CHAPTER THREE

PROBLEM DEFINITION

3.1 BACKGROUND

In Enterprise Application Integration, business enterprises representing various business processes and entities in heterogeneous sources are connected as virtual and networked environment. Based on the requirements of the consumer, selected entities or business process should be integrated through common standard and specifications. (Galasso, F. et al, 2014; Desmet, S. et al, 2011). In every business process, sharing of data and information is a constant need of every enterprise due to increased competition, improvements in technology and dynamic requirements of the consumer. As a result of this, the business enterprises generally have common interface for exchanging and understanding other business processes. (Panetto, H. et al, 2016). This is termed as business integration. In EAI, due to dynamic changes in requirements, technology updates, interfaces and heterogeneity problem lead to acquiring and modifying the existing knowledge sources and systems with respect to data, service, process and business level in business processes to become agile.

Due to agility in business process, work practices among the integrated enterprise systems do not always interoperate and produce complexity. Complexities increase along with agility in business to remain competitive for effective transformation with respect to priorities of business process. (Singh, N. et al, 2015; Wendzel, S. et al, 2011). Today’s competitive in enterprise application integration that focuses on seamless communication requires collaboration of data, service, process and business among various heterogeneous business processes. (Kuehn, A. et al, 2010; Rezaei, R. et al, 2014). To face the above challenges, the business should
make its resources and processes interoperable with other heterogeneous business processes. Due to changing requirements, business process usually requires systems to be evolved from existing models and also to add new opportunities in the current systems to improve the efficiency.

Increasing in various online e-services such as virtual education, e-publishing, e-marketing, etc running on different platforms having different data sources also insist on sharing and access of business process. (Terstyanszky, G. et al, 2014). Hence the significant challenge in business process is to provide integration in dynamic requirements in the perspective of data, service, process and business levels, irrespective of different domain sources and it is needed to ensure that, whom to share, how much to share for better accessibility over systems and usability. (Van Velsen, L. et al, 2016; Alonso- Calvo, R. et al, 2015). Effective sharing of information among business processes completely depends on process involved, mechanism adopted and how it reacts on dynamic changes between the systems. This statement clearly specifies that issues happened in those levels have been made the complexity towards business process. Several aspects of business process have made interoperability to be unavoidable in enterprise application integration.

For Example: Hospital information systems indicate that accessing and exchanging medical information related services to other information systems by identifying the strength and weakness to increase the potential of interoperability, is one of the significances that prove the need for effective interoperability. This difficulty leads to interoperability which is an important quality involved in order to achieve effective sharing of business process between enterprise application integration. Achieving interoperable communication among various businesses needs standard model and standardized interfaces.
Obtaining the common mechanism is not easy as it resides in heterogeneous locations. (Pai, F. et al, 2016; Ma, H. et al, 2012; Pang, L.Y. et al, 2015). The interoperability mechanism is needed in the form that resolves heterogeneity issues that directly reflects over agility in business. Existing models and frameworks follow specific approach between the business applications with respect to different domains and requirements taken that lead towards generality. The common standard have to be developed and maintained in the form of services has become completely open to all heterogeneous domains. Such changes have made the access and exchange of information among various business processes in heterogeneous environment to become simpler. (Rezaei, R. et al, 2014; Kocabicak, U. et al, 2012).

Likewise consider another business scenario where interoperability plays a major role in effective sharing and usability of business process is online booking systems. Consider the flight information system which is done through online, the various parties involved in booking systems, various airlines, payment gateway, various banks, the delivery channel and the consumer. In this business process, the request and the response have to be processed through various heterogeneous domains to check whether the intended information has reached as specified in the sender system. Each heterogeneous domain is understood to enable the business process to be integrated and coordinated in effective manner. Hence various distributed business process among enterprise applications which have to be interoperated in the required form is necessary.

Various interoperability frameworks and models are developed and organized based on their requirements and application system. For Example: E-Health Interoperability Framework (Milosevic, Z. et al, 2016, Rezaei, R. et al, 2014) is a framework for achieving interoperability in health care systems. This framework
which ensures interoperability in data, business and process level is specifically meant for exchanging and access over health related information. The complexity in this framework is that it is static and specific towards the objective. It also creates incompatibility over when any of the technological updates and inclusions in business process. For better operations, apart from participating domain based, interoperability measure in runtime to be extended improves the effectiveness of business processes. The frameworks are implemented using various technologies as represented in Figure 2.3. Hence frameworks are looking up technology as their major component on being successful understanding among the business processes.

Hence Business processes among enterprise application integration are always agile and noticed that greater and efficient interoperable solution can boost the responses which lead to effective business transformation. (Millerand, F. et al, 2011; Backman, J. et al, 2016). From the research it is identified that EAI has brought out that if an enterprise is looking for interoperability as its major concern, it should be successful in achieving the business process in data, service, process and business levels. (Guedria, W. et al, 2015; Cabellos, L. et al, 2011; Ordiyasa, W. et al, 2015; Rezaei, R. et al, 2014). From the review of literature it is identified that to ensure interoperability, it is done by developing interoperability frameworks and models.

Architecture that proves to meet the dynamic changes in the business process in EAI is handled by service oriented architecture. It is generally said as a style that supports integration of any business process by semantically understanding with each other, their business tasks and services. SOA helps to enable different end-users to use the necessary/provided services easily and interactively. It is an architectural approach which acts as a platform for building systems with reusable and loosely coupled solutions. (Benatallah, B. et al, 2008). Hence SOA has been identified as
design approach which possesses common principles which is acceptable to various heterogeneous sources used to build composite applications, monitoring the development and design of enterprise application integration.

The betterment of SOA has been attained and it has been carried out at specific interoperability frameworks but yet to gain a whole understanding of service oriented architecture. This has to be fulfilled by data, service, process and business levels in EAI. (Zhiying, T. et al, 2016, Astsatryan, H. et al, 2015). SOA leverages existing frameworks and models as well as enabling new requirements to be developed through loose coupling. By using SOA principles the business process can be made dynamically bound, reusable, coarse grained interface, network addressable, abstraction, seamless, and standardized to increase time and efficiency. This shift in SOA enables business process in EAI to form all level issues in the form of service that provides simple, integrated, agile, and flexible view of real time business, functional and non functional qualities towards enterprise application.

3.2 MOTIVATION

Interoperability is moving towards a goal to achieve error free access and sharing of business process between heterogeneous enterprise applications located in distributed sources. Changing requirements in business process challenges the interoperability in facilitating the various levels of EAI such as data, service, process and business towards effective integration. The scopes of interoperability are expanding significantly beyond those levels by ensuring the trust relationship among heterogeneous sources, enabling different software to interoperate and solve incompatibilities that creates value for the various domains by making themselves interoperable to other domains.
The process behind the interoperability involves major aspects such as, heterogeneous enterprise sources, process involved, approach adopted based on requirements, architecture style and techniques involved. The study of literature provides detailed perspective of interoperability inferred from various interoperability frameworks and models. This analysis has brought out a lot of existing frameworks and models that are very specific towards their requirements and unaddressed in dynamic perspective explicitly or given little consideration. These frameworks and models addressed interoperability among business process and unaddressed evaluation measures for finding the degree of interoperability. These provide ample opportunity for generating the research towards interoperability.

From the literature study, Interoperability among various business processes in EAI falls under three major levels such as data, service and process. Hence the limitations that are found are (Rezaei, R. et al, 2014; Emruli, B. et al, 2014; Hassanzadeh, A. et al, 2011; Hellberg, A.S. et al, 2013).

- In data perspective, addressing different syntactic and semantic representation, database languages, operating systems and context with respect to common specification requirements are addressed minimally.
- In Service perspective, lack of addressing the behaviour and compatibility between the business process when using adapter and wrapper services.
- In Process perspective, integration of internal process with respect to the exchanging business process requirements is addressed based on specific applications.
• Existing interoperability models and frameworks do not accomplish all the
  levels as a common solution that meets the requirements of different
  heterogeneous sources and hence provide limited interoperability.

• Due to incompleteness in addressing levels of interoperability, there is a lack
  of common architectural model that activates various business applications
  with respect to the heterogeneous data sources.

• Existing evaluation models confine to specific requirements or business
  applications and there exist minimal addressing in common evaluation
  parameters.

The research gap from the literature study aids in forming the research problem which
is going to provide solution to the above said gap by obtaining the effective and
seamless interoperability.

3.3 PROBLEM STATEMENT

Interoperability has to be accomplished in such a way that it is included
between various business processes distributed in heterogeneous locations associated
with platform, operating systems, languages and database software for effective
communication. Agility in business process leads to complexities in interoperability is
always challenging in integrating with other sources in run time. Hence
understanding incompatibilities on the fly is the principal requirement of any business
process communication in EAI. Existing works do not confine with any design
methodology that solves interoperability by understanding the process between the
communicating domains dynamically. Generic architecture for interoperability is the
one which exhibits all its requirements like request-response builder, retrieval of
required business process in the form of data, service or process, modelling of
components, integration of domains and requested delivery. For interoperable system to remain effective it should possess dynamic responsive qualities and changes have to be incorporated dynamically. Hence suitable architecture model is required in the way interoperability is adopted between heterogeneous sources should be formulated.

Design of architecture involves certain principles and way of implementing styles. Service oriented architecture offers better flexibility in integration, loosely coupled, reusable, standard interfaces and helps in achieving quality aspects such as scalability, reusability, modifiability and ease of creation. Service oriented interoperability between business processes provides enhanced access and sharing of resources in EAI. It tells how to integrate various cross platform, vendor neutral, distributed applications in a Web-based environment and all the requirements needed for integrating multiple implementation platforms to be identified. The request for interoperability is given either in data, service or process. The response for interoperability is provided in the form of services that exhibits data, service and process functionality from the requested domain sources. This architecture model stands between the heterogeneous sources systems. This in turn helps in integrating various business processes with less effort due to inclusion of required capabilities.

The primary objective of this research work is to provide generic and complete architecture model for interoperability using SOA. The research interest has been enclosed based on the literature review which clearly states the need for generic architectural model for interoperability using services among various business processes that addresses all the requirements of interoperability in enterprise applications. The question that relates with respect to the research need is given as:
Can an architecture model that ensures generic interoperability requirements be designed?

In order to frame architecture the existing interoperability models and frameworks, the design methodology and approach adopted are not reported generic. Mining has to be carried out and the limitations have to be identified. Based on this the following hypothesis is stated.

**Hypothesis 1**

The design aspect behind the existing interoperability frameworks and models has to be mined and formally modelled which consists of interoperability concerns and aspects in various sources. An analysis of existing works has to be carried out based on desired components and functionalities in order to build architecture model.

Can the proposed architecture for ensuring interoperability be evaluated?

The architectural model should be evaluated based on the existing models for evaluating interoperability has to be mined and it is not reported explicitly. These models have to be analyzed for expected parameters. Based on this the following research hypothesis is stated.

**Hypothesis 2**

Based on the analysis of mined existing models for evaluating interoperability, evaluation parameter has to be carried out to form an evaluation model for ensuring interoperability. These parameters have to be refined into reference parameter which exhibits the expected requirements.

Can the proposed architecture model for interoperability be verified?
The designed architecture model has to be verified based on the requirements to check components and behaviour to check deadlocks.

**Hypothesis 3**

The verification techniques for checking architecture flow have to be extracted. Based on the extracted verification technique, suitability of Colored Petri Net (CPN) is identified for design of architecture model that could be verified.

- **Whether the interoperability architecture could be applied?**

The designed architectural model has to be applied in heterogeneous business applications to check whether the effective information integration is done.

**Hypothesis 4**

The architecture model has been applied in business applications and evaluated. Certificate verification system is the case study and the architectural model for interoperability using service is applied and the results were analyzed and reported for the given experiment setup.

### 3.4 RESEARCH APPROACH

The identified research problem accomplishes the move towards the need for architectural model for interoperability that provides a generic nature of its elements and requirements for producing effective sharing of business process. Several models and frameworks and research attempts have been done towards various aspects and concerns of interoperability. The concentration here is to provide an architecture model that addresses the complete interoperability among heterogeneous systems in

Designer’s perspective has to be transferred into service based models for interoperability for sharing of business processes. (Pang, L.Y et al, 2015, Scholl, H.J et al., 2012, Nardin, L.G et al., 2011). With the help of software development paradigms the software models can be built from the scratch. But architecture designed from the existing architecture is a kind of approach for designing system as reference. Other than this there are also other notations such as Z-Notations is a technique that uses mathematical theorems, sets for formal modelling. (Ali Khan, W. et al, 2013). UML is also used for formal representation of models. (Pang, L.Y et al, 2015, Jochen Scholl, H. et al, 2012). Unit operations are another kind of design methodology that displays different software qualities and operations used by any system. (Cornu, C. et al, 2012; Bosin, A. et al, 2011) Unit operations fit well comparing to other techniques to architecture design as they provide basic qualities with respect to software and hardware operations. The proposed model for interoperability which adopts the existing architecture components wherever necessary for reference, interoperability solution in the form of service is adopted. Interoperability solution in the form of service in enterprise application integration provides each functionality as service is adopted for interoperability architecture that provides generic usage.

Verification of interoperation architecture can be carried out using approaches such as Colored Petri Net (CPN), Network flow techniques and Graph theory which allows analysis of infinite systems. However GT (Graph Theory) and NFT (Network flow technology) technique is very difficult and challenging to specify in run time. However these approaches works based on non interoperable request-response form
in integrating information. Colored Petri Net (CPN) is a kind of design tool that can be done using representation of states and transitions among the states created. It also provides the behaviour of the particular state of the system. Modelling and architecture verification can be done using GUI based tool and chaining of operation is executed well by generating state space graph. (Arul doss, M., et al, 2015; Madhusudanan, J., et al, 2014; Punitha Devi, C, et al, 2015). Hence to verify the proposed architectural model for interoperability, CPN is identified as appropriate due to its consistency and reachability to every state. Symmetry, liveness and fairness are the three essential properties for formal analysis of interoperability architecture that can be verified using CPN tool.

Ensuring the degree level of interoperability between business processes in EAI can be done using various maturity models. From those maturity models the evaluation parameters which exhibit the needed requirements to adopt in the proposed architecture. The collective list of parameters are identified which suits for generic requirements to evaluate the proposed architecture is examined using certificate verification system case study. The proposed design of architectural model for interoperability based on service fits well in EAI in data, service, process and business levels located in heterogeneous sources.

Evaluation of proposed architecture model for qualitative measure in functional and non functional aspects is done by existing models and identified the standard evaluation parameters to fit into the implementation of proposed architecture model. The evaluation parameters compared with the existing frameworks and models and the proposed model is found to be appropriate approach for obtaining the software qualities. The proposed architecture model is also quantitatively verified by
adopter the various categories of interoperability and implemented in certificate
verification case study.

The research approach is stated as shown in Figure 3.1

**Figure 3.1 Research Approach**

### 3.5 SUMMARY

From the literature review the need for the research towards interoperability in
rapidly changing enterprise application integration process clearly focussed the
limitations in the background to propose the research directions that motivate well for
error free services. From the research questions framed it leads to the problem
statement that requires a need for architecture model for interoperability in EAI based
on services that provide complete understanding among heterogeneous systems. The
research hypotheses are framed to the objective intended for the proposed research
approach is presented.