# REBS 2021 A2: Choreographies in CCS and Jolie

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## Exercise 1.1

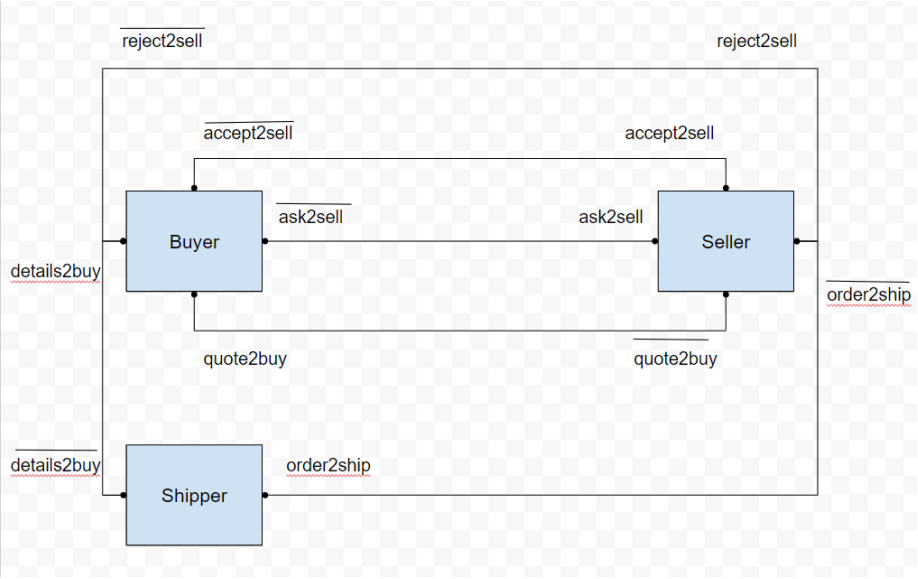


Figure 1: Interface diagram for Buyer, Seller and Shipper. Note that some of the activities are modelled to happen from the the same port which is possible since the activities are exclusive to one another which means that they cannot happen at the same time during the process.

## Exercise 1.2

1. $BUYER \stackrel{\text{def}}{=} \overline{ask2sell}.quote2buy.(\overline{accept2sell}.details2buy.BUYER + \overline{reject2sell}.BUYER)$
2. $BUYER_1 \stackrel{\text{def}}{=} quote2buy(\overline{accept2sell}.details2buy.BUYER + \overline{reject2sell}.BUYER)$
3. $BUYER_2 \stackrel{\text{def}}{=} \overline{accept2sell}.details2buy.BUYER$
4. $BUYER_3 \stackrel{\text{def}}{=} details2buy.BUYER$
5. $BUYER_4 \stackrel{\text{def}}{=} \overline{reject2sell}.BUYER$
6. $SELLER \stackrel{\text{def}}{=} ask2cell.\overline{quote2buy}.(accept2sell.\overline{order2ship}.SELLER + reject2sell.SELLER)$
7. $SELLER_1 \stackrel{\text{def}}{=} \overline{quote2buy}.(accept2sell.\overline{order2ship}.SELLER + reject2sell.SELLER)$
8. $SELLER_2 \stackrel{\text{def}}{=} accept2sell.\overline{order2ship}.SELLER$
9. $SELLER_3 \stackrel{\text{def}}{=} \overline{order2ship}.SELLER$
10. $SELLER_4 \stackrel{\text{def}}{=} reject2sell.SELLER$
11. $SHIPPER \stackrel{\text{def}}{=} order2ship.\overline{details2buy}.SHIPPER$
12. $SHIPPER_1 \stackrel{\text{def}}{=} \overline{details2buy}.SHIPPER$
13. $BUYSELL \stackrel{\text{def}}{=} (BUYER \mid SELLER)\backslash ask2cell\backslash quote2buy\backslash accept2sell\backslash reject2sell$
14. $SHIPSELL \stackrel{\text{def}}{=} (SHIPPER \mid SELLER)\backslash order2ship$
15. $BUYSHIP \stackrel{\text{def}}{=} (BUYER \mid SHIPPER)\backslash details2buy$

$$BUYER \stackrel{\overline{\text{ask2sell}}}{\rightarrow} BUYER_1 \stackrel{\text{quote2buy}}{\rightarrow} BUYER_2 \stackrel{\overline{\text{accept2sell}}}{\rightarrow} BUYER_3 \stackrel{\text{details2buy}}{\rightarrow} BUYER$$

$$BUYER \stackrel{\overline{\text{ask2sell}}}{\rightarrow} BUYER_1 \stackrel{\text{quote2buy}}{\rightarrow} BUYER_4 \stackrel{\overline{\text{reject2sell}}}{\rightarrow} BUYER$$

$$SELLER \stackrel{\text{ask2sell}}{\rightarrow} SELLER_1 \stackrel{\overline{\text{quote2buy}}}{\rightarrow} SELLER_2 \stackrel{\text{accept2sell}}{\rightarrow} SELLER_3 \stackrel{\overline{\text{order2ship}}}{\rightarrow} SELLER$$

$$SELLER \stackrel{\text{ask2sell}}{\rightarrow} SELLER_1 \stackrel{\overline{\text{quote2buy}}}{\rightarrow} SELLER_4 \stackrel{\text{reject2sell}}{\rightarrow} SELLER$$

$$SHIPPER \stackrel{\text{order2ship}}{\rightarrow} SHIPPER_1 \stackrel{\overline{\text{details2buy}}}{\rightarrow} SHIPPER$$

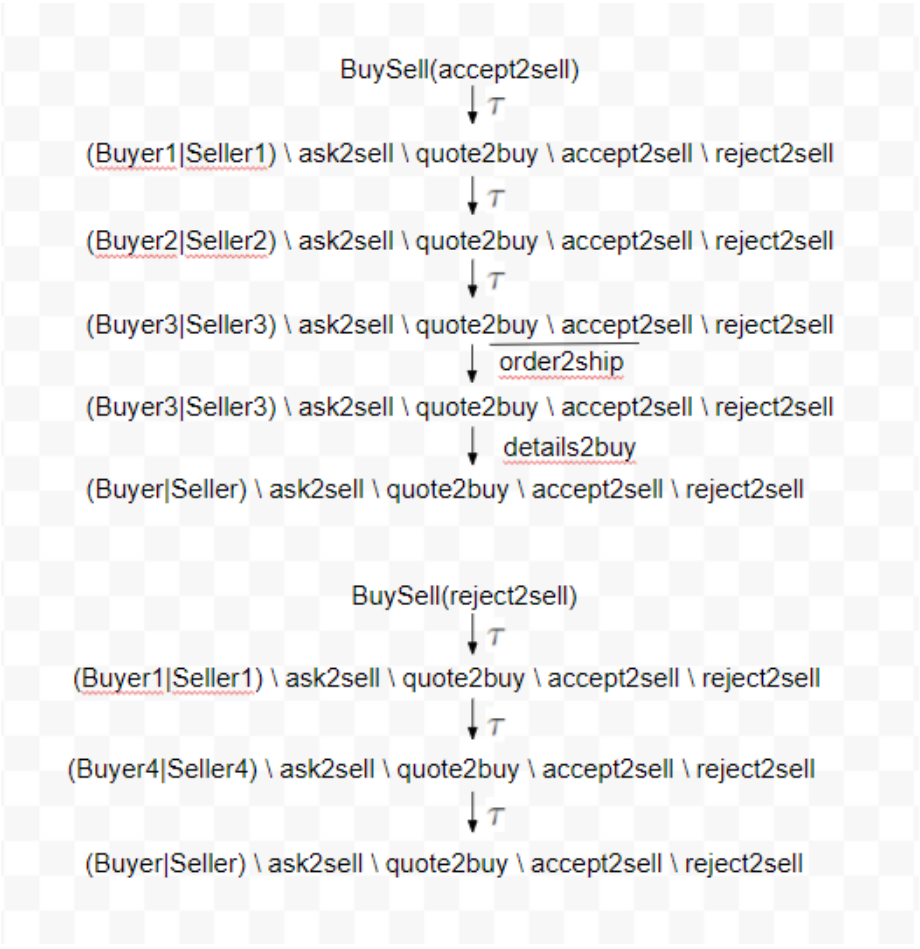


Figure 2: Transition systems for the processes (BUYER | SELLER) with the upper one being the accept-path and the lower one the reject-path. You'll find the modelled transition system for the processes ShipSell and BuyShip on the next page.

## Exercise 1.3

Instead of the SELLER process has a synchronized flow of actions as it runs in parallel with BUYER then the relaxed SELLER process has its actions divided into running parallels which means that the actions may occur independently of the other actions. However since all of the parallels start with waiting for an input from the BUYER process the actions from the SELLER process will not run independently of BUYER and thus this relaxed process is equally as safe as the original one.

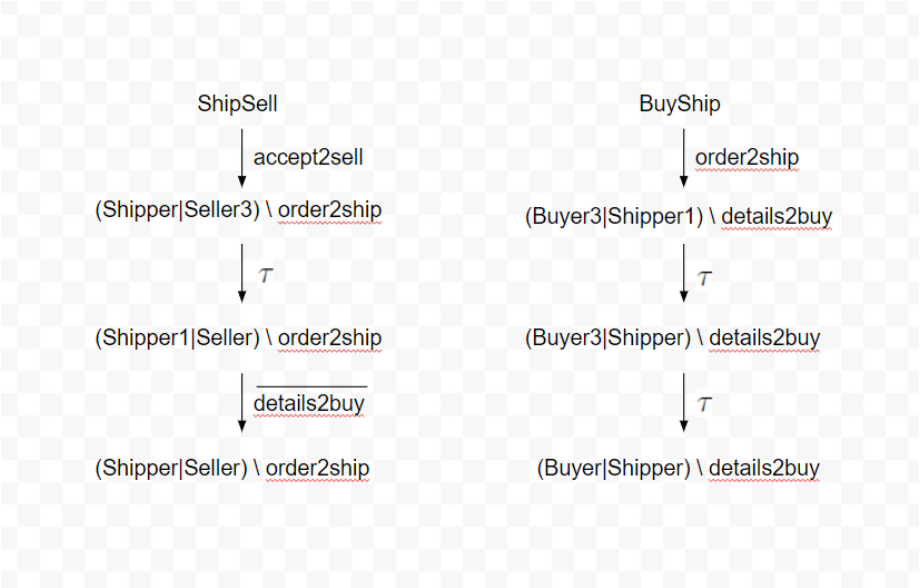


Figure 3: Transition systems for the processes (SHIPPER | SELLER) and (BUYER | SHIPPER).

## Exercise 1.4

```
BUYER = (ask2sell("chips").quote2buy(price1) | ask2sell2("chips").quote2buy(price2)).
        (if (price1 < 20 & price2 < 20) then
            (if (price1 < price2) then
                accept2sell("Ok to buy chips for " + price1).
                details2buy(invoice).0 |
                reject2sell2("Not ok to buy chips for " + price2).0
            else
                accept2sell2("Ok to buy chips for " + price2).
                details2buy(invoice).0 |
                reject2sell("Not ok to buy chips for " + price1).0)
        else if (price1 < 20) then
            accept2sell("Ok to buy chips for " + price1).
            details2buy(invoice).0 |
            reject2sell2("Not ok to buy chips for " + price2).0
        else if (price2 < 20) then
            accept2sell2("Ok to buy chips for " + price2).
            details2buy(invoice).0) |
            reject2sell("Not ok to buy chips for " + price1).0
        else
```

$$\overline{reject2sell}(\text{"Not ok to buy chips for "} + price1).0 \mid \overline{reject2sell2}(\text{"Not ok to buy chips for "} + price2).0)$$

$$SELLER_1 = ask2sell(product).\overline{quote2buy}(price).(accept2sell(order).\overline{order2ship}(order).0 + reject2sell(order).0)$$

$$SELLER_2 = ask2sell2(product).\overline{quote2buy}(price).(accept2sell2(order).\overline{order2ship}(order).0 + reject2sell2(order).0)$$

$$SHIPPER = order2ship(product).\overline{details2buy}(\text{"invoice for"} + product).0)$$

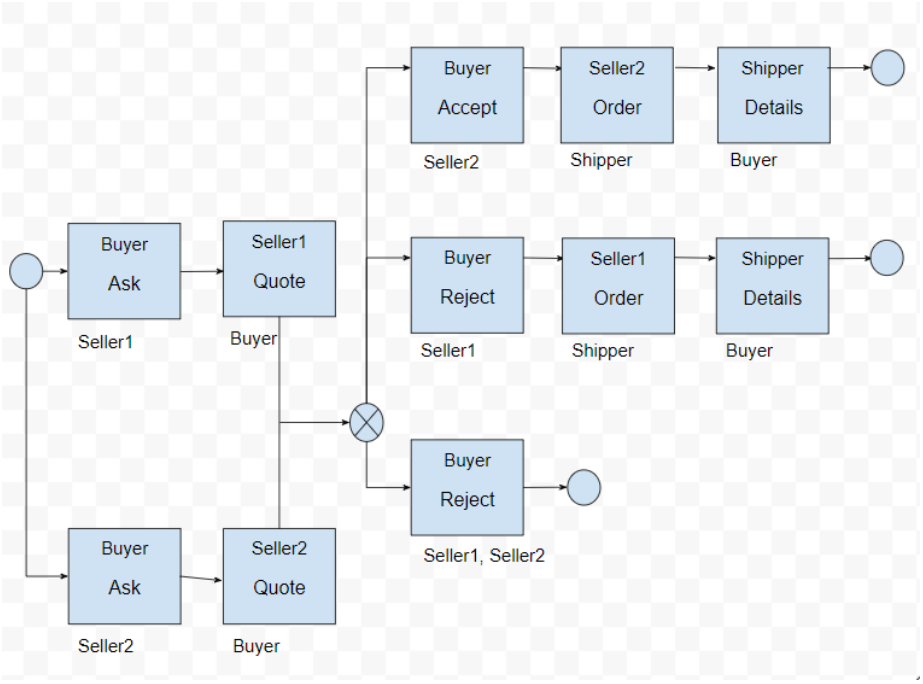


Figure 4: Choreography diagram for the extended process with $Seller_1$ and $Seller_2$. The receivers have also been written out from the box to denote that they are the on the receiving end.

## Exercise 2.1

The Seller and Shipper are implemented in the way in Exercise 1.3, which means that the Seller can deal with **ask**, **accept** and **order** concurrently. Also we set the execution model as concurrent to allow multiple concurrent requests.

## Exercise 2.2

Seller2 is implemented similar to Seller1. It uses the same interface to receive and send messages, except that it uses **quote2** to send prices to the buyers (to let buyer identify Seller1 and Seller2). Figure 5 shows the test: a buyer ask the chips' price from both Seller1 and Seller2 and prints their price in the terminal.

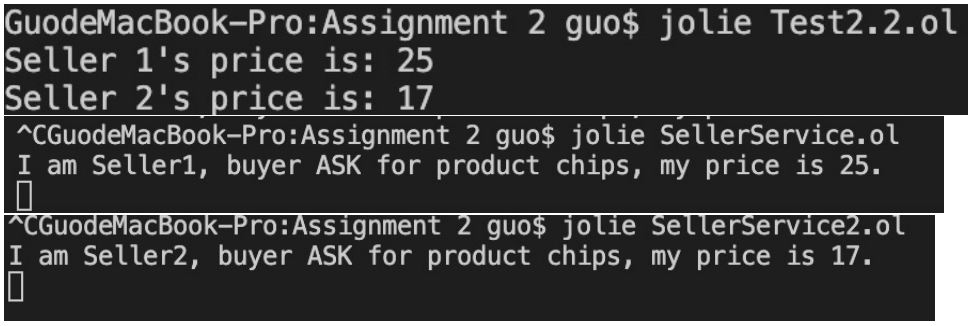


Figure 5: Test for 2.2

## Exercise 2.3

The buyer first asks Seller1 and Seller2 for the chips' prices and get their answers concurrently. After both Sellers reply, the buyer then decides which one to buy or rejection. If two sellers' prices are both greater than 20, the buyer rejects, otherwise it accepts the lower one and rejects the higher one.Figure 6, Figure 7 and Figure 8 show the tests for different conditions.

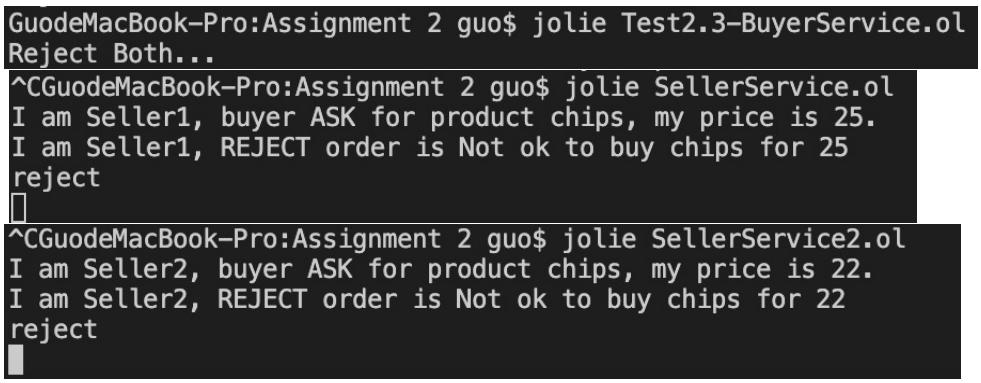


Figure 6: Test for 2.3: Both give high prices: Rejection

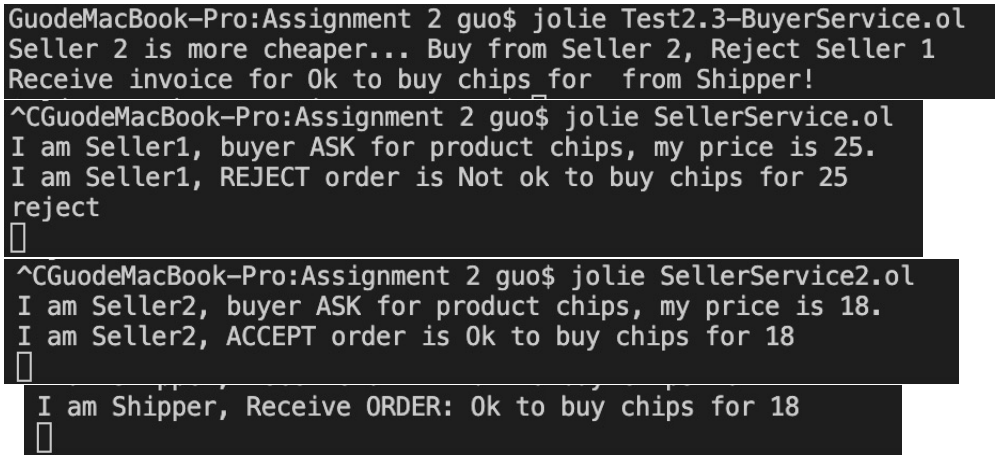


Figure 7: Test for 2.3: One very high price and one low price: accept low one

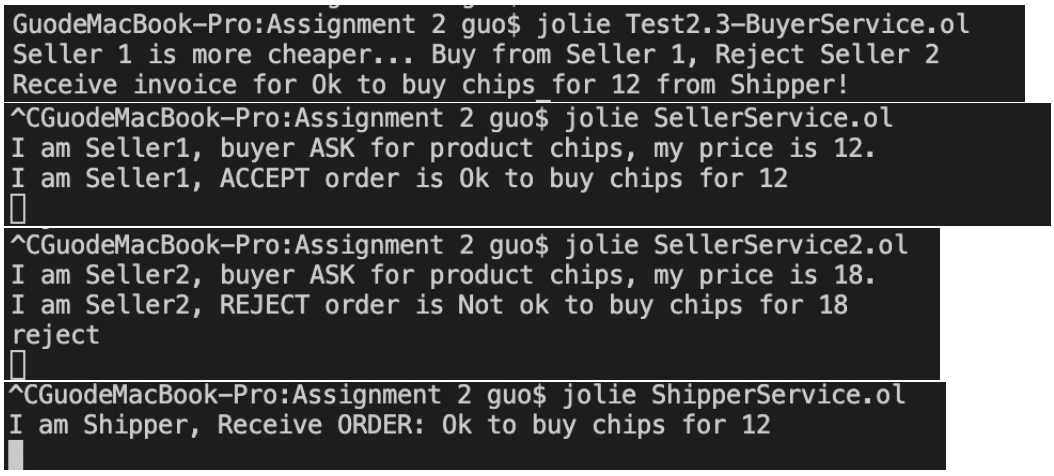


Figure 8: Test for 2.3: Both reasonable prices: accept lower one