Impact-Sensitive Framework for Dynamic Change Management

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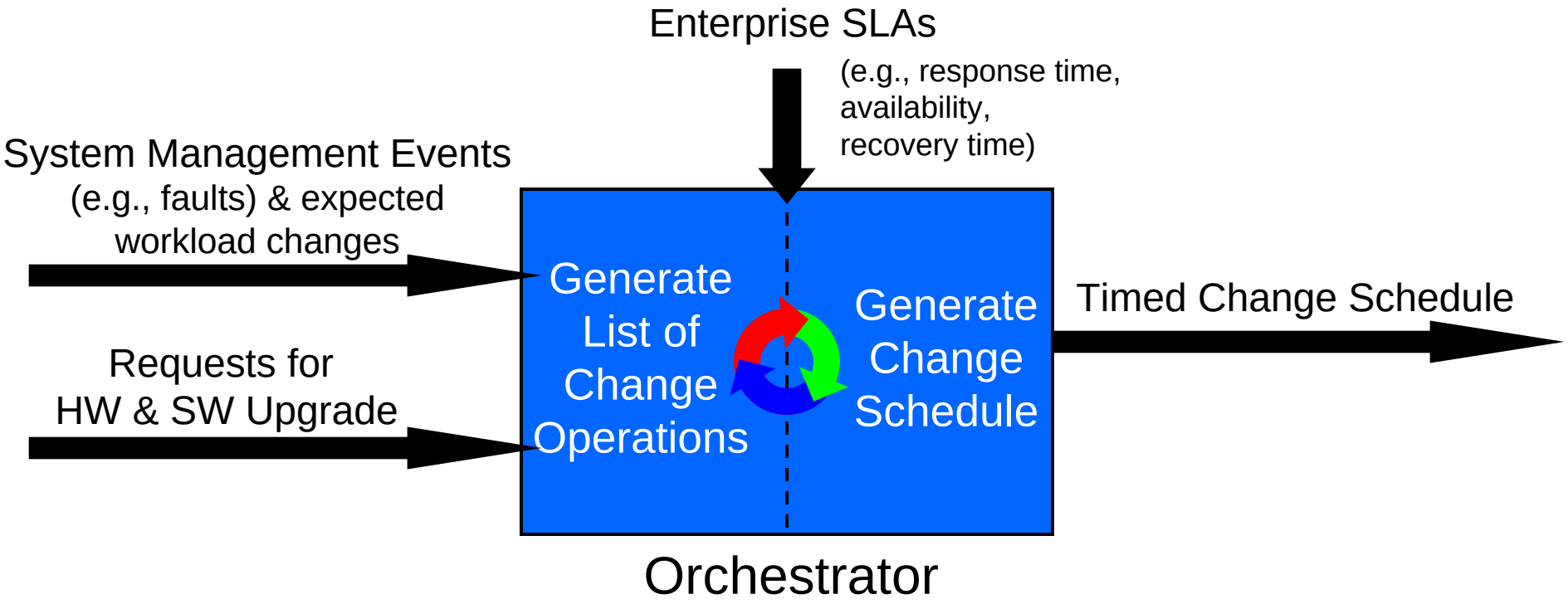
Research Problem



Change management in a live system:

- Minimize service disruption & meet change request objectives
- Optimize the overall business value of the live system over the change time horizon

Outline

- **Case study**
  - Hardware crash
- **Solution architecture and implementation**
  - Components
    - Orchestrator
    - Goal advisors
  - Interaction protocol
  - Scheduling
- **Conclusions and future work**

Related Work

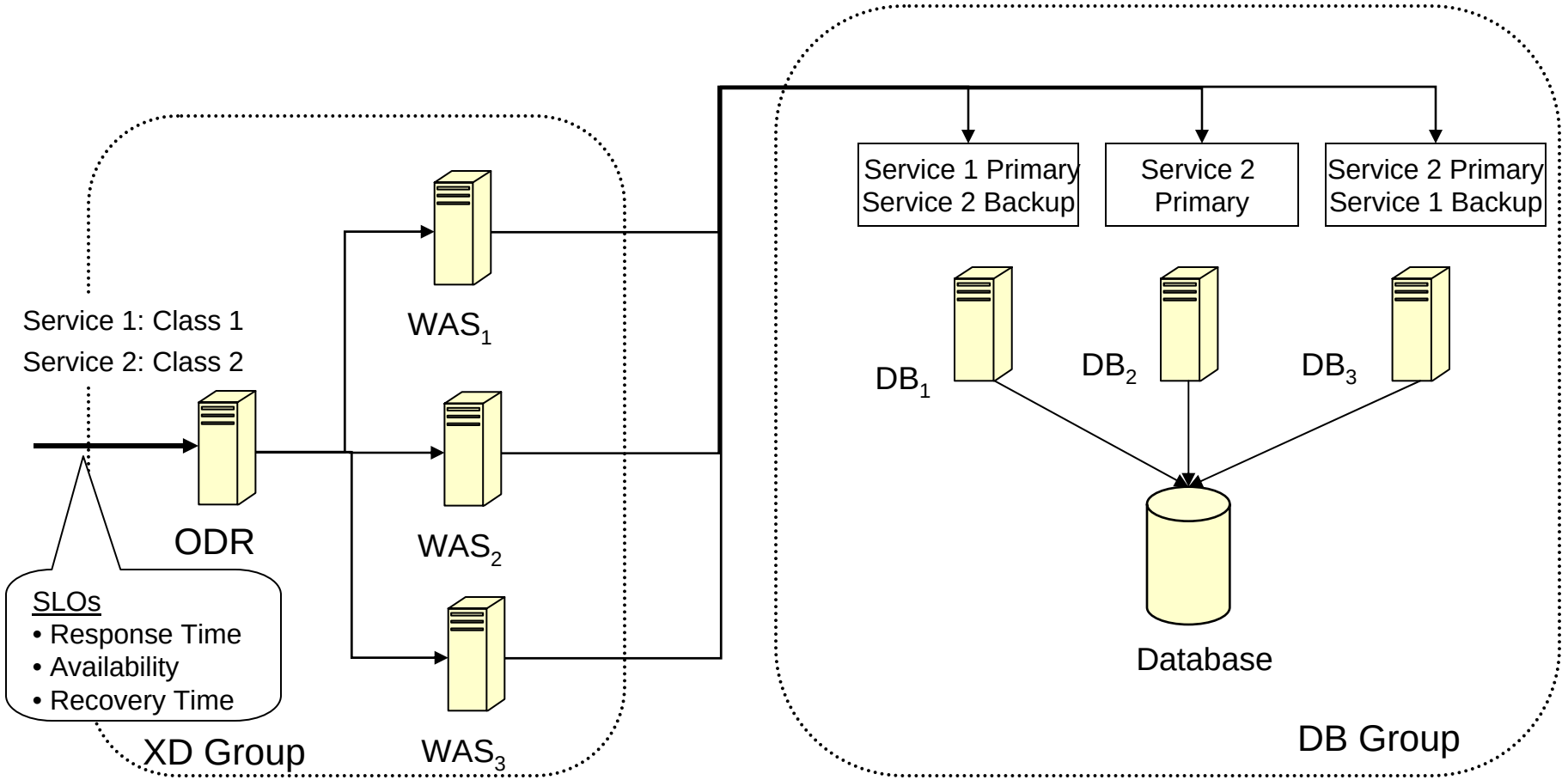
- **V. Kharchenko et al., "On dependability of composite Web services with components upgraded online," WADS 2004**
  - Estimates the "confidence in correctness" of composite Web services undergoing online upgrades
- **IBM Tivoli Intelligent Orchestrator. http://www-306.ibm.com/software/tivoli/products/intell-orch.**
  - Performs resource arbitration
  - Accounts only for immediate impact of resource changes
- **A. Keller et al., "The CHAMPS system: change management with planning and scheduling", NOMS 2004**
  - Scheduling of operations to satisfy external RFC time objectives
  - Focused on application deployment
  - Doesn't trade-off performance of live systems

Solution Approach

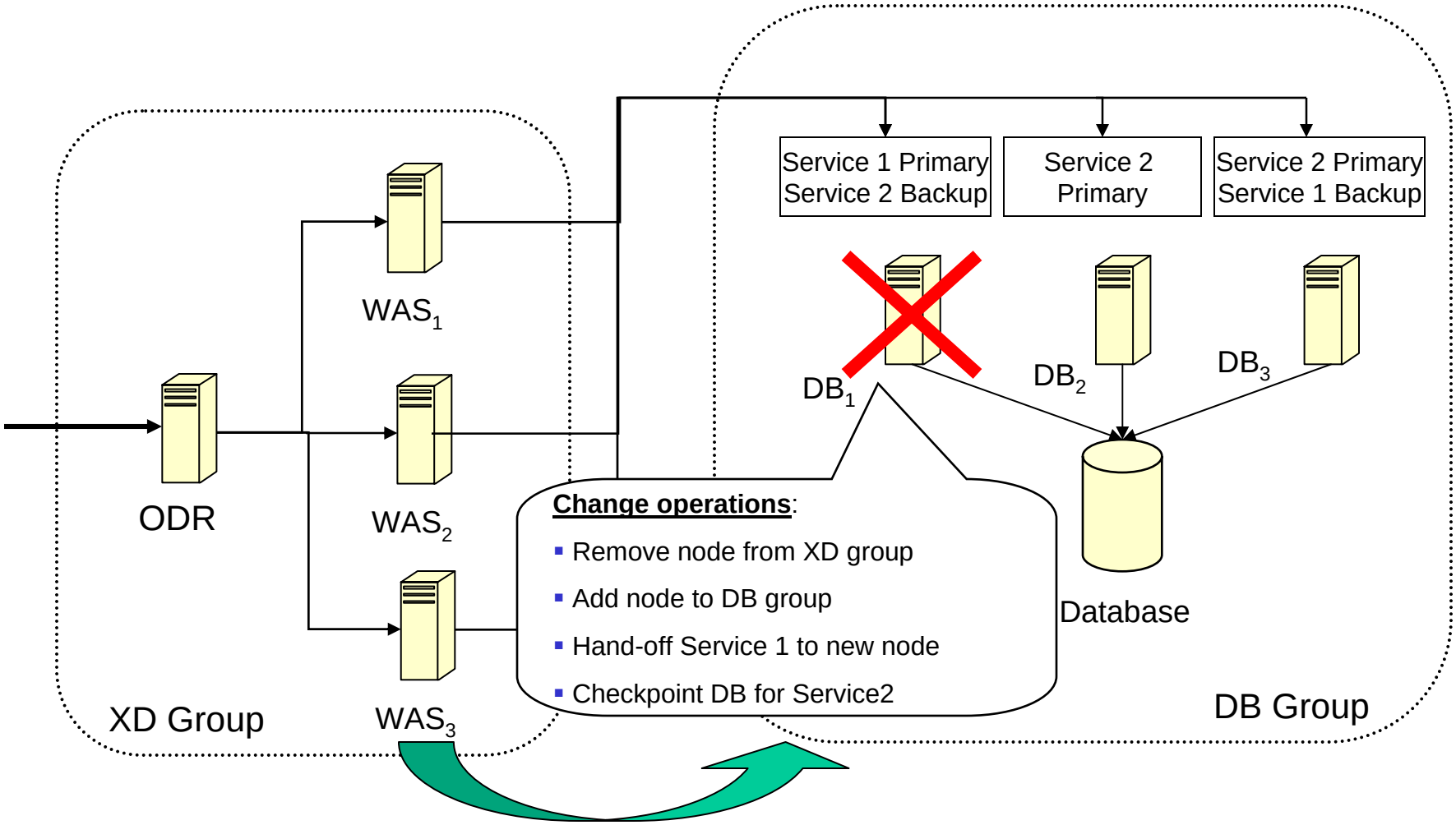
Generic architecture that takes into account:

- **Enterprise SLOs & change request deadlines**
  - Assessment of the overall impact of change schedules through interaction with multiple goal advisors
- **Variation of key performance indicators (KPIs) over a long time horizon, optimizing long-term business value**
  - Transient impact, during change execution
  - Permanent impact, after change
  - Monitoring both performance and dependability metrics
- **Heterogeneous types/sources of change operations:**
  - System management events (e.g., faults, workload surges)
  - Requests for Change (RFCs)

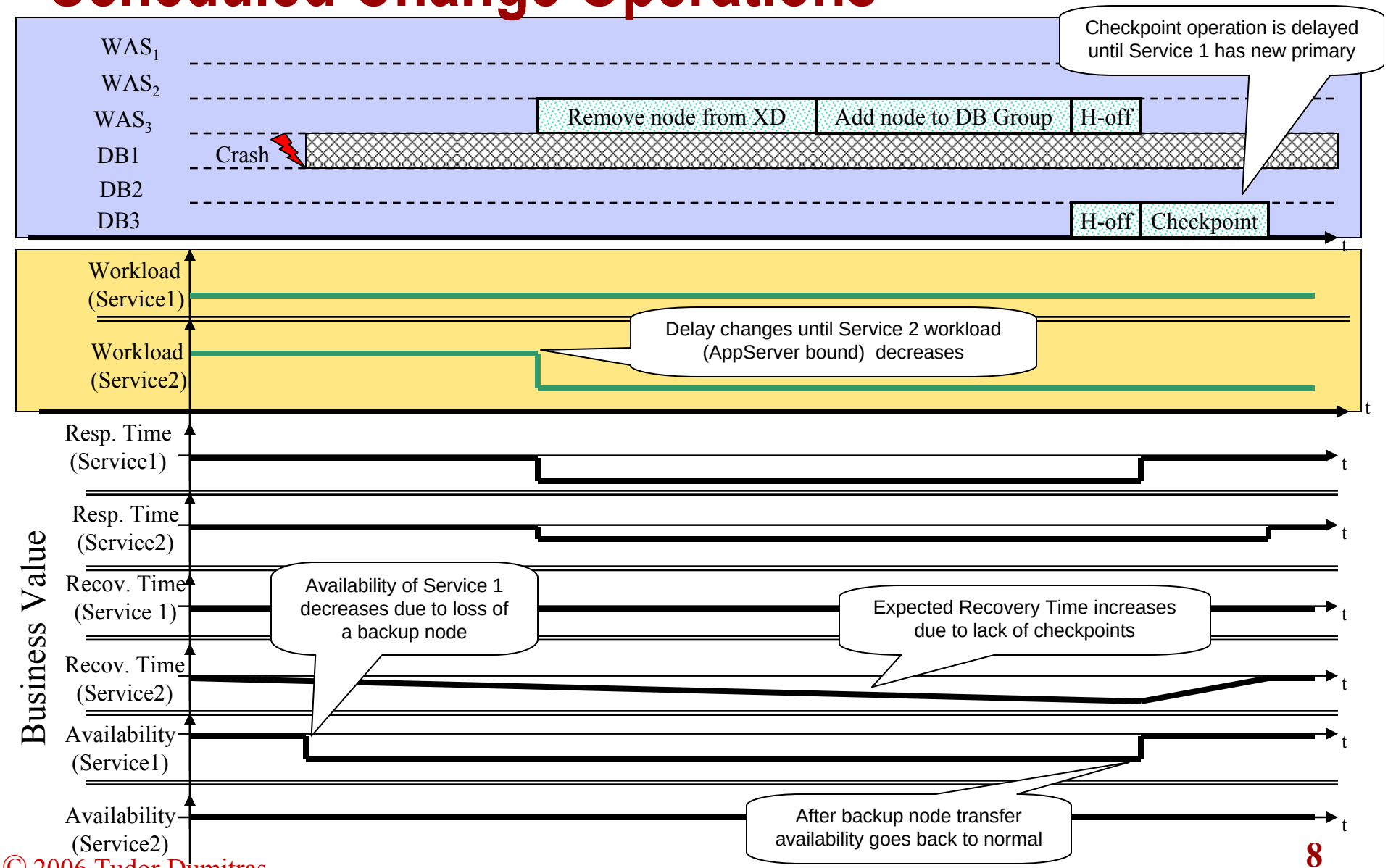
Sample Configuration: 2-Tier System



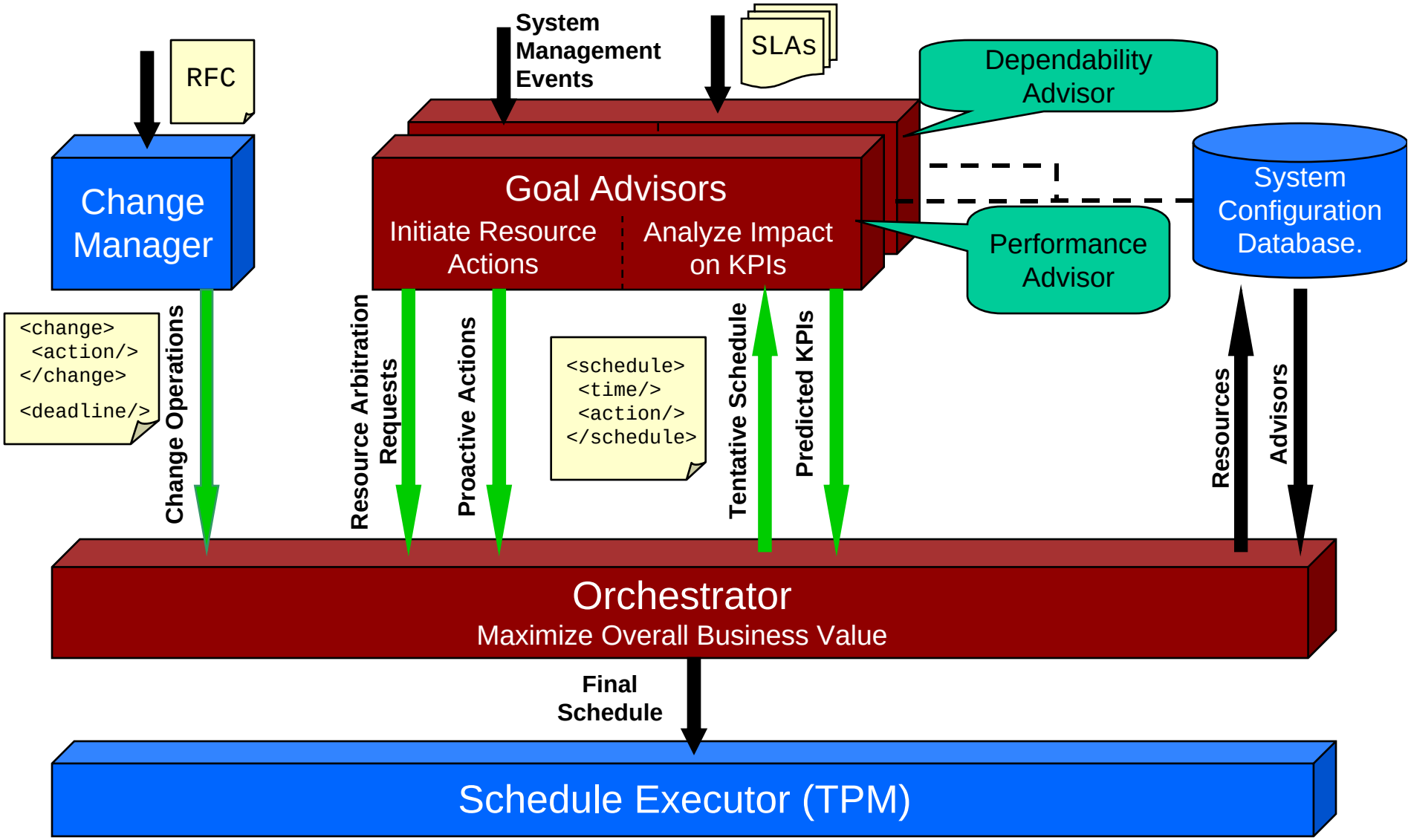
Case Study: Hardware Crash



Scheduled Change Operations

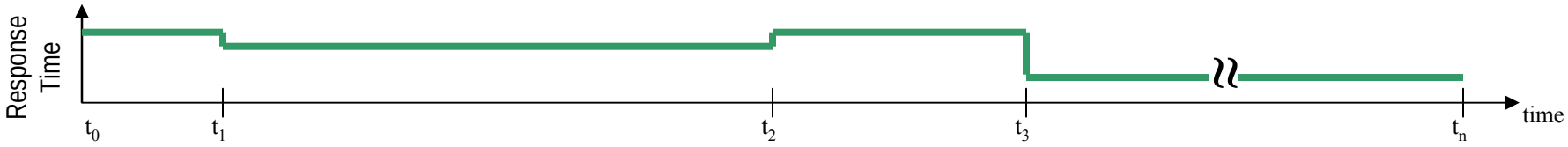


Solution Architecture & Interaction Protocol



Computing Long-Term Business Value

- **Compute BV(schedule)**
  - Analyze the schedule's impact on the KPIs:
    - Goal advisors return the KPI time variation



  - Get the business value associated with each KPI value from the SLAs
  - Compute the business value of each KPI for the time interval as a weighted average:

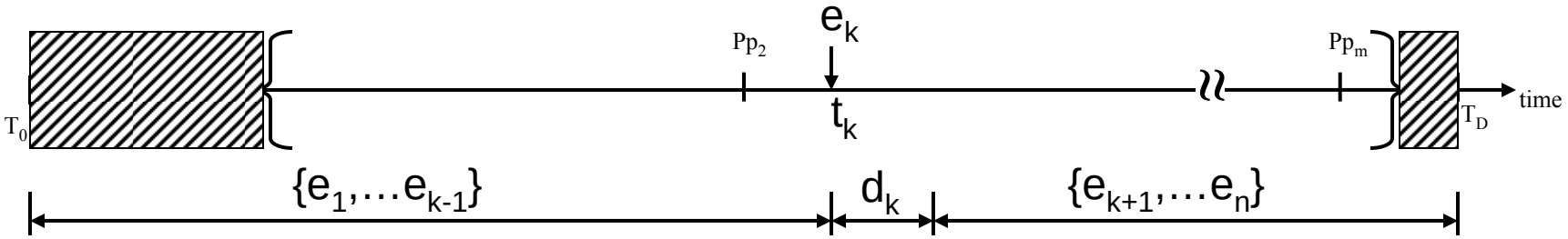
$$\mathrm{BV}_{\mathrm{KPI}}(t_0, t_n) = \frac{\sum_{i=0}^{n-1} \mathrm{BV}[KPI(t_i)] \cdot (t_{i+1} - t_i)}{t_n - t_0}$$

  - Sum the business values of all the KPIs

A Simple, Greedy Scheduler

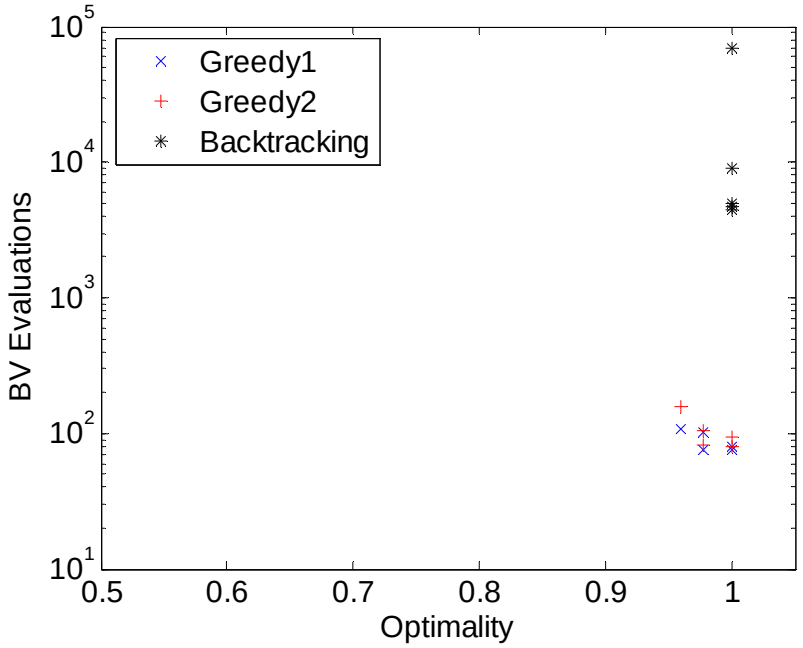
Change operations	$\{e_1, e_2, \ldots e_n\}$
Durations	$d_1, d_2, \ldots d_n$

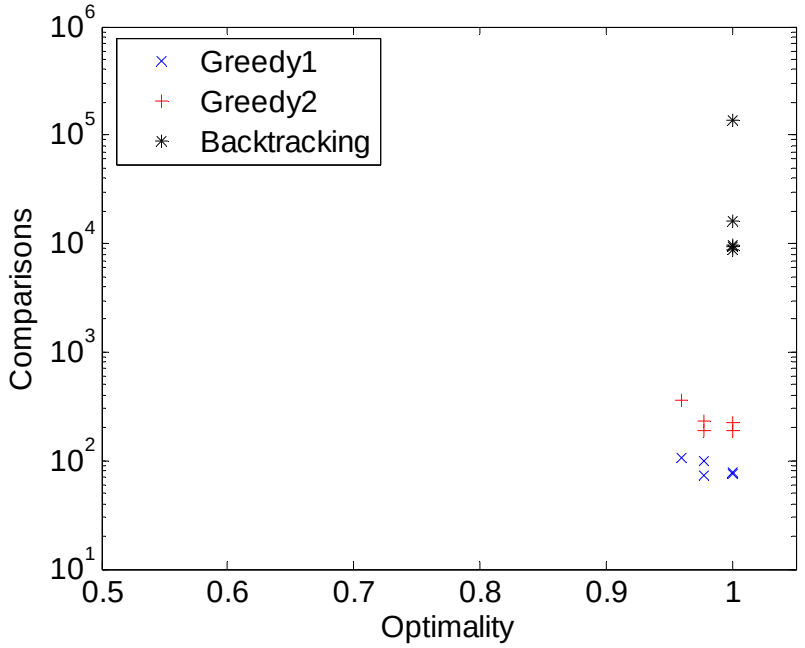
$$\text{For } e_k: \quad T_0 + \sum_{i=1}^{k-1} d_i \le t_k \le T_D - \sum_{i=k}^{n} d_i$$



- Find $<e_k, t_k>$ that give the best business value
- Outputs: $t_1, t_2, \ldots t_n$; BV(schedule)
- Worst-case complexity: $O(n^2 m)$

Scheduling Algorithms: Comparison





Conclusions

- **Contributions**
  - Generic architecture for change planning in a live system
    - Orchestrator, Goal Advisors
    - Interaction protocol for impact assessment
  - Assess impact over long time horizon for all enterprise SLOs
    - Maximize overall business value
      - Change operation deadline & SLO objectives
    - Include proactive actions proposed by Goal Advisors to improve service KPIs
  - Integrate decision for heterogeneous types/sources of change

- **Open questions**
  - Size of realistic change operation groups
  - The best way to express the KPI variation in time
  - Impact of inaccurate predictions on scheduling

Thank You!

For more information: www.ece.cmu.edu/~tdumitra