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Agenda Item : **Ad hoc 17**
Source : **Samsung Electronics Co.**
Title : **The performance enhancement of IPDL using Burst Pilot for LCS**
Document for: **Discussion and approval**

1. Introduction

In the 3GPP TSG RAN WG1 meeting #9, simulation results on the Burst Pilot concept [1] were presented and discussed. After careful review of feedbacks generated by a number of companies, general concept of the Burst Pilot application has been revised and is presented in this document

The basic concept of Burst Pilot is as follows. When one Node B enters in an idle period, the surrounding node Bs pump up the transmitting power of the pilot channel in order that the UE of the idle node B can detect their pilot channel signals easily.

It is very important for the IPDL [2] and/or TA-IPDL [3], which are OTDOA methods for Location Services, that UE detects other node Bs' signals. Therefore, in the IPDL, each node B periodically turns-off the downlink transmission for a predetermined time in order for UEs to easily detect other node Bs' Common Pilot Channel (CPICH). TA-IPDL uses a way of time aligned idle period for the same purpose.

With the IPDL or TA-IPDL, the received energy of the UE from the neighbor node B's may be too weak to be detected. Even though the UE can detect the neighbor cell's signal, the UE needs a long estimation time to detect neighbor cell's pilot channel signal and/or a greater frequency of idle period [3].

Therefore, we proposed the combination of the Burst Pilot with the IPDL and/or TA-IPDL for more efficient LCS. In this document, we explain the concept and the applications of the Burst Pilot and performed its simulation results to show the benefits of the Burst Pilot to IPDL.

2. Channel structure of Burst Pilot

2.1 Structure A of Burst Pilot

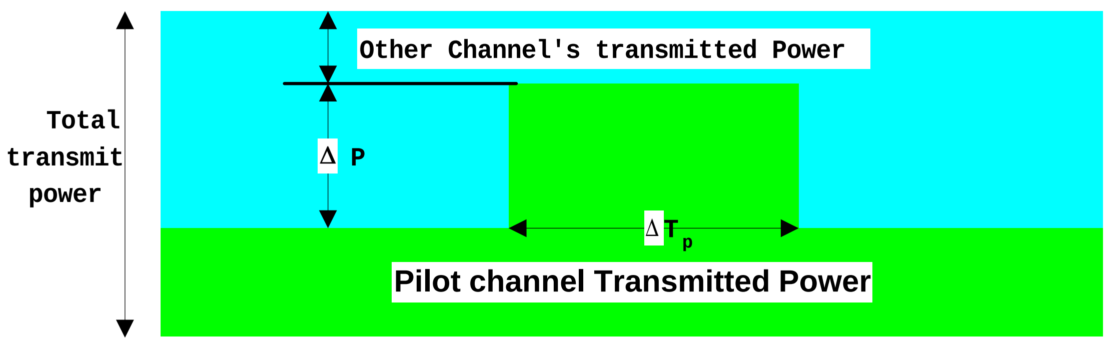


Figure 1. Channel structure A of Burst Pilot

Figure 1 shows the channel structure A of the Burst Pilot. UTRAN increases the CPICH channel power by ΔP (dB) for a predetermined time interval T_P, where ΔP and T_P can be system parameters. The UE knows the idle period T_P by higher layer signals and then searches the neighbor cell in that period.

2.2 Structure B of Burst Pilot

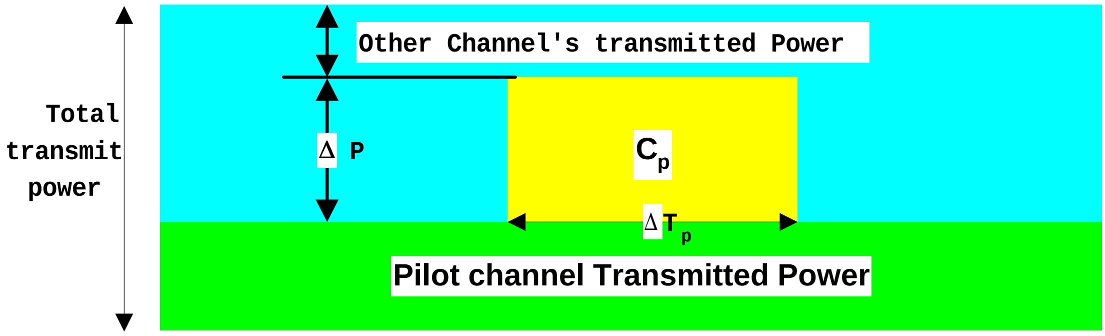


Figure 2. Channel structure B of Burst Pilot

Figure 2 shows the channel structure B of the Burst Pilot. The channelization code C_p of the structure B is different to that of CPICH. The spreading factor of C_P is 256.
The channel structure B of the Burst Pilot has two main advantages:

- When the unique channelization code (C_p) is used for LCS, the Burst Pilot has no impact on the UE receiver operations such as channel estimation, frequency estimation and searcher operation respectively.
- There is no problem originated from CPICH power variations, when UE is in the handover region.

3. Application of Burst Pilot for LCS

Considering the concept of the Burst Pilot, the Burst Pilot can be applied for both IPDL and TA-IPDL. In other words, if an idle period is occurred, the Burst Pilot can be used for that idle period. In the following subsection, we discuss the applications of the Burst Pilot with regards to the concepts presented above.

3.1 Burst Pilot applied for IPDL

The concept of IPDL was on generally proposed by Ericsson [5]. It is the basic principle of IPDL that UTRAN will turn-off downlink transmissions during the predetermined time for UEs to detect other node B's CPICH more easily. During the IPDL operations, the idle period is occurred pseudo-randomly [5,6]. The example of IPDL method has been shown figure 3.

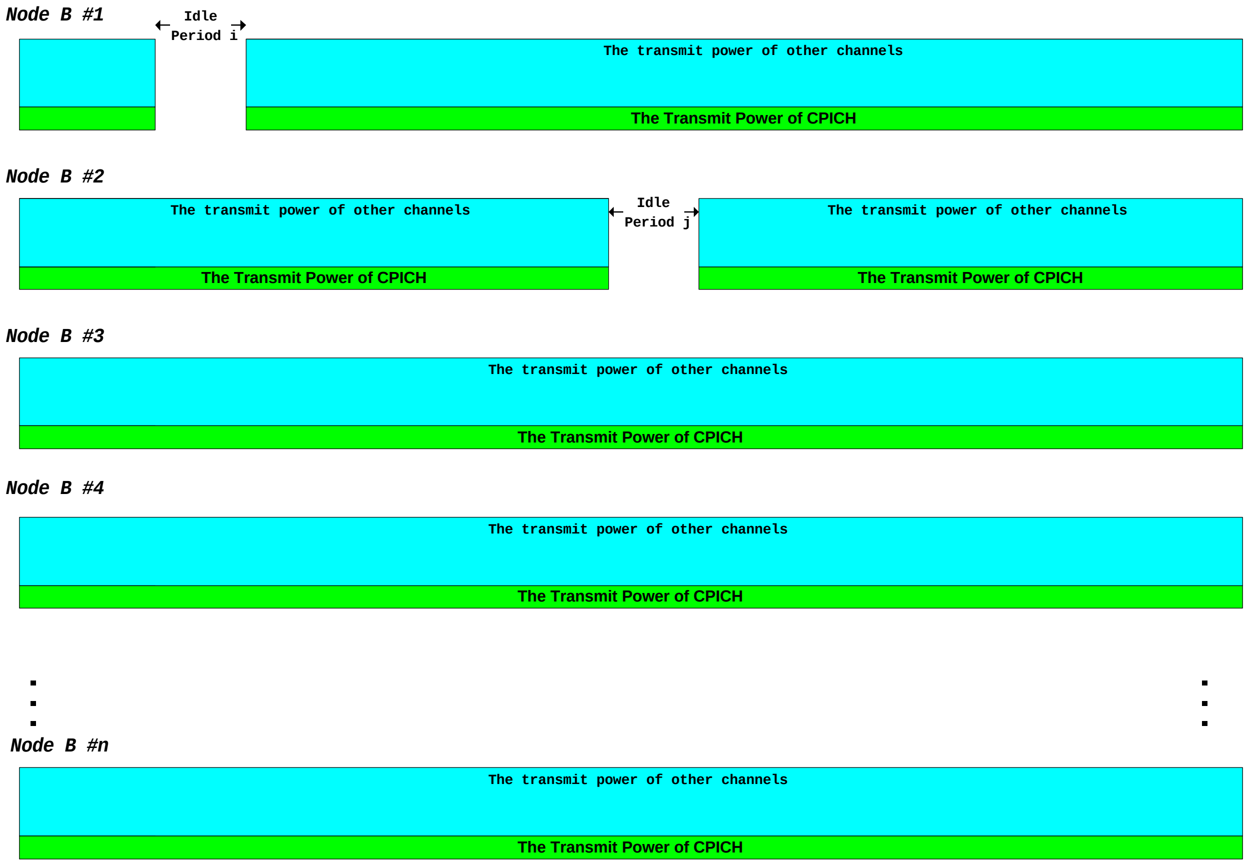


Figure 3. IPDL

In figure 3, when node B#1 entered in idle period i, The UEs in node B#1 could detect other node Bs (i.e. from node B#2 to node B#n, where n is an uncertain number and the number of neighbor node Bs) signal. In that time the other node Bs did not anything else but just transmit their CPICH and other downlink channels.

The example of IPDL with Burst Pilot has been shown figure 4. We can apply the concept of the Burst Pilot to the IPDL with simple procedures. As shown in figure 4. when node B#1 entered the idle period, the neighbor node Bs pumped up the Burst Pilot channel for the performance enhancement of LCS(Location Services). The n of figure 4 is an uncertain number and just the number of the neighbor node Bs. As shown in figure 4, the power up time does not have to be perfectly aligned.

In this case, the neighbor node Bs need node B#1's parameters used for generation of the idle periods[6].

Figure 4. IPDL with Burst Pilot

In the IPDL, UTRAN will adjust each node B's schedule in order to avoid the collisions of the idle period at the same time. So, in case of the IPDL with the Burst Pilot, UTRAN just send information regarding node B's schedule about idle period generations that UTRAN knew previously for each node B.

3.2 Burst Pilot applied for TA-IPDL

TA-IPDL was proposed by Motorola [3]. In TA-IPDL, it is proposed to time-align the idle periods from each node B rather than pesudo-randomly creating it. Referring to [3], time-alignment will not be prefect, as the difference in frame timing between node Bs can drift to any value. However, the periods can be aligned to be closest to some arbitrary time in TA-IPDL. The simple example of TA-IPDL has shown in Figure. 5.

The method of TA-IPDL in Figure5 is as follows. All of Node Bs will enter an idle period within some arbitrary time if idle period is occurred. Then, each node B transmits the CPICH signal with a probability of an arbitrary value in order that UE can easily detect node B's signal.

Burst pilot is easily applied for TA-IPDL because the idle period of each node B has already been time-aligned. the method of Burst pilot operation for the TA-IPDL is very similar to that for the IPDL. As shown in Figure 6,during the idle period, some of the node Bs power up the burst pilot channel and the others turn-off the downlink transmissions.

Figure 5. TA-IPDL

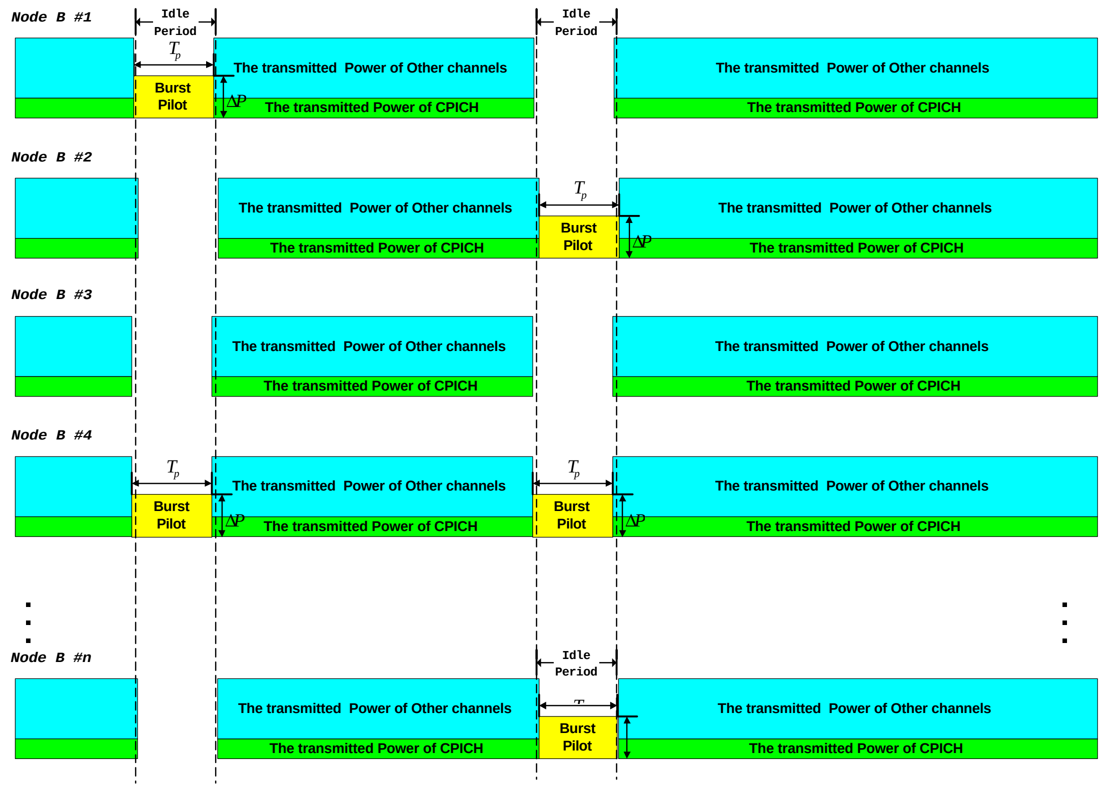


Figure 6. TA-IPDL with Burst Pilot

4. Network Simulator

Network simulator used includes the common network simulator general assumptions and methodology introduced in [3,5,7]. In the network configuration, the base stations are deployed as a hexagonal shape. Simulations are carried out for the area of a sector. For the simulation, 256 test points are selected at the regular spacing in a sector as shown in Figure 7.

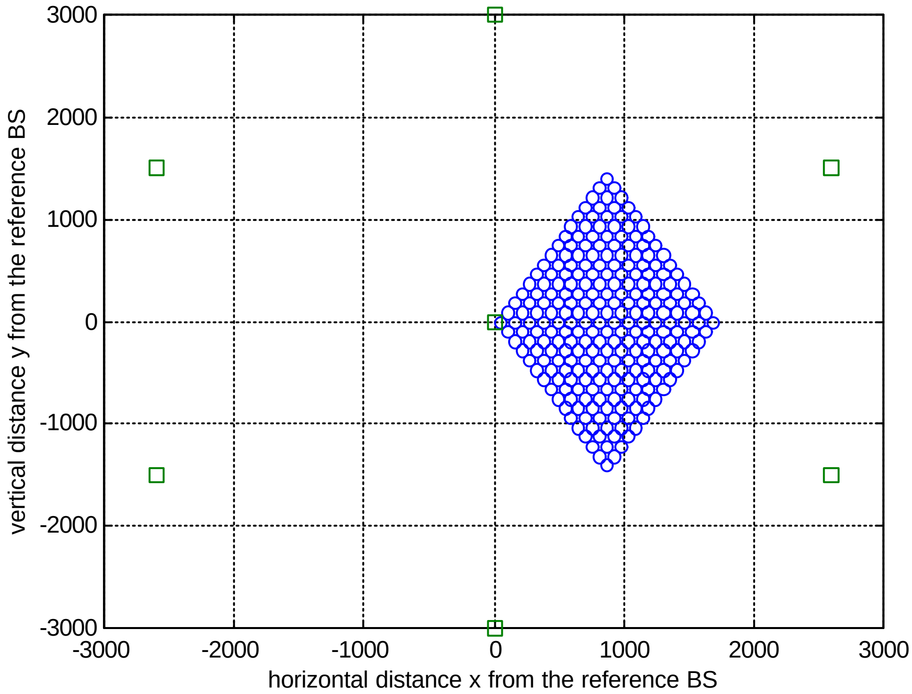


Figure 7.Base Station Deployment and Test Points for Simulation for the Suburban area

Simulation parameters are shown in Table 1. Since the ideal sectored antenna is assumed, the antenna gain equals the unity for the range of 120^o degree around the direction of main beam and zero for the other directions. Cable losses, the internal loss of LNA(Low Noise Amplifier) and body losses are ignored.

Attenuation due to shadowing is generated using a function following a log-normal distribution with zero mean and 8 dB standard deviation respectively. In a realistic operating scenario, shadowing coefficients for different users, and time slots are experiencing a certain degree of correlation. However, in this study un-correlated (independent) shadowing fading coefficients have been used for the aforementioned parameters (users, time slots, base stations). In addition, during the simulation, for all areas the shadowing fading has been assumed to remain constant during a slot.

Since the sampling rate is 4 times the chip rate, the resolution distance of the sampling time is 20 meters, or speed of light times the period of a sample T_s. The output of ADC (Analog to Digital Converter) after sampling is 4 bits. The noise floor is assumed to be –

118 dBm.

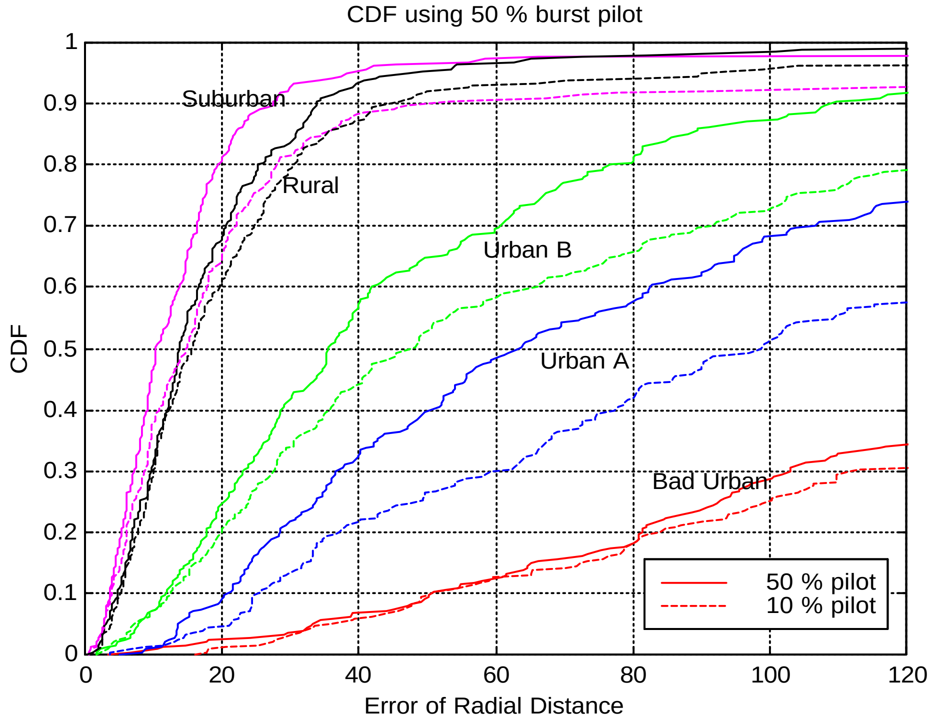
Table 1. Parameters for Common Simulation

Frequency of Idle Periods	10 Hz
Number of Idle Periods	10
Channel Model	T1P1.5 Models in reference [3]
BTS separation: Urban, Suburban, Rural	1 km, 3 km, 20 km
Pathloss Model	$b + a$ x 10 x log_{10}(range in meters)
Urban:	a = 3.52; b = 29.03
Suburban:	a = 3.48; b = 22.2
Rural:	a = 3.41; b = 0.34
Signal Used in Simulation	Common Pilot
Chip Rate	3.84 Mchips/sec
Sampling Rate	4 x Chip Rate
Integration Time	512 chips
Idle Period Length	5 x 256 chips
Sampling resolution	4 bits/sample
Vehicle Speed	50 km/hour
Transmit Power of BS	43 dBm (20W)
Transmit Power of Common Pilot	33 dBm (2W)
Noise Floor	-118 dBm
Standard Deviation of Slow Fading	8 dB
The number of Sectors in a Cell	3

5. Simulation Results

Since the proposed Burst Pilot can be used for Ericsson's IPDL and Motorola's TA-IPDL, both of those schemes have been studied. It should be pointed out that the aim of this document is not to compare the performance of the two methods (IPDL & TA-IPDL), nor to favor any, but rather to show the advantages when the Burst Pilot is applied. The performance results shown in this document might differ from the ones presented in the aforementioned companies' proposals due to different simulation parameters used such as the OTDOA algorithm, LPF(Low Pass Filter), searcher performance etc.
The advantages of the Burst Pilot are the accuracy of estimated positions and the reduction of the number of idle period for the desired accuracy. Simulations are carried out following two approaches. In the first the improved performance of the positioning with the Burst Pilot is evaluated, while in the second the impact of the number of slots using the Burst Pilot on the positioning accuracy is assessed.
As shown in Figure 8, position estimation using 50 % pilot power of the total power is more accurate than using 10 % pilot power for IPDL. Especially for the areas of Urban A and Urban B, more than 10 % performance improvement in terms of the probability that the radial distance error is within 120 meters is obtained by using the Burst Pilot for IPDL. Positioning performance for all areas including Bad Urban, Urban A, Urban B, Suburban and Rural is shown in Figure 9. The overall performance is obtained in a way

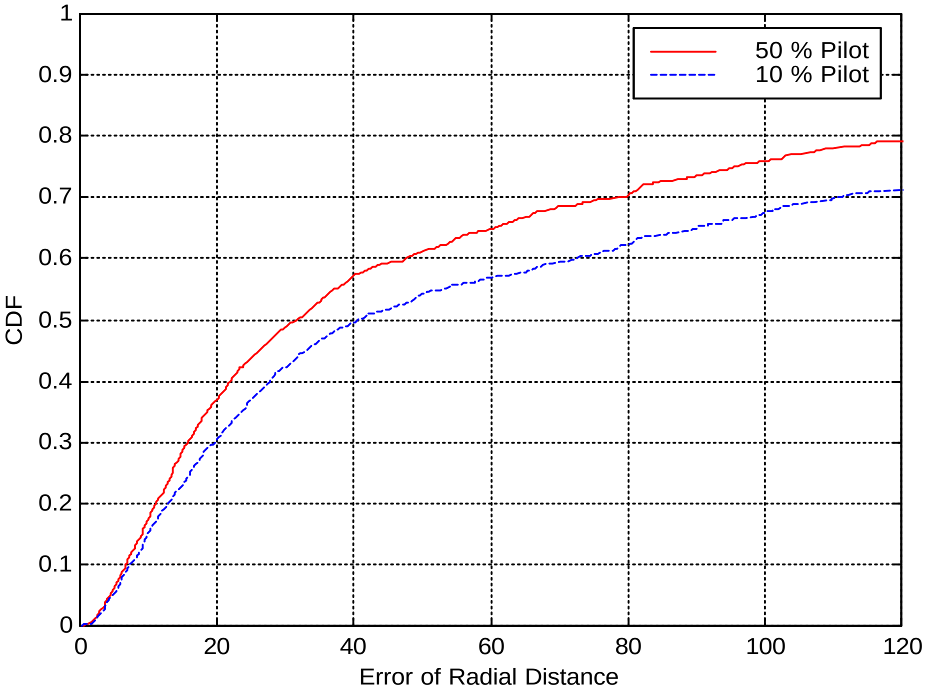
that CDF is calculated with all 5*256 simulation data. Accuracy of position estimation is improved by almost 9 % using 50 % pilot instead of 10 % pilot of the total transmitted power at the base station for IPDL. Table 2 illustrates that for IPDL method the radial distance errors are reduced by using the 50 % pilot power for all channel environments.



(a)IPDL

(b) TA-IPDL(Not yet)

Figure 8. Comparison of CDF for 10 % and 50 % pilot power for each channel models



(a) IPDL

(b) TA_IPDL(Not yet)

Figure 9. Comparison of CDF for 10 % and 50 % pilot power for overall area

Table 2. 67 % and 95 % radial distance errors

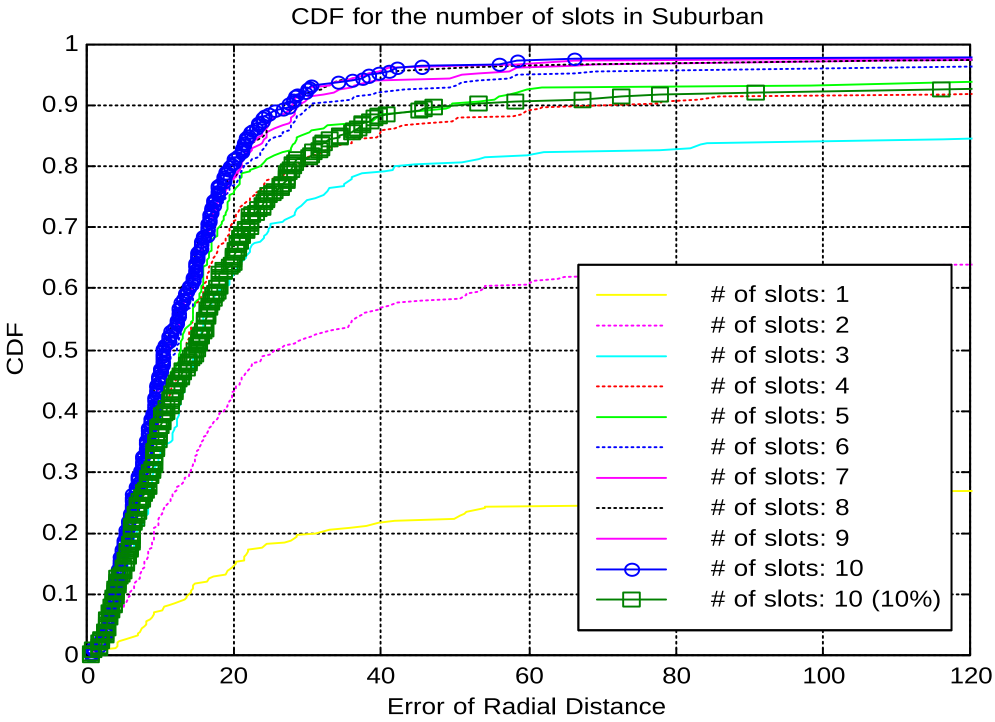
(a) IPDL method

	67 %		95 % Pilot	
	10%	50%	10%	50%
Rural (10 km)	23 meters	19 meters	90 meters	47 meters
Suburban	21 meters	16 meters	311 meters	38 meters
Urban A	148 meters	98 meters	449meters	325 meters
Urban B	81 meters	55 meters	317meters	170 meters
Bad Urban	274 meters	262 meters	717meters	688 meters
All	99 meters	66 meters	483meters	381 meters

(b) TA-IPDL(Not yet)

Both IPDL and TA-IPDL 10 time slots are being used to estimate the position. It is well known that the sophisticated positioning algorithm reduces the number of time slots to

estimate positions. If the Burst Pilot is used, the number of time slots can be reduced. Figure 10 shows that only 4~6 idle slots with 50 % pilot power are enough to satisfy the positioning accuracy requirement using 10 % pilot power because the increased pilot power is easier to detect than the normal 10 % pilot power. For example, the positioning performance of 10 % pilot using 10 idle slots is better than the case of using 4 idle slots but is worse than that of using 5 idle slots with 50 % pilot power for Urban A as illustrated in Figure 10.
So far, we have shown the advantages of Burst Pilot. For IPDL, 9 % performance improvement is obtained by adopting 50 % Burst Pilot instead of 10 % normal pilot and the number of time slots is reduced to half of that is required to estimate position using 10 % pilot.



(a)IPDL

(b) TA-IPDL(Not yet)

Figure 10. Effect of the number of idle slots on the positioning accuracy

6. Conclusion

In this paper, we explained the general concept and the application of the Burst Pilot for LCS operation. Furthermore, we showed simulation results of both the IPDL and the TA-IPDL with the Burst Pilot. Looking at the concept and simulation results of the burst pilot, the benefits of the burst pilot to IPDL and TA-IPDL can be seen. In other words, if the burst pilot is used for IPDL and TA-IPDL, the accuracy of the positioning scheme can be improved and the required frequency of idle period can be reduced.

Note : Simulation results on TA-IPDL will be added soon.

References.

[1] TSGR1#9(99)j67, Simulation results of Burst Pilot for LCS, Samsung Electronics Co.
[2] Tdoc SMG2 UMTS-L1 327/98, Method for downlink positioning (IP-DL), Ericsson.
[3] TSGR1#7(99)b79, Time-Aligned IP-DL positioning technique, Motorola.
[4] TSGR1#7(99)c36, Pilot signal coverage for Location Services (LCS), Nortel Networks.
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[6] TSGR1#9(99)k71, Text proposal for IPDL, Nokia.
[7] T1P1.5/98-110r1, Evaluation of Positioning Measurement System, Ericsson.

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