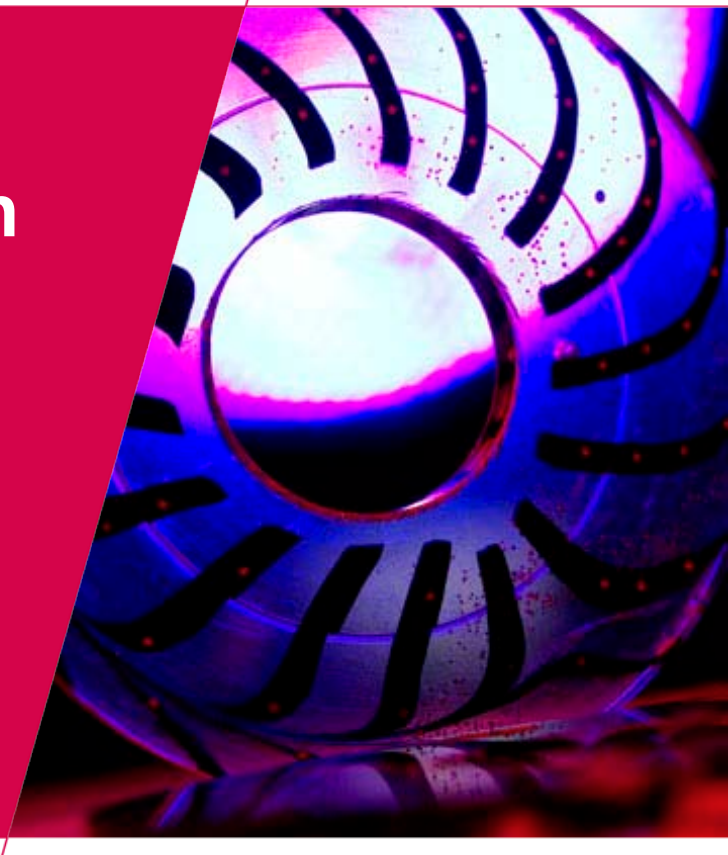
Translating synchronous to asynchronous communication and vice versa.

Jan Friso Groote



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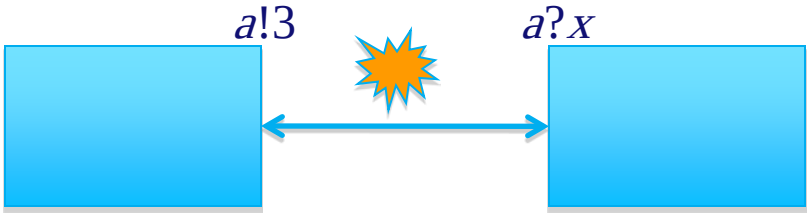
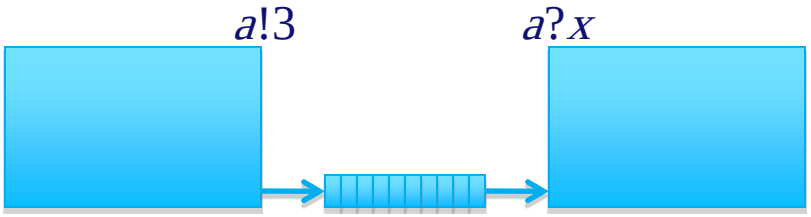
Where innovation starts

About which notion of (a)synchrony are we talking?

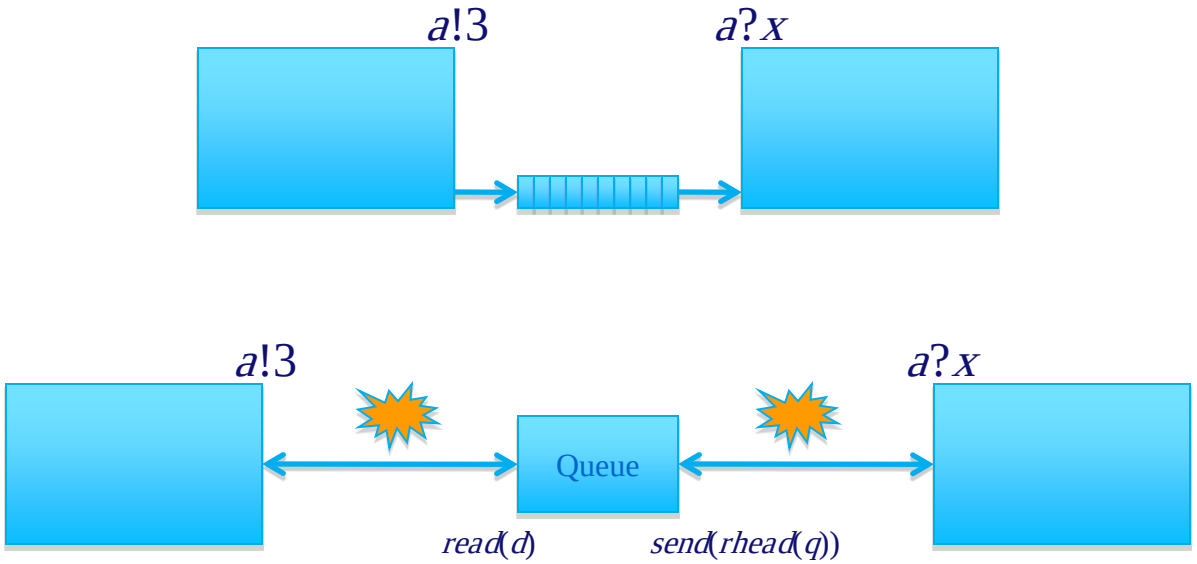


Synchronous communication: common in modelling



Asynchronous communication: common in implementation

Asynchronous → synchronous



$$Queue(q{:}List(D)) = \sum_{d:D} read(d).Queue(d \triangleright q)$$
$$+ (\neg empty(q)) \rightarrow send(rhead(q)).Queue(rtail(q));$$

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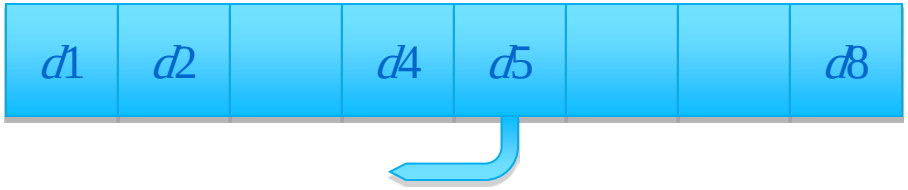
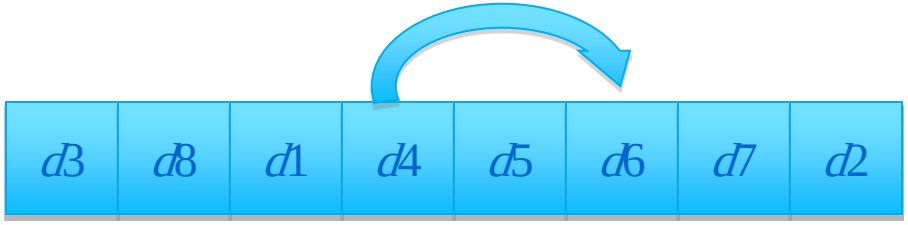
Asynchrony ≠ asynchrony

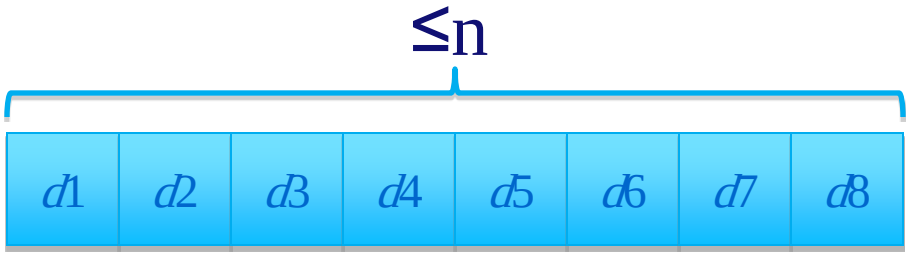
Lossy queue



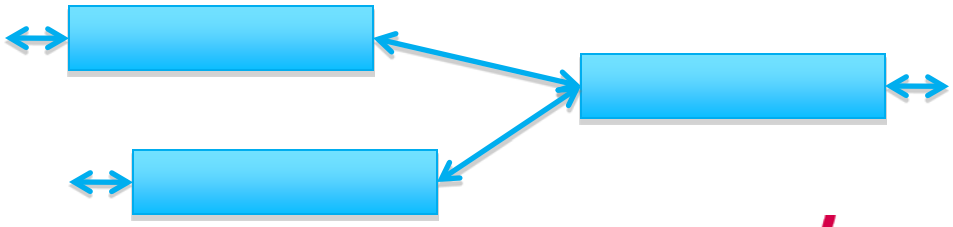
Priority queue



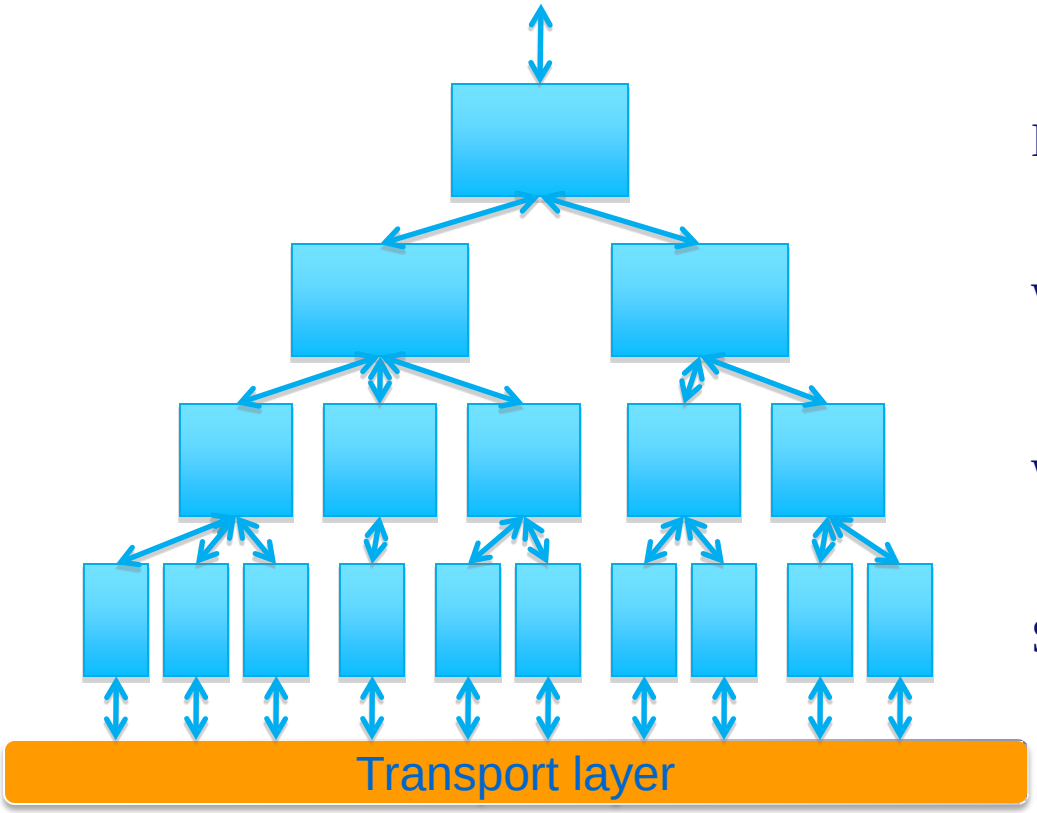
Bounded queue



Complex queue topologies



1986: Philips Computer Integrated Manufacturing architecture (Biemans, Sjoerdsma)

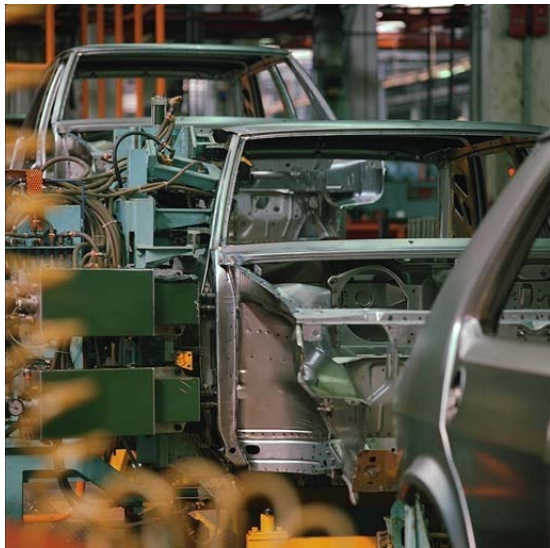


Management layer

Workcell layer

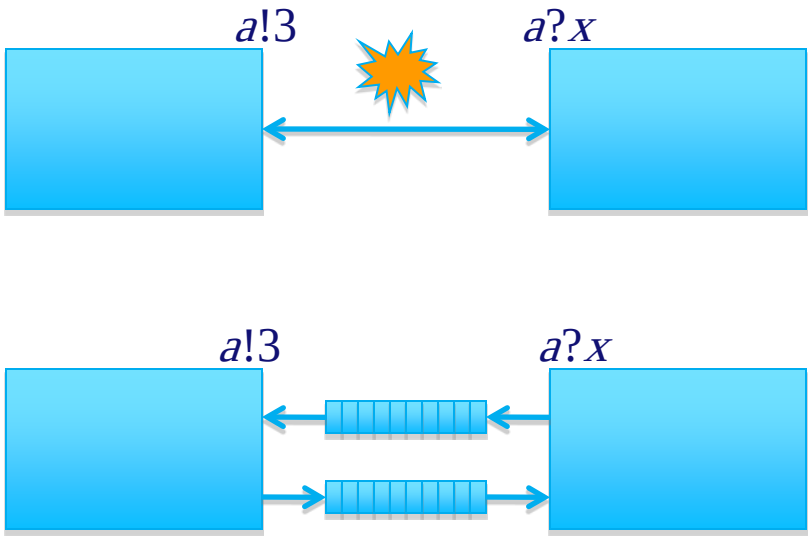
Workstation layer

Sensor/actuator layer



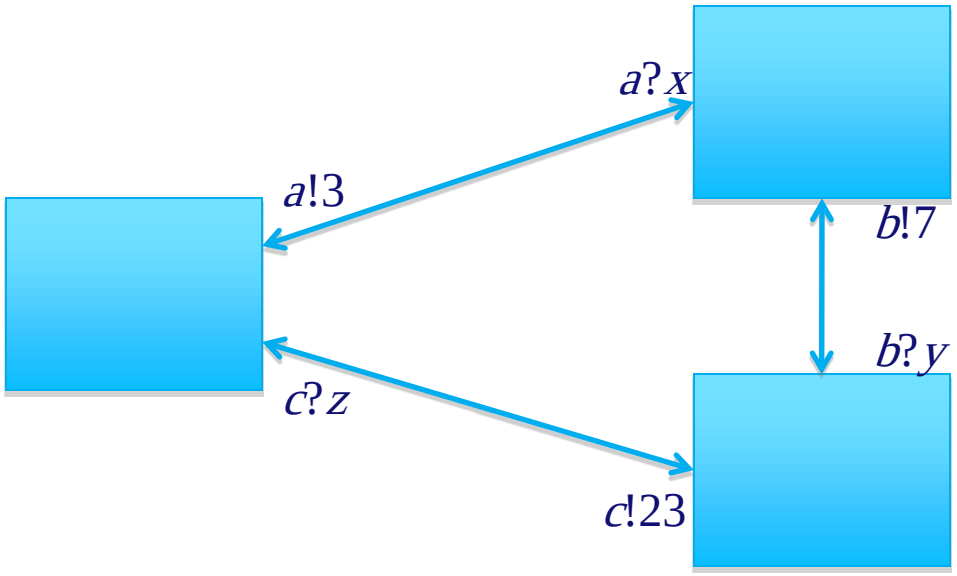
CIM architecture fully described in LOTOS
How to implement this synchronous language?

Synchronous → asynchronous



Buckley & Silberschatz 1983
Ramesh 1987
Occam & transputer

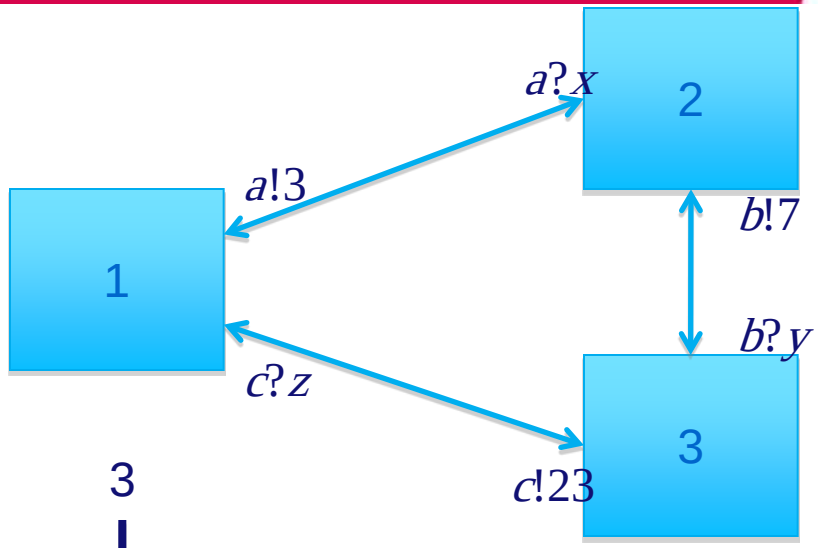
What is the problem? Conflicting interactions.

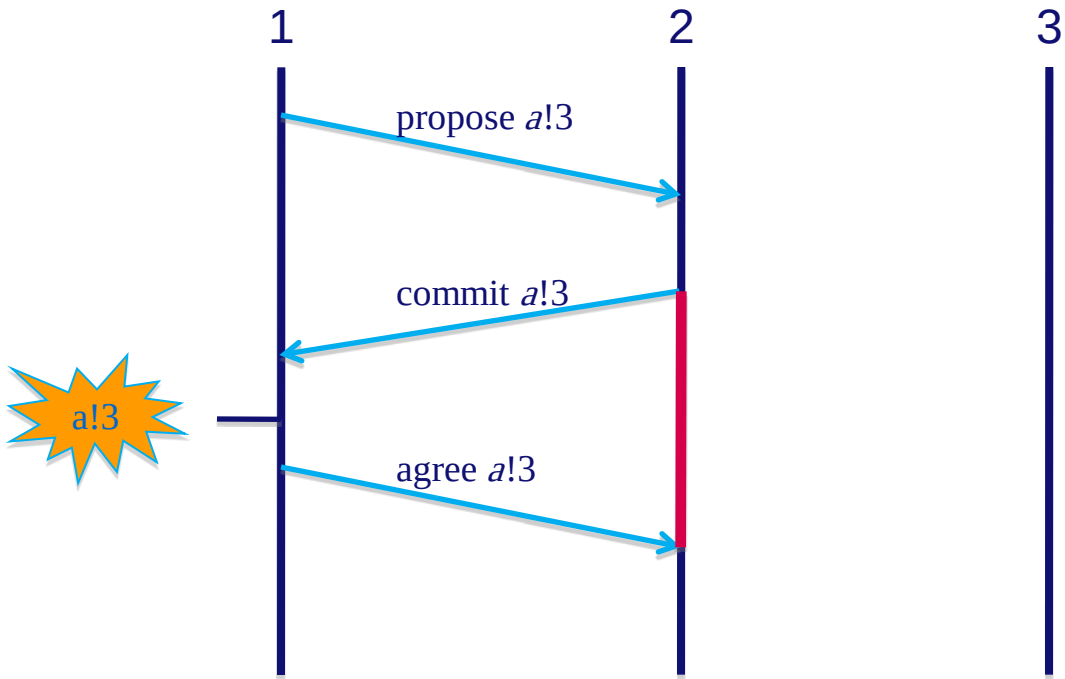


Which action will occur? $a!3$, $b!7$ or $c!23$

Solution.

1. Order all processes
2. Propose interaction to higher parties
3. Commit to proposals from lower parties
4. (Dis)agree to commits as soon as possible





Buckley and Silberschatz, 1983
Ramesh, 1987

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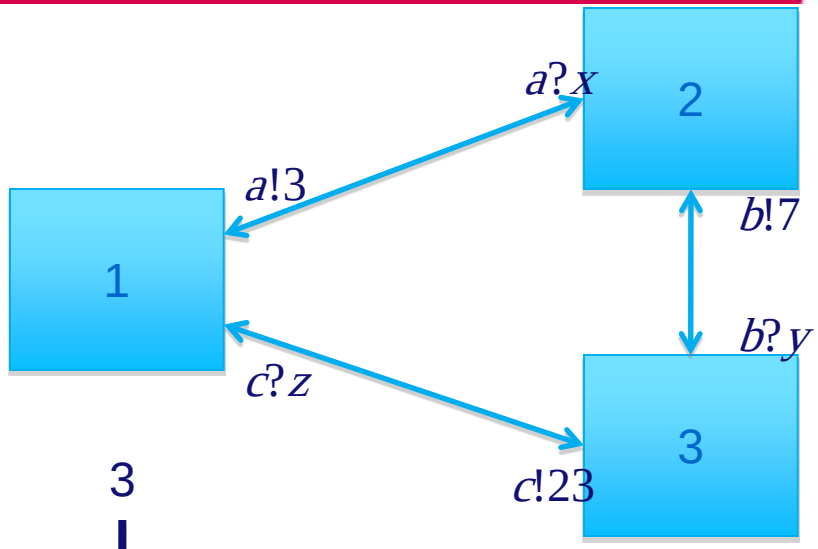

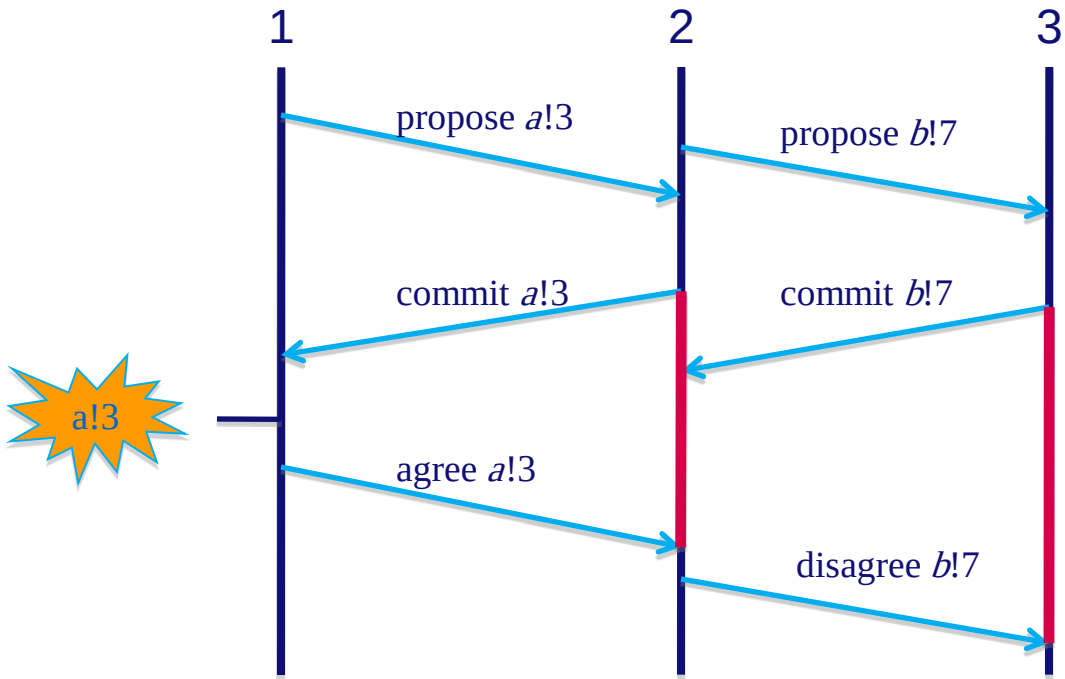

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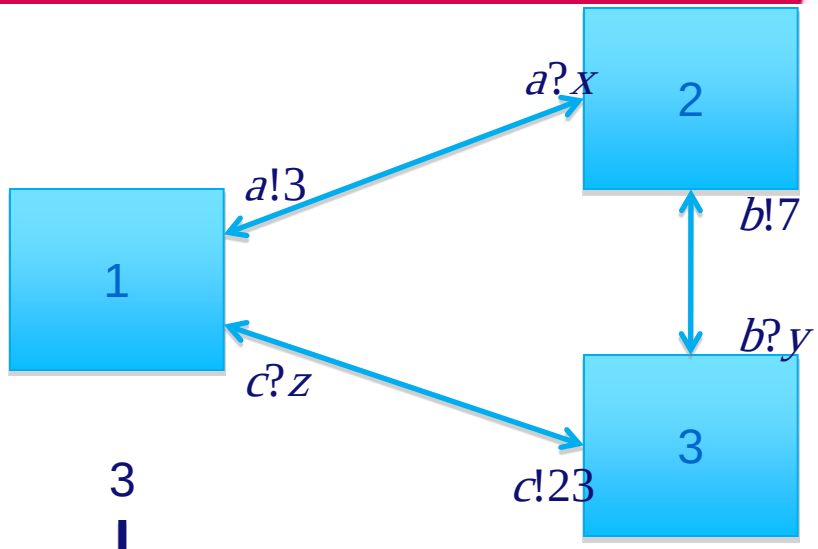
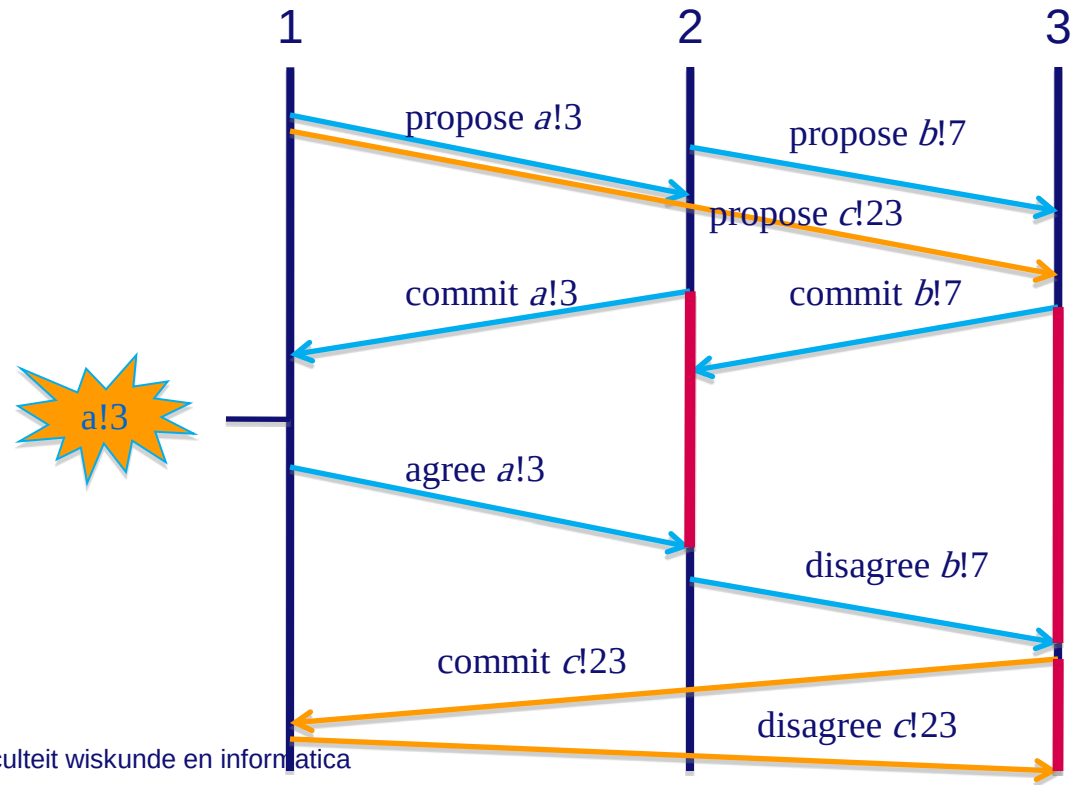
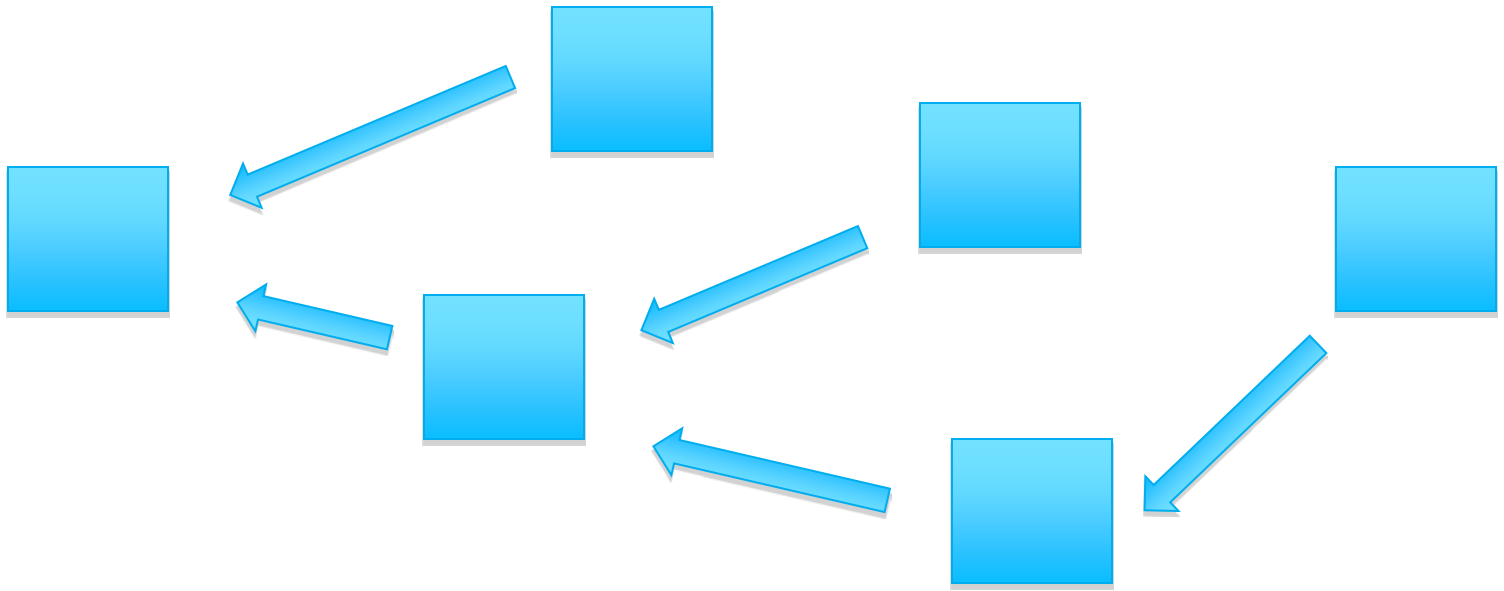




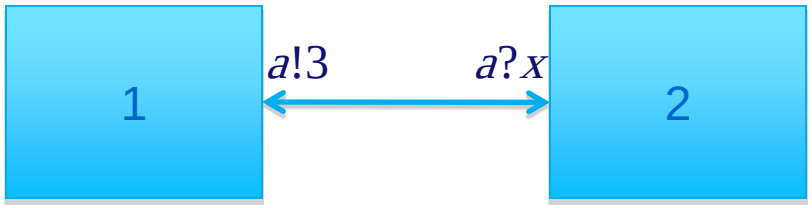
Commit dependencies are non cyclic.

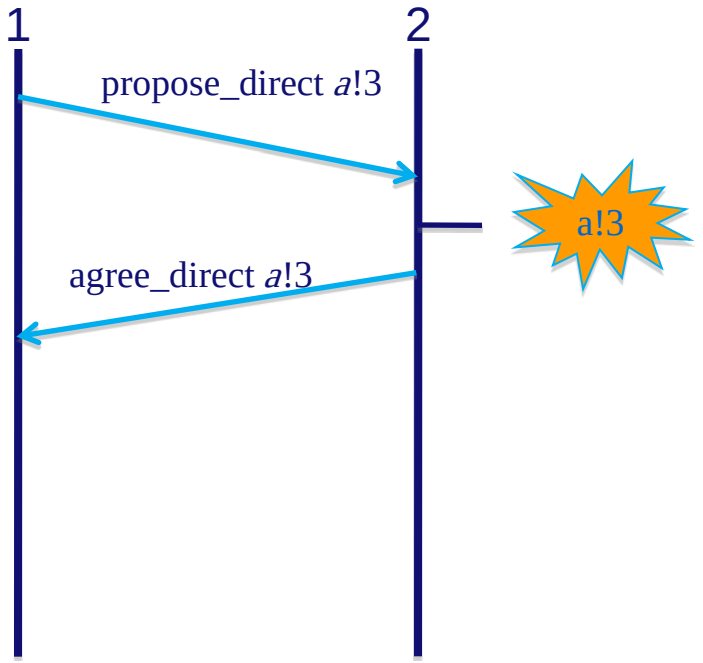


Waiting commits to be (dis)agreed.

Complexity: three messages per proposed interaction.

Optimisations are often possible: 2 messages.



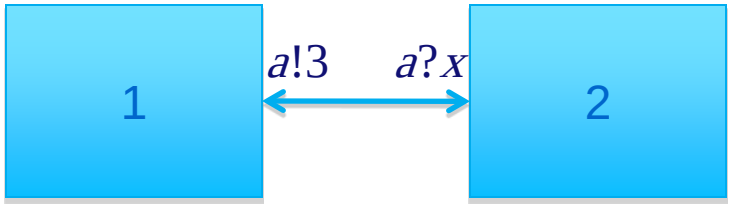


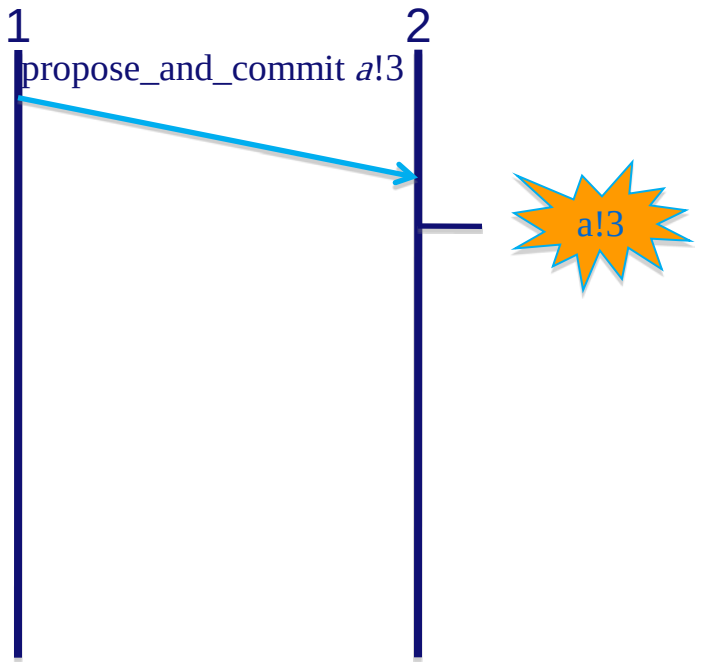
a!3 does not occur in a choice.

Theorem: Implementation by 2 messages preserves testing equivalence (LOTOS, 1988)

This is the communication scheme in OCCAM (Transputer)

Optimisations are often possible: 1 message.





a!3 does not occur in a choice, and has no subsequent activity.

Typical example: p || *a*!3.δ

Conclusion.

Asynchronous communication

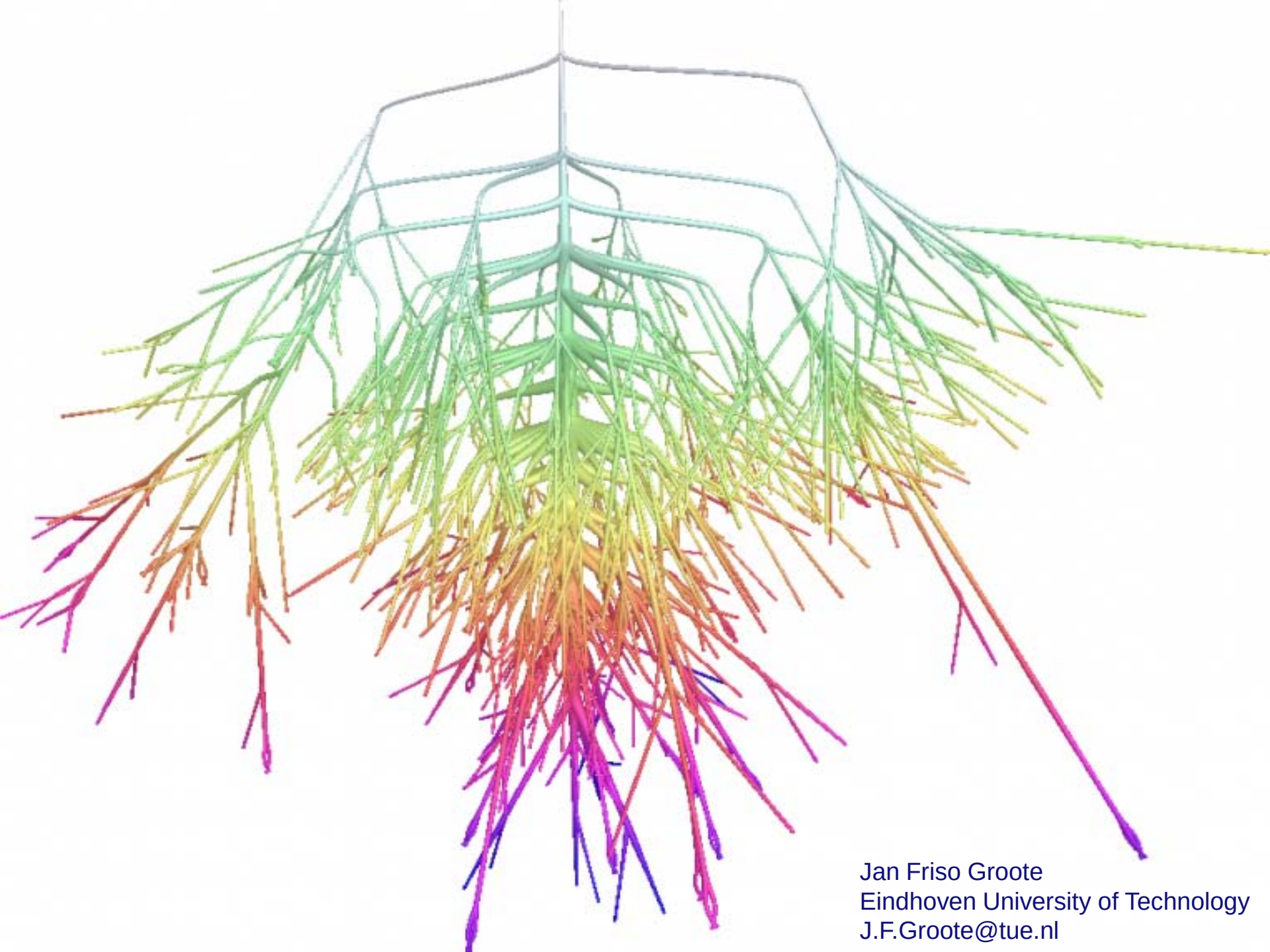
$\approx$

Synchronous communication

Challenge

Challenge: Implement synchronous models efficiently in an asynchrous, distributed way

obtain_resource1.Use_resource1
+
obtain_resource2.Use_resource2
+
receive_cancel_message.Do_something_else
+
…… (further alternatives)



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