TSG RAN WG1#4 **TSGR1#4(99)369**
Yokohama Japan
April 19-20, 1999

Agenda item: **Packet Mode Operation**
Source: **Golden Bridge Technology**
Title: **Comparison of CPCH, USCH, DPAC and some concerns on USCH**
Document for: **Discussion**

Abstract:

This contribution addresses the issue of harmonization between T1, Motorola's USCH, Alcatel's DPAC, ARIB's 'stop and resumption control' proposals by considering the similarities and differences between the four. The main emphasis is on CPCH and USCH. The top level analysis in this contribution proposes that CPCH and DPAC should be converged at the MAC layer and the CPCH scheme is considered as a RACH extension at the physical layer, while the USCH concept should be harmonized with the 'stop and resumption control' from ARIB. The USCH concept, CPCH scheme and DPAC all propose a MAC packet scheduling scheme whereas the 'stop and resumption control' relies on RRC scheduling which is slower.

Re-RACHing has been the main drawback associated with any kind of fast circuit assignment method for packet communications. There is a high level of overhead associated with this method as far as signaling on the RACH [which occurs per potentially short 'lease' at high loading condition], Common Control signaling, higher level of signaling in the backbone due to centralized assignment and re-assignment. The Re-RACH probability is quite high at high loading condition when several users are sharing the channel and are in the queue.

Introduction

The table in the next page captures the similarities and differences between the CPCH scheme and USCH concept. The CPCH/DCCH scheme is explained in detail in a separate contribution. In this contribution, we focus on USCH and raise some concerns regarding its operation.

Comparison Table for T1P1 and Motorola's proposals

	UL-CPCH	USCH
Access Method	Digital Sense Multiple Access Contention-based reservation Contention- free transmission	L2 Reservation based · No changes to RACH · Resource Request on RACH · Short packets may be transmitted on RACH
BS Resource Sharing (WG2 issue)	Random Sharing of Common Pool of Resources (UTRAN transmits the capacity availability)	UTRAN scheduled Sharing of the Uplink Power Resource
Preamble Structure	Identical to RACH	· 10 ms DPCCH used for resuming DCH · similar to S1.14 section 7, transmission resumption
Packet Length	Nx10 ms (N set by UTRAN on a Common Control Channel)	· 'Short lease' = DCH assigned for 10 ms · Multiple assignment may be concatenated by L23 for longer transmissions
Power Control	Closed Loop Power Control on the message part	Closed Loop Power Control
Downlink Control Channel	Dedicated Control Channel	Common Control Channel or (dedicated option still possible)
L1 ACK/NAK on Preamble	Supported	Not Applicable
Layer 1 CD	Supported	Not Applicable
Time alignment of transmission (see concerns below)	Based on RACH slots	Ues share a common time reference in a cell
Handover	HHO	HHO (Optional SHO of DCH is being investigated)
Uplink Channel Structure	Same coding Same DPDCH Same DPDCH L1 CD is placed in-band	No changes proposed
Channel Assignment	Immediate via L1 ACK/NAK (Assignment for N frames as broadcast by UTRAN)	Assigned by UTRAN based on requests from all Ues
Message Resource scheduling (WG#2 issue)	UE-Node B based de-centralized	CRNC based Centralized

An Overview of Synergies Between Various Methods

Our basic view of the USCH concept is that it resembles the use of DCH with the addition of 'stop and resumption control' method proposed by ARIB. The difference between USCH and 'resumption control'
is that in USCH there is no stop control and also, the preamble length is set to be 1 frame. Motorola has not shown that this will work properly and the simulation results in Stockholm 2 weeks ago (WG1 Tdoc 064, March 22-26) did not include simulation of that aspect of the USCH method. In summary, we view the USCH as being a DCH based approach which is very similar to 'stop and resumption control'. The CPCH scheme is very similar to the RACH at the physical layer. The CPCH's approach at the higher layers (packet scheduling) is very similar to Alcatel's approach called DPAC. In the USCH concept, the scheduling is MAC based whereas the DCH approach is RRC based.

Response to Motorola's Points on USCH from the CPCH Perspective

The basic principles of operation of USCH are sited here one by one. The comments on these principles are from GBT.

- USCH's Principle 1) Only make short leases on the radio resource

The 'short lease' means that the assignment is every 10 ms. this means that there is a high probability of Re-RACHing when there are other users to be served or when a packet in the packet call arrives a few tens of milliseconds later.

In the CPCH scheme, there are a maximum number of frames settable by the operator. So, the mobile selects the optimum data rate based on the availability of the bandwidth and the length of the packet in the queue.

- Principle 2) Indication of allocations on a common channel becomes more efficient when the shared channel is heavily loaded

There has been some other contributions showing that use of common control channel is much less efficient as compared to dedicated control channel. The contribution from Fujitsu to WG1 showed that the power requirement is an order of magnitude higher when common control channel is used.

- Principle 3) Access to the shared resource should be managed centrally

The high price paid by going to RNC to assigning and re-assigning resources is the time delay to access and Re-RACHing as well as inefficient use of resources in the dedicated channel approach. In CPCH scheme, the Node B makes the decision based on the information that it receives from RNC and interference measurements at Node B which is

the best information as far capacity availability is concerned. The issues surrounding the mobile on the cell edge should be viewed from the Handover and power control perspective.

- Principle 4) Minimize delay in request and assignment of resource

We believe that the CPCH approach provides minimum delay in access and transit time over the air interface. Our approach at L23 is similar to DPAC from Alcatel and their contribution showed a clear advantage in delay performance as compared to the USCH concept.

- Implementation impact #1) Removal of link maintenance between packet bursts (relates to principle 2)

We agree in principle that this should be done and the 'stop and resumption mode' achieves that as well. We think that USCH at the physical layer is extremely similar to 'stop and resumption control' . However, the claim that the preamble should always be set to 1 frame as it is proposed in USCH is unsubstantiated and unproven. In 'stop and resumption control', the number of preamble frames is a settable parameter.

- Implementation impact #2) Minimize capacity of ACCH (relates to principle 2)

Occasional indication of the available capacity by UTRAN as done in CPCH is more efficient than a frame by frame assignment in the DL direction as it is done in USCH. In the Common Packet Channel approach, the Node B, has the ability to L1 NAK the users if there is no capacity available. This minimizes the need for sending assignment messages every 10 ms as it is done in the USCH concept.

- Implementation impact #3) Indication of UE queue status in uplink (relates to principles 1 and 3)

This is also an extra information that is sent by the UE. This requires messaging on the RACH (1-2 messages before getting assigned). UE can request transmission rates based on the queue length, traffic condition and capacity availability as it is done in the CPCH scheme proposed by T1.

List of Concerns on USCH

The following list was partially compiled in the Ad-hoc 14 meeting (1-4) and is partially (5-7) coming from GBT:

1. Pre-cursor Detection probability/ Pre-cursor Probability of Miss and its implications
2. Inter-cell/intra-cell synchronization problem
3. Use of Downlink Common Control Channel

4. The ratio of energy contributed to pre-cursor vis-a-vis data transmission
5. UTRAN signaling/ Channel assignment and re-assignment (WG2 issue)

· Delays associated with circuit set-up
· Downlink signaling requirement (tight UTRAN scheduling per frame)

6. Probability of Re-RACHing within a packet call (WG#1 issue)

· Uplink and UTRAN messaging requirement (Re-RACH)
· If a new packet arrives in the buffer within the 10 ms lease, the UE will request piggybacking
· If there are other users requesting service (very possible at high utilization levels), then the
UE might have to Re-RACH
· If there is no packet in the buffer, UE will go to RACH state
· Known problem in fast circuit assignment

7. Tracing diagram for the protocol is required so that the overall protocol operation can be visualized and assessed.

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Harmonization between T1P1, Motorola, ARIB and DPAC

- @ Physical Layer

1. Various preamble structures (CPCH and USCH) is rooted in various assignment mechanisms

2. Various Radio Access methods: Random Access Packet Access in CPCH versus fast circuit assignment in USCH

3. USCH is similar to resumption control at the physical layer whereas CPCH is similar to RACH at the physical layer (Preamble)

- @ L23

1. T1P1'a proposal is similar to Alcatel's DPAC proposal (possibility of convergence @ higher layers)
2. USCH at the higher layers competes with RRC based scheduling.

Way Forward

- Categorize T1P1's CPCH as a RACH extension to transmit packet data at higher rates and payload sizes. CPCH's MAC is similar to Alcatel's, so convergence with Alcatel's basic de-centralized scheduling approach should be considered. This method will provide the most efficient connectionless and connection-oriented packet switching capability.

- Motorola's USCH to harmonize with the 'resumption control' from ARIB at the physical layer.