Introduction to Channel Access Clients

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Argonne National Laboratory

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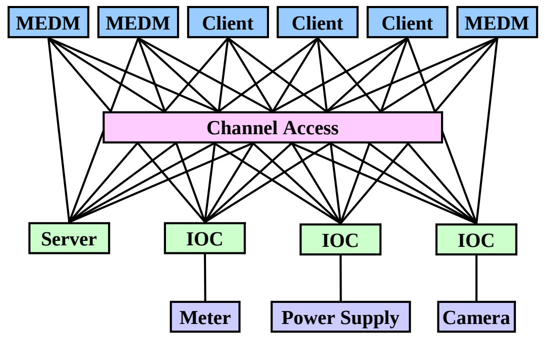
Outline

- **Channel Access Concepts**
- **Channel Access API**
- **Simple CA Client**
- **Simple CA Client with Callbacks**
- **EPICS Build System**

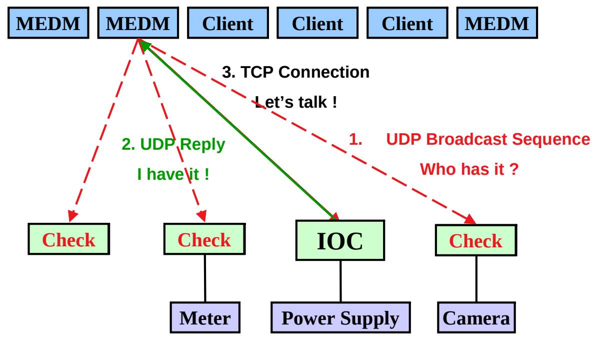
Channel Access Reference Manual

- **The place to go for more information**
- **Found in the EPICS web pages**
  - http://www.aps.anl.gov/epics/index.php
  - Look under Documents
  - Also under Base, then a specific version of Base

EPICS Overview



Search and Connect Procedure



Search Request

- **A search request consists of a sequence of UDP packets**
  - Only goes to EPICS_CA_ADDR_LIST
  - Starts with a small interval (30 ms), that doubles each time
  - Until it gets larger than 5 s, then it stays at 5 s
  - Stops after 100 packets or when it gets a response
  - Never tries again until it sees a beacon anomaly or creates a new PV
  - Total time is about 8 minutes to do all 100

- **Servers have to do an Exist Test for each packet**
- **Usually connects on the first packet or the first few**
- **Non-existent PVs cause a lot of traffic**
  - Try to eliminate them

Beacons

- **A Beacon is a UDP broadcast packet sent by a Server**
- **When it is healthy, each Server broadcasts a UDP beacon at regular intervals (like a heartbeat)**
  - EPICS_CA_BEACON_PERIOD, 15 s by default

- **When it is coming up, each Server broadcasts a startup sequence of UDP beacons**
  - Starts with a small interval (25 ms, 75 ms for VxWorks)
  - Interval doubles each time
  - Until it gets larger than 15 s, then it stays at 15 s
    - *Takes about 10 beacons and 40 s to get to steady state*

- **Clients monitor the beacons**
  - Determine connection status, whether to reissue searches

Virtual Circuit Disconnect

- **3.13 and early 3.14**
  - Hang-up message or no response from server for 30 sec.
  - If not a hang-up, then client sends "Are you there" query
  - If no response for 5 sec, TCP connection is closed
  - MEDM screens go white
  - Clients reissue search requests
- **3.14 5 and later**
  - Hang-up message from server
  - TCP connection is closed
  - MEDM screens go white
  - Clients reissue search requests

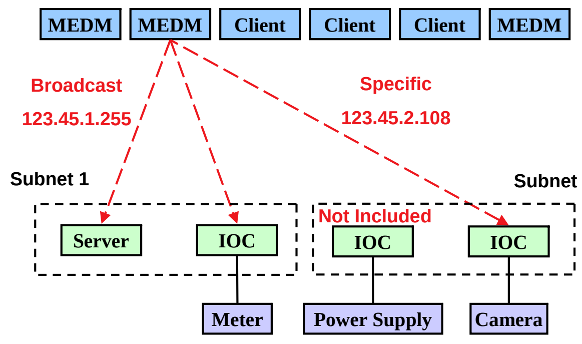
Virtual Circuit Unresponsive

- **3.14.5 and later**
  - No response from server for 30 sec.
  - Client then sends “Are you there” query
  - If no response for 5 sec, TCP connection is not closed
    - *For several hours, at least*
  - MEDM screens go white
  - Clients do not reissue search requests
    - *Helps with network storms*
  - Clients that do not call ca_poll frequently get a virtual circuit disconnect even though the server may be OK
    - *Clients written for 3.13 but using 3.14 may have a problem*
    - *May be changed in future versions*

Important Environment Variables

- **EPICS_CA_ADDR_LIST**
  - Determines where to search
  - Is a list (separated by spaces)
    - *“123.45.1.255 123.45.2.14 123.45.2.108”*
  - Default is broadcast addresses of all interfaces on the host
    - *Works when servers are on same subnet as Clients*
  - Broadcast address
    - *Goes to all servers on a subnet*
    - *Example: 123.45.1.255*
    - *Use ifconfig –a on UNIX to find it (or ask an administrator)*
- **EPICS_CA_AUTO_ADDR_LIST**
  - YES: Include default addresses above in searches
  - NO: Do not search on default addresses
  - If you set EPICS_CA_ADDR_LIST, usually set this to NO

EPICS_CA_ADDR_LIST



Other Environment Variables

CA Client	CA Server
EPICS_CA_ADDR_LIST	EPICS_CAS_SERVER_PORT
EPICS_CA_AUTO_ADDR_LIST	EPICS_CAS_AUTO_BEACON_ADDR_LIST
EPICS_CA_CONN_TMO	EPICS_CAS_BEACON_ADDR_LIST
EPICS_CA_BEACON_PERIOD	EPICS_CAS_BEACON_PERIOD
EPICS_CA_REPEATER_PORT	EPICS_CAS_BEACON_PORT
EPICS_CA_SERVER_PORT	EPICS_CAS_INTF_ADDR_LIST
EPICS_CA_MAX_ARRAY_BYTES	EPICS_CAS_IGNORE_ADDR_LIST
EPICS_TS_MIN_WEST	

- **See the Channel Access Reference Manual for more information**

3.13 and 3.14 Similarities

- **Much effort has done into making clients written for 3.13 work with 3.14 with no changes to the coding**
- **Even large programs like MEDM have had to make only a few minor changes**
- **This means existing programs typically do not need to be rewritten**
  - This is good!
- **In contrast, Channel Access Servers require many changes in converting to 3.14**

3.13 and 3.14 Differences

- **3.14 is threaded**
  - Your program does not have to be threaded
- **3.14 has different names for some functions**
  - ca_context_create for ca_task_initialize
  - ca_context_destroy for ca_task_exit
  - ca_create_channel for ca_search_and_connect
  - ca_create_subscription for ca_add_event
  - ca_clear_subscription for ca_clear_event
  - The new functions may have more capabilities, usually related to threading
  - We will use the new names
- **3.14 has a different mechanism for lost connections**
  - Virtual circuit unresponsive (Not available in 3.13)
  - Virtual circuit disconnected

Basic Procedure for a Channel Access Client

- **Initialize Channel Access**
  - ca_task_initialize or ca_context_create
- **Search**
  - ca_search_and_connect or ca_create_channel
- **Do get or put**
  - ca_get or ca_put
- **Monitor**
  - ca_add_event or ca_create_subscription
- **Give Channel Access a chance to work**
  - ca_poll, ca_pend_io, ca_pend_event
- **Clear a channel**
  - ca_clear_channel
- **Close Channel Access**
  - ca_task_exit or ca_context_destroy

cadef.h

- **All C or C++ programs must include cadef.h**
  - `#include <cadef.h>`
- **You can look at this file to get more insight into Channel Access**
- **This presentation will use C examples**
  - We will try to emphasize concepts, not the language
  - Even if you do not use C, it is important to understand what is going on behind what you do use

ca_context_create

```
enum ca_preemptive_callback_select {
      ca_disable_preemptive_callback,
      ca_enable_preemptive_callback };
int ca_context_create (
      enum ca_preemptive_callback_select SELECT );
```

- Should be called once prior to any other calls
- Sets up Channel Access
- Use `SELECT=ca_disable_preemptive_callback`
  - Unless you intend to do threads
- Can also use ca_task_initialize() for 3.13 compatibility

ca_context_destroy

```
void ca_context_destroy ();
```

- Should be called before exiting your program
- Shuts down Channel Access
- Can also use ca_task_exit() for 3.13 compatibility

ca_create_channel

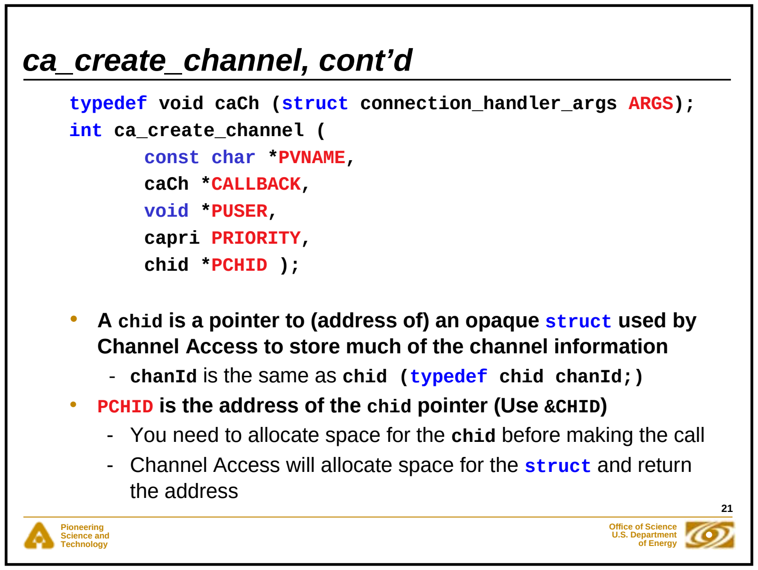
```
typedef void caCh (struct connection_handler_args ARGS);
int ca_create_channel (
      const char *PVNAME,
      caCh *CALLBACK,
      void *PUSER,
      capri PRIORITY,
      chid *PCHID );
```

- Sets up a channel and starts the search process
- `PVNAME` is the name of the process variable
- `CALLBACK` is the name of your connection callback (or NULL)
  - The callback will be called whenever the connection state changes, including when first connected
  - Information about the channel is contained in `ARGS`
  - Use NULL if you don't need a callback

ca_create_channel, cont'd

```
typedef void caCh (struct connection_handler_args ARGS);
int ca_create_channel (
      const char *PVNAME,
      caCh *CALLBACK,
      void *PUSER,
      capri PRIORITY,
      chid *PCHID );
```

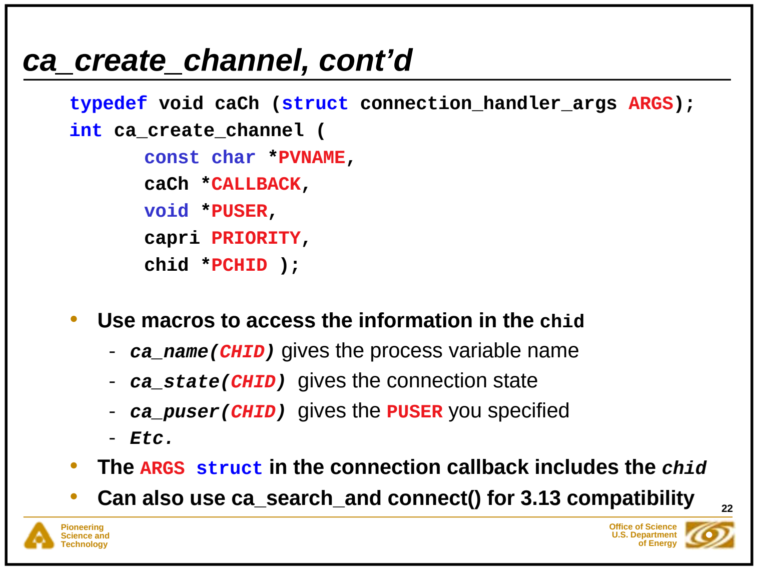
- `PUSER` is a way to pass additional information
  - Whatever you have stored at this address
  - It is stored in the `chid`
  - In C++ it is often the this pointer for a class
  - Use NULL if you don't need it
- Use `PRIORITY=CA_PRIORITY_DEFAULT`



ca_create_channel, cont’d

```
typedef void caCh (struct connection_handler_args ARGS);
int ca_create_channel (
        const char *PVNAME,
        caCh *CALLBACK,
        void *PUSER,
        capri PRIORITY,
        chid *PCHID );
```

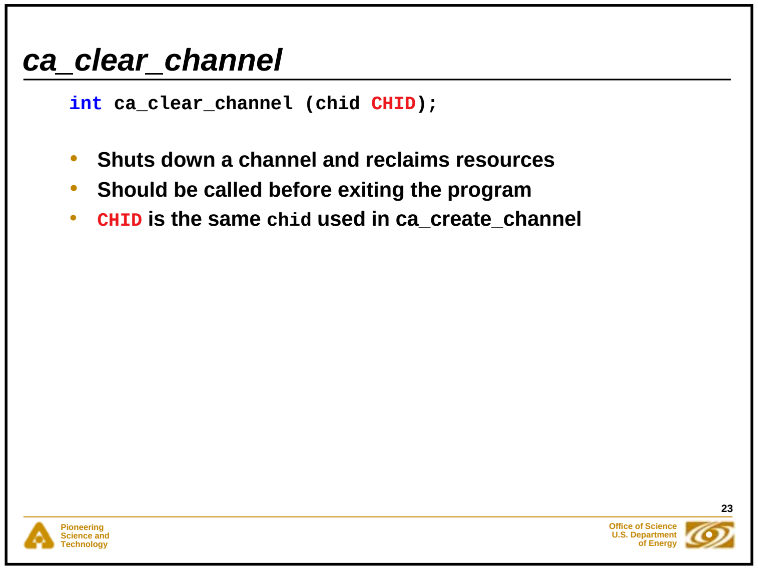
- **A `chid` is a pointer to (address of) an opaque `struct` used by Channel Access to store much of the channel information**
  - **`chanId`** is the same as **`chid`** **`(typedef chid chanId;)`**
- **`PCHID` is the address of the `chid` pointer (Use `&CHID`)**
  - You need to allocate space for the **`chid`** before making the call
  - Channel Access will allocate space for the **`struct`** and return the address



ca_create_channel, cont’d

```
typedef void caCh (struct connection_handler_args ARGS);
int ca_create_channel (
        const char *PVNAME,
        caCh *CALLBACK,
        void *PUSER,
        capri PRIORITY,
        chid *PCHID );
```

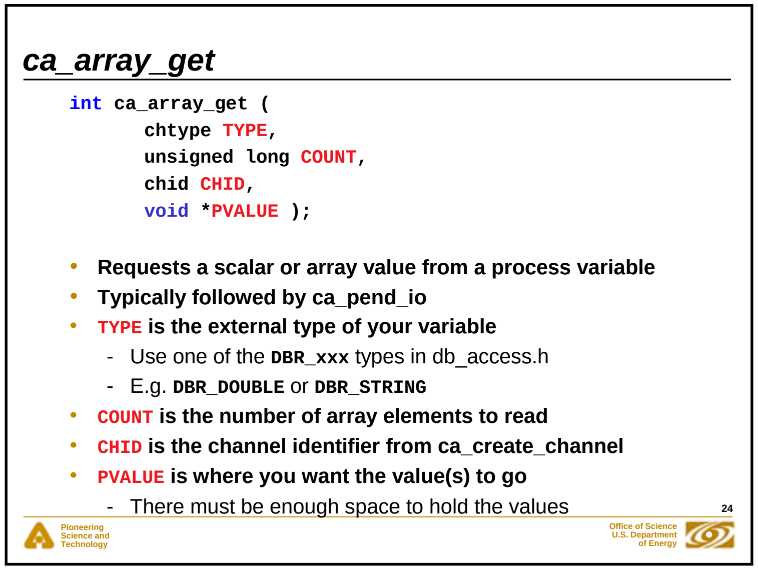
- **Use macros to access the information in the `chid`**
  - ***`ca_name(CHID)`*** gives the process variable name
  - ***`ca_state(CHID)`*** gives the connection state
  - ***`ca_puser(CHID)`*** gives the **`PUSER`** you specified
  - ***`Etc.`***
- **The `ARGS struct` in the connection callback includes the *`chid`***
- **Can also use ca_search_and connect() for 3.13 compatibility**



ca_clear_channel

```
int ca_clear_channel (chid CHID);
```

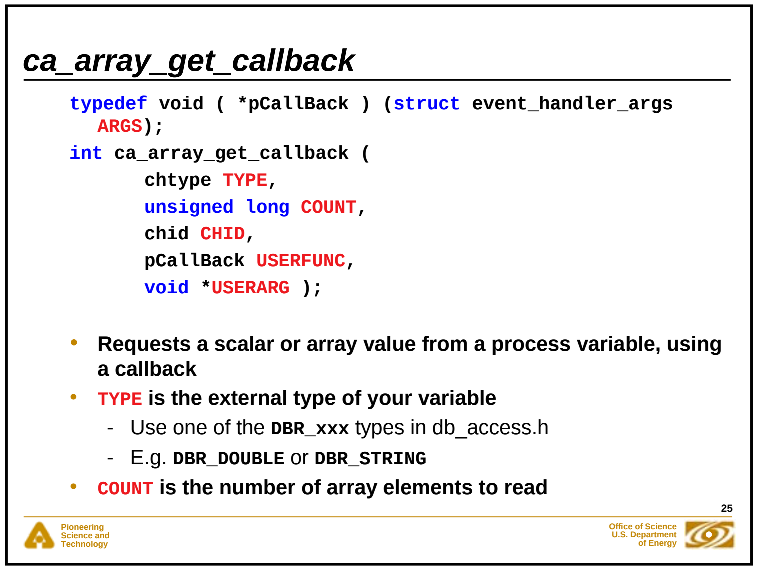
- **Shuts down a channel and reclaims resources**
- **Should be called before exiting the program**
- **`CHID` is the same `chid` used in ca_create_channel**



ca_array_get

```
int ca_array_get (
        chtype TYPE,
        unsigned long COUNT,
        chid CHID,
        void *PVALUE );
```

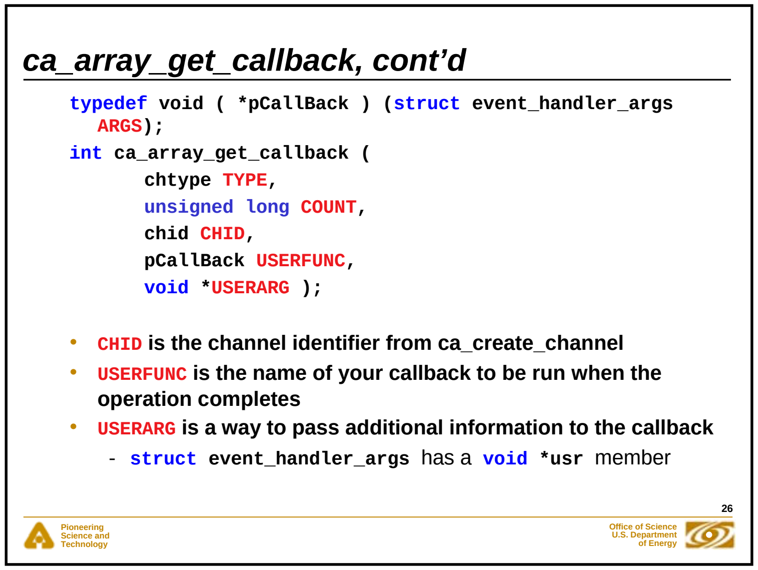
- **Requests a scalar or array value from a process variable**
- **Typically followed by ca_pend_io**
- **`TYPE` is the external type of your variable**
  - Use one of the **`DBR_xxx`** types in db_access.h
  - E.g. **`DBR_DOUBLE`** or **`DBR_STRING`**
- **`COUNT` is the number of array elements to read**
- **`CHID` is the channel identifier from ca_create_channel**
- **`PVALUE` is where you want the value(s) to go**
  - There must be enough space to hold the values



ca_array_get_callback

```
typedef void ( *pCallBack ) (struct event_handler_args
   ARGS);
int ca_array_get_callback (
        chtype TYPE,
        unsigned long COUNT,
        chid CHID,
        pCallBack USERFUNC,
        void *USERARG );
```

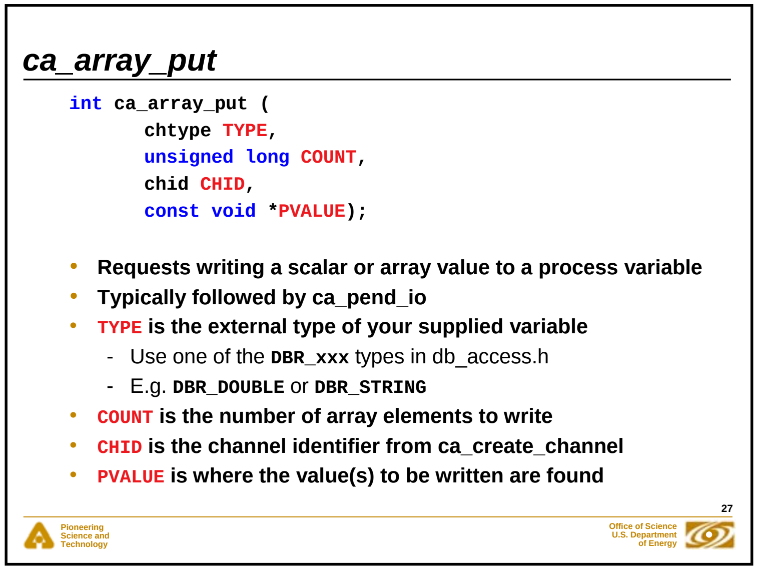
- **Requests a scalar or array value from a process variable, using a callback**
- `TYPE` **is the external type of your variable**
  - Use one of the `DBR_xxx` types in db_access.h
  - E.g. `DBR_DOUBLE` or `DBR_STRING`
- `COUNT` **is the number of array elements to read**



ca_array_get_callback, cont'd

```
typedef void ( *pCallBack ) (struct event_handler_args
   ARGS);
int ca_array_get_callback (
        chtype TYPE,
        unsigned long COUNT,
        chid CHID,
        pCallBack USERFUNC,
        void *USERARG );
```

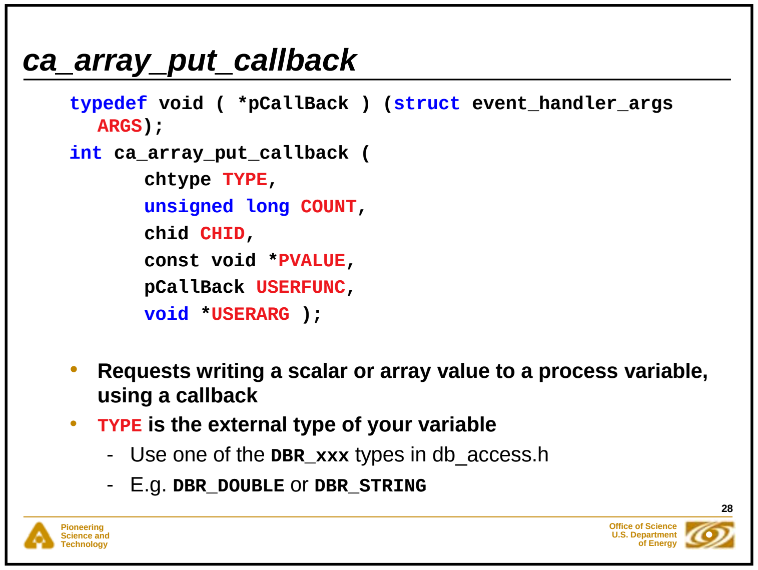
- `CHID` **is the channel identifier from ca_create_channel**
- `USERFUNC` **is the name of your callback to be run when the operation completes**
- `USERARG` **is a way to pass additional information to the callback**
  - `struct event_handler_args` has a `void *usr` member



ca_array_put

```
int ca_array_put (
        chtype TYPE,
        unsigned long COUNT,
        chid CHID,
        const void *PVALUE);
```

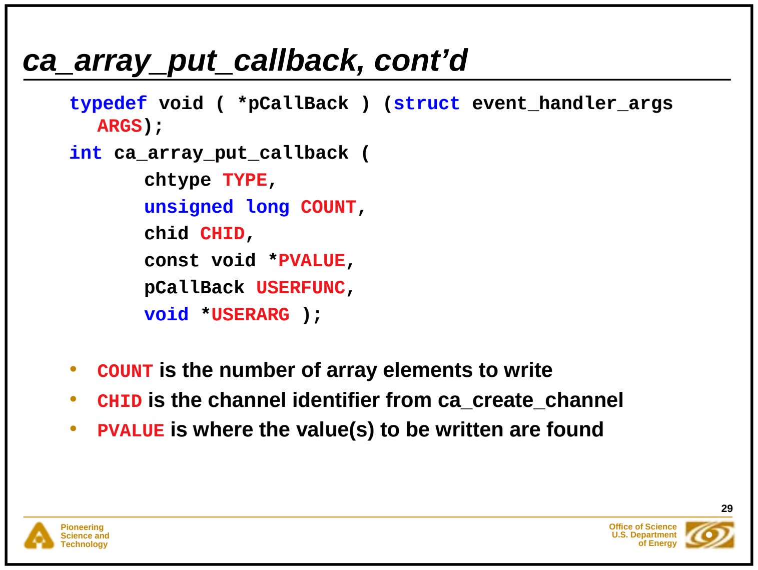
- **Requests writing a scalar or array value to a process variable**
- **Typically followed by ca_pend_io**
- `TYPE` **is the external type of your supplied variable**
  - Use one of the `DBR_xxx` types in db_access.h
  - E.g. `DBR_DOUBLE` or `DBR_STRING`
- `COUNT` **is the number of array elements to write**
- `CHID` **is the channel identifier from ca_create_channel**
- `PVALUE` **is where the value(s) to be written are found**



ca_array_put_callback

```
typedef void ( *pCallBack ) (struct event_handler_args
   ARGS);
int ca_array_put_callback (
        chtype TYPE,
        unsigned long COUNT,
        chid CHID,
        const void *PVALUE,
        pCallBack USERFUNC,
        void *USERARG );
```

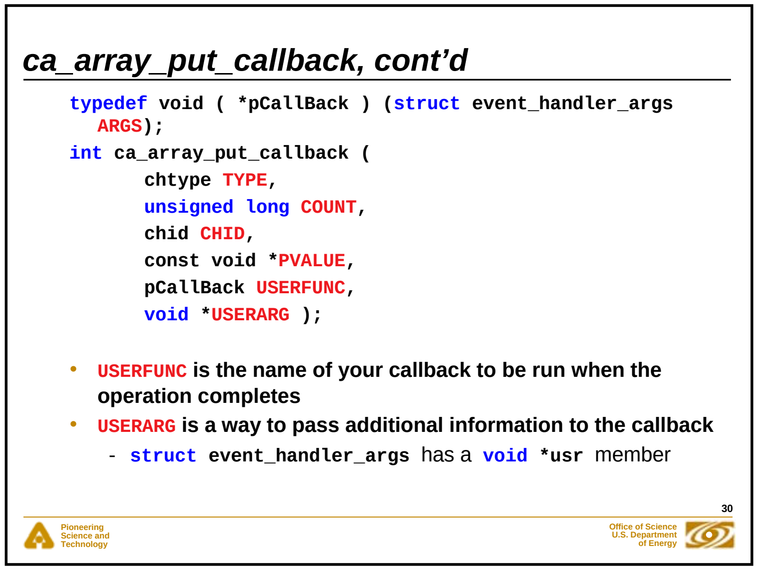
- **Requests writing a scalar or array value to a process variable, using a callback**
- `TYPE` **is the external type of your variable**
  - Use one of the `DBR_xxx` types in db_access.h
  - E.g. `DBR_DOUBLE` or `DBR_STRING`



ca_array_put_callback, cont'd

```
typedef void ( *pCallBack ) (struct event_handler_args
  ARGS);
int ca_array_put_callback (
        chtype TYPE,
        unsigned long COUNT,
        chid CHID,
        const void *PVALUE,
        pCallBack USERFUNC,
        void *USERARG );
```

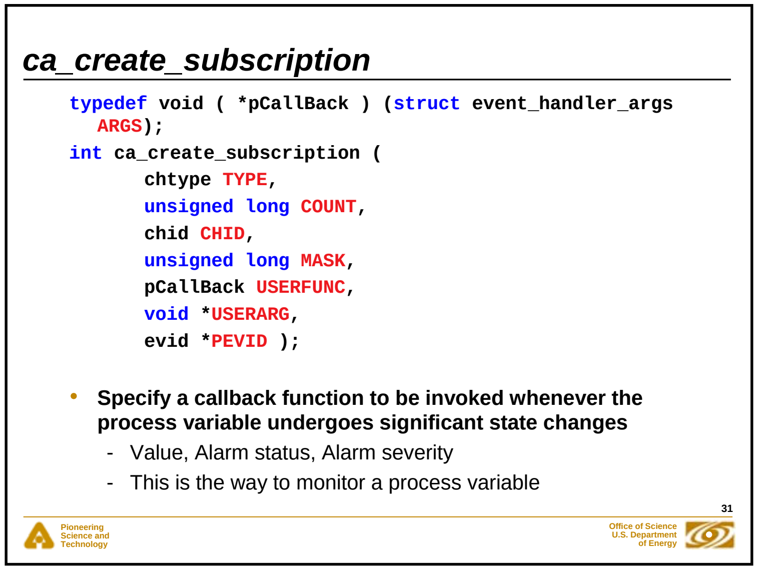
- **`COUNT` is the number of array elements to write**
- **`CHID` is the channel identifier from ca_create_channel**
- **`PVALUE` is where the value(s) to be written are found**



ca_array_put_callback, cont'd

```
typedef void ( *pCallBack ) (struct event_handler_args
  ARGS);
int ca_array_put_callback (
        chtype TYPE,
        unsigned long COUNT,
        chid CHID,
        const void *PVALUE,
        pCallBack USERFUNC,
        void *USERARG );
```

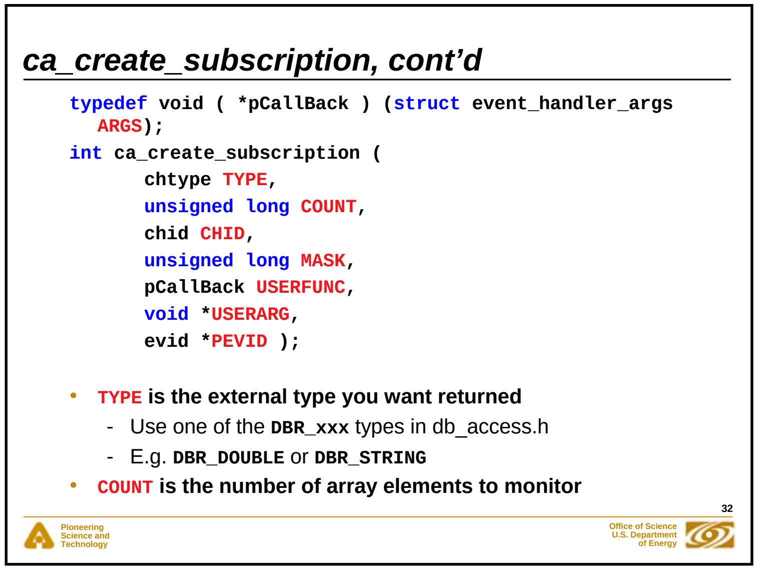
- **`USERFUNC` is the name of your callback to be run when the operation completes**
- **`USERARG` is a way to pass additional information to the callback**
  - `struct event_handler_args` has a `void *usr` member



ca_create_subscription

```
typedef void ( *pCallBack ) (struct event_handler_args
  ARGS);
int ca_create_subscription (
        chtype TYPE,
        unsigned long COUNT,
        chid CHID,
        unsigned long MASK,
        pCallBack USERFUNC,
        void *USERARG,
        evid *PEVID );
```

- **Specify a callback function to be invoked whenever the process variable undergoes significant state changes**
  - Value, Alarm status, Alarm severity
  - This is the way to monitor a process variable



ca_create_subscription, cont'd

```
typedef void ( *pCallBack ) (struct event_handler_args
  ARGS);
int ca_create_subscription (
        chtype TYPE,
        unsigned long COUNT,
        chid CHID,
        unsigned long MASK,
        pCallBack USERFUNC,
        void *USERARG,
        evid *PEVID );
```

- **`TYPE` is the external type you want returned**
  - Use one of the **`DBR_xxx`** types in db_access.h
  - E.g. **`DBR_DOUBLE`** or **`DBR_STRING`**
- **`COUNT` is the number of array elements to monitor**

ca_create_subscription, cont'd

```
typedef void ( *pCallBack ) (struct event_handler_args
   ARGS);
int ca_create_subscription (
        chtype TYPE,
        unsigned long COUNT,
        chid CHID,
        unsigned long MASK,
        pCallBack USERFUNC,
        void *USERARG,
        evid *PEVID );
```

- `CHID` is the channel identifier from ca_create_channel
- `MASK` has bits set for each of the event trigger types requested
  - `DBE_VALUE      Value changes`
  - `DBE_LOG        Exceeds archival deadband`
  - `DBE_ALARM      Alarm state changes`

ca_create_subscription, cont'd

```
typedef void ( *pCallBack ) (struct event_handler_args
   ARGS);
int ca_create_subscription (
        chtype TYPE,
        unsigned long COUNT,
        chid CHID,
        unsigned long MASK,
        pCallBack USERFUNC,
        void *USERARG,
        evid *PEVID );
```

- `USERFUNC` is the name of your callback to be run when the state change occurs
- `USERARG` is a way to pass additional information to the callback
  - `struct event_handler_args` has a `void *usr` member

ca_create_subscription, cont'd

```
typedef void ( *pCallBack ) (struct event_handler_args
   ARGS);
int ca_create_subscription (
        chtype TYPE,
        unsigned long COUNT,
        chid CHID,
        unsigned long MASK,
        pCallBack USERFUNC,
        void *USERARG,
        evid *PEVID );
```

- `PEVID` is the address of an `evid` (event id)
  - You need to allocate space for the **`evid`** before making the call
  - Similar to a **`chid`**
  - Only used to clear the subscription (Can be NULL if not needed)

ca_clear_subscription

```
int ca_clear_subscription ( evid EVID );
```

- Used to remove a monitor callback
- `EVID` is the `evid` from ca_create_subscription

ca_add_exception_event

```
typedef void (*pCallback) ( struct exception_handler_args
    ARGS );
int ca_add_exception_event (
        pCallback USERFUNC,
        void *USERARG );
```

- **Used to replace the default exception handler**
- **`USERFUNC` is the name of your callback to be run when an exception occurs**
  - Use NULL to remove the callback
- **`USERARG` is a way to pass additional information to the callback**
  - `struct exception_handler_args` has a `void *usr` member

Request Handling

- **The preceding routines are *requests***
  - They only queue the operation
  - They hardly ever fail
    - *The return values are almost always ECA_NORMAL*
    - *(But they should be checked)*
- **These requests are only processed when one of the following is called**

- ca_pend_io	Blocks until requests are processed
- ca_pend_event	Blocks a specified time
- ca_poll	Processes current work only

- **If these routines are not called, the requests are not processed and background tasks are also not processed**
- **The rule is that one of these should be called every 100 ms**
  - To allow processing of background tasks (beacons, etc.)

ca_pend_io

```
int ca_pend_io (double TIMEOUT);
```

- **Flushes the send buffer**
- **Blocks for up to `TIMEOUT` seconds until**
  - Outstanding gets complete
  - Searches with no callback have connected
- **Returns `ECA_NORMAL` when gets and searches are complete**
- **Returns `ECA_TIMEOUT` otherwise**
  - Means something went wrong
  - Get requests can be reissued
  - Search requests can be reissued after ca_clear_channel
- **Channel Access background tasks are performed**
  - Unless there were no outstanding I/O requests
- **Use with searches, gets, and puts that don't use callbacks**

ca_pend_event

```
int ca_pend_event (double TIMEOUT);
```

- **Flushes the send buffer**
- **Process background tasks for `TIMEOUT` seconds**
  - Does not return until `TIMEOUT` seconds have elapsed
- **Use this when your application doesn't have to do anything else**
- **Use ca_pend_event instead of sleep**

ca_poll

```
int ca_poll ();
```

- Flushes the send buffer
- Process outstanding tasks only
  - Exits when there are no more outstanding tasks
    - *Otherwise similar to ca_pend_event*
- Use this when your application has other things to do
  - E.g. most GUI programs
- Be sure it is called at least every 100 ms

CHID Macros

```
chtype ca_field_type ( CHID );
unsigned ca_element_count ( CHID );
char *ca_name ( CHID );
void *ca_puser ( CHID );
void ca_set_puser ( chid CHID, void *PUSER );
enum channel_state ca_state ( CHID );
  enum channel_state {
     cs_never_conn,   Valid chid, server not found or unavailable
     cs_prev_conn,    Valid chid, previously connected to server
     cs_conn,         Valid chid, connected to server
     cs_closed };     Channel deleted by user
char *ca_host_name ( CHID );
int ca_read_access ( CHID );
int ca_write_access ( CHID );
```

ca_connection_handler_args

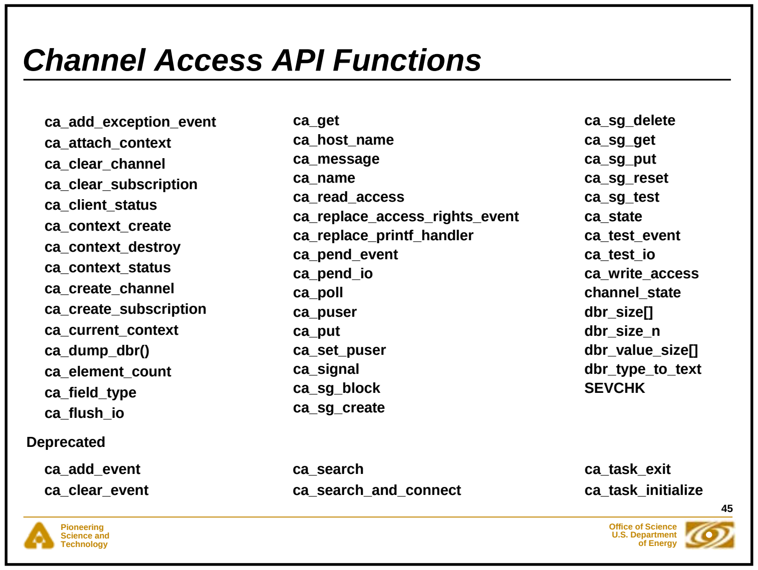
```
struct ca_connection_handler_args {
  chanId chid;    Channel id
  long op;        CA_OP_CONN_UP or
                  CA_OP_CONN_DOWN
};
```

- Used in connection callback
- Note `chanId` is used rather than `chid`
  - Some compilers don't like `chid chid;`

event_handler_args

```
typedef struct event_handler_args {
   void *usr;          User argument supplied with request
   chanId chid;        Channel ID
   long type;          The type of the item returned
   long count;         The element count of the item returned
   const void *dbr;    A pointer to the item returned
   int status;         ECA_xxx status of the requested op
} evargs;
```

- Used in get, put, and monitor callbacks
- Do not use the value in dbr if status is not ECA_NORMAL



Channel Access API Functions

ca_add_exception_event
ca_attach_context
ca_clear_channel
ca_clear_subscription
ca_client_status
ca_context_create
ca_context_destroy
ca_context_status
ca_create_channel
ca_create_subscription
ca_current_context
ca_dump_dbr()
ca_element_count
ca_field_type
ca_flush_io

ca_get
ca_host_name
ca_message
ca_name
ca_read_access
ca_replace_access_rights_event
ca_replace_printf_handler
ca_pend_event
ca_pend_io
ca_poll
ca_puser
ca_put
ca_set_puser
ca_signal
ca_sg_block
ca_sg_create

ca_sg_delete
ca_sg_get
ca_sg_put
ca_sg_reset
ca_sg_test
ca_state
ca_test_event
ca_test_io
ca_write_access
channel_state
dbr_size[]
dbr_size_n
dbr_value_size[]
dbr_type_to_text
SEVCHK

Deprecated

ca_add_event
ca_clear_event

ca_search
ca_search_and_connect

ca_task_exit
ca_task_initialize

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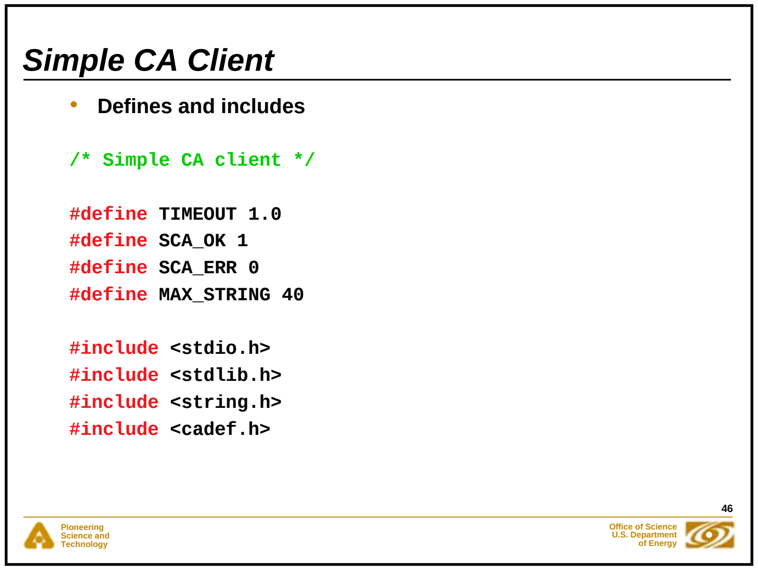

Simple CA Client

- Defines and includes

```
/* Simple CA client */

#define TIMEOUT 1.0
#define SCA_OK 1
#define SCA_ERR 0
#define MAX_STRING 40

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <cadef.h>
```

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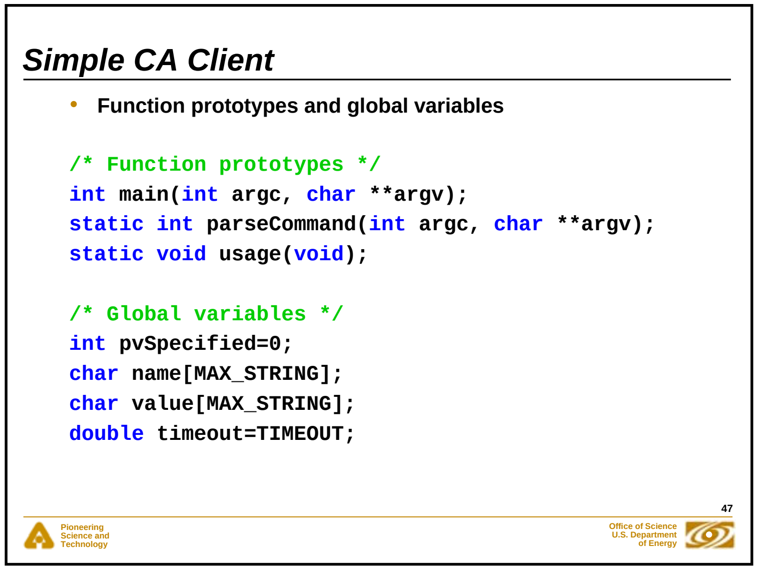

Simple CA Client

- Function prototypes and global variables

```
/* Function prototypes */
int main(int argc, char **argv);
static int parseCommand(int argc, char **argv);
static void usage(void);

/* Global variables */
int pvSpecified=0;
char name[MAX_STRING];
char value[MAX_STRING];
double timeout=TIMEOUT;
```

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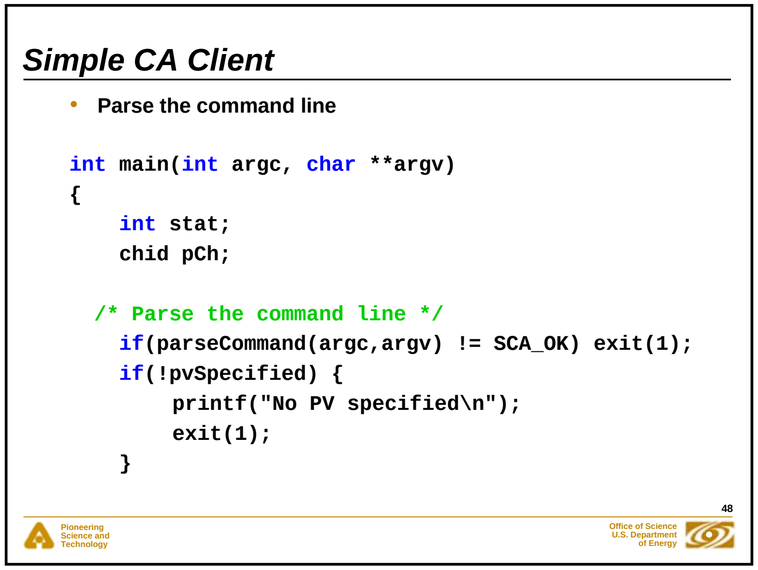

Simple CA Client

- Parse the command line

```
int main(int argc, char **argv)
{
    int stat;
    chid pCh;

  /* Parse the command line */
    if(parseCommand(argc,argv) != SCA_OK) exit(1);
    if(!pvSpecified) {
        printf("No PV specified\n");
        exit(1);
    }
```

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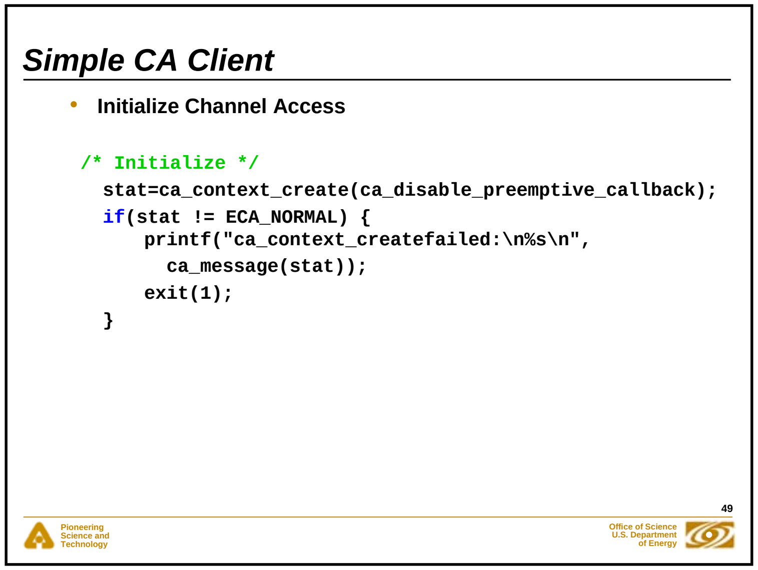
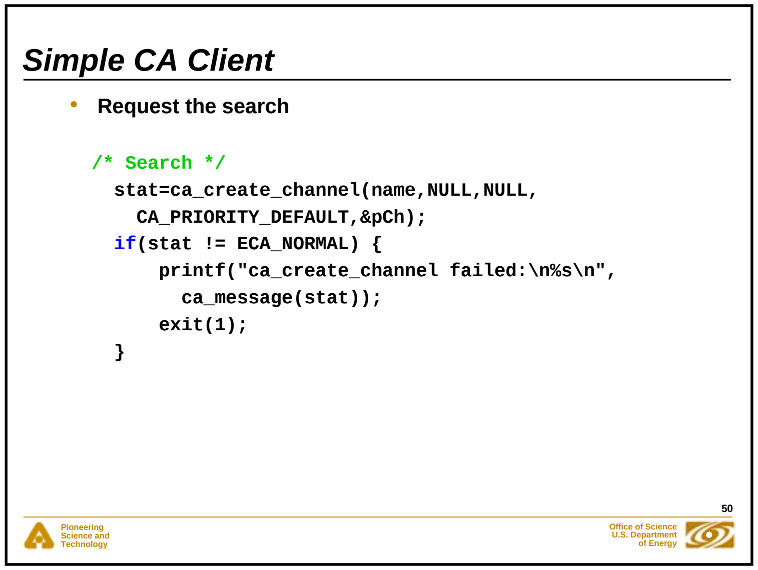


Simple CA Client

- Initialize Channel Access

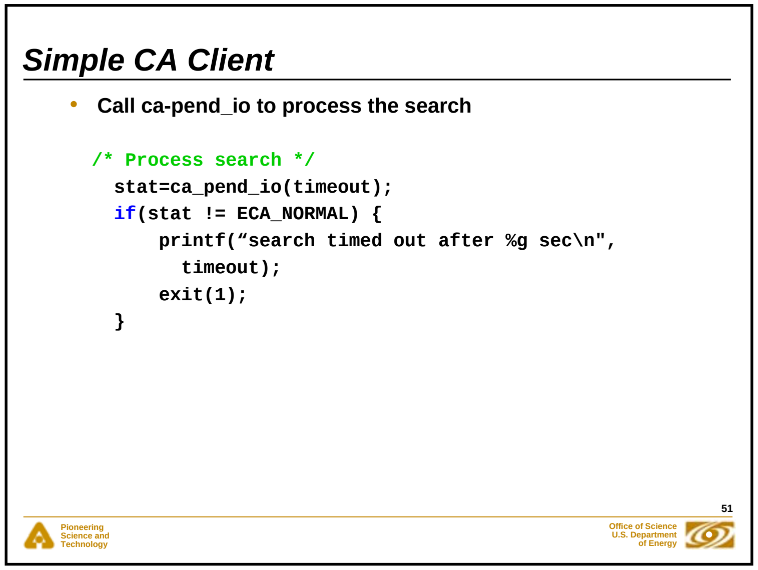
```
/* Initialize */
  stat=ca_context_create(ca_disable_preemptive_callback);
  if(stat != ECA_NORMAL) {
      printf("ca_context_createfailed:\n%s\n",
        ca_message(stat));
      exit(1);
  }
```



Simple CA Client

- Request the search

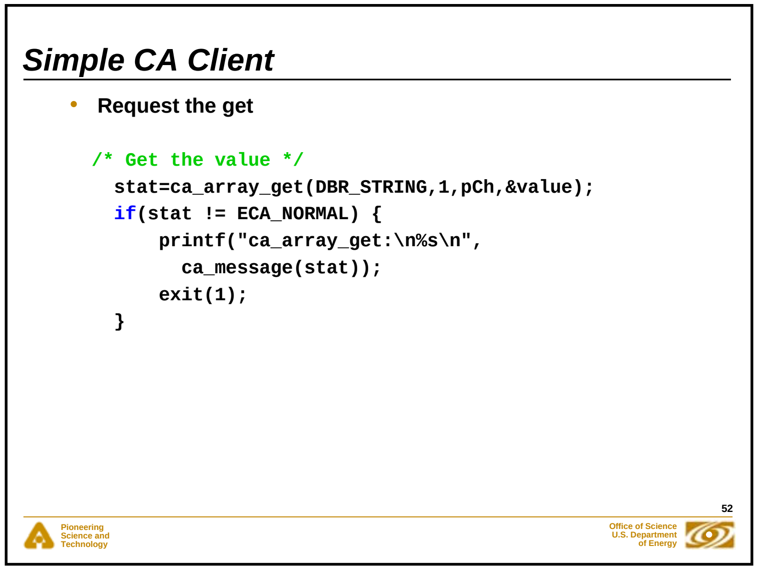
```
/* Search */
  stat=ca_create_channel(name,NULL,NULL,
    CA_PRIORITY_DEFAULT,&pCh);
  if(stat != ECA_NORMAL) {
      printf("ca_create_channel failed:\n%s\n",
        ca_message(stat));
      exit(1);
  }
```



Simple CA Client

- Call ca-pend_io to process the search

```
/* Process search */
  stat=ca_pend_io(timeout);
  if(stat != ECA_NORMAL) {
      printf(“search timed out after %g sec\n",
        timeout);
      exit(1);
  }
```



Simple CA Client

- Request the get

```
/* Get the value */
  stat=ca_array_get(DBR_STRING,1,pCh,&value);
  if(stat != ECA_NORMAL) {
      printf("ca_array_get:\n%s\n",
        ca_message(stat));
      exit(1);
  }
```

Simple CA Client

- Call ca-pend_io to process the get

```
  /* Process get */
    stat=ca_pend_io(timeout);
    if(stat != ECA_NORMAL) {
        printf(“get timed out after %g sec\n",
          timeout);
        exit(1);
    }
    printf("The value of %s is %s\n",name,value)
```

Simple CA Client

- Clean up

```
  /* Clear the channel */
    stat=ca_clear_channel(pCh);
    if(stat != ECA_NORMAL) {
       printf("ca_clear_channel failed:\n%s\n",
         ca_message(stat));
    }

  /* Exit */
    ca_context_destroy();
    return(0);
}
```

Simple CA Client

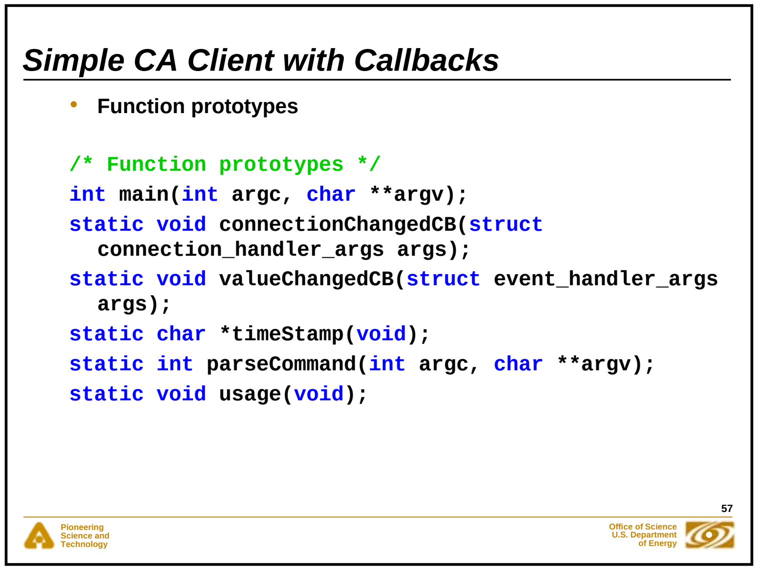
- Output

```
simplecaget evans:calc
The value of evans:calc is 6
```

Simple CA Client with Callbacks

- Defines and includes

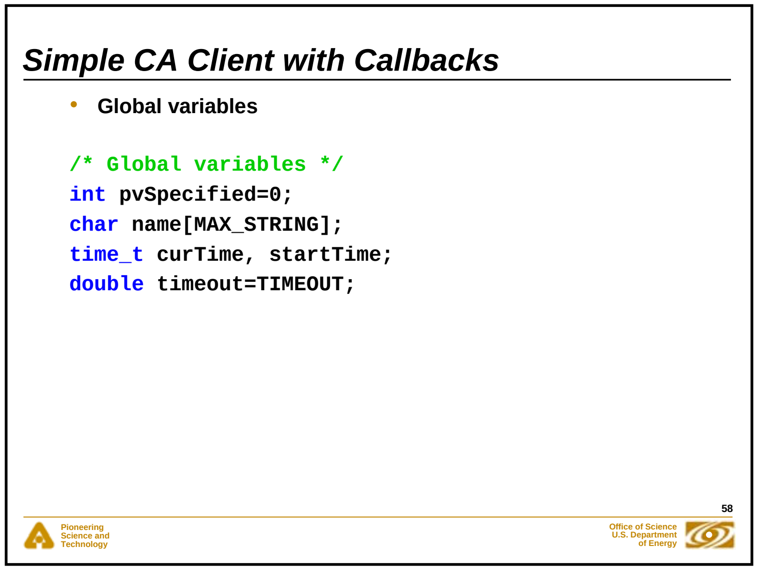
```
/* Simple CA client with Callbacks */

#define TIMEOUT 1.0
#define SCA_OK 1
#define SCA_ERR 0
#define MAX_STRING 40

#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#include <string.h>
#include <cadef.h>
```



Simple CA Client with Callbacks

- Function prototypes

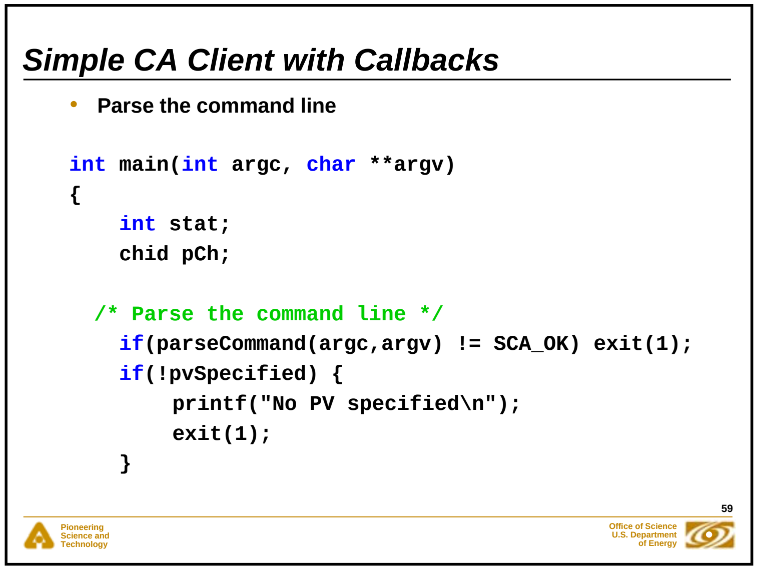
```
/* Function prototypes */
int main(int argc, char **argv);
static void connectionChangedCB(struct
  connection_handler_args args);
static void valueChangedCB(struct event_handler_args
  args);
static char *timeStamp(void);
static int parseCommand(int argc, char **argv);
static void usage(void);
```



Simple CA Client with Callbacks

- Global variables

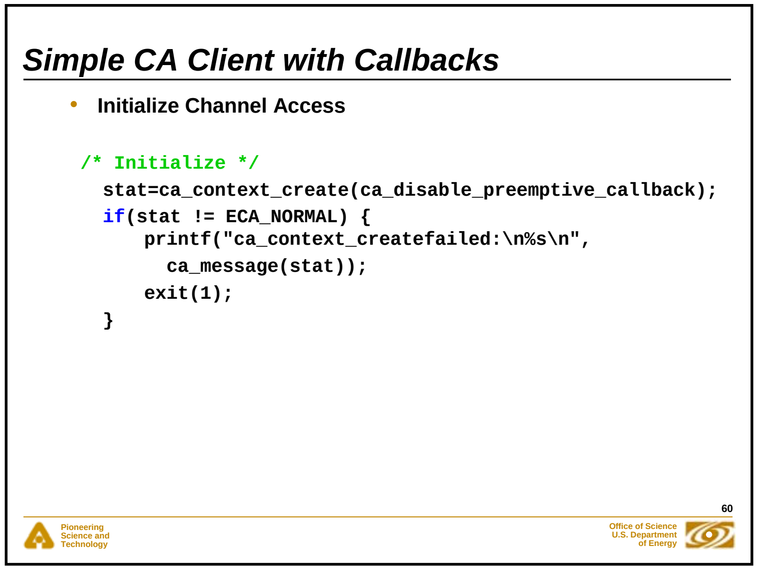
```
/* Global variables */
int pvSpecified=0;
char name[MAX_STRING];
time_t curTime, startTime;
double timeout=TIMEOUT;
```



Simple CA Client with Callbacks

- Parse the command line

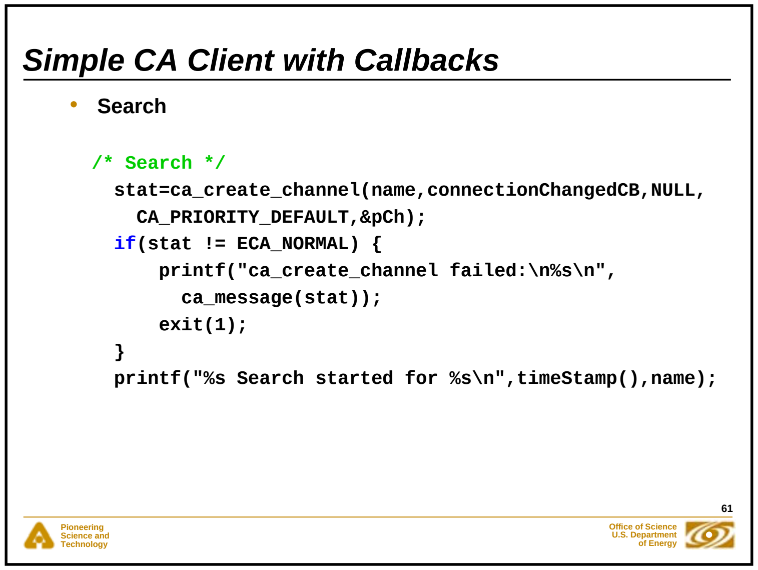
```
int main(int argc, char **argv)
{
    int stat;
    chid pCh;

  /* Parse the command line */
    if(parseCommand(argc,argv) != SCA_OK) exit(1);
    if(!pvSpecified) {
        printf("No PV specified\n");
        exit(1);
    }
```



Simple CA Client with Callbacks

- Initialize Channel Access

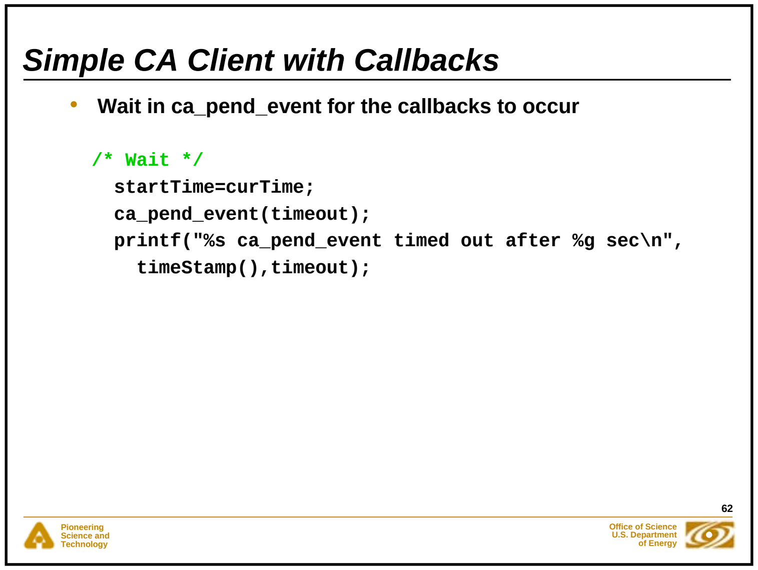
```
 /* Initialize */
   stat=ca_context_create(ca_disable_preemptive_callback);
   if(stat != ECA_NORMAL) {
       printf("ca_context_createfailed:\n%s\n",
         ca_message(stat));
       exit(1);
   }
```



Simple CA Client with Callbacks

- Search

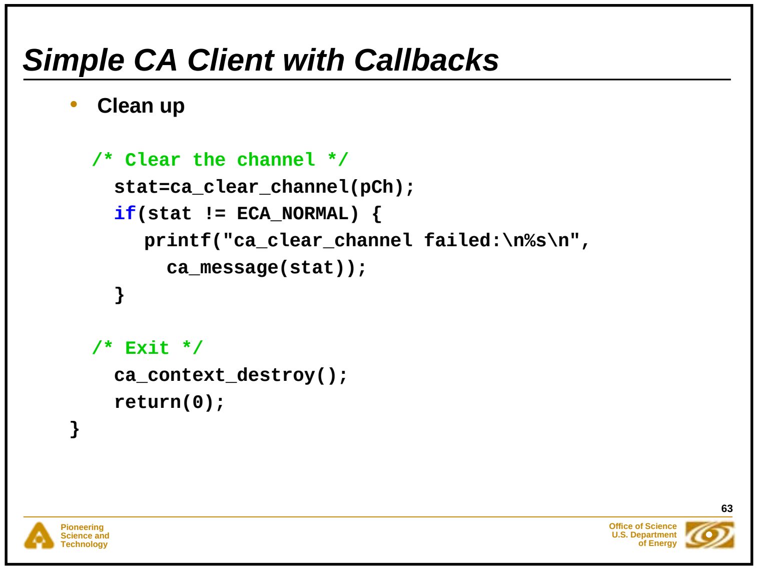
```
/* Search */
  stat=ca_create_channel(name,connectionChangedCB,NULL,
    CA_PRIORITY_DEFAULT,&pCh);
  if(stat != ECA_NORMAL) {
      printf("ca_create_channel failed:\n%s\n",
        ca_message(stat));
      exit(1);
  }
  printf("%s Search started for %s\n",timeStamp(),name);
```



Simple CA Client with Callbacks

- Wait in ca_pend_event for the callbacks to occur

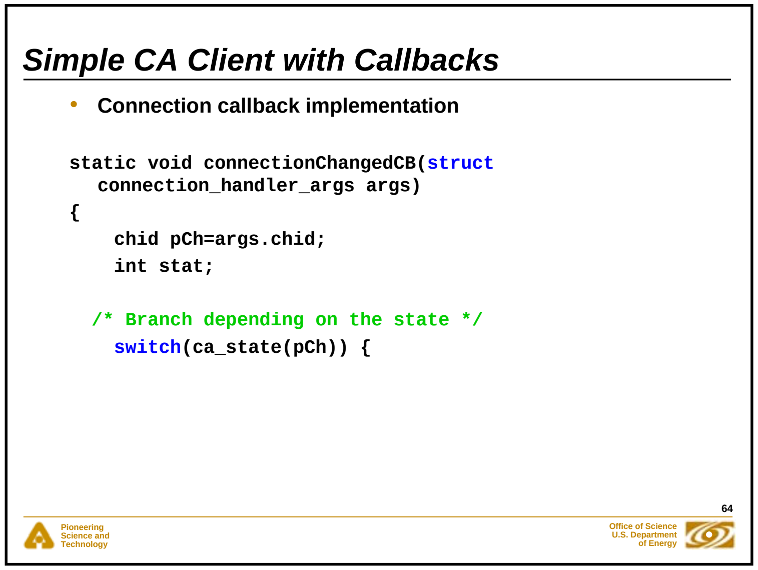
```
/* Wait */
  startTime=curTime;
  ca_pend_event(timeout);
  printf("%s ca_pend_event timed out after %g sec\n",
    timeStamp(),timeout);
```



Simple CA Client with Callbacks

- Clean up

```
 /* Clear the channel */
   stat=ca_clear_channel(pCh);
   if(stat != ECA_NORMAL) {
      printf("ca_clear_channel failed:\n%s\n",
        ca_message(stat));
   }

 /* Exit */
   ca_context_destroy();
   return(0);
}
```



Simple CA Client with Callbacks

- Connection callback implementation

```
static void connectionChangedCB(struct
  connection_handler_args args)
{
    chid pCh=args.chid;
    int stat;

  /* Branch depending on the state */
    switch(ca_state(pCh)) {
```

Simple CA Client with Callbacks

- Connection callback implementation

```
    case cs_conn:
        printf("%s Connection successful\n",timeStamp());
        stat=ca_array_get_callback(DBR_STRING,1,pCh,
          valueChangedCB,NULL);
        if(stat != ECA_NORMAL) {
            printf("ca_array_get_callback:\n%s\n",
              ca_message(stat));
            exit(1);
        }
        break;
```

Simple CA Client with Callbacks

- Connection callback implementation

```
    case cs_never_conn:
        printf("%s Cannot connect\n",timeStamp());
        break;
    case cs_prev_conn:
        printf("%s Lost connection\n",timeStamp());
        break;
    case cs_closed:
        printf("%s Connection closed\n",timeStamp());
        break;
    }
}
```

Simple CA Client with Callbacks

- Value changed callback implementation

```
static void valueChangedCB(struct event_handler_args args)
{
  /* Print the value */
    if(args.status == ECA_NORMAL && args.dbr) {
        printf("%s Value is: %s\n",timeStamp(),
          (char *)args.dbr);
        printf("Elapsed time: %ld sec\n",
          curTime-startTime);
    }
}
```

Simple CA Client with Callbacks

- Output

```
simplecagetcb evans:calc
Sep 14 18:31:55 Search started for evans:calc
Sep 14 18:31:55 Connection successful
Sep 14 18:31:55 Value is: 5
Elapsed time: 0 sec
Sep 14 18:31:56 ca_pend_event timed out after 1 sec
```

- Time for this operation is typically a few ms

Source files for Simple Get Clients

- **Some of the code that is not related to Channel Access has not been shown**
- **All the files necessary to build a project as an EPICS Extension should be available with the presentation**
  - Makefile
  - Makefile.Host
  - simplecaget.c
  - simplecagetcb.c
  - LICENSE
- **Stored as simpleCA.tar.gz**

EPICS Build System

- **Supports both native and GNU compilers**
- **Builds multiple types of components**
  - libraries, executables, headers, scripts, java classes, …
- **Supports multiple host and target operating systems**
- **Builds for all hosts and targets in a single <top> tree**
  - epics/base
  - epics/extensions
- **Allows sharing of components across <top> trees**
- **Has different rules and syntax for 3.13 and 3.14**

System Requirements

- **Required software**
  - Perl version 5 or greater
  - GNU make, version 3.78.1 or greater
  - C++ compiler and linker (GNU or host vendor's compiler)
- **Optional software**
  - Tornado II and board support packages
  - RTEMS development tools and libraries
  - Motif, X11, JAVA, TK/TCL…

User Requirements

- **Set an environment variable to specify the architecture**
  - EPICS_HOST_ARCH for 3.14
    - *solaris-sparc, linux-x86, win32-x86, darwin-ppc, etc.*
  - HOST_ARCH for 3.13
    - *solaris, Linux, WIN32, etc.*
- **Set the PATH so the required components can be found**
  - Perl, GNU make, C and C++ compilers
  - System commands (e.q. cp, rm, mkdir)

Typical Extensions Build Tree

epics/base	<top> for base
epics/extensions	<top> for extensions
config	3.13 configuration
configure	3.14 configuration
bin	Binaries by architecture
solaris	
solaris-sparc	
lib	Libraries by architecture
solaris	
solaris-sparc	
src	Sources by application
simpleCA	Application source files
O.solaris	Binaries for this application
O.solaris-sparc	

Getting Started with an Extension

- **Make a directory structure for base**
  - E.g. epics/base
- **Obtain base and build it**
  - Set COMPAT_TOOLS_313 first if necessary (see later)
- **Make a directory structure for extensions**
  - E.g. epics/extensions
- **Get extensions/config and configure from the EPICS pages**
  - http://www.aps.anl.gov/epics/extensions/index.php
- **Set EPICS_BASE to your desired version of base**
  - In extensions/config/RELEASE for 3.13
  - In extensions/configure/RELEASE for 3.14
- **Type gnumake (or make) in extensions**
- **Get an extension and put it under extensions/src**
- **Type gnumake (or make) in your application directory**

Using the 3.13 Build Rules for Extensions

- **Most existing extensions are still set up for 3.13 builds**
  - There is a Makefile and a Makefile.Host
  - Makefile.Host is most important and has 3.13 syntax
  - Can still use a 3.14 base
- **Set HOST_ARCH for your platform**
  - solaris, Linux, WIN32, etc.
- **Set EPICS_HOST_ARCH for your platform**
  - solaris-sparc, linux-x86, win32-x86, darwin-ppc, etc.
- **Configuration is in extensions/config**
  - RELEASE (Specifies what base to use, can be 3.14)
  - CONFIG_SITE_xxx (Specifies local changes for xxx arch)
- **Before building a 3.14 base**
  - Modify base/configure/CONFIG_SITE
    - *COMPAT_TOOLS_313 = YES*

Using the 3.14 Build Rules for Extensions

- **Go to the the EPICS page for your version of base**
  - http://www.aps.anl.gov/epics/base/index.php
- **Read the README**
  - It is very extensive
  - Should tell you everything you need to know
- **There is a only a Makefile and it uses 3.14 syntax**
- **Set EPICS_HOST_ARCH for your platform**
  - solaris-sparc, linux-x86, win32-x86, darwin-ppc, etc.
- **Configuration is in extensions/configure**
  - RELEASE (Specifies what base)
  - os/CONFIG_SITE_xxx (Specifies local changes for xxx arch)

Makefile for Simple Get Clients

```
TOP = ../..
include $(TOP)/config/CONFIG_EXTENSIONS
include $(TOP)/config/RULES_ARCHS
```

Makefile.Host for Simple Get Clients

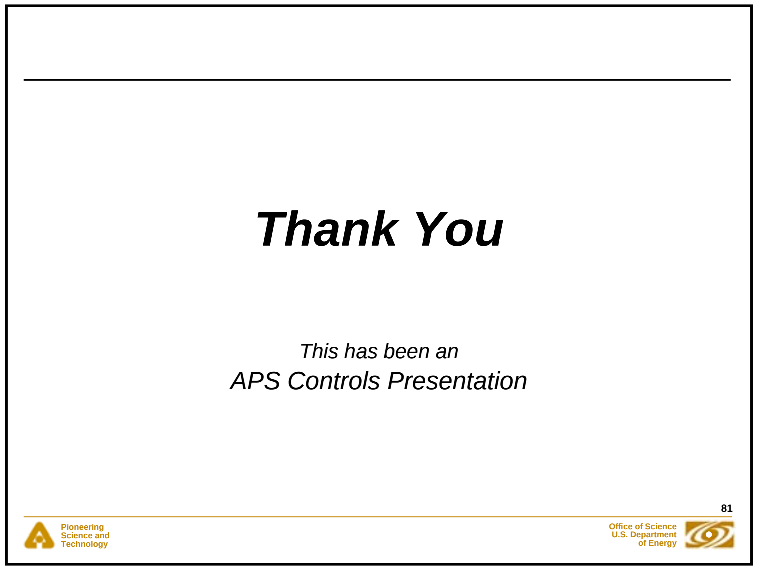
```
TOP = ../../..
include $(TOP)/config/CONFIG_EXTENSIONS

HOST_OPT = NO
CMPLR = STRICT

PROD = simplecaget simplecagetcb

PROD_LIBS = ca Com
ca_DIR = $(EPICS_BASE_LIB)
Com_DIR = $(EPICS_BASE_LIB)

simplecaget_SRCS += simplecaget.c
simplecagetcb_SRCS += simplecagetcb.c

include $(TOP)/config/RULES.Host
```

Acknowledgements

- **Jeff Hill [LANL] is responsible for EPICS Channel Access and has developed almost all of it himself**
- **Janet Anderson [ANL] is responsible for and has developed most of the EPICS Build System**

Thank You

This has been an
APS Controls Presentation



Thank You

This has been an

APS Controls Presentation