The Data Transport Network Turns 15!

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Remote Data Retrieval

NSF Research Facility in Sondrestrom, Greenland

What Are We Trying To Do?

Small Systems Have The Same Needs

What Makes This Difficult?

- Bandwidth constraints
- Unreliable or on-demand connections
- Instrument operations
- Multiple data sources
- Scale to multiple instruments and sites
- Legacy hardware and software

The Data Transport Network

Open-Source, NSF Information Technology Project

A system to access, process and transfer data from multiple instruments over unreliable networks.

Access: **common method to organize and access data**

Process: **monitor status, compute results, trigger actions**

Transfer: **transmit data between sites**

Multiple instruments: **many heterogeneous data feeds**

Unreliable network: **store-and-forward, on demand**

First code written in 1998 – 15 years and going strong!

How Does It Work?

Usenet Messages and Attachments

Headers

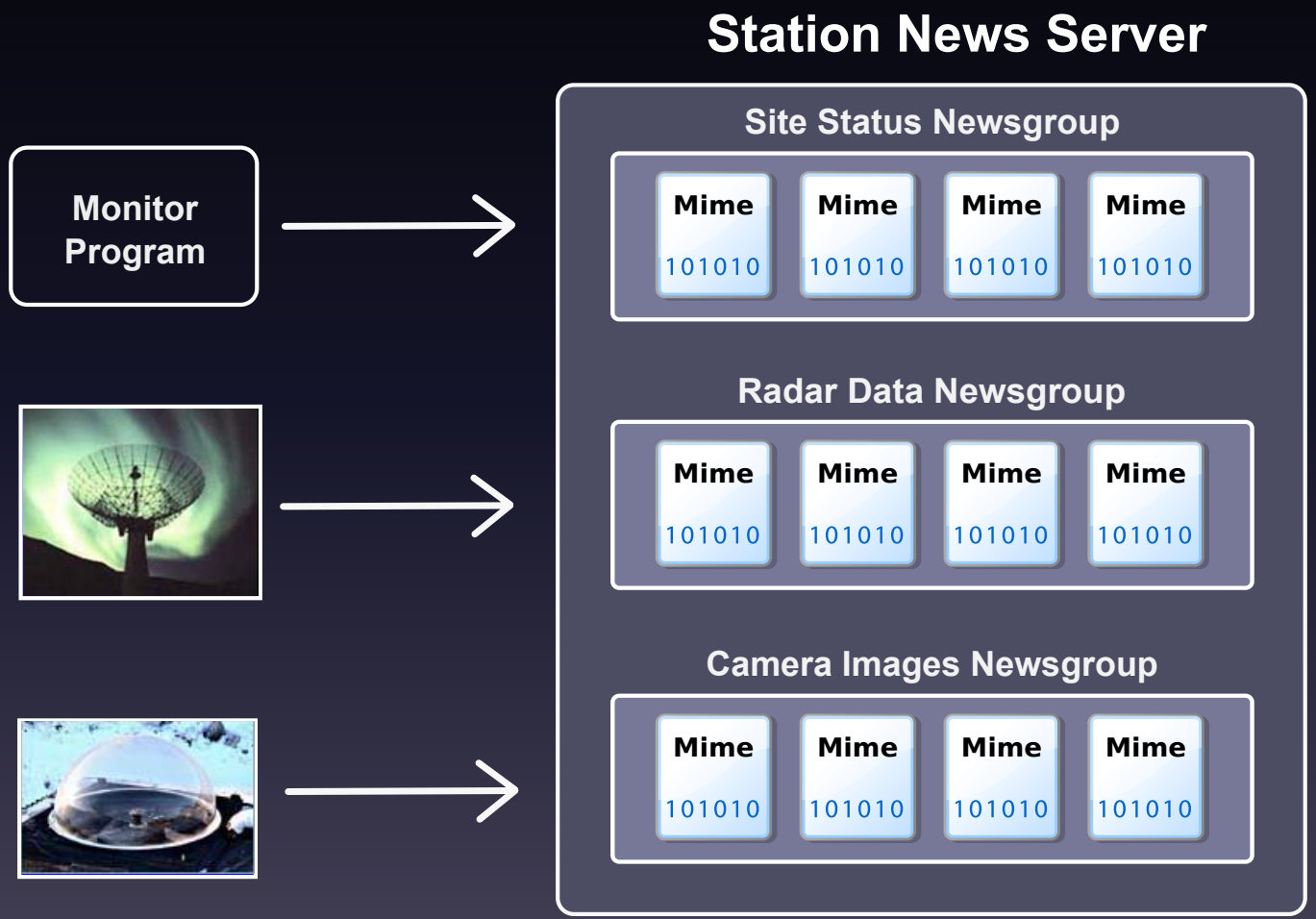
MIME Encoded Attachement

```
From:          transport@datatransport.org
Newsgroups:    transport.obuoy.1.webcam
Date:          Apr 4, 2013  12:23:46 UTC
Subject:       OBuoy camera image
X-Instrument:  Webcam-1

Filename:      camera-01.jpg
Content-type:  x-application/base-64
```

- Data files are sent as attachments
- Headers provide metadata
- Any type of data can be sent (text, images, binaries)

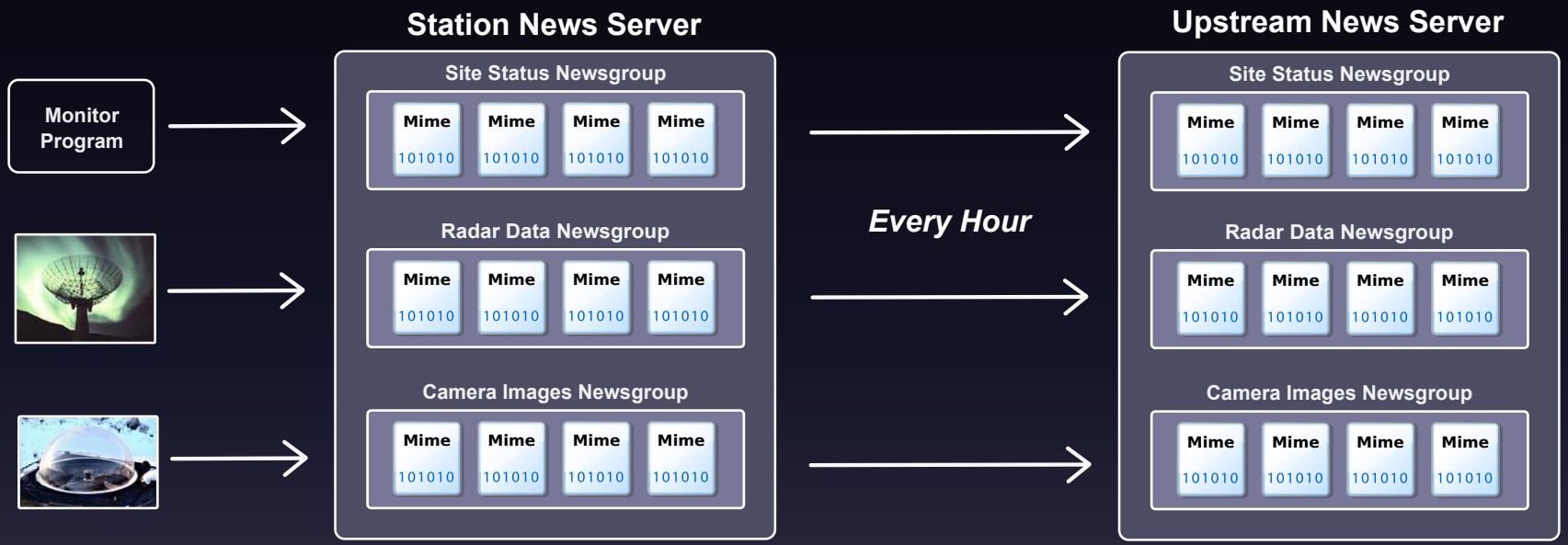
Messages Stored In Newsgroups

Instruments Post Data Files Into Separate Newsgroups



News Server Message Exchange

Store and Forward



- Periodic transfers (typically every hour)
- Access controls
- Bidirectional
- Data replication

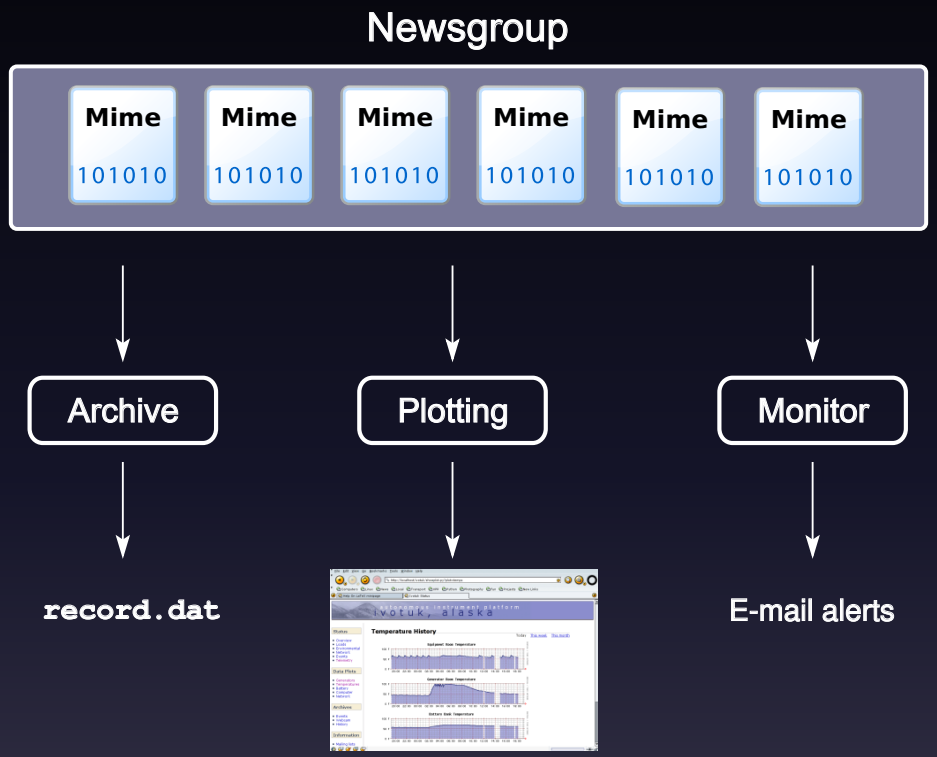
Buoy Server Newsgroups

228 newsgroups for 3 different buoy projects

transport.obuoy.000000009211ffc9.tobuoy
transport.obuoy.00000000922159fa.frombuoy.camera
transport.obuoy.00000000922159fa.frombuoy.campbell
transport.obuoy.00000000922159fa.frombuoy.co2
transport.obuoy.00000000922159fa.frombuoy.doas
transport.obuoy.00000000922159fa.frombuoy.gps
transport.obuoy.00000000922159fa.frombuoy.iridium
transport.obuoy.00000000922159fa.frombuoy.logs
transport.obuoy.00000000922159fa.frombuoy.ozone
transport.obuoy.00000000922159fa.frombuoy.sbc
transport.obuoy.00000000922159fa.frombuoy.schedules
transport.obuoy.00000000922159fa.frombuoy.system
transport.obuoy.00000000922159fa.frombuoy.updates
transport.obuoy.00000000922159fa.tobuoy
transport.obuoy.0000000092250547.frombuoy.camera
transport.obuoy.0000000092250547.frombuoy.campbell
transport.obuoy.0000000092250547.frombuoy.co2
transport.obuoy.0000000092250547.frombuoy.doas
transport.obuoy.0000000092250547.frombuoy.gps
transport.obuoy.0000000092250547.frombuoy.iridium
transport.obuoy.0000000092250547.frombuoy.logs
transport.obuoy.0000000092250547.frombuoy.ozone
transport.obuoy.0000000092250547.frombuoy.sbc
transport.obuoy.0000000092250547.frombuoy.system
transport.obuoy.0000000092250547.frombuoy.updates
transport.obuoy.0000000092250547.tobuoy
transport.obuoy.000000009225cd12.frombuoy.ack
transport.obuoy.000000009225cd12.frombuoy.camera
transport.obuoy.000000009225cd12.frombuoy.campbell
transport.obuoy.000000009225cd12.frombuoy.co2
transport.obuoy.000000009225cd12.frombuoy.doas
transport.obuoy.000000009225cd12.frombuoy.gps
transport.obuoy.000000009225cd12.frombuoy.iridium
transport.obuoy.000000009225cd12.frombuoy.logs
transport.obuoy.000000009225cd12.frombuoy.ozone
transport.obuoy.000000009225cd12.frombuoy.sbc
transport.obuoy.000000009225cd12.frombuoy.schedules
transport.obuoy.000000009225cd12.frombuoy.system
transport.obuoy.status.history
transport.obuoy.status.online
transport.usna.history
transport.usna.icegoat-1c.argos
transport.usna.icegoat-1c.frombuoy.camera0
transport.usna.icegoat-1c.frombuoy.camera1
transport.usna.icegoat-1c.frombuoy.iridium
transport.usna.icegoat-1c.frombuoy.sbc
transport.usna.icegoat-1c.frombuoy.schedules
transport.usna.icegoat-1c.frombuoy.system
transport.usna.icegoat-1c.frombuoy.updates
transport.usna.icegoat-1c.tobuoy
transport.usna.icegoat-2a.tobuoy
transport.usna.icekid-1.frombuoy.ack
transport.usna.icekid-1.frombuoy.camera0
transport.usna.icekid-1.frombuoy.camera1
transport.usna.icekid-1.frombuoy.iridium
transport.usna.icekid-1.frombuoy.sbc
transport.usna.icekid-1.frombuoy.schedules
transport.usna.icekid-1.frombuoy.system
transport.usna.icekid-1.frombuoy.updates
transport.usna.icekid-1.tobuoy
transport.usna.icekid-2a.frombuoy.ack
transport.usna.icekid-2a.frombuoy.camera0
transport.usna.icekid-2a.frombuoy.camera1
transport.usna.icekid-2a.frombuoy.gps
transport.usna.icekid-2a.frombuoy.hydrophone
transport.usna.icekid-2a.frombuoy.iridium
transport.usna.icekid-2a.frombuoy.sbc
transport.usna.icekid-2a.frombuoy.schedules
transport.usna.icekid-2a.frombuoy.system
transport.usna.icekid-2a.frombuoy.updates
transport.usna.icekid-2a.tobuoy
transport.usna.icekid-3.frombuoy.ack
transport.usna.icekid-3.frombuoy.camera0
transport.usna.icekid-3.frombuoy.camera1
transport.usna.icekid-3.frombuoy.iridium
transport.usna.icekid-3.frombuoy.sbc

Newsgroup Features

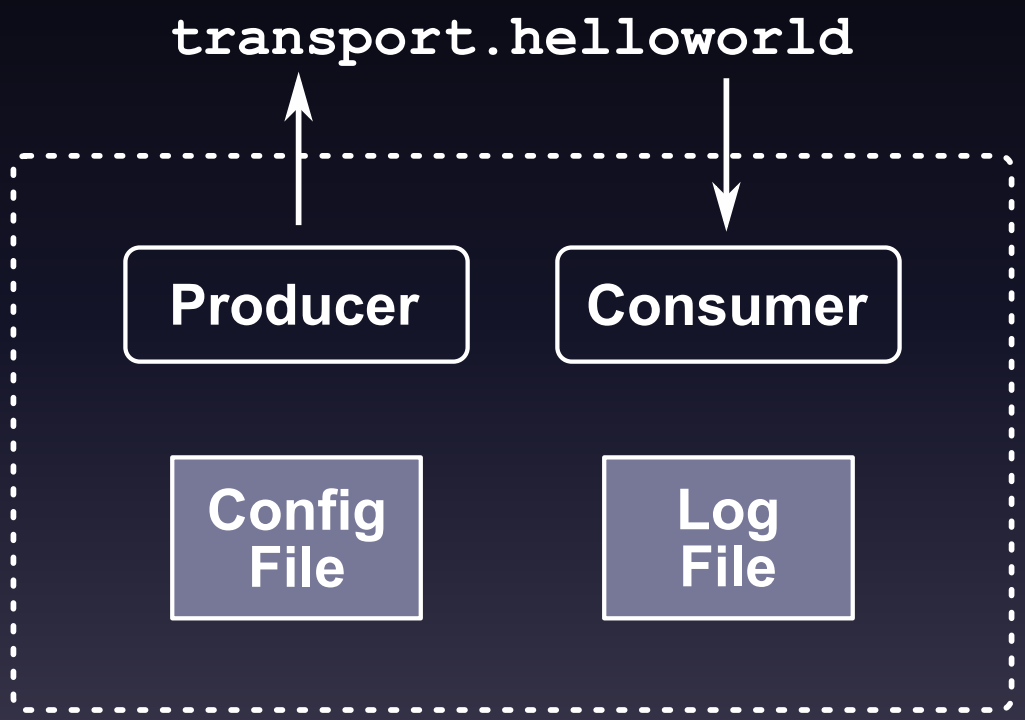
Publish and Subscribe



- Single producer, many consumers
- Copies of data are accessed
- Short-term history, automatic expiration (2 weeks)
- “Market place” for data

Data Transport “Hello World”

A Producer/Consumer Example



Hello World Example

Print Message To Log File Every 15-seconds

helloworld.conf

```
[ProcessGroup]
clients: hello

[hello]
command: helloworld.py
```

helloworld.py

```
from Transport import ProcessClient

class Client (ProcessClient):

   def __init__(self,args):
      ProcessClient.__init__(self,args)

   def run(self):
      while self.wait(15):
         self.log.info('Hello world!')

if __name__ == '__main__':
   import sys
   Client(sys.argv).run()
```

```
transportctl start helloworld
[2013−04−03 01:13:43.327 INFO] helloworld: Starting client hello
[2013−04−03 01:13:43.413 INFO] helloworld: Logging in client: hello (pid=30148)
[2013−04−03 01:13:58.440 INFO] helloworld/hello: Hello world!
[2013−04−03 01:14:13.466 INFO] helloworld/hello: Hello world!
```

Hello World Example

Reading From The Config File

helloworld.conf

```
[ProcessGroup]
clients: hello

[hello]
command: helloworld.py
rate: 00:15
text: Hello PTC!
```

helloworld.py

```
from Transport import ProcessClient

class Client (ProcessClient):

   def __init__(self,args):
      ProcessClient.__init__(self,args)

      self.rate = self.getRate('rate')
      self.text = self.get('text')

   def run(self):
      while self.wait(self.rate):
         self.log.info(self.text)

if __name__ == '__main__':
   import sys
   Client(sys.argv).run()
```

Publisher Example

Posting To A News Group

helloworld.conf

```
[ProcessGroup]
clients: hello

[hello]
command: helloworld.py
rate: 00:15
text: Hello PTC!
post.newsgroup: transport.helloworld
```

helloworld.py

```
from Transport import ProcessClient, NewsPostMixin

class Client (ProcessClient,NewsPostMixin):

   def __init__(self,args):
      ProcessClient.__init__(self,args)
      NewsPostMixin.__init__(self)

      self.rate = self.getRate('rate')
      self.text = self.get('text')

   def run(self):
      while self.wait(self.rate):
         self.log.info(self.text)
         self.newsPoster.postText(self.text)

if __name__ == '__main__':
   import sys
   Client(sys.argv).run()
```

Subscriber Example

Reading From A News Group

helloworld.conf

```
[DEFAULT]
newsgroup: transport.helloworld
rate: 00:15

[ProcessGroup]
clients: hello poller

[hello]
command: helloworld.py
text: Hello PTC!
post.newsgroup: %(newsgroup)s

[poller]
command: poller.py
poll.newsgroup: %(newsgroup)s
poll.rate: %(rate)s
```

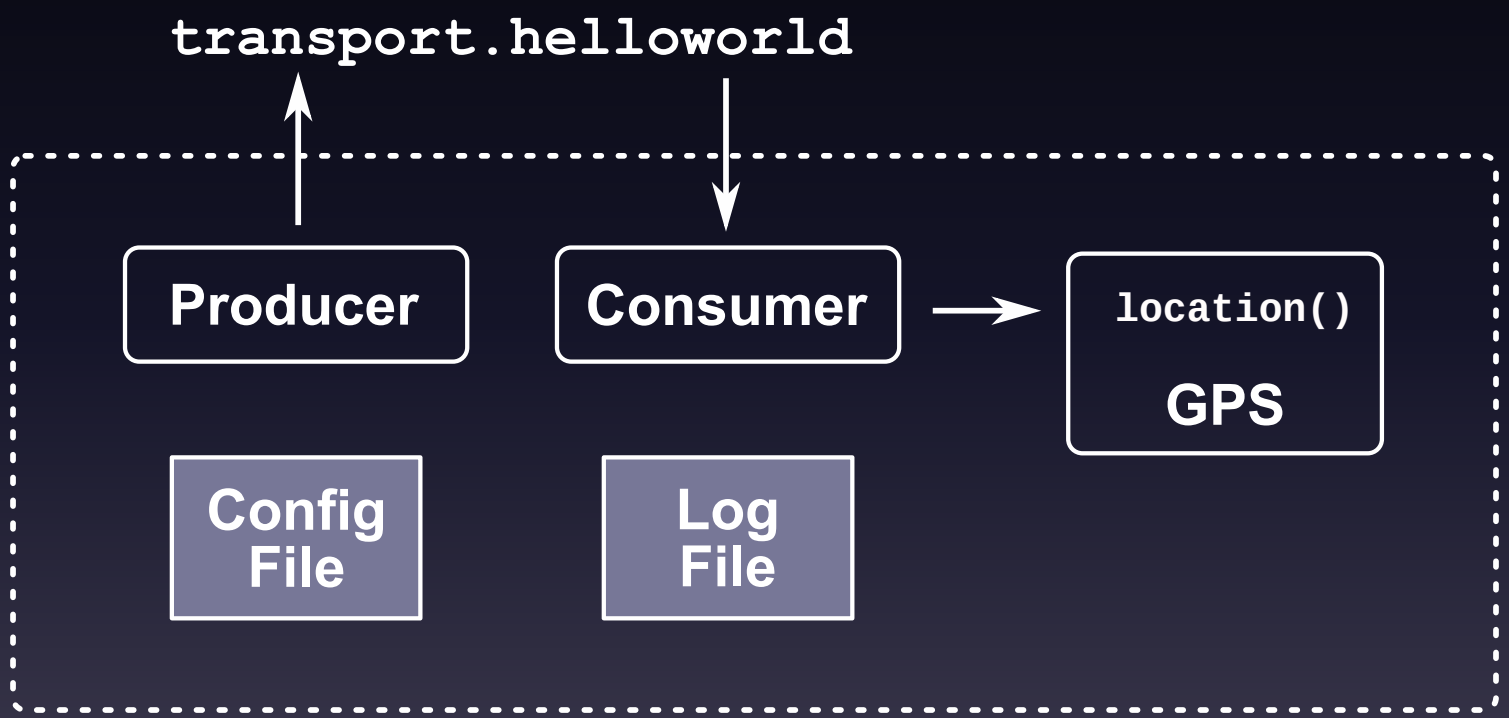
poller.py

```
from Transport import ProcessClient, NewsPollMixin

class Poller (ProcessClient,NewsPollMixin):

   def __init__(self,args):
      ProcessClient.__init__(self,args)
      NewsPollMixin.__init__(self,callback=self.process)

   def process(self,message):
      text = message.get_payload()
      self.log.info('Received: %s' % text)

if __name__ == '__main__':
   import sys
   Poller(sys.argv).run()
```

```
[2013−04−03 01:35:38.093 INFO] helloworld: Logging in client: poller (pid=631)
[2013−04−03 01:35:38.592 INFO] helloworld: Logging in client: hello (pid=636)
[2013−04−03 01:35:45.016 INFO] helloworld/hello: Hello PTC!
[2013−04−03 01:35:53.142 INFO] helloworld/poller: Received: Hello PTC!
```

XML-RPC Server/Client Example

Synchronous Communications Between Programs



XML-RPC Server Example

GPS Position Service

helloworld.conf

```
[DEFAULT]
newsgroup: transport.helloworld
rate: 00:15

[ProcessGroup]
clients: hello poller gps

[hello]
command: helloworld.py
text: Hello PTC!
post.newsgroup: %(newsgroup)s

[poller]
command: poller.py
poll.newsgroup: %(newsgroup)s

[gps]
command: server.py
service.name: gps
```

server.py

```
from Transport import ProcessClient
from Transport import XMLRPCServerMixin

class GPSServer (ProcessClient,XMLRPCServerMixin)

    def __init__(self,args):
        ProcessClient.__init__(self,args)
        XMLRPCServerMixin.__init__(self)

        self.register_function(self.location)

    def location(self):
        lat = 87.6
        lon = 138.3
        return lat,lon

if __name__ == '__main__':
    import sys
    GPSServer(sys.argv).run()
```

Calling an XML-RPC Service

helloworld.conf

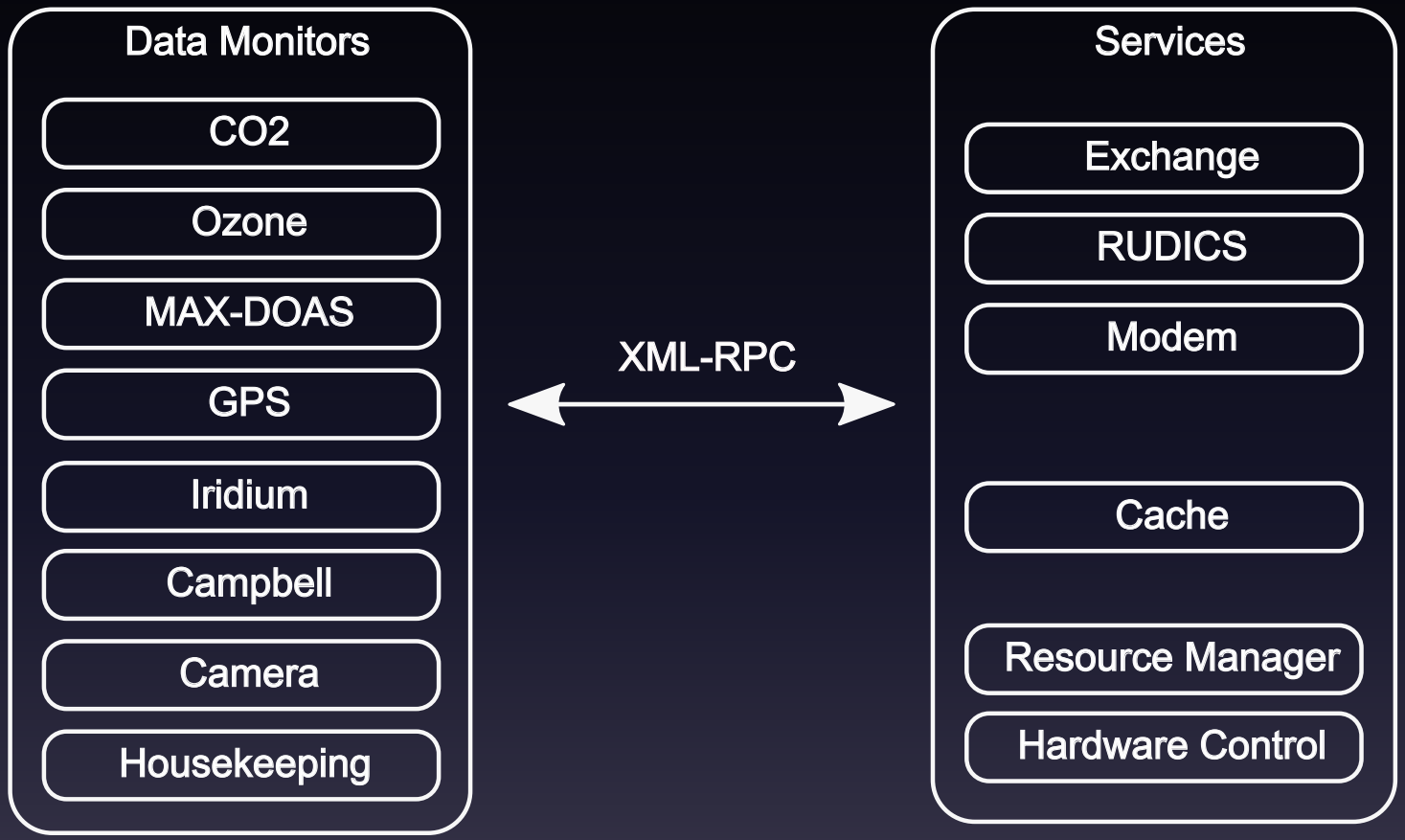
```
[DEFAULT]
newsgroup: transport.helloworld
rate: 00:15

[ProcessGroup]
clients: hello poller gps

[hello]
command: helloworld.py
text: Hello PTC!
post.newsgroup: %(newsgroup)s

[poller]
command: poller.py
poll.newsgroup: %(newsgroup)s

[gps]
command: server.py
service.name: gps
```

helloworld.py

```
from Transport import ProcessClient, NewsPostMixin
from Transport import DirectoryMixin

class Client (ProcessClient,NewsPostMixin,DirectoryMixin):

  def __init__(self,args):
    ProcessClient.__init__(self,args)
    NewsPostMixin.__init__(self)
    DirectoryMixin.__init__(self)

    self.rate = self.getRate('rate')
    self.text = self.get('text')
    self.gps = self.connect('gps')

  def run(self):
    while self.wait(self.rate):
      lat,lon = self.gps.location()
      msg = "Received: %s at (%s,%s)" % (self.text,lat,lon)
      self.log.info(msg)
      self.newsPoster.postText(msg)
```

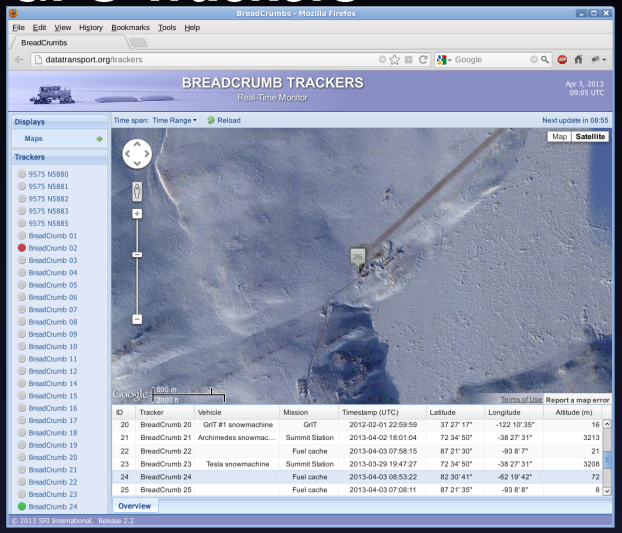
```
[2013−04−03 01:40:00.025 INFO] helloworld/hello: Hello PTC!
[2013−04−03 01:40:08.668 INFO] helloworld/poller: Received: Hello PTC! at (87.6,138.3)
```

Buoy System Architecture

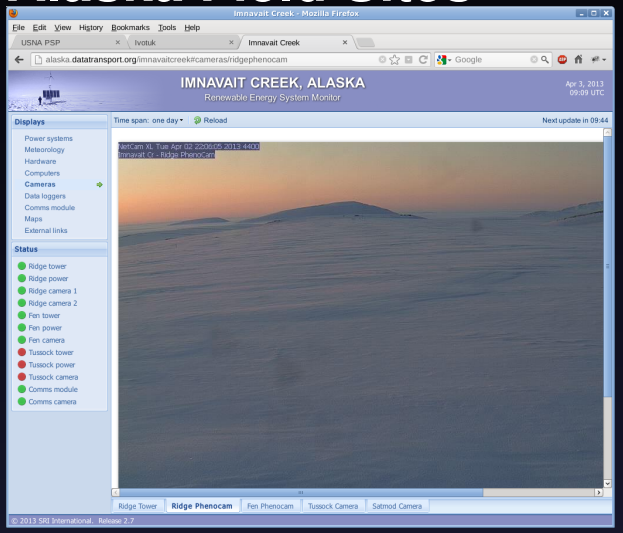


Example Uses

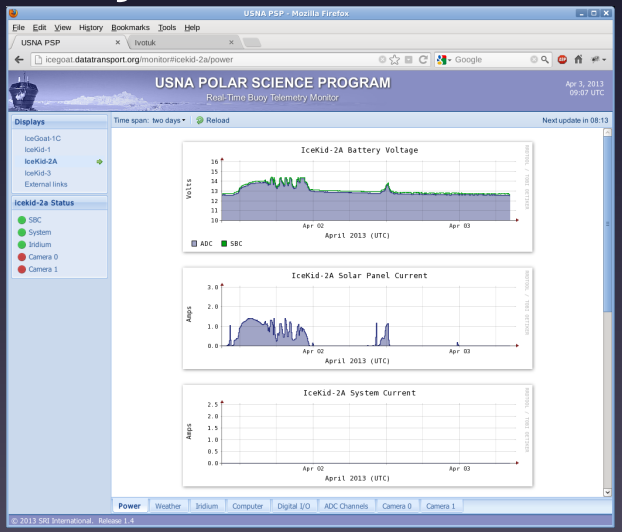
GPS Trackers



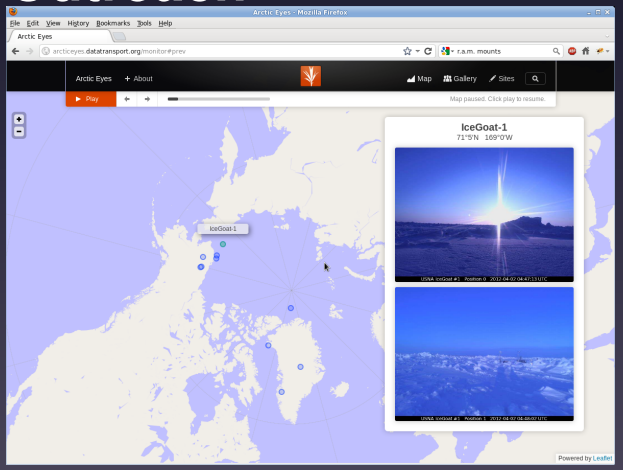
Alaska Field Sites



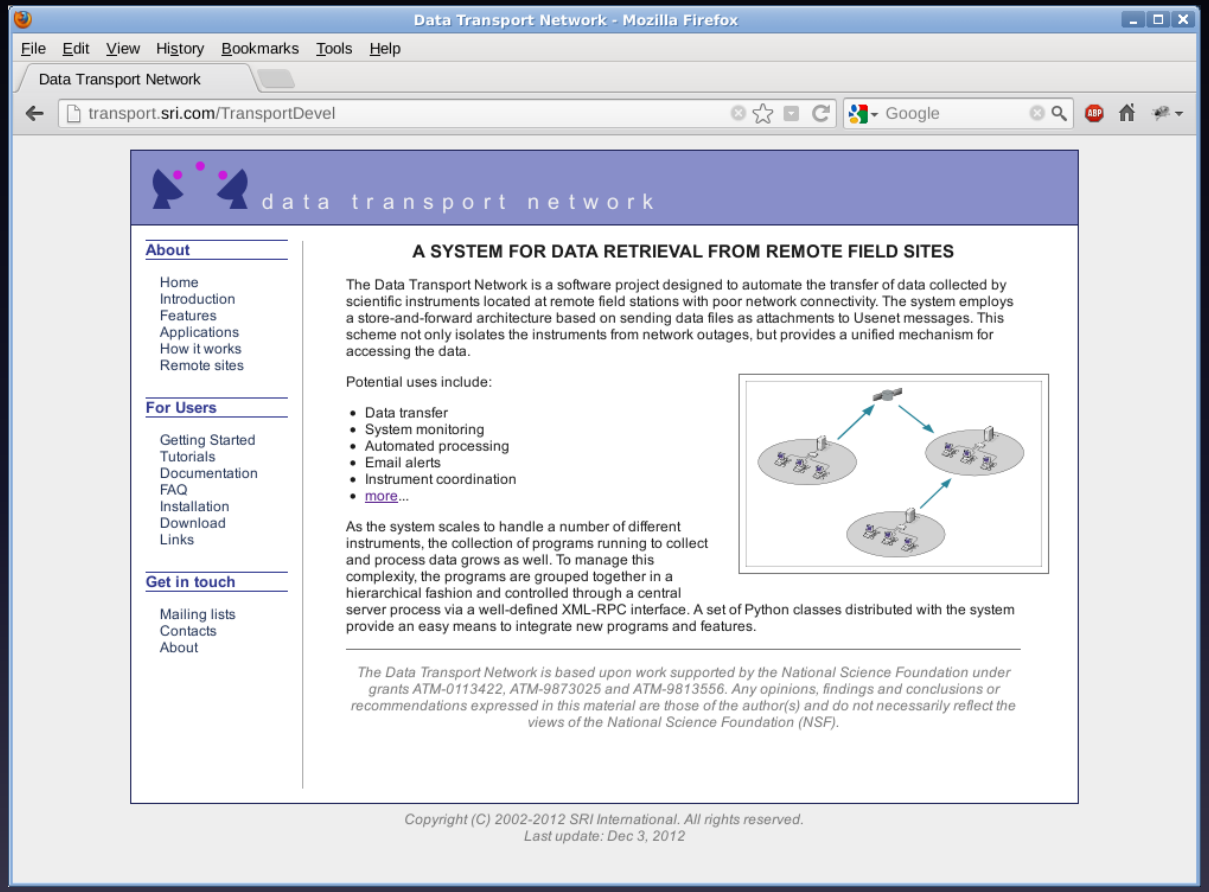
Buoys



Outreach



How To Get Started



- **Development site:** `www.datatransport.org`
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