Real-time CORBA code examples

Part 2b
Self Study Guide
Worked examples using RT-CORBA 1.0 mechanisms and use of the optional CORBA 1.0 Scheduling Service

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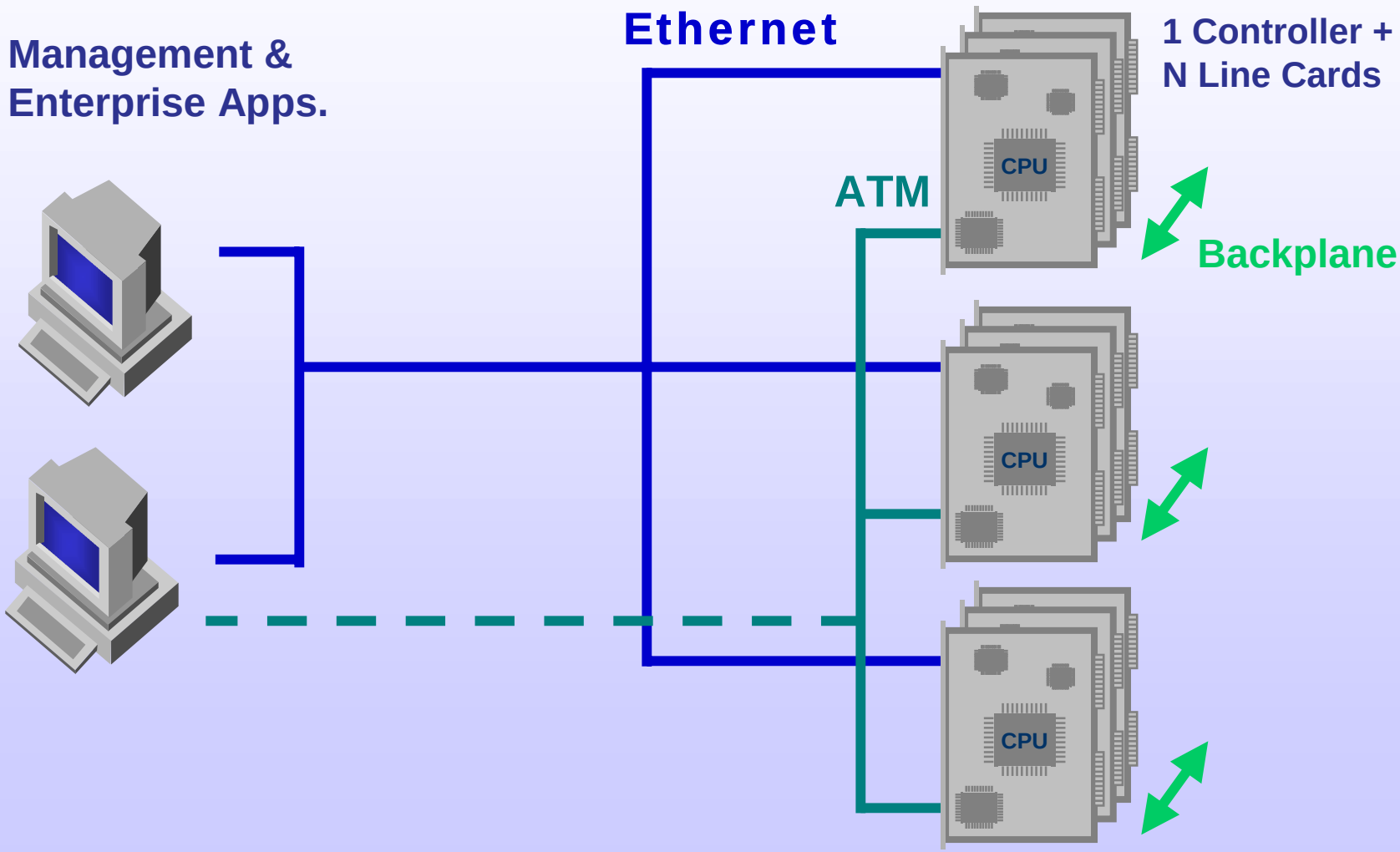
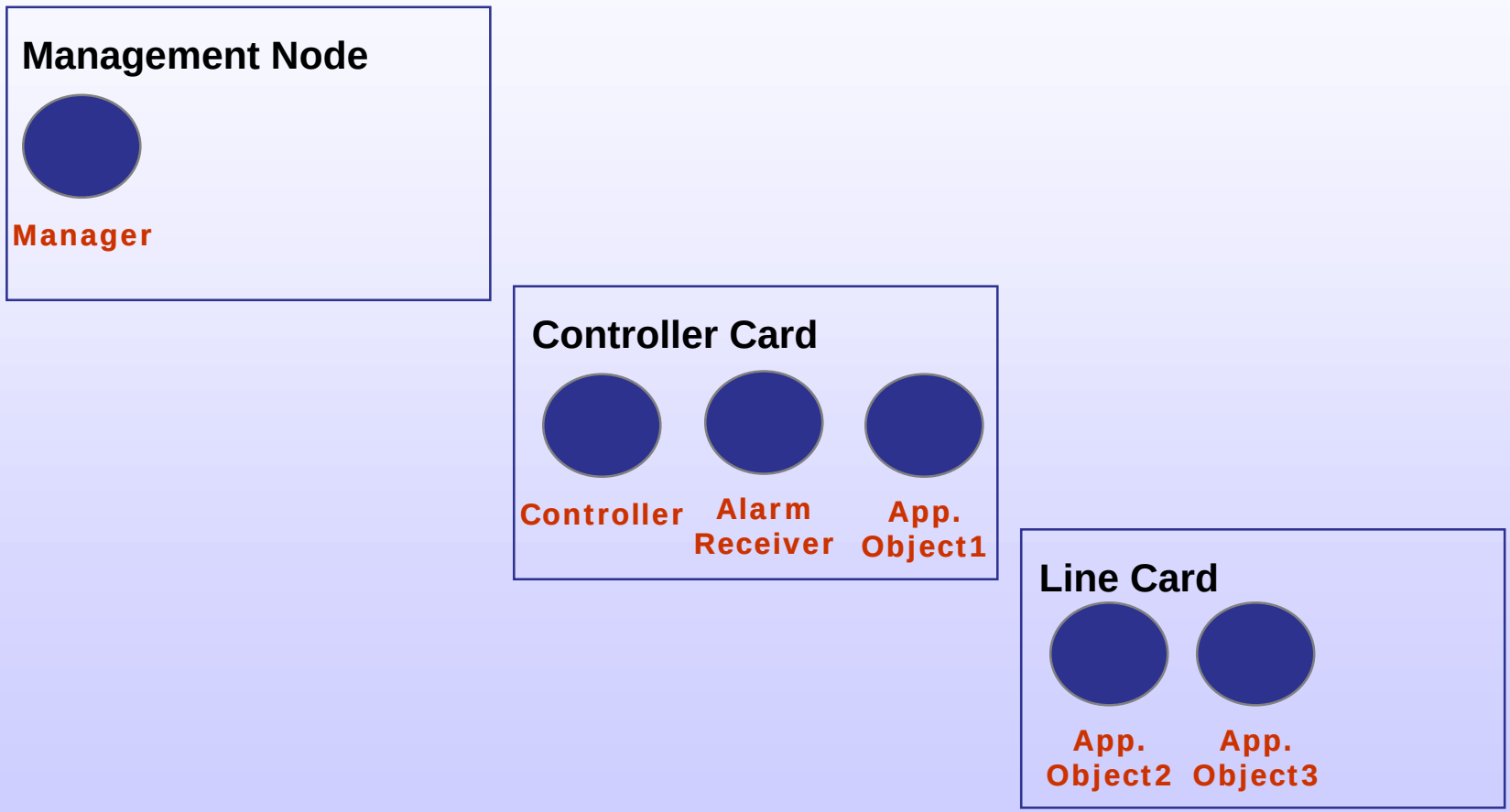
Network Management



Simplified Object Model



Object IDL

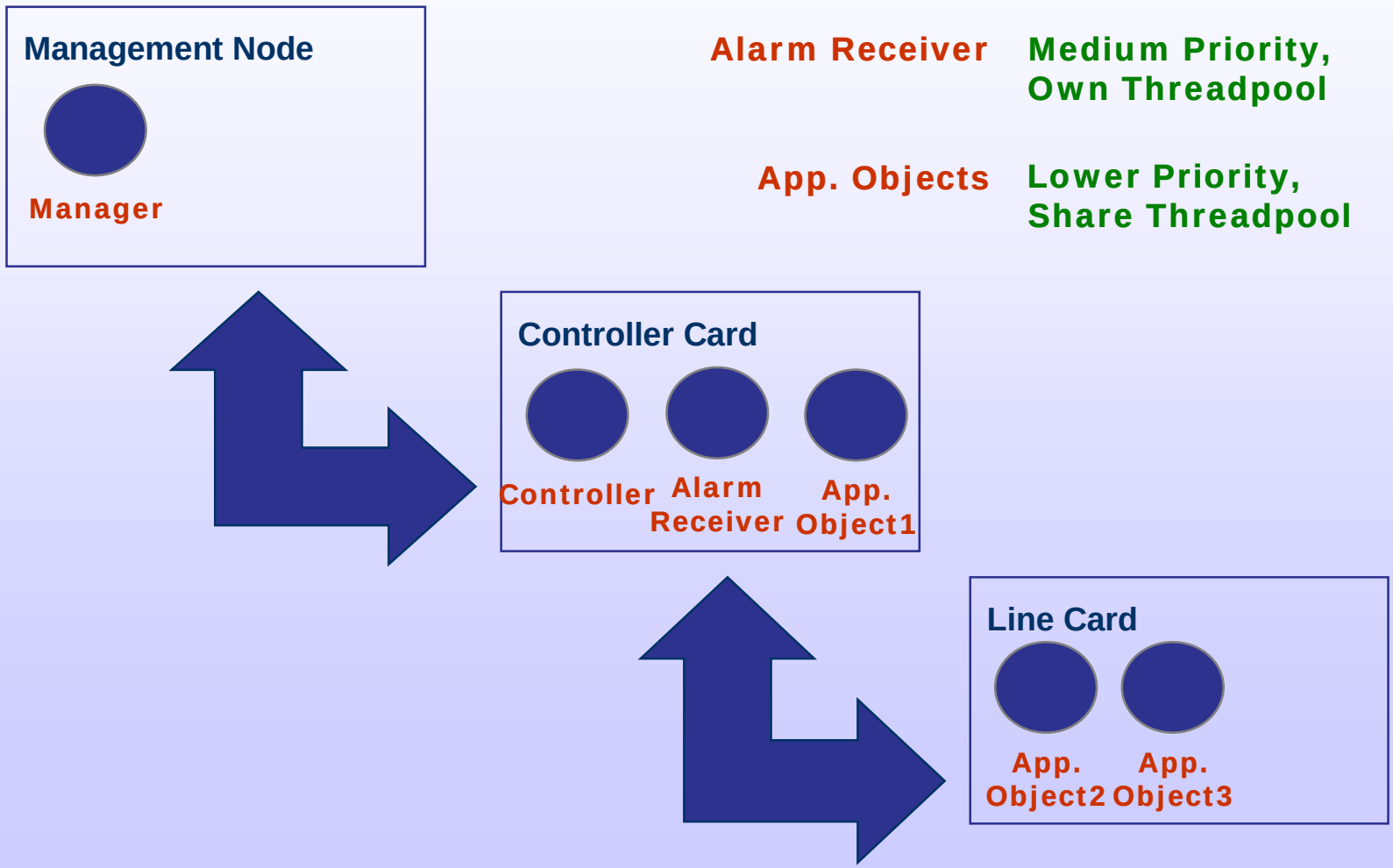
```
// IDL
interface Manager {

   void registerController (
            in Controller c );
   void removeController (
            in Controller c );

   StatusList reportStatus ();
   …
};

interface Controller {

   void registerObject (
             in Object o );

   StatusList reportStatus ();
   …
};
```

```
interface AlarmReceiver {
   void receiveAlarm (
            in Alarm a);
};

interface AppObject1 {
   …
};

interface AppObject2 {
   …
};
```

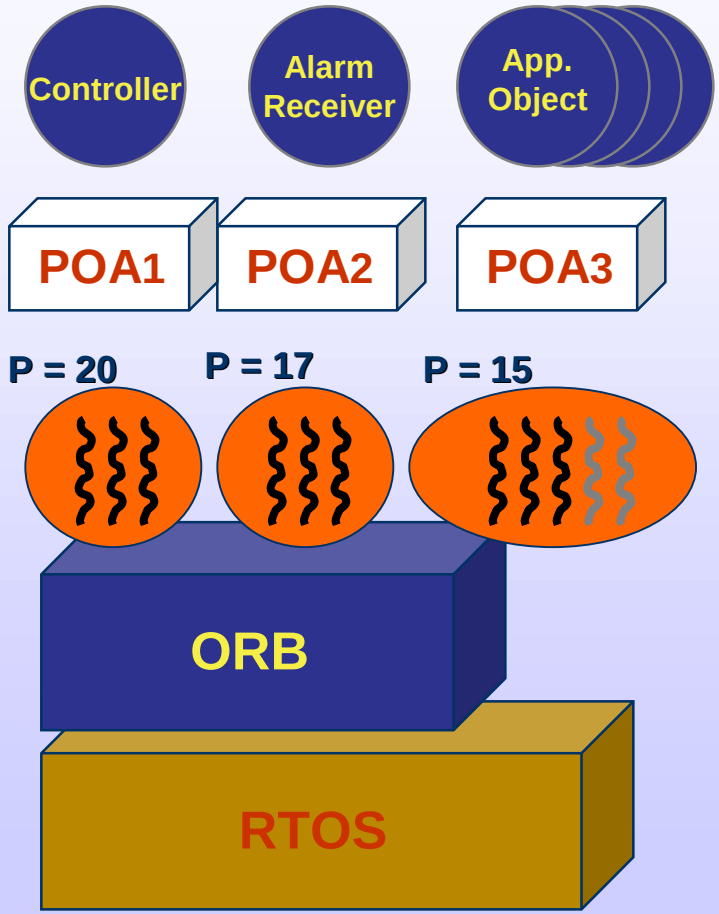
```
interface AppObject3
{
   …
};
```

Real-Time Design Considerations

Controller	High Priority, Own Threadpool
Alarm Receiver	Medium Priority, Own Threadpool
App. Objects	Lower Priority, Share Threadpool

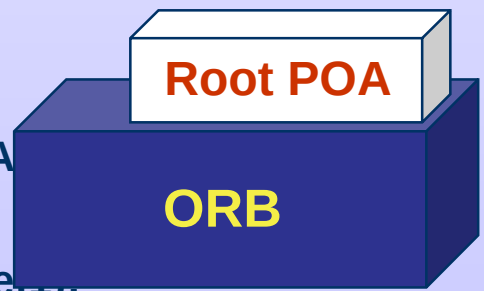


Controller Card Configuration



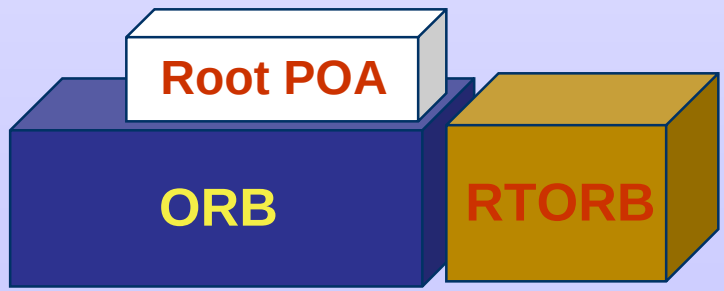
Initialize CORBA

```
// C++
CORBA::ORB_ptr orb;
PortableServer::POA_ptr root_poa;

void initController()
{

// initialize ORB
    orb = CORBA::ORB_init(argc, argv, orb_id);

// obtain Root Object Adapter
    CORBA::Object_var ref1 =
        orb->resolve_initial_references("RootPOA

    root_poa = PortableServer::POA::_narrow(ref1);
```



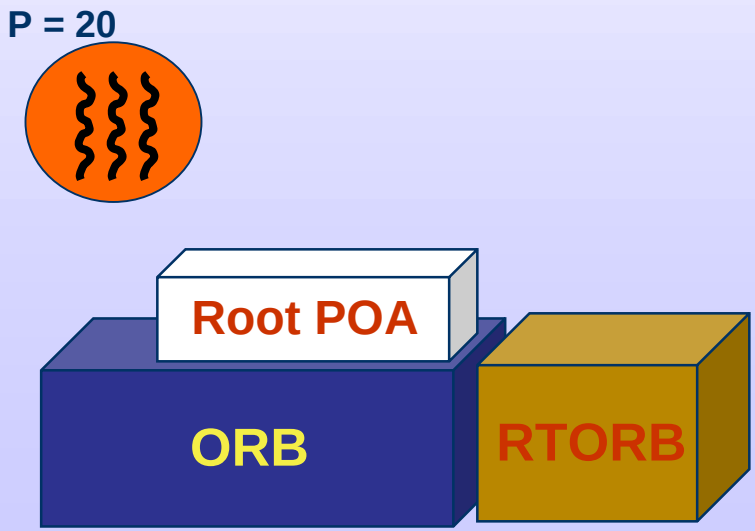
Access Real-Time CORBA API

```
RTCORBA::RTORB_ptr rt_orb;

// access Real-Time extensions to ORB
    CORBA::Object_var ref2 =
        orb->resolve_initial_references("RTORB");

    rt_orb = RTCORBA::RTORB::_narrow(ref2);
```



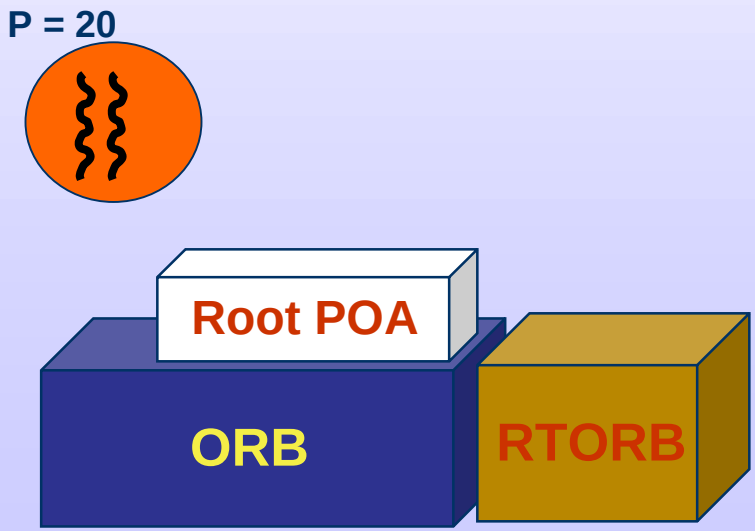
Create Threadpool

```
RTCORBA::ThreadpoolId controller_tpool;
RTCORBA::ThreadpoolPolicy_ptr threadpool_policy;

// create Threadpool for Controller
   controller_tpool =  rt_orb->create_threadpool(
                           30000, // stacksize
                           3, // num static threads
                           0, // num dynamic threads
                           20, // default thread priority
                           0, 0, 0);

// create Threadpool Policy object for that Threadpool
   threadpool_policy = rt_orb->
      create_threadpool_policy(controller_tpool);
```



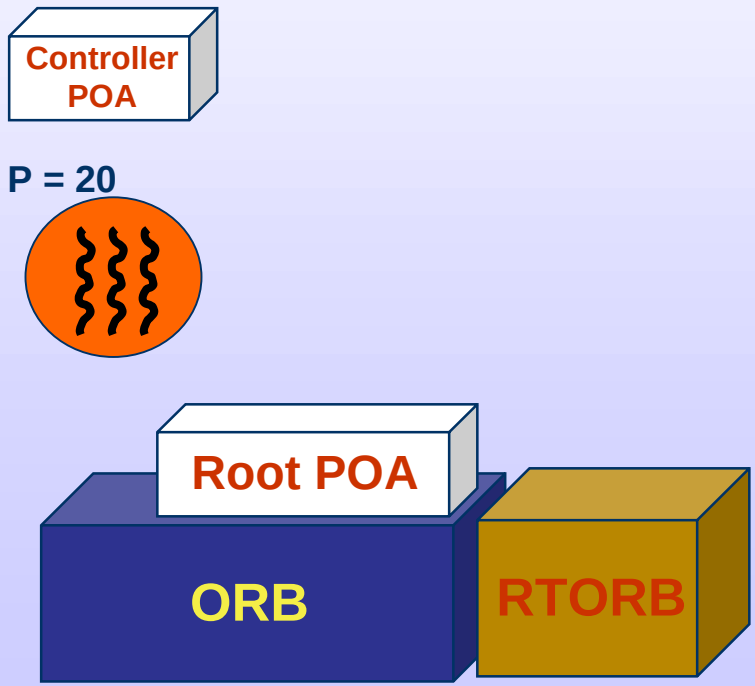
Prepare POA Configuration

```
RTCORBA::PriorityModelPolicy_var priority_model_policy;
CORBA::PolicyList controller_policies(2);

// create Server Declared Priority Model policy object
    priority_model_policy =
        rt_orb->create_priority_model_policy
                    (RTCORBA::SERVER_DECLARED,
                     20); // default object priority

// assemble policy list for initializing
// Controller object adapter
    controller_policies[0] = priority_model_policy;
    controller_policies[1] = threadpool_policy;
```



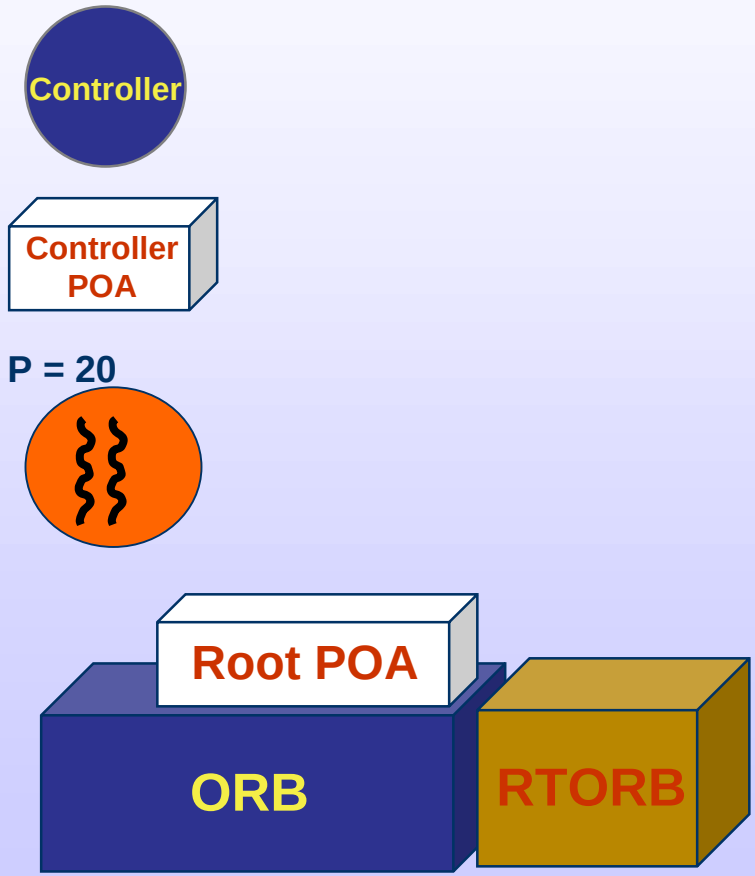
Create Controller POA

```
PortableServer::POA_ptr controller_poa;

// create Object Adapter
   controller_poa =
      root_poa->create_POA("ControllerPOA", 0,
                                    controller_policies);
```

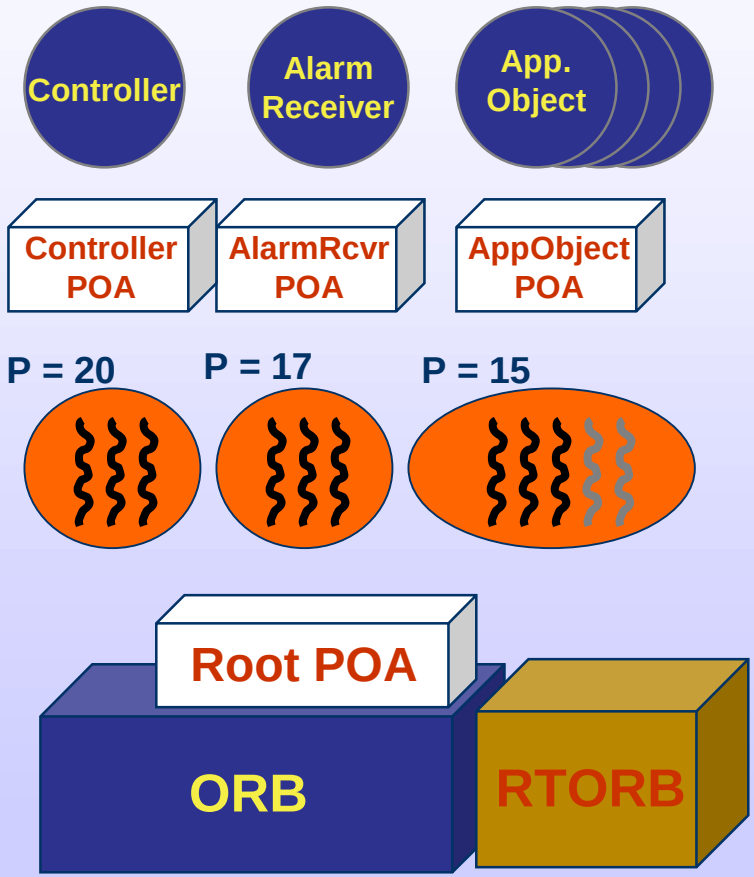


Create Controller Object

```
ControllerServant * controller_servant;

// create Controller object
    controller_servant = new ControllerServant();

// activate object
    controller_poa->
        activate_object(controller_servant);
```



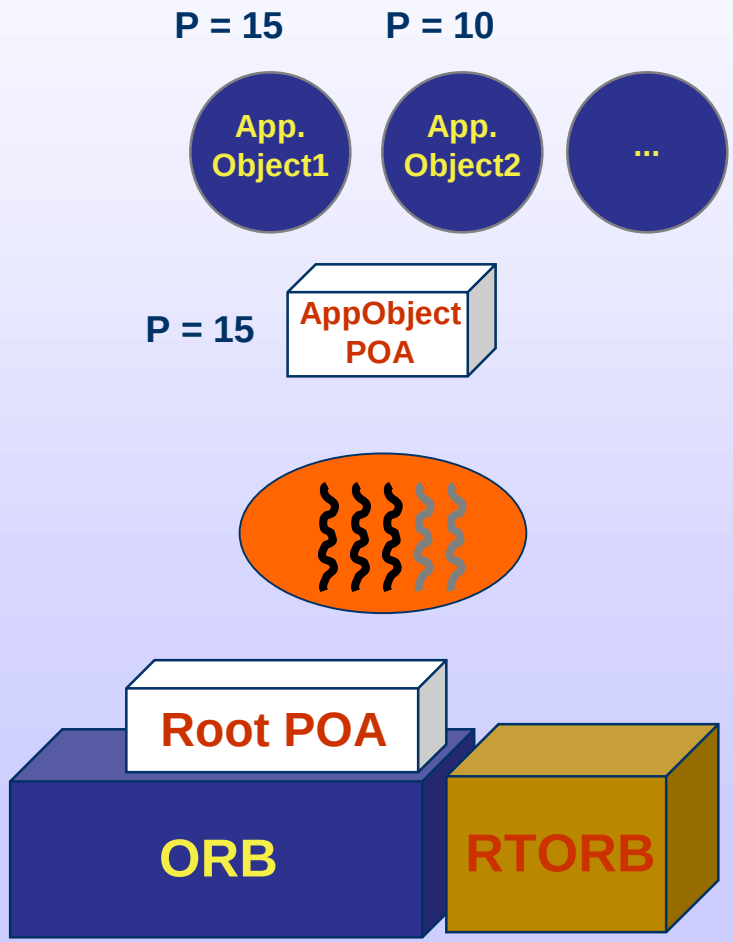
Complete CORBA Configuration



(Per-Object Priority Configuration)

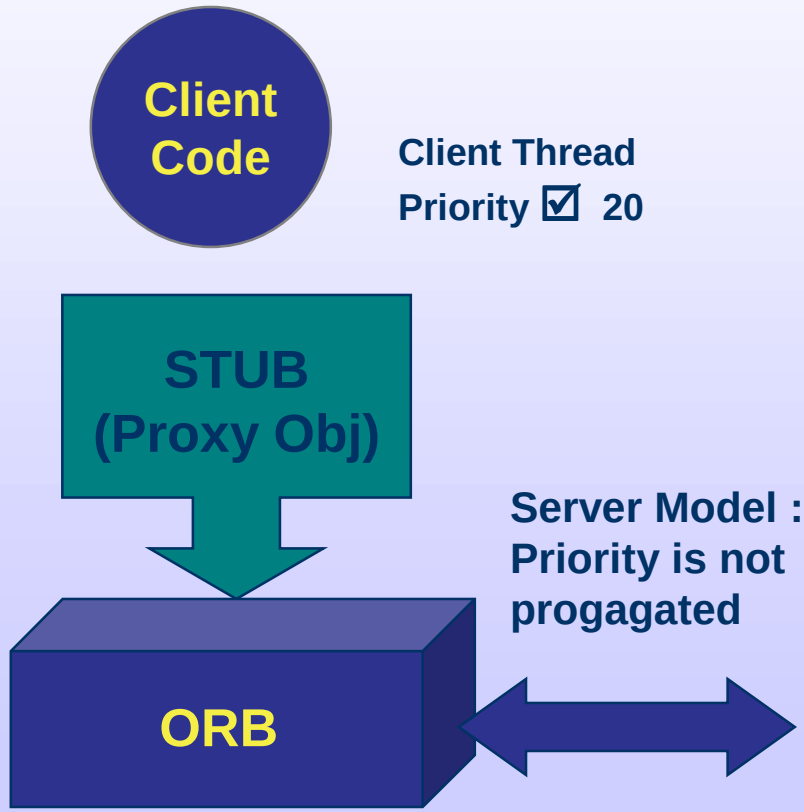
Server Declared Model only

```
AppObjectServant * app_object1, * app_object2;
app_object1 = new AppObjectServant();
app_object2 = new AppObjectServant();

// object activated through normal PortableServer API
// will have the (default) priority assigned to its POA
    appobject_poa->activate_object(app_object1);

// priority can be set to a different value by activating
// through RTPortableServer API
    RTPortableServer::POA_var appobject_poa_rt =
      RTPortableServer::POA::_narrow(app_object_poa);

    appobject_poa_rt
       ->activate_object_with_priority(app_object2, 10);
```

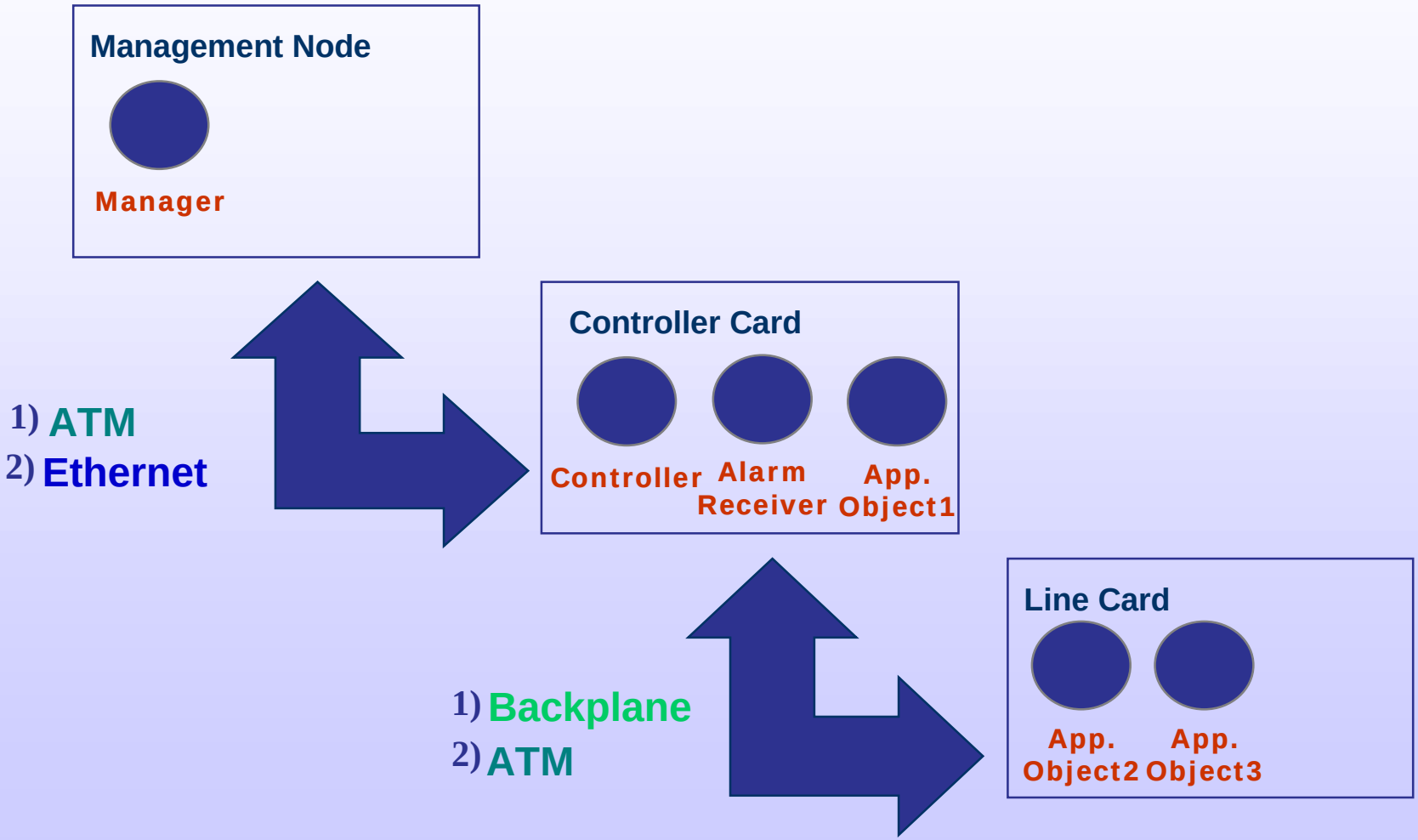


Client Priority Configuration

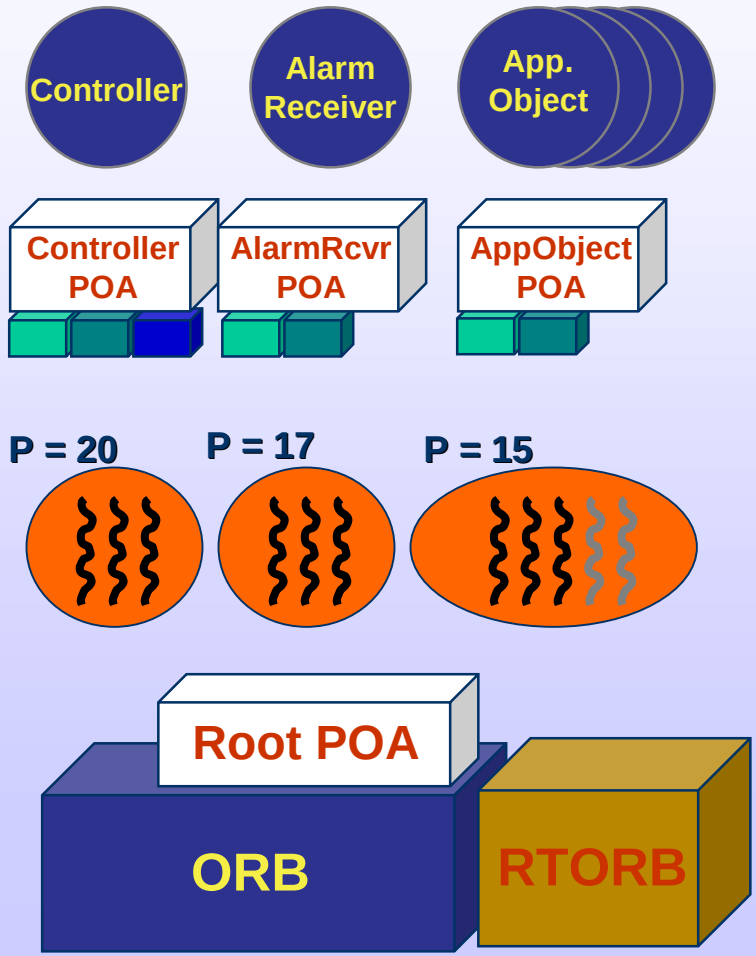
```
void main()
{

// initialize ORB
    orb = CORBA::ORB_init(argc, argv, orb_id);

// obtain handle to 'RT Current'
    CORBA::Object_var ref =
        orb->resolve_initial_references("RTCurrent");

    RTCORBA::Current_var rtcurrent =
        RTCORBA::Current::_narrow(ref);

// set priority of current thread
    rtcurrent->the_priority(20);

// invoke on CORBA Objects
// Priority is _not_ propagated to
// CORBA Objects that use the Server Model
alarm_handler->receive alarm(a);
```



Protocol Selection



Server-Side Protocol Selection



Server-Side Protocol Selection

```
// create ProtocolPolicy for each protocol want to use
    RTCORBA::Protocol ATM_giop(GIOP_AAL5,
                               0, // default GIOP config
                               0) // default AAL5 config
     RTCORBA::Protocol backplane_giop(GIOP_BP,
                               0, // default GIOP config
                               0) // default BP prot config

// create ProtocolList with protocols in order of preference
    RTCORBA::ProtocolList alarm_receiver_protocols(2);
    alarm_receiver_protocols[0] = backplane_giop;
    alarm_receiver_protocols[1] = ATM_giop;

// use ProtocolList to create a Server Protocol Policy
// object. Add it to the Policy List used to configure POA
    alarm_receiver_policy_list[2] = rtorb->
        create_server_protocol_policy( alarm_receiver_protocols );
```

Protocol Preference in Object Reference

Client-Side Protocol Selection

```
// create ProtocolPolicy for each protocol want to try using
   RTCORBA::Protocol ATM_giop(GIOP_AAL5, 0, 0);

// create ProtocolList with protocol(s) (in order of preference)
   RTCORBA::ProtocolList client_protocols(1);
   client_protocols[0] = ATM_giop;

// use ProtocolList to create a Client Protocol Policy object
   RTCORBA::ClientProtocolPolicy_var
     client_protocol_policy = rtorb->
       create_client_protocol_policy( alarm_receiver_protocols );

// apply the Policy at one of the client-side scopes specified
// in the CORBA QoS Policy Framework (ORB, Current or Object)

CORBA::Object_ptr ref = // Object reference for target object
CORBA::PolicyList policy_list(1) = client_protocol_policy;
CORBA::Object_var new_ref =
   ref->set_policy_overrides( policy_list,
                              CORBA::ADD_OVERRIDE);

// binding to the target CORBA Object via new_ref
// will only occur via one of  the protocols indicated
```

Protocol Preference in Object Reference

Invocation

Agenda

- Example 1
  - Server Priority Model
  - Threadpool configuration
  - RTCORBA::Current
  - Protocol Selection
- Example 2
  - Client Priority Model
  - Laned Threadpools
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- Example 3
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  - RTCORBA Mutex
- Example 4
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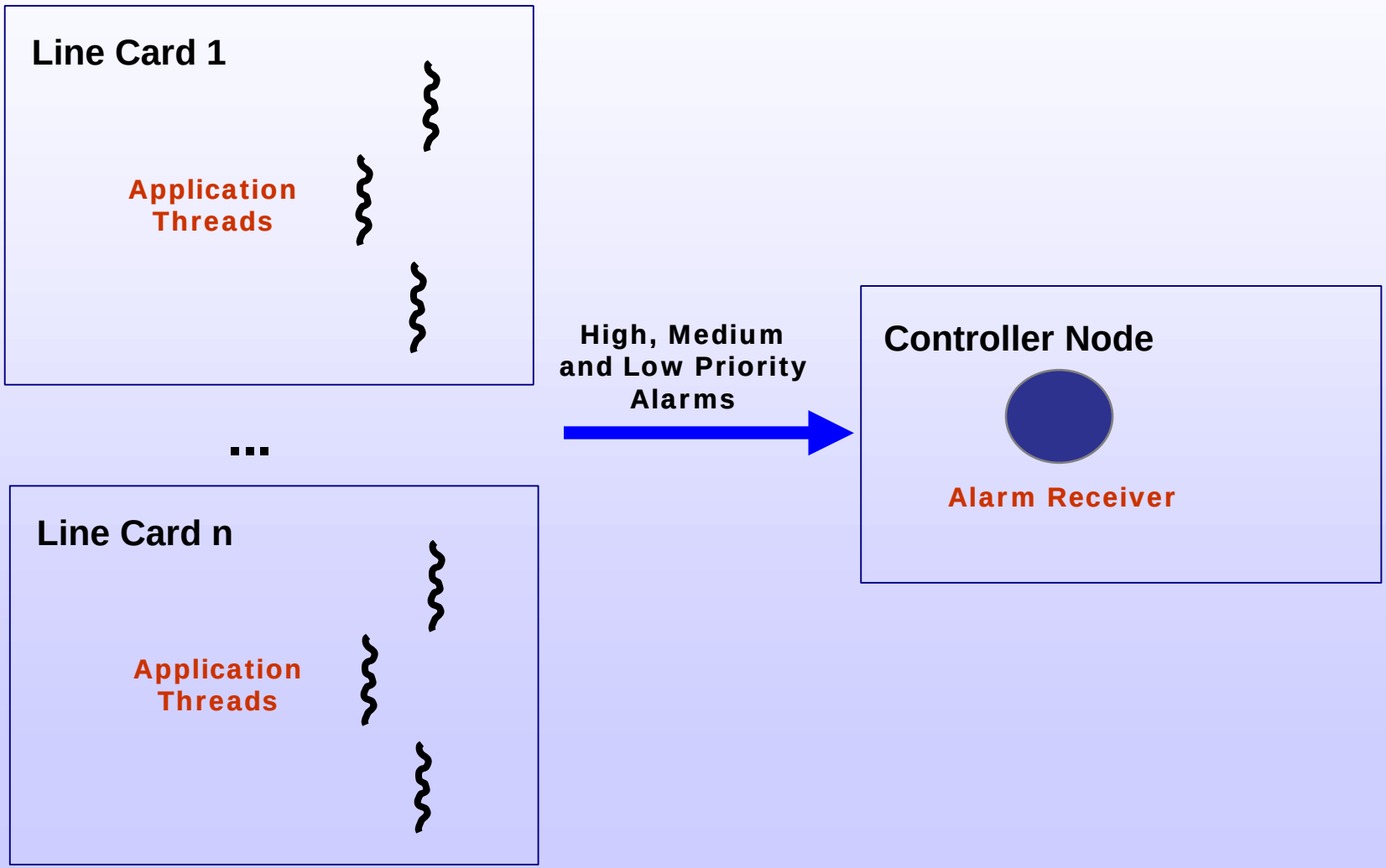
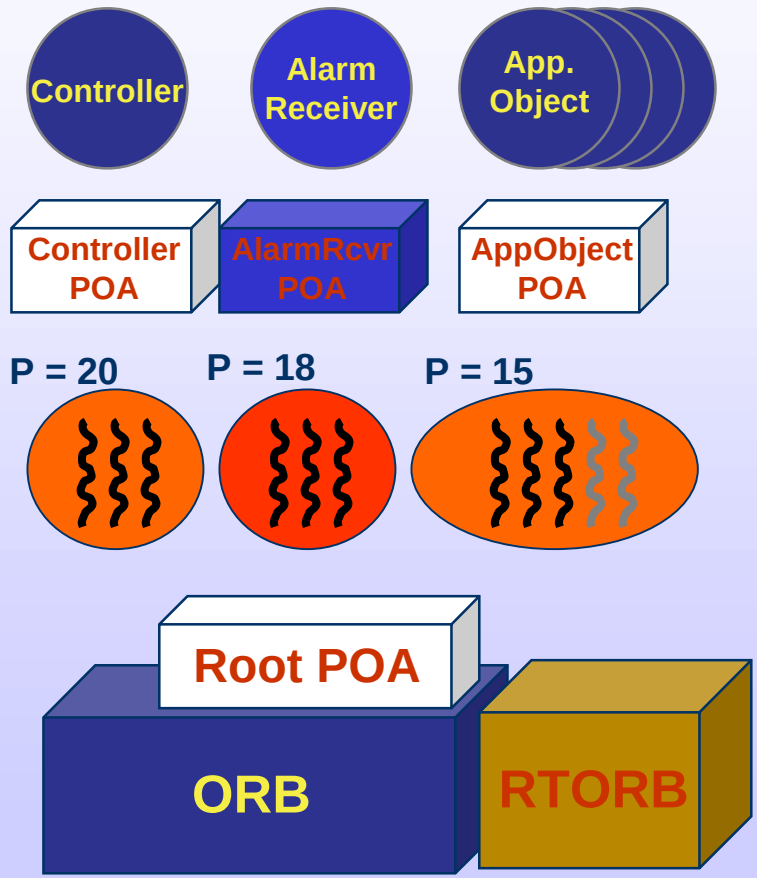
Prioritized Alarm Receiver



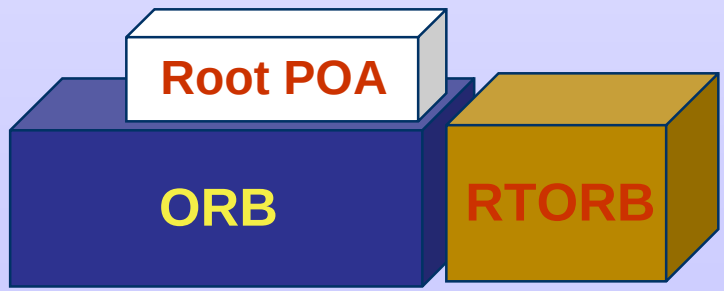
Configure Alarm Receiver Differently

- Client Declared Priority Model
- Laned Threadpool
- Priority Banded Connections



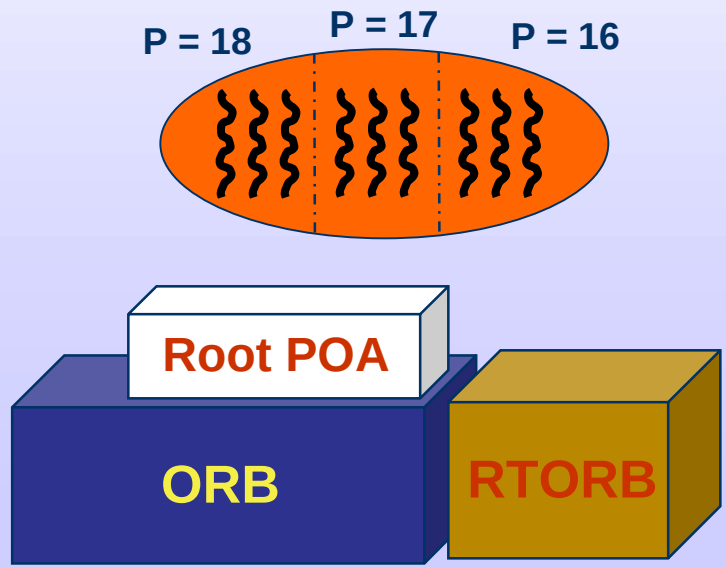
Create Laned Threadpool

```
// define three lanes, for High, Medium and
// Low priority alarms
   RTCORBA::ThreadpoolLane high_lane =
      { 18, // Priority
         3, // Static threads
        0 }; // Dynamic threads

   RTCORBA::ThreadpoolLane high_lane =
      { 17, // Priority
        3, // Static threads
        0 }; // Dynamic threads

   RTCORBA::ThreadpoolLane high_lane =
      { 16, // Priority
        3, // Static threads
        0 }; // Dynamic threads

   RTCORBA::ThreadpoolLanes pool_lanes[3];
   pool_lanes[0] = high_lane;
   pool_lanes[1] = medium_lane;
   pool_lanes[2] = low_lane;
```



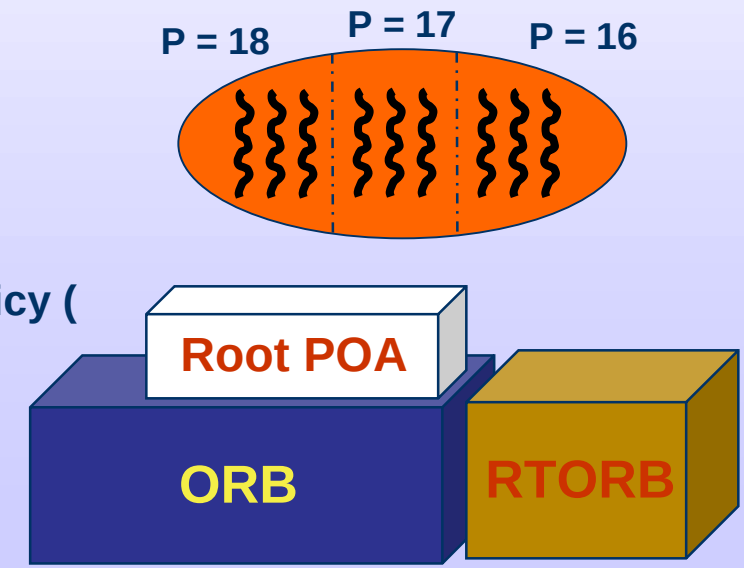
Create Laned Threadpool

```
RTCORBA::ThreadpoolId alarm_receiver_tpool;
RTCORBA::ThreadpoolPolicy_ptr threadpool_policy;

// create Threadpool for Alarm Receiver
    alarm_receiver_tpool =
            rt_orb->create_threadpool_with_lanes (
                        30000,        // stacksize
                        pool_lanes, // Lanes
                        FALSE,        // Don't allow thread borrowing
                        0, 0, 0 );

// create Threadpool Policy object for that Threadpool
    threadpool_policy =
            rt_orb->create_threadpool_policy (
                                alarm_receiver_tpool );
```



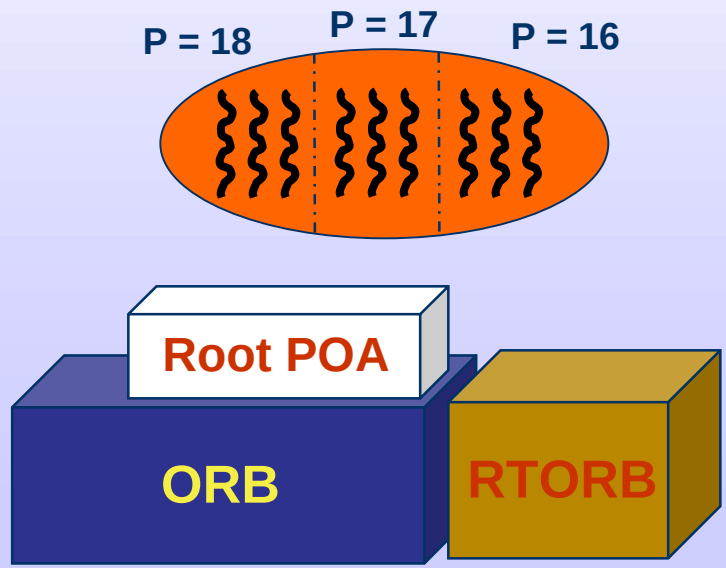
Specify Banded Connections

```
// specify three bands, corresponding to the
// Threadpool lanes
    RTCORBA::PriorityBand high_band = { 18, 18 };
    RTCORBA::PriorityBand medium_band = { 17, 17 };
    RTCORBA::PriorityBand low_band = { 16, 16 };

    RTCORBA::PriorityBands priority_bands(3);
    priority_bands[0] = high_band;
    priority_bands[1] = medium_band;
    priority_bands[2] = low_band;

// create a Banded Connection Policy object
    RTCORBA::PriorityBandedConnectionPolicy
    banding_policy =
      rt_orb->create_priority_banded_connection_policy (
                                        priority_bands );
```



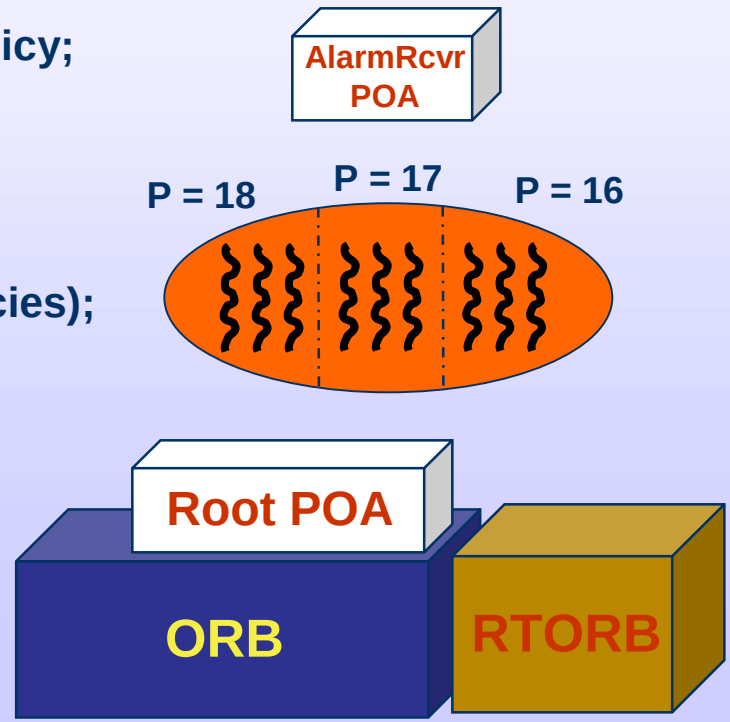
Client Propagated Priority Model

```
RTCORBA::PriorityModelPolicy_var priority_model_policy;

// create Client Propagated Priority Model policy object
    priority_model_policy =
        rt_orb->create_priority_model_policy (
                    RTCORBA::CLIENT_PROPAGATED,
                     16); // priority handle non-RT clients at
```



Create Alarm Receiver POA

```
PortableServer::POA_ptr alarm_receiver_poa;

// prepare Policy List for Alarm Receiver POA
    CORBA::PolicyList alarm_receiver_policies[3];
    alarm_receiver_policies[0] = threadpool_policy;
    alarm_receiver_policies[1] = banding_policy;
    alarm_receiver_policies[2] = priority_model_policy;

// create Object Adapter
    alarm_receiver_poa =
        root_poa->create_POA("AlarmRcvrPOA", 0,
                                        alarm_receiver_policies);
```



Agenda

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  - Threadpool configuration
  - RTCORBA::Current
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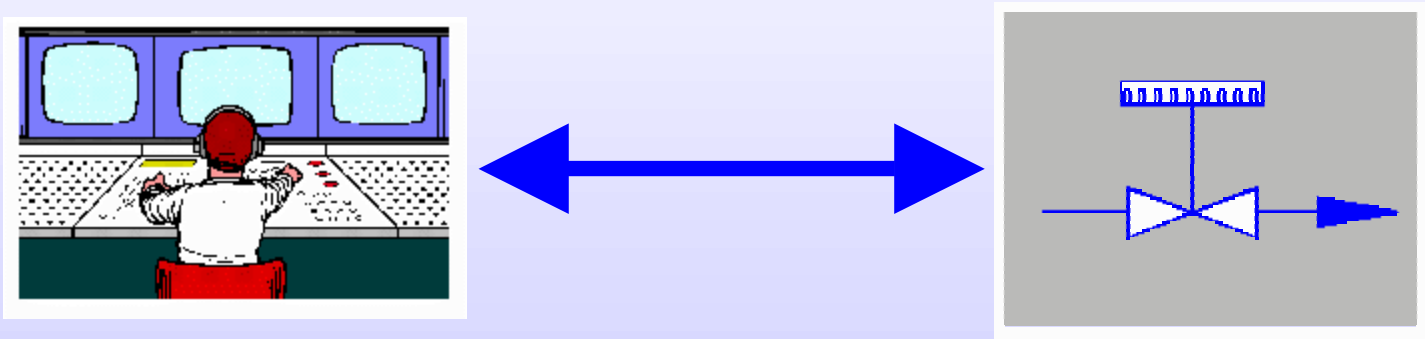
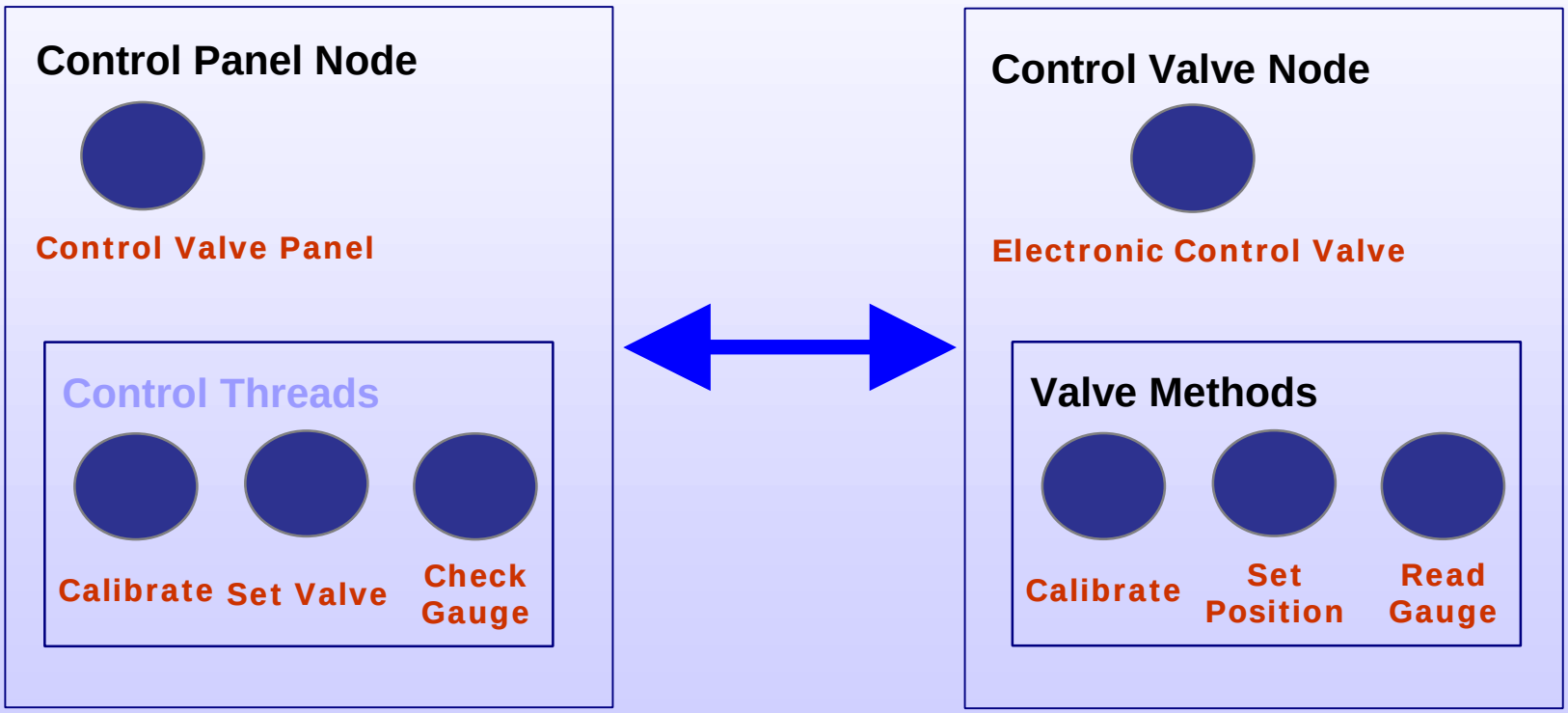
Electronic Control Valve System



Control Panel

Control Valve

Object Model



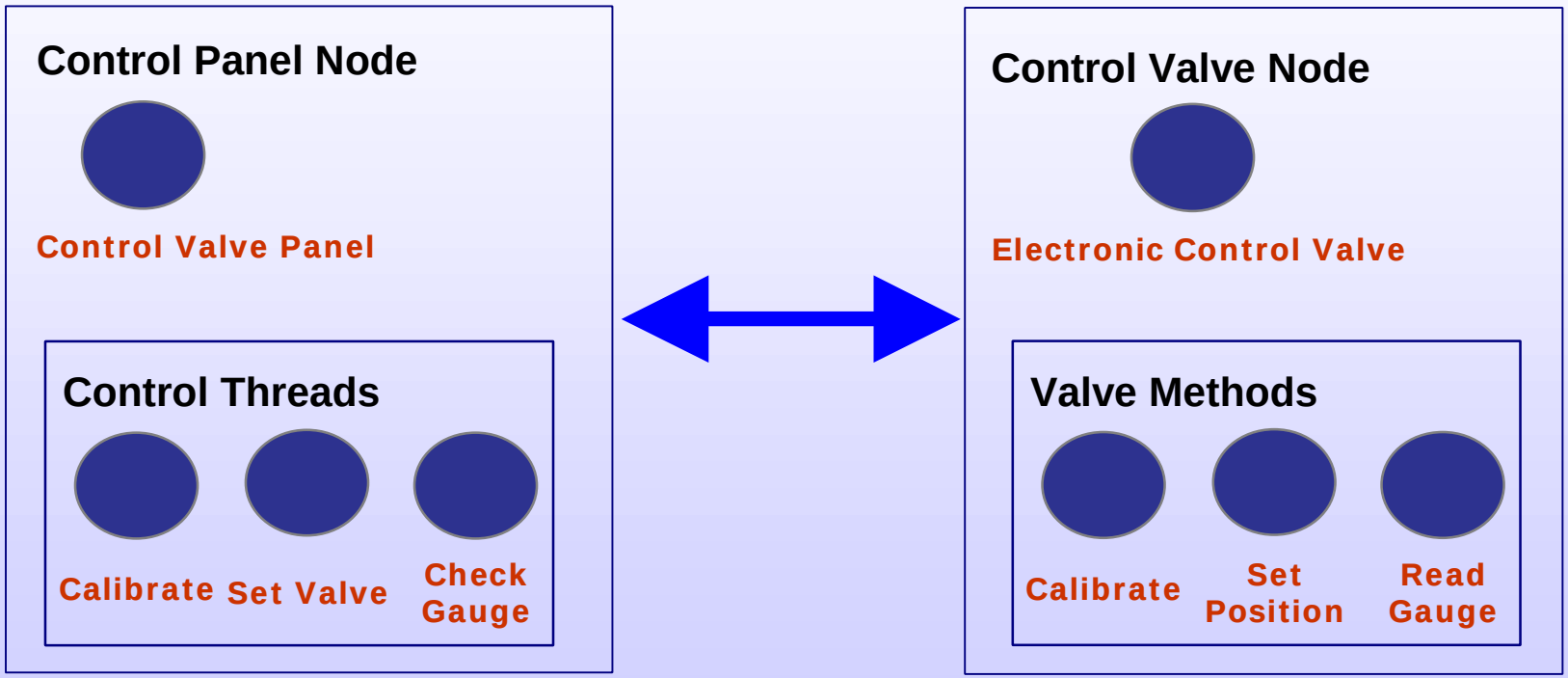
Object IDL

```
interface ControlValve
{

    boolean Calibrate ( in long Value );

    short SetValvePosition ( in short Degrees );

    long ReadGuage ( );

};
```

Real-Time Design Considerations

Rate Monotonic Analysis
Priority Ceiling Protocol

Shared Resources
Limited OS Priorities



Calibrate	Lower Priority
Set Position	Medium Priority
Read Gauge	High Priority

Priority Mapping

Support for 32,767 priorities

Two priority mappings: to_native() and to_CORBA()

Implementation defined

Unique mapping for each node

Priority Mapping Example

Control Panel Priorities

	RTCORBA Priority	OS Priority
Calibrate	1	53
Set Valve	2	54
Check Gauge	3	54

Control Valve Priorities

	RTCORBA Priority Ceiling	OS Priority
Valve Gauge	3	54
Valve Position	2	54

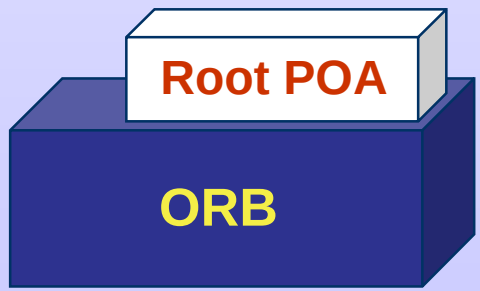
Priority Mapping Example

```
RTCORBA::NativePriority MappingTable[4] = {  0,
                                             53,
                                             54,
                                             54 }; // Index 0 is unused.

class MappingClass : public RTCORBA::PriorityMapping {
public:
  CORBA::Boolean to_native(RTCORBA::Priority corba_priority,
                           RTCORBA::NativePriority &native_priority)
  {
     if (corba_priority < 1 || corba_priority > (sizeof(MappingTable) / sizeof(int)))
        return FALSE;
     native_priority = MappingTable[corba_priority];
     return TRUE;
  }

  CORBA::Boolean to_CORBA(RTCORBA::Priority native_priority,
                          RTCORBA::NativePriority &corba_priority)
  {
     return FALSE;          // not used
  }
};
```

Valve Node Initialization

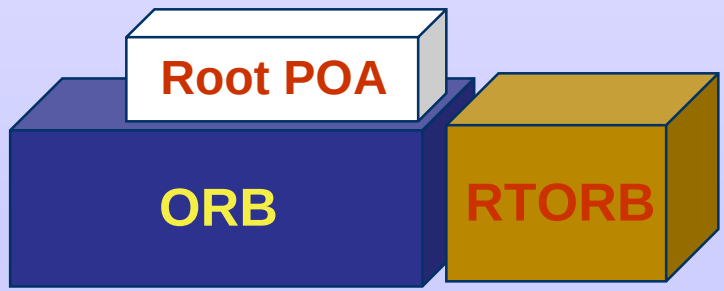
Begin with usual CORBA initialization

```
// C++
CORBA::ORB_ptr orb;
PortableServer::POA_ptr root_poa;

void initValve()
{

// initialize ORB
    orb = CORBA::ORB_init(argc, argv, orb_id);

// obtain Root Object Adapter
    CORBA::Object_var ref1 =
        orb->resolve_initial_references("RootPOA");

    root_poa = PortableServer::POA::_narrow(ref1);
```



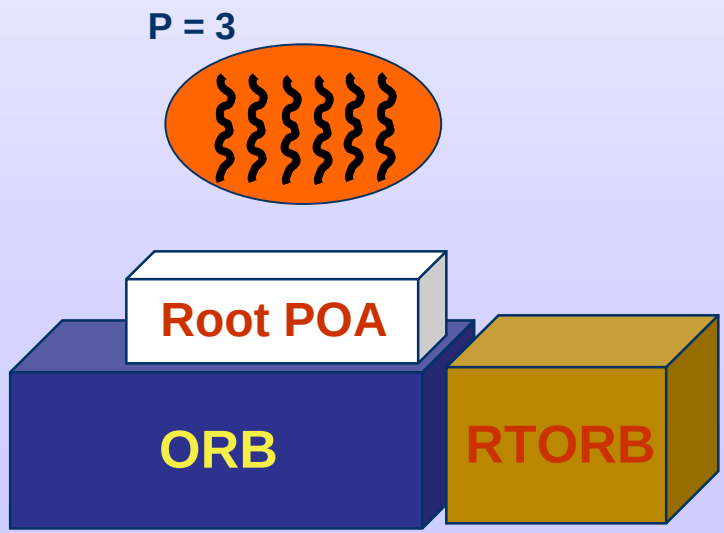
Access Real-Time CORBA API

```
RTCORBA::RTORB_ptr rt_orb;

// access Real-Time extensions to ORB
    CORBA::Object_var ref2 =
        orb->resolve_initial_references("RTORB");

    rt_orb = RTCORBA::RTORB::_narrow(ref2);
```



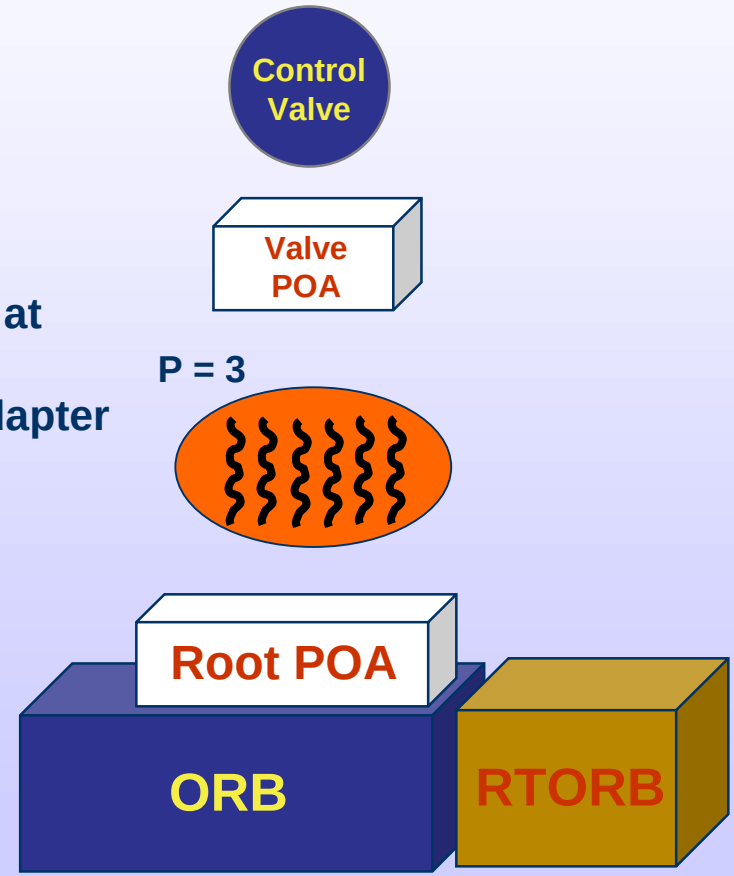
Create Threadpool

```
RTCORBA::ThreadpoolId valve_tpool;
RTCORBA::ThreadpoolPolicy_var threadpool_policy;

// create Threadpool for Valve
   valve_tpool =  rt_orb->create_threadpool (
                              30000, // stacksize
                              6, // num static threads
                              0, // num dynamic threads
                              3, // default thread priority
                              FALSE, 0, 0 );

// create Policy object for this Threadpool
   threadpool_policy =
       rt_orb->create_threadpool_policy(valve_tpool);
```



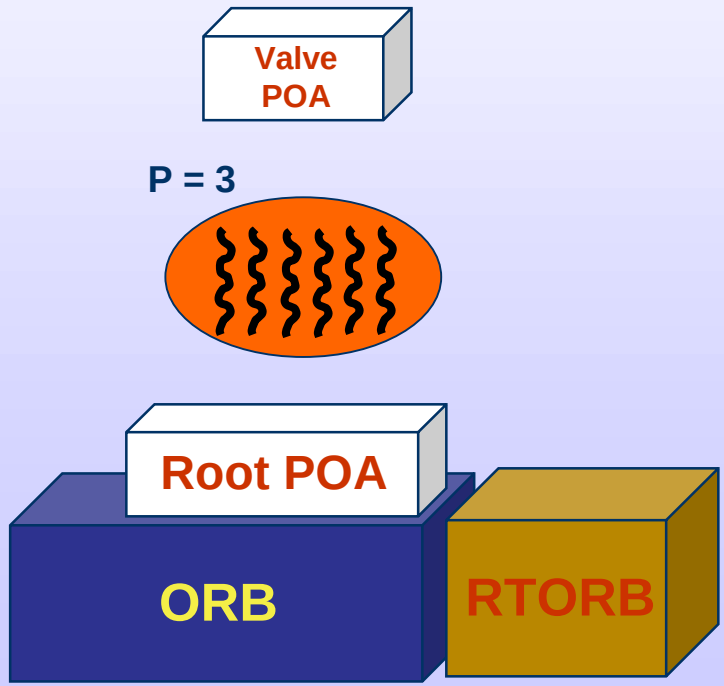
Prepare POA Configuration

```
RTCORBA::PriorityModelPolicy_var priority_model_policy;
CORBA::PolicyList valve_policies(2);

// create Client Propagated Priority Model policy
    priority_model_policy =
        rt_orb->create_priority_model_policy (
                    RTCORBA::CLIENT_PROPAGATED,
                      0 ); // priority handle non-RT clients at

// assemble policy list for initialising Valve object adapter
    valve_policies[0] = priority_model_policy;
    valve_policies[1] = threadpool_policy;
```



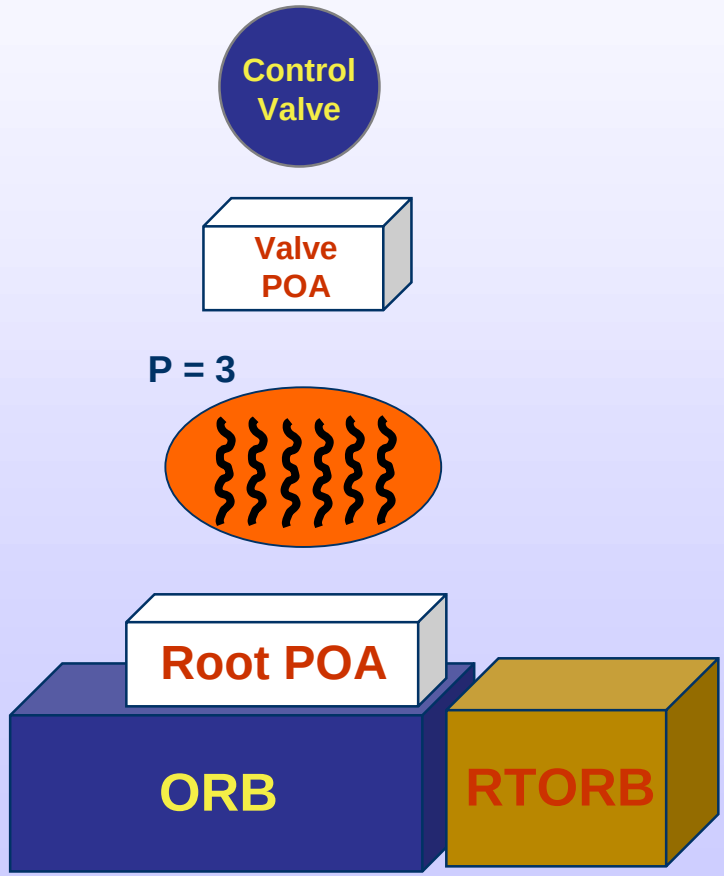
Create Valve POA

```
PortableServer::POA_ptr valve_poa;

// create Object Adapter
    valve_poa =
        root_poa->create_POA("ValvePOA", 0,
                                        valve_policies);
```



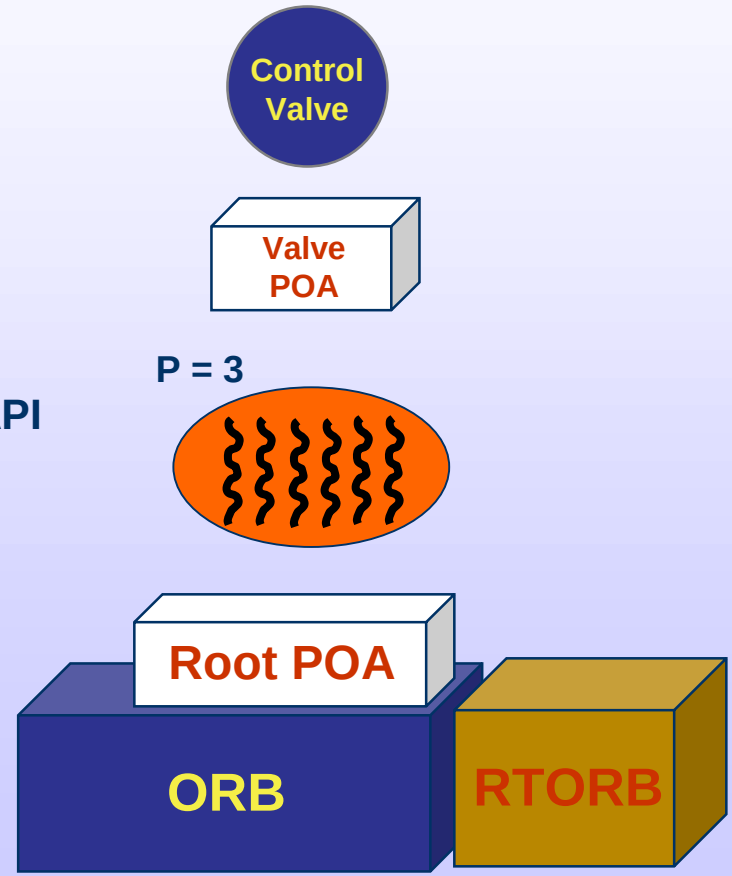
Create Valve Object

```
ValveServant * valve_servant;

// create Valve object
    valve_servant = new ValveServant();

// activate object
    valve_poa->activate_object(valve_servant);
```



Create RT Mutexes

```
RTCORBA::Mutex_ptr valve_mutex;
RTCORBA::Mutex_ptr gauge_mutex;

ValveServant::ValveServant()
{
        // Create RTCORBA mutexes
        valve_mutex = rt_orb->create_mutex( );
        gauge_mutex = rt_orb->create_mutex( );

        // configure priority ceilings
        // Note: Available priority protocols and API
        // are ORB implementation specific
        valve_mutex->set_ceiling   (2);
        gauge_mutex->set_ceiling (3);
}
```



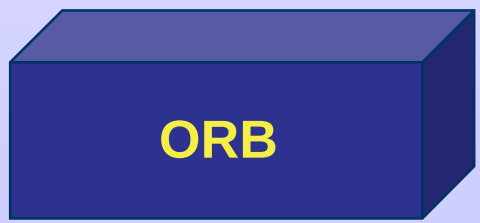
Object Implementation

```
CORBA::Boolean ValveServant::Calibrate(CORBA::Long Value)
{
   gauge_mutex->lock();
   ...
   gauge_mutex->unlock();
}

CORBA::Long ValveServant::SetValvePosition(CORBA::Short Degrees)
{
   valve_mutex->lock();
   ...
   valve_mutex->unlock();
}

CORBA::Long ValveServant::ReadGauge(
)
{
   gauge_mutex->lock();
   ...
   gauge_mutex->unlock();
}
```

Control Node Initialization

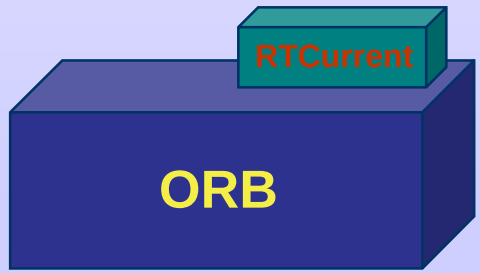
Client node has no CORBA Objects, so it does not need to access the RootPOA

```
// C++

... // initialize mapping table

CORBA::ORB_ptr orb;

void initControlPanel()
{

// initialize ORB
   orb = CORBA::ORB_init(argc, argv, orb_id);
```



Obtain RTCORBA::Current

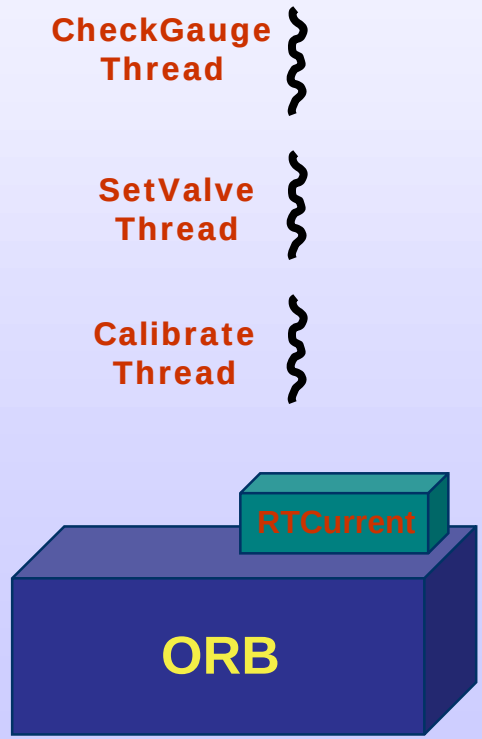
```
RTCORBA::Current_ptr rt_current;

// obtain the RTCurrent object
// Can obtain one instance and use it from all threads
    CORBA::Object_var ref3 =
        orb->resolve_initial_references("RTCurrent");

    rt_current = RTCORBA::Current_narrow(ref3);
```



Create Client Threads

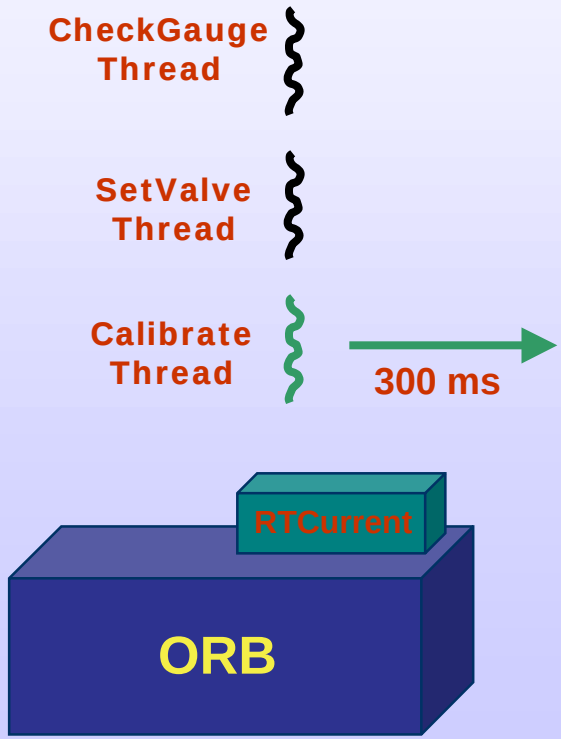
Client threads are implemented using native operating system methods

```
// Create client threads

    thread_create(&thread_id, Calibrate);

    thread_create(&thread_id, SetValve);

    thread_create(&thread_id, CheckGauge);
```



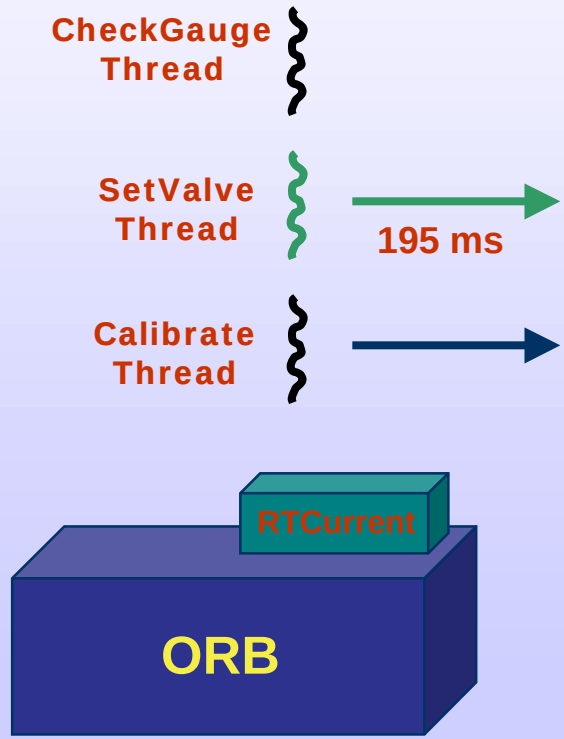
Calibrate Thread

```
void Calibrate( ) {

   CORBA::Long Value;

   // Get and bind object
   ControlValve_var valve = // Obtain Valve reference

   // Set the thread priority.
   rt_current->the_priority = 1;

   // Execute loop every 300 ms.
   while (1) {

      ... // Local code

      valve->Calibrate(Value);  // Call Valve object

      ... // Local code

      ... // Wait for period timer.
   }
}
```



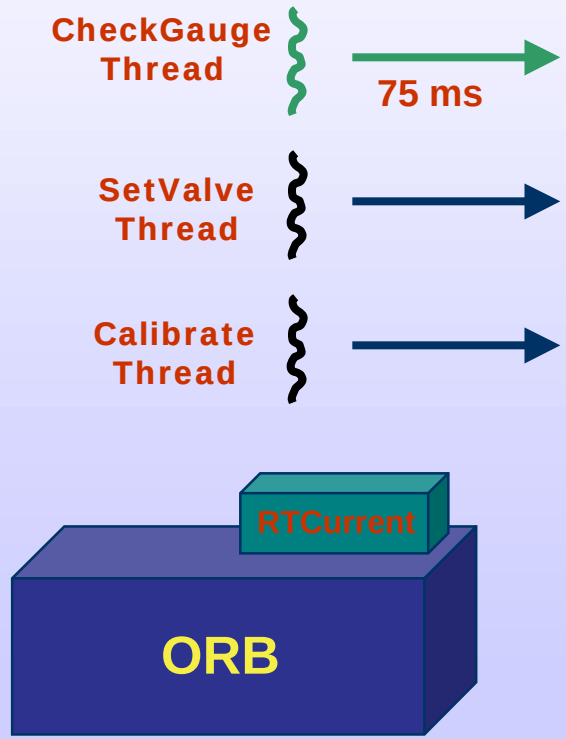
Set Valve Thread

```
void SetValve( ) {

   CORBA::Short Degrees;

   // Get and bind object
   ControlValve_var valve = // Obtain Valve reference

   // Set the thread priority.
   rt_current->the_priority = 2;

   // Execute loop every 195 ms.
   while (1) {

      ... // Local code

      // Call Valve object
      valve->SetValvePosition(Degrees);

      ... // Local code

      ... // Wait for period timer.
   }
}
```



Check Gauge Thread

```
void CheckGauge( ) {

   CORBA::Long Value;

   // Get and bind object
   ControlValve_var obj1 = // Obtain Valve reference

   // Set the thread priority.
   rt_current->the_priority = 3;

   // Execute loop every 75 ms.
   while (1) {

      ... // Local code

     // Call Valve object
      Value = valve->ReadGauge(Value);

      ... // Local code

      ... // Wait for period timer.
   }
}
```

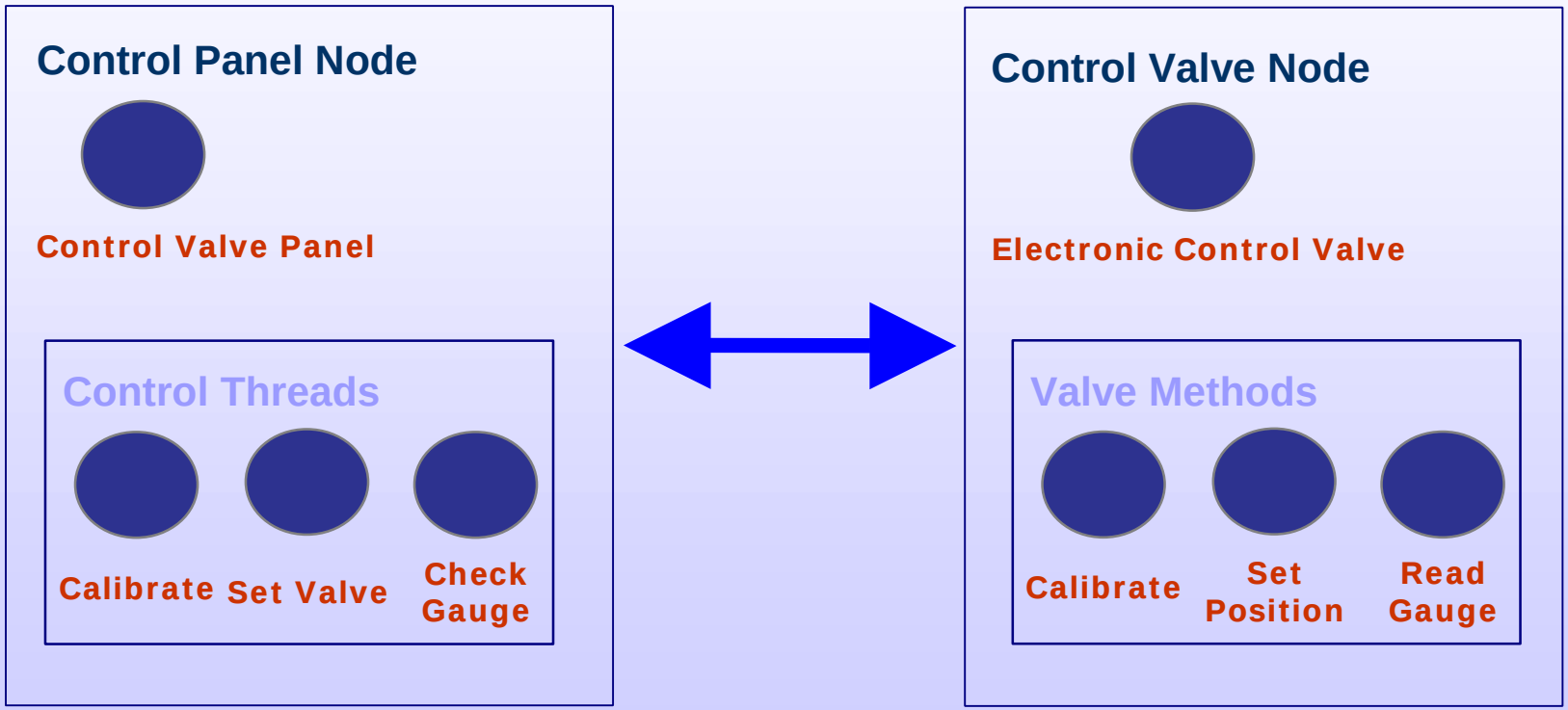


Agenda

- Example 1
  - Server Priority Model
  - Threadpool configuration
  - RTCORBA::Current
  - Protocol configuration
- Example 2
  - Client Priority Model
  - Laned Threadpools
  - Priority Banding
- Example 3
  - Priority Mapping
  - RTCORBA Mutex
- Example 4
  - Scheduling Service

Scheduling Service Example

Using same object model as previous example



Scheduling Service

Based on analytical tools

Performs all priority mapping

Handles all 32,767 priorities

Sets thread priorities

Enforces priority algorithm

Uses names instead of numbers

Change your scheduling, not your code

Priority Mapping

Control Panel Node Mapping

	RTCORBA Priority	OS Priority
Calibrate	1	53
Set Valve	2	54
Check Gauge	3	54

Control Valve Node Mapping

	RTCORBA Priority Ceiling	OS Priority
Valve Gauge	3	54
Valve Position	2	54

Same example mapping as before, but used as input to the Scheduling Service

However now there will be no mapping table in application code

Valve Node Initialisation

```
// No Scheduling Service
// C++
CORBA::ORB_ptr orb;
PortableServer::POA_ptr root_poa;
RTCORBA::RTORB_ptr rt_orb;

void initValve()
{

// initialize ORB
    orb = CORBA::ORB_init(argc, argv, orb_id);

// obtain Root Object Adapter
    CORBA::Object_var ref1 =
        orb->resolve_initial_references("RootPOA");

    root_poa = PortableServer::POA::_narrow(ref1);

// access Real-Time extensions to ORB
    CORBA::Object_var ref2 =
        orb->resolve_initial_references("RTORB");

    rt_orb = RTCORBA::RTORB::_narrow(ref2);
```

```
// Scheduling Service
// C++
CORBA::ORB_ptr orb;
PortableServer::POA_ptr root_poa;
RTCORBA::RTORB_ptr rt_orb;

void initValve()
{

// initialize ORB
    orb = CORBA::ORB_init(argc, argv, orb_id);

// obtain Root Object Adapter
    CORBA::Object_var ref1 =
        orb->resolve_initial_references("RootPOA");

    root_poa = PortableServer::POA::_narrow(ref1);

// access Real-Time extensions to ORB
    CORBA::Object_var ref2 =
        orb->resolve_initial_references("RTORB");

    rt_orb = RTCORBA::RTORB::_narrow(ref2);
```

Valve Node Initialisation

```
// No Scheduling Service
RTCORBA::ThreadpoolId valve_tpool;
RTCORBA::ThreadpoolPolicy_ptr threadpool_policy;

// create Threadpool for Valve
   valve_tpool =  rt_orb->create_threadpool(
                           30000, // stacksize
                           6, // num static threads
                           0, // num dynamic threads
                           3, // default thread priority
                           FALSE, 0, 0);

   threadpool_policy = rt_orb->
      create_threadpool_policy(valve_tpool);
```

```
// Scheduling Service

// Depending on the implemenation, threadpools
// may be may be configured by the Scheduling
// Service.
```

Valve Node Initialisation

```
// No Scheduling Service
RTCORBA::PriorityModelPolicy_var
                                priority_model_policy;
CORBA::PolicyList valve_policies(2);

// create Server Priority Model policy
    server_policy =
        rt_orb->create_priority_model_policy
                    (RTCORBA::CLIENT_PROPAGATED,
                     0); // priority handle non-RT clients at

// assemble policy lists for initializing
// Valve object adapter
    valve_policies[0] = priority_model_policy;
    valve_policies[1] = threadpool_policy;
```

```
// Scheduling Service


// server scheduler selects priority model
RTCosScheduling::ServerScheduler * sched;

sched = new RTCosScheduling::ServerScheduler;
```

Valve Node Initialisation

```
// No Scheduling Service
PortableServer::POA_ptr valve_poa;

// create Object Adapter
   valve_poa =
      root_poa->create_POA("ValvePOA", 0,
                           valve_policies);

ValveServant_ptr valve_servant;

// create Valve object
   valve_servant = new ValveServant();

// activate object
   valve_poa->activate_object(valve_servant);
```

```
// Scheduling Service
PortableServer::POA_ptr valve_poa;

// create Object Adapter
   valve_poa =
      sched->create_POA(root_poa, "ValvePOA",
      nil, nil);

ValveServant_ptr valve_servant;

// create Valve object
   valve_servant = new ValveServant();

// activate object
   valve_poa->activate_object(valve_servant);
```

Valve Node Initialisation

```
// No Scheduling Service
RTCORBA::Mutex_ptr valve_mutex;
RTCORBA::Mutex_ptr gauge_mutex;

ValveServant::ValveServant()
{
   // Configure ORB for PCP type mutex is
   // defined by the ORB implementation
   ...

   // Create RTCORBA mutexes
   valve_mutex = rt_orb->create_mutex();
   gauge_mutex = rt_orb->create_mutex();

   // Set PCP ceilings is defined
   // by the ORB implementation
   valve_mutex->set_ceiling(2);
   gauge_mutex->set_ceiling(3);

}
```

```
// Scheduling Service

// RTCORBA::Mutex handled by Scheduling Service

ValveServant::ValveServant()
{

   // schedule_object requires Object_ptr or
   // or Object_var.  Note the reuse of the object
   //  pointer.  This is due to using the DASPCP model.
   sched->schedule_object ( ::_this,
                            "Valve::Gauge");
   sched->schedule_object ( ::_this,
                            "Valve::Position");

}
```

Object Implementation

```
// No Scheduling Service
CORBA::Boolean
ValveServer::Calibrate(CORBA::Long Value) {
    gauge_mutex->lock();
    ...
    gauge_mutex->unlock();
}

CORBA::Long
ValveServant::SetValvePosition(CORBA::Short
Degrees) {
    valve_mutex->lock();
    ...
    valve_mutex->unlock();
}

CORBA::Long ValveServant::ReadGauge() {
    gauge_mutex->lock();
    ...
    gauge_mutex->unlock();
}
```

```
// Scheduling Service
CORBA::Boolean
    ValveServer::Calibrate(CORBA::Long Value) {

    ...

}

CORBA::Long
    ValveServant::SetValvePosition(CORBA::Short
    Degrees) {

    ...

}

CORBA::Long ValveServant::ReadGauge() {

    ...

}
```

Control Node Initialization

```
// No Scheduling Service
// C++

... // initialize mapping table

CORBA::ORB_ptr orb;

void initControlPanel()
{
// initialize ORB
   orb = CORBA::ORB_init(argc, argv, orb_id);
```

```
// Scheduling Service
// C++

// no mapping table needed

CORBA::ORB_ptr orb;

void initControlPanel()
{
// initialize ORB
   orb = CORBA::ORB_init(argc, argv, orb_id);
```

Control Node Initialization

```
// No Scheduling Service
RTCORBA::RTORB_ptr rt_orb;
RTCORBA::Current_ptr rt_current;

// access Real-Time extensions to ORB
   CORBA::Object_var ref2 =
      orb->resolve_initial_references("RTORB");

   rt_orb = RTCORBA::RTORB::_narrow(ref2);

// obtain RTCurrent
   CORBA::Object_ptr ref3 =
      orb->resolve_initial_references("RTCurrent");
   rt_current = RTCORBA::Current::_narrow(ref3);

// Create client threads
   thread_create(&thread_id, Calibrate);
   thread_create(&thread_id, SetValve);
   thread_create(&thread_id, CheckGauge);
```

```
// Scheduling Service

// no access to RTCurrent needed

// Create client threads
   thread_create(&thread_id, Calibrate);
   thread_create(&thread_id, SetValve);
   thread_create(&thread_id, CheckGauge);
```

Calibrate Thread

```
// No Scheduling Service
void Calibrate() {
   CORBA::Long Value;

   // Get and bind object
   ControlValve_var valve = // obtain Valve reference

   // Set the thread priority.
   rt_current->the_priority = 1;

   // Execute loop every 300 ms.
   while (1) {

      ... // Local code

      valve->Calibrate(Value);  // Call Valve

      ... // Local code

      ... // Wait for period timer.
   }
}
```

```
// Scheduling Service
void Calibrate() {
   CORBA::Long Value;

   // Get and bind object
   ControlValve_var valve = // obtain Valve reference

   // Set the thread priority.
   sched->schedule_activity("Calibrate");

   // Execute loop every 300 ms.
   while (1) {

      ... // Local code

      valve->Calibrate(Value);  // Call Valve

      ... // Local code

      ... // Wait for period timer.
   }
}
```

Set Valve Thread

```
// No Scheduling Service
void SetValve() {
    CORBA::Short Degrees;

   // Get and bind object
   ControlValve_var obj1 = // obtain Valve reference

   // Set the thread priority.
   rt_current->the_priority = 2;

   // Execute loop every 195 ms.
   while (1) {

      ... // Local code

      valve->SetValvePosition(Degrees);

      ... // Local code

      ... // Wait for period timer.
   }
}
```

```
// Scheduling Service
void SetValve() {
    CORBA::Short Degrees;

   // Get and bind object
   ControlValve_var valve = // obtain Valve reference

   // Set the thread priority.
   sched->schedule_activity("SetValve");

   // Execute loop every 195 ms.
   while (1) {

      ... // Local code

      valve->SetValvePosition(Degrees);

      ... // Local code

      ... // Wait for period timer.
   }
}
```

Check Gauge Thread

```
// No Scheduling Service
void CheckGauge() {
   CORBA::Long Value;

   // Get and bind object
   ControlValve_var valve = // Something

   // Set the thread priority.
   rt_current->the_priority = 3;

   // Execute loop every 75 ms.
   while (1) {

      ... // Local code

      Value = valve->ReadGauge(Value);

      ... // Local code

      ... // Wait for period timer.
   }
}
```

```
// Scheduling Service
void CheckGauge() {
   CORBA::Long Value;

   // Get and bind object
   ControlValve_var valve = // obtain Valve reference

   // Set the thread priority.
   sched->schedule_activity("CheckGauge");

   // Execute loop every 75 ms.
   while (1) {

      ... // Local code

      Value = valve->ReadGauge(Value);

      ... // Local code

      ... // Wait for period timer.
   }
}
```