Learn the OpenAccess API

Using Python

Initial Contribution By

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Intel - 2013
Updates & Additions
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Section 7 - oaShape

- All shapes are placed directly in oaBlock (not oaDesign)
- Same API calls in creating shapes for layout, schematic, and symbol designs
  - Focus in this training will be on layout design
- Be sure to view the “inherited members” in online documentation as shapes have many inherited methods

Getting oaLayer and oaPurpose

- All oaShape objects have an oaLayer and oaPurpose defined
  - Both layer and purpose number are required to create a shape
  - Layer and purpose numbers are mapped to names through the oaTech
  - May be a good idea to look up the layer and/or purpose numbers prior to usage once and then use many times in code (as opposed to looking up constantly)
    - Consider using a hash to pre--load all layers – the code below can be extensive if repeated for many layers

```
poly = oa.oaLayer.find(tech, "poly")
if poly:
  poly_num = poly.getNumber()
else:
  print "ERROR: cannot find layer 'poly' in tech!"
  sys.exit(1)

# Can use poly_num below anywhere the poly layer number
# is needed...
```

DBU/UU Conversion

- All shape coordinates must be in Database Units (DBU)
- The oaTech class has multiple functions to help in converting between user units (UU), like microns or your cursor coordinates, to DBU:
  - uuToDBU: Convert from user units (e.g. microns) to DBU
  - dbuToUU: Convert from DBU to user units (e.g. microns)
  - Both require a view type (e.g. maskLayout) to convert

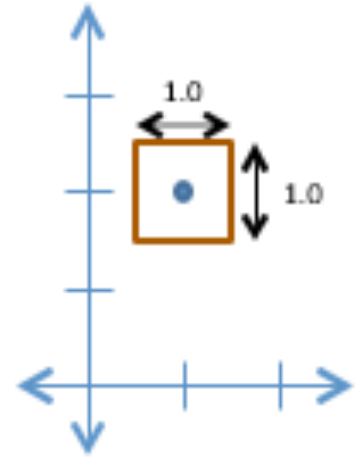
```
mlay = oa.oaViewType.get("maskLayout")
tech.uuToDBU(mlay, 0.250) #=> 250
tech.uuToDBU(mlay, 1.5) #=> 1500
```

- There are convenience methods in oaScript which will be shown later in this section to help in dealing with conversion to DBU

oaRect

- Rectangle dimensions come from the given oaBox

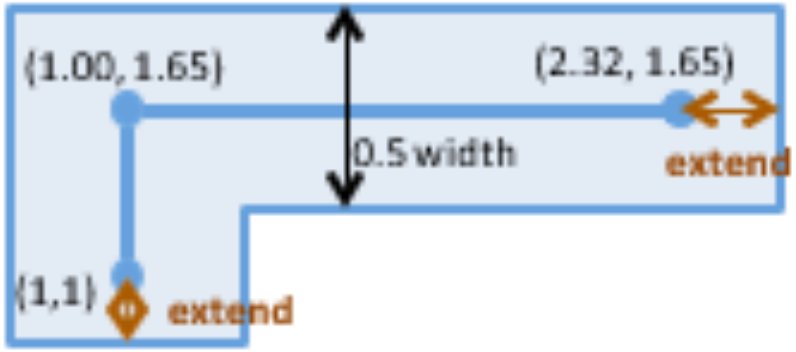
```
# Get layer and purpose numbers
m1 = oa.oaLayer.find(tech, "m1").getNumber()
drw   =  oa.oaPurpose.find(tech, "drawing").getNumber()

# Create 1.0um rectangle centered at (1.0, 2.0) [um]
# Placed on m1/drawing.
      width_2 = tech.uuToDBU(mlay, 0.5)
      ctr_pt = [tech.uuToDBU(mlay, 1.0),tech.uuToDBU(mlay, 2.0)]
      box = oa.oaBox(ctr_pt, width_2)
      rect = oa.oaRect.create(blk, m1, drw, box)
```



oaPath

- A path is two or more points with a width and op,onal begin/end styles (shown) and extension distances (not shown)

```
# Get layer and purpose numbers
m1 = oa.oaLayer.find(tech, "m1").getNumber()
drw = oa.oaPurpose.find(tech, “drawing”).getNumber()
wid = tech.uuToDBU(mlay, 0.5)
pts = [ [tech.uuToDBU(mlay, 1.00), tech.uuToDBU(mlay, 1.00)],
    [tech.uuToDBU(mlay, 1.00), tech.uuToDBU(mlay, 1.65)],
    [tech.uuToDBU(mlay, 2.32), tech.uuToDBU(mlay, 1.65)] ]
path = oa.oaPath(blk, m1, drw, wid, pts, "extend")
```



oaText

- Most advanced design methodologies attach shapes to nets to establish connectivity; however, text labels are sometimes used in final verification
- A text label is created using oaText which has the following attributes used most commonly:
  - Layer/purpose number
  - Text string of the text label
  - Origin (point) and text alignment
  - Font (nearly always “stick”)
  - Height (to control size of text)

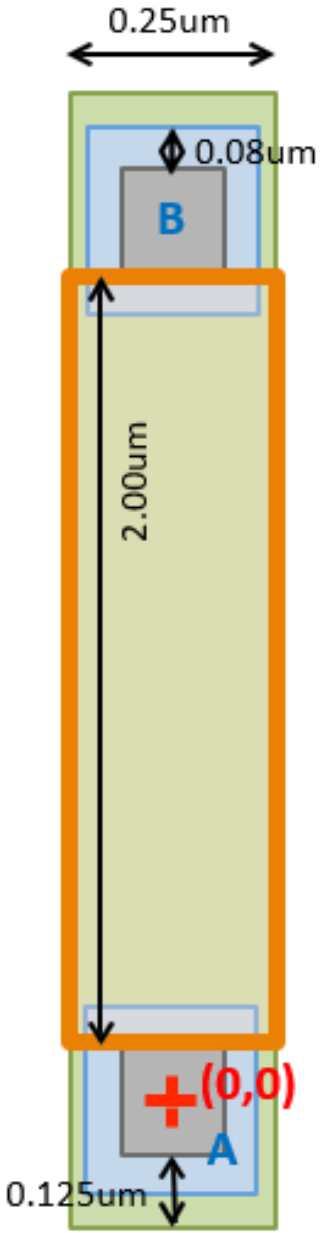
```
mlay =  oa.oaViewType.get("maskLayout")
m1 = oa.oaLayer.find(tech, "m1").getNumber()
drw  =  oa.oaPurpose.find(tech,
  "drawing").getNumber()


text = oa.oaText.create(rblk, m1, drw, "A", [0,0],
  oa.oacCenterCenterTextAlign, oa.oacR0,
  oa.oacStickFont,tech.uuToDBU(mlay, 0.5))
```

Lab 7.1: Create Resistor Layout

- Goal - Become familiar with creating various oaShape objects and converting microns to DBU
- Write a script to:
- Create resistor layout as shown on the next slide
  - Create “res” cell in “w” mode to overwrite any previous work (you will likely make several iterations before the code is perfected)
  - Try to get as far as you can; this lab is intended to be longer with a bigger emphasis on problem solving
    - Copy final library from the lab solutions if you run out of time
  - You will need to use the oaTech dbuToUU() function to convert from microns to the actual DBU in the design
  - **Don’t forget to save the design at the end of your code!**

Compare your script to labs/7.1/makeResistor.py

Resistor Design Rules (Lab 7.1)



Resistor device origin (0,0) is in the middle of the bottom contact as shown by the red cross "+" below

Contact size is 0.10um square

Poly width is 0.25um

Poly overlap of contact 0.125um

Metal 1 overlap of contact 0.08um

Resistor ID for this resistor should cover the entire poly region between the two contact edges and extend for 2.00um as shown in the diagram

Terminals "A" (bottom) and "B" (top) should be texted as such with a text label touching the edge or inside of the metal landing pad

Note: Diagram is not drawn to scale

oaScript DBU/UU Conversion Features

- OA Script comes with convenience classes to allow you to use user units (UU) instead of DBU
  - NOTE: these convenience methods have limited documentation and support (use with caution)
  - The **tech object** and **view type** are needed when constructing the oasUU* class objects (
    - By itself, it doesn't know the DBU/UU ratio)
    - These are put at the end of the constructor
- UU Classes
  - oasUUBox
  - oasUUBoxArray
  - oasUUPoint
  - oasUUPointArray
  - oasUUSegment
  - oasUUTransform
  - oasUUVector
- Example:

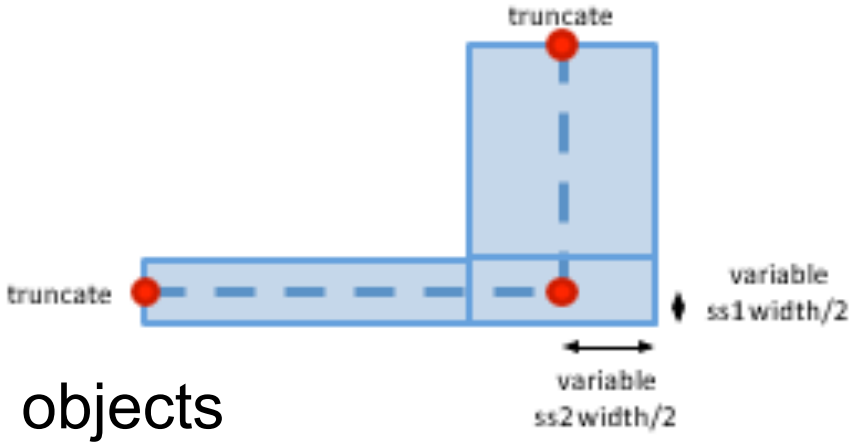
```
mlay  =  oa.oaViewType.get("maskLayout")
uubox =  oa.oasUUBox(0, 0, 3.195, 9.264, tech, mlay)
uubox.upperRight().y() #=> 9.264
```

oaPolygon (using UU)

- oaShapes may be created with user units by using the **createUU** constructor
  - Tech and view type are not needed for createUU constructors since the tech and view type can be found from the block object
- Coordinate points will be converted to DBU internally using the tech from the design where the shape is placed

```
# Get layer and purpose numbers
m1 = oa.oaLayer.find(tech, "m1").getNumber()
drw  =  oa.oaPurpose.find(tech,
  "drawing").getNumber()

poly = oa.oaPolygon.createUU(block, m1, drw,
  [[-1.1, -2.4], [1.06, 2.54], [3.12, -4.88]])
```

oaPathSeg (using UU)



- Most wires are now created using oaPathSeg objects
  - An oaPathSeg has exactly two points and an oaSegStyle
  - A series of oaPathSeg objects connected to each other creates a route
- oaSegStyle contains the following attributes:
  - Width, begin/end style, extension(s) of begin/end style
  - Begin/end styles: truncate, extend, variable, chamfer, custom
  - Recommend “variable” to extend to the next oaPathSeg to ensure smooth edges (see colors below for ss1 and ss2)
  - Note – no oasUUSegStyle yet (missing)

```
ss1 = oa.oaSegStyle(200, 'truncate', 'variable', 0, 225)
ps1 = oa.oaPathSeg.createUU(block,m1,drw,[0.00, 0.00],[2.34, 0.00],ss1)
ss2 = oa.oaSegStyle(500, 'variable', 'truncate', 100, 0)
ps1 = oa.oaPathSeg.createUU(block,m1,drw,[2.34, 0.00],[2.34, 1.55],ss2)
```

Lab 7.2: UU Familiarization

- Goal - Familiarize yourself with the UU features

- Write a script to:
  - Use the UU helper features to draw a few shapes in a new design including: oaRect, oaPolygon, and oaPathSeg

    Place two path segments orthogonally connected to each other

    compare your script to labs/7.2/uushapes.py

Final Word on UU Conversion

- Constantly converting UU to DBU (and back) can be a pain
- The oaScript built--in UU to DBU auto--conversion functions are still beta and do not fully cover the API yet
- For the remainder of this training, we will use our own UU to DBU conversion func,ons

```
tech = oa.oaTech.open(lib)
mlay = oa.oaViewType.get("maskLayout")

def cd2dbu(coord):
"""Map a single coord (in UU) to DBU"""  return(tech.uuToDBU(mlay, coord))

def pt2dbu(point):
"""Map a single point as python list (in UU) to DBU"""  return([cd2dbu(point[0]),
   cd2dbu(point[1])])

def pts2dbu(points):
"""Map a python list of points (in UU) to DBU"""  return( [pt2dbu(point) for point
   in points] )
```

Final Word on UU Conversion (cont'd)

```
def dbu2cd(coord):
"""Map a single coord   (in DBU) to UU"""  return(tech.dbuToUU(mlay,
    coord))

def dbu2pt(point):
"""Map a single point as python list (in DBU) to UU"""
return([dbu2cd(point[0]), dbu2cd(point[1])])

def dbu2pts(points):
"""Map a python list of points (in DBU) to UU"""
return([dbu2pt(point) for point in points] )
```

Iterating through Shapes

- You can query objects within an oaBlock using the get*() functions
  - Review the list in your OA API documentation now
- Iterating shapes using oaBlock::getShapes()
  - Will retrieve **all shape types** on **all layers**
  - Can be inefficient if you are only looking for a shapes on a given layer
    - In this case use oaBlock::getLayerHeaders::getShapes() instead
  - You will need to determine the shape type before doing much with it
    - Is it a rectangle, path, polygon, etc?

    - **Option 1:** Find the shape's type by checking the class in your language

```
for shape in block.getShapes():
if shape._class == oa.oaRect:
   # do oaRect stuff in here...
```

    - **Option 2:** Find the shape's type by calling OA's shape.getType() method

```
for shape in block.getShapes():
if int(shape.getType()) == oa.oacTextType:
   # do oaText stuff in here...
```

Iterating through LPP Headers

- Using oaBlock::getLayerHeaders() is an efficient way to quickly loop through shapes on a given layer without having to look at shapes on other layers
  - oaLPPHeader has getLayer() and getPurpose() methods

```
for lpph in  block.getLPPHeaders():
    if (some LPP filter):
       for shape in lpph.getShapes():
         # only iterates shapes on the selected LPP
```

- Can also get quick shape counts
- In the example below we'd want to make sure that getLayer() and getPurpose() return an object
  - if the tech doesn't have them defined, these will return NULL (None in Python)

```
for lpph in block.getLPPHeaders():
   layer = lpph.getLayer()
   purpose = lpph.getPurpose()
   shapes = lpph.getShapes()
   print "%d shapes on %s/%s" %(shapes.getCount(),layer.getName(),purpose.getName())
```

Lab 7.3: Iterate Through Shapes and LPP Headers

- Goal - Become familiar with iterating shapes in an oaBlock and understand how oaLPPHeaders can help efficiency

- Write a script to:
  - Open the “res” design from Lab 7.1 using **read access**

```
des = oa.oaDesign.open("mylib","res","layout","r")
blk = des.getTopBlock()
```

  - Iterate through the shapes in the block and print something out about the shapes

```
blk.getShapes()
```

    Hint – you will first need to determine the shape type and then decide what to print about the shape
  - Use the oaLPPHeader to filter shape iteration down to the m1/drawing LPP and print the layer count

```
blk.getLPPHeaders()
```

    Compare your script to labs/7.3/get_shapes.py

Section 7 Summary

- Examined User Units (UU) and Database Units (DBU) to understand their use and application
- Examined layers and purposes more closely
- Learned techniques for iterating over objects within a block
- Discovered the oaLPPHeader and how it improves your application's efficiency

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