Intent-Driven Networks
Challenges and Enablers

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NOKIA

Agenda

1 Why

Intent driven networking is important

2 What

Definitions and activities

3 How

Challenges and enablers

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Challenges and enablers

Our industry challenge is network complexity

Complexity

- is inherent to network as a system of (distributed) systems
- will not disappear
- will grow…

The more we enable and expose new data and behaviors, the more we create complexity

Complexity is good

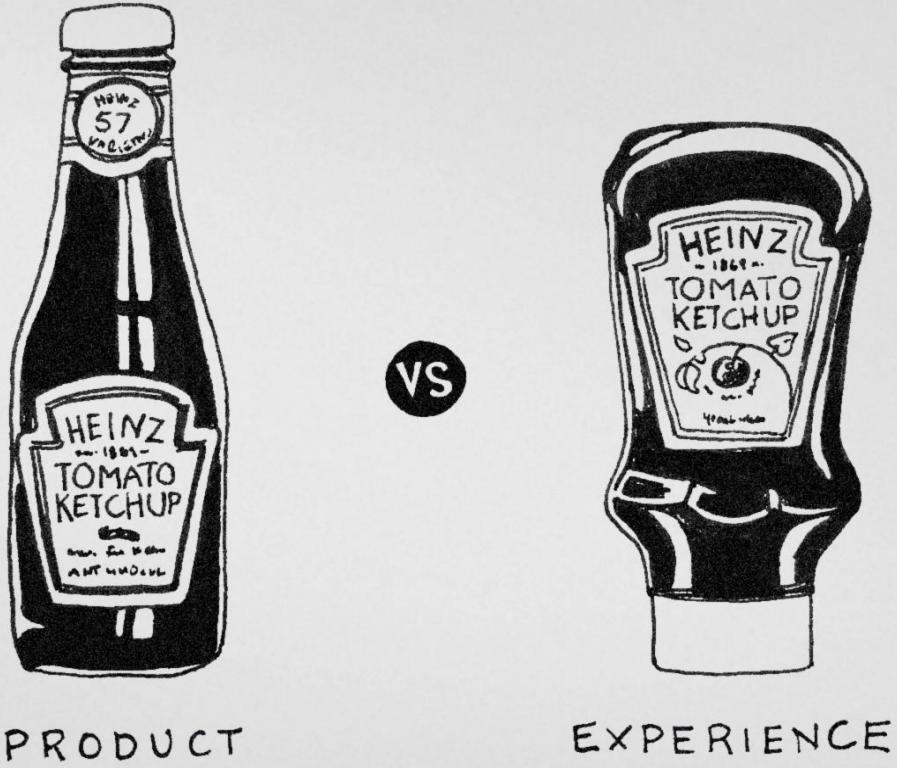
- machine learning and reasoning have their roots in complexity
- machine learning and reasoning are key elements of the solution

Complexity can be tamed

- think autonomics as a mean to hide/reduce complexity of network (micro-)management and related operations
- think agent based modeling
- think distributed problem solving
- think abstractions
- etc.

The problem…

We choose the wrong bottle of ketchup !


HEINZ
57
HEINZ
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VS
HEINZ
1869
TOMATO
KETCHUP
PRODUCT
EXPERIENCE

Networks need a radical shift in usability

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Enabling a shift in usability

Recognize intentions in any form of data

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Enabling a shift in usability

Intelligence drives automation and adaptation

Enabling a shift in usability

Accountable for decisions and efficiency

The promises of intent-driven networks

Performance gain

- 1 intent = 1000's command lines
- alleviate the (imperative) policy explosion problem
- lower personal training

Create time!

Functionality gain

- simpler (?) policy conflict detection and resolution
- greater flexibility in system response

More challenging to identify (and quantify) but respectively more important

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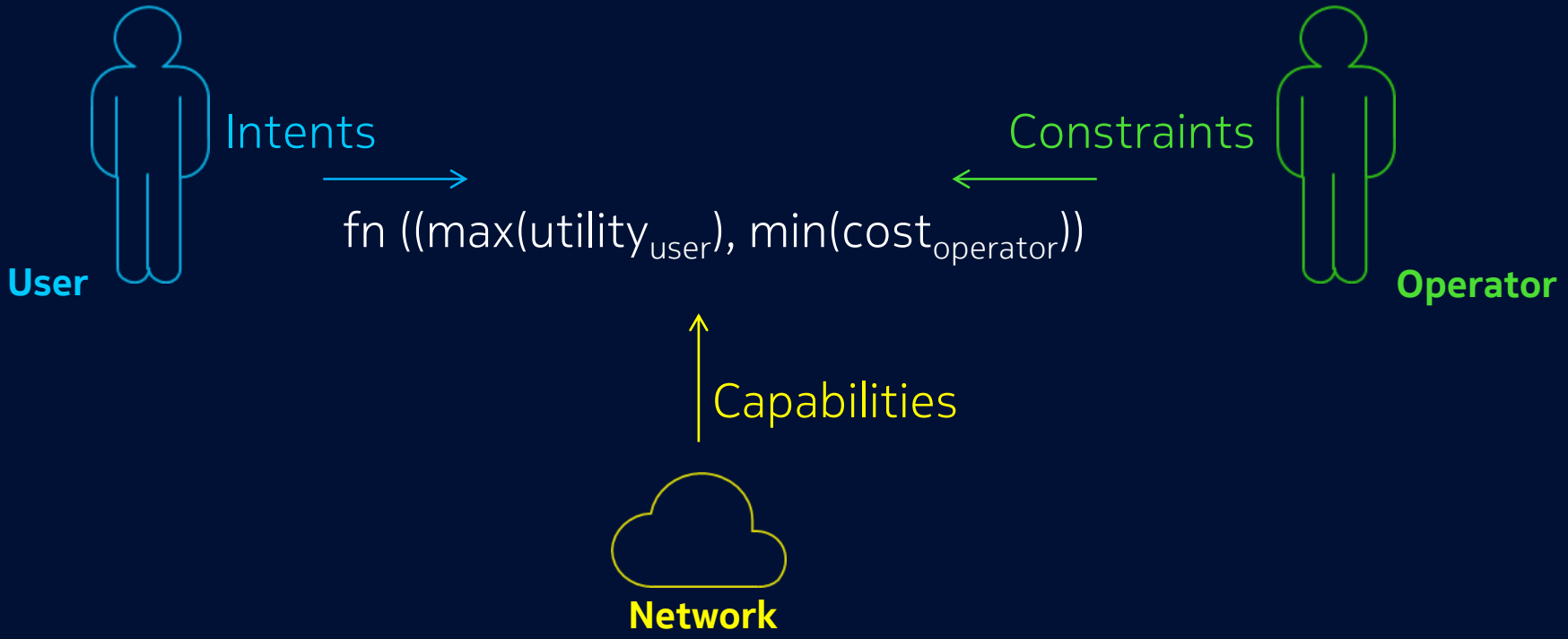
Intent = what not how

Intent-driven networks

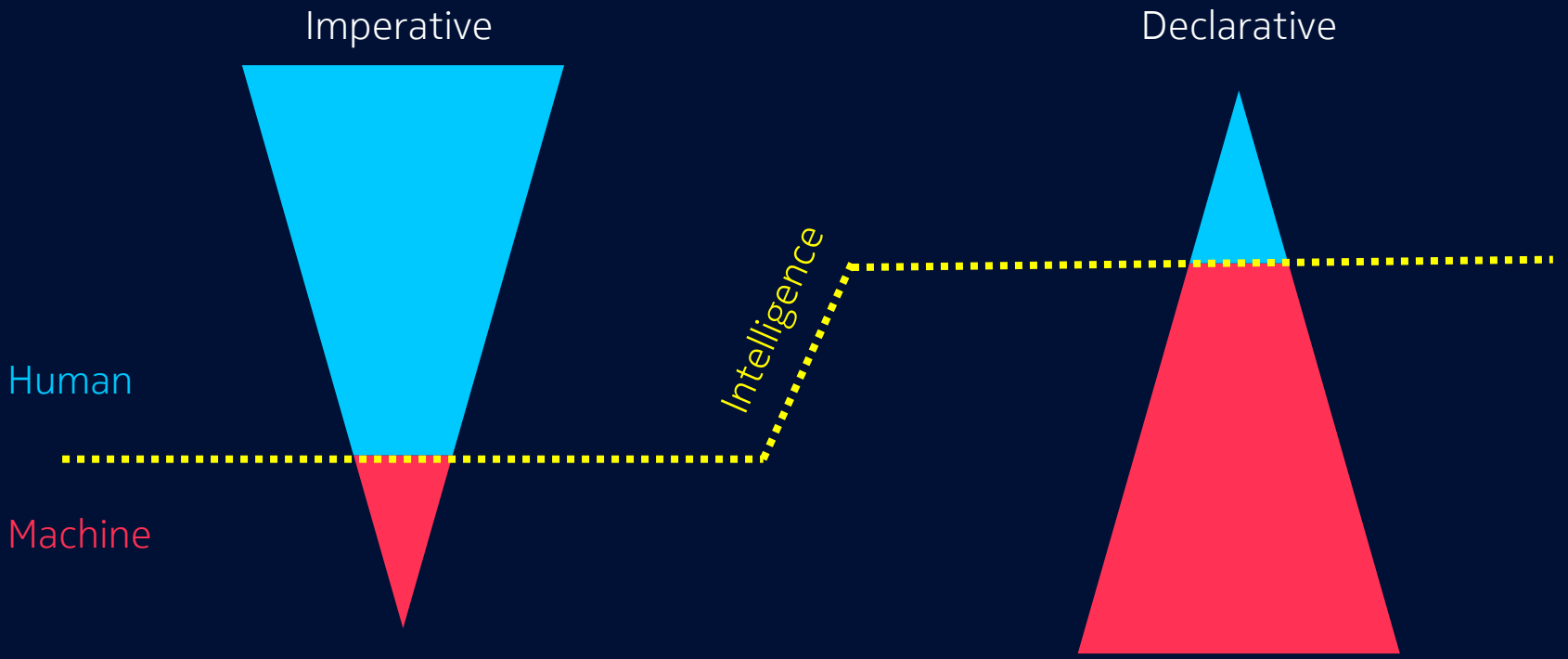
Networks configuring and **adapting autonomously to the user or operator intentions** (i.e., a desired state or behavior)

without the need to specify every technical detail of the process and operations to achieve it (i.e., **the "machines" will figure out on their own how to realize the user goal**).

Intent as an envelope of utility function



Intent as a declarative policy



from J. Strassner

Imperative policy

Event – Condition – Action (ECA)

Explicit programming of state

→ rationality is compiled into the policy !

Pros: can be simple, system knows exactly what to do

Cons: explosion of policies #, conflict detection and resolution can be very difficult, difficult to read, complex to write

Declarative policy

from J. Strassner

Express what should be done, not how to do it

Specifies criteria for choosing a set of states

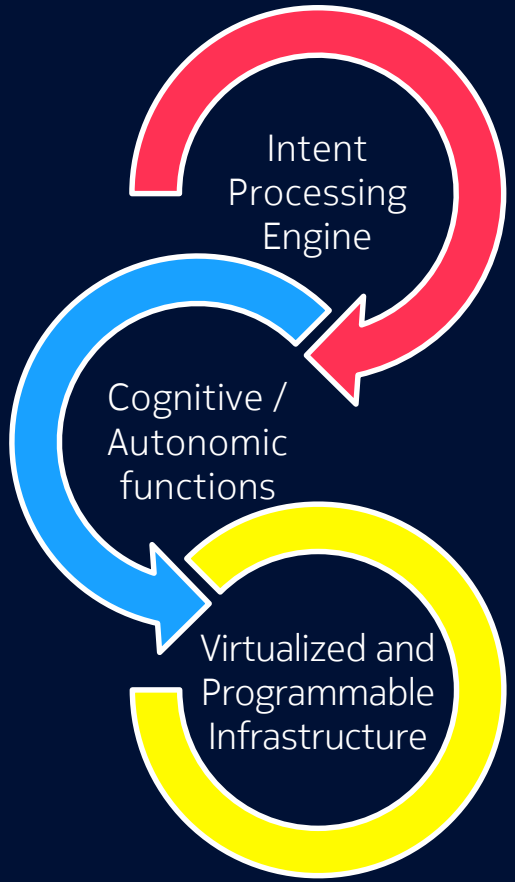
→ rationality is generated by optimizer/planner

Pros: more abstract, potentially more flexible, fewer, easier to write and comprehend

Cons: requires sophisticated translation and optimization modules

Intent Driven Networks
Ingredients

Ingredients



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Ingredients mix

Autonomic functions

- intermediate abstraction points in the policy continuum
- level(s) of autonomy to understand and react on intents

  → self-adaptation and self-organization properties

Ingredients mix

Software infrastructure

- 2 root classes of actions: install, (re-configure)
- if pre-determined capabilities
  → discovery and configuration (by autonomic functions)

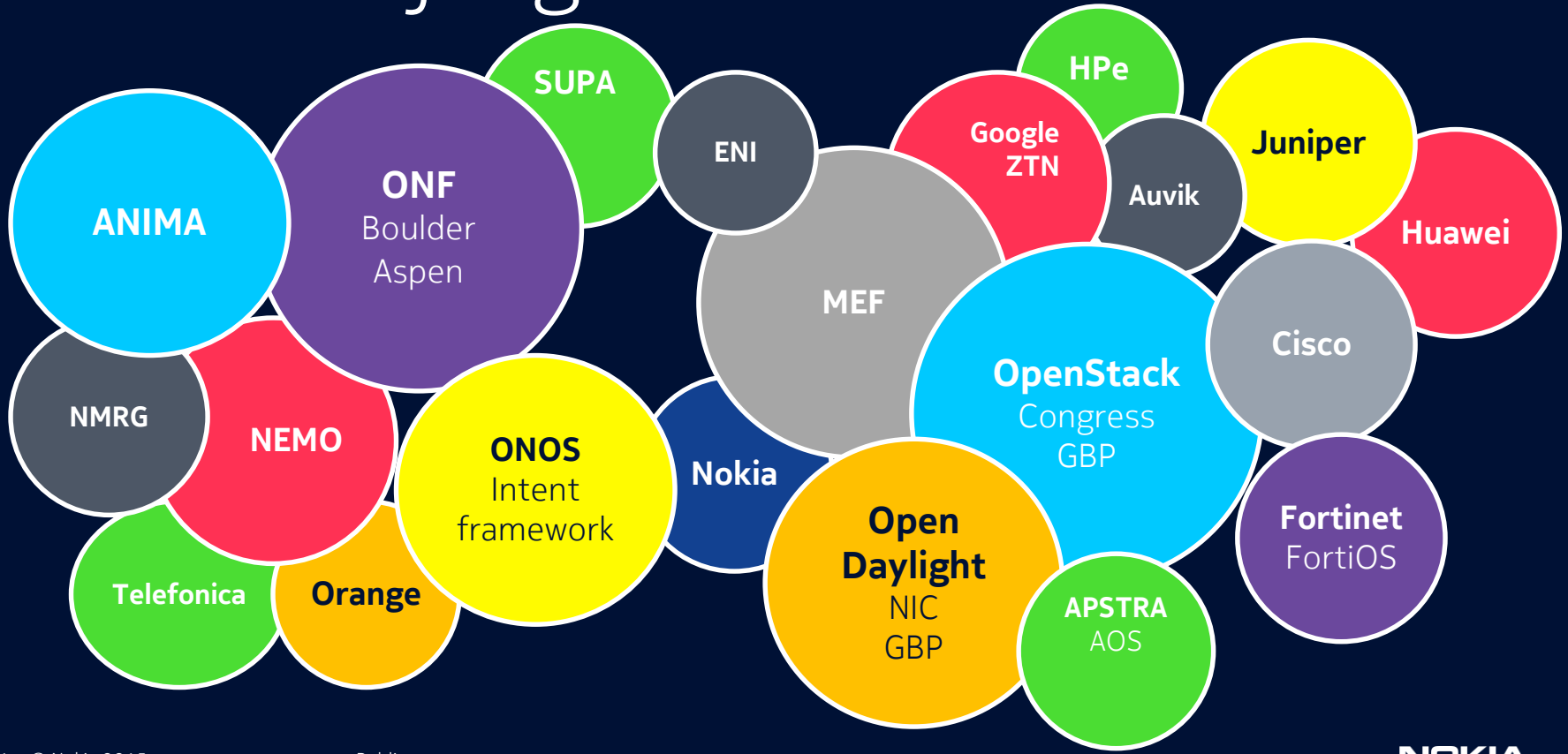
- if virtual and programmable
  → function placement, function composition

You need more than good ingredients to make a good cake

We are now writing the cook book for intent driven network

The intent jungle

The intent jungle



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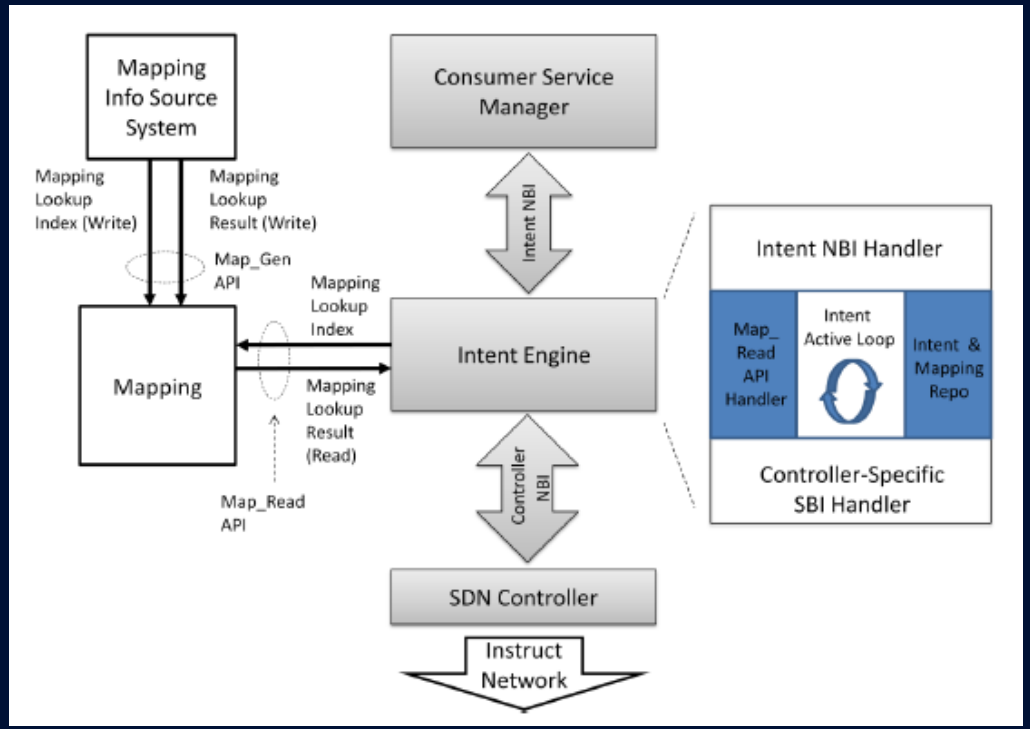
Open Networking Foundation (ONF)

A reference document:

Intent NBI – Definition and Principles

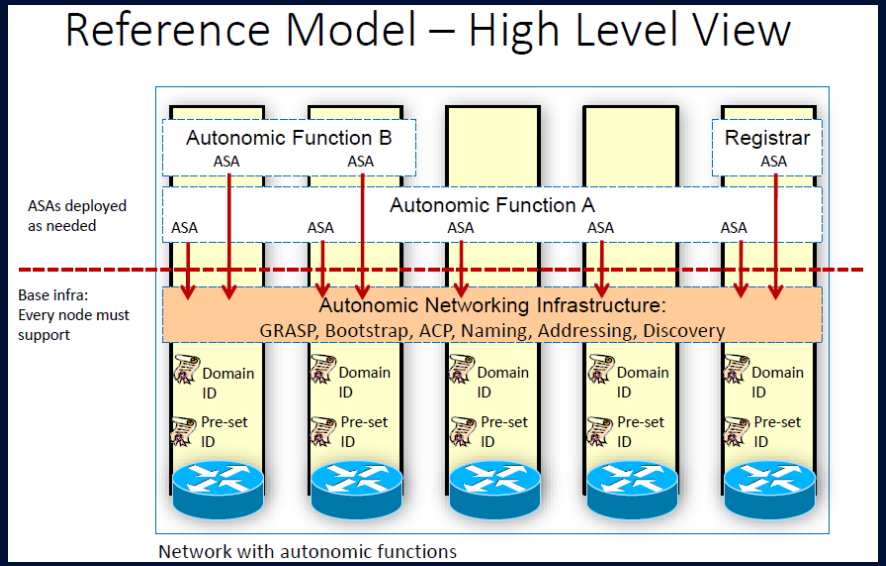
https://www.opennetworking.org/images/stories/downloads/sdn-resources/technical-reports/TR-523_Intent_Definition_Principles.pdf

Open Networking Foundation (ONF)



IETF ANIMA working group

Standardizing a reference framework and protocols for autonomic networks.



https://datatracker.ietf.org/wg/anima/documents/

IETF ANIMA working group

An abstract, declarative, high-level policy used to operate an autonomic domain

(as per draft-ietf-anima-reference-model-04 and RFC7575)

Intent lifecycle

One Autonomic Network = Multiple Intents

One Intent = Multiple Outputs

Network operators/administrators writes Intents

Autonomic Functions define what Intents they understand

IETF ANIMA working group

Examples of intents (not ANIMA specific)

- -Do the right thing
- -Freeze network enrollment
- -Arrange VM guest distribution so that (CPU) utilization is < 70%
- -Assign prefixes to RAN nodes
- -Protect premium users traffic
- -Maximize energy savings

Observations

A proper analysis would require a complete survey of all these initiatives and contributions. **Volunteers?**

Highly fragmented space, common denominator very small

Most preeminent work on “Intent for SDN” addressing essentially a pure connectivity need

Interestingly, “Intent for NFV” has a quite low activity threshold

Scientific literature is scarce or spread over multiple domains / disciplines

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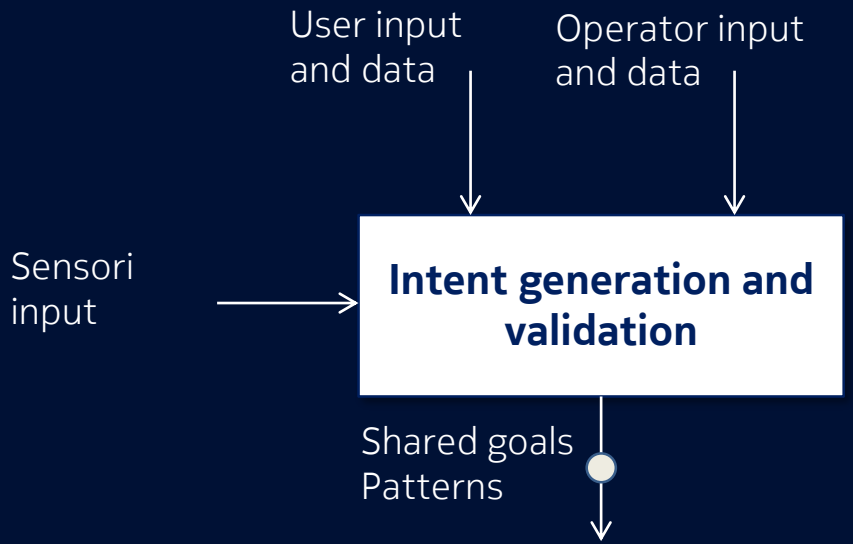
Challenge 1



Ability to learn and reason on intent sets

(some) Research directions

Natural Language Processing (NLP)

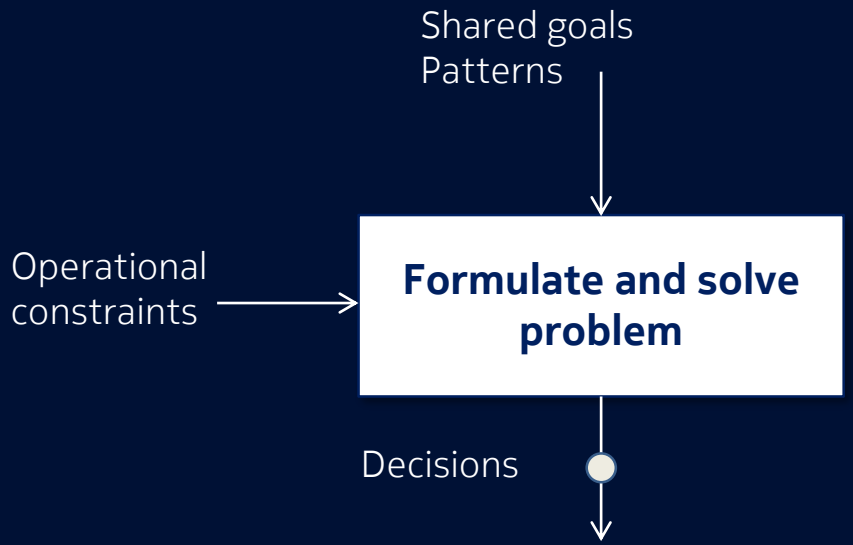
Ontologies and semantic analysis

Lazy learning

Knowledge representation and building:

- Languages, templates, models…
- graph databases, data dependencies…

Challenge 2



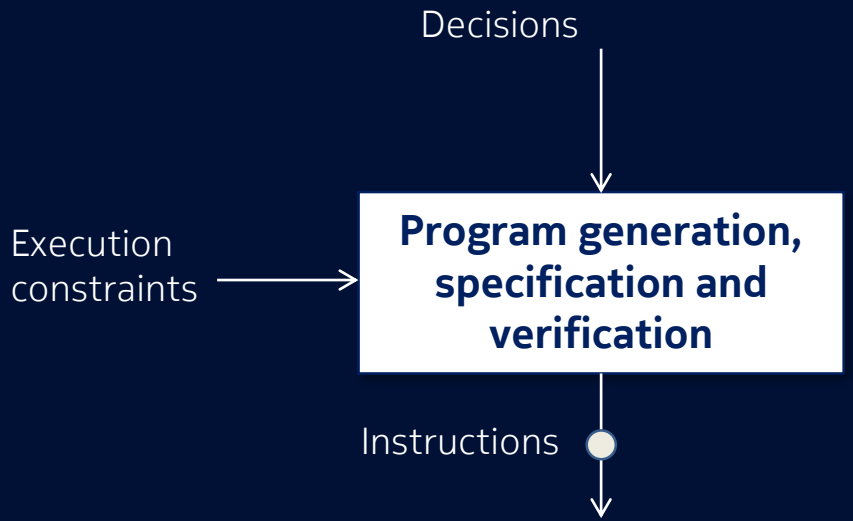
Ability to optimize and re-optimize decisions

(some) Research directions

Automatization of the generation of resolution methods (by decomposition)

Learning on choice of resolution method based on theoretical gain

Challenge 3



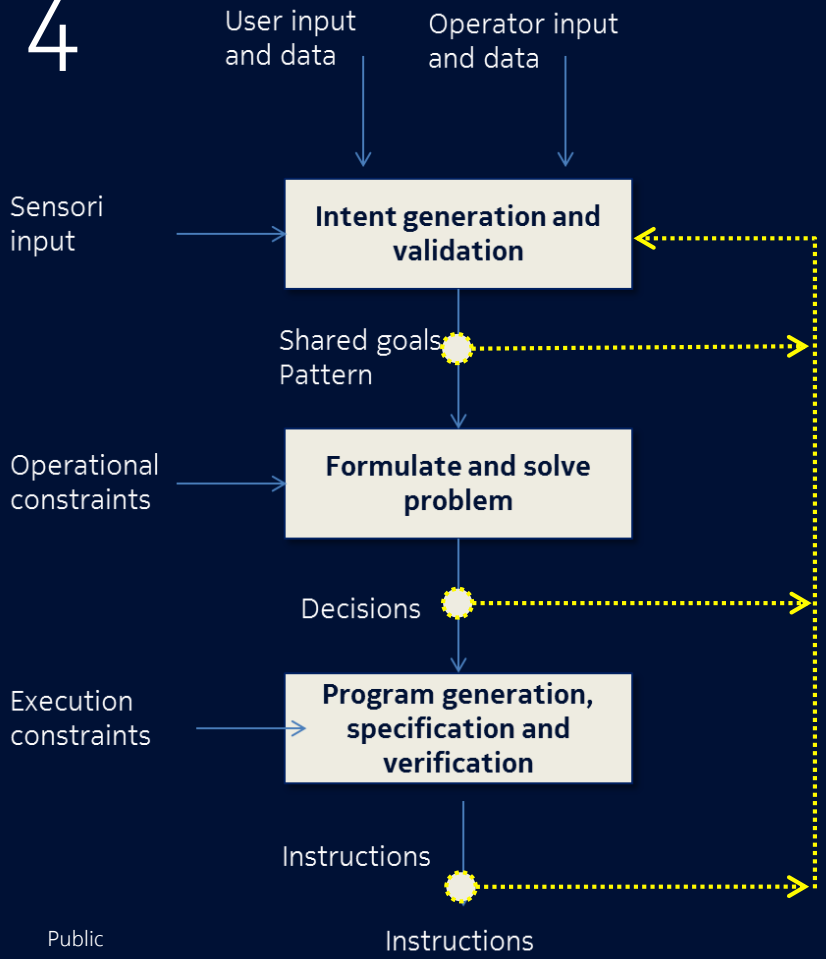
Ability to generate and verify programs

(some) Research directions

Automatic program generation

Program distribution towards agents and collective decision process on resolution approach considering local/global variables and constraints

Challenge 4



Control points and run-time assessment mechanisms

(some) Research directions

Quality of Intent (QoI) evaluation framework

Self-evaluation, self-testing mechanisms

Increased role for telemetry and analytics

and many other interesting things

Intent checking, normalization

Intent recommendation, learning, optimization

Intent extraction out of CLIs

Multiple sources, formats, time and space of intents

More or less explicit / implicit formulation of intents

Scale the problem by one order of magnitude

...IoT...

Conclusion