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3Nh&$J%7%9%F%‘$N<B8=N?$a!"%3%s%T%e!<%?!&3%m%K!<$G$O!"3FC<Kv$r9bB.$J%M%C%H%o!<%/$G7k$S!"3FC<KvF1;N$,6[L)$K6(D4F0:n$G$-$k4D6-$r@0$($k!#$=N?aK!"K\&5f<GO!"%O!<%I&%’%"$HJ,;6%*%Z%l!<%F%#%s%0%7%9%F%‘Colonia$NN>J}$+$i@_7W$r9TCF$$k!#

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3F%N!<%I$OJ#?t$N%W%m%;%C%5$H<g5-21AuCV!"3F%N!<%I$r6[L)$K7k$S9g$&$?aN%M%C%H%o!<%/!&%s%?!<%U%’!<%9$+$iJk!#$=$l$>$l$O!"%7%9%F%‘%P%9$K$hj7k$Plk$,!"FC$K%M%C%H%o!<%/!&%s%?!<%U%’!<%9$bF1MM$K%7%9%F%‘%P%9Kh$j7k$Plk3H$G!"%j%b!<%H%a%b%j$N%-%&C%7%s%0JI$G@8$8$k%3%R!<%l%s%9@)8f$r%O!<%I&%’%"Kh$j9bB.$K9T$&$3H,2DG=HJ$k!#

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%[!<%‘%Z!<%80\Aw$O85%[!<%‘%N!<%I$H?7%[!<%‘%N!<%I4V$N%Q%1%C%H$Ndj<hjKhj=hM}$,?J9T$7$F$$/!#<BAu$K:]$7FO!"%[!<%‘%Z!<%80\Aw=hM}$,9bB.$K9Tolk?aK!"%[!<%‘%Z!<%80\Aw%W%m%0%i%‘$rNIC $N%W%m%H%3%k%W%m%;%C%5>e$GF0:n5;!"5i$K%Q%1%C%H$NAw<u?.rJkY$/3d$j9~$_$r>/J/$7!"%]!<%j%s%0$GBP=h9kh&K7$?!#$^$?!"E,59!"@lMQ$N%O!<%I%&%’%"$r@_$1k3HG$bA4BN$N9bB.2=$r?^$C$?!#

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The implementation of homepage migration mechenism for distributed operating system Colonia

Daisuke Torii

Abstract

We are developing a distributed computer system "Computer Colony". By connecting computers on network, the total system will work as one big computer power.Nowadays, distributed systems are used in companies or schools by connecting computers on LAN. Apart from this,our system uses each computer resource efficiently by executing process in parallel, and theoretically working as one big parallel computer.

In our system, users access to one of computers, and can use the same computer resources wherever computer they are accessing to. They use this system, without recognizing that this system is consist of many computers.Also,we make a scheduling system for distributing fairly this computer resource.Finally,we make a module card in which processors, memory, and network interface are placed,so that users can increase the computer resource freely with ease, and we make this system with low cost performance.

To realize such a system, which we call Computer Colony, we connect each computer with high performance network, and make each computer communicate tightly with other computers. To realize this environment, we approach the structure of hardware system and a distributed operating system "Colonia".

The communication mechenismis important for each computer to communicate tightly. On Computer Colony, each computer communicates by distributed shared memory, and the cache-coherence is controlled by the hardware system.

Each node is consisted of more than one processor, memory, and network interface. Each part is connected with the system bus, but special network interface card is connected to the same system bus, so that it makes possible to execute cache-coherence control speedy by the hardware system. The cache-coherence control is necessary in caching the remoted memory.

To realize the distributed shared memory space, we have adopted the concept of shared virtual memory. In all shared virtual memory, there is a page called "homepage" at physical memory. Each virtual memory being mapped to a

homepage, we realize the virtual shared memory.

To refer to a homepage, it is necessary to communicate with the node where the homepage exists, but to decrease access latency and communication traffic, each node caches a part of the homepage to the main memory of each node. We call such a cached page "copypage". For the cache-coherence control of these copypages, there exists the information to control cache-coherece at the node where homepage is located(we call this node "homenode"). At each node, when accessing a copypage,if the necessity of remote access is neccessary, the network interface of each node needs to access to the homenode.In this way, many accesses to a homenode are expected and the efficiency of communication and execution of program at each node will depend on which node the homepage is located.

Colonia aims to change the placement of homepage appropriately and allocate to the best node. We call this "homepage migration". In such migration of the homepage, The main process will be the rewriting of the table managed by GDS, and the migration of the cachedirectory.The main problem, the treatment of the packet which comes to the homenode is implemented by returning the packet to the sending node.We consider this implementation is the best if there are a few packets on network when we execute the homepage migration.

The execution of homepage migration is proceeding with the communication of packets between the old homenode and the new homenode. About the implementation, to execute the homepage migration speedy, we make the program of the homepage migration execute on the protcol processor of the network interface card, and when receaving or sending of packets, we try to use the polling more than the interrupt. Moreover, to finish the migration speedy, we implement the hardware only for the execution.

Finally, I consider this implementarion, and notice the view of this reseach, and the relational reseach.

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2.2.2 NIC(Network Interface Card) 3

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2.3.1 %_%C%7%g%s$H%f%K%C%H. 4

2.3.2 %"%I%l%96u4V 4

2.4 Colonia K*1k%a%b%j6&M- 5

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3.2 GDS(Global Directory Service) 7

3.3 J,;66&M-%a%b%j4IM} 8

Bh**4** >O %[!<%‘%Z!<%80\Aw5!9=$N<BAu **10**

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Colonia $,F0:n$9$k%O!<%I%&%'%"4D6-$N<B8=NcH7$F6&M-%a%b%j%Y!<%9$N%o!<%/%9%F!<%7%g%s%/%i%9%?$rA[Dj$7$F$$k!#3l$O=hM}%N!<%I4V$r6&M-%a%b%j$H$$$&DL?.%W%m%H%3%k$G7k9g$7$?%/%i%9%?%7%9%F%`$G$"$k!#Colonia GOJ*M}E*$K6&M-%a%b%j6u4V$r;}$?$J$$N$G!"2>A[E*$J6&M-%a%b%j6u4V$r<B8=$9$kJ}K!$H7F!"Shared Virtual Memory $r:NMQ$7$F$$k!#

A4FN2>A[6&M-%Z!<%8KO!"$$$:l+$N%N!<%I$K%[!<%`%Z!<%8$H$h$VJ*M}%Z!<%8$,B8:_$7!"2>A[E*$J6&M-$r$9$k$?$a$K!"3F2>A[%Z!<%8$O%[!<%`%Z!<%8$K^%C%T%s%0$5lF$$k!#3F2>A[%Z!<%8$O%[!<%`%Z!<%8$N%G!<%?$r<+%N!<%I$K-%&C%7%s%0$9$k$3$H$,$G-$k$,!"$3$l$i$N%-%&C%7%s%0%G!<%?$N014S@-@)8f$N$?$a$K%[!<%`%Z!<%8$rM-9k%N!<%IGO4IM}@UG$$,$"$k!#7?$,$C$F3F2>A[%Z!<%8$O!"M-8z$J%G!<%?$N<hF@$d!"B>%N!<%I$N%G!<%?$rL58z2=$9kH$$$C$?=hM}$r9k:]%[!<%`%Z!<%8$K%"%/%;%9$kI,MW$,$"$k!#$3$N$h&$K!"%[!<%`%Z!<%8$r;}$D%N!<%I$K%B?$/$N%"%/%;%9$,$"$k!"M-B,5l!"%[!<%`%Z!<%8rI$N%N!<%I$KG[CV9k$+$O3F<o=hM}$N8zN($K1F6A$r5Z$\$9!#

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2.1 %3%s%T%e!<%?!&3%m%K!<$NL\I8

%3%s%T%e!<%?!&3%m%K!<$O!"J,;6%7%9%F%`$rH/E8$5$;$?^%k%A%f!<%64D6-$G$"$k!#$=$N>e$G!":#F|$NJ,;6%7%9%F%`$N7gE@G"$kDL?.%3%9%H$NBg$-$5$r9nI~$7!"JBNs%"%W%j%1!<%7%g%s$N<B9TG=NO$r<BMQ%l%Y%k$^$G9bak3H$rL\;X$9bNG"$k!#J,;6%7%9%F%`$N;}$DF3F~$N<j7Z$5$dM%$l$?3HD%@-$H$$C$?MxE@$r@8$+$7$D$D!"=>Mh$NJ,;6%7%9%F%`$G$O:$FqH5lF$$?JBNs=hM}K*1k9b@-G=$rL\;X$9!#$^$?!"%W%m%;%C%5!"%a%b%j!"%M%C%H%o!<%/%$%s%?!<%U%'!<%9$rEk:\$7$?%b%8%e!<%k$r3+H/9k3HKh$j!"%7%9%F%`9=@.$NJQ99$,MF0W$K9T$(!"F1;~$KDc2A3J@-$r<B8=$9$k!#

%3%s%T%e!<%?!&3%m%K!<GO5i$K!"OS $NF/$-KhCF7W;;5!;q8;$N0lCVF)2a@-$H9b@-G=$JIi2YJ,;6$N<B8=$rL\;X$9!#%f!<%6$,%3%s%T%e!<%?!&3%m%K!<$KEjF~7?%W%m%0%i%`$O=hM}%N!<%I$r0l@Z0U<1$9$kI,MW$,$J$/$J$k!#$^$?!"%7%9%F%`$rMxMQ$7$F$$k3F%f!<%6$K2]6b>u67$K1~8?%3%s%T%e!<%?;q8;$N3d$jEvFr9k%U%'%"%7%'%"%9%1%8%e!<%j%s%0$r9T$&!#

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2.2.1 %O!<%I%&%'%"4D6-9=@.Nc

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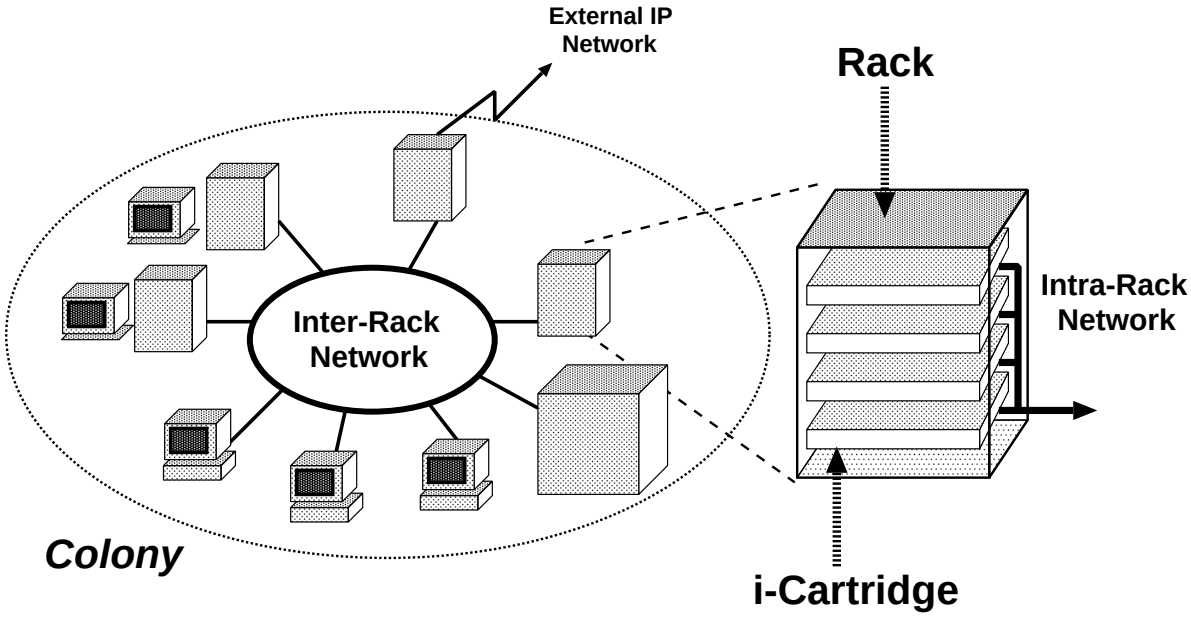

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21XN%"%/%;%9KBP9$k%-%&C%7%e$H7F$b;HMQ$9$k!#NIC $O!"9bB.!"DcCY1d $JDL?.$rDs6!9k@lMQ$N%O!<%I%&%'%"$G!"6&M-%a%b%j%Y!<%9$N4IM}%3%s%H%m!<%i$H7FF0:n9k!#

i-Cartridge $ORack $K<}MF$5lk!#Rack KO!"i-Cartridge $r<}MF$9$kBay,<}MF$9$ki-Cartridge 4V$r7k$VInter-Rack Network!"%7%9%F%'4V$r7k$VInter-Rack Network XN%$%s%?!<%U%'!<%9!"$=$NB>$NI/O %9%m%C%H!"EE8;AuCV$rFbB"$9$k!# Inter-Rack Network $G@\B3$5l?%7%9%F%'A4BN$rColony $H$$&!#

2.2.2 NIC(Network Interface Card)

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NIC $,%7%9%F%'%P%9$K@\B3$9$k3HKh$j!"%j%b!<%H%a%b%j$N%-%&C%7%s%0JI$N%3%R!<%l%s%9@)8f$r%O!<%I%&%'%"Kh$j9bB.$K9T$&$3H,G-$k!#

NIC KO!"%7%9%F%'%P%9HNDL?.$r%3%s%H%m!<%k$9$k%$%s%?!<%U%'!<%9!&3%s%H%m!<%i$,$"$j!">o$K%7%9%F%'%P%9>e$N<g5-21>e$X$N%"%/%;%9$r%9%L!<%W$7!"%j%b!<%H%"%/%;%9$NI,MW@-$rH=CG$9$k!#

%3%m%K!<$NDL?.5!9=$G$O!"%7%9%F%'%P%9$K@\B3$7$?NIC Kh$j!"%V%m%C%/C10L$N%-%&C%7%e%3%R!<%l%s%9@)8f$r9T$&!#3N?aK!"NIC $K<g5-21$N%V%m%C%/C10L$N>uBV$r<(7?<g5-21%?%0(B_Map) $r;}$D!#NIC Fb$N%$%s%?!<%U%'!<%9!&%3%s%H%m!<%i$O3$N<g5-21%?%0$K%"%/%;%9$r9T$$!"%j%b!<%H%"%/%;%9$NI,MW@-

$rH=CG$9$k!#

3Nh&$J%j%b!<%H%"%/%;%9$N:]$K!"Bg0h%"%I%l%9$X$NUQ49$r9T$&I,MW$,$"$k$,!"$3Nh$&$J%"%I%l%9UQ49KI,MWJ%F!<%V%kN‘$N4IM}$O!"NIC >eK"$k%W%m%H%3%k%W%m%;%C%5$,9T$&!#$^$?!"%W%m%H%3%k%W%m%;%C%5$O%O!<%I%&%′%"GO<BAuG-$J$$$MM!9$J=hM}$r9T$&!#NIC $O!"%F!<%V%k4IM}$NB>$K!"$5$^$6$^$J%M%C%H%o!<%/DL?.$N@)8f$r9T$&!#

2.3 %_%C%7%g%s %f%K%C%H%b%G%k

%_%C%7%g%s !&f%K%C%H%b%G%k$O!"J,;;66&M-%a%b%j4D6-$NCf$G!"JBNs%W%m%0%i%_%s%0$r8zN(BNI$/<B9T$9k?aKColonia $,Ds6!$9$k%W%m%0%i%_%s%0%b%G%k$G$"$k!#

%_%C%7%g%s !&f%K%C%H%b%G%kGO%W%m%0%i%‘rRHD$N%_%C%7%g%s$H9k!#$=$NCf$KJ#?t$N%f%K%C%H$rJBNs$K5-=R9k!#%f%K%C%HFb$O!"%_%C%7%g%sFb6&M-NN0h$H%f%K%C%H8GM-NN0hKJLl$F$$$k!#

3lKh$j!"%9%l%C%I$,%?%9%/$N;}$D%"%I%l%96u4V$r40A4$K6&M-9k%?%9%/!&%9%l%C%IJ}<0HO0c$$!"ITMW$J%G!<%?6&M-$Khk@-G=Dc2<$d%f%K%C%H$N%G!<%?$rGK2u$5lkJI$N4m81$r2sHrG-!"8zN(BNI$$%W%m%0%i%_%s%0%b%G%k$rDs6!$G$-$kNG$"$k!#

2.3.1 %_%C%7%g%s$H%f%K%C%H

%_%C%7%g%s %f!<%6$,%3%s%T%e!<%?Fb$GN)FkBeM}G"$j!"%7%9%F%‘$KEjF~5l$?0lO"$N;E;v$r*$3J&%W%m%0%i%‘G"$k!#%f!<%6$O%7%9%F%‘$K%_%C%7%g%s$rJ#?tEjF~9k3H,G-$k!#%_%C%7%g%s$O6(D4F0:n9kJ#?t$N%f%K%C%H$hjJ$k!#%_%C%7%g%s$K$O!"%7%9%F%‘Fb$G0l0U$J<1JL;R$G$"$k Mission ID $,IUM?$5lk!#

%f%K%C%H %_%C%7%g%s$rJBNs<B9T2DG=$JC10L$K:YJ,2=$7$?$bN,%f%K%C%HG"$k!#F10l%_%C%7%g%s$KB0$9$k3F%f%K%C%H$O!"0[$J$k%N!<%I$KBP7F3djIUlil!"%N!<%IFb$N%W%m%;%C%5$G<B9T5l$k!#$3Nh$&$K7F%f%K%C%H$OJBNs$K<B9T5l$k!#%f%K%C%H$K$O!"F10l%_%C%7%g%sFb$G0l0U$K<1JL2DG=$J Unit ID $,IUM?$5lk!#

2.3.2 %"%I%l%96u4V

%_%C%7%g%s !&f%K%C%H%b%G%kGO!"%f%K%C%H$,$=l>$l8GM-$N2>A[%"%I%l%96u4V$rM-$7F$$$k!#$=$N%"%I%l%96u4VKO!"F10l%_%C%7%g%sFb$N%f%K%C%H$H6&

M–9k%_%C%7%g%sFb6&M–NN0h$H!"3F%f%K%C%H$GFH<+$K;}$D%f%K%C%H8GM–NN0h$,$"$k[1]!#

%_%C%7%g%sFb6&M–NN0h %_%C%7%g%sFb6&M–NN0h$O!"$9YF$N%f%K%C%H$K$*$$$F F1$82>A[%"%I%l%9$KG[CV5l$k!#$hCF!"IN%f%K%C%HGbF1$8%]%$%s%?$GF1$8FbMF$r;X$9$3$H$,$G$-$k!#$3$3GO!"6&M–%G!<%?$d%F%–%9%H$JI,G[CV5l$k!#

%f%K%C%H8GM–NN0h %f%K%C%H8GM–NN0h$O!"%f%K%C%H$,40A4$K<+M3$KMxMQG–$k NN0h$G$"$j!"B>%f%K%C%H$+$i40A4$KJ]8n$5lk!#$3$3GO!"$=$N%f%K%C%H $N%9%?%C%/$JI,G[CV5l$k!#

2.4 Colonia K*1k%a%b%j6&M–

%f!<%6$O2>A[%"%I%l%9$rMQ$$$F%a%b%j%"%/%;%9$r9T$&!#%a%b%j%"%/%;%9$,$"kH%W%m%;%C%5$KIUB0$9$kMMU(Memory Manager Unit)$,%Z!<%8%F!<%V%k$r;2>H7F2>A[%"%I%l%9$rJ*M}%"%I%l%9$KJQ49$7!"J*M}%a%b%j$K%"%/%;%9$,$J5l$k!#

F10l%N!<%IFbN_$N%a%b%j6&M–$O!"F10l$NJ*M}%Z!<%8$KJ#?t$N2>A[%Z!<%8$r3djEvFk3HG<B8=5l$k!#

0[Jk%N!<%I4VGN%a%b%j6&M–KO!"%M%C%H%o!<%/rDL8$F%"%/%;%9$9kI,MW,$"$k!#Colonia GO3Nh&$J6&M–%a%b%j6u4V$r<B8=9kJ}K!H7$F!"Shared Virtual Memory[2] $r:NMQ$7$F$$$k!#

2.3.2$G=R$Y$?$h$&$K!"%_%C%7%g%sFb6&M–NN0hKOF1$82>A[%"%I%l%9$,3djEvFil$k!#$9YF$N2>A[6&M–%Z!<%8$K$O%[!<%\%Z!<%8$H8FPl$k%G!<%?$N<BBN$,$"$k%N!<%I$NJ*M}%a%b%j>e$K0l$DB8:_9k!#%_%C%7%g%s6&M–NN0h>e$N3F2>A[%Z!<%8$,A4$F!"NIC $NF/$–Kh$j!"%[!<%\%Z!<%8$K%^%C%T%s%0$5$l$k2>A[E*$J%a%b%j6&M–$r<B8=$7$F$$$k!#

%[!<%\%Z!<%8$,F1$8%N!<%IFb$KB8:_$7J>19g!"NIC KhCF%[!<%\%Z!<%8N"$k%N!<%I$K%"%/%;%9$9$k!#%[!<%\%Z!<%8XN%"%/%;%9,2?2s$b5/$3$k>19g!"%"%/%;%9%l%$%F%s%7!"DL?.%H%i%U%#%C/$N7Z8:$N$?$a!"%[!<%\%Z!<%8$rF1%N!<%IFb$N<g5–21$K%–%&%C%7%s%0$9$k!#$3$N%–%&%C%7%s%0$5l?%Z!<%8$r%3%T!<%Z!<%8$H8F$V!#

3Nh&$J%3%T!<%Z!<%8$NFbMF$O0l4S@–@)8f$NBP>]G"$j!"$=N?a$N%–%&%C%7%e&G%#%l/%H%j$JIN>pJs$O%[!<%\%Z!<%8,B8:_$9$k%N!<%I$KCV$+$l!"4IM}

5l$k!#$3$N0l4S@-@)8f$O!"%M%C%H%o!<%/%$%s%?!<%U%'!<%9$,<+N'E*$K%j%b!<%H%"%/%;%9$NI,MW@-$r8!CN$7!"DL?.$r3+;O$9k3HKhj9Tol$k!#

3Nh&$K!"%3%s%T%e!<%?!%&3%m%K!<GO%3%T!<%Z!<%8$N%a%b%jNN0h$N3NJ]$O!"%Z!<%8C10L$G9Tol$k!#$7$+$7!"%j%b!<%H%"%/%;%9$N:]$N%G!<%?E>Aw$O%V%m%C%/C10L$G9Tol$k!#$3lKhj!"6&M-C10L$r%Z!<%8C10L$H7?>l9g$Nfalse-sharing$d!"%G!<%?C10LH7$?>l9g$N%-%c%C%7%e%G%#%l%/%H%j$NMFNL$NA}Bg$NLdBj$r2r7h9k3H$,$G$-$k!#

3F2>A[6&M-%Z!<%8$N%[!<%`%Z!<%8$K$O!"%[!<%`$HJk%f%K%C%H$,0l$DBP1~E1il!"$=$N%Z!<%8$N%[!<%`%f%K%C%H$H$$$&!#$^$?!"%[!<%`%Z!<%8$,B8:_9k%N!<%I$r%[!<%`%N!<%I$H$$$&!#

Bh3 >O 6&M-%a%b%j4IM}5!9=

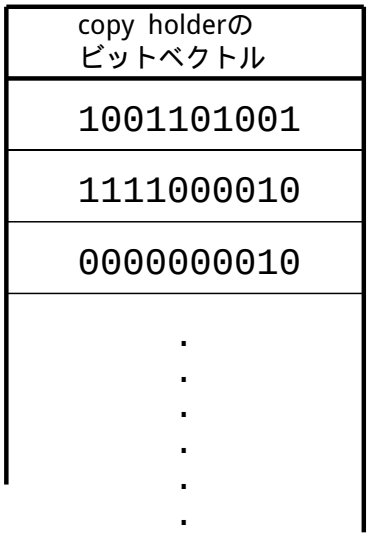
3l$^$G$G=R$YF-$?$h$&$K!"6&M-%a%b%j4D6-$ONIC $NF/$-KhGF<B8=5l$k!#%3%T!<%Z!<%8$K$*$$$F!"L58z$J%V%m%C%/$K%"%/%;%9$7$?>l9g!"NIC $O!"0lC6%[!<%`%N!<%I$K%"%/%;%9$7!"%-%c%C%7%e%G%#%l%/%H%j$r0z$$$F!"M-8z$J%G!<%?$rJ];}$7$F$$$k%N!<%I$X%"%/%;%9$9$kI,MW$,$"$k!#$^$?!"%[!<%`%N!<%I$rFCDj9k:]!"NIC $OGDS $,4IM}$9$kI=$r0z$/I,MW$,$"$k!#3N>OGO!"3l$i4IM}>pJs$G$"$k!"%-%c%C%7%e%G%#%l%/%H%j$HGDS KD$$$F@bL@7?8e!"3li,!"<B:]KINh$&$K;HMQ5lk+KD$$$F=RYk!#

3.1 %-%c%C%7%e%G%#%l%/%H%j

A0>O$G=R$Y$?$h$&$K!"%[!<%`%Z!<%8$NFbMF$r%-%c%C%7%e$7$?%3%T!<%Z!<%8$,B8:_$9$k>l9g!"$3$l$i$N%-%c%C%7%eFbMF$O0l4S@-@)8f$9$kI,MW$,$"$k!#$"$k%f%K%C%H$,%3%T!<%Z!<%8Fb$NL58z$J%V%m%C%/$K%"%/%;%9$r9T$&$H!"NIC $O$=$l$r8!CN$7$FM-8z$J%G!<%?$N>l=j$r%[!<%`%N!<%I$KLd$$9go;$k!#%[!<%`%N!<%I$G$O%-%c%C%7%e%G%#%l%/%H%j$H$$$&M-8z$J%G!<%?$,I3$N%N!<%I$KB8:_9k$+$r<($9I=$r%V%m%C%/Kh$K;}$C$F$$$FM-8z$J%G!<%?$N>l=jrCNk3H$,$G$-$k!#?^2$K%-%c%C%7%e%G%#%l%/%H%j$NNc$r<($9!#

%[!<%`%Z!<%8$KM-8z$J%G!<%?$N%N!<%I$rLd$$9go;$?%N!<%I$r!Vinitiator %N!<%I!W"M-8z$J%G!<%?$rJ]M-7F$$$?%N!<%I$r!Vowner %N!<%I!W$H8F$V!#

$^$?!"%-%c%C%7%e%G%#%l%/%H%j$O!"%f%K%C%HFb$G6&M-9k%Z!<%8KBP7FN



?^2: %-%&C%7%e&G%#%l%/%H%j$NNc

$_F0E*$K@8@.5lk?$a!"I,MW$J%Z!<%8$N%-%&C%7%e&G%#%l%/%H%j$r8!:w9k$?$a$K!"%-%&C%7%e&G%#%l%/%H%j8!:wMQ$N%F!<%V%k$bMQ0U9k!#

3.2 GDS(Global Directory Service)

Colonia $NJ,;62>A[6&M-%a%b%j4D6-$G$O!"2>A[6&M-%Z!<%8$H%[!<%'%N!<%I$NBP1~$r<(7?%F!<%V%k$,I,MW$G$"$j!"3liN%F!<%V%k$r4IM}$9$k5!9=$,I,MWHJ$k!#

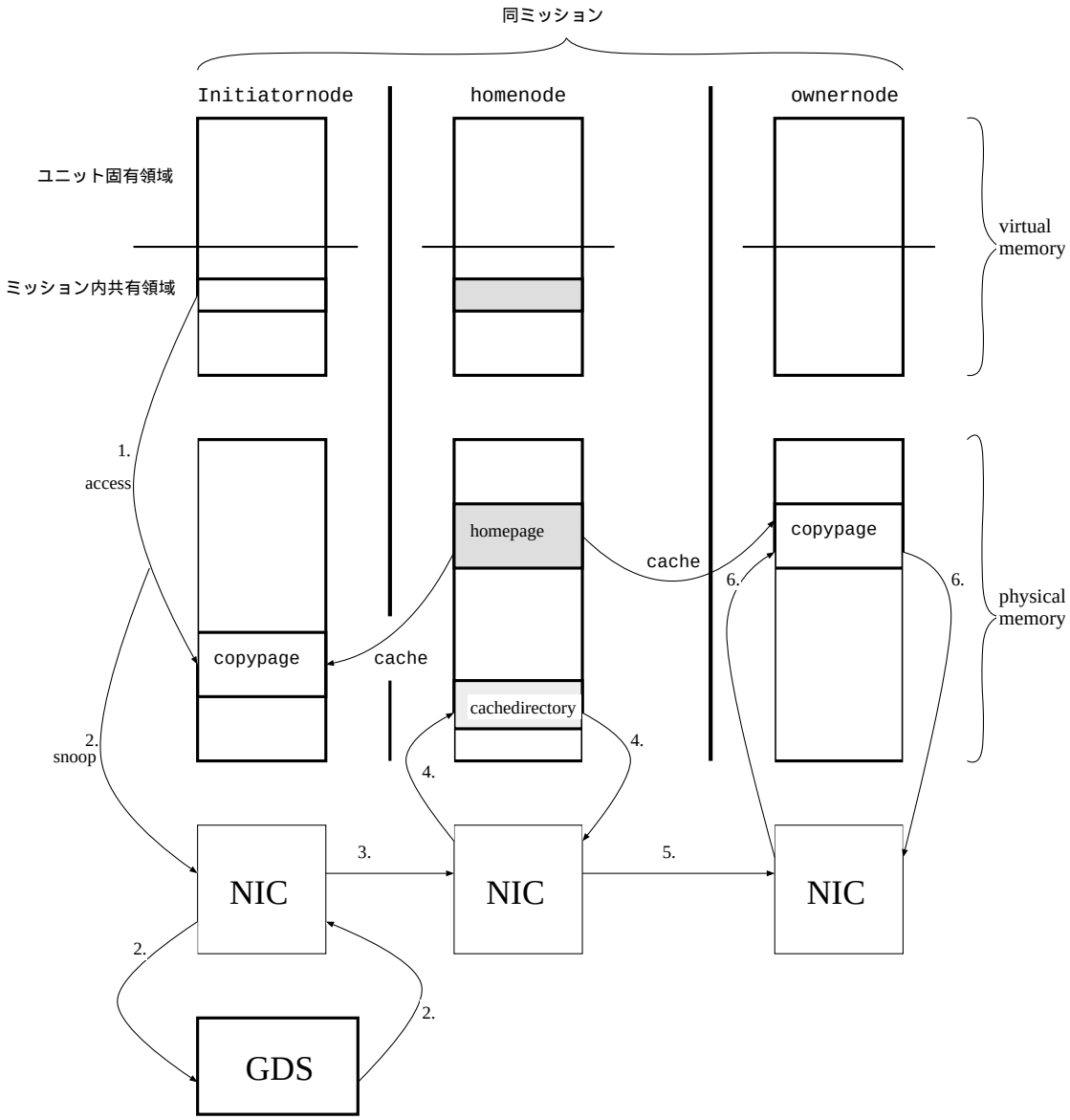
Colonia GO3N%F!<%V%k$N4IM}$r4^a?!"%7%9%F%'A4BN$G6&M-$9$kBg0hE*$J>pJs$N4IM}$r9T$&Bg0hE*%M!<%'%5!<%S%9$r9T$&!#$=NCfG$b!"J,;66&M-%a%b%j$r<B8=9k$?$a$NBg0hE*$J>pJs$r4IM}$r9T$&Global Directory Service(0J2<GDS)[3] KD$$$F=RYk!#GDS $O0J2<$N5!G=$r2L$?$9!#

%M!<%_%s%0 !!%_%C%7%g%s!&f%K%C%H$KBg0hE*$J<1JL;R$rM?$($k!#

0LCV>pJs4IM} !!%7%9%F%'Fb$KJ,;6$9$kA4$F$N%_%C%7%g%s!&f%K%C%H$N0LCV>pJs$rGD0.$9$k!#

%[!<%'%f%K%C%H>pJs$N4IM}$H3dEv !!3F6&M-%Z!<%8$N%[!<%'%f%K%C%H$O!"%7%9%F%'Fb$GM#0l$G$"$kNG!"3N>pJs$r4IM}$9$k!#6qBNE*$K$O!"Bg0h2>A[%"%I%l%9$H%[!<%'%f%K%C%H$NBP1~I=$rJ];}!"4IM}9k!#$^$?!"%[!<%'%f%K%C%H$N3d$jEv$r9T$&!#

%[!<%'%N!<%I>pJs$N4IM} !!%[!<%'%Z!<%8$NB8:_9k%N!<%I$r<($9>pJs$r4IM}



?^3: %M%C%H%o!<%/$r2p$7$?%a%b%j%"%/%;%9$NN.$l

9k!#

0J>e$GJ,;6%a%b%j4IM}$K$*$1$k4IM}>pJs$K$D$$F@bL@7?$,!"<!$K3N4IM}>pJs$,<B:]$KJ,;6%a%b%j4D6-K*$$FINh&$K;H$olkN+KD$$F=RYk!#

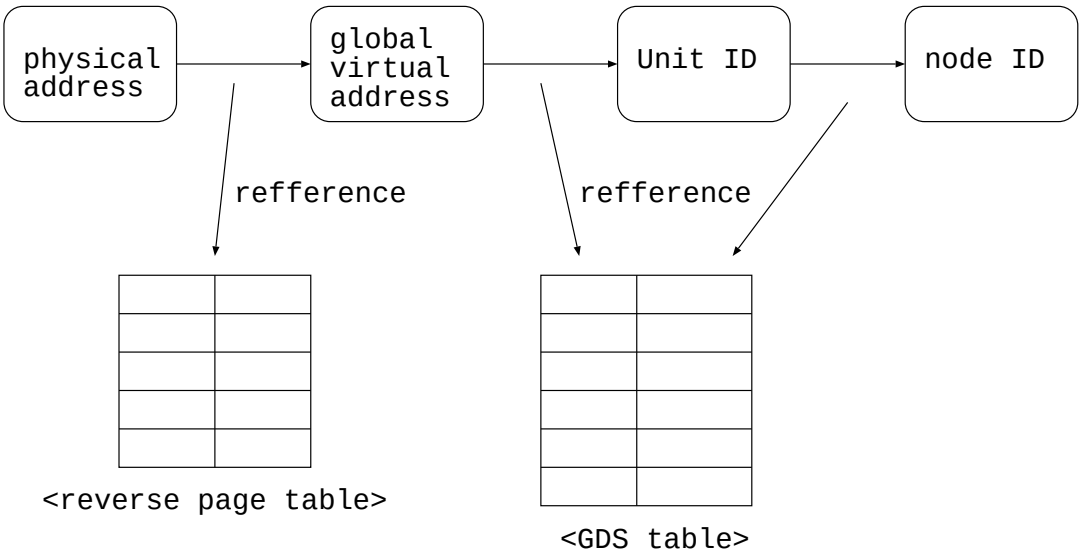
3.3 J,;66&M-%a%b%j4IM}

$3$3GO!"Colonia K*1k%M%C%H%o!<%/$r2p$7$?%a%b%j%"%/%;%9$NJ}K!$r%-%&%C%7%e&G%#%l/%H%j!"GDS $NF/$-$r4^$a$F@bL@$9$k!#

%M%C%H%o!<%/$r2p$7$?%a%b%j%"%/%;%9$NI,MW@-$QMM!9$J>lLL !8G!<%?E>Aw!"%G!<%?L58z2=JI!K$GH/@8$7$&$k$,!"$3$3$G$O%3%T!<%Z!<%8$r;}$D%N!<%I$GM-8z$J%G!<%?$rJ]M-7F$$J$+$C$?$?aK!"M-8z$J%G!<%?$NE>Aw$rowner %N!<%I$+$i9T$&>l9gKD$$F@bL@9k!#

1. %m!<%+%k%N!<%I !$J3$N%N!<%I$rInitiator %N!<%I$H8F$V!K$G$O>o$KJ*M}%a%b%jXN%"%/%;%9$ONIC Kh$j4F;k$5lF$*$j!"%"%/%;%9$7h&$H9k%V%m%C%/$KBP1~9kB_map $r;2>H$9k3HKhj!"%G!<%?$NM-8z@-$rH=Dj7F$$$k!#3lKh$j!"%"%/%;%9$7h&H9$k%V%m%C%/$,L58z$HH=Dj$5l?>l9g!"%M%C%H%o!<%/$r2p$7$?%a%b%j%"%/%;%9$NI,MW@-$,@8$8$k!#
2. $=$N>l9g!"NIC $QJ*M}%a%b%j$X$N%"%/%;%9$rCfCG5;!"0lC6!"JQ49$5$l$?J*M}%"%I%l%9$r5U0z$-%Z!<%8%F!<%V%k$rMQ$$$F!":FEY2>A[%"%I%l%9$KJQ49$9$k!#K!$K3N2>A[%"%I%l%9$KMission ID rAH_9go;k3HKhj!"Bg0h2>A[%"%I%l%9$r@8@.$9$k!#
3. Bg0h2>A[%"%I%l%9$r%-!<$KGDS $,4IM}$9$kBg0h2>A[%"%I%l%9$H%[!<%`%f%K%C%H$NBP1~%F!<%V%k$r0z$-!"Unit ID $rF@$k!#$5$i$KUnit ID $r%-!<$KGDS $,4IM}$9$k%[!<%`%f%K%C%H$H%[!<%`%N!<%I$NBP1~%F!<%V%k$r0z$-Node ID $rF@$k!#
4. 3lKh$j!"Initiator %N!<%I$NNIC $O%[!<%`%N!<%I$X%"%/%;%9$9$k$3$H,$G$-!"3:Ev$9$k%V%m%C%/$N%G!<%?E>AwMW5a%Q%1%C%H$r%[!<%`%N!<%I$NNIC XAwk!#
5. %G!<%?E>AwMW5a%Q%1%C%H$r<u$1<hC?%[!<%`%N!<%I$NNIC GO!"$=$N%Z!<%8$K4X9k%-%c%C%7%e%G%#%l%/%H%j$r0z$-!"M-8z$J%G!<%?$rJ];}7F$$k%N!<%I !$J3$N%N!<%I$rowner %N!<%I$H8F$V!K$rD4Yk!#
6. %[!<%`%N!<%I$NNIC $O3:Ev$9$k%V%m%C%/$N%G!<%?E>AwMW5a%Q%1%C%H$rowner %N!<%I$NNIC XAwk!#
7. %G!<%?E>Aw%Q%1%C%H$r<u$1<hC?NIC $O!"Mission ID $H2>A[%"%I%l%9$+$i%Z!<%8%F!<%V%k$r;2>H$7!"M-8z%G!<%?$,$"$k%V%m%C%/$X%"%/%;%9$9$k!#$=7F!"3N%G!<%?$rInitiator %N!<%I$XE>Aw9k!#

0J>e$,%M%C%H%o!<%/$r2p7?%b!<%H%"%/%;%9$NN.$lG"$k,!"5.$K$*$$F[%[!<%`%N!<%I!aowner %N!<%I]$G$"$C$?>l9g$O!"%[!<%`%N!<%IK*$$F7.$N<jB3$-$,9T$olk!#0J>e$NN.$l$NMM;R$r?^3$K<($9!#$^$?!"$=$N:]!"MxMQ9k%F!<%V%k$r?^4$K@0M}7F<($9!#



?^4: %j%b!<%H%"%/%;%9;~$KMxMQ$9$k%F!<%V%k

Bh4 >O %[!<%'%Z!<%80\Aw5!9=$N<BAu

A0>O$G=R$Y$?$h$&$K!"%j%b!<%H%a%b%j%"%/%;%9$,I,MW$HH=CG5l$?>19g$O!"%[!<%'%N!<%IK*$$$F4IM}>pJs$r;2>H$9kI,MW,$"$k!#3N$?$a!"%3%T!<%Z!<%8$r;}$D%N!<%IKHfY!"%[!<%'%N!<%IXN%"%/%;%9$OB?$/9Tol$k!#=>$C$F%[!<%'%Z!<%8$rI3$N%N!<%I$KG[CV9k$+$O!"%f%K%C%H$,9T$&3F<o=hM}XN8zN($dDL?.%M%C%H%o!<%/$N8zN($K1F6A$r5Z$\$9!#Colonia GO%[!<%'%Z!<%8$NG[CV$rE,59UQ99$9$k%[!<%'%Z!<%80\Aw$r9T$$!">o$K:G$b3F<o=hM}$N8zN($,9b$/$Jkh$&:GE,$J%N!<%I$XG[CV$9$k!#

K\>OGO!"%[!<%'%Z!<%80\Aw5!9=KD$$$F@bL@7?8e!"$=$N<BAuK!$r=R$Y!"$G8e$K$=$N9M;!$r9T$&!#

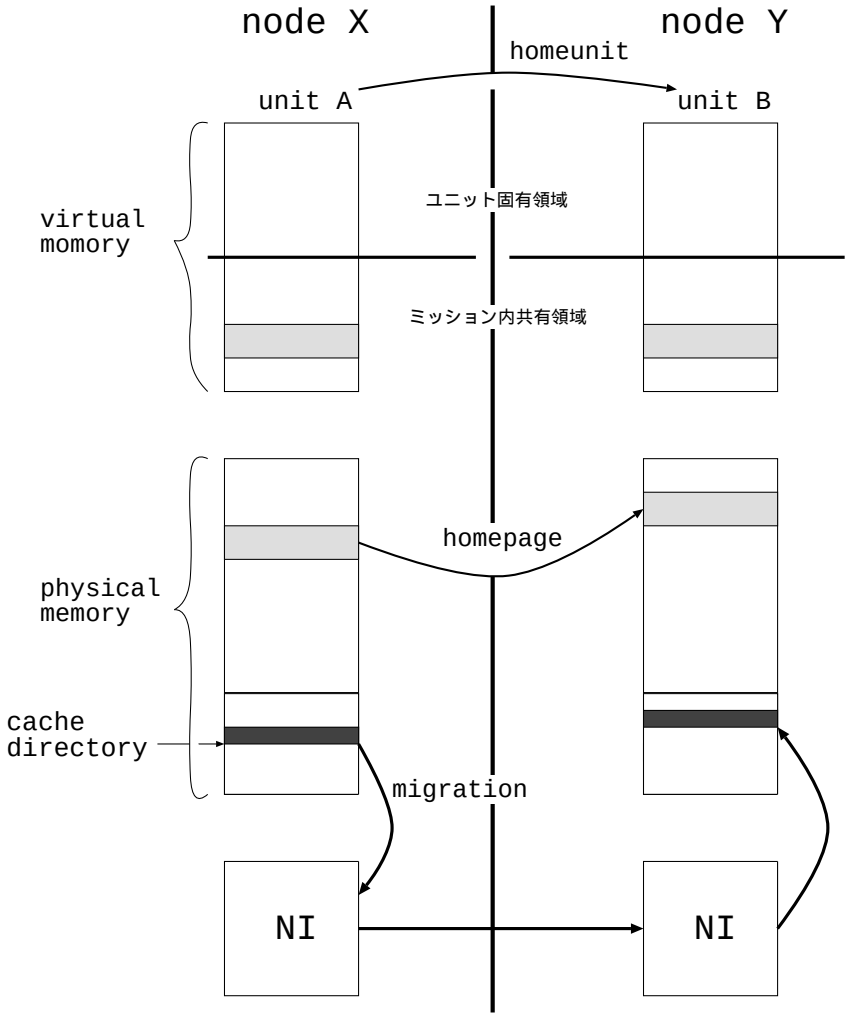
4.1 %[!<%'%Z!<%80\Aw

$3$3GO!"%[!<%'%Z!<%80\Aw$,9T$olkK"$?$C$F!"$=$N%?%$%_%s%0$dB9T$K4X9kMM!9$J<h$j7haK$D$$$F=RYk!#

4.1.1 %[!<%'%Z!<%80\Aw$N%?%$%_%s%0

%[!<%'%Z!<%80\Aw$,9T$olk%?%$%_%s%0$K$D$$$F!"0J2<$N2E@$rA[Dj7F$$$k!#

- %f!<%6$,L@<(E*$K0\Aw$N%?%$%_%s%0$r<($9!#



?^5: %[!<%`%Z!<%80\Aw$NMM;R

- OS $NH=CG$Khj!"0\Aw$r9T$&!#

%f!<%6$,0\Aw$N%?%$%_%s%0$r<($9>l9g$O!"Nc$($P!"%"%W%j%1!<%7%g%s$N<B9T%U%'!<%:$N0\$jJQok;~4|$K!"E,@Z$J%[!<%`%Z!<%8$N0LCV!#N!<%I!K$,%f!<%6KhCF<(5l$k>l9g$G$"$k!#

$^$?!"OS $NH=CG$Khj9Tol$k>l9g$O!"$"$k%N!<%I$+$i%[!<%`%N!<%I$KBP$7$F!"B?$/$N%j%/(%9%H%Q%1%C%H$,H/@8$7F$$$k>l9g$K!"Ev3:%j%/(%9%H$r9T$C$F$$$k%N!<%I$K%[!<%`%Z!<%8$r0\$7Fdk3H$G!"L5BL$J%N!<%I4V$N%Q%1%C%H$Nl}Mh$r8:$i$9$3H,G-$k!#

0J>e$N$$$:lN>l9gK*$$F$b!"0\Aw$,H/@8$9$k>l9g$O%N!<%I4V$N%Q%1%C%H$Nl}Mh$,>/$J$$HA[Dj5l$k!#

4.1.2 %[!<%`%Z!<%80\Aw$KH<$$JQ99$9$Y$-4IM}>pJs

3F%N!<%I$NNIC $OGDS $,4IM}$9$kBg0h2>A[%"%I%l%9$HUnit ID $N%F!<%V%k$r;2>H9k(?^4;2>H) 3HKh$j!"%[!<%`%Z!<%8$N0LCV$rG'<1$9$k!#$7$?$,$C$F!"GDS $,4IM}$9$k$3$N%F!<%V%k$NFbMF$r=q$-49$($F$d$k$3$H$G!"3F%N!<%I$NNIC $O%[!<%`%Z!<%8$N%N!<%I0LCV$,JQ$oC?$HG'<1$9ko1G$"$k!#7+$7!"%[!<%`%Z!<%8$G$O%-%&C%7%e0l4S@-@)8f$N$?$a$K%-%&C%7%e&G%#%l%/%H%j$rJ];}9kI,MW$,$"kN$G!"$3$N=q$-49$($HF1;~$K!"%-%&C%7%e&G%#%l%/%H%j$r?7$7$$%N!<%I$XE>Aw$7J/FOJi$J$$$!#

B($A!"%[!<%`%Z!<%80\Aw$O%-%&C%7%e&G%#%l%/%H%j$NE>Aw$H!"GDS $,4IM}$9$kI=$NJQ99$K$h$C$F9T$o$l$k!#$3$l$i$N:n6H$K$h$j!"%[!<%`%Z!<%8$,0\Aw$5$l!"$=$l$KH<$$!"%[!<%`%f%K%C%H$H%[!<%`%N!<%I$N0LCV$bJQ99$5$lkN$G"$k!#3NMM;R$r?^5$K<($9!#

4.1.3 %[!<%`%Z!<%80\Aw$KH<$$9MN8$9$Y$-;v9`

0J2<$K%[!<%`%Z!<%80\Aw$KH<$$9MN8$9$Y$-;v9`$r5s2k!#

1. %-%&C%7%e&G%#%l%/%H%jXN%"%/;%9$OE>AwCf$K$O9T$&3H$,$G$-$J$$$N$G!"$=$N4V$KH/9T5l$?%Q%1%C%H$KBP$7!"2?$i$+$N=hM}$r;\$9I,MW$,$"$k!#$^$?!"$=$N=hM}$KBP9k8e=hM}r7J1lPJi$J$$$!#
2. %[!<%`%Z!<%80\Aw=hM}=*N;0JA0$KH/9T$5$l$?%Q%1%C%H$O!"%[!<%`%Z!<%80\Aw=*N;8e$b85%[!<%`%N!<%I$X$d$C$F$/$k!#$3$l$i%M%C%H%o!<%/e$G=hM}Cf$N%Q%1%C%H$r?7$7$$%[!<%`%N!<%I$X8~$+$o$;$kI,MW$,$"$k!#$3N?aK$O!"$9YF$NNIC $K?7%[!<%`%N!<%I$rB.$d$+$KCN$i$;$k$H6&$K!"85%[!<%`%N!<%I$X8mCFdCF-$?%Q%1%C%H$K?7%[!<%`%N!<%I$rDLCN$7$F$d$i$J$/$F$O$J$i$J$$$!#$^$?!"85%[!<%`%N!<%I$K*$$$F!"?7%[!<%`%N!<%IrCNi$;$k$?$a$NJWNr>pJs$N:o=|$N%?%$_%s%0$r9MN8$7J1lPJi$J$$$!#

4.1.4 %[!<%`%Z!<%80\Aw5!9=$NJ}?K

$^$:!"A09`1.$G5s$2$?%-%&C%7%e&G%#%l%/%H%jE>AwCf$N%Q%1%C%H$N=hM}KBP9$kBP=hK!$r8!F$$9$k!#

%-%&C%7%e&G%#%l%/%H%jXCDL>o!"F1%N!<%I$+$i$HB>%N!<%I$+iN%"%/;%9$,$"$k!#F1%N!<%I$+iN%"%/;%9$O!"%7%9%F%`%P%9$N%3%s%H%m!<%i$,!"$=$N%-%&C%7%e&G%#%l%/%H%j$X%"%/;%9$r8!CN$7$?$i!"$=$N%"%/;%9$rAK;_$9kh$&&$KBP=h5;$k!#

$^$?!"B>%N!<%I$+$i@8$8$k%-%&C%7%e&G%#%l%/%H%jXN%"%/;%9$K4X$7FO!"

E>AwCf$K%-%&C%7%e&G%#%l%/%H%j$X%"%/%;%9$7$h$&$H9k%Q%1%C%HKBP9$kBP
=hK!$r0J2<$N#3DNJ}K!$GHf3S8!F$$7!":GE,$JJ}K!$rA*Br7?!#

1. %-%&C%7%e&G%#%l%/%H%jE>AwCf$K85%[!<%\%N!<%I$KAwilF/$k%[!<%\%Z!]
%8$K%"%/%;%9$7h&H9$k%Q%1%C%H$r?7%[!<%\%N!<%I$KE>Aw$7!"E>Aw=hM}
=*N;$^$G%Z%s%G%#%s%0$7$F$*$/!#%Z%s%G%#%s%05!9=$O%O!<%I%&%'%"E*$K<BAu
$7!"=hM}$r9bB.$K<B9T$G$-$kbNH9$k!#E>Aw=*N;8e!"B.$d$+$K=hM}$r:F
3+9k!#%Z%s%G%#%s%0$9$kNN0hO=$N%N!<%I$N<g5-21Fb$K@lMQ$K@_$1!"B?
$/$N%Q%1%C%H$NJ]B8$b2DG=K9$k!#

2. %-%&C%7%e&G%#%l%/%H%j$rE>Aw$9$kA0$K!"%[!<%\%f%K%C%H$HF1%_%C%7%g%s
$KB0$9$k%f%K%C%H$r;}$D%N!<%I$KBP7F!"%-%&C%7%e&G%#%l%/%H%jE>Aw3+
;CDLCN%Q%1%C%HrAwj!"%-%&C%7%e&G%#%l%/%H%jE>Aw=*N;$^$G!"%[!<%\%Z!<
%8XN%"%/%;%9$rCf;_$5$;$k!#$=$NDLCN%Q%1%C%H$r<u$1<hG?3F!9$N%N!<
%IGO!"%[!<%\%Z!<%8XN%"%/%;%9$rCf;_$9$k=hM}$,40N;7?8e!"%-%&C
%7%e&G%#%l%/%H%jE>AwDLCN%Q%1%C%HKBP9$kJV?.$rAw$k!#85%[!<%\%N!<%I
GOA4FN%N!<%I$+$iJV?.$r<u$1<hG?8e!"E>Aw$r3+;O$7!"E>Aw=hM}=*N;
8e!"E>Aw=hM}40N;DLCN$r@h$[IHF1$8%N!<%I$KAw$j!"%[!<%\%Z!<%8$X$N%"
%/%;%9$r:F3+$5$;$k!#

3. DL>o$N%N!<%I4VDL?.$K$*$$F!"%Q%1%C%H$N<u?.@h$N%N!<%INIC$,B?$/$N=h
M}rJz(F*$j!"$=$l0J>e%Q%1%C%H$N=hM}$,$G$-$J$$>l9g$O!"Aw?.85$X%Q
%1%C%H$,Aw$jJV5l$k!#Aw?.85$N%N!<%IGO!"AwjJV5ll$-$?%Q%1%C%H
$r:FAw$9$k!#$3$N>l9g!"%Q%1%C%H$NFbMF$O0l@ZJQ99$5l:!"Aw?.85$H<u?.
@h$N%N!<%I4V$r!"<u?.@h$,%Q%1%C%H$r=hM}2DG=KJk^$G1}I|$9$k!#$3$l
$HF1MM$K!"%-%&C%7%e&G%#%l%/%H%jE>AwCf$K%[!<%\%N!<%I$XdCF/$k%Q
%1%C%H$rAw?.85$XAwjJV7!"Aw?.85$N%N!<%I$H$N4V$r1}I|5;$k!#

1. $NJ}K!$O!"%-%&C%7%e&G%#%l%/%H%jE>AwCf$KB>$N%N!<%I$NNIC$N=hM}$K1F6A
$rM?$($:!"E>Aw=hM}=*N;8e!"E>AwCf$K=hM}$G$-$J$+$C$?%Q%1%C%H$rB.d+$K=h
M}G-$kJ}K!$G$"$k!#%Z%s%G%#%s%0$N:n6H$r%=%U%H%&%'%"$G9T$&$H!"%Z%s%G%#
%s%0$r9T$&EY$K%W%m%;%C%5$K3d$j9~$_$,$+$+$j!"Nc$(%Z%s%G%#%s%0$9$k%Q%1%C
%HNNL,>/$J$$$H7F$b!"3d$j9~$_$,$+$+k3HO%[!<%\%Z!<%80\Aw=hM}$rBg
$-$/CYi;$k860x$KJk!#7?$,$C$F%Z%s%G%#%s%0$r%O!<%I%&%'%"$G<BAu$9$k
bNH9$k!#$7$+$7!"%Z%s%G%#%s%0$r%O!<%I%&%'%"$G<BAu9kKO!"%O!<%I%&%'

%"; q8;KBP9$kMW5a$,B?$/!"8=;~E@$G3l$@$1$N%O!<%I%&%'%"; q8;$r;HMQG-k+$OH=CG$G$-$J$$!#

2. $NJ}K!$O!"3F%N!<%I$G%[!<%`%N!<%I$X$N%Q%1%C%H$NAw?.$rCf;_$9$k$N$G!"%-%&C%7%e&G%#%l%/%H%jE>AwCf$K!"%-%&C%7%e&G%#%l%/%H%j$X%"%/%;%9$7$h$&$H$9$k%Q%1%C%H$,H/@8$7$J$$$3$H$,J]>Z$5$l$F$$k!#$7$+$7!"%-%&C%7%e&G%#%l%/%H%jE>Aw$^$G$K=`Hw$9$k=hM}$N$?$a!"%-%&C%7%e&G%#%l%/%H%j$NE>Aw3+;O$,CY$/$J$k!#

$=$lKHfY!"3. $NJ}K!$O!"%-%&C%7%e&G%#%l%/%H%j3+;O$^$G$N=`Hw;~4V$,C;$$!#1.1.1$G=R$Y$?$h$&$K!"%-%&C%7%e&G%#%l%/%H%jE>AwCf$K%-%&C%7%e&G%#%l%/%H%j$K%"%/%;%9$7$h$&$H9k%Q%1%C%HNNLO>/$J$$$H$$$&>r7oNbHG$O!"%Q%1%C%H$rAw?.85KAwjJV$9$3HKhkDL?.%H%i%U%#%C%/$NA}Bg$,>/$J$$$H9M$($ilk!#7?$,$C$F!"$3$NJ}K!$O!"%-%&C%7%e&G%#%l%/%H%jE>Aw=hM}3+;O$^$G$N;~4V$,C;$/!"%O!<%I%&%'%"; q8;$KBP9kMW5a$,Hf3SE*>/$J$$!#

$^$?!"1.!"3. $NJ}K!$O2. $NJ}K!$KHf$Y!"B>$N%N!<%INIC KBP7!"FCJL$J=hM}$rMW5a7J$$!#85%[!<%`%N!<%I$H?7%[!<%`%N!<%I0J30$NNIC $ODL>o$HF1$8=hM}$r9TCF$$l$PNI$$!#

0J>e$N;vJA$HB>$NJ}K!$X$N1~MQ@-$r8!F$$7$?7k2L!"3. $NJ}K!$r:GE,$J=hM}K!$H9M$(!":NMQ$7$?!#

<!K3$NJ}K!$NbH$GA09`2. XNBP=hK!$r=RYk!#

%-%&C%7%e&G%#%l%/%H%jE>Aw=*N;8e$K!"GDS $N4IM}$9$k%F!<%V%k$O=q-49(ilk,!"%M%C%H%o!<%/>e$N%Q%1%C%H$O!"$=$N>pJsrCNk3HOG$-$J$$!#$=$3$G85%[!<%`%N!<%I$X8m$C$F$d$C$F$-$?%Q%1%C%H$KBP$7!":FEY!"Aw?.85$G%[!<%`%N!<%I$N0LCV$r3NG'$9kh$&$J>pJsr=$N%Q%1%C%H$KIU2C$7!"Aw?.85$XAwjJV9!#Aw?.85GO!"GDS $NBP1~I=$r:F3NG'$7!"?7%[!<%`%N!<%I$X%"%/%;%9,2DG=HJ$k!#

3N=hM}$O!"3F%N!<%INIC $,%O!<%I%&%'%"$H7$F%-%&C%7%e&7$F$$kGDS $N4IM}%F!<%V%k$r99?7$7!"$9YF$NGDS $N4IM}I=$,99?7$5$l$?;~E@$^$G%5%]!<%H$9kbNH9k!#

4.1.5 %[!<%`%Z!<%80\Aw5!9=$N35MW

K\<BAuK*1k!"%[!<%`%Z!<%80\Aw5!9=$N35MW$r=RYk!#

$^$:!"OS $"$k$$$O%f!<%6Kh$j%[!<%`%Z!<%80\Aw$NH=CG$,$J5l$?$N$r<u$1

$F!"<gCPU $N%W%m%;%C%5$ONIC $N%W%m%H%3%k%W%m%;%C%5$X%[!<%`%Z!<%80\Aw
%W%m%0%i%`$N3+;O$rL?Na9k!#0J2<O=$N8e$N=hM}G"$k!#
3+;O=hM} 85%[!<%`%N!<%I$+$i?7%[!<%`%N!<%I$X%[!<%`%Z!<%80\Aw$9k3HK
Jk!#$3$3GN=hM}$O!"85%[!<%`%N!<%I$H?7%[!<%`%N!<%I$NNIC $,6&$K
%[!<%`%Z!<%80\Aw=hM}$,9T$o$l$k$3$H$rG'<1$7!"?7%[!<%`%N!<%IGO!"Aw
ilF/kG$"$m$&%-%&C%7%e&G%#%l%/%H%j$NNN0h$r3NJ]$9k3HG$"$k!#
%-%&C%7%e&G%#%l%/%H%jE>AwN?aNA0=hM} $3$3GO!"%-%&C%7%e&G%#%l%/%H
%jE>AwCf$K!"%-%&C%7%e&G%#%l%/%H%j$X%"%/%;%9$,$"G?>l9g$K9T$&=hM}$N
=`Hwr9$k!#6qBNE*$K$O!"B>%N!<%I$+idCF$/$k%Q%1%C%HXN=hM} !#Aw
?.85$N%N!<%I$XAwjJV9!K$HF1%N!<%I$+iN%"%/%;%9KBP9$k=hM} !#7%9
%F%`%P%9$r%m%C%/!K$N2<cN`G"$k!#
%-%&C%7%e&G%#%l%/%H%jE>Aw=hM} %-%&C%7%e&G%#%l%/%H%jK\BN$r?7%[!<%`%N!<
%I$XE>Aw$7!"=jDj$N>l=j$K%-%&C%7%e&G%#%l%/%H%j$r3JG<$9$k!#
%-%&C%7%e&G%#%l%/%H%jE>Aw8e$N=hM} $3$3GO!"%[!<%`%Z!<%80\Aw=hM}$,=*
N;$7!"%7%9%F%`$,DL>o>uBV$K%9%`!<%:$K0\9T9k$?$a$N=hM}$r9T$&!#6qBN
E*KO!"!#%-%&C%7%e&G%#%l%/%H%jE>AwN?aNA0=hM}!W$G9T$C$?=hM}$KBP
7F!"$=$l$>$l$rDL>o=hM}$XLa$9=hM}$HGDS $N4IM}$9$k%F!<%V%kK\BN$H
$=$N%-%&C%7%e&rJQ99$9$k3HG"$k!#$^$?!"GDS $N4IM}$9$kI=$rJQ99$9
$k0JA0$KH/9T5l$?%Q%1%C%H$,?7%[!<%`%N!<%I$X@5$7$/%"%/%;%9$G$-$k$h
$&$J=hM}b9$k!#

4.2 %[!<%`%Z!<%80\Aw5!9=$N<BAu

$3$3GO!"%[!<%`%Z!<%80\Aw5!9=$N<BAu$K$D$$F>\:Y$K=R$Y$k!#

4.2.1 %[!<%`%Z!<%80\Aw5!9=<BAu$NMWE@

%[!<%`%Z!<%80\Aw5!9=$N9bB.2=$NMWE@H7$F0J2<$N3E@$r5s$2$k!#

1. NIC $N%W%m%H%3%k%W%m%;%C%5>e$G%[!<%`%Z!<%80\Aw$N%W%m%0%i%`$,F0:n$9
k3$H!#
2. %Q%1%C%H$NAw<u?.$K$*$$F!"JkY/!<%j%s%0r9k3HG3d$j9~$_$N
2s?t$r8:$i$9!#
3. 0lIt!"@lMQ$N%O!<%I%&%'%"$r@_1k3H$G9bB.2=$r?^$k!#

%[!<%`%Z!<%80\Aw5!9=$O!"%-%&C%7%e&G%#%l%/%H%j$NE>Aw$HGDS $N4IM}$9$k
I=$N=q49$(,<g$J:n6H$G$"$k!#$^$?!"85%[!<%`%N!<%I$H?7%[!<%`%N!<%I$N4V$N

%Q%1%C%HNd$j<h$jKh$j=hM}$,?J9T7F$$$/!#

7?$,$C$F!"1.$Nh&$K!"%-%&C%7%&G%#%l%/%H%j$dGDS$rDL>dMxMQ$7!"%Q%1%C%H$N=hM}$r;J$kNIC$N%W%m%H%3%k%W%m%;%C%5>e$G%W%m%0%i%`$,F0:n$9$k$N$,%[!<%`%Z!<%80\Aw$,9bB.$K<B9T$5lk$?$aI,MW$H9M$(il!"$=$Nh&$K<BAu$7$?!#

$^$?!"DL>o!"%Q%1%C%H$,$dCF$-$?%N!<%IGO!"$=$N%Q%1%C%H$rFCJL$J%O!<%I%&%'%"Kh$j=hM}$G$-$J$$>l9g$O!"%W%m%H%3%k%W%m%;%C%5$K3d$j9~$_[4]r+1k3H$G!"$=$N%Q%1%C%H$N<oJL$rH=JL$9$k!#$^$?!"3d$j9~$_$r$+$1k3HG!"%W%m%H%3%k%W%m%;%C%5Kh$kJ#;($J=hM}$r;XDj$9k3$H,$G$-$k!#7+$7!"3d$j9~$_$,$+$+k3HO!"%O!<%I%&%'%"N_GN=hM}KHfY!"B?$/$N%5%$%/%k?t$rMW9k!#hC$F!"%[!<%`%Z!<%80\Aw=hM}$r9bB.$K9T$&$?a$K$O!"3d$j9~$_$r:GDc8BK9k3HG$"$k!#K\<BAuGO!"2.Nh$&$K!"$"$k%Q%1%C%H$NAw?.$KBP$7!"$=$NUV?.$,B.d+$K5"$CF/kHA[Dj5l$k>l9g$O%Q%1%C%H$rAw?.$7$?$N$A!"$=$NUV?.$r<u$1<h$k$^$G]!<%j%s%0$9$k!#3lKhCF!"UV?.%Q%1%C%H$r<u$1<hC?8e$N=hM}$N:F3+$,B.$d$+$K9T$&$3H,G-$k!#

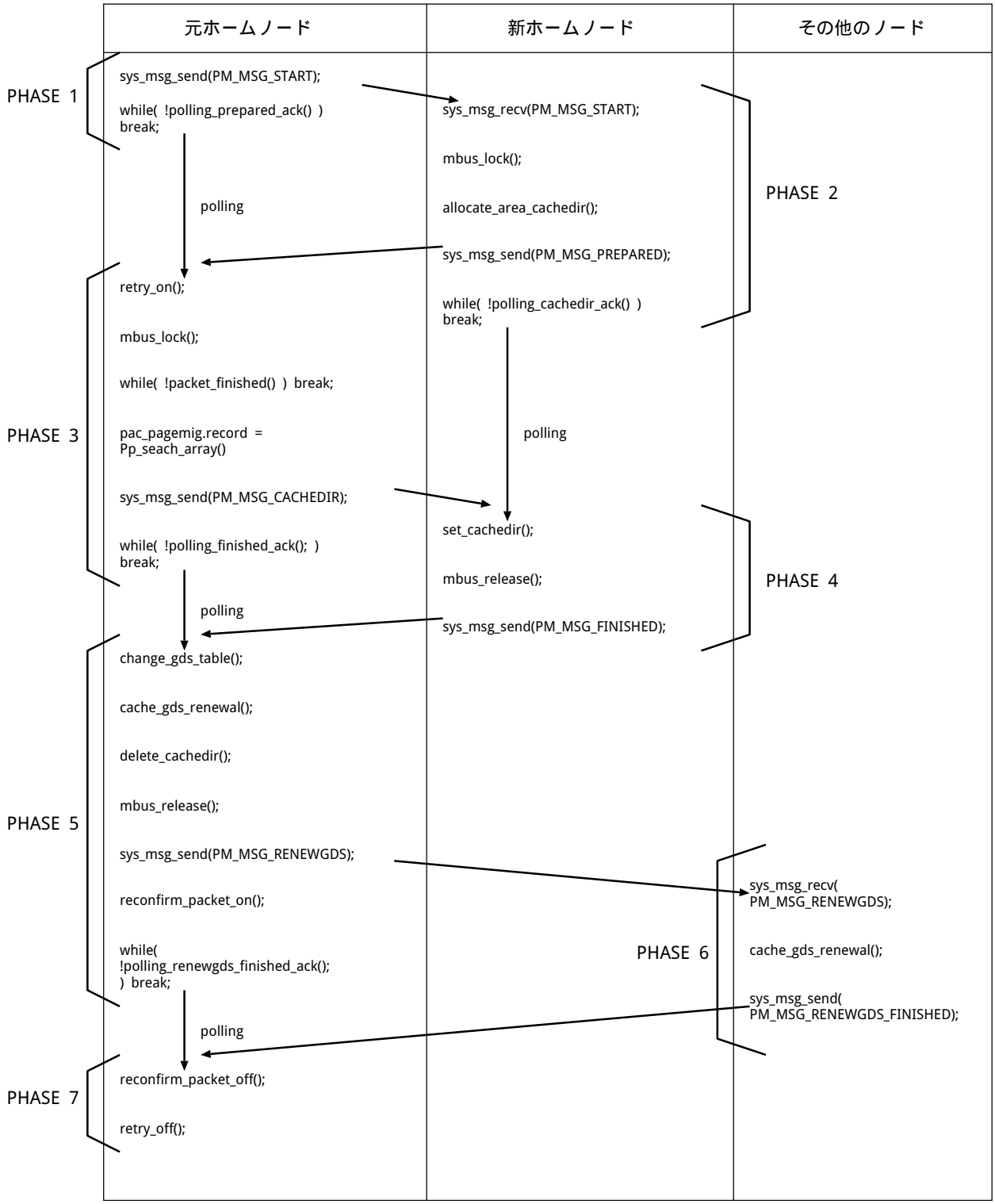
3.K*$$$F!"@lMQ$K@_$1$?%O!<%I%&%'%"$OJ2<NDLjG"$k!#

- %-%&C%7%&G%#%l%/%H%jE>AwCf$KF1%N!<%IFb$+$i%-%&C%7%&G%#%l%/%H%j$X%"%/%;%9$5$l$J$$$h$&$K!"NIC Fb$N%3%s%H%m!<%k%8%9%?$K@lMQ$NNN0h$r@_$1!"$=$N=hM}$r%O!<%I%&%'%"$G<BAu$9$k!#
- %-%&C%7%&G%#%l%/%H%jE>AwCf$K85%[!<%`%Z!<%N!<%I$XdCF-$?%Q%1%C%H$rAw?.85XAwjJV9?a$K!"NIC Fb$K@lMQ$N%l%8%9%?$r@_$1!"Aw$jJV$9=hM}$r%O!<%I%&%'%"$G<BAu$9$k!#
- %[!<%`%Z!<%80\Aw8e$K!"85%[!<%`%N!<%I$X8m$CFdCF$-$?%Q%1%C%HKBP7!":FEY%[!<%`%N!<%I$N0LCV$r3NG'9kh&$J>pJs$r$=$N%Q%1%C%H$KIU2C$7!"Aw?.85XAwjJV9?a$N@lMQ$N%l%8%9%?$r@_$1!"$=$N=hM}$r%O!<%I%&%'%"$G<BAu9k!#

4.2.2 %[!<%`%Z!<%80\Aw5!9=<BAu$N35MW

%[!<%`%Z!<%80\Aw$N%W%m%0%i%`$ONIC $N%W%m%H%3%k%W%m%;%C%5$KhC$F<B9T$5lk!#%[!<%`%Z!<%80\Aw$N%W%m%0%i%`OBg-$/J,$1$F!"#2$D$N4X?t$+$i9=@.$5lk!#%[!<%`%Z!<%80\Aw$r;O$a$k85%[!<%`%N!<%I$N=hM}$r;J$k4X?t$H!"%[!<%`%Z!<%80\Aw$K4X$9$k%Q%1%C%H$r<u?.7?H-$K=hM}$r;J$k4X?t$G$"$k!#

85%[!<%`%N!<%I$+$i$N=hM}$O!"start_page_migration() 4X?t$,8F$S=P5lk3


元ホームノード
新ホームノード
その他のノード
PHASE 1
PHASE 2
PHASE 3
PHASE 4
PHASE 5
PHASE 6
PHASE 7
sys_msg_send(PM_MSG_START);
while(!polling_prepared_ack()) break;
polling
retry_on();
mbus_lock();
while(!packet_finished()) break;
pac_pagemig.record = Pp_seach_array()
sys_msg_send(PM_MSG_CACHEDIR);
while(!polling_finished_ack();) break;
polling
change_gds_table();
cache_gds_renewal();
delete_cachedir();
mbus_release();
sys_msg_send(PM_MSG_RENEWGDS);
reconfirm_packet_on();
while(!polling_renewgds_finished_ack();) break;
polling
reconfirm_packet_off();
retry_off();
sys_msg_recv(PM_MSG_START);
mbus_lock();
allocate_area_cachedir();
sys_msg_send(PM_MSG_PREPARED);
while(!polling_cachedir_ack()) break;
polling
set_cachedir();
mbus_release();
sys_msg_send(PM_MSG_FINISHED);
sys_msg_recv(PM_MSG_RENEWGDS);
cache_gds_renewal();
sys_msg_send(PM_MSG_RENEWGDS_FINISHED);

?^6: %W%m%0%i% \$N?J9T

HKhj3+;O5l$k!#$3lKhj!"%[!<%`%Z!<%80\Aw$O3+;O$9$k!#?7%[!<%`%N!<%I$d!"$=$NB>%3%T!<%Z!<%8$r;}CF$$$k%N!<%IGN=hM}$O=jDj$N%Q%1%C%H$N<u?.$KhC$F3+;O$5lk!#

%[!<%`%Z!<%80\Aw$,H=CG$5$l$k$H!"<gCPU $+$i%[!<%`%Z!<%80\Aw$KI,MW$J>pJsHHbKNIC $N%W%m%H%3%k%W%m%;%C%5$X%[!<%`%Z!<%80\Aw3+;ODLCN$,Aw$i$l$k!#$=$l$r<u$1$F!"%W%m%H%3%k%W%m%;%C%5$O!"start_page_migration() $r<B9T$9$k!#$3$3$+$i%[!<%`%Z!<%80\Aw%W%m%0%i%`$,;OF0$9$k!#$3$N4X?t$K$O0z?t$H$7$F!"%[!<%`%Z!<%8$NBg0h%"%I%l%9$r9=@.9kmission ID $H2>A[%"%I%l%9!"$5iKI3$+$iI3$N%N!<%I$X0\Aw$9$k$+$r<($9%N!<%I ID $r5-=R$9$k!#$3$N4X?t$O!"%[!<%`%Z!<%8$r0\Aw$9$kB&!"B($A85%[!<%`%N!<%I$NNIC $G9T$&=hM}$r5-=R$7$F$$$k4X?t$G9=@.$5lk!#ESCf!"$"$k%N!<%IKBP9$kMW5a%Q%1%C%H$N1~EzBTAKhj=hM}$,0l;~5Y;_$9$k!#

<u?.B&$N%N!<%I$N4X?t$O!"start_page_migration() $GH/9T$5l?%Q%1%C%H$r<u?.$9k3HGF0:n$r3+;O$9k,!"<u?.9k%Q%1%C%H$N<dN`$Khj5/F0$9$k4X?t$,0[$J$k!#<u?.B&$N%N!<%I$N4X?t$O!"%Q%1%C%H$N<u?.$G5/F0$7!"1~Ez%Q%1%C%H$rH/9T9k3HKh$j!"=*N;$^$?$O!"0l;~5Y;_9k!#

%[!<%`%Z!<%80\Aw5!9=NJ$+$G!"%O!<%I%&%"$G<BAu$5lkItJ,$O%_%&l!<%?$Khj<BAu7?!#

4.2.3 %[!<%`%Z!<%80\Aw5!9=$N<BAu

$3$3GO!"%[!<%`%Z!<%80\Aw5!9=$N%W%m%0%i%`$N>\:Y$r5-=R9k!#K\<BAuGOJ2<$N%Q%1%C%H$r;HMQ9k!#

PM_MSG_START 85%[!<%`%N!<%I$+$i%[!<%`%Z!<%8$N0\Aw$r?7%[!<%`%N!<%IKEA($k%Q%1%C%H

PM_MSG_PREPARED ?7%[!<%`%N!<%I$G!"[PM_MSG_START] %Q%1%C%H$N<u?.$r<u$1$F%-%&%C%7%e&G%#%l%/%H%j$N<u?.=`Hwr7!"$=$l$N40N;DLCN%Q%1%C%H

PM_MSG_CACHEDIR 85%[!<%`%N!<%I$+$i?7%[!<%`%N!<%I$X%-%&%C%7%e%G%#%l%/%H%j$NE>Awr9$k%Q%1%C%H

PM_MSG_FINISHED ?7%[!<%`%N!<%I$G%-%&%C%7%e&G%#%l%/%H%j$r<u?.$7!"%-%&%C%7%e&G%#%l%/%H%j$r<g5-21$K3JG<$7$?8e!"85%[!<%`%N!<%IKBP7$FAw?.$9$k%Q%1%C%H

PM_MSG_RENEWGDS F1%_%C%7%g%s$KB0$9$kB>$N%N!<%IKBP7!"%-%&C %7%e7F$$$kGDS $NI=$N99?7$r<B9T$5$;$k%Q%1%C%H

PM_MSG_RENEWGDS_FINISHED [PM_MSG_RENEWGDS] %Q%1%C%H KBP9$k<B9T40N;DLCN%Q%1%C%H

%Q%1%C%H$NAw<u?.$O!"sys_msg_send() $Hsys_msg_recv() $N#2$D$N4X?t$Khj 9Tol$k!#%Q%1%C%H$K$O!"4pK\E*$K%[!<%`%f%K%C%H$,B0$9$kmission ID $H!"%[!<%`%Z!<%8$N2>A[%"%I%l%9!"?7%[!<%`%N!<%I$N%N!<%IID!"%G!<%?!J#2s$O%-%&C %7%e%G%#%l%/%H%jK\BN!K$rAw$k!#%G!<%?$OI,MW$J%H$-$N$_IU%1$i$l!"$=$l0J30 $ONULL $,3JG<$5$l$F$$$k!#%Q%1%C%H$N$"$F@h$K$O!"Aw$j@h%N!<%I$r;XDj$9$k!# %W%m%0%i%`$N?J9T$NMM;R$r?^6$K<($9!#0J2<!"%[!<%`%Z!<%80\Aw$G<B9T$5$l $k4X?t$r%Q%1%C%H$NAw?.!"<u?.$Khk%U%'!<%:J,1r7F@bL@9k!#

PHASE 1 85%[!<%`%N!<%I$K$*$1$k%W%m%0%i%`

- sys_msg_send(PM_MSG_START) !85%[!<%`%N!<%I$+$i?7%[!<%`%N!<%I KBP7!"%[!<%`%Z!<%80\Aw3+;O$rDLCN$9$k!#
- polling_prepared_ack() !?7%[!<%`%N!<%I$+$i$N JV?.%Q%1%C%H([PM_MSG_FINISHED]) $r<u?.$7$?$i!"1rJV9!#3N4X ?t$r>o$K4F;k9k3H$G%]!<%j%s%0$r9k!#$?$@$7!"$3$3$G$N%]!<%j%s %0$OPHASE2 $G3d$j9~$_$,$+$+k?$a!"$3$N%]!<%j%s%0$h$jM%@hEY$N9b $$=hM}$,H/@8$7$?>l9g$O!"%W%m%;%C%5r=Ai$N=hM}$K3djEvFk3$H $,$G$-$k!M%@hEYIU$-%]!<%j%s%0$G$"$k!#DL>oJi[PM_MSG_START] %Q%1%C%HKBP9$kJV?.%Q%1%C%H$r<u$1<h$k$^$G$N;~4V$,B?$/$+$+$k$H M=A[$5lk>l9g$O!"B>$N=hM}$,<B9T$G$-$J$$;~4V$,B?$/Jk$?$a!"%]!< %j%s%0$rA*Br$9$k3$HOG$-$J$$!#7+$7!"$3$3$G3d$j9~$_r+1k $H0J2<$NPHASE $N3+;O$N$?$S$K!"3d$j9~$_=hM}$r7J1lPJiJ $/$J$j!"A4BN$N=hM}$N=*N;$,BgI}KCYl$k!#$7$?$,CF!"%]!<%j%s%0 $rA*Br$7$?!#

PHASE 2 ?7%[!<%`%N!<%I$K$*$1$k%W%m%0%i%`

- sys_msg_recv(PM_MSG_START) !85%[!<%`%N!<%I$+$i$N%[!<%`%Z!<%80\AwDLCN$r<u?.$9$k!#$3$3GNIC $N%W%m%H%3%k%W%m%;%C%5$K3d$j9~$_ $,$+$+$j!"%W%m%;%C%5$,5/F0$9$k!#

- mbus_lock() !% [! <% '%Z! <%8$N2>A [%"%I%l%9$r0z?t$K<h$k! #F1%N! <%I !37 % [! <% '%N! <%I! K$+$i% [! <% '%Z! <%8XN%"%/%;%9$rCfCG$5$;$k! #<B:]$O NIC Fb$N%3%s%H%m! <%k%l%8%9%?K3$N2>A [%"%I%l%9$r=q$-$3$'$3HG %O! <%I%&%'%"E*$K<BAu$9$k! #
- allocate_area_cachedir() !% [! <% '%Z! <%8$N2>A [%"%I%l%9$r0z?t$K<h$k! # <g5-21>e$N%-%&C%7%e&G%#%l%/%H%jMQ$NNN0h$+$i! "E>Aw5lF/$k%-%&C %7%e&G%#%l%/%H%j$r3JG<9k$?$a$NNN0h$r@Z$j=P$9! #%-%&C%7%e&G%#%l %/%H%jMQ$NNN0h$O<g5-21>e$KB8:_$7! "NIC @lMQ$NNN0h$G$"$k! #
- sys_msg_send(PM_MSG_PREARED) !85% [! <% '%N! <%IKBP7! "%-%&C %7%e&G%#%l%/%H%j$NE>Aw='Hw$,@0C?3HrCNi$;$k! #
- polling_cacehdir_ack() !85% [! <% '%N! <%I$+$i$N %Q%1%C%H([PM_MSG_CACHEDIR]) $r<u?.$7$?$i! "l rJV9! #3N4X ?t$r>o$K4F;k9k3H$G%]! <%j%s%0$r9k! #

PHASE 3 ?7% [! <% '%N! <%I$+$i %Q%1%C%H[PM_MSG_PREARED] $r<u$1<hk3HG3+;O9k! #85% [! <% '%N! < %IGO! "3N%Q%1%C%H$N<u?.$^$G%]! <%j%s%0$7$F$$?NG! "B.d+$K=hM} $r3+;O$9$k! #

- retry_on() !% [! <% '%Z! <%8$N2>A [%"%I%l%9$r0z?t$K<h$k! #%-%&C%7%e&G%# %l%/%H%j$X%"%/%;%9$7h&H9$k%Q%1%C%H$rAw?.85KAwjJV$9! #$3$l $ONIC Fb$N%3%s%H%m! <%k%l%8%9%?ItK3$N2>A [%"%I%l%9$r=q$-$3$'$3 HG%O! <%I%&%'%"E*$K<BAu$5lk! #
- mbus_lock() !% [! <% '%Z! <%8$N2>A [%"%I%l%9$r0z?t$K<h$k! #F1%N! <%I !85 % [! <% '%N! <%I! K$+$i%-%&C%7%e&G%#%l%/%H%jXN%"%/%;%9$rCfCG$5$;$k! #
- packet_finished() !%retry_on() <B9T0JA0$K! "%-%&C%7%e&G%#%l%/%H%j$K %"%/%;%9$,$"$C$?%Q%1%C%H$N=hM}$,40A4$K=*N;7?$i! "l rJV9! #
- Pp_seach_array() !%-%&C%7%e&G%#%l%/%H%jK\BN$rE>Aw$9k?aK! "%Q %1%C%H$NFbMF$r5-=R9k9=BBNK! "%-%&C%7%e&G%#%l%/%H%j$r<($9%] %$%s%?$r3JG<9k! #3N4X?t$O%-%&C%7%e&G%#%l%/%H%j$N3JG<5l$F $$k%"%I%l%9rJV9! #
- sys_msg_send(PM_MSG_CACHEDIR) !?7% [! <% '%N! <%I$X%-%&C%7%e&G%# %l%/%H%j$rE>Aw9k! #

- polling_finished_ack() !85% [!<% '%N!<%I$+$i$N %Q%1%C%H([PM_MSG_FINISHED]) $r<u?.$7$?$i!"l rJV9!#3N4X?t $r>o$K4F;k9k3H$G%]!<%j%s%0$r9k!#

PHASE 4 85% [!<% '%N!<%I$+$i%Q%1%C%H[PM_MSG_CACHEDIR] $r<u$1<h$k 3H$G3+;O9k!#?7% [!<% '%N!<%IGO!"3N%Q%1%C%H$N<u?.$^$G%]!<%j%s %0$7$F$$?NG!"B.d+$K=hM}$r3+;O9k!#

- set_cachedir() !<u?.7?%-%&C%7%&G%#%l%/%H%j$rPHASE 2 $G3NJ]$7 $?<g5-21>e$NNN0h$K3JG<$9$k!#
- mbus_release !PHASE 2 GNmbus_lock() $G9T$C$?@_Dj$r2r=|9k!#
- sys_msg_send(PM_MSG_FINISHED) !85% [!<% '%N!<%I$X%-%&C%7%&G%# %l%/%H%j$NE>Aw:n6H$,=*N;$7$?$3HrDLCN9k!#

PHASE 5 ?7% [!<% '%N!<%I$+$i%Q%1%C%H[PM_MSG_FINISHED] $r<u$1<h$k 3H$G3+;O9k!#85% [!<% '%N!<%IGO!"3N%Q%1%C%H$N<u?.$^$G%]!<%j%s %0$7$F$$?NG!"B.d+$K=hM}$r3+;O9k!#

- change_gds_table() !GDS $K%"%/%;%9$7$F!'GDS $,4IM}$9$kBP1~I=$r=q $-$+$(!$k!#3NH-!'GDS GO3NBP1~I=$r%-%&C%7%&$7$F$$k%N!<%I KBP7!'L58z2=MW5arAwj9YFN%-%&C%7%&$NFbMF$r99?7$9$k!#GDS GO3N:n6H=*N;8e!"85% [!<% '%N!<%IKBP7=hM}40N;$rDLCN$9$k!#$3 $NDLCN$rBTCF<!$K?J$'!#
- cache_gds_renewal() !F1%N!<%I$GNIC $N@lMQ%l%8%9%?$K%-%&C%7%&$7 $F$$kGDS $NBP1~I=$r99?7$9$k!#0z?tH7FO?7% [!<% '%N!<%I$N%N!< %IID rH$k!#
- delete_cachedir() !85% [!<% '%N!<%IK"$k%-%&C%7%&G%#%l%/%H%j$r>C 5n9k!#
- mbus_release() !PHASE 3 GNmbus_lock() $G9T$C$?@_Dj$r2r=|9k!#
- sys_msg_send(PM_MSG_RENEWGDS) !F1%_%C%7%gsKB0$9$kB>$N%N!< %I$KBP$7!'%-%&C%7%&$7$F$$kGDS $NI=$N99?7$r<B9T$9kh$&$KDLCN 9k!#
- reconfirm_packet_on() !GDS $NUQ998e!"4{$K%M%C%H%o!<%/K"$k%Q %1%C%H$O!"7Pi/$N4V85% [!<% '%N!<%I$KAwilF/kN$G!"$3li $N%Q%1%C%H$K!GGDS :F3NG'MW5a!W$rIU2C$7$F!"UV?.$9kh$&$KNIC Fb

$N%3%s%H%m!<%k%l%8%9%?$K% [!<% `%Z!<%8$N2>A [%"%I%l%9$r=q$-$3$ `!#

- polling_renewgds_fineshed_ack() !F1%_%C%7%g%s$KB0$9$kB>$N%N!<%I$+$i$N%Q%1%C%H([PM_MSG_RENEWGDS_FINISHED]) $r<u?.$7$?$i!"l rJV9!#3N4X?t$r>o$K4F;k9k3H$G%]!<%j%s%0$r9k!#

PHASE 6 3N%U%'!<%:$CF1%_%C%7%g%s$KB0$9$kB>$N%N!<%I$G<B9T5l$k%W%m%0%i% `$G$"$k!#

- sys_msg_recv(PM_MSG_RENEWGDS) !85% [!<% `%N!<%I$+$i$N%Q%1%C%H[PM_MSG_RENEWGDS] $r<u$1<h$k!#$3$3$G$O!"$3$N%Q%1%C%H$NH=JL$r%O!<%I%&%'%"$G9T$$9bB.$K0J2<$N=hM}$K?J$`!#
- cache_gds_renewal() !F1%N!<%I$GNIC Fb$N@lMQ%l%8%9%?$K%-%&%C%7%e 7F$$k GDS $NBP1~I=$r99?7$9$k!#0z?tH7FO?7% [!<% `%N!<%I$N%N!<%I ID rH$k!#
- sys_msg_send(PM_MSG_RENEWGDS_FINISHED) !' cache_gds_renewal() $N=hM}$,40N;7?3H$r85% [!<% `%N!<%I$XCNi;$k!#

PHASE 7 85% [!<% `%N!<%I$G$N=hM}$G$"$k!#$3$N%U%'!<%:$G% [!<% `%Z!<%80\Aw=hM}$O40N;$9$k!#85% [!<% `%N!<%I$G$O!"$3$N%Q%1%C%H$N<u?.$^$G%]!<%j%s%0$7$F$$?NG!"B.d+$K=hM}$r3+;O9k!#

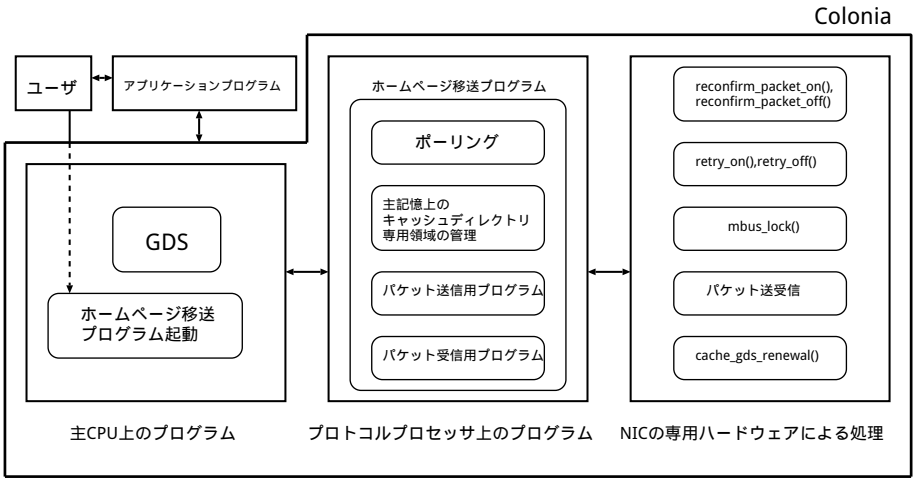
- reconfirm_packet_off() !PHASE 5 $Greconfirm_packet_on() $,9T$C$?@_Dj$r2r=|9k!#
- retry_off() !PHASE 3 $Gretry_on() $,9T$C$?@_Dj$r2r=|9k!#

4.2.4 %W%m%;%C%5>e$N%W%m%0%i% `!"%O!<%I%&%'%"$N=hM}$NAj4X4X78

K\<BAuGO!"<gCPU >e$N%W%m%0%i% `!"NIC $N%W%m%H%3%k%W%m%;%C%5>e$N%W%m%0%i% `!"$^$?%O!<%I%&%'%"$Khj<BAu5l$?=hM}$,Aj8_$K4X$oCFA4BN$N=hM}$r<B9T7F$$k!#$3$3GO=$N4X78$r$^$Hak!#

%"%W%j%1!<%7%g%s%W%m%0%i% `$OColony $NOS $G$"$kColonia $NF0:n4D6-$G<B9T$5$l$F$$k!#$3$N"%W%j%1!<%7%g%s%W%m%0%i% `$N<B9T>u67$Khj!"OS Colonia!"$"$k$$O%f!<%6$,%[!<% `%Z!<%80\Aw$N%?%$_%s%0$rH=CG9k!#

OS $,H=CG$7$?>19g$O!"<gCPU $+$iNIC $N%W%m%H%3%k%W%m%;%C%5$K%[!<% `%Z!<%80\Aw$N3+;O$rDLCN$9$k!#f!<%6$,H=CG$7$?>19g!"%7%9%F% `%3!<%k$rH/9T$7$F0lC6!"<gCPU $K%[!<% `%Z!<%80\Aw$N3+;O$rL?Na$9$k!#



?^7: 3F=hM}7O$NAj4X?^

%[!<%`%Z!<%80\Aw$N3+;O$,%W%m%H%3%k%W%m%;%C%5$KDLCN$5$l$k$H!"NIC $N%W%m%H%3%k%W%m%;%C%5$K=hM}$N<gF3$,0\$k!#%W%m%H%3%k%W%m%;%C%5$O NIC >e$N%O!<%I%&%'%"$HAj8_$K4X$o$j$J$,$i!"%N!<%I4VDL?.$d!"%Q%1%C%H$KBP$9$k=hM}$r<B9T$9$k!#%[!<%`%Z!<%80\Aw$,3+;O$5lk$H!"$[HsIN=hM}$O%W%m%H%3%k%W%m%;%C%5$H!"%O!<%I%&%'%"$N=hM}$G@jailk$,!"ESCfGDS $N4IM}$9$k%F!<%V%k$N=q49$($O<gCPU $N%W%m%;%C%5$,F0:n9k!#

<gCPU >e$N%W%m%0%i%`!"%W%m%H%3%k%W%m%;%C%5>e$N%W%m%0%i%`!"NIC $N%O!<%I%&%'%"$Khk=hM}$NAj8_4X78$r?^7$K<($9!#

4.3 9M;!

%3%s%T%e!<%?!&3%m%K!<GO!"6&M-%a%b%j$rMxMQ$7$?DL?.$r9T$&$3HG!"L5BL$JDL?.2s?t$r8:i9DL?.$N:GE,2=[5] $d8zN(E*$JIi2YJ,;6$rL\I8$H7F$$$k$r!#K\8&5f$G$O!"$=Nh$&$JL\I8C#@.$N0l4D$H7F!"%[!<%`%Z!<%8$N0\Aw5!9=$r9M0F7?!#

K\<BAuGO!"%-%c%C%7%e%G%#%l%/%H%jE>AwCfKdCF$/$k%Q%1%C%H$rAw?.85$KAwjJV9$3$H$,<g$JFCD'G"$k!#4.1.1$G=RY?h&$K!"<BAu$NA0DsH7$F!"%-%c%C%7%e%G%#%l%/%H%jE>AwCf$O%Q%1%C%H$N1}Mh$O>/$J$$$bNH7F$$$k!#%Q%1%C%H$N1}Mh$,B?$$$H2>Dj9k$H!"$3$NJ}K!$G$O!"85%[!<%`%N!<%I$HAw?.85$r9T$-8r$&%Q%1%C%H$NNL$,B?$/JkNG!"DL?.%H%i%U%#%C%/$NA}Bg$,L5;kG-J/Jj!"$=$N%Z!<%80J30$N%Q%1%C%H$NDL?.$KJ@32$,Gk$HM=A[$5lk!#

%-%&C%7%e&G%#%l%/%H%jE>AwCfKdCF$/$k%Q%1%C%H$Nl}Mh$,B?$$bNH9k$H!"K\<BAu$G:NMQ7?J}K!$O<h$l$J$$!#3N>l9g!"4.1.4$G=R$Y$?1.!"2.$N=hM}K!Ji$P!"BP=h$9k3H,G-$k!#

7?$,$C$F!":#8e$N8&5fKh$j!"%[!<%'%Z!<%80\Aw$N%?%$%_%s%0$d;HMQG-$k%O!<%I%&%'%";q8;$,3NDj9l$P!"8!F$$7$?B>$NJ}K!$X0\9T$9kH$$$&3H$b9M$(il$k!#

Bh5>O $*$ojK

%3%s%T%e!<%?!&3%m%K!<GO!"6&M-%a%b%j$rMxMQ$7$?DL?.$r9T$&$3HG!"L5BL$JDL?.2s?t$r8:i9DL?.$N:GE,2=$d8zN(E*$JIi2YJ,;6$r9T$&!#K\O@J8$G$O!"$=Nh$&$JL\I8$rC#@.$9k?aK%[!<%'%Z!<%8$N0\Aw5!9=$r9M0F7?!#

%[!<%'!<%Z!<%80\Aw5!9=$N<BAuK!$H7F$O!"$=$N9bB.@-$H%O!<%I%&%'%";q8;!"B>$N<BAuK!$X$Nl~MQ$r9M$(9g$o$;!"%-%&C%7%e&G%#%l%/%H%jE>AwCf$K%[!<%'%Z!<%8$K%"%/;%9$7$h$&$H9k%Q%1%C%H$rAw?.85$KAwjJV9J}K!$r:NMQ$7$?!#$^$?!"%[!<%'%Z!<%80\Aw$N%?%$%_%s%0$O!"%W%j1!<%7%g%s%W%m%0%i%'$N<B9T$K$*$1$k%U%'!<%:$N0\$j$+$ojJ$I!"%[!<%'%Z!<%8$KBP9k%Q%1%C%H$NAmNL$,>/$J$$$H$-$rA[Dj7?!#

:#8e$N8&5f$G$O!"%[!<%'%Z!<%80\Aw$rC/$,$INh$&$JH=CG$G9T$&N,:G$b8zN(E*$G$"$k$+!"B($A!"%f!<%6$"$k$$$OOS $,$INh$&$J%?%$%_%s%0$GH=CG7F9T$&$N$,:G$b8zN(E*G"k+$H$$$&LdBj$N8&5f$,2]BjG"k7!"$^$?!"$=$Nh&$&J%?%$%_%s%0K*$$FbCHbE,@Z$J<BAuK!$r9M0F7J1lPJiJ$$!#K\O@J8GO!"B>$N<BAuK!$NNc$r5s$2$?$,!"3liN<BAuK!$b>u67$K9go;FE,MQ5lk2DG=@-$,$"$k!#

4XO"8&5fH7FO!"%f!<%6$,%W%m%0%i%'$rEjF~$7!"%_%C%7%g%s!"%f%K%C%H$,@8@.5l$?$H$-$K%[!<%'%Z!<%8rI$KG[CV$5lk$+$H$$$&8&5f$,5s$2il$k!#$3$N8&5f$CK\O@J8Gb!"%[!<%'%Z!<%80\Aw$N%?%$%_%s%0$r7hDj$9$kLdBj$KBg$$$K78okbNG"$k!#

$^$?!"9G$K%3%s%T%e!<%?!&3%m%K!<$G$b07$olF$$$k$,!"%f%K%C%H0\Aw$N8&5f[6]$,$"$k!#$3lbDL?.$N:GE,2=!"8zN(E*$JIi2YJ,;6N?aK9Tol$k!#$3$3$G$O%f%K%C%H$=NbNN%G!<%?E>Aw$H6&$K!"GDS $N4IM}$9$kUnit ID $HNode ID $NBP1~$r49$($k!#[!<%'%Z!<%8$K%j%b!"%%;%9$rIQHK$K7+$jJV$9%f%K%C

%H$,$"lP!"$=$N%f%K%C%H$r%[!<%`%N!<%I$X0\Aw$7$Fdl$PNI$$!#3Nh&$J
>l9g!"K\O@J8$N%"%W%m!<%A$H%f%K%C%H0\Aw$N%"%W%m!<%A$K$O0c$$$O$"$k$,!"DL
?.$N:GE,2=!"8zN(E*$JIi2YJ,;6$N<B8=$rF1$8L\I8$H7F$$$k!#7?$,$C$F!"$I
Ai$NJ}K!$rA*Br9k$+$O!"$=$l$>$l$N0\Aw$N%3%9%H$H0\Aw8e$N$=$l$>$l$,M?
$($k1F6A$r9MN8$7$F7hDj$7J/FOJi$J$$!#3l$b:#8e$N8&5fH7$F5s$2$i
lk$@$m$&!#

Bh6>O <U<-

K\8&5f$N5!2q$rM?$($F$/$@5C$?!"K\8&5f<<$NIYEDbC<#65<x$K?<?S$J<U0U$r
I=7^$9!#

$^$?!"K\8&5f$K4X$7$FE,59$4;XF3!"$4J\Z%$r;rC??9bC0lO:=u65<x!"8^Eg@5
M5=u<j$K?<$/46<UCW7^$9!#

5i$K!"6&F18&5f<T$G$"$kA}EDJv5A;a!"D;:jM#G7;a!"@P@nCR>M;arO8a$H
7F!"F|:"MM!9$J3QEY$+$i=uNO$7$F2<$5C?5~ETBg3XBg3X1!>pJs3X8&5f2JDL?.
>pJs%7%9%F%`@l96IYED8&5f<<$N=t7;$K?4hj46<UCW7^$9!#

;29MJ88%

[1] @DLZ=(5., B>:6&M-%a%b%j%Y!<%9$N%7!<%`%l%9$JJBNs7W;;5!4D6-$r<B8=$9$k
%*%Z%l!<%F%#%s%0%7%9%F%`$N9=A[,>p=h8&Js, Vol. 97-OS-34 (1997).

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[3] A}EDJv5A, B>:J,;6OS Colonia K*1k6&M-%a%b%j$rMxMQ$7$?Bg0hE*%M!<
%`!&5!<%S%9,?.3X5;Js, Vol. CPSY99-53 (1999).

[4] JeanBacon !F#ED><J?,<DEDM[0l,:#@t5.;KLu):JBNsJ,;6%7%9%F%`!"%*%Z%l!<
%F%#%s%0%7%9%F%`!"%G!<%?%Y!<%9!"J,;6%^%k%A%a%G%#%"%7%9%F%`XNAm9g
E*%"%W%m!<%A,3t<02q<R%H%C%Q%s(1996).

[5] 0KC#?7:H:%M%C%H%o!<%/J,;67?JBNs%7%9%F%`$r<B8=$9$kDL?.5!9=(2000).

[6] ;3E:Gn;K,B>:%3%s%T%e!<%?!&3%m%K!<K*1k9bB.0\Aw2DG=$JJBNs%"%/%F%#
%S%F%#$N<B8=,%7%9%F%`%=%U%H%&%"%$%*%Z%l!<%F%#%s%0%7%9%F%`, Vol. 82-12 (1999).