Digital Land Surveying and Mapping(DLS&M)

Dr. Jayanta Kumar Ghosh
Department of Civil Engineering
Indian Institute of Technology, Roorkee

Lecture – 05
GPS Signal (Civilian Perspective)

Welcome students, Today is the 5th lecture, I am going to talk on GPS Signal. As I had told in the last class that GPS system consisting of the space segment then your control segment and user segment, and we as a user are more interested in the user segment, but we do receive GPS signal from GPS satellites. And that signal is important for us and we need to know more about that signal, so this class GPS signal has been coined. These class I will be discussing on: first I will introduce what is GPS signal, of course I have already told something to you, then the component of a GPS signal- I will discuss for your best summary, glossary and review questions.

Now, I have already told you usual segment receives the broadcast signal that has been from the satellite vehicles. And this signal actually contains a wealth of information also these signals are a modulated signal which are having a number of components. Actually, we need to know the defined components that the GPS signal contains; because most of the users do not make use all the components, depending upon our purpose also define users make use of different parts of the signal depending upon his or her need. So, we need to know in detail about that the GPS signal.

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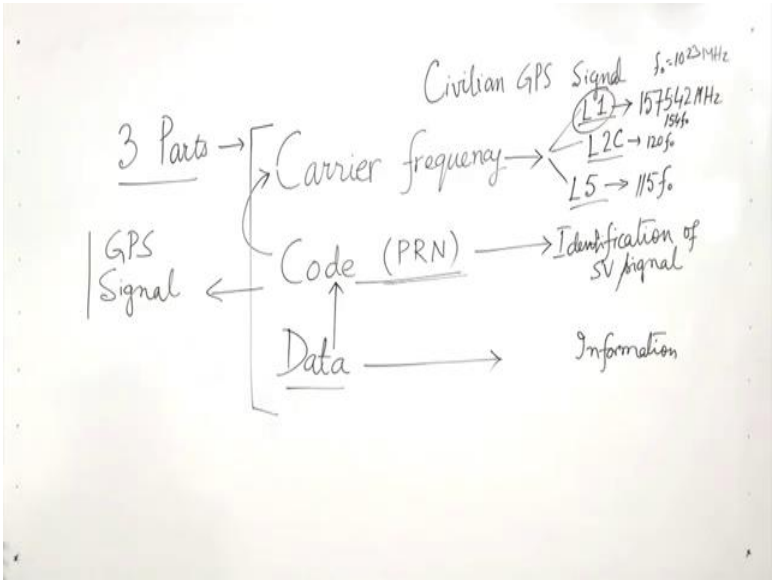

Now the GPS signal fundamentally consists of three parts: if we start with carrier frequency then it is the codes or PRN codes which is also known as n the data. No, we are as a user we are very much in need of the data that the GPS signal contains, but these data we do get is from the GPS along with some code and in a carrier frequency. Now the basic given is that why we take these two things also along with data. Actually, the data that is available in the GPS signal contains a wealth of information which will be useful for our different purposes, but when we will receive the data from some particular signal we also need to know from which satellite it is coming. You do not do get that identification actually these data get modulated with the code. So, code provides the identification of the satellites from which the data is being received.

Now, these code and data are in binary form and having very little energy. And as you know that GPS signal is coming from satellite vehicles which are about 20000 kilometer about the surface of the earth. So, this data and code will get lost in the atmosphere, in the path along which it will coming. So, in order to make these which to user it is modulator, carrier frequency which is having very high energy content; so now these three together actually constitute the GPS signal.

Now to make the thing more understandable we can compare this along with our; if we take the example of some information is coming to you so from the postal service in envelope. So, the information or suppose interview letter which is the most important

part is the equivalent to our data. And this interview letter has to reach you, so your address is required. And that is what is equivalent to your code of the GPS signal. And this together should come to you without any damage, so it is put inside an envelope. So, and all these three will be your mail. So, similar to our GPS signal the mail. So, you can (Refer Time: 06:46) this phenomena like this. So, carrier frequency is fundamentally provided to reach the data safely to the user. Code provides the identification of signal or the identification of the satellite vehicles for which it is coming and which is the information which we are looking for.

Now, this carrier frequency actually in replace signals there are more than one carrier frequencies. Actually there are different types of carrier frequency available also for military purpose; there are some carrier frequency, some data, some code, which are specifically useful for the military purpose which we will not like to discuss this class, so we will like to go for civilian GPS signal.

Now for civilian use actually there are three types of carrier frequency that is available in the inside the GPS signal and these are known as L1 means; this is the short form of the name link 1. That means, this is the first link that is being given between the satellite and the user when the system was developed. And it is having 1575.42 megahertz; this frequency. Then next, one more link has been used that is call L 2; link 2, but that was specifically for military purpose. And at present that has been converted to civilian signal and that is termed as L2C signal, which is having actually this is 154 f 0, this is 120 f 0; where f 0 is 10.23 megahertz. And subsequently another signal has been used or now it is l level that is the L5 signal that is having the frequency of 115 f 0.

Now, at present we have three civilian signal or three civilian carrier frequency and each of these carrier frequency has some advantages or strength. Like L1 signals; L1 frequency is the most powerful in the sense of it has very little ionospheric error. Actually in case of GPS when the signal is coming ionospheric (Refer Time: 10:41) maximum and that provides the maximum error. But and the amount of ionospheric error will be minimum for L1 signal. So, L1 signal provides the best position among all the three free carrier frequency.

Then L2C signal: actually this is a comparatively new signal which is available along with the GPS signal. This signal has very high power as a result of which this L2C

signal, we can get L2C signal under the tree also. So, whenever we will be need to carry out serving under a tree or some very little cover, we will like to go for L2C signal. Again, these L to 5; now this if you make use of L1 L 2 together then that will be better for our surveying of. Then L5 signal which is coming up still all our satellites are not providing L5 signals, but many of the satellites are providing. This L5 signal is very good for aerial navigation purpose; that means, that aircraft navigation we go for L5 signal.

So, each one of these signals has some advantages which we make use for the one strength.

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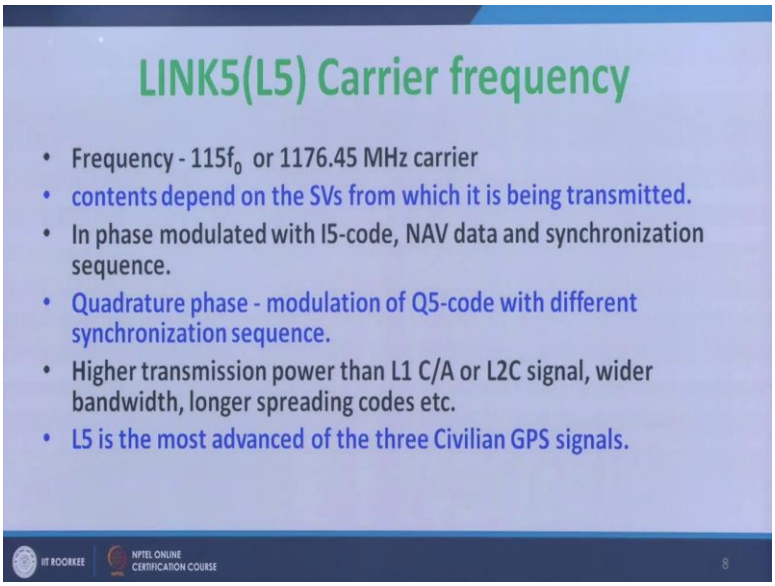

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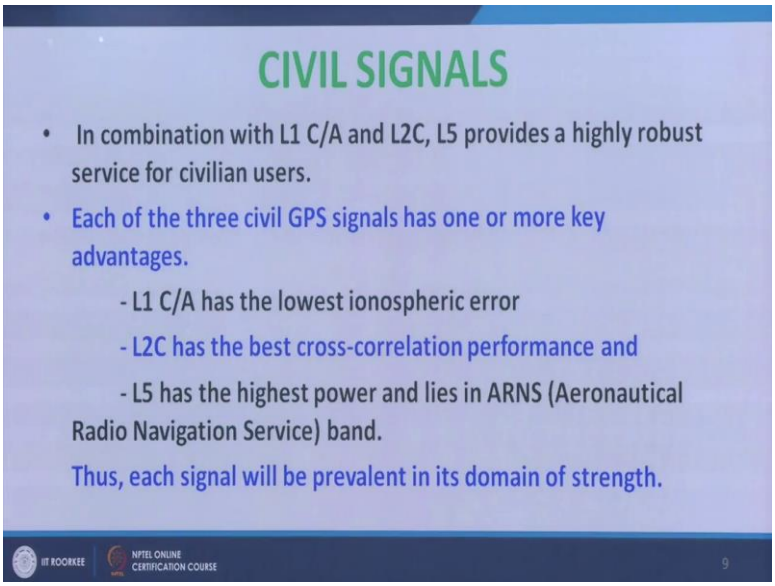

Like here I have summarized that in termination L1 C A and L2C L5 provides highly robust service. That means, if we take all of these signals together then that is a very good robust civilian use we can use L1 c has a lowest ionospheric error as I told you (Refer Time: 13:13) ionospheric error, so it provides as the best position. L2C has best cross correlation function performance. So, as a result of this L2C signal will be available even under a canopy or tree. And L5 signal has the highest power lies in ARNS- means Aeronautical Radio Navigation Service. So, L5 signal will be the best for our aircraft navigation purpose.

So, each of the signals has its own strength and we can make use of the signals as our purpose or as per our need. Now along with this carrier frequency we also get code. Now in case of GPS signal there are five types of codes which are useful for civilian use.

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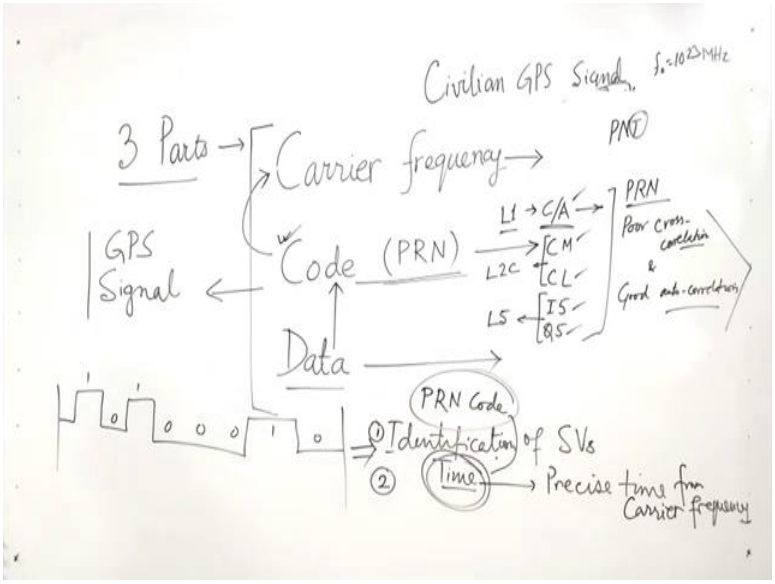

Now, the most important and fundamental code is C A code; that means, codes acquisition code which is the one, all GPS signal processing or GPS signal work has to be received or receiver. And C A code is available will be L1 signal, L1 frequency. Then C M and C L these are the two civilian codes; medium civilian one code. These two codes are available will be L2C frequency.

Now, you can see here that they codes are related to some particular frequency, all codes are not available to all frequency. And then I 5 and Q 5 are the two codes which are available with the frequency L5. And all these codes has there one particular way how it is being design, but one particular characteristics for all these codes are they are coming very poor cross correlation, and very good auto correlation. So, this is the characteristics which all these codes here that they will have a very good coordination and very poor cross coordination. And due to these characteristics actually these codes provides the identification of the satellite vehicles. And these codes are PRN; that means, (Refer Time: 16:55) code.

If we see each of this signal you will see that they are very random in nature. But if we see the whole sequence of the code, we will find that this randomness of the signals repeats after certain interval of time. So, because of these random of nature they are called pseudo random noise code, but this is also repeats after certain time so that repetition means making it unit to each satellite.

Now one of the functions as I told you of this code is to provide the identification of the satellites; identification of satellite vehicles. Another important function the code does is it provides the time. As I told you GPS provides position, navigation, and time or PNT time. So, the GPS time we get from the PRN code. So, the first approximate time we get from PRN code and later this time is précised; precised time we get from our carrier frequency.

Anyway, so the codes are having two primary functions: first one is that it provides the identification of the satellite vehicles for which the signal is coming to the receiver. Second function is that, it provides the approximate time; means first time it get. Now with this I am not going much in detail about all this, you can go through yourself. But the most important part of this whole of GPS signal is the data part.

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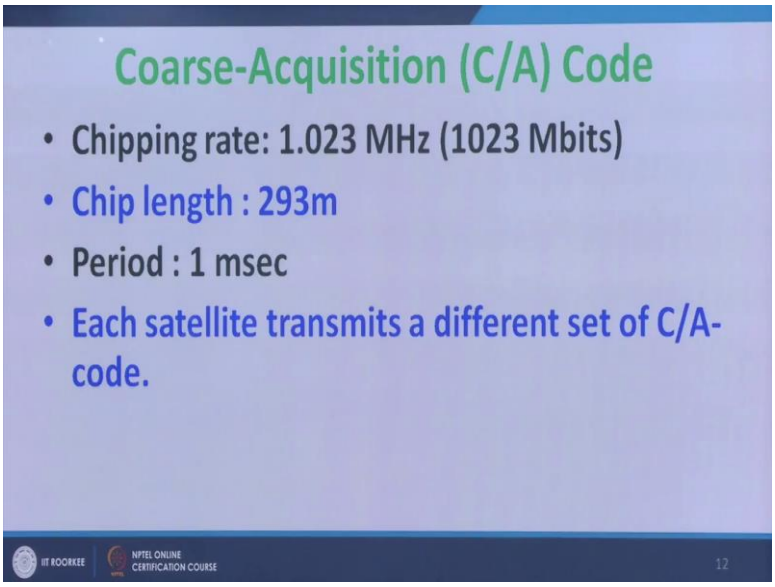

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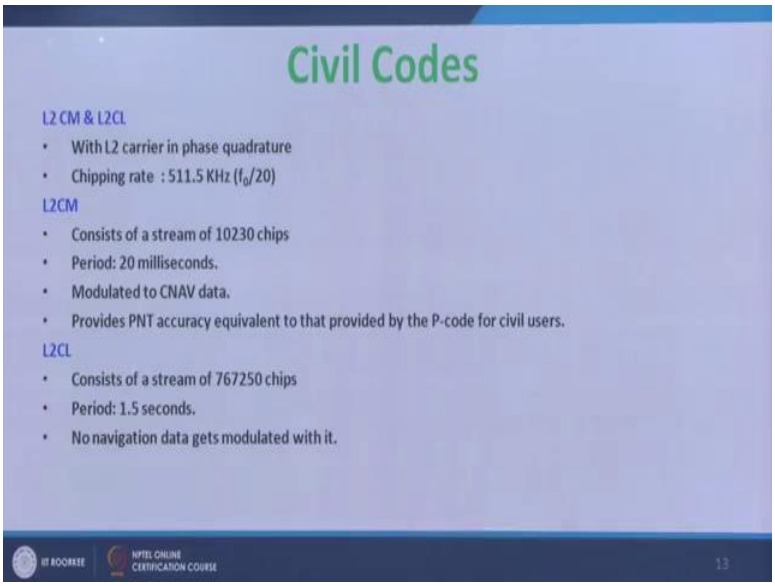

Now, as I told you that that data that is available with the GPS signal is modulated with the code and you can see that there are different types of code with respect to different types of carrier.

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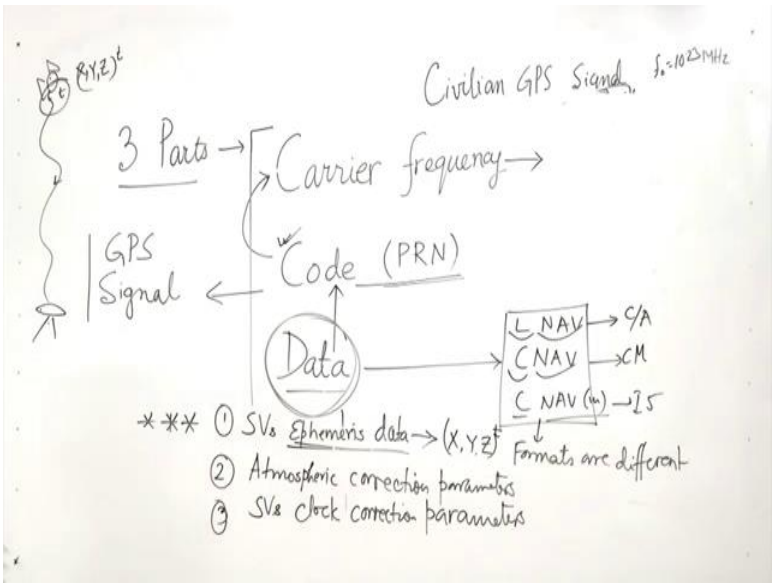

You will you have find the different types of code like C M C L and then I 5 Q 5. Now each of these codes will have the data which is fundamentally of same contents, but their formats are of different. So, you have to be cautious in making use of the GPS signals which will be having different types of codes that is different types of data. Actually

depending upon the type there are defined by like C NAV, L NAV, C NAV modified. These are the three formats of the data C, L NAV means legacy navigational data, civil navigational data; that means, this is the modified form of C NAV data. And this type of data is available with the C A, this is with the C M, and this is with the I 5.

Anyway, so now this (Refer Time: 21:30) represents some formats; formats are different. So, this is the thing we should remember that the data associated with the particular code will have some particular format, and when we will make use of the particular code we should be couscous about it deformative. However, these data fundamentally what really it contains that is the most important thing.

The most important thing about that they GPS signal contains data which are: basically it contains the satellite vehicles ephemeris data. This is the most important information which will be need to have from satellite signal. Now what does it represents? ephemeris data represents the some data which will provide us the location of the GPS satellite at an instant of time t. Suppose, at an instant of time the satellite vehicle have; at any time t if this signal is coming from the satellite vehicle and reaching at some other time at the receiver. Now at that time what was the location of the satellite? That we will be able to derive from the navigation data; from the data and which part of from the data and the part of the data which is known as ephemeris data they will provide some parameters, those parameters we can make use to find out the location of the satellite vehicle at an instant of time t. And that is the most is that information out of whole GPS signal.

Now, second thing which is important and available with the GPS signal is the atmospheric correction parameters then satellite vehicles clock correction parameters.

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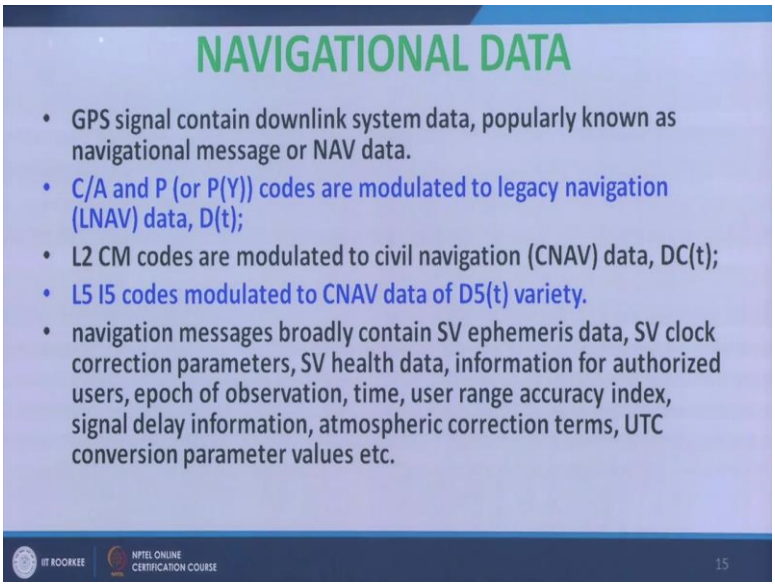

So, like that you can see that satellite health vehicle health data, information for authorized user. Of course, because as I told you the GPS signal contains the military signal. So, if someone want to use that military signal they must have some authorized code or authorized information and that they have to make use for using that signal and that has to be correlated with the something with the GPS signal. Epoch observation when the GPS signal has been arrived. I told you time, which we compute from the code part of the signal later from the first part of the signal. So, we can get time, then some other like user range accuracy index, this will provide the quality of the data, signal delay information atmospheric correction terms, time conversion parameters, etcetera.

So, there are so many other informations available with the GPS signal data part which we will really looking for. So, with this I will like to conclude about the GPS signal. In summary what we can say that GPS signal is the signal which we do receive or GPS user receive from GPS vehicles. And these signals are actually contents of a bundle of informations, those bundles of informations are divided into three parts: one is that carrier frequency, then code, and then data.

From the carrier frequency actually we could not only it provides the protection of the data to come from the satellite to receiver, but also (Refer Time: 27:03) we can decipher the carrier frequency phase from the phase of its transmission to phase of its reception, we can never the very precise time. So, another use of carrier frequency is to

measurement of precise time. And then another there are different types of frequencies are there for the civilians there are three types: L1, L2C and L5. And, apart from frequency there will be codes. There five types of codes for similar use: the C A code with the L1 frequency, then C M and C L codes with the L2C signal, and then I 5 and Q 5 codes with the L5 signals.

These codes are primarily provides the identification of the satellite from which it is coming, because with each satellite these codes are unique. And another function is that code provides us the time, which later we can make use with the carrier frequency to get the precise time. And the signal contains data. Data is again will be of different times depending upon the code for which it is being modulated. It may be L NAV data or C NAV data or C NAV modified depending upon the type of formats. But fundamentally they contain the prima some primary information, like the ephemeris of the GPS satellites, the clock correction parameters, the satellite vehicle health status and many other things like that.

So, after this I had given you some questions too, you can solve yourself; review questions. With this, and if you want to study more about this you can refer to this book.

Thank you very much.