D6JBNs7W;;5!JUMP-1 K*1k J,;66&M-%a%b%j4IM}<jK!

The Method of Controlling The Distributed Shared Memory on Massibly Parallel System JUMP-1

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J?@.9G/2 7n14F|

Abstract

D6JBNs7W;;5!JUMP-1 $O%/%i%9%?9=@.$rHCF*$j!"%3%R!<%l%s%9@)8f$O2 CJ3,$K3,AX2=$5lF$$$k!#9bB.DL?.2DG=$J%M%C%H%o!<%/$rMQ$$$?!"%9%L!<%WJ}<0$N%3%R!<%l%s%9@)8f$r<B8=9k%-%c%C%7%e%3%s%H%m!<%i$H!"%/%i%9%?4V%M%C%H%o!<%/K*1k%N!<%I4V$N%Q%1%C%HE>Aw$KhC$F%3%R!<%l%s%9@)8f$r<B8=9k%/%i%9%?4V%3%R!<%l%s%9@)8f5!9=G"$k!#%-%c%C%7%e%3%s%H%m!<%i$O!"=hM}MW5a$NIQEY$,9b$/9bB.=hM}$,MW5a$5lk$?$a!"%O!<%I%&%(%"KhCF9=@.5l$k!#$3lKBP$7%/%i%9%?4V$N%3%R!<%l%s%9@)8f5!9=$O!"=hM}$N9bB.@-b5$k;v$J$,$i!"=hM}$NJ#;($5ZS;EMM$NJQ99$KBP9k=@Fp@-$,MW5a$5lk$?$a!"%W%m%;%C%5>eGAvk%=%U%H%&%(%"KhCF9=@.5l$k!#%W%m%;%C%5$H7F$O!"%3%R!<%l%s%9@)8f$KFC2=7?%W%m%;%C%5$r3+H/$9$kJ}?K$GO"k,!"8=CJ3,K*$$$F@lMQ%W%m%;%C%5$O3+H/ESCf$G$"$k$?$a!"Beoj$KDSP $rMQ$$$kbNH9$k!#K\Js9p$G$O!"8=:_3+H/Cf$G$"$k%/%i%9%?4V%3%R!<%l%s%9$r@)8f$9$k DSP %W%m%0%i%`$N@_7WJ}?K!"5Z$S<BAu7A<0$K$D$$$FJs9p9k!#

%W%m%0%i%`$N3+H/$K$"$?$C$F$O!"2 3,AX$KJ,$1$F3+H/Cf$G$"$k!#DSP $K$*$1$k=hM}$N%9%1%8%e!<%j%s%0J}<0$r7hDj$9$k3,AX$H!"%3%R!<%l%s%9@)8f$K$*$1$k%W%m%H%3%k$d!"%Q%1%C%H$NEAAwJ}<0$r7hDj$9$k3,AX$G$"$k!#$=$l$>$l$N3,AX$N%W%m%0%i%`$rFHN)$KJB9T7F3+H/9k3HKh$j!"$*8_$$$N3,AX$N;EMM$KBP9k=@Fp@-$r;}$?$;$k3H$,$G$-!"%7%9%F%`$N;EMM$NJQ99$K=@Fp$KBP=h$G$-$k%W%m%0%i%`$N3+H/$,2DG=$HJk!#

=hM}$N%9%1%8%e!<%j%s%0$K$*$$$F$O!"3F=hM}$N1~Ez@-OFCK=EMWGOJ/!"A4BN$N=hM}$K$+$+$k;~4V$rC;=L9k3H$,MW5a$5lk!#hC$F!"=hM}$N%9%1%8%e!<%j%s%0J}<0H7FO!"3d$j9~$_Kh$kM%@hEYIU%9%1%8%e!<%j%s%0J}<0$r:NMQ$7$F$$$k!#3NJ}<0K*$$$F$O!"M%@hEY$N9b$$%3%R!<%l%s%9@)8f=hM}$+$i=g$K<B9T$7$F$$$/3HKh$k%7%9%F%`A4BN$H$7$F$N@-G=8~>e$,8+9~$^$l$k!#$5$i$K!"M%@hEY$,Dc$/=hM};~4V$ND9$$=hM}$K$h$k%W%m%;%C%5$NFH@j$rK8$2$k$3$H$,$G$-$k!#H?LL!"3d$j9~$_=hM}$KHs>o$KD9$$;~4V$,$+$+$k$?$a!"K\MhITI,MW$J=hM}$N@j$a$k3d9g$,A}Bg$9$k2DG=@-$b$"$k!#K\Js9p$K$*$1$k<BAu7A<0$K$*$$$F$O!"=hM}$NM%@hEY$r2 CJ3,$KJ,N`$7!"M%@hEY$NDc$$=hM}$O3 0It$+iN3d$j9~$_$r<uM}$7!"M%@hEY$N9b$$=hM}$O3d$j9~$_$r<uM}7J$$$H$$$&7A<0KJCF$$$k!#

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DSP K*1k=hM}$N%9%1%8%e!<%j%s%0%W%m%0%i%`$N<BAu8e!"@-G=I>2A$r$*$3JC$?!#?J9TCf$N=hM}$,$J$$>uBV$G?7$7$$=hM}$r9T$&$?$a$KLs 150 %9%F%C%WHq$d5l$k!#?J9TCf$N=hM}$rCfCG$7$F?7$7

$$%Q%1%C%H=hM}$r<B9T$7$?8e!"3d$j9~$^$l$?=hM}$r:F3+9k$^$G$K!"3d$j9~s@%Q%1%C%H$K4X$9$k=hM}0J30$KLs200 %9%F%C%WHqd5lk!#3N=hM};~4V$O%Q%1%C%HAw?.;~4V5Z$S%a%b%j%"%/%;%9;~4V$HHf3S$7$FHs>o$KD9$$!#hC$F!"%W%m%;%94IM}$KI,MWH5lk3HD%5!G=$r;}$D!"%a%b%j4IM}@lMQ%W%m%;%C%5$N3+H/$r5^$,$MPJiJ$$!#

A massively parallel computer JUMP-1 takes cluster structure and has two layers for coherence control. The cache controller realizes snoop cache control with a high speed network. The inter-cluster coherence control system realizes coherence control by packet forwarding on the network between clusters. The cache controller is composed of the hardware. Because the frequency of the processing request for the cache controller is high, so high-speed processing is required. On the other hand, the inter-cluster coherence control system is composed of the software which runs on a processor. Because flexibility to the complication of the processing and the change of the specification is required rather than the processing speed. As a processor, a special purpose processor for inter-cluster coherence control is under development. So DSP is used alternatively. The design policy and the implementation of the DSP program which controls the inter-cluster coherence is reported.

The DSP program is consist of two layers and each layer is under development. The method of the process scheduling is decided in the lower layer. The coherence protocol and the method of packet forwarding are decided in the higher layer. The program on each layer is developed independently, so each program is flexible to the other's specification. This style of development makes it possible to develop a flexible program to the change of the system.

Each process need not be done immediately. The reduction of the whole processing time is required on process scheduling layer. So the scheduling method by the interrupt with the priority is used as the process scheduling method. On this method, process of higher priority is done in order, therefore performance of the whole system will be improved. Moreover, the occupation of the processor by the process of lower priority which takes long time can be prevented. On the other hand, the interrupt handling takes long time, so unnecessary processing time will increase. Processes are classified into 2 degrees by the priority. Processes of lower priority accept the interrupt, and processes of higher priority do not accept the interrupt.

The ownership protocol by the distributed directory is used as the method of the inter-cluster coherence control. And, the cluster memory which is arranged to the cluster is used as the copy of the other cluster memory, in addition to the distributed shared memory. Net address is used to represent each area is the same area, and the address is virtualized and not related to peculiar clusters.

The performance of the process scheduling program is evaluated. It takes about 150 steps to handle a new process when there is no active process. To suspend current process and restart it after the execution of a new process, it takes about 200 steps. This does not contain the time for the execution of the new process. This processing time is much longer than the time of the memory access and the packet forwarding. So the special purpose processor for coherence control with extended functions required for process scheduling needs to be developed immediately.

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JUMP-1 $OJ,;66&M-%a%b%j7?$NJBNs7W;;5!G"$j!"3F%W%m%;%C%5Kh$K%-%c%C%7%e%a%b%j$,!"3F%/%i%9%?$4HK<g5-21!&J/%i%9%?%a%b%j) $,J,;6G[CV$5lF$$$k!#hC$F!"JUMP-1 K*$$$F$O%/%i%9%?Fb$N4DN%-%c%C%7%e%a%b%j4V!"5Z$S%/%i%9%?%a%b%j4V$N2 3,AX$N%3%R!<%l%s%9@)8f$,I,MWHJ$k!#$3$N2 3,AX$N%3%R!<%l%s%9@)8fK*$$$F$ODL?.IQEY!"DL?.B.EY!"4IM}%f%K%C%H?tJI$,Bg$-$/0[$Jk?$a!"3F3,AX$KFC2=7?%3%R!<%l%s%9@)8f5!9=$,9=@.$5lk!#

%/%i%9%?Fb$N%3%R!<%l%s%9$O!"DL?.$N9bB.@-$r3h$+$7!"6&M-%P%9%Y!<%9$N%9%L!<%WJ}<0$rMQ$$$?%O!<%I%&%(%"9=@.$N%-%c%C%7%e%3%s%H%m!<%i$KhC$F@)8f$5lk!#

%/%i%9%?4V$N%3%R!<%l%s%9@)8f<jK!$H7F$O!"MM!9$JJ}K!$,9M$(il$k!#$^$:!"%=%U%H%&%(%"$Khk9=@.K!$H%O!<%I%&%(%"$Khk9=@.K!$NA*Br$r9kI,MW$,$"$k!#$3$3$G9MN8$9$Y$-;v$O!"JUMP-1 $N%/%i%9%?4V%a%b%j4IM}5!9=KOOJ2<Nh$&$J=@Fp@-$,MW5a$5lk3HG"$k!#

(1) %/%i%9%??t$NA}8:$KBP9k=@Fp@-
(2) %Q%1%C%H$NEAC#;~4V$KBP9k=@Fp@-
(3) %/%i%9%?4V%3%R!<%l%s%9@)8f%]%j%7!<KBP9$k=@Fp@-
(4) %Q%1%C%H$NCY1dAw?.Ey$N5!G=3HD%KBP9$k=@Fp@-

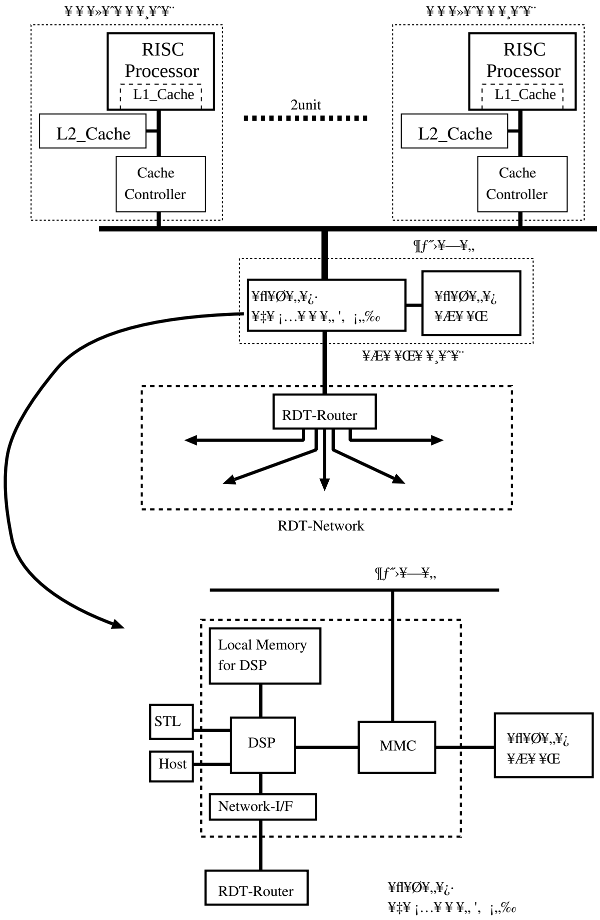
3liN=@Fp@-$rK~$?9h$&$J9=@.K!GJ$/$FOJiJ$$!#hC$F!"JUMP-1 $N%/%i%9%?4V%3%R!<%l%s%9@)8f$O%=%U%H%&%(%"$KhCFJ5l$k!#

%=%U%H%&%(%"$r<B9T$9$k5!9=$H7F$O!"K\Mh$O%/%i%9%?4V$N%a%b%j4IM}@lMQ$N%W%m%;%C%5$r@=:n$7$F!"$=$N%W%m%;%C%5>e$G%W%m%0%i%`rAvi$;$k7W2hG"C?$,!"$=$N%W%m%;%C%5$O8=:_@_7WCJ3,G"kN$G!"DSP %W%m%;%C%5$KhC$FBe9T$7$F$$$k!#

K\9FGO!"%/%i%9%?4V$N%3%R!<%l%s%9$r@)8f9kDSP >e$N%=%U%H%&%(%"$N@_7WJ}?K$K4X$9$k9M;!$r9T$$!"$=$N9M;!$K4p$E$$$?<BAuJ}K!KD$$$F=RYk!#0J2<!"2 >O$GBP>]$HJkD6JBNs7W;;5!JUMP-1 $N9=@.$K$D$$$F=RYk!#$=$N8e!"3 >O$G%/%i%9%?4V%3%R!<%l%s%9@)8f5!9=$N@_7WJ}?K$r=R$Y!"4 >O$G<BAuJ}<0KD$$$F=R$Y!"5 >O$G@-G=$K4X$9$kI>2A$r9T$&!#:G8e$K6 >O$GK\8&5f$N$^$Har9T$&!#

2 D6JBNs7W;;5!JUMP-1

K\>OGO!"%3%R!<%l%s%9@)8f$NBP>]$HJkD6JBNs7W;;5!JUMP-1[1] KD$$$F=RYk!#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1>O$G=R$Y$?$h$&$K%/%i%9%?4V$N%3%R!<%1%s%9$O!"%W%m%;%C%5>eGAvk%=%U%H%&%(%"$G@)8f$9$k!#%3%R!<%1%s%9@)8f5!9=$N9=@.$O?^12<It$K<(9H$*$jG"$k!#K\g$K!"%a%b%j4IM}$N3K$HJk%W%m%;%C%5DSP!"%a%b%jA`:n$KFC2=$7$?%O!<%I%&%(%"9=@.$NMMC$+$iJk!#0J2<$K3FItJ,$NLr3d5Z$S9=@.$K$D$$$F=RYk!#

- MMC
  DSP5Z$S%-%c%C%7%e%3%s%H%m!<%i$+$i%/%i%9%?%a%b%j$X$N%"%/%;%9$O%Q%1%C%H$H$$$&7A$GM?$(il!"<g5-21$KJ*M}E*$K6a$$0lCV$K%a%b%j%"%/%;%9$KFC2=7?%O!<%I%&%(%"MMC$r@_CV$7$F!"%Q%1%C%H$NFbMF$KBP1~$7$?%a%b%j%"%/%;%9$r9T$&!#%-%c%C%7%e%3%s%H%m!<%i$+$i$N%a%b%j%"%/%;%9$,%/%i%9%?FbKJD8$F$$$k;~KO!"6&M-%P%9$K%Q%1%C%H$rN.7F=hM}$O=*N;$9k,!"%/%i%9%?FbKJD8$F$$$J$$;~KO!"DSPKBP7$F3d$j9~$_$r$+$1!"%/%i%9%?4V$N%3%R!<%1%s%9@)8f0MMj$r9k!#

- DSP
  6&M-%a%b%j4IM}5!9=$NCf3K$rJ9%W%m%;%C%5G"$k!#MMC5Z$SRDT-Router$+$i$N=hM}MW5a%Q%1%C%H$r<u$1<h$j!"BP1~9k%a%b%j=hM}$r9T$C$?8e0 8D0J>e$NL~Ez%Q%1%C%HrAwk3HKh$j=hM}$r=*N;9k!#

- Network-I/F
  %/%i%9%?30HN%$%s%?%U%'!<%9$r4IM}9k!#DSP$+$i<u$1<h$C$?%Q%1%C%H$ONetwork-I/F$K%P%C%U%!%j%s%0$5$l!"RDT-Router$rDL7FRDT-NetworkKAwilk!#B>$N%/%i%9%?$+iN%Q%1%C%H$ORDT-Network$rDL7FNetwork-I/F$K%P%C%U%!%j%s%0$5l?8e!"Network-I/F$,DSP$KBP7F3d$j9~$_r+1F%Q%1%C%Hro$?$9!#

3 %/%i%9%?4V%3%R!<%1%s%9@)8f5!9=$N@_7WJ}?K

K\8&5fK*$$$F$O!"%3%R!<%1%s%9@)8f%W%m%0%i%`$r!"0J2<$K<($92 3,AX$N%W%m%0%i%`$KJ,$1$F3+H/$9$k!#

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%W%m%;%9@)8f3,AX DSPK*$$$F<B9T5l$k%W%m%;%9$N%9%1%8%e!<%j%s%0$NJ}?K$r7hDj$7!"$=$NJ}?K$K7?$,$C$F<BAu$9$k3,AX!#

3Nh&$K%W%m%0%i%`$r2 3,AX$KJ,$1$FFHN)$7$F3+H/$9$k$3$H$K$h$j!"$=$l$>$l$N3,AX$K$*$1$kBP1~$NI}$,9-$/$J$k!#$h$C$F!"%3%R!<%1%s%9@)8f$NJ}<02=$K=@Fp$KBP1~$G$-$k$h$&$J%W%m%0%i%`$r9=@.9k3H$,$G$-$k!#

0J2<$K\>O$G$O!"%Q%1%C%H@)8f3,AX5Z$S%W%m%;%9@)8f3,AX$=$l$>$l$N%W%m%0%i%`$r@_7W9kK"$?$CFNJ}?KKD$$$F=RYk!#

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%/%i%9%?4H$KJ,;6G[CV$5l?%/%i%9%?%a%b%j$NMxMQK!!"5Z$S%"%I%l%9BN7OKD$$$F=RYk!#

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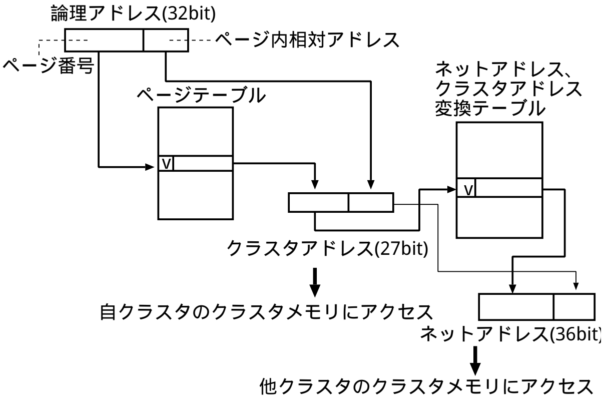

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$F%/%i%9%?30It$N%a%b%j%"%/%;%9;~KO3<!%-%&C%7%eH7$F5!G=$9$k!#

- %"%I%l%9BN7O

  3F%W%m%;%C%5$G<B9T$5lk%W%m%;%9$O!"$=l>$l2>A[5-216u4V$rJ];}9k!#3l$rO@M}%"%I%l%9$H8F$V!#3F%/%i%9%?$K$*$1$k%/%i%9%?%a%b%j$NJ*M}E*$J%"%I%l%9$r%/%i%9%?%"%I%l%9$H8F$V$H!"O@M}%"%I%l%9$H%/%i%9%?%"%I%l%9$O3F%W%m%;%C%5$K$*$$$FDL>o$N%Z!<%85!9=$Khk%"%I%l%9JQ49$,$J5l$k!#J,;66&M-%a%b%j7?JBNs7W;;5!K*$$$F$O!"$3$N2$D$N%"%I%l%9$K2C$($F%M%C%H%o!<%/>e$NDL?.$K$*$1$k%"%I%l%9BN7O$,I,MWHJCF$/$k!#D^$j!"J#?t$N%/%i%9%?$G6&M-$5lF$$$kNN0hKBP7$F!"$=l>lN%/%i%9%?K*1k%/%i%9%?%"%I%l%90J30$K!"$=l>lNNN0h$,F10l$G$"$k3H$r<($9$?$a$N%"%I%l%9$,I,MWHJ$k!#$3$N%"%I%l%9$r%M%C%H%"%I%l%9$H8F$V!#%"%I%l%9JQ49$N35G0?^$r?^2$K<($9!#3FJQ49%F!<%V%k$O5U0z$-2DG=G"kH9k!#%M%C%H%"%I%l%9rINh$&$K@_Dj9k$+$K$D$$$F$O<g$K<!$N2DL$j$NJ}K!$,9M$($ilk!#

  - %M%C%H%"%I%l%9$r2>A[2=$;$:!"%/%i%9%?%"%I%l%9$rMxMQ9kJ}K!

    J,;6G[CV5l$?%/%i%9%?%a%b%j$O!"3F%/%i%9%?K*$$$F%7%9%F%`A4BN$N<g5-215Z$SB>$N%/%i%9%?%a%b%j$N%3%T!<H7$FMxMQ$9$k!#3FNN0h$N%M%C%H%"%I%l%9$r!"Ev3:NN0h$r<g5-21H7$F;}$D%/%i%9%?HV9f$HEv3:%/%i%9%?$K$*$1$k%/%i%9%?%"%I%l%9$r9g@.7?bN$GI=$9$3$H$,$G$-$k!#3N;~3F%/%i%9%?K*$$$F$O!"O@M}%"%I%l%9$H%/%i%9%?%"%I%l%9$NBP1~$r<($9%Z!<%8%F!<%V%k$H!"%/%i%9%?%"%I%l%9$H%M%C%H%"%I%l%9$NBP1~$r<($9%Z!<%8%F!<%V%k$,4IM}$5lk!#3NJ}<0K*$$$F$O!"%M%C%H%"%I%l%9$,<+%/%i%9%?$N<g5-21>e$N%"%I%l%9G"$k%/%i%9%?$K$*$$$F$O!"%M%C%H%"%I%l%9$H%/%i%9%?%"%I%l%9$NJQ49$NI,MW$,$J$$$H$$$&MxE@$,$"k,!"0J2<$K<($9h&$JLdE@$,$"$k!#

    (1) <+%/%i%9%?$K%7%9%F%`$N<g5-21$,3d$jEvFilF$$$kNN0hKBP7FO!"J#?t$N%/%i%9%?$N%Z!<%8%F!<%V%kK*$$$FBP1~4X78$,4IM}$5lF$$$k!#hC$F!"<g5-21NN0h$N%Z!<%8$N%j%W%l!<%9$,5/3k$H!"NN0h$r6&M-7F$$$k%/%i%9%?A4FN%Z!<%8%F!<%V%k$r=q$-49$($kI,MW$,$"$k!#3F%/%i%9%?$K$*$1$k<g5-216u4V$rBg$-$/7?>l9gKO!"<g5-21$N%j%W%l!<%9$KhkDL?.$N*!<%P!<%X%C%I$OHs>oKBg-$/$J$k!#

    (2) %M%C%H%"%I%l%96u4V$O4{$K36 %S%C%H%"%I%l%9$H7hDj$5lF$$$k!#hC$F!"%M%C%H%"%I%l%9$r2>A[2=7J$$J}<0K*$$$F$O!"%/%i%9%??t$NA}Bg5Z$S3F%/%i%9%?%a%b%j$NNN0h3HBgKhCF%a%b%jNN0h$,%M%C%H%"%I%l%96u4V$hjBg-$/$JCF7^$&2DG=@-$,$"$k!#

  - %/%i%9%?%"%I%l%9$r2>A[2=$9$kJ}K!

    %M%C%H%"%I%l%9$r2>A[2=$7$F!"8GM-$N%/%i%9%?$N%/%i%9%?%"%I%l%9$H4XO"E1$J$$J}K!$,9M$(il$k!#$3$NJ}K!$G$O!"%M%C%H%"%I%l%9$,<+%/%i%9%?$K<g5-21NN0h$H7FG[CV5l$F$$$kNN0hKBP7Fb!"%M%C%H%"%I%l%9$r<+%/%i%9%?$N%/%i%9%?%"%I%l%9$KJQ49$7$J$$$H%"%/%;%9G-$J$$$H$$$&7gE@$,$"$k!#$7$+$7!"3F%/%i%9%?K*$$$FB>$N%/%i%9%?%a%b%j$N%3%T!<H7$FMxMQ$5lF$$$kNN0h$K%"%/%;%9$9$k;~$K$O!"Ev3:NN0h$r<g5-21H7$F;}$D

%/%i%9%?K*1k%Z!<%8%s%0$K4X78$J$/ %"%/%;%9$9k3H,G-$k!#$D$^$j!"3F NNO h$r<g5-21NNO h$H7F;}$D%/%i%9%?$K $*$$$FN_4IM}$9$1Ph$$!#

%M%C%H%"%I%l%9$H%/%i%9%?%"%I%l%9$NJQ49=h M}$H!"NNO h$r6&M-9kA4%/%i%9%?$N%Z!<%8%F!< %V%k$r=q-49($k=hM}$G$O!"=hM};~4V5Z$S<j 4V$,Bg$-$/0[$J$k!#$hCF!"%M%C%H%"%I%l%9$O 8GM-$N%/%i%9%?$H4XO"$E1:$K!"2>A[2=$9$k!#

%M%C%H%"%I%l%9$OO@M}%"%I%l%95Z$S%/%i%9 %?%"%I%l%9HNBP1~$,40A4$K2>A[2=5l$F$$ k?$a!"4pK\E*$K$O<+M3$J%"%I%l%9IU1,2D G=G"$k!#$7$+$7!"%M%C%H%"%I%l%9$NO lCW$K hC$F%G!<%?$N6&M-$,<B8=$5lk$?$a!"8zN(Nh$$=hM}r9$kO Y$K$O!"%M%C%H%"%I%l%9$N @8@.K!O"$kDxEY%7%9%F%^%F%#%C%/$G$"$j!"9b B.@8@.2DG=G"k3H,I,MWG"$k!#K\8&5f K*$$$F$O!"O@M}%"%I%l%9$r%W%m%;%9ID $G3H D%$7$?$bNr%M%C%H%"%I%l%9H7$F;HMQ$9$k!#

3.1.2 %3%R!<%l%s%9@)8fJ}<0

%/%i%9%?4VGO!"%G%#%l%/%H%jJ}<0$G%3%R!<%l %s%9$r@)8f9k!#%G!<%?$N%/%i%9%?4V6&M->uBV$r 4IM}9k%G%#%l%/%H%j$r1 8D=j$KG[CV7?>l9g$K $OD L?.$N=8Cf2=Kh$k@-G=Dc2<$,M=A[5l!"Kt3F %W%m%;%C%5$N%a%b%j%"%/%;%9$NBgH>$,<+%/%i%9%? $,<g5-21NNO h$G$"$k%G!<%?XN%"%/%;%9G"k3 Hr9MN8$7!"%G%#%l%/%H%j$O3F%/%i%9%?$KJ,;6G[CV$9$k!#

3.1.3 %3%R!<%l%s%9%W%m%H%3%k

%/%i%9%?4V$N%a%b%j%3%R!<%l%s%9$O!"%M%C%H%" %I%l%9KhCF6&M->uBV$r4IM}$9$k%/%i%9%?$r7h Dj$7!"$=$N%/%i%9%?$,%/%i%9%?4V$N6&M->uBV$r5- 21$9$k%G%#%l%/%H%j$rJ];}$9k3HG@)8f9k!#$3 $N%/%i%9%?$r$=$N%M%C%H%"%I%l%9KBP9$k Home %/%i%9%?$H8F$V!#%/%i%9%?4V$N%a%b%j4IM}A`:n$K $*$1$k%3%R!<%l%s%9%W%m%H%3%k$r0J2<Nh$&$KDj 5A9k!#

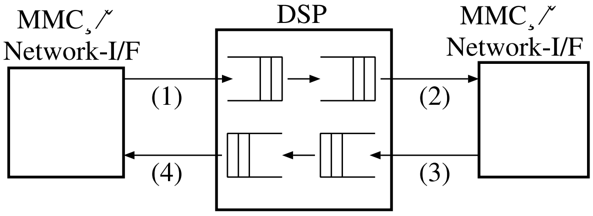
- %/%i%9%?%a%b%j9 9?7;~K*1k!"B>%/%i%9%? $N%a%b%j$NL58z2=!?9 9?7 %V%m%C%/Kt$O%Z!<%8C10L$G@ZjBX(2DG=G" $k!#$?$@$7!"J#?t$N%/%i%9%?$,%G!<%?$r6&M- 9k;~KO!"Ev3:NNO h$NHome %/%i%9%?$K:G ?7%G!<%?r*$/h&$K@_7W9kNG!"Home %/%i%9%?$N%G!<%?$O9 9?7$7$J1lPJiJ$$!#
- %_%9%R%C%H;~K*1kl~Ez@UG$ %*!<%J!<%7%C%W%W%m%H%3%k$r:NMQ$9$k!#$D$^ $j!"MW5a$KBP9kl~Ez$O%*!<%J!<%7%C%W$r=j M-9k%/%i%9%?$,9T$&!#MW5aN"C?NNO h$N Home %/%i%9%?$K:G?7%G!<%?$,$"$k>l9g$O!" Home %/%i%9%?$,%*!<%J!<%7%C%W$r=jM-9k!# :G?7%G!<%?$,Home %/%i%9%?$K$J$$>l9g$O!" :G?7%G!<%?$r;}$D%/%i%9%?$O$?$@0lD7$+$J $$$N$G!":G?7%G!<%?$r;}CF$$$k%/%i%9%?$, %*!<%J!<%7%C%W$r=jM-9k!#
- <g5-21$N=q$-La$7 J#?t$N%/%i%9%?4V$G6&M-$5lF$$$kNNO h$O!" Ev3:NNO h$NHome %/%i%9%?Kb:G?7%G!<%?$, $"$kNG=q$-La$7NI,MWO$J$$!#Home %/%i%9 %?0J30N?$@1 DN%/%i%9%?K7$+:G?7%G!< %?$,$J$$;~$K%G!<%?$N%j%W%l!<%9$,5/$3C? ;~$O!"Home %/%i%9%?$KBP7F=q$-La$7$N@U G$$,$"$k!#

3.1.4 %3%R!<%l%s%9@)8f$N6%9g

F10l$NNNO h$KBP9k%3%R!<%l%s%9@)8fMW5a$,J# ?t$N%/%i%9%?$+$i5/3C$F!"6%9g$,5/$-$k>l9g$, $"$k!#K\8&5fK*1k%3%R!<%l%s%9@)8f%W%m%0%i %`K*$$$F$O!"F10l%V%m%C%/$KBP9k%3%R!<%l%s %9@)8f$,?J9TCf$G$"$k%Q%1%C%H$N=hM}$O!"%3%R!< %l%s%9@)8f$,=*N;$9k^$G3+;O$7$J$$!#9JoA!" DSP KBP9$k%Q%1%C%H$NE~Ce=g=x$,$=N^$^=hM} $N=g=x$KJk!#3NJ}<0K*$$$F$O!"F10l%V%m%C %/$KBP9kJ#?t%/%i%9%?4VGN%"%/%;%9=g=x$,I, $:$7$b7k2L$KH?1G9kHO8BiJ$$!#

3.2 %W%m%;%9@)8f3,AX

DSP $KE~Ce$7$?%Q%1%C%H$r=hM}9kK"$?$C$F $NJ}?K$K$D$$$F=RYk!#0J8e!"%/%i%9%?4V$N%3%R!<



?^3: %Q%1%C%H$N=hM}

%l%s%9@)8frI,MWH9k%a%b%j%"%/%;%9$KH<$&0l
O"$N>uBVA+0\5Z$S%G!<%?E>Aw$r%H%i%s%6%/%7%g%s
$H8F$V!#

0J2<K\@aGO!"%H%i%s%6%/%7%g%sKBP9$kDSP
K*1k=hM}$NC10L!"5Z$S=hM}$N%9%1%8%e!<%j%s
%0$K4X$9$k9M;!$r9T$&!#

3.2.1 %H%i%s%6%/%7%g%sK*1k=hM}C10L

%H%i%s%6%/%7%g%sKBP9$k DSP K*1k=hM}
$O!"=hM}MW5a%Q%1%C%H$,E~Ce9k3HKhCF3+
;O9k!#=hM}MW5a%Q%1%C%H$,E~Ce$7F+iNDSP
K*1k=hM}$NN.$l$r?^3$K<($9!#3FCJ3,$K$*$1
$k=hM}$O0J2<$K<($9H*jG$"$k!#

(1) MMC Kt$O Network-I/F $+$i=hM}MW5a%Q%1%C
%H$,E~Ce$9k3HKhj!"DSP K*1k=hM}$,3+
;O9k!#

(2) MMC KBP9$k%a%b%j%"%/%;%9MW5a%Q%1%C%H!"
b7$/$O Network-I/F KBP9$k=hM}MW5a%Q%1%C%H
rAwj!"1~Ez%Q%1%C%HrBTD!#

(3) 1~Ez%Q%1%C%H$,JV$CF/kH!"1~Ez%Q%1%C%H$K
4pE/=hM}$r3+;O$9$k!#

(4) :G=i$NMW5a%Q%1%C%H$KBP9k0 8D0J>e$N1~Ez
%Q%1%C%H$rAw?.$9k3HG!"=hM}$O=*N;$9$k!#

DSP K*1k%9%1%8%e!<%j%s%0$N:G>.C10L$G$"
$k%W%m%;%9$N!">e5-$N=hM}$NN.lK$*$1$kDj5A$N
J}K!KO!"0J2<Nh$&$JJ}K!$,9M$(il$k!#

- MW5a%Q%1%C%H$r<u$1<hCF$+$i1~Ez%Q%1%C%H
  BTAKJk$^$G!"5Z$S1~Ez%Q%1%C%H$r<u$1<h$C
  F+$i0 8D0J>e$N%Q%1%C%H$rAw?.$7$F=hM}$r
  CfCG9k$^$G$=$l$>$l$r%W%m%;%9$H9k!#$3
  $NJ}<0$K$*$$$F$O!"1~Ez%Q%1%C%HBT$A$N4V%W%m%;%9A4BN$rJ]B8$;$:$K1~Ez%Q%1%C%H$KhC
  $F@8@.$5lk%W%m%;%9KI,MWJ%G!<%?N_$r
  J]B8$9$lPh$$$H$$$&MxE@b"k,!"1 2s$N
  %H%i%s%6%/%7%g%sKBP7$F2 DN%W%m%;%9$r
  @8@.9kI,MW$,$"kH$$$&7gE@$,$"$k!#
- MW5a%Q%1%C%H$r<u$1<hCF$+$i!"1~Ez%Q%1%C%H
  rJV7$F=hM}$,A4$F=*N;$9k^Gr%W%m%;%9
  H9$k!#$3$NJ}<0$K$*$$$F$O!"1~Ez%Q%1%C%H
  BTAN4V%W%m%;%9A4BN$rJ]B8$7J1lP$$1
  $J$$$H$$$&7gE@$,$"k,!"1~Ez%Q%1%C%HE~Ce
  ;~KO%W%m%;%9$r@8@.$7D>$9I,MW$,$J$$$H$$
  $&MxE@$b$"$k!#5i$K!"1~Ez%Q%1%C%HBT$A$N
  %W%m%;%9$rJ]B8$9k3HKhj!"Ev3:%V%m%C
  %/$,%3%R!<%l%s%9@)8fC f$G$"$k;v$,4IM}$5$l!"
  %3%R!<%l%s%9@)8f$N6%9g;~$KMxMQG-$k!#

>e5-$N9M;!$K4pE-!"MW5a%Q%1%C%H$,E~Ce$7F+
$i!"4XO"=hM}$,=*N;7F1~Ez%Q%1%C%H$rAw?.$9$k
$^$G$r%W%m%;%9$HDj5A$7!"DSP K*1k=hM}$N:G
>.C10LH7$F%9%1%8%e!<%j%s%0$NBP>]H9$k!#

3.2.2 %9%1%8%e!<%j%s%0J}<0

A09`$G=R$Y$?$h$&$K!"MW5a%Q%1%C%HKBP9$k0l
O"$N=hM}$r DSP K*1k%9%1%8%e!<%j%s%0$N:G
>.C10LH9$k!#K\9`$G$O!"MW5a%Q%1%C%H$N=hM}=g
=xKD$$$F$N@_7WJ}?K$K4X9k9M;!$r9T$&!#

;OaK!"%Q%1%C%H$NC`<!=hM}5Z$SJB9T=hM}$=$l
$>$l$NMxE@!"7gE@$K$D$$$F=RYk!#

1. %Q%1%C%H$rC`<!=hM}$7$?>l9g
   (1) MxE@
       - %Q%1%C%H$rE~Ce=g$K=hM}7F$$$/NG!"
         =hM}MW5aKBP9$k%j%"%k%?%$%`@-$,K~$?
         5l$k!#
       - MW5a%Q%1%C%H$KH<$&=hM}$,=*N;$b7/$O
         CfCG7?H-0J30$O!"=hM}%Q%1%C%H$N@Z
         jBX($r9T$o$J$$$N$G!"%Q%1%C%H$N@Z$j
         BX$($Khk%*!<%P!<%X%C%I$,>/$J$$!#
       - E~Ce%Q%1%C%H$N4IM}$O FIFO %-%e!<$K
         hC$FHf3SE*4JC1$K9Tol$k!#
   (2) 7gE@

- =hM}$NM%@hEY$,Hf3SE*Dc$/<B9T;~4V$ND9$$%Q%1%C%H$N=hM}$Khk%W%m%;%C%5$NFH@j$,5/3j!"M%@hEY$N9b$$%Q%1%C%H$N=hM}$,CYlk2DG=@-$,$"$k!#

2. %Q%1%C%H$rM%@h=g0LIUJB9T=hM}$7$?>l9g

   (1) MxE@

   - 6&M-%a%b%j4IM}5!9=K*$$$F!"=hM}$NM%@hEY$N9b$$%Q%1%C%H$r@h$K=hM}G-$k!#
   - M%@hEY$,Dc$/!"<B9T;~4V$ND9$$%Q%1%C%H=hM}Kh$k%W%m%;%C%5$NFH@jrKI0!#

   (2) 7gE@

   - 3F%Q%1%C%HKBP9$k=hM}$,!"%j%"%k%?%$%`$G9Tol$J$$!#
   - =hM}%Q%1%C%H$NJQ49$Khk%*!<%P!<%X%C%I$,Bg$-$$!#

%/%i%9%?4V%3%R!<%l%s%9@)8f5!9=K*$$$F$O!"3F%Q%1%C%H$KBP9k=hM}$N%j%"%k%?%$%`@-hj$bA4BN$N=hM};~4V$NC;=L$,MW5a5l$k!#

%3%R!<%l%s%9@)8fL?NaNCfK$O!"%Z!<%8C10L$N%/%i%9%?4VE>AwJI$N=hM};~4V$NHs>o$KD9$$%Q%1%C%H$bB8:_$9$k!#$3lKBP$7!"%G!<%?$NL58z2=L?Na!"Ev3:NN0h$N Read BT5!!"6&M->uBV4IM}%F!<%V%k$N=q$-49$(Ey$N=hM}$OC;;~4V$G=*N;9k!#3Nh&$K=hM};~4V$KBg$-$J:9$,$"kG$"$m$&%Q%1%C%H$N=hM}$r=c?h$KE~Ce=g$K9T$C$F$$$/NOL5BL$,B?$$!#Kt!"=hM}$NM%@hEY$NHs>o$K9b$$%Q%1%C%H$bB8:_$9$k!#0J>e$NM}M3Kh$j%Q%1%C%HJB9T=hM}J}<0$r:NMQ9k!#

%Q%1%C%HJB9T=hM}$r<B8=$9$kJ}K!$H7F!"<!$N2DL$j$NJ}<0$,9M$($ilk!#

- E~Ce%Q%1%C%H$N3d$j9~$_=hM}

  DSP KBP7$F Network-I/F 5Z$S MMC $,%Q%1%C%H$rAw?.9kH-$K3d$j9~$_$r$+$1$k!#8=:_=hM}Cf$N%Q%1%C%H$NM%@hEY$,Dc$$;~KO3N3d$j9~$_$,<uM}$5$l!"8=:_=hM}Cf$N%Q%1%C%H$rBTHr$5$;$FE~Ce7?%Q%1%C%H$N=hM}$r3+;O9k!#Network-I/F 5Z$S MMC KBP7FO!"3d$j9~$_$,<uM}$5lF%Q%1%C%H$,<u$1<hil$?$3HrCNi;$k!#8=:_=hM}Cf$N%Q%1%C%H$NM%@hEY$,9b$$;~KO3d$j9~$_$O5qH]$5$l!"=hM}$,=*N;9k$^$G%Q%1%C%H$N<u<h$jOBT?5l$k!#

- %9%1%8%e!<%iKh$k=hM}%Q%1%C%H$N%9%1%8%e!<%j%s%0

  DSP $KE~Ce$7$?%Q%1%C%H$r0lC6%-%e!<Kt$O%P%C%U%!$K3JG<9k!#8=:_<B9TCf$N%Q%1%C%H=hM}$,CfCGb7$/$O=*N;9k$H=hM}$r%9%1%8%e!<%i$K0\$9!#%9%1%8%e!<%iK*$$$F$O%-%e!<Kt$O%P%C%U%!$K3JG<$5l?%Q%1%C%H!"5Z$S8=:_=hM}$rCfCGCf$N%Q%1%C%H$NCf$+$iM%@hEY$N9b$$%Q%1%C%H$rA*Br$7$F=hM}$r3+;O9k!#=hM}$NM%@hEY$NDc$$%Q%1%C%HKh$k%W%m%;%C%5$NFH@jrKI0$?$a!"%Q%1%C%H$N=hM}L?Na$NCf$K!"=hM}$N=*N;5Z$SCfCGA0$K0lDj;~4VKh$K=hM}$r5Y;_7F%9%1%8%e!<%i$K@)8f$r0\$9L?NarKda9~$`!#

%/%i%9%?4V%3%R!<%l%s%9@)8f$N2 3,AX$N%W%m%0%i%`$r@_7W!"<BAu$9$k$K$"$?$C$F$O!"$G$-$k$?$1$*8_$$$KFHN)$7$?%W%m%0%i%`3+H/$r?J$a$?$$!#%9%1%8%e!<%iKh$k=hM}%Q%1%C%HA*BrJ}<0$K$*$$$F$O!"%Q%1%C%H@)8f3,AX$N%W%m%0%i%^$O5Y;_L?Na$rKd$a9~$`%?%$%_%s%0$JIr0U<1$7$J$/$F$O$$$1$J$$!#hC$F!"%W%m%;%9@)8f3,AX$N@_7WK"$?$CFO!"%Q%1%C%H@)8f3,AX$N%W%m%0%i%^$Khj@)Ls$rM?$($J$$3d$j9~$_J}<0$r:NMQ$9$k!#

%Q%1%C%H$NM%@hEY$H7F$O!"Hs>o$KM%@hEY$N9b$$$=hM}$+$i!"=hM};~4V$,D9$/M%@hEY$NDc$$=hM}$^$G!"?tCJ3,$KJ,$1k3H,9M$($i$k!#$hCF%Q%1%C%HE~Ce;~KO!"%Q%1%C%H$NM%@hEY$K1~8?3d$j9~$_$r3]$1!"=hM}Cf$N%Q%1%C%H$h$jM%@hEY$,9b$$$>l9gKO3d$j9~$_$,G'$ail$kJ}<0$,9M$($ilk!#$?$@$7K\9F$G$O4JC1$N$?$a!"%Q%1%C%H$NM%@hEY$,3d$j9~$_2DG=$G=hM}$9$k%Q%1%C%H$H3d$j9~$_IT2DG=$G<B9T$9$k%Q%1%C%H$N2 CJ3,N_G"$k7A<0$K$D$$$F=RYk!#

4 %/%i%9%?4V%3%R!<%l%s%9@)8f5!9=$N<BAu

K\>OGO!"%/%i%9%?4V$N%3%R!<%l%s%9$r@)8f9k!"%Q%1%C%H@)8f3,AX%W%m%0%i%`5Z$S%W%m%;%9@)

8f3,AX%W%m%0%i%`$=$l$>$l$N<BAu$K$D$$$F=RYk!#

4.1 %Q%1%C%H@)8f3,AX%W%m%0%i%`

K\@aGO!"%/%i%9%?4V%3%R!<%l%s%9@)8fK*1k%Q%1%C%HKh$k>pJsEAC#$NJ}<0!"5Z$S3F%/%i%9%?$K$*$1$k=hM}FbMF$r7hDj9k%W%m%0%i%`$N9=@.$K$D$$$F=RYk!#

4.1.1 %H%i%s%6%/%7%g%sK*1k3F%/%i%9%?$N>uBV

3>O$G=R$Y$?$h$&$K!"%/%i%9%?4V%3%R!<%l%s%9@)8fK*$$$F$OJ,;6%G%#%l%/%H%jJ}<0$r:NMQ7F$$$k!#%G!<%?$N%/%i%9%?4V6&M->uBV$r<($9%G%#%l%/%H%j$O!"%M%C%H%"%I%l%9KhCF3F%/%i%9%?$KJ,;6G[CV$5lF$$$k!#3F%/%i%9%?$O!"Ev3:%M%C%H%"%I%l%9$N%/%i%9%?4V6&M->uBV4IM}%G%#%l%/%H%j$rJ];}$9$k%/%i%9%?HV9f$r<($9I=$rJ];}7F$$$k!#

%/%i%9%?4V$N%3%R!<%l%s%9@)8f$rI,MWH9$k%a%b%j%"%/%;%9$r9T$$!"%H%i%s%6%/%7%g%s$r3+;O$7$?%/%i%9%?$rK\%H%i%s%6%/%7%g%sK*1kInitiator $H8F$V!#%H%i%s%6%/%7%g%s$NBP>]$HJk%G!<%?$N%G%#%l%/%H%j$OBP>]HJ$k%M%C%H%"%I%l%9$KBP1~7?Home %/%i%9%?$,J];}$9k3HK9k!#%3%R!<%l%s%9%W%m%H%3%kH7$F%*!<%J!<%7%C%W%W%m%H%3%k$r:NMQ$7$?7k2L!"3F%/%i%9%?$O%H%i%s%6%/%7%g%s$NBP>]$HJk%M%C%H%"%I%l%9$N%G!<%?$NJ]M->uBVKhCF!"0J2<Nh$&$KJ,N`5l$k!#

- Renter
  %H%i%s%6%/%7%g%s$NBP>]$HJk%"%I%l%9$N!"M-8z$J%G!<%?$r=jM-$9$k%/%i%9%?!#%_%9%R%C%H;~$KCMrJV9@UG$$O;}CF$$$J$$!#

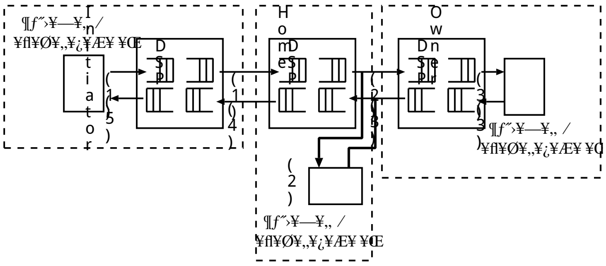
- Owner
  %H%i%s%6%/%7%g%s$NBP>]$HJk%"%I%l%9$NM-8z$J%G!<%?$r=jM-$7F*$j!"B>%/%i%9%?$K$*$1$k%_%9%R%C%H;~$KCMrJV9@UG$$r;}$D%/%i%9%?!#Home %/%i%9%?$KM-8z$J%G!<%?$,B8:_9kH-KO!"Home %/%i%9%?$,Owner HJ$k!#Home %/%i%9%?$KM-8z$J%G!<%?$,$J$$;~KO!"M#0lM-8z$J%G!<%?$r;}CF$$$k%/%i%9%?$,Owner HJ$k!#

- Others
  Home %/%i%9%?0J30$G!"%H%i%s%6%/%7%g%s$NBP>]HJ$k%"%I%l%9$N%G!<%?$r=jM-$7$J$$%/%i%9%?!#Ev3:%H%i%s%6%/%7%g%s$K4X$9$k%Q%1%C%H$OE~Ce7J$$!#

4.1.2 %Q%1%C%H5Z$S@)8f$NN.$l

3F%H%i%s%6%/%7%g%sK*$$$F!"3F%/%i%9%?O=l>lN>uBV$K1~$8$?=hM}$r9kI,MW$,$"$k!#E57?E*$J2%Q%?!<%s$N%H%i%s%6%/%7%g%s$K$*$1$k%Q%1%C%H$NN.$l!"5Z$S3F%/%i%9%?K*1k=hM}KD$$$F=RYk!#$3$3GO=hM}$N40N;$rAj<j%/%i%9%?$KDLCN$9$k?.9f$NN.lO>JN,9k!#

- Ev3:%/%i%9%?$K:G?7%G!<%?$N$J$$%"%I%l%9XNRead MW5a$,5/$3C?;~(%j!<%I%_%9%R%C%H)



?^4: Read ;~$N%Q%1%C%H$NN.$l

3F%/%i%9%?K*$$$F$O0J2<$Nh&$J=hM}$,9Tol$k!#%Q%1%C%H$NN.lr?^4$K<($9!#

1. Read MW5a$r5/$3$7$?%/%i%9%?$O%H%i%s%6%/%7%g%s$NInitiator HJ$j!"BP>]$HJk%"%I%l%9$NHome %/%i%9%?$KBP7EMW5a%Q%1%C%HrAwk!#(Initiator $, Home G"$k;~$O3N%Q%1%C%H$NAw<u?.$O>J$+lk)
2. Home $KEv3:%"%I%l%9$N:G?7%G!<%?$,$"$k;~$O Home $,CM$rJV$9@UG$$r;}DN$G!"MMC KBP7$F%a%b%jNFI_=P$7MW5a$r=P7F!"%a%b%j$NCMrFI_=P$9!#Home $K:G?7%G!<%?$,$J$$;~$O!"6&M->u

BV4IM}%G%#%1%/%H%j$r;2>H$7$F:G?7%G!<%?$r;}$DM#0l8D$N%/%i%9%?(Owner) $rC5$7!":G?7%G!<%?NFI_=P$7MW5a$N%Q%1%C%HrAwk!#

3. MW5a%Q%1%C%H$,Owner KFO/$HOwner $O MMC KBP7FCMNFI$_=P7rMW5a7?8e!"Home KBP71~Ez%Q%1%C%HrAwk!#Home $O Owner $+$i$N1~Ez%Q%1%C%H$r<u$1<h$k$H!"Home $N%/%i%9%?%a%b%j$K$*$1$kEv3:%"%I%l%9$N%G!<%?$r9?7$9$k!#$3lKhj!"Home $K:G?7%G!<%?$,B8:_9kh&KJC?NG!"Home $,Owner HJ$k!#

4. Home $O:G?7%G!<%?$r Initiator $KAw?.$9kH6&$K!"Initiator Kb:G?7%G!<%?$,B8:_$9kh$&$KJkNG!"6&M->uBV4IM}%G%#%l%/%H%j$r=q$-49$($k!#

5. Initiator $,Home $+$i$N1~Ez%Q%1%C%H$r<u$1<h$C$F MMC KBP7FFI_=P$7MW5aN"C?CM$rJV7?;~E@$G!"%H%i%s%6%/%7%g%s$O=*N;9k!#

- %/%i%9%?4V$G6&M-$5lF$$$kNN0hXN Write MW5a$,5/$3C?;~(%i%$%H%R%C%H)0J2<$K%/%i%9%?4V$N%Q%1%C%H$NN.$l5Z$S%/%i%9%?K*1k=hM}$r=R$Y$k!#

  1. Initiaor K*$$$F%-%c%C%7%e5Z$S%/%i%9%?%a%b%j$N99?7$,9T$ol?8e!"Write MW5a$NBP>]$HJk%"%I%l%9$N Home KBP7$F%3%R!<%l%s%9@)8fN?aNMW5a%Q%1%C%H$,Awil$k!#Initiator $,Home G"$k;~$O!"3N2aDx$O>J$+lk!#
  2. Home K*$$$F6&M->uBV4IM}%G%#%l%/%H%j$,;2>H$5$l!"Ev3:%"%I%l%9$N:G?7%G!<%?$r;}$D%/%i%9%?KBP7$F99?7Kt$OL58z2=N?aNMW5a%Q%1%C%H$rAw?.$9kHF1;~$K!"Home $N%G!<%?$b99?7Kt$OL58z2=$9$k!#Initiator $+$i$N99?7MW5a$,5/3C$?;~$K!"Home K*$$$F3F%/%i%9%?KBP9$k99?7Kt$OL58z2=$rA*Br$G$-$k5!G=3HD%$b9M$(il$k!#
  3. Home $+$i$N99?7Kt$OL58z2=$NMW5a%Q%1%C%H$r<u$1<h$C$?%/%i%9%?(Renter) K*$$$F%G!<%?$N99?7Kt$OL58z2=$r9T$&!#

- Ev3:%/%i%9%?$K:G?7%G!<%?$N$J$$$NNN0hXN Write MW5a$,$"C?;~(%i%$%H%_%9%R%C%H) Write $,%3%R!<%l%s%9@)8f$N:G>.C10LG"$k%V%m%C%/A4BN$K5ZsG$$$k>l9gKO!"%i%$%H%R%C%H;~$HF10l$N@)8f$,J5lk!#3lKBP7!"Write $,%V%m%C%/$N0lItJ,G"$k>l9g$K$O!"%3%R!<%l%s%9@)8f$N:G>.C10L$O%V%m%C%/$G$"$j Home %/%i%9%?K*$$$F3F%/%i%9%?$N%a%b%j$,%V%m%C%/Fb$GM-8z$JItJ,$HL58z2=$5lF$$$kItJ,$,$"k3HO4IM}G-$J$$$N$G!"Ev3:%V%m%C%/$N;DjNItJ,$N:G?7%G!<%?$rFI$_9~$sG/kI,MW,$"$k!#3N>l9g!"%i%$%H%_%9%R%C%H;~$NMW5a$O!"%j!<%I%_%9%R%C%H$Khk:G?7%G!<%?E>AwMW5a$H!"%i%$%HKh$k99?7Kt$OL58z2=MW5a$NN>J}$N%Q%1%C%H$rAw?.$9k3HKhC$F<B8=$5lk!#

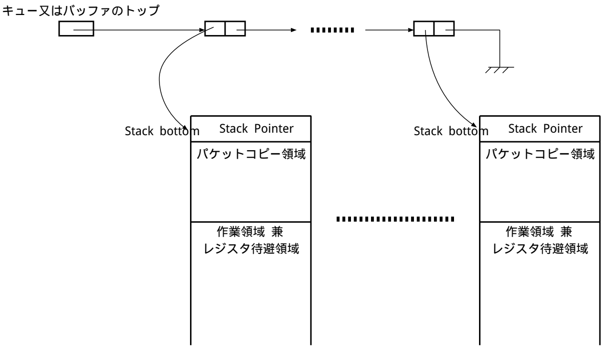
%/%i%9%?4V%3%R!<%l%s%9@)8f5!9=K*$$$F$O!"F10l%V%m%C%/$KBP9k%3%R!<%l%s%9@)8f$O!"3F%/%i%9%?$K$*$$$F40A4$KC`<!<B9T$9$k!#>e5-$K=R$Y$?$h$&$K!"$"$i$f$k%H%i%s%6%/%7%g%s$,Home %/%i%9%?7PM3$G<B8=$5$l!"Home %/%i%9%?$+$i%7%9%F%`A4BN$K9-$,$kNG!"F10l%V%m%C%/KBP9$k@)8f$,6%9g7?;~KO!"Home %/%i%9%?$KMW5a%Q%1%C%H$,E~Ce7?=g$K=hM}$5lk!#3N=g=x$O%H%i%s%6%/%7%g%s$NH/@8=g=xHOI,$:$7$b0lCW$7$J$$!#

7+$7!">e5-$N9M;!$O!"%Q%1%C%H$NH/?.85$N%/%i%9%?!"H/?.@h$N%/%i%9%?$=$l$>$l$,F1$8G"$k%Q%1%C%HE>Aw$K$*$$$F!"%Q%1%C%H$NDI$$1[7,5/$-$J$$$H$$$&>r7oNbHGN_@.$jN)$D!#RDT-Network Kh$k%/%i%9%?4VDL?.$O!"2>O$G=R$Y$?$h$&$K%/%i%9%?4V$N#1BP1DL?.!"5Z$S2<0L%N!<%IKBP9$k%V%m!<%I%-%c%9%H$KhkDL?.$N2<oN`$NDL?.7A<0$,B8:_$9$k!#$3$N2<oN`$NDL?.7A<0$O!"F1<o$NDL?.7A<04VGO%Q%1%C%H$NDI$$1[7O5/$-$J$$$,!"#1BP1DL?.$H%V%m!<%I%-%c%9%H$KhkDL?.$,O"B3$7$?;~$K$O!"DL?.$NDI$$1[7,5/3k2DG=@-$,$"$k!#$hCF!"3F%/%i%9%?K*$$$F%Q%1%C%H$NAw?.=g=x$r9MN8$9$kI,MW$,$"$k!#

$?$@$7!"K\8&5f$K$*$$$F$O!"DL?.7A<0$H7F%/%i%9%?4V$N#1BP1DL?.$N$_$r;HMQ7?bNKBP9$k<BAu7A<0$r=RYk!#

4.2 %W%m%;%9@)8f3,AX%W%m%0%i%`

DSP $KE~Ce$9$k=hM}MW5a%Q%1%C%H$KBP7F@8@.5l$k%W%m%;%9$N4IM}!"5Z$S%9%1%8%e!<%j%s%0$r9T$&%W%m%0%i%`$N9=@.$r<($9!#



?^5: %9%?%C%/$N9=@.

4.2.1 %W%m%;%9%9%?%C%/

3>O$G=R$Y$?$h$&$K!"DSP $KMW5a%Q%1%C%H$,E~Ce7F$+$i!"$=$N%Q%1%C%H$NFbMF$KH<$&=hM}$,40A4$K=*N;$9k^GN=hM}$r1$D$N%W%m%;%9$H7F07$&!#3F%W%m%;%9$K$O:n6HNN0h$H7F$=$l$>$l1D:$D%9%?%C%/$rMQ0U9k!#%9%?%C%/$N9=@.$r?^5$K<($9!#%9%?%C%/$O!"3F%W%m%;%9$N:n6HNN0hH7FP$+$jGOJ/!"0J2<$K<($9MM$JMM!9$JL\E*$N0Y$KMxMQ9k!#

- %Q%1%C%H$N%3%T!<

  3F%W%m%;%9$O!"$?$@0l8D$NMW5a%Q%1%C%HKhCF@8@.5l$k!#$^$?!"RDT-Network K*$$$FEAAw5l$k%Q%1%C%H!"5Z$S6&M-%P%9$+$iMMC rDL7$F DSP KAwilk%Q%1%C%H$O8GDjD9G"$k!#hC$F!"3F%W%m%;%9$K4Xok%Q%1%C%H$N@jM-9kNN0h$O0lDjG"kN$G!"%9%?%C%/>e$K%Q%1%C%H$N%3%T!<NN0h$r3NJ]7F!"%3%T!<9k!#MW5a%Q%1%C%HKO!"=hM}$NBP>]$HJk%"%I%l%9$d=hM}$NFbMF$r<($9L?NaJI$,F~$CF*$j!"%W%m%;%9<B9T;~$K9bB.%"%/%;%92DG=$J%9%?%C%/>l$K%Q%1%C%H%G!<%?r*$/$3HKhk@-G=$N8~>e$_3^lk!#Kt!"Ev3:%W%m%;%9$K4X78$9$k%G!<%?$rA4$F%9%?%C%/>e$KJ]B8$9$k;vKh$k!"%W%m%;%94IM}$N4JAG2=b_3^lk!#

- %l%8%9%?$NBTHr

  <B9TCf$K3d$j9~$_$,$+$+C?%W%m%;%9b7$/$O1~Ez%Q%1%C%HBTAKJC$?%W%m%;%9$O!"8=;~E@K*1k<B9T>uBV$rJ]B8$9k?aK!"A4%l%8%9%?NCMrBTHr7J1l$P$$$1$J$$!#3NBTHrNN0hH7$F%W%m%;%9$N%9%?%C%/$r;HMQ$9$k!#%l%8%9%?$NBTHr$r%f!<%6$N@UG$$G9T$&J}K!$b9M$($ilk$,!"%l%8%9%?$N;HMQ>u67$N4IM}$JIOJ#;(G"kN$G!"%Q%1%C%H@)8f3,AX$K$*$$$F%l%8%9%?$NJ]B8$r9T$&!#

- %W%m%;%9$NJ]B8

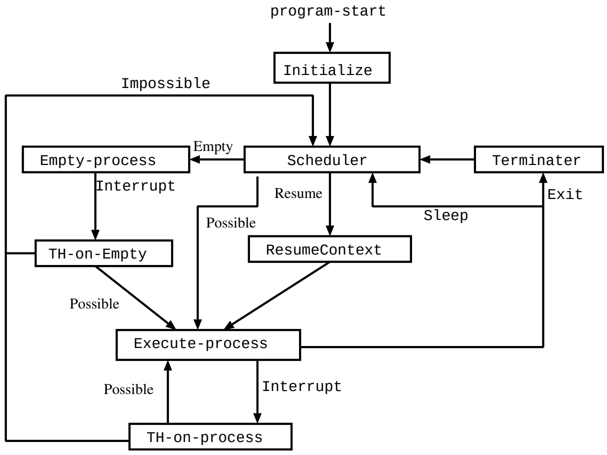
  3d$j9~$_KhCF=hM}$,CfCG$5l?%W%m%;%9!"1~Ez%Q%1%C%HBTAKJC$F=hM}$,CfCG7?%W%m%;%9!"F10l%V%m%C%/KBP9$k%3%R!<%l%s%9@)8f$,<B9TCf$G<B9T3+;O$G$-$J$$%W%m%;%9!"3liN%W%m%;%9$NJ]B85Z$S4IM}N?aK3F%W%m%;%9$N%9%?%C%/$rMxMQ9k!#3F%W%m%;%9$O%W%m%;%9%l%3!<%I$r;}$?$:!"%9%?%C%/NN0h$K%W%m%;%9$N<B9TKI,MWJ>pJs$,A4$F4^$^$lF*$j!"%l%8%9%?$rI|5"9k3H$G=hM}$,:F3+9k!#%9%?%C%/$O!"?^??$K<(9h$&$K!"%-%e!<Kt$O%P%C%U%!$KDJ$,$l$F4IM}$5lk!#

DSP K*$$$F3F%W%m%;%90J30$N%k!<%A%s$r<B9TCf9k;~KO!"%W%m%;%9MQ$N%9%?%C%/$GJ/#1K\$N%7%9%F%`%9%?%C%/NN0h$r;HMQ$9$k!#%W%m%;%9%9%?%C%/$H$OJL$KMQ0U$7$F!"%W%m%;%90J30$NA4$F$N=hM}$,%7%9%F%`%9%?%C%/$r6&F1;HMQ$9$k!#

4.2.2 %W%m%;%9@)8f%W%m%0%i%`

MMC 5Z$S Network-I/F $+$i DSP $KE~Ce$7$?%Q%1%C%H$KBP9k=hM}$NN.$l$r<($9!#@h$K=R$Y$?$h$&$K DSP K*$$$F$O%^%k%A%Q%1%C%H=hM}J}<0$r:NMQ7F$$$k!#%Q%1%C%H=hM}$NM%@h=g0L$O%Q%1%C%H@)8f3,AX$K7hDj8"$rBw$9!#

MW5a%Q%1%C%HE~Ce;~$K%W%m%;%9$r@8@.9k;~KO!"%Q%1%C%HGAwilF$-$?%M%C%H%"%I%l%9$r%/%i%9%?%"%I%l%9$KJQ49$9$kI,MW$,$"$k!#F1MM$K!"%Q%1%C%H$rAw?.$9$k;~$K$O%/%i%9%?%"%I%l%9$+$iBP



?^6: %W%m%0%i%`$N@)8f$NN.$1

1~9k%M%C%H%"%I%1%9$r5a$akI,MW,$"$k! #%M%C%H%"%I%1%9$H%/%i%9%?%"%I%1%9$NBP1~I=$O3F%/%i%9%?$G4IM}9k! #

3F%W%m%;%9KO:n6HNN0hH7$F%9%?%C%/NN0h$r3djEvF! "%W%m%;%9$N4IM}5Z$SBTHrKbMxMQ9k! #hC$F! "DSP $KE~Ce$7$?MW5a%Q%1%C%H$KBP9k%W%m%;%9$r@8@.$9kHO=$N%Q%1%C%H$KBP$7%9%?%C%/NN0h$r3NJ]9k3H$r0UL#$7! "%W%m%;%9$,=*N;!">CLG$9kH$O%9%?%C%/NN0h$r2rJ|9k3H$r0UL#$9$k! #

?^6$K%W%m%0%i%`A4BN$N@)8f$NN.$1$r<($9! #BF%k!<%A%s$N5!G=5Z$SL r3d$O0J2<$K<(9H$*$jG"$k! #

- Initialize
  DSP %W%m%0%i%`$G;HMQ$9$k;q8;$N3NJ]$H=i4|2=! "5Z$S3d$j9~$_@h7hDj%1%8%9%?$dDSP $NF0:nJ}<07hDj%1%8%9%?$JINDSP FbIt%1%8%9%?$N=i4|2=$r9T$$! "=*N;8eScheduler $r5/F0$9$k! #
- Scheduler
  DSP %W%m%0%i%`$NCf?43J$HJk%k!<%A%sG"$j! "0J2<$N=g$K=hM}$r<B9T9k! #
  - %Q%1%C%HAw?.
    %W%m%;%9<B9TCf$K%Q%1%C%H$rAw?.7h$&$H7?;~! "%P%C%U%!$N6u$-MFNL$,L5$$Ey$NM}M3$GAw?.IT2DG=$J;~$,$"$k! #$=$Nh&$J;~%Q%1%C%H$,Aw?.G-kh$&$KJk$^$GBT$?$:$K! "Aw?.%Q%1%C%H$r%-%e!<$KJ]B8$7$F%W%m%;%9$OCfCG! "=*N;9k! #Scheduler K*$$$F$O! "Aw?.%-%e!<$KDJ$,$1$?%Q%1%C%H$NM-L5$r3NG'$7! "B8:_$9$1$P%Q%1%C%H$rAw?.9k! #
  - <B9TIT2DG=G"C?%W%m%;%9$N3+;O
    %/%i%9%?4V%3%R!<%1%s%9@)8f5!9=K*$$$F$O! "F10l%V%m%C%/$KBP9k%3%R!<%1%s%9@)8f$rDSP $GJB9T=hM}$7$J$$$H$$$&J}?KG"kN$G! "MW5a%Q%1%C%HE~Ce;~$K$O=hM}$r3+;OG-$J$$%Q%1%C%H$,B8:_$9$k! #$=Nh$&$J%Q%1%C%H$O! "BP1~$9$k%W%m%;%9$,@8@.$5$1$?8e<B9TIT2DG=$P$C%U%!$KDJ$,$1$k! #6%9g$9$k%V%m%C%/$KBP9kEv3:%/%i%9%?K*1k=hM}$,=*N;$7$?;~E@$G%W%m%;%9$,<B9T2DG=$KJj! "Execute-process %k!<%A%sKo$?$5$1$k! #
  - BT5!Cf$N%W%m%;%9$NI|5"
    %W%m%;%9<B9TCf$K! "B>$N%Q%1%C%H$NE~Ce$Khk3d$j9~$_KhCF=hM}$rCfCG$5$1$?%W%m%;%9$O! "=hM}CfCG$P%C%U%!$KJ]B8$9$k! #Scheduler K*$$$F$O! "=hM}CfCG%P%C%U%!$KDJ$,$1$?%W%m%;%9$NM-L5$r3NG'$7$F! "B8:_$9$k>l9g$O%W%m%;%9$rResume-context %k!<%A%s$Ko?$9! #
  - Empty-process $N<B9T
    >e5-$NA`:n$,A4$F=*N;$7$?8e! "Empty-process $r<B9T$9$k! #
- Empty-process
  Ev3:%/%i%9%?K*$$$F<B9T9Y$-=hM}$,B8:_7J$$;~! "%Q%1%C%HE~CeKh$k3d$j9~$_$rBT$D>uBV$KJk! #3d$j9~$_$,5/$3kHTH-on-Empty $r5/F0$9$k! #
- Resume-context
  3d$j9~$_KhCFCfCG$5$1$?%W%m%;%9! "5Z$S1~Ez%Q%1%C%H$,5"$CF-$?$3HKhjSleep buffer $+$iI|5"$5$1$k%W%m%;%9$N<B9T$r:F3+$9k?aK! "%W%m%;%9$N%9%?%C%/NN0h$+$i%1%8%9%?Ey$NI|5"$r9T$&! #%1%8%9%?I|5"8eExcute-process $r<B9T$9$k! #
- Execute-process
  %W%m%;%9$r<B9T$9$k! #Hf3SE*=hM}$NM%@hEY$,

Dc$/3d$j9~$_2DG=$G<B9T9k%W%m%;%9$H!"Hf3SE*M%@hEY$,Dc$/3d$j9~$_IT2DG=$G<B9T9k%W%m%;%9$KJ,$+lk!#<B9T$,Dd;_$9kN$O0J2<$Nh&$J;~$G$"$k!#

- Exit
  $"$k%H%i%s%6%/%7%g%sK*1kEv3:%/%i%9%?K*$$$F$N=hM}$,40A4$K=*N;$9kH!"%W%m%;%9$O=*N;$7$FTerminater $r5/F0$9$k!#
- Sleep
  %W%m%;%9$,%Q%1%C%H$rAw?.7F1~Ez%Q%1%C%HBTAKJC$?;~!"%1%8%9%?$NBTHrr7$?8e!"%W%m%;%9$N%9%?%C%/$rSleep buffer KD$J$$$GScheduler $r5/F0$9$k!#
- Interrupt
  3d$j9~$_2DG=$J%W%m%;%9<B9TCf$K%Q%1%C%H$,E~Ce$9kH TH-on-process $r5/F0$9$k!#

- TH-on-empty
  Empty-process <B9TCf$K%Q%1%C%H$,E~Ce9k$H5/F0$9$kTrap-Handler G"$k!#%1%8%9%?$NBTHr$O9ToJ$$!#E~Ce%Q%1%C%H$N<oN`$KhC$FO0J2<$Nh&$K=hM}$,J,$+$l$k!#
  - MW5a%Q%1%C%H
    DSP $KE~Ce$7$?%Q%1%C%H$,MW5a%Q%1%C%HG"$k>l9g$K$OBP1~$9$k%W%m%;%9$r@8@.7F!"$=$N%W%m%;%9$,<B9T2DG=$J$iExcute-process $r5/F0$9$k!#F10l%V%m%C%/$N%3%R!<%l%s%9@)8f$,<B9TCf$N%W%m%;%9$O!"%9%?%C%/$r<B9TII T2DG=%P%C%U%!KD$J$$$GScheduler $r5/F0$9$k!#
  - 1~Ez%Q%1%C%H
    DSP $KE~Ce$7$?%Q%1%C%H$,1~Ez%Q%1%C%HG"$k;~$K$O!"BP1~$9$k%W%m%;%9$N%9%?%C%/$rSleep buffer $+$i<h$j=P$7!"I,MW$J%G!<%?$r%9%?%C%/$K=q$-9~s@8e!"Resume-context %k!<%A%sKo$?$9!#

    1~Ez%Q%1%C%H$HSleep buffer >e$N%9%?%C%/HNBP1~$O!"%W%m%;%9<1JL;R$KhC$FH=CG$9$k!#

- TH-on-process
  Empty-process 0J30$N3d$j9~$_2DG=$J%W%m%;%9<B9TCf$K%Q%1%C%HE~Ce$Khk3d$j9~$_$,5/$3kH5/F0$9$k Trap-Handler G"$k!#<B9TCf$N%W%m%;%9$N%1%8%9%?$rBTHr7F%9%?%C%/$r=hM}CfCG%P%C%U%!$KDJ$0!#$=$N8e!"E~Ce$7$?%Q%1%C%H$N<oN`$K1~$8$F TH-on-Empty $HF1MM$N=hM}r9$k!#
- Terminater
  <B9T$,=*N;$7$?%W%m%;%9$N%9%?%C%/$r2rJ|$9$k!#=*N;8eScheduler $r5/F0$9$k!#

4.2.3 3d$j9~$_2D!"IT2D

MMC 5Z$S Network-I/F $+$i$N DSP KBP9$k3d$j9~$_$,2DG=JH$-$HIT2DG=$J;~$,$"$k!#

- 3d$j9~$_2DG=JH$-
  Empty-process <B9TCf$H!"Hf3SE*M%@hEY$NDc$$%W%m%;%9$r<B9TCf$O3d$j9~$_$,2DG=$G$"$k!#3d$j9~$_$r2DG=$K9kL?Na$O!"Empty-process 5/F0;~$K=q$/!#M%@hEY$NDc$$%W%m%;%9$r3d$j9~$_2DG=$G<B9T9kKO!"%Q%1%C%H@)8f3,AX$N%W%m%0%i%^$,%W%m%;%9$N%3!<%I$N@hF,$K3d$j9~$_5v2DL?Na$r=q$/!#
- 3d$j9~$_IT2DG=$J;~
  >e5-$N%W%m%;%9<B9TCf0J30$O>o$K3d$j9~$_$OIT2DG=G"$k!#3d$j9~$_$rIT2DG=K9$kL?Na$O!"TH-on-Empty!"TH-on-Empty!"Terminater!"Scheduler $N:G=i$NL?Na$K=q$/!#

3d$j9~$_$,5v2D$5l?;~$O!"MMC Kt$O Network-I/F $K3d$j9~$_$,5v2D5l!"%Q%1%C%H$,<u$1<hil$?$3HrCNi;$k!#

5 @-G=I>2A5Z$S9M;!

K\>OGO!"%W%m%;%9@)8f%W%m%0%i%`$N@-G=I>2A$r85$K!"%W%m%;%9@)8f3,AX$K4X9k9M;!$r9T$&!#

5.1 @-G=I>2A

;OaK!"DSP K*$$$F%Q%1%C%H$N=hM}$,9To1$F$$$J$$!"D^$j Empty-process <B9TCf DSP $KMW5a%Q%1%C%H$,E~Ce7F$+$i!"%Q%1%C%H$rAw?.$7$F=hM}$r5Y;_9k$^$G$N=hM};~4V$K4X9kI>2A$r9T$&!#0lO"$N=hM}$K$*$1$k3F%k!<%A%s$N=hM};~4V(%9%F%C%W?t) $rI=1$K<($9!#

%W%m%;%9$N<B9T3+;O$^GNCY1d$,Ls 60 %9%F%C%W!"<B9T8e$N=hM}$K 90 %9%F%C%W$N=hM}$,9T$o1k!#9g7WLs 150 %9%F%C%W$N=hM}$,1 DN%Q%1%C%HKBP7FI,MWH5l$k!#=hM};~4V$NB?$/$O!"%9%?%C%/NNO hXN%1%8%9%?BTIHr5Z$S%9%?%C%/$N4IM}KHqd5l$F$$$k!#

<!$K!"DSP K*$$$F3d$j9~$_2DG=$G=hM}$5lk%Q%1%C%H=hM}$,<B9TCf$KDSP $KMW5a%Q%1%C%H$,E~Ce7F$+$i!"%Q%1%C%HAw?.8e5Y;_7F!"3d$j9~$_KhCFCfCG5l$?%W%m%;%9$N=hM}$r:F3+$9k^GN=hM};~4V$K4X$9$kI>2A$r9T$&!#=hM};~4V$rI=2$K<($9!#

3d$j9~$^l?%W%m%;%9$N=hM}$,CfCG7F$+$i:F3+9k$^$G$K!"3d$j9~s@%Q%1%C%H$K4X$9$k=hM}0J30$KLs200 %9%F%C%W$,I,MW$G$"$k!#3N=hM};~4V$NBgH>$,!"Empty-process <B9T;~$N3d$j9~$_$HF1$8$h$&$K!"%1%8%9%?$NBTIHr$HI |5"!"5Z$S%9%?%C%/$N4IM}KHqd5l$F$$$k!#

5.2 9M;!

%W%m%;%9@)8f3,AX%W%m%0%i%`$K$h$k%W%m%;%9$N%9%1%8%e!<%j%s%0$KHq$d$5$l$k<B9T;~4V$O!"%Q%1%C%H$NAw?.;~4V5Z$S%W%m%;%9$N<B9T;~4V$HHf3S$7$FHs>o$KD9$$!#$h$C$F!"8=CJ3,$N%W%m%0%i%`KhCF%9%1%8%e!<%j%s%0$N4IM}$r7?>l9g$N%*!<%P!<%X%C%I$OHs>oKBg-$$!#%W%m%;%9@)8fNCY5$N86 0x$HJC$F$$$k=hM}$O%1%8%9%?$NBTIHr!"I |5"5Z$S%W%m%;%9%9%?%C%/$N4IM}G"$k!#$hCF!"%/%i%9%?%a%b%j4IM}@lMQ%W%m%;%C%5KO!"%9%?%C%/@lMQ$NNNO h$rMQ0U7F%9%?%C%/$N4IM}5Z$S%1%8%9%?$NBTIHr!"I |5"$r9T$&%O!<%I%&%(%"9=@.$N4IM}5!9=$r@_$1kJIN2~A1$,MW5a$5lk!#

6 $*$ojK

K\9FGO!"D6JBNs7W;;5!JUMP-1 K*1k%/%i%9%?4V%3%R!<%1%s%9@)8f5!9=$N@_7WJ}?K5Z$S<BAu$K4X$9$k9M;!$r9TC?!#

%/%i%9%?4V%3%R!<%1%s%9@)8f5!9=$r!"DSP K*1k%W%m%;%9@)8f3,AX$H%/%i%9%?4V$N%3%R!<%1%s%9@)8f$N%]%j%7!<$r7hD j9k3,AX$KJ,$1$F3+H/$9k3HKhj!"$=$1$>$1$N3,AX$K$*$1$k;EMM$NJQ2=KBP7$F=@Fp$JBP1~$,2DG=$G$"$k%7%9%F%`$r9=@.$G$-$?!#

DSP K*1k=hM}%Q%1%C%H$N%9%1%8%e!<%j%s%0J}<O$H7F$O!"3d$j9~$_$Khk%^%k%A%Q%1%C%H=hM}J}<O$r:NMQ$7!"=hM}$NM%@hEY$K1~8?%9%1%8%e!<%j%s%0$,2DG=$HJC$?!#$5iKM%@hEY$,Dc$/=hM};~4V$ND9$$%Q%1%C%H=hM}Kh$k%W%m%;%C%5$NFH@j$rK8$2k3HKhk@-G=$N8~>e$b4 |BT5l$k!#H?LL!"3d$j9~$_@)8f$N$?$a$N=hM}$KD9;~4VHqd9$?$a!"K\MhI,MWH5lk=hM}0J30KHqd$9;~4V$,D9$/$JkH$$$&LdBj$,$"$k!#

%3%R!<%1%s%9@)8f$NJ}<O$H7F$O!"3F%M%C%H%"%I%l%9$KBP1~7?Home %/%i%9%?$rCf?4$H7?J,;6%G%#%l%/%H%j J}<O$r:NMQ$7$?!#$3$NJ}<O$K$*$$$F$O!"%/%i%9%?4V$N%3%R!<%1%s%9@)8fK*$$$F%"%/%;%9$N6I=j@-$,@8$^$l!"@-G=$N8~>e$KDJ$,$k3H$,4 |BT$5lk!#7+$7!"%M%C%H%"%I%l%9$KBP9kHome %/%i%9%?0J30$N%/%i%9%?$K$*$1$kEv3:NNO h$X$N%"%/%;%9$,=8Cf9kh&$J%W%m%0%i%`$K$*$$$F$O!"6&M->uBV4IM}%G%#%l%/%H%j$r8!:w$9$k:]$N6I=j@-$,<:$o$l!"=hM}@-G=$,Dc2<9k3HOHr1il$J$$!#

%W%m%;%9@)8f3,AX%W%m%0%i%`$N@-G=I>2A$K$*$$$F$O!"DSP K*$$$F?J9TCf$N=hM}$,$J$$$H$-$KE~Ce7?MW5a%Q%1%C%HKBP9$k=hM};~4V!"5Z$S?J9TCf$N=hM}$rCfCG7FE~Ce%Q%1%C%HKBP9$k=hM}$r9TCF$+$i!"=hM}$r:F3+$9k^GN=hM};~4V$rI>2A$7$?!#$3$N=hM};~4V$O%/%i%9%?4V$N%Q%1%C%HAw?.5Z$S%a%b%j%"%/%;%9$HHf3S$7$FHs>o$KD9$$!#hC$F!"%9%?%C%/5Z$S%1%8%9%?4XO"$N=hM}$r%O!<%I%&%(%"$G<B8=$G$-$k!"%a%b%j4IM}@lMQ%W%m%;%C%5$N3+H/$r5^$0I,MW$,$"$k!#

7 <UK-

K\8&5f$N5!2q$rM?$($F$/$@5j!"E,@Z$J8f;XF3$r;roG$?IYEDbC<#65<x$K?<?S$J<U0U$rI=7^$9!#

$^$?!"5.=EJ4=u8@$r$$$?$@$$$?CfEg9@=u65<x!"?9bC0lO:=u65<x!"8^Eg@5M5=u<j$K?<$/46<UCW7^$9!#

5i$K!$6&F18&5f<TG"$kJ!EgD>?M;a!"=.K\0l5W;a$rO8aH7F!$F|:"$+$i8fJ\Z%2<$5G?5~ETBg3XBg3X1!9)3X8&5f2J>pJs9)3X65<<IYED8&5f<<$N=t7;$K46<UCW7^$9!#

;29MJ88%

[1] H.Tanaka, Y.Muraoka, M.Amamiya, N.Saito, and S.Tomita, editors. The Massively Parallel Processing System JUMP-1. %*!<%`<R, 1996. IBSN4-274-90083-5.

[2] >>K\>0, J?LZ7I. Memory-Based Processor Kh$kJ,;66&M-%a%b%j. JBNs=hM}%7%s%]%8%&%` JSPP'93 O@J8=8, pp.245-252, 1993.

[3] Aj8_7k9gLV$H%k!<%?. J8It>J=EE@NNO h8&5f. D6JBNs86M}$K4p$E$/>pJs=hM}4pK\BN7O. Bh3 2s %7%s%]%8%&%`M=9F=8. pp.257-279,1993.

[4] M.Goshima. JUMP-1 6&M-%P%9;EMM=q. October, 1994.

[5] JUMP-1CBus ;EMM=q. February,1994.

[6] J!EgD>?M, IM8}@6<#, IYEDbC<#, LpEg=$;0. 7A<0E*<jK!$Khk%-%&%C%7%e%W%m%H%3%k$N@_7W8!>Z. March, 1996.

[7] J!EgD>?M D6JBNs7W;;5!JUMP-1 $N%/%i%9%?%P%9$K$*$1$k%a%b%j%"%/%;%9%P%C%U%!%j%s%0.1995.

[8] Texas Instruments !TMS320C4x User's Guide

I=1: %W%m%;%9@8@.$+$i%Q%1%C%HAw?.Kh$k5Y;_$^$G

TH-on-Empty 5/F0	10 %9%F%C%W
%7%9%F%`%9%?%C%/$K0\F0	3 %9%F%C%W
3d$j9~$_IT2DL?Na	1 %9%F%C%W
%W%m%;%9%9%?%C%/3NJ]	24 %9%F%C%W
%Q%1%C%HNN0h%3%T!<	4 - 12 %9%F%C%W
JQ?t$N@_Dj	8 %9%F%C%W
%W%m%;%9%9%?%C%/$K0\F0	3 %9%F%C%W
%W%m%;%9%3!<%I<B9T	
%l%8%9%?BTHr	30 %9%F%C%W
Sleep buffer KDJ0	60 %9%F%C%W
9g7W	Ls150 %9%F%C%W

I=2: %W%m%;%9@8@.$+$i%Q%1%C%HAw?.Kh$k5Y;_$^$G

TH-on-process 5/F0	10 %9%F%C%W
%l%8%9%?BTHr	30 %9%F%C%W
%7%9%F%`%9%?%C%/$K0\F0	3 %9%F%C%W
3d$j9~$_IT2DL?Na	1 %9%F%C%W
%W%m%;%9$r=hM}CfCG%P%C%U%!$KDJ$0	60 %9%F%C%W
%W%m%;%9%9%?%C%/3NJ]	24 %9%F%C%W
%Q%1%C%HNN0h%3%T!<	4 - 12 %9%F%C%W
%W%m%;%9%9%?%C%/$K0\F0	3 %9%F%C%W
%W%m%;%9%3!<%I<B9T	
%l%8%9%?BTHr	30 %9%F%C%W
Sleep buffer KDJ0	60 %9%F%C%W
Scheduler 5/F0	6 %9%F%C%W
=hM}CfCG%P%C%U%!$+$i%9%?%C%/<h$j=P$9	53 %9%F%C%W
%l%8%9%?I|5"	35 %9%F%C%W
%W%m%;%9%3!<%I<B9T:F3+	
3d$j9~$s$@%W%m%;%9$K4X9k =hM}$r=|$$$?9g7W	Ls200 %9%F%C%W