in the age of disruptive digital transformation

Eric Yu
University of Toronto

Keynote presentation at
8th international iStar workshop at RE'15
August 24, 2015

UNIVERSITY OF TORONTO
FACULTY OF INFORMATION

a confluence of emerging technologies

McKinsey Global Institute

May 2013

Disruptive technologies: Advances that will transform life, business, and the global economy

Ten IT-enabled business trends for the decade ahead

McKinsey Global Institute

May 2013


Cognizant
Don't Get SMACked:
How Social, Mobile, Analytics and Cloud Technologies are Reshaping the Enterprise
By Malcolm Frank
Cognizant Executive Vice President, Strategy & Marketing

… Data Data Data Data Data …

Harvard Business Review

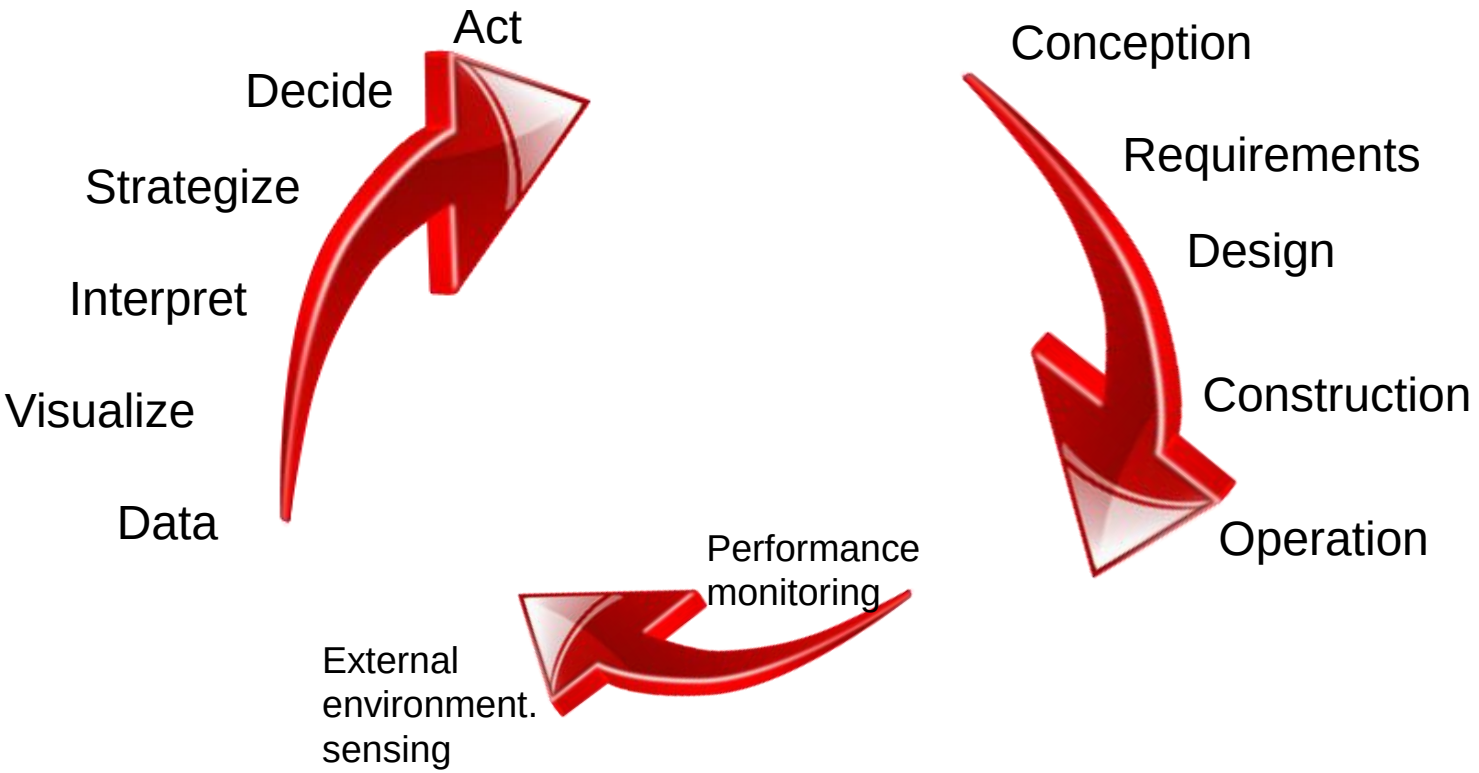
[HBR Oct 2012]

“sense & interpret” technologies

versus

“execution” technologies

Closing the loop
from sense-interpret to execute



- **RE in the adaptive enterprise**
  - **Where should these loops be located?**
  - **At what organization levels, scopes?**
  - **What data? What actions?**

NSERC Business Intelligence Network

Fundamental Question:

What RE techniques do we need in the age of digital transformation?

- The new reality
  - Fast-moving, fluid, dynamic, turbulent
  - Highly distributed, but hyper-connected and networked
  - Disruptors and disruptees
  - Data-rich
- What are the suitable abstractions?
  - Process models - ~BPMN?
  - Intentional strategic actors, network of relationships ~ i*?
  - Dynamics?? Higher-order?
    - adaptive systems theory?

Work in Progress

1. **The vision - From emerging technologies to adaptive enterprise**
   - [CASCON ACET13] [ETT14] [TEAR12, 15]
2. **How to model adaptive loops in the enterprise?**
   - An initial attempt, BDBI as example [RCIS13] [IJISMD14]
3. **What dimensions for re-designing enterprise process architecture?**
   - [RCIS15][ER15]
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   - [PoEM13, 14]
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6. **How are organizations and communities reconfiguring their boundaries and relationships?**
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     Business model innovation , disruption [ISEBM08]
7. **How to help disruptors and disruptees understand impact of emerging technological advances?**
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Adapting to Uncertain and Evolving Requirements

The case of Business-Driven Business Intelligence

Eric Yu, Alexei Lapouchnian, and Stephanie Deng

Faculty of Information and
Department of Computer Science
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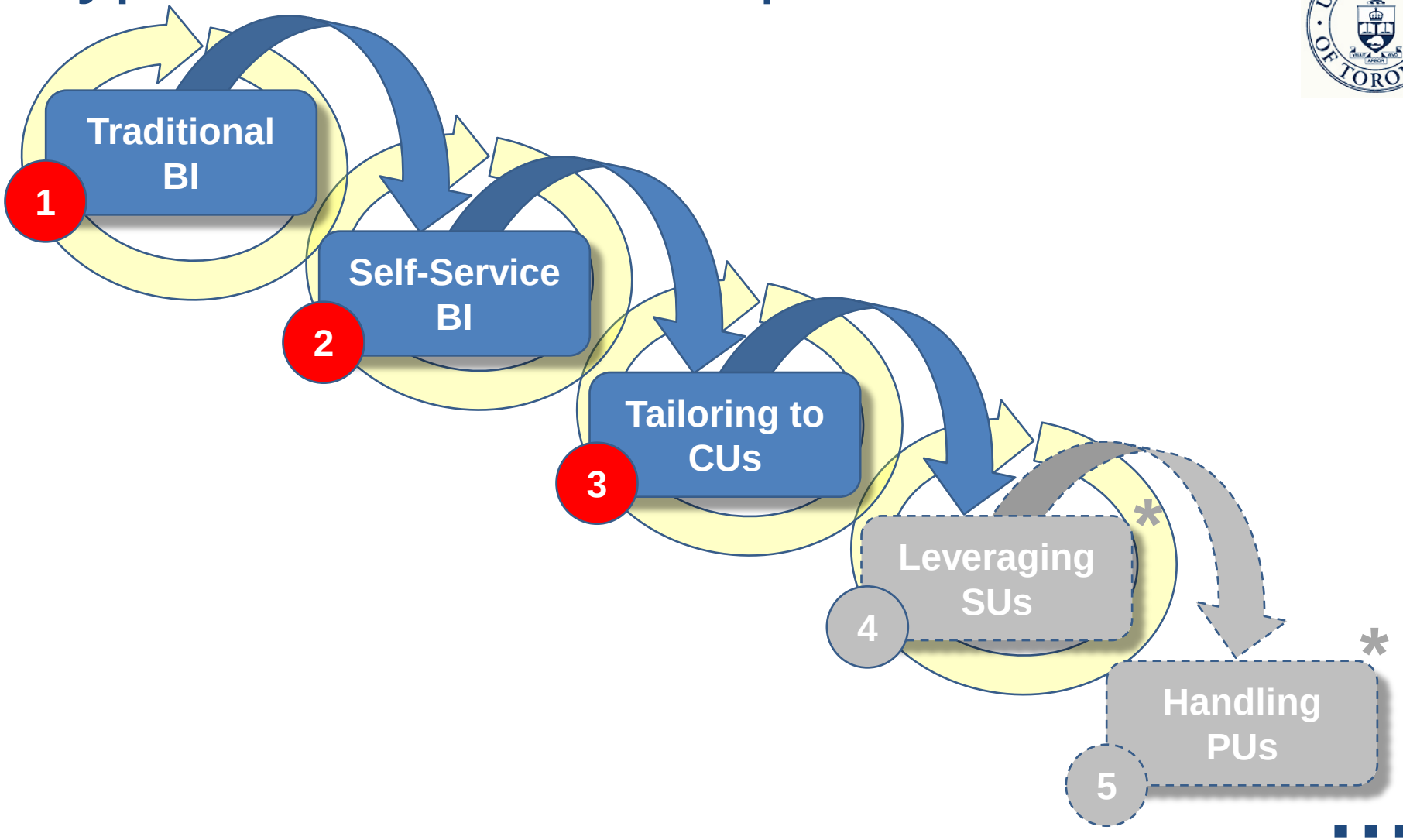
May 29, 2013

Typical Path in BI Adoption

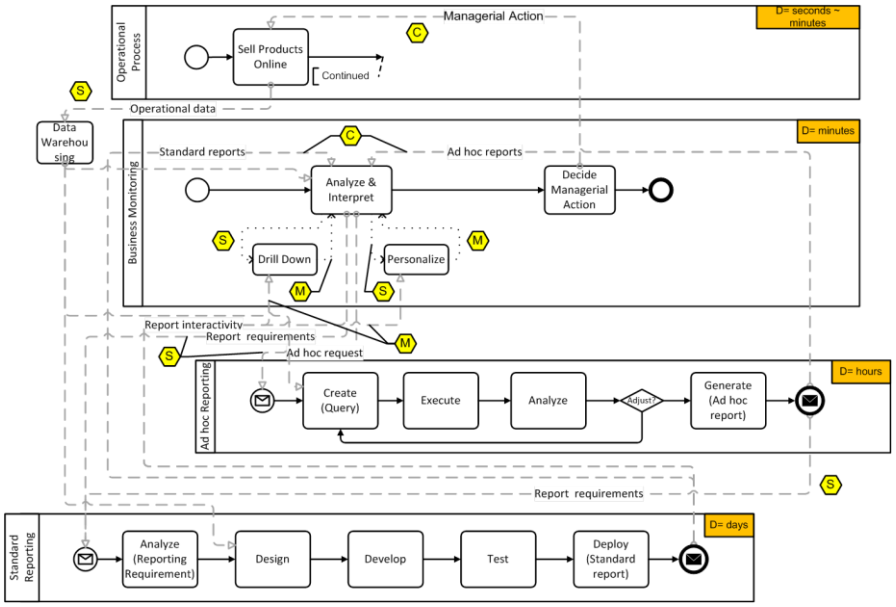


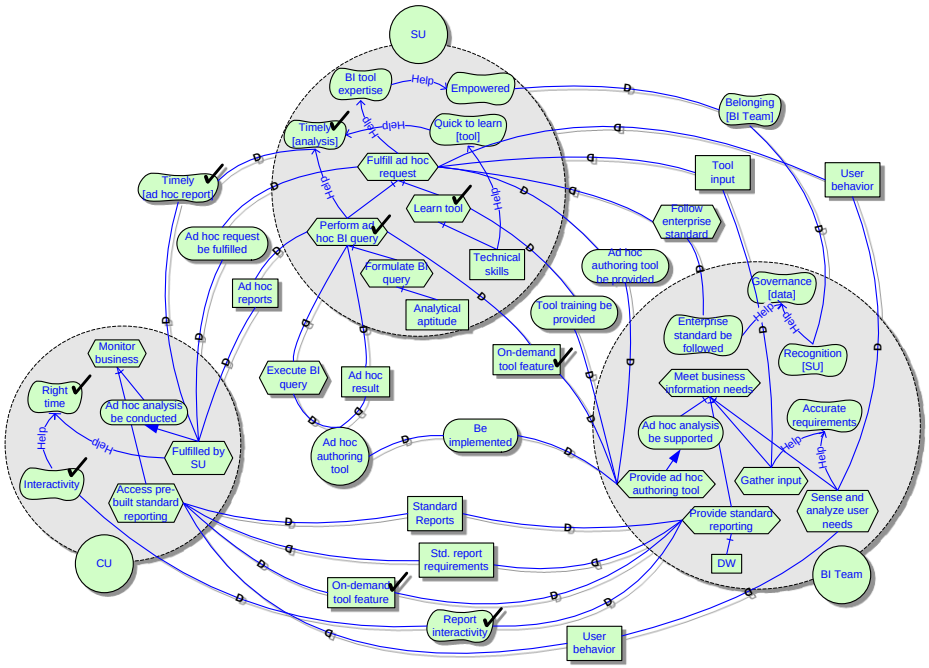
(Further iterations may follow)

*not shown in the presentation

Can Modeling Help? How?

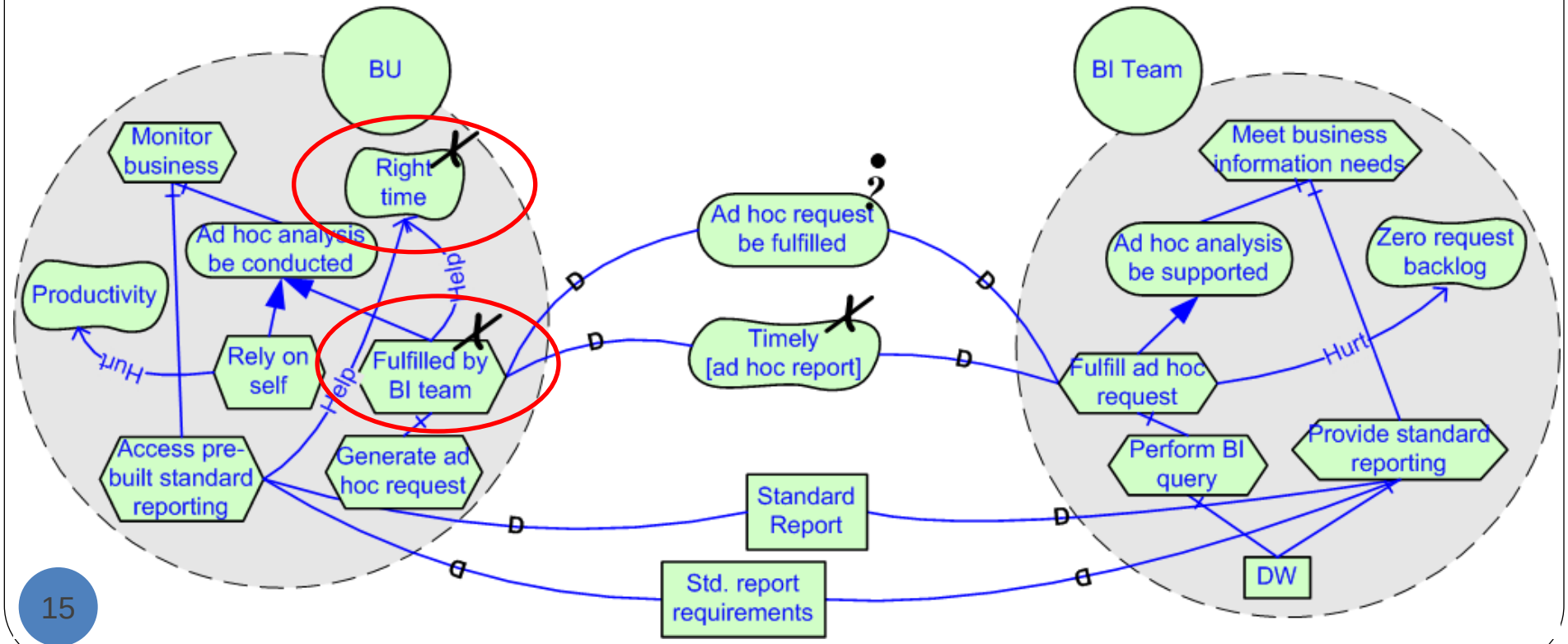
- Evolving Socio-Technical Solutions
  - **Process Models**: processes, lifecycles, change
  - **Social and Goal Models**: functional/non-functional objectives, actors, relationships





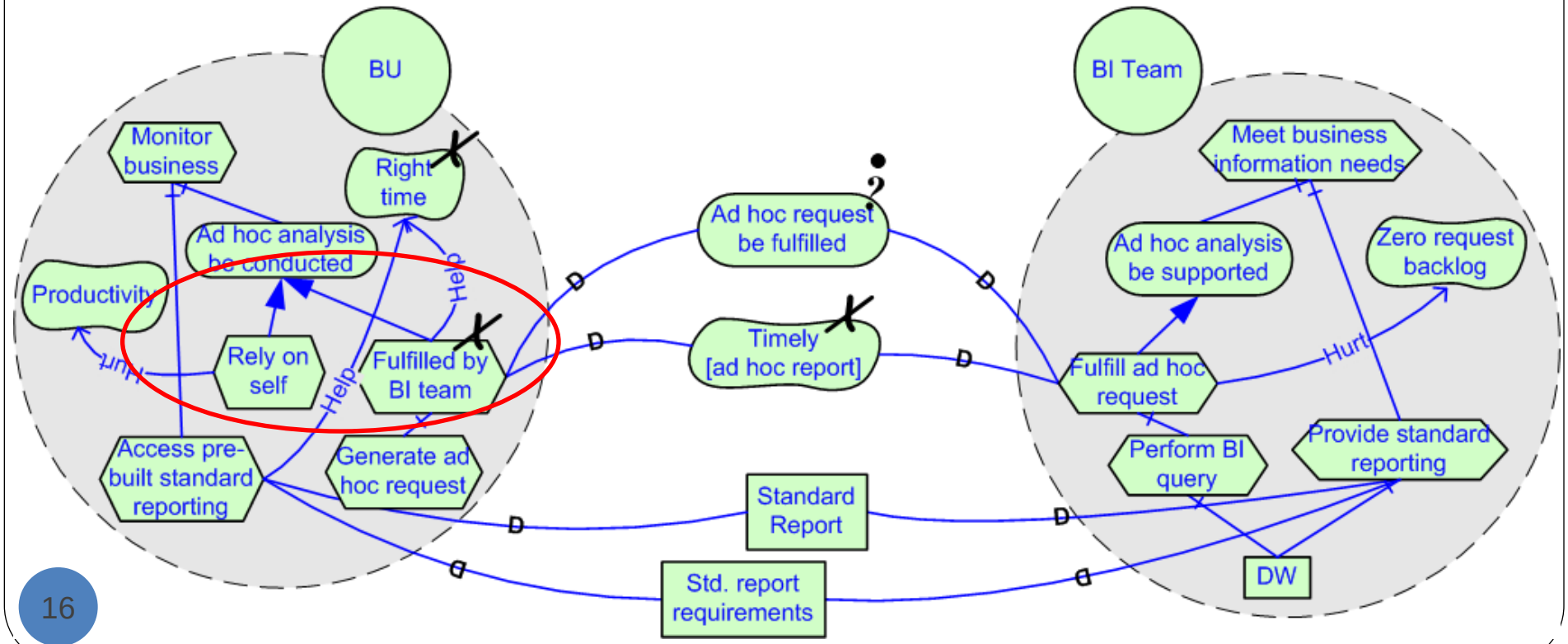
1: Traditional BI: Modeling

- Analyzing the model. With i*, *we are able to capture*:
  - Actors, their functional and non-functional goals, and dependencies
  - Unmet goals, the driving forces for change



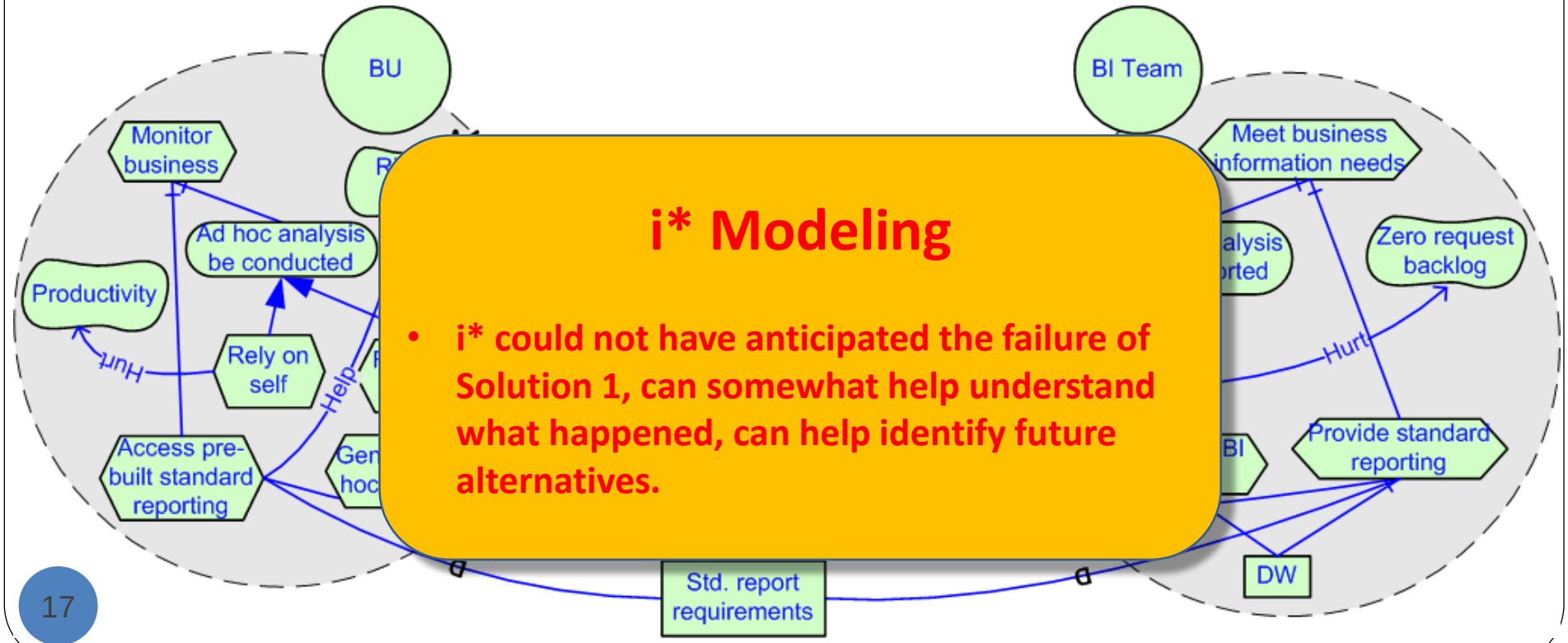
1: Traditional BI: Modeling

- Analyzing the model. With i*, *we are able to capture*:
  - Actors, their functional and non-functional goals, and dependencies
  - Unmet goals, the driving forces for change
  - Alternative ways of fulfilling goals – i.e., the *possible adaptation paths*



1: Traditional BI: Modeling

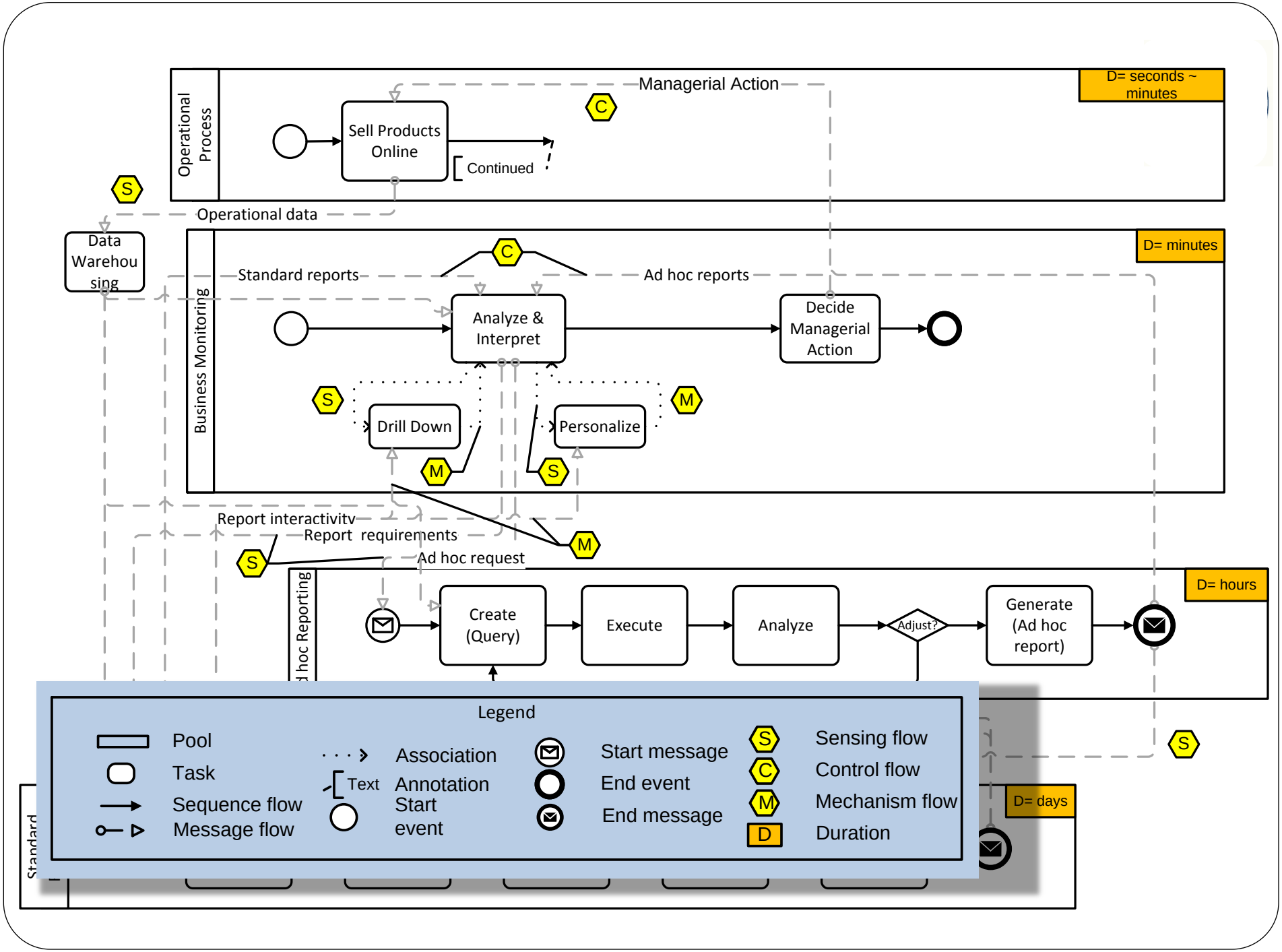
- Analyzing the model. With i*, *we are NOT able to capture*:
  - Dynamics of the scenarios – i* model is just a snapshot.
  - Speed and rates of change.
  - Frequencies of occurrences (e.g., of dependencies).



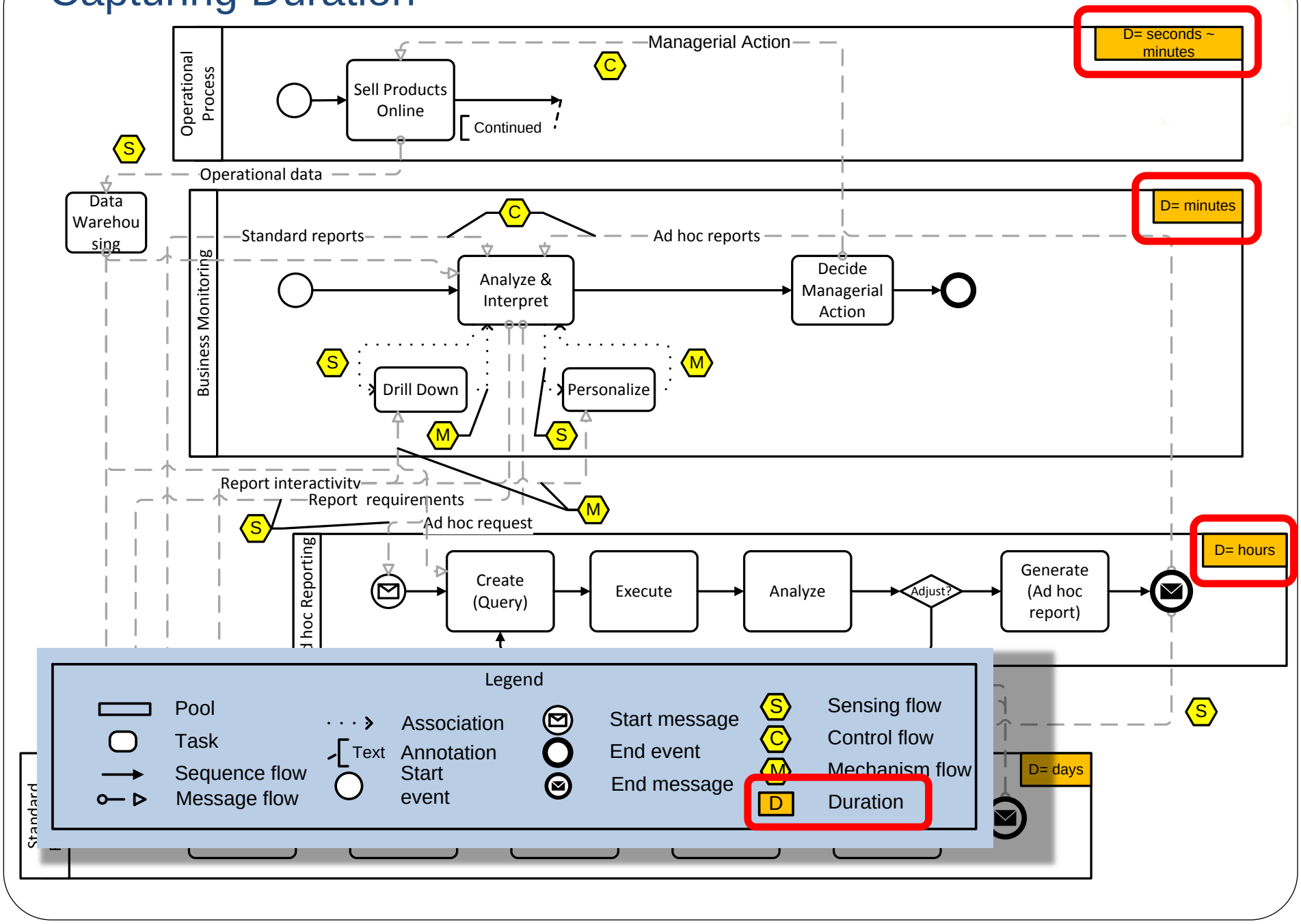
Process Models: Modeling Temporal and Iterative Aspects

- Social models
  - Can capture motivations and driving forces behind change (+social aspects)

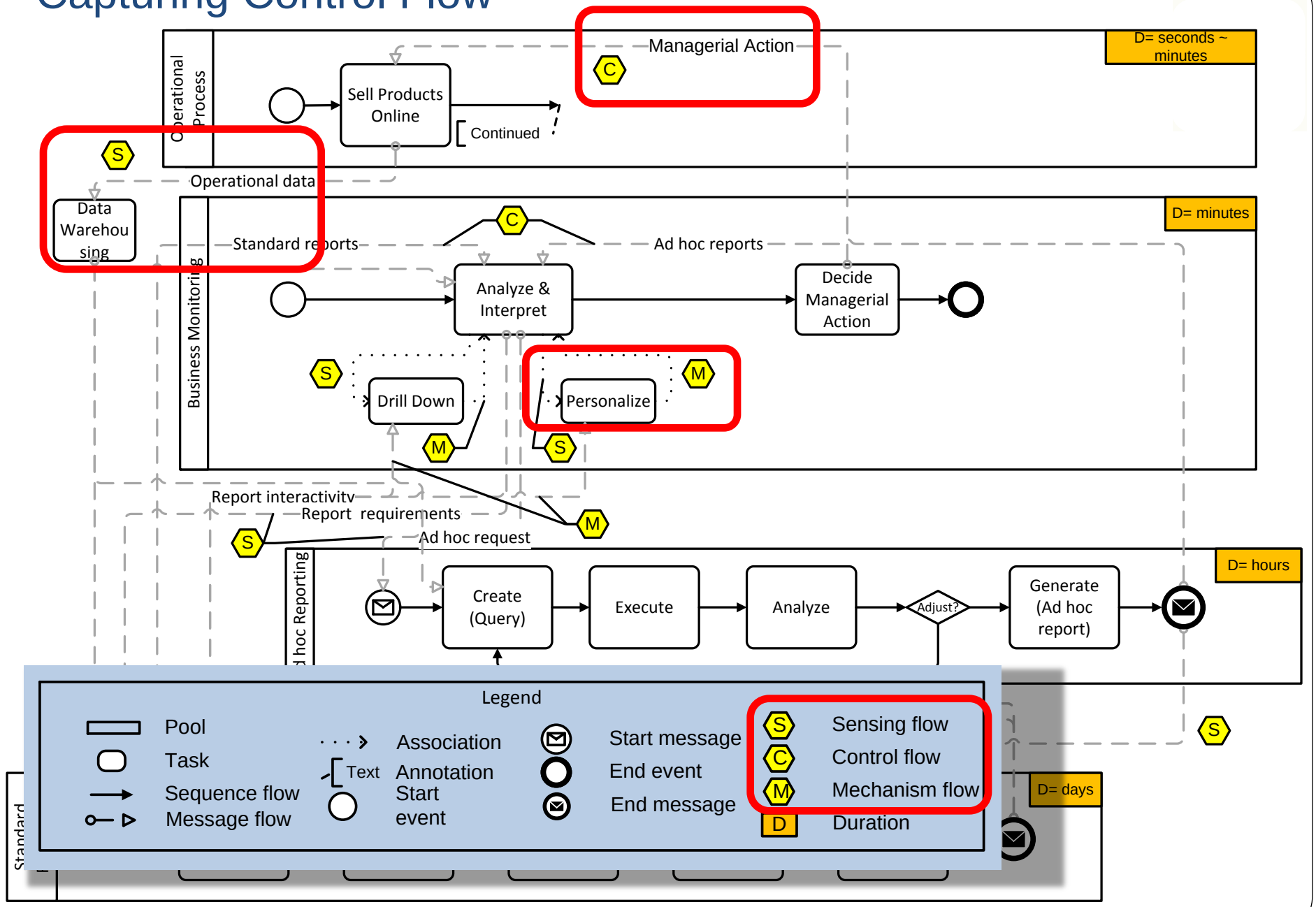
- We use BPMN (with extensions) to:
  - Look at multiple layers of change in dynamic environments
  - Determine if we can
    - Visualize feedback loops
    - Capture the details of (re-)design cycles, analyze their relative frequencies, duration.


Operational Process
Managerial Action
D= seconds ~ minutes
Sell Products Online
Continued
C
S
Operational data
Data Warehou sing
Business Monitoring
D= minutes
Standard reports
Ad hoc reports
Analyze & Interpret
Decide Managerial Action
Drill Down
Personalize
M
Report interactivity
Report requirements
Ad hoc request
d hoc Reporting
D= hours
Create (Query)
Execute
Analyze
Adjust?
Generate (Ad hoc report)
Legend
Pool
Task
Sequence flow
Message flow
Association
Text Annotation
Start event
Start message
End event
End message
Sensing flow
Control flow
Mechanism flow
Duration
D= days
Standard

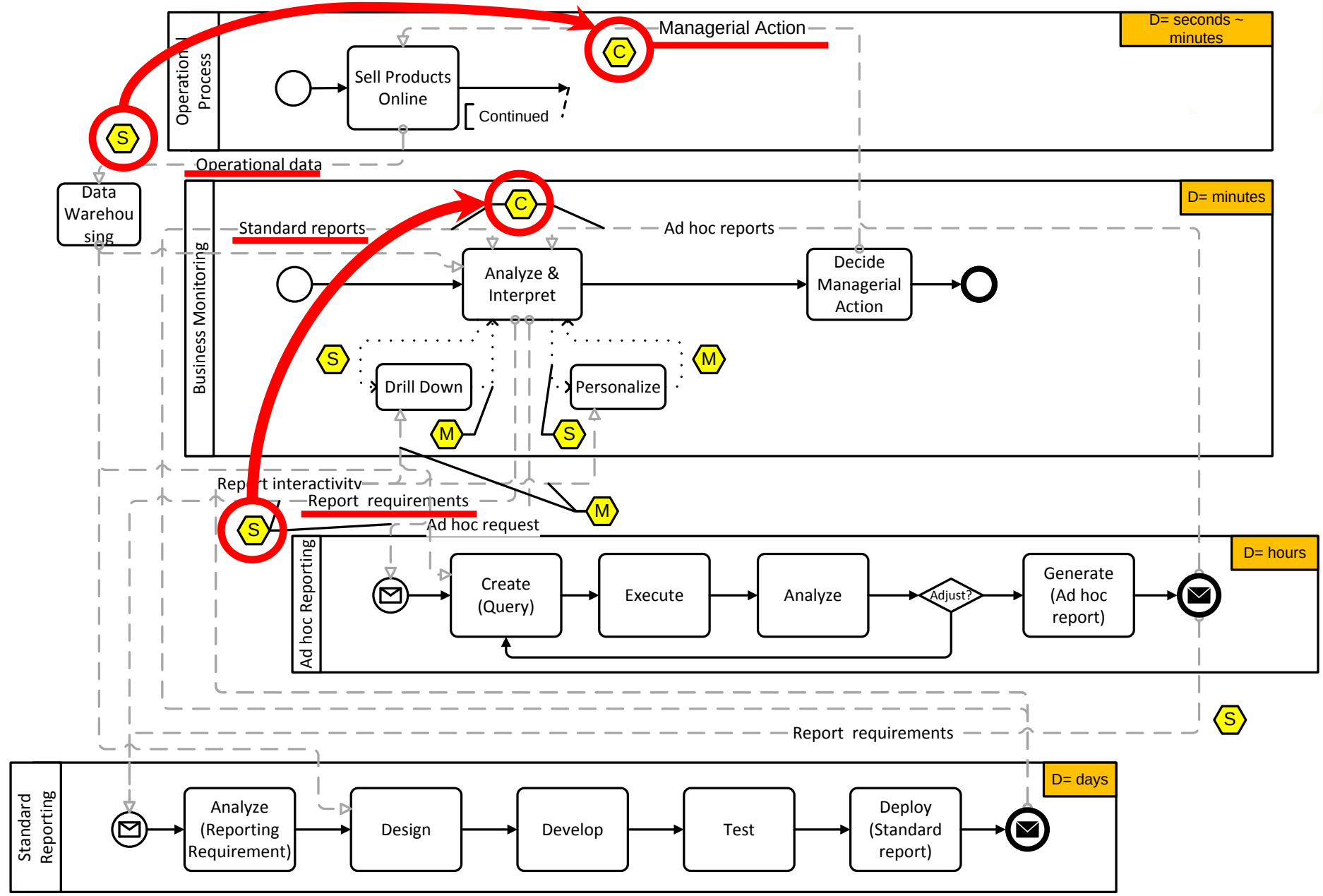
Capturing Duration



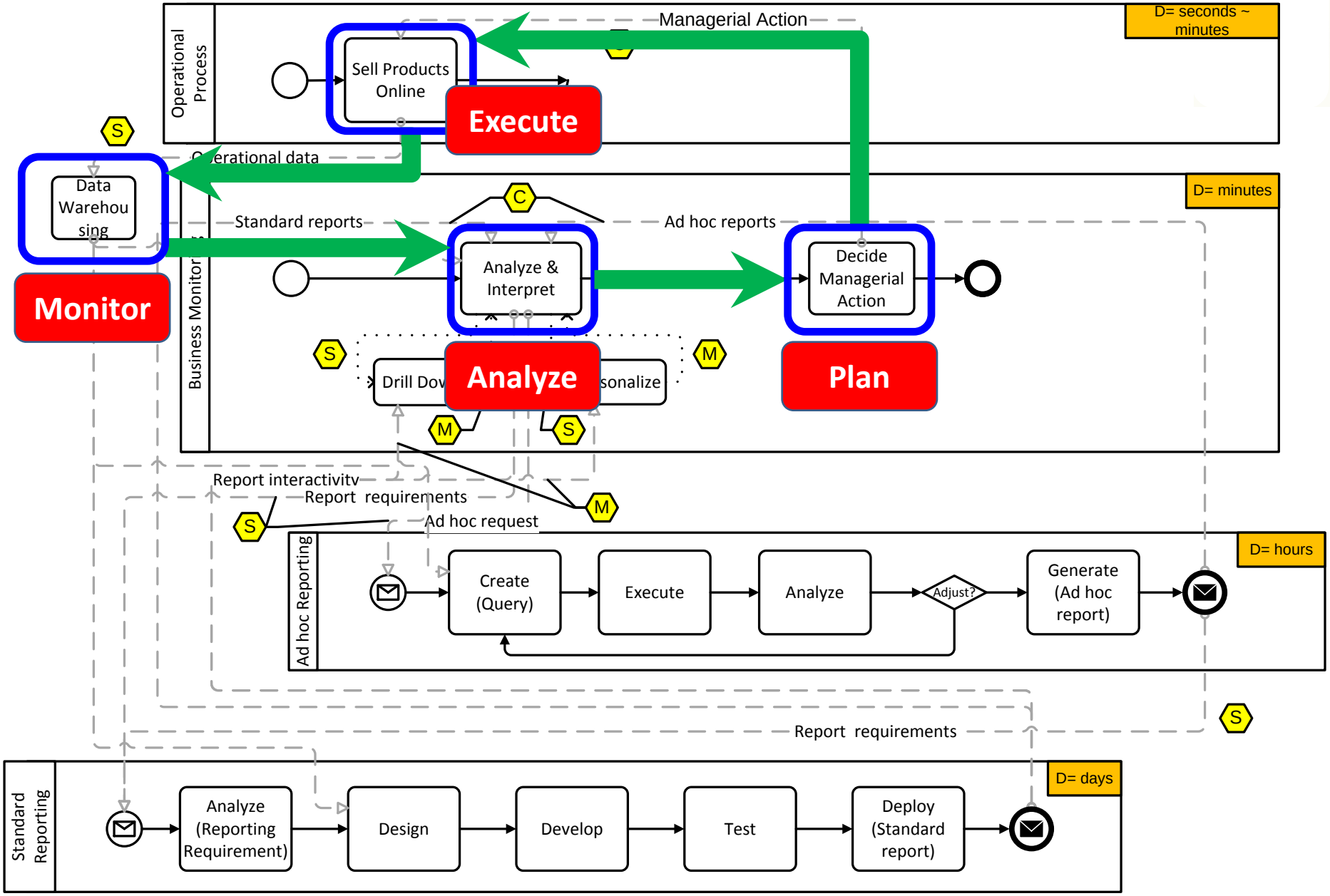
Capturing Control Flow



Identifying Sense-Control Pairs

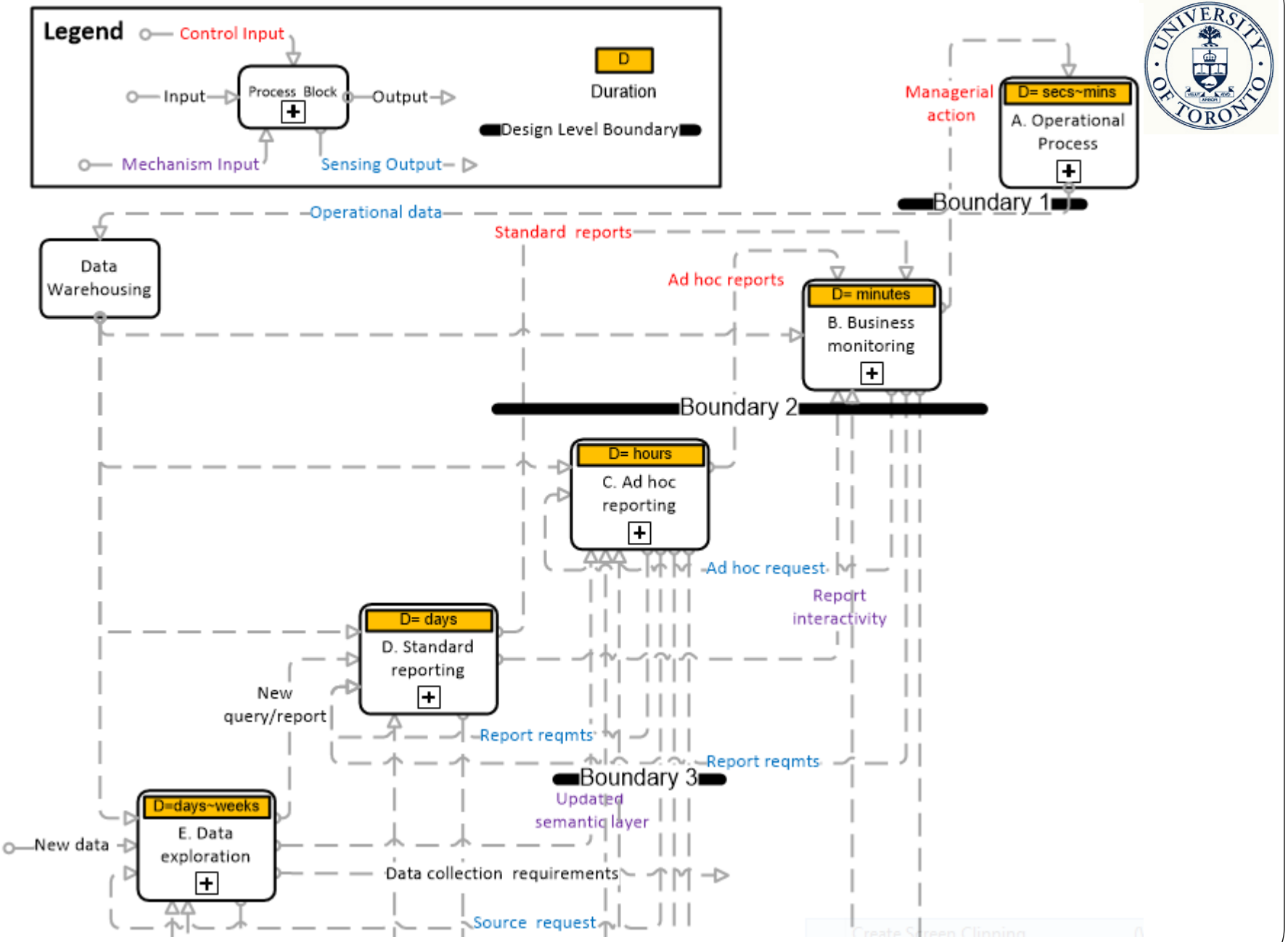


Identifying Feedback Loops



A Hierarchical View of Design Processes

- Adaptation loops reveal special relationships among processes
  - Higher-level process – control/design/change process
  - Lower-level processes – target/use/etc. processes
- Change though
  - Control – constrains the options for the target process. **Adaptation**.
  - Mechanism – changes the space of options for the target process. **Evolution**
- Result – hierarchy of processes reflecting their control order.
  - These also help when change cannot be accommodated at runtime (e.g., when we need to design new capabilities)


Legend
Control Input
Input
Process Block
Output
Mechanism Input
Sensing Output
D
Duration
Design Level Boundary
Managerial action
D= secs~mins
A. Operational Process
Boundary 1
Operational data
Standard reports
Data Warehousing
Ad hoc reports
D= minutes
B. Business monitoring
Boundary 2
D= hours
C. Ad hoc reporting
Ad hoc request
Report interactivity
D= days
D. Standard reporting
New query/report
Report reqmts
Report reqmts
Boundary 3
Updated semantic layer
D=days~weeks
E. Data exploration
New data
Data collection requirements
Source request

Conclusions

- Based on our experience with the case study
  - The need for **modeling ongoing adaptation and change** in the face of uncertain/evolving requirements is a fact of life for enterprises.
  - **Co-evolution and alignment** of the social and technical components of solutions is important.
  - Neither the i* social modeling notation nor the (augmented) BPMN notation is adequate.
- Aspects of modeling and analysis that are important to support:
  - **Variability Modeling and Binding**, criteria for alternative selection, barriers to adoption/change.
  - **Social Modeling** – physical vs. logical actors, skills/capabilities, personal goals, incentives.
  - **Feedback** (failures, changes in context, requirements), **multiple levels of design** – changes within/across levels, iterations.
  - **Temporal and dynamic aspects** – frequencies, duration, etc.

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Ben-Gurion University of the Negev
אוניברסיטת בן-גוריון בנגב

RE-DESIGNING PROCESS ARCHITECTURES

TOWARDS A FRAMEWORK OF DESIGN DIMENSIONS

ALEXEI LAPOUCHNIAN[1], ERIC YU[1], AND ARNON STURM[2]

[1] UNIVERSITY OF TORONTO, CANADA [2] BEN-GURION UNIVERSITY OF THE NEGEV, ISRAEL

BUSINESS PROCESS ARCHITECTURE

- PREVIOUSLY – INDIVIDUAL BP ANALYSIS/DESIGN
  - TOO NARROW TO ADDRESS THE ABOVE CHALLENGES
  - E.G., ONLY STANDALONE BP OPTIMIZATION
- NEED A BP ARCHITECTURE (BPA) PERSPECTIVE
  - ALL BPS IN AN ENTERPRISE & THEIR RELATIONSHIPS
- NUMEROUS CHOICES IN BP ARCHITECTURES
  - TYPES OF RELATIONSHIPS AMONG BPS
  - POSSIBLE MOVEMENTS OF FUNCTIONALITY AMONG PROCESSES, ETC.

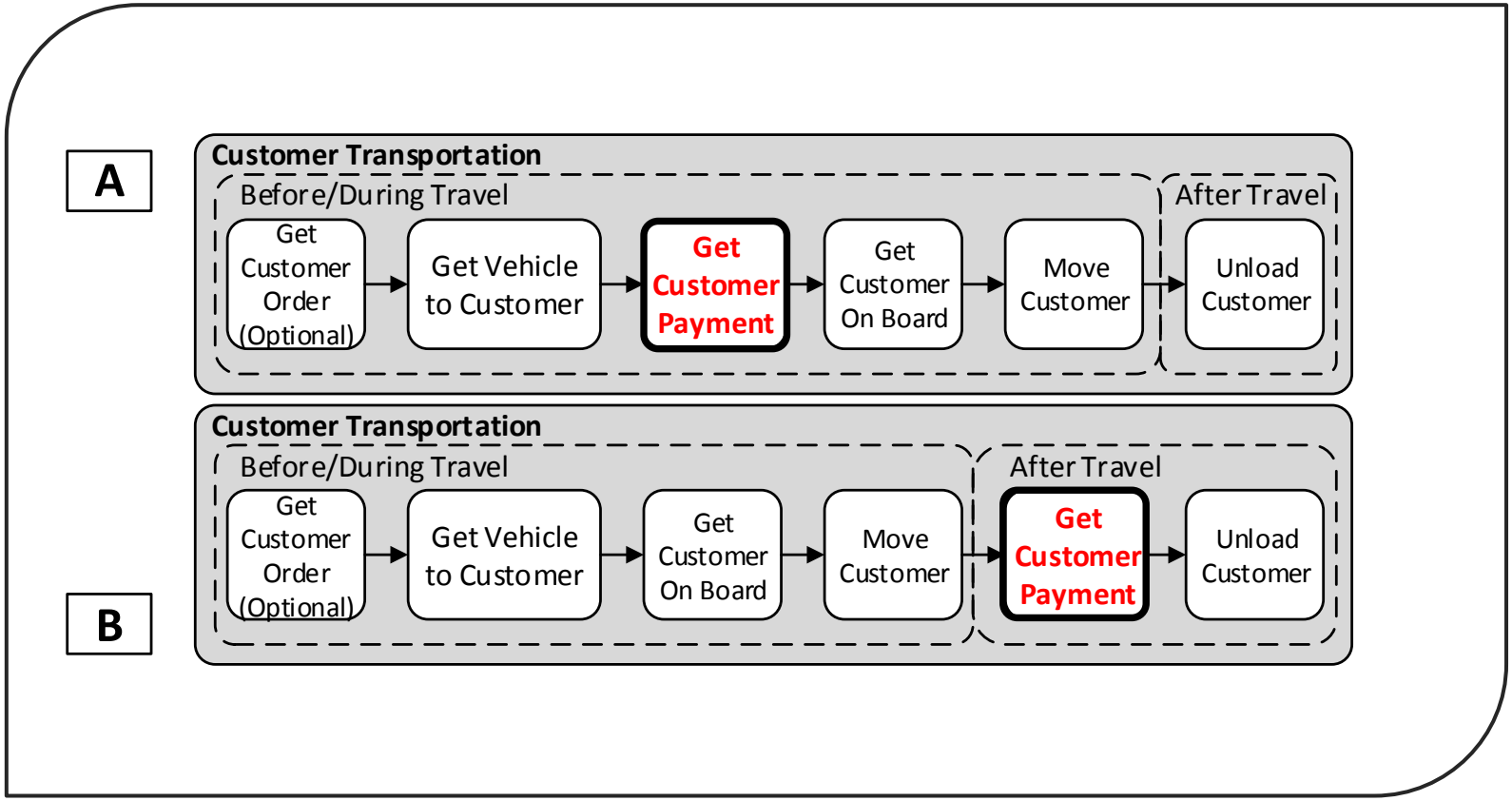
FEATURES OF THE APPROACH

- IDENTIFY AND MODEL RELEVANT RELATIONSHIPS ACROSS BP'S
- PROPOSE FOUR DIMENSIONS OF CHANGE IN SPACE OF **BPA ALTERNATIVES**
  - TEMPORAL
  - RECURRENCE
  - PLAN/EXECUTE
  - DESIGN/USE
- MODEL AND ANALYZE BPA ALTERNATIVES AND TRADE-OFFS (FLEXIBILITY VS. COST, EFFICIENCY, ETC.)
  - GOAL-DRIVEN APPROACH

THE TEMPORAL DIMENSION

- VARIATIONS IN PLACEMENTS OF PROCESS ELEMENTS (ACTIVITIES/DECISIONS, PES) IN BPS
  - DIFFERENT IN NON-FUNCTIONAL CHARACTERISTICS
  - EMPLOY *PHASES* – GROUPINGS OF PES
- POSTPONEMENT (VS. ADVANCEMENT)
  - POTENTIALLY MORE DATA AVAILABLE
  - POSITIVE: CONTEXT-AWARENESS, FLEXIBILITY
  - NEGATIVE: COST, UNPREDICTABILITY, COMPLEXITY

THE TEMPORAL DIMENSION EXAMPLE



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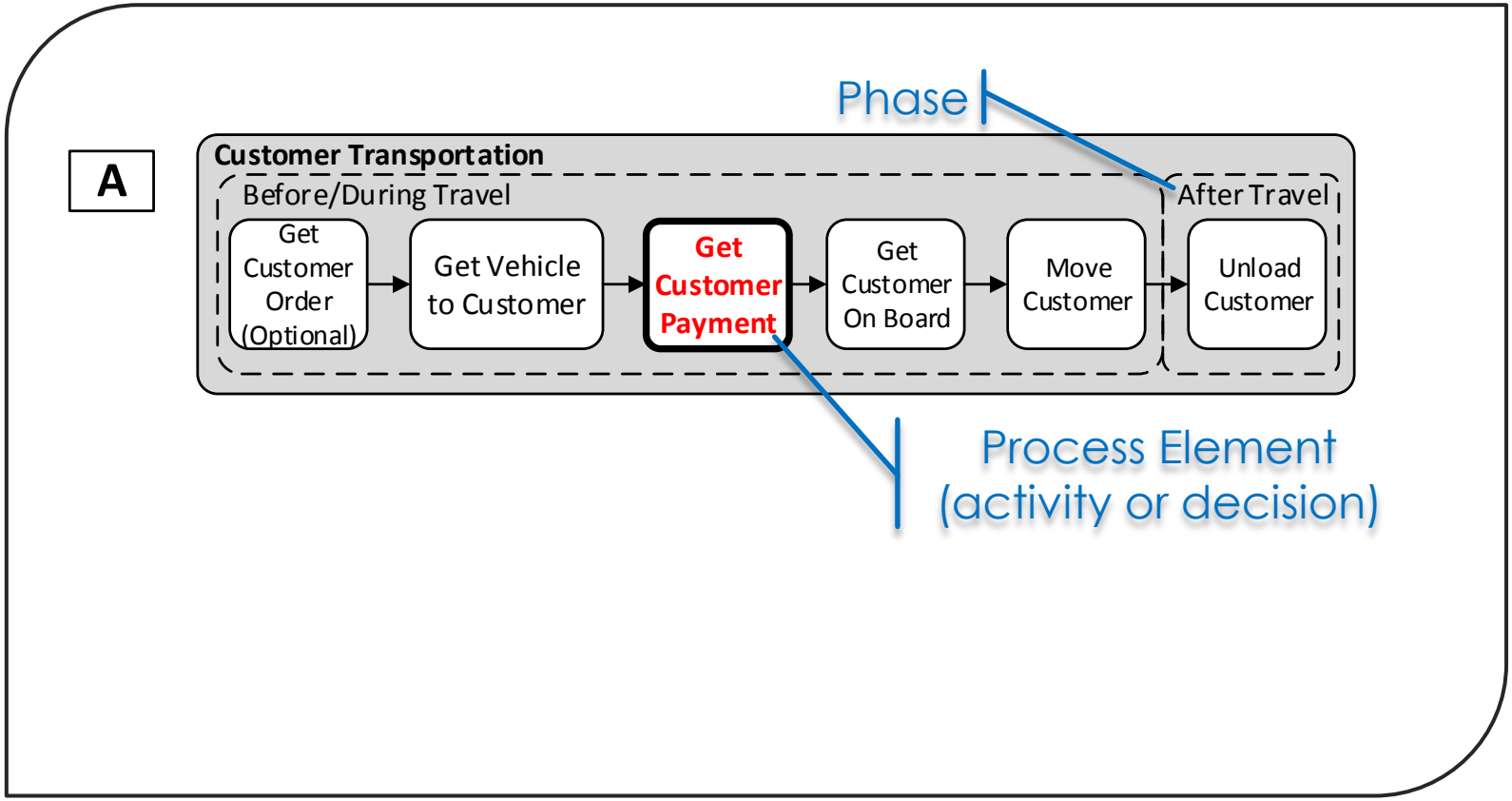

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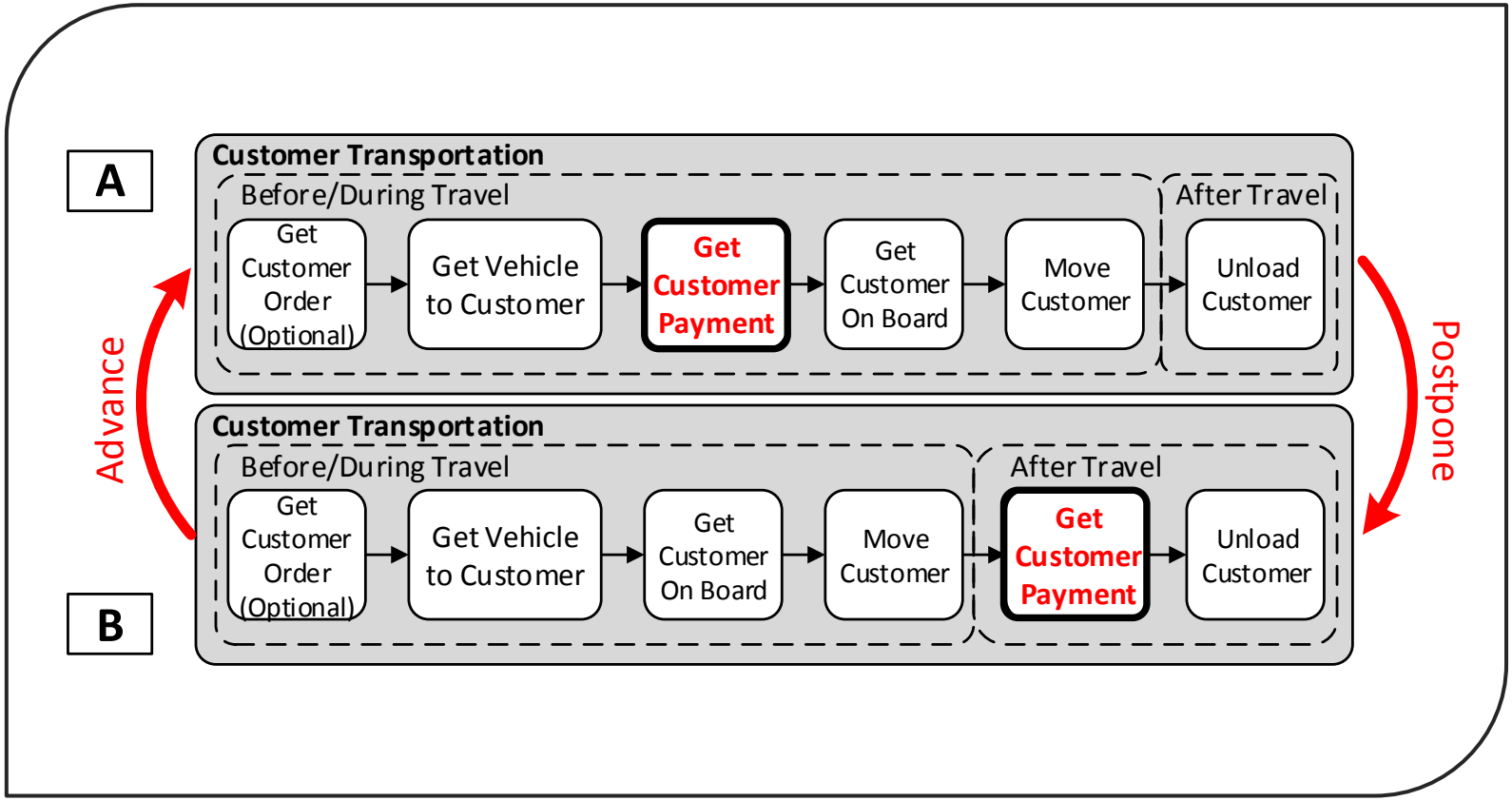
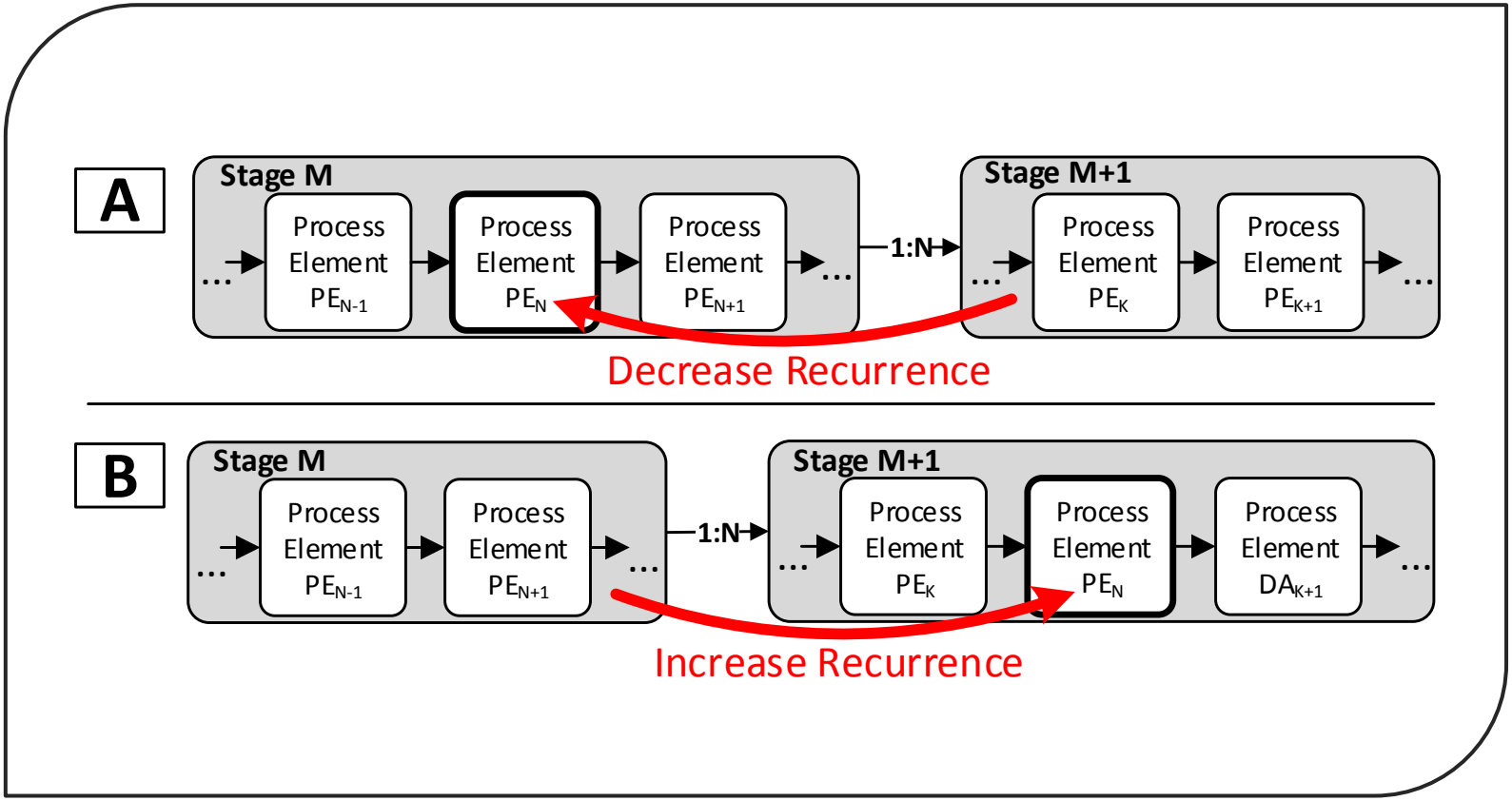


THE RECURRENCE DIMENSION

- RELATIVE FREQUENCIES OF EXECUTION OF *STAGES*
  - STAGE – A PROCESS CHUNK WITH PES WITH THE SAME EXECUTION CYCLE; STAGES CONTAIN PHASES
  - *FOR EACH EXECUTION OF S1, N EXECUTIONS OF S2*
- INCREASING RECURRENCE
  - MAKES USE OF CONTEXTUAL, INSTANCE-LEVEL INFO
  - POSITIVE: FLEXIBILITY, CONTEXT-AWARENESS
  - NEGATIVE: COST, REUSABILITY, PREDICTABILITY
- OPPOSITE EFFECTS FOR DECREASING RECURRENCE

THE RECURRENCE DIMENSION EXAMPLE



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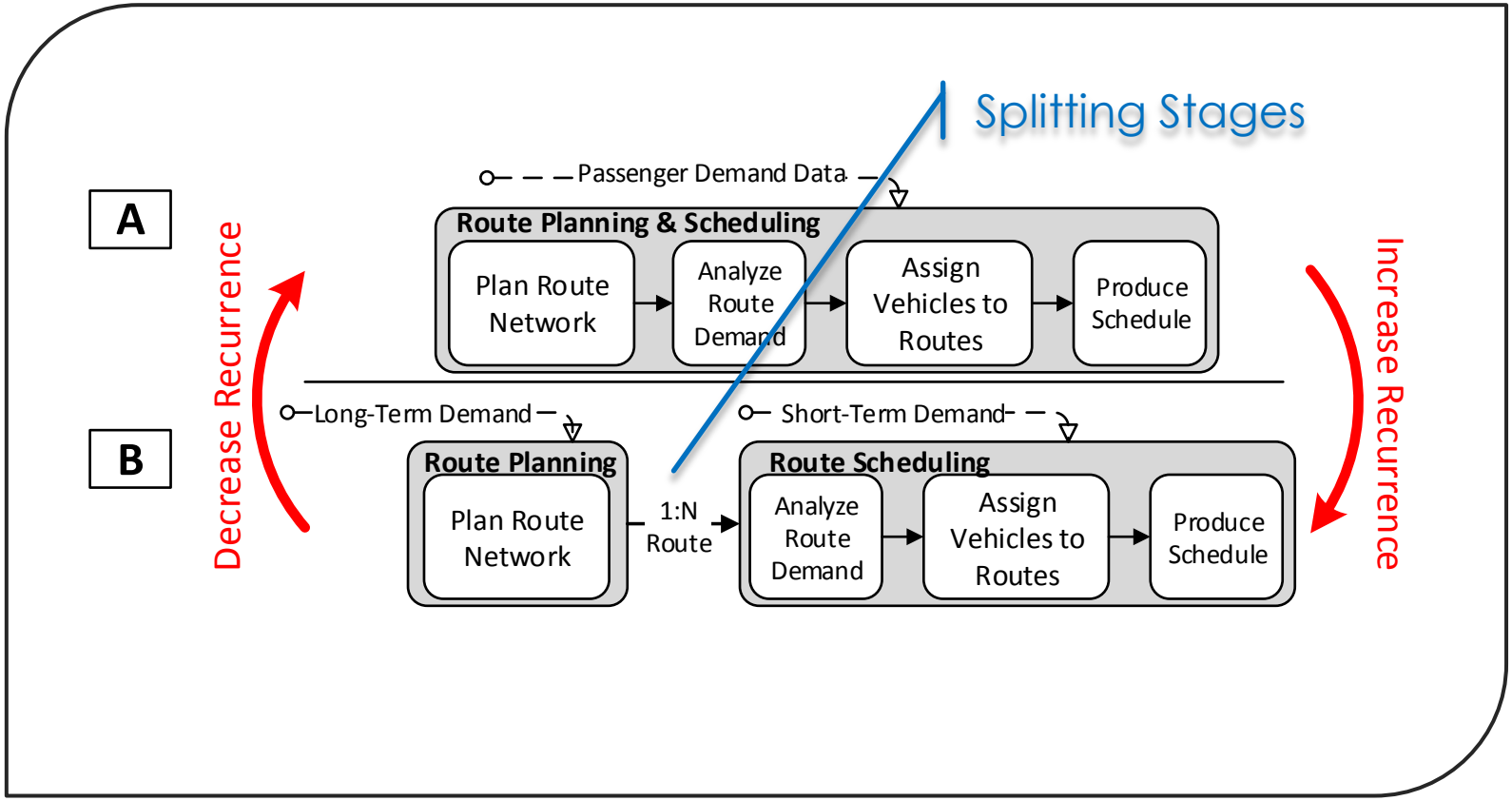


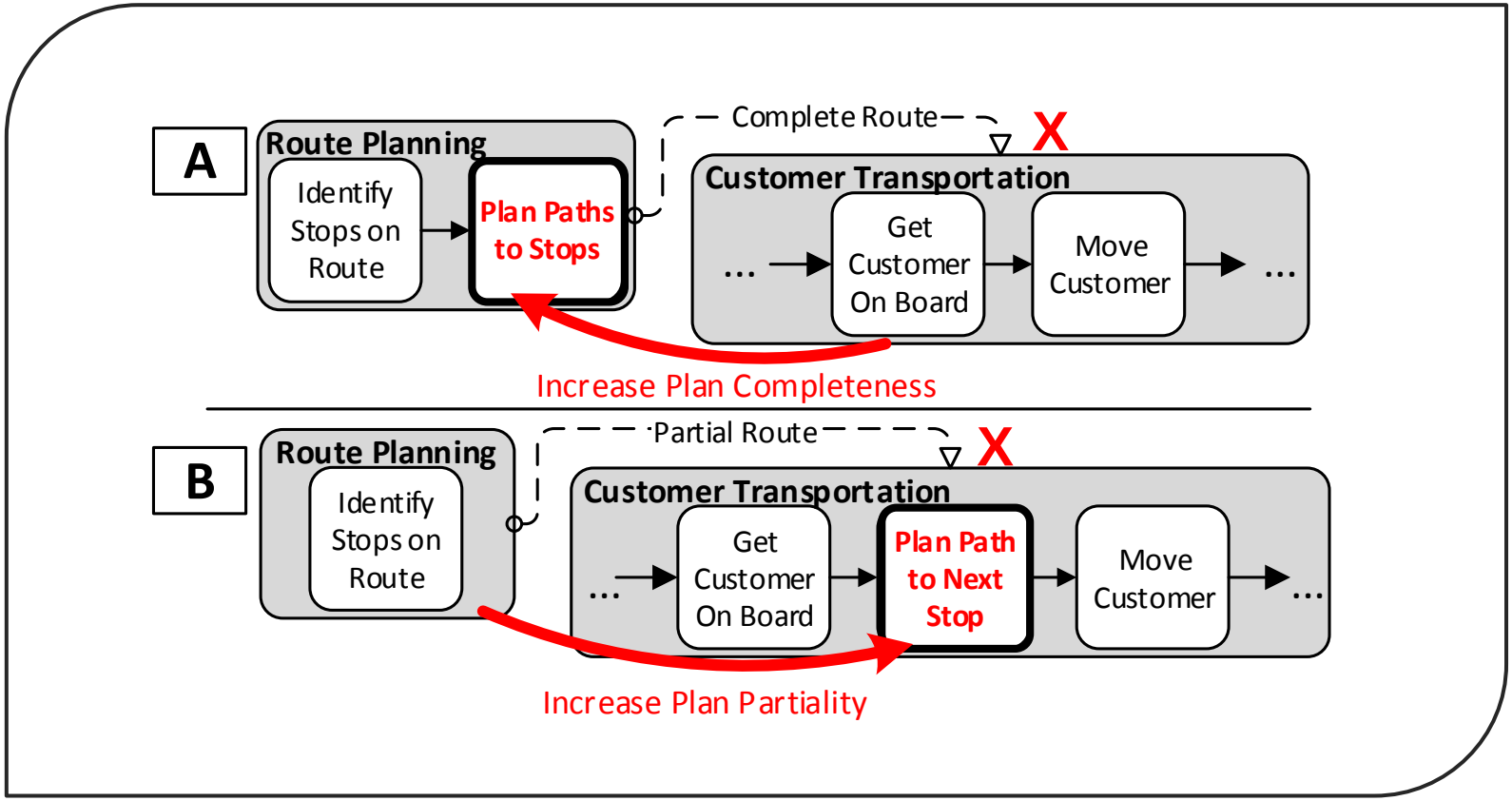
THE RECURRENCE DIMENSION

- GENERALIZES BINDING TIME
  - IMPROVES UPON THE STANDARD DESIGN-TIME VS. RUNTIME BINDING CHOICES IN VARIABILITY RESEARCH
  - INTRODUCES DOMAIN-SPECIFIC OPTIONS FOR MAKING DECISIONS AND EXECUTING ACTIVITIES
  - EARLIER STAGES ARE "CLOSER" TO DESIGN TIME
  - LATER STAGES ARE "CLOSER" TO RUNTIME
  - ALLOWS FOR MORE FLEXIBILITY IN (RE-)BINDING PES THAN THE CURRENT VARIABILITY APPROACHES

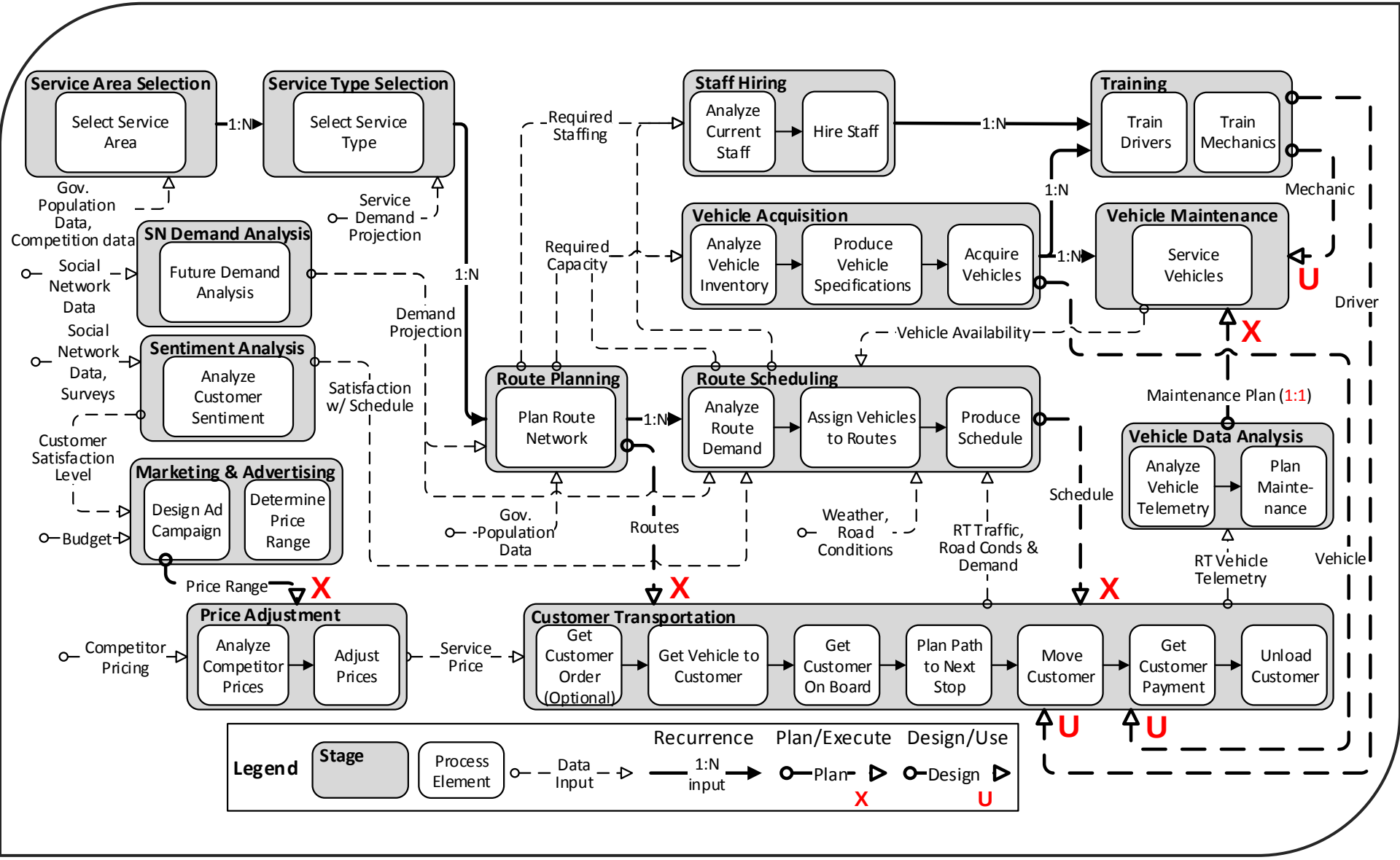
THE PLAN/EXECUTE (P/E) AND DESIGN/USE (D/U) DIMENSIONS

- For dynamic/evolving Orgs – Integration of planning & development into BPAs
  - P/E: Planning stages output Plans/Specs
  - D/U: Design Stages produce tools/capabilities
- Choices for a Process Element
  - P/E: Part of a plan or left to runtime
    - Concerns: Plan completeness/partiality, Flexibility
  - D/U: Built into a tool/capability or left out
    - Concern: Tool specialization vs. customizability

THE PLAN/EXECUTE DIMENSION EXAMPLE



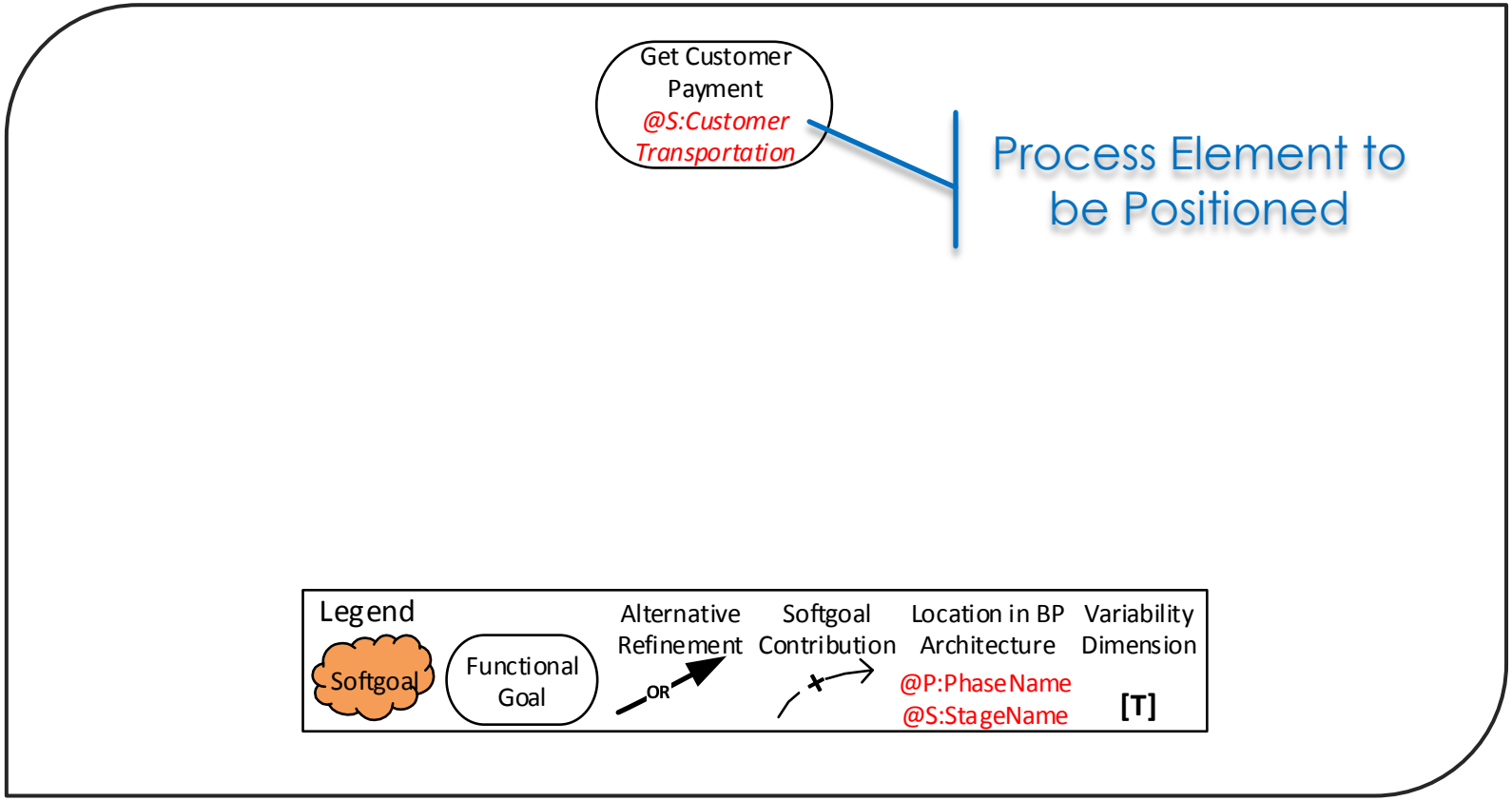
BPA FOR THE PUBLIC TRANSPORTATION CASE STUDY



ANALYZING BPA ALTERNATIVES

- FOR EACH SET OF PE PLACEMENT ALTERNATIVES
  - USE GOAL MODELS TO CAPTURE PLACEMENT CHOICES FOR THE PE IN THE BPA
  - USE NON-FUNCTIONAL REQUIREMENTS (NFRS) TO CAPTURE SELECTION CRITERIA
  - EVALUATE EACH ALTERNATIVE W.R.T. THE NFRS
- TO-BE BPA CONFIGURATION
  - IMPLEMENTS THE SELECTED VARIANT

ANALYZING BPA ALTERNATIVES



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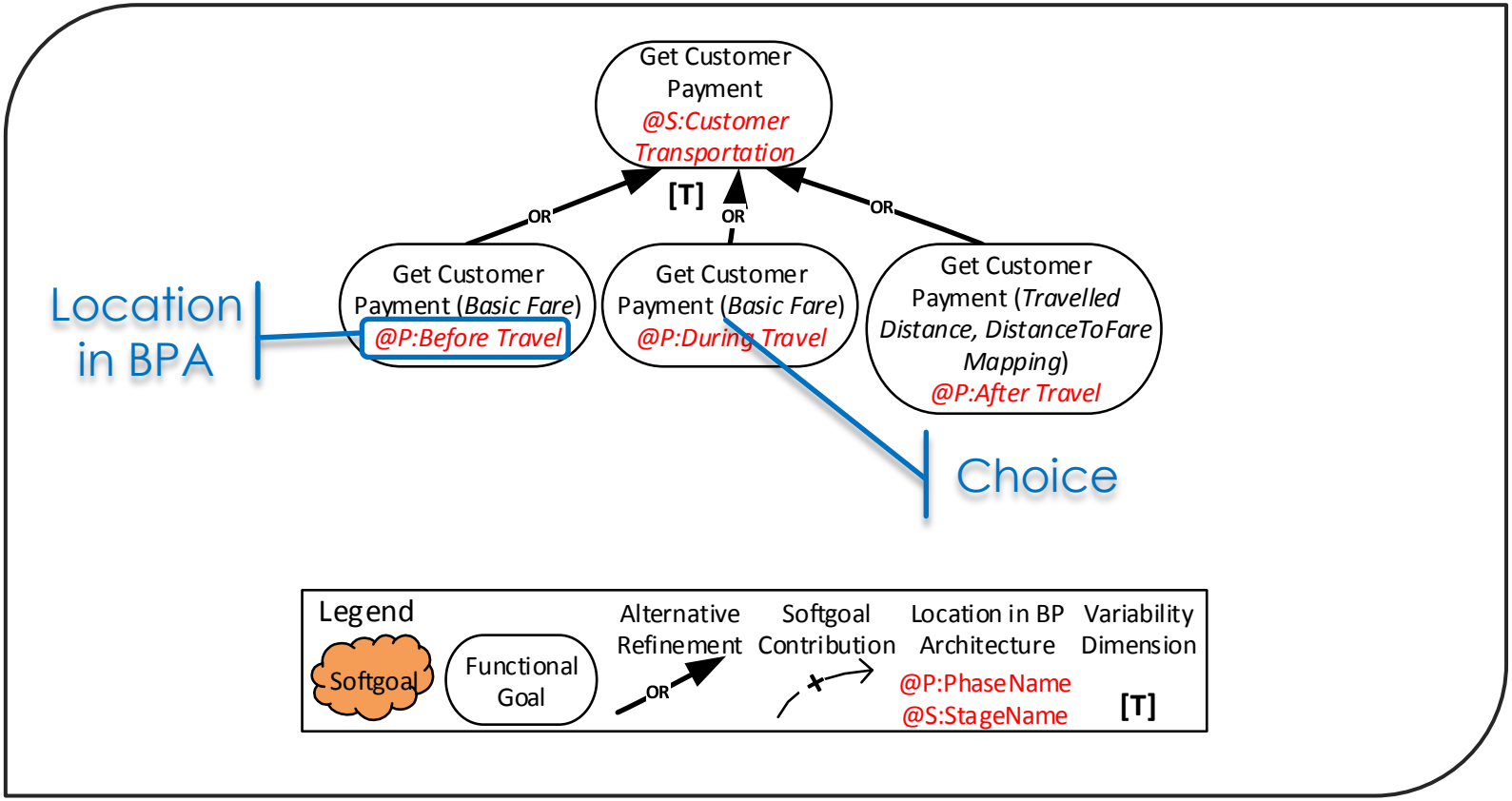

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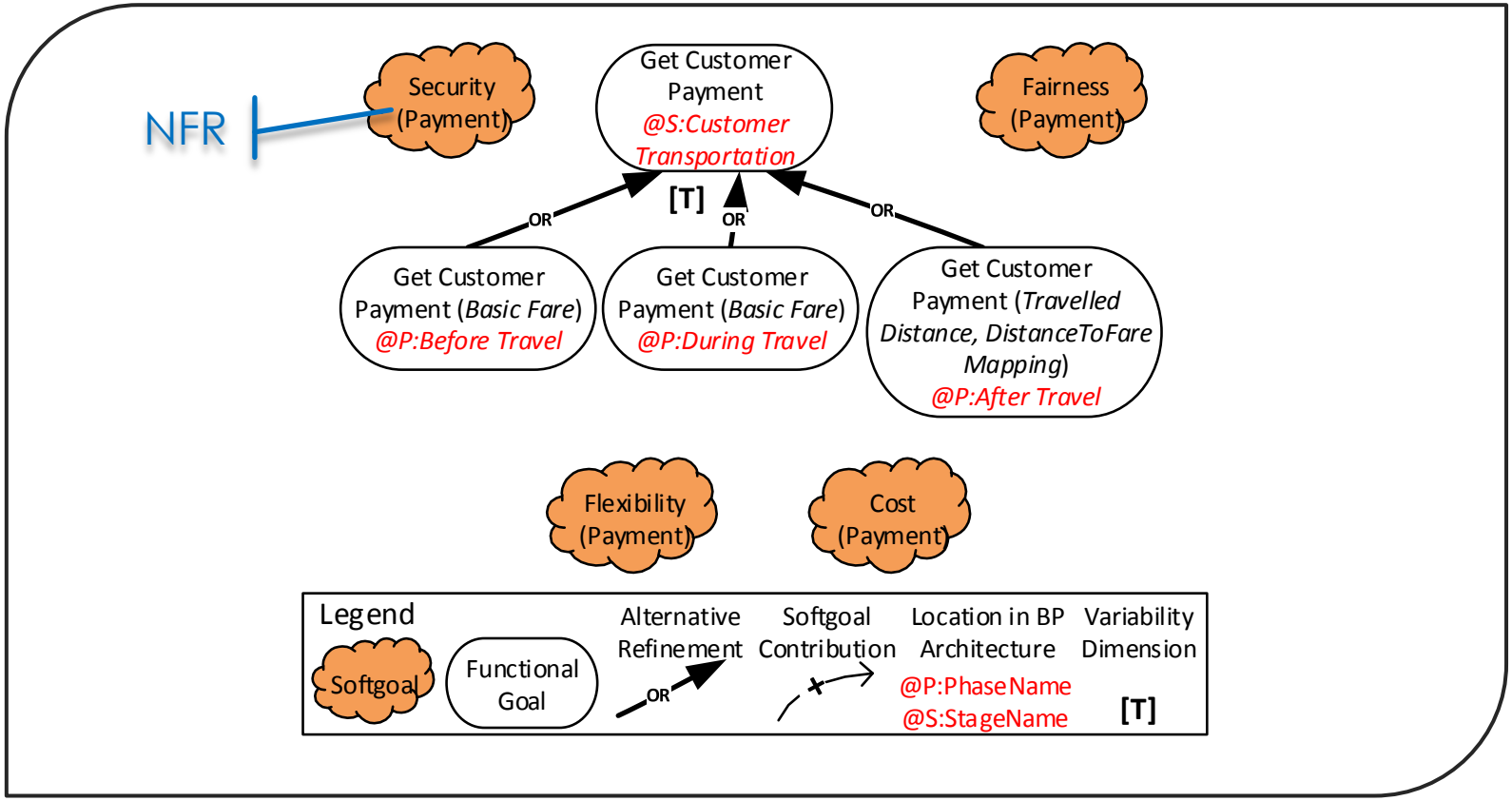

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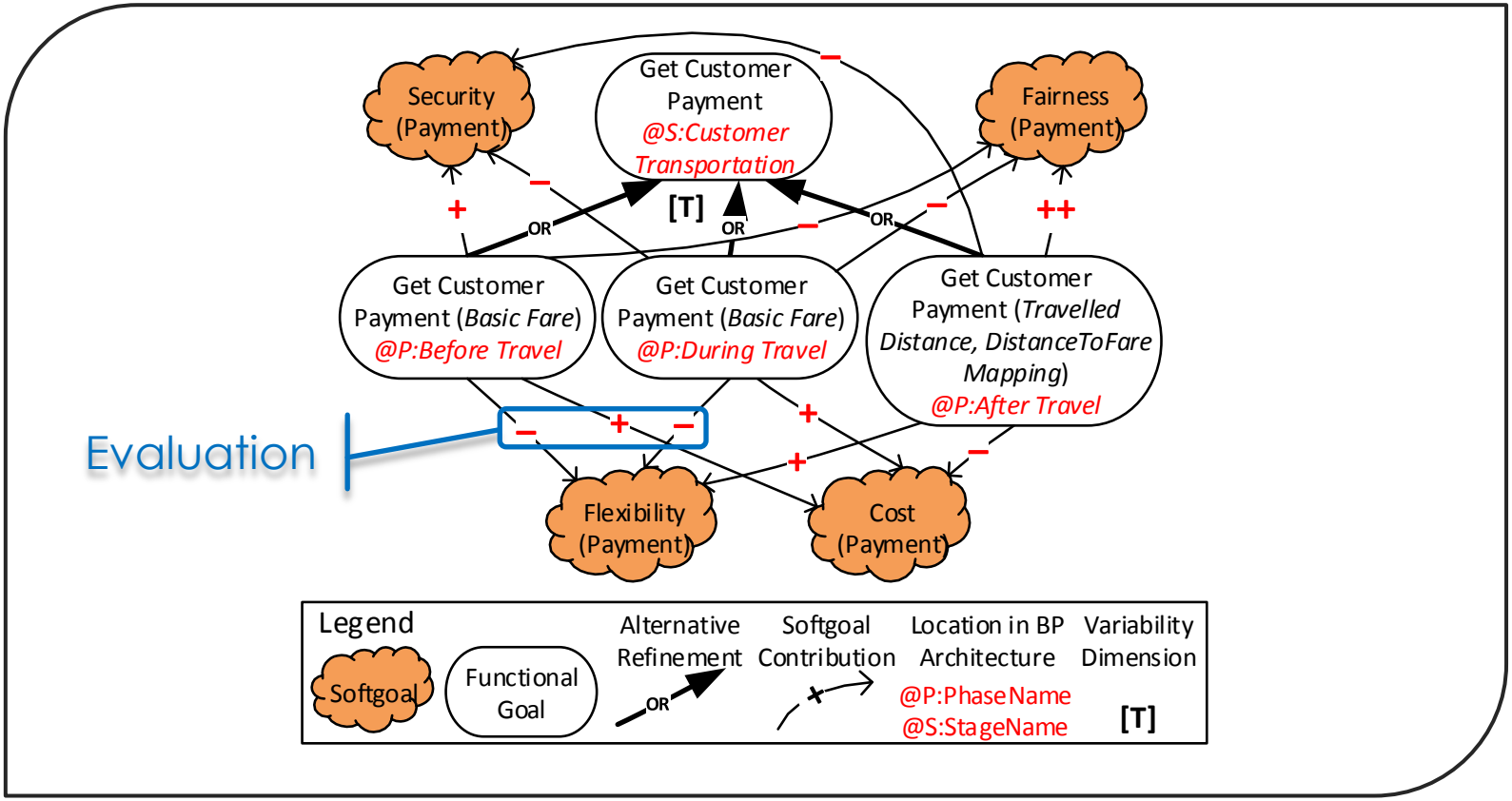

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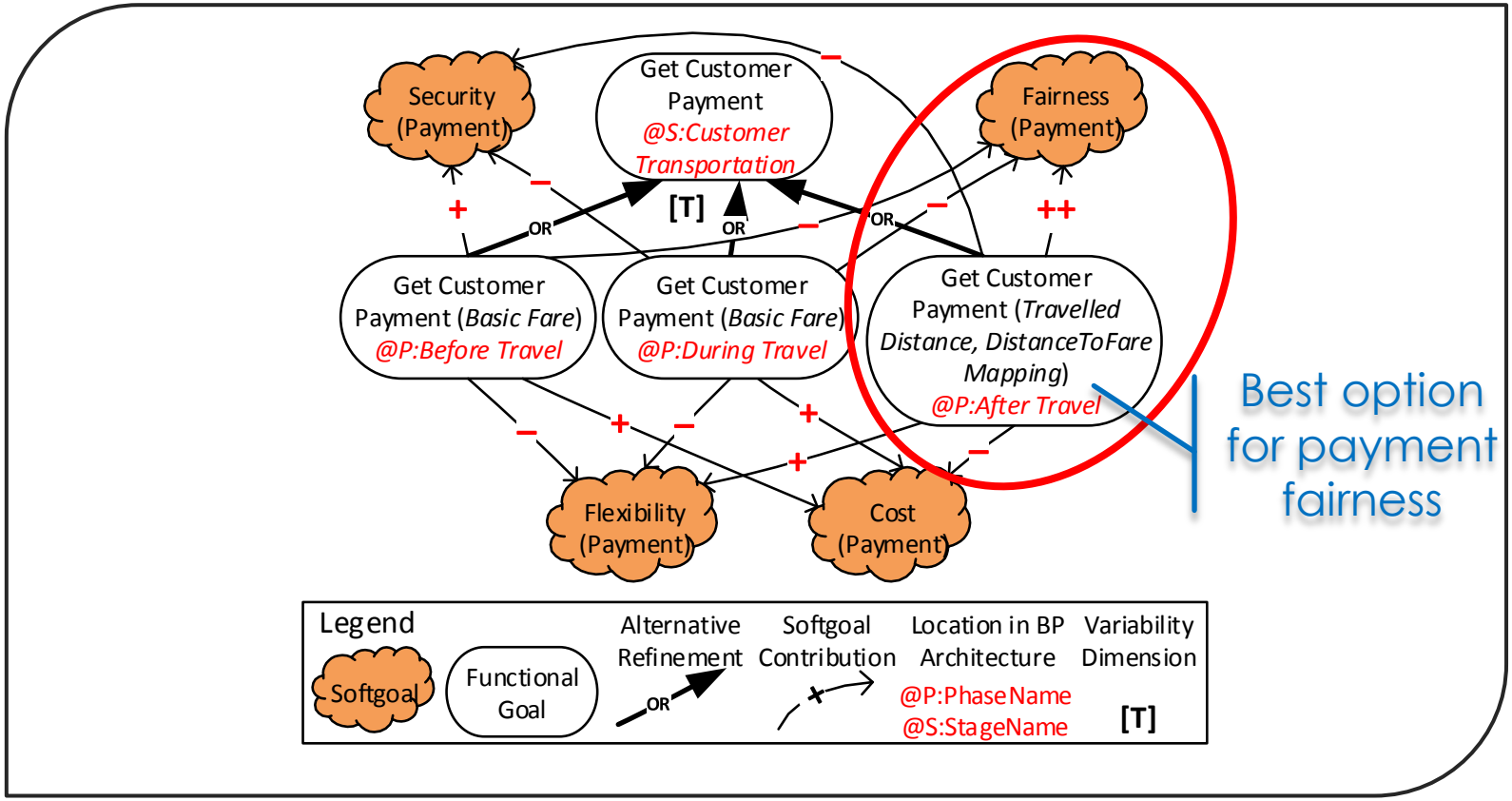

Conclusions and Future Work

- Presented an approach for
  - Identifying and analyzing BPA configurations
  - 4 dimensions to structure the space of options
  - Supporting both adaptation and evolution
- Future Work
  - Integration of multiple PE placement options
  - Thorough integration of data
  - Feedback loop integration

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Analyzing Second-Order Dependencies in *i**

8th International i* Workshop

Mohammad Hossein Danesh
Eric Yu

University of Toronto

Agenda

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1. Introduction & related work
2. Analyzing socio-technical inflexibilities
3. Uncovering potential inflexibilities using second order dependencies
4. Illustrative example
5. Discussion & conclusion

1. Introduction

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- Dealing with change is crucial for both IT & Business
- The intertwined nature of IT & Business calls for
  - Constant alignment and realignment
- Related Work in dealing with Change in IT
  - Enterprise & Requirement modeling
    - Focus Context & evolutionary requirement description
    - Enable automated/semi-automated adjustment of software & services

(Souza et al, 2012)
(Zdravkovic et al, 2013)

  - Software & Enterprise architecture
    - Focus on effort needed and process of implementing changes
    - Apply scenario oriented or structural analysis to estimate time & effort

(Breitman et al, 2004)
(Bohner, 2002)
(De Boer, et al 2005)

2. Need to Address Socio-technical Inflexibilities

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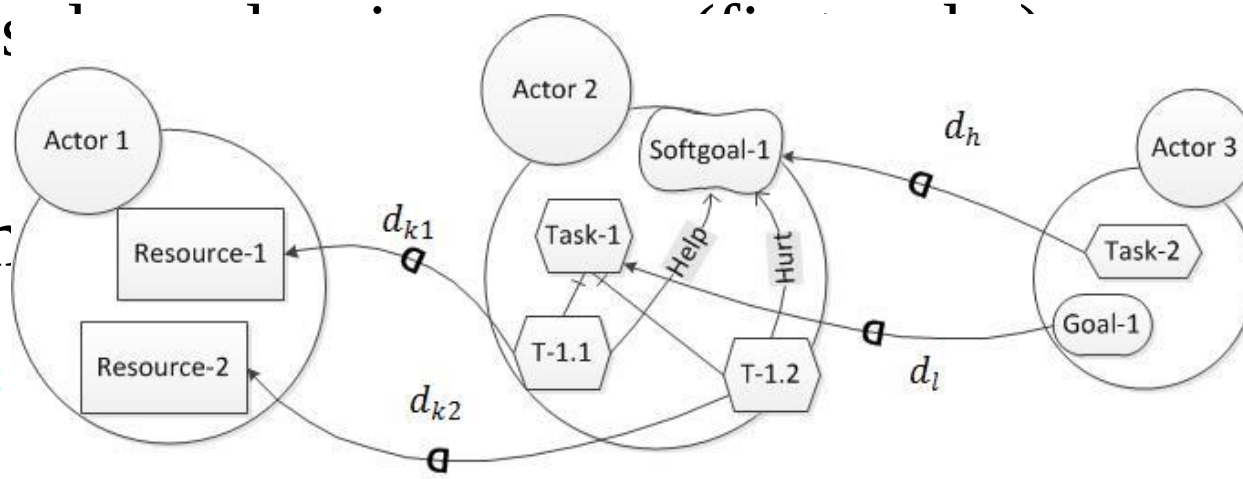
- Dealing with change has two dimensions
  - Ability to identify changing context and adjustment of software & Services
    - Addressed by the discussed related work
  - Flexibility of enterprise capabilities and organization setting to accommodate change, create new services & software and support their deployment
- Inflexibilities can arise as a result of
  - Social and technical dependencies that exists within an enterprise (Dreyfus & Iyer, 2008) (Furukawa & Minami, 2013)
  - Traveled path and commitments of enterprise capabilities (Leonard-Barton, 1992) (Teece et al, 1997)

3. Second Order Dependencies

- Second Order Dependency is defined as
  - reliance of one dependency to another
  - to the extent that it cannot perform with the required quality unless the former dependency is satisfied
  - In other words
    - dependencies
- Extracted from

d_h is dependent on d_{k-1} and d_{k-2}

d_l is dependent on d_{k-1} and d_{k-2}



3. Second Order Dependencies Extraction Rules

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- Extracted from SR model using
  - Rule 1:
    - If the dependee-side element of an i* dependency (A) is dependent on
      - some other actor, i.e., dependency (B)
    - Then a second order dependency exists from
      - A to B, i.e., A is dependent on B to be satisfied
  - Rule 2:
    - If dependee-side element is comprised of sub-elements
      - Sub-elements identified through
        - » Contribution
        - » Decomposition
        - » Mean-end links
    - Then a second-order dependency exists from
      - The dependency to each of the dependencies of sub-elements

4 Current State

- What are the Capabilities
- What are their
  - Intents
  - Routines
  - Resources
- How & Why do Capabilities depend on one another

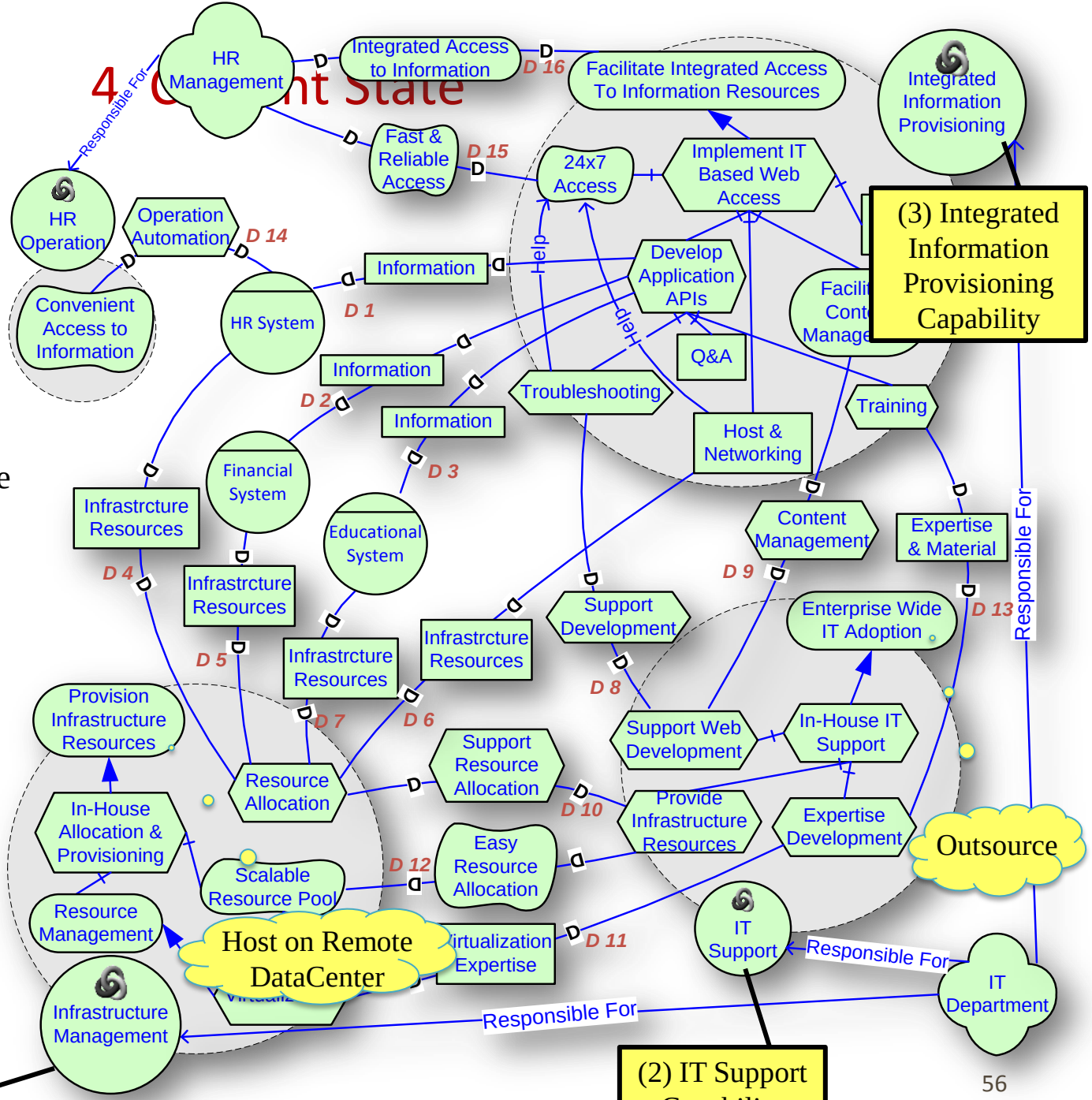
Three Main IS
- Modeled as i* Agents
- Managed by Partners
- Hosted in-house

HR Dependencies
- Others have similar relations

Hosting in House (1)

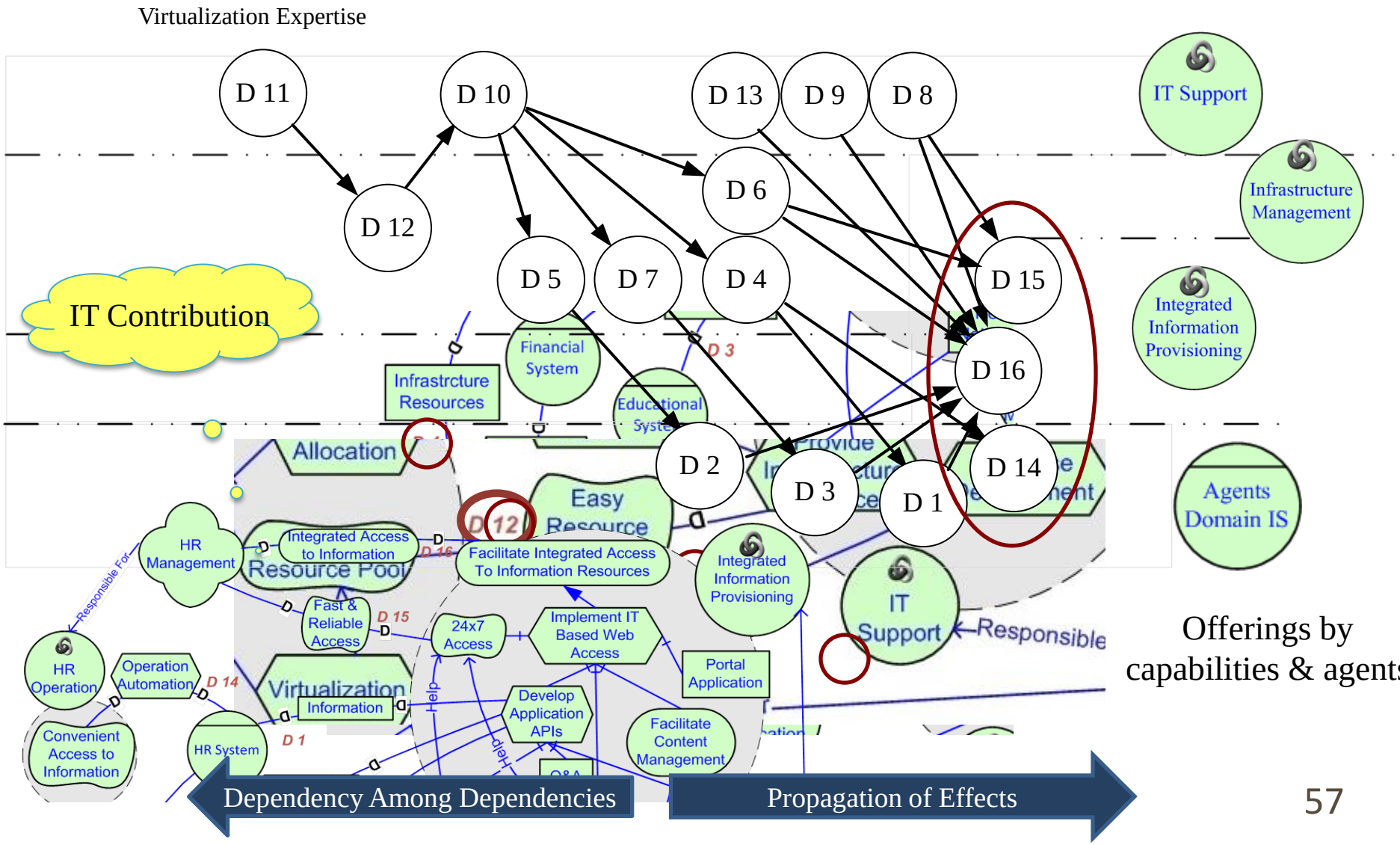
Support & Maintain (2)

SSO & Access (3)



4. Use a Dependency Propagation Graph to Depict Capability Offerings & Contribution

University of Toronto



Offerings by capabilities & agents

5. Summary

- Lack methods to analyze inflexibilities in
  - Socio-technical context
- Use second order dependencies to
  - Identify potential inflexibilities
- The analysis can be used
  - at design-time to
    - Plan and Mitigate the risk imposed by inflexibilities
  - at run-time to
    - Monitor & Measure activities that can produce inflexibilities

Work in Progress

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   - [CASCON ACET13] [ETT14] [TEAR12, 15]
2. **How to model adaptive loops in the enterprise?**
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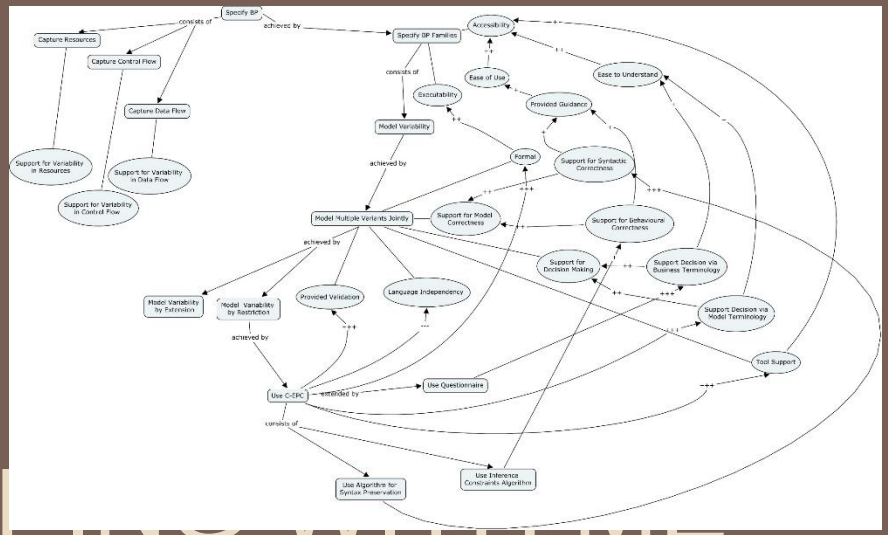
   - Knowhow mapping [iStar13, 14] [CAiSEforum14]



KNOW-HOW MAPPING WITH I* MAP

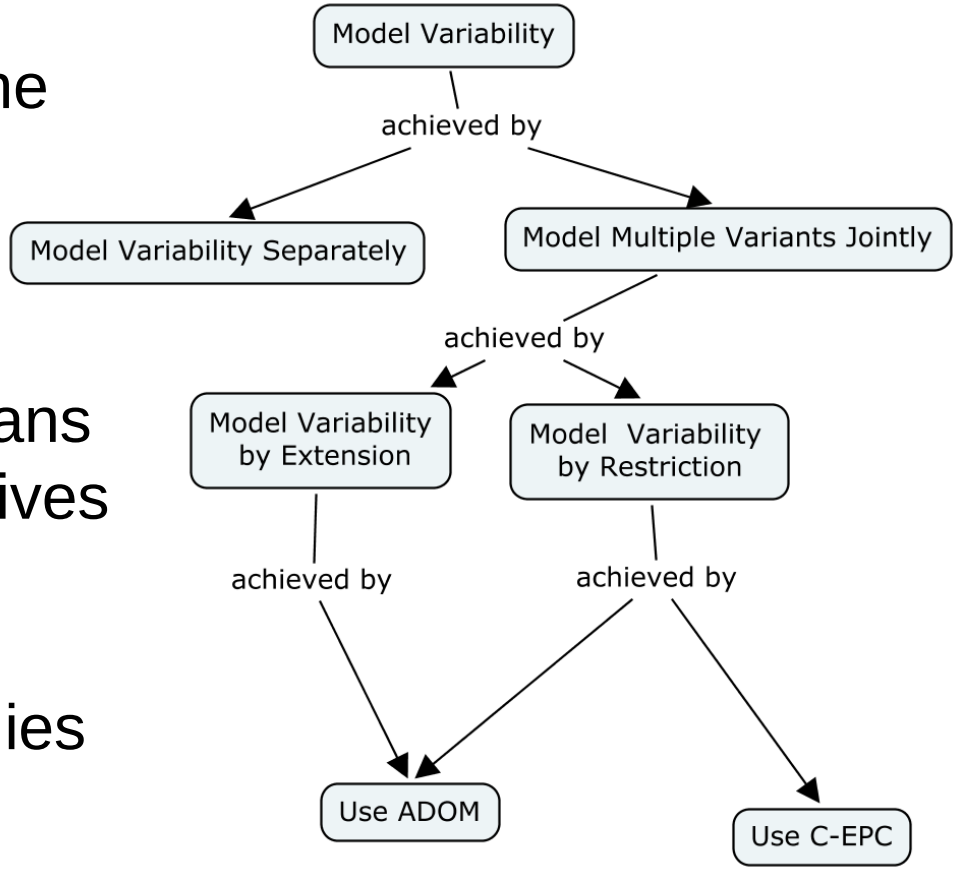
Eric Yu, Arnon Sturm

Daniel Gross, Soroosh Nalchigar, Jian Wang, Sadra Abrishamkar

Knowledge Mapping, Goal-Oriented Requirement Engineering, Modeling, Visualization, Literature Review

Achieved by link

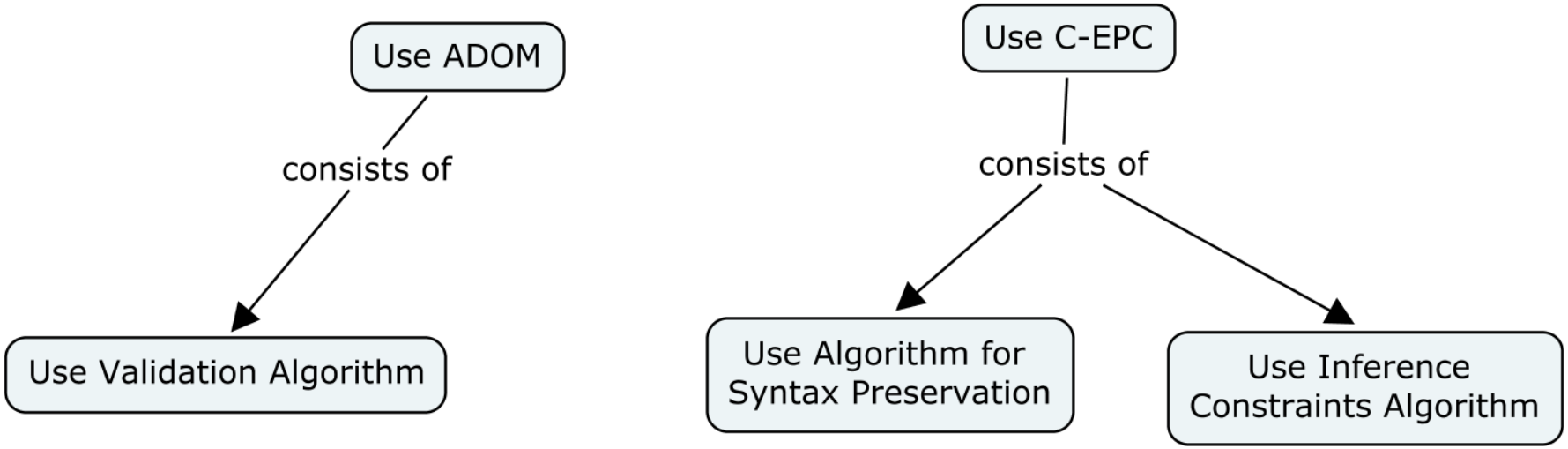
- *Definition*: An **achieved by** link represents a means-end relationship. It indicates that the target task is an alternative to achieve the source task.



- *Formulation*: Note that all means to achieve an end are alternatives which means that each of the alternative fully addresses the functional task. Thus, this implies **"or"** relationships among the alternatives.

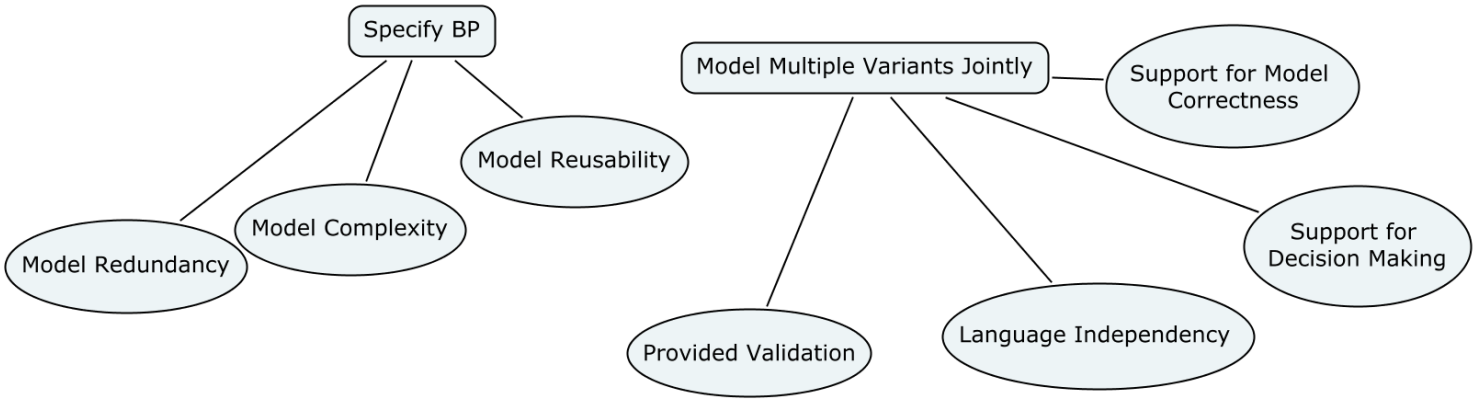
Consists Of Link

- *Definition*: A **consists of** link indicates that the target task is part of the source task, and that all connected target tasks should be accomplished in order to fully satisfy the source task. That means, that it is actually a problem or solution decomposition and all parts are required to fulfil the source task.

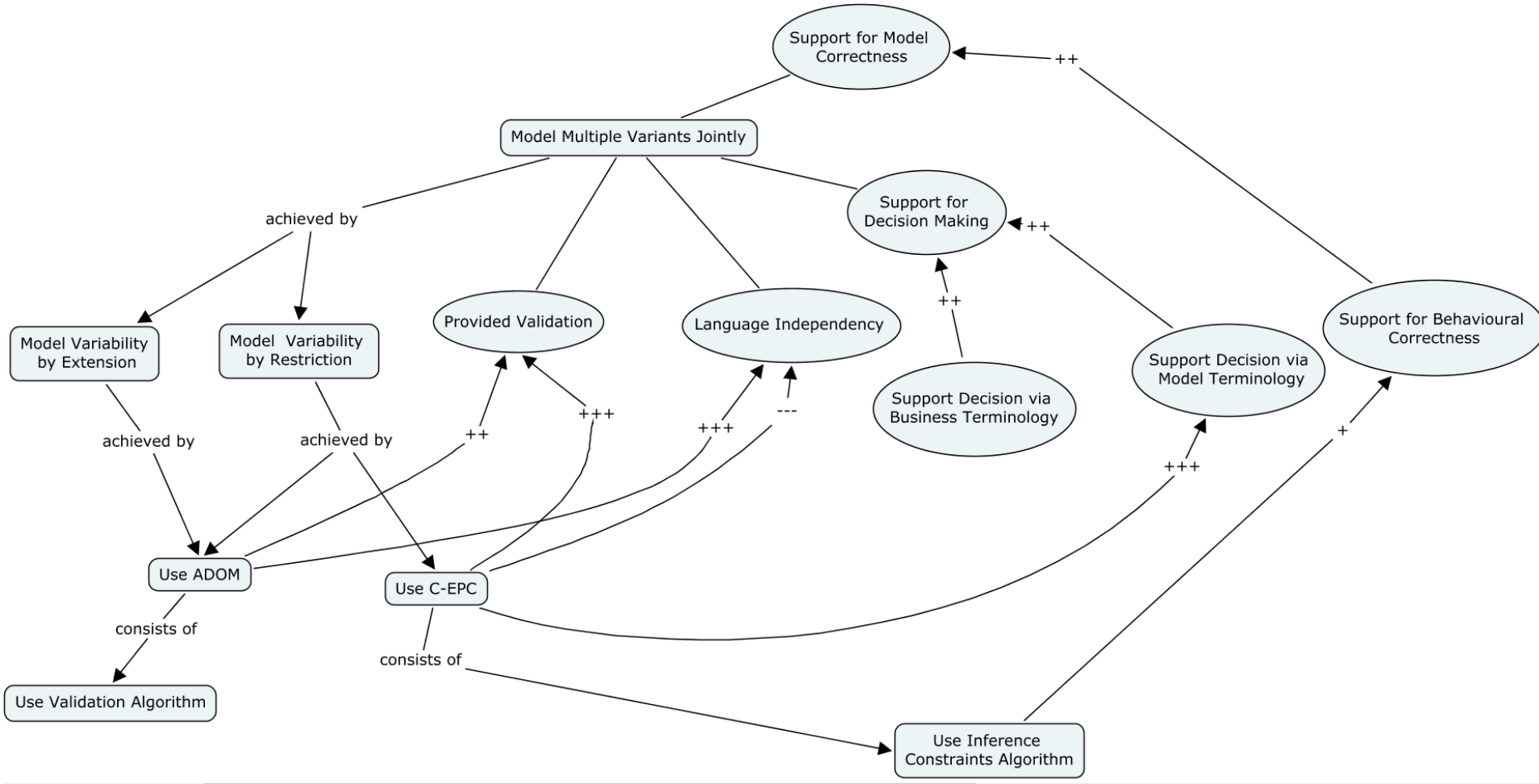


Association Link

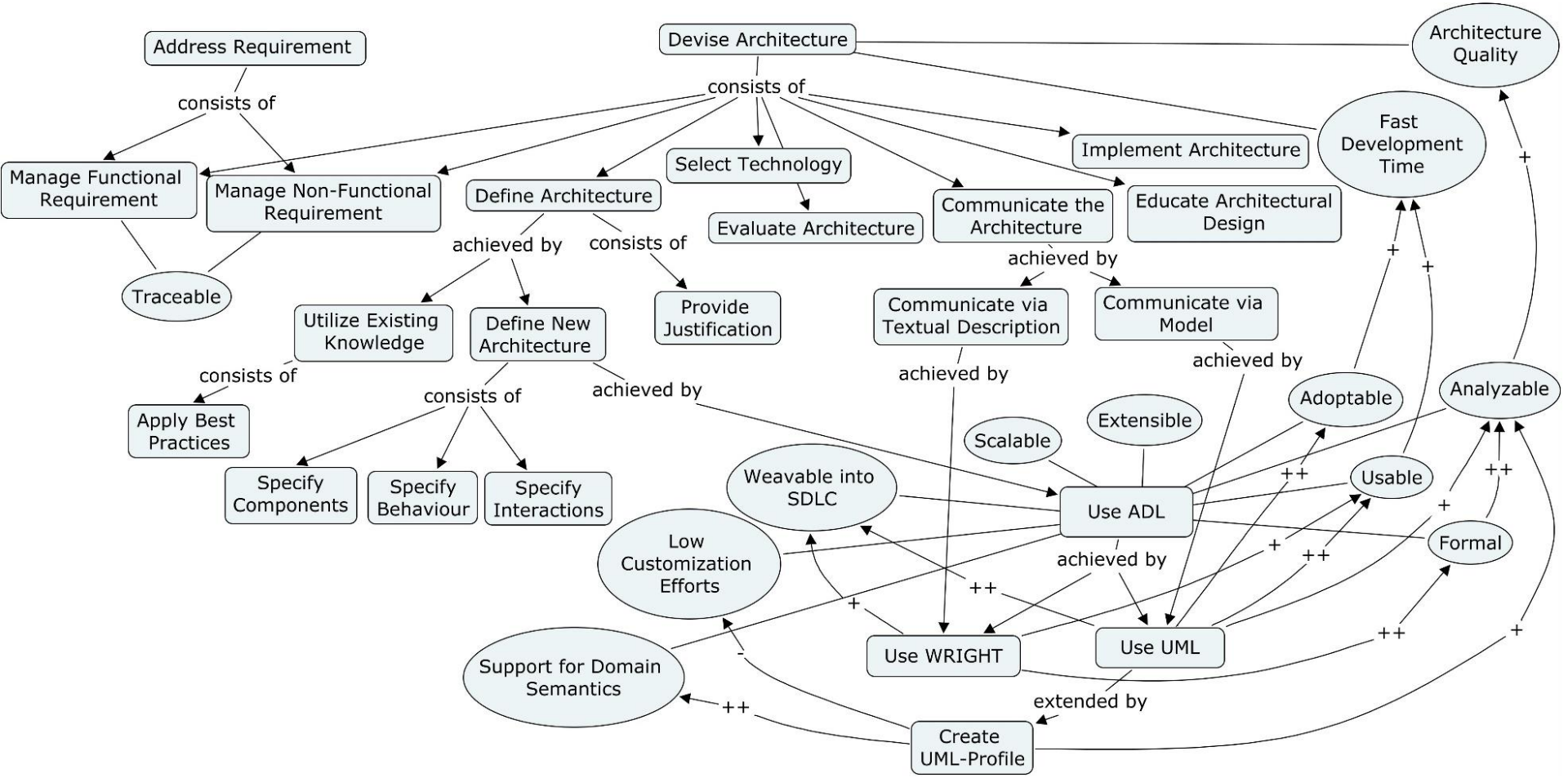
- *Definition*: An association links is used to connect qualities with tasks. It is specified by an unlabeled and non-directional line between a task and a quality. Its semantics implies that the qualities associated should be taken into account when evaluating alternatives for that task.
- *Formulation*: Note that qualities associated with a task affect also other tasks that further refined it via the achieved by links chain.



A sample ME-map

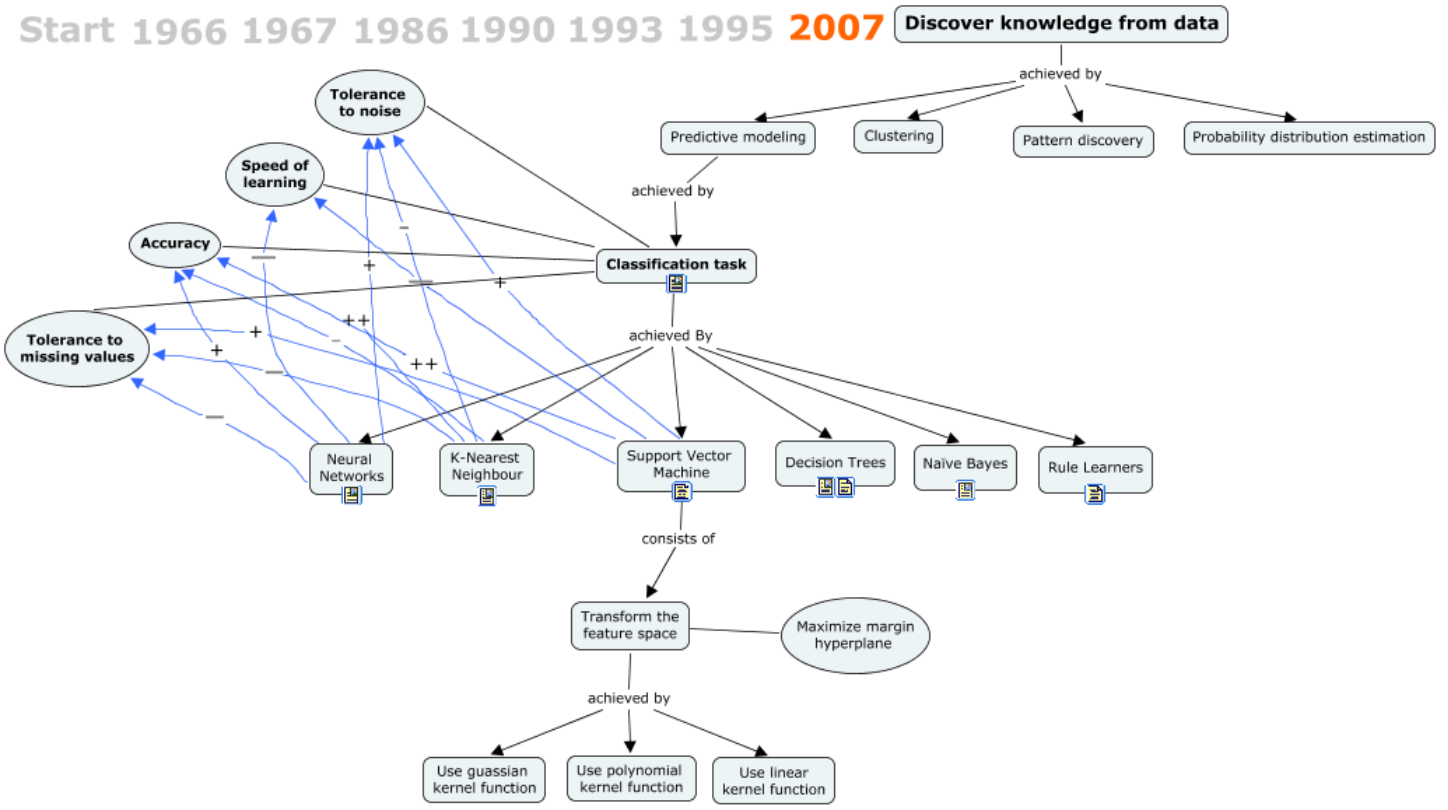


The Domain of ADL

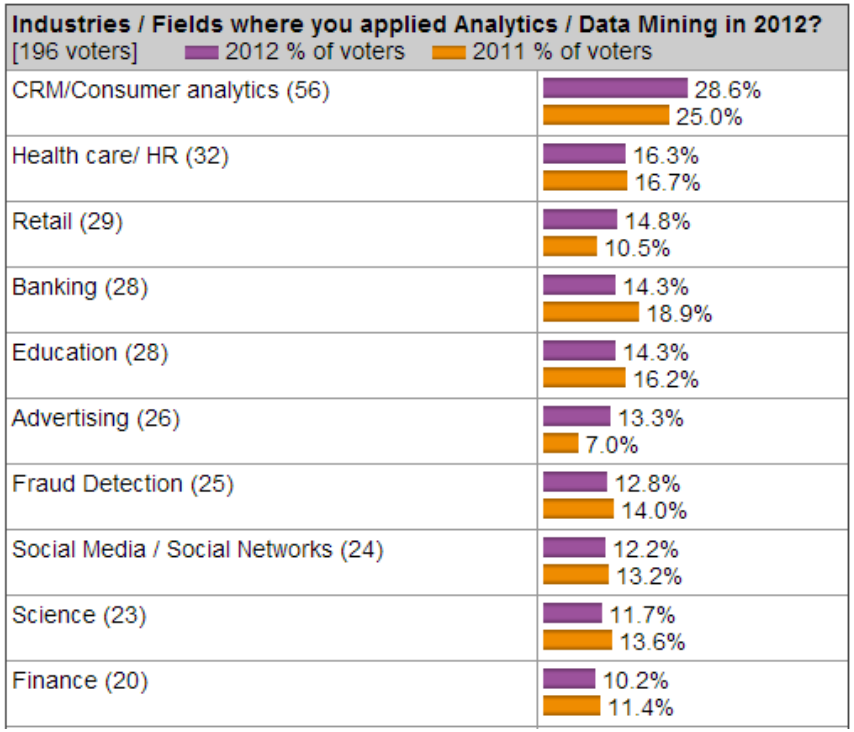


KNOW-HOW EVOLUTION

Solution Domain-Classification in DM

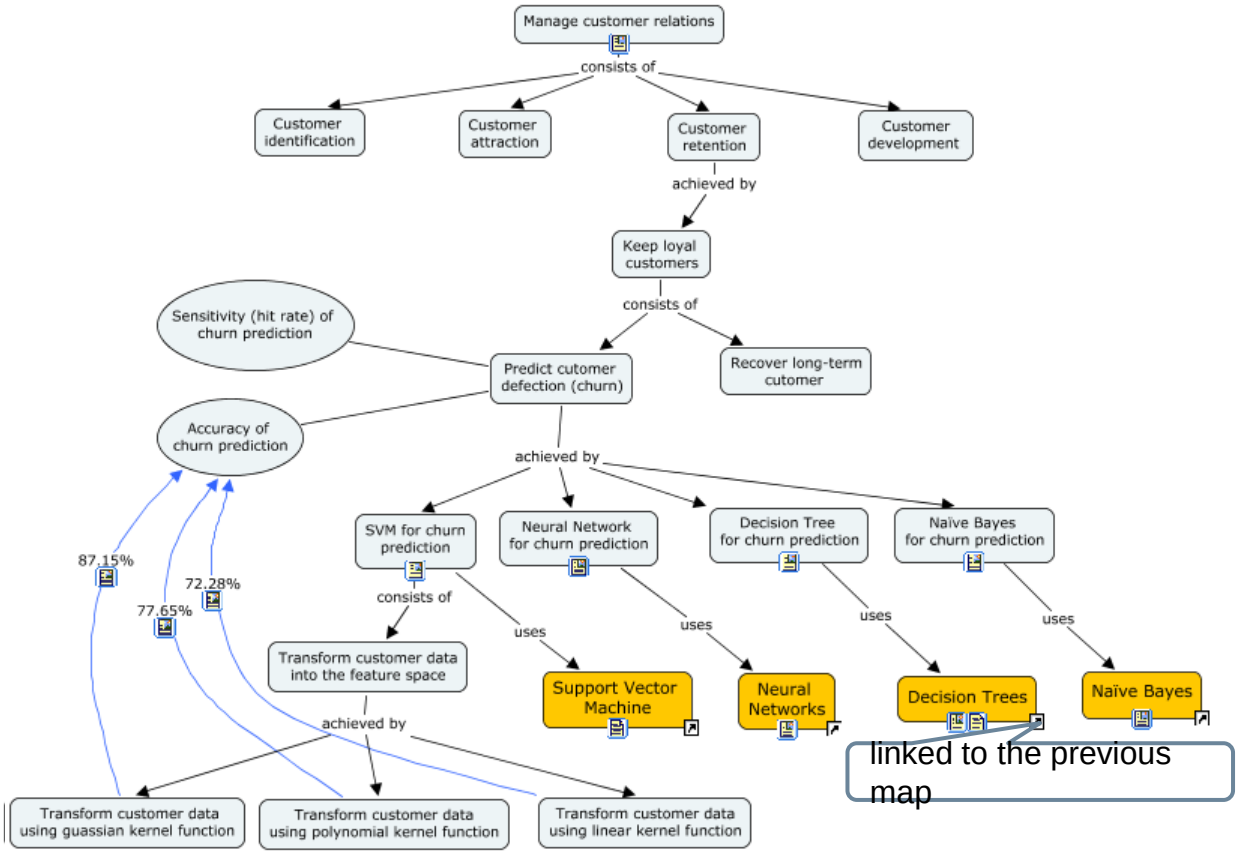


Top Data mining application domain is CRM



Source: http://www.kdnuggets.com/polls/2012/where-applied-analytics-data-mining.html

Problem Domain- Customer Relation Management



Recap

Fundamental Question:

What RE techniques do we need in the age of digital transformation?

- The new reality
  - Fast-moving, fluid, dynamic, turbulent
  - Highly distributed, but hyper-connected and networked
  - Disruptors and disruptees
  - Data-rich
- What are the suitable abstractions?
  - Process models - ~BPMN?
  - Intentional strategic actors, network of relationships ~ i*?
  - Dynamics?? Higher-order?
    - adaptive systems theory?

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Intellectual sources

- From many disciplines and areas…
  - Requirements engineering
  - Adaptive software systems
  - Variability in software product lines
  - Control systems theory
  - Systems dynamics
  - Dynamic capabilities
  - Complex adaptive systems
  - Organizational learning
  - Sense-making theory
  - …

References