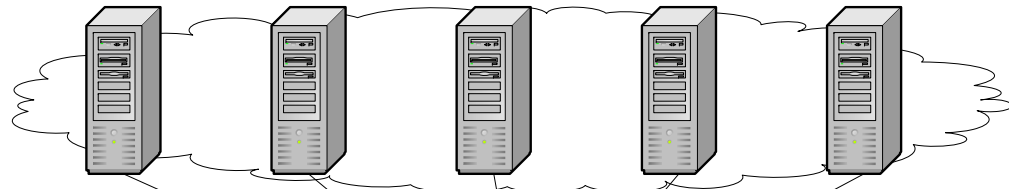


Automatic Storage Allocation using Fuzzy Control

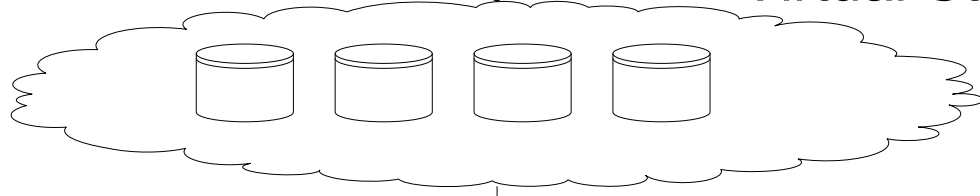
Philip Derbeko
SANRAD

Setup

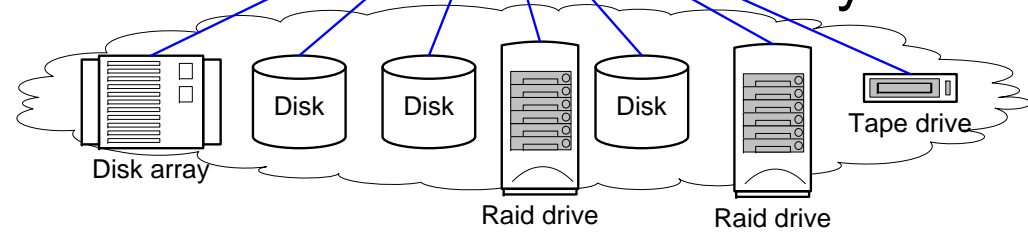
HOSTS



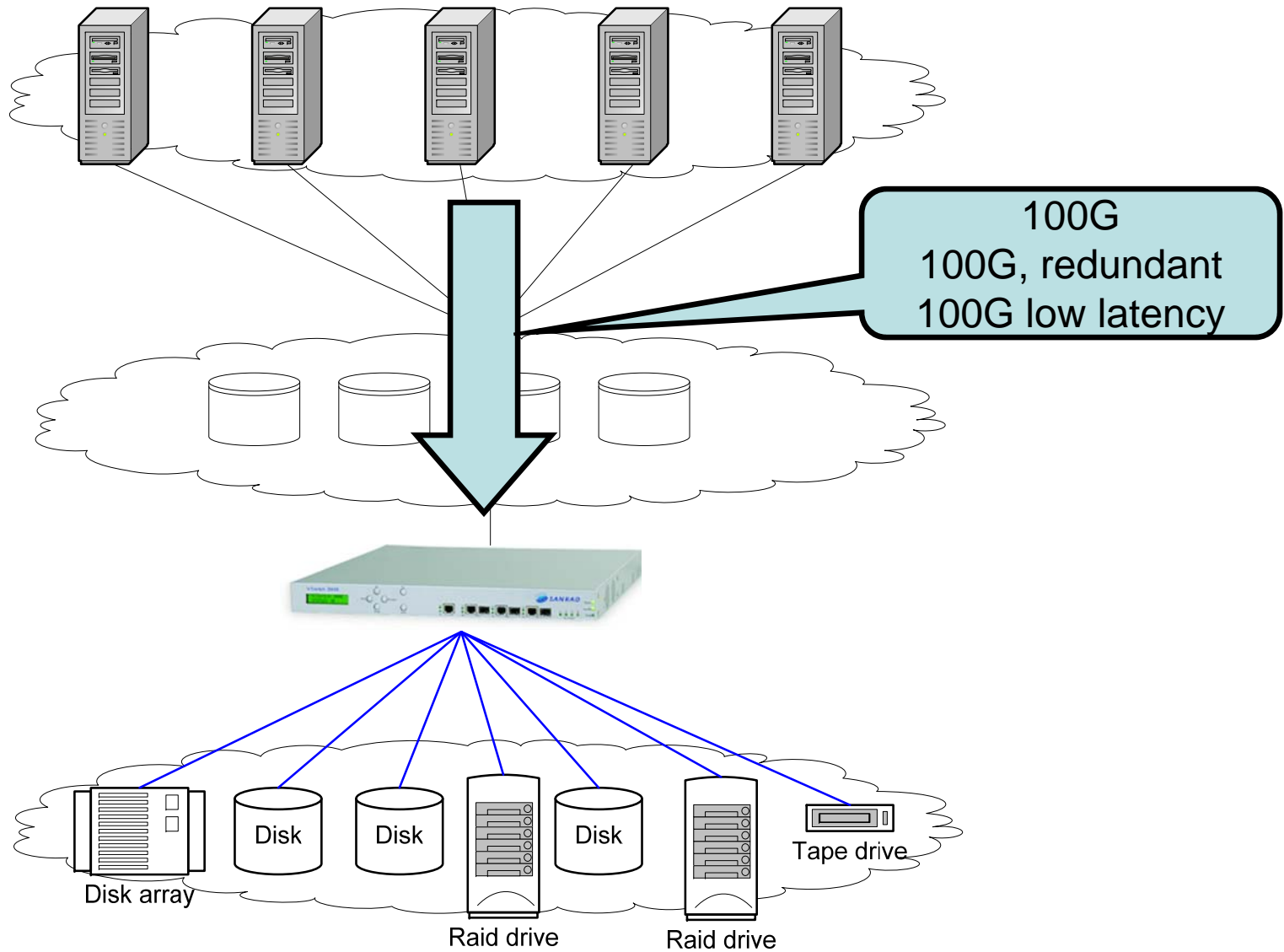
Virtual Storage



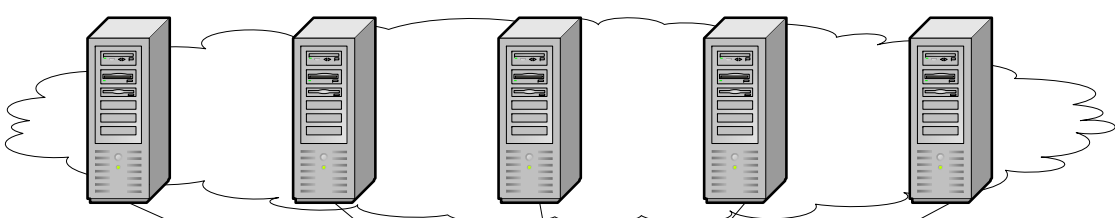
Physical Storage



Problem to solve



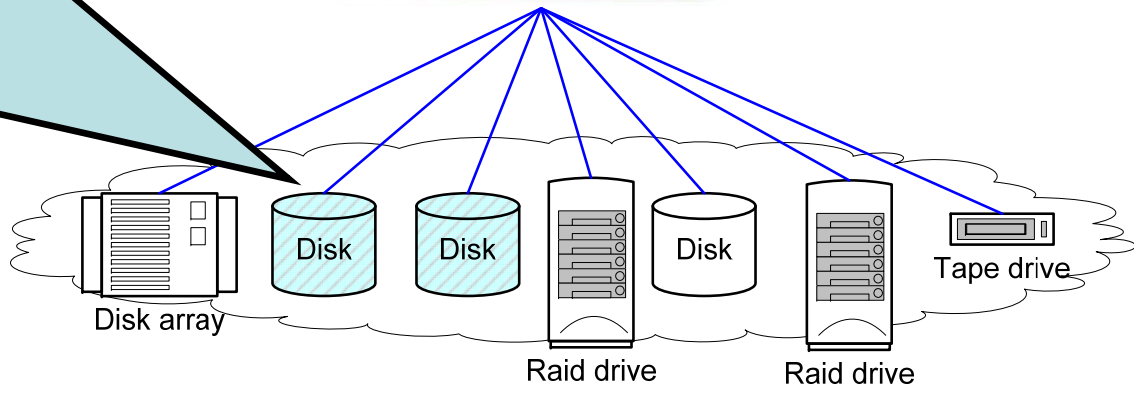
Problem to solve



100G
100G, redundant
100G low latency

- Properties:
- Redundancy
- Throughput
- Latency
- Bad blocks
- Cache size
- Cost
- Block Size
- Placement
- ...

How to choose the “right” disk for an allocation?

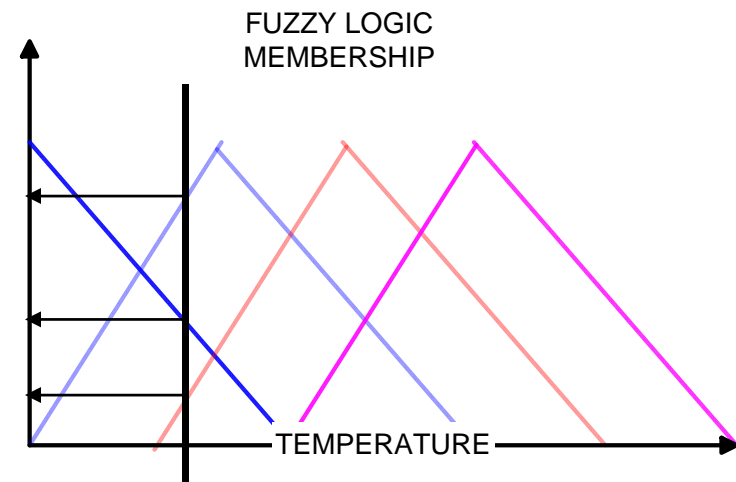
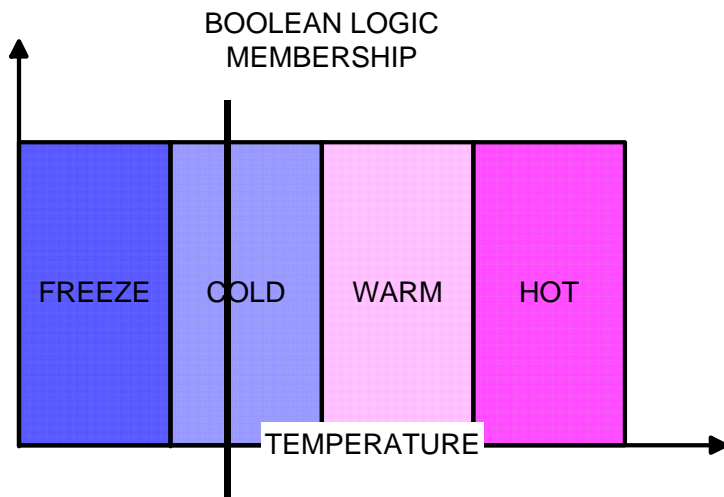


Why Fuzzy Logic?

- The decision function is human-like
- Can be modified and tweaked easily
- Parameters can be added/removed
- Human understandable
- Can control non-linear (complex) systems

What is Fuzzy Logic?

- Designed to represent uncertainty and vagueness and to make decisions under incomplete information.
- Each input parameter can belong to more than one class and its membership is a real value from $[0,1]$, instead of true/false.



What is Fuzzy Logic?

- Designed to represent uncertainty and vagueness and to make decisions under incomplete information.
- Each input parameter can belong to more than one class and its membership is a real value from $[0,1]$, instead of true/false.
- Decision Rules:
IF (*condition*) **THEN** (*conclusion*)

How does it work?

Available Storage:
Disk1 (*size, reliability, redundancy, bandwidth, latency, cache size, cost and etc.*)
Disk2 (*size, reliability, ...*)
Disk3 (*size, reliability, ...*)
Disk4 (*size, reliability, ...*)
Disk5 (*size, reliability, ...*)
Disk6 (*size, reliability, ...*)
...

Disk Request in human form:
size, speed, redundancy and etc.



Disk Request in detailed form:
size, speed, redundancy, reliability, bandwidth, latency and etc.



For each available disk check how well it suits the requirements (a number from 0 to 1)



Pick a disk with the highest suitability rating

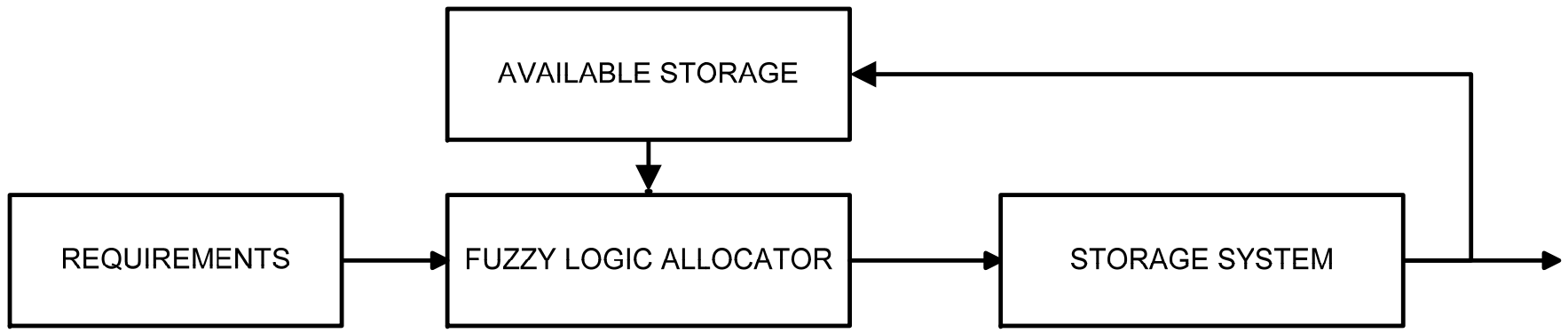


Fuzzy Logic Control System

“Regular” Fuzzy Logic Control system



Proposed Storage Fuzzy Logic Allocation system



- Creation of a new virtual disk
- How to enter manual feedback
- How to judge past allocations (automatic feedback)
- Human interface

The End

- Requirement:
very reliable, fast, 10G disk
- Reliability Rules:
 - IF (*required reliable*) AND (*disk is reliable*)
THEN (*disk can be picked*)
 - IF (*required not reliable*)
THEN (*disk can be picked*)

- Cascade of “IF”s
- Multi-Dimensional Optimization (Simulated Annealing, Hill Climbing and others)
- Nifty AI algorithm (Neural Networks, Associative memory, SVM and others)
- Fuzzy Logic

The winner is ...

Algorithm	Multi dimension	Fine-tuning	Parameter Addition	Human readable	Fast	Feedback and learning
“IF” cascades	HARDLY	NO	NO	NO	YES	HARDLY
Multi-dim. Optimization	YES	NO	NO	NO	NO	HARDLY
AI algorithm	YES	HARDLY	NO	NO	YES/ NO	YES
Fuzzy Logic	YES	YES	YES	YES	YES	YES

The winner is ...

Algorithm	Multi dimension	Fine-tuning	Parameter Addition	Human readable	Fast	Feedback and learning
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Fuzzy Logic	YES	YES	YES	YES	YES	YES