B4 6H O@ J8

PVM Kh$kJBNs%W%m%0%i%_%s%0
(I)

;a L> !'JIC+! !JY
3X@RHV9f !'2210960081-8
;XF3 65 0w !';3:j! !>!90 65<x
Ds =P F| !'2000 G/2 7n18 F|

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

FbMF9<35

#C#G$d!"2hA|2r@O$H$$$G$?$h$&$JBg5,LO$J=hM}$KBP$7!"C`<!=hM}$GBP1~7-lJ$/$JCFMh$F$$$k$?$a!"=hM};~4V$r0J2<$KC;=L9k2=$H$$$&J}K!$N#1$DH7$FJBNs=hM}$,$"$k!#$=$NJBNs2=$r9T$&bN$N#1$DH7$F#P#V#M$,$"$k!##P#V#MHO!"JBNs2=$r9T$&$?$a$N#1$D$NJ}K!$G$"$k!#J,;6%a%b%j%"!<%-%F%/%A%cKh$j<B8=$5lF$*$j!"%M%C%H%o!<%/GD$J$$$@0[5!<o$N#U#N#I#X%3%s%T%e!<%?72$r!"C10l$NJBNs%3%s%T%e!<%?$H7FMxMQ9k3H$r2DG=$K7F$$$k!#3N%=%U%H%&%'%"$r;HMQ$7%W%m%0%i%`$NJBNs2=$r9T$&$3HG!"=hM};~4V$rC;=L$rL\E*H9$k!#

K\O@J8GO!"<yLZ6J@~!"%i%s%l%s%0%905=L!"%S%8%M%k0E9fKD$$$F#P#V#M$rMQ$$$F!"JBNs2=$r;n$_$F$$$k!#

L\<!

1 O8aK

:#F|GO!"%3%s%T%e!<%?$N@-G=$N8~>eKh$j!"=hM}B.EY$O9bB.KJCF$-$F$$$k!#7+$7!"5$>]M=B,!"2hA|2r@O!"#C#G!"9R6u5!$N@_7W!$0eNE!"0eLtIJ!"6d2O7O$N2rL@!"0dEA;R$N2rL@Ey$H$$$C$?$h$&$JBg5,LO$J=hM}$r9T$&$bNK$O!"B?Bg$J;~4VrHq5J1lPJiJ/Jj!"C`<!E*$J=hM}$G$O4V$K9goJ$/$JCF$-$F$$$k!#JBNs=hM}$O!"%W%m%;%C%5J#?tBf$rJBNs$KF0:n$5$;$k3HKh$j!"9bB.2=$r?^k3H,G-$k5;=Q$G$"$k!#7+$7!"JBNs%W%m%0%i%_%s%0$K$O!"JBNs%W%m%0%i%_%s%0FCM-$NCN<1$H7P83$,I,MW$G!"=i?4%f!<%6!<KO!"Hs>o$KM}2r$7K/$/!":$FqG"$k!#

JBNs%W%m%0%i%_%s%0%i%$%V%i%j$K$O!"J,;6%a%b%j7?$G6&M-%"%/%;%9IT2DNbNH7F#M#P#I!JMessage Passing Interface!K$d#P#V#M!JParallel Virtual Machine!K"6&M-%"%/%;%92DG=$N!"$bNH7F#G#l#o#b#a#l #A#r#r#a#y$d#M#P#I-#2!"6&M-%a%b%j7?$N#p#t#h#r#e#a#d!JPosix thread!K$d#O#p#e#n#M#P$,$"$k!#$=$NJ+$G!"K\O@J8$G$O!"#P#V#M$r;HCF#3DN%W%m%0%i%`$NJBNs2=$r9T$$J#?tBf$N%o!<%/%9%F!<%7%g%s>e$G!"<B9T7F$$$k!#

#P#V#MHO!"#T#C#P/#I#P%M%C%H%o!<%/$G@\B3$5l?0[5!<o$N#U#N#I#X%3%s%T%e!<%?72$r!"C10l$NJBNs%3%s%T%e!<%?$H7FMxMQ9k3H$r2DG=$K7?%=%U%H%&%'%"%7%9%F%`G"$k!#$3lrMQ$$$k3HKh$j!"B?$/$N0[$JC?5!<o$N%3%s%T%e!<%?$r;HCF!"#1DNBg5,LO7W;;$N=hM}$r9T$&$3H,2DG=HJC?!#$=$N$?$a!"9b2A$J%9!<%Q!<%3%s%T%e!<%?$JIr;HoJ$/$F$b!"Dc2A3J$G$N9b@-G=7W;;$,2DG=HJC?!#$^$?!"#P#V#M$OL5NA$GG[I[5l!"Il$+0lBf$N%3%s%T%e!<%?$K%$%s%9%H!<%k9k$@$1$G!"%m%0%$%s9k3HNG$-$k%3%s%T%e!<%?A4FKBP7F#P#V#M$r5/F0$9k3H,G-$k!#$^$?85!9$O!"%o!<%/%9%F!<%7%g%s!&/%i%9%?N?aN#T#C#P/#I#P%Y!<%9$NDL?.%i%$%V%i%jG"C?$,!"8=:_$G$OB?$/$NJBNs7W;;5!$K$b0\?"$5lF$$$k!#

JBNs%"%k%4%j%:%`$O!"$"$k>r7o$K4p$E$$$FJ,3d$7$J$,$i=hM}$r9T$&J,3dE}<#K!!"%^%9%?!<$,LdBj$rJ,3d$7!"$=$l$>$l%9%l!<%V$,JB9T$7$F=hM}$r9T$&%W%m%;%C%5%U%!!<%`!"LdBj$rJ#?t$N%9%F!<%8$KJ,$1!"$=$N%9%F!<%8$N=hM}$,=*oj<!Bh!"<!$N%9%F!<%8$N=hM}$KO\$k%W%m%;%9%M%C%H%o!<%/!"LdBj$rJ#?t$KJ,$1!"$=l>lG$"$k0lDj$N>r7o$rK~$?$9$^$G7+jJV7=hM}$r9T$&7+jJV7JQ49$H$$$C$?#4$D$N%"%k%4%j%:%`$GI=8=9k3H$,$G$-$k!#

M?$($il?%W%m%0%i%`$N@-<A$K$h$j!"$=$l$KE,$7$?%"%k%4%j%:%`$r;HMQ$7!"JBNs2=$r9T$&!#

K\O@J8GO!"<yLZ6J@~!"%i%s%l%s%0%905=L!"%S%8%M%k0E9f$N#3$D$NJBNs%W%m%0%i%`$r#P#V#M$rMQ$$$F:n@.$7!"I>2A$7$?!#$J$*!"JBNs=hM}$r9T$&4D6-$H7F!"Sun Microsystems<R$NUltra1$r;HMQ7F$$$k!#

<yLZ6J@~HO:F5"E*$J%W%m%0%i%`$K$h$j%U%i%/%?%k?^7A$rIA$/%W%m%0%i%`$NRHDG$"

$j!"; ^$ND9$5!"J,4t3Q!"; ^$N?–$SN($rF~NO9k3H$G!"LZ$N; ^Nh$&$J2hA|rIA/3H$, G–$k!#

%i%s%l%s%0%905=LHO!"%G!<%?05=L$r9T$&%W%m%0%i%`$N$R$H$D$G$"$j!"%F%–%9%HCf ABBCCCC $H$$$C$?O"B3$7$?F1$8J8; z$NJB$S$K$D$$$F!"$=$NJ8; z$H$=$NJ8; z$,$$$/$DJB$s$G $$$k$+$rI=$9?t; z !J8; z$,#1J8; z$N>19g$OJ8; z$N$_$G!K$H$N#2%P%$%H$G AB2C4 $H$$$&$h $&$K05=L$9$k%W%m%0%i%`G"$k!#%F%–%9%H%G!<%?$K$OIT8~$–$J5;K!$G$"$k$,!"2hA|%G!<%? Ji3l$@$1G+Jj$N05=L$r9k3H$,G–$k!#

%S%8%M%k0E9fHO!"0E9f2=<jK!$N#1$DG"$j!"C;$$%–!<%o!<%I$r7+$jJV$7MQ$$$F!"3F%9 %F%C%W4H$K8 0$N1Q; z$NHV9f$HJ?J8$N1Q; z$NHV9fNOBr0E9fJ8$N1Q; z$H9k3H$G!"0E9f 2=$r9T$&%W%m%0%i%`$G$"$k!#

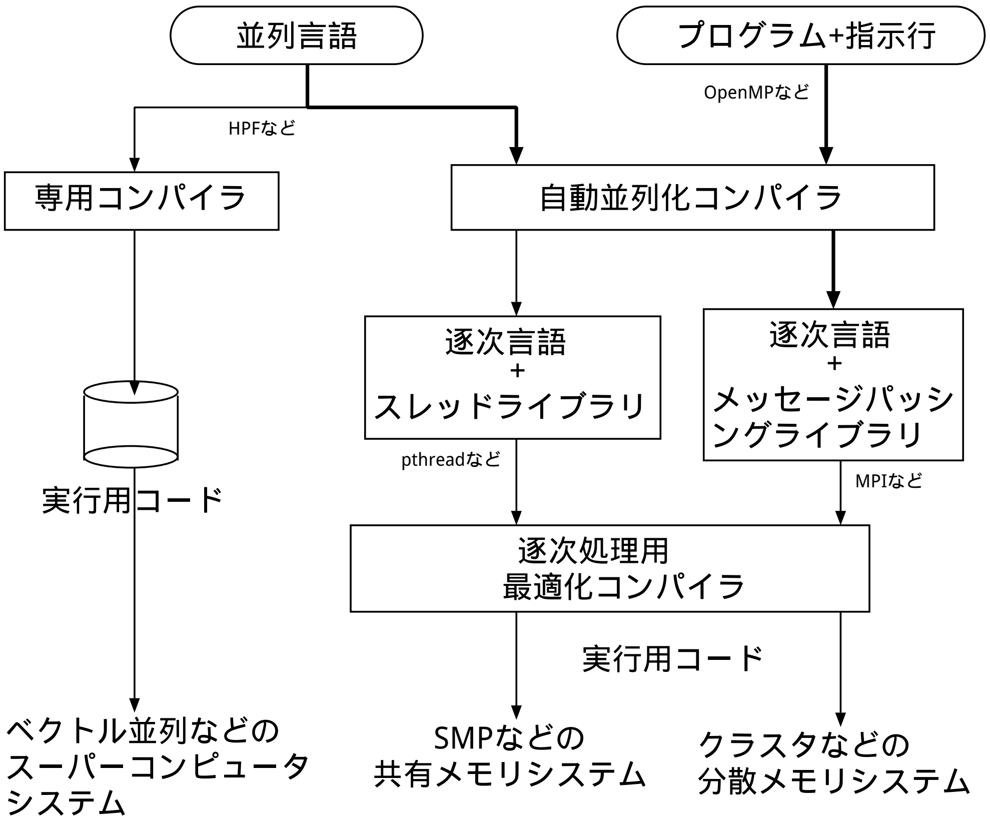
#2>OGOJBNs2=<jK!$H#P#V#M$K$D$$$F!"#3>OGO!"<yLZ6J@~!"%i%s%l%s%0%905=L!"%S%8 %M%k0E9f$N#P#V#M$KhkJBNs%W%m%0%i%`KD$$$F=RYk!##4>OGO!"#3>OGN%W%m%0%i%_ %s%0KD$$$F$NI>2A$H9M; !$r9T$$!"#5>OGOK\8&5fN^Ha$H:#8e$N2]Bj$r=R$Y$F$$$k!#

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

2.1 JBNs2=<jK!

JBNs%W%m%0%i%`$r5-=R$9$k>19g$K$O!"2<5-$N?^#1Nh$&$JN.1G5-=R7F$$$/[4]!#

JBNs8@81JIKhCF7W;;q8;$NDj5A!"$=1KBP9k%G!<%?J,;6$NJ}K!!"%G!<%?4V$N0MB84X78!"%W%m%0%i%`$N@)8f$NN.$1$H$$$C$?$b$N$r5-=R$7!"$3$1$r<+F0JBNs%3%s%Q%$%i$,2r@O$7C $dF $H$$$C$?C`<!8@81$K%9%1%C%I$d%a%C%;!<%8%Q%C%7%s%0Ey$NJBNs2=%i%$%V%i%j$rA^F~$7$?%3!<%I$r@8@.9k!#



?^1: JBNs%W%m%0%i%`$NN.$1

JBNs=hM}NCfKb5$^$6$^$J7?$,$"$k!#$=NJ$+$G!"#S#I#M#D!JSingle Instruction Stream Multiple Data Stream!KJ}<0$H!"#M#I#M#DMultiple Instruction Stream Miltiple Data Stream!KJ}<0$,$"$k!#

#S#I#M#DJ}<0HO!"#1<dN`$N1i;;$r!"J#?t8D$N%G!<%?$KBP7F;\$9$3$HG"$k!#$3$NJ}<0$K$O!"#18D$N1i;;4o$K%G!<%?$rN.$79~$_!"1i;;$r<B9T$5$;$k%Q%$%W%i%$%sJ}<0$H!"B??t$N1i;;4orJBY$F!"$*N*NGC4Ev9k%G!<%?KBP7$F1i;;$r9T$&%G!<%?JBNsJ}<0$,$"$k!##S#I#M#DJ}<0$O=EMW$J7+$78B$i1?LdBj$,$3$N9=B$$KHs>oKh$/E,9g$9kH$$$&3H$,$$$($k!#$7$+$7!"$"$k<oNBg-$JLdBj$K$O#S#I#M#DJ}<0$G$O8zN($h$/=hM}$9k3H,G-$J$$!#$=$Nh&$JLdBj$KMW5a$5$1$k1i;;$O6Q01$J9=B$$N%G!<%?KBP9$k1i;;$N7+jJV7KOJi$J$$!#9=B$$,J/$^$?M=B,IT2DG=J3H,B?$$!#%"%I%1%9$b%G!<%?$K0MB8$9$kNG>-Mh$N%"%/%;%9$rM=B,7F%G!<%?$r;vA0$KbCF-F*$/$h$&$J3HbG$-$J$$[4]!#

$=$Nh&$JLdBj$KBP7F9b@-G=$r<B8=$7J1lPJi$J$$>l9g!"#M#I#M#DJ}<0$rMQ$$$k!#<+J,<+?H$G%W%m%0%i%`$r<B9T$9$kG=NO$rHw$($?J#?t$N%W%m%;%C%5$+$i9=@.$5$l$k$b$N$G$"$j!"%^%k%A%W%m%;%C%5$N%W%m%;%C%5$I$&$7$O%W%m%0%i%`$,%G!<%?$r8r49$9$9$k3H$dF14|$r<hk?aNF0:n$,2DG=$J7A$GAj8_$K@\B3$5$1$k!#$=N?$a!"#M#I#M#DJ}<0$N$[$&$r0lHIE*$KMQ$$$k[4]!#

%^%k%A%W%m%;%C%5$,:G9b@-G=$GF0:n9kH-KO9YFN%W%m%;%C%5$OM-MQ$J;E;vr7$F$$$k!#7+$7!":G9b@-G=$OHs>o$KFC<1$J>uBV$G5)$K7+<B8=G-$J$$!#8zN($r2<$2$k860x$H7F$$$/D+$"$,$k!#

- %W%m%;%C%54VDL?.$KH<$&CY1d!#
- 1Bf$N%W%m%;%C%5$HB>$N%W%m%;%C%5$N;E;v$rF14|$5$;$k$?$a$N%*!<%P!<%X%C%I!#
- %7%9%F%`$N@)8f$dI&5N%9%1%8%e!<%j%s%0N?aN=hM}%3%9%H!#
- 1Bf$"$k$$$OJ#?tBf$N%W%m%;%C%5$N!&B9T9Y$-!K%?%9%/$,J/JC$?$H$-$N8zN(Dc2<!#

3N860x$N#1$DHJ$k%W%m%;%94VDL?.$H$O!"JBNs%W%m%0%i%_%s%0$r9T$&>e$GI,MWJbNG!"$=$N:]!"%W%m%;%94V$NF14|$dGSB>@)8f$,LdBj$HJk!#JBNs%W%m%0%i%`$O!"%W%m%;%9$,JBNs$KF0$/$,!"40A4$KFHN)7F$$$ko1GJ$/!"7W;;$NESCf$d?J9T>u67$K4X7F%W%m%;%94V$G>pJs$r8r49$7$J$,$i!"6(NO7FF0$$$F$$$k!#$=$NJ+$G!"F14|$rHkHO!"

- %U%!%$%k$N%m%C/$,2r$1kNrBTD!#
- %P%C%U%!$,K~GU$KJkNrBT$D!#
- B>$N%W%m%;%9$,$"$k;q8;$r;HMQ$7J/J/Jk$^$GBT$D!#

JI!"$"$k;vJA$,$*$-$kNrBTDH$$$&3HG"$k!#$3Nh$&$JBTANBP>]KJGF$$$k;v>]$r0z$-5/$3$9h&$JF0:n$r9k%W%m%;%9$rB>$N%W%m%;%9KCNi$;$kI,MW$,$"kH$$$&3H$+$iI,MWH5lk[8]!#

<!$K!"GSB>@)8f$H$O!"0lHL$K%W%m%;%9$,$=$N=hM}$r<B9T9k$?$aKI,MWJ;q8;!Jresource!K$O!"

- :FF~2DG=(re-entrant9 $J;q8;
- C`<!:F;HMQ2DG=(serially re-usable) $J;q8;
- :F;HMQIT2DG=$J;q8;

$N#3<oN`$KJ,N`$5lk!#

:FF~2DG=$J;q8;$OINh&$J%W%m%;%9$KhCFb!"$=$NFbMF5Z$S>uBV$,JQ99$5$l$J$$$bNG$"$j!"FI$_=P$7@lMQ$N%U%!%$%k$d!"<+J,<+?H$N%3!<%I$rJQ99$7$J$$$h$&$K@_7W5l$?%W%m%0%i%`Ey$,3lK"$?$k[8]!#

C`<!:F;HMQ2DG=$J;q8;$O%W%m%;%9$N<B9T$KhC$FFbIt$NCM$d>uBV$,JQ99$5$lkbNG$"$j!"0l;~E@GO$?$+$@$+#1DN%W%m%;%9$7$+;HMQG-$J$$!#$?$@$7!"A0$N%W%m%;%9$N;HMQ$,=*N;9l$P!"JL$N%W%m%;%9$,;HMQ$9k3HbG-$k!#B?$/$N6&DL%U%!%$%kEy$,$3lK$"$?$k[8]!#

9YFN;q8;$,:FF~2DG=$G$"$l$P!"$IsJ%W%m%;%9$,$IsJ%?%$%_%s%0$G$=$l$r;HMQ$7h&HbLdBj$O@8$8$J$$$,!"C`<!:F;HMQ2DG=$J;q8;$KBP7F$O!">o$K#1DN%W%m%;%9$7$+$=$N;q8;$r;HMQ$G$-$J$$$h$&$K4IM}9kI,MW$,$"$k!#$3Nh$&$K!"#1DN%W%m%;%9$,B>$N%W%m%;%9rDya=P7FFH@jE*$K;HMQ$G$-$kh&K9k3HrGSB>@)8f$H$$$&[8]!#

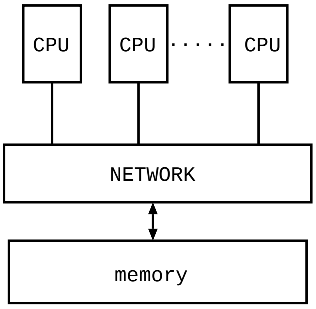
$"$k%W%m%;%9$,GSB>@)8f$rI,MWH9$k;q8;$r;HMQ7F$$$kH-$K!"B>$N%W%m%;%9$,$=$N;q8;$r;HMQ7h$&$H9l$P!";HMQCf$N%W%m%;%9$,$=$N;q8;$N;HMQrdak$^$GBT$?$J1lPJiJ$$!#9JoA!"FsDN%W%m%;%9$N4V$GF14|$r<h$kI,MW$,$"$k!#$3Nh$&$K!"F14|<jCJ$,$J1l$PGSB>@)8f$O<B8=G-$J$$[8]!#

2.2 PVM HO

JBNs7W;;5!%"!<%-%F%/%A%c$,%W%m%0%i%_%s%0$K1F6A$rM?$($k0x;R$H7F!"%a%b%j%b%G%k$,5s$2il$k!#<g$J%a%b%j%b%G%kH7$F0J2<$N#3<oN`NbN,$"$k!#

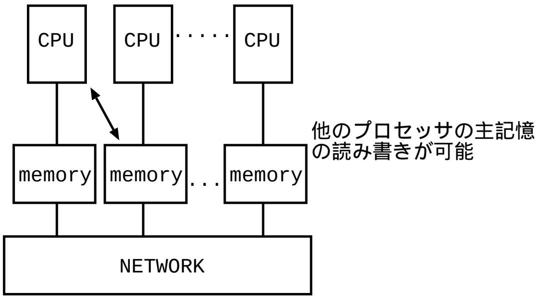
- 6&M-%a%b%j!'3P%97?$*$h$S!"6&M-J,;6%a%b%j$,B8:_9k!#K
- J,;6%a%b%j!'B>$N%W%m%;%C%5$N%a%b%j$,%"%/%;%9$G$-$kbN!#K
- J,;6%a%b%j!'B>$N%W%m%;%C%5$N%a%b%j$,%"%/%;%9$G$-$J$$$b$N!#K

6&M-%a%b%jHO#S#M#P!JSymmetrical Multi Processor!K$H8F$P$l!"J#?t$N%W%m%;%9$,%a%b%j%P%9!?%9%$%C%A7PM3$G!"<g5-211$K@\B3$5$l$k7ABV$G$"$j!"?^#2Nh$&$J%7%9%F%`$r;}$D!#



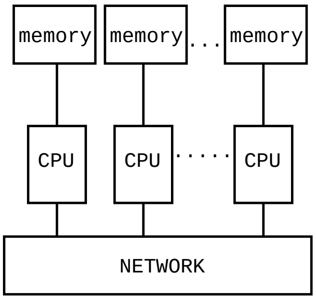
?^2: 6&M-%a%b%j%"!<%-%F%/%A%c

$^$?!"J,;6%a%b%j!J6&M-%"%/%;%92DG=!K$O!"%W%m%;%C%5$H<g5-21$+$i9=@.5l$k%7%9%F%`$,J#?t8D8_$$$K@\B3$5$l$?7ABV$G$"$k!#$3$N7ABV$NFCD'$H$7$F!"Bg5,LO$J%7%9%F%`$N9=C[$,2DG=$HJC$F$$$k!#7+$7!"<!$K=RYkHs6&M-%a%b%j%b%G%kHHfYkH<+M3EY$O9b$$$,!"#18DGb%P%j%"F14|$N>l=j$r4V0c$($k$H!"%?%$%_%s%00MB8$GHs>o$K2r@O7K$/$$%P%0$r:n$j3`3HKJ$k!#



?^3: J,;6%a%b%j%"!<%-%F%/%A%c(6&M-%"%/%;%92DG=)

J,;6%a%b%j!6T&M-%"%/%;%9I T2DG=!K$O!"%W%m%;%C%5$H<g5-21$+$i9=@.5l$k%7%9%F%`$,J#?t8D8_$$$K@\B3$5$l$?7ABV$G$"$k!#$?$@$7!"%W%m%;%C%5$OB>$N%W%m%;%C%5$N<g5-21NFI_=q$-$r9T$&$3H,G-$J$$!#



?^4: J,;6%a%b%j%"!<%-%F%/%A%c(6&M-%"%/%;%9I T2DG=)

3N>O$G=R$Y$k#P#V#M$H$O!"#38DL\$K<(7?J,;6%a%b%j!6T&M-%"%/%;%9I T2DG=!K7?K"FOak;v$,$G$-$k!#

@h$[$I=RY?h&$K#P#V#M$O!"J,;6%a%b%j!6T&M-%"%/%;%9I T2DG=!K7?$G<B8=$5lF$$$k!##P#V#M$O!"%"%W%j%1!<%7%g%s!"%^%7%s$*$h$S%M%C%H%o!<%/%l%Y%k$G$N0[5!<o4VMxMQ$r%5%]!<%H9k!#8@$$49$($k$H#P#V#M$N7?GO!"%"%W%j%1!<%7%g%s$r9=@.$9$k%?%9%/$O!"LdBj$K:G$bE,7?%"!<%-%F%/%A%c$rMxMQ$9k3H,G-$k!##P#V#M$O!"0[Jk%3%s%T%e!<%?4V$N@0?t$"$k$$$OIbF0>.?tE@$NI=8=$N0c$$$r5[<}9k$?$a$N%G!<%?JQ49$r07$&$3H,G-$k!#$=7F!"#P#V#M$OB?MM$J%M%C%H%o!<%/$G@\B3$5l?%t%!!<%A%c%k%^%7%s$r<B8=$9$k[3]!#

#P#V#M$N%=%U%H%&%'%"%7%9%F%`$N9=@.$O!"Bg$-$/#2$D$KJ,$1il$k!##1$D$O%G!<%b%s$G$"$jpvmd3 HhPl$k!#%G!<%b%s$O!"%t%!!<%A%c%k%^%7%s$r9=@.$9$kA4$F$N%3%s%T%e!<%?>e$K>oCs$7!"%f!<%6$O%m%0%$%s2DG=$G5($"$lPIsJ%3%s%T%e!<%?Kb!"pvmd3 $r%$%s

%9%H!<%k9k3H$,$G$-$k[3]!#

#P#V#M%=%U%H%&%'%"%7%9%F%`$r9=@.$9$k$b$&#1$D$O!"#P#V#M%$%s%?%U%'!<%9%k!<%A%s$N%i%$%V%i%j$G$"$k!#$3$l$Olibpvm3.a $H8F$P$l$k!#%i%$%V%i%j$O!"%a%C%;!<%8%Q%C%7%s%0!"%W%m%;%9$N@8@.!"%?%9%/$N6(D4!"5Z$S%t%!!<%A%c%k%^%7%s$N:F9=@.$N$?$a$N%k!<%A%s$rDs6!$9$k!##P#V#M$rMxMQ$9$k$?$a$K$O!"%"%W%j%1!<%7%g%s%W%m%0%i%`H3$N%i%$%V%i%j$rI,$:%j%s%/rI,MWH9k[3]!#

#P#V#M$NFCD'$r<($9!#

- PVM %?%9%/!(W%m%;%9!K$rC10L$H7?JBNs%W%m%0%i%`$r5-=R$G$-$k!#
- %?%9%/4V$N%a%C%;!<%8DL?.$r<B9T9k$?$a$N4X?t%i%$%V%i%j$r;}$D!#
- 4X?t$r;HMQ$7$F!$%"%W%j%1!<%7%g%s%W%m%0%i%`$N<B9TCf$K%?%9%/$r@8@.$7$?$j>C5n7?jG$-$k!#
- J#?t$N%?%9%/$r%0%k!<%W2=7F$*$-!$0lEY$KDL?.$r<B9T$G$-$k!#

$H$$$&E@$,5s$2il$k!#$^$?!"#P#V#M$O!"BPOC=hM}$G#P#V#M$r<B9T9k$?$a$N%7%'%k%W%m%0%i%`$N01<oG"$k#P#V#M%3%s%=!<%k$r;HMQ7F<B9TG-$k5!G=$H7F!"

- #P#V#M$N5/F0!&=*N;!#
- #P#V#M%?%9%/$N<B9T!#
- %Q!<%F%#%7%g%s$N3d$jIU$1!#

$H$$$C$?$bNr;}$D!#

#P#V#M%3%s%=!<%kGO!"BPOC=hM}KhCF$@$1GOJ/!"$"$i$+$8$aJ#?t$N%3%^%s%I$r%U%!%$%k$KEPO?$7F*$-!"%P%C%A=hM}$KhC$FA`:n$9k3HbG-$k!#

<!$K#P#V#M$N%W%m%;%9@)8fKD$$$F@bL@9k!#

- *int tid = pvm_mytid(void)*

  :G=i$N8F$S=P7KhC$F!"8F$S=P7?%W%m%;%9$r#P#V#M$KEPO?9k!#$=$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$$!##P#V#M$r5/F0$7$J$$$^%^%"%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$Jpvmd KBP7 FCNi$;$k!#K\%k!<%A%s$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 numt = pvm_spawn(char *task, char **argv, int flag, char *where, ntask, int *tids)*

pvm_spawn() $O!"<B9T2DG=%U%!%$%ktask $N%3%T!<$rntask 8D@8@.$7!"%t%!!<%A%c%k %^%7%s$G5/F0$9$k!#argv $Otask $KM?$($k0z?t$NG[NsXN%]%$%s%?$G$"$j!"$=$N=*$o jONULL $G<($5lk!#

- *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;$5$;$kh&KO@_7W5l$F$$$J$$!#<+J,<+?H$r=*N;$5$;$kKO!"pvm_exit() $H exit() $rB3$1$F8F$S=P$9!#

<!$K#P#V#M$NAw<u?.KD$$$F@bL@9k!#

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

pvm_send() %k!<%A%s$O!"%a%C%;!<%8$K@0?t<1JL;Rmsgtag $r%i%Y%kIU$1$7!"tid $G;X D$j5l$k%W%m%;%9$XD>AKAw?.9k!#

- *int bufid = pvm_nrecv(int tid, int msgtag)*

MW5a7?%a%C%;!<%8$,E~Ce$7$F$$$J$$>l9g!"Hs%V%m%C%/<u?.pvm_nrecv() $Obufid !a #0$GJV$k!#$3$N%k!<%A%s$r7+jJV78F$S=P$7$F%a%C%;!<%8$,E~Ce7F$$$k$+$I$&$+$r %A%'%C%/$9k3HG!"3F8F$S=P$74V$rB>$NM-MQ$J=hM}$K=<Fk3H$,$G$-$k!#B>K9

Y-M-MQ$J=hM}$,$J$$>19g$O! "%V%m%C%/<u?.pvm_recv() $rMQ$$$k3H$,$G$-$k! #tid $+$imsgtag $G%i%Y%kIU$1$5$1$?%a%C%;!<%8$,E~Ce9k$H! "pvm_nrecv() $O%"%/%F%# %V<u?.%P%C%U% !$r?7$7$/@8@.$7! "$=$3$K%a%C%;!<%8$rCV$$$?8e! "%P%C%U% !$N<1JL;R$r JV$9! #0JA0$N%"%/%F%#%V<u?.%P%C%U% !$O%/%j%"$5$1$kNG! "I,MWJi$Ppvm_sctrbuf() 8F$S=P7KhC$FJ]B8$7F*$/! #

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

%V%m%C%/<u?.%k!<%A%s$O! "tid $+$imsgtag $G%i%Y%kIU$1$5$1$?%a%C%;!<%8$,E~Ce$9 k^GBTD! #msgtag $"$k$$$Otid $,-1 Ji$P! "%o%$%k%I%+!<%IH7$F$$$+JkBP>] Hb%^%C%A9k! #%a%C%;!<%8$,E~Ce$9kH! "%"%/%F%#%V<u?.%P%C%U% !$r?7$7$/@8@.$7 %a%C%;!<%8rCV/! #0JA0$N%"%/%F%#%V<u?.%P%C%U% !$O%/%j%"$5$1kN$G! "I,MW$JiP pvm_sctrbuf() 8F$S=P$7KhCFJ]B8$7$F$*$/! #

- *int bufid = pvm_probe(int tid, int msgtag)*

MW5a9k%a%C%;!<%8$,E~Ce$7$F$$$J$$>19g! "pvm_probe() $Obufid $K#0$rJV$9! #E~Ce 7F$$$1$P%a%C%;!<%8$Nbufid rJV9$,! "$^$@<u?.$O9ToJ$$! #3N%k!<%A%s$r7+$j JV$78F$S=P7F%a%C%;!<%8$,E~Ce$7$F$$$k$+$I$&$+$r%A%'%C%/$9k3HG, 3F8F$S=P $74V$rB>$NM-MQ$J=hM}$K=<$Fk3H,G-$k! #$5iKJV$5$1$?bufid $r0z?t$H7F pvm_bufinfo() $r8F$S=P$;$P! "<u?.A0$K%a%C%;!<%8$K4X9k>pJs$r$$$k3H$,$G$-$k! #

- *int (*old)() = pvm_recvf(int (*new)(int buf, int tid, int tag))*

pvm_recvf() %k!<%A%s$O! "<u?.4X?t$GMQ$$$i1k<u?.%3%s%F%-%9%H$rJQ99$9$9$k3H$G #P#V#M$N3HD%$r2DG=$K9k! #%G%U%)%k%H$N<u?.%3%s%F%-%9%H$O! "Aw?.85$H%a%C%;!<%8 $N%?%0$N%^%C%AG"k,! "$3$1$r%f!<%6$,G$0U$NHf3S4X?t$KJQ99$9$9$k3H$,$G$-$k! #

Ey$H$$$C$?$h$&$JbN$,MQ0U$5$1$F$$$k[3]! #

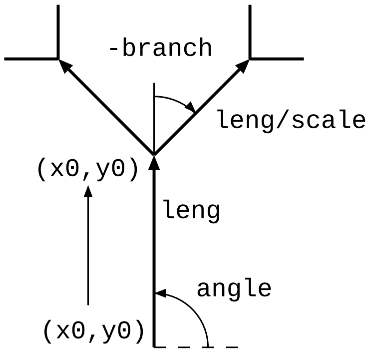
3 #P#V#MKh$kJBNs%W%m%0%i%_%s%0

3.1 <yLZ6J@~

3.1.1 LdBjDj5A

:F5"E*$KDj5A$5l?4JC1$J?^7A$G<yLZNh$&$J?^7ArIA/!#3N?^7A$O!"<+J,<+?H$N=L>.JQ49$N=89g$GI=$9$3H,G-kh$&$J7A>u$r;}$C$F$$$k$?$a!"%U%i%/%?%k?^7A$N0l<o$G$"$k!#

3N%W%m%0%i%`$NJBNs2=$rO+$j!"=hM};~4V$N7WB,$H!"$=lKH<$&B.EY8~>e$r7WB,9k!#



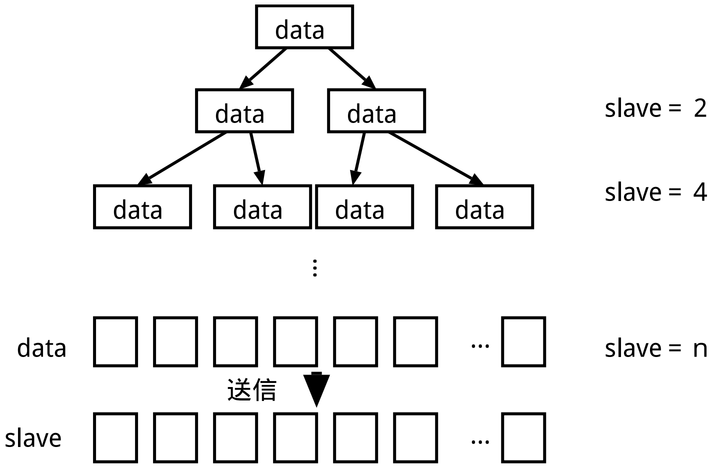
1. ;OE@(x0,y0) rH$k!#
2. ;OE@(x0,y0) $+$i!"angle $N3QEY$Gleng $ND9$5$G;^$r#1DIA/!#
3. 0z$-=*$oC?=*E@$N:BI8$r?7$7$$(x0,y0) H9$k!#
4. 3QEYangle $+$i!"branch $r0z$$$?bN$Hblanch $rB-$7$?#2$D$N@~$r!"leng/scale $ND9$5GIA/!#
5. #n!]#1<!$N1&ItJ,$N:F5"8F$S=P$7$r9T$&!#
6. #n!]#1<!$N:8ItJ,$N:F5"8F$S=P$7$r9T$&!#

?^5: <yLZ6J@~

3l$O!"?F$N;^$+$i#2K\$N;R$N;^$r=P7F$$$/NG#2J,LZ$NLZ9=B$$H$^$C$?$/F1$8$H9M$($k;v$,$G$-$k!#$^$?:81&$N;^$N?-SN((scale) rJQ(k3HGJQ7A<oNLZ,F@il$k!#

3.1.2 JBNs2=$N2r@O

3NJBNs%W%m%0%i%`$N%"%k%4%j%:%`$O!"%W%m%;%C%5!<%U%!!<%`$K$F<B8=$7$F$$$k!#%G!<%?$NJ,3dJ}K!$O!"?^#6Nh$&$K9T$&!#



1. master KF!"slave ?t#n$N;~!";^$N?t$,#n8D$KJ,$+$lk^$G?^#5$N=hM}$r9T$&!#
2. master KhCF5aail?CMr=l>lNslave $KM?$($k!#
3. CMr&1CH?slave $,=hM}$r9T$$!"CM$rmaster KJV9!#
4. master KAwil??tCM$rMQ$$$F<yLZ6J@~rIA/!#

?^6: %G!<%?$NJ,3dJ}K!

3.1.3 <B837k2L

;^?t(n) !a#2#0!"#2#5NH$-!"slave ?t#1Bf!"#4Bf!"#8Bf!"#1#6Bf!"#3#2Bf!"KF<B9T;~4V$H!"$=lKhkB.EY8~>e$r<($7$?!#$^$?!"<B9TNc$H7FI=<(5l$k?^7A$r2<$N>r7o$NbH?^#8<(7?!#

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

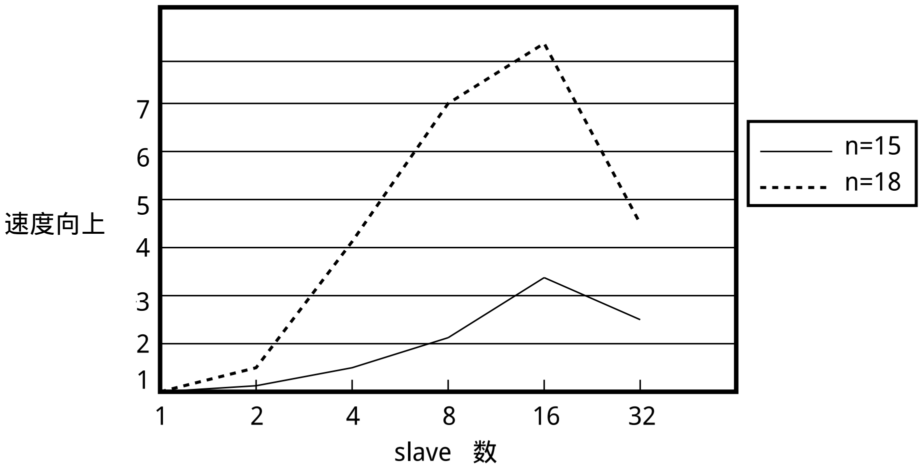
!JJC! K

data\slave	1 Bf	2 Bf	4 Bf	8 Bf	16 Bf	32 Bf
n=15	26.36	21.31	16.86	12.40	8.63	10.07
n=18	441.7	269.3	100.5	60.19	50.89	100.3

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

!GJ\! K

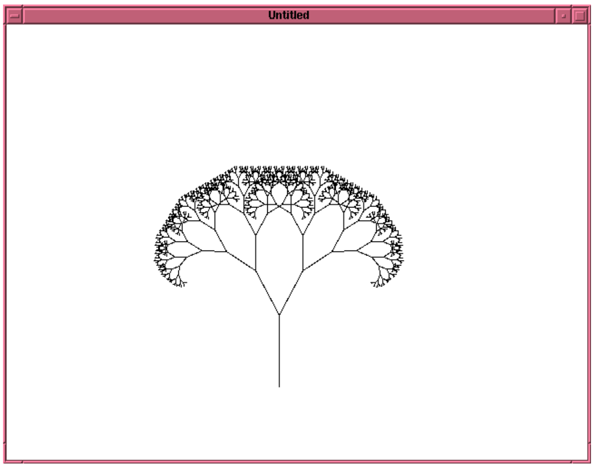
data\slave	1 Bf	2 Bf	4 Bf	8 Bf	16 Bf	32 Bf
n=15	1.000	1.237	1.563	2.125	3.534	2.616
n=18	1.000	1.639	4.393	7.339	8.679	4.401



?^ 7: B .EY8 ~>e

; ^?t$,# 1# 88DNH$ -! "slave # 8Bf$G# 8G\<e$NJBNs8 z2L$rF@$ilF$ $$k$,! "# 3# 2BfGO# 4. # 5G\DxEY$H$JGF$ $$k! #

- ;^?t (n) !a 10 3QEY (angle) !a 90 D9$5 (leng) !a 100 ?-$SN ((scale) !a 0.7 J,4t3Q (blanch) !a20 EY

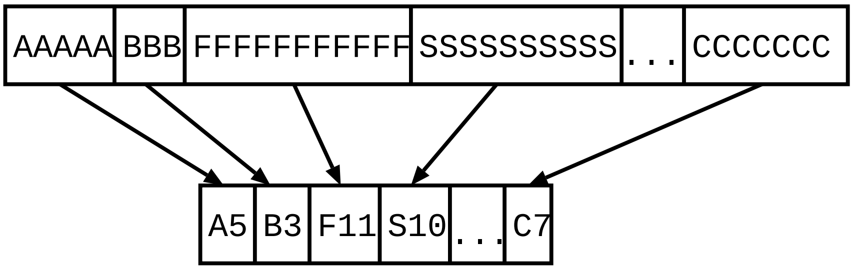


?^ 8: <B9T7k2L

3.2 %i%s%l%s%0%90 5=L

3.2.1 LdB jD j5A

%i%s%l%s%0%90 5=LHO! "%G! <%?0 5=L$r9T$&%W%m%0%i% `$N$R$H$D$G$ "$j! "%F%-%9%HCf AB-BCCCC $H$$$G$?O"B3$7$?F1$8J8; z$NJB$S$K$D$$$F! "0 5=L$r9T$&%W%m%0%i% `G "$k! #



1. F1$8J8; z$,B3$/$^$G?J$ `! #

2. $=$NJ8; zKBP7$F! "J8; z#1$D$HJ8; z$N8D?t$N#2$D$r! "=PNO$9$k! #

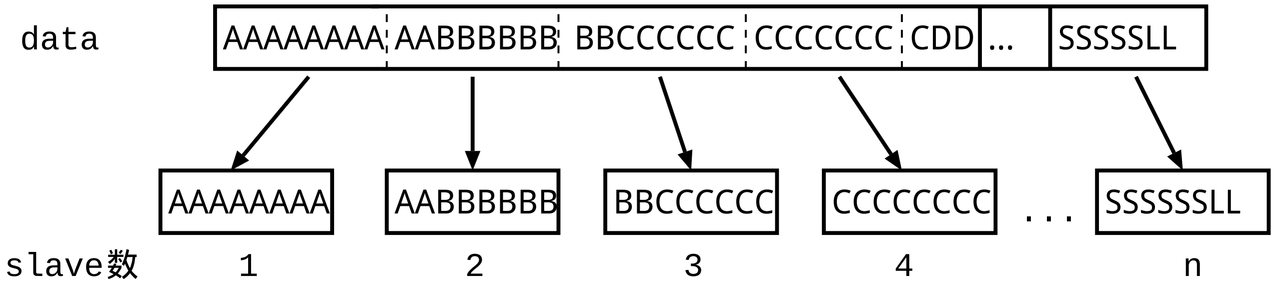
3. J8; z$,#1$D$N; ~$O! "$=$NJ8; z$@$1$r=PNO$9$k! #

?^9: %i%s%l%s%0%90 5=L

3N=g=x$G0 5=L$r9T$&! #DL>o$N%F%-%9%H%U%!%$%k$d! "%i%s%@%`$JJ8; zNs$KBP7FO"$^$jM-8zGO$J$$$,! "#2CM%U%!%$%k$G$O#5#0! s$+$i#9#0! s$b$N0 5=L$,2DG=HJ$k! #

3.2.2 JBNs2=$N2r@O

3NJBNs%W%m%0%i% `$N%"%k%4%j%:% `$O! "%W%m%;%C%5! <%U%!!<% `$K$F<B8=$7$F$$$k! #$=$7$F! "$3$N%W%m%0%i% `$O<!$N?^#1#0Nh$&$K%G! <%?J,3d$r9T$C$F$$$k! #



1. master KF! "slave ?t#n$N; ~! "%G! <% ?$r#nEyJ,9k! #
2. master $GJ,$1i1$?%G! <% ?$r! "3Fslave KAwk! #
3. $=$1$>$1$Nslave $G=hM}$r9T$$! "master KAwk! #
4. $=$1$>$1$Nslave $+$iAwi1$?%G! <% ?$rmaster G^Ha$k! #

?^10: %G! <% ?J,3d

3.2.3 <B8 37k2L

%G! <% ??t#2K |J8; z! "#2K |#5#0#0#0J8; zNH$-slave ?t#1Bf! "#1#0Bf! "#2#0Bf! "#3#0Bf! "#4 #0Bf! "#5#0Bf! "#6#0Bf$G9T$C$F$$$k! #

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

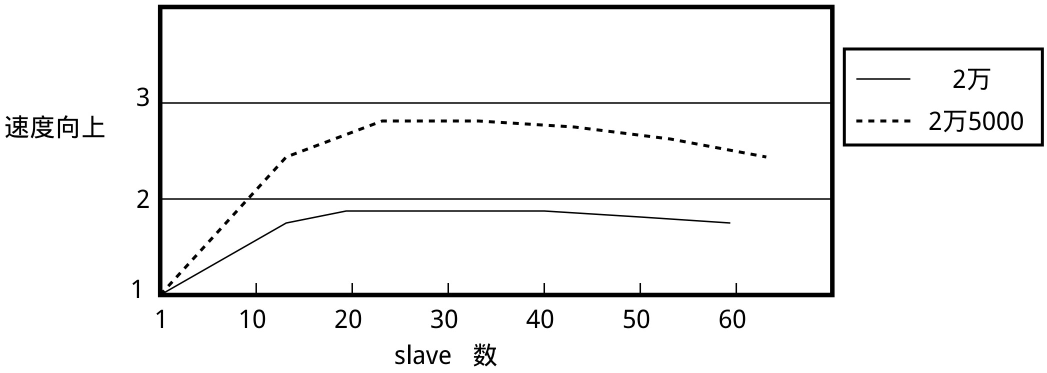
!JJC! K

data\slave	1 Bf	10 Bf	20 Bf	30 Bf	40 Bf	50 Bf	60 Bf
2 K|	2.050	1.169	1.042	1.102	1.138	1.204	1.356
2 K|5000	3.769	1.454	1.384	1.379	1.393	1.447	1.462

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

!G\!K

<table>
<tr><th>data\slave</th><th>1 Bf</th><th>10 Bf</th><th>20 Bf</th><th>30 Bf</th><th>40 Bf</th><th>50 Bf</th><th>60 Bf</th></tr>
<tr><td>2 K|</td><td>1.000</td><td>1.753</td><td>1.967</td><td>1.860</td><td>1.801</td><td>1.702</td><td>1.511</td></tr>
<tr><td>2 K|5000</td><td>1.000</td><td>2.592</td><td>2.723</td><td>2.733</td><td>2.706</td><td>2.605</td><td>2.578</td></tr>
</table>



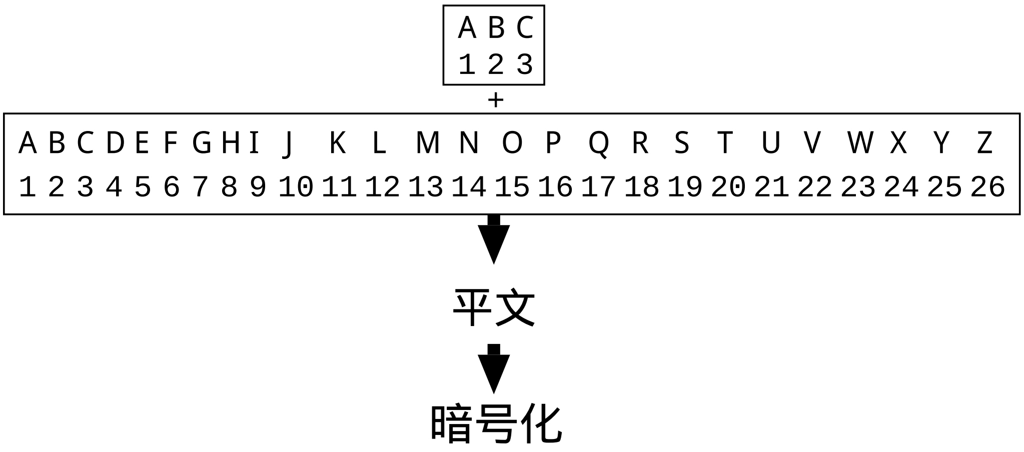
?^11: B .EY8 ~>e

%G!<%??t#2K|#5#0#0#0J8;zNH$-slave ?t#3#0Bf$G!"#3G\<e$^$GJBNs8z2L$rF@$ilF$$$k$,!"#6#0Bf$G$O!"#2.#5G\DxEY$HJC$F$$$k!#

3.3 %S%8%M%k0E9f

3.3.1 LdBjDj5A

0E9fHO!">pJs$N0UL#$,Ev;v<T0J30KOo+iJ$$$h$&$K>pJs$rJQ49$9k3Hr8@$&!#0E9f$K$*$$$F!85NJ8$rJ?J8$H$$$!"$=$l$rBh;0<T$K0UL#No$+$i$J$$0E9fJ8KJQ(k3Hr0E9f2=!"$=$N8r49<j=g$r0E9f2=%"%k%4%j%:%`$H$$$&[10]!#%S%8%M%k0E9f$O!"J?J8$KBP$7C1$KJ?J8$r#1J8;z$:D:i7$F0E9f2=$9kNGOJ/!"l J8;zKhK:i9?trJQ(k3HKhj!"hjJ#;($J0E9f2=$r9T$($kh&K7$?$bNG$"$k!#0E9f8 0HJkbNr?t8DJB$Y!"%-!<%o!<%I$H7F;HMQ7F$$$k!##A!A#ZNJBSKBP7$F!"#A#B#C$H$$$&%-!<%o!<%I$r:n$C$?$H9k!#



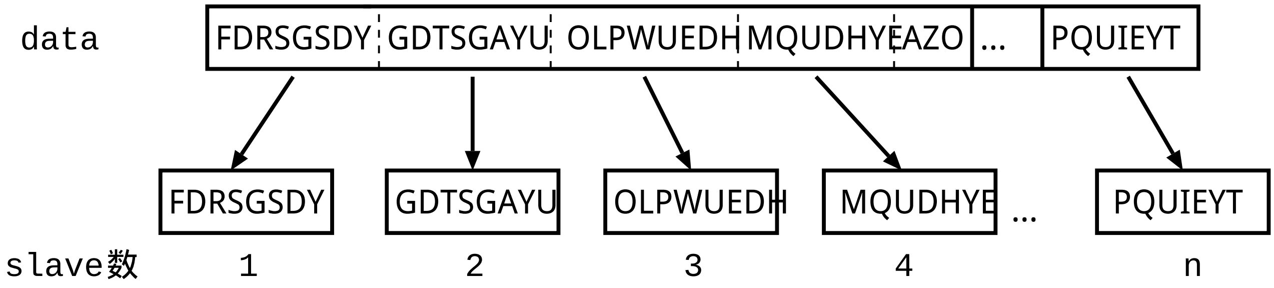
?^12: 0E9f2=$NN.$1

0E9fJ8KBP7!"%-!<%o!<%I$,#A$J$iJ8;z$r#1$D!"#B$J$iJ8;z$r#2$D!"#C$J$iJ8;z$r#3D:D:i9$3$H$G0E9f2=$r9T$&!#

?^13: 0E9f2=

3.3.2 JBNs2=$N2r@O

3NJBNs%W%m%0%i%`$N%"%k%4%j%:%`$O!"%W%m%;%C%5!<%U%!!<%`$K$F<B8=$7$F$$$k!#$=$7$F!"$3$N%W%m%0%i%`$O<!$N?^#1#4Nh$&$K%G!<%?J,3d$r9T$C$F$$$k!#



1. master KF! "slave ?t#n$N; ~! "%G! <% ?$ r#nEyJ,$ 9$k! #
2. master $GJ,$1i1$?%G! <% ?$ r! "3Fslave KAwk! #
3. $=$1$>$1$Nslave $G=hM}$r9T$ $! #master KAwk! #
4. $=$1$>$1$Nslave $+$iAwi1$?%G! <% ?$ rmaster G^Ha$k! #

?^14: %G! <% ?J,3d

3.3.3 <B8 37k2L

%G! <% ??t#1#0#0K |J8; zNH$-slave ?t#1Bf! "#1#0Bf! "#2#0Bf! "#3#0Bf! "#4#0Bf! "#5#0Bf! "#6#0Bf$G9T$CF $$k! #

I=#5 ! !<B9T; ~4V

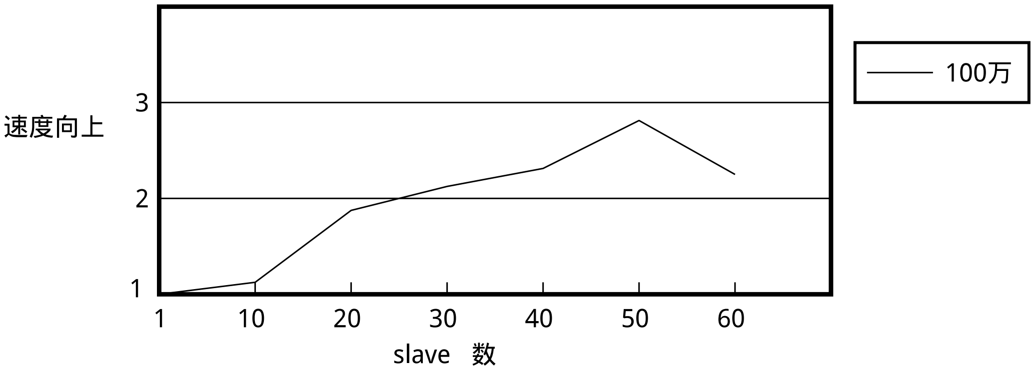
!JJC!K

data\slave	1 Bf	10 Bf	20 Bf	30 Bf	40 Bf	50 Bf	60 Bf
100 K|	1.402	1.129	0.779	0.681	0.592	0.508	0.605

I=#6! !! !B.EY8~>e

!G\!K

data\slave	1 Bf	10 Bf	20 Bf	30 Bf	40 Bf	50 Bf	60 Bf
100 K|	1.000	1.241	1.800	2.059	2.368	2.760	2.317



?^15: B.EY8~>e

JBNs8z2LH7$Fslave ?t#5#0Bf$G#3G\<e$N8z2L$rF@$F$$$k$,!"#6#0Bf$G$O#2G\$[IHJC$F$$$k!#

4 I>2A$H9M;!

K\8&5fGO!"#P#V#M$rMQ$$$?JBNs%W%m%0%i%_%s%0H7$F!"<yLZ6J@~!"%i%s%l%s%0%905=L!"%S%8%M%k0E9f$N#3$D$N%W%m%0%i%`$K$D$$$FJBNs2=$r9T$C$F$$$k!##3$D$N%W%m%0%i%`$NB.EY8~>e$r8+$k$H!"slave ?t$KHfNc7FB.EY8~>e$,F@$ilF$$$J$$!#B.EY8~>e$,F@$ilJ$$MW0xH7$F9M$(ilkN$O!"DL?.$N%*!<%P!<%X%C%I$d!"Ii2Y$NPiD-!"JI$,9M$(il$k!#

#P#V#MJI!"%M%C%H%o!<%/$rMQ$$$?JBNs%W%m%0%i%`$O!"%W%m%;%C%54V$NDL?.$,I,MW$H$J$k!#$=$N7k2L$H$7$F!"%W%m%0%i%`$N=hM};~4V$KBP7FDL?.;~4V$,B?$/Jj!"%*!<%P!<%X%C%I$r5/$3$7$F7^$&!#$=$N7k2L$H7F!"slave ?t$r#6#0Bf$JIK9k$H!"B.EY8~>e$,F@il$J$$7k2LHJCF7^$&!#$=lr9nI~9k$?$aKO!"%G!<%??t$rB?$/$7!"$h$j=hM};~4V$rD9$/$9k3H,Bg@Z$@$H;Wol$k!#

<yLZ6J@~GO!"master $GC`<!=hM}$r9T$&$3$H$G%G!]%?J,3d$r9T$C$F$$$k!#$=$N$?$a!"slave ?t$,>/$J$$;~$H!"B?$$;~$H$NC`<!=hM}ItJ,$N:9$,=P$k$?$a!"=c?h$KJBNs=hM}$@1G$N<B9T;~4V$G$J$$$?$a!"slave ?t$rA}d7$F$$$C$?$H$-B.EY8~>e$,0BDj7J$$!#$=$N$?$a!"JBNs=hM}ItJ,$N%G!<%??t$rB?$/$9k3HGC`<!=hM}$,$"$^$j5$$KJiJ/9k3H$,Bg@Z$G$"$k!#

%i%s%l%s%0%905=LGO!"%"%k%4%j%:%`$r%W%m%;%C%5%U%!!<%`$G<B8=$7$F$$$k!#%W%m%;%C%5%U%!!<%`$O!"Hf3SE*JBNs8z2L$rF@d9$$!#:#2s!"%G!<%??t$,%a%b%j$N4X78$G;W$&h&$KB?$/G-J+C?$?$a!"#1Bf$G<B9T$7$?$H$-$N<B9T;~4V$,#4IC<e$G$"$C$?$?$a;W$&h&$JB.EY8~>e$,F@ilJ+C?!#

%S%8%M%k0E9fGO!"%"%k%4%j%:%`$r%W%m%;%C%5%U%!!<%`$G<B8=$7$F$$$k!#3N%W%m%0%i%`$b%i%s%l%s%0%905=IF1MM!"l BfGN<B9T;~4V$,#1 #5IC$"$^$jG"C?$?$a!"slave ?t$K1~$8$?B.EY8~>e$rF@$k;v$,G-J+C?!#b&>/$7%G!<%?$rA}d9$3$H$G!"JBNs8z2L$rF@$k;v$,G-kH;Wol$k!#

3Nh&$JJ}K!$r9MN8$7$F@-G=$r8~>e$r5;$F$$+J1lPJi$J$$!#

5 $*$ojK

K\8&5fGO#P#V#M$rMQ$$$?JBNs%W%m%0%i%_%s%0$r9T$C$?!#9b2A$JD6JBNs7W;;5!KBP7$F!"#P#V#M$d#M#P#IEy$N!"%a%C%;!<%8DL?.%i%$%V%i%j$r%$%s%9%H!<%k9k3H$G!"4JC1$KJBNs%W%m%0%i%_%s%0$r9T$(kh$&$KJj!"JBNs%W%m%0%i%_%s%0$H$$$&bN$,$h$j?H6a$KJC$?!#$^$?!"#o#p#e#n#M#PEy$Nh&$J6&M-%a%b%j7?$NbN$,07$($k!"6&M-%a%b%j7?%^%k%A%W%m%;%C%5$N%o!<%/%9%F!<%7%g%s$b0BCMKJCF$-$F$*$j!"Hs>o$K?H6a$KJCF-$F$$$k!#K\8&5fGO!"6&F17W;;5!<B83<<$r;H$$!"#6#0BfGNJBNs7W;;$r<B8=$9k3H,G-kH$$$&;v$G!"slave ?t$rB?$/$7$?$H$-$N%*!<%P!<%X%C%IKhCFINDxEY$NB.EY8~>e$rF@k3H,G-k+JI!"%G!<%?KBP7$Fslave ?t$rA}d7!"I3$^$G$NB.EY8~>e$rF@ilk+7WB,9k3H$,$G$-$?!#

:#8e$N2]Bj$H7F$O!"DL?.$dC`<!ItJ,$N%*!<%P!<%X%C%I$r$"$^$j0U<1$;$:$K!"JBNs=hM}$r9T$(kh$&$K9k3H$,Bg@Z$H;Wol$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$j?<$/46<U$$$?7^$9!#$^$?!"K\8&5f$K$"$?$j!"MM!9$JLL$G=u8@!";XF3$rD:$-$^7?JFED7r<#;a!"?"Ln<BD>;arO8aH9$kK\8&5f<<$N3'MM!"6&F17W;;5!<B83<<$N;HMQ$K$*$$$F!"$*@$OC7F$$$?$@$$$?650i8&5f%7%9%F%`2]$N3'MM$K?<$/46<U$N0U$rI=$7$^$9!#

;29MJ88%

[1] 2O@>D+M::#C8@8lKh$k O8aF$N%"%k%4%j%:% `F~Lg, 5;=QI>O@<R,1992.

[2] 1|B<@2I':#C8@8lKh$k %"%k%4%j%:% `;vE5, 5;=QI>O@<R,1991.

[3] AL Geist,Adam Beguelin,Jack Dongarra,Weicheng Jiang,Robrt Manchek,Vaidy Sunderam(LuB<ED1QL@):PVM3 %f!<%6!<%:%,%$%I&%j%U%!%l%s%9%^%K%e%"%kF|K\8l,1995.

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

[5] Bg?97r;y:JBNs%W%m%0%i%_%s%0$N4pAC, 4]A1,1990.

[6] ;0LZ8wHO, W"0BCNG7, C+B<M&Je, >.HDN49@:#P#C%/%i%9%?D6F~Lg, D6JBNs7W;;8&5f2q!! 9V=,2q,1999.

[7] @>86@60l:%G!<%?9=B$, %*!<%`<R,1995.

[8] 5\B<7.:JBNs=hM}8@8l, %^%0%m%&%R%k,1986.

[9] H/ED90, snF#CiIW:9b@-G=%3%s%T%e!<%?%"!<%-%F%/%A%c, 4]A1,1989. !!

[10] 2,K\1I;J:0E9fM}O@F~Lg, 6&N)=PHG,1993.

[11] ?@:jN<B@:#P#V#MKh$kJBNs%W%m%0%i%_%s%0(II), N)L?4[Bg3XM}9)3XIt>pJs3X2JB46HO@J8,2000.

[12] @>C+??<y:#P#V#MKh$kJBNs%W%m%0%i%_%s%0(III), N)L?4[Bg3XM}9)3XIt>pJs3X2JB46HO@J8,2000.