QT Canberra | Australia

29 April – 1 May 2019

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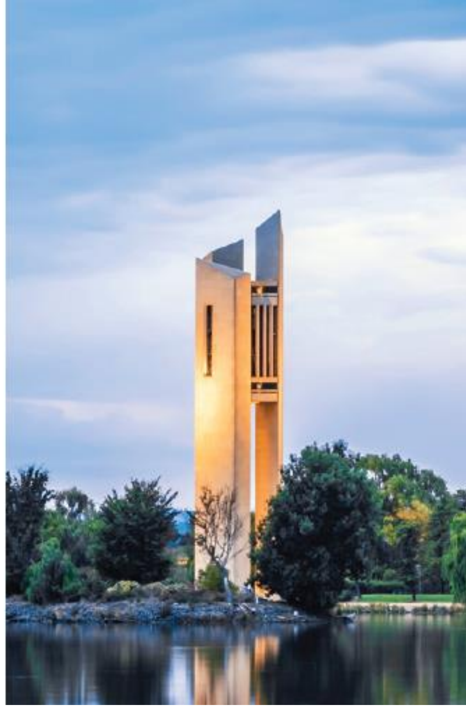
SYSTEMS ENGINEERING TEST AND EVALUATION CONFERENCE 2019



SYSTEMS SCIENCE & ENGINEERING FOR A BETTER AUSTRALIA SETE2019.COM.AU

Model-based approach to improve design and operation of databases

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Outline

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Purpose of the presentation

Industry presentation :

to outline current and future CAE Australia activities and directions in Systems Engineering space

CAE background

- CAE is a Canadian company founded more than 70 years ago
- A leader in provision of modelling, simulation and training technologies for the civil aviation, defence and security, and healthcare
- Global presence with more than 8500 employees, over 160 sites and training locations in 35 countries
- Head office of CAE Australia is in Sydney
- CAE office in Canberra is at 4/2 Brindabella Circuit, Canberra Airport, ACT

CAE directions

Traditionally, CAE business is to:

- Develop training systems for air and to a smaller extent sea domains
- Provide "turn key " training solutions
- Develop, provide and maintain training simulators
- Be a Training System Integrator (TSI)

More recently, some additional effort directed at *experimentation domain* including:

- Capability definition
- Needs and requirements phases
- Capability system architecting
- Operational analysis
- MBSE

Approach : “ Experimentation as a service” concept

- One of the CAE initiatives to provide “end-to-end” client support is a *experimentation as a service* concept, to essentially:
  - Link concepts of TSI and experimentation (modelling, simulation, analysis)
  - Link all phases of capability development cycle
  - Address Defence requirement for experimentation and training

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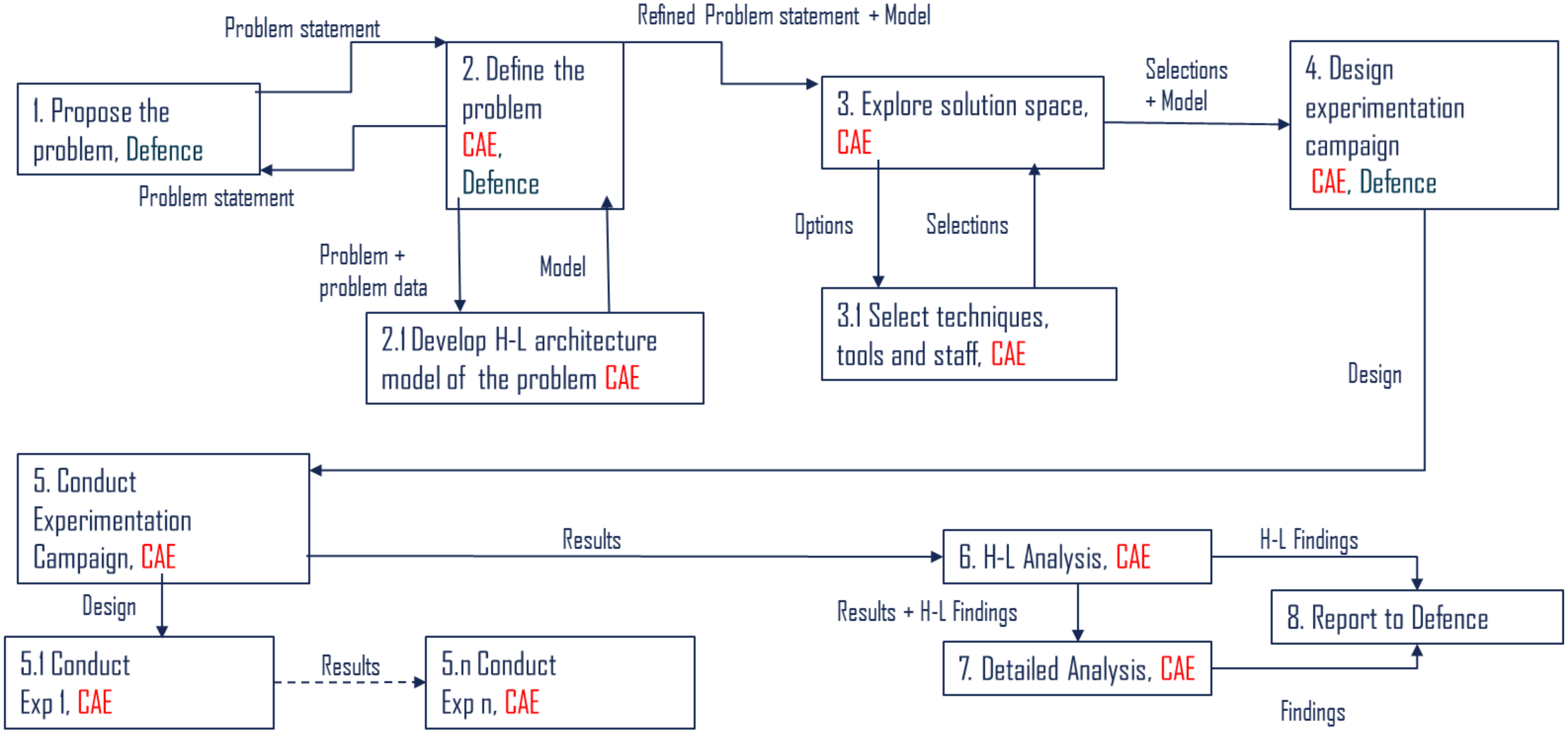
Approach : " Experimentation as a service" concept



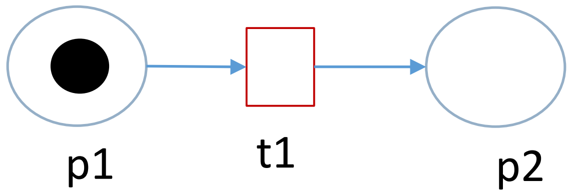
Approach implementation : Coloured Petri Nets (CPN)

Introduction

- a mathematical technique for modelling distributed and concurrent systems
- Petri Nets were introduced by a German mathematician Carl Adam Petri in the early 1960s
- extended in number of ways to enable greater modelling fidelity and expressiveness
- one such extension are CPN introduced by Kurt Jensen in 1980s
  - in essence, CPNs combine the strengths of Petri Nets and high-level programing languages
  - tokens have types (of any complexity)
- CPN is one of our modelling approach in the experimentation work.

Approach implementation : Coloured Petri Nets

Introduction



A Petri Net consists of:

- a set of places (represented by ellipses)
- a set of transitions (represented by rectangles)
- a set of directed arcs connecting places to transition and transitions to places, and
- the initial marking (distribution of data values to places)

Petri Net behaviour

- A transition is enabled when the required number of tokens are present in its input places
- Enabled transition may occur
- Occurrence of a transition results in change of the system state

Approach implementation : Coloured Petri Nets

Introduction

Analytical capabilities :

- Static and dynamic analysis
- Simulations
  - Step through simulation run
  - Complete simulation run or many runs
- State space
  - Behaviour properties
    - Graph statistics
    - Boundedness
    - Home properties
    - Liveness properties
  - Functional properties
  - Graph metrics

Approach implementation : Coloured Petri Nets

Motivation

Need techniques with rigorous mathematical foundations, strong syntax and semantics

Petri Nets meet this requirement

- Formal specification and analysis
- Rigorous static and dynamic system analysis, verification of behaviour and functionality
- Strong tool support

Example : Common database

Problem description

- Synthetic Environment databases are critical knowledge management mechanism to support training and decision making
  - main component of simulators
  - contain simulated environment (terrain and environmental data, forces configurations, models, etc.)

- Modern warfare increased the need for interoperability of simulators, to connect them for joint and combined training
  - the usage of simulators and simulations across defence is increasing
  - however architecture of simulators is not evolving at the same rate
  - purpose built : “wrapping an environment around platform simulation”

Example : Common database

Problem description

- Hence, the process of interoperating multiple simulators poses number of difficulties including:
  - the size of synthetic environment (storage, duplication, run-time representation)
  - limited scalability (data formats, architecture, various providers)
  - correlation of databases

So how can modelling and analysis address this problem ?

Example : Common database

Synthetic environment database is developed through execution of a set of activities. Each activity:

- consumes resources, takes as input some artefacts and returns new (or existing) artefacts
- takes time and has a cost

When developing multiple databases, our aim is to re-use “common” elements of those activities.

Hence, informally we could state our aim as:

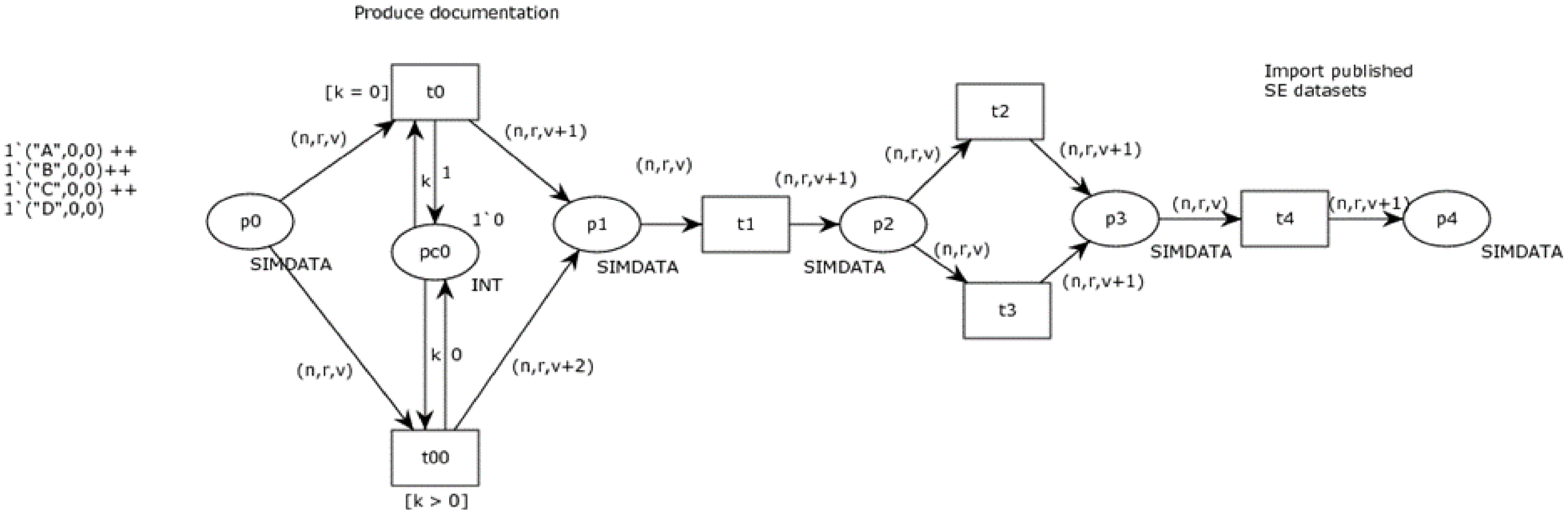
Given a set S of processes, executing a set of P of activities, utilise "common parts" of elements of P, in order to make S "more efficient".

For example, efficiency could be improved by:

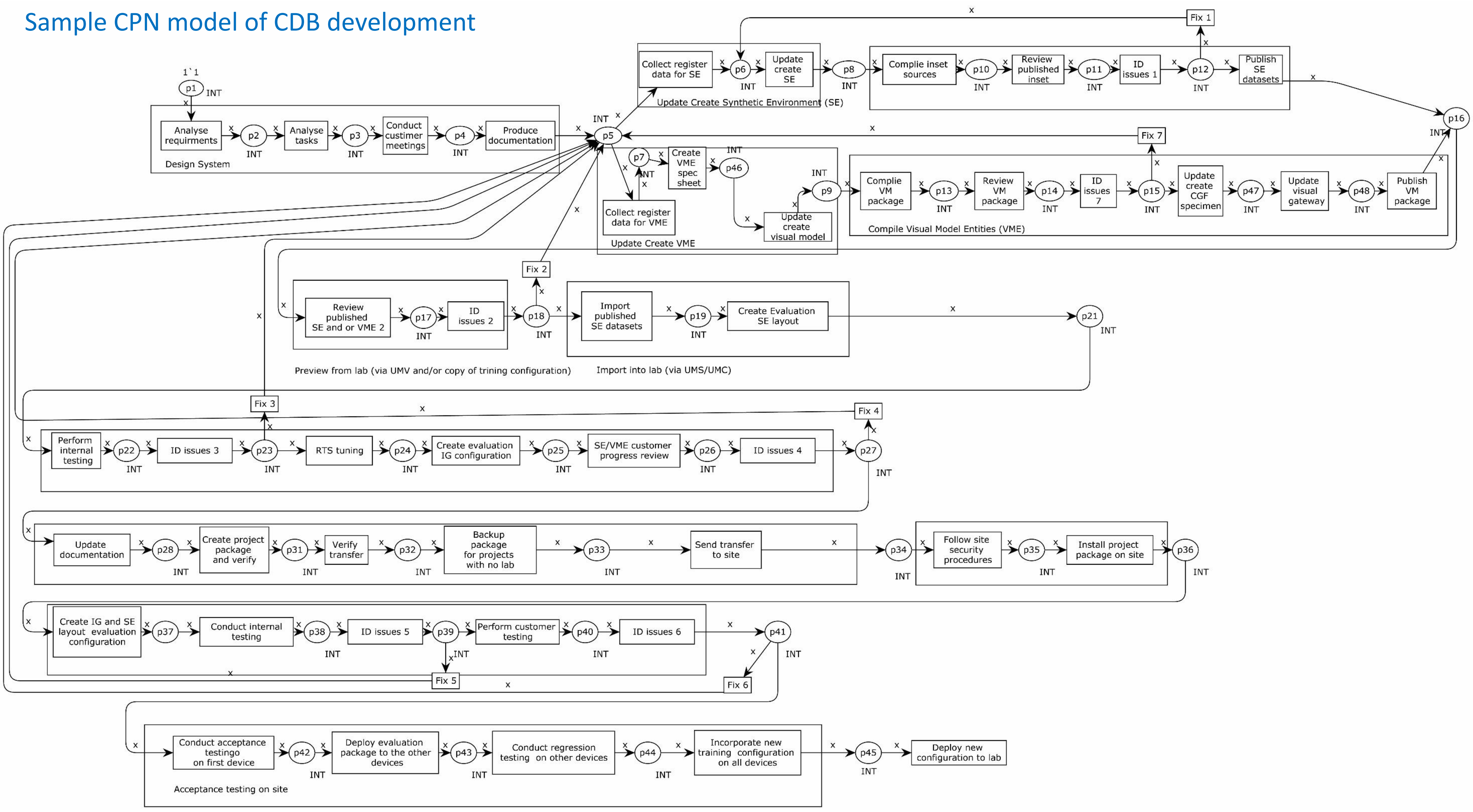
i. Reusing components (e.g. artefacts, resources, storage)
ii. Increasing interoperability
iii. Increasing agility
iv. Less steps in a process
v. Taking less time
vi. Reducing cost

Example : Common database

Sample construct to model usage of common artefacts



Sample CPN model of CDB development



Sample CPN model of CDB development

The CPN model also contains resource information:

- resource type
- number of hours resource (s) type needs to conduct an activity
- available number of hours for each resource

Summary

CPN modelling and analysis of synthetic environment database development resulted in:

For both, the current and Common database processes:

- Documentation of a process
- Improved understanding of that process
- Demonstrating correctness of that process

For Common database:

- Demonstrating efficiencies in terms of database development time and effort
- Ability to pose and answer “what if “ questions to investigate various development and commercial options

Thank you for your time and attention

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ENGINEERS AUSTRALIA SESA INCOSE SOUTHERN CROSS ITEA CHAPTER

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29 APRIL – 1 MAY 2019

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