APPARATUS AND METHOD FOR APICAL DOMINANCE WIRELESS

Inventor: Kevin O'Shea, Enfield Center, NH (US)

Correspondence Address:
Hayes Soloway PC
175 Canal Street
Manchester, NH 03101 (US)

Appl. No.: 11/007,415
Filed: Dec. 8, 2004

Related U.S. Application Data

Provisional application No. 60/527,908, filed on Dec. 8, 2003.

Publication Classification

Int. Cl. 7 ................................................ E04G 1/36

U.S. Cl. .................................................. 182/128, 182/133

ABSTRACT

An apparatus and method for removably connecting a support structure to a tree for communication support are provided. The apparatus contains a first extension element and a second extension element that are removably coupled to the tree. A support device is removably connected to the first extension element and the second extension element. In addition, at least one electronic device for providing wireless communication is provided, wherein the at least one electronic device is removably connected to the support device. The method comprising the steps of: determining a geographic area for location of the support structure; examining and ranking selected trees within the geographic area for supporting the support structure thereon; and removably connecting the support structure to a tree within a selected geographic area having numerous high ranking trees within the geographic area for supporting the support structure thereon.
FIG. 3
DETERMINE ACCEPTABLE RISK OF INSTALLATION FAILURE

DETERMINE GEOGRAPHIC AREA FOR LOCATION OF SUPPORT STRUCTURE

TEST SELECTED GEOGRAPHIC LOCATION OF THE SUPPORT STRUCTURE FOR POTENTIAL TREES

DETERMINE EASE OF ACCESS TO SELECTED GEOGRAPHIC AREA

EVALUATE SELECTED TREE FOR ATTACHMENT OF SUPPORT STRUCTURE

INSTALL SUPPORT STRUCTURE

FIG. 4
1. Clean tree (402)
2. Add structural support to tree (404)
3. Assemble as much of support structure as possible prior to climbing (406)
4. Locate suitable location for installation of support structure (408)
5. Determine required thickness of wood and vertical separation of extension elements (410)
6. Install support structure (412)

**FIG. 5**
APPARATUS AND METHOD FOR APICAL DOMINANCE WIRELESS

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of U.S. Provisional Patent Application Ser. No. 60/527,908, filed on Dec. 8, 2003, and entitled “Method for Apical Dominance Wireless Infrastructure,” which is incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

The present invention is generally related to the field of supporting devices or structures and, more particularly, to a support device attached to a tree for the purpose of mounting electronic equipment on the support device.

BACKGROUND OF THE INVENTION

In recent times, there has been a considerable growth in the availability of wireless telecommunication services. This growth has been fuelled by the classic elements of supply and demand. Some signs of saturation in this growth have been observed in the United States, but in many other parts of the world, the availability of wireless telecommunication services continues to expand at a phenomenal rate.

The expansion of wireless telecommunication services, as well as a more efficient design of the “cell” in which a wireless device operates, has resulted in a need to provide an ever larger number of “cell sites.” A larger number of cell sites means a larger number of antennas and transceivers, power supplies, and associated equipment. With improving living standards and an awareness of environmental factors, as well as an urge to preserve historic communities and buildings, there has been a change in social attitude toward cell site installations. On one hand, there is a growing reluctance or opposition to indiscriminate installation of towers that support an antenna and associated electronic equipment. Alternatively, there is a stronger public support to conserve and maintain nature, such as trees, and not to injure or destroy nature just to let the suburban sprawl expand.

It is well known that trees have been used to support antennas and other equipment necessary for providing a cell. Unfortunately, with improper installation, mounting, and/or maintenance, such trees may become permanently damaged or die. There are techniques and devices that exist to achieve a purpose of appearing like a tree, or just camouflaging. In one such technique, tower hardware is made to resemble the appearance of a tree by adding a trunk, branches, and leaves that do not interfere with the electromagnetic performance of electronic devices. The drawback with this approach is that the technique still requires a complete tower to be built to support all the needed devices and fails to take advantage of an existing tree that may meet all structural and electrical requirements otherwise. In a different technique, the tower hardware is camouflaged to blend with its surroundings that may be foliage, buildings, or just the background of sky. This technique has the drawback of an inability to utilize an existing tree as well as a need to maintain and replace the camouflage if background conditions or objects change as a result of human activity or natural events.

Thus, a heretofore unaddressed need exists in the marketplace to address the aforementioned deficiencies and inadequacies.

SUMMARY OF THE INVENTION

Embodiments of the present invention provide an apparatus and a method for removably connecting a support structure to a tree for communication support.

Briefly described, in architecture, one embodiment of the apparatus, among others, can be implemented as follows. The apparatus contains a first extension element and a second extension element that are removably coupled to the tree. A support device is removably connected to the first extension element and the second extension element. In addition, at least one electronic device for providing wireless communication is provided, wherein the at least one electronic device is removably connected to the support device.

The present invention can also be viewed as providing methods for removably attaching a support structure to a tree for providing communication support, comprising the steps of: determining a geographic area for location of the support structure; examining and ranking selected trees within the geographic area for supporting the support structure thereon; and removably connecting the support structure to a tree within a selected geographic area having numerous high ranking trees within the geographic area for supporting the support structure thereon.

Other systems, apparatus, methods, feature, and advantages of the present invention will be, or become, apparent to one with skill in the art upon examination of the following drawings and detailed description. It is intended that all such additional systems, apparatus, methods, features, and advantages be included within this description, be within the scope of this invention, and be protected by the accompanying claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Many aspects of the invention can be better understood with reference to the following drawings. The components in the drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the principles of the present invention. Moreover, in the drawings, like reference numerals designate corresponding parts throughout the several views.

FIG. 1 is a perspective view of the support structure located within a tree, in accordance with the first exemplary embodiment of the invention.

FIG. 2 is a side view of the present support structure of FIG. 1, that is utilized to support electronic equipment in a tree.

FIG. 3 is a cross-sectional top view of the extension elements of the support structure of FIG. 1, located within a tree.

FIG. 4 is a flowchart illustrating the process of determining location to install the present support structure.

FIG. 5 is a flowchart illustrating the process of installing the support structure in the selected tree.
DETAILED DESCRIPTION

[0017] The present invention provides a support structure and a manner of using the same, which is suitable for attaching an antenna, transceiver, and/or associated electronic, or non-electronic, equipment for providing a communication network. The support structure is erected on extension elements inserted into holes made in a trunk of a tree where the tree serves as a supporting structure. Other supporting structures may be utilized as well. The present description assumes use of a tree as the supporting structure.

[0018] The present invention combines the design, installation, and operation of equipment installed on the tree with an evaluation of the health and structural soundness of the tree. The present invention also provides for long-term health management of the tree. All equipment is installed in a reasonably healthy tree that is structurally sound for expected mechanical and environmental stresses. Through proper management and planning, the health of the tree is maintained throughout its lifespan, while the tree serves as a supporting structure. Therefore, significant cost savings may be realized through an investment into health of the tree and its life cycle, thereby extending wireless services into desired geographical areas, while also addressing environmental and aesthetic concerns.

[0019] FIG. 1 is a perspective view of the present support structure 100 that is utilized to support electronic equipment in a tree. In addition, FIG. 2 is a side view of the present support structure 100 that is utilized to support electronic equipment in a tree. It should be noted that the present description assumes that the supported electronic equipment is an antenna 150 or a transceiver 160. Of course, other electronic equipment may be substituted. It should also be noted that FIG. 1 shows a smaller sized support device 140 than FIG. 2.

[0020] Referring to FIG. 1 and FIG. 2, the support structure 100 includes a first extension element 110, a second extension element 120, and a reinforcing element 130 connected to a support device 140. The first and second extension elements 110, 120 are used to connect the support structure 100 to a tree 200, as described below. The support device 140 supports a range of electronic equipment that may be connected thereto via use of many different devices. The electronic equipment could be an antenna 150 or a transceiver 160. The electronic equipment may include a power supply, amplifiers, regenerators, or other electronic equipment. The support structure 100 also contains fastening hardware 170 for keeping the first extension element 110 and the second extension element 120 removably connected to the support device 140.

[0021] The antenna 150, which may be a wireless communications antenna, may be secured to the support device 140 using any of a number of methods, depending on the type of components used for securing and recommendation of the manufacturer. Any cabling, such as, for example, coaxial cable or Ethernet cable, may also be secured to the support device 140 with the use of zip ties, electrical tape, or any other suitable securing elements. To prevent water seepage into any cabling connections that are not weather-tight, electrical tape or any other suitable sealing element may be used.

[0022] The support device 140 may be a mast, a tube, or a pole made of a material capable of supporting the antenna 150 and transceiver 160. Specifically, the support device 140 is preferably light in weight, yet strong enough to support the antenna 150 and transceiver 160 regardless of weather conditions. The support device 140 may be fabricated from aluminum (e.g., T6 aluminum tubing), fiberglass, wood, a composite material (e.g., graphite composite), or another material capable of fulfilling the above criteria.

[0023] The support device 140 may be provided with additional support in its connection to the tree 200, at a point away from the extension elements 110, 120, although supported by the extension elements 110, 120, through a reinforcing element 130, thereby making installation of the support device 140 more robust. It should be noted that the reinforcing element 130 may be a cable or a guide wire.

[0024] Grounding for the support device 140 and electronic equipment may be provided by a lightning protection system that meets ANSI specifications. For example, the lightning protection system may involve the installation of a special braided copper wire (not shown) that extends down the length of the tree 200. This wire is tied into special connectors at the top of the tree 200 called air terminals, and to a length of copper rod driven into the ground at the base of the tree 200.

[0025] Since the first and second extension elements 110, 120 are located within a portion of the tree 200, the first and second extension elements 110, 120 preferably are fabricated and used in accordance with ANSI specifications for tree bracing, and may include, for example, wood lag bolts, lag threaded extension elements or machine threaded extension elements. Machine threaded extension elements are preferably used, however, any plates, bolts, and extension elements that meet ANSI specifications for tree bracing, and are capable of supporting attachment of the support device 140 to the tree 200, may be used. The size of the first and second extension elements 110, 120 is based on diameter of the tree 200, weight of the support device 140, and weight of the antenna 150 and transceiver 160 attached to the support device 140. Further description of the first and second extension elements 110, 120 is provided herein.

[0026] The extension elements 110, 120 support attachment of the supporting device 140 to the tree 200 via use of the fastening hardware 170. Specifically, as is shown by FIG. 1 and FIG. 2, the fastening hardware 170 is used to apply external pressure on the first and second extension elements 110, 120, thereby ensuring that the first and second extension elements 110, 120 remain removably attached to the support device 140. The fastening hardware 170 may be any device, or series of devices, that is capable of removably attaching the extension elements 110, 120 to the support device 140, such as, but not limited to, a bolt and clasp arrangement, a U-bolt, or a metal clasp having a screw-drive that tightens with turning of the screw. The fastening hardware 170 may also be made of many different material including, but not limited to, a zinc alloy.

[0027] The tree 200 has a plurality of tree holes sized to accommodate the extension elements 110, 120. Each extension element 110, 120 is essentially a rigid cylinder with at least one machine thread sized to accept one or more fasteners. However, the extension elements 110, 120 may have a different cross-section shape based on the suitability for a particular application. As an example, the cross-section shape of the extension elements 110, 120 may instead be...
square, rectangular, or elliptical. Selection of the size and other properties of the extension elements 110, 120 are described in detail herein with regard to the description of the flowcharts. It should be noted, however, that a tree hole diameter of \( \frac{1}{16} \) inch is less intrusive on the tree 200, yet is large enough to support extension elements 110, 120 that are strong enough to support the support device 140.

[0028] FIG. 3 is a cross-sectional top view of the extension elements 110, 120 of the support structure 100 of FIG. 1, located within the tree 200, in accordance with the first exemplary embodiment of the invention. The extension elements 110, 120, preferably having a diameter of \( \frac{1}{3} \) inch since the tree-holes are preferably \( \frac{1}{16} \) inch in diameter, have been inserted into tree-holes. It should be noted that different sized tree-holes and extension elements 110, 120, may be utilized. At each point that the extension elements 110, 120 protrude out of the tree 200, a washer 124 and a nut 122 is attached using the machine threads of the extension elements 110, 120. It should be noted that the nut 122 and washer 124 combination shown in FIG. 3 exaggerates the size of the nut 122 and washer 124 for purposes of illustration. Of course, it may also be possible to use a nut and washer combination the size of that shown in FIG. 3.

[0029] Preferably, the washer 124 is a heavy-duty washer and the nut 122 is a double nut. It should be noted that countersinking of the washer 124 is not recommended since it accelerates decay of the tree 200. On a side of the tree 200 facing where the support device 140 is mounted, the extension elements 110, 120 extend beyond the tree 200 an appropriate distance that will safely secure the support device 140, preferably at least six inches beyond the tree 200, although a different distance may be utilized.

[0030] FIG. 3 also provides a better view of an angular relationship between the first extension element 110 and the second extension element 120. The angle between the extension elements 110, 120 is preferably 30°. This angle permits an easier and stronger attachment of a range of diameters of support device 140 to the extension elements 110, 120. Of course, a different angle between the extension elements 110, 120 may be utilized, depending on the strength and resistance to damage of the tree 200.

[0031] It should be noted that when positioning the extension elements 110, 120 within the tree 200, it is preferred that the extension elements 110, 120 are spaced a distance apart so as to maximize strength of supporting the support device 140, yet minimizing damage to the tree 200. As an example, the extension elements 110, 120 may be vertically separated by a distance equivalent to one quarter the length of the support device 140. Therefore, if the support device 140 was twelve feet long, the vertical distance between the extension elements 110, 120 would be three feet.

[0032] FIG. 4 is a flowchart 300 illustrating the process of determining location to install the present support structure 100, in accordance with the first exemplary embodiment of the invention. It should be noted that any process descriptions or blocks in flowcharts should be understood as representing modules, segments, portions of code, or steps that include one or more instructions for implementing specific logical functions in the process, and alternative implementations are included within the scope of the present invention in which functions may be executed out of order from that shown or discussed, including substantially concurrently or in reverse order, depending on the functionality involved, as would be understood by those reasonably skilled in the art of the present invention.

[0033] As is shown by block 302, an acceptable risk of installation failure is determined. It should be noted that the lower the acceptable risk of installation failure, the more important the following steps become. Specifically, for installation of equipment required to support wireless communication (i.e., the antenna and the transceiver), acceptable risk of installation failure is very low. In addition, to ensure long-term functionality of the equipment with minimal maintenance, the following steps should be followed.

[0034] As is shown by block 304, a geographic area for location of the support structure 100 is determined. In determining the geographic area for location of the support structure 100, the existence of a need for a wireless node or a wireless communication network in a geographic area, and therefore, the location of an antenna and wireless transceiver, is considered.

[0035] As is shown by block 306, the selected geographic area for location of the support structure 100 is tested for potential trees for attachment of the support structure 100. It should be noted that a site containing several potential trees should be chosen over a site with fewer potential trees or one excellent tree in the event that relocation of the support structure 100 is required due to unforeseen events. Determination of the site is preferably left to a qualified arborist. The arborist should examine and evaluate the tree or trees of the subject area at least according to the criteria specified below. The arborist may prioritize the trees of the area. It should be noted that a minimum amount of disturbance should be done to the root zone area, which can extend at least two to three times the height of a tree on a horizontal plane. This should be considered in testing the selected geographic area for potential trees.

[0036] As is shown by block 308, ease of access to the selected geographic area is determined. Specifically, the feasibility of tools and utilities to reach the selected geographic area is determined. If it is feasible to bring required tools and utilities to the selected geographic area, the geographic area is acceptable.

[0037] As is shown by block 310, the selected tree is evaluated for attachment of the support structure 100. Regarding the examination and evaluation of the tree or trees by the qualified arborist, it should be noted that measuring the health of a tree, and its structural soundness, is an exercise in risk management, rather than an absolute science. Any tree may be capable of holding a support structure 100, however, certain trees are better suited for the task. The qualified arborist will help determine which trees are most suitable. Traditional tree risk evaluation, as detailed in, for example, the "Photographic Guide to the Evaluation of Hazard Trees in Urban Areas," published by the International Society of Arboriculture (ISA), 1994, which is incorporated herein entirely by reference, looks at three variables: target rating; failure potential; and size of defective part. The target rating rates the use and occupancy of the area that would be struck by any defective part. The failure potential identifies the most likely failure and rates the likelihood that any structural defect(s) will result in failure. The size of defective part rates the size of the part most likely to fail. An arborist would begin to evaluate the tree by using, for
example, the Evaluation Form provided in the ISA Guide, or any similar suitable evaluation form, and then summarize the information about the tree and target into a failure risk sum by assigning a value for each criteria on the form, such as the three categories described above.

[0038] In addition to obtaining the failure risk sum, three additional categories of evaluation should also be used, namely, compartmentalization of decay in trees (CODIT) ability, form, and tree wood/strength resilience. It should be noted that instead of using the failure risk sum and the three additional categories of evaluation, one may instead use either the failure risk sum or the three additional categories of evaluation.

[0039] CODIT ability rates the ability of the tree to heal over the necessary wounds created during a typical installation of the support structure 100 and the ability of the tree to resist decay. Trees with a high CODIT ability should be rated higher than trees with a lesser CODIT ability. Trees with a high CODIT ability include, for example, oaks, maples, and white pines. A CODIT ranking system may be used where ranking levels of one, two, three, and four are associated with a tree having a high, average, low, and poor, respectively, ability to heal over wounds and to resist decay.

[0040] The overall form of the tree will play a part in the effectiveness of the tree as a base for the support structure 100 and in determining the ease of installation of the support structure 100. Additionally, the form will affect the performance of the devices installed on the support structure 100 (i.e., the antenna and the transceiver). Ranking of overall form of the tree 200 is as follows. A form rank of one is associated with trees having excurrent growth form (i.e., having a single dominant central leader) and balanced branching, which are preferred and should be rated highest by the qualified arborist. Such trees have a strong central leader, and include, for example, most evergreens, dawn redwoods, maples, oaks, and yellow poplar.

[0041] A form rank of two is associated with trees having decurrent growth (i.e., having multiple stems for much of its height) with upright form, strong branch attachments, and good taper, or trees having excurrent growth with unbalanced branching. Sugar maples grown in an open field often have a decurrent growth form. The qualified arborist should rate trees with decurrent growth that have an upright form, strong branch attachments, and good taper, or with excurrent form but unbalanced branching, at a lower rating than the trees having a rank of one.

[0042] A form rank of three is associated with trees having excurrent form with multiple stems and/or growth following topping. In addition, a form rank of four is associated with trees having decurrent form with an outward and spreading crown.

[0043] The tree wood/strength resilience is important to the selection of a tree due to the tree wood/strength resilience focusing on the ability of a selected tree to withstand stress on the upper crown of the tree, which is where the support structure 100 is releasably mounted. A tree wood/strength resilience rank of one is associated with tree species having a very high wood strength and resilience. Examples of trees having a wood/strength resilience rank of one may include red and black oaks, sugar maples, and hickories. A tree wood/strength resilience rank of two is associated with tree species having a high wood strength and resilience. Examples of trees having a wood/strength resilience rank of two may include the white pine, the Norway spruce, and the red maple.

[0044] Following the above ranking system for the tree wood/strength resilience rank, a rank of three is associated with tree species having moderate wood strength and resilience, and a rank of four is associated with tree species having low wood strength resilience.

[0045] Using the above failure risk sum and three additional categories of evaluation, the arborist can examine the sums to find a balance between the need for the site versus the risk of failure. Specifically, a lower total sum is associated with a low short-term and long-term risk in providing the support structure 100 in the tree. It should also be noted that the greater the need for providing the communication network in the selected geographic area, the higher the allowed total sum.

[0046] Inspection of the Selected Tree

[0047] The ISA Guide provides a rather comprehensive review of the warning signs and symptoms of decay and structural failure precursors. However, the Guide focuses primarily on the worst-case scenarios to determine if a tree is at an elevated risk for failure. The qualified arborist may consider such factors. However, it is preferred that the qualified arborist consider best case scenarios in determining if a tree may be a potential support structure assembly site. Such best-case scenarios may include, but are not limited to, the following examples.

[0048] Regarding roots, in general, the root-zone area can extend up to and beyond a horizontal distance three times the height of the tree. However, the functional root-zone is generally considered the root area within the drip edge, or the area delineated by coverage of the crown. The root system should be intact and free from any damage. Damage to a root system may include any excavation, filling, compaction, trenching, paving, construction (recent or historic), chemical spill, or long term changes to the water table within or near the root-zone area. Damage to the root-zone area may be detrimental to the health and structural integrity of the tree. Damage to fifty percent or more of the functional root zone area, without proper preparation and mitigation, is generally considered highly detrimental/fatal to the long-term health of a tree. Because any damage to the root zone area can have detrimental results that may become apparent many years from the initial damage event, it is highly recommended that a subject tree should be free from any damage within the functional root zone area.

[0049] Careful examination by a qualified arborist should include, but is not limited to, examining the root zone area for the presence of decay fungi fruiting bodies (mushrooms), and examining the root zone area for the presence of loose or cracked soil that may indicate lifting of the root zone, which may further indicate root/soil failure. Root decay often occurs from the bottom or down-facing side of the root through to the top of the root, so careful examination may include, but is not limited to, small test borings into large supporting roots. If any area of the functional root zone has been damaged, the qualified arborist should address mitigation, such as aeration and fertilization, root pruning, and other maintenance activities, in the management plan of the
selected geographic site. It should be noted that use of a management plan is described in detail herein.

[0050] Regarding the trunk and the crown of a tree, in general, the trunk of the tree should be structurally intact and free from any large poorly structured branch/trunk attachments, large scars, wounds, loose bark, or evidence of insect or disease problems. A qualified arborist should carefully examine the trunk of the tree to determine if any defects raise the risk of structural failure and/or a decline in the health of the tree. Similarly, the crown should be free from poorly structured branch/trunk attachments, large scars, wounds, loose bark, or evidence of insect or disease problems. Often the leaves of the tree are a high priority target for insect and disease problems and should be examined closely by the qualified arborist. More specifically, in a preferred embodiment, the trunk is single steamed, free from disease and insect problems, and free from poorly structured branch unions that may cause a large wound to be formed if the branch were to break away from the main stem.

[0051] Poorly structured branch/trunk attachments in the trunk and crown are characterized by a narrow V attachment where the two members come together. Such narrow V attachments are prone to failure over the life of the tree. It is preferable to prune poorly structured branches before they break from the tree, however, there is often not a large enough size difference between the two members for a proper branch collar to develop. Pruning large limbs that have not developed a branch collar will often lead to the inability of the tree to quickly close the wound and will lead to rapid decay. The branch collar is a raised area near where a branch connects back into the tree, and research has shown that pruning at the branch collar improves the ability of the tree to compartmentalize the wound. If neither of the limbs/trunk sections can be pruned, hardware such as, but not limited to, cabling and bracing should be considered to reduce the risk of structural failure. Such cabling and bracing should be according to ANSI specifications for cabling and bracing.

[0052] Further, the outward signs of decay and/or insect infestation are often apparent on the stem of a tree. Loose bark, discolored areas of bark, mushrooms, bore holes, frass, wounds, apparent rot, cavities, and longitudinal scars are all warning signs that additional investigation into the structural soundness of the stem should be investigated. There are several techniques, from low tech to high tech, available to the qualified arborist for further investigating and documenting the extent of estimated structural loss due to decay. An example of this would be the use of a Shigimetr or a resistograph, both of which measure the soundness of the wood, based on its resistance as a small drill is advanced through the tree.

[0053] Regarding leaves, the overall vigor of the leaves should be examined closely as should the average growth per year on branch tips. These indicators, along with many others, can lead a qualified arborist to make an evaluation on the overall health of the tree. As nutrient deficiencies, root zone problems, and many insect and disease problems manifest themselves through symptoms in, and lack of, the leaves, it is imperative that they be closely examined. It is highly recommended that the tree’s leaves be of good color and vigor, thus showing a tree in moderate to perfect health.

[0054] Returning to FIG. 4, after the selected tree is evaluated for attachment of the support structure 100, the support structure 100 is installed (block 312). The process of the installing the support structure 100 is further illustrated by FIG. 5. Specifically, FIG. 5 is a flowchart 400 illustrating the process of installing the support structure 100 in the selected tree.

[0055] It should be noted that during the installation, should new, detrimental data regarding the health of the tree 200 be discovered, a decision will need to be made as to whether to continue with the installation, or to move onto a secondary location within the selected geographic area. As with the other steps to the method, this process is a long-term investment in the overall health of the tree 200. Thus, all attempts to maintain and improve health of the tree will be made through all aspects of the installation. In addition, in accordance with a second exemplary embodiment of the invention, a management plan may be used after installation of the support structure 100. An example of such a management plan is described in detail herein.

[0056] As is shown by block 402, prior to installation, dead, dying, and poorly structured branches are removed from the tree 200. Minor pruning is acceptable to clear a work location, but ‘topping’ (i.e., removal of medium to large upward growing limbs/trunk at the top of the tree 200) is very damaging to the long-term health and structural soundness of the tree 200 and is preferably avoided. All pruning should be done according to the ANSI specifications for pruning.

[0057] Structural support for the tree 200 for use during installation, such as cabling and bracing, is preferably added if necessary, and should be done according to the ANSI specifications for cabling and bracing (block 404). It is preferred that as much as is possible of the support structure 100 be assembled prior to installation in the tree 200, to limit the work that needs to be done by the climber while on the tree 200 (block 406). As an example, the antenna 150 and the transceiver 160 may be attached to the support device 140 prior to the climber climbing the tree 200 for installation of the support structure 100.

[0058] All climbing is preferably performed by a qualified tree climber. The qualified tree climber ascends the tree in any appropriate method that does not damage the tree, for example, with the use of ladders, a bucket truck, or by rope and saddle climbing techniques. Preferably, spikes are not used. It is highly recommended that the climber maintain at least one point of safety connection with the tree at all times.

[0059] After the qualified climber has ascended the tree, the climber locates a suitable location for the installation of the support structure 100 (block 408). A suitable location may include, for example, an area that is relatively straight and free from structural defects and branches either in the crown or along the stem of the tree 200. As discussed above, minor pruning is acceptable to clear a work location, but ‘topping’ (removal of medium to large upward growing limbs/trunk at the top of the tree 200) is very damaging to the long-term health and structural soundness of the tree 200 and is preferably avoided.

[0060] Based on the support structure 100 height, weight, and sail (i.e., surface area of the support structure 100 exposed to the wind), calculations will be made to determine the thickness (diameter) of the sound wood that will be needed to support the support structure 100 and the vertical
separation required between the extension elements 110, 120 (block 410). As mentioned above, it should be noted that when positioning the extension elements 110, 120 within the tree 200, it is preferred that the extension elements 110, 120 are spaced a distance apart so as to maximize strength of supporting the support structure 100, yet minimizing damage to the tree 200. As an example, the extension elements 110, 120 may be vertically separated by a distance equivalent to one quarter the length of the support device 140. As an example, if the support device 140 was twelve feet long, the vertical distance between the extension elements 110, 120 would be three feet.

After measurements have been taken, the support structure 100 is installed into the tree 200 (block 412). The following is an example of installation of the support structure 100. It should be noted, however, that a different method of installing the support structure 100 within the tree 200 may be utilized.

To install the support structure 100, two holes are made within the tree 200. The holes may be of any size, however, they preferably measure 1/4" of an inch and are created by drilling. As mentioned above, the holes are separated by a vertical distance of some amount, preferably one quarter of the length of the support device 140. The first hole is created level through the center of the tree 200. The second hole is created level, but offset on the horizontal plane in relation to the first hole, preferably by thirty degrees. Any holes created should go completely through the tree 200. The first and second extension elements 110, 120 are then placed within the first and second holes, respectively, and secured by securing elements such as the washer 124 and nut 122 assembly.

On the side of the tree 200 where the support device 140 is to be mounted, the first and second extension elements 110, 120 should extend beyond the tree 200 an appropriate distance that will safely secure the support device 140 itself, preferably at least six inches beyond the tree 200. Using suitable fastening hardware 170, such as, but not limited to, metal plates, preferably aluminum, and a suitable attaching element, such as U-bolts, preferably made of zinc alloy, the support device 140 may then be secured to the extension elements 110, 120. Suitable spacing elements may also be placed between the support device 140 and the extension elements 110, 120.

Optionally, a safety cable may be installed to connect the support device 140 and top of the tree 200 to the lower section of the tree 200. The safety cable should be of sufficient strength to support the upper part of the tree 200 above the lowest part of the support device 140. The safety cable may be attached to the tree 200 in any appropriate manner, for example, it may be loosely looped around the upper and middle portions of the trunk. It is preferred that several inches of slack be present to allow for the tree 200 to continue growing without being girdled by the cable. If the tree 200 were to fail at the point of the installation of the support structure 100, the safety cable would prevent the support structure 100 and upper part of the tree from falling to the ground.

The lightning protection may be installed at any time, per ANSI specifications, although it is preferred that the lightning protection be installed prior or concurrent to support structure 100 installation.
elements required at the base of the tree 200 (preferably annually but may occur at any time interval); a schedule for revision and/or updating the site management plan; and inspection and maintenance of the ancillary and support equipment at the site. Particulars for each part of the site management plan may be determined by the qualified arborist. Additionally, any necessary ancillary and support equipment maintenance should be outlined in the site management plan. A schedule of regular inspections should be developed and followed to ensure continuous operation of the communication network and health of the selected tree 200.

[0072] It should be emphasized that the above-described embodiments of the present invention are merely examples of implementation, merely set forth for a clear understanding of the principles of the invention. Many variations and modifications can be made to the above-described embodiments of the invention without departing substantially from the spirit and principles of the invention. All such modifications and variations are intended to be included herein within the scope of this disclosure and the present invention. The following claims protect all such modifications and variations.

What is claimed is:

1. A support structure for providing communication support that is removable connected to a tree, comprising:
   a first extension element and a second extension element that are removable coupled to said tree;
   a support device removable connected to said first extension element and said second extension element; and
   at least one electronic device for providing wireless communication, wherein said at least one electronic device is removable connected to said support device.
2. The support structure of claim 1, wherein said at least one electronic device is an antenna and a transceiver.
3. The support structure of claim 1, wherein said first extension element and said second extension element are vertically space in said tree a distance equal to one quarter of a length of said support device.
4. The support structure of claim 1, wherein said first extension element and said second extension element are removable coupled to said tree via at least one nut and bolt arrangement.
5. The support structure of claim 1, wherein an angle of entry of said first extension element into said tree, compared to said second extension element, is thirty degrees.
6. The support structure of claim 1, further comprising a reinforcing element connected to said tree and said support device for reinforcing support of said support device to said tree.
7. The support structure of claim 6, wherein said reinforcing element is a cable.
8. The support structure of claim 1, wherein said support device is fabricated from a material selected from the group consisting of fiberglass, wood, aluminum, and a composite material.
9. The support structure of claim 1, wherein said first extension element and said second extension element are elongated and cylindrical in shape.
10. The support structure of claim 1, further comprising a structure for preventing lightening from damaging said at least one electronic device.

11. The support structure of claim 1, wherein said at least one electronic device is wirelessly connected to a communication network.
12. A method of removable connecting a support structure to a tree for providing communication support, comprising the steps of:
   determining a geographic area for location of said support structure;
   examining and ranking selected trees within said geographic area for supporting said support structure thereon; and
   removable connecting said support structure to a tree within a selected geographic area having numerous high ranking trees within said geographic area for supporting said support structure thereon.
13. The method of claim 12, further comprising the step of determining acceptable risk of installation failure for installing said support structure to said tree.
14. The method of claim 12, wherein said step of determining said geographic area for location of said support structure further comprises the steps of:
   determining a need for a communication network in said geographic area;
   determining whether there are many or few potential trees that may support said support structure thereon within said geographic area; and
   determining ease of access to said geographic area for bringing required tools and utilities to said geographic area.
15. The method of claim 12, wherein said step of examining and ranking selected trees within said geographic area for supporting said support structure thereon, further comprises the steps of:
   ranking compartmentalization of decay in trees (CODIT) ability, thereby ranking the ability of said tree to heal over necessary wounds created during said step of removable connecting said support structure to said tree and the ability of said tree to resist decay;
   ranking overall form of said tree, thereby ranking effectiveness of said tree to act as a base for supporting said support structure; and
   ranking said tree wood/strength resilience, thereby ranking ability of said tree to withstand stress on an upper crown of said tree.
16. The method of claim 12, wherein said step of removable connecting said support structure to said tree within said selected geographic area having numerous high ranking trees within said geographic area for supporting said support structure thereon, further comprises the steps of:
   drilling at least a first hole and a second hole within said tree for supporting a first extension element and a second extension element, respectively, therein;
removably locating said first extension element within said first hole and said second extension element within said second hole; and
removably connecting said first extension element and said second element to said support device.

17. The method of claim 16, further comprising the step of removing dead, dying, or poorly structured branches from said tree.

18. The method of claim 16, further comprising the step of adding structural support to said tree prior to said step of removably connecting said electronic equipment to said support device.

19. The method of claim 16, wherein said electronic equipment comprises an antenna and a transceiver.

20. The method of claim 16, wherein a central axis of said first hole compared to a central axis of said second hole provides an angle of thirty degrees.

21. A support structure for providing communication support that is removably attached to a tree, comprising:
means for providing wireless communication;
means for supporting said means for providing wireless communication; and
means for maintaining said means for supporting in a location adjacent to said tree, wherein said means for maintaining is removably connected to said tree.

* * * * *