

**REDUCING COST OF CELLULAR BACKHAUL****TECHNICAL FIELD**

The following description relates to radio systems.

5

**PRIORITY TO OTHER APPLICATIONS**

This application claims priority from and incorporates herein U.S. Provisional Application No. 60/578,266, filed June 9, 2004, and titled "REDUCING THE COST OF CELLULAR BACKHAUL".

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**BACKGROUND**

In cellular systems today, voice, data and signaling traffic must be backhauled from the cell tower sites to the central office where the mobile switching center is located.

15 In general, backhauling refers to getting data to the core network, e.g., between the base station and the base station controller. In some cases, backhauling may include sending network data over an out-of-the-way route (including taking it farther than its destination) in order to get the data to its

20 destination sooner or at a lower cost. Currently, a majority of this backhaul takes place over dedicated T1 lines. There are also some wireless backhaul schemes used primarily in

short range niche applications that utilize both licensed and unlicensed bands.

Cellular backhaul primarily utilizes dedicated T1 lines. The guaranteed bandwidth and latency are important to support  
5 real time voice calls. Typically, T1 slots are dedicated to particular voice circuits or data channels. Bandwidth efficiencies of using IP over the backhaul to aggregate traffic and dynamically adapt capacity to the varying demand for data and voice are available, but are not used in the  
10 majority of deployments today.

While there are several wireless backhaul technologies, the interface to these systems is typically made to look like a T1 line. This allows the same interfaces and time slot assignments to be used. The advantage of wireless backhaul is  
15 lower cost compared to leasing T1 lines, but the wireless systems are often limited in range and by terrain.

There has been interest in using the public internet to backhaul cellular traffic given the wide availability and relatively low cost of internet connections compared with  
20 dedicated T1 lines.

#### **SUMMARY**

In some aspects, the invention includes a method for backhauling wireless voice and data transmissions. The method

includes receiving, at a base station, a wireless transmission. The method also includes forwarding the transmission from the base station to a base station controller over a shared network.

5           Embodiments can include one or more of the following.

          The method can include receiving, at the base station controller, a second transmission and forwarding the second transmission to the base station over the shared network. The shared network can be a non-private network. The shared  
10   network can be the internet.

          The method can also include providing a jitter buffer at the base station controller and using the jitter buffer to compensate for jitter introduced by the shared network. The method can also include providing a jitter buffer at the base  
15   station and using the jitter buffer to compensate for jitter introduced by the shared network.

          Forwarding the transmission can include forwarding the transmission using a secure protocol. The secure protocol can be SSL.

20           The method can also include determining a priority of the received transmission and forwarding the transmission based on the determined priority. Determining a priority can include assigning a first priority to voice transmissions and

assigning a second priority to data transmissions. The first priority can be greater than the second priority.

Forwarding the transmission can include forwarding the transmission using voice over IP technology. The method can  
5 also include performing decryption of the transmission at the base station controller. The method can also include performing encryption of the second transmission at the base station controller. The method can also include performing power control at the base station. The transmission can be a  
10 transmission from a cellular telephone.

In additional aspects, the invention includes a method that includes receiving, at a base station, a wireless transmission from a first mobile unit to be routed to a second mobile unit. The method also includes determining if the  
15 second mobile unit is within a communication range of the base station and if the second mobile unit is within the range, locally routing the transmission from the first mobile unit to the second mobile unit at the base station.

Embodiments can include one or more of the following.

20 The method can include forwarding the transmission from the base station to a base station controller if the second mobile unit is not within the range. Forwarding the transmission from the base station to the base station

controller can include forwarding the transmission from the base station to the base station controller over a shared network. The shared network can be the internet.

In additional aspects, the invention includes a system for backhauling wireless voice and data transmissions. The system includes a base station configured to receive a wireless transmission and forward the transmission to a base station controller over a shared network.

Embodiments can include one or more of the following.

The system can also include a base station controller configured to receive a second transmission and forward the second transmission to the base station over the shared network. The shared network can be the internet. The base station controller can include a jitter buffer configured to compensate for jitter introduced by the shared network. The base station can include a jitter buffer configured to compensate for jitter introduced by the shared network. The base station can be further configured to determine a priority of the received transmission and forward the transmission based on the determined priority.

In additional aspects, the invention includes a system that includes a base station. The base station is configured to receive a wireless transmission from a first mobile unit to

be routed to a second mobile unit and determine if the second mobile unit is within a communication range of the base station. If the second mobile unit is within the range, the base station is configured to locally route the transmission  
5 from the first mobile unit to the second mobile unit at the base station.

Embodiments can include one or more of the following.

The system can also include a base station controller. The base station can be configured to forward the transmission  
10 to the base station controller if the second mobile unit is not within the range.

Advantages that can be seen in particular implementations include one or more of the following.

In some embodiments, using a software radio system can  
15 reduce the cost of cellular backhaul.

In some embodiments, the software radio system allows one to perform rapid experiments and any changes to the system or protocol can be software downloads to the infrastructure.

In some embodiments, the software radio system employs  
20 QoS measurements and mechanisms to ensure adequate bandwidth and latency to support voice and data user requirements.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

FIG. 1A is a block diagram of a network.

FIG. 1b is a block diagram of a network.

FIG. 2 is a block diagram of a network.

FIG. 3 is a block diagram of a network.

FIG. 4 is a flow chart.

5 FIG. 5 is a block diagram of a network.

FIG. 6 is a block diagram of a network.

#### DETAILED DESCRIPTION

Referring to FIG. 1A, a system 10 includes a mobile unit  
10 12, a base station 14. The base station is connected to the  
internet 14 close to the backbone and routs cellular traffic  
to the core network of a cellular service provider with  
lightweight, QoS mechanisms in place. The QoS mechanisms  
provide the required level of service for system 10 such that  
15 the system does not rely on the existence of excess bandwidth  
to provide the required level of service.

More particularly, system 10 includes a mobile unit 12  
which sends wireless signal transmissions to a base station  
14. The base station 14 routs the transmissions to a base  
20 station controller 18 over the internet 16 (e.g., the public  
internet). The base station controller 18 subsequently routs  
the calls to the mobile switching unit 20 and the mobile  
switching unit 20 routs the calls to the public switched

telephone network 22. In some embodiments, the signal transverses a second network (e.g., internet 24) which is disposed between the base station controller 18 and the mobile switching unit 20 (FIG. 1B)

5           Signals can also be sent from the public switched telephone network 22 to the mobile unit 12 via the mobile switching unit 20, base station controller 10, internet 16, and base station 15.

          Software radios can aid in the characterization of  
10 performance of the public Internet 16 for backhauling real-time cellular voice and data traffic. Various types of QoS measurements and mechanisms can be used to support such real-time cellular voice and data traffic.

          In order to reduce the cost of cellular backhaul, it is  
15 useful to use the Internet. At this point in time, one of the easiest ways to assure a high level of Internet service is to connect devices close to the backbone. The location of the device relative to the backbone avoids a portion of the additional hops and constrained bandwidth at the edges of the  
20 network. The excess bandwidth in the backbone of the Internet 16 today, a result of overbuilding fiber in the core, can generally support the QoS requirements for cellular traffic. However, as users demand services in remote locations, more

hops are typically required to provide services in those locations and QoS deteriorates. Similarly, when extraordinary traffic is experienced in the core network, even the current excess bandwidth may not provide adequate resources to efficiently meet demand.

Various protocols can be used to provide efficiency and bandwidth optimization. Exemplary protocols include TCP, UDP and RTP, as well as end-to-end application level QoS protocols implemented on top of these protocols.

In some embodiments, existing devices on the public internet 16 can be used to rout the calls from the mobile unit 12 to the public switched telephone network 22 using the public internet for backhaul without requiring the deployment of new routers or other hardware in the network. This enables use of the Internet for backhaul on a much more rapid timescale. It is believed that such an implementation will result in significant cost savings for wireless carriers today.

Referring to FIG. 2, an exemplary routing of a call over the internet 36 is shown. In this example, base stations located in Texas 32 and Cambridge 34, connected via the public internet 36 to mobile switching center 38 in Vancouver. Table 1 shows the number of hops between the base station 34 located

in Cambridge and the switch 38 in Vancouver, and Table 2 shows the hops between the base station 32 located in Texas and the switch 38 in Vancouver.

**Table 1: Traceroute to 207.23.93.38 from Cambridge, 30 hops max, 38 byte packets**

|   |                                             |                   |               |               |               |
|---|---------------------------------------------|-------------------|---------------|---------------|---------------|
| 1 | pos                                         | (192.168.0.1)     | 0.436 ms      | 0.291 ms      | 0.211 ms      |
| 2 | w225.z064221090.bos-<br>ma.dsl.cnc.net      | (64.221.90.225)   | 1.062 ms      | 0.872 ms      | 0.877 ms      |
| 3 | 208.177.193.1.ptr.us.xo.net                 | (208.177.193.1)   | 146.914<br>ms | 200.582<br>ms | 168.402<br>ms |
| 4 | ge5-<br>00.MAR2.Cambridge-<br>MA.us.xo.net  | (207.88.86.53)    | 170.937<br>ms | 204.480<br>ms | 187.509<br>ms |
| 5 | p5-1-0-2.RAR2.NYC-<br>NY.us.xo.net          | (65.106.3.33)     | 204.374<br>ms | 87.548 ms     | 95.330 ms     |
| 6 | p1-0.IR1.NYC-NY.us.xo.net                   | (65.106.3.42)     | 111.932<br>ms | 113.313<br>ms | 181.227<br>ms |
| 7 | 206.111.13.18.ptr.us.xo.net                 | (206.111.13.18)   | 132.570<br>ms | 148.973<br>ms | 98.475 ms     |
| 8 | core1-newyork83-pos0-<br>3.in.bellnexus.net | (206.108.103.177) | 20.721 ms     | 127.483<br>ms | 148.096<br>ms |

|    |                                               |                  |               |               |               |
|----|-----------------------------------------------|------------------|---------------|---------------|---------------|
| 9  | core4-montreal02-pos6-<br>3.in.bellnexxia.net | (206.108.99.189) | 133.495<br>ms | 314.225<br>ms | 248.051<br>ms |
| 10 | 64.230.243.238                                | (64.230.243.238) | 269.619<br>ms | 93.072 ms     | 94.338 ms     |
| 11 | core1-vancouver-pos10-<br>2.in.bellnexxia.net | (64.230.229.38)  | 93.456 ms     | 106.692<br>ms | 93.993 ms     |
| 12 | dis4-vancouver-pos6-<br>0.in.bellnexxia.net   | (206.108.101.66) | 92.230 ms     | 91.601 ms     | 91.677 ms     |
| 13 | 69.156.254.254                                | (69.156.254.254) | 104.744<br>ms | 104.470<br>ms | 103.289<br>ms |
| 14 | blnt1-vlan2.hc.BC.net                         | (207.23.240.232) | 102.966<br>ms | 104.999<br>ms | 103.303<br>ms |
| 15 | telostech2.BC.net                             | (134.87.24.62)   | 170.350<br>ms | 128.600<br>ms | 120.643<br>ms |
| 16 | 134.87.54.6                                   | (134.87.54.6)    | 115.420<br>ms | 132.120<br>ms | 111.732<br>ms |
| 17 | 207.23.93.38                                  | (207.23.93.38)   | 111.607<br>ms | 127.547<br>ms | 125.545<br>ms |

**Table 2: traceroute to 207.23.93.38 from MidTex, 30 hops max, 38 byte packets**

|   |                                                      |                   |            |           |           |
|---|------------------------------------------------------|-------------------|------------|-----------|-----------|
| 1 | com-sa-<br>1.cctc.net                                | (208.6.233.1)     | 0.276 ms   | 7.027 ms  | 0.262 ms  |
| 2 | sl-gw30-fw-1-1-0-<br>TS24.sprintlink.net             | (144.228.139.237) | 235.334 ms | 17.840 ms | 10.711 ms |
| 3 | sl-bb23-fw-2-<br>0.sprintlink.net                    | (144.232.12.174)  | 8.653 ms   | 46.239 ms | 19.150 ms |
| 4 | sl-bb25-chi-6-<br>0.sprintlink.net                   | (144.232.9.25)    | 37.363 ms  | 37.972 ms | 37.075 ms |
| 5 | sl-bb21-sea-1-<br>0.sprintlink.net                   | (144.232.20.156)  | 77.978 ms  | 73.554 ms | 73.691 ms |
| 6 | sl-gw11-sea-8-<br>0.sprintlink.net                   | (144.232.6.118)   | 119.849 ms | 73.350 ms | 73.333 ms |
| 7 | sl-teleg-4-<br>0.sprintlink.net                      | (160.81.36.14)    | 82.840 ms  | 74.541 ms | 74.457 ms |
| 8 | core2-seattle-<br>pos0-<br>1.in.bellnexus.net        | (206.108.102.197) | 74.743 ms  | 87.826 ms | 74.935 ms |
| 9 | core2-<br>vancouver-<br>pos10-<br>1.in.bellnexus.net | (206.108.102.210) | 83.550 ms  | 91.493 ms | 78.653 ms |

|    |                                                 |                  |            |            |            |
|----|-------------------------------------------------|------------------|------------|------------|------------|
| 10 | dis4-vancouver-<br>pos9-<br>0.in.bellnexxia.net | (206.108.101.70) | 99.620 ms  | 78.485 ms  | 159.792 ms |
| 11 | 69.156.254.254                                  | (69.156.254.254) | 78.796 ms  | 78.648 ms  | 78.711 ms  |
| 12 | blnt1-<br>vlan2.hc.BC.net                       | (207.23.240.232) | 82.164 ms  | 81.627 ms  | 78.636 ms  |
| 13 | Telostech2.BC.net                               | (134.87.24.62)   | 87.021 ms  | 100.408 ms | 84.433 ms  |
| 14 | 134.87.54.6                                     | (134.87.54.6)    | 97.545 ms  | 88.719 ms  | 101.795 ms |
| 15 | 207.23.93.38                                    | (207.23.93.38)   | 136.840 ms | 110.697 ms | 98.773 ms  |

As shown in tables 1 and 2 above, routing the call utilizing the available internet connections can provide adequate quality of service. It is noted that the number and contribution of the hops towards the edge of the network comprise a significant portion of the delay. Therefore, it is believed that with a connection closer to the internet backbone or other public network of a data network service provider, there may be enough excess bandwidth to consistently meet the cellular backhaul QoS requirements with no QoS protocols or lightweight QoS protocols.

**Table 3: traceroute to vanu-bsc.dyn.nimlabs.org (24.239.114.151), 30 hops max, 38 byte packets:**

|   |                                     |                  |           |           |           |
|---|-------------------------------------|------------------|-----------|-----------|-----------|
| 1 | *** (internal network node)         |                  |           |           |           |
| 2 | *** (internal network node)         |                  |           |           |           |
| 3 | acs-24-239-114-151.zoominternet.net | (24.239.114.151) | 25.417 ms | 26.531 ms | 34.788 ms |
| 4 | acs-24-239-114-151.zoominternet.net | (24.239.114.151) | 25.561 ms | 20.253 ms | 52.069 ms |

As shown in table 3 above, routing the call utilizing the available internet connections can provide adequate quality of service. The voice is transmitted using the RTP protocol, and there is potential backhaul bandwidth savings through the use of RTP header compression. This use of IP and other standard internet protocols provides a smooth path to transitioning to internet-based backhaul. It is noted that placing the base station near the internet reduces the number of hops. The impact on number of hops and total latency of transmission is significant. Placing the base station near the internet backbone (thereby reducing the number of hops) can reduce the

latency and ensure a higher level of QoS for voice transmission.

While the internet 36 typically provides excess bandwidth capable of providing adequate QoS, additional routing  
5 procedures and features may be used to provide the adequate QoS during loaded or crisis situations.

As described above, the use of multiple hops between the base station and the base station controller can increase the signal latency. For example, a typical Internet connection  
10 goes through several hops and bandwidth constrained links at the edge of the network. These edge routers and links are a major contributor to the overall bandwidth and latency of the connection. ISP's may choose to charge a higher fee to connect close to the backbone, but it is likely that this fee will  
15 still be much lower than T1 costs today which can range from \$400 - \$2,000 per month, depending upon location and distance.

In order to test the operability of replacing T1 lines with a communication path utilizing the internet, various testing has been completed. A typical connection between a  
20 base station and base station controller using existing T1 lines can be used to measure the baseline bandwidth, latency and jitter for comparison purposes. The traffic load was generated by standard GSM mobiles, wirelessly connected to the

software radio base station. The T1 connections were replaced with public Internet connections (e.g., as shown in FIG. 1A). The effective bandwidth latency and jitter were measured using similar load conditions as the baseline experiment.

5           Due to the unpredictable variation in use of the public internet, various types of application level QoS and failure recovery are desirable, although service without QoS mechanisms is also possible. In many real-time systems, TCP-style re-transmission is not appropriate, since the data will  
10   be too old by the time it is re-transmitted. Other approaches involve embedding error correction into the data stream so that lost packets can be reconstructed, or rules for dropping or repeating packets in the event of a loss. The most important parameter is keeping the call alive. In cellular  
15   systems, callers are accustomed to occasional drop outs or degradation in voice quality, but a dropped call is a significant problem. The recovery mechanism must insure that the mobile unit does not determine that the call has been dropped and terminate the connection.

20           As described above, various QoS mechanisms can be used to ensure the latency and quality of the signal transmitted from the mobile unit 12 to the public switched telephone network 22 over the internet 16. Since the internet 16 is a shared

network it can be beneficial to use various techniques to ensure that the QoS is maintained such that there is not an interruption in the voice service for the customer.

In some embodiments, admission control can be used in  
5 data networks to insure a smooth flow of call data during times of extreme load in the network. In this case, the system would be making a quality/capacity tradeoff, supporting fewer voice calls but maintaining minimum quality standards.

Referring to FIG. 3, a system 70 includes multiple mobile  
10 units 72, 74, and 76 and a base station 78. In operation, the mobile units 72, 74, and 76 generate signals and rout calls through the base station 78 to a base station controller and telephone network over the internet. Due to the variability of the bandwidth available on the shared network, the base  
15 station 78 can limit the number of mobile units and additional users for which the base station will concurrently process and rout the voice calls. If the internet is busy or does not have available bandwidth to ensure a predicted QoS, the base station 78 will reject the transmission from one or more of  
20 the mobile units.

Referring to FIG. 4, a process for insuring a QoS for a call during times of extreme load in the network is shown. The base station monitors and determines 82 an available

bandwidth of the shared network. For example, the base station can ping another device on the network and monitor the response time for the ping packet. While using a ping packet does not provide a precise measurement of bandwidth, it can be used as a metric to determine if there is enough bandwidth available to ensure a particular level of quality for a voice call routed over the network. Based on the measured bandwidth, the base station determines 88 if there is enough bandwidth to support the voice call. If there is enough bandwidth, then the base station routes 90 the call through the base station over the internet to the base station controller. If there is not enough bandwidth, then the base station blocks 86 the call such that the call is not routed over the internet to the base station controller.

Referring to FIG. 5, a system 100 including multiple mobile units 102, 104, 106, and 108 and a base station 118 is shown. In operation, the mobile units 102, 104, 106, and 108 route signals through the base station 118 to a base station controller. The mobile units 102, 104, 106, and 108 can route both voice and data over the network. For example, mobile units 102, 106, and 108 are shown as transmitting voice data 110, 114, and 116 which mobile unit 104 is shown transmitting data 112. In general, the latency required for voice

transmissions to ensure a desired quality level is lower than the latency required for a data transmission. Due to the variability of the bandwidth available on the shared network, the base station 118 can shift the transmission time for some transmissions in order to account for the bandwidth of the network. For example, if the network is at or near capacity, the base station 118 can delay the transmission of the data transmissions by a predetermined time, e.g., about 1 to 3 seconds. The shifting of the transmission time for data transmissions based on the available bandwidth allows users to more effectively use the bandwidth available on the shared network.

In some embodiments, the shared network can include a guaranteed bandwidth for a particular user. For example, if the network supports dedication of bandwidth, the base station can be allocated a sufficient bandwidth to ensure a particular level of quality for the transmission of calls.

In some embodiments, the system can include a jitter buffer at one or both ends of the backhaul link to compensate for jitter in the shared network. In general, signal processing systems include some jitter which is a random variation in the time required to complete any particular task. At the lowest levels of the system, the jitter is due

to hardware effects, such as the relative time at which two chips request access to a shared bus. At higher levels, the jitter comes from variable and unpredictable network performance. The jitter buffers can ensure that the system will continue to process signals and present them to the system users in accordance with the relevant communications protocol even when significant jitter exists in the network.

In some embodiments, the use of software based radios can allow the functionality of the base station and the base station controller to be allocated as desired. For example, in a cellular link, the encryption/decryption of the data can be moved to the back end (e.g., the base station controller) side of the link. In addition, other functionality typically executed in the base station controller (e.g., power control) can be moved to the front end (e.g., the base station) of the link.

One exemplary re-distribution of functionality between the base station and the base station controller is shown in FIG. 6. A system 130 includes multiple mobile units 132 and 134, a base station 136, and a base station controller 140. During typical operation, certain switching operations occur at the base station controller. Therefore, if a mobile unit 132 desired to call mobile unit 134, the transmission would

travel from mobile unit 132 to the base station 136 and across network 138 to the base station controller 140. This transmission can introduce latency in the transmission. In addition, the transmission will require a portion of the bandwidth of network 138. In a software based system, some of the switching functionality can be moved from the base station controller 140 to the base station 136. For example, the base station 136 can determine if a call is being routed to a callee on the same base station and if so then the call can be routed at the base station. Routing such calls locally at the base station reduces the backhaul bandwidth because the call never transverse network 138.

While in some of the embodiments described above, a QoS mechanism is used, other embodiments exist in which a QoS mechanism is not implemented.

There has been described novel apparatus and techniques for reducing the cost of cellular backhaul. It is evident that those skilled in the art may now make numerous modifications and uses of and departures from specific apparatus and techniques herein disclosed without departing from the inventive concepts. Consequently, the invention is to be construed as embracing each and every novel feature and novel combination of features present in or possessed by the

apparatus and techniques herein disclosed and limited solely by the spirit and scope of the appended claims.

Other implementations are within the scope of the following claims:

What is claimed is:

1. A method for backhauling wireless voice and data transmissions, the method comprising:

receiving, at a base station, a wireless transmission;

5 forwarding the transmission from the base station to a base station controller over a shared network.

2. The method of claim 1, further comprising:

receiving, at the base station controller, a second

10 transmission;

forwarding the second transmission to the base station over the shared network.

3. The method of claim 1, wherein the shared network

15 comprises a non-private network.

4. The method of claim 1, wherein the shared network comprises the internet.

20 5. The method of claim 1, further comprising:

providing a jitter buffer at the base station controller;

and

using the jitter buffer to compensate for jitter introduced by the shared network.

6. The method of claim 2, further comprising:  
5 providing a jitter buffer at the base station; and  
using the jitter buffer to compensate for jitter introduced by the shared network.

7. The method of claim 1, wherein forwarding the  
10 transmission comprises forwarding the transmission using a secure protocol.

8. The method of claim 7, wherein the secure protocol comprises SSL.

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9. The method of claim 1, further comprising:  
determining a priority of the received transmission; and  
forwarding the transmission based on the determined  
priority.

20

10. The method of claim 9, wherein determining a priority comprises:  
assigning a first priority to voice transmissions; and

assigning a second priority to data transmissions,  
wherein the first priority is greater than the second  
priority.

5           11. The method of claim 1 wherein forwarding the  
transmission comprises forwarding the transmission using voice  
over IP technology.

12. The method of claim 1, further comprising performing  
10 decryption of the transmission at the base station controller.

13. The method of claim 2, further comprising performing  
encryption of the second transmission at the base station  
controller.

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14. The method of claim 1, further comprising performing  
power control at the base station.

15. The method of claim 1, wherein the transmission  
20 comprises a transmission from a cellular telephone.

16. A method comprising:

receiving, at a base station, a wireless transmission  
from a first mobile unit to be routed to a second mobile unit,  
determining if the second mobile unit is within a  
communication range of the base station; and

5 if the second mobile unit is within the range, locally  
routing the transmission from the first mobile unit to the  
second mobile unit at the base station.

17. The method of claim 16, further comprising  
10 forwarding the transmission from the base station to a base  
station controller if the second mobile unit is not within the  
range.

18. The method of claim 17, wherein forwarding the  
15 transmission from the base station to the base station  
controller comprises forwarding the transmission from the base  
station to the base station controller over a shared network.

19. The method of claim 18, wherein the shared network  
20 comprises the internet.

20. A system for backhauling wireless voice and data  
transmissions, the system comprising:

a base station configured to:  
receive a wireless transmission; and  
forward the transmission to a base station controller  
over a shared network.

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21. The system of claim 20, further comprising:  
a base station controller configured to:  
receive a second transmission; and  
forward the second transmission to the base station over  
the shared network.

10

22. The system of claim 20, wherein the shared network  
comprises the internet.

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23. The system of claim 21, wherein the base station  
controller comprises a jitter buffer configured to compensate  
for jitter introduced by the shared network.

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24. The system of claim 20, wherein the base station  
comprises a jitter buffer configured to compensate for jitter  
introduced by the shared network.

25. The system of claim 20, wherein the base station is further configured to:

determine a priority of the received transmission; and  
forward the transmission based on the determined

5 priority.

26. A system comprising:

a base station configured to:

receive a wireless transmission from a first mobile unit  
10 to be routed to a second mobile unit;

determine if the second mobile unit is within a  
communication range of the base station; and

if the second mobile unit is within the range, locally  
route the transmission from the first mobile unit to the  
15 second mobile unit at the base station.

27. The system of claim 26, further comprising a base  
station controller, wherein the base station is further  
configured to forward the transmission to the base station  
20 controller if the second mobile unit is not within the range.