"Using Heteropoiesis in the SSP to Understand and Design Data Storage Systems."

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Overview

System of System's processes enables an abstract but simultaneously very detailed point of view of systems that serves to increase the level of understanding of specific systems and how they work. This in turn allows new insights on how to improve system functioning and why specific system solutions emerge.

This poster demonstrates this by exploring only one specific isomorph from the 80+ isomorphs of SSP in data storage systems. It describes the system processes features and functions and then gives examples of them in data storage systems. A specific improvement in data storage system design is then highlighted for this process.

The system processes (isomorph) explored in this poster is hierarchy. Dr. T. uses the term "heteropoiesis" to designate the natural processes by which heterarchical or hierarchical structure originates in nature.

System Process - Hierarchies

- **General Description and Features of Hierarchies**
  - A system is defined as hierarchical if it can be described as composed of stable, observable subunits unified by a superordinate relation.
  - " " from Ahl and Allen.
  - Levels, sets of ordered levels
  - Interactions between levels are less frequent than within levels
  - Interactions within levels are more frequent
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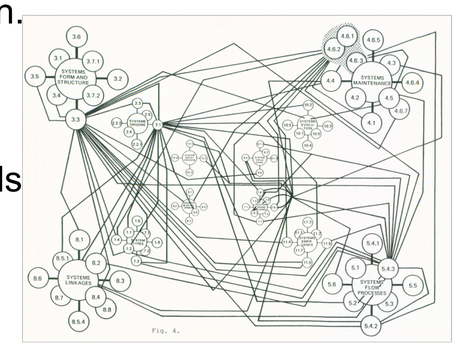


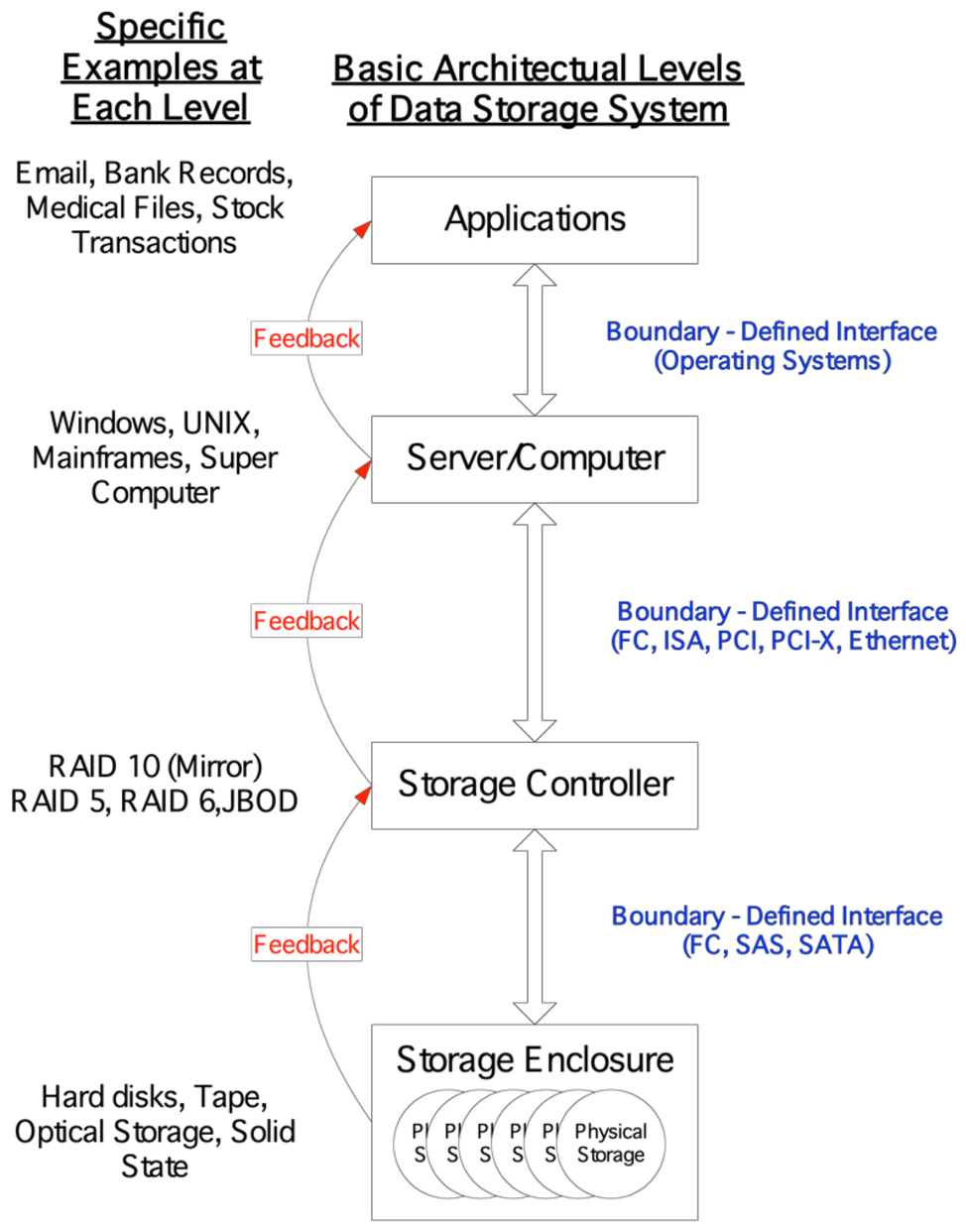
- **Data Storage Examples of Hierarchical Features:**
  - Data storage systems have several levels. The included diagram shows an overview of some of the basic levels of data storage systems.
  - Interactions are limited between levels by predefined interfaces. The interactions within each of the levels is much higher than between levels.

- **Functions of Hierarchies**
  - Allows for increased complexity - an organizing function of parts
    - Its modularity allows for increased possibilities for combinations provides more than one pathway to get to the same result (equifinality) within hierarchies of a system (weaker than networks)
  - Efficient search strategies and file organization in complex systems/minimum paths for speed and access
  - Interactions between levels are less frequent than within levels
  - Interactions within levels are more frequent
  - Provides a transcendence/emergence function that solves problems at a former levels
  - Provides stability at one level while allowing exploration of new design spaces at another level
  - Reduces complexity by limiting interactions

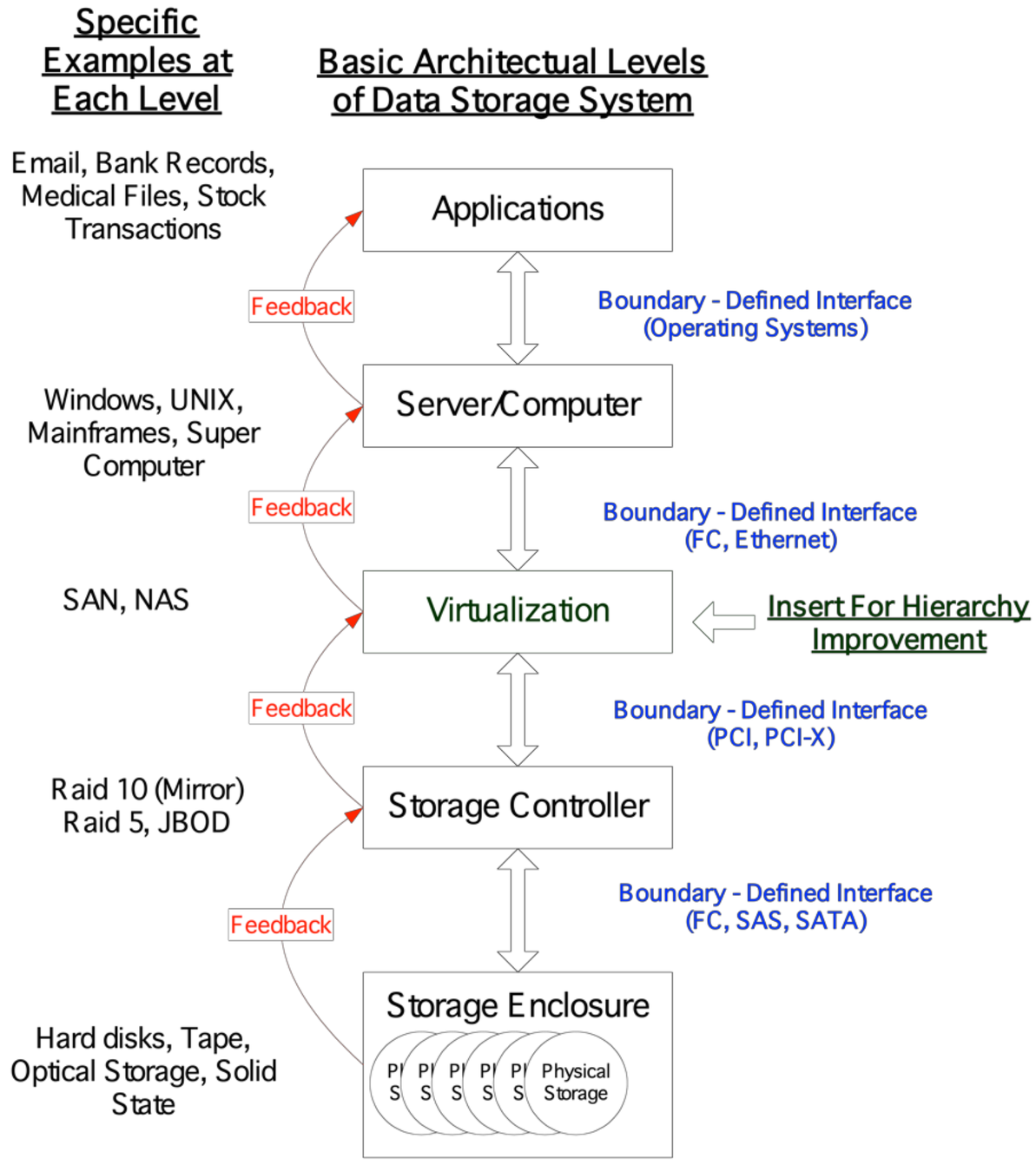
- **Data Storage Examples of Hierarchical Functions:**
  - Each level has several possible interchangeable parts. There are several types of applications that can run on several types of different servers/computers that can run with several different types of storage controllers which can control several different types of storage systems. Companies specialize and compete to supply products at each level. Interactions are limited between levels by predefined interfaces. The interactions within each of the levels is much higher than between levels.
  - The hierarchical levels in storage systems allow complex development and innovation to occur at each level without disrupting other levels.

- **Data Storage Improvement Example:**
  - Adding a virtualization block to the hierarchy between the server/computer and storage controller block emerged as a way to further separate and limit the interaction between the server and controller. This allows the storage system at the virtualization block level to provide storage to several different servers at the same time. It creates "volumes" of storage for the server. The server no longer has to care where/how or what kind of storage the volume actually resides on. This improves the efficiency and manageability of the storage that the servers need.

Data Storage Diagram



Data Storage Diagram with Improvement



Technical Definitions

- RAID – Redundant Arrays of Inexpensive Drives. These are different ways of distributing the data across the storage devices. Depending on the levels, it can improve performance and allow data to be recovered if a number of devices fail.
- JBOD – Just a Bunch of Disks – no data layout techniques are used.
- FC, SAS, SATA – Different types of communication interfaces used for communicating to storage devices. Each of them have standards that are developed so that any controller using a certain protocal can communicate with any device using the same protocal.
- ISA, PCI, PCI-X, Ethernet – Some examples of communication protocals used to communicate to internal or external storage controllers.
- SAN, NAS – Storage Area Network, Network Attached Storage. Different ways of creating another level of abstraction for organizing storage devices for servers.