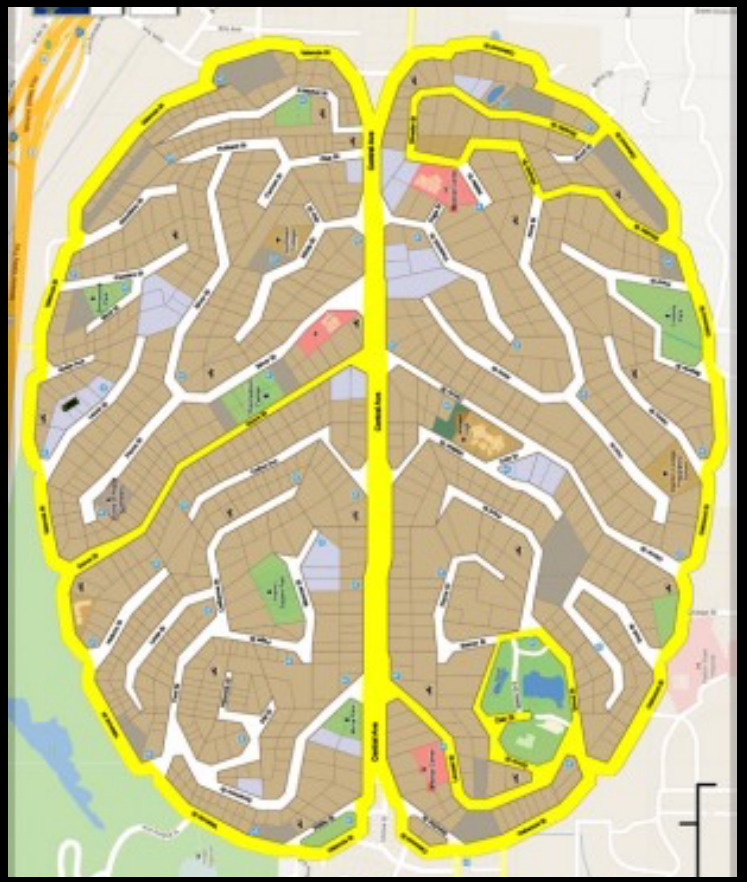
Síntesis de Controladores Discretos
(o sobre cómo anticiparse a lo inesperado)

CIMS3 - Sebastian Uchitel, Universidad de Buenos Aires

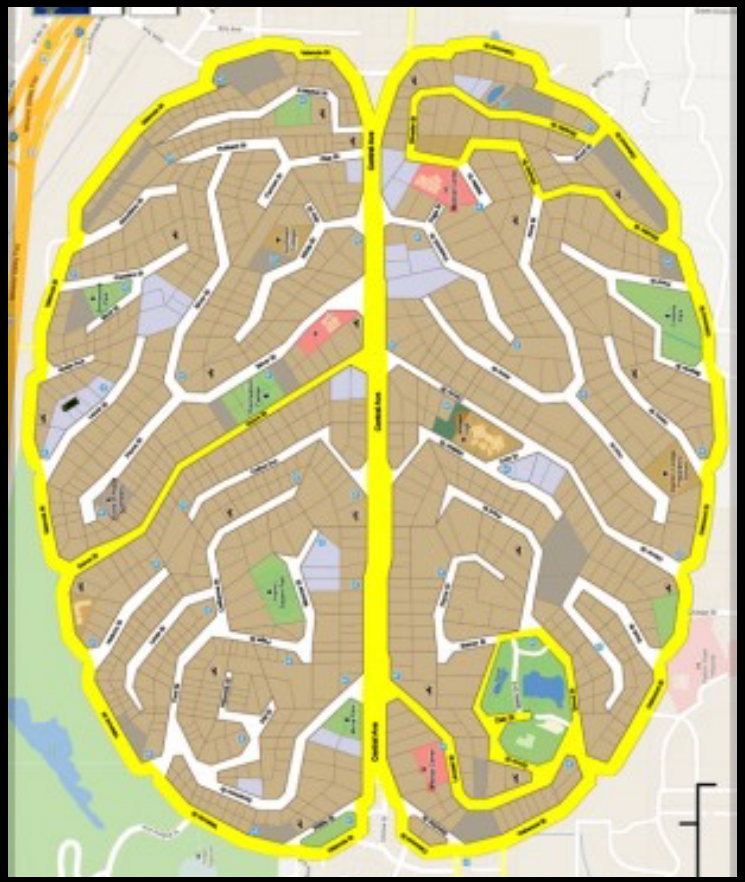
Ciudades Inteligentes

- Sensores y actuadores distribuidos ubicuamente
- Sistema de comunicación de alta cobertura (y confiable?)
- Software de control sofisticado
- Modelos de predicción complejos



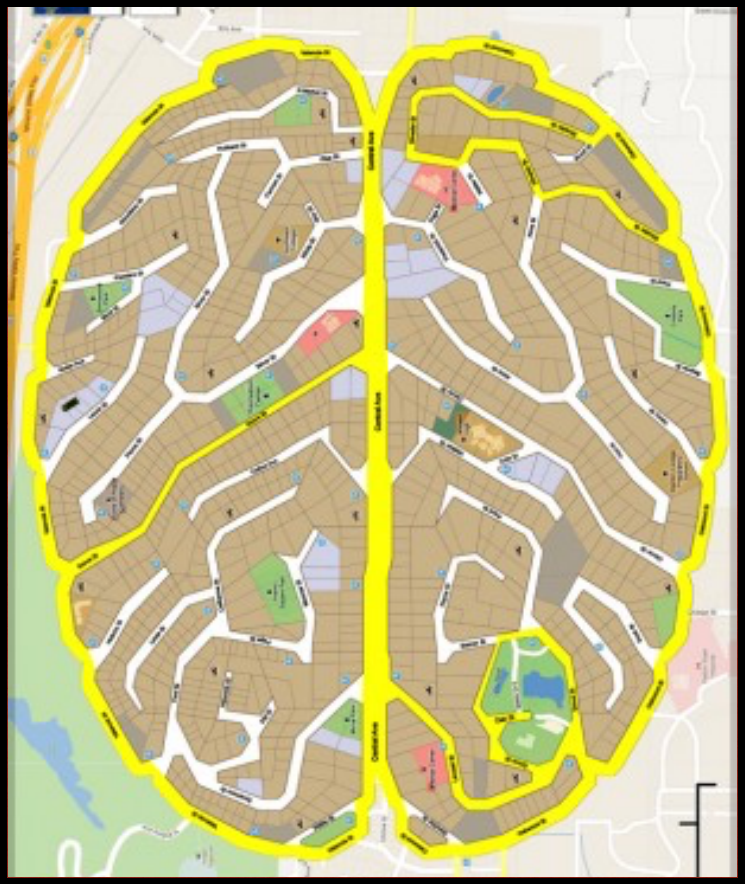
Ciudades Inteligentes

Un mundo de oportunidades!



Ciudades Inteligentes

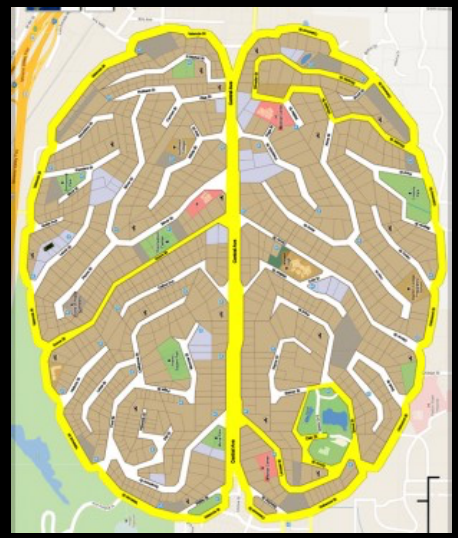
Un mundo de oportunidades!



Enfoque Clásico de Ingeniería de Software

(Versión simplificada y algo cínica)

1. Identificar los requerimientos
2. Desarrollar el sistema
3. Testearlo (un poco)
4. Ponerlo en producción

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LA CIUDAD DE HUMO
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LA CIUDAD DEL HUMO
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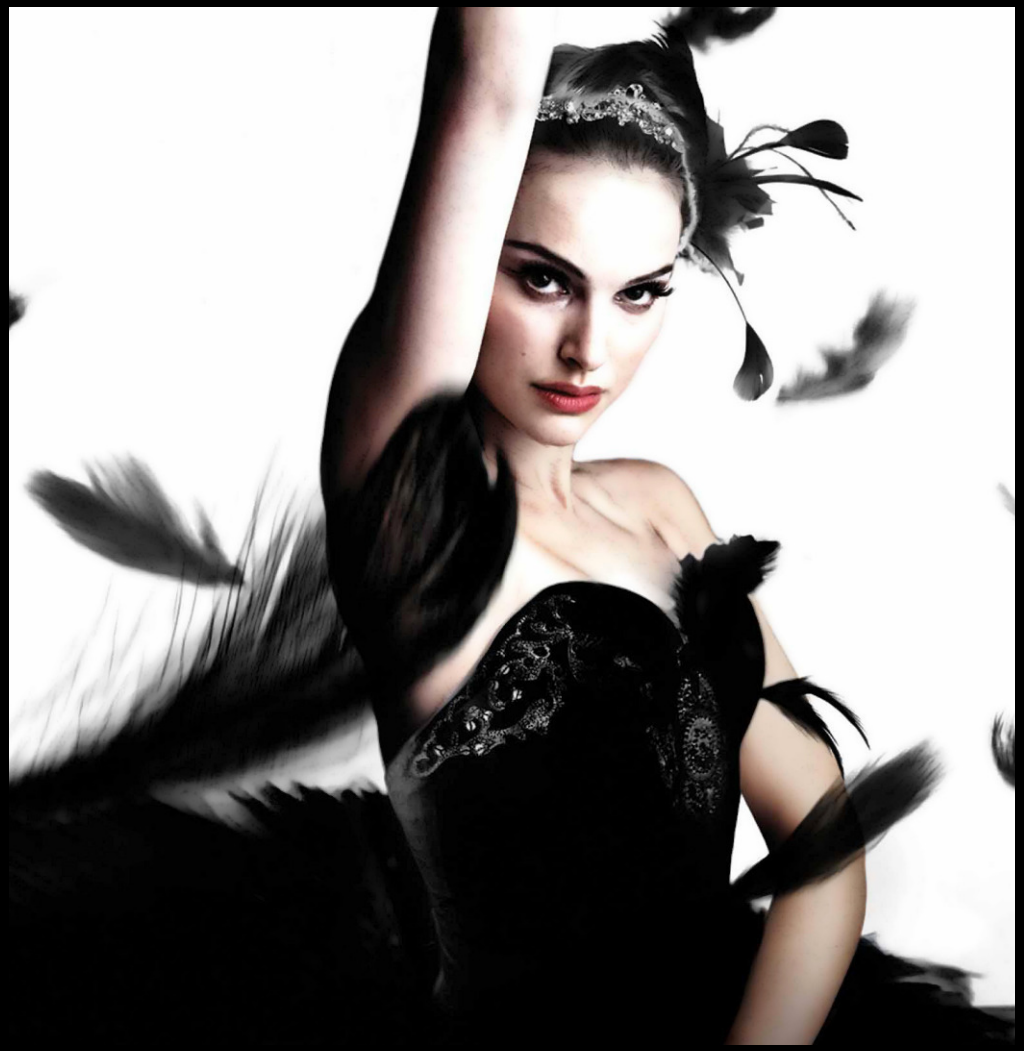
S DE ESTAR PRESO EN MARCOS PAZ, LUIS PATTI RECUPERÓ

Enfoque Clásico ante un evento inesperado

1. Pensar en qué pasó y los requerimientos nuevos
2. Modificar el sistema
3. Testearlo (un poco)
4. Ponerlo en producción


Softwatch
Salvador Dalí
www.todocoleccion.net



NASSIM NICHOLAS TALEB

EL CISNE NEGRO

El impacto de lo altamente improbable

DIVULGACIÓN

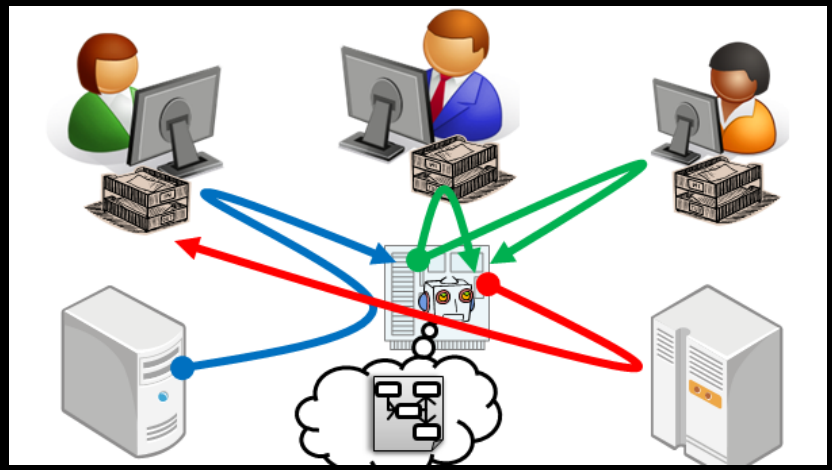
booket

Cómo diseñamos
sistemas adaptativos?
ser *modificados en tiempo de ejecución*
para lidiar con
cambios no previstos en tiempo de diseño

Adapting to Changes Unforeseen at Design Time

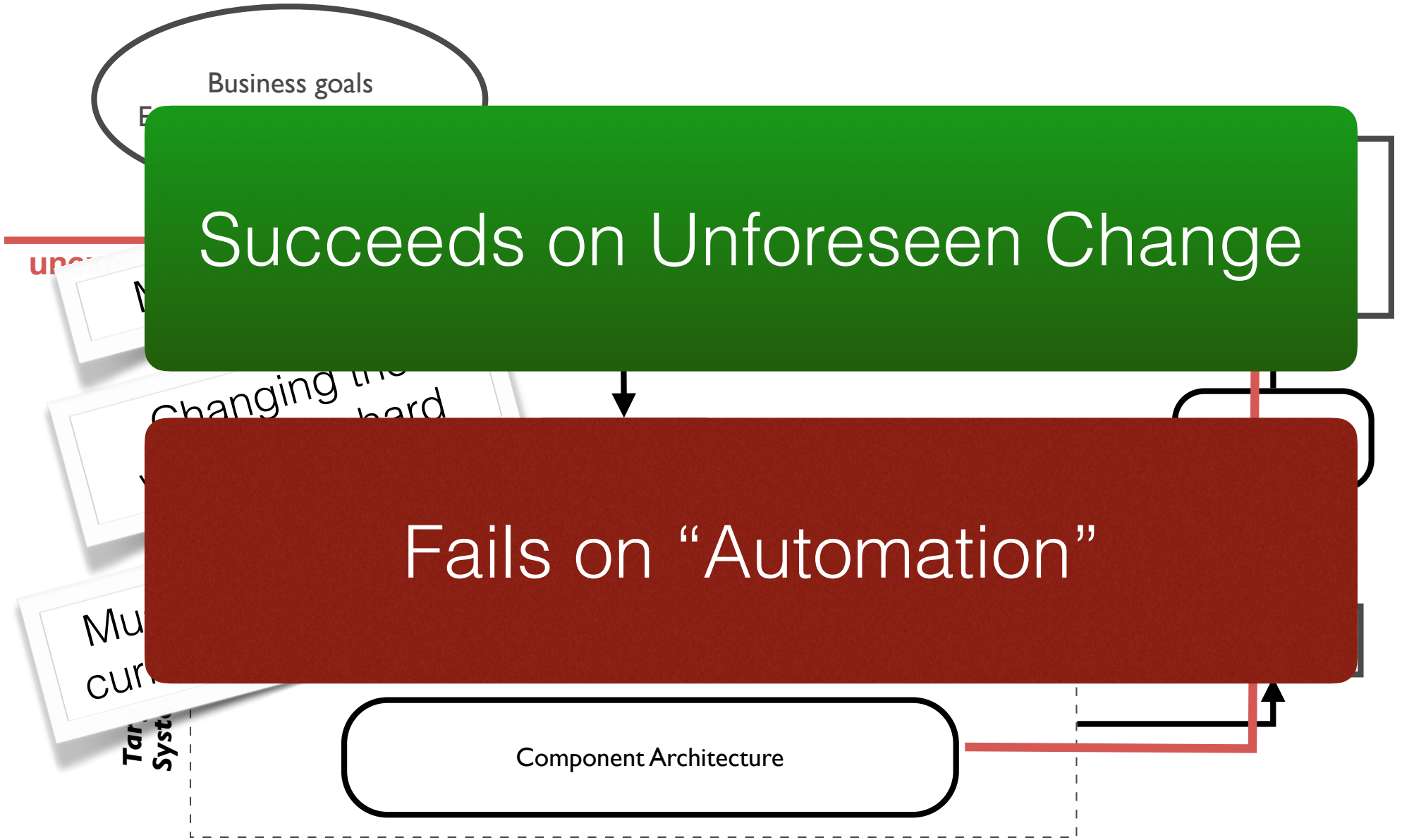
Workflow Management Systems

- Arguable, the most successful adaptive system design, ever.
- Designed for the inevitable change of business environment
- Changes unknown at design time.
- 24x7 business operation



Workflow Management Systems

(Adaptive System. Most successful adaptive systems, ever?)




NASA
LOVELL

Environment Change

Resource consumption assumptions change

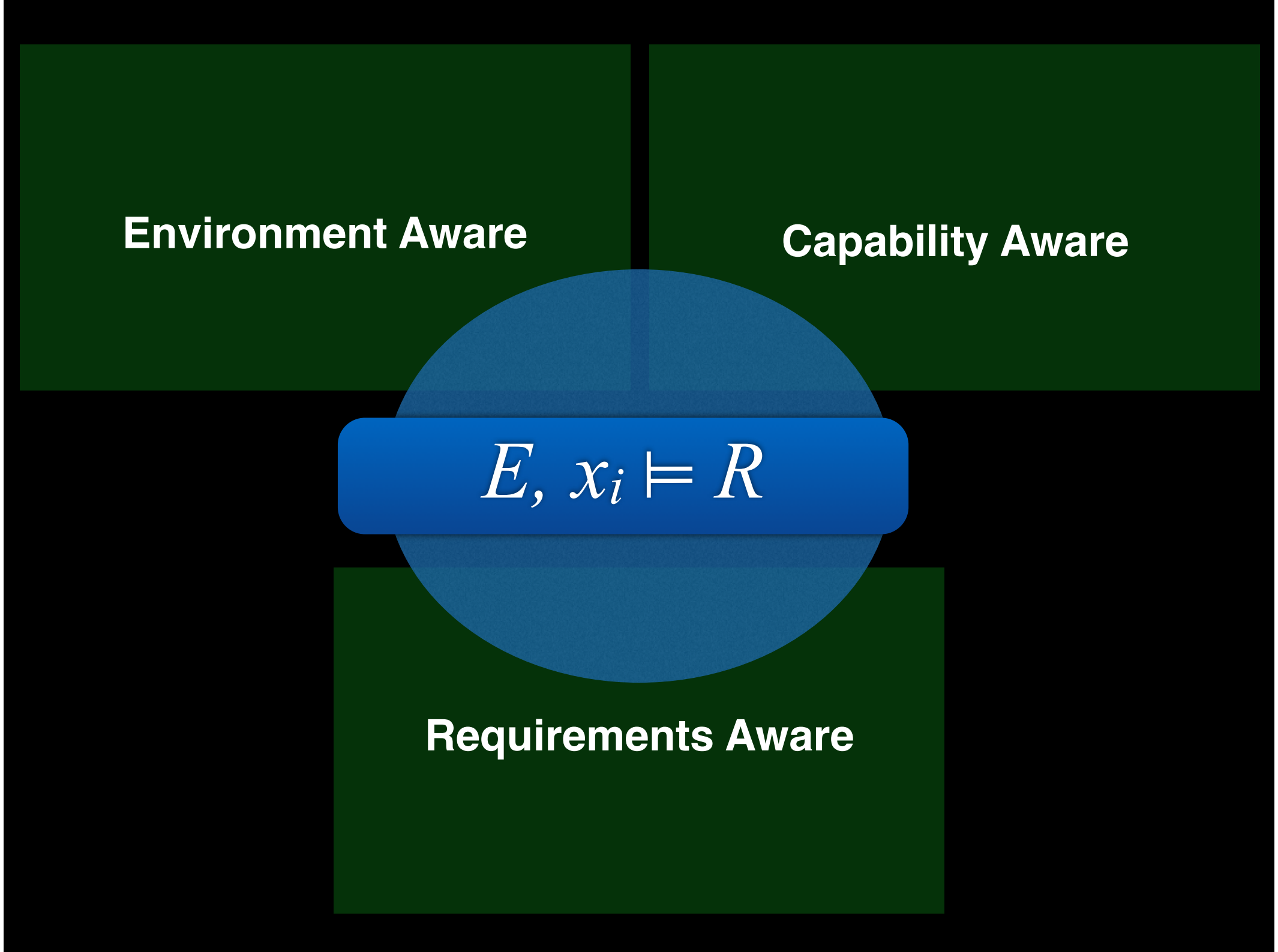
Capabilities Change

Multiple subsystems failed

Goals Change

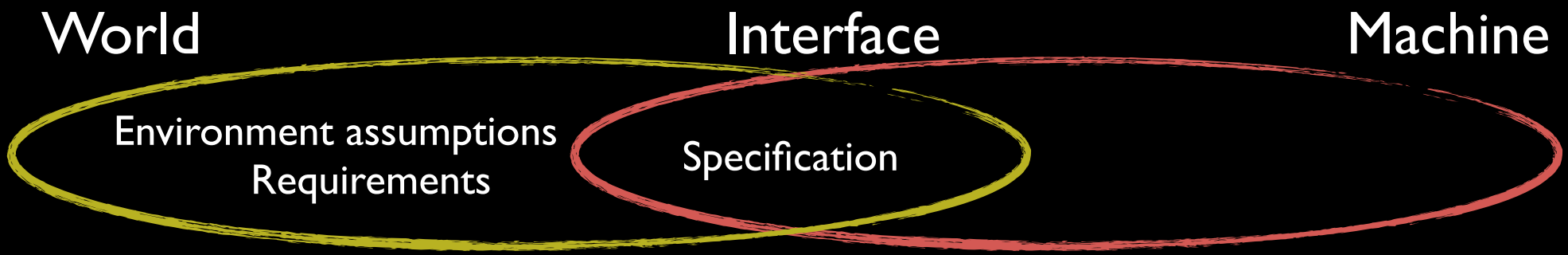
Bring them home

How should we *design*
adaptive systems?


Environment Aware
Capability Aware
$E, x_i \models R$
Requirements Aware

Requirements Engineering

The phenomena of interest lives in the world, not in the machine-to-be



$$E, x_i \models R$$

Adaptation is Requirements Engineering at Runtime.
Difficult!

Self-Adaptation is about RE@Runtime

Environment Aware

Capability Aware

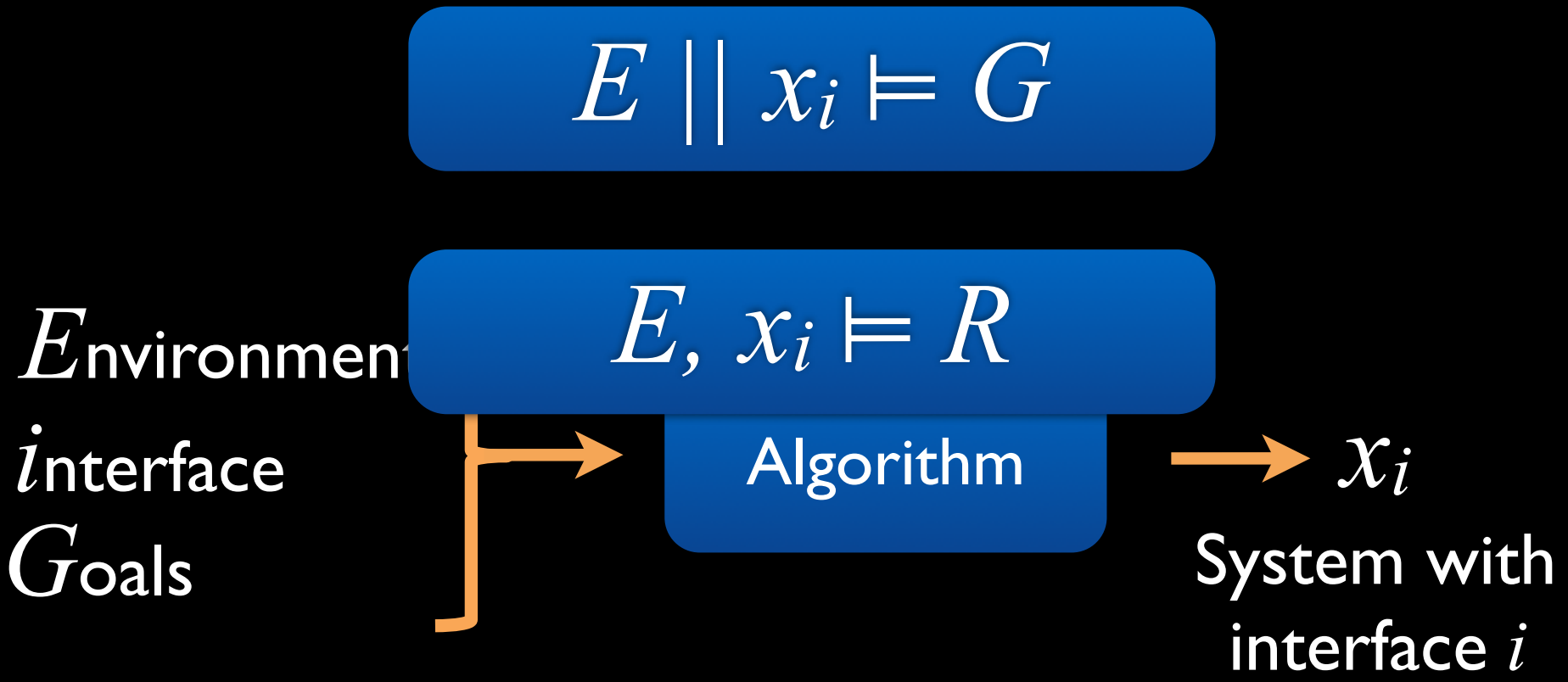
$$E, x_i \models R$$

Requirements Aware

$$E \,||\, x_i \models G$$

$$E,\, x_i \models R$$

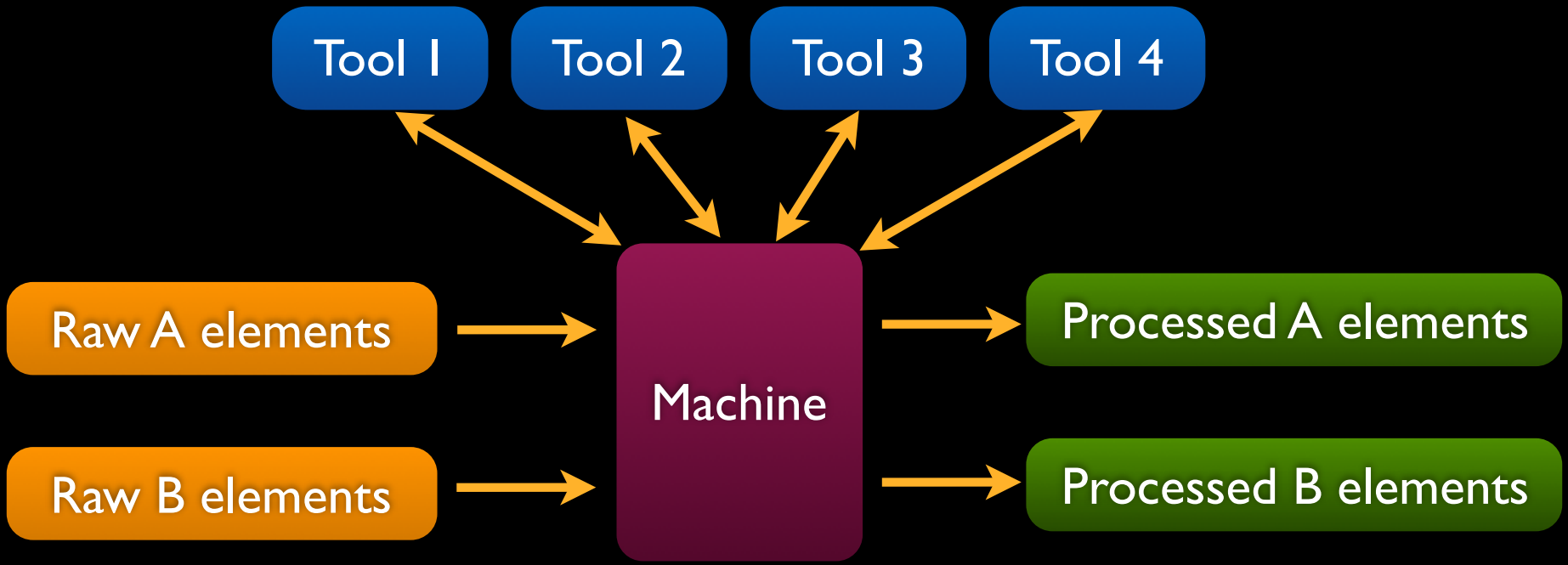
Discrete Event Controller Synthesis



Build a strategy for the controller that always beats its adversary

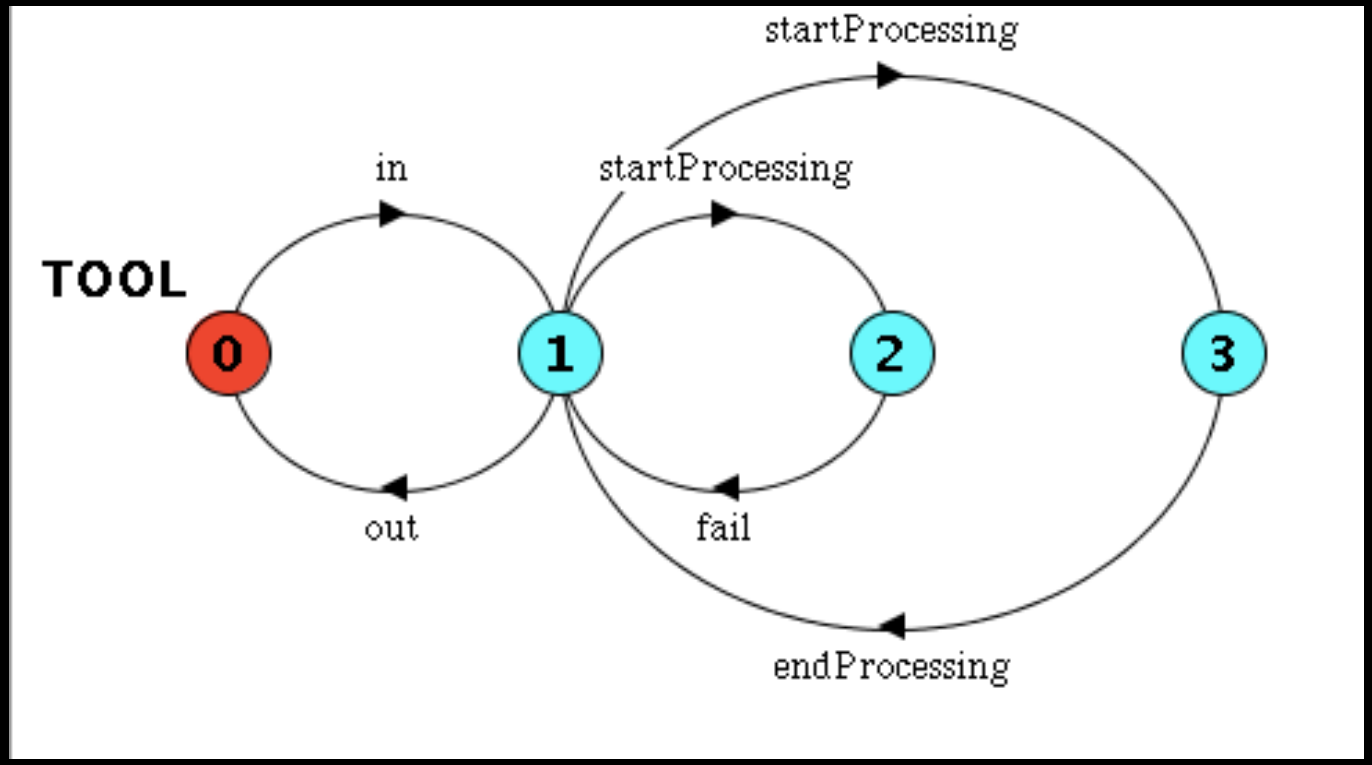

ATOP
POKA YOKE

System Structure



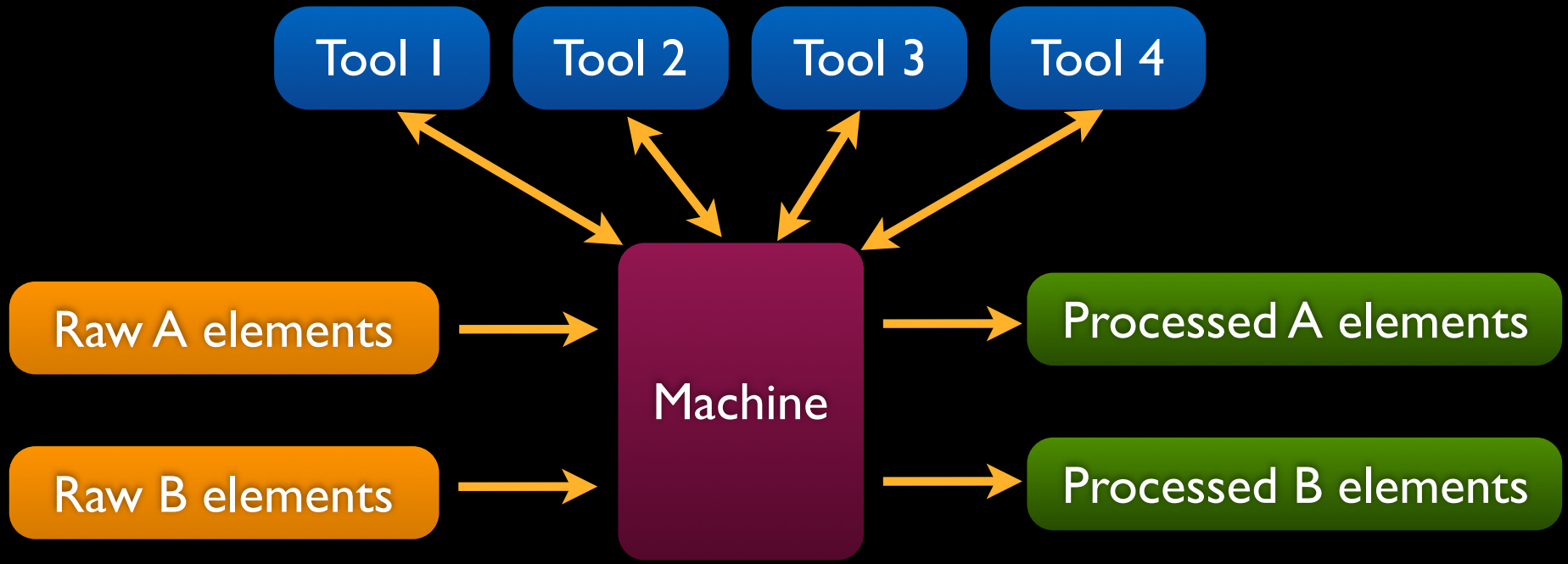
$$E \,||\, x_i \models G$$

Environment Assumption Modelling



$$E \,||\, x_i \models G$$

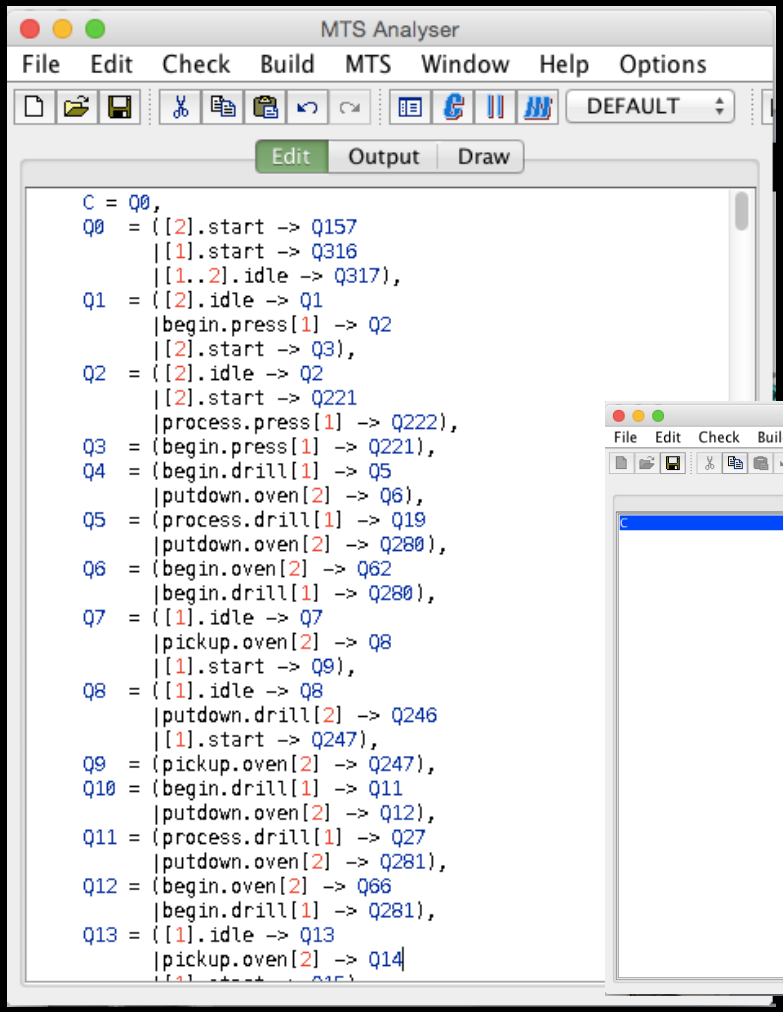
System Goal



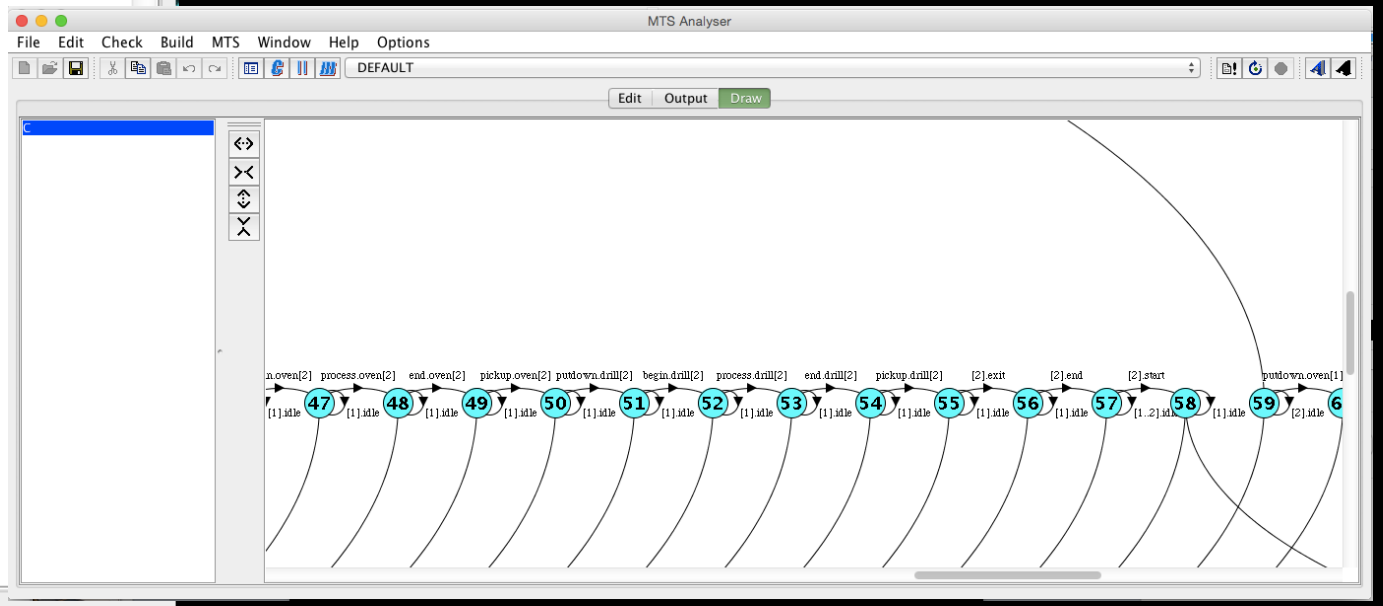
$$\square\diamond InRawA \wedge \square\diamond InRawB \Rightarrow \square\diamond OutProcessedA \wedge \square\diamond OutProcessedB$$

$$E \,||\, x_i \models G$$

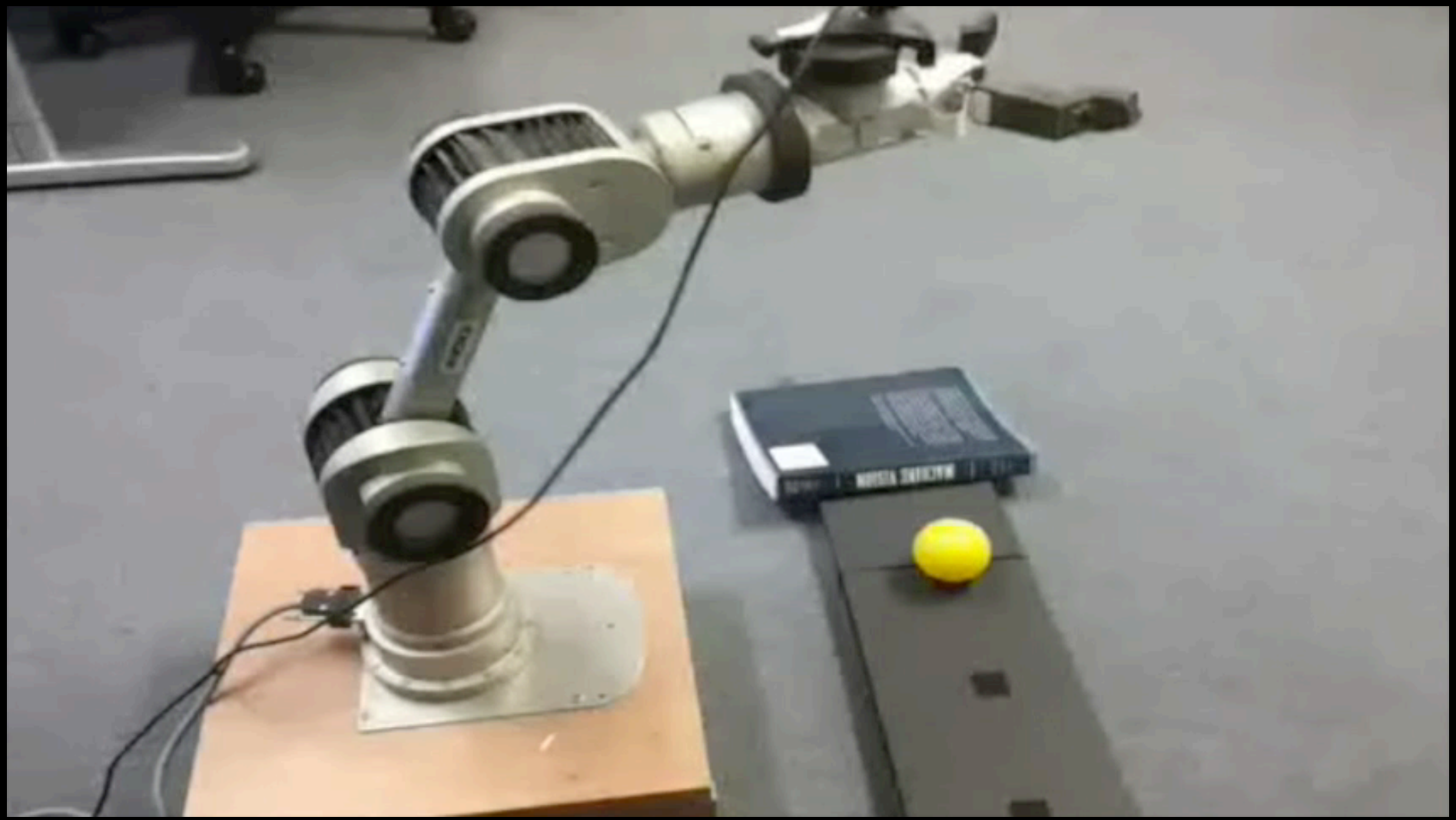
Automatic and Correct Construction



$$E \| x_I \models G$$



[ACSD14][ACM TOSEM13][FM12][ICSE11]

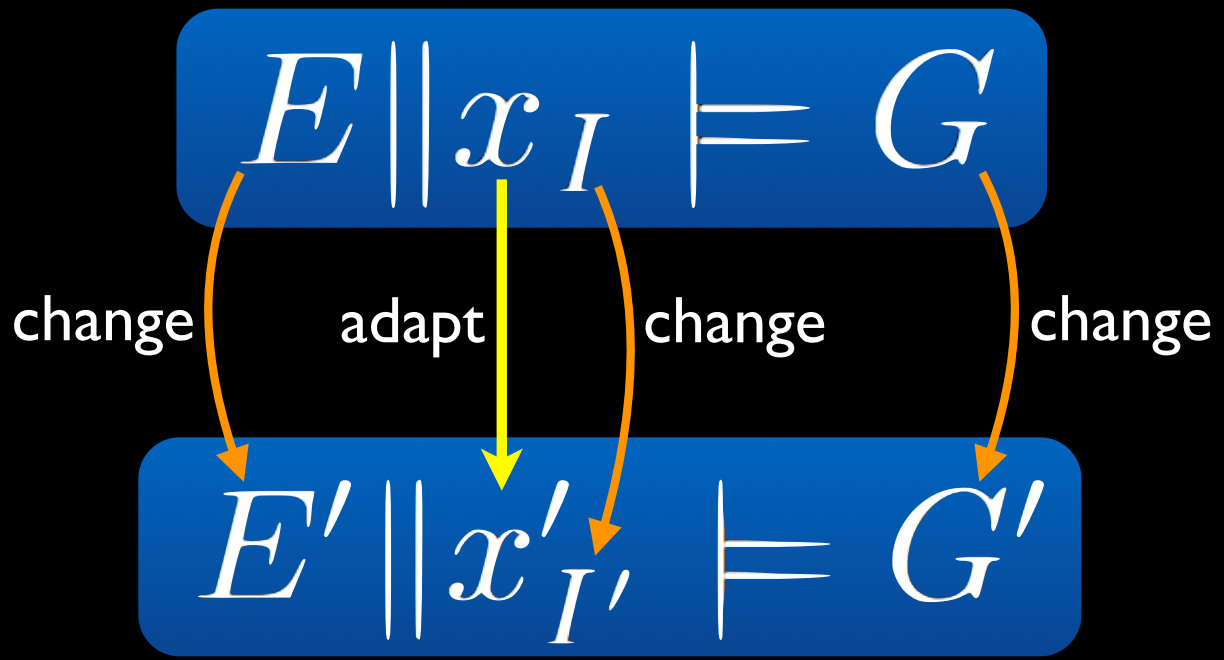


How does Discrete Event Control Fit into Adaptive System Design?

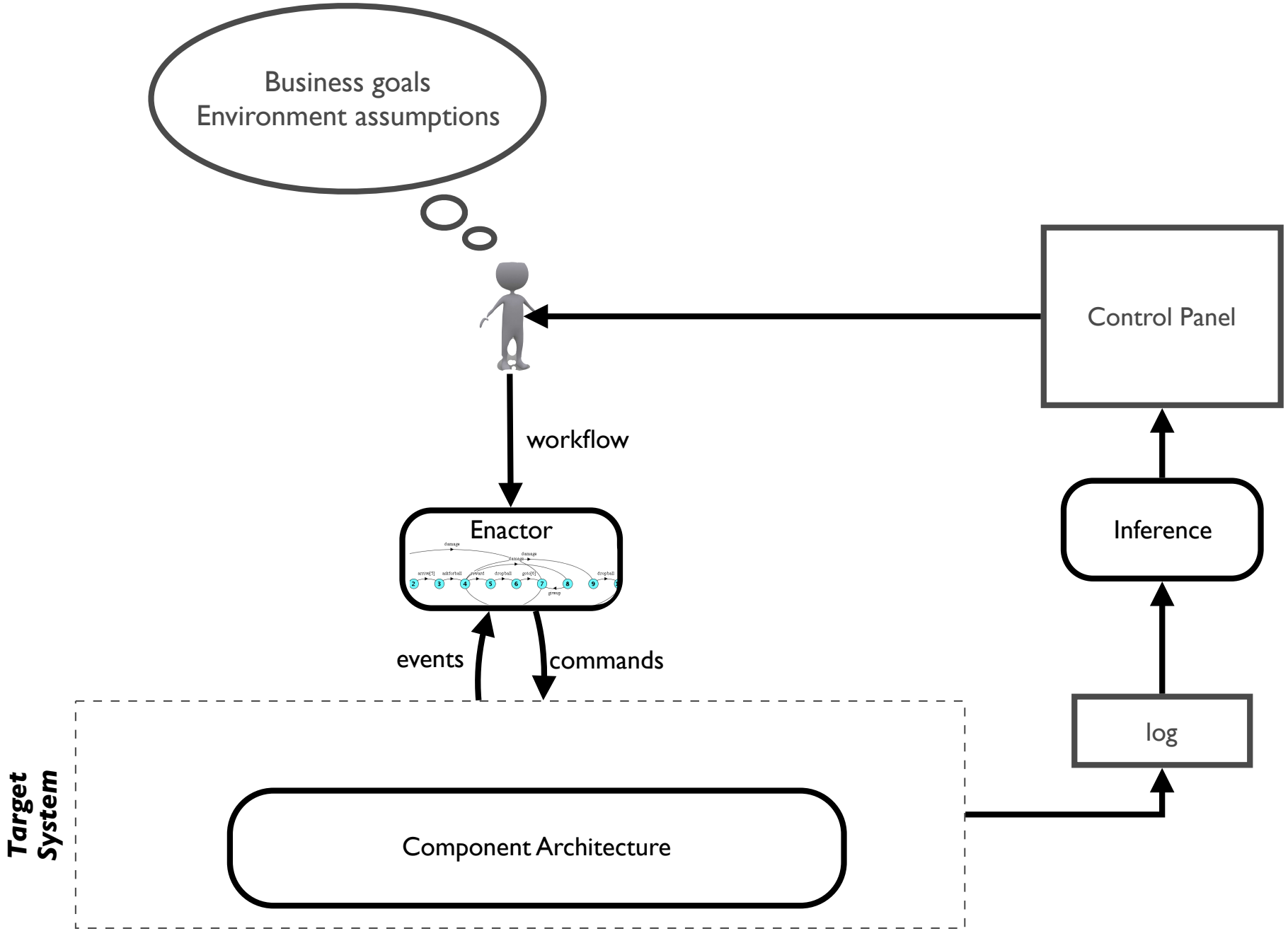
System Goals

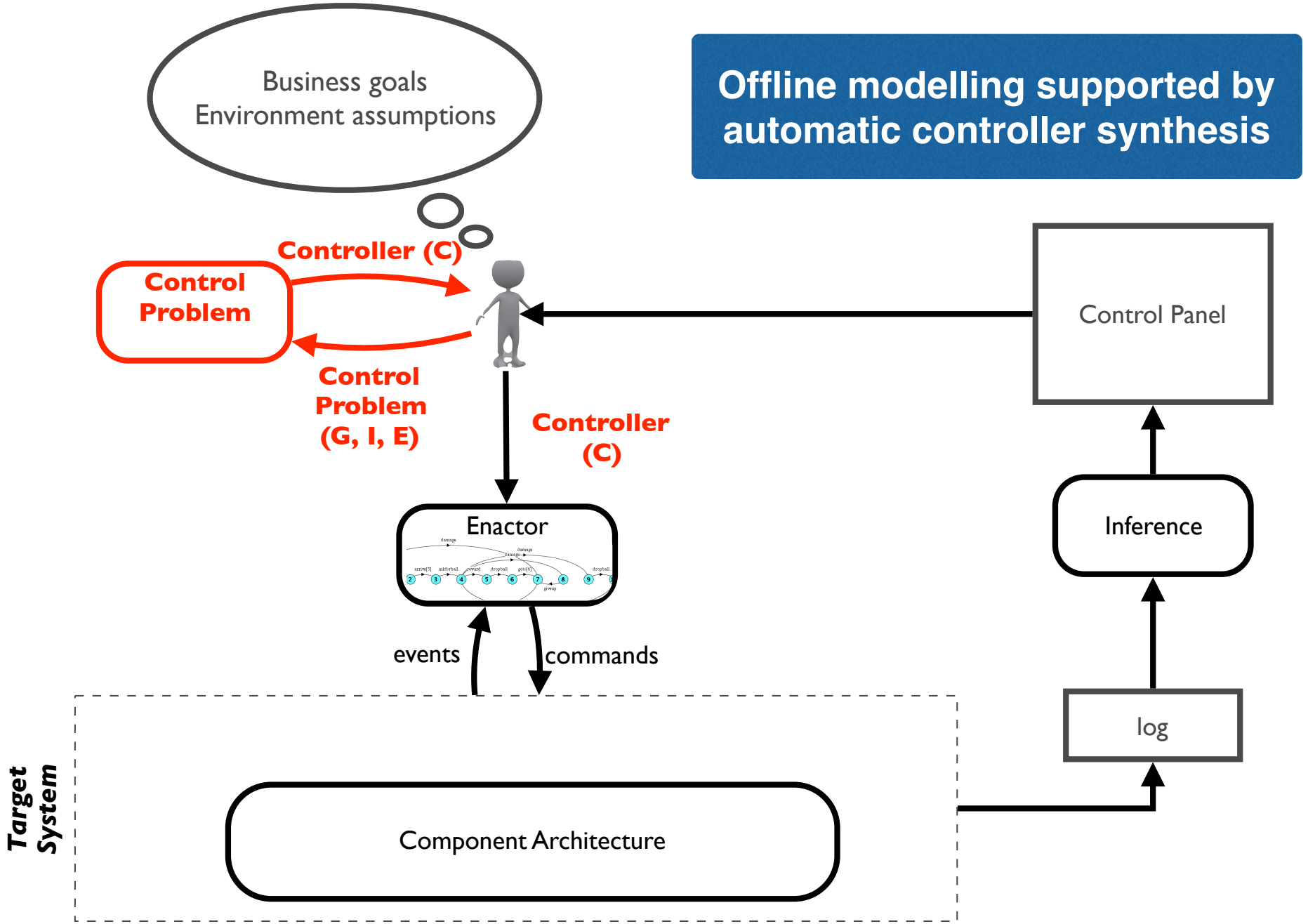
Environment Assumptions

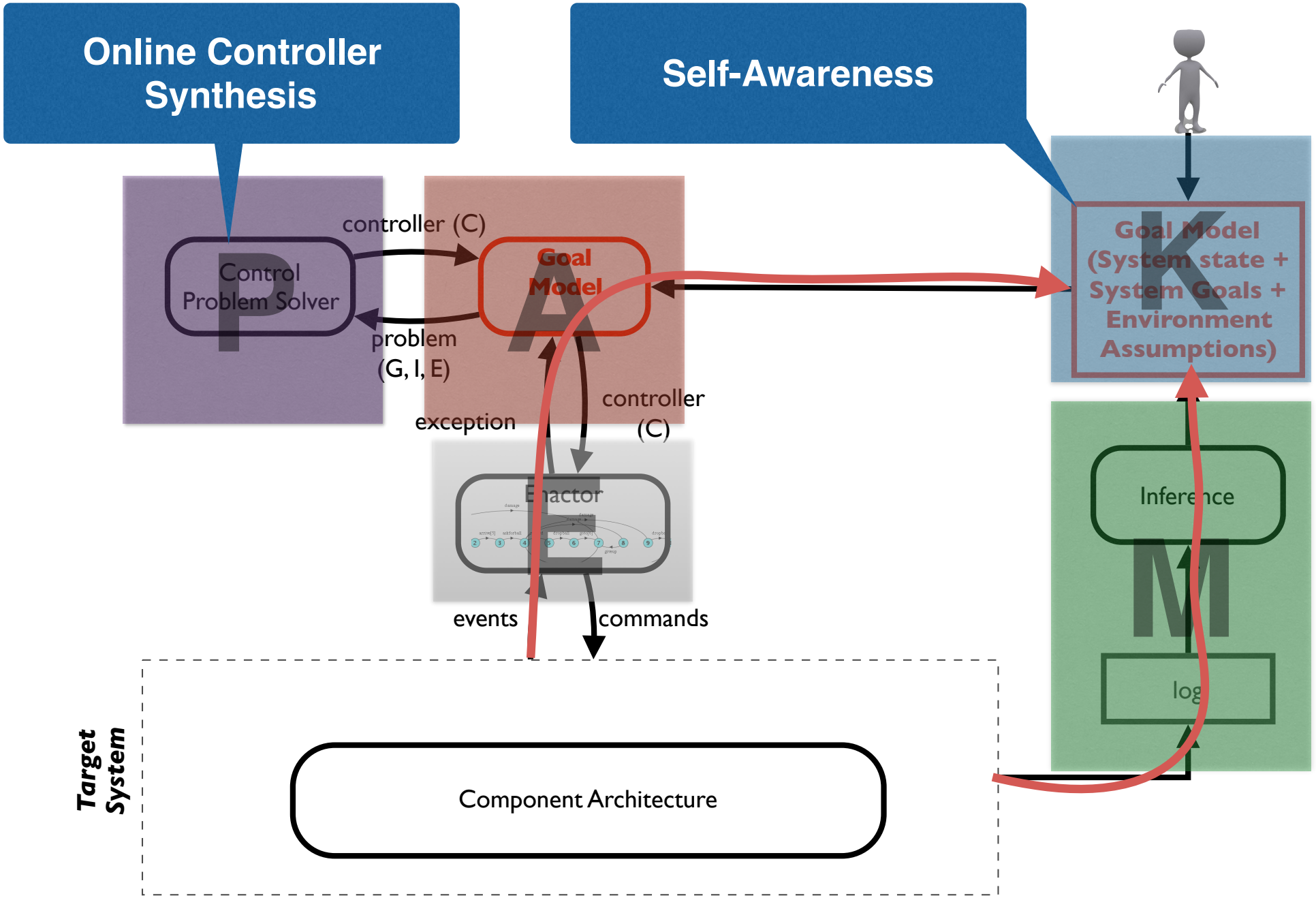
System Capabilities (Interface)

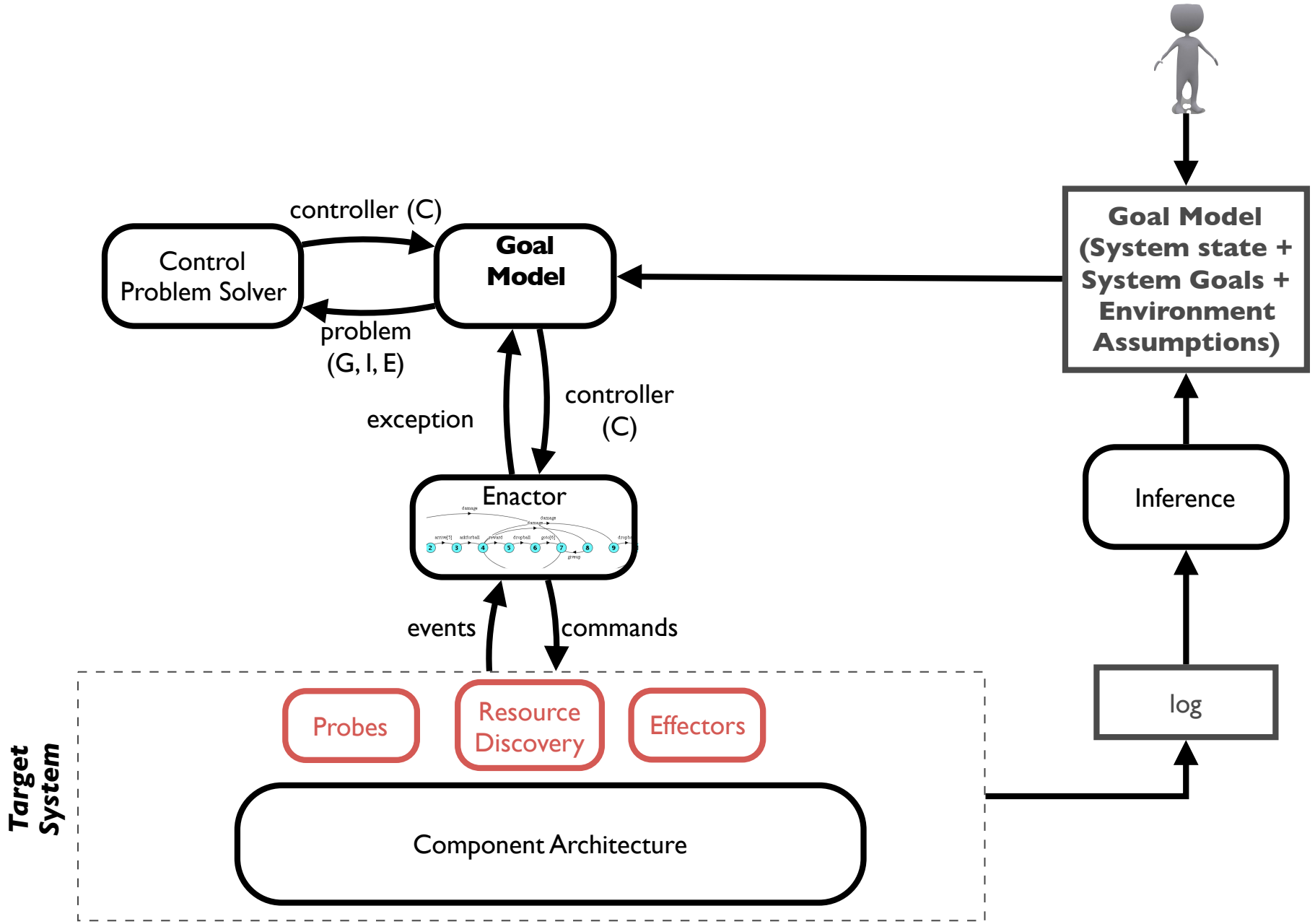


Synthesis at Runtime

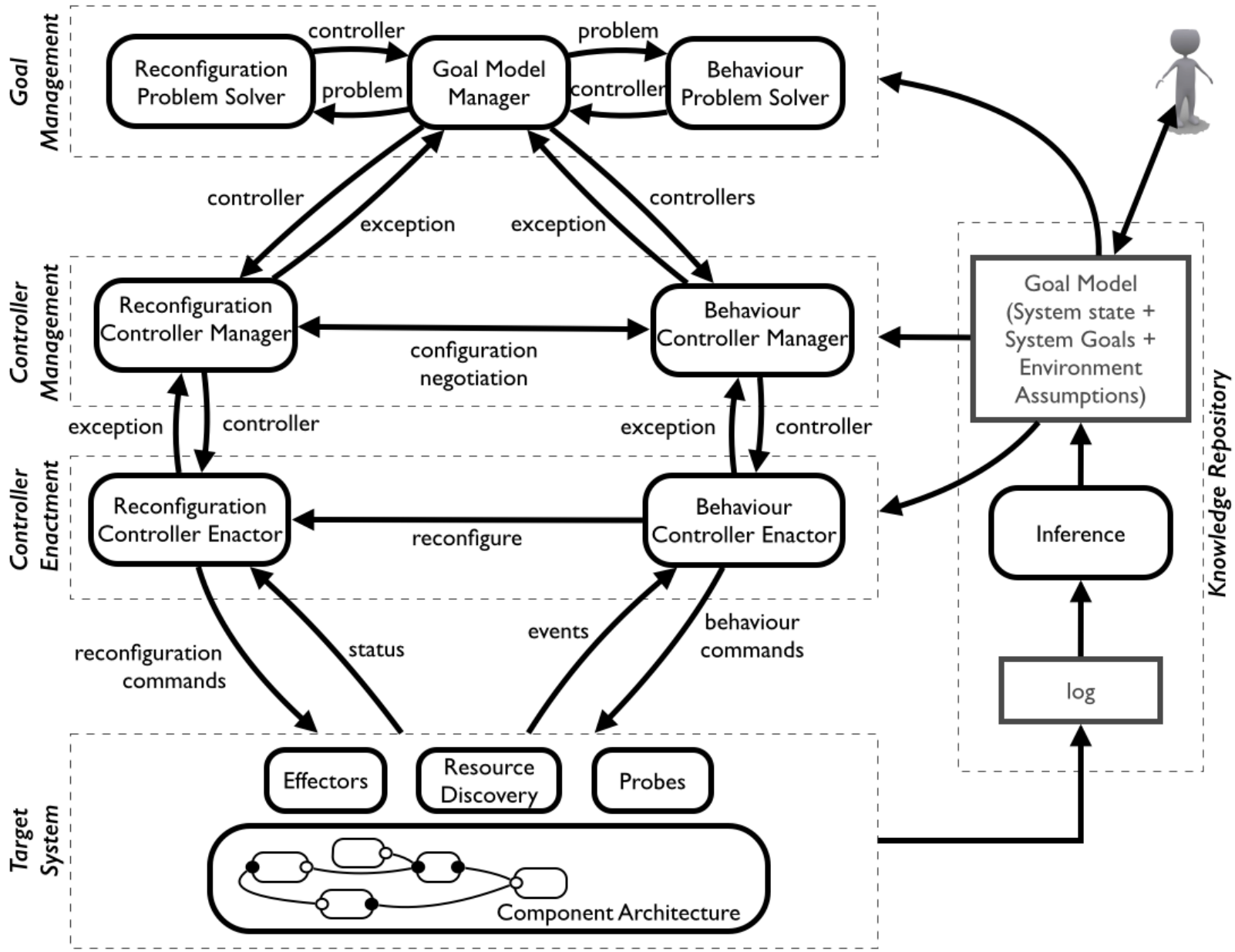

Business goals
Environment assumptions
Control Panel
workflow
Enactor
Inference
events
commands
log
Component Architecture
Target System

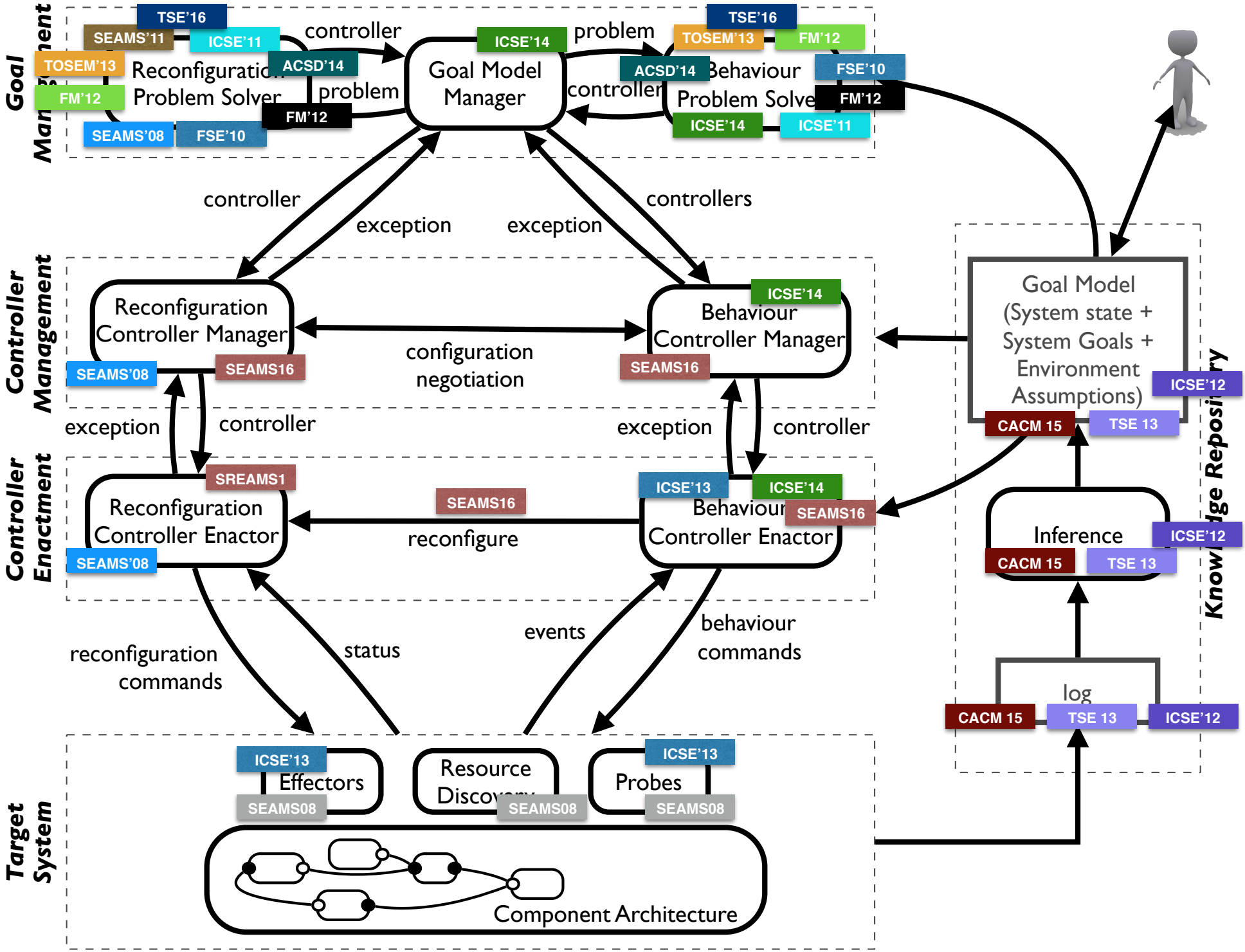

Business goals
Environment assumptions
Offline modelling supported by automatic controller synthesis
Controller (C)
Control Problem
Control Problem (G, I, E)
Controller (C)
Control Panel
Enactor
Inference
events
commands
log
Target System
Component Architecture

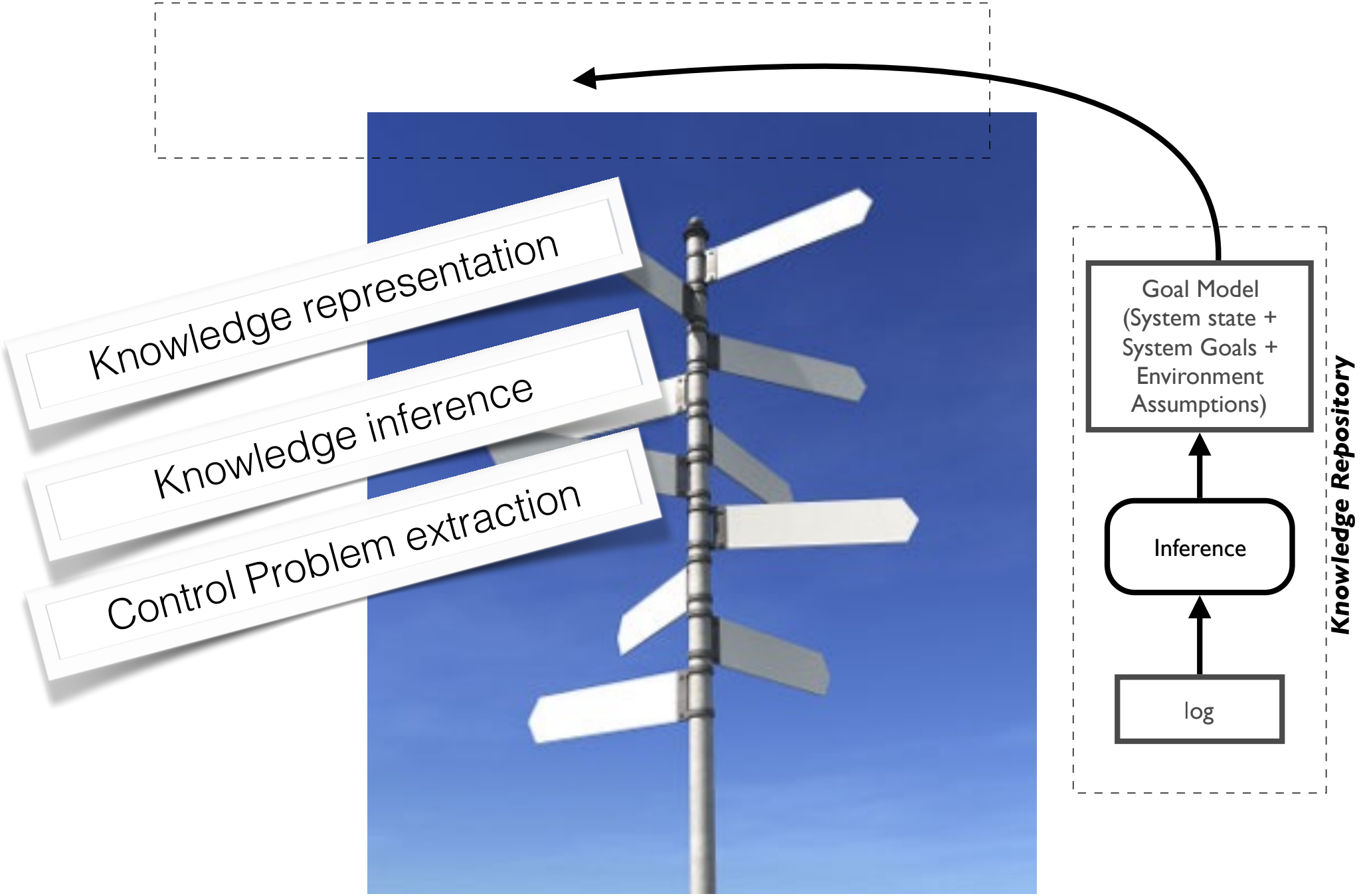

Online Controller Synthesis
Self-Awareness
P
Control Problem Solver
controller (C)
problem (G, I, E)
A
Goal Model
exception
controller (C)
E
Enactor
events
commands
K
Goal Model (System state + System Goals + Environment Assumptions)
M
Inference
log
Target System
Component Architecture


Goal Model (System state + System Goals + Environment Assumptions)
Inference
log
Goal Model
Control Problem Solver
controller (C)
problem (G, I, E)
exception
controller (C)
Enactor
events
commands
Probes
Resource Discovery
Effectors
Component Architecture
Target System

Morph: A Reference Architecture




Goal Management
Controller Management
Controller Enactment
Target System
Knowledge Repository
TSE'16
SEAMS'11
ICSE'11
TOSEM'13
FM'12
SEAMS'08
FSE'10
ACSD'14
Reconfiguration Problem Solver
controller
problem
FM'12
ICSE'14
Goal Model Manager
problem
controller
TSE'16
TOSEM'13
FM'12
ACSD'14
Behaviour Problem Solver
FSE'10
FM'12
ICSE'14
ICSE'11
controller
exception
exception
controllers
Reconfiguration Controller Manager
SEAMS'08
SEAMS16
configuration negotiation
ICSE'14
Behaviour Controller Manager
SEAMS16
exception
controller
exception
controller
SREAMS1
Reconfiguration Controller Enactor
SEAMS'08
SEAMS16
reconfigure
ICSE'13
ICSE'14
Behaviour Controller Enactor
SEAMS16
reconfiguration commands
status
events
behaviour commands
ICSE'13
Effectors
SEAMS08
Resource Discovery
SEAMS08
ICSE'13
Probes
SEAMS08
Component Architecture
Goal Model (System state + System Goals + Environment Assumptions)
ICSE'12
CACM 15
TSE 13
Inference
ICSE'12
CACM 15
TSE 13
log
CACM 15
TSE 13
ICSE'12


Knowledge representation
Knowledge inference
Control Problem extraction
Goal Model
(System state +
System Goals +
Environment
Assumptions)
Inference
log
Knowledge Repository

Smart Cities

Adaptive Systems

- Design for the unknown at design time
- Discrete event controller synthesis for reasoning at runtime about achieving changing goals in changing in environments with changing capabilities.
- MORPH: A reference architecture for architectural adaptation

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(o sobre cómo anticiparse a lo inesperado)

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