Lecture
0_4.1

Systems: Definitions

cini
Cybersecurity
National Lab

Paolo PRINETTO
Politecnico di Torino (Italy)
Univ. of Illinois at Chicago, IL (USA)
CINI Cybersecurity Nat. Lab. (Italy)

Paolo.Prinetto@polito.it

www.consorzio-cini.it
www.comitato-girotondo.org

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Goal

- The lecture aims at introducing the concept of System from a hierarchical perspective
- The concept of Processing Element (PE) is then introduced
- Each PE is then presented in terms of DataPath & Control Unit
- An extensive presentation of the most widely used taxonomies for digital systems concludes the lecture.

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Prerequisites

- None

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Homework

- None

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Further readings

- **Students interested in making a reference to a text book on the arguments covered in this lecture can refer, for instance, to:**
  - ***G. Conte, A. Mazzeo, N. Mazzocca, P. Prinetto*: "Architettura dei calcolatori", *Città Studi, 2015* (Chapter 1: Classificazioni e Concetti base) (In Italian)**

Outline

- Systems
  - Definitions
  - Processing Strategies
- Processing Elements
- Data & Control

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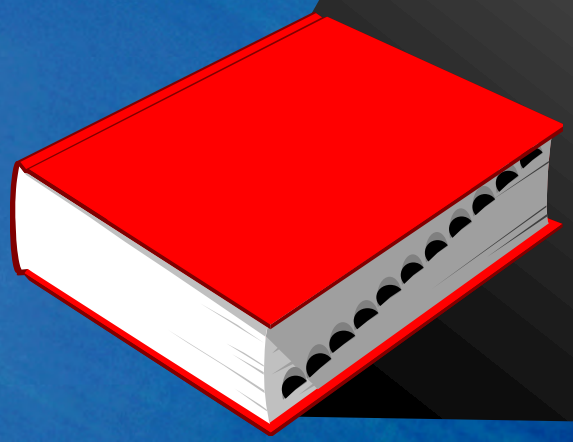

System

An entity that interacts with other entities, i.e., other systems, including hardware, software, humans, and the physical world with its natural phenomena

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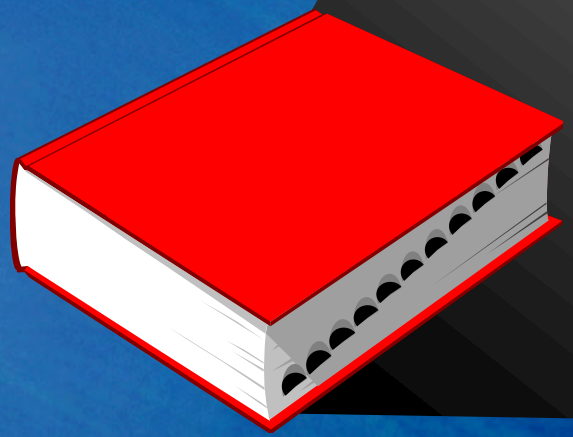
System

An entity that interacts with other entities, i.e., other systems, including hardware, software, humans, and the physical world with its natural phenomena

These other systems are the *environment* of the given system



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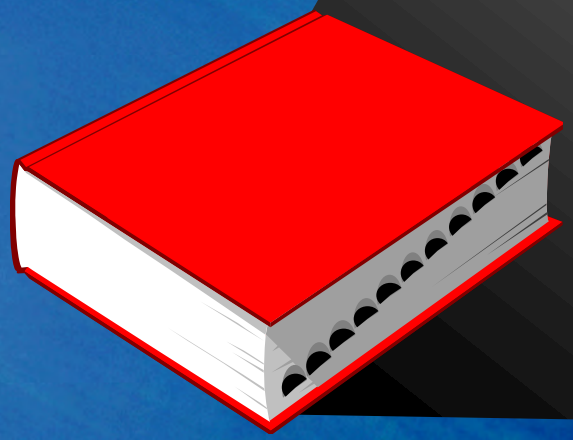

The service delivered by a system

(in its role as a provider) is its behavior as it is perceived by its user(s); a user is another system that receives service from the provider

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Correct service

Correct service is delivered when the service implements the system function

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Managing complexity

To manage complexity, the key method is to describe the system resorting to several *levels of abstraction*

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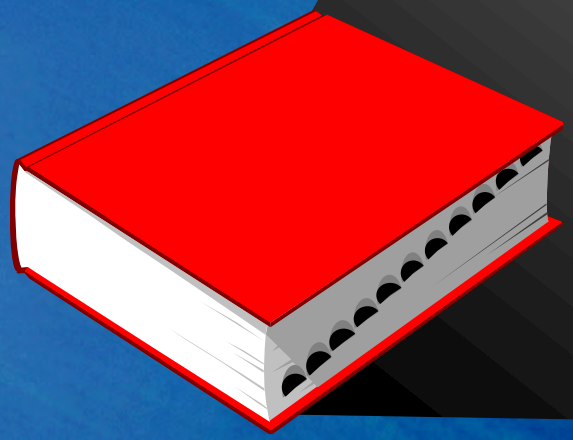
Abstraction



An abstraction is a simplified model of the system, showing only the selected features and ignoring the associated details

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Top-down vs. Bottom-up

- Top-down and bottom-up are both strategies of information processing and knowledge ordering, used in a variety of fields including software, humanistic and scientific theories, and management and organization.
- In practice, they can be seen as a style of thinking, teaching, or leadership

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Top-down

- Proceeding by breaking large general aspects (as of a problem) into smaller more detailed constituents: working from the general to the specific

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From High to Low

- **A high-level abstraction contains only the most vital data**
- **A low-level abstraction is more detailed and takes account of previously ignored information**
- **Although it is more complex, a low-level abstraction model is more accurate and is closer to the actual system.**

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System: hierarchical decomposition

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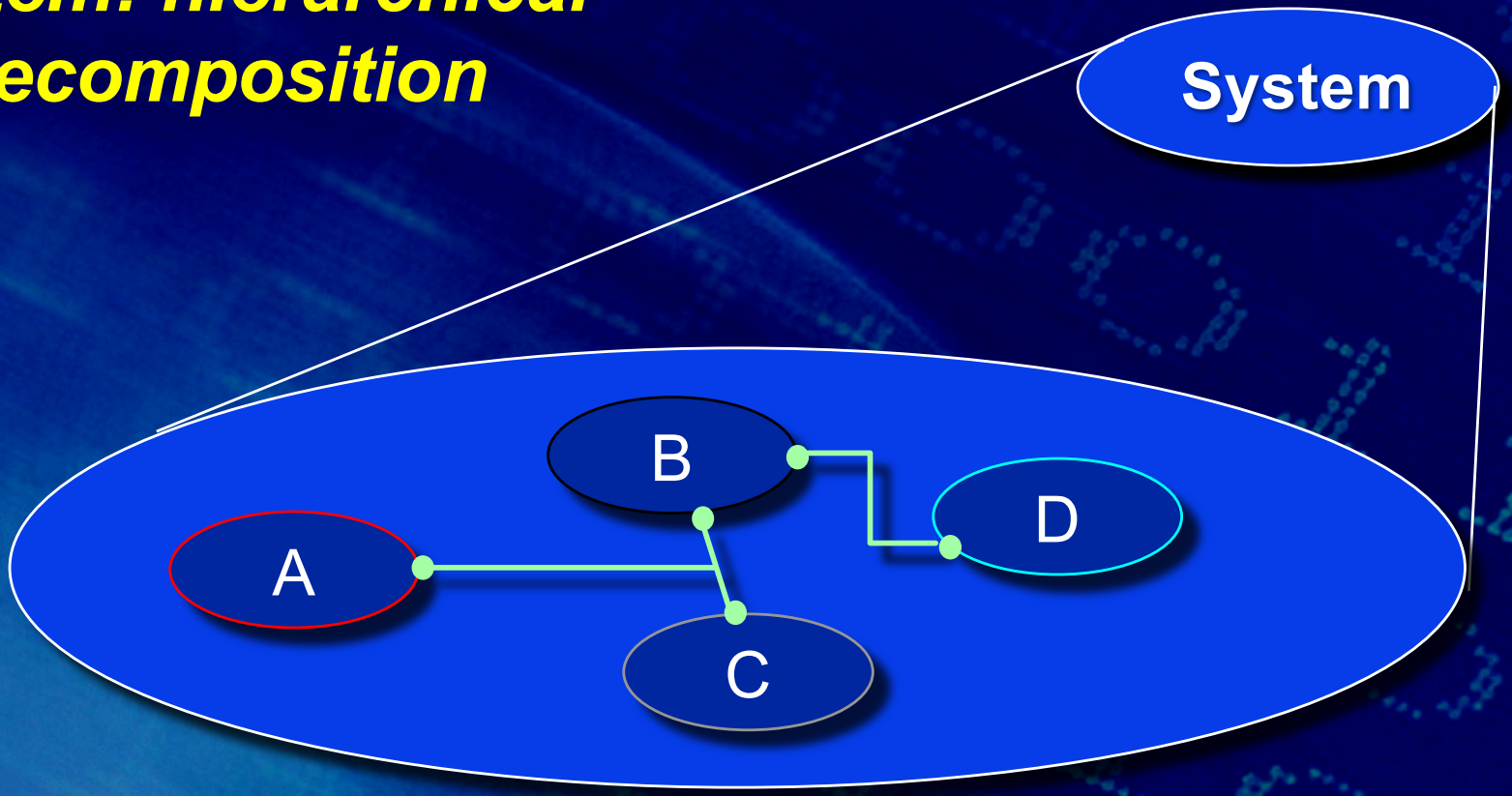
System: hierarchical decomposition



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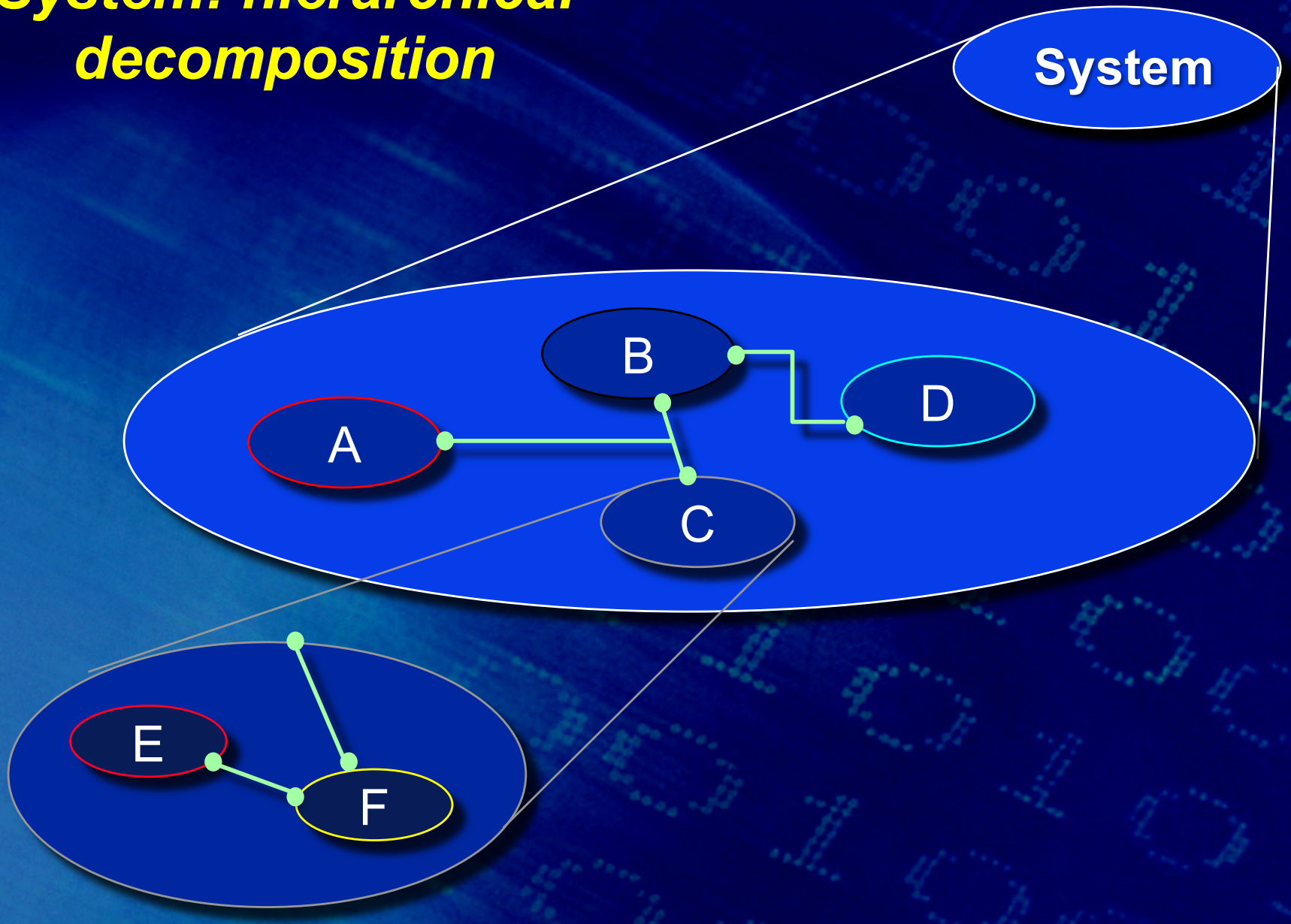
System: hierarchical decomposition



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Bottom-up

- **Piecing together of systems to give rise to more complex systems, thus making the original systems sub-systems of the emergent system.**

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System: bittom-up composition

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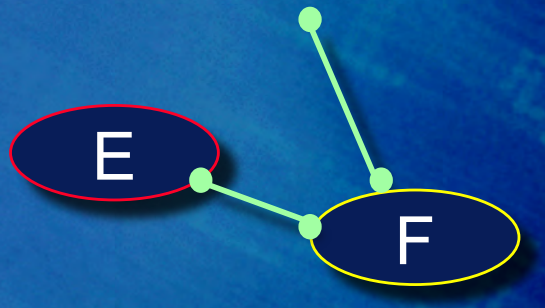
System: bittom-up composition



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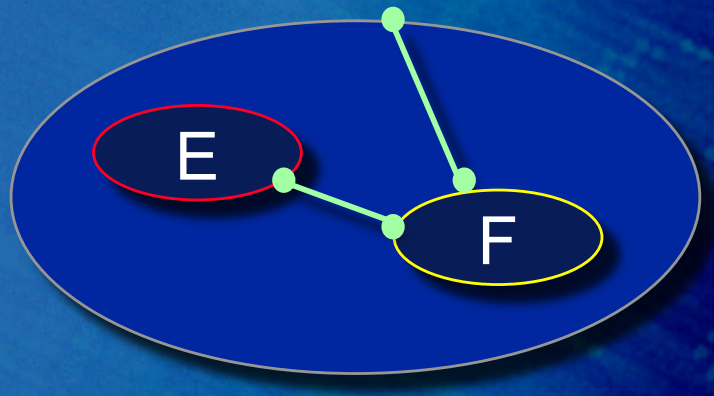

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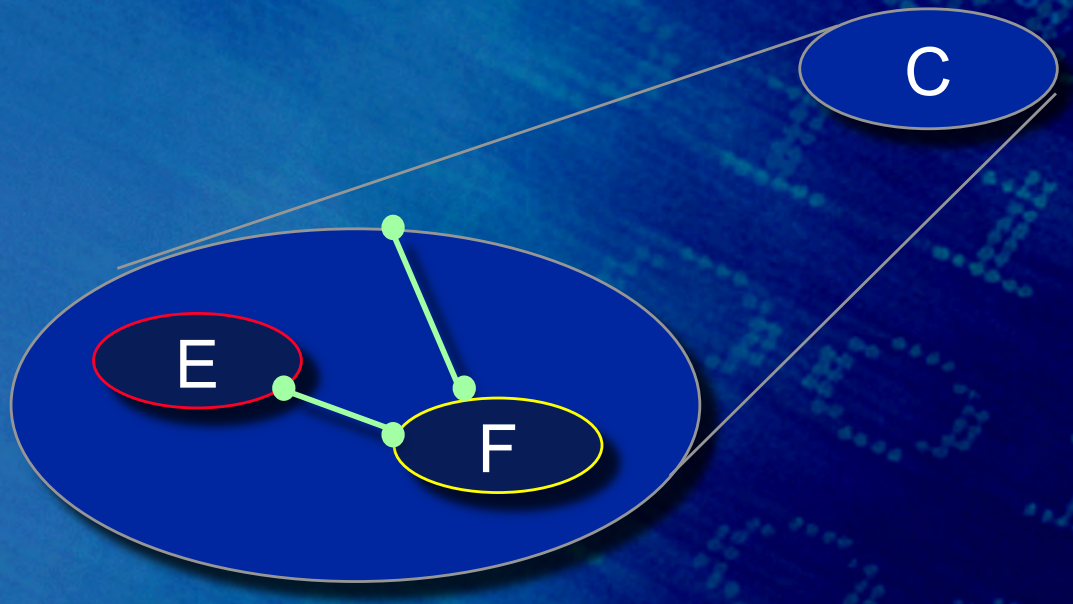

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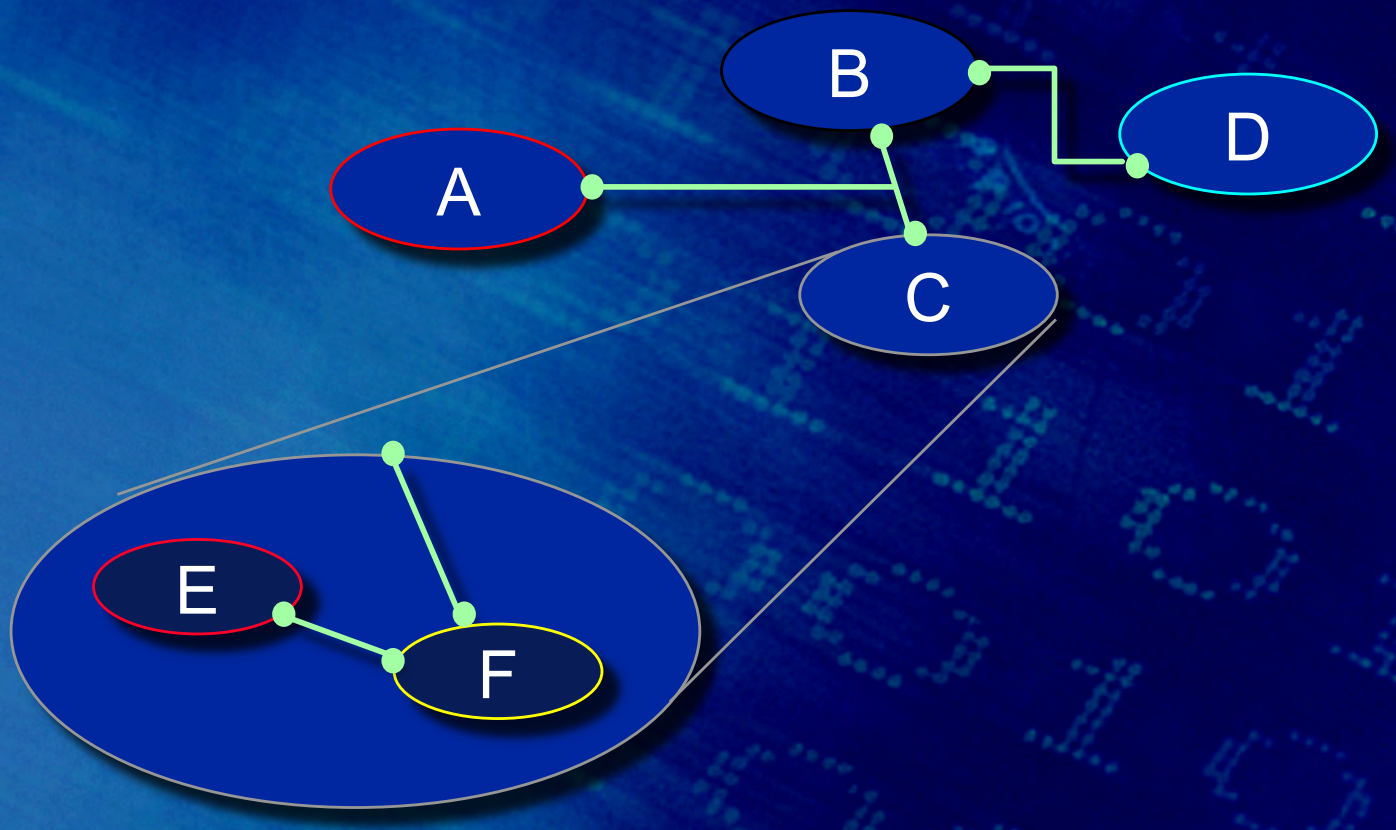

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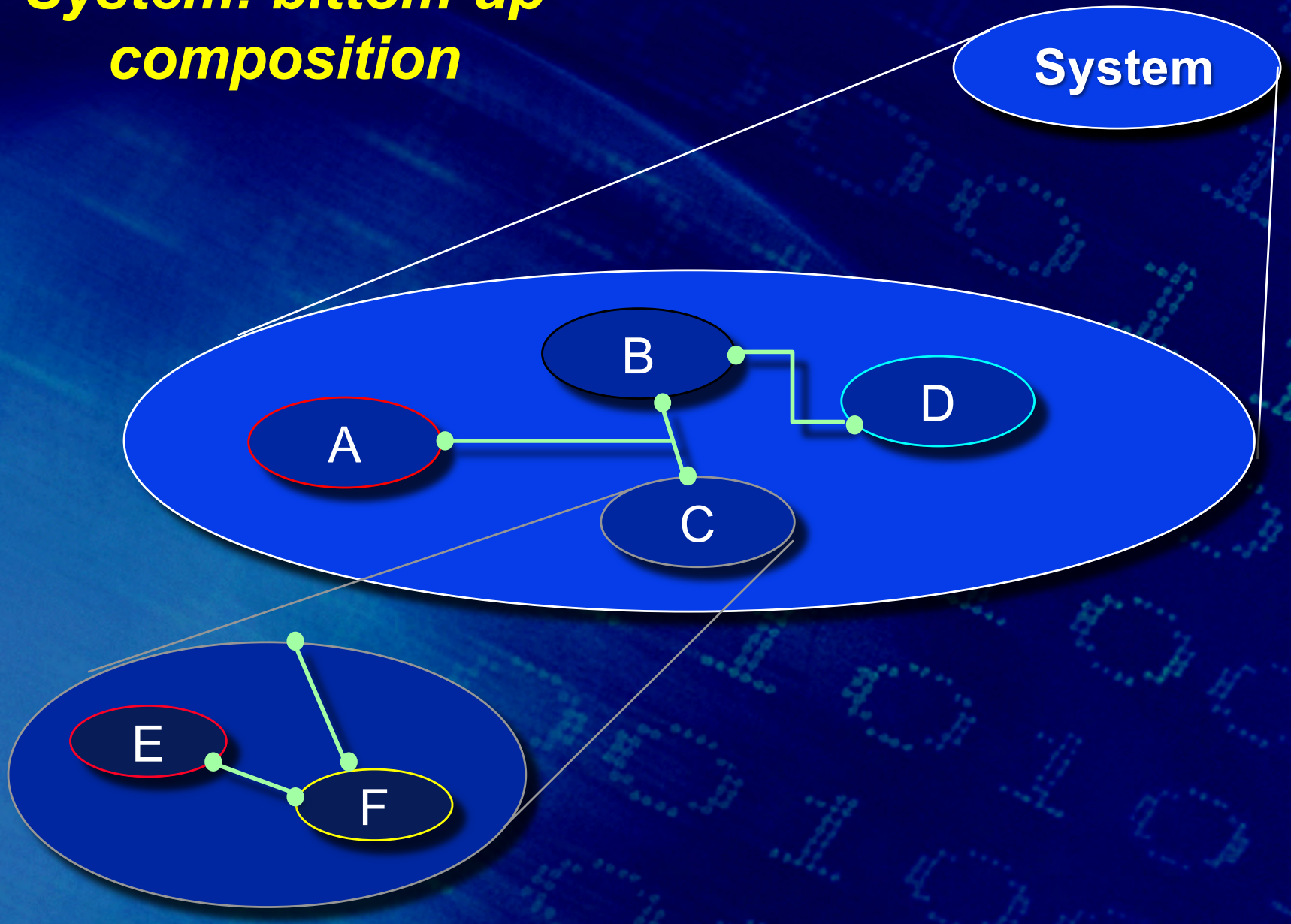

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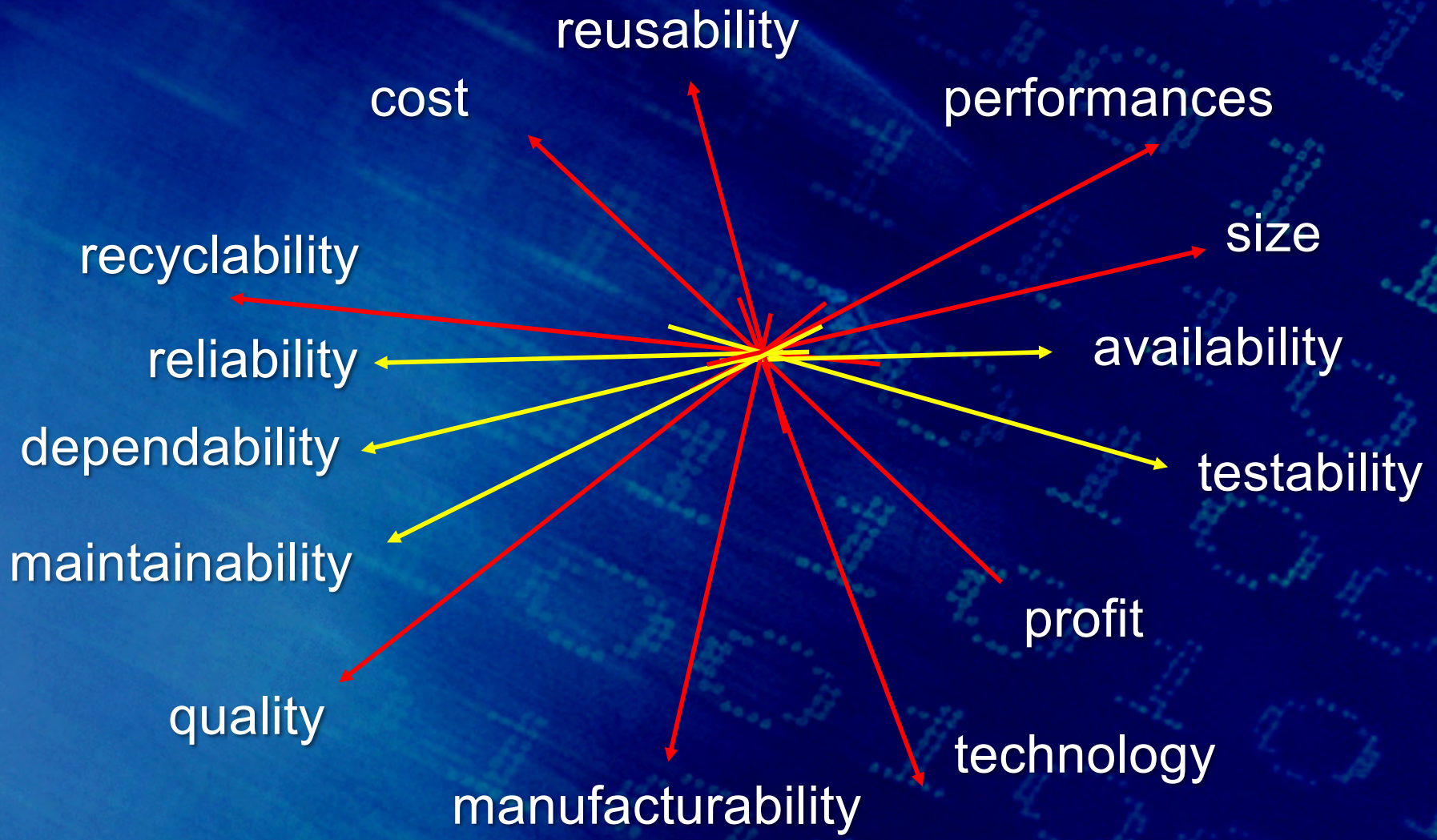
The design space



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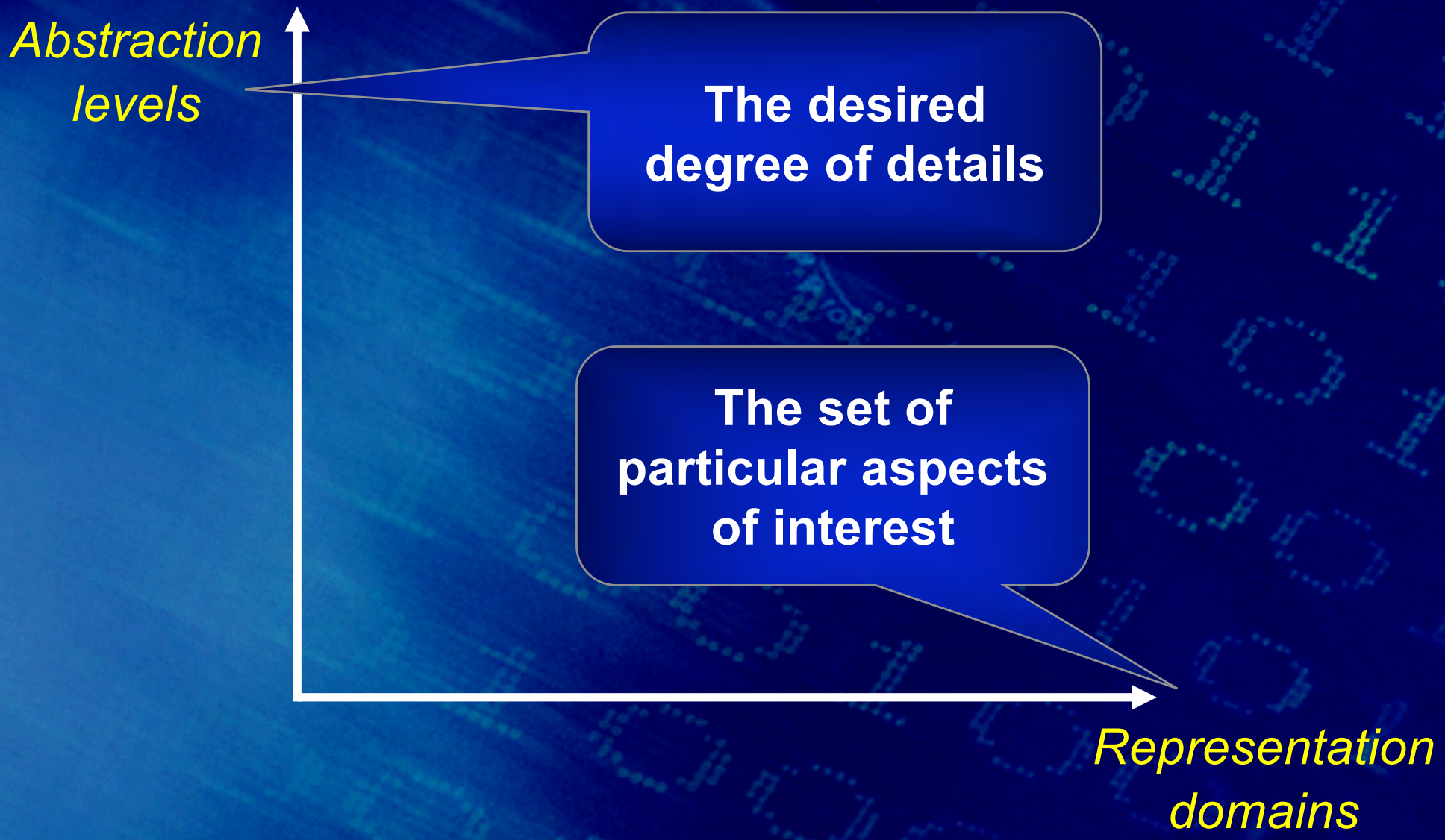
The sub-space abstraction ↔ domain



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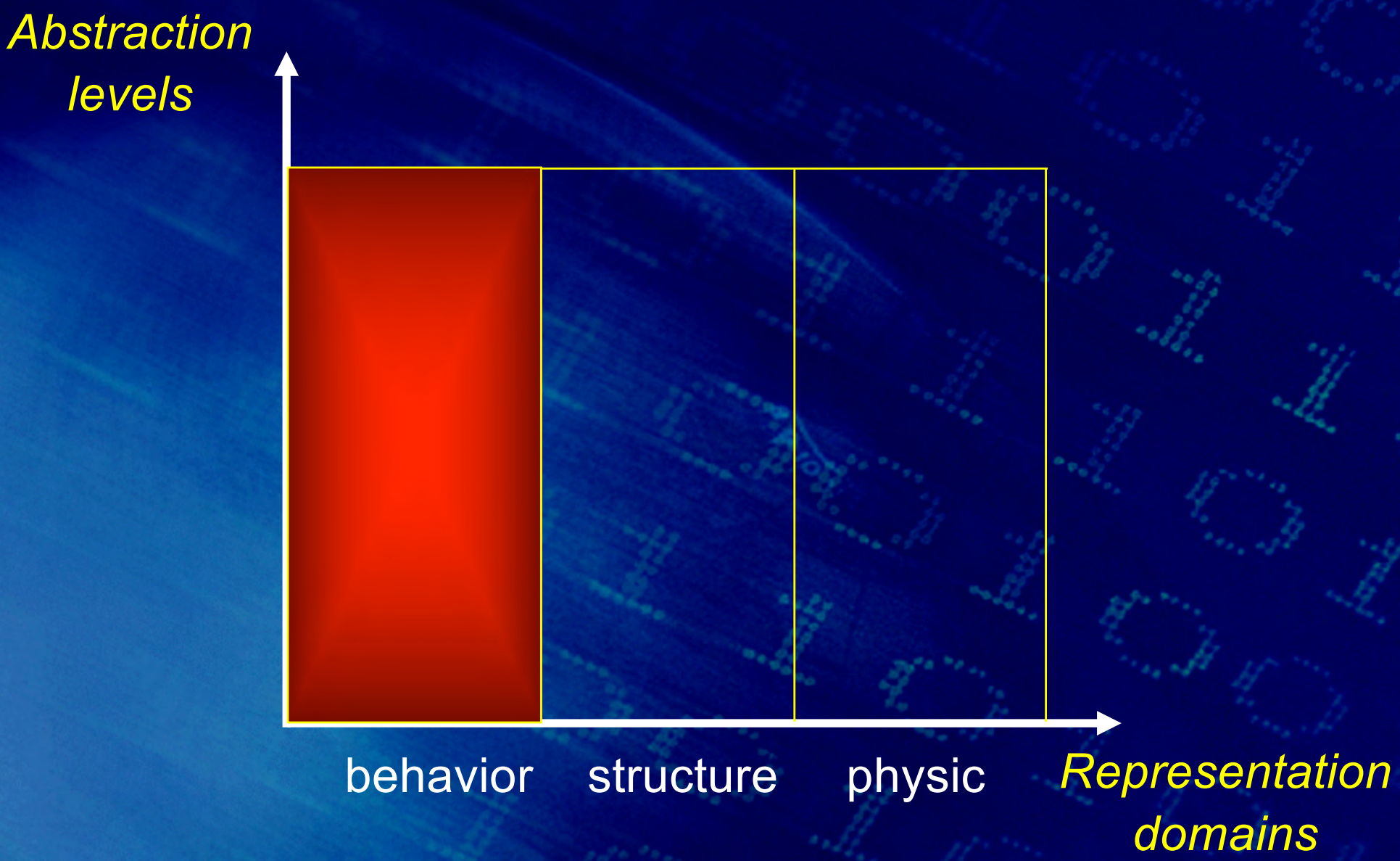

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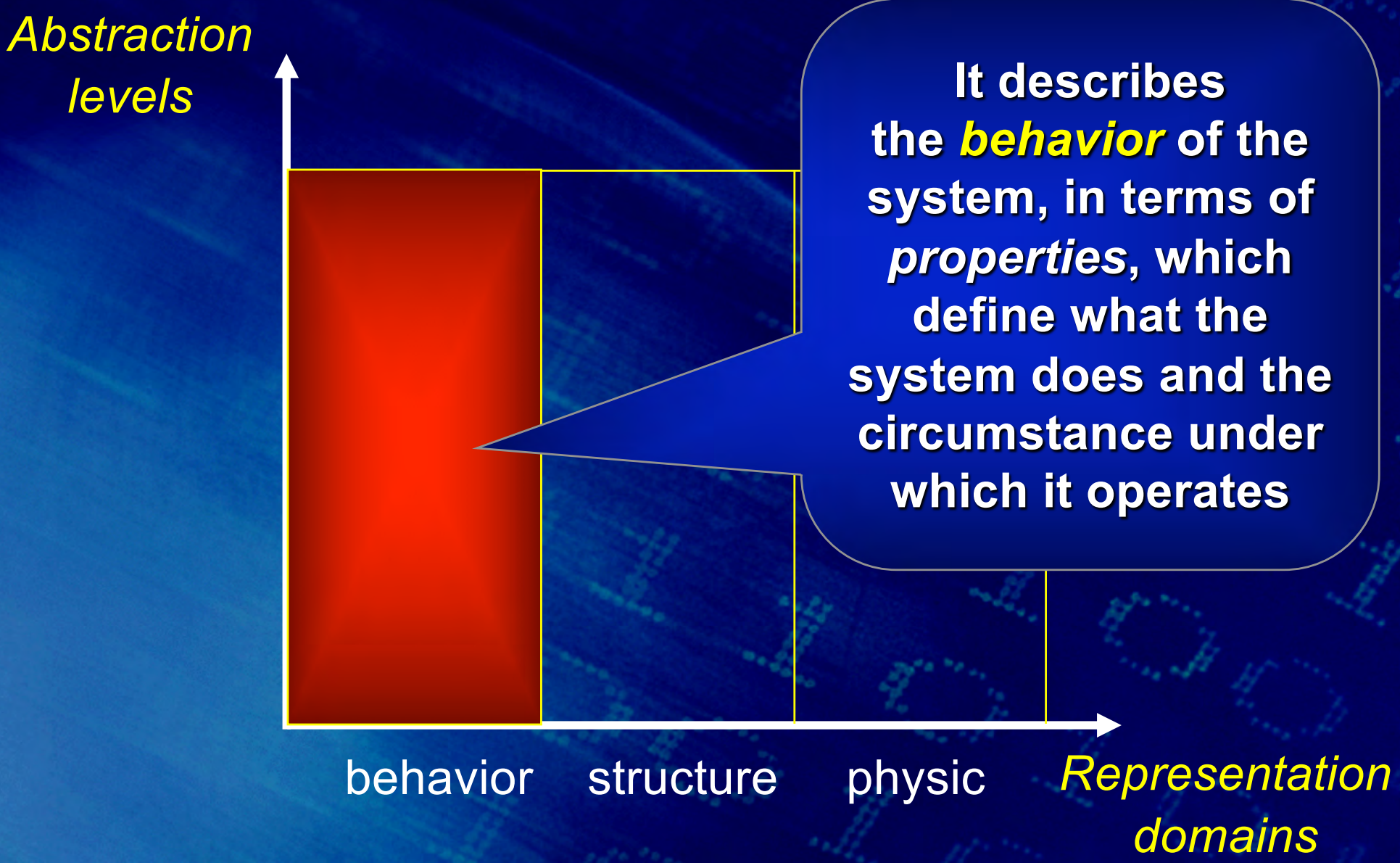

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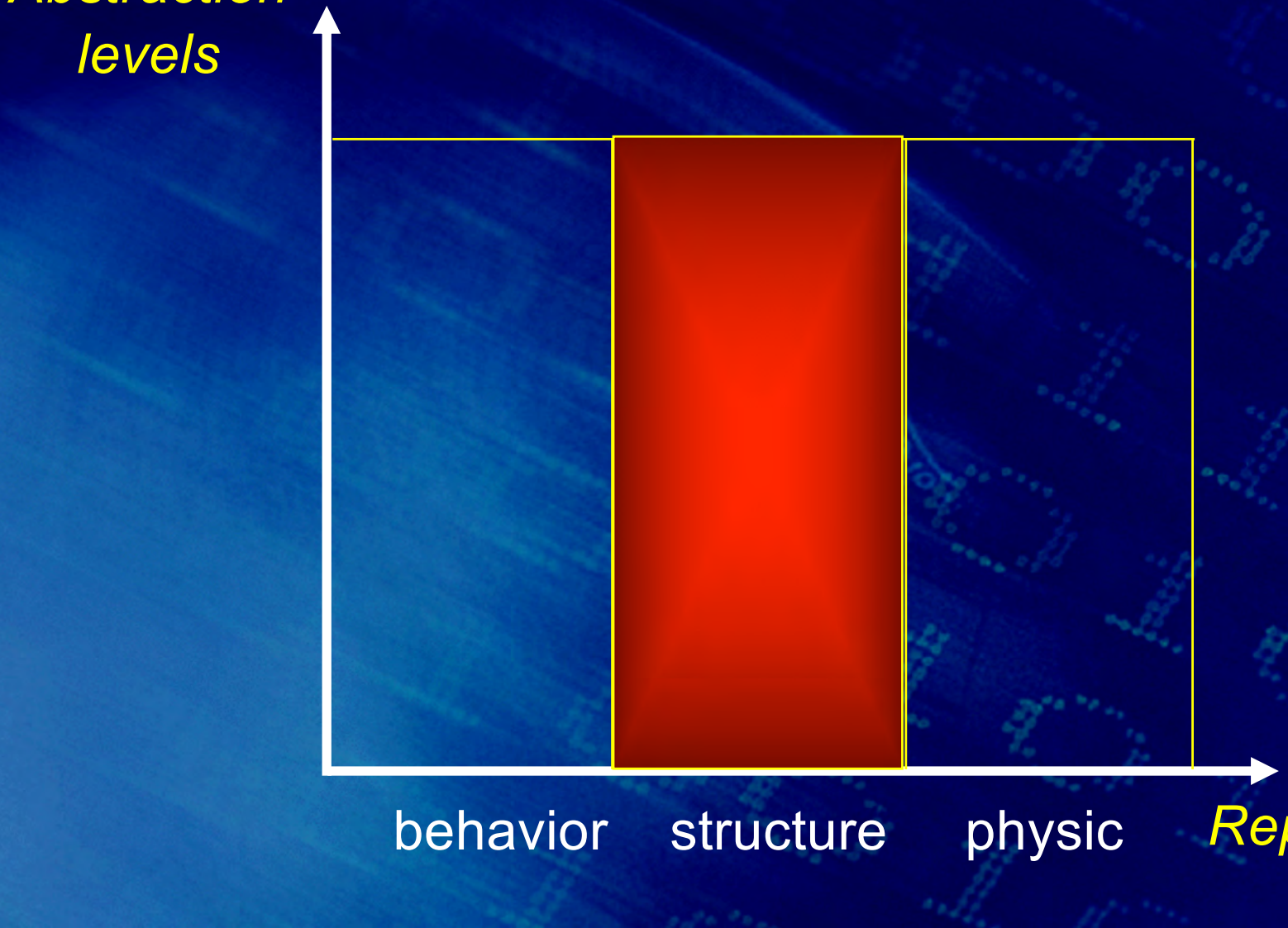

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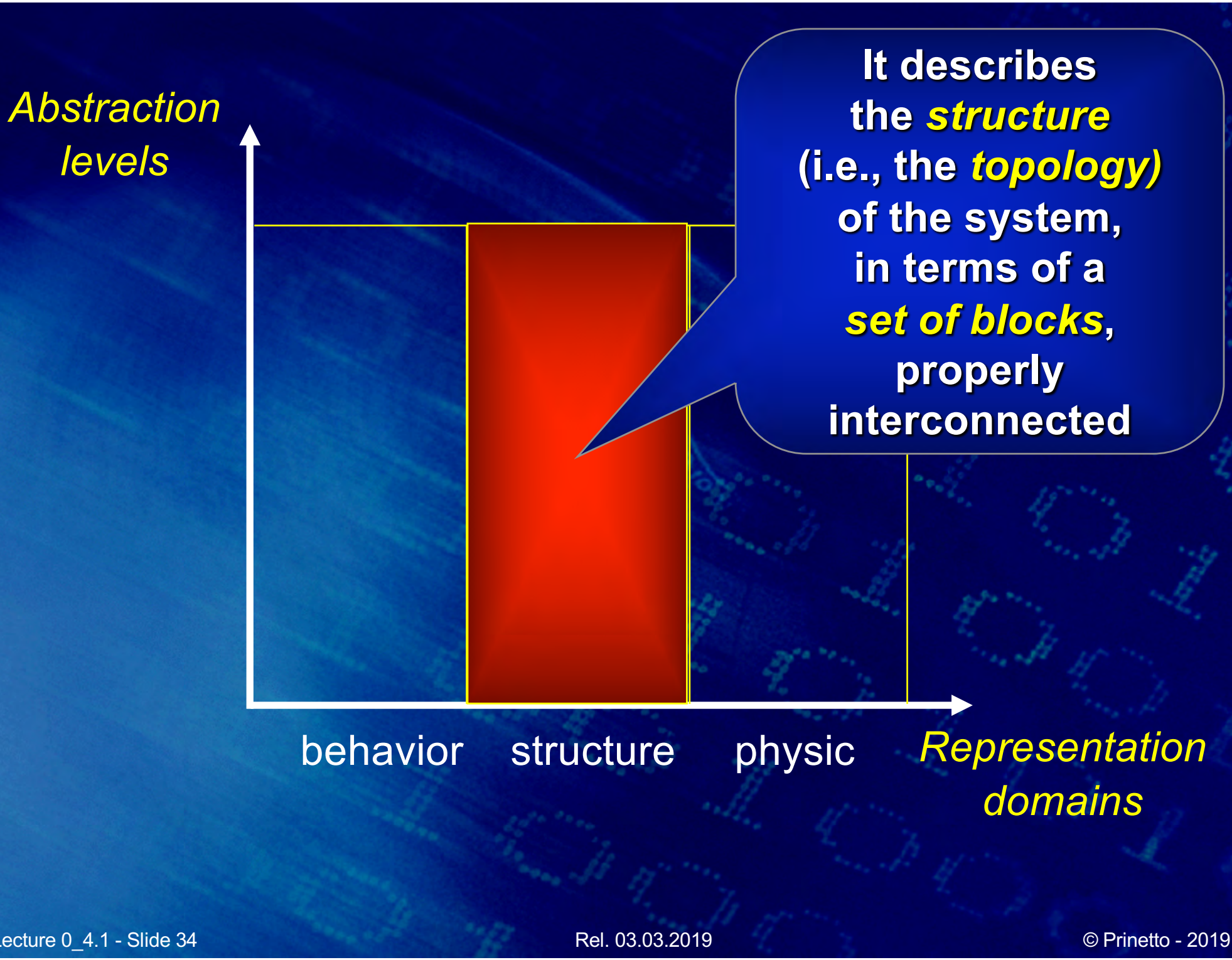

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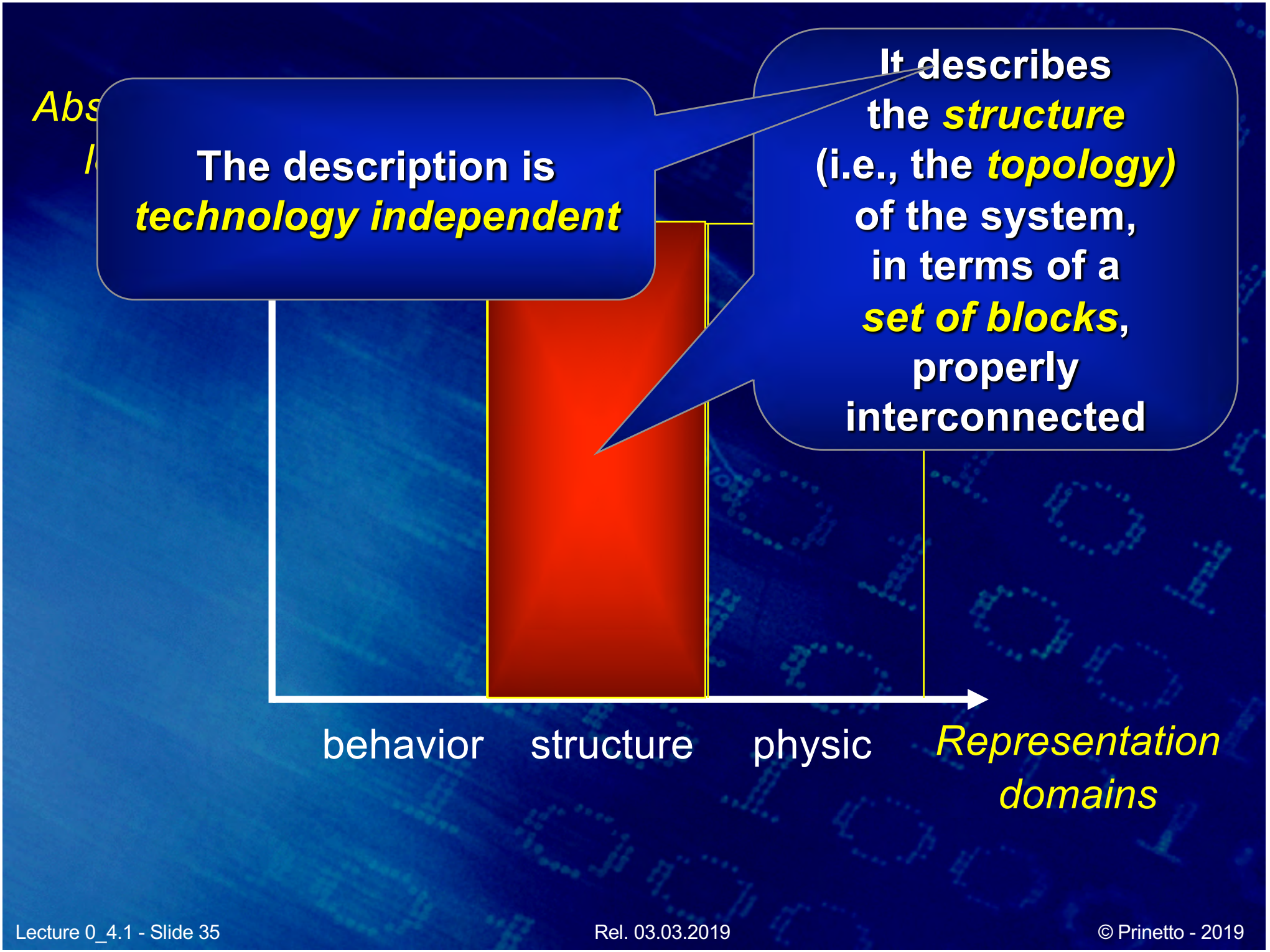

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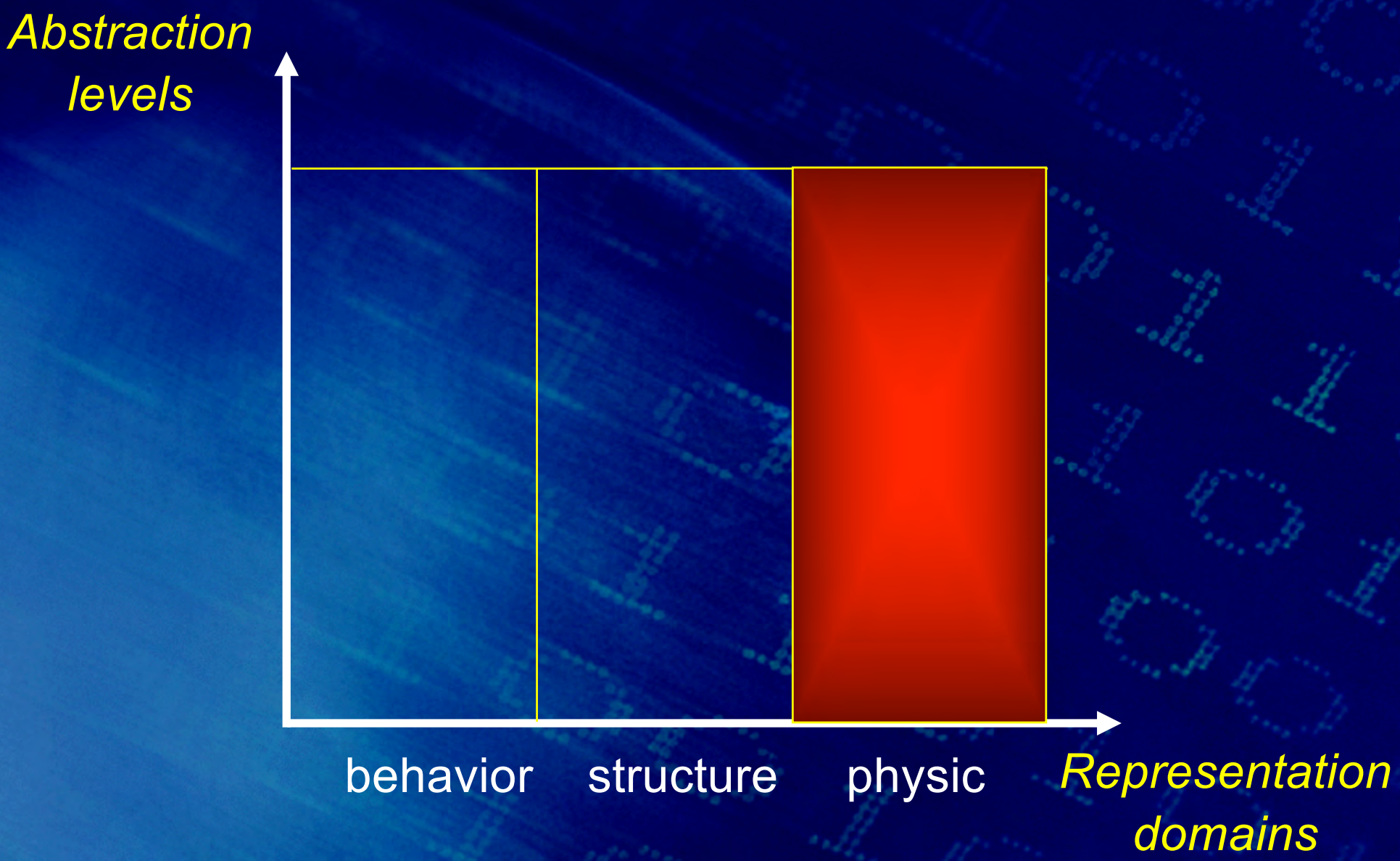

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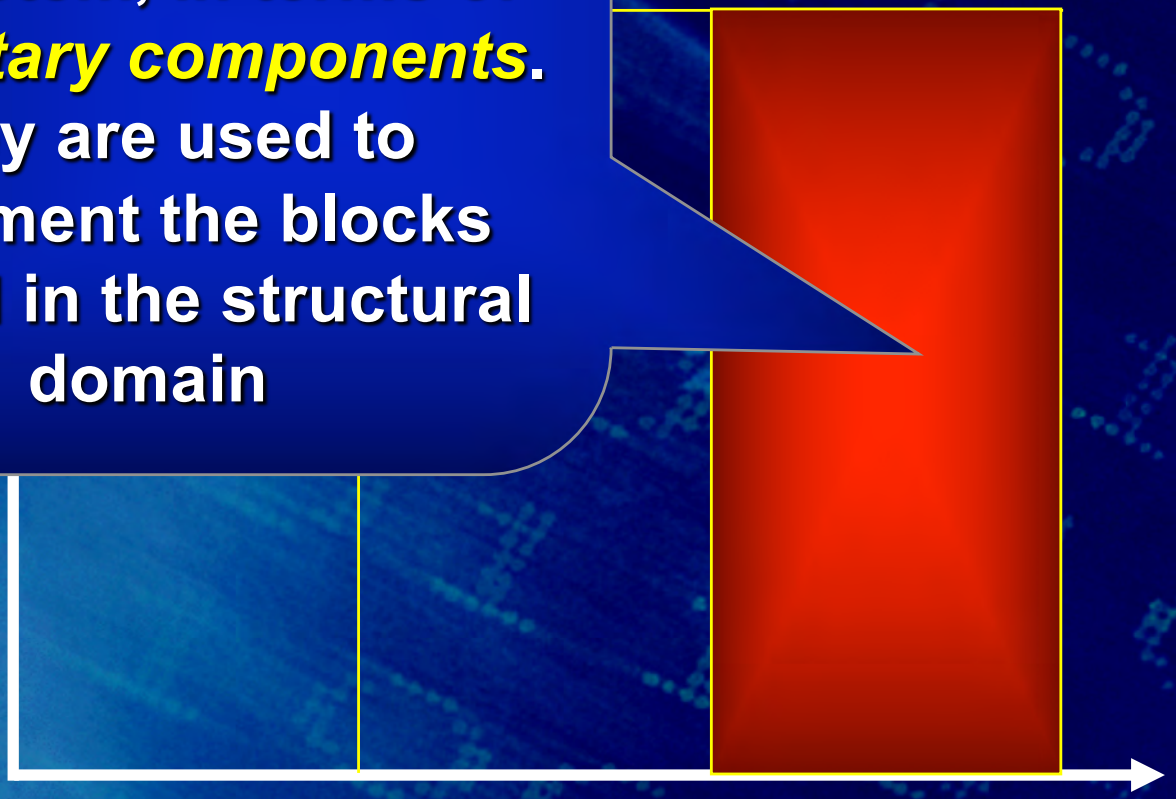
Al

It describes the ***physical structure*** of the system, in terms of ***elementary components***. They are used to implement the blocks defined in the structural domain



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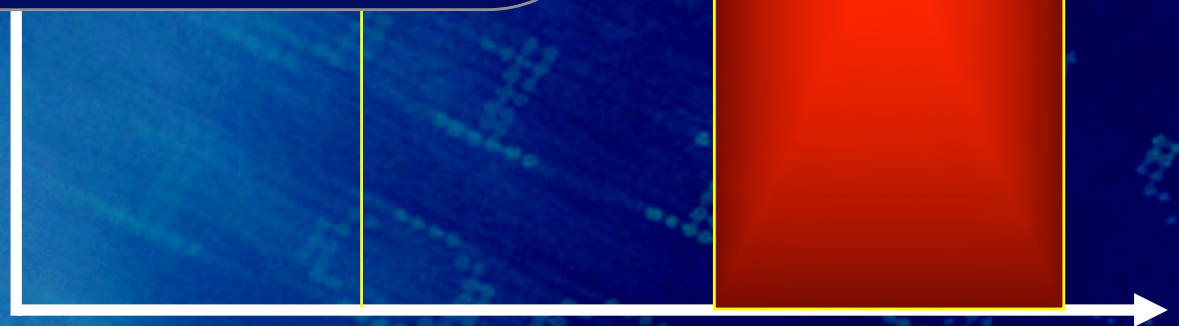
It describes the ***physical structure*** of the system, in terms of ***elementary components***. They are used to implement the blocks defined in the structural domain

The description is ***technology dependent***



behavior structure physic

Representation domains

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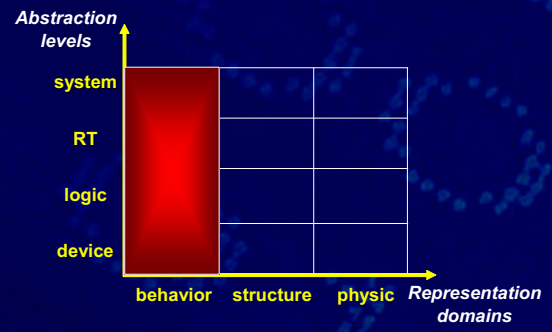
Behavioral domain



- Systems utility is determined by its *functional* as well as its *non-functional* properties

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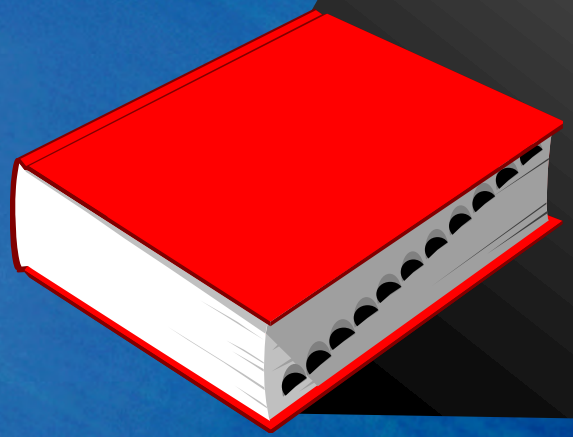
Functional Property



A property that specifies:

- *the inputs (stimuli) to the system*
- *the outputs (responses) from the system*
- *the behavioral relationships between them*

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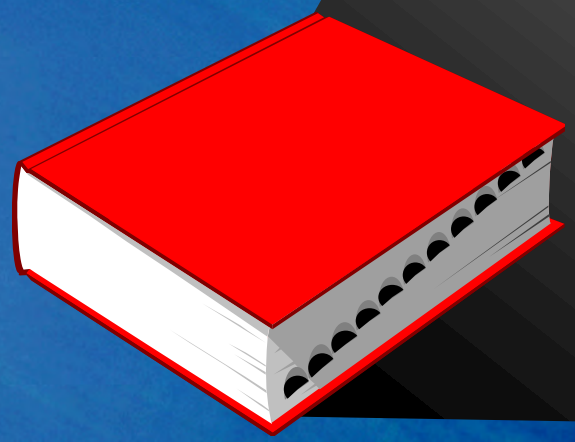

Non-Functional Property

An attribute or a constraint on the system

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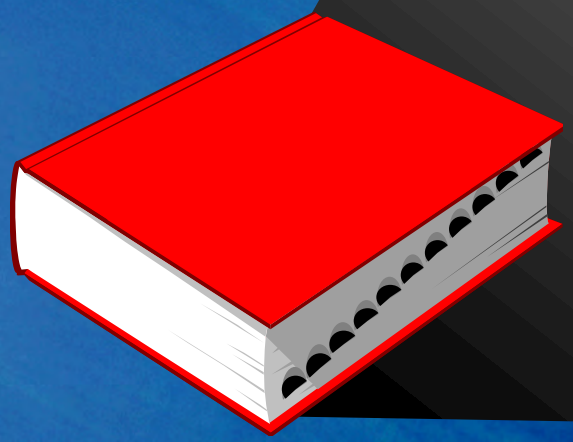

Attribute

A performance specification or a specific quality of the system

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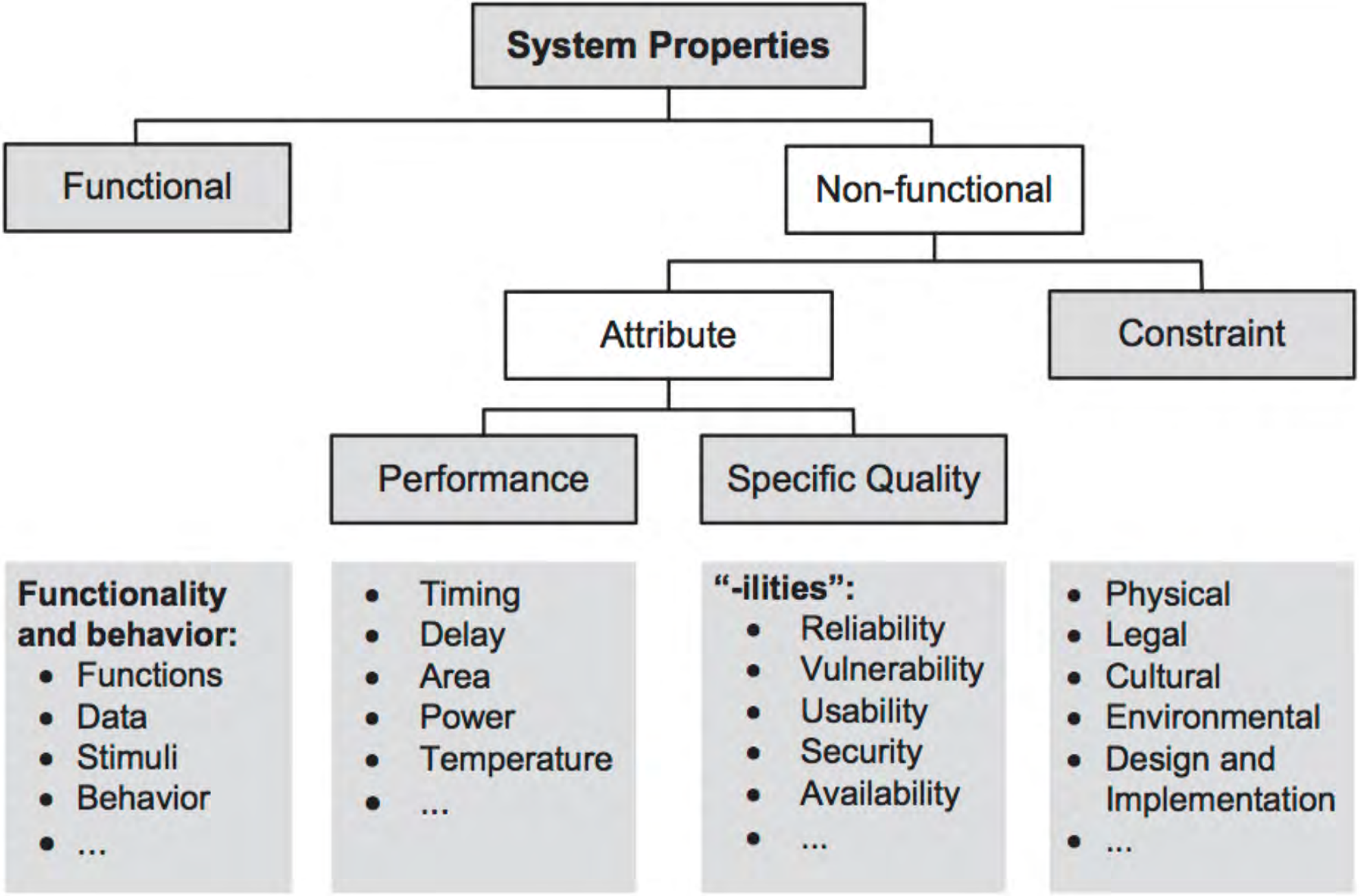
A taxonomy of system properties



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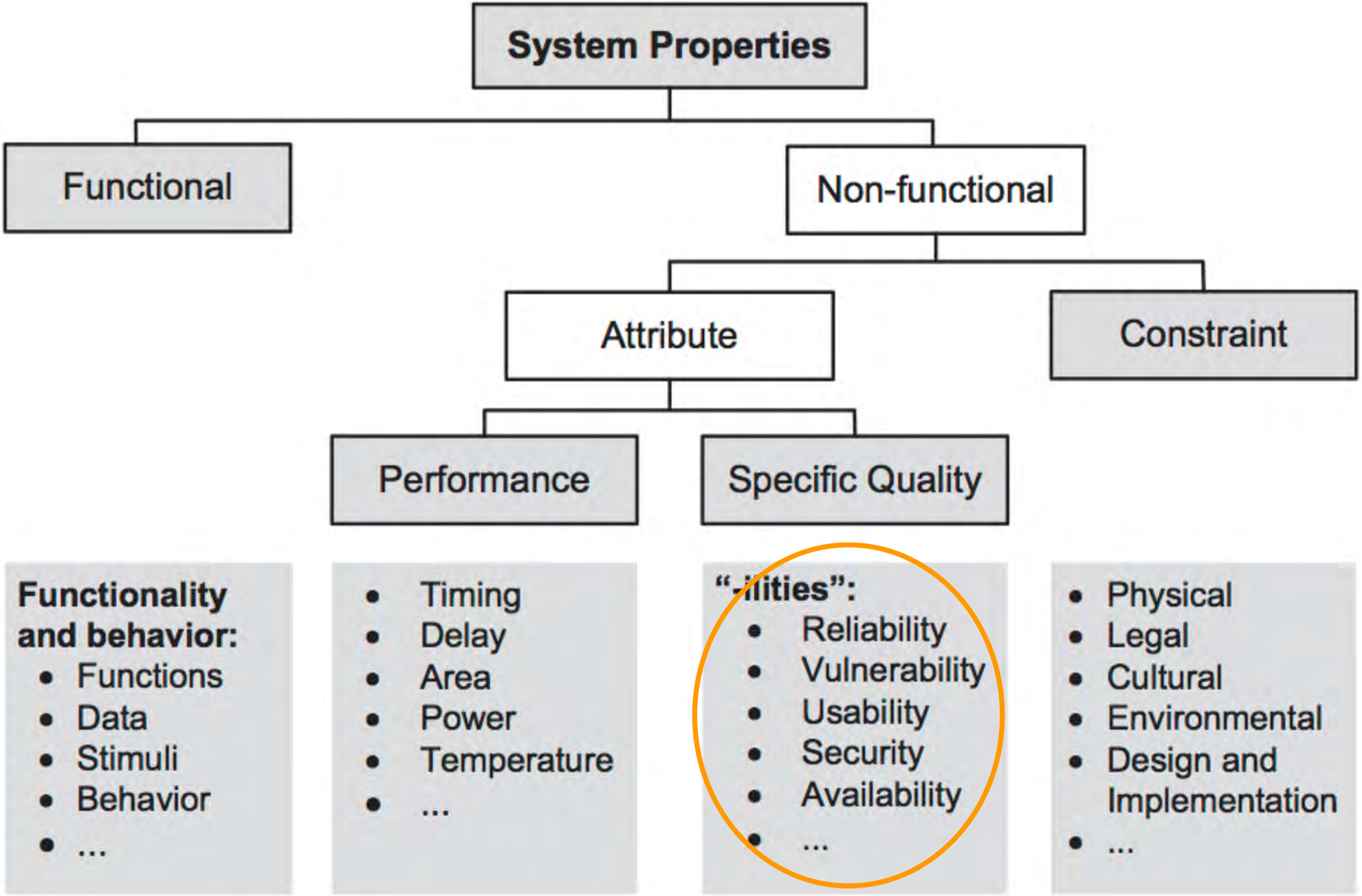

Dependability

Property of a system that allows reliance to be placed justifiably on service it delivers

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Dependability

The ability to deliver service that can justifiably be trusted

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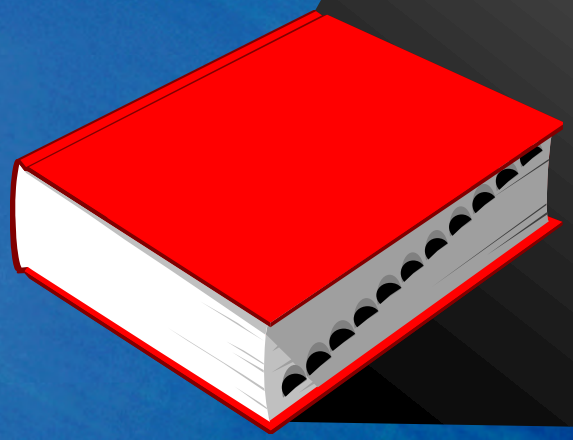
Dependability

The quality of the "delivered service" such that "reliance" can justifiably be placed on this service.



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Parameter	*Consumer*	*Industrial*	*Automotive*
temperature	0°C → 40°C	-10°C → 70°C	-40°C → 85/155°C
operation time	1-3 years	5-10 years	up to 15 years
humidity	low	environment	0% up to 100%
tolerated field failure rates	< 10%	<< 1%	zero failure
documentation	none	conditional	true
supply	none	up to 5 years	up to 30 years

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Safety

The condition of being protected from or unlikely to cause danger, risk, or injury

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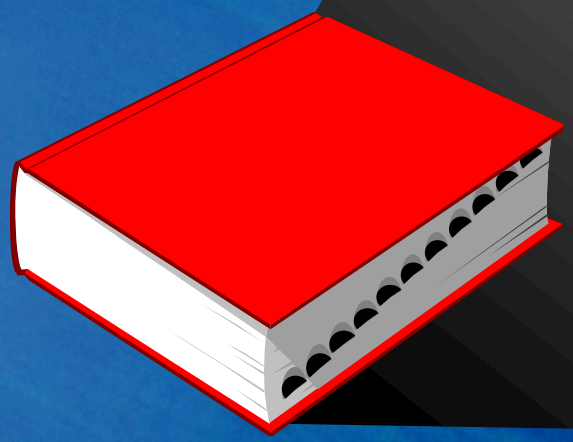

Security

The state of being free from danger or threat

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Security

It provides "a form of protection where a separation is created between the assets and the threat"

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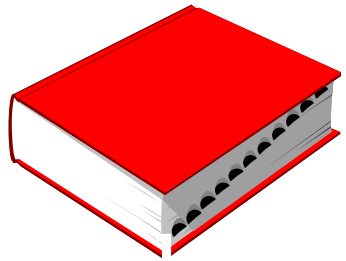
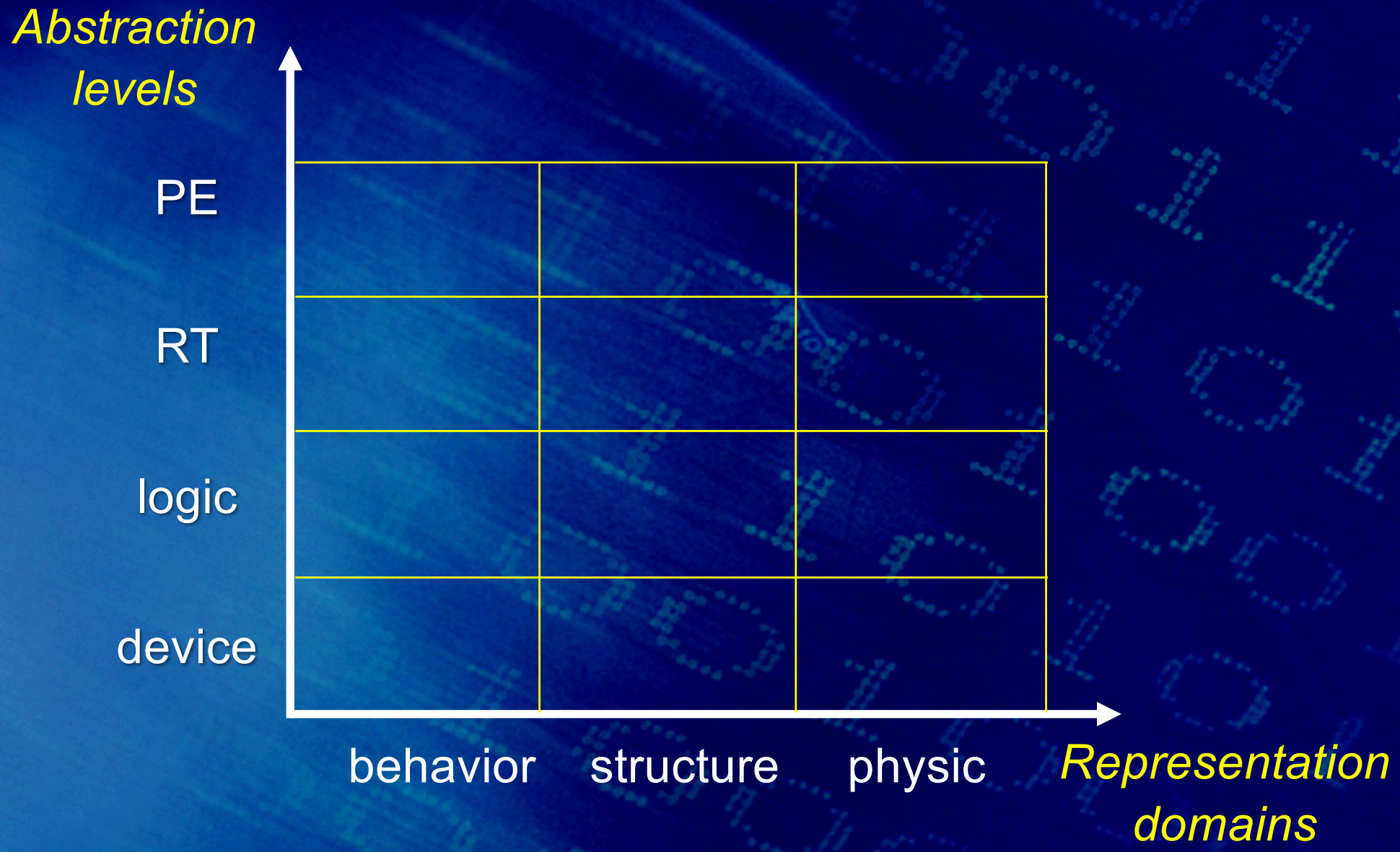
Computer security



- Measures and controls that ensure *confidentiality*, *integrity*, and *availability* of information system assets including hardware, software, firmware, and information being processed, stored, and communicated

[The NIST Internal/Interagency Report NISTIR 7298
- Glossary of Key Information Security Terms, May 2013
(**NIST** = U.S. National Institute of Standards and Technology)]

The Representation Matrix



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Outline

- System
- Processing Elements
- Data & Control

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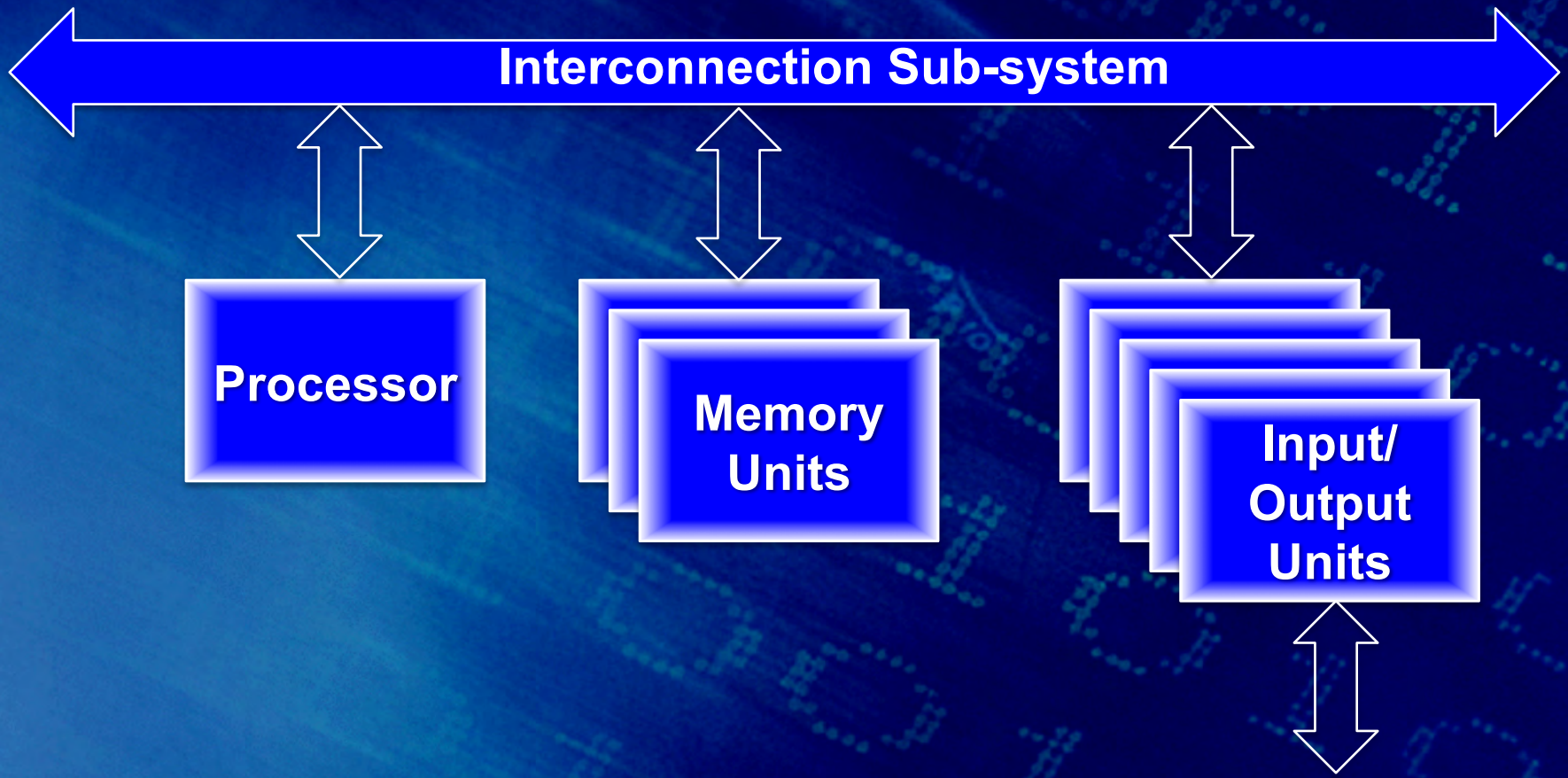
Processing Element



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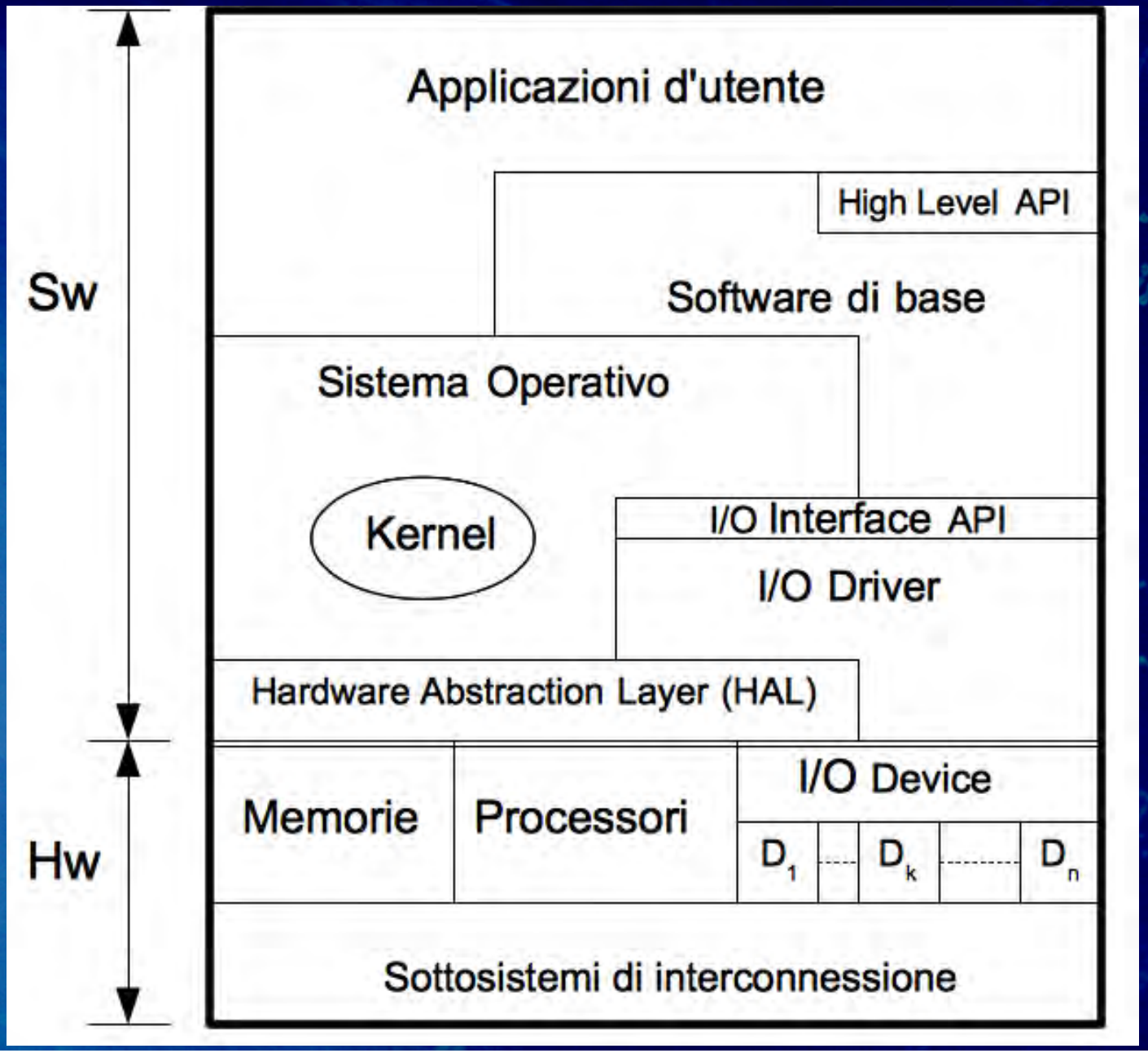
Processing Elements



Outline

- System: a hierarchical approach
- Processing Elements
- Data & Control

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Data & Control

- A clear distinction must be done between Data & Control, in terms of:
  - *Signals*
  - *Functional units*

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System I/O signals

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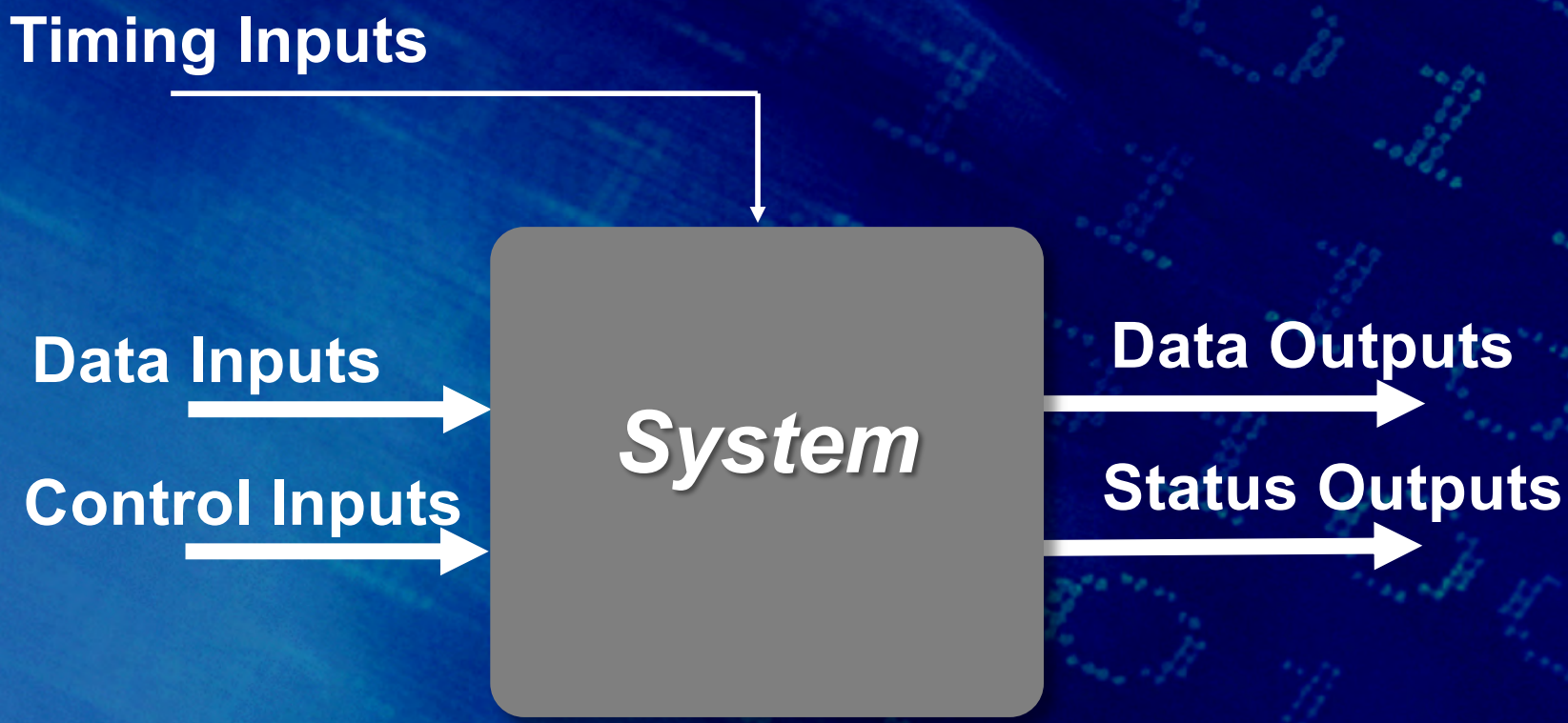
System I/O signals



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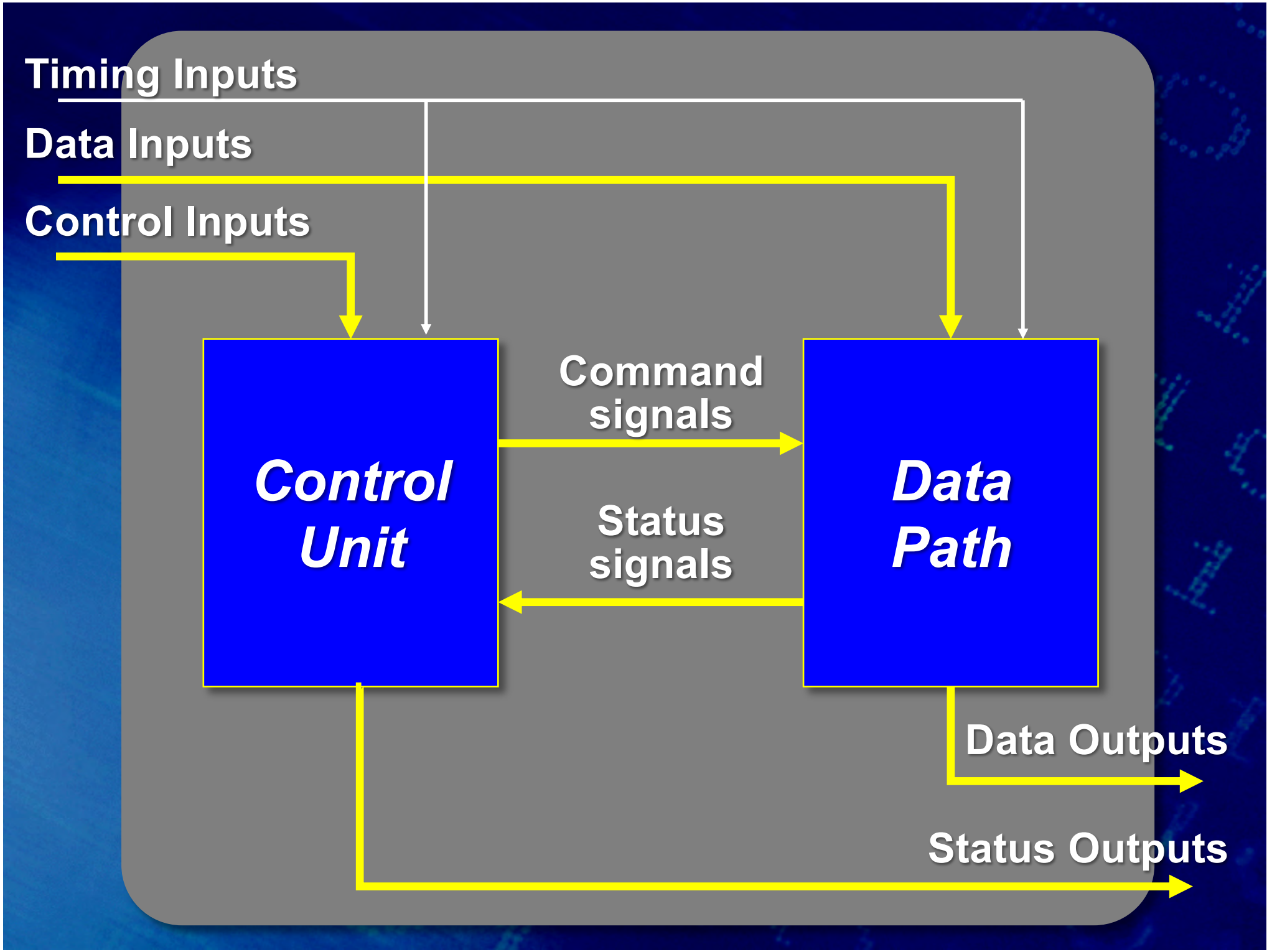
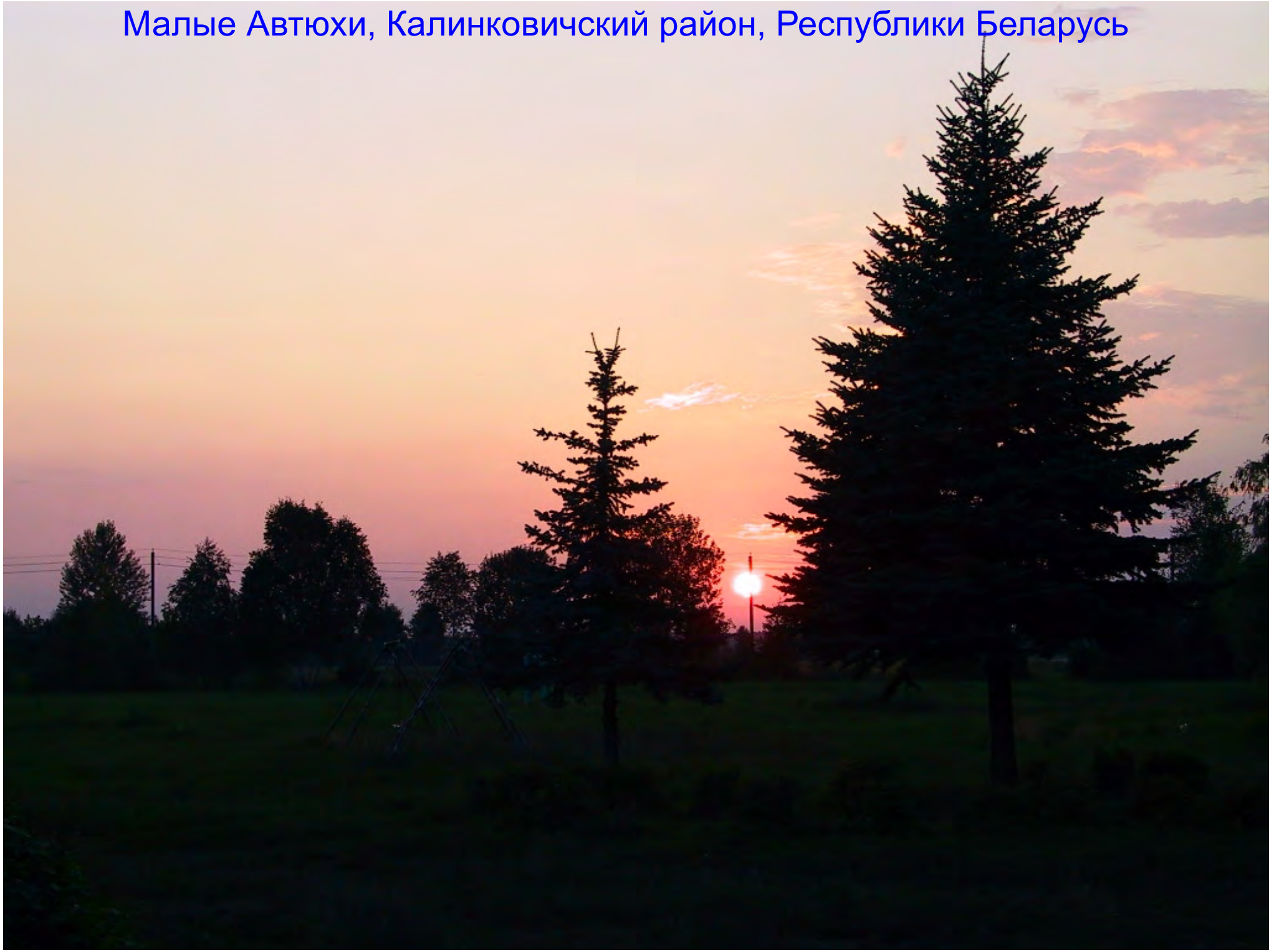

Timing Inputs
Data Inputs
Control Inputs
Control Unit
Command signals
Status signals
Data Path
Data Outputs
Status Outputs


Малые Автюхи, Калинковичский район, Республики Беларусь