

Delivering PI ACE Applications in .NET

Presented By:

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Talk Outline

- PI ACE
- PI ACE and Asset Framework (AF)
- PI ACE 2010
- .NET coding examples



PI Advanced Computing Engine

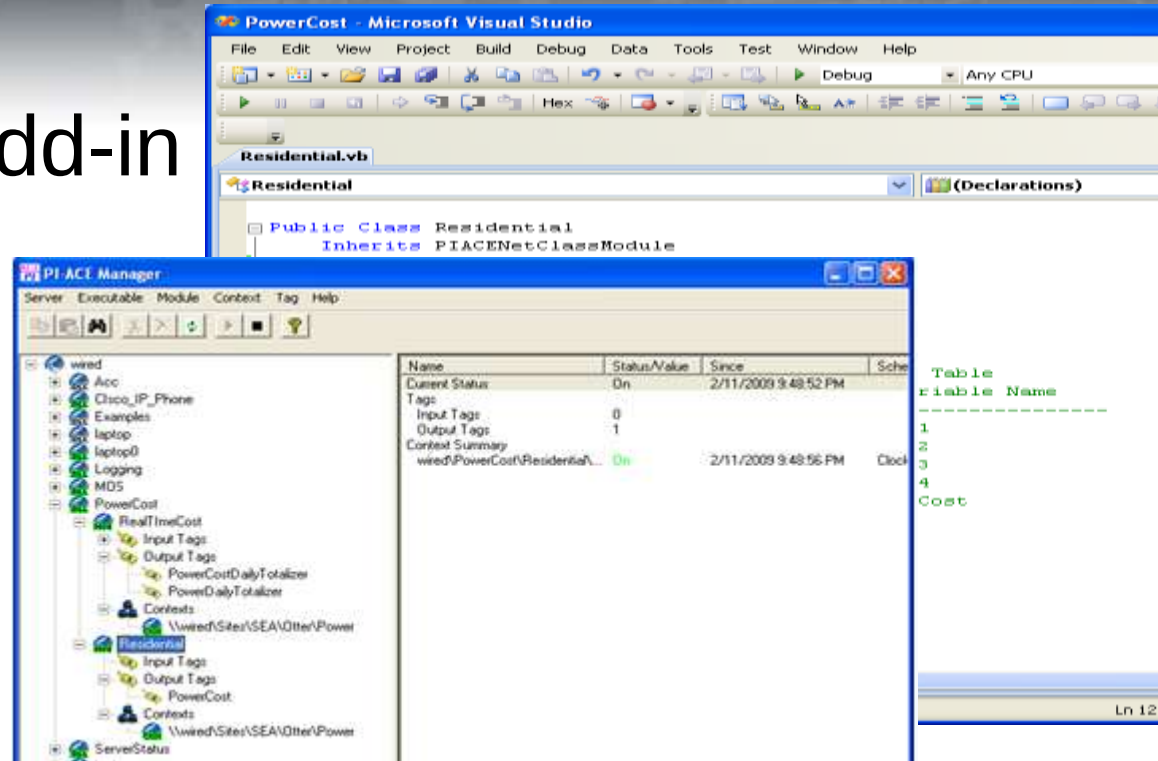
PI ACE

- Create calculations using Visual Studio
- Wizard to configure access to PI data
- Write once and apply multiple times



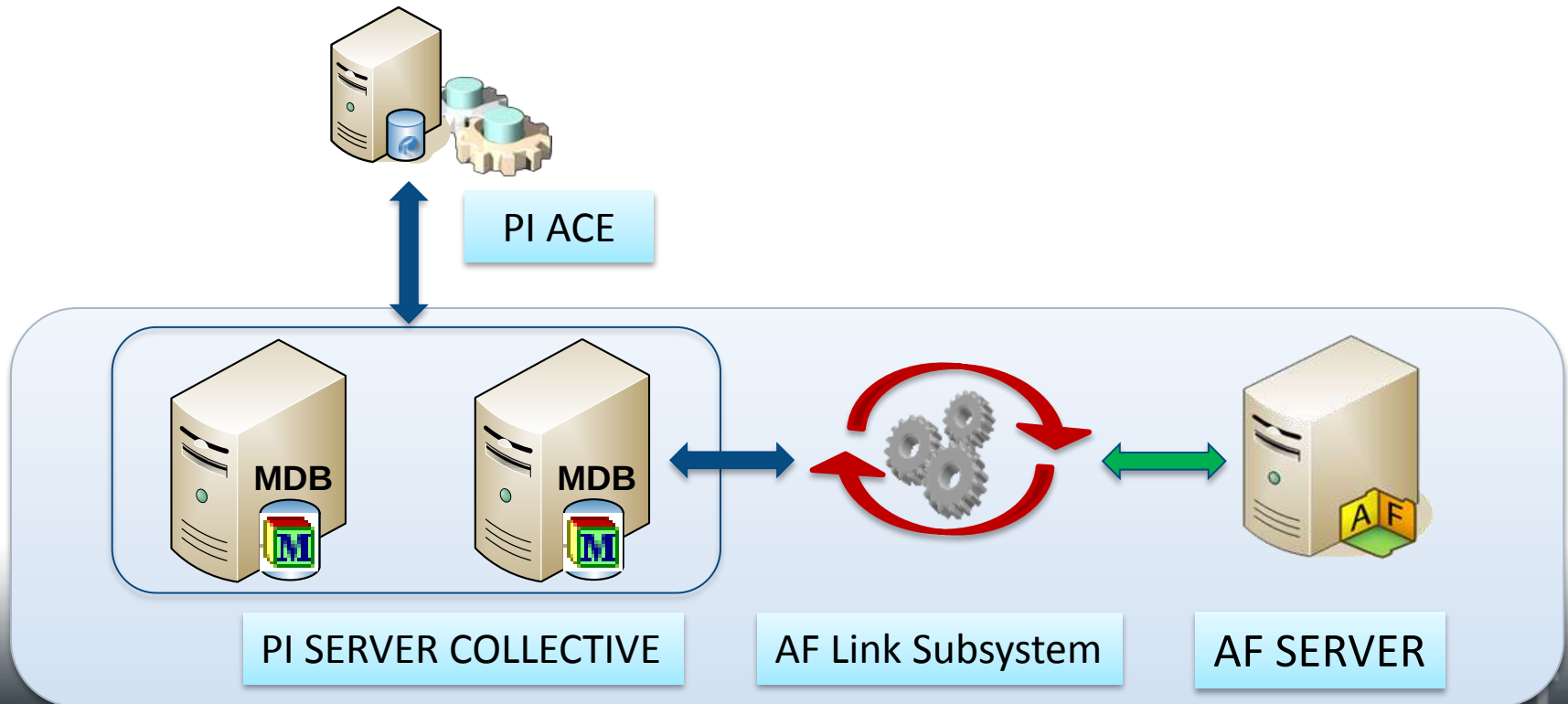
PI ACE Components

- Visual Studio add-in
 - develop
- Manager client
 - configure
- Scheduler 
 - execute



PI ACE and PI Asset Framework (AF)

ACE uses the PI Variable Database (PI DB) for configuration and calculation metadata



PI ACE 2010

- Scheduled to be released later this year
- Multiple Schedulers
 - ACE Scheduler 1
 - ACE Scheduler N
- Performance Improvements
 - Components re-written in .NET
- Visual Studio 2010 support
- Native 64-bit operating system support



ACE Scheduler 1



ACE Scheduler N

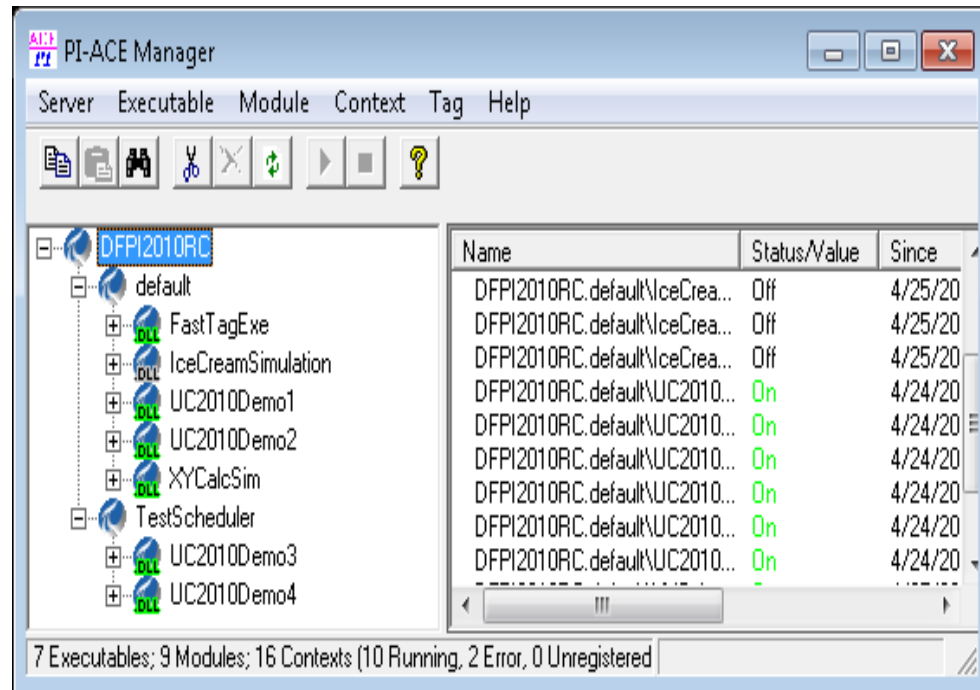
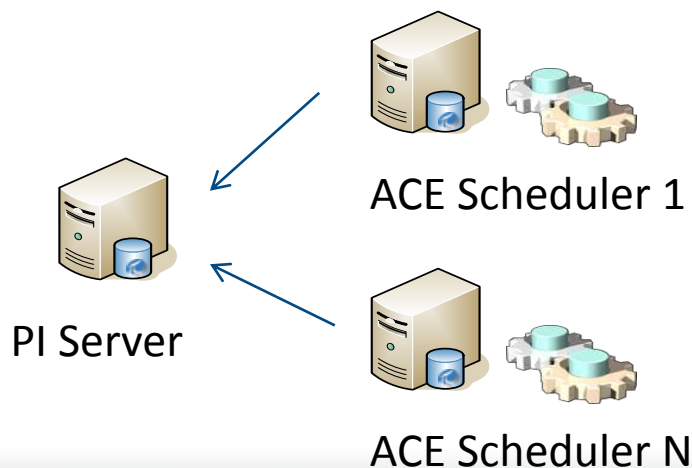


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Multiple PI ACE Schedulers

New!

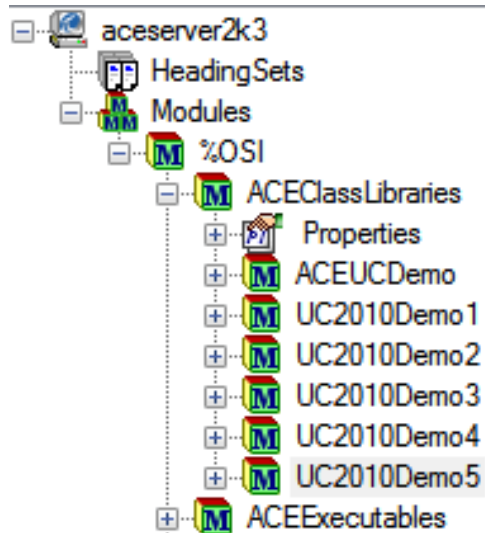
- Split or increase number of calculations
- One scheduler per machine



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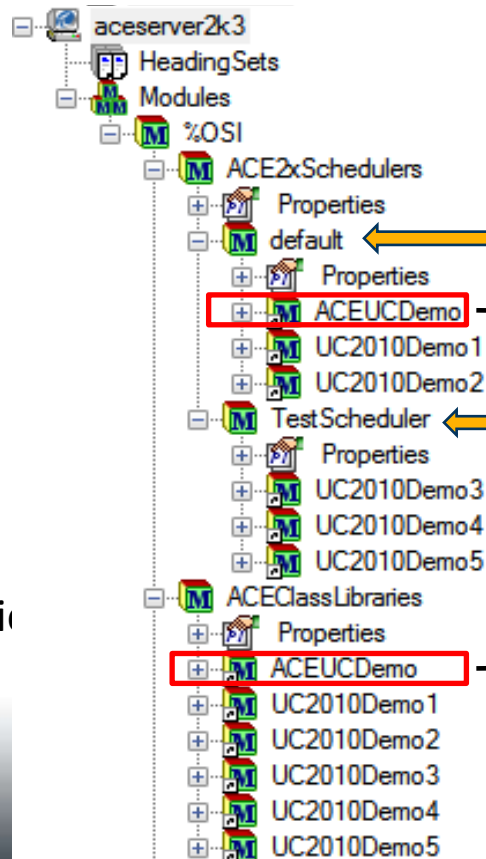
Multiple PI ACE Schedulers

PI ACE 2.1.32

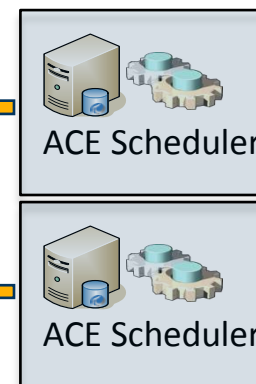


Scheduler reads/writes properties
Under ACEClassLibraries

PI ACE 2010



Distribute heavy-duty calculations across
multiple schedulers.

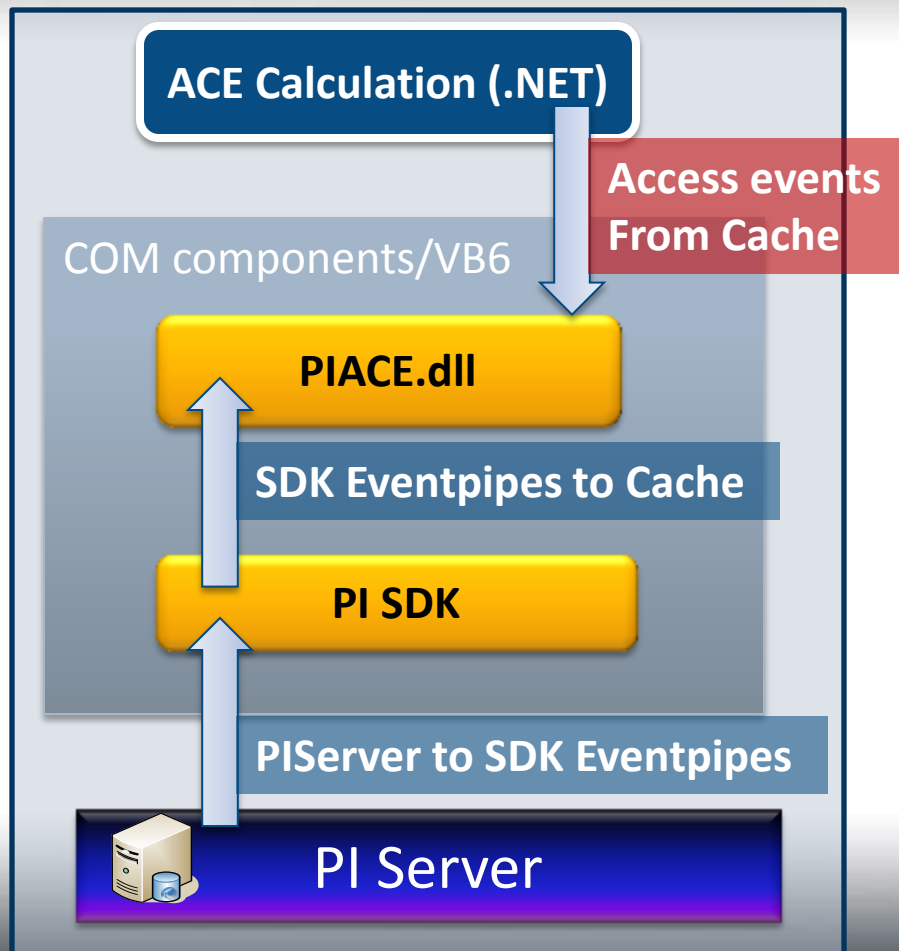


Each scheduler node holds a link
to the Executable PIModule

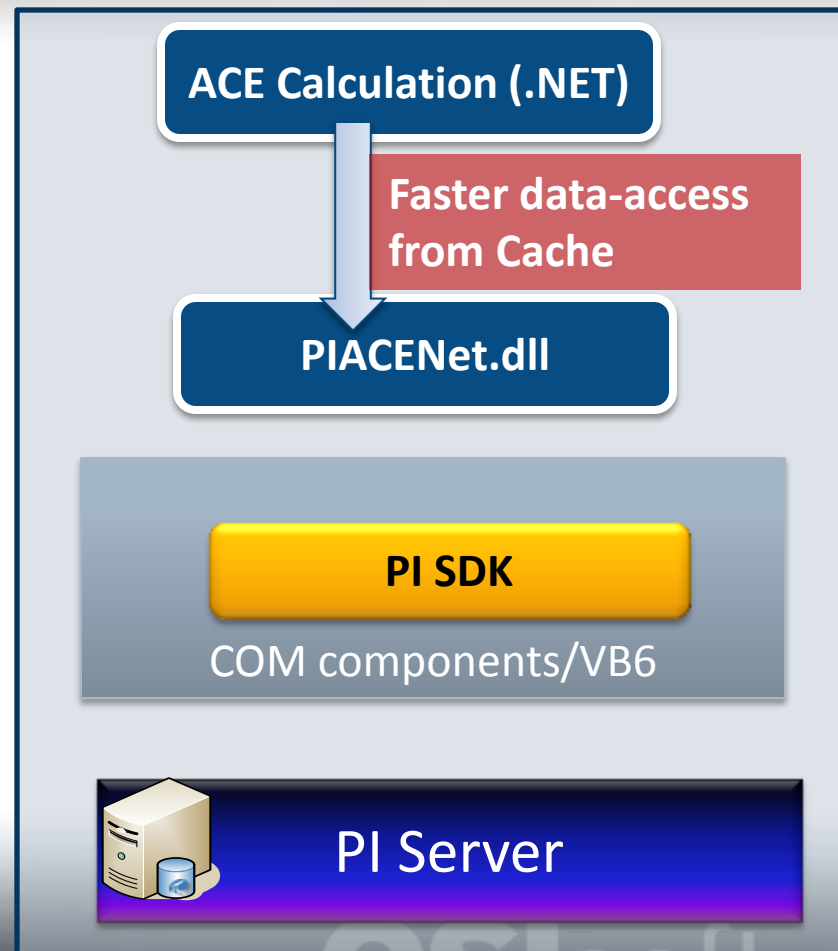
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PI ACE Performance Improvements

PI ACE 2.1.32

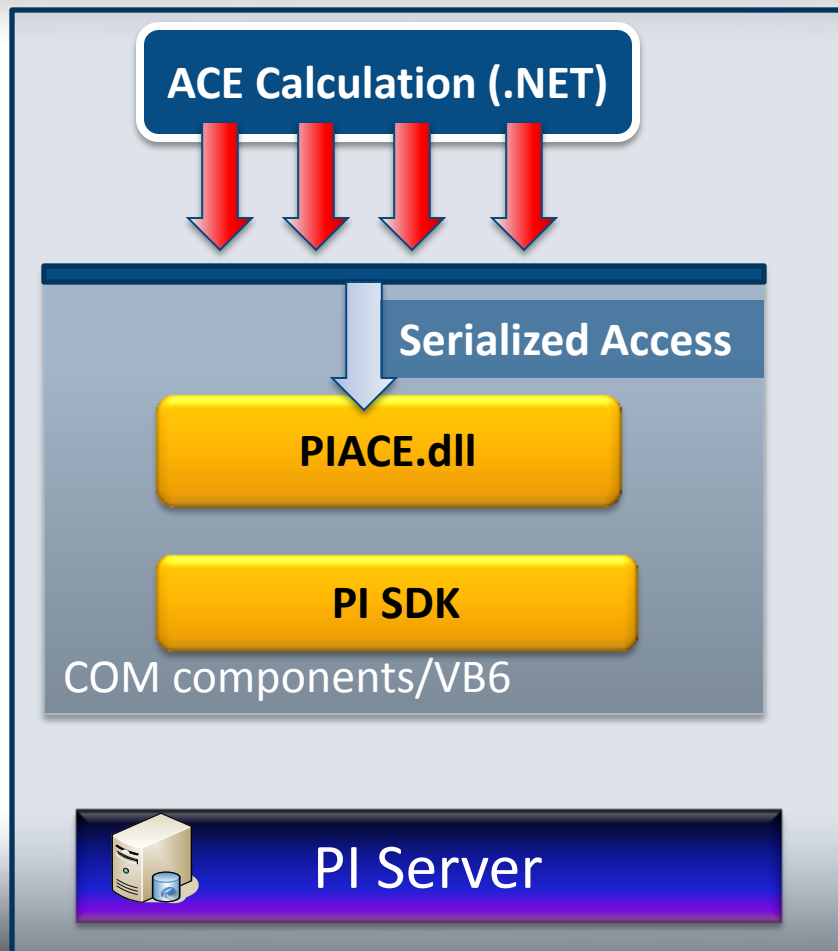


PI ACE 2010

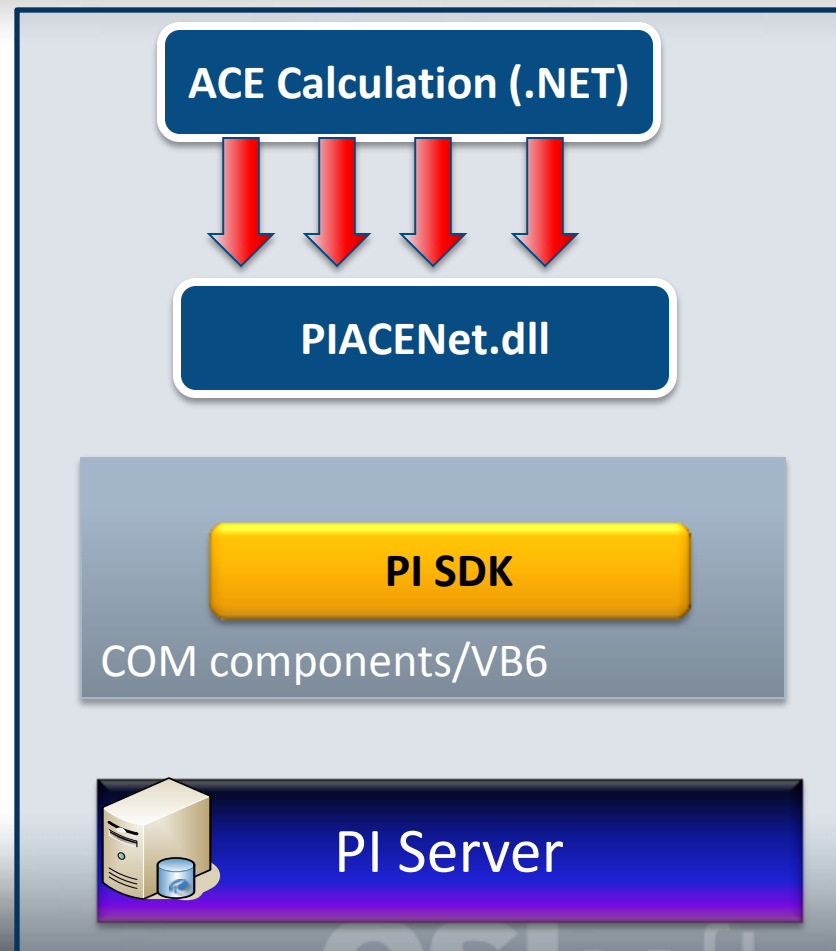


PI ACE Performance Improvements

PI ACE 2.1.32



PI ACE 2010



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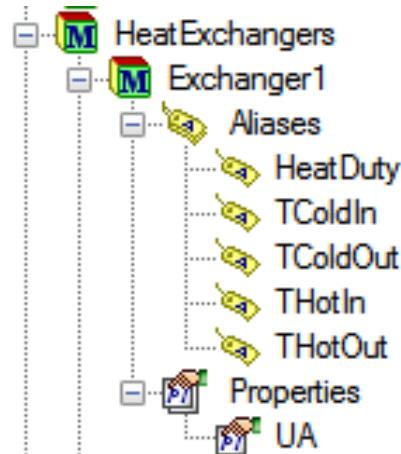
PI ACE 2010 Performance Improvements

Example ACE calculation

```
Public Overrides Sub ACECalculations()  
    Dim LMTD As Double  
    Dim dT1, dT2 As Double  
    Try  
        dT1 = System.Math.Abs(THotIn.Value - TColdOut.Value)  
        dT2 = System.Math.Abs(THotOut.Value - TColdIn.Value)  
        If Not (dT1 = 0) And Not (dT2 = 0) Then  
            LMTD = (dT1 - dT2) / Log(dT1 / dT2)  
            HeatDuty.Value = UA * LMTD  
        Else  
            HeatDuty.Value = 0.0  
        End If  
    Catch ex As Exception  
        HeatDuty.SendDataToPI = False  
        LogPIACEMessage(mErrors, ex.Message, MyBase.Name)  
    End Try  
End Sub
```



PI ACE Best Practices
Error handling is important !



- 2000 Contexts
- 4 Input tags/context
- 1 output tag/context

Clock scheduled

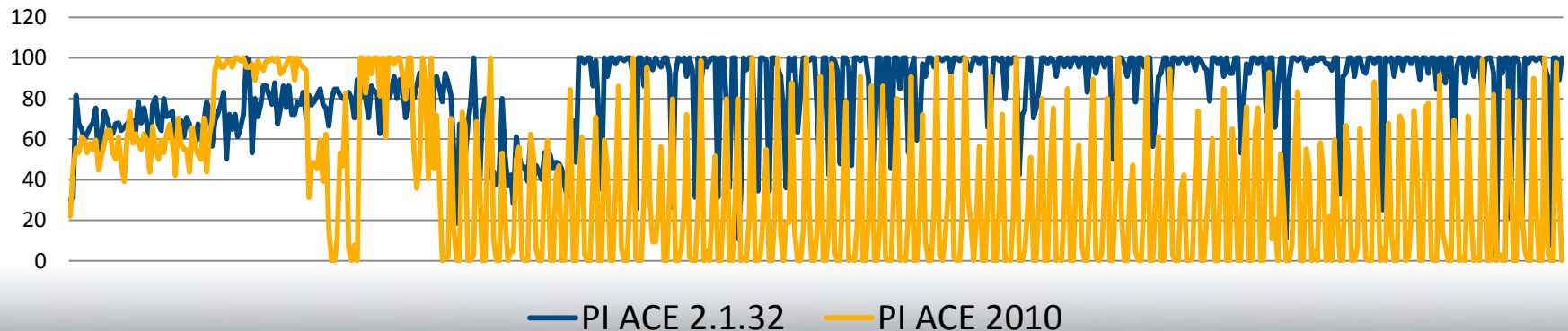
- **Period = 4 seconds**
- **Offset = 0**
- **Calculation rate = 500 calcs/second**

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PI ACE 2010 Performance Improvements

PI ACE Version	Calculations/CPU Second			%CPU Utilization	Memory (Private bytes)
	Input Events 1600/Sec	Input Events 800/Sec	Input Events 0/Sec		
Current (32-bit)	478	514	554	92%	509MB
PI ACE 2010 beta(64-bit)	2150	3851	12500	23%	877MB

CPU Utilization (%Processor_Time)



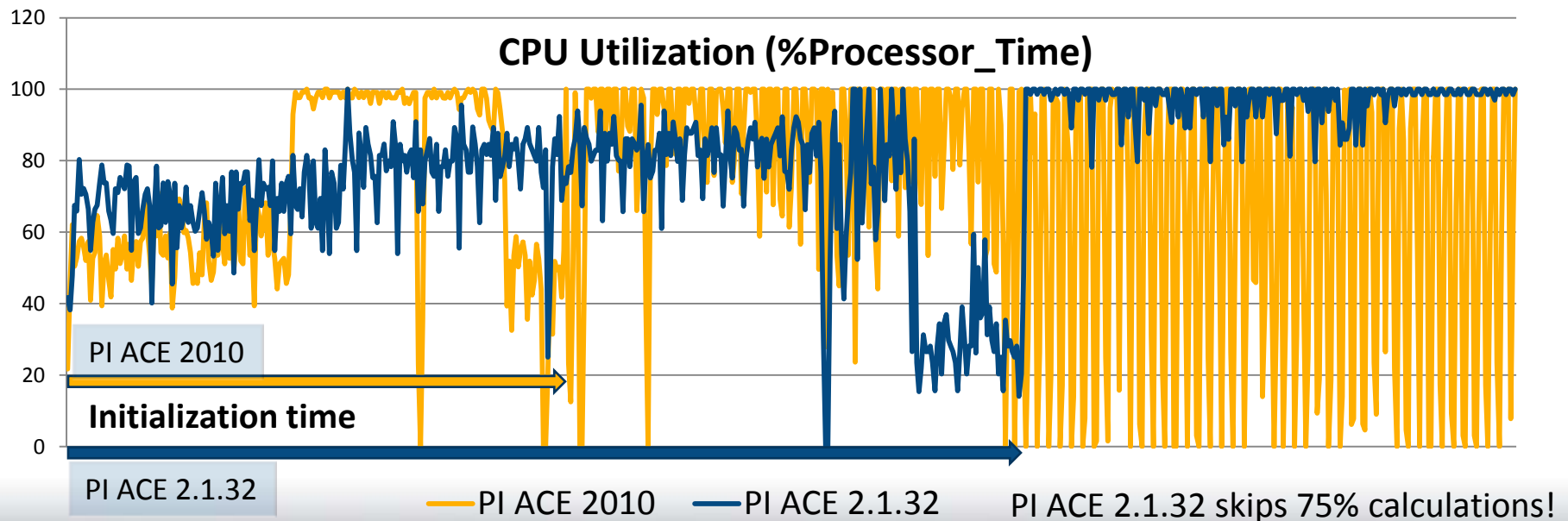
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Performance Improvements (contd.)

- 5000 Contexts
- 4 Input tags/context
- 1 output tag/context

Clock scheduled (2 second period)

- Calculation rate = 2500 calcs/second
- Input event rate = 4000 events/second



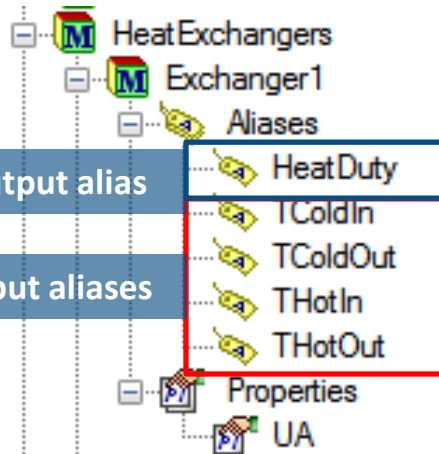
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Example 1: Programmatic Manipulation of ACE Contexts

- Create a new ACE context (clock or natural scheduled)
- Modify schedule for an existing context
 - period or offset for clock schedule
 - trigger tags or latency for natural schedule
 - Auto-recalculation tags
- Modify status for an ACE context
 - Stop/Resume calculation
- Modify message log level

Create or Schedule ACE Context

Asset module



- Create a new VB project and add reference to **PIACECommon.dll**.
- Add **Imports** PIACECommon
- Instantiate an object of type PIACEModuleDBFunctions

```
Public mPIACEMDBFunctions As New PIACEModuleDBFunctions
```

*Adds a new context to an existing PI ACE calculation.

Create Context (contd.)

AddPIACEContextSchedule(strACEContext, nvsScheduleInfo)

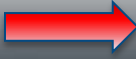
- strACEContext: ACE context name [string]
- nvsScheduleInfo: PISDKCommon.NamedValues collection

EditPIACEContextRecalcInfo(strACEContext, nvsRecalcInfo)

- strACEContext: ACE context name [string]
- nvsScheduleInfo: PISDKCommon.NamedValues collection

strACEContext format: \\server\scheduler\executable\module\context

\\mypi server\HeatExchangerCalcs\HeatDutyCalc\\mypi server\HeatExchangers\Exchanger1

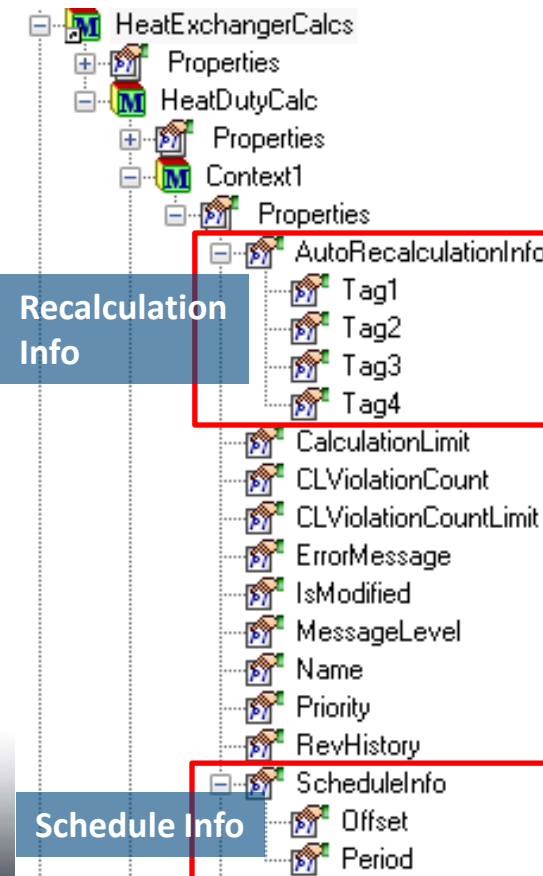


For current release PI ACE 2.1.32

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Clock-Scheduled Context

Clock-scheduled context



```
Dim nvRecalcInfo As New PIPPropertyInfo()  
nvRecalcInfo.Name = "AutoRecalculationInfo"  
nvRecalcInfo.DataType = PIPPropertyInfo.DataType.String  
nvRecalcInfo.Value = "TColdIn"
```

Edit/View PIP Property Attributes

Property Name:

Data Type:

Property Value

LBound:

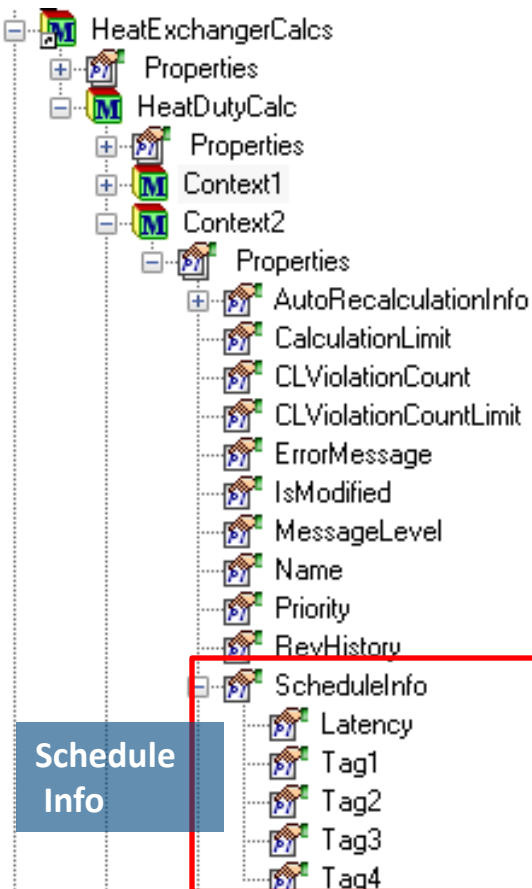
Elms:

```
Dim nvScheduleInfo As New PIPPropertyInfo()  
nvScheduleInfo.Name = "ScheduleInfo"  
nvScheduleInfo.DataType = PIPPropertyInfo.DataType.String  
nvScheduleInfo.Value = "Period"  
nvScheduleInfo.Add("Period", 10)  
nvScheduleInfo.Add("Offset", 0)
```

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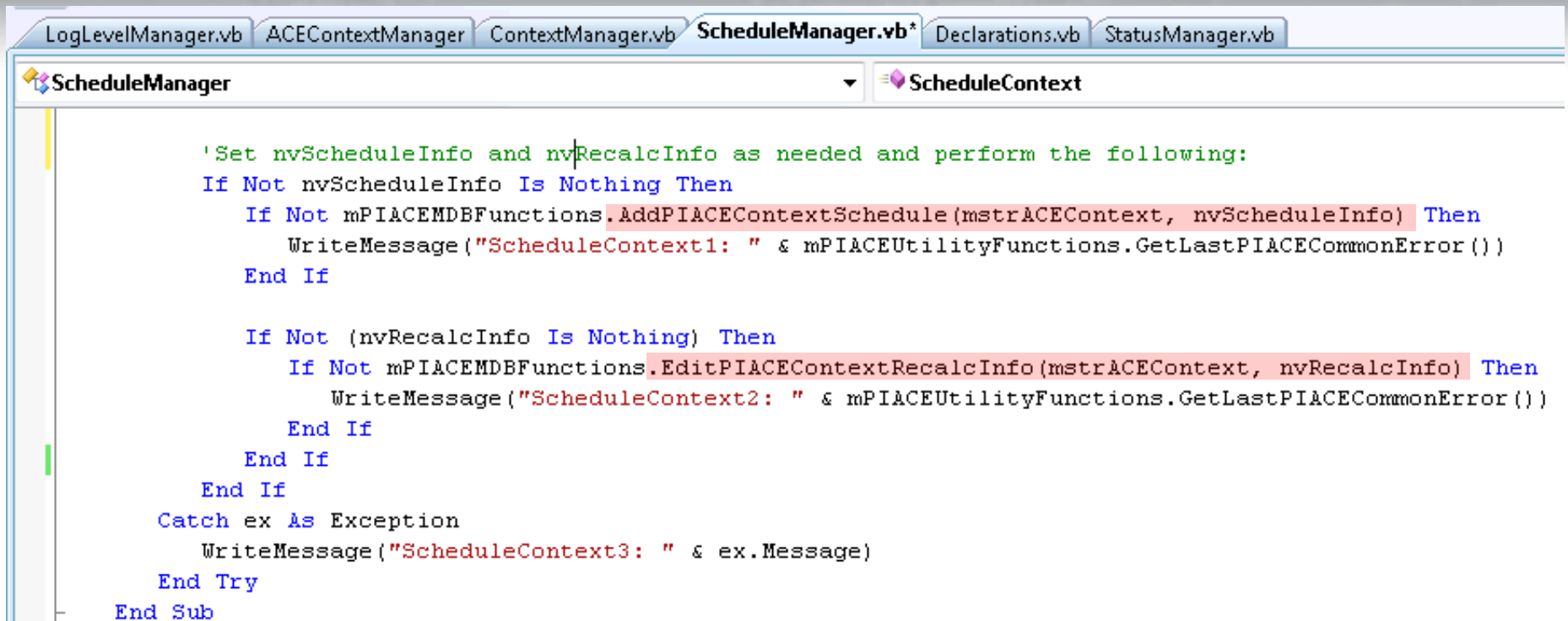
Natural-Scheduled Context

Natural-scheduled context



```
Dim nvScheduleInfo As New PISDKCommon.NamedValues()  
nvScheduleInfo.Add("Priority", enupriorityCode.pcNormal)  
nvScheduleInfo.Add("Type", enuScheduleType.stNaturalScheduled)  
nvScheduleInfo.Add("Latency", 15)  
nvScheduleInfoInfo.Add("Tag1", "TColdIn1")  
nvScheduleInfoInfo.Add("Tag2", "THotIn1")  
nvScheduleInfoInfo.Add("Tag3", "TColdOut1")  
nvScheduleInfoInfo.Add("Tag4", "THotOut1")
```

Create or Schedule Context



```
LogLevelManager.vb  ACEContextManager  ContextManager.vb  ScheduleManager.vb*  Declarations.vb  StatusManager.vb
ScheduleManager
ScheduleContext

' Set nvScheduleInfo and nvRecalcInfo as needed and perform the following:
If Not nvScheduleInfo Is Nothing Then
    If Not mPIACEMDBFunctions.AddPIACEContextSchedule(mstrACEContext, nvScheduleInfo) Then
        WriteMessage("ScheduleContext1: " & mPIACEUtilityFunctions.GetLastPIACECommonError())
    End If

    If Not (nvRecalcInfo Is Nothing) Then
        If Not mPIACEMDBFunctions.EditPIACEContextRecalcInfo(mstrACEContext, nvRecalcInfo) Then
            WriteMessage("ScheduleContext2: " & mPIACEUtilityFunctions.GetLastPIACECommonError())
        End If
    End If
End If
Catch ex As Exception
    WriteMessage("ScheduleContext3: " & ex.Message)
End Try
End Sub
```

- Newly created contexts automatically started for running calculations.
- Scheduler automatically picks-up schedule changes for running contexts.

Resume/Stop ACE Context

ChangePIACEMCStatus(strACEContext, StatusCode)

- strACEContext: ACE context name [string]
- Status Code: PIACECommon.enumStatusCode enumeration

```
LogLevelManager.vb | ACEContextManager | ContextManager.vb | ScheduleManager.vb | Declarations.vb | StatusManager.vb
StatusManager
ResumeContext

Imports PIACECommon

Public Class StatusManager

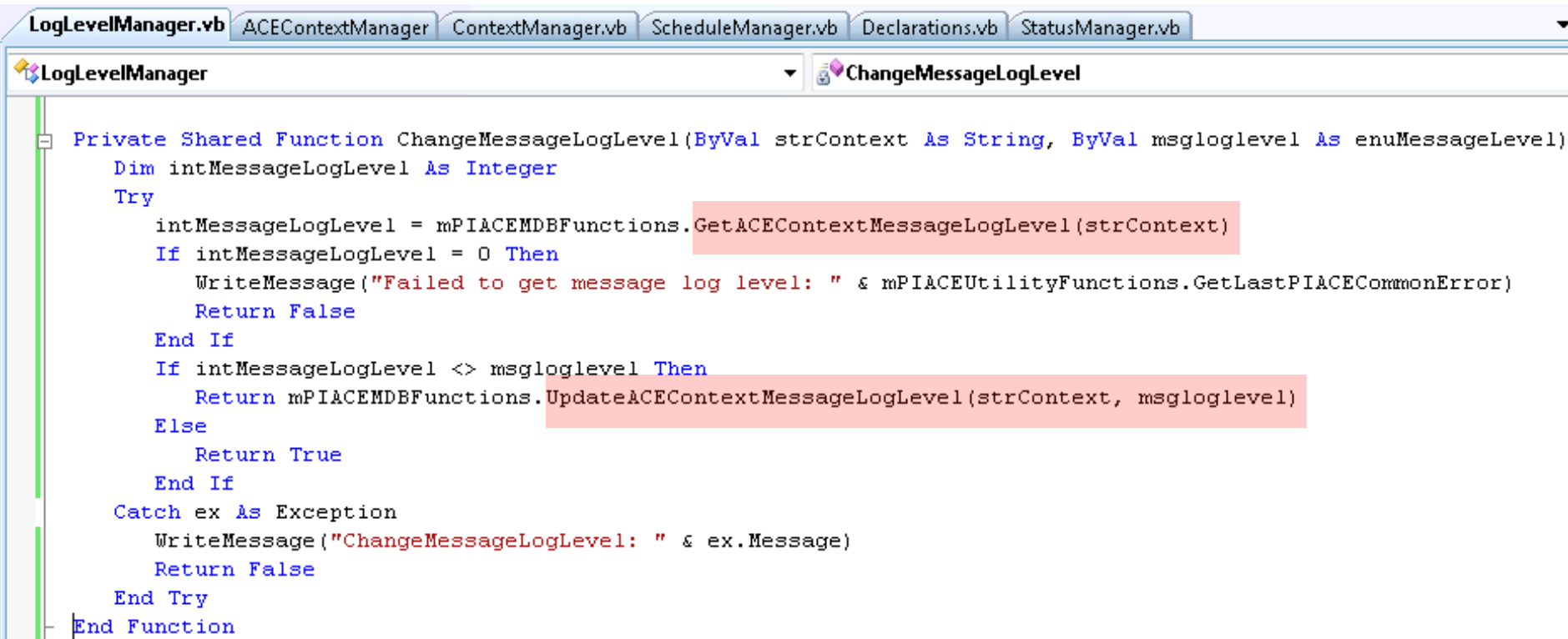
    Public Shared Function ResumeContext() As Boolean
        Return mPIACEMDBFunctions.ChangePIACEMCStatus(mstrACEContext, enumStatusCode.scOff)
    End Function

    Public Shared Function StopContext() As Boolean
        Return mPIACEMDBFunctions.ChangePIACEMCStatus(mstrACEContext, enumStatusCode.scOutOfService)
    End Function

End Class
```

Modify Message Log Level

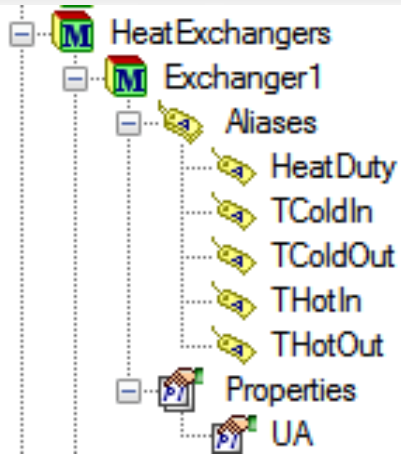
- Message log level defined as PIACECommon.enumMessageLevel
 - mlErrors, mlWarnings, mlCalculationExecuted, mlCounterInfo, mlChange



```
LogLevelManager.vb | ACEContextManager | ContextManager.vb | ScheduleManager.vb | Declarations.vb | StatusManager.vb
LogLevelManager | ChangeMessageLogLevel

Private Shared Function ChangeMessageLogLevel(ByVal strContext As String, ByVal msgloglevel As enumMessageLevel)
    Dim intMessageLogLevel As Integer
    Try
        intMessageLogLevel = mPIACEMDBFunctions.GetACEContextMessageLogLevel(strContext)
        If intMessageLogLevel = 0 Then
            WriteMessage("Failed to get message log level: " & mPIACEUtilityFunctions.GetLastPIACECommonError)
            Return False
        End If
        If intMessageLogLevel <> msgloglevel Then
            Return mPIACEMDBFunctions.UpdateACEContextMessageLogLevel(strContext, msgloglevel)
        Else
            Return True
        End If
    Catch ex As Exception
        WriteMessage("ChangeMessageLogLevel: " & ex.Message)
        Return False
    End Try
End Function
```

Example 2: Monitoring Database Changes from ACE Calculations



```
'
' User-written module dependent initialization code
'
Private pimdbcontext As PIModule

Protected Overrides Sub ModuleDependentInitialization()
    pimdbcontext = GetPIModuleFromPath(Context)
    UA = pimdbcontext.PIProperties.Item("UA").Value
End Sub
```

- Asset modules not updated automatically.
- Need to sign-up for database changes.
- **Not recommended for frequently changing properties.**

```
Dim rfr as PISDKCommon.IRefresh
rfr = CType(pimdbcontext, IRefresh)
mIRefresh.Refresh()
```

PI ACE Best Practices

Module level variables – variables that do not change from one calculation to other.

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Monitoring Database Changes

1. Setup PI SDK Eventpipe at PISDK.PIModuleDB level

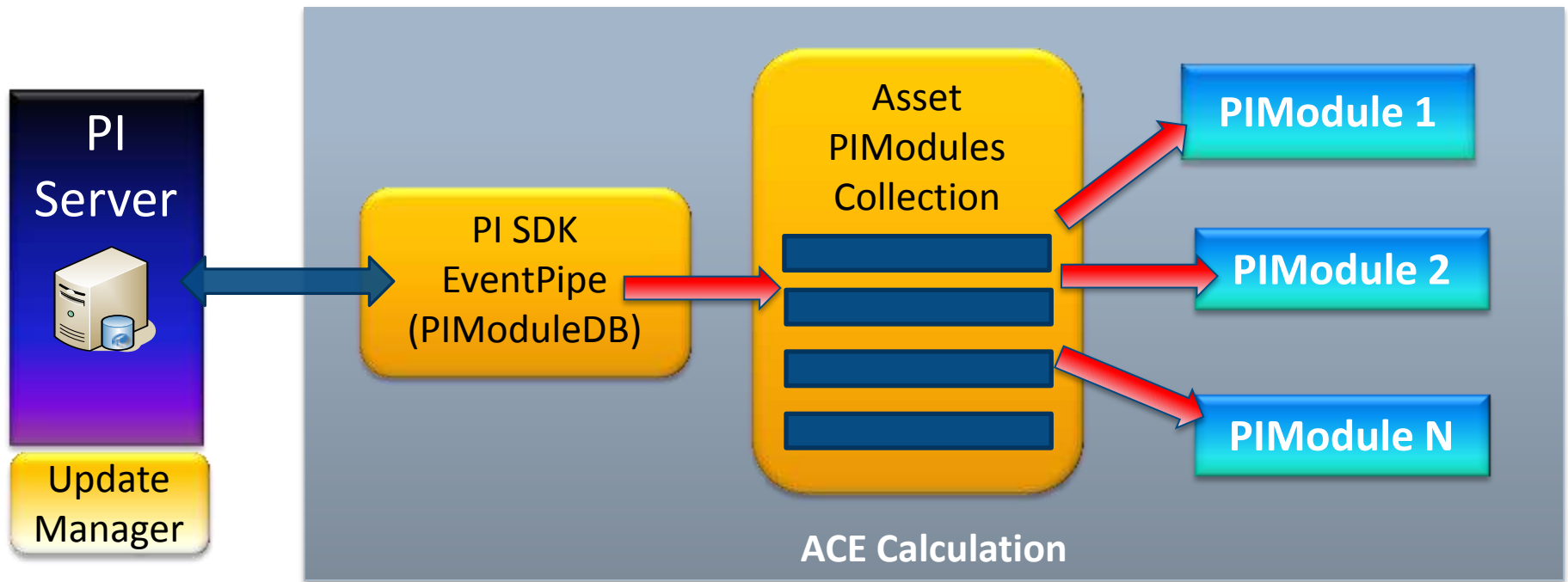
```
Private Shared mPISDK As PISDK.PISDK
Private Shared mServer As PISDK.Server
Private Shared mstrServerName As String = "mypiserver" '
Private Shared mobjDBEventPipe As IEventPipe2

mPISDK = New PISDK.PISDK
mServer = mPISDK.Servers(mstrServerName)
mobjDBEventPipe = CType(mServer.PIModuleDB.EventPipe,IEventPipe2)
```

2. Create a collection for relevant PIModules during ModuleDependentInitialization() routine

3. Periodically retrieve updates and refresh corresponding PIModules

Monitoring Database Changes



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Monitoring Database Changes

HeatDutyCalc

ACE Calculation Module

CheckMDBAssetUpdates

Method for checking updates – running on a dedicated thread.

```
While mobjDBEventPipe.Count > 0
  tmpEvent = mobjDBEventPipe.Take
  tmpEventData = CType(tmpEvent.EventData, NamedValues)
  tmpAction = tmpEvent.Action
  tmpUID = CType(tmpEventData.Item("UID").Value, String)
  'If events with action eaEdit received for any relevant module, refresh it.
  If (tmpAction = EventActionConstants.eaEdit AndAlso mcolAssetModules.TryGetValue(tmpUID, tmpPIModule)) Then
    'Refresh pimodule
    RefreshPIModule(tmpPIModule)
    'Update blnIsRefreshed flag so the calculations can pick up the change
    If mcolUpdateFlags.ContainsKey(tmpUID) Then
      mcolUpdateFlags.Item(tmpUID) = True
    Else
      mcolUpdateFlags.Add(tmpUID, True)
    End If
  End If
End If
End While
```

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PI ACE Best Practices

- Error handling
- Module level variables
- Performance counters (create PITags)
 - ACE performance counters (_total calcs executed/skipped)
 - %Processor_time, Private/Virtual Bytes for host process



Sample Code on OSIsoft vCampus

- Sample code for both examples on OSIsoft vCampus
- Queries directed to PI ACE Development forum
- **Caution: Internal functions**

Discussion Hall > Development with Other OSIsoft Products > PI ACE Development

PI ACE DEVELOPMENT

This forum is for all questions related to development in PI ACE (Advanced Computing Engine).

- Discussion forum
- Webinars
- White papers – e.g. Developing ACE calculations in C#



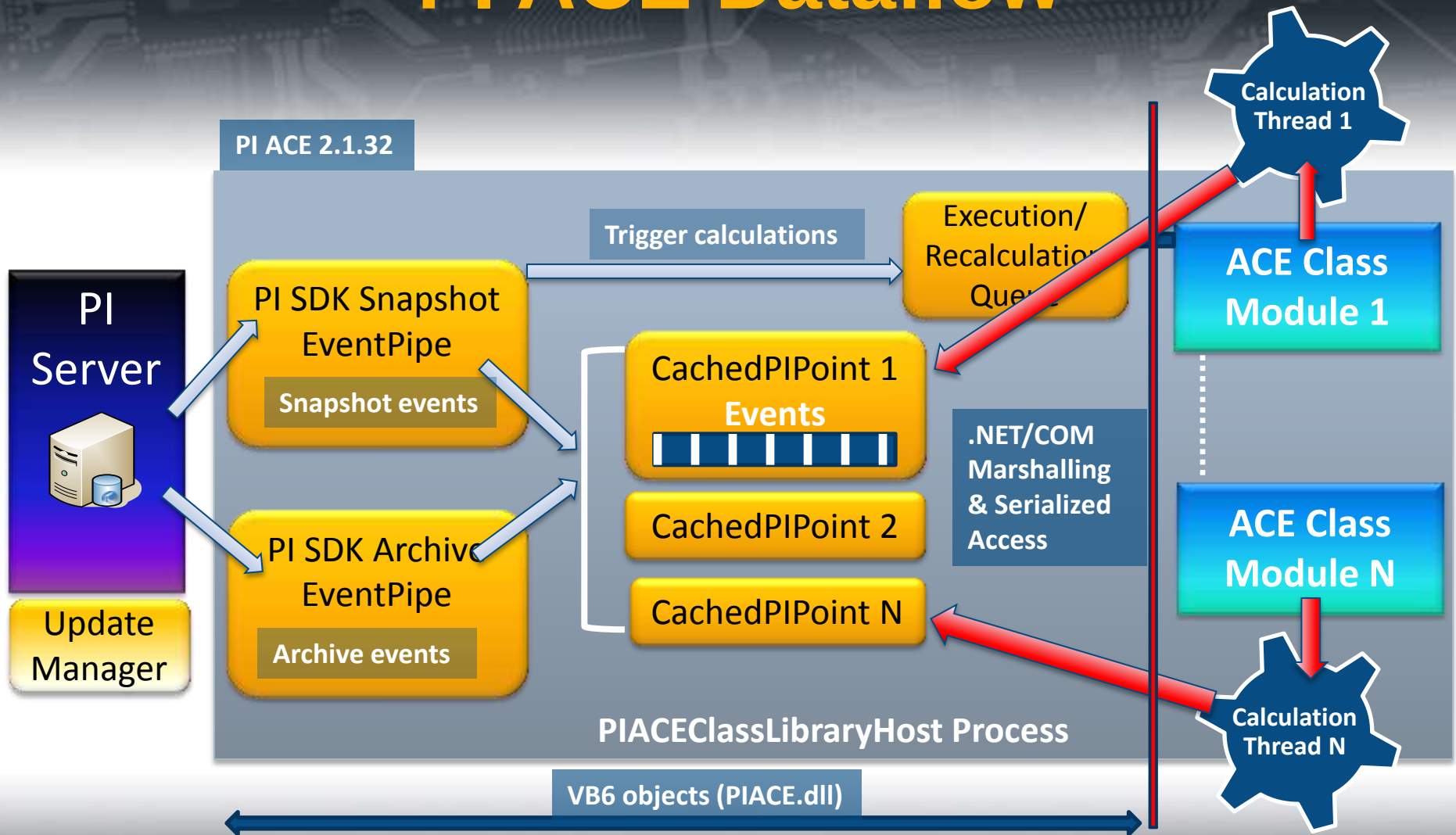
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Thank You!

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PI ACE Dataflow



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PI ACE Dataflow

