Chapter 4

Situation Awareness Process

Situation awareness is defined along with the process, configuration and other related details in Chapter 2. A comprehensive modeling strategy appropriate for the situation awareness for complex dynamical system is introduced in Chapter 3. Conceptual models provided step-by-step building process to capture all the required features of UoD. The attributes are carefully selected and captured using empirical methods. This being supported by information and communication technology infrastructure, implementation strategy provides modeling in software environment.

From conceptual modeling to realization, the coordinating agency must cover all the required aspects. With the scale and complexity involved, collaboration from multiple individuals and organizations are required. In this scenario, the consistency and interoperability becomes important. Section 2.4.4 introduce the situation awareness process that provides guidance to large collaborations.

The process content should identify roles, tasks and work products needed to cover complete requirements. These unit elements should be created, organized in to groups and delivered to appropriate actors. Similar to the modeling effort, the task of authoring the process itself becomes complex and requires continuous collaborations from experts. A meta-level solution is required that can guide the collaborative process. These experts should identify workflows for set of role players in realizing a complex task. To support collaboration from users, work breakdown structure of complex activity, work allocation logic, work estimation and other aspects should be recommended. These provisions allow handling of work according to project management discipline.

The meta-level solution must allow identification and handling of task allocation. The monitoring and tracking of activities should also be supported. Due to its nature and complexity,
there are multiple disciplines requiring roles with specific process and outcome. While identification of “who is doing what” is important to establish on continuous basis, the roles should be allowed access to content providing proper separation of concern. A tool environment must therefore be identified that can support such capability. Computer Aided Software Engineering (CASE) tools are set of applications created to support such tasks. They allow authoring of process with provision for breaking complex activities into unit tasks and manage into workflows. It also provides facility to provide role-specific content, along with various types of guidance.

The present chapter introduces the Situation Awareness Unified Process. As the content cannot be provided by single author, it allows identification of approach that will lead towards generation of process content. Using process-authoring tools, multiple experts can collaborate in developing, maintaining and upgrading process content that will lead toward realization of situation awareness goals. The first step towards creation of process content is to identify elements in UoD that must be incorporated in the process.

4.1 Process Elements in Universe of Discourse

The Universe of Discourse (UoD) contains the complex dynamical system of interest. Various relevant aspects of the system should be modeled using the strategy proposed in Chapter 3. The elements of UoD can be modeled from many domain point-of-views. The purpose of information management is to furnish appropriate information to various agents or actors that can bring and keep the system in desired state. This is achieved by appropriate actions. Hence the elements of UoD can be identified as actors and their activities and related elements.

Actors play various roles during their lifetime. In entity modeling process, capturing of roles and various role-specific attributes was discussed. The tasks are the activities or behavior performed by the actors. Based on the performed tasks, role can be identified. A single actor
is expected to have one or more roles. The activities those taken by them are also useful. They can be in the form of workflow. They can be separately identified in to specific sub-activities or unit tasks. Some of them require unique resources like consumables or equipments. Some of them have specific work condition requirements. Some of the activities can be carried out in many possible ways, yet due to legal requirements, specific workflows must be followed within specific administrative units. These workflows, related entities and resources are sometimes specific to some domain and have unique requirements. These requirements include skill level, quality and quantity criteria and legal obligations and many other constrains applicable to specific geographical area.

4.2 Stakeholders and Environments

The elements associated with specific role and activity can be collectively handled. The relation and interdependence can also be established. The interrelated roles are called the stakeholders. Stakeholders are active members in UoD. Their contribution is important in elements of UoD. Their collaboration can be implicit or explicit in Chapter 1 stakeholders were introduced. Figure 1.2 indicated complex interdependence among stakeholder activity.

Each stakeholder can be considered as active in specific domain based on type of activities involved, nature of skill set, resource, environment required and the potential use of the work products. Based on this five environments can be identified. Natural and built environment consists of actors and activities in most general sense. The reporting environment those who take preliminary notice and report. Based on the severity of the problem, the organizations take up for further investigation. Technology organizations provide solutions to address the issues. The configuration environment identifies the needs, from actual needs, legal provisions, and technological availability; it provides access to some service. The next sub section briefly introduces each environment.

In activity and process modeling introduced in Chapter 3, the kind of activities possible in given UoD are not defined. Yet, from the outcome of modeling of such diverse activities, it is possible to determine classification of similar activities. Considering only roles and activities relevant to the identified goals, resulting selection include all the stakeholders. For these relevant stakeholder activities in UoD should be handled appropriately to meet the information needs. In order to do this, stakeholder environment boundaries can be established by following criteria:

- Goals
- Type of activity
4.2 Stakeholders and Environments

- Information need for activity
- Impact footprint of the activity
- Work flow and other activity specific requirements

4.2.1 Natural and Built Environment

Natural and built environment consists of all general aspect of the environment. The natural environment includes natural resources and processes on most of which cannot be controlled. Another is the built environment that is the outcome of human activity. The human processes responsible for and related to built environment can be subjected to control by various means.

While natural environment can be identified to include multiple role players, the current discussion will focus more toward human actors and possible roles played by them. The Role can be identified with reference to activity carried out by an individual. Typical roles can be identified with professional activities, voluntary activities and other behavior rendered by individuals during their lifetime. The resource in this environment include all the natural or man made resource that are produced, consumed or involved in the activities. Natural resources, raw material, finished products, wastes are examples.

The processes in natural and built environment can be classified in to natural processes and human activities. Natural processes may have deep impact on individuals and their activities. They are well studied from many branches of science. Their characteristics and impact on human activity is established. These facts can be utilized in determining their role in the process being authored. Various activities carried out by individuals include, professional activity, voluntary activity, routine activity, social activity etc. Their activity is limited to specific domain and local to their surroundings. For natural process, the published articles providing characteristics of the natural processes can be considered as artifacts that can be utilized in authoring the process. In case of human activity, the personal goal statement, communications, memory and related aspects can be considered as artifacts. Personal activity statement is one of the artifacts that can be generated by the individual. The activities can be benefited by establishing professional best practice, work flows to aid professional or voluntary activities.

These artifacts can be in various states like: identified, created, updated and utilized. Artifacts can be found in specific repository. For example who is doing what or who did what type of information in natural in built environment is in the memory of the individuals. The public repositories containing the profiles of individuals also indicate their capabilities for execution of specific tasks. Such repositories can be seen as available pool of resources. The typical artifact
4.2 Stakeholders and Environments

Figure 4.2: Life Cycle in Natural Built Environment

life cycle is depicted in Figure 4.2. For the identification of an activity, individuals are continuously monitoring the natural and built environment. The observed data is been interpreted to determine future course of action. The additional information required for action is collected with information seeking behavior. This includes the decision regarding the activity. The activity is then carried out. The preformed activity stays in the memory of the related individuals. The cycle continues in this manner. According to the punctuated equilibrium theory discussed in Chapter 2, the same process continues with minor modifications and similar activities are getting repeated.

Unless a potential hazard or prospect shown by some other individuals, the perception of individual regarding the activity remains unchanged. The continuous occurrence of routine activity is also not registered until it indicates major incapability, trouble experienced by many. Training is provided that can improve self-efficacy. Knowledge about what is relevant to their personal goals. They engage in social exchange to increase their power by obtaining the best return for their skills and actions. Identification of the most critical action is a plus to them. According to the socio technical theory, more they come in to contact with others, more value attained by them. Hence, for power, they will take up appropriate activity under their skills.

4.2.2 Reporting Environment

Within natural and built environment, there are individuals who are involved in goal-oriented activities mainly in response to events. They monitor various natural and human activities in UoD and investigate and report uncommon events. The purpose of this assumed role is to bring the undesired changes to appropriate role players so that necessary steps can be taken. They themselves are not legally responsible for change, but voluntarily participate in social exchange. The elements in reporting environment include the special events and role players that observe and report them. The resources include equipments, consumables and reporting related items. The processes include survey process, ground investigation and related activities. The environment includes reporting environment with restricted access to certain information.

The purpose of processes in reporting environment is to identify and create awareness about
special events that have already taken place or are likely to happen. It is based on data collection, analysis and comprehension about such special events. In order to do this, the roles have to possess and utilize special capabilities that allow them to carry out surveys, investigations and observations. This may span multiple subject or domain point of views. Hence in order to carry out they have to have general knowledge about various disciplines. They can handle many domains and many types of stakeholders and organizations.

Work products of these activities are generally in the form of reports that can be communicated in audio, visual or print form. Some reports may be shorter in length providing observations and interpretation about event. Surveys on the other hand can be based on groundwork and may include data and analysis. News story in video form including interviews with the related individuals may have unique utility.

![Observer Activity in reporting environment](image)

Figure 4.3: Observer Activity in reporting environment

These work products can be in the state of being collected, published, reported, under preparation, and communicated status. These artifacts depending upon their format can reside in various types of repository. News archives in the form of published printed or digital content that is shared in searchable repository.

The process life cycle for a typical news items follows typical life cycle as depicted in Figure 4.4. First an event is identified by the respondent as critical event that must be investigated further. Proper groundwork is required and information gathering is carried out to understand the event. The reports are then prepared. They are appropriately published to draw attention from the stakeholders. Tracking of stakeholder activity is also carried out and follow ups are reported as extension updated.

A new event is detected when a major incapability or trouble experienced by many in the natural and built environment. Many respondents will report the same event affirming the importance of event, yet indicating the need for further investigation requiring help from the domain knowledge. Impact footprint of the role specific activity in the reporting environment is unique. The spatial footprint may span globally dealing with global affairs. The subject
or conceptual footprint may span various disciplines like environment, politics, sports, culture, business etc. Temporal footprint is relatively smaller due to the dynamics of the events. Information needs can be quite high spanning various domains from which the event can be evaluated. The sources of information can also be multiple spanning larger geographical areas. Information processing needs may require pattern identification in spatial and temporal dimensions. The domain independent knowledge is required to carry out these tasks and taking decisions regarding the comprehension of the events.

4.2.3 Organizational Environment

Organization is collection of goal oriented individuals devoted to render specific service or product. Here focus is to meet goal in the area under impact footprint. Based on the type of contribution, and goal the organization can be classified in coarsely as:

- Governmental organization
- Non-Governmental organization (NGO)
- Research organization
- Standardization organization
- Business organization

In the context of present discussion, governmental organization, research organization and standardization organizations are considered as basic types and hence elaborated further. The business organizations, NGOs and many other organizations can be understood as derived as special types of these base organizations.

**Governmental Organization**

In all activities discussed so far, contains reference to an impact footprint. Government is assumed to be legally responsible for certain activities in a specific spatial footprint. This
geographical area is considered to be under its jurisdiction, and is expected to provide services according to the policies.

Figure 4.5: Governmental Activity in Organizational Environment

In governmental environment specific elements like roles, resource, processes, activities and environments can be identified. The typical roles can largely be classified into the administrative roles and the citizens or people who are legally entitled beneficiaries in that jurisdiction. The resources include governmental properties, critical infrastructures, consumables, raw material, goods, finished products, instruments, and other related items. The main activities also include governmental activities like administration, basic services provision, and efforts ensuring peace, welfare and development in the area. The governmental environment consists of the status of relations of the roles, resources within and outside jurisdictions that may affect the processes.

The processes in this environment include making policies, building consensus, providing basic infrastructure services, responding to special events etc. Critical infrastructure services, products are basic work products in governmental environment. They are overall results of various activities carried out by roles in defined hierarchies. Each role have specific work product outcome that can contribute to overall service. The policy, rules, etc. are outcome of the higher level. At detailed level standard operating procedures, guidelines and plans are important artifacts that guide the activities.

These work product outcomes are in various status of availability. They can be in the form of identified, created, published, accessible, discontinued, withdrawn states. Repository is in the form of governmental facility that holds, and shares governmental rules, regulations, policy cases etc. The processes continue to be in the same states of answering the questions raised by the media, public at large or identified by it. Scope and footprint is defined by local jurisdiction that makes the roles legally responsible for certain features. The goal here is to identify potential risks and minimize the damage. Expertise in local goal, decision making, prioritizing and handling in given funds contribute to the tasks.
4.2 Stakeholders and Environments

Research Organization

A research organization has unique role in various stakeholder environments as it is devoted for understanding of a particular discipline. Its outcome can be useful and can bring critical changes and hence treated accordingly.

![Figure 4.6: Research Activity in Organizational Environment](image)

Basic elements in research environment include the researcher role. Activities include various activities leading to investigations; research and innovation employed in particular discipline or way of problem solving. The resources in these environments are scientific and research equipments, tools, consumables, technologies etc. that facilitate the research and innovation process. The research environment is social exchange of ideas, information, research outcomes, resources among research roles that either facilitate or inhibit the research related activities.

Various activities in research domain include investigation of events in more scientific manner. The assumptions and logic applied in solving problems are based on theoretical framework. Careful data collection and analysis is utilized for decision making.

Work products in the research environment are scientific theories, designs, applicable research prototypes, and findings that can be used for decision making. While most of these work product outcomes are retained by their creators, the descriptions are made available to the community in the form of vision papers, working papers, experience reports, discussion papers, project reports, research papers etc.

A typical work product in research area can be in various states like identified, investigated, designed, developed, tested, published etc. The repository in the research environment is generally the library of research literature. This include on- line repository of research papers that are indexed, cataloged and accessed through search interface. Apart from digital repositories or organizations, such literature is made available in libraries and personal collections.

A typical life cycle in research environment starts with the identification of a research issue. The base data and literature survey is carried out as preparatory step to the research activ-
4.2 Stakeholders and Environments

Stakeholders and Environments

Research issue is noticed in research environment when reports regarding inadequacy and impairments are reported by many, and policies to respond them are identified. When usable results are published in the research repositories, it crosses the boundary to the next level of research problem.

Standardization Organization

Standardization process mostly have global spatial footprint, due to global relevance of the process. It covers special aspects, to improve interoperability and quality of work. It incorporates various business organizations to include outcome of research organizations and using voluntary based participation. Basic elements in the standardization environment are various role players spanning governmental organizations, research organizations, business, industry etc. playing role of participant of a consensus building process. They provide case studies, opinions, comments, and experience reports to guide the process of standardization. This environment does not require specific equipments, scientific instruments or items in order to facilitate the process. The consensus building is generally carried out by meetings and conferences. The standardization environment includes regulations, participation of stakeholders and compliance and up gradation of standards that affects the overall standardization process.

The main process in standardization is consensus building upon various aspects of the issues on hand. Major work product in the standardization is a process, method, or guideline in the form of standard. In order to achieve this, various intermediate work products are also contributed by involved stakeholders. This include experience reports, discussion document, specification, request for comments etc.

Standard can be in the state of being identified, investigated, under discussion, specification state, standard form, withdrawn, super seeded stats. Standardization body provides a digital content repository as a library of standards.

A typical life cycle of the standardization process starts with identification of requirement
for a standard. This is facilitated by first identification of available products or services, a common feature offered by them. At next level it is required to identify various features and aspects that should be addressed in the standardization process determining the scope of the work. Next part can be the publishing the initial draft in the form of candidate specification that undergoes review from the community. In final stage, the comments are incorporated and standard is finalized.

The standardization can first be realized when interoperability issues are faced in practice by using various incompatible products and service providing the same utility. The standardization will continue to iterate the loop discussed above until, a promising implementation confirming to the standard is opened for public use. Considering the applicability of standards, their spatial footprint is global and temporal footprint is for long term where as semantic footprint is specific concept covered in the process.

### 4.2.4 System Engineering Environment

System engineering environment is the specialized type of environment that is devoted in creation of system instances.

Elements in system engineering environment include system engineering related roles. It includes resources like equipments, devices, machinery, instruments and various types of consumables required in the engineering activity.
Processes include analysis of the requirement, design of the appropriate system that fulfills the identified requirements, creation, testing, delivery deployment and upgradation of the system. Software systems are primarily based on these processes. The rational unified process (RUP) provides most comprehensive guidance for these processes.

Work product in the system engineering environment is primarily a system. In order to achieve this various artifacts and work product from numerous role players may be required. The roles specific artifacts defined in the rational unified process can be the deliverables during various phases of system engineering environment.

The work product state can be varying in the form of identified, created, designed, deployed, tested etc. The repository of the designed system can be in the form of product of system catalog. Service or utility offered by various designed systems can be included in this searchable product catalogs. Specific types of products can be found in specific repositories. Software systems, electronic systems, communication systems, engineering systems are appropriately maintained in catalogs. Specifically, software systems can be made easily accessible to users so that it can be immediately brought in utilization. This may include not only the products but, can also be components library that act as building blocks for designing other systems.

A typical life cycle in system engineering environment starts with requirement identification for the product, followed by the analysis and design aspect, construction phase, testing phase, deployment phase etc. For software systems, software development life cycle (SDLC) is well addressed in literature. The waterfall model, the spiral model, the V model are different models for engineering software systems[76].

Figure 4.10: Life cycle in System Engineering Environment

Software systems continue to iterate in any of the life cycle approaches discussed above unless major change in requirement or strategy or technology is not changed. Also, the changes and delivery of software system remained unnoticed in the other environments, unless it is solving or providing efficient solution of problem that are faced by larger community.
4.2 Stakeholders and Environments

4.2.5 Configuration Environment

Configuration environment is identified as a provider of a service instance that is utilized by various users.

![Figure 4.11: Service Provision in Configuration Environment](image)

Configuration environment consists of various elements that are related with the given configuration. The primary role in this environment is service provider. The configurer role is also unique to this environment. Service consumers are also complimentary roles. The services can be in the form of basic infrastructure, or computing or information handling service. Resources in the configuration environment are consumables required for basic infrastructure services. This also includes specific equipments, instruments and devices that are associated with the functioning of the services. Other elements include working environmental conditions. The environmental conditions make it possible for the service provider and service consumer to provide or access services in desired form.

First, it must be determined which services that can be exposed in given area. Once service need is identified, appropriate technology needs to be specified for realization of the service. The technology required for service, needs resources, hence resource identification and acquisition take place. Once resource and technology are acquired, the service is configured to function in desired mode. Configured service is published for general purpose. During the execution, the service maintenance needs to be done. Meeting the changing requirements, availability of new technology and new policies, these services needs to be upgraded.

The work product in this environment is the configured services. The configuration is a result of many activities carried out right from determining the service provision goal, identification, configuration and provisioning of service. Various artifacts are created in the process include: the mission statement of the service providers, the survey about need and market of the service, the survey of the potential services, agreements and contracts with various infrastructure and other basic service providers and specifications of the services and related elements.
These work products and artifacts undergo various state changes during the activities. These states include artifacts as identified, created, hosted, shared, published, and updated.

The work product is made available in the form of configured services. These services are published in service registry. They are also published in specialized service directories, yellow pages, etc. The availability is publicized in communication media to improve uptake.

The process undergoes various phases. The services are in their initial phase identified. Next phase they are surveyed. Appropriate technologies are identified. Contracts and agreements with collaborators are made. The service is then configured and tested. The configured service is exposed for general use. The usage is continuously monitored. And later it is updated, or discontinued or replaced with other services.

The same cycle continues unless new products or technologies enabling the services are introduced to the service providers. If the same services are offered in the overlapping footprint, the services will go to the next level of performance. Configurations are suffered with lack of resources or other constraints. Generally, a configuration is a localized concept. A geographical area may have configuration environment in which various infrastructure service, data services, and other services are configured appropriately to furnish the required functionality. In information management, this provides the facility at runtime, executing and processing of the data and communication platform. A service configuration is an example of configuration environment.

**4.3 Implicit Traceability**

Activities in various work environments have been discussed. This included the how practice is carried out. It is also stated that major changes are incorporated within such life cycles. This depends on how information is passed on to the actors. This also confirms to the punctuated equilibrium theory. Any major change communicated will have major changes in the system process.
4.3 Implicit Traceability

Figure 4.13: Artifacts Traceability Across Environments

4.3.1 Example

This traceability figure tries to depict how any instance (of software, instrument, tool, service) present in given UoD can be trace back to the real life process in Natural or built Environment. The given traceability span across five different environments identified earlier. In each environment, various stakeholders (actors) carry out some tasks (activity) based on the input (stimuli) from the environment and the resulting outcome (work product) is exposed back into the environment by various means (reports, publication, dissemination, deployment) such that some other stakeholders can take appropriate actions for the same.

It becomes clear that the stakeholders active in different environments possess orthogonal concerns yet they depend on each other for input and output of their activity. For illustration of this idea, an example of natural process can be considered. Rainfall is a natural process that has considerable influence on many other natural processes and human activities. With this background, a Rain Gauge\(^1\) mounted on a monitoring station designated for an administrative block can be analyzed for cross environmental traceability.

A rain gauge is a scientific instrument utilized for measuring the rainfall over a defined period of time at particular place it is mounted. Following can be identified as elements in various stakeholder environments.

**Process** Natural process of hydrologic cycle (water cycle\(^2\)) that results in an event of rainfall

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or liquid precipitation. This process is part of natural and built environment as identified earlier.

**Events** The occurrence of rainfall at particular time and place is considered as event in natural and built environment.

**Observations** Heavy or scares rain in a geographical area is observed to intervene other natural and human activities.

**Reports** In one scenario, an incident of heavy rain resulted in water logging and flooding of land; destroying agriculture, transportation network and other built infrastructure. In other scenario, scarce rain resulted in famine affecting agricultural yield of a farming community.

**Findings** As amount of rainfall is affecting human and natural activities, standard methods for accurately measuring and reporting it are established. Impact of various climatic conditions and environmental parameters that enhance or inhibit chances of rainfall events are identified.

**Policy** Based on past experience of rainfall, the government resolves to monitor the seasonal precipitation and to take corrective action as per the scientific findings available till date covering all states under its jurisdiction. State Government makes a local department responsible for tracking liquid precipitation as a part of this policy.

**Requirements** Based on scientific findings and requirements identified by the local departments, requirement of an instrument for monitoring and reporting rainfall in a given area with specific operating range and sensitivity is identified.

**Design** A rainfall logging system is design by an technology firm.

**Implementation** Sensor logging application developed based on design.

**Instance** An instance of instrument mounted at a monitoring station providing representative liquid precipitation data for a local administrative unit.

Hence, with this example, it is identified at how given instance of a rain gauge can be traced to the processes and activities in various stakeholder environments.
4.3 Implicit Traceability

4.3.2 Critical Infrastructure Revisited

Critical infrastructure was indicated as one of the challenging application area for situation awareness. UoD consists of a complex network of critical infrastructures and any undesired state impairs specific service rendered directly or indirectly offered by them. A single critical service may require many other basic critical services. If each service is considered as unique network of related elements, several such actor networks can be identified. Commonly used basic critical infrastructures are found in all identified actor networks. Hence, as depicted in Figure 4.14, an area can be visualized to have multiple overlapping actor networks.

![Figure 4.14: Service as Artifact Across Environment](image)

From the example and implicit traceability discussed earlier, it can be visualized that each actor network is outcome of activities being carried out in various stakeholder environments. Hence, any attempt to monitor and manage critical infrastructure must identify and appropriately handle related stakeholders in appropriate environments. This allows identification the relationship of activities resulting in policy, research, standards, designs, technologies, that are not visibly present in the UoD are directly affecting the quality and availability of services in given area.

4.3.3 Traceability Across Environment

Observations done in the reporting environment are based on processes and activities carried out in natural and built environment. These published reports are taken as reference for governmental policy and decision making processes. If reports introduce issues that need to be further investigated in view of some discipline, the research organization environment takes
4.4 Situation Awareness Needs

The way the information management is handled, it is not possible to design the supporting system in isolation and later deployed for use. The information management needs to be handled as a critical infrastructure service, and supporting system environment is created, updated managed on the runtime. For required scale of effort, an isolated system development team may have limited staff only fixing bugs and getting extensions. Information management for dynamic environment requires a team with specific roles, and need to maintain a live connection with many other role players in stakeholders. Hence, this task should be created as a service as what role Air Traffic Control plays for the aviation domain. The system related roles must constantly identify and address emergent needs and provide their contribution in successful operation of the service. In other words, all roles must be provided task related situation awareness.

In Figure 4.15, the work product usage is found to go across the environment. Once shared in respective repositories, these work products are identified by the stakeholders in other environment. Generally this takes place in response to two events. In planning phase, when plans are made, the survey is made about basic reference documents, and relevant work product outcomes are searched and retrieved from their repositories. In punctuation scenario, they are accessed the similar manner, but in response to a punctuation. In any of the cases, availabil-
ity of all the work products that are required to sufficiently meet the information need of the stakeholder should be shared in the repository. On the other hand, from all the available work product relevant to the present activity should be identified and accessed by the stakeholder. In both the cases, for complete coverage the stakeholder must have to keep the track of all work products being shared. In other words, those sharing and the others who are searching and utilizing these work products should be aware of all the repositories for complete coverage. Or, there must be some mechanisms defined that can allow sharing and searching of work product outcome is various repositories that stakeholders may use in different environments. This calls for a unifying approach across environments that enable consistent sharing and using of artifacts across environment.

Apart from using shared work products as input to the process, the stakeholder activity can have specific information needs. The human activity modeling approach introduced in Section 3.3, indicated information that is required to complete the task. This includes information about task allocation, status of related inputs, work flow, state transitions, process outcome, guidance required for activity. All these contribute to the situation awareness of the specific user planning for the activity.

4.5 Method Engineering Approach

System engineering domain provides solution for the identified needs. It recommends identification of elements like process, methods, tools and environment to support the system development task[76]. A logical sequence of activities employed to achieve particular objective is identified as process. While process defines the “what” part of the solution by identifying the required activities, detail steps and required guidance is defined as “methodology’ to provide the “how’ part of the solution. In order to execute the process according to the method content, set of systems may be required to support them. The systems supporting the method part are known as tools.

The management strategies applied for general project management or software project management are examples of such strategy. The domain addressing issues related to development of method content is known as Method Engineering [77]. Method engineering targeted for systems that is continuously faced with dynamism may require event and scenario specific method content. Situation Method Engineering [78] is one such technique employed in the domain. In software development environment, Rational unified process (RUP) is widely accepted method content among the practitioners [79]. Some domain or application specific approaches
Figure 4.15: Implicit Traceability across Environments
may involve special consideration in system design process. For example, utilization of product specific knowledge can be employed to enhance the performance of the development process [80]. Project management discipline provides comprehensive guidance in the form of Project Management Body of Knowledge (PMBOK).

During the development of systems and work products, commitment to method content proves beneficial. During the requirement gathering stage of an enterprise information system many non-functional requirements that are essential for collaboration in dynamic environment can be missed. Efforts toward team integration later become difficult task. The basic principle of the unified process is that, organizations will define their commitment toward methods instead, and then the developers will develop and test according to the given reference model. Thus, rapid adoption of missing components in the system could be made possible.

4.6 Situation Awareness Unified Process

The roles, activities, work product outcome, repository workflow, life cycle, discussed needs to be arranged based on following criteria:

- Use of models (Chapter 3) to assemble activity related aspects
- Use of situation awareness theory to determine information needs of the roles
- Use of Method Engineering Strategy to create content

Rational unified process provides comprehensive method content and tool support for large-scale collaborative efforts. The feature of authoring and customizing the process to suit the emergent need is also included in the process. Hence, the content that can be reusable can be directly adopted from RUP and extensions provided by the collaborators. Content for situation awareness suitable for targeted stakeholders can be managed in similar manner.

Situation Awareness unified process is defined considering these aspects, following is the brief summary introducing the content of the Situation Awareness Unified Process (SAUP) [81].

4.6.1 Role and Role Sets

Roles defined in the process represents the specific responsibility assumed by the actors. This responsibility includes generation of specific artifact or work products by engaging in various tasks as prescribed in the method. The method content regarding a role typically include general information regarding the role, detail description of the duty, staffing information and
other information regarding the date and versions of the role specific content. The roles are associated with specific work products. They are also prescribed specific guidance. Depending upon the type of work and skill-set possessed by the role, it can be assigned specific category. This information is handled by conventional method engineering approaches.

From situation awareness point of view additional information is required. The SAUP recommends these additional features to be identified for the roles. The need of the role is explicitly identified so that appropriate stakeholders can be allocated for the task. Typical use cases of the roles are represented stating the role in the collaboration. Common challenges faced by the role are required to provide guidance and make provisions to solve the difficult issues. The input to situation awareness and output to situation awareness are two important elements defined for each role. The frequency of accessing the method content is to be defined. The matrix created for the role to establish cross environment traceability is also identified. Set of all possible events regarding the role is also enumerated. Duration of typical activity is identified. Type of system requirement in accessing the situation awareness artifacts are also specified for each roles.

Figure 4.16 represents major role sets identified by the Situation Awareness Unified Process (SAUP). The role sets are identified is respective stakeholder environments.

4.6.2 Tasks and Disciplines

The tasks are the activities identified by the process that can be executed by related role players. Typical task related content in conventional method engineering approach include purpose of task, description, key considerations and alternatives. The content variability type is also defined for given tasks. Elements providing task related guidance include steps, associated roles and additional performers, related work products in form of mandatory and optional inputs and
Figure 4.16: Unified Process Roles Sets in Stakeholder Environments
outputs, and guidance. Each activity known in stakeholder environment is converted as task and appropriate content is developed.

From generated content regarding tasks, the related tasks are aggregated to build a discipline. Each identified disciplines therefore contains set of tasks, and workflows that involves execution of tasks in logical sequence. Conventional disciples are analysis and design, business modeling etc., recommended by the RUP. The SAUP deals with five stakeholder environments and specific disciplines are introduced for each environment. Table 4.2 indicates the disciplines introduced in SAUP.

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional Activities</td>
<td>Activities of specific profession</td>
</tr>
<tr>
<td>Reporting</td>
<td>Activities related to reporting of events</td>
</tr>
<tr>
<td>Standardization</td>
<td>Activities related to standardization</td>
</tr>
<tr>
<td>Research</td>
<td>Research activities</td>
</tr>
<tr>
<td>Administration</td>
<td>Administrative activities</td>
</tr>
<tr>
<td>System Engineering</td>
<td>System engineering activities</td>
</tr>
<tr>
<td>Configuration Activity</td>
<td>Service configuration and provisioning activities</td>
</tr>
<tr>
<td>SA Process</td>
<td>Building situation awareness process content</td>
</tr>
<tr>
<td>SA Configuration</td>
<td>Configuration of SA system</td>
</tr>
</tbody>
</table>

Table 4.2: Disciplines in SA Unified Process

4.6.3 Work Products and Domains

During content development of roles and tasks, work products are identified as one of the element. Work product is the outcome of task or activity carried out by the role. Typical content in work product include, description, key considerations, outline, representation options, impact of not having the work product, reason for not having the work product, version information, content variability type information and suitable guidance.

Similar to role and tasks, related work products can be aggregated to form a Domain. Some known domains in RUP are analysis and design, business modeling, configuration and change management, deployment, project management etc. Analysis and design domain is logical collection of analysis and design related artifacts like analysis model, data model, design model, architectural proof of concept, software architecture model etc.

Situation awareness unified process recommends domains that logically collect products in different environment. Table 4.3 enumerates domains proposed by SAUP.
4.6 Situation Awareness Unified Process

### Table 4.3: Domains in SA Unified Process

<table>
<thead>
<tr>
<th>Domain</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional Activities</td>
<td>Work products related to professional activity</td>
</tr>
<tr>
<td>Reporting</td>
<td>Work Product related to reporting</td>
</tr>
<tr>
<td>Standardization</td>
<td>Standards, specification and related documents</td>
</tr>
<tr>
<td>Research</td>
<td>Research documentation and work products</td>
</tr>
<tr>
<td>Administration</td>
<td>Administrative documentation and work products</td>
</tr>
<tr>
<td>System Engineering</td>
<td>System work products</td>
</tr>
<tr>
<td>Configuration Activity</td>
<td>Configuration work products</td>
</tr>
<tr>
<td>SA Process</td>
<td>SA process and related content</td>
</tr>
<tr>
<td>SA Configuration Specifications</td>
<td>SA configuration related work product</td>
</tr>
</tbody>
</table>

### 4.6.4 Processes

The tools for building method content support two forms of the process, namely “Capability Pattern” and “Delivery Process”. Table 4.4 represents the process content with examples. The process made available as complete life cycle or a fragment as indicated in table 4.4, it is having specific features. Capability pattern and process package are managed in RUP.

A typical delivery process has general information, name, brief description, external ID, purpose, etc., detail Information like main description, scope, usage note, alternatives, staffing, key considerations, scale, project characteristics, risk level, estimating techniques, project member expertise and type of contract, A delivery process may include content from other existing method plug-ins. A proper configuration is required that allows incorporation of existing content.

Work breakdown structure breaks the large process into breakdown like phase, iteration, activity, and task. Phase signifies considerable period of a project resulting in important project outcome or deliverable. Iteration indicates the recurring activity or asks with repetitive nature. Activity is an important building block for a process. Team allocation indicates the roles and role sets are allocated the task. Work product usage Indicates links to the identified work product. SAUP have three types of Delivery Process namely: SA Global Configuration, and SA Local Configuration separated based upon configuration requirement. Local requires minimal setup whereas international requires maximal setup, connecting and monitoring to globally relevant

### Table 4.4: Process Components in SA Unified Process

<table>
<thead>
<tr>
<th>Process</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capability Pattern</td>
<td>Fragments of process</td>
<td></td>
</tr>
<tr>
<td>– Discipline Work flow</td>
<td>focusing a discipline</td>
<td>Analysis and design</td>
</tr>
<tr>
<td>– Template for Delivery Process</td>
<td>focusing a discipline</td>
<td>Construction iteration</td>
</tr>
<tr>
<td>– Typical Pattern</td>
<td>focusing a goal</td>
<td>Create product to release</td>
</tr>
<tr>
<td>Delivery Process</td>
<td>Complete life cycle</td>
<td>Classic RUP</td>
</tr>
</tbody>
</table>

...
activities, work products and roles.

4.6.5 Guidance

The purpose of the process is to provide guidance to the development process. The roles, tasks and work products discussed are the concepts that are characterized by various attributes in the context of the process. Mere identification and enumeration is not sufficient in realization of process. To aid this process, material in various forms is introduced to guide the process.

For example, representation model recommends the knowledge engineer to carry out conceptual modeling in description logic. A useful step-by-step guide for building KB using this manner is discussed by Borgida and Brachman [68, page 359] providing the guidance required in knowledge representation. Similarly, converting multidimensional conceptual models in to physical design, Malinowsk and Zimanyi [69] provide comprehensive reference. Current method composing technologies supports following types of guidance.

**Checklists** Checklists are common mechanisms to verify the status of a list of important items. In verifying operating conditions, availability of inputs, generated outputs, processing steps etc, these checklists can be useful.

**Concepts** The process content have to incorporate business specific, information processing and handling specific, application specific terms. For explanation of critical vocabulary entries, the conpets are defined. RUP supplied an Actor Checklist for identification of various actors in the system.

**Estimation Considerations** Considerations required in estimating the effort in completing the task.

**Example** Examples are sample worked out solution of a work product created according to various aspects of the rational unified process.

**Practice** Practice is a proven approaches to successfully complete the activity. Some examples are Risk management, continuous testing or component based development demonstrated by an organization.

**Report** Report is a documentation of work product outcome resulting from the recommended process. Outcomes and results are collected in represented in predefined template and may be automatically generated by the tool.

**Reusable Asset** Assets are solution to context specific problems. Therefore they can be utilized in similar situations, enabling the reuse. Such reusable assets are supplied in the form of rules for its usage.

**Roadmap** Roadmap provide simplified representation of the process. They are useful in
4.6 Situation Awareness Unified Process

depicting how tasks and activity may lead to specific outcomes.

Template Documents, conceptual models or physical data models are generated as a part of the process. Template provides guidance for content of these artifacts. The content guidance include various sections, diagrams, packages or snapshots that must be arranged in specific sequence to improve readability and comprehension of the work product outcome.

Team Definition Uncommon terms, domain specific vocabulary or concepts mentioned in process is defined using Term Definition.

Tool Mentor Tools provide important support in managing various work products and outcomes from collaborating roles. The utilization of tool in managing various roles is provided as tool mentors.

White Paper General introductory document prepared to cover specific aspect of process, is published as white paper. It can be referred independent of the other component of the process.

Guideline Best practices and various ways to perform the activities or group of activities to achieve desired outcome is captured and provided as guideline.

Supporting Material Supporting material is any other type of guidance that are not falling into various guidance categories discussed above.

4.6.6 Authoring the Process

Process engineering is currently supported with method composition tools both in open-source and commercial domain. The Eclipse Process framework (EPF) have provided tooling with open method library like OpenUP. A well-established commercial counterpart is Rational Method Composer (RMC). RMC is packaged with Rational Unified Process plug-in with various extensions for business and enterprise development with a number of software engineering paradigms. RMC also provides additional method plug-ins like SOMA and DoDAF. As of now, the first version of SA Unified Process is authored as RMC Plug-in extending these available required method parts. Benefits of composing tools is that community contributed methods can be incorporated to suit the requirement. Also, reusable components can be directly utilized to suit the needs. In EPF, OpenUP and others are available. Upon availability, there can be may others from community contribution. The method plug-ins authored in Rational Method Composer product, contains rich library addressing various issues. RUP SOA plug in etc provide extension to RUP to develop service-oriented product. Apart from this, they also provide Asset based development, business modeling, system engineering and others. These method fragments can be utilized by specifying configuration and appropriately integrating with the custom made processes.
4.7 Summary

For identified “Situation Awareness” capability, a suitable framework was proposed that can appropriately enable the actors to collaborate and fulfill the required information needs. It is proposed that situation awareness can be realized in a process-like form. Rational Unified Process is one commonly used effective process that enhances the software development capability in team environment. The proposed theory can also be delivered in similar form, as all the required features for situation awareness are achievable in process form. Various stakeholders like: observers, researchers, standards organization, service organization etc. can share their outcomes in form of artifacts or work products. The theory proposed here requires incorporating the local business rules and operating procedures. This requirements demand for the feature for extending or customizing the template process. Stakeholders and members of “active publics” assume specific roles, and engage in input output dependence with other actors. Monitoring of the status of various activities carried out by roles is also important feature of the proposal. Similar to the software development scenario the checklists, best practices, white papers and other kind of guidance is equally useful to various stakeholders like respondents, government organizations, research organizations, service providers etc. active in respective stakeholder environments.