B4 6H O@ J8

PVMKh$kJBNs%W%m%0%i%_%s%0
(II)

;a L> !’?@:jN<B@
3X@RHV9f !’2210960086-9
;XF3650w !’;3:j>!9065<x
Ds =P F| !’2000G/27n18F|

N)L?4[Bg3XM}9)3XIt>pJs3X2J

FbMF9<35

:#F|$N7W;;5!$N?JJbO9$5$^$8$$$bN,$"$k$,!"7W;;5!$=NbNNB.EY8~>eKO8B3&$,$"kH9M$($ilk$?$a!"JBNs=hM}N*$+$l$kN)>l$,=EMWJbNKJC$F$$$k!#JBNs=hM}$r<B8=$9k?aK!"K\8&5f<<GO%W%m%0%i%_%s%0%$%s%?%U%'!<%9$H7F#P#V#M$rMQ$$$FJBNs%W%m%0%i%_%s%0$r9T$$!"$=$N8z2L$rI>2A$7$F$$$k!#

#P#V#MHO!"%M%C%H%o!<%/$G@\B3$5l?0[5!<o$NJBNs%3%s%T%e!<%?5Z$SC`<!%3%s%T%e!<%?$r!"C10l$NBg$-$JJBNs7W;;5!;q8;$KE}9g$9$k%Q%C%1!<%8%=%U%H%&%'%"$G$"$j!"$"$?$+$b#1Bf$NJBNs7W;;5!$Nh&$KMxMQ$9k3HrL\E*H7$F$$$k!#I,$:$7$bF1$87W;;5!G"kI,MWOJ/!"0[5!<o4VGNDL?.$b2DG=$K9kh&@_7W5l$F$$$k!#3N$?$a$N%G!<%?JQ49$JIN%*!<%P%X%C%I$,$"$j!"C1BN$NJBNs7W;;5!>e$G;HMQ$9$k>l9g$O!"$=$N7W;;5!MQ$K<BAu$5l?#M#P#IHHfYkH@-G=$,Mn$Ak,!"5!G=E*KO#M#P#Ihj$b;H$$$d$9$$>l9g$,$"$j!"8=:_$b<BMQ$K6!$7$F$$$k!#

K\O@J8GO!"%=!<%F%#%s%0$H$$$&?H6a$J%F!<%^$r<h$j>e$2!"C`<!%W%m%0%i%`$+$iJBNs%W%m%0%i%`$r:n@.$7!"$=$N8z2L$NI>2A$K$D$$$F=RYF$$$k!#

L\ <!

?^0lMw

1. !!6&M-%a%b%j%"!<%-%F%/%A%c
2. !!J,;6%a%b%j%"!<%-%F%/%A%c!J6&M-2DG=!K
3. !!J,;6%a%b%j%"!<%-%F%/%A%c!J6&M-IT2DG=!K
4. !!%/%$%C%/%=!<%H
5. !!%/%$%C%/%=!<%H$NJBNs2=<jK!
6. !!%/%$%C%/%=!<%H$NB.EY8~>e
7. !!%R!<%W2=$NNc
8. !!%R!<%W%=!<%H$NJBNs2=<jK!
9. !!%R!<%W%=!<%H$NB.EY8~>e

I=0lMw

1. <B9T;~4V!J%/%$%C%/%=!<%H!K
2. B.EY8~>e!J%/%$%C%/%=!<%H!K
3. <B9T;~4V!J%R!<%W%=!<%H!K
4. B.EY8~>e!J%R!<%W%=!<%H!K

1 O8aK

:#F|$N7W;;5!$N?JJbKOa6$^$7$$$bN,$"$k$,!"9=@.MWAG$N4pK\$rJ9AG;R$NB.EY8~>e$K$O8B3&$,$"$k$H9M$(ilk?$a!"JBNs=hM}$KhkB.EY8~>e$NI,MW@-$,6/$/G'<1$5lF$$$k[5]!#JBNs=hM}$r9T$&3HKh$j!"#C#P#U$N?t$KHfNc$7$F<B9TB.EY$r8~>eG-!"#1BfGOMFNLITB-$G07$($J$$Bg5,LOLdBj$,2r$1kh$&$KJkJI$NMxE@$,$"$k!#$^$?!"JBNs2=r9k3HKhj!"%3%9%H!"=@Fp@-!"$*$h$S?.Mj@-$KM%l?%7%9%F%`$r9=C[$9$k$3$H$,$G$-!"D9;~4V$+$+$k7W;;$b!"C;;~4V$G7k2L$rF@$k$3$H$,$G$-$k!#<B:]!"JBNs7W;;5!$O@hC<E*$JJ,Ln$G3hMQ$5$l!"Bg$-$J@.2L$r>e$2$F$$$k!#$7$+$7!"2J3X!&@)3X$NB?$/$N8&5f<T!"5;=Q<T$,F|>oE*$KMQ$$$k7W;;5!$K$J$C$F$$$J$$$N$,;v<B$H$7$F$"$k!#$=$N860x$H$7$F!"JBNs7W;;5!$NJ}<0$OB?MM@-$KIY$s$G$$$F!"%W%m%0%i%`$O5!<o0MB8@-$,9b$/!"0lJ}$G!"40A4<+F0JBNs2=%3%s%Q%$%i$O8=>uGOFq$7$$$3$H!"%o!<%/%9%F!<%7%g%s$d%Q!<%=%J%k%3%s%T%e!<%?O"jUl?bN$G!"<j7Z$K;HMQG-$k0lJ}!"K\3JE*$JJBNs7W;;5!$O9b2A$JbN$G!"8=>u$G$OMxMQ$G$-$k4D6-K"$k?M$N?t$,8B$ilF$$$k3H!"$^$?!"JBNs7W;;5!$K4X$9$k650i$d652J=q$O@lLg650iMQ$G$"$kN,8=>uG"k3H,$"$2il$k[4]!#

7+$7!"%W%m%0%i%_%s%0%$%s%?%U%'!<%9KD$$$F8@$($P!"#M#P#I!JMessage Passing Interface!K$d#P#V#M!JParallel Virtual Machine!K$N=P8=$*hS9b?e=`8@8l$NI8=`2=$N?JE8$Khj!";vBV$,2~A1$5lDD"$k!#$^$?!"%o!<%/%9%F!<%7%g%s$d%Q!<%=%J%k%3%s%T%e!<%?$r#L#A#N$G7k9g7?%/%i%9%?$b9b@-G=7W;;4D6-$H7F8=<BE*JbNHJjDD$"$j!"B?$/$N?M$,JBNs7W;;$r9T$($kh&KJCF$-$F$$$k[4]!#

#P#V#MHO!"%M%C%H%o!<%/$G@\B3$5l?0[5!<o$NJBNs%3%s%T%e!<%?!"5Z$SC`<!%3%s%T%e!<%?$rC10l$NBg$-$JJBNs7W;;5!;q8;$KE}9g$9$k%Q%C%1!<%8%=%U%H%&%'%"$G$"$j!"$"$?$+$b#1Bf$NJBNs7W;;5!$Nh&$KMxMQ$9k3HrL\E*H7$F$$$k!#I,$:$7$bF1$87W;;5!G"kI,MWOJ/!"0[5!<o4VGNDL?.$b2DG=$K9kh&@_7W5l$F$$$k!#3N$?$a$N%G!<%?JQ49$JIN%*!<%P%X%C%I$,$"$j!"C1BN$NJBNs7W;;5!>e$G;HMQ$9$k>l9g$O!"$=$N7W;;5!MQ$K<BAu$5l?#M#P#IHHfYkH@-G=$,Mn$Ak,!"5!G=E*KO#M#P#Ihj;H$$$d$9$$>l9g$,$"$j!"8=:_$b<BMQ$K6!$7$F$$$k[4]!#

K\8&5f$O!"C`<!%W%m%0%i%`$+$i#P#V#M$rMQ$$$FJBNs%W%m%0%i%`$r:n@.$7!"$=$N<jK!$NM}2r$H8z2L$rI>2A$9$k$3$H$rL\E*$H$7$F$*$j!"Bj:`H7$F%/%$%C%/%=!<%H!"%R!<%W%=!<%H$NJBNs2=$r?^$j!"JBNs8z2L$rI>2A7F$$$k!#

%=!<%F%#%s%0%"%k%4%j%:%`$O!"<BMQE*$J7W;;5!=hM}$NJ,Ln$K$*$$$FHs>o$KBg$-$J%&%'%$%H$r@j$a$k$b$N$G$"$j!"JBNs%"%k%4%j%:%`$r8l$kH-$KBh0l$K<h$j>e$2il$kLdBj$H7FU5o7$$!#7W;;5!$G<B9T$5lkA4FN;E;vN&$A!"25%∼50%$O%G!<%?$N%=!<%F%#%s%0$G

$"$kHh$/$$$o1F$$$k[5]!#

%/%$%C%/%=!<%H$O!"?tNsCfNE,EvJCM!$J3$1$r<4$H8FV3HK9k!K$r4p='CM$H7F!"$=$1hj>.$5$$$+Ey$7$$$bNr:8B&!"Bg$-$$$+Ey$7$$$bNr1&B&KMhkh&KJBYBX$($k!#3&7FG-$?:8ItJ,Ns$H1&ItJ,NsKBP7F1$8$3Hr7+jJV9%=!<%HK!G"$k[7]!#

%R!<%W%=!<%H$O!"F~NOG[Ns%G!<%?$r4OA4FsJ,LZ$N=gG[CVI=8=$H$_$J$7!"$$$ofk%H!<%J%a%s%H$NJ}<0$G:GBg%-!<$r<!!9$H<h$j=P$7$F$$$/%=!<%HK!G"$k[7]!#

$^$?!"K\8&5f$O<B834D6-$H7F!"6&F17W;;5!<B83<<$N%5%s!&%^%$%/%m%7%9%F%`%:<R$N%o!<%/%9%F!<%7%g%s!"Ultra 1 $r#3#2Bf;HMQ$7$F$$$k!#

K\O@J8GO!"Bh#2>O$GJBNs%W%m%0%i%_%s%0<jK!!#P#V#MKD$$$F$N@bL@!"Bh#3>O$G%/%$%C%/%=!<%H!"%R!<%W%=!<%H$N#P#V#M$rMQ$$$?JBNs%W%m%0%i%_%s%0KD$$$F$N@bL@$H<B837k2L!"Bh#4>O$GJBNs=hM}$NI>2A$H9M;!!"Bh#5>O$GK\O@J8N^Ha$H:#8e$N2]BjKD$$$F=RYk!#

2 JBNs%W%m%0%i%_%s%0$HPVM

2.1 JBNs%W%m%0%i%_%s%0<jK!

JBNs=hM}KO!"Bg$-$/J,1F#2DNJ}<0$,$"$j!"SIMD !Single Instruction Stream Multiple Data Stream) J}<0$HMIMD(Multiple Instruction Stream Multiple Data Stream) J}<0G"$k!#SIMD J}<0$H$O!"#1<oN`$N1i;;$r!"J#?t8D$N%G!<%?$KBP$7$F;\$9$3$H$r0UL#$9$k!#Nc$($P A $H$$$&%Y%/%H%k$H B $H$$$&%Y%/%H%k$NOB$r C $H$$$&%Y%/%H%k$K3JG<$9$k>l9g!"2C;;$H$$$&1i;;$r!"A!"B $N%Y%/%H%k$N$9$Y$F$NMWAG$K;\$9$3$H$K$J$k!#0lJ}!"MIMD J}<0$H$O!"3F1i;;4o(%W%m%;%C%5) $,FH<+$N%W%m%0%i%`$r2r<a7J$,$i:nF0$9$kJBNs=hM}G"$j!"A0=R$NSIMD J}<0HHfYkH<+M3EY$OA}$9$,!"%W%m%;%C%54V$NF14|JI!"6(D4F0:n$r$$$+$K9T$o$;$k$+$r9Y$F%W%m%0%i%^$K0QMk3HKJ$k!#0J8e!"MIMD J}<0$K$D$$$F=RYk[4]!#

MIMD J}<0K*1kJBNs2=$NJ}K!$H7F$O!"%"%k%4%j%:%`$r<B8=9kbN$r5!G=E*$J%V%m%C%//%W%m%;%9$KJ,3d$7F=$N4V$r%G!<%?$NN.$1$G7k$VJ}K!!!$J$$$ofk5!G=E*J,3d!K"LdBj$,07$&%G!<%?$rJ,3d$7$F!"J,3d$7$?%G!<%?$r3F%W%m%;%9/%W%m%;%C%5$K3d$jEvFkJ}K!!!$J$$ofk%G!<%?J,3d!K"I,MW$K1~$8$F;E;v$rM?$($F$$$/!";^4"$jK!$,$"$k!#<B:]KO%W%m%;%C%5$NBf?t$rA}2C5;$k>l9g!"=c?h$K5!G=E*$JJ,3d$@1rMQ$$$k3HO[HsIJ$/!"2?$i$+$NJ}K!$G!"%G!<%?J,3d$r07$&I,MW$,$"$k[4]!#

MIMD J}<0GNJBNs2=Kh$k@-G=8~>e$N$?$aKON10U9Y$-E@$,#3E@5s2ilk!#0J2<#3E@KD$$$F=RYk[4]!#

(1) C`<!=hM}ItJ,$N%*!<%P%X%C%I!!C`<!=hM}ItJ,$N3d9g$,A4BN$N $s(0\le s\le 1)$ B8:_9l$P n Bf$N%W%m%;%C%5$rMQ$$$FF@il$kB.EY8~>e$O

$$\frac{1}{s+\frac{1-s}{n}}$$

KJ$k!#Nc$($P#1Bf<B9T;~$KC`<!ItJ,$N3d9g$, 5% $"$l$P!"$?H(10,000 Bf$N%W%m%;%C%5$rMQ$$$F$bF@$ilkB.EY8~>e$O9b!920 G\$G$"$k!#

(2) Ii2YNPiD$-!'JBNs%7%9%F%`$G$O n Bf$N%W%m%;%C%5$rMQ$$$?>l9g!"9Y$FJBNs=hM}2DG=$G$"$l$PM}A[E*$K$O 1/$n$ $N;~4V$KJBNs<B9TItJ,$rC;=L$G$-$kO:G"$k!#$7$+$7J,$i!"<B:]$K$O3F%W%m%;%C%5$GIi2Y$N%P%i%D%-$,$"$k>l9g!":G$bCY$$%W%m%;%C%5$K0z$CD%ilk3HKJk!#

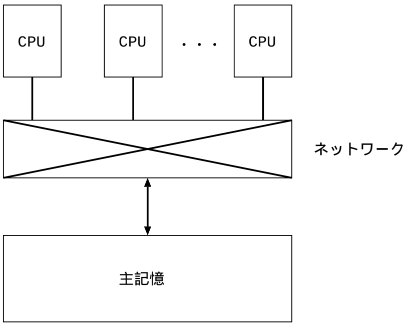
(3) DL?./F14 |$N%*!<%P%X%C%I!J%BN%s%7%9%F%`$G$O!"@5$7$$2r$rF@$k$?$a$K$OC`<!%W%m%0%i%`$K$O$J$$!"B>$N%W%m%;%C%5$H%G!<%?$rDL?.$9$k$3$H/$"$k$$$OA4%W%m%;%C%5$GF14|$r$H$k$3$H$,I,MW$H$J$k!#$3$N$?$a$N;~4V$OL5@C`<!%W%m%0%i%`KO$J$$%*!<%P%X%C%IHJ$k!#

3lKBP9$kBP:v$r$?$FilkN$O!"<!$N#3E@$,5s$2il$k!#

- C`<!=hM}$N%*!<%P%X%C%I!4pK\E*$K$O%"%k%4%j%:%`$d!"%i%$%V%i%j%l%Y%k$G!"JBNsIt J,$N3d$j9g$$$,Bg$-$/Jkh&$K%"%k%4%j%:%`$r9)IW9k
- Ii2YJ,;6NPiD$-!$3lb<g$K%"%k%4%j%:%`/%i%$%V%i%j/JBN%s%3%s%Q%$%i$GBP1~9Y$-$3HG$"$k!#
- DL?./F14|$N%*!<%P%X%C%I!$3l,M#0l%O!<%I%&%'%"/%"!<%-%F%/%A%c$GBP1~$G$-$kIt J,G"$k!#

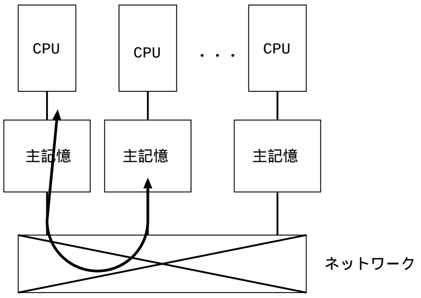
JBN%s7W;;5!%"!<%-%F%/%A%c$,%W%m%0%i%_%s%0$K1F6A$rM?$($k0x;R$H7F$O!"%a%b%j%b%G%k$,5s2ilk!#<g$J%a%b%j%b%G%k$H7F$O!"6&M-%a%b%j!"J,;6%a%b%j!&6&M-%"%/%;%92DG=!&K"J,;6%a%b%j!&6&M-%"%/%;%9IT2DG=!K$N#3<oN`$,$"$j!"0J8e#3DK$D$$$F=RYk[4]!#

- 6&M-%a%b%jHO!"J#?t$N%W%m%;%C%5$,%a%b%j%P%9/%9%$%C%A7PM3$G!"<g5-21$K@\B3$5lk7ABVG"$k!#$3$N7ABV$O!"%a%b%j%b%G%k$,:G$bHFMQ$G!"%W%m%0%i%`$,AH$_$d$9$/!"JBN%s=hM}$@$1$G$J$/!"%9%k!<%W%C%H$r=E;k$9$k%5!<%P%^%7%s!&C`<!%W%m%0%i%`/%W%m%;%9$rB??t=hM}$9$k%^%7%s!K$H7F$bE,$7$F$$$k!#



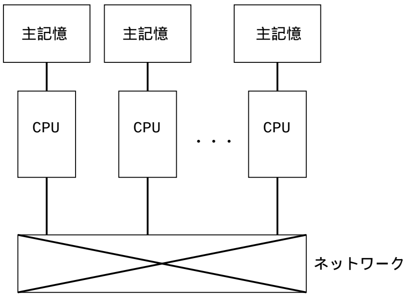
?^1: 6&M-%a%b%j%"!<%-%F%/%A%c

- J,;6%a%b%j!6J&M-%"%/%;%92DG=!KHO!"%W%m%;%C%5$H<g5-21$+$i9=@.$5lk%7%9%F%‘$,J#?t8D8_$$$K@\B3$5$l$?7ABV$G$"$k!#$?$@$7!"%W%m%;%C%5$OB>$N%W%m%;%C%5$N<g5-21NFI_=q$-$r9T$&$3H,G-$k!#$3$N7ABV$NFCD'$O!"Bg5,LO$J%7%9%F%‘9=C[$,2DG=$G$"$k$H$$$&3HG"$k!#$^$?!":G6aCmL\$5lF$$$kPC%/%i%9%?Gb3N%"!<%-%F%/%A%c$N7ABV$rM-7F$$$k!#<!$K=R$Y$kHs6&M-%a%b%j%b%G%k$HHfYk$H<+M3EY$O9b$$$,!"#18DGb%P%j%"F14|$N>l=j$r4V0c$($k$H!"%?%$%_%s%00MB8$GHs>o$K2r@O7K$/$$%P%0$r:n$j9~$‘$3HKJk!#



?^2: J,;6%a%b%j%"!<%-%F%/%A%c!6J&M-2DG=!K

- J,;6%a%b%j!6J&M-%"%/%;%9IT2DG=!KHO!"%W%m%;%C%5$H<g5-21$+$i9=@.$5lk%7%9%F%‘$,J#?t8D8_$$$K@\B3$5$l$?7ABV$G$"$k!#$?$@$7!"%W%m%;%C%5$OB>$N%W%m%;%C%5$N<g5-21NFI_=q$-$r9T$&$3H,G-$J$$!#I,$:Aj<j$N%W%m%;%C%5$K2p:_$7Fbi&I,MW$,$"$k!#$3$N7ABV$NFCD'$O!"Bg5,LO$J%7%9%F%‘9=C[$,2DG=$G$"$k$H$$$&3HG"$k!#$^$?!"6KO@$9lP!"PC$dEWS$rLAN$G@\B3$7$?$bNb3N7ABV$KB0$9$k!#PVM$O!"3N%"!<%-%F%/%A%c$KB($7$?%W%m%0%i%_%s%0%i%$%V%i%jG"$k!#



?^3: J,;6%a%b%j%"!<%-%F%/%A%c!6J&M-IT2DG=!K

2.2 PVM

J,; 6%a%b%j7 ?$NJBNs7W; ;5 !$K$ *$ $$F$O! "3F%W%m%;%C%5$K#1DN%W%m%;%9$,5/F0$5lk! # #U#N#I#XGO%W%m%;%9HO! "FHN)7FF0$/%W%m%0%i%`$N3H$r$$$&! #7+$7$3lG$O! "3F %W%m%;%C%5$G<B9TCf$N%W%m%;%9$O%m!<%+%k$J%G!<%?$7$+;2>H$G$-$J$$! #$=$N$?$a$K3F%W%m %;%94V$G%G!<%?$N8r4 9$r9T$$! "I,MW$J%G!<%?$r6&M-9k$?$a$N%a%C%;!<%8 !&Q%C%7%s%0$N ;EAH$_$,I,MWHJ$k! #%a%C%;!<%8 !&Q%C%7%s%0$O! "$"$k%W%m%;%9$N%a%b%j6u4V$+$iJL$N%W%m %;%9$N%a%b%j6u4VXN%G!<%?E>AwG"$k! #J,; 6%a%b%j7 ?$NJBNs%W%m%0%i%`$G$O! "%a%C%;!< %8 !&Q%C%7%s%0 !&i%$%V%i%j$rMQ$$$F%O!<%I%&%'%"$N9=@.$KB($7$?%Q%U%)!<%^%s%9$NNI$$ JBNs%W%m%0%i%`$r5-=R$9$k! ##P#V#M$O%a%C%;!<%8 !&Q%C%7%s%0 !&i%$%V%i%j!<$NBeI=$N#1 DG$"$k[6]!#

#P#V#M$O#T#C#P! ?#I#C%M%C%H%o!<%/$G@\B3$5l?2 ?BfbN%3%s%T%e!<%?$r2>A[E*$K#1Bf $N%^%7%s$HHi$($F! "JBNs%W%m%0%i%`rAvi$;$k3HNG$-$k%a%C%;!<%8 !&Q%C%7%s%0$N 4D6-$H%i%$%V%i%j$rDs6!9k! ##P#V#M$O8=:_$b3+H/$,B3$1ilF*$j! "G[I[$,<+M3J?$a $K@hC<2J3XJ,Ln$K$*$1$kBg5,LO7W; ;$N$?$a$N%=%U%H%&%'%"$H7F@$3&Cf$GMxMQ5l$F$$$k! # $^$?! "85!9$O! "%o!<%/%9%F!<%7%g%s !&/%i%9%?N?aN#T#C#P/#I#P%Y!<%9$NDL?.%i%$%V%i %jG"C?$,!"8=:_$G$OB?$/$NJBNs7W; ;5 !$K$b0\?"$5lF$$$k[6]!#

%W%m%0%i%`$r=q$/$K$"$?$C$FJBNs%W%m%0%i%`$N<B9TJ}K!$K$D$$$F35G0E*$KM}2r$7F*$/ I,MW$,$"$k! #<j=g$r=R$YkH! "$^$:%f!<%6$O%/%i%9%?$N#1DN%^%7%s! "$"$k$$$O@lMQ$NJB Ns7W; ;5 !$N%[%9%HHJCF$$$k%^%7%s$K%m%0%$%s$r9T$&! #$=$3$G%f!<%6$O%/%i%9%?! "$"$k $$$O@lMQ$NJBNs7W; ;5 !$KBP7F%8%g%V$NEjF~$r9T$&! ##P#V#M$N>l9gKO<+%[%9%HFb$G5/F0 7?%W%m%;%9$+$i! "B>%[%9%H$N%W%m%;%9$,8F$S5/$3$5l?$j9k! #%W%m%0%i%`$,L5; v=*N; $9$k$H! "%U%!%$%k! "$"$k$$$O%f!<%6$N%b%K%?$K7k2L$,=PNO$5$l$k! #$3$N$h$&$K<B:]$KJBNs $KAv$k8D!9$N%W%m%;%9$N5/F0$O! "<B9T4D6-$KG$$5$l$F$$$k! #%W%m%0%i%^$O%W%m%0%i%`$NCf $G! ":G=i$KDL?.%i%$%V%i%j$rMxMQ9k$?$a$N4JC1$J<jB3$-$r5-=R$7! "$=$N8e$G<B:]$NJBNs =hM}$NItJ,$r=q$$$F$$$1Ph$$$3HKJk[6]!#

#P#V#M$NJBNs<B9T%b%G%k$G$O! "%"%W%j%1!<%7%g%s$N<B9T$K; 22C$9$k%W%m%;%9?t$rF0E*$K JQ99$9k3H,G-$k! #$3lKhjHs>o$K=@Fp$J%W%m%0%i%`$r=q$/$3$H$,$G$-$k! #K\8&5f $G$O%W%m%;%9$K%^%9%?!<$H%9%l!<%V$N4X78$,@8$8$k%^%9%?!<!&9%l!<%V7 ?$N%W%m%0%i%`$r :n@.$7$?! #%^%9%?!<!&9%l!<%V7 ?%W%m%0%i%`$H$O! "%f!<%6$,#1$D$N%W%m%;%9$r5/F0$7! "$= $N%W%m%;%9$+$iI,MW$J?t$N%W%m%;%9$,5/F0$5$l$k%W%m%0%i%`G"$k! #

#P#V#M$N%W%m%;%9@)8f$K$D$$$F0J2<$K@bL@$9$k[1]!#

- *int tid = pvm_mytid(void)*

  :G=i$N8F$S=P7G$O!"%W%m%;%9$r#P#V#M$KEPO?$9$k!#$=$N:]!"pvm_spawn() $G5/F0$5l?%W%m%;%9GJ1l$P!"0l0U$Jtid $r@8@.$9$k!#2?2s$G$b8F$S=P$9$3H,G-!"8F$S=P$7%W%m%;%9$Ntid rJV9!#pvm_mytid() $O!"B>$NA4FN#P#V#M8F$S=P$7$K@hN)$C$F8F$S=P5lJ/FOJi$J$$!##P#V#M$,5/F0$7$J$$$^$^%"%W%j%1!<%7%g%s$,pvm_mytid() $r8F$S=P9H!"8F$S=P$5l?%k!<%A%s$O!"%(%i!<%3!<%I$rJV$9!#

- *int info = pvm_exit(void)*

  pvm_exit() $O!"8F$S=P$7%W%m%;%9$,#P#V#M$rN%$lk3Hr!"%m!<%+%k$Jpvmd KBP7FCNi$;$k!#K\%k!<%A%s$O!"8F$S=P$7%W%m%;%9$r=*N;5;ko1GOJ$$!#%W%m%;%9$O!"8F=P$78e$bB>$N#U#N#I#X%W%m%;%9$HF1MM$K=hM}$rB3$1k3H,G-$k!#

- *int bufid = pvm_spawn(char *task, char **argv, int flag, char *where, int ntask, char *tids)*

  pvm_spawm() $O!"<B9T2DG=%U%!%$%ktask $N%3%T!<$rntask 8D@8@.$7!"%P!<%A%c%k%^%7%s$G5/F0$9$k!#argv $Otask $KM?$($k0z?t$NG[NsXN%]%$%s%?$G$"$j!"$=$N=*oj$ONULL $G<($5lk!#0z?t$r2?$bM?$($J$$>l9gargv $ONULL HJ$k!#flag $O0J2<$N%*%W%7%g%s$r;XDj$9$k!#

  - 0 PvmTaskDefault !#P#V#M$,%W%m%;%9$N@8@.>l=j$r7hDj$9$k!#
  - 1 PvmTaskHost !where 0z?t$G@8@.$9$k%[%9%H$r;XDj9k!#
  - 2 PvmTaskArch !where 0z?t$G!"ARCH NCf+$i@8@.9k%"!<%-%F%/%A%c$r;XDj9k!#
  - 4 PvmTaskDebug !%G%P%C%,!]$N@)8f2<$G%W%m%;%9$r5/F0$9$k!#
  - 8 PvmTaskTrace !%W%m%;%9$+$i$N#P#V#M8F$S=P7N%H%l!<%9%G!<%?$r=PNO$9$k!#

- *int info = pvm_kill(int tid)*

  pvm_kill() $O!"tid Jk<1JL;R$r;}$D%?%9%/$r=*N;5;$k!#K\%k!<%A%s$O!"<+J,<+?H$r=*N;5;kh$&KO@_7W$5lF$$$J$$!#<+J,<+?H$r=*N;$5$;$kKOpvm_exit() $Hexit() $rB3$1$F8F$S=P$9!#

#P#V#M$N4pK\E*$J#1BP#1DL?.$N4X?t$K$D$$$F@bL@9k!##P#V#MGO%G!<%?$NAw?.$N:]$K!"%P%C%U%!$N=i4|2=!"%G!<%?$N%Q%C%/!!$P%C%U%!$K%G!<%?$r3JG<!K"%P%C%U%!$N%G!<%?$NAw?.$N#3$D$N%9%F%C%W$G9Tol$k!#%G!<%?$N<u?.KO3l$H5U$NA*:n!"D^$j%G!<%?$r<u?.$7%"%s%Q%C%/$7$F%G!<%?$rF@$k!#0J2<$K!"<g$J#1BP#1DL?.$N4X?t$r>R2p$9$k[6]!#

- *int bufid = pvm_initsend(int encoding)*

  Aw?.%P%C%U%!$r=i4|2=$9$k!#

  - int encoding !'Aw?.%P%C%U%!$K%G!<%?$rC_@Q9k;~$N%(%s%3!<%I}<0$r;XDj!#Pvm-DataDefault!"PvmDataRaw!"PvmDataInPlace!"(PvmDataFoo)$rA*Br$G$-$k!#PvmDataDafault $OXDR(External Data Representation)Kh$k%(%s%3!<%I$r9T$$!"PvmDataRaw $O%(%s%3!<%I$r9ToJ$$!#$?$@$70[5!<o4V$G2>A[%^%7%s$,9=C[$5lF$$$kJi$P!"%(%s%3!<%I$OI,MWG"$k!#$=$l0J30$OKD$$$F$O!"$3$3$G$O@bL@$r>JN,9k!#
  - int bufid !'%a%C;!<%8!&%P%C%U%!$N<1JL;R!#Ii$G$"$l$P%(%i!<

- *int info = pvm_pkstr(char *sp)*

  Aw?.%P%C%U%!$K%G!<%?$r3JG<9k!#!$G!<%?7?$,STRING $N>l9g!K

  - char *sp !'Aw?.%P%C%U%!$KC_@Q$9$k%G!<%?$N3+;O%"%I%l%9
  - int info !'%9%F!<%?%9!&3!<%I!#IiG"lP%(%i!<

- *int info = pvm_pkint(int *ip, int nitem, int stride)*

  Aw?.%P%C%U%!$K%G!<%?$r3JG<9k!#!$G!<%?7?$,INT $N>l9g!K

  - int *ip !'Aw?.%P%C%U%!$KC_@Q$9$k%G!<%?$N3+;O%"%I%l%9
  - int nitem !'Aw?.%P%C%U%!$KC_@Q$9$k%G!<%??t
  - int stride !'stride 8D4H$N%G!<%?$rAw?.%P%C%U%!$KC_@Q$9$k!#0"B3$7$F$$$k%G!<%?$rC_@Q$9kH$-$O1 HJ$k!#
  - int info !'%9%F!<%?%9!&3!<%I!#IiG"lP%(%i!<

- *int info = pvm_send(int tid, int tag)*

  Aw?.%P%C%U%!$N%G!<%?$rF@j$N%?%9%/$KAw?.9k!#

  - int tid !'<u?.@h$N%?%9%/ID
  - int tag !'%a%C;!<%8!&%?%0

- int info !%9%F!<%?%9 !&3!<%I! #I iG"1P% (%i!<

- *int info = pvm_upkstr(char *sp)*

  <u?.%P%C%U% !$+$i%G!<%?$r<h$j=P$9! #!@G!<%?7?$, STRING $N>19g! K

  - char *sp !<u?.%P%C%U% !$+$i<h$j=P$9%G!<%?$N3+;O%"%I%l%9
  - int info !%9%F!<%?%9 !&3!<%I! #I iG"1P% (%i!<

- *int info = pvm_upkint(int *ip, int nitem, int stride)*

  <u?.%P%C%U% !$+$i%G!<%?$r<h$j=P$9! #

  - int *ip !<u?.%P%C%U% !$+$i<h$j=P$9%G!<%?$N3+;O%"%I%l%9
  - int nitem !<u?.%P%C%U% !$+$i<h$j=P$9%G!<%??t
  - int stride !stride 4H$K%G!<%?$r<u?.%P%C%U% !$+$i<h$j=P$9! #O"B3$7$F$$$k%G!<%?$r<h$j=P9H$-$O1 HJ$k! #
  - int info !%9%F!<%?%9 !&3!<%I! #I iG"1P% (%i!<

- *int bufid = pvm_recv(int tid, int tag)*

  %a%C%;!<%8$NE~Ce$rBT$D! #

  - int tid !Aw?.85$N%?%9%/ID !-1 GOAw?.85$rFCDj7J$$! K
  - int tag !%a%C%;!<%8 !&?%0 !-1 $O%a%C%;!<%8 !&?%0$rFCDj7J$$! K
  - int bufid !?7$7$$%"%/%F%#%V<u?.%P%C%U% !$N<1JL;R! #I i$G$"$1$P% (%i!<

%?%9%/ID !#P#V#MKO! "#O#S$,4IM}$7$F$$$k%W%m%;%9ID HOJL$K! "#P#V#M%G!<%b%s$,4IM}7F$$$k%?%9%/ID $H8F$P1k%W%m%;%9$r<1JL$9$kHV9f$"$k! ##P#V#M$G$O%?%9%/ID $G! "DL?.$NAw?.85$d<u?.@h$r;XDj9k! #

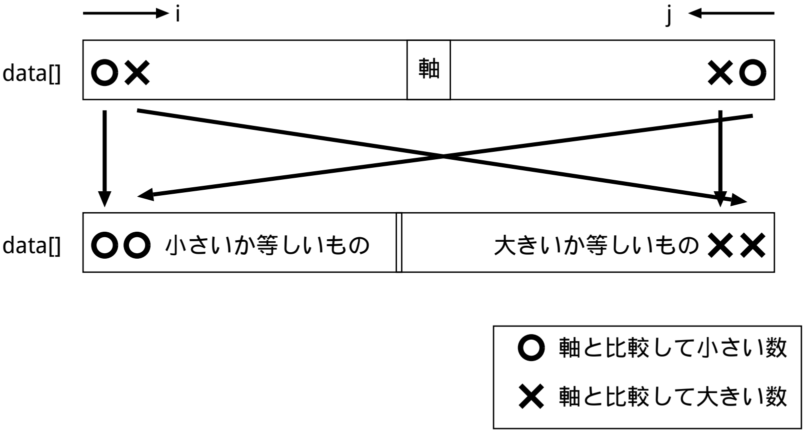
%a%C%;!<%8 !&?%0 !%a%C%;!<%8Aw?.$N:]$KAw?.%a%C%;!<%8$K@0?t$N<1JLIHV9frIU1k3H,G-$k! #$=1,%a%C%;!<%8 !&?%0G"$k! #$3$1$Khj<u?.$N:]$K%?%0$r;XDj$9k3HG! "HsF14 |E*$KE~Ce$7$F$$$k%a%C%;!<%8$+$iFCDjNbNrA*Br9k3H$,$G$-$k! #

3 PVM Kh$kJBNs%W%m%0%i%_%s%0

3.1 %/%$%C%/%=!<%H

3.1.1 LdBj$NDj5A

%=!<%H$NBP>]$HJkMWAGNsNCfG%5%s%W%kMWAG$r#1$DA*$S!"$=lr4p=`$K$7$F$=$l$h$j>.$5$$%0%k!<%W$HBg$-$$%0%k!<%W$KJ,3d$9$k!#$=$NMM;R$r?^#4$K<($9!#K\8&5f$G$O4p=`HJkCMrMWAGNs$NCf1{$H7?!#3F!9$N%0%k!<%W$N@0NsO3$NJ,3d$r:F5"E*KE,MQ7$F9T$&!"$H$$$&%=!<%HK!$,%/%$%C%/%=!<%HK!G"$k!#%/%$%C%/%=!<%HK!$O!"4p=`CM$,M}A[$K6a$/A*Pl$?$H$-$O!"Hf3S2s?t$C$$O$ $n\log n$ $K6a$/Jk!#%-!<$N0\F02s?t$b $O(n\log n)$ HJ$j!"$=$NL>$NH*$j!":G$bAa$$@0NsK!$H$$$olF$$$k!#$^$?!"J,3d5l$?$"HO!"$=$l$>$l$NIt J,Ns$OFHN)$K=hM}$7Fh$$$N$G!"JBNs=hM}$K8~$$$F$$$k[2, 7]!#

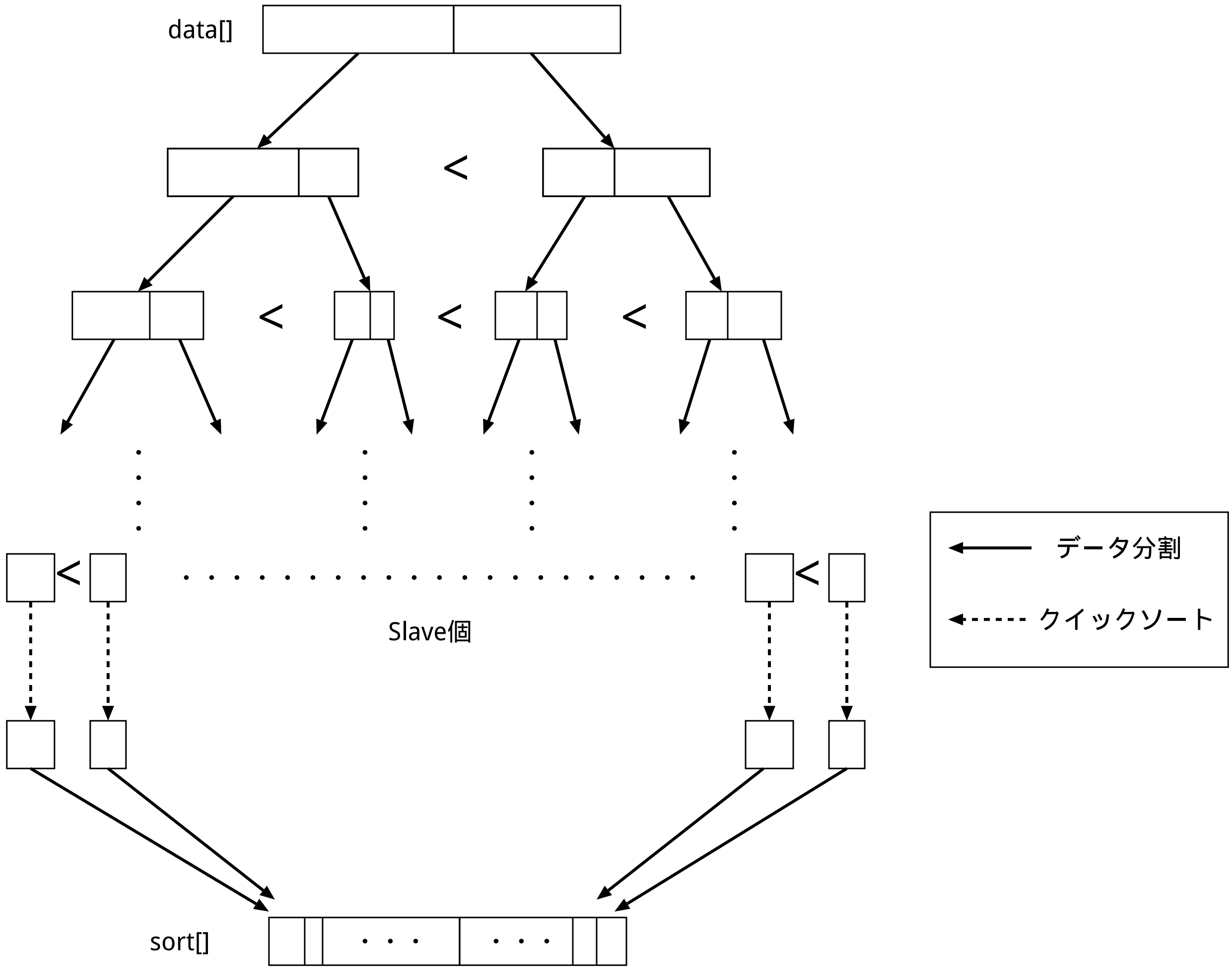


1. i $r?tNs$N:8C<!"j $r?tNs$N1&C<$K@_Dj$9$k!#
2. ?tNs$r1&$KAv::7F9T$-!"<40J>e$NbN$,$"$k0LCV$i$ $r8+$D1k!#
3. ?tNs$r:8$KAv::7F9T$-!"<40J2<$NbN$,$"$k0LCV$j$ $r8+$D1k!#
4. $i \geq j$ Ji%k!<%W$rH4$1$k!#
5. i 9`$H$j$ 9`$r8r49$9$k!#
6. $2 \sim 5$ $r7+$jJV$9!#

?^4: %/%$%C%/%=!<%H

3.1.2 JBNs2=$N2r@O

%/%$%C%/%=!<%H$O!"#12s$N%=!<%F%#%s%0$GMWAGNs$r4p=`CM$h$j>.$5$$ItJ,NsHBg-$$ItJ,Ns$K#2J,3d$9$k!#$3$NFCD'$rMxMQ7F Slave ?tJ,$NJ,3d$r9T$&$H!"$=$l$>$l$KBg>.4X78$N$"$kItJ,Ns$, Slave 8D$G$-$k!#3N=hM}$r Master $G9T$$!"%G!<%?$r Slave $KAw?.$9$k!# Slave GO<u?.%G!<%?KBP7!"%/%$%C%/%=!<%H$Khj%=!<%F%#%s%0$N;$^$G9T$&!#%=!<%F%#%s%0$5$l$?%G!<%?$r Master KAwjJV$7!"Master $G#1$D$NG[Ns$K3JG<7F7k2L$rI=<($9$k!#$=$NMM;R$r?^#5$K<($9!#



?^5: %/%$%C%/%=!<%H$NJBNs2=<jK!

3.1.3 <B837k2L

%=!<%F%#%s%0BP>]%G!<%?$r10,000 8D!"25,000 8D$NMp?tH7!"Slave $r#1Bf!"#2Bf!"#4Bf!" #8Bf!"#1#6Bf!"#3#2BfH7!"<B9T;~4V$r7WB,$7$?!#I=#1$K<B9T;~4V$r<($9!#$^$?!"7WB,$7 $?7k2L$K4pE-!"B.EY8~>e$rD4$Y$?7k2L$rI=#2!"?^#6$K<($7$?!#

I=#1 ! !<B9T;~4V

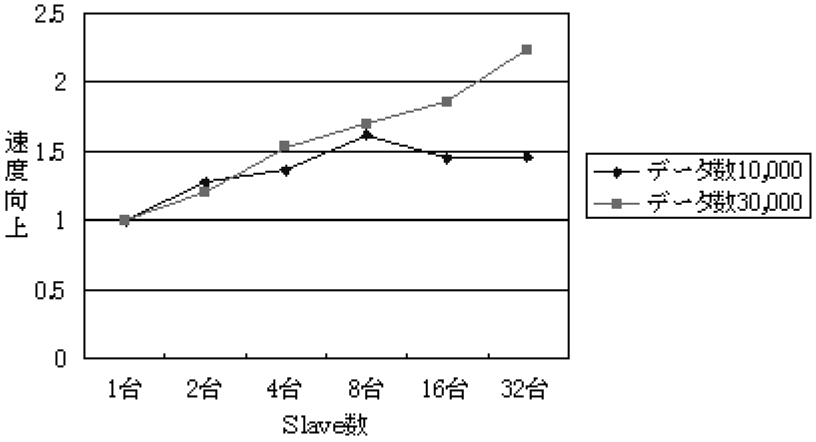
!JC!K

data \ slave	1 Bf	2 Bf	4 Bf	8 Bf	16 Bf	32 Bf
%G!<%??t10,000	0.201	0.157	0.147	0.124	0.138	0.137
%G!<%??t30,000	0.420	0.351	0.274	0.247	0.226	0.187

I=#2! !! !B.EY8~>e

!G\!K

data \ slave	1 Bf	2 Bf	4 Bf	8 Bf	16 Bf	32 Bf
%G!<%??t10,000	1.000	1.276	1.364	1.617	1.452	1.464
%G!<%??t30,000	1.000	1.197	1.535	1.697	1.855	1.241



?^6: %/%$%C%/%=!<%H$NB.EY8~>e

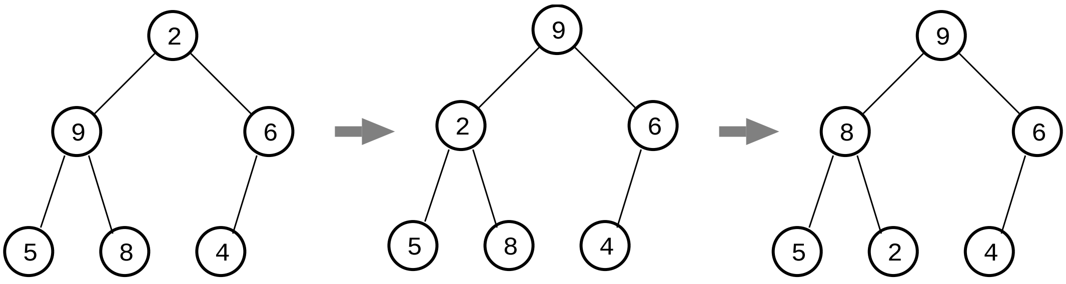
%G!<%??t$r10,000 $+$i30,000 $KA}$d9H!"B?>/$NB.EY8~>e$,F@il$?!#

3.2 %R!<%W%=!<%H

3.2.1 LdBj$NDj5A

%R!<%WHO!"G$0U$N@aKD$$$F$=$N@a$N%-!<CM$,$=$N;R$N%-!<CM0J>e$G$"$kh&$J40A4FsJ,LZ$N3H$r$$$&!#%R!<%WK*$$$F$O!"$INh$&$JItJ,LZrHCF$b:,$N%-!<$,:GBg$NCMHJCF$$$k[7]!#

%R!<%W%=!<%H$r=R$Y$kA0$K!"40A4FsJ,LZ$r%R!<%W$K;EN)$FD>$9$3$H$r9M$($k!#$$$^!"$"$k40A4FsJ,LZ$,$"CF!":,H=$N:81&$N;RHNBg>.4X78$r=|$$$F!"%R!<%W$N>r7o$rK~$?$7$F$$$kbNH9$k!#$3Nh$&$J>l9g$O!":81&$N;RN&ABg-$$J}NCMH:,HrHf3S7F!":,$NJ}$,>.5+C?$i?F;R$r8r49$9$k!#$=$&7F!"0lCJ2<$X9_$j$?:,$H;RHr:F$SHf3S$9$k!#$3lr7+jJV7$F$$$/$H!":,$O$=$NBg$-$5$K8+9g$C$?0LCV$^$G9_$j$F$$$/!#3&7F85$N40A4FsJ,LZ$O%R!<%WKJ$k[7]!#



(a) 根以外はヒープ (b) 1段降りた (c) ヒープ

?^7: %R!<%W2=$NNc

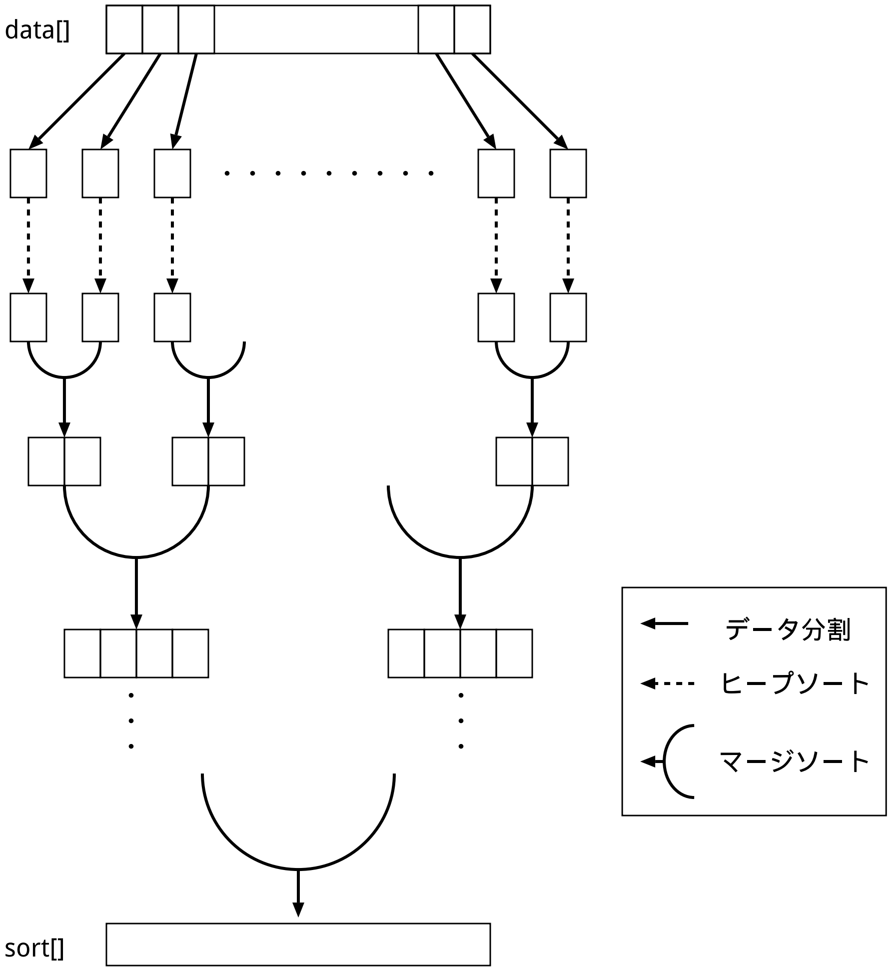
Nc$($P!"?^#7(a)$O!":,$H$=$N;R$NBg>.4X780J30$O%R!<%WKJCF$$$k!#3l$K!">e$G=RY?h&$JA`:n$r;\$9$H!"2<9_$,#22s5/3j!":G=*E*$KF1?^(c)$Nh&$J%R!<%W$KJk!#

%R!<%W%=!<%H$O!"FsJ,LZ$r%R!<%W$K;EN)$Fk3H+$i;O$a$k!#:G$bKvC<$NFsJ,LZ$+$i%R!<%W$X$N;EN)$F=hM}$,;O$^$j!"=g<!!"@hF,$^$G7+$jJV5l$k!#$3lKhj!"LZ$N%k!<%H$K$O:GBgCM$,F~$j!"<!$K!"%k!<%H$HG[Ns$N:G8eHx$r8r49$9$k!#$=$N7k2L!"Jx$l$?%R!<%W$N:G8eHx$r=|$$$?;DjNLZ$r:FEY%R!<%W2=$9$k!#8e$O!"LZ$,%k!<%H$@1KJk$^$G3l$r7+$jJV$9!#$D$^$j!">:=g$K%=!<%H$9kN$K:GBg$NbN$rC5$7$F0lHV8e$mKCV/$H$$$&=hM}$r9T$&!#$3$3$G!"LZ$NBg$-$5$O#1$D$:$D8:CF$$$/NG!"7+jJV7:n6H$O n 2sKJ$k!#7+$7!":G=i$N%R!<%W2=$r=|$$$F!"%k!<%H$H:G8eHx$r8r49$7$?3HKhCFJxl?%R!<%W$N=$I|$O $\log_2 n$ $KHfNc$9$k!#$D$^$j!"7W;;$N<j4V$NAm7W$O $O(n\log n)$ HJ$k!#

3.2.2 JBNs2=$N2r@O

3N%W%m%0%i%`$NJBNs2=<jK!$O!"%=!<%F%#%s%0BP>]%G!<%?$rMaster $GC1=c$KSlave ?tJ,$NJ,3d$r7F!"J,3d5l$?%G!<%?$rSlave $XAw?.$9$k!#Slave GO!"<u?.7?%G!<%?$r%R!<%W%=!<%H$Khj%=!<%F%#%s%0$9$k!#%=!<%F%#%s%0$7$?%G!<%?$rMaster $XAw?.$7!"Master $O<u?.$7$?%G!<%?$r%^!<%8%=!<%HKh$j#1$D$NG[Ns$K3JG<$7!"7k2L$rI=<(9k!#$=$NMM;R$r?^#8$K<($9!#

%^!<%8HO!"%=!<%H5l$?#2$D$N!J#3$D0J>eGb$h$$!K%G!<%?Ns$r9g$o$;$F!"#1K\$N%=!<%H5l$?%G!<%?Ns$K9k3HG"$k!#$=$N%^!<%8$N9M$(J}$r%=!<%HKE,MQ7$?$bN,%^!<%8!&%=!<%HG"$k!#



?^8: %R!<%W%=!<%H$NJBNs2=<jK!

3.2.3 <B837k2L

%=!<%F%#%s%0BP>]%G!<%?$r10,000 8D!"25,000 8D$NMp?tH7!"Slave $r#1Bf!"#2Bf!"#4Bf!"#8Bf!"#1#6Bf!"#3#2BfH7!"<B9T;~4V$r7WB,$7$?!#I=#3$K<B9T;~4V$r<($9!#$^$?!"7WB,7?7k2L$K4p$E$-!"B.EY8~>e$rD4Y?7k2L$rI=#4!"?^#9$K<(7?!#

I=#3 !!<B9T;~4V

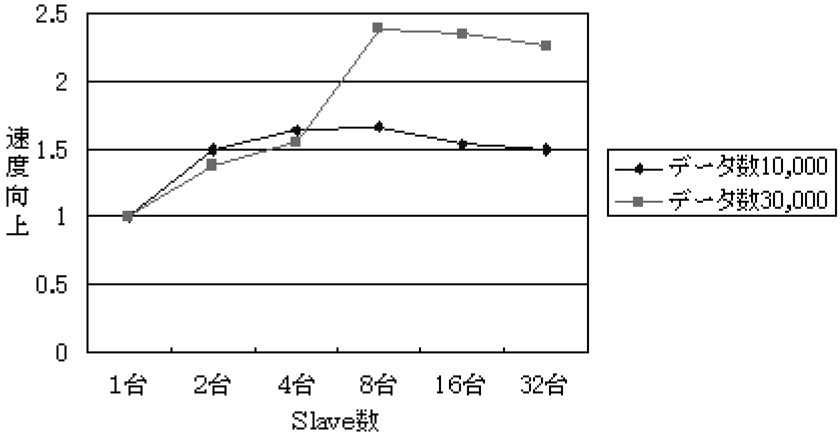
!JIC!K

data \ slave	1 Bf	2 Bf	4 Bf	8 Bf	16 Bf	32 Bf
%G!<%??t10,000	0.219	0.144	0.139	0.134	0.134	0.156
%G!<%??t30,000	0.423	0.333	0.277	0.169	0.170	0.206

I=#4!!!!!B.EY8~>e

!JG\!K

data \ slave	1 Bf	2 Bf	4 Bf	8 Bf	16 Bf	32 Bf
%G!<%??t10,000	1.000	1.521	1.576	1.635	1.640	1.403
%G!<%??t30,000	1.000	1.271	1.525	2.498	2.482	2.055



?^9: %R!<%W%=!<%H$NB.EY8~>e

%G!<%??t$,10,000 NH$-O[$HsIB.EY8~>e$,F@ilJ+C?$,!"%G!<%??t$r30,000 $KA}$d9HB.EY8~>e$,B?>/F@$il?!#7+$7!"Slave ?t#1#6Bf0J9_$OB.EY8~>e$,F@$ilJ$+$C$?!#

4 I>2A$H9M;!

K\8&5f$G<h$j07C?%/%$%C%/%=!<%H!"%R!<%W%=!<%H$N#P#V#M$rMQ$$$?JBNs%W%m%0%i%_%s%0$O!"Slave ?t$KHfNc7FB.EY8~>e$,F@$ilk$H$$$C$?!"M}A[E*$J7k2L$rF@$k3H$,$G$-$J$+$C$?!#$=$NM}M3$H7F9M$($ilkbNH7$F!"C`<!=hM}ItJ,$NA4BN$K@j$a$k3d9g$,Bg$-$$$3HH!"<h$j07$&%G!<%??t$,>.$5$$$3$H!"Ii2YJ,;6$NPiD-JI$,$"2ilk!#

%/%$%C%/%=!<%H$NJBNs2=$r;n$_h&H9kH!"$^$:!"JBNs2=<jK!H7$FJ,3dE}<#$,$"$2il$k!##P#V#M$G$OSlave 4VDL?.$,MF0WGOJ/!"J,3dE}<#$N<B8=$,:FqG$"$k!#$^$?!"L5M}$KJ,3dE}<#$r;n$_$k$H!"Slave ?t$,A}$($k$[$IDL?.2s?t$,A}2C$7F7$^$$!"C`<!=hM}$G9T$&$h$j$b=hM}$K;~4V$,$+$+$C$F$7$^$&!#$=$3$G!"DL?.$N%?%$%`%m%9rKI0$?$a$K!"Master $GJ,3d=hM}$r9T$$!"Slave $G%=!<%F%#%s%0$r9To;$?$,!"Master $G9T$&C`<!=hM}$N@j$a$k3d9g$,Bg$-$/!"<h$j07$&%G!<%??t$N>.$5$5$b1F6A7F!"Slave ?t$rA}$d7F$b;W$&h&$KB.EY8~>e$,F@ilJ+C?!#$^$?!"%/%$%C%/%=!<%H$O%=!<%F%#%s%0BP>]%G!<%?$rI,$:7b#2EyJ,9ko1GOJ/!"JBNs=hM}$r9T$&K"$?$j!"Ii2YJ,;6NPiD$-$,Bg$-$/JjB.EY8~>e$NK8$2HJ$k!#

%R!<%W%=!<%HKD$$$F$bF1MM$K!"C`<!=hM}ItJ,$N@j$a$k3d9g$,Bg$-$$$?aKM}A[E*$JB.EY8~>e$rF@k3HO=PMhJ+C?!#

0J>ehj!"J,;6%a%b%j7?!HJs6&M-!KG"$k#P#V#M$G$O!"%W%m%;%C%5%U%!!<%`$N$h$&$J!"Hf3SE*DL?.2s?t$N>/$J$$JBNs2=<jK!$r$H$k$[$&$,$h$$$H;W$o$l$k!#$=$NM}M3$H$7$F!"J,;6%a%b%j4D6-$G$N%W%m%0%i%`$K$*$1$kDL?.%*!<%P%X%C%I$,$"$2il$k!#DL?.$O!"JBNs%W%m%;%9$,Aj8_$K1F6A$rM?$(J,$i7W;;$r?Jak$?$aKOI,MWJbNG$"$k$,!"$3$NDL?.$OC1$K%G!<%?$N0\F0G"$j=c?h$J%*!<%P%X%C%IH7$F8=$l$k!#$3$NDL?.%*!<%P%X%C%I$r8:i9$?$aKO!"%"%k%4%j%:%`$r=$@5!"2~NI$7!"DL?.$N:o8:$r9T$&N,0lHV8z2LE*G"kH9M$($ilk!#

5 $*$ojK

K\8&5fGO!"#P#V#MKh$kJBNs%W%m%0%i%_%s%0$r9TC?!#$=$NBj:`$H$7$F!"%/%$%C%/%=!<%H$H%R!<%W%=!<%H$rA*$S!"JBNs2=$r?^$C$?!#%=!<%F%#%s%0$O!"<BMQE*$J7W;;5!=hM}$NJ,Ln$K$*$$$FHs>o$KBg$-$J%&%'%$%H$r@j$a$k$b$N$G$"$j!"JBNs%"%k%4%j%:%`$r8l$kH-$KBh0l$K<h$j>e$2il$kLdBj$H7FU5o7$$!#!VO8aK!WGb=RYF$$$k$,!"K\8&5f$NL\E*$OJBNs%W%m%0%i%_%s%0<jK!$NM}2rH=$NJBNs8z2L$NI>2AG"C?!#M}A[E*$JB.EY8~>e$OF@ilJ+C?$,!"JBNs%W%m%0%i%_%s%0<jK!$NM}2r$HI>2AOG$-$?NGOJ$$$+$H;W$olk!#

:#8e$N2]Bj$H7F$O!"<h$j07$$$BP>]%G!<%?rBg-$/$9k3HH!"Ii2YJ,;6$N6Q9U$rHk3H!"C`<!=hM}ItJ,$N@j$a$k3d9g$r>.5/9k3H$,5s$2il$k!#

<U<-

K\8&5f$N5!2q$rM?$($F2<5j!"?t!9$N=u8@$rD:$-$^7?;3:j>!9065<x!"@>B<=SOB=u65<x$K?4$h$j46<UCW$7$^$9!#$^$?!"K\8&5fK"$?$j!"6&F17W;;5!<B83<<$N;HMQ$N5v2D$rM?$(F/$@$5C?650i8&5f%7%9%F%`2]$N3'MM!"MM!9$JLL$G=u8@!";XF3$rD:$-$^7??"Ln<BD>;a!"JFED7r<#;arO8aH9$kK\8&5f<<$N3'MMKb?4hj46<U7^$9!#

; 29MJ88%

[1] Al Geist!$Adam Beguelin!$Jack Dongarra!$Weicheng Jiang!$Robert Manchek!$Vaidy Sunderam!$(Lu B<ED 1QL@) !PVM3 %f!<%6!<%:%,%$%I&%j%U%!%l%s%9%^%K%e%"%k!$F|K\8lHG, 1995.

[2] @n@>D+M: !C 8@8lKhkO8aFN%"%k%4%j%:% 'F~Lg!$5;=QI>O@<R, 1992.

[3] 1|B<@2I' !C 8@8lKh$k%"%k%4%j%:% ';vE5!$5;=QI>O@<R, 1997.

[4] Er@uB@0l, 0BB<DL98, CfED EP;VG7: O8aF$NJBNs%W%m%0%i%_%s%0!$6&N)=PHG, 1998.

[5] Selim G. Aki!$(Lu 0$9>Ci!$;32<2m;K!$Aj86NhFs): JBNs%=!<%F%#%s%0 !&"%k%4%j%: % '!$7<3X=PHG, 1988.

[6] ;0LZ8wHQ, W"0BCNG7, C+B<M&Je!PC %/%i%9%?D6F~Lg!$D6JBNs7W;;8&5f2q9V=,2q, 1999.

[7] @>86@60l!%G!<%?9=B$!$%*!<% '<R, 1997.

[8] JIC+JY!PVM Kh$kJBNs%W%m%0%i%_%s%0(I), N)L?4[Bg3XM}9)3XIt>pJs3X2JB46HO@J8, 2000.

[9] @>C+??<y!PVM Kh$kJBNs%W%m%0%i%_%s%0(III), N)L?4[Bg3XM}9)3XIt>pJs3X2JB46HO@J8, 2000.

3OIt;EMM

```
%pvm       /*pvm$N5/F0*/

pvm> add %^%7%sL>      /*!!%[%9%H$NDI2C!!*/

pvm> conf       /*!!EPO?$5$l$F$$$k%[%9%H$N3NG'!!*/

pvm> quit       /*!!PVM$N@)8f=*N;!!*/

pvmd still running.

%

% ~/pvm3/bin/SUN4SOL02/<%^%9%?!<!&W%m%0%i%`L>>      /*!!<B9T!!*/

%pvm

pvmd already running.

pvm> halt       /*!!PVM$NDd;_!!*/
```

FbIt;EMM

(1) %/%$%C%/%=!<%H

- quick_master.c
  - data !NO! ! !%=!<%F%#%s%0BP>]%G!<%?$r3JG<$9$kG[Ns
  - jiku1 !NO, jiku2 !NO! ! !%=!<%F%#%s%04 0N;0LCV$r3JG<$9$kG[Ns
  - owari !NO! ! !%=!<%F%#%s%0%G!<%??t$r3JG<$9$kG[Ns
  - irnd(void) ! ! !'8F$S=P$5lk$HMp?t$r@8@.$7!"7k2L$rreturn J8GJV9
  - quick(int data !NO,int left,int right) :G[Nsdata $K3JG<$5lF$$$k?tNs$rleft HVCO$+$iright HVCO$^$G%=!<%F%#%s%0$7!"7k2LrJV9
- quick_slave.c
  - quick(int q !NO,int left,int right) ! ! !G[Nsdata $K3JG<$5lF$$$k?tNs$rleft HVCO$+i+$iright HVCO$^$G%=!<%F%#%s%0$7!"7k2LrJV9

(2) %R!<%W%=!<%H

- h_master.c
  - h !NO! ! !%=!<%F%#%s%0BP>]%G!<%?$r3JG<$9$kG[Ns
  - data !NO! ! !'85$NMp?t%G!<%?$r3JG<9kG[Ns
  - sort !NO!NO! ! !%=!<%F%#%s%07k2L$r3JG<$9$kG[Ns
  - num !NO! ! !%^!<%8%=!<%H$NBP>]%G!<%??t$r3JG<9kG[Ns
  - irnd(void) ! ! !'8F$S=P$5lk$HMp?t$r@8@.$7!"7k2L$rreturn J8GJV9
- h_slave.c
  - heap(int n,int data !NO) ! ! !G[Nsdata $rn HVCO$^$G%=!<%F%#%s%0$7!"7k2LrJV9