# Follow the Wave(length)

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## Comparing the 915MHz and 5.8GHz AVI Systems

*A timely insight into the families of electronic toll collection AVI frequencies now emerging on both sides of the Atlantic*

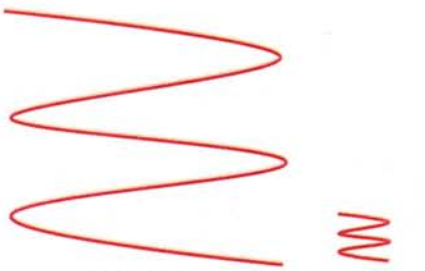
Emerging technologies are always provocative efforts, both for providers and users. Electronic Toll Collection (ETC) is no exception. A myriad of system types, joint ventures, partnerships, manufacturers, and system integrators have evolved to meet the demand for automatic vehicle identification (AVI) systems – a key element of ETC.

Some surfing enthusiasts might compare catching the 'big one' to developments in the current marketplace for ETC. Catching, then following, the ultimate wave is the quintessential challenge.

In the USA, AVI systems predominantly use radio frequency (RFID) to identify vehicles. Such RFID systems use the 902-928MHz frequency range. Often this ISM band is referred to as the 'garbage' band because it covers emitters ranging from spread-spectrum data to amateur radio operators. The range is also becoming crowded as the use of cellular phones and other wireless devices explodes beyond all previousa expectations. In this environment, garbage takes on a new meaning: signals can interfere with each other. System design and installation then become critical to preventing errors in determining, for example, vehicle identification.

In Europe, the 915MHz frequency range is unavailable because it is already assigned to such uses as fire and ambulance radio in the UK and the military in France (Figure 1).

To accommodate and encourage intelligent transportation systems (ITS) worldwide, the Comité Européen de Normalisation (CEN), the governing body for European standards, just approved the 5.8GHz range (5.795–5.805) for use by AVI systems and other road telematics. The frequency is available in Europe, the USA and in Southeast Asia.




***The shorter 5.8GHz wavelength carries more information and makes it easier to fine-tune the antenna read zone***

At least one multinational company foresaw the need for a 5.8GHz AVI system. After TIRIS – a division of Texas Instruments – took part in a long-term study sponsored by the German government in the spring of 1994, it saw a need to develop the 5.8GHz AVI system. In a

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multivendor evaluation of the experimental 5.8GHz systems on Autobahn 555, TIRIS was chosen as the best of the single-gantry RFID systems tested.

According to Anne Tip, general manager operations, TIRIS Highway Systems, "We will have working systems in Europe fully operational in two to three years." He predicts that in Southeast Asia, "We will see a growing proliferation of 5.8GHz systems to get a headstart on the Europeans. In the USA, many will shift to 5.8GHz after the end of the century."

In the near future, TIRIS will offer both 915MHz and 5.8GHz systems in the USA. In several years time, conversions from the 915 to the 5.8 will be available. For now, the 915MHz remains a very viable solution. To gain a better understanding of each system type a summary of the differences between the two is given in Table 1.

## COMPONENT COST AND AVAILABILITY

One of the drawbacks of the 915 is also the basis for one of its advantages. Because the 915 bandwidth is in a more crowded field, more components are manufactured to support systems designed for this range. Also, the lower the frequency, the lower the cost of components. While spectrum crowding is not a problem at 5.8GHz, few parts are being mass-produced yet to support systems using this bandwidth.

Furthermore, in the backscatter technology used by TIRIS and implied for use in the CEN standards, the transponder requires an amplifier for the shorter 5.8GHz wavelength. Generally, the higher the frequency (and the shorter the wavelength), the more sophisticated the components must be to maintain the signal.

## TECHNOLOGY LIFECYCLE

As the technology is in the early stages of its lifecycle at the higher frequency, very few applications exist at the 5.8GHz range. The military market, including Texas Instruments' Defense Group, has helped to bring down the cost of higher frequency components, but such electronics are still more expensive than those for the lower frequency 915. For example, semiconductor chips that generate and detect high frequency signals must be made of gallium arsenide, a much more expensive material to process than silicon.

Proven technology means there are more manufacturers. TIRIS, Amtech, and Mark IV for example have established systems on the road today. At present, however, nothing exists for the 5.8GHz except in trials and for a few systems on a limited scale in Europe.

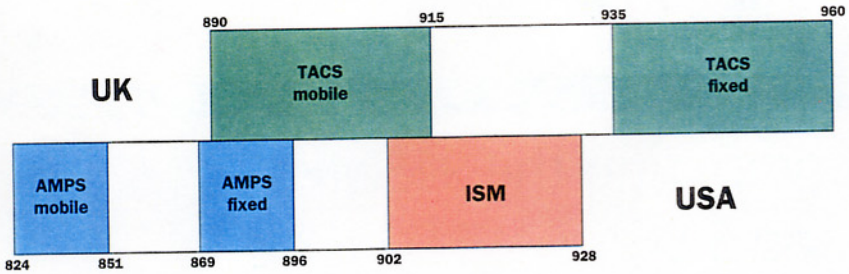
## STANDARDS

CEN's decision to choose a standard, benefits both manufacturers and suppliers, such as Texas Instruments TIRIS, because it eliminates a lot of the guesswork – and cost – in building a system.

Other nations have yet to adopt standards officially regarding these types of highway applications. To date, countries like the USA and Japan have let the marketplace determine *de facto* standards in the area of ITS, although most are closely following the European effort. It costs more to have many independent, individual non-compatible elements trying to solve the problems of congested highways. The cost of competition is less when the playing field is level.

In the Far East, countries such as Japan, Singapore and Korea, are accepting the 5.8GHz bandwidth for AVI, even though standards have not yet been approved.

Historically, establishing standards has always been critical to a country's economy. By minimizing the difficulty of inter- and intrastate flow of goods and




**TACS – Total Access Communication Systems (UK)**
**AMPS – Advanced Mobile Phone Service (USA)**

*Figure 1: 902 – 928MHz Allocations in the USA and the UK*

*Table 1: Comparing the 915MHz and 5.8GHz AVI Systems*

| + Advantages – Disadvantages | |
|---|---|
| **915** | **5.8** |
| **Strategic Differences** | |
| + More readily available components | – Less available components |
| + Lower cost components | – Higher frequency; higher cost; more sophisticated electronics |
| + Fewer parts required | – More parts required |
| + Proven technology | – Emerging technology |
| – Use of frequency band is a de facto standard only | + Use of frequency band now approved in Europe and being accepted in Southeast Asia |
| – Crowded bandwidth means more noise, more interference. | + Uncrowded bandwidth means less noise, less interference in bandwidth. |
| – Less able to fine-tune antenna pattern | + Better able to define antenna pattern |
| – Carries less data | + Carries more data |
| **Physical Differences** | |
| – Larger size of antenna<br>Wavelength 33cm<br>Dimensions 107cm x 92cm | + Smaller size of antenna<br>Wavelength 5.2cm<br>Dimensions 51cm x 41cm |
| – Total redesign for transponder to be smart card ready | + Transponder is smart card ready. |

people, a country can reap financial rewards. For example, in the late 1800s after Britain adopted the standard gauge (1.44m between rails) for train tracks, railroad development flourished in that country. Soon afterwards, other countries followed, as did prosperity within their boundaries. Also, globalization brings economies of scale and increases the efficiency of goods movement. The builders, installers, operators, users – all the shareholders benefit from standardization.

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## ANTENNA PATTERN

The 5.8GHz frequency provides a more defined antenna pattern. It's the difference between painting with a house-painter's boor-bristle brush and with an artist's mink-tipped brush. More precision can be applied to individual systems with the higher frequency. Read areas for recognizing vehicles can be more finely tuned.

However, one potential drawback to the 5.8 is that antennas are less efficient – they capture less energy – and more vulnerable to climatic conditions. To compensate, a preamplifier is added to the transponder unit – part of why the tag has more complicated electronics than with the 915. The 915 tag is simpler and cheaper.

## SIZE

One very noticeable difference between the 915MHz and the 5.8GHz systems is the size of the overhead antenna. The area of a 915 antenna is roughly 25–36 times as large as the 5.8GHz.

## MEETING DEMANDS

To meet the demands of both official and *de facto* standards, TIRIS will offer automatic vehicle identification (AVI) solutions for both bandwidths. To appeal to the European market, the 5.8GHz will be smart card ready. The transponder will have read/write capability with full encryption.

Currently, TIRIS offers a 915–928MHz AVI system for integration into electronic toll collection systems. Conversion options will be available in year 2000.

The best way to follow the wave (length), then, is to stay alert to shifts in requirements and closely watch global developments while simultaneously developing new technology.