Ryan Eberhardt and Julio Ballista April 13, 2021

Error Handling

Logistics

- Congrats on making it to week 3!
 - Already 1/3 through the quarter! \bigcirc
- Please submit Github usernames ASAP
 - \bigcirc away
- Week 2 exercises due Thursday
 - Let us know if you need more time \bigcirc
 - Blog posts welcome \bigcirc
- Ownership code examples on the website (see lecture notes)
- Please submit reflections
 - \bigcirc you

May also want to accept the Github invite even if you aren't starting the assignment right

Also would love to hear if this is not so helpful, or if we could make this more helpful to



Error handling



More Remote Code Execution

- Imagine a server receives messages from the network
- Message is variable length. A header at the start of the message specifies where data is located within the message payload

length	field1 offset	field2 offset	field3 offset			
64	32	48	56	field1	field2	field3
Header					Payload	



More Remote Code Execution

length field1 offset field2 offset field3 offset 64 32 48 56

Header

```
struct message {
    size_t length;
    size_t field1_offset;
    size_t field2_offset;
    size_t field3_offset;
    char payload[];
```

FIELD_1_LENGTH);



```
Payload
```

```
// Processing part of a received message:
void *local_copy = malloc(message->length);
// Validate field1_offset is within the buffer (no buffer overflows!)
assert(message->field1_offset + FIELD_1_LENGTH <= message->length);
// Copy the field and process it
memcpy(local_copy + message->field1_offset,
       message->payload + message->field1_offset,
process_field_1(local_copy + message->field1_offset);
```



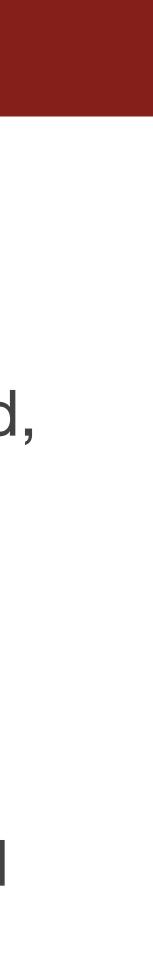
Lack of proper error handling Use of NULL in place of a real value

Handling errors



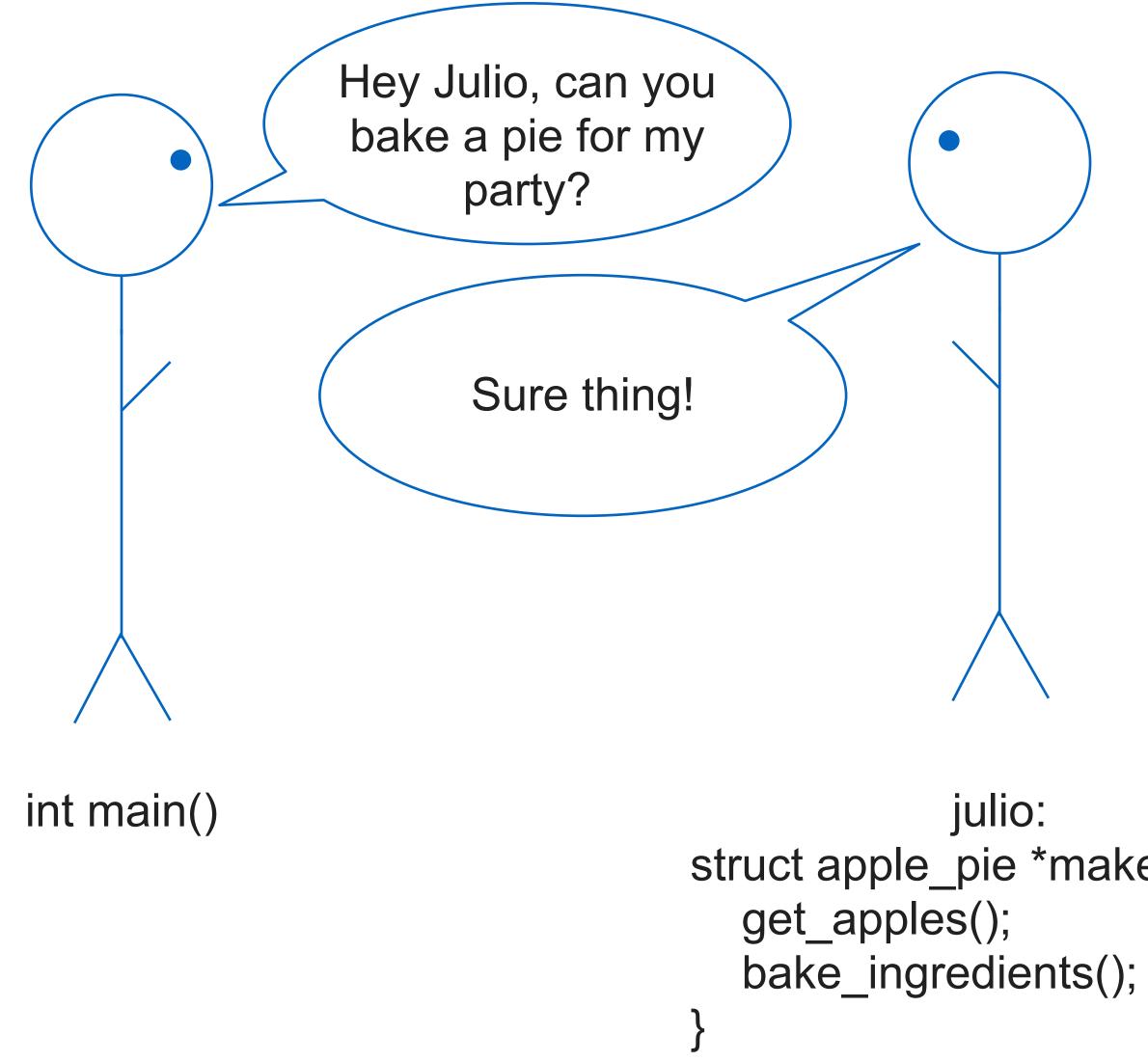
- If a function might encounter an er sometimes void*).
- If the function is successful, it returns 0. Otherwise, if an error is encountered, it returns -1. (If the function is returning a pointer, it returns a valid pointer in the success case, or NULL if an error occurs.)
- The function that encountered the error sets the global variable errno to be an integer indicating what went wrong. If the caller sees that the function returned -1 or NULL, it can check errno to see what error was encountered

If a function might encounter an error, its return type is made to be int (or

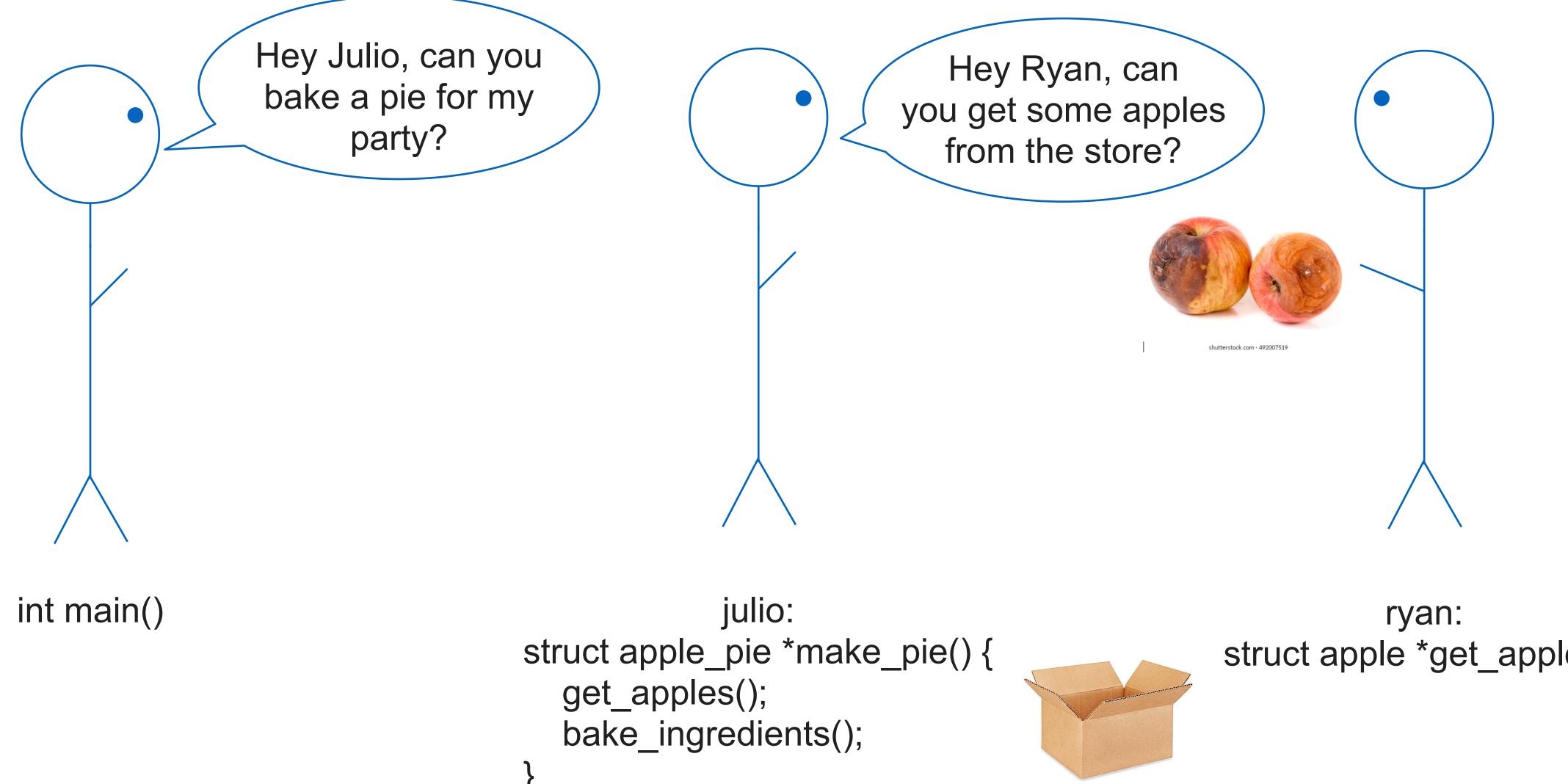


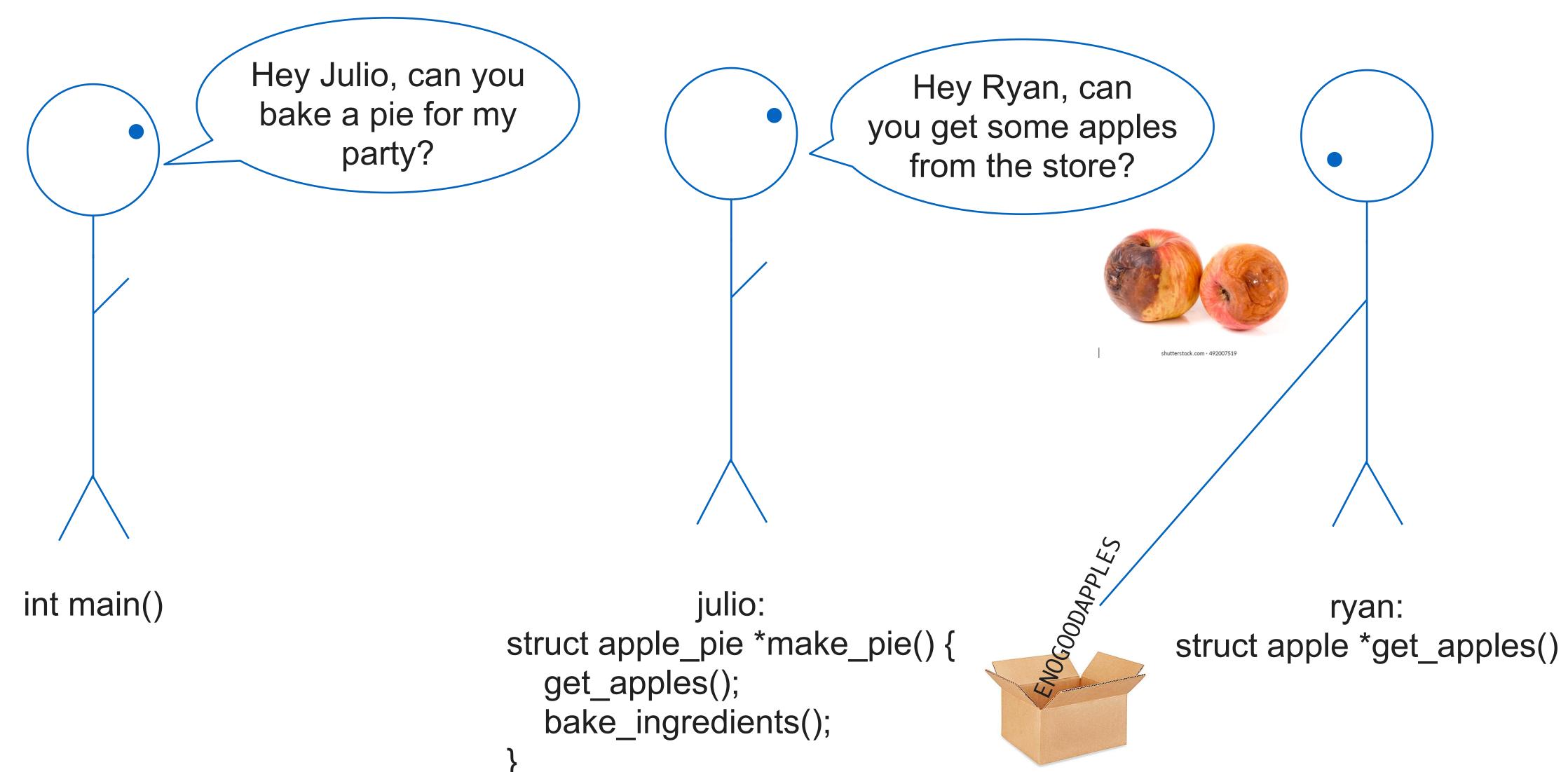
definis SROUTT 0 /* No such file of directory */ Adding SROUTS 0 /* two induces // definis SROUTS 1 No such process // Adding SROUTS 0 /* two induces pinc */ definis SROUTS 1 No such process // Adding SROUTS 0 /* two induces pinc */ definis CRUE 1 No such file of directory */ Adding SROUTS 0 /* two induces pinc */ definis CRUE 1 No such sectors */ Adding SROUTS 0 /* two induces */ definis CRUE 1 No such sectors */ Adding SROUTS 0 /* two induces */ definis CRUE 1 No such sectors */ Adding SROUTS 0 /* two induces */ definis CRUE 1 /* To sectors */ Adding SROUTS 0 /* the sectors */ definis SROUT 1 /* To sectors */ Adding SROUTS 0 /* two induces */ definis SROUT 1 /* To sectors */ Adding SROUTS 0 /* two induces */ definis SROUT 1 /* To sectors */ Adding SR	#define EPERM	1	/* Operation not permitted */	#define EL2HLT	51	/* Level 2 halted */
Addrine SKAC 3 /* invalid requise description */ Addrine STAR 6 /* invalid requise description */ Addrine Star 5 /* IO error */ Addrine SKAL /* invalid requise description */ Addrine Star 5 /* IO error */ Addrine Star /* invalid interview invalid Addrine Star 7 /* on id interview invalid /* invalid interview invalid Addrine Star 7 /* on id interview invalid /* invalid interview invalid Addrine Star 7 /* on id interview invalid /* invalid interview invalid Addrine Star 7 /* on id interview invalid /* invalid interview invalid Addrine Star 7 /* on id interview invalid /* invalid interview invalid Addrine Star 1 /* on id interview invalid /* invalid interview invalid Addrine Star 1 /* on id interview invalid /* invalid interview invalid Addrine Star 1 /* on id interview invalid /* identifier invalid Addrine Star 1 /* identifier invalid /* identifier invalid Addrine Star 1 /* identifier invalid /* identifier invalid		2				
dusting EVPR 4 // Incorrupted system call */ Function EVPRL 54 // Dechagge (L) */ dealing EVR0 6 // Voruch device or address */ Function EVR000 55 // Voruch device or address */ dealing EVR0 6 // Voruch device or address */ Forther EVR000 56 // Voruch address */ dealing EVR0 8 / Exceptore or address */ Forther EVR000 57 // Tand forther forwart */ dealing EVR0 8 / Exceptore or address */ Forther EVR000 67 // Tand forther forwart */ dusting EVR0 11 / Try syain */ Function EVR000 67 // Tand forther forwart */ dusting EVR00 12 / Dut on among */ Function EVR000 67 // Void streame resources */ dusting EVR00 16 / Dut or address */ Fortic EVR0000 67 // Address // Address // define EVR00 16 / Dut or address */ Fortic EVR0000 // Address // // Address // define EVR00 16 / Dut or address */ Fortic EVR0000 // Address // // Address //		- 3				
descrime EDO 5 /* 1/0 error /* 4-error endowned of the second error of		4	-			
Modifies RAND 6 /* ho such device or address '/ Fidefine RANDC 56 /* invalid informatic conditions Modeline RANDERT 9 /* kate format error */ #define RANDERT 7 /* mail is from one */ Modeline RANDERT 9 /* kate format error */ #define RANDERT 7 /* Bad foot file format */ Additise RANDERT 10 /* No child processes */ #define RANDERT 10 /* No child processes */ Additise RANDERT 10 /* No child processes */ #define RANDERT 10 /* additise RANDERT Modeline RANDERT 13 /* deminstrom denied */ #define RANDERT 64 /* additise RANDERT 10 /* define RANDERT 10 <td< td=""><td></td><td>5</td><td></td><td></td><td></td><td></td></td<>		5				
-define FX0FNC 6 7 /* Arg list too long */ Areline FX0FXT 7 37 /* Environment */ Adding FX0FNC 6 6 /* Soc fromt error */ Adding FX0FXT 7 37 /* Bad fort file from t/ Adding FX0FNC 6 7 /* Soc fromt error */ Adding FX0FXT 7 37 /* Device on a stream */ Adding FX0FXT 7 /* Soc data Xx110 processes */ Adding FX0FXT 7 Adding FX0FXT 7 37 Adding FX0FXT 7 /* Or of a strong resources */ Adding FX0FXT 7 Adding FX0FXT 7 37 Adding FX0FXT 7 1 /* Device or resource hug */ Adding FX0FXT 7 47 Adding FX0FXT 7 47 Adding FX0FXT 7 15 /* Proces or resource hug */ Adding FX0FXT 7 47 FX File FX0FXT 7 47 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
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edefine EACPY 9 * Bod file number */ #define FNORTA 60 / * Portice not a stronm */ #define EACAIN 11 / * Try again */ #define FNORTA 60 / * No date available */ #define EACAIN 11 / * Try again */ #define FNORTA 61 / * No date available */ #define EACAIN 12 / * Durd memory */ #define FNORTA 63 / * Out of stronms resurces */ #define EACAIN 13 / * Permission denied */ #define FNORTA 65 / * Nachne is not on the network */ #define ENCRIM 15 / * Block device resource bay */ #define FNORTA 66 / * Durden ort installed */ #define ENCRIM 17 / * Pla exists */ #define FNORTA 63 / * Encount error */ #define ENCRIM 13 / * No use device '/ #define FNORTA 63 / * Encount error */ #define ENCRIM 21 / * No use device '/ #define FNORTA 70 / * Encount error */ #define ENCRIM 21 / * No use device '/ #define FNORTA 70 / * Encount error */ #define ENCRIM 24 / * Nouse device '/ #define FNORTA		, 8				
define EXELLD 10 /* No child processes */ édefine ENDERTA 61 /* Ko data available */ fdofine EXCES 13 /* Particular product */ édefine ENDERTA 63 /* Out of streams resources */ fdofine EXCES 13 /* Particular define enderts 64 64 14 Xachine EXCES 7 fdofine ENDERK 15 /* Stock dovice required */ édefine ENDERTA 67 /* Dokage not installed */ fdofine ENDERK 16 /* Particular enderta /* Out of memory */ édefine ENDERTA 67 /* Out of memory */ fdofine ENDERK 16 /* Particular enderta /* Out of memory */ édefine ENDERTA 67 /* Out of memory */ fdofine ENDERK 16 /* Particular enderta /* Out of memory */ édefine ENDERTA 7 /* The Advice or resource busy */ fdofine ENDERT 10 /* None advice or neodrace busy */ édefine ENDERTA 7 /* Out of memory */ fdofine ENDERT 21 /* To a directory */ édefine ENDERTA 7 /* Null advice advice */ fdofine ENTAL 23 /* The a directory */ édefine ENDERTA 7 * Nu		9				
eMdafine EXALT 11 /* Try again */ #define EXXE 62 /* Timer expired */ eMdafine EXXCES 13 /* Permission denied */ #define EXXER 64 /* Wachine is not on the network */ Medicine EXXCES 13 /* Permission denied */ #define EXXER 64 /* Wachine is not on the network */ Medicine EXXEX 15 /* block device required */ #define EXXER 66 /* Out of the network */ Medicine EXXEX 15 /* block device required */ #define EXXER 66 /* Out of the network */ Medicine EXXEX 15 /* block device required */ #define EXXER 66 /* Object is remote */ Medicine EXXEX 17 /* block device */ #define FXXER 67 Statume error */ Medicine EXXEX 19 /* ks such device */ #define FXXER 67 Statume error */ Medicine EXXEX 19 /* ks a directory */ #define FXXER 74 #define FXXER 74 Statume error */ Medicine EXXEX 17 /* ts a directory */ #define FXXER 74 Yut the bold error */ Medicine EXXEX 24 /* to carra		10				
#define FXONTM 12 /* Dui, of memory */ #define FXORT 63 /* Out of memory */ #define FXORT 14 /* Bad address */ #define FXORT 64 /* Decage not installed */ #define FXORT 14 /* Bad address */ #define FXORT 66 /* Decage not installed */ #define FXORT 16 /* Device or cresource busy */ #define EXORT 66 /* Decode is remote */ #define EXORT 16 /* Device or cresource busy */ #define EXORT 66 /* Decode is remote */ #define EXORT 18 /* Cress-device link */ #define EXORT 67 /* Strount error */ #define EXORT 20 /* Not a directory */ #define EXORT 7 /* Drotoci arror */ #define EXORT 20 /* Not a directory */ #define EXORT 7 /* Drotoci arror */ #define EXORT 20 /* Invalid argument */ #define EXORT 7 /* Not a directory #define EXORT 21 /* Itab advector #define EXORT 7 /* Value too large for defined data type */ #define EXTEL 21 /* Itab Decore #define EXORT 7			-			
eMedian13/* Permission denied */46 // 40 kins NONET64/* Machine is not on the network */édefine ENUTE15/* Block device reguired */édefine ENUENS66/* Object is reactor */édefine ENUEN15/* Block device reguired */édefine ENUENS66/* Object is reactor */édefine ENUEN17/* File exists */édefine ENUENS68/* Advertise error */édefine ENUENT18/* Cross-device l'ink */édefine ENUENT68/* Advertise error */édefine ENUENT19/* No such device */édefine ENUENT70/* Communitation error on sond */édefine ENUENT19/* No such device */édefine ENUENT70/* Communitation error on sond */édefine ENUENT21/* No ta directory */édefine ENUENT71/* Proteoil error */édefine ENUENT21/* No ta directory */édefine ENUENT72/* Nutlikog attempted */édefine ENUENT23/* Tile table overflow */édefine ENUENT74/* Not a date message */édefine ENUENT25/* So ta typerriter */édefine ENUENT74/* Not a date message */édefine ENUENC27/* File table averflow */édefine ENUENT74/* Not a date message */édefine ENUENC27/* So ta typerriter */édefine ENUENC76/* Name not unique on network */édefine ENUENC27/* File table averflow */édefine ENUENC76/* Name not unique on network */édefine ENUENC <td></td> <td></td> <td></td> <td></td> <td></td> <td>-</td>						-
#idine DFARLT 14 /* Bad address */ #idine BNOPKE 65 /* Package not installed */ #idine DENTLE 16 /* Device or required */ #idine BNOINK 67 /* Link has boon severed */ #idine DENTY 16 /* Device or required */ #idine BNOINK 67 /* Link has boon severed */ #idine TNDEY 18 /* Cross-device link */ #idine BNOINK 67 /* Enhancement */ #idine RNOTDIR 20 /* Not a directory */ #idine BNOINC 71 /* Protocol error */ #idine RNOTDIR 20 /* Not a directory */ #idine BNOINC 73 /* Brownh error */ #idine RNOTDIR 20 /* Not a directory */ #idine BNOINC 73 /* Brownh error */ #idine RNOTDIR 20 /* Ivalia droment */ #idine BNOINC 73 /* Brownh error */ #idine RNOTDIR 21 /* Not a directory */ #idine BNOINC 73 /* Brownh error */ #idine BNOINC 22 /* Not a directory */ #idine BNOINC 73 /* Brownh error */ #idine BNOINC 23 /* File table overlow */ #idine BNOINC 73 /* Brow			-			
#isofic ENDYS15/ block device required */#ising ERHOTE66/ * Object is rance */#isofice ENDYS16/ bevice or resource busy */#isfine ENDUTMS68/ * devents error */#isofice ENDY18/ Cross-device link */#isfine ENDUTMS68/ * devents error */#isofine ENDEV18/ Cross-device link */#isfine ENDUTMS70/ * Greanat error */#isofine ENDEV19/ No such device */#isfine ENDUTMS70/ * Communication error on send */#isofine ENDEV19/ No a directory */#isfine ENDTOT71/ * Hist specific error */#isofine ENDIM21/ To a directory */#isfine ENDTOT72/ * Nultibop attempted */#isofine ENVAL22/ Floid able overflow */#isfine ENDTOT71/* Nultibop attempted */#isofine ENVILS23/ Floid able overflow */#isfine ENDTOT7/* Nultibop attempted */#isofine ENTIFIS23/ Floid able overflow */#isfine ENDTOT7/* Nultibop attempted */#isofine ENTIFIS25/ Not a typewriter */#isfine ENDTOT7/* Nultibop attempted */#isofine ENTIFIS26/ Toxi filo busy */#isfine ENDTOT7/* Nultibop attempted */#isofine ENDSC27/ Y iso and resore */#isfine ENDTOT7/* Isle astempted */#isofine ENDSC26/ No space left on device */#isfine ENDTOT7/* Isle astempted */#isofine ENDSC27/ Y isofine ENDTOT <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
effetine ENURY16/* Device or resource busy */Fideline ENULING67/* Link has been severed */Fueline EXENT17/* File exists */Fideline ENURING68/* Adventise error */Fueline EXENT18/* Cross-dovice link */Fideline ENURING68/* Adventise error */Fideline ENDEW18/* To such device */Fideline ENURING70/* Scrount error */Fideline ENDEW20/* Not a directory */Fideline ENURING71/* Protocol error */Fideline ENDEN21/* Is a directory */Fideline ENURING73/* Not a directory */Fideline ENDENC23/* File table overflow */Fideline ENDENCO74/* Not a directory */Fideline ENTIES24/* Too many opon files */Fideline ENDENCO75/* Value too large for defined data type */Fideline ENTIES26/* Not a directory */Fideline ENDENCO75/* Value too large for defined data type */Fideline ENTIES26/* Not a directory */Fideline ENDENCO74/* Not a directory */Fideline ENTIES26/* Text file busy */Fideline ENDENCO75/* Value too large for defined data type */Fideline ENTIES26/* Text file busy */Fideline ENTIES26/* rest file busy */Fideline ENTIES26/* Text file busy */Fideline ENTIES26/* rest file busy */Fideline ENTIES26/* Text file busy */Fideline ENTIES27* risk sendias sendias sendias sendias sendia						
#define EXXIST 17 /* Pile exists */ #define EXDV 68 /* Advertise error */ #define EXDDV 18 /* Cross-device link */ #define EXDUTK 69 /* Strount error */ #define EXDDVL 19 /* No.s adirectory */ #define EXDUTK 70 /* Communication error on send */ #define EXDUTK 21 /* is a directory */ #define EXDUTHOP 72 /* Kulthop attempted */ #define EXDUTK 21 /* is a directory */ #define MUNTHOP 72 /* Kulthop attempted */ #define EXDUTK 21 /* is a directory */ #define MUNTHOP 72 /* Kulthop attempted */ #define EXDUTK 22 /* invalid argument */ #define MUNTHOP 72 /* Kult attempted */ #define EXDUTY 23 /* invalid argument */ #define NOTATION 75 /* Value too large for defined dat type */ #define EXDUTY 24 /* Too many open files */ #define EXDUTON 75 /* Value too large for defined dat type */ #define EXDUTY 25 /* Not at green time */ #define EXDUTON 75 /* Value too large for defined dat type */ #define EXDUTY 26			-			-
#define ENDRY18/* Cross-device link */#define ENDRY69/* Strount error */#define ENORDY10/* Not a directory */#define ENORD70/* Communication error on send */#define ENDRY20/* Not a directory */#define ENURTID72/* Nutlop altempted */#define ENDRY22/* Invalid argument */#define ENURTID72/* Nutlop altempted */#define ENTIR23/* File table overflow */#define ENURTID73/* RFS specific error */#define ENTIR24/* Too many open files */#define ENURTID75/* Nut a data message */#define ENTIR24/* Too many open files */#define ENURTID76/* Nut a data message */#define ENTIR26/* Toot argoertiter */#define ENURTID76/* Nut a data message */#define ENTIR26/* Toot argoertiter */#define ENURTID76/* Nut actor metvok */#define ENTIR26/* Toot argoertiter */#define ENURTID76/* Nut actor metvok */#define ENTRE29/* Not a typewriter */#define ENURTID76/* Reactor address changed */#define ENDRS28/* Not astgewriter */#define ENDRS78/* Reactor address changed */#define ENDRS29/* Not astgewriter */#define ENDRS78/* Nut access a meded shared libeary */#define ENDRS29/* Not astgewriter */#define ENDRS74/* Libeard#define ENDRS31/* Read-only file sy			-			
#define RNODEV19/* No a dravice */#define RNODEV70/* Communication error on send */#define RNODEN20/* Not a dravicouty */#define EMUTINOP71/* Froiocol error */#define ENDVAL22/* Invalid argument */#define EMUTINOP73/* RNOt a drave message */#define ENTLE22/* Invalid argument */#define ENDVAL73/* Not a drave message */#define ENTLE23/* Too many open files */#define ENDVAL75/* Not a drave message */#define ENTLE24/* not any open files */#define ENDVAL76/* Name on unique on network */#define ENDTX25/* Not a typesviter */#define ENDVAL76/* Name on unique on network */#define ENDTX25/* Not a typesviter */#define ENDVENU76/* Name on unique on network */#define ENDTX26/* Not a typesviter */#define ENDVENU76/* Name of the data type */#define ENDTX26/* Not a typesviter */#define ENDVENU76/* Name of the data type */#define ENDTX26/* Nos a typesviter */#define ENDVENU77/* Tile descriptor in bad state */#define ENDVEN27/* File tool arge */#define ENDVENU78/* Readored Elbary */#define ENDVEN30/* Readored Ibrary */#define ENDVENC78/* Readored Elbary */#define ENDVEN30/* Readored Ibrary */#define ENDVENC81/* Too anay type ilbary */#define ENDVEN						
#define ENOTOR20/* Not a directory */#define ENOTOR71/* Protocol error */#define ENDRL21/* Is a directory */#define ENOTOR73/* RFS specific error */#define ENTLE21/* File table overflow */#define ENOTOR73/* RFS specific error */#define ENTLE21/* File table overflow */#define ENOTOR75/* Not a diata message */#define ENTLE24/* Too many open files */#define ENOTORIQ76/* Not a diata message */#define ENTT25/* Not a typewriter */#define ENOTORIQ76/* Name not unique on network */#define ENTTS26/* Text file busy */#define ENTCRION75/* Name not unique on network */#define ENTTS26/* Text file busy */#define ENTCRION76/* Name not unique on network */#define ENTTS26/* No space left on device */#define ENTCRION77/* File descriptor in bads tabte */#define ENTS30/* Nead-only file system */#define ENTSRINC80/* Accessing a corrupted shared library */#define ENTS31/* Too many links */#define ENTSRINC81/* Attempting to link in too many shared libraries */#define ENAGE34/* Math result not representable */#define ENTSRINC81/* Interrupted system call should be restarted */#define ENAGE34/* Math result not representable */#define ENTSRINC84/* Interrupted system call should be restarted */#define ENAGE34 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
#define EISDIR21/* Is a directory */#define ENULTHOP72/* Multihop attempted */#define EINVAL22/* Invalid argument */#define ENULTHOP73/* RFG specific error */#define ENTLE23/* Pile table overflow */#define ENDERDON73/* Not a data message */#define ENTLE24/* Too many open files */#define ENDERDON75/* Value too large for defined data type */#define ENTT25/* Not a type viter */#define ENDERDON76/* Name not unique on network */#define ENDTY25/* Not alge set */#define ENDERDON77/* File descriptor in bad state */#define ENDSC26/* Text file busy */#define ELBADFD77/* File descriptor in bad state */#define ENDSC28/* No space left on device */#define ELBADFD/* Can not access a needed shared library */#define ENDSC30/* Read-only file system */#define ELBADR80/* Attempting to link in too many shared libraries */#define ENDS30/* Read-only file system */#define ELBANX81/* attempting to link in too many shared libraries */#define ENDS33/* Math argument out of domain of func */#define ELDANX82/* Attempting to link in too many shared libraries */#define ENDS34/* Secore deadock would occur */#define ENDS/* Cannot exce a shared library directly */#define ENDS35/* Resource deadock would occur */#define ENDS/* Streams pipe error */#define						
#define EINVLE22/* Invalid argument */#define EDOTOOT73/* FFR spacific error */ #define ENFILE#define EMFILE23/* File table overflow */#define ENOMSC75/* Not a data message */#define EMOTTY25/* Too many open files */#define ENOMSC75/* Value too large for defined data type */#define ENOTTY25/* Not a typewriter */#define ENOTONT76/* Name not unique on network */#define ENOTTY26/* Text file basy */#define ENOTONT77/* File descriptor in bad state */#define ENOSC28/* No space left on device */#define ELBACC78/* Remote address changed */#define ENOSC28/* No space left on device */#define ELBACC78/* Accessing a corrupted shared library */#define ENOSC30/* Read-only file system */#define ELBACC78/* Accessing a corrupted shared library */#define ENOSC30/* Read-only file system */#define ELBACC81/* Accessing a corrupted shared library */#define ENOSC31/* Too many links */#define ELBACC83/* Accessing a corrupted shared library */#define ENOSC34/* Nath argument out of domain of func */#define ELBACC84/* Alternupted system call should be restarted */#define ENOSC36/* Resource deadlock would occur */#define ENOSC84/* Tinternupted system call should be restarted */#define ENOSC37/* No re coda lock available */#define ENOSCK85 <td></td> <td></td> <td>- · · · · · · · · · · · · · · · · · · ·</td> <td></td> <td></td> <td></td>			- · · · · · · · · · · · · · · · · · · ·			
#define ENTLE23/* File table overflow */#define EBADMSG74/* Not a data message */#define ENTLE24/* Too many open files */#define EDADMSG75/* Value too large for defined dat type */#define ENTTSY25/* Not a typewriter */#define EBADMSG76/* Name not unique on network */#define ENTESY26/* Toxt file busy */#define EBADMSG77/* File descriptor in bad state */#define ENOSC28/* No space left on device */#define ELIBACC79/* Can not access a needed shared library */#define ENOSC28/* No may acce left on device */#define ELIBACC79/* Can not access a needed shared library */#define ENOSC28/* No many links */#define ELIBACC79/* Can not access a needed shared library */#define ENOSC30/* Read-only file system */#define ELIBACC81/* .lib section in a.out corrupted */#define ENDE32/* Booken pips */#define ELIBACC33/* Attempting to link in too many shared library */#define EDDM33/* Math argument out of domain of func */#define ELIBACC34/* .lib section in a.out corrupted */#define EDDALK35/* Resource dealock would occur */#define ELIBACC83/* Cannot exec a shared library */#define EDDALK35/* Resource dealock would occur */#define ENSTART85/* Interrupted system call should be restarted */#define ENOSS38/* Not record locks available */#define ENSTARTE<			-			
#define ENTLE24/* Too many open files */#define EOVERFLOW75/* Value too large for defined data type */#define ENOTTY25/* Not a typewriter */#define ENOTUNO76/* Name not unique on network */#define ENTENSY26/* Text file busy */#define ENDTUNO76/* Name not unique on network */#define EFEIG27/* Tile too large */#define ERADTD77/* File descriptor in bad state */#define ENOSEC28/* No space left on device */#define ELIBAC79/* Can not access a needed shared library */#define ENOSE30/* Read-only file system */#define ELIBAC80/* Accessing a corrupted shared library */#define ENDINK31/* Too many links */#define ELIBAC81/* .lib section in a.out corrupted */#define ENDINK31/* Too many links */#define ELIBAC83/* Cannot exec a shared library directly */#define ENDINK33/* Math argument out of domain of func */#define ELIBAC84/* Tilegal byte sequence */#define ENDAL35/* Resource dealook would occur */#define ENSERS87/* Too many users */#define ENOLCK37/* No record locks available */#define ENSERS88/* Too many users */#define ENOLCK37/* No record locks available */#define ENOTSOCK88/* Socket operation on non-socket */#define ENOSE38/* Function not implemented */#define ENOTROPT91/* Protocol not supported */#d			•			-
#define ENOTY25/* Not a typewriter */#define ENOTINIQ76/* Name not unique on network */#define ETRIESY26/* Text file busy */#define EDADED77/* File descriptor in bad state */#define EFPIG27/* File too large */#define ERDADED77/* Remote address changed */#define ENDSPC28/* No space left on device */#define ELTBACC79/* Can not access a needed shared library */#define ERDFS30/* Read-only file system */#define ELTBACC79/* Attempting to link in too many shared library */#define ENDSPC28/* Noth argument out of domain of func */#define ELTBACX81/* Attempting to link in too many shared libraries */#define EDFE32/* Broken pipe */#define ELTBKAX82/* Attempting to link in too many shared libraries */#define EDADLK33/* Math argument out of domain of func */#define ELTBKAC84/* Illegal byte sequence */#define EDADLK35/* Resource deadlock would occur */#define ESTRFIPE86/* Streams pipe error */#define ENOTYS38/* File name too long */#define EMSGEIZE90/* Too many users */#define ENOTYS38/* Function not implemented */#define EMSGEIZE90/* Message too long */#define ENOTYS38/* Function not implemented */#define EMSGEIZE90/* Mostage too long */#define ENOTYS38/* Function not implemented */#define EMSGEIZE90/* Message too long */<		23				
#define ETXTBSY26/* Text file busy */#define EBADFD77/* File descriptor in bad state */#define ETXTBSY27/* File too large */#define ELDEAC78/* Remote address changed */#define ENOSPC28/* No space left on device */#define ELIBACC78/* Can not access a needed shared library */#define ENOSPC29/* Illegal seek */#define ELIBACC79/* Accessing a corrupted shared library */#define ENOSPC30* Reado-Nly file system */#define ELIBACN80/* Accessing a corrupted shared library */#define EMLINK31/* Too many links */#define ELIBANX82/* Attempting to link in too many shared libraries */#define ENOSPC32/* Broken pipe */#define ELIBANX82/* Attempting to link in too many shared libraries */#define ENOSC34/* Math result not representable */#define ELIBANC83/* Cannot exec a shared library directly */#define ENOSCX35/* Renocte dolok would occur */#define ENOSCX86/* Interrupted system call should be restarted */#define ENOSYS36/* File name too long */#define ENOSCX86/* Destination address required */#define ENOSYS36/* Function not implemented */#define ENOSCX86/* Destination address required */#define ENOSYS38/* Function not implemented */#define ENOSCX86/* Destination address required */#define ENOSYS36/* Function not implemented */#define ENOSCXIZ <td></td> <td>24</td> <td></td> <td></td> <td></td> <td>• • • • • • • • • • • • • • • • • • • •</td>		24				• • • • • • • • • • • • • • • • • • • •
#define EFBIG27/* File too large */#define EREMCHG78/* Remote address changed */#define ENOSPC28/* No space left on device */#define ELIBACC79/* Can not access a needed shared library */#define ESPIPE29/* Illegal seek */#define ELIBACC79/* Accessing a corrupted shared library */#define ENOSPC30/* Read-only file system */#define ELIBACC81/* Accessing a corrupted shared library */#define ENOSPC30/* Read-only file system */#define ELIBACC81/* Attempting to link in corrupted */#define ENOSE30/* Read-only file system */#define ELIBACC81/* Attempting to link in corrupted */#define EDEN31/* Too many links */#define ELIBEXC81/* Attempting to link in corrupted */#define EDEN33/* Math argument out of domain of func */#define ELIBEXC84/* Illegal byte sequence */#define EDEADLK35/* Resource deadlock would occur */#define ESTRPIPE86/* Socket operation on non-socket */#define ENOSCK36/* File name too long */#define EDESTADDREND89/* Destination address required */#define ENOSTS38/* Function not implemented */#define EDSTADDREND89/* Destination address required */#define ENOSTS38/* Function not implemented */#define ENOSTDE90/* Message too long */#define ENOSTS38/* Function not implemented */#define ENOSTDE91/* Protocol not s				~	76	-
#define ENOSPC28/* No space left on device */#define ELIBACC79/* Can not access a needed shared library */#define ENOSPC29/* Illegal seek */#define ELIBACD80/* Accessing a corrupted shared library */#define ENOSPS30/* Read-only file system */#define ELIBACN81/* Accessing a corrupted shared library */#define ENDS31/* Too many links */#define ELIBACN81/* Accessing a corrupted shared library */#define ENDS32/* Broken pip */#define function a.out corrupted */#define ELIBACC83/* Attempting to link in too many shared libraries */#define EDOM33/* Math argument out of domain of func */#define ELIBEAC83/* Illegal byte sequence */#define EDALK35/* Resource deadlock would occur */#define ENSTRATE85/* Interrupted system call should be restarted */#define ENOSYS38/* No record locks available */#define ENOSSCK88/* Socket operation on non-socket */#define ENOSYS38/* Too many symbolic links encountered */#define ENOSTOPTP91/* Protocol not supported */#define ENOSS42/* No message of desired type */#define ENOTONOFTP92/* Protocol not supported */#define ENOSS42/* No message of desired type */#define ENOSOPTP91/* Protocol not supported */#define ENOSS42/* No message of desired type */#define ENOTONOFTP91/* Protocol not supported */#define ENOSS42	#define ETXTBSY	26	-	#define EBADFD	77	/* File descriptor in bad state */
#define ESPIPE29/* Illegal seek */#define ELIBBAD80/* Accessing a corrupted shared library */#define EROFS30/* Read-only file system */#define ELIBBAD81/* .lib section in a.out corrupted */#define EDLINK31/* Too many links */#define ELIBMA82/* Attempting to link in too many shared libraries */#define EDEM32/* Broken pipe */#define ELIBEAC83/* Cannot exec a shared library directly */#define EDM33/* Math argument out of domain of func */#define ELIBEAC84/* Illegal byte sequence */#define EDAMETOOLONG36/* File name too long */#define ESTRPIPE86/* Streams pipe error */#define ENOTEX37/* No record locks available */#define EDESTAS87/* Too many users */#define ENOTEX37/* No record locks available */#define ENOTSCCK88/* Socket operation on non-socket */#define ENOTEX38/* Function not implemented */#define ENOTSCCK88/* Destination address required */#define ENOTEX39/* Directory not empty */#define ENOTSCCK89/* Destination address required */#define ENOTEX39/* Directory not empty */#define ENOTSCCK89/* Protocol not available */#define ENOTEX40/* Too many symbolic links encountered */#define ENOTSCOCK89/* Portocol not available */#define ENOTEX42/* No message of desired type */#define ENOTSCOCF91/* Protocol not availabl	#define EFBIG	27	/* File too large */	#define EREMCHG	78	/* Remote address changed */
#define EROFS30/* Read-only file system */#define ELIBSCN81/* .lib section in a.out corrupted */#define EMDINK31/* Too many links */#define ELIBNAX82/* Attempting to link in too many shared libraries */#define EDIPE32/* Broken pipe */#define ELIBNAX82/* Attempting to link in too many shared libraries */#define EDOM33/* Math argument out of domain of func */#define ELIESC84/* Illegal byte sequence */#define EDEADLK35/* Resource deadlock would occur */#define ENSTART85/* Interrupted system call should be restarted */#define ENAMETOOLONG36/* File name too long */#define ENOTSOCK88/* Stocket operation on non-socket */#define ENOTSN38/* Function not implemented */#define ENOTSOCK88/* Socket operation on non-socket */#define ENOTEMPTY39/* Directory not empty */#define ENOTSOCK88/* Socket operation on non-socket */#define ENOTEMPTY39/* Directory not empty */#define ENOTOPTP91/* Protocol wrong type for socket */#define ENOTSOCKKAGAIN/* Regaring removed */#define ENOTOPTP91/* Protocol not supported */#define ENOTEMPTY39/* Directory not empty */#define ENOTOPTP91/* Protocol not supported */#define ENOTEMPTY34/* Identifier removed */#define ENOTOPTP91/* Protocol not supported */#define ENOMSG42/* No message of desired type */#define EDEAT	#define ENOSPC	28	<pre>/* No space left on device */</pre>	#define ELIBACC	79	<pre>/* Can not access a needed shared library */</pre>
#defineEMLINK31/* Too many links */#defineELIBMAX82/* Attempting to link in too many shared libraries */#defineEDPN32/* Broken pipe */#defineELIBEXEC83/* Cannot exec a shared library directly */#defineEDOM33/* Math argument out of domain of func */#defineELIBEXEC84/* Illegal byte sequence */#defineERANGE34/* Math argument out of domain of func */#defineERESTART55/* Interrupted system call should be restarted */#defineEDNDLK35/* Resource deadlock would occur */#define#defineESTRFIPE86/* Streams pipe error */#defineENOLCK37/* No record locks available */#defineENOTSOCK88/* Stock operation on non-socket */#defineENOSYS38/* Function not implemented */#defineEDESTADDRREQ89/* Destination address required */#defineELOOP40/* Too many symbolic links encountered */#defineENOSYS90/* Potocol nor available */#defineELOOP40/* Operation would block */#defineENOROTOPF91/* Protocol not supported */#defineELONSG42/* No message of desired type */#defineENOROTOPF92/* Protocol not supported */#defineELONSK43/* Identifier removed */#defineENOROTOPF92/* Protocol not supported */#defineELONSK42/* No message of	#define ESPIPE	29	/* Illegal seek */	#define ELIBBAD	80	<pre>/* Accessing a corrupted shared library */</pre>
#define EPIPE32/* Broken pipe */#define ELIBEXEC83/* Cannot exec a shared library directly */#define EDOM33/* Math argument out of domain of func */#define ELISEQ84/* Illegal byte sequence */#define ERANGE34/* Math result not representable */#define ELISEQ84/* Interrupted system call should be restarted */#define EDEADLK35/* Resource deadlock would occur */#define ESTRPIPE86/* Streams pipe error */#define ENOLCK36/* File name too long */#define EUSERS87/* Too many users */#define ENOSYS38/* Function not implemented */#define EDSTADDREQ89/* Destination address required */#define ELOP40/* Too many symbolic links encountered */#define ENOFROTOPT91/* Protocol not support of socket */#define EDOP40/* Too many symbolic links encountered */#define ENOFROTOPT92/* Protocol not support of socket */#define ENONSG42/* No message of desired type */#define ENOFNOSUPPORT93/* Socket type not supported */#define ELIBEN43/* Identifier removed */#define ESONSUPPORT93/* Socket type not supported */#define ELISNYNC45/* Level 2 not synchronized */#define EPFNOSUPPORT96/* Protocol family not supported */#define ELISNYNC45/* Level 3 halted */#define EPFNOSUPPORT96/* Protocol family not supported */#define ELISNYNC45/* Level 3 nated */#define EADDRINUS	#define EROFS	30	/* Read-only file system */	#define ELIBSCN	81	<pre>/* .lib section in a.out corrupted */</pre>
#define EDOM33/* Math argument out of domain of func */#define EILSEQ84/* Illegal byte sequence */#define ERANGE34/* Math result not representable */#define ERESTART85/* Interrupted system call should be restarted */#define EDEADLK35/* Resource deadlock would occur */#define ESTRPIPE86/* Strems pipe error */#define EDEADLK35/* Resource deadlock would occur */#define EUSERS87/* Too many users */#define ENAMETOOLONG6/* File name too long */#define EUSERS87/* Too many users */#define ENOTS38/* Function not implemented */#define EDESTADDREQ89/* Destination address required */#define ENOTEMPTY39/* Directory not empty */#define EDESTADDREQ89/* Protocol non or long */#define ELOOP40/* Too many symbolic links encountered */#define ENOTSOCK88/* Socket operation on long */#define ENONGS42/* No message of desired type */#define ENOTONOPT91/* Protocol not available */#define ELONG43/* Identifier removed */#define EOSCTNONSUPPORT93/* Protocol not supported */#define ELONG44/* Channel number out of range */#define EONTONOSUPPORT93/* Protocol not supported */#define EL2NSYNC45/* Level 2 not synchronized */#define EADRINUSE95/* Operation not supported */#define EL2NSGNC48/* Level 3 reset */#define EADDRNOTAVAIL99/* Address fa	#define EMLINK	31	/* Too many links */	#define ELIBMAX	82	<pre>/* Attempting to link in too many shared libraries */</pre>
#define ERANGE34/* Math result not representable */#define ERSTART85/* Interrupted system call should be restarted */#define EDADLK35/* Resource deadlock would occur */#define ESTRPIPE86/* Streams pipe error */#define ENAMETOOLONG36/* File name too long */#define EUSERS87/* Too many users */#define ENOLK37/* No record locks available */#define EDSTADDRREQ80/* Socket operation on non-socket */#define ENOTEMPTY39/* Directory not empty */#define ENOTOTYPE91/* Protocol not address required */#define ELOOP40/* Too many symbolic links encountered */#define ENOTOTYPE91/* Protocol not available */#define ELOOP40/* No message of desired type */#define ENONOSUPPORT91/* Protocol not available */#define ENOMSG2/* No message of desired type */#define ENONOSUPPORT91/* Protocol not supported */#define ELOPM43/* Identifier removed */#define ENONOSUPPORT92/* Protocol not supported */#define ELORNG44/* Channel number out of range */#define EONOTSUPP95/* Operation not supported */#define ELSISTNC45/* Level 3 nalted */#define EANOSUPPORT96/* Protocol family not supported */#define ELSISTNC46/* Level 3 nalted */#define EANOSUPPORT97/* Address family not supported */#define ELSISTNC45/* Level 3 nalted */#define EANOSUPPORT96/* Prot	#define EPIPE	32	/* Broken pipe */	#define ELIBEXEC	83	<pre>/* Cannot exec a shared library directly */</pre>
#define EDADLK35/* Resource deadlock would occur */#define ESTRPIPE86/* Streams pipe error */#define ENAMETOOLONG36/* File name too long */#define EUSERS87/* Too many users */#define ENOLCK37/* No record locks available */#define ENOTSOCK88/* Socket operation on non-socket */#define ENOSYS38/* Function not implemented */#define EDSTADDRRQ89/* Destination address required */#define ENOTEMPTY39/* Directory not empty */#define ENOSTOTYPE91/* Message too long */#define ENOULDBLOCKEAGAIN/* Operation would block */#define ENOPROTOTYPE91/* Protocol wrong type for socket */#define ENOMSG42/* No message of desired type */#define ENORTOTOTYPE91/* Protocol not available */#define ELORM43/* Identifier removed */#define ESOCKTNOSUPPORT93/* Protocol not supported */#define ELNSYNC44/* Channel number out of range */#define EOPNOTSUPP95/* Operation not supported */#define ELSNSYNC45/* Level 2 not synchronized */#define EADDRINOSUPPORT96/* Protocol family not supported */#define ELSNST47/* Level 3 halted */#define EADDRINUSE98/* Address family not supported */#define ELSNST48/* Link number out of range */#define EADDRINUSE96/* Protocol family not supported */#define ELNNGG48/* Link number out of range */#define EADDRINUSE98/*	#define EDOM	33	<pre>/* Math argument out of domain of func */</pre>	#define EILSEQ	84	/* Illegal byte sequence */
#define ENAMETOOLONG36/* File name too long */#define EUSERS87/* Too many users */#define ENOLCK37/* No record locks available */#define ENOTSOCK88/* Socket operation on non-socket */#define ENOSYS38/* Function not implemented */#define EDESTADDRREQ89/* Destination address required */#define ENOTEMPTY39/* Directory not empty */#define EDESTADDRREQ89/* Destination address required */#define ELOOP40/* Too many symbolic links encountered */#define ENORTOPTP91/* Protocol wrong type for socket */#define ENOMSG42/* No message of desired type */#define ENORTOPTOPT92/* Protocol not available */#define ELIDRM43/* Identifier removed */#define ESOCKTNOSUPPORT93/* Socket type not supported */#define ELINRM43/* Channel number out of range */#define EOPNOTSUPP95/* Operation not supported */#define ELINSYNC45/* Level 2 not synchronized */#define EAFNOSUPPORT96/* Protocol family not supported */#define ELINST47/* Level 3 halted */#define EAFNOSUPPORT97/* Address family not supported */#define ELINSNG48/* Link number out of range */#define EAFNOSUPPORT97/* Address family not supported */#define ELINSNG43/* Link number out of range */#define EAFNOSUPPORT97/* Address family not supported */#define ELINSNG48/* Link number out of range */#define EA	#define ERANGE	34	<pre>/* Math result not representable */</pre>	#define ERESTART	85	<pre>/* Interrupted system call should be restarted */</pre>
#defineENOLCK37/* No record locks available */#defineENOTSOCK88/* Socket operation on non-socket */#defineENOSYS38/* Function not implemented */#defineEDESTADDRREQ89/* Destination address required */#defineENOTEMPTY39/* Directory not empty */#defineEMSGSIZE90/* Message too long */#defineELOOP40/* Too many symbolic links encountered */#defineEPROTOTYPE91/* Protocol wrong type for socket */#defineENOMSG42/* No message of desired type */#defineENOPROTOOPT92/* Protocol not available */#defineEIDRM43/* Identifier removed */#defineEPROTONOSUPPORT93/* Protocol not supported */#defineELXNSYNC44/* Channel number out of range */#defineEOPNOTSUPP95/* Operation not supported */#defineELXNSYNC45/* Level 3 halted */#defineEPROSUPPORT97/* Address family not supported */#defineELXNSYNC48/* Link number out of range */#defineEADDRINUSE98/* Address already in use */#defineELXNSYNC48/* Link number out of range */#defineEADDRINUSE98/* Address already in use */	#define EDEADLK	35	<pre>/* Resource deadlock would occur */</pre>	#define ESTRPIPE	86	/* Streams pipe error */
#define ENOSYS38/* Function not implemented */#define EDESTADDRREQ89/* Destination address required */#define ENOTEMPTY39/* Directory not empty */#define EMSGSIZE90/* Message too long */#define ELOOP40/* Too many symbolic links encountered */#define EPROTOTYPE91/* Protocol wrong type for socket */#define EWOULDBLOCKEAGAIN/* Operation would block */#define ENOPROTOOPT92/* Protocol not available */#define EINMSG42/* No message of desired type */#define EPROTONOSUPPORT93/* Protocol not supported */#define ELORM43/* Identifier removed */#define EONTOSUPPORT93/* Operation not supported */#define ELORM44/* Channel number out of range */#define EONTSUPP95/* Operation not supported */#define ELINSYNC45/* Level 2 not synchronized */#define EPFNOSUPPORT96/* Protocol family not supported */#define EL3RST47/* Level 3 nalted */#define EADDRINUSE98/* Address family not supported by protocol */#define EL3RST48/* Link number out of range */#define EADDRINUSE98/* Address already in use */#define EL3RST48/* Link number out of range */#define EADDRINOTAVAIL99/* Cannot assign requested address */	#define ENAMETOOLONG	36	/* File name too long */	#define EUSERS	87	/* Too many users */
#defineENOTEMPTY39/* Directory not empty */#defineEMSGSIZE90/* Message too long */#defineELOOP40/* Too many symbolic links encountered */#defineEPROTOTYPE91/* Protocol wrong type for socket */#defineEWOULDBLOCKEAGAIN/* Operation would block */#defineENOPROTOOPT92/* Protocol not available */#defineENOMSG42/* No message of desired type */#defineEPROTONOSUPPORT93/* Protocol not supported */#defineEIDRM43/* Identifier removed */#defineESOCKTNOSUPPORT94/* Socket type not supported */#defineELNSYNC44/* Channel number out of range */#defineEOPNOTSUPP95/* Operation not supported on transport endpoint */#defineEL3NSYNC45/* Level 2 not synchronized */#defineEAFNOSUPPORT96/* Protocol family not supported */#defineEL3RST47/* Level 3 halted */#defineEADDRINUSE98/* Address already in use */#defineEL3RNG48/* Link number out of range */#defineEADDRINOTAVAIL99/* Cannot assign requested address */	#define ENOLCK	37	/* No record locks available */	#define ENOTSOCK	88	<pre>/* Socket operation on non-socket */</pre>
#define ELOOP40/* Too many symbolic links encountered */ #define EWOULDBLOCK#define EPROTOTYPE91/* Protocol wrong type for socket */#define EWOULDBLOCKEAGAIN/* Operation would block */#define ENOPROTOOPT92/* Protocol not available */#define ENOMSG42/* No message of desired type */#define EPROTONOSUPPORT93/* Protocol not supported */#define EIDRM43/* Identifier removed */#define ESOCKTNOSUPPORT94/* Socket type not supported */#define ECHRNG44/* Channel number out of range */#define EOPNOTSUPP95/* Operation not supported on transport endpoint */#define EL2NSYNC45/* Level 2 not synchronized */#define EAFNOSUPPORT96/* Protocol family not supported */#define EL3HLT46/* Level 3 halted */#define EAFNOSUPPORT97/* Address family not supported by protocol */#define EL3RST47/* Level 3 reset */#define EADDRINUSE98/* Address already in use */#define ELNRNG48/* Link number out of range */#define EADDRNOTAVAIL99/* Cannot assign requested address */	#define ENOSYS	38	<pre>/* Function not implemented */</pre>	#define EDESTADDRREQ	89	<pre>/* Destination address required */</pre>
#define EWOULDBLOCKEAGAIN/* Operation would block */#define ENOPROTOOPT92/* Protocol not available */#define ENOMSG42/* No message of desired type */#define EPROTONOSUPPORT93/* Protocol not supported */#define EIDRM43/* Identifier removed */#define ESOCKTNOSUPPORT94/* Socket type not supported */#define ECHRNG44/* Channel number out of range */#define EOPNOTSUPP95/* Operation not supported on transport endpoint */#define EL2NSYNC45/* Level 2 not synchronized */#define EPFNOSUPPORT96/* Protocol family not supported */#define EL3HLT46/* Level 3 halted */#define EAFNOSUPPORT97/* Address family not supported by protocol */#define EL3RST47/* Level 3 reset */#define EADDRINUSE98/* Address already in use */#define ELNRNG48/* Link number out of range */#define EADDRNOTAVAIL99/* Cannot assign requested address */	#define ENOTEMPTY	39	/* Directory not empty */	#define EMSGSIZE	90	/* Message too long */
#define EWOULDBLOCKEAGAIN/* Operation would block */#define ENOPROTOOPT92/* Protocol not available */#define ENOMSG42/* No message of desired type */#define EPROTONOSUPPORT93/* Protocol not supported */#define EIDRM43/* Identifier removed */#define ESOCKTNOSUPPORT94/* Socket type not supported */#define ECHRNG44/* Channel number out of range */#define EOPNOTSUPP95/* Operation not supported on transport endpoint */#define EL2NSYNC45/* Level 2 not synchronized */#define EPFNOSUPPORT96/* Protocol family not supported */#define EL3HLT46/* Level 3 halted */#define EADDRINUSE98/* Address already in use */#define EL3RST47/* Level 3 reset */#define EADDRINOTAVAIL99/* Cannot assign requested address */	#define ELOOP	40	/* Too many symbolic links encountered */	#define EPROTOTYPE	91	/* Protocol wrong type for socket */
#define EIDRM43/* Identifier removed */#define ESOCKTNOSUPPORT 94/* Socket type not supported */#define ECHRNG44/* Channel number out of range */#define EOPNOTSUPP95/* Operation not supported on transport endpoint */#define EL2NSYNC45/* Level 2 not synchronized */#define EPFNOSUPPORT96/* Protocol family not supported */#define EL3HLT46/* Level 3 halted */#define EAFNOSUPPORT97/* Address family not supported by protocol */#define EL3RST47/* Level 3 reset */#define EADDRINUSE98/* Address already in use */#define ELNRNG48/* Link number out of range */#define EADDRNOTAVAIL99/* Cannot assign requested address */	#define EWOULDBLOCK	EAGAIN	/* Operation would block */	#define ENOPROTOOPT	92	
#define EIDRM43/* Identifier removed */#define ESOCKTNOSUPPORT 94/* Socket type not supported */#define ECHRNG44/* Channel number out of range */#define EOPNOTSUPP95/* Operation not supported on transport endpoint */#define EL2NSYNC45/* Level 2 not synchronized */#define EPFNOSUPPORT96/* Protocol family not supported */#define EL3HLT46/* Level 3 halted */#define EAFNOSUPPORT97/* Address family not supported by protocol */#define EL3RST47/* Level 3 reset */#define EADDRINUSE98/* Address already in use */#define ELNRNG48/* Link number out of range */#define EADDRNOTAVAIL99/* Cannot assign requested address */	#define ENOMSG	42	/* No message of desired type */	#define EPROTONOSUPPORT	93	/* Protocol not supported */
#define ECHRNG44/* Channel number out of range */#define EOPNOTSUPP95/* Operation not supported on transport endpoint */#define EL2NSYNC45/* Level 2 not synchronized */#define EPFNOSUPPORT96/* Protocol family not supported */#define EL3HLT46/* Level 3 halted */#define EAFNOSUPPORT97/* Address family not supported by protocol */#define EL3RST47/* Level 3 reset */#define EADDRINUSE98/* Address already in use */#define ELNRNG48/* Link number out of range */#define EADDRNOTAVAIL99/* Cannot assign requested address */	#define EIDRM	43	5 11			
#define EL2NSYNC45/* Level 2 not synchronized */#define EPFNOSUPPORT96/* Protocol family not supported */#define EL3HLT46/* Level 3 halted */#define EAFNOSUPPORT97/* Address family not supported by protocol */#define EL3RST47/* Level 3 reset */#define EADDRINUSE98/* Address already in use */#define ELNRNG48/* Link number out of range */#define EADDRNOTAVAIL99/* Cannot assign requested address */						
#define EL3HLT46/* Level 3 halted */#define EAFNOSUPPORT97/* Address family not supported by protocol */#define EL3RST47/* Level 3 reset */#define EADDRINUSE98/* Address already in use */#define ELNRNG48/* Link number out of range */#define EADDRNOTAVAIL99/* Cannot assign requested address */			-			
#define EL3RST 47 /* Level 3 reset */ #define EADDRINUSE 98 /* Address already in use */ #define ELNRNG 48 /* Link number out of range */ #define EADDRNOTAVAIL 99 /* Cannot assign requested address */						
#define ELNRNG 48 /* Link number out of range */ #define EADDRNOTAVAIL 99 /* Cannot assign requested address */						
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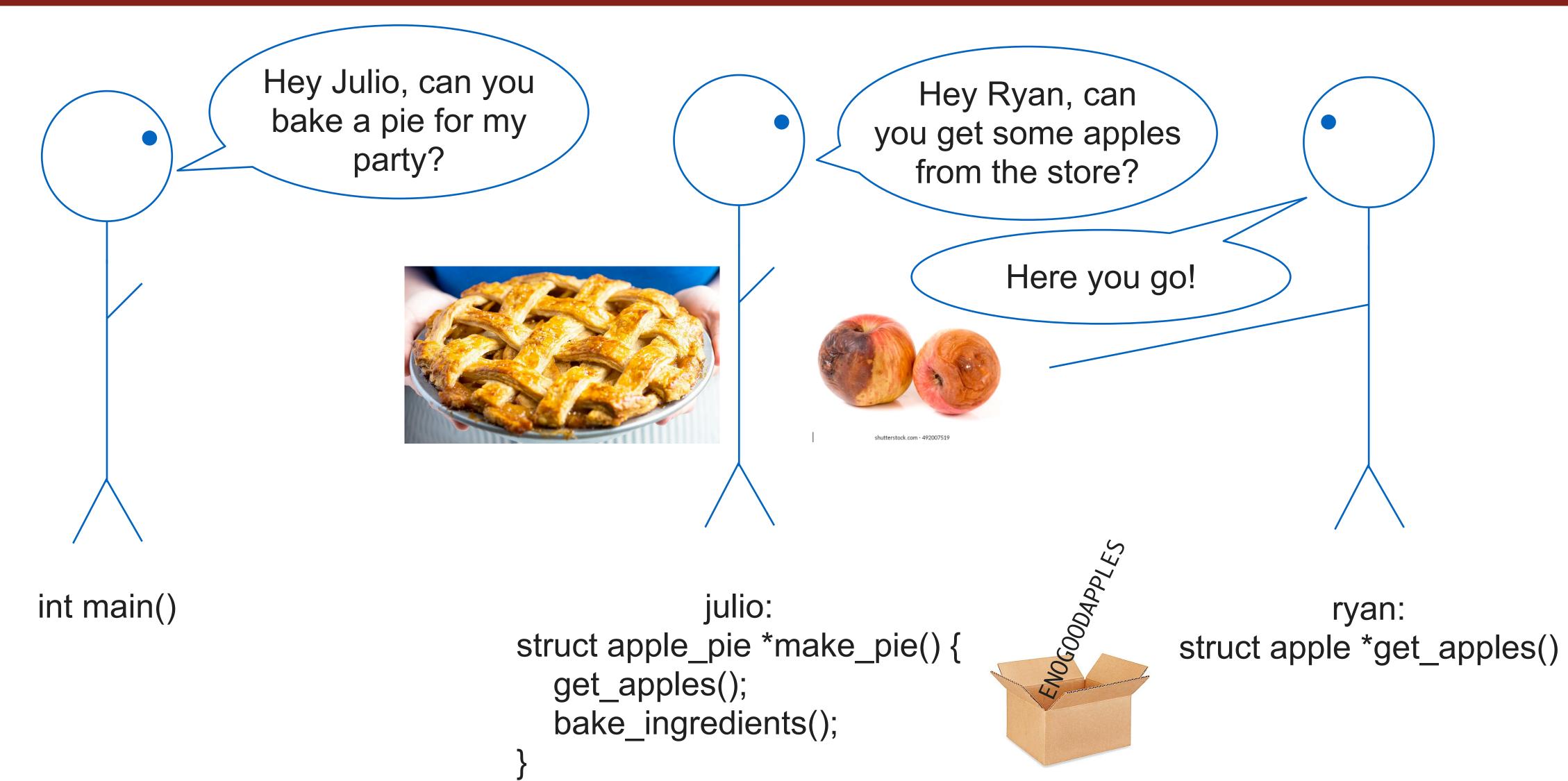
*/

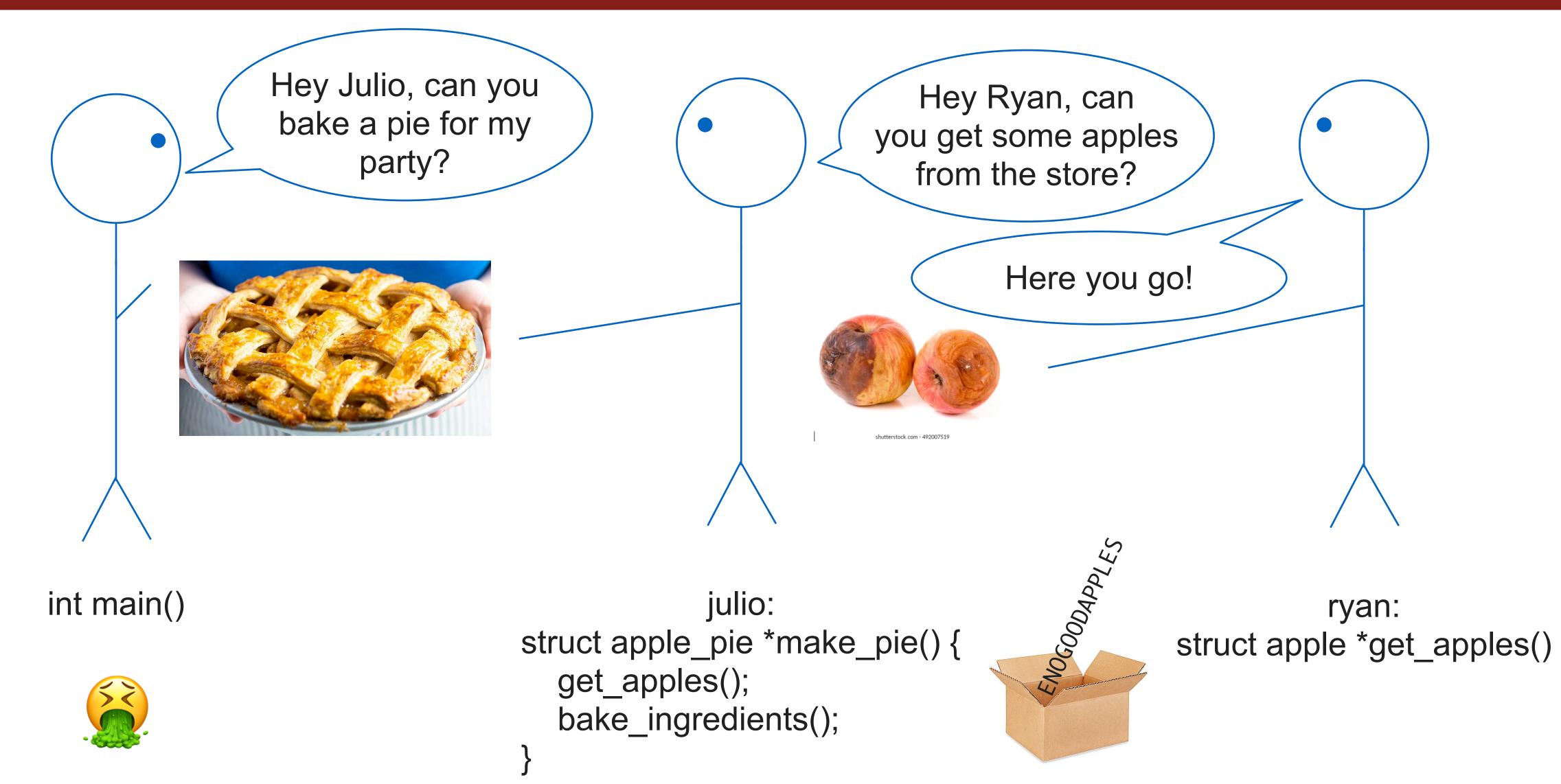


```
julio:
struct apple_pie *make_pie() {
```









Broken code from earlier

```
struct message {
    size_t length;
    size_t field1_offset;
    size_t field2_offset;
    size_t field3_offset;
    char payload[];
```

// Processing part of a received message: void *local_copy = malloc(message->length); // Validate field1_offset is within the buffer (no buffer overflows!) assert(message->field1_offset + FIELD_1_LENGTH <= message->length); // Copy the field and process it memcpy(local_copy + message->field1_offset, message->payload + message->field1_offset, FIELD_1_LENGTH); process_field_1(local_copy + message->field1_offset);



```
Missing error check!
```







CVE-2015-8812

- Critical Linux kernel vulnerability: by sending a malformed network packet, a remote attacker could execute arbitrary code in the kernel
- A set of kernel networking functions were returning -1 for error, 0 for success, but also other values for "warnings"
 Returned NET_XMIT_CN (defined to be 2) when congestion was detected
- Code calling these functions saw r was a network error
- Freed memory that was still being used for the network. Use-after-free + double free!
- Returned NET_XMIT_CN (defined to be 2) when congestion was detected Code calling these functions saw nonzero return code and assumed there



The fix

--- a/drivers/infiniband/hw/cxgb3/iwch cm.c +++ b/drivers/infiniband/hw/cxgb3/iwch_cm.c 12t_en error = l2t_send(tdev, skb, l2e);

```
if (error < 0)
```

kfree_skb(skb);

```
return error;
```

```
return error < 0 ? error : 0;</pre>
```

@@ -149,7 +149,7 @@ static int iwch_l2t_send(struct t3cdev *tdev, struct sk_buff *skb, struct





Proper C error checking is ugly

- \bigcirc
- handle it **correctly**

```
This isn't good enough (why not?):
\bigcirc
   void *buf = malloc();
   if (buf == NULL) {
       perror("error allocating memory");
```

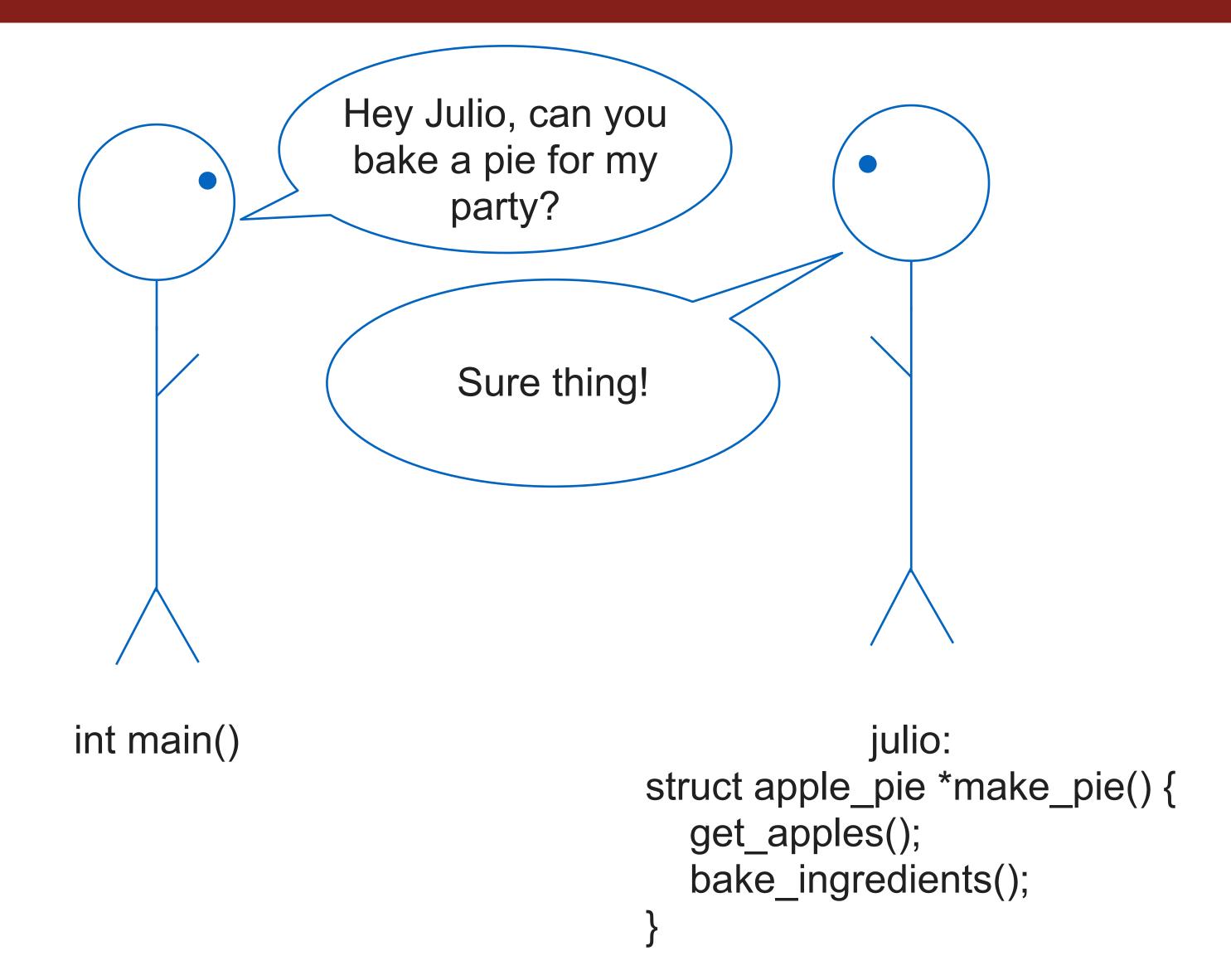
```
memcpy(buf + offset, src, size);
```

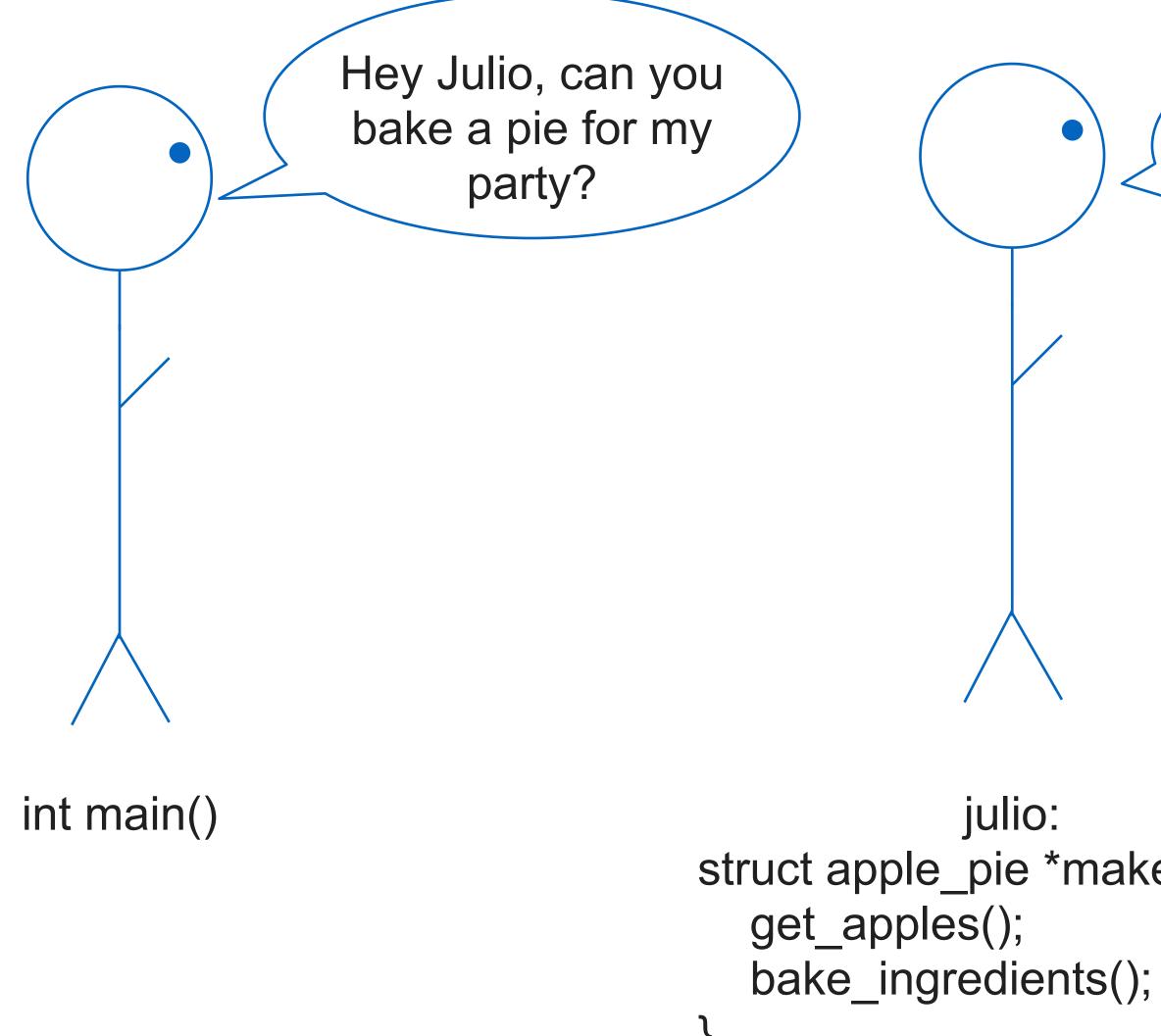
- - \bigcirc returned

Programmer must remember whether the function they are calling might return an error Places immense burden on the programmer to remember how each specific function works After every function call that might return an error, must check whether an error occurred and

Handling specific errors using errno can produce an error-prone mess of if statements Sometimes function documentation does not even properly document what errors might be



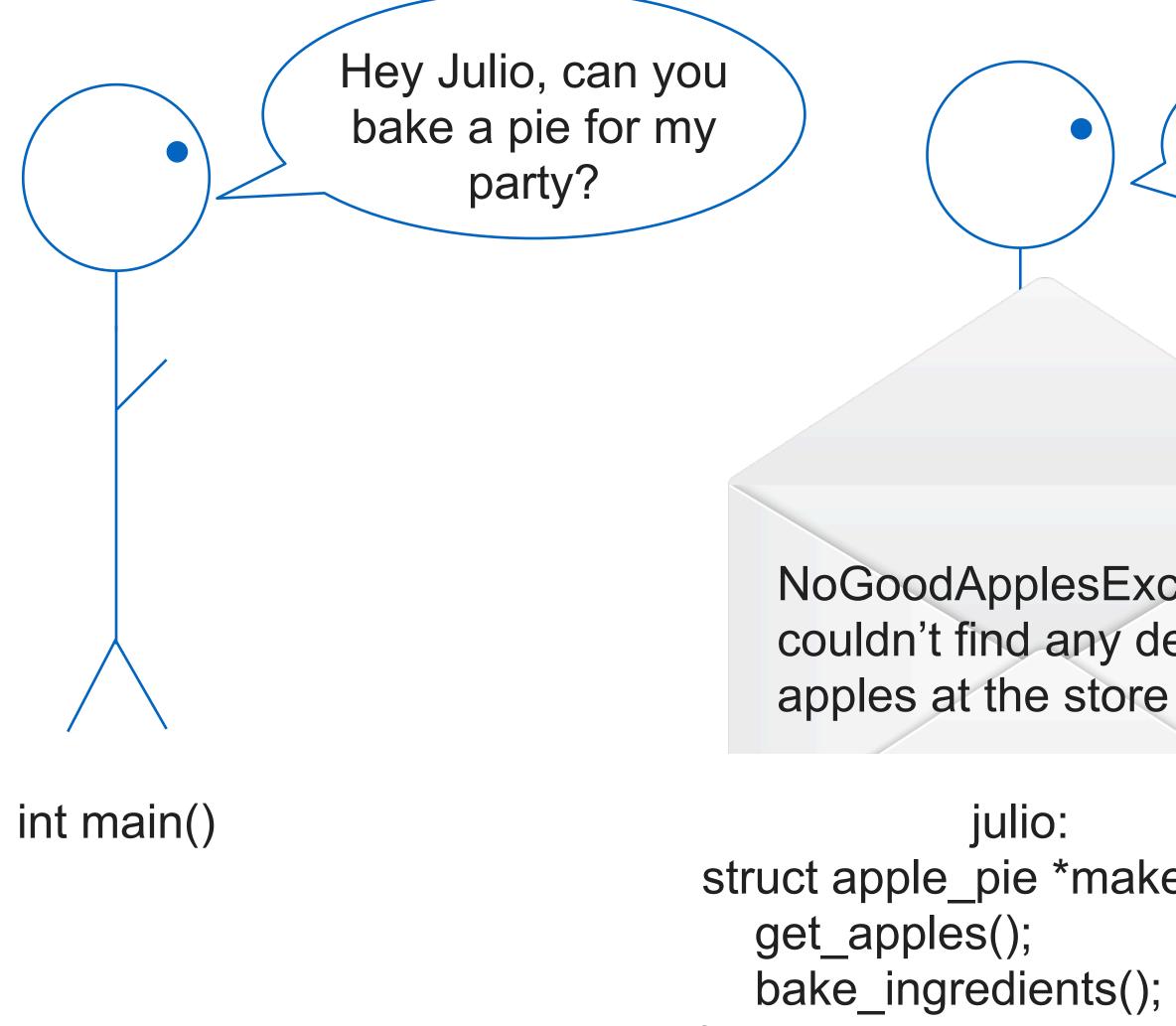




Hey Ryan, can you get some apples from the store?

> NoGoodApplesException: couldn't find any decent apples at the store

julio: struct apple_pie *make_pie() {



Hey Ryan, can you get some apples from the store?

NoGoodApplesException: couldn't find any decent

julio: struct apple_pie *make_pie() {

Hey Julio, can you bake a pie for my party?

NoGoodApplesException: couldn't find any decent apples at the store

int main()



julio: struct apple_pie *make_pie() { get_apples(); bake_ingredients();

Hey Ryan, can you get some apples from the store?

Massive improvements over C-style error handling

- You don't have to write error propagation code every time you call a function that might produce an error
 - Exceptions propagate up the stack automatically until they are handled by \bigcirc a try/catch
- Errors will not go unnoticed
 - Worst case scenario, they'll propagate up to main() and crash the program \bigcirc Sounds bad, but a crash is much better than the program continuing to
 - \bigcirc run in an undefined state







Except Exceptions

- Why might exceptions not be so hot?
 - Failure modes become hard to reason about: any function can throw any \bigcirc exception at any time
 - Code might fail because of an exception that was thrown by a totally unrelated function twelve function calls away
 - Hard to spot where errors may occur
 - What if you call a helper function in a destructor that ends up throwing an exception?
 - Even harder to manage in evolving codebases as new errors are added Exceptions are forbidden in many codebases for this reason
 - Can cause resource leaks and other unexpected behavior \bigcirc

Exceptions without RAII = sad times

```
void process_input() {
    char *buf = malloc(128);
```

```
// read input from user:
fgets(buf, 128, stdin);
// do more processing on input:
some_helper(input);
```

```
free(buf);
```

```
}
```

Looks good to me?

```
int main() {
    while (true) {
        try {
            process_input();
        } catch (BadInputError) {
            cerr << "That wasn't valid, try again" << endl;</pre>
        }
    }
void some_helper(string input) {
    if (input == "uh oh") {
        throw BadInputError("I don't like that");
```

}

An enum (enumeration) is a type that can contain one of several variants enum TrafficLightColor { Type TrafficLightColor Red, Yellow, Variants Green,

let current_state: TrafficLightColor = TrafficLightColor::Green;

must be covered fn drive(light_state: TrafficLightColor) { match light_state { TrafficLightColor::Green => println!("zoom zoom!"), TrafficLightColor::Red => println!("sitting like a boulder!"),

A match expression is like a switch statement in C/C++/Java, except all possible variants

```
error[E0004]: non-exhaustive patterns: `Yellow` not covered
 --> src/lib.rs:8:11
     enum TrafficLightColor {
1
          Red,
2
3
          Yellow,
          ---- not covered
          Green,
5
        `TrafficLightColor` defined here
. . .
         match light_state {
8
                ^^^^^^ pattern `Yellow` not covered
  = help: ensure that all possible cases are being handled, possibly by
adding wildcards or more match arms
```

= note: the matched value is of type `TrafficLightColor`



An enum (enumeration) is a type that can contain one of several variants enum TrafficLightColor { Type TrafficLightColor Red, Yellow, Variants Green,

let current_state: TrafficLightColor = TrafficLightColor::Green;

- must be covered fn drive(light_state: TrafficLightColor) { match light_state { TrafficLightColor::Green => println!("zoom zoom!"), TrafficLightColor::Yellow => println!("slowing down..."), TrafficLightColor::Red => println!("sitting like a boulder!"),
 - The compiler will warn you if there's a possibility you missed!

A match expression is like a switch statement in C/C++/Java, except all possible variants

interested in: match light_state { TrafficLightColor::Green => println!("zoom zoom!"), }

Can use a default binding to catch all other cases if there's only a few you're

```
Unlike enums in most common languages, Rust enums can store arbitrary data!
enum Location {
      Coordinates(f32, f32),
      Address(String),
      Unknown,
   You can extract data from variants using a match expression:
fn print_location(loc: Location) {
      match loc {
           Location::Coordinates(lat, long) => {
               println!("Person is at ({}, {})", lat, long);
           },
           Location::Address(addr) => {
              println!("Person is at {}", addr);
           },
           Location::Unknown => println!("Location unknown!"),
```

print_location(Location::Address("353 Jane Stanford Way".to_string());

Error handling in Rust

 \bigcirc If an error happens, return Err(some error object) \bigcirc enum Result<T, E> { Ok(T),Err(E),}

What if we use enums to clearly represent successful returns / errors? If the functions run successfully, return Ok(whatever return value)

> (this Result type is part of the Rust standard library, no need to define it yourself)

Usage of Result

fn gen_num_sometimes() -> Result<u32, &'static str> { if get_random_num() > 10 { Ok(get random num()) } else { Err("Spontaneous failure!")

```
fn main() {
   match gen num sometimes() {
```

Success return type Error return type

Ok(num) => println!("Got number: {}", num), Err(message) => println!("Operation failed: {}", message),

Comparison to C errors

- We had two main issues with C error handling:
 - It's too easy to miss errors \bigcirc
 - \bigcirc
- Second problem is still an issue!



Proper error handling is too verbose (need too much extra code to propagate errors) This fixes the first problem: it's now obvious from the function signature which functions can return errors, and the compiler will verify that you do something with a returned error

Comparison to C errors

- Error handling is still too verbose:
- fn read file(filename: &str) -> Result<String, io::Error> { let mut s = String::new();
 - let result = File::open(filename);

```
let mut f = match result {
   Ok(file) => file,
   Err(e) => return Err(e),
};
```

```
match f.read_to_string(&mut s) {
    Ok(_) => Ok(s),
    Err(e) => Err(e),
}
```

Meet the ? operator

- Suppose we have helper_function() -> Result<T, E>
- let val: T = helper_function()? means:
 If helper_function returns 0k(some value), set val = that value
 If helper function returns Err(some error), stop and return/propagate that error

```
fn read_file(filename: &str) -> Result<String, io::Error> { fn read_file(filename: &str) -> Result<String, io::Error> {
    let mut s = String::new();
    let mut f = match File::open(filename) {
        Ok(file) => file,
        Err(e) => return Err(e),
    };
    match f.read_to_string(&mut s) {
        ok(_) => Ok(s),
        Err(e) => return Err(e),
    }
}
```



Meet the ? operator

- Suppose we have helper_function() -> Result<T, E>
- let val: $T = helper_function()?$ means: If helper_function returns 0k(some value), set val = that value \bigcirc If helper function returns Err(some error), stop and return/propagate that error \bigcirc

```
fn read file(filename: &str) -> Result<String, io::Error> {
   let mut s = String::new();
                                                             Even shorter:
   let mut f = match File::open(filename) {
                                                             fn read file(filename: &str) -> Result<String, io::Error> {
       Ok(file) => file,
                                                                 let mut s = String::new();
       Err(e) => return Err(e),
                                                                 File::open(filename)?.read to string(&mut s)?;
   };
                                                                 Ok(s)
   match f.read to string(&mut s) {
       Ok() => Ok(s),
       Err(e) => return Err(e),
```



Meet the ? operator

- Why doesn't this code compile? fn read_file(filename: &str) -> String { let mut contents = String::new(); File::open(filename)?.read_to_string(&mut contents)?; contents
 - }
- (i.e. it cannot return an error)

Note that the ? operator is for *propagating* errors, and this function returns String

Panics

- What about errors that we don't wish to propagate/handle?
 - Could be a serious, unrecoverable error \bigcirc
 - Could be an error that we don't anticipate ever happening and don't want to put the effort into \bigcirc handling
- The panic! macro crashes a program immediately with an error message if sad_times() { panic!("Sad times!");

- Sometimes, a library function may give us an Err that we really don't care to handle in any graceful way E.g. if we are a terminal program and we fail to read input from the terminal, there isn't really \bigcirc
 - anything graceful to do
 - Result::unwrap() and Result::expect() allow us to extract the returned value from an 0k() Ο result, panicking if we got an Err



unwrap() and expect()

// Panic if opening a file fails:
let mut file = File::open(filename).unwrap();
// Same thing, but print a more descriptive error message when panicking:
let mut file = File::open(filename).expect("Failed to open file");

// Panic if reading from stdin fails:
let mut input = String::new();
io::stdin().read_to_string(&mut input).expect("Failed to read from stdin");

Handling nulls



"I call it my billion-dollar mistake. It was the invention of the null reference in 1965. At that time, I was designing the first comprehensive type system for references in an object oriented language (ALGOL W). My goal was to ensure that all use of references should be absolutely safe, with checking performed automatically by the compiler. But I couldn't resist the temptation to put in a null reference, simply because it was so easy to implement. This has led to innumerable errors, vulnerabilities, and system crashes, which have probably caused a billion dollars of pain and damage in the last forty years."

- Tony Hoare



CVE Listy

CNAs₇

Search CVE List

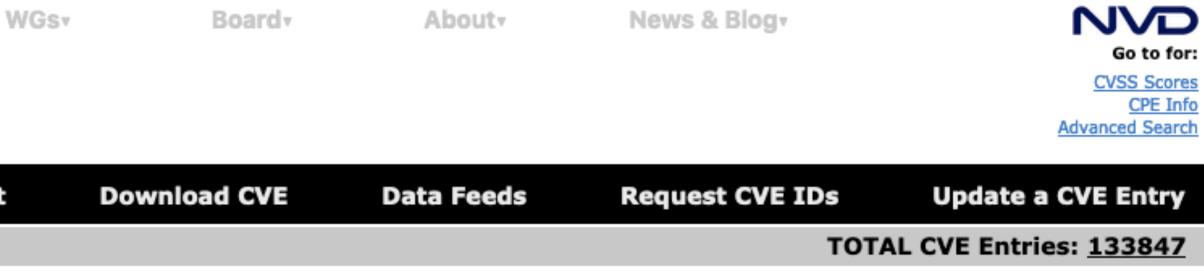
HOME > CVE > SEARCH RESULTS

Search Results

There are **1627** CVE entries that match your search.

Name	
<u>CVE-2020-9759</u>	An issue was discovered in WeeChat before 2.7.1 (0.4.0 to 2.7 are a function, resulting in a crash.
<u>CVE-2020-9385</u>	A NULL Pointer Dereference exists in libzint in Zint 2.7.1 because m during EAN barcode generation.
CVE-2020-9327	In SQLite 3.31.1, isAuxiliaryVtabOperator allows attackers to trigger
<u>CVE-2020-8859</u>	This vulnerability allows remote attackers to create a denial-of-servi not required to exploit this vulnerability. The specific flaw exists with pointer. An attacker can leverage this vulnerability to create a denia
CVE-2020-8448	In OSSEC-HIDS 2.7 through 3.5.0, the server component responsib via crafted messages written directly to the analysisd UNIX domain
CVE-2020-8011	CA Unified Infrastructure Management (Nimsoft/UIM) 9.20 and belo attacker can crash the Controller service.
CVE-2020-8002	A NULL pointer dereference in vrend_renderer.c in virglrenderer thre without previously providing a Compute Shader (CS).
CVE-2020-7105	async.c and dict.c in libhiredis.a in hiredis through 0.14.0 allow a NU
<u>CVE-2020-7062</u>	In PHP versions 7.2.x below 7.2.28, 7.3.x below 7.3.15 and 7.4.x be session.upload_progress.cleanup is set to 0 (disabled), and the file pointer dereference, which would likely lead to a crash.
CVE-2020-6795	When processing a message that contains multiple S/MIME signatur crash. This vulnerability affects Thunderbird < 68.5.
CVE-2020-6631	An issue was discovered in GPAC version 0.8.0. There is a NULL poin

NULL pointer dereferences



Description

affected). A malformed message 352 (who) can cause a NULL pointer dereference in the callback

nultiple + characters are mishandled in add_on in upcean.c, when called from eanx in upcean.c

er a NULL pointer dereference and segmentation fault because of generated column optimizations.

vice condition on affected installations of ELOG Electronic Logbook 3.1.4-283534d. Authentication is thin the processing of HTTP parameters. A crafted request can trigger the dereference of a null ial-of-service condition. Was ZDI-CAN-10115.

ble for log analysis (ossec-analysisd) is vulnerable to a denial of service (NULL pointer dereference) socket by a local user.

ow contains a null pointer dereference vulnerability in the robot (controller) component. A remote

rough 0.8.1 allows attackers to cause a denial of service via commands that attempt to launch a grid

IULL pointer dereference because malloc return values are unchecked.

below 7.4.3, when using file upload functionality, if upload progress tracking is enabled, but upload fails, the upload procedure would try to clean up data that does not exist and encounter null

res, a bug in the MIME processing code caused a null pointer dereference, leading to an unexploitable

pinter dereference in the function gf_m2ts_stream_process_pmt() in media_tools/m2ts_mux.c.

Nulls -> not null damage

- Most null pointer dereferences simply cause crashes (denial of service)... but not all CVE-2009-2694 in Pidgin messenger: https://www.cvedetails.com/cve/CVE-2009-2694/ msn_slplink_message_find() retrieves previously-received parts of a message Special types of messages ("acknowledgement messages") don't have any message contents. message->buffer is set to NULL

- When trying to re-assemble received data, msn_slplink_process_msg() calls msn_slplink_message_find() and then runs memcpy(slpmsg->buffer + offset, data, len);
- slpmsg->buffer is null, so the attacker-supplied offset can be used to control what memory gets overwritten
- Similar vulnerability in Adobe Acrobat Pro: https://www.zerodayinitiative.com/advisories/ ZDI-19-871/





A sticky situation

- Why are NULLs so dangerous?
 - \bigcirc pointer, you need to think, is it possible for this to be NULL?
 - \bigcirc riddled with false positives
- What should we do about it?

They place a huge burden on the programmer: any time you have a Static analyzers can't warn about all the possible NULLs without being

enum Option<T> {
 None,
 Some(T),
}

(also from in the standard library)

```
fn feeling_lucky() -> Option<String> {
    if get_random_num() > 10 {
        Some(String::from("I'm feeling lucky!"))
    } else {
        None
    }
}
```

```
fn feeling_lucky() -> Option<String> {
    if get_random_num() > 10 {
        Some(String::from("I'm feeling lucky!"))
    } else {
        None
    }
}
```

```
match feeling_lucky() {
   Some(message) => {
      println!("Got message: {}", message);
   },
   None => {
      println!("No message returned :-/");
   },
}
```

```
fn feeling lucky() -> Option<String> {
    if get random num() > 10 {
    } else {
        None
```

// Check if is none/is some(): if feeling lucky().is none() { println!("Not feeling lucky :("); }

// unwrap/expect work here too: let message = feeling lucky().unwrap(); **let** message = feeling lucky().expect("feeling lucky failed us!");

// you can also provide a default value in case None was returned: **let** message = feeling lucky().unwrap or("Not lucky :(".to string());

// ? operator also works in functions that return Option: **let** expanded message = feeling lucky()? + " Are you?";

Some(String::from("I'm feeling lucky!"))