

TXI Access Protocol and Phantom Lockup Problems

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Introduction

A number of people have been commenting recently on potential lockup problems in a C-Port^{1,3} attached to a DTR Station^{2,3}, operating the TXI access protocol. The problems occur when the C-Port either fails to detect phantom being asserted by the Station, or fails to see phantom being de-asserted by the Station. With the development of HSTR, it has become possible to introduce transitions and object to prevent these problems, and an initial attempt has been made by introducing the C-Port timer, TPRF. This is not a complete solution, and a question remains about what value TPRF should have. This document will attempt to classify the actual problems that can occur, and recommend a complete work-around to the problem.

This is a working document, and comments from the committee are requested. In particular this document attempts to answer these specific open StrawMan comments: DWW-T24, RDL-T3.

Important information

I have written this document from the latest DTR standard, and I must re-visit the issue of interpreting what **FPINSD=0** means. (a.k.a. levels versus edges). When I read a condition **FPINSD=0** in a transition, I interpret this to mean that condition is true when the value of FPINSD is 0, and *not* that the condition is true when the value of FPINSD has changed to 0. I take as my justification for this interpretation the text in clause 9.1.1.1 (especially item 1.) which describes how to *execute* the state operation tables.

I believe this is important as the opposite interpretation changes the analysis in the next few sections dramatically.

Lockup problem classification

There are two causes of lockup problems that this document is investigating, both relating to phantom.

In a working DTR link, phantom is raised by the DTR Station at the end of the TXI join process, after it receives the INS_REQ MAC frame from the C-Port, and before transitioning to Join complete (JS=SJC). The C-Port does not require phantom to be raised to enter Join complete (JS=PJCI). Instead, the C-Port will set two flags when phantom is detected (FPINSD=1 and FPINSLE=1). Once in Join complete, the C-Port uses the loss of phantom to detect when the DTR Station has returned to bypass, or during the beacon process, to detect when the DTR Station requires a repeat path to perform its lobe test. Both of these cases rely on phantom having been detected after Join complete.

The first cause of a lockup problem is when the C-Port fails to detect phantom after Join complete. This can be due to the Station MAC asking to raise phantom, the Station hardware not generating phantom, the link not transporting the phantom current, the C-Port phantom circuitry not detecting that current, or the C-Port MAC not dealing with the phantom detect event. Irrespective of the cause, and assuming a correctly implemented C-Port MAC, the effect is that PM_STATUS.indication(Insert=Detected) is never indicated. (Ref. 1812⁴).

The second cause of a lockup problem is when the C-Port does detect phantom, but never detects its subsequent loss. This can be due to the Station MAC never asking to remove phantom, the Station

¹ *C-Port* is used throughout this document to refer to a C-Port in port mode, operating the TXI Access Protocol.

² *DTR Station* is used throughout this document to refer to a DTR Station or a C-Port in station emulation mode, operating the TXI Access Protocol.

³ All capitalisations in this document are correct.

⁴ Cue cannon fire in background...

hardware being stuck generating phantom, the C-Port phantom circuitry being stuck detecting the current, or the C-Port MAC not dealing with the phantom loss event. Irrespective of the cause, and assuming a correctly implemented C-Port MAC, the effect is that PM_STATUS.indication(Insert=Not_detected) is never indicated. (Ref. 1813).

There are four different conditions that are affected by these two cause. The DTR Station returning to bypass, the DTR Station beaconing, the C-Port beaconing, and both the DTR Station and C-Port beaconing. This last condition is highly unlikely (both DTR Station and C-Port must have TxRHB=E occur at the same time), and exhibits the same problems as the normal two beaconing conditions. This condition will therefore not be covered by this document, as is left as an exercise for the reader. For each of the other three conditions, both causes will now be examined in turn to determine what problems can occur.

Cause 1: DTR Station fails to raise phantom/C-Port fails to detect phantom

Condition 1: DTR Station return to bypass

Comment	DTR Station	C-Port
Join complete	JS=SJC; MS=SOPT	JS=PJCI; MS=POPT FPINSD=0 and FPINSLE=0 << Phantom not detected>>
DTR Station returns to bypass	REMOVE; JS=BP	<< Phantom loss not detected >>
DTR Station attempts reopen within 5s (TPRHB)	JS=SREG; TXI_REG_REQ_PDU => JS=BP	<< FR_REG_REQs ignored >>
DTR Station does not receive FR_REG_RSP MAC frames, and may try TKP Access Protocol	JS=LT; TEST => TEST_FAILURE => JS=BP	<< No repeat path to support lobe test >>
C-Port heart beat failure after 5s (TPRHB)	-	MS=PTBN << 1400 >> JS=BP << 1033 >>

This condition leads to a 5 second (TPRHB) lockup in the C-Port. During this period any re-open attempts by the DTR Station will result in failure. The lockup clears abruptly when the C-Port attempts to beacon after heart beat failure, and which will cause Ref. 1033 to fire. From the state tables this looks like the DTR Station went away when the C-Port started beaconing. This interpretation is not correct.

Condition 2: DTR Station beaconing

Comment	DTR Station	C-Port
Join complete	JS=SJC; MS=SOPT	JS=PJCI; MS=POPT FPINSD=0 and FPINSLE=0 << Phantom not detected>>
DTR Station detects heart beat loss and starts beaconing	MS=STBN; TXI_BN; TSIT=R; TSLMT=R	FR_BN => MS=PIT << 1401 >> => FPBNT=1 << 1406 >> => JS=PLT; Enable repeat path << 1051 >>
DTR Station transmits another beacon frame	TXI_BN	FR_BN & JS=PLT => JS=BP << 1027 >> << Unexpected beacon frame >>
DTR Station stops beaconing and prepares for lobe media test	TSIT=E => MS=SIT; Remove_station	-
DTR Station starts lobe media test	TSLMT=E => JS=SLT; TXI_TEST	-
DTR Station fails lobe media test	TEST_FAILURE => JS=BP	-

This condition does not lead to a lockup in the C-Port. However, the close reason on the C-Port is again misleading, and the depending on when the C-Port re-opens, the Station may have to attempt joining a number of times before success.

Condition 3: C-Port beaconing

Comment	DTR Station	C-Port
Join complete	JS=SJC; MS=SOPT	JS=PJCI; MS=POPT FPINSD=0 and FPINSLE=0 << Phantom not detected>>
C-Port detects heart beat loss and starts beaconing	FR_BN => MS=SWFD; TSIT=R; TSLMT=R	MS=PTBN; TXI_BN << 1400 >> and then JS=BP << 1033 >>
DTR Station prepares for lobe media test	TSIT=E => MS=SIT; Remove_station	-
DTR Station starts lobe media test	TSLMT=E => JS=SLT; TXI_TEST	-
DTR Station fails lobe media test	TEST_FAILURE => JS=BP	-
DTR Station attempts reopen	JS=SREG; TXI_REG_REQ_PDUs => JS=BP	-
DTR Station does not receive FR_REG_RSP MAC frames, and may try TKP Access Protocol	JS=LT; TEST => TEST_FAILURE => JS=BP	-

This condition does not lead to a lockup in the C-Port. However, the close reason on the C-Port is again misleading, and the depending on when the C-Port re-opens, the Station may have to attempt joining a number of times before success.

Cause 2: DTR Station fails to drop phantom/C-Port fails to detect phantom loss

Condition 1: DTR Station return to bypass

Comment	DTR Station	C-Port
Join complete	JS=SJC; MS=SOPT	JS=PJCI; MS=POPT FPINSD=1 and FPINSLE=1 << Phantom detected>>
DTR Station returns to bypass	REMOVE; JS=BP	<< Phantom loss not detected >>
DTR Station attempts reopen within 5s (TPRHB)	JS=SREG; TXI_REG_REQ_PDUs => JS=BP	<< FR_REG_REQs ignored >>
DTR Station does not receive FR_REG_RSP MAC frames, and may try TKP Access Protocol	JS=LT; TEST => TEST_FAILURE => JS=BP	<< No repeat path to support lobe test >>
C-Port heart beat failure after 5s (TPRHB)	-	MS=PTBN => TPIT=R << 1400 >> TPIT=E => MS=PIT << 1403 >>

This condition causes a permanent lockup in the C-Port, which can only be cleared by management. During the lockup, the DTR Station will be unable to join, reporting either no registration response (for a TXI only DTR Station) or a lobe media test error (for a DTR Station that attempts TKP).

Condition 2: DTR Station beaconing

Comment	DTR Station	C-Port
Join complete	JS=SJC; MS=SOPT	JS=PJCI; MS=POPT FPINSD=1 and FPINSLE=1 << Phantom detected >>
DTR Station detects heart beat loss and starts beaconing	MS=STBN; TXI_BN; TSIT=R; TSLMT=R	FR_BN => MS=PIT << 1401 >>
DTR Station stops beaconing and prepares for lobe media test	TSIT=E => MS=SIT; Remove_station	<< Phantom loss not detected >>
DTR Station starts lobe media test	TSLMT=E => JS=SLT; TXI_TEST	<< No repeat path >>
DTR Station fails lobe media test	TEST_FAILURE => JS=BP	-
DTR Station attempts reopen	JS=SREG; TXI_REG_REQ_PDUs => JS=BP	<< FR_REG_REQs ignored >>
DTR Station does not receive FR_REG_RSP MAC frames, and may try TKP Access Protocol	JS=LT; TEST => TEST_FAILURE => JS=BP	<< No repeat path to support lobe test >>

This condition causes a permanent lockup in the C-Port, which can only be cleared by management. During the lockup, the DTR Station will be unable to join, reporting either no registration response (for a TXI only DTR Station) or a lobe media test error (for a DTR Station that attempts TKP).

Condition 3: C-Port beaconing

Comment	DTR Station	C-Port
Join complete	JS=SJC; MS=SOPT	JS=PJCI; MS=POPT FPINSD=1 and FPINSLE=1 << Phantom not detected >>
C-Port detects heart beat loss and starts beaconing	FR_BN => MS=SWFD; TSIT=R; TSLMT=R	MS=PTBN; TXI_BN; TPIT=R << 1400 >>
C-Port stops beaconing	-	TPIT=E => MS=PIT << 1403 >>
DTR Station prepares for lobe media test	TSIT=E => MS=SIT; Remove_station	<< Phantom loss not detected >>
DTR Station starts lobe media test	TSLMT=E => JS=SLT; TXI_TEST	-
DTR Station fails lobe media test	TEST_FAILURE => JS=BP	<< No repeat path >>
DTR Station attempts reopen	JS=SREG; TXI_REG_REQ_PDUs => JS=BP	-
DTR Station does not receive FR_REG_RSP MAC frames, and may try TKP Access Protocol	JS=LT; TEST => TEST_FAILURE => JS=BP	<< No repeat path >>

This condition causes a permanent lockup in the C-Port, which can only be cleared by management. During the lockup, the DTR Station will be unable to join, reporting either no registration response (for a TXI only DTR Station) or a lobe media test error (for a DTR Station that attempts TKP).

Summary

This document shows that there are lockup problems with a DTR Station and C-Port communicating using the TXI Access Protocol.

If, for what ever reason, a C-Port can detect phantom being asserted, but subsequently cannot detect its removal, then the DTR link goes into a lockup state which can only be cleared by management of the C-Port. Of lesser importance is the case where, for what ever reason, a C-Port never detects phantom being asserted, then the DTR link will recover, but may give misleading management indications as to what is going wrong, and causing multiple retries to re-establish the link.

Recommendations

1. In a C-Port in port mode, operating using the TXI Access Protocol, add the condition "FPINSLE=1" to all transitions that check FPINSLE=0. This prevents loss of phantom being wrongly *detected* until phantom has been detected for the first time.
Modified transitions: 1049 (already done), 1033 and 1406 - add FPINSLE=1 to conditions
2. In a C-Port in port mode, operating using the TXI Access Protocol, add a new timer TPPDP (Timer, C-Port Phantom Detect Problem), that is reset every time an insert response frame is transmitted to the DTR Station. If the timer expires, and FPINSLE=0, then phantom has not been detected by the C-Port, and it should return to bypass. A clear indication to management of the problem is possible. TPPDP should have a value of between 0.8s and 1.2s. A value of 1s is recommended. A problem with phantom not being detected must be noticed before a beacon cycle can start. This is should be longer than 1.2s, but I invite readers to verify this.
Modified transitions: 1047, 1076 - add TPPDP=R to actions
New transitions: TPPDP=E & FPINSLE=0 => JS=BP << Phantom not detected >>
3. In a C-Port in port mode, operating using the TXI Access Protocol, add a new timer TPPLP (Timer, C-Port Phantom Loss Problem), that is reset on entry to MS=PIT during beaconing. In addition set a new flag FPDPLP (Flag, C-Port Detecting Phantom Loss Problem) at the same time. If phantom loss is detected, then FPDPLP should be cleared. If the timer expires while FPDPLP is set, then phantom loss has not been detected by the C-Port, and it should return to bypass. A clear indication to management of the problem is possible. TPPLP should have a value of between 7.8s and 8.2ms. A value of 8s is recommended. This value is calculated as the longest time the C-Port should have to wait in MS=SIT before phantom should go away. This should be greater than TSIT but less than TSLMT. Readers, please check this.
Modified transitions: 1401, 1404, 1043 - add TPPLP=R; FPDPLP=1 to actions
Modified transitions: 1406 - add FPDPLP=0 to actions
New transitions: TPPLP=E & FPDPLP=1 & JS=PJCI => JS=BP << Phantom loss not detected >>

Conclusions

Assuming all the recommendations are adopted, I will now revisit the causes and conditions, to see how the problems have been fixed.

In the case where the C-Port does not detect phantom, the new timer TPPDP should expire before any of the conditions arise, indicating to management that there is a problem with the link.

In the case where the C-Port does detect phantom but fails to detect its loss, the new timer TPPLP should get the C-Port out of MS=PIT and back to bypass with a suitable management indication as to what the problem with the link is. The DTR Station will eventually catch up, and also return to bypass. The important effect of the recommendations is that the lockup problem has been removed.

After thought

Although these recommendation detect and prevent the lockup problems identified, it does not help in reducing the problem domain beyond saying there is a problem with phantom somewhere between the DTR Station's MAC and the C-Port's MAC. Does anybody care?