

# Mastering Systems Integration; Systems of Systems

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## Abstract

Most end-user functionality and services are realized by Systems of Systems. Many of these systems may include organizations and humans; the systems aren't technical artifacts anymore. These systems evolve over time individually and typically lack a centralized governance. The resulting end-to-end qualities depend on all constituent systems and their interoperability.

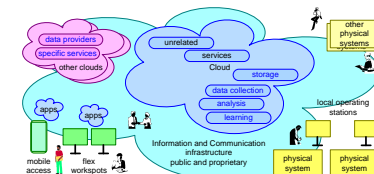
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# Types of Systems of Systems

**Directed** - The SoS is centrally managed

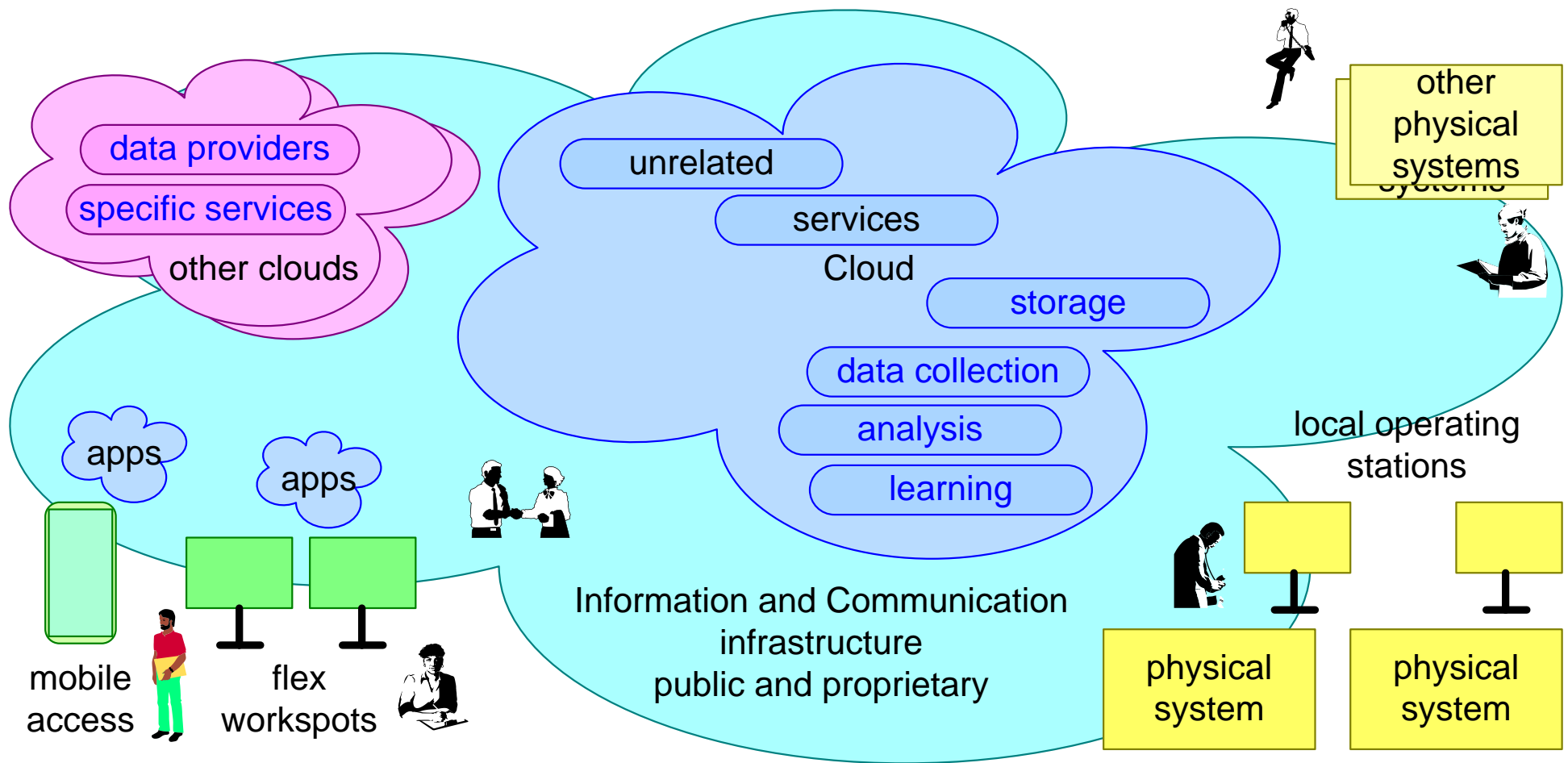
**Acknowledged** - The SoS has recognized objectives, and active cooperation between SoS and constituent systems

**Collaborative** - The constituent systems and stakeholders cooperate

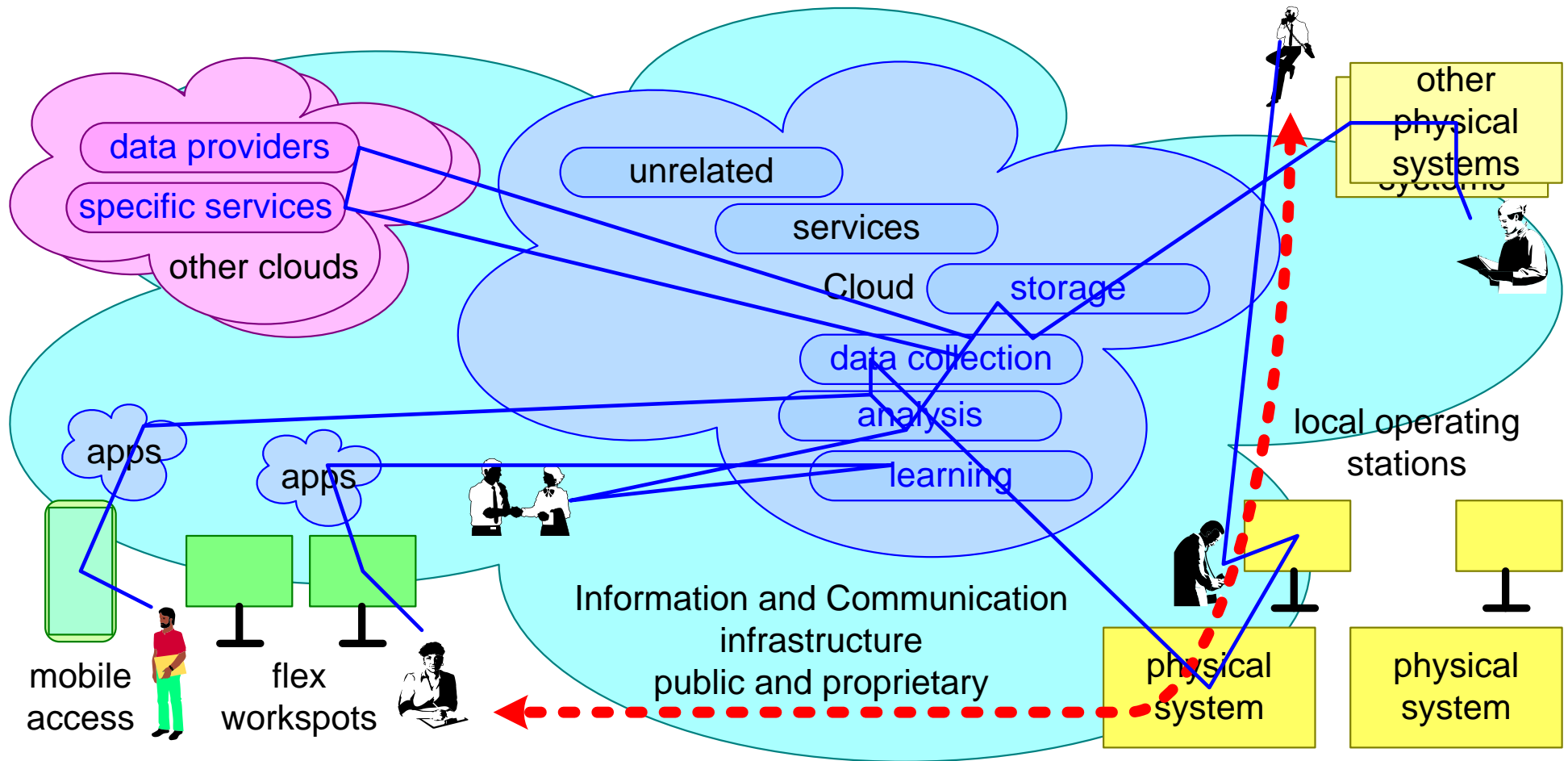
**Virtual** - The SoS nature more or less emerge from the constituent systems

**J. Dahmann and K. Baldwin.** 2008. "Understanding the Current State of US Defense Systems of Systems and the Implications for Systems Engineering." IEEE Systems Conference 2008 in Montreal, 2008

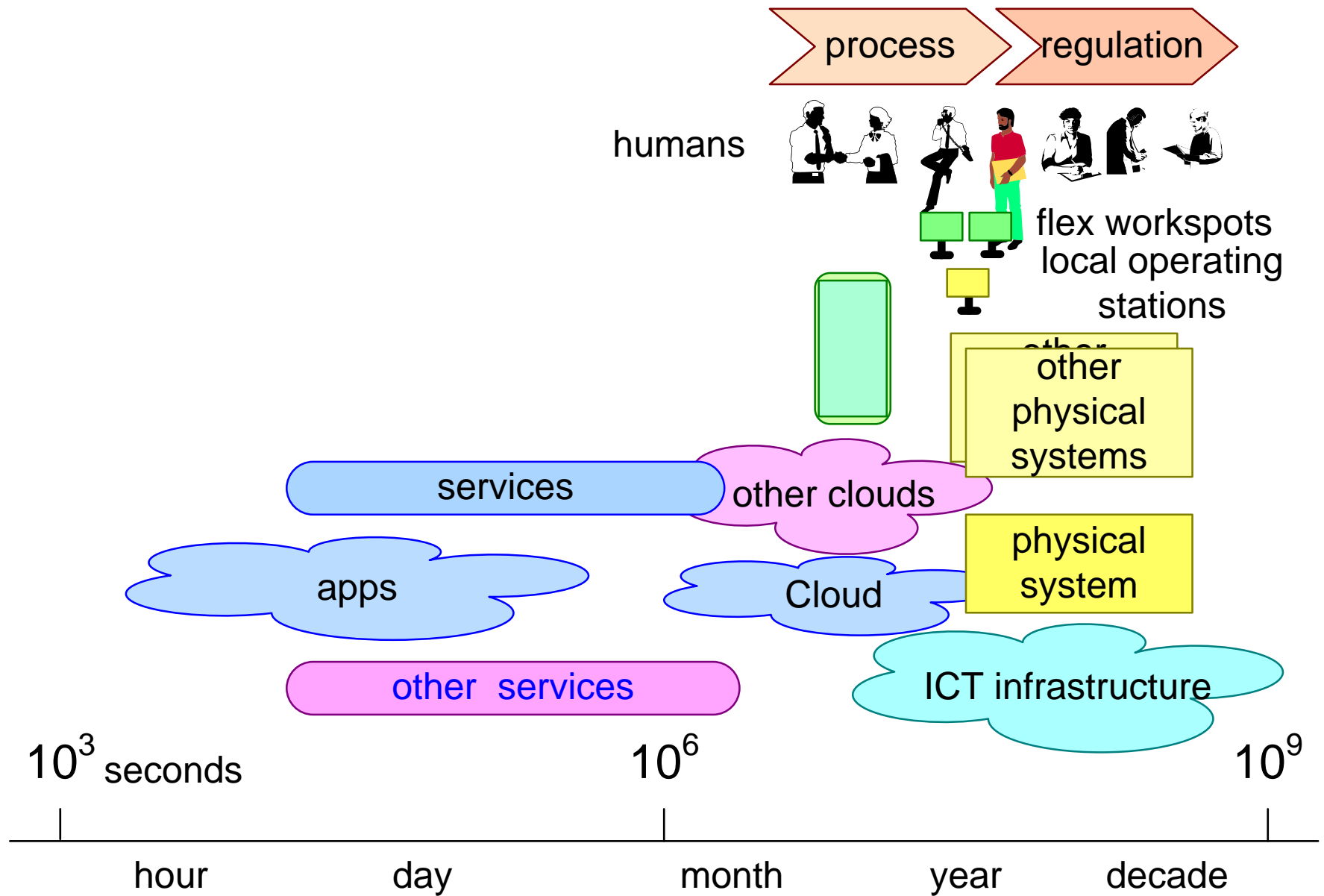
# Where are the System Boundaries?



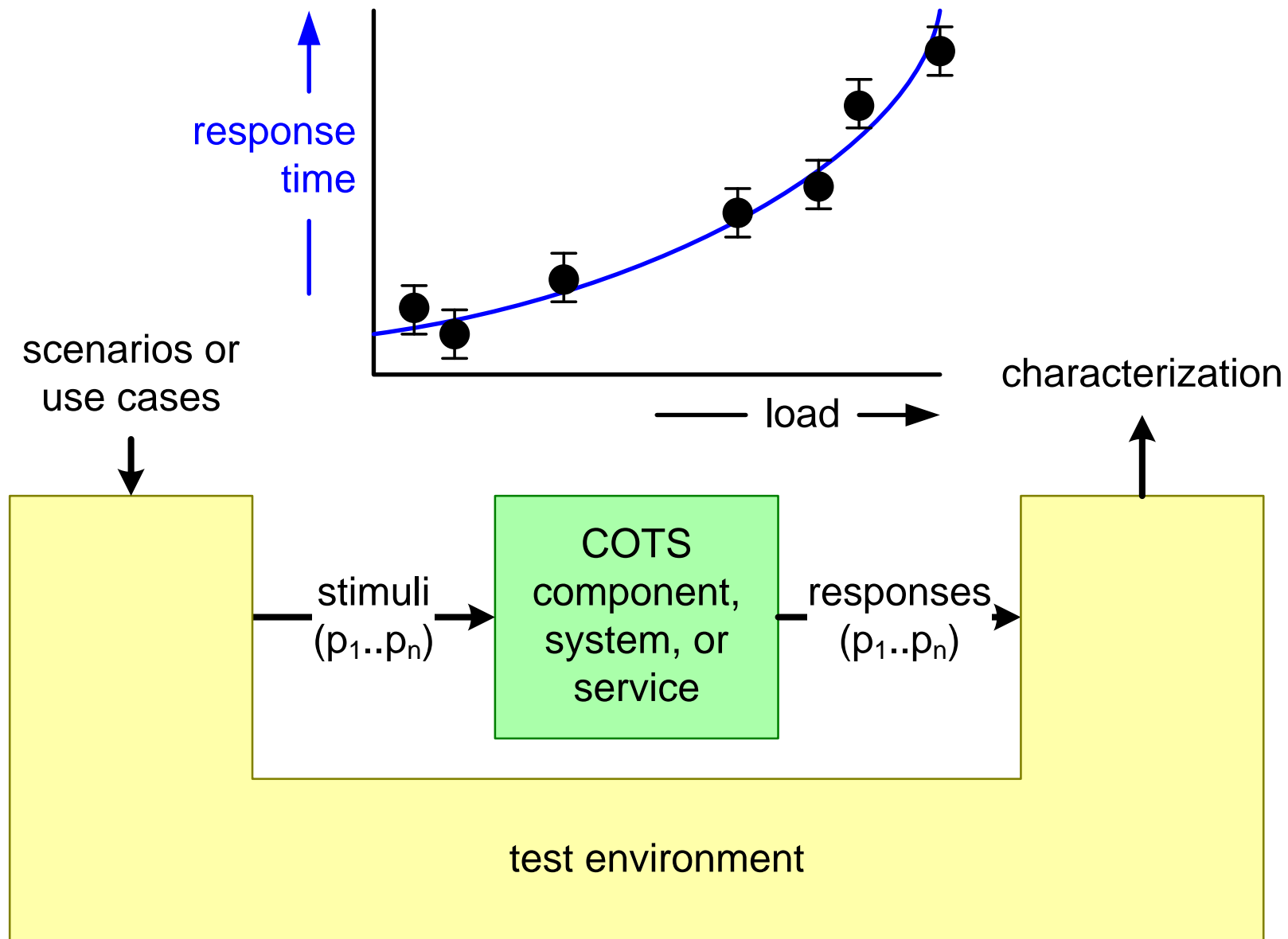
# End-to-End Function



# Varying Dynamics



# Characterization of Black Box Parts



# Summary

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- Systems of Systems Integration **continues in the field** during operation
- **Ownership** and **responsibility** for end-to-end performance is **ill-defined**
- **Your system** may be **blamed** for problems with a **root cause elsewhere**
- End-to-end performance depends on a mix of
  - traditional **technical** systems
  - **modern technologies** like learning
  - **humans** in their organizational and societal context (psychological, social, political, economical, legal, etc.)
  - the **physical** context (location, climate, etc.) and laws of physics

# Keywords from various SoS models in literature

Boardman and Sauser	Maier	DeLaurentis	Dahmann and Baldwin
Autonomy	Operational independence	Type	Directed
Belonging	Managerial independence	Control (or autonomy)	Acknowledged
Connectivity	Geographic separation	Connectivity	Collaborative
Diversity	Emergent behavior		Virtual
Emergence	Evolutionary development		