Toward Factory Optima: A Web-based System for Composition and Analysis of Manufacturing Service Networks based on a Reusable Model Repository

Alex Brodsky\textsuperscript{1}, Mohan Krishnamoorthy\textsuperscript{1}, M. Omar Nachawati\textsuperscript{1}, William Z. Bernstein\textsuperscript{2}, Daniel A. Menascé\textsuperscript{1}

\textsuperscript{1}Department of Computer Science, George Mason University, Fairfax, VA
\textsuperscript{2}Systems Integration Division, NIST, Gaithersburg, MD
Manufacturing Service Network example: Heat sink (HS) production and supply chain

Heat Sink Supply Chain (L0)

- **Alumina (L2)**
  - **Alumina Powder**
  - **Smelting (L2)**
- **Accessories (L2)**
- **Supply (L1)**
- **Accessory Package**
  - **Accessory Package**
  - **Manufacturing (L1)**
  - **Aluminum Plate Contract Manufacture (L2)**
  - **Aluminum Plate**
- **HS Base Contract Manufacture (L2)**
  - **HS Base Shearing (L3)**
  - **HS Base Drilling (L3)**
  - **HS Base PL (L2)**
- **Heat Sink Base**
  - **Heat Sink Base Shearing (L3)**
  - **Heat Sink Base Drilling (L3)**
  - **Heat Sink Base PL (L2)**
- **HS PL (L2)**
  - **HS Shearing (L3)**
  - **Anodizing (L3)**
  - **CNC Machining (L3)**
  - **Quality Inspection (L3)**
  - **Assembly (L3)**
- **Finished Heat Sink Part**
  - **Demand (L1)**
  - **Finished Heat Sink Part**
  - **Finished Heat Sink Part**
  - **Finished Heat Sink Part**
  - **Finished Heat Sink Part**
  - **Finished Heat Sink Part**
Composition of service network

L0

supply_11 manufacturing_11 demand_11

L1

Alumina
Accessories package
Aluminum Plate
Accessories package
Heat Sink Base

L2

aluminum_plate_contract_manuf_12 hs_base_pl_12
smelting_12 hs_pl_12 hs_base_contract_manuf_12
hs_shearing_13 cnc_machining_13
quality_inspection_13 anodizing_13 assembly_13

L3

Cut Aluminum Plate atomic PM Anodized Plate

Heat Sink
Heat Sink

Heat Sink
Factory Optima

- Web-based system to compose, optimize and perform trade-off analysis of arbitrary complex service networks:
  - UMPs
  - cells, production lines, factories, supply chains, ...

- Based on a reusable repository of performance models (PMs) of
  - UMPs
  - supply chain components

- Unique in modular, reusable modeling like in simulation models, yet efficiency of best MP algorithms due to symbolic analysis and meta-optimization

- Based on Unity Decision Guidance Management System
Factory Optima Architecture

Figure 11. Conceptual architecture of Factory Optima and underlying software system based on reusable model repository and Unity DGMS. Adopted from Brodsky et al. [2017].
Initial deployment architecture

Factory Optima
Web interface

NIST Repository in GitLab

Unity DGMS

MP Solvers

GMU Datacenter

GIT

REST

ATOM IDE

add, commit, push

REST call to Analytical Function, e.g., argmin, argmax
Ontology + Repository views
Ontology + Repository views
Optimization, analysis, results