Ontology Engineering for Distributed Collaboration in Manufacturing

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Outline

- Definitions and use of ontologies
- Challenges to interoperability
- The Process Specification Language
- Scenarios for PSL

What are ontologies?

- The basic terms and relations comprising the vocabulary of a topic area
- A set of definitions for these terms
- The rules for combining terms and relations

Some definitions

- Definitions [in an ontology] associate the names of entities of discourse (i.e. classes, relations, functions or other objects) with human-readable text describing what the names mean, and formal axioms the constrain the interpretation and well-formed use of these names. (Huhns and Singh, 1997, “Ontologies for agents”)
- A theory defines its ontology by defining entities which exist in its reality. These entities cannot be reduced or eliminated by analysis from the theory.

Challenges to communication

Enterprise A

vehicle

material

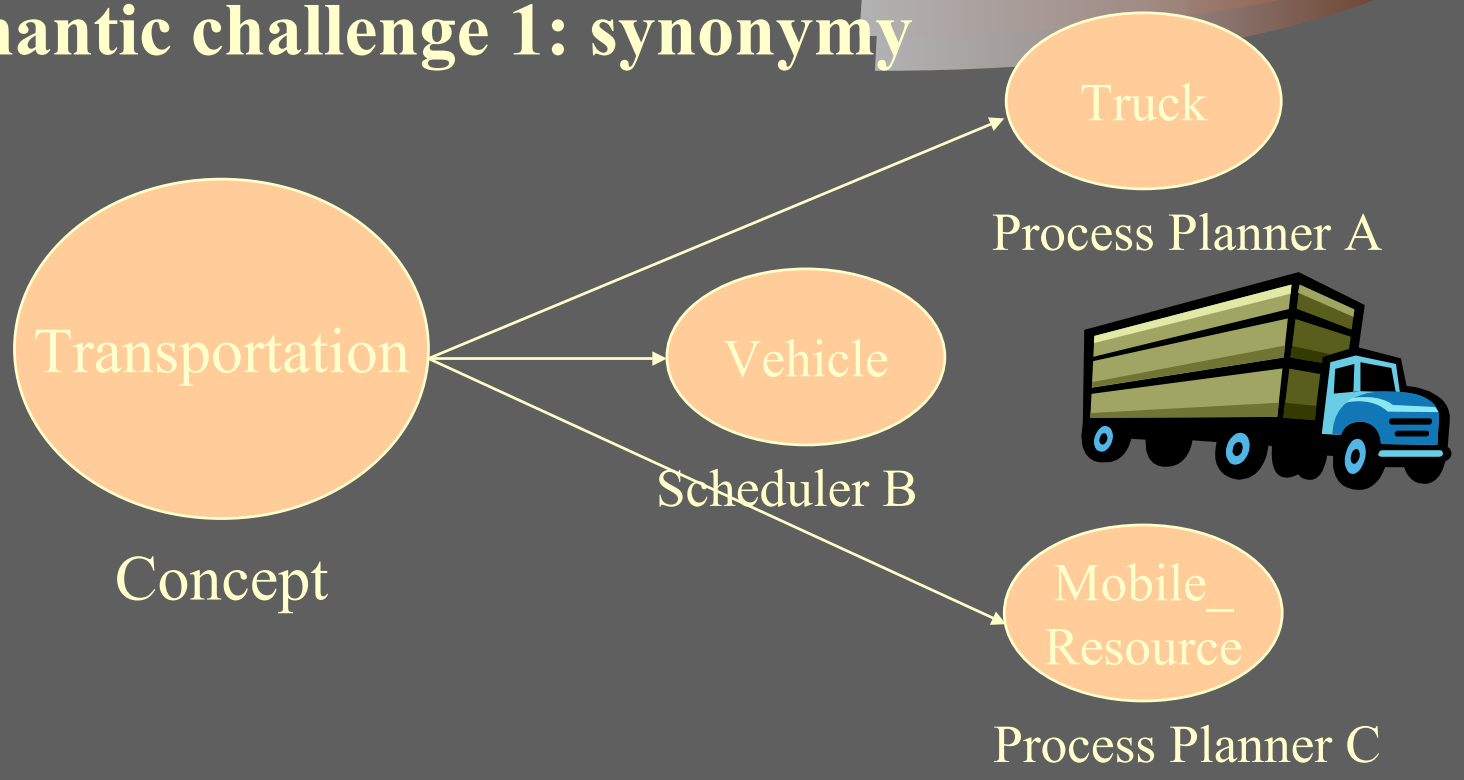
resource

workpiece

Enterprise B

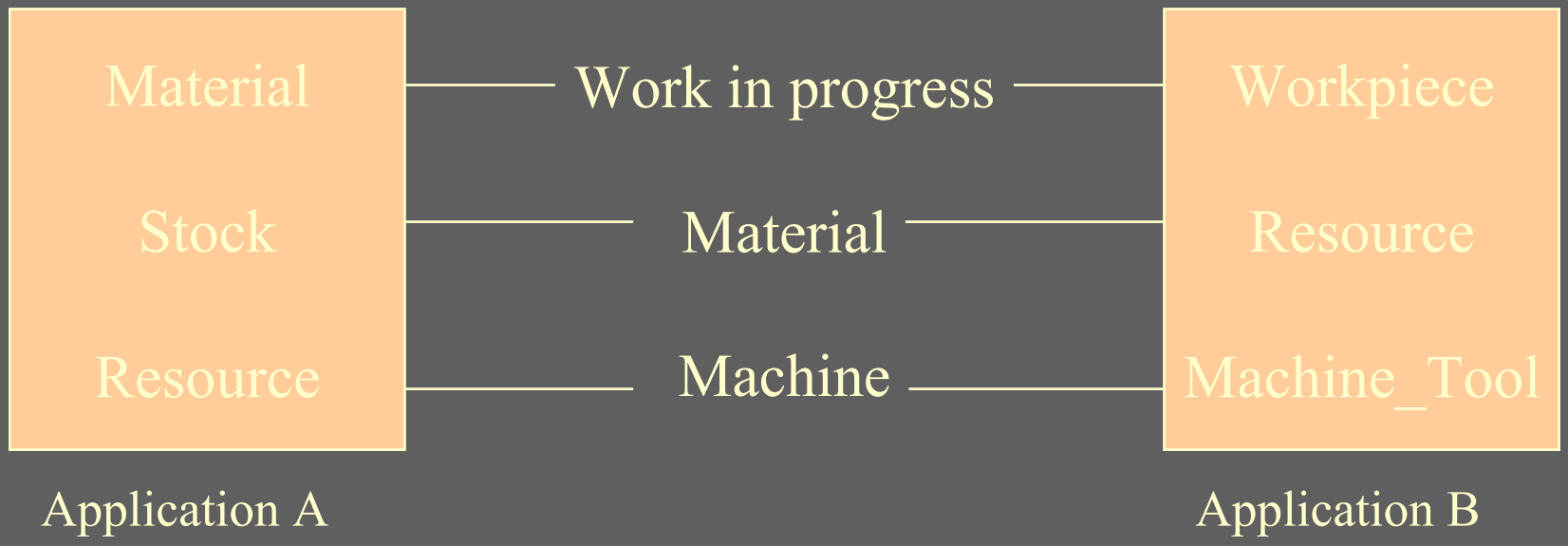
Challenges to inter-operability

Semantic challenge 1: synonymy



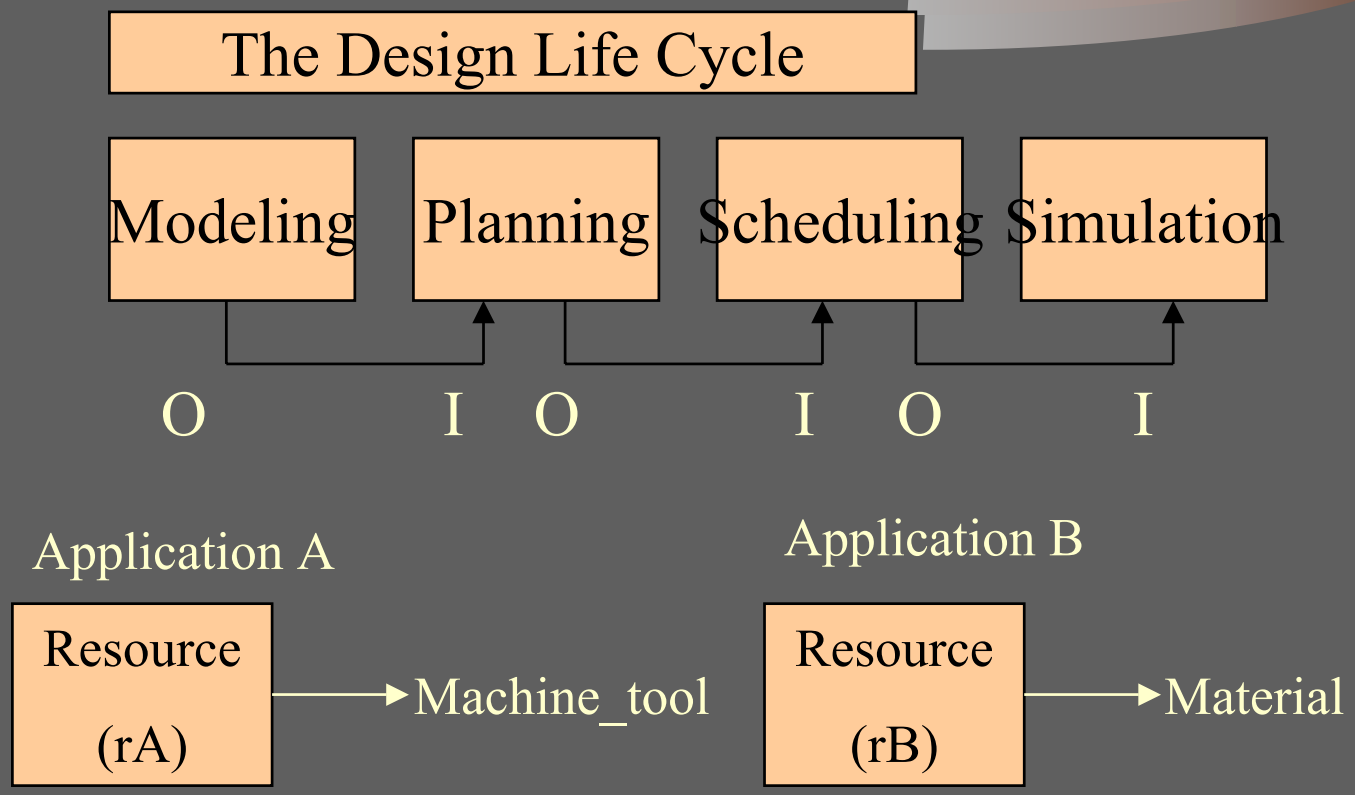
Challenges to inter-operability

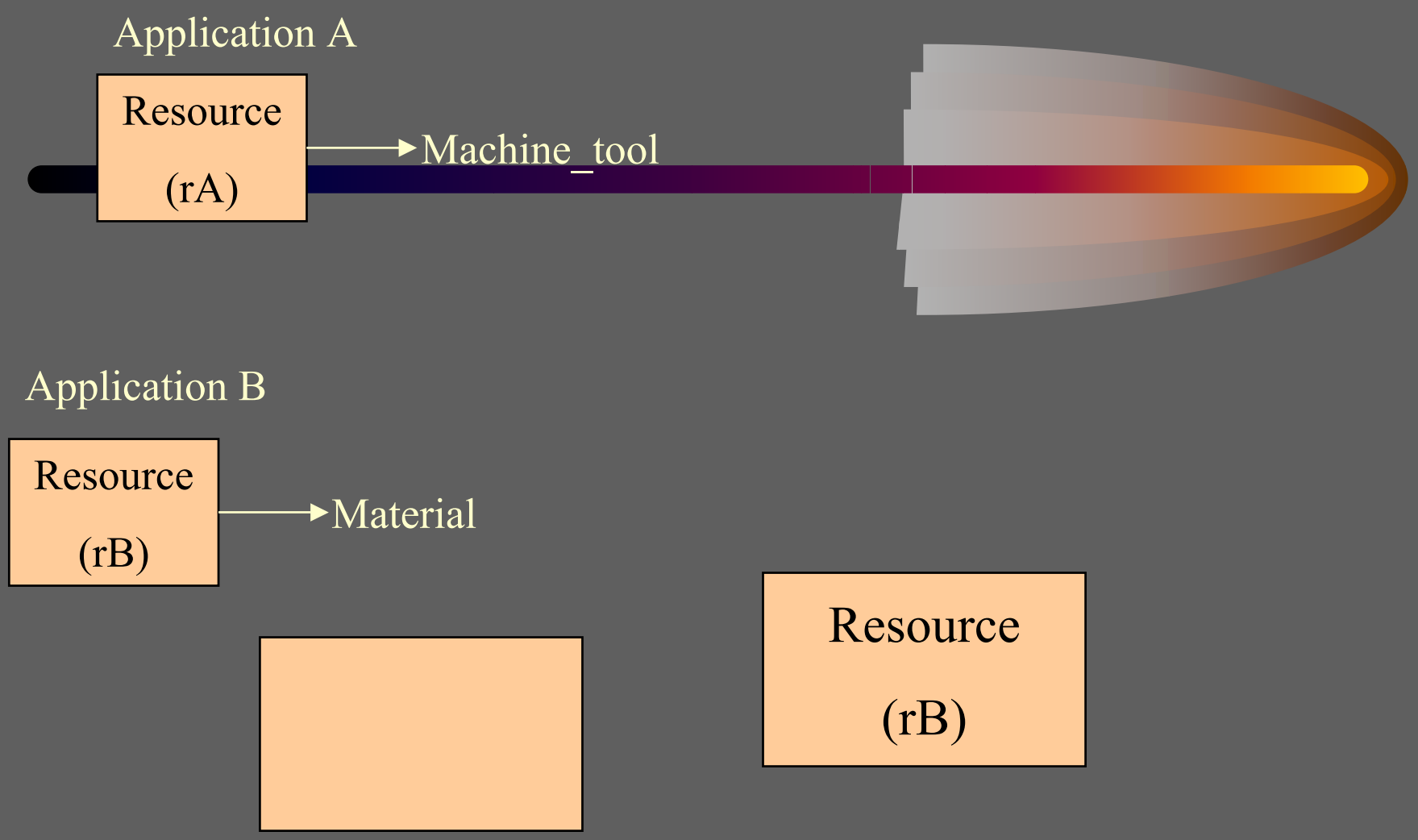
Semantic challenge 2: term ambiguity



The case for manufacturing processes

Exchange of Processes



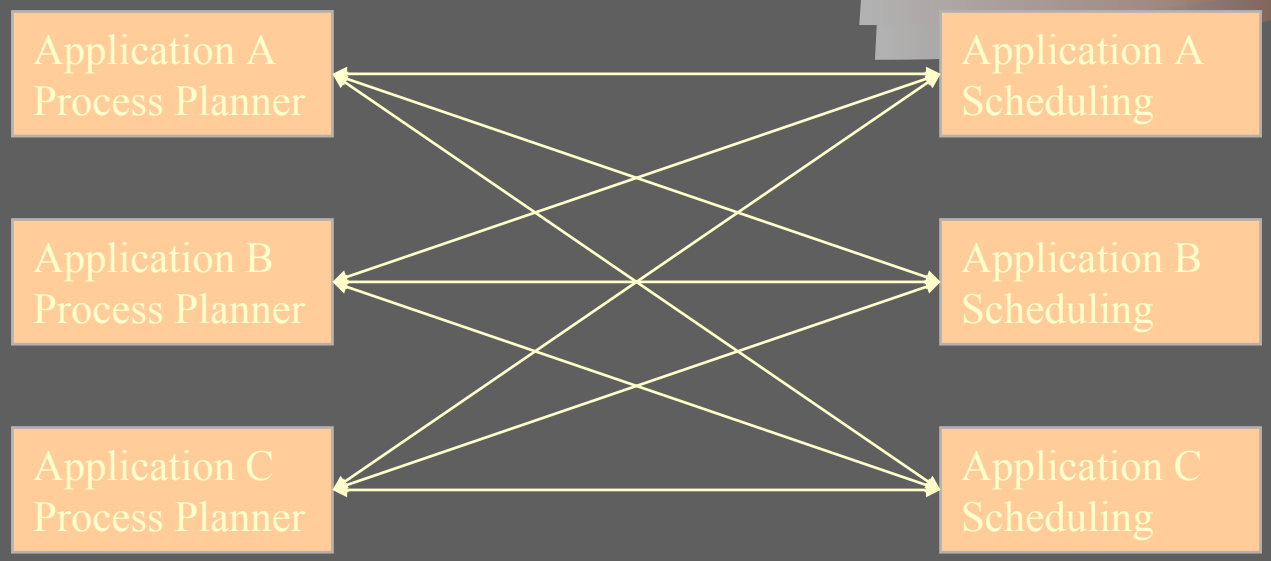

Application A
Resource
(rA)
Machine_tool
Application B
Resource
(rB)
Material
Resource
(rB)

Process Specification Language

- A neutral, standard description of manufacturing processes expressed in KIF
- A core ontology and extensions for each process domain
- Translation mechanisms between individual applications and PSL
- Two pilot implementations completed

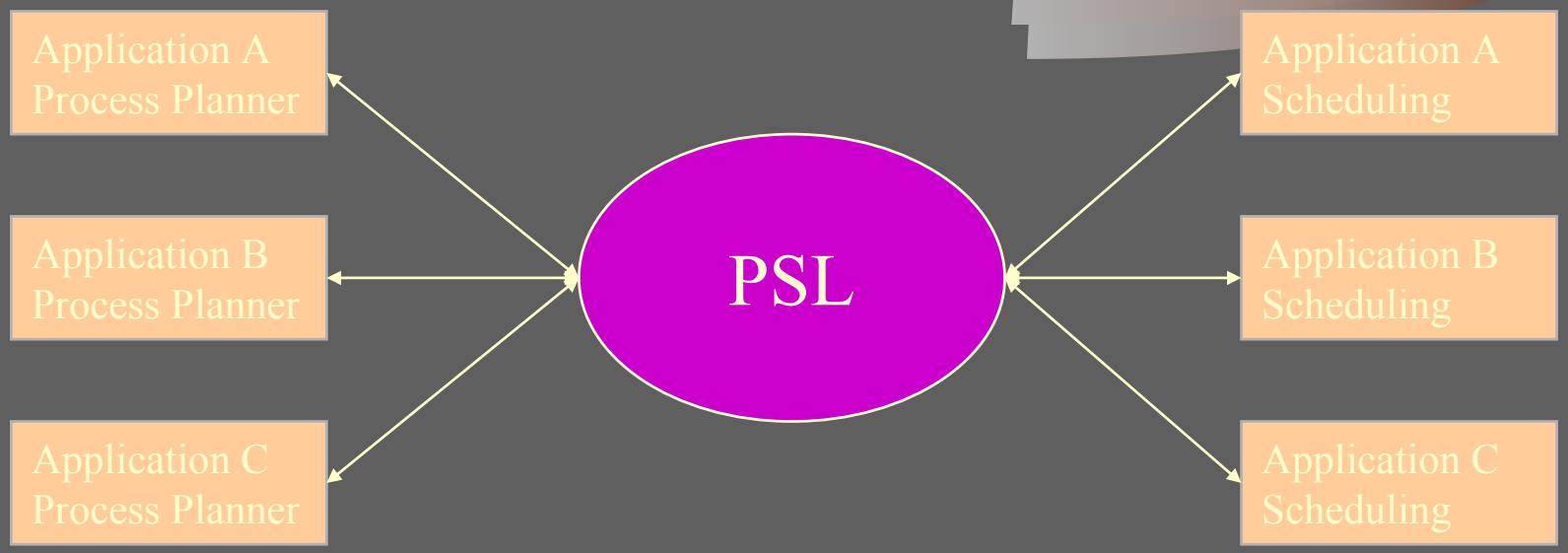
http://www.mel.nist.gov/psl

Scenario 1: point-to-point translation



n planners, m schedulers ⟶ n*m translations

Scenario 2: translation using PSL

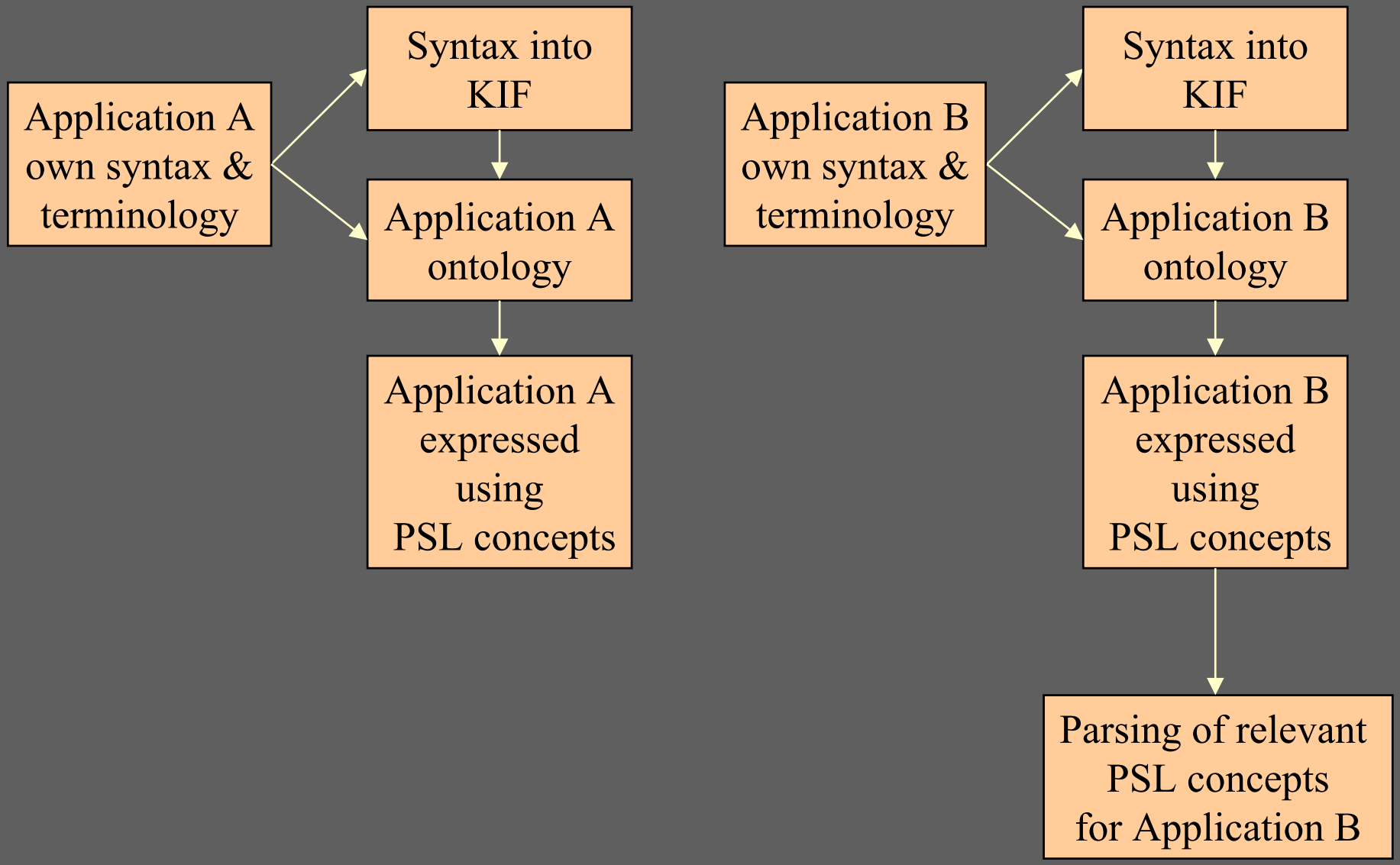


n planners, m schedulers ⟶ n + m translations

Some axioms in PSL

- Core concepts
  - activity, object, timepoint
  - activity occurrence
- Concepts for object
  - resource roles, paths, sets, usage, etc...
  - states
- Relations
  - before, begin_of, participates_in

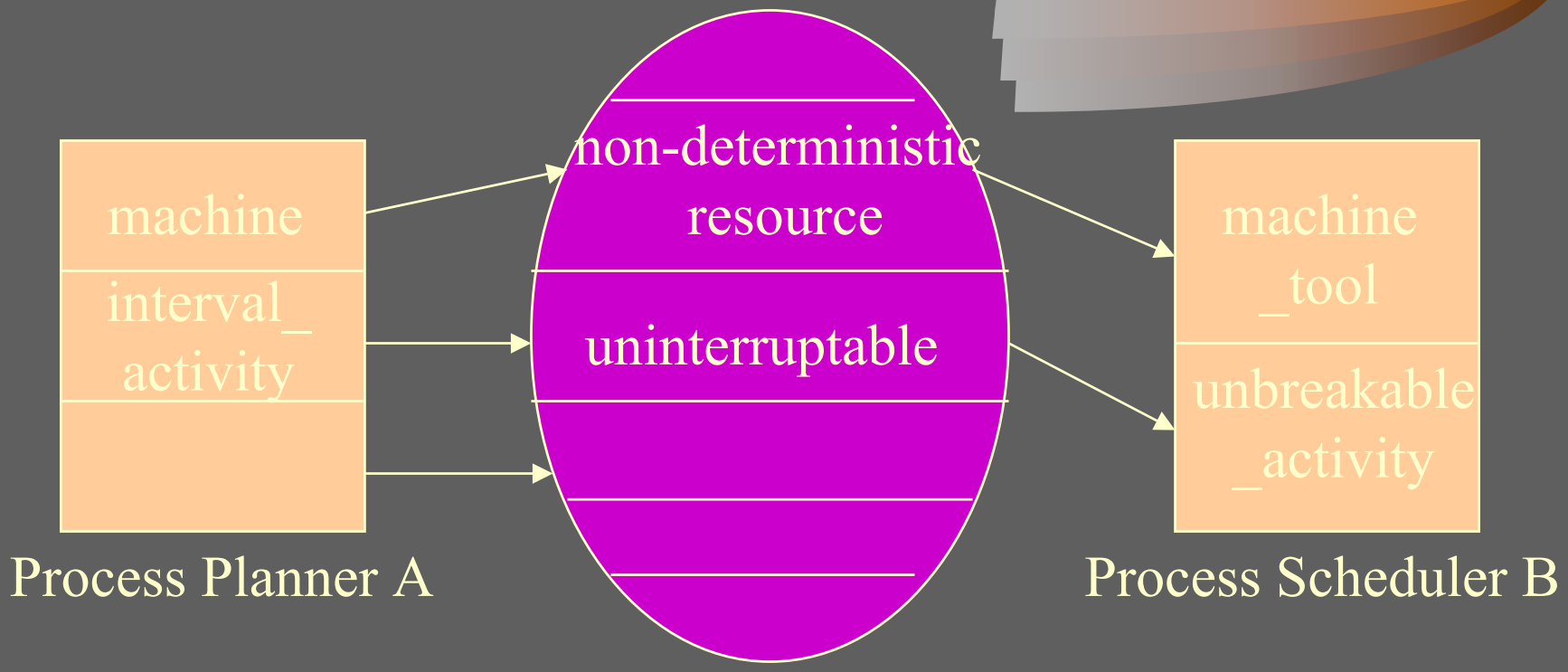
http://www.mel.nist.gov/psl/psl-ontology/


Application A own syntax & terminology
Syntax into KIF
Application A ontology
Application A expressed using PSL concepts
Application B own syntax & terminology
Syntax into KIF
Application B ontology
Application B expressed using PSL concepts
Parsing of relevant PSL concepts for Application B

Process Exchange using PSL

- The ontology for each application is expressed using PSL concepts
- A direct mapping can occur
- OR the application's term is more restrictive =>constraints on its use
- OR PSL is extended to accommodate a new concept

Process exchange



Ontologies for agents

- Agent Communication Languages such as KQML only deal with syntactic problems
- Heterogeneous agents need to agree on a content language - a common representation - for communication to be meaningful
- PSL can serve as the basis for this content language

Summary

- PSL as a domain ontology for manufacturing concepts
- An interchange language for inter-operability semantic challenges
- Use in agent-based systems for manufacturing

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