I/O Functions

- recv and send functions
- readv and writev functions
- recvmsg and sendmsg functions
- Ancillary data

Socket Timeouts

- Call alarm which generates SIGALRM before calling socket functions
- Block waiting for I/O in select which has a time limit built in
- Set SO_RCVTIMEO and SO_SNDTIMEO socket options by setsockopt

recv and send Functions

```
#include <sys/socket.h>
    ssize_t recv (int sockfd, void *buff, size_t nbytes, int flags);
    ssize_t send (int sockfd, const void *buff, size_t nbytes, int flags);
      both return: number of bytes read or written if OK, -1 on error
```

flags	Description	recv	send
MSG_DONTROUTE	bypass routing table lookup		X
MSG_DONTWAIT	only this operation is nonblocking	X	X
MSG_OOB	send or receive out-of-band data	X	X
MSG_PEEK	peek at incoming message	X	
MSG_WAITALL	wait for all the data	X	X

```
char *buffer="stringa da spedire";  int sockfd; int ris;
….  /* dopo avere creato il socket (ad es. TCP) e instaurato la connessione */
ris=send ( sockfd,  buffer, strlen(buffer)+1  );
if (   (ris<0) && (errno!=EINTR) )  /* mannaggia, errore, termino */  exit(1);
```

readv and writev functions

#include <sys/uio.h>

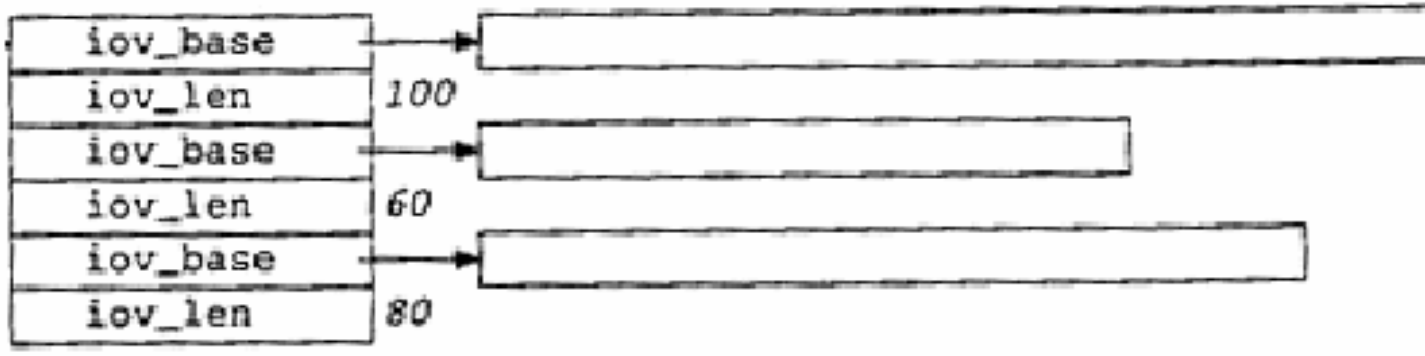
ssize_t readv (int filedes, const struct iovec *iov, int iovcnt);

ssize_t writev (int filedes, const struct iovec *iov, int iovcnt);

both return: number of bytes read or written, -1 on error

*iov: a pointer to an arrary of iovec structure

```
struct iovec {
    void   *iov_base;   /* starting address of buffer */
    size_t   iov_len;     /* size of buffer */
};
```



recvmsg and sendmsg Functions the most general socket I/O functions

```
#include <sys/socket.h>
ssize_t recvmsg (int sockfd, struct msghdr *msg, int flags);
ssize_t sendmsg (int sockfd, struct msghdr *msg, int flags);
```

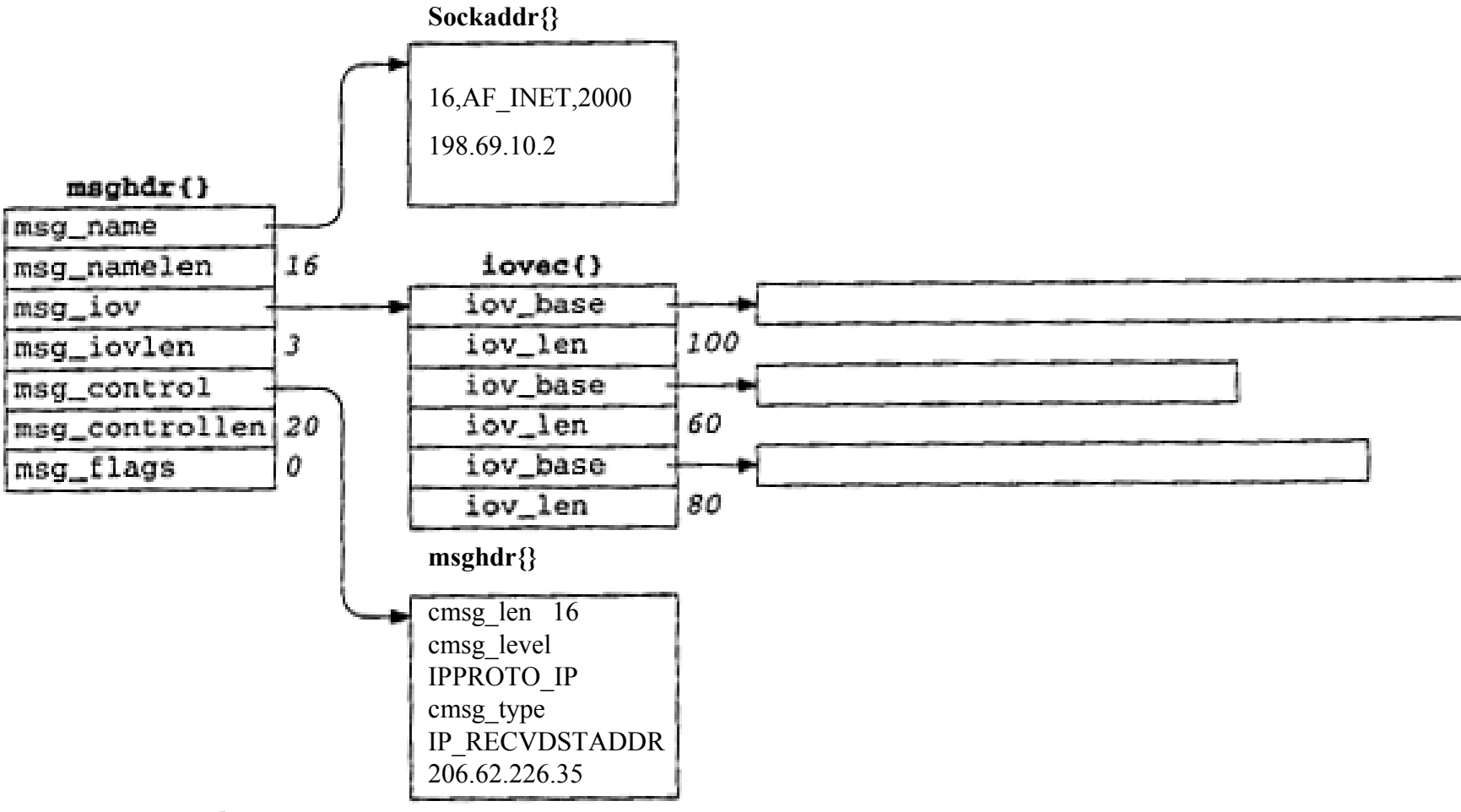
both return: number of bytes read or written if OK, -1 on error

```
struct msghdr  {
  void     *msg_name;          /* protocol address */
  socklen_t    msg_namelen;    /* size of protocol address */
  struct iovec   *msg_iov;     /* scatter/gather array */
  size_t     msg_iovlen;       /* # elements in msg_iov */
  void      *msg_control;      /* ancillary data; must be aligned
                                    for a cmsghdr structure */
  socklen_t   msg_controllen;  /* length of ancillary data */
  int     msg_flags;           /* flags returned by recvmsg ( ) */
};
```

Summary of I/O Flags by Various I/O Functions

Flag	Examined by: *send flags* *sendto flags* *sendmsg flags*	Examined by: *recv flags* *recvfrom flags* *recvmsg flags*	Returned by: recvmsg msg_flags
MSG_DONTROUTE	X		
MSG_DONTWAIT	X	X	
MSG_PEEK		X	
MSG_WAITALL		X	
MSG_EOR	X		X
MSG_OOB	X	X	X
MSG_BCAST			X
MSG_MCAST			X
MSG_TRUNC			X
MSG_CTRUNC			X
MSG_ERRQUEUE			**X**

msghdr When recvmsg Returns



Comparison of Five Groups of I/O Functions

Functions	Any descriptor	Only socket descriptor	Single buffer	Scatter buffer	Optional flags	Optional peer address	Optional control info
read,write	x		x				
readv,writev	x			x			
recv,send		x	x		x		
recvfrom, sendto		x	x		x	x	
recvmsg,sendmsg		x		x	x	x	x

Ancillary Data (Control Info)

Protocol	cmsg_level	cmsg_type	Description
IPv4	IPPROTO_IP	IP_RECVDSTADDR	receive dest addr with UDP data
		IP_RECVIF	receive interface index with UDP
IPv6	IPPROTO_IPV6	IPV6_DSTOPTS	specify/receive dest options
		IPV6_HOPLIMIT	specify/receive hop limit
		IPV6_HOPOPTS	specify/receive hop-by-hop options
		IPV6_NEXTHOP	specify next-hop addr
		IPV6_PKTINFO	specify/receive packet info
		IPV6_RTHDR	specify/receive routing header
Unix domain	SOL_SOCKET	SCM_RIGHTS	send/receive descriptors
		SCM_CREDS	send/receive user credentials

IPv4	IPPROTO_IP	IP_RECVERR	receive error messages
IPv6	IPPROTO_IPV6	IP_RECVERR	receive error messages

extended error description

```
struct sock_extended_err{
    __u32           ee_errno;
    __u8            ee_origin;
    __u8            ee_type;
    __u8            ee_code;
    __u8            ee_pad;
    __u32           ee_info;
    __u32           ee_data;
};
#define SO_EE_ORIGIN_NONE    0
#define SO_EE_ORIGIN_LOCAL 1
#define SO_EE_ORIGIN_ICMP    2
#define SO_EE_ORIGIN_ICMP6   3
#define SO_EE_ORIGIN_LOCAL_NOTIFY   4  /* non standard */
#define SO_EE_OFFENDER(ee)    ((struct sockaddr*)((ee)+1))
```