TSG-RAN Working Group1 meeting #3
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Agenda Item:

Source: **SAMSUNG Electronics Co.**

Title: **Gated transmission of DPCCH in DCH/DCH control only substates**

Document for: **Discussion**

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1. Introduction

3GPP TSG RAN WG1 has approved the use of either the common physical channel or dedicated physical channel for packet transmission according to traffic characteristics, i.e. common physical channel for infrequent and short packets, dedicated physical channel for frequent and long packets[2]. In addition, the transmission stop and resumption scheme proposed by NTT DoCoMo may be used to improve the throughput performance of the packet services[1][2]. On dedicated physical channels, especially in *DCH/DCH substates in cell connected state* [4], the DPDCH is not transmitted when there is no higher layer data, in order to save channel capacity. However, the network and the UE continue to transmit the DPCCH until the absence of transmitted packet data by the UE and Network has been detected according the criterion described in [2]. Maintenance of a power controlled link during the suspended DPDCH transmission, requires continuous transmission of the uplink/downlink DPCCH(pilot symbols, power control bits etc.). This means that the uplink/downlink capacity will be consumed due to the interference caused by the continuous DPCCH transmission. In order to reduce the response time for the transition to a user data active substate, it is necessary for the packet services to remain in the control only substates for a longer period of time. However, it is also desirable that the network and UE reduce the interference to a minimum level when no packet data is transmitted so as to maximise the available capacity. Samsung therefore propose the use of gated transmission of the uplink/downlink DPCCH in the DCH/DCH control only substates, to reduce interference in the uplink/downlink and UE power consumption, whilst maintaining the power controlled radio link.

2. Proposed gated transmission of uplink/downlink DPCCH

The DCH/DCH control only substates in cell connected states maintain air link between network and UE with adequate QoS such as,

- network controls the transmit power level of UE
- UE controls the transmit power level of network
- Physical channel synchronization(power level, timing etc.) be maintained for fast transition to the user data active substates.

Control only substates need to reduce the response time of transition to user data active substates. During control only substate, power controlled air link requires continuous transmission of the uplink DPCCH. This means that the link capacity will be consumed due to the interference caused by the continuous DPCCH transmission. In addition, UE consumes battery due to continuous uplink DPCCH transmission. The reduction of interference level and UE power consumption during control only substates can be achieved by *gated transmission of uplink DPCCH*. The unit period of the gating ON/OFF is 0.625ms(1 slot) and gating rate option can be 1(No gating), 1/2, 1/4, and 1/8 gating.

The key features of gated transmission of DPCCH during DCH/DCH control only substates are summarised as follows,

- Maintaining power controlled air link
- Reduction of uplink interference level and UE power consumption
- Reduction of downlink interference level
- Unit period of uplink/downlink DPCCH gating: 0.625ms
- Multiple options for the gating rate: 1, 1/2, 1/4, 1/8 gating
- Gating pattern: regular(periodic) gating
- gating rate, action time: negotiation by higher layer signaling

Performance of DPDCH with DPCCH gated transmission in control only substates might be slightly degraded due to

- Reduced effective power control rate of DPCCH before the transmission of DPDCH
- Reduced channel estimation quality before the transmission of DPDCH

Channel estimation performance of the downlink DPCCH is affected by the gated uplink DPCCH transmission. However, The degradation can be compensated by increasing the transmit power of each field of downlink DPCCH of gated on slot and gated off downlink DPCCH reduces the downlink interference.

Figure 1 and 2 illlustrate the DPDCH/DPCCH slot structure[3], however the exact slot structure will be decided later based on results of Adhoc 7 discussion.

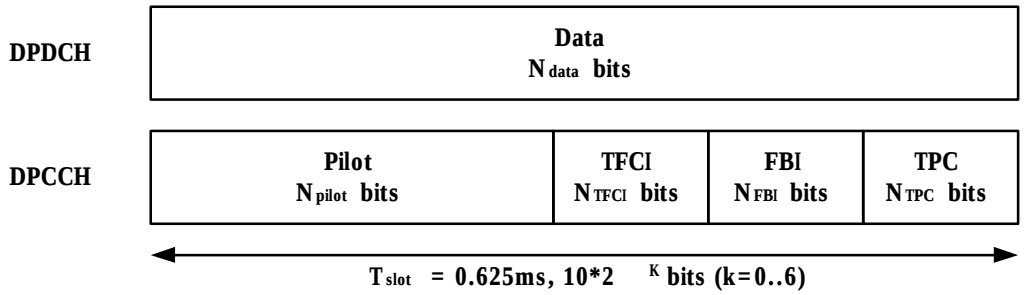

Figure 1. Slot structure for uplink DPDCH/DPCCH

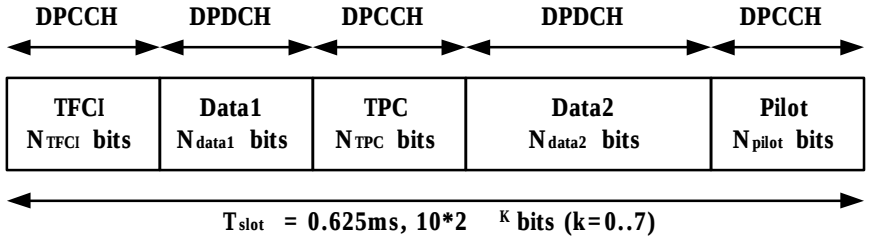

Figure 2. Slot structure for downlink DPDCH/DPCCH

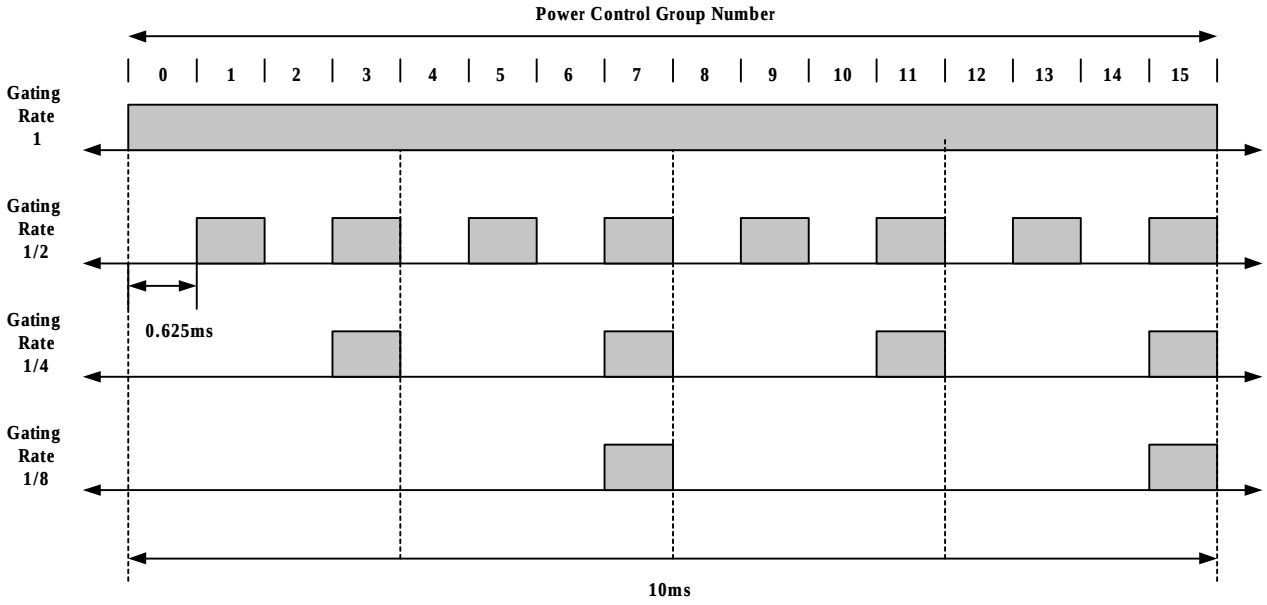

Figure 3. DPCCH gating

Figure 3 illustrates DPCCH gating, the Network/UE shall periodically gate off certain power control groups of the DPCCH at a specified rate.

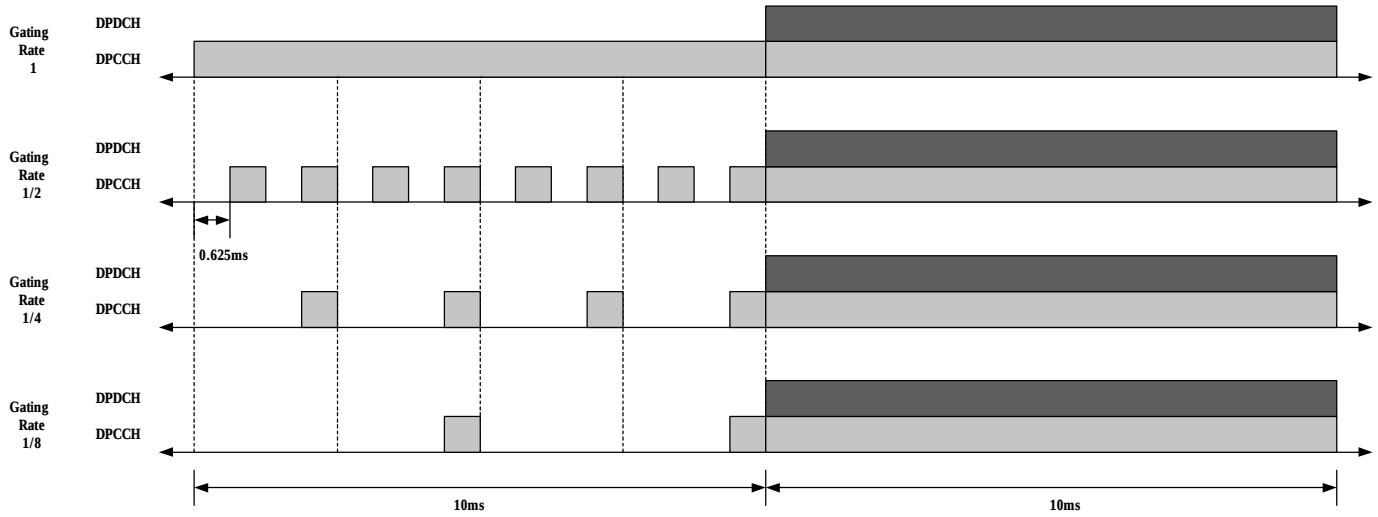

Figure 4. DPCCH gating during DPDCH transmission

Figure 4 illustrates DPCCH gating during DPDCH transmission, the DPCCH shall be fully gated on for the duration of the active DPDCH frame.

The signaling message used for state transition can be initiated from either network side or UE side. Network can initiate state transition from user data active substate to control only, PCH or RACH/FACH substates etc. by sending signaling mesage to UE. Network can initiate state transition from control only substate to user data active, PCH, RACH/FACH substates etc. by sending signaling message to UE. UE can also initiate the above state transitions by sending request message to network, then network control requested state transition by signaling message. In the following examples, we assume that the state transition from control only substate to user data active substate.

When user data occurrs at the network side during control only substate, then network sends the RRC message to inform that user data occurred. After receiving the response from UE, network starts transmission of the user data at the activation time. Figure 5 – 8 show the situation that network initiates the state trnasition.

Similarly when user data occurrs at the UE side during control only substate, then UE sends the RRC message to inform that user data occurred. After receiving the response from network, UE starts transmission of the user data at the activation time. Figure 9 – 12 show the situation that UE initiates the state trnasition.

- Performance related issue
  In the consideration of the gated transmission, the following performance degradation may be possible in DCH/DCH control only substates
  - Reduced effective power control rate for DPCCH before the transmission of DPDCH
  - Channel estimation inaccuracy due to gated transmission before the transmission of DPDCH

  Among them the major performance degradation source is the reduced effective power control rate. The performance degradation is much smaller than the reduced interference with the gated transmission case. For example, the interference reduction gain for 1/2 gating rate is about 3dB. The DPCCH shall be fully gated on for the transmission duration of the user active DPDCH frame. Therefore, the actuall user packet data performance degradation due to gated transmission is not so much.

3. Conclusion

The followings are summary of the advantage with the gated transmission in the DCH/DCH control only substates.

- Uplink/downlink interference can be reduced
  - ➔ UE send DPCCH signal only fractional time duration
  - ➔ Put more users in control only substates which provides fast reponse time to user data active substates
- UE power consumption can be saved
  - ➔ Can increase the talk time/stand by time of UE
  - ➔ Can increase the staying duration in the control only substates
  - ➔ Can increase the mean response time of transition to the user data active substates

4. Reference

[1] 3GPP RAN S1.14 V1.1.0(1999-03) “FDD Physical layer procedures”.
[2] TSGR1#3(99)191 “Detail description of transmission stop and resumption control”
[3] 3GPP RAN S1.11 V1.1.0(1999-03) “FDD Transport channels and physical channels”
[4] 3GPP RAN S2.03 V0.1.0(1999-03) “UE Functions and Interlayer Procedures in Connected Mode”

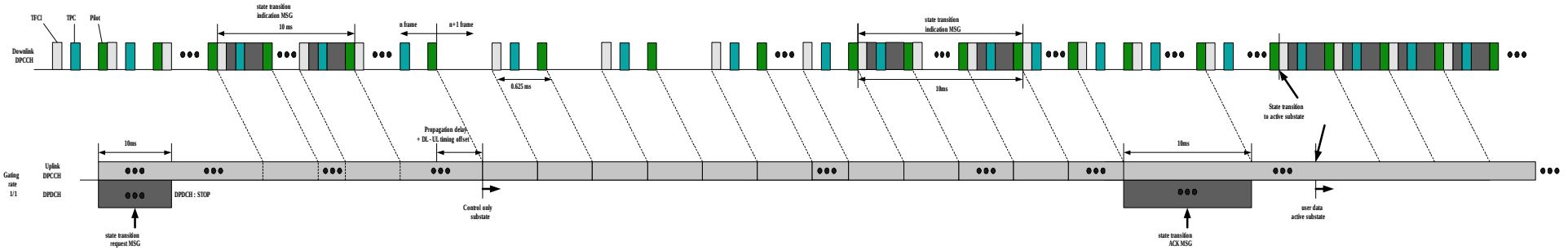

Figure 5. DPCCH gating (gating rate 1, network initiate)

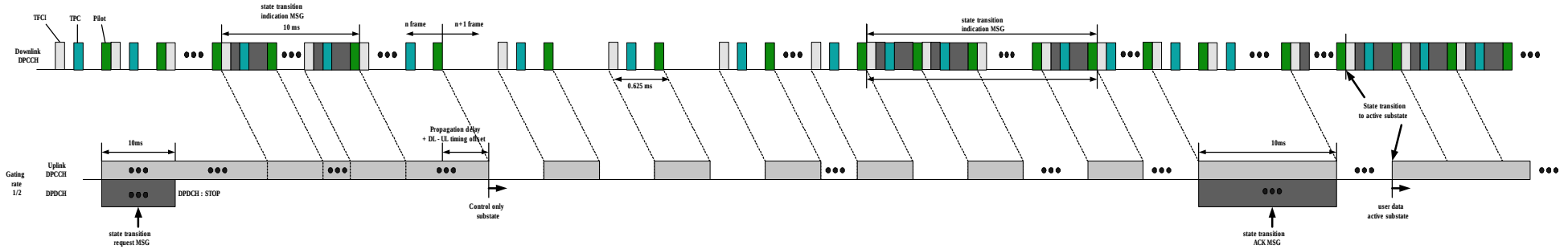

Figure 6. DPCCH gating(gating rate 1/2, network initiate)

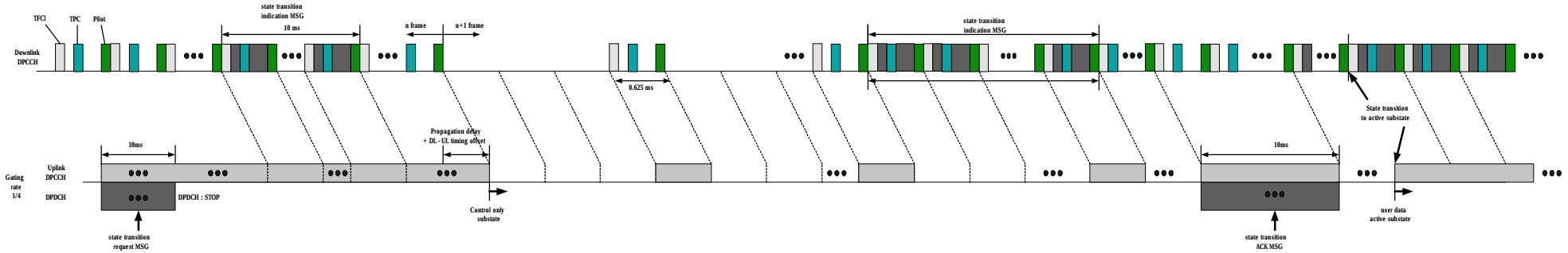

Figure 7. DPCCH gating(gating rate 1/4, network initiate)

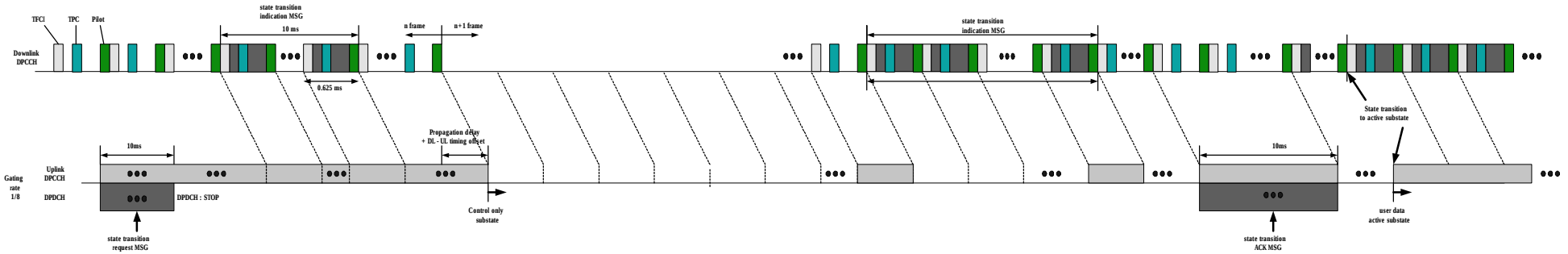

Figure 8. DPCCH gating(gating rate 1/8, network initiate)

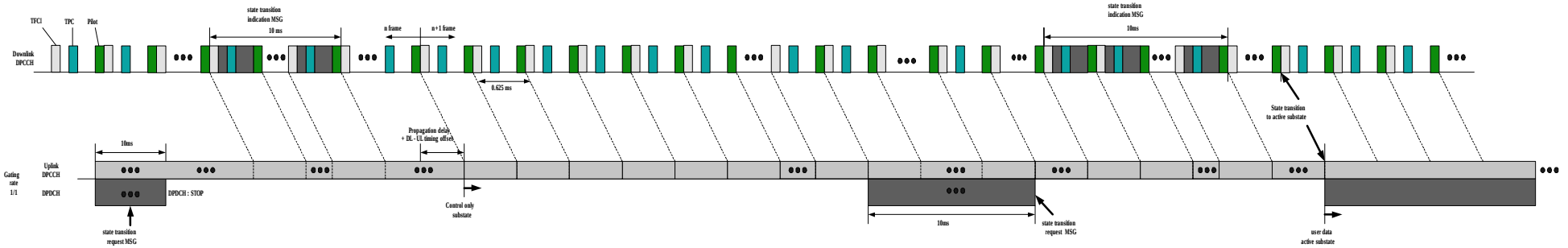

Figure 9. DPCCH gating(gating rate 1, UE initiate)

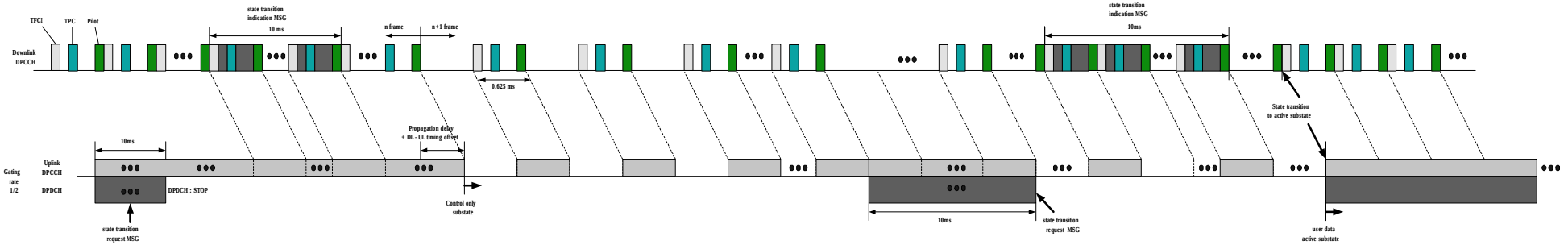

Figure 10. DPCCH gating(gating rate 1/2, UE initiate)

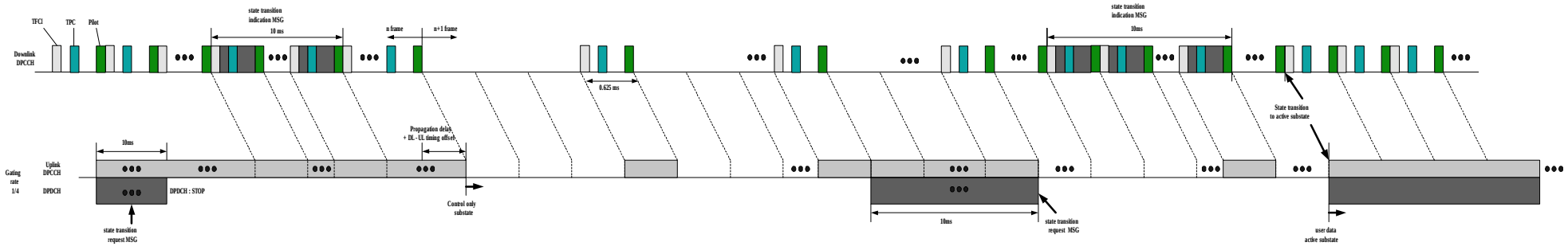

Figure 11. DPCCH gating(gating rate 1/4, UE initiate)

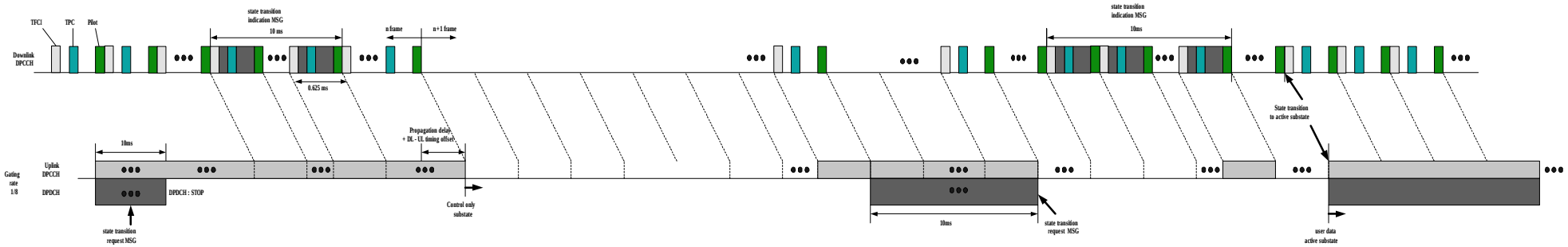

Figure 12. DPCCH gating(gating rate 1/8, UE initiate)