



UNIVERSITY OF NOVI SAD
FACULTY OF TECHNICAL SCIENCES
DAIS RESEARCH GROUP



A Novel Approach and a Language for Facilitating Collaborative Production Processes in Virtual Organizations Based on DLT Networks

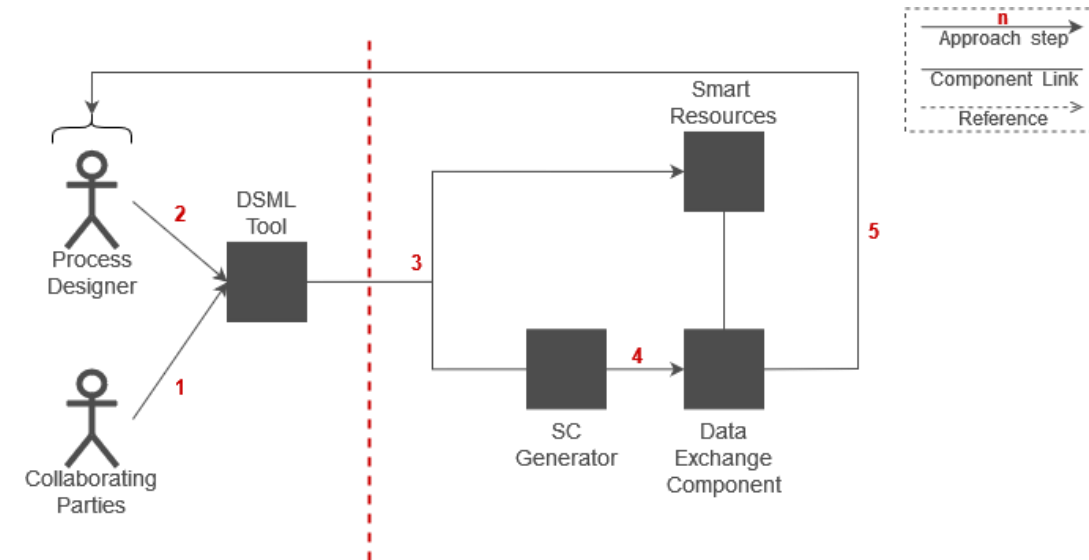
Nikola Todorović
Marko Vještica
Nenad Todorović
dr Vladimir Dimitrieski
dr Ivan Luković

Introduction

- Small and Medium-sized Enterprises (SMEs) form **Virtual Organizations (VOs)**
 - An emphasis on **Non-Hierarchical Networks (NHNs)**
- Among the most important **requirements** for supporting collaborative production processes
 - Improvement of communication
 - Updating production statuses
- Existing solutions address these requirements by **integrating participants' IT systems**
 - Enable **sharing data about events** of interest during production execution
- Most solutions don't promote **transparent cooperation**
 - Production records primarily stored within isolated participant's IT systems
- The issue of **exposing confidential enterprise data** should also be addressed
 - A **mechanism for configuring what data should be shared** is required
 - Strict **authorization** rules should protect data

Main Contributions

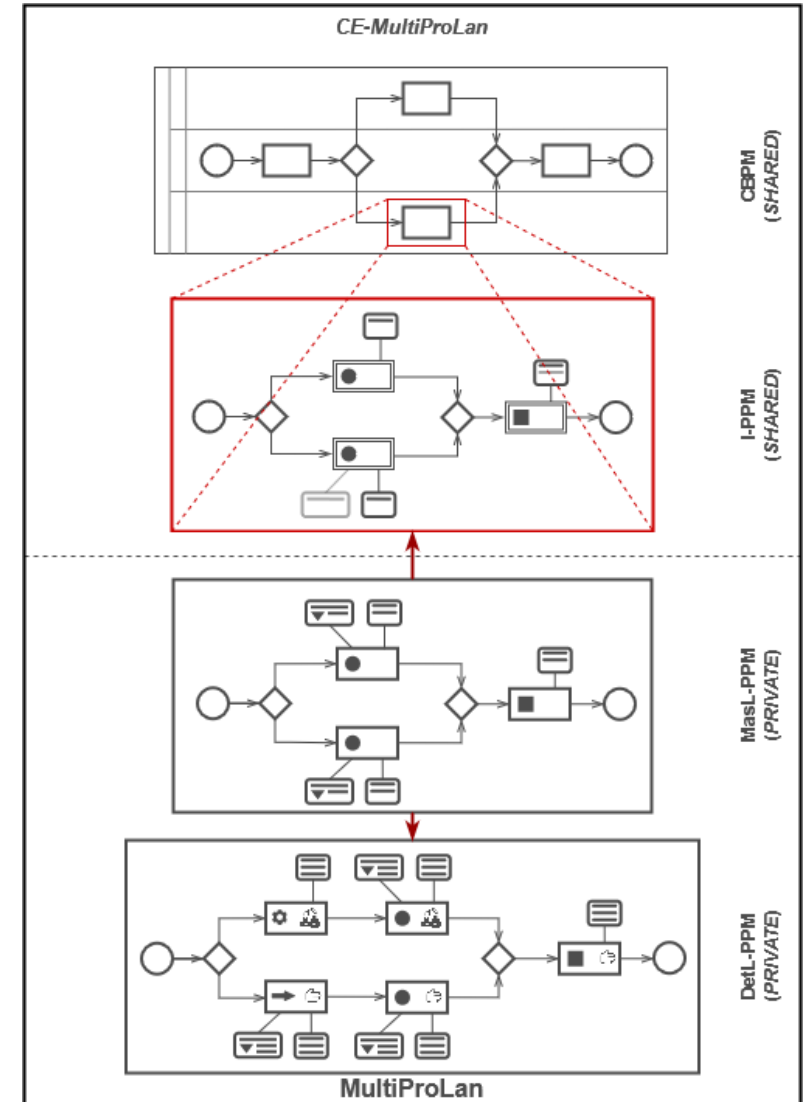
- **A novel methodological approach**
 - Based on the **Net-Challenge methodology**
 - Improves how collaborative processes are **modeled** and **executed**
 - **Higher level of integration**
- **Domain-Specific Modeling Language (DSML) used to**
 - **Model collaborative production processes**
 - **Configure what data should be shared**
- Data exchanged using **Distributed Ledger Technology (DLT) and smart contracts**
 - Smart contracts **automatically generated**
 - By following the **Model-Driven (MD)** principles
 - Generated smart contracts stored in a DLT network and used to
 - **Distribute production data**
 - **Validate production execution**



Outline of the Approach

DSML for Modeling Collaborative Production Processes

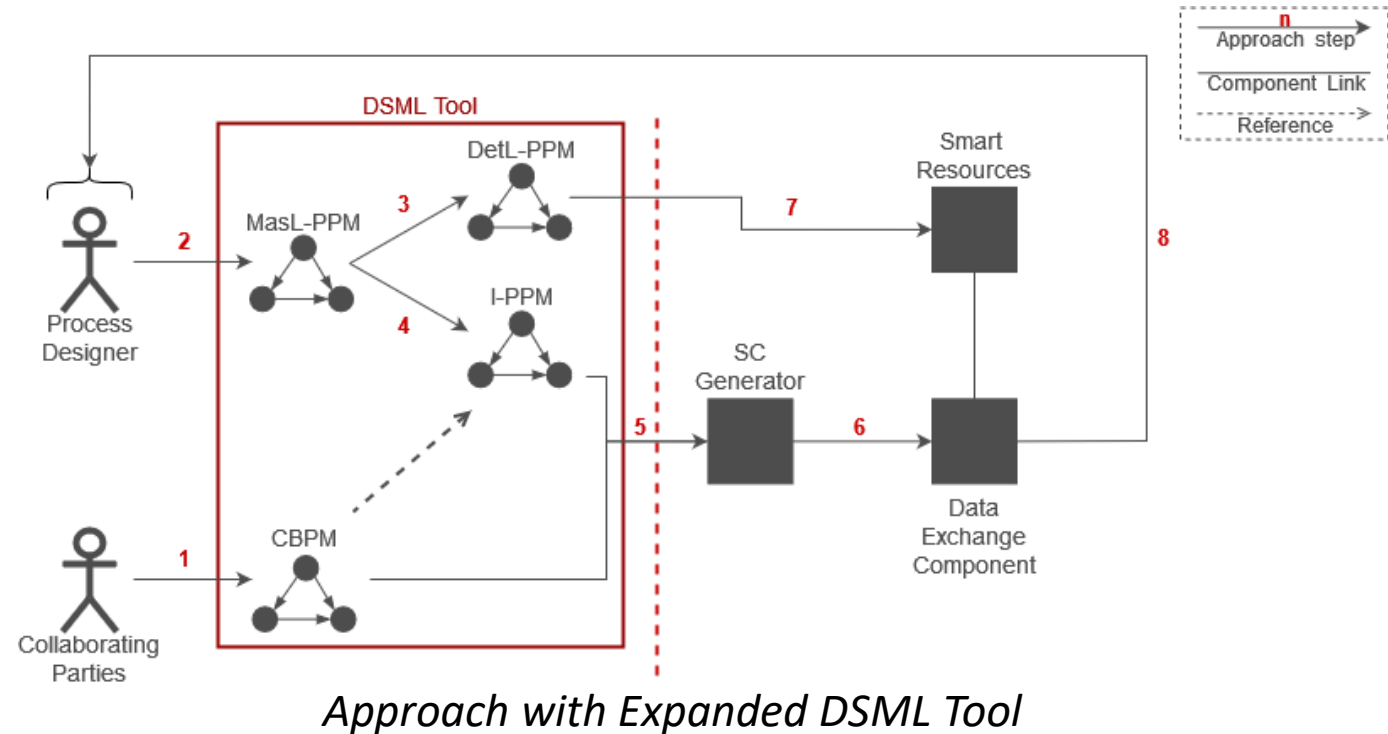
- Different process types investigated
 - **Cross-Organizational Business Processes (CBPs), Private processes, and Interface processes**
- **MultiProLan** selected as a basis for modeling collaborative production processes
 - Built to support process designers
 - Modeling **execution-ready** production processes in **multiple levels of detail**
 - **Tested** by process designers on the shop floor within a small-scale industrial production setup
- Collaborative Extension of MultiProLan (**CE-MultiProLan**)
 - Supports additional process types



Different Process Types

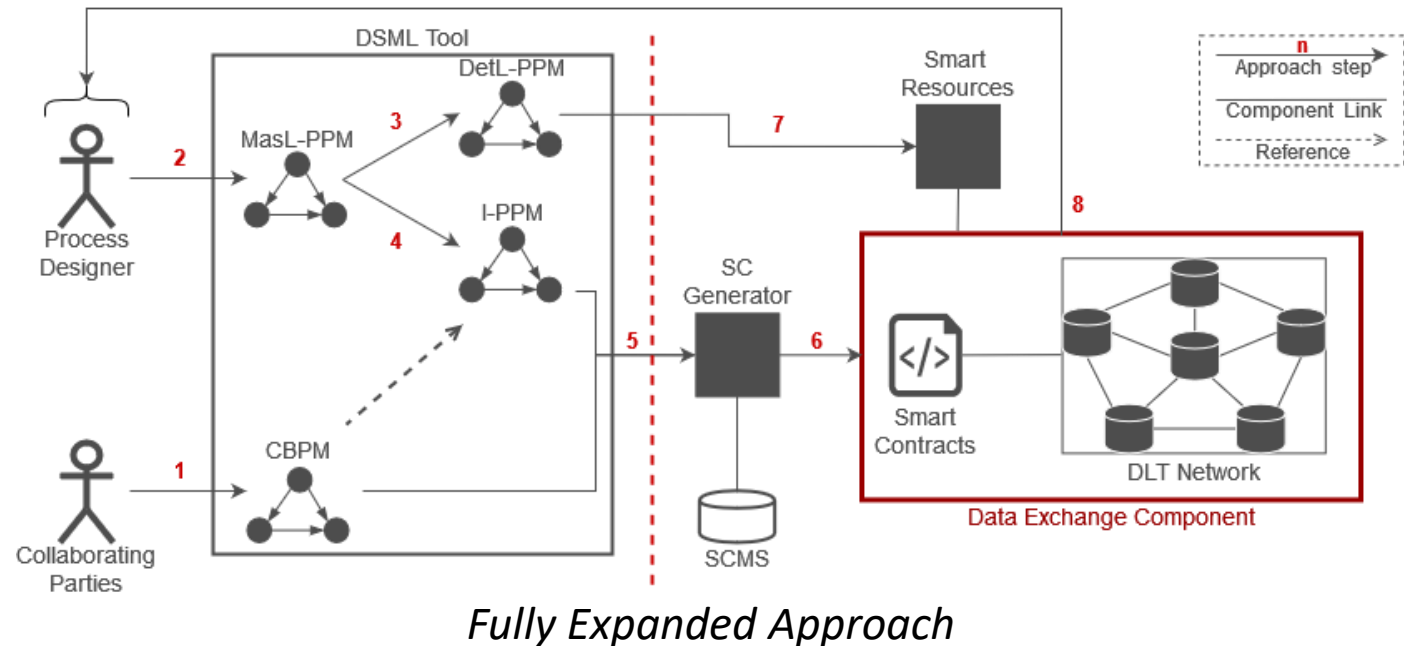
DSML for Modeling Collaborative Production Processes

- Relies in the existing **eBOM** and **BOO** documents
- CBPM – for **coordinating production**
 - A sequence of production activities allocated to participants
- MasL-PPM – a **private** production process specification
 - Basis for creating **execution-ready** production process model – **DetL-PPM**
- I-PPM – a public **interface** over a private MasL-PPM
 - **Insight** into how a VO participant executes a specific CBPM operation
 - Each **value-adding** step from CBPM needs to refer to a corresponding I-PPM



Facilitating VOs with DLTs and Smart Contracts

- Smart contracts **generated** based on CBPMs and I-PPMs
 - By relying on **SCGenerator** and Smart Contract Meta-Store (**SCMS**)
- The DLT network and smart contracts – **Data Exchange Component (DEC)**
- Smart contract used to
 - **Distribute production records**
 - **Validate production execution**
 - That it is conducted according to the contracted specifications
- Collaborating parties can **monitor** production execution in near real-time



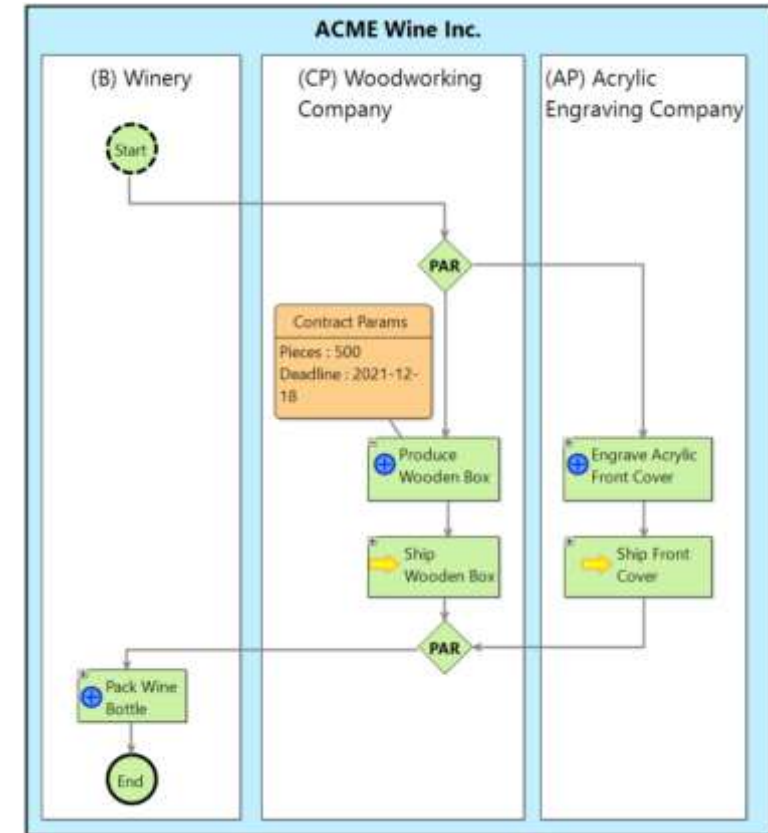
Facilitating VOs with DLTs and Smart Contracts

- Most important **quality attributes** when developing a platform for sharing data during the enactment of CBPs
 - **Security**
 - **Scalability and performance**
- **Hyperledger Fabric** selected as the most appropriate platform
 - Enterprise-level **private, permissioned, consortium-based** DLT platform
 - Imposes **restrictions** on who can access the network and see/submit transactions
 - Uses a more traditional Crash Fault-Tolerant (CFT) **consensus protocol**
 - Suitable for **scaling** the transaction throughput in the network

CE-MultiProLan Showcase

- CBPM -

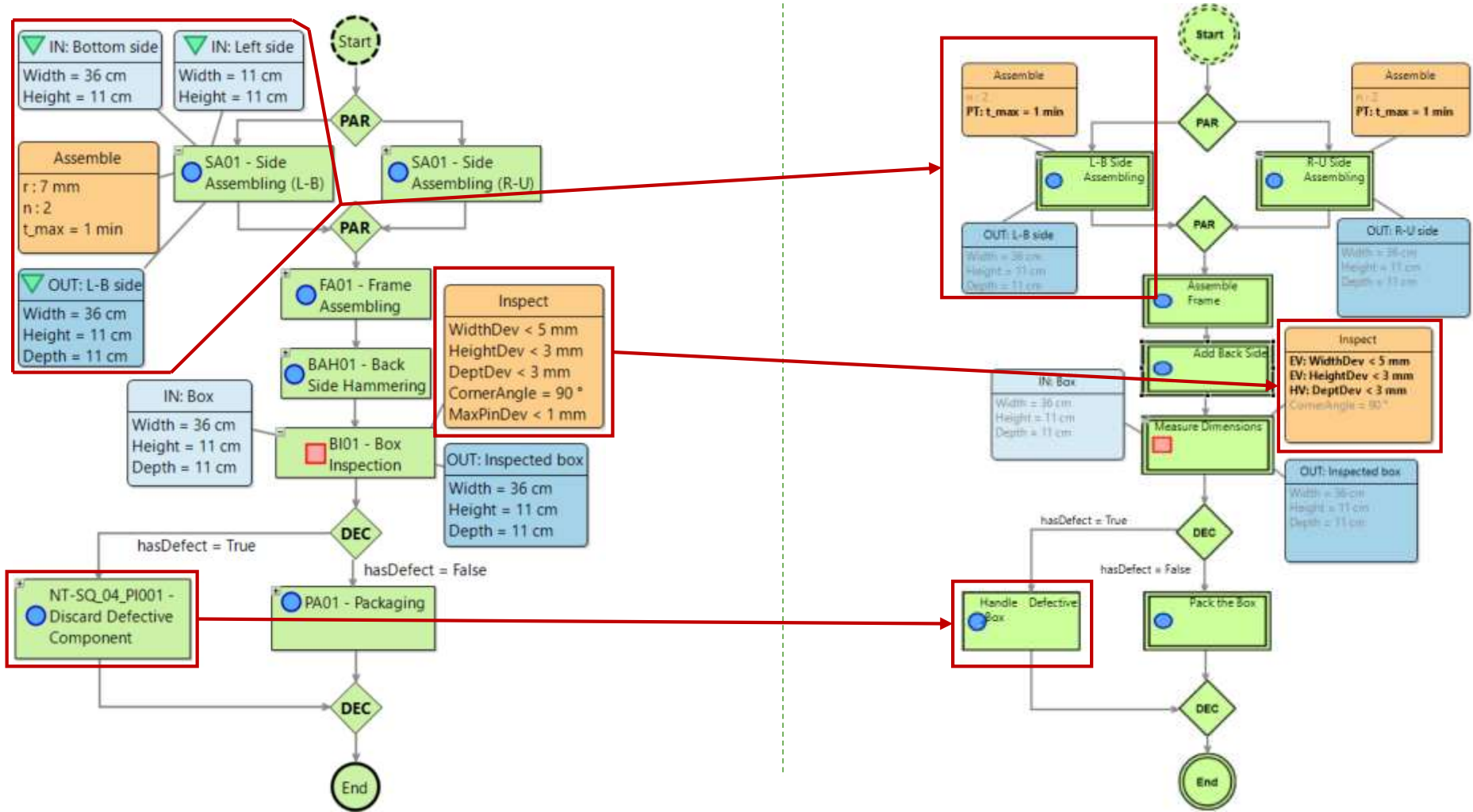
- The application of our **approach demonstrated**
 - By showcasing the use of the CE-MultiProLan DSML and its concepts on a **use case**
- Use case – collaborative production of a decorative wooden wine box with an engraved acrylic front
- Devised to **cover core concepts** for the domain of collaborative production process modeling



CBPM for the Use Case

Showcase of CE-MultiProLan on a Use Case

- MasL-PPM and I-PPM -



MasL-PPM for the Use Case

I-PPM for the Use Case

Conclusion

- The **expected advantages** of applying the presented approach
 - A more **real-time insight** into production status
 - **Improved trust** between participants as **transparency** within the network is **increased**, and **contract validations** are **automated and tamper-proof**
 - **Faster time to market** due to the automatic generation of smart contracts
- These advantages jointly create **trustworthy conditions for collaboration** between SMEs involved in a VO and allow them to be **more competitive** in the market

Future Work

- CE-MultiProLan will be **systematically evaluated and tested** on a case study common for VOs with a non-hierarchical structure
- We plan to **improve the possibilities** of CE-MultiProLan for modeling collaborative production processes by expanding the set of concepts available on the interface process level
 - Advanced concepts already present on the private process level, like sub-processes and unordered steps, should also be available on the interface level
- We are investigating the possibility of **utilizing enterprise modeling constructs** defined in the newly introduced **ISO standard for Enterprise Modelling and Architecture (ISO 19440:2020, 2020)**
 - This standard focuses on engineering and the integration of manufacturing and related services in the enterprise
 - We are analyzing the possibility of using those constructs for production process modeling

THANK YOU FOR LISTENING!
Q & A