Introduction to Network Programming Part II

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Today's Outline

1. Some useful Python modules
2. Bluetooth programming
3. GPS device interface
4. Further self studies

1. Some useful Python modules

1.1 Date & time module (time)

```
>>> import time
>>> dir( time )
['__doc__', '__name__', '__package__', 'accept2dyear', 'altzone', 'asctime
', 'clock', 'ctime', 'daylight', 'gmtime', 'localtime', 'mktime', 'sleep',
'strftime', 'strptime', 'struct_time', 'time', 'timezone', 'tzname', 'tzse
t']
>>> time.gmtime()
time.struct_time(tm_year=2010, tm_mon=9, tm_mday=15, tm_hour=8, tm_min=6,
tm_sec=3, tm_wday=2, tm_yday=258, tm_isdst=0)
>>> time.localtime()
time.struct_time(tm_year=2010, tm_mon=9, tm_mday=15, tm_hour=15, tm_min=6,
tm_sec=7, tm_wday=2, tm_yday=258, tm_isdst=0)
>>> time.asctime( time.gmtime() )
'Wed Sep 15 08:06:17 2010'
>>> time.asctime( time.localtime() )
'Wed Sep 15 15:06:24 2010'
>>> time.ctime()
'Wed Sep 15 15:06:29 2010'
```

This returns a struct_time representing UTC time.

This returns a struct_time representing local time.

time.asctime() converts the input struct_time to a readable string

time.ctime() returns a string showing local time.

time.sleep()

```
>>> import time
>>> def GoToSleep( n_sec ):
        print 'Going to sleep on ', time.ctime()
        time.sleep( n_sec )
        print 'Waking up on ', time.ctime()
```

```
>>> GoToSleep( 12 )
Going to sleep on  Wed Sep 15 15:22:50 2010
Waking up on  Wed Sep 15 15:23:02 2010
>>> GoToSleep( 15 )
Going to sleep on  Wed Sep 15 15:23:13 2010
Waking up on  Wed Sep 15 15:23:28 2010
```

Sleep for 12 and 15 seconds

1.2 System module (sys)

```
# SysArgv.py : showing how to access command line parameters

import sys
print sys.argv
```

```
File  Edit  View  Terminal  Help
interlab@ubuntu104:~/PythonNetworking$ python SysArgv.py Network Programming is fun
['SysArgv.py', 'Network', 'Programming', 'is', 'fun']
interlab@ubuntu104:~/PythonNetworking$
```

1.3 Operating system module (os)

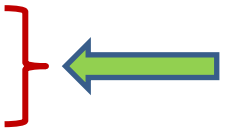
```
>>> import os
>>> os.getcwd()
'/home/interlab/PythonNetworking'
>>> os.listdir( '.' )
['helloworld.py', 'WebbrowserControl.py', 'SysArgv.py', 'RecvMesgUDP.py', 'RecvM
esgTCP.py', 'Part II', 'speak.py', 'SimpleHTMLParser.py', 'SendMesgUDP.py', 'Sen
dMesgTCP.py']
>>> os.stat( 'helloworld.py' )
posix.stat_result(st_mode=33188, st_ino=146737L, st_dev=2049L, st_nlink=1, st_ui
d=1000, st_gid=1000, st_size=20L, st_atime=1284451149, st_mtime=1284450857, st_c
time=1284450857)
>>> os.chdir( 'Part II' )
>>> os.getcwd()
'/home/interlab/PythonNetworking/Part II'
>>> os.mkdir( 'Section 2.1' )
>>> os.chdir( 'Section 2.1' )
>>> os.getcwd( )
'/home/interlab/PythonNetworking/Part II/Section 2.1'
```

Get the current working directory

List the contents of the current directory

Get the information of a specific file

Change the current working directory



Create a new directory and change the current directory to it.

1.3 Operating system module (os) continues

```
>>> import os
>>> p = os.popen( 'ls' )
>>> result = p.read()
>>> result
'helloworld.py\nPart II\nRecvMesgTCP.py\nRecvMesgUDP.py\nSendMesgTCP.py\nSendMesgU
DP.py\nSimpleHTMLParser.py\nspeak.py\nSysArgv.py\nWebbrowserControl.py\n'
>>> print result
helloworld.py
Part II
RecvMesgTCP.py
RecvMesgUDP.py
SendMesgTCP.py
SendMesgUDP.py
SimpleHTMLParser.py
speak.py
SysArgv.py
WebbrowserControl.py

>>> lines = result.split( '\n' )
>>> lines
['helloworld.py', 'Part II', 'RecvMesgTCP.py', 'RecvMesgUDP.py', 'SendMesgTCP.py',
'SendMesgUDP.py', 'SimpleHTMLParser.py', 'speak.py', 'SysArgv.py', 'WebbrowserCont
rol.py', '']
```

Open a pipe and execute the /bin/ls Linux command. Then read the result from the opened pipe.

The result is in fact a string received from the output of the /bin/ls command. Entries of the result are separated by '\n' (the newline character).

If we print this result, it looks nice. But do not forget that it is still a string which can be very long.

str.split() can break down a string into a list. Here we use '\n' as a field separator.

Exercise

- The iwlist command in linux can scan for WiFi access points and show their characteristics (e.g. channels, cell ids, signal strengths). Write a Python program to read the whole output of the iwlist command (e.g. from “iwlist scan”) and keep it as a (very long) string.

Solving a problem

- We are doing a Vehicle-to-Infrastructure (V-2-I) communication project. Suppose that our first step is to monitor and record WiFi access points, their channels and signal strengths, along the road while we drive. Can we build a simple automated tool for this purpose ?

We shall revisit this problem after we learn more about Regular Expressions.

1.4 Regular expression (re) module

- Matching or searching for a specific pattern (specified by a regular expression)
- Substituting one or more occurrences of a pattern (specified by a regular expression)
- Splitting the string based on a regular expression

Common uses of regular expressions

- Re.match() = match if the pattern occurs at the beginning of a string
- Re.search() = search for the first occurrence of a pattern in the whole string
- Re.findall() = search for every occurrence of a pattern in the whole string
- Re.sub() = replace all occurrences of the pattern with a different string.

re.match() vs. re.search()

```
>>> import re
>>> result1 = re.match( 'aa',   'aabbccddeeffaabbccddeeff' )
>>> print result1
<_sre.SRE_Match object at 0x937aa30>
>>> result2 = re.match( 'bb',   'aabbccddeeffaabbccddeeff' )
>>> print result2
None
>>> result3 = re.search( 'bb', 'aabbccddeeffaabbccddeeff' )
>>> print result3
<_sre.SRE_Match object at 0x937ae90>
>>> result1.span()
(0, 2)
>>> result3.span()
(2, 4)
>>> result3.start()
2
>>> result3.end()
4
```

re.match() sees if the pattern occurs at the beginning of a string.

Pattern 'bb' does not occur at the beginning.

Re.search() looks for the pattern inside the whole string.

When we look into a search result, we can see the index range where the pattern occurs in the string.

Note that re.search() returns only the first occurrence.

re.findall() vs. re.finditer()

```
>>> import re
>>> result4 = re.findall( 'cc', 'aabbccddeeffaabbccddeeff' )
>>> print result4
['cc', 'cc']
```

re.findall() returns all occurrences of the matches

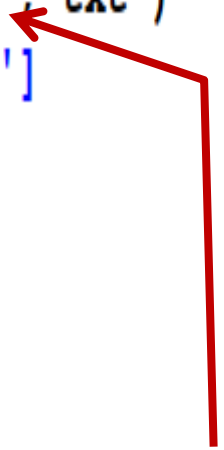
```
>>> iterator = re.finditer( 'cc', 'aabbccddeeffaabbccddeeff' )
>>> for i in iterator:
        print i.span()


(4, 6)
(16, 18)
```

re.finditer() returns an iterator on which you can run a loop (e.g. to find the spans of the occurrences)

Here ‘cc’ occurs twice, at index 4 and index 16.

Example

```
>>> import re
>>> txt = "John actively runs a science project. He probably discovers a new method."
>>> re.findall( '\w+ly', txt )
['actively', 'probably']
```



\w matches any alphanumeric character and the underscore (equivalent to [a-zA-Z0-9_])

\+ means one or more occurrences of the pattern ahead of it.

\w+ly then means one or more of \w instances which end with ly

Adapted from Python documentation: http://docs.python.org/howto/regex.html

Example

```
>>> import re
>>> txt = "John actively runs a science project. He probably discovers a new method."
>>> re.findall( '[rp]\w+', txt )
['runs', 'project', 'probably', 'rs']
>>>
>>> re.findall( '\s+[rp]\w+', txt )
[' runs', ' project', ' probably']
```

[rp] matches r or p.

\w+ matches one or more of any alphanumeric or the underscore.

\s+ matches one or more of whitespaces

Adapted from Python documentation: http://docs.python.org/howto/regex.html

re.sub() : pattern substitution

```
>>> import re
>>> text = 'This\t \tis\fa::very\v,weird\n\tstring.'
>>> text
'This\t \tis\x0ca::very\x0b,weird\n\tstring.'
>>> print text
This             is♩a::very♪,weird
        string.
>>> text1 = re.sub( '[\s:,]+', ' ', text )
>>> text2 = re.sub( 'weird', 'easy to read', text1 )
>>> print text2
This is a very easy to read string.
```

Here we replace every occurrence of this pattern with a single space.

Here we replace “weird” by “easy to read”.

re.split() : splitting a string using RE

```
>>> import re
>>> text = 'This\t \tis\fa::very\v,weird\n\tstring.'
>>> text
'This\t \tis\x0ca::very\x0b,weird\n\tstring.'
>>> print text
This             is♩a::very♪,weird
        string.
>>> re.split( '[\s:,.]+', text )
['This', 'is', 'a', 'very', 'weird', 'string', '']
>>>
```

[\s:,.]+ matches one or more of whitespace, colon, comma and dot.

In this case, we split the string text using this expression as field separator.

Further references on regular expressions

- http://docs.python.org/howto/regex.html
- http://docs.python.org/library/re.html

Revisiting our problem

- We are doing a Vehicle-to-Infrastructure (V-2-I) communication research. Suppose that our first step is to monitor and record WiFi access points, their channels and signal strengths, along the road while we drive. Can we build a simple automated tool for this purpose ?

One problem of RE – we can easily overdo it..

```
>>> import os, re
>>> txt = os.popen( 'iwlist scan' ).read()
>>> entries = re.split( '[\s.:=]+', txt )
>>> entries
['ra0', 'Scan', 'completed', 'Cell', '01', '-', 'Address', '00', '14', '6C', 'D9', '7A', '
46', 'ESSID', '"Interlab', 'AP-1B"', 'Mode', 'Managed', 'Channel', '6', 'Quality', '70/100
', 'Signal', 'level', '-62', 'dBm', 'Noise', 'level', '-81', 'dBm', 'Encryption', 'key', '
on', 'Bit', 'Rates', '36', 'Mb/s', 'IE', 'WPA', 'Version', '1', 'Group', 'Cipher', 'TKIP',
'Pairwise', 'Ciphers', '(1)', 'TKIP', 'Authentication', 'Suites', '(1)', 'PSK', 'Cell', '0
2', '-', 'Address', '00', '14', '6C', 'D9', '78', 'A8', 'ESSID', '"intERLab', 'AP-1C"', 'M
ode', 'Managed', 'Channel', '1', 'Quality', '65/100', 'Signal', 'level', '-64', 'dBm', 'No
ise', 'level', '-81', 'dBm', 'Encryption', 'key', 'on', 'Bit', 'Rates', '36', 'Mb/s', 'Cel
l', '03', '-', 'Address', '00', '25', '9C', 'DC', '24', 'E6', 'ESSID', '"Cam_AIT_A06"', 'M
ode', 'Managed', 'Channel', '3', 'Quality', '34/100', 'Signal', 'level', '-76', 'dBm', 'No
ise', 'level', '-81', 'dBm', 'Encryption', 'key', 'on', 'Bit', 'Rates', '11', 'Mb/s', 'Cel
l', '04', '-', 'Address', '00', '11', '33', '55', '77', '99', 'ESSID', '"TEST1234"', 'Mode
', 'Ad-Hoc', 'Channel', '11', 'Quality', '91/100', 'Signal', 'level', '-54', 'dBm', 'Noise
', 'level', '-81', 'dBm', 'Encryption', 'key', 'on', 'Bit', 'Rates', '18', 'Mb/s', 'Cell',
'05', '-', 'Address', '00', '25', '9C', 'DC', '02', '9C', 'ESSID', '"Cam_AIT_A5"', 'Mode',
'Managed', 'Channel', '13', 'Quality', '15/100', 'Signal', 'level', '-84', 'dBm', 'Noise',
'level', '-81', 'dBm', 'Encryption', 'key', 'on', 'Bit', 'Rates', '11', 'Mb/s', '']
```

This was supposed to be a string:
"Interlab AP-1B" but it got split !!

ApScanV1.py

```
# ApScanV1.py : access point scanning

import os

txt = os.popen( 'iwlist scan' ).read()
lines = txt.split( '\n' )
xlines = map( lambda i : i.strip(), lines )
print xlines
```

Output of ApScanV1.py

```
IDLE 2.6.4
>>> ========================== RESTART ==========================
>>>
['ra0       Scan completed :', 'Cell 01 - Address: 00:14:6C:D9:7A:46', 'ESSID:"I
nterlab AP-1B"', 'Mode:Managed', 'Channel:6', 'Quality:65/100  Signal level:-64
dBm  Noise level:-81 dBm', 'Encryption key:on', 'Bit Rates:36 Mb/s', 'IE: WPA Ve
rsion 1', 'Group Cipher : TKIP', 'Pairwise Ciphers (1) : TKIP', 'Authentication
Suites (1) : PSK', 'Cell 02 - Address: 00:14:6C:D9:78:A8', 'ESSID:"intERLab AP-1
C"', 'Mode:Managed', 'Channel:1', 'Quality:70/100  Signal level:-62 dBm  Noise l
evel:-81 dBm', 'Encryption key:on', 'Bit Rates:36 Mb/s', 'Cell 03 - Address: 00:
25:9C:DC:24:E6', 'ESSID:"Cam_AIT_A06"', 'Mode:Managed', 'Channel:3', 'Quality:15
/100  Signal level:-84 dBm  Noise level:-81 dBm', 'Encryption key:on', 'Bit Rate
s:11 Mb/s', 'Cell 04 - Address: 00:11:33:55:77:99', 'ESSID:"TEST1234"', 'Mode:Ad
-Hoc', 'Channel:11', 'Quality:76/100  Signal level:-60 dBm  Noise level:-81 dBm'
, 'Encryption key:on', 'Bit Rates:18 Mb/s', 'Cell 05 - Address: 00:25:9C:DC:02:9
C', 'ESSID:"Cam_AIT_A5"', 'Mode:Managed', 'Channel:13', 'Quality:15/100  Signal
level:-84 dBm  Noise level:-81 dBm', 'Encryption key:on', 'Bit Rates:11 Mb/s', '
', '']
```

Well, it seems good, but we'll need some re-formatting effort

ApScanV2.py (Part 1 of 2)

```
# ApScanV2.py : access point scanning
WLAN = 'ra0'
import os, re, time

def ParseLines( lines ):
    cells = dict()
    c = None
    for l in lines:
        if re.match( '^Cell', l ) is not None:
            c = l.split(' ')[4]
            cells[c] = dict()
            continue
        if c is not None and re.match( '^ESSID', l ) is not None:
            essid = l.split(':')[1]
            cells[c]['ESSID'] =  essid
            continue
        if c is not None and re.match( '^Quality', l ) is not None:
            qsn = re.sub( 'Quality[:=]','Q=', l )
            qsn = re.sub( 'Signal [Ll]evel[:=]', 'S=', qsn )
            qsn = re.sub( 'Noise level[:=]', 'N=', qsn )
            qsn = re.sub( '\s+', ' ', qsn )
            cells[c]['QSN'] = qsn
            continue
        if c is not None and re.match( '^Channel', l ) is not None:
            ch = re.sub( 'Channel[:=]', '', l )
            cells[c]['CH'] = ch
            continue
    return cells
```

Cell ID

ESSID

Quality
Signal Level
Noise

Channel

ApScanV2.py (Part 2 of 2)

```
def DoScan():
    txt = os.popen( 'iwlist ' + WLAN + ' scan' ).read()
    lines = txt.split( '\n' )
    xlines = map( lambda i : i.strip(), lines )
    cells = ParseLines( xlines )
    fmt = '%-17s | %-2s | %-30s | %s'

    print '\n' + time.ctime()
    print fmt % ( 'Cell', 'CH', '(Q)uality & (S)ignal & (N)oise', 'ESSID' )

    for c in cells.keys():
        print fmt%(c,cells[c].get('CH'),cells[c].get('QSN'),cells[c].get('ESSID'))

if __name__ == '__main__':
    while True:
        DoScan()
        time.sleep( 3 )
```

Output of ApScanV2.py

```
Fri Sep 17 19:47:56 2010
Cell               | CH | (Q)uality & (S)ignal & (N)oise | ESSID
00:14:6C:D9:7A:46 | 6  | Q=60/100 S=-66 dBm N=-81 dBm   | "Interlab AP-1B"
00:25:9C:DC:24:E6 | 3  | Q=24/100 S=-80 dBm N=-81 dBm   | "Cam_AIT_A06"
00:11:33:55:77:99 | 11 | Q=81/100 S=-58 dBm N=-81 dBm   | "TEST1234"
00:14:6C:D9:78:A8 | 1  | Q=55/100 S=-68 dBm N=-81 dBm   | "intERLab AP-1C"
00:25:9C:DC:02:9C | 13 | Q=15/100 S=-84 dBm N=-81 dBm   | "Cam_AIT_A5"

Fri Sep 17 19:47:59 2010
Cell               | CH | (Q)uality & (S)ignal & (N)oise | ESSID
00:14:6C:D9:7A:46 | 6  | Q=60/100 S=-66 dBm N=-81 dBm   | "Interlab AP-1B"
00:25:9C:DC:24:E6 | 3  | Q=24/100 S=-80 dBm N=-81 dBm   | "Cam_AIT_A06"
00:11:33:55:77:99 | 11 | Q=81/100 S=-58 dBm N=-81 dBm   | "TEST1234"
00:14:6C:D9:78:A8 | 1  | Q=55/100 S=-68 dBm N=-81 dBm   | "intERLab AP-1C"
00:25:9C:DC:02:9C | 13 | Q=15/100 S=-84 dBm N=-81 dBm   | "Cam_AIT_A5"
```

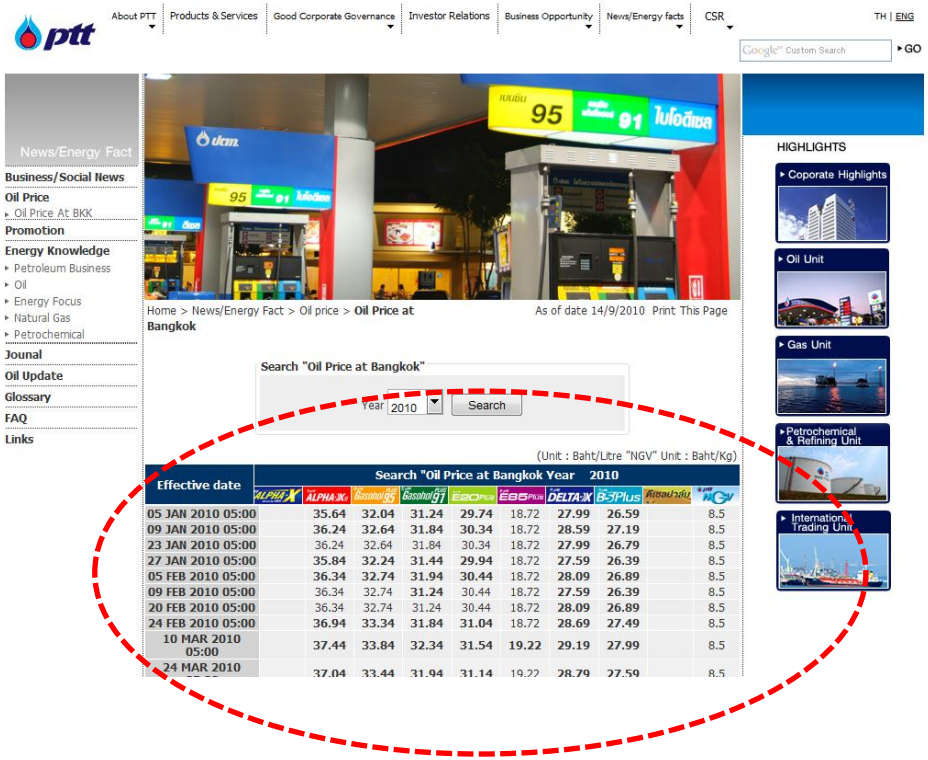
You can move your laptop around and observe signal quality.

Exercise

- Extend ApScanV2.py so that it can display
  - Network mode (“managed” vs. “ad-hoc”)
  - Whether the network is encrypted

Exercise

- Recall the HTML parser example from last time. We would like to make it smarter.




```
Table data found: ♩

Table data found: 22 AUG 2010 05:00
Table data found: 35.04
Table data found: 31.24
Table data found: 29.74
Table data found: 28.94
Table data found: 18.82
Table data found: 28.19
Table data found: 26.99
Table data found: 8.5
Table data found: ♩

Table data found: ♩

Table data found: 26 AUG 2010 05:00
Table data found: 34.44
Table data found: 30.64
Table data found: 29.14
Table data found: 28.34
Table data found: 18.42
Table data found: 27.79
Table data found: 26.59
Table data found: 8.5
Table data found: ♩
```

Say, we would like to have the lists of oil prices, kept and indexed in a dictionary by their dates.

2. Bluetooth Programming

Bluetooth basics

- Personal Area Network (PAN) 2.402-2.480 GHz ISM
- There are 3 classes of Bluetooth devices:
  - Class 1: Max power 100mW (range ~100 meters)
  - Class 2: Max power 2.5mW (range ~10 meters)
  - Class 3: Max power 1mW (range ~1 meter)
- There are several versions of Bluetooth
  - Bluetooth v1.2 (~1Mbps)
  - Bluetooth v2.0+EDR (~3 Mbps)
  - Bluetooth v2.1+EDR (e.g. “secure simple pairing”, SSP)
  - Bluetooth v3.0+HS (~24Mbps)

Bluetooth modules for Python

- Bluez (Pybluez)
  - Homepage: http://www.bluez.org/
  - Ubuntu: sudo apt-get install bluez python-bluez
  - Tutorial:
    - http://people.csail.mit.edu/albert/bluez-intro/
- Lightblue
  - Homepage: http://lightblue.sourceforge.net/
  - Ubuntu: sudo apt-get install python-lightblue
  - Tutorial: See the lightblue's homepage

lightblue.finddevices() : search for nearby BT devices

```
>>> import lightblue
>>> devices = lightblue.finddevices()
>>> devices
[('00:1B:C1:02:F0:8B', 'HOLUX_M-1000', 7936), ('00:21:FC:FC:F5:91', 'Good Old No
kia', 5898756)]
>>> for d in devices:
        print d


('00:1B:C1:02:F0:8B', 'HOLUX_M-1000', 7936)
('00:21:FC:FC:F5:91', 'Good Old Nokia', 5898756)
>>>
```

Returns a list of tuples

lightblue.findservices() : search for nearby BT services

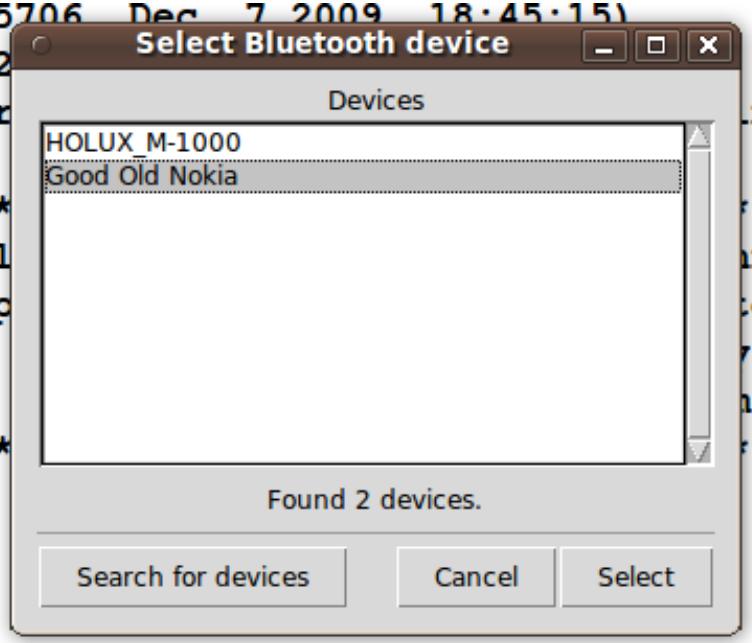
```
>>> import lightblue
>>> services = lightblue.findservices()
>>> services
[('00:1B:C1:02:F0:8B', 1, 'SPP slave'), ('00:21:FC:FC:F5:91', 1, 'Dial-up networking'), ('
00:21:FC:FC:F5:91', 15, 'Nokia PC Suite'), ('00:21:FC:FC:F5:91', 3, 'COM 1'), ('00:21:FC:F
C:F5:91', 13, 'Voice Gateway'), ('00:21:FC:FC:F5:91', 12, 'Audio Gateway'), ('00:21:FC:FC:
F5:91', 21505, None), ('00:21:FC:FC:F5:91', 14, None), ('00:21:FC:FC:F5:91', 22529, None),
('00:21:FC:FC:F5:91', 15, 'Network Access Point Service'), ('00:21:FC:FC:F5:91', 24, None)
, ('00:21:FC:FC:F5:91', 9, 'OBEX Object Push'), ('00:21:FC:FC:F5:91', 10, 'OBEX File Trans
fer'), ('00:21:FC:FC:F5:91', 7, 'Nokia SyncML Server'), ('00:21:FC:FC:F5:91', 11, 'SyncML
Client'), ('00:21:FC:FC:F5:91', 25, 'Music-Player'), ('00:21:FC:FC:F5:91', 23, 'Media Play
er'), ('00:21:FC:FC:F5:91', 23, 'Media Player'), ('00:21:FC:FC:F5:91', 4, 'SIM ACCESS')]
>>> for s in services:
        print s


('00:1B:C1:02:F0:8B', 1, 'SPP slave')
('00:21:FC:FC:F5:91', 1, 'Dial-up networking')
('00:21:FC:FC:F5:91', 15, 'Nokia PC Suite')
('00:21:FC:FC:F5:91', 3, 'COM 1')
('00:21:FC:FC:F5:91', 13, 'Voice Gateway')
('00:21:FC:FC:F5:91', 12, 'Audio Gateway')
```

The SPP slave service is available on Holux M-1000 GPS

These are the services available on my Nokia phone

lightblue.selectdevice() : device selection GUI

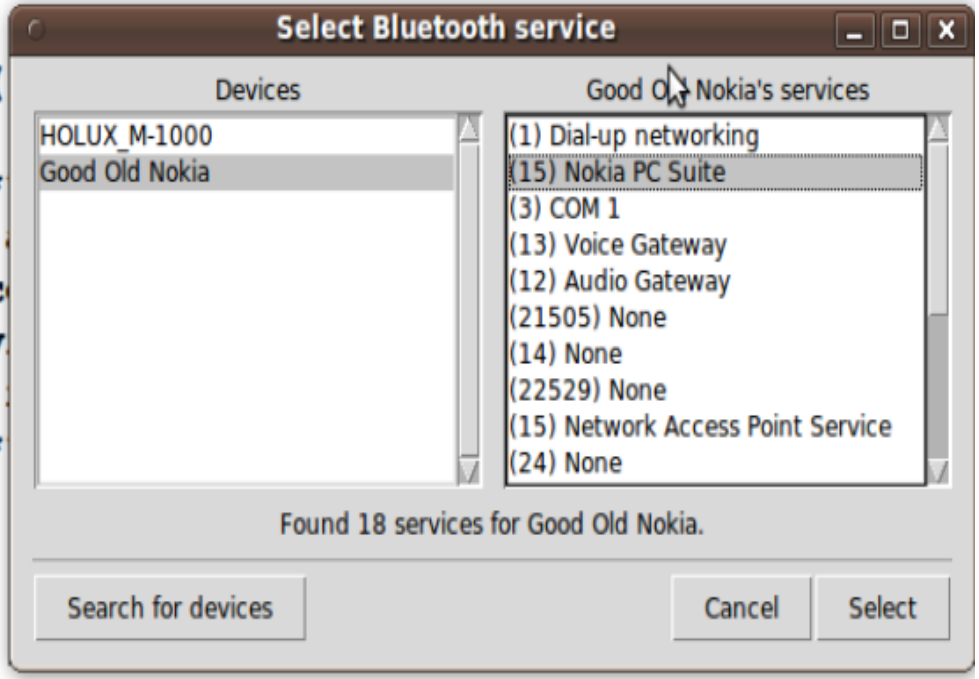
```
Python 2.6.4 (r264:75706, Dec  7 2009, 18:45:15)
[GCC 4.4.1] on linux2
Type "copyright", "cr                                  nformation.

    ****************                                   ***************
    Personal firewall                                  nection IDLE
    makes to its subp                                  ternal loopback
    interface.  This                                   external
    interface and no                                   the Internet.
    ****************                                   ***************

IDLE 2.6.4      ====
>>> import lightblue
>>> dir( lightblue )
['BluetoothError', 'L2CAP', 'OBEX', 'RFCOMM', '__builtins__', '__doc__', '__file
__', '__name__', '__package__', '__path__', '_docstrings', '_lightblue', '_light
bluecommon', '_obex', '_obexcommon', 'advertise', 'finddevicename', 'finddevices
', 'findservices', 'gethostaddr', 'gethostclass', 'obex', 'selectdevice', 'selec
tservice', 'socket', 'splitclass', 'stopadvertise']
>>> lightblue.selectdevice()
```



Note: this program may freeze IDLE. You should run it from linux command line..

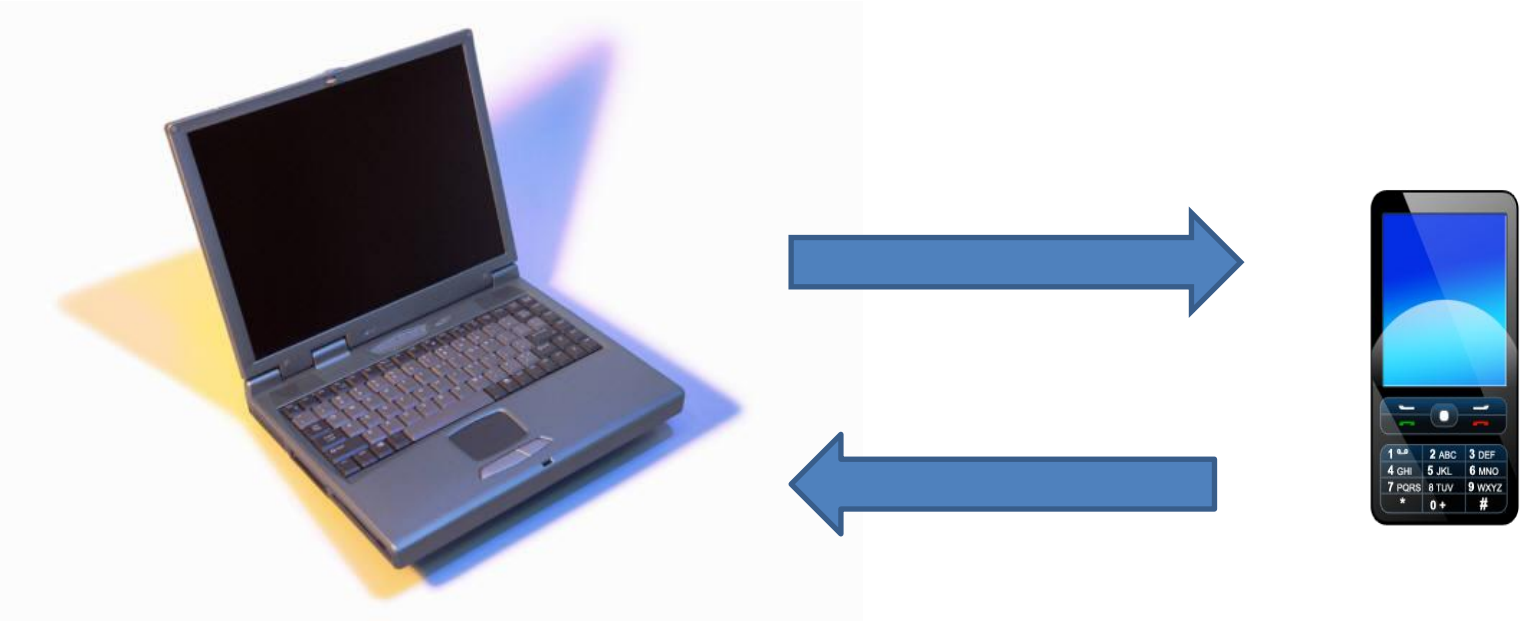
lightblue.selectservice() : service selection GUI

```
Python 2.6.4 (r264:75706, Dec  7 2009, 18:45:15)
[GCC 4.4.1] on linux2
Type "copyright", "credits" or "license(

    **********************************
    Personal firewall software may warn
    makes to its subprocess using this c
    interface.  This connection is not v
    interface and no data is sent to or
    **********************************

IDLE 2.6.4      ==== No Subprocess ====
>>> import lightblue
>>> choice = lightblue.selectservice()
```



Note: this program may freeze IDLE. You should run it from linux command line..

Sending objects via Object Exchange (OBEX)

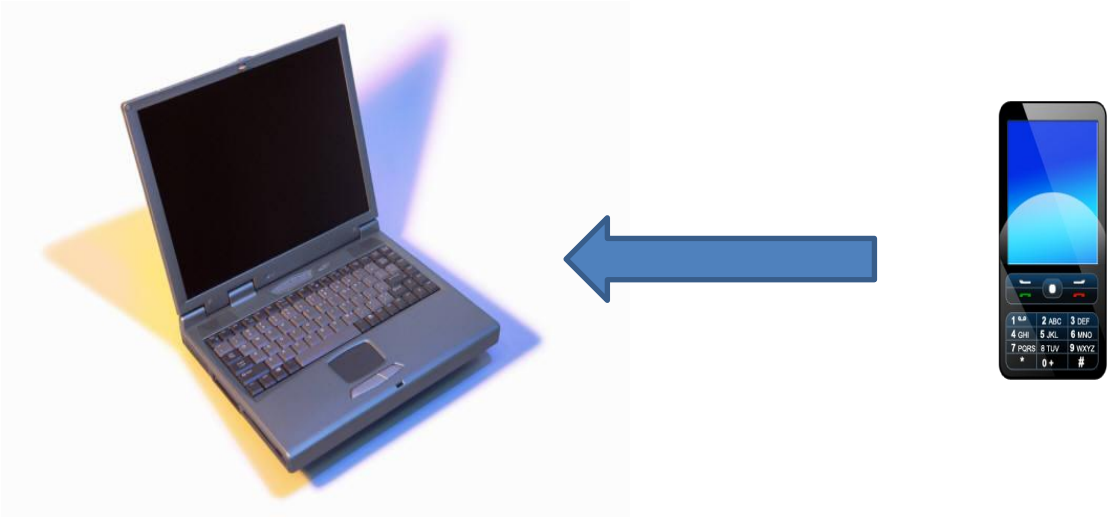


Object Exchange (OBEX) Push Example

```
# LightblueSend.py: Apinun Tunpan, intERLab, AIT

import lightblue

print "Finding Devices.."
device = lightblue.selectdevice()

if device is not None:
  print "Device selected was: ", device
else:
  print "No device was selected. Exiting.."
  exit()

obex_push = None
print "Finding OBEX Object Push service..."

for s in lightblue.findservices( addr = device[0] ):
  print s
  if s[2] == 'OBEX Object Push':
    obex_push = s[1]

if obex_push is not None:
  client = lightblue.obex.OBEXClient( str(device[0]), obex_push )
  print client.connect()
  print client.put( {"name":"Myfile.jpg"}, file("Myfile.jpg","rb" ) )
  client.disconnect()
else:
  print "OBEX Object Push service was not listed on the device. Exiting.
```

Exercise

- Implement a program to receive a file from mobile phone via OBEX push



3. GPS device interface

Bluetooth GPS

Ideas for interfacing with GPS

- Connect (e.g. via bluetooth) to the GPS
- Read data lines
- Get to the right line (e.g. $GPGGA)
- Split & Decode the line
  - To get UTC, Lat, Lon, Height, Validity…
- Disconnect

Connecting with a Bluetooth device

- This time we need to transfer stream of data
- There are two protocols:
  - RFCOMM : reliable, stream-based
  - L2CAP : best-effort, datagram

More information at

http://people.csail.mit.edu/albert/bluez-intro/x95.html

The bluez (bluetooth) module

```
>>> import bluetooth
>>> services = bluetooth.find_service()
>>> for  s in services:
        print s
```

GPSBlue1.py : basic GPS reading

```
import sys, time, bluetooth
deviceAddress = '00:1B:C1:02:F0:8B' # Change this line to your device's MAC

def main():

  # Find RFCOMM port
  services = bluetooth.find_service(address=deviceAddress)
  port = None
  for svc in services:
    if svc["name"] == "SPP slave":
      port = svc["port"]
      break

  if port is None:
    print "Could not find RFCOMM port for SPP slave service."
    sys.exit(4)

  # Create bluetooth socket
  bluesock = bluetooth.BluetoothSocket(bluetooth.RFCOMM)
  bluesock.connect((deviceAddress, port))

  while True:
    gpsdata = bluesock.recv(2048)
    gpslines = gpsdata.splitlines()
    print '**************************   Printing raw GPS data: **************'
    for l in gpslines:
      print l
    time.sleep( 1 )

if __name__ == '__main__':
  main()
```

Finding a right port to connect to

Making an RFCOMM connection to the GPS module.

Reading the data

Sample output from GPSBlue1.py

```
**************************   Printing raw GPS data: **********************************
$GPGGA,042230.000,1404.6657,N,10036.7734,E,1,10,0.88,34.5,M,-28.0,M,,*7F
$GPGSA,A,3,23,17,03,19,07,20,13,28,11,08,,,1.51,0.88,1.23*0E
$GPGSV,4,1,14,13,56,236,33,19,51,024,28,11,50,169,34,07,44,343,36*75
$GPGSV,4,2,14,23,41,192,38,24,30,078,,03,20,035,35,28,13,290,25*70
$GPGSV,4,3,14,08,12,326,18,17,11,226,23,20,08,171,24,06,07,039,*7F
$GPGSV,4,4,14,32,02,154,,45,,,*4E
$GPRMC,042230.000,A,1404.6657,N,10036.7734,E,0.00,268.33,210910,,,A*6E
$GPZDA,042230.000,21,09,2010,,*58
**************************   Printing raw GPS data: **********************************
$GPGGA,042231.000,1404.6657,N,10036.7734,E,1,10,0.88,34.5,M,-28.0,M,,*7E
$GPGSA,A,3,23,17,03,19,07,20,13,28,11,08,,,1.51,0.88,1.23*0E
$GPRMC,042231.000,A,1404.6657,N,10036.7734,E,0.01,268.33,210910,,,A*6E
$GPZDA,042231.000,21,09,2010,,*59
**************************   Printing raw GPS data: **********************************
$GPGGA,042232.000,1404.6657,N,10036.7734,E,1,10,0.88,34.5,M,-28.0,M,,*7D
$GPGSA,A,3,23,17,03,19,07,20,13,28,11,08,,,1.51,0.88,1.23*0E
$GPRMC,042232.000,A,1404.6657,N,10036.7734,E,0.01,268.33,210910,,,A*6D
$GPZDA,042232.000,21,09,2010,,*5A
**************************   Printing raw GPS data: **********************************
$GPGGA,042233.000,1404.6657,N,10036.7733,E,1,10,0.88,34.5,M,-28.0,M,,*7B
$GPGSA,A,3,23,17,03,19,07,20,13,28,11,08,,,1.51,0.88,1.23*0E
$GPRMC,042233.000,A,1404.6657,N,10036.7733,E,0.01,268.33,210910,,,A*6B
$GPZDA,042233.000,21,09,2010,,*5B
```

Some of NMEA GPS data types

- $GPGAA – Fix information (2D or 3D)
- $GPGSA – Satellite status
- $GPGSV – Satellites in view
- $GPRMC – Recommended minimum
- $GPZDA -- UTC date and time

For more information, search Google™ , or visit:
http://www.gpsinformation.org/dale/nmea.htm

Understanding the lat/lon formats

- Common formats
  - Decimal degrees (e.g. 100.12345)
  - Degrees, decimal minutes (e.g. 100 7.407’)
  - Degrees, minutes, decimal seconds (e.g. 100 7’ 24.42”)

With a straight forward conversion:

Decimal degrees

= Degrees + minutes/60 + seconds/3600

GPSBlue2.py (part 1 of 2)

```
# GPSBlue.py:  reading and decoding from Holux M-1000 BT GPS
# IntERLab, September, 2010. Based on the code by Dr.Mahtab and Dr.Apinun.

import sys, time, bluetooth
deviceAddress = '00:1B:C1:02:F0:8B'  # Change this line to your device's MAC

def DecodeGPS(line):
  'From a $GPGGAA sentence, decode lat, lon, alt and utc'
  fields = line.split(',')
  if fields[0] != '$GPGGA' or len(fields) < 6 or int(fields[6]) < 1:
    return None

  else:
    utc      = fields[1]

    lat_deg = int(float(fields[2]))/100
    lat_min = (float(fields[2]) - lat_deg*100)/60.0
    lat = lat_deg + lat_min

    lon_deg = int(float(fields[4]))/100
    lon_min = (float(fields[4]) - lon_deg*100)/60.0
    lon = lon_deg + lon_min

    if fields[3] != 'N': lat = lat * -1    # Adjust for the sign

    if fields[5] != 'E': lon = lon * -1    # Adjust for the sign

    altitude = fields[9]

    quality = fields[6]

    return (utc,lat,lon,altitude,quality)
```

Transforming the format of lat, lon from DDMM.MMMM to DD.DDDDD

Altitude

Quality of the GPS fix.

GPSBlue2.py (part 2 of 2)

```
def main():

  # Find RFCOMM port
  services = bluetooth.find_service(address=deviceAddress)
  port = None
  for svc in services:
    if svc["name"] == "SPP slave":
      port = svc["port"]
      break

  if port is None:
    print "Could not find RFCOMM port for SPP slave service."
    sys.exit(4)

  # Create bluetooth socket
  bluesock = bluetooth.BluetoothSocket(bluetooth.RFCOMM)
  bluesock.connect((deviceAddress, port))

  while True:
    gpsdata = bluesock.recv(2048)
    gpslines = gpsdata.splitlines()
    for l in gpslines:
      data = DecodeGPS(l)
      if data is not None:
        mesg="utc= %s lat= %f lon= %f alt= %s q= %s" % data
        print mesg
    time.sleep( 1 )

if __name__ == '__main__':
  main()
```

Sample Output of GPSBlue2.py

```
utc= 080557.000 lat= 14.077713 lon= 100.612975 alt= 13.5 q= 1
utc= 080558.000 lat= 14.077715 lon= 100.612975 alt= 13.4 q= 1
utc= 080559.000 lat= 14.077717 lon= 100.612970 alt= 13.2 q= 1
utc= 080600.000 lat= 14.077720 lon= 100.612972 alt= 13.2 q= 1
utc= 080601.000 lat= 14.077725 lon= 100.612963 alt= 13.2 q= 1
utc= 080602.000 lat= 14.077725 lon= 100.612965 alt= 13.2 q= 1
utc= 080603.000 lat= 14.077727 lon= 100.612968 alt= 13.2 q= 1
utc= 080604.000 lat= 14.077728 lon= 100.612968 alt= 13.2 q= 1
utc= 080605.000 lat= 14.077732 lon= 100.612958 alt= 13.1 q= 1
utc= 080606.000 lat= 14.077730 lon= 100.612947 alt= 13.0 q= 1
utc= 080607.000 lat= 14.077730 lon= 100.612940 alt= 12.9 q= 1
utc= 080608.000 lat= 14.077730 lon= 100.612935 alt= 12.9 q= 1
utc= 080609.000 lat= 14.077732 lon= 100.612923 alt= 12.8 q= 1
utc= 080610.000 lat= 14.077732 lon= 100.612918 alt= 12.7 q= 1
utc= 080611.000 lat= 14.077733 lon= 100.612910 alt= 12.7 q= 1
utc= 080612.000 lat= 14.077735 lon= 100.612903 alt= 12.4 q= 1
utc= 080613.000 lat= 14.077735 lon= 100.612905 alt= 12.4 q= 1
utc= 080614.000 lat= 14.077735 lon= 100.612907 alt= 12.3 q= 1
utc= 080615.000 lat= 14.077733 lon= 100.612908 alt= 12.3 q= 1
utc= 080616.000 lat= 14.077732 lon= 100.612910 alt= 12.2 q= 1
utc= 080617.000 lat= 14.077730 lon= 100.612910 alt= 12.2 q= 1
utc= 080618.000 lat= 14.077728 lon= 100.612912 alt= 12.1 q= 1
utc= 080619.000 lat= 14.077728 lon= 100.612913 alt= 12.1 q= 1
```

Exercises

- Extend GPSBlue.py so that it displays the current location of your PC + GPS on Google Maps™

- Add GPS coordinate reading to the Access Point scan (ApScanV2.py) so that it displays the lat/lon of the reading.

4. Further self studies

What makes Python full of useful modules and libraries?

- The answer: language wrappers and bindings.

- http://www.swig.org/exec.html
- http://code.google.com/p/pybindgen/

For your research

Python may already have the modules that make your life easier:

- Graph Theory
  - http://networkx.lanl.gov/
  - http://code.google.com/p/python-graph/
- Scientific Computing & Optimization
  - http://www.scipy.org/
  - http://mdp-toolkit.sourceforge.net/
  - http://cvxmod.net/

For your research

- GIS
  - http://trac.gispython.org/lab
  - http://trac.gispython.org/lab/wiki/OwsLib
  - http://trac.osgeo.org/gdal/wiki/GdalOgrInPython
- Social Network
  - http://code.google.com/p/python-twitter/
  - http://code.google.com/p/pyfacebook/

Thank you for your attention

Hope you have fun and learn a lot from this class.