Batches: Unifying RPC, WS and Database access

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Typical Approach to Distribution/DB

1. **Design** a programming language

   Finalize specification, then...

2. Implement distribution/queries as **library**

   RPC library, stub generator
   SQL library
   Web Service library, wrapper generator

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1. **Design** a programming language

   Finalize specification, then...

2. Implement distribution/queries as **library**

   RPC library, stub generator
   SQL library
   Web Service library, wrapper generator

3. **Rejected and ignored** by community

   CORBA, DCOM, RMI are complete disaster

Using a Mail Service

```
int limit = 500;
for ( Message m : mailer.Messages )
    if ( m.Size > limit ) {
      print( m.Subject + ": " + m.Sender.Name);
      m.delete();
    }
```

Using a Mail Service

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int limit = 500;
for ( Message m : mailer.Messages )
    if ( m.Size > limit ) {
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      m.delete();
    }
```

Works great if mailer is a local object, but is terrible if mailer is remote

Goals: Why not Have it All?

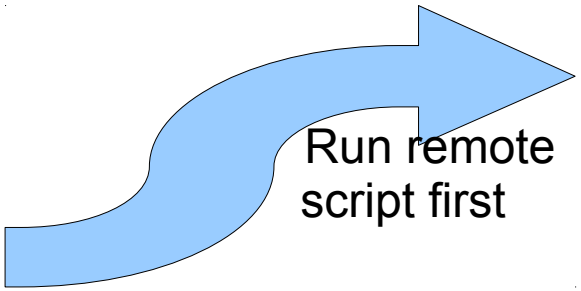
A Note on Distributed Computing

Low latency	**One** round trip
Stateless	**No** Proxies
Platform independent	**No** Serialization
Clean Server APIs	**No** Data Transfer Object **No** Server Facade **No** Superclass/type (e.g. java.rmi.Remote)

Using a Mail Service

```
int limit = 500;
for ( Message m : mailer.Messages )
    if ( m.Size > limit ) {
      print( m.Subject + ": " + m.Sender.Name);
      m.delete();
    }
```

Separate *local* and *remote* code!




```
for (m : ROOT.Messages) {
 if (m.Size > In("A")) {
  OUT("B", m.Subject);
  OUT("C", m.Sender.Name);
  m.delete();
 }
```

```
int limit = 500;
Remote<Mailer> connection = ....;
batch (Mailer mailer : connection) {
  for ( Message m : mailer.Messages )
     if ( m.Size > limit ) {
       print( m.Subject + ": " + m.Sender.Name);
       m.delete();
     }
}
```

B	C
RE: testing	Will Cook
JVM Summit	Dan Smith
...	...

```
Remote<Mailer> connection = ....;
Forest in = new Forest("A", limit);
Forest mailer = connection.execute(script, in);
for (m : mailer.getIteration("m"))
  print(m.getStr("B") + ": " + m.getStr("C") );
```

Batch Pattern

Execution model: Batch Command Pattern

1. Client **sends *script*** to the server
   (Creates Remote Façade on the fly)
2. Server **executes** the script
3. Server **returns results in bulk** (name, size)
   (Creates Data Transfer Objects on the fly)
4. Client **runs the local code** (print statements)

Batch Script to SQL

```
for (m : ROOT.Messages) {
 if (m.Size > In("A")) {
  out("B", m.Subject);
  out("C", m.Sender.Name);
  m.delete();
 }
```

```
SELECT m.Subject as B, u.Name as C
FROM Message m INER JOIN User u
   ON m.Sender = User.ID
WHERE m.Size > ?

DELETE FROM Message
  WHERE m.Size > ?
```

Always *constant* number of queries

Batch Script
(Subset of JavaScript)

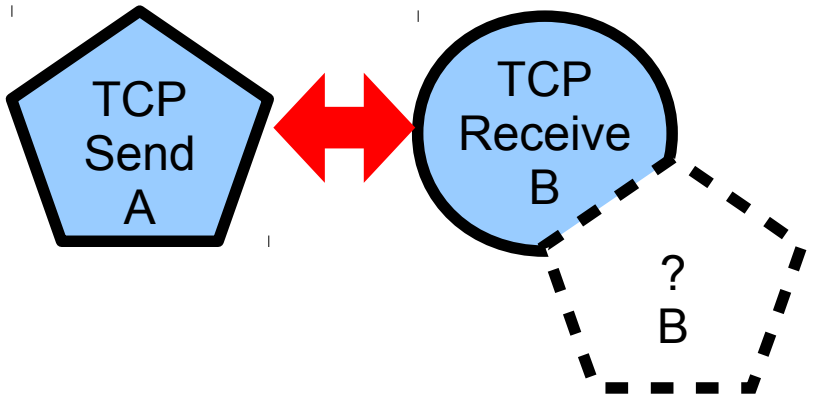
s ::=	<literal>	variables, constants
|	e.x	fields
|	e.m(e, ..., e)	method call
|	e = e	assignment
|	e ⊕ e | !e | e ? e : e	primitive operators
|	**if** (e) { e } [**else** { e }]	conditionals
|	**for** (x **in** e) { e }	loops
|	**var** x = e; e	binding
|	OUTPUT(label, e)	outputs
|	INPUT(label)	inputs
|	**function**(x) { e }	functions

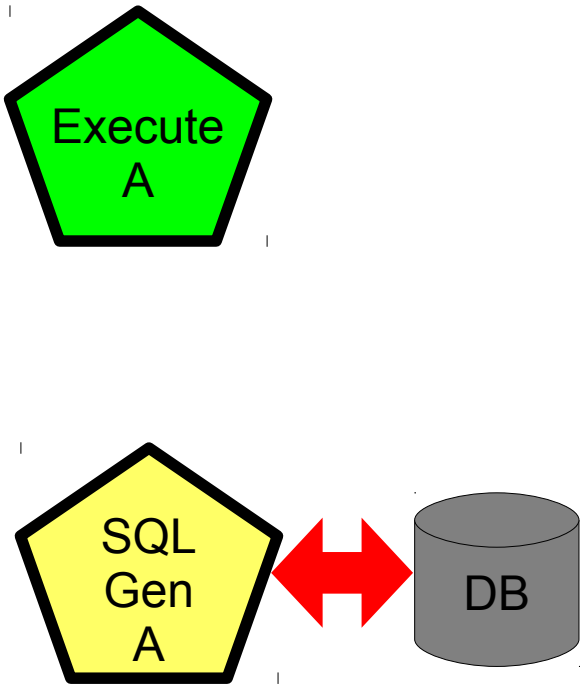
⊕ = + - * / % < <= == => > && || ;

Batch Providers

Execution:

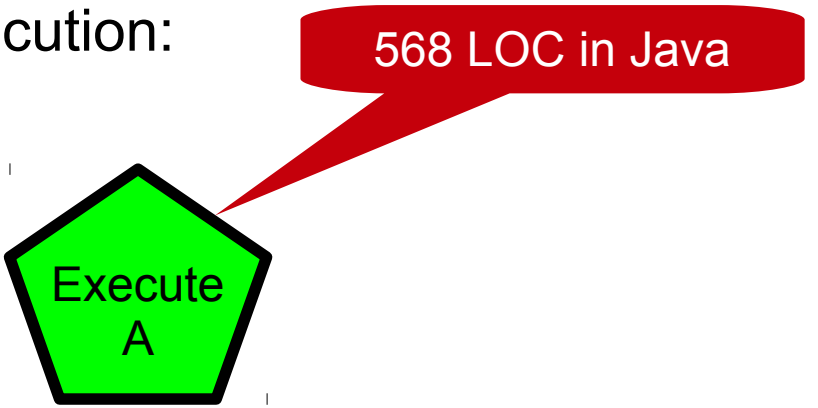
Forwarder:



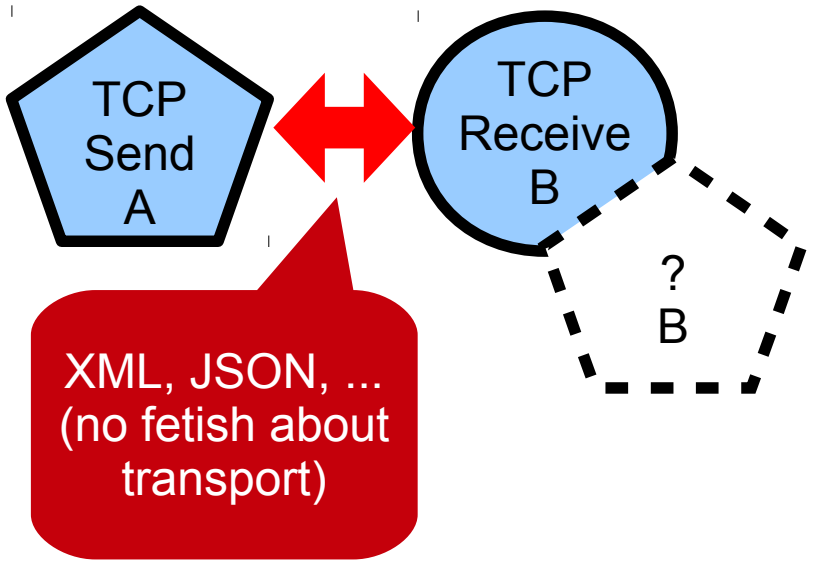


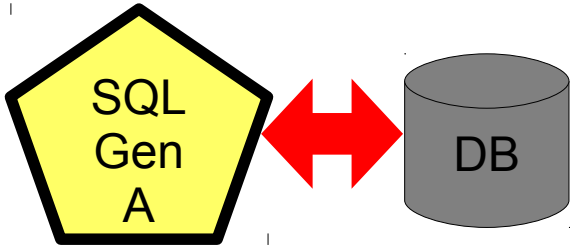
Batch Providers

Execution:



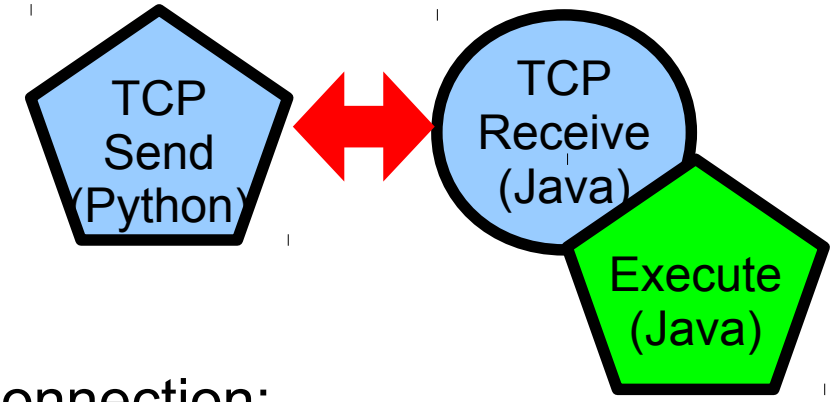
Forwarder:



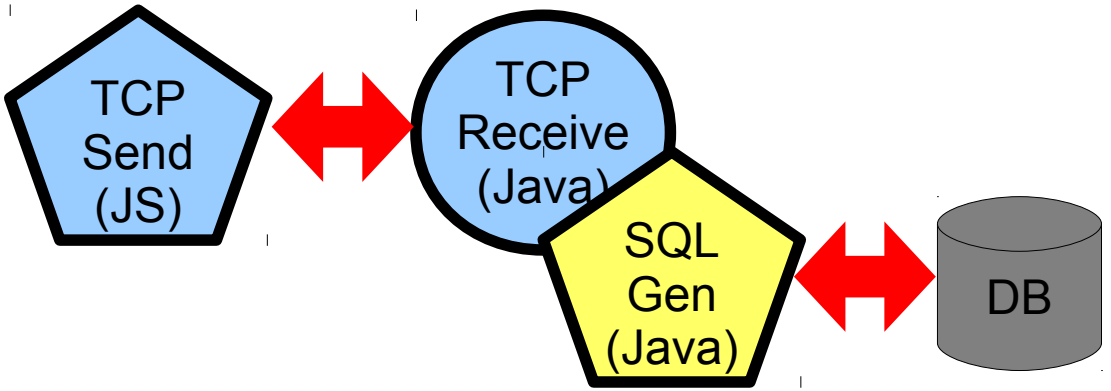


Combining Batch Providers

Traditional RPC:



Database Connection:

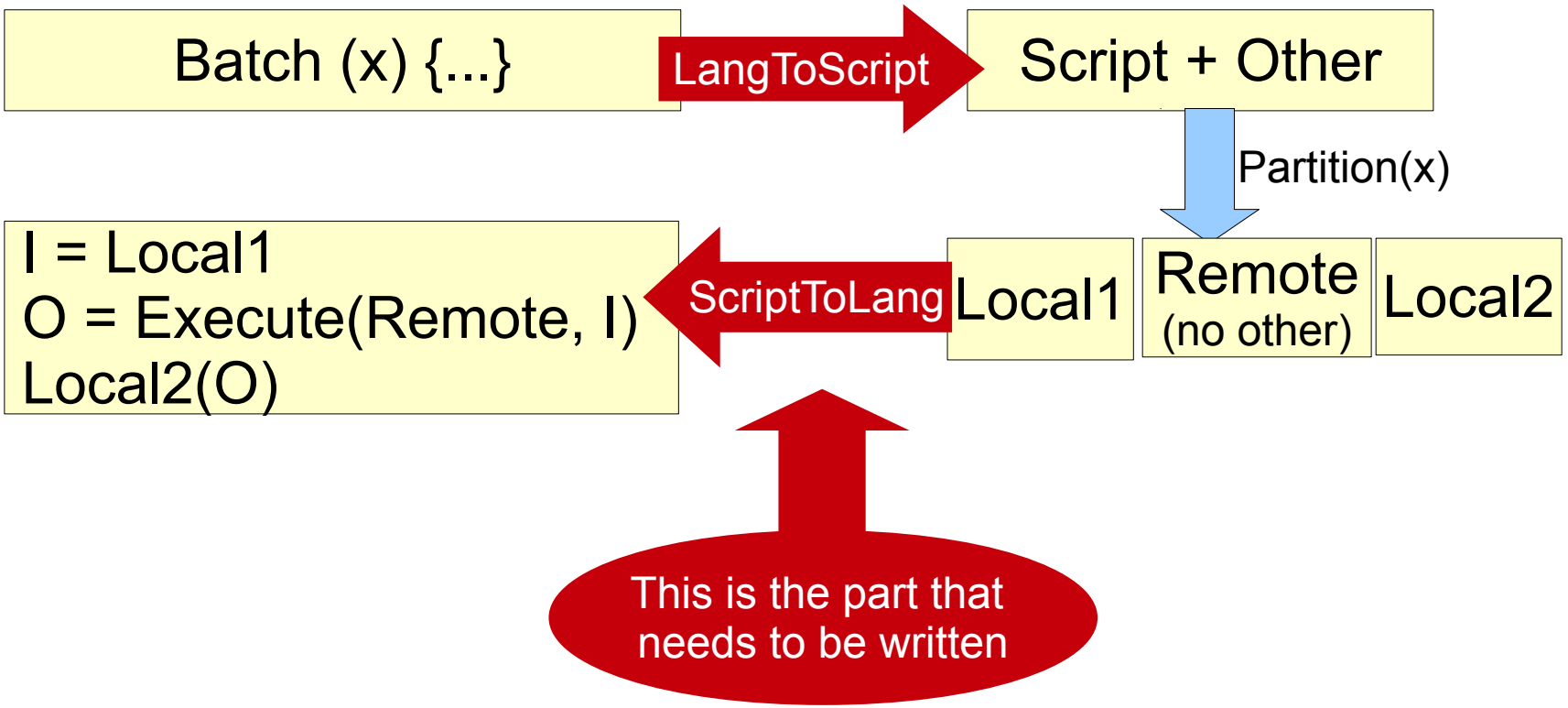


The Hard Part

Add Batch Statement to your favorite language

JavaScript, Python, ML, F#, Scala, etc

(More difficult in dynamic languages)



Batch Summary

Client

Batch statement: compiles to Local/Remote/Local

Works in any language (e.g. Java, Python, JavaScript)

- Completely cross-language and cross-platform

Server

Small engine to execute scripts

- Call only public methods/fields (safe as RPC)
- Stateless, no remote pointers (aka proxies)

Communication

Forests (trees) of primitive values (no serialization)

- Efficient and portable

Batch = One Round Trip

Clean, simple performance model

Some batches would require more round trips

```
batch (..) {
    if (AskUser("Delete " + msg.Subject + "?")
        msg.delete();
}
```

Pattern of execution

OK: Local → Remote → Local

Error: Remote → Local → Remote

Can't just mark everything as a batch!

What about Object Serialization?

Batch only transfers primitive values, not objects

But they work with any object, not just *remotable* ones

Send a local set to the server?

```
java.util.Set<String> local = … ;
batch ( mail : server ) {
    mail.sendMessage( local, subject, body);
     // compiler error sending local to remote method
}
```

Serialization by Public Interfaces

```
java.util.Set<String> local = … ;
batch ( mail : server ) {
    service.Set recipients = mail.makeSet();
    for (String addr : local )
        recipients.add( addr );
    mail.sendMessage( recipients, subject, body);
}
```

Sends list of addresses with the batch

Constructors set on server and populates it

Works between different languages

Interprocedural Batches

Reusable serialization function

```
@Batch
service.Set send(Mail server, local.Set<String> local) {
    service.Set remote = server.makeSet();
    for (String addr : local )
        remote.add( addr );
    return remote;
}
```

Main program

```
batch ( mail : server ) {
    remote.Set recipients = send( localNames );
```

Exceptions

Server Exceptions

- Terminate the batch
- Return exception in forest
- Exception is raised in client at same point as on server

Client Exceptions

- Be careful!
- Batch has already been fully processed on server
- Client may terminate without handling all results locally

Transactions and Partial Failure

Batches are not necessarily transactional

- But they do facilitate transactions
- Server can execute transactionally

Batches reduce the chances for partial failure

- Fewer round trips
- Server operations are sent in groups

Order of Execution Preserved

All local and remote code runs in correct order

```
batch ( remote : service ) {
   print( remote.updateA( local.getA() ));  // getA, print
   print( remote.updateB( local.getB() ));  // getB, print
}
```

Partitions to:

```
input.put("X", local.getA() );  // getA
input.put("Y", local.getB() );  // getB
.... execute updates on server
print( result.get("A) );              // print
print( result.get("B") );             // print
```

Compiler Error!

Lambdas

```
for (InfoSchema db : connection)
  for (Group<Category, Product> g :
          db.Products.groupBy(Product.byCategory))
    print("Category={0}\t ProductCount={1}",
            g.Key.CategoryName,
            g.Items.count());


Fun<Product, Category> byCategory =
 new Fun<Product, Category>() {
   public Category apply(Product p) {
      return p.Category;
   }
};
```

Available Now...

Batch Java

100% compatible with Java 1.7 (OpenJDK)

Transport: XML, JSON, easy to add more

Available now (alpha)

Batch statement as "for"

for (RootInterface r : serviceConenction) { ... }

Full SQL generation and ORM

Select/Insert/Delete/Update, aggregate, group, sorting