so infrastructure must be added to power the tower equipment. Generating power for the tower equipment has been described in a previous section. When a Starlink antenna is installed the power requirements are increased considerably as a Starlink antenna consumes much more power then a PtP backhaul antenna. The capacity of power generation should be increased to 500 Watts or higher. A solar array and wind turbine are installed as the sources of power and energy is stored in a battery. The battery storage should be planned to power the installation for 100 hours without charge, which is approximately 4 days of use. Vendors of tower power systems will give advice about the characteristics of the components to provide adequate power.

WISP network administration using LEO satellite backhauls

The WISP can choose how to implement the management automation of the network with LEO satellite Internet access at each tower. The approach recommended here is to have billing and network monitoring software installed at a central site or use a cloud service and configure each tower access control router for authentication, rate-plan settings, activation and deactivation in case of non-payment. A record of customers associated with each tower facilitates the individual access control router programming.

The WISP can select software or a cloud service that has the facility to automate the control of multiple access control routers while maintaining a record of customers who are authenticated by each router. WISP software can be hosted on a cloud service such as Amazon AWS or Microsoft Azure.

Routers have three types of remote interfaces, listed below.

- Command line terminal.
- Graphic user interface (GUI).
- Application program interface (API).

The router is programmed by adding scripts which are command lines of instructions that tell the router how to process incoming data streams. Scripts can be entered via the command line interface and some routers provide a graphic user interface (GUI), which will facilitate entering scripts that take action on customer data. Scripts can also be downloaded and installed using the API interface.

A WISP can program routers manually by connecting remotely to each router command line terminal or GUI interface to enter scripts. Automation systems will download scripts using the API interface. Initially scripts must be added to the router using the command line terminal or GUI to enable the API interface for remote access. Once the API interface is enabled the management software can communicate with the router to configure the customer access control rules.

The next diagram illustrates a WISP administration software or cloud service that automates the interface with each access control router.

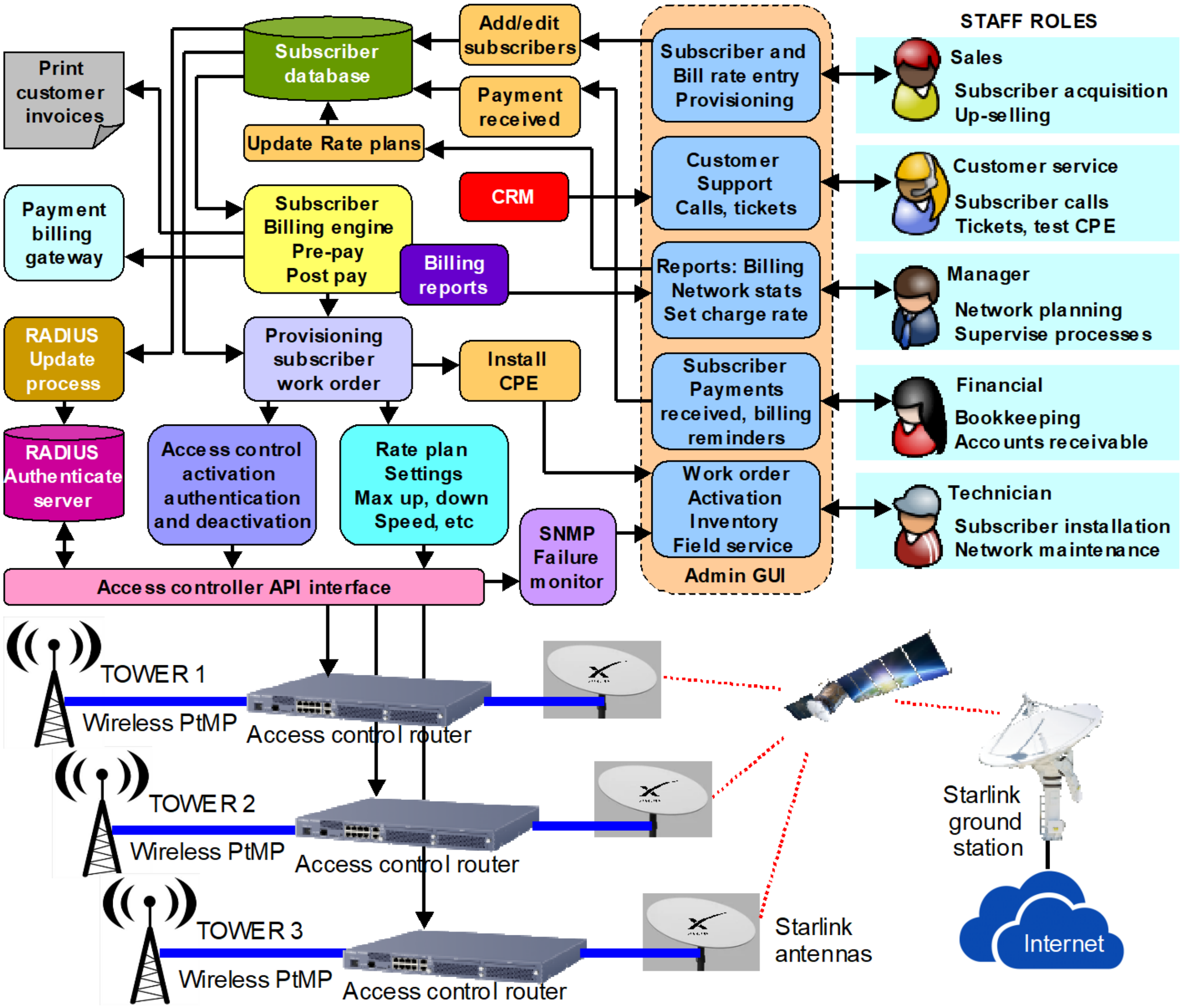

Figure 16. Administration software access control automation of multiple towers, each with a LEO backhaul.

There are six points of contact between the WISP management software and the interface API of the router that is selected for configuration.

- Configure the customer authentication method; this can be as simple as setting the CPE MAC address for simple authentication, or configuring the PPPoE server that will interface with an external RADIUS authentication server.

- Configure the SNMP agent for monitoring.
- Set the rate plan for each customer accessing the Internet through the tower site.
- Activate the customer allowing the customer to access the Internet.
- Deactivate the customer if the account is past due then redirect the customer to a CRM captive portal page.
- Poll the SNMP agent periodically to verify that the device is alive and gather operational information.

Each time that a customer opens a connection with the access control router the CPE will send the authentication credential to the PPPoE server, which will then authenticate the customer via the external RADIUS server, by passing the authentication key for validation.

The features listed are essential to fully automate the access control router functioning. Each WISP management system determines the access control automation specifics. Some systems may implement a partial list leaving some router programming for the WISP technician. Some systems may include additional features not described in the list above that improve performance of the access control process and add functionality.

New opportunities for WISP's that adopt LEO satellite services

An established WISP can begin to transition to Starlink when the service becomes available where the WISP is located. As of this writing satellite coverage is available only in the northern part of North America and countries in Europe, such as the UK. Some countries have satellite coverage but their government communications departments have not yet approved a license for Starlink to begin offering the service to customers.

In some parts of the world such as North America, WISP customers can afford the cost of the Starlink antenna and monthly subscription so the WISP's will see Starlink as a threat. Starlink is likely to take some of their customers. Those WISPs will also see the opportunity to expand networks into remote rural areas where they are not able now because there is no wholesale Internet access service but there are prospective Internet service customers who cannot afford the cost of the Starlink antenna and service.

In other parts of the world where there is no access to a wholesale Internet connection then a WISP can set up in business with Starlink, as there will inevitably be a pent-up demand of potential customers seeking an Internet access service. Starlink will empower entrepreneurs who would like to start a WISP business but are currently not able due to lack of backhaul infrastructure.

People who start WISP businesses in areas like North America are usually technically well qualified, with years of IT experience. They have qualifications such as certifications from router manufacturers, and have the capital required to start the business. People in many other parts of the world don't have the same good fortune; there are few IT jobs for them to gain experience, no access for formal technical training programs and very limited access to capital to start a business. In order that entrepreneurs in many parts of the world can start WISP businesses the following criteria for the WISP technology are essential.

- Extensive technical knowledge should not be required, the WISP system components should be very easy to connect and use, sometimes called plug-and-play technical solutions.
- The technical solution should be frugal so that the minimum amount of investment is required to start a WISP business.
- The technical solution should have a low operating cost, in the range of cents per subscriber per month.
- The economics of the business should permit providing a very low cost Internet service for a population with economic limitations where the charge will be in the range of a few dollars per month.
- The WISP should offer mobile broadband in addition to fixed broadband as potential customers with limited economic means will use low cost smart phones as Internet access terminals and seek locations where mobile broadband is offered. The cost of installing fixed broadband CPE equipment at the customers premises may be too high for the customer.

The criteria for the WISP management system for developing regions of the world are listed below.

- Must have the essential functionality for provisioning new customers, billing customers, monitoring network performance and alerting of network failures.
- Ideal to have an API Interface with popular routers for access control configuration that does not require learning the router command language to prepare configuration scripts.
- Where a PtMP wireless access point supports a router programming language (e.g. Mikrotik) then configure the product to serve as the access controller for customers who are assigned to that wireless access point.
- Must function with any type of PtMP wireless access point and CPE wireless unit.
- Should have multiple authentication methods for flexible configuration, including CPE MAC authentication, and a RADIUS server for PPPoE or WPA2-enterprise authentication.
- The operating cost per subscriber must be in the cents per month range, not the dollars per month.
- The billing system should support both fixed broadband monthly subscription billing and mobile broadband on-demand billing.

- The technical solution must be comparable with both a centralized NOC configuration and also a distributed configuration with a LEO satellite antenna at each tower to permit a WISP to set up in business anywhere in the world.
- The initial network investment must be the lowest of any system available in the market.