Enhanced Connection Manager Design by Using Systematic Innovation Method

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***Abstract*—The paper is dealing with improving the connection manager in mobile phones by using one of Systematic Innovation method that is recently invented. Systematic innovation is a structured process and set of practical tools that can be used for value creation and the mathematical analysis shows the theoretical software scheme of enhancing the number selection of Packet Data Protocol context in mobile phones. The connection manager enhancement is designed based on mathematical analysis by using the innovative method. The general approach of technology enhancement in Information Technology software development is demonstrated by optimized implementation to enhance the performance of the connection manager to handle the Packet Data Protocol contexts more effectively.**

***Index Terms*—Systematic innovation, connection manager, mobile software, TRIZ, TIPS, enhanced su-field notations.**

I. Introduction

Connection manager is the software module in protocol layer that controls the network connections between phones and mobile networks (GPRS, UMTS and LTE). The main function of a connection manager is handling the contexts in Packet Data Protocol (PDP) (see Fig. 1). The packet data protocol (PDP; e.g., IP, X.25, FrameRelay) context is a data structure present on both the serving mobile network support node and the gateway which contains the session information when the subscriber has an active session [1].

The PDP context contains routing information for packet transfer between a mobile phone and a mobile network element to have access to an external packet-switching network. It is identified by an exclusive mobile IP address. It means that the mobile phone will have as many PDP addresses as activated PDP contexts. The concept of secondary PDP context has been introduced in order to have several PDP contexts sharing the same PDP address and the same access to the external packet-switching network. This concept was introduced for multimedia applications where each medium type requires specific transport characteristics and is mapped into a specific PDP context. The actual number of PDP contexts depends on not only the capability of mobile phones but also the capability of mobile network elements. The number of PDP contexts should be aligned with a mobile phone and a mobile access network system. Otherwise, the data connection of a mobile phone may not have full speed of (mobile) internet connection. Finding the available number of PDP contexts of the networks is one of major function of the connection manager in the mobile phone.

Systematic Innovation [2] is a structured process and set of practical tools anyone can use to create (or improve) products, process or services that deliver new value to customers. It is also a set of continuous evolving tools that will improve ability to solve the problems. TRIZ is the most powerful methods for systematic innovation methodologies. The substance-field model [3], [4] and 76 Inventive Standard [4]-[6] were conceptualized by the founding father of TRIZ, Genrich Altshuller [7], [8]. The Inventive Standards (76 Standard Solutions) are well defined and organized [5]. But it is still difficult to learn and complicated even for TRIZ specialists. More importantly, the 76 Inventive Standards are not intuitive [4].

Algorithmic implementation of searching the optimal number of available PDP contexts is the critical issue for the connection manager. Specially, it should be well implemented in case the configurations of mobile networks are different within the networks because of different systems, different operators and different countries.

II. Summary of Enhanced Su-Field Model

Innovative notation schema is classified the Inventive Standards more simple way and users can be guided to the candidate solutions from the problems based on Su-Field model with the minimal knowledge of 76 Inventive Standard solutions. There are several limitations that the Inventive Standards are not applied widely. For instant, people who are learning TRIZ still must do a lot of case studies that illustrate the principles of TRIZ using terms and technologies before using Inventive Standard correctly. In addition, the standards are categorized by physical interactions. The Inventive Standards (76 Standard Solutions) are well defined and organized [5]. But it is still difficult to learn and be complicated even for TRIZ specialists. More importantly, the 76 Inventive Standards are not intuitive [6]. Recently, simpler way to describe 76 Inventive Standards has been developed. The problem can be described more effectively by using the certain types of notations for Su-Field model. In this paper, the new notation for Su-Field model is applied (aka. Enhance Su-Field Notations) to develop the concept design [9]. The Su-Field model for Inventive standard solution can exhibits the summarized main characteristics of a Su-Field model [9].

$$\left(x/s/f\right):\left(/a\right) \tag{1}$$

where the symbols *x*, *s*, *f* and *a* stand for basic elements of the model as follows:

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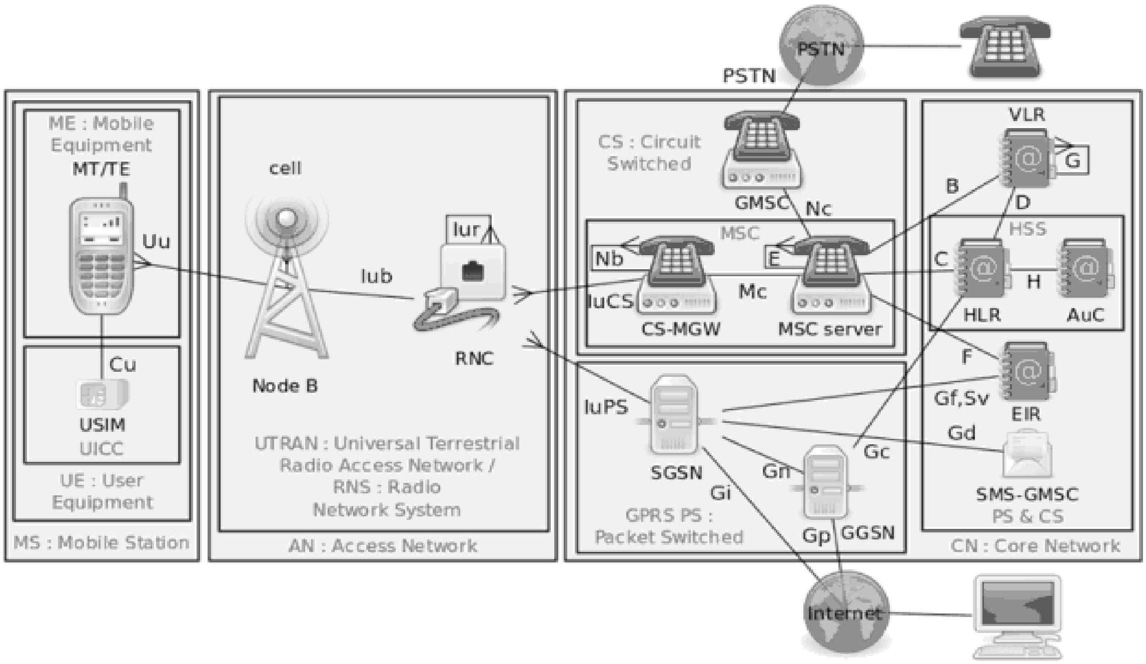

Fig. 1. Mobile network architecture.

x = solution (or problem) types (x = 1, 2 or 4)

s = substance attributes,

f = field attributes,

a = strength of actions (a=0; *Normal* or a=1; *Stronger*)

The attributes of the substance s are as follow:

S^* = general terms of the substance that can solve the problems

S^+ = +1 substance from basic structure to solve the problems

S' = modify the substance (tool) to solve the problems without changing the number of components from basic structure

S^- = -1 substance from basic structure (i.e., tool is missed)

S^∞ = substance (tool) is divided infinitely (Technical System Evolution)

S'' or S^2 = adding the clone of the substance (+1)

The attributes of the field F are similar with substance attributes:

F^* = general terms of the field that can solve the problems

F^+ = +1 field from basic structure to solve the problems

F'= modify the field to solve the problems without changing the number of components from basic structure

F^- = -1 field from basic structure

F^∞= field is divided infinitely (Technical System Evolution)

F'' = adding the clone of the field (+1)

$\overleftarrow{F}$ = reverse direction of the field

The attributes for fields and substances indicate how to modify the substances and the fields.

III. Concept Development of Connection Manager Based on Enhanced Su-Field Model

The problem for enhancing the performance of finding the capability of PDP contexts of the mobile network elements can be described as Su-Field models. Object (S1) is the application layers that use the information of PDP contexts and Tool (S2) is the connection manager by itself. Based on Su-Field Model, Problem Type-1 [9] as Su-Field Notation is the problem that contains the useful function but not effective (see Fig. 2).

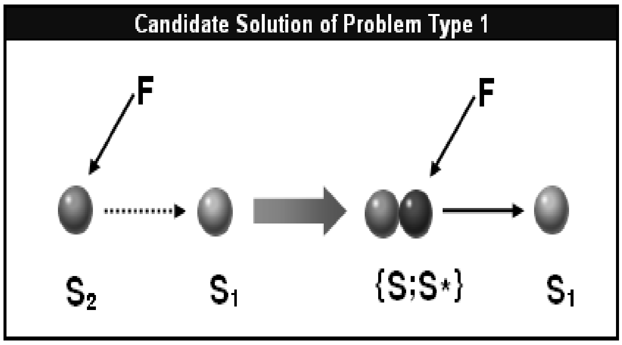

Fig. 2. Su-field solution diagram of $1/S^*/F$.

From Fig. 2, the candidate solution of Problem Type 1 can be determined as follow:

$$1/S^{\{-1\}}/F^{\{-1\}} \rightarrow \begin{cases} 1/S/F, & \because Type-1 \\ 1/S^*/F, & \{S^* | S', S^+, S^2, S^\infty, S^n\} \\ 1/S/F^*, & \{F^* | F', F'', F^+, F^\infty\} \\ 1/S^*/F^*, & \end{cases} \quad (2)$$

Even the formula gives the concept solution by adding a new substance (S^*=S^+) or modifying the substance (S^*=S^+), not limited. The candidate attribute of substance for Type-2 Solution can be:

$$S^*=\{S^*: S', S^+, S^2, S, S^n\}$$

According to (2) and (3), the concept solution for enhanced software architecture is

$$1/S/F\{/0\} \rightarrow 1/S^+/F$$

where S^+ indicates that one more substance is added to improve the current function.

IV. Connection Manager Implementation

Enhanced connection manager is designed based on the concept solution. S^+ in the concept solution indicates that another substance can be added. Basically, software codes are added and explained by using mathematical schema as following set ups:

$$x_n \leftarrow \textit{Total number of PDP context for n-th trial}$$

$$x_0 \leftarrow \textit{Number of PDP context in the last location}$$

$$e_n \leftarrow \textit{Offset of Error Code}$$

$$e_n \leftarrow \begin{cases} 0, & \textit{Non-Error} \\ 1, & \textit{Error} \end{cases}, \; e_0 \leftarrow 0$$

Usual approach to find the capable number of PDP contexts in the network is robust method which means that it starts one (1) and increasing one by one to get the number of PDP context in the network side. In the other hand, the proposed scheme in this paper gives more efficient way to find the number of PDP contexts in the mobile network element:

$$x_{n+1} \leftarrow I_{\{x_n<0.5\}} + \left\lceil \frac{x_n}{2} \right\rceil$$

And the predicted number of PDP contexts is decreased if errors are occurred during the communication between a mobile phone and a network element. Same scheme are applied recursively:

$$x_{n+1} \leftarrow \begin{cases} x_n + 1, & e_n = 0 \,\&\, e_{n+1} = 0, \\ x_n \left(= x^*\right) & e_n = 1 \,\&\, e_{n+1} = 0, \\ I_{\{x_n<0.5\}} + \left\lceil \frac{x_n}{2} \right\rceil, & e_{n+1} = 1. \end{cases}$$

The connection manager can be implemented based on the mathematical schemes. The implementation guideline (workflow) can be described as follow (see Fig. 3):

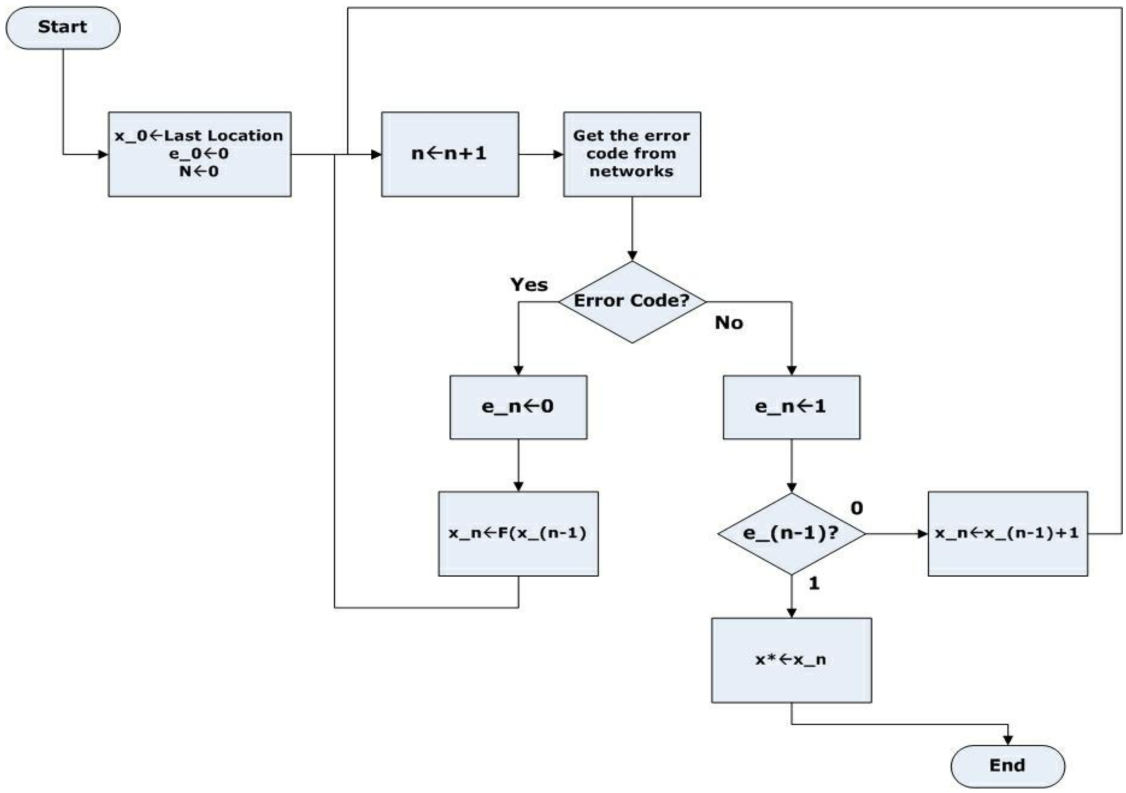

Fig. 3. Implementation guidelines.

Even though the workflow is not actual code, it is still enough to implement on the connection manager in the mobile phone by using any programming languages. This implementation is targeting to improve the performance (lead time) to find the number of PDP contexts of the mobile network elements.

V. Conclusion

The major target of this project is developing the enhanced connection manager that manages the operations of PDP contexts. The new approach of systematic innovation method is applied for solving problems for software implementation in mobile phones. Su-Field Notation provides a user to be guided even with minimal knowledge of Theory of Inventive Problem Solving (TRIZ) method. The problem solvers can adopt the candidate solutions based on the notations without the full knowledge of 76 Inventive Standard solutions in TRIZ. Even though the research is dedicated with mobile industries, the pattern of TRIZ approach in this paper can be also applied to other IT related problems [10]-[12].

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