**TR-95-28**

# %M%C%H%o!<%/?tCM>pJs%i%$%V%i%j **Ninf** $N$?$a$N **RPC** %7%9%F%`$N35MW

## An overview of the RPC System Implementation for Ninf: Networked Information Library for High Performance Computing

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**1995** G/ **10** 7n **23** F| <uIU

35MW

%M%C%H%o!<%/?tCM>pJs%i%$%V%i%j Ninf (**N**etwork based **Inf**omation library for High Performance Computing) $O!"7W;;2J3X5;=Q!"?tCM2r@O5;=Q$X$N9bB.$J%M%C%H%o!<%/$NMxMQ$K?7$7$$2DG=@-$rM?$($k$b$N$G$"$k!#$o$l$o$l$O $3$N Ninf $N$?$a$K!"?7$?$J RPC %7%9%F%`$N@_7W$H<BAu$r9T$J$C$?!#K\9F$G$O!"$3$N Ninf RPC $N@_7WJ}?K$H<BAu$K4X$7$F=R$Y$k!#

## 1 $O$8$a$K

%3%s%T%e!<%?%M%C%H%o!<%/$NH/E8$K$H$b$J$$!"%M%C%H%o!<%/$rMxMQ$7$?>pJsDs6!%5!<%S%9$,@9$s$K9T$J$o
$k!#$3$l$i$N%5!<%S%9$NFCD'$O!">pJs$N<B:]$KB8:_$9$k0LCV$NF)L@@-$G$"$j!">pJs;q8;$N2>A[E*6&M-2=$G$"$k
$k$3$H$,$G$-$k!#

7W;;2J3X5;=Q!"?tCM2r@O5;=QNN0h$K$*$1$k>pJs;q8;$N6&M-2=$r9M$($F$_$h$&!#$3$N>l9g$N>pJs;q8;$O!"?t
$dFC<l4X?t!"?tCM7W;;%i%$%V%i%j$K$J$k$@$m$&!#8=:_$N%M%C%H%o!<%/4D6-$K$*$$$F$bNc$($P ftp $d WWW $J$I
$3$l$i$N;q8;$N6&M-$O$"$kDxEY$O<B8=$5$l$F$$$k$H9M$($k$3$H$b$G$-$k!#$7$+$78=:_$N>uBV$G$O!"Nc$($P$"$k
%i%j$r;H$*$&$H;W$C$?>l9g$K ftp $G$H$C$F$-$F$=$l$r%3%s%Q%$%k$9$k$H$$$&<j4V$,$+$+$k!#$^$?!"%3%s%Q%$%i
%-%F%/%A%c$,0c$&>l9g$K$O$=$N%i%$%V%i%j$,4|BT$5$l$k$h$&$J@:EY$r=P$7$F$$$k$N$+$r3NG'$9$k$3$H$O$G$-
$D$^$j!"?tCM7W;;%i%$%V%i%j$r6&M-$9$k$?$a$K$O!"%=!<%9%3!<%I$N$_$N6&M-$G$OIT==J,$G!"<B9T$KI,MW$J%"!<
%A%c$r4^$s$@<B9T2DG=>uBV$G$N!"$$$o$PF0BVJ]B8 / 6&M-$,I,MW$J$N$G$"$k!#

$3$N$h$&$J>pJs;q8;$N6&M-$N$?$a$NOHAH$H$7$F!"$o$l$o$l$O Ninf (**N**etwork based **Inf**omation library for High
Performance Computing) $rDs>'$7$F$$$k [1, 2]!# Ninf $O%5!<%P!&%/%i%$%"%s%H%b%G%k$N%7%9%F%`$G$"$k!#%M%C%H
%o!<%/>e$K?tCM>pJs$d7W;;<+?H$rDs6!$9$k%5!<%P$r@_$1!"%f!<%6$K$O%5!<%P$K@\B3$9$k%/%i%$%"%s%H5!G=$r;}
%V%i%j$rDs6!$9$k!#$3$N%i%$%V%i%j$K$h$C$F Ninf %7%9%F%`$O1#JC$5$l$k$N$G!"%f!<%6$O7W;;$,<B:]$K$I$3$G9
$l$k$+$r0U<1$9$kI,MW$O$J$$!# Ninf $N0&>N$O ME@:$r0UL#$9$k!VNymph!W$+$iMh$F$*$j!"$"$?$+$b%M%C%H%o!<
?9$K@3$`ME@:$N$h$&$K?MCN$l$:4j$$$r$+$J$($F$/$l$k$h$&$J%7%9%F%`$rL\;X$7$F$$$k!#

$3$N%7%9%F%`$N<B8=$N0l$D$N%-!<$H$7$F RPC(Remote Procedure Call) $,$"$k!# RPC $NB8:_$r0U<1$5$;$:$K
%f!<%6!<$K;H$C$F$b$i$&$?$a$K$O!"=@Fp$JOHAH$r;}$D RPC $,I,MW$G$"$k!#8=:_$BMQE*$KMQ$$$i$l$F$$$kBeI=E*
$H$7$F UNIX RPC $,$"$k!#$3$N RPC $OO1HLE*$KMQ$$$i$l$F$*$j!"$=$N>e$K5$^$6$^$J%"%W%j%1!<%7%g%s$,<BA
$l$F$$$k$,!"<!@a$G=R$Y$k$h$&$K!"$o$l$o$l$NL\E*$K$O=@Fp$5$*$$$FITB-$,$"$k!#$3$N$?$a$o$l$o$lFH<+$N R
OHAH!" Ninf RPC $r@_7W3+H/$7$?!#K\9F$G$O$3$N Ninf RPC $N@_7WJ}?K$H<BAu$N>\:Y$K$D$$$F=R$Y$k!#

K\9F$G$O!"$^$: Ninf RPC $N@_7WJ}?K$K$D$$$F=R$Y!"$D$.$K Ninf RPC $r9=@.$9$k8D!9$N%W%m%0%i%`$N>\:Y$K
$$$F=R$Y$k!#$5$i$K!" Ninf RPC $G$b$A$$$i$l$F$$$k%W%m%H%3%k$r>\=R$7$9$k!#:G8e$K Ninf RPC $GMQ$$$k IDL(In
Description Language) $K$D$$$F=R$Y$k!#

## 2 Ninf RPC $N@_7W

### 2.1 Ninf RPC $X$NMW@A

J#?t$N7W;;5!$G7W;;$r9T$J$&>l9g$K=EMW$K$J$kE@$N0l$D$H$7$F0z?t$N0zEO$7J}K!$,$"$k!#8F$PB&$N%W%m%0%
8F$P$l$kB&$N%W%m%0%i%`$N4V$K!"0z?t$N7?!"Bg$-$5!"=gHV$J$I$K4X$7$F!"2?$i$+$N7A$G9g0U$,$J$1$l$P$J$i$J$

C1=c$K7W;;$r%5!<%P!&%/%i%$%"%s%H$KJ,;6$9$k$b$N$H$7$F$O UNIX RPC(Remote Procedure Call) $,$"$k!# UNIX
RPC $O!"%5!<%P$+$i5/F0$5$l$k%?!<%2%C%H%W%m%0%i%`$H%/%i%$%"%s%H$N%W%m%0%i%`$N4V$K$OL)$J4X78$,$"$k$
A0Ds$H$7$F$*$j!"$3$N$?$a0z?t$OC10l$N9=B$BN$H$7$FEO$7$F$$$k!#$7$+$7!"$3$N$?$a$K$O%?!<%2%C%H%W%m%0%i
%i%$%"%s%H$,0z?t$N$?$a$N9=B$BN$N5-=R$r6&M-$7$F$$$kI,MW$,$"$k!#$3$N$?$a RPC $r$b$A$$$F Ninf $r<B8=$9$k
0z?t9=B$BN$N%X%C%@!<%U%!%$%k$rNc$($P ftp $J$I$G<hF@$7$J$1$l$P$J$i$J$$!#

Ninf $O!"%/%i%$%"%s%H%W%m%0%i%`$N%W%m%0%i%^$K$O!"7W;;5!%M%C%H%o!<%/$K4X$9$kCN<1$rMW5a$7$J$$<jK!$
$H$7$F$$$k!#$3$N$?$a>e5-$N$h$&$JJ}K!$OH$l$J$$!#$3$l$r2r7h$9$k$?$a$K$O!"%?!<%2%C%H$N%$%s%?!<%U%'%
E*$KE>Aw$9$kI,MW$,$"$k!#

$^$?!" Ninf $N%?!<%2%C%H$G$"$k?tCM1i;;J,Ln$G$O!"7W;;%i%$%V%i%j$KBP$9$k%G!<%?$NE>AwNL$,F0E*$KJQ2=$
9g$,$"$k!#$?$H$($P9TNs$N>h;;$rNc$K$H$C$F9M$($F$_$h$&!#0lHL$K9TNs$N%5%$%:$O9TNs>h;;%W%m%0%i%`$N%3%s
;~$K$O7hDj$7$J$$!#$3$N$?$a1i;;%i%$%V%i%j$O!"0z?t$K$h$C$F9TNs$N%5%$%:$r;XDj$9$k!#$3$N%i%$%V%i%j$N%
%U%'%$%9$O2<$N$h$&$K$J$k!#

```
matrix_multiply(int size, double * A, double * B, double * C)
```

$3$l$OO1JU size $N9TNs A $H B $r>h;;$7$F C $KBeF~$9$k$H$$$&7W;;%i%$%V%i%j$N%$%s%?!<%U%'%$%9$G$"$k!#$3
$-!">h;;%k!<%A%s$r8F$S=P$9%a%$%s%W%m%0%i%`$H>h;;%k!<%A%s$N4V$G!"%$%s%?!<%U%'%$%9$H$7$F$O!" Integer 0
%]%$%s%?$, 3 $D$,EO$5$l$F$$$k$@$1$G$"$k!#$7$+$7<B:]$K7W;;$r9T$J$&$K$O!"9TNs A,B,C $N$=$l$>$l$KBP$7$F

$$sizeof(double) * size * size$$

$NBg$-$5$NNN0h$r6&M-$7$J$1$l$P$J$i$J$$!#

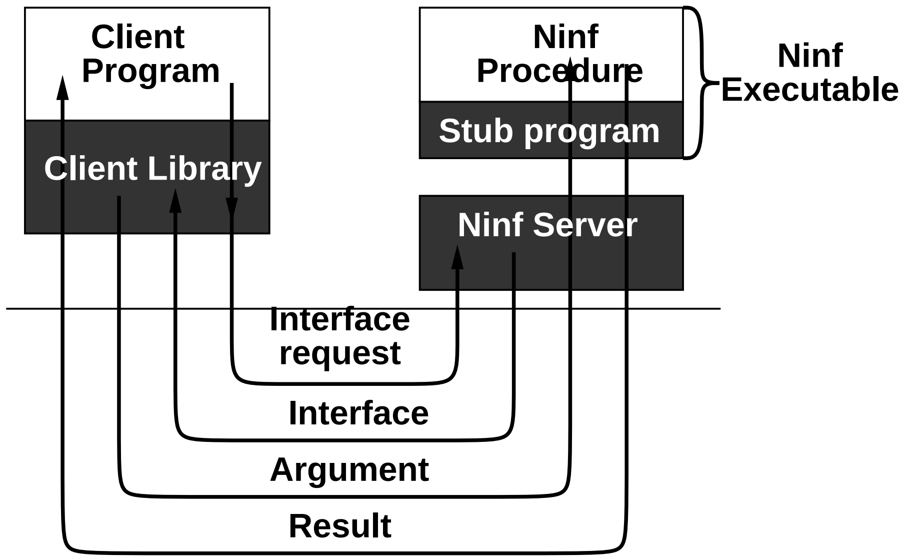
C10l$N%W%m%;%C%5$G<B9T$9$k>l9g$K$O!"%a%$%s%W%m%0%i%`$H>h;;%k!<%A%s$,A4%a%b%jNN0h$r6&M-$7$F$$$k$
$l$OLdBj$K$J$i$J$$!#$7$+$7>h;;%k!<%A%s$rJL$N7W;;5!$G<B9T$9$k$?$a$K$O!"$3$NNN0h$rE>Aw$7$J$1$l$P$J$i
$3$N$?$a9TNs$N%5%$%:$,JQ2=$9$k$HE>AwNL$,JQ2=$9$k$3$H$K$J$k!# UNIX RPC $G$O$3$l$r<B8=$9$k$3$H$O$G
$$!#

## 2.2 Ninf RPC $N35MW

2f!9$O!"0J>e$N$h$&$JMW@A$K4p$E$- Ninf RPC %7%9%F%`$r3+H/<BAu$7$?!#$3$N%7%9%F%`$G$O%$%s%?!<%U%'%$
<B9T;~$KF0E*$KE>Aw$9$k$3$H$G!"%f!<%6!<$NIi2Y$r8:$i$7$F$$$k!#$^$?!"%$%s%?!<%U%'%$%9$K<B9T;~$KI>2A$9
4^$_!"F0E*$K$3$N<0$rI>2A$9$k$3$H$G!"E>AwNL$r<B9T;~$K7hDj$9$k

2f!9$N%7%9%F%`$O!"%5!<%P$H%/%i%$%"%s%H!&%i%$%V%i%j$G9=@.$5$l$k!#7W;;%i%$%V%i%j$rDs6!$9$k?M$O!"
$J$k%i%$%V%i%j$N;EMM$r Ninf IDL(Interface Description Language) $H8F$P$l$k8@8l$G5-=R$9$k!# Ninf stub generator $,!"$3$N IDL $+$i0z?t$K4X$9$k>pJs$r$H$j$@$7!"7W;;%i%$%V%i%j$H$N4V$r66EO$7$9$k stub %W%m%0%i%`$r
$9$k!#$3$N stub %W%m%0%i%`$H7W;;%i%$%V%i%j$r%j%s%/$9$k$3$H$G!"%?!<%2%C%H%W%m%0%i%`$,@8@.$5$l$k!#$3$
%2%C%H%W%m%0%i%`$r Ninf Executable $H8F$V!#7W;;%i%$%V%i%j$N%$%s%?!<%U%'%$%9$O Ninf Executable <+?H$KC_$
$i$l$F$$$k!#%5!<%P$O$"$i$+$8$a Ninf Executable $K%"%/%;%9$7!" Ninf Executable $N%$%s%?!<%U%'%$%9$r%F!<%V%
$K3JG<$7$F$*$/!#%/%i%$%"%s%H!&%i%$%V%i%j$O Ninf Executable $N<B9T$N:]$K!"0z?t$NAw?.$K@h$@$C$F%5!<%P$HI
$7!"%$%s%?!<%U%'%$%9$r<hF@$7!"$=$N>pJs$K$7$?$,$C$F0z?t$rAw?.$9$k!#$b$A$m$s!"$3$l$i$N2aDx$O!"%i%$%V
$h$C$F%f!<%6$+$i1#JC$5$l$k!#

?^ 1$K Ninf RPC $N35MW$r<($9!#




?^ 1: Ninf RPC $N35MW

## 2.3 Ninf RPC %7%9%F%`$N9=@.

Ninf RPC %7%9%F%`$O!"0J2<$NMWAG$+$i9=@.$5$l$k!#

- **Ninf Server**
  %/%i%$%"%s%H$+$i$N%j%/%(%9%H$r<u$1$H$k$H!"<B:]$K7W;;$r9T$J$& Ninf Executable $r5/F0$7!"$=$N8e$N Ni
  Executable $H%/%i%$%"%s%H$NDL?.$rCf7Q$9$k!#

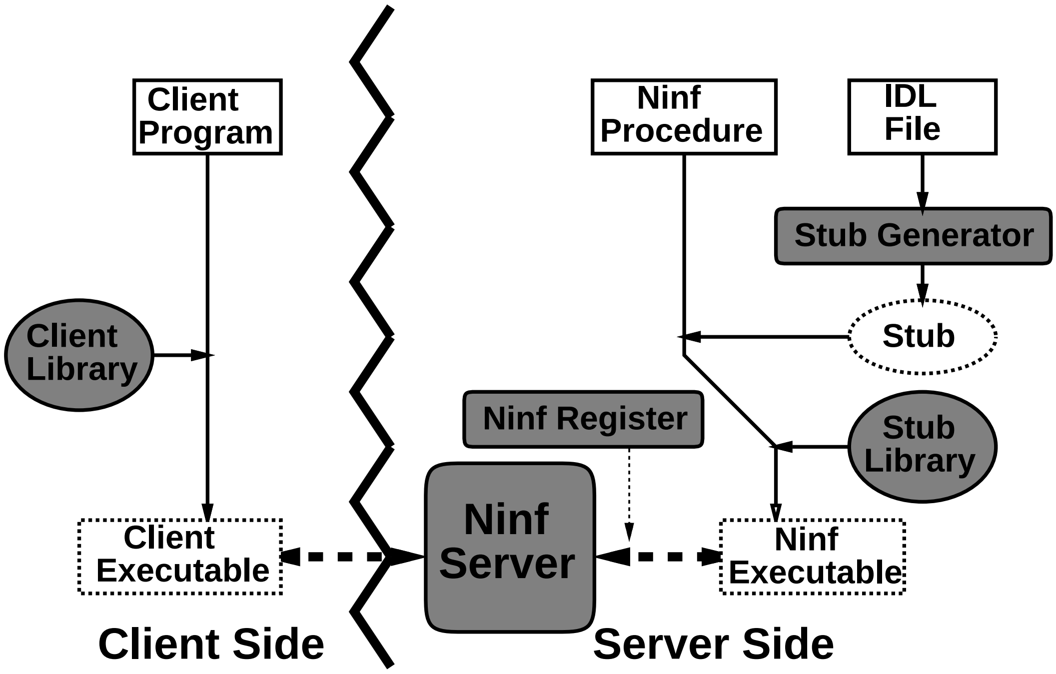
- **Ninf Client Library**
  %/%i%$%"%s%H%W%m%0%i%`$H%j%s%/$9$k%i%$%V%i%j!#

  `Ninf_call(` *funcname*, *arg*, `)`

  $r<B8=$9$k!#

- **Ninf Stub Generator**
  Ninf IDL $K$h$C$F5-=R$5$l$?Dj5A%U%!%$%k$+$i!"%9%?%V$H make file $r:n@.$9$k!#
- **Ninf Stub Library**
  %9%?%V$, Ninf %5!<%P$d%/%i%$%"%s%H$HDL?.$9$k$N$KI,MW$J%k!<%A%s$rDs6!$9$k!#
- **Ninf Register**
  Ninf %5!<%P$K Ninf 2=$7$?%W%m%0%i%`$rEPO?$9$k!# Ninf 2=$7$?%W%m%0%i%`$r0J2<$G$O Ninf Executable!" Ninf 2=$5$l$k%k!<%A%s$r Ninf Procedure $H8F$V!#

?^ 2$K!" Ninf RPC $N9=@.$r<($9!#0J9_$G$=$l$>$l$NMWAG$K4X$7$F>\$7$/8+$k!#




?^ 2: Ninf RPC $N9=@.

## 3 Ninf Server

Ninf Server $O!" Ninf RPC $NCf3K$r$J$9%^%9%?!<!&%9%l!<%V<0$NJB9T<B9T%5!<%P%W%m%0%i%`$G$"$k!#%^%9%? %5!<%P$O!"FCDj$N%]!<%H$+$i$N%3%M%/%7%g%s$r<u$1IU$1$k$H%9%l!<%V%5!<%P%W%m%;%9$r0l$D5/F0$9$k!#<B:]$N %7%g%s$KBP$9$k=hM}$O%9%l!<%V%5!<%P$,<u$1;}$A!"%^%9%?!<%5!<%P$O>o$K%]!<%H$+$i$N%3%M%/%7%g%s$r<u$1IU $k!#

Ninf Server $NLr3d$O!"%/%i%$%"%s%H$+$i$N%j%/%(%9%H$K$7$?$,$C$F!" Ninf Executable $N%$%s%?!<%U%'%$%9$rE Aw$7$?$j!" Ninf Executable $r<B:]$K5/F0$7$?$j!"%/%i%$%"%s%H$+$i$N%a%C%;!<%8$r Ninf Executable $KCf7Q$7$?$ $9$k$3$H$G$"$k!#$3$l$i$N2aDx$O 5.2$K<($9%W%m%H%3%k$G9T$J$o$l$k!#

%/%i%$%"%s%H$+$i$NMW5a$O Ninf Executable $NL>A0$G$J$/4X?tL>$G9T$J$o$l$k!#$3$N$?$a Ninf Server $O4X?tL $+$i Ninf Executable $rFCDj$9$k%F!<%V%k$r;}$DI,MW$,$"$k!#$3$N%F!<%V%k$X$NEPO?$O<!>O$G=R$Y$k Ninf Regist $G9T$J$o$l$k!#$3$N$H$-!" Ninf Server $O<B:]$K Ninf Executable $r5/F0$7!"$=$N Ninf Executable $+$i%$%s%?!< %U%'%$%9$rF@!"$3$l$b%F!<%V%k$KEPO?$9$k!#$3$N$?$a!"%/%i%$%"%s%H$+$i%$%s%?!<%U%'%$%9$rMW5a$5$l$?:]$K :]$K Ninf Executable $r5/F0$9$k$3$H$J$/%$%s%?!<%U%'%$%9$rJVEz$9$k$3$H$,$G$-$k!#

## 4 Ninf Register

Ninf register $O Ninf Server $KBP$7$F Ninf Executable $rEPO?$9$k$?$a$N%f!<%F%#%j%F%#%W%m%0%i%`$G$"$k!#

**Usage:** **ninf_register** %U%!%$%kL>

Ninf Server $O EPO?MQ$K UNIX %I%a%$%s$N%=%1%C%H$r01$D$D$/$k!# Ninf register $O!"$3$N%=%1%C%H$K%"%/%;%9$
$F0z?t$N%U%!%$%kL>$r0z$-EO$9!# Ninf Server $O%U%!%$%kL>$rMQ$$$F!" Ninf Executable $r01EY5/F0$7%$%s%?!<%U
%$%9$r<h$j=P$7EPO?$9$k!#

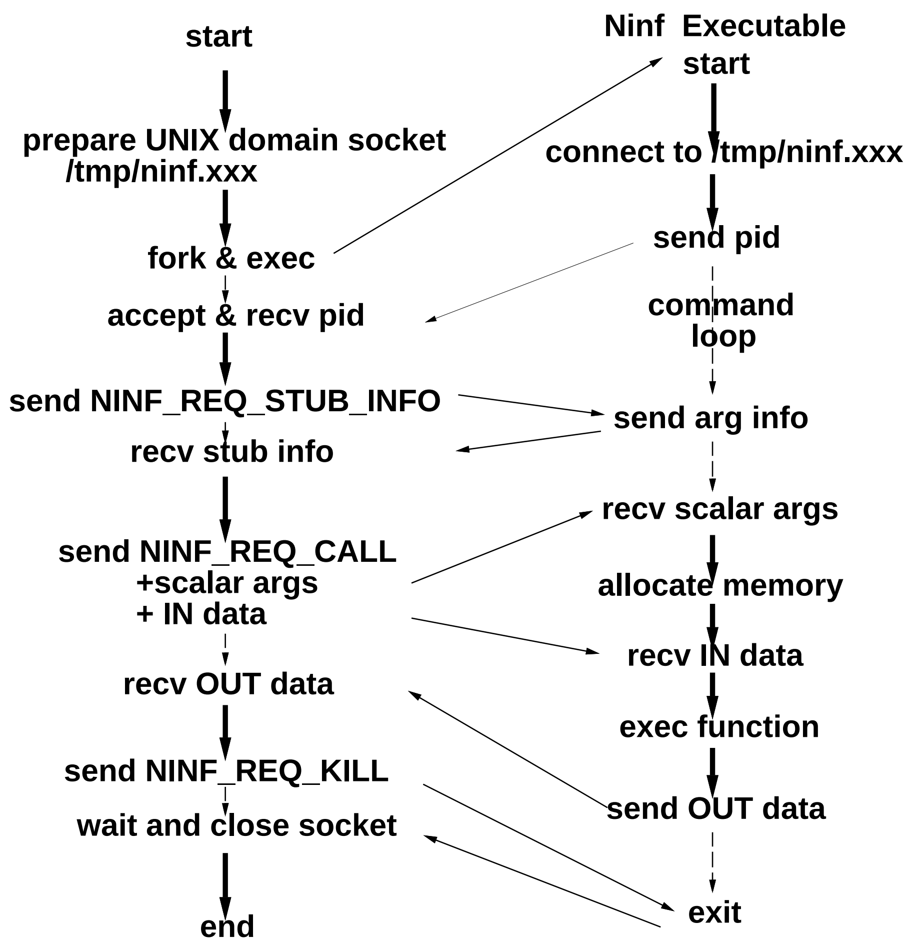
## 5 Ninf RPC $N%W%m%H%3%k

K\>O$G$O!" Ninf RPC $GMQ$$$i$l$k%W%m%H%3%k$K$D$$$F=R$Y$k!#8=%P!<%8%g%s$N Ninf RPC $O!"0J2<$N 3 $D$N
%m%H%3%k$G9=@.$5$l$F$$$k!#

- Ninf Executable $H8r?.$9$k$?$a$N%W%m%H%3%k
  $3$N%1%Y%k$O!"4pK\E*$K xdr[1]$h$k stream DL?. (TCP/IP) $K4p$E$$$F9T$o$l$k!#
- client $H server 4V$N%W%m%H%3%k
  $3$N%1%Y%k$O!"%Q%1%C%HC10L$GDL?.$r9T$&!#8=:_$N%$%s%W%j%a%s%H$G$O!" TCP/IP $rMQ$$$F!"%Q%1%C%HC1
  DL?.$r<B8=$7$F$$$k!#
- Ninf server $H Ninf Register $H$N4V$N%W%m%H%3%k

Ninf_call $r9T$& client $O!" server $H$NDL?.$N%W%m%H%3%k$rDL$7$F!" Ninf Executable $H$NDL?.$r9T$J$C$F$$$k!#

### 5.1 Ninf Executable $H$N8r?.$N$?$a$N%W%m%H%3%k




?^ 3: Ninf RPC $NMQ$$$k%W%m%H%3%k

Ninf Executable $H$NDL?.$O!" xdr $rMQ$$$? stream DL?.$G9T$J$&!#

[1]External Data Representation!# UNIX RPC $G$b$D$+$o$l$F$$$k%G!<%?I=8=$N;v<B>e$NI8=`!#%P%$%H%*!<%@!<$J$I$N5!<o4V$NAj0c$r5[<
$9$k$?$a$KMQ$$$i$l$k!#

Ninf Executable $O!" fork $5$1$?8e execute $5$1$F<B9T$5$1$k$3$H$r2>Dj$7$F@_7W$5$1$F$$$k!# Ninf Executable $N5/F0$^$G$N<j=g$O0J2<$NDL$j$G$"$k!#

- Ninf Executable $O!"5/F0$5$1$k$H!"<+J,$N parent process $N%W%m%;%9 id **<ppid>** $rMQ$$$F **/tmp/ninf.<ppid>** $H$$$&L>A0$N unix domain $N%=%1%C%H$KBP$7$F connect [2]$9$k!#

- connect $,40N;$7$?$i!"<+J,$N%W%m%;%9 id $r xdr $G connect $7$? socket $K=q$-9~$_!"5/F0$7$?$3$H$rDLCN$9 $k!#$3$1$O!"?F%W%m%;%9$NB&$G connect $7$F$-$?%W%m%0%i%`$,K\Ev$K<+J,$,5/F0$7$?$b$N$G$"$k$+$H$$$& C1$JG'>Z$r$*$3$J$&$?$a$G$"$k!#

- $=$N8e!"%3%^%s%I<B9T%k!<%W$r<B9T$9$k!#

%3%^%s%I<B9T%k!<%W$O!"%3%^%s%I$r@hF,$H$9$kF~NO$r<u$1<h$j!"$=$1$KBP1~$9$k=PNO$9$k%k!<%W$G$"$k!#=E Ninf Executable $r=*N;$5$;$k%3%^%s%I (**NINF_REQ_KILL**) 0J30$O!" ack %3!<%I (**NINF_ACK_ERROR** $^$?$O!" **NINF_ACK_OK** $rJV$7!" **NINF_ACK_OK** $N>l9g$K$O!"E,Ev$J=PNO$r9T$&!#%3%^%s%I$O0J2<$N$b$N$,$"$k!'

- **NINF_REQ_STUB_INFO**
  B3$/F~NO$O$J$7!# Ninf Procedure $N%$%s%?!<%U%'%$%9$rJV$9!#

- **NINF_REQ_CALL**
  F~NO$H$7$F!"%9%+%i0z?t$NCM$r<u$1<h$j!" IN $G;XDj$5$1$F$$$kG[Ns%G!<%?$r<u$1<h$k!#$3$1$i$N%G!<%?$ $G<hF@$7$?%$%s%?!<%U%'%$%9$K$7$?$,$C$F9T$o$1$J$/$F$O$J$i$J$$!#

  7W;;$,40N;$9$k$H OUT $G;XDj$5$1$F$$$kG[Ns%G!<%?$rJV$9!# client B&$G$O!"$3$N%G!<%?$rMQ$$$F!" OUT ;XDj$7$?G[Ns$r update $9$k!#

- **NINF_REQ_DESCRIPTION**
  NINF IDL $K5-=R$5$1$F$$$k description >pJs$rJV$9!#

- **NINF_REQ_KILL**
  B3$/F~NO$O$J$7!# Ninf Executable $r=*N;$5$;$k!#=PNO$O9T$o$J$$!#

?^ 3$K Ninf Executable $H$N8r?.$NMM;R$r<($9!#

## 5.2 Ninf Server $H$NDL?.

remote client $H Ninf Server 4V$O!"%Q%1%C%HC10L$NDL?.$r9T$&!#$3$N%1%Y%k$N%W%m%H%3%k$O!" Ninf library $N4X ?tL>$+$i$N%$%s%?!<%U%'%$%9$N<hF@!" Ninf Executable $N5/F0$r9T$&$b$N$G$"$k!#

$3$N%1%Y%k$N%W%m%H%3%k$O!" **MAX_PKT_LEN** 0J2<$N%Q%1%C%H$rC10L$H$7$FDL?.$9$k!#%Q%1%C%H$N header $K$O!" 2<$N>pJs$,3JG<$5$1$F$$$k!#

- size: %Q%1%C%H$N%5%$%:
- code: %3%^%s%I!"%Q%1%C%H$N<oJL$r<($9!#
- arg1,arg2: code $K1~$8$?>pJs$r3JG<$9$k!#

Ninf Server $K$O!"EPO?$5$1$F$$$k Ninf Executable $H4X?tL>$NBP1~I=$,$"$j!"4X?tL>$r;XDj$7$F!"$3$N%F!<%V% $N index $r<hF@$7$F!"$3$N index $rMQ$$$F!" Ninf Executable $r5/F0$9$k!#

%Q%1%C%H$N%3%^%s%I$O0J2<$NDL$j$G$"$k!#

- **NINF_PKT_REQ_STUB_INFO**
  %G!<%?$H$7$F!"4X?tL> (Ninf Executable L>$G$O$J$$!) $r;XDj$7$F!"4X?t$KBP1~$9$k Ninf Executable $N index $rMW5a$9$k!# Server $O$3$1$KBP$7$F!" **NINF_PKT_RPY_STUB_INFO** %Q%1%C%H$G!"$3$N index $rJV$9!#

- **NINF_PKT_RPY_STUB_INFO**
  **NINF_PKT_REQ_STUB_INFO** $KBP$9$k1~Ez%Q%1%C%H!# arg1 $K index $,3JG<$5$1$F$*$j!"%G!<%?It$K$O xdr 7A<0 $N %$%s%?!<%U%'%$%9$rJV$9!#

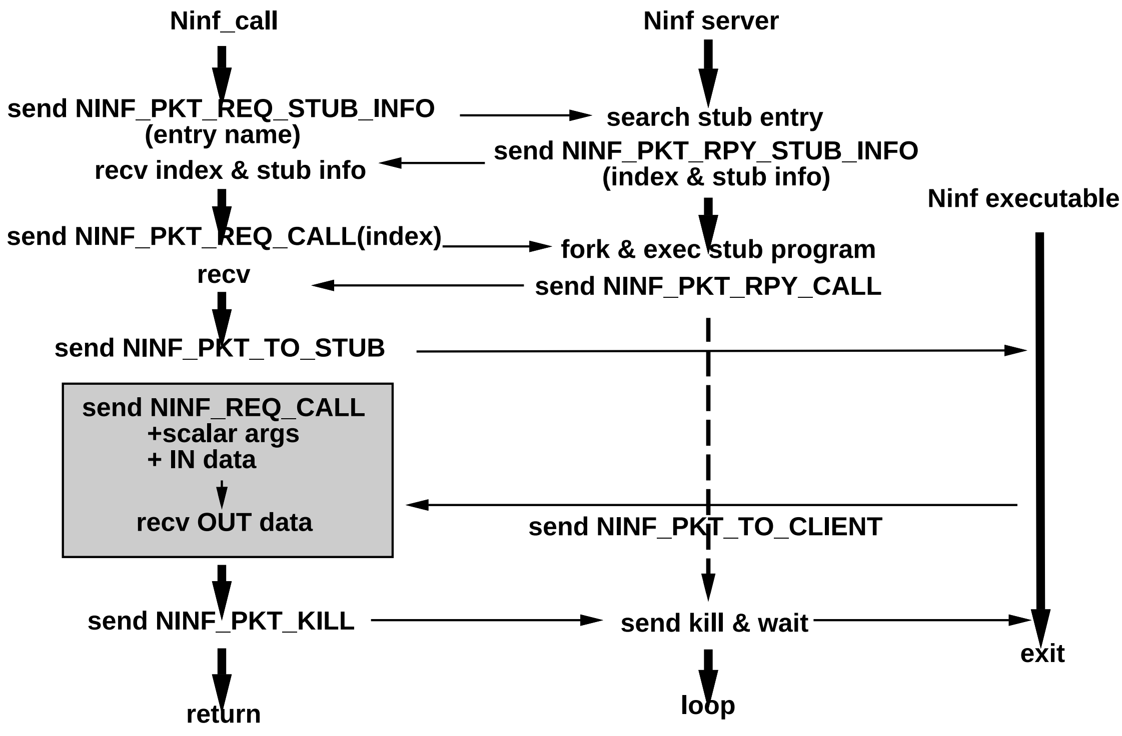
---

[2] Be$o$j$K sockpair $rMQ$$$?<BAu$b9T$J$C$F$$$k!#

- NINF_PKT_REQ_CALL
  arg1 $K index $r;XDj$7!"$=$N index $KBP1~$9$k Ninf Executable $r5/F0$9$k!#5/F0$K@.8y$9$1$P!" NINF_PKT_R
  $rJV$9!#
- NINF_PKT_RPY_CALL
  NINF_PKT_REQ_CALL $,@.8y$7$?$3$H$rDLCN$9$k!#
- NINF_PKT_KILL
  5/F0$5$1$F$$$k Ninf Executable $r=*N;$5$;$k!#JVEz%Q%1%C%H$O$J$$!#
- NINF_PKT_TO_STUB
  $3$N%Q%1%C%H$N%G!<%?$r!"8=:_$K5/F0$5$1$F$$$k Ninf Executable $KAw$k!#
- NINF_PKT_TO_CLIENT
  $3$N%Q%1%C%H$N%G!<%?$,!"5/F0$5$1$F$$$k Ninf Executable $+$i!" client $KBP$9$k%G!<%?$G$"$k$3$H$r<($9!
- NINF_PKT_ERROR
  request %Q%1%C%H$,%(%i!<$G$"$C$?$3$H$r<($9!#

%/%i%$%"%s%H%W%m%0%i%`$H Ninf Executable $NDL?.$O$3$N%1%Y%k$N%W%m%H%3%k$KKd$a9~$s$G9T$J$&!#%/%i%$% %H%W%m%0%i%`$+$i Ninf Executable $X$NDL?.$O NINF_PKT_TO_STUB %Q%1%C%H$KKd$a9~$^$l$k!# Ninf Server $O$3$N %Q%1%C%H$N%X%C%@$r<h$j30$7!"Cf?H$r Ninf Executable $X$N%9%H%j!<%`$KN.$9!# Ninf Executable $+$i%/%i%$%"%s% %W%m%0%i%`$X$NDL?.$O!" NINF_PKT_TO_CLIENT $KKd$a9~$^$l$k!# Ninf Server $, Ninf Executable $+$i$N%9%H%j!< %`$r@Z$j$o$1!"%X%C%@$r$D$1$F NINF_PKT_TO_CLIENT $N%Q%1%C%H$H$7$F%/%i%$%"%s%H%W%m%0%i%`$XAw?.$9$k!#

?^ 4$K!" remote client Ninf_call $N35MW$r<($9!#




?^ 4: Ninf RPC $NMQ$$$k%W%m%H%3%k

## 5.3 Ninf Server 4IM}%W%m%H%3%k

Ninf_call $G$O!"EPO?$5$1$F$$$k4X?t$NL>A0 (entry name $H module name?) $rMQ$$$F!"8F$S=P$9$3$H$,$G$- $k!#$=$N$?$a$K!" Ninf server $G$O!"$=$N4X?tL>$H Ninf Executable $NBP1~I=$rJ];}$7$F$$$k!#

Ninf server $G$O!" Unix domain $N local socket /tmp/ninf.register $rMQ$$$F!"4IM}%W%m%0%i%`$H$NDL?.$r 9T$C$F!" Ninf Executable $NEPO?$r9T$C$F$$$k!#$=$N%W%m%H%3%k$O!"8GDjD9$N%Q%1%C%H$rMQ$$$k!#$3$N%W%m%H%3 %m!<%+%k$K$7$+MQ$$$i$1$J$$$?$a!" xdr $rMQ$$$F$$$J$$!#

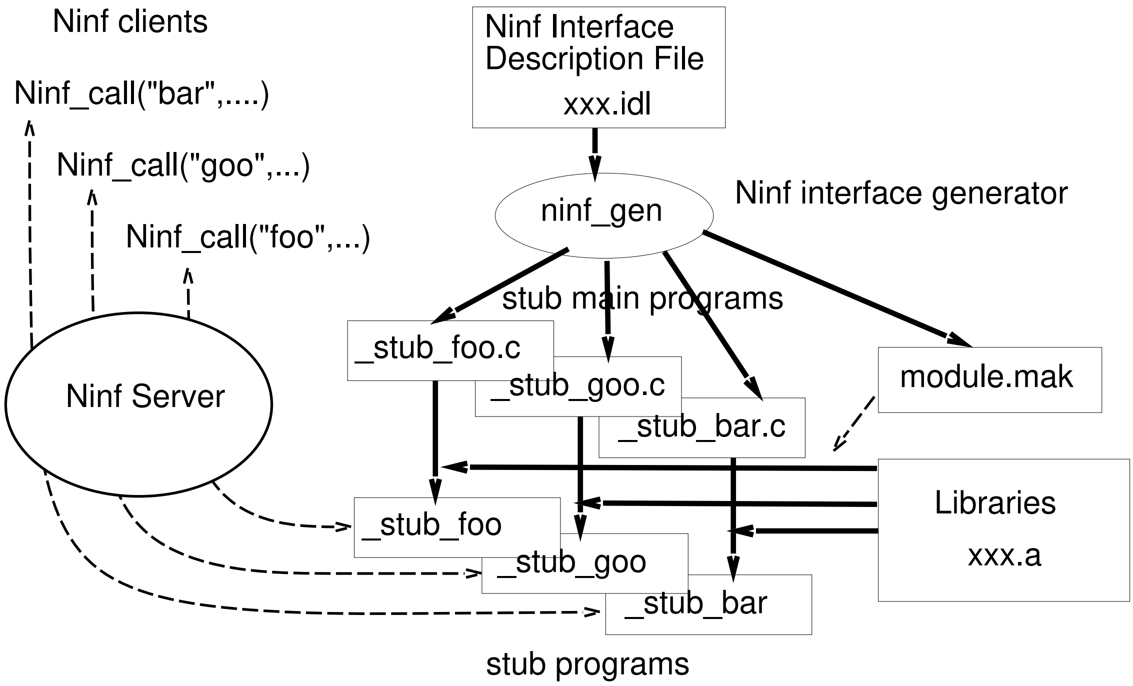
Ninf server 4IM}%W%m%H%3%k$K$O0J2<$N<oN`$N%Q%1%C%H$,$"$k!#

- **NINF_REG_ENTER_STUB**
  %G!<%?It$K;XDj$5$1$? Ninf Executable $rEPO?$9$k!#6qBNE*$K$O!" Ninf Executable $r01EY5/F0$7!"%$%s%?!<
  %U%'%$%9$r<hF@$7!"$=$NL>A0$H program $rBP1~I=$KEPO?$9$k!#
- **NINF_REG_REMOVE_STUB** (not implemented yet)
  %G!<%?It$K;XDj$5$1$?4X?tL>$r:o=|$9$k!#
- **NINF_REG_STOP** (not implemented yet)
  Ninf Server $rDd;_$9$k!#

# 6 Ninf Interface Definition Langage $H Stub generator

## 6.1 IDL %U%!%$%k$NLr3d $H IDL $N@_7WJ}?K

Ninf $G$O!"?tCM1i;;%i%$%V%i%j$r3+H/<T$N<B9T4D6-$G$=$N$^$^Ds6!$7$F$b$i$&$3$H$rL\I8$H$7$F$$$k!#$3$
$K$O!"%i%$%V%i%jDs6!<T$K$H$C$F!"%i%$%V%i%j$r Ninf 2=$9$k$3$H$,==J,$KMF0W$G$J$1$l$P$J$i$J$$!# IDL %U%
$H stub generator $O$3$N2aDx$r;Y1g$9$k$b$N$G$"$k!#?tCM1i;;%i%$%V%i%j:n@.<T$K%i%$%V%i%j$N%$%s%?!<%U%'%
$d!"I,MW$J%*%V%8%'%/%H%U%!%$%k!"%i%$%V%i%j$r5-=R$7$F$b$i$$!"$=$l$+$i Ninf 2=$7$?%i%$%V%i%j$r9=C[$9$
I,MW$J %9%?%V$H$=$l$r%3%s%Q%$%k$9$k$N$KI,MW$J %a%$%/%U%!%$%k$r@8@.$9$k!#?^ 5$K Ninf stub generator $NF0:
35MW$r<($9!#




?^ 5: NINF stub generator $NF0:n

IDL $O!"?tCM1i;;%i%$%V%i%j@_7W<T$K5-=R$7$F$b$i$&4X78>e$J$k$Y$/B?$/$N%W%m0i%^$K?F$7$_$d$9$$9=J
MQ$9$kI,MW$,$"$k!#$=$3$G Ninf IDL $O ANSI C $r4pK\$K$7$?%$%s%?!<%U%'%$%95-=R$r:NMQ$7$?!#

## 6.2 IDL $K$h$k5-=R$NFbMF

IDL %U%!%$%k$K$O, 0J2<$N>pJs$,5-=R$5$1$k!#

- %b%8%e!<%kL>
- 3F4X?t$N8F$S=P$7J} (marshaling >pJs)
- %b%8%e!<%kA4BN$N Make $N$?$a$N>pJs!#

- (JLL>$NDj5A)

$3$N5-=R$+$i!" Ninf Procedure $H$N66EO$7$r$9$k %9%?%V$H$=$1$i$r%3%s%Q%$%k$9$k$?$a$N Makefile $r@8@.$9$

$3$N%U%!%$%k$r!" NINF stub generator "ninf_gen" $G=hM}$9$k$3$H$K$h$C$F!"$=$1$>$14X?tDj5A$K1~$8$? %9%?%V$H$=$1$i$r%3%s%Q%$%k$9$k Makefile $r@8@.$9$k$3$H$,$G$-$k!#

```
Usage:          ninf_gen [-d] infile.idl
```

(-d $O%G%P%C%/%*%W%7%g%s)
3F Ninf Executable $O!" Ninf_call $KBP$7$F!" Ninf sever $K$h$j5/F0$5$1!"3F%i%$%V%i%j4X?t$r<B9T$9$k!#

## 6.3 Ninf IDL $N9=J8

Ninf IDL $K$h$k5-=R$O0J2<$NMWAG$+$i$J$k!#

- **Module** name ';'
  $3$N%U%!%$%k$K5-=R$5$1$k4X?t72$K%b%8%e!<%kL>$rM?$($k!# ninf_gen $G$O!" ¡module L>¿.mak $H$$$& Make-file $r:n$k!#

- **CompileOptions** '"'....'"' ';'
  Makefile $G9T$o$J$/$F$O$J$i$J$$Dj5A!"$=$NB>$rM?$($k!#

- **Library** '"'....'"' ';'
  3F4X?t$K6&DL$K%j%s%/$9$k%*%V%8%'%/%H%U%!%$%k!"%i%$%V%i%j$r;XDj$9$k!#

- **Globals** '{ ' ... C descriptions ... '}'
  3F4X?t$K6&DL$N global JQ?tEy$r@k8@$9$k!#

- **Define** ninf-name '('paramter1, paramter2, ....')' [ '"' description '"' ] [ **Required** '"' files-or-libs '"'] { '{' C descriptions '}' | **Calls** lang-spec function-name '(' arg1,arg2, ...')"';'}
  4X?t$N%$%s%?%U%'!<%9$J$i$S$KI,MW$H$9$k%U%!%$%k$d%i%$%V%i%j$rDj5A$9$k!#%$%s%?%U%'!<%9$N5-=R$KI
  parameter $N5-=R$O:

  [mode-spec] [type-spec] param-name [ [dimension [: range] ][[...]...]]

  $H5-=R$9$k!# type-spec $O%Q%i%a!<%?$N%?%$%W!" mode-spec $G$OF~NO$+=PNO$+$r;XDj$9$k (mode_in, mode_out, mode_inout)!# OUT %Q%i%a!<%?$OG[Ns$G$O$J$/$F$O$J$i$J$$!#

  G[Ns$NMWAG?t$r;XDj$9$k dimension $K$O!";;=Q<0$,5-=R$G$-$k!#;HMQ$G$-$k1i;;;R$O!" +,−,*,/,% $G$"$k 1i;;;R$NM%@h=g0L$O C $K=`5r$9$k!#3g8L$r;HMQ$7$FM%@h=g0L$rJQ99$9$k$3$H$b$G$-$k!# dimension $GMQ$ $1$kJQ?t$O!" IN %Q%i%a!<%?$G$+$DG[Ns$G$J$$$b$N$G$J$1$1$P$J$i$J$$!#

  G[Ns$K$O!"NN0h$r;XDj$9$k$3$H$,$G$-$k!#NN0h$K$O>e8B!"2<8B!"%9%F%C%W$r;XDj$9$k!#%9%F%C%W!"2<8B$ $>$1>JN,$9$k$3$H$b2DG=$G$"$k!#$3$1$i$NCM$K$O dimension $HF1MM$K;;=Q<0$r=q$/$3$H$,2DG=$G$"$k

  ;;=Q<0$O!"5U%]!<%i%s%I5-K!$K%3%s%Q%$%k$5$1!"%$%s%?!<%U%'%$%9$N0lIt$H$J$k!#%9%?%V$N%i%$%V%i%j$ %$%"%s%H$N%i%$%V%i%j$O$3$N5-K!$r2r<a$9$k4JC1$J%$%s%?!<%W%j%?$r;}$C$F$$$k!#$3$N%$%s%?!<%W%j%?$ $K;;=Q<0$r2r<a$9$k$3$H$G!"F0E*$KE>AwNL$,JQ2=$9$k%"%W%j%1!<%7%g%s$KBP1~$7$F$$$k!#

Appendix A. $K Ninf IDL $N40A4$J%7%s%?%C%/%9$r!" Appendix B. $K Ninf IDL $K$h$k%9%/%j%W%H$N%5%s%W%k $H!"$=$1$K Ninf stub generator $rE,MQ$9$k$3$H$GF@$i$1$k%a%$%/%U%!%$%k$H%9%?%V$N0lIt$r<($9!#

# 7 $*$o$j$K

K\9F$G$O!" Ninf RPC %7%9%F%`$N@_7W$H TCP/IP >e$N<BAu$K$D$$$F$N$Y$?!# Ninf RPC $O!"F0E*$K%$%s%?!<%U% %$%9>pJs$rE>Aw$7!"E>AwNL$rF0E*$K;;=P$9$kOHAH$rM?$($k!#$3$1$K$h$j=>Mh$N RPC $rMQ$$$F$OIT2DG=$G$"$C$ $rJ,;62=$9$k$3$H$,2DG=$K$J$C$?!#

:#8e$N2]Bj$H$7$F$O!"0J2<$N$3$H$,9M$($i$1$k!#

- %/%i%$%"%s%H!&%5!<%P4VDL?.$N UDP 2=
  UDP $G<BAu$9$k$3$H$K$h$j!":FAw$N%a%+%K%:%`$r:GE,2=$9$k$3$H$,2DG=$H$J$j!"DL?.@-G=$N8~>e$,8+9~$a
  8=:_$N<BAu$G$O%/%i%$%"%s%H!&%5!<%P4V$NDL?.$O TCP/IP >e$G$O$"$k$,!"2>A[E*$K$O%Q%1%C%H$rMQ$$$F$*
  MF0W$K UDP 2=$9$k$3$H$,2DG=$@$H;W$o$l$k!#

- %O!<%H!&%S!<%H$N<B8=
  J,;67W;;$N0l$D$NLdBj$H$7$F!"@\B3$N@ZCG$N8!=P$,$"$k!# UNIX RPC $G$O%?%$%`%"%&%H$r$b$A$$$F!":F<
  $r9T$J$C$F$$$k!# Ninf $N<g$JBP>]$G$"$k?tCM1i;;$K$*$$$F$O!"7W;;$KHs>o$K;~4V$,$+$+$j!"$7$+$b7W;;
  $,M=8+$G$-$J$$$3$H$,B?$$$?$a!"C1=c$J%?%$%`%"%&%H$rMQ$$$k$3$H$O$G$-$J$$!#$3$N$?$a$N<jK!$H$7$F!
  %H!&%S!<%H$H$$$&<jK!$,$"$k!#$3$l$O!"7W;;%k!<%A%s$,0lDj;~4V$4$H$KFC<l$J%Q%1%C%H$r%/%i%$%"%s%H$
  J}K!$G$"$k!#%/%i%$%"%s%H$O0lDj;~4V0J>e%Q%1%C%H$,Mh$J$1$l$P!"@\B3$,@ZCG$5$l$?$HH=CG$9$k$3$H$,$
  8=:_$O$3$N<jK!$O%$%s%W%j%a%s%H$5$l$F$$$J$$!#

<U<-

K\8&5f$O;XDj8&5f!V8&5f>pJs4pHW@0Hw8&5f3+H/@)EY“9-0hJ,;6>pJs%Y!<%9%7%9%F%‘”$N0l4D$H$7$F<B;\$7$F
F|:"$h$j$4;Y1g$$$?$@$/EE;R5;=QAm9g8&5f=j Bg<,OB?N4k2h<<D9$K46<UCW$7$^$9!#$^$?!" Ninf %_!<%F%#%s%0$K$
G.?4$KF$O@D:$/$*Cc$N?e=w;RBg3X M}3XItD9Eh1@J<=u65<x!"El5~Bg3X 9)3XIt >>2, Ao 9V;U!$IY;NAm9g8&5f=j @>@
8&5f0w $J$i$S$K3X@8=t;a$K46<UCW$7$^$9!#

## Appendix A: Ninf IDL Syntax

```
/* program toplevel */
program:  /* empty */
      | declaration_list
    ;

declaration_list:
      declaration
    | declaration_list declaration
    ;

declaration:
      ‘‘Module’’ IDENTIFIER ’;’
    | ‘‘FortranFormat’’ STRING ’;’
    | ‘‘CompileOptions’’ STRING ’;’
    | ‘‘Globals’’ globals_body
    | ‘‘Define’’ interface_definition opt_string required interface_body
    ;

interface_definition:
        IDENTIFIER ’(’ parameter_list ’)’
    ;

parameter_list:
       parameter
    | parameter_list ’,’ parameter
    ;

parameter:
       decl_specifier declarator
    ;

decl_specifier:
    type_specifier
    | MODE
    | MODE type_specifier
    | type_specifier MODE
    | type_specifier MODE type_specifier
    ;

type_specifier:
      TYPE
    | TYPE TYPE
    | TYPE TYPE TYPE    /* ex. unsigned long int */
      | TYPENAME
    ;
```

```
declarator:
      IDENTIFIER
    | '(' declarator ')'
    | declarator '['expr_or_null ']'
    | declarator '['expr ':' range_exprs ']'
    | '*' declarator
    ;

range_exprs:
       expr     /* upper limit */
     | expr ',' expr    /* lower limit and upper limit */
     | expr ',' expr ',' expr /* lower, upper and step */

opt_string:
    /* empty */
    | STRING
    ;

required:
    /* empty */
    | ``Required'' STRING
    ;

interface_body:
    '{' /* C statements */ '}'
    | ``Calls'' opt_string IDENTIFIER '(' id_list ')' ';'
    ;

globals_body:
    '{'/* C statements */ '}'
    ;

id_list: IDENTIFIER
    | id_list ',' IDENTIFIER
    ;

/* index descrition */
expr_or_null:
       expr
    | /* null */
    ;

expr:
      unary_expr
    | expr '/' expr
    | expr '%' expr
    | expr '+' expr
    | expr '-' expr
    | expr '*' expr
    ;

unary_expr:
      primary_expr
    | '*' expr
    | '-' expr
    ;

primary_expr:
     primary_expr '[' expr ']'
    | IDENTIFIER
    | CONSTANT
    | '('  expr  ')'
    ;

/* TYPE = int, unsigned, char, short, long, float, double */
/* MODE = mode_in, mode_out, mode_inout, mode_work, IN, OUT, INOUT, WORK*/
/* TYPENAME $O$^$@%5%]!<%H$5$l$F$$$J$$ */
/* IDENTIFER = L>A0 */
/* CONSTANT = @0?t!"IbF0>.?tE@?t */
/* STRING = "..." */
```

## Appendix B: Ninf IDL Sample

sample.idl:

```
Module sample;
Library "-lm";

Globals { int x,y,z; }

Define sin(IN double d, OUT double result[])
" This is test ..."
{
    double sin();
    *result = sin(d);
}

Define mmul(long mode_in int n, mode_in double A[n][n],
    mode_in double B[n][n],
    mode_out double C[n][n])
Required "sample.o"
Calls "C" mmul(n,A,B,C);

Define mmul2(long mode_in int n, mode_in double A[n*n+1-1],
        mode_in double B[n*n+2-3+1],
        mode_out double C[n*n])
Required "sample.o"
Calls "C" mmul(n,A,B,C);


Define FFT(IN int n,IN int m, OUT float x[n][m], float INOUT y[m][n])
Required "sample.o"
Calls "Fortran" FFT(n,x,y);
```

sample.mak:

```
# This file 'sample.mak' was created by ninf_gen. Don't edit

# CompileOptions:

# stub sources
NINF_STUB_SRC = _stub_sin.c  _stub_mmul.c  _stub_FFT.c

# stub programs
NINF_STUB_PROGRAM = _stub_sin _stub_mmul _stub_FFT

all: $(NINF_STUB_PROGRAM)

_stub_sin:
    $(CC) $(LDFLAGS) -o _stub_sin _stub_sin.c ninf_stub_lib.a  -lm

_stub_mmul:
    $(CC) $(LDFLAGS) -o _stub_mmul _stub_mmul.c ninf_stub_lib.a sample.o -lm

_stub_mmul2:
    $(CC) $(LDFLAGS) -o _stub_mmul2 _stub_mmul2.c ninf_stub_lib.a sample.o -lm

_stub_FFT:
    $(CC) $(LDFLAGS) -o _stub_FFT _stub_FFT.c ninf_stub_lib.a sample.o -lm


clean:
    rm $(NINF_STUB_PROGRAM)

# END OF Makefile
```

_stub_mmul2.c:

```
/* _stub_mmul2.c : generated by ./ninf_gen, don't edit. */
#include "ninf_stub.h"

NINF_STUB_INFO ninf_stub_info = {
0,0,0,  "sample","mmul2",4,
{
        { 5, 1, 0,},
        { 13, 1, 1,{
                { 3, 2,
                        {
                          {2,2,4,1,4,1,4,5,0,0,0,0,0,0,0,0,0,0,0,0,0,},
                          {0,0,3,1,1,1,2,0,0,0,0,0,0,0,0,0,0,0,0,0,0,}
```

```
                        },
                  0, 0,
                        {
                          {0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,},
                          {0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,}
                        },
                  0, 0,
                        {
                          {0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,},
                          {0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,}
                        },
                  0, 0,
                        {
                          {0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,},
                          {0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,}
                        },
                },
                }},
        { 13, 1, 1,{
                { 3, 1,
                        {
                          {2,2,4,1,4,1,4,1,4,5,0,0,0,0,0,0,0,0,0,0,},
                          {0,0,3,2,1,3,2,1,1,0,0,0,0,0,0,0,0,0,0,0,}
                        },
                  0, 0,
                        {
                          {0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,},
                          {0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,}
                        },
                  0, 0,
                        {
                          {0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,},
                          {0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,}
                        },
                  0, 0,
                        {
                          {0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,},
                          {0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,}
                        },
                },
                }},
        { 13, 2, 1,{
                { 3, 3,
                        {
                          {2,2,4,5,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,},
                          {0,0,3,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,}
                        },
                  0, 0,
                        {
                          {0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,},
                          {0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,}
                        },
                  0, 0,
                        {
                          {0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,},
                          {0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,}
                        },
                  0, 0,
                        {
                          {0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,},
                          {0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,}
                        },
                },
                }},
}
};

/* Globals */
 int x,y,z;

/* Stub Main program */
main(argc,argv){
        long n;
        double *A;
        double *B;
```

```
        double *C;

        Ninf_stub_INIT(argc,argv);
        while(Ninf_stub_REQ()){
                Ninf_stub_SET_ARG(&n,0);
                Ninf_stub_SET_ARG(&A,1);
                Ninf_stub_SET_ARG(&B,2);
                Ninf_stub_SET_ARG(&C,3);
                mmul(n,A,B,C);
                Ninf_stub_END();
        }
        Ninf_stub_EXIT();
}
 /* END OF Stub Main */
```

;29MJ88%


[1] 4X8}CR;L, :4F#;05W, D9Eg1@J<. %M%C%H%o!<%/?tCM>pJs%i%$%V%i%j: - ninf $N@_7W -. >pJs=hM}3X2q8&5fJs9p *HP*
Vol. 94, No. 94-HPC-52, pp. 127, 1994.

[2] HS2,H~7C, ?75oM32B;R, D9Eg1@J<, 4X8}CR;L, :4F#;05W, >>2,Ao, :YLp<#IW. %M%C%H%o!<%/?tCM>pJs%i%$%V%i%j
$NDL?.J}K!$NM=HwE*9M;!. >pJs=hM}3X2q8&5fJs9p *HPC*, Vol. 95, No. 28-HPC-55, pp. 81–88, march 1995.