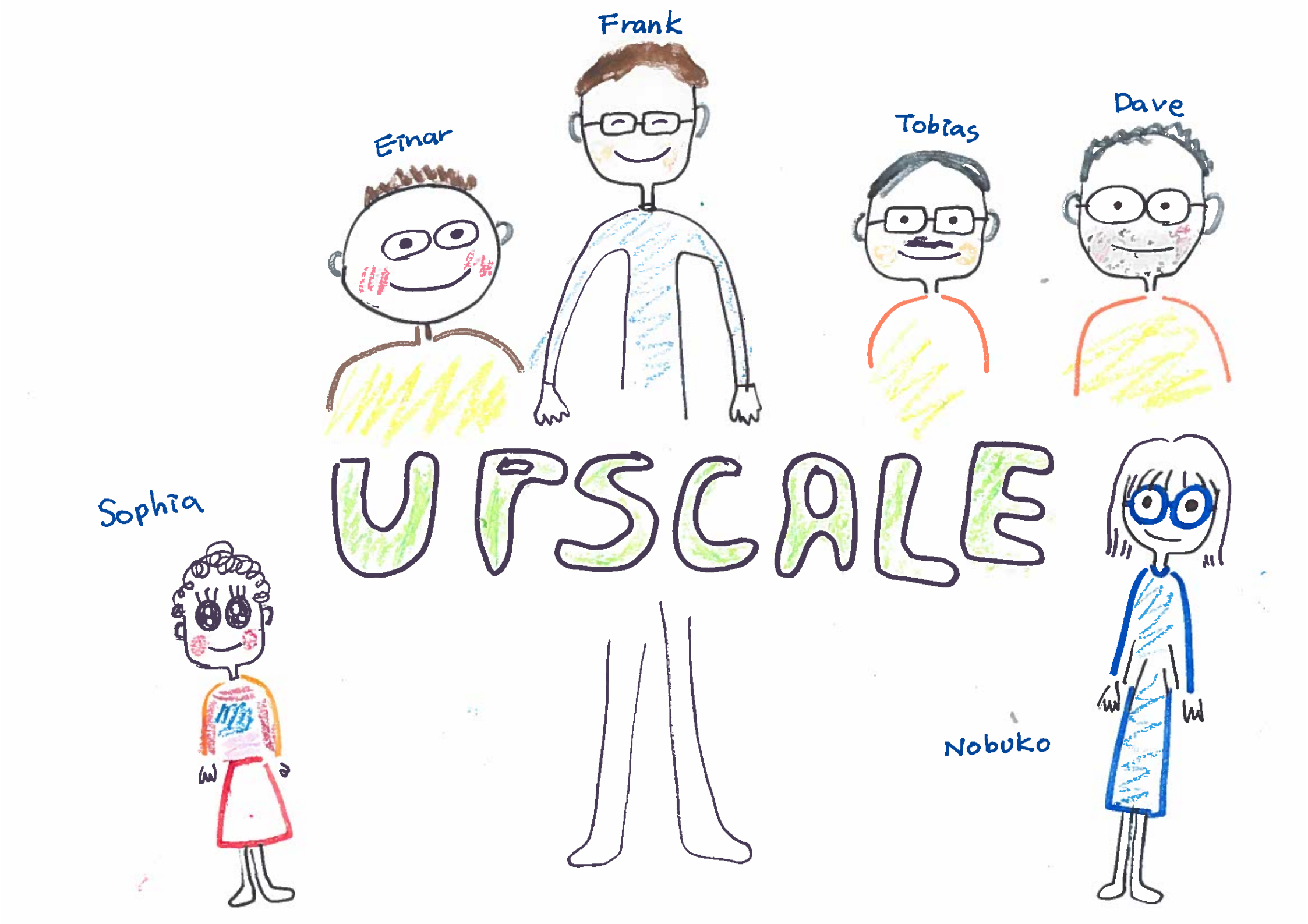

Frank
Einar
Tobias
Dave
UPSCALE
Sophia
Nobuko

UpScale Project (FP7)

- CWI, Imperial College London, University of Oslo and Uppsala University
- Study how an OO PL can support the development of applications that seamlessly scale to the available parallelism of manycore chips.
- Take an actor-based concurrency model as a starting point, rather than multi-threading, and use types to "open up the actors" for further parallelism, keeping the amount of concurrency implicit in the language.
- Capability types, Ownership types, Session Types, etc.

An overview of

UpScale @ Imperial College London

Nobuko Yoshida

Sophia Drossopoulou

Juliana Franco

An Overview of UPSCALE @ OSLO

UiO : Department of Informatics
University of Oslo

Shiji Bijo, Einar Broch Johnsen, Violet Ka I Pun, S. Lizeth Tapia Tarifa

	Parallel Combinators	Reference Capabilities	Hot Objects	Disjointness Domains
Problem	Actors are **sequential**; need to abstractly specify parallel computations for **scheduler flexibility**	Avoiding **data-races**/ **copying**/**non-determinism** both at application level and in the run-time	Popular actors risk becoming bottlenecks—lowering **throughput**; increasing **latency**	Sharing semantics of object-oriented programs **misaligned** with language defaults
Approach	Strongly typed mini-DSL for **orchestrating parallel computation**	A **hierarchy** of **annotations** that express how programmers **share** objects **across computations**	New class of actors whose message processing semantics is **controlled from deployment spec**.	**Invert defaults** — track sharing instead of alias-freedom
Details	**Reify** pipeline; **operations** on pipeline for **forking**, **pruning**, **speculating**, etc.	Capabilities are tracked in **types** which are formed from **sharing modes** and **traits**	Several possible implementations: lock-based **synchronous** actors, **STM**, **lock-free** capabilities	Sharing is tracked through **types**; what parts of a program **may alias statically visible**
Difficulties	Integration with scheduling of actors; killing on-going computation	Balancing expressivity and syntactic overhead; capturing the relevant properties; polymorphism	Actor semantics sequential, difficult engineering to get good performance	Balancing expressivity and syntactic overhead; measuring how aliasing is used in practise
Deliver-ables	Submitted to COORDINATION'16 + UU Master Thesis *Implemented in Encore*	IWACO'14, submitted to ECOOP' 16, submission in prep for OOPSLA'16 *Partial impl. in Encore*	In prep. *Implementation on-going*	Published OOPSLA'15, submission in prep for OOPSLA'16

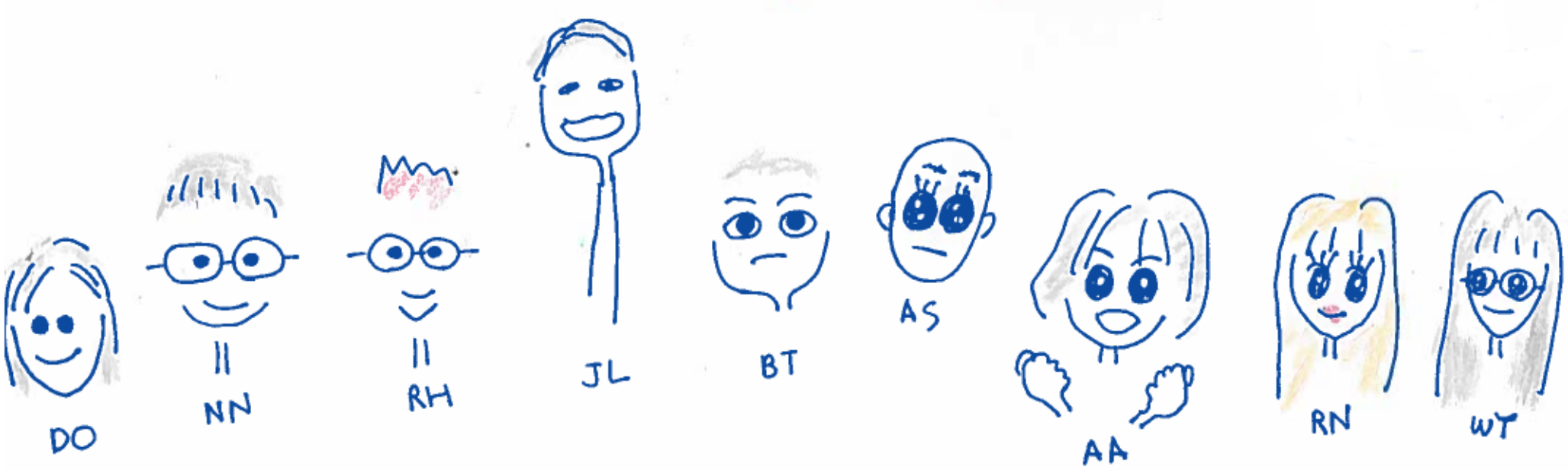
CWI

Overview

- **Transferring parallelism from inter-object to intra-object level**
  - Notion of Multi-threaded Actors
- **Extending the notion of Cooperative Scheduling**
  - Efficient await on boolean conditions by means of Promises in Haskell

Nobuko Yoshida

Imperial College London



Mobility Reading Group

mrg.doc.ic.ac.uk

Selected Publications 2015/2016

- **[CC'16]** Nicholas Ng, NY: Static Deadlock Detection for Concurrent Go by Global Session Graph Synthesis.
- **[FASE'16]** Raymond Hu, NY: Hybrid Session Verification through Endpoint API Generation.
- **[TACAS'16]** Julien Lange, NY: Characteristic Formulae for Session Types.
- **[ESOP'16]** Dimitrios Kouzapas, Jorge A. Pérez, NY: On the Relative Expressiveness of Higher-Order Session Processes.
- **[POPL'16]** Dominic Orchard, NY: Effects as sessions, sessions as effects .
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- **[OOPSLA'15]** Hugo A. López, Eduardo R. B. Marques, Francisco Martins, Nicholas Ng, César Santos, Vasco Thudichum Vasconcelos, NY: Protocol-Based Verification of Message-Passing Parallel Programs .
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- **[CC'15]** Nicholas Ng, Jose G.F. Coutinho, NY: Protocols by Default: Safe MPI Code Generation based on Session Types.
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- **[POPL'15]** Julien Lange, Emilio Tuosto, NY: From communicating machines to graphical choreographies.

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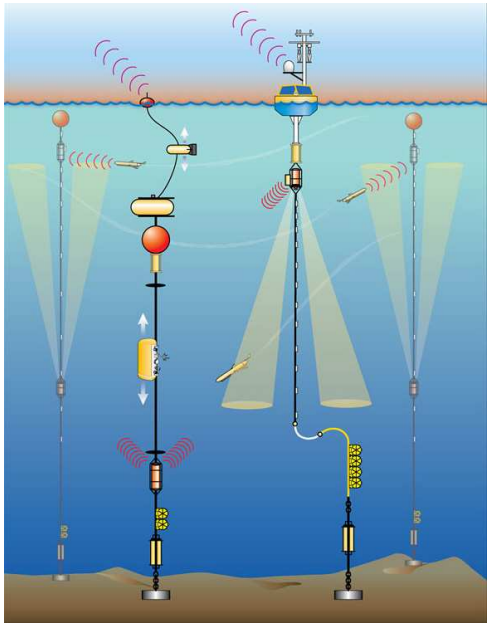
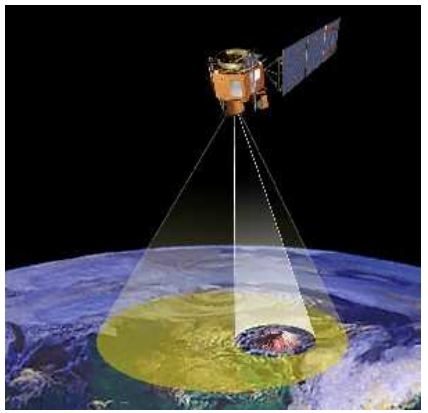
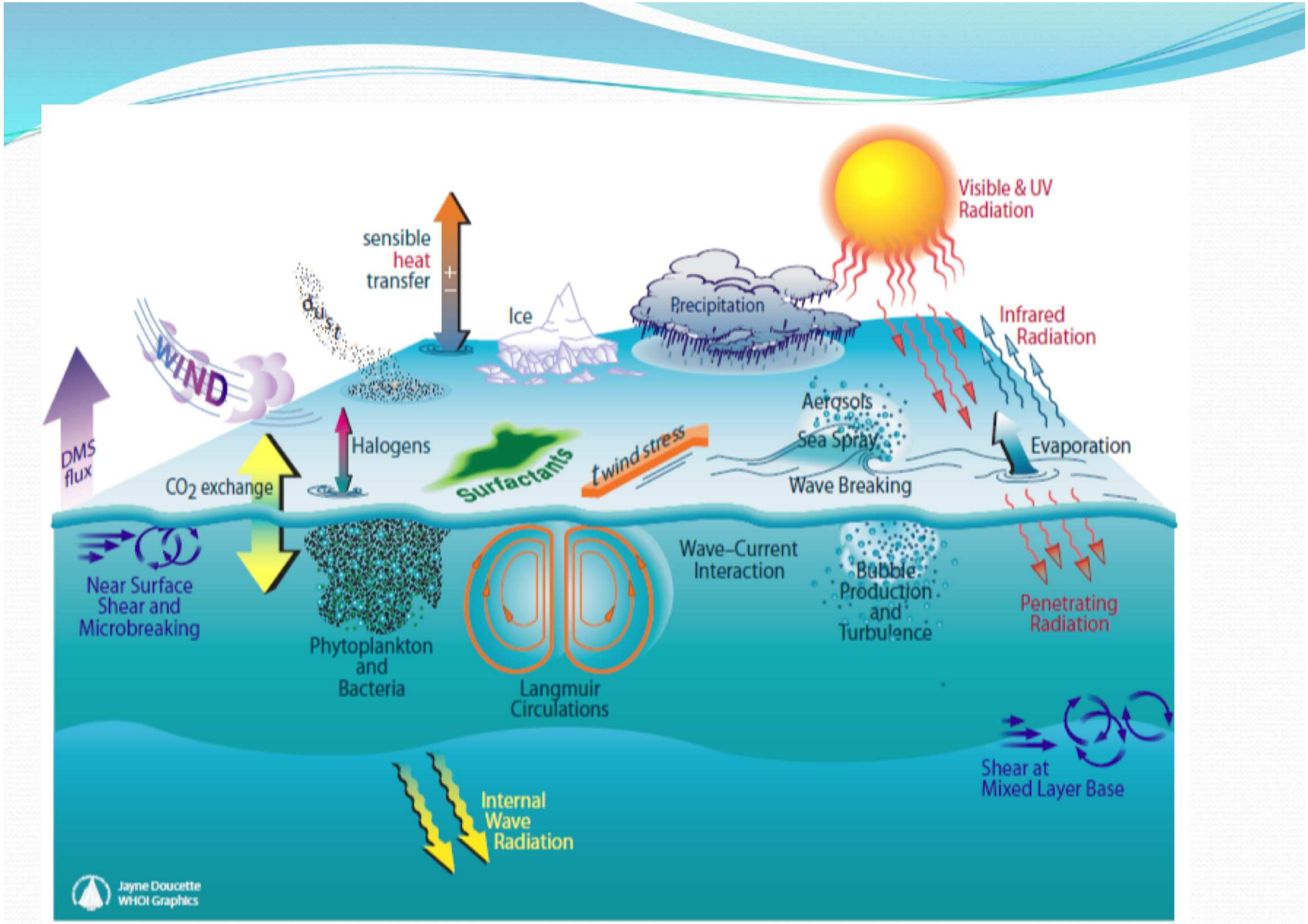
- **[POPL'15]** Julien Lange, Emilio Tuosto, NY: From communicating machines to graphical choreographies.

Ocean Observatories Initiative

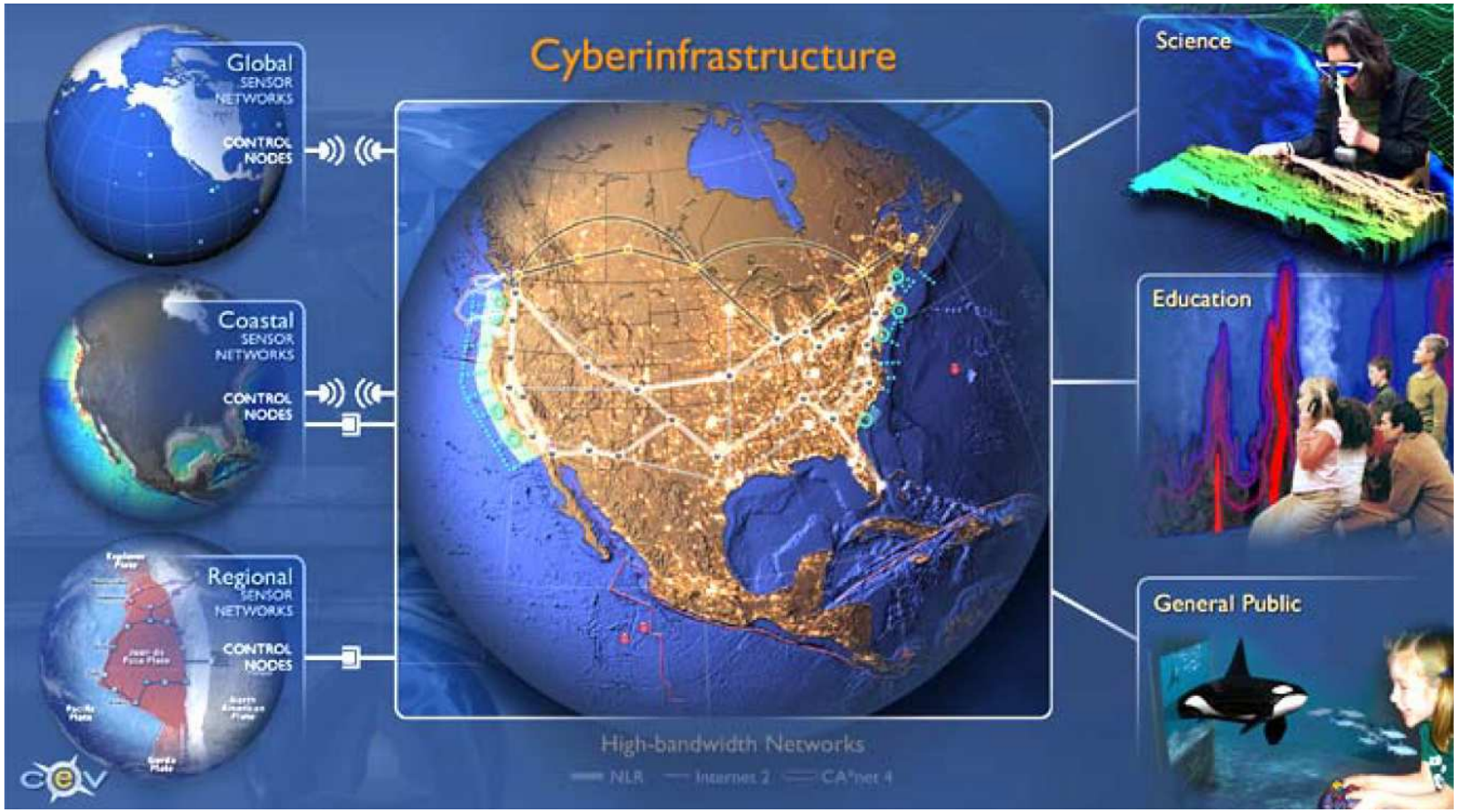
- A NSF project (400M$, 5 Years) to build a cyberinfrastructure for observing oceans around US and beyond.
- Real-time sensor data constantly coming from both off-shore and on-shore (e.g. buoys, submarines, under-water cameras, satellites), transmitted via high-speed networks.

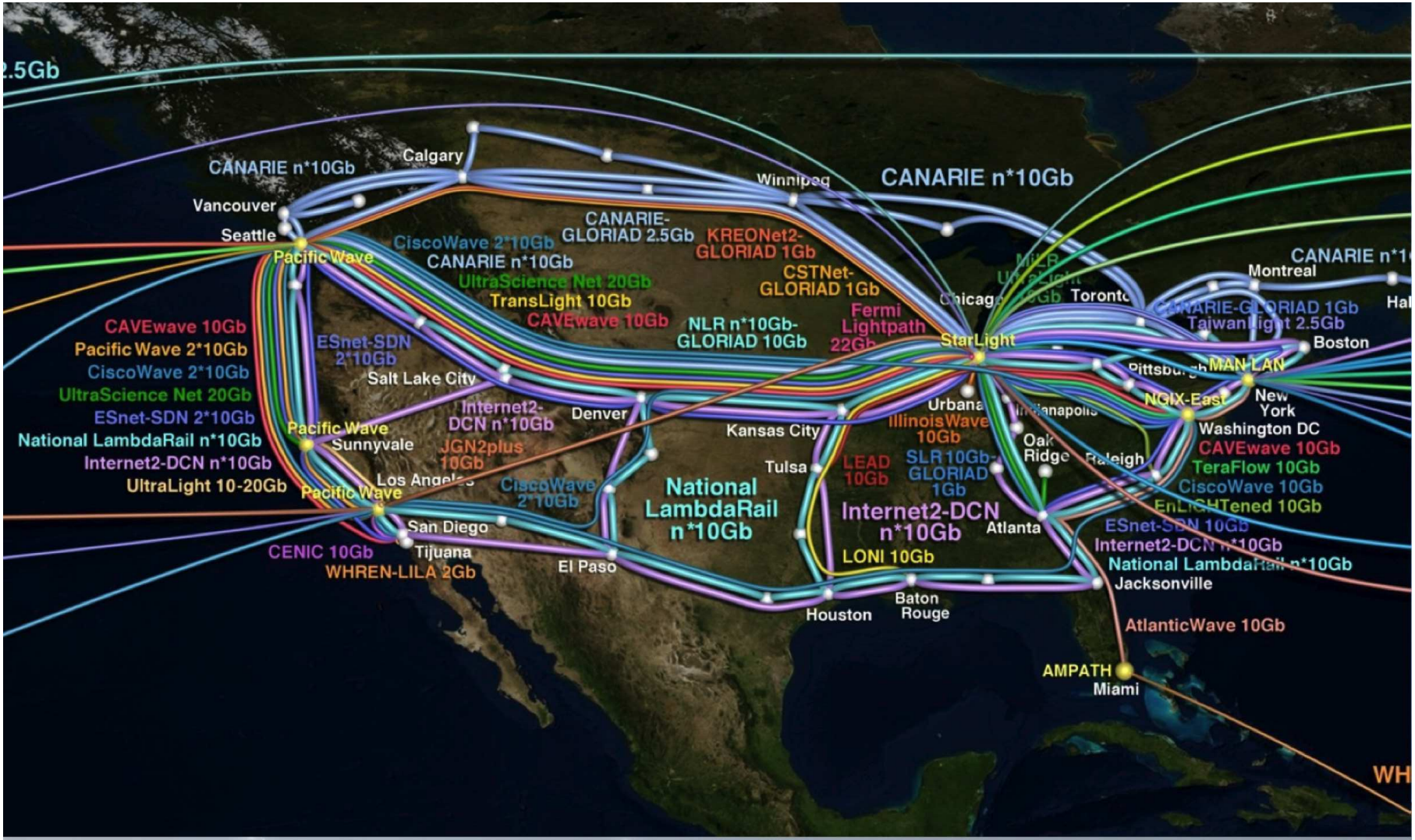





Visible & UV Radiation
sensible heat transfer
+
−
Ice
Precipitation
Infrared Radiation
WIND
dust
DMS flux
Halogens
Aerosols
Sea Spray
Evaporation
CO2 exchange
Surfactants
t wind stress
Wave Breaking
Near Surface Shear and Microbreaking
Wave–Current Interaction
Bubble Production and Turbulence
Penetrating Radiation
Phytoplankton and Bacteria
Langmuir Circulations
Shear at Mixed Layer Base
Internal Wave Radiation
Jayne Doucette
WHOI Graphics

Ocean Observatories Initiative



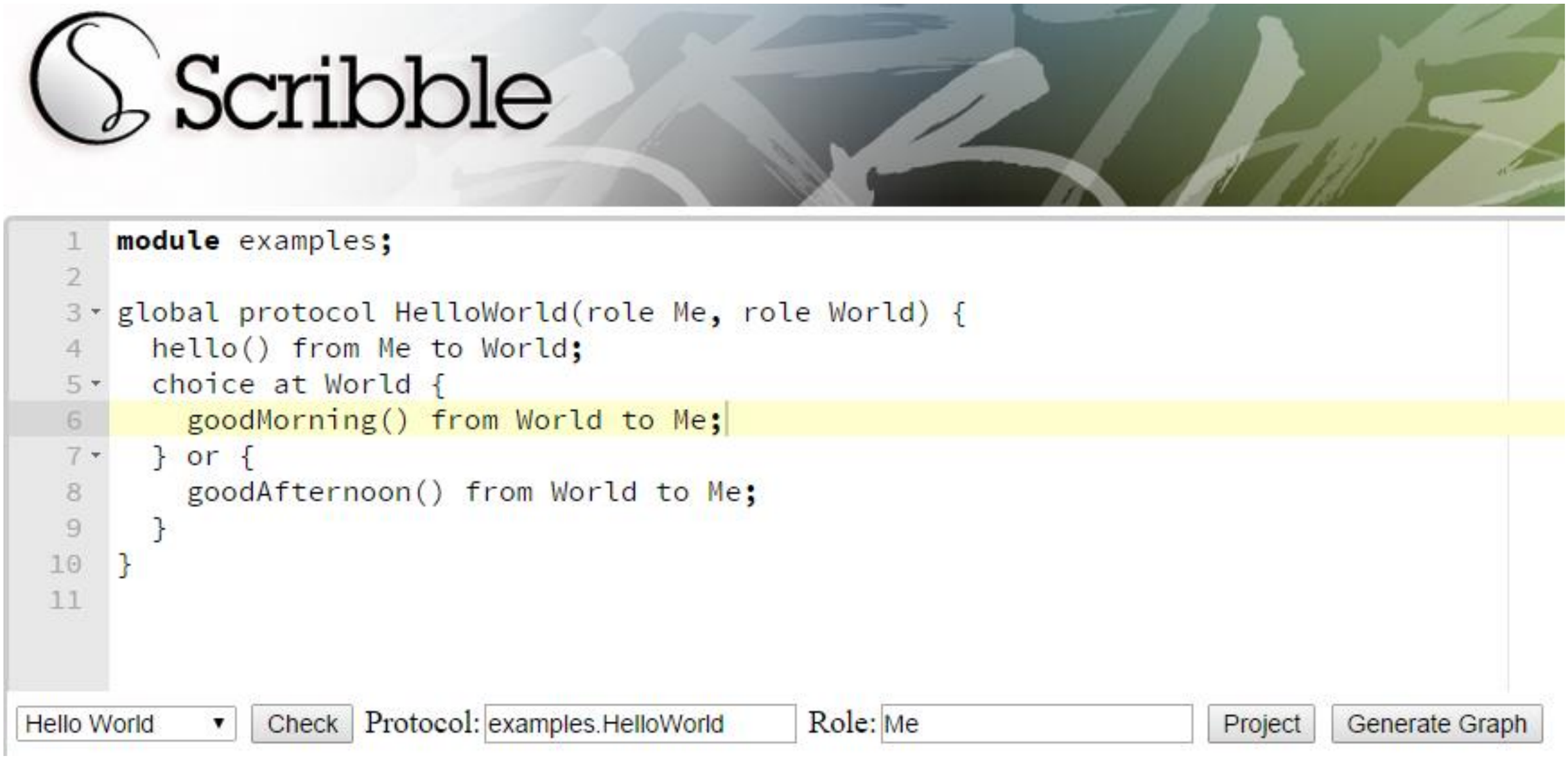


Ocean Observatories Initiative

Challenges

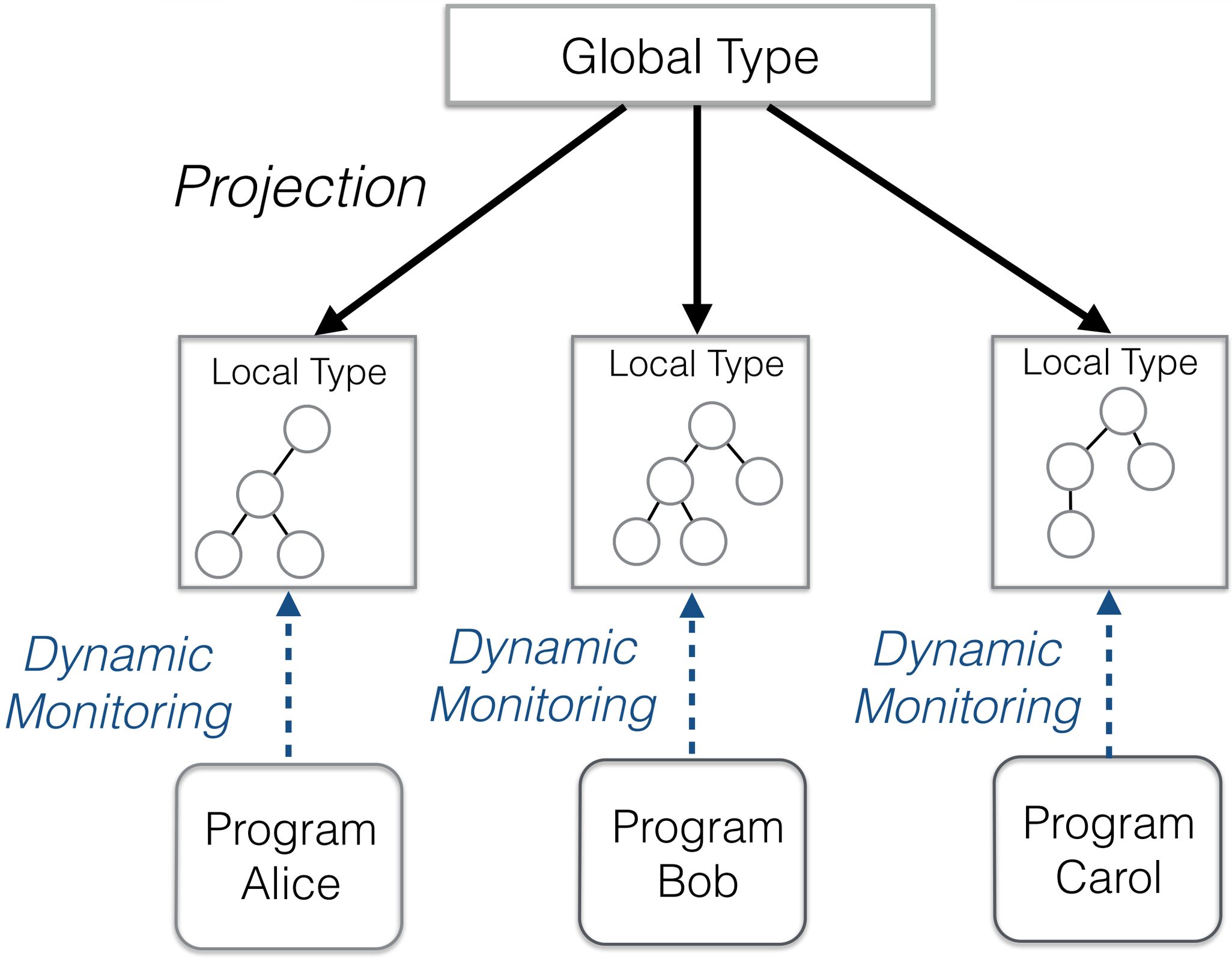
- The need to specify, catalogue, program, implement and manage *multiparty message passing protocols*.
- Communication assurance
  - Correct message ordering and synchronisation
  - Deadlock-freedom, progress and liveness
  - Dynamic message monitoring and recovery
  - Logical constraints on message values
- Shared and used over a long-term period (e.g. 30 years in OOI).

http://scribble.doc.ic.ac.uk:55000/

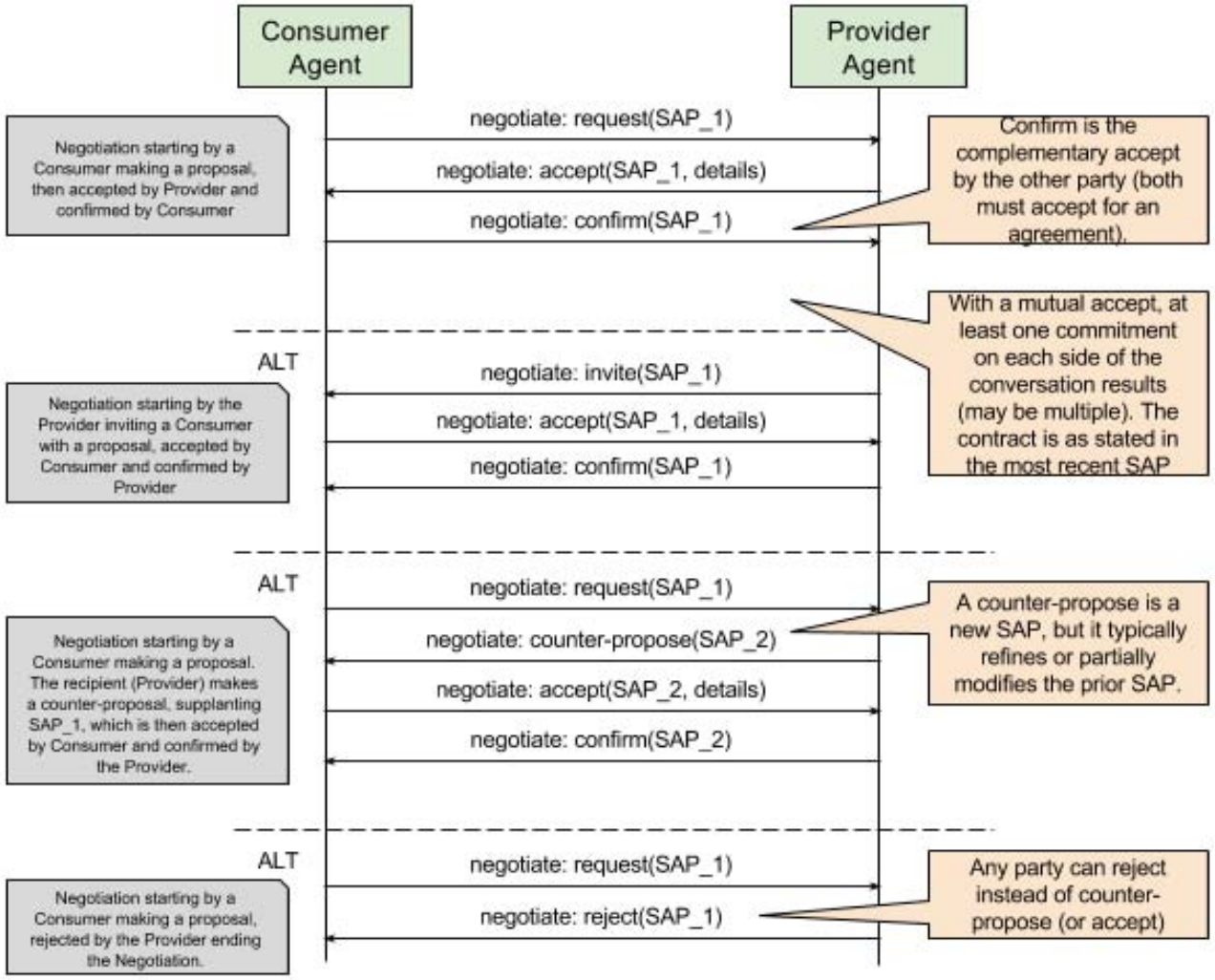


Dynamic Monitoring

[RV'13, COORDINATION'14, FMSD'15]



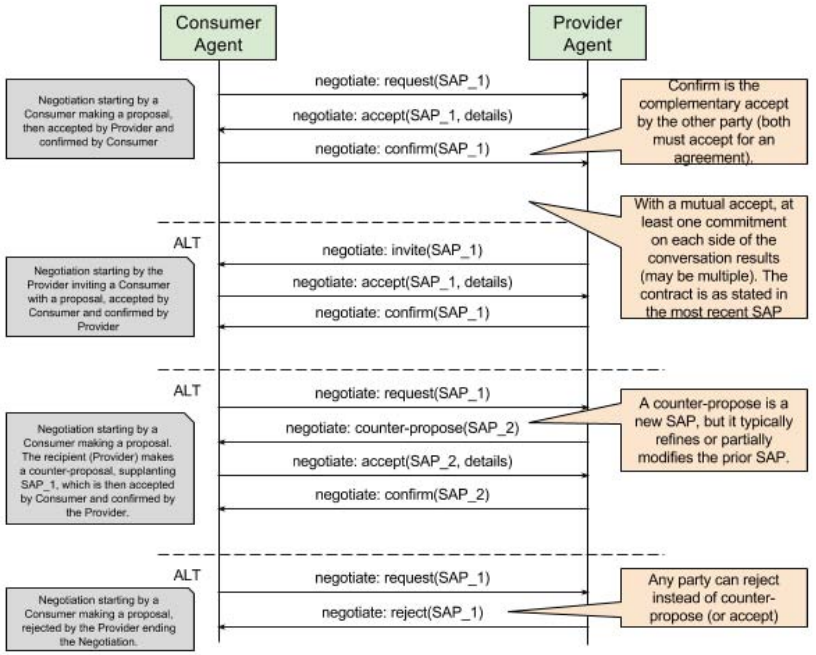
OOI agent negotiation 1/5



- `https://confluence.oceanobservatories.org/display/syseng/CIAD+COI+OV+Negotiate+Protocol`

OOI agent negotiation 2/5

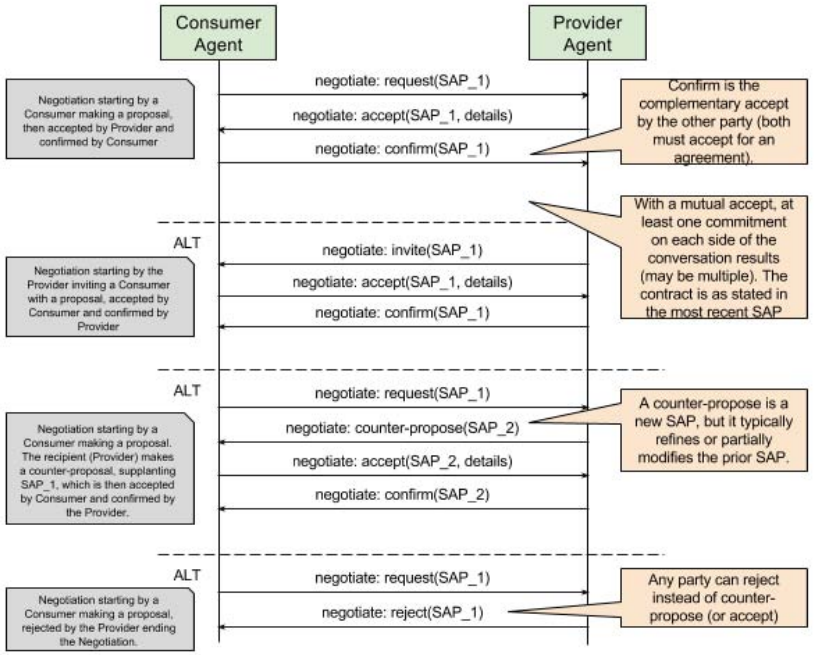
```
type <yml> "SAPDoc1" from "SAPDoc1.yml" as SAP;

global protocol Negotiate(role Consumer as C, role Producer as P) {
```




```
}
```

OOI agent negotiation 3/5 (choice)

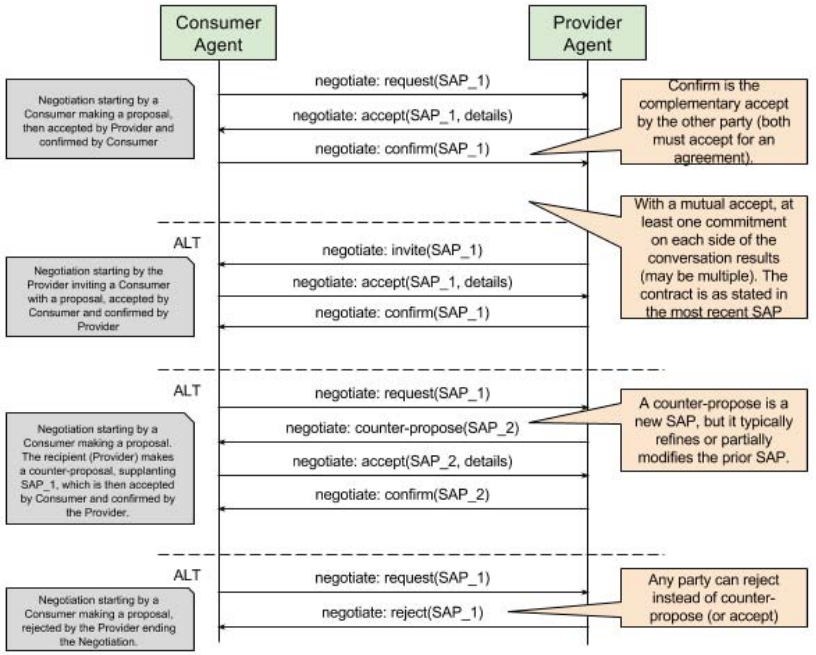
```
type <yml> "SAPDoc1" from "SAPDoc1.yml" as SAP;

global protocol Negotiate(role Consumer as C, role Producer as P) {
  propose(SAP) from C to P;

    choice at P {
      accept() from P to C;
      confirm() from C to P;
    } or {
      reject() from P to C;
    } or {
      propose(SAP) from P to C;
```




```
} }
```

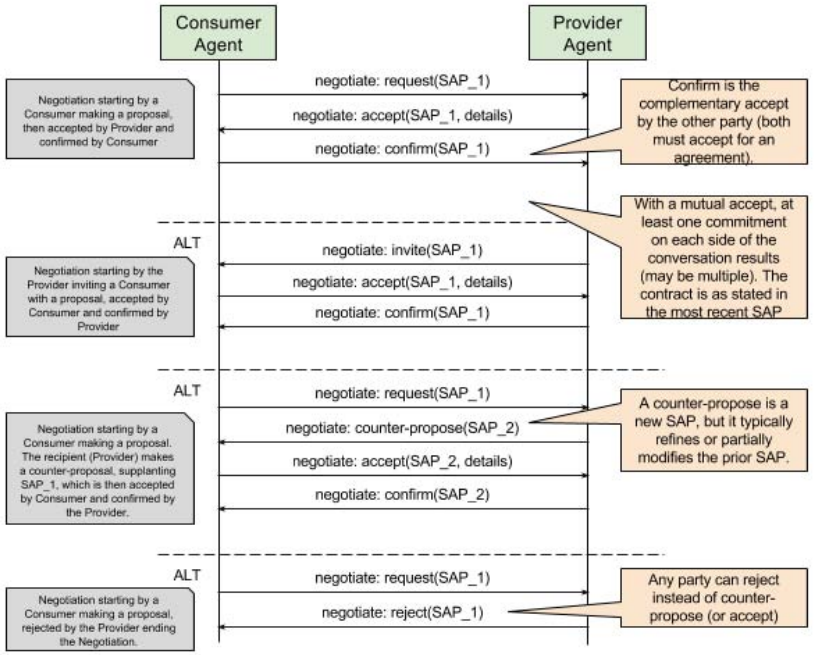
OOI agent negotiation 4/5

```
type <yml> "SAPDoc1" from "SAPDoc1.yml" as SAP;

global protocol Negotiate(role Consumer as C, role Producer as P) {
  propose(SAP) from C to P;

    choice at P {
      accept() from P to C;
      confirm() from C to P;
    } or {
      reject() from P to C;
    } or {
      propose(SAP) from P to C;
      choice at C {
        accept() from C to P;
        confirm() from P to C;
      } or {
        reject() from C to P;
      } or {
        propose(SAP) from C to P;

} } }
```



OOI agent negotiation 5/5 (recursion)

```
type <yml> "SAPDoc1" from "SAPDoc1.yml" as SAP;

global protocol Negotiate(role Consumer as C, role Producer as P) {
  propose(SAP) from C to P;
  rec X {
    choice at P {
      accept() from P to C;
      confirm() from C to P;
    } or {
      reject() from P to C;
    } or {
      propose(SAP) from P to C;
      choice at C {
        accept() from C to P;
        confirm() from P to C;
      } or {
        reject() from C to P;
      } or {
        propose(SAP) from C to P;
        continue X;
      }
    }
```

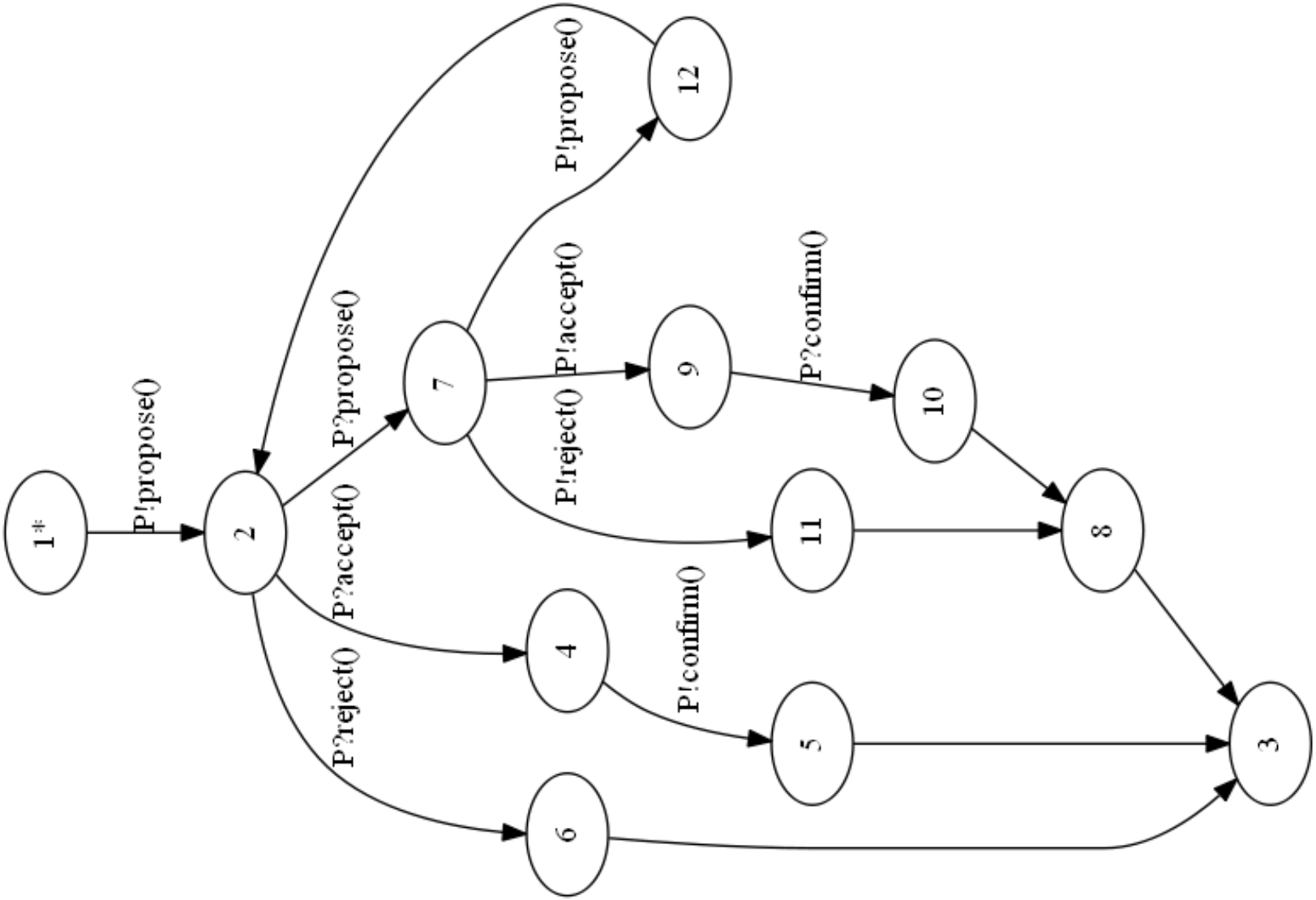


Local protocol projection (Negotiation Consumer)

```
// Global
propose(SAP) from C to P;
rec START {
  choice at P {
    accept() from P to C;
    confirm() from C to P;
  } or {
    reject() from P to C;
  } or {
    propose(SAP) from P to C;
    choice at C {
      accept() from C to P;
      confirm() from P to C;
    } or {
      reject() from C to P;
    } or {
      propose(SAP) from C to P;
      continue START;
} } }
```

```
// Projection for Consumer
propose(SAP) to P;
rec START {
  choice at P {
    accept() from P;
    confirm() to P;
  } or {
    reject() from P;
  } or {
    propose(SAP) from P;
    choice at C {
      accept() to P;
      confirm() from P;
    } or {
      reject() to P;
    } or {
      propose(SAP) to P;
      continue START;
} } }
```

FSM generation (Negotiation Consumer)



Scribble Community

- Webpage:
  - www.scribble.org
- GitHub:
  - https://github.com/scribble
- Tutorial:
  - www.doc.ic.ac.uk/~rhu/scribble/tutorial.html
- Specification (0.3)
  - www.doc.ic.ac.uk/~rhu/scribble/langref.html

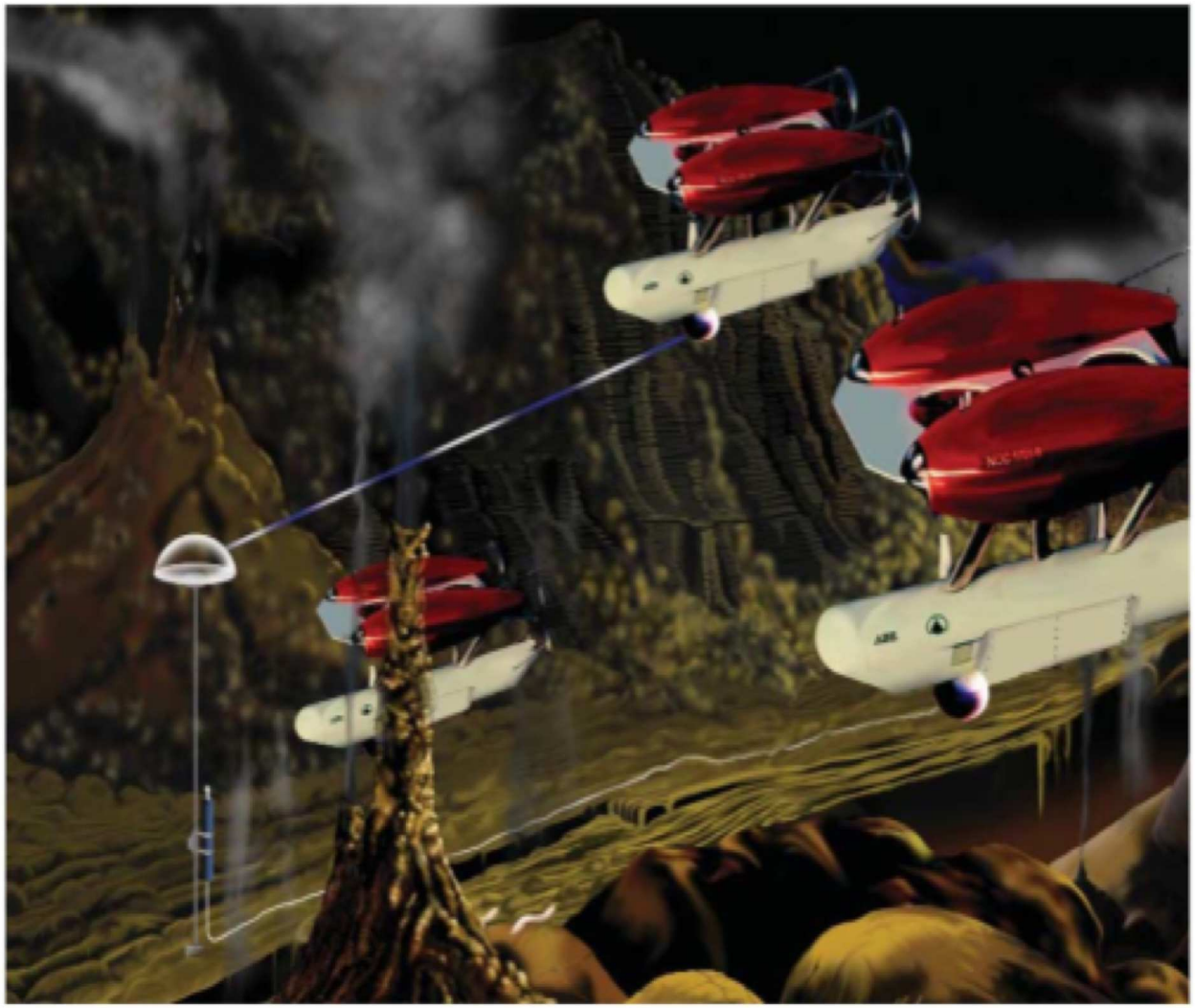


Figure 5: A coordinated set of autonomous underwater vehicles

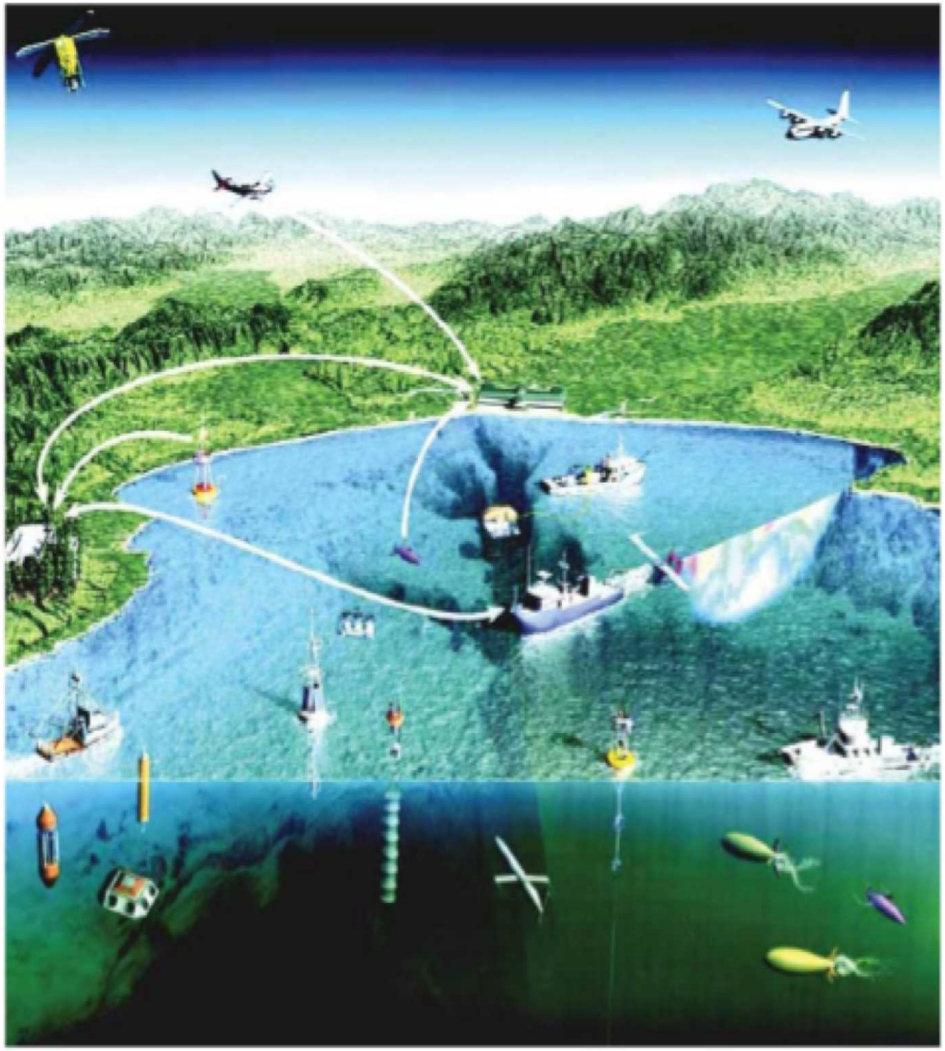


Figure 3: Observatory comprised of ships, aircraft and autonomous vehicles linked to assimilation modeling capabilities on shore

Ocean Observatory Initiative

CREATE ACCOUNT | SIGN I

SEARCH

RESOURCES

- All Resources
- Data Products ✓
- Observatories
- Platforms
- Instruments

Welcome to Release 2 of the Ocean Observatories Initiative Observatory (OOI). You already have access to many OOI features and real-time data. Just click on something that looks interesting on this page to start using the OOI as our Guest.

For personalized services, such as setting up notifications and preserving settings for your next visit, create a free account by clicking on "Create Account" at the top of the page.

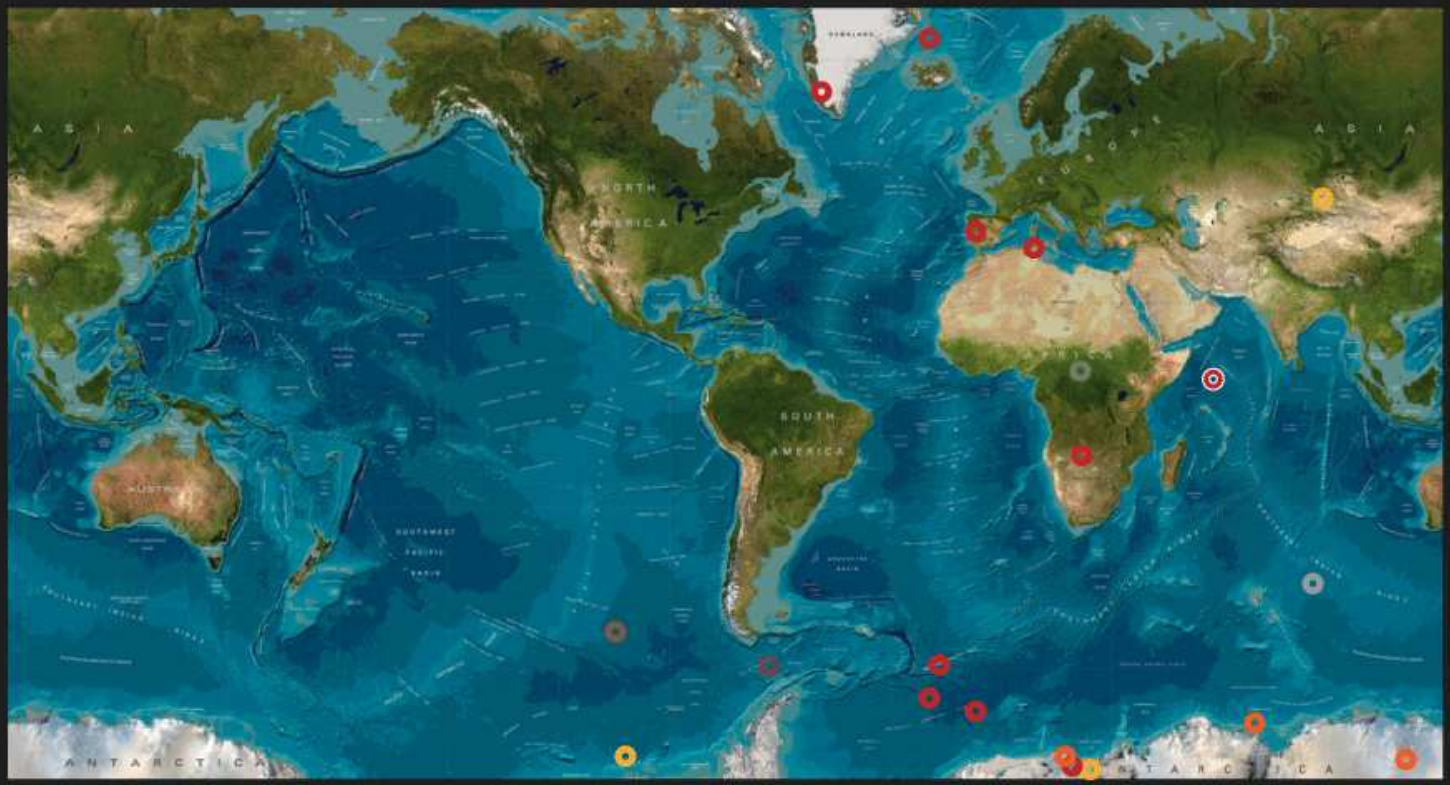
National Science Foundation working with *Consortium for Ocean Leadership*

Funding for the Ocean Observatories Initiative is provided by the National Science Foundation through a Cooperative Agreement with the Consortium for Ocean Leadership. The OOI Program Implementing Organizations are funded through sub-awards from the Consortium for Ocean Leadership.

Location

CURRENT LOCATION

FILTER



DATA LEGEND

- Temperature ✓
- Salinity
- Oxygen ✓
- Density
- Currents
- Sea Surface Height (SSH)
- Chlorophyll
- Turbidity ✓
- pH
- Seismology ✓
- Other ✓

RECENCY

1 Hour
2 hours
3 hours
5 hours
8 hours
12 hours
18 hours
24 hours
48 Hours
72 Hours

RECENT UPDATES

	NAME	DATE	TYPE	EVENT	DESCRIPTION	NOTE
01 m	Oregon Coast North Salinity	2012-01-10 23:55:55	Type	Event	Description goes here	Note goes here
01 m	California South 100m pH	2012-01-10 23:55:55	Type	Event	Description goes here	Note goes here
01 m	California South salinity	2012-01-10 23:55:55	Type	Event	Description goes here	Note goes here
03 m	Oregon North Turbidity	2012-01-10 23:55:55	Type	Event	Description goes here	Note goes here
05 m	Oregon SouthTemperature	2012-01-10 23:55:55	Type	Event	Description goes here	Note goes here
20 m	Oregon Coast Currents	2012-01-10 23:55:55	Type	Event	Description goes here	Note goes here
01 h	California South Seismology	2012-01-10 23:55:55	Type	Event	Description goes here	Note goes here
01 h	Oregon Coast South 1000m Ox	2012-01-10 23:55:55	Type	Event	Description goes here	Note goes here
02 h	California Coast Seismology	2012-01-10 23:55:55	Type	Event	Description goes here	Note goes here
04 h	California North Seismology	2012-01-10 23:55:55	Type	Event	Description goes here	Note goes here

FACEPAGE | RELATED | COMPOSITE | STATUS

Dashboard

RECENT IMAGES

Glider
Last Modified: 2011-06-15
Last Viewed: 2011-12-15
Last Updated: 2011-12-30, 13.24

Gorgonian Coral
Last Modified: 2011-06-15
Last Viewed: 2011-12-15
Last Updated: 2011-12-30, 13.24

Acoustic Release
Last Modified: 2011-06-15
Last Viewed: 2011-12-15
Last Updated: 2011-12-30, 13.24

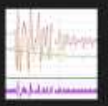
POPULAR RESOURCES

SeaBird CDT
Last Modified: 2011-06-15
Last Viewed: 2011-12-15
Last Updated: 2011-12-30, 13.24

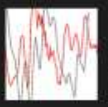
Marine caption
Last Modified: 2011-06-15
Last Viewed: 2011-12-15
Last Updated: 2011-12-30, 13.24

Surface Buoy
Last Modified: 2011-06-15
Last Viewed: 2011-12-15
Last Updated: 2011-12-30, 13.24

UNUSUAL EVENTS



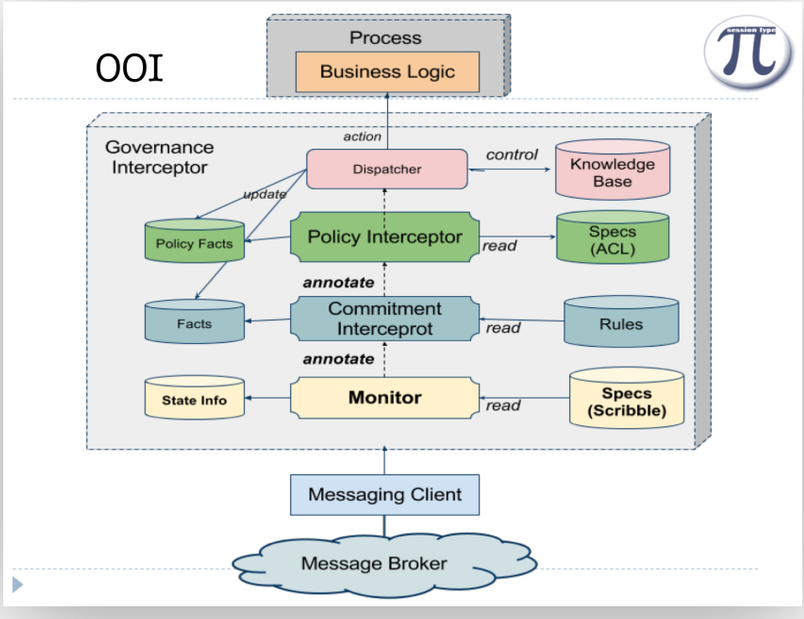
Oregon Coast Wave Heigh
Last Modified: 2011-06-15
Last Viewed: 2011-12-15
Last Updated: 2011-12-30, 13.24



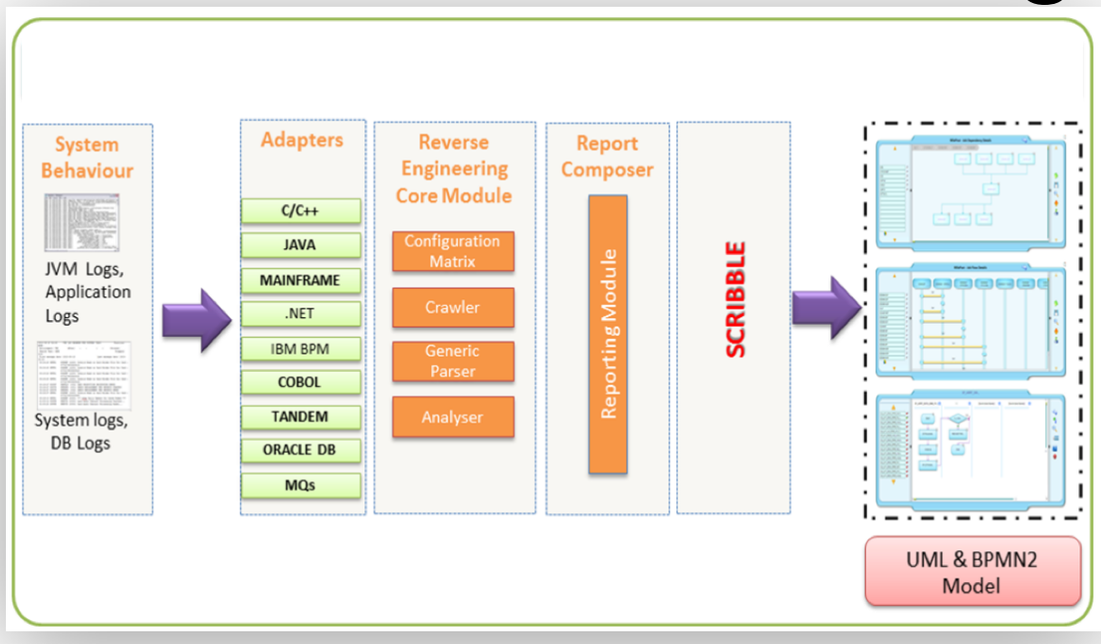
Water Surface Elevation
Last Modified: 2011-06-15
Last Viewed: 2011-12-15
Last Updated: 2011-12-30, 13.24

Applications

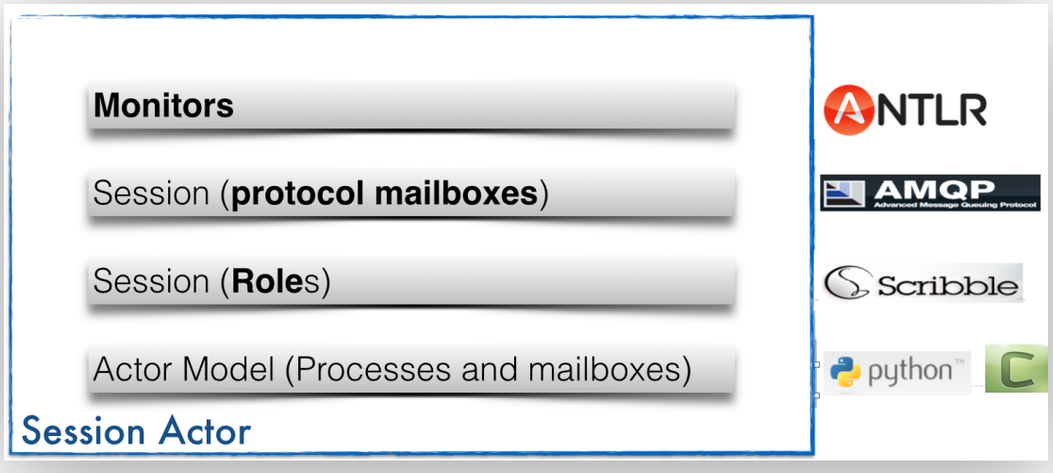
OOI Governance



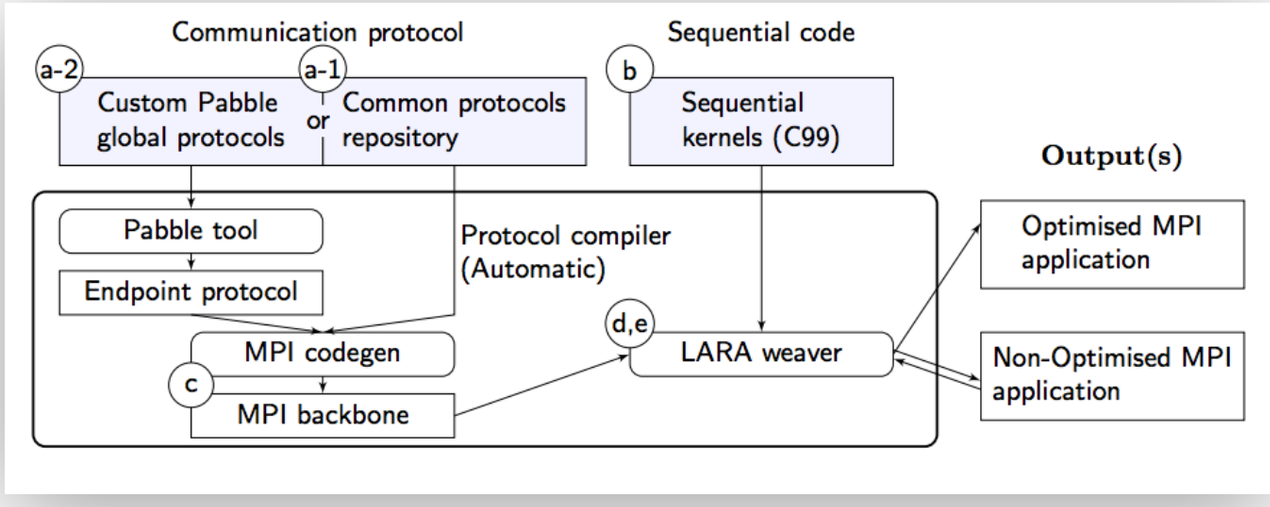
ZDLC: Process Modeling



Protocol Verification

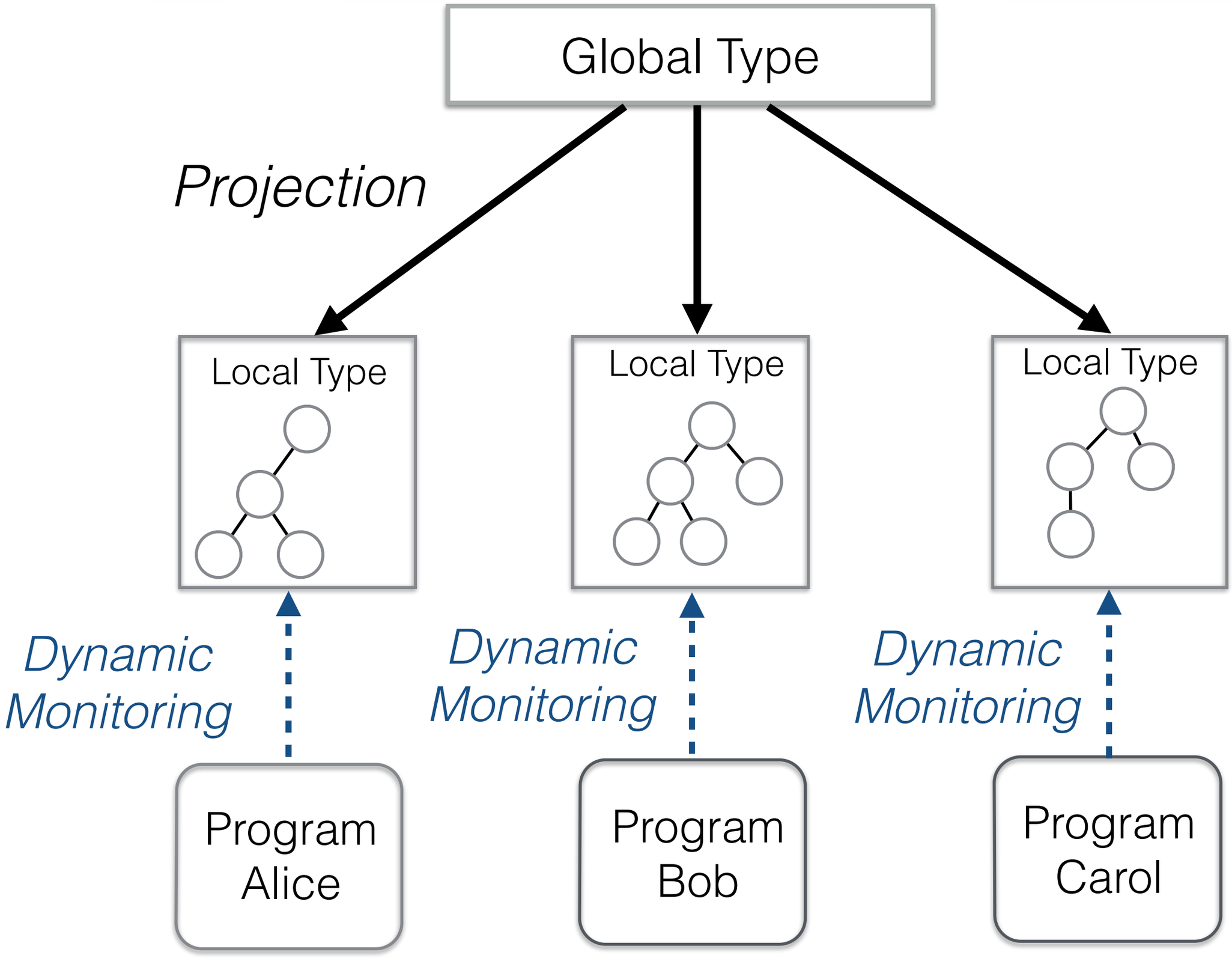


MPI code generations

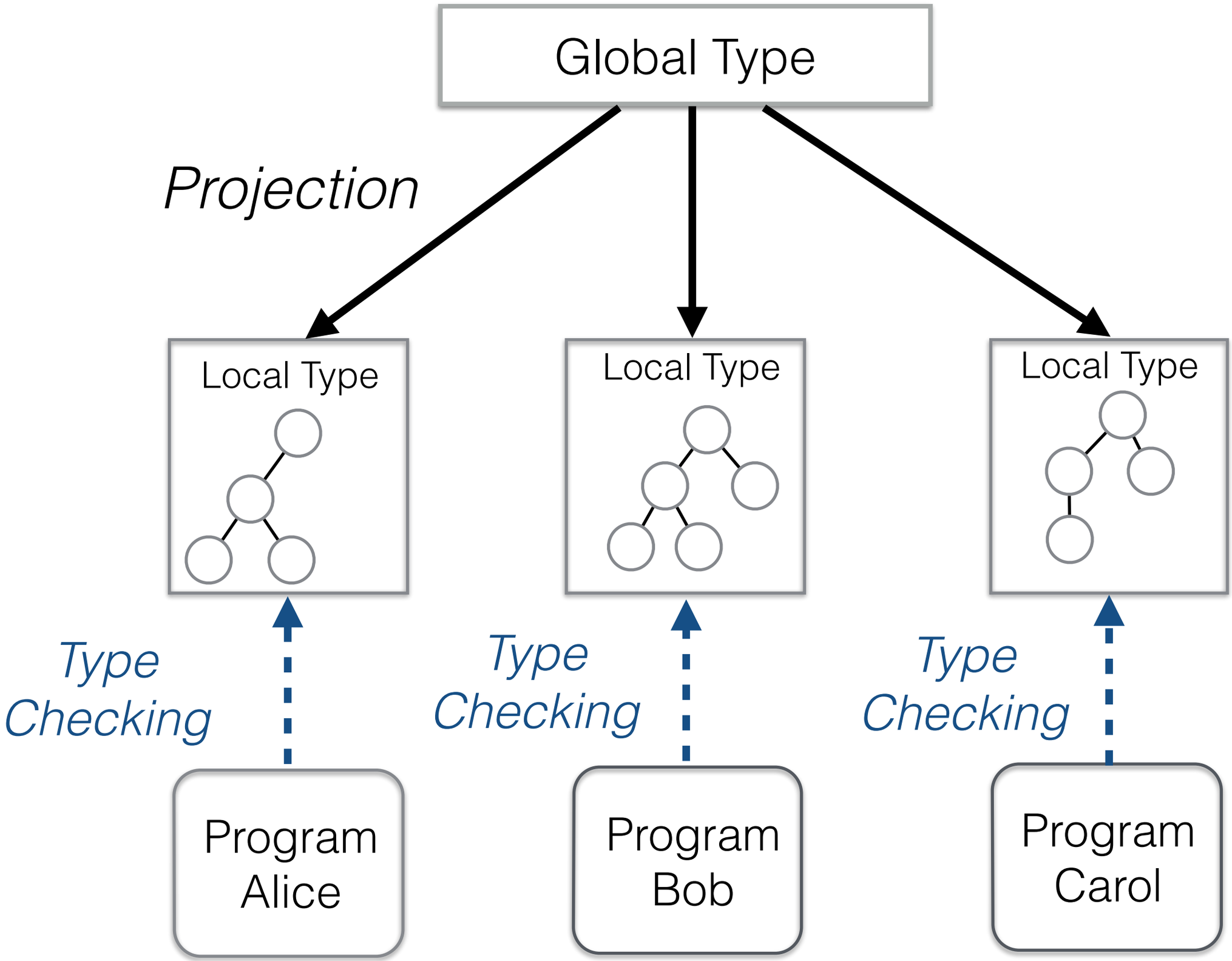


Dynamic Monitoring

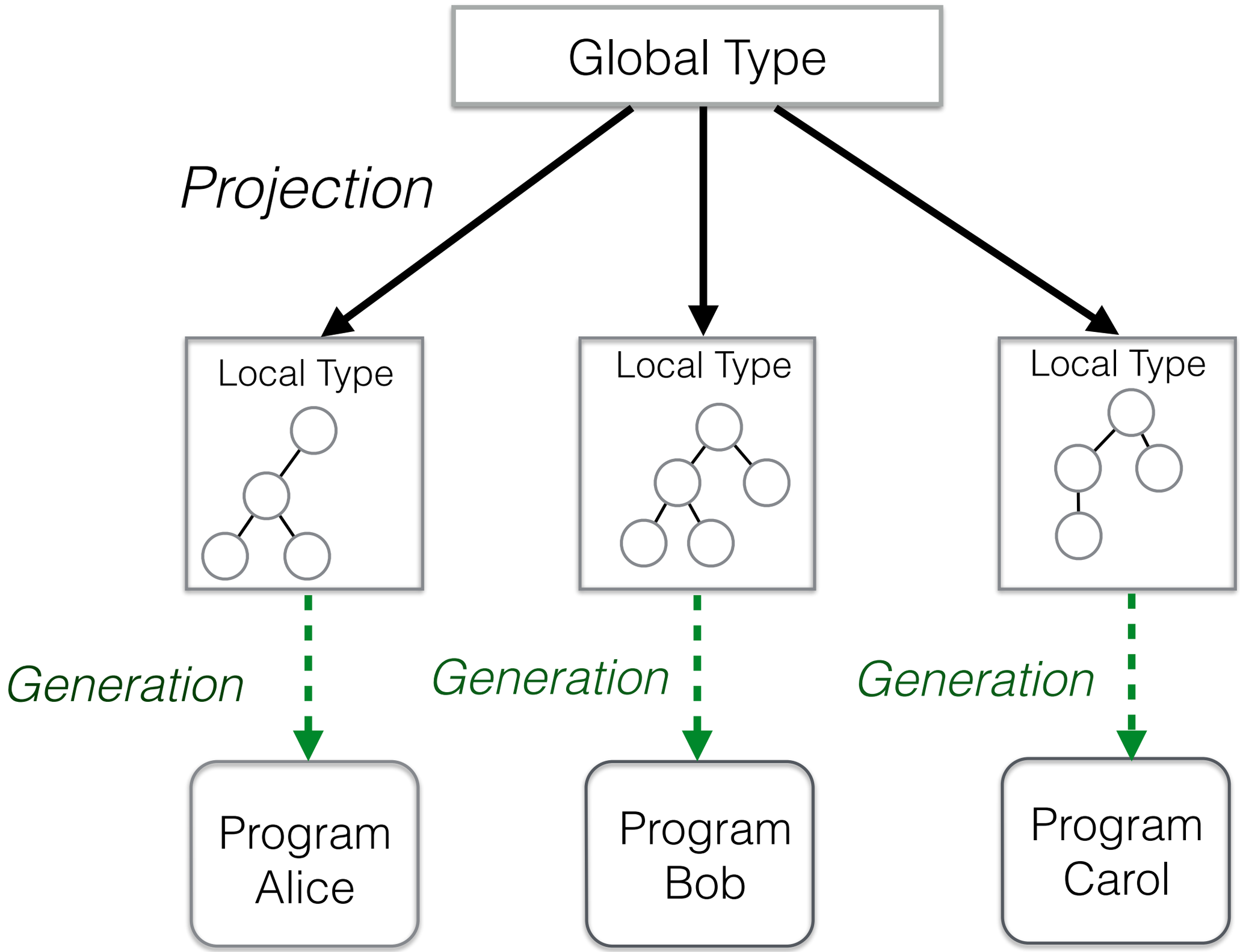
[RV'13, COORDINATION'14, FMSD'15]



Type Checking [OOPSLA'15, POPL'16]

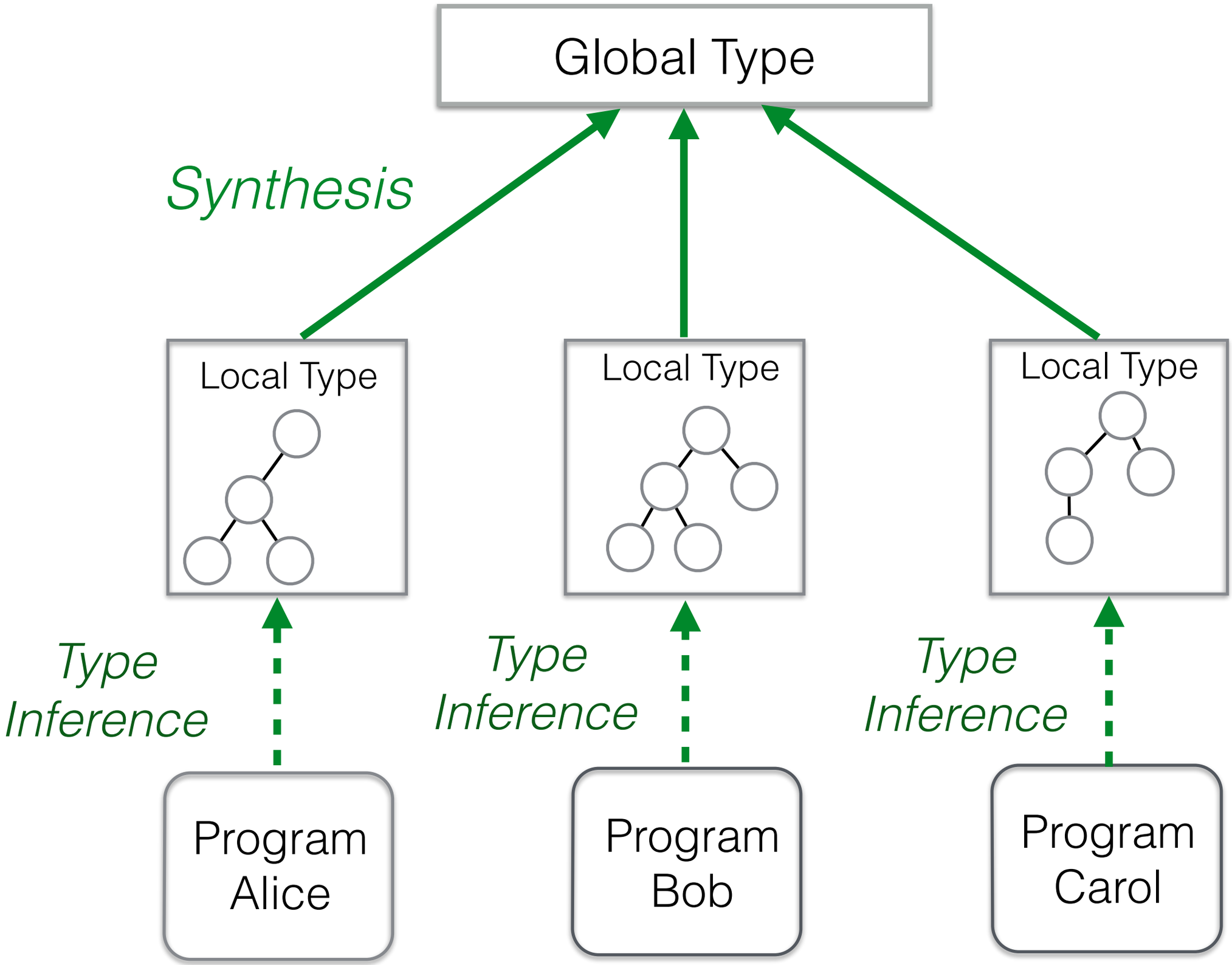


Code Generation [CC'15, FASE'16]



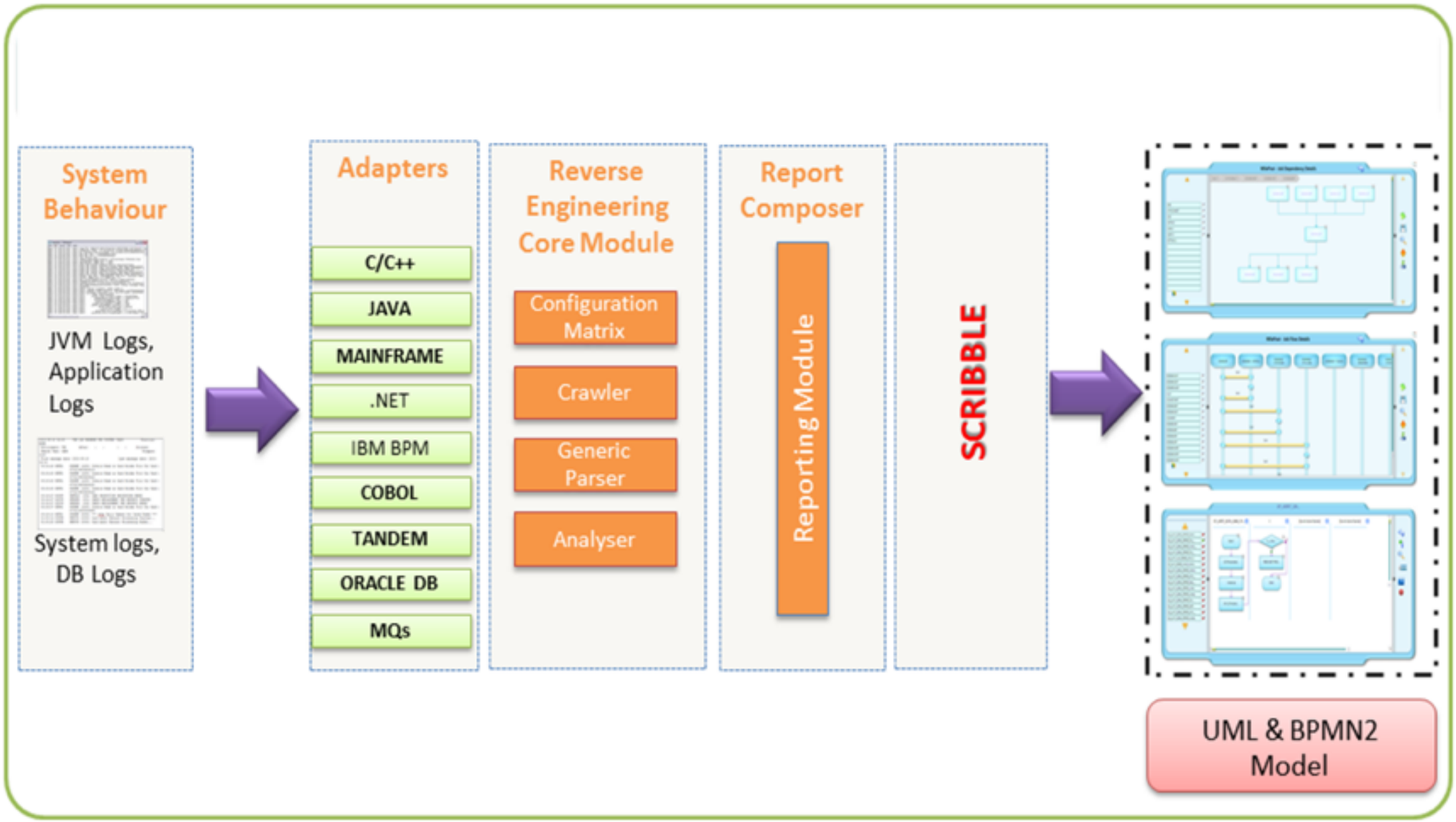
Synthesis

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

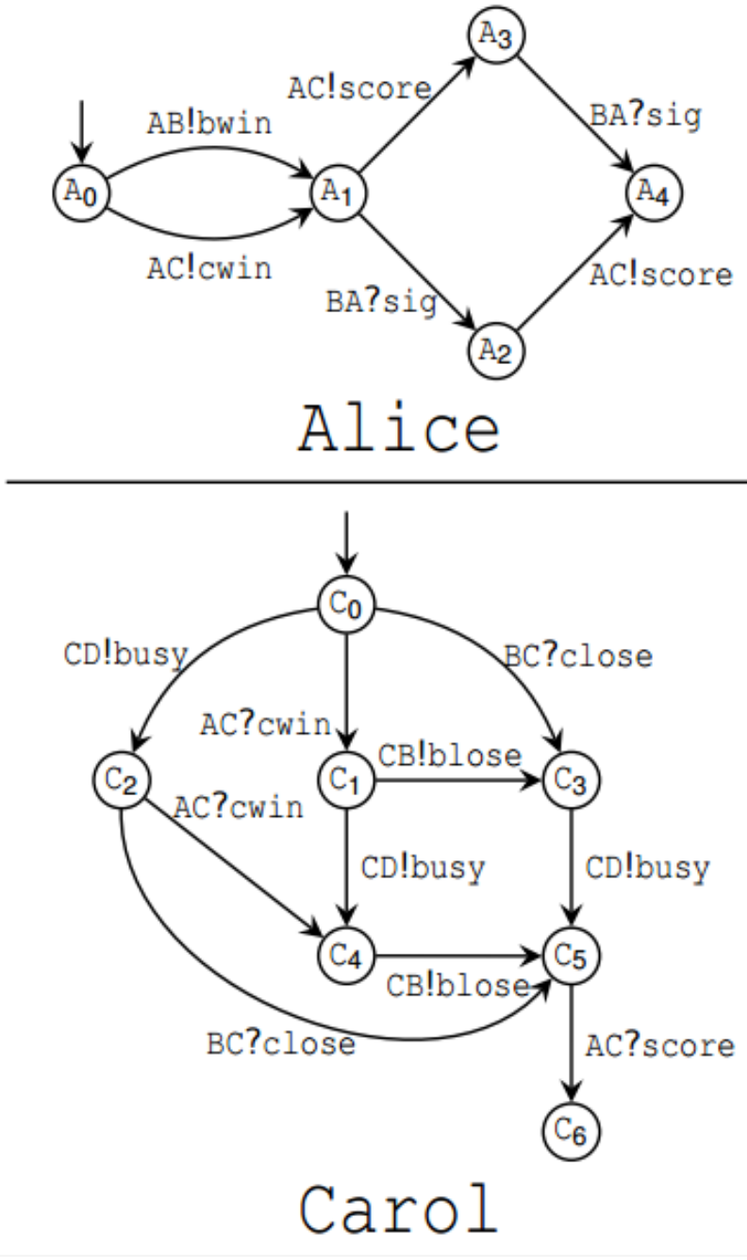


http://www.zdlc.co/faq/

Zero Deviation Life Cycle Platform



From Communicating Machines to Graphical Choreographies [POPL'15, CONCUR'15]



[ESOP'10,ESOP'12,CONCUR'12,CONCUR'14]

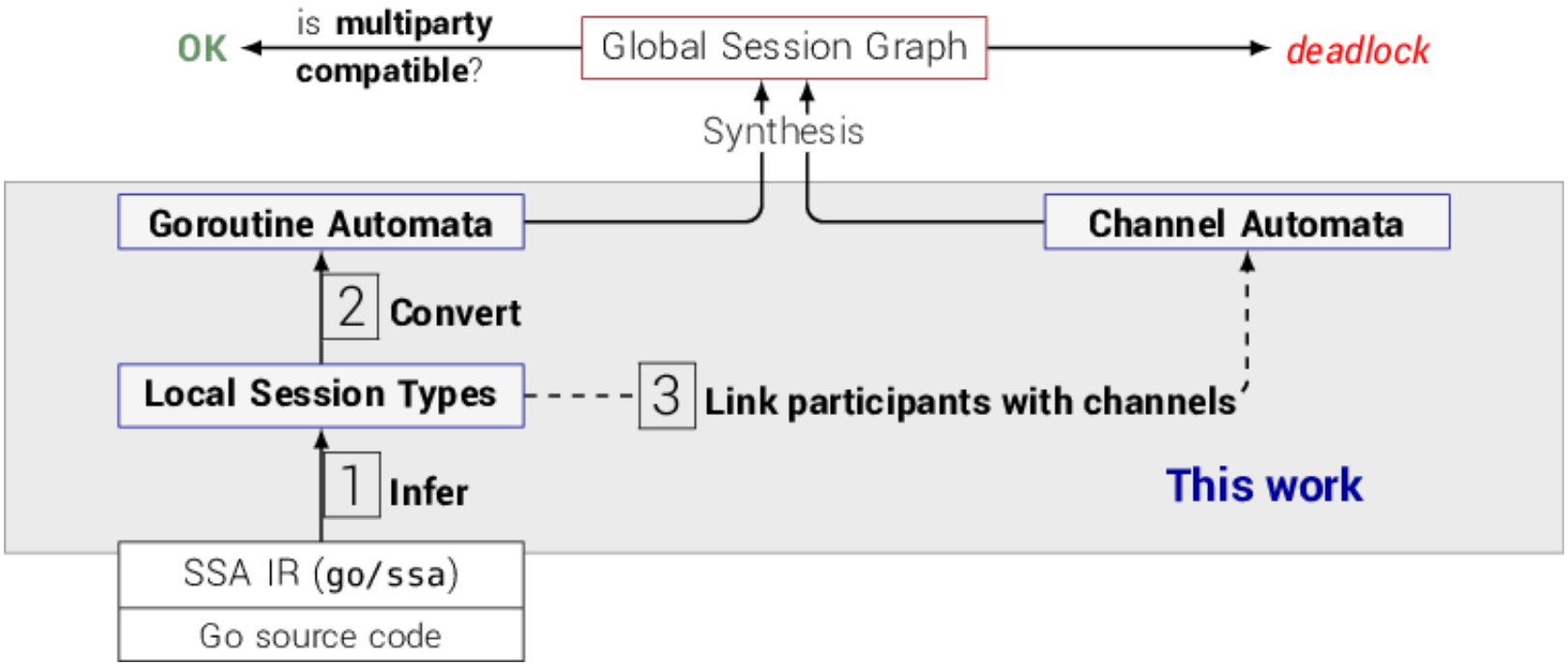
Go and Concurrency

- Developed by Google for multi-core programming
- Concurrency model built on CSP (process calculi)
- Message-passing **communication** over channels

" *Do not communicate by sharing memory*; *instead*, *share memory by communicating*. "
-- Effective Go (developer guide)

Contributions

- Static deadlock detection tool *dingo-hunter*
- Deadlock detection based on session types
- **Infer** session types as Communicating Automata
- **Synthesise** global session graphs from CA



HAPPY BIRTHDAY

FRANK