Session Types in Applied Type System

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Overview

- **Session Types** enforce correct implementation of communication protocols in distributed programming. Global progress is guaranteed.

- **ATS** is a statically typed functional language with DML-style dependent types and linear types.

- **Session types** can be readily implemented **in ATS**.

Session Types

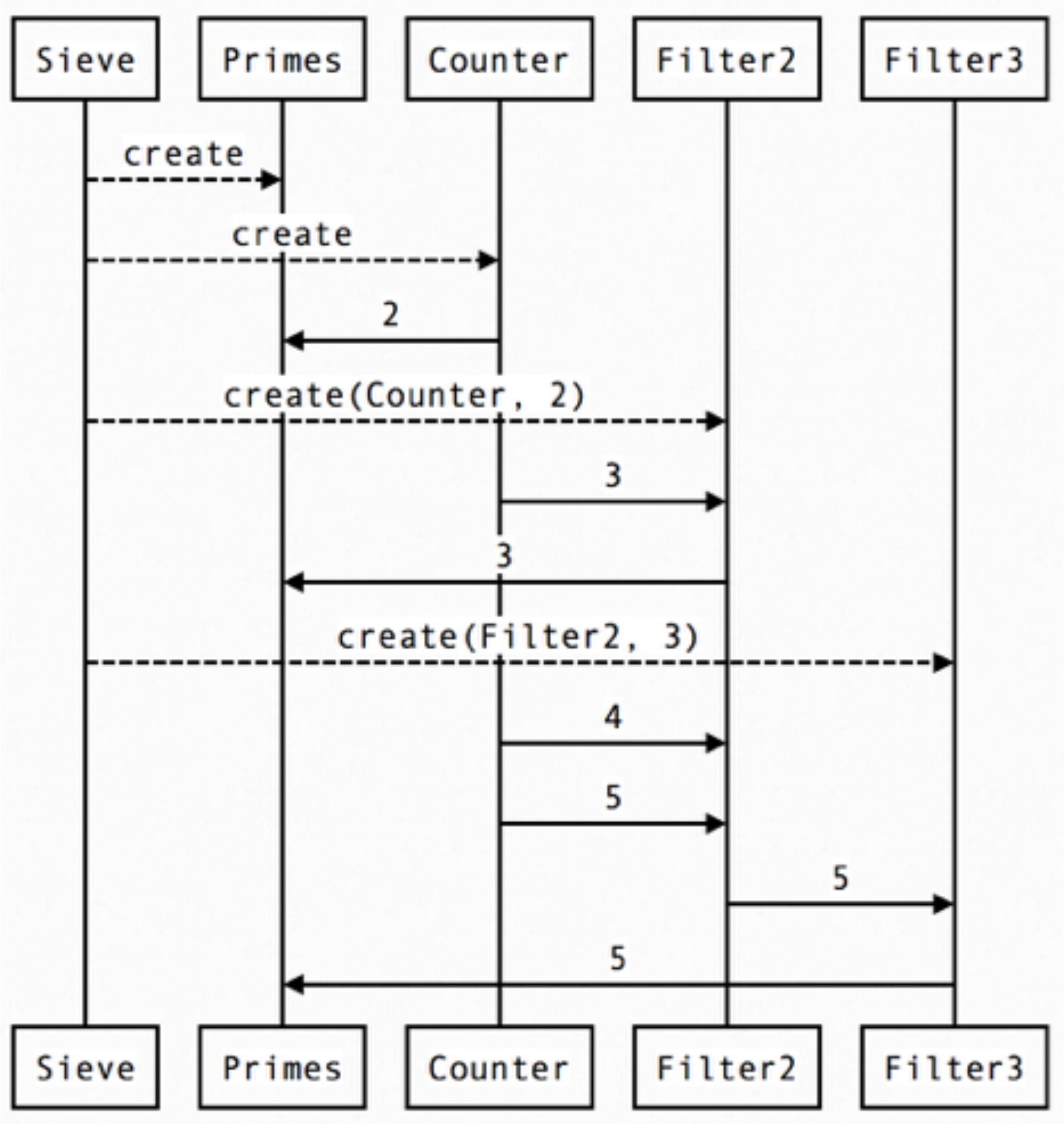
pseudo code:

```
counter_loop(counter, N):
  send(counter, N)
  counter_loop(counter, N+1)

filter_loop(in, out, P):
  N = recv(in)
  if N % P != 0
  then send(out, N)
  else filter_loop(in, out, P)

filter(in, P):
  mod_n = new channel
  spawn filter_loop(in, mod_n, P)
  return mod_n

primes_loop(in, primes):
  N = recv(in)
  send(primes, N)
  filter_n = filter(in, P)
  sieve_loop(filter_n, primes)
```



Session Types

```
fun channeg_create {ss:type}
      (chanpos(ss) -<lincloptr1> void): channeg(ss)

fun chanpos_send {a:vt@ype} {ss:type}
      (!chanpos(chsnd(a)::ss) >> chanpos(ss), a): void
fun chanpos_recv {a:vt@ype} {ss:type}
      (!chanpos(chrcv(a)::ss) >> chanpos(ss)): a
fun channeg_nil_close (channeg(chnil)): void

fun counter (int): channeg (rpt int)
fun cloop (chanpos (rpt int), int): void

fun filter (channeg (rpt int), int): channeg (rpt int)
fun floop (chanpos (rpt int), channeg (rpt int), int): void
```

Note:

- Positive channels are endpoints hold by the server side.
- Negative channels are endpoints hold by the client side.

Demo

http://steinwaywhw.github.io/nepls-15-demo/

requires ATS/Erlang/Elixir to be installed

Advantages

- Global progress (deadlock-free) is guaranteed.
- Session protocol is strictly enforced through type checking.
- Resource leaking is prevented through linear typed channels.
- Extensive support of distributed computing through compiling into Erlang.
- ATS co-programming with Erlang.
- Asynchronous session.
- Session type is part of the language instead of an embedding. Utilizing everything provided by ATS, e.g. dependent type (DML-style), linear type, and proofs.

Q&A

Thanks!
for more info
http://steinwaywhw.github.io/nepls-15-demo/

Backup

- Session types in ATS supports:
  - dependent types, linear types
  - high-order sessions (mobile sessions)
  - dyadic session for now
- Implementation details
  - Sessions are not symmetric. two endpoints are denoted negative(client) and positive(server) respectively. Though symmetric can be implemented in ATS, too.
  - Global progress is proved based on a formalization of multi-threaded linear lambda calculus extended with channels.
  - A channel is a process in Erlang.