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Process Composition: Quality of Service Specification, Semantics and Adaptation

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Process Composition:
Quality of Service Specification Semantics, and Adaptation

EI3-IC Workshop 3
Gaithersburg MD, February 6-8 2002

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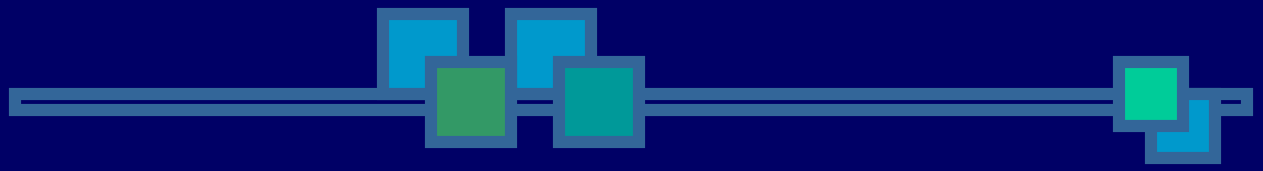
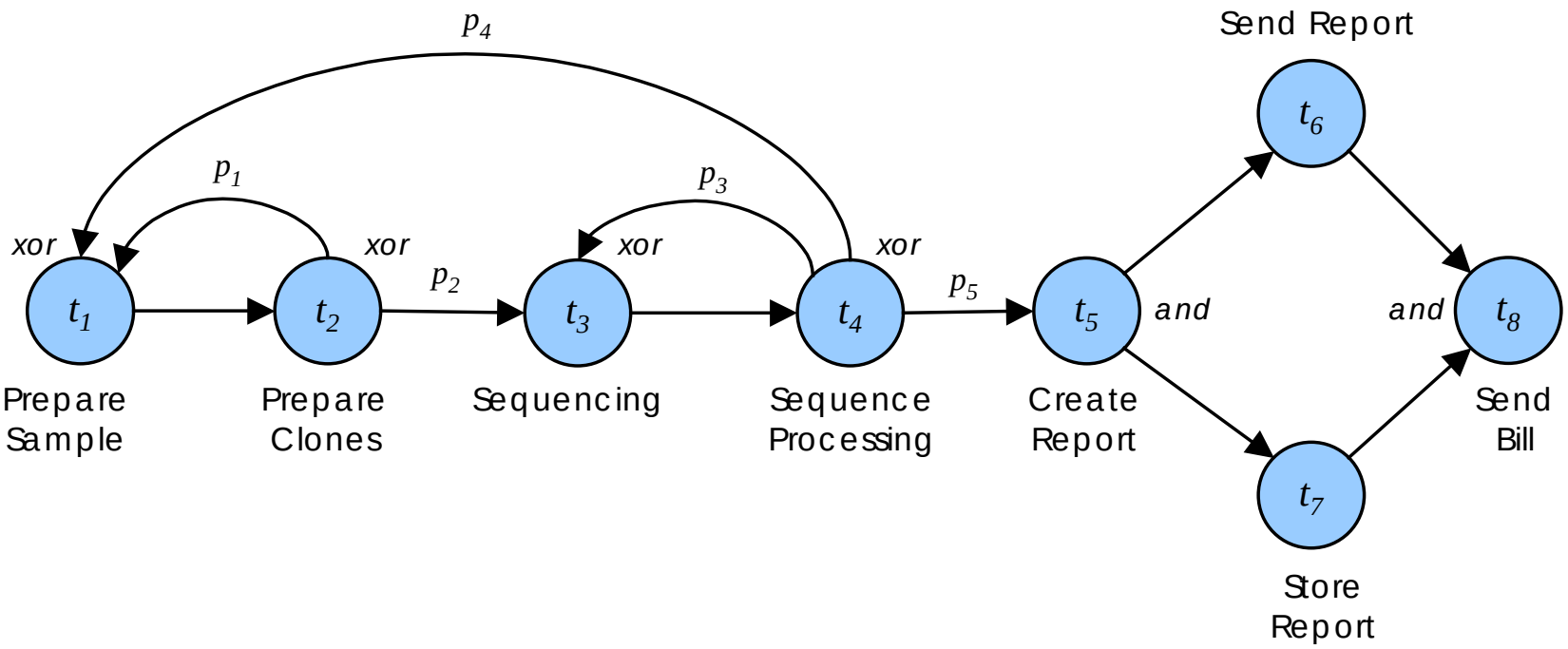
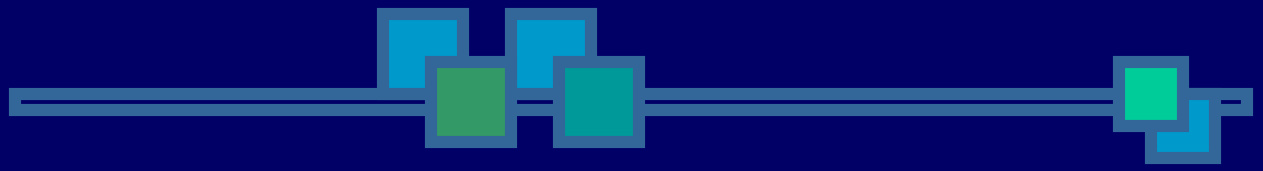


Workflows

- Workflows are an abstraction of business processes.
- A workflow normally comprises a number of logical steps, which are known as tasks, dependencies between tasks, routing rules, and participants.
- A Workflow system reads, automates, processes, and manages workflows by coordinating the sharing and routing of information.

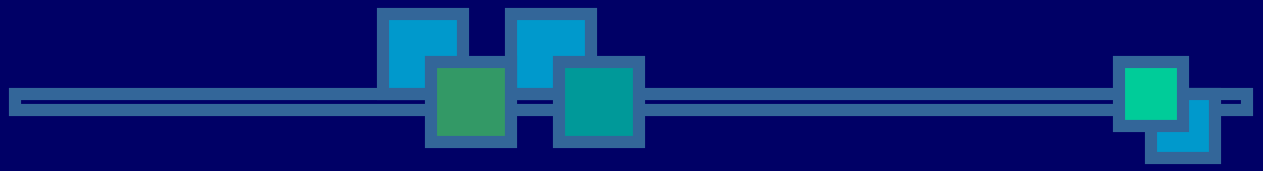
Workflow Example





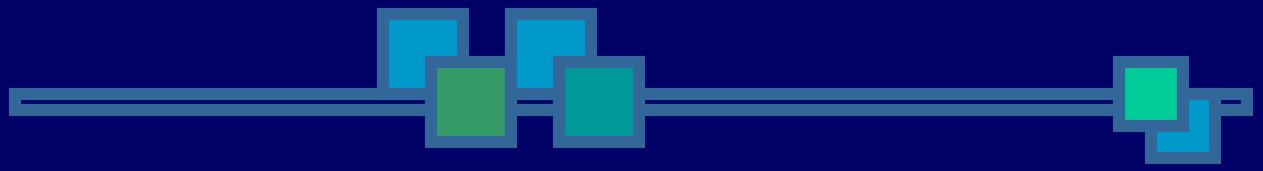
Web Services

- The importance of Web services has been recognize by the academia and by commercial organizations.
- Several efforts are being carried to develop a specification language for Web services.
- Approaches include XLANG [XLANG, 01], WSLF [WSLF, 01], and DAML-S [DAML-S, 01].



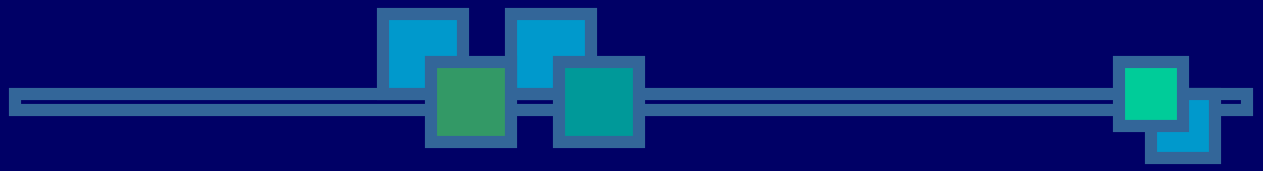
Web Services and Workflows

- Web service composition can be represented using workflows
- Of specific interest is cross-organizational workflow (workflows that span across organizations)



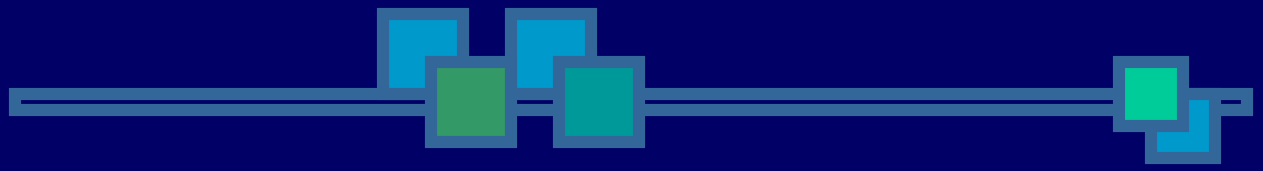
Problem Statement

- In e-commerce processes, suppliers and customers define a binding agreement or contract between the two parties, specifying quality of service (QoS) items such as products or services to be delivered, deadlines, quality of products, and cost of service. Management of QoS directly impacts success of organizations participating in e-commerce.



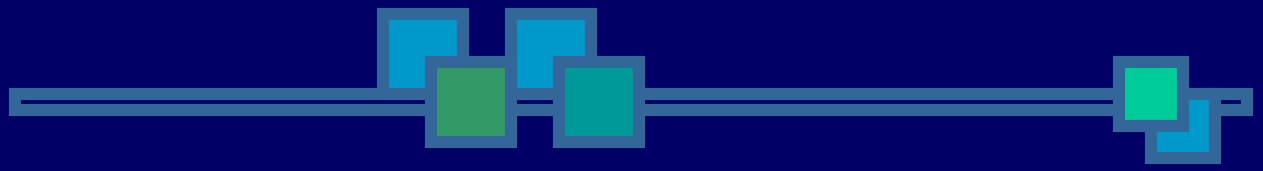
Quality of service

- Quality of service management is indispensable for organizations striving to achieve a higher degree of competitiveness.
- Processes executed under the control of a enactment systems can be characterized and quantified according to various dimensions.
- We call the set of dimensions associated with quality of service workflow quality of service (QoS).
- The computation of QoS metrics allow organizations to better align their vision and operational processes.



Research issues

- Specification. What dimensions need to be part of the Quality of Service for workflows?
- Computation. What methods and algorithms can be used to predict QoS?
- Monitoring. What king of wQoS monitoring tools need to be developed?
- Control. What mechanisms need to be developed to control workflow processes, in response to unsatisfactory QoS metrics?



QoS Model Requirements

- The quality dimensions represented in the QoS model needs to be computable
- There must exist a QoS function at each node of the process tree that can be applied to its children.
- From this observation we developed a QoS model for which all its dimensions are computable.

QoS Model

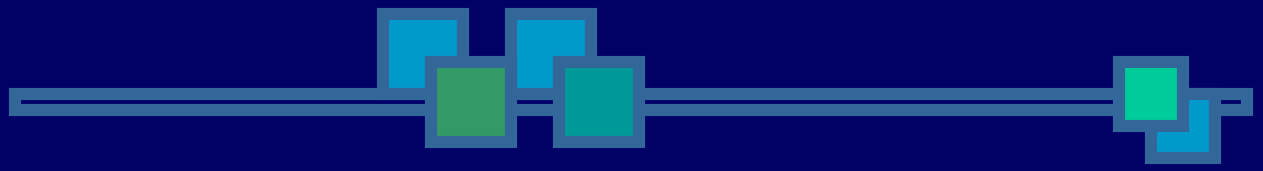
- QoS describes non-functional properties of a workflow. It is an important complement to the operational description of workflows.
- The QoS model is composed with four dimensions

QoS

- Time
  - Time associated with the execution of a task or workflow.
- Cost
  - Cost associated with the execution of a task or of a workflow.
- Reliability
  - The probability of a task or workflow to succeed.
- Fidelity
  - The accuracy of task's operations

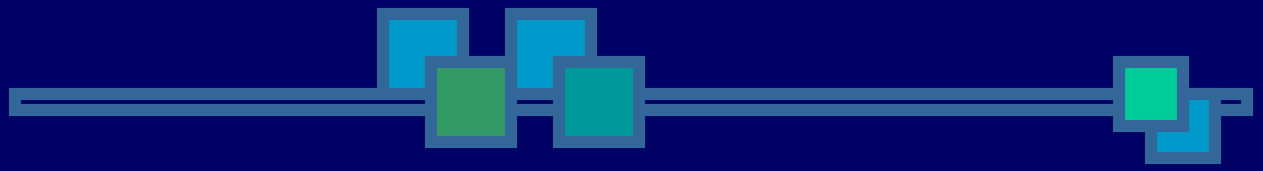
QoS - Time

- Time is a common and universal measure of performance.
- For workflow systems, it can be characterize defined as the total time needed by an instance to transform a set of inputs into outputs.
- The first measure of time is task cycle time (T_{CT}).
- The task cycle time can be breakdown in two major components: delay time and process time.
  - $T_{CT}(i) = T_{DT}(i) + T_{PT}(i)$



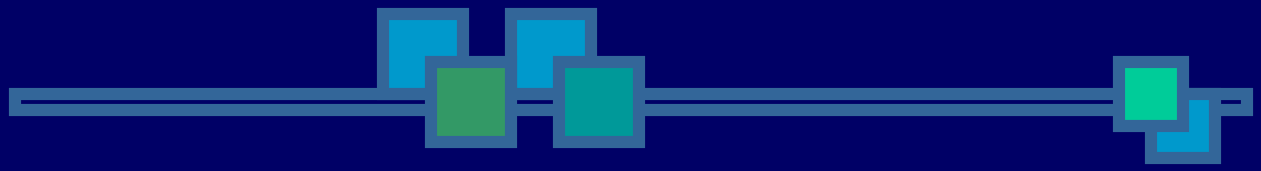
QoS - Cost

- Task cost represents the cost associated with the execution of workflow tasks.
- Cost is an important factor, since organizations need to operate according to their financial plan.
- Task cost (TC) can be broken down in into two major components: processing enactment cost and task realization cost.
  - TC(t) = TEC(t) + TRC(t)



QoS - Reliability

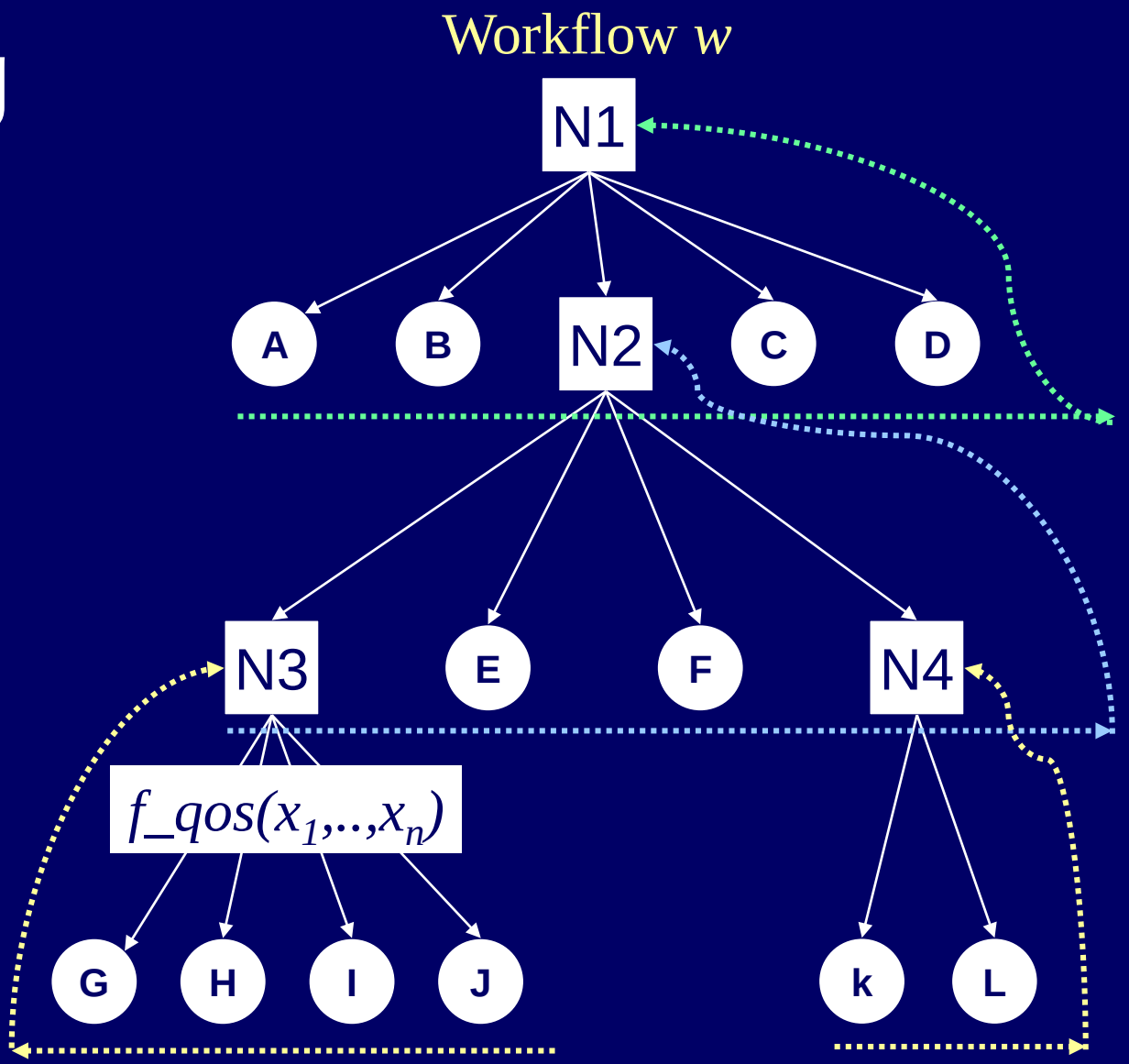
- Task Reliability (T_R) corresponds to the likelihood that the components will perform for its users when the user demands it and it is a function of failure rate.
- This dimension follows from one of the popular discrete-time stable reliability model proposed in [Nelson, 73].
  - TR(t) = 1 - failure rate

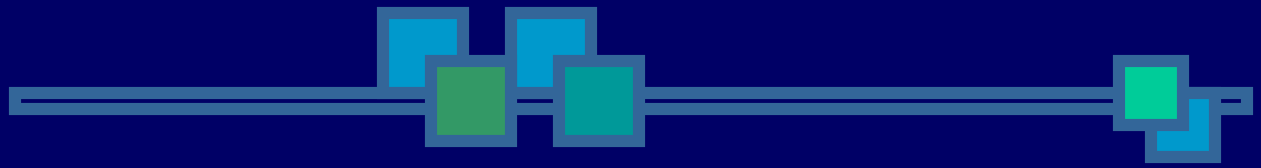


QoS - Fidelity

- Fidelity is a function of effective design and refer to an intrinsic property or characteristic of a good produced or service rendered.
- Workflow tasks have a fidelity (T_F) vector dimension composed by a set of fidelity attributes ($T_{F(t).ai}$), to reflect and quantify tasks operations.
- Depending on the task type different strategies are used to set fidelity attributes.

Computing QoS





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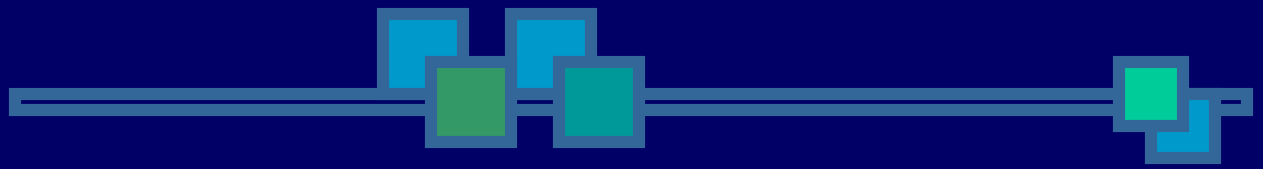
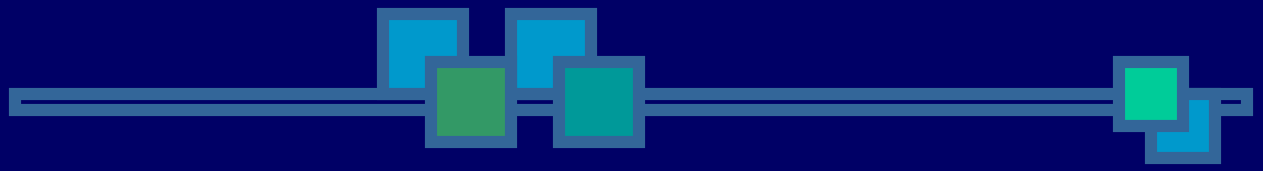
- [DAML-S] http://www.daml.org
- [WSFL,01] http://www-4.ibm.com/software/solutions/webservices/pdf/WSFL.pdf
- [XLANG, 01] http://www.gotdotnet.com/team/xml_wsspecs/xlang-c/default.htm
- [Nelson, 73] E. C. Nelson, “A Statistical Basis for Software Reliability”, TRW Software Series, TRW-SS-73-02, March 1973.



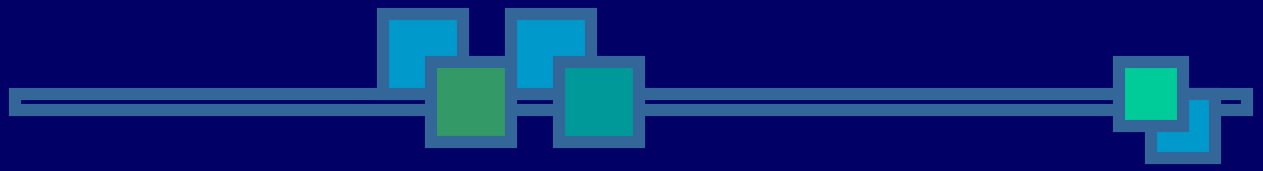
Computer Aided Workflow Design based on Semantics and QoS specifications.

Dynamic Workflow Adaptation.



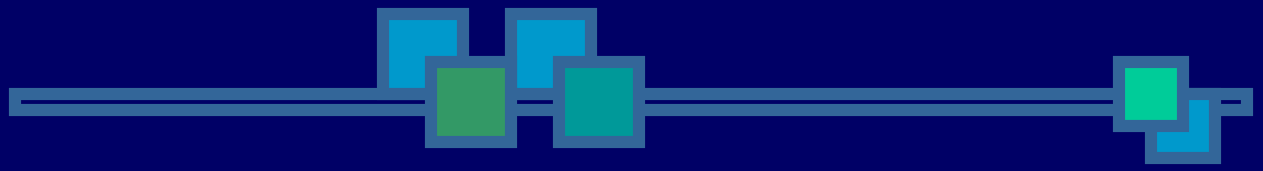
Computer-Aided Design based on Semantics

- Designing cross-organizational workflows is a complex process.
- Different components (tasks) from different organizations need to be coupled together.
- It is important for users to be aided during the design process.
- The system can help users, with the provision of task semantic fitness indicators.
- Design time validation



Research issues

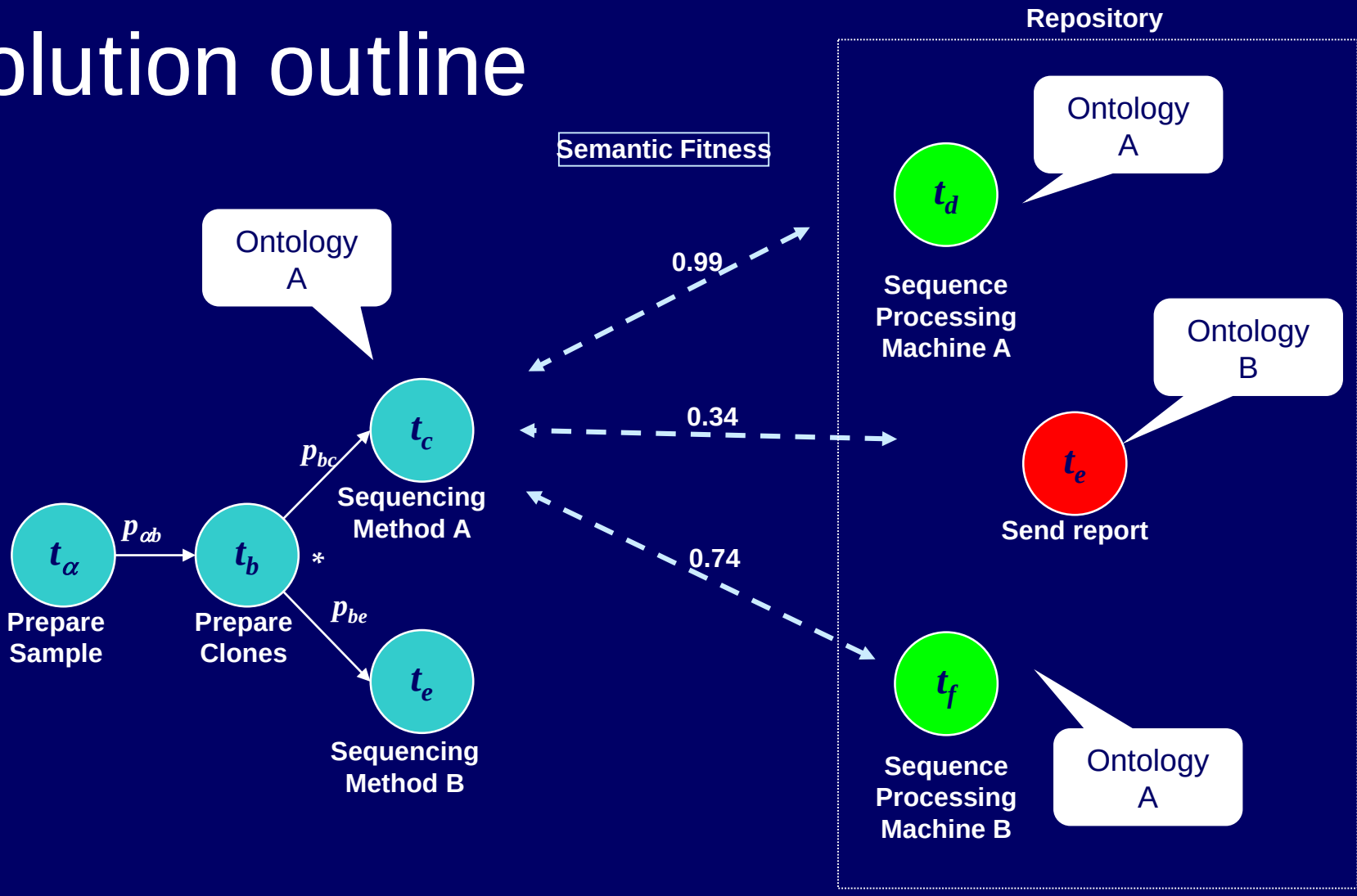
- Specification. How semantics can increase workflow tasks specification richness to facilitate and automate workflow process design.
- Selection/Reuse. How can tasks be searched, ranked and selected from repositories based on syntactic and semantic match.
- Composition. How semantics can facilitate the resolution of data and schematic conflicts among tasks.



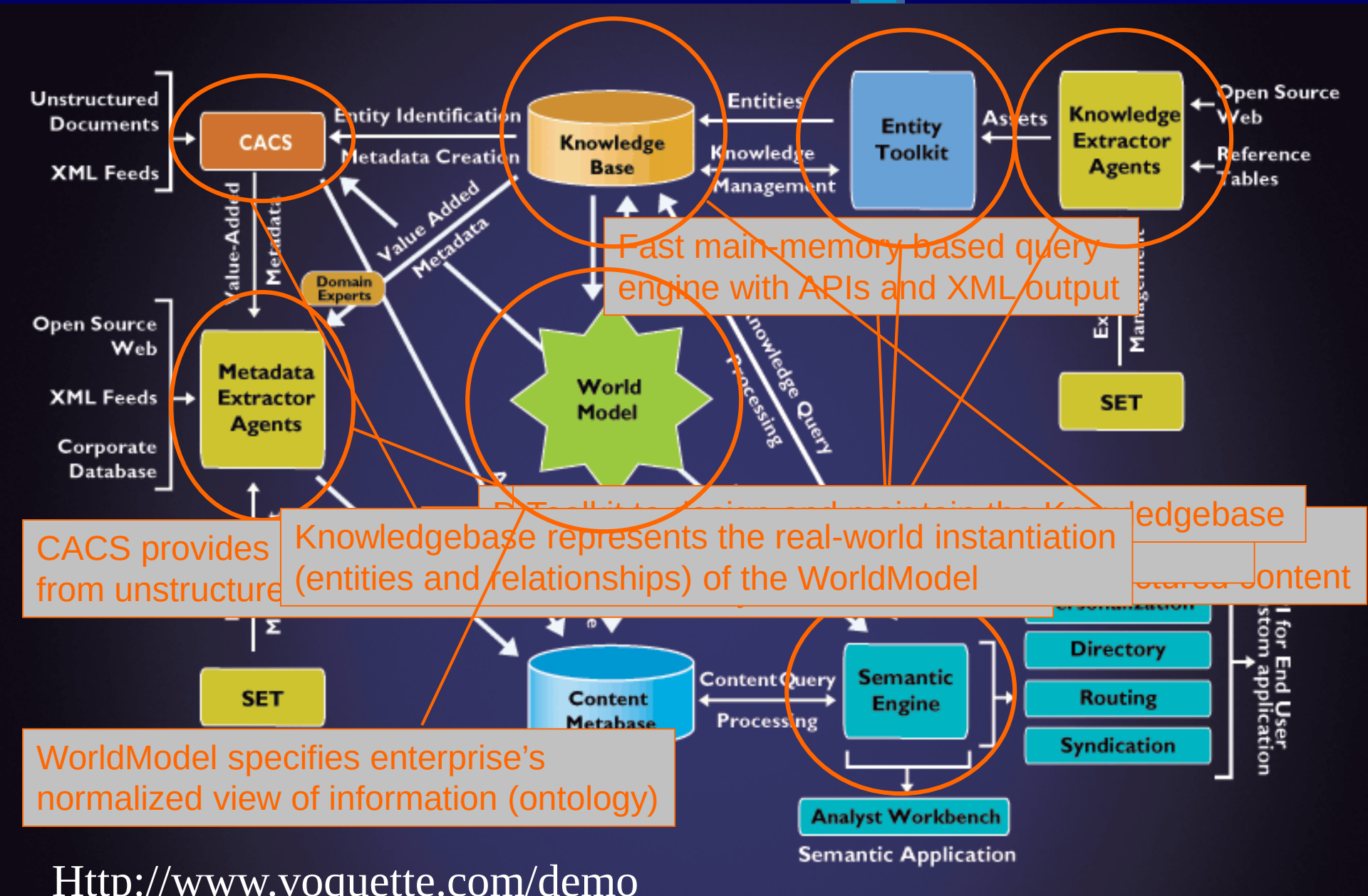
Solution Outline

- Specification. Each workflow task is associated with ontologies, describing the task functionality, interface, and QoS.
- Selection. The tasks selected to design a workflow are ranked based on a semantic and syntactic fitness function.
- Composition. During workflow composition wQoS metrics are computed to allow the user to control workflow quality of service.

Solution outline



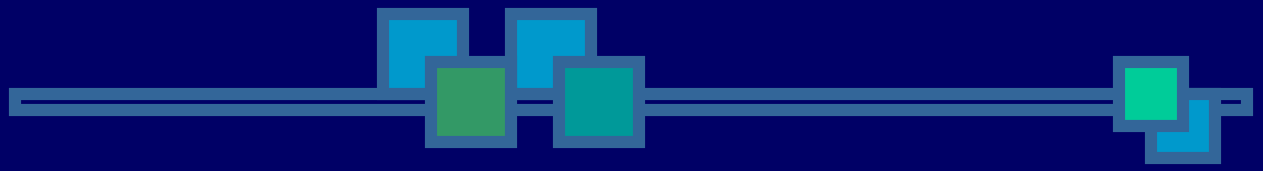
SCORE Semantic Technology System Architecture



Http://www.voquette.com/demo

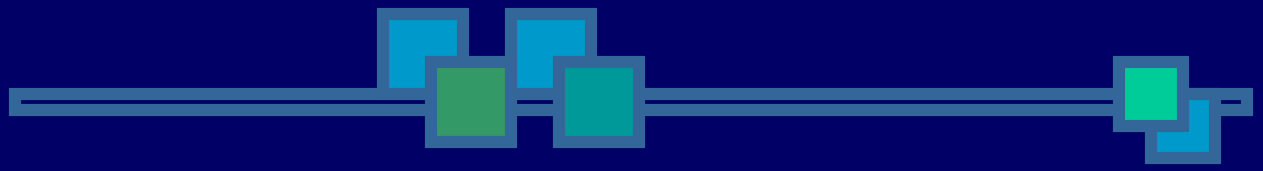
Workflow Adaptation

- In modern economies and organizations, business processes change has become a constant.
- There is a constant need for continuous workflow design improvement.



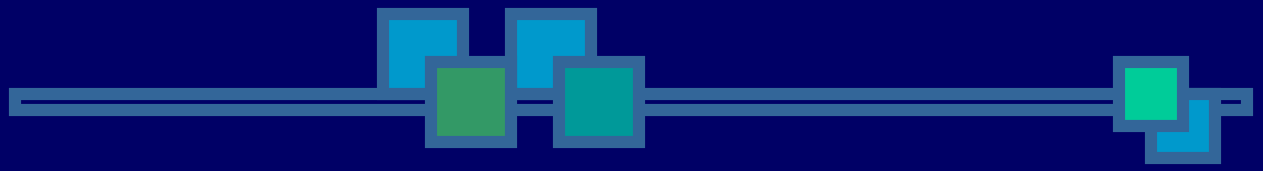
Research issues

- Detection. When should workflows be dynamically adapted?
- Change Analysis. When adaptation is required how can alternative be generated?
- Change Introduction. When can adaptation be made to currently running workflows without violating its consistency and other constraints?



Solution Outline

- Detection. Workflows are dynamically adapted when their wQoS metrics are not satisfactory.
- Change Analysis. Adaptation alternatives are generated based on adaptation patterns.
- Change Introduction. Adaptation is made to currently running workflows through the use of a dynamic change layer to guarantee consistency of workflows after changes.

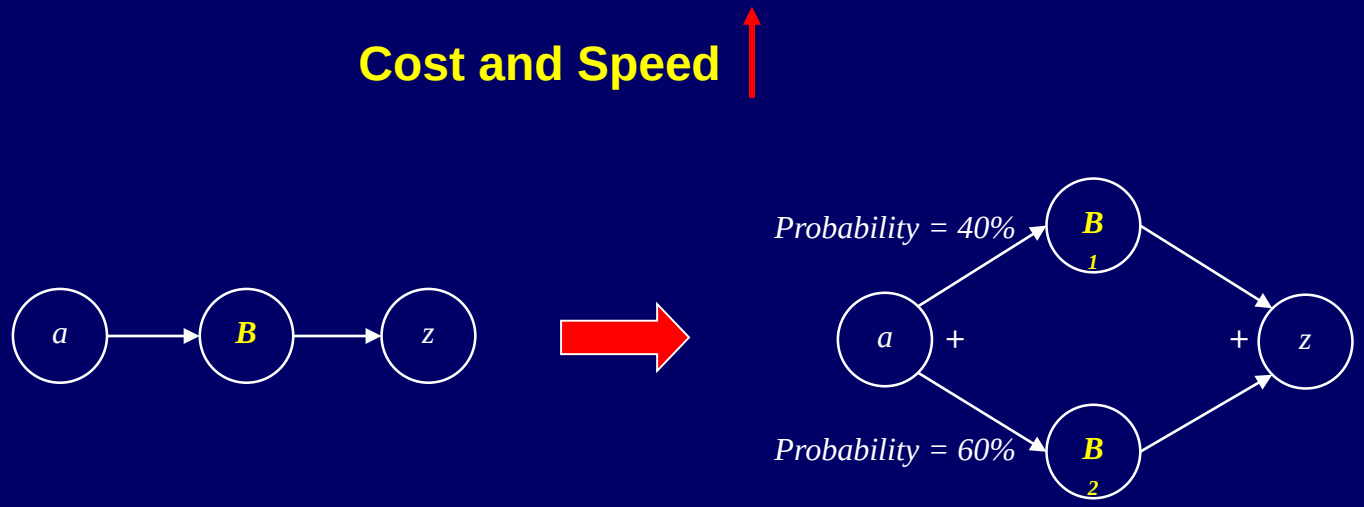


Workflow Adaptation

- Dynamically and automatically change a workflow to meet wQoS requirements
  - Non-structural Adaptation
    - Replace a task with an alternative task with attributes that will permit a workflow to exhibit satisfactory wQoS
  - Structural Adaptation
    - Load distribution pattern
      - Decrease Time, Increase Cost
    - Redundant pattern
      - Increase Fidelity, Increase Cost
    - More patterns ...

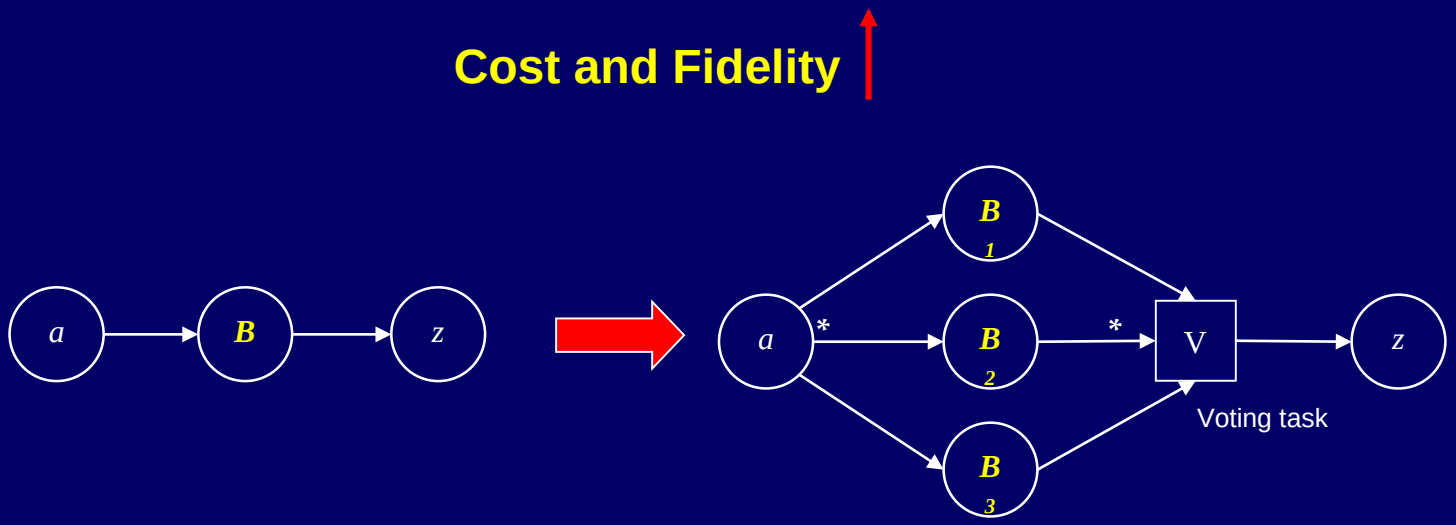
Examples of Structural changes (1)

- Load distribution pattern

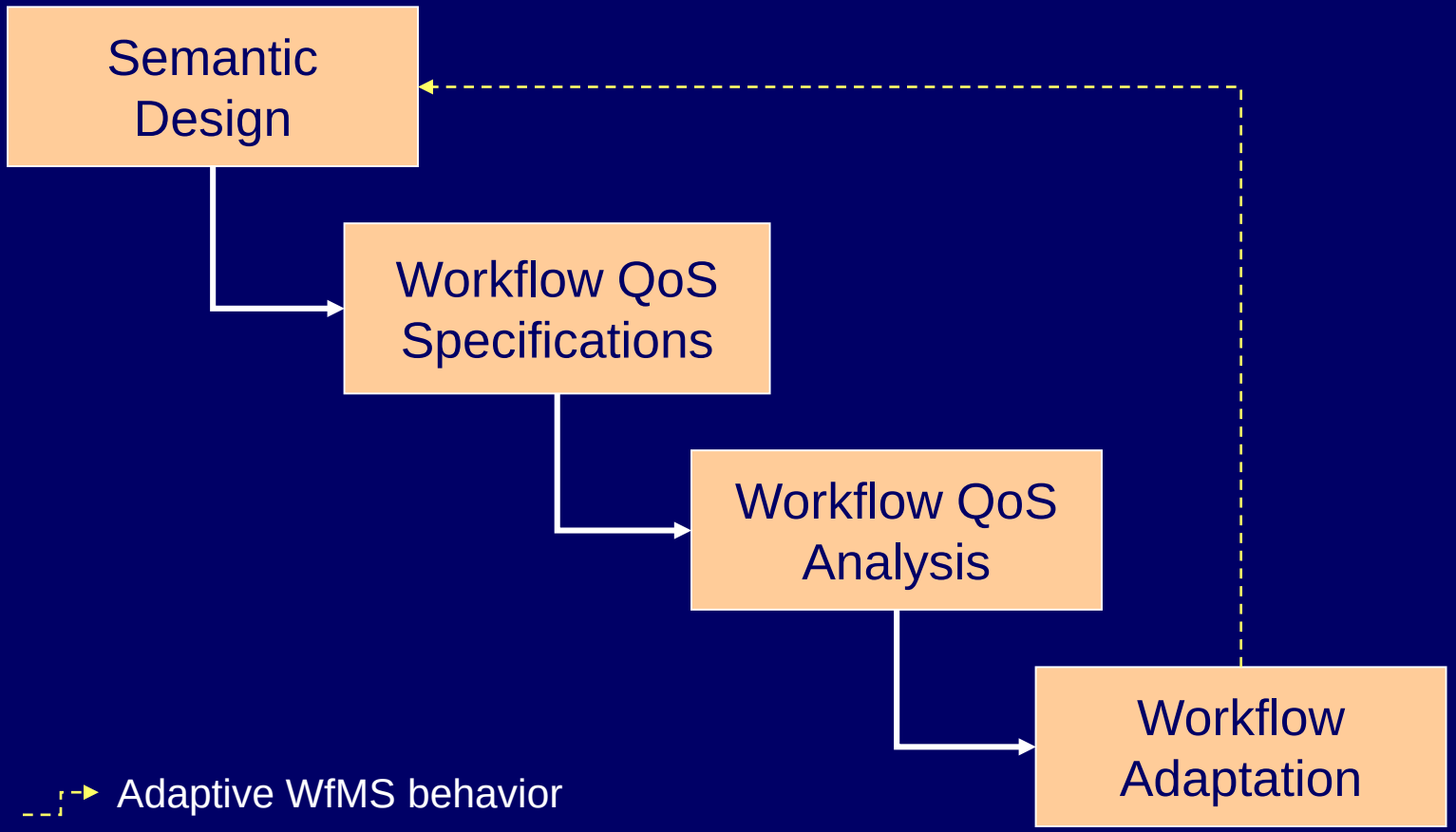


Examples of Structural changes (2)

- Redundancy pattern



Putting all together



For more information: http://lsdis.cs.uga.edu/proj/meteor/meteor.html