

# Systems of Systems and Emergent System Context

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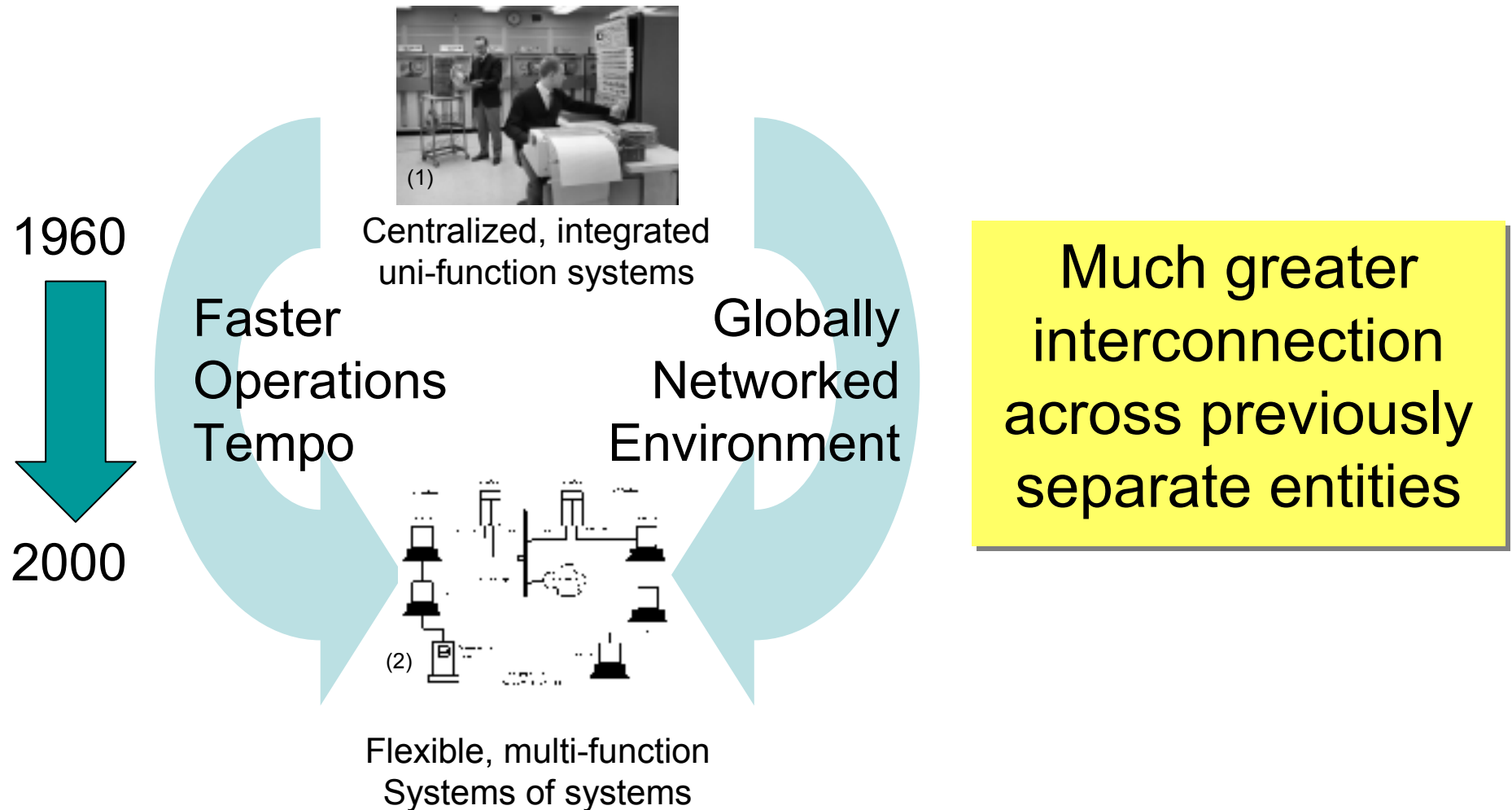
Prof. Daniel E. Hastings



# Agenda

- What is a system of systems (SOS)?
- What is the context of a system?
- What is the context of a SOS?
- How is SOS context created?
- What are the implications for future work in SOS?

# What is a systems of systems?



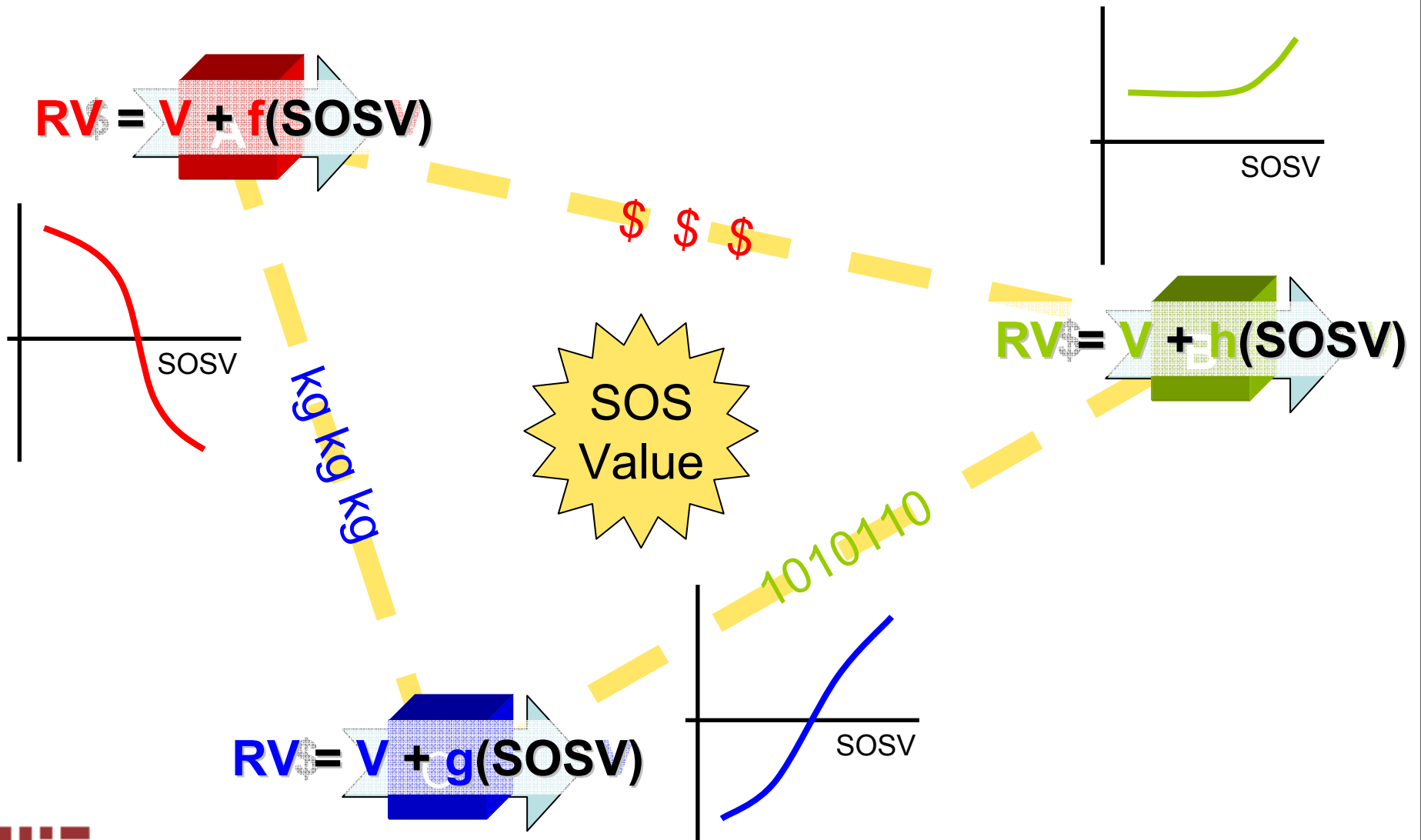
# SOS are Systems

- What is an [engineered] system?
  - We use the INCOSE handbook definition:

*An interacting combination of elements to accomplish a defined objective. These include hardware, software, firmware, people, information, techniques, facilities, services, and other support elements.*

- What is system-of-systems?
  - Is it just a collection of *systems* working together as a *system*?

# Value Gained through Interaction



# Independence Retained

*Literally:* Any system that is composed of an integrated group of systems is a system of systems.

Must form a *useful* taxonomic division, i.e. identify a class of problems that require different approaches than 'traditional' systems

*Collaborative SOS:* Satisfies literal definition, but also exhibits *operational independence* and *managerial independence*



# What is system context?

“The environment of a system is a set of elements and their relevant properties, which elements are **not part of the system** but a change in any of **which can produce a change in the state of the system** ... External elements which effect **irrelevant properties** of a system are **not part of its environment.**” (Ackoff 1971)

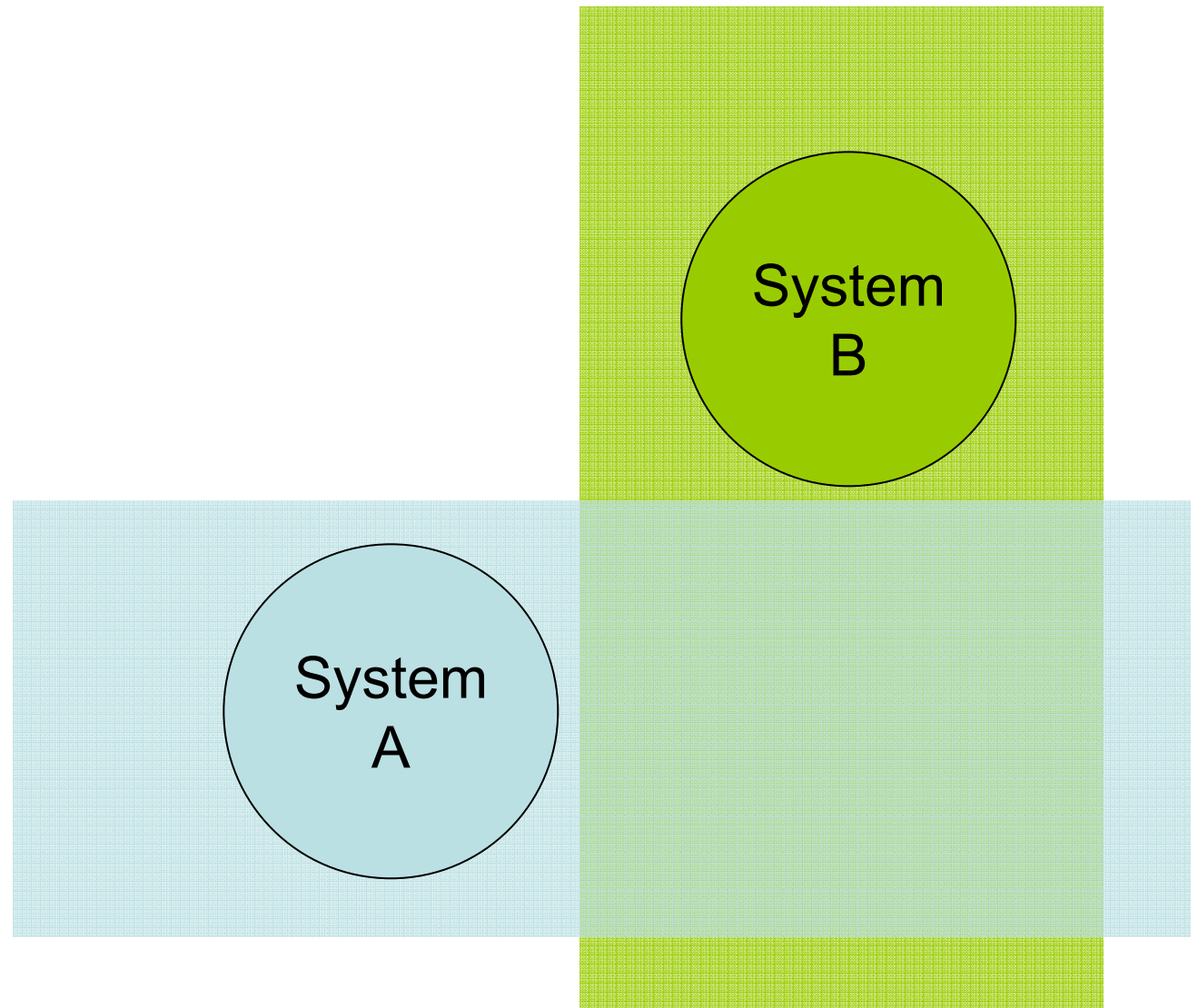
**Context (analytic):** The external entities and conditions that need to be taken into account in order to understand system behavior.

Simon (1996) describes the environment as ‘**mold**’ into which the **system must fit to satisfy its goals**

**Context (architectural):** The mold to which the architecture must conform. It is a result of the objectives and constraints that the designer is trying to satisfy.

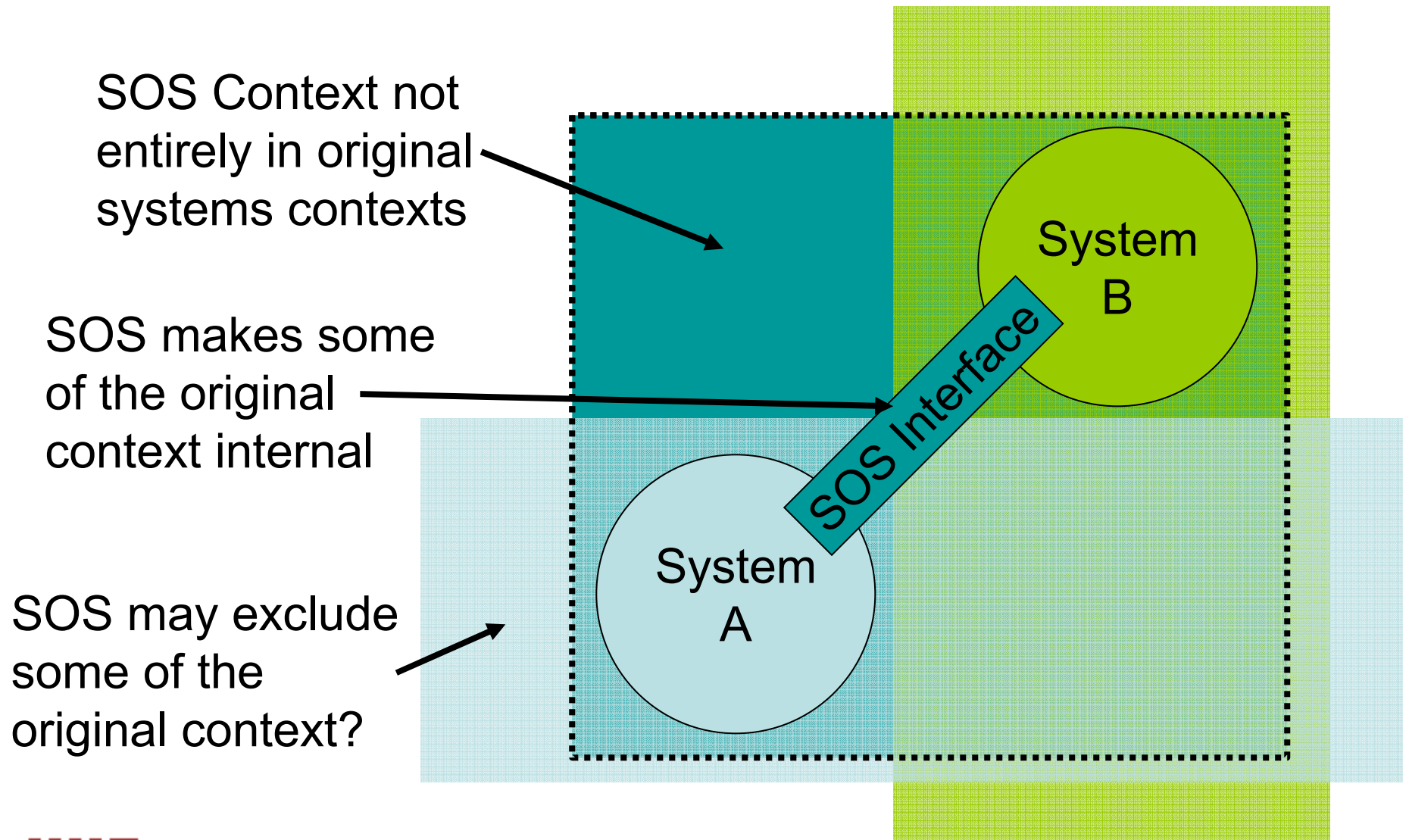


# What is the context of an SOS?

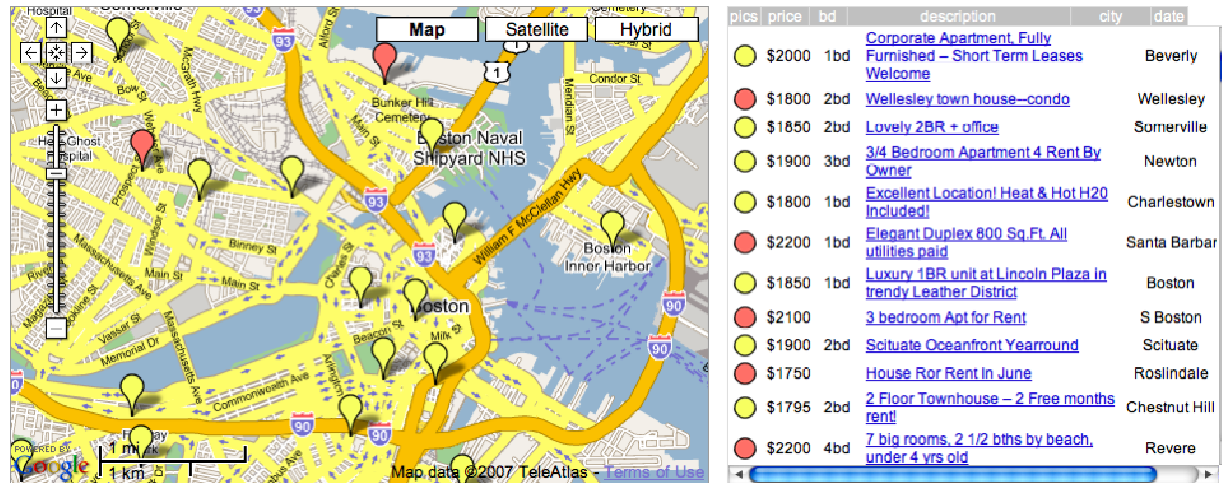




# What is the context of an SOS?

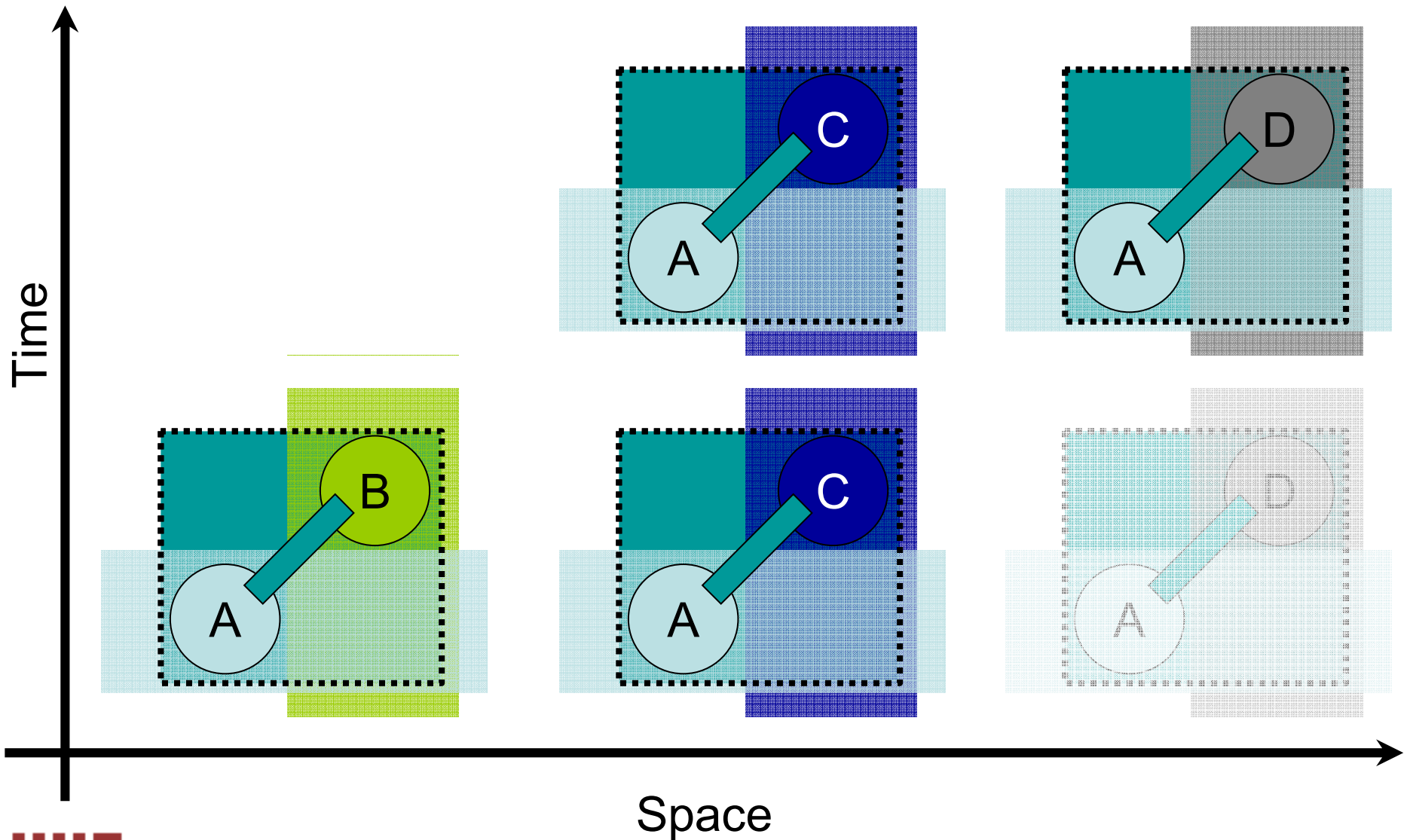


# Example: HousingMaps



- Website connecting Google Maps and Craigslist
- HousingMaps' context includes some aspects from Google, some from Craigslist and some unique to its purpose

# Participation in multiple SOS



# How is SoS context created?

- Maier points out that, given operational and managerial independence, the architecture of a SoS is the architecture of the interfaces between constituents
- When viewed as socio-technical objects, interfaces create the joint context
- The nature of the context is determined by the interface creation and management process

# Two sample approaches

## HousingMaps

*Bottom up*

- SOS created by the users to meet a new need
- Success factors:
  - Open standards
  - Clear protocols
  - Low initial burden

(Rademacher 2005)

## Task Force XXI

*Top down*

- SOS architected by empowered group
  - Success factors:
    - Authority to mandate compliance
    - Strong and frequent communication with stakeholders
    - Rapid design iteration to prevent creep
- (Krygiel 1999, Chap. 5)

## What are the implications for future work in SOS?

- Context is a crucial issue in system design as it determines the conditions for success
- SOS context cannot easily be determined from the context's of the constituents
- SOS context emerges as a result of the socio-technical nature of SOS interfaces
- Using different approaches to SOS architecture will result in very different contexts

# References

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# Backup

