Imperial College London

Activity Report

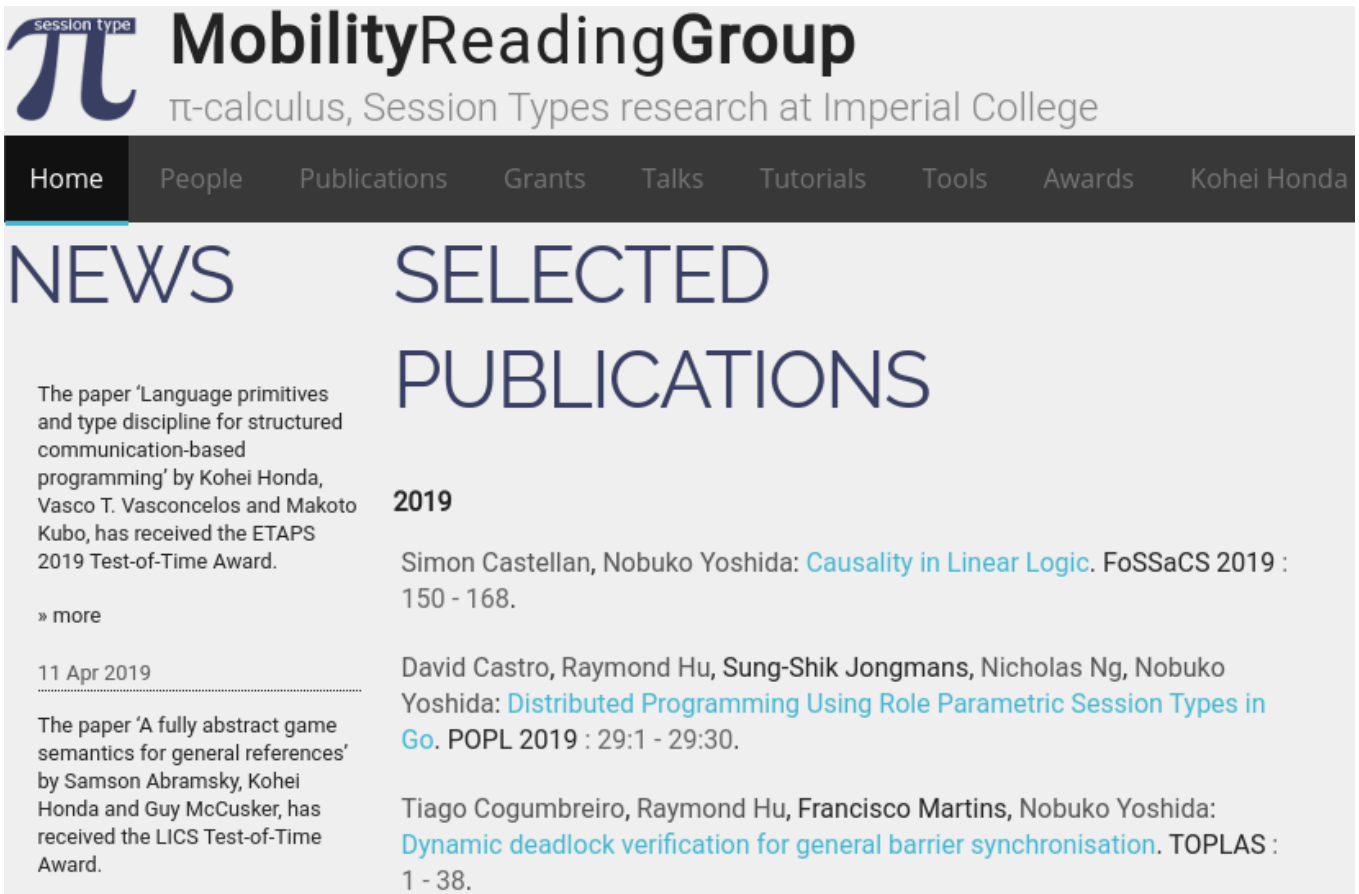
Nobuko Yoshida

2019

The Mobility Reading Group at Imperial College

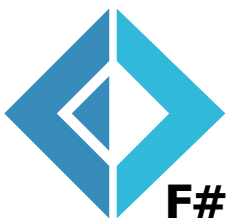
Our research group is **specialised in π-calculus** and **session types** — both **theory** and **applications**

http://mrg.doc.ic.ac.uk/



Session types in programming languages

(Elements of) the **multiparty session types** theory have been **implemented in many languages and libraries**, e.g.:
Java, Go, Python, Scala, C, MPI-C, F#, F⋆, Erlang, Haskell, OCaml, Dotty3, PureScript, TypeScript and Rust.

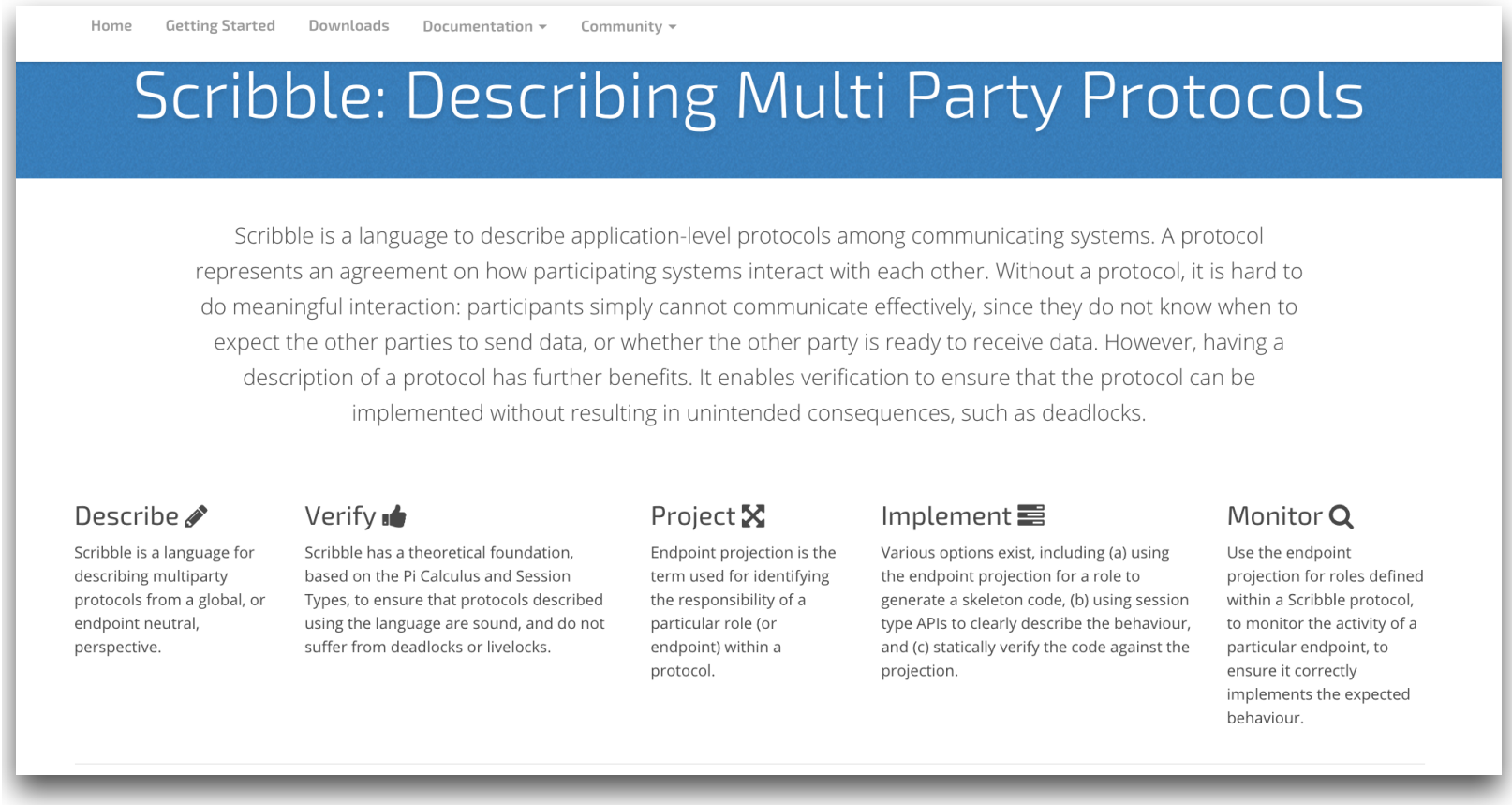


Industrial Collaborations

- Red Hat, **IBM**
- **Cognizant**, Thoughtworks, Estafet, **RChain**
- Ocean Observatories Initiative, **November Group**
- VMWare, Povotal, **Weaveworks**
- **Actyx**, **Barclays**, JPMorgan, AstraZeneca, **Preqin**
- Amazon, Google, Microsoft, Facebook

Impacts (I): Scribble

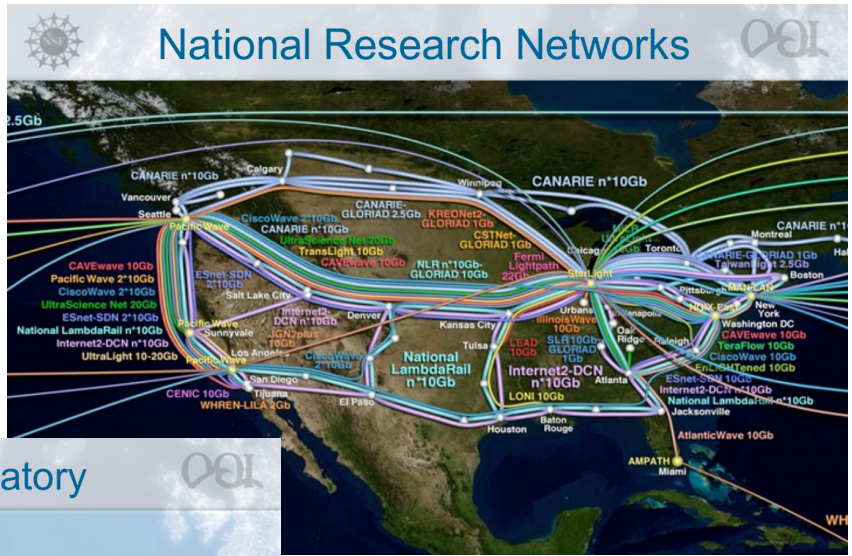
www.scribble.org

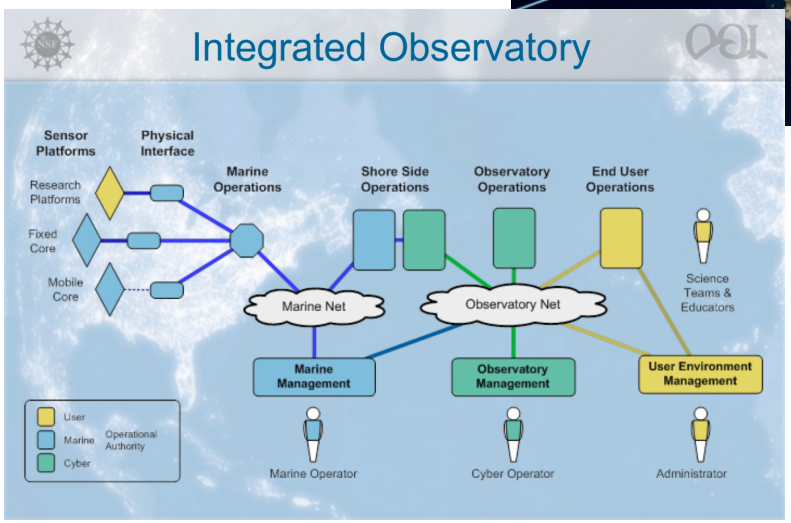


Impacts (II): Ocean Observatories Initiative

Collaboration: use session types on top of OOI network to **guarantee global safety**

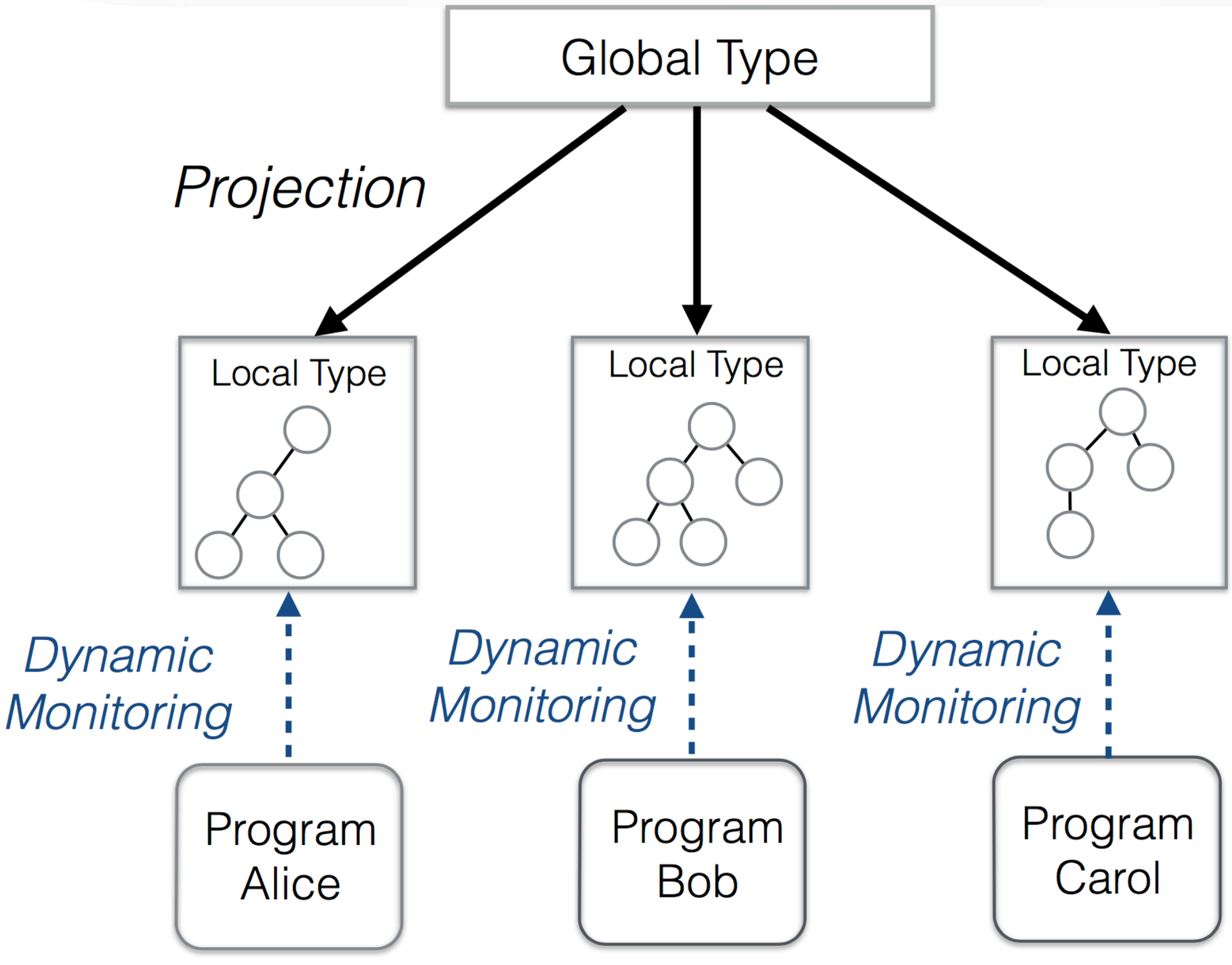
OCEAN OBSERVATORIES INITIATIVE





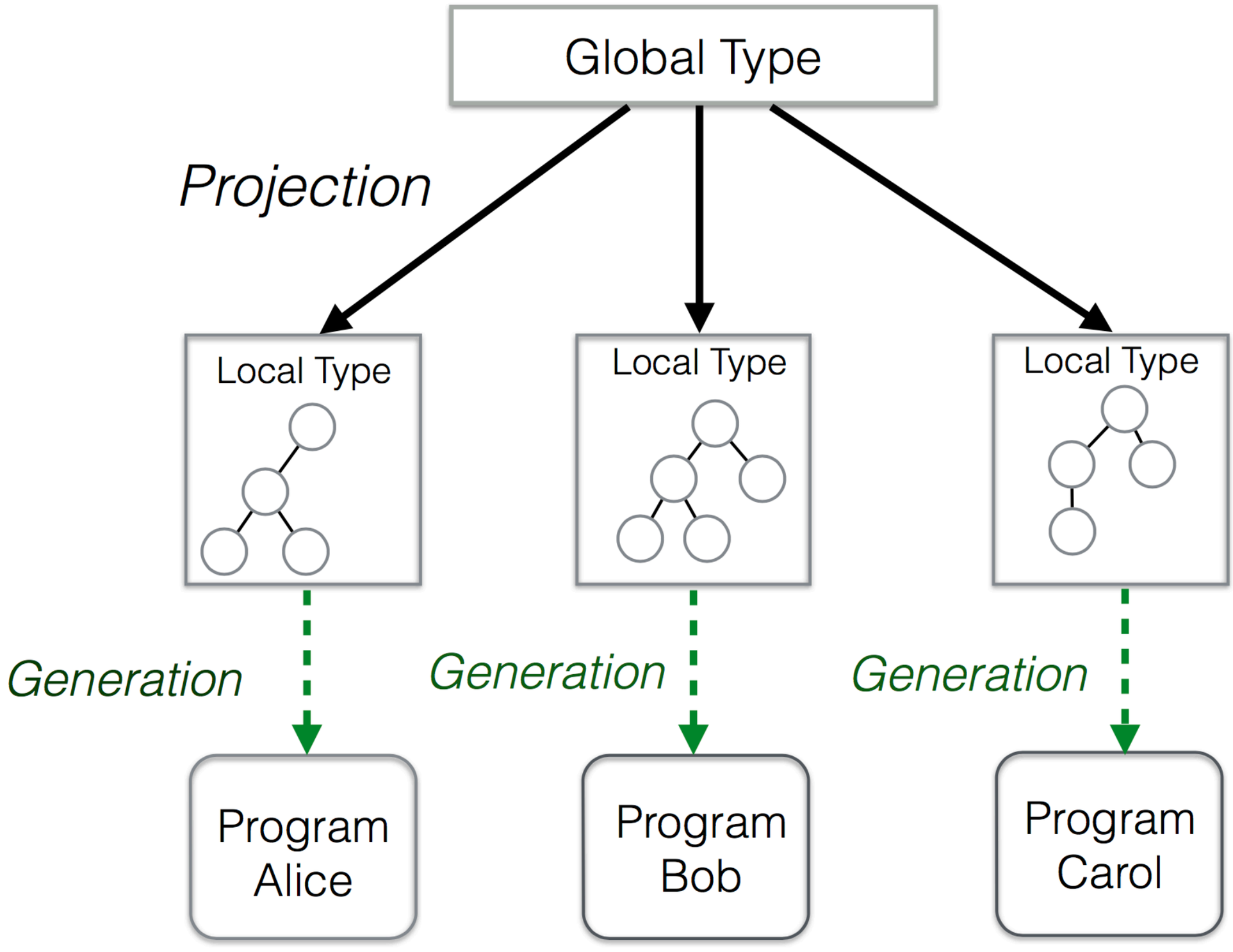
Dynamic Monitoring

[RV'13, COORDINATION'14, FMSD'15, LMCS'17, CC'17]

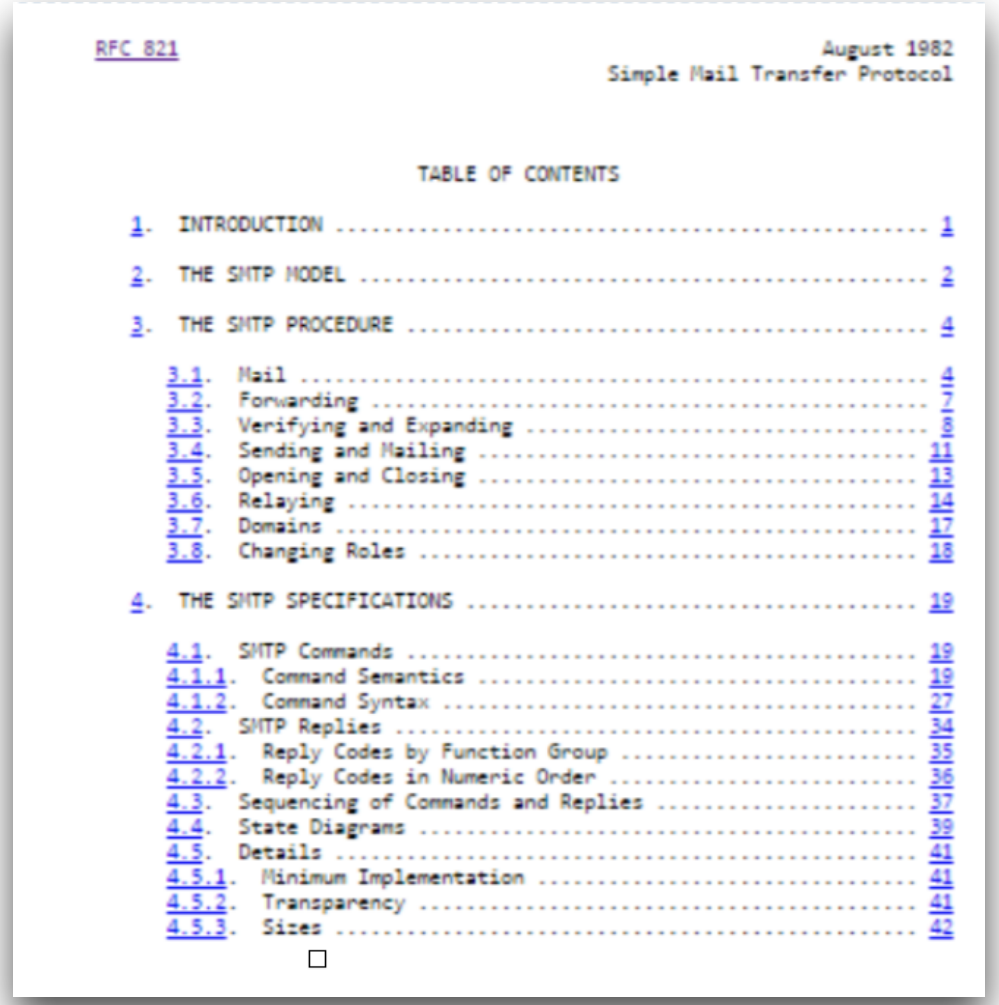


Code Generation

[CC'15, FASE'16, FASE'17]



Java API Generation [FASE'16]



RFC 821 August 1982
Simple Mail Transfer Protocol

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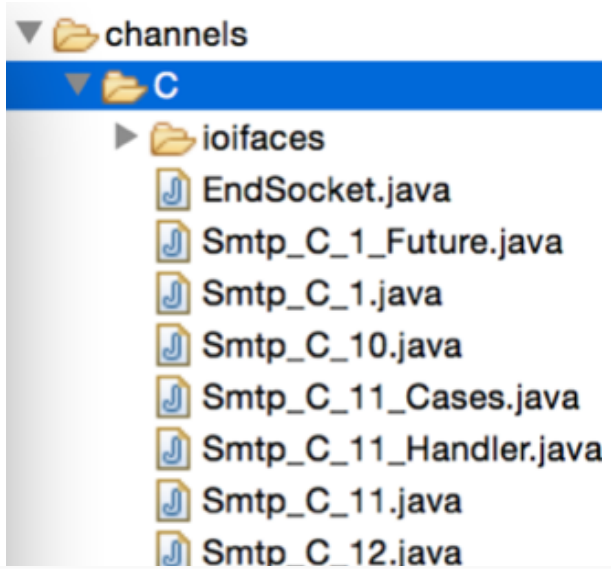



```
.send(Smtp.S, new DataLine("Session
.send(Smtp.S, new EndOfData())
.receive(Smtp.S, Smtp._250, new Buf
.s
```

send(S role, Mail m) : Smtp_C_11 - Smtp_C_10
send(S role, Quit m) : EndSocket - Smtp_C_10

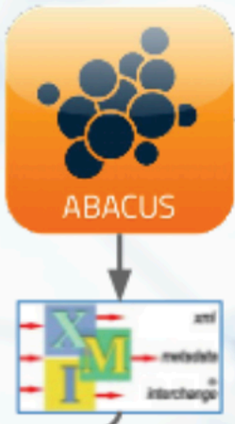
Scribble – Proving a distributed design

Estafet

Innovate | Deliver | Transform

1. All design work takes place in ABACUS, DCC's enterprise architecture tool. This can export standard XMI files (an open standard for UML5)

2. XMI is converted into OpenTracing format for consumption by managed service



7. Generate exception report and send back to DCC

3. OpenTracing files are combined to build a model in Scribble

4. Model holds *types* rather than *instances* to understand behaviour

5. Scribble compiler identifies inconsistency, change & design flaws

6. Issues highlighted graphically in Eclipse

www.estafet.com

Estafet Managed Service

Relationship with Communicating AUTOMATA

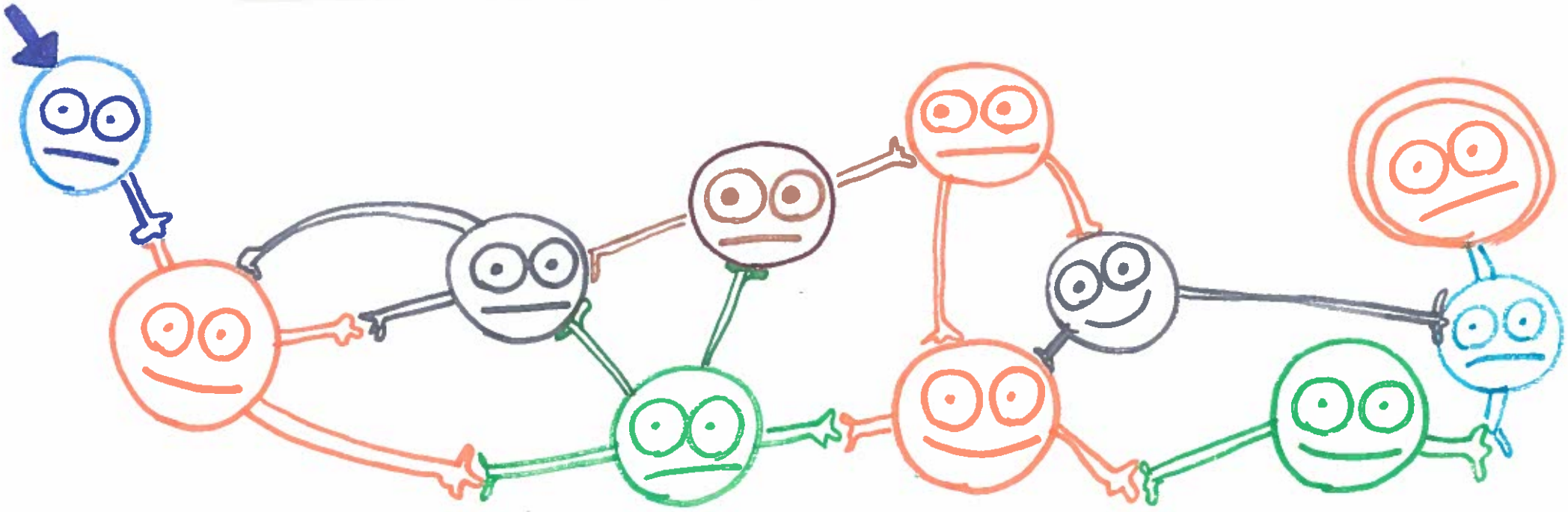
ESOP 12
ICALP 13
Characterisation
Synthesis

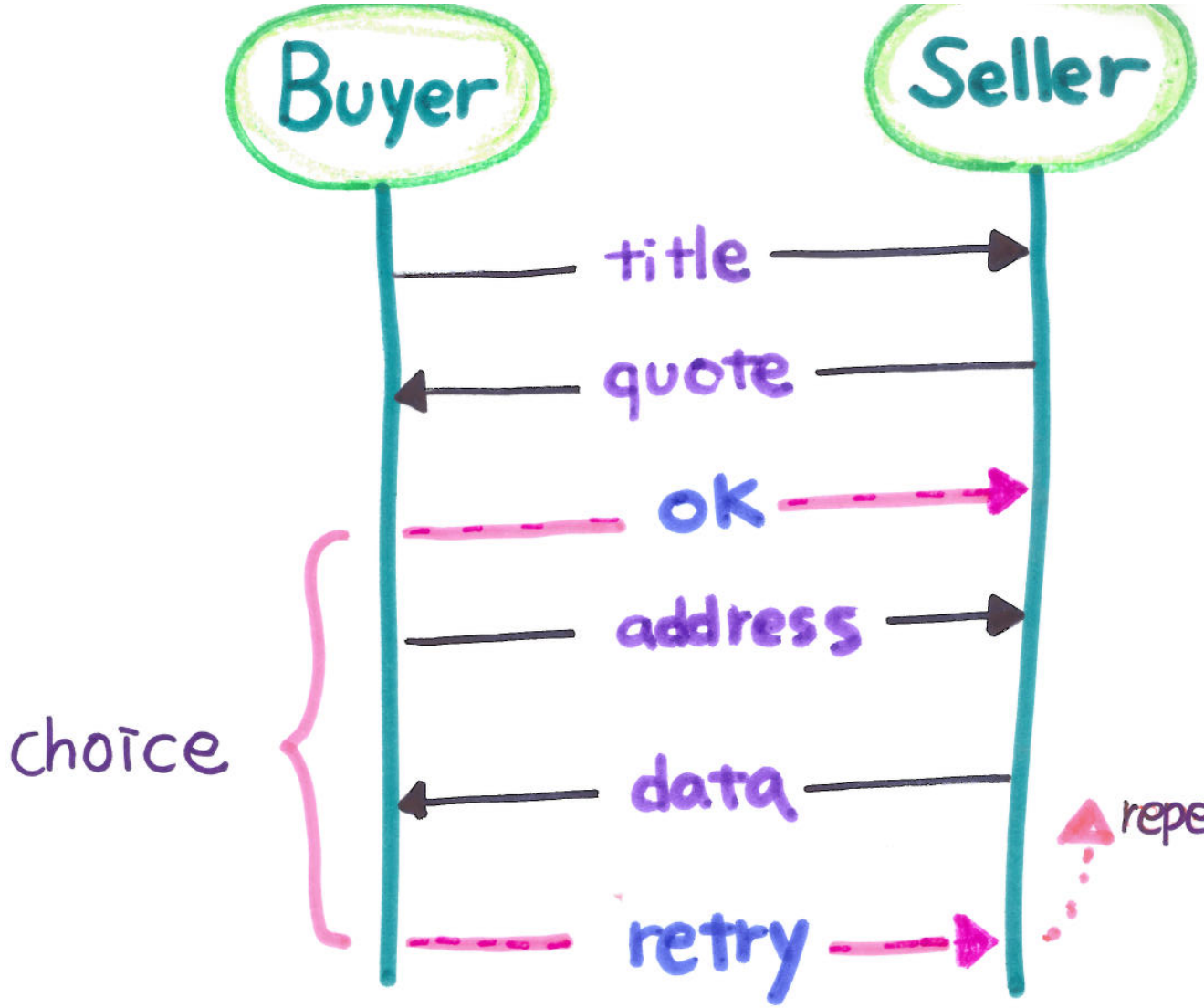
CONCUR 15
Timed Automata

POPL 15
Graphical Synthesis

TACAS 16
Subtyping + Model-checking

FOSSACS17
Undecidability





P has T

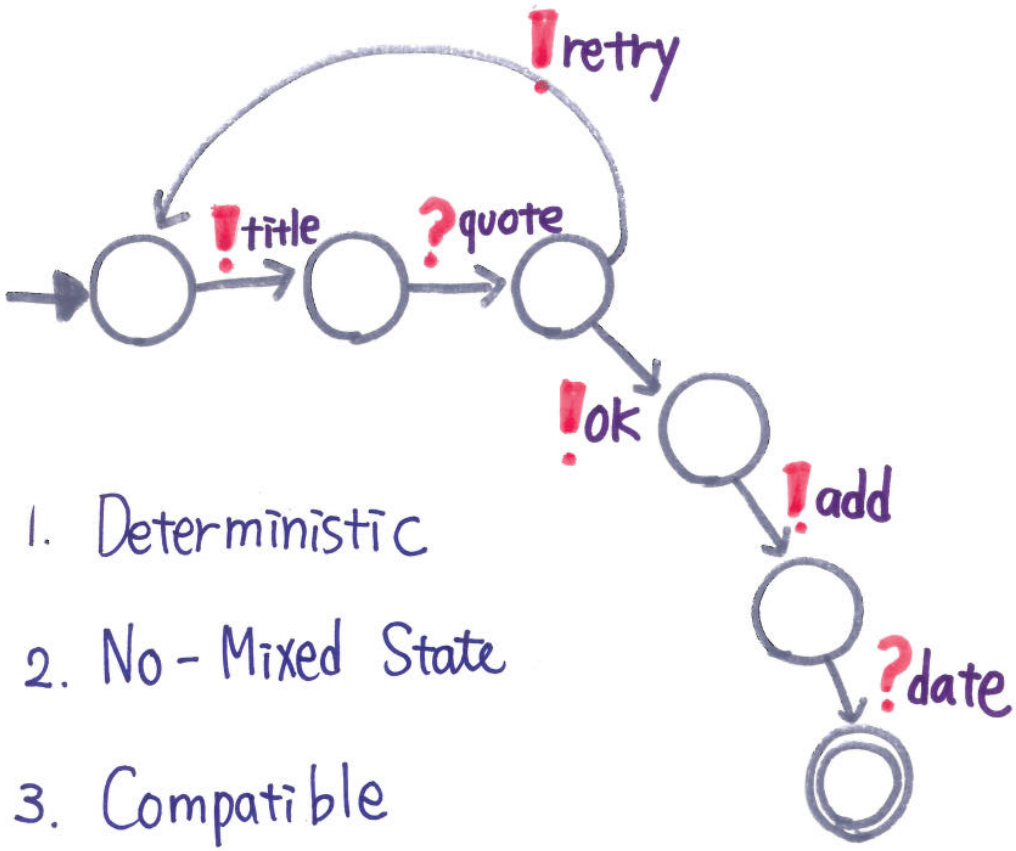
Q has $\overline{T}$

dual

P | Q typable

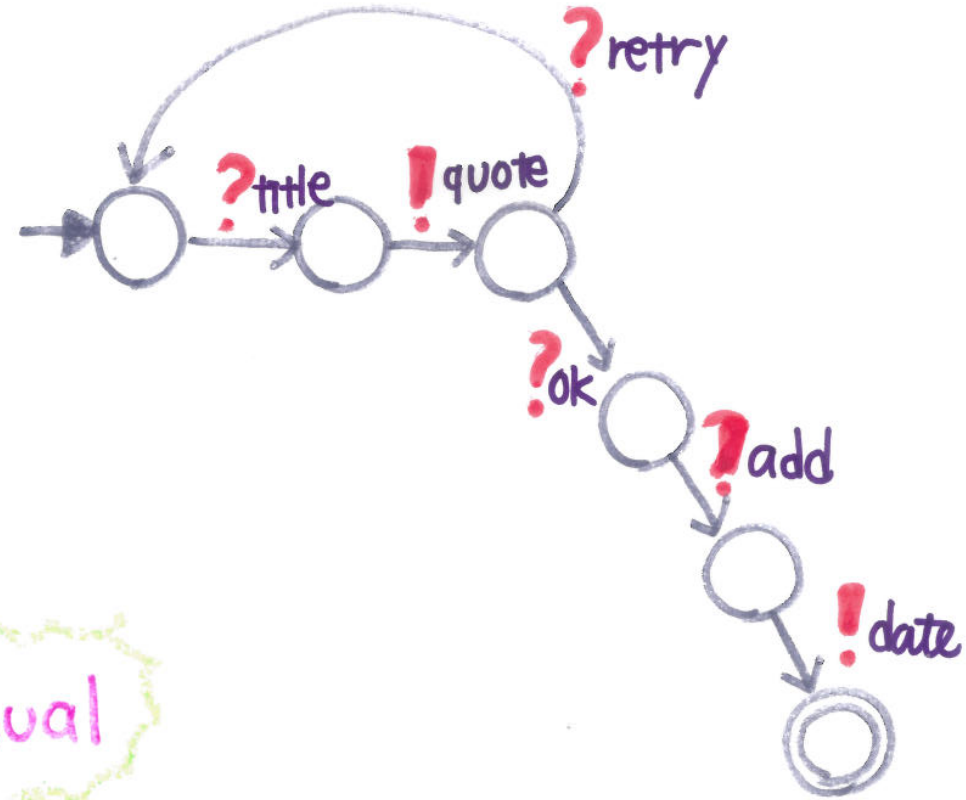
$\mu t.!\ \text{Title}\ ;?\ \text{Quote}\ ;!\ \{\text{ok}:!\ \text{Add}\ ;?\ \text{Date}\ ,\ \text{retry}:t\}$

$\mu t.?\ \text{Title}\ ;!\ \text{Quote}\ ;?\ \{\text{ok}:?\ \text{Add}\ ;!\ \text{Date}\ ,\ \text{retry}:t\}$



1. Deterministic
2. No-Mixed State
3. Compatible

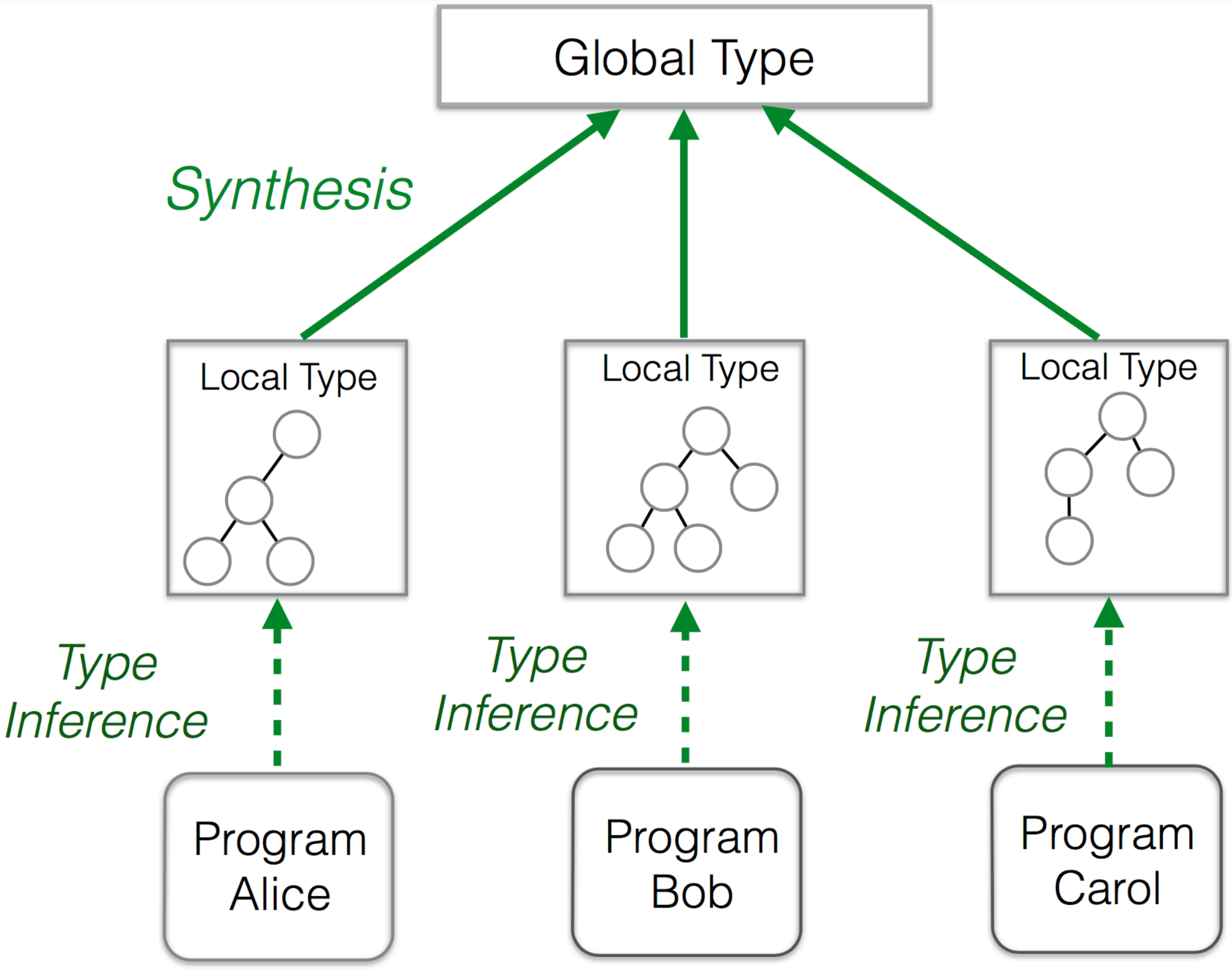
dual



[Gouda et al 1986] Two compatible machines without mixed states which are deterministic satisfy deadlock-freedom.

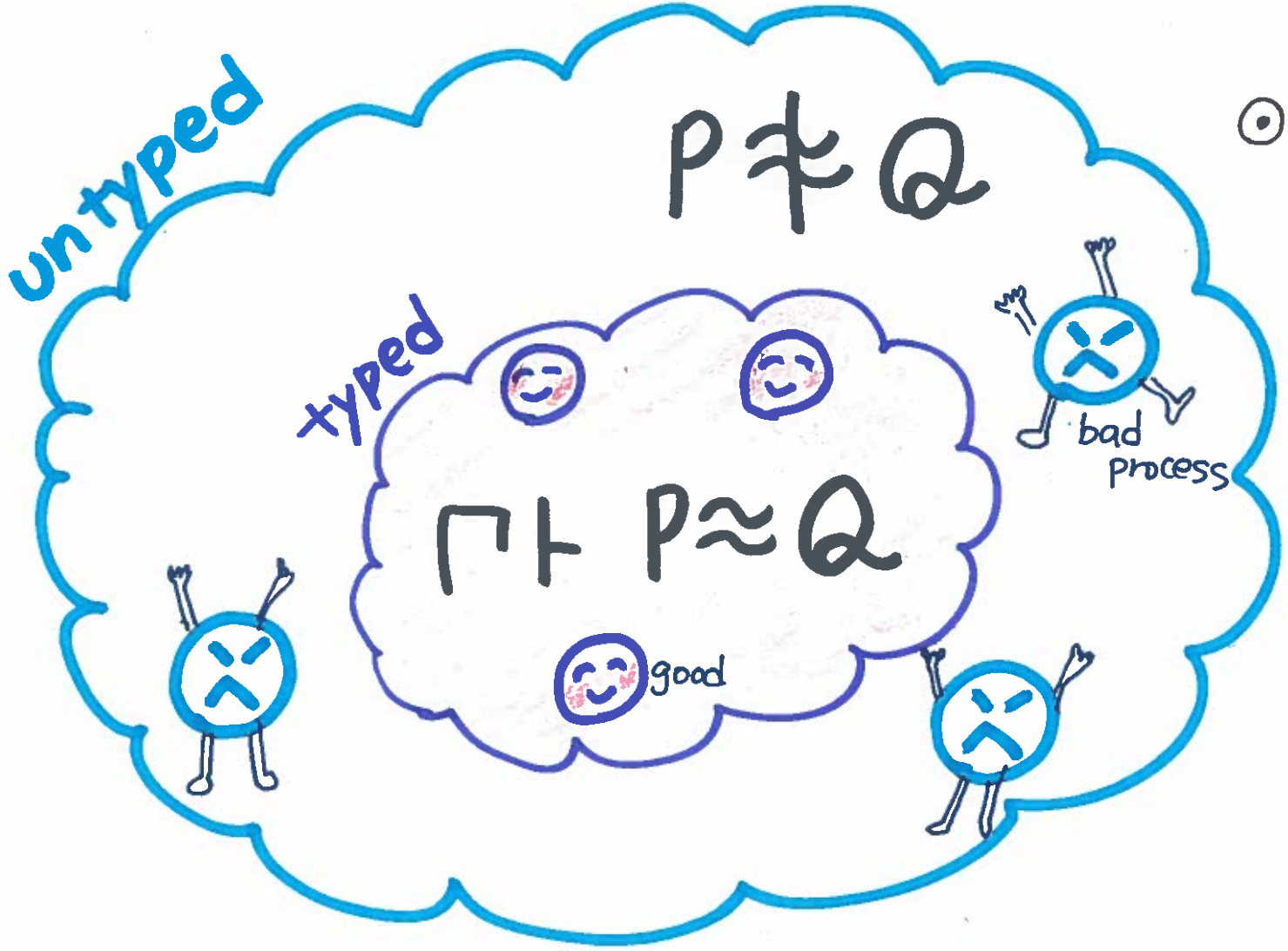
Synthesis

[ICALP'13, POPL'15, CONCUR'15, TACAS'16, CC'16]



Typed Semantics in π 1991→

IO-subtyping, Linear types, Secure Information Flow, ...



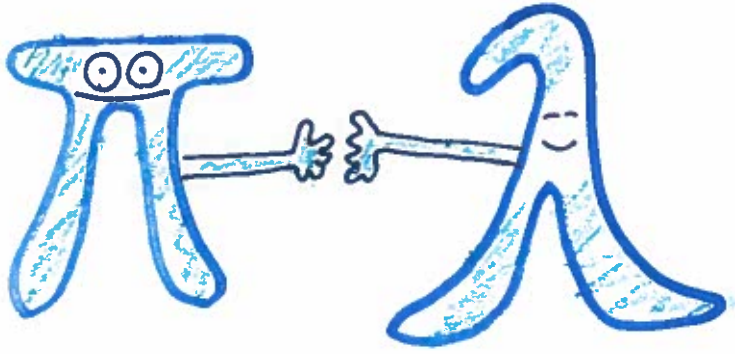
- ⊙ Correctness of Encoding
- ⊙ Limit environment Γ
  ⇒ Equate more processes
- ⊙ Compositional

GLOBALLY GOVERNED SESSION SEMANTICS

Dmitrios Kouzapas
Glasgow

Nobuko Yoshida
Imperial college London

HOπ and TYPES



CONCUR 16 Characteristic Bisimulations

ESOP 16 Expressiveness

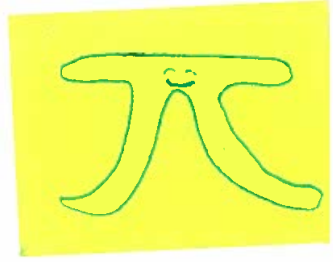
ACTA INFORMATICA

on Polymorphic Sessions and Functions or a Tale of Two Encodings

Bernardo Toninho @ Nova

Nobuko Yoshida @ Imperial

On Polymorphic Sessions and Functions

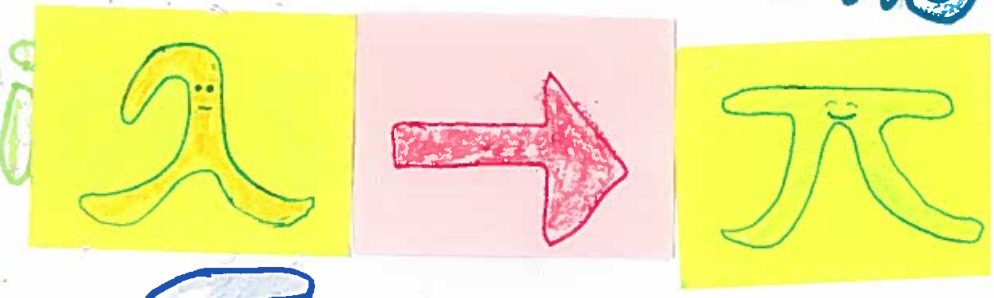


A Tale of Two Fully Abstract Encodings

Bernardo Toninho @ Nova

Nobuko Yoshida @ Imperial

On Polymorphic Sessions and Functions



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On Polymorphic Sessions and Functions

A Tale of Two Encodings

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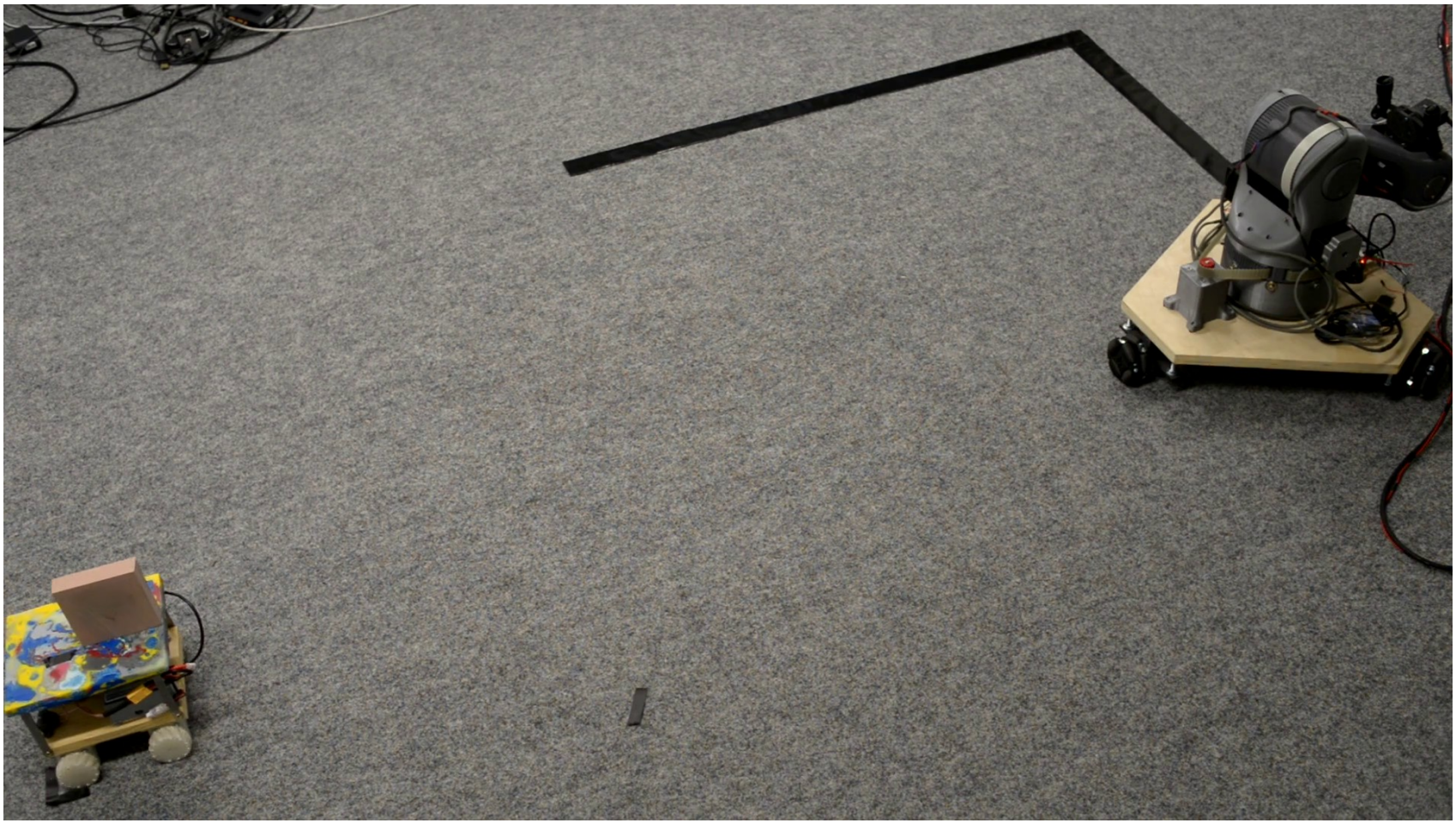
Impacts (V): Session Types for Robotics



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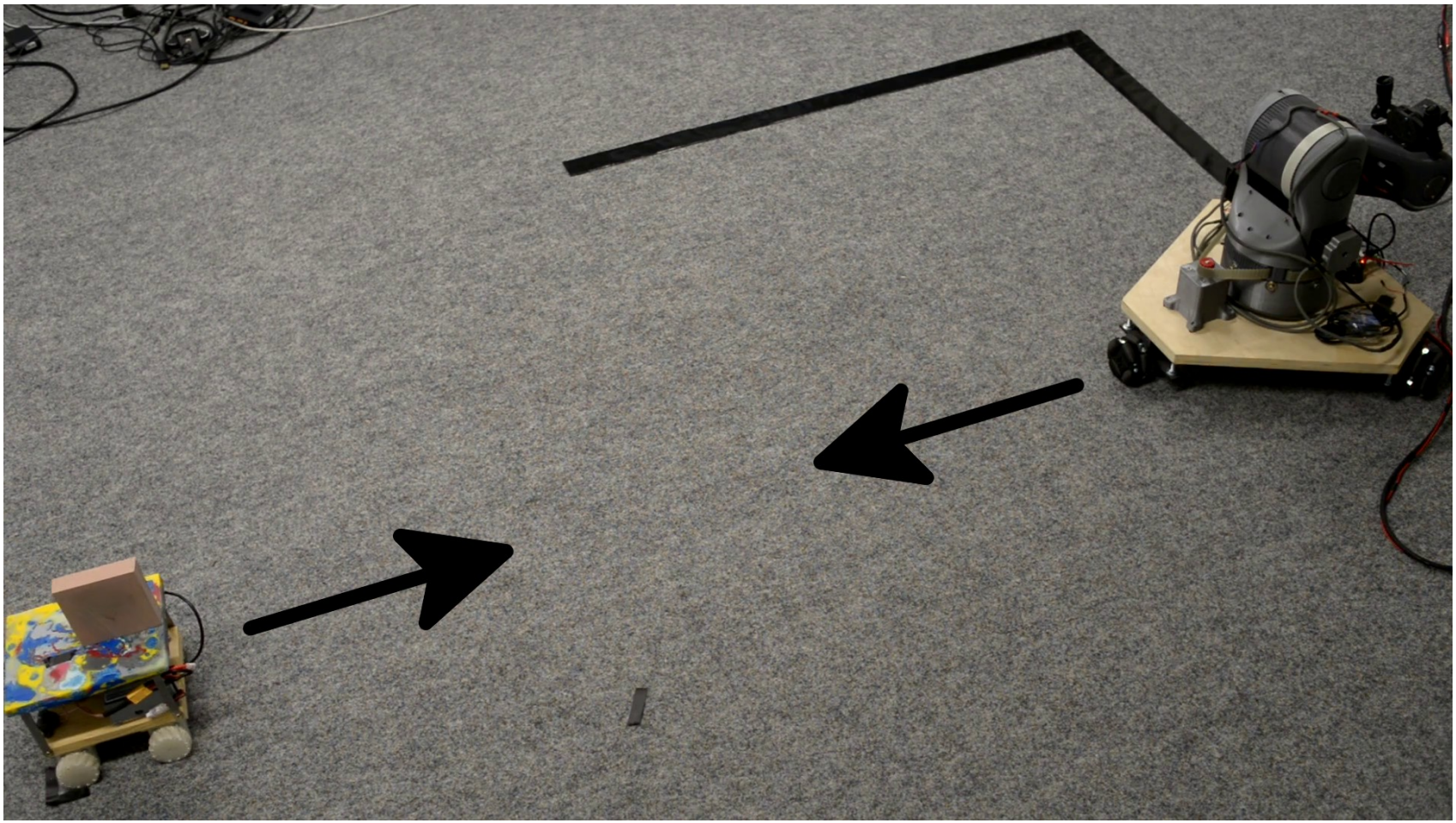

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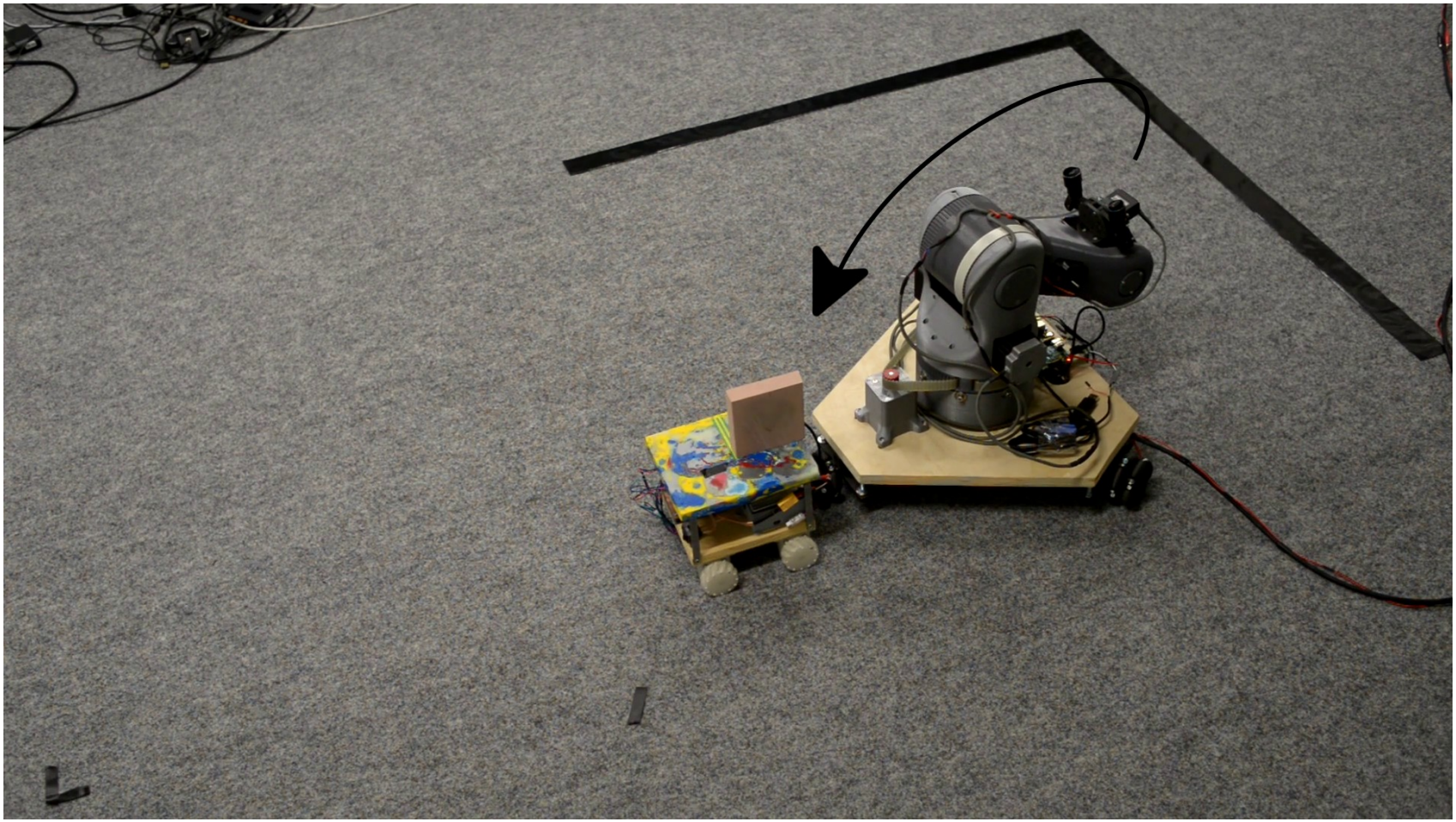

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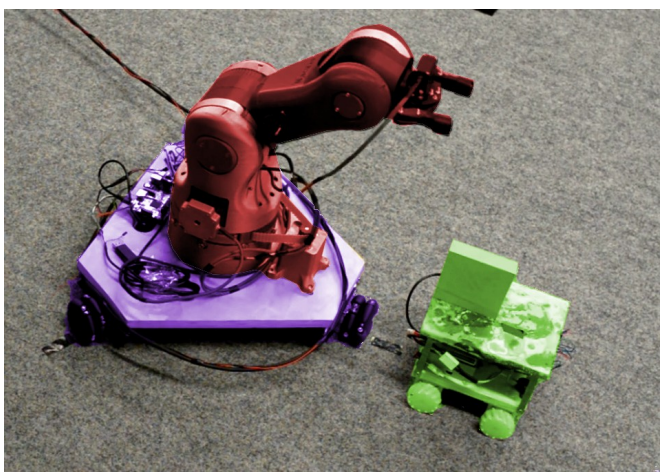
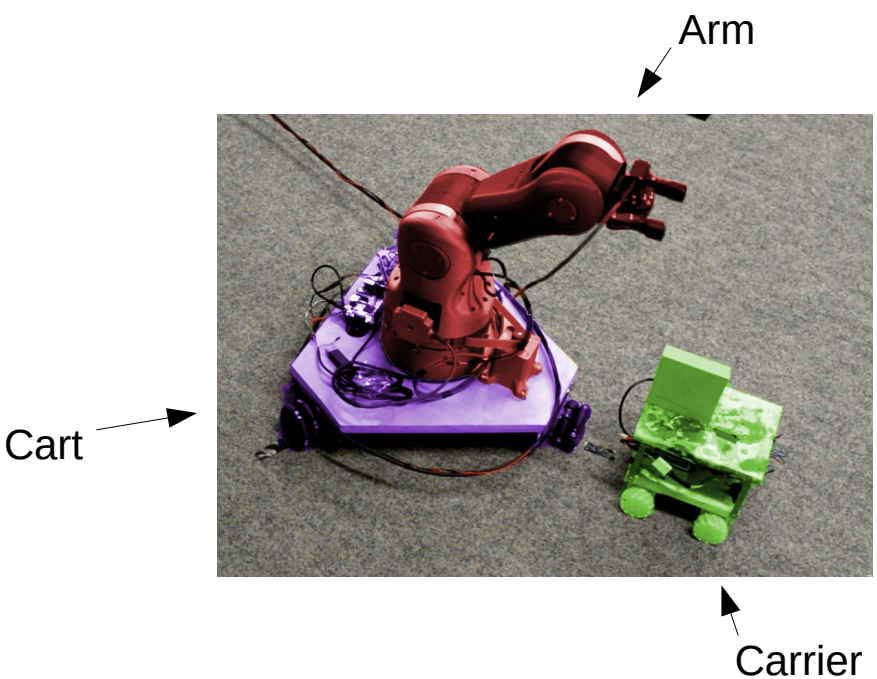
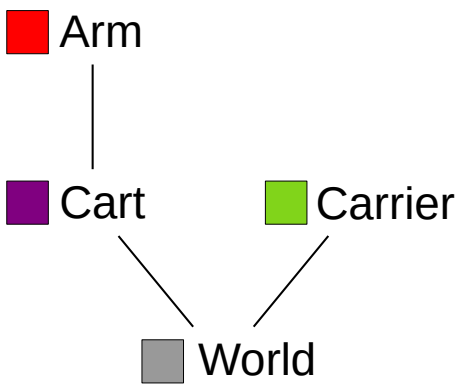


Cart & Arm:

Two robots attached together that act as “one” robot (communication)

Impacts (V): Session Types for Robotics





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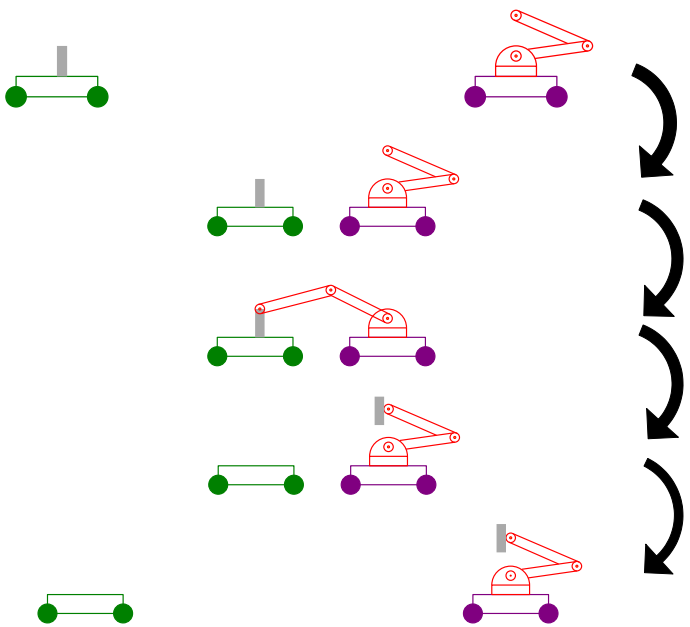


$\mathsf{Cart} \to \mathsf{Arm} : \mathit{fold}(\mathtt{unit}).\mathsf{dt}\langle \mathsf{Cart} : \mathsf{idle}, \mathsf{Carrier} : \mathsf{idle}, \mathsf{Arm} : \mathsf{fold}\rangle.$

$\mathsf{Arm} \to \mathsf{Cart} : \mathit{ok}(\mathtt{unit}).\mathsf{Cart} \to \mathsf{Carrier} : \mathit{ok}(\mathtt{unit}).$

$\mathsf{dt}\langle \mathsf{Cart} : \mathsf{move}, \mathsf{Carrier} : \mathsf{move}, \mathsf{Arm} : \mathsf{idle}\rangle.$

$\mathsf{Carrier} \to \mathsf{Cart} : \mathit{ok}(\mathtt{unit}).\mathsf{Cart} \to \mathsf{Arm} : \mathit{grab}(\mathtt{unit}).$

$\mathsf{dt}\langle \mathsf{Cart} : \mathsf{idle}, \mathsf{Carrier} : \mathsf{idle}, \mathsf{Arm} : \mathsf{grip}\rangle.$

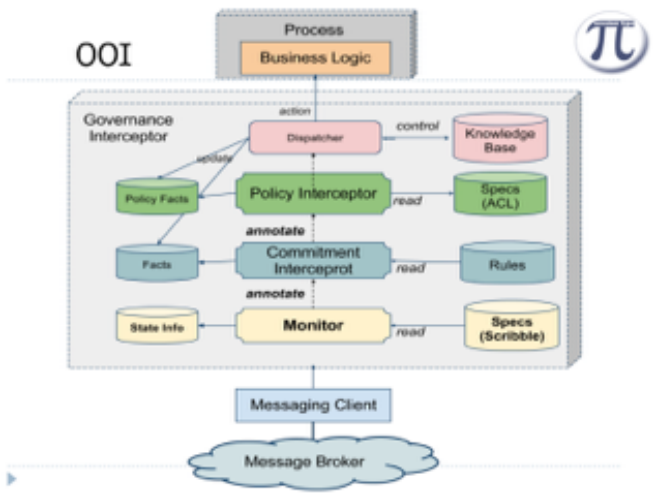
$\mathsf{Arm} \to \mathsf{Cart} : \mathit{ok}(\mathtt{unit}).\mathsf{Cart} \to \mathsf{Carrier} : \mathit{ok}(\mathtt{unit}).$

$\mathsf{dt}\langle \mathsf{Cart} : \mathsf{move}, \mathsf{Carrier} : \mathsf{move}, \mathsf{Arm} : \mathsf{idle}\rangle.$

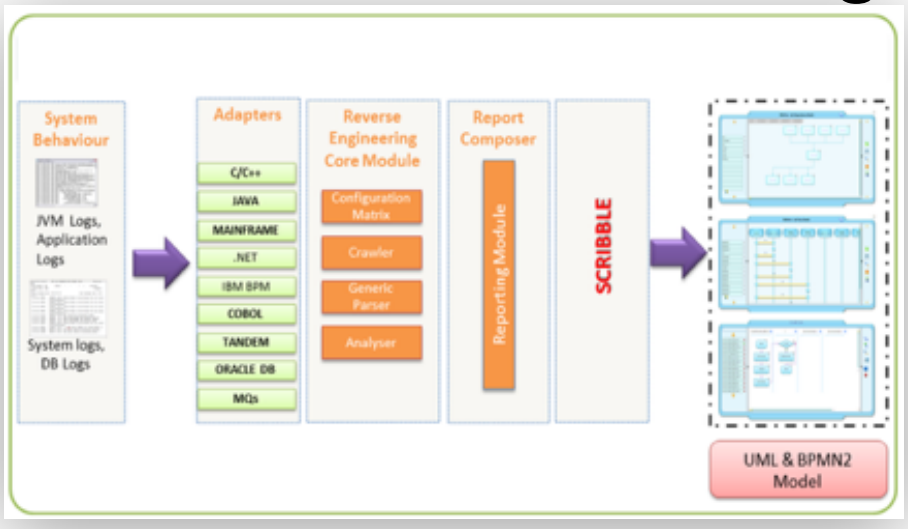
$\mathsf{Cart} \to \mathsf{Arm} : \mathit{done}(\mathtt{unit}).\mathsf{Cart} \to \mathsf{Carrier} : \mathit{done}(\mathtt{unit}).\mathtt{end}$

Session Type based Tools

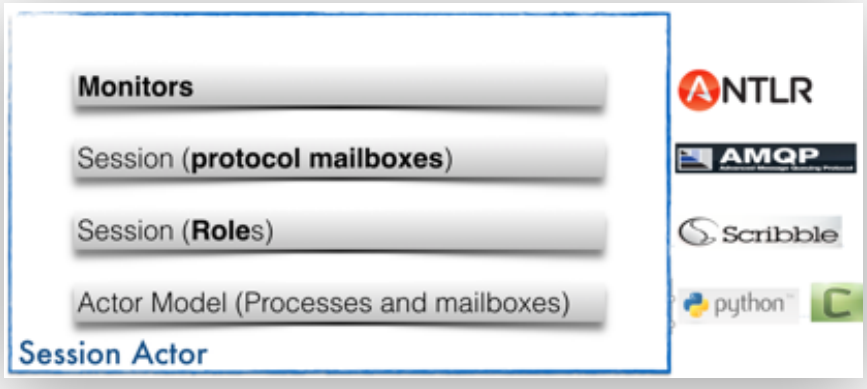
OOI Governance



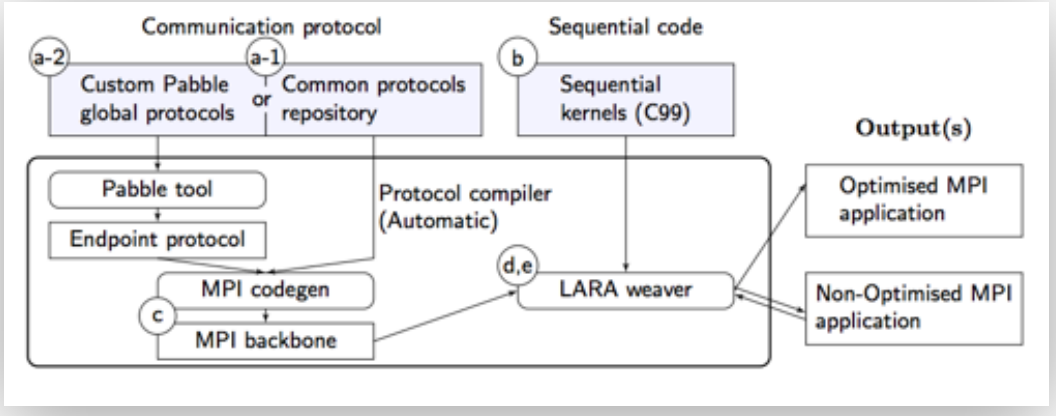
ZDLC: Process Modeling



Actor Verification



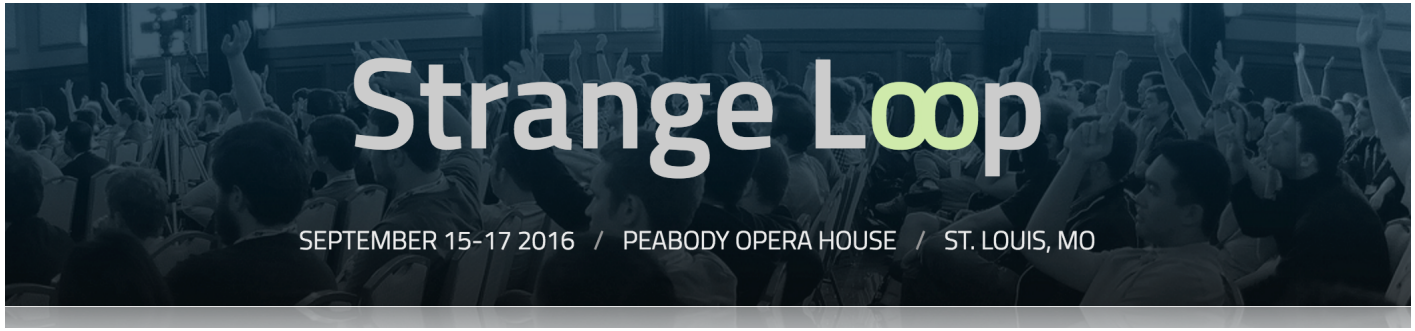
MPI code generations



Public Engagements/Lectures/Keynote Talks

- **Lectures**
  - **Courses: Imperial College London**, Concurrent Processes (4th MEng, MSc), **Keio University** (since 2016), **Taipei University** (2018), **L'Aquila** (2014)
  - **Tutorials/Schools:** BeheAPI (2019), CGO'18 (Venice), FM'16 (Cyprus), Saint-Malo (France) 2016, Bertinoro (Italy) 2015, and BETTY (Cyprus 2016/Lovran 2014), and POPL'14.
- **Industrial Seminars and Conferences:** Many, e.g. Newton IT seminar (42 companies attended, London).
- **STEM:** ACM PLMW Co-Chair (POPL 2019, 2020), London Hoppers, etc.
- **Invited Keynote Talks:** ICDCIT'20 (India), CONFESTA'18 (Beijing), TLT'17 (Torino), OPT'17 (Venice), STRANGE-LOOP'16 (St. Louis), RTA-TLCA'14 (Venice) and TGC'13 (Buenos Aires)

Interactions with Industries



Adam Bowen @adamnbowen · Sep 15
I didn't even know that session types existed an hour ago, but thanks to Nobuko Yoshida's great talk at **#pwlconf**, I want to learn more.

Nobuko Yoshida
Imperial College, London

DoC researcher to speak at Golang UK conference

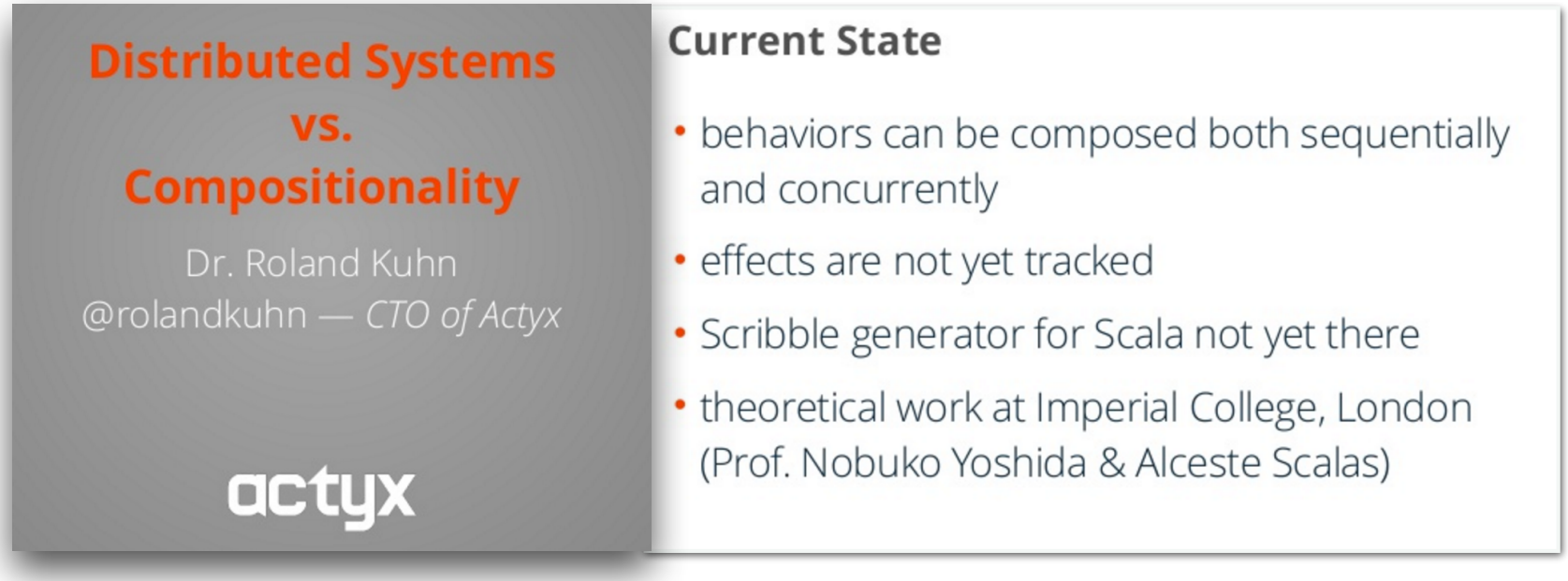
by Vicky Kapogianni
20 July 2016

DoC researcher to speak at industry-focused Golang UK conference on results of concurrency research

Click here to add content

.@nicholascwng rocking on @GolangUKconf about static deadlock detection in #golang #gouk16

Interactions with Industries



Publications

- NY GS: from 4500 to 10140 (MPST 742); 4833 since 2014
- **75 Conferences Papers**
  - POPL'15, POPL'16, POPL'17, POPL'19 (A), POPL'19 (B), POPL'19 (C)
  - ECOOP'19, ECOOP'17, ECOOP'16, OOPSLA'15
  - ESOP'19, ESOP'18, ESOP'17, ESOP'16, CONCUR'19, CONCUR'15 (A), CONCUR'15 (B), CONCUR'15 (C), CONCUR'14, CONCUR'13 (A), CONCUR'13 (B)
  - LICS'18, FOSSACS'19, FOSSACS'18, FOSSACS'17, ICALP'13
  - **Artifacts Evaluations:** All submissions were accepted.
  - **New Venues:** PLDI'19, ICSE'18, FSE'19, FASE'17, FASE'16, CAV'19, TACAS'16, FPL'16, PPoPP'15
    CC'15, CC'16, CC'17, CC'18.
- **33 Journal Articles** including JACM, ACM TOPLAS, Information and Computations, and Logical Methods of Computations.

Selected Publications [2018-2019]

- [PLDI19] Alceste Scalas, NY, Elias Benussi: Verifying message-passing programs with dependent behavioural types.
- [CAV19] Julien Lange, NY: Verifying Asynchronous Interactions via Communicating Session Automata.
- [CONCUR19] Mario Bravetti, Marco Carbone, Julien Lange, NY, Gianluigi Zavattaro: A Sound Algorithm for Asynchronous Session Subtyping
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- [FoSSaCs18] Bernardo Toninho, Nobuko Yoshida: Depending On Session Typed Process
- [ESOP18] Bernardo Toninho, NY: On Polymorphic Sessions And Functions: A Tale of Two (Fully Abstract) Encodings
- [CC18] Rumyana Neykova, Raymond Hu, NY, Fahd Abdeljallal: A Session Type Provider: Compile-time API Generation for Distributed Protocols with Interaction Refinements in F#

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