Agenda item:	**AdHoc #24 HSDPA**
Source:	**Motorola**
Title:	**Comments on Lucent's Proposal on HSDPA**
Document for:	**Discussion**

1. Explicit Rate Information from the UE

The proposal supports explicit feedback of rate from the UE to the NODE B. The UE computes the supportable rate based on path loss, finger information of active legs and information about power fraction and channelization code space which is sent over a new broadcast channel. This approach has the following disadavantages:

?? A low cost terminal controls an expensive set of Node Bs. Although, the Node B may not schedule a user if it is unable to provide the data rate demanded by the user, this philosophy of assigning rates to the HS-DSCH by the UE is unlikely to be popular with the operators since they do not want to relinquish the control of their infrastructure to a low cost UE.

?? The UE has to continously monitor all the broadcast channels transmitted from multiple cells. This will require additional despreading resources at the UE.

?? Assigning an additional common control channel, will increase the overhead at the Node B. Further, in multi-coverage regions where the geometry is quite low, the amount of power required for reliable reception of the common broadcast channel will be prohibitive.

?? A simpler alternative for picking the best Node B is to measure the pilot Ec/Io at the UE and use absolute pilot strength information. This information allows the UE to correctly choose the Node B with the best transmission gain. As currently defined in 25.331, the UE would get the pilot strength of each entry in the monitored set via the measurement command message (MCM). The Node B physical resource limited case can be handled by managing the UEs active set. Typically, this management would only need to be done for stationary users.

In the original HSDPA proposal, the C/I information can also be computed based on the power control gain information of the downlink dedicated channel. In fact both the C/I information transmitted by the UE and the power control gain information can be used jointly to assign the data rate to a user.

2. Preamble Based User Identification on the HS-DSCH

In the proposal a user-specific preamble is time multiplexed prior to user-data transmission on the downlink shared channel (HS-DSCH). It is claimed that this method is a more efficient approach to identifying a user as compared to methods that use dedicated channels for notification. It may be noted since the HS-DSCH operates at a reasonably high FER (because of fast repeats and H-ARQ), the preamble needs to be heavily coded so that its is received at the UE with an FER of 0.1% or less.

It also claimed that, since the preamble uses codes from the same set as that used for HS-DSCH data transmission, this approach is more efficient in terms of downlink channelization code usage. However, in [4] a new downlink dedicated channel (DACCH) is proposed to carry uplink power control information and pilot bits. This seems to be inconsistent. The preamble can easily be eliminated by replacing some of the pilot bits in the DACCH. Finally, for higher order modulation (16 QAM or higher) the pilot to data ratio needs to be explicitly communicated to the UE for proper demodulation of the HS-DSCH channel which couldn't be done with the Lucent's approach.

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Read Brdcst
Measure,     Transmit     Schedule        Preamble     Frame
MCS sel.     Rate Info    Decision        Transmit     Transmit        ✍ Lucent Approach
|------------|------------|---------------|------------|---------------|


Measure      Transmit     Sched Decsion   Frame
             C/I          MCS selection   Transmit
                          (C/I & PC)                          ✍ Current HSDPA Approach
|------------|------------|---------------|------------|---------------|
UE ✍                      Node B ✍
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The current MCS selection approach performed at the Node B eliminates the delay associated with transmitting the preamble since the indicator sent on the dedicated channel only needs to be sent at the same time as the actual DSCH frame tranmission and not before. Making the rate decision at the UE is inflexible and excludes detailed network information and requirements as well as enforcing increased latency compared to using power control information resident at the Node B.

3. FCS

It was pointed out in [3] that selecting the best cell based purely on signal strength measurement when the UE is unaware of the loading in the surrounding cells can result in selecting a cell that is heavily loaded. By defining a downlink broadcast channel that transmits both the available Node-B transmitter power fraction and its channelization code space, the UE can read the available resources on all active legs. This allows for a better selection of the best cell by the UE.

However, the above scenario could be avoided in the existing proposal by removing the cell which is heavily loaded from the eligible set (subset of the active set). The cell which is heavily loaded can send an indication using L2/L3 messaging that it does not want to be selected. It is conjectured that the cell loading does not change quickly and as such L2/L3 signalling can be used.

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4. Adaptive Asychonous Incremental Redundancy

In the Lucent's Adaptive Asychronous Incremental Redundancy (AAIR) proposal, HS-DSCH slot duration is variable with the lowest granularity being one slot or 0.667 msec. The implementation of a variable sized block adds significant complexity to the mobile unit. Furthermore, the benefits claimed over the Dual-Channel Stop-and-Wait (DC-SW) (refered to as synchronous IR) are unsubstantiated and based on a incomplete understanding of the flexibility available within Dual-Channel Stop-and-Wait scheme.

Some clarifications on HSDPA's DC-SW:

- ?? Although, the DC-SW does allow for a UE's retransmissions to occur vary rapidly (i.e. after one frame delay) they are not required to be retransmitted immediately and may be delayed in favor of other UEs. In fact, DC-SW only requires the acknowledgement to be transmitted by the UE to enable the rapid retransmission. The scheduler has the flexibility to defer retransmissions and scheduled other users in the interim. Therefore, the DC-SW scheme can take advantage of multi-user scheduling and provides a great deal of flexibility. This flexibility has been incorporated in Motorola's detailed system simulation and is represented in the results reported.
- ?? HS-DSCH has proposed the study of 0.67, 3.33, and 10 ms frame sizes. The shortest frame size has both advantages and disadvantages. Having a slot duration of 0.67 msec may be advantageous when simultaneous voice and data is to be supported since one doesn't have to include the margin due to voice users. However, the short frame increases the overhead by requiring the addressing of each individual every 0.67 msec. The signalling overhead should be 5 times higher when a 0.67 ms frame is used instead of a 3.33 ms frame. This increase is especially problematic since the header reliability is critical. Errors in the header will degrade from HS-DSCH throughput. In other words, a 10% header error rate translates directly into a 10% reduction in HS-DSCH throughput. The shortcomings of a short frame size were not given adequate attention in the Lucent proposal.

Some issues with Lucent's AAIR:

- ?? The mix of large and small frames can increase the latency of delay sensitive services. Consider an example where an unconstrained delay transfer is transmitted in a 15-slot frame while delay sensitive data is transmitted in a 5-slot frame. If both packets took two retries to get across the channel the latency for the delay sensitive data would be increased from 16 ms using a DC-SW approach to 30 ms using the AAIR approach. This represents a 100% increase in the latency.
- ?? The benefit of delayed acknowledgements is unjustified. UE's which can not respond in the allotted acknowledgment window will reduce the efficiency of the HS-DSCH. Data traffic is self-similar and there will be short periods where only one UE has data queued. A UE that transmits a deferred acknowledgement will not be able to fully utilize the channel resulting in idle periods on the HS-DSCH. Therefore, system capacity will go wasted lowering the overall

service throughput of the cell. Furthermore, the idle periods on the HS-DSCH represent a missed opportunity to complete the data transfer and may backlog newly arriving data PDUs causing additional latency for the next UE. Lastly, the idle periods may coincide with constructive fades and reduce the scheduler's ability to take advantage of good channel conditions.

Some more comments on the proposed asynchronous scheme are summarized below:

1. The IR operation in stop-and-wait mode to minimize the block addressing overhead i.e., no need for sequence numbers. Dual Channel Stop-and-Wait (DC-SW) does not transmit sequence numbers either. Therefore, there is no advantage with AAIR.

2. The operation in stop-and-wait mode also minimizes the memory requirements in the UE i.e., only one block will be outstanding at a given time per stop-and-wait instance that the UE need to store. The memory requirements will likely be larger in AAIR than DC-SW using the same atomic size. The memory requirement will be defined by the largest packet not the smallest. Again, there is no advantage with AAIR over DC-SW.

3. The scheme works asynchronously i.e. no synchronized timing relationship is needed between different transmissions (re-transmissions) from the same user. The transmitter waits for a minimum of round-trip time called Tack (see Figure 2 of [2]) between different transmissions (retransmissions) to the same user. However, unlike the synchronous scheme, the maximum time between two transmissions to the same user is not fixed. The sender can always schedule other users' transmissions for any number of slot before more information/redundancy is sent to the same user. This allows one to fully exploit the multi-user diversity gains [6]. This also true for DC-SW. Transmissions from multiple users may be interleaved together. However, long packets will not delay the transmission from short packet users.

4. A NEW/CONTINUE flag is used to indicate whether a transmitted sub-block is the beginning of a new code block or the continuation (redundant information) for a previous code sub-block. This helps the receiver to determine code block boundaries in case an ACK/NACK is misinterpreted. This feature has weakness and increases the complexity of the system.

5. The NEW code block indication also helps the receiver IR engine get in synchronization with the transmitter if a NEW/CONTINUE flag error occurs. Under error conditions, a receiver may miss a transmission or detect a NEW/CONTINUE flag in error. In either case, the receiver will try to decode the code block by combining wrong (or out-of-order) encoded sub-blocks thus making it difficult or impossible to recover the correct code block. Recovery occurs on the receipt of the next NEW code block indication, when the receiver will discard any previously stored coded sub-blocks and will start to decode the new coded sub-block. A missed NEW code block will cause the UE to combine both the previous aborted packet and the continued frames.

References:

[1] Lucent, R1-00-1381 "Downlink and Uplink Channel Structures for HSDPA"
[2] Lucent, R1-00-1382 "Asynchronous and Adaptive Incremental Redundancy (A2IR) Proposal for HSDPA
[3] Lucent, R1-00-1383 "Downlink Transport Channel Multiplexing Structure for HSDPA"
[4] Lucent, R1-00-1384 "Text Proposal for the HSDPA Technical Report"