

White Paper

Wireless and Intra-System Call Routing for 511 Advanced Traveler Information Systems (ATIS)

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List of Acronyms

ATIS.....Advanced Traveler Information System
CCIS.....Common Channel Interoffice Signaling
E-911.....Enhanced 911
FCC.....Federal Communications Commission
FDOT.....Florida Department of Transportation
I-4.....Interstate 4
ICB.....Individual Case Basis
IVR.....Interactive Voice Response
MPC.....Mobile Position Center
MSC.....Mobile Switching Center
NPA.....Numbering Plan Area
PBX.....Private Business Exchange
PSTN.....Public Switched Telephone Network
SS7.....Signaling System 7
VoIP.....Voice over Internet Protocol

1. Purpose

This document outlines the issues and costs associated with the transfer of calls between Florida's regional and statewide 511 systems, and addresses the inherent difficulties in translating wireless calls to the proper 511 system due to the general nature of wireless call routing.

This document also outlines the possible solutions and the costs for implementing these solutions. Finally, there is a discussion of alternative solutions for the wireless routing issues.

2. Landline Issues: Transferring Calls between 511 Systems

The *Florida's 511 Statewide Implementation Plan's* goal is for any user in any part of the State of Florida to be able to dial 511 from any telephone and have access to pertinent advanced traveler information systems (ATIS). Landline telecommunications allow for the precise placement of these calls by translating the 511 dialing code to a predetermined number based on the caller's physical location. Since landline telephone services do not move, each caller can be identified by their area code and telephone number prefix (NPA-NXX¹) and 511 calls emanating from this geographic area can be programmed for translation to a particular telephone number associated with an ATIS.

However, at final implementation, the *Florida's 511 Statewide Implementation Plan* calls for five separate regional systems and one overlaying statewide system, all responding to the same 511 dialing code. It is possible and, in fact, highly likely that some callers may live in an area covered by one system and work in an area covered by another system. These users will routinely travel between two different 511 system coverage areas, such as between Tampa Bay and Orlando, and may wish to check travel conditions in the "other" area before they travel out of their "home" area.

With this in mind, it is recommended that users be able to retrieve information from 511 services outside of their local area.

2.1 Transferring Calls between the Statewide and Regional Systems

The most straightforward method of retrieving this information is to transfer the caller between the two systems. A call transfer can readily be accomplished using interactive voice response (IVR) systems in much the same manner as one transfers a call on an office or home telephone system.

In an office environment, a caller may receive a call and then wish to transfer it to a colleague in the same office. The recipient initiates a "flash-hook call-transfer," accessing a new dial tone and then transferring the call to the new extension.²

In 511 implementations, a caller may access one of the regional 511 systems or the statewide system, and then desire information that is available on another system. The 511 menu will present an option to transfer to another system and, once enacted, the system will perform the same flash-hook call-transfer to complete the call.

¹ Numbering Plan Area (NPA) – This is the area code assigned as part of the North American Numbering Plan. NXX, where "N" is any digit except 1 or 0 and "X" is any digit. Under the current version of the North American Numbering Plan, the NXX is the first three digits of your seven-digit telephone number.

² *Section 2.2, What Happens When a Call is Transferred?*, explores the transfer of a call to an outside number.

2.2 What Happens When a Call is Transferred?

In an office environment, the recipient of an incoming call initiates the flash-hook function, placing the caller on hold and accessing a new dial tone. The recipient then dials a new extension and instigates another flash-hook function, connecting the original caller to the new extension. The original recipient may then hang up or continue monitoring the call by simply staying on the line. Most often, these functions are included in the office's private business exchange (PBX)³ system. There is no additional charge for these transfers, since the call never leaves the PBX and no outside dial tone (i.e., no telephone company dial tone) is required.⁴

For a call to be transferred to a number outside of the PBX system, the recipient must first access an outside line. The recipient initiates the flash-hook function to access a dial tone, but then dials "9" (or another predesignated number) to gain access to an outside line before dialing the desired number. Dialing an outside line causes the telephone company switch to recognize that a new call is being placed and that charges for this call should be applied. Since the recipient of the first call is placing this new call, all charges for the new call apply to the recipient's service. In some cases, there is a per-call access charge. In others, the charges are only based on the cost of the actual call.

In many areas, similar services to these are available to residential users. However, it is unusual to find a residential user with a PBX system and, as such, all call transfers incur appropriate telephone company charges.

In applying this information to Florida's 511 systems, calls terminating in one 511 system when transferred to another 511 system will likely instigate some level of call charges to either the sending system, the receiving system, or in some cases, both.

Additionally, when a call comes into a PBX or, in this case, the 511 IVR, it occupies either a single channel on a T-1 circuit or a single telephone line. When the user requests a call transfer to another system, the system "grabs" another channel or line within the system for the outbound call. Until the call is terminated, the call is using *two* channels or lines in the system. If 50 users of a 100-line system request call transfers at the same time, those 50 users will use all 100 lines available within the system.

³ The PBX is used in an office environment to allow intra-office calling without accessing outside telephone services.

⁴ In most business environments, a caller must dial a 9 (or another digit) to access an outside line. This allows intra-office communications without the need for an outside dial tone.

2.3 Cost of a Call Transfer

2.3.1 Local-to-Local or Local-to-Toll Transfer

In the best-case scenario, a 511 call is terminated to a local number within the caller's coverage area. Florida implementations have revealed only one area thus far where this is possible. The Southeast Florida 511 system terminates all landline calls that are local to the Miami Operations Center to a local 305-914-XXXX telephone number. The caller sees the call as no more than the cost of a local call and the service provider – in this case, the Florida Department of Transportation (FDOT) – does not realize any additional charges for receiving these calls.

Should the call terminate at a number that is a toll or long distance call to the Miami Operations Center (i.e., the facility transferring the call), then toll or long distance charges are paid by the service provider (i.e., FDOT) and not the caller.

Other transportation partners in the area (e.g., transit operators, Miami International Airport) may afford this system the opportunity to transfer a call to another local number. In this case, the flash-hook call-transfer function will access an outside line and dial a local telephone number. The FDOT will be charged for these transfers only if the telephone service incurs "business minute" charges. However, there are no other 511 systems within this local calling area and, as such, there will be charges and technical obstacles that need to be overcome.

2.3.2 Toll-Free to Toll-Free Transfer

Both the Southeast Florida 511 and Central Florida ATIS services make use of a toll-free backbone to carry 511 calls. In Southeast Florida, 511 calls placed from outside the local dialing area to Miami (i.e., Palm Beach and most of Broward County) are carried over a toll-free backbone to their terminating point in Miami. The Central Florida system carries *all* 511 calls over a toll-free backbone because the IVR server is located out-of-state through an agreement with an off-premises service provider.

In the above scenarios, where a caller to one 511 system is transferred to another 511 system, the same function takes place (i.e., flash-hook call-transfer); however, since the original call was carried over a toll-free backbone, the per-minute charges paid by the original call recipient will continue until the call is terminated – in other words, throughout the length of the second call – as indicated in the following example.

Example: A Palm Beach caller dials the Southeast Florida 511 and is transferred to the Central Florida system.

Result: The original 511 call is translated to the Southeast Florida service provider's toll-free backbone and is terminated at the Miami Operations Center. Per-minute charges are incurred against the Southeast Florida service provider for this call. The call is then transferred to the Central Florida system through that system's toll-free backbone. The Central Florida system's service provider, according to their toll-free service agreement, incurs per-minute charges. However, since the original call has not been terminated, the per-minute charges to the Southeast Florida system continue throughout the life of the call.

The above scenario is called a trunk-to-trunk transfer, where a call comes in on one service trunk (i.e., one phone line or one channel of a T-1 line) and is then transferred by bridging the call to another trunk. The first connection cannot be broken without losing the call.

Additionally, in a trunk-to-trunk transfer, the trunk carrying the original call remains in use, as does the trunk carrying the transferred call, until both calls are completed. This essentially diminishes the number of incoming trunks available to new callers on the system. As noted previously, a system with 100 lines or channels can be used by only 50 callers if all callers request a call transfer at the same time. If it is believed that a system will transfer a large number of calls, as may be the case between the statewide and regional systems, the system must be sized appropriately to accommodate the enhanced call volume. Such sizing may drive up the cost of providing service by necessitating more telephone lines/channels.

2.4 Mitigating the Costs

There are methods for mitigating *a portion* of these call transfer costs; however, costs are associated with these solutions, and certain assumptions must be made to validate their value.

2.4.1 Two-B-Channel Transfer

One method for mitigating call transfer costs is the elimination of the continuing cost of the second B-channel requirement once the transfer has been completed. If the incoming trunks (i.e., lines or channels) are programmed with the capability to perform a Two-B-Channel transfer, the first call can be dropped once the transfer is completed. This will free both the incoming trunk and the trunk being used for the transfer.

Of course, adding this capability to a series of trunks or lines will have an associated per-line, per-month charge. This charge is based on the terms of the service contract and usually varies between carriers and services.

What does not change in this scenario is that the service provider receiving the original call is responsible for the cost of the incoming call (assuming a toll-free backbone is used), as well as for any toll charges applicable to the transferred call.⁵ Any toll-free charges for the original call will also continue for the life of the call.

2.4.2 Dedicated Service or Flat Rate Private Line

This solution offers the opportunity to connect two systems together directly. A dedicated service, for example, a T-1 line, can connect to each service, offering a caller the chance to transfer to the other connected system without the current system having to access an outside line. In essence, this will appear as an in-house transfer similar to one made by a PBX system in an intra-office transfer. The connection will be bi-directional, offering transfers between the two systems in either direction. The cost of this type of dedicated T-1 service is based in part on the distance between the two “ends” of the call. Typical charges range from \$750 to \$1000 per month.

Implementing this type of service will allow a call to be transferred without incurring additional charges; however, the original 511 call will continue until the transferred call is terminated. In other words, if a call is placed to the Southeast Florida system through the toll-free backbone and transferred to another system, the per-minute charges to the Southeast Florida system will continue throughout the second part of the call, though the second call will not incur any additional charges. In addition, though the system will be transferring the call to a new T-1 line (running between the connected systems), the channel used by the original call will continue to be occupied and any associated toll-free charges will continue for the life of the call.

2.4.3 Voice over Internet Protocol (VoIP)

Another viable solution is the implementation of a voice over Internet protocol (VoIP) service, using the Internet to carry the voice calls between systems. The cost for this service is roughly the same as a T-1 connection to the Internet, or about \$1000 per end. The benefit to this solution is that the VoIP connection can be compressed allowing more than 24 voice calls to be carried across the circuit at one time. The benefits will need to be weighed regarding the exchange of capacity for voice quality before a decision is made on how to implement this solution. At this time, the quality of service over the public Internet (i.e., across state lines and across the country) is unknown.

Each of these solutions offers some level of savings or cost containment. However, they should be explored on a site-specific basis in order to discern the proper mixture of solutions to savings (versus quality of service) formula.

⁵ If the transfer is to a toll-free number, there are no additional charges.

3. Wireless Issues: Misdirected Calls

Wireless communications is currently an imprecise science when it comes to determining the precise path of a telephone call. By nature, most types of wireless communications are omnidirectional,⁶ meaning the signal emanates from the transmitter in all directions until it is received at a receiver, be it a tower, a radio, or another form of receiver.

Wireless or cellular telephones operate in this omnidirectional mode. Typically, a wireless telephone will broadcast a signal in all directions until it is received at a tower site. If it is received at more than one tower (as is usually the case), the carrier's system analyzes the signal and chooses which tower is receiving a better signal from the telephone. The call is then routed to one of the company's "switches" for processing (i.e., directing the call to the proper terminating point) and sending the call to a public switched telephone network (PSTN), if necessary, for completion⁷. Then, while completing the call for the user, the system continues to analyze the signal as it is received at however many towers are able to accept it. As the caller moves, their signal changes based on their proximity to each tower. As a signal gets stronger at one tower and weaker at another, the first tower will "hand-off" the call to the second tower.⁸ Using this method, wireless calls may begin when the user is in one location and continue indefinitely as the user travels across town or across the country.

However, this "negotiating" between towers can mean that, based on signal strength, a user's call may be routed through a tower across a county or even a state line from where they are located. Also, since every wireless carrier is different, with each having their own set of towers and switches, a call that is routed through a local tower and switch for one carrier may be routed through a tower and switch over a county line for another. Furthermore, the towers and switches often execute what is known as "load balancing" in order to assure that a line (or channel) is always available for a new caller. What this means is that if an area is experiencing a particularly high call volume, the switch that operates in that area may reroute a certain number of calls coming from a particular tower to another switch in order to assure that another tower's calls are able to get through. In effect, this may mean that a call routed through one switch on a given day may be routed through another switch on another day.

Carriers utilize these scenarios in order to maximize the use and utility of their systems to the benefit of their customers. The reason these scenarios are problematic for Florida's 511 services is outlined below.

⁶ Certain types of wireless communications use unidirectional or focused transmission antennae, such as microwave or directional beacons. For the purposes of this paper, we are focused on omnidirectional transmissions emanating from cellular telephones.

⁷ If the call is being placed between wireless telephones using the same service, the call may be connected without traversing the PSTN.

⁸ During this "hand-off," the call may also change frequencies.

3.1 Switch-Level Translations

In current 511 implementations, wireless carriers translate the 511 dialing code to a specific telephone number (local or toll-free) that terminates at the facility providing traveler information to a specific geographic region. The translations occur on a “switch” level, meaning the 511 code is translated according to the switch with which the wireless call is processed.

As indicated previously, each wireless carrier has their own towers and their own switches for routing calls. Depending on the carrier’s investment in the market, their market share of wireless users, and even the topography of the area, the density of towers in each area may vary widely. In rural areas, carriers may share a single switch amongst any number of tower sites, including towers that may be across county and even state lines. This is where the issue of misplaced wireless calls becomes problematic.

Carriers construct and operate towers and switches based on usage density. The more subscribers a carrier has, the more potential concurrent users they have. In order to assure each user a circuit on which to complete their call, the carrier may construct additional towers in a particular area. However, since calls received at a tower are then routed to a switch for processing, carriers are able to increase the size of the switch, within limits, to accommodate a greater number of concurrent calls from more towers without building a new switch. In some cases, carriers may operate dozens of tower locations through a single switch.

The carriers, in all but one case, prefer to program by switch instead of by tower. To date, none of the carriers have charged for such programming. The carriers do this with the understanding that switch coverage will likely include a larger geographic area than that covered by the 511 information and that some calls will be translated to the “wrong” 511 service, as the tower receiving the call may route the call to a switch outside of the local area.

Each carrier offering 511 translations in Florida and, in particular, the Orlando area was asked to review their 511 coverage with a mind toward expanding the Central Florida ATIS’ coverage to include Polk County. The issue at hand is programming the switch that covers Polk County to translate the 511 code to the Orlando system.

- How much over-coverage will be realized (e.g., will coverage extend to Tampa and other areas)?
- What charges might there be if this switch were *temporarily* programmed to translate to the Orlando system and then reprogrammed for the Tampa Bay system once it becomes operational?

The carriers’ responses are indicated in Table 3.1.

Table 3.1 – Orlando Switch Coverage and Programming

Carrier	Current Coverage in Polk County (Yes or No)	Current Over-Coverage (<u>beyond</u> requested coverage area)	.1.1.1.1.2 Over-Coverage (if adding Polk County)	Charges for Reprogramming
Verizon Wireless ⁹	Yes, coverage exists in the eastern two-thirds of Polk County	Hardee and DeSoto counties, and portions of Highlands County are currently covered.	N / A	No charges have been requested since most of Polk County is within the coverage area.
Sprint PCS	No	Flagler, Putnam, St. Johns, Duval, Sumter, Hernando, Citrus, and Marion counties, and a portion of Alachua County are currently covered.	Over-coverage is anticipated in Portions of Hillsborough, Highlands, Hardee, DeSoto, Sarasota, and Manatee counties.	No charges are anticipated.
Nextel	Yes	No over-coverage exists.	N / A	No charges have been requested since Polk County is within the coverage area.
Cingular Wireless	No	No over-coverage exists.	N / A	Cingular is instituting primary programming costs that will be repeated if reprogramming is requested.
AT&T Wireless – TDMA Network	No	Marion, Sumter, Flagler, Indian River, Clay, Duval, St. Johns, Nassau, and Baker counties are currently covered.	Over-coverage is anticipated in Citrus, Hernando, Manatee, and Sarasota counties.	No charges are anticipated.
AT&T Wireless – GSM Network	Yes	Marion, Sumter, Flagler, Polk, DeSoto, Manatee, Sarasota, Citrus, Hardee, Hernando, Highlands, Hillsborough, Pasco, and Pinellas counties are currently covered.	N / A	No charges are anticipated. ¹⁰
T-Mobile	No	No over-coverage exists.	No over-coverage is anticipated.	T-Mobile currently performs their translations through tower programming.

⁹ As of this writing, Verizon Wireless is NOT translating the 511 code; however, discussions continue in an effort to have Verizon Wireless on-line by May 1, 2003.

¹⁰ It is important to note that AT&T has stated they “cannot break down our GSM network routing to any more of a granular level than it already is.”

3.2 Tower-Level Translations

While it is technically possible to program 511 translations at the tower level and, in some cases, by cell sector,¹¹ most carriers are reluctant to offer this level of programming due to the labor hours involved. The cost per tower multiplied by the number of towers each carrier has assigned to each switch can quickly bring these costs to a staggering figure.

Each carrier offering 511 translations in Florida and, in particular, the Orlando area was asked to review their 511 coverage with a mind toward expanding the Central Florida ATIS' coverage to include only the eastern part of Polk County, with the precise area to be determined at a later date. The following issues must be addressed:

- Is the carrier able to program at the tower level?
- What is the cost for tower-level programming?
- If one portion of a switch is programmed at the tower level, will the remainder of the towers require the same programming or will we be able to request partial tower-level and partial switch-level programming?

The carriers' responses are indicated in Table 3.2.

¹¹ A wireless tower traditionally has three sectors or "faces." Each tower sector has antennae that point in a different direction from the tower body, allowing the carrier to receive or reject calls from a particular direction in relation to a particular tower.

Table 3.2 – Tower- Level Programming and Costs

Carrier	Current Coverage in Polk County? (Yes or No)	Capable of Tower-Level Programming? (Yes or No)	1 2 Able to Combine Tower and Switch Programming? (Yes or No)	3.2.1.1.3 Charges for Programming
Verizon Wireless ¹²	Yes, coverage exists in the eastern two-thirds of the county.	Yes	No	Special programming is on an individual case basis (ICB). Tower programming will require <u>all</u> towers within a switch to receive programming. There are 100~200 towers in each switch area (Orlando and Tampa).
Sprint PCS	No	No	No	N / A
Nextel	Yes	No	No	N / A
Cingular Wireless	No	Yes	Yes	Possible charges include the following: <ul style="list-style-type: none"> • Setup/Analysis: \$400; • 1-50 tower faces: \$100 a piece; • 50-200 tower faces: \$50 a piece; and • 200+ tower faces: \$25 a piece.¹³
AT&T Wireless – TDMA Network	No	No	No	N / A
AT&T Wireless – GSM Network	Yes	No	No	N / A
T-Mobile	No	Yes	Yes	No charges are anticipated. ¹⁴ However, T-Mobile reserves the right to revisit programming charges for programming if the complexity of the programming changes.

¹² See footnote 9.

¹³ Cingular is instituting tower site and tower face-level programming. In Polk County, Cingular operates 36 tower sites, or 108 tower faces. Approximately 9-15 of these towers may be appropriate for translations to the 511 system in Orlando and are located in the area along Interstate 4 (I-4). The precise number will need to be determined when programming is requested.

¹⁴ T-Mobile is the only carrier that currently programs 511 translations by tower. They have delineated the current programming in accordance with county line designations. Requesting a single change, such as splitting Polk County, may not evoke a charge for programming; however, T-Mobile has stated that continued requests for complex programming might require them to revisit this decision.

3.3 Location-Based Solutions

3.3.1 Leveraging Enhanced 911 (E-911) Requirements

The Federal Communications Commission (FCC) mandated wireless carriers to deliver caller locations for wireless enhanced emergency calls under docket 94-102 (including orders 96-264, 99-96, and 99-245). The mandate is for a phased deployment. Phase 1 is focused on the delivery of the location of an emergency caller based on cell tower/cell sector. Phase 2 is focused on the delivery of the emergency caller's location, which is determined by latitude and longitude. The accuracy of the caller's location is based on the location technology used by the wireless carrier.

This same technology and capability can be used to locate a caller and route their call to an appropriate 511 service.

3.3.2 Location-Based Service Providers (Intrado and Others)

Intrado is a leading provider of 911 and Enhanced 911 (E-911) location services and systems for the landline and wireless markets. In using location information garnered from a carrier's mobile switching center (MSC), Intrado can assign cell towers and sectors to translate 511 calls to the appropriate service, acting as intermediary between the FDOT and the wireless carriers. Using Intrado or another location-based solution provider will allow for the sharing of maps between the FDOT and wireless carriers without raising the carriers' concern over proprietary data being shared with a government agency. Tower locations can be determined and each tower/sector designated to translate to one of the 511 systems.

3.3.3 Carrier Cooperation

Carriers must have connectivity to a Signaling System 7 (SS7)¹⁵ network, which is used for Phase II-type deliveries of E-911 information. They must also have a service control point or MSC that is aware of the tower/sector network. Most carriers have these capabilities as they are equivalent to the Phase I requirements for E-911.

The carrier will be required to program translations into their MSC to launch an SS7 query to the Intrado mobile position center (MPC) with the serving cell tower/sector (and latitude/longitude, if available) included. The MPC responds back to the MSC with the ten-digit routing instruction on where to send the call.

¹⁵ Signaling System 7 (SS7) – The SS7 is an internationally standardized version of a common channel interoffice signaling (CCIS) system where network information, such as address and routing information, are handled externally to the actual communications (voice) path.

As noted in *Section 3.2, Tower-Level Translations*, at least one carrier, Cingular, is proposing this type of solution on their own. Other carriers have either stated that they are unable or uninterested in offering this sort of solution. Using an intermediary like Intrado may provide a solution for these carriers.

3.3.4 Service Offering Key Issue

Location services for wireless 511 calls are not a current service offering. If the FDOT decides to explore location services further, an expression of interest and understanding must be reached between the FDOT and Intrado or another location-based service provider in order to begin the process of evaluating the business model for such services.

Technology is less of an issue than understanding the volume of calls and number of carriers to be accounted for along with the pricing that will be developed to insure a quality of service that meets the FDOT's needs.

One issue that will need to be understood and managed is that of carriers who are currently contracting with other E-911 location service providers. If this location solution were implemented for 511, the FDOT must designate one company as the location-based service provider for 511 services. Carriers must then agree to provide their tower and switch information to this designated company as well as to their E-911 provider, if they are contracted with another provider for E-911 services.

It is assumed that the FDOT will pay the location-based service provider for its services and it is possible that the FDOT will be asked to pay certain costs to the carriers for this solution as well. The reason for this is because programming information will need to be exchanged between the location-based service provider and the carrier.

4. Conclusions / Recommendations

4.1 Switch-Level Programming

Implementation of a switch-level programming solution will provide the most immediate results in adding Polk County to the 511 translations of four wireless carriers. However, this must be viewed as a short-term solution because the pending launch of 511 services for the Tampa Bay area will require the reversal of this programming for two of these carriers so as not to impinge on the Tampa Bay system's coverage area.

Tables 3.1 and 3.2 indicate that of all the carriers currently offering 511 translations for the Central Florida ATIS, only four carriers – Sprint PCS, Cingular, AT&T Wireless' TDMA network, and T-Mobile – are not currently offering 511 in Polk County.

The FDOT may request that these carriers add Polk County to the current translations, but must completely understand the ramifications of this decision. These ramifications being that at least one carrier will charge for this change and that two of the carriers will then over-cover the area, translating calls from as far out as Citrus and Sarasota counties to the Central Florida ATIS.

Table 4.1 illustrates the costs and over-coverage when implementing this recommendation.

Table 4.1 – Polk County 511 Implementation Costs and Over-Coverage

Carrier	Over-Coverage with the Addition of Polk County	Charges for Reprogramming	Required Changes after the Tampa Bay System Launch
Sprint PCS	Over-coverage will occur in portions of Hillsborough, Highlands, Hardee, DeSoto, Sarasota, and Manatee counties.	No charges are anticipated.	Programming must be reversed to offer services to the Tampa Bay system users.
Cingular Wireless	No over-coverage is anticipated.	Anticipated costs include: <ul style="list-style-type: none"> • Setup/Analysis, \$400; • A minimum of \$900-\$1500 for tower programming along I-4 near Osceola County; and • As much as \$3600 for Polk County tower programming. 	No changes are anticipated. (Careful analysis is required before implementation to insure that coverage will not change when the Tampa Bay system is launched.)
AT&T Wireless – TDMA Network	Over-coverage will occur in Citrus, Hernando, Manatee, and Sarasota counties.	No charges are anticipated.	Programming must be reversed to offer services to the Tampa Bay system users
T-Mobile	No over-coverage is anticipated.	No charges are anticipated. ¹⁶	No changes are anticipated. (Careful analysis is required before implementation to insure that coverage will not change when the Tampa Bay system is launched.)

¹⁶ T-Mobile currently performs programming at the tower level without charge.

4.2 Tower-Level Programming

This solution is not recommended at this time. Though tower-level programming is only available from three of the carriers, two of these solutions are represented in the recommendation for switch-level programming (Cingular and T-Mobile) outlined above. Requesting tower-level programming from these carriers will yield results similar to those seen by adding Polk County to their switch-level programming. The third carrier capable of tower-level programming is Verizon Wireless. Once Verizon's 511 coverage is implemented, it will include the eastern two-thirds of Polk County by virtue of their switch coverage and, thus, tower programming, which is available at an unknown cost, will not be necessary.

The other two carriers of concern, AT&T Wireless' TDM Network and Sprint PCS, do not offer tower-level programming.

4.3 Location-Based Services

Finally, for the long term, location-based services appear to be the best solution for the FDOT's consideration. This solution may offer the FDOT the ability to designate tower locations along county lines for specific 511 translations. A location-based service solution can be implemented to assist in proper call routing not only between the Central Florida and Tampa Bay ATIS, but also along the borders between the statewide and regional 511 systems as they are deployed.

Further investigation is required to validate the capabilities of a location-based services company and to ascertain a pricing structure, schedule, and the agreeability of the wireless carriers to implementing this solution. It is recommended that the FDOT continue to investigate this option to determine its viability as a solution to the issue of misplaced wireless calls.