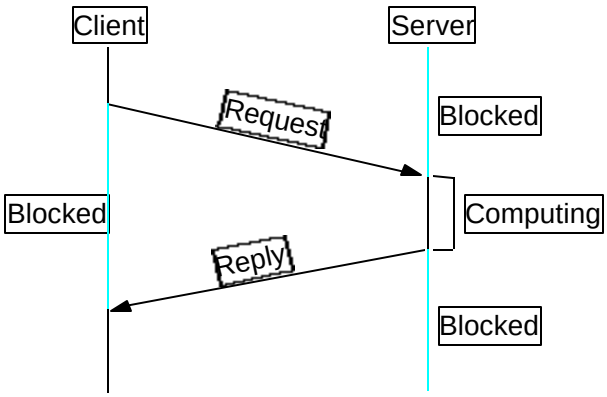
Remote Procedure Call

Outline

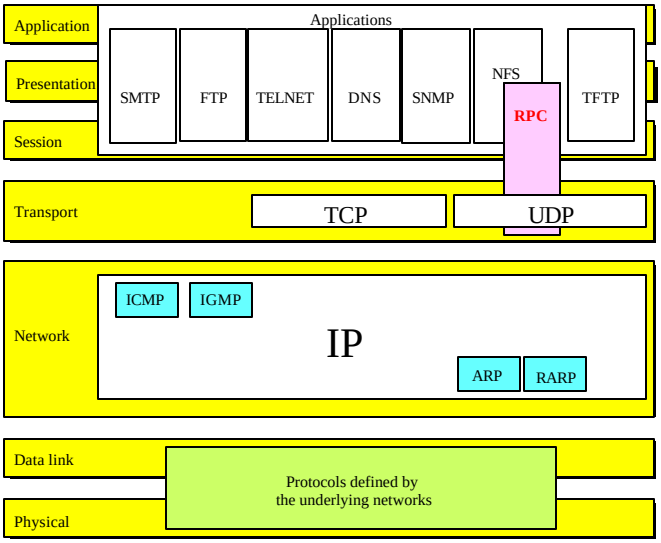
- Protocol Stack
- Presentation Formatting

based on section 5.3 of Peterson & Davie's book

RPC Timeline



Where RPC fits in OSI model



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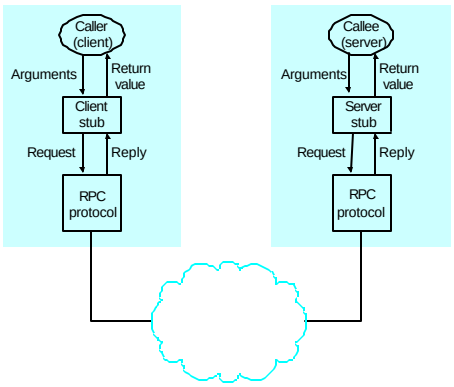
From: *TCP/IP Protocol Suite, McGraw-Hill, 2000*

RPC Components

- Protocol Stack
  - fragments and reassembles large messages (BLAST)
  - synchronizes request and reply messages (CHAN)
  - dispatches request to the correct process (SELECT)
- Stubs



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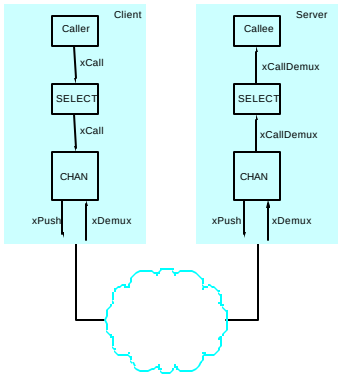
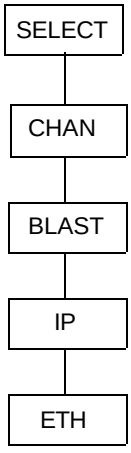
Programming Benefits

- The programming is easier since little or no network programming involved.
- If an unreliable protocol such as UDP is used, details like timeout and retransmission are handled by RPC package.
- The RPC library handles any required data translation for the arguments and return values.

TCP/IP Illustrated, Vol. I, Chap. 29 5

Simple RPC Stack





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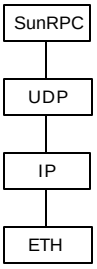
SunRPC

- IP implements BLAST-equivalent
  - except no selective retransmit
- SunRPC implements CHAN-equivalent
  - except not at-most-once



- UDP + SunRPC implement SELECT-equivalent
  - UDP dispatches to program (ports bound to programs)
  - SunRPC dispatches to procedure within program

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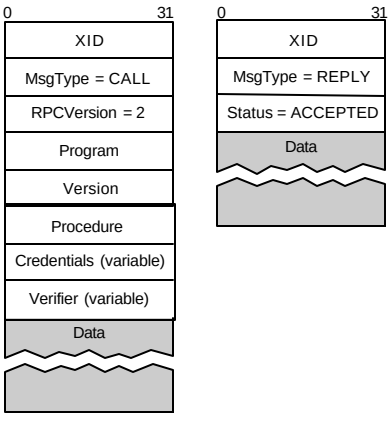
SunRPC Header Format

- XID (transaction id) is similar to CHAN's MID
- Server does not remember last XID it serviced
- Problem if client retransmits request while reply is in transit



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Port Mapper

- Just another RPC program
- Listen to UDP port 111 and TCP port 111
- Provide server procedures:
  - *PMAPPROC_SET*: Called by an RPC server on startup to register a program no, version no, protocol with port no.
  - *PMAPPROC_UNSET*: Called by server to remove a previously registered mapping.
  - *PMAPPROC_GETPORT*: Called by an RPC client on start up to obtain the port no for a given program no, version no, and protocol.
  - *PMAPPROC_DUMP*: Returns all entries (program no, version no, protocol, and port no) in the port mapper database.
- Port mapper starts first (listen to 111) →
  RPC Server prog. starts (register with *PMAPPROC_SET*) →
  RPC Client prog. starts (*PMAPPROC_GETPORT*) →
  RPC Client sends an RPC call message

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DCE-RPC

- Distributed Computing Environment (DCE) was defined by Open Software Foundation (OSF).
- DCE-RPC is the PRC protocol at the core of the DCE and CORBA (Common Object Request Broker Architecture).
- Run on top of UDP.
- Besides RPC, DCE also includes security services, LAN namespace services, and network time services. (Sun has a "*Secure RPC*" for authentication.)

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Presentation Formatting

- Marshalling (encoding) application data into messages
- Unmarshalling (decoding) messages into application data

- Data types we consider
  - integers
  - floats
  - strings
  - arrays
  - structs
- Types of data we do not consider
  - images
  - video
  - multimedia documents

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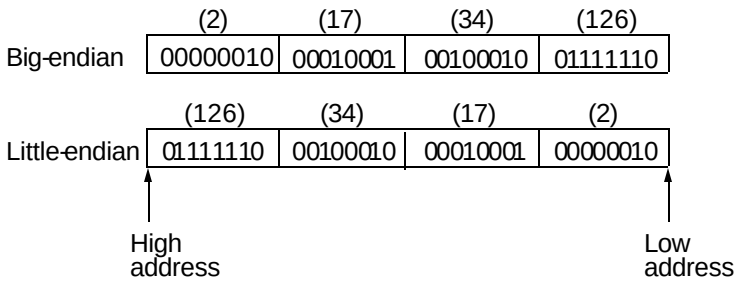
Difficulties

- Representation of base types
  - floating point: IEEE 754 versus non-standard
  - integer: big-endian versus little-endian (e.g., 34,677,374)



- Compiler layout of structures

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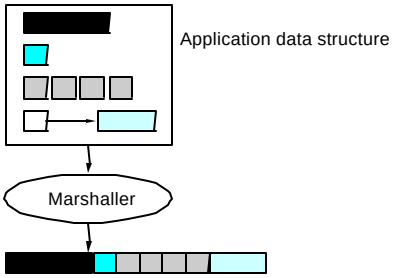
Taxonomy

- Data types
  - base types (e.g., ints, floats); must convert
  - flat types (e.g., structures, arrays); must pack
  - complex types (e.g., pointers); must linearize



- Conversion Strategy
  - canonical intermediate form
  - receiver-makes-right (an *N* x *N* solution)

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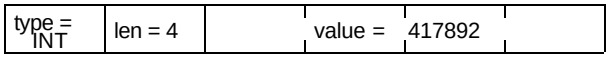
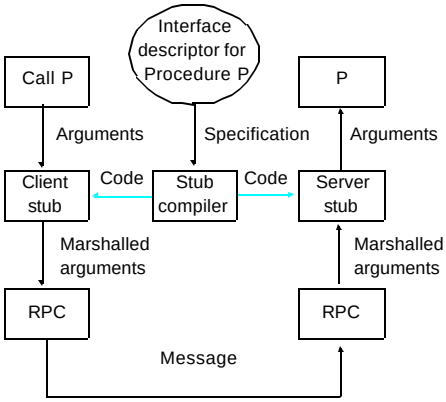
Taxonomy (cont)

- Tagged versus untagged data



- Stubs
  - compiled
  - interpreted



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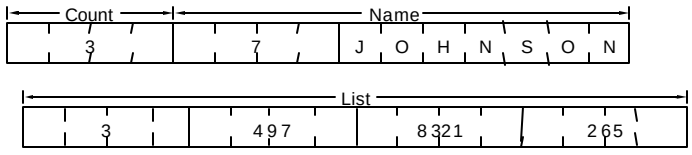
eXternal Data Representation (XDR)

- Defined by Sun for use with SunRPC
- C type system (without function pointers)
- Canonical intermediate form
- Untagged (except array length)
- Compiled stubs

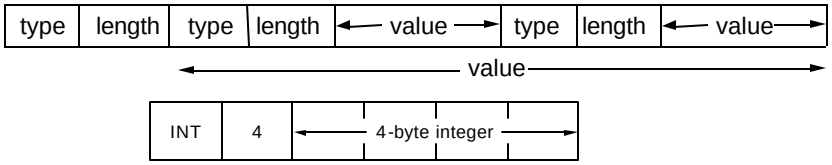

```
#define MAXNAME 256;
#define MAXLIST 100;

struct item {
   int     count;
   char    name[MAXNAME];
   int     list[MAXLIST];
};

bool_t
xdr_item(XDR *xdrs, struct item *ptr)
{
   return(xdr_int(xdrs, &ptr->count) &&
       xdr_string(xdrs, &ptr->name, MAXNAME) &&
       xdr_array(xdrs, &ptr->list, &ptr->count,
                 MAXLIST, sizeof(int), xdr_int));
}
```



Abstract Syntax Notation One (ASN-1)

- An ISO standard
- Essentially the C type system
- Canonical intermediate form
- Tagged
- Compiled or interpretted stubs
- BER: Basic Encoding Rules

```
(tag, length, value)
```



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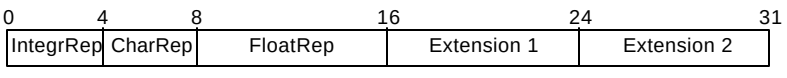
Network Data Representation (NDR)

- Defined by DCE
- Essentially the C type system
- Receiver-makes-right (architecture tag)
- Individual data items untagged
- Compiled stubs from IDL
- 4-byte architecture tag

– IntegerRep
  - 0 = big-endian
  - 1 = little-endian

– CharRep
  - 0 = ASCII
  - 1 = EBCDIC

– FloatRep
  - 0 = IEEE 754
  - 1 = VAX
  - 2 = Cray
  - 3 = IBM



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