Deriving a Good Trade-off Between System Availability and Time Redundancy

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Orientation

- Trade-off between time (steps to wait for intended service) and availability increase (to get intended service) in distributed systems
- How much ddelay is desired? $\Rightarrow$ as short as possible...
- How available should your system be? $\Rightarrow$ as high as possible...
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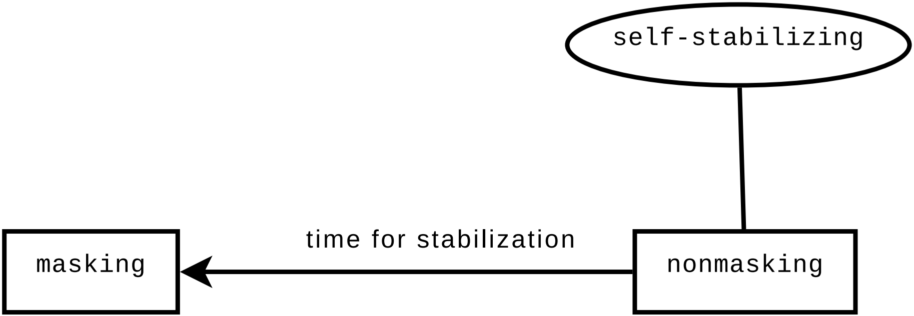
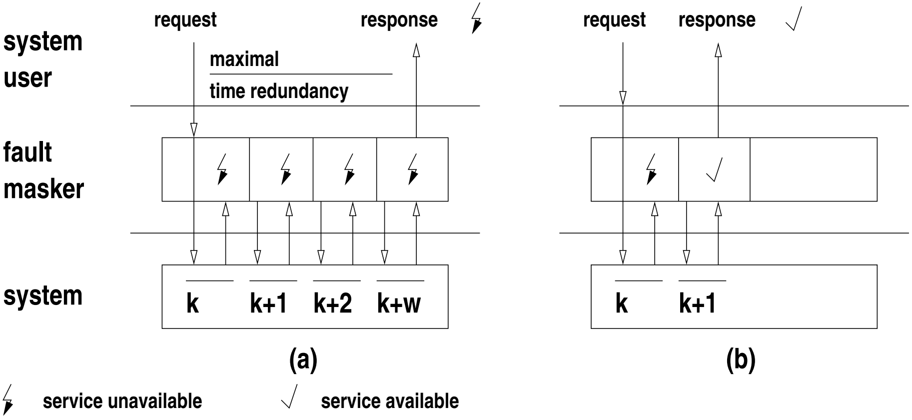


Instantaneous Window Availability



Availability

$$Availability : A = \frac{MTTF}{MTBF} \tag{1}$$

- **instantaneous availability**: at some arbitrary time k the system is available: $A(k)$
- **limiting availability**: the same, as k approaches ∞
- analysis determines limiting, but for simulation we can only choose high k
- at some arbitrary point k, what are the chances that we get the intended (correct) service?
- and what would happen if the system fails but we can wait for at most w timesteps for the system to recover?
- **Instantaneous Window Availability (IWA)**: given that a system is not available at k, what is the **availability increase** if we wait for at most w steps?
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- serial execution semantics
- central demon/scheduler/monitor
- shared memory model
- perfect fault detection
- fault model: transient faults strike mem register with static probability
- distributed self-stabilizing algorithm
  - convergence: $\exists t \geq t_0 : c(t) \models P$
  - consistency: $\forall t_l > t_k : c(t_k) \models P \Rightarrow c(t_l) \models P$
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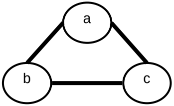

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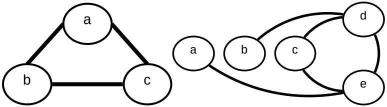

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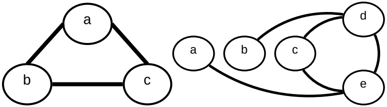

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1. Analysis: build state space (3p: 6561, 5p: $\sim$7 Billion), form IWA in PCTL with *final* argument, calculate with PRISM [KNP07]

   $P =?[F <= 100 \text{"}state6523\text{"}\{true\}\{min\}]$

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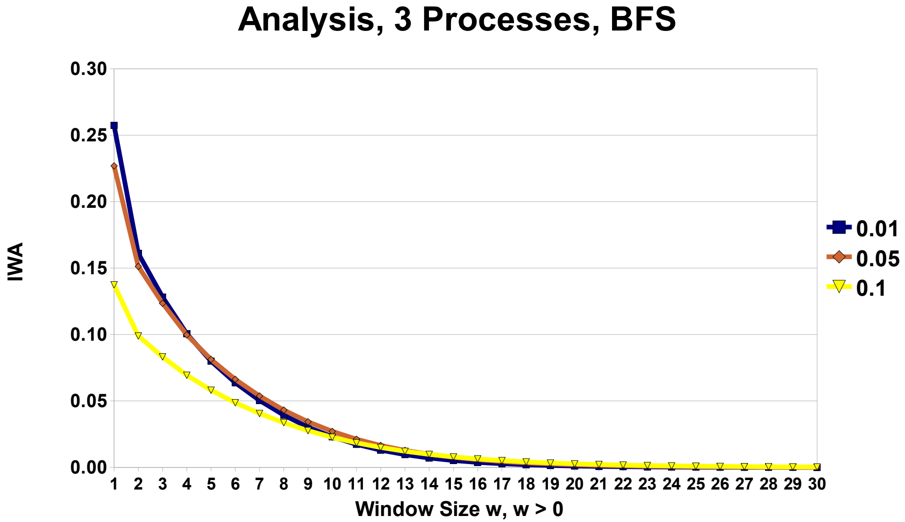
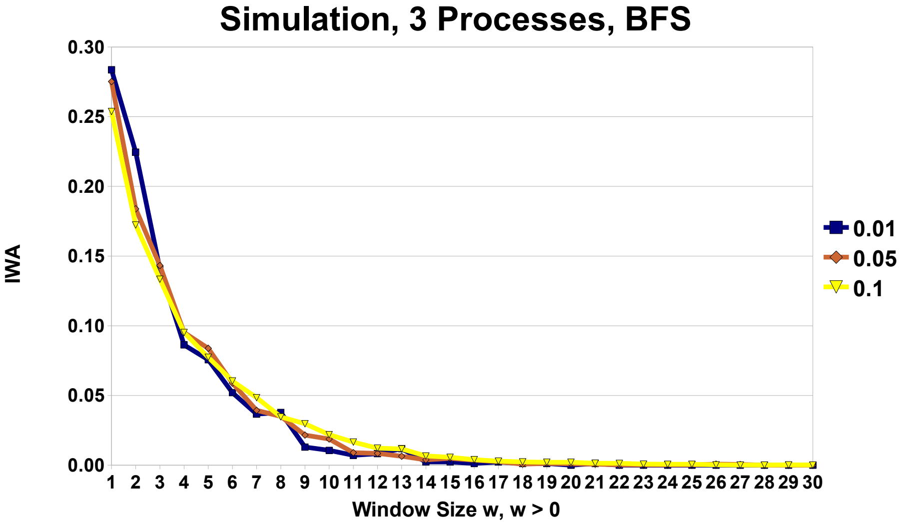
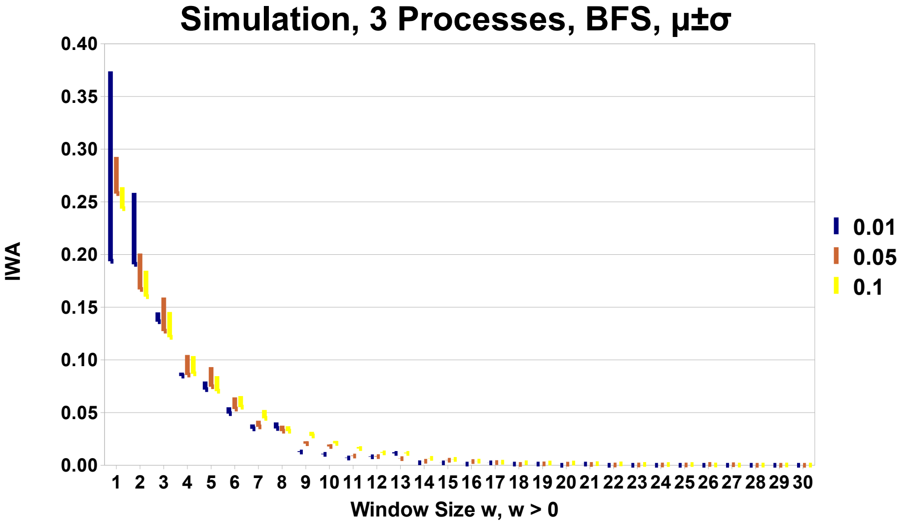


Results 3p System - Simulation



Results 3p System - Simulation - Standard Deviation



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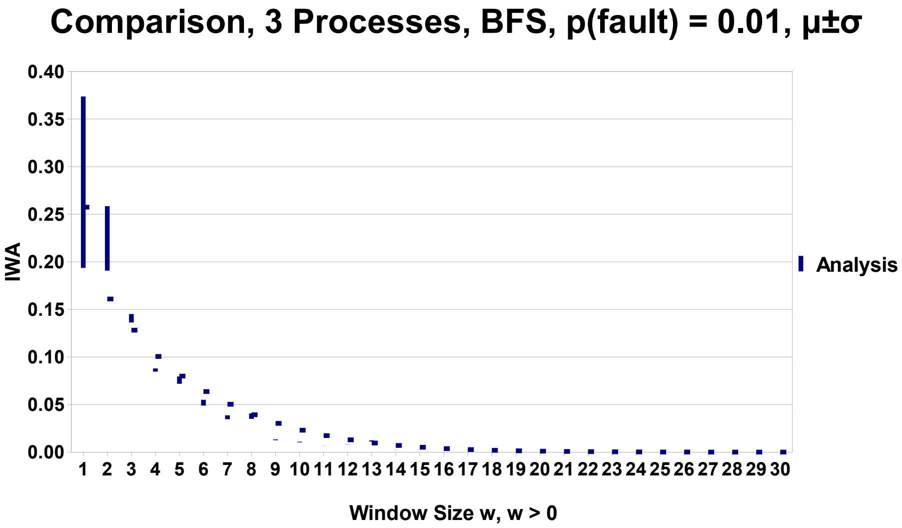

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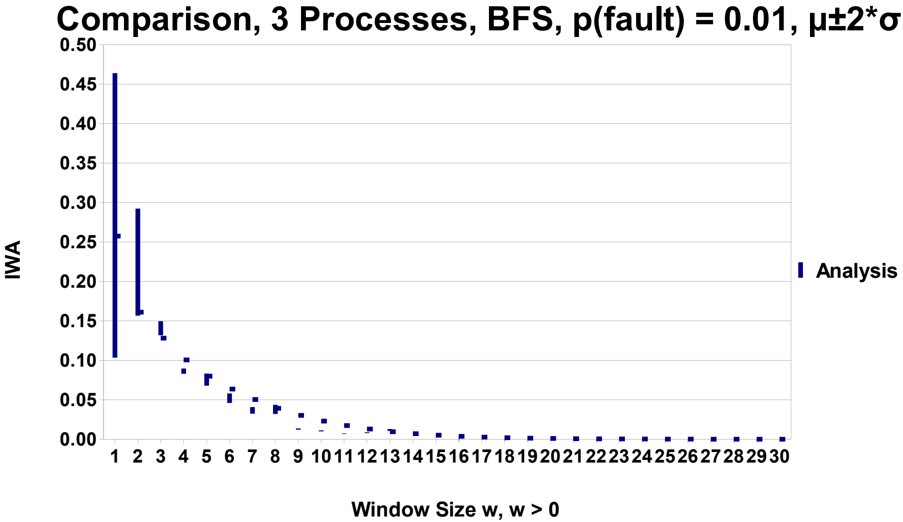
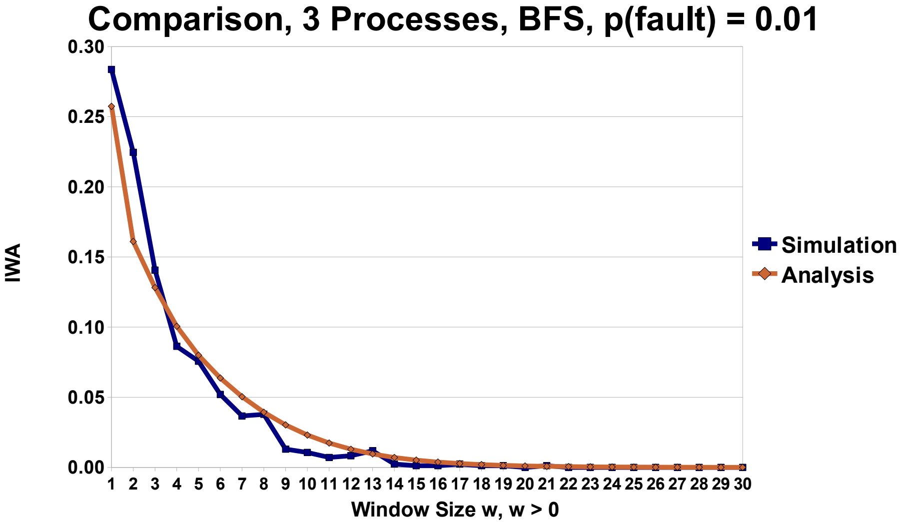
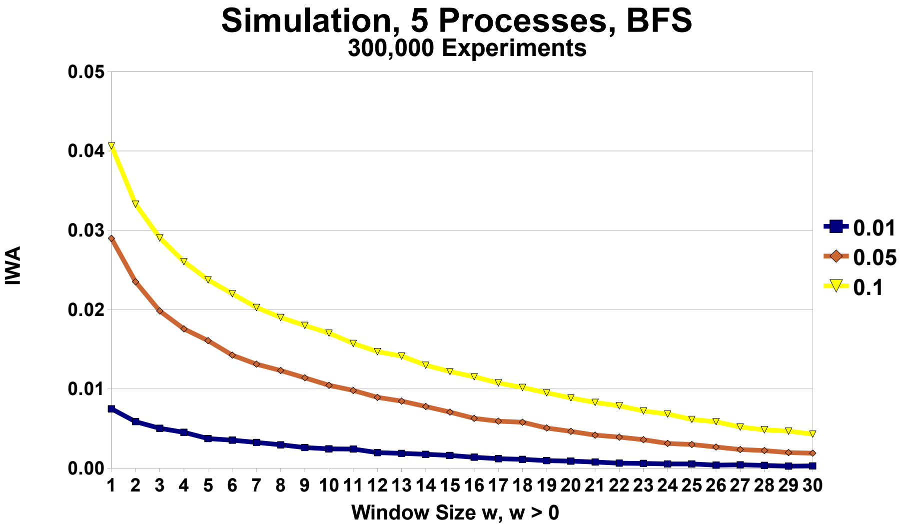


Comparison - Analysis & Simulation



Results 5p System - Simulation



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- Notion of IWA necessary to argue for trade-off.
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    - find Pareto-optimal solutions
    - more dimensions (consistency, frequency, ...)
    - distributed analysis to cope with complex systems
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