TSG-RAN Working Group 1 meeting #7
Hannover, Germany
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TSGR1#7(99)b88

Agenda item:

Source: Ericsson

Title: Answer to questions from Fujitsu on IPDL

Document for: Discussion

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1 Introduction

This document answers questions raised by Fujitsu on the Idle-Period Down-Link (IPDL) positioning method. The original Fujitsu contribution to the 3GPP RAN WG1 reflector is attached in section 3.

2 Answers to the questions

1. What is meant by “detected sites”?

In the case of sectored sites, a detected site means that one or more sectors have been detected. This can include more than one sector for one base station. Note that the IPDL detection is not the same as detecting the CPICH for channel estimation, or being able to decode the Primary CCPCH. By "detected" cell we mean that the positioning algorithm has detected at least one peak in the channel impulse response of that cell, and can use that to calculate the time of arrival. After correlating and summing, threshold detection is used to determine whether a candidate peak is “detected”. Please also note that the system simulations are the same as the ones used for the ITU simulations.

2. What transmit power have been used for CPICH (or PCCPCH) in your simulation to define cells of 1.5 and 4.5 km radius?

33 dBm. Note however that the simulations that we are discussing used the old channel set (based on PCCPCH pilot symbols).

3. Assuming a maximum power of 30 dBm for a DTCH, what is the relative transmit power of CPICH (or PCCPCH) in your simulations?

The relative power is 4%.

4. What are detection probabilities (Figure 8) in large cells or rural environments?

We have not performed any simulations for larger cells. The simulation setup and how it should be carried out could be discussed in AH17, perhaps on the basis that Luis Lopes suggests. The reason why we did not perform simulations for large cells is that the most critical case is the urban environment due to strong multipath signals. In rural areas with high mountains this could also lead to reduced accuracy.

5. Performance of IPDL in large cells or rural environments?

Not studied yet.

6. The time required for positioning in large cells and rural environments?

The time is directly proportional to the timing uncertainty, number of BSs, the number of idle periods used, the idling frequency etc. and the computational capability of the terminal. The question is impossible to answer without making many assumptions. With an uncertainty of 64 chips (~4.8 km), and the exemplary terminal in the paper the positioning would take about 1.5 sec if 15 idle periods are used. If, e.g., the cells are increased so that the uncertainty is about 20 km, the time could be up to four times of that. With a good implementation the time can however be reduced significantly.

7. When do you expect the positioning time of "less than a second", and when do you expect the "many seconds"?

This depends on the parameters described in question 6. With the exemplary parameters given, we could achieve positioning times of less than a second for cells with lower radius than approximately 5 km. Positioning times of less than a second can be achieved also for larger cells by altering the parameters (with a cost in performance of course).

8. For Speech services in urban and rural areas what type of positioning time do you expect?

We expect 0.5-1.5 sec in urban, depending on the service requirement. The higher the accuracy the longer the response time. . In rural we expect maybe 0.5-5 sec. for a simple terminal.

9. With positioning times of "many seconds", what is the maximum tolerable mobile speed (or minimum channel coherence time)?

Please note in your calculation of "blank" probability that it does not matter that much if one or a few blanks occur during the 15 IPs. Compare e.g. figure 4. Say for instance that you will have one blank out of 15. Then you still have 14 useful IPs, and in fact when another BS blanks, the signal to interference ratio of the other BSs will be improved. This means that for the weakest BSs it can actually help if blanking occurs. As a remark your probability calculations are in error. You cannot calculate probabilities by multiplying with a fixed number. Some additional probabilities:

Probability of 1 blank $P_1 = 0.0911$

Probability of 2 blanks $P_2 = 0.0043$

Probability of 3 blanks $P_3 = 0.0001$

As one can see it is a very small probability that more than one or two blanks will occur.

This is not really related to your specific question but rather to the general issue you raise. To answer your question, it does not matter if the positioning takes many or few seconds. The reason is that one search interval is used for a certain number of IPs and if nothing is found in that interval the result is discarded and another search interval is used. There is no need for coherence between different search intervals. Of course the accuracy of the position might be inaccurate, but this is always true if you have an old position estimate of a fast moving vehicle.

10. Remembering that the 67%@125 meters specified accuracy is already very relaxed. All the indications are that these specifications would be tightened up in the near future. If a given technique already has problems with 70km/h (44 mile/h) mobiles, what are the chances that it would meet the tighter future standards?

The 67%@125 m requirement was decided to be a reasonable accuracy requirement in SWG2/SG9 (and ST4). Note however that IPDL has a much higher accuracy in most cases. A significantly better positioning performance is very difficult to obtain. In urban environments it is difficult to reach 50m even with DGPS. All positioning methods are limited by multipath propagation.

<u>Further questions:</u>

11. How is idle slotting carried out with mobiles in two and three way soft handoff?

There is no difference. No impact because the mobile knows already the distance to 2-3 base stations in this case. As it is near the cell border there is no hearability problem.

3 Questions distributed on August 11 on RAN WG1 reflector

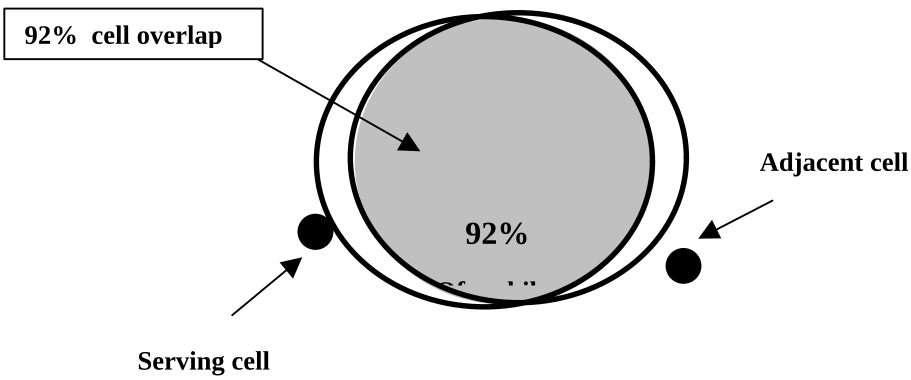
<u>Fujitsu questions on IPDL</u>

Mat,

Thank you very much for the answers you provided. However, I feel some of my questions did not address the issue very well, so I will reiterate them here with more discussion. Also, some of the answers that you provided were not quite clear and requires further elaboration. In any case, please find several further questions from Fujitsu.

Regards.

In the conventional cellular networks, where “frequency reuse” can be used for cell orthogonality, adjacent cell transmit power is not an issue. In such cells a “broadcast” or “pilot” channel can be transmitted at maximum allowed power, without any performance degradation in the neighbouring cells (provided the reuse is planned to meet the required CIR). However, in a CDMA network with a “one-cell reuse”, to maximise system capacity, the forward common control channels (PCCPCH and CPICH) have to be transmitted such that they do not interfere excessively with the adjacent neighbouring cells, reducing the network capacity unnecessarily (this is specially critical on the downlink, which has a lower capacity compared to the uplink of the network). Therefore, in CDMA networks, it is desirable to “hear” a single “pilot” channel (the serving cell), until a mobile is near a soft handoff region. This is usually achieved by antenna tilt and antenna height adjustments. Static power control of the BS transmit power can also be used to control cell footprint, however, this has the disadvantage of reducing the indoor penetration and hence coverage. Looking at figure 8, the probabilities of detection of other cells seem very similar to conventional systems with “frequency reuse”. <u>Therefore it is still not clear whether there is excessive “Pilot Pollution” in your simulations or not?</u> If you look at the cell geometry, you will see the implication of **“92% of mobiles can detect 2 sites or more”** cell overlap, and hence see my concern. I have tried to show a 92% cell overlap in the figure below;



So as you can see the cells are virtually on top of each other. In such scenario, detection of far away sites is more probable, facilitating forward positioning with the required accuracy. However, this detection capability is at the expense of system capacity. Reducing the cell overlap will reduce the ability to detect distant sites, leading to;

- Increase repetition of "Idle" slots, reducing system performance further.
- Increased duration of "Idle" slots, reducing system performance further.
- Better UE receiver performance and more UE processing, leading to higher terminal cost and shorter battery life.
- And at worst, inability to meet the required accuracy.

Therefore, I am interested to know

1- **What is meant by "detected Sites"?**

2- **What transmit power have been used for CPICH (or PCCPCH) in your simulation to define cells of 1.5 and 4.5 km radius?**

3- **Assuming a maximum power of 30 dBm for a DTCH, what is the relative transmit power of CPICH (or PCCPCH) in your simulations?**

The simulation results provided are for urban and suburban environments where the network is mostly interference limited. Therefore it is not clear what IPDL performance would be in large cells or cells in rural areas, where a network may be mostly noise limited. Therefore it is interesting to know;

4- **What are detection probabilities (Figure 8) in large cells or rural environments?**

5- **Performance of IPDL in large cells or rural environments?**

6- **The time required for positioning in large cells and rural environments?**

In the previous answers that you provided, you mentioned that the positioning time can be as little as "slightly less than a second", or as long as "many seconds". This begs the questions;

7- **When do you expect the positioning time of "less than a second", and when do you expect the "many seconds"?**

8- **For Speech services in urban and rural areas what type of positioning time do you expect?**

I am still <u>very</u> confused about the maximum mobile speed (or more appropriately the maximum coherent time of the channel), in which IPDL can operate with an acceptable performance. In Tdoc: TSGR1#4(99)346 you have mentioned that with a <u>one second positioning time the maximum mobile speed that can be accommodated is 140 km/h</u>. However, the maximum "1 second" positioning time seems to be unrealistic for the following reasons. For example, in a suburban areas, where 15 time slots are used for positioning (figure5), with a ideal period of 10 Hz, you will need at least 1.5 seconds to gather sufficient data for correlation purposes. However, since other cells are also transmitting idle slots, there are "blank" slots where no data is detected from other cells. The probability of accuracy of a "blank" slots can be calculated as follows;

In average the Idle repetition rate = 10 Hz	T_{IDLE} = 100 msec
Frame length = 10 msec	
The probability of a "blank" in every 10 frames (150 time slots)	$p = 1/150$
Probability of **NO** "blanks" in 1.5 sec (15 idle slots)	$p_n = (1-p)^{15} = 0.9045$
Probability of "blanks" in 15 idle slots with one other BS	$P_b = (1-P_n) = 0.0954$

Probability of “blanks” with **5** other BS $P_{Total} = P_b \times 5 = 0.477$

So there is a ***47.7%*** chance of a “**blank**” slot is encountered in a positioning process. Therefore considering the high chance of “blanks”, to collect 15 segments of neighbouring BS CPICH more than 1.5 sec is required. If we assume a 2 second positioning time, this leads to a maximum mobile speed of 70 km/h. Since the accuracy is in terms of “one-chip offset”, the mobile can be assumed stationary, while the offset can still be caused by the movement of other scatterers in the channel. Therefore the system can only cope with a channel coherence time of 3.8 msec, or above (0.38 x frame length). Therefore the question is;

9- With positioning times of “many seconds”, what is the maximum tolerable mobile speed (or minimum channel coherence time)?

10- **Remembering that the 67%@125 meters specified accuracy is already very relaxed. All the indications are that these specifications would be tightened up in the near future. If a given technique already has problems with 70km/h (44 mile/h) mobiles, what are the chances that it would meet the tighter future standards?**

<u>Further questions:</u>

11- **How is idle slotting carried out with mobiles in two and three way soft handoff?**