4.0 – Service-Oriented Architecture (SOA) Robustness: The Road Ahead

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ABSTRACT

Service-Oriented Architecture is a significant and integral part of the whole enterprise strategy. It must harmonize business process re-engineering with a power of enterprise technology infrastructure focusing Stability and Agility on the Enterprise Business Processes tier and Robustness on the SOA services tier. Robustness can be very effectively applied for SOA Enterprise Solutions by two ways; using enterprise System Engineering Support models for Short-Term solutions and using Robustness Patterns at the lower layers of SOA architecture for Long-Term solutions. Because SOA is more managerial then technological problem we propose Robustness based SOA Roadmap.

Keywords – SOA architecture, availability, robustness, risk analysis and management, system engineering

1.0 INTRODUCTION

The armed forces in East European Countries are under massive redesigning that requires a combination of process oriented and technologically oriented efforts. The border between these two efforts stimulates research activities oriented to service delivery in accordance with the needs of enterprise agility. At the same time we can observe increasing popularity of modeling that combines three main components – People, Process, and Technology [13,12,2,5]. Process re-engineering results mutual influences of these three components but it has to be synchronized with information security planning that corresponds with the robustness as a mechanism improving system stability and security. This is very important indicium but we feel that it has to be encapsulated into more comprehensive system engineering discipline [14,15,4].

SOA is much matter of management as it is technology [17]. To understand all key SOA management issues is difficult. Nowadays more typical SOA management practices stress only some of these issues increasing "stove pipe" risks in SOA project management. It is especially critical in military domain where stabile services directly influence Force Management.

This paper attacks SOA Robustness strategy in the context of the SOA based Robustness Roadmap that is understood as one of possible ways how to improve SOA management applying system engineering approach.

SOA Roadmap includes three main phases (Figure 1):

- Phase 1: Synthesize Enterprise Application Integration (EAI) Environmental Model and Decision Support Models.
- Phase 2: Establish SOA based Scenario Landscape.
- Phase 3: Establish SOA Robustness Enterprise Solutions using System Engineering Support Models and Robustness Patterns.

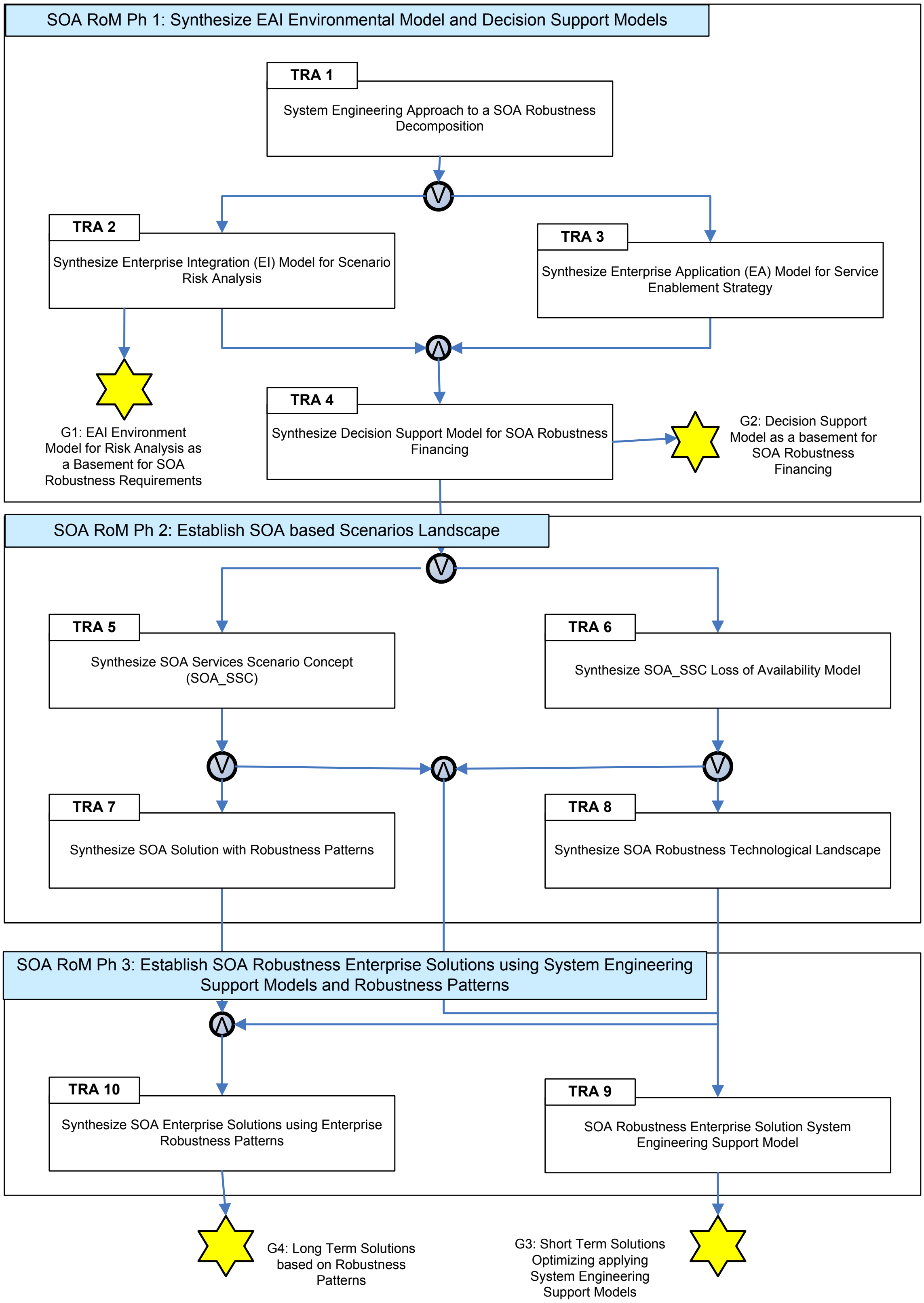

Figure 1: Robustness Based SOA Roadmap.

Following this roadmap we hope to achieve four management goals:

- Goal 1: EAI Environment Model for Risk Analysis as a Basement for SOA Robustness Requirements Specification.
- Goal 2: Decision Support Model as a basement for SOA Robustness Financing.
- Goal 3: Short-Term Solutions Optimizing applying System Engineering Support Models.
- Goal 4: Long-Term Solutions based on Robustness Patterns.

Each of these phases encapsulates relatively comprehensive modeling constructs; it was the reason why we decided to prepare this paper as the outcome of the model named “SOA Robustness – The Road Ahead” developed in accordance with Component Architecture Framework (CAF) approach [6,7,8]. The paper itself describes the most important milestones. Appendix 1 explains steps characterizing particular milestones.

Paragraph 1 describes Phase 1 that includes 4 tracks. The track TRA1 explains SOA Robustness decomposing this topic applying system engineering approach in accordance with ISO / IEC 15288 [15]. The track TRA2 explains Enterprise Integration (EI) Model synthesis for Scenario Risk Analysis. TRA4 is the most critical for SOA Robustness initiative financing. Using decision support modeling we developed some useful decision support templates that avoid decision makers intuitive, not optimal decision making.

Second SOA Roadmap phase (paragraph 2) introduces two concepts that allow better management of huge amount of potential scenarios that relate to the SOA implementation. TRA5 illustrates key steps in designing SOA Services Scenario Concept. This Concept cam be further used for synthesis of SOA solution with robustness patterns (TRA7) or in a combination with Loss of Availability Model (TRA 6) for Short-Term SOA robustness solutions. TRA6 explains key items characterizing SOA Loss of availability Model that we need for SOA Robustness Landscape synthesis (TRA 8) and for optimizing of the Short Term system solutions.

Third SOA Roadmap phase (paragraph 3) consists of two tracks. TRA9 produces one of the main goals of SOA Roadmap – Short-Term Solutions Optimizing applying System Engineering Support Models. TRA10 is more implementation oriented and produces Long-Term Solutions based on Robustness Patterns.

2.0 ENTERPRISE APPLICATION INTEGRATION (EAI) ENVIRONMENT MODEL AND DECISION SUPPORT MODEL

The SOA Robustness decomposition approach considers that in the final stage of SOA deployment strategy Robustness Patterns will become a core of Enterprise Technology Infrastructure on which depend all key business processes (Figure 2). SOA based interoperability among Enterprises will require Stability and Agility at the business process (BP) tier and Reliability at the SOA services tier. To achieve these two very fundamental requirements we must be able to manage all important factors that significantly influence these requirements. In accordance with the Figure 2 they are:

- System Engineering experience based on Architecture Design Process, Risk Management Process, Information Management Process, and Decision Making Process.
- System Integration experience based on well understanding of Enterprise Technology Infrastructure.
- Enterprise Application experience based on well understanding of Service-Oriented Architecture and its practices.
- Decision Making experience capable combining all previously mentioned experiences with the robustness oriented goals that deal with a Balance between Business Process Impacts and a Cost of SOA Robustness.

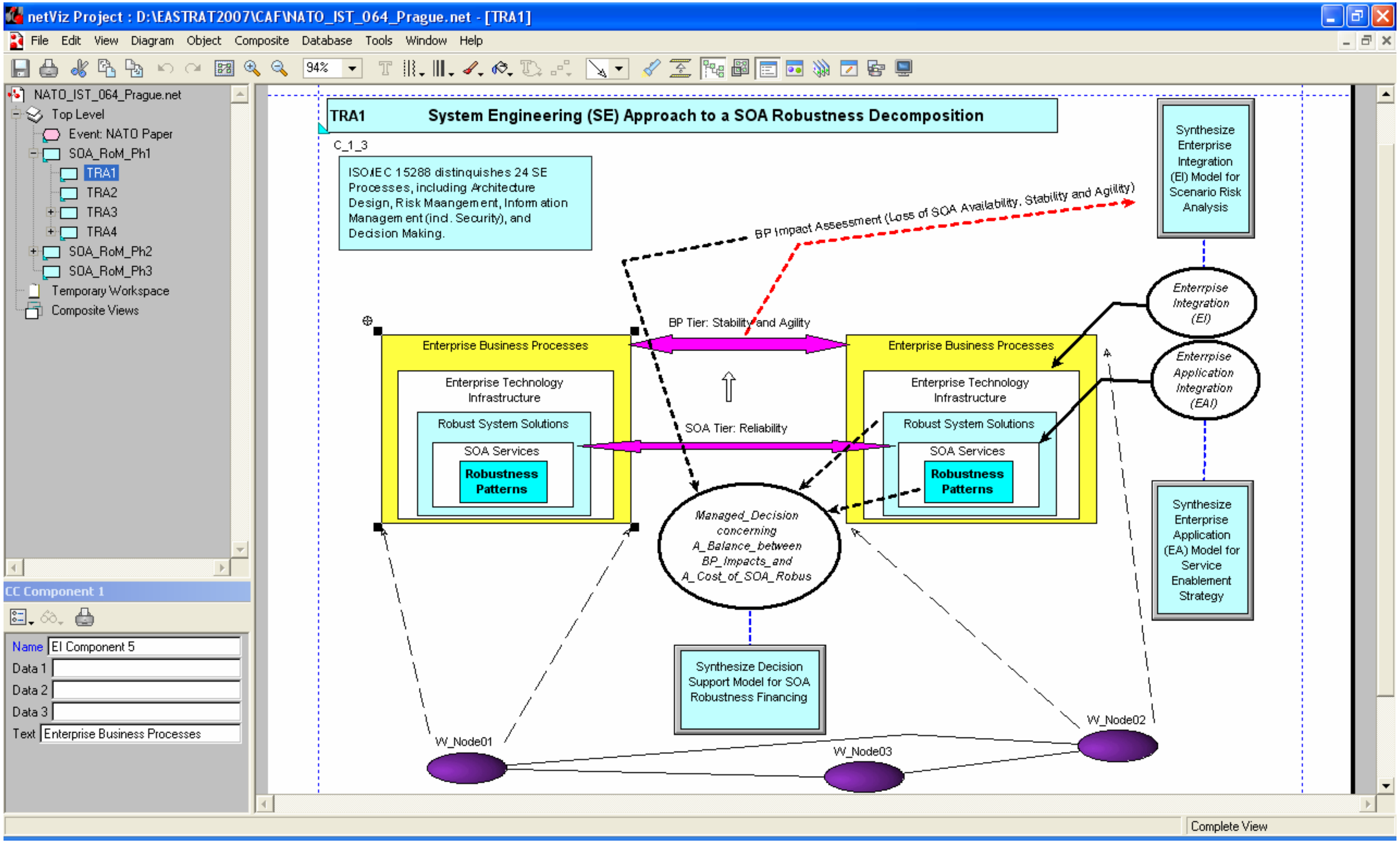

Figure 2: System Engineering Approach to a SOA Robustness Decomposition.

Rapid increasing of the IT service delivery market stimulates research activities in the area of Service Quality and Marketing [19, 22]. Significantly less progress we can see in the area of service delivery in a risk environment [9]. It is serious problem; without risk motivated basement it is difficult to create robustness solution because we loss opportunity to argue robustness cost comparing it with business process impacts.

Figure 3 focuses Enterprise Integration (EI) Model; we consider this model as a model of environment in which SOA exists (SOA is primarily about applications). Enterprise node anatomy is analyzed from two perspectives – business process (BP) Impact and Threats / Vulnerabilities. Risk landscape results of these two perspectives. Particular risks can be calculating using automated tools like CRAMM [3] or analyzed through Threat Agents [16]. Next step following risk Analysis is a Risk Treatment. Figure 3 associates this step with designing of measures allowing decreasing risks to the acceptable level. We consider this framework as appropriate for merging with robustness oriented activities as for example Frederics' High-Availability Solutions [18].

Service Enablement Strategy requires a development of Enterprise Application (EA) model that consists of three parts:

- Enterprise Integration Roadmap encapsulating SOA Architecture (Figure 4);
- Hitchin's Model of System Engineering, Defense Force horizons and SOA life cycle (Figure 5); and
- Force Management and Force Development Process and SOA Milestones (Figure 6 and 7).

Service Integration Architecture allows effective management of the SOA deployment strategy only if we understand influences of other architectures within particular enterprise (Figure 4). For example, Business Process Architecture allows us understanding a Vision (SOA deployment target) and Current Integration Assessment let us realistically assess constrains we must consider for our SOA milestones establishment.

SOA Concept distinguishes five components that differ from viewpoint of their life cycle (Figure 5). Robustness can be applied primarily for Technology Infrastructure (it's life cycle (LC) longs approximately 20 years) and for Services (their LC longs approximately 15 years). At the beginning of our paper we stress that SOA addresses a space between processes and technology respectively between process owners and IT specialists. To analyze People behavior in the SOA deployment strategy we need additional perspective oriented to the capability. It is the reason why we recommend combining SOA life cycle with Hitchin's model [13]. To achieve the Socio – Economic level, the Capability acquired during technology acquisition (Layer 2 of Hitchin's model) is not enough and must be followed with process owners oriented capability development (levels 3 and 4).

Enterprise SOA strategy distinguishes five milestones [8] in accordance with Figure 6 and 7. M1 relates to enterprise in which all key areas (Planning and Budgeting, HR Management, and Logistic) are supported by monolithic applications. For better synchronization of these milestones with East European armed forces transformation process we can omit first two milestones and start with milestone M3 and M4. The first one is typical for armed forces developing their key information systems as bespoke applications; milestone M4 is more appropriate for armed forces starting with ERP systems like SAP, Oracle Business Suite, PeopleSoft or Axapta.

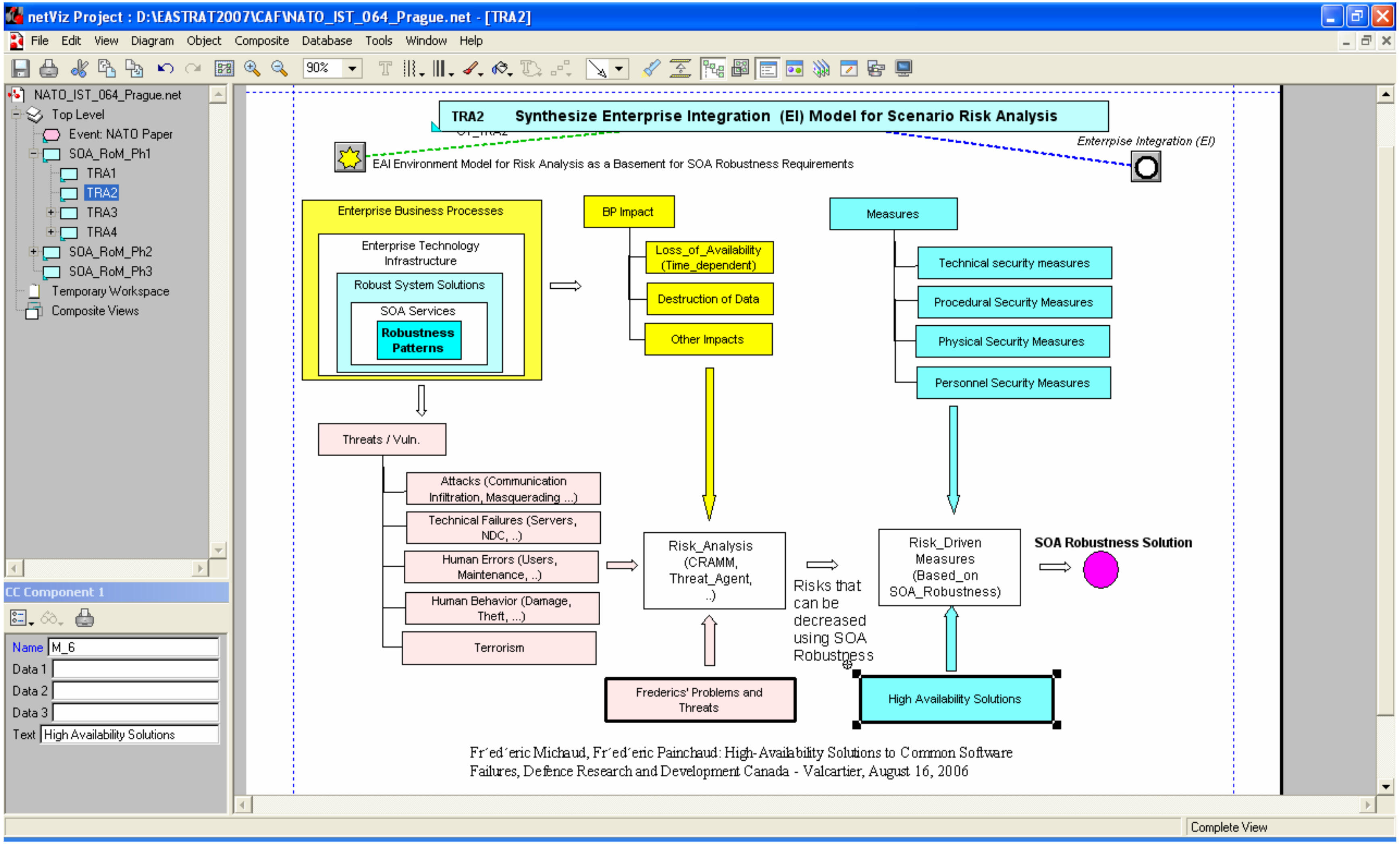

Figure 3: Enterprise Integration (EI) Model for Scenario Risk Analysis.

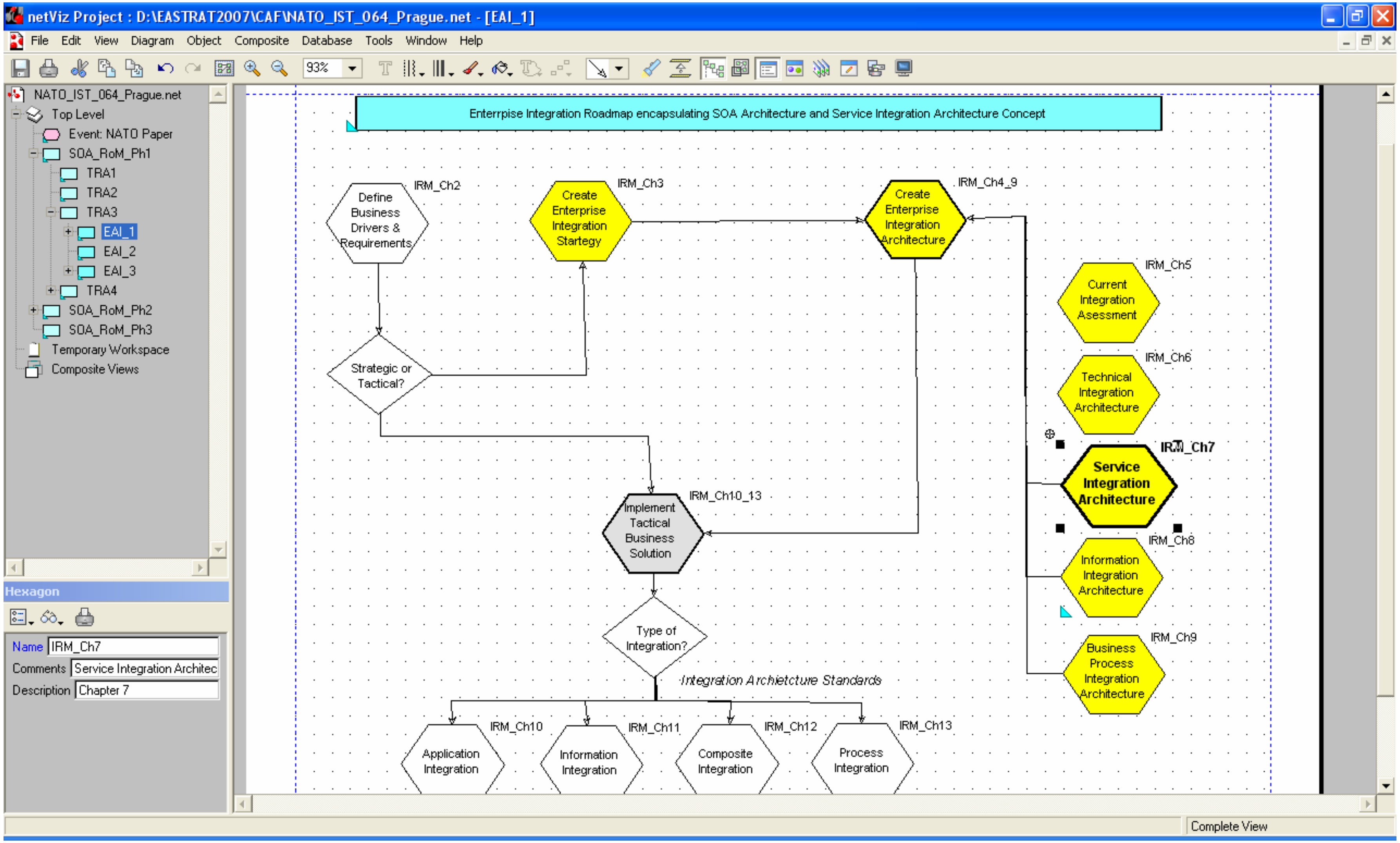

Figure 4: Service Integration Architecture in the Context of Enterprise Integration Strategy.

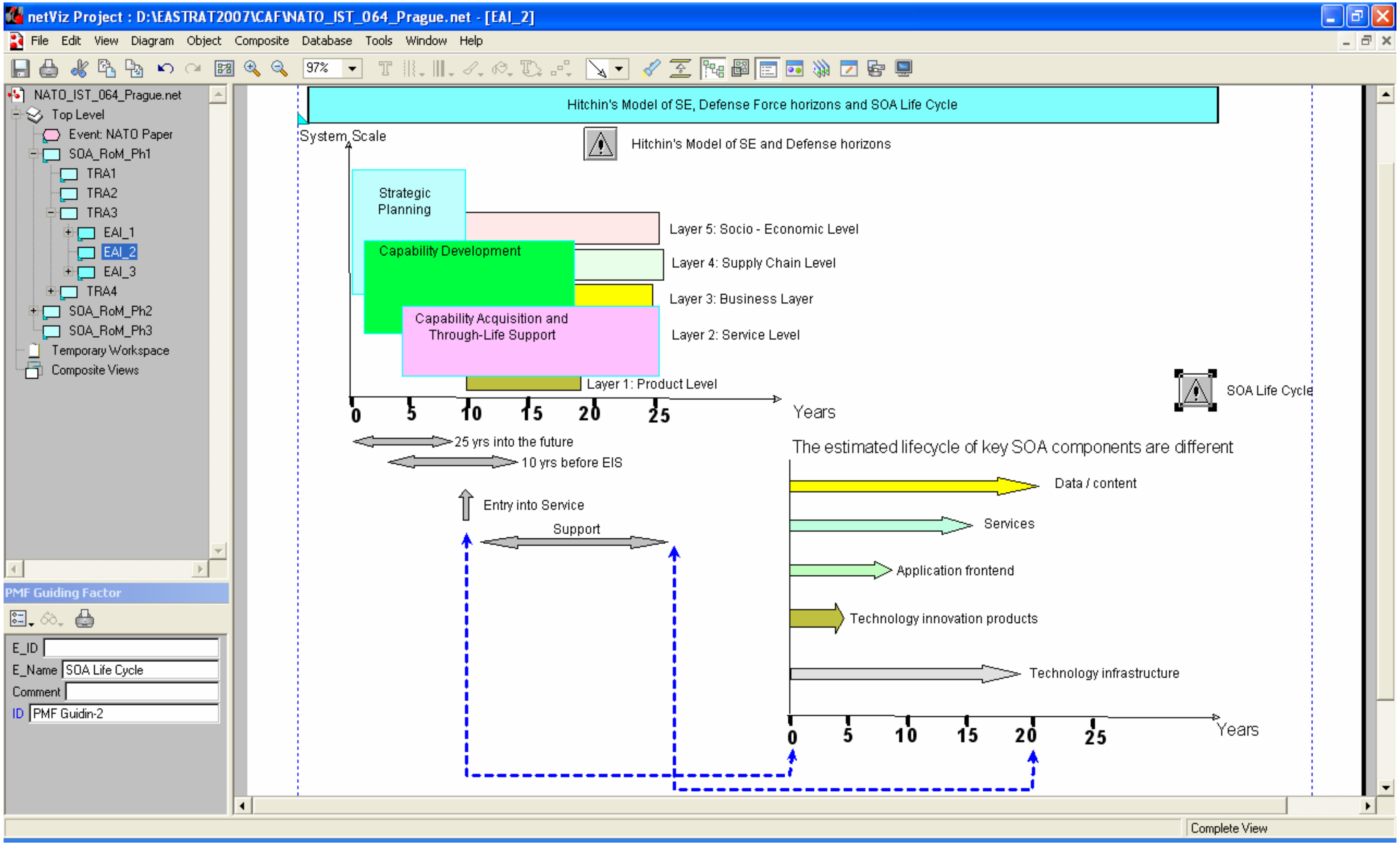

Figure 5: Harmonization of the SOA Life Cycle and Defence Force Capability Development.

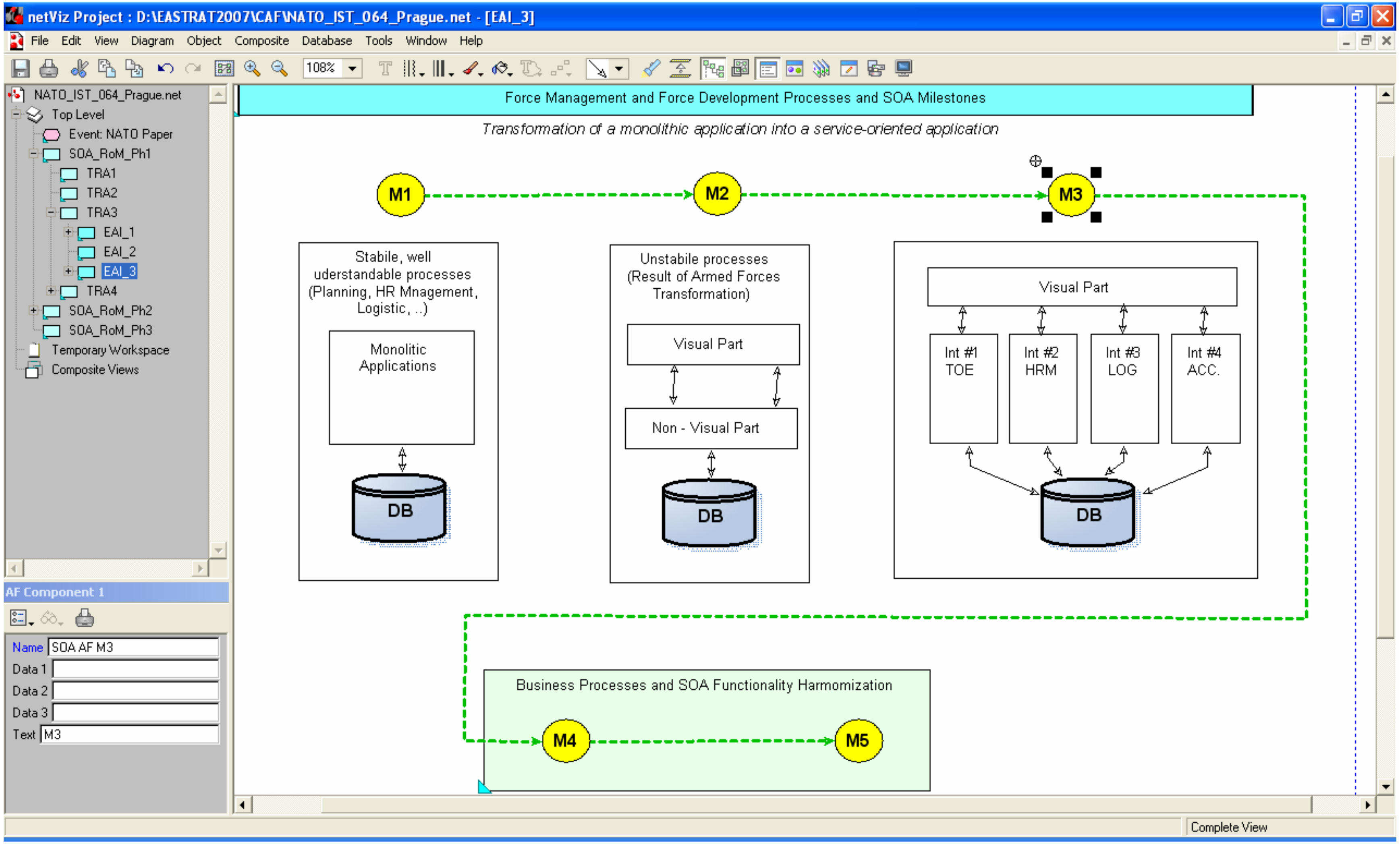

Figure 6: Force Development and Force Management Processes and SOA Milestones.

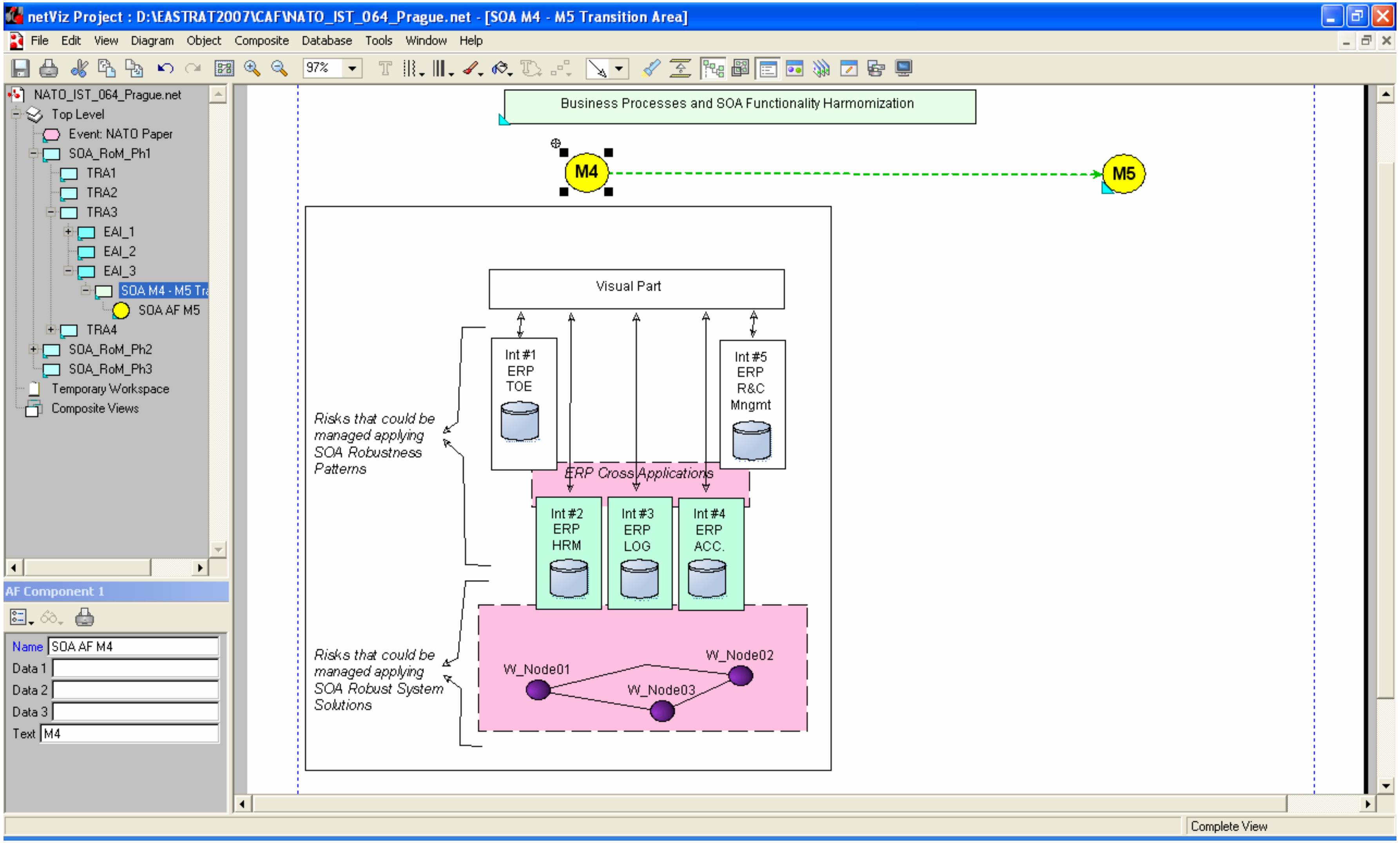

Figure 7: Business Processes and SOA Functionality Harmonization (Milestone M4).

During explanation of SOA Robustness decomposition concept (Figure 2) we stress how important are Stability and Agility at the business process (BP) tier and Reliability at the SOA services tier. Achieving these two requirements at the end of the SOA Roadmap we should probably apply different approaches for milestone M3 and M4. **M3** seems to be more suitable for **long term robustness solutions** because it offers a possibility to develop SOA services using robustness patterns (in this case our SOA concept is deployed from Bottom to Up). **M4** requires Top Down approach. We have not enough time diving into technological aspects because our main attention must be given to process re-engineering. In this case **short term robustness** solutions seem to be more appropriate because they directly increase stability of ICT environment of business processes that are not stabile as result of transformation process.

Tracks TRA1 up to TRA3 clearly show a complexity that must be managed to successfully achieve SOA strategic goals. Robustness is very important piece of the whole picture but requires appropriate support at the decision makers' level.

It is worth to stress that right decision requires also modeling support that allows decision makers clear understanding the goal of decision, alternatives and criteria. Track TRA4 (Figure 8) describes decision oriented modeling for SOA Robustness Financing putting together.

Main goals:

- Goal 1: Justifying a Budget for Robustness oriented System Engineering Support in the information and communication technology (ICT) total cost of ownership (TCO) Context.
- Goal 2: Justifying a Budget for Robustness oriented System Engineering Support in the Information Security Context.
- Prioritize Robustness SOA Solutions Alternatives.

And main groups of activities:

- Arguing Robustness based SOA System Engineering Support Benefit in the ICT TCO Context analyzing SOA Life Cycle alternatives.
- Arguing Robustness based SOA System Engineering Support Benefit in the Information Security Context analyzing Risk Treatment Alternatives.
- Development and application of the Decision Support Model allowing choosing the best Robustness based SOA Solution.

Figures 9 and 10 briefly illustrate first and third activities.

One of the most popular ERP systems is SAP. A.W. Scheer – The main SAP architect – explains his experience with application of ARIS for SAP life cycle [21] (Figure 9). Scheer's experience relates two curves 1 and 2. Curve 1 characterizes total cost of ownership (TCO) across ERP life cycle when we omit system engineering support completely. Curve 2 introduces significant TCO savings especially during operational stage when we need constantly improved processes. Both curves also had shown unstable stages that follow ERP infrastructure upgrades. Robustness is the right mechanism to solve problems like these, but it must become an integral part of the whole ERP strategy from the beginning (see curve 3). TCO / ERP LC diagram in the Figure 9 is also acceptable for senior staff that can see the space for its decision.

Figure 10 illustrates a decision support modeling inspired by Frederics' paper that is also presented on this meeting [18]. They describe five products allowing significantly improve system robustness. We developed this model in accordance with AHP theory [20] applying EC 2000 software. More detailed explanation is included in Appendix 1.

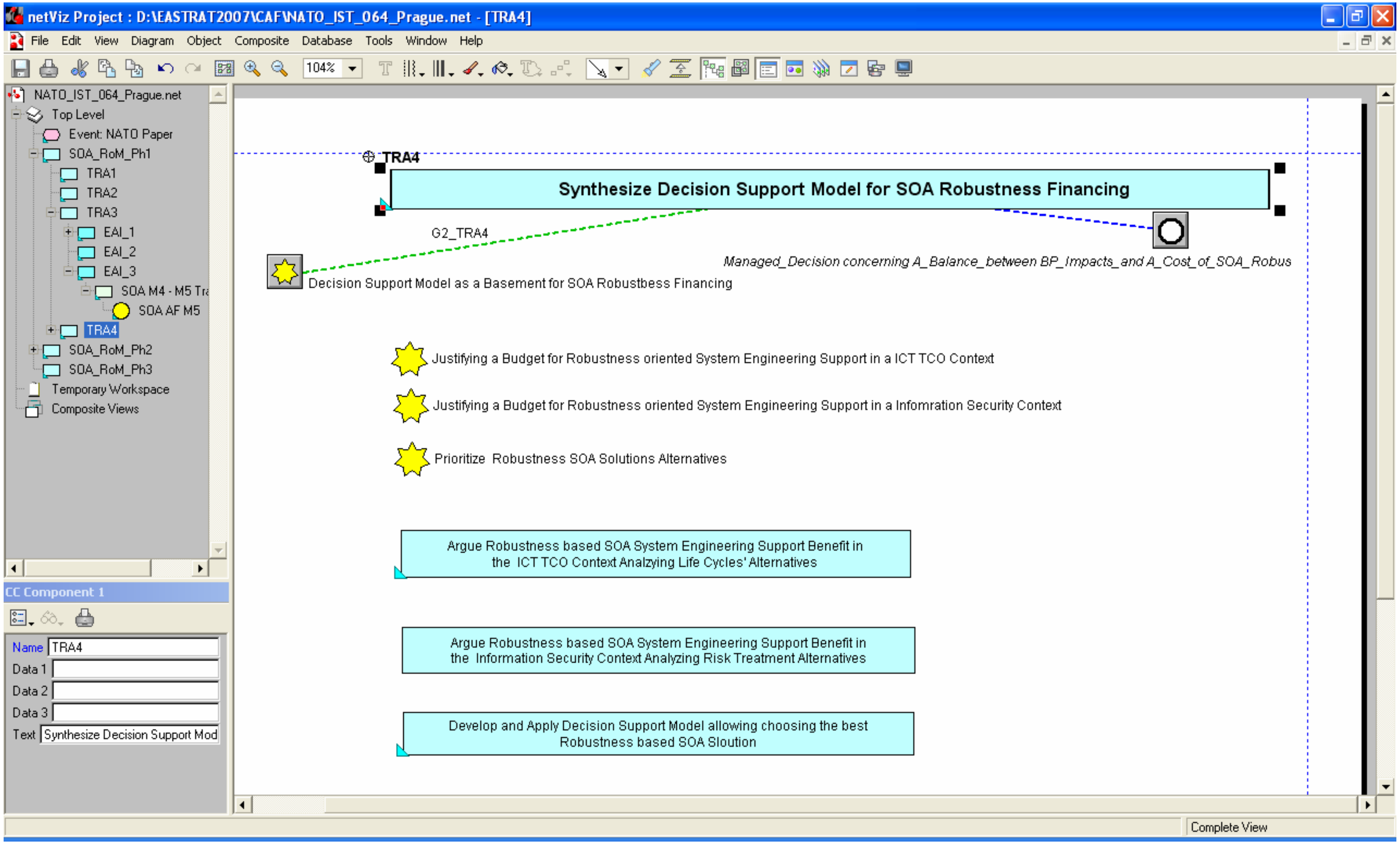

Figure 8: Decision Support Model for SOA Robustness Financing.

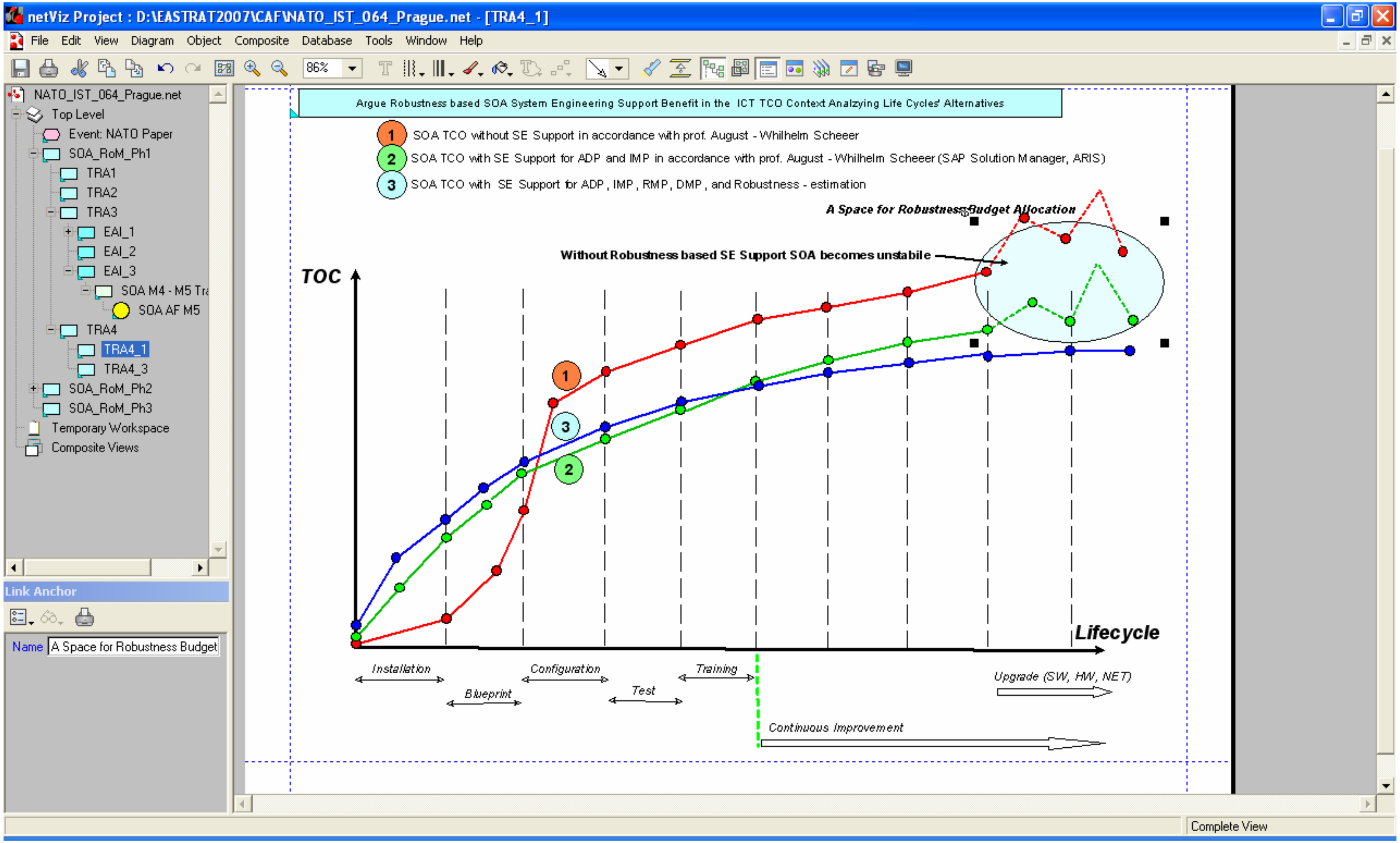

Figure 9: Identification of the Space for Robustness Budget Allocation.

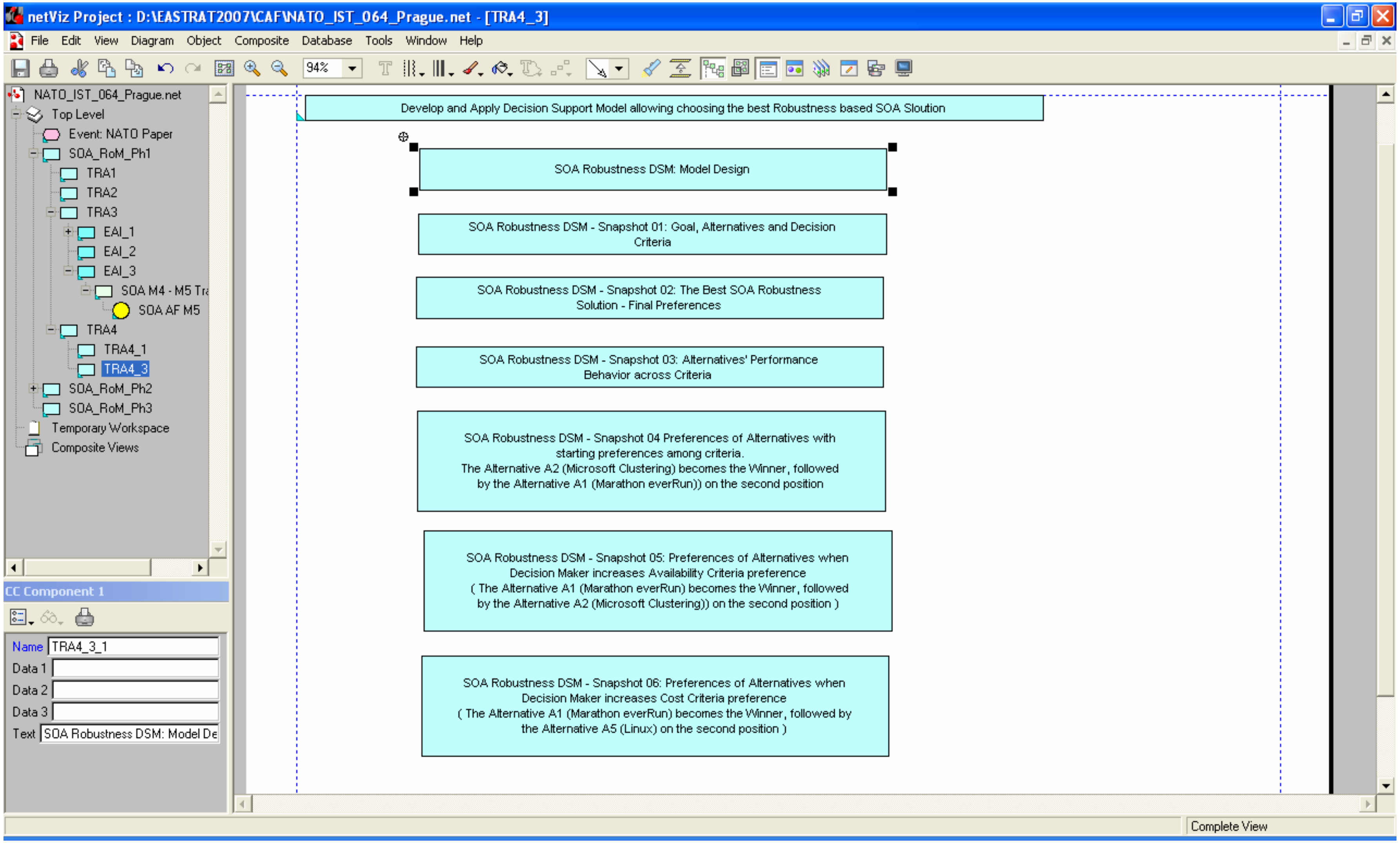

Figure 10: SOA Robustness Decision Support Model.

3.0 SERVICE-ORIENTED ARCHITECTURE (SOA) BASED SCENARIOS LANDSCAPE

First 4 tracks described in the previous paragraph are oriented primarily to the frameworks within which we can successfully manage SOA based Robustness strategy. But we also need bricks allowing us building the walls. SOA strategy offers a plenty of ways how to assembly SOA services to meet process requirements. Before we start doing this we must carefully arrange our workspace, another words we need scenarios.

Track TRA5 (Figure 11) shows:

- Enterprise SOA Services and Layers; and
- SOA Services Scenario Concept (SOA SSC).

SOA SCC distinguishes four basic parts necessary for process modeling in SOA environment. We explain these parts more detailed in Appendix 2 (see Material Request Order (MRO) process sample). SOA SSC uses following constructs:

- *Organizing Diagrams* let us understanding parts of an enterprise affected by a process.
- *Enterprise Service Structure Diagrams* let us understanding requested functionality decomposition across Enterprise SOA services.
- *Event Process Chain (EPC) Diagrams* let us visualize processes by the way that can be easily understand by business process owners.
- *Service Interaction Diagrams* are preferred by designers. These diagrams are usually derived from functional blocks used in EPC diagrams.

Figure 12 depicts SOA services and layers. Basic and Intermediary Services seems to be suitable for implementation of SOA Robustness Patterns that can be used for SOA Enterprise Solution building.

Robustness that applies high-availability products [18] requires a development of appropriate SOA SSC that can be used for synthesizing of a Loss of Availability Model. This kind of synthesizing starts with a decomposition of particular high level process (like operation planning (OPLAN)) into functionalities that can be overlapped by SOA services functionality (Figure 13). Figure 13 depicts a decomposition of a Material Order Request (MRO) processing at the Enterprise Level (this process is owned by logisticians) Process layer splits enterprise level process into three sub-processes – Material Management (MM), Logistic Execution, and Sales and Distribution (SD). Each of these sub-processes needs support of lower SOA layers. SOA SSC Loss of Availability Model usually consists of three modeling constructs (Figure 14). A content of these layers is depicted in Appendix 2.

4.0 SOA ROBUSTNESS ENTERPRISE SOLUTIONS USING SYSTEM ENGINEERING SUPPORT MODELS AND ROBUSTNESS PATTERNS

Last two tracks of the Robustness based SOA Roadmap (TRA9, TRA10) produce outcomes corresponding two main goals (Figure 15):

- Short Term Solutions Optimizing applying System Engineering Support Models (goal G3); and
- Long Term Solutions based on Robustness Patterns (goal G4).

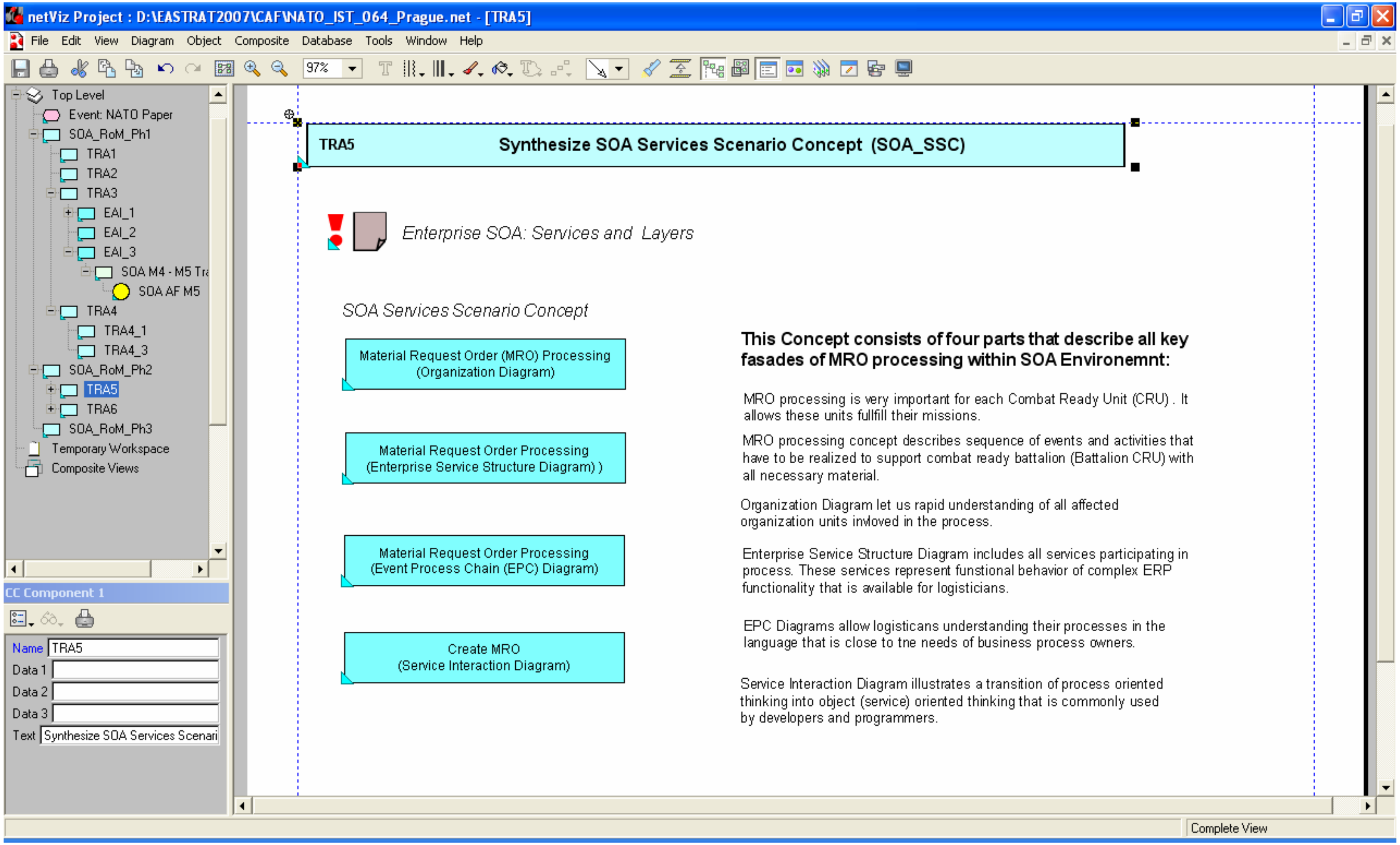

Figure 11: SOA Services Scenario Concept, SOA Services and Layers.

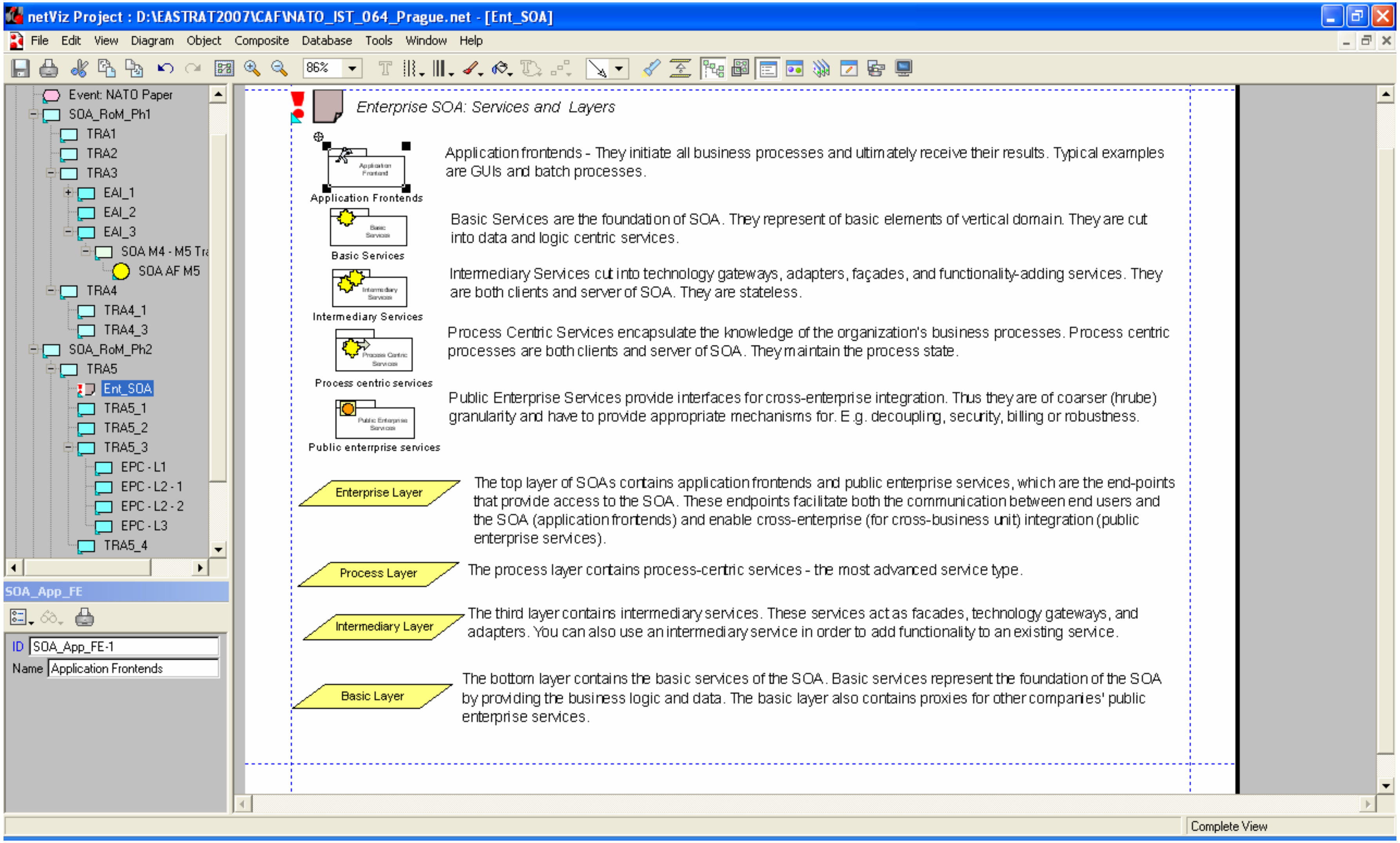

Figure 12: Enterprise SOA: Services and Layers.

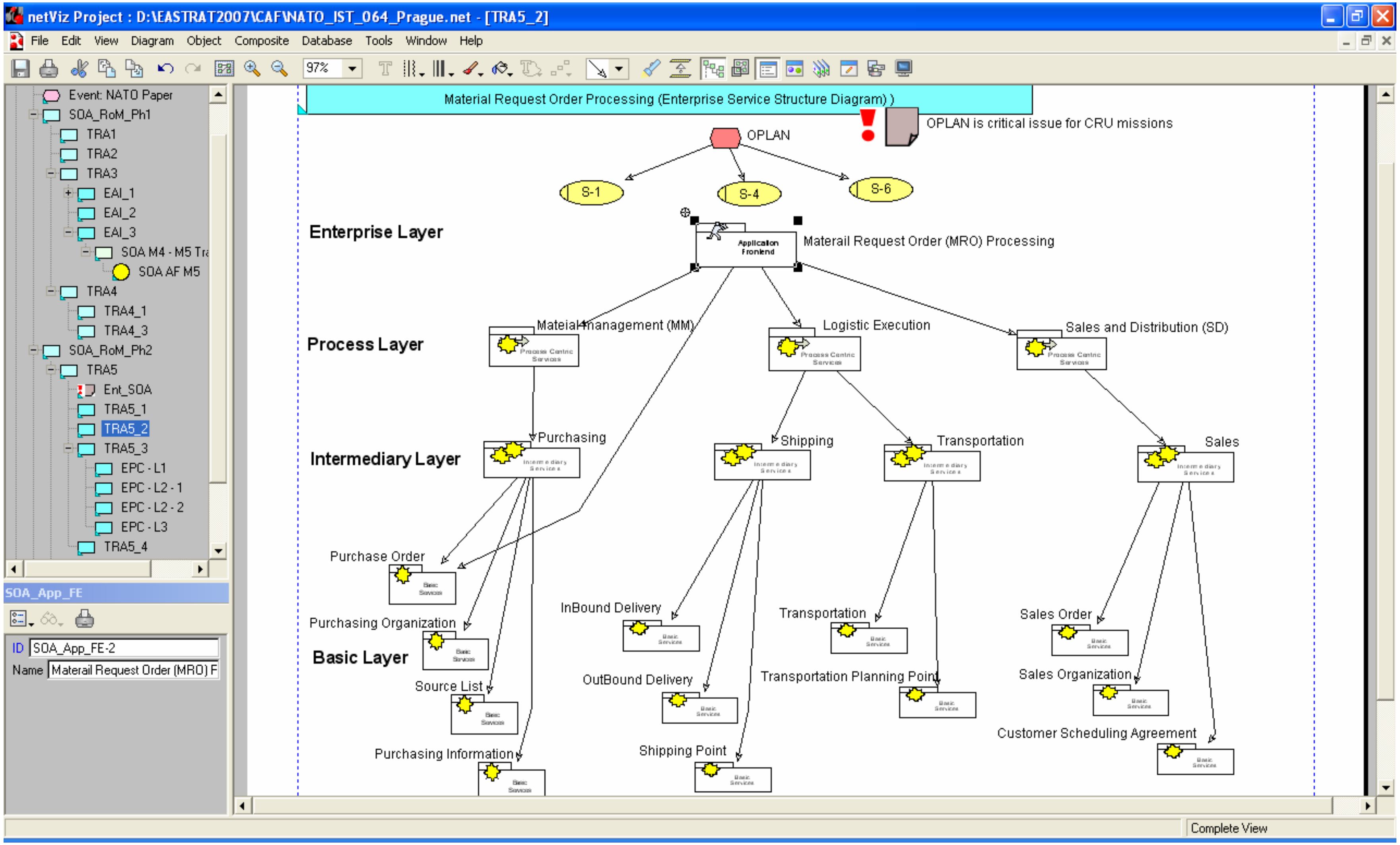

Figure 13: Enterprise Service Structure Diagram: MRO Process Decomposition.

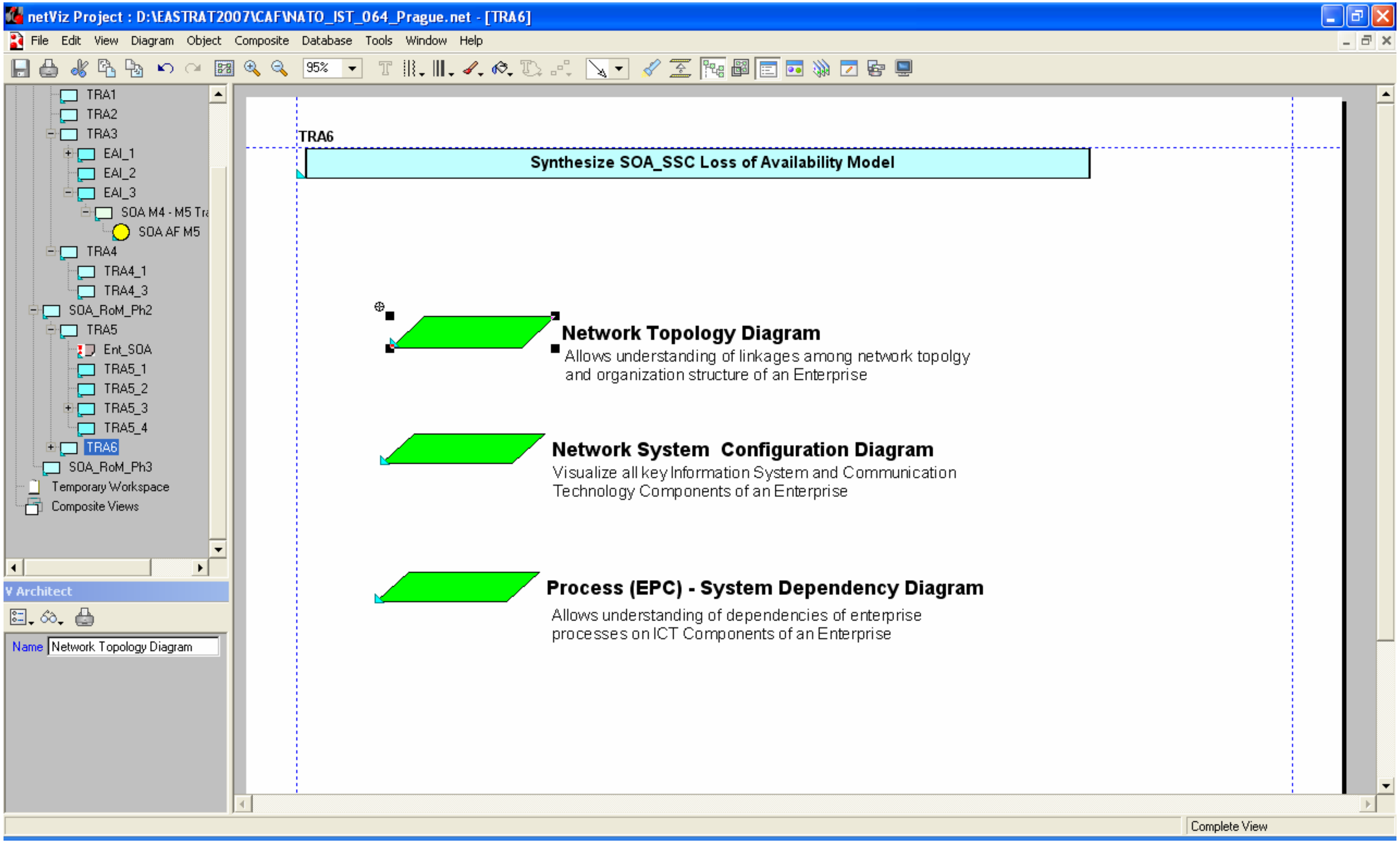

Figure 14: Main Parts of the SOA SSC Loss of Availability Model.

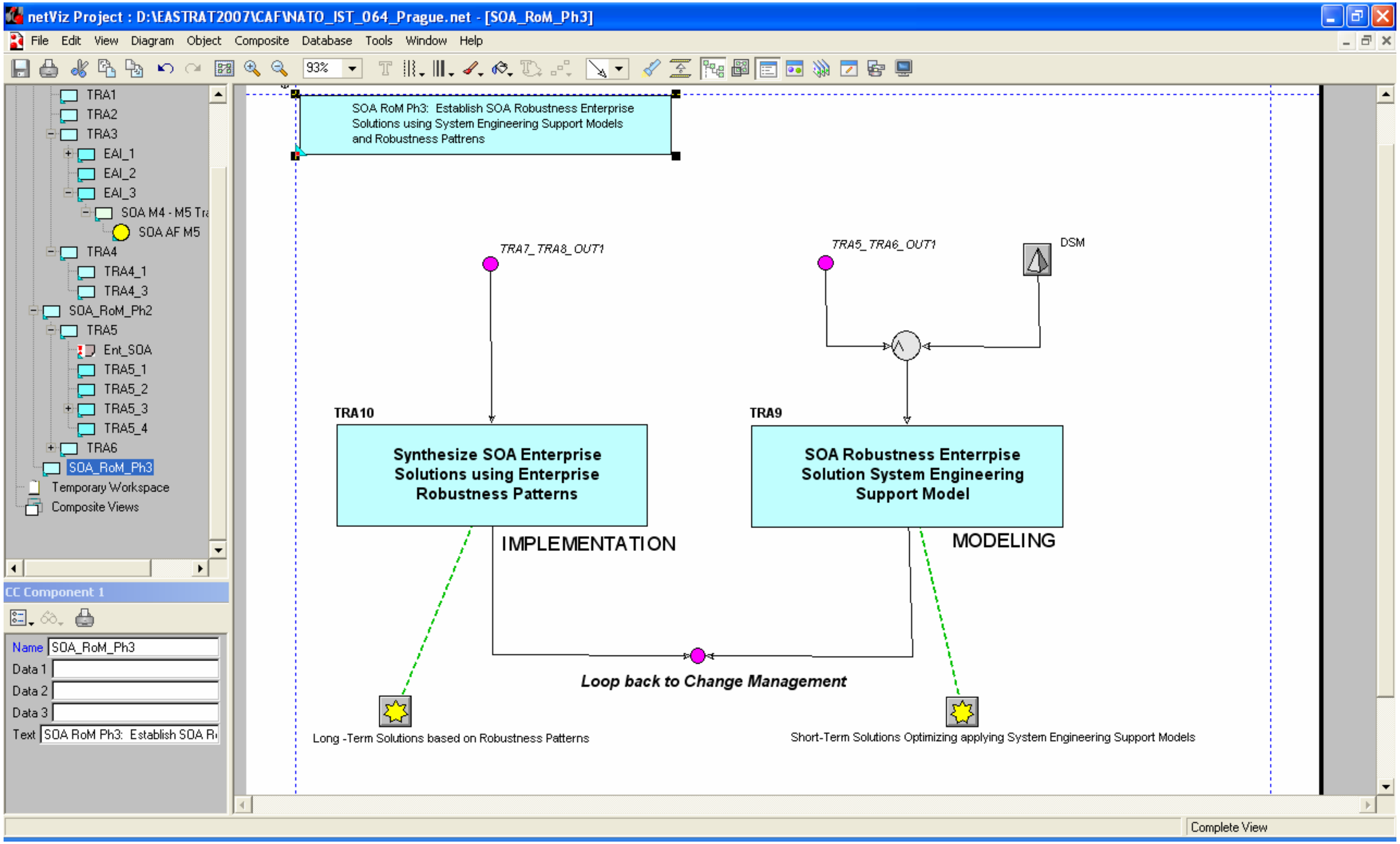

Figure 15: Last Two Tracks of the Robustness Based SOA Roadmap.

High-Availability products are more expensive and require more sophisticated maintenance then standard products. As architects we must be sure that ways how we apply these products improve system stability without negative impacts to enterprise agility.

System engineering let us solving this kind of problems. Loss of Availability Models capture all aspects of process impacts from process owners' perspective and allow architects understanding dependencies of business processes on Enterprise Technology Infrastructure. Risk Analysis and Risk Management (RARM) Models allow us controlling of risk levels on acceptable level. Robustness is one of key issues that participate in risk management. RARM Models in a combination with Decision Support Models (DSM) let us involving Robustness directly into BOCR (Benefits, Opportunities, Cost, and Risk) decision process. All these system engineering models can be further applied during SOA life cycle significantly increasing overall system stability and availability (see Figure 7).

Robustness patterns address primarily bottom two layers in the Enterprise SOA – Basic and Intermediary (Figure 12). These two layers are subject of enterprise application architects' interest [1,10,11]. Patterns of Enterprise Application Architecture can be principally enhanced with robustness methods and properties but it is not easy job. Object oriented programming experience is not enough because requirements for robustness must be derived from dynamic behavior of services in enterprise context. Managing process integrity is a nice example how designers can identify requirements for dynamic behavior of SOA services [17]. Designer starts with analysis of technical failures and business exceptions. Technical Concepts for Robustness can be design using one or more approaches:

- Logging and Tracing.
- ACID (Atomicity, Consistency, Isolation, and Durability) Transactions.
- Transaction Monitors and distributed 2PC (Two-Phase Commit Protocol).
- Nested and Multilevel Transactions.
- Persistent Queues and Transactional Steps.
- Transaction Chains and Compensation.

5.0 CONCLUSION

Robustness based SOA Roadmap is very effective way of management in situations when SOA strategy has harmonizing technological capabilities with business process changes. It allows flexible combination of two kinds of efforts. First, oriented to Short-Time solutions uses power of the System Engineering Support; second approach dives into lower layers of the Enterprise SOA increasing their stability and availability.

The topic discussed in this paper stimulates few interesting research activities for near future:

- Enterprise Integration Model for Scenario Risk Analysis (Figure 3) opens an opportunity to show high available products outcome [20] in the context of enterprise risk analysis and risk management.
- SOA Robustness Decision Support Model (Figure 10) can be developed as etalon model supporting decision makers responsible for SOA deployment.
- SOA Services Scenario Concepts (Figure 11) in a combination with Loss of Availability Model (Figure 14) significantly improve communication between business process owners and robustness designers linking processes understandable to owners with robustness solutions developed by designers.

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Appendix 1: The Decision Support Model for a Choice of "The Best Solution Based on SOA Robustness"

Appendix 1 describes very simple AHP model that allows choosing the most optimal alternative using criteria for their comparison.

Model structure is depicted in the Figure 1. Alternatives represent high-availability products described by Frederic Michaud and Frederic Painchaud ("High-Availability Solutions to Common Software Failures"). In accordance with AHP methodology we firstly design preferences for chosen criteria and then we compare alternatives across each criteria respectively sub-criteria.

Figures 2 – 7 show characteristic snapshots used by decision makers.

Figure 2 shows finial model in which all preferences were successfully calculated and checked for integrity.

Figure 3 visualize final preferences; the most preferable high-availability solution is alternative A2 – Microsoft Clustering Services; the second best is alternative A1 – Marathon everRun.

Figure 4 illustrates very different performance of alternatives for different criteria. For example alternative A2 has very high performance in criteria C2 (Adding Value), but very low in criteria C4 (Cost). Alternative A5 (Linux) has very low performance in criteria C1 but very high in criteria C4.

In situation like just described decision makers want to avoid mistakes that relate to criteria preferences calculations. Dynamic graphs allow us elaboration with other criteria preferences.

Figure 5 depicts starting situation (Alternative A2 is the most preferable).

Figure 6 illustrates the situation when decision maker increases preference for criteria C1 (Availability Improvement) from 19.1 % to 28.5 %. We can see that preferences of alternatives become different – the winner is alternative A1.

In figure 7 we increased preference for criteria C5 (Cost) from 10.9 % to 33.2 %. A1 is still the winner but followed by alternative A5 (Linux).

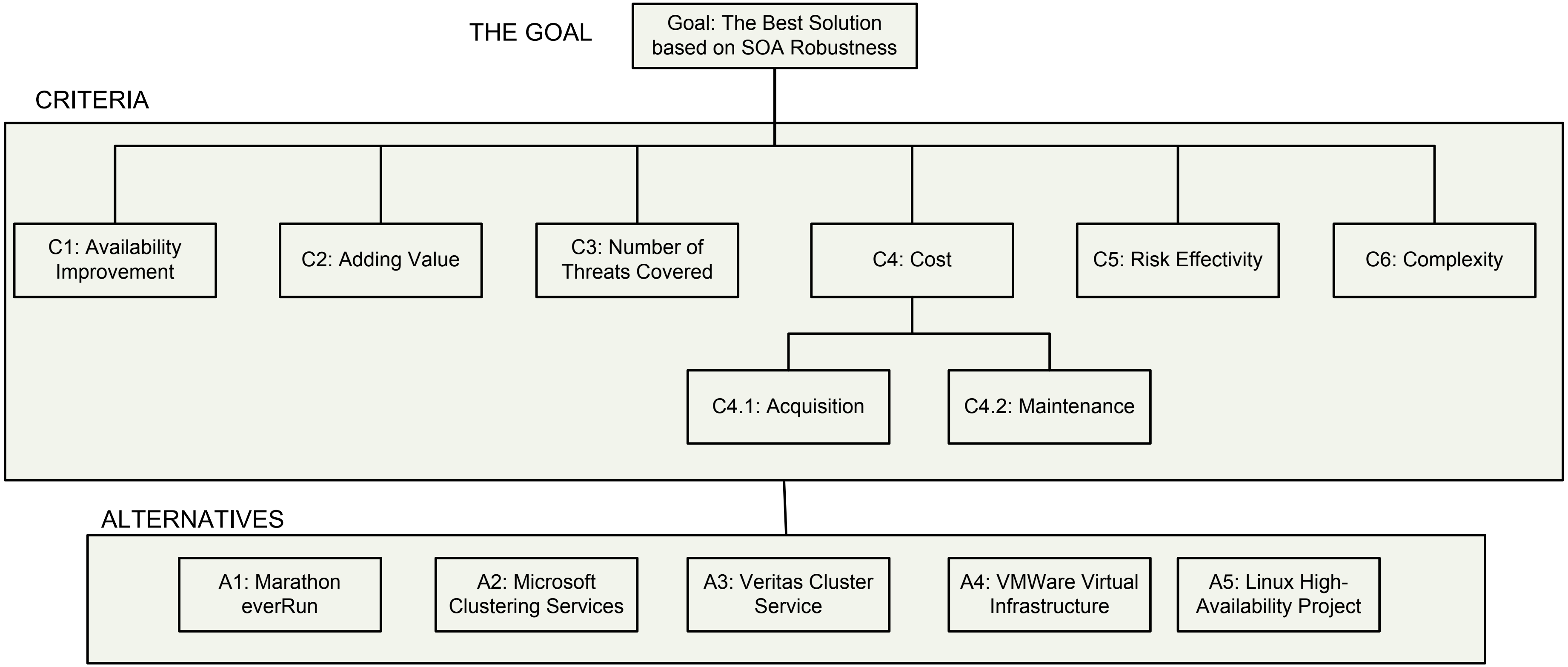

Figure 1: Decision Model Structure.

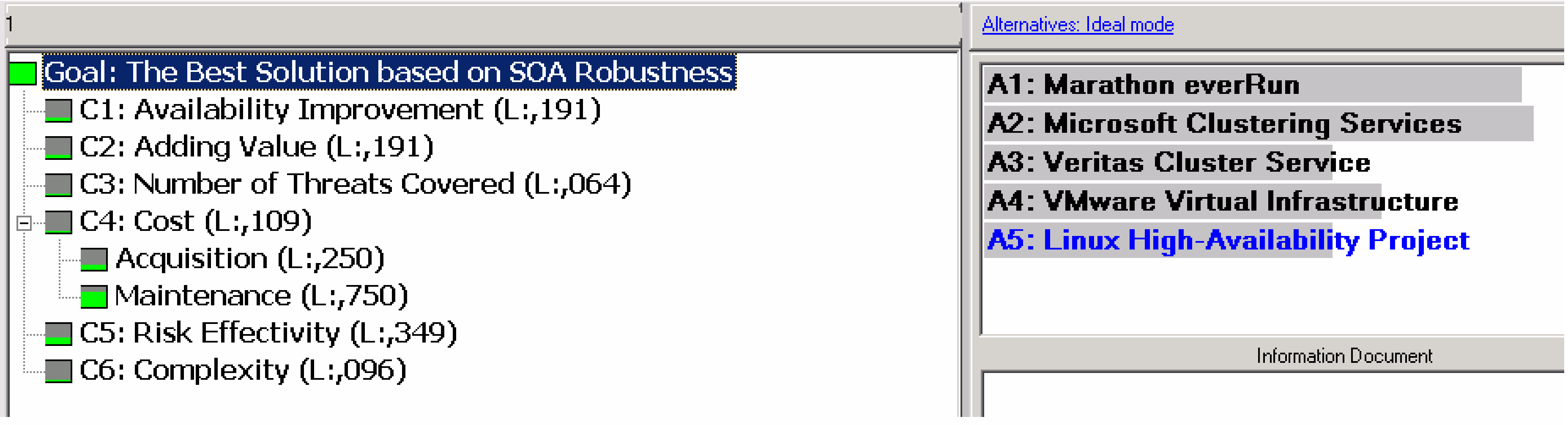

Figure 2: Final Decision Support Model in which All Calculations were Successfully Finished.

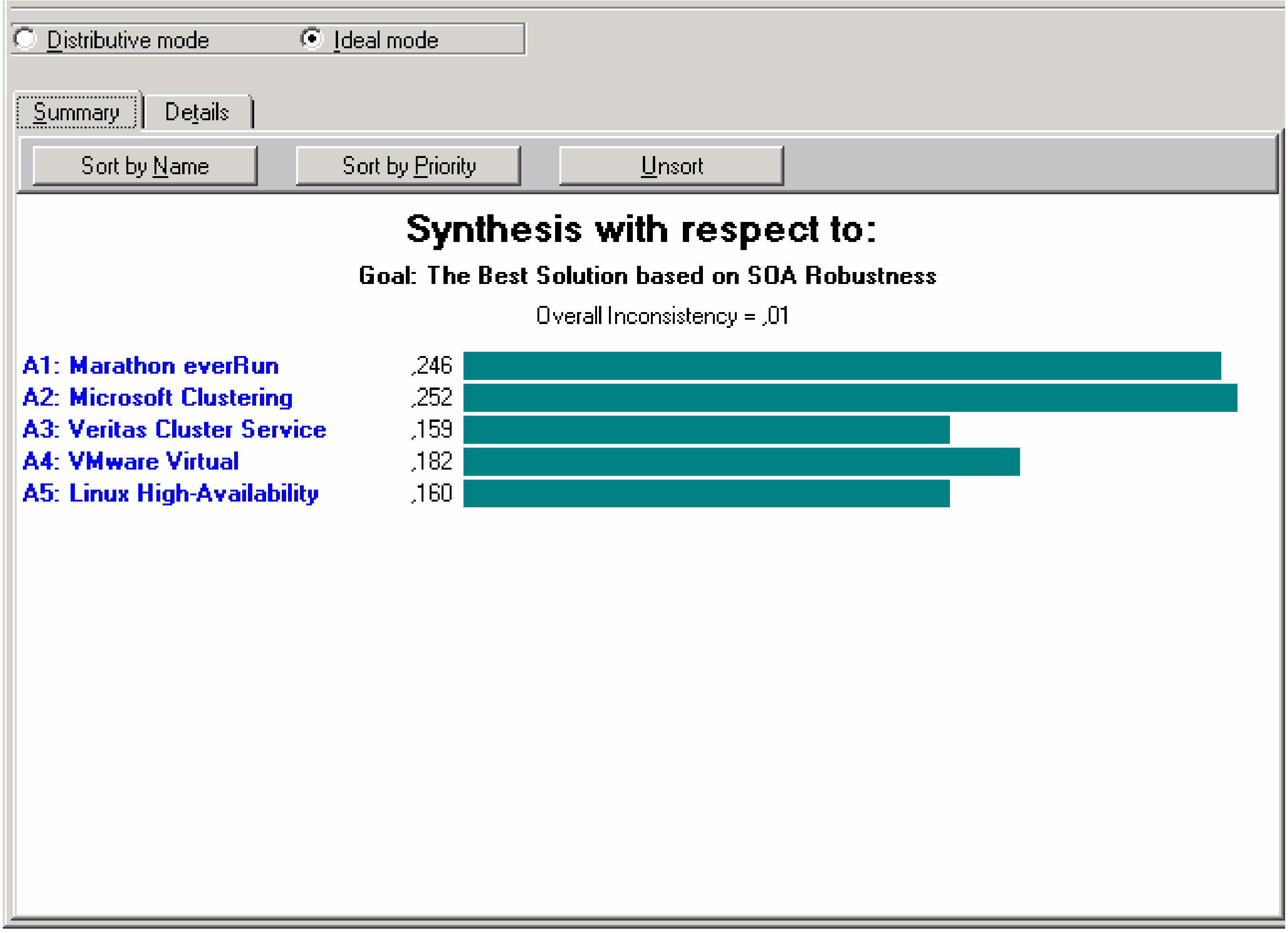

Figure 3: The Winner Alternative is A1 – Microsoft Clustering Services; the Second Best Alternative is Marathon everRun. We want to know more about decision making process and we use Performance graph in accordance with next figure.

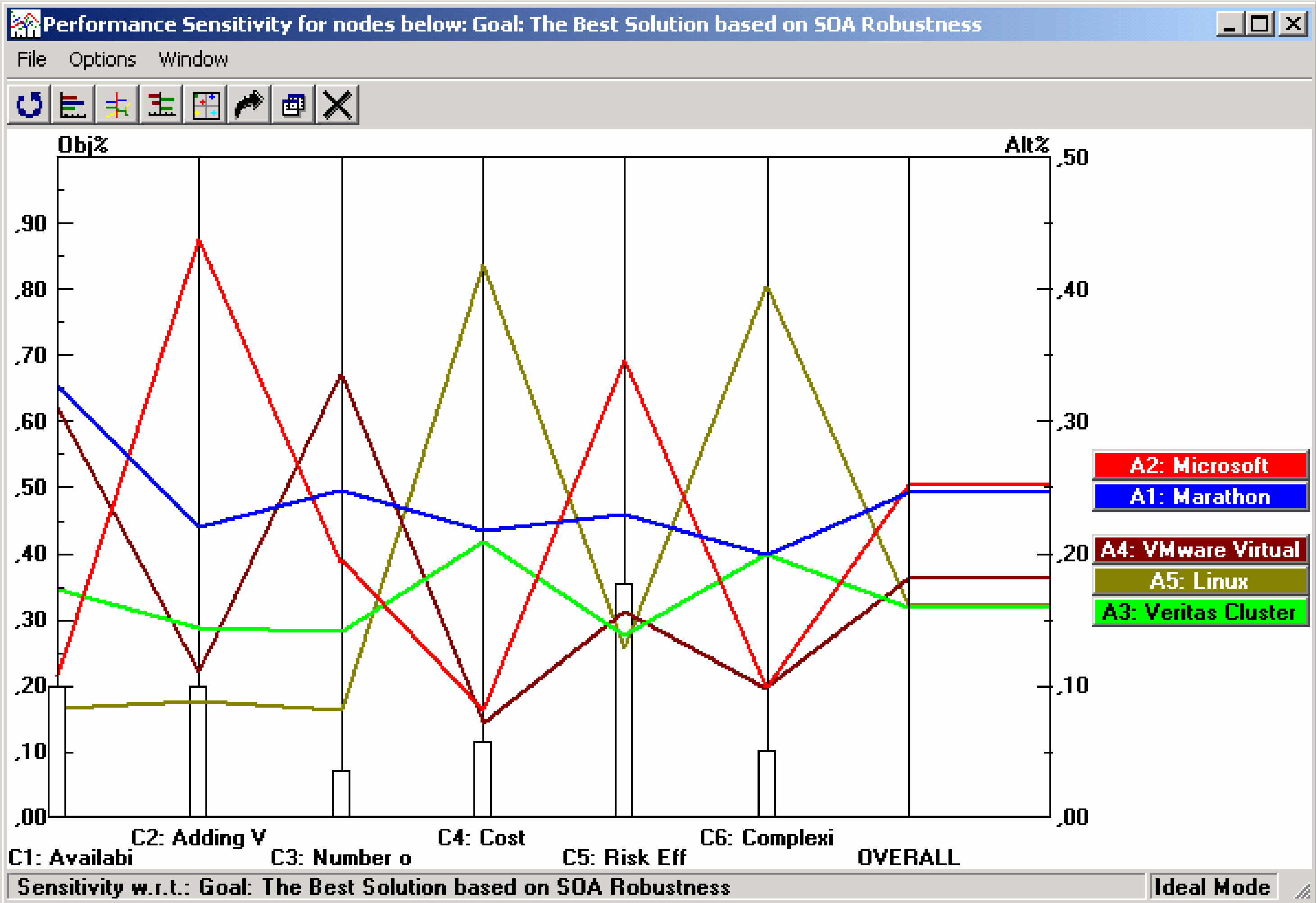

Figure 4: Performance Graph Shows very Different Behavior of Alternatives in Dependency on Particular Criteria. Because alternatives are so heavily dependent on criteria and their preferences we want to know how situation could change in the case that we change preferences among criteria.

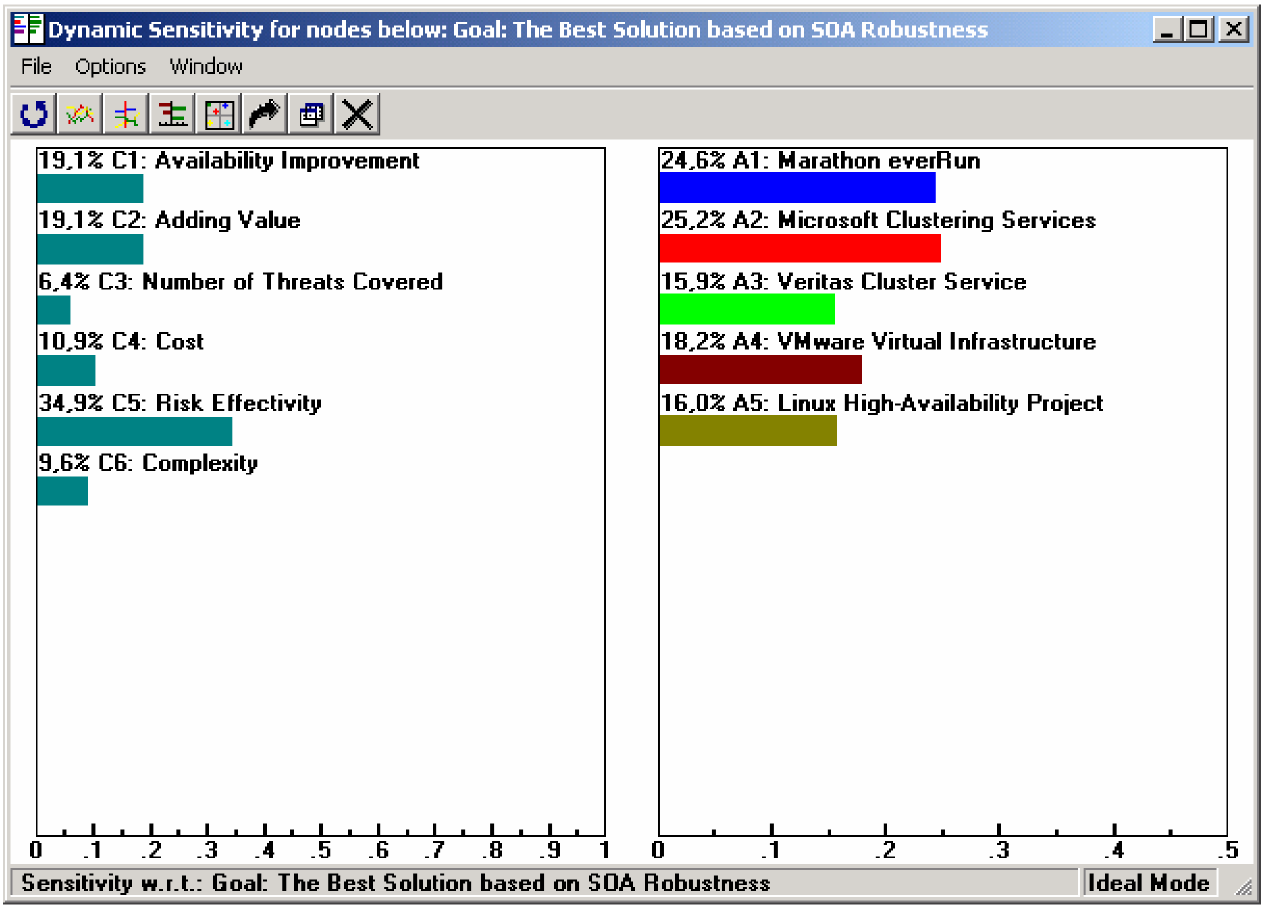

Figure 5: Dynamic Graph let us Observe Influence how Criteria Preferences could Change Results of Our Decision. In this case we consider criteria preferences that results situation described in the Figure 3 (A2 winner, A1 second best).

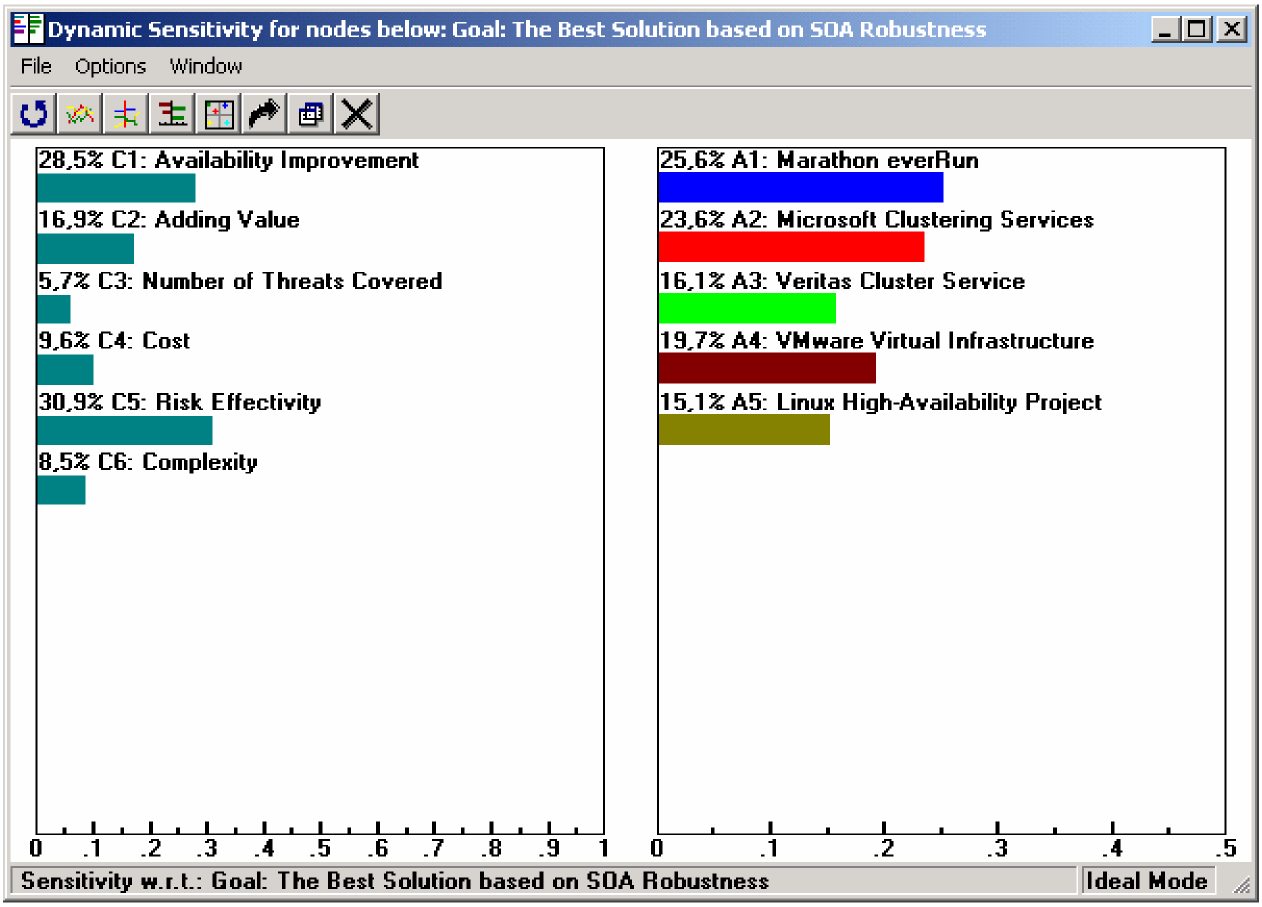

Figure 6: We have Increased Preference of the Criteria C1 (Availability Improvement) from 19.1 % to 28,5 %. We can see that preferences of alternatives become different – the winner is alternative A1.

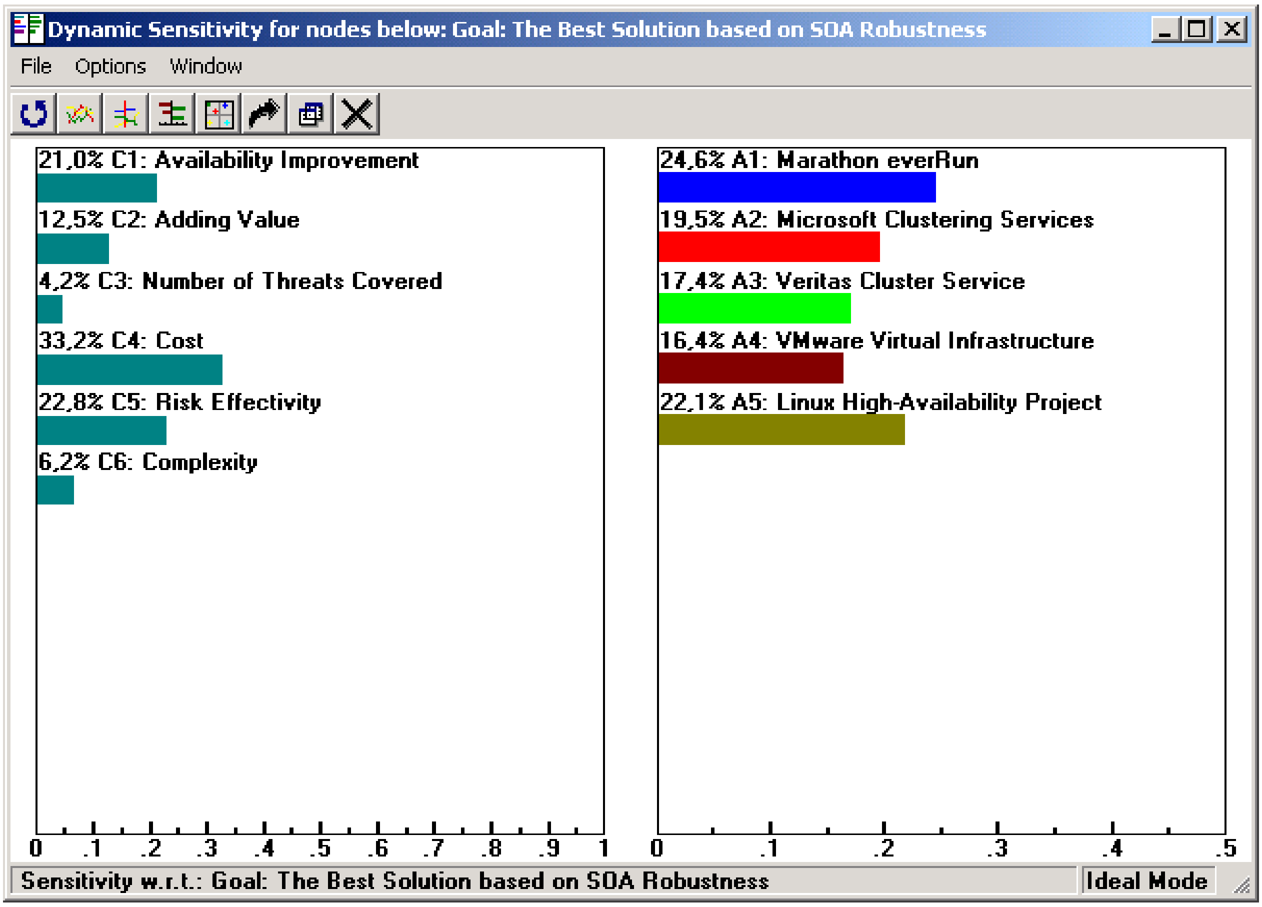

Figure 7: We have Increased Preference of the Criteria C5 (Cost) from 10.9 % to 33.2 %. A1 is still the winner but followed by alternative A5 (Linux).

Appendix 2: The Material Request Order (MRO) Process Sample

Appendix 2 describes scenario for MRO processing and how this scenario is applied for a synthesize of the Loss of Availability model. This sample let us understanding of tracks TRA5 and TRA 6 in the Robustness based SOA Roadmap.

Each scenario is developed in two synchronized tracks – TRA5 and TRA6 (Figure 1).

Figures 2 – 8 show snapshots characterizing SOA Services Scenario Concept (SOA SSC). Figures 9 – 13 show snapshots characterizing SOA SSC Loss of Availability model.

Figure 2. Four main parts of the SOA SCC – Organization Diagram, Enterprise Service Structure Diagram, EPC Diagram, and Service Interaction Diagram.

Figure 3. SOA SCC Organizing Diagram captures all key actors (organization units) involved in the MRO processing.

Figure 4. Enterprise Service Structure Diagram let us understanding SOA services hierarchy that must be available for the MRO processing.

Figure 5. EPC Diagram visualizes information and material flows among various organizational levels involved in the MRO processing. EPC diagrams are also applied for modeling inside each organizational level (see next figures).

Figure 6. Request for Material Order (MRO) appears at the tactical level and it is created by logisticians in the CRU Battalion.

Figure 7. The first superordinate organization unit that reacts to the battalion's MRO is the CRU Brigade.

Figure 8. Activities described as green blocks in EPC diagrams are supported by SOA services functionality that is a result of interaction among particular SOA services in accordance with Service Interaction Diagrams.

Last five snapshots deal with the SOA SSC Loss of Availability model.

Figure 9. Three main parts of the SOA SSC Loss of Availability model – Network System Configuration Diagram, Network Topology Diagram, and Process (EPC) – System Dependency Diagram.

Figure 10. Network System Configuration Diagram captures all ICT components that must be available for the MRO processing. ICT components are associated with network nodes.

Figure 11. Network Topology Diagram captures all organization units involved in the MRO processing. Organization units are associated with network nodes.

Figure 12. Process (EPC) – System Dependency Diagram copies EPC Diagram used for visualization of the MRO processing (see Figure 5).

Figure 13. Process (EPC) – System Dependency Diagram is applied for each organizational level involved in the MRO processing (Figure 11). It allows understanding of dependencies among events, functions, and information objects (services) and ICT components.

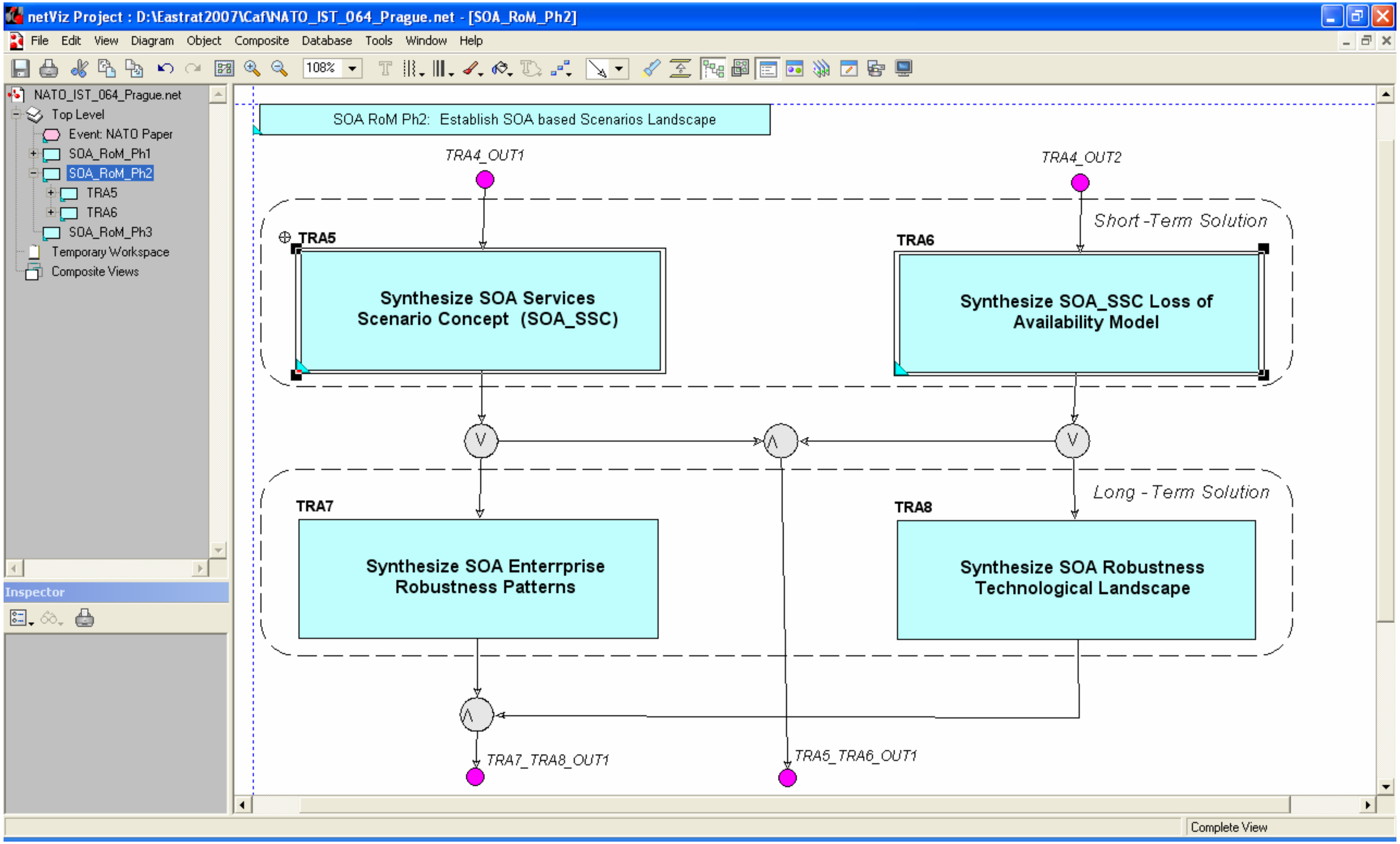

Figure 1: Each SOA Services Scenario is Developed within Two Synchronized Tracks TRA5 and TRA6.

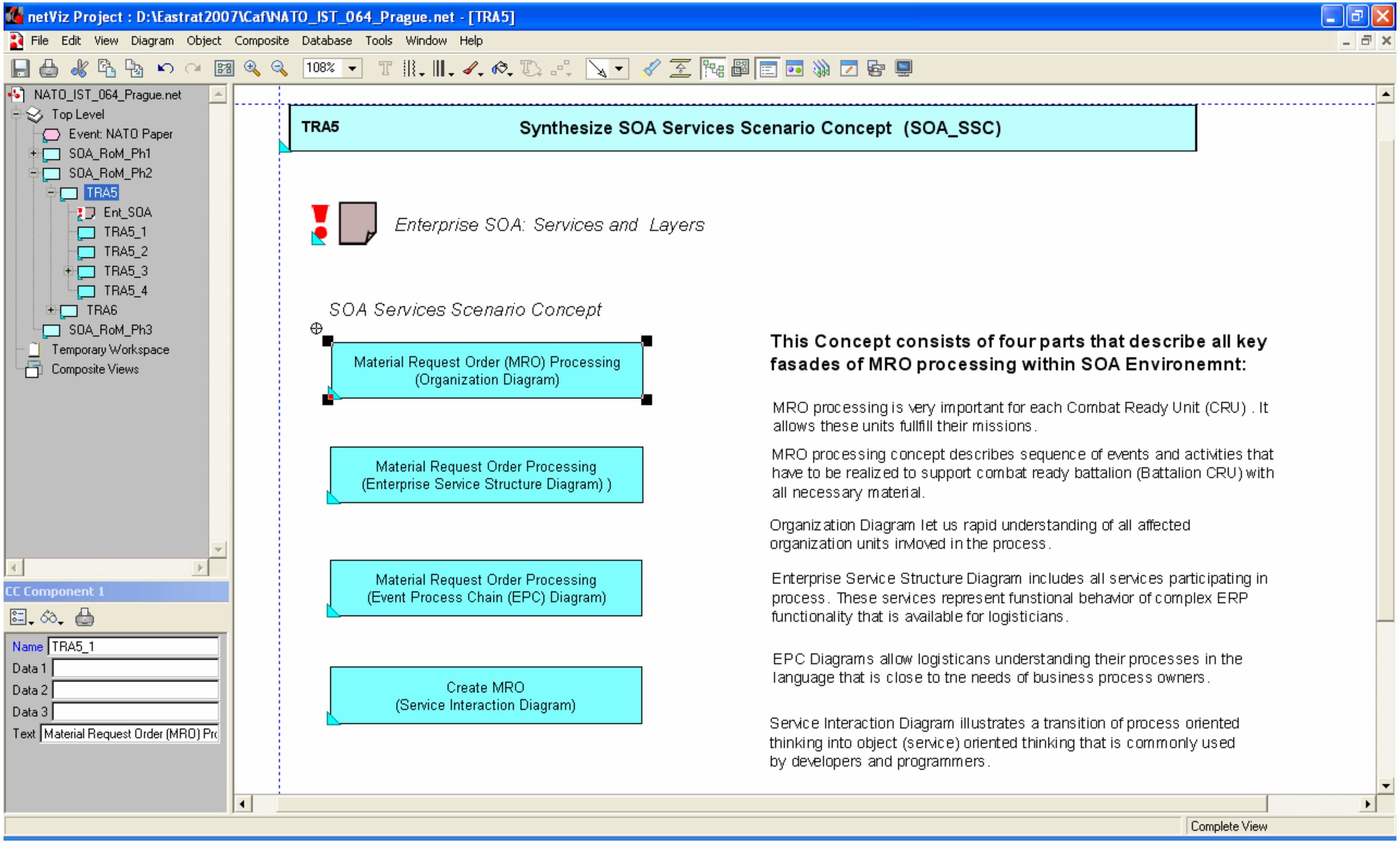

Figure 2: Four Main Parts of the SOA SCC – Organization Diagram, Enterprise Service Structure Diagram, EPC Diagram, and Service Interaction Diagram.

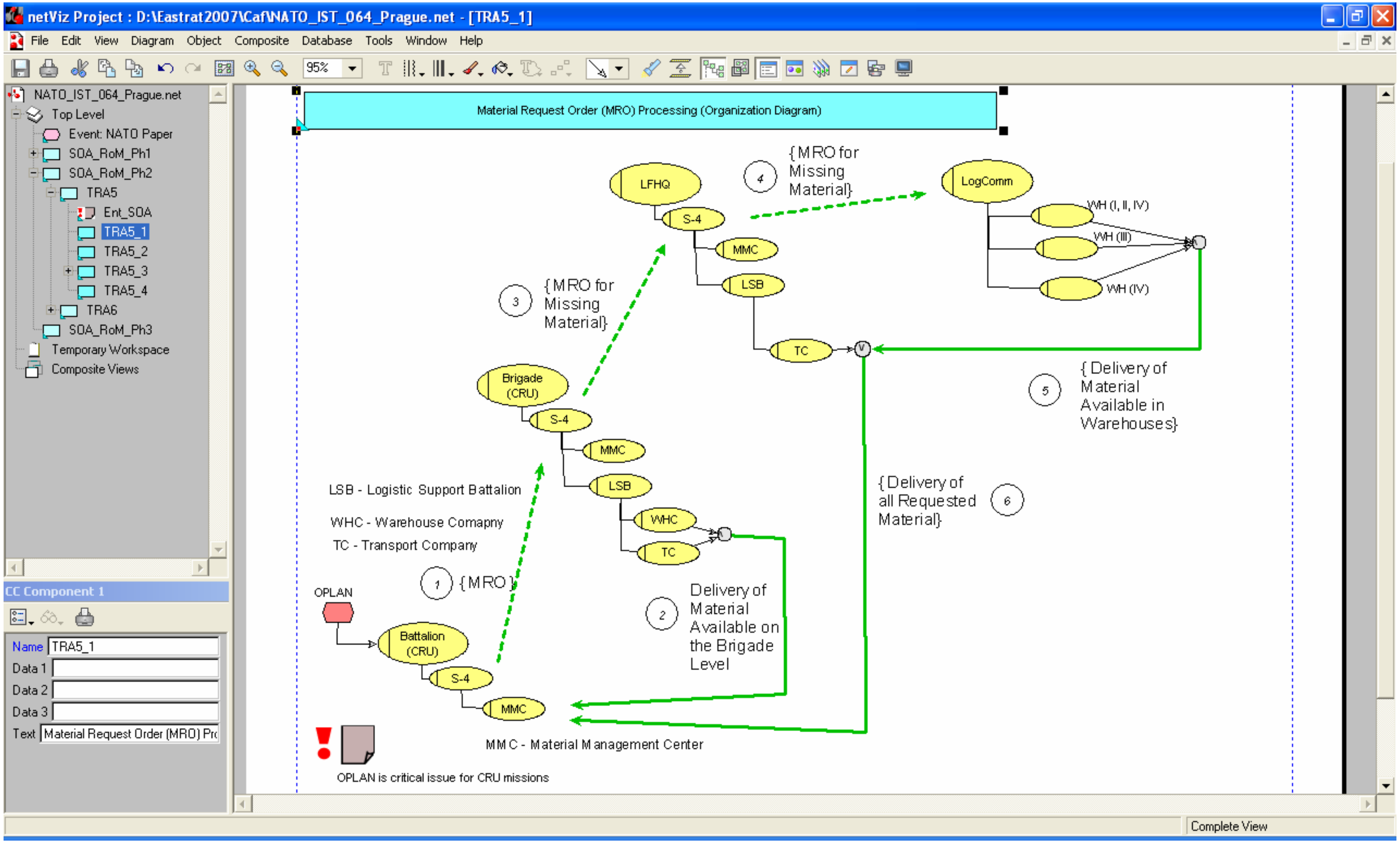

Figure 3: SOA SCC Organizing Diagram Captures All Key Actors (Organization Units) Involved in the MRO Processing.

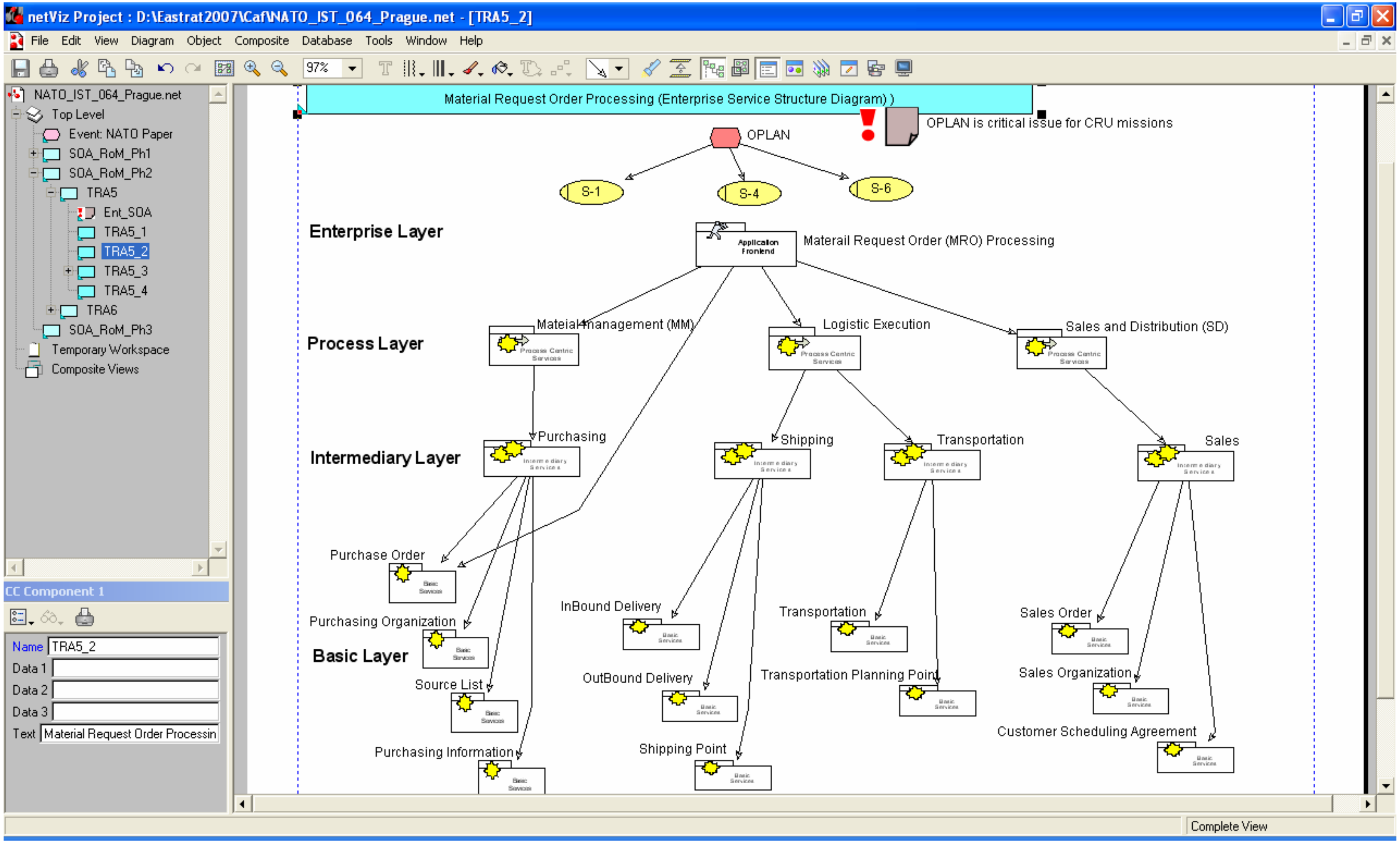

Figure 4: Enterprise Service Structure Diagram let us Understanding SOA Services Hierarchy that Must be Available for the MRO Processing.

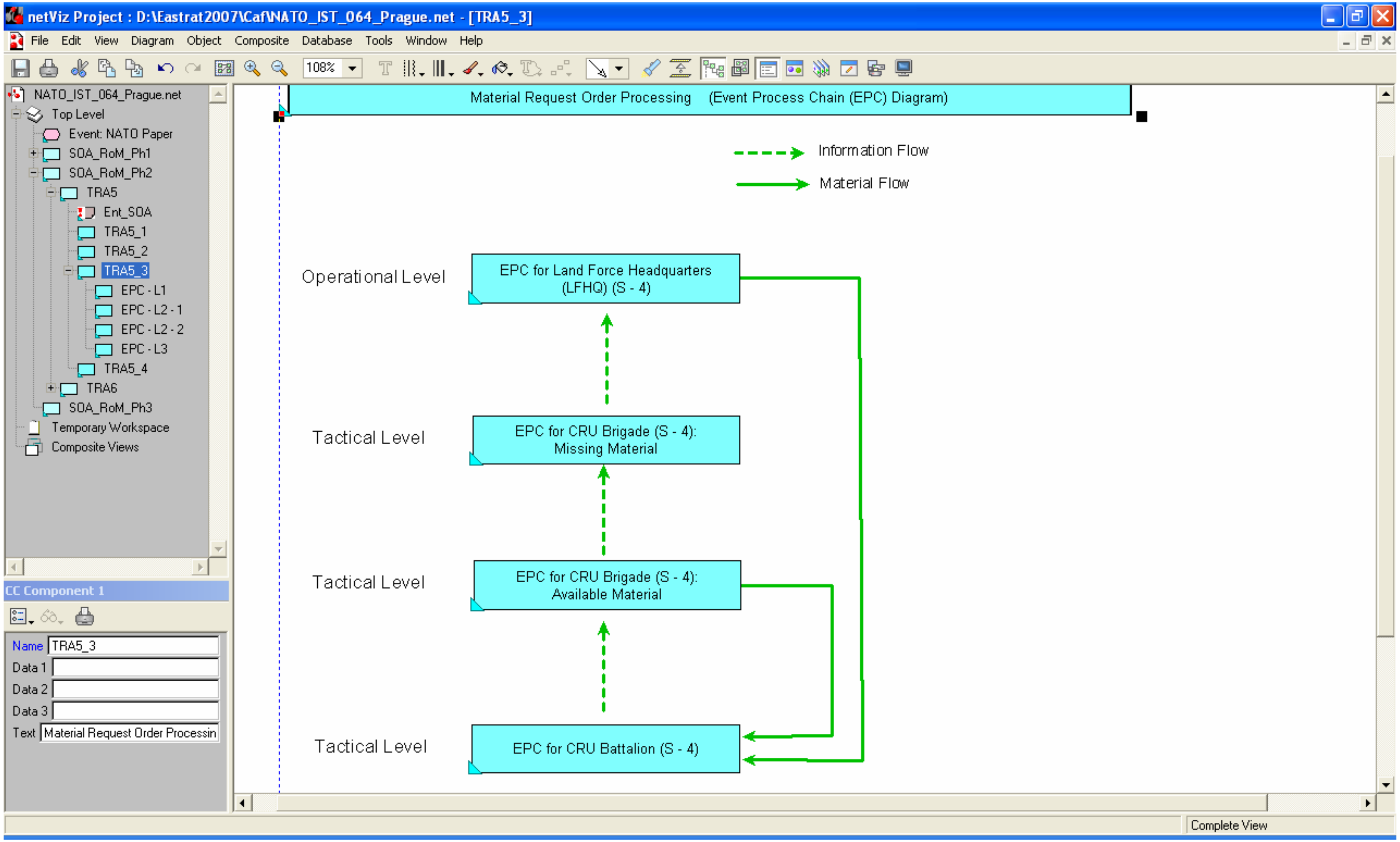

Figure 5: EPC Diagram Visualizes Information and Material Flows among Various Organizational Levels Involved in the MRO Processing. EPC diagrams are also applied for modeling inside each organizational level (see next figures).

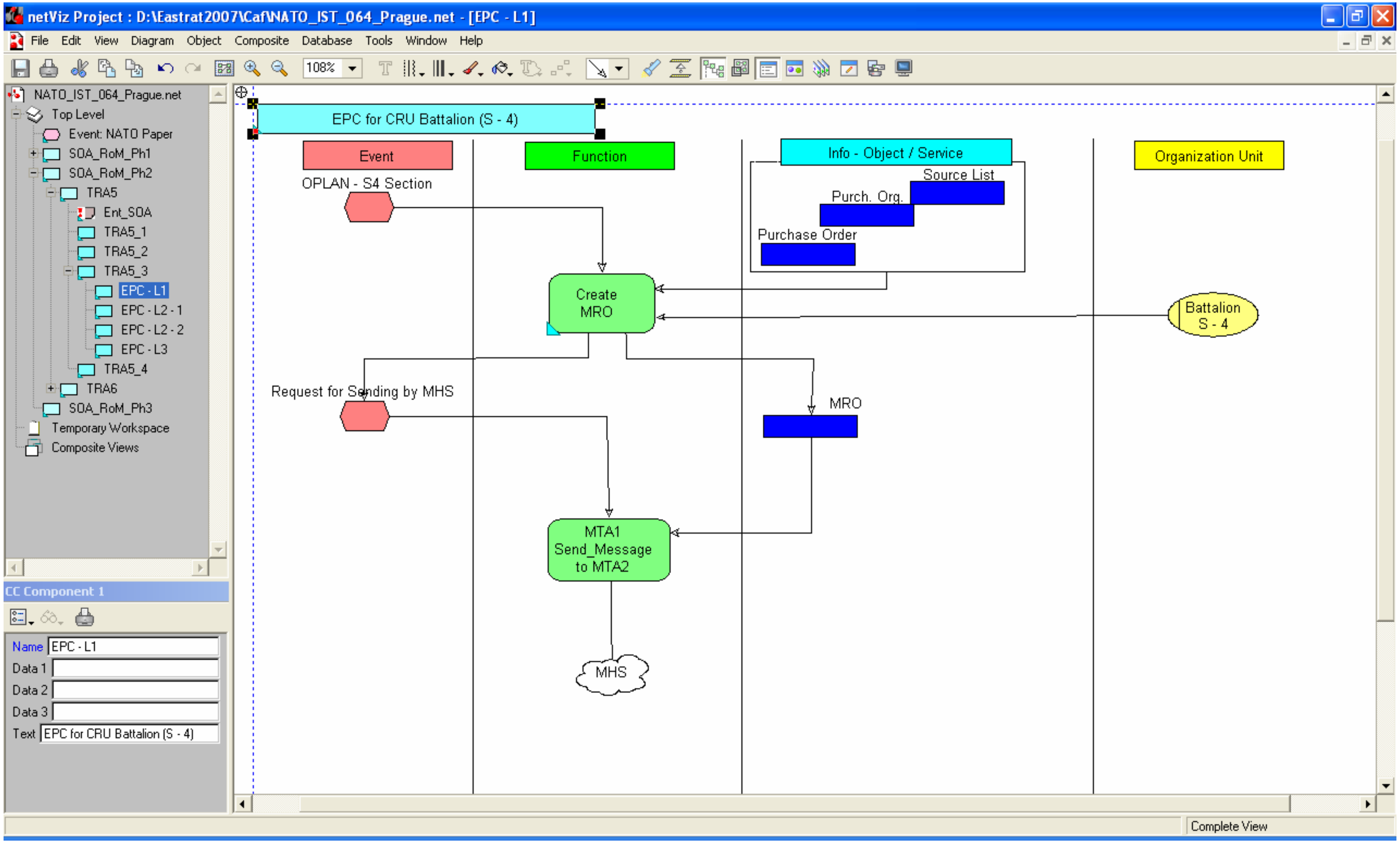

Figure 6: Request for Material Order (MRO) Appears at the Tactical Level and it is Created by Logisticians in the CRU Battalion.

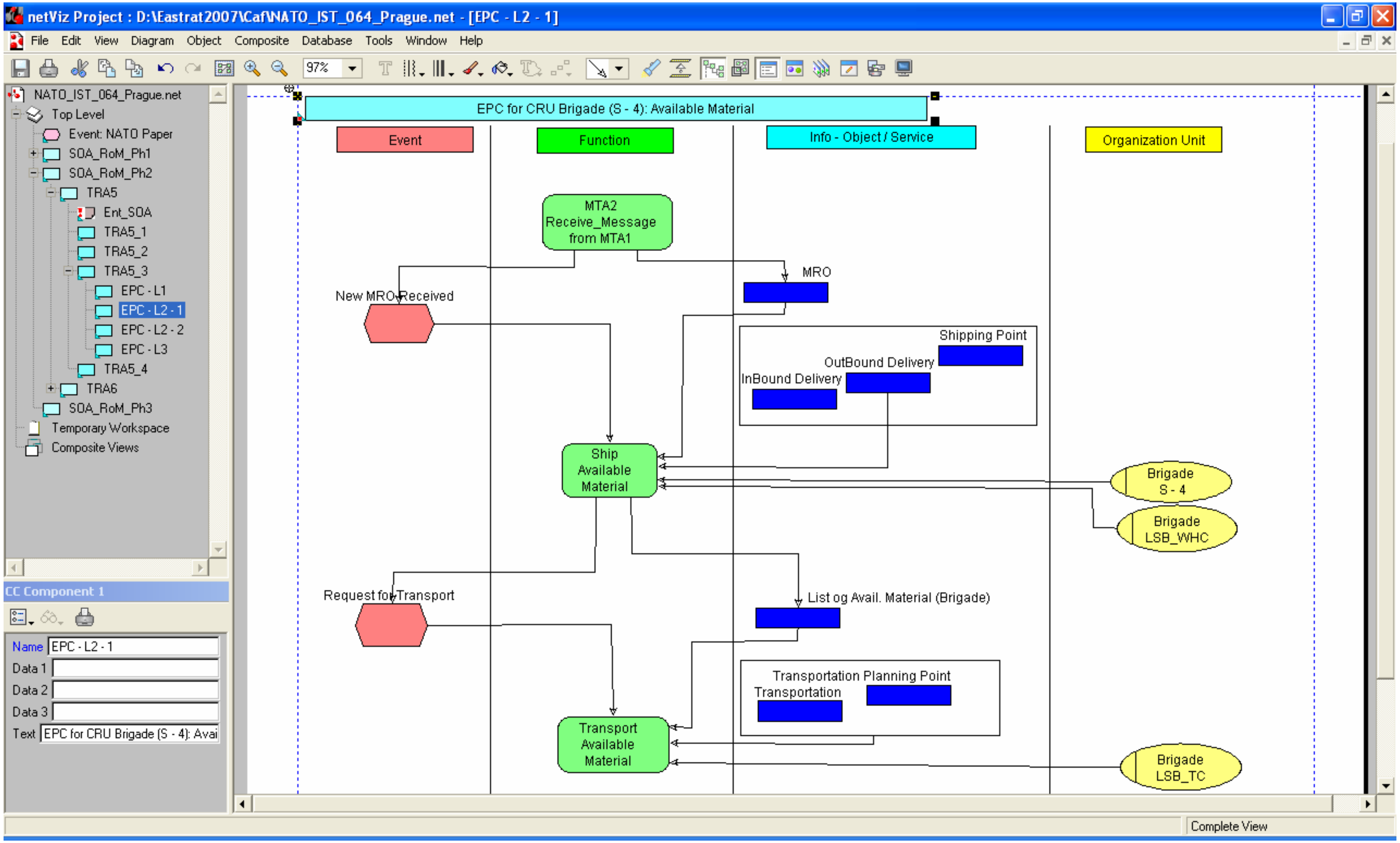

Figure 7: The First Superordinate Organization Unit that Reacts to the Battalion's MRO is the CRU Brigade.

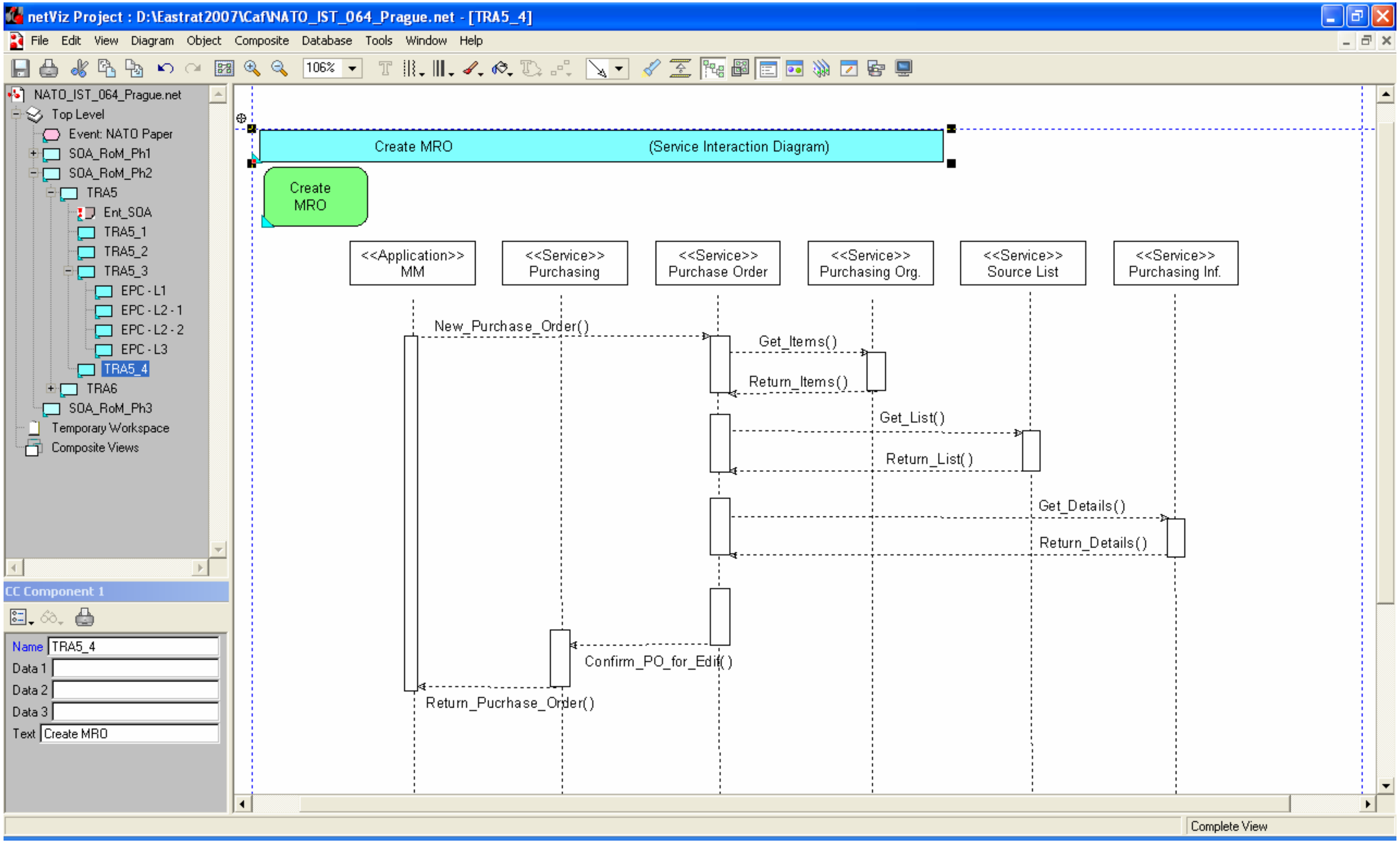

Figure 8: Activities Described as Green Blocks in EPC Diagrams are Supported by SOA Services Functionality that is a Result of Interaction among Particular SOA Services in Accordance with Service Interaction Diagrams.

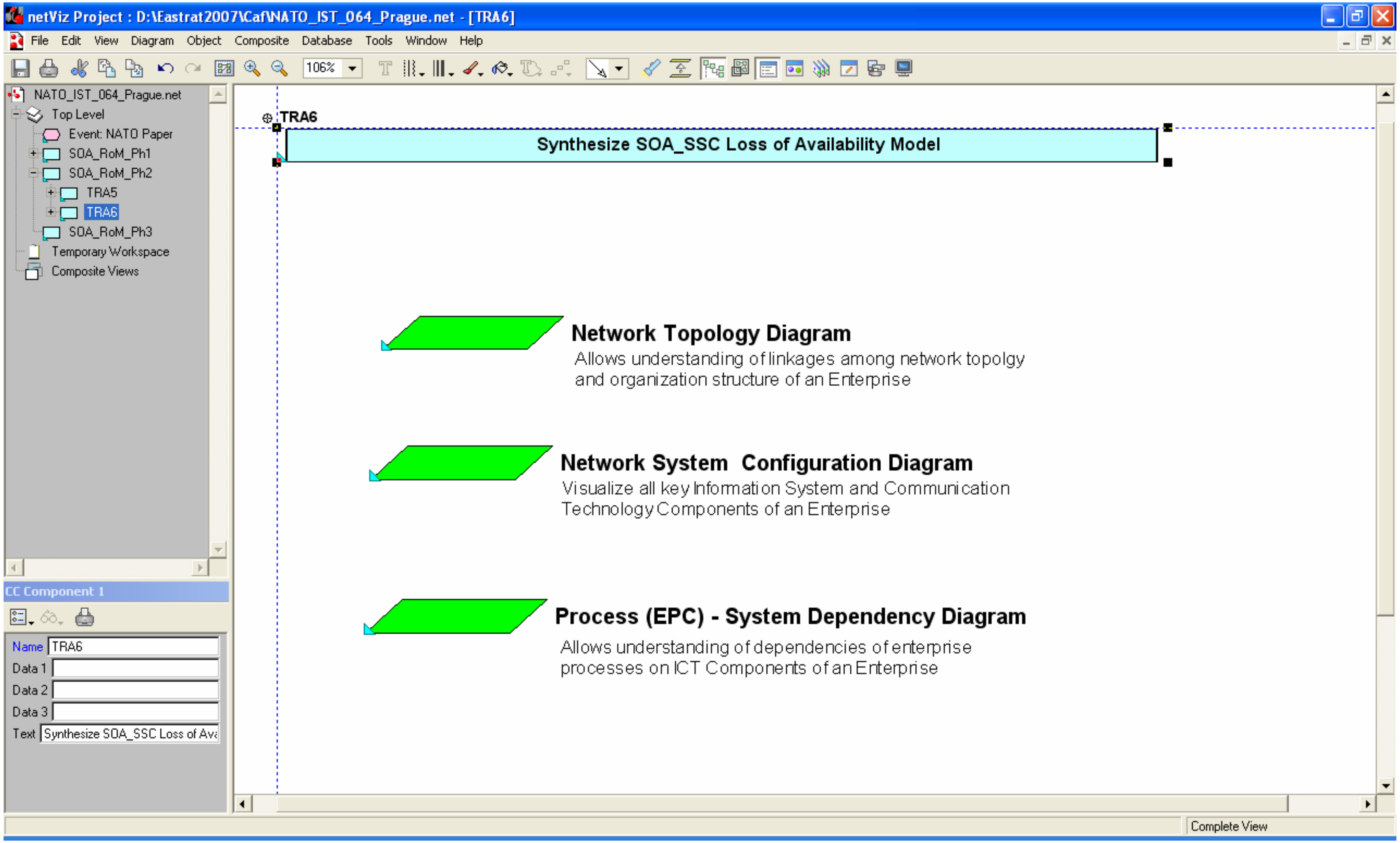

Figure 9: Three Main Parts of the SOA SSC Loss of Availability Model – Network System Configuration Diagram, Network Topology Diagram, and Process (EPC) – System Dependency Diagram.

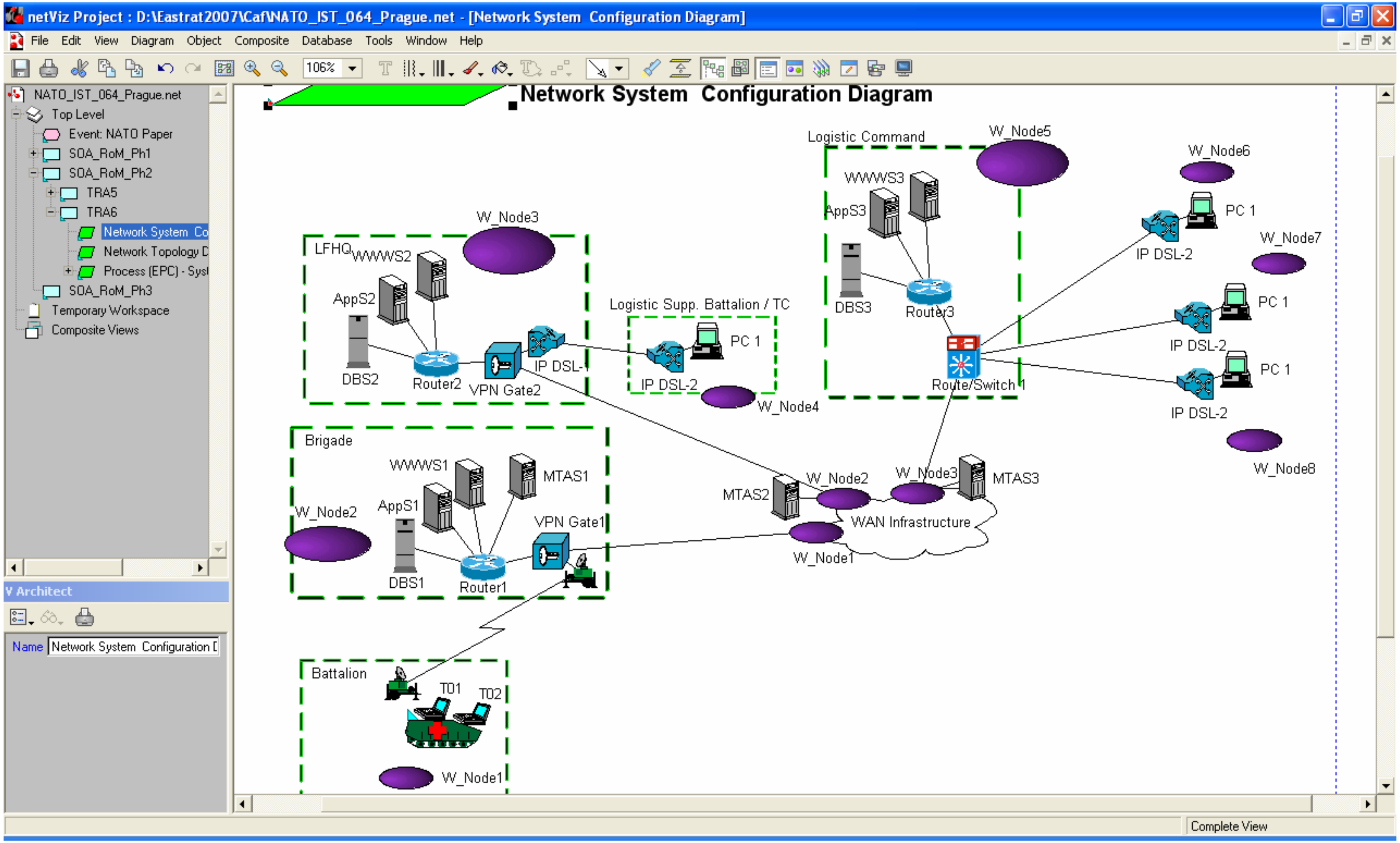

Figure 10: Network System Configuration Diagram Captures All ICT Components that Must be Available for the MRO Processing. ICT Components are Associated with Network Nodes.

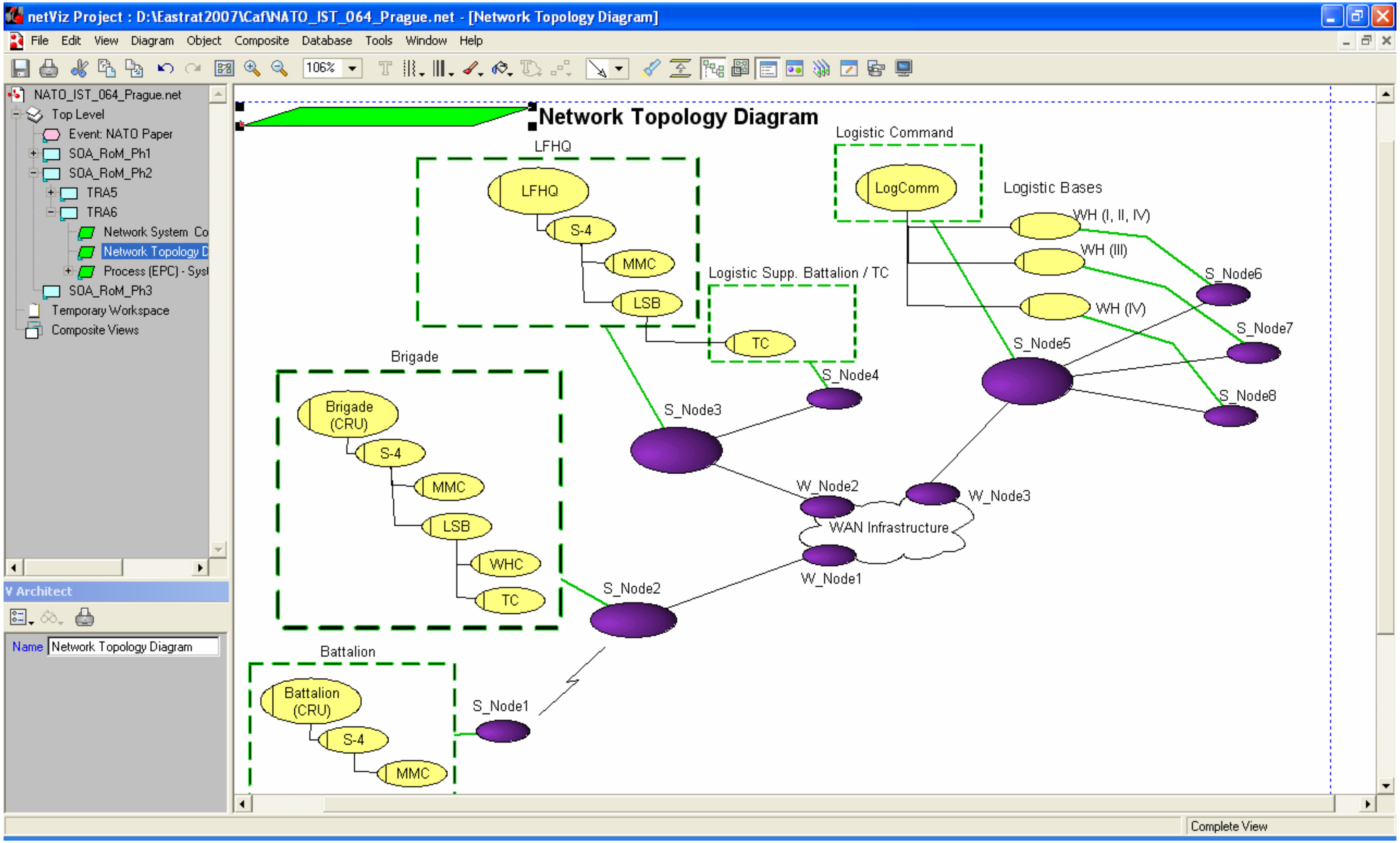

Figure 11: Network Topology Diagram Captures All Organization Units Involved in the MRO Processing. Organization units are associated with network nodes.

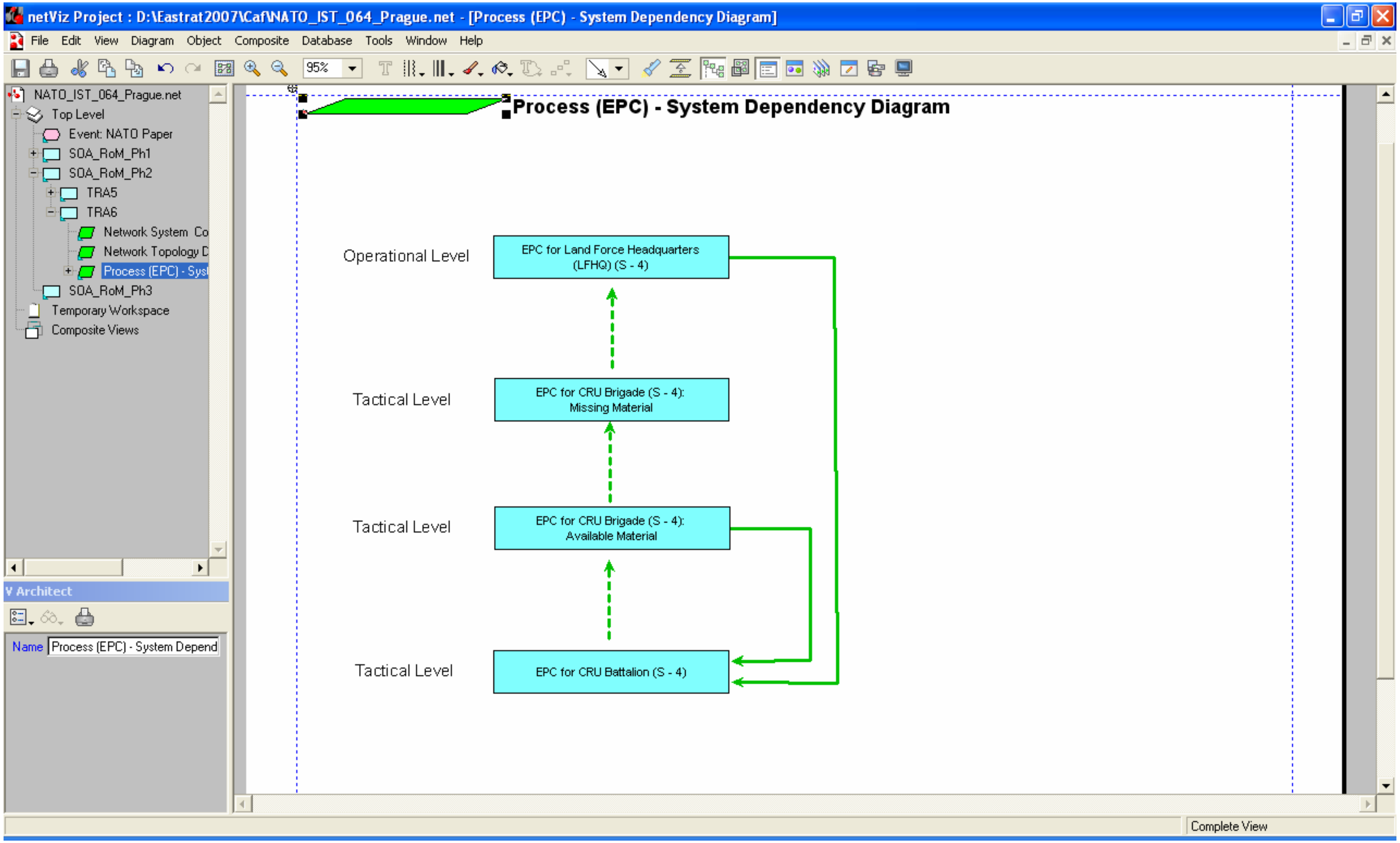

Figure 12: Process (EPC) – System Dependency Diagram Copies EPC Diagram Used for Visualization of the MRO Processing (see Figure 5).

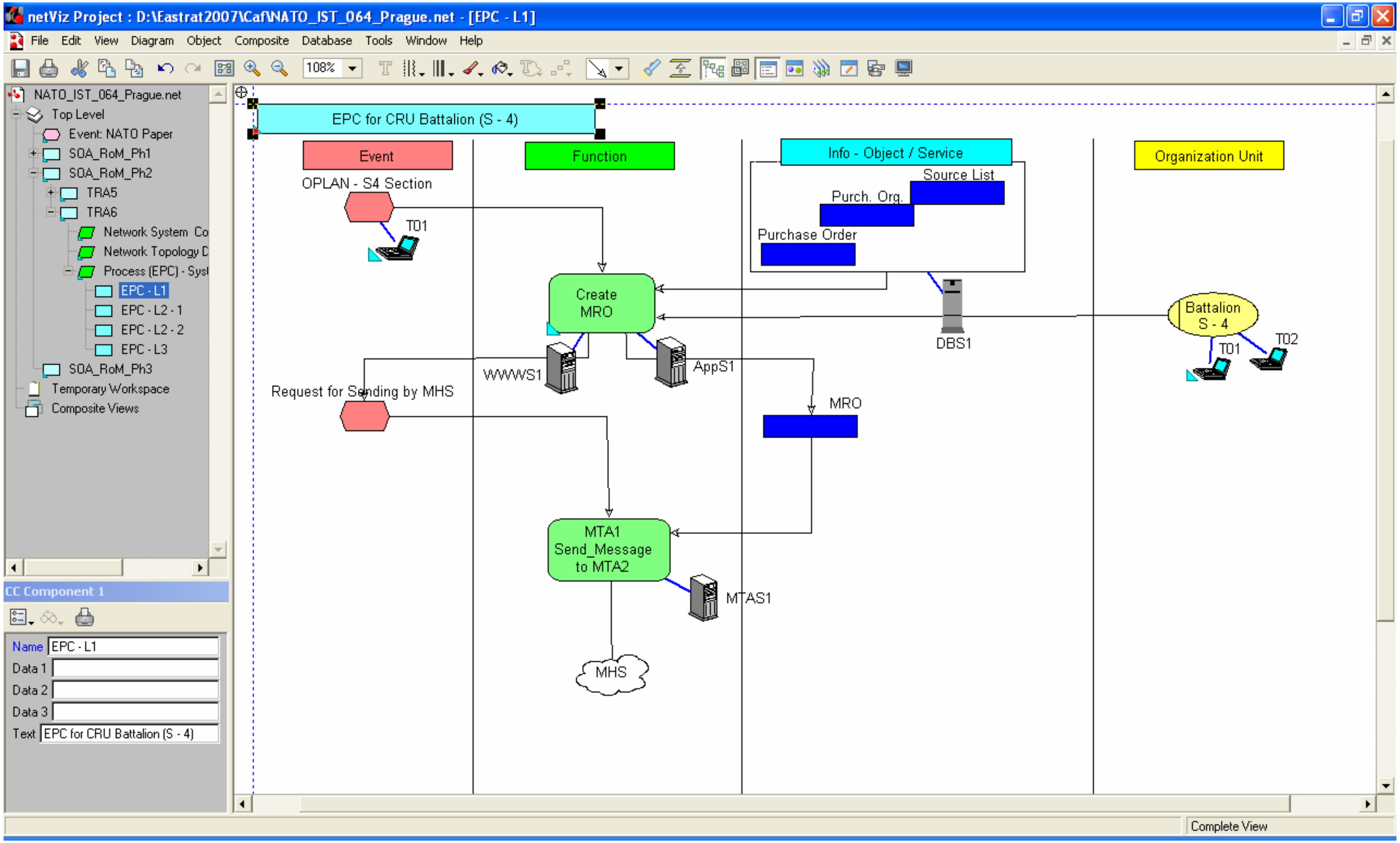

Figure 13: Process (EPC) – System Dependency Diagram is Applied for Each Organizational Level Involved in the MRO Processing (Figure 11). It allows understanding of dependencies among events, functions, and information objects (services) and ICT components.