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Ninf Project

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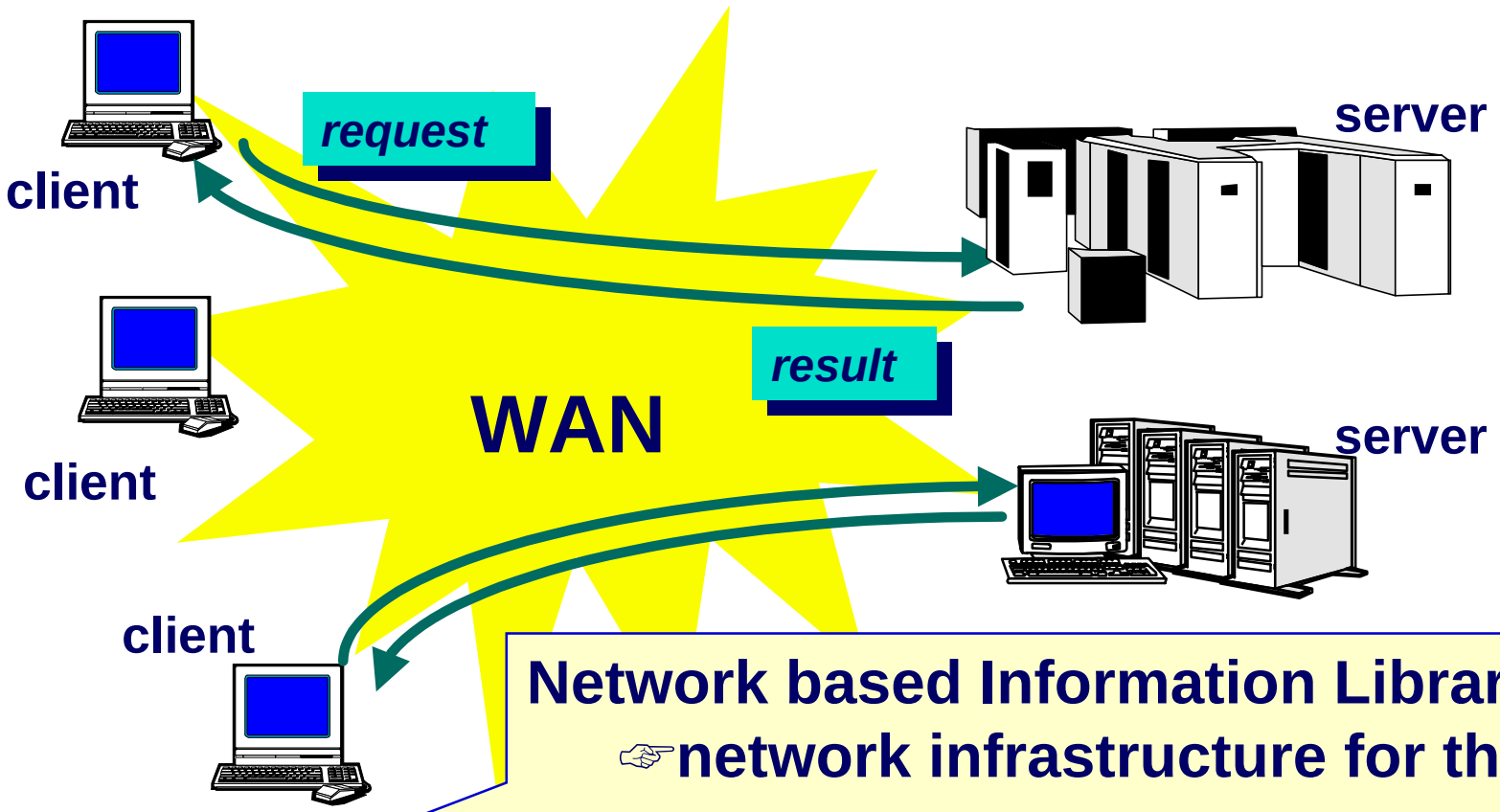
URL: http://ninf.etl.go.jp

Towards Global Computing

- **Rapid increase in speed and availability of WAN enables:**
  - **sharing distributed data resources**
    - ☞**email, file archives, WWW**
  - **sharing distributed computational power**
    - ☞**“Grid”, Global Computing**

Starting Grid / global computing projects

Global Computing



Network based Information Library

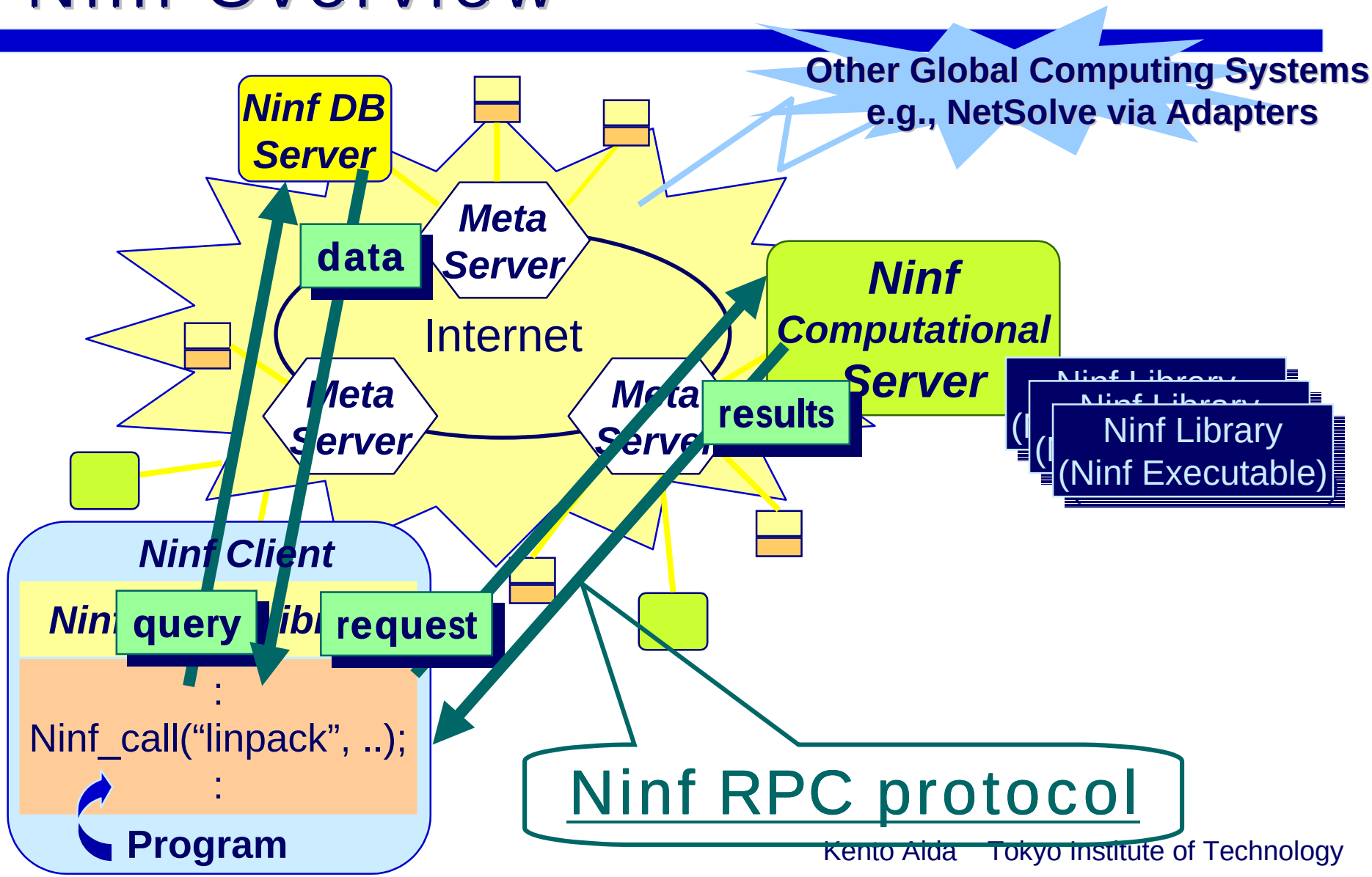
- ☞**network infrastructure for the “Grid”**
- ☞**RPC based system**

❍Ninf, **NetSolve, RCS, Legion, Javelin, Globus,...**

Outline

- overview of Ninf system
  - Ninf RPC protocol
  - Client API
  - Providing Ninf library program
- applications
- scheduling
  - Metaserver
  - Bricks
- conclusions

Ninf Overview



Ninf Overview (cont'd.)

- **Ninf server + Ninf RPC protocol**

  transparent execution of Ninf library program on computational server

- **Ninf database server**

  direct query on accurate constant database

- **Ninf Client Interface**

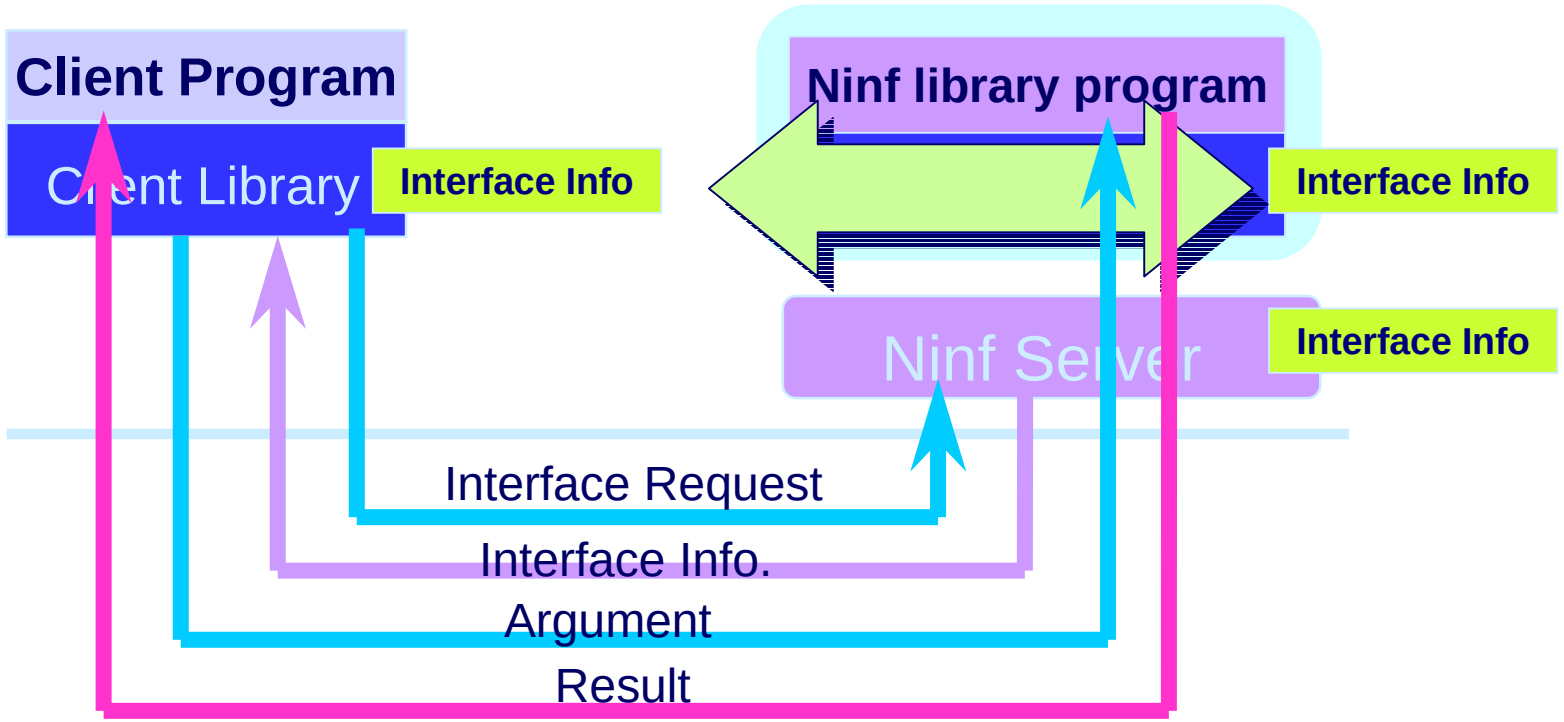
  easy-to-use programming interface

- **Ninf Metaserver**

  scheduling of computation, asynchronous and automatic parallel computation,

Ninf RPC Protocol

- **Exchange interface information at run-time**
  - No need to generate client stub routines (cf. SunRPC)
  - No need to modify a client program when server's libraries are updated.

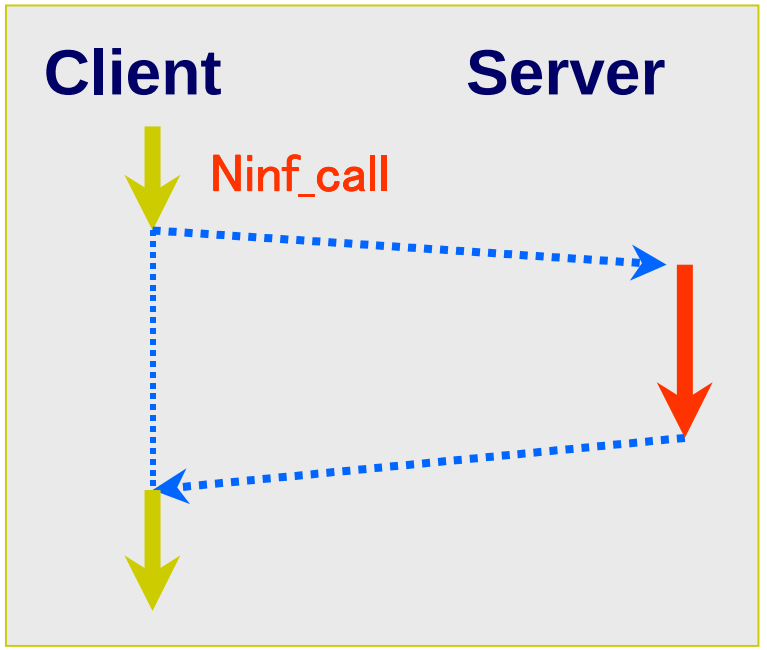


Ninf Client API

- A client user only needs to specify the name of libraries to invoke.

```
Ninf_call("ninf://HOST:PORT/ENTRY_NAME", arg,...)
```

- Implemented API:
  - C, C++, Fortran, Java,
  - Lisp …,Mathematica,
  - Excel,...



Ninf Client API (cont'd.)

- **Example**

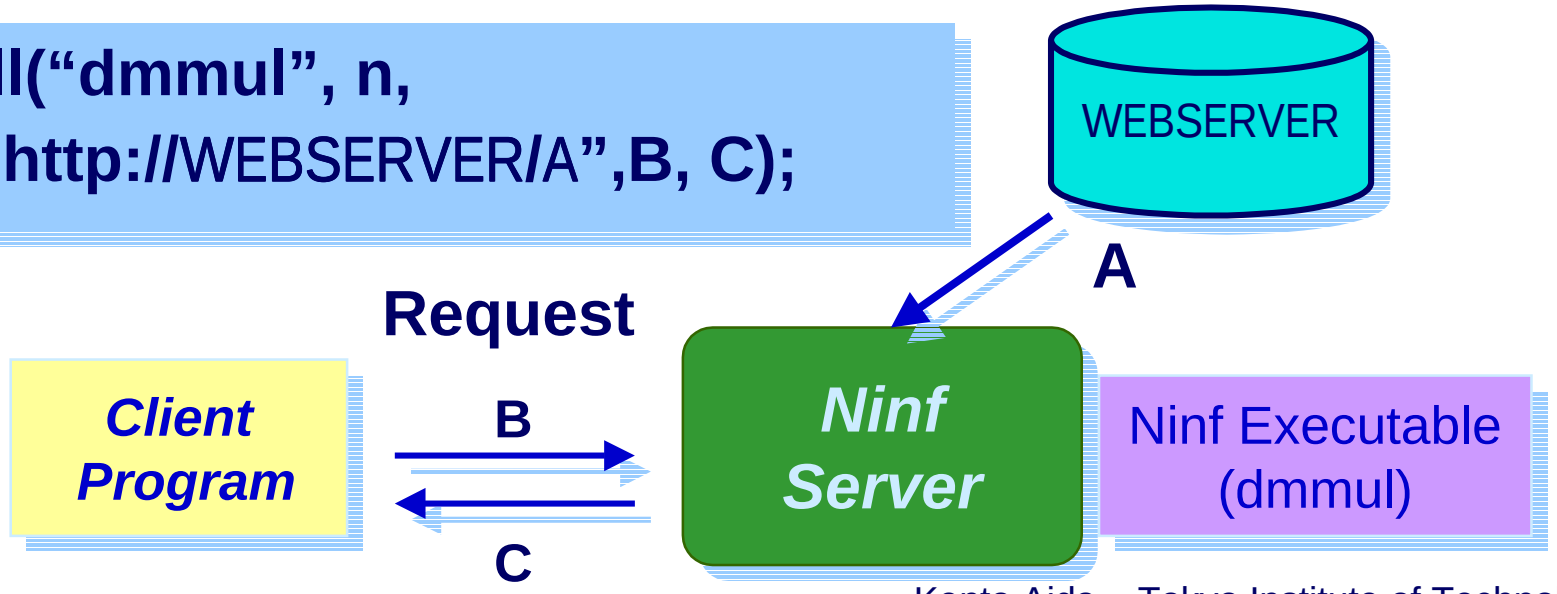
```
double A[n][n],B[n][n],C[n][n];  /* Data Decl.*/
:
dmmul(n,A,B,C);                  /* Call local function*/
```


```
double A[n][n],B[n][n],C[n][n];   /* Data Decl.*/
:
Ninf_call("dmmul",n,A,B,C);       /* Call Ninf Executable*/
```

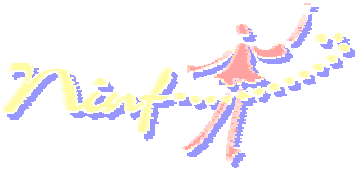
Direct Web Access

- URL can be specified as an argument.
- computation of Ninf library using data on a specified Web server
  - ☞(ex.) important constant for physics or chemistry
- storing interim results to a Web Server

```
Ninf_call("dmmul", n,
        "http://WEBSERVER/A",B, C);
```

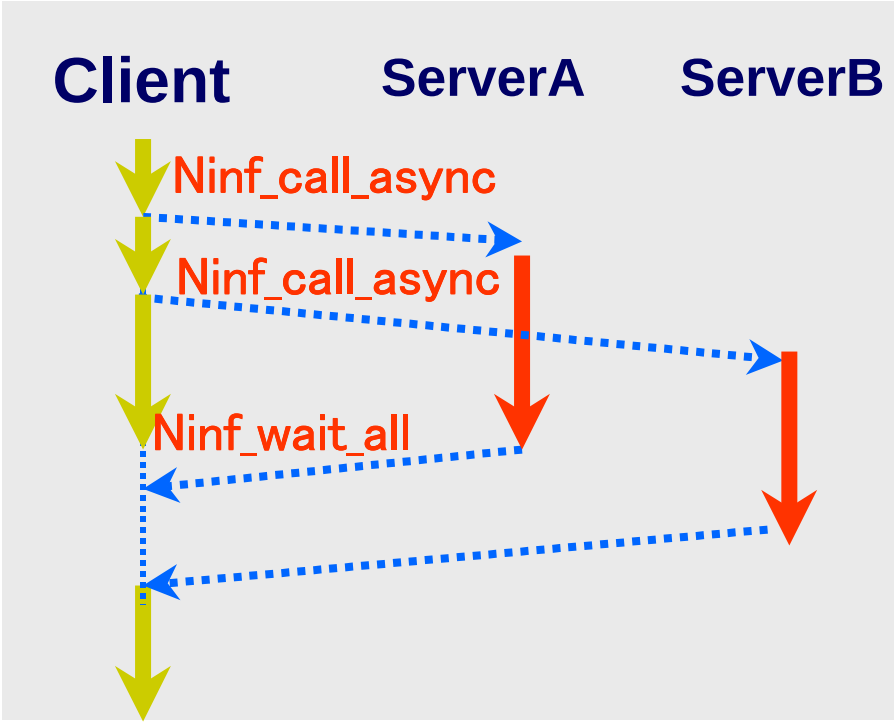


Ninf Client API(2)
- asynchronous call -



Asynchronous Call

```
Ninf_call_async("FUNC", ...);
```



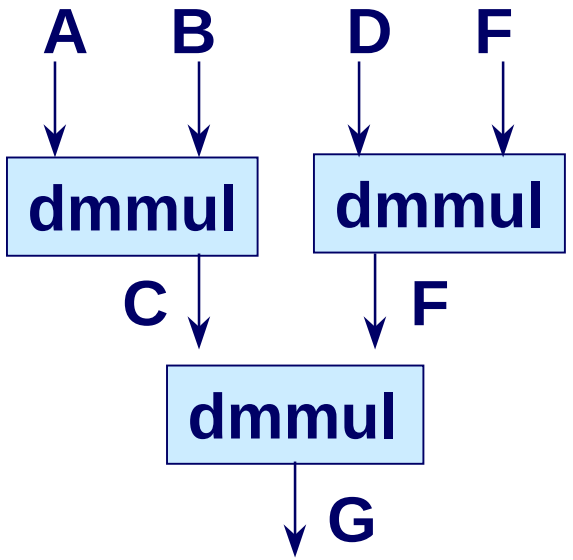
Waiting the reply

```
Ninf_wait(ID);
Ninf_wait_all();
Ninf_wait_and(IDList, len);
Ninf_wait_or(IDList, len);
Ninf_cancel(ID);
```

Ninf Client API(3)
- Transaction-

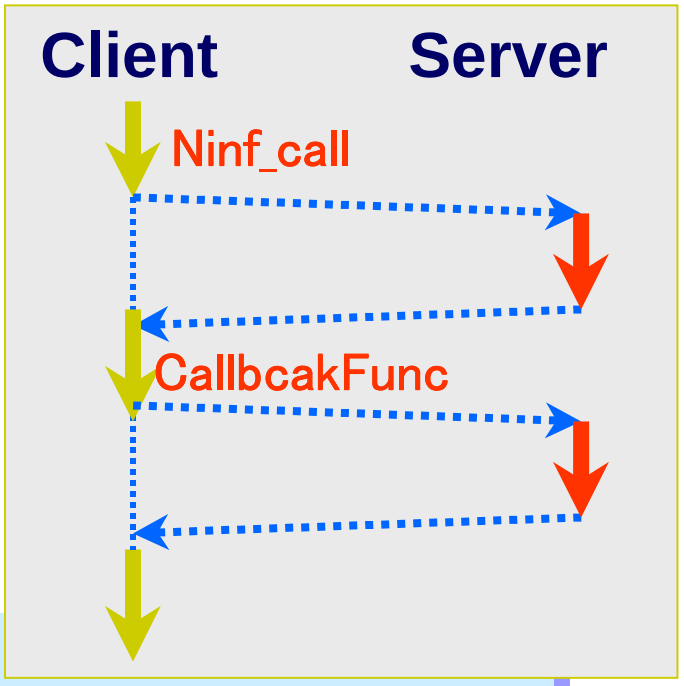
- Aggregate invocation of user specified code region
- Macrodataflow execution by Metaserver

```
Ninf_transaction_start();
Ninf_call("dmmul,n,A,B,C);
Ninf_call("dmmul",n,D,E,F);
Ninf_call("dmmul",n,C,F,G);
Ninf_transaction_end();
```



Ninf Client API(4)
- Callback -

- Server side routine can callback client side routine.
- (ex.) Display of interim results of computation on servers to a client machine




```
void CallbackFunc(...){
    ....    /* define callback routine */
}
Ninf_call("Func", arg .., CallbackFunc);
   /* call with pointer to the function */
```

Providing Ninf Library

(1)Writing interface description for a library (computational) program in Ninf IDL

- ➨ **Ninf IDL file**

(2)Running Ninf interface generator

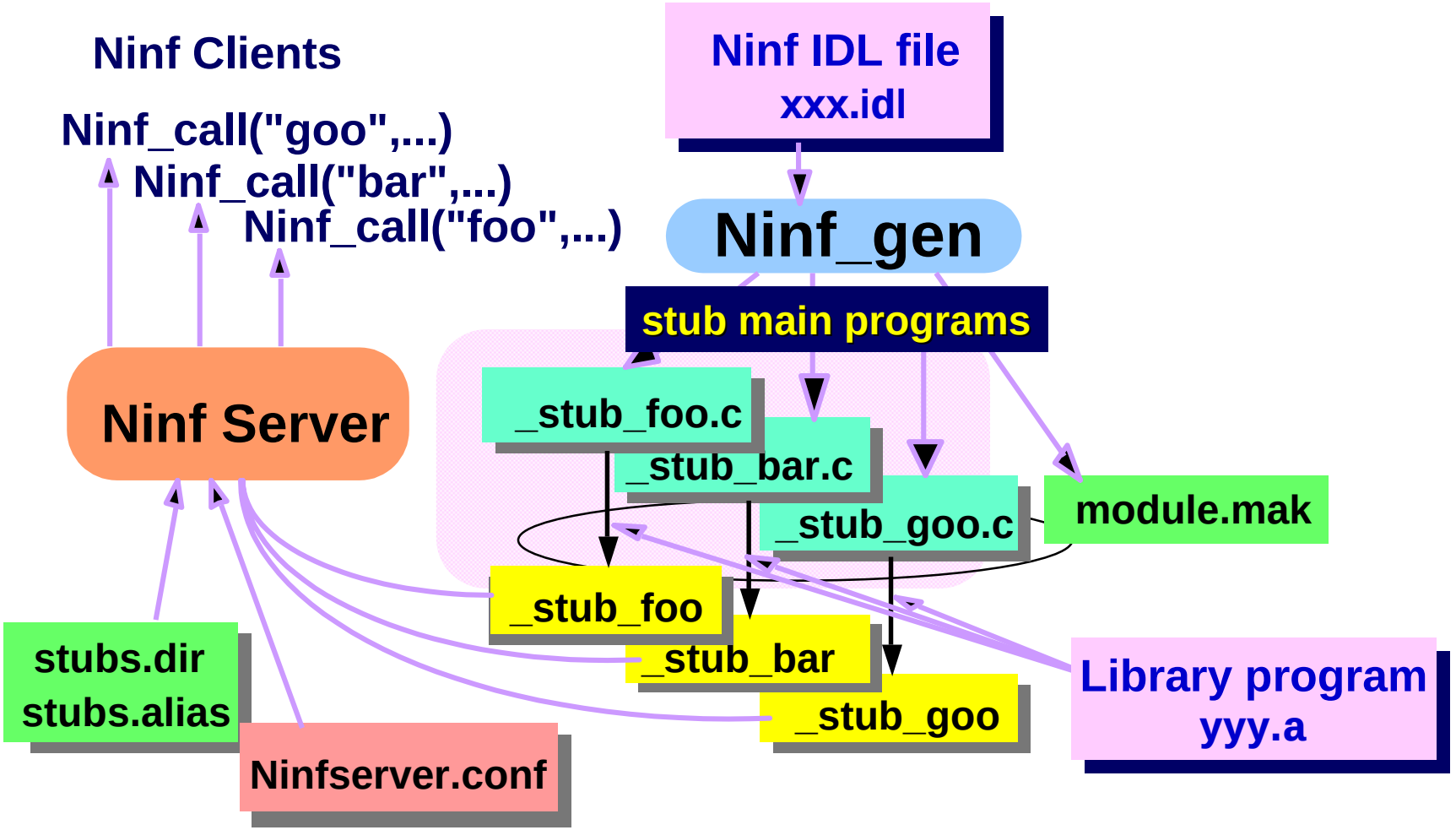
- ➨ **stub programs and Makefile**

(3)Compiling the library program and linking with the stub programs

- ➨ **Ninf executables**

(4)Registering the Ninf executables with Ninf server

Generating Ninf executables



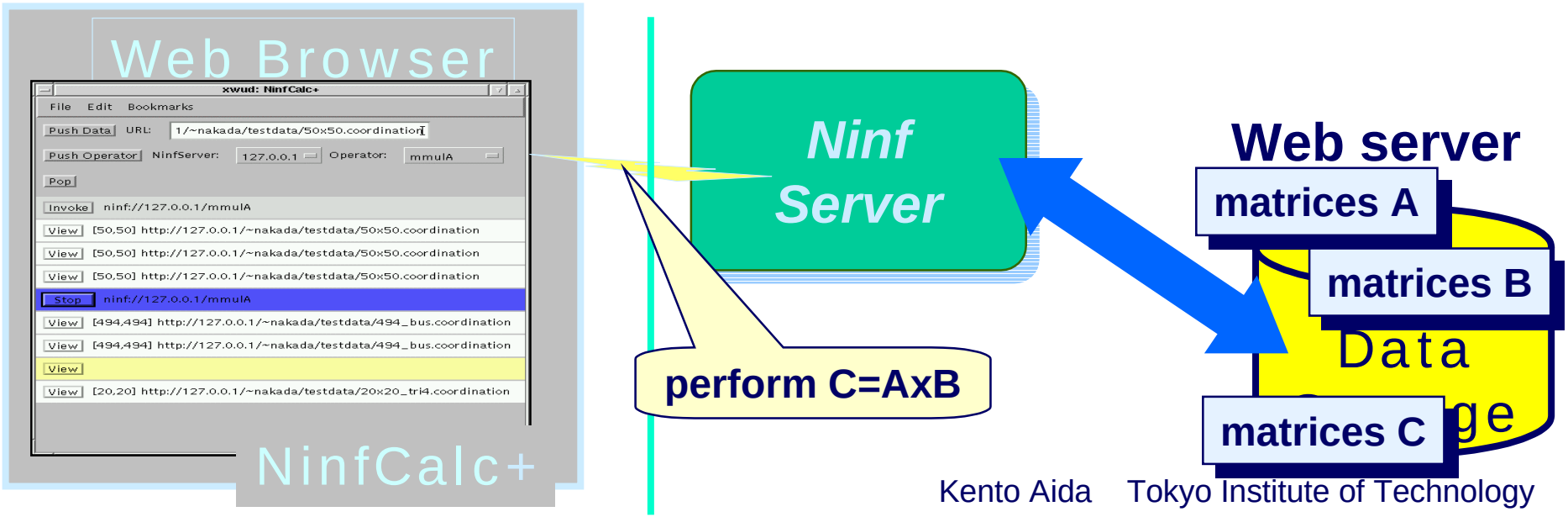
Ninf Interface Description (Ninf IDL)

```
Define dmmul(long mode_in int n,
  mode_in double A[n][n], mode_in double B[n][n],
  mode_out double C[n][n])
" description "
Required "libXXX.o"
CalcOrder n^3
Calls "C" dmmul(n,A,B,C);
```

- IDL information:
  - library function's name, and its alias (Define)
  - arguments' access mode, data type (mode_in, out, inout, ...)
  - required library for the routine (Required)
  - computation order (CalcOrder)
  - source language (Calls)

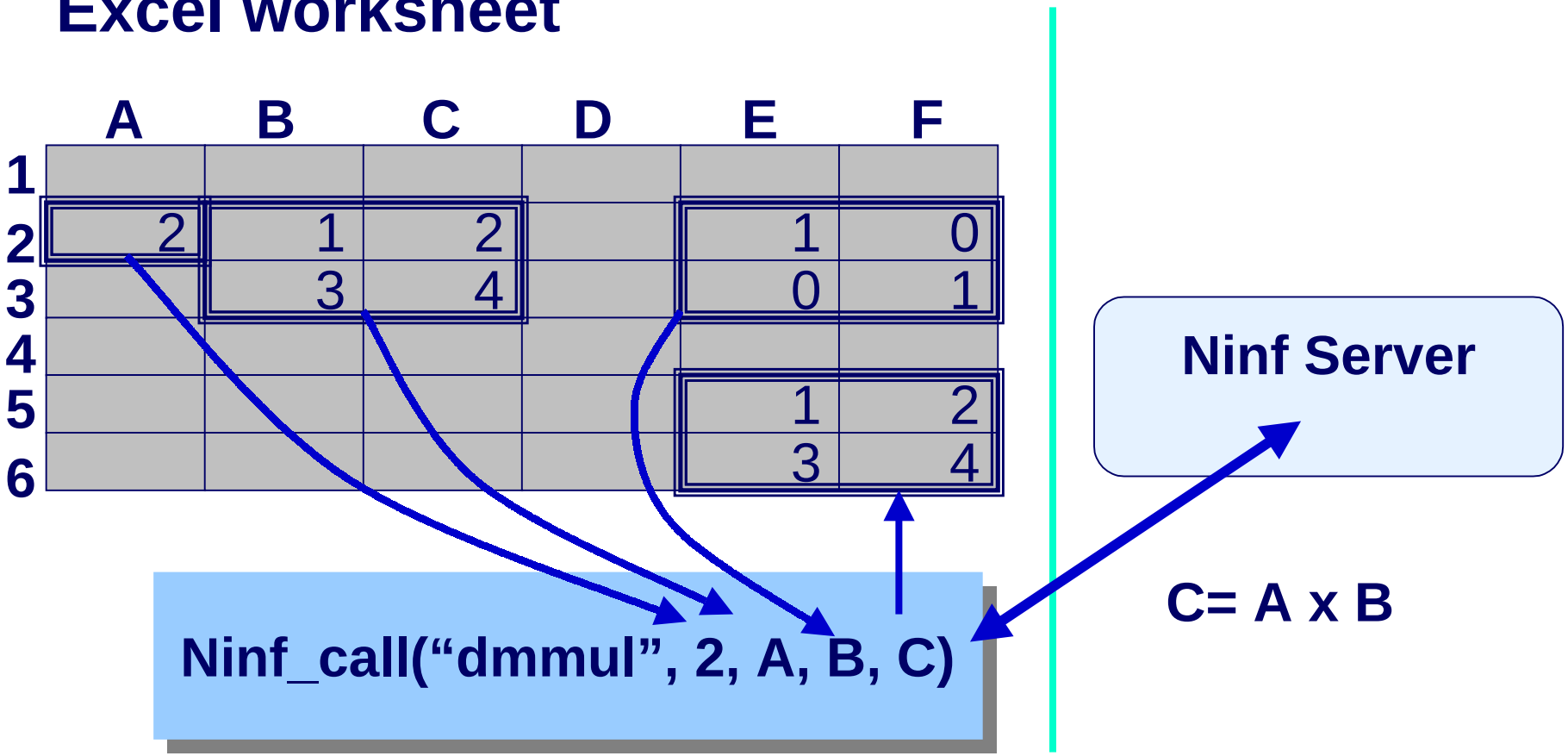
Application on Ninf: NinfCalc+

- **Matrix Calculator implemented as an Applet in browser**
  - **linear system solver, eigen-value problem, …**
  - **click and quick operation**
- **direct Web access**
  - **Huge matrices are stored to Web servers.**
  - **interactive control of huge matrix calculation via thin network**



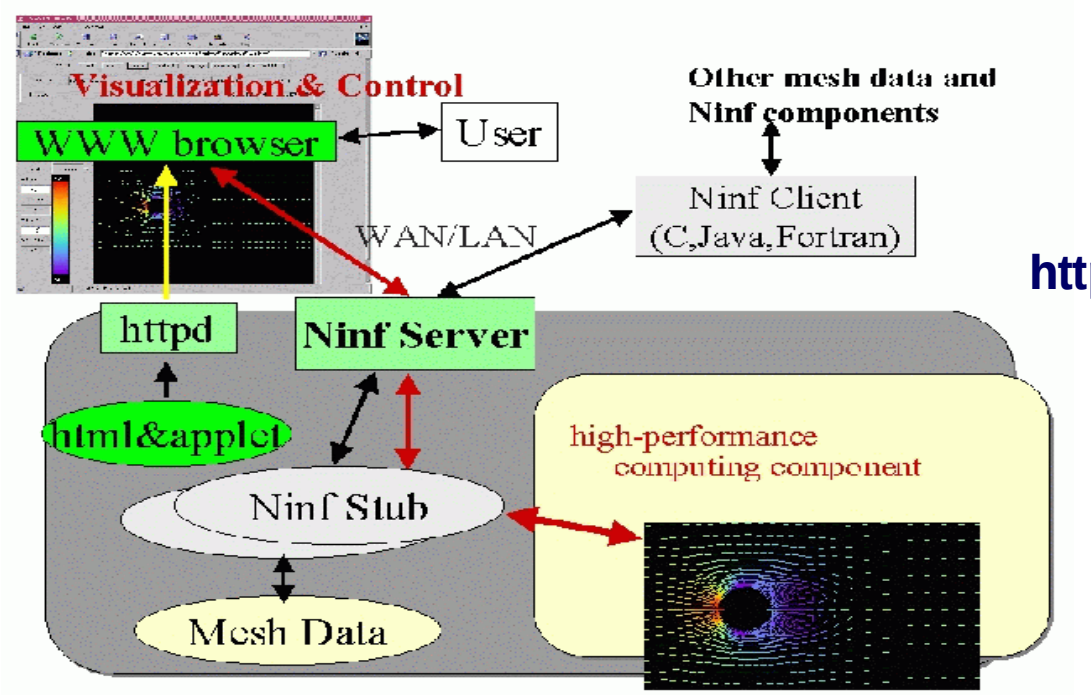
Application on Ninf : Excel Ninf

- **Arguments for Ninf_call are specified on the Excel worksheet**



Application on Ninf : NetCFD

- **Ninf computational component for CFD**
  - **Parallelized CFD program is “ninfied” on Ninf server.**
  - **providing an interface to a parallel CFD program running on MPP, PC cluster,...**

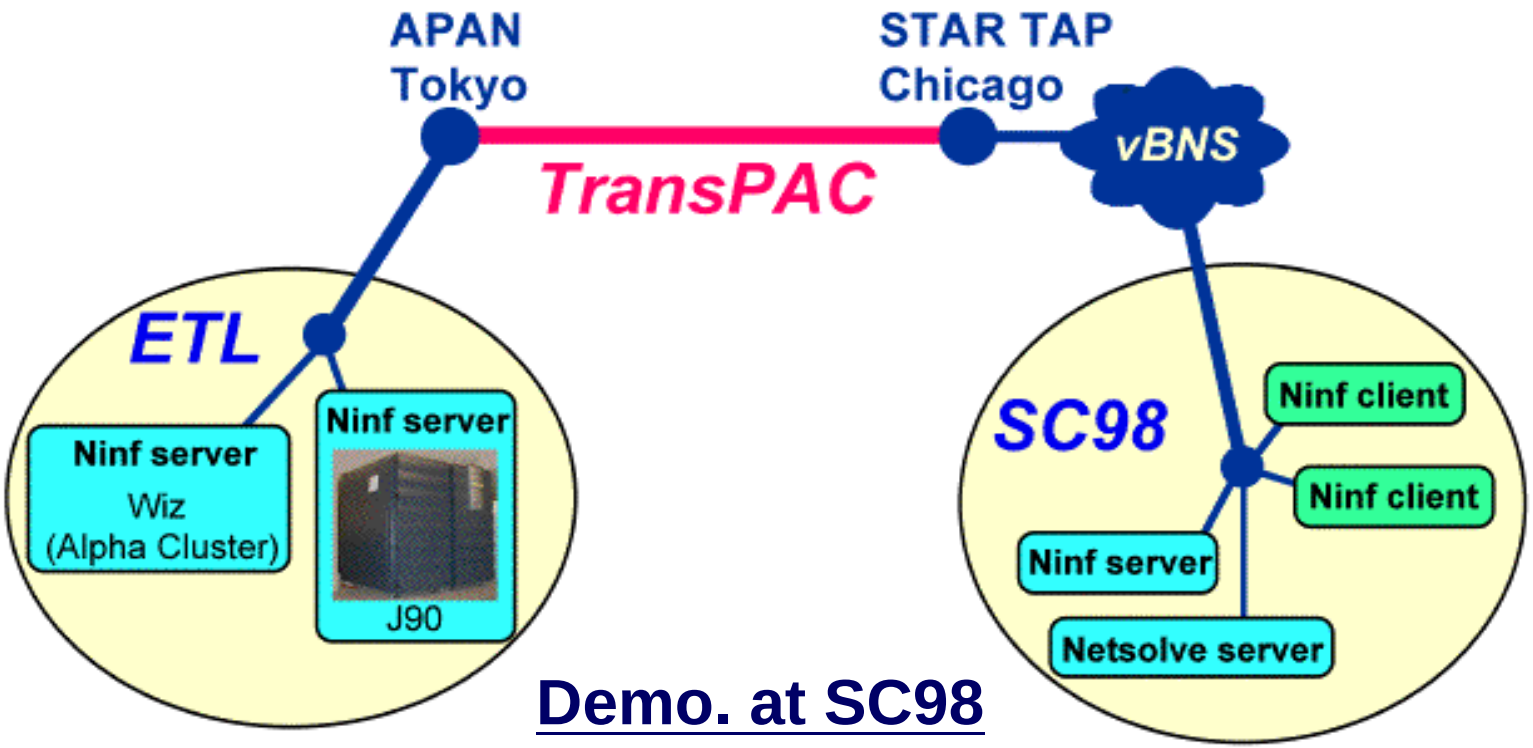


Callback function

http://pdplab.trc.rwcp.or.jp/netCFD/

Ninf over TransPAC

- **Demonstration of Ninf system over TransPAC**
  - **SC98, SC99**

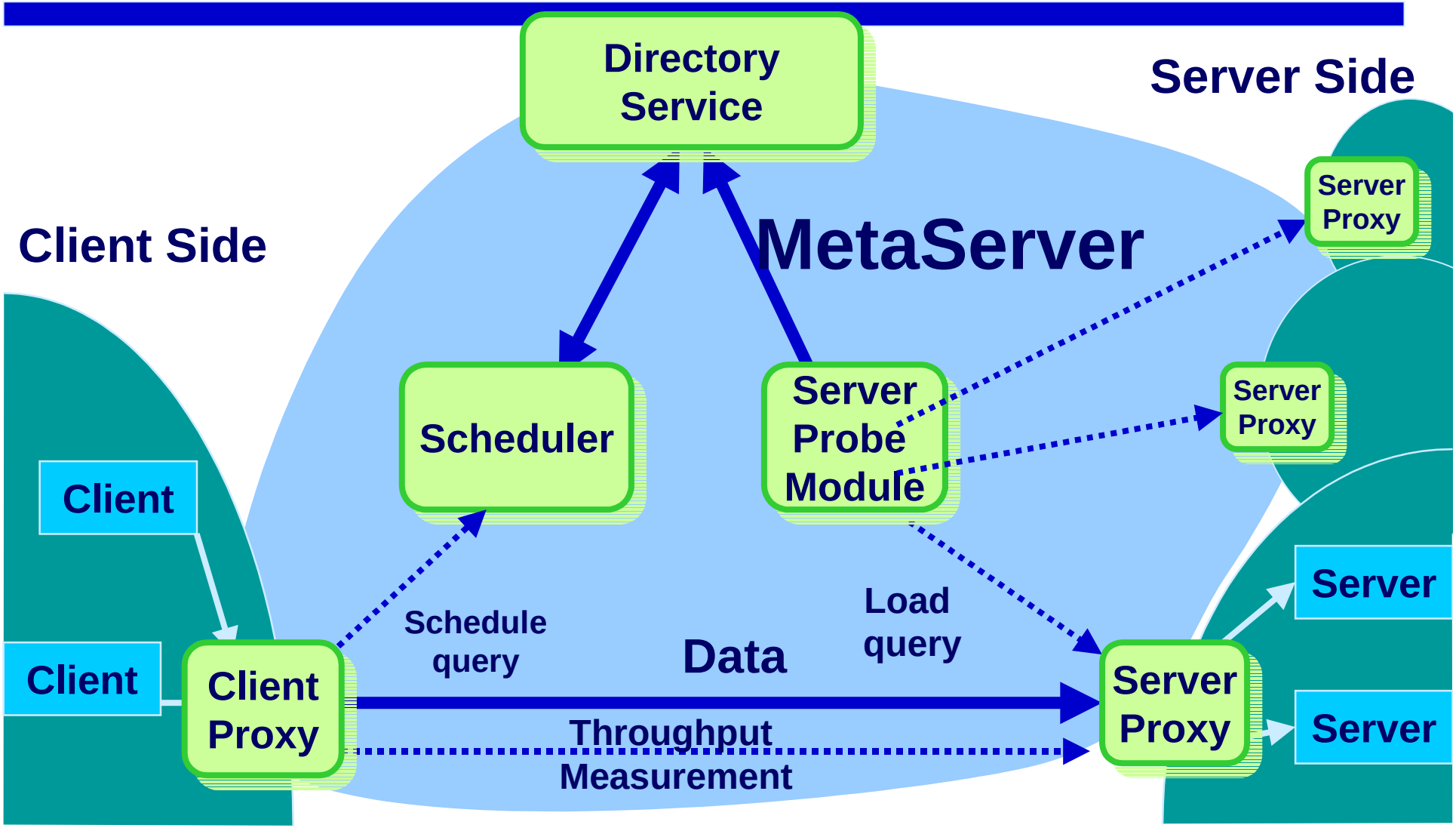


Demo. at SC98

Scheduling

- An effective scheduling is required!
  - Server/Network status dynamically change.
  - Status information is distributed in WAN.
  - Servers may be located inside Firewall.
- Our approaches
  - Metaserver
    - monitoring server/network status, performing scheduling
    - development of effective scheduling systems
  - Bricks
    - simulating scheduling in Grid
    - modeling computation in Grid, discussion of scheduling algorithm by simulation

MetaServer Architecture



Scheduling Algorithm

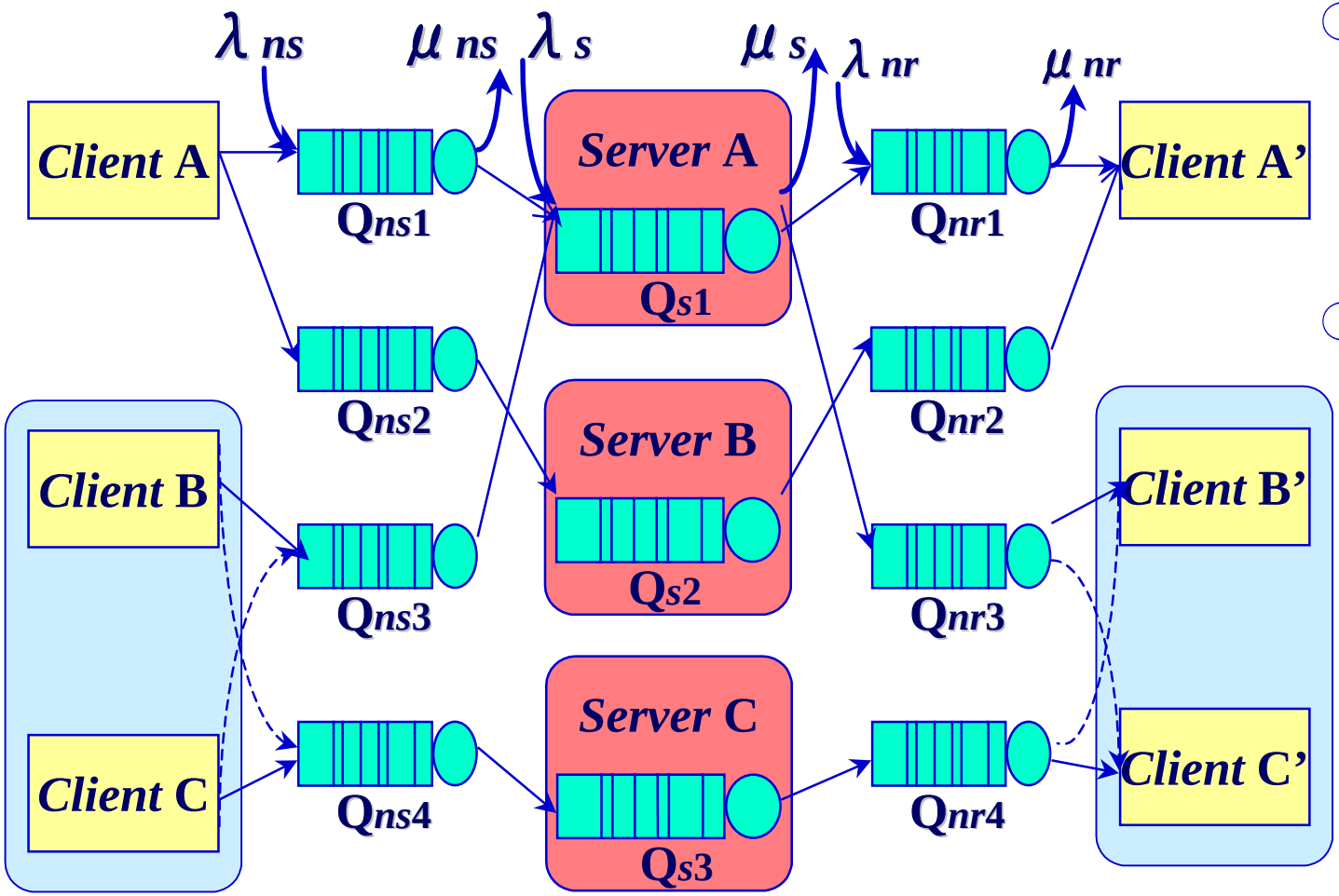
- **Metaserver needs to select the most suitable server for client jobs using effective scheduling algorithm.**
- **Performance evaluation/estimation for scheduling algorithm**
  - **measurement on real “Grid” system**
    - ☞**practical measurement**
    - ☞**difficult to perform large-scale experiments**
    - ☞**difficult to have reproducible results**

partial solution

Bricks

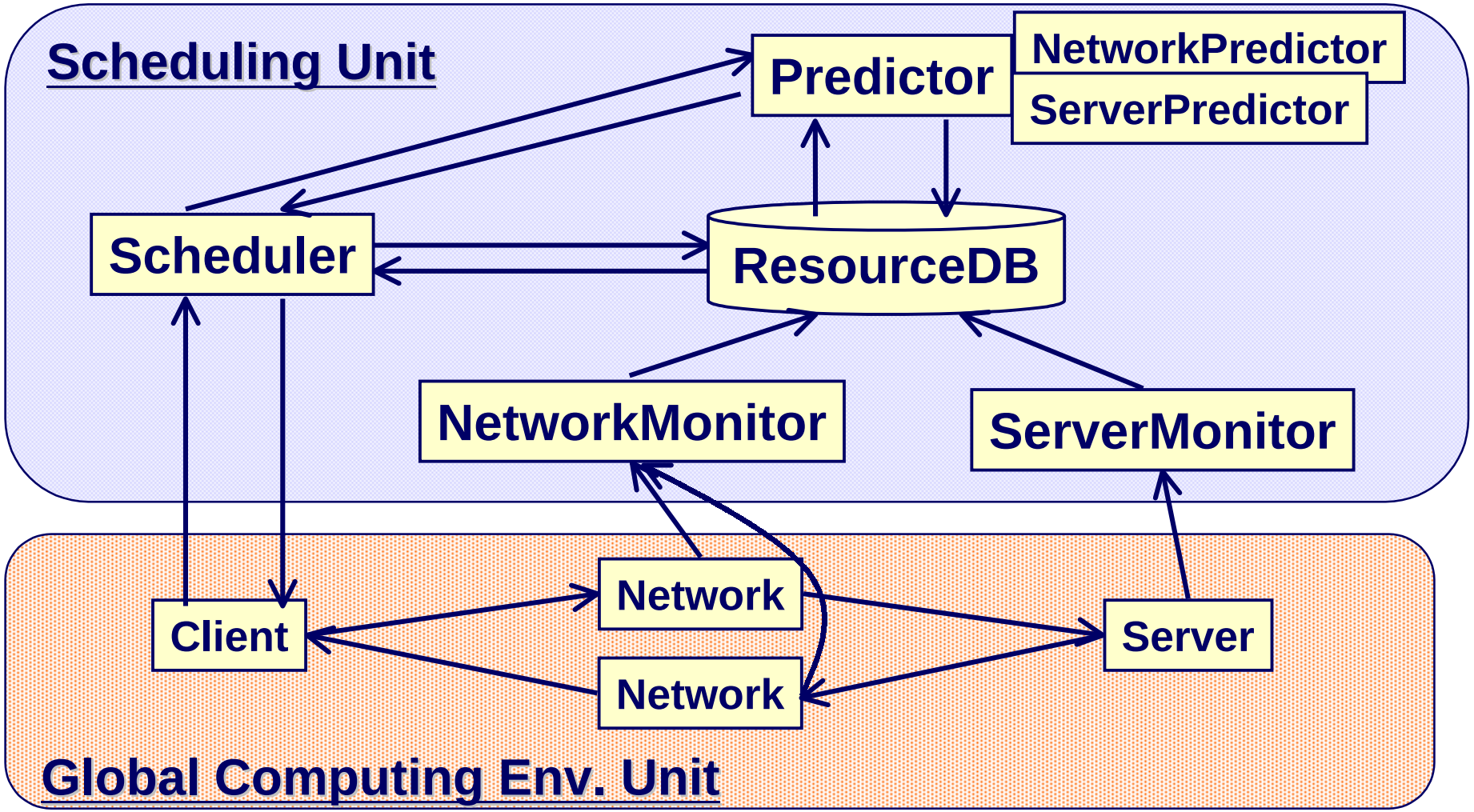
- Simulation system for scheduling in "Grid"
- Queuing Model
  - A global computing system is modeled by queuing network
- Features
  - evaluation/estimation of scheduling performance by simulation
  - verification of existing scheduling modules for actual Grid environment

The Model in Bricks (Queuing System)



- Networks / Servers are represented as queues
- External network traffic / server jobs represent congestion

Software Architecture of Bricks



Verification of Scheduling Modules with Bricks

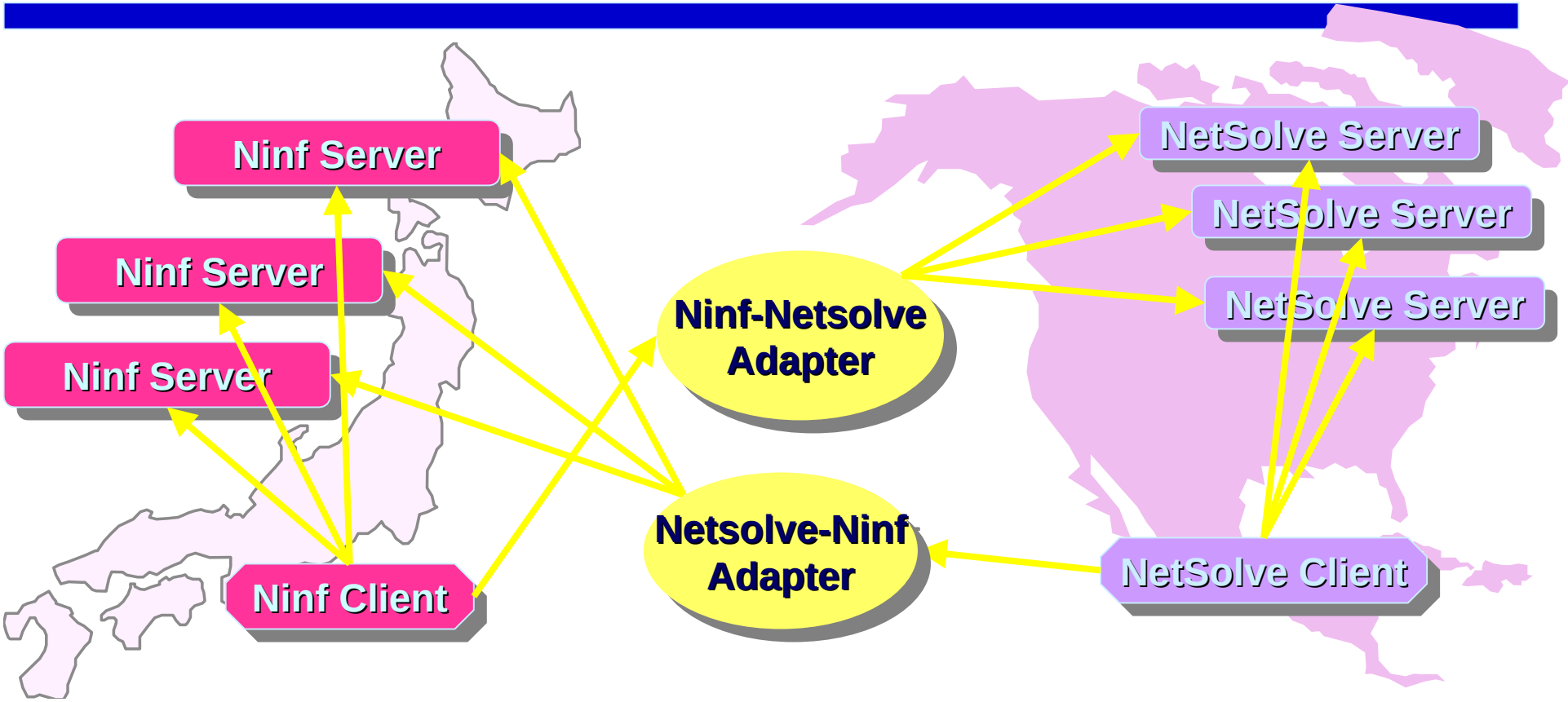
- **Replaceable component**
  - **Components in Scheduling Unit are easily replaceable with other software modules (modules for actual Grid environment).**
    - ☞**(ex.) Monitor/Predictor ↔ NWS**
- **Verification of modules with low cost**
  - **Developers of scheduling module can verify/debug/evaluate their developed modules by Bricks with low cost.**

The verification in actual Grid env. needs expensive cost!

Related Work

- RPC based systems → use existing programming languages
  - **NetSolve** [Casanova and Dongarra, Univ. Tennessee]
    - The same basic API as Ninf_call (now interchangeable)
    - load-balancing with a daemon process called Agent.
  - **RCS** [Arbenz, ETH Zurich]
    - PVM-based
- systems using parallel distributed language etc.
  - **Legion** [Grimshaw, Univ. Virginia]
    - An user distributes his programs written with the parallel object-oriented language Mentat.
  - **Javelin** [Schauser et al., UCSB]
    - High portability due to using Java and WWW.

Ninf-NetSolve Collaboration



- Ninf client can use NetSolve server via adapter
- NetSolve client can use Ninf server via adapter

Related Work (cont'd.)

- systems for scheduling
  - **AppLes** [Berman, UCSD]
    - ☞application level scheduler
  - **NWS** [Wolski, UCSD/NPACI]
    - ☞monitoring and predicting congestion of server/network
- toolkits:
  - **Globus** [Argonne/USC]

Conclusions

- Ninf is a RPC based global computing infrastructure.
  - Ninf RPC protocol
  - easy-to-use client API
  - direct web access, transaction,…
- Applications
  - NinfCalc+, Excel Ninf, NetCFD,...
  - Demo. over TransPAC [SC98, SC99]
- Scheduling
  - Metaserver
  - Bricks

Conclusions (cont'd.)

- **Ninf platforms**
  - **Server: Solaris1,2, DEC, UNICOS, Linux, FreeBSD**
  - **Client: server platforms + Win32**

- **Contact**

  http://ninf.etl.go.jp/